

Princeton Instruments, inc.

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Docket No. 030-34100
Control No. 122994

MS-16
P6

Penny Lanzisera
Division of Nuclear Materials Safety
U. S. Nuclear Regulatory Commission, Region I
475 Allendale Road
King of Prussia, PA 19406-1415

SUB: Application for an x-ray sealed source:

Dear Ms. Lanzisera:

This is in reference to your letter requesting additional information to complete the application I had submitted on March 11, 1996.

The additional information requested is as follows:

1. The total possession limit for this license will be 120 mCi (for one Fe55 sealed source).
2. This Fe55 sealed source;
 - a) is not intended to be used inside any device.
 - b) the source will be used only to test the functionality of our CCD camera models designed for x-ray crystallography application (in research, development, testing repair, servicing and demonstration). The source will illuminate a phosphor screen inside the camera to (a) confirm that the CCD camera can detect x-rays and (b) the phosphor screen is uniformly attached to the fiber optic taper and the uniformity of the phosphor is acceptable.

A brief description of our CCD cameras is attached, for which this x-ray source will be used. The complete functional testing of the CCD camera, without the phosphor screen, is done using visible light. Then the phosphor screen is applied on the fiber optic taper and the x-ray source is used, as the last step in testing, to illuminate the phosphor screen. If the uniformity is acceptable then the system is packed and shipped.

c) I confirm that only I will be handling this sealed source to test the CCD cameras. Also, I will follow the written procedure provided by the device manufacturer for all repair and servicing operations involving this sealed source.

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OFFICIAL RECORD COPY, ML 10

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3. At Princeton Instruments, Inc. we have a radiation dosimetry program in place since January 1995 to monitor any exposure to stray x-rays from our Transmission Electron Microscope. The list of people on this program are

- (1) Shah Manjul
- (2) Dubovis Alex
- (3) Christenson Mark
- (4) Nir Ishai
- (5) West John

If new people will join the project they will be issued a film badge, just as a precautionary measure to monitor any stray x-ray exposure.

Landauer, Inc. is issuing and processing our film badges and their NVLAP certificate is attached. New film badges are issued every month to all the people and old badges are send back to Landauer for processing.

4. For the survey and monitoring I am using an instrument manufactured by Ludlum Measurements, Inc.

The model number for the instrument is 177-35 (alarm monitor serial no. 105007), and the model number of the probe is 44-7 (serial no. PR-112716). This is an alarm ratemeter that provides visual and audio alarm. With four multiplier scales of 1, 10, 100 and 1000, the range of this meter is from 0 - 500,000 counts per minute.

The probe 44-7 is a thin end window GM detector and can detect Alpha, Beta and Gamma radiation. The efficiency for each ray is:

Beta - 10% c-14, 45% Sr-90

Alpha - 30%

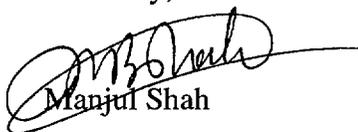
Gamma - 2100 cpm/mR/hr for Cs-137.

I, herewith confirm that the calibration records will be maintained for 3 years.

5. The leak testing service I will be using is provided by Siemens Medical Systems, NRC license no. 12-00369-01. (Please see the attached page for a brief discription of their service).

I hope this information will be sufficient to complete the procedure to issue the license. But if you need any further information, please let me know.

Sincerely,


Manjul Shah

Fiber-Optic-Taper CCD Cameras for X-ray Crystallography

SCX-TE/CCD-1242E

Special Applications

Application #1:

Wide Angle Scattering of Monochromatic X-Rays From Complex Crystals such as Proteins.

Rotating anode sources are used in a laboratory with either copper (8 keV) or Molybdenum (17 keV) anodes. Alternatively, synchrotron sources can provide high brilliance illumination, typically in the range 10-12 keV. Detailed spot patterns must be digitized at small increments of crystal rotation (i.e. "phi-slicing"). Spots are typically 100-200 microns FWHM, with an approximately exponential spot brightness histogram. This leads to a requirement for a large area detector, high dynamic range, and low noise readout.

Application #2:

Small Angle Scattering from Larger Scale Morphological Domains in Materials (e.g. aligned regions in polymers, and grains or precipitates in metals).

The X-Ray sources used are similar to those for the first application (above). Patterns may be more diffuse than wide angle scattering. Relatively rapid imaging may be required to capture phase or morphology changes during thermal or mechanical processing.

Detection Requirements for These Applications

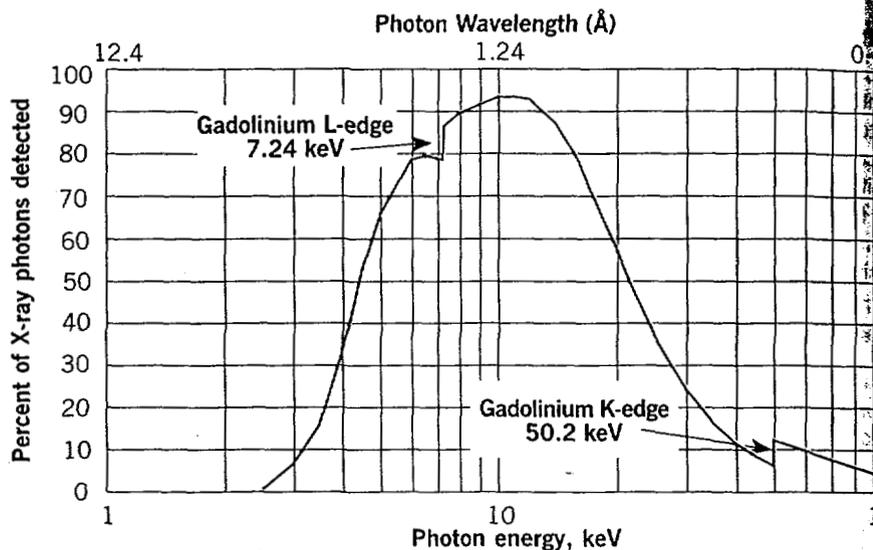
Typically 16 bits dynamic range, large detection area, and low noise.

X-Ray Detection Mechanism Used in This Camera Design

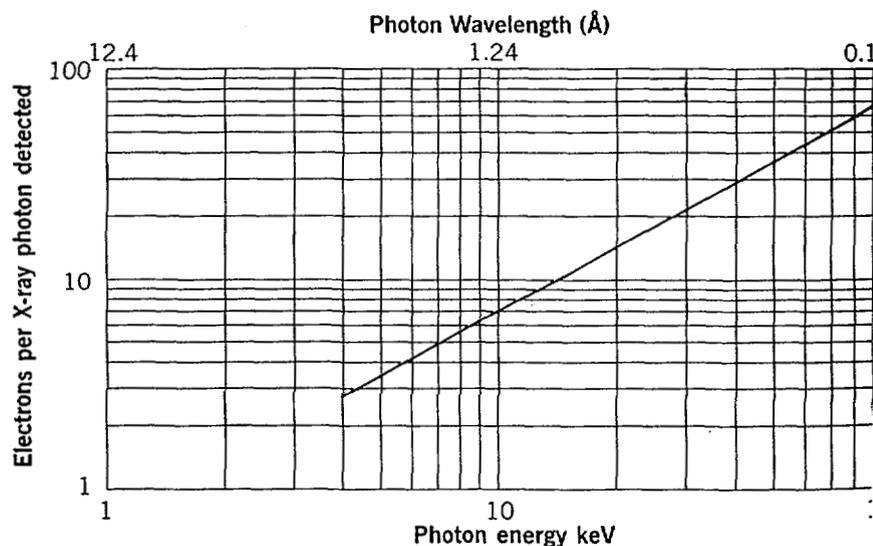
X-Rays are absorbed by a phosphor screen (GdOS:Tb) which emits visible light (500-550 nm). This is coupled to the CCD by a reducing fused fiber optic taper. The CCD detects one or more visible photons per X-ray photon absorbed.

Camera Configuration

The phosphor is attached to the front face of the taper. The phosphor, taper, and CCD are all enclosed in a vacuum chamber,



X-ray quantum efficiency, including GdOS phosphor (25 mg/cm²) and Be window absorption



Detection gain with a 2.3:1 taper ratio. Data in both of the above graphs are representative. Other phosphor screens can be provided with different performance at a tradeoff of resolution.

with a thin (0.5 mm) Beryllium window to admit X-rays. This configuration allows efficient cooling without condensation on the phosphor. Tapers up to 115 mm (full circular aperture viewable) are supported, for maximum field of view. Smaller taper ratios are also supported, for higher sensitivity. The former are best

matched to high brilliance sources and latter to weaker sources and smaller crys

Shuttering and Synchronization

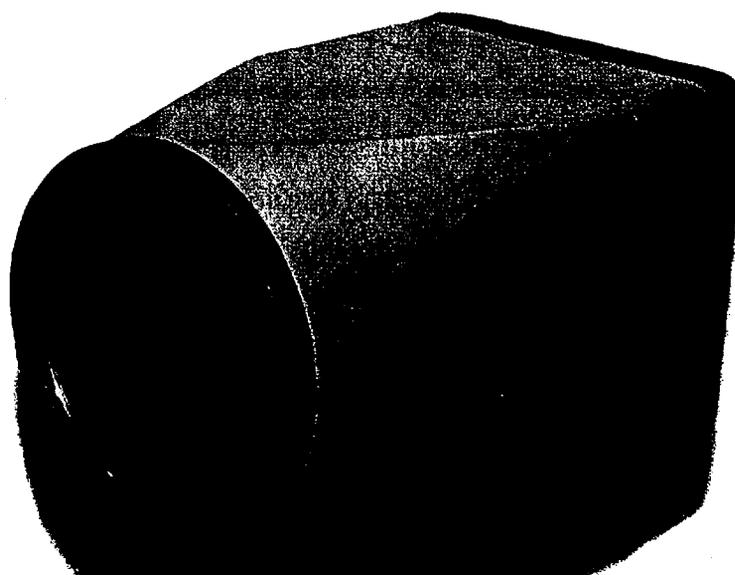
Electrical timing signals are available to the camera controller, for synchronization with a customer provided X-ray shu

The CCD can be continuously cleared of dark charge while waiting for an exposure to begin.

Special Configurations

On a special order basis, custom fiber optic taper configurations can be provided, including configurations to support backscatter imaging or simultaneous wide and small angle scattering (with two cameras).

Frame transfer operation can also be provided, for higher frame rates. Configurations with multiple CCD/taper assemblies can also be provided, on a special order basis. Contact your regional Princeton Instruments salesperson for the latest information concerning these and other options for fiber-optic taper cameras used in X-ray crystallography applications.



Performance Specifications

CCD Array:	EEV CCD-05-30 Grade 1; MPP (lowest dark current), or non-MPP (largest well capacity)	$90\text{ mm} = 14.5\ \mu\text{s}$ $115\text{ mm} =$
Format:	1152×1242 pixels $22.5 \times 22.5\ \mu\text{m}$ pixels (at the CCD) $25.9 \times 27.5\text{ mm}$ (at the CCD)	
Full Well Capacity:	Without binning, 500,000 electrons for non-MPP device, 300,000 electrons for MPP (AIMO) device; With 2×2 binning, 1,200,000 electrons, MPP or non-MPP	
Read Noise:	4-8 electrons at 50 kHz (i.e. <1 X-ray photon at 8 electrons/X-photon) 15 electrons at 150 kHz	
Cooling:	-30°C with water circulation	
CCD Damage Protection:	In this design the CCD itself is not exposed to X-rays, and so is therefore not at risk to X-ray damage	
CCD Blemish Specifications:	43 or fewer point defects; 6 or fewer cluster defects; 2 or fewer partial column defects or 1 or fewer full column defects; Higher and lower grade devices are available on request, please call the factory for details	
Taper Field of View:	Model 1, 115 mm diameter, circular view; Model 2, $65 \times 65\text{ mm}$ square view (90 mm diameter taper, corners of CCD may be underilluminated)	
Taper Reduction Factor:	4.6:1 for Model 1; 2.5:1 for Model 2	
Taper EMA:	5% standard	
Taper Dimensions at CCD:	25 mm diameter for Model 1; $25 \times 25\text{ mm}$ for Model 2	
Taper Gross Distortion:	Includes bow, pincushion, and barrel distortion. Measurement is the deviation from straight of a straight line after passing through the taper. Calculated as a percentage of the taper diameter at the end the measurement is made on. $\leq 2\%$ for both models.	
Taper Shear Distortion:	This type of distortion is where a straight continuous line at one end of the taper becomes a discontinuous line at the other end; Shear magnitude (lateral displacement) $10\text{-}25\ \mu\text{m}$; Shear length, $\leq 60\ \mu\text{m}$; Maximum number allowed, 15; Larger shear distortions not allowed	
Taper Defects:	These are areas with light transmission less than 70% of average; Blemishes less than $75\ \mu\text{m}$ at the small end of the taper, $< 1\%$ of the imaging area; Blemishes $75\text{-}150\ \mu\text{m}$, ≤ 10 ; Blemishes greater than $150\ \mu\text{m}$, none; Chicken wire pattern, $3\text{-}6\text{ mm}$ length, ≤ 5 , none greater than 6 mm	

Special Applications

United States Department of Commerce
National Institute of Standards and Technology

NVLAP[®]

ISO/IEC GUIDE 25:1990
ISO 9002:1987

Certificate of Accreditation



LANDAUER, INC.
GLENWOOD, IL

is recognized under the National Voluntary Laboratory Accreditation Program for satisfactory compliance with criteria established in Title 15, Part 285 Code of Federal Regulations. These criteria encompass the requirements of ISO/IEC Guide 25 and the relevant requirements of ISO 9002 (ANSI/ASQC Q92-1987) as suppliers of calibration or test results. Accreditation is awarded for specific services, listed on the Scope of Accreditation for:

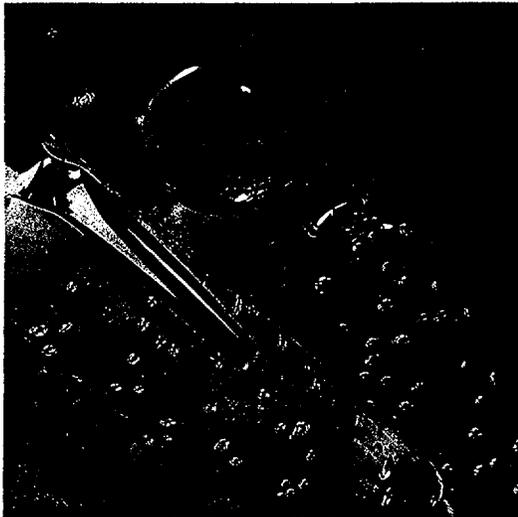
IONIZING RADIATION DOSIMETRY

December 31, 1996

Effective through

David F. Alderman

*For the National Institute of Standards and Technology
NVLAP Lab Code: 100518-0*



BD 100R Bubble Detector

BTI FAST NEUTRON BUBBLE DETECTORS

	Quantity*	Unit Price
BD-100R On/Off	6	\$59.00 each
	12-48	\$55.00 each
BD-100R (TCD)	6	\$95.00 each
	12-48	\$90.00 each

Other BD products and quantity prices available on request.

*BD-100R On/Off & TCD detectors must be ordered in multiples of six units

NRC # 12-00369-01

SIEMENS DOSIMETRY SERVICE

Our easy to use, economical leak testing service helps you comply with NRC requirements as stated in Title 10, Code of Federal Regulations, Parts 30, 31, 32 and 34, and with those of Agreement States. The test kit contains clear step-by-step instructions, along with all the materials you need to perform each test. We'll provide the necessary leak test certificate- and also notify you immediately of any result above 0.001 microcurie

The price is \$35.00 for each kit shipped to you and includes analysis when the kit is returned to Siemens.



Siemens Medical Systems manufacturing facilities in Hoffman Estates

Issued by Siemens Dosimetry Service
 2501 Barrington Road, Hoffman Estates, IL 60195
 Phone 800-666-4552 Phone (708) 304-7282 Fax (708) 304-7723

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Printed in the U.S.A. DOS 12/94