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PG&E Letter HBL-17-003

U.S Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 50-133, License No. DPR-7
Humboldt Bay Power Plant, Unit 3
License Termination Plan Technical Basis Documents

Dear Commissioners and Staff:

On May 3, 2013, Pacific Gas and Electric Company (PG&E) submitted PG&E Letter HBL-13-008, "Humboldt Bay Power Plant, Unit 3 License Termination Plan Supplemental Information." That letter included five technical basis documents (TBDs) to aid the NRC in its review of the License Termination Plan (LTP). One of the TBDs was titled "In Situ Object Counting System (ISOCS) as Applied to Scan Requirements in Support of Final Status Survey at HBPP," dated September 26, 2012.

Recently, PG&E discovered an instrument geometry error in the original ISOCS TBD. This error has been entered into the HBPP Corrective Action Program (CAP). PG&E reviewed every field use of ISOCS for Final Status Survey and found that in no case did it affect the conclusion of the area meeting the clearance criteria. PG&E has corrected the error in the "In Situ Object Counting System (ISOCS) as Applied to Scan Requirements in Support of the Final Status Survey at HBPP," TBD. Revision 2 of the TBD is contained in Enclosure 1.

In addition, on August 13, 2014, PG&E submitted PG&E Letter HBL-14-015, "Humboldt Bay Power Plant, Unit 3 License Termination Plan, Revision 1." LTP Section 5.4.2.5.3, states that a TBD will be developed for the bulk assay system and submitted to the NRC prior to being used. The TBD, which is titled "Technical Basis for Design, Calibration, and Operation of the Gardian Mobile Assay System," has been developed and is contained in Enclosure 2. The TBD, however, was used and provided to NRC inspectors during the August 9-11, 2016 inspection, but not formally submitted. This oversight has been entered into the HBPP (CAP).

There are no new or revised regulatory commitments (as defined in NEI 99-04) made in this letter.

NMSS01

If you have any questions regarding this submittal, please contact Mr. William Barley at (707) 444-0856.

Sincerely,

Loren D. Sharp
Senior Director, Nuclear Decommissioning

Enclosures
cc: Kriss M. Kennedy, NRC Region IV Administrator
John B. Hickman, NRC Project Manager
HBPP Humboldt Distribution

Enclosure 1
PG&E Letter HBL-17-003

Technical Basis Document

In Situ Object Counting System™ (ISOCS) as Applied to Scan Requirements in Support of the Final Status Survey at HBPP

Revision 2

(Procedure Classification – Quality Related)

1.0 SCOPE

1.1 This TBD is intended to cover the use of the Canberra ISOCS® detector system as a scanning instrument for Final Status Surveys. This revision addresses SAPN 1425160 regarding a work group evaluation of a review of the Geometry Composer ISOCS Model used to determine investigation levels for Class 1 area scans.

2.0 DISCUSSION

2.1 The Canberra characterized High Purity Germanium (HPGe) detector will be used in conjunction with the Canberra Genie™ software suite to achieve Final Status Survey (FSS) scans of building surfaces and land areas and possibly other media as deemed appropriate (e.g. piping systems). The ISOCS® scanning technique achieves scan coverage over a defined area to set a-priori detection limits. These detection limits must be capable of detecting the investigation level to facilitate follow-up investigations where required.

2.2 System Description

Two ISOCS-characterized P-type HPGe detectors, manufactured by Canberra Industries, have been procured. As the project progresses, other ISOCS® detectors (e.g. reverse electrode coaxial) may be employed. The key factor regarding the use of other ISOCS® characterized detectors is that specific efficiency calibrations will be developed and evaluated to account for each detector's unique characteristics.

The HPGe detector is mounted on a bracket designed to hold the detector cryostat assembly and associated collimators. This bracket may be mounted in a cage-like frame. This frame permits the detector to be oriented (pointed) over a full range from a horizontal to vertical orientation while being positioned above the surface being evaluated.

The InSpector (MCA) unit that drives the signal chain and the laptop computer that runs the acquisition software (Genie-2000) are mounted either in the frame or on a wheeled cart. These components are may be battery powered. Back-up power supplies (e.g. inverter) may be used to support the duty cycle. A wireless network may also be installed so that the laptop computers used to run the systems can be controlled from remote laptop, eliminating the need for a direct cable connection between the operator's station and the ISOCS unit.

2.3 LTP Chapter 5 Performance Criteria

In the performance of required survey unit measurements, levels of radioactivity may be identified that warrant investigation. Depending on the results of the investigation, the survey unit may require no action, remediation, and/or reclassification and resurvey. In order to satisfy the requirements of the HBPP LTP (Ref 1), the scan sensitivity and coverage must be adequate to meet the dual specifications for coverage and investigation level as presented in Table 1 and Table 2.

Table 1 Scan Survey Coverage Requirements

	Class 1	Class 2	Class 3
Scan Coverage	100%	10-100 %*	Judgmental (1-10%)

* For Class 2 Survey Units, the amount of scan coverage will be proportional to the potential for finding areas of elevated activity or areas close to the release criterion in accordance with MARSSIM Section 5.5.3. Accordingly, HBPP will use historical information and the results of individual measurements collected during characterization to correlate this activity potential to scan coverage levels.

Table 2 Investigation Levels

Classification	Scan Investigation Levels	Direct Investigation Levels
Class 1	$> DCGL_{EMC}$	$>DCGL_{EMC}$ or $>DCGL_W$ and > a statistical parameter-based Value
Class 2	$>DCGL_W$ or $>MDC_{SCAN}$ if MDC_{SCAN} is greater than $DCGL_W$	$> DCGL_W$
Class 3	Detectable over Background	$> 0.5\ DCGL_W$

2.4 Traditional Scan Methodologies

Traditional gamma scan surveys have been performed with handheld instruments such as NaI(Tl) scintillation detectors for gamma in potentially contaminated media or gas flow proportional probes when alpha/beta detection is desired.

Technicians will respond to all instrument indications of elevated activity while surveying. Upon receiving an indication, the technician will stop and resurvey the last square meter of area surveyed to verify the increase. Technicians are cautioned, in training, about the importance of the verification survey and are given specific direction in the procedure as to survey extent and scan speed. If the indication is verified, the technician will mark the area with a flag or other appropriate means. Each area marked will be addressed in an investigation survey instruction prepared for the survey unit. The instruction will specify the required actions, such as a re-scan of the area, direct measurements, and collection of a soil sample (for land surveys). Each investigation will be evaluated and reported in the survey area report. (Investigation levels are shown in Table 2.)

With respect to Class 1 Survey Units, surveillance for elevated activity is performed via scan surveys using hand-held field instruments. Acceptance criteria (i.e. $DCGL_{EMC}$) is derived by multiplying the $DCGL_W$ by the area factor associated with that area bounded by the grid used to locate soil samples. Occasionally, due to either background radioactivity or the size of the sample location grid, the detection sensitivity for these hand-held instruments exceeds the $DCGL_{EMC}$. In such instances, the survey grid is reduced so that area factors yielding higher $DCGL_{EMC}$ values can be used. This approach has a side effect of additional sampling, which impacts project schedules and costs. Additional sampling is further experienced to distinguish between natural radioactivity and plant-derived radioactivity to investigate elevated instrument responses.

2.5 ISOCS Scan methodologies

For the ISOCS scan method, the primary assumption made is that a potential one-square-meter of elevated radioactivity exists at the edge of the area being evaluated by a single in-situ measurement.

To account for detection (i.e. efficiency) radionuclide-specific investigation levels are developed. Since the investigation levels approximate the $DCGL_W$, assay results below investigation level(s) satisfy both the $DCGL_W$ and $DCGL_{EMC}$ criteria.

The ability of ISOCS to perform radionuclide identification is also beneficial where influences from background radioactivity (e.g. ISFSI) impede survey efforts. Count times can be tailored to achieve required detection sensitivities and the detector can be collimated to minimize the influence from sources outside the detector's field of view.

2.6 Setup

The ISOCS is most commonly deployed on its cart, a tripod or a crane to accommodate the physical requirements of various measurements. Power may be supplied by battery, AC line or generator. The decision regarding the selection of collimator configuration is determined by the engineer. In some cases it may be desirable to use a 180 degree collimator, taking advantage of exposing more of the detector's sensitive volume whenever background sources are at an insignificant level. Accordingly, it should be noted that such a design should be used in large Class 3 open land areas where the survey design requires a greater efficiency and field of view for optimal coverage and detection of discrete activity. It also should be noted that scan survey designs of this nature should be such that the calibration ISOCS model generated incorporates a "95% Efficiency" model relative to the infinite plane efficiency for the most limiting radionuclide of concern.

Data collection to support FSS activities will be administered by a specific Survey Plan. Survey Plans may include an index of measurement locations with associated spectrum filenames to ensure that all the required measurements are made and results appropriately managed. Personnel specifically trained to operate the system will perform data collection activities.

Data collection activities will address environmental conditions that may impact soil moisture content. Logs shall be maintained so as to provide a mechanism to annotate such conditions to ensure that efficiency calibration files address the in-situ condition(s). In extreme cases (e.g. standing water, etc.) specific conditions will be addressed to ensure that analysis results reflect the conditions. As previously discussed with respect to water, when unique environmental conditions exist that may impact analysis results, conservative compensatory factors will be applied to the analysis of the data to the analysis of the data.

2.7 Efficiency Calibration

The central feature of the portable ISOCS technology is to support in-situ gamma spectroscopy via the application of mathematically derived efficiency calibrations. Due to the nature of the environment and surfaces being evaluated (assayed), input parameters for the ISOCS efficiency calibrations will be reviewed on a case-by-case basis to ensure the applicability of the resultant efficiency. Material densities applied to efficiency calibrations will be documented. In practice, a single efficiency calibration file may be applied to the majority of the measurements.

The geometry most generally employed will be a circular plane assuming uniformly distributed activity. Efficiency calibrations will address a depth of 15 cm for soil and a depth up to 5 cm for concrete surfaces to account for activity embedded in cracks, etc. Other geometries (e.g. exponential circular plane, rectangular plane, etc.) will be applied if warranted by the physical attributes of the area or surface being evaluated. Efficiency calibrations are developed by radiological engineers who have received training with respect to the ISOCS software. Efficiency calibrations will be documented in accordance with procedure C&RP B-20, "Modeling Counting Geometries for Final Status Surveys."

Attenuation by standing water will need to be modeled into the shot and carefully verified so as to not understate the depth. Experience has shown that it becomes difficult to meet detection limits with more than two inches of water in a scan shot. Damp soil should have a lower density than the default value of 1.6 g/cm^3, thus it should not reduce the measured *in situ* activity of the soil.

2.8 Designing coverage

It is frequently desirable or required to ensure 100% scan coverage of a survey unit. This may be achieved through the use of a triangular grid pattern with positions determined using the Visual Sample Plan (VSP) software. For the purposes of this discussion, it is assumed that the 90 degree collimators are installed and that the detector face is orientated downward and is lifted to the desired height, h above the horizontal plane. The field of view of the detector is a circle of radius h. By geometric construction, the maximum horizontal distance L, between the scan shots becomes:

Equation 1

$$L = \sqrt{3} * h$$

Where,
L is the triangular grid spacing; and
h is the vertical height of the detector

To use VSP to design a triangular grid pattern for a given survey unit, we recommend using a random start point. The current version (v. 6.2d) of the VSP software requires the number of desired samples N, be used as Samples desired, N be input to establish a triangular grid with a random start point of appropriate grid spacing. This input may be determined by using the familiar triangular grid equation from the MARSSIM:

Equation 2

$$L = \sqrt{\frac{A}{0.866N}}$$

Or, stated more purely;

Equation 3

$$L = \sqrt{\frac{A}{\frac{\sqrt{3}}{2} * N}}$$

Thus Using Equations 1 and 3:

$$\sqrt{3} * h = \sqrt{\frac{A}{\frac{\sqrt{3}}{2} * N}}$$

Thus,

$$3h^2 = \frac{A}{N * \frac{\sqrt{3}}{2}}$$

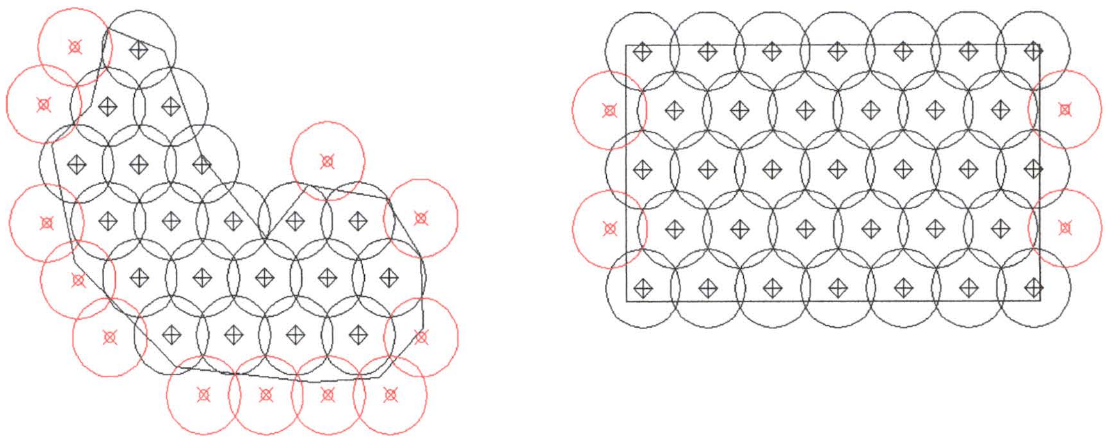
Solving for N,

Equation 4

$$N = \frac{A}{3h^2 * \frac{\sqrt{3}}{2}}$$

It is recommended that N+1 be input into the VSP run to ensure a slight additional overlap for conservative margin. As shown in Figure 1, once the triangular grid is constructed it will be necessary to verify that 100% of the area is covered by plotting the scan measurement locations and the field of view for each measurement in a drafting program such as AutoCAD. Additional scan shots on the periphery of the survey unit may be readily added by plotting additional measurement locations using the sample points along the triangular grid. The manually added scan shot locations are shown in red.

Figure 1- Using VSP for plotting ISOCS scan locations



3.0 <u>HBPP Required Detection levels</u>

3.1 Class 1 Survey units

As noted earlier, the primary assumption made is that a potential one-square-meter of elevated radioactivity exists at the edge of the area being evaluated by a single in-situ measurement. In order to determine the required scan MDC one needs to determine the $DCGL_{EMC}$ for this hypothetical case. Tables 3 and 4 present the $DCGL_{EMC}$ scan requirement for Class 1 Areas for the primary nuclides of concern Cs-137 and Co-60.

Table 3 Soil Values

Nuclide	$DCGL_W$ (pCi/g)	Area Factor ($1m^2$)	$DCGL_{EMC}$ (pCi/g)
Cs-137	7.9	14	110
Co-60	3.8	10	38.0

Table 4 Surface Values

Nuclide	$DCGL_W$ (dpm/100 cm^2)	Area Factor ($1m^2$)	$DCGL_{EMC}$ (dpm/100 cm^2)
Cs-137	4.6 E4	13	5.98 E5
Co-60	1.3 E4	15	1.95 E5

3.2 Discussion of Calculation of Class 1 Effective Investigation Levels for ISOCS

For calculation of an effective investigation ISOCS scan value for each radionuclide of concern above for Class 1 areas, it is important to note that the very conservative (worst case) assumption that an elevated $1m^2$ area is present at the $DCGL_{EMC}$ on the edge of the detector's field of view (12.6 m^2). As the ISOCS system is only sensitive to gamma photons that interact within the active detector volume, moving a homogenous source term in a $1m^2$ circular plane offset approximately 1.44 m to reflect its location on the edge of the field of view, the source term activity appears as more of an isotropic point source, with activity falling off as a function of two phenomenon: the inverse square law, and to a smaller degree source directionality (angular dependency) relative to the active detector volume. For a collimated system used above, another factor that reduces the efficiency for a point source offset at the edge of the field of view is the masking (shielding effect) of a significant portion of the detector volume by the lead collimator. To account for these effects, a calculation of the "effective" investigation level must be performed. The key parameters used for the effective investigation calculation involve comparing the efficiency for a circular plane modeled for a 2 m detector field surface height fitted with a 90 degree lead collimator (12.6 m^2 field of view), with the efficiency for a $1m^2$ circular plane at the same height above the surface but offset to the edge of the 2 m diameter field of view. The ISOCS Geometry Composer Reports and associated model calibration efficiencies are provided in Attachment 2, with a summary of the results provided in Table 5:

Table 5 Investigation Levels

Nuclide	Line Energy (keV)	$1m^2$ $DCGL_{EMC}$ (pCi/g)^A	$1m^2$ Line Efficiency^B modeled with an 1.44 m offset	12.6 m^2 Line Efficiency^B	Adjustment Factor^C	Derived Investigation Level (pCi/g)^D
Cs-137	661.7	110	4.31E-01	6.68E+00	6.46E-02	7.14E+00
Co-60	1332.5	38	3.64E-01	5.47E+00	6.65E-02	2.53E+00

Note A: $1m^2$ soil $DCGL_{EMC} = DCGL_W$ * AF from Table 3 above
Note B: Line Efficiencies provided from Geometry Composer and ISOCS Calibration Reports provided in Attachment 2.
Note C: Adjustment factor = (1 m^2 efficiency/12.6 m^2 efficiency)
Note D: Derived Investigation Level = $1m^2$ $DCGL_{EMC}$ * Adjustment factor

It should be noted that a soil density of 1.6 grams/cubic centimeter (g/cm^3) was used for the two geometries modeled above as it is the a reasonable density given the densities typically encountered from dry soils sampled at HBPP.

3.3 Class 2 Survey Units

Since the investigation Level for Class 2 Survey units is given from Table 2 as:

>$DCGL_W$ or >MDC_{SCAN} if MDC_{SCAN} is greater than $DCGL_W$

This requirement is met by setting detection limits such that:

>$DCGL_W$ in a 1 m^2 area at the edge of the field of view may be detected.

3.4 Class 3 Survey Units

Since the investigation Level for Class 3 Survey units is given from Table 2 as:

Detectable over background.

This requirement is met by investigating any scan that positively detects activity in excess of the site assessed soil background level of 0.1 pCi/g Cs-137 as provided in TBD-200, "Site Background Levels of Cs-137" (Ref. 8).

Attachment 1 provides a site specific ISOCS run that demonstrates the scan detection limits that may be met for varying count times.

4.0 <u>LIMITATIONS</u>

The use of the in-situ techniques should be limited to characterized HPGe detectors utilizing appropriate geometries and will be used in conjunction with the Canberra Genie™ software suite.

All operations should be conducted in accordance with applicable site procedures. Additionally, the following condition must be satisfied:

- The geometries must be reviewed by a Subject Matter Expert (SME) to ensure they are correctly developed and accurate or conservative approximations of the media being measured.

5.0 CONCLUSION

Caution needs to be used in the application of geometries for ISOCS scanning. Careful verification that the environmental conditions and geometric arrangement are appropriate to the detector geometry is pivotal to ensuring the accuracy of the results.

Field conditions may also significantly influence the practical applicability of the ISOCS as a field instrument. Experience has shown that the impact of attenuation from standing water may be particularly problematic in achieving the required detection sensitivity. Consequently, it is recommended that standing water be avoided to the extent practical and sufficient counting times are planned for where it is impractical to eliminate.

The ISOCS methodology presented has been demonstrated as an acceptable means for achieving survey scan objectives; provided that proper care is taken to ensure that the results are valid.

6.0 REFERENCES

6.1 NUREG- 1575, MARSSIM "Multi-Agency Radiation Site Survey and Investigation Manual", Rev 1, August, 2000.

6.2 HBPP License Termination Plan DRAFT (May 2012)

6.3 ENG-HB-003 "Humboldt Bay Soil Derived Concentration Guideline Levels", Rev 0, 2-29-12

6.4 ENG-HB-004 "Humboldt Bay Building Surface Derived Concentration Guideline Levels", Rev 0, 2-29-12.

6.5 ENG-HB-005 "Area Factors for Use with Humboldt Bay Soil DCGLs", Rev 0, 3-02-12.

6.6 ENG-HB-006 "Area Factors for Use with Humboldt Bay Building Surface DCGLs", Rev 0, 3-02-12.

6.7 C&RP B-9 Vol. 8, Rev 0, "OPERATION OF THE GENIE-2000 GAMMA SPECTROSCOPY SYSTEM"

6.8 TBD-200,"Site Background Levels of Cs-137", Rev 3, 7/06/06

7.0 ATTACHMENTS

7.1 Demonstration of Achieving Required Detection Limits for Soils in a 10 Minute Count Interval

7.2 Geometry Composer and ISOCS Calibration Results Reports

8.0 RECORDS

None

9.0 RESPONSIBLE ORGANIZATION

Site Closure

Attachment 1

Demonstration of Achieving Required Detection Limits for Soils in a 10 Minute Count Interval

```
*****************************************************************************
*****        G A M M A   S P E C T R U M   A N A L Y S I S            *****
*****************************************************************************

Detector SN_3920

Report Generated On              : 5/22/2012  11:38:36 AM

Sample Identification            : Det 3920
Sample Title                     : 2m LLD, FOV 12m
Sample Information               :
                                 :
Sample Type                      :
Sample Geometry                  :

Peak Locate Threshold            :  3.00
Peak Locate Range (in channels)  :   100 -   4096
Peak Area Range (in channels)    :   100 -   4096
Identification Energy Tolerance  :    1.000 keV

Sample Size                      :  1.000E+000 g

Sample Taken On                  : 5/17/2012  11:51:00 AM
Acquisition Started              : 5/17/2012  11:51:22 AM

Live Time                        :       600.0 seconds
Real Time                        :       601.0 seconds

Dead Time                        :   0.16 %

              Energy Calibration Used Done On      : 8/4/2011
              Efficiency Calibration Used Done On  : 8/17/2011
              Efficiency ID                        : 2m Soil Sm Shld
```

TEST DATA ONLY FOR DEMONSTRATION PURPOSES

Performed by **N/A** Date **N/A**

Reviewed by **N/A** Date **N/A**

****
***** P E A K   L O C A T E   R E P O R T *****
****

Detector Name: SN_3920
Sample Title: 2m LLD, FOV 12m
Peak Locate Performed on: 5/22/2012 11:38:36 AM
Peak Locate From Channel: 100
Peak Locate To Channel: 4096
Peak Search Sensitivity: 3.00

Peak No.	Centroid Channel	Centroid Uncertainty	Energy (keV)	Peak Significance
1	1165.13	0.3892	582.85	3.09
2	2921.16	0.2137	1460.66	7.89

? = Adjacent peak noted

Errors quoted at 1.000 sigma

```
*************************************************************************
*****          P E A K   A N A L Y S I S   R E P O R T             *****
*************************************************************************
```

Detector Name: SN_3920
Sample Title: 2m_LLD, FOV 12m
Peak Analysis Performed on: 5/22/2012 11:38:36 AM
Peak Analysis From Channel: 100
Peak Analysis To Channel: 4096

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	1162-	1169	1165.13	582.85	1.25	1.08E+001	7.10	1.62E+001
2	2915-	2928	2921.16	1460.66	1.54	1.71E+002	13.37	3.04E+000

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

```
*************************************************************************
*****  N U C L I D E   I D E N T I F I C A T I O N   R E P O R T  *****
*************************************************************************
```

Sample Title: 2m LLD, FOV 12m
Nuclide Library Used: C:\GENIE2K\CAMFILES\HBPP.NLB

.... IDENTIFIED NUCLIDES ....

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (pCi/g)	Activity Uncertainty
K-40	0.996	1460.81*	10.67	1.374E+001	1.207E+000
Tl-208	0.688	277.35	6.80		
		583.14*	84.20	8.342E-002	5.491E-002
		860.37	12.46		

* = Energy line found in the spectrum.
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

********** U N I D E N T I F I E D   P E A K S **********

Peak Locate Performed on: 5/22/2012 11:38:36 AM
Peak Locate From Channel: 100
Peak Locate To Channel: 4096

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide

All peaks were identified.

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

```
*************************************************************************
*****            N U C L I D E   M D A   R E P O R T              *****
*************************************************************************
```

Detector Name: SN_3920
Sample Geometry:
Sample Title: 2m LLD, FOV 12m
Nuclide Library Used: C:\GENIE2K\CAMFILES\HBPP.NLB

	Nuclide Name	Energy (keV)	Yield (%)	Line MDA (pCi/g)	Nuclide MDA (pCi/g)	Activity (pCi/g)
+	K-40	1460.81*	10.67	9.5472E-001	9.55E-001	1.3739E+001
	Co-60	1173.22	100.00	1.8273E-001	1.83E-001	-6.5896E-002
		1332.49	100.00	1.9793E-001		4.5600E-002
	Nb-94	702.63	100.00	1.7495E-001	1.68E-001	-4.7263E-002
		871.10	100.00	1.6800E-001		-1.4617E-002
	Ag-108m	79.20	7.10	1.1801E+001	2.19E-001	-1.2975E+000
		433.93	89.90	2.2376E-001		-9.2283E-002
		614.37	90.40	2.4723E-001		-2.0506E-001
		722.95	90.50	2.1874E-001		9.1741E-002
	Cs-134	569.31	15.43	1.4419E+000	2.21E-001	-3.6585E-001
		604.70	97.60	2.2080E-001		-3.2585E-002
		795.84	85.40	2.6160E-001		-1.2721E-002
	Cs-137	661.65	85.12	2.9969E-001	3.00E-001	2.7738E-001
	Eu-152	121.78	28.40	1.3258E+000	7.10E-001	1.1491E-002
		244.69	7.49	3.3434E+000		9.8786E-001
		344.27	26.50	7.0956E-001		-6.1133E-001
		778.89	12.74	1.5412E+000		-3.6755E-001
		867.32	4.16	4.7168E+000		-1.0484E+000
		964.01	14.40	1.5175E+000		-1.3070E-001
		1085.78	10.00	2.0568E+000		-3.6315E-001
		1112.02	13.30	1.6850E+000		-9.5302E-001
		1407.95	20.70	8.4534E-001		3.5688E-001
	Eu-154	123.07	40.50	9.1728E-001	5.15E-001	3.5029E-001
		247.94	6.60	3.7264E+000		-9.5294E-001
		723.30	19.70	1.0339E+000		6.8229E-001
		873.19	11.50	1.4954E+000		-7.4302E-001
		996.32	10.30	1.5732E+000		-5.1660E-001
		1004.76	17.90	9.7848E-001		-1.1725E-001
		1274.45	35.50	5.1461E-001		2.8913E-001
	Eu-155	105.31	20.70	2.0415E+000	2.04E+000	-1.3835E-001
	Pb-206	803.10	100.00	2.1576E-001	2.16E-001	6.0968E-002
	Ac-228	338.32	11.40	1.8988E+000	8.49E-001	9.8160E-001
		911.07	27.70	8.4911E-001		5.6391E-001
		969.11	16.60	1.3370E+000		7.3501E-001
	Th-234	63.29	3.80	4.5458E+001	1.08E+001	2.9680E+001
		92.59	5.41	1.0831E+001		4.3335E+000
	U-235	143.76	10.50	3.0022E+000	4.98E-001	1.5837E-001
		163.35	4.70	6.1955E+000		5.0275E-001
		185.72	54.00	4.9762E-001		-2.0189E-001
		205.31	4.70	4.8387E+000		-5.0339E+000
	Np-237	311.98	38.60	5.9409E-001	5.94E-001	1.3611E-001
	Am-241	59.54	35.90	6.0109E+000	6.01E+000	-2.1662E+000

Nuclide Name	Energy (keV)	Yield (%)	Line MDA (pCi/g)	Nuclide MDA (pCi/g)	Activity (pCi/g)

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = Calculated MDA is zero due to zero counts in the region or
  the region is outside the spectrum
@ = Half-life too short to be able to perform the decay correction

Attachment 2

Geometry Composer and ISOCS Calibration Results Reports

Geometry Composer Report

CANBERRA

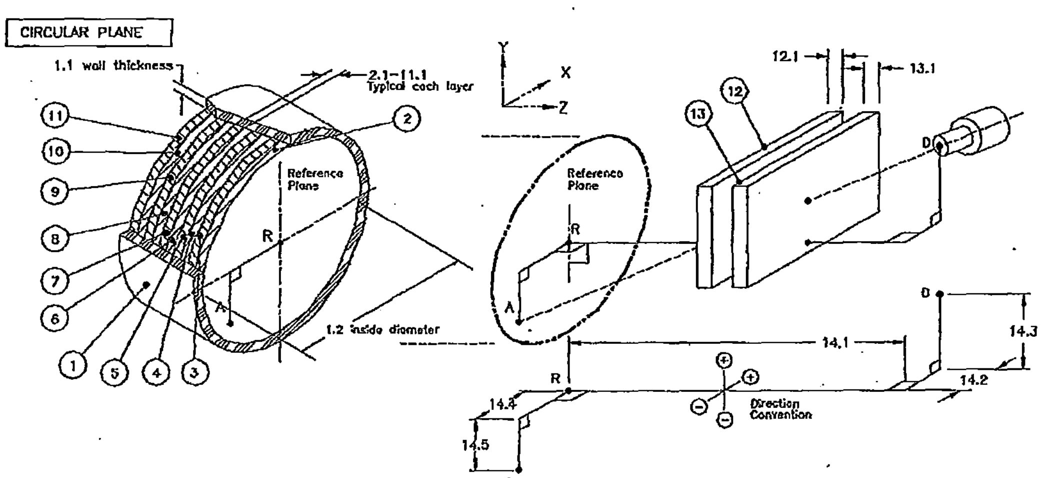
Date: Wednesday, August 17, 2011 - 09:58:45
Description: 2m Soil, Sm Collimator (12M FOV)
Comment: 2m Soil, Sm Collimator
File Name: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\2m Soil, Sm Collimator.geo
Software: ISOCS
Template: CIRCULAR_PLANE, Version: (default)
Detector: 3920
Collimator: 25mm-90d old (oldISOCS 25mm side 90deg collimation [large hole collimator])
Environment: Temperature = 60 °F, Pressure = 760 mm Hg, Relative Humidity = 80%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (cm)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Side Walls	0	400							
2	Layer 1	15						dirt2	1.6	1.00
3	Layer 2	0								
4	Layer 3	0								
5	Layer 4	0								
6	Layer 5	0								
7	Layer 6	0								
8	Layer 7	0								
9	Layer 8	0								
10	Layer 9	0								
11	Layer 10	0								
12	Absorber 1									
13	Absorber 2									
14	Source - Detector	200	0	0	0	0				

List of energies for efficiency curve generation

10.0	20.0	30.0	45.0	58.0	59.5	60.0	61.0
70.0	80.0	100.0	150.0	200.0	300.0	400.0	600.0
660.0	661.7	662.0	663.0	800.0	1000.0	1172.0	1173.2
1174.0	1331.0	1332.5	1333.0	1500.0	2500.0		

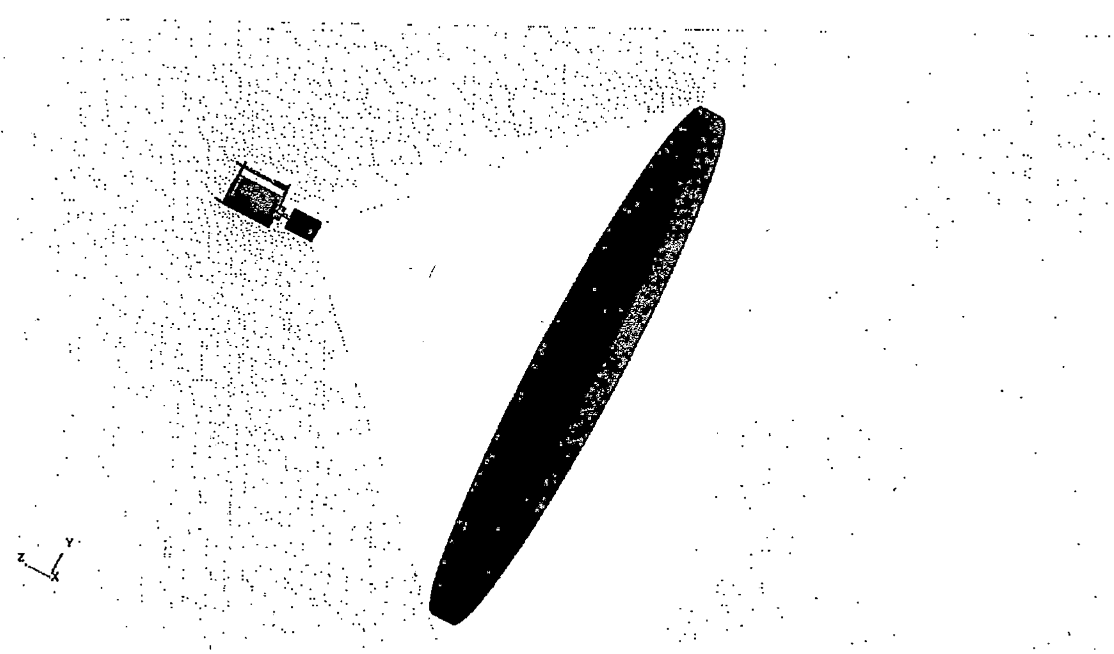


COPY

Geometry Composer Report

CANBERRA

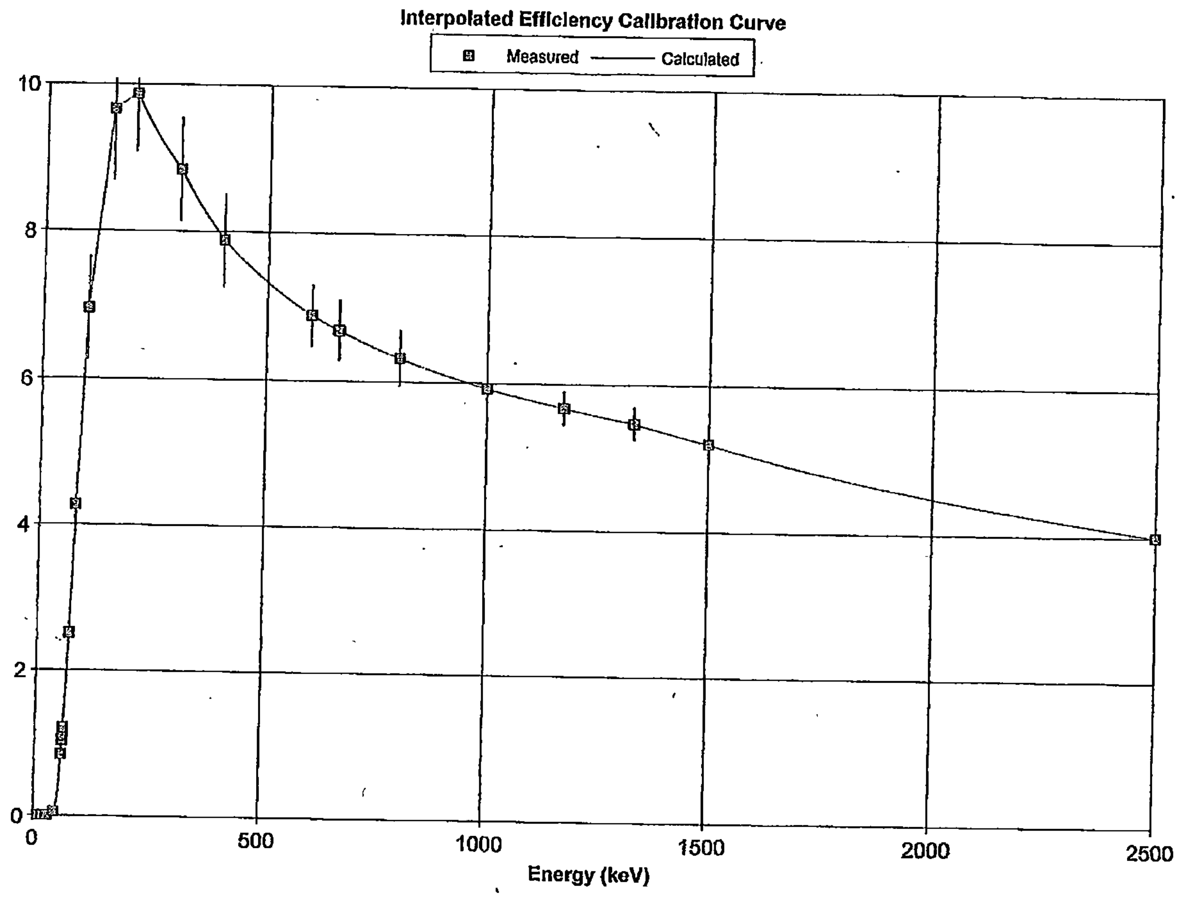
Date:	Wednesday, August 17, 2011 - 09:58:45
Description:	2m Soil, Sm Collimator
Comment:	2m Soil, Sm Collimator
File Name:	C:\GENIE2K\Isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\2m Soil, Sm Collimator.geo
Software:	ISOCS
Template:	CIRCULAR_PLANE, Version: (default)



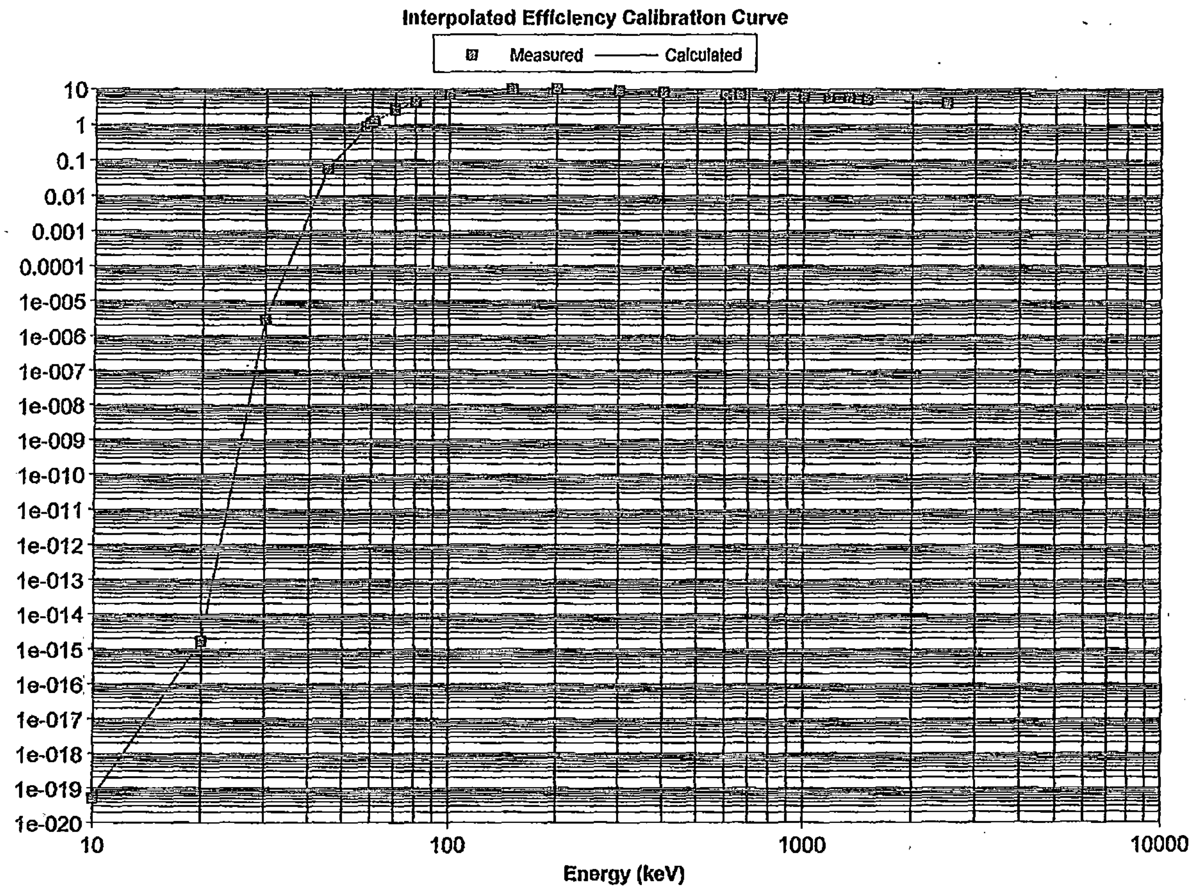
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\2m Soil
ISOCS/LabSOCS Time: 08/17/11 09:37:46
Genie Cal File: C:\GENIE2K\CALFILES\2m_Soil_Sm .CAL
Genie Cal Time: 08/17/11 10:04:05
Template: CIRCULAR PLANE
Geom Description: 2m Soil Sm Shld
Comment: ISOCS:UNITS=ACT/G 2M_SOIL,_SM_COLLIMATOR
Detector: 3920
Collimator: 25MM-90D_OLD
Convergence: 1.00 %
Area [Sq Meters]: 1.2566e+001 (C)
Mass [Grams]: 3.0159e+006 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency (X Mass)	%Uncertainty	%Convergence	Final # of Voxels
10.00	4.98337e-020	20.0	0.765830	27220
20.00	1.62725e-015	20.0	0.022777	872925
30.00	2.82366e-006	20.0	-0.086117	218225
45.00	5.68310e-002	15.0	0.228611	436465
58.00	8.40232e-001	10.0	-0.242875	6775
59.54	1.03257e+000	10.0	-0.298996	6775
60.00	1.09605e+000	10.0	-0.303913	6775
61.00	1.20881e+000	10.0	-0.333334	6775
70.00	2.50849e+000	10.0	-0.464690	6775
80.00	4.26787e+000	10.0	-0.556374	6775
100.00	6.95166e+000	10.0	-0.516969	6775
50.00	9.65846e+000	10.0	-0.548414	6775
00.00	9.86728e+000	8.0	-0.530546	6775
300.00	8.84319e+000	8.0	-0.350321	6775
400.00	7.88400e+000	8.0	-0.213358	6775
600.00	6.88428e+000	6.0	-0.091989	6775
660.00	6.69235e+000	6.0	-0.073433	6775
661.65	6.68068e+000	6.0	-0.071660	6775
662.00	6.69778e+000	6.0	-0.071590	6775
663.00	6.67896e+000	6.0	-0.071649	6775
800.00	6.31889e+000	6.0	-0.066937	6775
1000.00	5.91949e+000	4.0	-0.071232	6775
1172.00	5.66953e+000	4.0	-0.064342	6775
1173.22	5.66651e+000	4.0	-0.062582	6775
1174.00	5.66395e+000	4.0	-0.063173	6775
1331.00	5.46725e+000	4.0	-0.046045	6775
1332.49	5.46833e+000	4.0	-0.041743	6775
1333.00	5.46025e+000	4.0	-0.041392	6775
1500.00	5.19425e+000	4.0	-0.042582	6775
2500.00	3.99988e+000	4.0	-0.044001	6775



Datasource: SN_3920



Datasource: SN_3920

Geometry Composer Report

CANBERRA

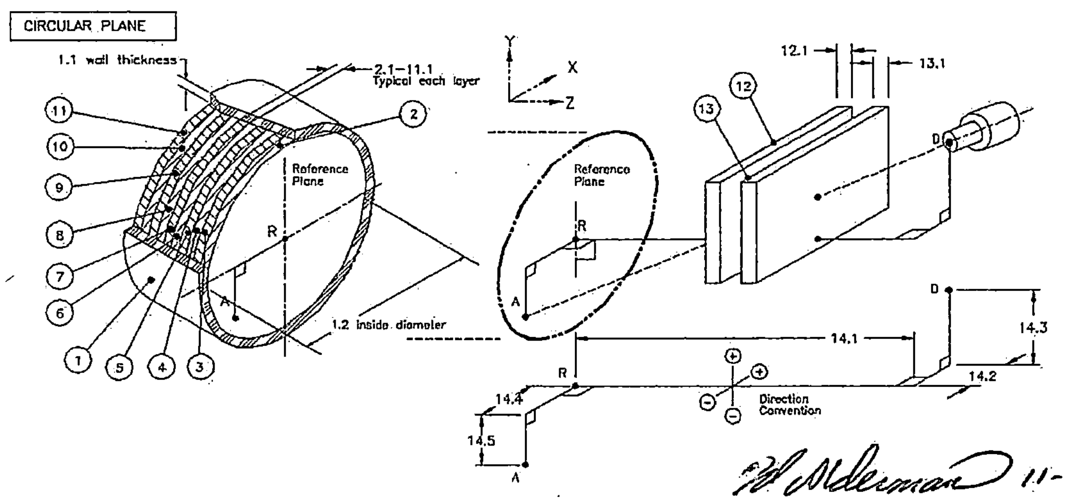
Date: Wednesday, November 23, 2016 - 09:34:16
Description: 3920 2m Soil (12mFOV) 1m on o/s edge of FOV Sm Collimator D1.6
Comment: Calib. Date 11/23/16
File Name: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\3920 12m FOV 1m Soil Sm Col.geo
Software: ISOCS
Template: CIRCULAR_PLANE, Version: (default)
Detector: Det_3920
Collimator: 25mm-90d old (oldISOCS 25mm side 90deg collimation [large hole collimator])
Environment: Temperature = 60 °F, Pressure = 760 mm Hg, Relative Humidity = 80%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (cm)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Side Walls	0	113					none		
2	Layer 1	15						dirt2	1.6	1.00
3	Layer 2	0						<none>		
4	Layer 3	0						<none>		
5	Layer 4	0						<none>		
6	Layer 5	0						<none>		
7	Layer 6	0						<none>		
8	Layer 7	0						<none>		
9	Layer 8	0						<none>		
10	Layer 9	0						<none>		
11	Layer 10	0						<none>		
12	Absorber1									
13	Absorber2									
14	Source-Detector	200	144	0	144	0				

List of energies for efficiency curve generation

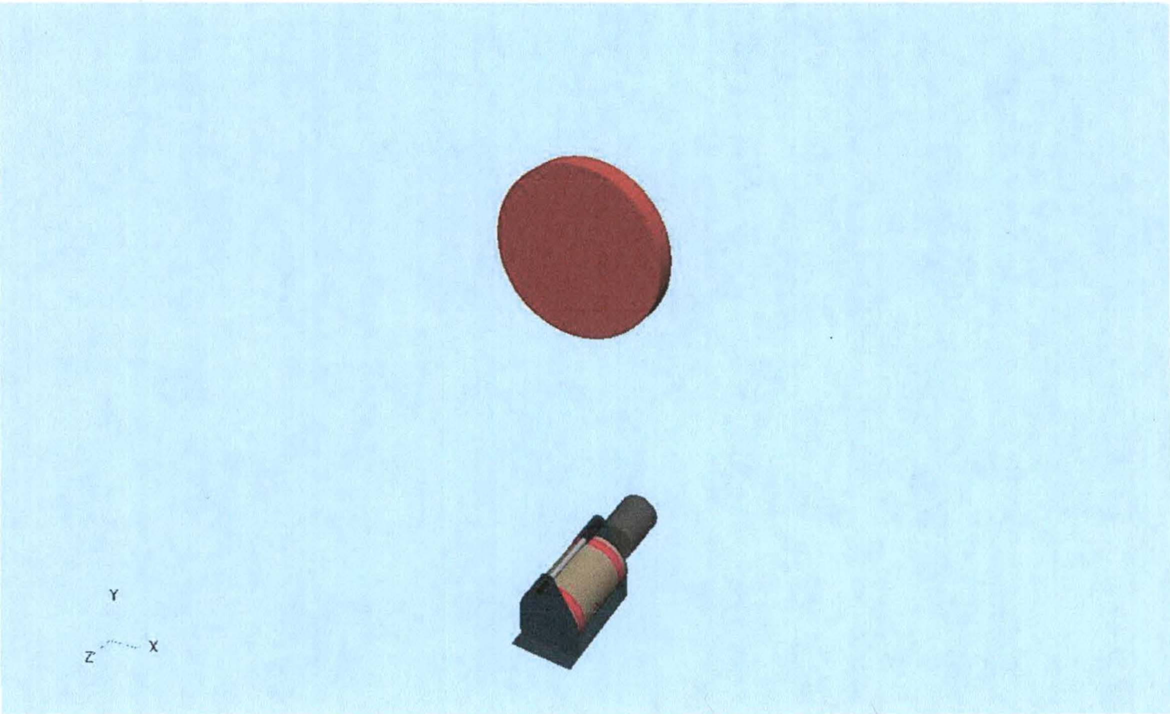
45.0	58.0	59.5	60.0	61.0	70.0	80.0	100.0
150.0	200.0	300.0	400.0	600.0	660.0	661.7	662.0
663.0	800.0	1000.0	1172.0	1173.2	1174.0	1331.0	1332.5
1333.0	1500.0	2500.0					



11-23-16
D. Anderson 11.29.16

Geometry Composer Report

Date:	Wednesday, November 23, 2016 - 09:34:16
Description:	3920 2m Soil (12mFOV) 1m on o/s edge of FOV Sm Collimator D1.6
Comment:	Calib. Date 11/23/16
File Name:	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\3920 12m FOV 1m Soil Sm Col.geo
Software:	ISOCS
Template:	CIRCULAR_PLANE, Version: (default)

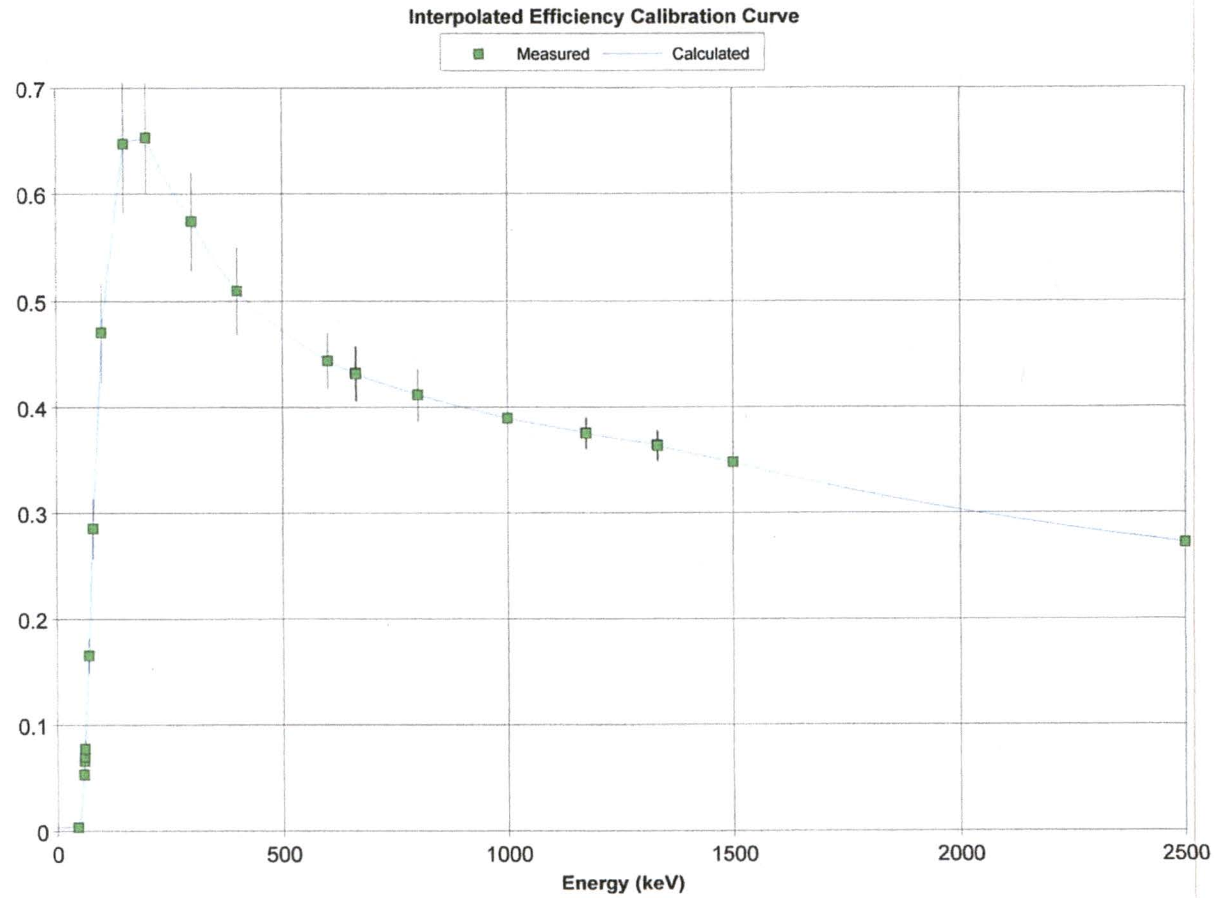


ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\CIRCULAR_PLANE\3920 12r
ISOCS/LabSOCS Time: 11/23/16 09:34:04
Genie Cal File: C:\GENIE2K\CALFILES\Old Calib\3920 12m FOV 1m SC d1.6.CAL
Genie Cal Time: 11/23/16 09:43:19
Template: CIRCULAR PLANE
Geom Description: 2M Soil 1M D1.6
Comment: ISOCS:UNITS=ACT/G CALIB._DATE_11/23/16
Detector: DET 3920
Collimator: 25MM-90D_OLD
Convergence: 1.00 %
Area [Sq Meters]: 1.0029e+000 (C)
Mass [Grams]: 2.4069e+005 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Eff by MASS

Energy	Efficiency (X Mass)	%Uncertainty	%Convergence	Final # of Voxels
45.00	3.31096e-003	15.0	0.010437	128670
58.00	5.32072e-002	10.0	-0.010192	128670
59.54	6.58330e-002	10.0	-0.010398	128670
60.00	7.00307e-002	10.0	-0.010589	128670
61.00	7.75108e-002	10.0	-0.010872	128670
70.00	1.65132e-001	10.0	-0.758796	8090
80.00	2.84960e-001	10.0	-0.612222	8090
100.00	4.70226e-001	10.0	-0.455607	8090
150.00	6.46712e-001	10.0	-0.342978	8090
200.00	6.52564e-001	8.0	-0.297887	8090
300.00	5.74178e-001	8.0	-0.253011	8090
400.00	5.09197e-001	8.0	-0.113870	4070
600.00	4.43596e-001	6.0	-0.099499	4070
660.00	4.31935e-001	6.0	-0.098339	4070
661.65	4.31341e-001	6.0	-0.098689	4070
662.00	4.32450e-001	6.0	-0.098686	4070
663.00	4.31422e-001	6.0	-0.099303	4070
800.00	4.11411e-001	6.0	-0.098225	4070
1000.00	3.89338e-001	4.0	-0.097886	4070
1172.00	3.75662e-001	4.0	-0.093654	4070
1173.22	3.75139e-001	4.0	-0.093216	4070
1174.00	3.74978e-001	4.0	-0.092434	4070
1331.00	3.64003e-001	4.0	-0.087873	4070
1332.49	3.63656e-001	4.0	-0.087118	4070
1333.00	3.62819e-001	4.0	-0.086902	4070
1500.00	3.47333e-001	4.0	-0.081391	4070
2500.00	2.71472e-001	4.0	-0.055561	4070



Datasource: SN_3920

Technical Basis Document

Technical Basis for Design, Calibration, and Operation of the Gardian Mobile Assay System

(Procedure Classification – Quality Related)

1.0 SCOPE

1.1 This document presents a large volume assay system and its potential application as a bulk material survey system in support of decommissioning of the Humboldt Bay Power Plant (HBPP) site. GARDIAN, which stands for GAmma Radiation Detection and In-container ANalysis, is a large container assay system designed to determine the radioactive material content in large containers or other similar volumes of waste. The system includes the capability of monitoring truck-mounted loads of waste or material (e.g., roll-offs, intermodals, sealands, etc.) and other containerized waste volumes (e.g., 55-gallon drums, B-12 or B-25 boxes, etc.)

The first field use of GARDIAN was during the Big Rock Point Nuclear Plant decommissioning project. Specific setup and calibration data used for the Big Rock Point project are included in this document as examples of typical evaluations/calibrations that can be performed with GARDIAN.

2.0 DISCUSSION

2.1 The Energy Solution GARDIAN Mobile Assay System consists of two semi-trailers positioned in a parallel configuration (see Figure 9.1). Truck or trailer-mounted containers/waste (e.g., roll-off containers or intermodals) or other similar waste volumes are processed through the system by slowly moving the container/waste between the two trailers. The survey/assay of the material in the containers is monitored by a combination of plastic scintillation detectors and high-purity germanium (HPGe) detectors. The plastic scintillation detectors (one per trailer) are mounted on the inboard ends of the trailers (see Figure 9.1) to perform a gross scan survey of the container/waste as it is moved into position between the trailers. The scan survey ensures that significantly elevated or highly non-uniform radioactivity is not present in the container (a pass/fail survey).

At the end of the scan survey, the container is positioned at a designated position between the trailers to allow the HPGe detectors (two per trailer) to conduct a qualitative and quantitative nondestructive assay of the waste. The HPGe detectors are pre-positioned for each large container type/configuration to optimize coverage of the containerized waste during the count as illustrated by Figure 9.2. The HPGe detectors are controlled by state-of-the-art nuclear instrumentation module (NIM) electronics, or equivalent, interfaced to a multi-channel analyzer that is controlled by an IBM-compatible computer system.

The combination of detector types, and both scan and fixed position counting ensure that the radioactivity content of each surveyed container or item is effectively measured. This allows proper characterization of the radioactivity content or verification of its absence to allow release of the waste/material as allowed by approved release limits and protocols.

The GARDIAN system also includes the capability to assay waste or material in conventional containers (e.g., 55-gallon drums, B-12 or B-25 boxes, etc.). In this mode of operation, the system's conveyor and platform are used with the Main Assay Trailer to move and position containers in designated counting positions as appropriate for the given container (see Figure 9.3). The detectors are rotated inward to allow a detector view on each side of the box or container. Alternatively, all four system detectors may be used (as shown in Figures 9.3) if greater coverage of the container is desired. Multiple counting positions may be pre-programmed based on the desired number of measurements and locations using the system's PLC control unit and measurement control software.

The GARDIAN system is controlled using Canberra Industries Genie-2000/NDA-2000 software. Genie-2000 is the basic gamma spectroscopy software and NDA-2000 (Non-Destructive Assay) is supplemental software designed to facilitate the use of gamma spectroscopy in waste assay applications. NDA-2000 allows various counters, count types, containers, and geometries to be defined. Quality control features (e.g., control and trending of source checks and background checks) are also included with the Genie-2000/NDA-2000 software to ensure proper operation of the system prior to use.

Calibration curves for the various geometries established for GARDIAN are created using Canberra's ISOCS (In-Situ Object Counting System) software. ISOCS, in conjunction with a specific characterization of the system's detectors, allow detector efficiencies to be mathematically determined and applied to counting results. This calibration method is especially useful and necessary for large geometries where construction of large calibration sources or phantoms is not practical.

All operations including the calibration and routine counting of the GARDIAN system are controlled by specific procedures. TBD-GC-003 (Reference 8.1) and TBD-GC-001 (Reference 8.2) have been developed to ensure proper calibration, operation and maintenance of the system. Unit 3 exterior surfaces are relatively clean in terms of hazardous materials and radiological contamination; however, as surfaces are disturbed and Systems, Structures, and Components (SSC) configuration changes during D&D, radiological hazards have decreased as components are removed and disposed. Facility configuration is managed using the design change process under and HBAP C-1.

Alpha emission from transuranic elements dispersed throughout structures, systems, and components (SSC) is the primary radiological concern during D&D. Decommissioning Accident Analysis, "Dry Active Waste (DAW) Fire" (Calc NX-323) results indicate the dose acceptance criteria in 10CFR20 would be met in a postulated fire with the bounding conditions for DAW stated as Precautions and Instruction in procedure RCP-6I, "Collection, Labeling, Packaging, Storage, and Accountability of Radioactive Material." Any postulated fire in the Environmental Count Room Building is enveloped by this analysis.

3.0 SYSTEM DESIGN

3.1 Conceptual Designs

To select an appropriate design for GARDIAN, various design options were studied during its development. Questions answered by the study included: 1) how many detectors should be used, 2) what type of detectors should be used, 3) what should the placement/orientation of the detectors be relative to the assayed container and 4) the overall process of how the system will be used (i.e., how best to optimize use of the system for both quality of performance and efficiency of use). The following paragraphs in this section provide a brief summary of the designs considered and rationale for the design selected.

3.1.1 Number of Detectors

To answer the question of how many detectors are needed for a given assay system, consideration should be made for the required counting sensitivity, the size of container(s) to be assayed, and the potential for non-homogenous activity distributions within the containers. More detectors, when summed to provide an overall response of a system, increase the sensitivity of the system. A greater number of detectors also allow larger containers to be more fully "covered" and closer spacing of detectors provides better accounting of non-homogeneous activity distributions (provided the detectors can be placed close enough to the container for meaningful differentiation).

Conversely, a system with a greater number of detectors is more costly, more difficult to calibrate and maintain, and has a greater chance of failure of a given component of the system. Therefore; an appropriate balance between the requirements of a given application and potential drawbacks must be made when selecting a system design.

In balancing the above, the optimum number of detectors for GARDIAN was determined to be four. Modeling and sensitivity analysis indicated that a four detector system would be able to meet the minimum detectable activities (MDA) required by HBPP Site Closure. Placing the four detectors, two per side, also provides for a reasonable sectioning of a large roll-off type container into quadrants (Figure 9.2). The advantage of better coverage for non-homogeneous activity distributions provided by a system with more detectors can be addressed (as was done with GARDIAN) by supplementing the system with scanning detectors as described in this document.

3.1.2 Type of Detectors

Qualitative analysis of potential gamma-emitters is required by the HBPP Site Closure Group for the disposition of bulk materials. Therefore, some of GARDIAN's detectors had to include gamma spectroscopy capability. High purity germanium (HPGe) detectors were selected over sodium iodide due to their greater peak resolution, gain stability, and available calibration benefits (i.e., may be characterized for ISOCS calibrations, which are necessary for practical calibrations of large geometries). To supplement the system with scanning detectors, sodium iodide and plastic scintillation detectors were considered. While sodium iodide was initially considered, plastic scintillation detectors were ultimately chosen due to their low cost and availability in large sizes/volumes, high sensitivity, and durability in rugged environments. The complementary combination of HPGe and plastic scintillation detectors used with GARDIAN makes optimum use of two proven radiation measurement technologies.

3.1.3 Placement/Orientation of Detectors

To assay a large container of waste, such as an intermodal or roll-off type container, radiation sensitive detectors may be positioned under the container, above the container, at the side of the container or some combination thereof. Positioning detectors under a large container such as inter-modals or roll-offs, was considered to be the least practical option for the following reasons: 1) there is greater and non-homogeneous shielding at the bottom of typical large containers (i.e., heavy gauge metal and loading/unloading rails) that complicates the modeling and efficiency determination necessary for accurate assay measurements; 2) positioning containers into such a position would be the most difficult and time consuming (i.e., lifting/placing large containers by forklift), and/or 3) high cost and setup time of an alternative underground system, which also adds shielding from the truck bed/structure. Therefore, the most viable positions for placement of assay detectors were considered to be above the container and/or at the side the container.

Two specific preliminary assay system designs were evaluated for potential use for GARDIAN. These were an overhead system, where assay detectors are positioned above the container, and a side viewing system, where assay detectors are positioned along each side of the container. With both systems, a supplementary scanning system would be included to perform a gross contamination level screening and to scan for significant non-uniformities (i.e., hot spots). Both of the conceptual designs were reviewed and compared and the side viewing system was selected due to its simplicity, flexibility, portability and ease of use, while still meeting all assay measurement requirements of HBPP Site Closure.

3.1.4 Conclusion

A side-viewing system with multiple detectors (i.e., four HPGe and two plastic scintillation detectors) was the selected configuration for GARDIAN. This combination and configuration is flexible (i.e., easily adapted to count boxes as well as larger containers of various shapes and sizes), can be quickly setup (simply pull and park trailers in setup location), is portable should the system need to be relocated (only a power supply and truck road/path is required), and combines the best of complementary and proven technologies. The system as designed will meet all the assay measurement requirements of HBPP.

3.2 Equipment Descriptions

This section describes in more detail each of the components comprising the GARDIAN Mobile Assay System as constructed. Information concerning calibration, operation and testing of the assembled system is found in the applicable section later in this document.

3.2.1 Assay Trailers

The GARDIAN Mobile Assay System includes two semi-trailers that house and provide support for the system's equipment/instrumentation as well as transportation means. The trailers include a 51 feet long by 8.5 feet wide Main Assay Trailer and a 48 feet long by 8.5 feet wide Support Trailer (Figure 9.1). Mounted inside of each trailer are two detector tracks and towers that are used to position the system's HPGe detectors at the correct spacing and height. The Main Assay Trailer also includes the assay office or control room for the system.

3.2.2 GARDIAN Assay Office/Control Room

The front end of the Main Assay Trailer includes a temperature-controlled office that serves as the control room for the GARDIAN system. The system's computer and accessories, detector electronics, monitors, and desk are located in this office to provide a convenient location for control and oversight of GARDIAN's operation. A closed circuit camera/monitoring system is also present in the office (with cameras mounted at strategic locations between the trailers) to allow the Gardian operator to view the trucks/containers during their survey and assay.

3.2.3 Platform/Conveyor

When GARDIAN is operated in its box container mode (i.e., for survey of smaller containers), the system's platform and conveyor are used (Figure 9.3). The conveyor is positioned perpendicular to the Main Assay Trailer and connected to the platform and track in the trailer to allow the platform to move in and out of the trailer. Boxes or other similar containers are loaded on the platform outside the Main Assay Trailer and brought inside the trailer and positioned adjacent to the detectors. The HPGe detectors inside the Main Assay Trailer are rotated inward (i.e., facing each other) during this mode of operation to view the containers during their assay. Counting may be performed with one detector per side or two detectors per side (if Support Trailer detectors are transferred to the Main Assay Trailer as shown in Figure 9.3).

3.2.4 Detector Tracks

There are four detector track units included with the GARDIAN system. Two tracks are located in each trailer to provide support for the detector towers and allow a variable spacing between the towers. As appropriate for the container type and size, designated positions on the tracks are pre-selected for each tower to optimize the assay of the containers (i.e., center each detector at its container quadrant). Lock-down clamps secures and maintains the towers at the designated position on the tracks.

3.2.5 Detector Towers

There are also four detector tower units included with the GARDIAN system. As is the case with the detector tracks, two detector towers are located in each trailer (i.e., one tower on each track) to provide support for the detector housings and allow a variable height adjustment of the detectors. For a given container type/size, designated heights are selected for the detectors to optimize the assay of the container and are maintained in proper position by the tower lead screw and gear drive.

3.2.6 Detector Housings

Each detector is supported by an enclosure that houses and supports the detector and secures the detector and associated housing to a detector tower via a lead screw. The vertical position of the detector is set by manual adjustment using a gear drive (driven by a powered hand-tool/attachment) that raises or lowers the detector and housing on the lead screw.

3.2.7 System Detectors

GARDIAN currently uses HPGe detectors manufactured by Canberra. The detectors are germanium coaxial detectors with a 20% efficiency rating (i.e., relative to a 3" by 3" NaI) and 2.0 keV resolution rating based on the 1332 keV gamma from Co-60 (GC2020 model designation). The detectors include an integral liquid nitrogen cryostat (dewar) with a five-day rating. The detectors must be cooled down to liquid nitrogen temperature before applying voltage to the detectors, which include a high voltage inhibit circuit to protect the detectors from unscheduled/accidental warm up.

To allow use of Canberra's ISOCS calibration software, each of the GARDIAN detectors has been characterized by Canberra. The characterization process included detailed measurements of the detectors and modeling using the Monte Carlo N-Particle (MCNP) transport code developed by Los Alamos National Laboratory. Actual measurements of point sources in various locations about the detectors are also performed during the modeling process to confirm the detector's characterization.

Replacement or significant repairs to any of GARDIAN's HPGe detectors requires a repeat of the characterization process and re-establishment of the associated calibration files.

3.2.8 System Electronics

The GARDIAN system includes state-of-the-art spectroscopy electronic equipment including the following:

- ICB Digital Signal Processors (4 each)
- ICB 6 KV High Voltage Power Supplies (4 each)
- NIM BIN/Power Supply (6, 12, 24V) 110 V AC (2 each)
- Acquisition Interface Modules (2 each)

Each of the above components is housed/mounted in an environmental cabinet and powered via an Uninterrupted Power Supply system (UPS) for system continuity and stability. The cabinet with components is located in the environmentally controlled assay office.

3.2.9 Computer Hardware/Software

The GARDIAN computer system currently consists of the following equipment:
- Computer: Pentium III-600 PC
- SDRAM: 128MB
- Hard Disk: 10/20 GB TR5 Internal EIDE D
- CD-ROM: 48X Internal IDE
- Ethernet Interface Adapter (PC I Bus)
- Display: 17" Color SVGA
- Printer: HP LaserJet 4050

The operating software for GARDIAN has been developed by Canberra and includes the following:

- Windows NT, V 4.0 Operating System
- Genie-2000 Gamma Spectroscopy Software
- Genie-2000. Quality Assurance
- NDA 2000 Integrated Neutron/Gamma Analysis Software
- ISOCS Efficiency Calibration Software

3.2.10 Ludlum Model 3500-1000 Radiation Detection System

The Ludlum Model 3500-1000 Radiation Detection System includes two large plastic scintillation detectors, infrared sensors monitor, and computer control software. The detectors are 2" by 5" by 48" long and are contained along with their associated photo-multiplier tube in a cylindrical PVC housing. The detectors/housings and infrared sensors are mounted at the inboard ends of the GARDIAN system trailers (see Figure 9.1). The infrared sensors allow the system to operate in a background measurement mode until the presence of a truck/container is sensed at which time the system switches into "measurement" mode (with measurement subtraction of continuously updated background).

The monitor for the system, located inside the Main Assay Trailer office, supplies detector high voltage, signal processing, measurement readout and alarm settings/features (including both visual and audible alarms). Computer control software is also included with the system to allow additional alarm setting controls/instructions, visual indication of background corrected readings and specific locations of alarms (i.e., a front or back, and right or left side indication is provided when a preset alarm setting is exceeded).

The Ludlum scanning system is included with GARDIAN to provide a more thorough and comprehensive survey/assay of large containers of waste. The large active volume of the system's detectors provide for a very sensitive and timely go/no-go analysis of containerized waste and also a guard against the release of significant localized activity via its top-to-bottom, front-to-back, scan survey of both sides of the container/waste.

The alarm setting for the Ludlum scanning system is adjustable in increments of background standard deviations. The recommended setting for the system and basis (depending on specific project or customer needs) is detailed in Section 4.4.2 of this document.

3.3 Design Specifications

3.3.1 System Capacity

NOTE: The quoted capacity is based on high-density concrete rubble or similar type waste and includes time requirements reasonably expected for staging, Ingress/egress, and subsequent processing and review of results (higher throughputs may be possible in specific cases).

- 84 million pounds per year
- 420,000 pounds per ten-hour work shift (four ten-hour shifts/week for 50 weeks)
- 14 roll-off type containers per work shift (assumes approximately 30,000 pounds per roll-off container)
- 30 minute total processing time per roll-off (assay in operation 70% of each work day to allow for daily startup/shutdown, QC tests and system maintenance)

3.3.2 Sensitivity Criteria

The GARDIAN system was designed to meet a minimum detectable activity (MDA) of 5.0 pCi/g (at 95% confidence) or less of total gamma emitters principally present in commercial nuclear power waste (i.e., primarily Co-60 and Cs-137). For most waste types and gamma emitters a counting sensitivity at or below 1.0 pCi/g for individual nuclides will be possible with relatively short count times (i.e., a few minutes or less).

3.3.3 System Support Needs

The following equipment and other support requirements are necessary to support the field operation of GARDIAN:

• Power Supply-200 Amps @ 240 V AC/60HZ (Single Phase, Neutral, Ground)
• Setup Area- 45' by 60' area required for setup of the Main and Support Trailers (additional space as necessary for trucks/containers to maneuver through the system)
• Scale with capacity capable of weighing containers/waste to be processed
• A means or method of determining container fill volume (this information is used with waste weight to determine the average waste density in the container)
• An entry awning or other suitable enclosure is recommended for the trailers if GARDIAN is used in locations subject to inclement weather

3.3.4 Backup Mode of Operation

The design of GARDIAN allows up to a 50% loss of detectors and/or associated electronics without a significant impact to operation or project schedule. If part of GARDIAN is inoperable, the system is re-configured to perform the assay of containers in a two-step process. The functioning detectors and electronics (if not already) are placed in the front positions in the trailers and truck mounted containers are assayed in two steps (front half followed by back half after re-positioning the truck/container). This backup mode of operation allows repair or replacement of malfunctioning equipment without significant impact to system performance or schedule.

4.0 CALIBRATION METHOD

4.1 Energy Calibration

4.1.1 Energy Calibration Source

The source used to perform the energy calibration of the Energy Solutions GARDIAN Mobile Assay System is the multi-energy nuclide Eu-152. Specifically, the energy calibration is performed using the seven (7) predominant gamma energies listed in Table 4-1 below. As shown in Table 4-1, Eu-152 has a wide range of abundant energy lines that cover the bulk of the energy range of nuclides expected to be potentially present in waste forms assayed by GARDIAN. For example, the two most prominent gamma emitters potentially present in most waste or material from nuclear power facilities are Co-60 and Cs-137, whose gamma energies of 1173 keV and 1332 keV (for Co-60) and 662 keV (for Cs-137) are within the range of Eu 152 gamma.

Table 4- 1 Energies and Abundances of Eu-152

Energy (keV)	Abundance (%)
121.8	28.4
244.7	7.49
344.3	26.5
778.9	12.7
964.1	14.4
1112.1	13.3
1408.0	20.7

4.1.2 Energy Calibration Process

The energy calibration is performed in accordance with the Genie-2000/NDA-2000: software developed by Canberra. The process involves collection of a spectrum using each of the system's detectors and the Eu-152 calibration source. After adjusting the system amplifier gain and/or ADC zero setting (as necessary) for approximately 0.5 keV per channel; the primary Eu-152 gamma energies are identified to the system and a fitted energy calibration curve is determined by the software. This calibration allows the energy of detected gamma peaks to be identified.

4.2 Shape Calibration

During the performance of the energy calibration, the FWHM values (Full Width at Half Maximum) for each calibration source peak are also determined. From the measured FWHM values, a calibration curve is determined, which allows the system to determine the expected peak shape versus peak energy. Region of Interest (ROI) and peak identification parameters are based on the expected peak shape (i.e., FWHM), which are applied to each potentially present gamma energy.

4.3 Efficiency Calibration

4.3.1 ISOCS Calibration Software

To calibrate the various counters, containers and geometries used by GARDIAN, Canberra's ISOCS calibration software is used; ISOCS is a mathematical method of determining detector efficiencies. Several densities are modeled for each general material type expected in order to determine a multi-curve efficiency file that allows correction of assay results over the range of expected waste/material densities.

The first step in conducting an ISOCS calibration is the preparation of a Geometry Template (i.e., a description of the particular container and counting arrangement). The geometry template file is then processed to create (via mathematical modeling) an efficiency curve for the geometry and detector(s). The ISOCS efficiency curve is then combined with other curves as appropriate (e.g., various waste densities to cover the expected range) to form a multi-curve efficiency. This process is repeated for each geometry, container, and count type of each counter defined for GARDIAN. The results are subsequently specified as an overall efficiency file for each possible arrangement.

Additional detail of the ISOCS calibration process is provided below. Preparation of geometry templates and the completion of each step of the process is conducted in accordance with Reference 8.1.

4.3.2 Geometry Templates

Performance of an ISOCS calibration for a given geometry requires the establishment of an input data file or geometry template. The geometry template fully specifies all necessary parameters for the geometry including: detector characterization file; description/dimensions of collimator; description of all shields/attenuators (e.g., detector housing plate, trailer wall, and container wall thickness and material types); source to detector geometry; density, dimensions and waste material type(s) of source; and gamma energies to be evaluated.

Geometry templates were prepared for both concrete rubble and soils for the HBPP decommissioning project including a set of densities that would span the range that could be encountered for each. Average waste densities of 0.5, 1.0, 1.5 and 2.5 g/cc were included for concrete (typical concrete rubble is between 1.0 and 1.5 g/cc due to intermixed air space) and 1.2, 1.6 and 2.0 g/cc for soils. To illustrate how geometry templates are prepared, copies of the geometry templates prepared during establishment of the initial efficiency calibrations performed for GARDIAN at HBPP are included in Attachment 10.1.

4.3.3 Efficiency Curves

Geometry template files are processed using the ISOCS software to calculate efficiency values for the arrangement at energies specified in the template (e.g., energies in the range of 0.1 to 2.0 MeV were selected to span the Possible gamma emitters present in HBPP bulk materials). A best-fit curve is mathematically determined from the calculated data to allow assay results for any detected gamma energy to be properly corrected for efficiency in the given geometry/arrangement.

Since multiple HPGe detectors are used with GARDIAN, a summed efficiency is also determined by summing the results for each individual detector into a summed efficiency file. This allows an overall or average response for an entire container to be determined. With the individual and summed efficiency files, GARDIAN is able to determine both the overall (i.e., average) results in a given container as well as the results from individual detectors. The efficiency curve results for both individual detectors and summed responses are provided on ISOCS MEfficiency reports. Attachment 10.2 includes the efficiency curve results determined for the geometries and material types specified-for use at HBPP.

4.3.4 Multi-Curve Efficiencies

After efficiency curves are established for each density and geometry, a multi-curve efficiency-file is constructed. The multi-curve consists of all applicable densities for each given geometry so sample results can be corrected for the actual density of the sample. When the waste weight and volume are entered during the start of an assay, the average waste density is determined for the sample. The sample density is then used to determine (via interpolation) an efficiency curve for the actual sample density.

For HBPP, multi-curve efficiencies were created for both concrete rubble and soils as previously noted. Copies of the combined multi-efficiency curves initially prepared for HBPP are included in Attachment 10.3.

4.3.5 Efficiency Files

The final step in the completion of an ISOCS based calibration is the generation of an efficiency file for each geometry, combination of detectors, and container type for each specified counter. For GARDIAN, this includes efficiency curves for each separate detector as well as the summed detector response to determine the overall average results in a given container using the multi-detector system.

4.4 Calibration of Ludlum Model 3500-1000 Radiation Detection System

4.4.1 Electronic Calibration

The Ludlum Model 3500-1000 is factory set. Detector high voltages, thresholds and other required settings (except for alarm set-point setting as described below) are preset by Ludlum and no further field calibrations are required. Source checks are required to verify the proper operation of the system prior to use each day. System failures will require return of the unit to Ludlum for repair and re-adjustment. The system includes a startup self-diagnostic that ensures proper operation of the system prior to each use.

4.4.2 Scan Alarm Point Setting

For GARDIAN's use with HBPP bulk materials, an alarm set point of approximately 10 μR/hr above background was selected. This level is consistent with the approximate alarm setting of the truck monitor used as the final check for released waste at HBPP and also provides assurance that the total activity potentially present in a given container is minimized.

To actually set the alarm level, MicroShield was used to determine the distance between the 10 μCi. Cs-137 button source (that came with the Ludlum system) and the center of the scanning detector required to produce 10 μR/hr. The source was then placed at this distance from each detector while adjusting the alarm set point until an alarm was just received. For the MicroShield modeling, a two-foot section of the four-foot long detector was evaluated by dividing the detector half into four six-inch sub-sections (with the dose point at the center of each subsection). Due to symmetry, modeling of only one-half of the detector is required. The results of the calculation, based on the initial activity of the source, are provided in Attachment 10.4.

4.4 Calibration of Ludlum Model 3500-1000 Radiation Detection System

> NOTE: Management has opted not to use this feature of the GARDIAN monitor system for the following reasons:
>
> - The Ludlum Model 3500-100 monitor was included in the GARDIAN monitor primarily to enhance the ability to detect Co-60 particles. Co-60 has not been observed to be a major concern for the HBPP project due to several half-lives of Co-60 having transpired since HBPP's cessation of power reactor operations in 1976.
> - Co-60 is readily detectable by the gamma spec systems of the GARDIAN making the use of this gross count detector redundant.
> - Increased false positive rates have been experienced with other applications these detectors.

4.4.1 Electronic Calibration

The Ludlum Model 3500-1000 is factory set. Detector high voltages, thresholds and other required settings (except for alarm set-point setting as described below) are preset by Ludlum and no further field calibrations are required. Source checks are required to verify the proper operation of the system prior to use each day. System failures will require return of the unit to Ludlum for repair and re-adjustment. The system includes a startup self-diagnostic that ensures proper operation of the system prior to each use.

4.4.2 Scan Alarm Point Setting

For GARDIAN's use with HBPP bulk materials, an alarm set point of approximately 10μR/hr above background was selected. This level is consistent with the approximate alarm setting of the truck monitor used as the final check for released waste at HBPP and also provides assurance that the total activity potentially present in a given container is minimized.

To actually set the alarm level, MicroShield was used to determine the distance between the 10 μCi. Cs-137 button source (that came with the Ludlum system) and the center of the scanning detector required to produce 10 μR/hr. The source was then placed at this distance from each detector while adjusting the alarm set point until an alarm was just received. For the MicroShield modeling, a two-foot section of the four-foot long detector was evaluated by dividing the detector half into four six-inch sub-sections (with the dose point at the center of each subsection). Due to symmetry, modeling of only one-half of the detector is required. The results of the calculation, based on the initial activity of the source, are provided in Attachment 10.4.

4.5 Routine Calibration Checks

4.5.1 Quality Control (QC) Source Checks

A daily QC source check prior to use of the GARDIAN system each day will be performed and plotted on a control chart with established limits for performance. The QC source will be a multi-gamma energy source with energies that span the range of expected gamma emitters present in the waste. Parameters of the QC source check include peak location (i.e., channel number to confirm the system's energy calibration) and peak activity (to confirm the system's efficiency calibration) for a low and high end gamma energy (as appropriate for the potential gamma energies of interest for the given waste). Each of the system's four HPGe detectors are separately checked and monitored during the check.

4.5.2 Weekly Environmental Background Count

A weekly Environmental Background Count is performed to determine the presence of any low-level interfering nuclide specific activity. The Environmental Background Count establishes background correction values that are subtracted from any detected activity results in subsequent sample assays. The Environmental Background Count is also repeated any time there are significant changes to the background in the area the system is operated.

4.5.3 Daily Background Check

In addition to the weekly Environmental Background Count a daily Background Check will also be performed while the system is in operation. The Background Check ensures that background levels in the counting area are not significant and are consistent to levels established during the Environmental Background Count. This is confirmed by performing a count (with a count time at least as long as the longest expected sample count time) and verifying the absence of any detected nuclides (excluding naturally occurring nuclides).

5.0 GEOMETRY CONSIDERATIONS

5.1 Container Placement Sensitivity Analysis

5.1.1 General Discussion

The GARDIAN Mobile Assay System is calibrated assuming the truck/container being monitored is centered between the two system trailers with regard to position along the trailer lengths (i.e., longitudinal position) and spacing between the trailers (i.e., lateral position). Since the exact placement of a given truck/container of waste may vary, the effect of positional imprecision has been evaluated using the system's ISOCS calibration software.

To evaluate the effect of non-centered trucks/containers, the position of the truck/container was varied up to 12 inches on each side of center. ISOCS calibrations cases were modeled using the same input parameters as the actual calibration files, except for the varied longitudinal or lateral position. A typical concrete density was assumed and three of the standard calibration energies (i.e., 500 keV, 1000 keV, and 1400 keV) were used in the modeling to span the primary energies expected in typical waste (i.e., 662 keV from Cs-137 and 1173 keV and 1332 keV from Co-60).

5.1.2 Longitudinal Variations

As shown in Figure 9.4, variations in the longitudinal position of a given truck/container result in only a very minor relative system error (relative system error is the difference between the modeled response of a specified position versus the modeled response of the centered position assumed by calibration). The relative error for an individual detector was only about 3% at a 12 inch offset. By symmetry, each of the system's four detectors responded the same to a given offset. The potential error on average (i.e., summed response of all four system detectors) was less (within 1.5%) because while the response of two detectors decrease as the container moves away, the response increases for the other two detectors which are moving closer to the center of the container.

It should also be noted that the difference in the response between the three energies evaluated was negligible indicating the slight difference observed was primarily due to geometric effects.

5.1.3 Lateral Variations

A similar evaluation as described above was performed for lateral variations in the position of a truck/container between the GARDIAN system trailers. Figure 9.5 depicts the relative system error noted: for variations up to ±12 inches. As shown in the figure, the potential error vanes by a greater degree than for longitudinal variations (i.e., up to about 20% at ±12 inches). This is expected since lateral variations move the container (i.e., the source) away from or closer to the detectors in a more direct way. The average response, however, isn't significantly affected. As the response of the detectors in one of the GARDIAN trailers decreases, the response of the opposite side detectors correspondingly increases resulting in only a minor difference in the overall response of the system (i.e., average response within 3% at ±12 inches offset).

As was observed by longitudinal variations, there was also a negligible difference between the responses of each of the three gamma energies evaluated in the lateral case (i.e., effect is geometry related as expected).

5.1.4 Conclusion

It is expected that routine methods used to aid in correct placement of a given truck/container within the GARDIAN system will be able to ensure placement within ±12 inches. Therefore, truck/container placement and its effect on the results will not be significant. Even the approximate ±20% noted for individual detectors for a 12-inch lateral offset is within typical counting uncertainties for activity levels near the Minimum Detectable Activity (MDA). The potential error for the system due to longitudinal offsets as well as the system as a whole in both longitudinal and lateral cases was shown to be negligible.

5.2 Container Fill Volume Sensitivity Analysis

5.2.1 General Discussion

Variation of position or placement of a given container within the GARDIAN System's trailers and the associated effect on the system's response was evaluated in the previous section for two dimensions (i.e., front-to-back or longitudinal and side-to-side or lateral variations). The third possible dimension (i.e., height of container relative to GARDIAN's system detectors) is not evaluated since use of a specified truck/container type and associated placement of the detectors on the detector towers will center and fix the arrangement. However, a related effect could occur due to a variable fill level/volume in a given container. This section evaluates the effect that partially filled containers could have on the response of the GARDIAN system.

5.2.2 Analysis

To evaluate the effect of partially filled containers, multiple ISOCS calibration files were prepared as previously described with the same parameters used during calibration except for the container fill volume. Fill volumes, in six-inch increments from 12" of material up to a full container (i.e., 42" for the container to be filled at Big Rock Point) were compared to the nominally expected fill of 30" to 36" (based on typical waste densities and container weight limitations). Figure 9.6 illustrates the relative system response for the different fill volumes evaluated.

As shown in Figure 9.6, the effect of fill volume is negligible. There was only a very small difference observed (approximately 1% or less) over the range of fill levels evaluated (no difference between gamma energies as before). The minimal effect is understood since the conical field-of-view of the GARDIAN system detectors/collimators and detector-to-container distance is sufficient to encompass one-half of a given container's length, which is much greater than the height of a typical container. Therefore, from a geometry standpoint, variable fill volumes are relatively minor and are still in the approximately center of the detector's field-of-view.

5.2.3 Conclusion

Although knowledge of the approximate fill volume within a given container is important (in order to properly access the volume and therefore density of the waste in the container), the actual fill level is not. The response of the GARDIAN system to a wide range of possible fill levels will not significantly affect the reported result or its accuracy.

5.3 Layered Contamination within a Container

5.3.1 General Discussion

An additional evaluation was performed to determine the effect of "layered" contamination within a given container. For-example, if a large roll-off container is loaded and only the first "bucket or two of waste is contaminated; a contamination layer could reside in the bottom of the container (assuming clean material is subsequently loaded on top of the contaminated waste). Contamination could also similarly reside in the middle or top regions of a container. This evaluation was prompted in part as a follow-up to help explain and evaluate some of the empirical measurements observed during testing of the GARDIAN system as will be discussed in Section 6 of this document.

5.3.2 Analysis

To perform the layered contamination evaluation, multiple layers of contaminated waste were placed in the bottom, center, top, and mid-points between center and top/bottom of the roll-off container specified for the Big Rock Point project. A 12-inch layer of contamination was assumed (very thin layers of contamination were not considered reasonable). The results of this evaluation are provided in Figure 9. 7.

As shown by the figure, the variation in the GARDIAN system's response to the summed layered contamination profile was not significant nor gamma energy dependent. The system's response would be slightly high if centered in the container (since the contamination is more centered within the detector's field-of-view) and slightly low if in the top or bottom of the container (where the modeled relative system error was determined to be within 6%). By symmetry, each of the four system detectors would respond the same and therefore, Figure 9.7 also represents the overall system response.

5.3.3 Conclusion

The precise location of a layer of contamination within a container is not a significant concern. The overall modeling and assumptions provide for a reasonable assessment of the total amount of contamination (or potential contamination if not detected) present in an assayed container without regard to the specific location of the contamination.

5.4 Highly Localized Contamination Considerations

5.4.1 General Discussion

The evaluations and analysis presented thus far in this document have examined the effects of gamma energy, waste type and density, geometrical variations, and a realistic non-uniform contamination profile on the results of the GARDIAN assay system. Another question often asked, in regard to the assay of large volumes of waste, is the effect of localized contamination (i.e., highly non-uniform spatial distribution of contamination within a waste volume). This section summarizes some of the features of GARDIAN as well as other technical considerations that mitigate potential consequences of non-uniform activity distributions.

5.4.2 Maximum Activity Potentially Present per Container

To begin a discussion of non-uniform activity in a given large container, it is helpful to first identify the maximum total activity potentially released in the container due to its size and sensitivity of the assay. This information, by comparison, aids further discussion of the maximum activity potentially present in highly non-uniform activity distributions. The nuclide Cs-137 is used in the following discussion since it represents the principle nuclide potentially present in most HBPP bulk materials.

The maximum activity concentration of Cs-137 that is allowed per HBPP LTP (DCGL) is 7.9 pCi/g. For a 10 yard dump truck loaded with approximately 20,000 pounds of waste; this would result in about 71 μCi of potential activity (i.e.; 20,000 lbs x 454 g/lb x 7.9E-6 μCi/g-= 71 μCi). Therefore, in order to be released, assay of the example truck will show that the total Cs-137 activity potentially present is below 71 μCi.

5.4.3 GARDIAN Scanning System Response to Localized Contamination

As previously discussed, a Ludlum Model 3500-1000 Radiation Detection System is included with the GARDIAN system to supplement the overall survey of a large container of waste. This system includes plastic scintillation detectors on each side of the monitored container and is provided to allow for a timely go/no-go screening survey and a guard against highly non-uniform activity.

The worst-case contamination distribution for GARDIAN would be a very small source (in physical size) located in or near the center of the container. For a large roll-off container loaded with concrete rubble of typical density, a couple of tenth-value layers of waste would shield/attenuate a source located in the center of the roll-off.

Nevertheless, the GARDIAN system still provides an upper limit on the maximum amount of activity that could be present as an isolated point source.

In addition to container size and waste density, the upper limit of localized activity in a large container of concrete rubble is dependent on the alarm set point of the Ludlum scanning system. As previously described in Section 4.4.2, the recommended set point for GARDIAN corresponds to an exposure rate of approximately 10 μR/hr above background. Modeling using MicroShield (with a point source placed in the middle of a concrete rubble filled container of the type used at Big Rock Point) indicates that a source of about eight (8) mCi of Co-60 (the principle nuclide potentially present in most Energy Solutions customer waste) would result in a 10 μR/hr increase in the exposure rate at the position of the Ludlum plastic scintillation detectors (MicroShield report included in Attachment 10.4).

Eight (8) mCi of Co-60 activity is approximately a factor of 20 above the amount of total activity assumed to be present during the radiological dose assessment as was previously shown. A factor of 20 (although large for some measurement situations) is considered to be a reasonable and practical limitation for such a hypothetical (and highly unlikely) scenario. Realistic non-uniform activity distributions are more readily accounted for by GARDIAN due to the statistical averaging that occurs with randomly distributed localized sources of activity.

5.4.4 Statistical Considerations

Another consideration regarding the use of GARDIAN as a waste disposal survey system is the statistical nature of randomly distributed activity when considered over several containers of waste. While it is possible for a worst-case deposition of activity in, or near, the center of a roll-off container, it is also possible that such activity is located near the side of the container resulting in an over-response. In a statistical data set, the average of a number of measurements (if system bias is not present) approaches the true mean activity as the number of measurements increase.

To further illustrate by example, consider a pile of 15 million pounds of waste debris or rubble (the maximum amount of waste that may be released to a given landfill in a given year per Energy Solution's BWAP). If the pile of waste was assessed by random sampling, there would be a very high statistical certainty associated with the mean result of 500 samples. This total number of samples is roughly the number of containers (assuming 15 million pounds were released at approximately 30,000 pounds per container) that could be released in a given year. When considering the total activity potentially released to a given landfill over several years, the statistical power improves even more.

The GARDIAN approach is further strengthen (relative to sampling) by the fact that the final survey of waste via GARDIAN effectively assays a much larger amount of waste by assaying 100% of all containers than would be achieved by grab sampling. Therefore, when considering all waste released to a landfill over time, a properly calibrated and operated assay system should be able to demonstrate that the total amount of activity potentially released is within the amount assumed and justified by assessment. This is true even for non-uniform activity due to the statistical averaging that occurs in a large data set.

5.4.5 Conclusion

The radiological assessment performed to establish the appropriate release limits and sensitivity requirements for GARDIAN's use in conjunction with Energy Solution's BWAP accounts for the low levels of radioactivity potentially released. Even if non-uniform activity is potentially present, GARDIAN is capable of verifying that the total amount of radioactivity potentially released via the system is within the amounts assumed by the assessment used to establish the HBPP limits. The maximum amount of activity in a given container is also limited by the system's sensitivity requirements and the combination of detection technologies used by GARDIAN.

6.0 SYSTEM VERIFICATION AND VALIDATION

6.1 Introduction

To V&V each of GARDIAN's HPGe (high purity germanium) detectors and ensure the system is ready for use at the Humboldt Bay Power Plant, testing was performed of each detector using a NIST traceable multi-energy source. The source modeled for testing using ISOCS calibration software included the radionuclide Eu-152, which has several key gamma energy lines across the energy spectrum of interest at HBPP (i.e., 100 to 2000 keV). Each detector MCA was configured with a 4 channel per keV conversion gain using channels 400 to 8,000 to span the energy range.

After verification of each detectors ISOCS characterization file (including evaluation of current dead layer thickness which can grow for p-type HPGe detectors like those used with GARDIAN), base line measurements were collected with each detector and its associated check source (i.e., a source originally containing 1 μCi each of Eu-155 and Na-22). The low and high energy range of the source (i.e., 86.5 keV and 1274.5 keV) were specifically measured to establish a reference point for future response testing to confirm detector responses remain consistent throughout system operation.

The following sections describe the testing configuration and present V&V test results. The attachments in the V&V document (Reference 8.6) provide detailed information on the ISOCS models, assay reports and spreadsheet evaluations of results.

6.2 V&V Test Configuration

6.2.1 Test Source

A NIST traceable source containing Eu-152 was used to perform the V&V tests of the GARDIAN-1 HPGe detectors. The source (EnergySolutions ID number 099803) is a point source sealed in a thin layer of epoxy forming a 3/8" diameter spot in the bottom of a 1" diameter plastic vial. Seven key energies from Eu-152 were specifically evaluated including 122, 244, 344, 779, 964, 1112, and 1408 keV. These energies provide a good representation of the GARDIAN-I system energy range (100 to 2000 keV) as well as the range of energies expected to be encountered in HBPP waste/materials.

The original source activity of the source included 33.54 μCi ±5% of Eu-152 (9/21/1998 certificate date), but had decayed to 14.621μCi at the time of V&V testing. The higher activity level of the source (relative to typical check sources) provided better counting precision at a distance that avoided coincidence summing issues and minimized potential error with precise source positioning. A copy of the source certificate for source #099803 is included in Reference 8.6.

6.2.2 Measurement Configuration

To minimize coincidence summing loses and positioning errors, the outside of the source vial was positioned 24 inches from the detector end cap during testing (i.e., 24.5" from the center of the 1' diameter vial). The source (in the bottom of the vial) was positioned in line with the center of the detector as shown by Figure 6.1 below.

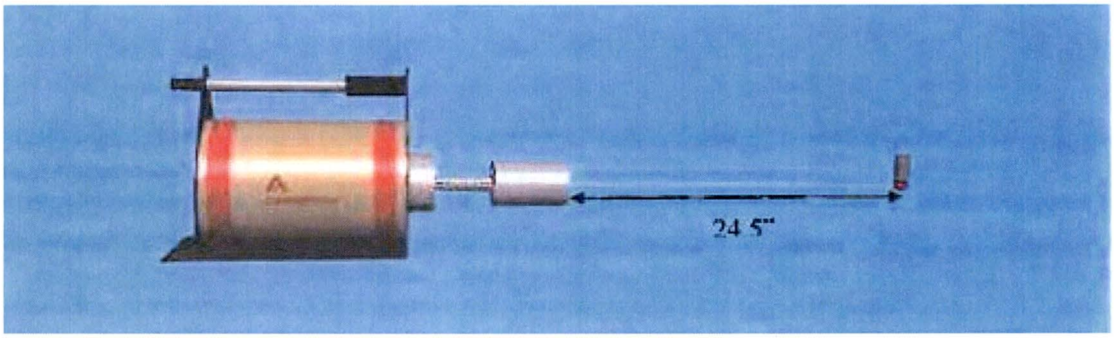


Figure 6- 1 Measurement Configuration
(detector aligned with point source in bottom of vial)

The vial (liquid scintillation vial) included a 0.033" wall of light density polyethylene. The Model S573 ISOCS Calibration Software Technical Reference Manual was used to ensure proper setup of the geometry composer reports for each detector. Copies of the geometry composer reports for each of the four detectors are included in Reference 8-6.

6.3 V&V Measurement Results

Table 6-1 below presents the individual detector results obtained for each of the key Eu-152 energies and the result for the four-detector system as a whole. Although individual detector results are obtained when operating the GARDIAN-1 system (to provide an indication of the activity distribution in containers/materials assayed), the primary result is the summed detector response, which effectively is the average activity concentration throughout the container.

The weighted mean activity of Eu-152 measured by each of the system detectors, which provides the best quantification of Eu-152 present in the vial, was also evaluated. Table 6-2 below provides the weighted mean activity for each of the detectors and the system's summed (i.e., average) response.

Table 6- 1 V&V Test Results for GARDIAN HPGE Detectors

Energy keV	Det #1 3994 µCi	Det #2 3996 µCi	Det #3 3997 µCi	Det #4 3998 µCi	Det SUM µCi	Current Activity µCi	% Difference
121.8	15.33	15.44	14.91	15.34	15.26	14.62	+4.4%
244.7	14.45	14.23	14.22	15.26	14.54	14.62	-0.1%
344.3	13.69	13.57	13.85	15.70	14.20	14.62	-2.9%
778.9	14.18	13.23	13.53	15.98	14.23	14.62	-2.7%
964.0	14.26	13.93	13.42	14.80	14.10	14.62	-3.6%
1112.0	14.40	13.23	14.08	15.17	14.22	14.62	-2.7%
1408.0	13.24	13.35	13.90	14.66	13.79	14.62	-5.7%

Table 6- 2 Eu-152 Activity Reported by GARDIAN HPGE Detectors

Detector	Eu-152 Reported Activity (µCi)	Eu-152 Source Activity (µCi)	% Difference
#1 3994	14.15	14.62	-3.2%
#2 3996	13.86	14.62	-5.2%
#3 3997	14.01	14.62	-4.2%
#4 3998	15.34	14.62	+4.9%
SUM (Average)	14.34	14.62	-1.9%

6.4 Baseline Measurements

Upon completion of V & V testing, a base line for the current performance of each of the system detectors was established using the detector's specific response test source to provide a reference value for future detector evaluations. The standard source provided by Canberra for ISOCS detectors was used for this evaluation by attaching the source to the top end of the detector as shown in Figure 6-2 below. The 1" button source at the end of the source jig is positioned 3.5" from the detector end cap when positioned with the tab against the end cap as shown in the figure below.

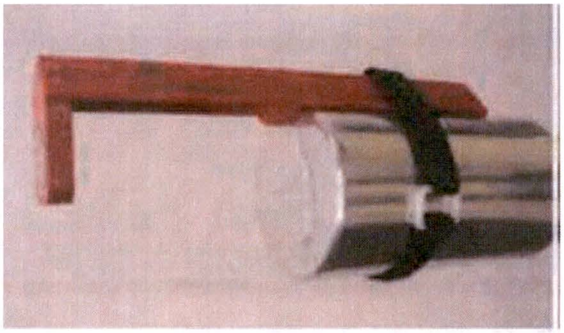


Figure 6- 1 Position of Check Source and Detector for Base Line Measurements

Three measurements were collected for each detector and its associated check source and the average result for both the 86.5 keV peak (from Eu-155) and the 1274.5 keV peak (from Na-22) is shown in Table 4-1 below.

Table 6- 3 Base Line Measurements for GARDIAN HPGE Detectors

Detector	Source Control Number	86.5 keV Line Activity (cps)	1274.5 keV Line Activity (cps)	Test Date
#1 – 3994	080701 HBS598	30.94	6.27	10/13/14
#2 – 3996	080702 HBS599	28.44	5.81	10/13/14
#3 – 3997	080703 HBS600	27.17	6.09	10/13/14
#4 - 3998	010702 HBS601	36.00	7.17	10/10/14

Quality Control charts have been setup for each detector to monitor the response at both the high and low energy peaks. QC parameters to be monitored include peak centroid for both peaks (to provide validation of the detector energy calibration) and peak activities for both peaks (to provide validation of the detector efficiency calibration).

6.5 Summary/Conclusion

V & V testing has been completed for all four HPGe detectors associated with the GARDIAN-I assay system. Activities at several gamma energies in the range expected at HBPP have shown proper response using each detector's associated ISOCS characterization file. All gamma energies tested were within 10% of the certified source activity for all four detectors and the summed detector response (i.e., indication of the overall system result) was within 6% of source certified activity for each energy and within 2% of the weighted mean activity for Eu-152.

Base line measurements have been collected for the system's detectors to allow future evaluations of detector responses. Quality Control charts have been setup to allow future response testing and comparison to acceptance criteria. The system's HPGe detectors are ready for operation.

7.0 SUMMARY/CONCLUSION

Energy Solution's GARDIAN Mobile Assay System was designed to assay bulk materials targeted for potential beneficial reuse on-site or other similar characterization needs. Specifically, its design and detector locations/orientations were selected to simplify the operation of the system in support of an efficient and reliable means of performing assays of large volumes of material. It combines proven technologies to allow accurate measurements to be taken of materials in a variety of geometries including truck mounted roll-off, 10 yard dump trucks or intermodal type containers. The system is portable and flexible to accommodate a variety of project or field situations. An Engery Solutions GARDIAN Mobile Assay system with 6 detectors is also available at HBPP and has a similiar configuration to the 4 dectetor system described herein.

The calibration method for GARDIAN is well documented and has been validated through evaluation and testing as presented in this document. The effects of gamma energy waste type and density, and container type/geometry are all taken into account by the system's calibration. The reliability of the system has been supported through both a comprehensive vendor V &V of the GARDIAN system software and by empirical measurements of NIST traceable sources and previously assayed waste distributions. As a result of the design and post-development testing, the Energy Solutions GARDIAN Mobile Assay System is considered to be a reliable and an appropriate system for assay and characterization of waste/materials in various containers (including large roll-off, dump trucks or intermodal type containers) prior to reuse or disposal.

8.0 REFERENCES

8.1 EnergySolutions, LLC. TBD-GC-003, Technical Basis for Design, Calibration, and Operation of the GARDIAN Mobile Assay System

8.2 EnergySolutions, LLC. TBD-GC-001, Technical Basis for Design and Calibration of the Duratek Box Assay System

8.3 Model S573/S574 ISOCS/LabSOCS, Validation & Verification Manual

8.4 Model 8573 ISOCS Calibration Software, User's Manual/ Detection System

8.5 MicroShield Version 6.02, Grove Engineering, 2003

8.6 Pre-Operational Validation and Verification Testing of GARDIAN-1 System HPGE Detectors for use at Humboldt Bay Power Plant, 2014

9.0 FIGURES

10.0 ATTACHMENTS

11.0 RECORDS

None

12.0 RESPONSIBLE ORGANIZATION

Site Closure

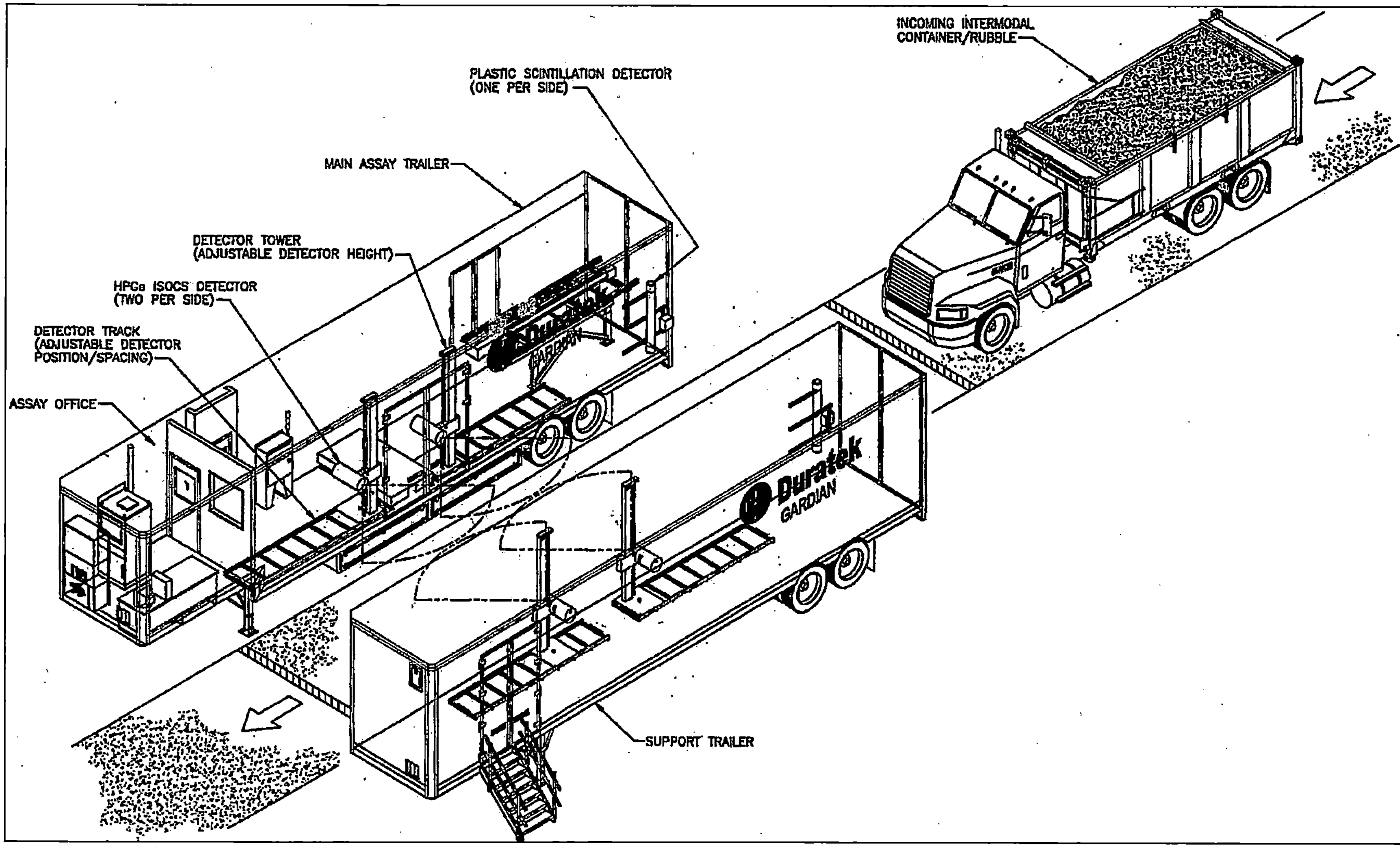


Figure 9- 1 Gardian Mobile Assay System - Large Container Mode

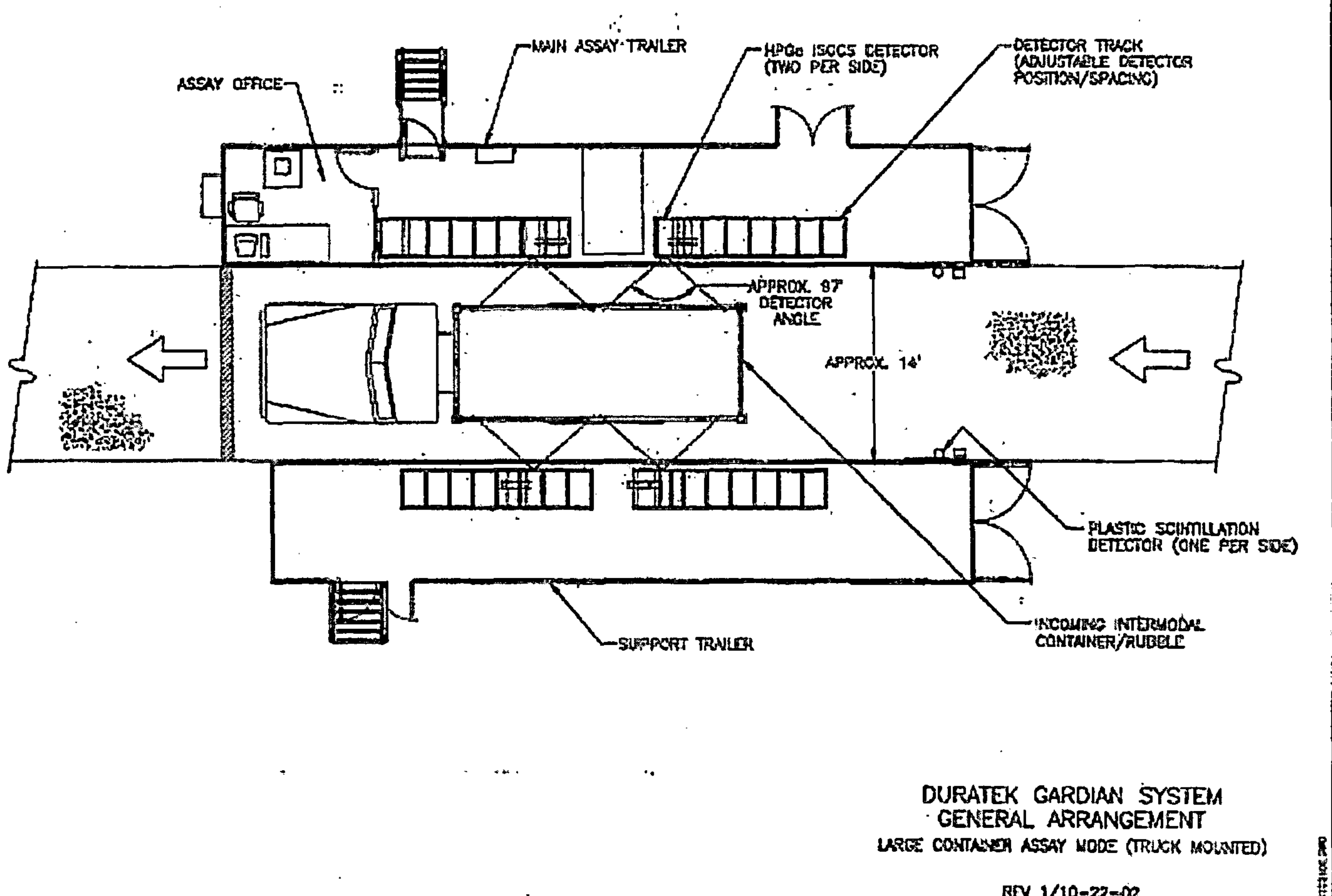


Figure 9- 2 Gardian Mobile Assay System - Top View

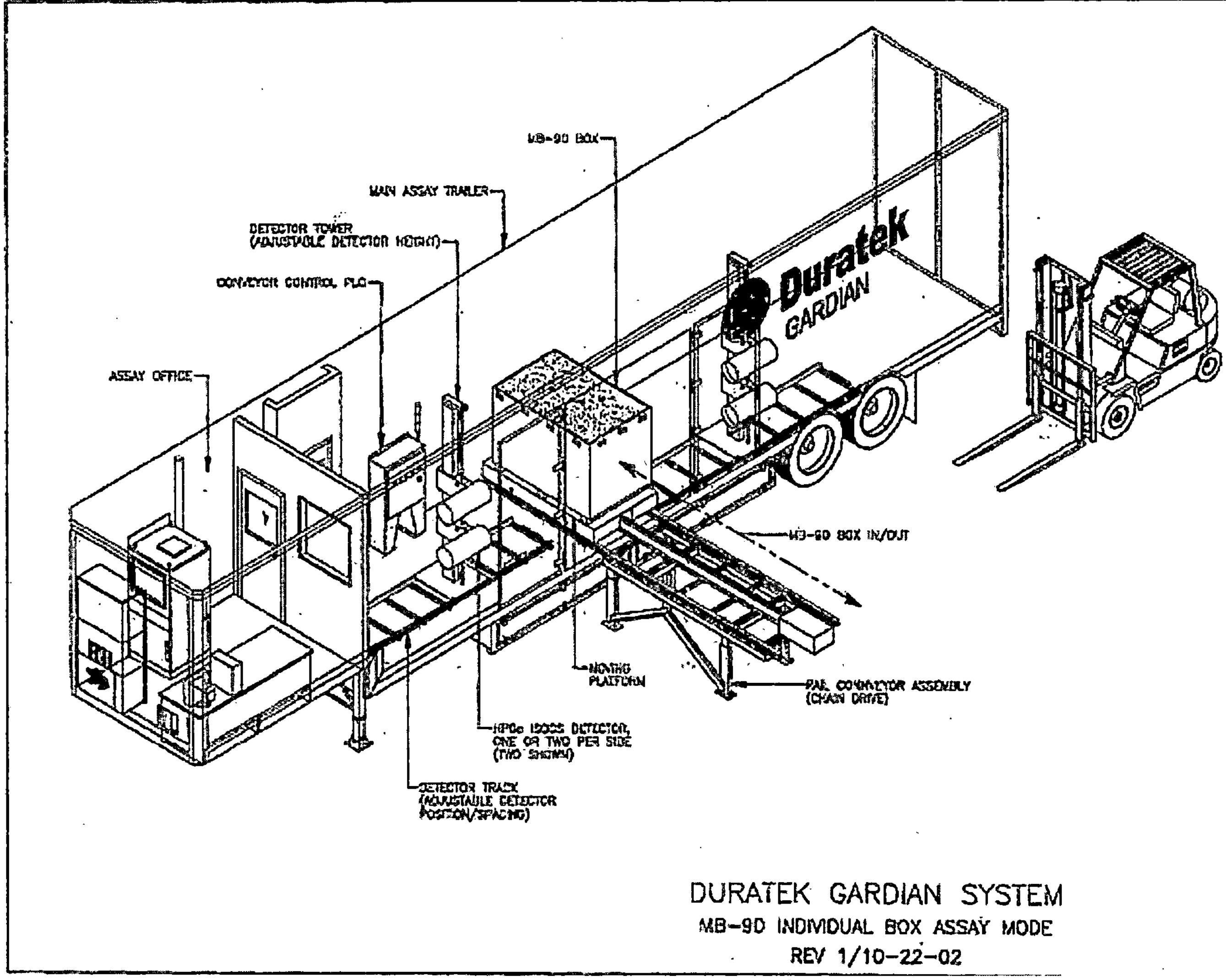


Figure 9- 3 Gardian Mobile Assay System - Box Container Mode

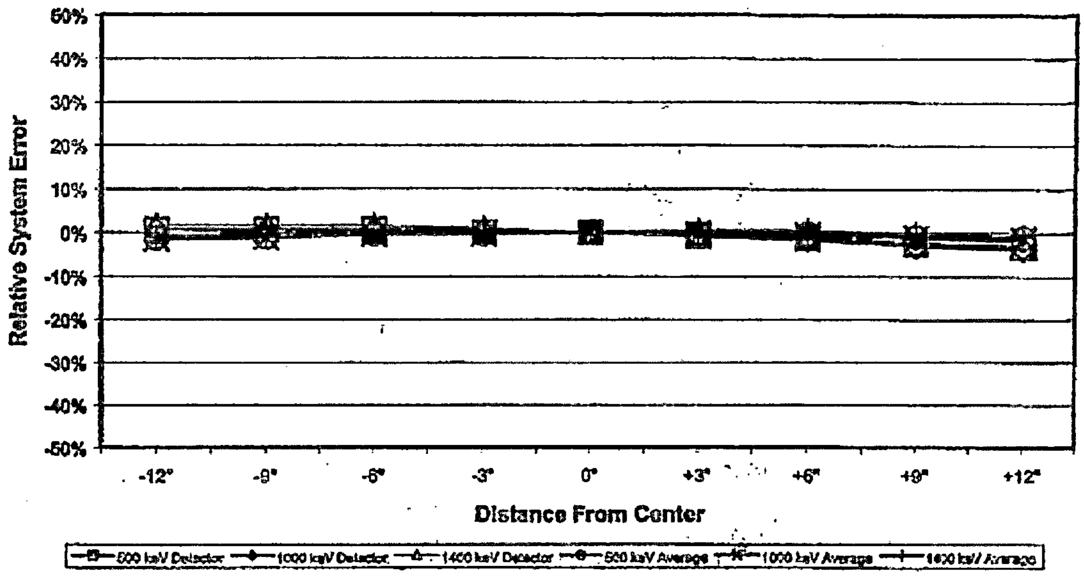


Figure 9.4: Gardian Response versus Longitudinal Placement of Container

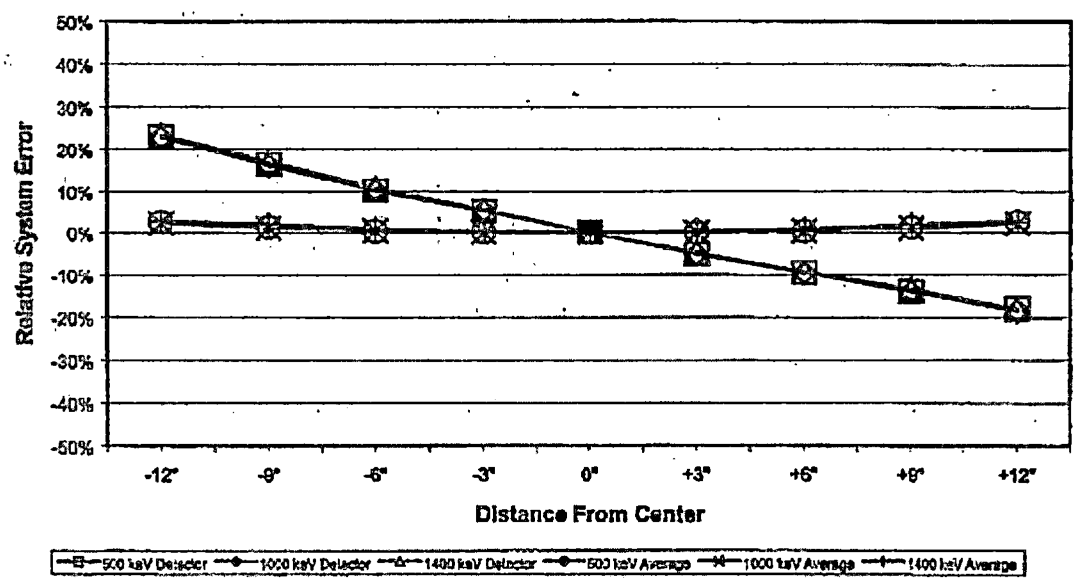


Figure 9.5: Gardian Response versus Lateral Placement of Container

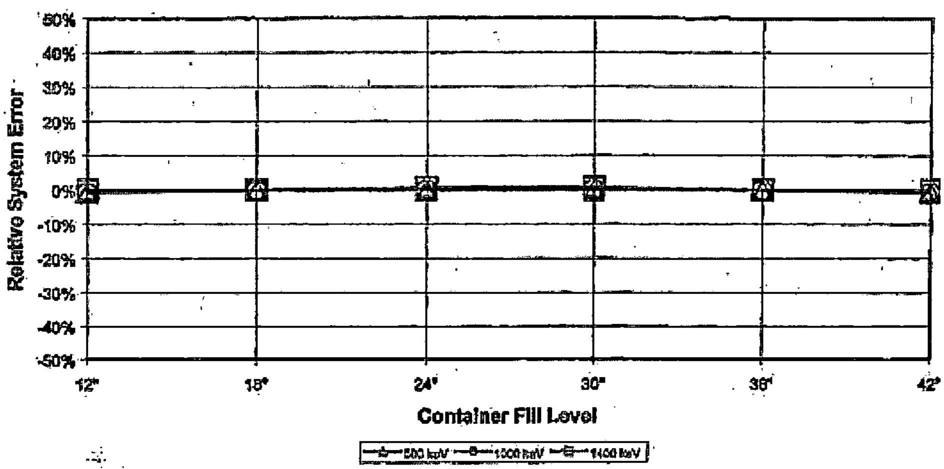


Figure 9.6: Gardian Response versus Container Fill Level

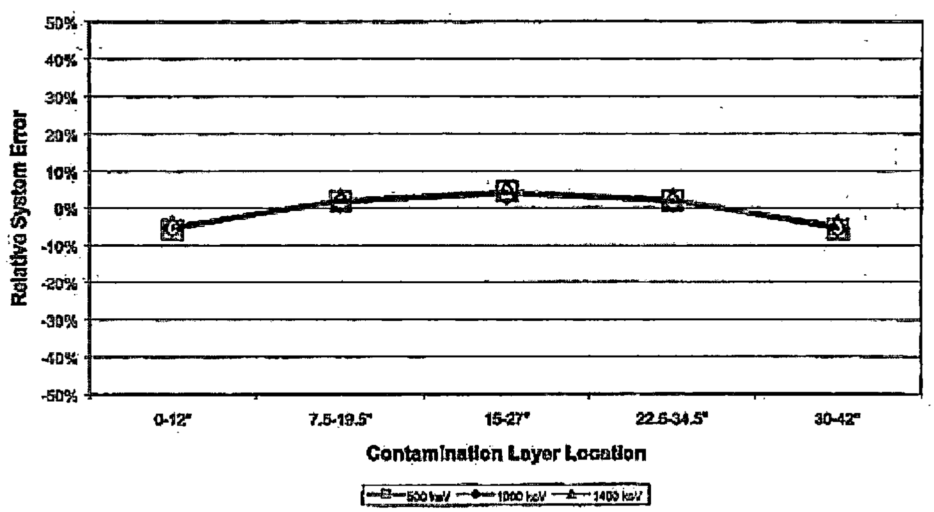


Figure 9.7: Gardian Response versus Layered Contamination

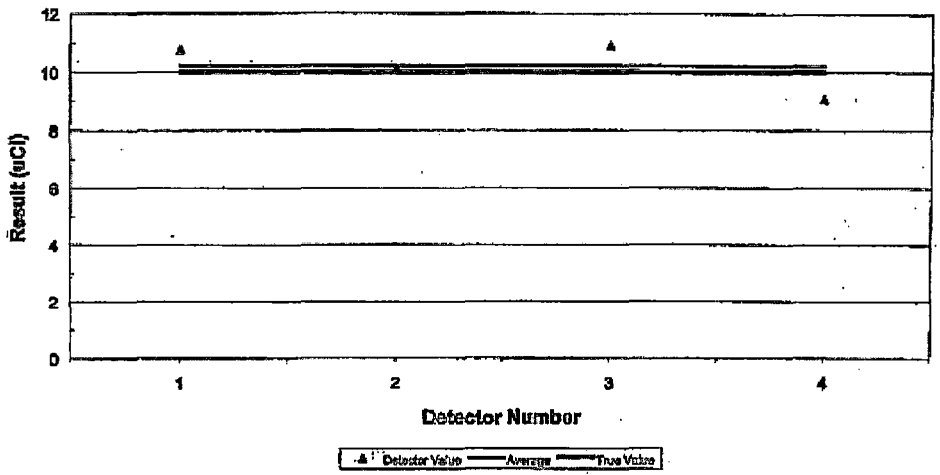


Figure 9.8: Gardian Response to a 10 µCi Cs-137 Button Source

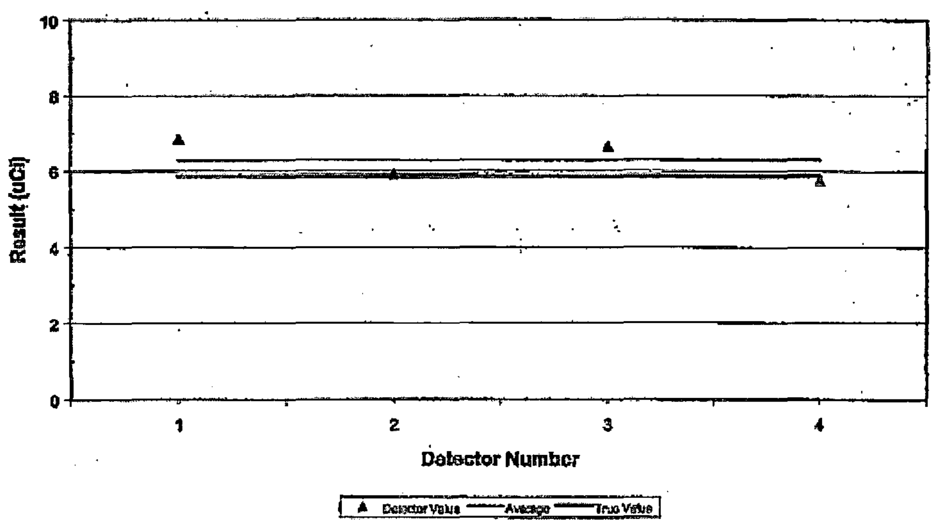


Figure 9.9: Gardian Response to Eu-152 Vial Source

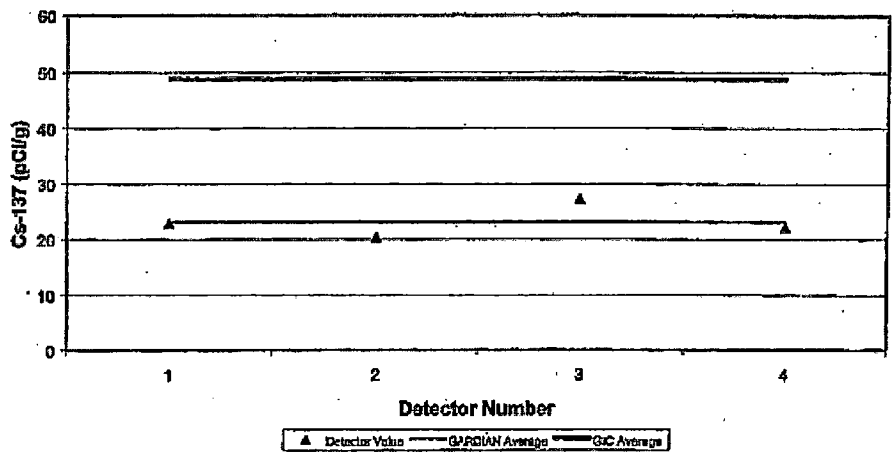


Figure 9.10: Gardian Response versus GIC Assayed Concrete Rubble

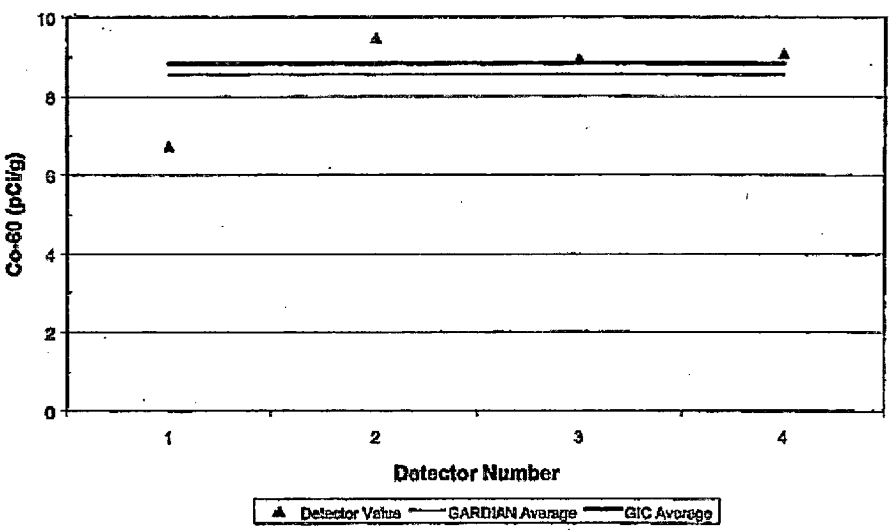


Figure 9.11: Gardian Response versus GIC Assayed DAW

Attachment 10.1
ISOCS Geometry Template Files

GARDIAN SYSTEM
Calibration Records

Energy / FWHM Calibration

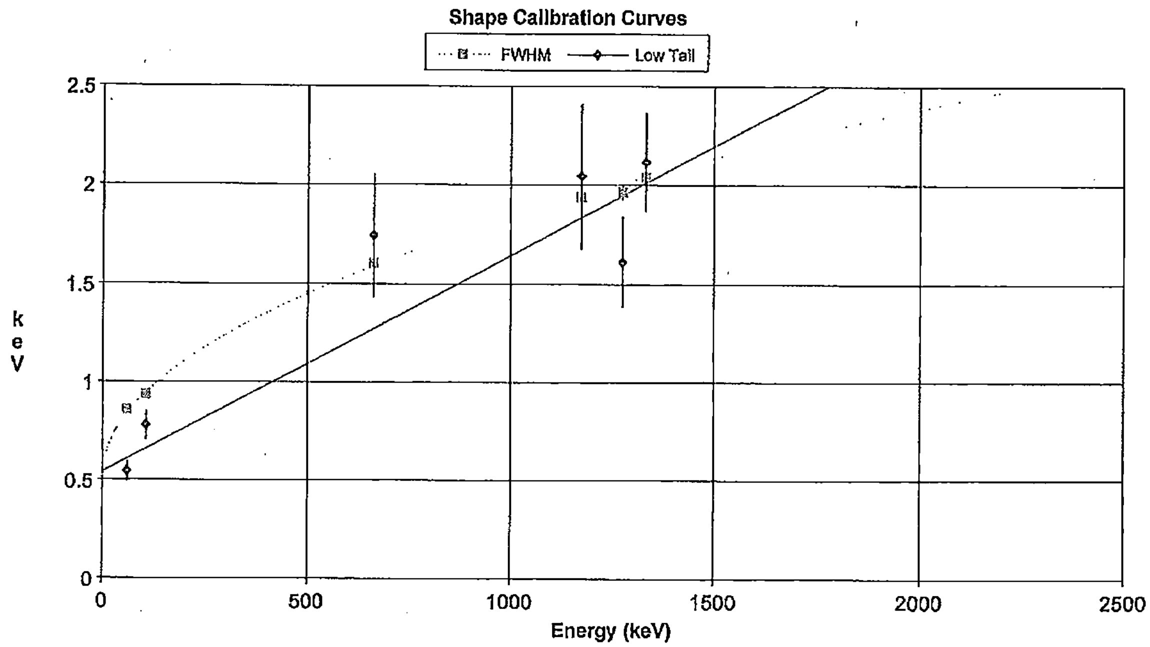
```
****************************************************************************
*****        E N E R G Y   C A L I B R A T I O N   R E P O R T        *****
****************************************************************************

     Detector Name:   DET01
     Sample Title:    Det 01 3994 7000 Sec 111814

       *************  ENERGY CALIBRATION COEFFICIENTS  *************

                Energy Calibrate Performed on:  11/18/2014  3:30:01 AM
                        by:
                Energy Calibrate Type:          POLY

   Energy(keV) =    -0.655 +     0.251*ch + -2.39E-007*ch^2 +  1.80E-011*ch^3

       *************  SHAPE CALIBRATION COEFFICIENTS   *************

                Shape Calibrate Performed on:  11/18/2014  3:30:01 AM
                        by:

                FWHM      =     0.515  +   0.042*E^1/2

                LOW TAIL =   5.4E-001 +  1.1E-003*E
```

**************** ENERGY CALIBRATION RESULTS TABLE ****************

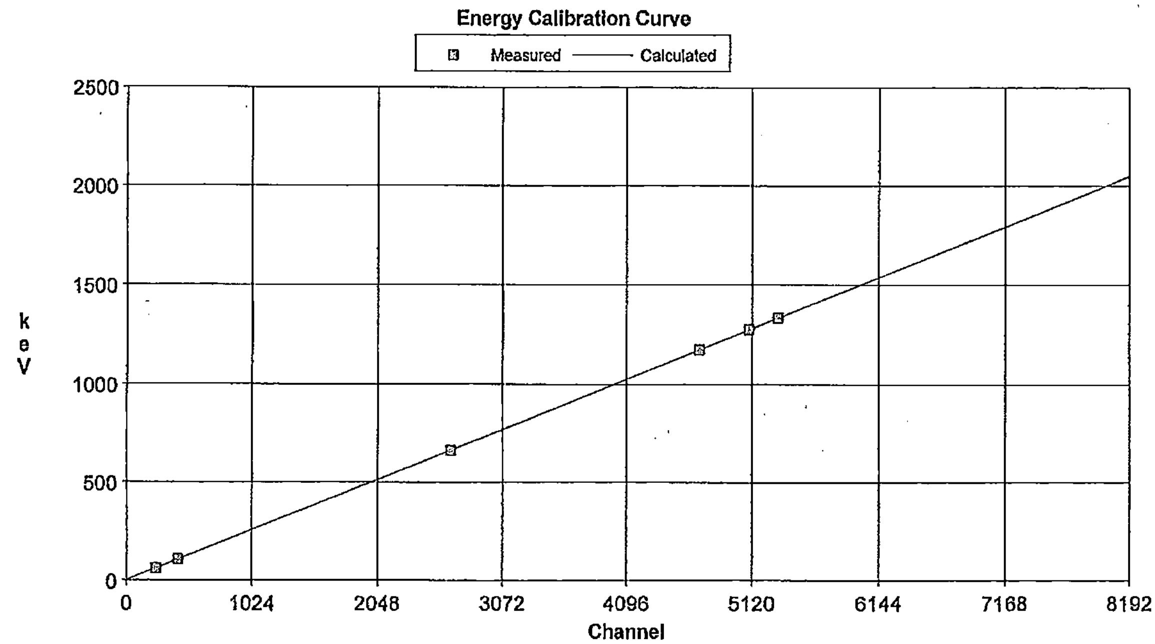
Centroid Channel	Centroid error	Energy (keV)
239.95	0.03	59.54
422.47	0.02	105.31
2644.90	0.02	661.64
4691.98	0.03	1173.21
5097.33	0.07	1274.53
5329.30	0.04	1332.46

********* SHAPE CALIBRATION RESULTS TABLE *********

Energy (keV)	FWHM channels	FWHM error	TAIL channels	TAIL error
59.54	3.42	0.07	2.17	0.20
105.31	3.72	0.04	3.10	0.30
661.64	6.39	0.04	6.95	1.23
1173.21	7.73	0.06	8.15	1.46
1274.53	7.83	0.14	6.43	0.90
1332.46	8.13	0.07	8.43	1.00



Datasource: DET01
Energy = -6.548e-001 keV + 2.509e-001*Ch - 2.387e-007*Ch^2 + 1.804e-011*Ch^3
FWHM = 5.147e-001 keV + 4.179e-002*E^1/2
Lo Tail = 5.411e-001 keV + 1.102e-003*E



Datasource: DET01
Energy = -6.548e-001 keV + 2.509e-001*Ch - 2.387e-007*Ch^2 + 1.804e-011*Ch^3
FWHM = 5.147e-001 keV + 4.179e-002*E^1/2
Lo Tail = 5.411e-001 keV + 1.102e-003*E

Energy Calibration Report 11/18/2014 3:33:45 AM Page 1

****
***** E N E R G Y C A L I B R A T I O N R E P O R T *****
****

Detector Name: DET02
Sample Title: Det02 3996 7000 Sec 111814

************* ENERGY CALIBRATION COEFFICIENTS *************

Energy Calibrate Performed on: 11/18/2014 3:25:48 AM
by:
Energy Calibrate Type: POLY

Energy(keV) = -0.132 + 0.250*ch + 4.82E-008*ch^2 + -1.04E-011*ch^3

************* SHAPE CALIBRATION COEFFICIENTS *************

Shape Calibrate Performed on: 11/18/2014 3:25:48 AM
by:

FWHM = -0.020 + 0.083*E^1/2

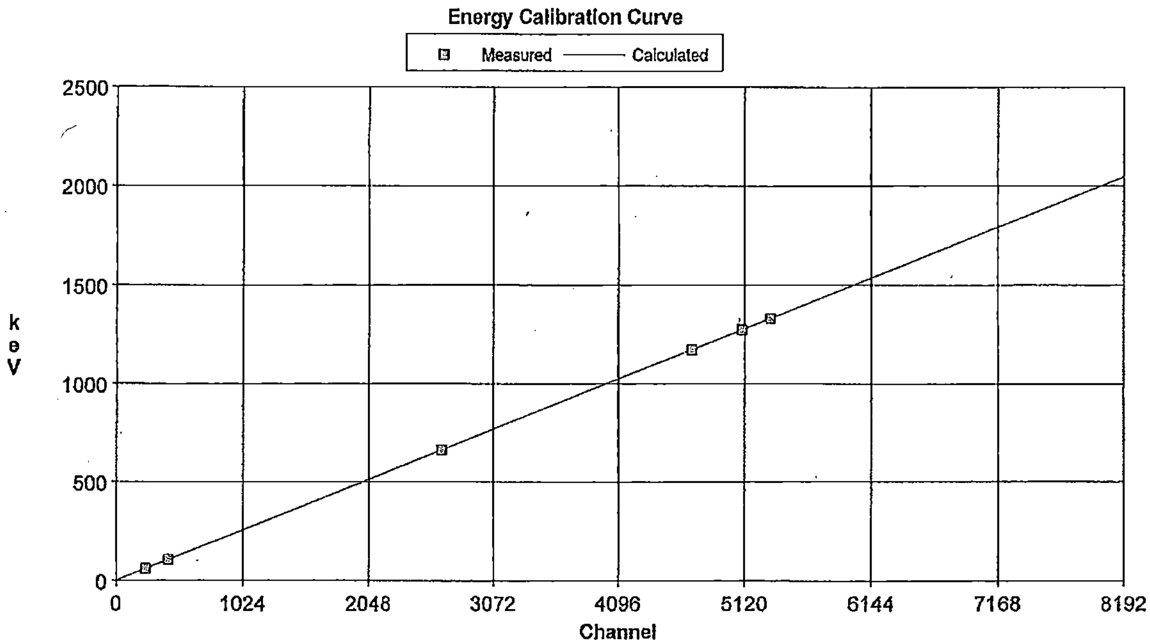
LOW TAIL = 4.2E-001 + 1.2E-003*E

**************** ENERGY CALIBRATION RESULTS TABLE ****************

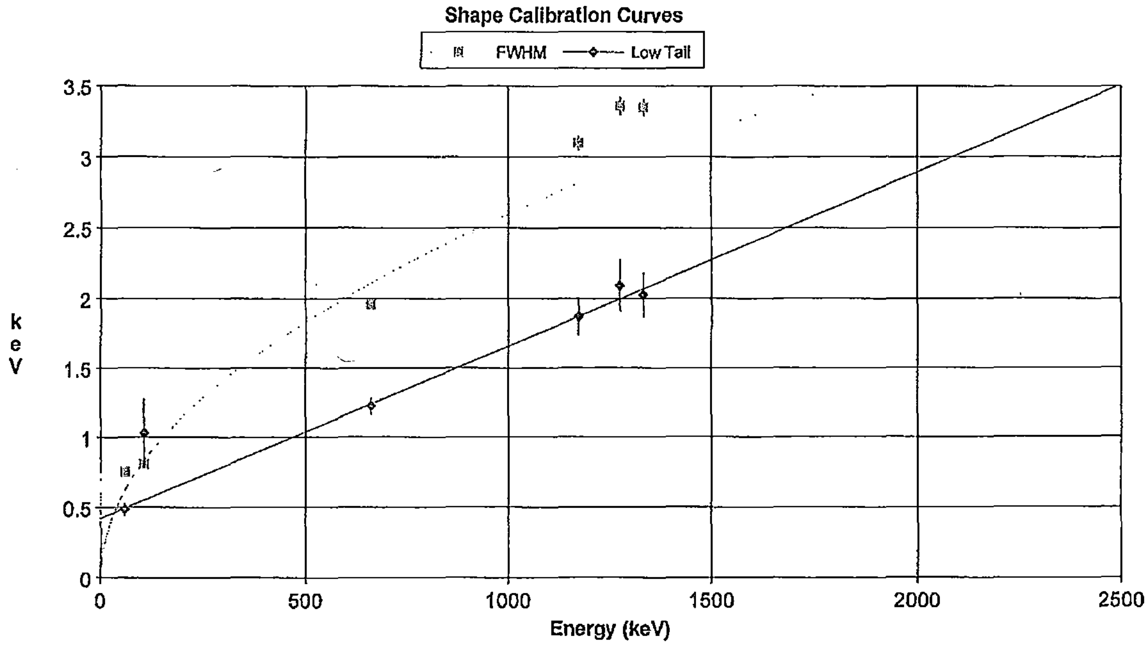
Centroid Channel	Centroid error	Energy (keV)
238.63	0.02	59.54
421.69	0.01	105.31
2646.28	0.04	661.64
4693.23	0.10	1173.21
5098.67	0.13	1274.53
5330.67	0.13	1332.46

********* SHAPE CALIBRATION RESULTS TABLE *********

Energy (keV)	FWHM channels	FWHM error	TAIL channels	TAIL error
59.54	3.00	0.05	1.93	0.17
105.31	3.23	0.02	4.12	1.00
661.64	7.82	0.08	4.90	0.24
1173.21	12.39	0.20	7.48	0.54
1274.53	13.43	0.25	8.37	0.73
1332.46	13.39	0.24	8.11	0.64



Datasource: DET02
Energy = -1.317e-001 keV + 2.500e-001*Ch + 4.820e-008*Ch^2 - 1.037e-011*Ch^3
FWHM = -1.951e-002 keV + 8.270e-002*E^1/2
Lo Tail = 4.190e-001 keV + 1.237e-003*E



Datasource: DET02
Energy = -1.317e-001 keV + 2.500e-001*Ch + 4.820e-008*Ch^2 - 1.037e-011*Ch^3
FWHM = -1.951e-002 keV + 8.270e-002*E^1/2
Lo Tail = 4.190e-001 keV + 1.237e-003*E

Energy Calibration Report 11/12/2014 3:05:27 PM Page 1

****

***** E N E R G Y   C A L I B R A T I O N   R E P O R T *****

****

Detector Name: DET03
Sample Title: Det03_3997_7000_11114

************* ENERGY CALIBRATION COEFFICIENTS *************

Energy Calibrate Performed on: 11/12/2014 3:03:41 PM
by:
Energy Calibrate Type: POLY

Energy(keV) = -0.267 + 0.251*ch + -1.58E-007*ch^2 + 9.51E-012*ch^3

************* SHAPE CALIBRATION COEFFICIENTS *************

Shape Calibrate Performed on: 11/12/2014 3:03:41 PM
by:

FWHM = 0.459 + 0.035*E^1/2

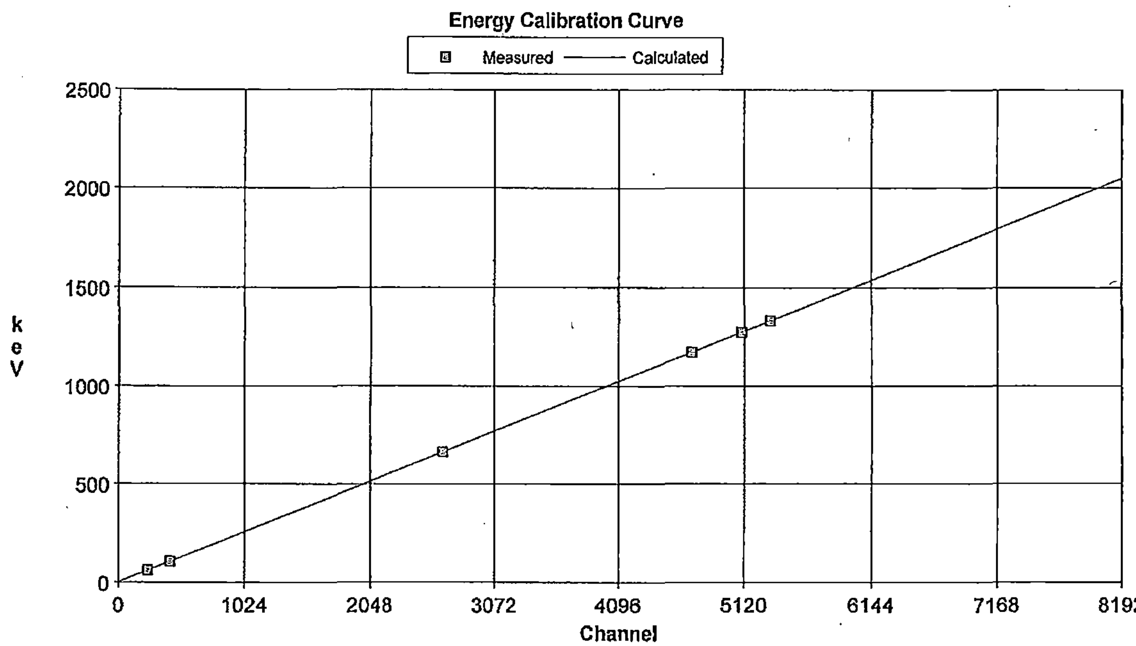
LOW TAIL = 5.7E-001 + 8.5E-004*E

**************** ENERGY CALIBRATION RESULTS TABLE ****************

Centroid Channel	Centroid error	Energy (keV)
238.64	0.02	59.54
421.35	0.01	105.31
2644.68	0.02	661.64
4692.11	0.03	1173.21
5097.67	0.04	1274.53
5329.67	0.02	1332.46

********* SHAPE CALIBRATION RESULTS TABLE *********

Energy (keV)	FWHM channels	FWHM error	TAIL channels	TAIL error
59.54	3.04	0.03	2.15	0.16
105.31	3.22	0.02	15.30	1.00
661.64	5.24	0.03	6.30	1.00
1173.21	6.67	0.06	5.46	0.39
1274.53	6.84	0.08	9.47	1.00
1332.46	7.05	0.05	6.90	0.47



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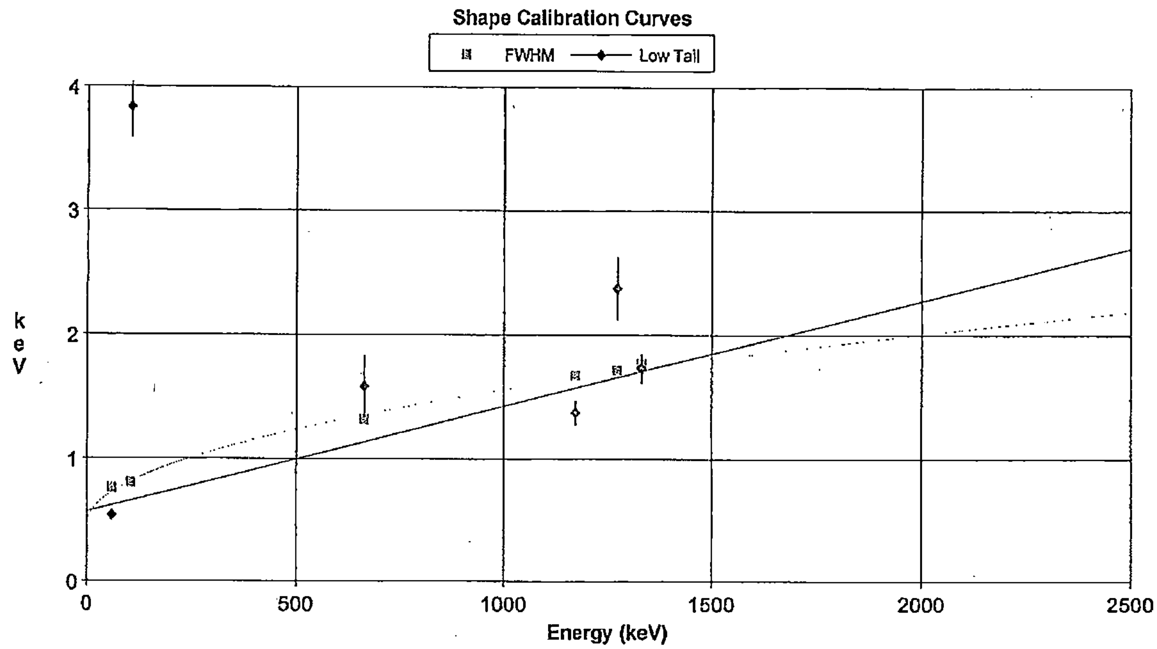
Energy = -2.672e-001 keV + 2.506e-001*Ch - 1.576e-007*Ch^2 + 9.512e-012*Ch^3
FWHM = 4.585e-001 keV + 3.461e-002*E^1/2
Lo Tail = 5.684e-001 keV + 8.527e-004*E



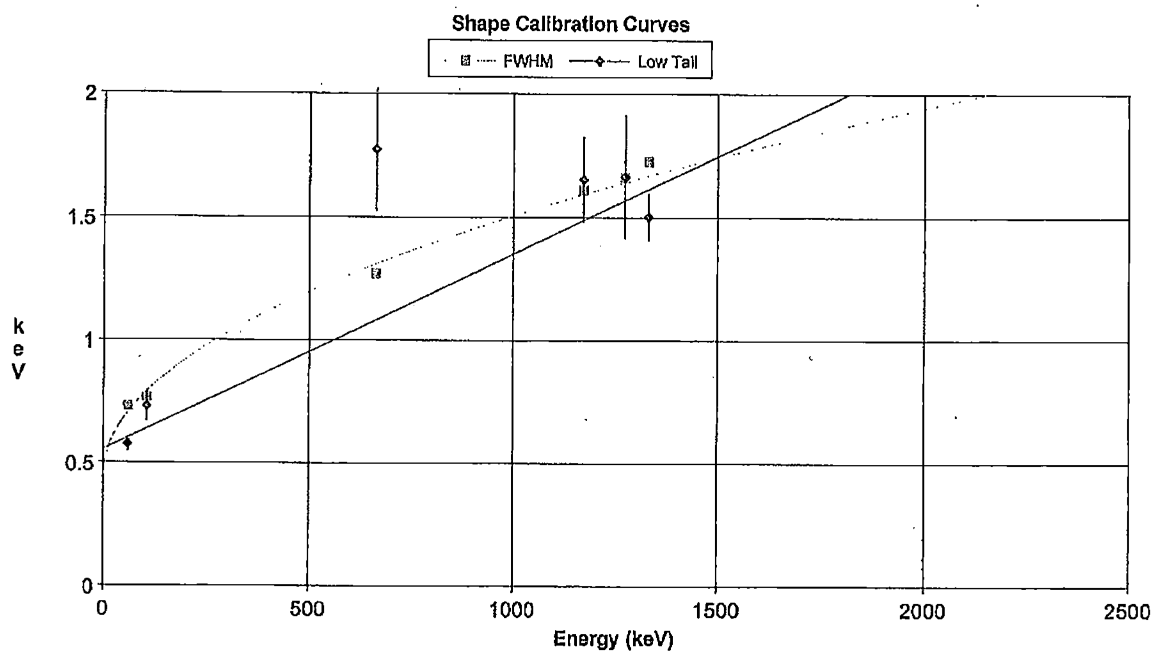
Datasource: C:\GENIE2K\CAMFILES\DET03_3997_70000_111114.CNF
Energy = -2.672e-001 keV + 2.506e-001*Ch - 1.576e-007*Ch^2 + 9.512e-012*Ch^3
FWHM = 4.585e-001 keV + 3.461e-002*E^1/2
Lo Tail = 5.684e-001 keV + 8.527e-004*E

```
Energy Calibration Report              11/12/2014  2:58:43 PM       Page  1

*************************************************************************
*****       E N E R G Y   C A L I B R A T I O N   R E P O R T       *****
*************************************************************************

     Detector Name:  DET04
     Sample Title:   DET04 3998 7000 SEC 111214

       *************  ENERGY CALIBRATION COEFFICIENTS  *************

                 Energy Calibrate Performed on:  11/12/2014  2:56:55 PM
                         by:
                 Energy Calibrate Type:           POLY

   Energy(keV) =    -0.148 +     0.250*ch + -1.62E-008*ch^2 + -3.25E-013*ch^3

       *************  SHAPE CALIBRATION COEFFICIENTS   *************

                 Shape Calibrate Performed on:  11/12/2014  2:56:55 PM
                         by:

                 FWHM      =      0.445  +   0.034*E^1/2

                 LOW TAIL =   5.5E-001 +  8.0E-004*E

****************      ENERGY CALIBRATION RESULTS TABLE      ****************
```

Centroid Channel	Centroid error	Energy (keV)
238.58	0.01	59.54
421.57	0.01	105.31
2645.92	0.02	661.64
4692.02	0.03	1173.21
5097.32	0.05	1274.53
5329.05	0.03	1332.46

```
       *********      SHAPE CALIBRATION RESULTS TABLE      *********
```

Energy (keV)	FWHM channels	FWHM error	TAIL channels	TAIL error
59.54	2.92	0.02	2.30	0.12
105.31	3.05	0.02	2.92	0.25
661.64	5.07	0.04	7.09	1.00
1173.21	6.44	0.05	6.61	0.69
1274.53	6.64	0.09	6.66	1.00
1332.46	6.90	0.06	6.00	0.38



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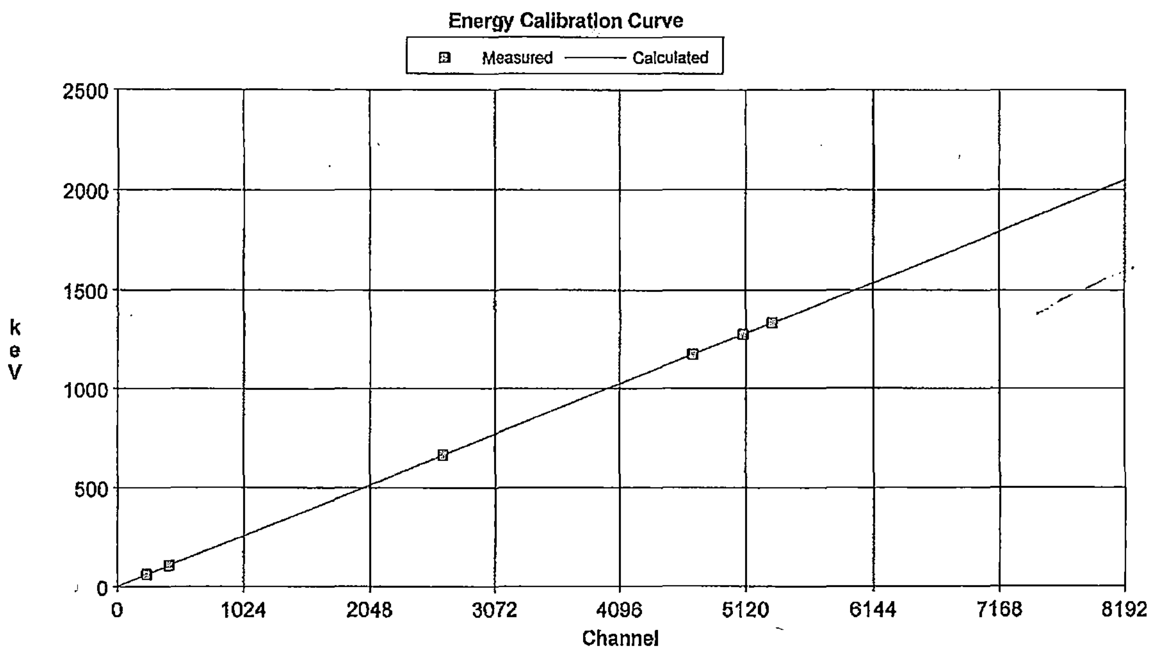
Energy = -1.476e-001 keV + 2.502e-001*Ch - 1.618e-008*Ch^2 - 3.251e-013*Ch^3
FWHM = 4.451e-001 keV + 3.354e-002*E^1/2
Lo Tail = 5.530e-001 keV + 7.967e-004*E



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FWHM = 4.451e-001 keV + 3.354e-002*E^1/2
Lo Tail = 5.530e-001 keV + 7.967e-004*E

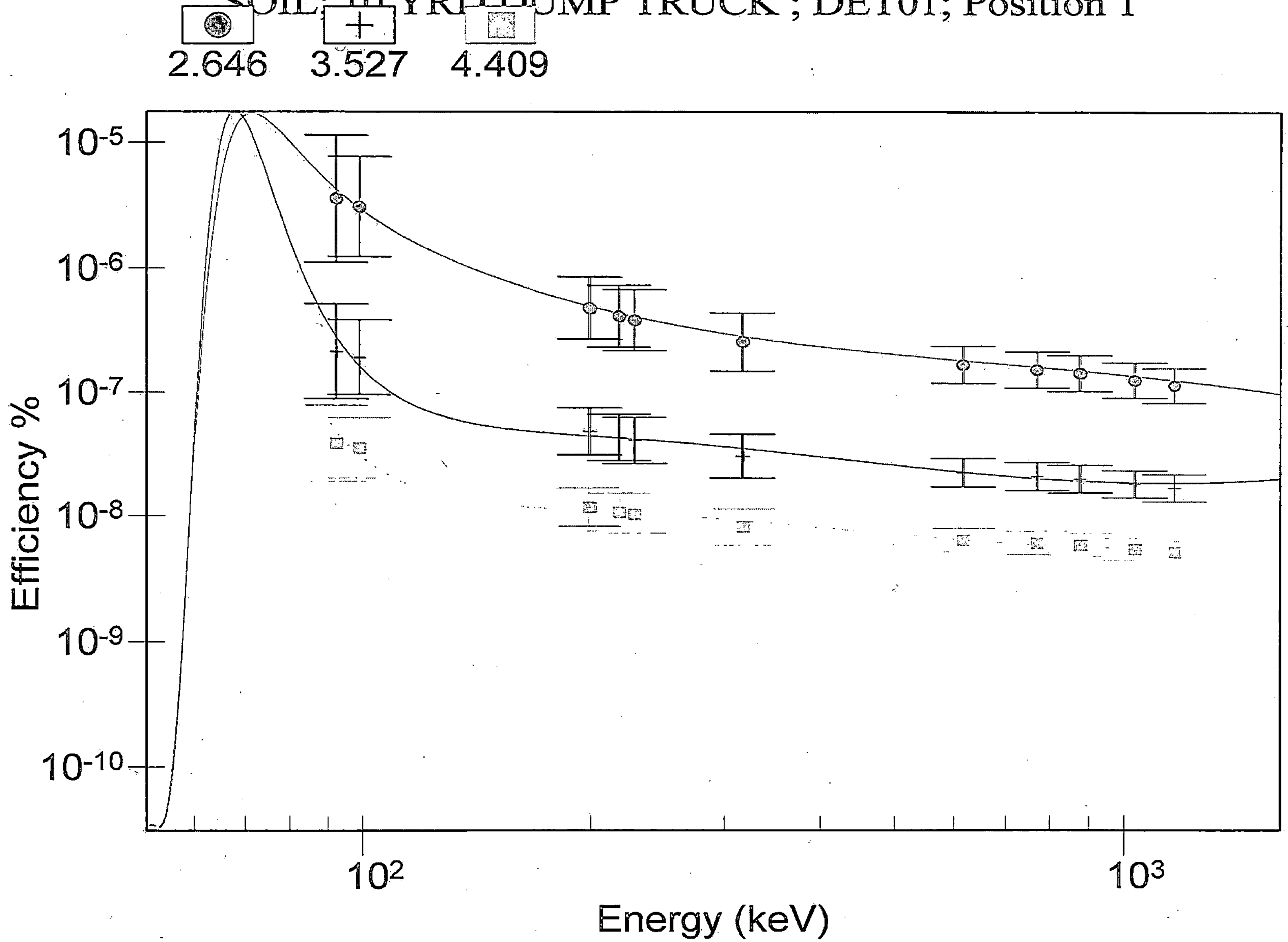
Attachment 10.2
ISOCS Efficiency Curve Reports

GARDIAN SYSTEM
Calibration Records
10 Yard End Dump

Summations

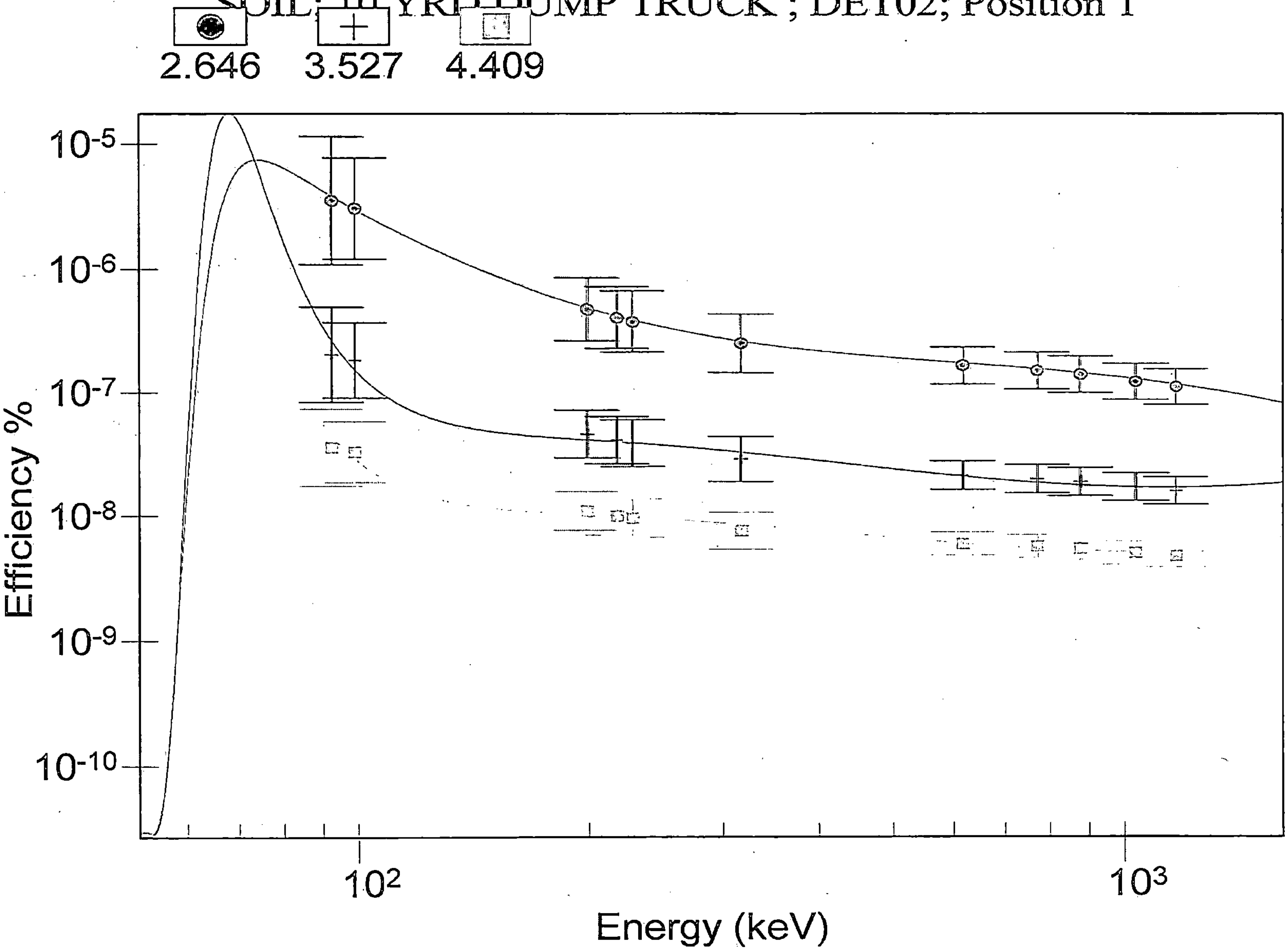
10 Yard End Dump 11/19/14 11/18/2014 10:05:58 PM

SOIL; 10 YRD DUMP TRUCK ; DET01; Position 1



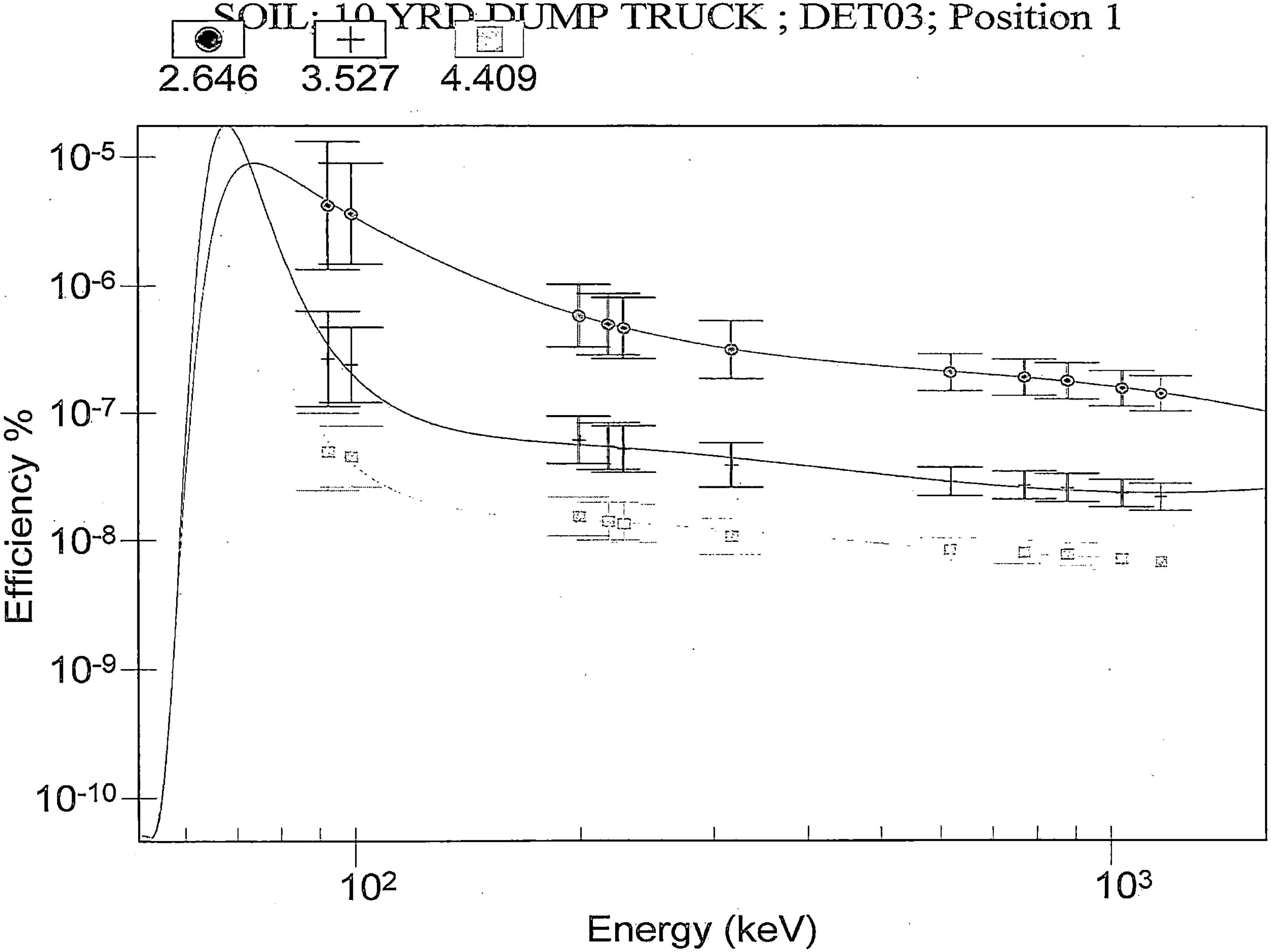
10 Yard End Dump 11/19/14 11/18/2014 10:06:57 PM

SOIL; 10 YRD DUMP TRUCK ; DET02; Position 1



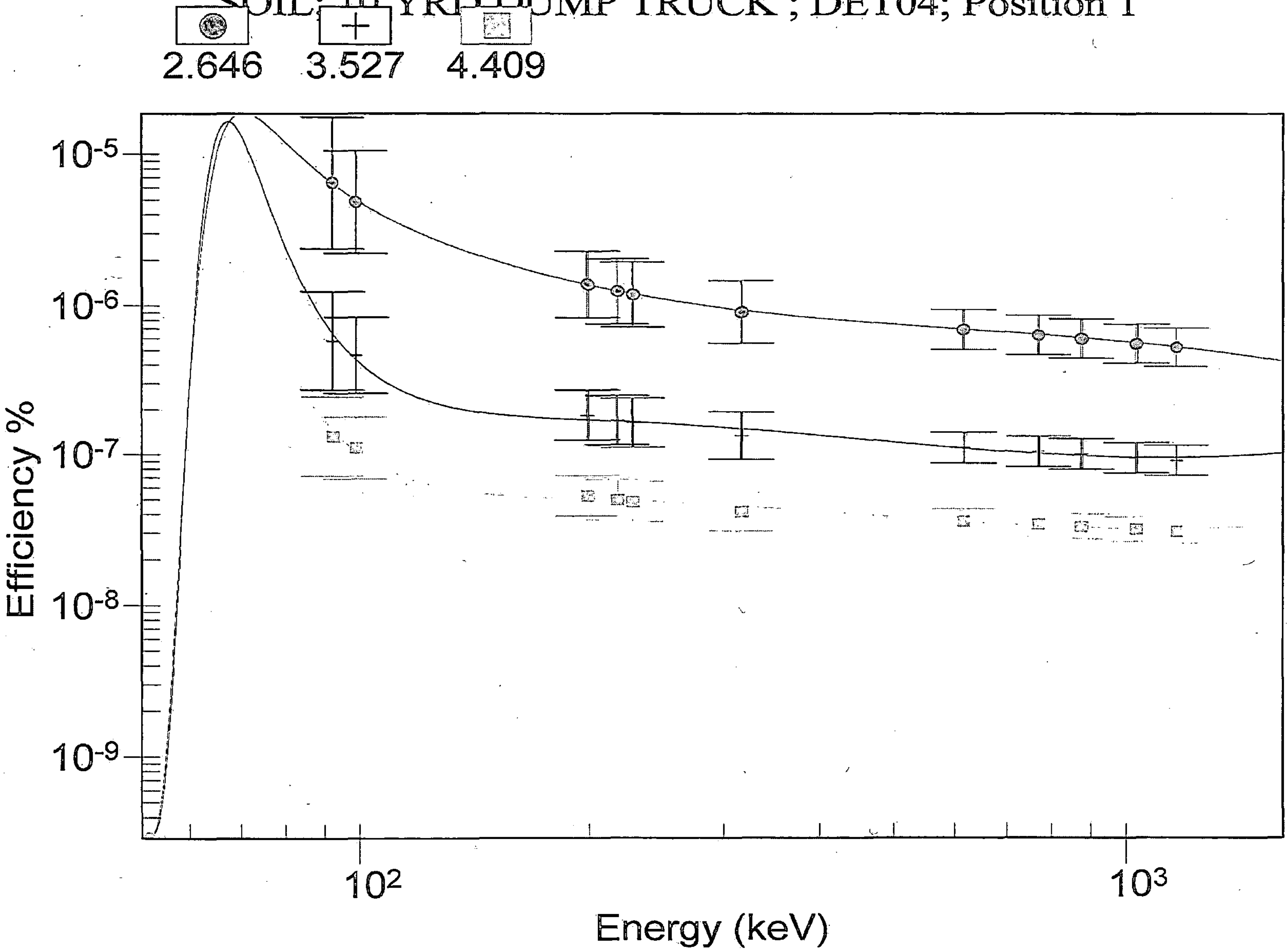
10 Yard End Dump 11/19/14 11/18/2014 10:07:44 PM

SOIL; 10 YRD DUMP TRUCK ; DET03; Position 1



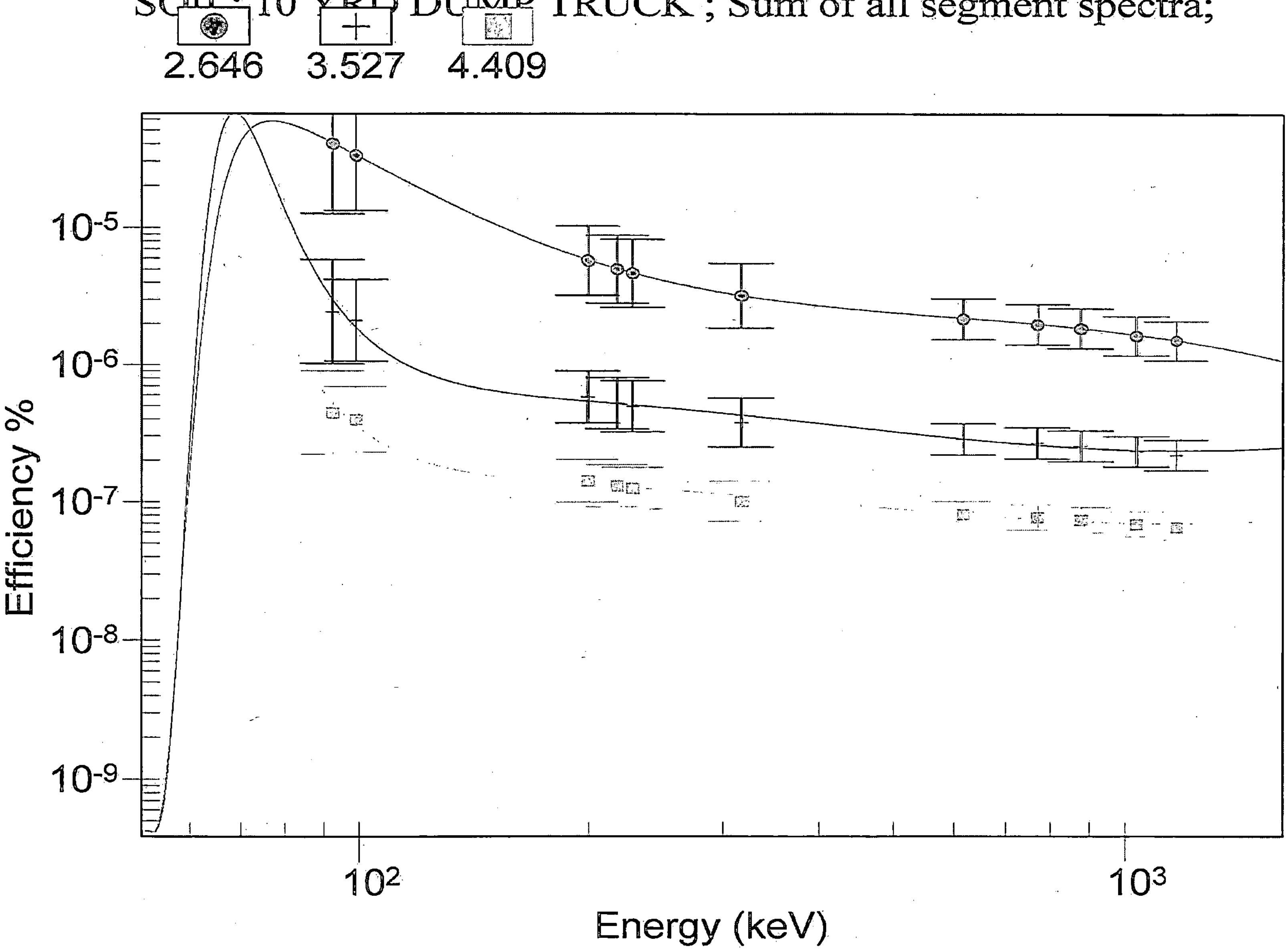
10 Yard End Dump 11/19/14 11/18/2014 10:08:45 PM

SOIL; 10 YRD DUMP TRUCK ; DET04; Position 1



10 Yard End Dump 11/19/14 11/18/2014 10:09:45 PM

SOIL : 10 YRD DUMP TRUCK ; Sum of all segment spectra;



GARDIAN SYSTEM
Calibration Records
10 Yard End Dump

Attached-

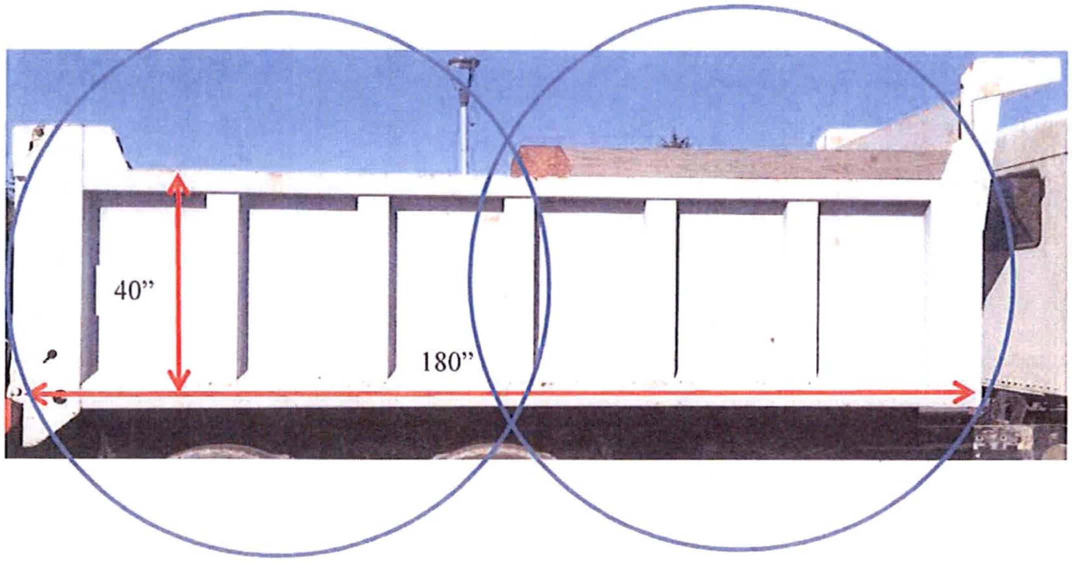
- **10 Yard End Dump Wall Thickness**
- **Gardian Trailer Wall Thickness**
- **End Dump Positioning**
- **Det. 1-4 Density 1.2 models, individual efficiency cals, Summation Cal.**
- **Det. 1-4 Density 1.6 models, individual efficiency cals, Summation Cal.**
- **Det. 1-4 Density 2.0 models, individual efficiency cals, Summation Cal.**
- **Det. 1-4 Sum Curves for Density 1.2, 1.6, & 2.0.**
- **Sum of all Segment Spectra**

Performed by [signature] **Date** 11-19-14

Reviewed by [signature] **Date** 11-20-14

10 Yard End Dump Wall Thickness

(Homogenized)



Each detector is positioned 54" from side of dump truck walls with a 90 degree collimator, giving a Field of View of 108" diameter.

Wall Steel = 3/16" = 0.1875"

108" x 36" = 3888 in^2 at 0.1875" thick

In the field of view,

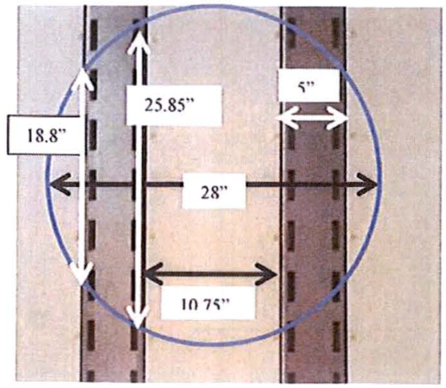
+ 3 Vertical Rails 6" x 35" = 630 in^2
+ 1 Lower support beam 98" x 6" = 588 in^2
+ 1 End Rails 36" x 10" = 360 in^2

Top 98" x 4" support beam not included, sample matrix is expected to be 4" below top.

Total Area = 3888+630+588+360 = 5466 in^2

Effective Thickness = 5466/3888 x 0.1875" thickness = **0.26" Steel**

Energy Solutions Main Trailer Wall



Steel Channel flattened = 7"

Detector is positioned 14" behind the outside wall of the Main Trailer. Utilizing a 90 degree collimator will give a 28" diameter Field of View. Worst case positioning will place the detector between two of the channels, thus including both in the field of view. The channels also contain 0.5" by 2 3/8" rectangular holes which will not subtracted from the steel area thus being more conservative.

<u>Material area</u>

Total area of the field of view: $A = \pi r^2 = \pi 14^2$ = 615.75 in^2.

Area of flattened steel channel: (7" x 18.8") + (1/2 7" x 3.525" x 2ends) x 2channels =312.55 in^2.

Area of PVC: 615.75 in^2 – 312.55 in^2 = 303.20 in^2.

Area of trailer skin: 615.75 in^2.

<u>Effective Thickness</u>

PVC = 1/16"thick x (303.2/615.75) = 0.031"

Steel = 1/16" thick x (312.55/615.75) = 0.032"

Al Skin = 1/16" thick x 615.75/615.75) = 0.063"

<u>Homogenized Wall Density</u>

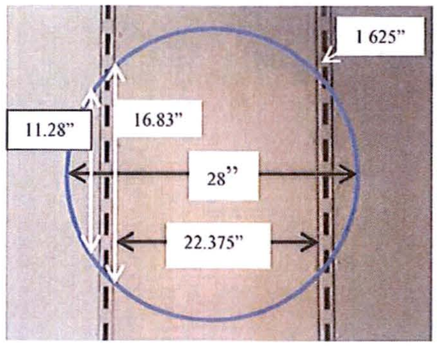
Total Effective wall thickness = 0.031 + 0.032 + 0.063 = 0.126"

Density = 0.031/0.126*1.4g/cc PVC + 0.032/0.126*7.86g/cc steel + 0.063/0.126*2.7g/cc Al = 3.69 g/cc.

Material percentage = 0.344/3.69 = 9% PVC, 2.00/3.69=54% Steel, 1.35/3.69= 37% Al.

For Modeling purposes, the Main Trailer Wall (MTWall) (Absorber 1) = 0.126" thick at 3.69 g/cc comprised of 9% PVC, 54% Steel and 37% Al.

Energy Solutions Support Trailer Wall



Steel Channel flattened = 3 5/8"

Detector is positioned 14" behind the outside wall of the Support Trailer. Utilizing a 90 degree collimator will give a 28" diameter Field of View. Worst case positioning will place the detector between two of the channels, thus including both in the field of view. The channels also contain 0.5" by 2 3/8" rectangular holes which will not subtracted from the steel area thus being more conservative.

Material area

Total area of the field of view: $A = \pi r^2 = \pi 14^2 = 615.75$ in^2.

Area of flattened steel channel: (3.625" x 11.28") +(1/2 3.625" x 2.775" x 2ends) x 2channels = 102 in^2.

Area of wood: 615.75 in^2 – 102 in^2 = 513.75 in^2.

Area of trailer skin: 615.75 in^2.

Effective Thickness

Wood = 1/4" thick x (513.75/615.75) = 0.209"

Steel = 1/16" thick x (102/615.75) = 0.010"

Al Skin = 1/16" thick x 615.75/615.75) = 0.063"

Homogenized Wall Density

Total Effective wall thickness = 0.209 + 0.010 + 0.063 = 0.282"

Density = 0.209/0.282*0.75g/cc wood + 0.010/0.282*7.86g/cc steel + 0.063/0.282*2.7g/cc Al = 1.44g/cc.

Material percentage = 0.556/1.44 = 39% wood, 0.279/1.44=19% Steel, 0.603/1.44= 42% Al.

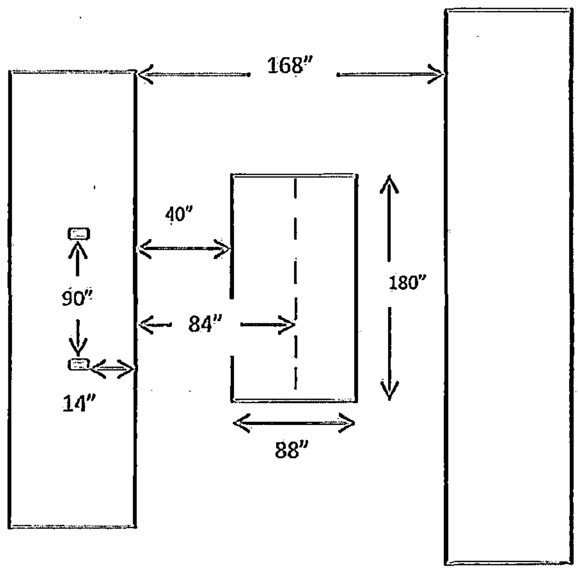
For Modeling purposes, the Support Trailer Wall (STWall) (Absorber 1) = 0.282" thick at 1.44g/cc comprised of 39% wood, 19% Steel and 42% Al.

10 Yard End Dump

With Det ± 45"

54" standoff= FOV 108"

36" overlap



GARDIAN SYSTEM
Calibration Records
10 Yard End Dump

Density 2.0

Geometry Composer Report

CANBERRA

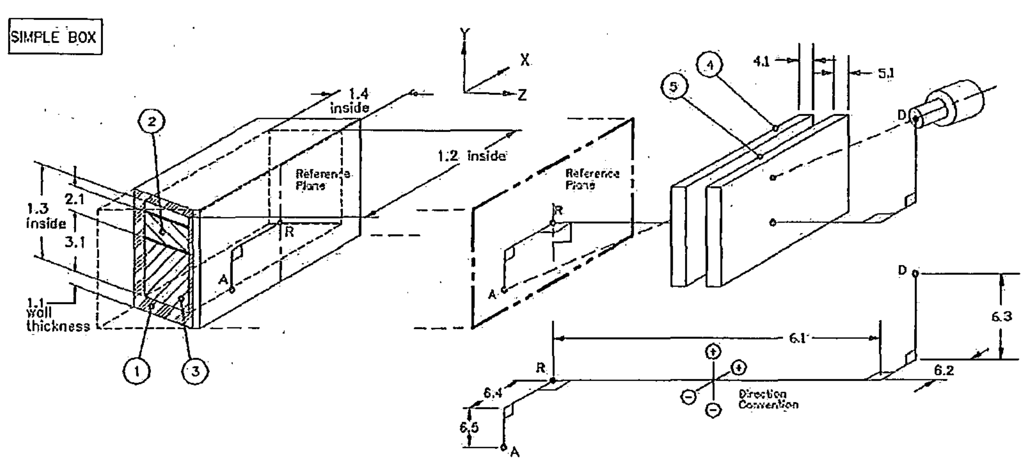
Date: Wednesday, November 19, 2014 - 07:28:29
Description: 10YRD_DET1_D20
Comment: CAL DATE 11_19_14
File Name: E:\SIMPLE_BOX\10YRD_DET1_D20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3994
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 22 °C, Pressure = 760 mm Hg, Relative Humidity = 30%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt3	2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.027559						germanum	5.4	
6	Source-Detector	54	45	0	45	0				

List of energies for efficiency curve generation

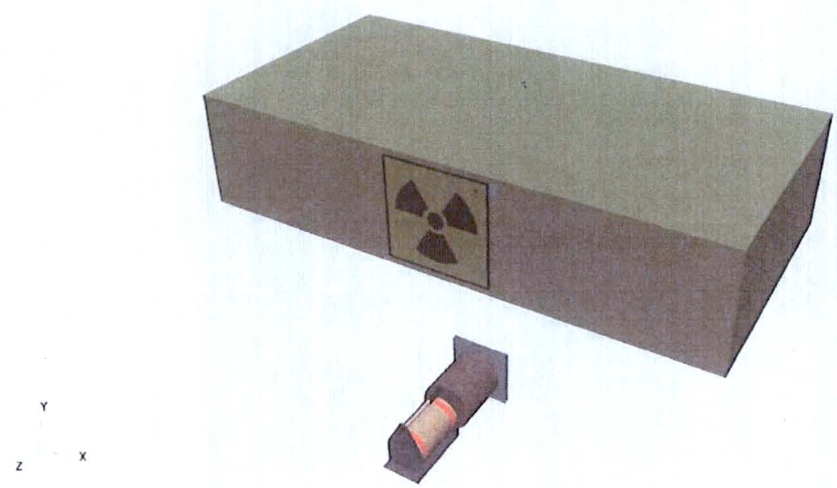
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

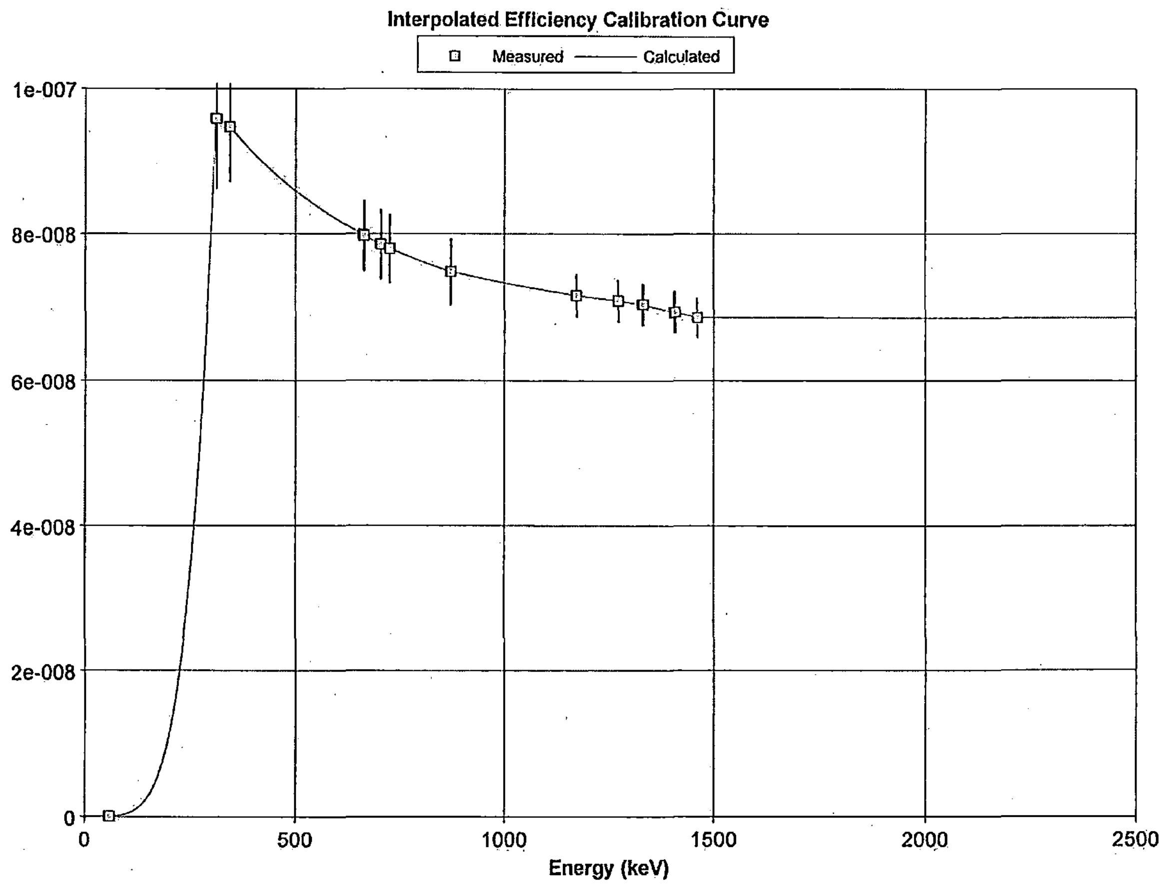
Date:	Wednesday, November 19, 2014 - 07:28:29
Description:	10YRD_DET1_D20
Comment:	CAL DATE 11_19_14
File Name:	E:\SIMPLE_BOX\10YRD_DET1_D20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



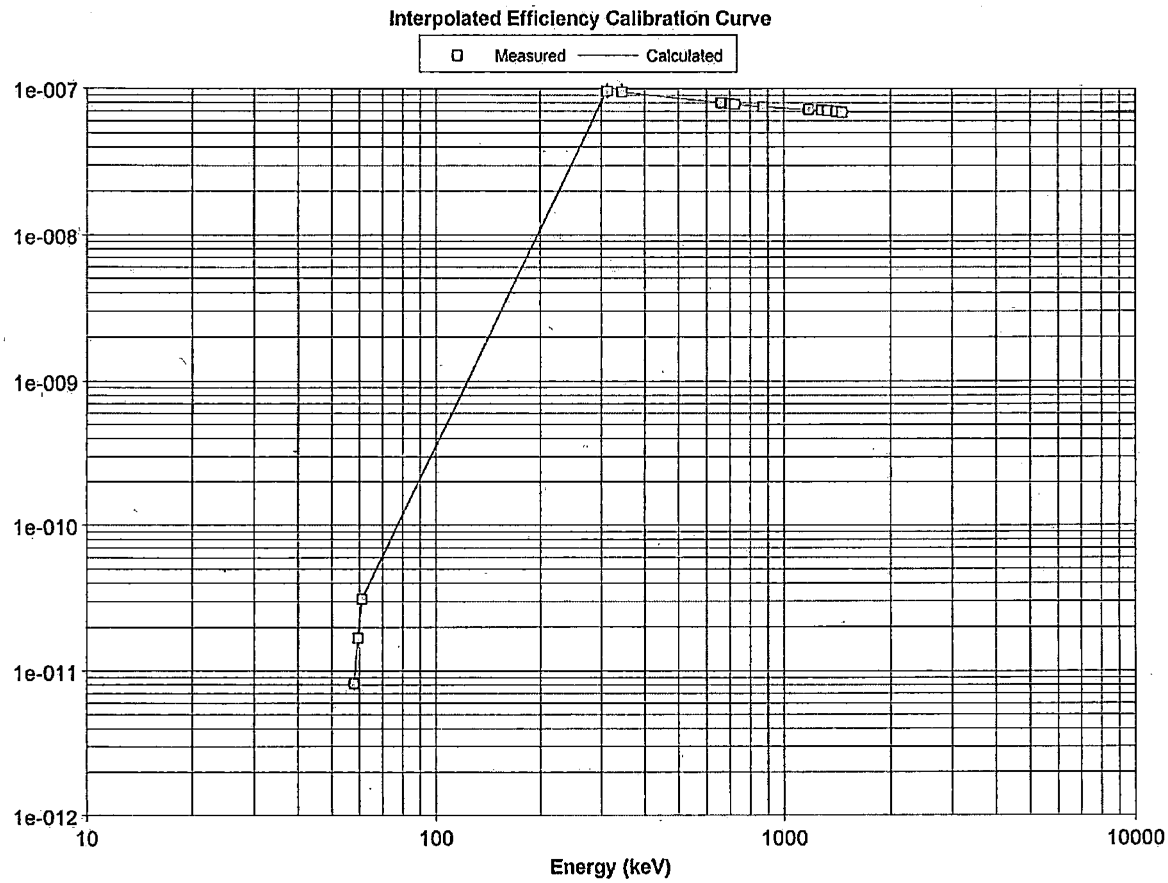
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/18/14 19:06:45
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET1_D20.CAL
Genie Cal Time: 11/18/14 20:04:30
Template: SIMPLE BOX
Geom Description: 10Yard DET1 D20
Comment: ISOCS:CAL_DATE_11_19_14
Detector: 3994
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.8689e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	8.15031e-012	10.0	0.069643	77672
59.54	1.67946e-011	10.0	0.069955	77672
61.00	3.09474e-011	10.0	0.069981	77672
311.00	9.57934e-008	10.0	0.014674	77672
311.98	9.57408e-008	10.0	0.014821	77672
313.00	9.57056e-008	10.0	0.014500	77672
343.00	9.46628e-008	8.0	0.009458	77672
344.27	9.45986e-008	8.0	0.009386	77672
345.00	9.45654e-008	8.0	0.009336	77672
660.00	7.98467e-008	6.0	-0.008603	77672
661.65	7.97217e-008	6.0	-0.008623	77672
663.00	7.96932e-008	6.0	-0.008717	77672
701.00	7.85861e-008	6.0	-0.009200	77672
702.63	7.85016e-008	6.0	-0.009169	77672
703.00	7.85056e-008	6.0	-0.009254	77672
722.00	7.80072e-008	6.0	-0.009190	77672
723.00	7.79657e-008	6.0	-0.009413	77672
724.00	7.79431e-008	6.0	-0.009362	77672
870.00	7.48425e-008	6.0	-0.009585	77672
871.10	7.47975e-008	6.0	-0.009548	77672
872.00	7.48454e-008	6.0	-0.009686	77672
1172.00	7.16231e-008	4.0	-0.008179	77672
1173.22	7.16213e-008	4.0	-0.008190	77672
1174.00	7.15900e-008	4.0	-0.008222	77672
1273.00	7.09065e-008	4.0	-0.007795	77672
1274.45	7.08861e-008	4.0	-0.007726	77672
1275.00	7.08790e-008	4.0	-0.007798	77672
1331.00	7.03723e-008	4.0	-0.007414	77672
1332.49	7.03928e-008	4.0	-0.007369	77672
1334.00	7.03716e-008	4.0	-0.007296	77672
1406.00	6.93281e-008	4.0	-0.006728	77672
1407.95	6.93304e-008	4.0	-0.006837	77672
1409.00	6.93300e-008	4.0	-0.006619	77672
1460.80	6.85815e-008	4.0	-0.006207	77672



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

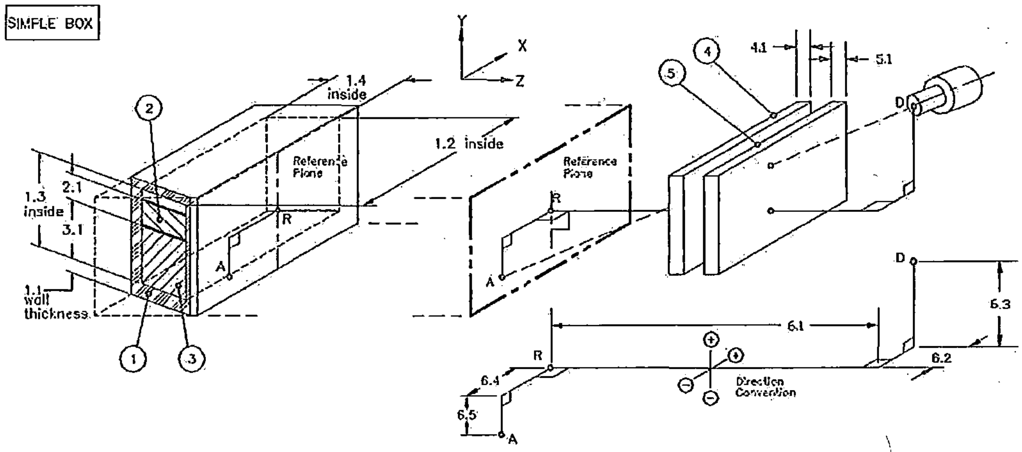
Date: Thursday, November 13, 2014 - 17:04:30
Description: 10YRD_Soil_DET2_D20
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET2_D20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3996
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.0315						germanum	5.4	
6	Source-Detector	54	-45	0	-45	0				

List of energies for efficiency curve generation

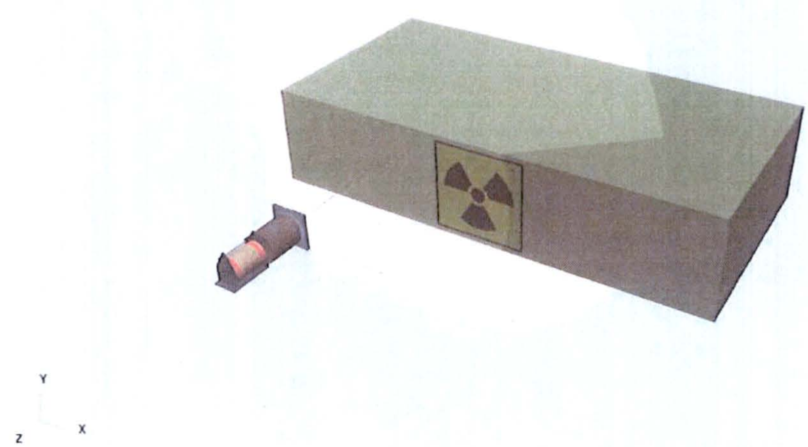
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

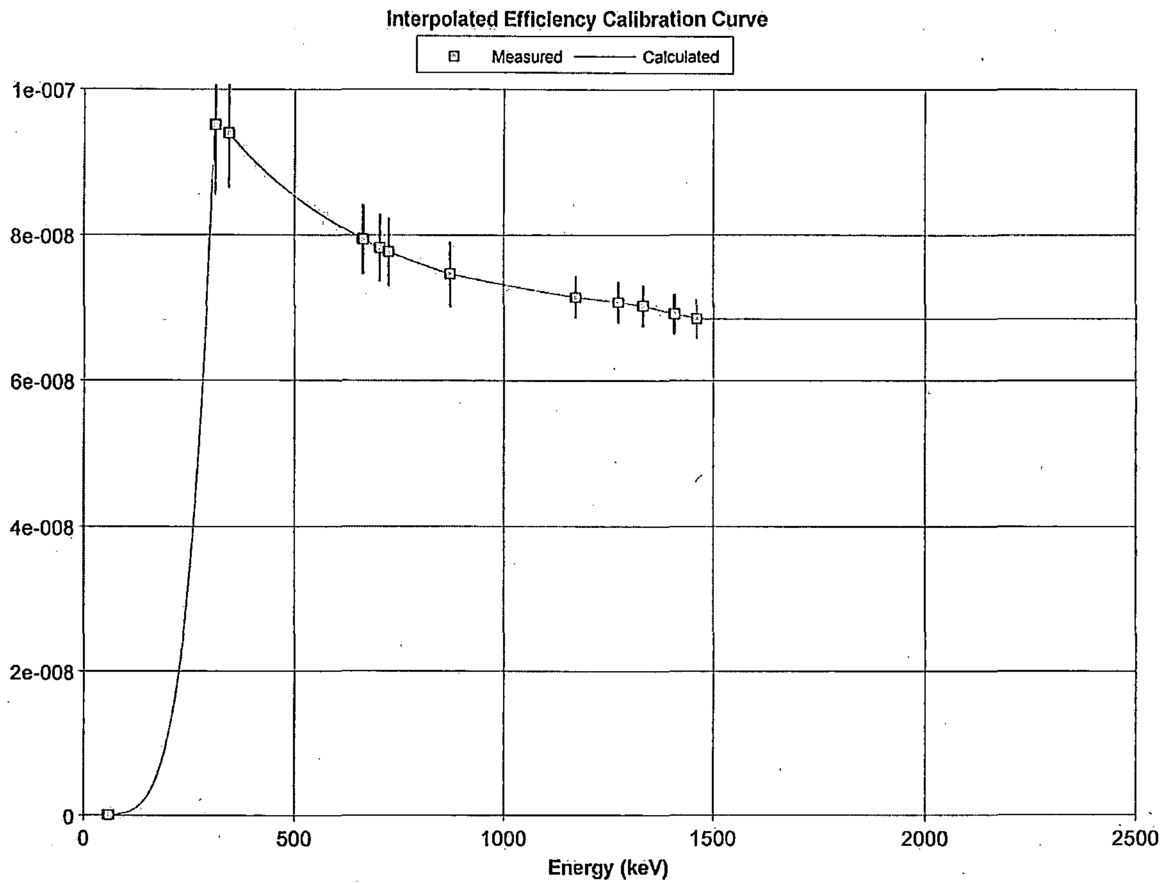
Date:	Thursday, November 13, 2014 - 17:04:30
Description:	10YRD_Soil_DET2_D20
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\10YRD_Soil_DET2_D20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



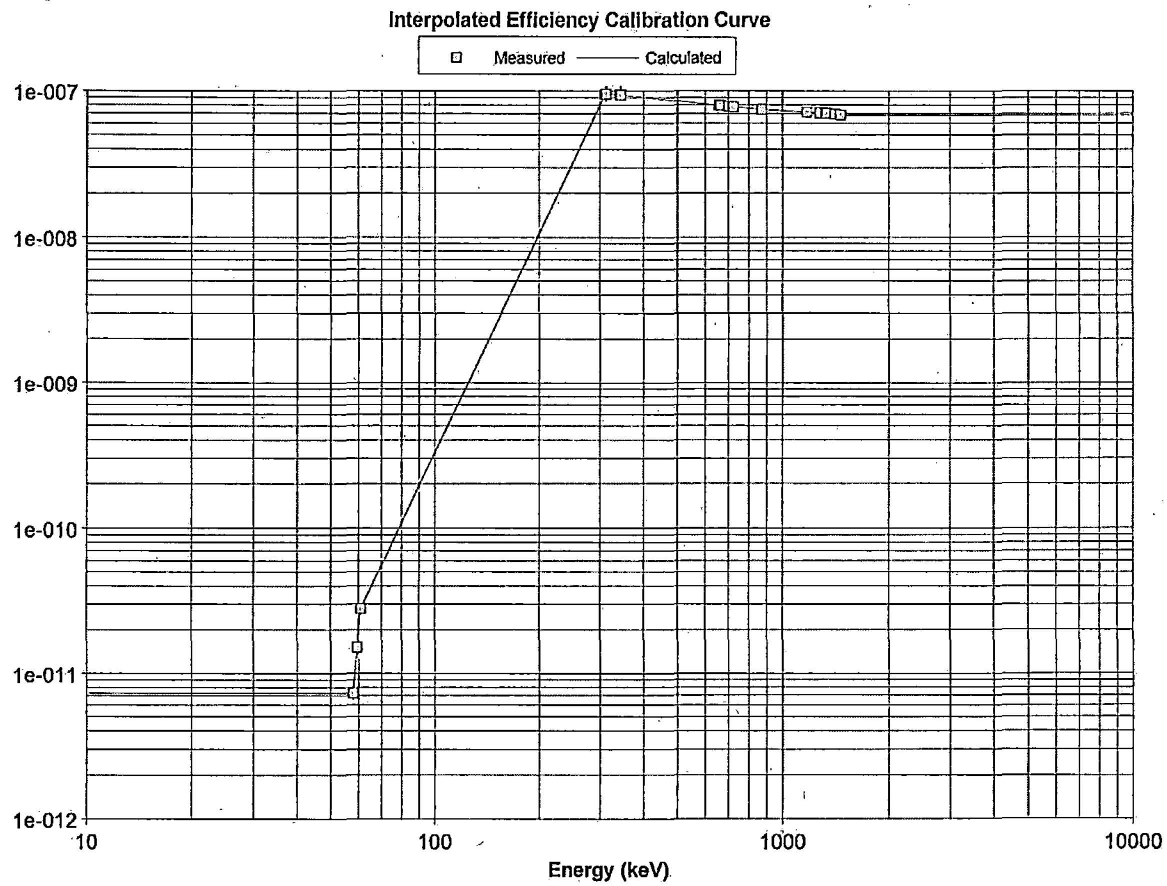
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/13/14 02:38:43
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET2_D20.CAL
Genie Cal Time: 11/13/14 03:41:58
Template: SIMPLE BOX
Geom Description: 10YRD DET2 D20
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3996
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.8689e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	7.23612e-012	10.0	0.072978	77672
59.54	1.50329e-011	10.0	0.073368	77672
61.00	2.78963e-011	10.0	0.073443	77672
311.00	9.51758e-008	10.0	0.027414	77672
311.98	9.51248e-008	10.0	0.027628	77672
313.00	9.50911e-008	10.0	0.027307	77672
343.00	9.40890e-008	8.0	0.022680	77672
344.27	9.40265e-008	8.0	0.022586	77672
345.00	9.39942e-008	8.0	0.022508	77672
660.00	7.95025e-008	6.0	0.007774	77672
661.65	7.93786e-008	6.0	0.007748	77672
663.00	7.93505e-008	6.0	0.007698	77672
701.00	7.82570e-008	6.0	0.007553	77672
702.63	7.81732e-008	6.0	0.007568	77672
703.00	7.81773e-008	6.0	0.007505	77672
722.00	7.76850e-008	6.0	0.007682	77672
723.00	7.76440e-008	6.0	0.007523	77672
724.00	7.76216e-008	6.0	0.007551	77672
870.00	7.45598e-008	6.0	0.008246	77672
871.10	7.45151e-008	6.0	0.008276	77672
872.00	7.45631e-008	6.0	0.008094	77672
1172.00	7.13897e-008	4.0	0.010576	77672
1173.22	7.13880e-008	4.0	0.010581	77672
1174.00	7.13569e-008	4.0	0.010563	77672
1273.00	7.06843e-008	4.0	0.011462	77672
1274.45	7.06641e-008	4.0	0.011537	77672
1275.00	7.06570e-008	4.0	0.011489	77672
1331.00	7.01563e-008	4.0	0.012137	77672
1332.49	7.01769e-008	4.0	0.012209	77672
1334.00	7.01558e-008	4.0	0.012243	77672
1406.00	6.91207e-008	4.0	0.013043	77672
1407.95	6.91232e-008	4.0	0.013002	77672
1409.00	6.91229e-008	4.0	0.013126	77672
1460.80	6.83800e-008	4.0	0.013761	77672



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

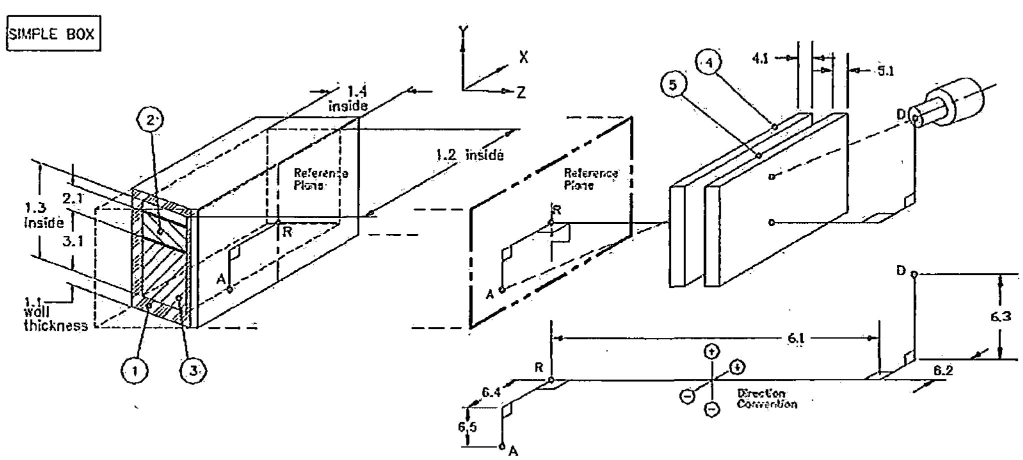
Date: Thursday, November 13, 2014 - 17:05:57
Description: 10YRD_Soil_DET3_D20
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET3_D20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3997
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2	0.03543						germanum	5.4	
6	Source-Detector	54	45	0	45	0				

List of energies for efficiency curve generation

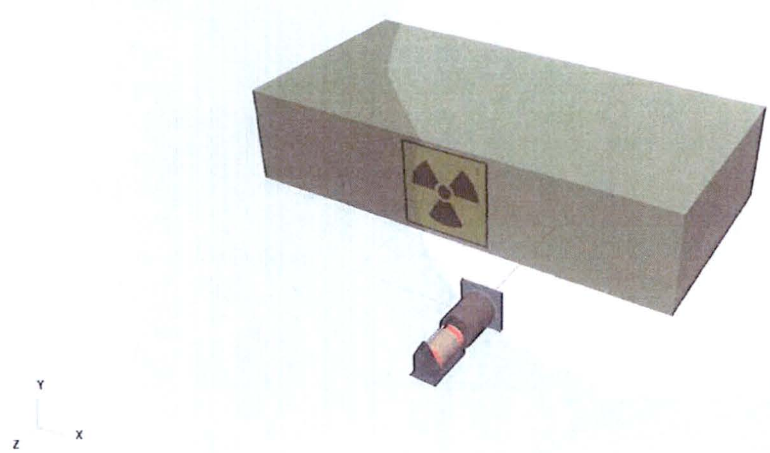
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

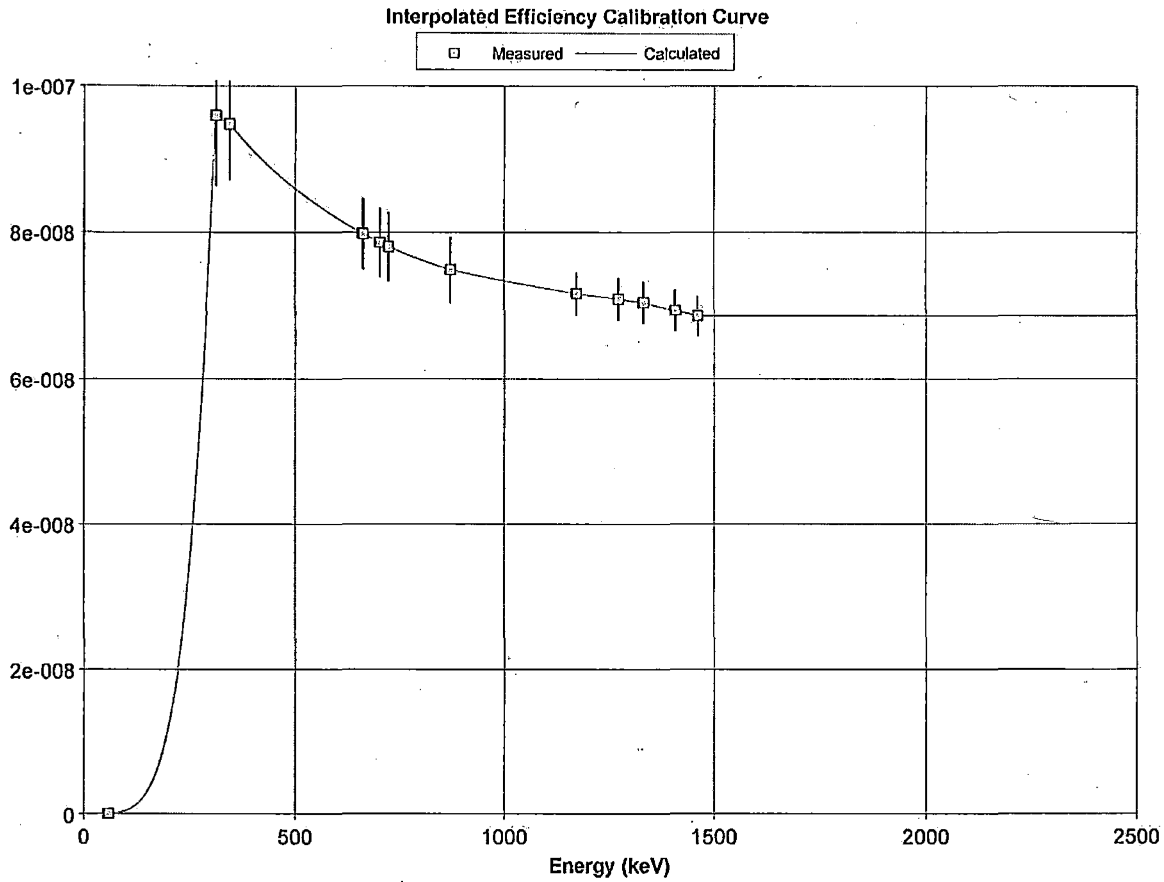
Date:	Thursday, November 13, 2014 - 17:05:57
Description:	10YRD_Soil_DET3_D20
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\10YRD_Soil_DET3_D20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



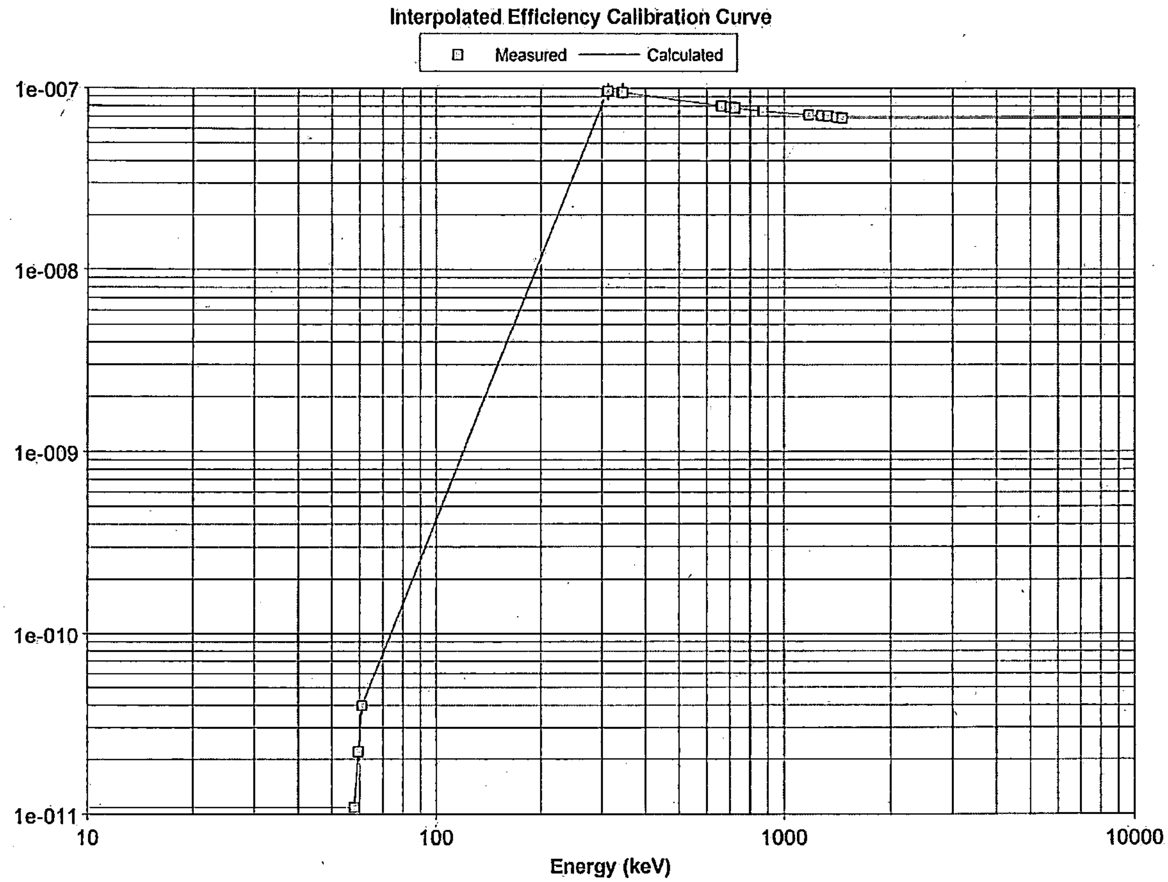
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/13/14 02:44:56
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET3_D20.CAL
Genie Cal Time: 11/13/14 03:46:23
Template: SIMPLE BOX
Geom Description: 10YRD DET3 D20
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3997
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.8689e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.08926e-011	10.0	0.070983	77672
59.54	2.19507e-011	10.0	0.071186	77672
61.00	3.96820e-011	10.0	0.071114	77672
311.00	9.59608e-008	10.0	0.014680	77672
311.98	9.59068e-008	10.0	0.014827	77672
313.00	9.58701e-008	10.0	0.014507	77672
343.00	9.47924e-008	8.0	0.009463	77672
344.27	9.47270e-008	8.0	0.009391	77672
345.00	9.46931e-008	8.0	0.009341	77672
660.00	7.98805e-008	6.0	-0.008602	77672
661.65	7.97554e-008	6.0	-0.008622	77672
663.00	7.97268e-008	6.0	-0.008716	77672
701.00	7.86173e-008	6.0	-0.009198	77672
702.63	7.85327e-008	6.0	-0.009168	77672
703.00	7.85366e-008	6.0	-0.009253	77672
722.00	7.80371e-008	6.0	-0.009189	77672
723.00	7.79956e-008	6.0	-0.009412	77672
724.00	7.79729e-008	6.0	-0.009361	77672
870.00	7.48664e-008	6.0	-0.009584	77672
871.10	7.48214e-008	6.0	-0.009547	77672
872.00	7.48694e-008	6.0	-0.009685	77672
1172.00	7.16420e-008	4.0	-0.008178	77672
1173.22	7.16402e-008	4.0	-0.008189	77672
1174.00	7.16089e-008	4.0	-0.008222	77672
1273.00	7.09255e-008	4.0	-0.007795	77672
1274.45	7.09051e-008	4.0	-0.007725	77672
1275.00	7.08980e-008	4.0	-0.007797	77672
1331.00	7.03917e-008	4.0	-0.007414	77672
1332.49	7.04122e-008	4.0	-0.007368	77672
1334.00	7.03910e-008	4.0	-0.007296	77672
1406.00	6.93482e-008	4.0	-0.006727	77672
1407.95	6.93506e-008	4.0	-0.006836	77672
1409.00	6.93502e-008	4.0	-0.006618	77672
1460.80	6.86024e-008	4.0	-0.006207	77672



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

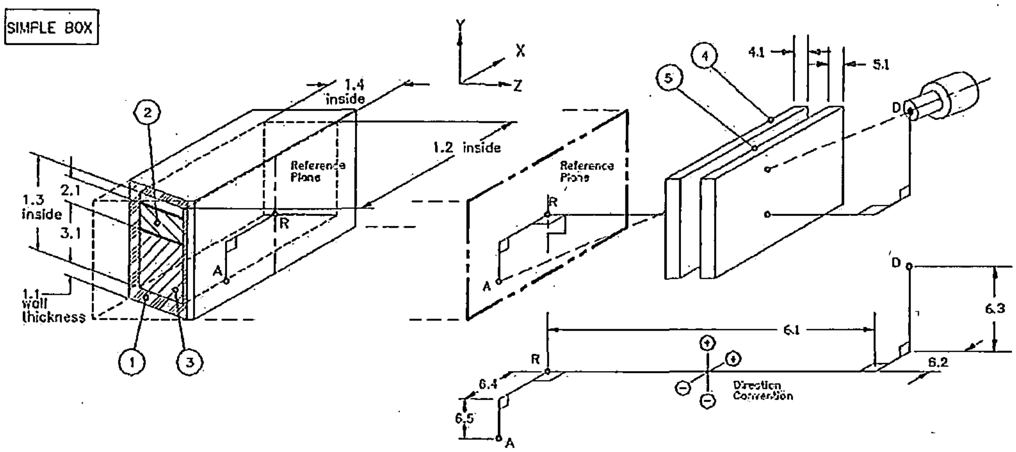
Date: Thursday, November 13, 2014 - 17:07:00
Description: 10YRD_Soil_DET4_D20
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET4_D20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3998
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2							none		
6	Source-Detector	54	-45	0	-45	0				

List of energies for efficiency curve generation

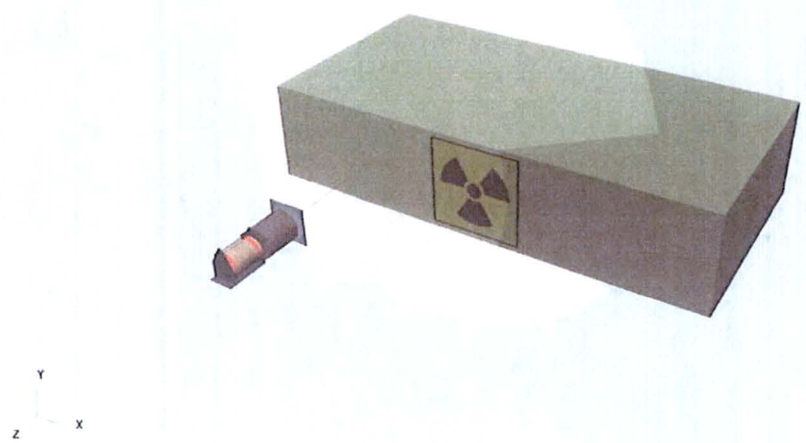
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

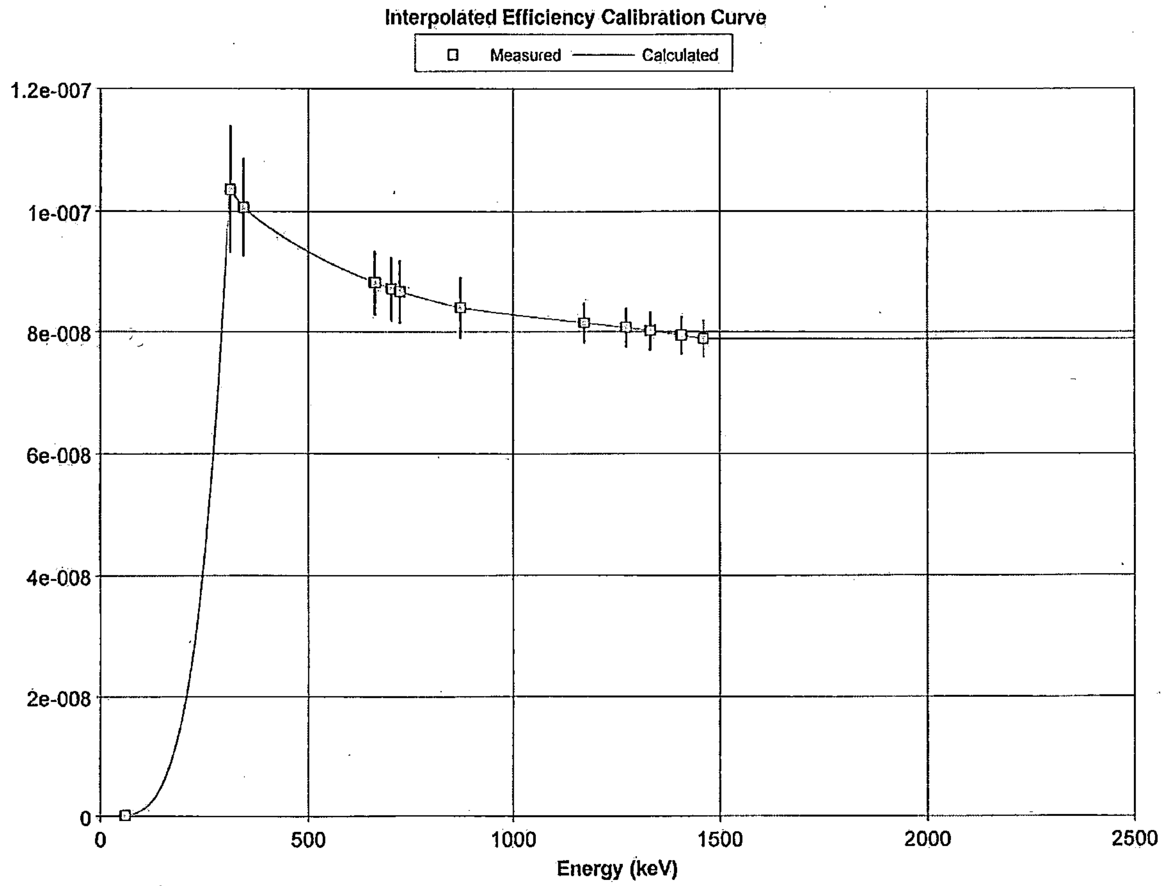
Date:	Thursday, November 13, 2014 - 17:07:00
Description:	10YRD_Soil_DET4_D20
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\10YRD_Soil_DET4_D20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



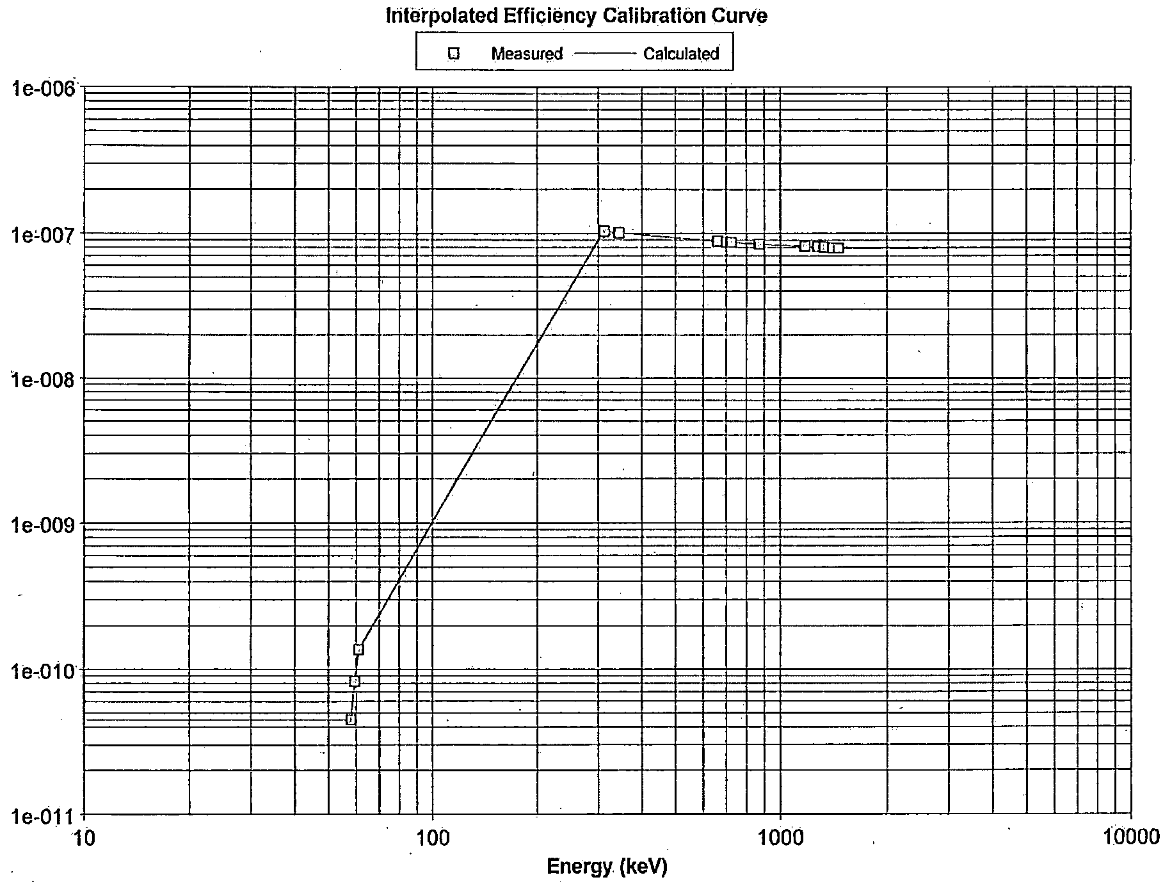
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/13/14 02:50:38
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET4_D20.CAL
Genie Cal Time: 11/13/14 03:51:55
Template: SIMPLE BOX
Geom Description: 10YRD DET4 D20
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3998
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.8689e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	4.49302e-011	10.0	-0.073740	77672
59.54	8.20018e-011	10.0	-0.071545	77672
61.00	1.36332e-010	10.0	-0.069738	77672
311.00	1.03752e-007	10.0	0.016161	77672
311.98	1.03594e-007	10.0	0.015924	77672
313.00	1.03536e-007	10.0	0.016068	77672
343.00	1.00723e-007	8.0	0.015831	77672
344.27	1.00604e-007	8.0	0.015864	77672
345.00	1.00588e-007	8.0	0.015728	77672
660.00	8.81793e-008	6.0	0.008555	77672
661.65	8.80832e-008	6.0	0.008398	77672
663.00	8.80873e-008	6.0	0.008279	77672
701.00	8.71192e-008	6.0	0.007715	77672
702.63	8.70804e-008	6.0	0.007650	77672
703.00	8.70489e-008	6.0	0.007428	77672
722.00	8.66337e-008	6.0	0.006982	77672
723.00	8.65977e-008	6.0	0.007046	77672
724.00	8.65910e-008	6.0	0.007203	77672
870.00	8.40002e-008	6.0	0.005234	77672
871.10	8.39893e-008	6.0	0.005376	77672
872.00	8.39969e-008	6.0	0.005237	77672
1172.00	8.14758e-008	4.0	0.004310	77672
1173.22	8.15067e-008	4.0	0.004193	77672
1174.00	8.14578e-008	4.0	0.004013	77672
1273.00	8.07000e-008	4.0	0.004305	77672
1274.45	8.07045e-008	4.0	0.004461	77672
1275.00	8.06919e-008	4.0	0.004560	77672
1331.00	8.01464e-008	4.0	0.004946	77672
1332.49	8.01938e-008	4.0	0.004855	77672
1334.00	8.01985e-008	4.0	0.004898	77672
1406.00	7.94446e-008	4.0	0.005401	77672
1407.95	7.94099e-008	4.0	0.005389	77672
1409.00	7.94078e-008	4.0	0.005431	77672
1460.80	7.88892e-008	4.0	0.005855	77672



Datasource: DET01



Datasource: DET01

#	Weight	Primary Efficiency taken from ECC files, for set energies (keV): 58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3	345.0	660.0	661.7
1	1.000	8.15e-012	1.68e-011	3.09e-011	9.58e-008	9.57e-008	9.57e-008	9.47e-008	9.46e-008	9.46e-008	7.98e-008	7.97e-008
2	1.000	7.24e-012	1.50e-011	2.79e-011	9.52e-008	9.51e-008	9.51e-008	9.41e-008	9.40e-008	9.40e-008	7.95e-008	7.94e-008
3	1.000	1.09e-011	2.20e-011	3.97e-011	9.60e-008	9.59e-008	9.59e-008	9.48e-008	9.47e-008	9.47e-008	7.99e-008	7.98e-008
4	1.000	4.49e-011	8.20e-011	1.36e-010	1.04e-007	1.04e-007	1.04e-007	1.01e-007	1.01e-007	1.01e-007	8.82e-008	8.81e-008
	Sum	7.12e-011	1.36e-010	2.35e-010	3.91e-007	3.90e-007	3.90e-007	3.84e-007	3.84e-007	3.84e-007	3.27e-007	3.27e-007
	Error,%	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	8.00e+000	8.00e+000	8.00e+000	6.00e+000	6.00e+000

Information for input ECC files

	File Name	File Stamp	Path
1	10YRD_Soil_DET1_D20.gis	Tue_Nov_18_19:05:55_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
2	10YRD_Soil_DET2_D20.gis	Thu_Nov_13_02:37:53_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
3	10YRD_Soil_DET3_D20.gis	Thu_Nov_13_02:44:06_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
4	10YRD_Soil_DET4_D20.gis	Thu_Nov_13_02:49:47_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

File Name	File Stamp	Path

Description: 10YRD_Soil_SUM_D20
Comment: Calib Date 11/19/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

663.0	701.0	702.6	703.0	722.0	723.0	724.0	870.0	871.1	872.0	1172.0	1173.2
7.97e-008	7.86e-008	7.85e-008	7.85e-008	7.80e-008	7.80e-008	7.79e-008	7.48e-008	7.48e-008	7.48e-008	7.16e-008	7.16e-008
7.94e-008	7.83e-008	7.82e-008	7.82e-008	7.77e-008	7.76e-008	7.76e-008	7.46e-008	7.45e-008	7.46e-008	7.14e-008	7.14e-008
7.97e-008	7.86e-008	7.85e-008	7.85e-008	7.80e-008	7.80e-008	7.80e-008	7.49e-008	7.48e-008	7.49e-008	7.16e-008	7.16e-008
8.81e-008	8.71e-008	8.71e-008	8.70e-008	8.66e-008	8.66e-008	8.66e-008	8.40e-008	8.40e-008	8.40e-008	8.15e-008	8.15e-008
3.27e-007	3.23e-007	3.22e-007	3.22e-007	3.20e-007	3.20e-007	3.20e-007	3.08e-007	3.08e-007	3.08e-007	2.96e-007	2.96e-007
6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

10YRD_Soil_SUM_D20
Calib Date 11/19/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

1174.0	1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9	1409.0	1460.8
7.16e-008	7.09e-008	7.09e-008	7.09e-008	7.04e-008	7.04e-008	7.04e-008	6.93e-008	6.93e-008	6.93e-008	6.86e-008
7.14e-008	7.07e-008	7.07e-008	7.07e-008	7.02e-008	7.02e-008	7.02e-008	6.91e-008	6.91e-008	6.91e-008	6.84e-008
7.16e-008	7.09e-008	7.09e-008	7.09e-008	7.04e-008	7.04e-008	7.04e-008	6.93e-008	6.94e-008	6.94e-008	6.86e-008
8.15e-008	8.07e-008	8.07e-008	8.07e-008	8.01e-008	8.02e-008	8.02e-008	7.94e-008	7.94e-008	7.94e-008	7.89e-008
2.96e-007	2.93e-007	2.93e-007	2.93e-007	2.91e-007	2.91e-007	2.91e-007	2.87e-007	2.87e-007	2.87e-007	2.84e-007
4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

10YRD_Soil_SUM_D20
Calib Date 11/19/14

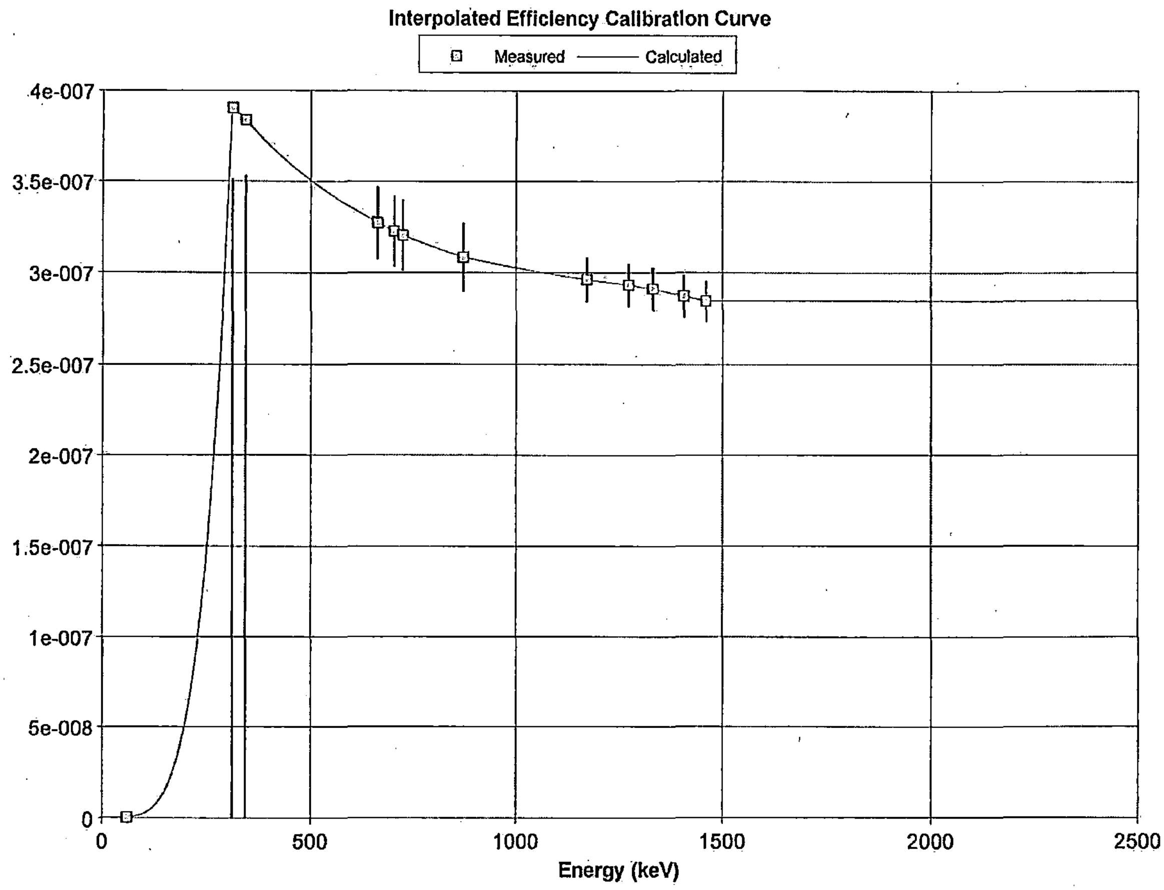
CANBERRA

Multi-Efficiency Report

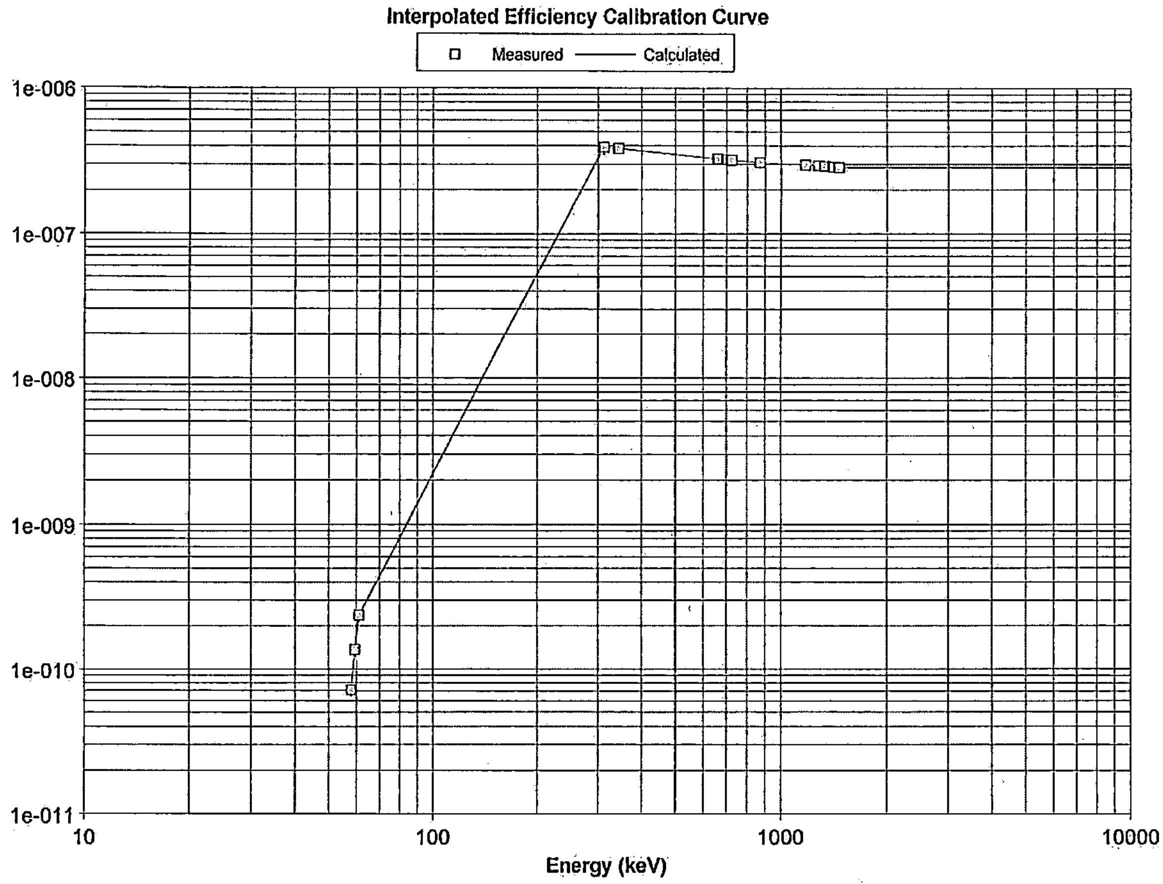
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\Multiefficiency\10YRD_
ISOCS/LabSOCS Time: 11/18/14 19:09:31
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_SUM_D20.CAL
Genie Cal Time: 11/18/14 20:06:52
Template: (SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+
Geom Description: 10Yard SUM D20
Comment: ISOCS:Calib Date 11/19/14
Detector: (3994)+(3996)+(3997)+(3998)+
Collimator: (GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+
Convergence: 1.00 %
Area [Sq Meters]: 1.0000e-004 (C)
Mass [Grams]: 1.0000e+000 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	7.12092e-011	10.0	0.0729780	64000
59.54	1.35780e-010	10.0	0.0729780	64000
61.00	2.34858e-010	10.0	0.0729780	64000
311.00	3.90682e-007	10.0	0.0729780	64000
311.98	3.90366e-007	10.0	0.0729780	64000
313.00	3.90203e-007	10.0	0.0729780	64000
343.00	3.84267e-007	8.0	0.0729780	64000
344.27	3.83956e-007	8.0	0.0729780	64000
345.00	3.83841e-007	8.0	0.0729780	64000
660.00	3.27409e-007	6.0	0.0729780	64000
661.65	3.26939e-007	6.0	0.0729780	64000
663.00	3.26858e-007	6.0	0.0729780	64000
701.00	3.22580e-007	6.0	0.0729780	64000
702.63	3.22288e-007	6.0	0.0729780	64000
703.00	3.22268e-007	6.0	0.0729780	64000
722.00	3.20363e-007	6.0	0.0729780	64000
723.00	3.20203e-007	6.0	0.0729780	64000
724.00	3.20129e-007	6.0	0.0729780	64000
870.00	3.08269e-007	6.0	0.0729780	64000
871.10	3.08123e-007	6.0	0.0729780	64000
872.00	3.08275e-007	6.0	0.0729780	64000
1172.00	2.96131e-007	4.0	0.0729780	64000
1173.22	2.96156e-007	4.0	0.0729780	64000
1174.00	2.96014e-007	4.0	0.0729780	64000
1273.00	2.93216e-007	4.0	0.0729780	64000
1274.45	2.93160e-007	4.0	0.0729780	64000
1275.00	2.93126e-007	4.0	0.0729780	64000
1331.00	2.91067e-007	4.0	0.0729780	64000
1332.49	2.91176e-007	4.0	0.0729780	64000
1334.00	2.91117e-007	4.0	0.0729780	64000
1406.00	2.87242e-007	4.0	0.0729780	64000
1407.95	2.87214e-007	4.0	0.0729780	64000
1409.00	2.87211e-007	4.0	0.0729780	64000
1460.80	2.84453e-007	4.0	0.0729780	64000



Datasource: DET01



Datasource: DET01

GARDIAN SYSTEM
Calibration Records
10 Yard End Dump

Density 1.6

Geometry Composer Report

CANBERRA

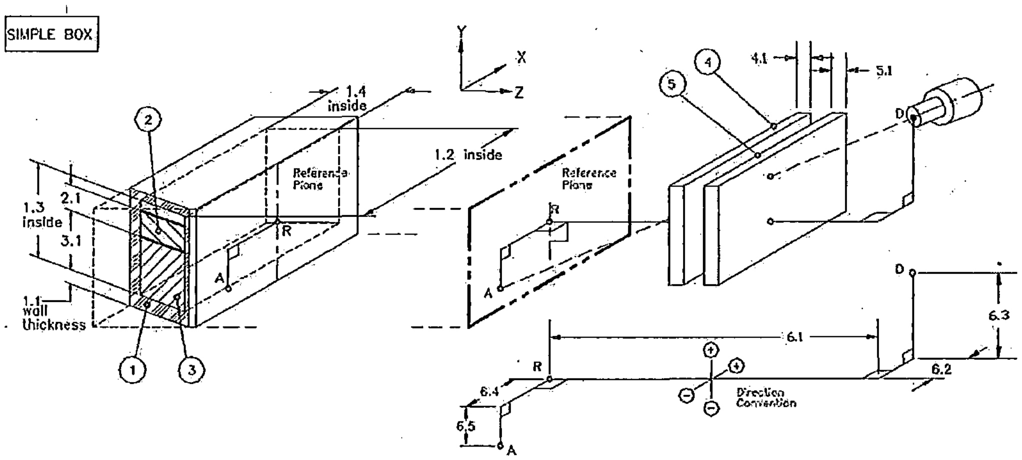
Date: Wednesday, November 19, 2014 - 09:41:03
Description: 10YRD_DET1_D16
Comment: CAL DATE 11_19_14
File Name: E:\SIMPLE_BOX\10YRD_DET1_D16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3994
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 22 °C, Pressure = 760 mm Hg, Relative Humidity = 30%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt2	1.6	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.027559						germanum	5.4	
6	Source-Detector	54	45	0	45	0				

List of energies for efficiency curve generation

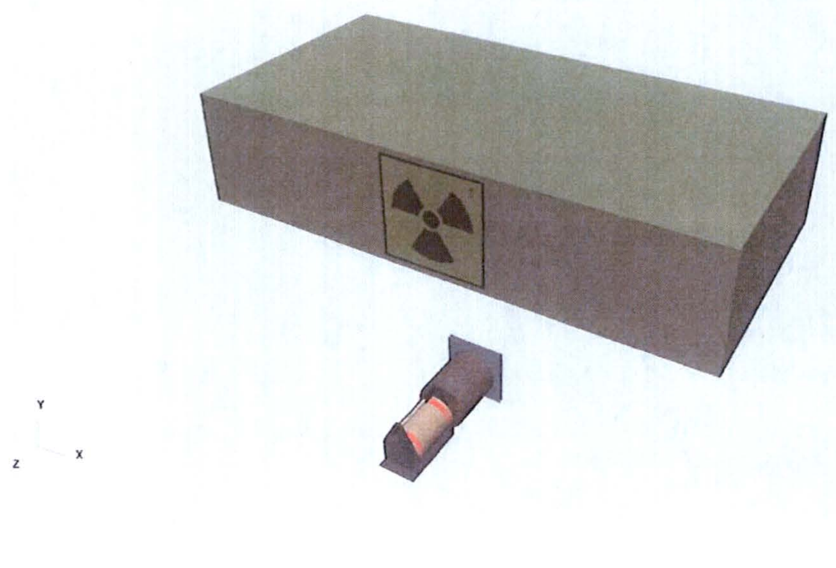
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

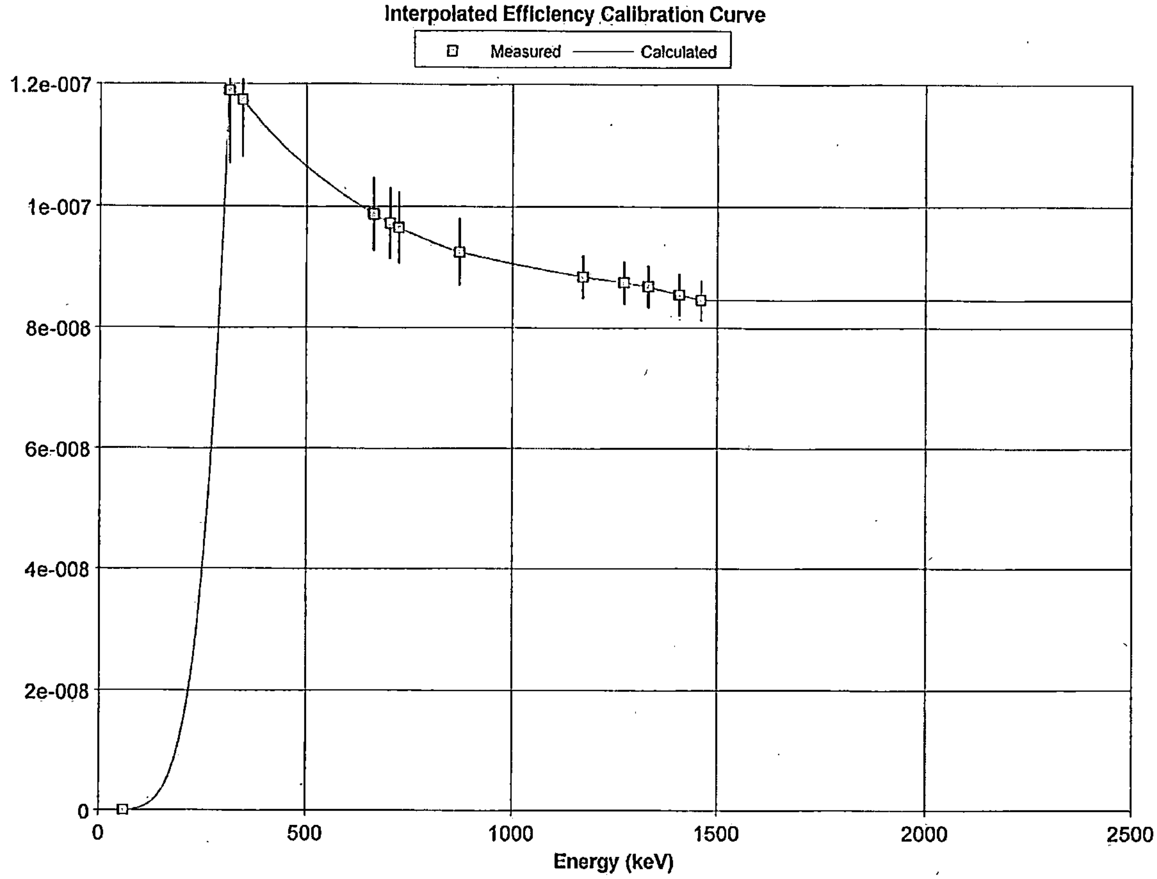
Date:	Wednesday, November 19, 2014 - 09:41:03
Description:	10YRD_DET1_D16
Comment:	CAL DATE 11_19_14
File Name:	E:\SIMPLE_BOX\10YRD_DET1_D16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



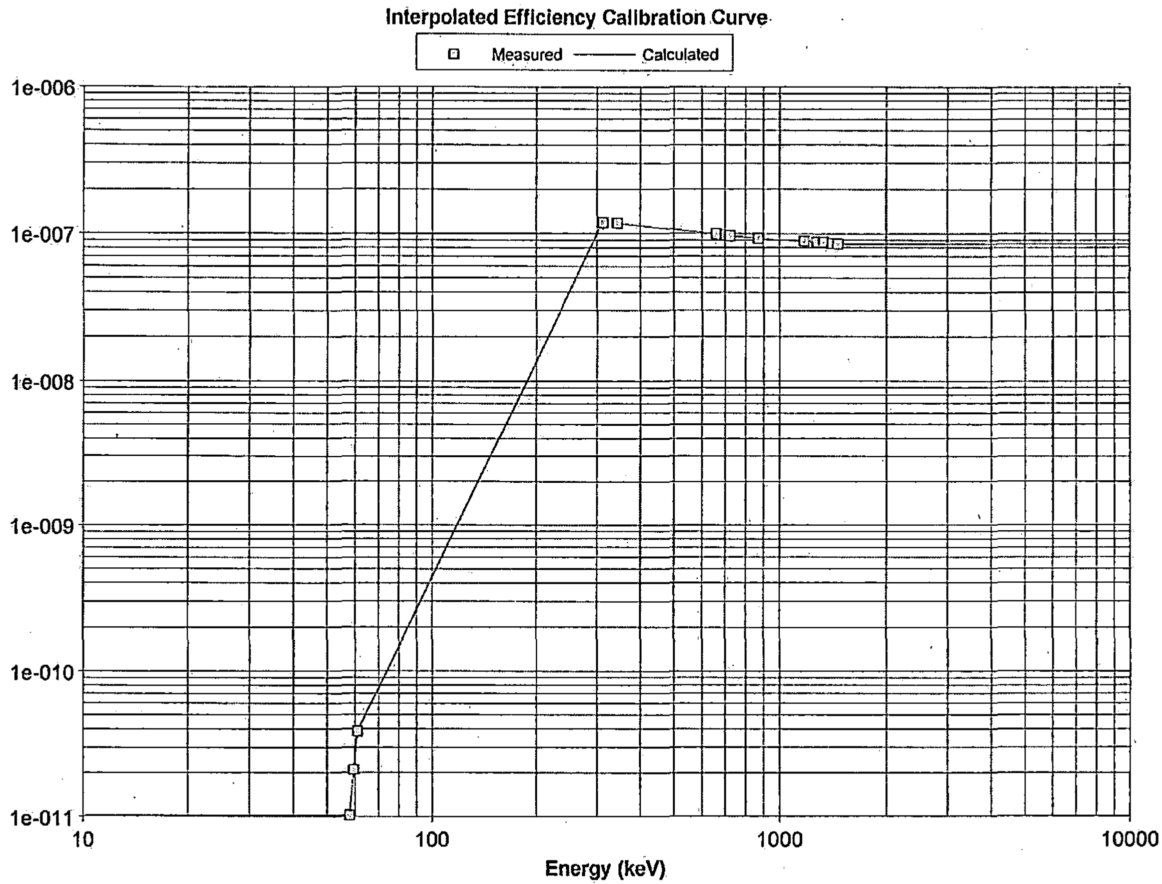
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/18/14 21:54:49
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET1_D16.CAL
Genie Cal Time: 11/18/14 22:01:40
Template: SIMPLE BOX
Geom Description: 10 Yard DET1 D16
Comment: ISOCS:CAL_DATE_11_19_14
Detector: 3994
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.4951e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.01605e-011	10.0	-0.161760	77672
59.54	2.09345e-011	10.0	-0.158453	77672
61.00	3.85728e-011	10.0	-0.155549	77672
311.00	1.18915e-007	10.0	-0.045167	77672
311.98	1.18846e-007	10.0	-0.044722	77672
313.00	1.18808e-007	10.0	-0.044708	77672
343.00	1.17489e-007	8.0	-0.040519	77672
344.27	1.17406e-007	8.0	-0.040274	77672
345.00	1.17369e-007	8.0	-0.040069	77672
660.00	9.88879e-008	6.0	-0.015800	77672
661.65	9.87294e-008	6.0	-0.015711	77672
663.00	9.86978e-008	6.0	-0.015696	77672
701.00	9.73006e-008	6.0	-0.014058	77672
702.63	9.71922e-008	6.0	-0.013961	77672
703.00	9.71998e-008	6.0	-0.014011	77672
722.00	9.65681e-008	6.0	-0.013142	77672
723.00	9.65143e-008	6.0	-0.013272	77672
724.00	9.64891e-008	6.0	-0.013185	77672
870.00	9.25701e-008	6.0	-0.008256	77672
871.10	9.25154e-008	6.0	-0.008317	77672
872.00	9.25695e-008	6.0	-0.008331	77672
1172.00	8.84542e-008	4.0	-0.002153	77672
1173.22	8.84420e-008	4.0	-0.002124	77672
1174.00	8.84034e-008	4.0	-0.002094	77672
1273.00	8.75225e-008	4.0	-0.000601	77672
1274.45	8.74960e-008	4.0	-0.000571	77672
1275.00	8.74882e-008	4.0	-0.000623	77672
1331.00	8.68524e-008	4.0	0.000170	77672
1332.49	8.68678e-008	4.0	0.000243	77672
1334.00	8.68371e-008	4.0	0.000299	77672
1406.00	8.55200e-008	4.0	0.001228	77672
1407.95	8.55199e-008	4.0	0.001194	77672
1409.00	8.55226e-008	4.0	0.001205	77672
1460.80	8.45792e-008	4.0	0.001890	77672



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

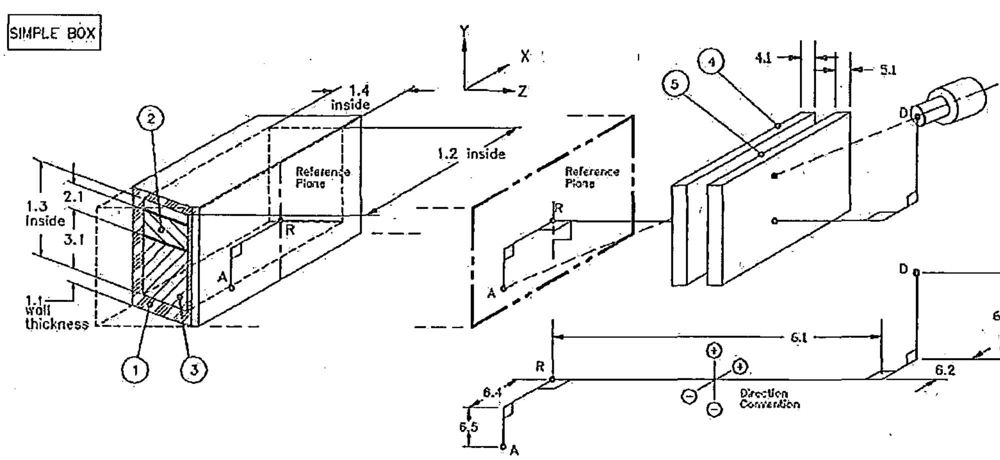
Date: Thursday, November 13, 2014 - 17:04:13
Description: 10YRD_Soil_DET2_D16
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET2_D16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3996
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	1.6	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.0315						germanum	5.4	
6	Source-Detector	54	-45	0	-45	0				

List of energies for efficiency curve generation

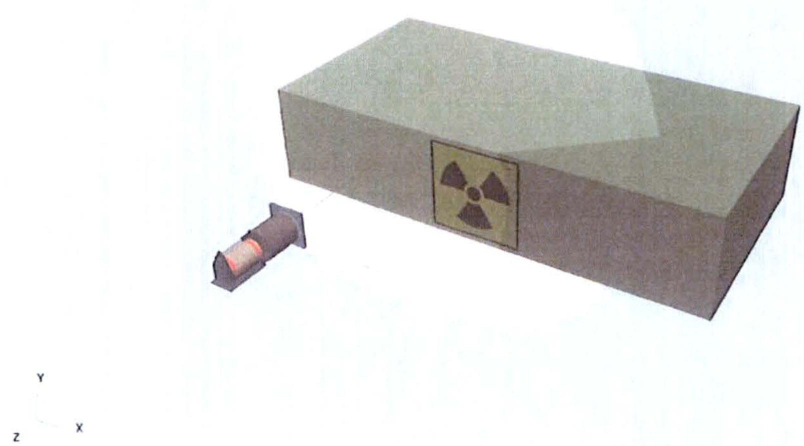
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

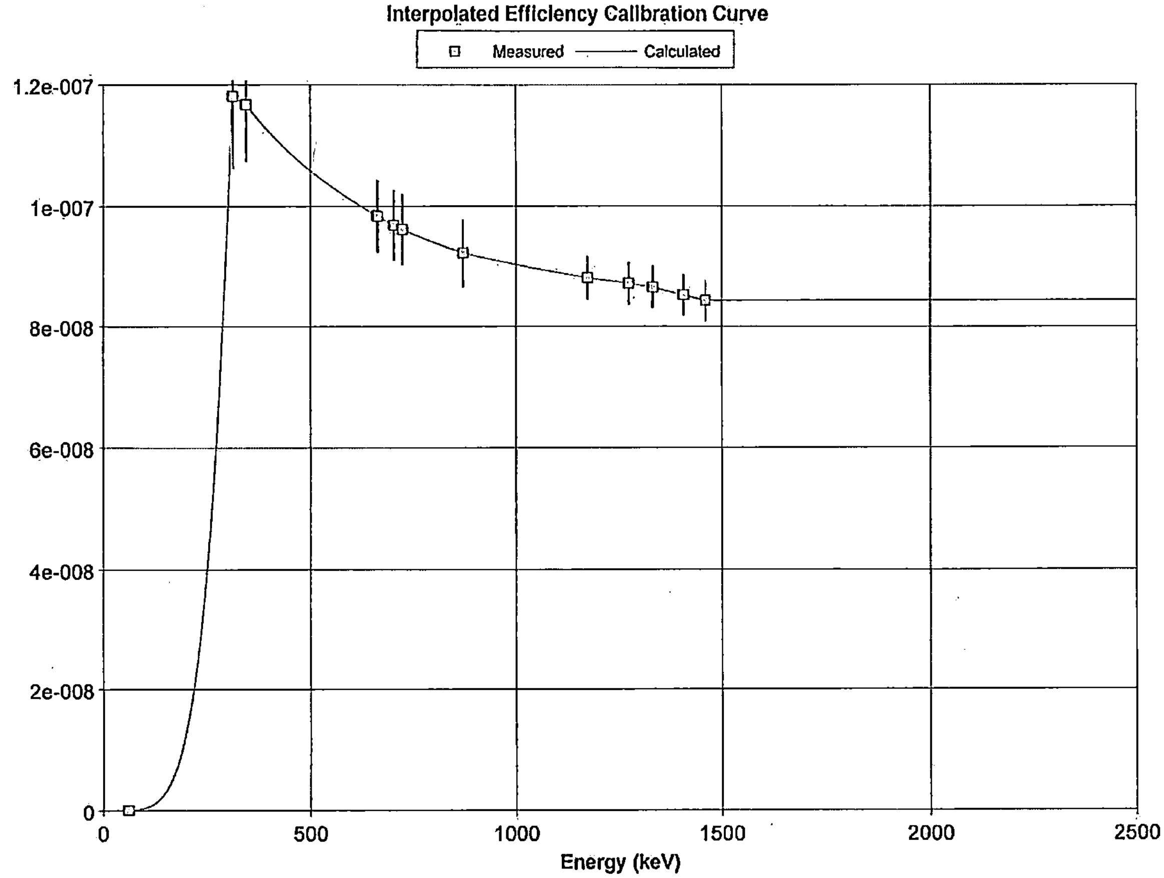
Date:	Thursday, November 13, 2014 - 17:04:13
Description:	10YRD_Soil_DET2_D16
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\10YRD_Soil_DET2_D16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



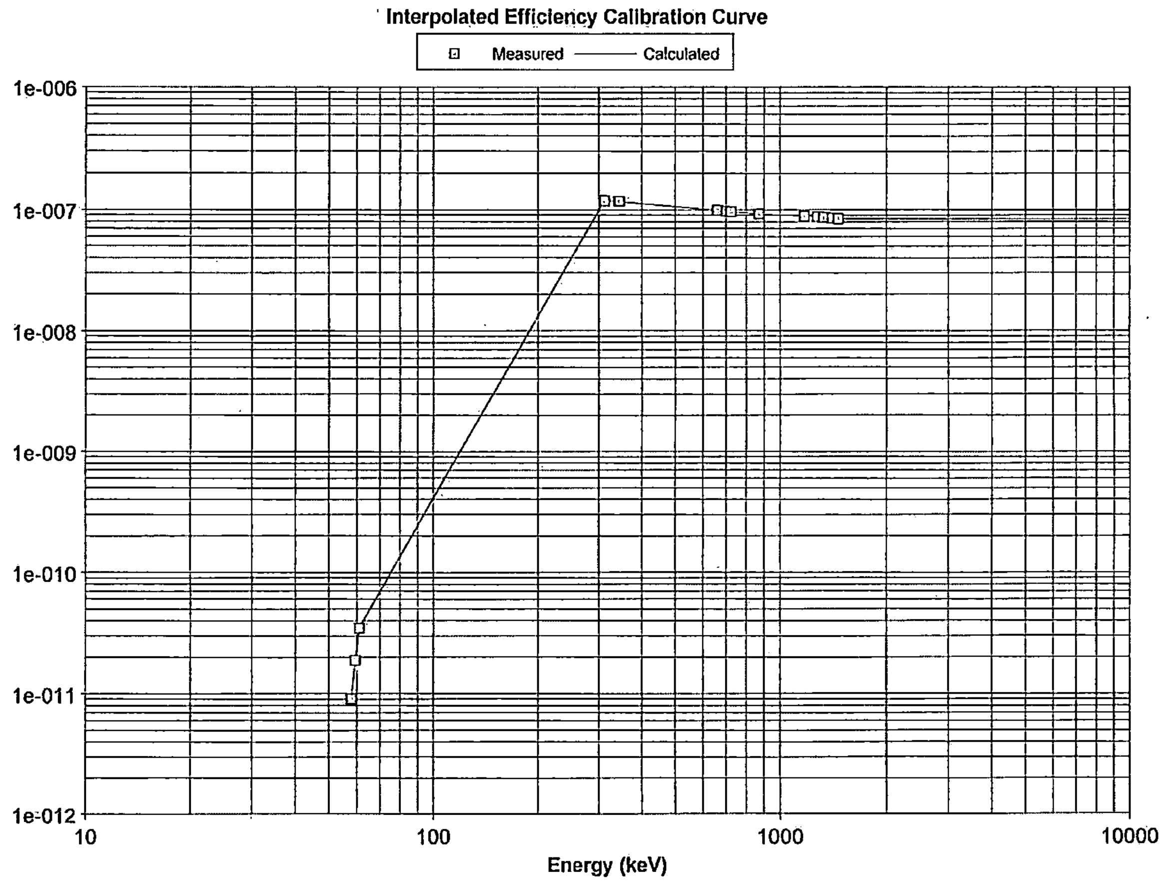
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/13/14 02:34:43
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET2_D16.CAL
Genie Cal Time: 11/13/14 03:40:39
Template: SIMPLE BOX
Geom Description: RD SOIL DET2 D16
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3996
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.4951e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	9.01847e-012	10.0	-0.156533	77672
59.54	1.87334e-011	10.0	-0.153068	77672
61.00	3.47604e-011	10.0	-0.150053	77672
311.00	1.18133e-007	10.0	-0.057013	77672
311.98	1.18066e-007	10.0	-0.056600	77672
313.00	1.18029e-007	10.0	-0.056581	77672
343.00	1.16762e-007	8.0	-0.052637	77672
344.27	1.16682e-007	8.0	-0.052419	77672
345.00	1.16646e-007	8.0	-0.052247	77672
660.00	9.84607e-008	6.0	-0.029700	77672
661.65	9.83034e-008	6.0	-0.029648	77672
663.00	9.82724e-008	6.0	-0.029629	77672
701.00	9.68930e-008	6.0	-0.028071	77672
702.63	9.67856e-008	6.0	-0.027992	77672
703.00	9.67933e-008	6.0	-0.028058	77672
722.00	9.61697e-008	6.0	-0.027219	77672
723.00	9.61163e-008	6.0	-0.027334	77672
724.00	9.60916e-008	6.0	-0.027200	77672
870.00	9.22230e-008	6.0	-0.022175	77672
871.10	9.21686e-008	6.0	-0.022252	77672
872.00	9.22228e-008	6.0	-0.022296	77672
1172.00	8.81702e-008	4.0	-0.014922	77672
1173.22	8.81581e-008	4.0	-0.014891	77672
1174.00	8.81197e-008	4.0	-0.014866	77672
1273.00	8.72530e-008	4.0	-0.013145	77672
1274.45	8.72268e-008	4.0	-0.013092	77672
1275.00	8.72191e-008	4.0	-0.013097	77672
1331.00	8.65909e-008	4.0	-0.012165	77672
1332.49	8.66064e-008	4.0	-0.012059	77672
1334.00	8.65759e-008	4.0	-0.011984	77672
1406.00	8.52694e-008	4.0	-0.010787	77672
1407.95	8.52694e-008	4.0	-0.010784	77672
1409.00	8.52722e-008	4.0	-0.010789	77672
1460.80	8.43359e-008	4.0	-0.009817	77672



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

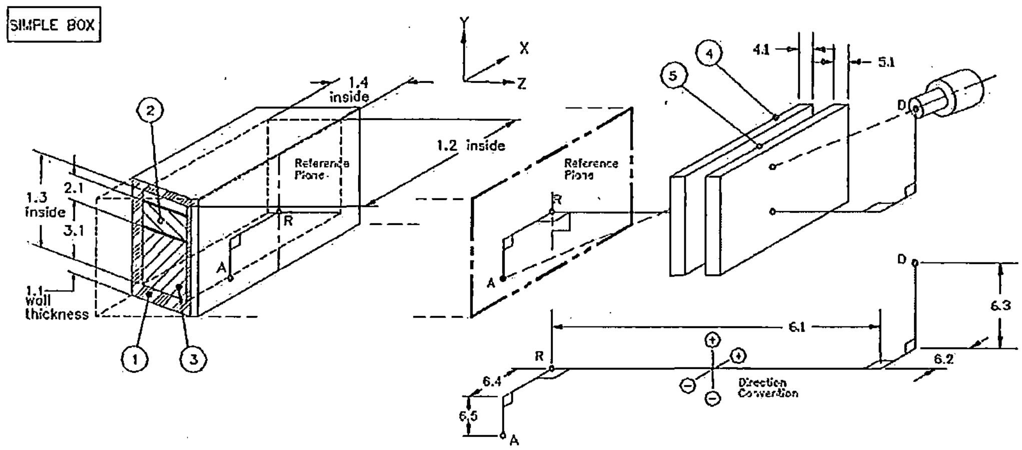
Date: Thursday, November 13, 2014 - 17:05:15
Description: 10YRD_Soil_DET3_D16
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET3_D16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3997
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	1.6	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2	0.03543						germanum	5.4	
6	Source-Detector	54	45	0	45	0				

List of energies for efficiency curve generation

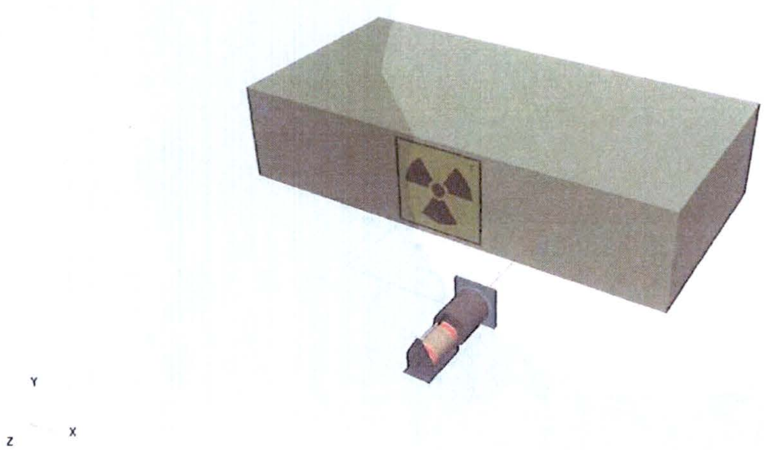
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

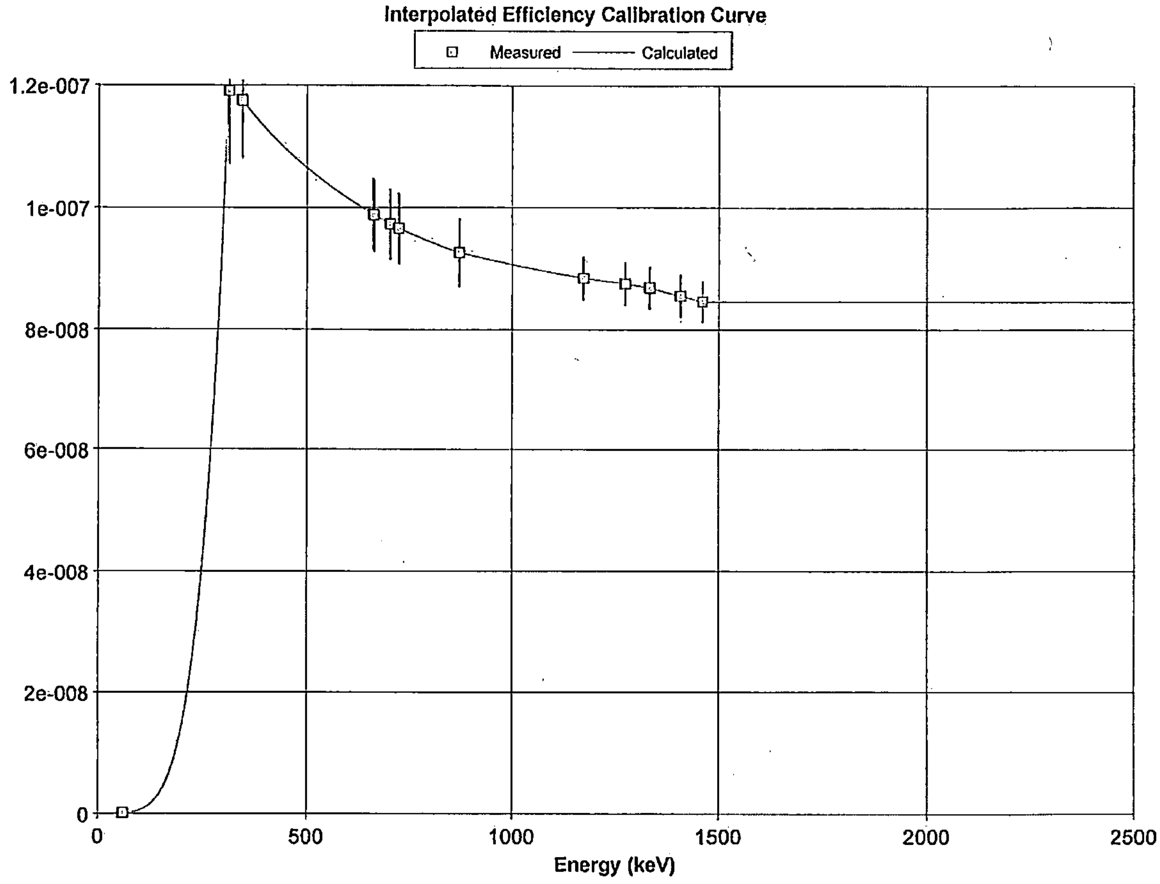
Date:	Thursday, November 13, 2014 - 17:05:15
Description:	10YRD_Soil_DET3_D16
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\10YRD_Soil_DET3_D16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



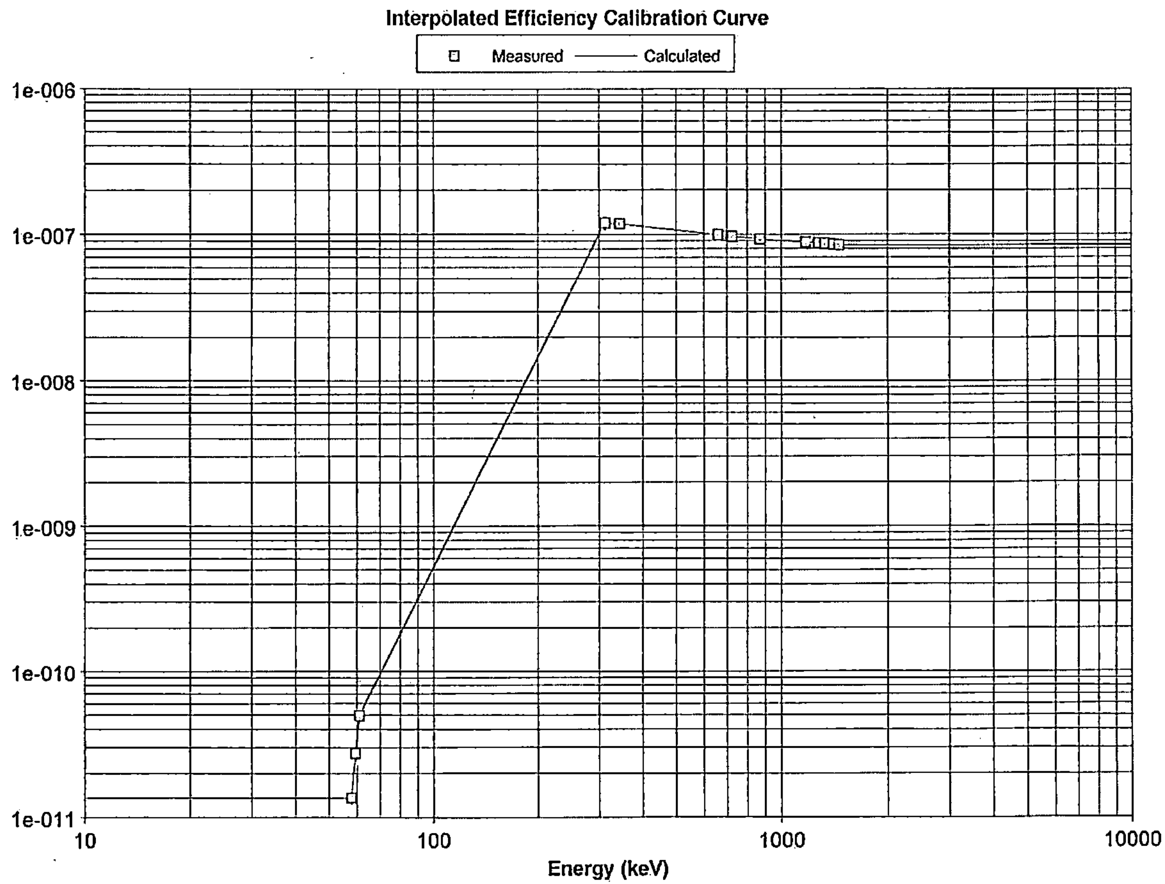
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/13/14 02:43:00
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET3_D16.CAL
Genie Cal Time: 11/13/14 03:45:14
Template: SIMPLE BOX
Geom Description: 10YRD DET3 D16
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3997
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.4951e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.35747e-011	10.0	-0.160582	77672
59.54	2.73528e-011	10.0	-0.157357	77672
61.00	4.94437e-011	10.0	-0.154530	77672
311.00	1.19100e-007	10.0	-0.045153	77672
311.98	1.19030e-007	10.0	-0.044709	77672
313.00	1.18989e-007	10.0	-0.044695	77672
343.00	1.17628e-007	8.0	-0.040509	77672
344.27	1.17544e-007	8.0	-0.040264	77672
345.00	1.17506e-007	8.0	-0.040059	77672
660.00	9.89158e-008	6.0	-0.015798	77672
661.65	9.87571e-008	6.0	-0.015709	77672
663.00	9.87254e-008	6.0	-0.015694	77672
701.00	9.73257e-008	6.0	-0.014056	77672
702.63	9.72172e-008	6.0	-0.013959	77672
703.00	9.72249e-008	6.0	-0.014009	77672
722.00	9.65921e-008	6.0	-0.013140	77672
723.00	9.65382e-008	6.0	-0.013270	77672
724.00	9.65129e-008	6.0	-0.013183	77672
870.00	9.25882e-008	6.0	-0.008254	77672
871.10	9.25334e-008	6.0	-0.008315	77672
872.00	9.25876e-008	6.0	-0.008330	77672
1172.00	8.84681e-008	4.0	-0.002152	77672
1173.22	8.84559e-008	4.0	-0.002123	77672
1174.00	8.84172e-008	4.0	-0.002093	77672
1273.00	8.75369e-008	4.0	-0.000599	77672
1274.45	8.75104e-008	4.0	-0.000570	77672
1275.00	8.75026e-008	4.0	-0.000621	77672
1331.00	8.68676e-008	4.0	0.000171	77672
1332.49	8.68830e-008	4.0	0.000244	77672
1334.00	8.68522e-008	4.0	0.000301	77672
1406.00	8.55365e-008	4.0	0.001229	77672
1407.95	8.55364e-008	4.0	0.001195	77672
1409.00	8.55391e-008	4.0	0.001207	77672
1460.80	8.45969e-008	4.0	0.001891	77672



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

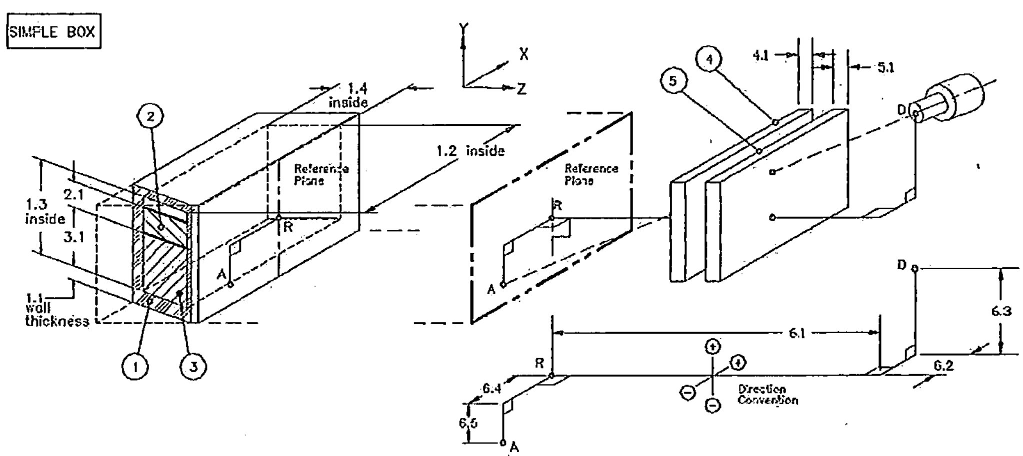
Date: Thursday, November 13, 2014 - 17:06:42
Description: 10YRD_Soil_DET4_D16
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET4_D16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3998
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	1.6	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2							none		
6	Source-Detector	54	-45	0	-45	0				

List of energies for efficiency curve generation

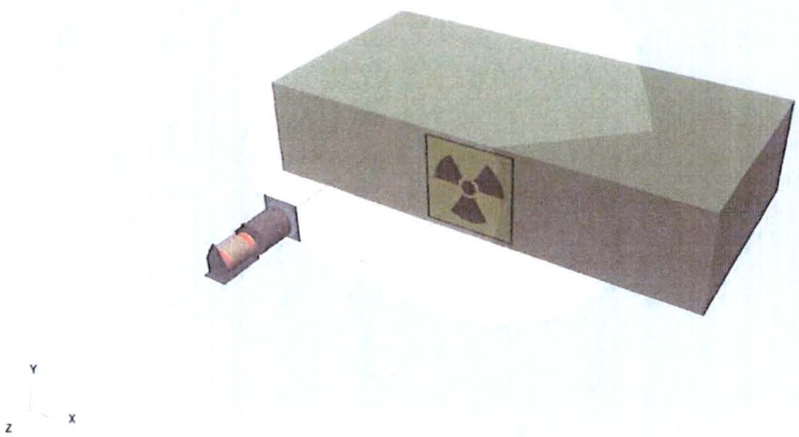
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

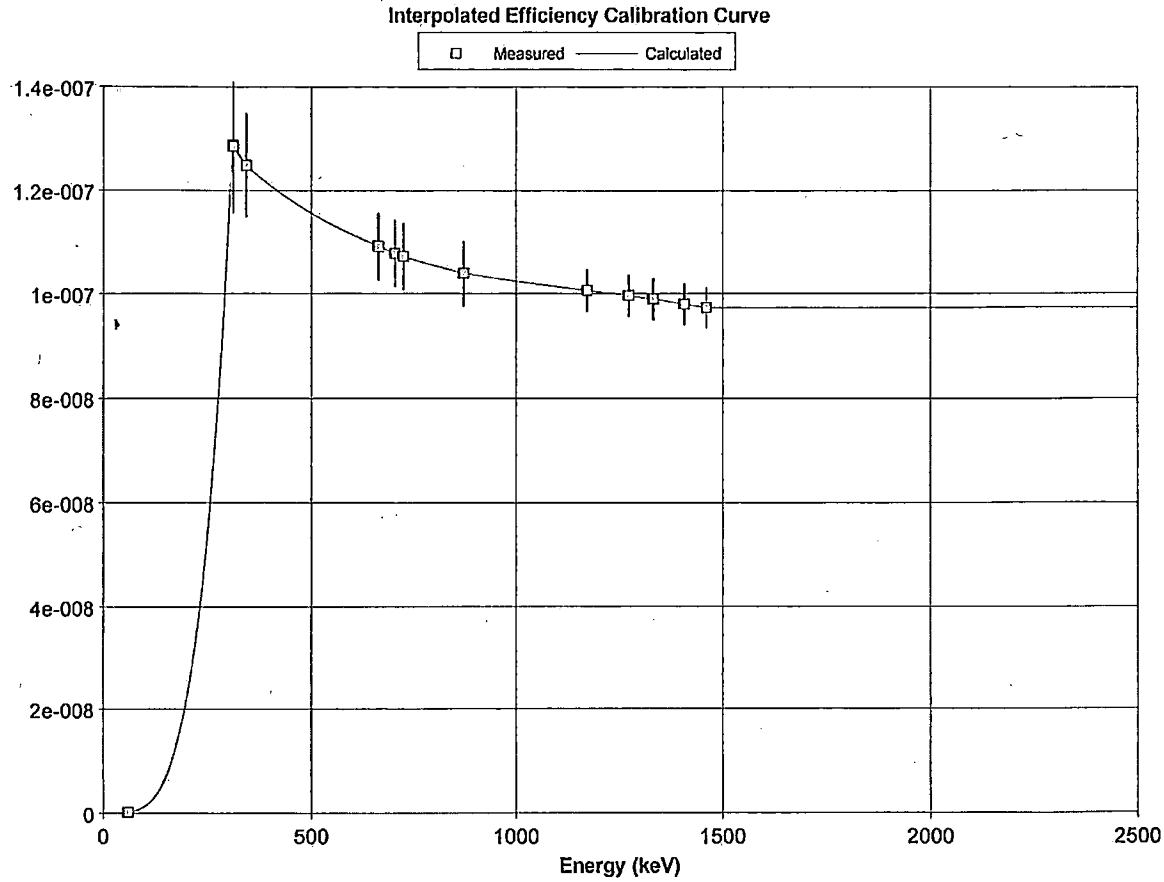
Date:	Thursday, November 13, 2014 - 17:06:42
Description:	10YRD_Soil_DET4_D16
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\10YRD_Soil_DET4_D16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



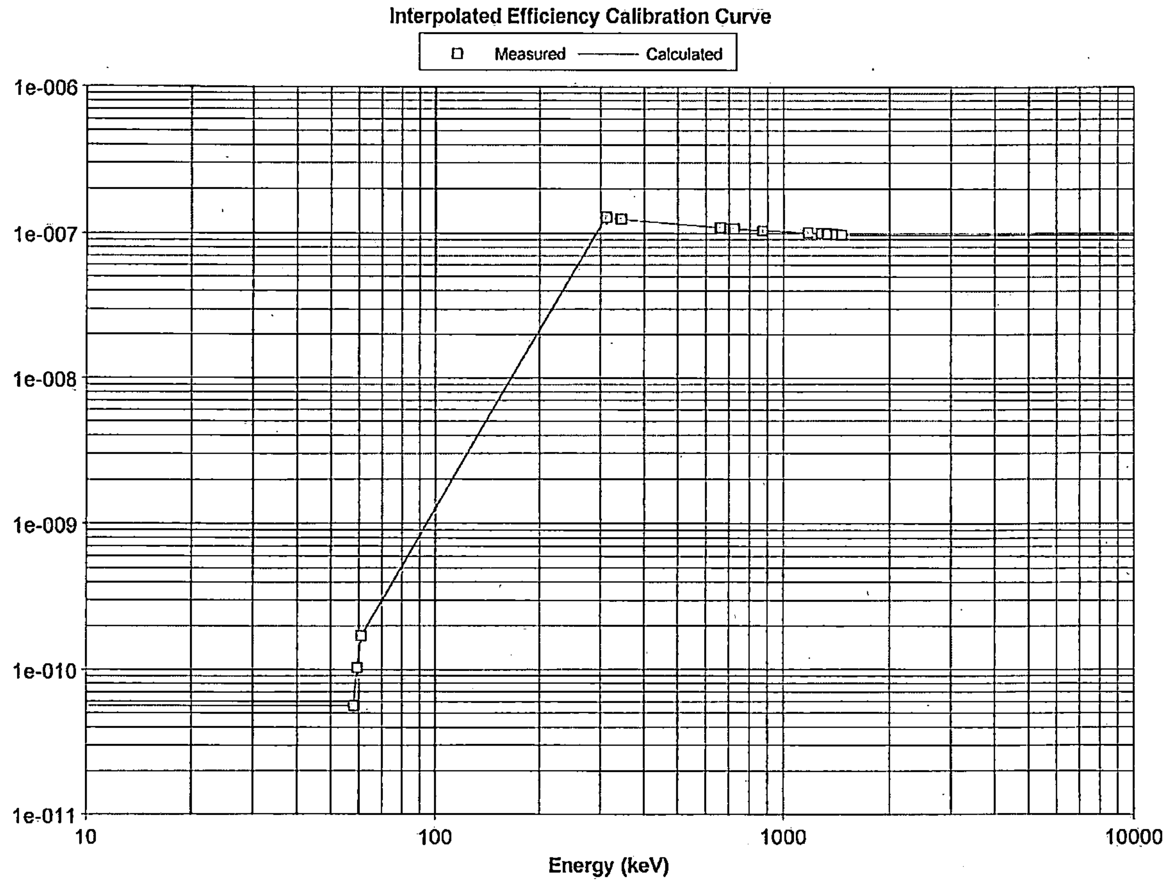
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/13/14 02:48:46
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET4_D16.CAL
Genie Cal Time: 11/13/14 03:50:28
Template: SIMPLE BOX
Geom Description: 10YRD DET4 D16
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3998
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.4951e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	5.60906e-011	10.0	-0.077528	77672
59.54	1.02353e-010	10.0	-0.075364	77672
61.00	1.70138e-010	10.0	-0.073501	77672
311.00	1.28772e-007	10.0	-0.015791	77672
311.98	1.28588e-007	10.0	-0.015865	77672
313.00	1.28507e-007	10.0	-0.015640	77672
343.00	1.24991e-007	8.0	-0.013394	77672
344.27	1.24843e-007	8.0	-0.013203	77672
345.00	1.24819e-007	8.0	-0.013355	77672
660.00	1.09196e-007	6.0	-0.006283	77672
661.65	1.09071e-007	6.0	-0.006350	77672
663.00	1.09074e-007	6.0	-0.006320	77672
701.00	1.07849e-007	6.0	-0.006148	77672
702.63	1.07800e-007	6.0	-0.006097	77672
703.00	1.07765e-007	6.0	-0.006236	77672
722.00	1.07234e-007	6.0	-0.006339	77672
723.00	1.07195e-007	6.0	-0.006231	77672
724.00	1.07184e-007	6.0	-0.006063	77672
870.00	1.03895e-007	6.0	-0.005238	77672
871.10	1.03877e-007	6.0	-0.005068	77672
872.00	1.03889e-007	6.0	-0.005196	77672
1172.00	1.00622e-007	4.0	-0.002468	77672
1173.22	1.00651e-007	4.0	-0.002507	77672
1174.00	1.00594e-007	4.0	-0.002532	77672
1273.00	9.96057e-008	4.0	-0.001293	77672
1274.45	9.96058e-008	4.0	-0.001370	77672
1275.00	9.95888e-008	4.0	-0.001336	77672
1331.00	9.88965e-008	4.0	-0.000403	77672
1332.49	9.89484e-008	4.0	-0.000519	77672
1334.00	9.89486e-008	4.0	-0.000529	77672
1406.00	9.79944e-008	4.0	0.000338	77672
1407.95	9.79486e-008	4.0	0.000376	77672
1409.00	9.79398e-008	4.0	0.000490	77672
1460.80	9.72771e-008	4.0	0.001086	77672



Datasource: DET01



Datasource: DET01

#	Weight	Primary Efficiency taken from ECC files, for set energies (keV): 58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3	345.0	660.0	661.7
1	1.000	1.02e-011	2.09e-011	3.86e-011	1.19e-007	1.19e-007	1.19e-007	1.17e-007	1.17e-007	1.17e-007	9.89e-008	9.87e-008
2	1.000	9.02e-012	1.87e-011	3.48e-011	1.18e-007	1.18e-007	1.18e-007	1.17e-007	1.17e-007	1.17e-007	9.85e-008	9.83e-008
3	1.000	1.36e-011	2.74e-011	4.94e-011	1.19e-007	1.19e-007	1.19e-007	1.18e-007	1.18e-007	1.18e-007	9.89e-008	9.88e-008
4	1.000	5.61e-011	1.02e-010	1.70e-010	1.29e-007	1.29e-007	1.29e-007	1.25e-007	1.25e-007	1.25e-007	1.09e-007	1.09e-007
	Sum	8.88e-011	1.69e-010	2.93e-010	4.85e-007	4.85e-007	4.84e-007	4.77e-007	4.76e-007	4.76e-007	4.05e-007	4.05e-007
	Error,%	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	8.00e+000	8.00e+000	8.00e+000	6.00e+000	6.00e+000

Information for input ECC files

#	File Name	File Stamp	Path
1	10YRD_Soil_DET1_D16.gis	Tue_Nov_18_21:53:59_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
2	10YRD_Soil_DET2_D16.gis	Thu_Nov_13_02:33:52_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
3	10YRD_Soil_DET3_D16.gis	Thu_Nov_13_02:42:09_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
4	10YRD_Soil_DET4_D16.gis	Thu_Nov_13_02:47:55_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

File Name	File Stamp	Path

Description: 10Yard Soil SUM D16

Comment: Cal Date 11/19/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

663.0	701.0	702.6	703.0	722.0	723.0	724.0	870.0	871.1	872.0	1172.0	1173.2
9.87e-008	9.73e-008	9.72e-008	9.72e-008	9.66e-008	9.65e-008	9.65e-008	9.26e-008	9.25e-008	9.26e-008	8.85e-008	8.84e-008
9.83e-008	9.69e-008	9.68e-008	9.68e-008	9.62e-008	9.61e-008	9.61e-008	9.22e-008	9.22e-008	9.22e-008	8.82e-008	8.82e-008
9.87e-008	9.73e-008	9.72e-008	9.72e-008	9.66e-008	9.65e-008	9.65e-008	9.26e-008	9.25e-008	9.26e-008	8.85e-008	8.85e-008
1.09e-007	1.08e-007	1.08e-007	1.08e-007	1.07e-007	1.07e-007	1.07e-007	1.04e-007	1.04e-007	1.04e-007	1.01e-007	1.01e-007
4.05e-007	3.99e-007	3.99e-007	3.99e-007	3.97e-007	3.96e-007	3.96e-007	3.81e-007	3.81e-007	3.81e-007	3.66e-007	3.66e-007
6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

10Yard Soil SUM D16
Cal Date 11/19/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

1174.0	1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9	1409.0	1460.8
8.84e-008	8.75e-008	8.75e-008	8.75e-008	8.69e-008	8.69e-008	8.68e-008	8.55e-008	8.55e-008	8.55e-008	8.46e-008
8.81e-008	8.73e-008	8.72e-008	8.72e-008	8.66e-008	8.66e-008	8.66e-008	8.53e-008	8.53e-008	8.53e-008	8.43e-008
8.84e-008	8.75e-008	8.75e-008	8.75e-008	8.69e-008	8.69e-008	8.69e-008	8.55e-008	8.55e-008	8.55e-008	8.46e-008
1.01e-007	9.96e-008	9.96e-008	9.96e-008	9.89e-008	9.89e-008	9.89e-008	9.80e-008	9.79e-008	9.79e-008	9.73e-008
3.66e-007	3.62e-007	3.62e-007	3.62e-007	3.59e-007	3.59e-007	3.59e-007	3.54e-007	3.54e-007	3.54e-007	3.51e-007
4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

10Yard Soil SUM D16
Cal Date 11/19/14

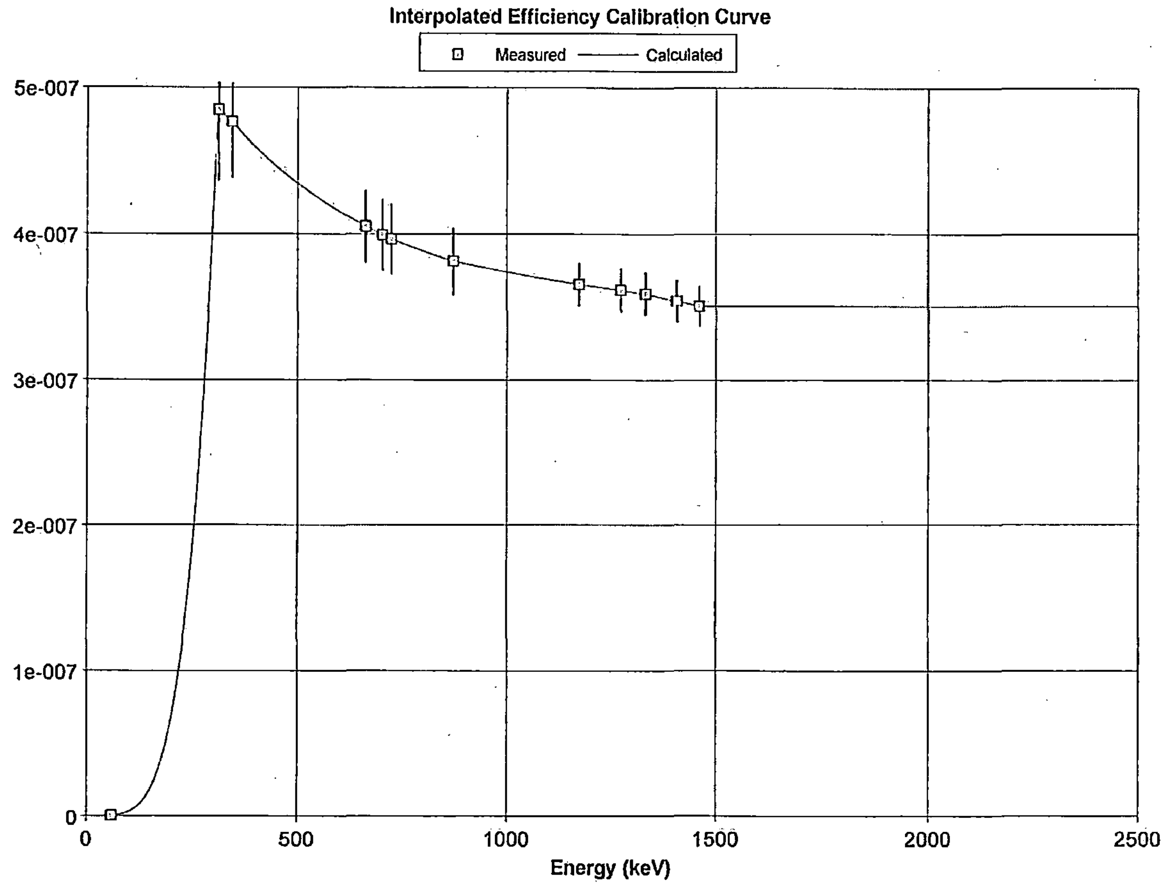
CANBERRA

Multi-Efficiency Report

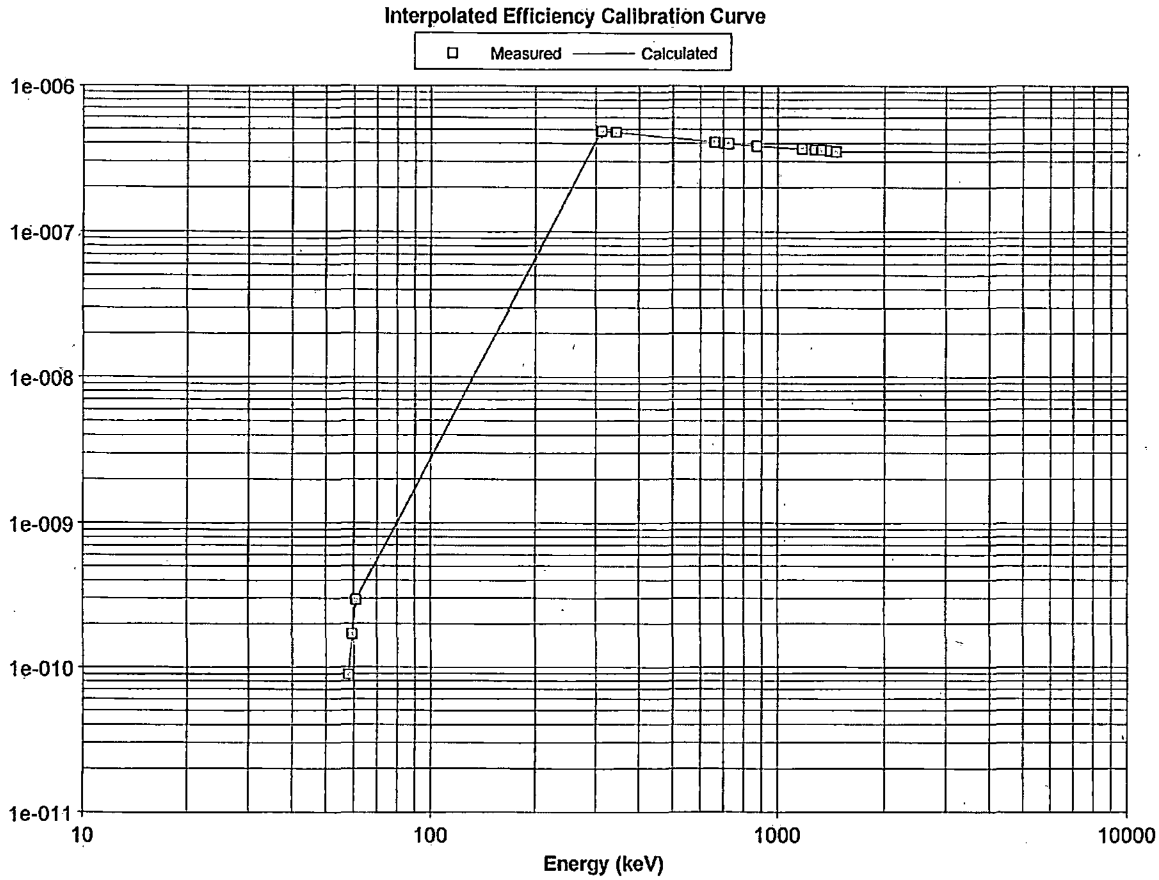
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\Multiefficiency\10YRD_
ISOCS/LabSOCS Time: 11/18/14 21:59:28
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_SUM_D16.CAL
Genie Cal Time: 11/18/14 22:03:08
Template: (SIMPLE BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+
Geom Description: 10 Yard SUM D16
Comment: ISOCS:Cal Date 11/19/14
Detector: (3994)+(3996)+(3997)+(3998)+
Collimator: (GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+
Convergence: 1.00 %
Area [Sq Meters]: 1.0000e-004 (C)
Mass [Grams]: 1.0000e+000 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	8.88443e-011	10.0	0.0000000	64000
59.54	1.69374e-010	10.0	0.0000000	64000
61.00	2.92915e-010	10.0	0.0000000	64000
311.00	4.84920e-007	10.0	0.0000000	64000
311.98	4.84530e-007	10.0	0.0000000	64000
313.00	4.84333e-007	10.0	0.0000000	64000
343.00	4.76870e-007	8.0	0.0000000	64000
344.27	4.76475e-007	8.0	0.0000000	64000
345.00	4.76340e-007	8.0	0.0000000	64000
660.00	4.05460e-007	6.0	0.0000000	64000
661.65	4.04861e-007	6.0	0.0000000	64000
663.00	4.04770e-007	6.0	0.0000000	64000
701.00	3.99368e-007	6.0	0.0000000	64000
702.63	3.98995e-007	6.0	0.0000000	64000
703.00	3.98983e-007	6.0	0.0000000	64000
722.00	3.96564e-007	6.0	0.0000000	64000
723.00	3.96364e-007	6.0	0.0000000	64000
724.00	3.96278e-007	6.0	0.0000000	64000
870.00	3.81276e-007	6.0	0.0000000	64000
871.10	3.81094e-007	6.0	0.0000000	64000
872.00	3.81269e-007	6.0	0.0000000	64000
1172.00	3.65714e-007	4.0	0.0000000	64000
1173.22	3.65707e-007	4.0	0.0000000	64000
1174.00	3.65534e-007	4.0	0.0000000	64000
1273.00	3.61918e-007	4.0	0.0000000	64000
1274.45	3.61839e-007	4.0	0.0000000	64000
1275.00	3.61799e-007	4.0	0.0000000	64000
1331.00	3.59207e-007	4.0	0.0000000	64000
1332.49	3.59306e-007	4.0	0.0000000	64000
1334.00	3.59214e-007	4.0	0.0000000	64000
1406.00	3.54320e-007	4.0	0.0000000	64000
1407.95	3.54274e-007	4.0	0.0000000	64000
1409.00	3.54274e-007	4.0	0.0000000	64000
1460.80	3.50789e-007	4.0	0.0000000	64000



Datasource: DET01



Datasource: DET01

GARDIAN SYSTEM
Calibration Records
10 Yard End Dump

Density 1.2

Geometry Composer Report

CANBERRA

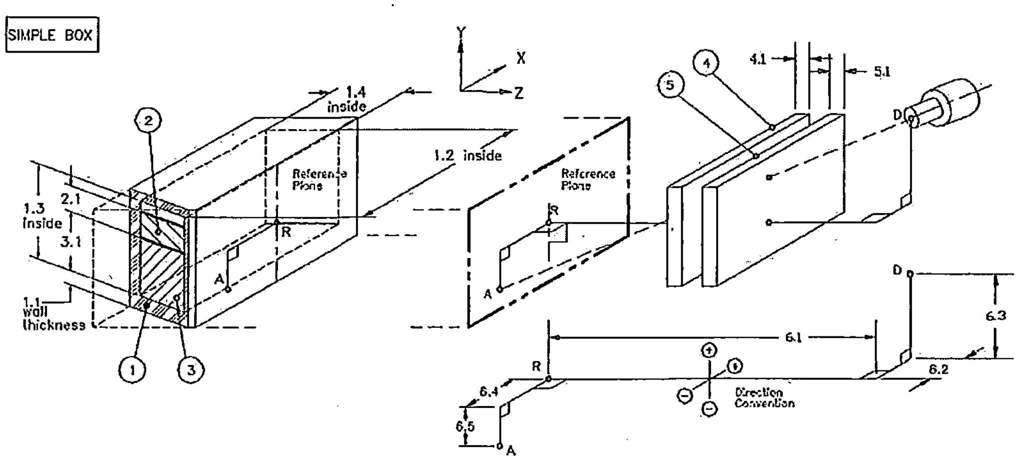
Date: Thursday, November 13, 2014 - 17:01:42
Description: 10YRD_Soil_DET1_D12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET1_D12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3994
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	1.2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.02756						germanum	5.4	
6	Source-Detector	54	45	0	45	0				

List of energies for efficiency curve generation

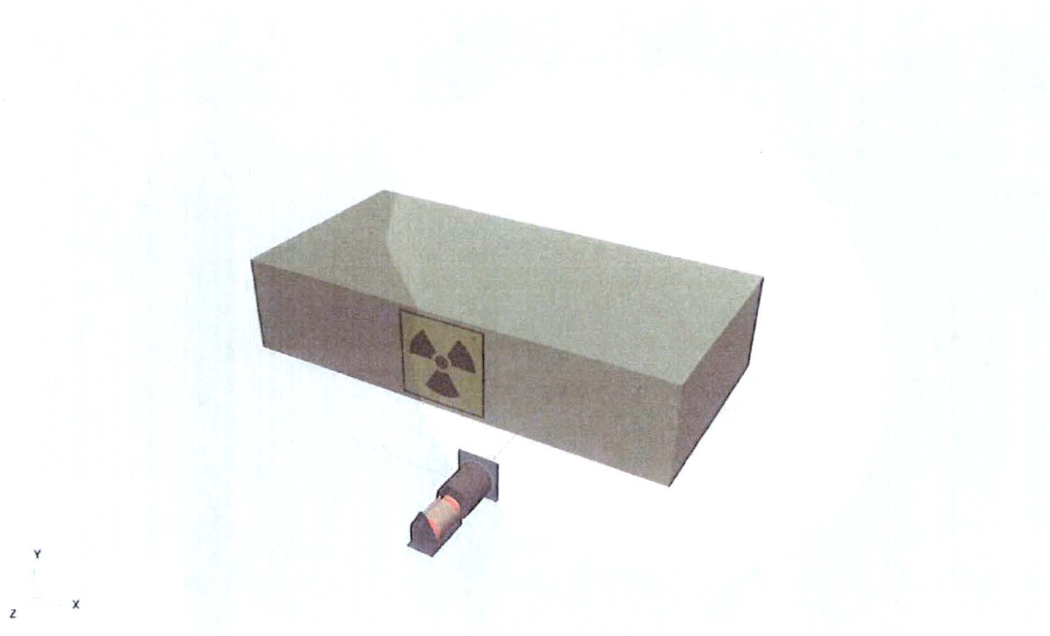
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

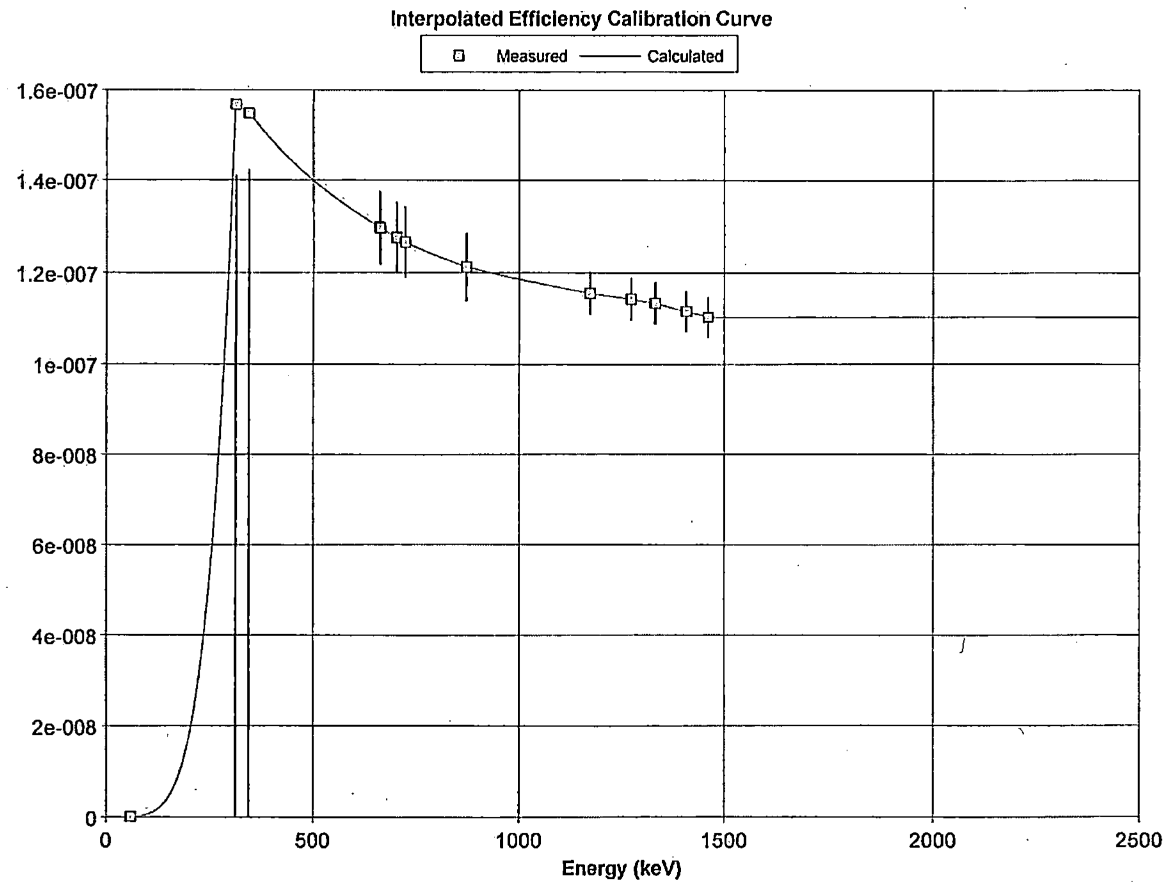
Date: Thursday, November 13, 2014 - 17:01:42
Description: 10YRD_Soil_DET1_D12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET1_D12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)



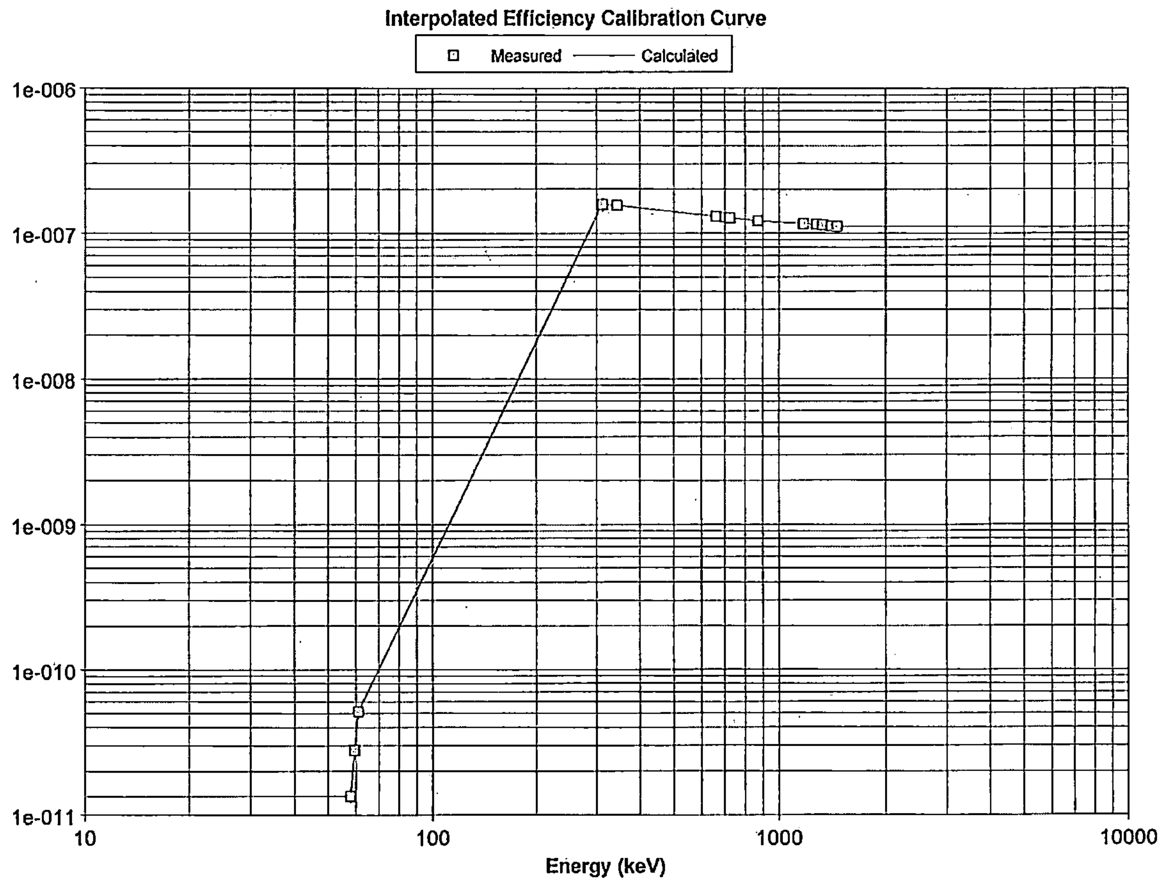
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/13/14 02:25:31
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET1_D12.CAL
Genie Cal Time: 11/13/14 03:33:43
Template: SIMPLE BOX
Geom Description: 10YRD DET1 D12
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3994
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.1214e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.34969e-011	10.0	0.092520	87381
59.54	2.78046e-011	10.0	0.086318	87381
61.00	5.12263e-011	10.0	0.081175	87381
311.00	1.56802e-007	10.0	0.007994	87381
311.98	1.56706e-007	10.0	0.008175	87381
313.00	1.56660e-007	10.0	0.007931	87381
343.00	1.54857e-007	8.0	0.004391	87381
344.27	1.54744e-007	8.0	0.004364	87381
345.00	1.54698e-007	8.0	0.004339	87381
660.00	1.29849e-007	6.0	-0.004267	87381
661.65	1.29635e-007	6.0	-0.004238	87381
663.00	1.29601e-007	6.0	-0.004288	87381
701.00	1.27707e-007	6.0	-0.004267	87381
702.63	1.27563e-007	6.0	-0.004228	87381
703.00	1.27575e-007	6.0	-0.004359	87381
722.00	1.26716e-007	6.0	-0.004200	87381
723.00	1.26642e-007	6.0	-0.004383	87381
724.00	1.26612e-007	6.0	-0.004308	87381
870.00	1.21300e-007	6.0	-0.004133	87381
871.10	1.21231e-007	6.0	-0.004071	87381
872.00	1.21291e-007	6.0	-0.004142	87381
1172.00	1.15627e-007	4.0	-0.003736	87381
1173.22	1.15596e-007	4.0	-0.003702	87381
1174.00	1.15545e-007	4.0	-0.003717	87381
1273.00	1.14318e-007	4.0	-0.003545	87381
1274.45	1.14282e-007	4.0	-0.003570	87381
1275.00	1.14274e-007	4.0	-0.003660	87381
1331.00	1.13416e-007	4.0	-0.003463	87381
1332.49	1.13423e-007	4.0	-0.003422	87381
1334.00	1.13372e-007	4.0	-0.003436	87381
1406.00	1.11596e-007	4.0	-0.003239	87381
1407.95	1.11588e-007	4.0	-0.003249	87381
1409.00	1.11596e-007	4.0	-0.003191	87381
1460.80	1.10328e-007	4.0	-0.003034	87381



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

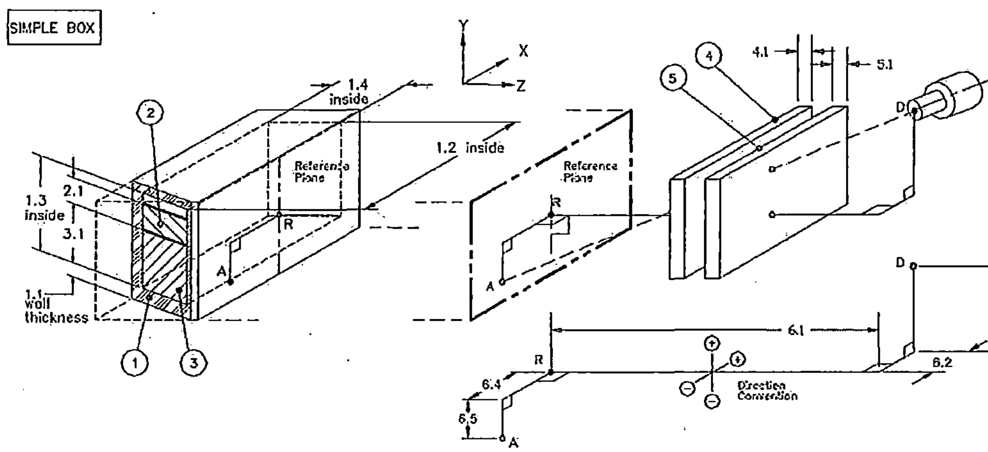
Date: Thursday, November 13, 2014 - 17:03:55
Description: 10YRD_Soil_DET2_D12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET2_D12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3996
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	1.2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.0315						germanum	5.4	
6	Source-Detector	54	-45	0	-45	0				

List of energies for efficiency curve generation

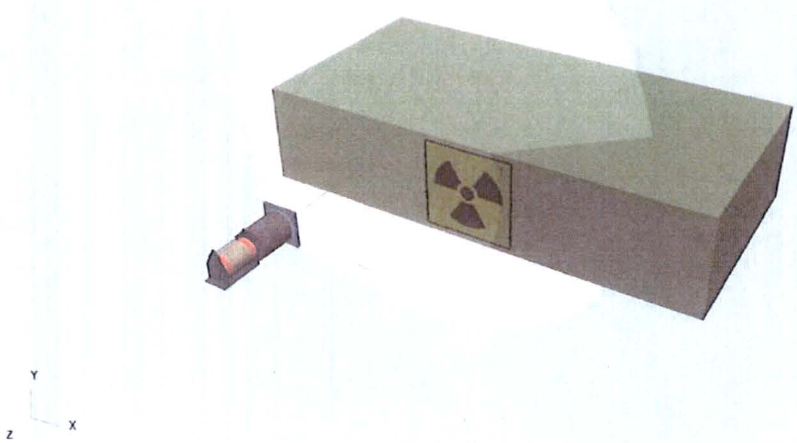
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

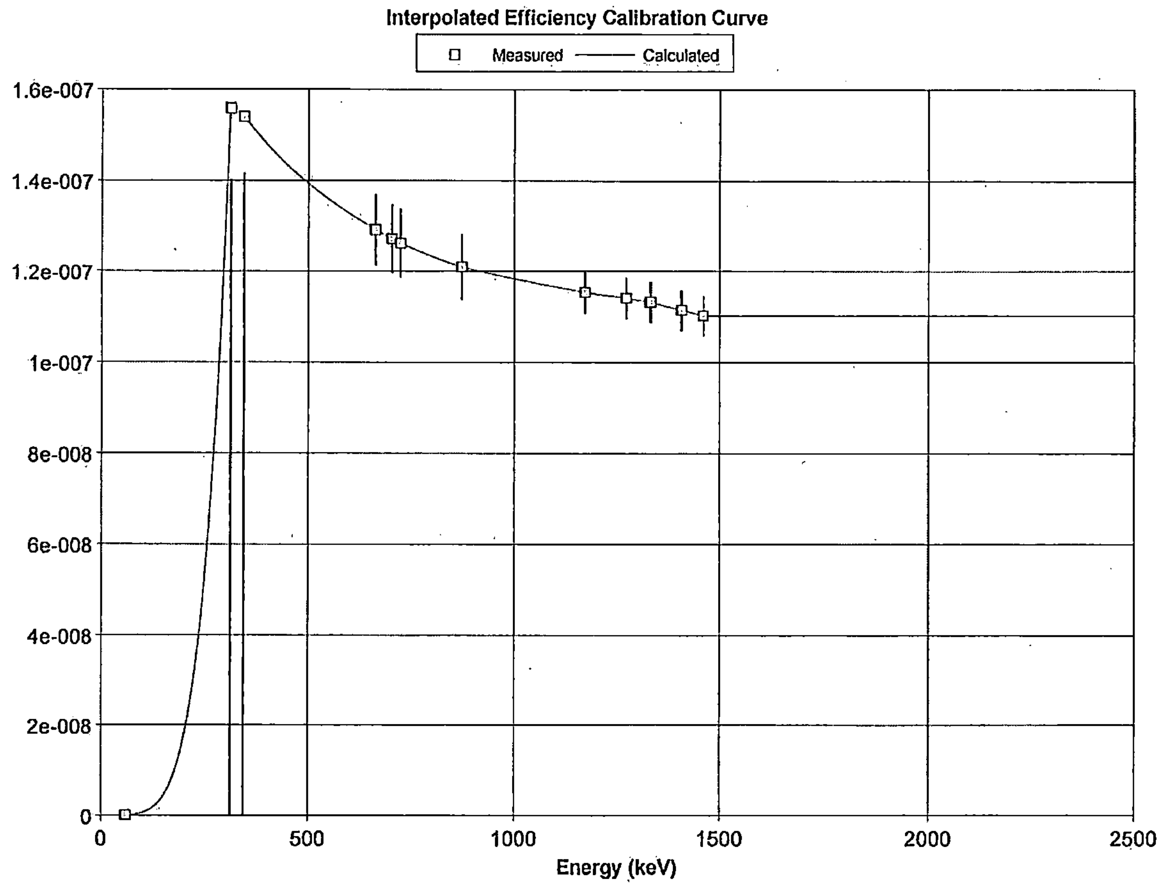
Date:	Thursday, November 13, 2014 - 17:03:55
Description:	10YRD_Soil_DET2_D12
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\10YRD_Soil_DET2_D12.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



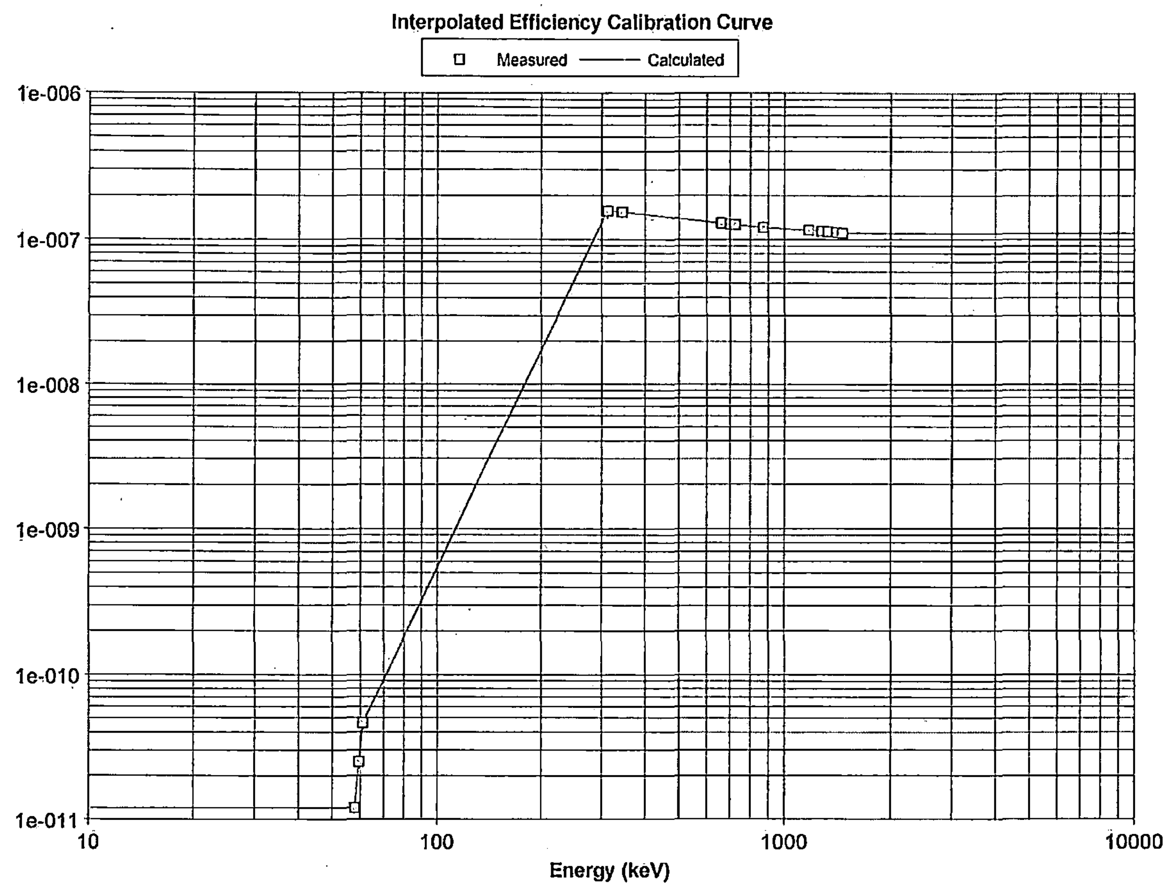
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/13/14 02:32:37
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET2_D12.CAL
Genie Cal Time: 11/13/14 03:39:06
Template: SIMPLE BOX
Geom Description: 10YRD DET2 D12
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3996
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.1214e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.19868e-011	10.0	0.115154	87381
59.54	2.48963e-011	10.0	0.110206	87381
61.00	4.61920e-011	10.0	0.106257	87381
311.00	1.55888e-007	10.0	0.052999	87381
311.98	1.55794e-007	10.0	0.053115	87381
313.00	1.55751e-007	10.0	0.052782	87381
343.00	1.54009e-007	8.0	0.046588	87381
344.27	1.53899e-007	8.0	0.046394	87381
345.00	1.53855e-007	8.0	0.046281	87381
660.00	1.29344e-007	6.0	0.017183	87381
661.65	1.29131e-007	6.0	0.017120	87381
663.00	1.29098e-007	6.0	0.017049	87381
701.00	1.27224e-007	6.0	0.015833	87381
702.63	1.27081e-007	6.0	0.015736	87381
703.00	1.27093e-007	6.0	0.015643	87381
722.00	1.26244e-007	6.0	0.015219	87381
723.00	1.26170e-007	6.0	0.014991	87381
724.00	1.26141e-007	6.0	0.015072	87381
870.00	1.20888e-007	6.0	0.011807	87381
871.10	1.20819e-007	6.0	0.011852	87381
872.00	1.20879e-007	6.0	0.011723	87381
1172.00	1.15289e-007	4.0	0.007933	87381
1173.22	1.15259e-007	4.0	0.007957	87381
1174.00	1.15208e-007	4.0	0.007956	87381
1273.00	1.13998e-007	4.0	0.007195	87381
1274.45	1.13963e-007	4.0	0.007123	87381
1275.00	1.13954e-007	4.0	0.007108	87381
1331.00	1.13105e-007	4.0	0.006762	87381
1332.49	1.13112e-007	4.0	0.006809	87381
1334.00	1.13062e-007	4.0	0.006766	87381
1406.00	1.11298e-007	4.0	0.006501	87381
1407.95	1.11291e-007	4.0	0.006456	87381
1409.00	1.11299e-007	4.0	0.006518	87381
1460.80	1.10039e-007	4.0	0.006363	87381



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

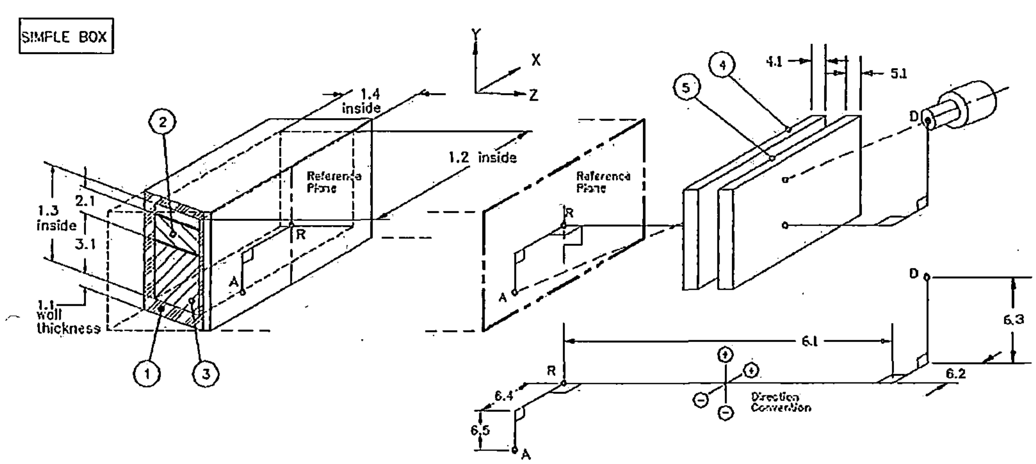
Date: Thursday, November 13, 2014 - 17:05:37
Description: 10YRD_SOIL_DET3_12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_SOIL_DET3_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3997
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	1.2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2	0.03543						germanum	5.4	
6	Source-Detector	54	45	0	45	0				

List of energies for efficiency curve generation

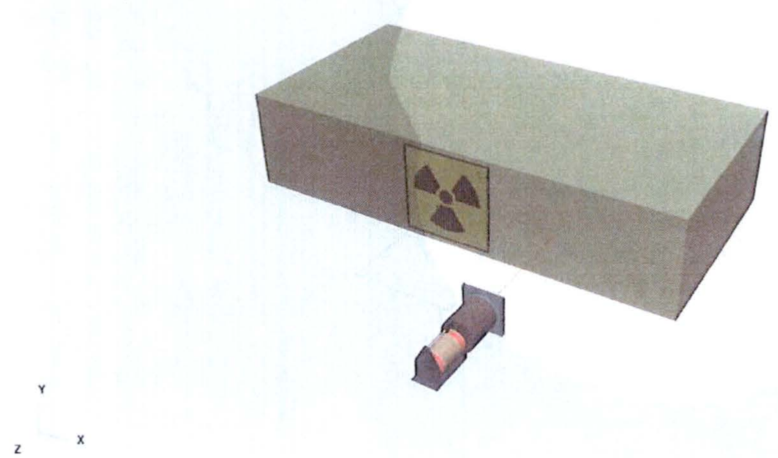
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

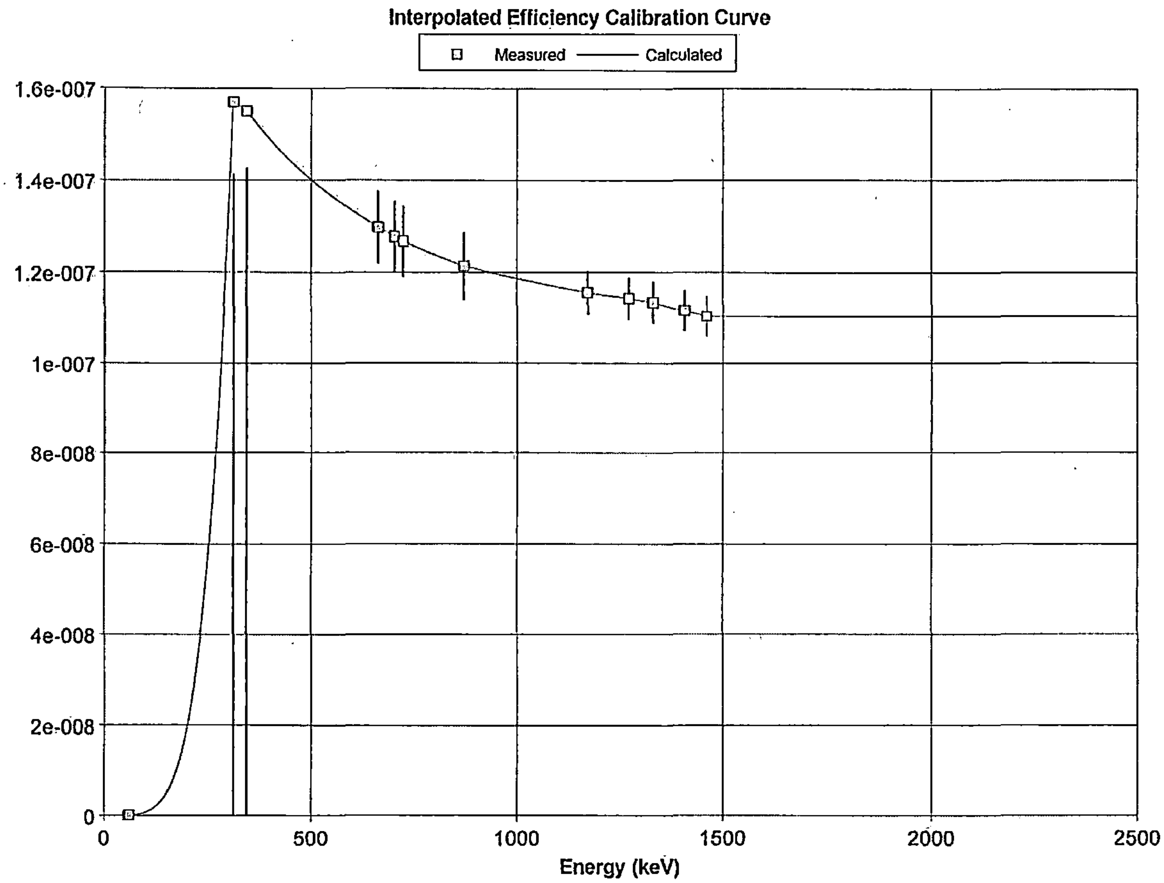
Date:	Thursday, November 13, 2014 - 17:05:37
Description:	10YRD_SOIL_DET3_12
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\10YRD_SOIL_DET3_12.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



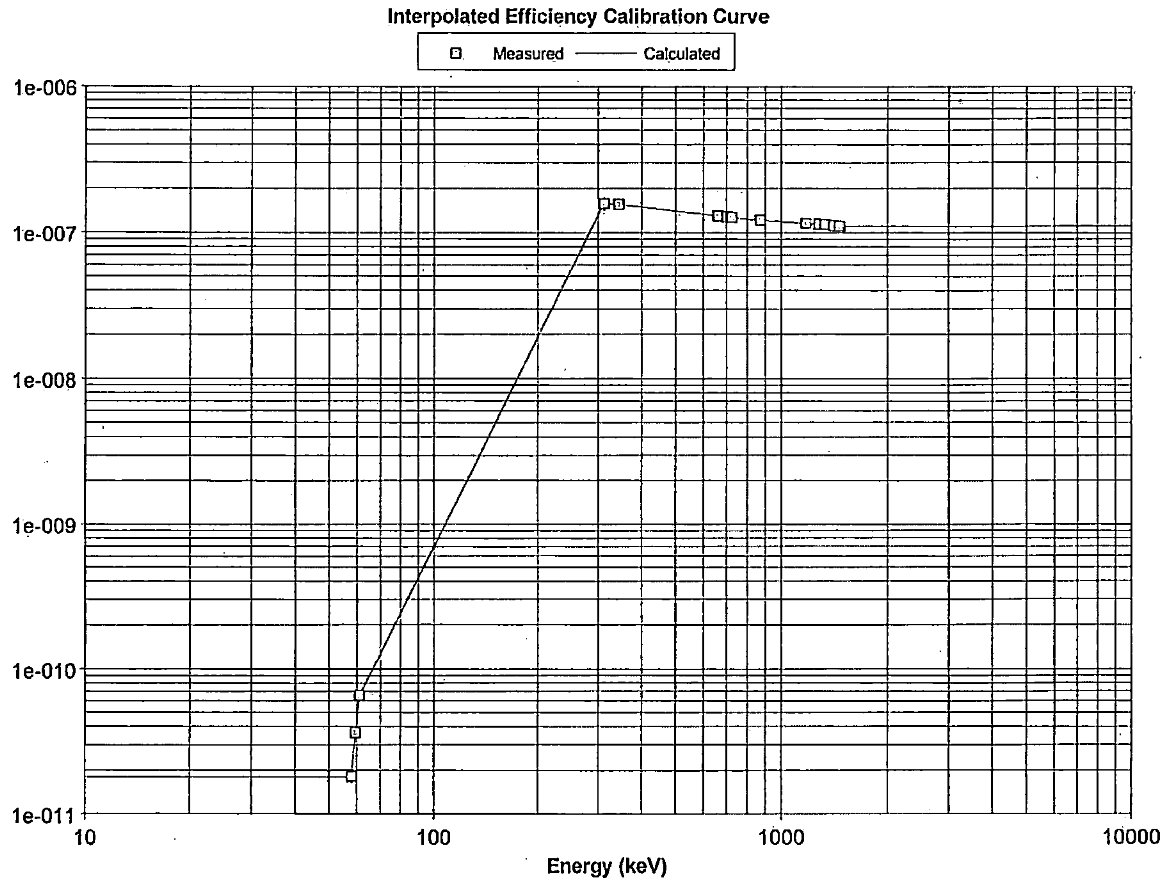
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_SOIL_
ISOCS/LabSOCS Time: 11/13/14 02:40:51
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET3_12.CAL
Genie Cal Time: 11/13/14 03:43:42
Template: SIMPLE BOX
Geom Description: 10YRD DET3 12
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3997
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.1214e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.80374e-011	10.0	0.092653	87381
59.54	3.63396e-011	10.0	0.086449	87381
61.00	6.56820e-011	10.0	0.081303	87381
311.00	1.57076e-007	10.0	0.008001	87381
311.98	1.56977e-007	10.0	0.008182	87381
313.00	1.56929e-007	10.0	0.007938	87381
343.00	1.55069e-007	8.0	0.004397	87381
344.27	1.54953e-007	8.0	0.004370	87381
345.00	1.54907e-007	8.0	0.004345	87381
660.00	1.29904e-007	6.0	-0.004265	87381
661.65	1.29690e-007	6.0	-0.004235	87381
663.00	1.29656e-007	6.0	-0.004286	87381
701.00	1.27757e-007	6.0	-0.004265	87381
702.63	1.27613e-007	6.0	-0.004226	87381
703.00	1.27625e-007	6.0	-0.004357	87381
722.00	1.26765e-007	6.0	-0.004198	87381
723.00	1.26690e-007	6.0	-0.004381	87381
724.00	1.26661e-007	6.0	-0.004306	87381
870.00	1.21339e-007	6.0	-0.004131	87381
871.10	1.21270e-007	6.0	-0.004070	87381
872.00	1.21330e-007	6.0	-0.004140	87381
1172.00	1.15657e-007	4.0	-0.003734	87381
1173.22	1.15627e-007	4.0	-0.003700	87381
1174.00	1.15576e-007	4.0	-0.003716	87381
1273.00	1.14349e-007	4.0	-0.003544	87381
1274.45	1.14313e-007	4.0	-0.003569	87381
1275.00	1.14305e-007	4.0	-0.003659	87381
1331.00	1.13447e-007	4.0	-0.003462	87381
1332.49	1.13454e-007	4.0	-0.003420	87381
1334.00	1.13404e-007	4.0	-0.003434	87381
1406.00	1.11628e-007	4.0	-0.003237	87381
1407.95	1.11621e-007	4.0	-0.003247	87381
1409.00	1.11628e-007	4.0	-0.003190	87381
1460.80	1.10362e-007	4.0	-0.003033	87381



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

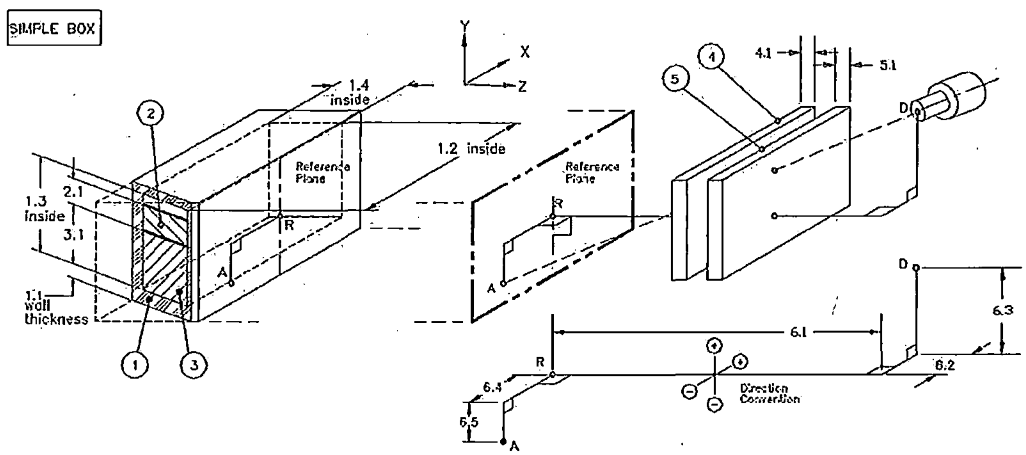
Date: Thursday, November 13, 2014 - 17:06:19
Description: 10YRD_Soil_DET4_D12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\10YRD_Soil_DET4_D12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3998
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.26	180	40	88			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	36						dirt1	1.2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2							none		
6	Source-Detector	54	-45	0	-45	0				

List of energies for efficiency curve generation

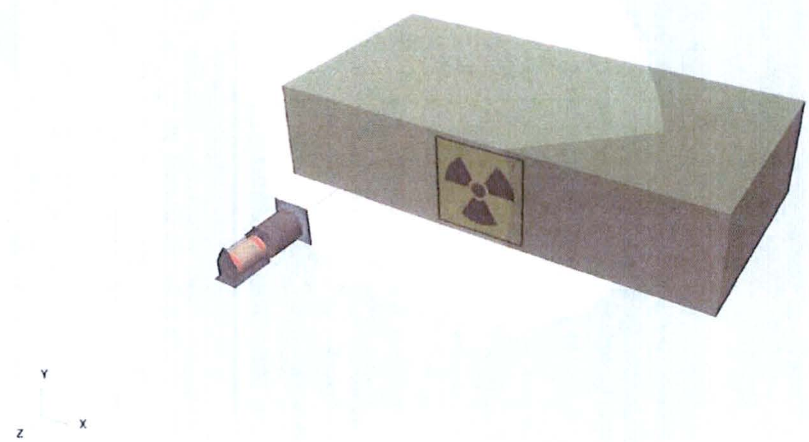
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

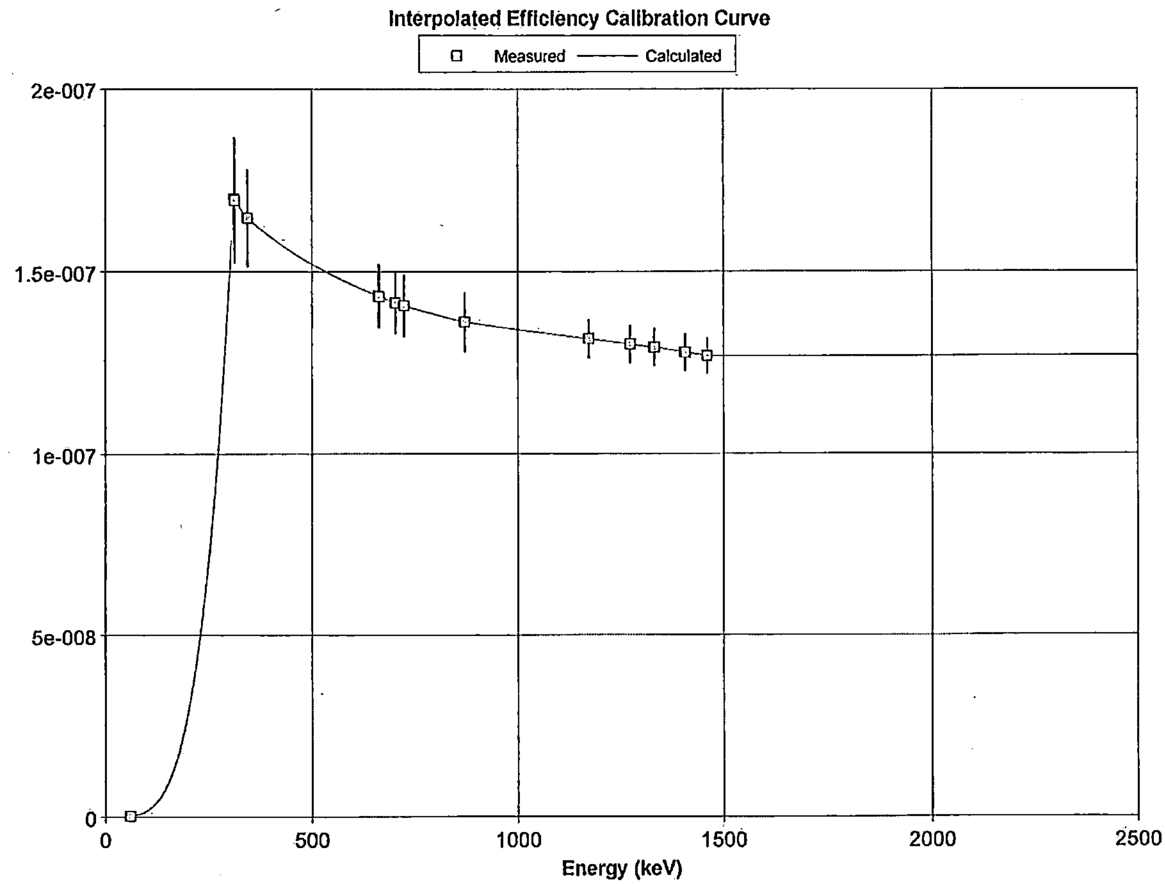
Date:	Thursday, November 13, 2014 - 17:06:19
Description:	10YRD_Soil_DET4_D12
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\10YRD_Soil_DET4_D12.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



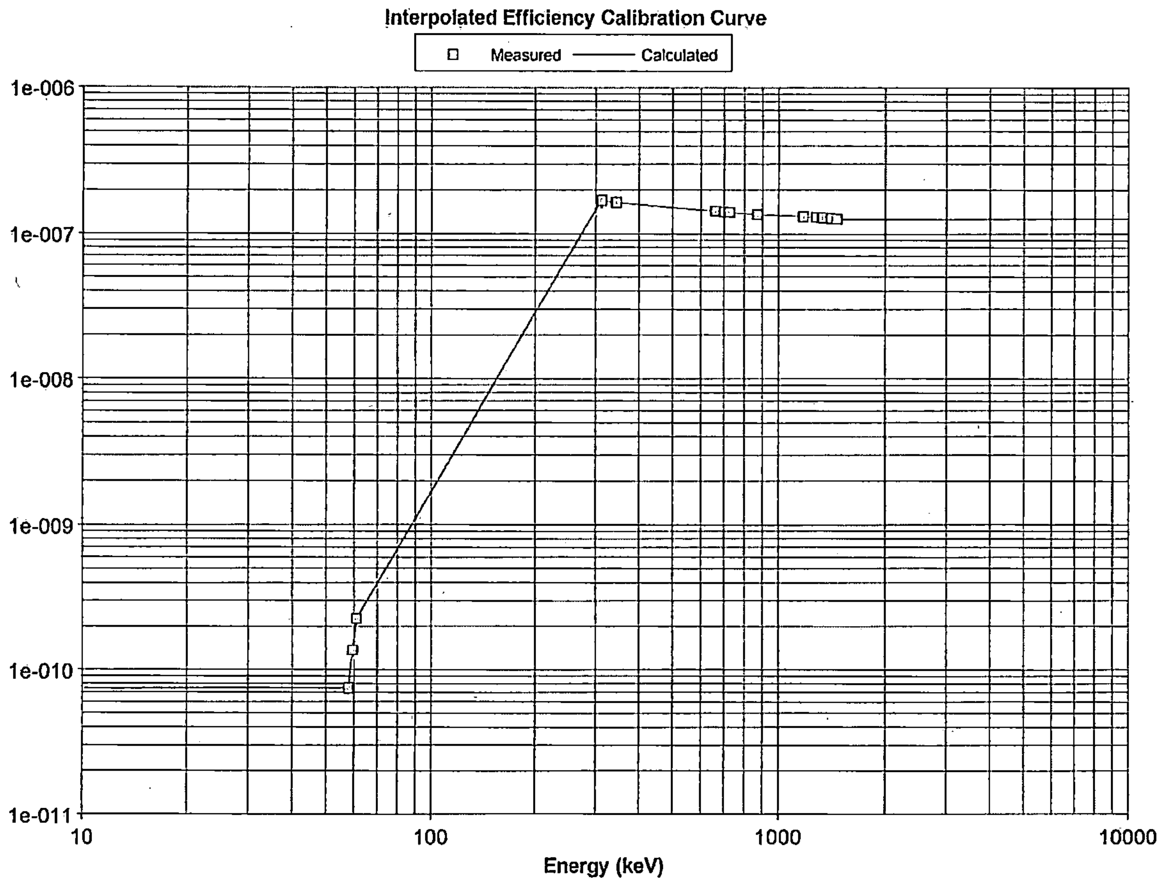
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\10YRD_Soil_
ISOCS/LabSOCS Time: 11/13/14 02:46:50
Genie Cal File: C:\GENIE2K\CALFILES\10YRD_Soil_DET4_D12.CAL
Genie Cal Time: 11/13/14 03:47:42
Template: SIMPLE BOX
Geom Description: 10YRD DET4 D12
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3998
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 4.1806e+000 (C)
Mass [Grams]: 1.1214e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	7.43934e-011	10.0	-0.060210	87381
59.54	1.35728e-010	10.0	-0.060704	87381
61.00	2.25585e-010	10.0	-0.061424	87381
311.00	1.69713e-007	10.0	-0.036141	87381
311.98	1.69490e-007	10.0	-0.036232	87381
313.00	1.69370e-007	10.0	-0.036174	87381
343.00	1.64688e-007	8.0	-0.035327	87381
344.27	1.64496e-007	8.0	-0.035269	87381
345.00	1.64456e-007	8.0	-0.035464	87381
660.00	1.43400e-007	6.0	-0.024850	87381
661.65	1.43227e-007	6.0	-0.024859	87381
663.00	1.43227e-007	6.0	-0.024788	87381
701.00	1.41562e-007	6.0	-0.023900	87381
702.63	1.41497e-007	6.0	-0.023886	87381
703.00	1.41458e-007	6.0	-0.023936	87381
722.00	1.40728e-007	6.0	-0.023689	87381
723.00	1.40683e-007	6.0	-0.023592	87381
724.00	1.40663e-007	6.0	-0.023322	87381
870.00	1.36174e-007	6.0	-0.020944	87381
871.10	1.36146e-007	6.0	-0.020829	87381
872.00	1.36160e-007	6.0	-0.020815	87381
1172.00	1.31564e-007	4.0	-0.016714	87381
1173.22	1.31584e-007	4.0	-0.016771	87381
1174.00	1.31514e-007	4.0	-0.016842	87381
1273.00	1.30111e-007	4.0	-0.015539	87381
1274.45	1.30103e-007	4.0	-0.015654	87381
1275.00	1.30079e-007	4.0	-0.015531	87381
1331.00	1.29132e-007	4.0	-0.014809	87381
1332.49	1.29187e-007	4.0	-0.014905	87381
1334.00	1.29176e-007	4.0	-0.014808	87381
1406.00	1.27876e-007	4.0	-0.014015	87381
1407.95	1.27812e-007	4.0	-0.014093	87381
1409.00	1.27792e-007	4.0	-0.014048	87381
1460.80	1.26875e-007	4.0	-0.013575	87381



Datasource: DET01



Datasource: DET01

#	Weight	58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3	345.0	660.0	661.7
	Primary Efficiency taken from ECC files, for set energies (keV):											
1	1.000	1.35e-011	2.78e-011	5.12e-011	1.57e-007	1.57e-007	1.57e-007	1.55e-007	1.55e-007	1.55e-007	1.30e-007	1.30e-007
2	1.000	1.20e-011	2.49e-011	4.62e-011	1.56e-007	1.56e-007	1.56e-007	1.54e-007	1.54e-007	1.54e-007	1.29e-007	1.29e-007
3	1.000	1.80e-011	3.63e-011	6.57e-011	1.57e-007	1.57e-007	1.57e-007	1.55e-007	1.55e-007	1.55e-007	1.30e-007	1.30e-007
4	1.000	7.44e-011	1.36e-010	2.26e-010	1.70e-007	1.69e-007	1.69e-007	1.65e-007	1.64e-007	1.64e-007	1.43e-007	1.43e-007
	Sum	1.18e-010	2.25e-010	3.89e-010	6.39e-007	6.39e-007	6.39e-007	6.29e-007	6.28e-007	6.28e-007	5.32e-007	5.32e-007
	Error,%	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	8.00e+000	8.00e+000	8.00e+000	6.00e+000	6.00e+000

Information for input ECC files

#	File Name	File Stamp	Path
1	10YRD_Soil_DET1_D12.gis	Thu_Nov_13_02:24:34_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
2	10YRD_Soil_DET2_D12.gis	Thu_Nov_13_02:31:39_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
3	10YRD_SOIL_DET3_12.gis	Thu_Nov_13_02:39:54_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
4	10YRD_Soil_DET4_D12.gis	Thu_Nov_13_02:45:53_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

File Name File Stamp Path

Description: 10YRD_Soil_SUM_D12
Comment: Cal Date 11/13/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

663.0	701.0	702.6	703.0	722.0	723.0	724.0	870.0	871.1	872.0	1172.0	1173.2
1.30e-007	1.28e-007	1.28e-007	1.28e-007	1.27e-007	1.27e-007	1.27e-007	1.21e-007	1.21e-007	1.21e-007	1.16e-007	1.16e-007
1.29e-007	1.27e-007	1.27e-007	1.27e-007	1.26e-007	1.26e-007	1.26e-007	1.21e-007	1.21e-007	1.21e-007	1.15e-007	1.15e-007
1.30e-007	1.28e-007	1.28e-007	1.28e-007	1.27e-007	1.27e-007	1.27e-007	1.21e-007	1.21e-007	1.21e-007	1.16e-007	1.16e-007
1.43e-007	1.42e-007	1.41e-007	1.41e-007	1.41e-007	1.41e-007	1.41e-007	1.36e-007	1.36e-007	1.36e-007	1.32e-007	1.32e-007
5.32e-007	5.24e-007	5.24e-007	5.24e-007	5.20e-007	5.20e-007	5.20e-007	5.00e-007	4.99e-007	5.00e-007	4.78e-007	4.78e-007
6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

10YRD_Soil_SUM_D12
Cal Date 11/13/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

1174.0	1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9	1409.0	1460.8
1.16e-007	1.14e-007	1.14e-007	1.14e-007	1.13e-007	1.13e-007	1.13e-007	1.12e-007	1.12e-007	1.12e-007	1.10e-007
1.15e-007	1.14e-007	1.14e-007	1.14e-007	1.13e-007	1.13e-007	1.13e-007	1.11e-007	1.11e-007	1.11e-007	1.10e-007
1.16e-007	1.14e-007	1.14e-007	1.14e-007	1.13e-007	1.13e-007	1.13e-007	1.12e-007	1.12e-007	1.12e-007	1.10e-007
1.32e-007	1.30e-007	1.30e-007	1.30e-007	1.29e-007	1.29e-007	1.29e-007	1.28e-007	1.28e-007	1.28e-007	1.27e-007
4.78e-007	4.73e-007	4.73e-007	4.73e-007	4.69e-007	4.69e-007	4.69e-007	4.62e-007	4.62e-007	4.62e-007	4.58e-007
4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

10YRD_Soil_SUM_D12
Cal Date 11/13/14

CANBERRA

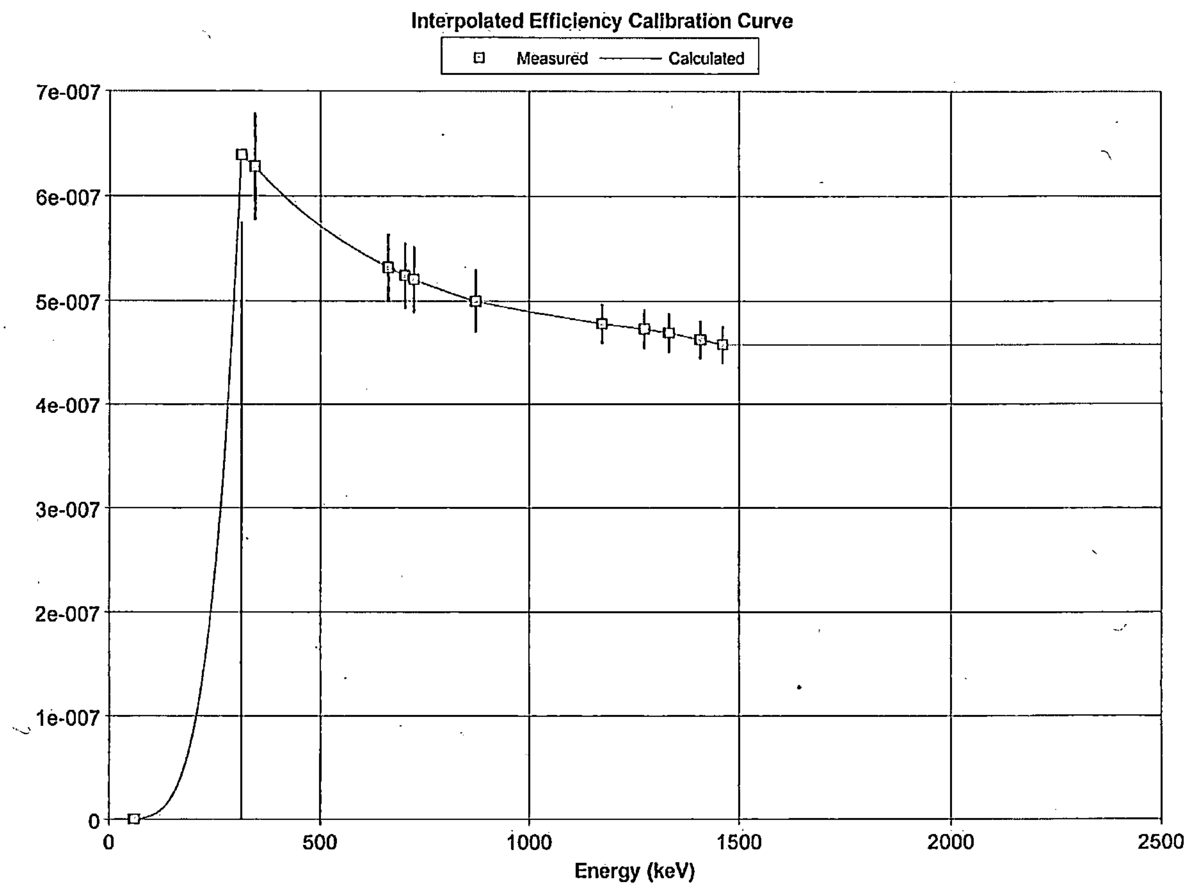
Multi-Efficiency Report

ISOCS/LABSOCS RESULTS

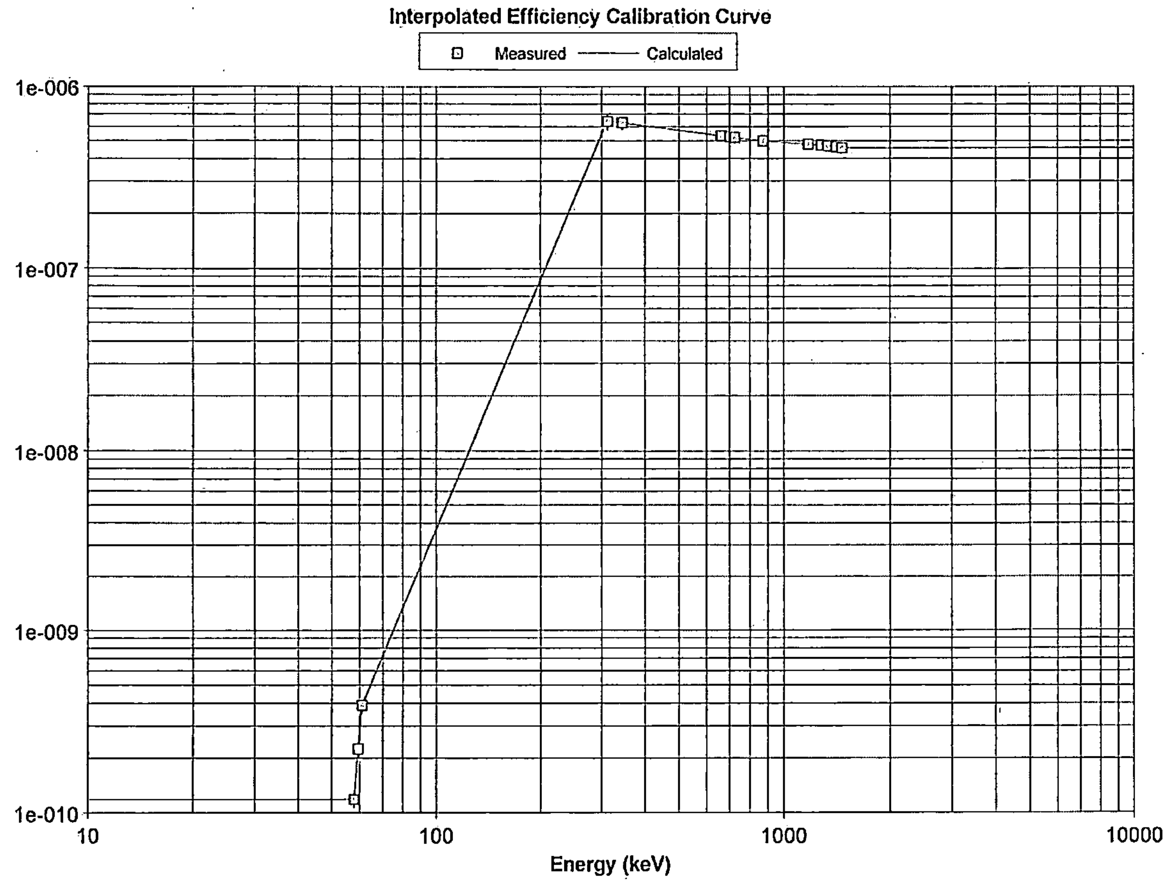
ISOCS/LabSOCS File:	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\Multiefficiency\10Yrd_
ISOCS/LabSOCS Time:	11/13/14 03:18:06
Genie Cal File:	C:\GENIE2K\CALFILES\10YRD_Soil_SUM_D12.CAL
Genie Cal Time:	11/13/14 03:57:02
Template:	(SIMPLE BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+
Geom Description:	10YRD SUM D12
Comment:	ISOCS:Cal Date 11/13/14
Detector:	(3994)+(3996)+(3997)+(3998)+
Collimator:	(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+
Convergence:	1.00 %
Area [Sq Meters]:	1.0000e-004 (C)
Mass [Grams]:	1.0000e+000 (C)
Length [Meters]:	not used

(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.17915e-010	10.0	0.1151540	64000
59.54	2.24769e-010	10.0	0.1151540	64000
61.00	3.88685e-010	10.0	0.1151540	64000
311.00	6.39479e-007	10.0	0.1151540	64000
311.98	6.38967e-007	10.0	0.1151540	64000
313.00	6.38710e-007	10.0	0.1151540	64000
343.00	6.28623e-007	8.0	0.1151540	64000
344.27	6.28092e-007	8.0	0.1151540	64000
345.00	6.27916e-007	8.0	0.1151540	64000
660.00	5.32497e-007	6.0	0.1151540	64000
661.65	5.31683e-007	6.0	0.1151540	64000
663.00	5.31582e-007	6.0	0.1151540	64000
701.00	5.24250e-007	6.0	0.1151540	64000
702.63	5.23754e-007	6.0	0.1151540	64000
703.00	5.23751e-007	6.0	0.1151540	64000
722.00	5.20453e-007	6.0	0.1151540	64000
723.00	5.20185e-007	6.0	0.1151540	64000
724.00	5.20077e-007	6.0	0.1151540	64000
870.00	4.99701e-007	6.0	0.1151540	64000
871.10	4.99466e-007	6.0	0.1151540	64000
872.00	4.99660e-007	6.0	0.1151540	64000
1172.00	4.78137e-007	4.0	0.1151540	64000
1173.22	4.78066e-007	4.0	0.1151540	64000
1174.00	4.77843e-007	4.0	0.1151540	64000
1273.00	4.72776e-007	4.0	0.1151540	64000
1274.45	4.72661e-007	4.0	0.1151540	64000
1275.00	4.72612e-007	4.0	0.1151540	64000
1331.00	4.69100e-007	4.0	0.1151540	64000
1332.49	4.69176e-007	4.0	0.1151540	64000
1334.00	4.69014e-007	4.0	0.1151540	64000
1406.00	4.62398e-007	4.0	0.1151540	64000
1407.95	4.62312e-007	4.0	0.1151540	64000
1409.00	4.62315e-007	4.0	0.1151540	64000
1460.80	4.57604e-007	4.0	0.1151540	64000



Datasource: DET01



Datasource: DET01

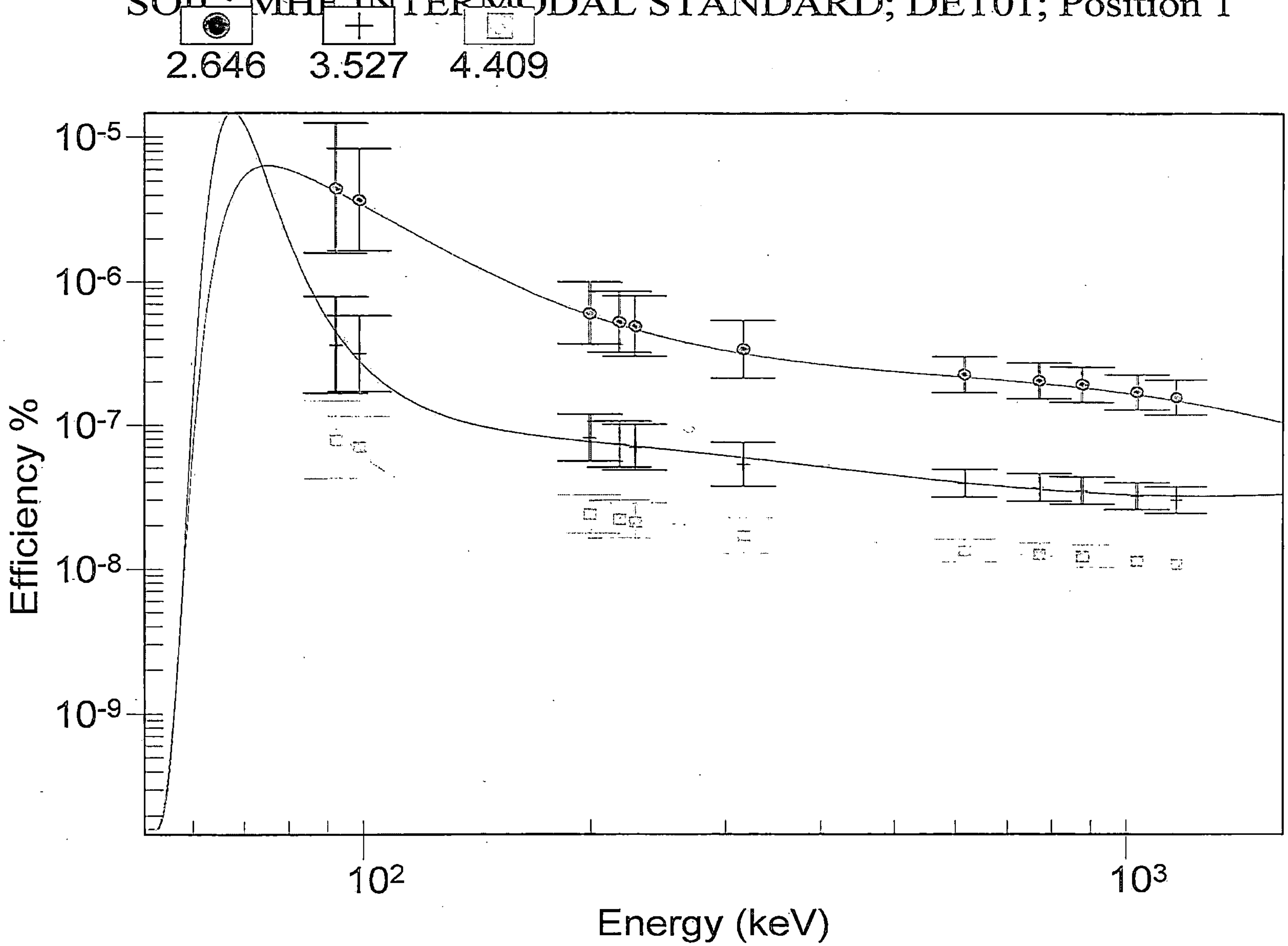
Attachment 10.3
ISOCS Multi-Curve Efficiency Plots

GARDIAN SYSTEM
Calibration Records
MHF IP-1 & IP-2 Intermodal

Summation

MHF STD Soil 11_18_14 11/17/2014 10:14:15 PM

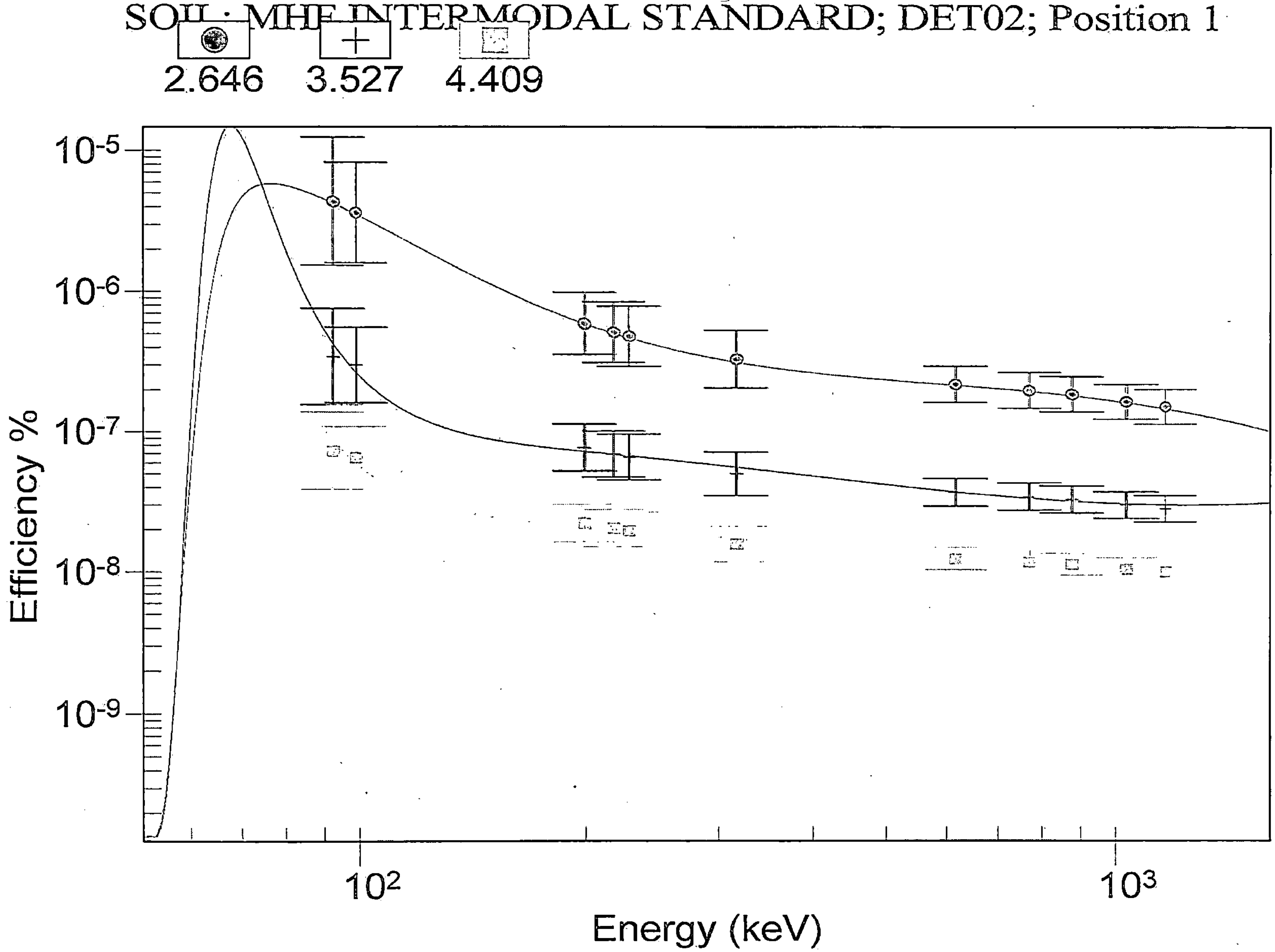
SOIL : MHF INTERMODAL STANDARD; DET01; Position 1



Attachment 10.3
ISOCS Multi-Curve Efficiency Plots

MHF STD Soil 11_18_14 11/17/2014 10:15:17 PM

SOIL: MHF INTERMODAL STANDARD; DET02; Position 1



TBD-401

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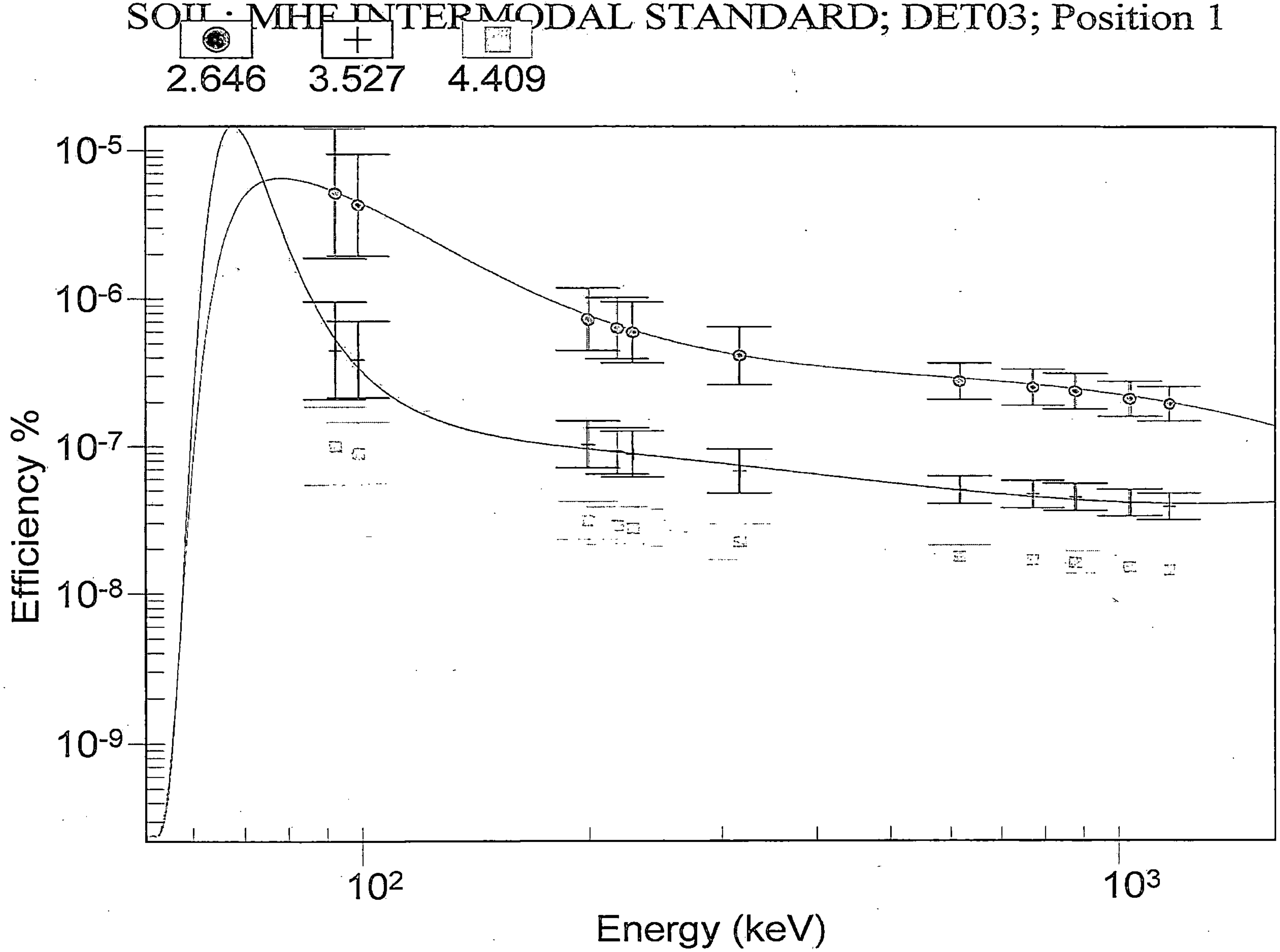
Attachment 10.3
ISOCS Multi-Curve Efficiency Plots

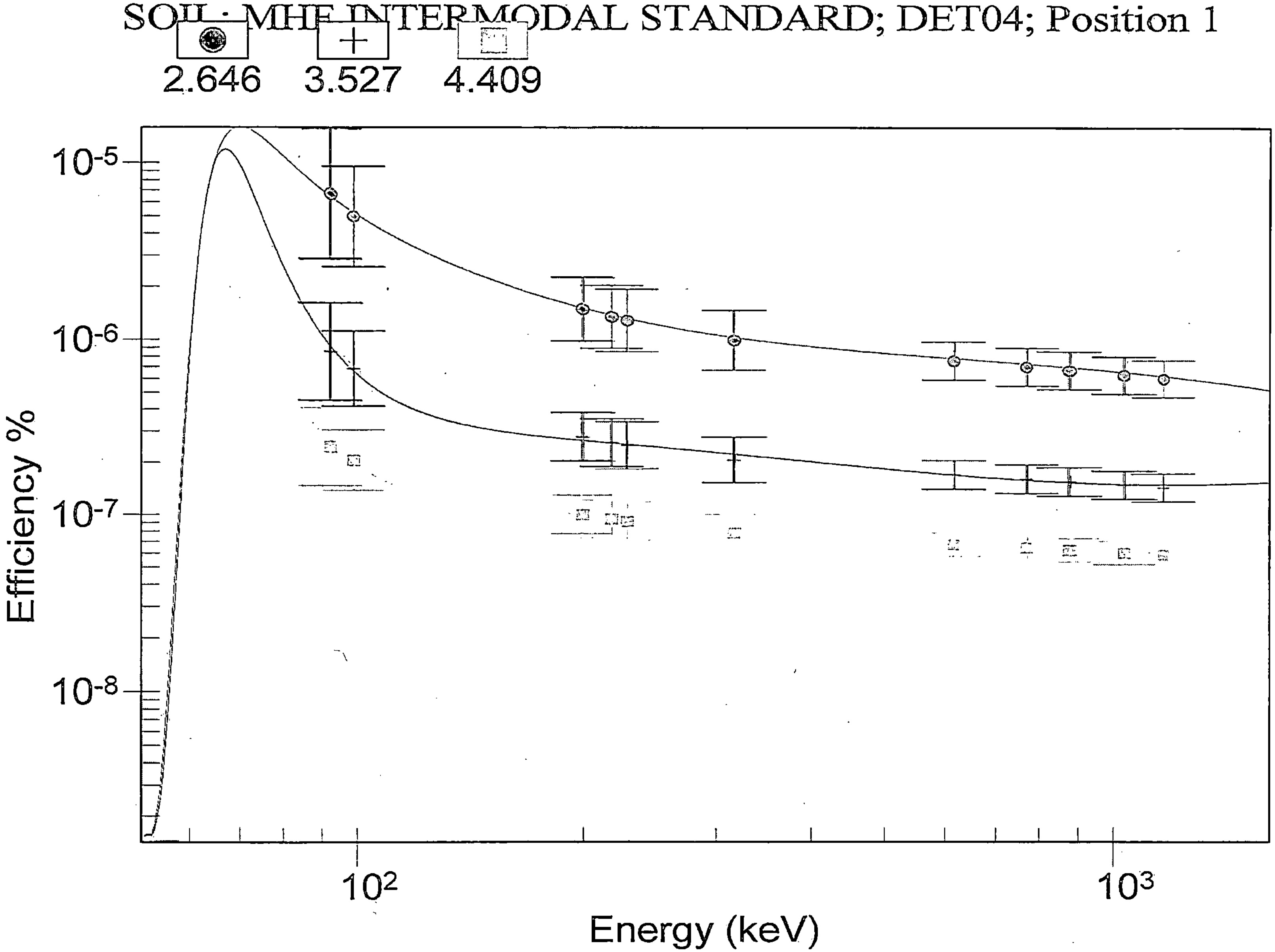
MHF STD Soil 11_18_14 11/17/2014 10:17:04 PM

SOIL : MHF INTERMODAL STANDARD; DET03; Position 1



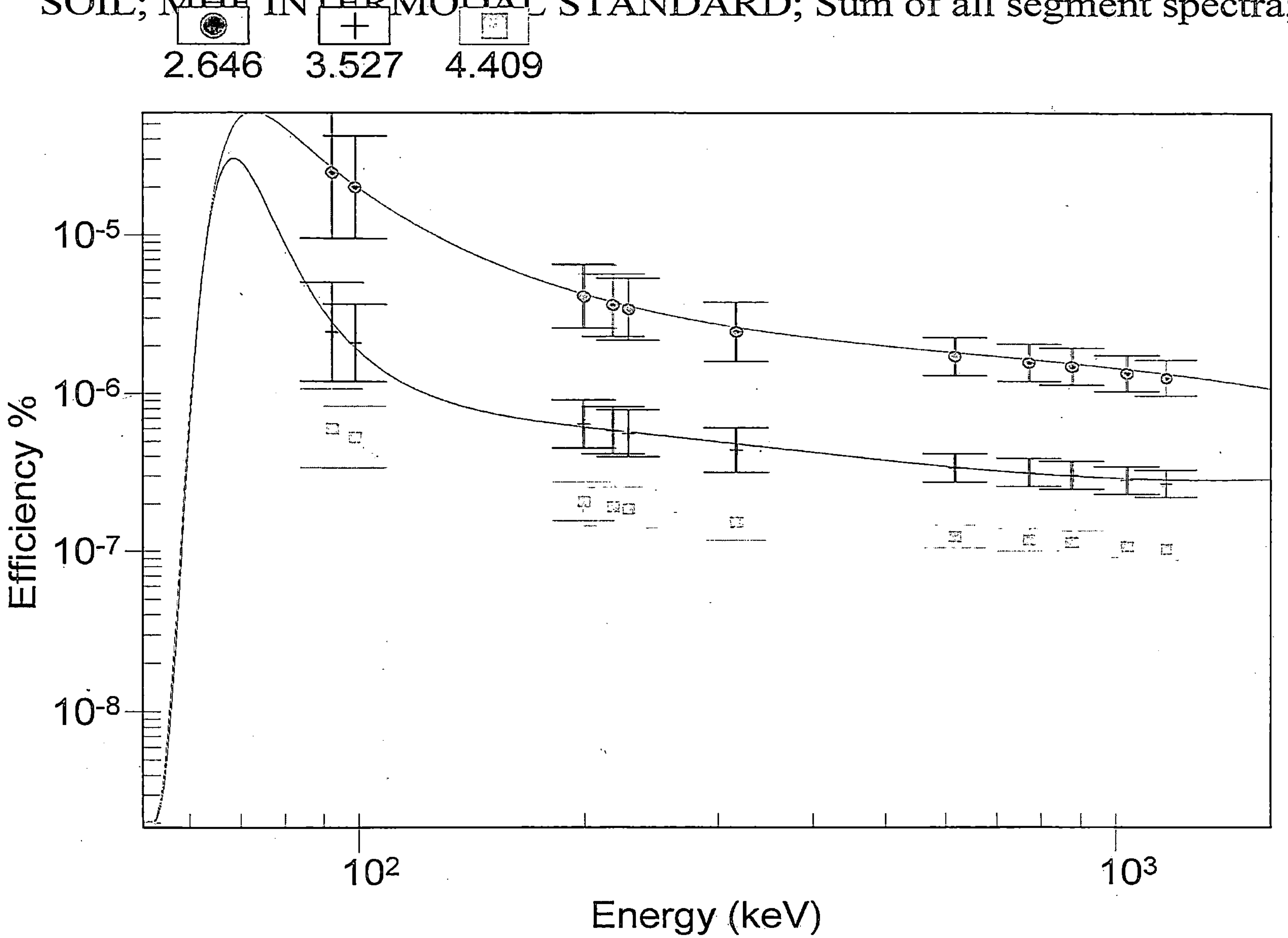
MHF STD Soil 11_18_14 11/17/2014 10:18:01 PM

SOIL : MHF INTERMODAL STANDARD; DET04; Position 1



MHF STD Soil 11_18_14 11/17/2014 10:19:04 PM

SOIL; MHF INTERMODAL STANDARD; Sum of all segment spectra;



GARDIAN SYSTEM
Calibration Records
MHF IP-1 & IP-2 Intermodal

Attached-

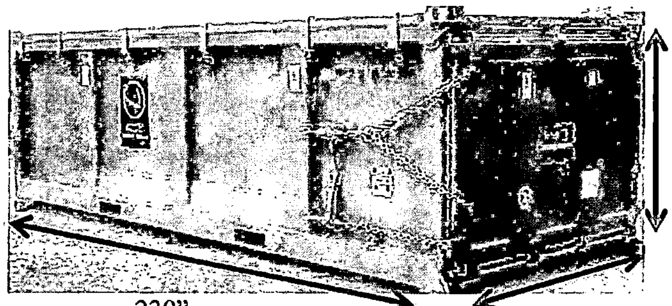
- **MHF Intermodal Wall Thickness, IP-1 & 2 Specs.**
- **Gardian Trailer Wall Thickness**
- **Intermodal Positioning**
- **Det. 1-4 Density 1.2 models, individual efficiency cals, Summation Cal.**
- **Det. 1-4 Density 1.6 models, individual efficiency cals, Summation Cal.**
- **Det. 1-4 Density 2.0 models, individual efficiency cals, Summation Cal.**
- **Det 1-4 Sum Curves for Density 1.2, 1.6, & 2.0.**
- **Sum of all Segment Spectra**

Performed by [signature] **Date** 11-19-14

Reviewed by [signature] **Date** 11-20-14

MHF Intermodal Wall Thickness

(Homogenized)



Wall Steel = 10 gauge = 0.1345"

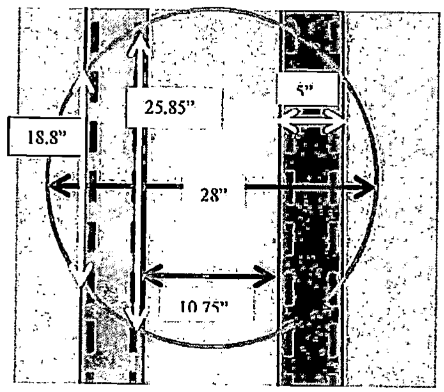
230" x 60" = 13,800 in^2 at 0.1345" thick

+ 3 Vertical Rails 60" x 15" = 2700 in^2
+ 2 Horizontal support beam 480" = 960 in^2
+ Chain guard 2"x2"x22" = 176 in^2
+ ~100 lbs hardware 2,617 in^2
    - (if 100lbs x 453.6g/lb / 7.86g/cc = 5771cc = 352in^3/0.1345"=2617 in^2)

Total Area = 13800+2700+960+176+2617 = 20253 in^2

Effective Thickness = 20253/13800 x 0.1345" thickness = **0.20" Steel**

Energy Solutions Main Trailer Wall



Steel Channel flattened = 7"

Detector is positioned 14" behind the outside wall of the Main Trailer. Utilizing a 90 degree collimator will give a 28" diameter Field of View. Worst case positioning will place the detector between two of the channels, thus including both in the field of view. The channels also contain 0.5" by 2 3/8" rectangular holes which will not subtracted from the steel area thus being more conservative.

Material area

Total area of the field of view: $A = \pi r^2 = \pi 14^2$ = 615.75 in^2.

Area of flattened steel channel: (7" x 18.8") + (1/2 7" x 3.525" x 2ends) x 2channels =312.55 in^2.

Area of PVC: 615.75 in^2 – 312.55 in^2 = 303.20 in^2.

Area of trailer skin: 615.75 in^2.

Effective Thickness

PVC = 1/16"thick x (303.2/615.75) = 0.031"

Steel = 1/16" thick x (312.55/615.75) = 0.032"

Al Skin = 1/16" thick x 615.75/615.75) = 0.063"

Homogenized Wall Density

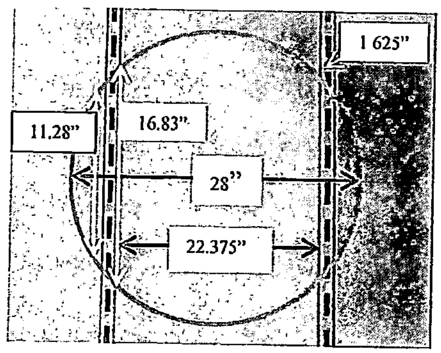
Total Effective wall thickness = 0.031 + 0.032 + 0.063 = 0.126"

Density = 0.031/0.126*1.4g/cc PVC + 0.032/0.126*7.86g/cc steel + 0.063/0.126*2.7g/cc Al = 3.69 g/cc.

Material percentage = 0.344/3.69 = 9% PVC, 2.00/3.69=54% Steel, 1.35/3.69= 37% Al.

For Modeling purposes, the Main Trailer Wall (MTWall) (Absorber 1) = 0.126" thick at 3.69 g/cc comprised of 9% PVC, 54% Steel and 37% Al.

Energy Solutions Support Trailer Wall



Steel Channel flattened = 3 5/8"

Detector is positioned 14" behind the outside wall of the Support Trailer. Utilizing a 90 degree collimator will give a 28" diameter Field of View. Worst case positioning will place the detector between two of the channels, thus including both in the field of view. The channels also contain 0.5" by 2 3/8" rectangular holes which will not subtracted from the steel area thus being more conservative.

Material area

Total area of the field of view: $A = \pi r^2 = \pi 14^2 = 615.75$ in^2.

Area of flattened steel channel: (3.625" x 11.28") +(1/2 3.625" x 2.775" x 2ends) x 2channels = 102 in^2.

Area of wood: 615.75 in^2 – 102 in^2 = 513.75 in^2.

Area of trailer skin: 615.75 in^2.

Effective Thickness

Wood = 1/4" thick x (513.75/615.75) = 0.209"

Steel = 1/16" thick x (102/615.75) = 0.010"

Al Skin = 1/16" thick x 615.75/615.75) = 0.063"

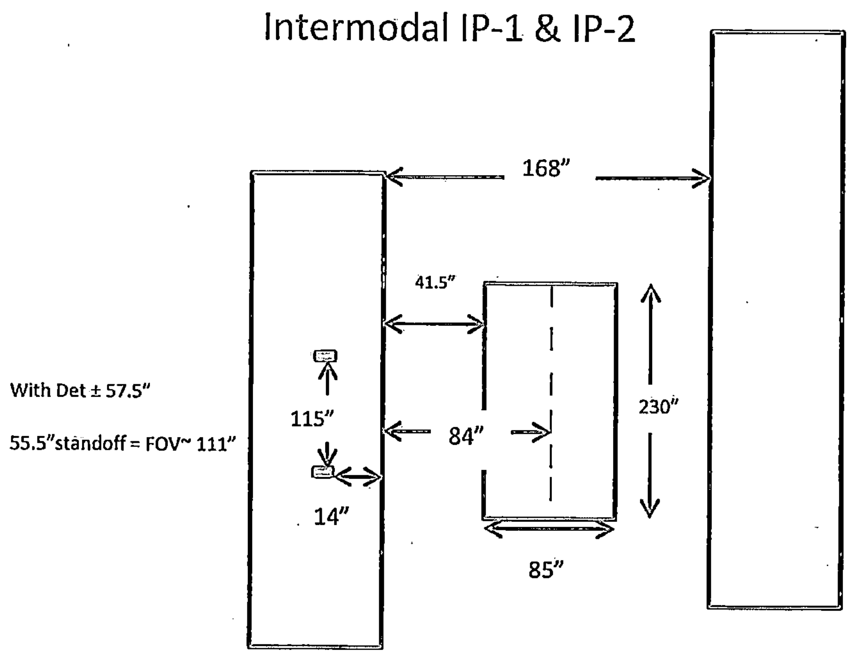
Homogenized Wall Density

Total Effective wall thickness = 0.209 + 0.010 + 0.063 = 0.282"

Density = 0.209/0.282*0.75g/cc wood + 0.010/0.282*7.86g/cc steel + 0.063/0.282*2.7g/cc Al = 1.44g/cc.

Material percentage = 0.556/1.44 = 39% wood, 0.279/1.44=19% Steel, 0.603/1.44= 42% Al.

For Modeling purposes, the Support Trailer Wall (STWall) (Absorber 1) = 0.282" thick at 1.44g/cc comprised of 39% wood, 19% Steel and 42% Al.


Intermodal IP-1 & IP-2
168"
41.5"
With Det ± 57.5"
55.5"standoff = FOV~ 111"
115"
84"
230"
14"
85"

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GARDIAN SYSTEM
Calibration Records
MHF IP-1 & IP-2 Intermodal

Density 2.0

CANBERRA

Geometry Composer Report

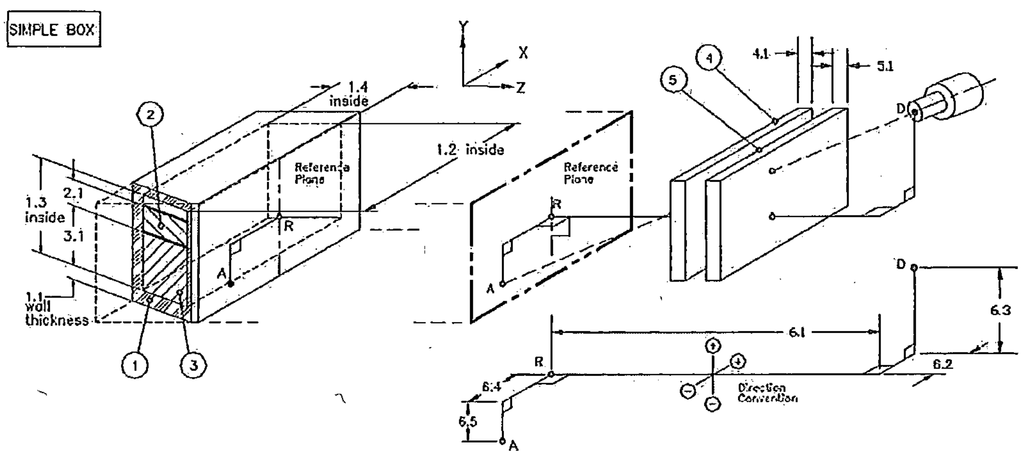
Date: Thursday, November 13, 2014 - 17:08:14
Description: MHF_STD_SOIL_DET1_20
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET1_20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3994
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.02756						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

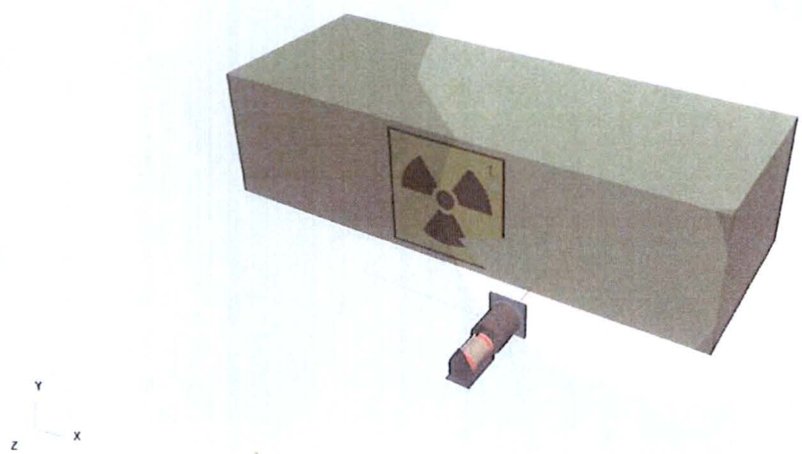
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

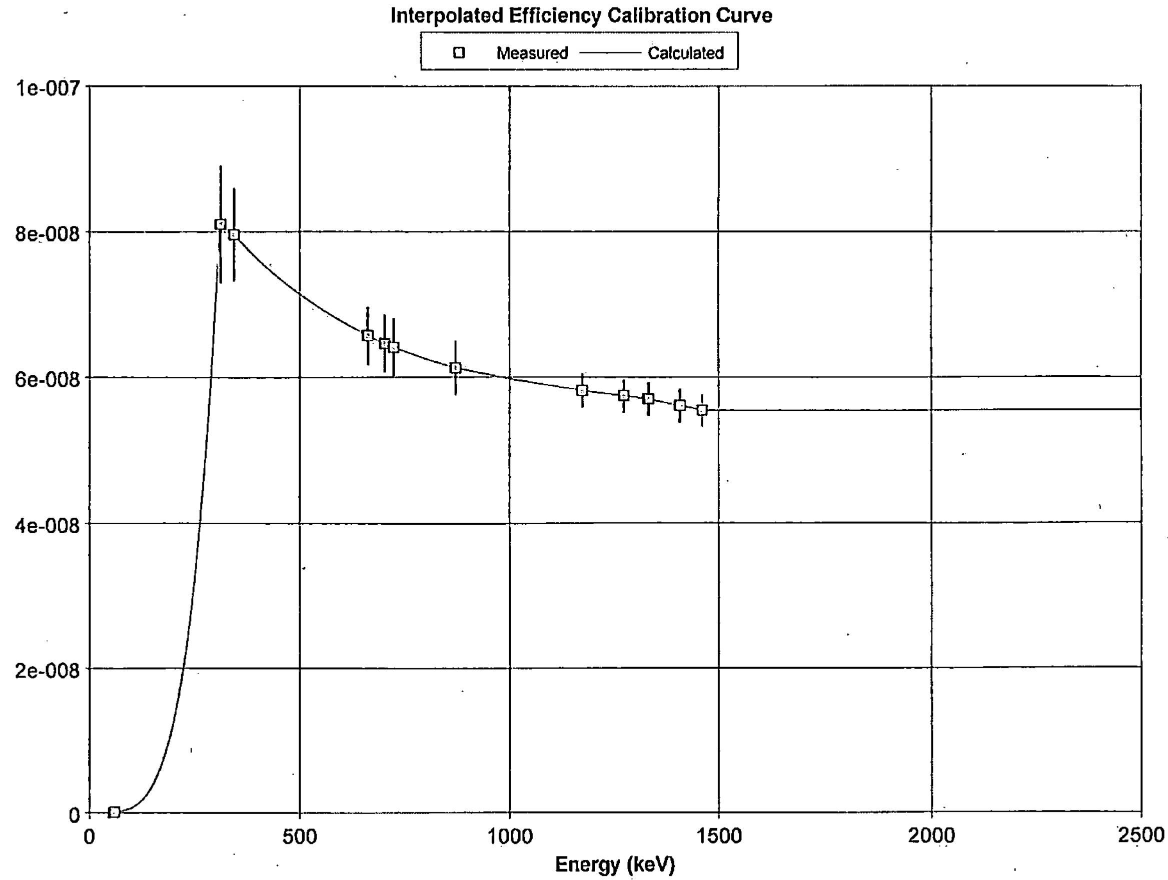
Date:	Thursday, November 13, 2014 - 17:08:14
Description:	MHF_STD_SOIL_DET1_20
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\MHF_STD_SOIL_DET1_20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



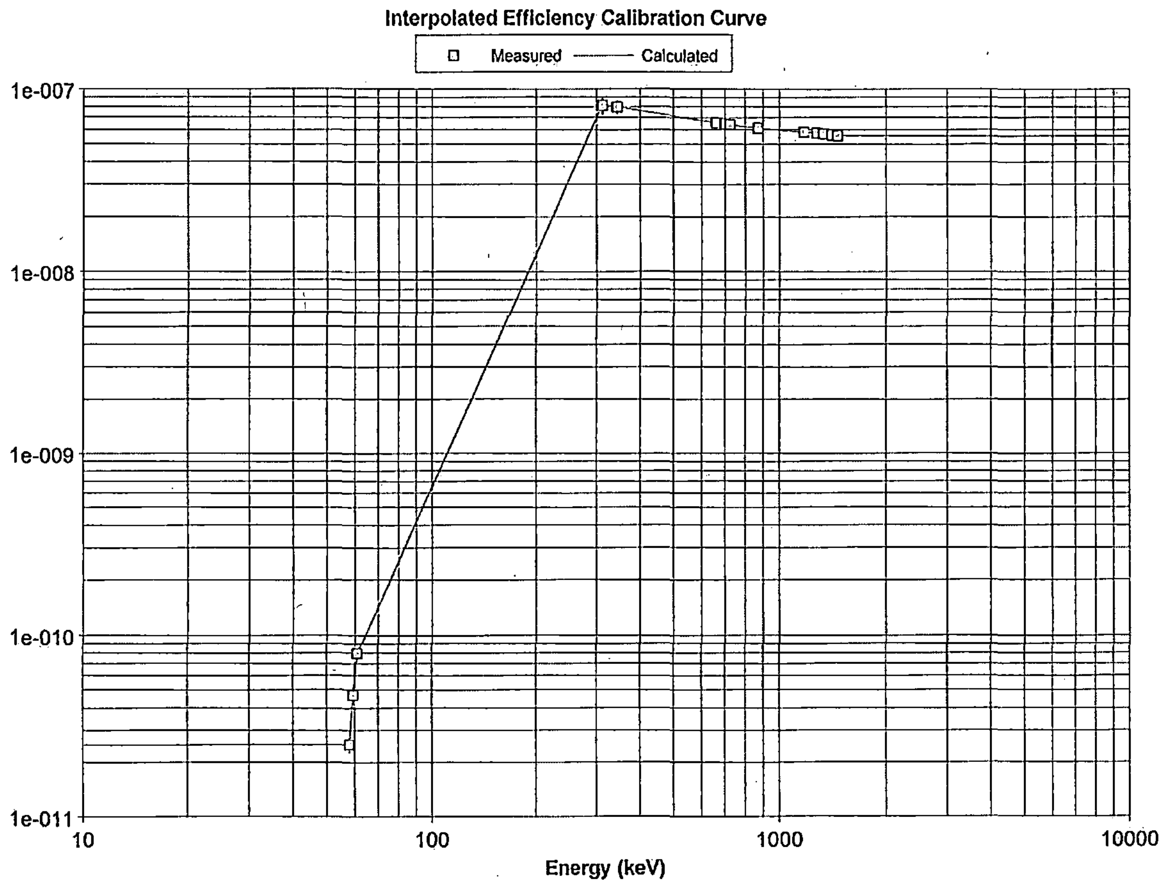
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time: 11/13/14 03:00:10
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_DET1_20.CAL
Genie Cal Time: 11/13/14 04:35:56
Template: SIMPLE BOX
Geom Description: HMF STD DET1 20
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3994
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 3.5881e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	2.49876e-011	10.0	-0.140676	81760
59.54	4.68281e-011	10.0	-0.139760	81760
61.00	7.95050e-011	10.0	-0.138392	81760
311.00	8.10604e-008	10.0	-0.019955	81760
311.98	8.09781e-008	10.0	-0.019420	81760
313.00	8.09599e-008	10.0	-0.019616	81760
343.00	7.96462e-008	8.0	-0.017149	81760
344.27	7.95558e-008	8.0	-0.016964	81760
345.00	7.95516e-008	8.0	-0.017014	81760
660.00	6.57400e-008	6.0	-0.010410	81760
661.65	6.56224e-008	6.0	-0.010589	81760
663.00	6.56097e-008	6.0	-0.010200	81760
701.00	6.46329e-008	6.0	-0.010061	81760
702.63	6.45412e-008	6.0	-0.010248	81760
703.00	6.45537e-008	6.0	-0.010236	81760
722.00	6.41027e-008	6.0	-0.010247	81760
723.00	6.40636e-008	6.0	-0.010101	81760
724.00	6.40506e-008	6.0	-0.010141	81760
870.00	6.12813e-008	6.0	-0.009137	81760
871.10	6.12408e-008	6.0	-0.009192	81760
872.00	6.12646e-008	6.0	-0.009080	81760
1172.00	5.82074e-008	4.0	-0.007433	81760
1173.22	5.81753e-008	4.0	-0.007350	81760
1174.00	5.81511e-008	4.0	-0.007157	81760
1273.00	5.74669e-008	4.0	-0.006351	81760
1274.45	5.74458e-008	4.0	-0.006582	81760
1275.00	5.74413e-008	4.0	-0.006315	81760
1331.00	5.70082e-008	4.0	-0.005966	81760
1332.49	5.69939e-008	4.0	-0.005833	81760
1334.00	5.69663e-008	4.0	-0.006223	81760
1406.00	5.60672e-008	4.0	-0.004980	81760
1407.95	5.60634e-008	4.0	-0.005078	81760
1409.00	5.60761e-008	4.0	-0.005068	81760
1460.80	5.54286e-008	4.0	-0.004699	81760



Datasource: DET01



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Geometry Composer Report

CANBERRA

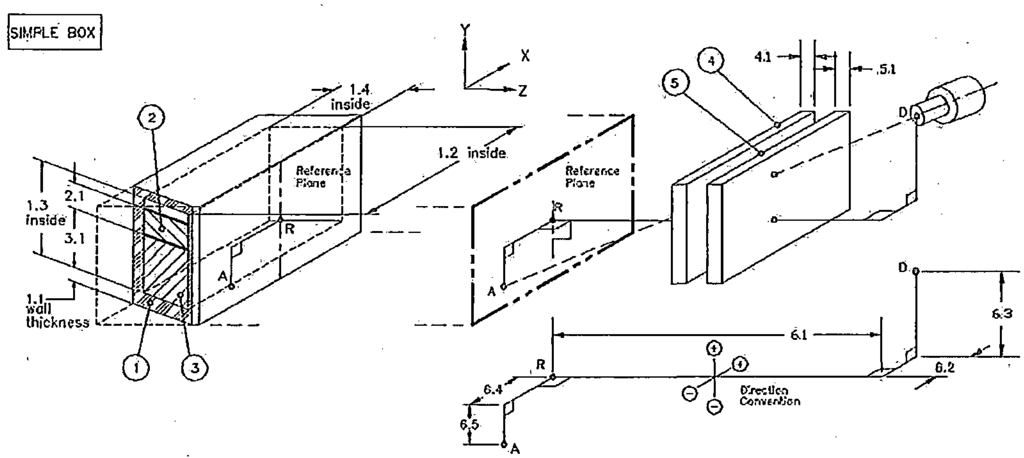
Date: Thursday, November 13, 2014 - 17:08:59
Description: MHF_STD_SOIL_DET2_20
Comment: Calib 11/13/14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET2_20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3996
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.0315						germanum	5.4	
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

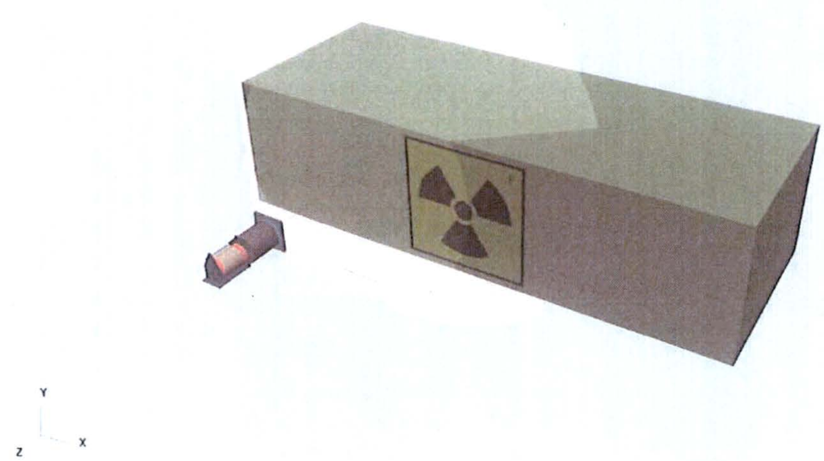
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

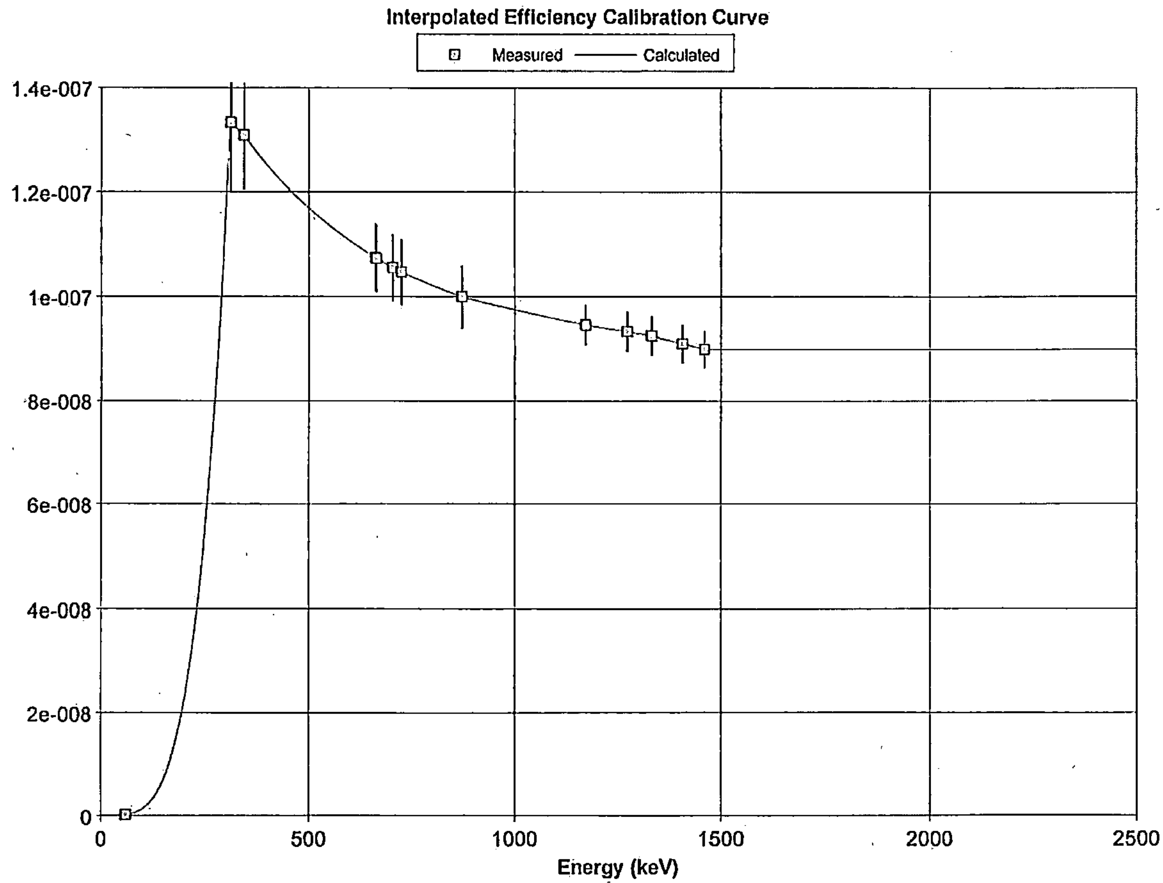
Date:	Thursday, November 13, 2014 - 17:08:59
Description:	MHF_STD_SOIL_DET2_20
Comment:	Calib 11/13/14
File Name:	E:\GEOS\In-Situ\MHF_STD_SOIL_DET2_20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



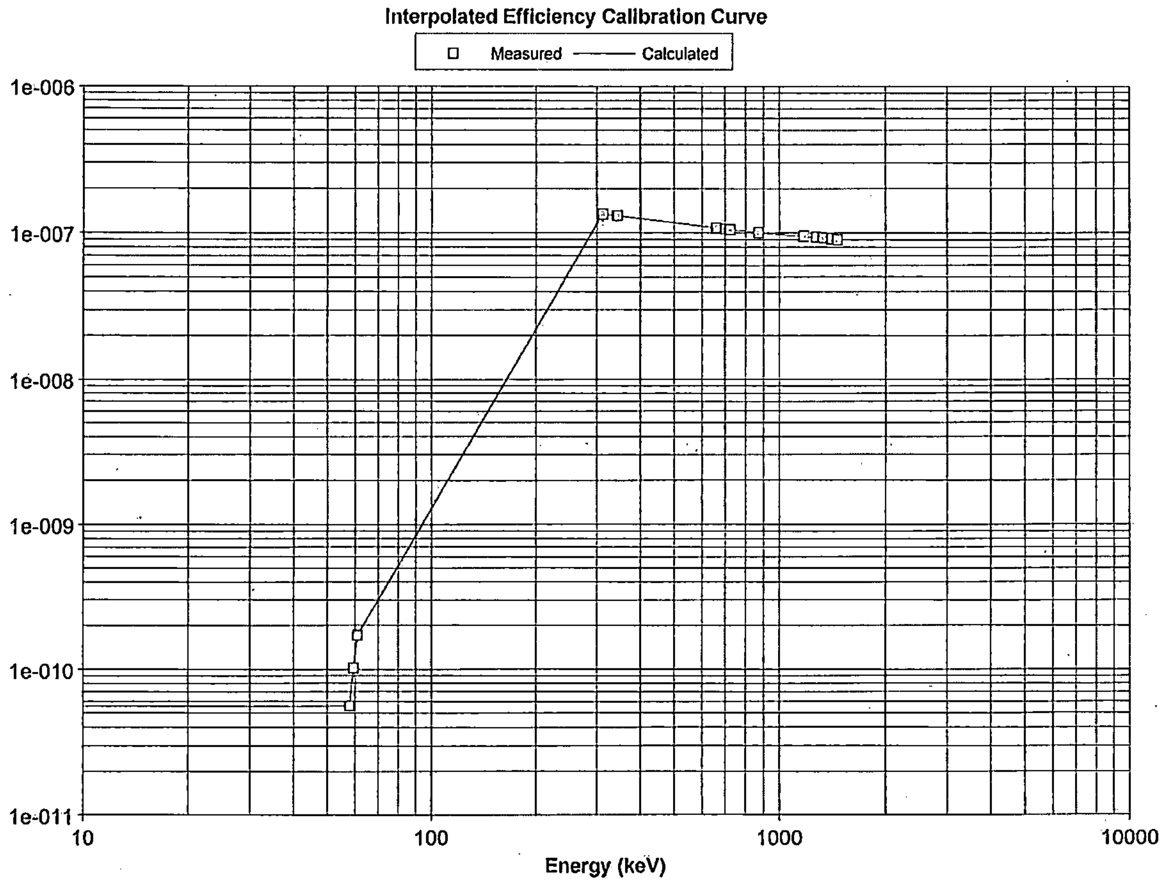
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time: 11/13/14 03:05:08
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_DET2_20.CAL
Genie Cal Time: 11/13/14 04:39:32
Template: SIMPLE BOX
Geom Description: HMF STD DET2 20
Comment: ISOCS:CALIB_11/13/14
Detector: 3996
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 3.5881e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	2.21412e-011	10.0	-0.132789	81760
59.54	4.18375e-011	10.0	-0.131275	81760
61.00	7.15396e-011	10.0	-0.129357	81760
311.00	8.05642e-008	10.0	-0.010783	81760
311.98	8.04834e-008	10.0	-0.010302	81760
313.00	8.04663e-008	10.0	-0.010620	81760
343.00	7.91876e-008	8.0	-0.009344	81760
344.27	7.90987e-008	8.0	-0.009077	81760
345.00	7.90951e-008	8.0	-0.009236	81760
660.00	6.54683e-008	6.0	-0.007340	81760
661.65	6.53515e-008	6.0	-0.007470	81760
663.00	6.53391e-008	6.0	-0.007098	81760
701.00	6.43732e-008	6.0	-0.007031	81760
702.63	6.42822e-008	6.0	-0.007272	81760
703.00	6.42948e-008	6.0	-0.007160	81760
722.00	6.38486e-008	6.0	-0.007168	81760
723.00	6.38099e-008	6.0	-0.007153	81760
724.00	6.37971e-008	6.0	-0.007186	81760
870.00	6.10588e-008	6.0	-0.006087	81760
871.10	6.10186e-008	6.0	-0.006073	81760
872.00	6.10424e-008	6.0	-0.005918	81760
1172.00	5.80243e-008	4.0	-0.003865	81760
1173.22	5.79923e-008	4.0	-0.003731	81760
1174.00	5.79683e-008	4.0	-0.003471	81760
1273.00	5.72930e-008	4.0	-0.002482	81760
1274.45	5.72721e-008	4.0	-0.002809	81760
1275.00	5.72676e-008	4.0	-0.002463	81760
1331.00	5.68392e-008	4.0	-0.001970	81760
1332.49	5.68251e-008	4.0	-0.001852	81760
1334.00	5.67976e-008	4.0	-0.002246	81760
1406.00	5.59051e-008	4.0	-0.000826	81760
1407.95	5.59014e-008	4.0	-0.000960	81760
1409.00	5.59142e-008	4.0	-0.001009	81760
1460.80	5.52712e-008	4.0	-0.000525	81760



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

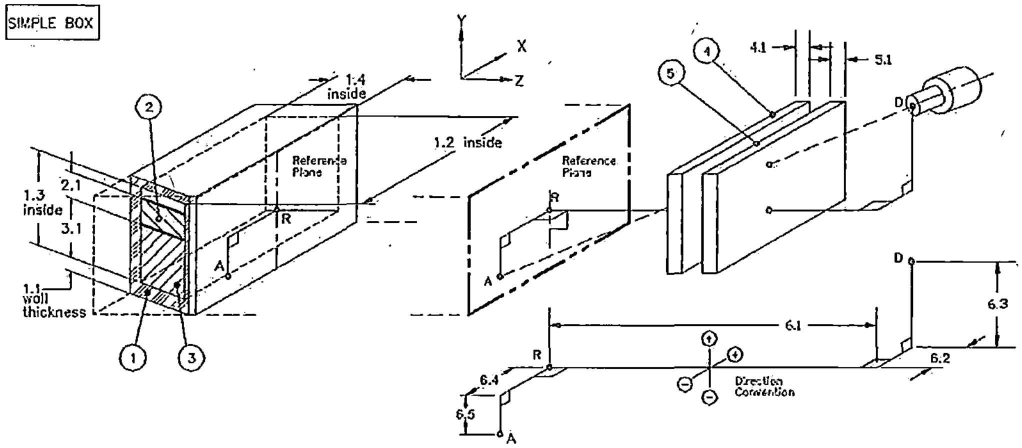
Date: Thursday, November 13, 2014 - 17:10:29
Description: MHF_STD_SOIL_DET3_20
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET3_20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3997
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2	0.03543						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

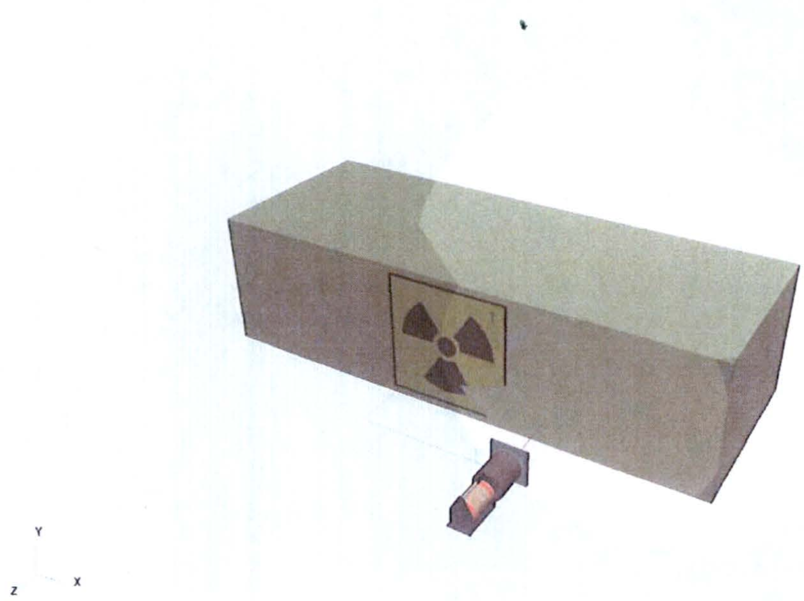
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

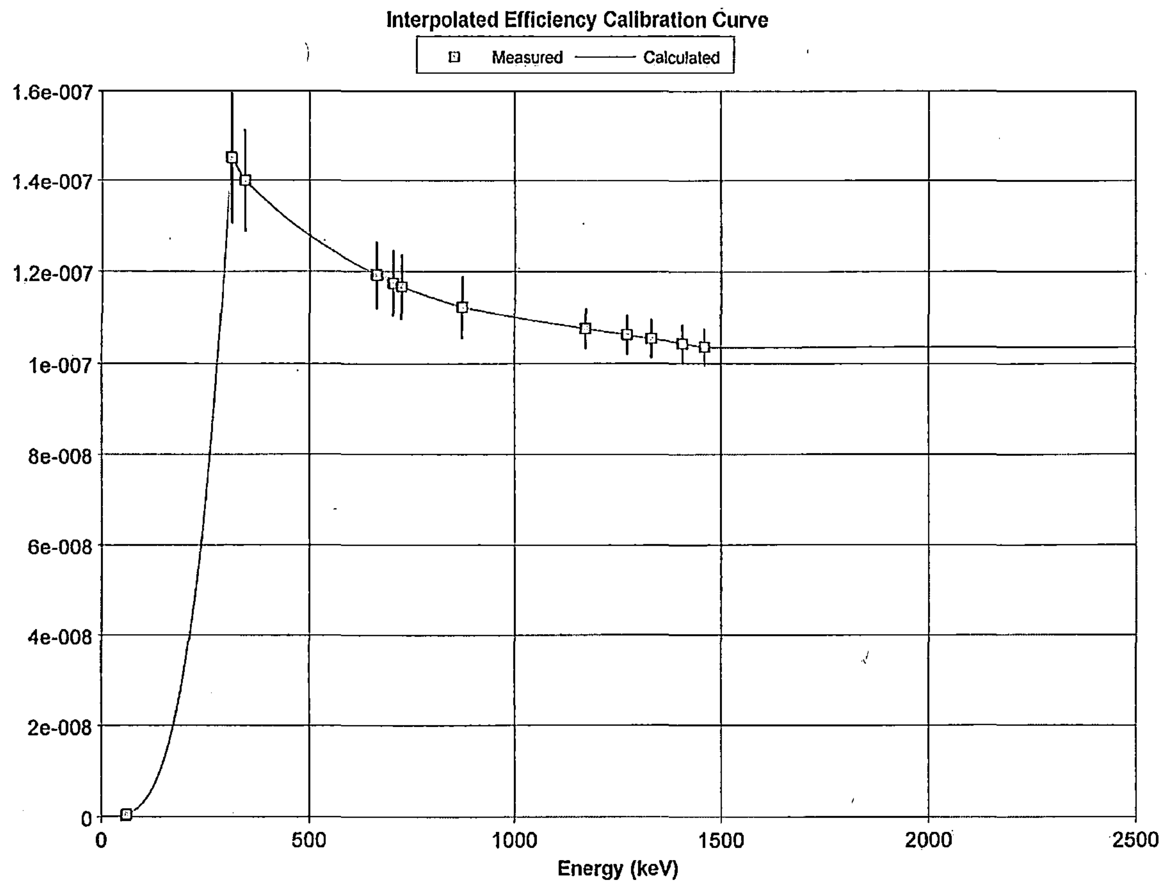
Date: Thursday, November 13, 2014 - 17:10:29
Description: MHF_STD_SOIL_DET3_20
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET3_20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)



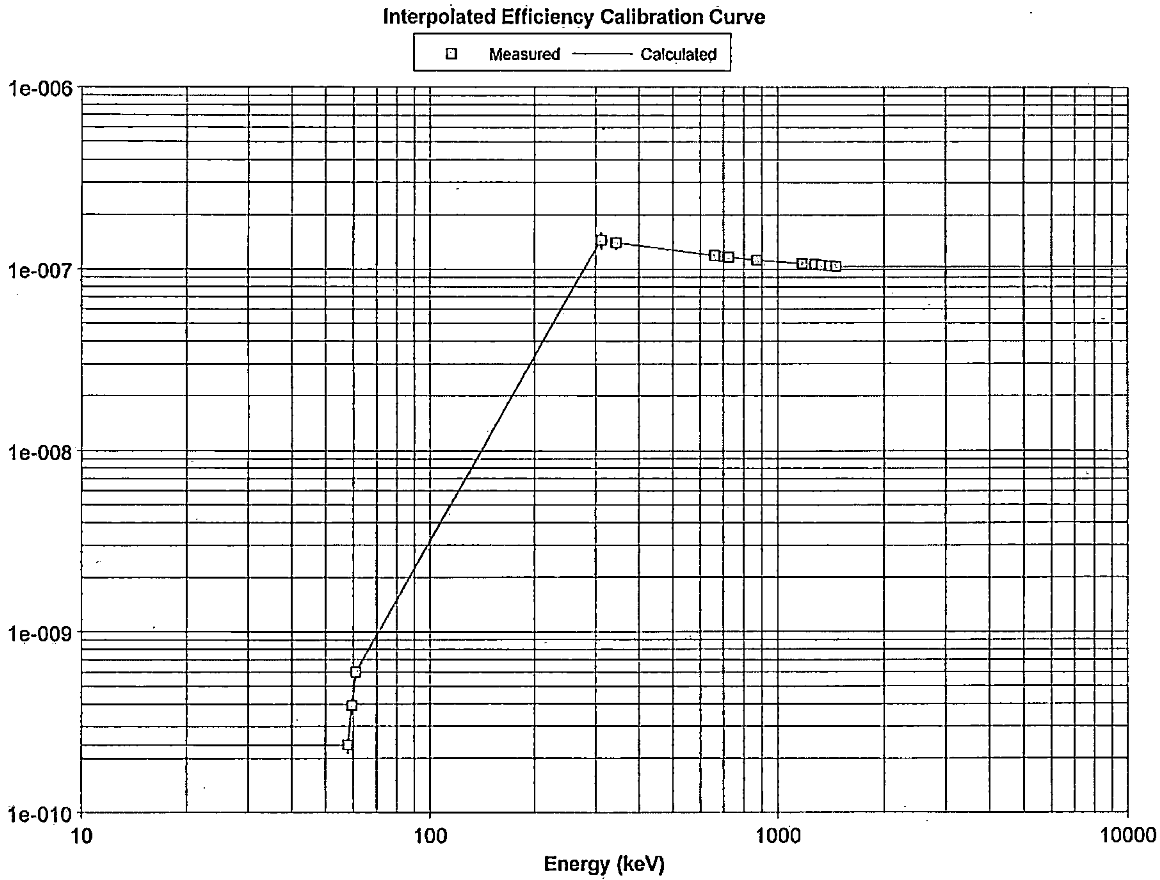
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time: 11/13/14 03:09:42
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_DET3_20.CAL
Genie Cal Time: 11/13/14 04:42:54
Template: SIMPLE BOX
Geom Description: STD SOIL DET3 20
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3997
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 3.5881e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	3.35690e-011	10.0	-0.140207	81760
59.54	6.15083e-011	10.0	-0.139286	81760
61.00	1.02424e-010	10.0	-0.137916	81760
311.00	8.12054e-008	10.0	-0.019950	81760
311.98	8.11217e-008	10.0	-0.019415	81760
313.00	8.11023e-008	10.0	-0.019611	81760
343.00	7.97579e-008	8.0	-0.017145	81760
344.27	7.96664e-008	8.0	-0.016960	81760
345.00	7.96616e-008	8.0	-0.017010	81760
660.00	6.57685e-008	6.0	-0.010409	81760
661.65	6.56507e-008	6.0	-0.010588	81760
663.00	6.56380e-008	6.0	-0.010199	81760
701.00	6.46591e-008	6.0	-0.010060	81760
702.63	6.45673e-008	6.0	-0.010247	81760
703.00	6.45798e-008	6.0	-0.010234	81760
722.00	6.41278e-008	6.0	-0.010246	81760
723.00	6.40887e-008	6.0	-0.010100	81760
724.00	6.40757e-008	6.0	-0.010140	81760
870.00	6.13013e-008	6.0	-0.009136	81760
871.10	6.12608e-008	6.0	-0.009191	81760
872.00	6.12846e-008	6.0	-0.009078	81760
1172.00	5.82231e-008	4.0	-0.007432	81760
1173.22	5.81910e-008	4.0	-0.007349	81760
1174.00	5.81668e-008	4.0	-0.007156	81760
1273.00	5.74826e-008	4.0	-0.006350	81760
1274.45	5.74615e-008	4.0	-0.006581	81760
1275.00	5.74570e-008	4.0	-0.006314	81760
1331.00	5.70242e-008	4.0	-0.005965	81760
1332.49	5.70099e-008	4.0	-0.005832	81760
1334.00	5.69823e-008	4.0	-0.006222	81760
1406.00	5.60838e-008	4.0	-0.004979	81760
1407.95	5.60800e-008	4.0	-0.005077	81760
1409.00	5.60928e-008	4.0	-0.005067	81760
1460.80	5.54459e-008	4.0	-0.004698	81760



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

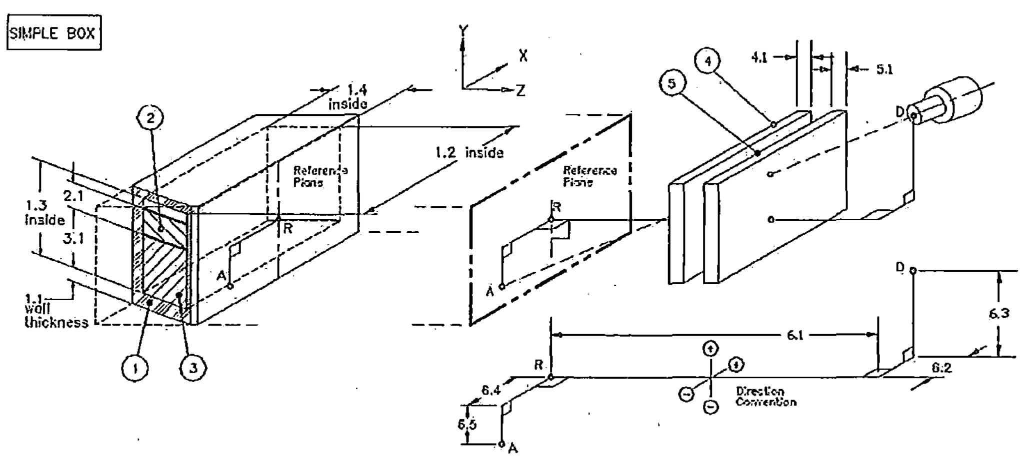
Date: Thursday, November 13, 2014 - 17:11:39
Description: MHF_STD_SOIL_DET4_20
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET4_20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3998
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						none		
3	Source - Bottom Layer	56						dirt1	2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2							none		
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

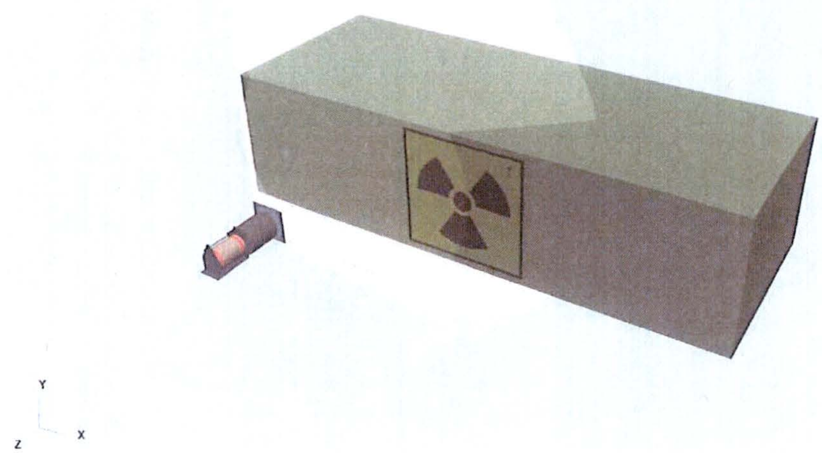
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

Date:	Thursday, November 13, 2014 - 17:11:39
Description:	MHF_STD_SOIL_DET4_20
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\MHF_STD_SOIL_DET4_20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)

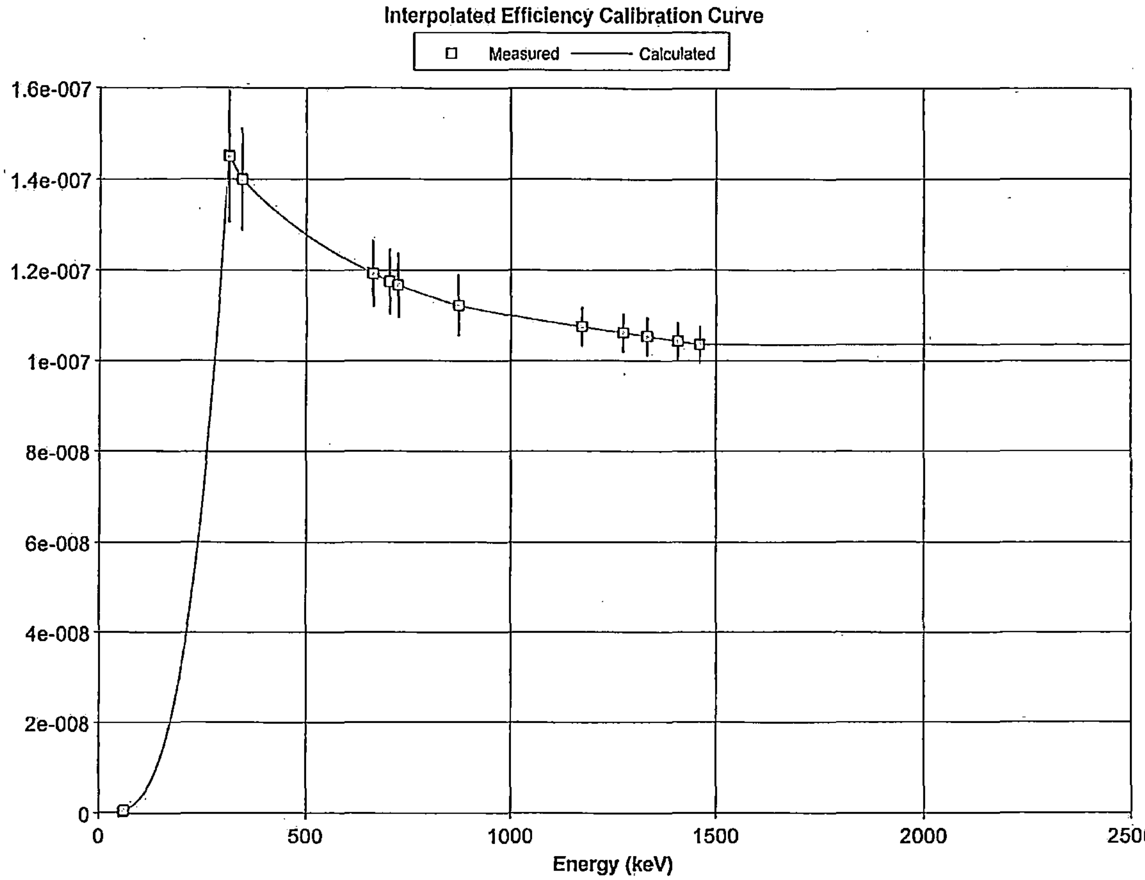


ISOCS/LABSOCS RESULTS

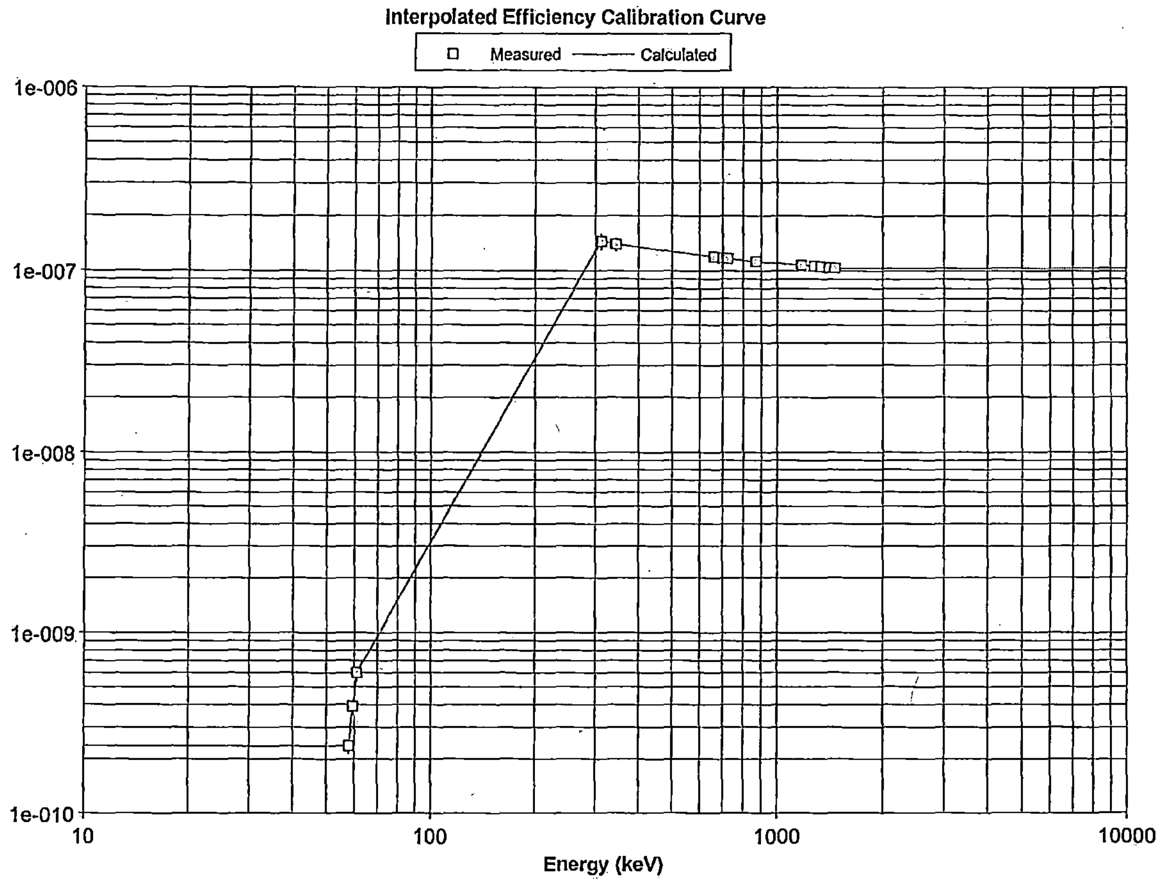
ISOCS/LabSOCS File:	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time:	11/13/14 03:14:11
Genie Cal File:	C:\GENIE2K\CALFILES\HMF_STD_Soil_DET4_20.CAL
Genie Cal Time:	11/13/14 04:45:53
Template:	SIMPLE BOX
Geom Description:	HMF STD DET4 20
Comment:	ISOCS:CAL_DATE_11_13_14
Detector:	3998
Collimator:	GARDIAN_G1
Convergence:	1.00 %
Area [Sq Meters]:	8.3097e+000 (C)
Mass [Grams]:	3.5881e+007 (C)
Length [Meters]:	not used

(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.42266e-010	10.0	0.043834	81760
59.54	2.35740e-010	10.0	0.046117	81760
61.00	3.60753e-010	10.0	0.048386	81760
311.00	8.83735e-008	10.0	0.025769	81760
311.98	8.82670e-008	10.0	0.025580	81760
313.00	8.81727e-008	10.0	0.025542	81760
343.00	8.52944e-008	8.0	0.018807	81760
344.27	8.51903e-008	8.0	0.018856	81760
345.00	8.51633e-008	8.0	0.018577	81760
660.00	7.29918e-008	6.0	-0.005087	81760
661.65	7.28881e-008	6.0	-0.005192	81760
663.00	7.28870e-008	6.0	-0.005077	81760
701.00	7.19214e-008	6.0	-0.006307	81760
702.63	7.18730e-008	6.0	-0.006296	81760
703.00	7.18649e-008	6.0	-0.006323	81760
722.00	7.14353e-008	6.0	-0.006815	81760
723.00	7.14239e-008	6.0	-0.006744	81760
724.00	7.14017e-008	6.0	-0.006985	81760
870.00	6.88278e-008	6.0	-0.009108	81760
871.10	6.88089e-008	6.0	-0.008843	81760
872.00	6.88170e-008	6.0	-0.009136	81760
1172.00	6.61894e-008	4.0	-0.010379	81760
1173.22	6.61901e-008	4.0	-0.010275	81760
1174.00	6.61584e-008	4.0	-0.010077	81760
1273.00	6.54372e-008	4.0	-0.010389	81760
1274.45	6.54260e-008	4.0	-0.010020	81760
1275.00	6.54166e-008	4.0	-0.010127	81760
1331.00	6.49469e-008	4.0	-0.010131	81760
1332.49	6.49788e-008	4.0	-0.010008	81760
1334.00	6.49619e-008	4.0	-0.009991	81760
1406.00	6.43762e-008	4.0	-0.009344	81760
1407.95	6.43428e-008	4.0	-0.009342	81760
1409.00	6.43252e-008	4.0	-0.009227	81760
1460.80	6.39156e-008	4.0	-0.009238	81760



Datasource: DET01



Datasource: DET01

#	Weight	Primary Efficiency taken from ECC files, for set energies (keV): 58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3	345.0	660.0	661.7
1	1.000	2.50e-011	4.68e-011	7.95e-011	8.11e-008	8.10e-008	8.10e-008	7.96e-008	7.96e-008	7.96e-008	6.57e-008	6.56e-008
2	1.000	2.21e-011	4.18e-011	7.15e-011	8.06e-008	8.05e-008	8.05e-008	7.92e-008	7.91e-008	7.91e-008	6.55e-008	6.54e-008
3	1.000	3.36e-011	6.15e-011	1.02e-010	8.12e-008	8.11e-008	8.11e-008	7.98e-008	7.97e-008	7.97e-008	6.58e-008	6.57e-008
4	1.000	1.42e-010	2.36e-010	3.61e-010	8.84e-008	8.83e-008	8.82e-008	8.53e-008	8.52e-008	8.52e-008	7.30e-008	7.29e-008
	Sum	2.23e-010	3.86e-010	6.14e-010	3.31e-007	3.31e-007	3.31e-007	3.24e-007	3.24e-007	3.23e-007	2.70e-007	2.70e-007
	Error,%	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	8.00e+000	8.00e+000	8.00e+000	6.00e+000	6.00e+000

Information for input ECC files

#	File Name	File Stamp	Path
1	MHF_STD_SOIL_DET1_20	Thu_Nov_13_02:59:18_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
2	MHF_STD_SOIL_DET2_20	Thu_Nov_13_03:04:16_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
3	MHF_STD_SOIL_DET3_20	Thu_Nov_13_03:08:50_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
4	MHF_STD_SOIL_DET4_20	Thu_Nov_13_03:13:19_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

File Name	File Stamp	Path

Description: MHF_STD_Soil_SUM_D20
Comment: Cal Date 11/13/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

663.0	701.0	702.6	703.0	722.0	723.0	724.0	870.0	871.1	872.0	1172.0	1173.2
6.56e-008	6.46e-008	6.45e-008	6.46e-008	6.41e-008	6.41e-008	6.41e-008	6.13e-008	6.12e-008	6.13e-008	5.82e-008	5.82e-008
6.53e-008	6.44e-008	6.43e-008	6.43e-008	6.38e-008	6.38e-008	6.38e-008	6.11e-008	6.10e-008	6.10e-008	5.80e-008	5.80e-008
6.56e-008	6.47e-008	6.46e-008	6.46e-008	6.41e-008	6.41e-008	6.41e-008	6.13e-008	6.13e-008	6.13e-008	5.82e-008	5.82e-008
7.29e-008	7.19e-008	7.19e-008	7.19e-008	7.14e-008	7.14e-008	7.14e-008	6.88e-008	6.88e-008	6.88e-008	6.62e-008	6.62e-008
2.69e-007	2.66e-007	2.65e-007	2.65e-007	2.64e-007	2.63e-007	2.63e-007	2.52e-007	2.52e-007	2.52e-007	2.41e-007	2.41e-007
6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_STD_Soil_SUM_D20
Cal Date 11/13/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

1174.0	1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9	1409.0	1460.8
5.82e-008	5.75e-008	5.74e-008	5.74e-008	5.70e-008	5.70e-008	5.70e-008	5.61e-008	5.61e-008	5.61e-008	5.54e-008
5.80e-008	5.73e-008	5.73e-008	5.73e-008	5.68e-008	5.68e-008	5.68e-008	5.59e-008	5.59e-008	5.59e-008	5.53e-008
5.82e-008	5.75e-008	5.75e-008	5.75e-008	5.70e-008	5.70e-008	5.70e-008	5.61e-008	5.61e-008	5.61e-008	5.54e-008
6.62e-008	6.54e-008	6.54e-008	6.54e-008	6.49e-008	6.50e-008	6.50e-008	6.44e-008	6.43e-008	6.43e-008	6.39e-008
2.40e-007	2.38e-007	2.38e-007	2.38e-007	2.36e-007	2.36e-007	2.36e-007	2.32e-007	2.32e-007	2.32e-007	2.30e-007
4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_STD_Soil_SUM_D20
Cal Date 11/13/14

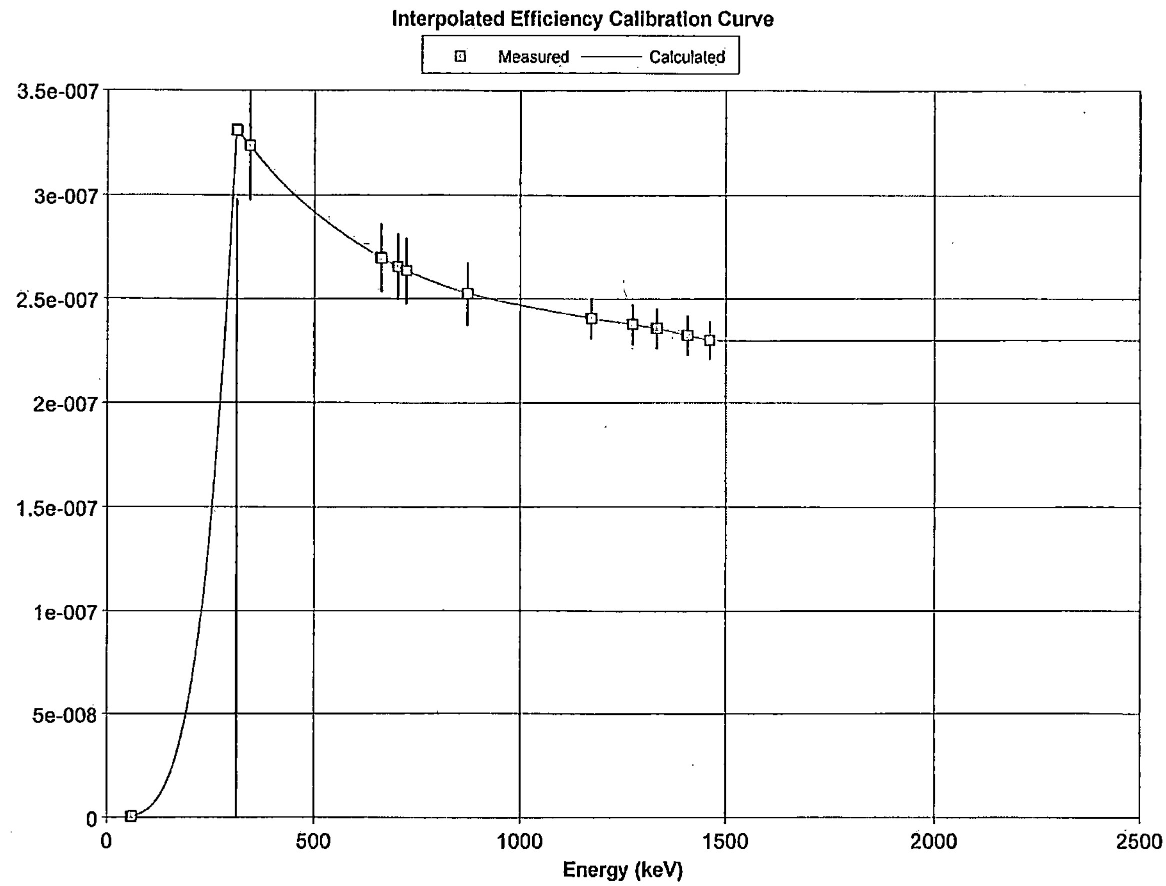
CANBERRA

Multi-Efficiency Report

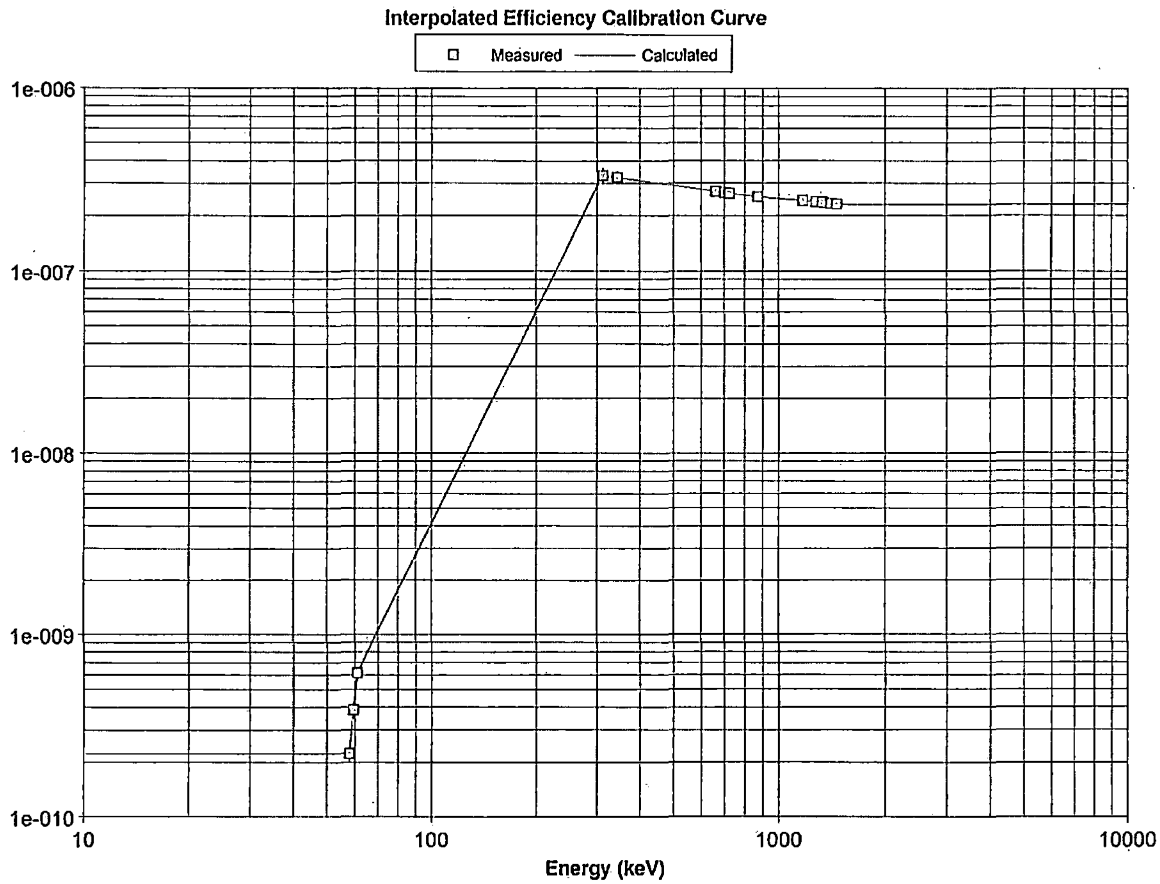
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\Multiefficiency\MHF_ST
ISOCS/LabSOCS Time: 11/13/14 03:27:03
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_SUM_D20.CAL
Genie Cal Time: 11/13/14 04:49:14
Template: (SIMPLE BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+
Geom Description: HMF STD SUM D20
Comment: ISOCS:Cal Date 11/13/14
Detector: (3994)+(3996)+(3997)+(3998)+
Collimator: (GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+
Convergence: 1.00 %
Area [Sq Meters]: 1.0000e-004 (C)
Mass [Grams]: 1.0000e+000 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	2.22964e-010	10.0	0.0438340	64000
59.54	3.85914e-010	10.0	0.0438340	64000
61.00	6.14222e-010	10.0	0.0438340	64000
311.00	3.31203e-007	10.0	0.0438340	64000
311.98	3.30850e-007	10.0	0.0438340	64000
313.00	3.30701e-007	10.0	0.0438340	64000
343.00	3.23886e-007	8.0	0.0438340	64000
344.27	3.23511e-007	8.0	0.0438340	64000
345.00	3.23472e-007	8.0	0.0438340	64000
660.00	2.69969e-007	6.0	0.0438340	64000
661.65	2.69513e-007	6.0	0.0438340	64000
663.00	2.69474e-007	6.0	0.0438340	64000
701.00	2.65587e-007	6.0	0.0438340	64000
702.63	2.65264e-007	6.0	0.0438340	64000
703.00	2.65293e-007	6.0	0.0438340	64000
722.00	2.63514e-007	6.0	0.0438340	64000
723.00	2.63386e-007	6.0	0.0438340	64000
724.00	2.63325e-007	6.0	0.0438340	64000
870.00	2.52469e-007	6.0	0.0438340	64000
871.10	2.52329e-007	6.0	0.0438340	64000
872.00	2.52409e-007	6.0	0.0438340	64000
1172.00	2.40644e-007	4.0	0.0438340	64000
1173.22	2.40549e-007	4.0	0.0438340	64000
1174.00	2.40445e-007	4.0	0.0438340	64000
1273.00	2.37680e-007	4.0	0.0438340	64000
1274.45	2.37605e-007	4.0	0.0438340	64000
1275.00	2.37583e-007	4.0	0.0438340	64000
1331.00	2.35818e-007	4.0	0.0438340	64000
1332.49	2.35808e-007	4.0	0.0438340	64000
1334.00	2.35708e-007	4.0	0.0438340	64000
1406.00	2.32432e-007	4.0	0.0438340	64000
1407.95	2.32388e-007	4.0	0.0438340	64000
1409.00	2.32408e-007	4.0	0.0438340	64000
1460.80	2.30061e-007	4.0	0.0438340	64000



Datasource: DET01



Datasource: DET01

GARDIAN SYSTEM
Calibration Records
MHF IP-1 & IP-2 Intermodal

Density 1.6

Geometry Composer Report

CANBERRA

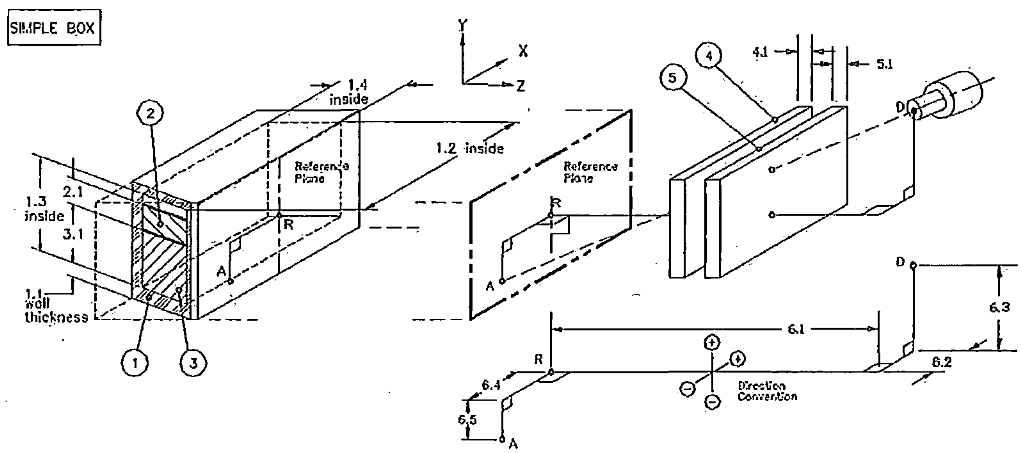
Date: Thursday, November 13, 2014 - 17:08:00
Description: MHF_STD_SOIL_DET1_16
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET1_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3994
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.6	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.02756						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

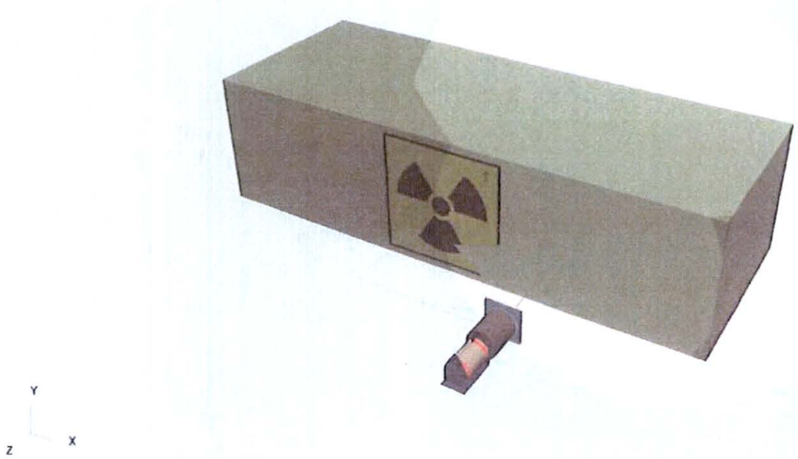
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

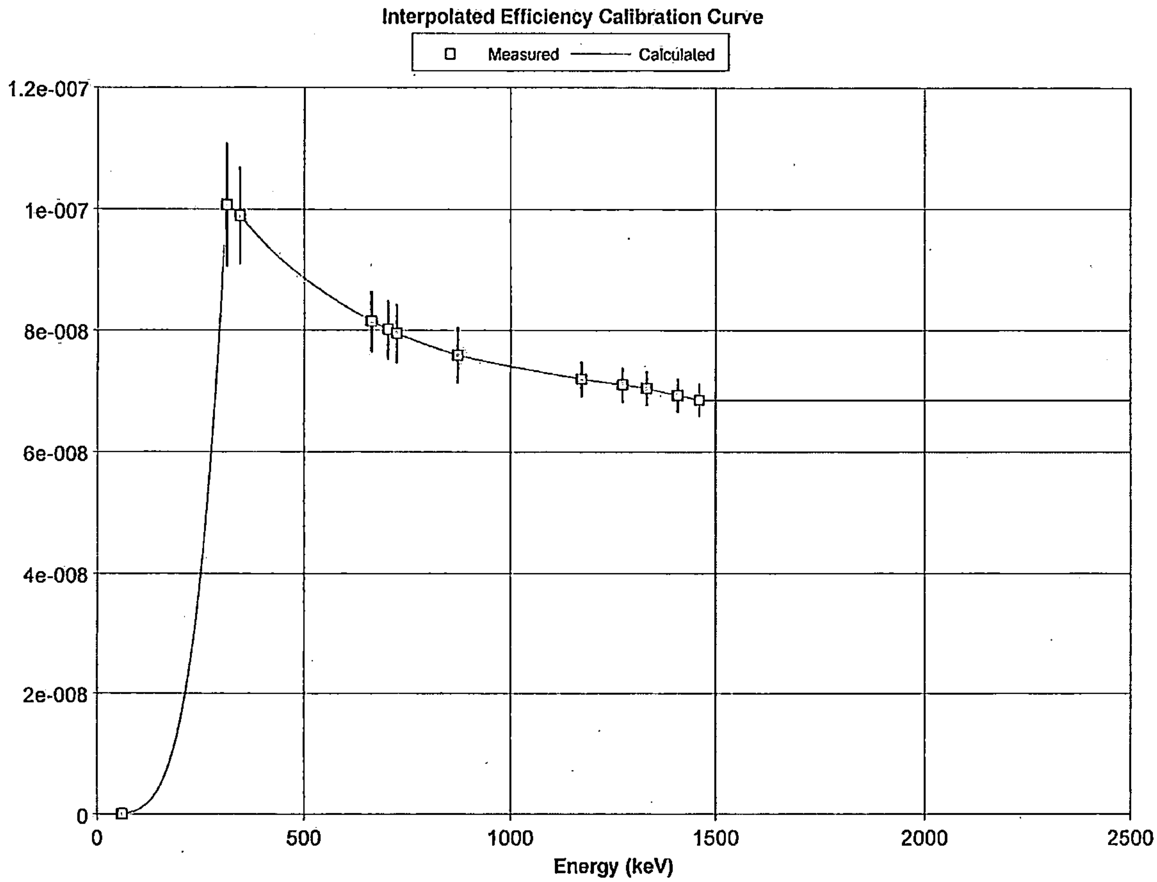
Date: Thursday, November 13, 2014 - 17:08:00
Description: MHF_STD_SOIL_DET1_16
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET1_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)



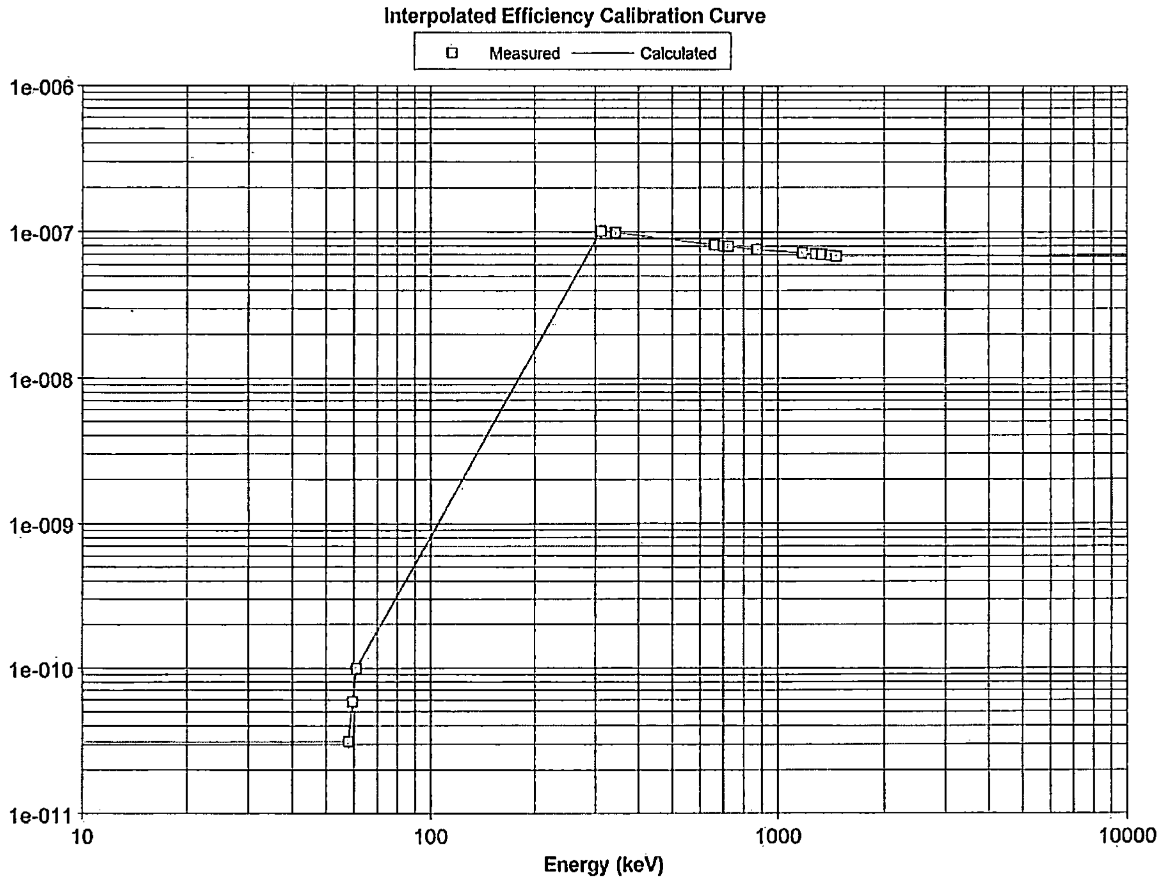
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time: 11/13/14 02:57:59
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_DET1_16.CAL
Genie Cal Time: 11/13/14 04:34:55
Template: SIMPLE BOX
Geom Description: HMF STD DET1 16
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3994
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.8705e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	3.12367e-011	10.0	0.176087	81760
59.54	5.85305e-011	10.0	0.163146	81760
61.00	9.93642e-011	10.0	0.152347	81760
311.00	1.00814e-007	10.0	-0.021565	81760
311.98	1.00714e-007	10.0	-0.021104	81760
313.00	1.00691e-007	10.0	-0.021551	81760
343.00	9.90373e-008	8.0	-0.023355	81760
344.27	9.89250e-008	8.0	-0.023157	81760
345.00	9.89169e-008	8.0	-0.023358	81760
660.00	8.15883e-008	6.0	-0.025608	81760
661.65	8.14412e-008	6.0	-0.025749	81760
663.00	8.14289e-008	6.0	-0.025400	81760
701.00	8.01935e-008	6.0	-0.025135	81760
702.63	8.00826e-008	6.0	-0.025316	81760
703.00	8.00976e-008	6.0	-0.025343	81760
722.00	7.95294e-008	6.0	-0.025267	81760
723.00	7.94792e-008	6.0	-0.025071	81760
724.00	7.94637e-008	6.0	-0.025102	81760
870.00	7.59700e-008	6.0	-0.023477	81760
871.10	7.59220e-008	6.0	-0.023394	81760
872.00	7.59474e-008	6.0	-0.023274	81760
1172.00	7.20711e-008	4.0	-0.020161	81760
1173.22	7.20275e-008	4.0	-0.020073	81760
1174.00	7.19963e-008	4.0	-0.019895	81760
1273.00	7.11249e-008	4.0	-0.018839	81760
1274.45	7.10986e-008	4.0	-0.019015	81760
1275.00	7.10939e-008	4.0	-0.018857	81760
1331.00	7.05470e-008	4.0	-0.018274	81760
1332.49	7.05266e-008	4.0	-0.018189	81760
1334.00	7.04885e-008	4.0	-0.018498	81760
1406.00	6.93572e-008	4.0	-0.017341	81760
1407.95	6.93491e-008	4.0	-0.017367	81760
1409.00	6.93658e-008	4.0	-0.017276	81760
1460.80	6.85559e-008	4.0	-0.016776	81760



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

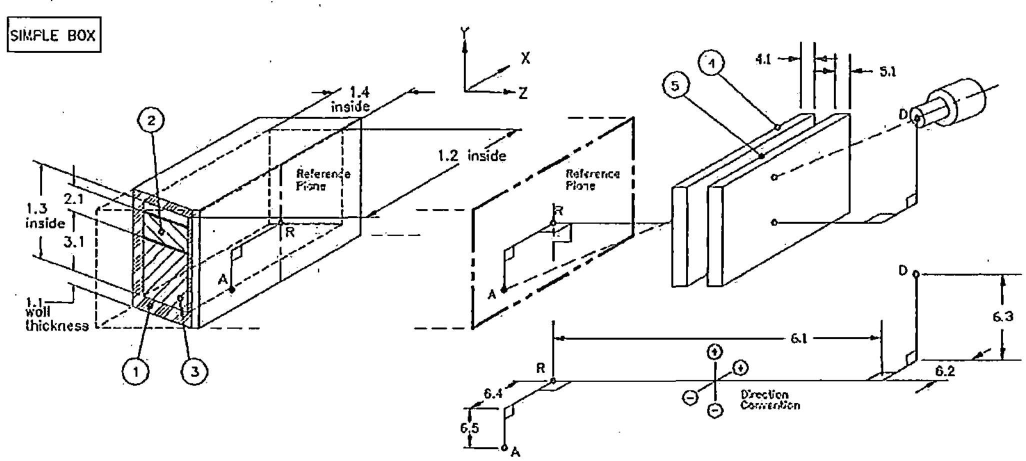
Date: Thursday, November 13, 2014 - 17:08:44
Description: MHF_STD_SOIL_DET2_16
Comment: Calib Date 11/13/14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET2_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3996
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.6	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.0315						germanum	5.4	
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

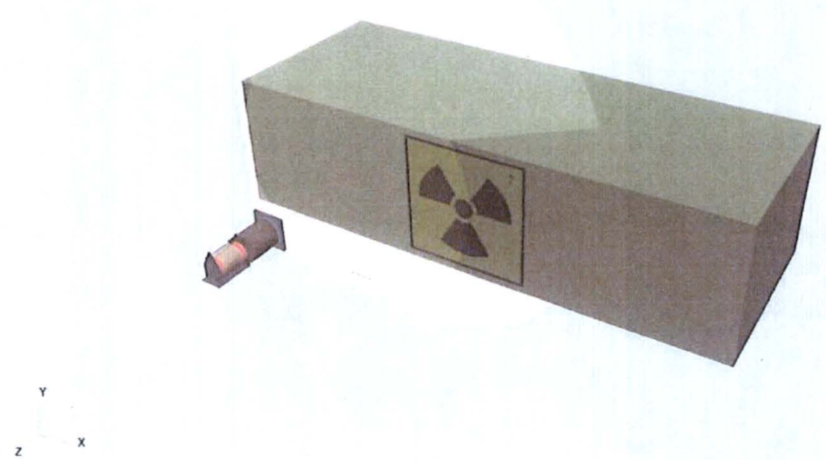
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

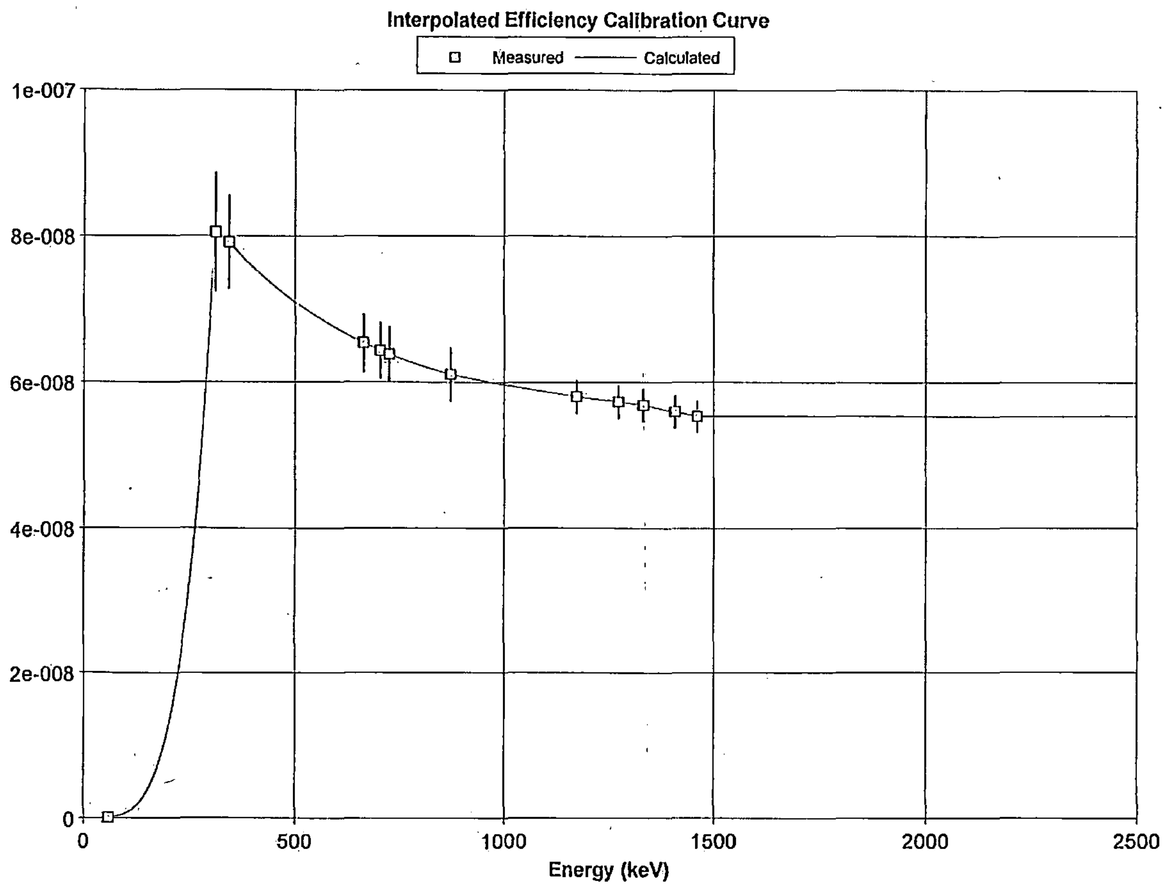
Date:	Thursday, November 13, 2014 - 17:08:44
Description:	MHF_STD_SOIL_DET2_16
Comment:	Calib Date 11/13/14
File Name:	E:\GEOS\In-Situ\MHF_STD_SOIL_DET2_16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



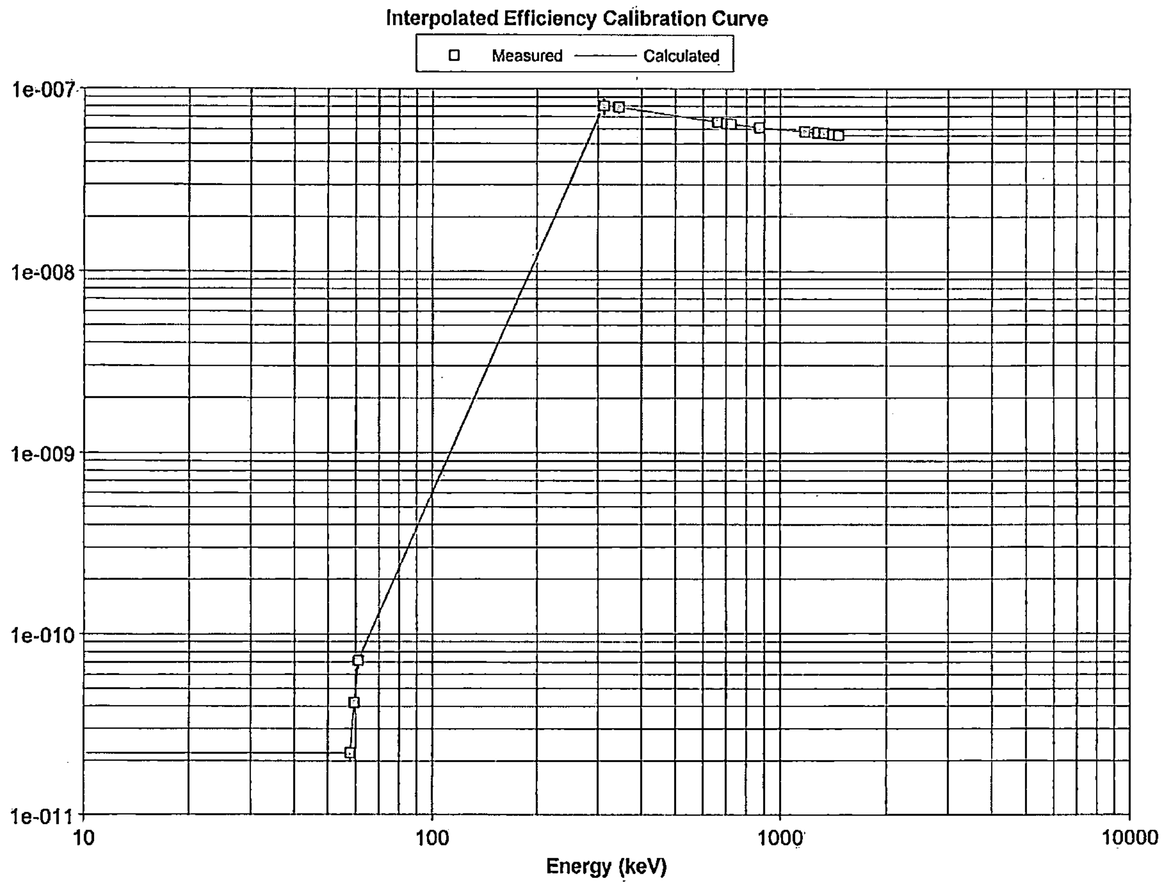
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time: 11/13/14 03:03:35
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_DET2_16.CAL
Genie Cal Time: 11/13/14 04:38:26
Template: SIMPLE BOX
Geom Description: HMF STD DET2 16
Comment: ISOCS:CALIB_DATE_11/13/14
Detector: 3996
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.8705e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	2.76775e-011	10.0	0.191809	81760
59.54	5.22905e-011	10.0	0.180106	81760
61.00	8.94047e-011	10.0	0.170357	81760
311.00	1.00180e-007	10.0	0.003898	81760
311.98	1.00082e-007	10.0	0.004259	81760
313.00	1.00061e-007	10.0	0.003663	81760
343.00	9.84523e-008	8.0	-0.000715	81760
344.27	9.83420e-008	8.0	-0.000519	81760
345.00	9.83347e-008	8.0	-0.000855	81760
660.00	8.12464e-008	6.0	-0.021893	81760
661.65	8.11003e-008	6.0	-0.022030	81760
663.00	8.10884e-008	6.0	-0.021759	81760
701.00	7.98674e-008	6.0	-0.022656	81760
702.63	7.97573e-008	6.0	-0.022874	81760
703.00	7.97723e-008	6.0	-0.022865	81760
722.00	7.92106e-008	6.0	-0.023278	81760
723.00	7.91608e-008	6.0	-0.023191	81760
724.00	7.91457e-008	6.0	-0.023233	81760
870.00	7.56926e-008	6.0	-0.024652	81760
871.10	7.56451e-008	6.0	-0.024558	81760
872.00	7.56705e-008	6.0	-0.024424	81760
1172.00	7.18459e-008	4.0	-0.024722	81760
1173.22	7.18026e-008	4.0	-0.024620	81760
1174.00	7.17715e-008	4.0	-0.024424	81760
1273.00	7.09120e-008	4.0	-0.024037	81760
1274.45	7.08859e-008	4.0	-0.024270	81760
1275.00	7.08812e-008	4.0	-0.024150	81760
1331.00	7.03406e-008	4.0	-0.023778	81760
1332.49	7.03204e-008	4.0	-0.023752	81760
1334.00	7.02825e-008	4.0	-0.024043	81760
1406.00	6.91598e-008	4.0	-0.023170	81760
1407.95	6.91519e-008	4.0	-0.023208	81760
1409.00	6.91687e-008	4.0	-0.023168	81760
1460.80	6.83646e-008	4.0	-0.022862	81760



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

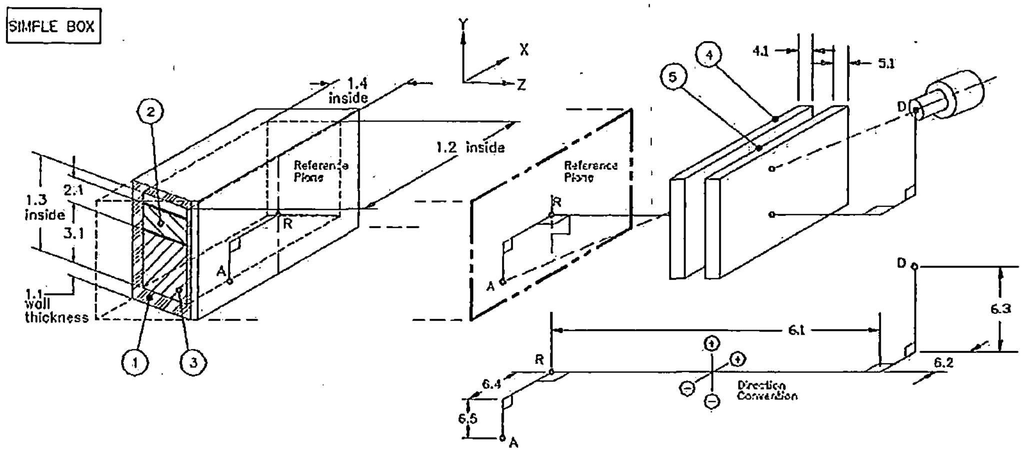
Date: Thursday, November 13, 2014 - 17:10:12
Description: MHF_STD_SOIL_DET3_16
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET3_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3997
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.6	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2	0.03543						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

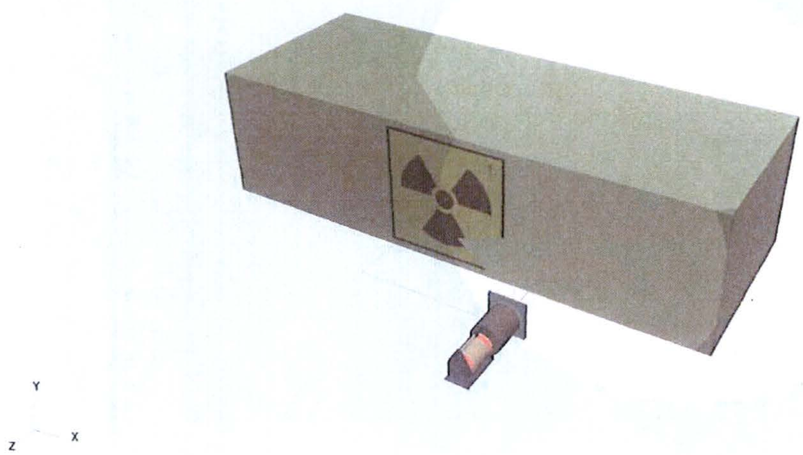
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

Date:	Thursday, November 13, 2014 - 17:10:12
Description:	MHF_STD_SOIL_DET3_16
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\MHF_STD_SOIL_DET3_16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)

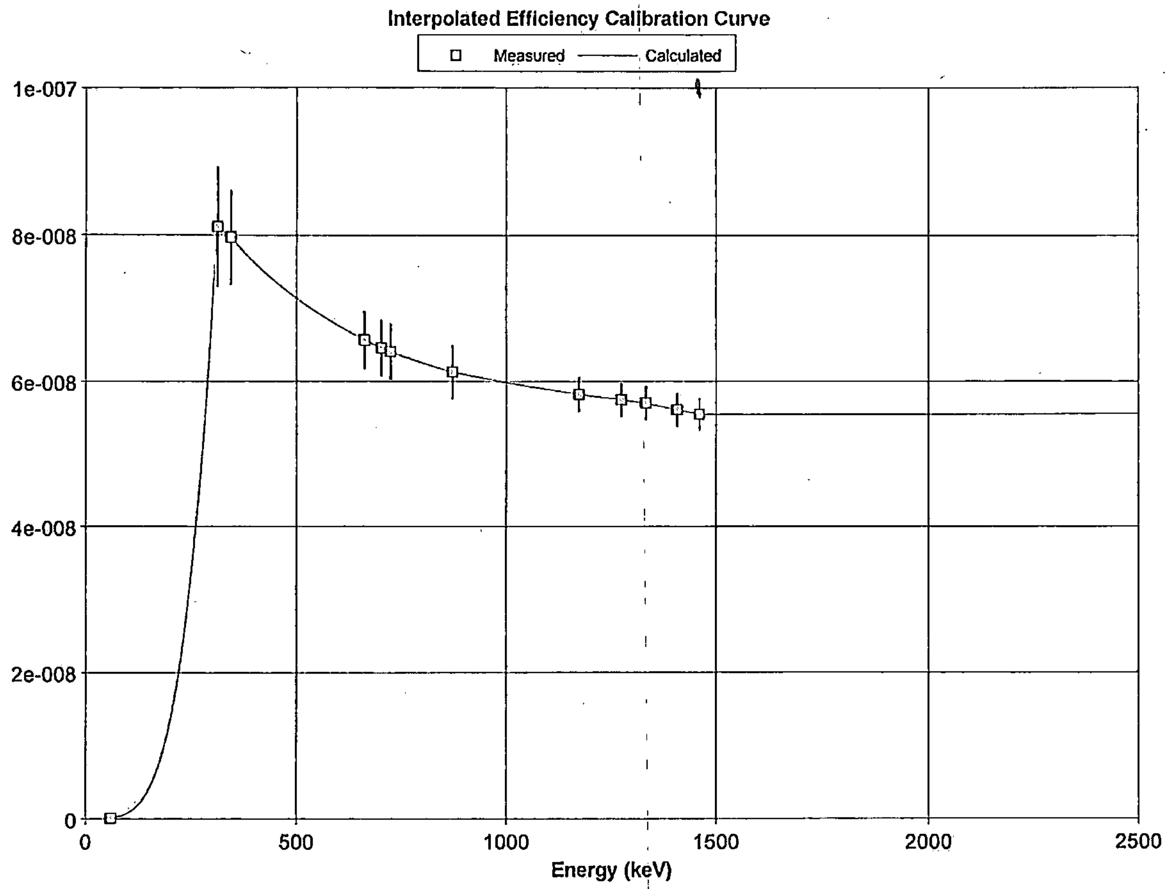


ISOCS/LABSOCS RESULTS

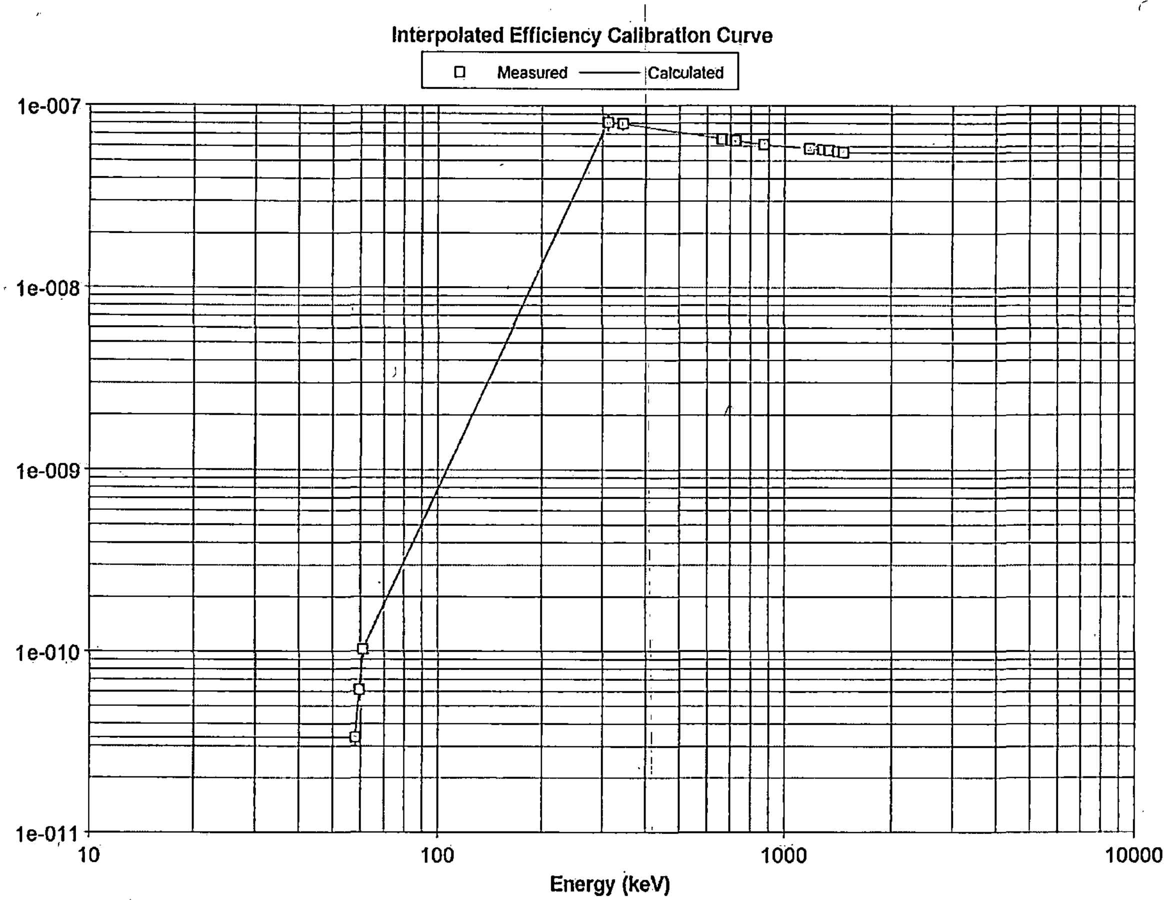
ISOCS/LabSOCS File:	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time:	11/13/14 03:08:10
Genie Cal File:	C:\GENIE2K\CALFILES\HMF_STD_Soil_DET3_16.CAL
Genie Cal Time:	11/13/14 04:41:51
Template:	SIMPLE BOX
Geom Description:	STD SOIL DET3 16
Comment:	ISOCS:CAL_DATE_11_13_14
Detector:	3997
Collimator:	GARDIAN_G1
Convergence:	1.00 %
Area [Sq Meters]:	8.3097e+000 (C)
Mass [Grams]:	2.8705e+007 (C)
Length [Meters]:	not used

(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	4.19632e-011	10.0	0.173868	81760
59.54	7.68771e-011	10.0	0.161047	81760
61.00	1.28004e-010	10.0	0.150373	81760
311.00	1.00994e-007	10.0	-0.021570	81760
311.98	1.00892e-007	10.0	-0.021110	81760
313.00	1.00868e-007	10.0	-0.021557	81760
343.00	9.91761e-008	8.0	-0.023359	81760
344.27	9.90624e-008	8.0	-0.023160	81760
345.00	9.90536e-008	8.0	-0.023362	81760
660.00	8.16237e-008	6.0	-0.025607	81760
661.65	8.14763e-008	6.0	-0.025749	81760
663.00	8.14639e-008	6.0	-0.025399	81760
701.00	8.02260e-008	6.0	-0.025135	81760
702.63	8.01150e-008	6.0	-0.025316	81760
703.00	8.01300e-008	6.0	-0.025342	81760
722.00	7.95606e-008	6.0	-0.025266	81760
723.00	7.95103e-008	6.0	-0.025071	81760
724.00	7.94948e-008	6.0	-0.025101	81760
870.00	7.59948e-008	6.0	-0.023476	81760
871.10	7.59469e-008	6.0	-0.023393	81760
872.00	7.59722e-008	6.0	-0.023273	81760
1172.00	7.20906e-008	4.0	-0.020160	81760
1173.22	7.20469e-008	4.0	-0.020072	81760
1174.00	7.20157e-008	4.0	-0.019895	81760
1273.00	7.11444e-008	4.0	-0.018838	81760
1274.45	7.11180e-008	4.0	-0.019014	81760
1275.00	7.11133e-008	4.0	-0.018856	81760
1331.00	7.05669e-008	4.0	-0.018273	81760
1332.49	7.05465e-008	4.0	-0.018188	81760
1334.00	7.05084e-008	4.0	-0.018497	81760
1406.00	6.93777e-008	4.0	-0.017340	81760
1407.95	6.93697e-008	4.0	-0.017366	81760
1409.00	6.93865e-008	4.0	-0.017275	81760
1460.80	6.85773e-008	4.0	-0.016774	81760



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

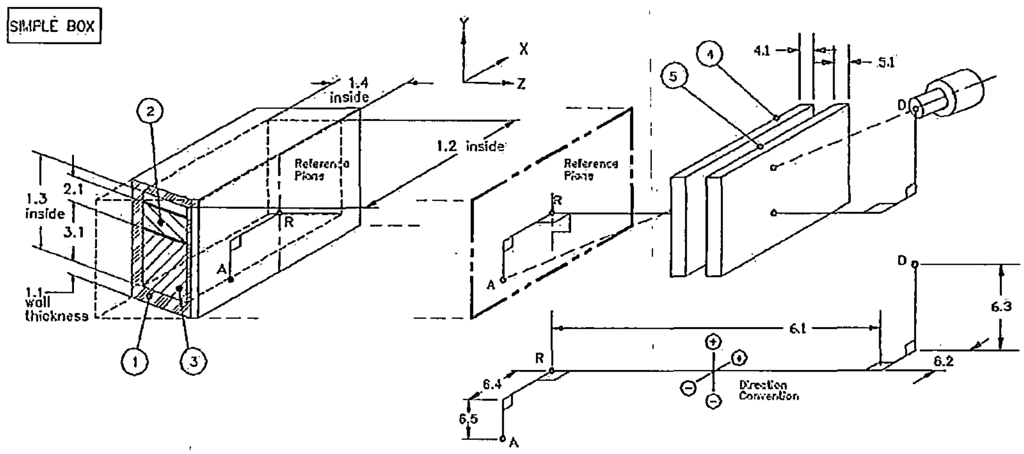
Date:	Thursday, November 13, 2014 - 17:11:25
Description:	MHF_STD_SOIL_DET4_16
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\MHF_STD_SOIL_DET4_16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)
Detector:	3998
Collimator:	GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment:	Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration:	Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						none		
3	Source - Bottom Layer	56						dirt1	1.6	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2							none		
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

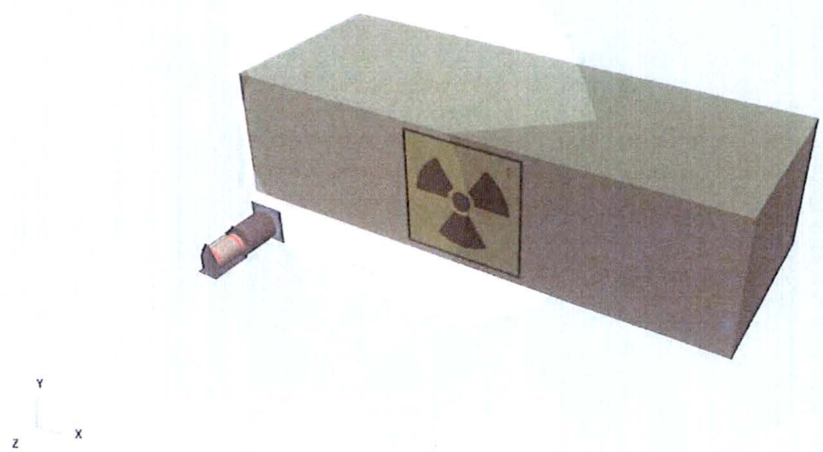
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

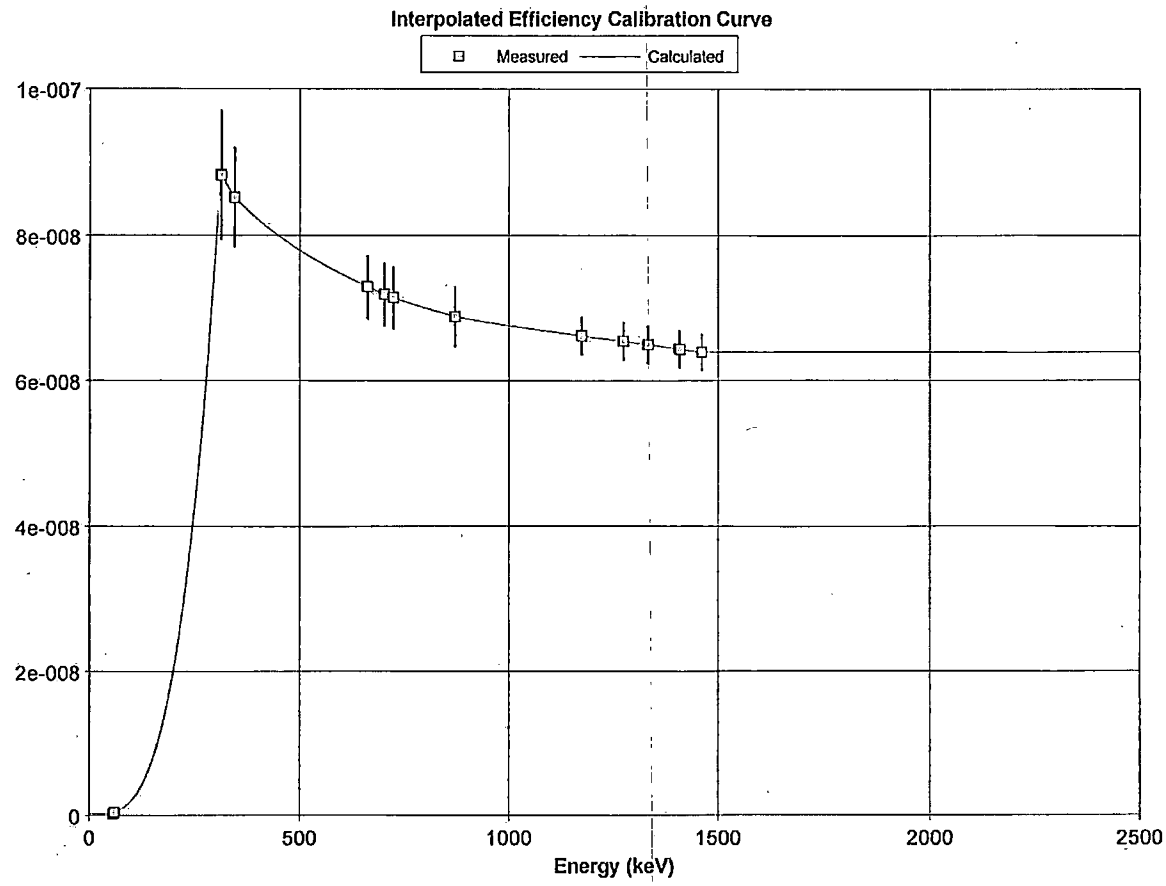
Date:	Thursday, November 13, 2014 - 17:11:25
Description:	MHF_STD_SOIL_DET4_16
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\MHF_STD_SOIL_DET4_16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



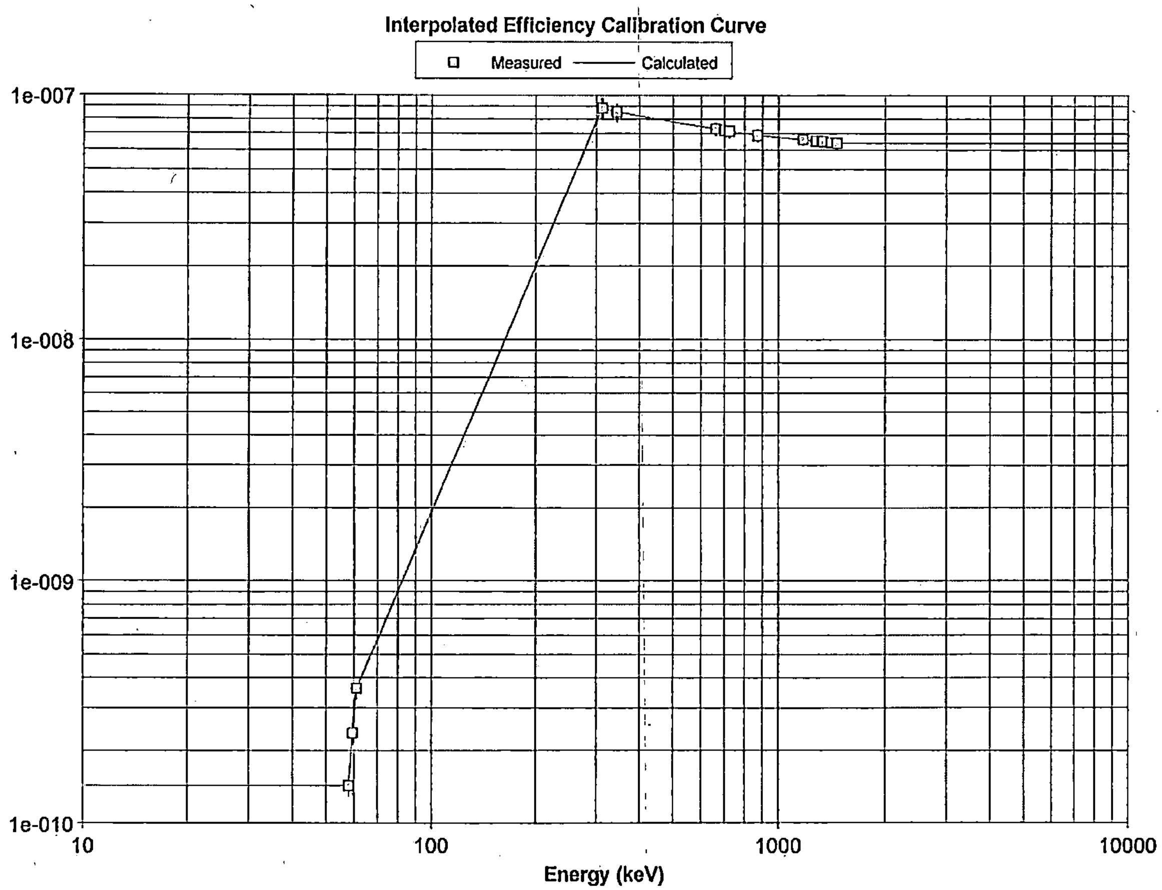
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time: 11/13/14 03:12:44
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_DET4_16.CAL
Genie Cal Time: 11/13/14 04:44:55
Template: SIMPLE BOX
Geom Description: HMF STD DET4 16
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3998
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.8705e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.77637e-010	10.0	-0.224842	81760
59.54	2.94312e-010	10.0	-0.213056	81760
61.00	4.50364e-010	10.0	-0.202258	81760
311.00	1.09841e-007	10.0	-0.025382	81760
311.98	1.09716e-007	10.0	-0.025292	81760
313.00	1.09593e-007	10.0	-0.025087	81760
343.00	1.06001e-007	8.0	-0.024978	81760
344.27	1.05872e-007	8.0	-0.024483	81760
345.00	1.05832e-007	8.0	-0.024774	81760
660.00	9.05776e-008	6.0	-0.022321	81760
661.65	9.04469e-008	6.0	-0.022381	81760
663.00	9.04425e-008	6.0	-0.022238	81760
701.00	8.92289e-008	6.0	-0.022424	81760
702.63	8.91712e-008	6.0	-0.022355	81760
703.00	8.91625e-008	6.0	-0.022435	81760
722.00	8.86208e-008	6.0	-0.022430	81760
723.00	8.86058e-008	6.0	-0.022480	81760
724.00	8.85783e-008	6.0	-0.022634	81760
870.00	8.53372e-008	6.0	-0.022560	81760
871.10	8.53120e-008	6.0	-0.022292	81760
872.00	8.53215e-008	6.0	-0.022468	81760
1172.00	8.19703e-008	4.0	-0.021828	81760
1173.22	8.19640e-008	4.0	-0.021687	81760
1174.00	8.19268e-008	4.0	-0.021457	81760
1273.00	8.09978e-008	4.0	-0.021443	81760
1274.45	8.09813e-008	4.0	-0.021349	81760
1275.00	8.09696e-008	4.0	-0.021141	81760
1331.00	8.03774e-008	4.0	-0.021152	81760
1332.49	8.04096e-008	4.0	-0.021075	81760
1334.00	8.03851e-008	4.0	-0.021115	81760
1406.00	7.96422e-008	4.0	-0.020245	81760
1407.95	7.95991e-008	4.0	-0.020295	81760
1409.00	7.95752e-008	4.0	-0.020214	81760
1460.80	7.90476e-008	4.0	-0.020145	81760



Datasource: DET01



Datasource: DET01

#		Primary Efficiency taken from ECC files, for set energies (keV):										
	Weight	58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3	345.0	660.0	661.7
1	1.000	3.12e-011	5.85e-011	9.94e-011	1.01e-007	1.01e-007	1.01e-007	9.90e-008	9.89e-008	9.89e-008	8.16e-008	8.14e-008
2	1.000	2.77e-011	5.23e-011	8.94e-011	1.00e-007	1.00e-007	1.00e-007	9.85e-008	9.83e-008	9.83e-008	8.12e-008	8.11e-008
3	1.000	4.20e-011	7.69e-011	1.28e-010	1.01e-007	1.01e-007	1.01e-007	9.92e-008	9.91e-008	9.91e-008	8.16e-008	8.15e-008
4	1.000	1.78e-010	2.94e-010	4.50e-010	1.10e-007	1.10e-007	1.10e-007	1.06e-007	1.06e-007	1.06e-007	9.06e-008	9.04e-008
	Sum	2.79e-010	4.82e-010	7.67e-010	4.12e-007	4.11e-007	4.11e-007	4.03e-007	4.02e-007	4.02e-007	3.35e-007	3.34e-007
	Error,%	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	8.00e+000	8.00e+000	8.00e+000	6.00e+000	6.00e+000

Information for input ECC files

	File Name	File Stamp	Path
1	MHF_STD_SOIL_DET1_16	Thu_Nov_13_02:57:07_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
2	MHF_STD_SOIL_DET2_16	Thu_Nov_13_03:02:43_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
3	MHF_STD_SOIL_DET3_16	Thu_Nov_13_03:07:18_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
4	MHF_STD_SOIL_DET4_16	Thu_Nov_13_03:11:52_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

File Name File Stamp Path

Description: MHF_STD_Soil_SUM_D16
Comment: Cal Date 11/13/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

663.0	701.0	702.6	703.0	722.0	723.0	724.0	870.0	871.1	872.0	1172.0	1173.2
8.14e-008	8.02e-008	8.01e-008	8.01e-008	7.95e-008	7.95e-008	7.95e-008	7.60e-008	7.59e-008	7.59e-008	7.21e-008	7.20e-008
8.11e-008	7.99e-008	7.98e-008	7.98e-008	7.92e-008	7.92e-008	7.91e-008	7.57e-008	7.56e-008	7.57e-008	7.18e-008	7.18e-008
8.15e-008	8.02e-008	8.01e-008	8.01e-008	7.96e-008	7.95e-008	7.95e-008	7.60e-008	7.59e-008	7.60e-008	7.21e-008	7.20e-008
9.04e-008	8.92e-008	8.92e-008	8.92e-008	8.86e-008	8.86e-008	8.86e-008	8.53e-008	8.53e-008	8.53e-008	8.20e-008	8.20e-008
3.34e-007	3.30e-007	3.29e-007	3.29e-007	3.27e-007	3.27e-007	3.27e-007	3.13e-007	3.13e-007	3.13e-007	2.98e-007	2.98e-007
6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_STD_Soil_SUM_D16
Cal Date 11/13/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

1174.0	1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9	1409.0	1460.8
7.20e-008	7.11e-008	7.11e-008	7.11e-008	7.05e-008	7.05e-008	7.05e-008	6.94e-008	6.93e-008	6.94e-008	6.86e-008
7.18e-008	7.09e-008	7.09e-008	7.09e-008	7.03e-008	7.03e-008	7.03e-008	6.92e-008	6.92e-008	6.92e-008	6.84e-008
7.20e-008	7.11e-008	7.11e-008	7.11e-008	7.06e-008	7.05e-008	7.05e-008	6.94e-008	6.94e-008	6.94e-008	6.86e-008
8.19e-008	8.10e-008	8.10e-008	8.10e-008	8.04e-008	8.04e-008	8.04e-008	7.96e-008	7.96e-008	7.96e-008	7.90e-008
2.98e-007	2.94e-007	2.94e-007	2.94e-007	2.92e-007	2.92e-007	2.92e-007	2.88e-007	2.87e-007	2.87e-007	2.85e-007
4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_STD_Soil_SUM_D16
Cal Date 11/13/14

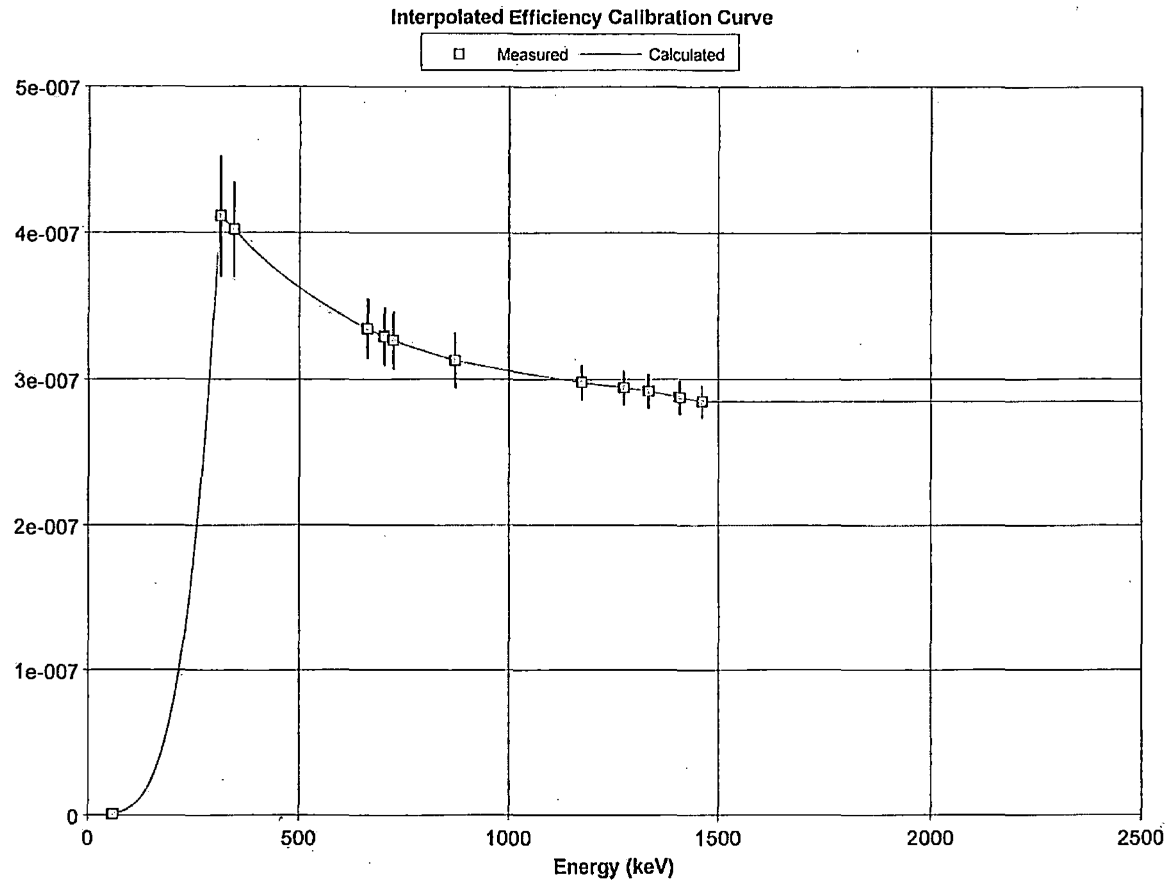
CANBERRA

Multi-Efficiency Report

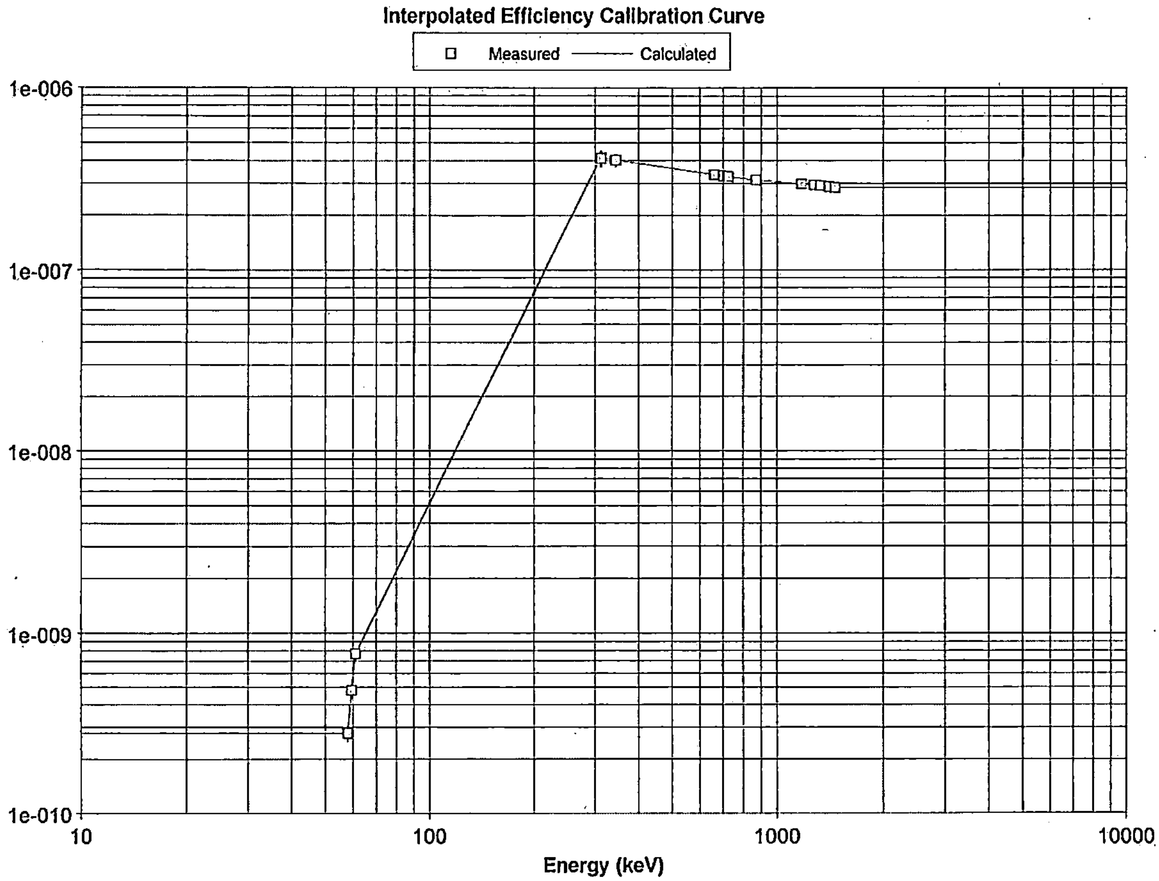
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\Multiefficiency\MHF_ST
ISOCS/LabSOCS Time: 11/13/14 03:25:39
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_SUM_D16.CAL
Genie Cal Time: 11/13/14 04:48:16
Template: (SIMPLE BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+
Geom Description: HMF STD SUM D16
Comment: ISOCS:Cal Date 11/13/14
Detector: (3994)+(3996)+(3997)+(3998)+
Collimator: (GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+
Convergence: 1.00 %
Area [Sq Meters]: 1.0000e-004 (C)
Mass [Grams]: 1.0000e+000 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	2.78514e-010	10.0	0.1918090	64000
59.54	4.82010e-010	10.0	0.1918090	64000
61.00	7.67137e-010	10.0	0.1918090	64000
311.00	4.11829e-007	10.0	0.1918090	64000
311.98	4.11404e-007	10.0	0.1918090	64000
313.00	4.11213e-007	10.0	0.1918090	64000
343.00	4.02667e-007	8.0	0.1918090	64000
344.27	4.02201e-007	8.0	0.1918090	64000
345.00	4.02137e-007	8.0	0.1918090	64000
660.00	3.35036e-007	6.0	0.1918090	64000
661.65	3.34465e-007	6.0	0.1918090	64000
663.00	3.34424e-007	6.0	0.1918090	64000
701.00	3.29516e-007	6.0	0.1918090	64000
702.63	3.29126e-007	6.0	0.1918090	64000
703.00	3.29162e-007	6.0	0.1918090	64000
722.00	3.26921e-007	6.0	0.1918090	64000
723.00	3.26756e-007	6.0	0.1918090	64000
724.00	3.26682e-007	6.0	0.1918090	64000
870.00	3.12995e-007	6.0	0.1918090	64000
871.10	3.12826e-007	6.0	0.1918090	64000
872.00	3.12912e-007	6.0	0.1918090	64000
1172.00	2.97978e-007	4.0	0.1918090	64000
1173.22	2.97841e-007	4.0	0.1918090	64000
1174.00	2.97710e-007	4.0	0.1918090	64000
1273.00	2.94179e-007	4.0	0.1918090	64000
1274.45	2.94084e-007	4.0	0.1918090	64000
1275.00	2.94058e-007	4.0	0.1918090	64000
1331.00	2.91832e-007	4.0	0.1918090	64000
1332.49	2.91803e-007	4.0	0.1918090	64000
1334.00	2.91665e-007	4.0	0.1918090	64000
1406.00	2.87537e-007	4.0	0.1918090	64000
1407.95	2.87470e-007	4.0	0.1918090	64000
1409.00	2.87496e-007	4.0	0.1918090	64000
1460.80	2.84545e-007	4.0	0.1918090	64000



Datasource: DET01



Datasource: DET01

GARDIAN SYSTEM
Calibration Records
MHF IP-1 & IP-2 Intermodal

Density 1.2

Geometry Composer Report

CANBERRA

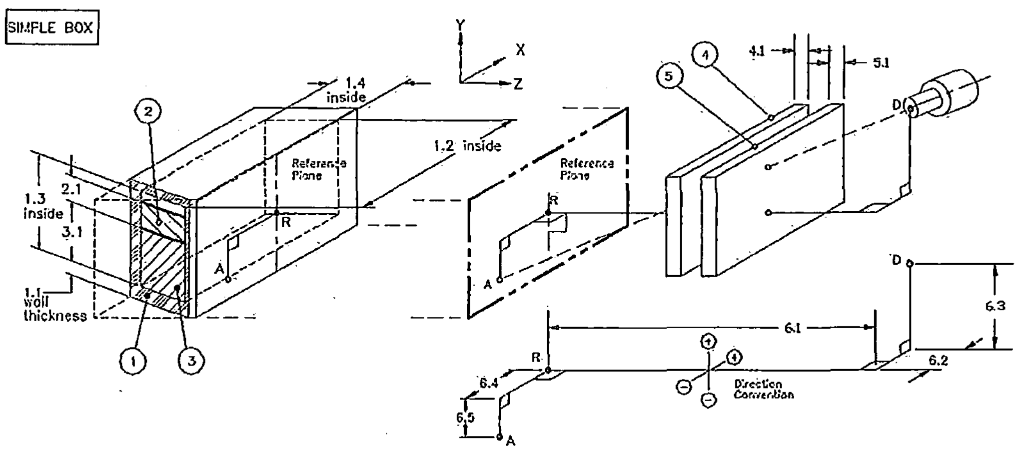
Date: Thursday, November 13, 2014 - 17:07:30
Description: MHF_STD_SOIL_DET1_12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET1_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3994
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.02756						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

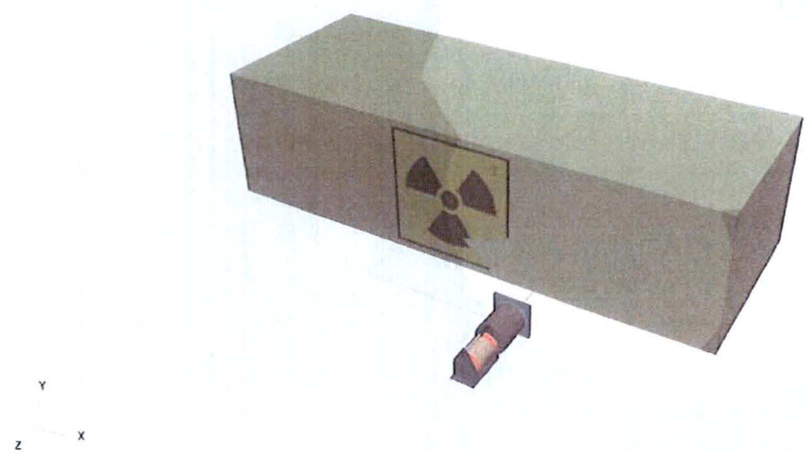
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

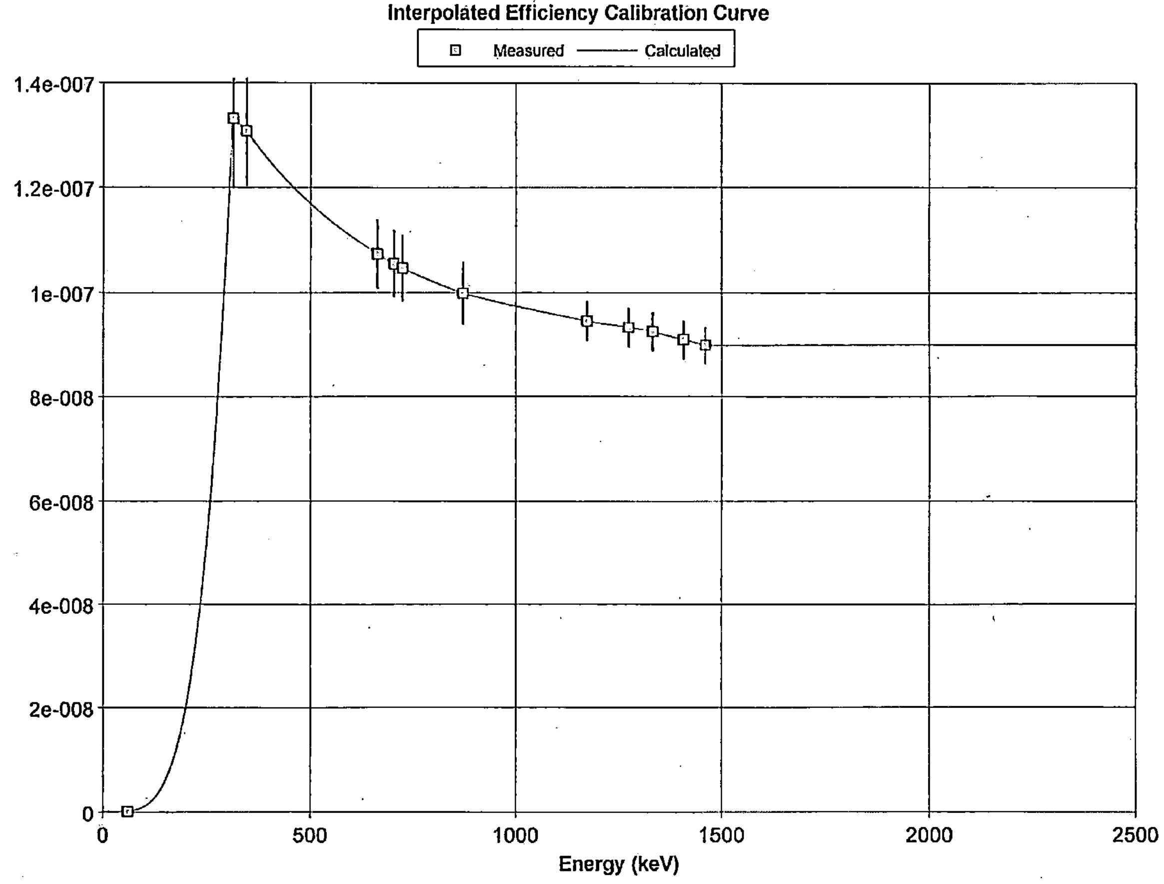
Date:	Thursday, November 13, 2014 - 17:07:30
Description:	MHF_STD_SOIL_DET1_12
Comment:	CAL DATE 11_13_14
File Name:	E:\GEOS\In-Situ\MHF_STD_SOIL_DET1_12.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



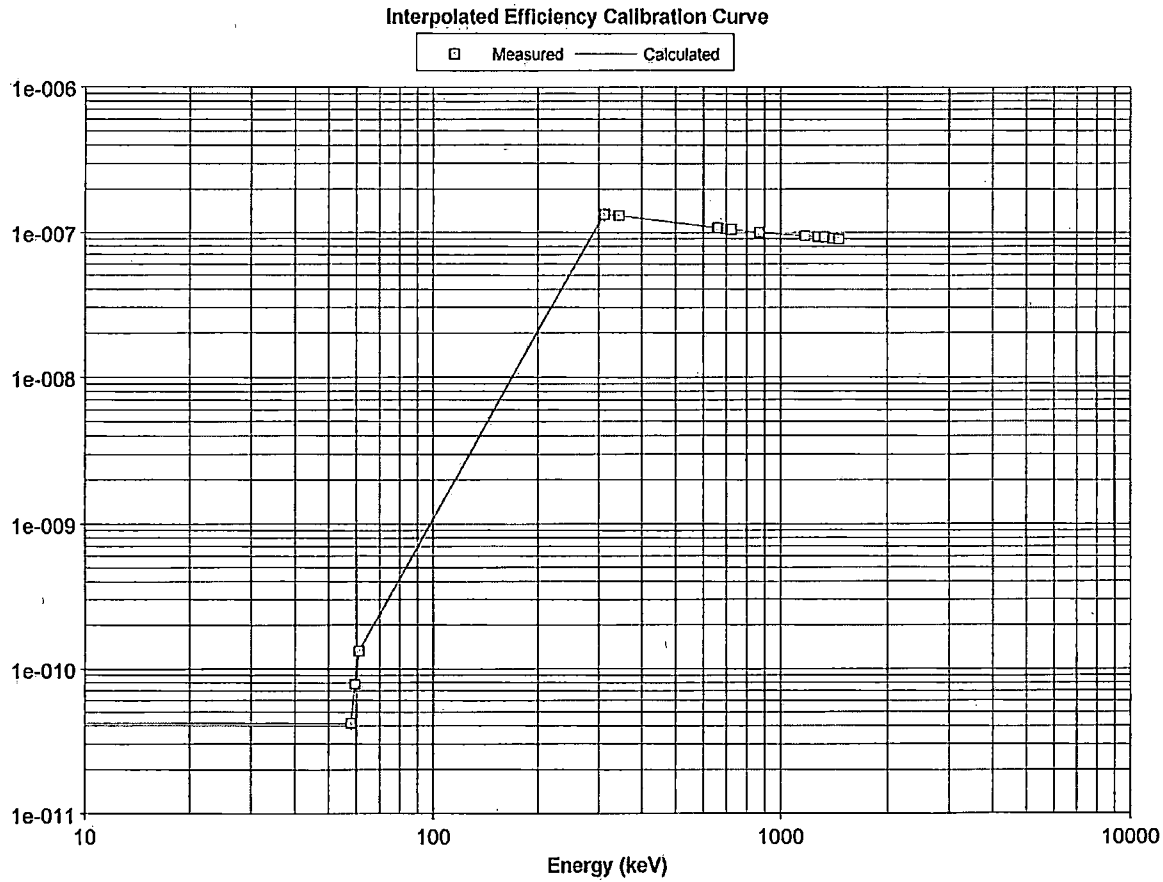
ISOCS/LABSOCS RESULTS

```
ISOCS/LabSOCS File:   C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time:   11/13/14 02:56:24
Genie Cal File:       C:\GENIE2K\CALFILES\HMF_STD_Soil_DET1_12.CAL
Genie Cal Time:       11/13/14 04:33:28
Template:             SIMPLE BOX
Geom Description:     HMF STD DET1 12
Comment:              ISOCS:CAL_DATE_11_13_14
Detector:             3994
Collimator:           GARDIAN_G1
Convergence:          1.00 %
Area [Sq Meters]:     8.3097e+000 (C)
Mass [Grams]:         2.1529e+007 (C)
Length [Meters]:      not used
 (C) = Value calculated by ISOCS
 (U) = Value modified by user
```

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	4.15405e-011	10.0	-0.112929	91980
59.54	7.78247e-011	10.0	-0.113004	91980
61.00	1.32108e-010	10.0	-0.112798	91980
311.00	1.33208e-007	10.0	-0.068607	91980
311.98	1.33081e-007	10.0	-0.068161	91980
313.00	1.33047e-007	10.0	-0.068302	91980
343.00	1.30831e-007	8.0	-0.066094	91980
344.27	1.30684e-007	8.0	-0.065931	91980
345.00	1.30668e-007	8.0	-0.065958	91980
660.00	1.07491e-007	6.0	-0.046395	91980
661.65	1.07297e-007	6.0	-0.046403	91980
663.00	1.07286e-007	6.0	-0.046163	91980
701.00	1.05613e-007	6.0	-0.044700	91980
702.63	1.05475e-007	6.0	-0.045028	91980
703.00	1.05491e-007	6.0	-0.044993	91980
722.00	1.04726e-007	6.0	-0.044413	91980
723.00	1.04658e-007	6.0	-0.044329	91980
724.00	1.04637e-007	6.0	-0.044340	91980
870.00	9.99225e-008	6.0	-0.040962	91980
871.10	9.98635e-008	6.0	-0.040929	91980
872.00	9.98883e-008	6.0	-0.040878	91980
1172.00	9.46111e-008	4.0	-0.037512	91980
1173.22	9.45498e-008	4.0	-0.037432	91980
1174.00	9.45068e-008	4.0	-0.037359	91980
1273.00	9.33125e-008	4.0	-0.036299	91980
1274.45	9.32786e-008	4.0	-0.036724	91980
1275.00	9.32735e-008	4.0	-0.036563	91980
1331.00	9.25305e-008	4.0	-0.036077	91980
1332.49	9.25018e-008	4.0	-0.036043	91980
1334.00	9.24434e-008	4.0	-0.036217	91980
1406.00	9.09236e-008	4.0	-0.035386	91980
1407.95	9.09060e-008	4.0	-0.035390	91980
1409.00	9.09277e-008	4.0	-0.035442	91980
1460.80	8.98473e-008	4.0	-0.035059	91980



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

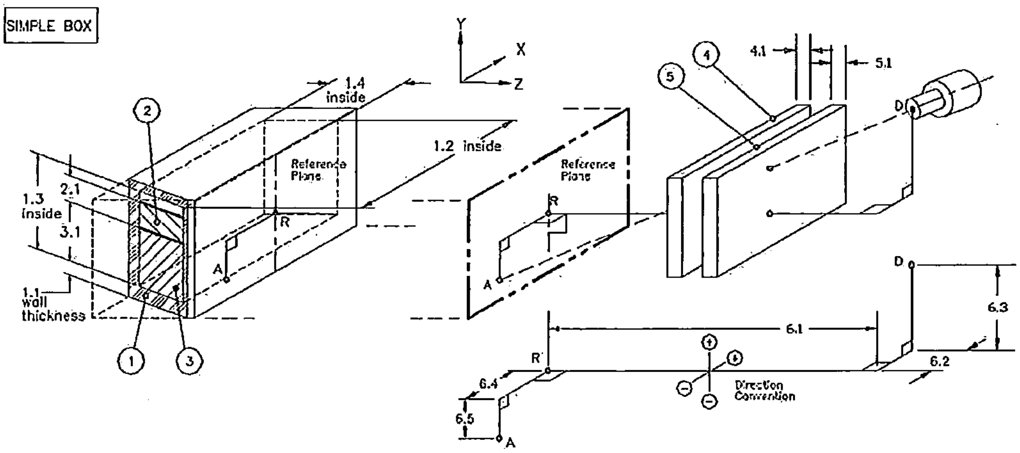
Date: Thursday, November 13, 2014 - 17:08:29
Description: MHF_STD_SOIL_DET2_12
Comment: Calib. Date 11/13/14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET2_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3996
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.0315						germanum	5.4	
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

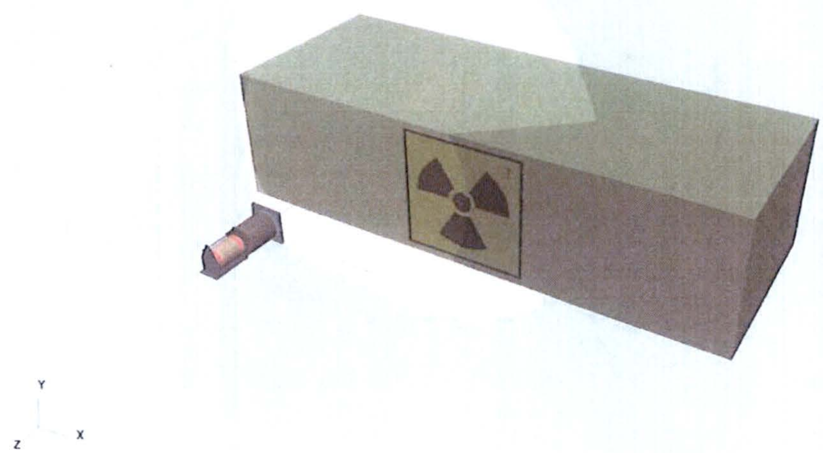
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

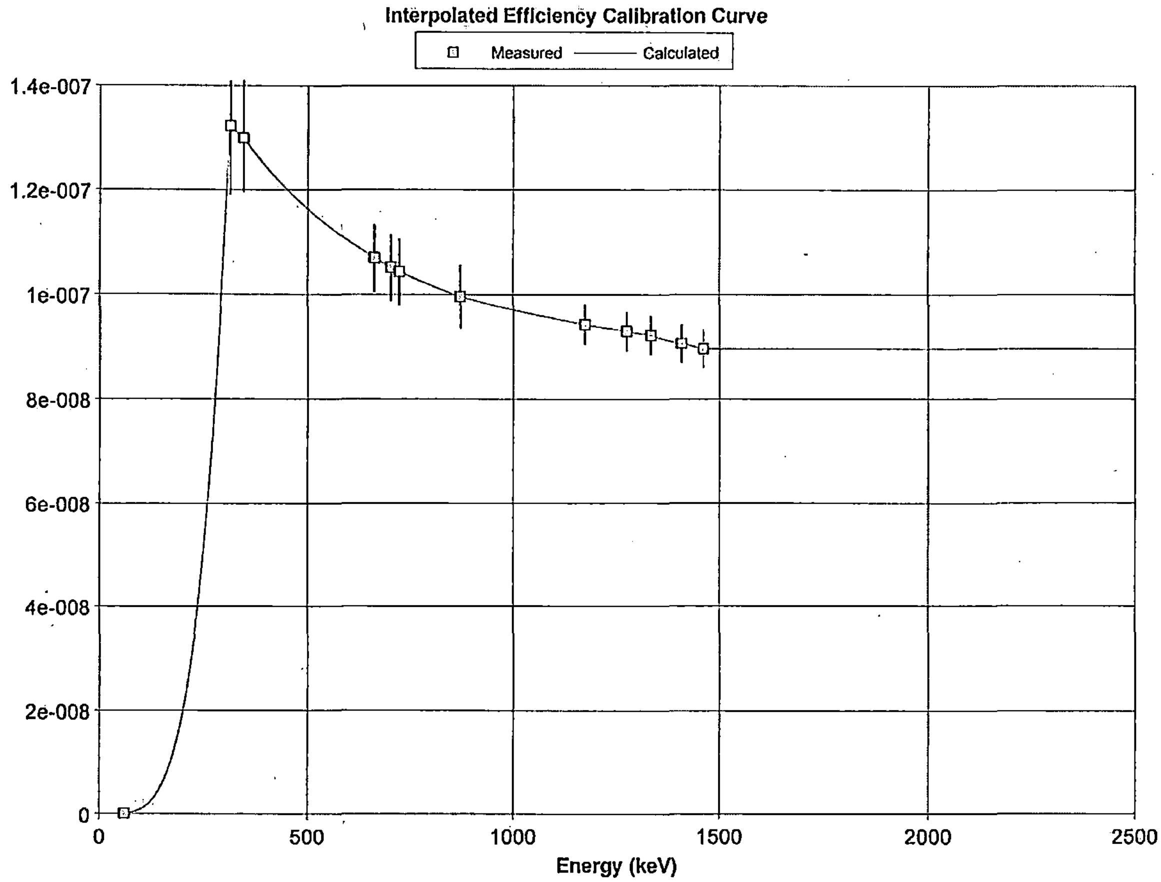
Date:	Thursday, November 13, 2014 - 17:08:29
Description:	MHF_STD_SOIL_DET2_12
Comment:	Calib. Date 11/13/14
File Name:	E:\GEOS\In-Situ\MHF_STD_SOIL_DET2_12.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



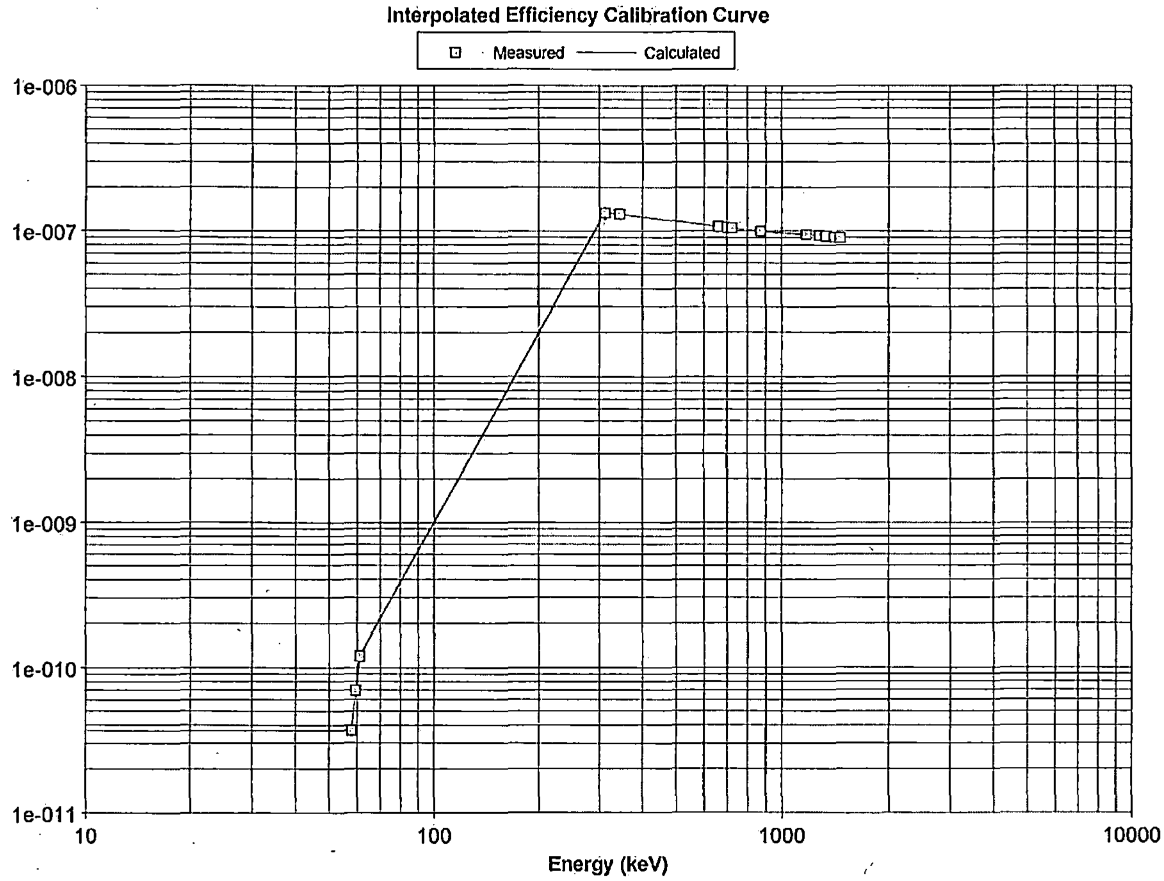
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time: 11/13/14 03:01:50
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_DET2_12.CAL
Genie Cal Time: 11/13/14 04:37:29
Template: SIMPLE BOX
Geom Description: HMF STD DET2 12
Comment: ISOCS:CALIB._DATE_11/13/14
Detector: 3996
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.1529e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	3.68042e-011	10.0	-0.122626	91980
59.54	6.95213e-011	10.0	-0.123519	91980
61.00	1.18855e-010	10.0	-0.123962	91980
311.00	1.32364e-007	10.0	-0.101613	91980
311.98	1.32239e-007	10.0	-0.101154	91980
313.00	1.32208e-007	10.0	-0.101345	91980
343.00	1.30051e-007	8.0	-0.098883	91980
344.27	1.29907e-007	8.0	-0.098567	91980
345.00	1.29892e-007	8.0	-0.098676	91980
660.00	1.07037e-007	6.0	-0.074511	91980
661.65	1.06844e-007	6.0	-0.074510	91980
663.00	1.06834e-007	6.0	-0.074252	91980
701.00	1.05180e-007	6.0	-0.072371	91980
702.63	1.05043e-007	6.0	-0.072628	91980
703.00	1.05059e-007	6.0	-0.072602	91980
722.00	1.04303e-007	6.0	-0.071761	91980
723.00	1.04235e-007	6.0	-0.071762	91980
724.00	1.04215e-007	6.0	-0.071695	91980
870.00	9.95545e-008	6.0	-0.066523	91980
871.10	9.94959e-008	6.0	-0.066449	91980
872.00	9.95209e-008	6.0	-0.066342	91980
1172.00	9.43124e-008	4.0	-0.059501	91980
1173.22	9.42514e-008	4.0	-0.059413	91980
1174.00	9.42086e-008	4.0	-0.059300	91980
1273.00	9.30300e-008	4.0	-0.057482	91980
1274.45	9.29963e-008	4.0	-0.057909	91980
1275.00	9.29914e-008	4.0	-0.057758	91980
1331.00	9.22565e-008	4.0	-0.056821	91980
1332.49	9.22281e-008	4.0	-0.056756	91980
1334.00	9.21700e-008	4.0	-0.056860	91980
1406.00	9.06617e-008	4.0	-0.055483	91980
1407.95	9.06444e-008	4.0	-0.055550	91980
1409.00	9.06661e-008	4.0	-0.055516	91980
1460.80	8.95934e-008	4.0	-0.054770	91980



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

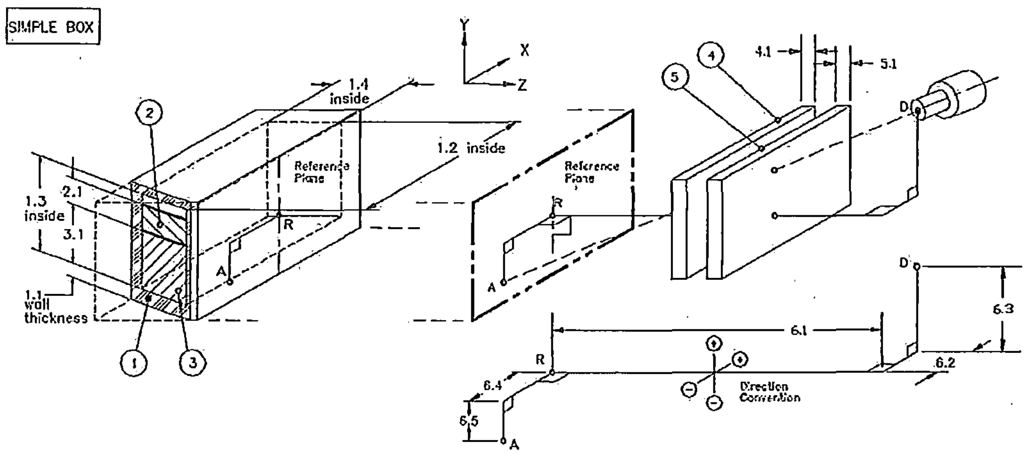
Date: Thursday, November 13, 2014 - 17:09:58
Description: MHF_STD_SOIL_DET3_12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET3_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3997
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2	0.03543						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

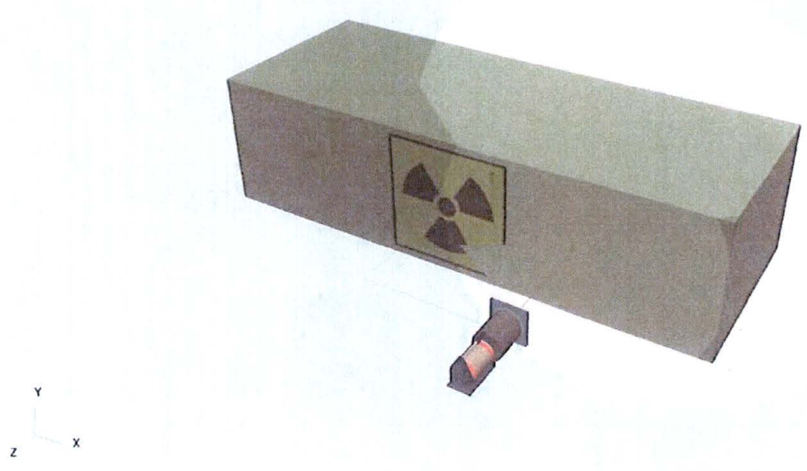
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

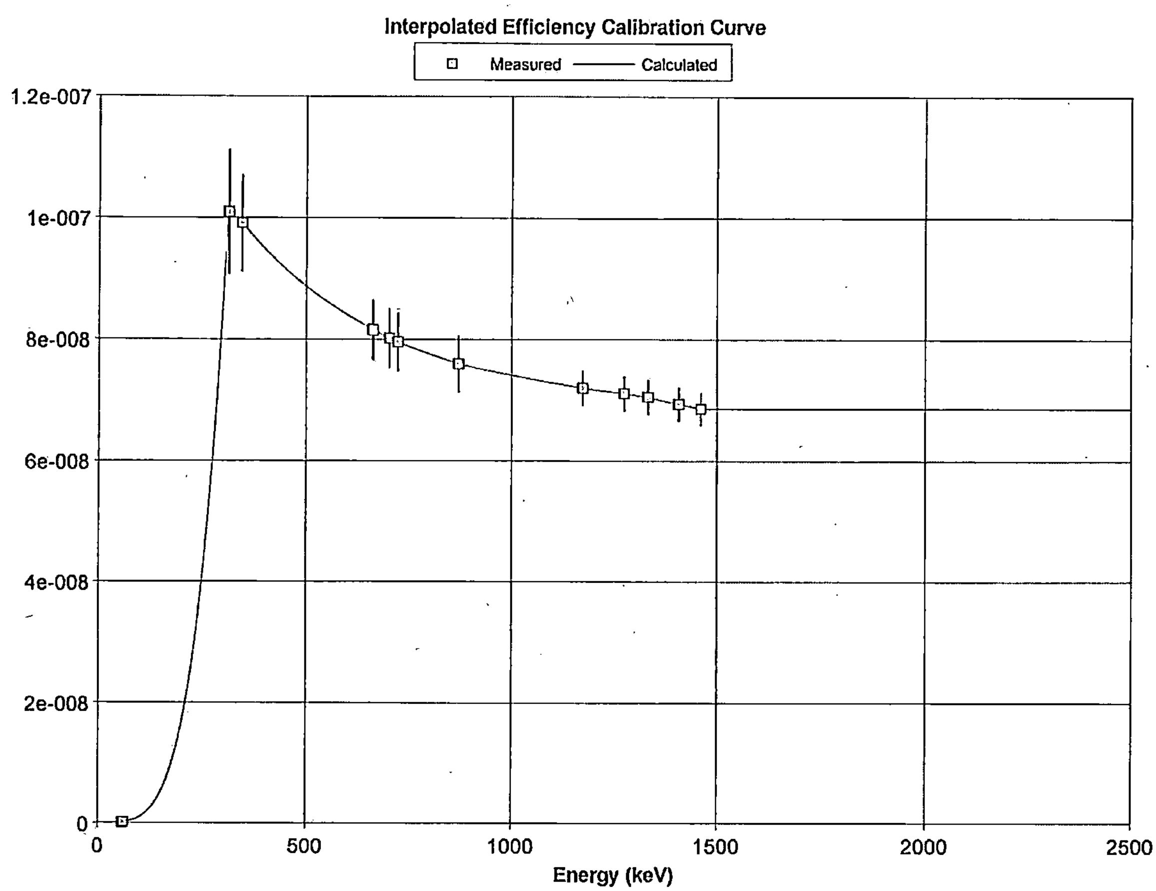
Date: Thursday, November 13, 2014 - 17:09:58
Description: MHF_STD_SOIL_DET3_12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET3_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)



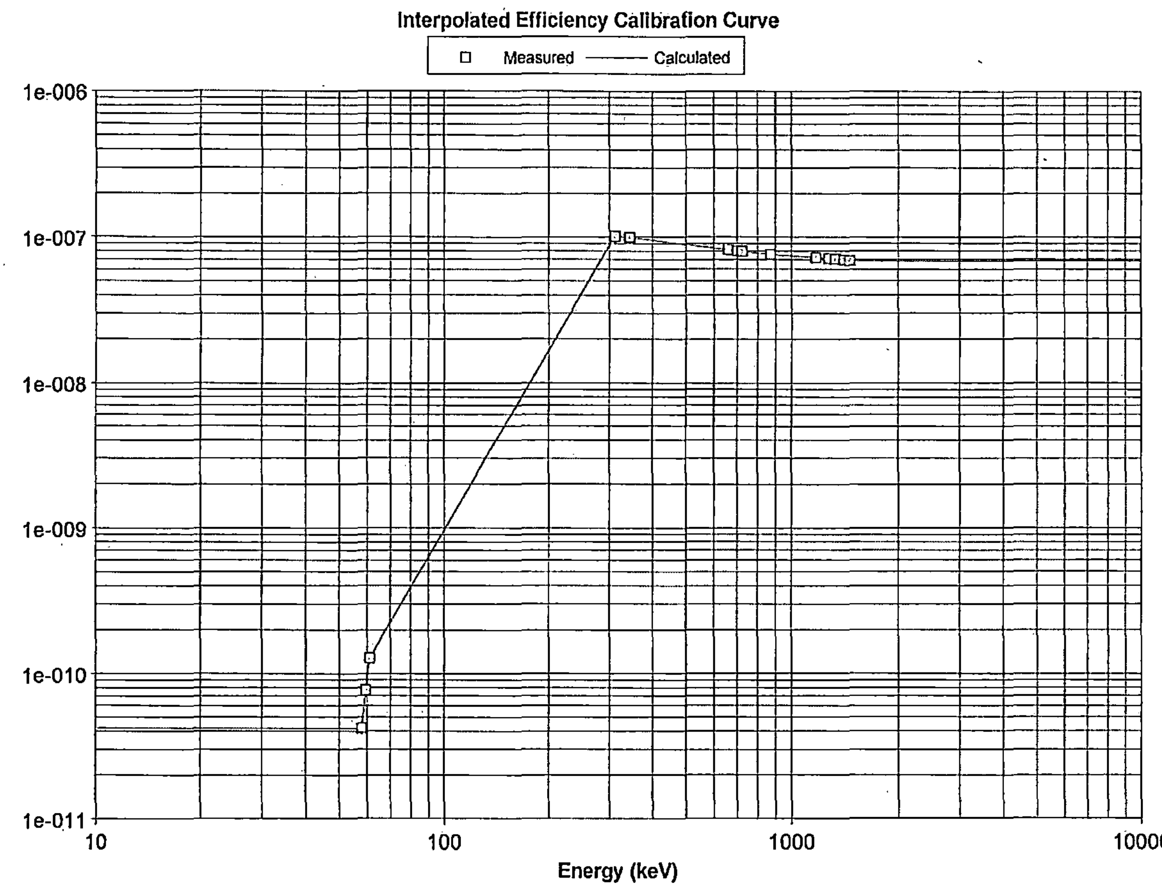
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time: 11/13/14 03:06:41
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_DET3_12.CAL
Genie Cal Time: 11/13/14 04:40:49
Template: SIMPLE BOX
Geom Description: STD SOIL DET3 12
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3997
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.1529e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	5.58031e-011	10.0	-0.111629	91980
59.54	1.02215e-010	10.0	-0.111660	91980
61.00	1.70179e-010	10.0	-0.111436	91980
311.00	1.33446e-007	10.0	-0.068584	91980
311.98	1.33316e-007	10.0	-0.068138	91980
313.00	1.33281e-007	10.0	-0.068280	91980
343.00	1.31014e-007	8.0	-0.066076	91980
344.27	1.30866e-007	8.0	-0.065913	91980
345.00	1.30848e-007	8.0	-0.065941	91980
660.00	1.07538e-007	6.0	-0.046390	91980
661.65	1.07343e-007	6.0	-0.046399	91980
663.00	1.07332e-007	6.0	-0.046158	91980
701.00	1.05656e-007	6.0	-0.044696	91980
702.63	1.05517e-007	6.0	-0.045024	91980
703.00	1.05533e-007	6.0	-0.044989	91980
722.00	1.04767e-007	6.0	-0.044410	91980
723.00	1.04699e-007	6.0	-0.044325	91980
724.00	1.04678e-007	6.0	-0.044336	91980
870.00	9.99552e-008	6.0	-0.040959	91980
871.10	9.98961e-008	6.0	-0.040925	91980
872.00	9.99209e-008	6.0	-0.040875	91980
1172.00	9.46366e-008	4.0	-0.037510	91980
1173.22	9.45753e-008	4.0	-0.037430	91980
1174.00	9.45323e-008	4.0	-0.037356	91980
1273.00	9.33380e-008	4.0	-0.036296	91980
1274.45	9.33041e-008	4.0	-0.036721	91980
1275.00	9.32991e-008	4.0	-0.036561	91980
1331.00	9.25565e-008	4.0	-0.036075	91980
1332.49	9.25278e-008	4.0	-0.036041	91980
1334.00	9.24694e-008	4.0	-0.036215	91980
1406.00	9.09506e-008	4.0	-0.035384	91980
1407.95	9.09330e-008	4.0	-0.035388	91980
1409.00	9.09547e-008	4.0	-0.035440	91980
1460.80	8.98753e-008	4.0	-0.035057	91980



Datasource: DET01



Datasource: DET01

Geometry Composer Report

CANBERRA

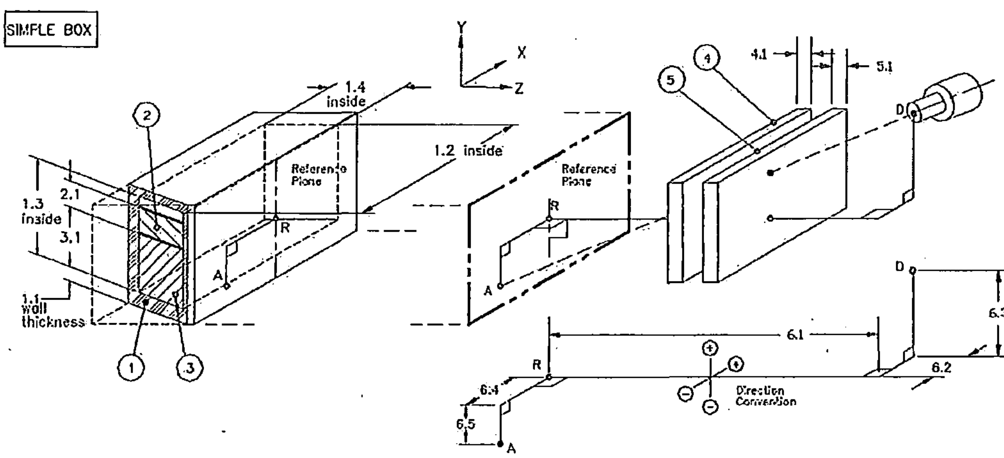
Date: Thursday, November 13, 2014 - 17:10:55
Description: MHF_STD_SOIL_DET4_12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET4_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3998
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.2	230	61	85			csteel	7.9	
2	Source - Top Layer	0						none		
3	Source - Bottom Layer	56						dirt1	1.2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2							none		
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

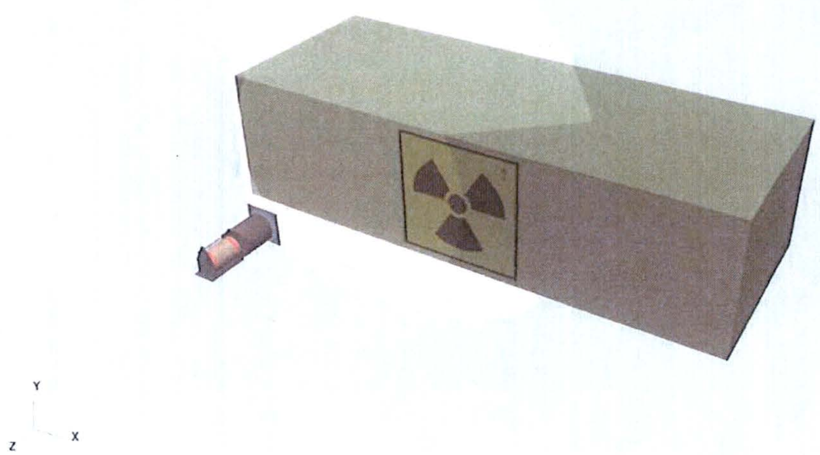
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

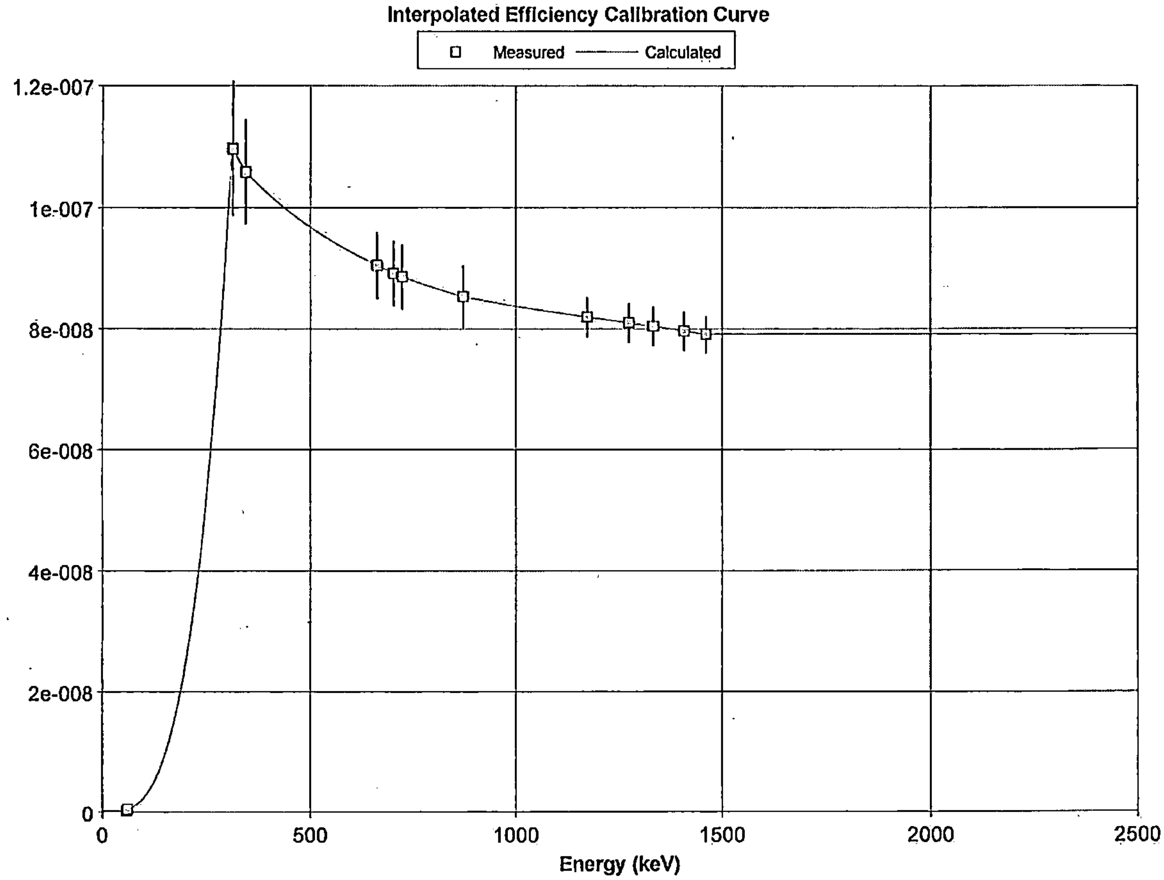
Date: Thursday, November 13, 2014 - 17:10:55
Description: MHF_STD_SOIL_DET4_12
Comment: CAL DATE 11_13_14
File Name: E:\GEOS\In-Situ\MHF_STD_SOIL_DET4_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)



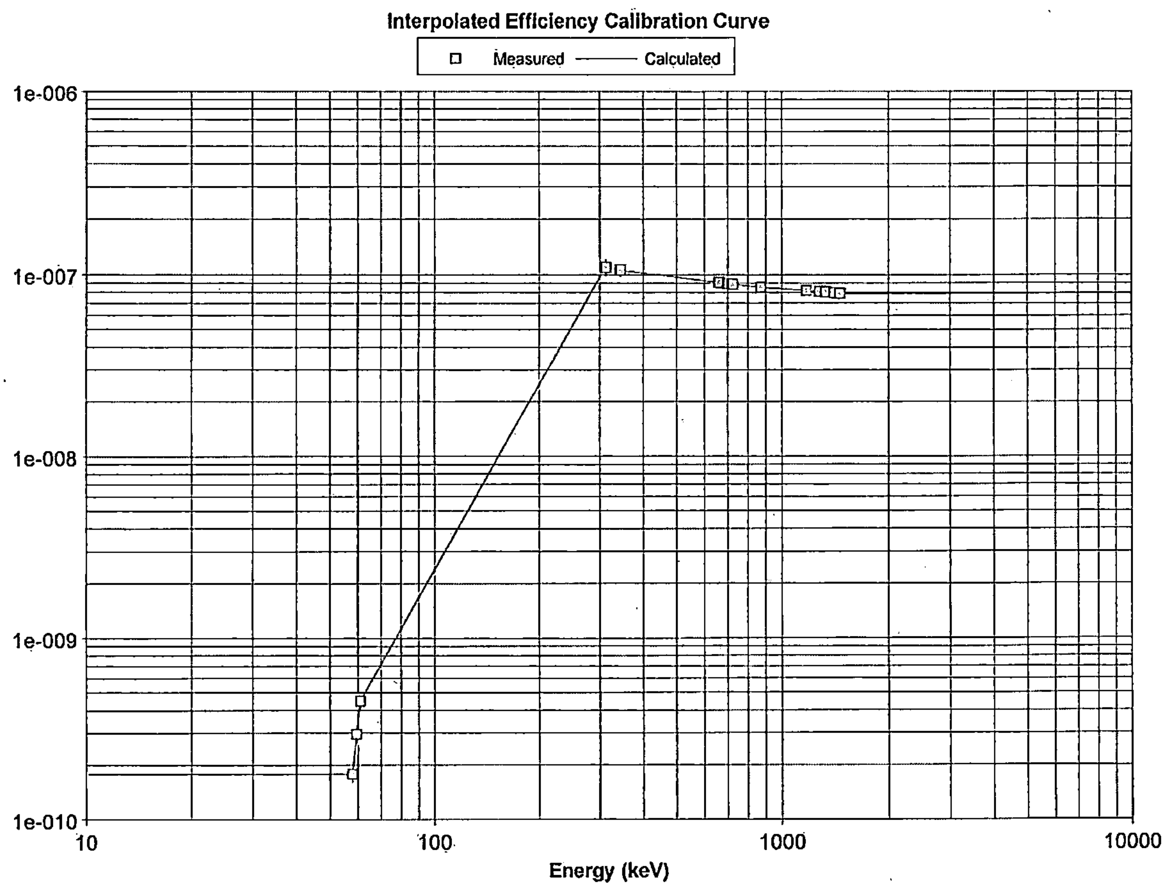
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_STD_SOI
ISOCS/LabSOCS Time: 11/13/14 03:11:11
Genie Cal File: C:\GENIE2K\CALFILES\HMF_STD_Soil_DET4_12.CAL
Genie Cal Time: 11/13/14 04:44:00
Template: SIMPLE BOX
Geom Description: STD SOIL DET4 12
Comment: ISOCS:CAL_DATE_11_13_14
Detector: 3998
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.1529e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	2.36237e-010	10.0	-0.066905	91980
59.54	3.91345e-010	10.0	-0.062494	91980
61.00	5.98820e-010	10.0	-0.058443	91980
311.00	1.45221e-007	10.0	-0.025770	91980
311.98	1.45065e-007	10.0	-0.025710	91980
313.00	1.44895e-007	10.0	-0.025719	91980
343.00	1.40109e-007	8.0	-0.027005	91980
344.27	1.39939e-007	8.0	-0.026636	91980
345.00	1.39875e-007	8.0	-0.026768	91980
660.00	1.19375e-007	6.0	-0.028793	91980
661.65	1.19201e-007	6.0	-0.028894	91980
663.00	1.19192e-007	6.0	-0.028781	91980
701.00	1.17555e-007	6.0	-0.029015	91980
702.63	1.17483e-007	6.0	-0.028967	91980
703.00	1.17473e-007	6.0	-0.028869	91980
722.00	1.16740e-007	6.0	-0.028978	91980
723.00	1.16718e-007	6.0	-0.028942	91980
724.00	1.16682e-007	6.0	-0.029083	91980
870.00	1.12300e-007	6.0	-0.028853	91980
871.10	1.12265e-007	6.0	-0.028616	91980
872.00	1.12274e-007	6.0	-0.028820	91980
1172.00	1.07649e-007	4.0	-0.027592	91980
1173.22	1.07629e-007	4.0	-0.027463	91980
1174.00	1.07582e-007	4.0	-0.027231	91980
1273.00	1.06283e-007	4.0	-0.026774	91980
1274.45	1.06258e-007	4.0	-0.026776	91980
1275.00	1.06243e-007	4.0	-0.026788	91980
1331.00	1.05436e-007	4.0	-0.026531	91980
1332.49	1.05467e-007	4.0	-0.026446	91980
1334.00	1.05427e-007	4.0	-0.026491	91980
1406.00	1.04410e-007	4.0	-0.025708	91980
1407.95	1.04351e-007	4.0	-0.025660	91980
1409.00	1.04317e-007	4.0	-0.025598	91980
1460.80	1.03581e-007	4.0	-0.025466	91980



Datasource: DET01



Datasource: DET01

Primary Efficiency taken from ECC files, for set energies (keV):

#	Weight	58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3	345.0	660.0	661.7
1	1.000	4.15e-011	7.78e-011	1.32e-010	1.33e-007	1.33e-007	1.33e-007	1.31e-007	1.31e-007	1.31e-007	1.07e-007	1.07e-007
2	1.000	3.68e-011	6.95e-011	1.19e-010	1.32e-007	1.32e-007	1.32e-007	1.30e-007	1.30e-007	1.30e-007	1.07e-007	1.07e-007
3	1.000	5.58e-011	1.02e-010	1.70e-010	1.33e-007	1.33e-007	1.33e-007	1.31e-007	1.31e-007	1.31e-007	1.08e-007	1.07e-007
4	1.000	2.36e-010	3.91e-010	5.99e-010	1.45e-007	1.45e-007	1.45e-007	1.40e-007	1.40e-007	1.40e-007	1.19e-007	1.19e-007
	Sum	3.70e-010	6.41e-010	1.02e-009	5.44e-007	5.44e-007	5.43e-007	5.32e-007	5.31e-007	5.31e-007	4.41e-007	4.41e-007
	Error,%	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	8.00e+000	8.00e+000	8.00e+000	6.00e+000	6.00e+000

Information for input ECC files

	File Name	File Stamp	Path
1	MHF_STD_SOIL_DET1_12	Thu_Nov_13_02:55:25_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
2	MHF_STD_SOIL_DET2_12	Thu_Nov_13_03:00:51_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
3	MHF_STD_SOIL_DET3_12	Thu_Nov_13_03:05:42_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
4	MHF_STD_SOIL_DET4_12	Thu_Nov_13_03:10:12_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

File Name   File Stamp   Path

Description: MHF_STD_Soil_SUM_D12
Comment: Cal Date 11/13/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

663.0	701.0	702.6	703.0	722.0	723.0	724.0	870.0	871.1	872.0	1172.0	1173.2
1.07e-007	1.06e-007	1.05e-007	1.05e-007	1.05e-007	1.05e-007	1.05e-007	9.99e-008	9.99e-008	9.99e-008	9.46e-008	9.45e-008
1.07e-007	1.05e-007	1.05e-007	1.05e-007	1.04e-007	1.04e-007	1.04e-007	9.96e-008	9.95e-008	9.95e-008	9.43e-008	9.43e-008
1.07e-007	1.06e-007	1.06e-007	1.06e-007	1.05e-007	1.05e-007	1.05e-007	1.00e-007	9.99e-008	9.99e-008	9.46e-008	9.46e-008
1.19e-007	1.18e-007	1.17e-007	1.17e-007	1.17e-007	1.17e-007	1.17e-007	1.12e-007	1.12e-007	1.12e-007	1.08e-007	1.08e-007
4.41e-007	4.34e-007	4.34e-007	4.34e-007	4.31e-007	4.30e-007	4.30e-007	4.12e-007	4.12e-007	4.12e-007	3.91e-007	3.91e-007
6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_STD_Soil_SUM_D12
Cal Date 11/13/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

1174.0	1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9	1409.0	1460.8
9.45e-008	9.33e-008	9.33e-008	9.33e-008	9.25e-008	9.25e-008	9.24e-008	9.09e-008	9.09e-008	9.09e-008	8.98e-008
9.42e-008	9.30e-008	9.30e-008	9.30e-008	9.23e-008	9.22e-008	9.22e-008	9.07e-008	9.06e-008	9.07e-008	8.96e-008
9.45e-008	9.33e-008	9.33e-008	9.33e-008	9.26e-008	9.25e-008	9.25e-008	9.10e-008	9.09e-008	9.10e-008	8.99e-008
1.08e-007	1.06e-007	1.06e-007	1.06e-007	1.05e-007	1.05e-007	1.05e-007	1.04e-007	1.04e-007	1.04e-007	1.04e-007
3.91e-007	3.86e-007	3.86e-007	3.86e-007	3.83e-007	3.83e-007	3.83e-007	3.77e-007	3.77e-007	3.77e-007	3.73e-007
4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_STD_Soil_SUM_D12
Cal Date 11/13/14

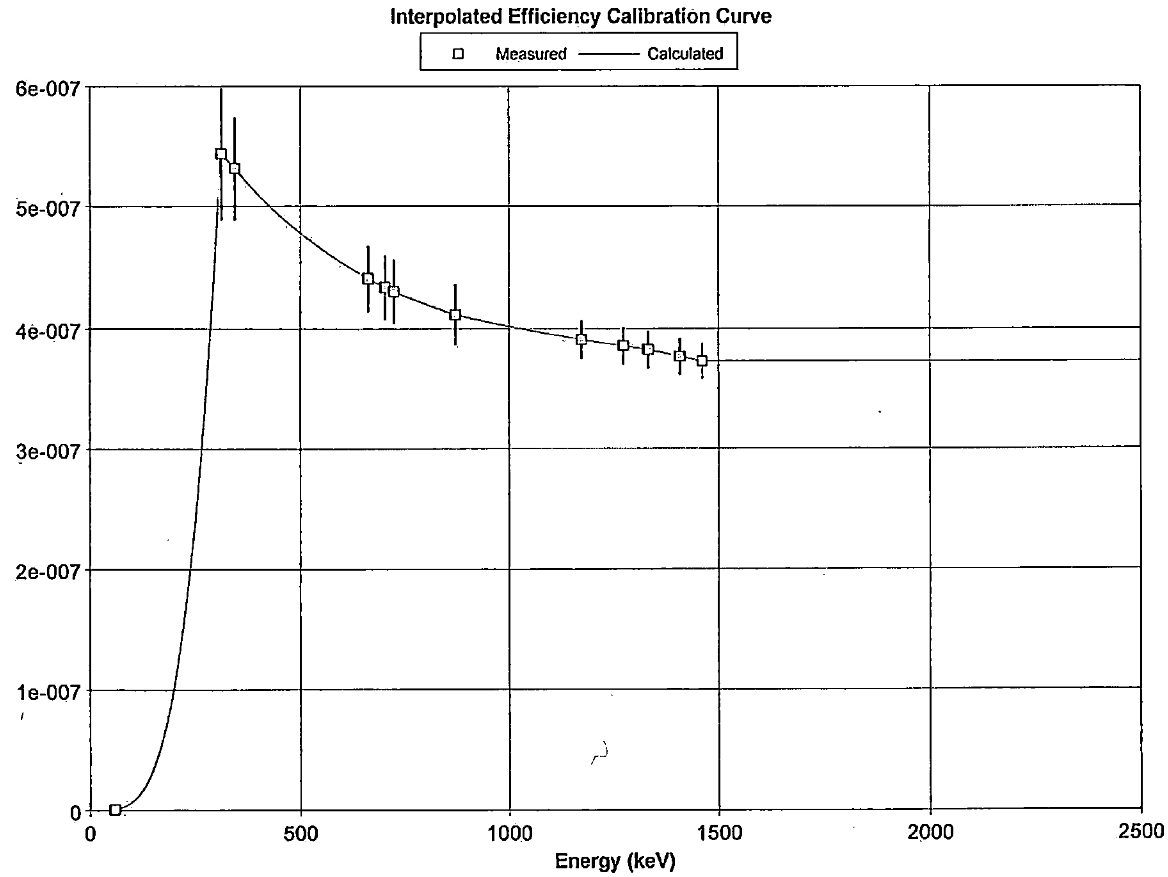
CANBERRA

Multi-Efficiency Report

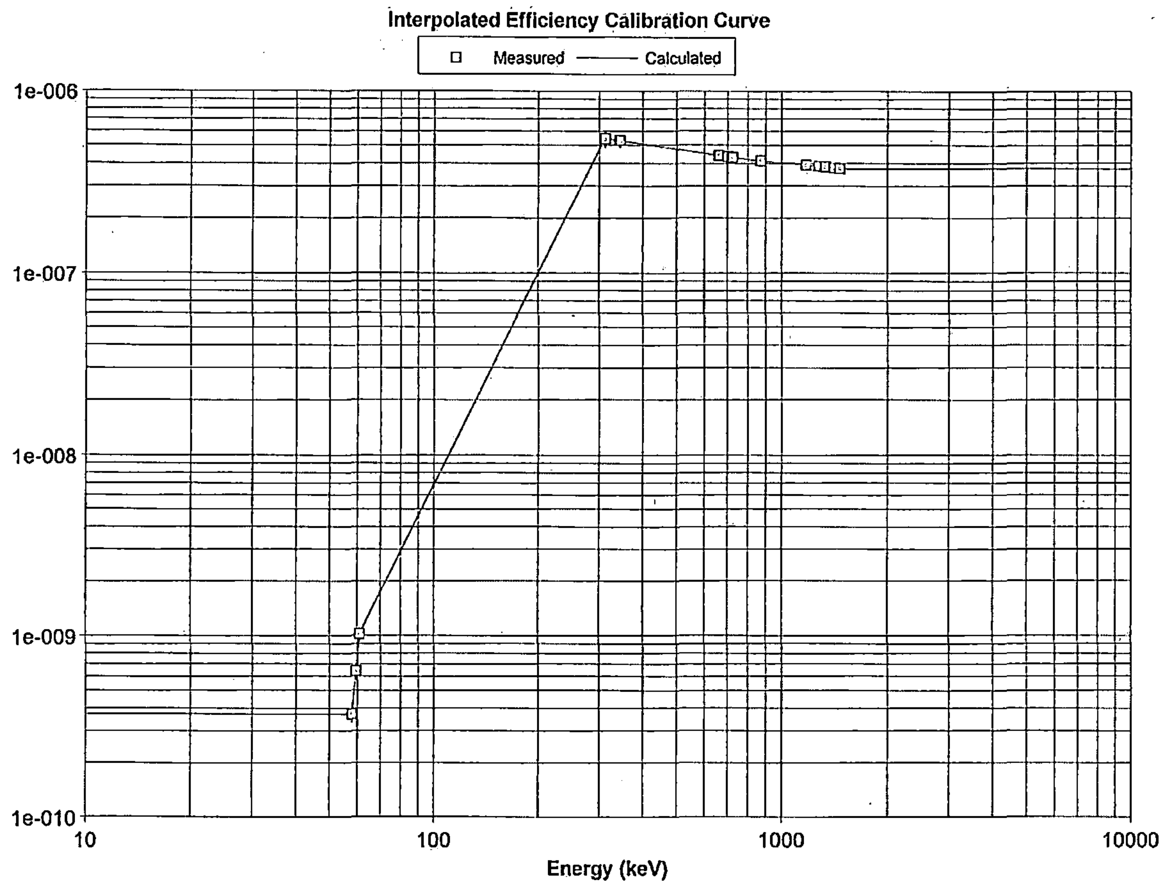
ISOCS/LABSOCS RESULTS

```
ISOCS/LabSOCS File:   C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\Multiefficiency\MHF_ST
ISOCS/LabSOCS Time:   11/13/14 03:24:17
Genie Cal File:       C:\GENIE2K\CALFILES\HMF_STD_Soil_SUM_D12.CAL
Genie Cal Time:       11/13/14 04:47:11
Template:             (SIMPLE BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+
Geom Description:     STD Soil SUM D12
Comment:              ISOCS:Cal Date 11/13/14
Detector:             (3994)+(3996)+(3997)+(3998)+
Collimator:           (GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+
Convergence:          1.00 %
Area [Sq Meters]:     1.0000e-004 (C)
Mass [Grams]:         1.0000e+000 (C)
Length [Meters]:      not used
 (C) = Value calculated by ISOCS
 (U) = Value modified by user
```

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	3.70385e-010	10.0	0.0000000	64000
59.54	6.40906e-010	10.0	0.0000000	64000
61.00	1.01996e-009	10.0	0.0000000	64000
311.00	5.44239e-007	10.0	0.0000000	64000
311.98	5.43701e-007	10.0	0.0000000	64000
313.00	5.43431e-007	10.0	0.0000000	64000
343.00	5.32005e-007	8.0	0.0000000	64000
344.27	5.31396e-007	8.0	0.0000000	64000
345.00	5.31283e-007	8.0	0.0000000	64000
660.00	4.41441e-007	6.0	0.0000000	64000
661.65	4.40685e-007	6.0	0.0000000	64000
663.00	4.40644e-007	6.0	0.0000000	64000
701.00	4.34004e-007	6.0	0.0000000	64000
702.63	4.33518e-007	6.0	0.0000000	64000
703.00	4.33556e-007	6.0	0.0000000	64000
722.00	4.30536e-007	6.0	0.0000000	64000
723.00	4.30310e-007	6.0	0.0000000	64000
724.00	4.30212e-007	6.0	0.0000000	64000
870.00	4.11732e-007	6.0	0.0000000	64000
871.10	4.11520e-007	6.0	0.0000000	64000
872.00	4.11604e-007	6.0	0.0000000	64000
1172.00	3.91209e-007	4.0	0.0000000	64000
1173.22	3.91005e-007	4.0	0.0000000	64000
1174.00	3.90830e-007	4.0	0.0000000	64000
1273.00	3.85963e-007	4.0	0.0000000	64000
1274.45	3.85837e-007	4.0	0.0000000	64000
1275.00	3.85807e-007	4.0	0.0000000	64000
1331.00	3.82779e-007	4.0	0.0000000	64000
1332.49	3.82725e-007	4.0	0.0000000	64000
1334.00	3.82510e-007	4.0	0.0000000	64000
1406.00	3.76946e-007	4.0	0.0000000	64000
1407.95	3.76834e-007	4.0	0.0000000	64000
1409.00	3.76865e-007	4.0	0.0000000	64000
1460.80	3.72897e-007	4.0	0.0000000	64000



Datasource: DET01

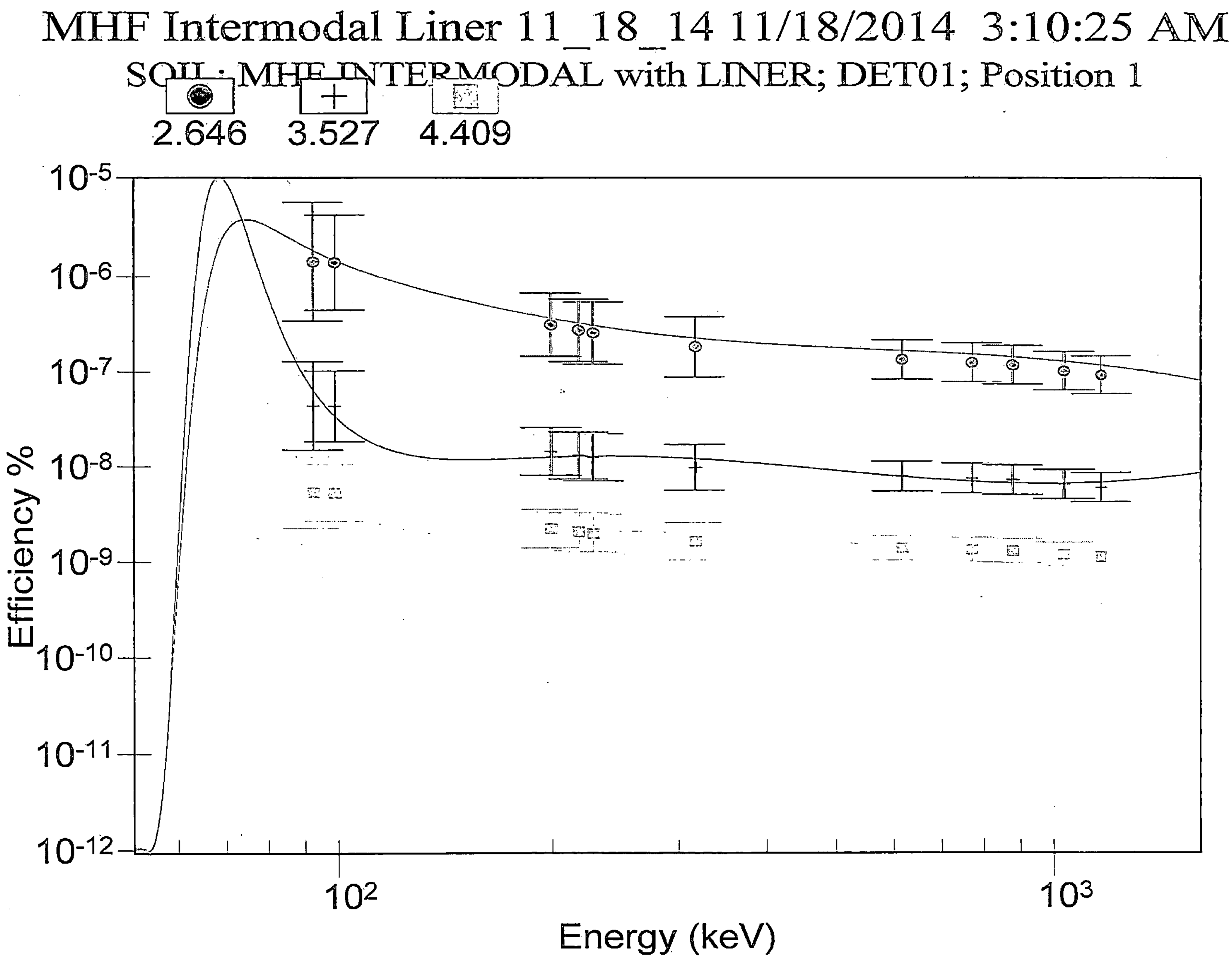


Datasource: DET01

Attachment 10.4
MicroShield® Modeling Results

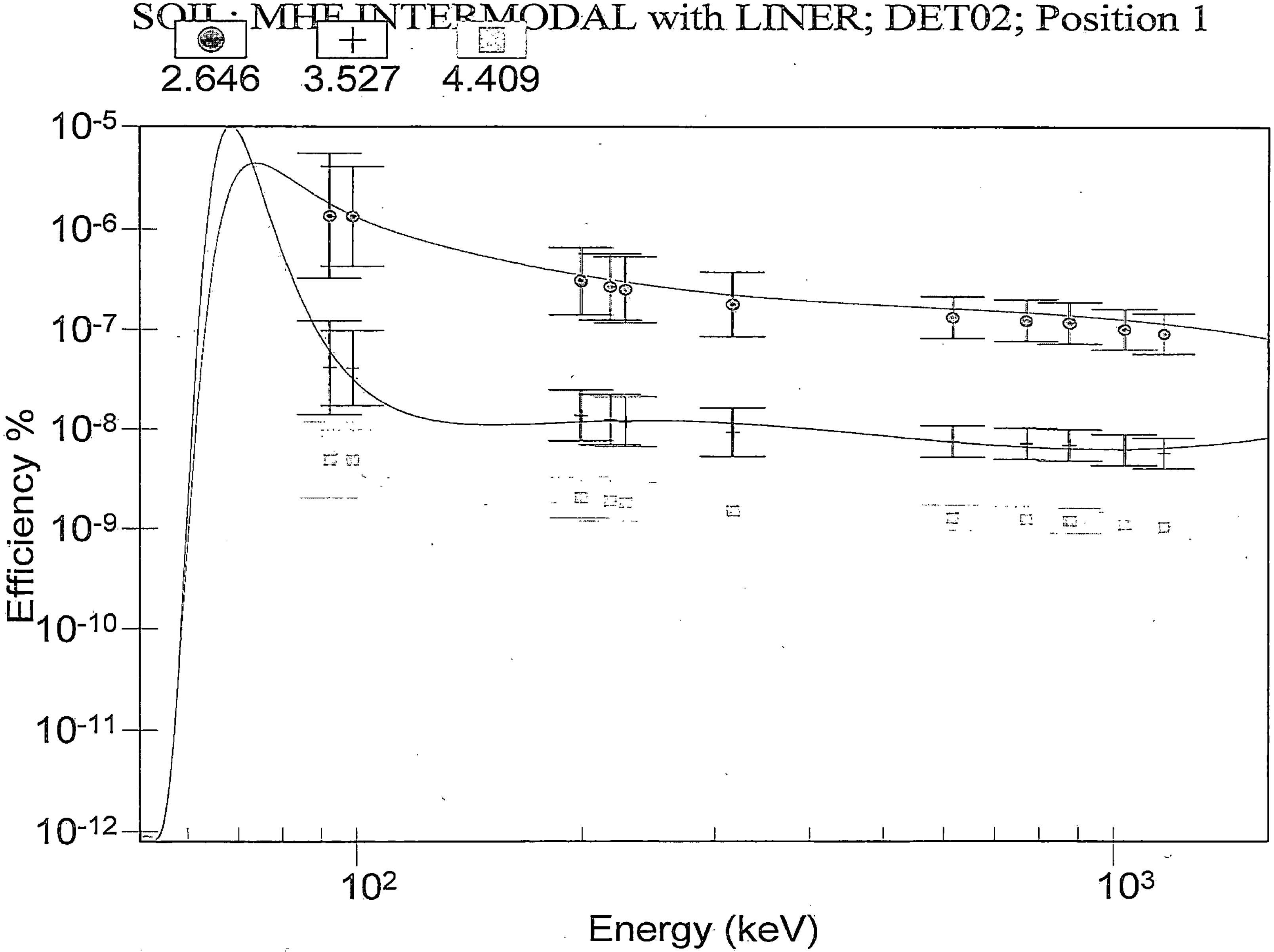
GARDIAN SYSTEM
Calibration Records
MHF IP-1 Intermodal with Liner

Summation


MHF Intermodal Liner 11_18_14 11/18/2014 3:10:25 AM
SOIL : MHF INTERMODAL with LINER; DET01; Position 1
2.646
3.527
4.409
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
Efficiency %
10^{2}
10^{3}
Energy (keV)

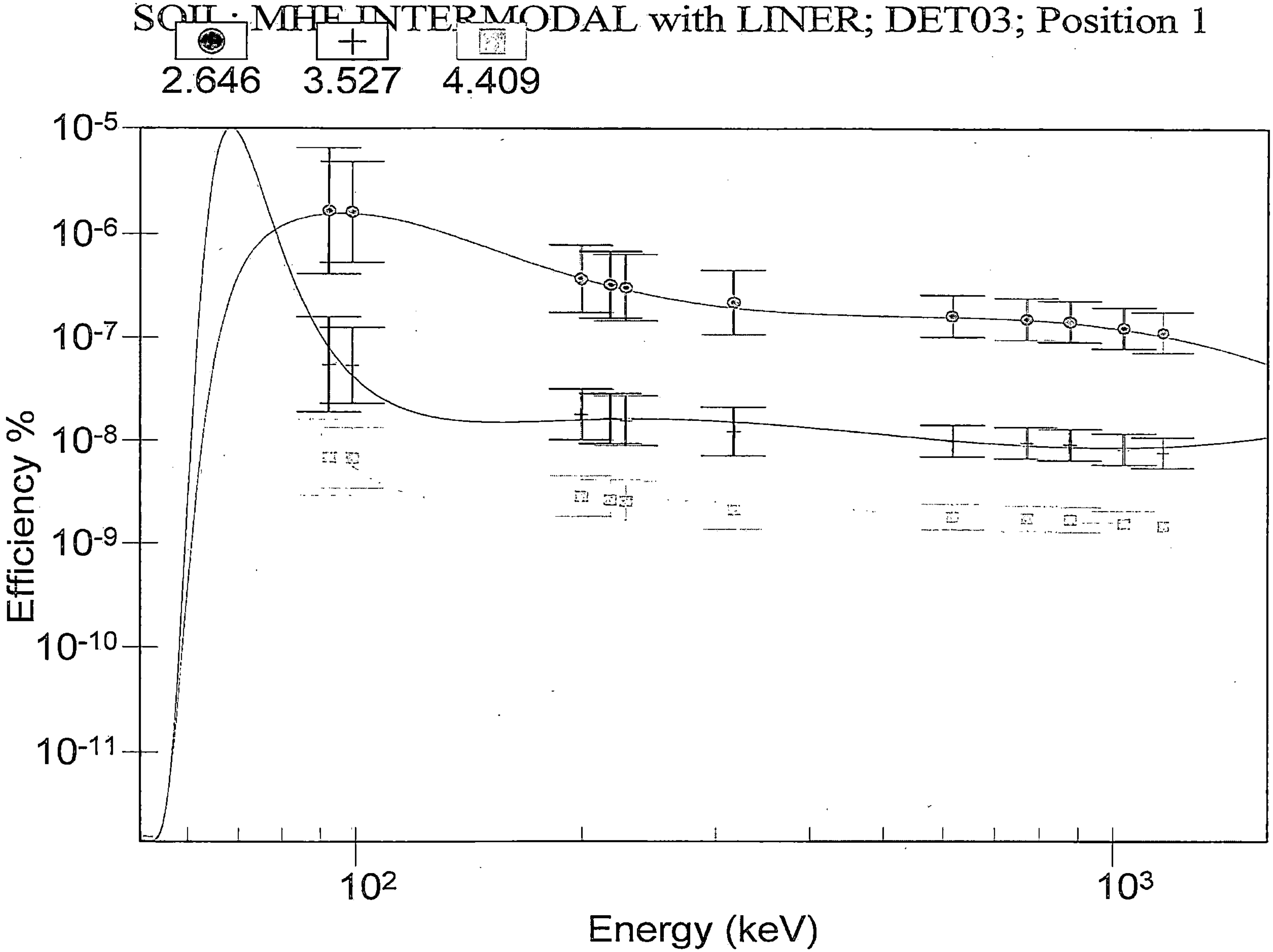
MHF Intermodal Liner 11_18_14 11/18/2014 3:11:31 AM

SOIL: MHF INTERMODAL with LINER; DET02; Position 1



MHF Intermodal Liner 11_18_14 11/18/2014 3:12:32 AM

SOIL : MHF INTERMODAL with LINER; DET03; Position 1

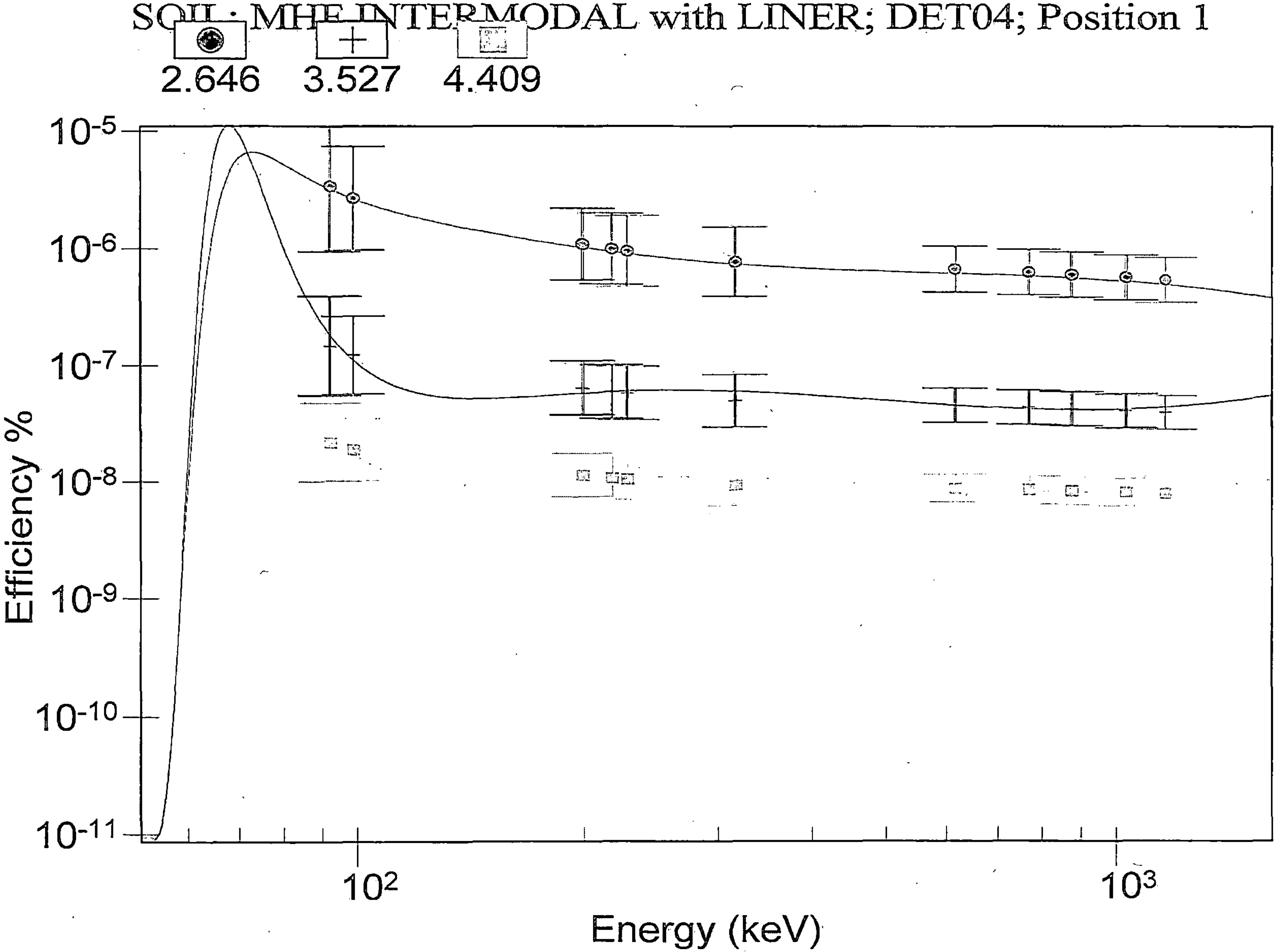


TBD-401

Attachment 10.4
MicroShield Modeling Results

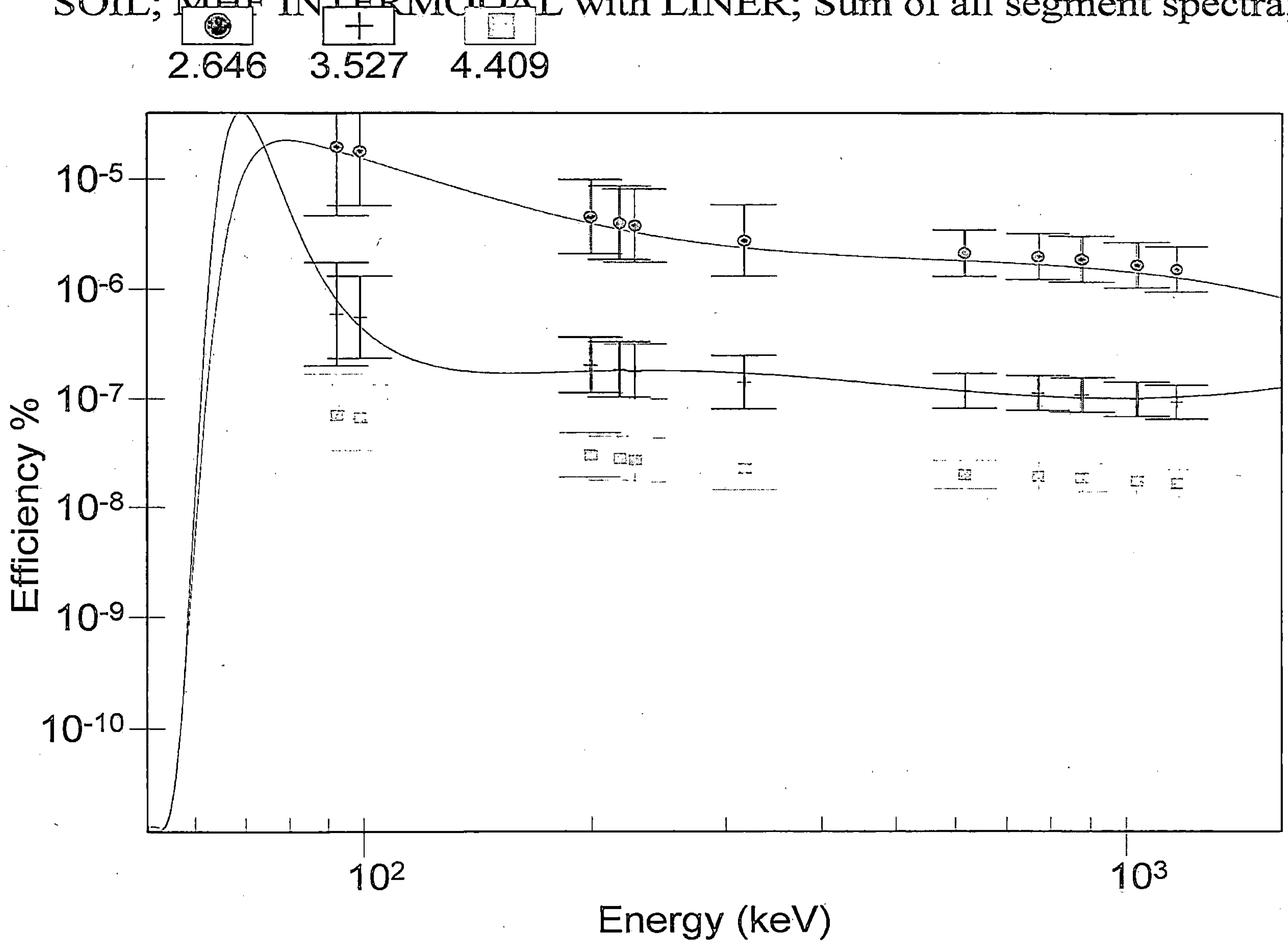
MHF Intermodal Liner 11_18_14 11/18/2014 3:14:47 AM

SOIL: MHF INTERMODAL with LINER; DET04; Position 1



MHF Intermodal Liner 11_18_14 11/18/2014 3:15:50 AM

SOIL; MHF INTERMODAL with LINER; Sum of all segment spectra;



GARDIAN SYSTEM
Calibration Records
MHF IP-1 Intermodal with Liner

Attached-

- **MHF Intermodal Wall Thickness, IP-1 Specs.**
- **Gardian Trailer Wall Thickness**
- **Intermodal Positioning**
- **Det. 1-4 Density 1.2 models, individual efficiency cals, Summation Cal.**
- **Det. 1-4 Density 1.6 models, individual efficiency cals, Summation Cal.**
- **Det. 1-4 Density 2.0 models, individual efficiency cals, Summation Cal.**
- **Det 1-4 Sum Curves for Density 1.2, 1.6, & 2.0.**
- **Sum of all Segment Spectra**

Performed by [signature] **Date** 11-19-14

Reviewed by [signature] **Date** 11-20-14

MHF Intermodal with Liner Wall Thickness

(Homogenized)

Wall Steel = 10 gauge = 0.1345"

230" x 60" = 13,800 in^2 at 0.1345" thick

+ 3 Vertical Rails 60" x 15" = 2700 in^2
+ 2 Horizontal support beam 480" = 960 in^2
+ Chain guard 2"x2"x22" = 176 in^2
+ ~100 lbs hardware 2,617 in^2
    - (if 100lbs x 453.6g/lb / 7.86g/cc = 5771cc = 352in^3/0.1345"=2617 in^2)

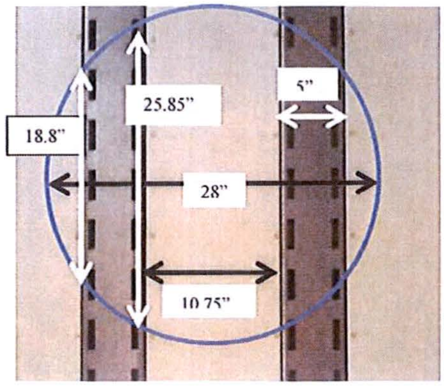
Total Area = 13800+2700+960+176+2617 = 20253 in^2

Effective Thickness = 20253/13800 x 0.1345" thickness = **0.20" Steel**

+ 1 **Steel Liner Plate** 230" x 48" = 11040 in^2 / 13800 in^2 x 0.1875" Thick = **0.15" Steel**

Total Effective Thickness = 0.35" Steel

Energy Solutions Main Trailer Wall



Steel Channel flattened = 7"

Detector is positioned 14" behind the outside wall of the Main Trailer. Utilizing a 90 degree collimator will give a 28" diameter Field of View. Worst case positioning will place the detector between two of the channels, thus including both in the field of view. The channels also contain 0.5" by 2 3/8" rectangular holes which will not subtracted from the steel area thus being more conservative.

Material area

Total area of the field of view: $A = \pi r^2 = \pi 14^2$ = 615.75 in^2.

Area of flattened steel channel: (7" x 18.8") + (1/2 7" x 3.525" x 2ends) x 2channels =312.55 in^2.

Area of PVC: 615.75 in^2 – 312.55 in^2 = 303.20 in^2.

Area of trailer skin: 615.75 in^2.

Effective Thickness

PVC = 1/16"thick x (303.2/615.75) = 0.031"

Steel = 1/16" thick x (312.55/615.75) = 0.032"

Al Skin = 1/16" thick x 615.75/615.75) = 0.063"

Homogenized Wall Density

Total Effective wall thickness = 0.031 + 0.032 + 0.063 = 0.126"

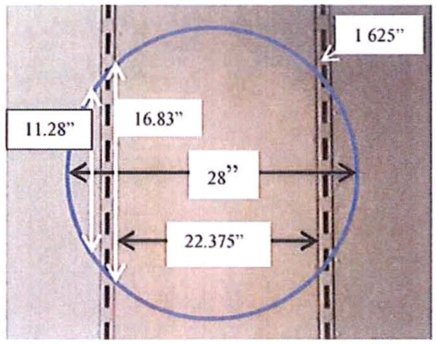
Density = 0.031/0.126*1.4g/cc PVC + 0.032/0.126*7.86g/cc steel + 0.063/0.126*2.7g/cc Al = 3.69 g/cc.

Material percentage = 0.344/3.69 = 9% PVC, 2.00/3.69=54% Steel, 1.35/3.69= 37% Al.

For Modeling purposes, the Main Trailer Wall (MTWall) (Absorber 1) = 0.126" thick at 3.69 g/cc comprised of 9% PVC, 54% Steel and 37% Al.

C&RP B-20
Appendix 8.2
Rev. 0
Page 1 of 1

Energy Solutions Support Trailer Wall



Steel Channel flattened = 3 5/8"

Detector is positioned 14" behind the outside wall of the Support Trailer. Utilizing a 90 degree collimator will give a 28" diameter Field of View. Worst case positioning will place the detector between two of the channels, thus including both in the field of view. The channels also contain 0.5" by 2 3/8" rectangular holes which will not subtracted from the steel area thus being more conservative.

<u>Material area</u>

Total area of the field of view: $A = \pi r^2 = \pi 14^2 = 615.75$ in^2.

Area of flattened steel channel: (3.625" x 11.28") +(1/2 3.625" x 2.775" x 2ends) x 2channels = 102 in^2.

Area of wood: 615.75 in^2 – 102 in^2 = 513.75 in^2.

Area of trailer skin: 615.75 in^2.

<u>Effective Thickness</u>

Wood = 1/4" thick x (513.75/615.75) = 0.209"

Steel = 1/16" thick x (102/615.75) = 0.010"

Al Skin = 1/16" thick x 615.75/615.75) = 0.063"

<u>Homogenized Wall Density</u>

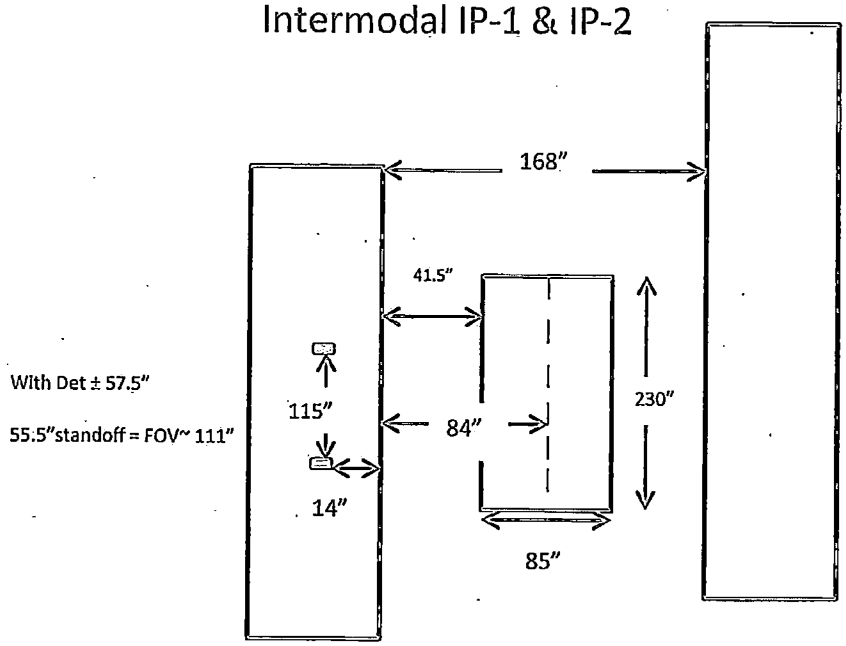
Total Effective wall thickness = 0.209 + 0.010 + 0.063 = 0.282"

Density = 0.209/0.282*0.75g/cc wood + 0.010/0.282*7.86g/cc steel + 0.063/0.282*2.7g/cc Al = 1.44g/cc.

Material percentage = 0.556/1.44 = 39% wood, 0.279/1.44=19% Steel, 0.603/1.44= 42% Al.

For Modeling purposes, the Support Trailer Wall (STWall) (Absorber 1) = 0.282" thick at 1.44g/cc comprised of 39% wood, 19% Steel and 42% Al.

Intermodal IP-1 & IP-2



HBPP IM Containers

Type A/IP2 Intermodals (Gray)	Type IP1 Intermodals (Gray)	Type IP1 Intermodals (Purple, Non-lined)	Type IP1 Intermodals (Purple, lined)
Tare Weight = 9450 lbs	Tare Weight = 8000 lbs	Tare Weight = 8150 lbs	Tare Weight = 10680 lbs
1 PGEU 1001	1 MHFU-1281	1 PGEU 1000	1 PGEU 1044
2 SDCU 1002	2 MHFU-1451	2 PGEU 1003	2 PGEU 1047
3 SDCU 1004	3 MHFU-1554	3 PGEU 1030	3 PGEU 1033
4 SDCU 1005	4 MHFU-1565	4 PGEU 1040	4 PGEU 1034
5 SDCU 1006	5 MHFU-1641	5 PGEU 1052	5 PGEU 1035
6 PGEU 1007	6 MHFU-1712	6 PGEU 1055	6 PGEU 1036
7 PGEU 1008	7 MHFU-1746	7 PGEU 1056	7 PGEU 1037
8 PGEU 1009	8 MHFU-1757	8 PGEU 1061	8 PGEU 1038
9 SDCU 1010	9 MHFU-1870	9 PGEU 1081	9 PGEU 1039
10 PGEU 1011	10 MHFU-1895	10 PGEU 1109	10 PGEU 1041
11 PGEU 1012	11 MHFU-1905	11 PGEU 1132	11 PGEU 1042
12 SDCU 1013	12 MHFU-1913	12 PGEU 1142	12 PGEU 1043
13 PGEU 1014	13 MHFU-1938	13 PGEU 1158	13 PGEU 1045
14 PGEU 1015	14 MHFU-2005	14 PGEU 1169	14 PGEU 1046
15 PGEU 1016	15 MHFU-2036	15 PGEU 1193	15 PGEU 1048
16 SDCU 1017	16 MHFU-2044	16 PGEU 1201	16 PGEU 1049
17 SDCU 1018	17 MHFU-2071		17 PGEU 1050
18 PGEU 1019	18 MHFU-2093		18 PGEU 1051
19 SDCU 1020	19 MHFU-2114		19 PGEU 1059
20 PGEU 1021	20 MHFU-2129		20 PGEU 1063
21 PGEU 1022	21 MHFU-2152		21 PGEU 1066
22 SDCU 1023	22 MHFU-2180		22 PGEU 1079
23 SDCU 1024	23 MHFU-2206		23 PGEU 1087
24 PGEU 1025	24 MHFU-2207		24 PGEU 1094
25 PGEU 1026	25 MHFU-2210		25 PGEU 1098
26 SDCU 1027	26 MHFU-2212		26 PGEU 1104
27 PGEU 1028	27 MHFU-2245		27 PGEU 1106
28 SDCU 1029	28 MHFU-2271		28 PGEU 1107
29 SDCU 1031	29 MHFU-2297		29 PGEU 1108
30 SDCU 1032	30 MHFU-2310		30 PGEU 1110
	31 MHFU-2337		31 PGEU 1112
	32 MHFU-2380		32 PGEU 1113
	33 MHFU-2383		33 PGEU 1118
	34 MHFU-2413		34 PGEU 1119
	35 MHFU-2417		35 PGEU 1121
	36 MHFU-2422		36 PGEU 1136
			37 PGEU 1143
			38 PGEU 1151
			39 PGEU 1172
			40 PGEU 1175
	The Intermodals shaded in light blue are designated for RPV Shipments and have an additional 2" of Steel on the Floor and a tare Weight of ~18,600 lbs		The Lined Intermodals have an additional 3/16" sheet of steel lining the inner walls of the container. The sheeting covers the floor, both ends and sides and extends 45" up from the base.

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GARDIAN SYSTEM
Calibration Records
MHF IP-1 Intermodal with Liner

Density 2.0

Geometry Composer Report

CANBERRA

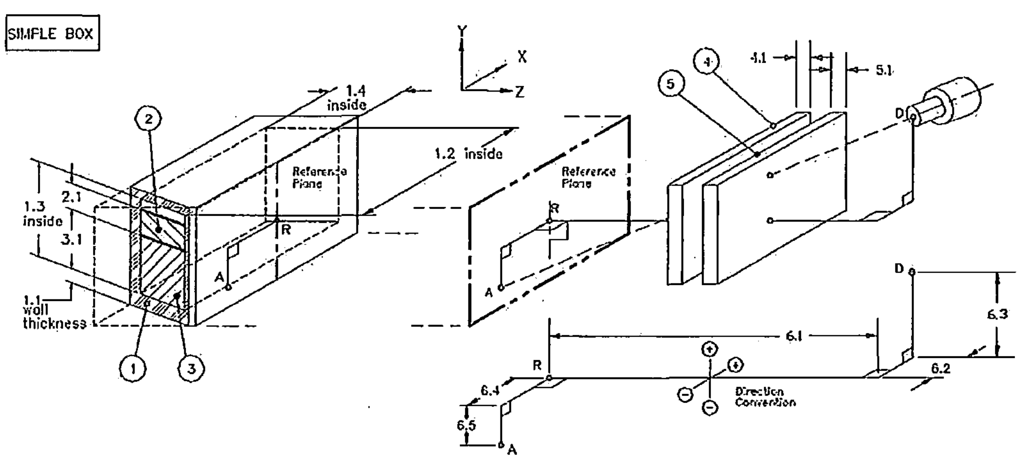
Date: Tuesday, November 18, 2014 - 15:43:14
Description: MHF_Liner_SOIL_DET1_20
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET1_20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3994
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.02756						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

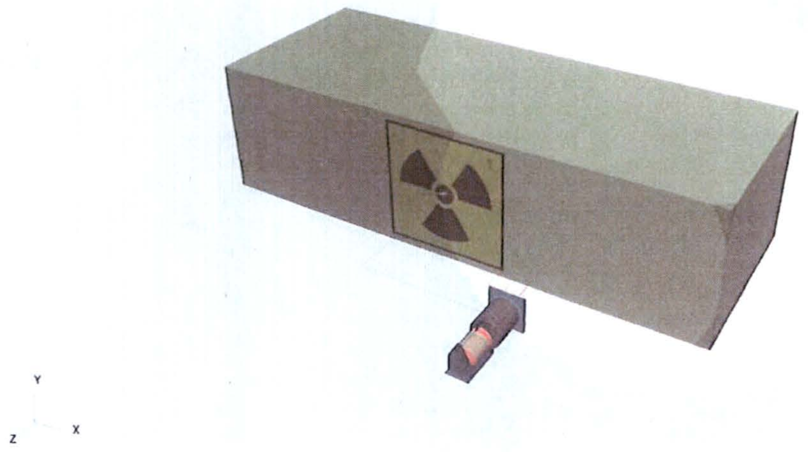
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

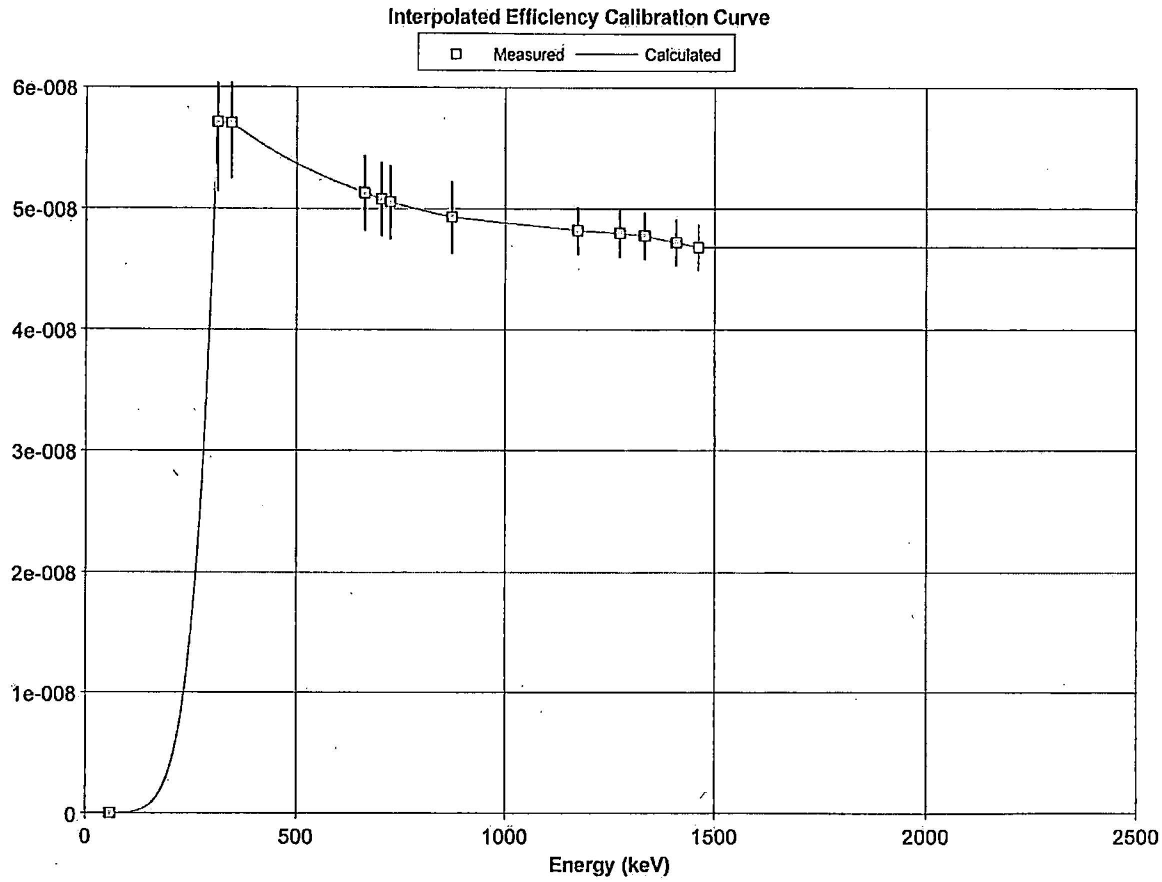
Date:	Tuesday, November 18, 2014 - 15:43:14
Description:	MHF_Liner_SOIL_DET1_20
Comment:	CAL DATE 11_18_14
File Name:	E:\SIMPLE_BOX\MHF_Liner_SOIL_DET1_20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



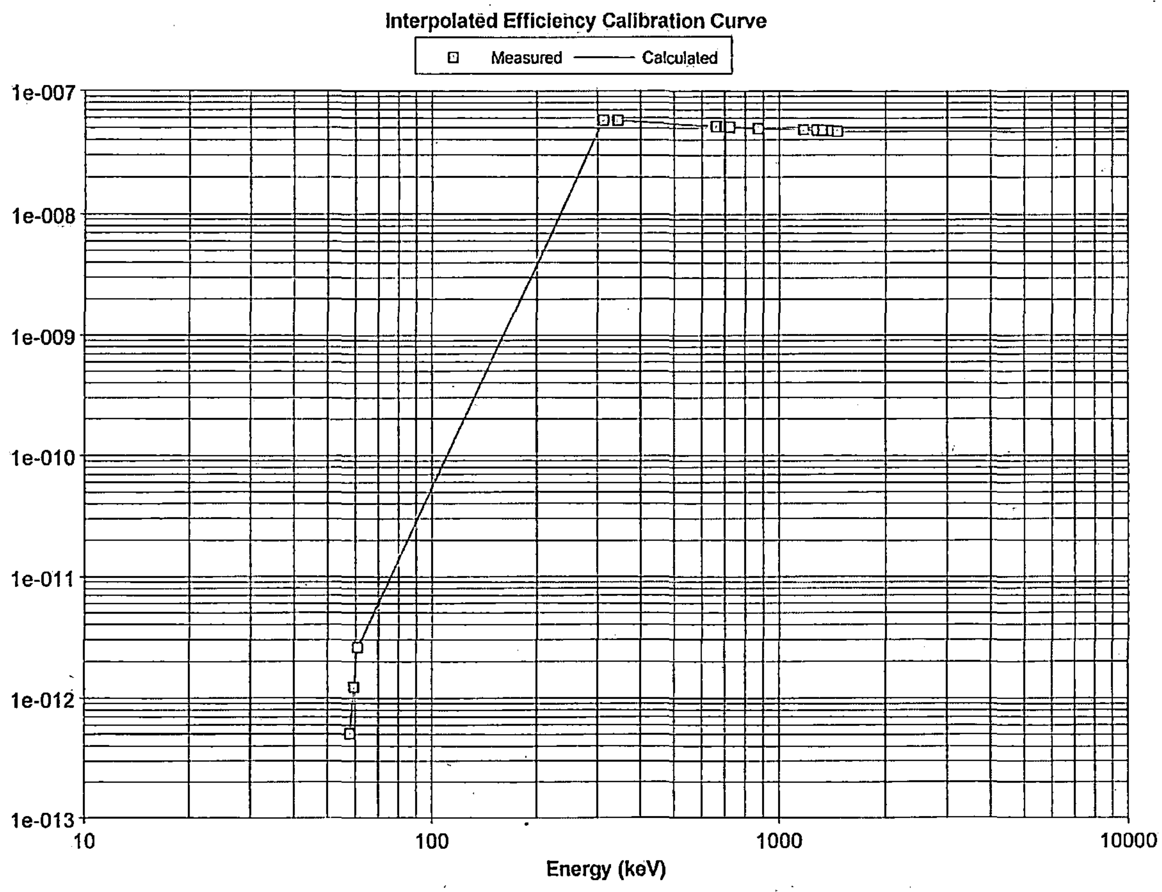
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:05:41
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET1_20.CAL
Genie Cal Time: 11/18/14 02:41:00
Template: SIMPLE BOX
Geom Description: HMF Liner D1 20
Comment: ISOCS:CAL_DATE_11_18_14
Detector: 3994
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 3.5881e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	5.07355e-013	10.0	-0.118527	81760
59.54	1.22849e-012	10.0	-0.112697	81760
61.00	2.60106e-012	10.0	-0.107622	81760
311.00	5.70837e-008	10.0	-0.030549	81760
311.98	5.70579e-008	10.0	-0.030180	81760
313.00	5.70803e-008	10.0	-0.030422	81760
343.00	5.70316e-008	8.0	-0.031052	81760
344.27	5.70019e-008	8.0	-0.030868	81760
345.00	5.70183e-008	8.0	-0.031117	81760
660.00	5.13165e-008	6.0	-0.033302	81760
661.65	5.12385e-008	6.0	-0.033479	81760
663.00	5.12407e-008	6.0	-0.033135	81760
701.00	5.07914e-008	6.0	-0.033172	81760
702.63	5.07306e-008	6.0	-0.033386	81760
703.00	5.07452e-008	6.0	-0.033377	81760
722.00	5.05368e-008	6.0	-0.033410	81760
723.00	5.05129e-008	6.0	-0.033298	81760
724.00	5.05115e-008	6.0	-0.033372	81760
870.00	4.92791e-008	6.0	-0.032413	81760
871.10	4.92528e-008	6.0	-0.032391	81760
872.00	4.92768e-008	6.0	-0.032272	81760
1172.00	4.82107e-008	4.0	-0.029503	81760
1173.22	4.81875e-008	4.0	-0.029425	81760
1174.00	4.81703e-008	4.0	-0.029266	81760
1273.00	4.79540e-008	4.0	-0.028286	81760
1274.45	4.79408e-008	4.0	-0.028483	81760
1275.00	4.79390e-008	4.0	-0.028212	81760
1331.00	4.77585e-008	4.0	-0.027758	81760
1332.49	4.77495e-008	4.0	-0.027658	81760
1334.00	4.77311e-008	4.0	-0.027999	81760
1406.00	4.71881e-008	4.0	-0.026588	81760
1407.95	4.71900e-008	4.0	-0.026713	81760
1409.00	4.72039e-008	4.0	-0.026645	81760
1460.80	4.67976e-008	4.0	-0.026163	81760



Datasource: DET02



Datasource: DET02

Geometry Composer Report

CANBERRA

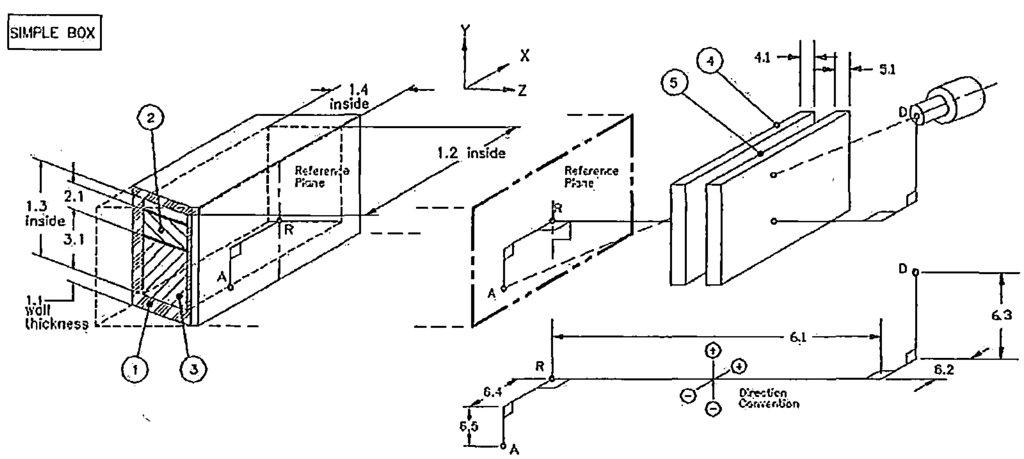
Date: Tuesday, November 18, 2014 - 15:44:15
Description: MHF_Liner_SOIL_DET2_20
Comment: Calib 11/18/14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET2_20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3996
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.0315						germanum	5.4	
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

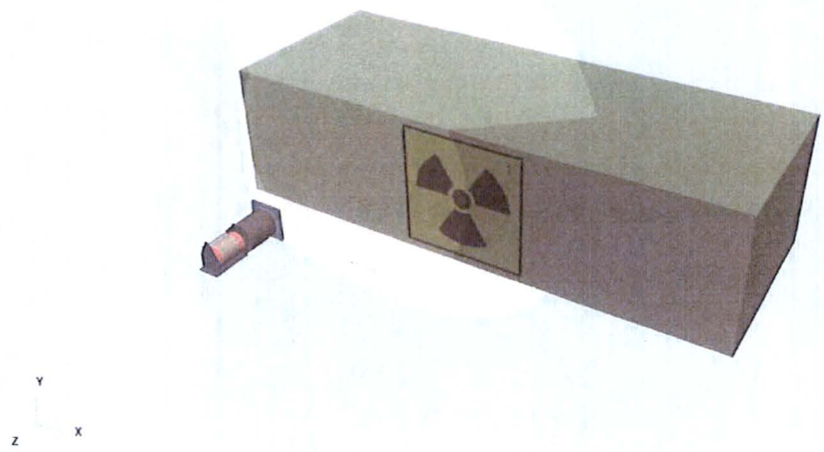
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

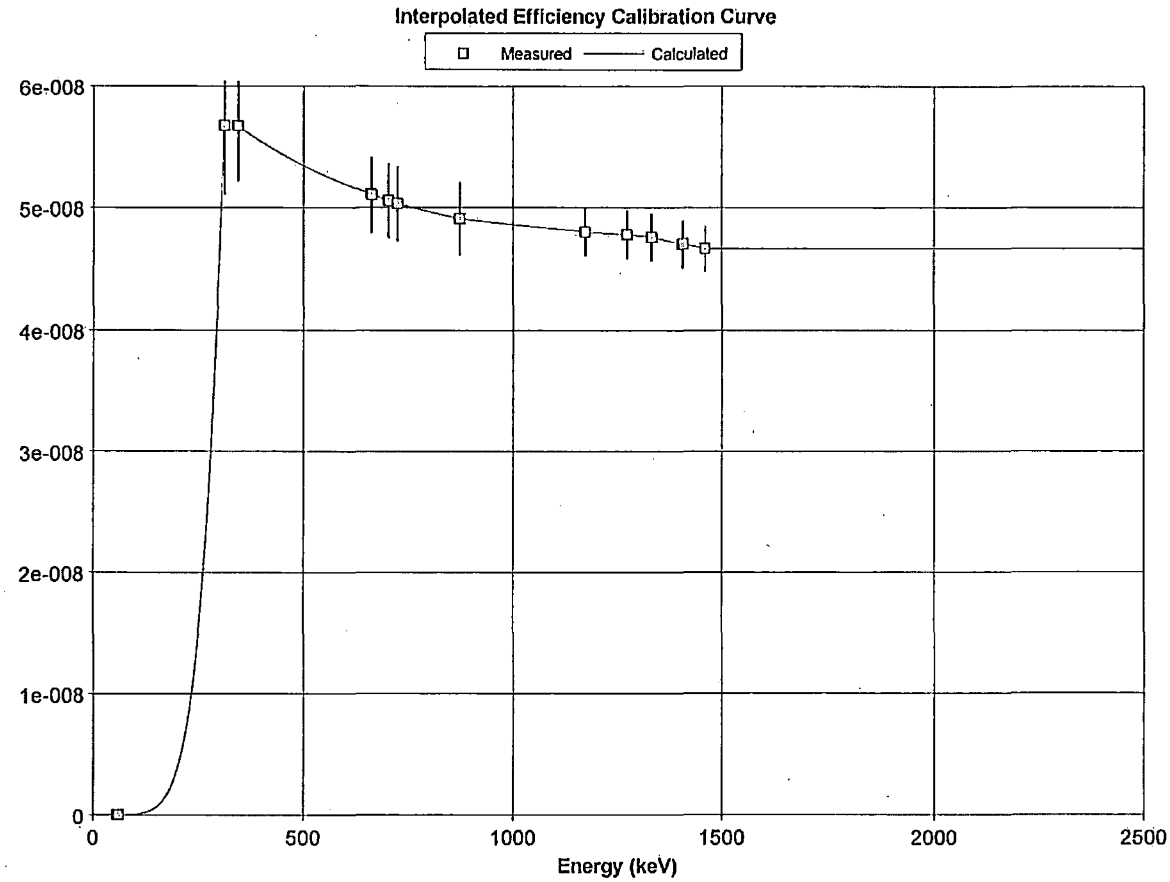
Date:	Tuesday, November 18, 2014 - 15:44:15
Description:	MHF_Liner_SOIL_DET2_20
Comment:	Calib 11/18/14
File Name:	E:\SIMPLE_BOX\MHF_Liner_SOIL_DET2_20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



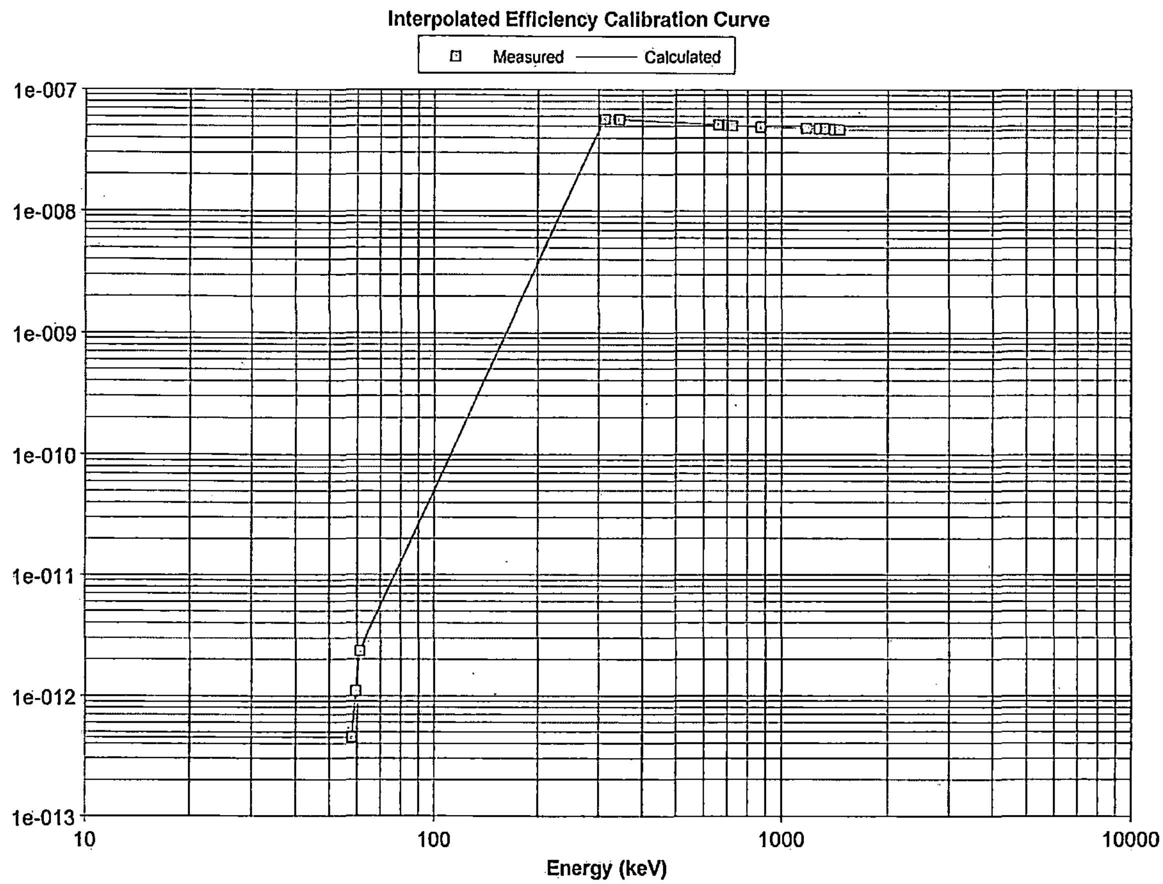
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:13:49
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET2_20.CAL
Genie Cal Time: 11/18/14 02:48:22
Template: SIMPLE BOX
Geom Description: MHF Liner D2 20
Comment: ISOCS:CALIB_11/18/14
Detector: 3996
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 3.5881e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	4.50229e-013	10.0	-0.113920	81760
59.54	1.09907e-012	10.0	-0.107239	81760
61.00	2.34344e-012	10.0	-0.101340	81760
311.00	5.67251e-008	10.0	-0.004884	81760
311.98	5.67002e-008	10.0	-0.004519	81760
313.00	5.67233e-008	10.0	-0.004837	81760
343.00	5.66950e-008	8.0	-0.006479	81760
344.27	5.66662e-008	8.0	-0.006220	81760
345.00	5.66830e-008	8.0	-0.006548	81760
660.00	5.11028e-008	6.0	-0.016226	81760
661.65	5.10254e-008	6.0	-0.016373	81760
663.00	5.10278e-008	6.0	-0.016077	81760
701.00	5.05863e-008	6.0	-0.016620	81760
702.63	5.05259e-008	6.0	-0.016855	81760
703.00	5.05405e-008	6.0	-0.016791	81760
722.00	5.03357e-008	6.0	-0.017079	81760
723.00	5.03120e-008	6.0	-0.017052	81760
724.00	5.03107e-008	6.0	-0.017141	81760
870.00	4.91007e-008	6.0	-0.017868	81760
871.10	4.90746e-008	6.0	-0.017803	81760
872.00	4.90986e-008	6.0	-0.017663	81760
1172.00	4.80615e-008	4.0	-0.017553	81760
1173.22	4.80385e-008	4.0	-0.017450	81760
1174.00	4.80214e-008	4.0	-0.017229	81760
1273.00	4.78119e-008	4.0	-0.016637	81760
1274.45	4.77989e-008	4.0	-0.016905	81760
1275.00	4.77971e-008	4.0	-0.016586	81760
1331.00	4.76203e-008	4.0	-0.016301	81760
1332.49	4.76113e-008	4.0	-0.016231	81760
1334.00	4.75931e-008	4.0	-0.016564	81760
1406.00	4.70553e-008	4.0	-0.015423	81760
1407.95	4.70573e-008	4.0	-0.015561	81760
1409.00	4.70712e-008	4.0	-0.015551	81760
1460.80	4.66684e-008	4.0	-0.015254	81760



Datasource: DET02



Datasource: DET02

Geometry Composer Report

CANBERRA

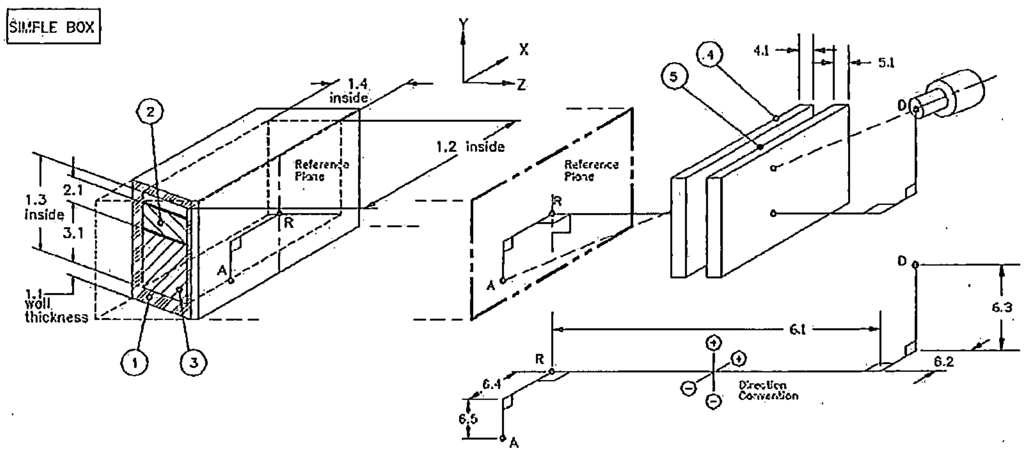
Date: Tuesday, November 18, 2014 - 15:45:15
Description: MHF_Liner_SOIL_DET3_20
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET3_20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3997
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2	0.03543						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

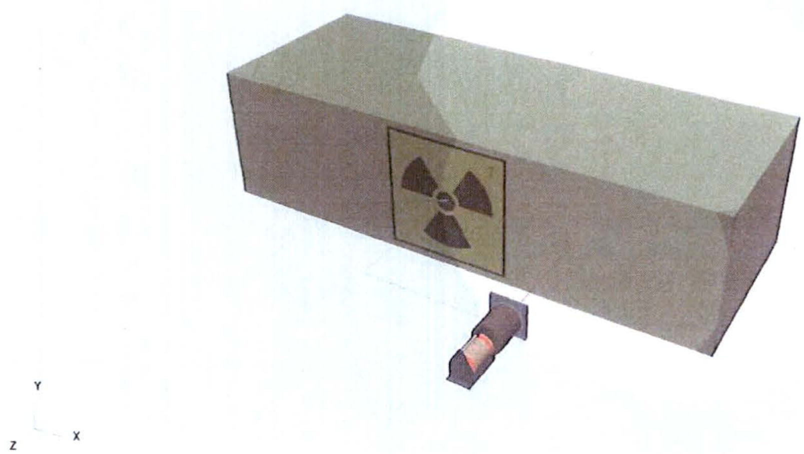
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

Date:	Tuesday, November 18, 2014 - 15:45:15
Description:	MHF_Liner_SOIL_DET3_20
Comment:	CAL DATE 11_18_14
File Name:	E:\SIMPLE_BOX\MHF_Liner_SOIL_DET3_20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)

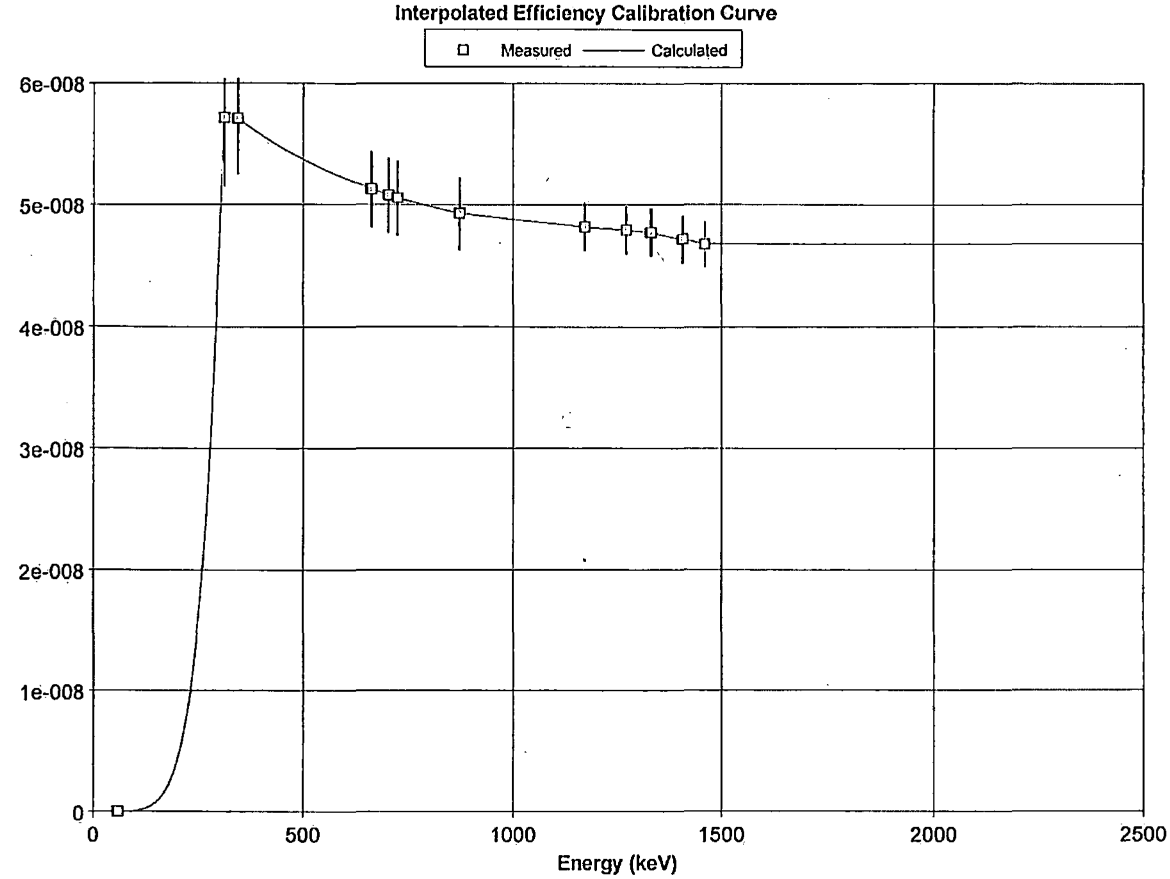


ISOCS/LABSOCS RESULTS

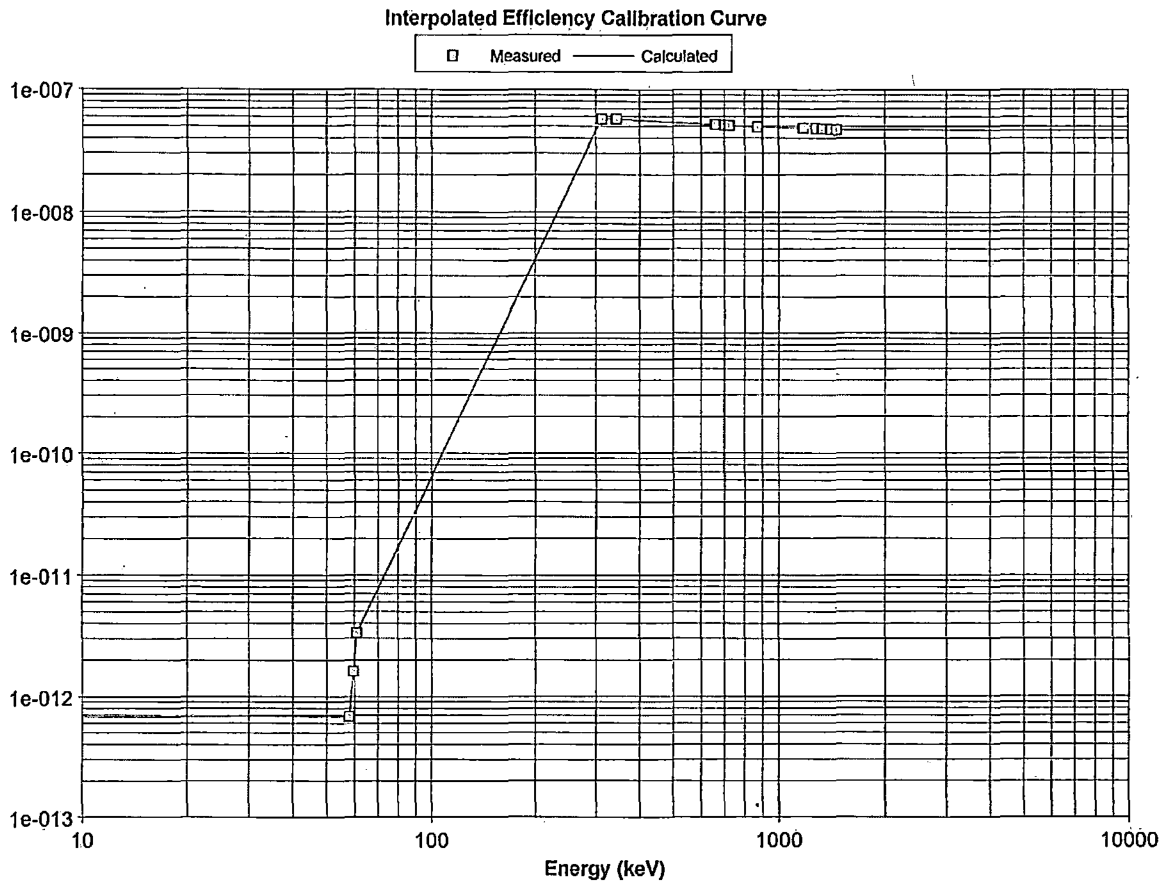
ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:19:31
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET3_20.CAL
Genie Cal Time: 11/18/14 02:54:17
Template: SIMPLE BOX
Geom Description: MHF Liner D3 20
Comment: ISOCS:CAL_DATE_11_18_14
Detector: 3997
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 3.5881e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	6.78963e-013	10.0	-0.116644	81760
59.54	1.60782e-012	10.0	-0.110901	81760
61.00	3.33974e-012	10.0	-0.105918	81760
311.00	5.71854e-008	10.0	-0.030549	81760
311.98	5.71588e-008	10.0	-0.030180	81760
313.00	5.71804e-008	10.0	-0.030422	81760
343.00	5.71113e-008	8.0	-0.031052	81760
344.27	5.70808e-008	8.0	-0.030868	81760
345.00	5.70969e-008	8.0	-0.031117	81760
660.00	5.13387e-008	6.0	-0.033302	81760
661.65	5.12605e-008	6.0	-0.033479	81760
663.00	5.12628e-008	6.0	-0.033135	81760
701.00	5.08120e-008	6.0	-0.033172	81760
702.63	5.07511e-008	6.0	-0.033385	81760
703.00	5.07656e-008	6.0	-0.033377	81760
722.00	5.05566e-008	6.0	-0.033409	81760
723.00	5.05327e-008	6.0	-0.033297	81760
724.00	5.05312e-008	6.0	-0.033371	81760
870.00	4.92952e-008	6.0	-0.032412	81760
871.10	4.92689e-008	6.0	-0.032391	81760
872.00	4.92929e-008	6.0	-0.032271	81760
1172.00	4.82237e-008	4.0	-0.029502	81760
1173.22	4.82005e-008	4.0	-0.029424	81760
1174.00	4.81833e-008	4.0	-0.029266	81760
1273.00	4.79671e-008	4.0	-0.028286	81760
1274.45	4.79539e-008	4.0	-0.028482	81760
1275.00	4.79521e-008	4.0	-0.028212	81760
1331.00	4.77719e-008	4.0	-0.027758	81760
1332.49	4.77629e-008	4.0	-0.027658	81760
1334.00	4.77445e-008	4.0	-0.027999	81760
1406.00	4.72020e-008	4.0	-0.026587	81760
1407.95	4.72040e-008	4.0	-0.026712	81760
1409.00	4.72179e-008	4.0	-0.026644	81760
1460.80	4.68121e-008	4.0	-0.026162	81760

Interpolated Efficiency Calibration Curve



Datasource: DET02



Datasource: DET02

Geometry Composer Report

CANBERRA

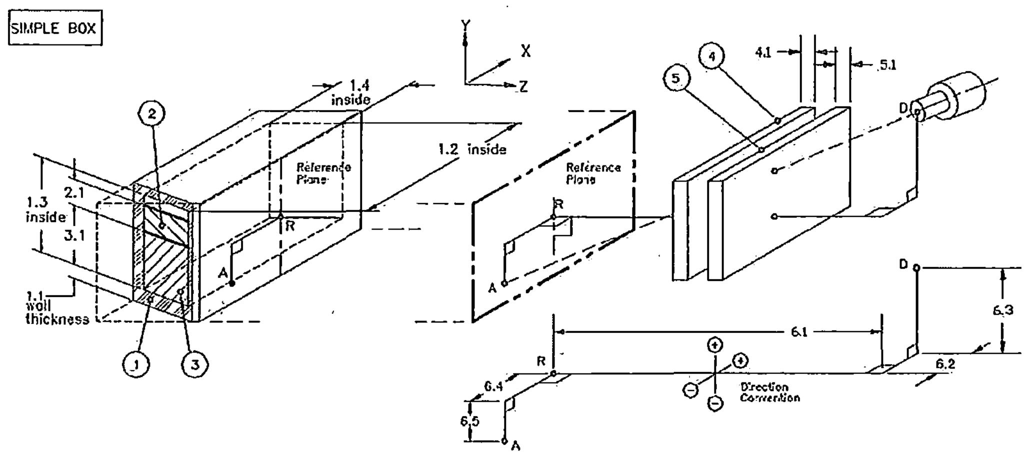
Date: Tuesday, November 18, 2014 - 15:46:11
Description: MHF_Liner_SOIL_DET4_20
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET4_20.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3998
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						none		
3	Source - Bottom Layer	56						dirt1	2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2							none		
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

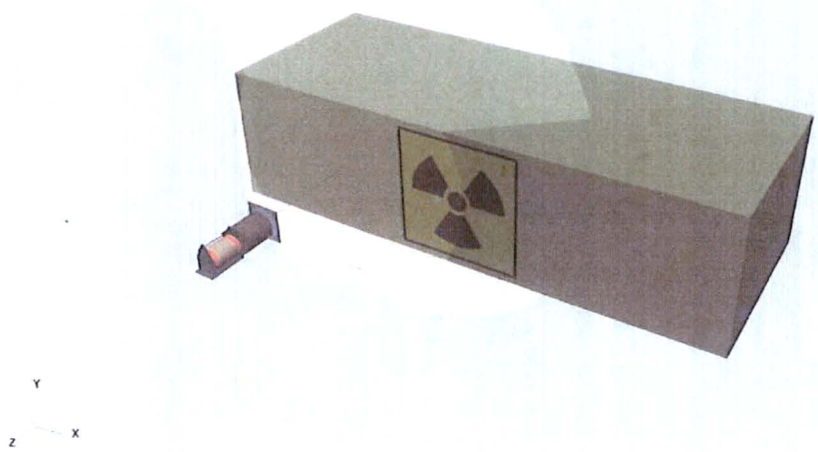
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

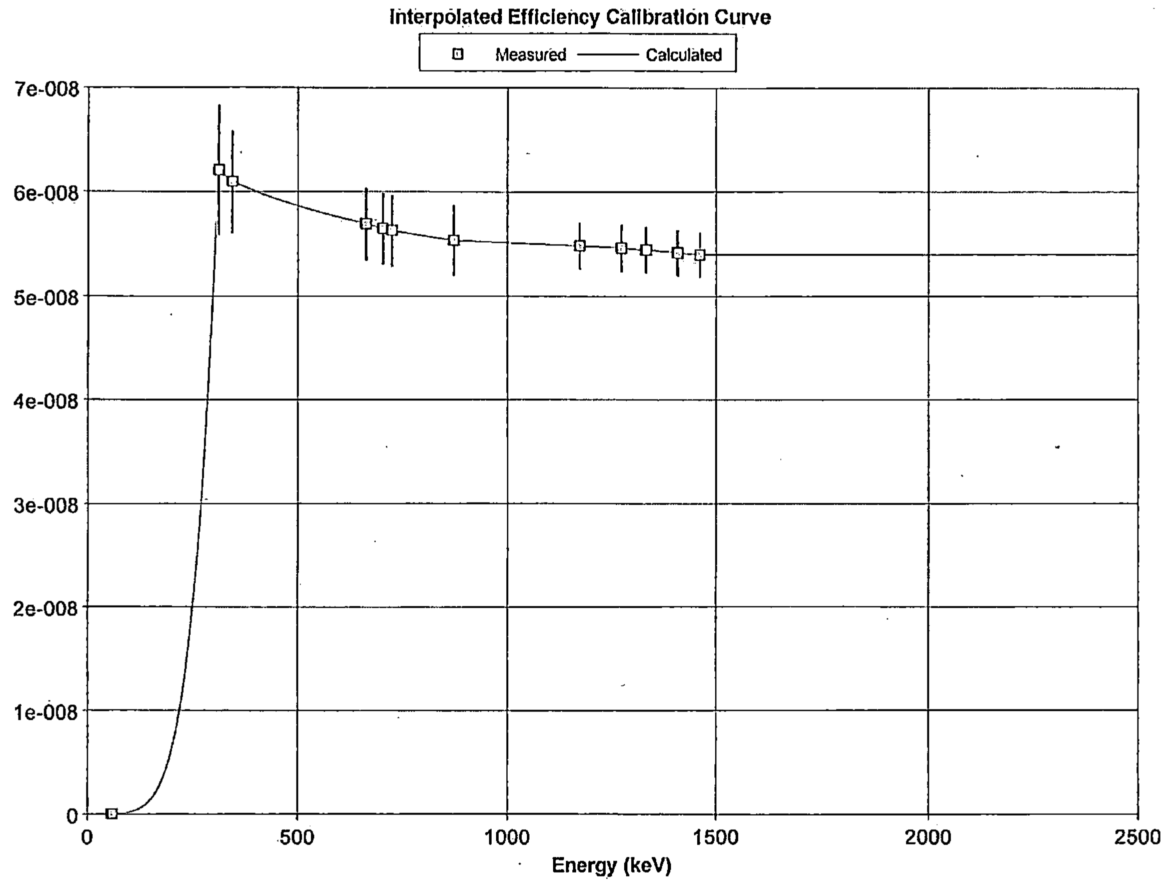
Date:	Tuesday, November 18, 2014 - 15:46:11
Description:	MHF_Liner_SOIL_DET4_20
Comment:	CAL DATE 11_18_14
File Name:	E:\SIMPLE_BOX\MHF_Liner_SOIL_DET4_20.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



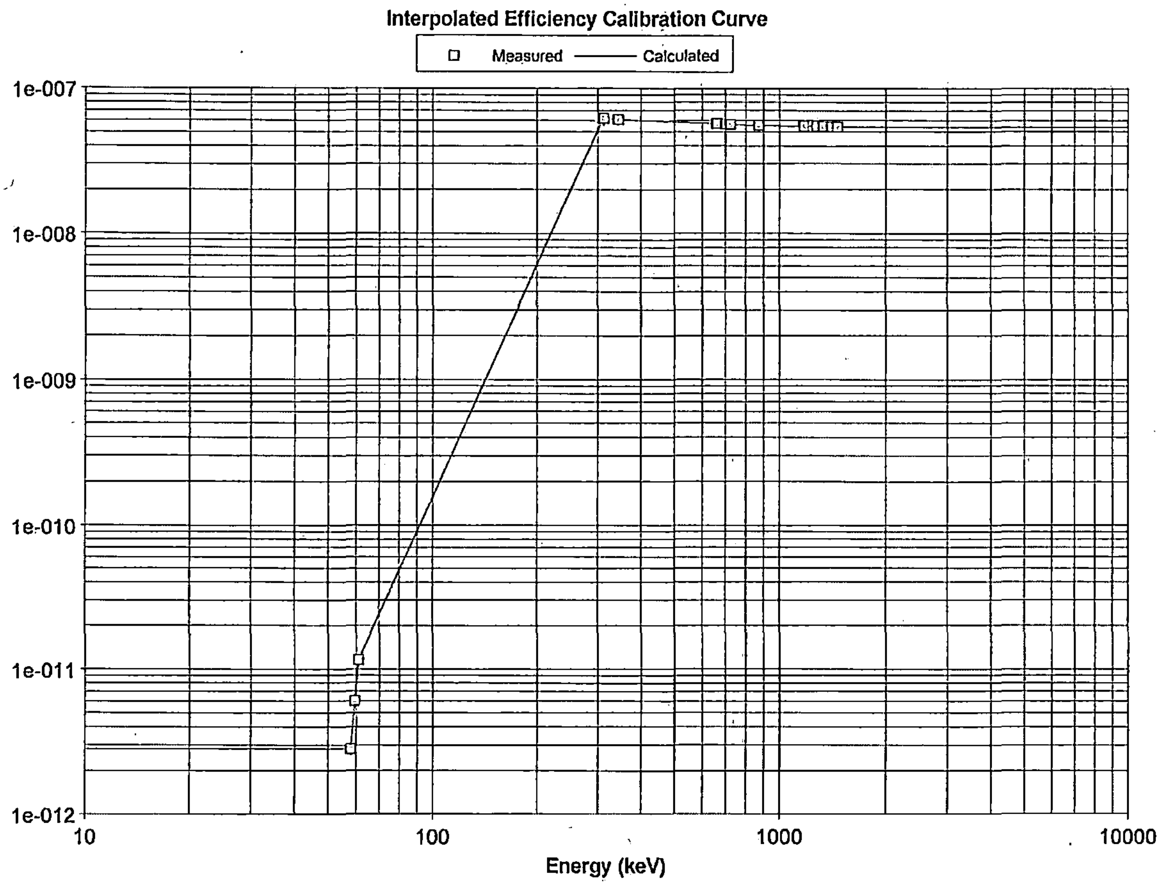
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:25:34
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET4_20.CAL
Genie Cal Time: 11/18/14 02:57:39
Template: SIMPLE BOX
Geom Description: MHF Liner D4 20
Comment: ISOCS:CAL_DATE_11_18_14
Detector: 3998
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 3.5881e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	2.81601e-012	10.0	-0.023530	81760
59.54	6.03942e-012	10.0	-0.018229	81760
61.00	1.15387e-011	10.0	-0.013421	81760
311.00	6.21344e-008	10.0	0.013212	81760
311.98	6.20973e-008	10.0	0.013226	81760
313.00	6.20642e-008	10.0	0.013210	81760
343.00	6.09865e-008	8.0	0.009237	81760
344.27	6.09483e-008	8.0	0.009533	81760
345.00	6.09493e-008	8.0	0.009222	81760
660.00	5.69372e-008	6.0	-0.009404	81760
661.65	5.68717e-008	6.0	-0.009517	81760
663.00	5.68834e-008	6.0	-0.009409	81760
701.00	5.64863e-008	6.0	-0.010667	81760
702.63	5.64625e-008	6.0	-0.010648	81760
703.00	5.64606e-008	6.0	-0.010658	81760
722.00	5.62901e-008	6.0	-0.011118	81760
723.00	5.62907e-008	6.0	-0.011111	81760
724.00	5.62813e-008	6.0	-0.011278	81760
870.00	5.53379e-008	6.0	-0.013359	81760
871.10	5.53289e-008	6.0	-0.013109	81760
872.00	5.53425e-008	6.0	-0.013353	81760
1172.00	5.48156e-008	4.0	-0.013869	81760
1173.22	5.48208e-008	4.0	-0.013776	81760
1174.00	5.47985e-008	4.0	-0.013572	81760
1273.00	5.46021e-008	4.0	-0.013477	81760
1274.45	5.45974e-008	4.0	-0.013195	81760
1275.00	5.45917e-008	4.0	-0.013232	81760
1331.00	5.44040e-008	4.0	-0.013070	81760
1332.49	5.44358e-008	4.0	-0.012956	81760
1334.00	5.44270e-008	4.0	-0.012937	81760
1406.00	5.41744e-008	4.0	-0.012096	81760
1407.95	5.41522e-008	4.0	-0.012092	81760
1409.00	5.41387e-008	4.0	-0.011995	81760
1460.80	5.39531e-008	4.0	-0.011874	81760



Datasource: DET02



Datasource: DET02

#	Weight	58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3	345.0	660.0	661.7
		Primary Efficiency taken from ECC files, for set energies (keV):										
1	1.000	5.07e-013	1.23e-012	2.60e-012	5.71e-008	5.71e-008	5.71e-008	5.70e-008	5.70e-008	5.70e-008	5.13e-008	5.12e-008
2	1.000	4.50e-013	1.10e-012	2.34e-012	5.67e-008	5.67e-008	5.67e-008	5.67e-008	5.67e-008	5.67e-008	5.11e-008	5.10e-008
3	1.000	6.79e-013	1.61e-012	3.34e-012	5.72e-008	5.72e-008	5.72e-008	5.71e-008	5.71e-008	5.71e-008	5.13e-008	5.13e-008
4	1.000	2.82e-012	6.04e-012	1.15e-011	6.21e-008	6.21e-008	6.21e-008	6.10e-008	6.09e-008	6.09e-008	5.69e-008	5.69e-008
	Sum	4.45e-012	9.97e-012	1.98e-011	2.33e-007	2.33e-007	2.33e-007	2.32e-007	2.32e-007	2.32e-007	2.11e-007	2.10e-007
	Error,%	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	8.00e+000	8.00e+000	8.00e+000	6.00e+000	6.00e+000

Information for input ECC files

	File Name	File Stamp	Path
1	MHF_Liner_SOIL_DET1_2(	Tue_Nov_18_02:04:49_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
2	MHF_Liner_SOIL_DET2_2(	Tue_Nov_18_02:12:56_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
3	MHF_Liner_SOIL_DET3_2(	Tue_Nov_18_02:18:38_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
4	MHF_Liner_SOIL_DET4_2(	Tue_Nov_18_02:24:41_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

File Name	File Stamp	Path

Description: MHF_Liner_SOIL_SUM_20
Comment: Calib Date 11/18/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

663.0	701.0	702.6	703.0	722.0	723.0	724.0	870.0	871.1	872.0	1172.0	1173.2
5.12e-008	5.08e-008	5.07e-008	5.07e-008	5.05e-008	5.05e-008	5.05e-008	4.93e-008	4.93e-008	4.93e-008	4.82e-008	4.82e-008
5.10e-008	5.06e-008	5.05e-008	5.05e-008	5.03e-008	5.03e-008	5.03e-008	4.91e-008	4.91e-008	4.91e-008	4.81e-008	4.80e-008
5.13e-008	5.08e-008	5.08e-008	5.08e-008	5.06e-008	5.05e-008	5.05e-008	4.93e-008	4.93e-008	4.93e-008	4.82e-008	4.82e-008
5.69e-008	5.65e-008	5.65e-008	5.65e-008	5.63e-008	5.63e-008	5.63e-008	5.53e-008	5.53e-008	5.53e-008	5.48e-008	5.48e-008
2.10e-007	2.09e-007	2.08e-007	2.09e-007	2.08e-007	2.08e-007	2.08e-007	2.03e-007	2.03e-007	2.03e-007	1.99e-007	1.99e-007
6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_Liner_SOIL_SUM_20
Calib Date 11/18/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

1174.0	1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9	1409.0	1460.8
4.82e-008	4.80e-008	4.79e-008	4.79e-008	4.78e-008	4.77e-008	4.77e-008	4.72e-008	4.72e-008	4.72e-008	4.68e-008
4.80e-008	4.78e-008	4.78e-008	4.78e-008	4.76e-008	4.76e-008	4.76e-008	4.71e-008	4.71e-008	4.71e-008	4.67e-008
4.82e-008	4.80e-008	4.80e-008	4.80e-008	4.78e-008	4.78e-008	4.77e-008	4.72e-008	4.72e-008	4.72e-008	4.68e-008
5.48e-008	5.46e-008	5.46e-008	5.46e-008	5.44e-008	5.44e-008	5.44e-008	5.42e-008	5.42e-008	5.41e-008	5.40e-008
1.99e-007	1.98e-007	1.98e-007	1.98e-007	1.98e-007	1.98e-007	1.97e-007	1.96e-007	1.96e-007	1.96e-007	1.94e-007
4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000

Information for input ECC files.

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_Liner_SOIL_SUM_20
Calib Date 11/18/14

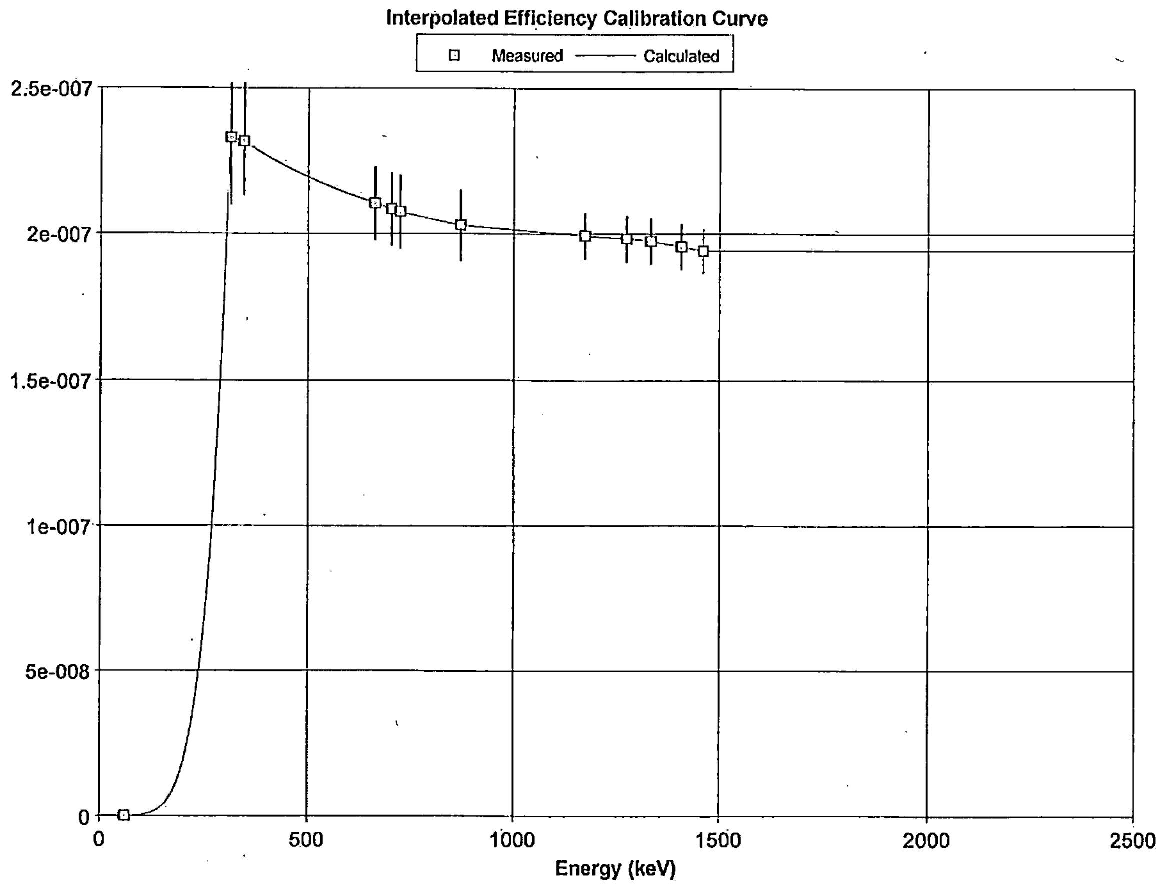
CANBERRA

Multi-Efficiency Report

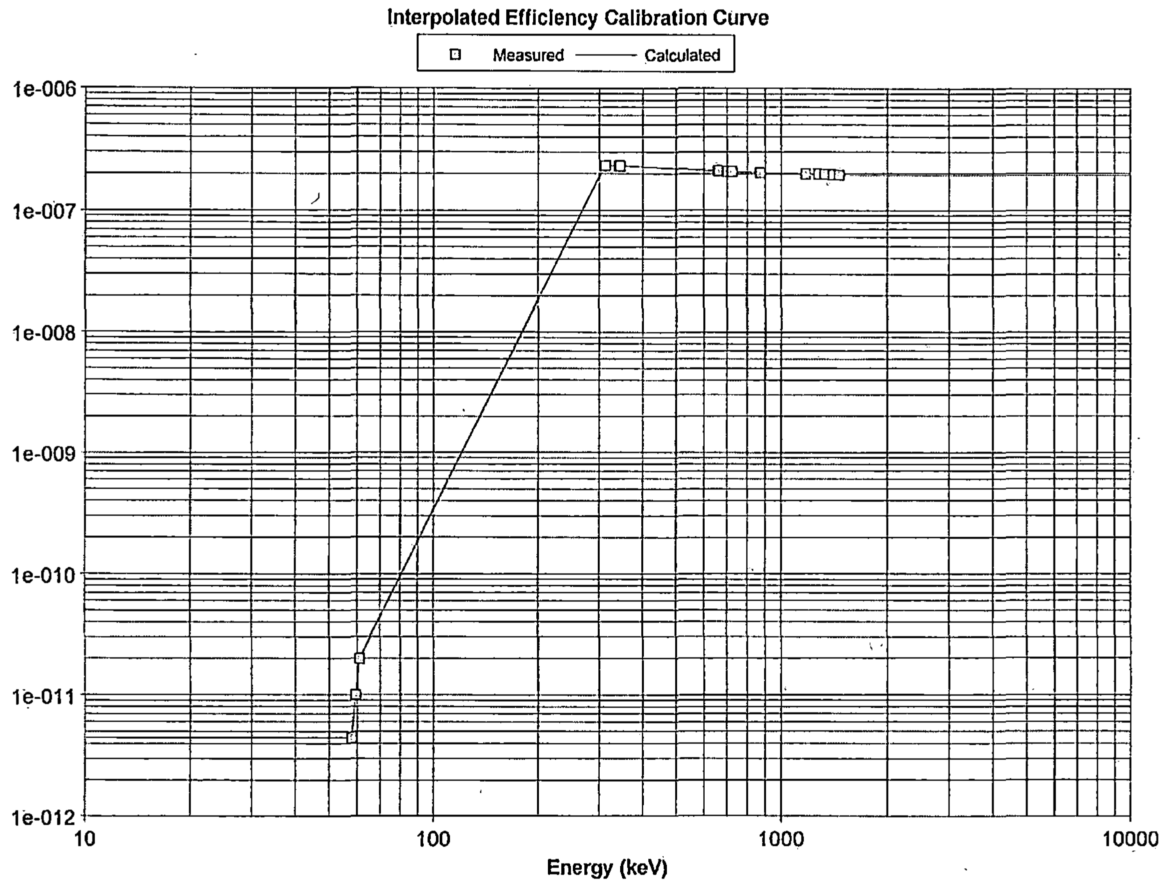
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\Multiefficiency\MHF_Li
ISOCS/LabSOCS Time: 11/18/14 02:31:57
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_SUM_D20.CAL
Genie Cal Time: 11/18/14 03:02:26
Template: (SIMPLE BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+
Geom Description: MHF Liner SUM 20
Comment: ISOCS:Calib Date 11/18/14
Detector: (3994)+(3996)+(3997)+(3998)+
Collimator: (GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+
Convergence: 1.00 %
Area [Sq Meters]: 1.0000e-004 (C)
Mass [Grams]: 1.0000e+000 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	4.45256e-012	10.0	0.0000000	64000
59.54	9.97480e-012	10.0	0.0000000	64000
61.00	1.98229e-011	10.0	0.0000000	64000
311.00	2.33129e-007	10.0	0.0000000	64000
311.98	2.33014e-007	10.0	0.0000000	64000
313.00	2.33048e-007	10.0	0.0000000	64000
343.00	2.31824e-007	8.0	0.0000000	64000
344.27	2.31697e-007	8.0	0.0000000	64000
345.00	2.31748e-007	8.0	0.0000000	64000
660.00	2.10695e-007	6.0	0.0000000	64000
661.65	2.10396e-007	6.0	0.0000000	64000
663.00	2.10415e-007	6.0	0.0000000	64000
701.00	2.08676e-007	6.0	0.0000000	64000
702.63	2.08470e-007	6.0	0.0000000	64000
703.00	2.08512e-007	6.0	0.0000000	64000
722.00	2.07719e-007	6.0	0.0000000	64000
723.00	2.07648e-007	6.0	0.0000000	64000
724.00	2.07635e-007	6.0	0.0000000	64000
870.00	2.03013e-007	6.0	0.0000000	64000
871.10	2.02925e-007	6.0	0.0000000	64000
872.00	2.03011e-007	6.0	0.0000000	64000
1172.00	1.99311e-007	4.0	0.0000000	64000
1173.22	1.99247e-007	4.0	0.0000000	64000
1174.00	1.99173e-007	4.0	0.0000000	64000
1273.00	1.98335e-007	4.0	0.0000000	64000
1274.45	1.98291e-007	4.0	0.0000000	64000
1275.00	1.98280e-007	4.0	0.0000000	64000
1331.00	1.97555e-007	4.0	0.0000000	64000
1332.49	1.97559e-007	4.0	0.0000000	64000
1334.00	1.97496e-007	4.0	0.0000000	64000
1406.00	1.95620e-007	4.0	0.0000000	64000
1407.95	1.95604e-007	4.0	0.0000000	64000
1409.00	1.95632e-007	4.0	0.0000000	64000
1460.80	1.94231e-007	4.0	0.0000000	64000



Datasource: DET02



Datasource: DET02

GARDIAN SYSTEM
Calibration Records
MHF IP-1 Intermodal with Liner

Density 1.6

Geometry Composer Report

CANBERRA

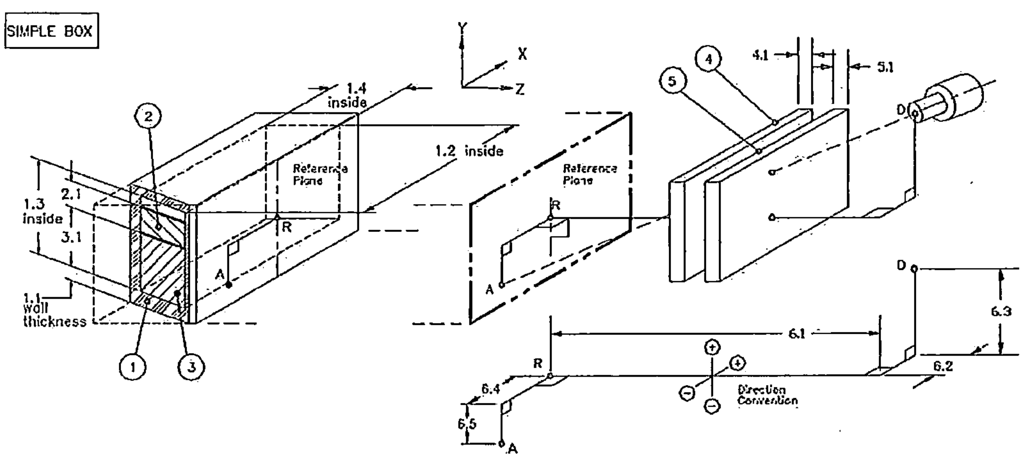
Date: Tuesday, November 18, 2014 - 15:42:56
Description: MHF_Liner_SOIL_DET1_16
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET1_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3994
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.6	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.02756						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

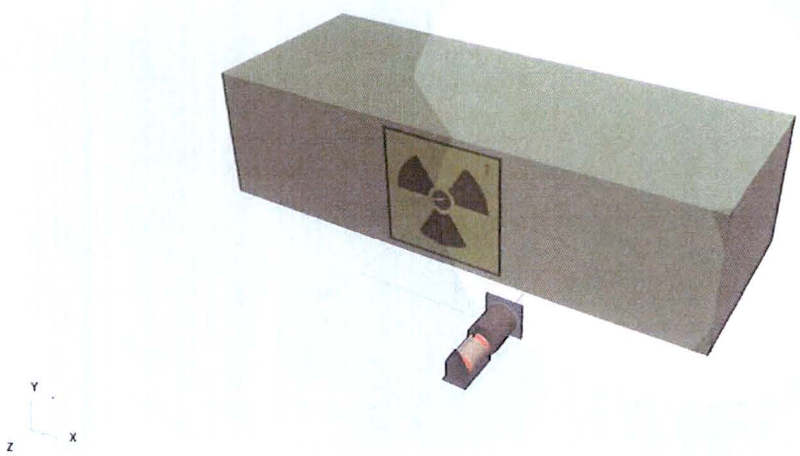
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

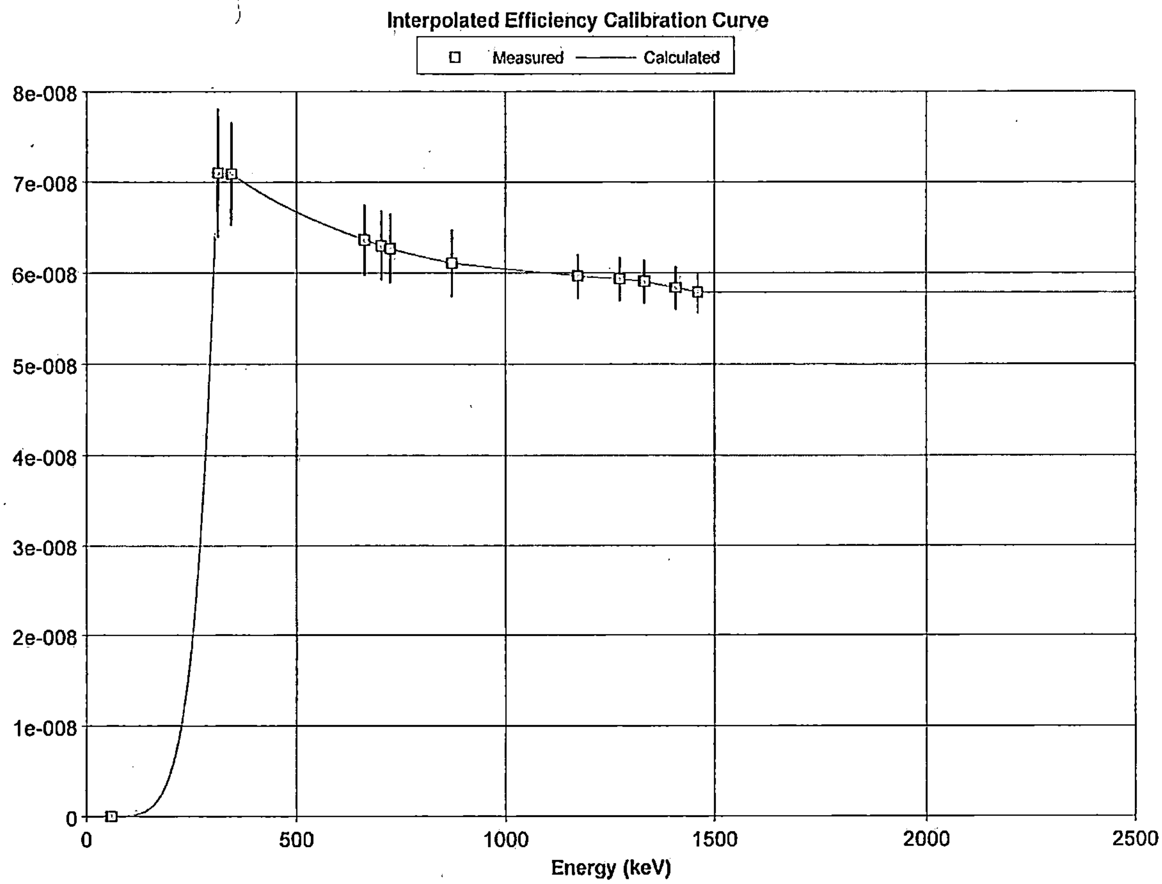
Date:	Tuesday, November 18, 2014 - 15:42:56
Description:	MHF_Liner_SOIL_DET1_16
Comment:	CAL DATE 11_18_14
File Name:	E:\SIMPLE_BOX\MHF_Liner_SOIL_DET1_16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



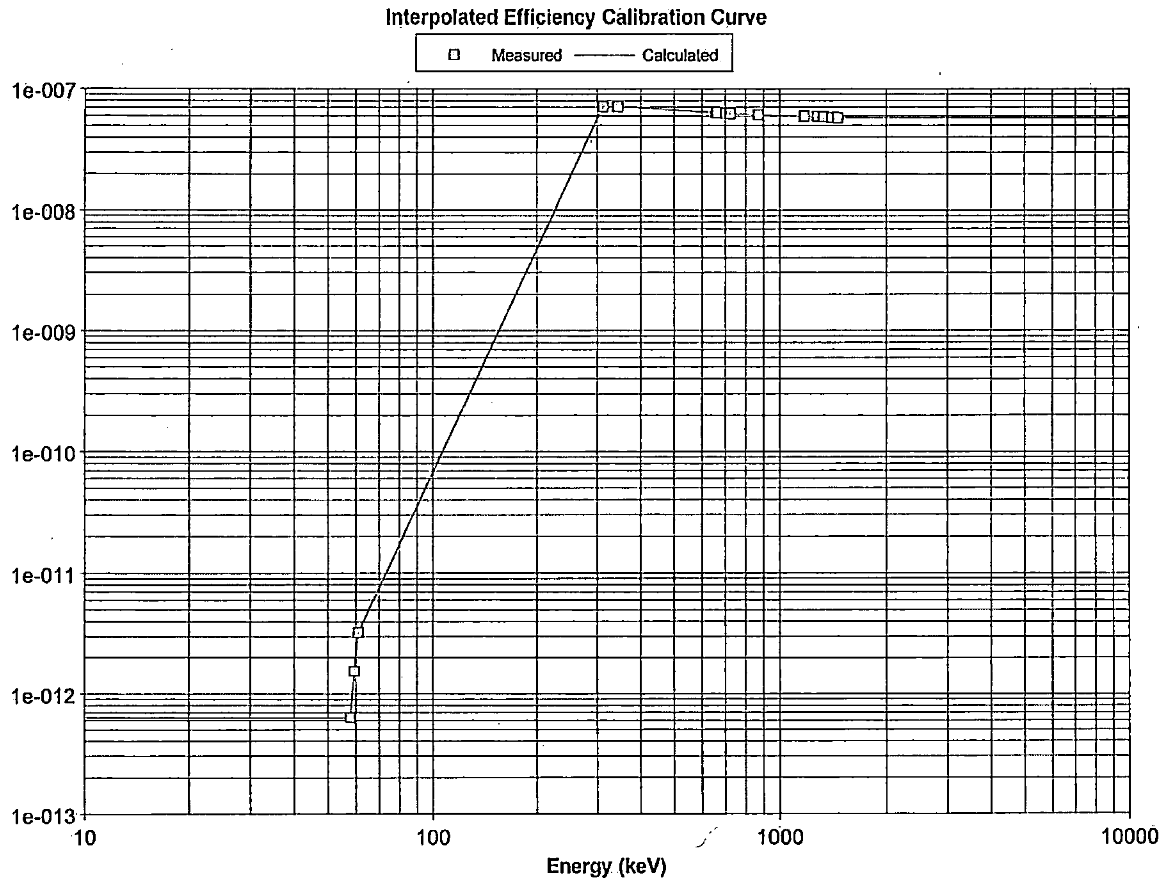
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:03:44
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET1_16.CAL
Genie Cal Time: 11/18/14 02:39:22
Template: SIMPLE BOX
Geom Description: HMF Liner D1 16
Comment: ISOCS:CAL_DATE_11_18_14
Detector: 3994
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.8705e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	6.33573e-013	10.0	0.087456	81760
59.54	1.53396e-012	10.0	0.080981	81760
61.00	3.24770e-012	10.0	0.075679	81760
311.00	7.09848e-008	10.0	-0.028446	81760
311.98	7.09546e-008	10.0	-0.028008	81760
313.00	7.09817e-008	10.0	-0.028447	81760
343.00	7.09089e-008	8.0	-0.030478	81760
344.27	7.08720e-008	8.0	-0.030225	81760
345.00	7.08902e-008	8.0	-0.030508	81760
660.00	6.36907e-008	6.0	-0.031712	81760
661.65	6.35930e-008	6.0	-0.031830	81760
663.00	6.35986e-008	6.0	-0.031523	81760
701.00	6.30231e-008	6.0	-0.031072	81760
702.63	6.29504e-008	6.0	-0.031264	81760
703.00	6.29676e-008	6.0	-0.031268	81760
722.00	6.27029e-008	6.0	-0.031150	81760
723.00	6.26720e-008	6.0	-0.030929	81760
724.00	6.26706e-008	6.0	-0.030975	81760
870.00	6.10965e-008	6.0	-0.029119	81760
871.10	6.10659e-008	6.0	-0.029118	81760
872.00	6.10924e-008	6.0	-0.028929	81760
1172.00	5.97013e-008	4.0	-0.025862	81760
1173.22	5.96696e-008	4.0	-0.025795	81760
1174.00	5.96471e-008	4.0	-0.025642	81760
1273.00	5.93596e-008	4.0	-0.024495	81760
1274.45	5.93432e-008	4.0	-0.024726	81760
1275.00	5.93416e-008	4.0	-0.024583	81760
1331.00	5.91092e-008	4.0	-0.023944	81760
1332.49	5.90960e-008	4.0	-0.023895	81760
1334.00	5.90698e-008	4.0	-0.024160	81760
1406.00	5.83823e-008	4.0	-0.023088	81760
1407.95	5.83819e-008	4.0	-0.023105	81760
1409.00	5.83999e-008	4.0	-0.022994	81760
1460.80	5.78899e-008	4.0	-0.022531	81760



Datasource: DET02



Datasource: DET02

Geometry Composer Report

CANBERRA

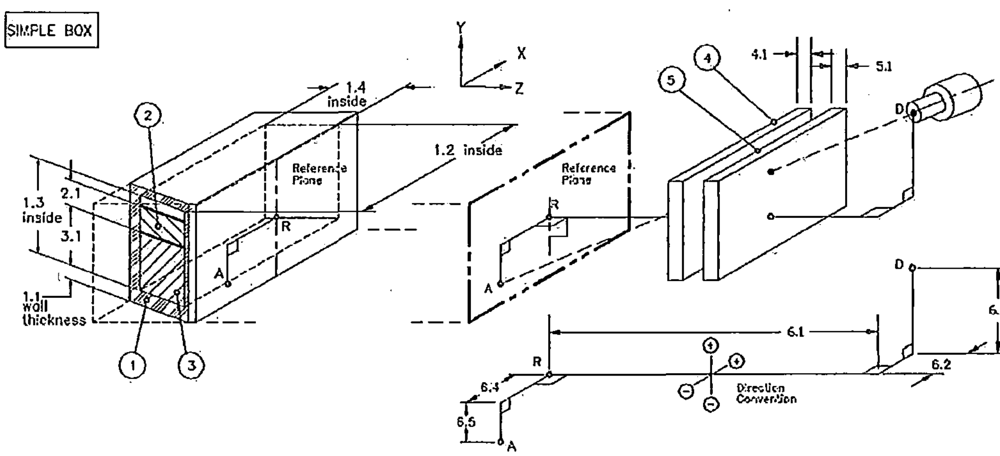
Date: Tuesday, November 18, 2014 - 15:43:58
Description: MHF_Liner_SOIL_DET2_16
Comment: Calib Date 11/18/14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET2_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3996
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.6	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.0315						germanum	5.4	
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

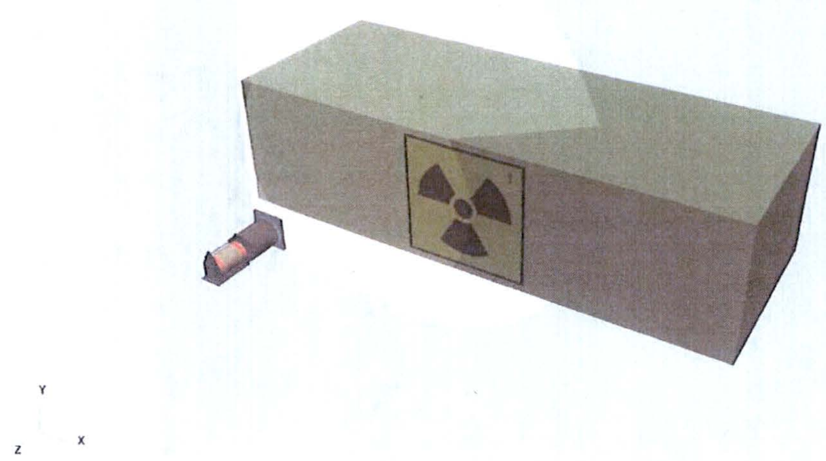
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

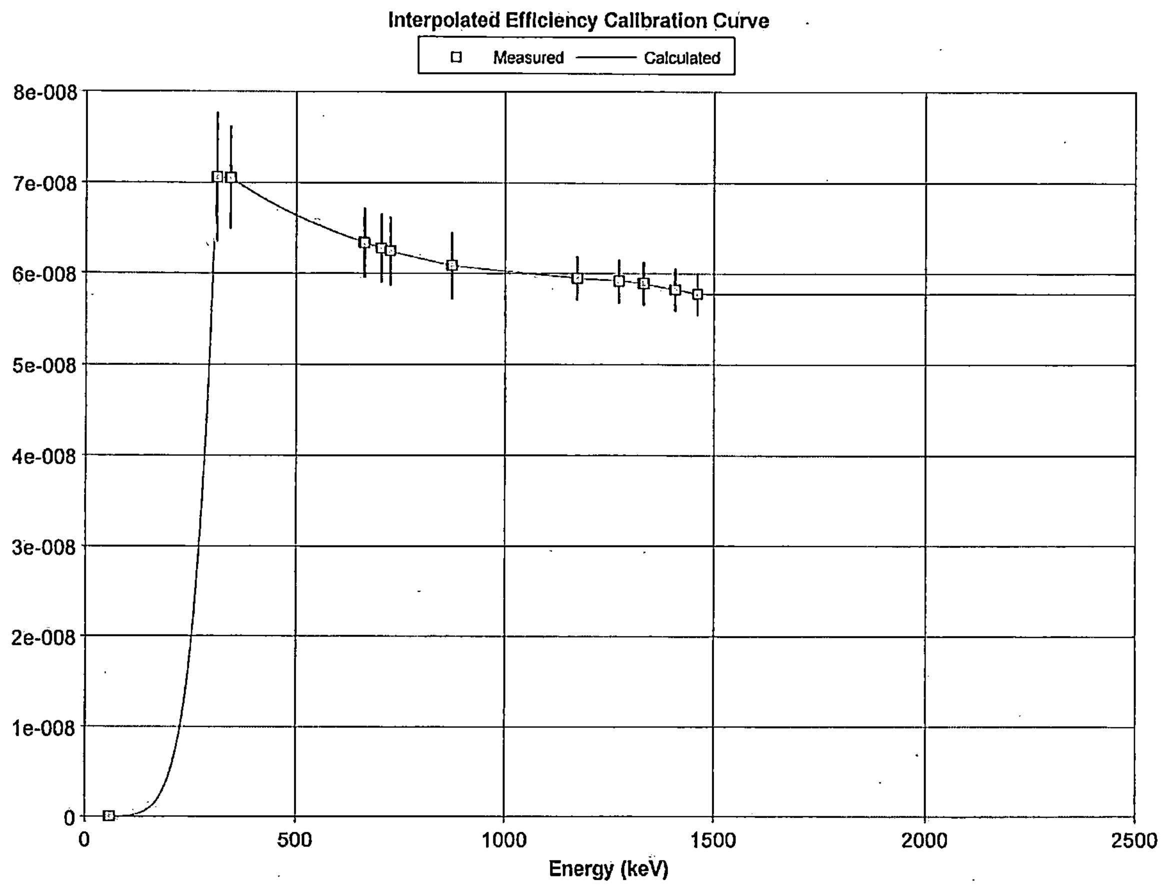
Date: Tuesday, November 18, 2014 - 15:43:58
Description: MHF_Liner_SOIL_DET2_16
Comment: Calib Date 11/18/14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET2_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)



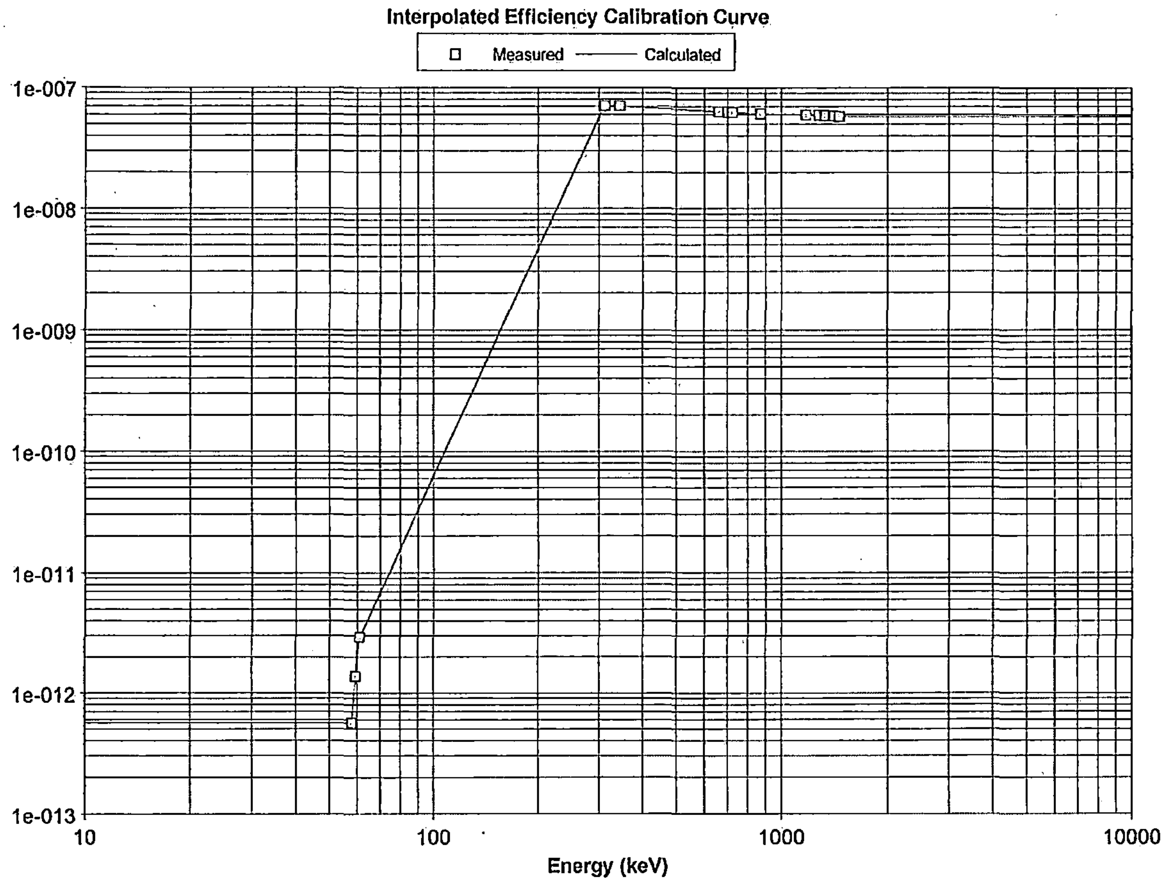
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:11:20
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET2_16.CAL
Genie Cal Time: 11/18/14 02:47:01
Template: SIMPLE BOX
Geom Description: MHF Liner D2 16
Comment: ISOCS:CALIB_DATE_11/18/14
Detector: 3996
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.8705e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	5.62258e-013	10.0	0.094637	81760
59.54	1.37243e-012	10.0	0.088870	81760
61.00	2.92622e-012	10.0	0.084219	81760
311.00	7.05694e-008	10.0	-0.011033	81760
311.98	7.05402e-008	10.0	-0.010657	81760
313.00	7.05681e-008	10.0	-0.011217	81760
343.00	7.05194e-008	8.0	-0.014503	81760
344.27	7.04837e-008	8.0	-0.014262	81760
345.00	7.05023e-008	8.0	-0.014571	81760
660.00	6.34421e-008	6.0	-0.024023	81760
661.65	6.33451e-008	6.0	-0.024133	81760
663.00	6.33509e-008	6.0	-0.023852	81760
701.00	6.27842e-008	6.0	-0.023817	81760
702.63	6.27121e-008	6.0	-0.024038	81760
703.00	6.27293e-008	6.0	-0.024020	81760
722.00	6.24686e-008	6.0	-0.024027	81760
723.00	6.24380e-008	6.0	-0.023912	81760
724.00	6.24367e-008	6.0	-0.023954	81760
870.00	6.08879e-008	6.0	-0.023104	81760
871.10	6.08575e-008	6.0	-0.023070	81760
872.00	6.08840e-008	6.0	-0.022897	81760
1172.00	5.95253e-008	4.0	-0.020810	81760
1173.22	5.94938e-008	4.0	-0.020712	81760
1174.00	5.94715e-008	4.0	-0.020544	81760
1273.00	5.91917e-008	4.0	-0.019544	81760
1274.45	5.91754e-008	4.0	-0.019792	81760
1275.00	5.91739e-008	4.0	-0.019687	81760
1331.00	5.89455e-008	4.0	-0.019028	81760
1332.49	5.89325e-008	4.0	-0.018976	81760
1334.00	5.89065e-008	4.0	-0.019266	81760
1406.00	5.82248e-008	4.0	-0.018140	81760
1407.95	5.82245e-008	4.0	-0.018191	81760
1409.00	5.82426e-008	4.0	-0.018104	81760
1460.80	5.77366e-008	4.0	-0.017642	81760



Datasource: DET02



Datasource: DET02

Geometry Composer Report

CANBERRA

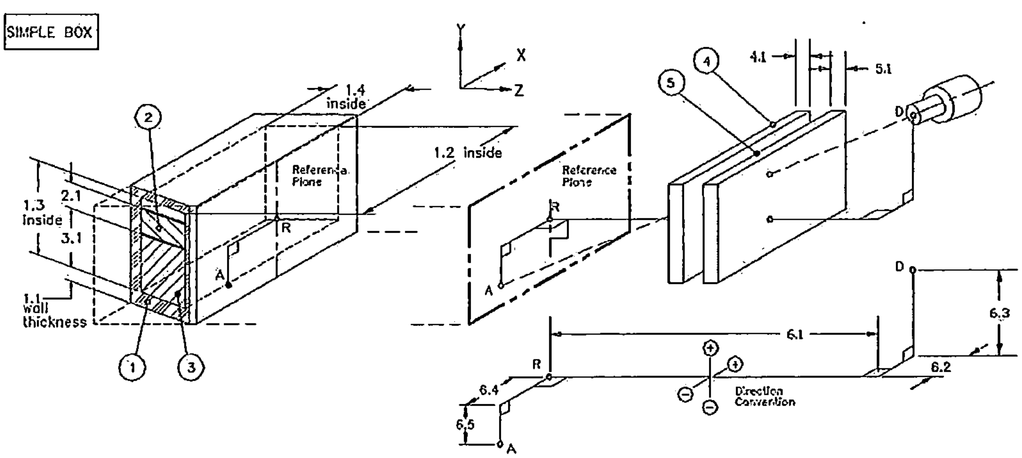
Date: Tuesday, November 18, 2014 - 15:44:57
Description: MHF_Liner_SOIL_DET3_16
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET3_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3997
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.6	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2	0.03543						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

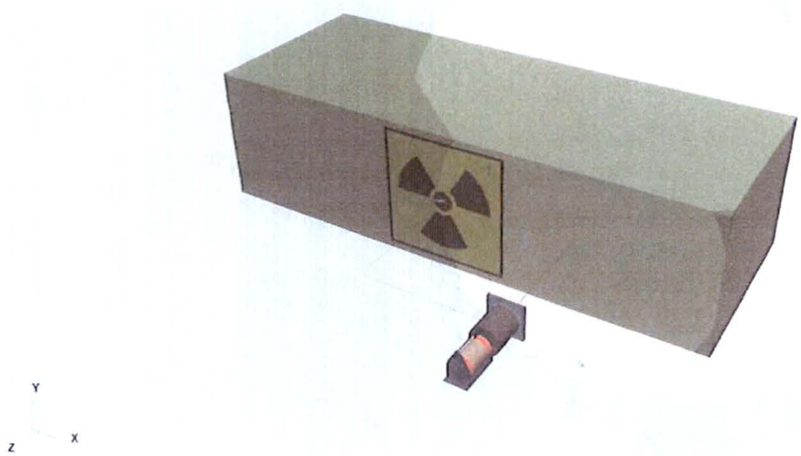
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

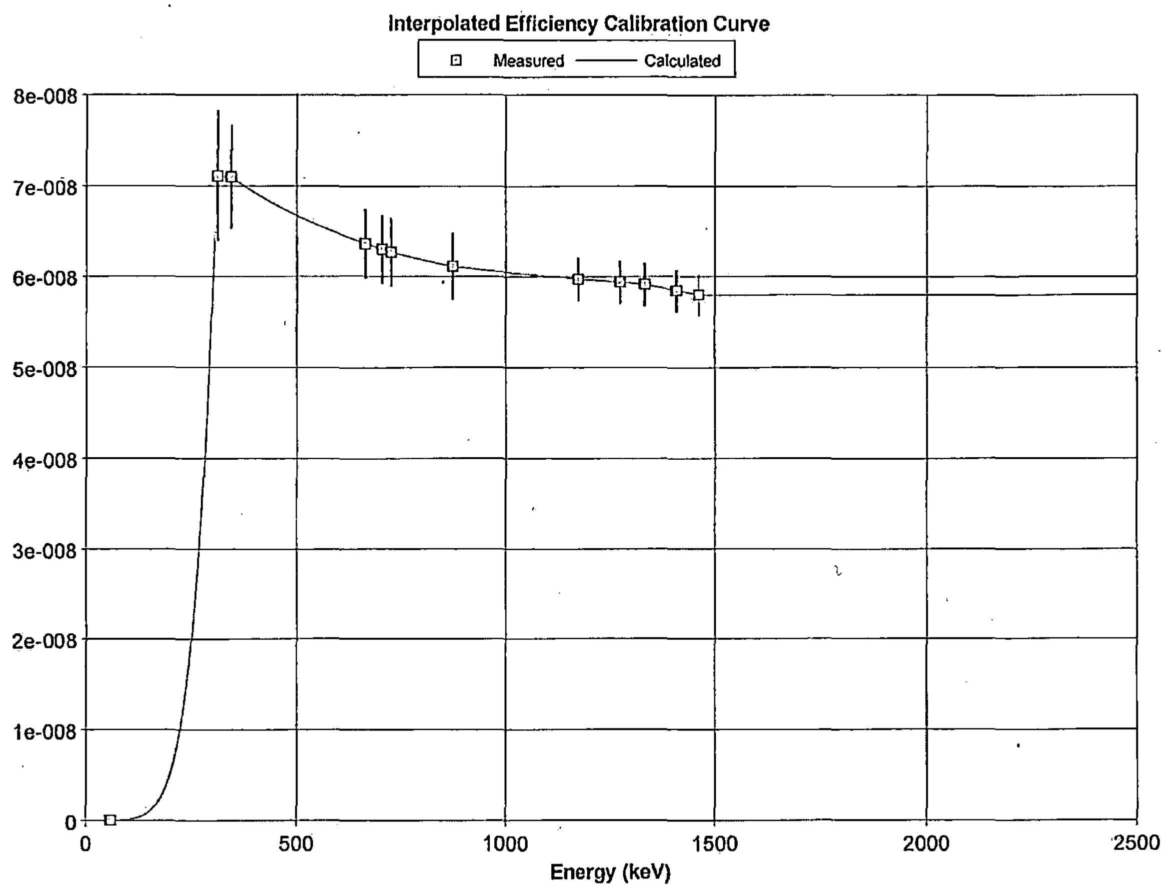
Date:	Tuesday, November 18, 2014 - 15:44:57
Description:	MHF_Liner_SOIL_DET3_16
Comment:	CAL DATE 11_18_14
File Name:	E:\SIMPLE_BOX\MHF_Liner_SOIL_DET3_16.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



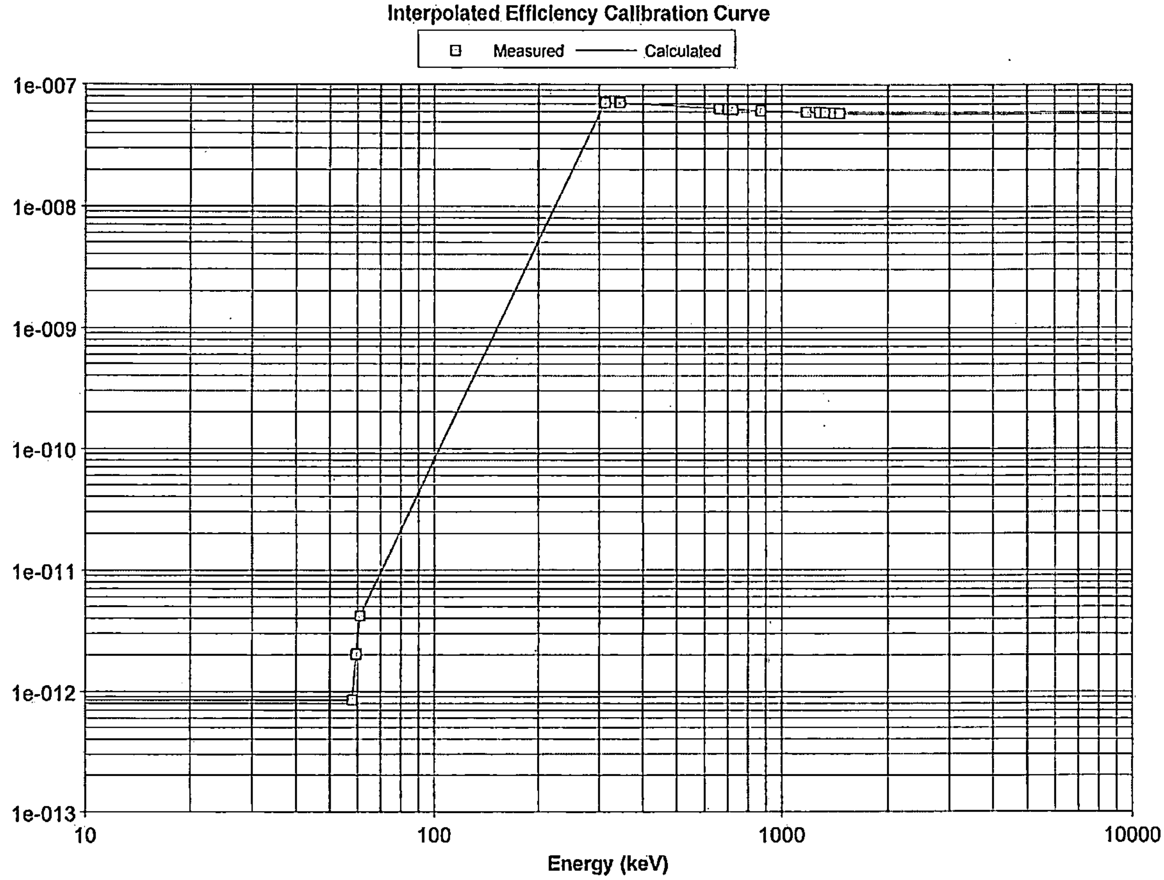
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:17:45
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET3_16.CAL
Genie Cal Time: 11/18/14 02:51:10
Template: SIMPLE BOX
Geom Description: MHF Liner D3 16
Comment: ISOCS:CAL_DATE_11_18_14
Detector: 3997
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.8705e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	8.47855e-013	10.0	0.086462	81760
59.54	2.00758e-012	10.0	0.080053	81760
61.00	4.16993e-012	10.0	0.074815	81760
311.00	7.11112e-008	10.0	-0.028445	81760
311.98	7.10800e-008	10.0	-0.028007	81760
313.00	7.11061e-008	10.0	-0.028446	81760
343.00	7.10079e-008	8.0	-0.030476	81760
344.27	7.09701e-008	8.0	-0.030223	81760
345.00	7.09879e-008	8.0	-0.030506	81760
660.00	6.37182e-008	6.0	-0.031710	81760
661.65	6.36204e-008	6.0	-0.031829	81760
663.00	6.36259e-008	6.0	-0.031521	81760
701.00	6.30486e-008	6.0	-0.031071	81760
702.63	6.29758e-008	6.0	-0.031262	81760
703.00	6.29930e-008	6.0	-0.031267	81760
722.00	6.27274e-008	6.0	-0.031148	81760
723.00	6.26965e-008	6.0	-0.030927	81760
724.00	6.26950e-008	6.0	-0.030973	81760
870.00	6.11164e-008	6.0	-0.029117	81760
871.10	6.10858e-008	6.0	-0.029116	81760
872.00	6.11123e-008	6.0	-0.028928	81760
1172.00	5.97174e-008	4.0	-0.025861	81760
1173.22	5.96856e-008	4.0	-0.025794	81760
1174.00	5.96632e-008	4.0	-0.025640	81760
1273.00	5.93758e-008	4.0	-0.024494	81760
1274.45	5.93594e-008	4.0	-0.024725	81760
1275.00	5.93579e-008	4.0	-0.024581	81760
1331.00	5.91258e-008	4.0	-0.023943	81760
1332.49	5.91126e-008	4.0	-0.023893	81760
1334.00	5.90864e-008	4.0	-0.024159	81760
1406.00	5.83996e-008	4.0	-0.023087	81760
1407.95	5.83992e-008	4.0	-0.023104	81760
1409.00	5.84172e-008	4.0	-0.022993	81760
1460.80	5.79079e-008	4.0	-0.022530	81760



Datasource: DET02



Datasource: DET02

Geometry Composer Report

CANBERRA

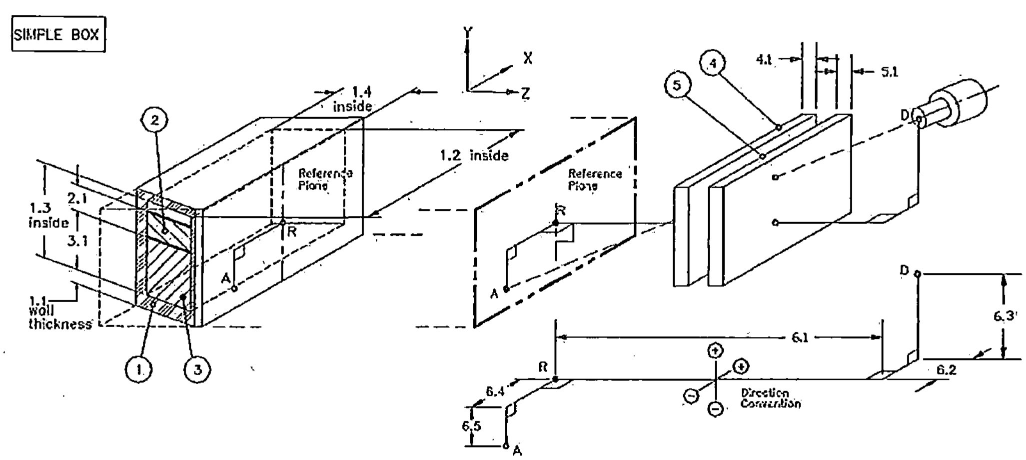
Date: Tuesday, November 18, 2014 - 15:45:55
Description: MHF_Liner_SOIL_DET4_16
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET4_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3998
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						none		
3	Source - Bottom Layer	56						dirt1	1.6	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2							none		
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

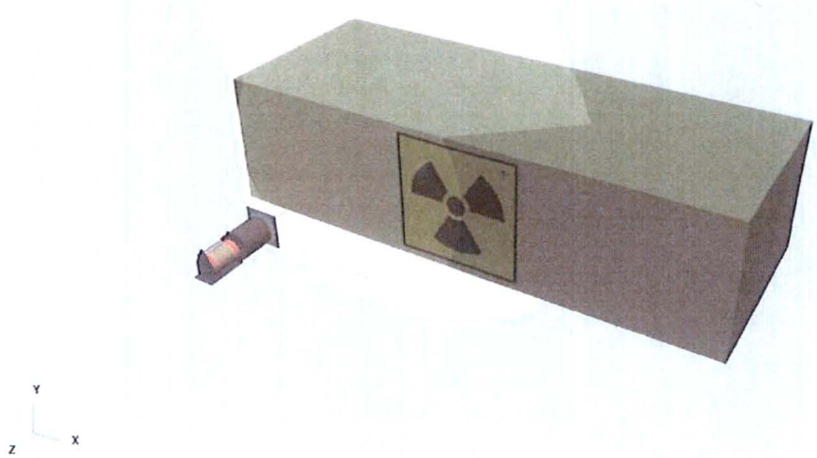
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

Date: Tuesday, November 18, 2014 - 15:45:55
Description: MHF_Liner_SOIL_DET4_16
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET4_16.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)

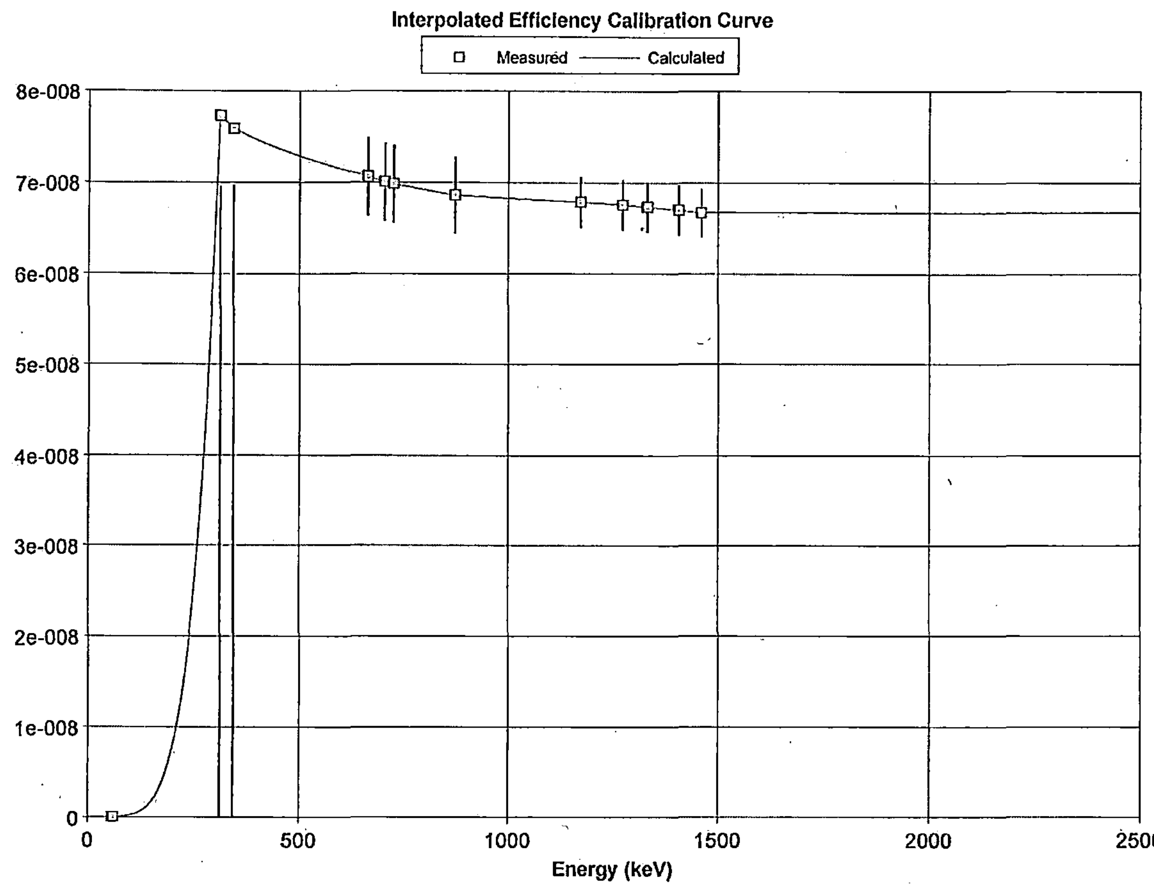


ISOCS/LABSOCS RESULTS

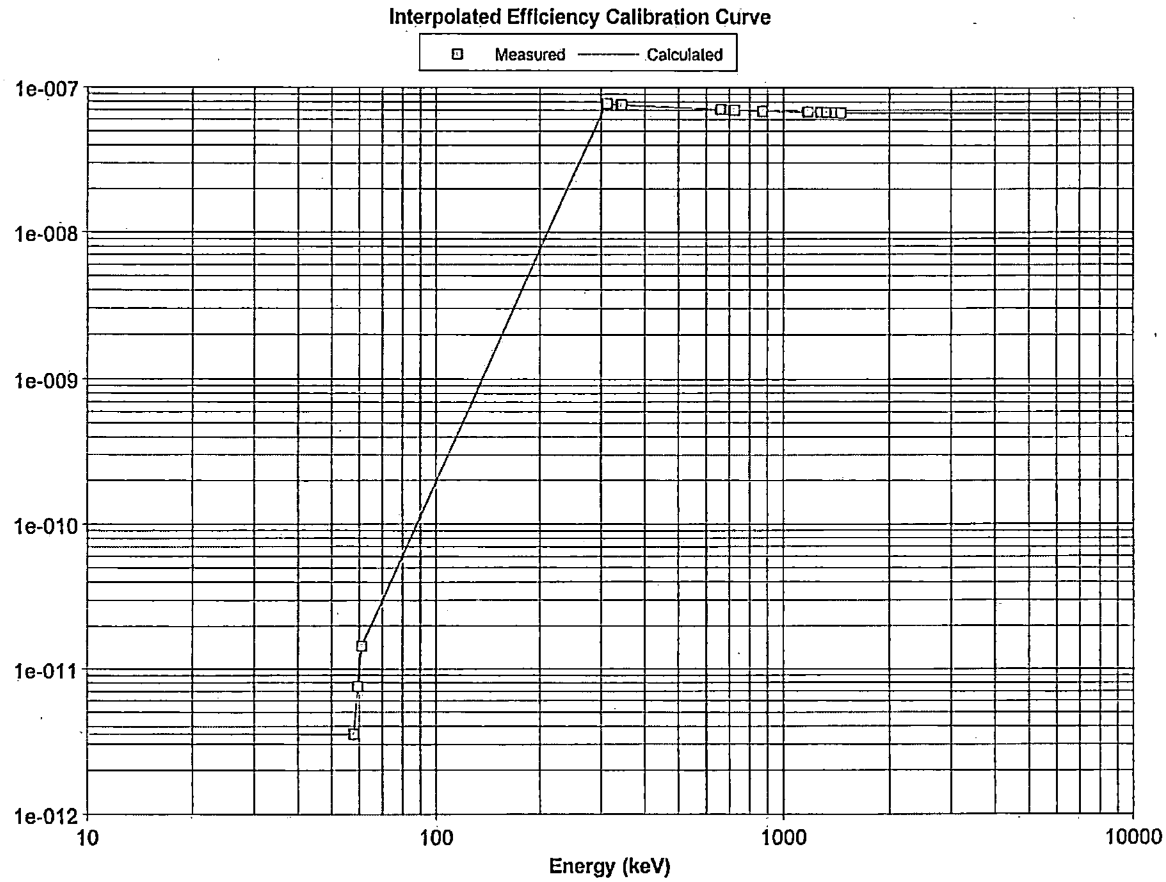
ISOCS/LabSOCS File:	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time:	11/18/14 02:23:20
Genie Cal File:	C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET4_16.CAL
Genie Cal Time:	11/18/14 02:56:41
Template:	SIMPLE BOX
Geom Description:	MHF Liner D4 16
Comment:	ISOCS:CAL_DATE_11_18_14
Detector:	3998
Collimator:	GARDIAN_G1
Convergence:	1.00 %
Area [Sq Meters]:	8.3097e+000 (C)
Mass [Grams]:	2.8705e+007 (C)
Length [Meters]:	not used

(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	3.51674e-012	10.0	-0.106567	81760
59.54	7.54136e-012	10.0	-0.099314	81760
61.00	1.44079e-011	10.0	-0.092374	81760
311.00	7.72792e-008	10.0	-0.005557	81760
311.98	7.72379e-008	10.0	-0.005596	81760
313.00	7.71930e-008	10.0	-0.005423	81760
343.00	7.58412e-008	8.0	-0.007321	81760
344.27	7.57938e-008	8.0	-0.007034	81760
345.00	7.57900e-008	8.0	-0.007220	81760
660.00	7.06843e-008	6.0	-0.014125	81760
661.65	7.06013e-008	6.0	-0.014153	81760
663.00	7.06135e-008	6.0	-0.013945	81760
701.00	7.01071e-008	6.0	-0.014423	81760
702.63	7.00797e-008	6.0	-0.014372	81760
703.00	7.00782e-008	6.0	-0.014428	81760
722.00	6.98590e-008	6.0	-0.014472	81760
723.00	6.98589e-008	6.0	-0.014555	81760
724.00	6.98474e-008	6.0	-0.014714	81760
870.00	6.86345e-008	6.0	-0.014608	81760
871.10	6.86220e-008	6.0	-0.014296	81760
872.00	6.86383e-008	6.0	-0.014513	81760
1172.00	6.79031e-008	4.0	-0.012609	81760
1173.22	6.79035e-008	4.0	-0.012484	81760
1174.00	6.78775e-008	4.0	-0.012206	81760
1273.00	6.76033e-008	4.0	-0.011848	81760
1274.45	6.75953e-008	4.0	-0.011803	81760
1275.00	6.75882e-008	4.0	-0.011577	81760
1331.00	6.73464e-008	4.0	-0.011334	81760
1332.49	6.73795e-008	4.0	-0.011289	81760
1334.00	6.73655e-008	4.0	-0.011341	81760
1406.00	6.70369e-008	4.0	-0.010037	81760
1407.95	6.70080e-008	4.0	-0.010066	81760
1409.00	6.69899e-008	4.0	-0.009990	81760
1460.80	6.67418e-008	4.0	-0.009666	81760



Datasource: DET02



Datasource: DET02

#	Weight	Primary Efficiency taken from ECC files, for set energies (keV): 58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3	345.0	660.0	661.7
1	1.000	6.34e-013	1.53e-012	3.25e-012	7.10e-008	7.10e-008	7.10e-008	7.09e-008	7.09e-008	7.09e-008	6.37e-008	6.36e-008
2	1.000	5.62e-013	1.37e-012	2.93e-012	7.06e-008	7.05e-008	7.06e-008	7.05e-008	7.05e-008	7.05e-008	6.34e-008	6.33e-008
3	1.000	8.48e-013	2.01e-012	4.17e-012	7.11e-008	7.11e-008	7.11e-008	7.10e-008	7.10e-008	7.10e-008	6.37e-008	6.36e-008
4	1.000	3.52e-012	7.54e-012	1.44e-011	7.73e-008	7.72e-008	7.72e-008	7.58e-008	7.58e-008	7.58e-008	7.07e-008	7.06e-008
	Sum	5.56e-012	1.25e-011	2.48e-011	2.90e-007	2.90e-007	2.90e-007	2.88e-007	2.88e-007	2.88e-007	2.62e-007	2.61e-007
	Error,%	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	8.00e+000	8.00e+000	8.00e+000	6.00e+000	6.00e+000

Information for input ECC files

#	File Name	File Stamp	Path
1	MHF_Liner_SOIL_DET1_16	Tue_Nov_18_02:02:51_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
2	MHF_Liner_SOIL_DET2_16	Tue_Nov_18_02:10:28_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
3	MHF_Liner_SOIL_DET3_16	Tue_Nov_18_02:16:52_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
4	MHF_Liner_SOIL_DET4_16	Tue_Nov_18_02:22:28_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

File Name   File Stamp   Path

Description: MHF_Liner_SOIL_SUM_16
Comment: Calib Date 11/18/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

663.0	701.0	702.6	703.0	722.0	723.0	724.0	870.0	871.1	872.0	1172.0	1173.2
6.36e-008	6.30e-008	6.30e-008	6.30e-008	6.27e-008	6.27e-008	6.27e-008	6.11e-008	6.11e-008	6.11e-008	5.97e-008	5.97e-008
6.34e-008	6.28e-008	6.27e-008	6.27e-008	6.25e-008	6.24e-008	6.24e-008	6.09e-008	6.09e-008	6.09e-008	5.95e-008	5.95e-008
6.36e-008	6.30e-008	6.30e-008	6.30e-008	6.27e-008	6.27e-008	6.27e-008	6.11e-008	6.11e-008	6.11e-008	5.97e-008	5.97e-008
7.06e-008	7.01e-008	7.01e-008	7.01e-008	6.99e-008	6.99e-008	6.98e-008	6.86e-008	6.86e-008	6.86e-008	6.79e-008	6.79e-008
2.61e-007	2.59e-007	2.59e-007	2.59e-007	2.58e-007	2.58e-007	2.58e-007	2.52e-007	2.52e-007	2.52e-007	2.47e-007	2.47e-007
6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_Liner_SOIL_SUM_16
Calib Date 11/18/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

1174.0	1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9	1409.0	1460.8
5.96e-008	5.94e-008	5.93e-008	5.93e-008	5.91e-008	5.91e-008	5.91e-008	5.84e-008	5.84e-008	5.84e-008	5.79e-008
5.95e-008	5.92e-008	5.92e-008	5.92e-008	5.89e-008	5.89e-008	5.89e-008	5.82e-008	5.82e-008	5.82e-008	5.77e-008
5.97e-008	5.94e-008	5.94e-008	5.94e-008	5.91e-008	5.91e-008	5.91e-008	5.84e-008	5.84e-008	5.84e-008	5.79e-008
6.79e-008	6.76e-008	6.76e-008	6.76e-008	6.73e-008	6.74e-008	6.74e-008	6.70e-008	6.70e-008	6.70e-008	6.67e-008
2.47e-007	2.46e-007	2.45e-007	2.45e-007	2.45e-007	2.45e-007	2.44e-007	2.42e-007	2.42e-007	2.42e-007	2.40e-007
4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_Liner_SOIL_SUM_16
Calib Date 11/18/14

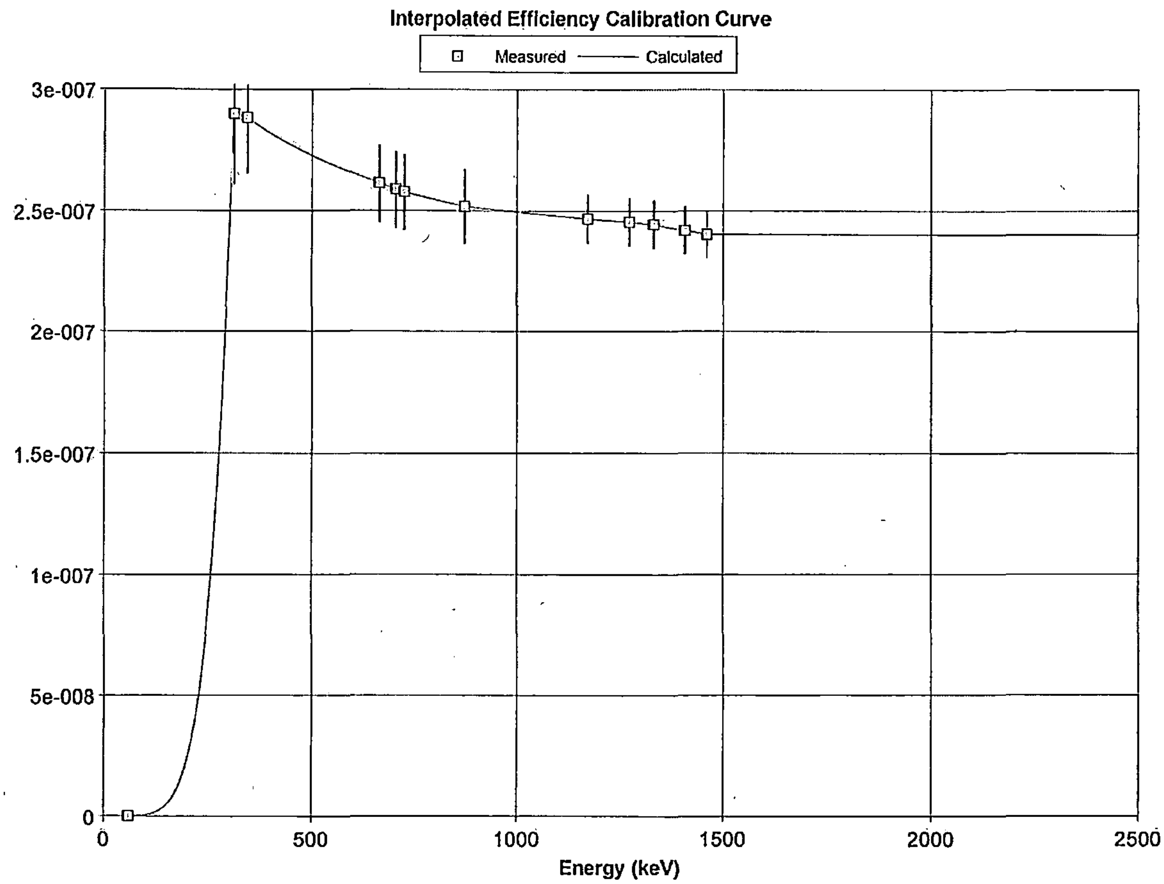
CANBERRA

Multi-Efficiency Report

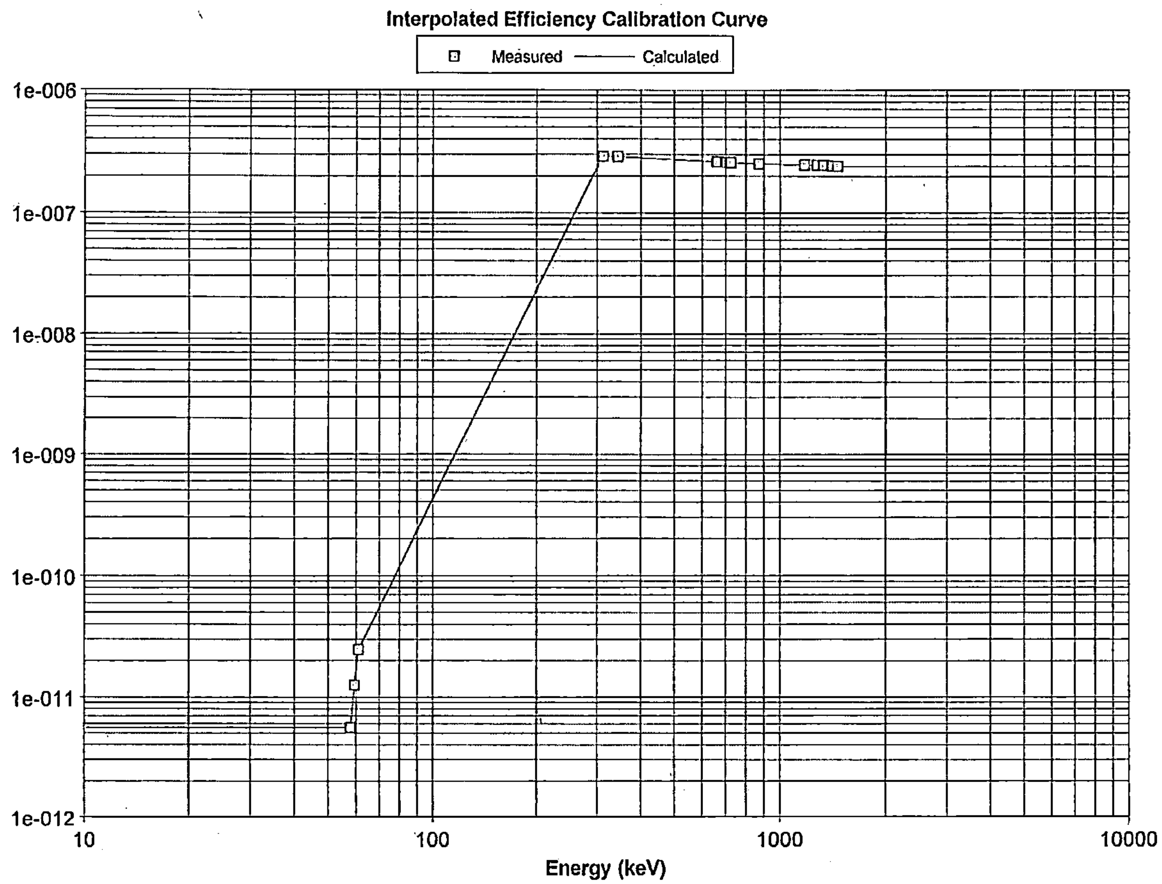
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\Multiefficiency\MHF_Li
ISOCS/LabSOCS Time: 11/18/14 02:30:26
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_SUM_D16.CAL
Genie Cal Time: 11/18/14 03:01:18
Template: (SIMPLE BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+
Geom Description: MHF Liner SUM 16
Comment: ISOCS:Calib Date 11/18/14
Detector: (3994)+(3996)+(3997)+(3998)+
Collimator: (GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+
Convergence: 1.00 %
Area [Sq Meters]: 1.0000e-004 (C)
Mass [Grams]: 1.0000e+000 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	5.56043e-012	10.0	0.0946370	64000
59.54	1.24553e-011	10.0	0.0946370	64000
61.00	2.47518e-011	10.0	0.0946370	64000
311.00	2.89945e-007	10.0	0.0946370	64000
311.98	2.89813e-007	10.0	0.0946370	64000
313.00	2.89849e-007	10.0	0.0946370	64000
343.00	2.88277e-007	8.0	0.0946370	64000
344.27	2.88120e-007	8.0	0.0946370	64000
345.00	2.88170e-007	8.0	0.0946370	64000
660.00	2.61535e-007	6.0	0.0946370	64000
661.65	2.61160e-007	6.0	0.0946370	64000
663.00	2.61189e-007	6.0	0.0946370	64000
701.00	2.58963e-007	6.0	0.0946370	64000
702.63	2.58718e-007	6.0	0.0946370	64000
703.00	2.58768e-007	6.0	0.0946370	64000
722.00	2.57758e-007	6.0	0.0946370	64000
723.00	2.57665e-007	6.0	0.0946370	64000
724.00	2.57650e-007	6.0	0.0946370	64000
870.00	2.51735e-007	6.0	0.0946370	64000
871.10	2.51631e-007	6.0	0.0946370	64000
872.00	2.51727e-007	6.0	0.0946370	64000
1172.00	2.46847e-007	4.0	0.0946370	64000
1173.22	2.46753e-007	4.0	0.0946370	64000
1174.00	2.46659e-007	4.0	0.0946370	64000
1273.00	2.45530e-007	4.0	0.0946370	64000
1274.45	2.45473e-007	4.0	0.0946370	64000
1275.00	2.45462e-007	4.0	0.0946370	64000
1331.00	2.44527e-007	4.0	0.0946370	64000
1332.49	2.44521e-007	4.0	0.0946370	64000
1334.00	2.44428e-007	4.0	0.0946370	64000
1406.00	2.42044e-007	4.0	0.0946370	64000
1407.95	2.42014e-007	4.0	0.0946370	64000
1409.00	2.42050e-007	4.0	0.0946370	64000
1460.80	2.40276e-007	4.0	0.0946370	64000



Datasource: DET02



Datasource: DET02

GARDIAN SYSTEM
Calibration Records
MHF IP-1 Intermodal with Liner

Density 1.2

Geometry Composer Report

CANBERRA

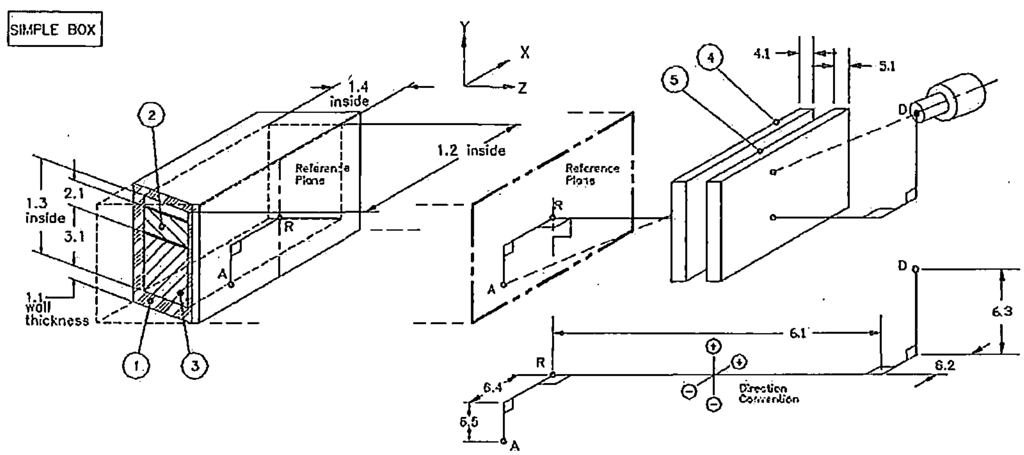
Date: Tuesday, November 18, 2014 - 15:42:13
Description: MHF_Liner_SOIL_DET1_12
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET1_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3994
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.02756						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

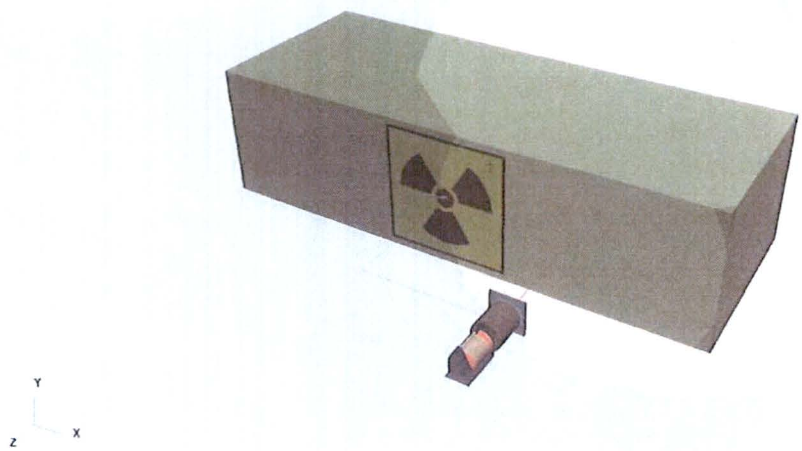
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

Date:	Tuesday, November 18, 2014 - 15:42:13
Description:	MHF_Liner_SOIL_DET1_12
Comment:	CAL DATE 11_18_14
File Name:	E:\SIMPLE_BOX\MHF_Liner_SOIL_DET1_12.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)

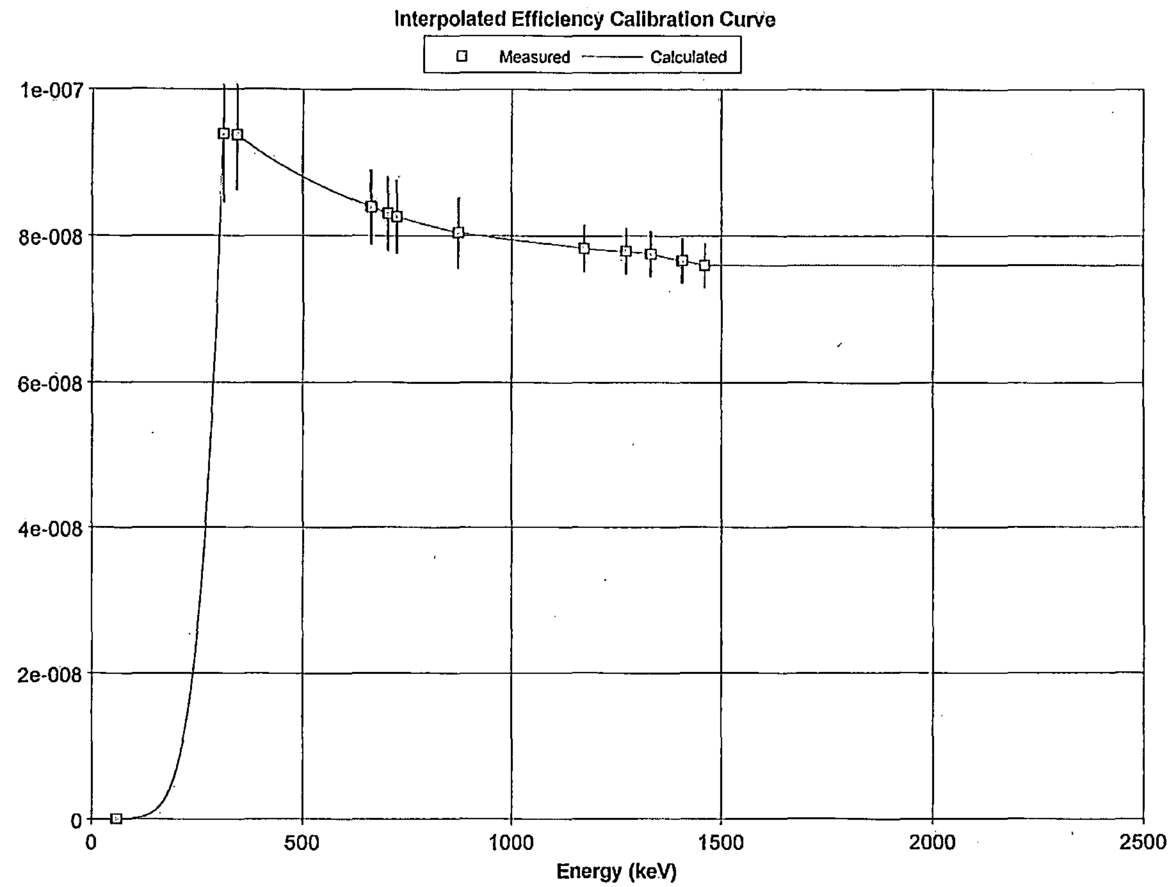


ISOCS/LABSOCS RESULTS

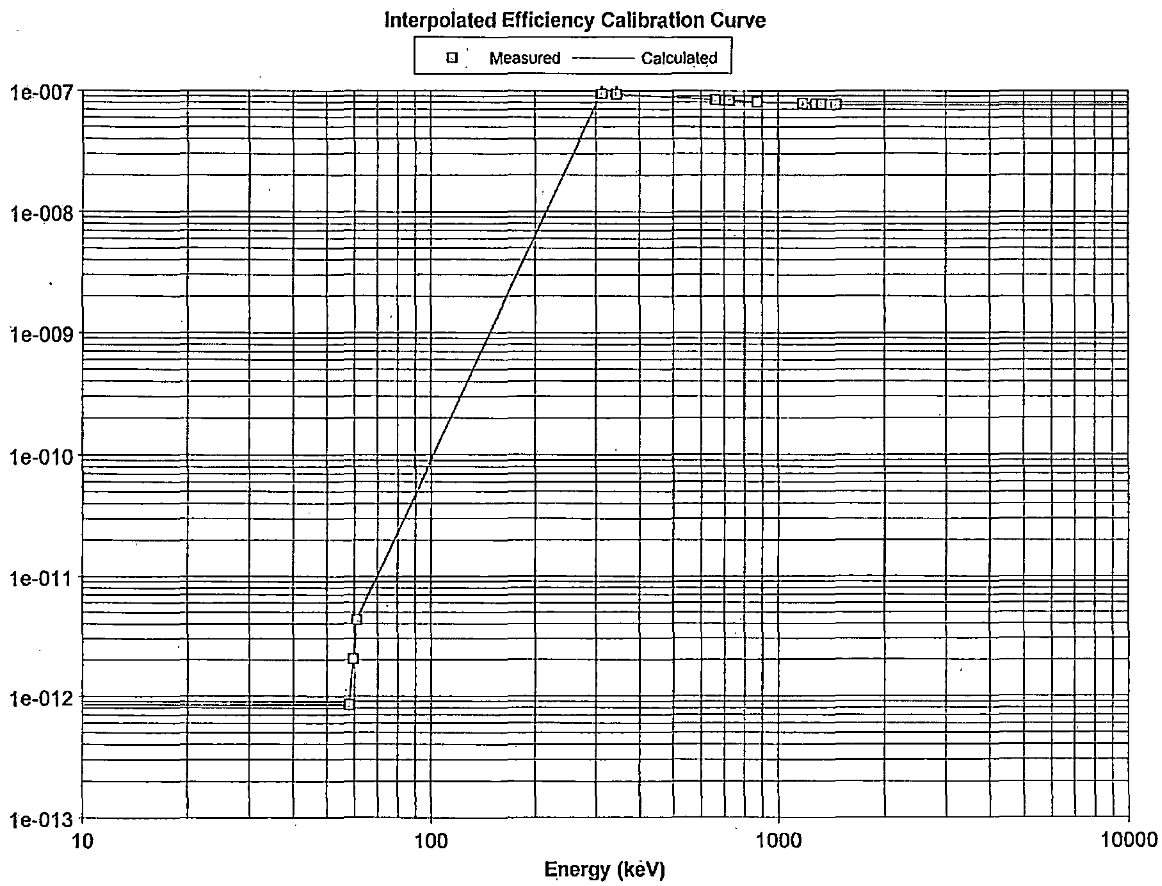
ISOCS/LabSOCS File:	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time:	11/18/14 01:57:22
Genie Cal File:	C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET1_12.CAL
Genie Cal Time:	11/18/14 02:37:02
Template:	SIMPLE BOX
Geom Description:	HMF Liner D1 12
Comment:	ISOCS:CAL_DATE_11_18_14
Detector:	3994
Collimator:	GARDIAN_G1
Convergence:	1.00 %
Area [Sq Meters]:	8.3097e+000 (C)
Mass [Grams]:	2.1529e+007 (C)
Length [Meters]:	not used

(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	8.44445e-013	10.0	0.088722	91980
59.54	2.04422e-012	10.0	0.083712	91980
61.00	4.32774e-012	10.0	0.079547	91980
311.00	9.39137e-008	10.0	-0.024447	91980
311.98	9.38764e-008	10.0	-0.024172	91980
313.00	9.39094e-008	10.0	-0.024589	91980
343.00	9.37828e-008	8.0	-0.029085	91980
344.27	9.37350e-008	8.0	-0.029093	91980
345.00	9.37546e-008	8.0	-0.029295	91980
660.00	8.39616e-008	6.0	-0.040080	91980
661.65	8.38325e-008	6.0	-0.040150	91980
663.00	8.38441e-008	6.0	-0.039926	91980
701.00	8.30464e-008	6.0	-0.039736	91980
702.63	8.29575e-008	6.0	-0.040105	91980
703.00	8.29767e-008	6.0	-0.040109	91980
722.00	8.26140e-008	6.0	-0.040137	91980
723.00	8.25719e-008	6.0	-0.040063	91980
724.00	8.25695e-008	6.0	-0.040080	91980
870.00	8.03971e-008	6.0	-0.039646	91980
871.10	8.03602e-008	6.0	-0.039647	91980
872.00	8.03881e-008	6.0	-0.039589	91980
1172.00	7.84016e-008	4.0	-0.038832	91980
1173.22	7.83568e-008	4.0	-0.038768	91980
1174.00	7.83257e-008	4.0	-0.038681	91980
1273.00	7.79048e-008	4.0	-0.038140	91980
1274.45	7.78840e-008	4.0	-0.038564	91980
1275.00	7.78828e-008	4.0	-0.038424	91980
1331.00	7.75552e-008	4.0	-0.038177	91980
1332.49	7.75367e-008	4.0	-0.038152	91980
1334.00	7.74952e-008	4.0	-0.038306	91980
1406.00	7.65622e-008	4.0	-0.037686	91980
1407.95	7.65557e-008	4.0	-0.037724	91980
1409.00	7.65790e-008	4.0	-0.037724	91980
1460.80	7.58944e-008	4.0	-0.037543	91980



Datasource: DET02



Datasource: DET02

Geometry Composer Report

CANBERRA

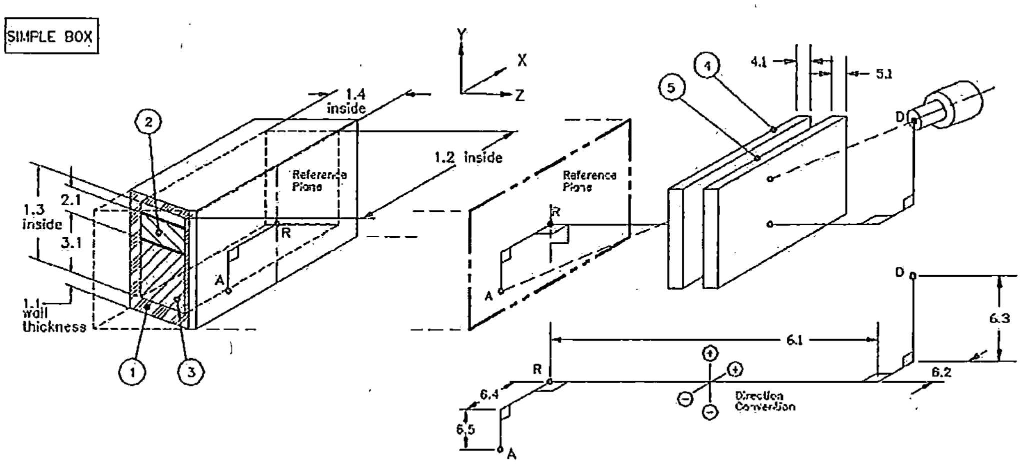
Date: Tuesday, November 18, 2014 - 15:43:35
Description: MHF_Liner_SOIL_DET2_12
Comment: Calib. Date 11/18/14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET2_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3996
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.2	1.00
4	Absorber1	0.126						mtwall	3.7	
5	Absorber2	0.0315						germanum	5.4	
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

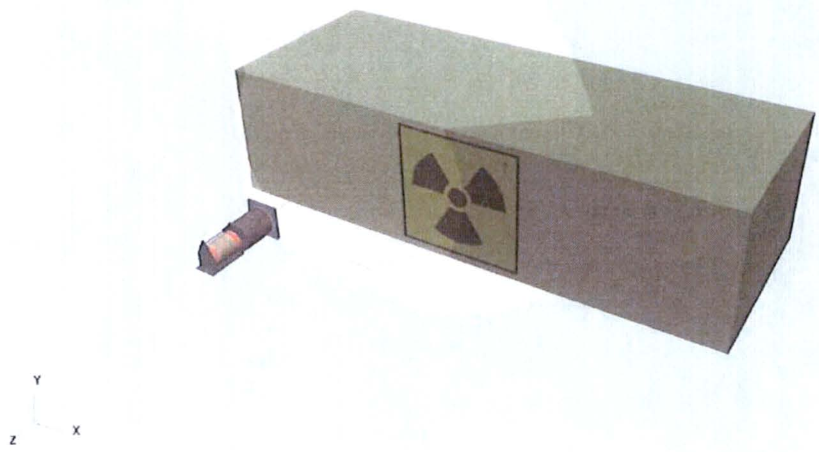
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

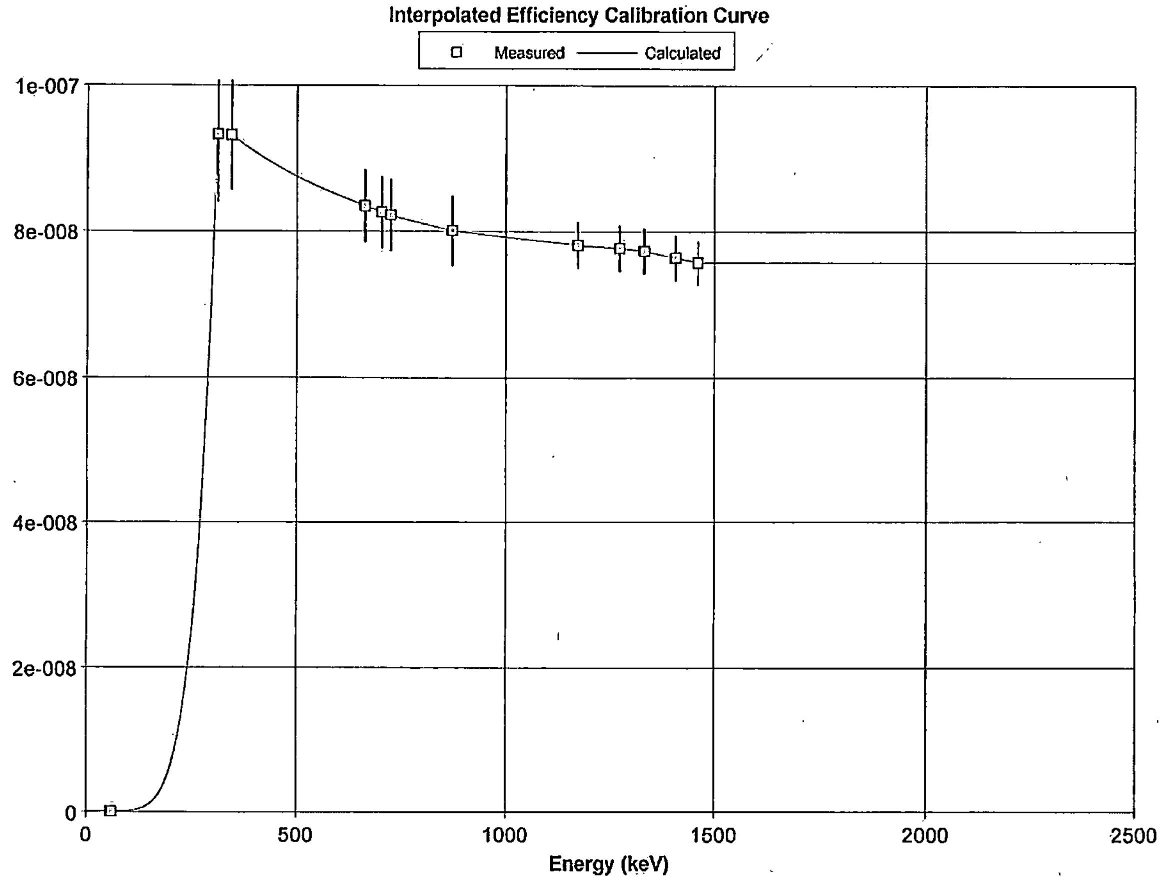
Date:	Tuesday, November 18, 2014 - 15:43:35
Description:	MHF_Liner_SOIL_DET2_12
Comment:	Calib. Date 11/18/14
File Name:	E:\SIMPLE_BOX\MHF_Liner_SOIL_DET2_12.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



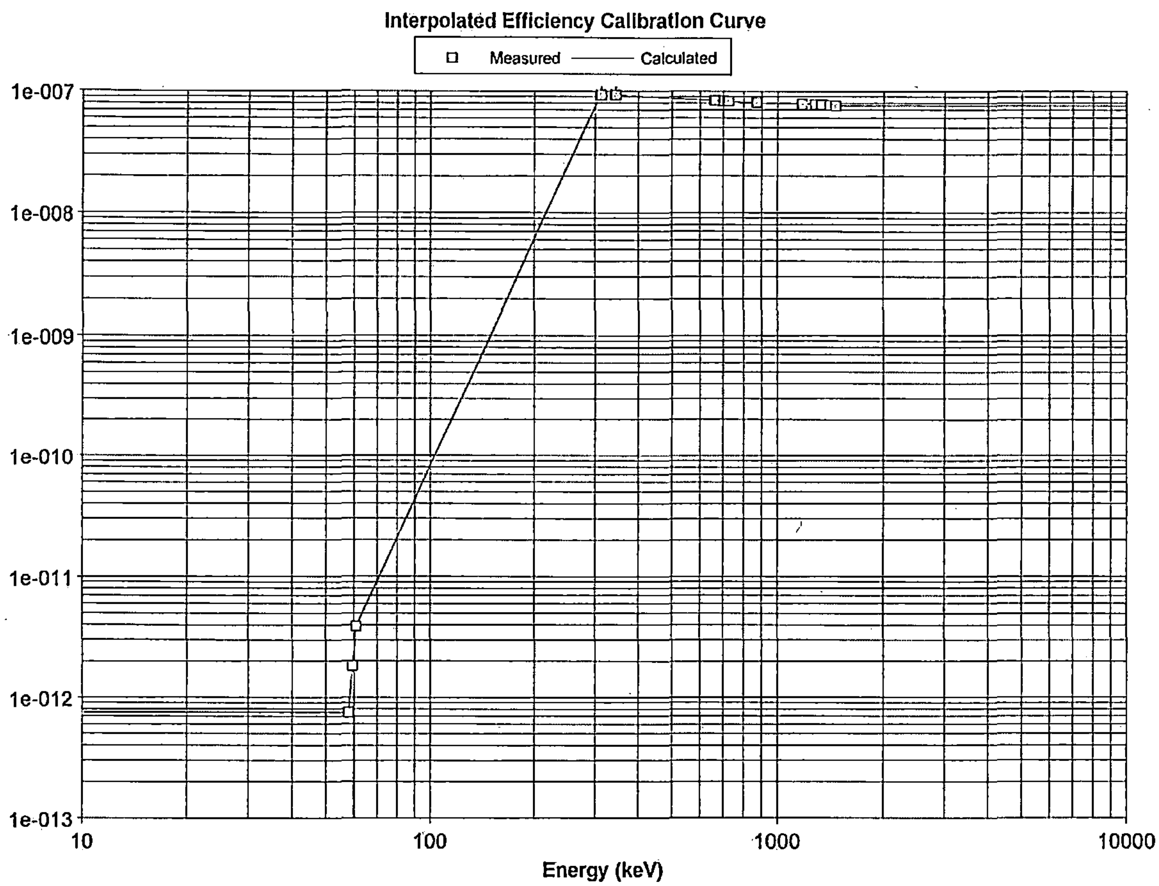
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:09:12
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET2_12.CAL
Genie Cal Time: 11/18/14 02:45:01
Template: SIMPLE BOX
Geom Description: MHF Liner D2 12
Comment: ISOCS:CALIB._DATE_11/18/14
Detector: 3996
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.1529e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	7.49281e-013	10.0	0.080712	91980
59.54	1.82865e-012	10.0	0.075307	91980
61.00	3.89860e-012	10.0	0.070819	91980
311.00	9.32928e-008	10.0	-0.015912	91980
311.98	9.32571e-008	10.0	-0.015573	91980
313.00	9.32912e-008	10.0	-0.016074	91980
343.00	9.32008e-008	8.0	-0.019763	91980
344.27	9.31546e-008	8.0	-0.019620	91980
345.00	9.31749e-008	8.0	-0.019843	91980
660.00	8.35990e-008	6.0	-0.024412	91980
661.65	8.34709e-008	6.0	-0.024446	91980
663.00	8.34829e-008	6.0	-0.024199	91980
701.00	8.26989e-008	6.0	-0.023559	91980
702.63	8.26107e-008	6.0	-0.023862	91980
703.00	8.26299e-008	6.0	-0.023859	91980
722.00	8.22735e-008	6.0	-0.023657	91980
723.00	8.22317e-008	6.0	-0.023631	91980
724.00	8.22297e-008	6.0	-0.023607	91980
870.00	8.00963e-008	6.0	-0.022100	91980
871.10	8.00597e-008	6.0	-0.022050	91980
872.00	8.00876e-008	6.0	-0.021960	91980
1172.00	7.81512e-008	4.0	-0.020953	91980
1173.22	7.81067e-008	4.0	-0.020829	91980
1174.00	7.80758e-008	4.0	-0.020713	91980
1273.00	7.76665e-008	4.0	-0.019922	91980
1274.45	7.76458e-008	4.0	-0.020353	91980
1275.00	7.76447e-008	4.0	-0.020202	91980
1331.00	7.73233e-008	4.0	-0.019823	91980
1332.49	7.73050e-008	4.0	-0.019768	91980
1334.00	7.72638e-008	4.0	-0.019926	91980
1406.00	7.63395e-008	4.0	-0.019253	91980
1407.95	7.63332e-008	4.0	-0.019349	91980
1409.00	7.63565e-008	4.0	-0.019317	91980
1460.80	7.56779e-008	4.0	-0.019099	91980



Datasource: DET02



Datasource: DET02

Geometry Composer Report

CANBERRA

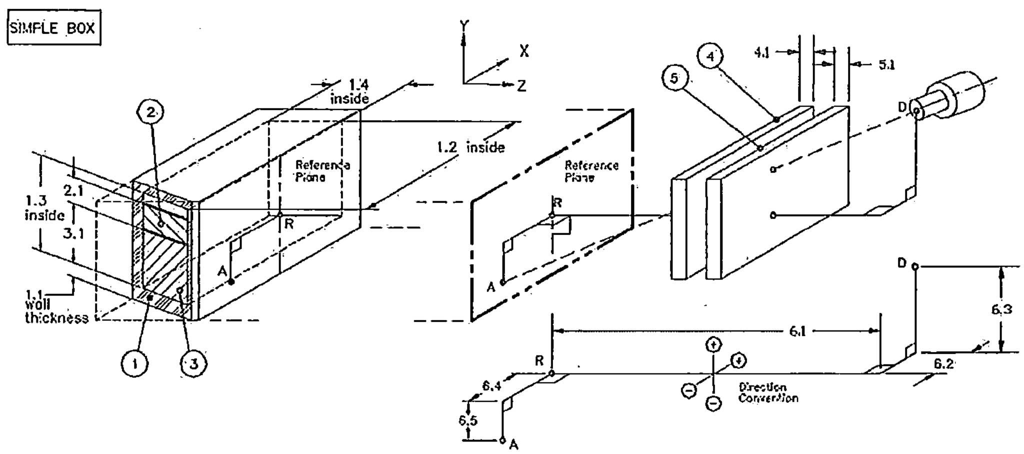
Date: Tuesday, November 18, 2014 - 15:44:35
Description: MHF_Liner_SOIL_DET3_12
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET3_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3997
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	56						dirt1	1.2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2	0.03543						germanum	5.4	
6	Source-Detector	55.5	57.5	0	57.5	0				

List of energies for efficiency curve generation

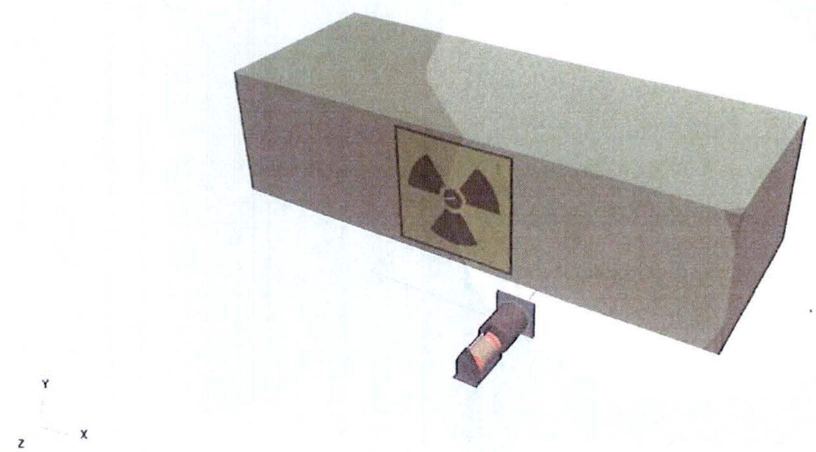
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

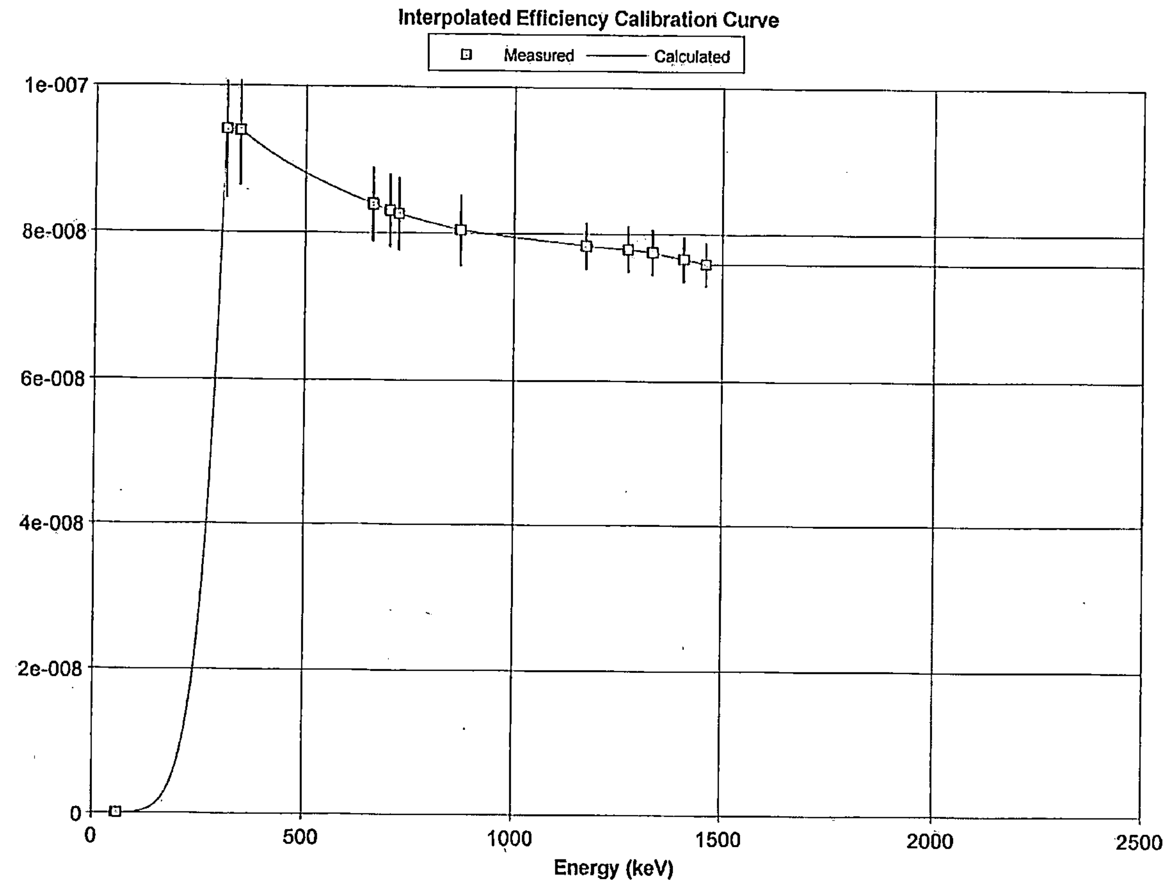
Date:	Tuesday, November 18, 2014 - 15:44:35
Description:	MHF_Liner_SOIL_DET3_12
Comment:	CAL DATE 11_18_14
File Name:	E:\SIMPLE_BOX\MHF_Liner_SOIL_DET3_12.geo
Software:	ISOCS
Template:	SIMPLE_BOX, Version: (default)



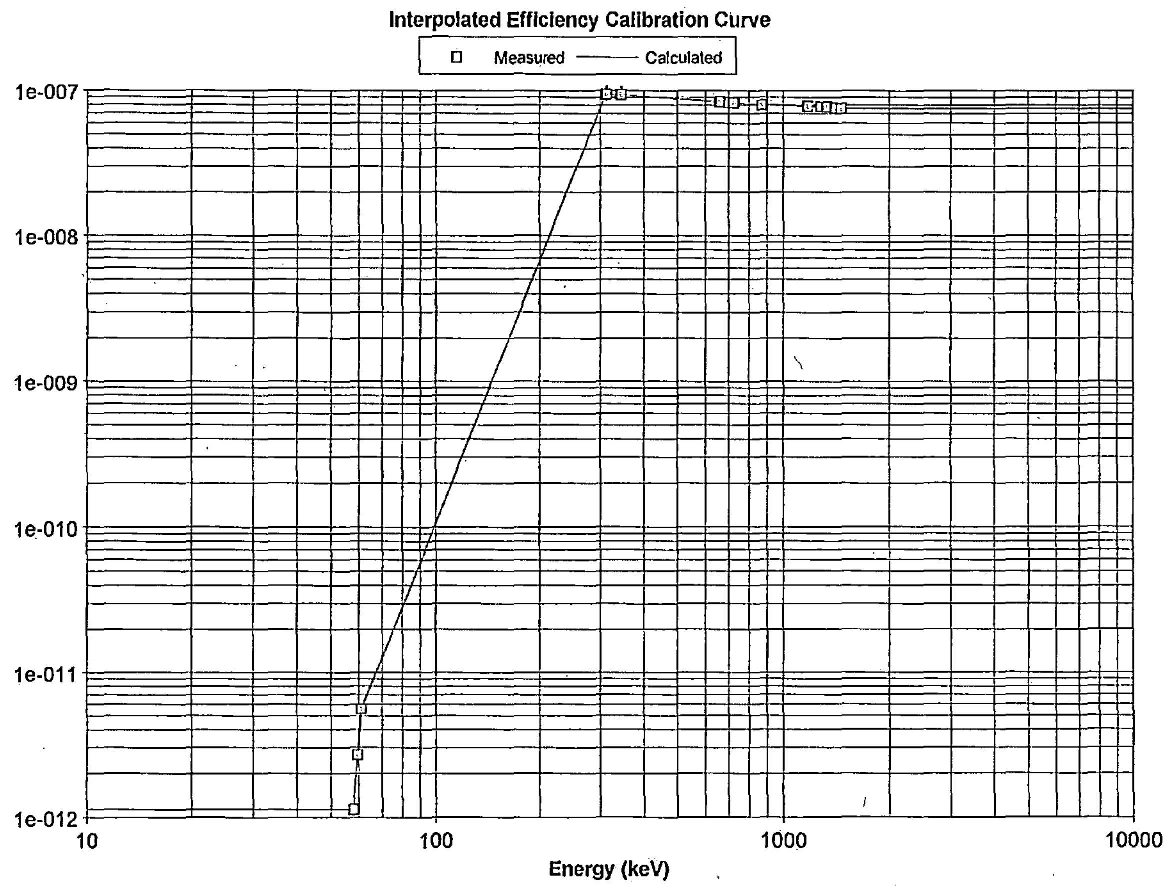
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:15:59
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET3_12.CAL
Genie Cal Time: 11/18/14 02:49:44
Template: SIMPLE BOX
Geom Description: MHF Liner D3 12
Comment: ISOCS:CAL_DATE_11_18_14
Detector: 3997
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.1529e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	1.13002e-012	10.0	0.088202	91980
59.54	2.67532e-012	10.0	0.083271	91980
61.00	5.55651e-012	10.0	0.079174	91980
311.00	9.40809e-008	10.0	-0.024436	91980
311.98	9.40422e-008	10.0	-0.024161	91980
313.00	9.40739e-008	10.0	-0.024578	91980
343.00	9.39137e-008	8.0	-0.029076	91980
344.27	9.38646e-008	8.0	-0.029084	91980
345.00	9.38836e-008	8.0	-0.029287	91980
660.00	8.39979e-008	6.0	-0.040078	91980
661.65	8.38686e-008	6.0	-0.040148	91980
663.00	8.38801e-008	6.0	-0.039924	91980
701.00	8.30800e-008	6.0	-0.039734	91980
702.63	8.29909e-008	6.0	-0.040103	91980
703.00	8.30101e-008	6.0	-0.040107	91980
722.00	8.26463e-008	6.0	-0.040135	91980
723.00	8.26041e-008	6.0	-0.040061	91980
724.00	8.26017e-008	6.0	-0.040078	91980
870.00	8.04233e-008	6.0	-0.039645	91980
871.10	8.03864e-008	6.0	-0.039646	91980
872.00	8.04142e-008	6.0	-0.039588	91980
1172.00	7.84227e-008	4.0	-0.038831	91980
1173.22	7.83779e-008	4.0	-0.038767	91980
1174.00	7.83468e-008	4.0	-0.038679	91980
1273.00	7.79261e-008	4.0	-0.038139	91980
1274.45	7.79052e-008	4.0	-0.038563	91980
1275.00	7.79041e-008	4.0	-0.038423	91980
1331.00	7.75769e-008	4.0	-0.038176	91980
1332.49	7.75585e-008	4.0	-0.038151	91980
1334.00	7.75170e-008	4.0	-0.038305	91980
1406.00	7.65849e-008	4.0	-0.037685	91980
1407.95	7.65783e-008	4.0	-0.037723	91980
1409.00	7.66017e-008	4.0	-0.037723	91980
1460.80	7.59180e-008	4.0	-0.037542	91980



Datasource: DET02



Datasource: DET02

Geometry Composer Report

CANBERRA

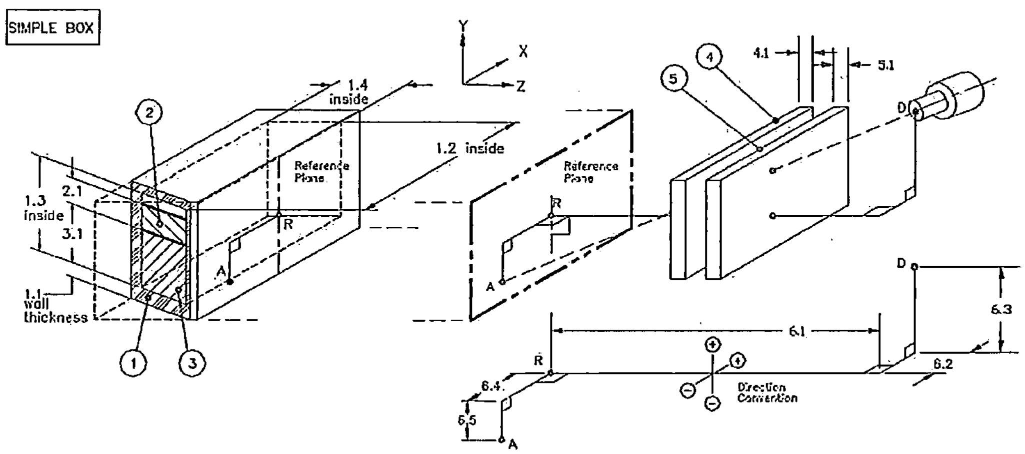
Date: Tuesday, November 18, 2014 - 15:45:33
Description: MHF_Liner_SOIL_DET4_12
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET4_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)
Detector: 3998
Collimator: GARDIAN G1 (GARDIAN 1 COLLIMATION MODEL)
Environment: Temperature = 65 °F, Pressure = 760 mm Hg, Relative Humidity = 70%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Box	0.35	230	61	85			csteel	7.9	
2	Source - Top Layer	0						none		
3	Source - Bottom Layer	56						dirt1	1.2	1.00
4	Absorber1	0.282						stwall	1.4	
5	Absorber2							none		
6	Source-Detector	55.5	-57.5	0	-57.5	0				

List of energies for efficiency curve generation

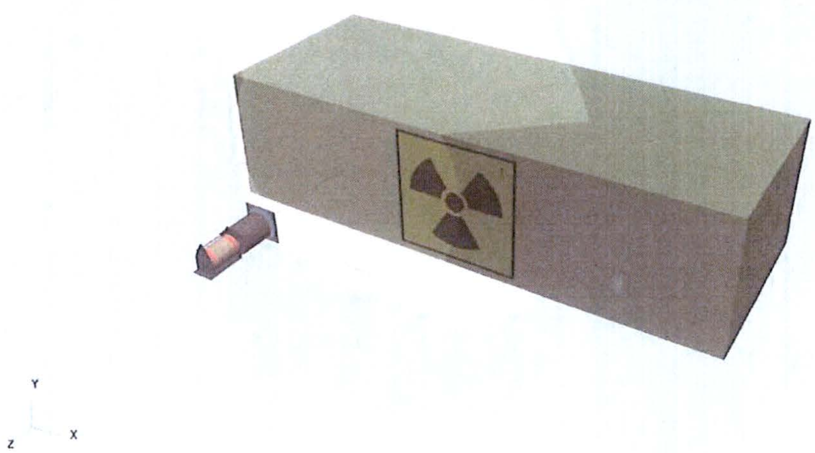
58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3
345.0	660.0	661.7	663.0	701.0	702.6	703.0	722.0
723.0	724.0	870.0	871.1	872.0	1172.0	1173.2	1174.0
1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9
1409.0	1460.8						



Geometry Composer Report

CANBERRA

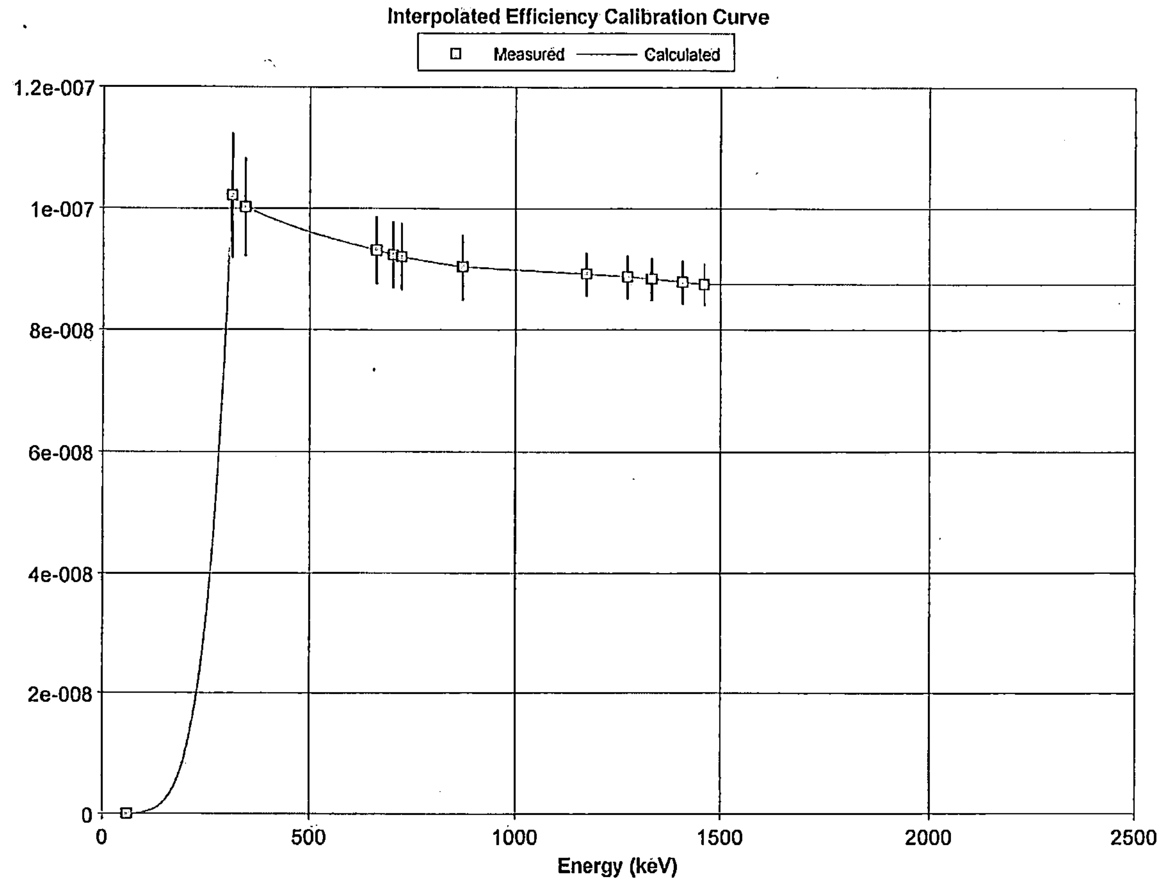
Date: Tuesday, November 18, 2014 - 15:45:33
Description: MHF_Liner_SOIL_DET4_12
Comment: CAL DATE 11_18_14
File Name: E:\SIMPLE_BOX\MHF_Liner_SOIL_DET4_12.geo
Software: ISOCS
Template: SIMPLE_BOX, Version: (default)



ISOCS/LABSOCS RESULTS

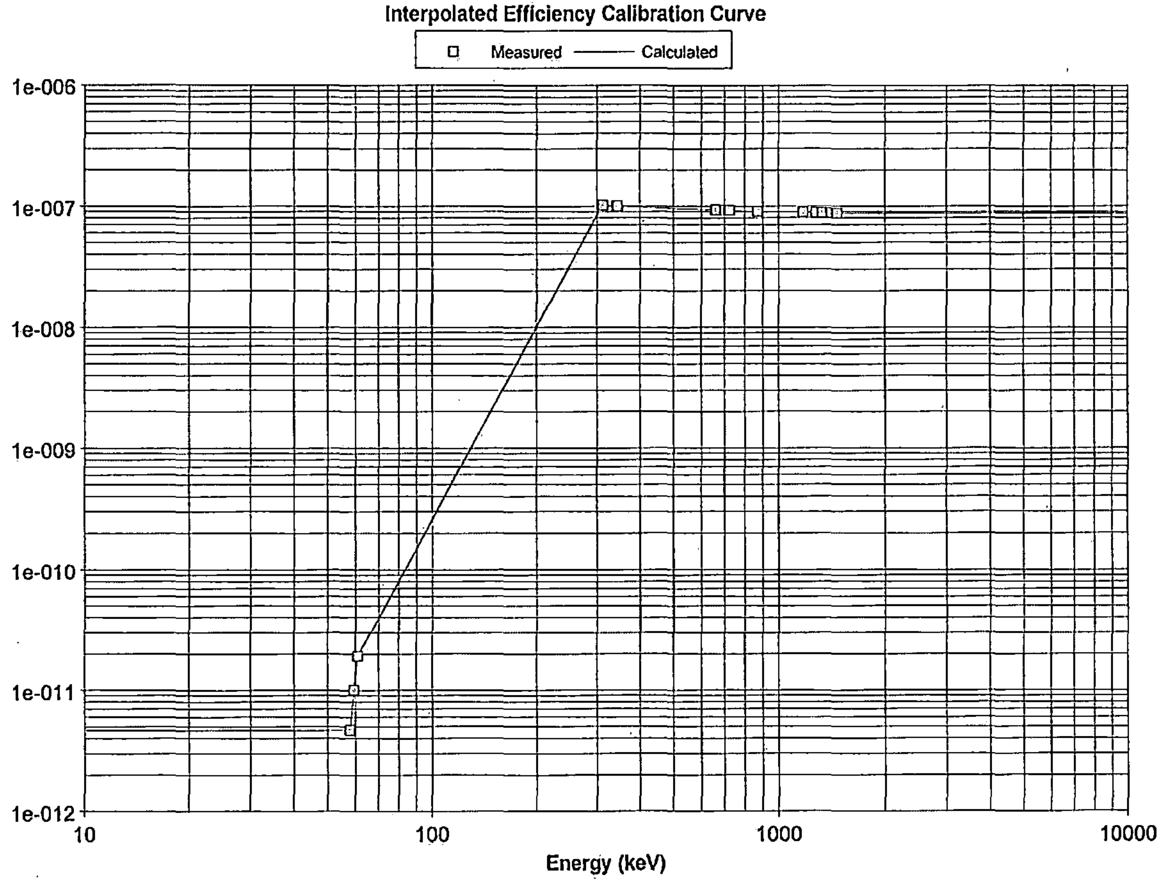
ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\MHF_Liner_S
ISOCS/LabSOCS Time: 11/18/14 02:21:37
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_DET4_12.CAL
Genie Cal Time: 11/18/14 02:55:46
Template: SIMPLE BOX
Geom Description: MHF Liner D4 12
Comment: ISOCS:CAL_DATE_11_18_14
Detector: 3998
Collimator: GARDIAN_G1
Convergence: 1.00 %
Area [Sq Meters]: 8.3097e+000 (C)
Mass [Grams]: 2.1529e+007 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	4.68234e-012	10.0	0.116420	91980
59.54	1.00389e-011	10.0	0.108744	91980
61.00	1.91777e-011	10.0	0.102527	91980
311.00	1.02179e-007	10.0	0.013974	91980
311.98	1.02130e-007	10.0	0.013989	91980
313.00	1.02066e-007	10.0	0.013959	91980
343.00	1.00251e-007	8.0	0.010098	91980
344.27	1.00189e-007	8.0	0.010372	91980
345.00	1.00176e-007	8.0	0.010201	91980
660.00	9.31600e-008	6.0	-0.005344	91980
661.65	9.30496e-008	6.0	-0.005414	91980
663.00	9.30631e-008	6.0	-0.005296	91980
701.00	9.23664e-008	6.0	-0.006252	91980
702.63	9.23336e-008	6.0	-0.006233	91980
703.00	9.23319e-008	6.0	-0.006247	91980
722.00	9.20284e-008	6.0	-0.006577	91980
723.00	9.20261e-008	6.0	-0.006624	91980
724.00	9.20116e-008	6.0	-0.006718	91980
870.00	9.03228e-008	6.0	-0.008769	91980
871.10	9.03049e-008	6.0	-0.008496	91980
872.00	9.03232e-008	6.0	-0.008707	91980
1172.00	8.91776e-008	4.0	-0.010700	91980
1173.22	8.91684e-008	4.0	-0.010604	91980
1174.00	8.91356e-008	4.0	-0.010369	91980
1273.00	8.87091e-008	4.0	-0.010596	91980
1274.45	8.86957e-008	4.0	-0.010662	91980
1275.00	8.86866e-008	4.0	-0.010661	91980
1331.00	8.83446e-008	4.0	-0.010712	91980
1332.49	8.83785e-008	4.0	-0.010676	91980
1334.00	8.83531e-008	4.0	-0.010758	91980
1406.00	8.78860e-008	4.0	-0.010295	91980
1407.95	8.78466e-008	4.0	-0.010282	91980
1409.00	8.78211e-008	4.0	-0.010200	91980
1460.80	8.74575e-008	4.0	-0.010322	91980



Datasource: DET02

Interpolated Efficiency Calibration Curve



Datasource: DET02

#	Weight	58.0	59.5	61.0	311.0	312.0	313.0	343.0	344.3	345.0	660.0	661.7
	Primary Efficiency taken from ECC files, for set energies (keV):											
1	1.000	8.44e-013	2.04e-012	4.33e-012	9.39e-008	9.39e-008	9.39e-008	9.38e-008	9.37e-008	9.38e-008	8.40e-008	8.38e-008
2	1.000	7.49e-013	1.83e-012	3.90e-012	9.33e-008	9.33e-008	9.33e-008	9.32e-008	9.32e-008	9.32e-008	8.36e-008	8.35e-008
3	1.000	1.13e-012	2.68e-012	5.56e-012	9.41e-008	9.40e-008	9.41e-008	9.39e-008	9.39e-008	9.39e-008	8.40e-008	8.39e-008
4	1.000	4.68e-012	1.00e-011	1.92e-011	1.02e-007	1.02e-007	1.02e-007	1.00e-007	1.00e-007	1.00e-007	9.32e-008	9.30e-008
	Sum	7.41e-012	1.66e-011	3.30e-011	3.83e-007	3.83e-007	3.83e-007	3.81e-007	3.81e-007	3.81e-007	3.45e-007	3.44e-007
	Error,%	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	1.00e+001	8.00e+000	8.00e+000	8.00e+000	6.00e+000	6.00e+000

Information for input ECC files

	File Name	File Stamp	Path
1	MHF_Liner_SOIL_DET1_12	Tue_Nov_18_01:56:23_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
2	MHF_Liner_SOIL_DET2_12	Tue_Nov_18_02:08:12_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
3	MHF_Liner_SOIL_DET3_12	Tue_Nov_18_02:15:00_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
4	MHF_Liner_SOIL_DET4_12	Tue_Nov_18_02:20:38_2014	C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

File Name	File Stamp	Path

Description: MHF_Liner_SOIL_SUM_12
Comment: Calib Date 11/18/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

663.0	701.0	702.6	703.0	722.0	723.0	724.0	870.0	871.1	872.0	1172.0	1173.2
8.38e-008	8.30e-008	8.30e-008	8.30e-008	8.26e-008	8.26e-008	8.26e-008	8.04e-008	8.04e-008	8.04e-008	7.84e-008	7.84e-008
8.35e-008	8.27e-008	8.26e-008	8.26e-008	8.23e-008	8.22e-008	8.22e-008	8.01e-008	8.01e-008	8.01e-008	7.82e-008	7.81e-008
8.39e-008	8.31e-008	8.30e-008	8.30e-008	8.26e-008	8.26e-008	8.26e-008	8.04e-008	8.04e-008	8.04e-008	7.84e-008	7.84e-008
9.31e-008	9.24e-008	9.23e-008	9.23e-008	9.20e-008	9.20e-008	9.20e-008	9.03e-008	9.03e-008	9.03e-008	8.92e-008	8.92e-008
3.44e-007	3.41e-007	3.41e-007	3.41e-007	3.40e-007	3.39e-007	3.39e-007	3.31e-007	3.31e-007	3.31e-007	3.24e-007	3.24e-007
6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	6.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_Liner_SOIL_SUM_12
Calib Date 11/18/14

CANBERRA

Multi-Efficiency Report

Primary Efficiency taken from ECC files, for set energies (keV):

1174.0	1273.0	1274.4	1275.0	1331.0	1332.5	1334.0	1406.0	1407.9	1409.0	1460.8
7.83e-008	7.79e-008	7.79e-008	7.79e-008	7.76e-008	7.75e-008	7.75e-008	7.66e-008	7.66e-008	7.66e-008	7.59e-008
7.81e-008	7.77e-008	7.76e-008	7.76e-008	7.73e-008	7.73e-008	7.73e-008	7.63e-008	7.63e-008	7.64e-008	7.57e-008
7.83e-008	7.79e-008	7.79e-008	7.79e-008	7.76e-008	7.76e-008	7.75e-008	7.66e-008	7.66e-008	7.66e-008	7.59e-008
8.91e-008	8.87e-008	8.87e-008	8.87e-008	8.83e-008	8.84e-008	8.84e-008	8.79e-008	8.78e-008	8.78e-008	8.75e-008
3.24e-007	3.22e-007	3.22e-007	3.22e-007	3.21e-007	3.21e-007	3.21e-007	3.17e-007	3.17e-007	3.17e-007	3.15e-007
4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000	4.00e+000

Information for input ECC files

C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\
C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\SIMPLE_BOX\

Information for saved file with multiefficiency data:

MHF_Liner_SOIL_SUM_12
Calib Date 11/18/14

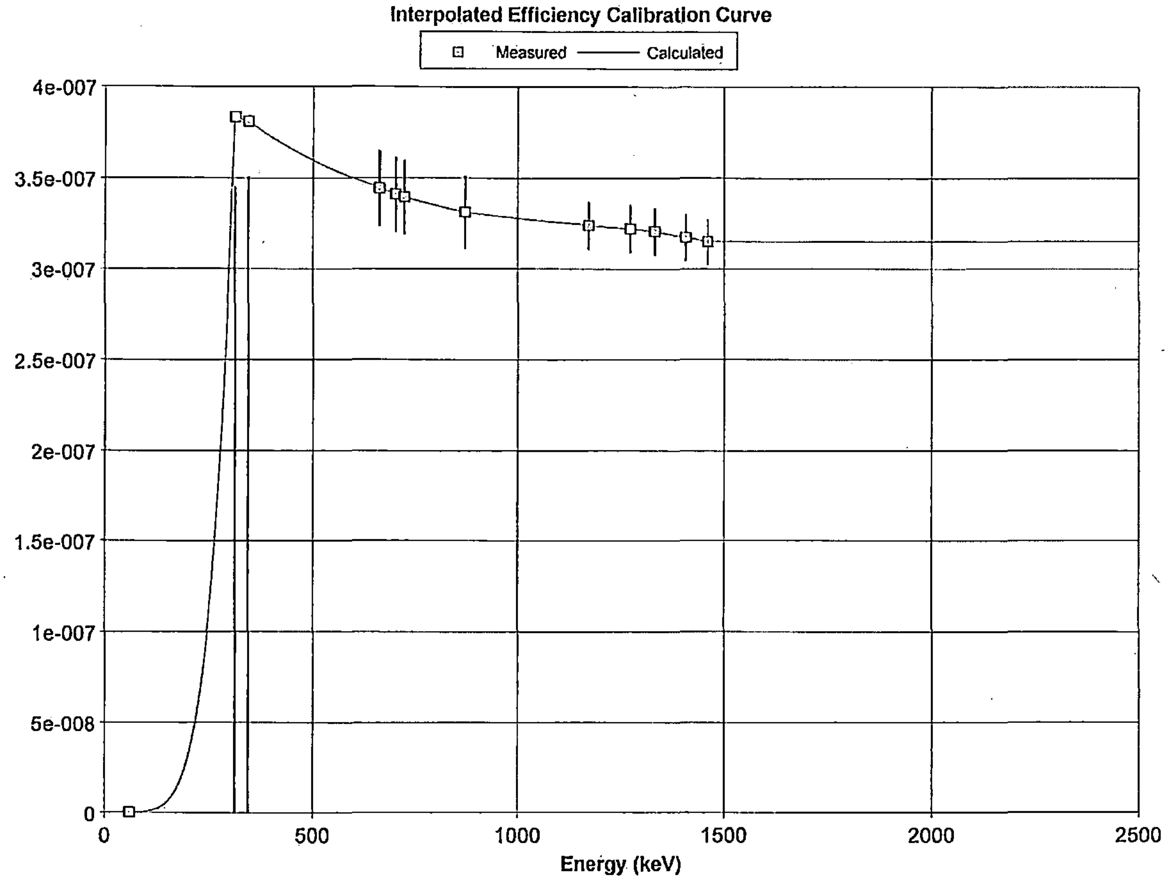
CANBERRA

Multi-Efficiency Report

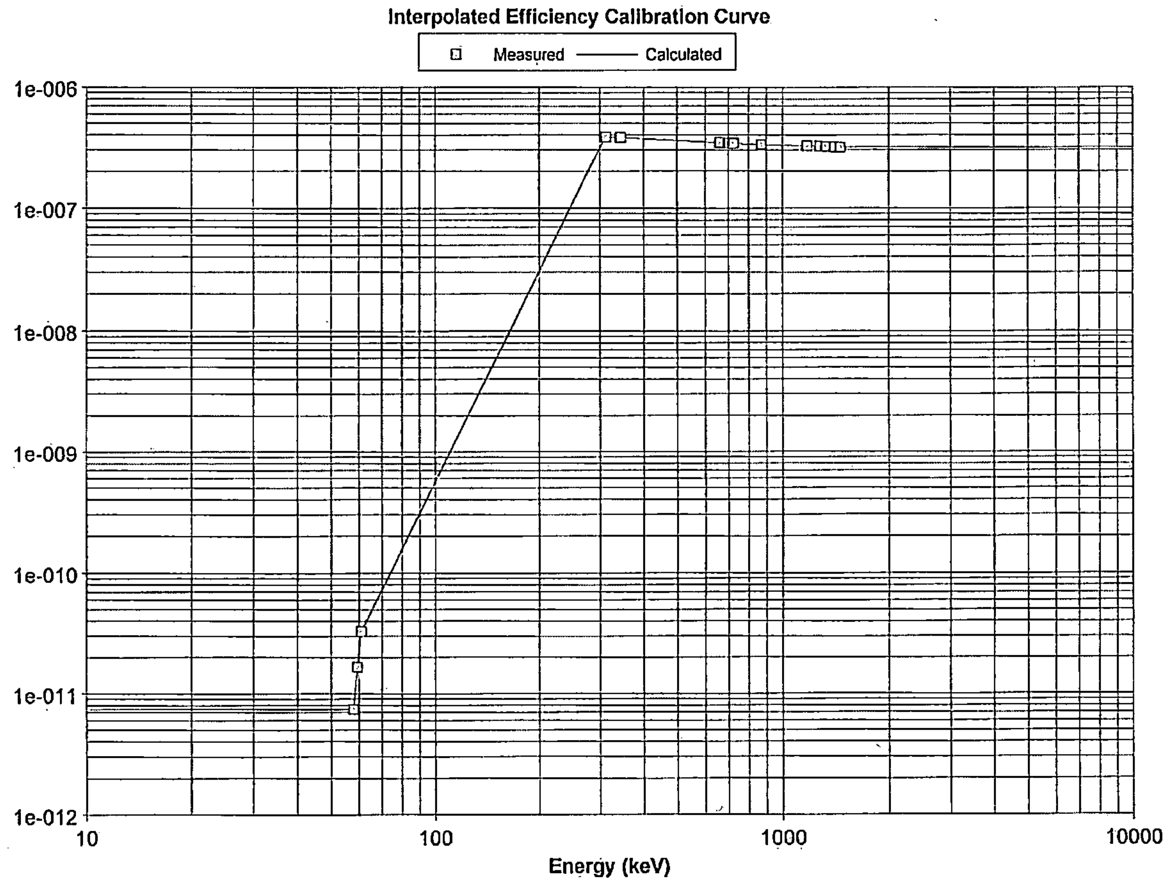
ISOCS/LABSOCS RESULTS

ISOCS/LabSOCS File: C:\GENIE2K\isocs\data\GEOMETRY\In-Situ\Multiefficiency\MHF_Li
ISOCS/LabSOCS Time: 11/18/14 02:28:30
Genie Cal File: C:\GENIE2K\CALFILES\HMF_Liner_Soil_SUM_D12.CAL
Genie Cal Time: 11/18/14 03:00:09
Template: (SIMPLE BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+(SIMPLE_BOX)+
Geom Description: MHF Liner SUM 12
Comment: ISOCS:Calib Date 11/18/14
Detector: (3994)+(3996)+(3997)+(3998)+
Collimator: (GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+(GARDIAN_G1)+
Convergence: 1.00 %
Area [Sq Meters]: 1.0000e-004 (C)
Mass [Grams]: 1.0000e+000 (C)
Length [Meters]: not used
(C) = Value calculated by ISOCS
(U) = Value modified by user

Energy	Efficiency	%Uncertainty	%Convergence	Final # of Voxels
58.00	7.40609e-012	10.0	0.1164200	64000
59.54	1.65871e-011	10.0	0.1164200	64000
61.00	3.29606e-011	10.0	0.1164200	64000
311.00	3.83466e-007	10.0	0.1164200	64000
311.98	3.83306e-007	10.0	0.1164200	64000
313.00	3.83341e-007	10.0	0.1164200	64000
343.00	3.81148e-007	8.0	0.1164200	64000
344.27	3.80943e-007	8.0	0.1164200	64000
345.00	3.80989e-007	8.0	0.1164200	64000
660.00	3.44718e-007	6.0	0.1164200	64000
661.65	3.44222e-007	6.0	0.1164200	64000
663.00	3.44270e-007	6.0	0.1164200	64000
701.00	3.41192e-007	6.0	0.1164200	64000
702.63	3.40893e-007	6.0	0.1164200	64000
703.00	3.40949e-007	6.0	0.1164200	64000
722.00	3.39562e-007	6.0	0.1164200	64000
723.00	3.39434e-007	6.0	0.1164200	64000
724.00	3.39413e-007	6.0	0.1164200	64000
870.00	3.31239e-007	6.0	0.1164200	64000
871.10	3.31111e-007	6.0	0.1164200	64000
872.00	3.31213e-007	6.0	0.1164200	64000
1172.00	3.24153e-007	4.0	0.1164200	64000
1173.22	3.24010e-007	4.0	0.1164200	64000
1174.00	3.23884e-007	4.0	0.1164200	64000
1273.00	3.22206e-007	4.0	0.1164200	64000
1274.45	3.22131e-007	4.0	0.1164200	64000
1275.00	3.22118e-007	4.0	0.1164200	64000
1331.00	3.20800e-007	4.0	0.1164200	64000
1332.49	3.20779e-007	4.0	0.1164200	64000
1334.00	3.20629e-007	4.0	0.1164200	64000
1406.00	3.17373e-007	4.0	0.1164200	64000
1407.95	3.17314e-007	4.0	0.1164200	64000
1409.00	3.17358e-007	4.0	0.1164200	64000
1460.80	3.14948e-007	4.0	0.1164200	64000



Datasource: DET02



Datasource: DET02

Attachment 10.5
Pre-Operational Validation and Verification Testing of GARDIAN-1 System HPGE Detectors for use at Humboldt Bay Power Plant, Revision 0

ENERGYSOLUTIONS

PRE-OPERATIONAL VALIDATION AND VERIFICATION TESTING OF GARDIAN-1 SYSTEM HPGE DETECTORS FOR USE AT HUMBOLDT BAY POWER PLANT

Revision 0

Prepared By:	Jeff Dickinson, Energy*Solutions*, LP&D GARDIAN System SME, CHP	10/23/14 Date
Reviewed By:	Glenn Centola, Energy*Solutions*, PP&T GARDIAN Operations Manager	10/23/14 Date
Reviewed By:	Dee Anderson, Bartlett Services, Inc. Counting Room Supervisor	11-4-14 Date
Approved By:	FOR BILL BARLEY Bill Barley, PG&E FSS Manager	11/4/14 Date
Approved By:	Dave Gilson, CB&I Waste Manager	11/4/14 Date

1.0 Introduction

Energy*Solutions*' GARDIAN-I mobile waste assay system includes four (4) Canberra ISOCS (*In-Situ Object Counting System*) characterized detectors. ISOCS technology allows large containers/volumes of waste to be accurately modeled for proper efficiency correction of measurement results. An important component of the ISOCS based calibration is the characterization file used with each container/geometry model. The model and applicable detector characterization file allow the detector's efficiency response to be determined for each container/geometry. Validation & Verification (V&V) of each detector's characterization file as part of pre-operational testing of the system is therefore an important part of the system's quality control.

To V&V each of GARDIAN-I's HPGe (high purity germanium) detectors and ensure the system is ready for use at the Humboldt Bay Power Plant (HBPP), testing was performed of each detector using a NIST traceable multi-energy source. The source modeled for testing using ISOCS calibration software included the radionuclide Eu-152, which has several key gamma energy lines across the energy spectrum of interest at HBPP (i.e., 100 to 2000 keV). Each detector MCA was configured with a 4 channel per keV conversion gain using channels 400 to 8,000 to span the energy range.

After verification of each detectors ISOCS characterization file (including evaluation of current dead layer thickness which can grow for p-type HPGe detectors like those used with GARDIAN-I), base line measurements were collected with each detector and its associated check source (i.e., a source originally containing 1 µCi each of Eu-155 and Na-22). The low and high energy range of the source (i.e., 86.5 keV and 1274.5 keV) were specifically measured to establish a reference point for future response testing to confirm detector responses remain consistent throughout system operation.

The following sections describe the testing configuration and present V&V test results. The attachments at the end of the report provide detailed information on the ISOCS models, assay reports and spreadsheet evaluations of results.

2.0 V&V Test Configuration

2.1 Test Source

A NIST traceable source containing Eu-152 was used to perform the V&V tests of the GARDIAN-I HPGe detectors. The source (Energy*Solutions* ID number 099803) is a point source sealed in a thin layer of epoxy forming a 3/8" diameter spot in the bottom of a 1" diameter plastic vial. Seven key energies from Eu-152 were specifically evaluated including 122, 244, 344, 779, 964, 1112, and 1408 keV. These energies provide a good representation of the GARDIAN-I system energy range (100 to 2000 keV) as well as the range of energies expected to be encountered in HBPP waste/materials.

The original source activity of the source included 33.54 μCi ±5% of Eu-152 (9/21/1998 certificate date), but had decayed to 14.62 μCi at the time of V&V testing. The higher activity level of the source (relative to typical check sources) provided better counting precision at a distance that avoided coincidence summing issues and minimized potential error with precise source positioning. A copy of the source certificate for source #099803 is included as Attachment 6.1.

2.2 Measurement Configuration

To minimize coincidence summing loses and positioning errors, the outside of the source vial was positioned 24 inches from the detector end cap during testing (i.e., 24.5" from the center of the 1' diameter vial). The source (in the bottom of the vial) was positioned in line with the center of the detector as shown by Figure 2-1 below.

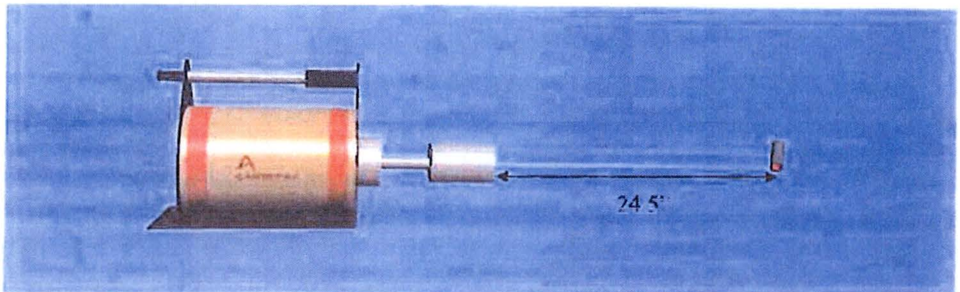


Figure 2-1: Measurement Configuration (detector aligned with point source in bottom of vial)

The vial (liquid scintillation vial) included a 0.033" wall of light density polyethylene. The Model S573 ISOCS Calibration Software Technical Reference Manual was used to ensure proper setup of the geometry composer reports for each detector. Copies of the geometry composer reports for each of the four detectors are included in Attachment 6.2.

3.0 V&V Measurement Results

Table 3-1 below presents the individual detector results obtained for each of the key Eu-152 energies and the result for the four-detector system as a whole. Although individual detector results are obtained when operating the GARDIAN-I system (to provide an indication of the activity distribution in containers/materials assayed), the primary result is the summed detector response, which effectively is the average activity concentration throughout the container.

The weighted mean activity of Eu-152 measured by each of the system detectors, which provides the best quantification of Eu-152 present in the vial, was also evaluated. Table 3-2 below provides the weighted mean activity for each of the detectors and the system's summed (i.e., average) response.

Table 3-1: V&V Test Results for GARDIAN-I HPGE Detectors

Energy (keV)	Det #1 3994 (µCi)	Det #2 3996 (µCi)	Det #3 3997 (µCi)	Det #4 3998 (µCi)	Det SUM (µCi)	Current Activity (µCi)	% Difference
121.8	15.33	15.44	14.91	15.34	15.26	14.62	+4.4%
244.7	14.45	14.23	14.22	15.26	14.54	14.62	-0.1%
344.3	13.69	13.57	13.85	15.70	14.20	14.62	-2.9%
778.9	14.18	13.23	13.53	15.98	14.23	14.62	-2.7%
964.0	14.26	13.93	13.42	14.80	14.10	14.62	-3.6%
1112.0	14.40	13.23	14.08	15.17	14.22	14.62	-2.7%
1408.0	13.24	13.35	13.90	14.66	13.79	14.62	-5.7%

Table 3-2: Eu-152 Activity Reported by GARDIAN-I HPGe Detectors

Detector	Eu-152 Reported Activity (µCi)	Eu-152 Source Activity (µCi)	% Difference
#1 – 3994	14.15	14.62	-3.2%
#2 – 3996	13.86	14.62	-5.2%
#3 – 3997	14.01	14.62	-4.2%
#4 – 3998	15.34	14.62	+4.9%
SUM (Average)	14.34	14.62	-1.9%

4.0 Base Line Measurement Results

Upon completion of V&V testing, a base line for the current performance of each of the system detectors was established using the detector's specific response test source to provide a reference value for future detector evaluations. The standard source provided by Canberra for ISOCS detectors was used for this evaluation by attaching the source to the top end of the detector as shown in Figure 4-1 below. The 1" button source at the end of the source jig is positioned 3.5" from the detector end cap when positioned with the tab against the end cap as shown in the figure below.

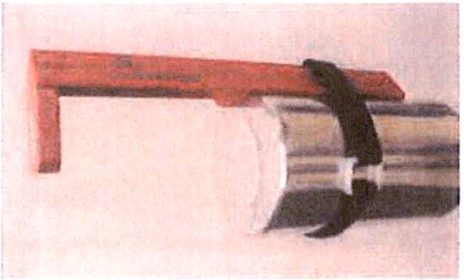


Figure 4-1: Position of Check Source and Detector for Base Line Measurements

Three measurements were collected for each detector and its associated check source and the average result for both the 86.5 keV peak (from Eu-155) and the 1274.5 keV peak (from Na-22) is shown in Table 4-1 below.

Table 4-1: Base Line Measurements for GARDIAN-I HPGe Detectors

Detector	Source Control Number	86.5 keV Line Activity (cps)	1274.5 keV Line Activity (cps)	Test Date
#1 – 3994	080701 (HBS598)	30.94	6.27	10/13/14
#2 – 3996	080702 (HBS599)	28.44	5.81	10/13/14
#3 – 3997	080703 (HBS600)	27.17	6.09	10/13/14
#4 – 3998	010702 (HBS601)	36.00	7.17	10/10/14

Quality Control charts have been setup for each detector to monitor the response at both the high and low energy peaks. QC parameters to be monitored include peak centroid for both peaks (to provide validation of the detector energy calibration) and peak activities for both peaks (to provide validation of the detector efficiency calibration).

5.0 Summary/Conclusion

V&V testing has been completed for all four HPGe detectors associated with the GARDIAN-I assay system. Activities at several gamma energies in the range expected at HBPP have shown proper response using each detector's associated ISOCS characterization file. All gamma energies tested were within 10% of the certified source activity for all four detectors and the summed detector response (i.e., indication of the overall system result) was within 6% of source certified activity for each energy and within 2% of the weighted mean activity for Eu-152.

Base line measurements have been collected for the system's detectors to allow future evaluations of detector responses. Quality Control charts have been setup to allow future response testing and comparison to acceptance criteria. The system's HPGe detectors are ready for operation.

6.0 Attachments

6.1 V&V Source Certificate
6.2 ISOCS Geometry Composer Reports
6.3 V&V Measurement Assay Reports
6.4 Detector V&V Measurement Results
6.5 Detector Base Line Measurement Results

ATTACHMENT 6.1

V&V Source Certificate

(2 pages including this cover sheet)

ANALYTICS 099803
G is C

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 · U.S.A.

Phone (404) 352-8677
Fax (404) 352-2837

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

56436-466

Point Source in Liquid Scintillation Vial

This standard radionuclide source was prepared using aliquots measured gravimetrically from master radionuclide solution sources. The Am-241 was calibrated by 4 pi alpha liquid scintillation counting. The Eu-152 was calibrated in an ion chamber that was calibrated by the National Physical Laboratory, Teddington, U.K., and is directly traceable to national standards. ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

CALIBRATION DATE: September 21, 1998 12:00 EST

ISOTOPE:	Am-241	Eu-152
ACTIVITY (dps):	4.975 E+05	1.241 E+06
HALF-LIFE:	432.2 y	13.4 y
TOTAL UNCERTAINTY:	5.0%	5.0%
SYSTEMATIC:	4.7%	4.7%
RANDOM:	0.3%	0.3%

P O NUMBER P00002429, Item 2

SOURCE PREPARED BY: M. D. Currie
M. D. Currie, Radiochemist

Q A APPROVED: DM Mty 9-16-98

ATTACHMENT 6.2

ISOCS GEOMETRY COMPOSER REPORTS

(9 pages including this cover sheet)

Geometry Composer Report

CANBERRA

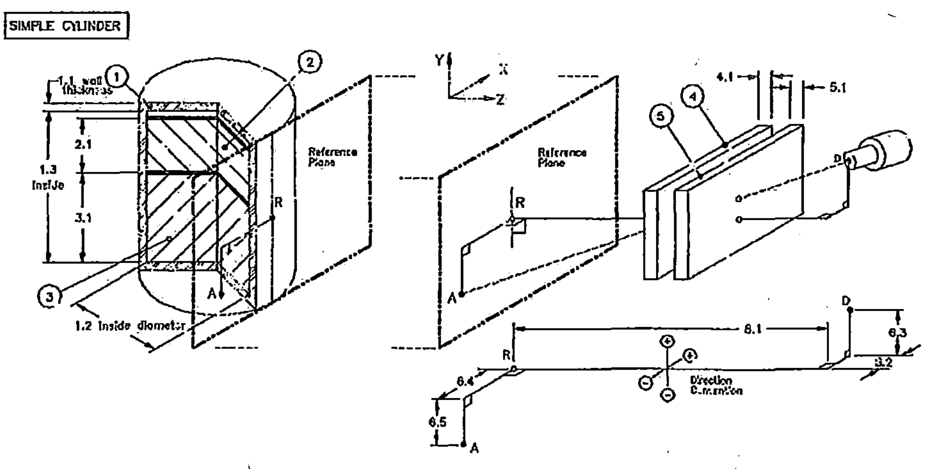
Date: Thursday, October 16, 2014 - 17:14:26
Description: Det 3994 V&V Test
Comment:
File Name: E:\3994_VV.geo
Software: ISOCS
Template: SIMPLE_CYLINDER, Version: (default)
Detector: 3994
Environment: Temperature = 22 °C, Pressure = 760 mm Hg, Relative Humidity = 30%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Container	0.033	0.375	0.05				lpolyeth	0.92	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	0.05						epoxy	1.1	1.00
4	Absorber1	0.027559						germanum	5.4	
5	Absorber2							none		
6	Source-Detector	24.5	0	0	0	0				

List of energies for efficiency curve generation

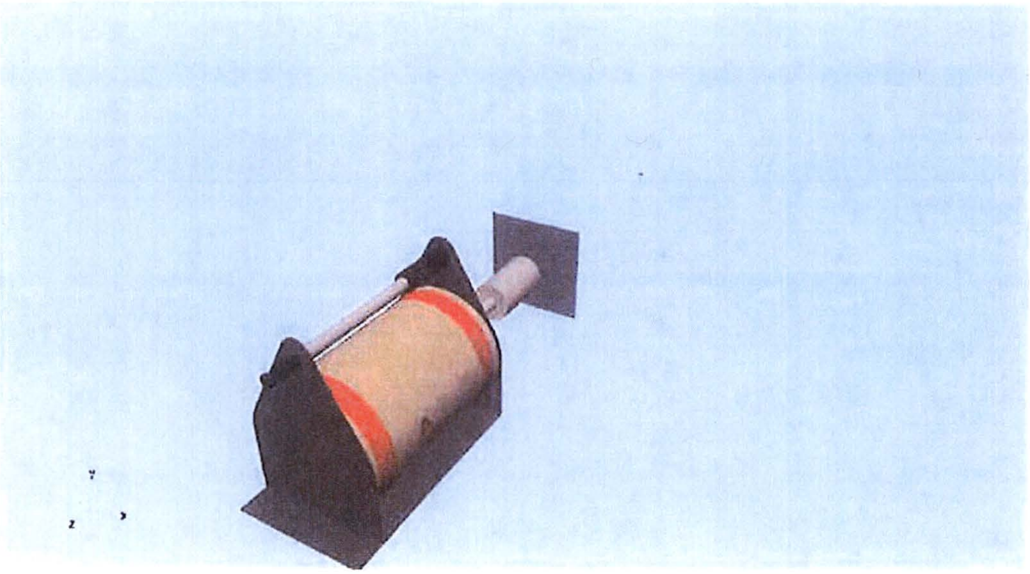
59.5	122.0	244.0	344.0	779.0	964.0	1112.0	1408.0



Geometry Composer Report

CANBERRA

Date: Thursday, October 16, 2014 - 17:14:26
Description: Det 3994 V&V Test
Comment:
File Name: E:\3994_VV.geo
Software: ISOCS
Template: SIMPLE_CYLINDER, Version: (default)



Geometry Composer Report

CANBERRA

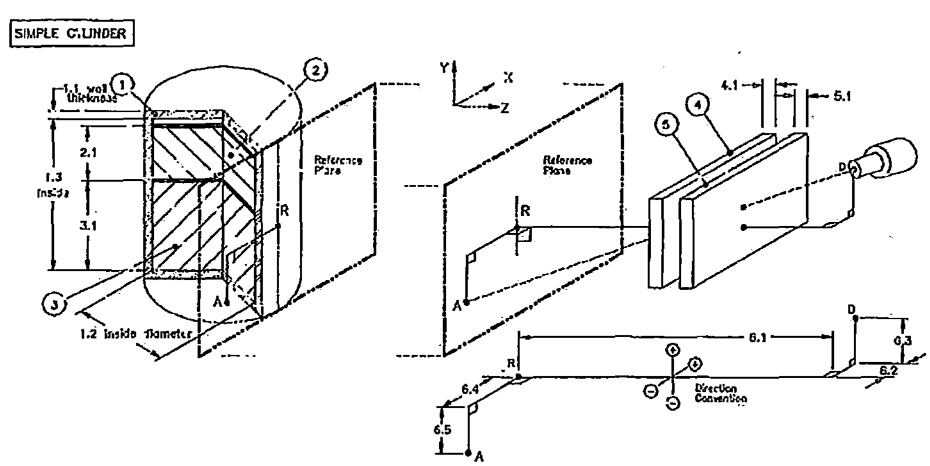
Date: Thursday, October 16, 2014 - 17:13:14
Description: Det 3996 V&V Test
Comment:
File Name: E:\3996_VV.geo
Software: ISOCS
Template: SIMPLE_CYLINDER, Version: (default)
Detector: 3996
Environment: Temperature = 22 °C, Pressure = 760 mm Hg, Relative Humidity = 30%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Container	0.033	0.375	0.05				lpolyeth	0.92	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	0.05						epoxy	1.1	1.00
4	Absorber1	0.031496						germanum	5.4	
5	Absorber2							none		
6	Source-Detector	24.5	0	0	0	0				

List of energies for efficiency curve generation

59.5	122.0	244.0	344.0	779.0	964.0	1112.0	1408.0



Geometry Composer Report

CANBERRA

Date: Thursday, October 16, 2014 - 17:13:14
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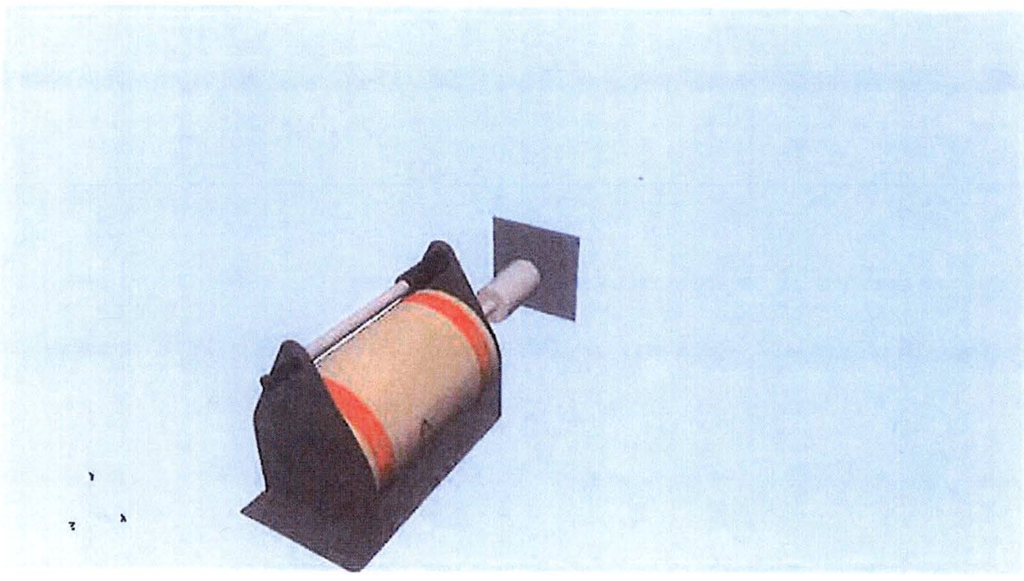
Comment:
File Name: E:\3996_VV.geo
Software: ISOCS
Template: SIMPLE_CYLINDER, Version: (default)



Geometry Composer Report

CANBERRA

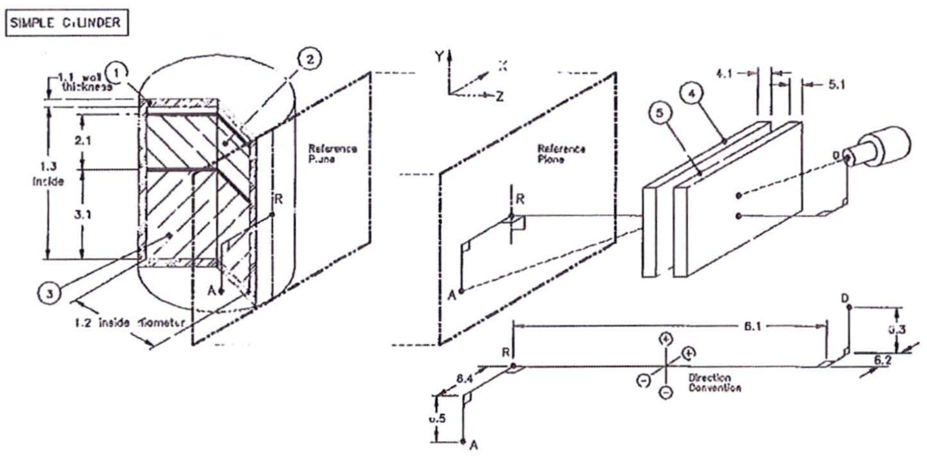
Date: Thursday, October 16, 2014 - 17:14:02
Description: Det 3997 V&V Test
Comment:
File Name: E:\3997_VV.geo
Software: ISOCS
Template: SIMPLE_CYLINDER, Version: (default)
Detector: 3997
Environment: Temperature = 22 °C, Pressure = 760 mm Hg, Relative Humidity = 30%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Container	0.033	0.375	0.05				lpolyeth	0.92	
2	Source - Top Layer	0						<none>		
3	Source - Bottom Layer	0.05						epoxy	1.1	1.00
4	Absorber1	0.035433						germanum	5.4	
5	Absorber2							none		
6	Source-Detector	24.5	0	0	0	0				

List of energies for efficiency curve generation

59.5	122.0	244.0	344.0	779.0	964.0	1112.0	1408.0



Geometry Composer Report

CANBERRA

Date:	Thursday, October 16, 2014 - 17:14:02
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Comment:	
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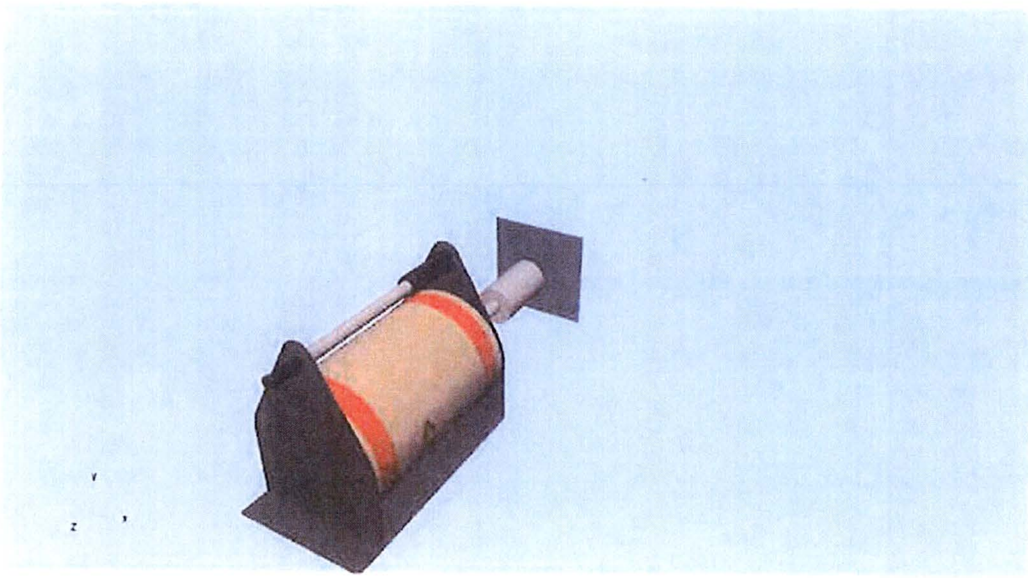
Software:	ISOCS
Template:	SIMPLE_CYLINDER, Version: (default)



Geometry Composer Report

CANBERRA

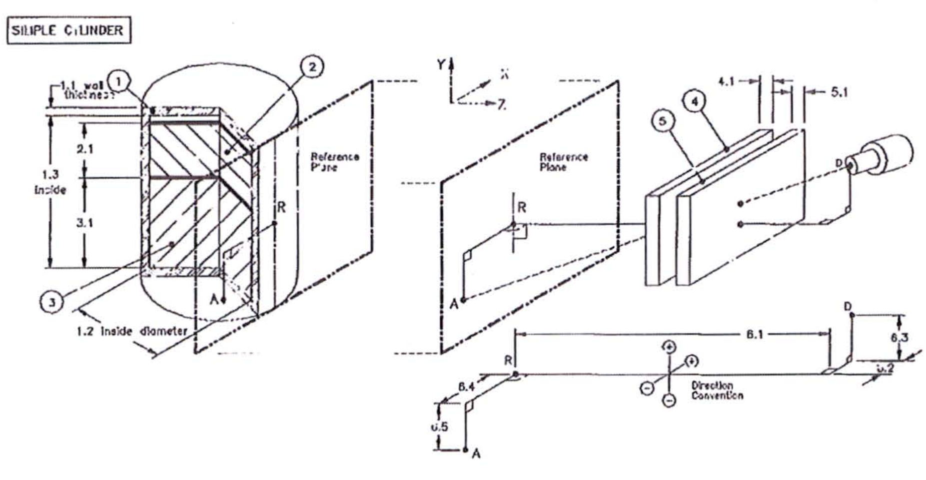
Date: Thursday, October 16, 2014 - 10:37:55
Description: Det 3998 V&V Test
Comment:
File Name: E:\3998_VV.geo
Software: ISOCS
Template: SIMPLE_CYLINDER, Version: (default)
Detector: 3998
Environment: Temperature = 22 °C, Pressure = 760 mm Hg, Relative Humidity = 30%
Integration: Convergence = 1.00%, MDRPN = 2^4 (16), CRPN = 2^4 (16)

Dimensions (inches)

No.	Description	d.1	d.2	d.3	d.4	d.5	d.6	Material	Density	Rel. Conc.
1	Container	0.033	0.375	0.05				Ipolyeth	0.92	
2	Source - Top Layer	0						none		
3	Source - Bottom Layer	0.05						epoxy	1.1	1.00
4	Absorber1							none		
5	Absorber2							none		
6	Source-Detector	24.5	0	0	0	0				

List of energies for efficiency curve generation

59.5	122.0	244.0	344.0	779.0	964.0	1112.0	1408.0



Geometry Composer Report

CANBERRA

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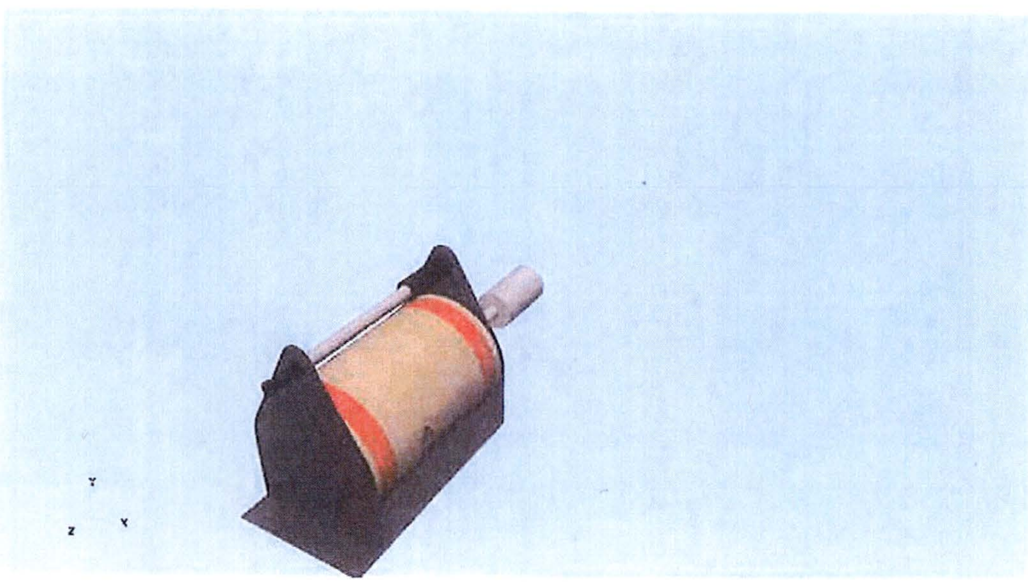
File Name: E:\3998_VV.geo
Software: ISOCS
Template: SIMPLE_CYLINDER, Version: (default)



ATTACHMENT 6.3

V&V MEASUREMENT ASSAY REPORTS

(18 pages including this cover sheet)

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*****************************************************************************
*****        G A M M A   S P E C T R U M   A N A L Y S I S          *****
*****************************************************************************

Filename: E:\DET01_101314_1ST VIAL 600 SEC  COUNT.CNF

Report Generated On              : 10/16/2014  4:26:39 PM

Sample Title                     : DET 1
Sample Description               : VIAL 600 SEC
Sample Identification            : SPECT 1
Sample Type                      :
Sample Geometry                  :

Peak Locate Threshold            :  3.00
Peak Locate Range (in channels)  :     1 - 65535
Peak Area Range (in channels)    :   400 -  8000
Identification Energy Tolerance  :    1.000 keV

Sample Size                      :  1.000E+000 Unit

Sample Taken On                  :
Acquisition Started              : 10/13/2014 10:55:03 AM

Live Time                        :       600.0 seconds
Real Time                        :       602.5 seconds

Dead Time                        :    0.42 %

              Energy Calibration Used Done On      : 9/16/2014
              Efficiency Calibration Used Done On  : 10/16/2014
              Efficiency ID                        : ET_3994_V&V_TEST
```

Peak Analysis Report 10/16/2014 4:26:39 PM Page 2

****
***** P E A K A N A L Y S I S R E P O R T *****
****

Detector Name: DET01
Sample Title: DET 1
Peak Analysis Performed on: 10/16/2014 4:26:39 PM
Peak Analysis From Channel: 400
Peak Analysis To Channel: 8000

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	412-	421	418.07	104.59	0.30	3.19E+000	73.24	2.37E+003
2	480-	495	487.60	122.00	1.02	2.68E+004	199.10	4.29E+003
3	970-	987	978.89	244.98	1.13	4.80E+003	98.82	1.53E+003
4	1098-	1106	1101.52	275.67	0.68	3.42E+001	34.67	5.47E+002
5	1175-	1190	1183.62	296.22	0.56	1.95E+002	51.93	8.30E+002
6	1367-	1386	1376.90	344.58	1.16	1.12E+004	124.07	1.21E+003
7	1461-	1480	1470.89	368.10	1.24	4.19E+002	47.58	5.27E+002
8	1637-	1653	1643.96	411.41	1.07	7.10E+002	47.50	4.93E+002
9	1692-	1701	1696.79	424.62	0.58	-6.82E+000	23.87	2.56E+002
10	1767-	1785	1775.49	444.31	1.34	1.02E+003	51.74	4.91E+002
11	1924-	1936	1929.01	482.72	0.60	2.75E+001	28.82	3.02E+002
12	2249-	2259	2254.66	564.17	0.99	4.59E+001	28.58	3.20E+002
13	2335-	2353	2345.28	586.84	0.39	1.14E+002	38.13	3.96E+002
14	2704-	2721	2713.61	678.95	1.35	1.49E+002	32.31	2.75E+002
15	2748-	2766	2754.67	689.21	1.04	1.43E+002	35.40	3.28E+002
16	2974-	2987	2979.67	745.47	0.25	-1.39E+001	25.76	2.46E+002
17	3102-	3127	3115.01	779.30	1.57	2.41E+003	66.18	4.65E+002
18	3236-	3247	3241.55	810.94	1.16	3.38E+001	22.52	1.85E+002
19	3456-	3482	3469.37	867.88	1.62	6.60E+002	50.99	4.43E+002
20	3842-	3869	3856.22	964.56	1.68	2.25E+003	59.35	2.84E+002
21	4012-	4030	4020.48	1005.60	1.27	1.04E+002	22.25	1.13E+002
M 22	4329-	4370	4343.72	1086.36	1.81	1.34E+003	38.35	1.36E+002
m 23	4329-	4370	4359.68	1090.35	1.81	2.34E+002	18.04	1.33E+002
24	4434-	4462	4448.67	1112.58	1.54	1.84E+003	53.31	2.17E+002
25	4842-	4863	4851.69	1213.24	1.66	1.83E+002	23.21	9.41E+001
26	4995-	5008	5000.97	1250.52	0.25	2.29E+001	11.82	4.11E+001
27	5187-	5209	5197.24	1299.53	1.25	1.60E+002	18.75	4.91E+001
28	5619-	5648	5633.47	1408.44	1.77	2.12E+003	50.80	9.75E+001
M 29	5823-	5853	5831.04	1457.76	1.83	4.87E+001	7.55	5.00E+000
m 30	5823-	5853	5844.43	1461.10	1.83	1.04E+002	10.62	5.25E+000

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

Interference Corrected Activity Report   10/16/2014 4:26:40 PM   Page 3

****
*****   N U C L I D E   I D E N T I F I C A T I O N   R E P O R T   *****
****

Sample Title: DET 1
Nuclide Library Used: C:\GENIE2K\CAMFILES\Eu152.NLB

.... IDENTIFIED NUCLIDES ....

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/Unit)	Activity Uncertainty
EU-152	0.974	121.78*	28.40	1.53284E+001	4.23369E-001
		244.69*	7.49	1.44549E+001	4.52689E-001
		344.27*	26.50	1.36930E+001	2.90951E-001
		778.89*	12.74	1.41788E+001	4.99683E-001
		964.01*	14.40	1.42625E+001	5.00773E-001
		1112.02*	13.30	1.43965E+001	5.48277E-001
		1407.95*	20.70	1.32445E+001	4.69961E-001

* = Energy line found in the spectrum.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

Interference Corrected Activity Report 10/16/2014 4:26:40 PM Page 4

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*********************************************************************************
*****   I N T E R F E R E N C E   C O R R E C T E D   R E P O R T   *****
*********************************************************************************
```

Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/Unit)	Wt mean Activity Uncertainty
EU-152	0.974	1.414865E+001	1.619683E-001

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000 sigma

Interference Corrected Activity Report 10/16/2014 4:26:40 PM Page 5

********** U N I D E N T I F I E D P E A K S **********

Peak Locate Performed on: 10/16/2014 4:26:39 PM
Peak Locate From Channel: 400
Peak Locate To Channel: 8000

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
1	104.59	5.3202E-003	2294.43		
4	275.67	5.6954E-002	101.45		
5	296.22	3.2461E-001	26.66		
7	368.10	6.9873E-001	11.35		
8	411.41	1.1826E+000	6.69		
9	424.62	-1.1372E-002	-349.88		
10	444.31	1.6938E+000	5.09		
11	482.72	4.5751E-002	105.00		
12	564.17	7.6560E-002	62.22		
13	586.84	1.9022E-001	33.41		
14	678.95	2.4818E-001	21.70		
15	689.21	2.3911E-001	24.67	Sum	
16	745.47	-2.3238E-002	-184.77		
18	810.94	5.6309E-002	66.65		
19	867.88	1.1006E+000	7.72		
21	1005.60	1.7359E-001	21.36		
M 22	1086.36	2.2396E+000	2.85	Sum	
m 23	1090.35	3.9030E-001	7.71		
25	1213.24	3.0487E-001	12.69		
26	1250.52	3.8216E-002	51.54		
27	1299.53	2.6652E-001	11.72		
M 29	1457.76	8.1180E-002	15.50	Sum	
m 30	1461.10	1.7336E-001	10.21		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

```
*************************************************************************
*****        G A M M A   S P E C T R U M   A N A L Y S I S        *****
*************************************************************************

Filename: E:\DET02_101314_2ND VIAL 600 SEC  COUNT.CNF

Report Generated On              : 10/16/2014   4:27:56 PM

Sample Title                     : DET02
Sample Description               : VIAL 101314 @ 24"
Sample Identification            : SPEC 2
Sample Type                      :
Sample Geometry                  :

Peak Locate Threshold            :  3.00
Peak Locate Range (in channels)  :     1 - 65535
Peak Area Range (in channels)    :   400 -  8000
Identification Energy Tolerance  :    1.000 keV

Sample Size                      :  1.000E+000 Unit

Sample Taken On                  :
Acquisition Started              : 10/13/2014   3:10:17 PM

Live Time                        :       600.0 seconds
Real Time                        :       602.3 seconds

Dead Time                        :   0.39 %

              Energy Calibration Used Done On       : 9/16/2014
              Efficiency Calibration Used Done On   : 10/16/2014
              Efficiency ID                         : ET_3996_V&V_TEST
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Peak Analysis Report 10/16/2014 4:27:56 PM Page 2

****
***** P E A K A N A L Y S I S R E P O R T *****
****

Detector Name: DET02
Sample Title: DET02
Peak Analysis Performed on: 10/16/2014 4:27:56 PM
Peak Analysis From Channel: 400
Peak Analysis To Channel: 8000

	Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
	1	479-	495	487.71	121.84	0.91	2.65E+004	198.58	4.15E+003
	2	970-	988	979.31	244.85	0.99	4.69E+003	99.39	1.54E+003
	3	1179-	1189	1183.94	296.05	1.28	3.04E+002	38.86	5.06E+002
	4	1367-	1387	1377.53	344.49	1.13	1.10E+004	124.24	1.22E+003
	5	1464-	1479	1471.62	368.03	1.16	2.91E+002	41.54	4.78E+002
M	6	1637-	1670	1644.80	411.35	1.24	7.89E+002	31.87	4.10E+002
m	7	1637-	1670	1664.92	416.38	1.24	6.75E+001	16.90	4.02E+002
	8	1768-	1786	1776.16	444.21	1.24	9.89E+002	51.17	4.81E+002
	9	2247-	2267	2256.23	564.30	1.49	1.45E+002	41.88	4.44E+002
	10	2340-	2352	2345.52	586.63	0.47	1.03E+002	29.21	2.84E+002
	11	2708-	2725	2714.56	678.93	1.55	1.39E+002	32.73	2.84E+002
	12	2745-	2764	2754.84	689.00	1.39	1.73E+002	35.89	3.18E+002
	13	2866-	2885	2879.20	720.10	1.01	8.16E+001	33.73	3.00E+002
	14	3054-	3066	3059.88	765.29	0.73	4.17E+001	23.89	2.00E+002
	15	3105-	3128	3115.94	779.30	1.50	2.24E+003	62.00	4.01E+002
	16	3458-	3482	3469.98	867.83	1.73	6.84E+002	46.89	3.66E+002
	17	3669-	3685	3677.08	919.61	0.38	8.57E+001	23.08	1.41E+002
	18	3845-	3870	3856.92	964.58	1.48	2.19E+003	57.34	2.60E+002
	19	4013-	4029	4021.45	1005.71	1.31	5.85E+001	20.57	1.16E+002
M	20	4331-	4370	4344.18	1086.39	1.79	1.36E+003	37.25	2.14E+002
m	21	4331-	4370	4359.49	1090.22	1.79	2.41E+002	17.61	1.73E+002
	22	4434-	4463	4449.23	1112.65	1.57	1.68E+003	52.97	2.36E+002
	23	4846-	4861	4852.75	1213.51	2.15	1.14E+002	20.46	1.00E+002
	24	5185-	5207	5197.58	1299.70	1.60	1.74E+002	18.11	3.98E+001
	25	5619-	5649	5633.53	1408.65	1.66	2.13E+003	50.33	8.39E+001
M	26	5824-	5854	5833.15	1458.53	1.77	5.34E+001	7.78	5.00E+000
m	27	5824-	5854	5845.15	1461.53	1.77	7.69E+001	8.98	5.75E+000

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

Interference Corrected Activity Report 10/16/2014 4:27:56 PM Page 3

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*************************************************************************
*****   N U C L I D E   I D E N T I F I C A T I O N   R E P O R T   *****
*************************************************************************
```

Sample Title: DET02
Nuclide Library Used: C:\GENIE2K\CAMFILES\Eu152.NLB

.... IDENTIFIED NUCLIDES ....

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/Unit)	Activity Uncertainty
EU-152	0.970	121.78*	28.40	1.54352E+001	4.26594E-001
		244.69*	7.49	1.42339E+001	4.51163E-001
		344.27*	26.50	1.35700E+001	2.89565E-001
		778.89*	12.74	1.32251E+001	4.68338E-001
		964.01*	14.40	1.39266E+001	4.86895E-001
		1112.02*	13.30	1.32294E+001	5.28954E-001
		1407.95*	20.70	1.33470E+001	4.70520E-001

* = Energy line found in the spectrum.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

Interference Corrected Activity Report 10/16/2014 4:27:56 PM Page 4

****
***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****
****

Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/Unit)	Wt mean Activity Uncertainty
EU-152	0.970	1.385616E+001	1.597139E-001

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000 sigma

********** U N I D E N T I F I E D P E A K S **********

Peak Locate Performed on: 10/16/2014 4:27:56 PM
Peak Locate From Channel: 400
Peak Locate To Channel: 8000

	Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
	3	296.05	5.0746E-001	12.76		
	5	368.03	4.8530E-001	14.26		
M	6	411.35	1.3145E+000	4.04		
m	7	416.38	1.1245E-001	25.05		
	8	444.21	1.6491E+000	5.17		
	9	564.30	2.4225E-001	28.81		
	10	586.63	1.7089E-001	28.49		
	11	678.93	2.3133E-001	23.58		
	12	689.00	2.8893E-001	20.70	Sum	
	13	720.10	1.3606E-001	41.32		
	14	765.29	6.9496E-002	57.30		
	16	867.83	1.1394E+000	6.86		
	17	919.61	1.4278E-001	26.94		
	19	1005.71	9.7543E-002	35.14		
M	20	1086.39	2.2661E+000	2.74	Sum	
m	21	1090.22	4.0248E-001	7.29		
	23	1213.51	1.8922E-001	18.02		
	24	1299.70	2.9028E-001	10.40		
M	26	1458.53	8.9070E-002	14.55		
m	27	1461.53	1.2822E-001	11.67		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

```
*****************************************************************************
*****        G A M M A   S P E C T R U M   A N A L Y S I S        *****
*****************************************************************************

Filename: E:\DET03_101314_1ST VIAL 600 SEC  COUNT.CNF

Report Generated On              : 10/16/2014  4:28:34 PM

Sample Title                     : DET 3
Sample Description               : VIAL @24"  600 SEC
Sample Identification            : SPECT 1
Sample Type                      :
Sample Geometry                  :

Peak Locate Threshold            :  3.00
Peak Locate Range (in channels)  :     1 - 65535
Peak Area Range (in channels)    :   400 -  8000
Identification Energy Tolerance  :    1.000 keV

Sample Size                      :  1.000E+000 Unit

Sample Taken On                  :
Acquisition Started              : 10/13/2014  4:17:21 PM

Live Time                        :      600.0 seconds
Real Time                        :      602.4 seconds

Dead Time                        :   0.40 %

            Energy Calibration Used Done On      : 9/16/2014
            Efficiency Calibration Used Done On  : 10/16/2014
            Efficiency ID                        : ET_3997_V&V_TEST
```

Peak Analysis Report 10/16/2014 4:28:34 PM Page 2

****
***** P E A K A N A L Y S I S R E P O R T *****
****

Detector Name: DET01
Sample Title: DET 3
Peak Analysis Performed on: 10/16/2014 4:28:34 PM
Peak Analysis From Channel: 400
Peak Analysis To Channel: 8000

Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
1	479-	494	487.01	121.85	0.92	2.51E+004	193.08	4.06E+003
2	972-	987	978.25	244.82	1.05	4.66E+003	94.11	1.39E+003
3	1175-	1189	1183.04	296.07	0.65	2.21E+002	49.25	7.65E+002
4	1366-	1385	1376.22	344.41	1.11	1.12E+004	124.88	1.26E+003
5	1463-	1476	1470.10	367.91	1.07	2.93E+002	38.60	4.33E+002
6	1635-	1653	1643.41	411.27	1.27	7.93E+002	49.83	5.01E+002
7	1764-	1785	1774.63	444.10	1.26	9.59E+002	56.03	5.81E+002
8	1949-	1959	1953.53	488.85	1.06	8.66E+001	26.93	2.67E+002
9	2339-	2350	2344.16	586.56	0.67	9.12E+001	28.10	2.78E+002
10	2706-	2721	2711.60	678.44	1.09	1.31E+002	30.05	2.54E+002
11	2743-	2761	2753.83	689.00	1.14	1.55E+002	35.52	3.28E+002
12	2870-	2884	2876.00	719.55	0.78	9.10E+001	28.51	2.50E+002
13	3102-	3127	3114.67	779.22	1.63	2.28E+003	67.34	5.30E+002
14	3458-	3478	3468.76	867.73	1.50	6.20E+002	44.29	3.70E+002
15	3844-	3869	3855.82	964.46	1.67	2.10E+003	57.64	2.86E+002
16	4012-	4028	4020.08	1005.50	0.80	9.13E+001	21.21	1.15E+002
M 17	4329-	4368	4343.45	1086.29	1.93	1.36E+003	38.94	1.67E+002
m 18	4329-	4368	4358.71	1090.10	1.93	2.52E+002	19.40	1.64E+002
19	4434-	4462	4448.33	1112.49	1.81	1.79E+003	54.12	2.47E+002
20	4841-	4862	4852.75	1213.50	1.82	1.70E+002	23.69	1.05E+002
21	5188-	5207	5198.00	1299.72	1.95	1.62E+002	17.16	3.76E+001
22	5619-	5648	5633.34	1408.41	1.78	2.21E+003	51.13	8.37E+001
23	5839-	5855	5845.56	1461.38	1.10	7.62E+001	14.56	3.88E+001

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

Interference Corrected Activity Report   10/16/2014 4:28:34 PM   Page 3

```
*********************************************************************
*****   N U C L I D E   I D E N T I F I C A T I O N   R E P O R T   *****
*********************************************************************
```

Sample Title: DET 3
Nuclide Library Used: C:\GENIE2K\CAMFILES\Eu152.NLB

.... IDENTIFIED NUCLIDES ....

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/Unit)	Activity Uncertainty
EU-152	0.984	121.78*	28.40	1.49051E+001	4.12708E-001
		244.69*	7.49	1.42189E+001	4.41600E-001
		344.27*	26.50	1.38544E+001	2.94762E-001
		778.89*	12.74	1.35308E+001	4.98531E-001
		964.01*	14.40	1.34189E+001	4.81521E-001
		1112.02*	13.30	1.40822E+001	5.50084E-001
		1407.95*	20.70	1.39017E+001	4.85202E-001

* = Energy line found in the spectrum.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

Interference Corrected Activity Report 10/16/2014 4:28:34 PM Page 4

****
***** I N T E R F E R E N C E   C O R R E C T E D   R E P O R T *****
****

Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/Unit)	Wt mean Activity Uncertainty
EU-152	0.984	1.400573E+001	1.613797E-001

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000 sigma

********** U N I D E N T I F I E D   P E A K S **********

Peak Locate Performed on: 10/16/2014 4:28:34 PM
Peak Locate From Channel: 400
Peak Locate To Channel: 8000

Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
3	296.07	3.6771E-001	22.32		
5	367.91	4.8751E-001	13.20		
6	411.27	1.3217E+000	6.28		
7	444.10	1.5988E+000	5.84		
8	488.85	1.4438E-001	31.09	Sum	
9	586.56	1.5204E-001	30.81		
10	678.44	2.1841E-001	22.93		
11	689.00	2.5870E-001	22.88	Sum	
12	719.55	1.5171E-001	31.33		
14	867.73	1.0333E+000	7.14		
16	1005.50	1.5208E-001	23.24		
M 17	1086.29	2.2736E+000	2.85	Sum	
m 18	1090.10	4.2077E-001	7.68		
20	1213.50	2.8250E-001	13.98		
21	1299.72	2.7063E-001	10.57		
23	1461.38	1.2703E-001	19.10		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

```
*****************************************************************************
*****       G A M M A   S P E C T R U M   A N A L Y S I S             *****
*****************************************************************************

Filename: E:\100914_1ST 600 COUNT.CNF

Report Generated On              : 10/16/2014  4:25:49 PM

Sample Title                     : DET 4
Sample Description               : AM - EU MULTI LINE @24"
Sample Identification            : SPECT 1
Sample Type                      :
Sample Geometry                  :

Peak Locate Threshold            :  3.00
Peak Locate Range (in channels)  :     1 - 65535
Peak Area Range (in channels)    :   400 -  8000
Identification Energy Tolerance  :    1.000 keV

Sample Size                      :  1.000E+000 Unit

Sample Taken On                  :
Acquisition Started              : 10/9/2014  10:58:38 AM

Live Time                        :       600.0 seconds
Real Time                        :       602.9 seconds

Dead Time                        :   0.48 %

             Energy Calibration Used Done On      : 9/16/2014
             Efficiency Calibration Used Done On  : 10/16/2014
             Efficiency ID                        : ET_3998_V&V_TEST
```

Peak Analysis Report 10/16/2014 4:25:50 PM Page 2

```
****************************************************************************
*****              P E A K   A N A L Y S I S   R E P O R T             *****
****************************************************************************
```

Detector Name: DET01
Sample Title: DET 4
Peak Analysis Performed on: 10/16/2014 4:25:50 PM
Peak Analysis From Channel: 400
Peak Analysis To Channel: 8000

	Peak No.	ROI start	ROI end	Peak centroid	Energy (keV)	FWHM (keV)	Net Peak Area	Net Area Uncert.	Continuum Counts
	1	479-	494	486.80	121.80	0.88	3.07E+004	212.68	4.85E+003
	2	908-	916	912.12	228.27	0.68	2.09E+001	42.55	8.35E+002
	3	970-	986	977.97	244.75	1.02	5.28E+003	103.47	1.73E+003
	4	1173-	1189	1182.92	296.04	1.05	3.51E+002	58.80	9.94E+002
	5	1366-	1385	1375.91	344.34	1.13	1.32E+004	137.22	1.61E+003
	6	1459-	1478	1469.76	367.82	1.01	3.85E+002	55.18	7.60E+002
M	7	1635-	1667	1643.14	411.20	1.17	8.41E+002	35.88	5.03E+002
m	8	1635-	1667	1662.29	415.99	1.17	4.85E+001	18.59	4.36E+002
	9	1768-	1784	1774.18	443.98	1.09	1.09E+003	53.13	5.45E+002
	10	1943-	1962	1953.13	488.75	1.13	2.05E+002	44.62	5.08E+002
	11	2249-	2261	2254.39	564.11	0.59	1.29E+002	33.91	3.86E+002
	12	2338-	2349	2343.54	586.40	0.51	7.28E+001	31.28	3.60E+002
M	13	2692-	2718	2697.64	674.95	1.22	4.68E+001	16.05	2.90E+002
m	14	2692-	2718	2713.38	678.89	1.22	1.12E+002	19.19	2.72E+002
	15	2742-	2757	2752.67	688.71	1.42	2.29E+002	33.96	3.08E+002
	16	3100-	3125	3113.40	778.90	1.55	2.85E+003	70.17	4.88E+002
	17	3232-	3246	3240.83	810.75	1.29	1.29E+002	27.51	2.17E+002
	18	3459-	3480	3467.63	867.44	1.61	8.15E+002	49.55	4.31E+002
	19	3697-	3712	3703.29	926.34	1.00	8.44E+001	22.04	1.33E+002
	20	3841-	3867	3854.49	964.13	1.83	2.49E+003	65.62	4.15E+002
	21	4006-	4029	4019.97	1005.47	0.81	1.25E+002	29.51	1.86E+002
M	22	4329-	4369	4342.06	1085.94	1.84	1.58E+003	42.23	2.28E+002
m	23	4329-	4369	4357.33	1089.76	1.84	2.89E+002	20.89	2.19E+002
	24	4432-	4460	4446.82	1112.11	1.80	2.10E+003	58.87	2.95E+002
	25	4842-	4860	4850.72	1213.00	1.02	1.59E+002	24.38	1.29E+002
	26	5185-	5207	5195.56	1299.11	1.98	2.16E+002	21.64	6.41E+001
	27	5616-	5646	5631.39	1407.92	1.88	2.63E+003	57.42	1.36E+002
	28	5835-	5852	5843.90	1460.97	0.66	8.42E+001	16.47	5.58E+001
	29	6106-	6120	6113.17	1528.17	0.56	4.09E+001	6.88	2.06E+000

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

Errors quoted at 1.000 sigma

Interference Corrected Activity Report 10/16/2014 4:25:50 PM Page 3

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*****************************************************************************
*****   N U C L I D E   I D E N T I F I C A T I O N   R E P O R T   *****
*****************************************************************************
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Sample Title: DET 4
Nuclide Library Used: C:\GENIE2K\CAMFILES\Eu152.NLB

.... IDENTIFIED NUCLIDES ....

Nuclide Name	Id Confidence	Energy (keV)	Yield (%)	Activity (uCi/Unit)	Activity Uncertainty
EU-152	0.999	121.78*	28.40	1.53425E+001	4.21735E-001
		244.69*	7.49	1.52565E+001	4.67700E-001
		344.27*	26.50	1.56955E+001	3.27724E-001
		778.89*	12.74	1.59824E+001	5.28048E-001
		964.01*	14.40	1.48020E+001	5.18535E-001
		1112.02*	13.30	1.51696E+001	5.65938E-001
		1407.95*	20.70	1.46645E+001	4.99159E-001

* = Energy line found in the spectrum.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 1.000 keV
Nuclide confidence index threshold = 0.30
Errors quoted at 1.000 sigma

Interference Corrected Activity Report 10/16/2014 4:25:50 PM Page 4

****
***** I N T E R F E R E N C E C O R R E C T E D R E P O R T *****
****

Nuclide Name	Nuclide Id Confidence	Wt mean Activity (uCi/Unit)	Wt mean Activity Uncertainty
EU-152	0.999	1.534008E+001	1.716352E-001

? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 1.000 sigma

********** U N I D E N T I F I E D P E A K S **********

Peak Locate Performed on: 10/16/2014 4:25:49 PM
Peak Locate From Channel: 400
Peak Locate To Channel: 8000

	Peak No.	Energy (keV)	Peak Size in Counts per Second	Peak CPS % Uncertainty	Peak Type	Tol. Nuclide
	2	228.27	3.4888E-002	203.25		
	4	296.04	5.8496E-001	16.75		
	6	367.82	6.4210E-001	14.32		
M	7	411.20	1.4015E+000	4.27		
m	8	415.99	8.0841E-002	38.32		
	9	443.98	1.8162E+000	4.88		
	10	488.75	3.4118E-001	21.80	Sum	
	11	564.11	2.1475E-001	26.31		
	12	586.40	1.2137E-001	42.95		
M	13	674.95	7.7928E-002	34.32		
m	14	678.89	1.8637E-001	17.16		
	15	688.71	3.8202E-001	14.81	Sum	
	17	810.75	2.1441E-001	21.39		
	18	867.44	1.3577E+000	6.08		
	19	926.34	1.4059E-001	26.13		
	21	1005.47	2.0818E-001	23.62		
M	22	1085.94	2.6303E+000	2.68	Sum	
m	23	1089.76	4.8167E-001	7.23		
	25	1213.00	2.6536E-001	15.32		
	26	1299.11	3.5988E-001	10.02		
	28	1460.97	1.4033E-001	19.56		
	29	1528.17	6.8227E-002	16.81		

M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet

ATTACHMENT 6.4

DETECTOR V&V MEASUREMENT RESULTS

(5 pages including this cover sheet)

HPGe ISOCS Detector Verification & Validation Testing						
Detector Position:	1					
Detector ID Number:	3994					
Source ID Number	099803					
Source Certification Date:	9/21/1998					
Detector Dead Layer (mm)	0.7					
Test Date:	10/13/2014					
Nuclide	**Half-Life (days)**	**Energy (keV)**	**Original Activity (uCi)**	**Decay Corrected Activity (uCi)**	**Measured Activity (uCi)**	**% Difference**
Eu-152	4.894E+03	121.8	33.54	14.617	15.33	4.88%
Eu-152	4.894E+03	244.7	33.54	14.617	14.45	-1.14%
Eu-152	4.894E+03	344.3	33.54	14.617	13.69	-6.34%
Eu-152	4.894E+03	778.9	33.54	14.617	14.18	-2.99%
Eu-152	4.894E+03	964.0	33.54	14.617	14.26	-2.44%
Eu-152	4.894E+03	1112.0	33.54	14.617	14.40	-1.48%
Eu-152	4.894E+03	1408.0	33.54	14.617	13.24	-9.42%

HPGe ISOCS Detector Verification & Validation Testing						
Detector Position:	2					
Detector ID Number:	3996					
Source ID Number	099803					
Source Certification Date:	9/21/1998					
Detector Dead Layer (mm)	0.80					
Test Date:	10/13/2014					
Nuclide	Half-Life (days)	Energy (keV)	Original Activity (uCi)	Decay Corrected Activity (uCi)	Measured Activity (uCi)	% Difference
Eu-152	4.894E+03	121.8	33.54	14.617	15.44	5.63%
Eu-152	4.894E+03	244.7	33.54	14.617	14.23	-2.65%
Eu-152	4.894E+03	344.3	33.54	14.617	13.57	-7.16%
Eu-152	4.894E+03	778.9	33.54	14.617	13.23	-9.49%
Eu-152	4.894E+03	964.0	33.54	14.617	13.93	-4.70%
Eu-152	4.894E+03	1112.0	33.54	14.617	13.23	-9.49%
Eu-152	4.894E+03	1408.0	33.54	14.617	13.35	-8.67%

HPGe ISOCS Detector Verification & Validation Testing						
Detector Position:	3					
Detector ID Number:	3997					
Source ID Number	099803					
Source Certification Date:	9/21/1998					
Detector Dead Layer (mm)	0.90					
Test Date:	10/13/2014					
Nuclide	**Half-Life (days)**	**Energy (keV)**	**Original Activity (uCi)**	**Decay Corrected Activity (uCi)**	**Measurement 1 Activity (uCi)**	**% Difference**
Eu-152	4.894E+03	121.8	33.54	14.617	14.91	2.01%
Eu-152	4.894E+03	244.7	33.54	14.617	14.22	-2.71%
Eu-152	4.894E+03	344.3	33.54	14.617	13.85	-5.25%
Eu-152	4.894E+03	778.9	33.54	14.617	13.53	-7.43%
Eu-152	4.894E+03	964.0	33.54	14.617	13.42	-8.19%
Eu-152	4.894E+03	1112.0	33.54	14.617	14.08	-3.67%
Eu-152	4.894E+03	1408.0	33.54	14.617	13.90	-4.90%

HPGe ISOCS Detector Verification & Validation Testing

Detector Position:	4					
Detector ID Number:	3998					
Source ID Number	099803					
Source Certification Date:	9/21/1998					
HPGe Dead Layer (mm)	0					
Test Date:	10/9/2014					
Nuclide	**Half-Life (days)**	**Energy (keV)**	**Original Activity (uCi)**	**Decay Corrected Activity (uCi)**	**Measured Activity (uCi)**	**% Difference**
Eu-152	4.894E+03	121.8	33.54	14.625	15.34	4.89%
Eu-152	4.894E+03	244.7	33.54	14.625	15.26	4.34%
Eu-152	4.894E+03	344.3	33.54	14.625	15.70	7.35%
Eu-152	4.894E+03	778.9	33.54	14.625	15.98	9.27%
Eu-152	4.894E+03	964.0	33.54	14.625	14.80	1.20%
Eu-152	4.894E+03	1112.0	33.54	14.625	15.17	3.73%
Eu-152	4.894E+03	1408.0	33.54	14.625	14.66	0.24%

ATTACHMENT 6.5

DETECTOR BASE LINE MEASUREMENT RESULTS

(5 pages including this cover sheet)

Verification Measurements For HPGe ISOCS Detectors						
Baseline Measurements for Detector #3994:						
Detector ID:	3994					
Source ID	080701					
Current Date:	10/13/2014					
Nuclide	**Half-Life (days)**	**Energy (keV)**	**Count 1(cps)**	**Count 2 (cps)**	**Count 3 (cps)**	**Mean (cps)**
Eu-155	1.812E+03	86.5	31.500	30.667	30.667	30.944
Na-22	9.504E+02	1274.5	6.367	6.333	6.117	6.272
Verification Measurements for Detector #3994:						
Date:	10/13/2014					
Decay Corrected Eu-155 (cps)	30.944					
Decay Corrected Na-22 (cps)	6.272					
Measured Eu-155 (cps)	30.944					
Measured Na-22 (cps)	6.272					
Eu-155 Error (+/- 10%)	0.00%					
Na-22 Error (+/- 10%)	0.00%					
Eu-155 Channel (344 - 348)	346.50					
Na-22 Channel (5096 - 5100)	5098.48					

Verification Measurements For HPGe ISOCS Detectors						
Baseline Measurements for Detector #3996:						
Detector ID:	3996					
Source ID	080702					
Current Date:	10/13/2014					
Nuclide	Half-Life (days)	Energy (keV)	Count 1(cps)	Count 2 (cps)	Count 3 (cps)	Mean (cps)
Eu-155	1.812E+03	86.5	28.333	28.667	28.333	28.444
Na-22	9.504E+02	1274.5	5.883	5.767	5.767	5.806
Verification Measurements for Detector #3996:						
Date:	10/13/2014					
Decay Corrected Eu-155 (cps)	28.444					
Decay Corrected Na-22 (cps)	5.806					
Measured Eu-155 (cps)	28.444					
Measured Na-22 (cps)	5.806					
Eu-155 Error (+/- 10%)	0.00%					
Na-22 Error (+/- 10%)	0.00%					
Eu-155 Channel (344 - 348)	346.67					
Na-22 Channel (5096 - 5100)	5098.16					

Verification Measurements For HPGe ISOCS Detectors

Baseline Measurements for Detector #3997:						
Detector ID:	3997					
Source ID	080703					
Current Date:	10/13/2014					
Nuclide	**Half-Life (days)**	**Energy (keV)**	**Count 1(cps)**	**Count 2 (cps)**	**Count 3 (cps)**	**Mean (cps)**
Eu-155	1.812E+03	86.5	26.833	27.333	27.333	27.167
Na-22	9.504E+02	1274.5	6.183	6.183	5.917	6.094
Verification Measurements for Detector #3997:						
Date:	10/13/2014					
Decay Corrected Eu-155 (cps)	27.167					
Decay Corrected Na-22 (cps)	6.094					
Measured Eu-155 (cps)	27.167					
Measured Na-22 (cps)	6.094					
Eu-155 Error (+/- 10%)	0.00%					
Na-22 Error (+/- 10%)	0.00%					
Eu-155 Channel (344 - 348)	346.21					
Na-22 Channel (5096 - 5100)	5098.59					

Verification Measurements For HPGe ISOCS Detectors						
Baseline Measurements for Detector #3998:						
Detector ID:	3998					
Source ID	010702					
Current Date:	10/10/2014					
Nuclide	**Half-Life (days)**	**Energy (keV)**	**Count 1(cps)**	**Count 2 (cps)**	**Count 3 (cps)**	**Mean (cps)**
Eu-155	1.812E+03	86.5	36.000	35.833	36.167	36.000
Na-22	9.504E+02	1274.5	7.133	7.000	7.383	7.172
Verification Measurements for Detector #3998:						
Date:	10/10/2014					
Decay Corrected Eu-155 (cps)	36.000					
Decay Corrected Na-22 (cps)	7.172					
Measured Eu-155 (cps)	36.000					
Measured Na-22 (cps)	7.172					
Eu-155 Error (+/- 10%)	0.00%					
Na-22 Error (+/- 10%)	0.00%					
Eu-155 Channel (345 - 349)	346.17					
Na-22 Channel (5096 - 5100)	5098.41					