3 Dimensional Planning in Carcinoma Breast

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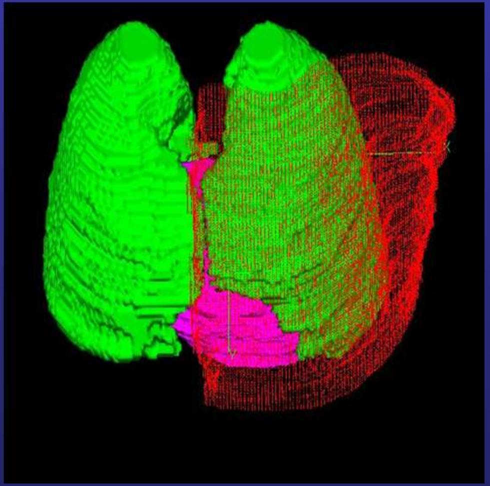


3 D Planning: A Clinical Perspective

- Unique power to create and manipulate dose gradients
- Detailed quantitative treatment objectives

3 D Planning: A Clinical Perspective
3 D Planning: A Clinical Perspective

- Need to control and determine treatment margins through objective measurement of set-up uncertainties internal organ motion.
- All aspects of the radiotherapy process should be re-examined under more stringent requirements for accuracy and precision.

What is 3 D PLANNING???

- Its complicated!
- A integrated system of technologies:
  - Patient setup and immobilization
  - CT-Sim, with complimentary imaging

3 D PLANNING???

  - Computer-aided treatment planning
  - Linac and MLC
  - Verification Imaging

- It is not a treatment modality or technique!

IMRT: A Technical Perspective

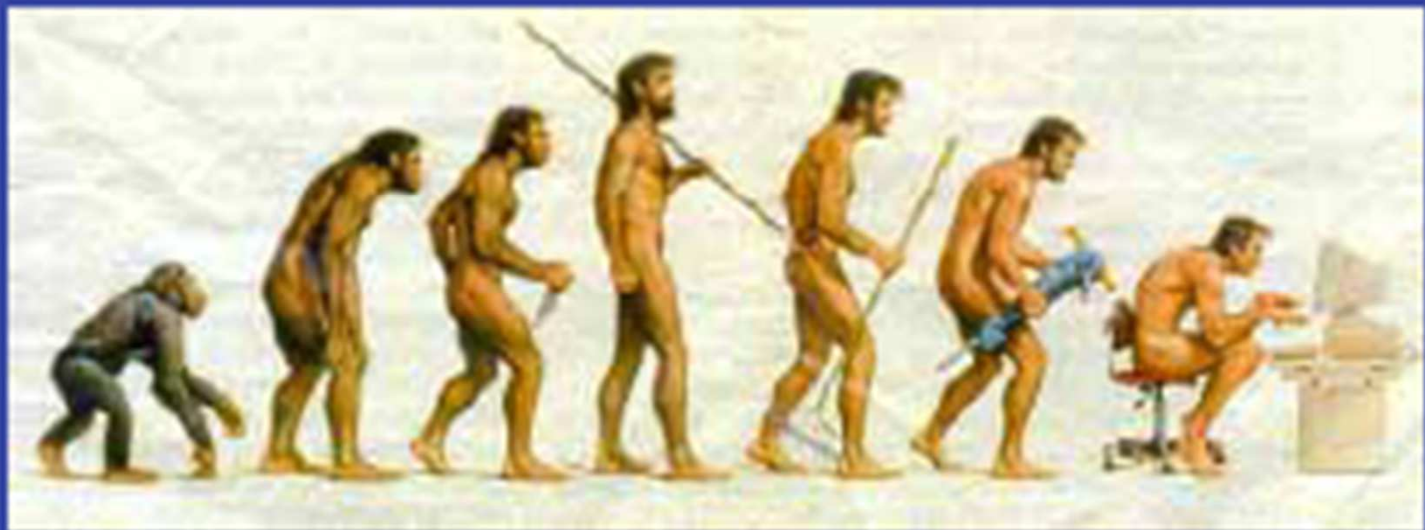
- IMRT is an extension of "3D Conformal" practices.
- Existing recommendations for RTP QA are applicable.

- IMRT technologies are *integrated; i.e.,* quality of IMRT/RTP plans depends on "up- and down-stream" technologies:
  - Imaging, segmentation, R&V, accelerator, and PROCESS

The Evolution of IMRT

- The history of the arts and sciences could be written in terms of the continuing process by which new technologies create new environments for old technologies.
- You have to perceive the consequences of the new environment on the old environment before you know what the new environment is.

Marshall MacLuhan



3 DCRT Requirements

- Key technologies:
  - Imaging and Segmentation
  - Delivery
  - Optimization
  - *Strongly interdependent*
- Training.
- Systematic technical procedures and quality assurance.

When to use IMRT?

- Rapidly expanding applications:
  - GU, GI, GYN; Pelvic node irradiation, Dose escalation
  - Head & Neck: RTOG H0022, RTOG H0225

✓ **Missing tissue and dose compensation (e.g. BREAST)**

- Preferably under protocol (e.g., RTOG)
- Previously treated patients

- Use caution:
  - moving targets (e.g., breathing, bladder filling, bowel gas)
  - tissue density variations (i.e., heterogeneities)
  - Simultaneous integrated boost (i.e., differential fractionation)
  - Achieve dose uniformity where possible

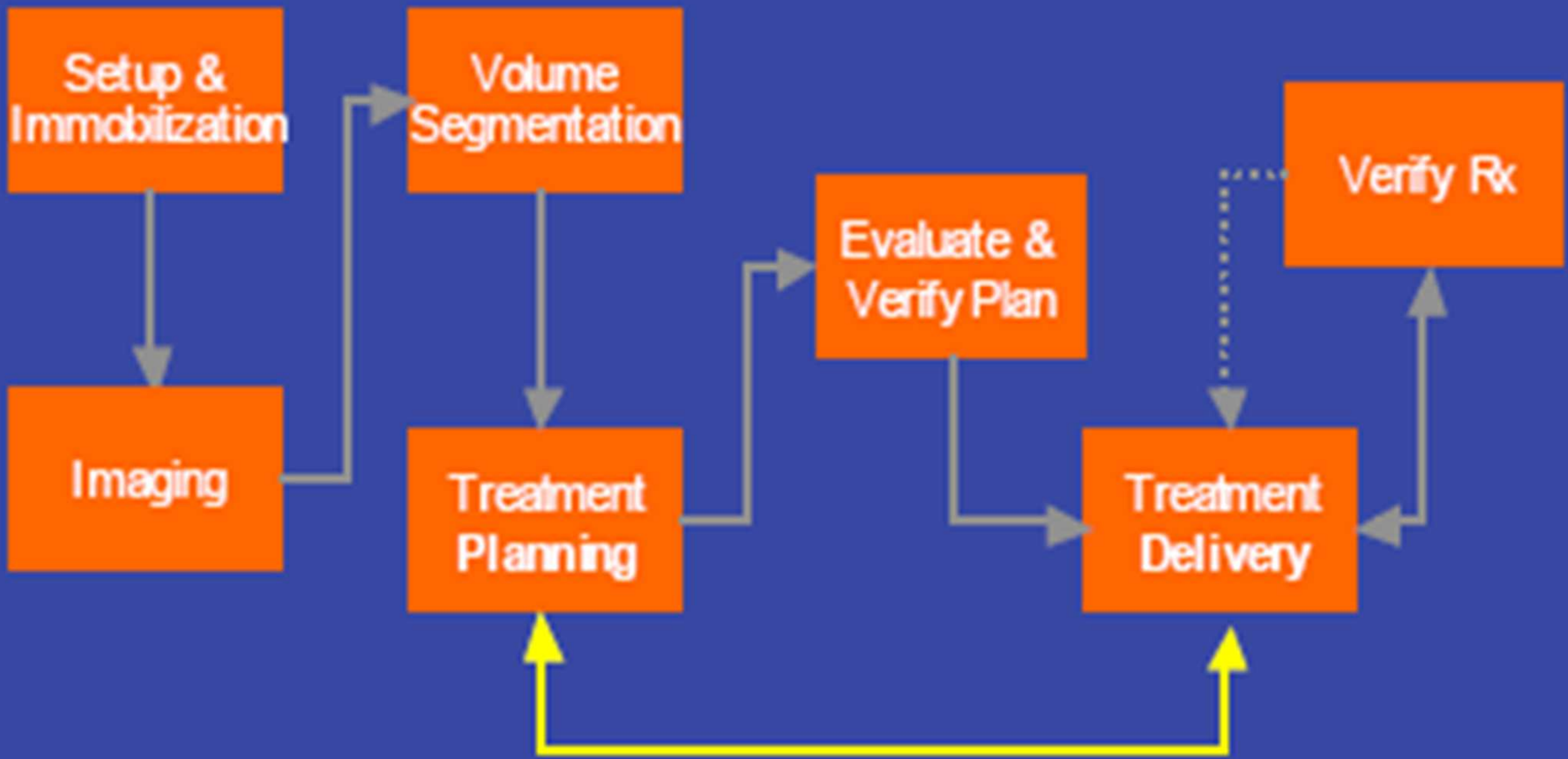
Breast 3 DCRT
Why do we need it?

- More conformal dose to breast
- Lower doses to lungs and heart
- Lower doses to contralateral breast

3 D Planning: A Clinical Perspective

- Inclusion of regional nodes

3 D PLANNING PROCESS



Immobilization

- Minimize/control positioning uncertainties.
- Margins for uncontrolled uncertainty:
  - Internal organ movement
  - Tissue deformation
  - Breathing, cardiac motion
- Develop consistent "rituals" for use.
- Assess effectiveness, comfort.
- Reassess as treatment progresses.
- Be aware of weight loss, medications.
- Be ware of dosimetric impact, e.g., potential loss of skin sparing.
- Level of effort match clinical goal and resources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Initial Simulation

- Immobilization: alpha-cradle
- Position arms above head, keeping elbows tucked in
- Treatment side of the cradle is compressed to avoid interference with the lateral tangent setup and SSD readings

Initial Simulation

- Position the patient level and straighten under fluoroscopy
- Level marks (tattoos) are made on each side of the patient at about 5 cm below xiphoid with the lateral lasers
- Tattoos at ~10 cm off the tabletop

CT Scan

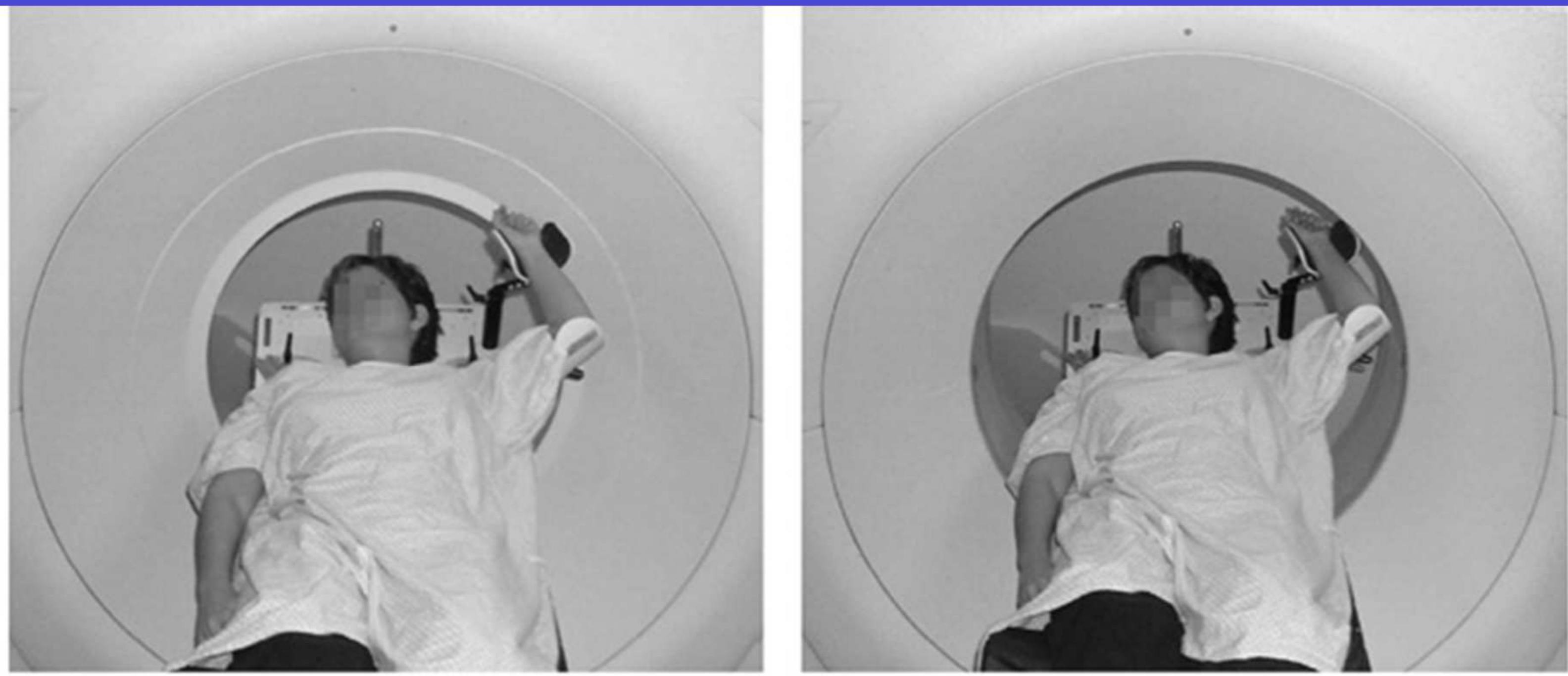
- Position patient level and straighten on the table using the midline, level marks, and the marks on the cradle
- Place a "b.b." on midline, if the medial wire placed by physician is not located on the midline

CT Scan

- Patient should be in the center of the table, unless the affected breast is too large
- If the treatment site is not in the field of view, move the patient off-center to assure a complete scan of the affected breast

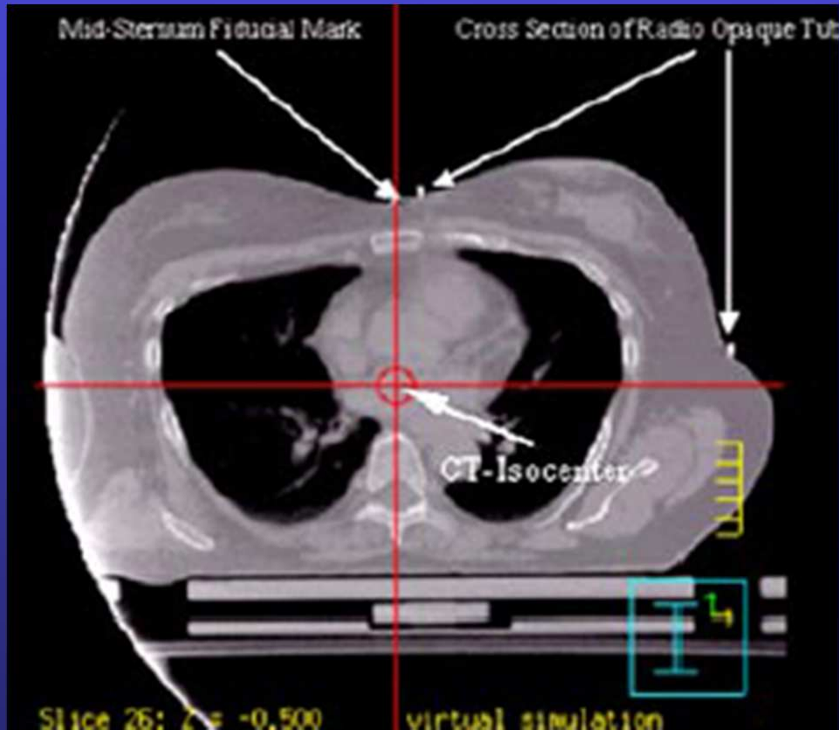
CT Scan

- Acquire a scout view of the entire chest, start superiorly from the chin and end inferiorly below the leveling marks.
- Image set should include above and below the 1st and 12th thoracic rib respectively.
- Set center of the field (zero slice) in middle of the breast, between catheters placed by physician.
- Scan the central axis slice; check for straightness and rotation.



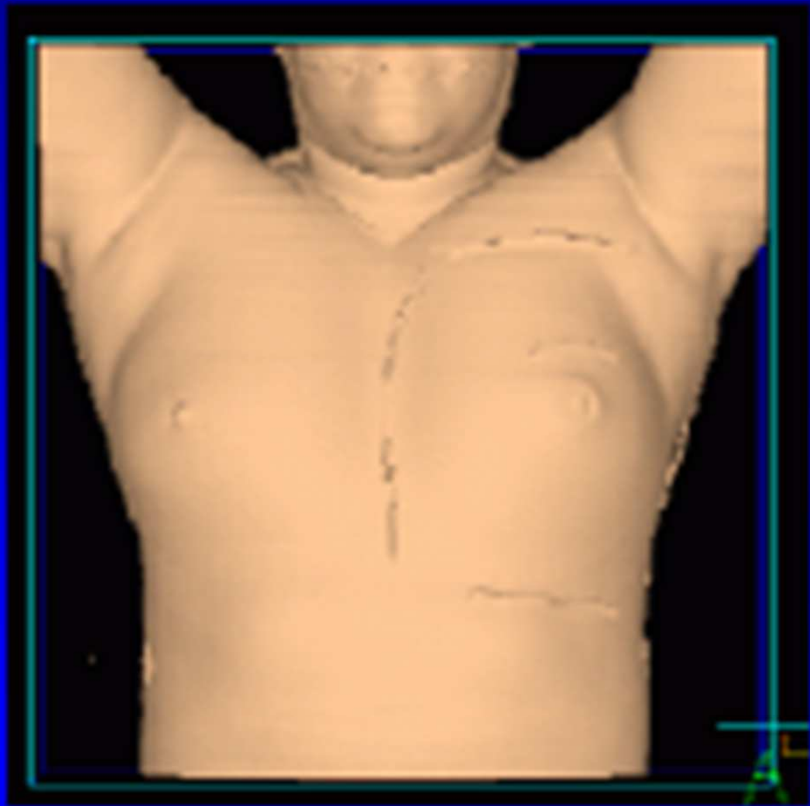
A B

Marker Placement for Reference to Isocenter



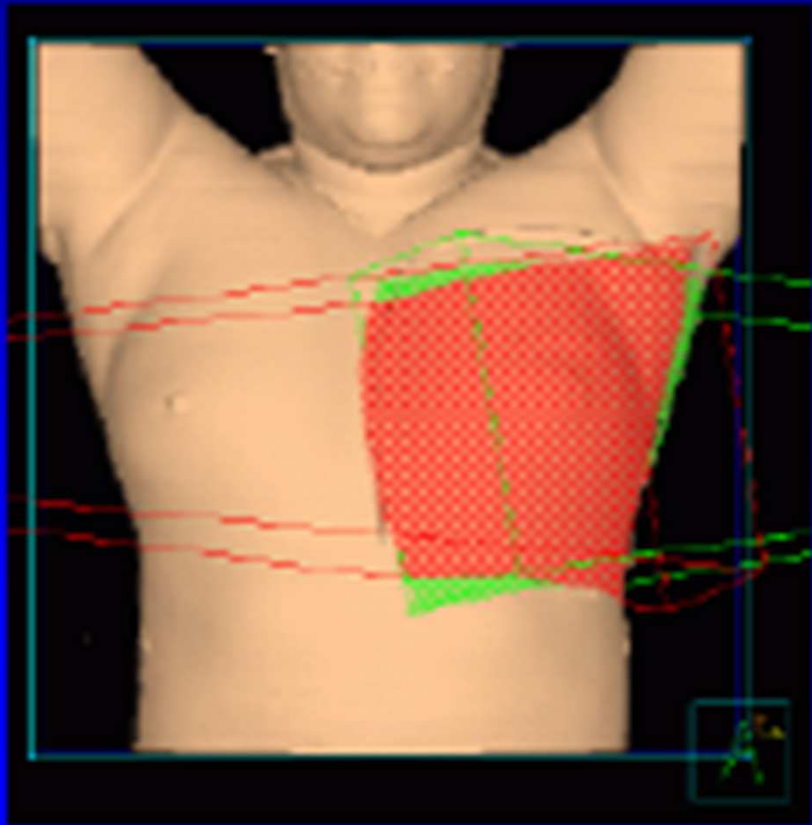
Virtual Simulation

- Virtual CT simulation in the standard treatment position
- Treating physician places radio-opaque markers at the clinical borders of the ipsilateral breast tissue



Virtual Simulation

- During treatment planning: the superior, inferior, and deep edges of the unopposed tangential beams are aligned with the radio-opaque markers



Treatment Planning

- Contour
- Beam alignment
- Beam weight

Key to Successful Treatment

OPTIMAL TARGET DELINEATION

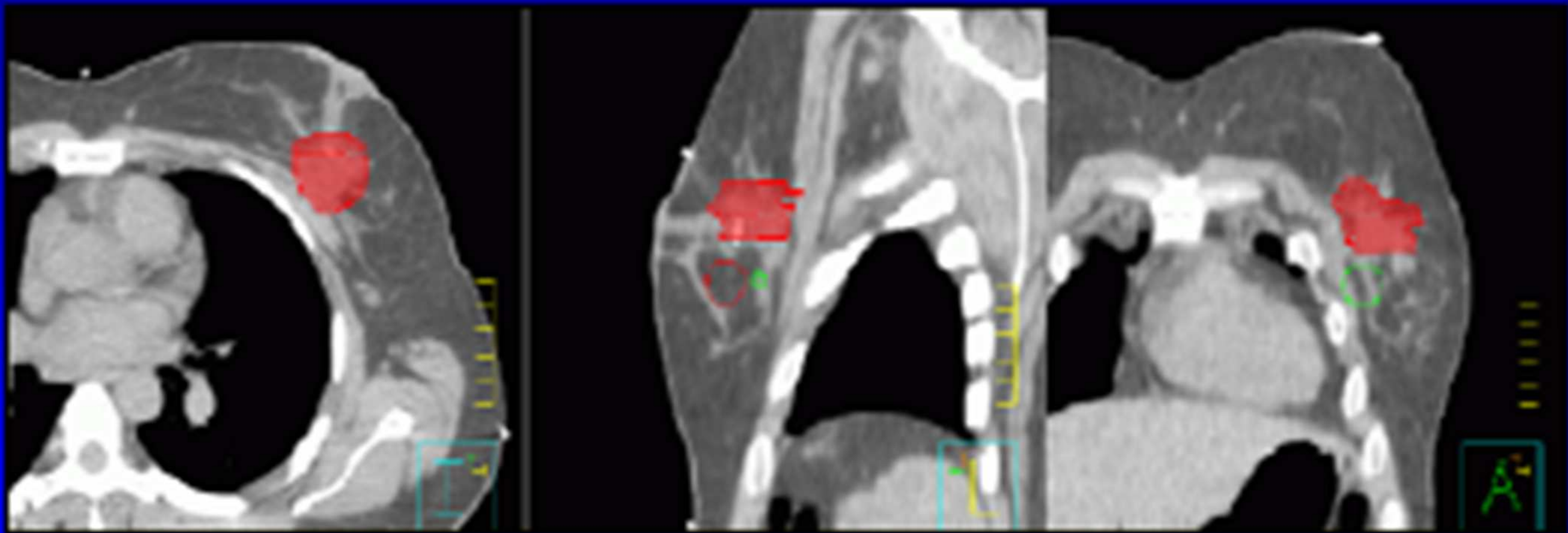
General Tissue Segmentation

- Explicitly delineate targets requiring dose, and every organ at risk (objectives, and evaluation)
- Generally more volumes than 3D planning.
- Margins:
  - Adequate evidence for designing PTV?
  - Consider margins around critical structures to partially account for organ motion, patient movement and setup uncertainties (cord + 0.5 cm)
- Avoid volumes extending outside the patient.
- If target includes buildup region, consider bolus.

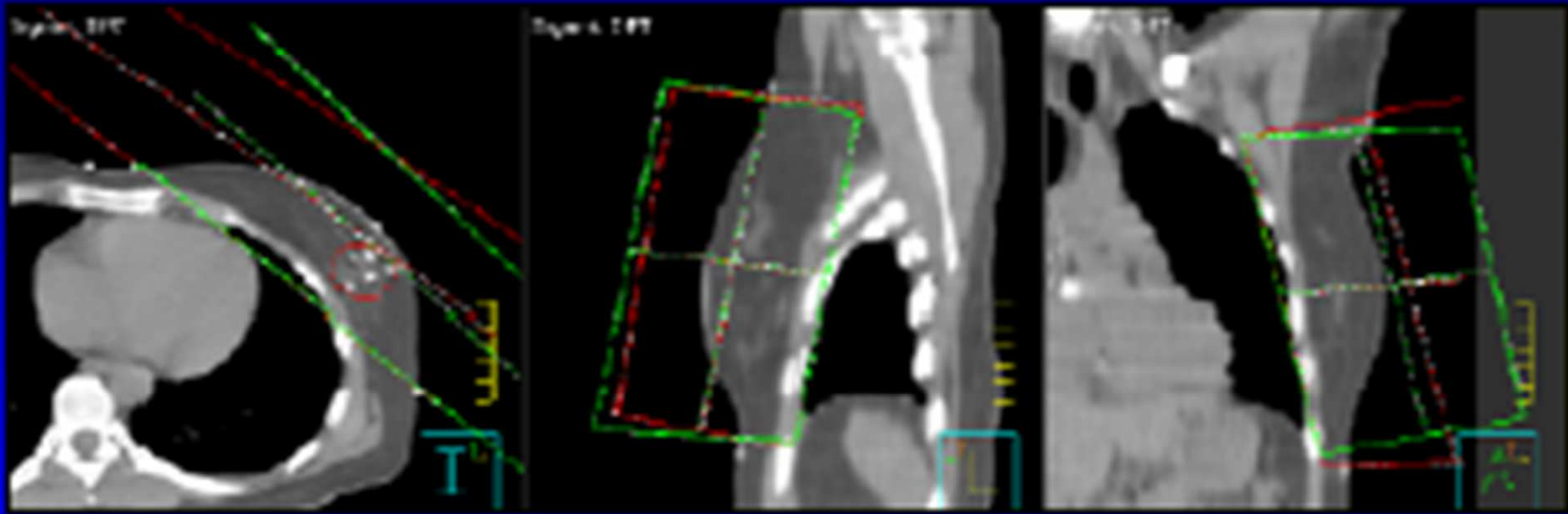
Target Volumes

- ICRU 50 & 62
- GTV - Gross Tumour Volume
- CTV - Clinical Target Volume
- PTV - Planning Target Volume
  - Accounts for internal organ motion and patient setup variations.
- Margins should also be applied to organ at risk (OAR's->PRV's).
- The PTV must be large enough to ensure the CTV receives the prescribed dose.
- The larger the PTV, the more normal tissue irradiated.
- Need to reconcile PTV/PRV overlap

Delineate Lumpectomy Cavity



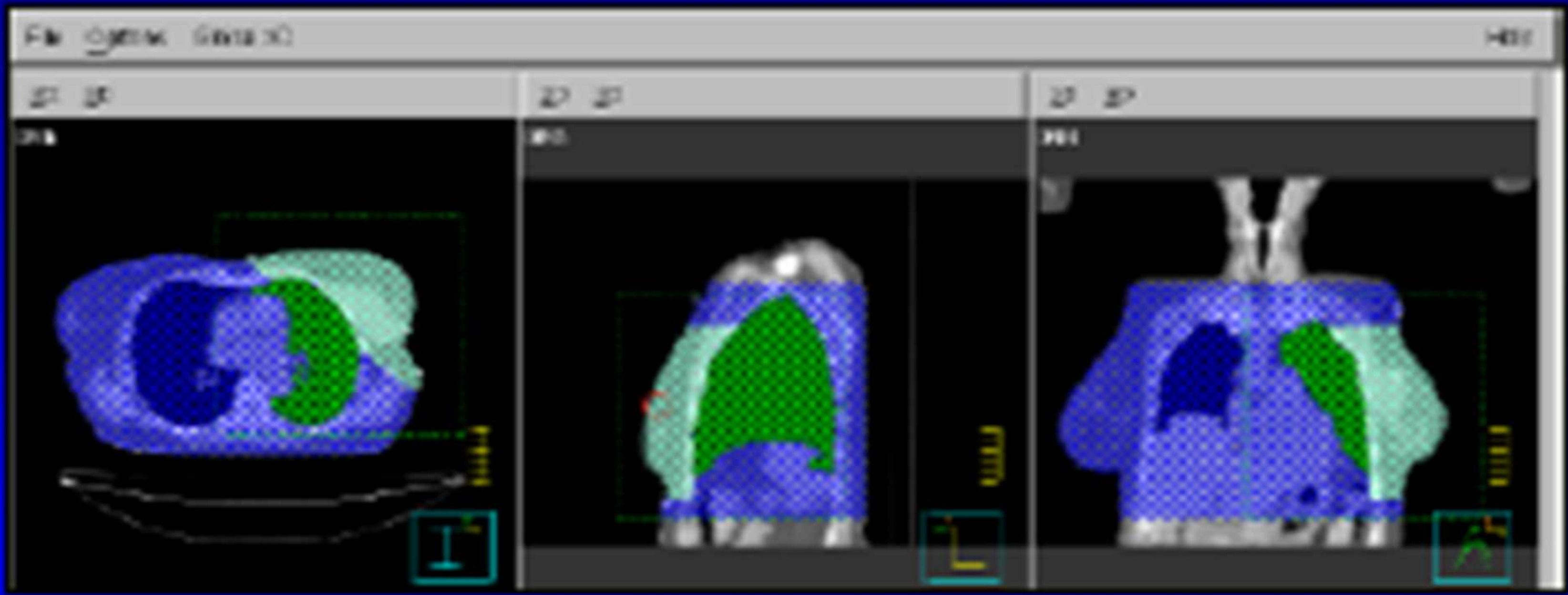
Tangent Beam Alignment



- Align tangential beams to coincide with radio-opaque markers

- 1.5 cm - 2 cm depth into lung

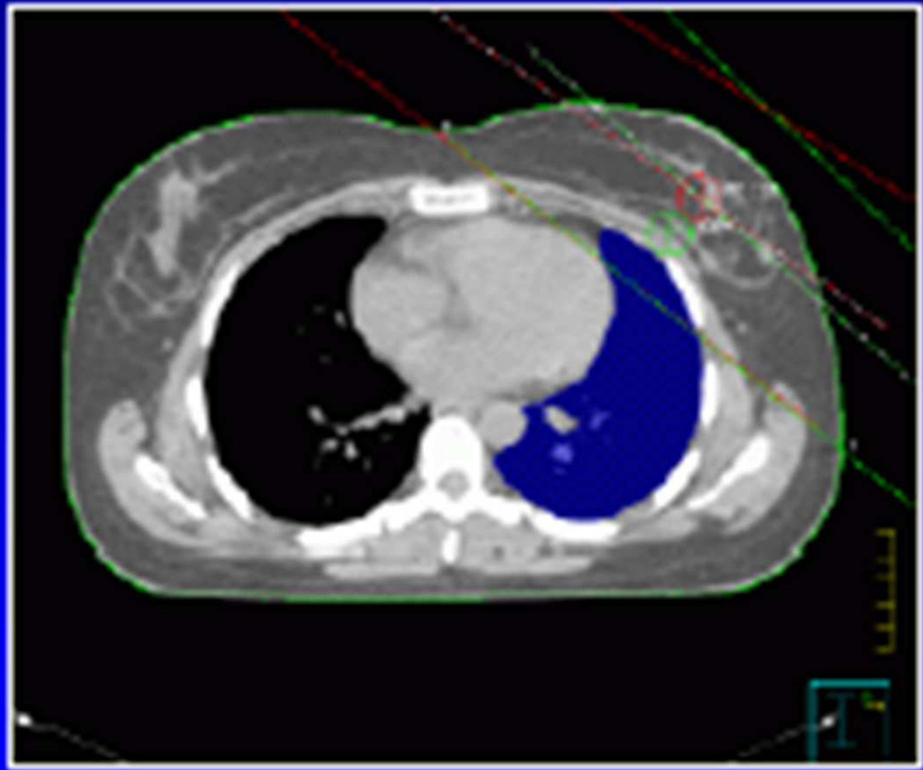
SKIN, LUNG, and BREAST



- Contour skin and lung
- Create breast contour through contraction tool

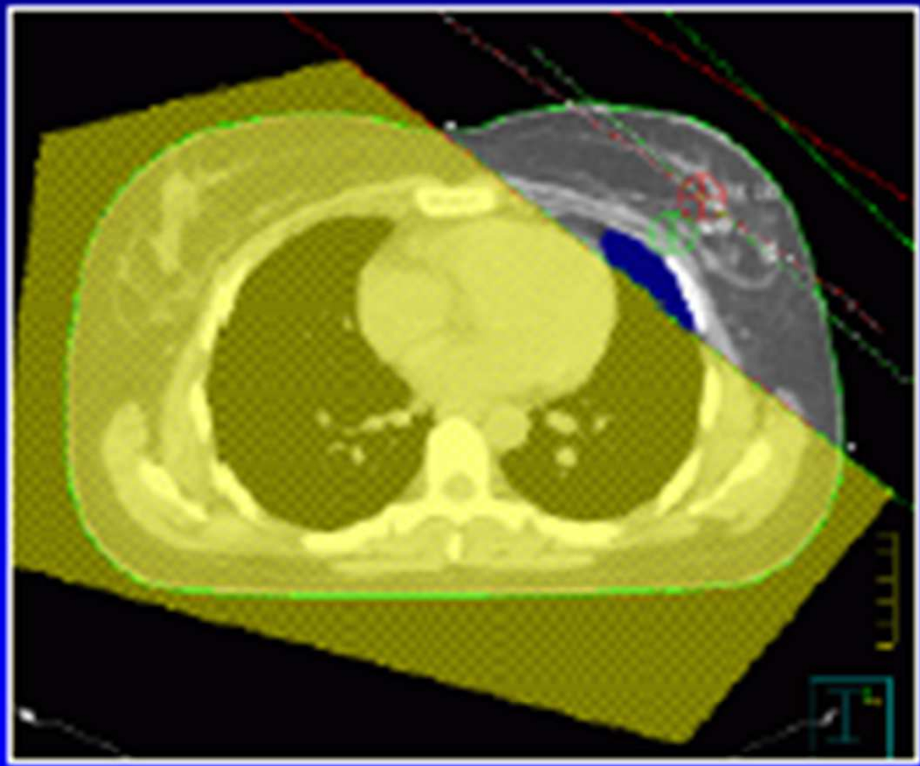
CONTOURS - Skin & Lung

- Auto contour skin and lung
- Lung
  - lower threshold 150
  - upper threshold 800



CONTOURS - Beam Edge

- Contour the tangential beam edge to create a "Dummy ROI"



CONTOURS - Beam Edge

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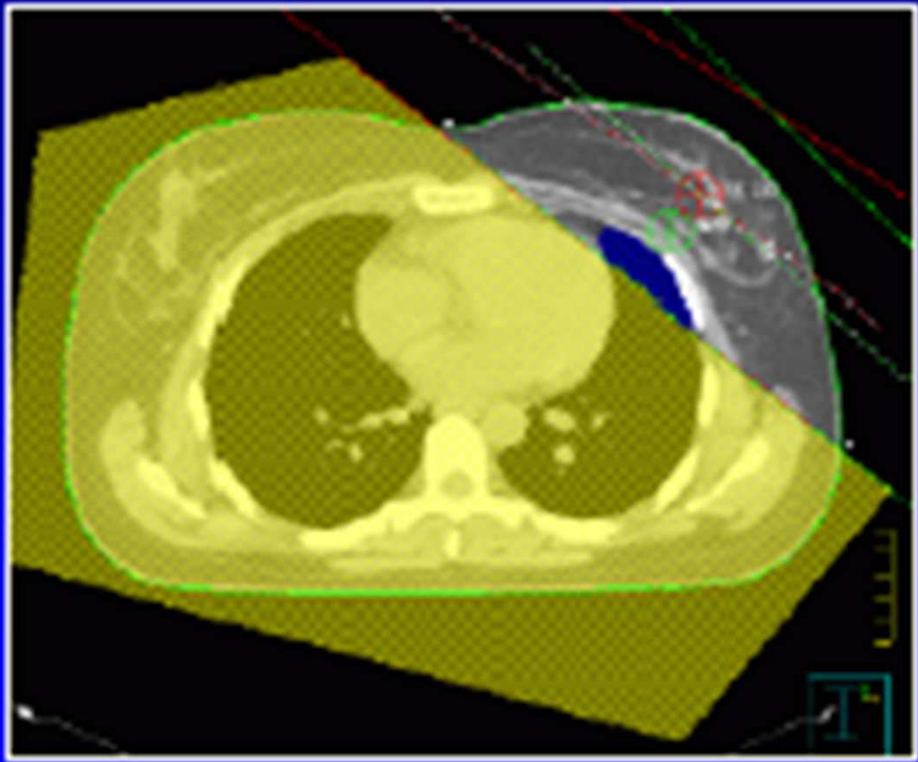
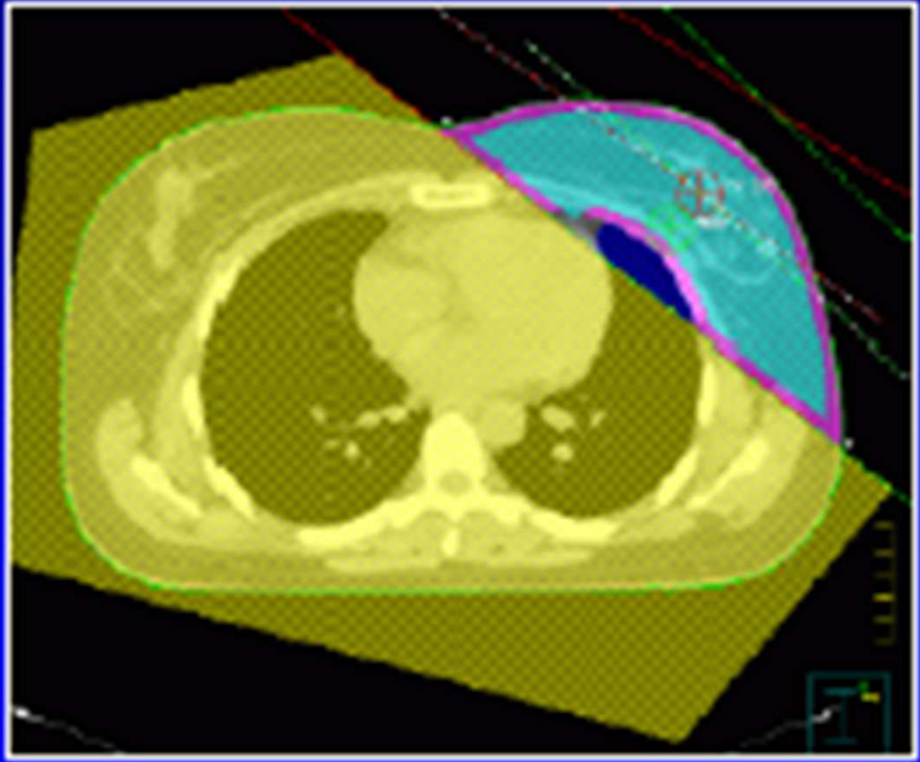


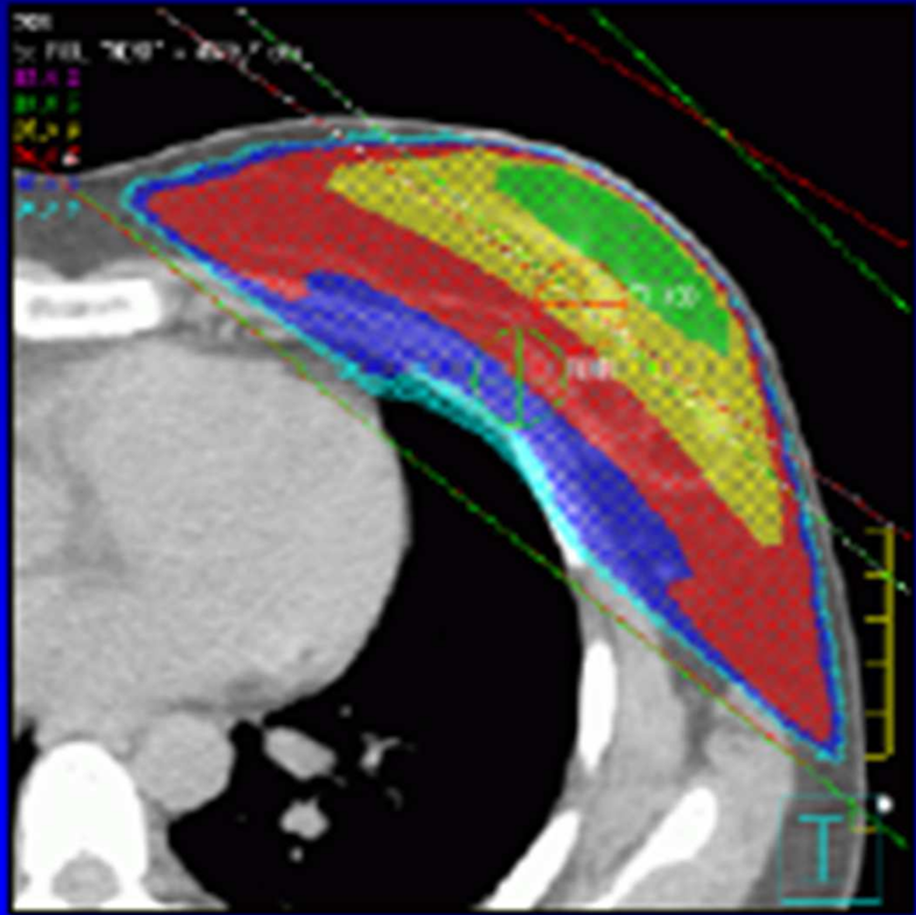
CONTOURS - PTV_eval

- Create PTV_EVAL by contracting BREAST ROI by 5mm



Beam Weight

- Open field plan is created
- Heterogenity correction is utilized
- Beams are weighted to a normalization point 1 cm anterior to the chestwall



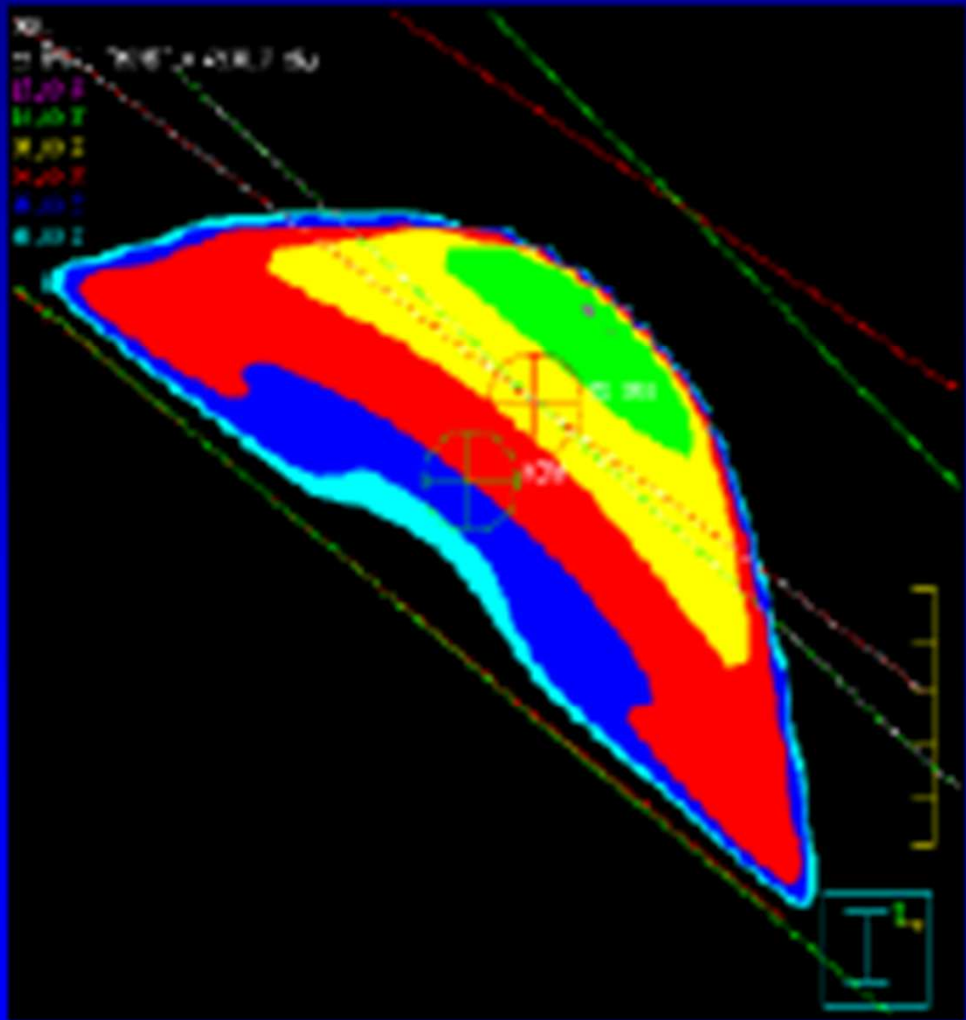
Beam Selection

- Often, equally-spaced, unopposed, coplanar beams
- Use geometry to advantage; ie , angle beams to:
  - miss critical structures,
  - treatment table (couch bars)
  - immobilization devices
- Minimize number of beams, to reduce planning, setup, and delivery time.
- Higher energies reduce peripheral dose and less impact when more beams.
- Depends on the complexity of the target shape and its proximity to critical structures.

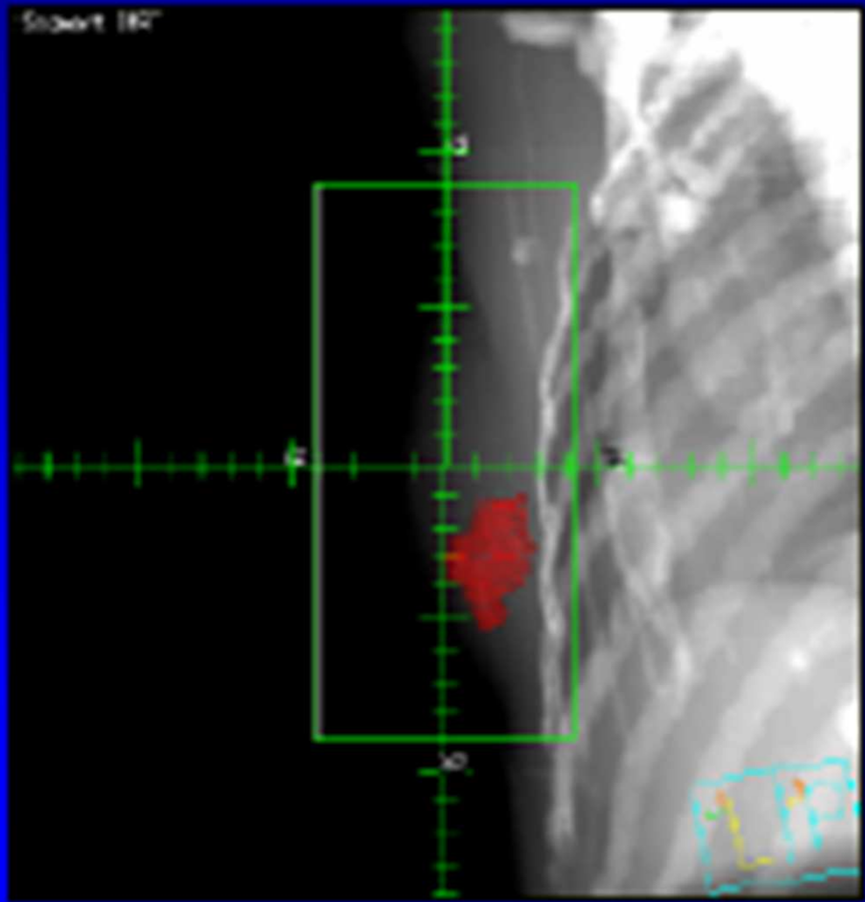
G. Ezzell at al. JACMP 2(2), 59-68, 2001.

A. Pugachev et al. IJROBP 50(2):551-560, 2001.

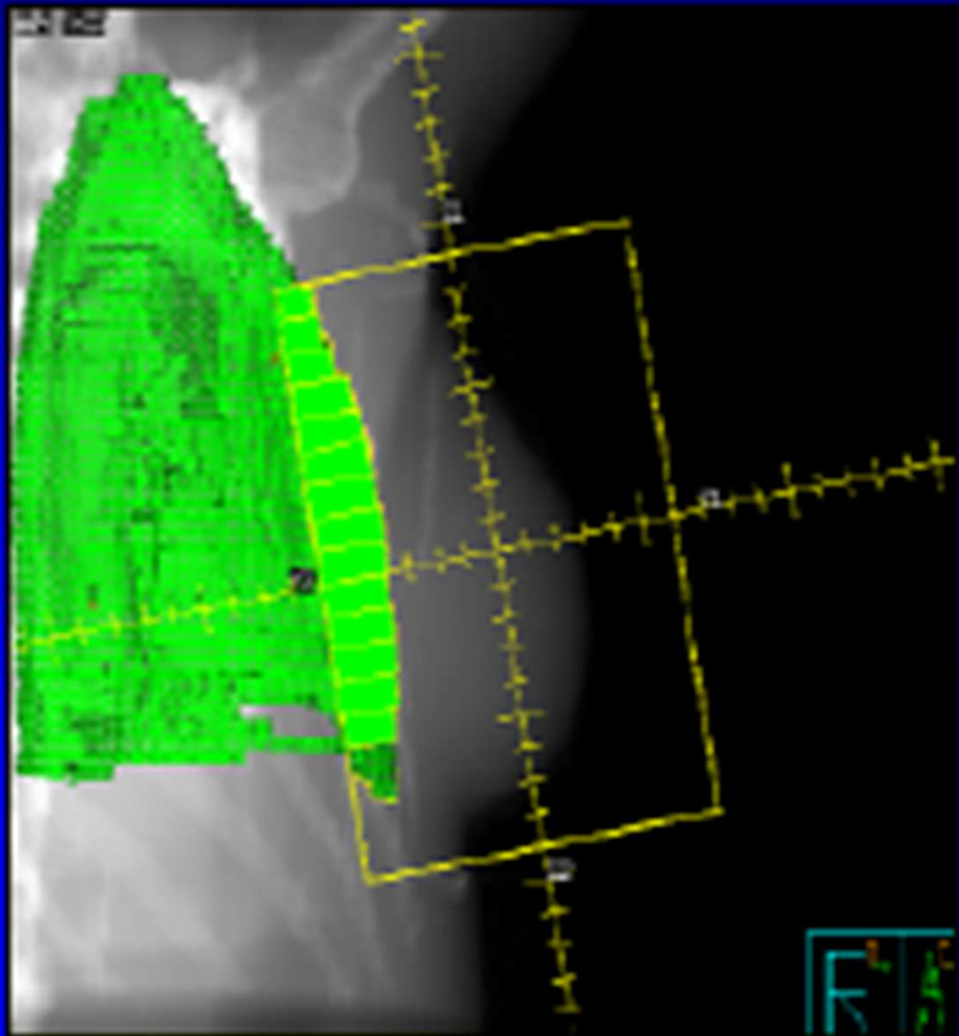
Dose Segment - ROI



Beam Segments - Open Field

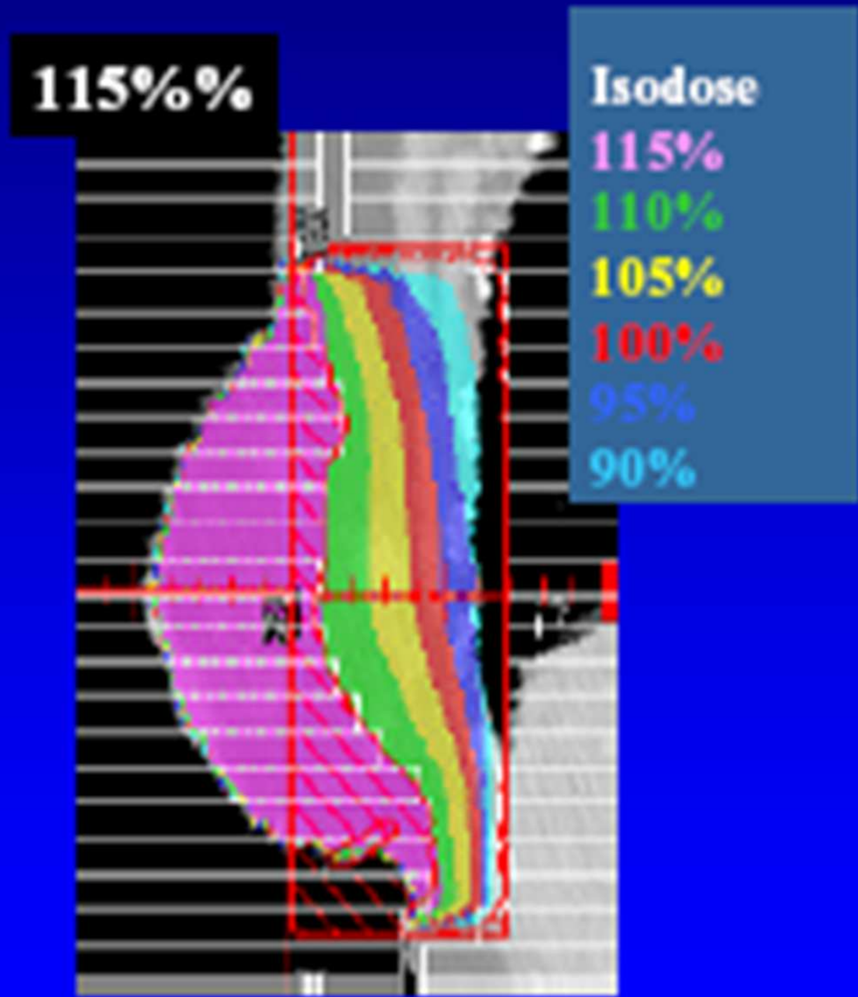


BEV: Block to Lung

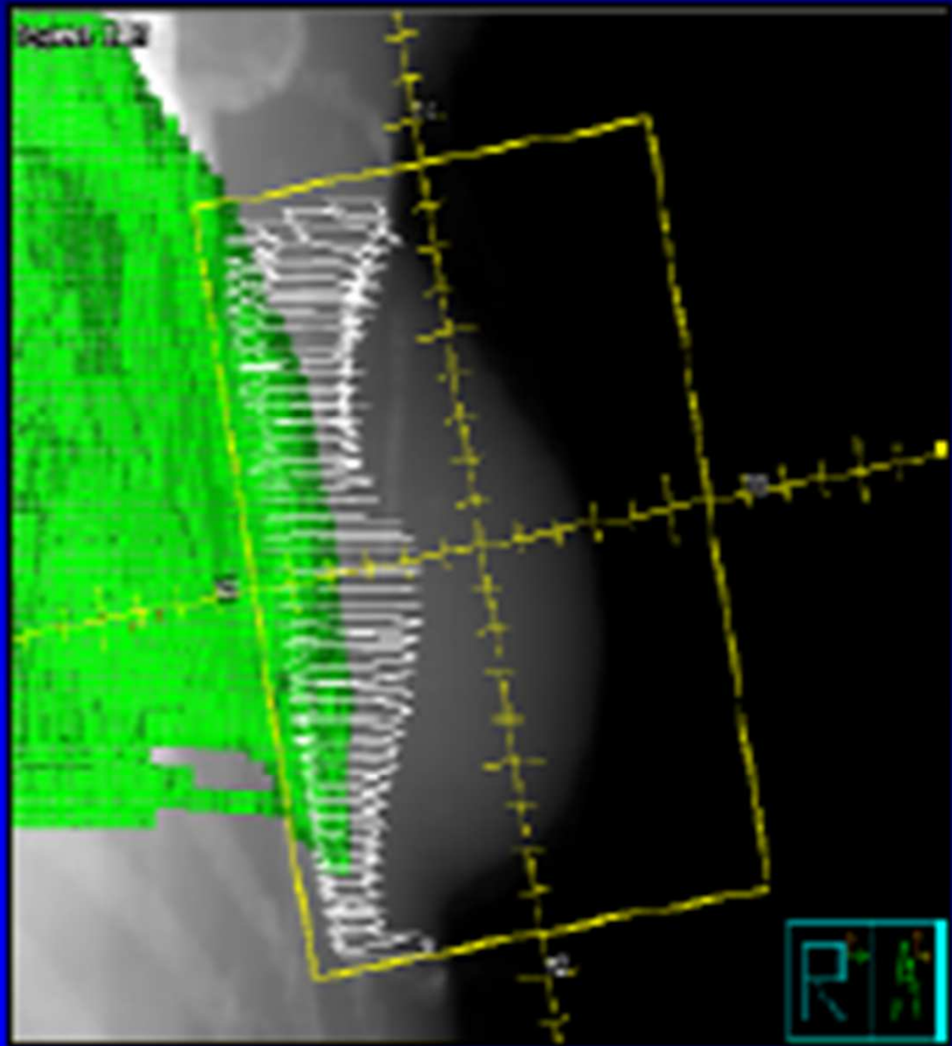


MLC Segments

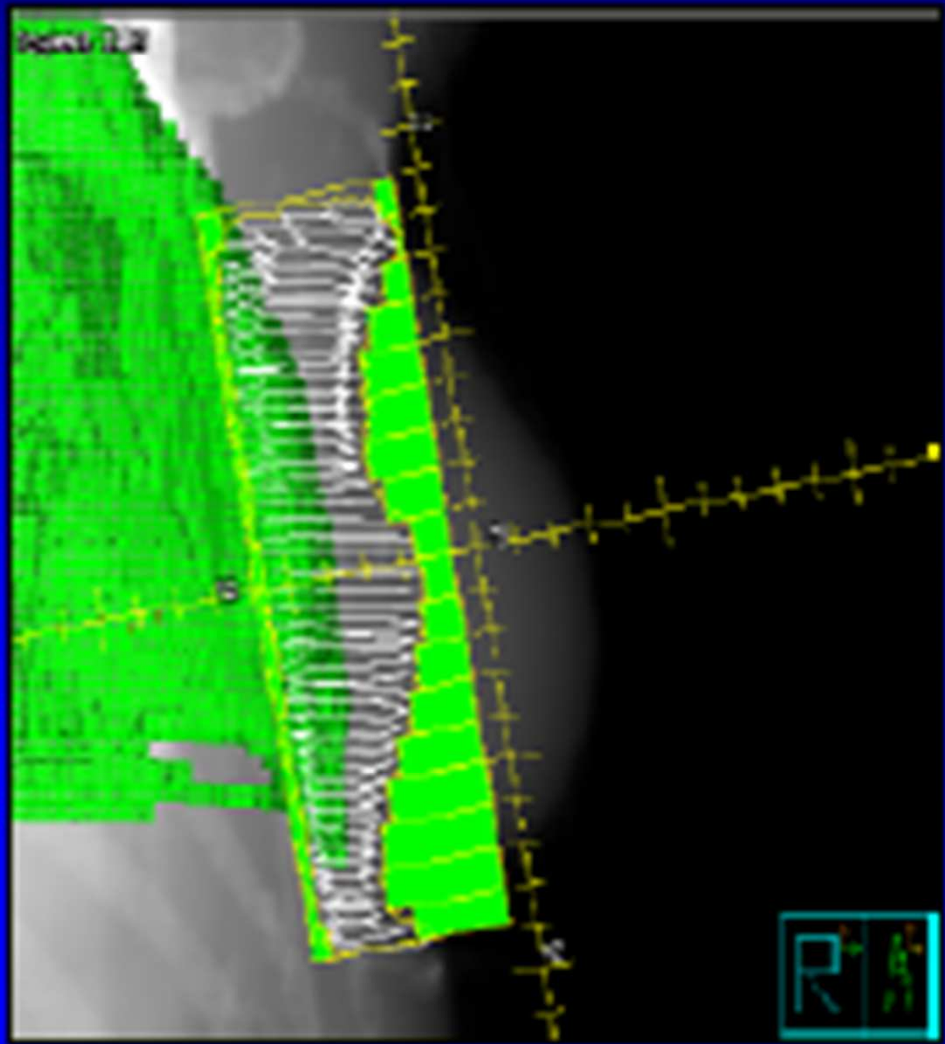
- Calculate an isodose distribution for a pair of open tangential fields (no blocks or wedges)
- Subdivide medial and lateral beams into MLC segments; conform to isodose lines, in 5% increments, i.e., 120%,115%,110%, 105% …



BEV: Dose ROI

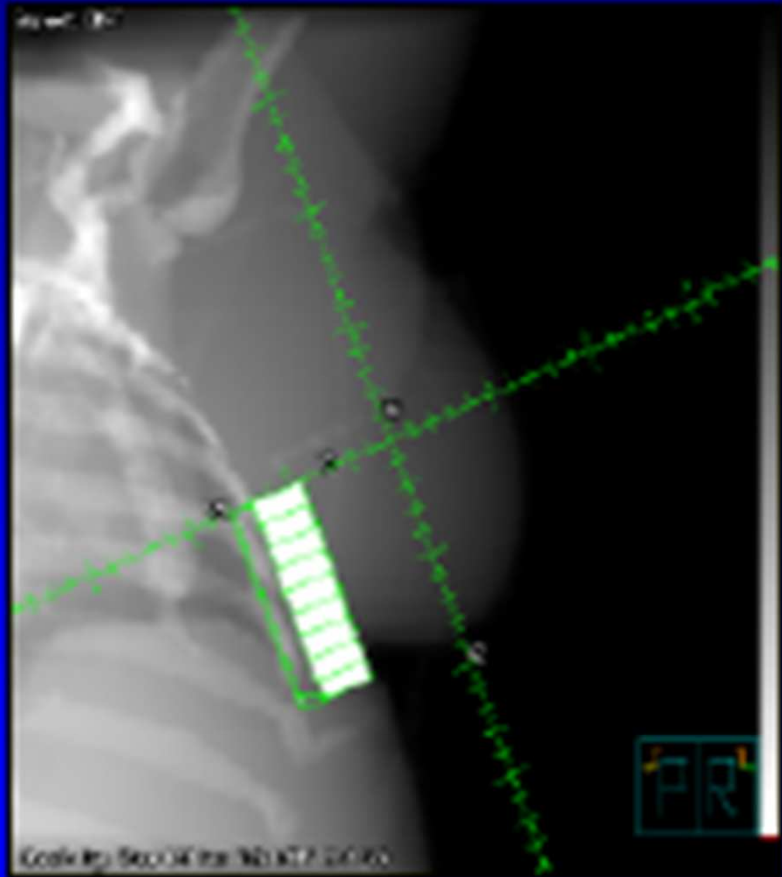


BEV: Block to Dose ROI

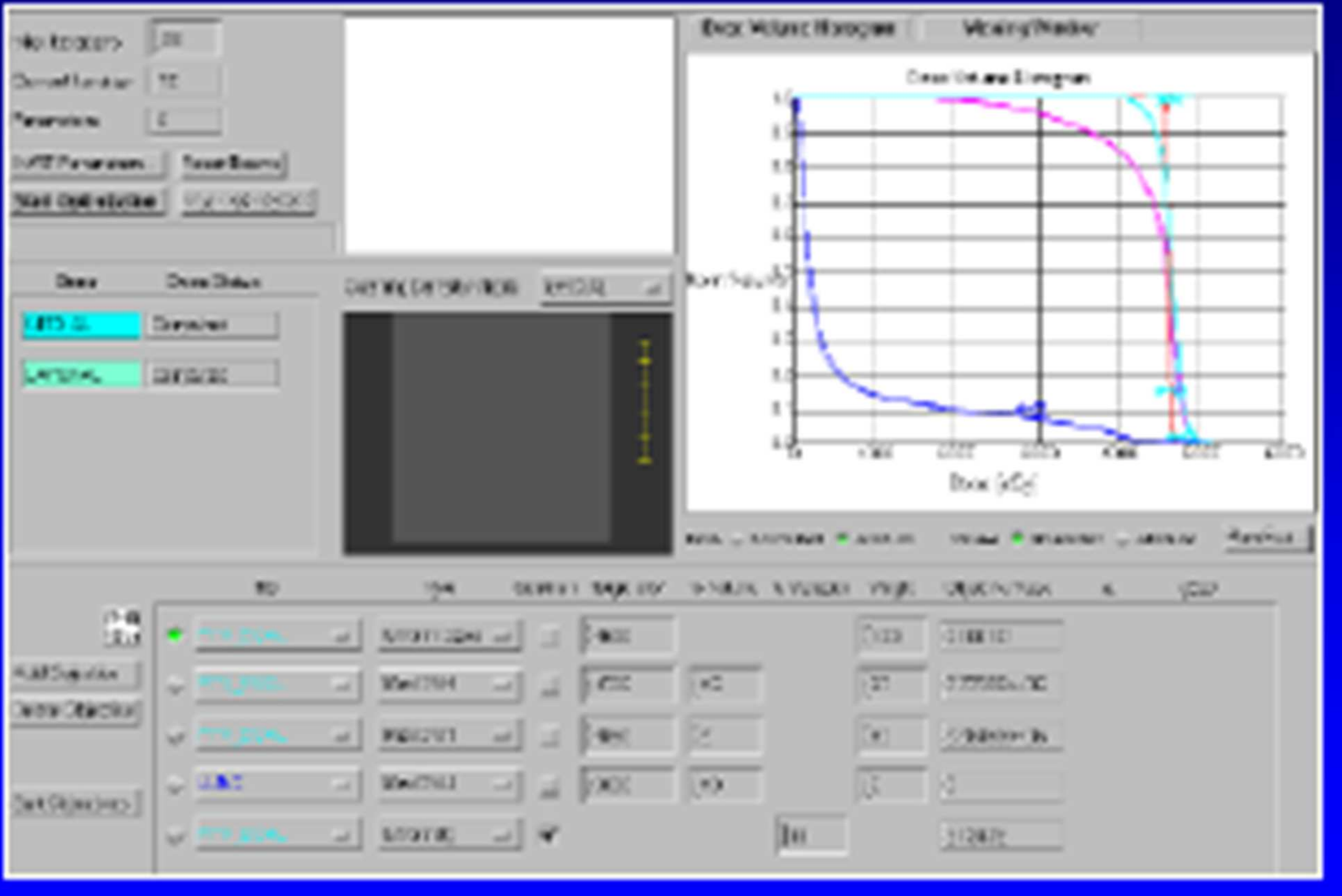


MLC Segments

- Open Field
- Lung Block
- Multiple Segments



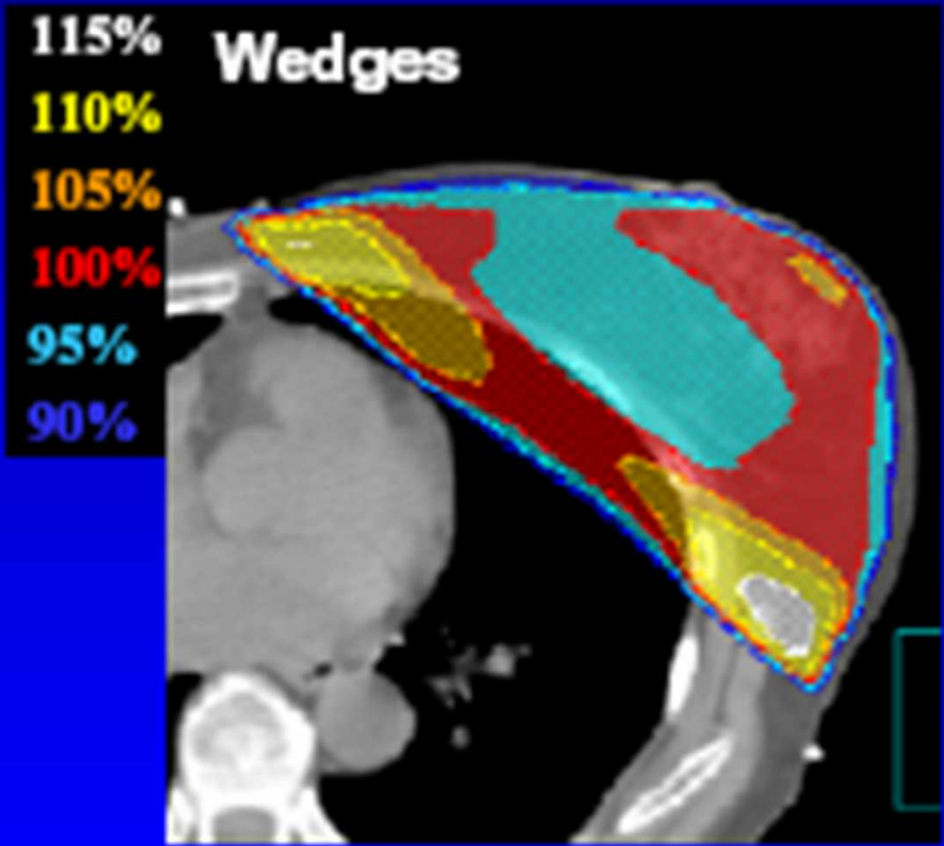
3 DCRT : Optimization



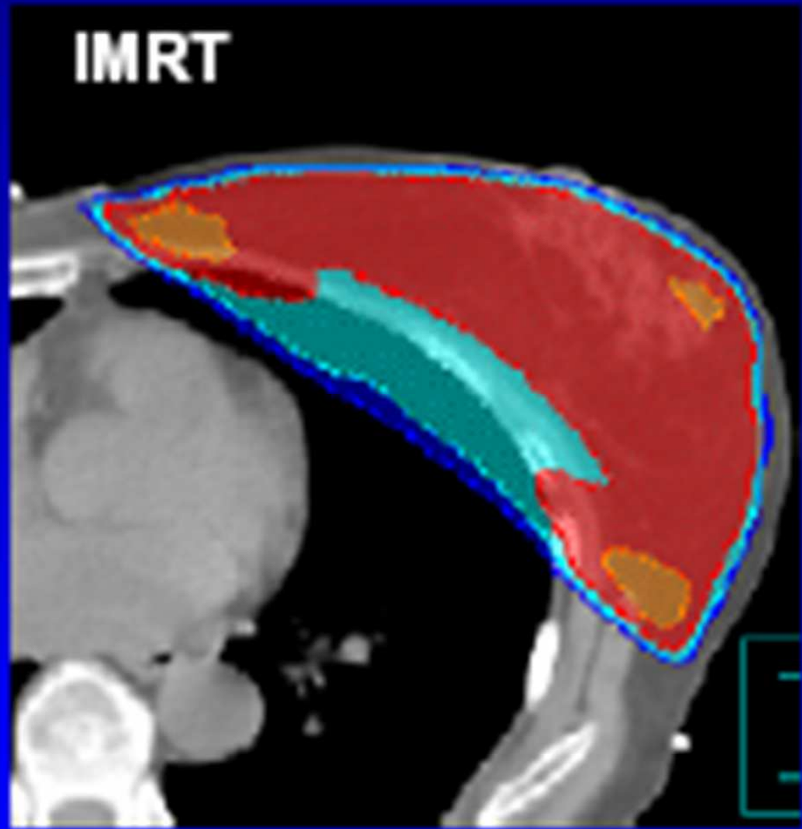
PLAN EVALUATION

- Dose uniformity is achieved throughout the treatment volume
- <15% of breast volume receives >105% of the prescribed dose
- < 2% of breast volume receives >110% of the prescribed dose

Transverse View

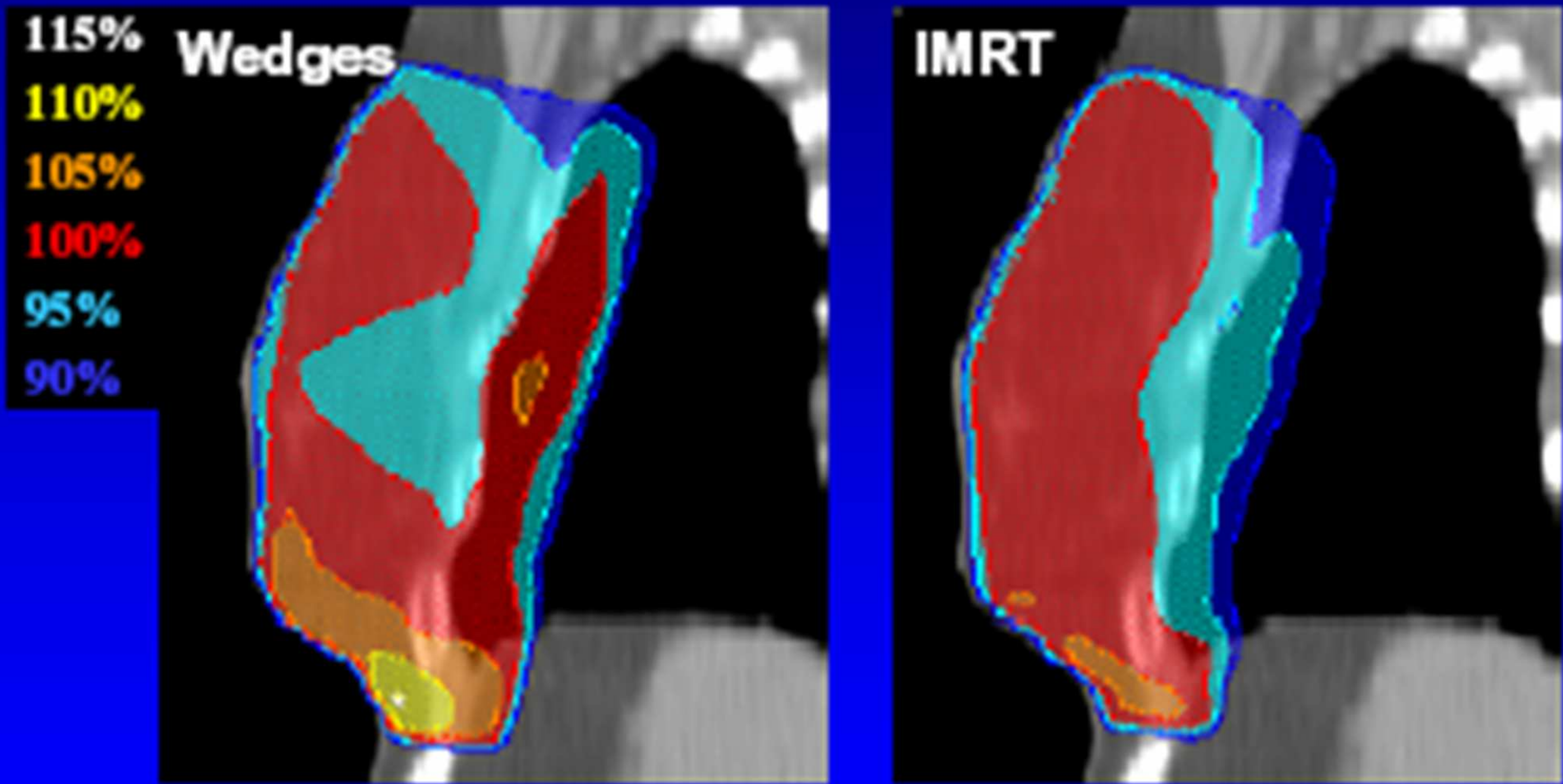


Wedge Plan



IMRT Plan

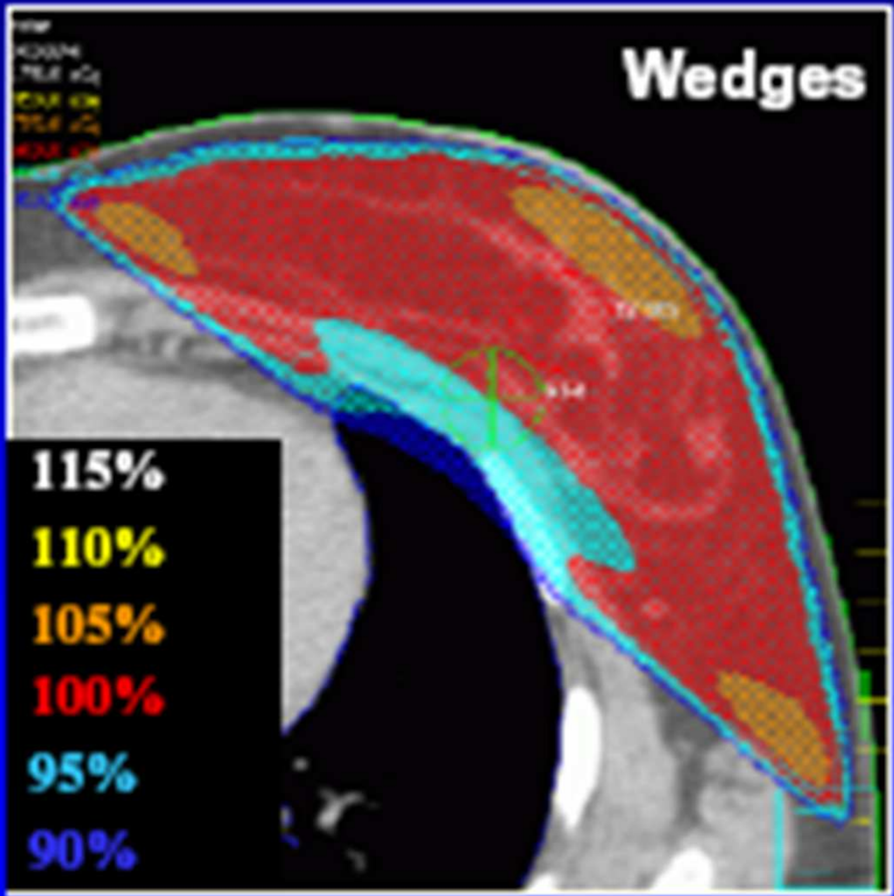
Sagittal View



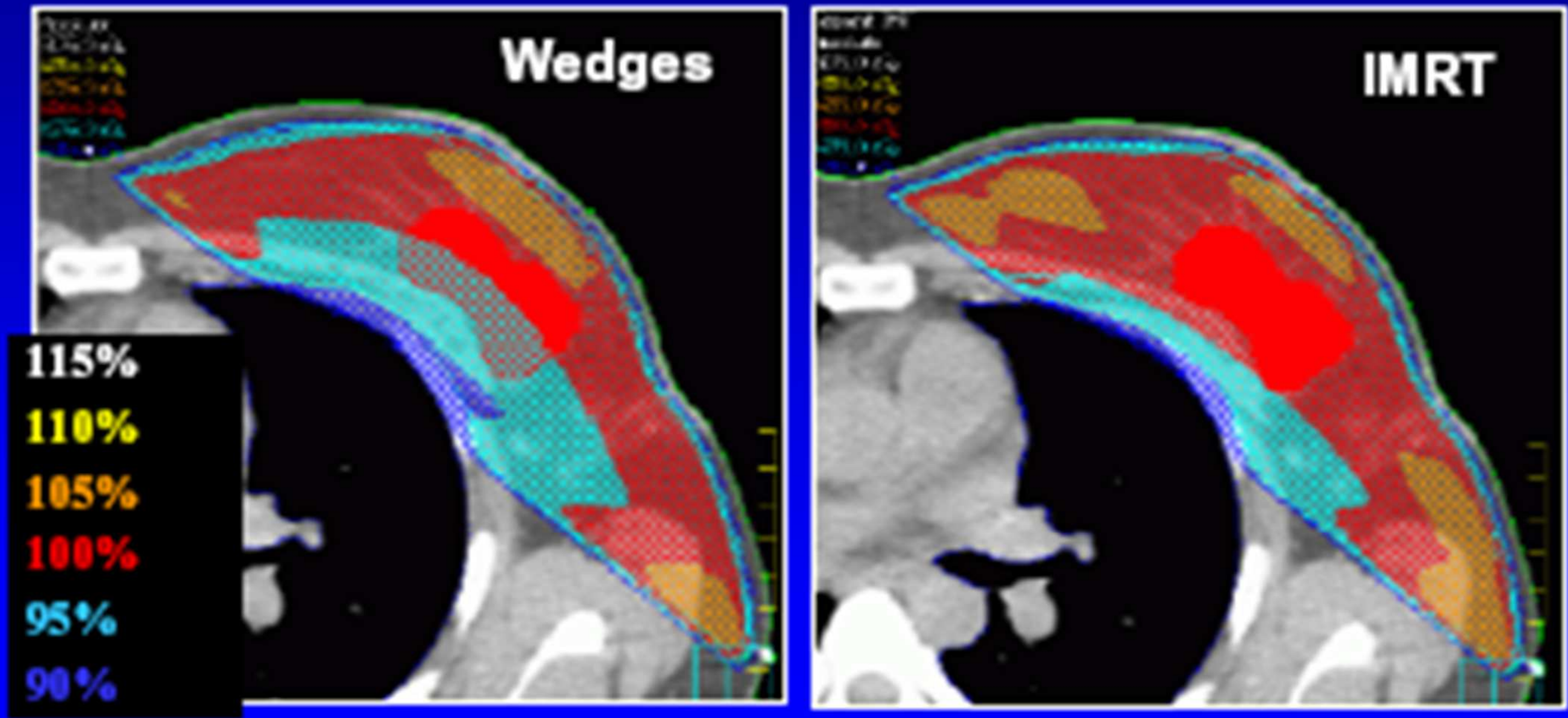
Wedge Plan

IMRT Plan

Isodose Distribution
Central Axis

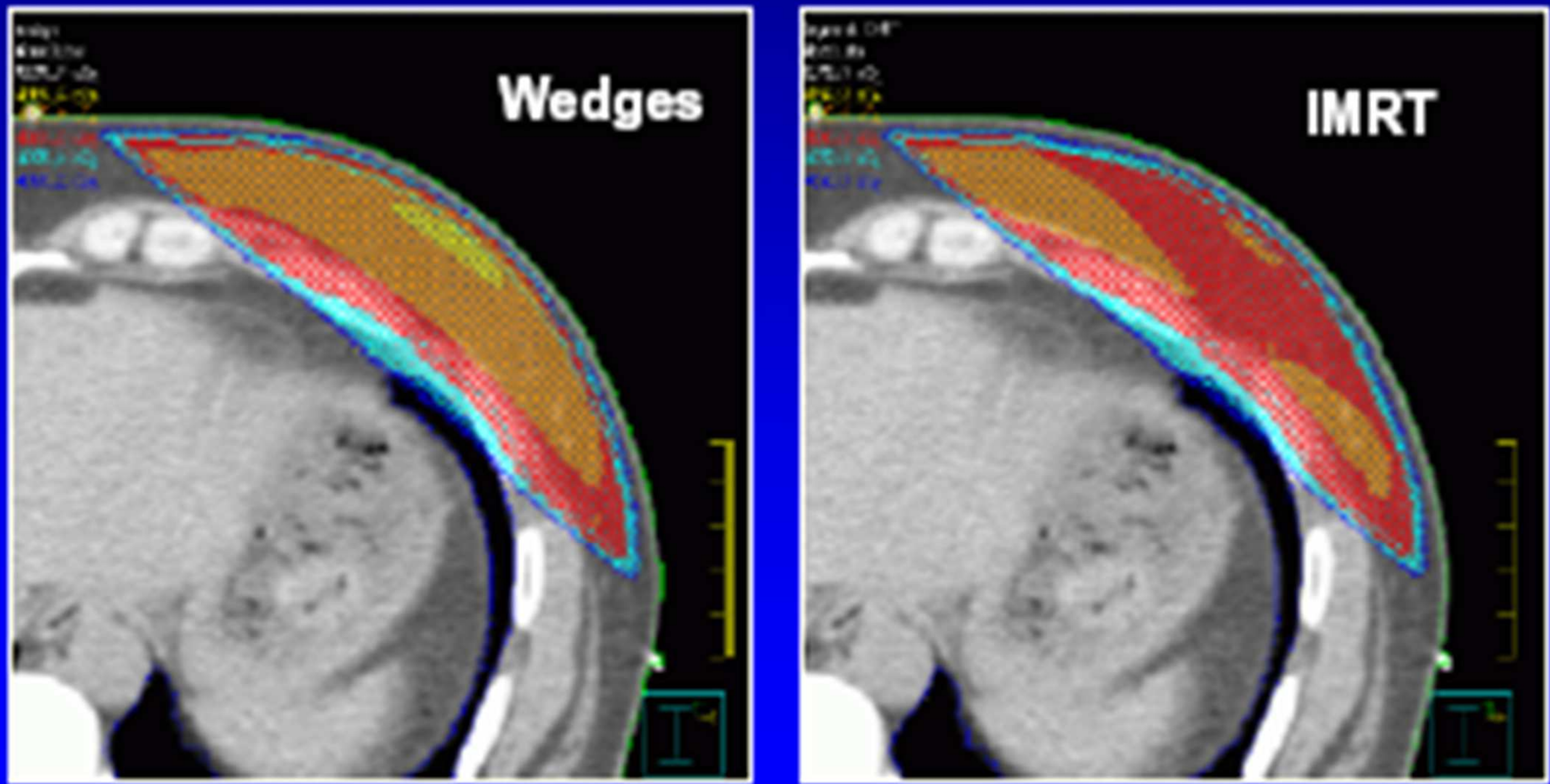


Isodose Distribution
Biopsy Cavity



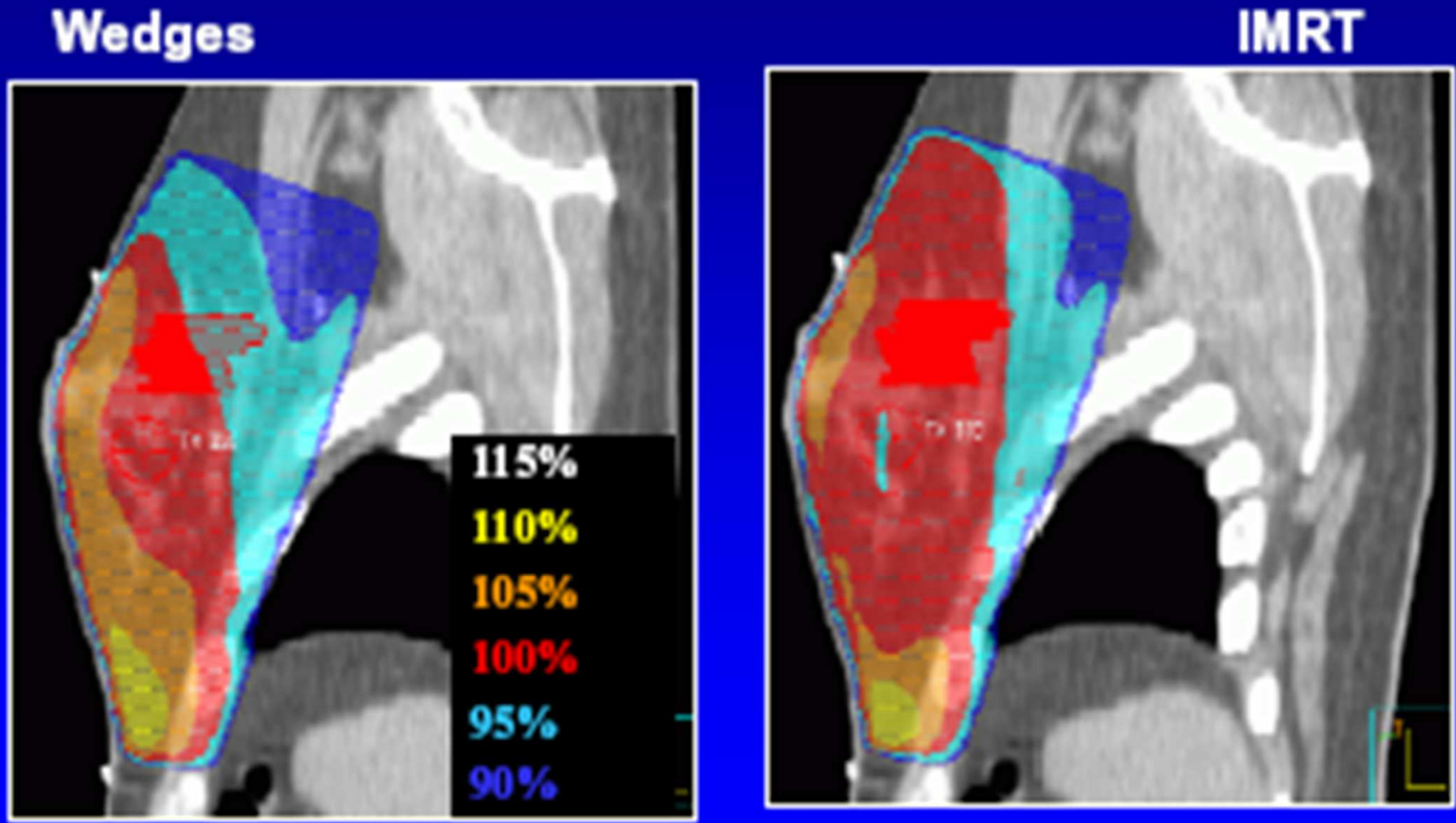
Isodose Distribution

Inframammary Fold



Isodose Distribution

Sagittal View



Final plan evaluation

- Review the DVHs, all structures.
- Review ROI statistics (min, mean, max dose)
- Adjust your prescription isodose, if necessary.
- Review the isodose distribution:
  - in multiple planes;
  - 3D dose clouds.
  - Un-segmented tissues.
- Check the maximum dose for the plan.
- Several different dose distributions may satisfy the same set of dose-based objectives
- Run several competing plans scenarios if needed.

Technical Procedures & QA

- Key to success
- Clear (Documented)
- Concise
- Meaningful
- Maintainable
- Review and Revise
- Avoid Moving Targets!

Quality Assurance

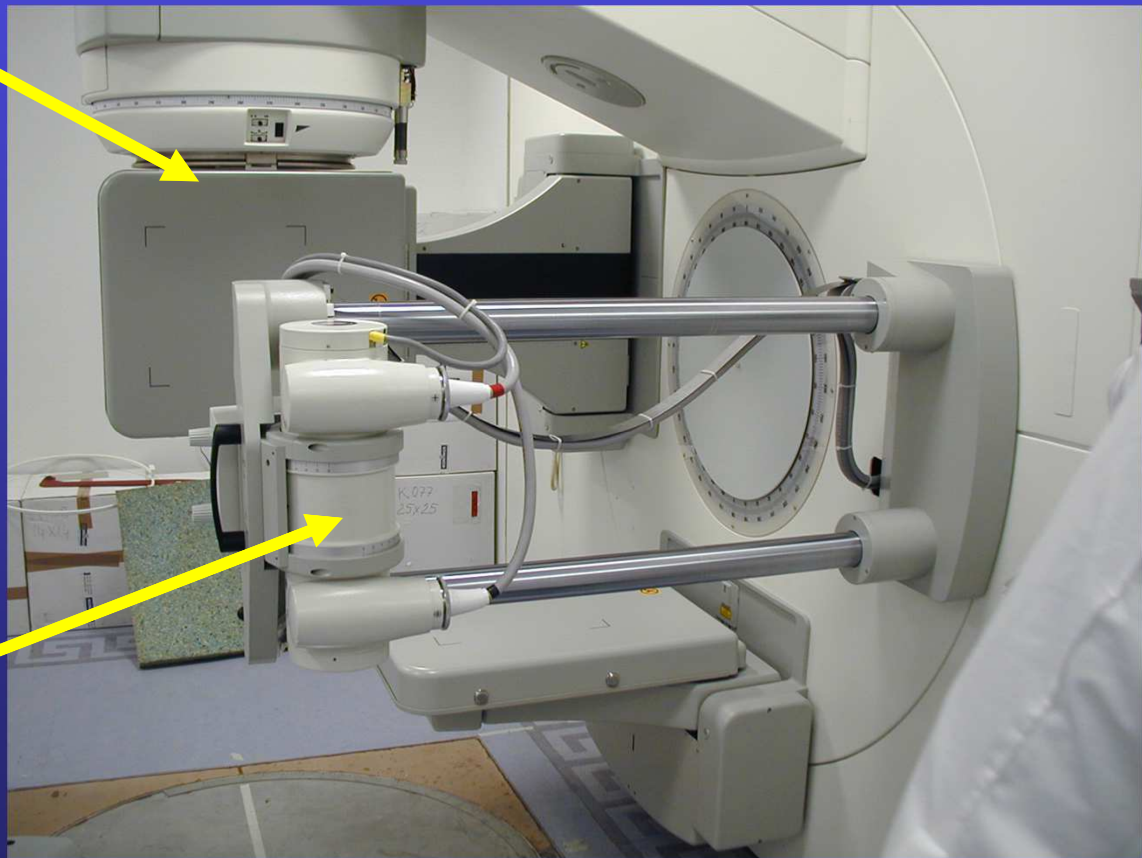
- Hand calculation at isocenter
- Central axis diode measurement
- Daily electronic portal verification
- Segment review
- MapCheck measurements

EPID (Electronic Portal Imaging Device)

2nd Generation Electronic Imaging Amorphous silicon panel

KV Imaging on the Treatment Machine

Amorphous silicon panel

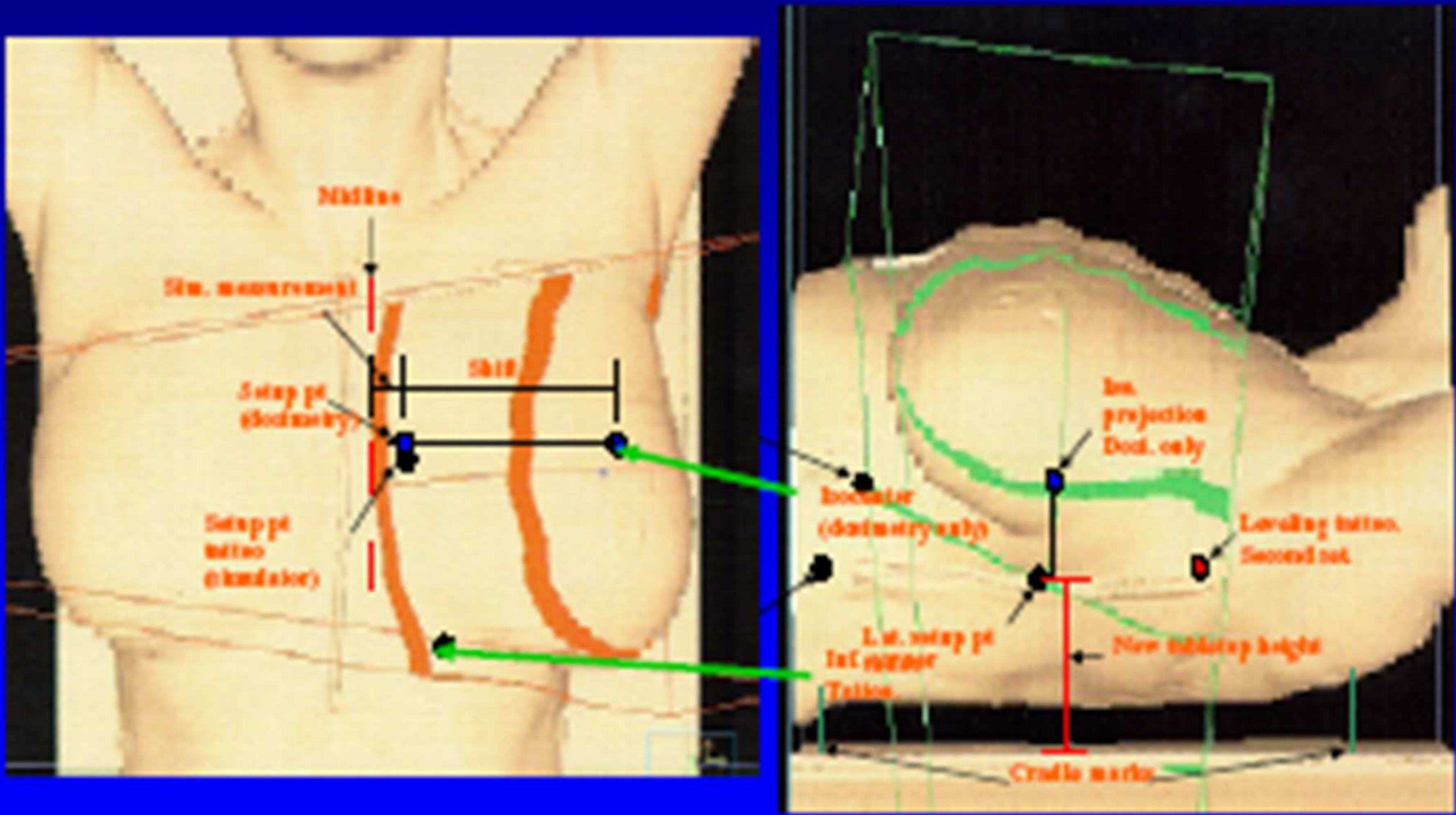


Retractable Kilovoltage X-ray tube

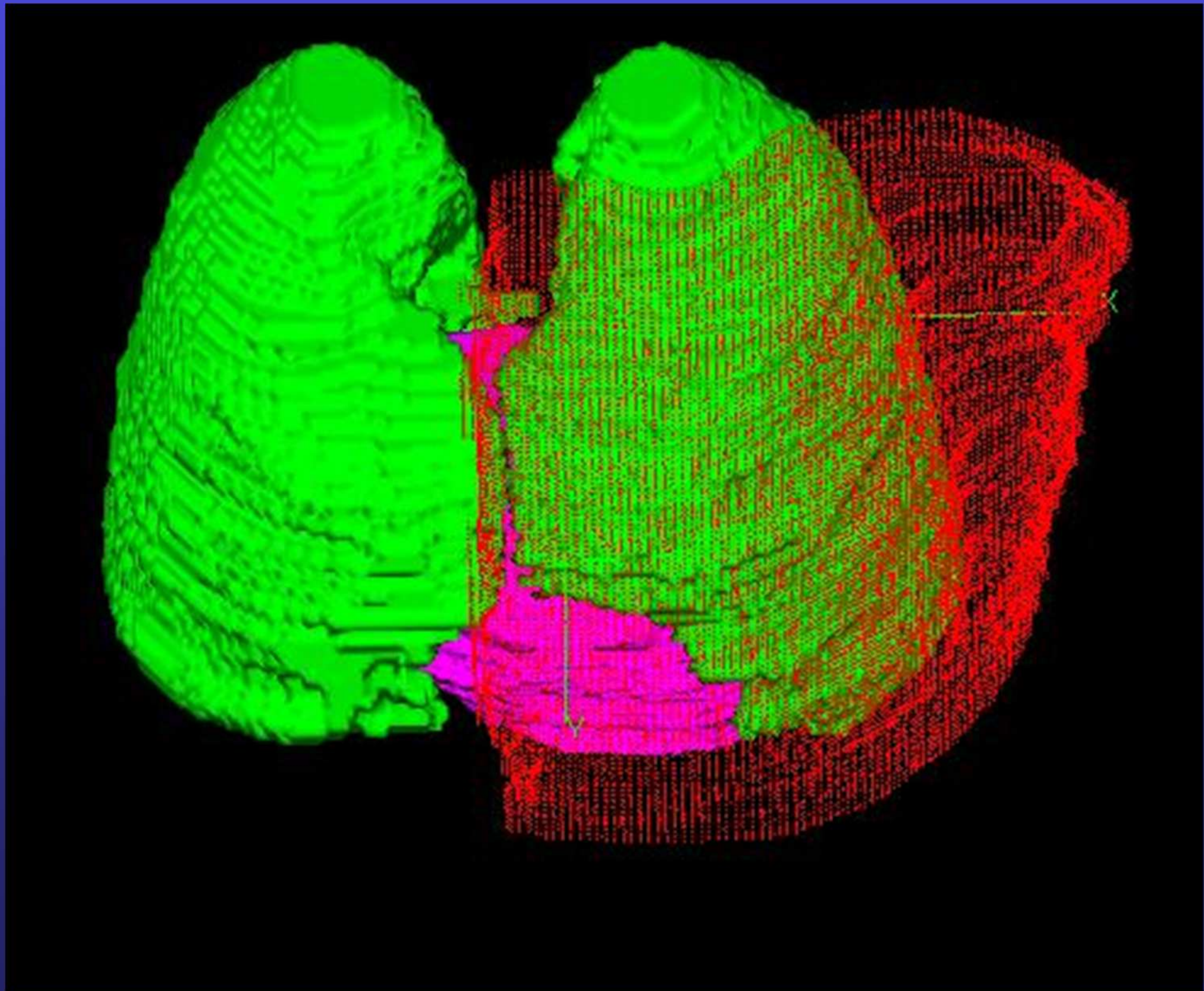
Treatment Delivery

- Treatment time (~10 minutes) is not increased compared to conventional techniques
- Electronic portal images of medial and lateral daily
- Image acquired during first few monitor units of open segment

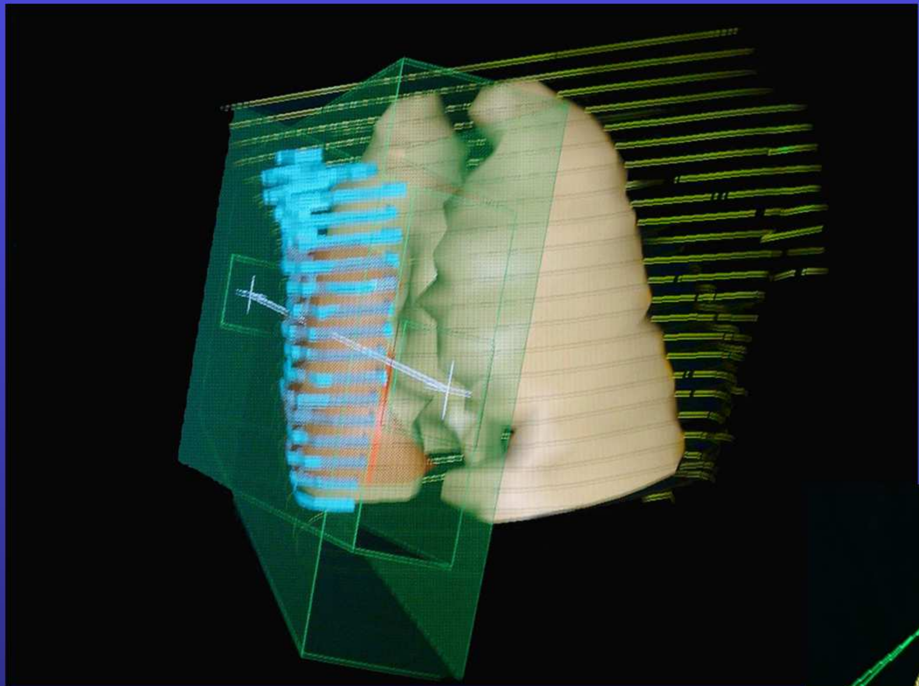
Treatment Delivery

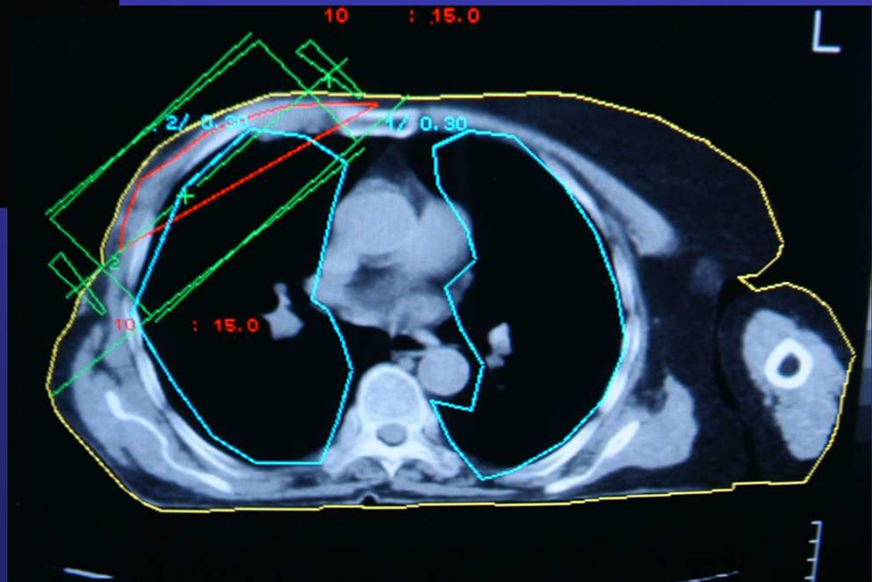


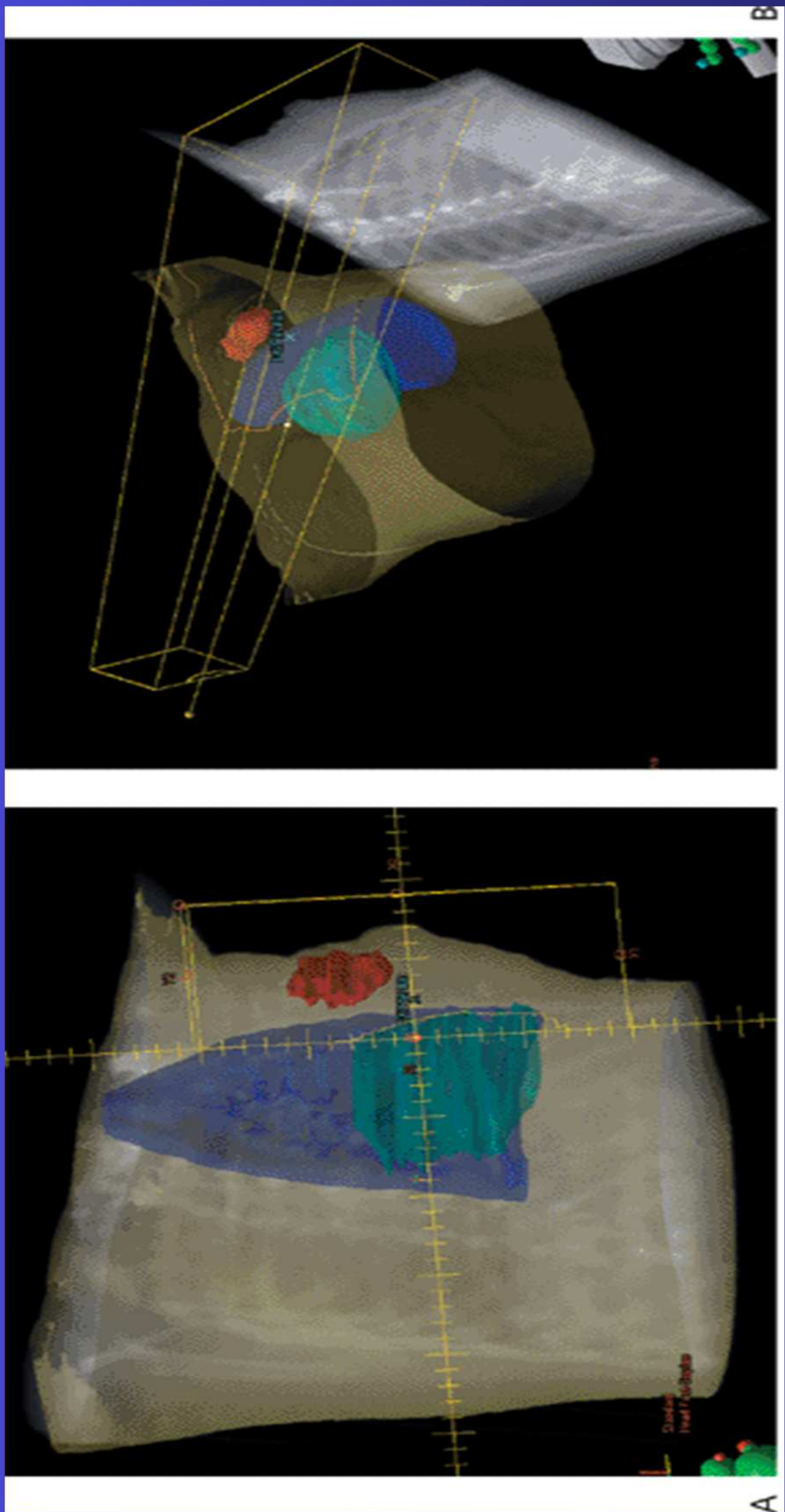
Ca Breast



3D planning of two tangential beams






A
B

Ca Breast - Isodose

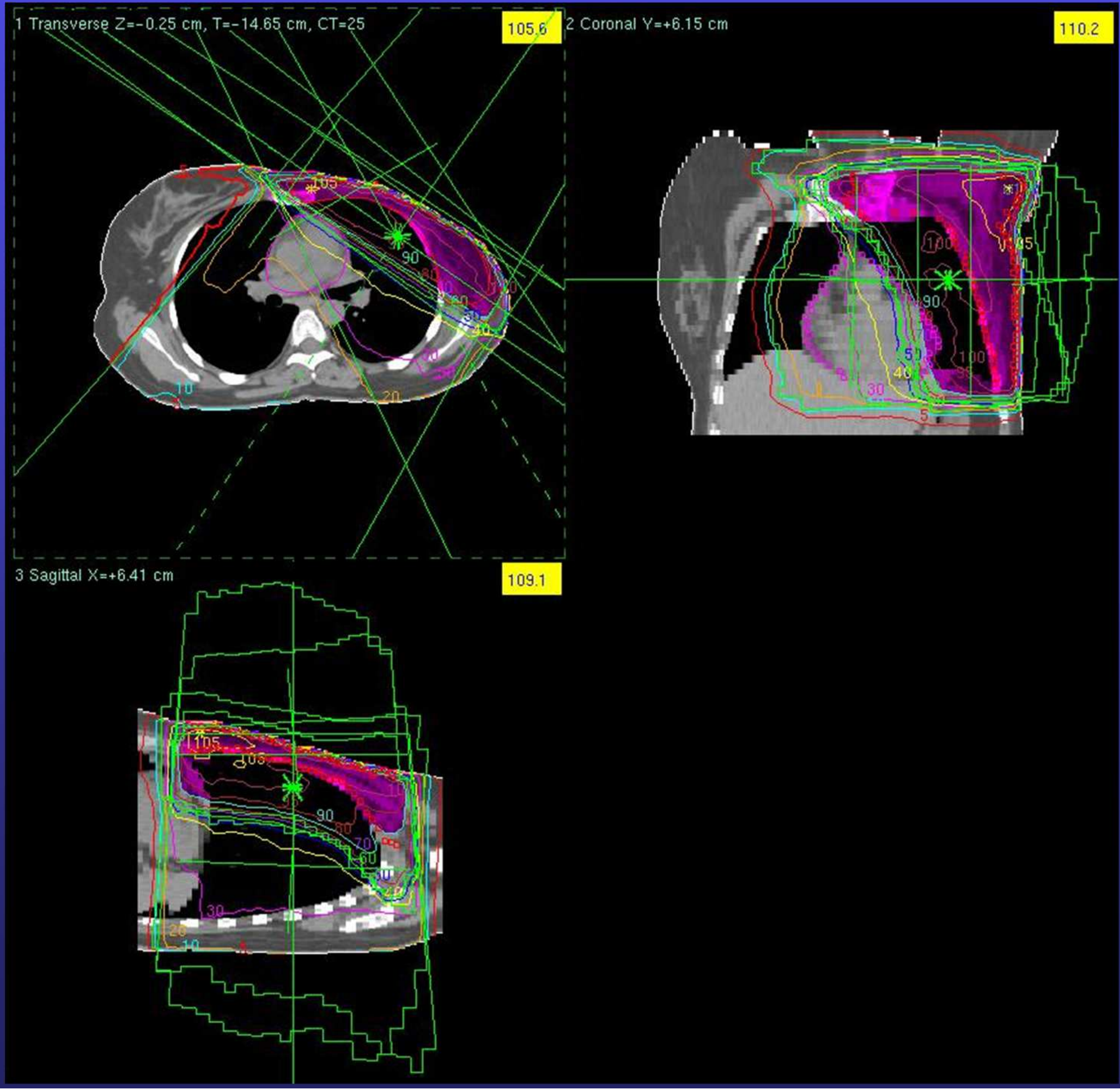
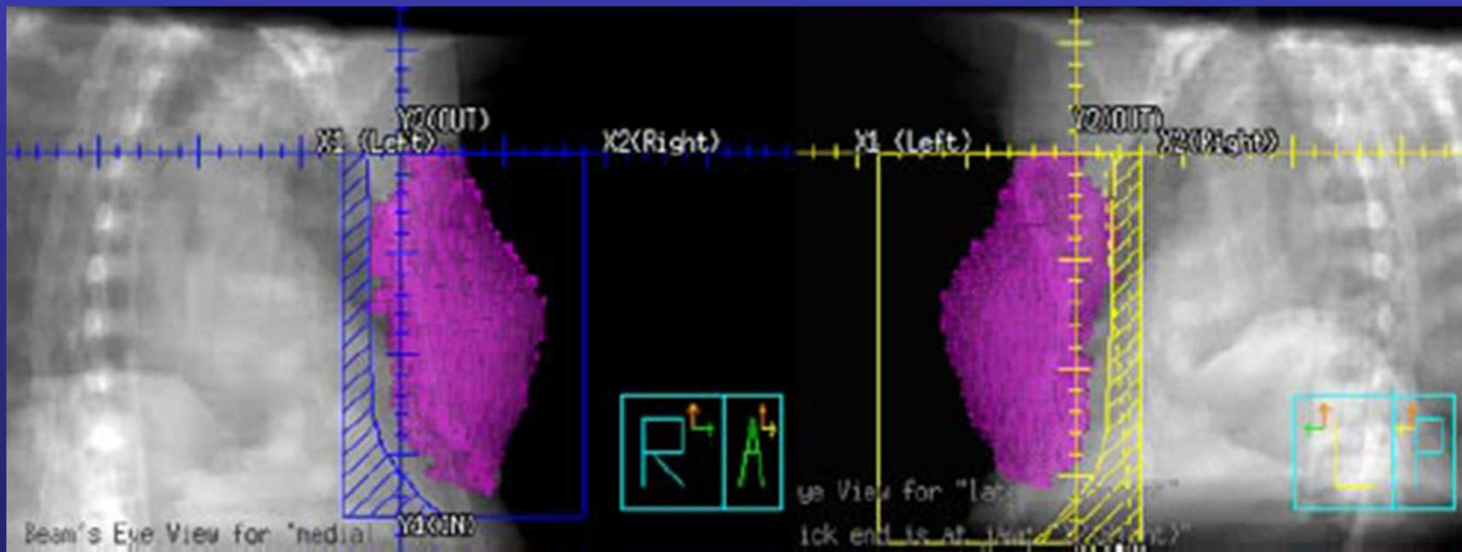


FIG. 12. (Color) Lateral and medical tangent digitally reconstructed radiographs for setup verification of the lateral and medial tangent treatment field. The heel of lthe wedge is towards the X_1 (left) yaw as indicated in the DDR of the lateral tangent field on the right.

DRR



DVH

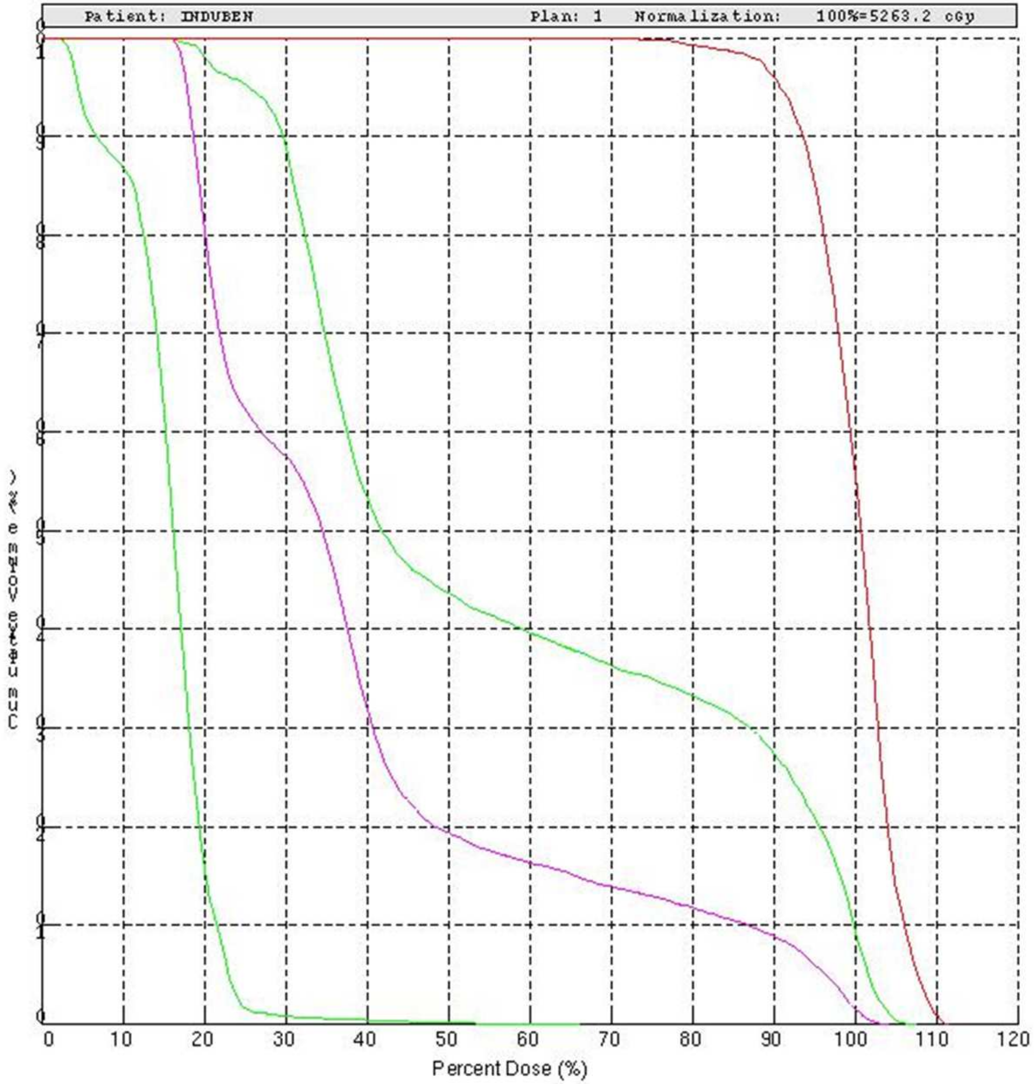
PrecisePLAN Release 2.11 - 476.01

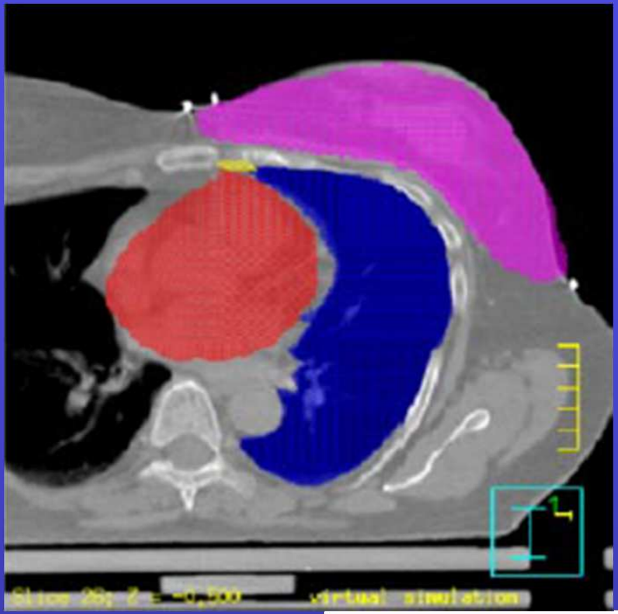
Page 1 of 1

CPU ID: 1762690814

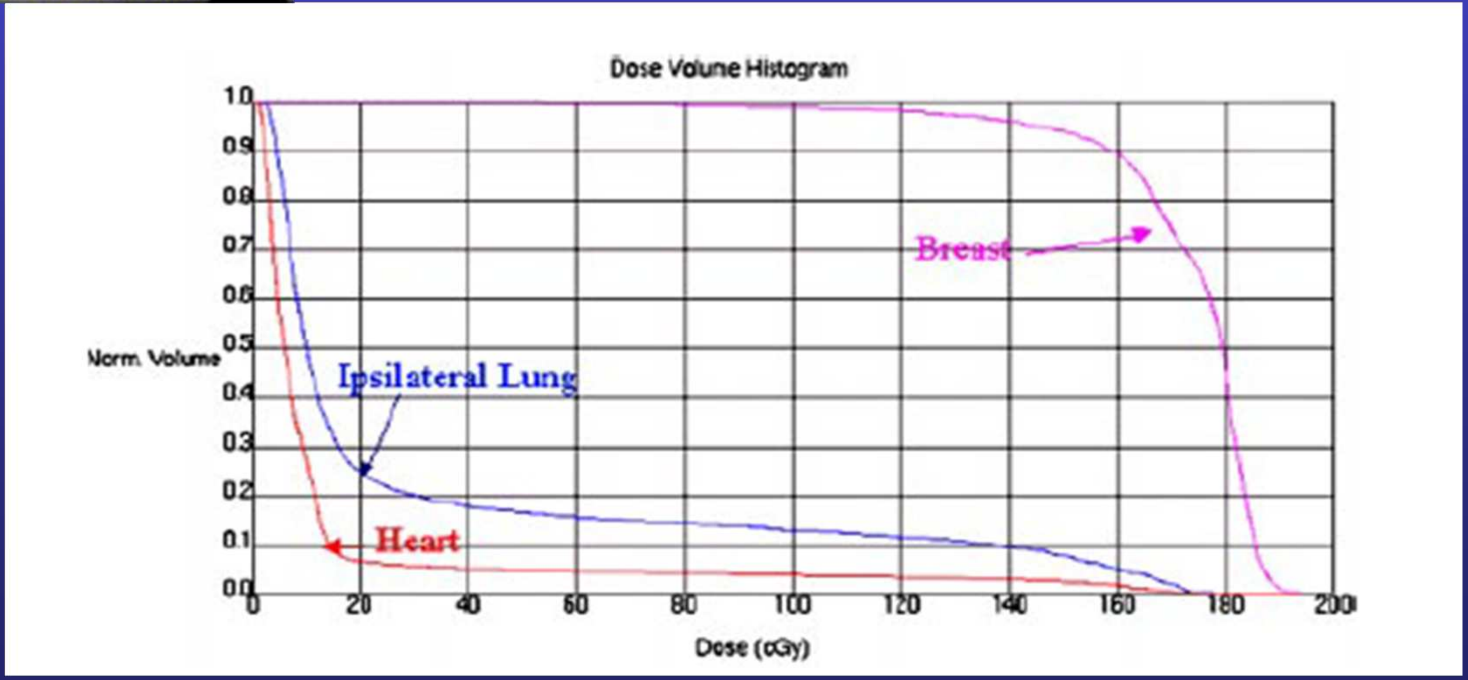
Patient ID	D-19538	Print Date	11-DEC-2006 13:26
Patient Name	INDUBEN SHUKLA F/38YRS	Image Dataset	INDUBEN
Plan: 1	3DCRT	Plan Date	16-OCT-2006 12:01
Signature			

Key	Structure	Plan	Min Dose (%)	Max Dose (%)	Mean Dose (%)	Total Vol (cc)
	Lt. Lung	INDUBEN(01)	15	107	58	1150.6
	Rt. Lung	INDUBEN(01)	2	65	16	1307.9
	Heart	INDUBEN(01)	16	103	39	488.4
	PTV	INDUBEN(01)	64	111	100	801.1





Dose Volume Histogram (DVH)



ASTRO Meeting 2006
Philadelphia

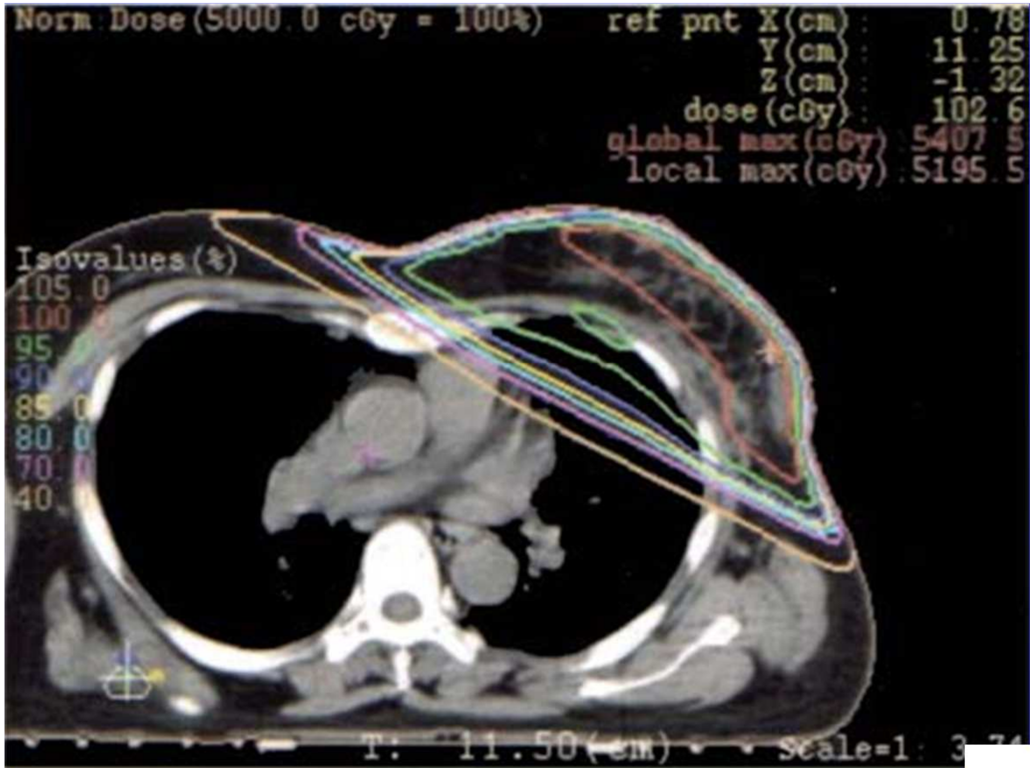
Plenary 1

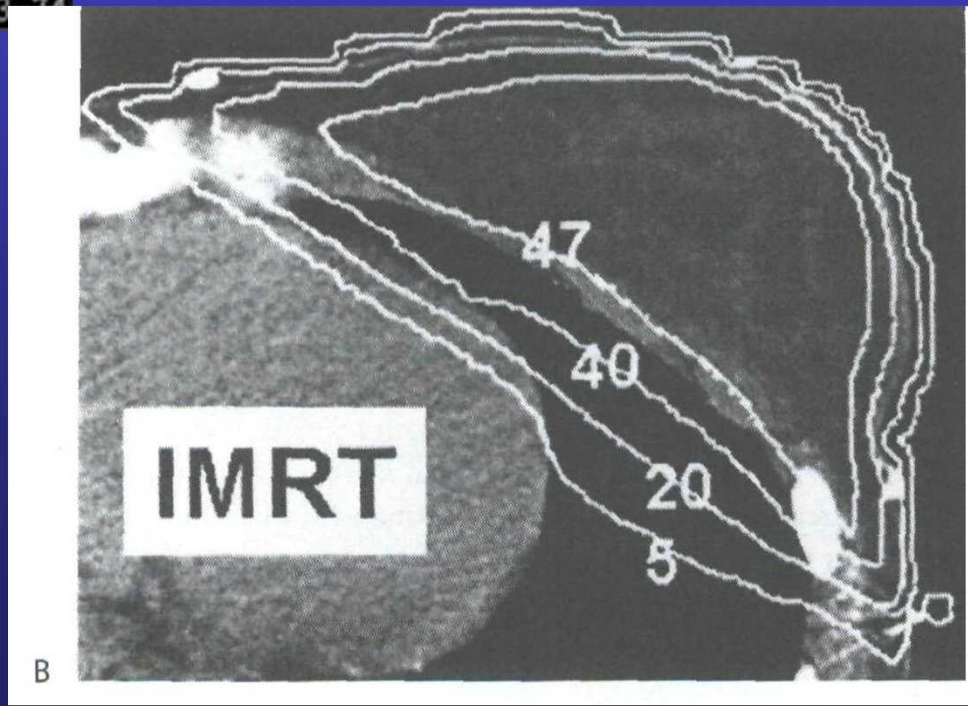
Phase III Randomized Study of Intensity Modulated Radiation Therapy Versus Standard Wedging Technique for Adjuvant Breast Radiotherapy

J. Pignol[1], I. Olivotto[2], E. Rakovitch[1], S. Gardner[1], I. Ackerman[1], K. Sixel[1], W. Beckham[2], T. Vu[1], E. Chow[1] and L. Paszat[1]

[1]Sunnybrook Health Sciences Centre, Toronto, ON, Canada

[2]Vancouver Island Cancer Centre, Victoria, BC, Canada


Norm Dose(5000.0 cGy = 100%)
ref pnt X(cm): 0.78
Y(cm): 11.25
Z(cm): -1.32
dose(cGy): 102.6
global max(cGy) 5407.5
local max(cGy) 5195.5
Isovalues(%)
105.0
95
85.0
80.0
T: 11.50(cm)
Scale=1


47
40
20
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IMRT
B

3 DCRT SUMMARY

- 3 DCRT technical evolution, not a treatment modality *per se*.
- Consider all aspects of the radiotherapy process.
- Commission planning system, "learn how to drive", and validate each treatment planning procedure.
- It is difficult to "decouple" all components of 3 DCRT planning software.
- The dependence of 3 DCRT on images and segmentation requires adherence to clinical protocols

3 DCRT SUMMARY PLANNING


THANK
YOU
Funglitz.com