CBCT for Prone Breast

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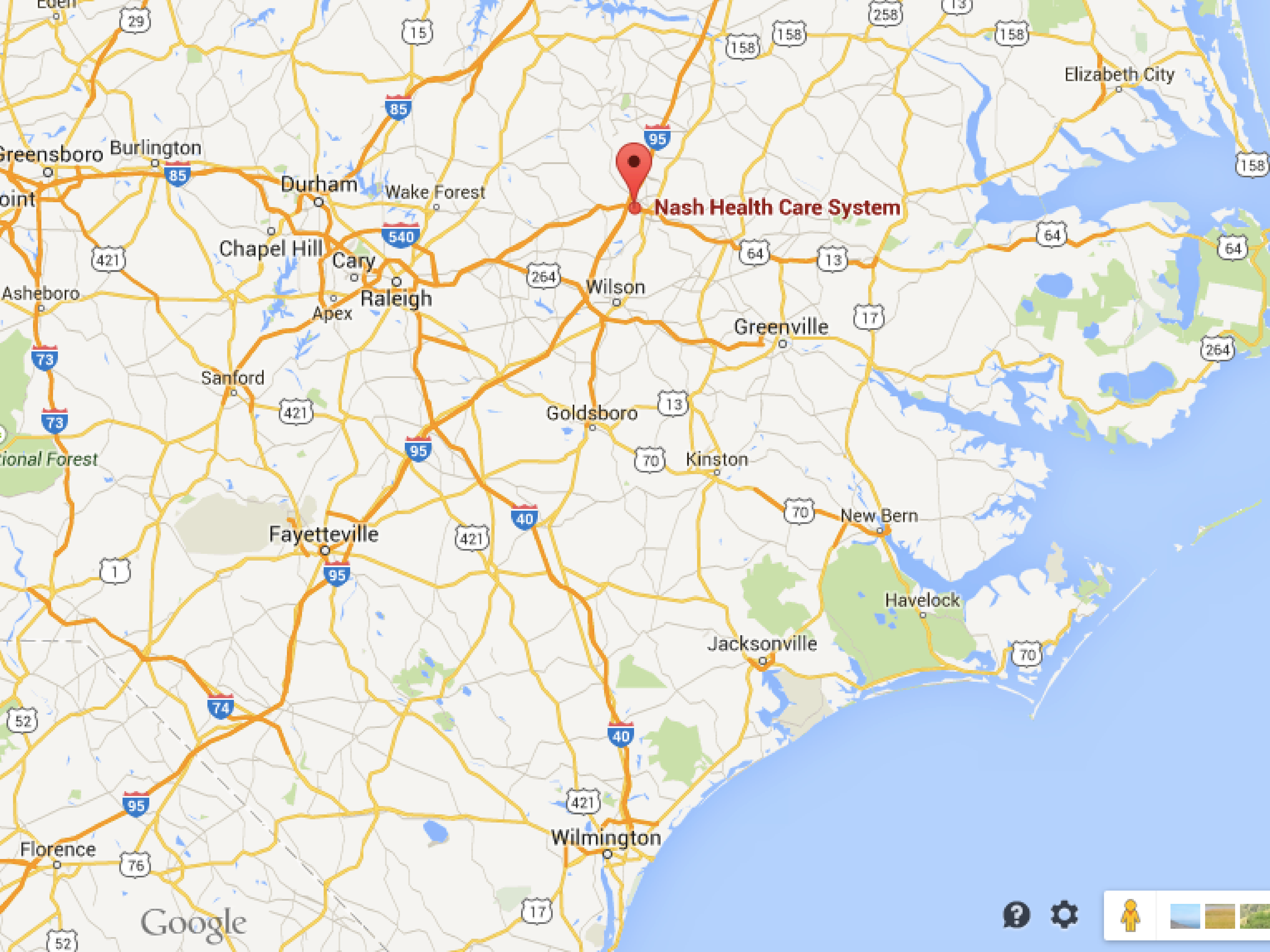
Nash Cancer Treatment Center



Nash Health Care System
Elizabeth City
Greensboro
Burlington
Durham
Wake Forest
Chapel Hill
Cary
Raleigh
Apex
Asheboro
Wilson
Greenville
Sanford
Goldsboro
Kinston
New Bern
Fayetteville
Havelock
Jacksonville
Wilmington
Florence
Google

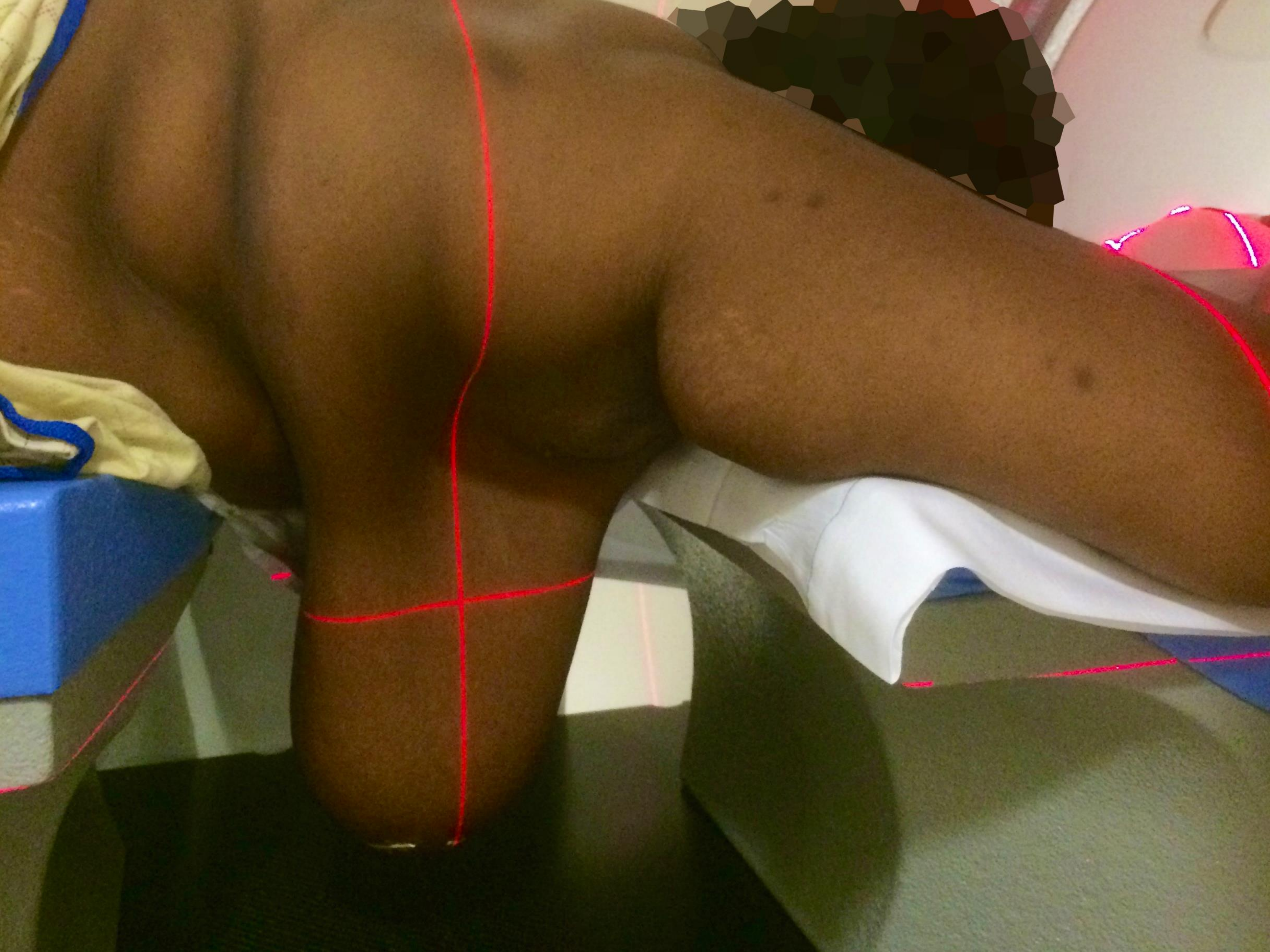
Disclosures

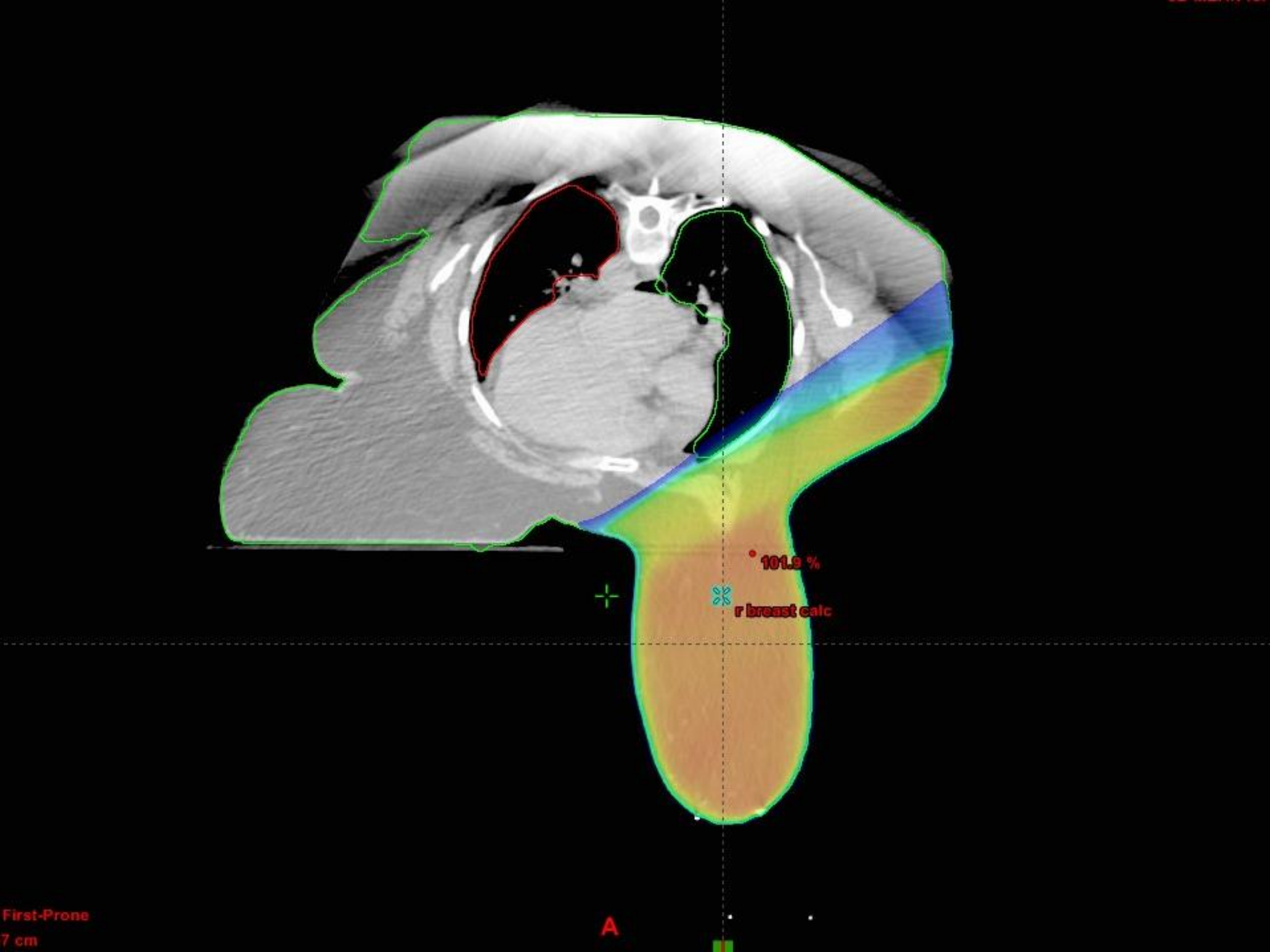
- No outside funding or support

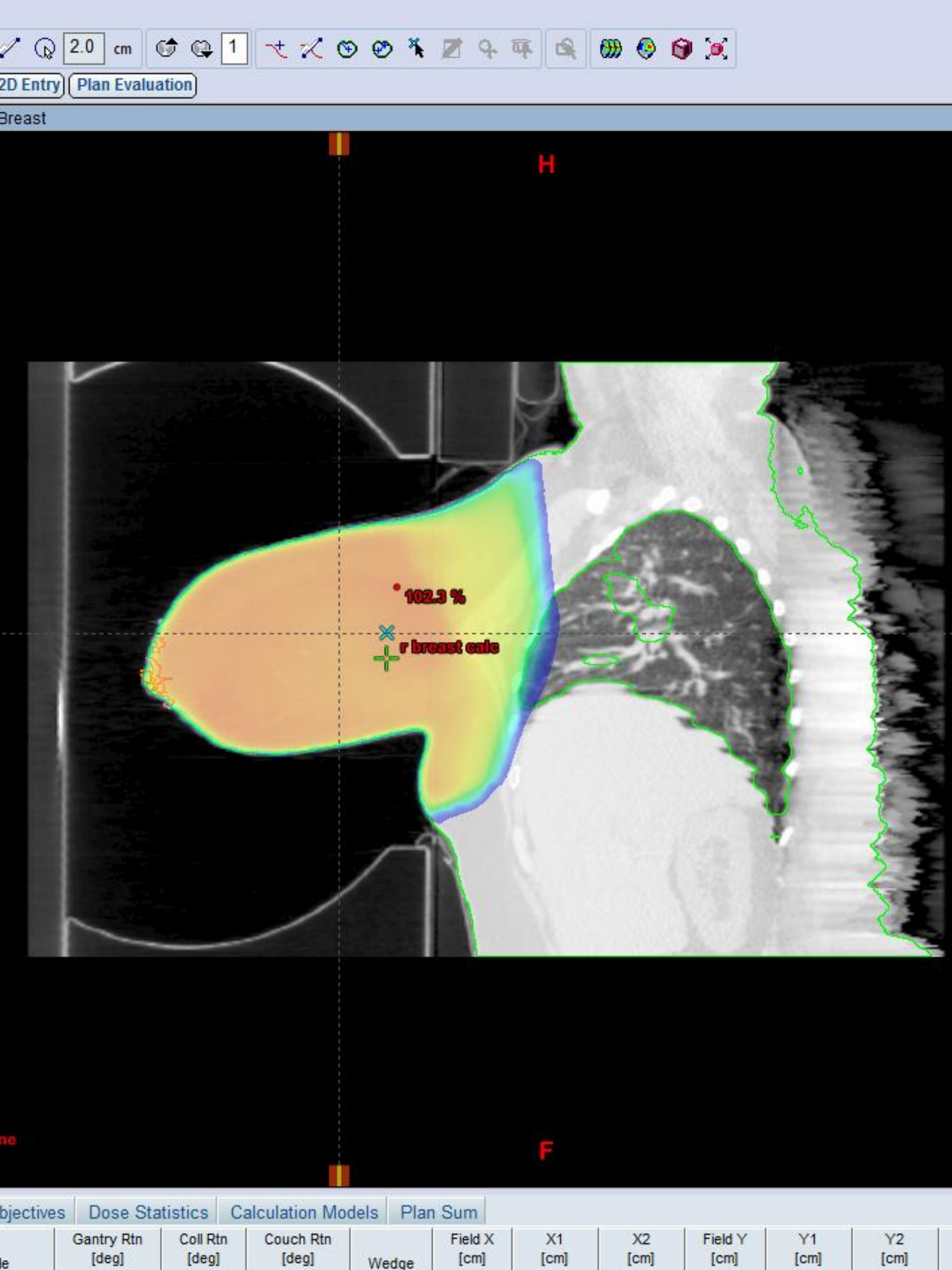
Disclosures

- Techniques likely apply across vendors

Prone Breast Technique




101.9 %
r breast calc
First-Prone
7 cm
A



2.0 cm
1
2D Entry
Plan Evaluation
Breast
H
102.3 %
r breast calc
F
Objectives
Dose Statistics
Calculation Models
Plan Sum
Gantry Rtn [deg]
Coll Rtn [deg]
Couch Rtn [deg]
Wedge
Field X [cm]
X1 [cm]
X2 [cm]
Field Y [cm]
Y1 [cm]
Y2 [cm]

Rationale
for Prone Breast

- Several studies have documented the benefits of prone setup for breast irradiation.

Prone position breast irradiation

Merchant, T., and McCormick, B.
Red Journal 30.1 (1994): 197-203.

- “Irradiation of the heart, lungs, chest wall and contralateral breast are minimized with this technique.”

Prone position breast irradiation

Merchant, T., and McCormick, B.
Red Journal 30.1 (1994): 197-203.

- “The improvements appear to benefit women with large breasts, pendulous breasts, large separations and/or irregularly shaped chest contours.”

Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry

Kirby, A., *et al.*

Green Journal 96.2 (2010): 178-184.

- Prone positioning reduced ipsilateral-lung mean
  - 65/65 WBI
  - 61/65 PBI cases

Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry

Kirby, A., *et al.*
Green Journal 96.2 (2010): 178-184.

- Prone positioning reduced heart and LAD doses
  - 19/30 WBI cases
  - 7/30 PBI cases

Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry

Kirby, A., *et al.*
Green Journal 96.2 (2010): 178-184.

- However, prone positioning **increased** cardiac doses
  - 8/30 WBI cases
  - 19/30 PBI cases

Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry

Kirby, A., *et al.*
Green Journal 96.2 (2010): 178-184.

- "In the context of tangential-field WBI and PBI, prone positioning is likely to benefit left-breast-affected women of larger breast volume, but to be detrimental in left-breast-affected women of smaller breast volume."

Prone versus supine positioning for whole and partial-breast radiotherapy: A comparison of non-target tissue dosimetry

Kirby, A., *et al.*

Green Journal 96.2 (2010): 178-184.

- “Right-breast-affected women are likely to benefit from prone positioning regardless of breast volume.”

Long-term Clinical Outcomes of Whole-Breast Irradiation Delivered in the Prone Position

Stegman, L. D., Beal, K. P., Hunt, M. A., Fornier, M. N., & McCormick, B.
Red Journal 68.1 (2007): 73-81.

- 245 women treated with prone breast board between 1992 and 2004

Long-term Clinical Outcomes of Whole-Breast Irradiation Delivered in the Prone Position

Stegman, L. D., Beal, K. P., Hunt, M. A., Fornier, M. N., & McCormick, B.
Red Journal 68.1 (2007): 73-81.

- “Prone position breast radiation results in similar long-term disease control with a favorable toxicity profile compared with standard supine tangents.”

Rationale for Prone Breast

- Improves cosmesis
- Reduces lung dose
- Reduces heart dose (for large breasts)
- Reduces intra-fraction motion from breathing

Clinical Challenges

Prone Position:
Panacea for Large Breast Treatment?

Not exactly…

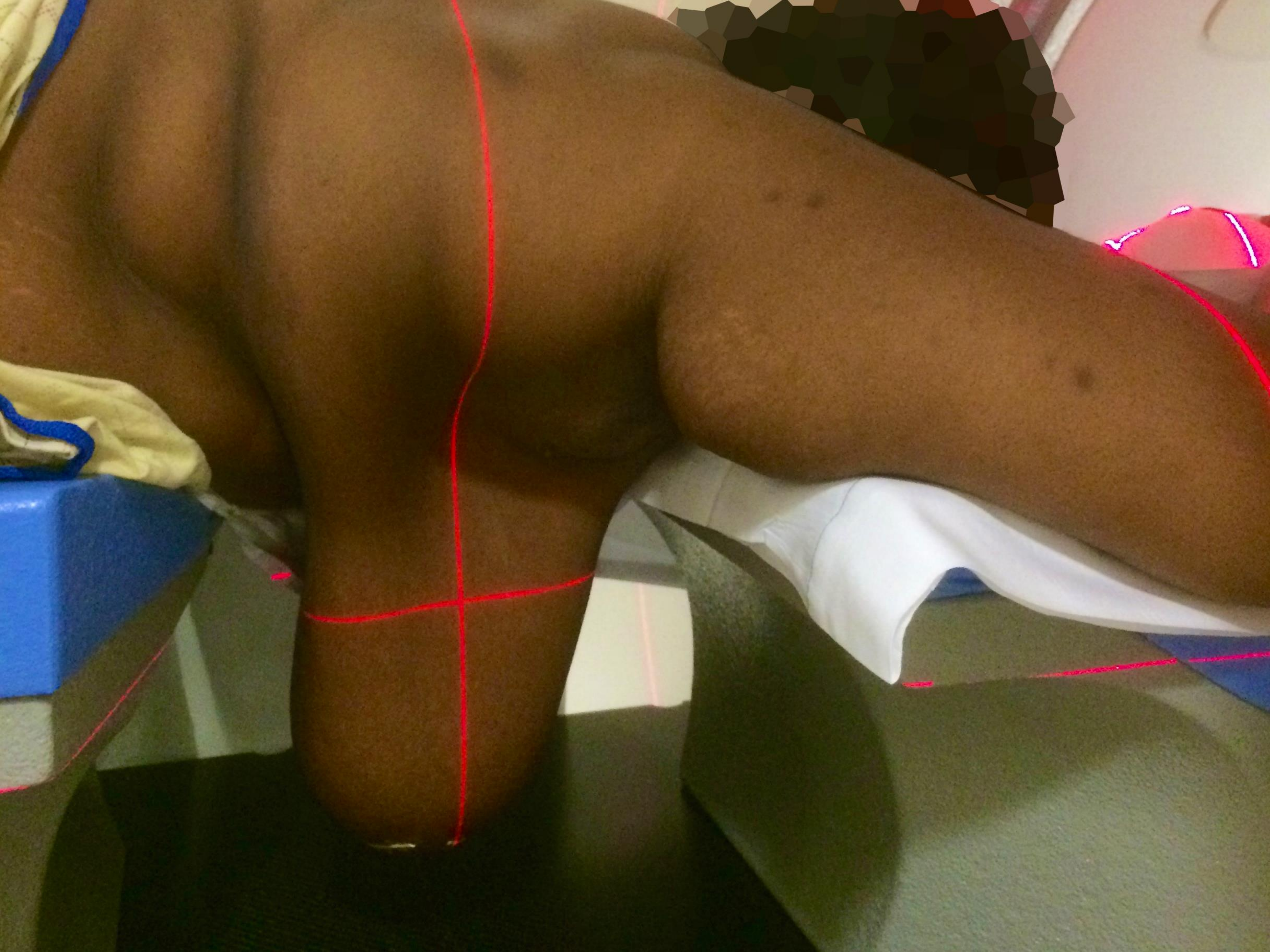
Consistent Setup

Consistent Setup

- Our initial prone patients exhibited large inter-fraction variability:
  - New technique for therapists
  - Patients often overweight

Consistent Setup

- Our initial prone patients exhibited large inter-fraction variability:
    - Leveling marks not very useful
    - Isocenter on soft tissue



Intra- and Inter-fractional Variations for Prone Breast Irradiation: An Indication for Image-Guided Radiotherapy

Morrow, N., *et al.*
Red Journal 69.3 (2007): 910–917.

- Prone setup reduced **intra**-fractional variation (respiratory motion)

Intra- and Inter-fractional Variations for Prone Breast Irradiation: An Indication for Image-Guided Radiotherapy

Morrow, N., *et al.*
Red Journal 69.3 (2007): 910–917.

- However they found large **inter**-fractional variations

Intra- and Inter-fractional Variations for Prone Breast Irradiation: An Indication for Image-Guided Radiotherapy

Morrow, N., *et al.*
Red Journal 69.3 (2007): 910–917.

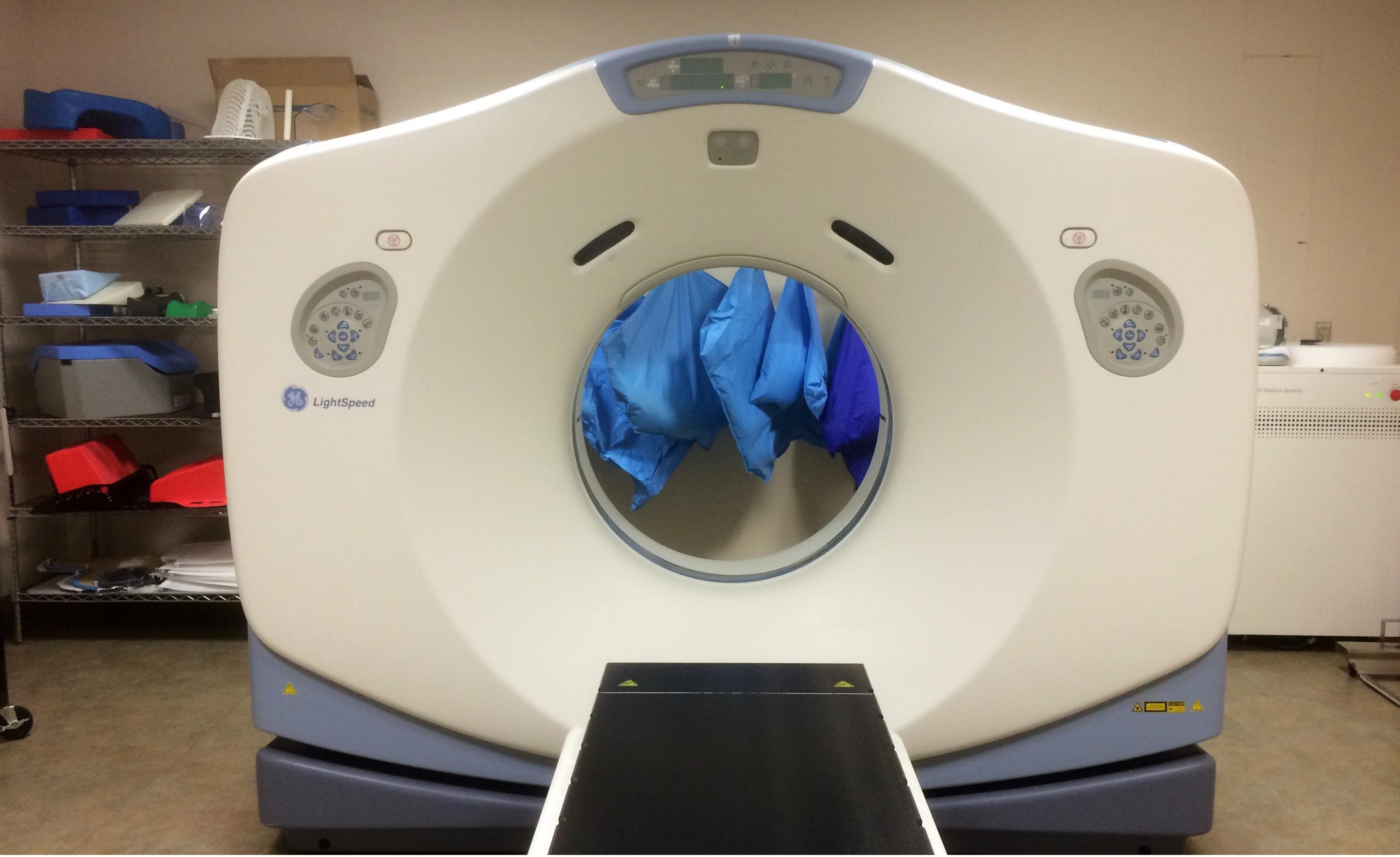
- “indicates the importance of image guidance for partial breast irradiation in the prone position”

Consistent Setup

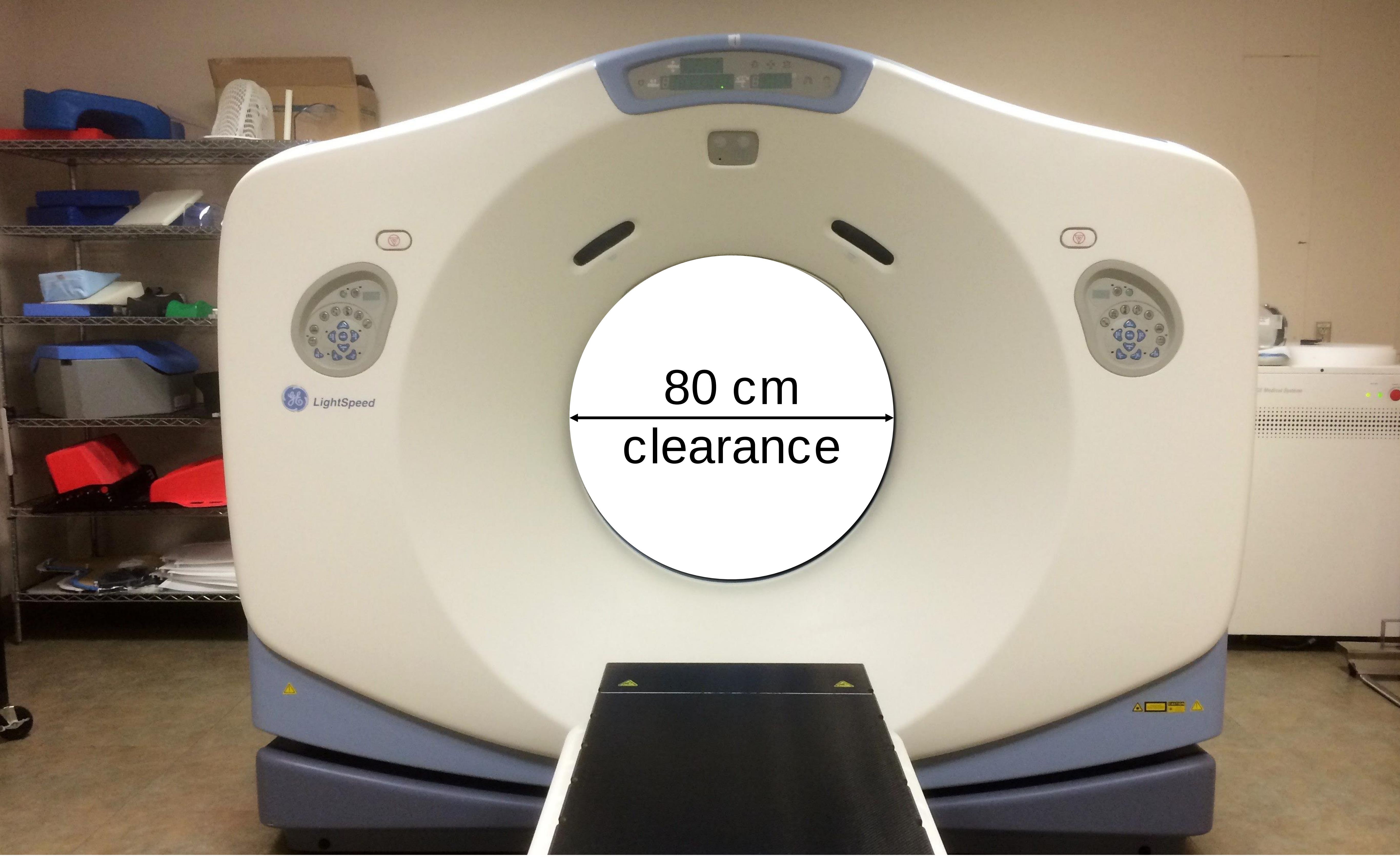
- In our clinic, kV port films were insufficient to solve setup issues.

Consistent Setup

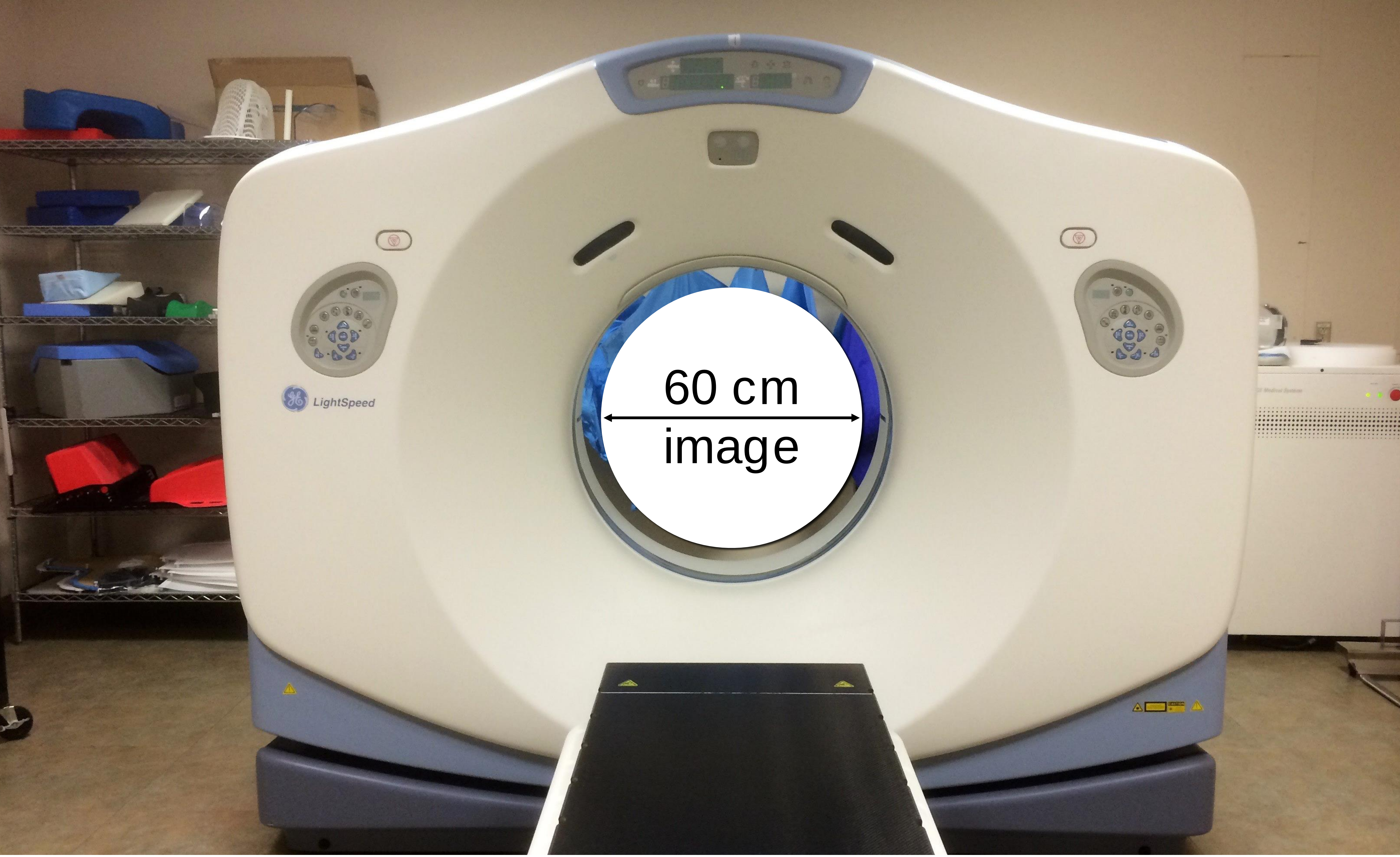
- CBCT provided the extra information needed to achieve more consistent setups



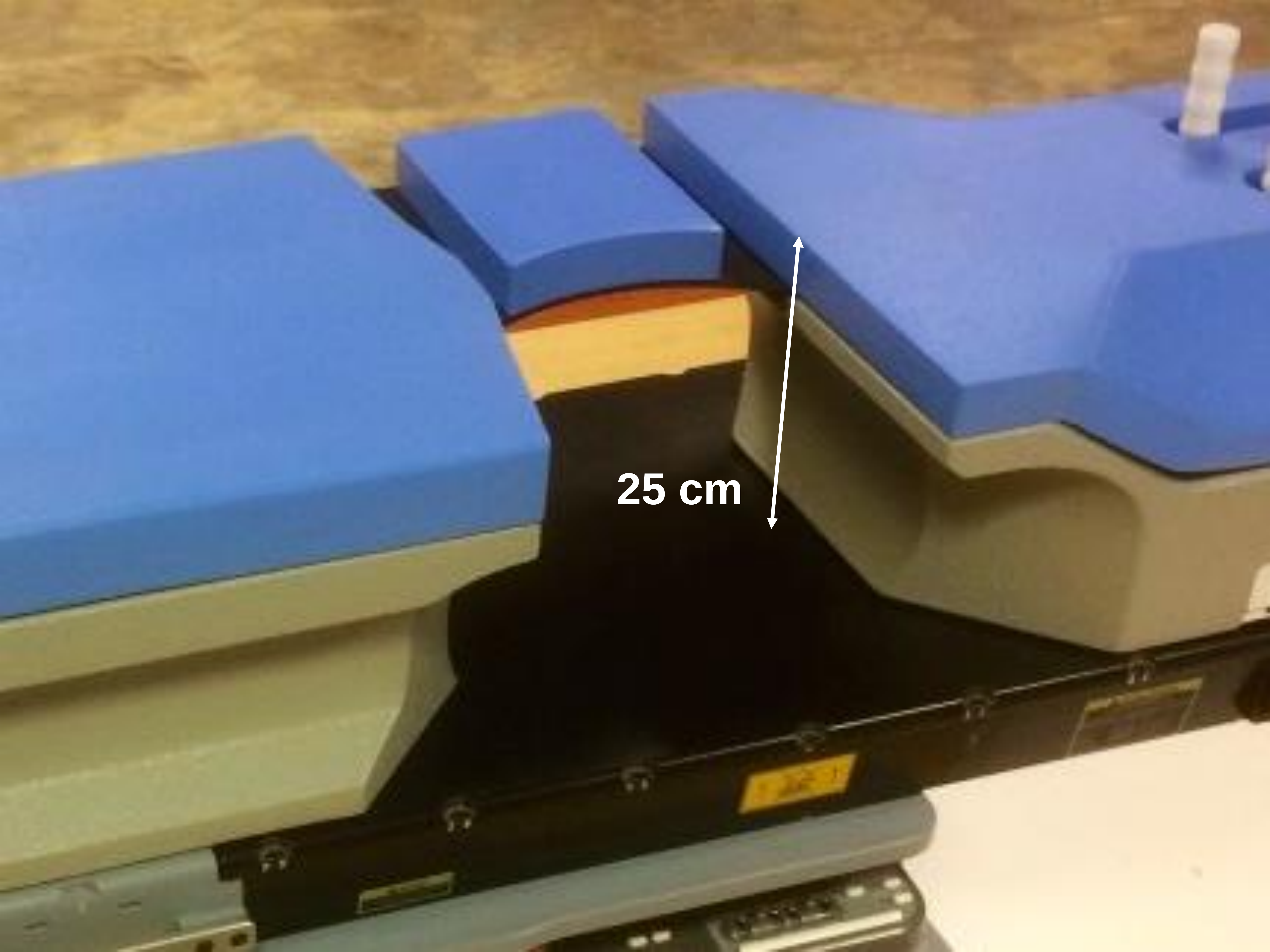
Planning CT

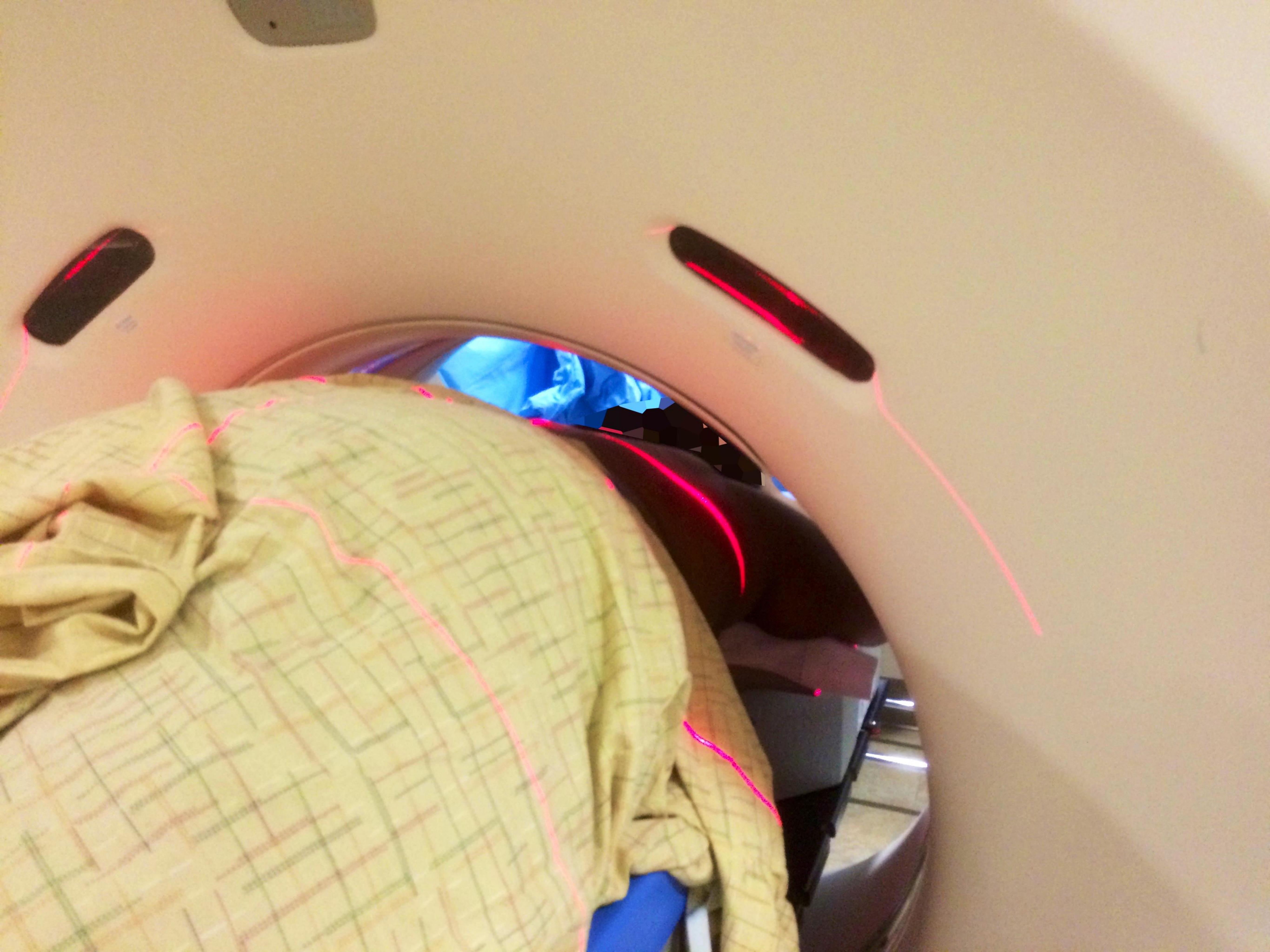


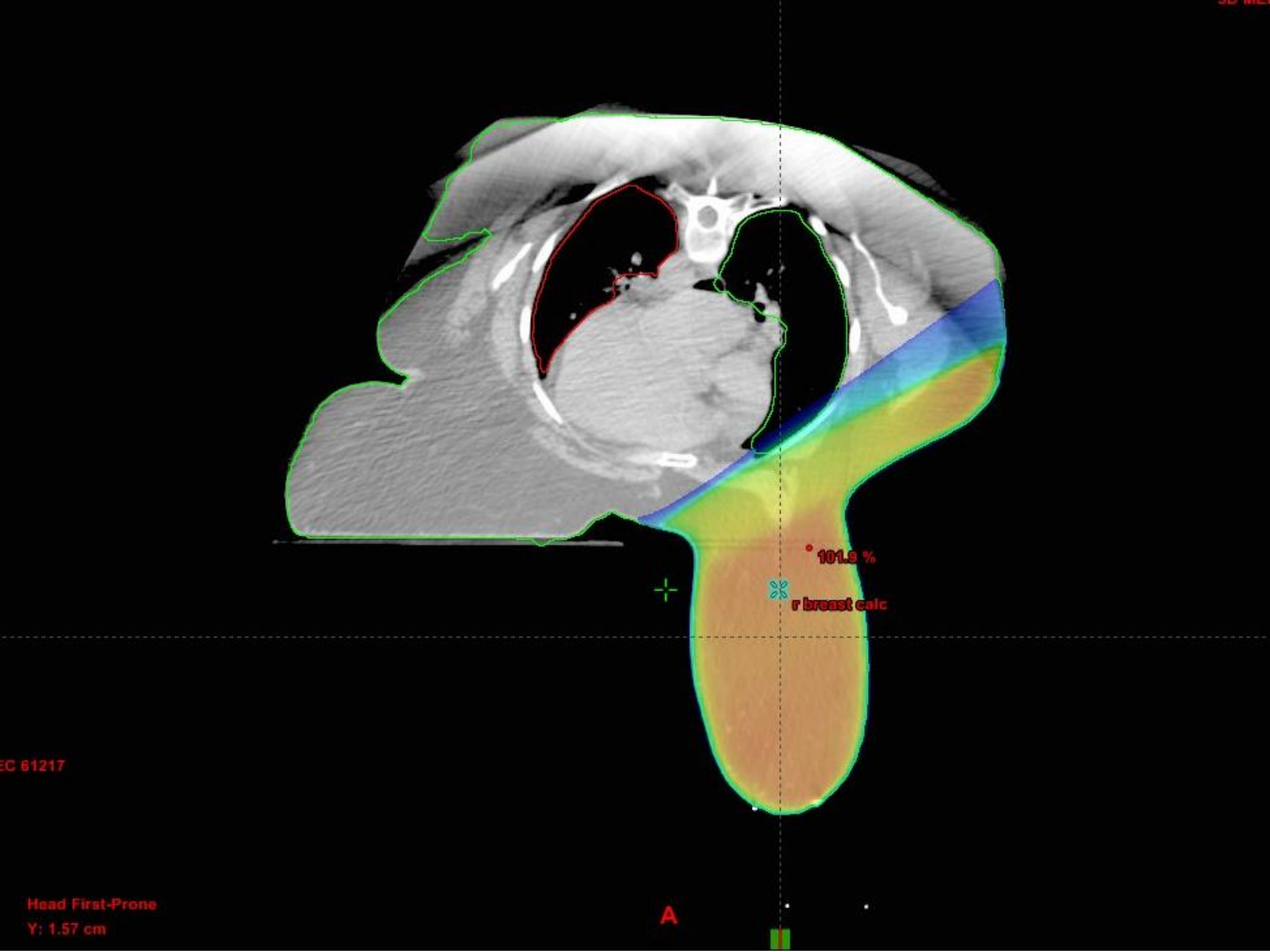
Planning CT

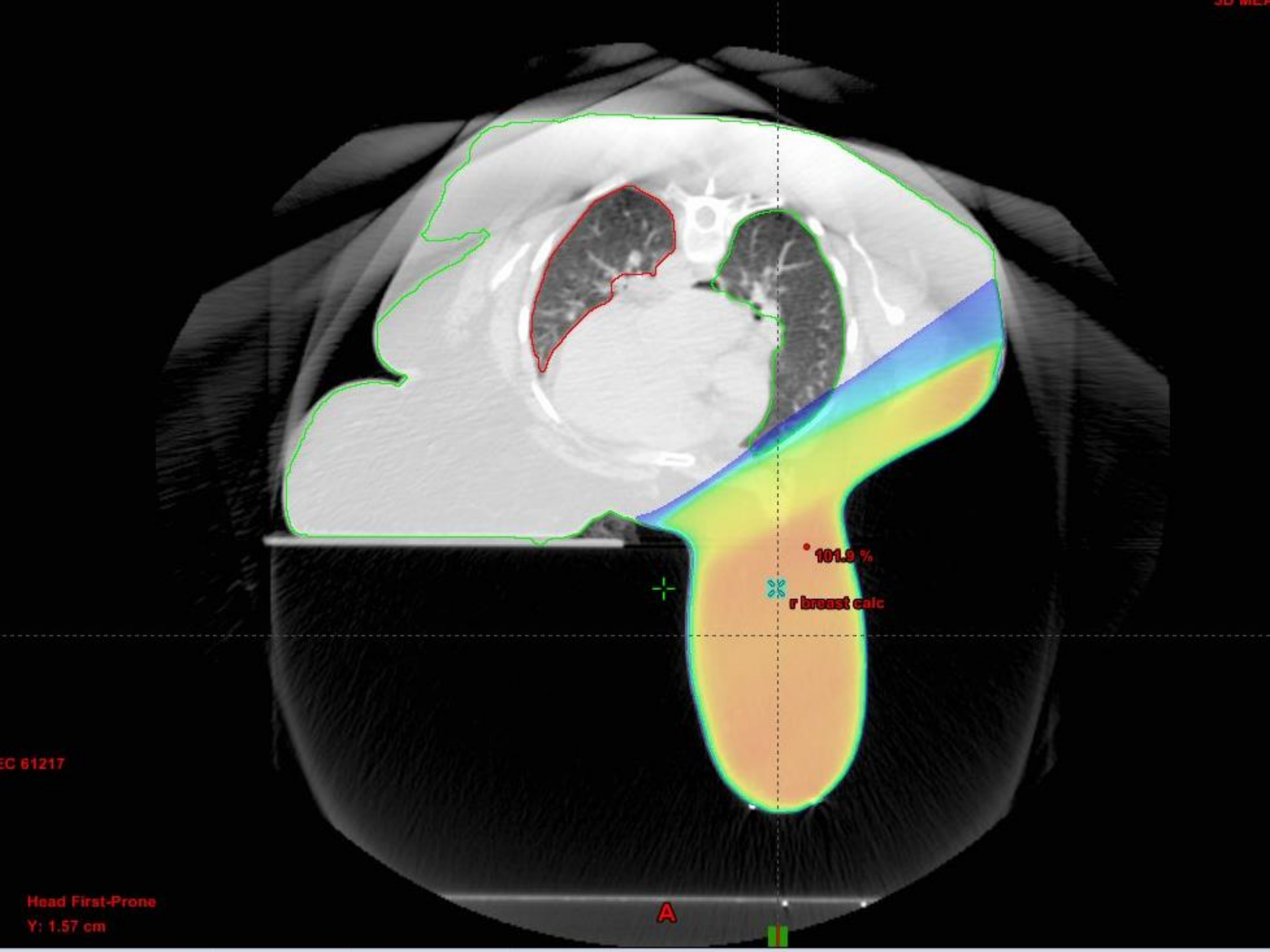


Planning CT


25 cm




101.9 %
r breast calc
EC 61217
Head First-Prone
Y: 1.57 cm
A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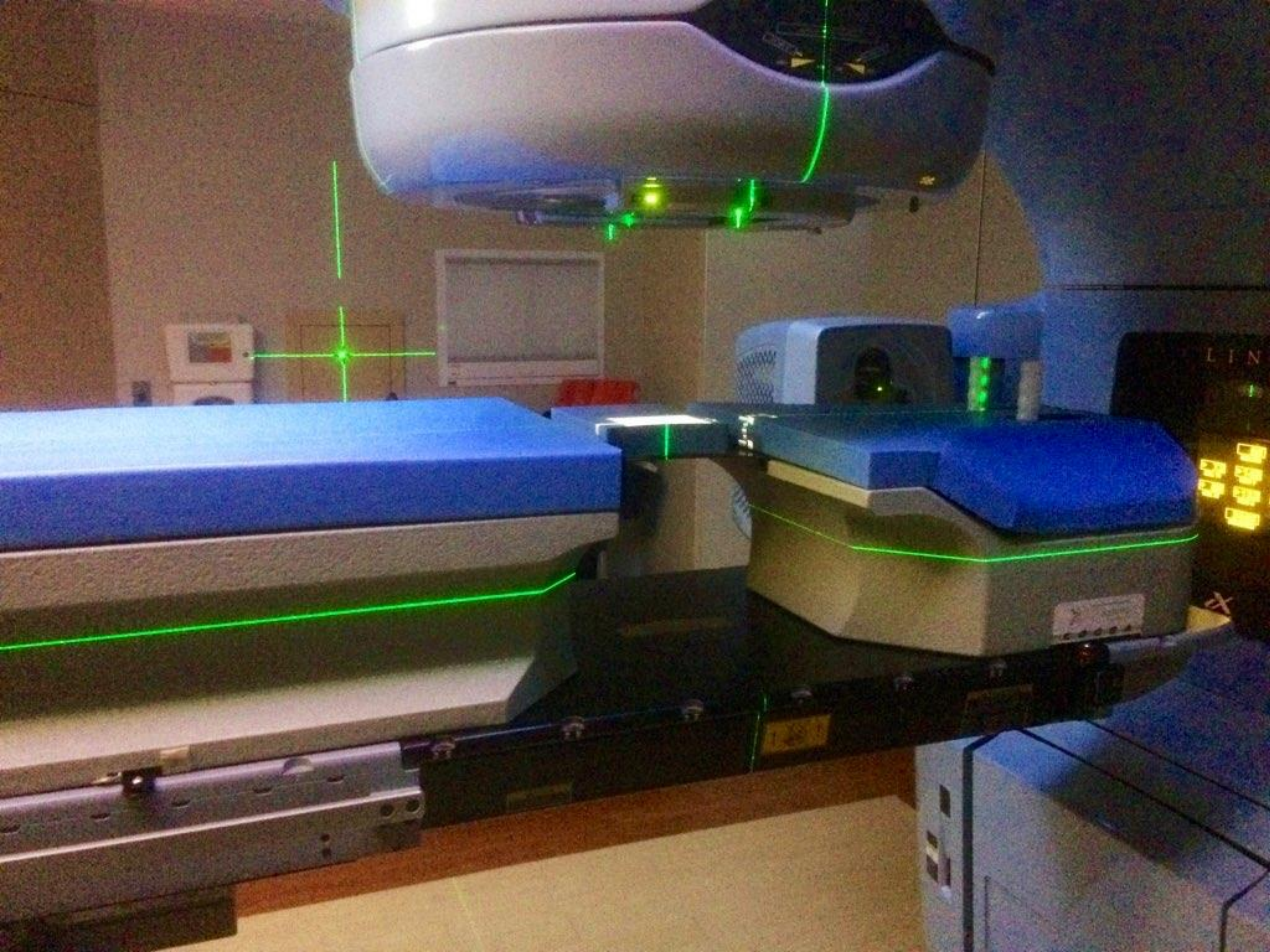
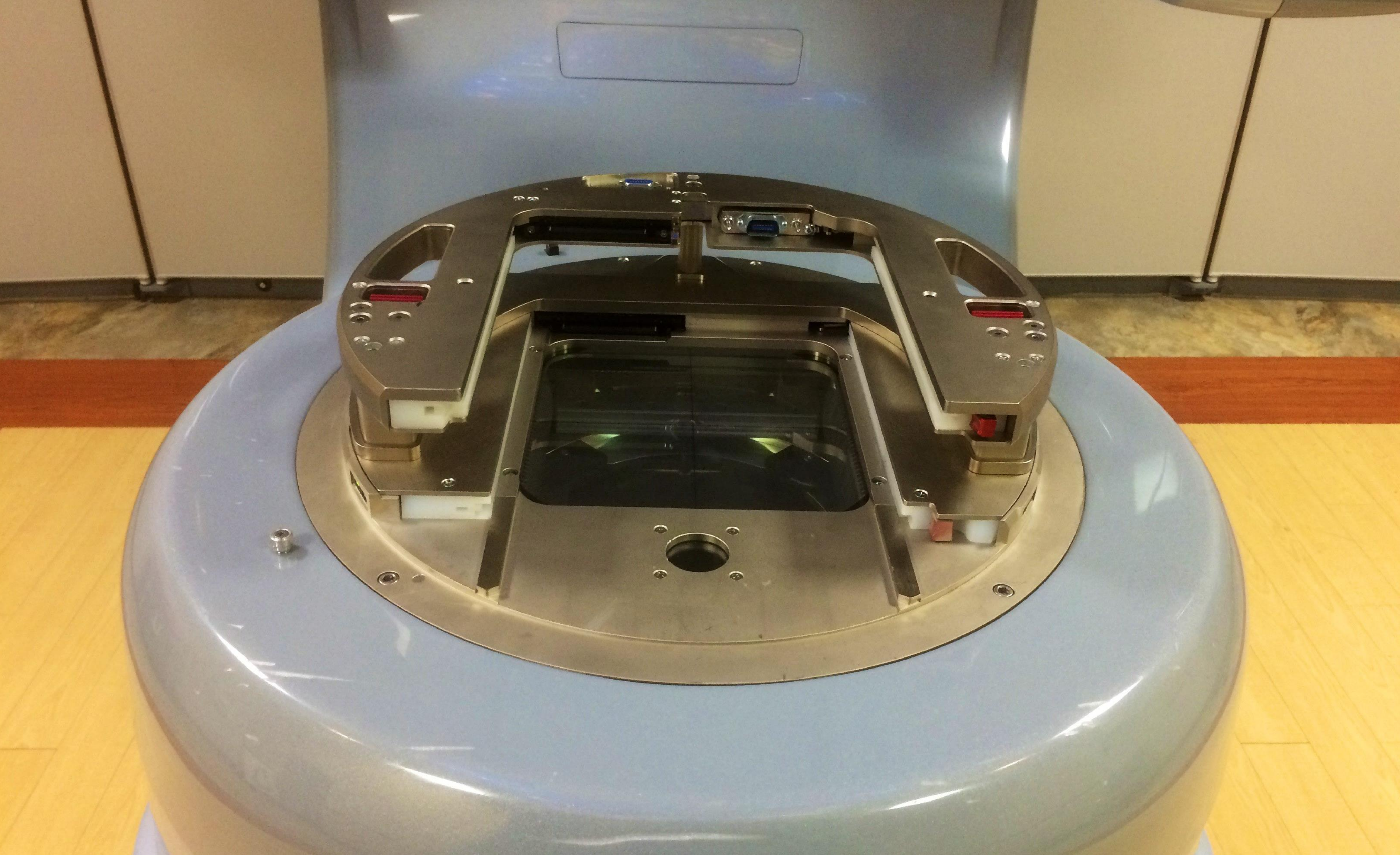
Gantry Clearance

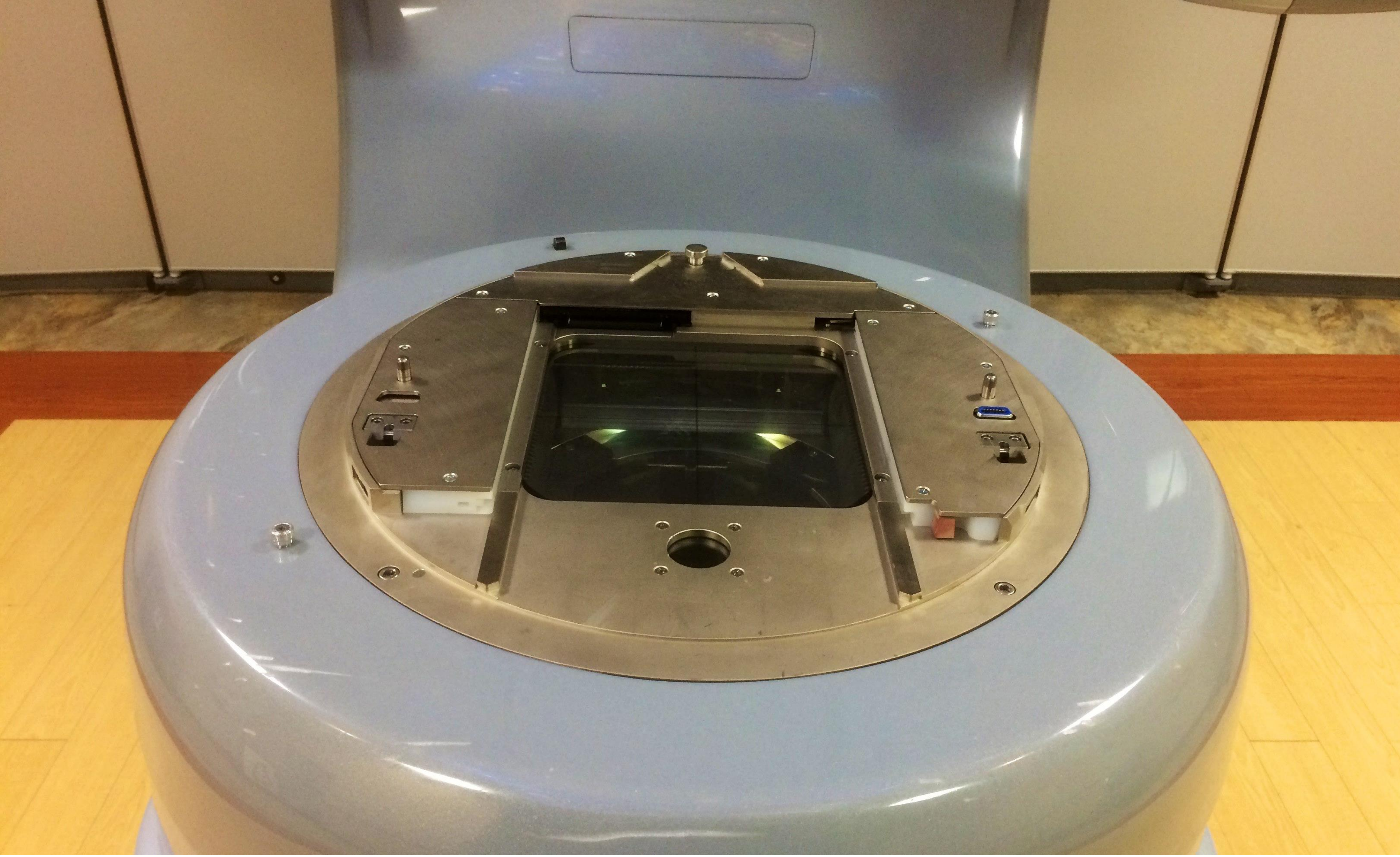


Isocenter on breast is difficult for CBCT
due to likely gantry collision

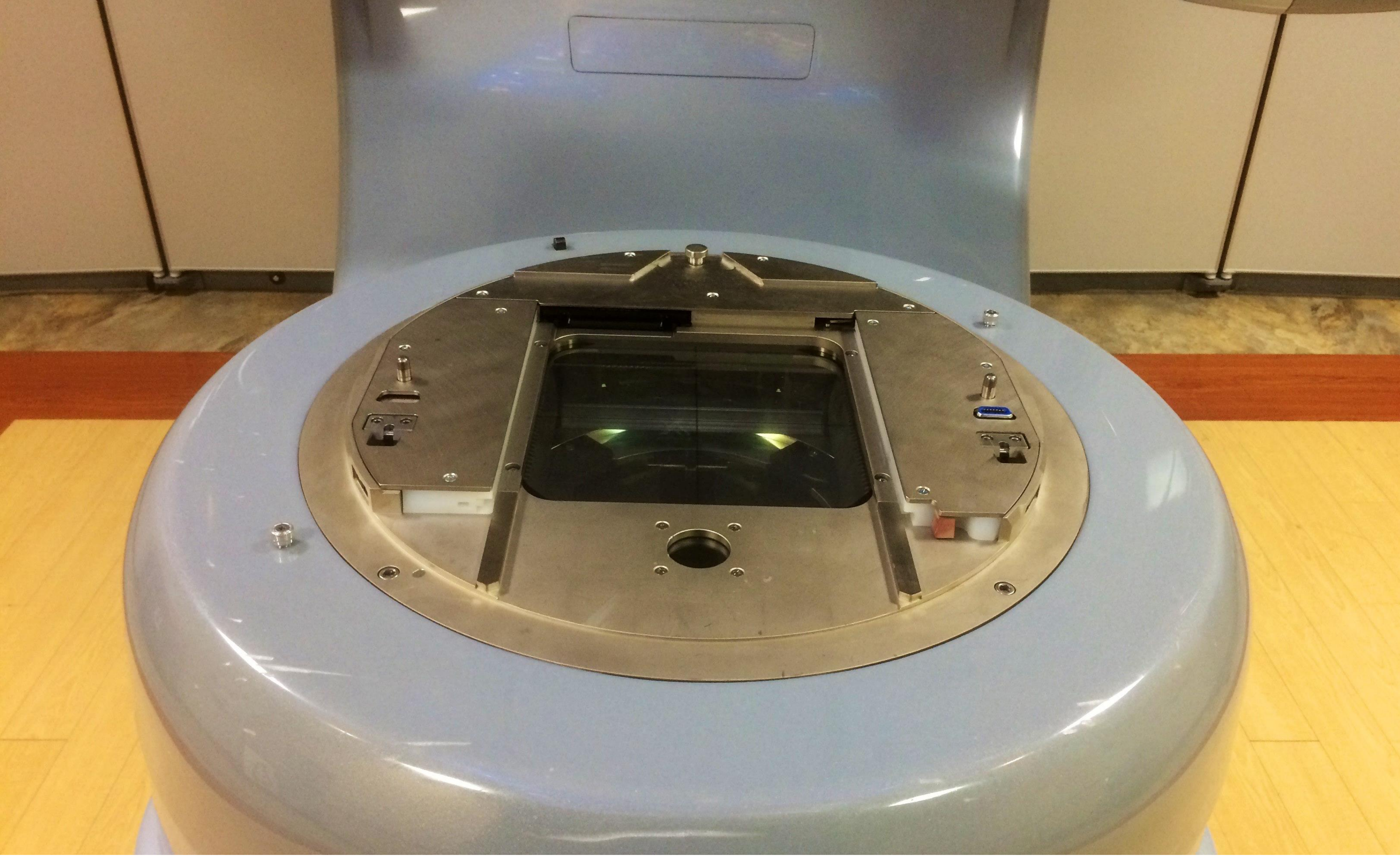
Center table laterally for imaging
(with known shift back to treatment position)



Avoid use of wedges and accessories
that might interfere with patient clearance



No “horse shoe”



Replace wedges with FinF if dose shaping required

Time Considerations

- About one minute to acquire CBCT
- Another couple of minutes to analyze and discuss
- Can easily add five minutes to overall treatment time

Dose Considerations

ALARA CBCT Technique

- Existing CBCT modes can be copied and changed

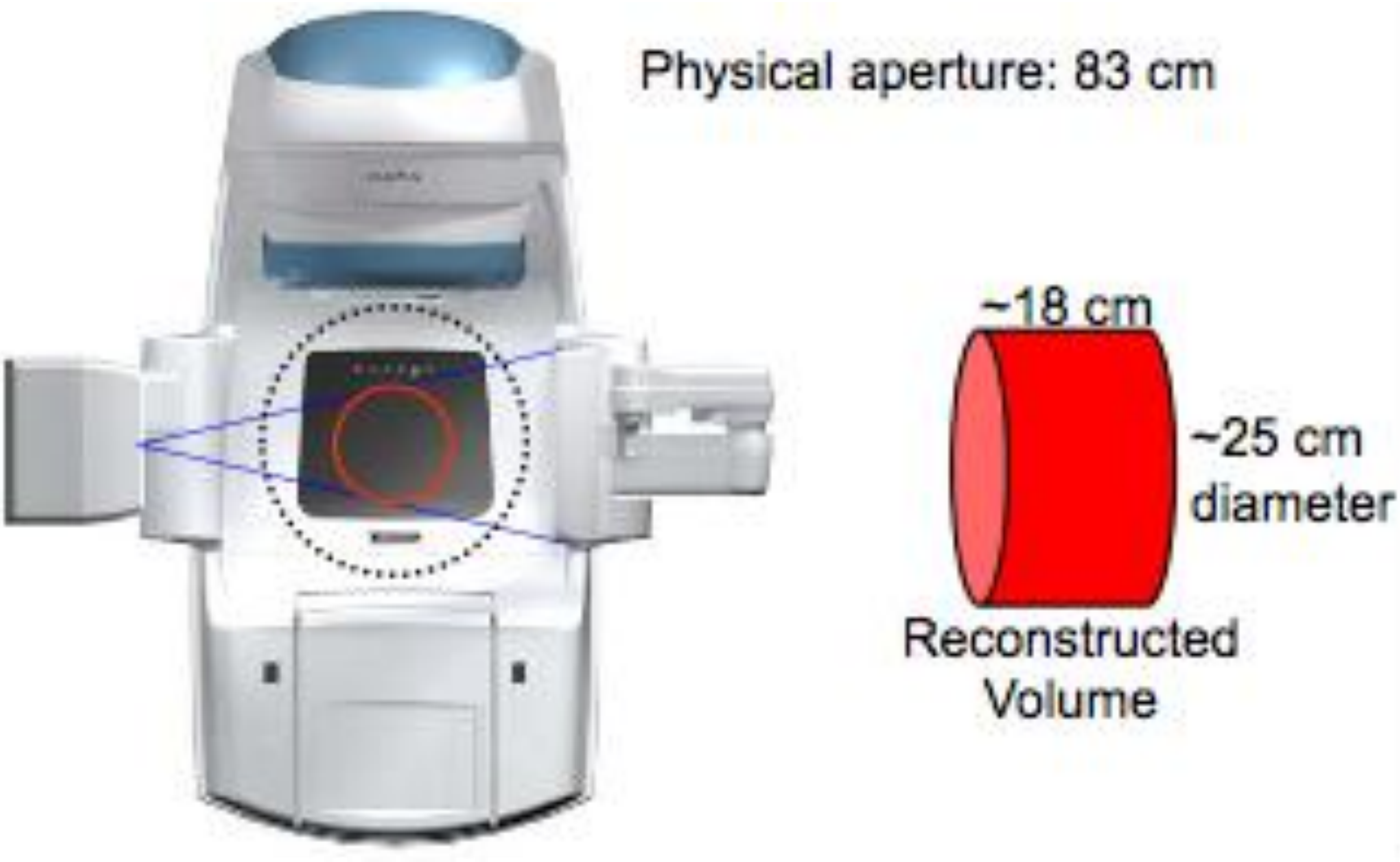
ALARA CBCT Technique

- Changing the mAs does not require recalibration
- Dose is directly proportional to mAs

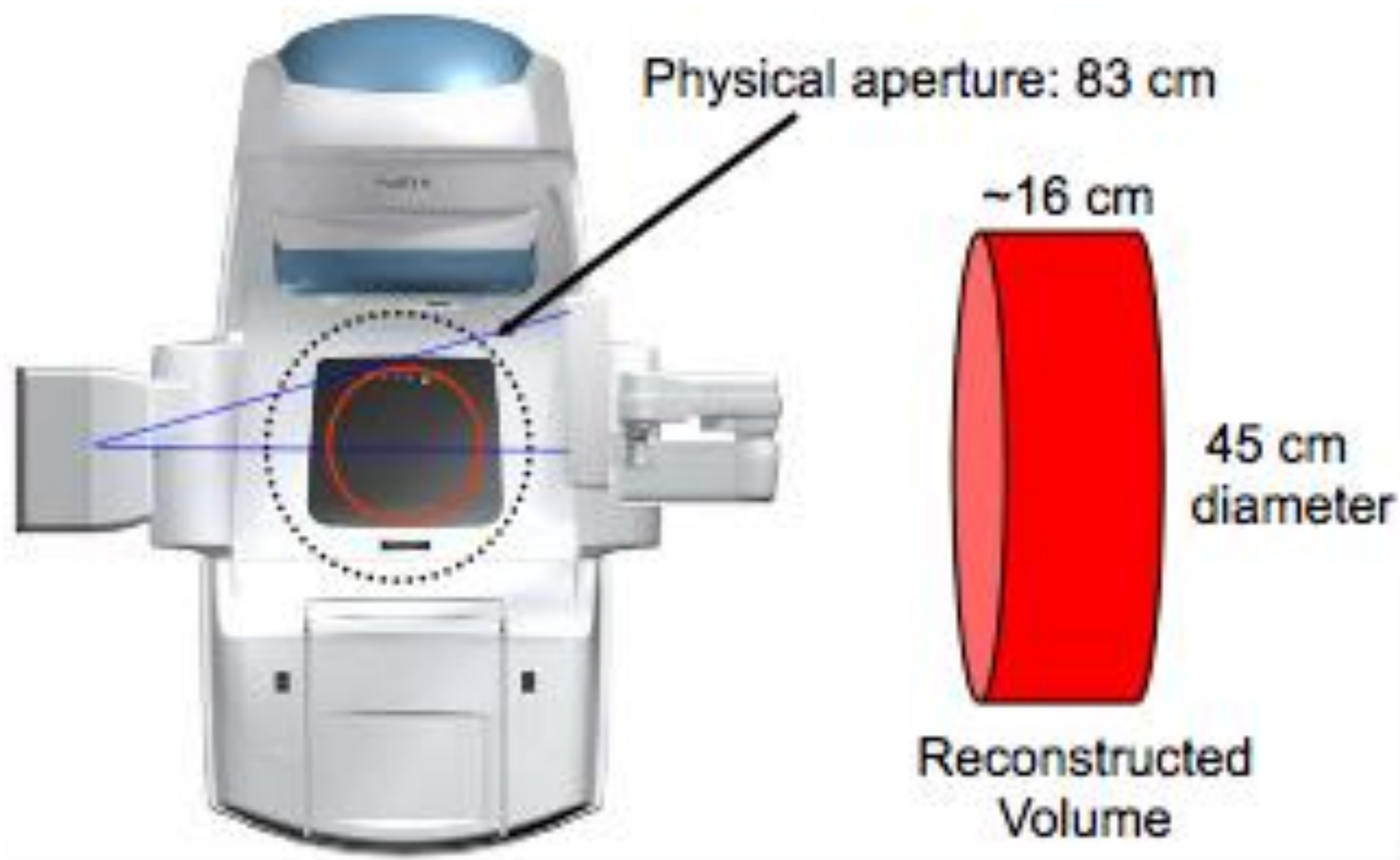
ALARA CBCT Technique

- Modify pre-defined CBCT technique most appropriate for prone breast.

Full Fan Acquisition



Half Fan Acquisition

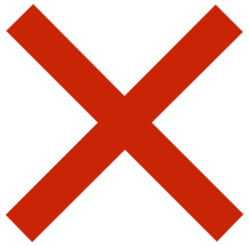


Bow-Tie Filter

- Reduces dose
- Improves image quality

Bow-Tie Filter

- **Full** bow-tie filter
- **Full** fan acquisition modes



Bow-Tie Filter

- **Half** bow-tie filter
- **Half** fan acquisition modes

✓

	Standard-Dose Head	Low-Dose Head	High-Quality Head	Pelvis	Pelvis-Spot light (Full Fan Bow-Tie Filter). Note – mode not typically calibrated	Pelvis-Spot light (Half Fan Bow-Tie Filter)	Low-Dose Thorax
X-Ray Voltage (kVp)	100	100	100	125	125	125	110
X-Ray Current (mA) per Projection	20	10	80	80	80	80	20
X-Ray Millisecond (ms) per projection	20	20	25	13	25	25	20
Gantry Rotation Range (degrees)	200	200	200	360	200	200	360
Number of Projections	360	360	360	655	360	360	655
Exposure (mAs)	145	72	720	680	720	720	262
$CTDI_{w,norm}$ (mGy / 100 mAs)	2.7	2.7	2.7	2.6	2.0	3.4	1.8
$CTDI_w$ (mGy)	3.9	2.0	19.4	17.7	14.4	24.5	4.7
Fan Type	Full fan	Full fan	Full fan	Half fan	Full fan	Half fan	Half fan
Default Pixel Matrix	384 x 384	384 x 384	384 x 384	384 x 384	384 x 384	384 x 384	384 x 384
Slice Thickness (mm)	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Reconstruction Filter	Sharp	Standard	Sharp	Standard	Standard	Standard	Standard
Ring Suppression Algorithm	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Table 1: Pre-defined CBCT modes installed with OBI Advanced Imaging ($CTDI_w$ and $CTDI_{w,norm}$ values are ± 10%)

	Standard-Dose Head	Low-Dose Head	High-Quality Head	Pelvis	Pelvis-Spot light (Full Fan Bow-Tie Filter). Note – mode not typically calibrated	Pelvis-Spot light (Half Fan Bow-Tie Filter)	Low-Dose Thorax
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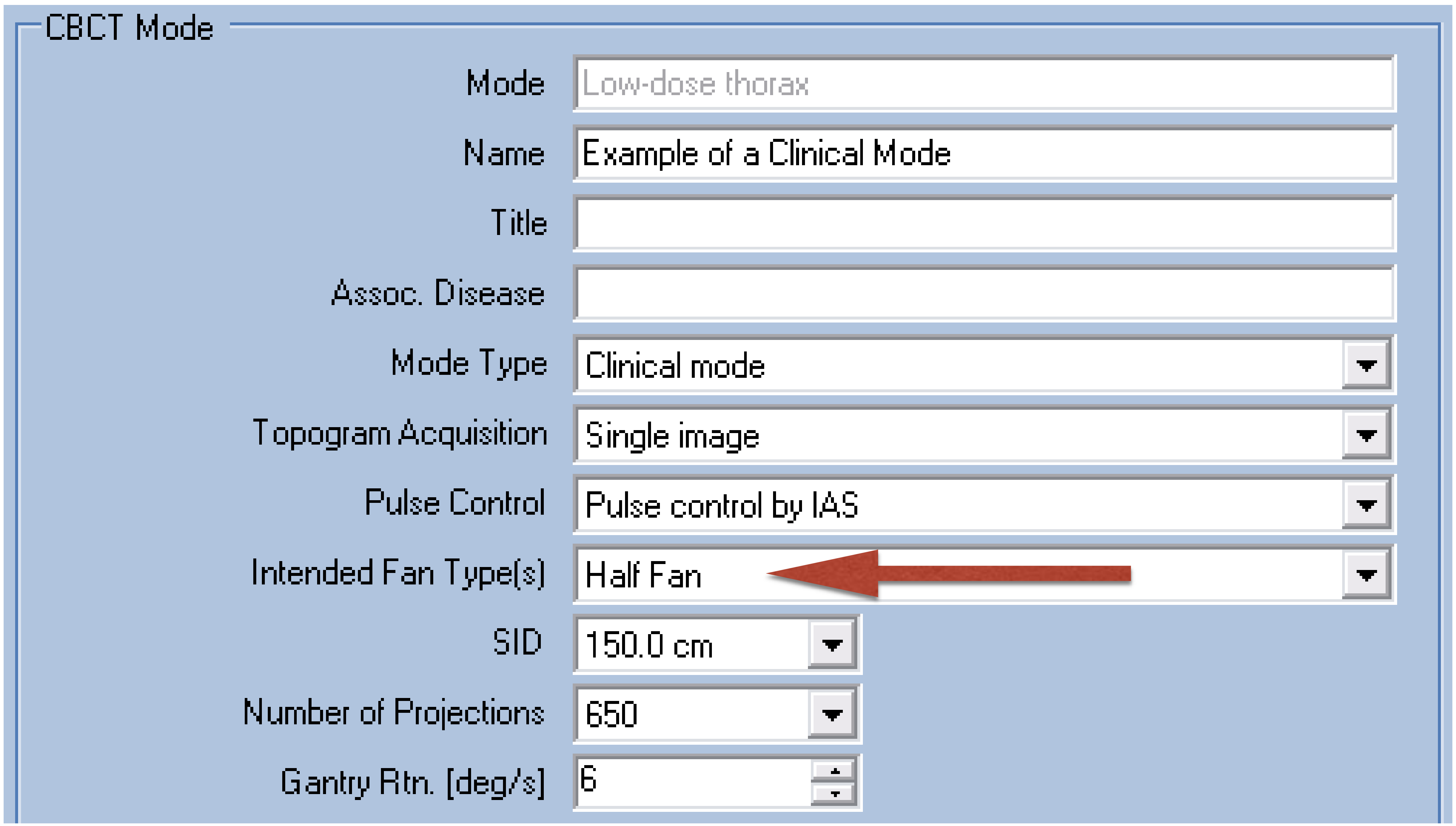
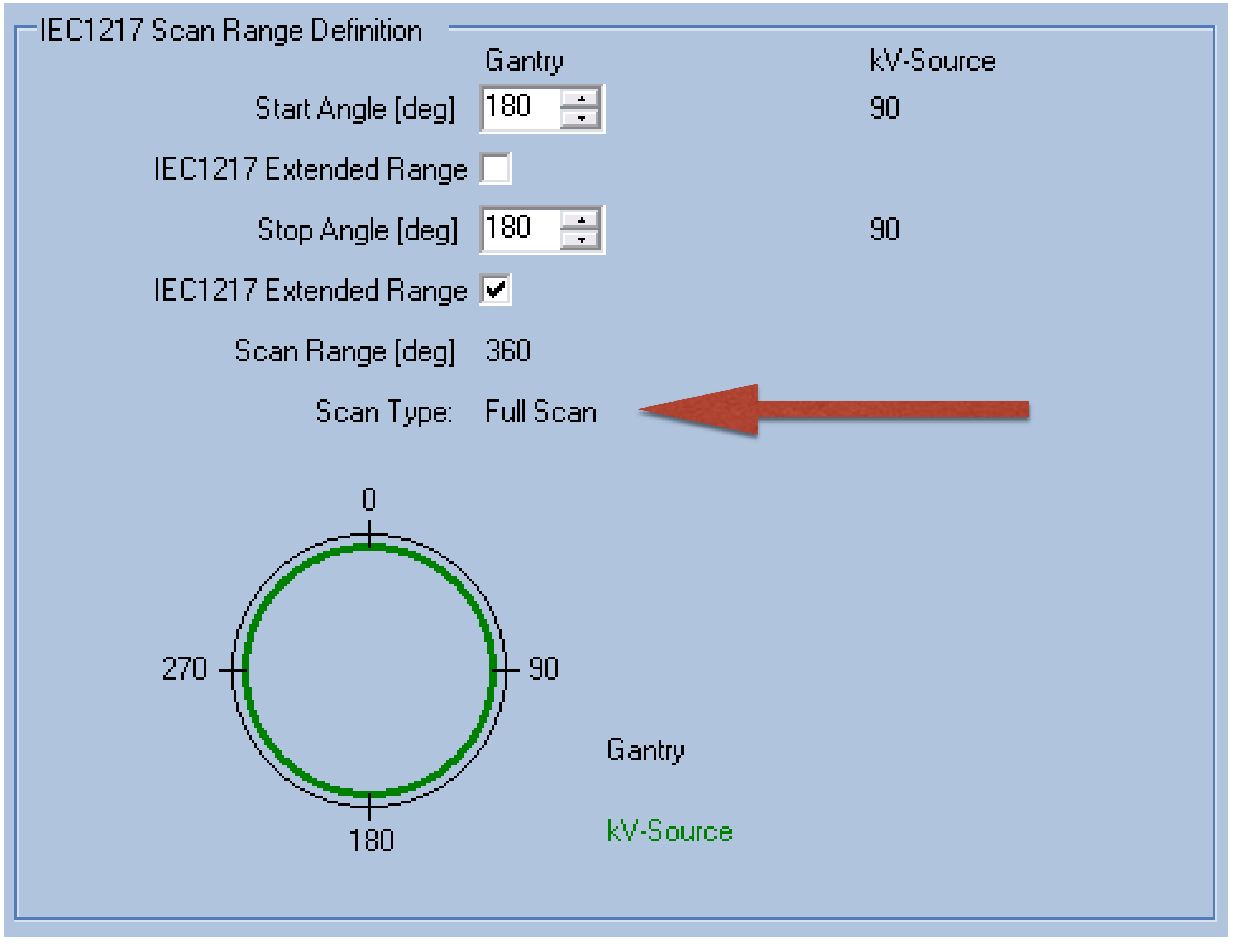
Low Dose Thorax

(Varian Pre-Defined CBCT Mode)



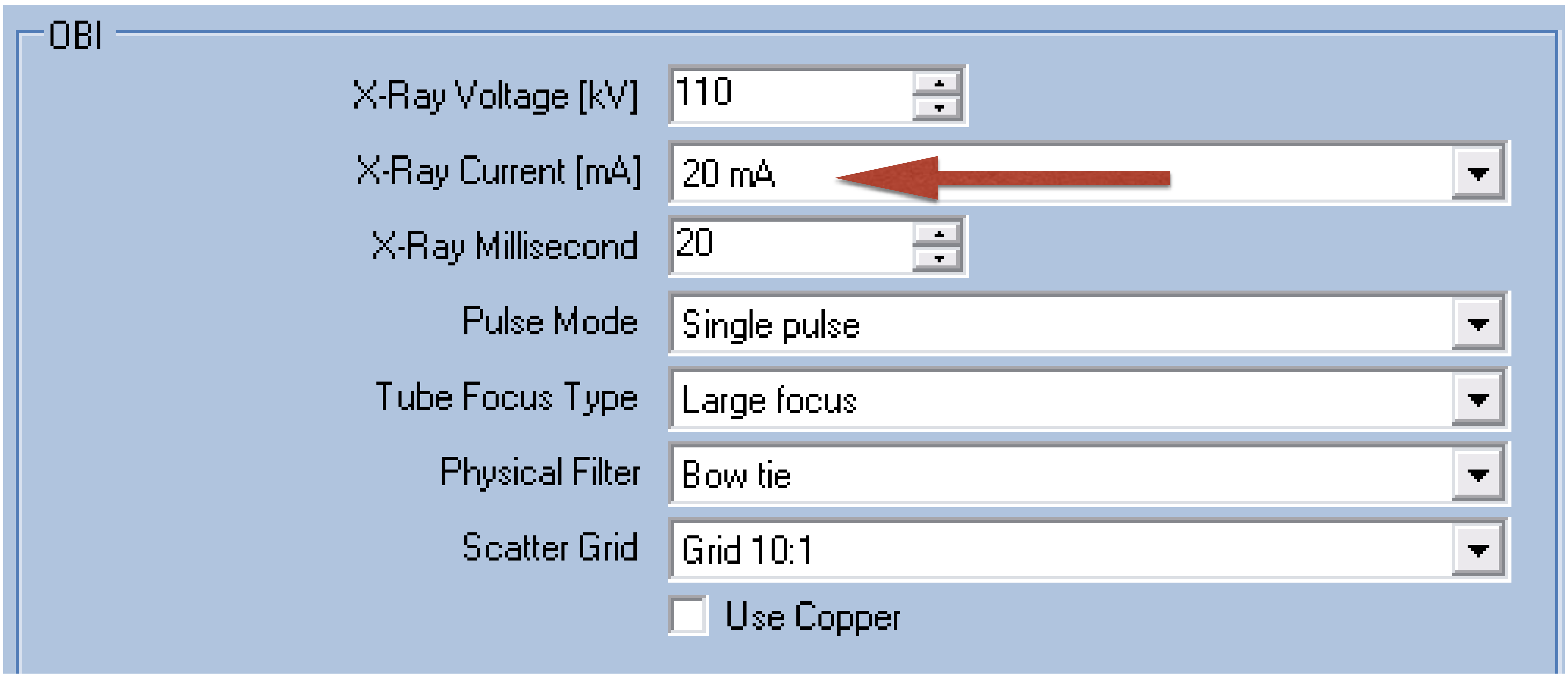
Low Dose Thorax

(Varian Pre-Defined CBCT Mode)



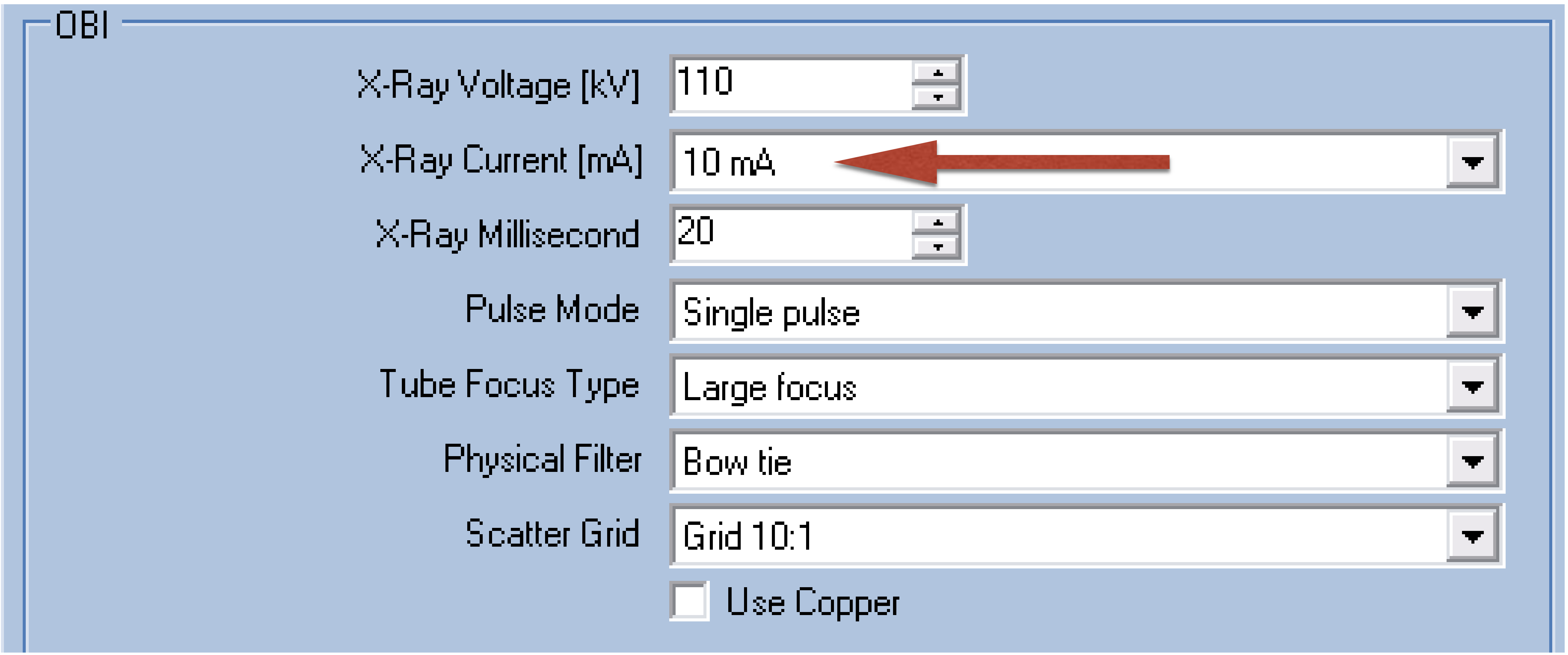
Low Dose Thorax

(Varian Pre-Defined CBCT Mode)



Very Low Dose Thorax

(Modified CBCT Mode)



Very Low Dose Thorax

(Modified CBCT Mode)

- Tube current reduced from 20 mA to 10 mA
- $CTDI_W$ should lower from 4.7 mGy to 2.4 mGy

Very Low Dose Thorax

(Modified CBCT Mode)

	CBCT	Orthogonal MV Port Images
Dose	0.2 - 0.3 cGy (estimated from $CTDI_W$)	2 - 4 cGy (very rough estimate assuming 2 - 4 MU)

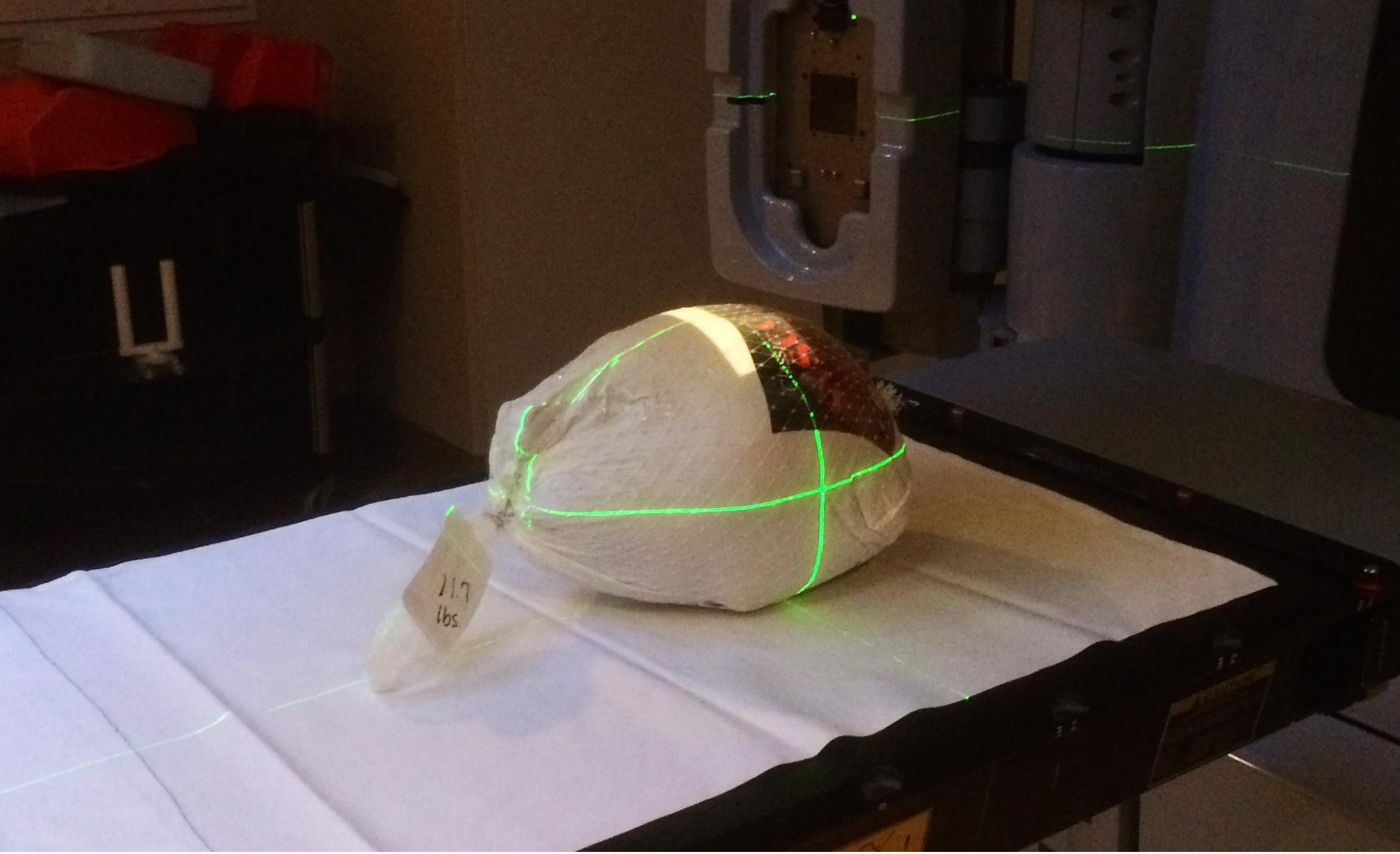
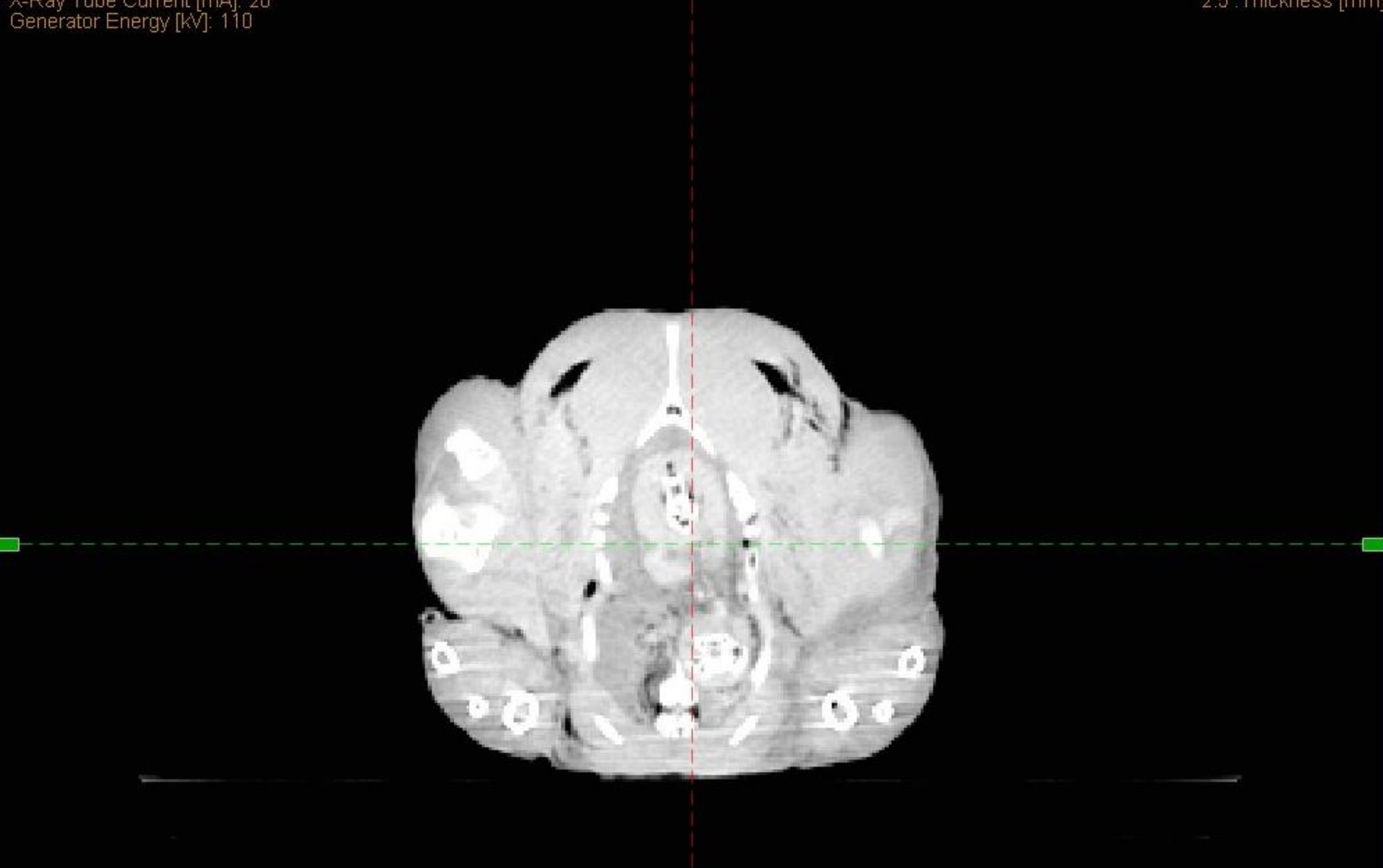
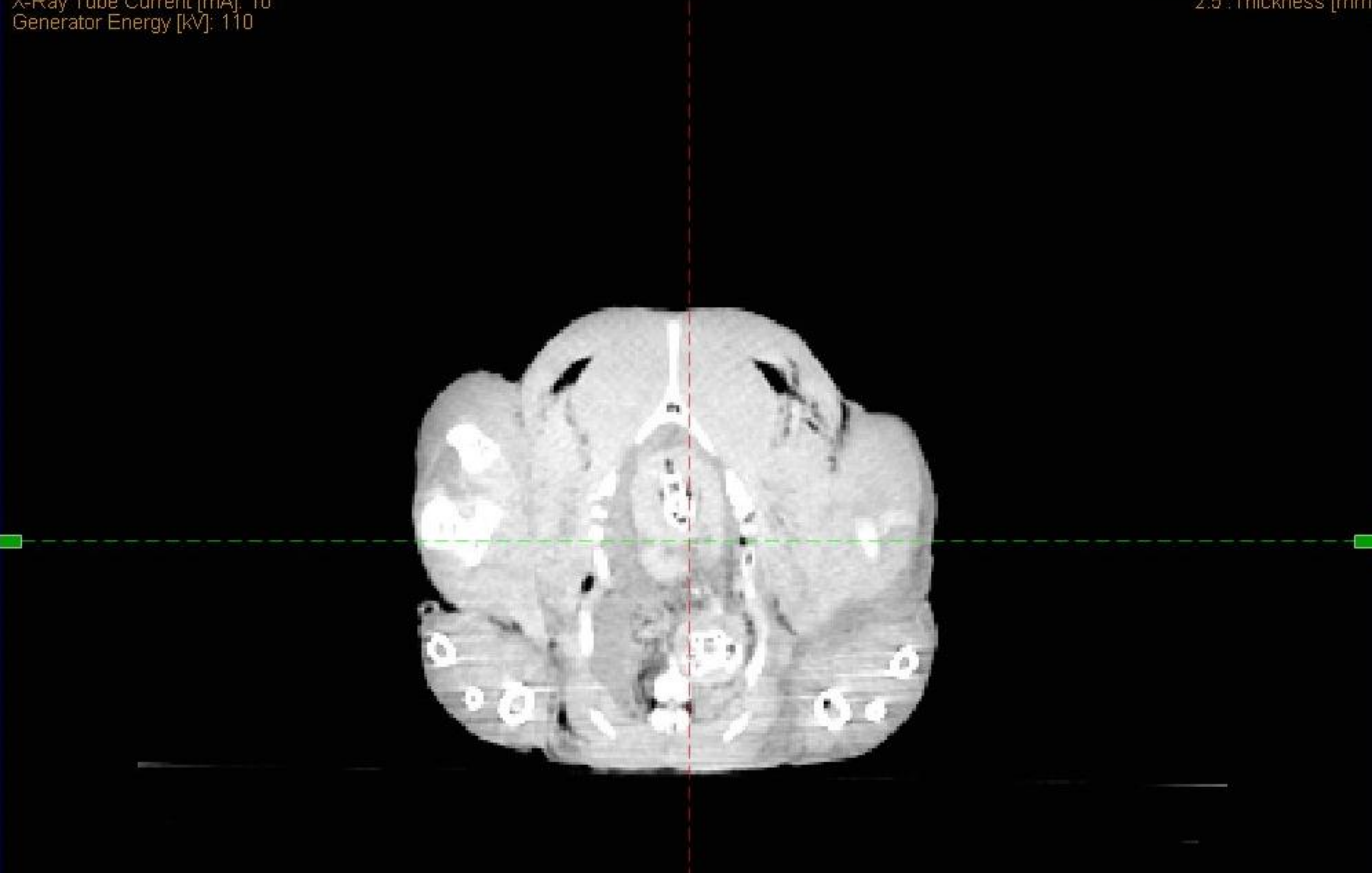


Image Quality Effects

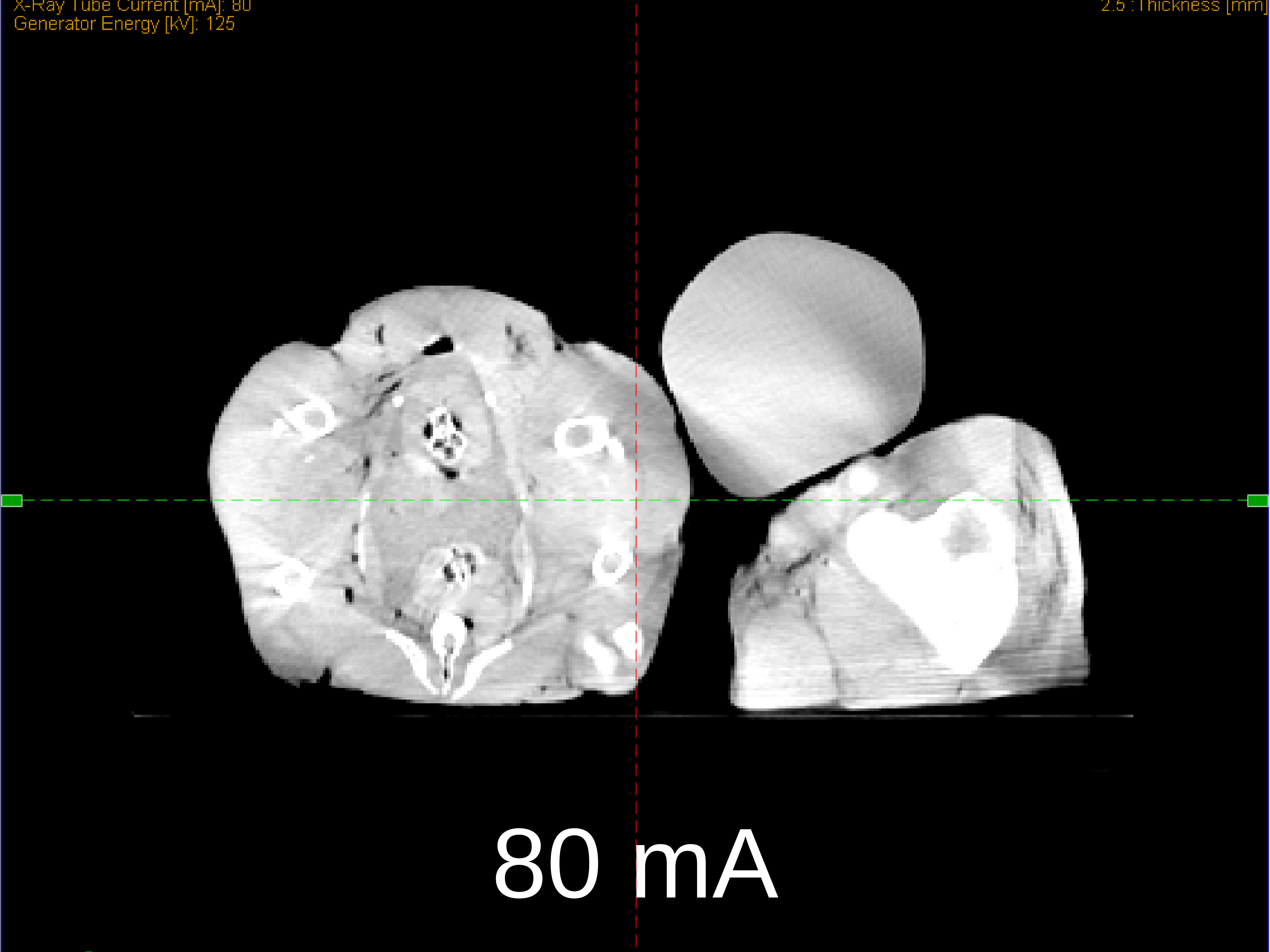


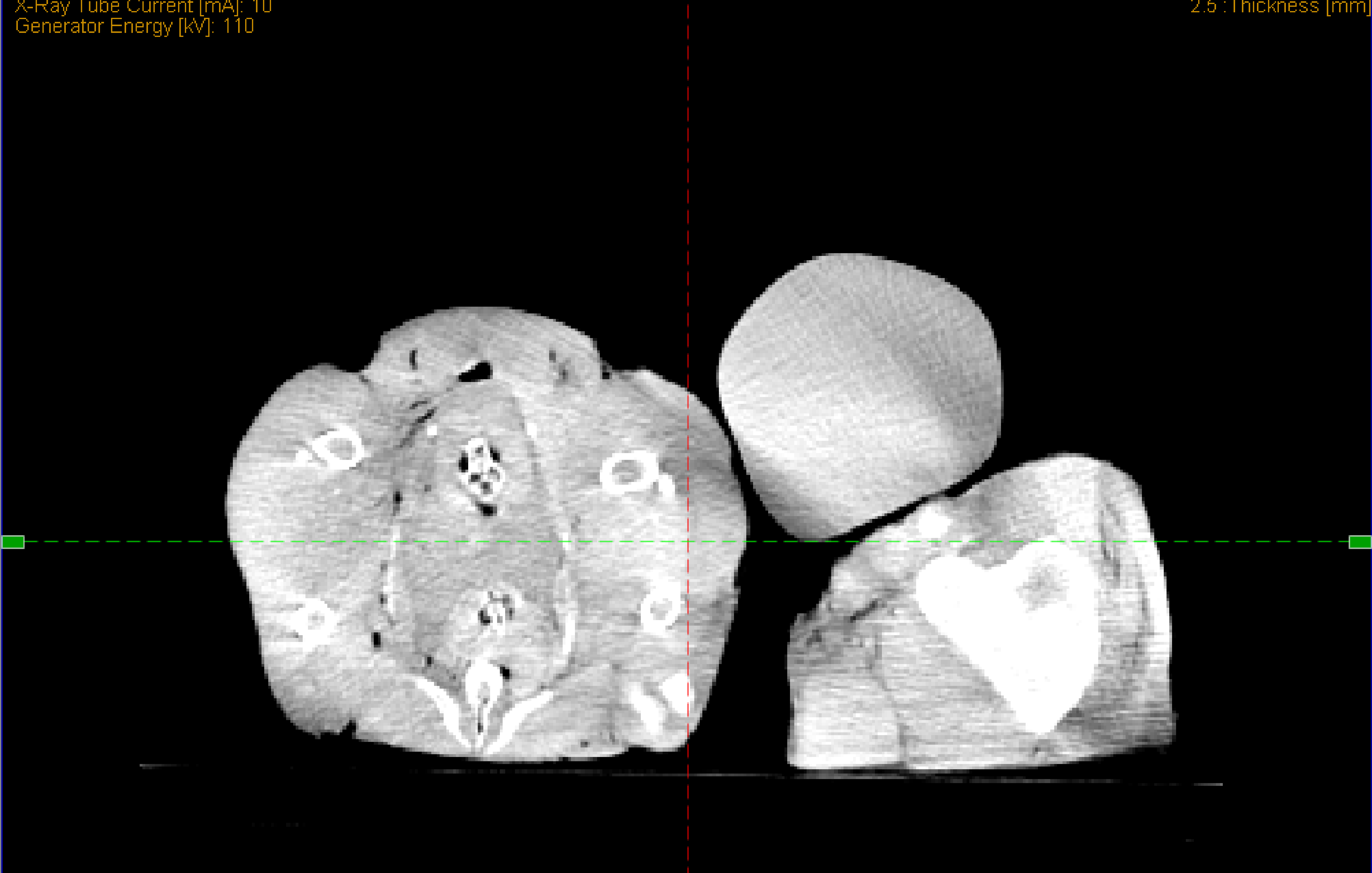
20 mA



10 mA

Image Quality Effects


X-Ray Tube Current [mA]: 80
Generator Energy [kV]: 125
2.5 :Thickness [mm]
80 mA


X-Ray Tube Current [mA]: 10
Generator Energy [kV]: 110
2.5 :Thickness [mm]

10 mA

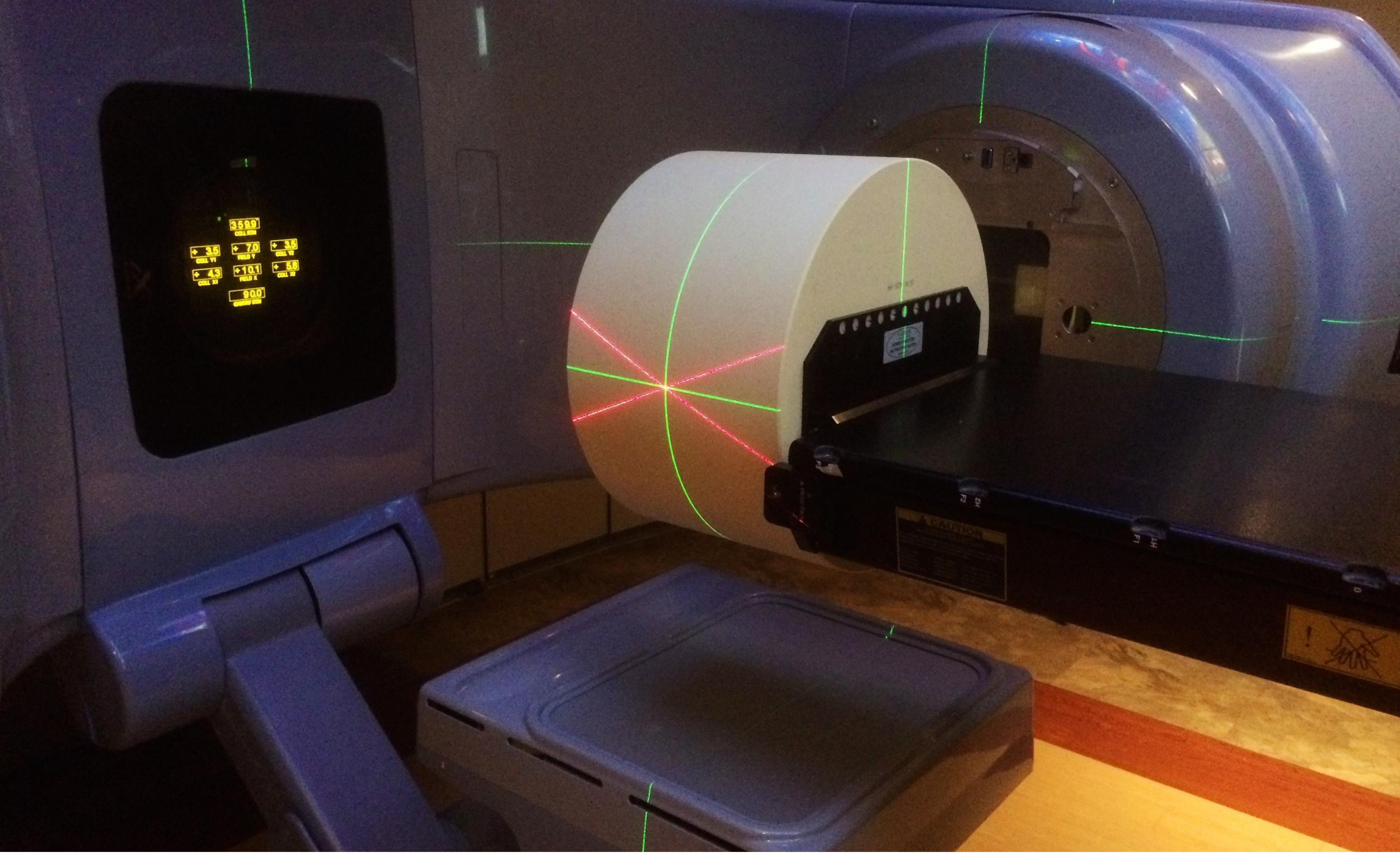
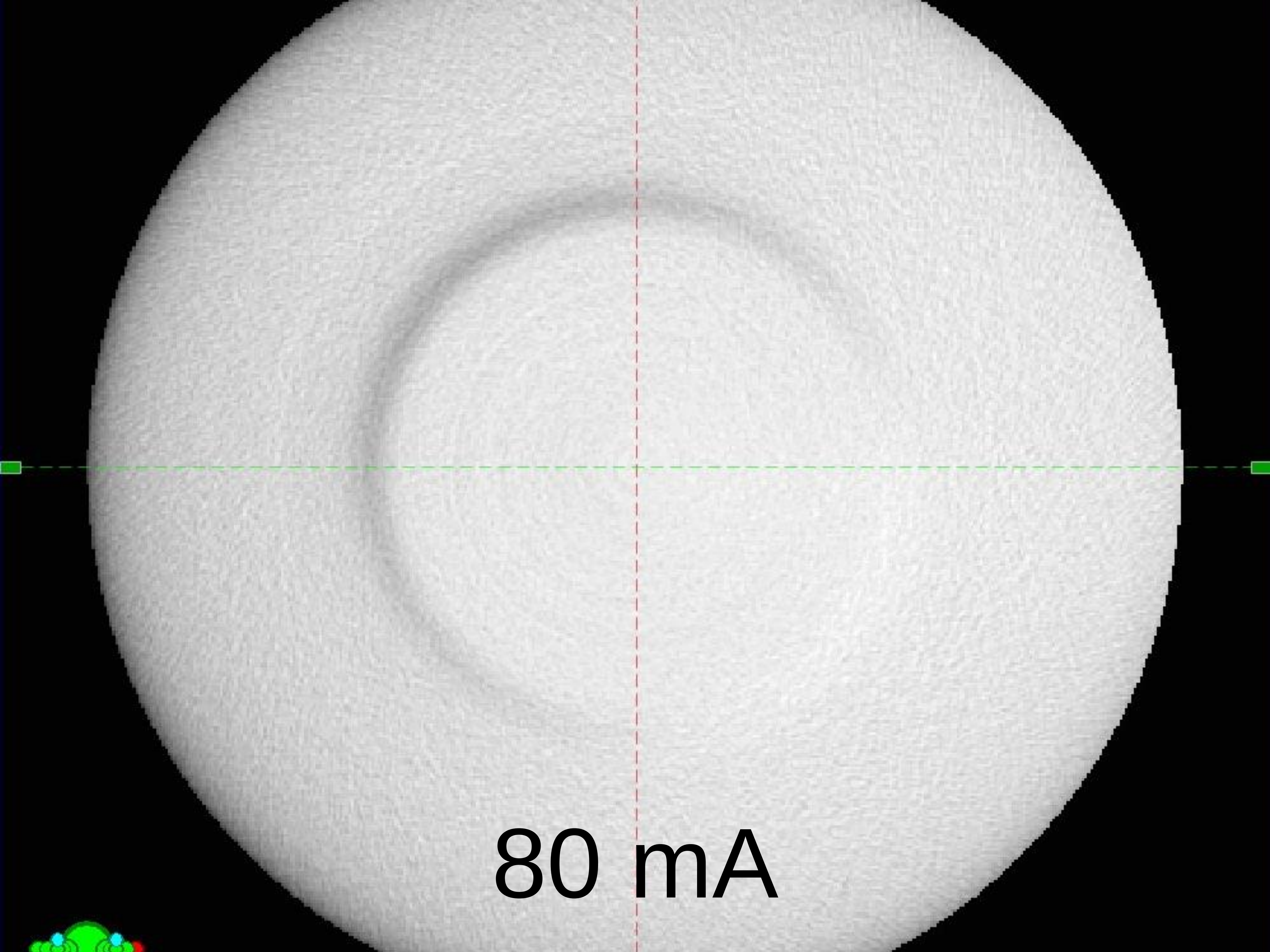
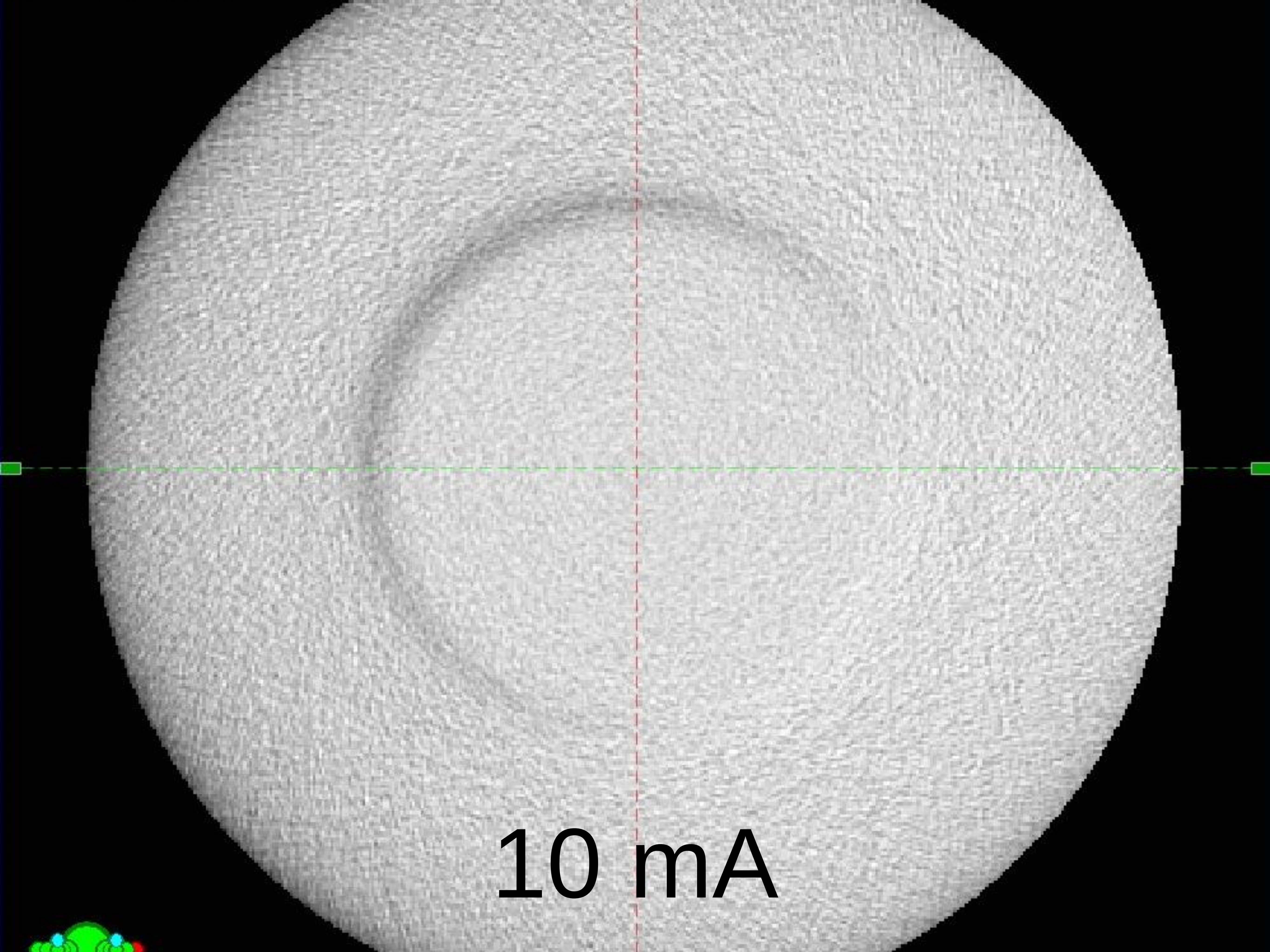
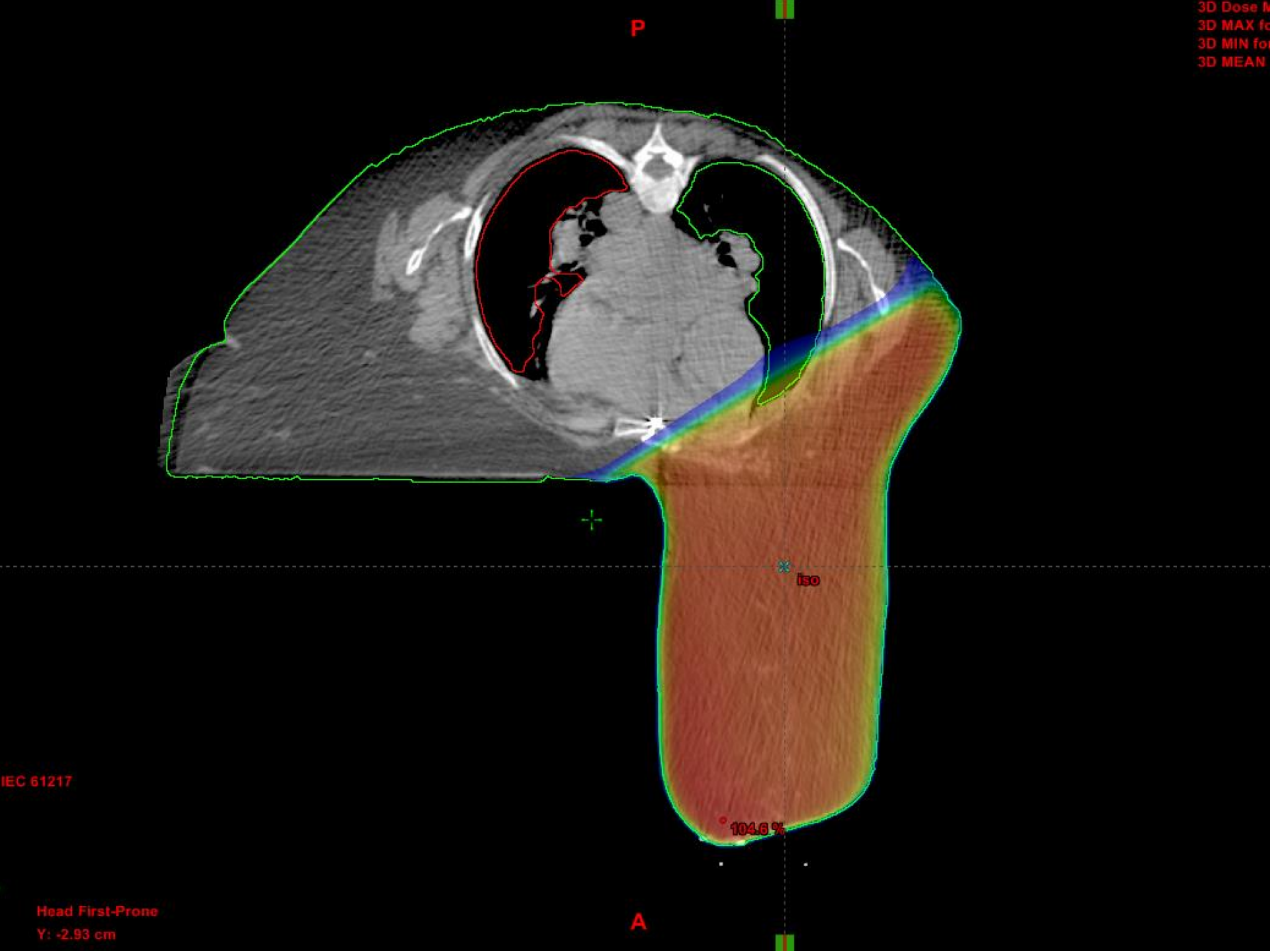


Image Quality Effects

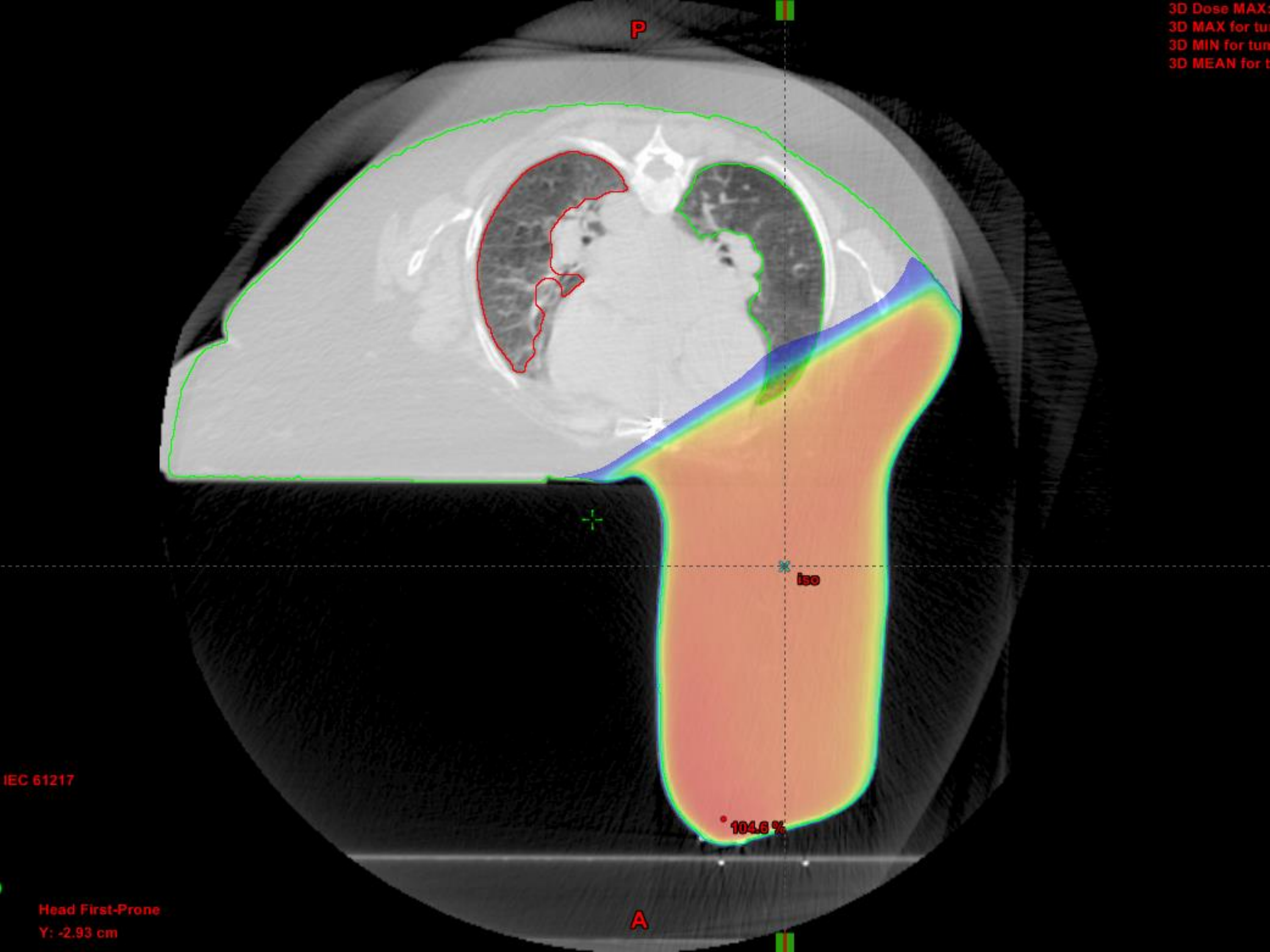

80 mA


10 mA

Case Study



3D Dose M
3D MAX fo
3D MIN fo
3D MEAN
P
iso
104.6 %
IEC 61217
Head First-Prone
Y: -2.93 cm
A


3D Dose MAX
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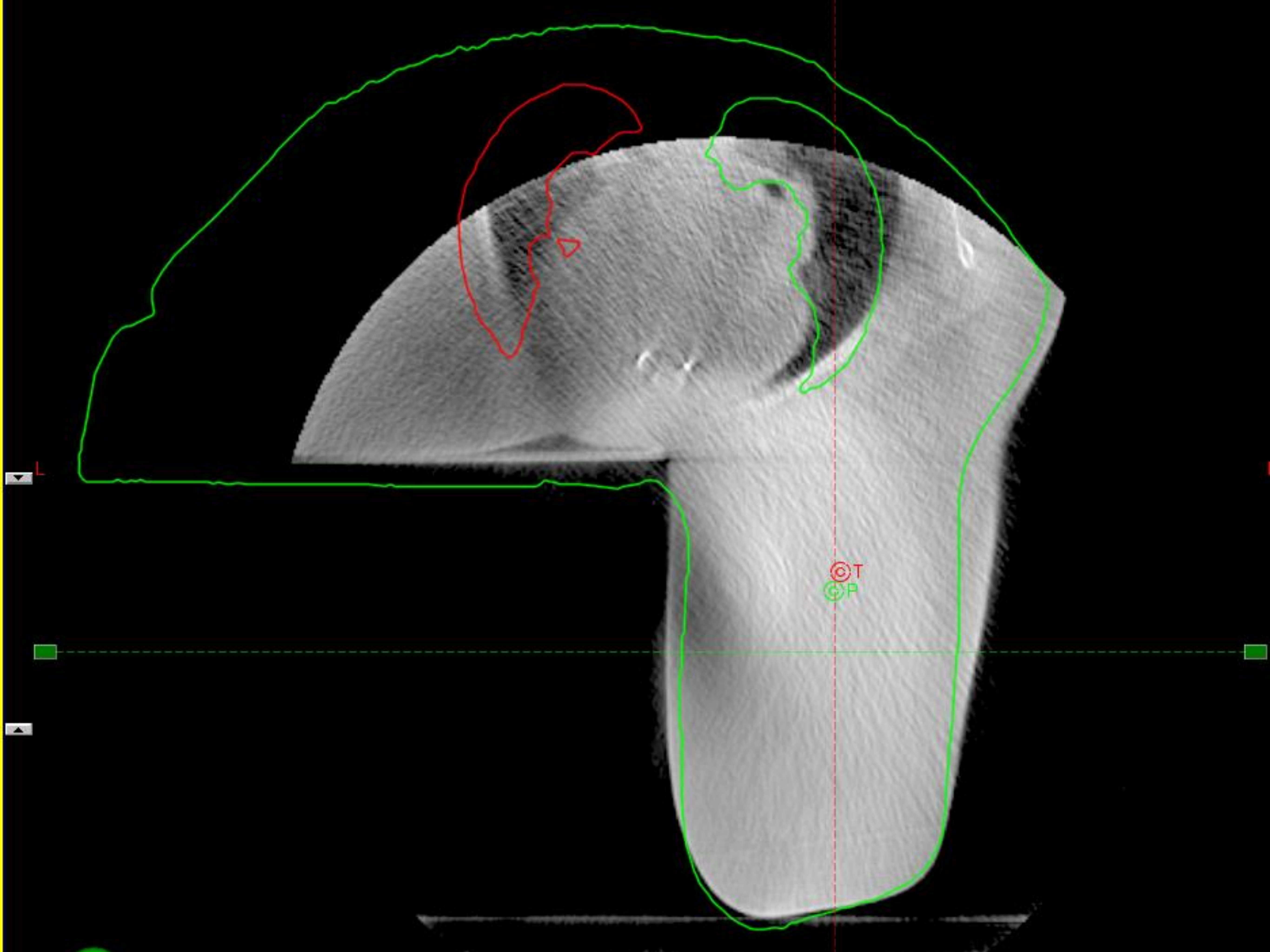
iso
104.6 %
IEC 61217
Head First-Prone
Y: -2.93 cm
A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T
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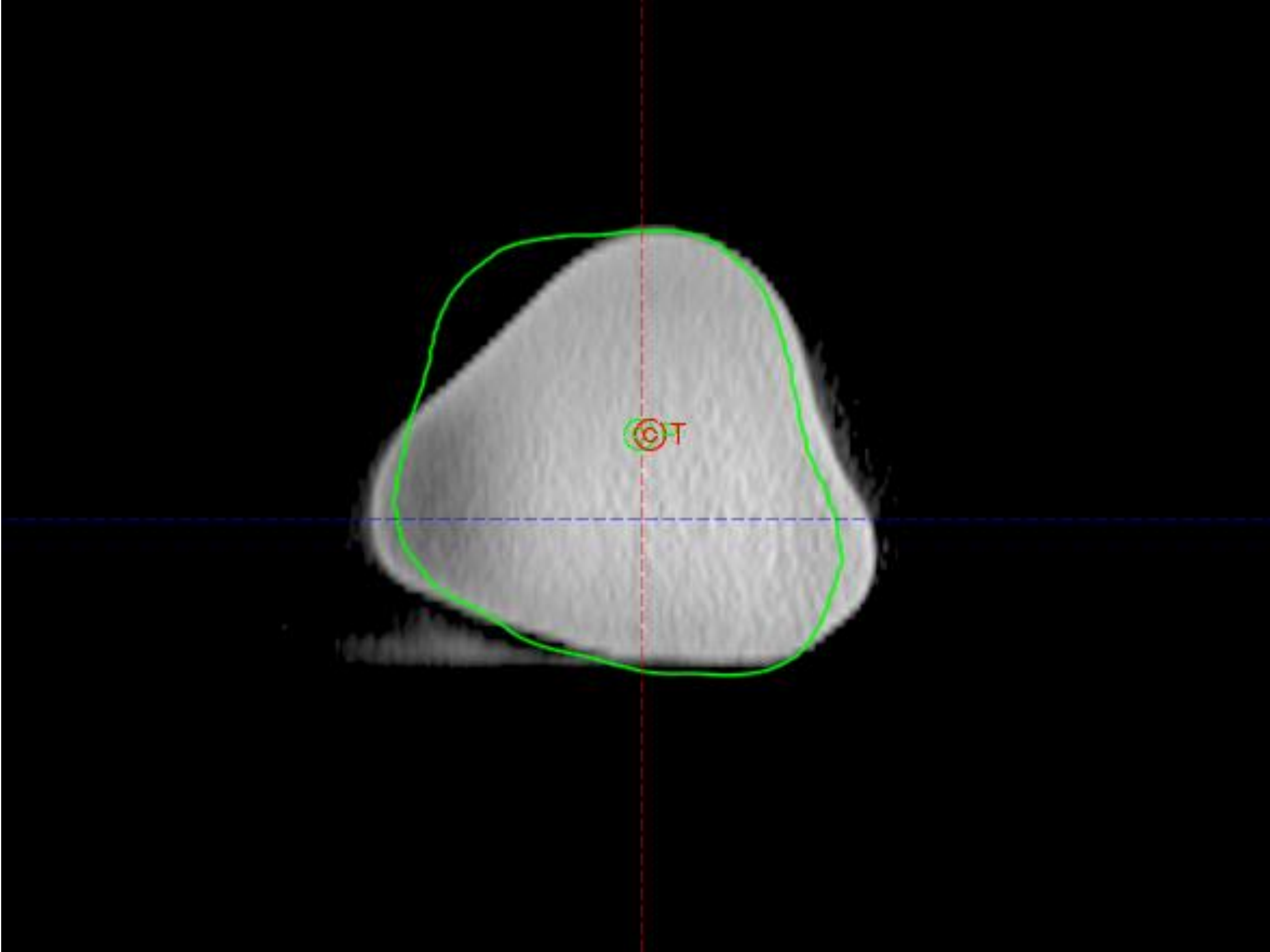
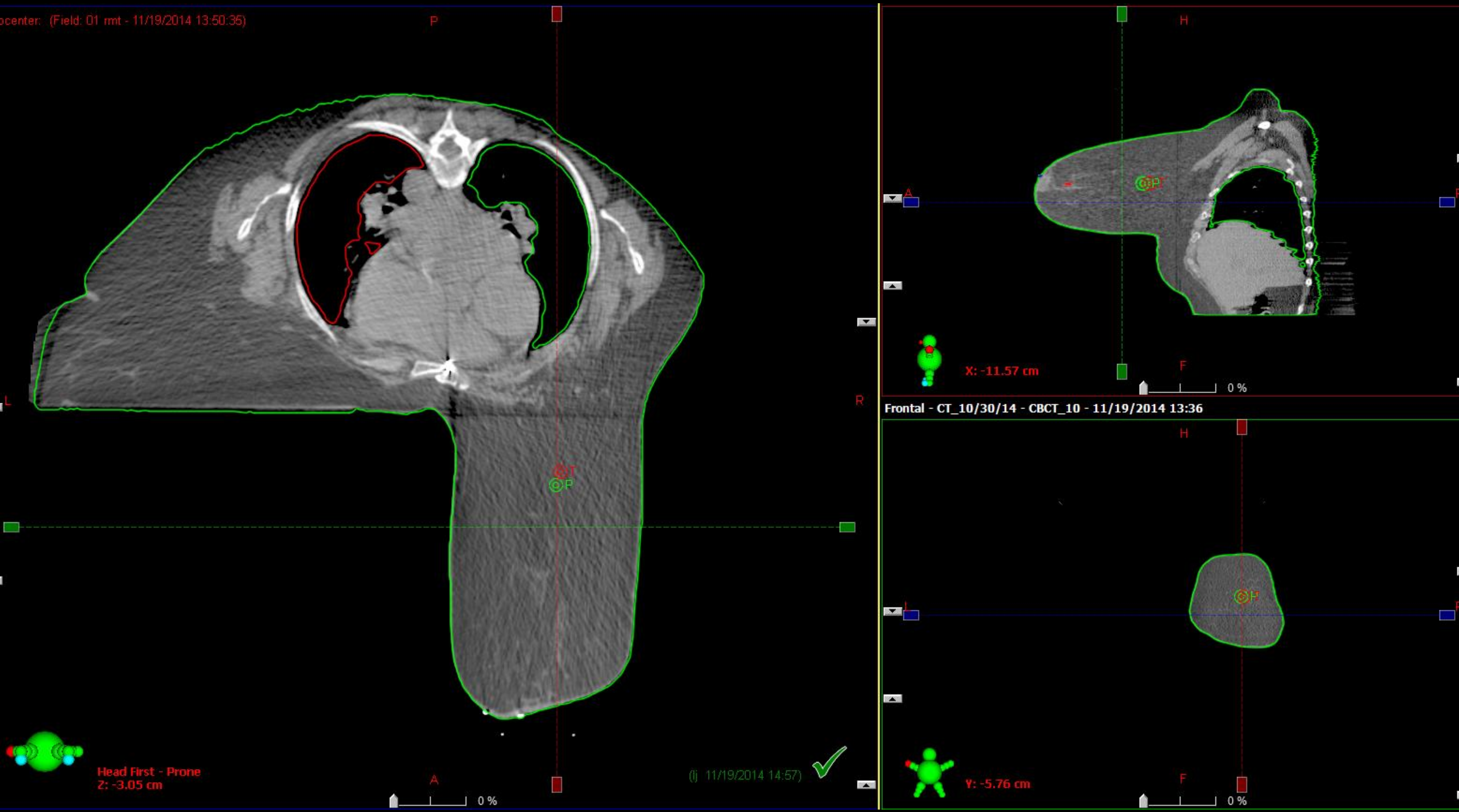
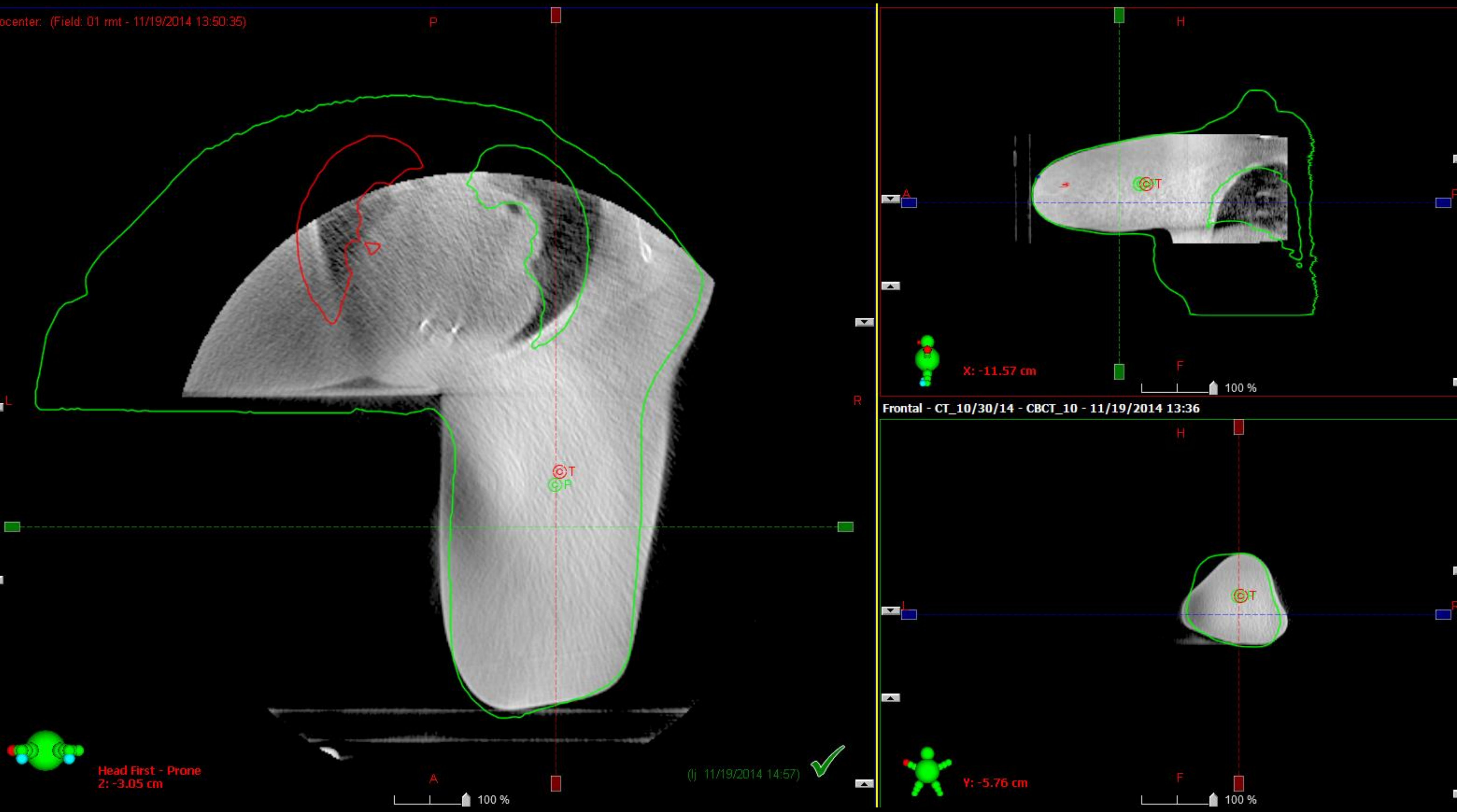

C
T



ocenter: (Field: 01 rmt - 11/19/2014 13:50:35)
P
L
R
Head First - Prone
Z: -3.05 cm
A
0 %
(lj 11/19/2014 14:57)
H
A
X: -11.57 cm
F
0 %
Frontal - CT_10/30/14 - CBCT_10 - 11/19/2014 13:36
H
Y: -5.76 cm
F
0 %


ocenter: (Field: 01 rmt - 11/19/2014 13:50:35)
P
L
R
Head First - Prone
Z: -3.05 cm
A
100 %
(lj 11/19/2014 14:57)
H
X: -11.57 cm
F
100 %
Frontal - CT_10/30/14 - CBCT_10 - 11/19/2014 13:36
H
Y: -5.76 cm
F
100 %

Key Points

- A very low dose CBCT technique was developed to address inter-fraction setup variability for prone breast patients.

Key Points

- Patients were imaged daily (as needed), target volumes were compared in 3D (actual versus planned), shifts were automatically applied, and setup problems were readily visible and corrected if significant.

Key Points

- Low image dose and reduced image quality were acceptable as the breast contour, tumor bed, lung interface, and ribs were easily visible.

Key Points

- Over time our therapists and patients became acclimated to prone setup and the frequency of CBCTs was reduced.

Nash Cancer Treatment Center Colleagues

Nash Cancer Treatment Center Colleagues

Nash Cancer Treatment Center Colleagues

Nash Cancer Treatment Center Colleagues

Nash Cancer Treatment Center Colleagues