

# RI - DNMS Licensee Event Report Disposition

Licensee: Pennsylvania Hospital  
 Event Description: Underdose due to possible Patient Intervention (comm. knife)  
 License No: 37-0084-06 Docket No: 0205163 MLER-RI: 2006-035  
 Event Date: 05/19/06 Report Date: 09/19/06 HQ Ops Event #: 42850

## 1. REPORTING REQUIREMENT

<input type="checkbox"/> 10 CFR 20.1906 Package Contamination	<input type="checkbox"/> 10 CFR 30.50 Report
<input type="checkbox"/> 10 CFR 20.2201 Theft or Loss	<input checked="" type="checkbox"/> 10 CFR 35.3045 Medical Event
<input type="checkbox"/> 10 CFR 20.2203 30 Day Report	<input type="checkbox"/> License Condition
<input type="checkbox"/> Other	

## 2. REGION / RESPONSE

<input checked="" type="checkbox"/> Immediate Site Inspection - <u>identified during routine inspection</u>	Inspector/Date: <u>Gabriel 9/18/06</u>
<input type="checkbox"/> Special Inspection	Inspector/Date:
<input type="checkbox"/> Telephone Inquiry	Inspector/Date:
<input type="checkbox"/> Preliminary Notification/Report	<input type="checkbox"/> Daily Report
<input checked="" type="checkbox"/> Information Entered in RI Log	<input type="checkbox"/> Review at Next Inspection
<input type="checkbox"/> Report Referred To:	

## 3. REPORT EVALUATION

<input checked="" type="checkbox"/> Description of Event	<input checked="" type="checkbox"/> Corrective Actions
<input checked="" type="checkbox"/> Levels of RAM Involved	<input checked="" type="checkbox"/> Calculations Adequate
<input checked="" type="checkbox"/> Cause of Event	<input type="checkbox"/> Additional Information Requested from Licensee

## 4. MANAGEMENT DIRECTIVE 8.3 EVALUATION

<input type="checkbox"/> Release w/Exposure > Limits	<input type="checkbox"/> Deliberate Misuse w/Exposure > Limits
<input type="checkbox"/> Repeated Inadequate Control	<input type="checkbox"/> Pkging Failure > 10 rads/hr or Contamination > 1000x Limits
<input type="checkbox"/> Exposure 5x Limits	<input type="checkbox"/> Large# Indivs w/Exp > Limits or Medical Deterministic Effects
<input type="checkbox"/> Potential Fatality	<input type="checkbox"/> Unique Circumstances or Safeguards Concerns
<input type="checkbox"/> If any of the above are involved:	
<input type="checkbox"/> Considered Need for IIT	<input type="checkbox"/> Considered Need for AIT
Decision/Made By/Date:	

## 5. MANAGEMENT DIRECTIVE 8.10 EVALUATION (additional evaluation for medical events only)

<input checked="" type="checkbox"/> Timeliness - Inspection Meets Requirements (5 days for overdose / 10 days for underdose)
<input checked="" type="checkbox"/> Medical Consultant Used-Name of Consultant/Date of Report: <u>Diamond 10/10/06</u>
<input type="checkbox"/> Medical Consultant Determined Event Directly Contributed to Fatality
<input type="checkbox"/> Device Failure with Possible Adverse Generic Implications
<input type="checkbox"/> HQ or Contractor Support Required to Evaluate Consequences

## 6. SPECIAL INSTRUCTIONS OR COMMENTS

\*per email from RSO, source activity was 5191 Ci on date of event.

☒ Non-Public

Inspector Signature: A. Gabriel

Date: 10/11/06

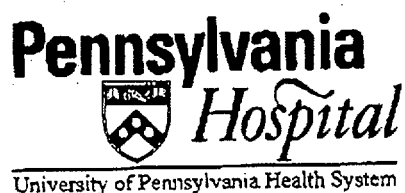
☐ Public-SUNSI REVIEW COMPLETE

Branch Chief Initials: [Signature]

Date: 10/17/06

Location of File: G:\Reference\Blank Forms\LER FORM.wpd

Rev. 02/25/05



September 19, 2006

Leonard Shabason, Ph.D.  
Radiation Oncology  
Pennsylvania Hospital  
800 Spruce Street  
Philadelphia, PA 19107

Sandra Gabriel  
Senior health Physicist  
U. S. Nuclear Regulatory Commission  
Division of Nuclear Safety  
Region I  
475 Allendale Road  
King of Prussia, PA 19406

RE: License Number 37-06864-06  
Gamma Knife

Dear Ms. Gabriel:

As we discussed on your inspection of September 18, 2006, we are providing you with a formal report of the incident involving a Gamma Knife patient on May 19, 2006.

We have just received a copy of NRC Information Notice 2006-11 regarding the definition patient intervention regarding slippage of a Leksell frame for a Gamma Knife treatment. After reviewing the document, we have decided to report an event that occurred on May 19, 2006 that we also classified as being caused by patient intervention.

Copies of the reports that were generated at the time are attached. To summarize, on May 19, 2006 an elderly patient was framed an imaged for the treatment of single large metastatic lesion. The measurements indicated that there would be a "collision" between the anterior left post and the gamma knife helmet. The neurosurgeon who was responsible for the patient decided that it would be in the best interest of the patient to remove the anterior left pin and post rather than having to re-frame and re-image the

Gamma Knife Report- Pennsylvania Hospital  
License Number 37-06864-06

- 2 -

patient. After the left post was removed the other pins were checked to confirm that the frame was still firmly attached to the patient. In the middle of the first of nine shots, the patient became very agitated and her body was observed to shift. Unfortunately, the patient's head is not observable with either of our closed circuit TV cameras when the patient is in treatment position. We halted the treatment after the first shot to examine the patient and found that she was not held in place by the pins. Dr. LeRoux, the patient's neurosurgeon immediately spoke with the patient's daughter to explain what had happened and they decided to reschedule the treatment for the following week. On May 26, 2006 the patient was treated to a dose of 18 Gy to a volume of about 6.5 cc. If the patient was in one position during the shot delivered on May 19, the delivered dose is estimated to be 6 Gy to a volume of about 0.6 cc. We have no way of knowing the exact position of the patient's head during this 3.86 minute treatment. At the end the shot we could see that her head was at the correct level but that her head may have dropped down which potentials would have resulted in a dose delivered anterior to the lesion. Since dose homogeneity is not important for gamma knife treatment and the volume in question is a small fraction of the volume prescribed treatment volume and the position was uncertain, the dose from May 19 was not considered for the treatment of May 26. The area of the patient's brain that could have received unintended incorrect dose did not include an area that would be detrimentally affected by the dose given.

We have included a copy of the departmental policy that governs the use of three pins fixation. Since the decision to remove the pin and attempt to treat the patient that day was made in the patient's best interest, we cannot say that we would have decided differently in this case. The remaining pins were tested and the physicians responsible for framing checked that the frame appeared to be securely fixed to the patient's head. In retrospect, the treatment should have been paused earlier when we first noticed significant patient movement. Incidentally, we have not removed a pin and post since the incident of May 19. In one instance where it might have been possible to proceed if a post was removed, the neurosurgeon elected to reframe and re-image the patient. We are reluctant to entirely give up the possibility of a three pin treatment if the responsible physicians believe that this is feasible and in the best interest of the patient.

What we will do in the future is to take the patient's mental status and the degree to which the patient is able to comply with the requirements of the treatment as to whether or not we will remove one of the four pins and posts. We are convinced that the treatment of this patient would have been completed without incident through all the nine planned shots in the first treatment plan if she had no struggled. The subsequent treatment on May 26 was done with the frame placed in a manner so that there would be no need to remove a pin and post. The plan was also designed to use a larger helmet so that the entire treatment would require the least amount of time and cover the required volume.

Gamma Knife Report- Pennsylvania Hospital  
License Number 37-06864-06

- 3 -

We did not report this incident to you at the time the event occurred because we believed that the incident was due to patient intervention as did the sites discussed in the information notice. If we experience any similar events in the future, they will be promptly reported to the NRC as required by 10 CFR 35.3045.

We have enclosed copies of the directives for both treatments, reports of the incident, the two treatment plans and the radiation oncologist's report of the second treatment. We commit to ensuring that any partial treatment will have an appropriate internal report regardless of the reason that a treatment could not be completed as planned. We will report any future occurrences that may have its origin in either the equipment itself (here the frame) or how we may have handled the equipment. We will not file reports in situations where the treatment was interrupted or canceled due to patient illness.

Please contact me if you have any additional question about this incident.

Sincerely,

A handwritten signature in black ink, appearing to read "Leonard Shabason", followed by a horizontal line.

Leonard Shabason, Ph.D.  
Radiation Safety Officer

Attachments

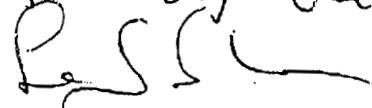
## GAMMA KNIFE WRITTEN DIRECTIVE

PENNSYLVANIA HOSPITAL  
RADIATION ONCOLOGYPATIENT NAME: ~~XXXXXXXXXX~~ NO. ~~XXXXXXXXXX~~ DATE: May 19, 2006RADIOISOTOPE: COBALT 60Deliver 15.0 Gy to the 50% isodose as specified in the approved treatment plan.

One metastatic lesion

RADIATION ONCOLOGIST (PRINT): Jeffrey G. Rosenstock, MDRADIATION ONCOLOGIST (SIGNATURE): DATE: 5/19/06

Patient moved about and  
was examined after  
first "shot" and was found  
to be out of focus.

Patient was rescheduled  
for new framing and  
imaging for following week.  


PENNSYLVANIA HOSPITAL  
RADIATION ONCOLOGY  
GAMMA KNIFE

Patient: [REDACTED]

Date: May 19, 2006

Chart #: GK 05-345

Diagnosis: lung cancer, nsc

Region Treated: tumor bed, right posterior

Following obtaining written permission including review of specific risks and potential benefits as well as answering questions, the patient had the Leksell Gamma Knife frame attached using local anesthesia. The region to be treated was defined by MRI as per protocol. The images were transferred to Gamma plan and the target volume and shot planning were done along with the neurosurgeon.

The patient was brought in to the Gamma Knife and the course of treatment was begun using three pins for immobilization because of collision issue. The patient was agitated and came out of frame during first planned shot or 8 mm. The rest of the frame was removed. The patient was held over night and rescheduled. Less than 10% of the prescribed dose was delivered before the plan was aborted.

Jeffrey Rosenstock MD



**GAMMA KNIFE CENTER  
PENNSYLVANIA HOSPITAL**

**INTERNAL REPORT**

On May 19, 2006 [REDACTED] was to be treated for one metastatic lesion. Framing was done by the neurosurgeon, Peter LeRoux, M.D. The Leskell frame was placed on the patient in the normal manner.

MRI images were obtained for treatment planning purposes. The prescription was to deliver 15 Gy to the 50% isodose. The volume enclosed by this was approximately 5.5 cc.

The planning system indicated that there would be a "collision" between the anterior left post and the helmet. The physicians decided that they would like to avoid having to reframe the patient because of her frail condition. The decision was made to remove the anterior left pin and post and proceed with the treatment. In accordance the department's policy regarding the removal of pin and posts, the physicians checked to determine whether or not the frame was still firmly attached to the patient before proceeding.


During the first shot, it was noticed that the patient became very agitated. It was decided to pause the treatment after the first shot in order to further sedate the patient. When the staff approached the patient, it was noticed that she had worked loose of the remaining pins. At that point the treatment was stopped. Dr. LeRoux immediately spoke with the patient's daughter who was in the department to inform her of what had occurred. They decided that they would attempt the treatment again sometime during the following week.

The single shot consisted of a 3.86 min exposure with the 8 mm helmet. If the patient was in the proper position for the entire treatment a dose of approximately 6 Gy would have been delivered to a volume of about 0.6 cc. Since there is no way of definitely knowing when the patient was out of the frame and the exact location her head, there is no way of definitely know what the doses actually were. It appeared that her head was a about the level of where she was framed.

It is not obvious what could have been done to avoid this incident. The physicians used their judgment as to what was best for the patient since they believe that the gamma knife treatment was the preferred treatment rather than not treating the lesion or recommending surgery.

Since the patient was primarily responsible for the fact that the treatment could not be completed as planned, this should not be considered a reportable medical event per the definition given in 10 CFR 35.3045 since patient intervention was the cause of the event.

A copy of this report will be maintained for evaluation by the NRC during our next inspection.

  
Leonard Shabason, Ph.D.  
Radiation Safety Officer



**GAMMA KNIFE WRITTEN DIRECTIVE**

**PENNSYLVANIA HOSPITAL  
RADIATION ONCOLOGY**

PATIENT NAME:                     ; NO.                     ; DATE: May 26, 2006

RADIOISOTOPE: COBALT 60

Deliver 18.0 Gy to the 50% isodose as specified in the approved treatment plan.

One metastatic lesion

RADIATION ONCOLOGIST (PRINT): Jeffrey G. Rosenstock, MD

RADIATION ONCOLOGIST (SIGNATURE): 

DATE: 5/26/06

**GAMMA KNIFE CENTER  
PENNSYLVANIA HOSPITAL**

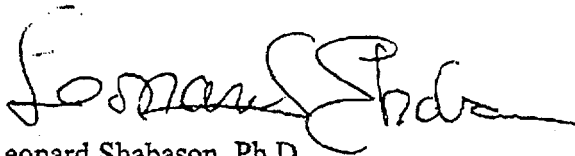
**INTERNAL REPORT#2**

On May 26, 2006 [REDACTED] was treated for one metastatic lesion. Framing was done by the neurosurgeon, Peter LeRoux, M.D. Dr. LeRoux adjusted the frame placement in order to avoid the problems encountered during the first attempt to treat the patient.

MRI images were obtained for treatment planning purposes. The prescription was to deliver 18 Gy to the 50% isodose. The volume enclosed by this was approximately 6.5 cc.

This time the plan was fashioned so that there would be a minimum number of "shots" with the largest helmet to reduce the time the patient was in the gamma knife. The treatment consisted of three shots with the 18 mm helmet. It was agreed that the treatment would be paused if there was any suspicion that the patient was sufficiently agitated that she might be out of the frame. The patient was examined between the first and second shot and was found to be firmly locked in the frame. The patient was found to be in the correct position at the conclusion of the treatment.

No attempt was made to compensate for the partial treatment from the first attempt since there was no way of knowing how much of the dose was actually delivered to the target volume. Since there were no critical structures near the treatment volume, the physicians decided that it was most important that the target volume not be underdosed.



Leonard Shabason, Ph.D.  
Radiation Safety Officer

# Pennsylvania



# Hospital

University of Pennsylvania Health System

Patient Name: [REDACTED]  
DOB: 03/07/1930  
MRN: [REDACTED]  
Accession: 1667461  
Patient Address: [REDACTED]

Patient Location: XRT RADTH Patient Status: 1  
Date/Time of Exam: 5/26/06 2:18 pm  
Visit #: 108359415  
Admit Date: 08/26/2005

Requesting Provider: ROSENSTOCK, JEFFREY, MD  
800 SPRUCE STREET (8/2004)  
RADIATION ONCOLOGY  
PHILADELPHIA, PA 19107

Attending Provider: ROSENSTOCK, JEFFREY, MD  
800 SPRUCE STREET (8/2004)  
RADIATION ONCOLOGY  
PHILADELPHIA, PA 19107

Report To Provider: Hartner, Lee,  
230 W Washington Sqr  
Philadelphia, PA  
19107

Report To Provider: LEROUX, PETER,  
PENN NEUROLOGICAL INST 4TH FLR(8/2004)  
PHILA, PA  
19107

CPT Code: Exam: Note to Record

Signs & Symptoms: BRAIN MET

History:

Chart Number: 05-345  
Diagnosis: brain mets  
Dose to the Periphery: 18 Gy  
Date of Procedure: May 26 2006

The patient following evaluation and giving permission was fitted with the Leksell frame using local anesthesia by the neurosurgeon. Following framing, the patient was transported to MRI for imaging per the protocol. The images were then transferred to the Gamma Plan and following target definition, the plan was formulated by the neurosurgeon along with the radiation oncologist using shots- 3 with the 18 mm helmet to encompass the target with 18 Gy at the 50 % isodose. The patient following agreement of the plan and the dose prescription by the neurosurgeon and the radiation oncologist was positioned in the Gamma Knife couch. Following all QA by the physicist, the patient was treated with all the planned shots in 10.49 minutes of treatment time without complication. Following the procedure the Leksell frame was removed.

I participated in the shot planning and dose planning and was present and observed the complete treatment.

Jeffrey Rosenstock MD

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5/26/2006 2:52:10 PM PAGE 2/002 Fax Server

Patient Name: [REDACTED]  
DOB: [REDACTED]  
MRN: [REDACTED]  
Accession: 1667461  
Patient Address: [REDACTED]

Patient Location: XRT RADTH Patient Status: I  
Date/time of Exam: 5/26/06 2:18 pm  
Visit #: 108359415  
Admit Date: 08/26/2005

ROSENSTOCK, JEFFREY  
Approved By: ROSENSTOCK, JEFFREY

Treatment Plan of 5/19/06

<b>Gamma Knife Clinic</b> <b>Treatment Planning Protocol</b> <i>for the</i> <b>Leksell Gamma Knife C</b> <b>Leksell GammaPlan Wizard 4C</b>	Patient: <span style="background-color: black; color: black;">XXXXXXXXXX</span> Patient ID: <span style="background-color: black; color: black;">XXXXXXXXXX</span> Diagnosis: <b>Metastasis Single</b> Treatment Date: <b>MAY 19, 2006</b> Operator: <b>PLR/JGR/LS</b>
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**Treatment Data**

Point	X	Y	Z	Comment
Dose matrix center	68.3	72.0	132.4	Grid: 1.6 mm
Reference point	69.9	73.6	134.0	At max point
Max point in matrix	69.9	73.6	134.0	Dose: 30.00 Gy
Number of target points: 9				
Verify that all shots can be achieved in the Gamma Knife!				
Prescription Dose: 15.00 Gy to Prescription Isodose: 50.00 %				

**A:Matrix Data**

Point	X	Y	Z	Comment
Dose matrix center	68.3	72.0	132.4	Grid: 1.6 mm
Max point in matrix	69.9	73.6	134.0	Dose: 30.00 Gy
Number of target points: 9				

**Target Point Summary for A:Matrix**

Target	Shot	X	Y	Z	$\gamma$	Coll	Plug	Weight	Time	Notes
1-1	A2	64.6	75.7	130.0	90°	14	None	0.80	2.92	*
2-1	A1	67.5	63.6	131.8	90°	14	None	0.50	1.80	*
3-1	A3	59.6	66.8	124.8	90°	8	None	1.00	3.61	*
4-1	A4	67.6	58.8	125.0	90°	8	None	1.00	3.66	*
5-1	A5	70.9	70.3	124.9	90°	8	None	0.60	2.29	*
6-1	A9	69.1	81.2	134.3	90°	8	None	0.30	1.16	*
7-1	A7	71.5	75.6	135.0	90°	8	None	1.00	3.86	*
8-1	A6	68.6	65.3	135.1	90°	8	None	1.00	3.74	*
9-1	A8	77.3	66.9	137.7	90°	8	None	1.00	3.86	*
Shots marked with '*' are estimated to be unachievable due to collision.										

**Comments:**

Pt twisted seat off  
frame at first shot #

Shot 9-1  
tracked

Gamma Knife Clinic

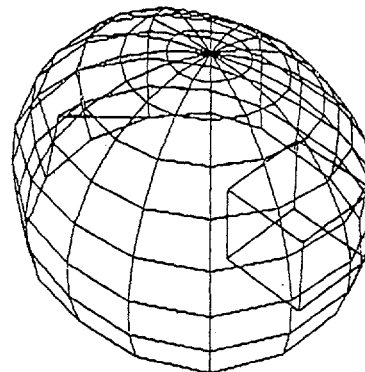
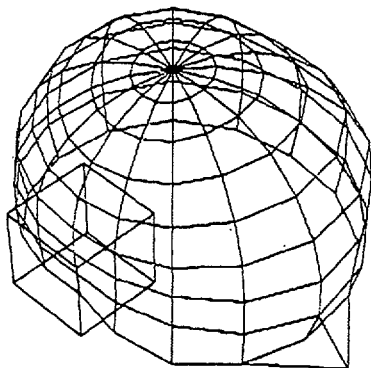
Leksell GammaPlan 4C

**Skull Geometry**

Top	78.0							
	1	2	3	4	5	6	7	8
A	85.0		87.0		74.0		84.0	
B		95.0		76.0		75.0		93.0
C	89.0	91.0	92.0	70.0	60.0	72.0	86.0	94.0
D	89.0	95.0		82.0	62.0	75.0	85.0	94.0

Anterior right view

Posterior left view

**Approved for Treatment**

*[Signature]*

*[Signature]*

*[Signature]*

## Gamma Knife Clinic

Leksell GammaPlan 4C

**Target Point 1-1 (Shot A2)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
14 mm	64.6, 75.7, 130.0	90°	None	2.92
Effective plug pattern:				0 sources plugged

**Target Point 2-1 (Shot A1)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
14 mm	67.5, 63.6, 131.8	90°	None	1.80
Effective plug pattern:				0 sources plugged

**Target Point 3-1 (Shot A3)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
8 mm	59.6, 66.8, 124.8	90°	None	3.61
Effective plug pattern:				0 sources plugged

**Target Point 4-1 (Shot A4)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
8 mm	67.6, 58.8, 125.0	90°	None	3.66
Effective plug pattern:				0 sources plugged

**Target Point 5-1 (Shot A5)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
8 mm	70.9, 70.3, 124.9	90°	None	2.29
Effective plug pattern:				0 sources plugged



## Gamma Knife Clinic

Leksell GammaPlan 4C

**Target Point 6-1 (Shot A9)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
8 mm	69.1, 81.2, 134.3	90°	None	1.16
Effective plug pattern:				0 sources plugged

**Target Point 7-1 (Shot A7)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
8 mm	71.5, 75.6, 135.0	90°	None	3.86
Effective plug pattern:				0 sources plugged

**Target Point 8-1 (Shot A6)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
8 mm	68.6, 65.3, 135.1	90°	None	3.74
Effective plug pattern:				0 sources plugged

**Target Point 9-1 (Shot A8)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
8 mm	77.3, 66.9, 137.7	90°	None	3.86
Effective plug pattern:				0 sources plugged

Gamma Knife Clinic



Leksell GammaPlan 4C

**Shot Dose Data**

Target Run-Step	Shot	Dose rate at Focus [Gy/min]	Contribution to max point [%]	Distance to max point [mm]	Extrapolated Skull Radii
1-1	A2	3.4	28.6	7.0	38
2-1	A1	3.4	8.0	10.5	45
3-1	A3	3.4	1.9	15.4	11
4-1	A4	3.4	2.4	17.5	9
5-1	A5	3.2	0.5	9.7	9
6-1	A9	3.2	3.6	7.6	59
7-1	A7	3.2	39.1	2.7	58
8-1	A6	3.3	9.0	8.5	66
9-1	A8	3.2	6.8	10.6	65

**Formula for calculating individual shot time:**

Shot Time = (Normalization factor for absolute dose) \* Weight / (Dose rate at Focus)

<b>Gamma Knife Clinic</b> <b>Physics Protocol</b> <i>for the</i> <b>Leksell Gamma Knife C</b> <b>Leksell GammaPlan Wizard 4C</b>	Patient:	
	Patient ID:	
	Diagnosis:	<i>Metastasis Single</i>
	Treatment Date:	<i>MAY 19, 2006</i>
	Operator:	<i>PLR/JGR/LS</i>

### Gamma Knife Data

Calibration dose	3.466 Gy/min at Nov 9, 2005
Treatment date decay factor	0.933
Current dose rate (MAY 19, 2006)	3.233
Collimator factors (4,8,14,18)	0.870, 0.956, 0.984, 1.000
Linear attenuation coefficient [1/mm]	0.0063
Source to Focus Distance [mm]	400.00

### Treatment Dose Data

Maximum dose [%] (Before normalization)	243.635
Maximum dose [%] (After normalization)	100.000
A:Matrix: Number of matrix points with dose > 30%	2740 (of 29791)
Normalization factor for relative dose	0.410
Normalization factor for absolute dose [Gy]	12.314
Total treatment time [min]	26.89

*PL* 5/19/06

Treatment plan of 5/26/06

<b>Gamma Knife Clinic</b> <b>Treatment Planning Protocol</b> <i>for the</i> <b>Leksell Gamma Knife C</b> <b>Leksell GammaPlan Wizard 4C</b>	Patient:	<del>XXXXXXXXXX</del>
	Patient ID:	<del>XXXXXXXXXX</del>
	Diagnosis:	Metastasis Single
	Treatment Date:	may 26, 2006
	Operator:	PLR, JR, LS

### Treatment Data

Point	X	Y	Z	Comment
Dose matrix center	78.2	61.1	111.0	Grid: 1.7 mm
Reference point	81.6	61.1	114.4	At max point
Max point in matrix	81.6	61.1	114.4	Dose: 36.00 Gy
Number of target points: 3				
Verify that all shots can be achieved in the Gamma Knife!				
Prescription Dose: 18.00 Gy to Prescription Isodose: 50.00 %				

### A:Matrix Data

Point	X	Y	Z	Comment
Dose matrix center	78.2	61.1	111.0	Grid: 1.7 mm
Max point in matrix	81.6	61.1	114.4	Dose: 36.00 Gy
Number of target points: 3				

### Target Point Summary for A:Matrix

Target	Shot	X	Y	Z	$\gamma$	Coll	Plug	Weight	Time	Notes
1-1	A2	80.0	57.2	110.9	110°	18	None	1.00	4.72	
1-2	A1	76.3	67.1	115.2	110°	18	None	1.00	4.80	C
1-3	A3	88.7	57.9	117.1	110°	18	None	0.20	0.96	C

No collisions detected.

Check shots marked with 'C' for collision (estimated margin less than 12 mm).

### Comments:

Previous right cerebellar met, attempted LGK one week ago

Gamma Knife Clinic

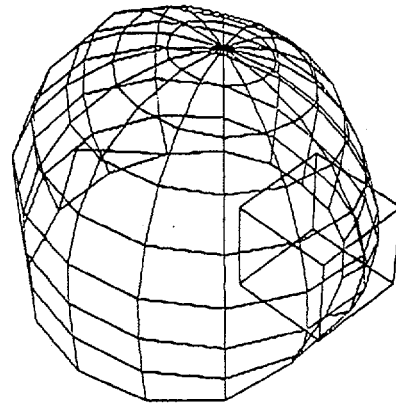
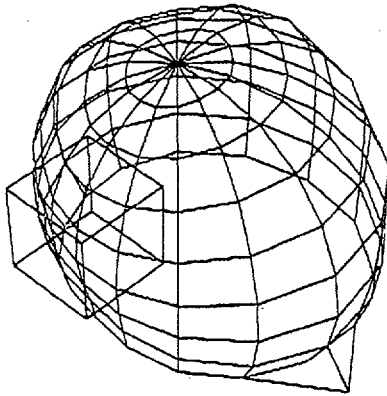
Leksell GammaPlan 4C

**Skull Geometry**

Top	98.0							
	1	2	3	4	5	6	7	8
A	109.0		105.0		85.0		96.0	
B		103.0		84.0		69.0		100.0
C	95.0	95.0	96.0	76.0	57.0	63.0	82.0	93.0
D	100.0	100.0		72.0	57.0	60.0	68.0	92.0

Anterior right view

Posterior left view

**Approved for Treatment**

*[Signature]*

*[Signature]*

*[Signature]*

Gamma Knife Clinic

Leksell GammaPlan 4C

**Target Point 1-1 (Shot A2)**



Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
18 mm	80.0, 57.2, 110.9	110°	None	4.72
Effective plug pattern:				0 sources plugged

**Target Point 1-2 (Shot A1)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
18 mm	76.3, 67.1, 115.2	110°	None	4.80
Effective plug pattern:				0 sources plugged

**Target Point 1-3 (Shot A3)**

Collimator Helmet	Coordinate x, y, z	Gamma Angle	Plugging	Treatment Time
18 mm	88.7, 57.9, 117.1	110°	None	0.96
Effective plug pattern:				0 sources plugged

<b>Gamma Knife Clinic</b> <b>Physics Protocol</b> <i>for the</i> <b>Leksell Gamma Knife C</b> <b>Leksell GammaPlan Wizard 4C</b>	Patient:	
	Patient ID:	
	Diagnosis:	<b>Metastasis Single</b>
	Treatment Date:	<b>may 26, 2006</b>
	Operator:	<b>PLR, JR, LS</b>

### Gamma Knife Data

Calibration dose	3.466 Gy/min at Nov 8, 2005
Treatment date decay factor	0.931
Current dose rate (may 26, 2006)	3.225
Collimator factors (4,8,14,18)	0.870, 0.956, 0.984, 1.000
Linear attenuation coefficient [1/mm]	0.0063
Source to Focus Distance [mm]	400.00

### Treatment Dose Data

Maximum dose [%] (Before normalization)	214.159
Maximum dose [%] (After normalization)	100.000
A:Matrix:Number of matrix points with dose > 30%	2703 (of 29791)
Normalization factor for relative dose	0.467
Normalization factor for absolute dose [Gy]	16.810
Total treatment time [min]	10.49

### Shot Dose Data

Target Run-Step	Shot	Dose rate at Focus [Gy/min]	Contribution to max point [%]	Distance to max point [mm]	Extrapolated Skull Radii
1-1	A2	3.6	45.2	5.5	0
1-2	A1	3.5	45.8	8.0	0
1-3	A3	3.5	9.0	8.2	0

**Formula for calculating individual shot time:**

$$\text{Shot Time} = (\text{Normalization factor for absolute dose}) * \text{Weight} / (\text{Dose rate at Focus})$$



# **Penn Gamma Knife at Pennsylvania Hospital**

## **Three Point Frame Fixation Policy**

Under normal circumstances, four posts and pins will be used to secure the Leksell stereotactic frame to the patient's skull. However, there may be situations where the removal of a pin or an entire post may be considered in order to avoid a collision with the collimator helmet. The choices under these circumstances are the following: 1) to change the treatment plan to avoid positions that create the collision, 2) to reframe, rescan, and recreate a treatment for the patient, or 3) to remove the pin or post that is responsible for the collision.

It is the policy of the Penn Gamma Knife Center at Pennsylvania Hospital that if a collision cannot be avoided by either of the first two methods, and the only solution is to remove the offending pin or post, and then the responsible physicians will perform the following procedures:

1. Prior to initiation of the treatment, the responsible physicians will physically confirm that the frame is firmly attached to the patient's skull. This can be accomplished by manual inspection and confirmation.
2. During the treatment, all efforts will be made to monitor the patient to insure that the frame remains secure.
3. At the completion of treatment, another inspection will be made to confirm secure fixation to the skull

If there is any doubt or concern about secure fixation that is raised during the manual inspection, the options include removing the frame and redoing the frame placement, or repeating the MRI and/or CT scan to verify that there has been no change in position or accuracy.