University of Michigan Medical School

Treatment Planning Considerations for Breast Cancer

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August 6, 2013

Disclosures

I receive research support from Blue Cross Blue Shield of Michigan and Varian Medical Systems.

Some of the work was funded by NIH Grants R01 CA102435-01 and P01-CA59827.

Objectives

- **Describe needs for using advanced beam treatment planning and delivery technologies**

Moving from conventional treatment to advanced techniques

- What are the targets? How are they defined?
- Advanced techniques such as IMRT require contoured volumes
  - Allows more control when using optimization methods
  - Need to consider margins
- Planning goals must be clearly identified for planning

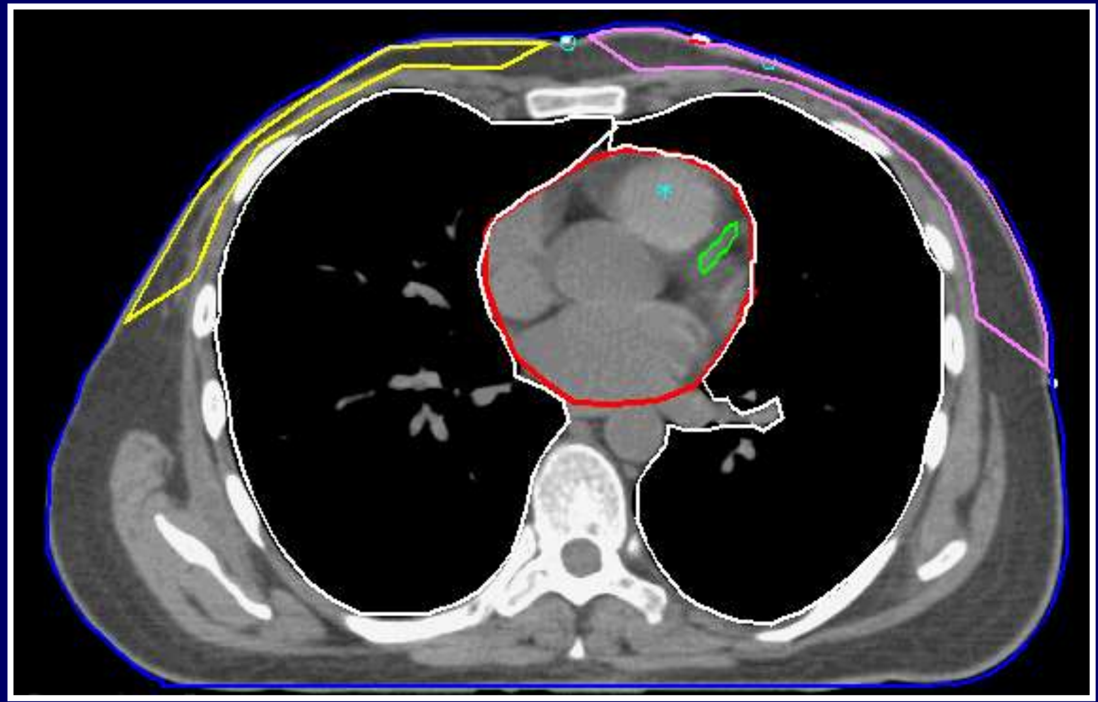
Considerations for IMRT/VMAT

- Impact of respiratory motion and target reproducibility
- Target: breast and lumpectomy cavity
  – Planning Target Volume?
- Organs at risk
  – Heart and sub-structures such as the left-anterior descending artery
  – Lungs
  – Contralateral breast
  – Brachial plexus
- Determine beam arrangement

Targets

- Breast
  - Edit back 5 mm from surface
    - Inaccuracies in surface modeling could lead to excess surface dose planned for during optimization
  - Did physician place catheters?
- Nodal regions – if treated
  - Supraclavicular
  - Infraclavicular
  - Internal mammary

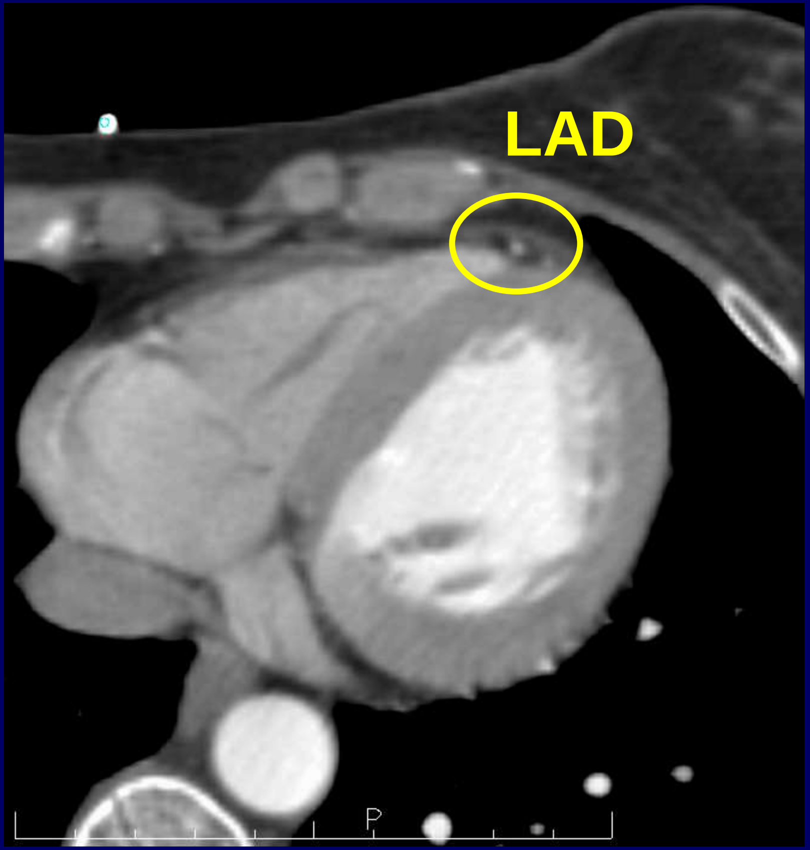
Contouring for Breast Cancer



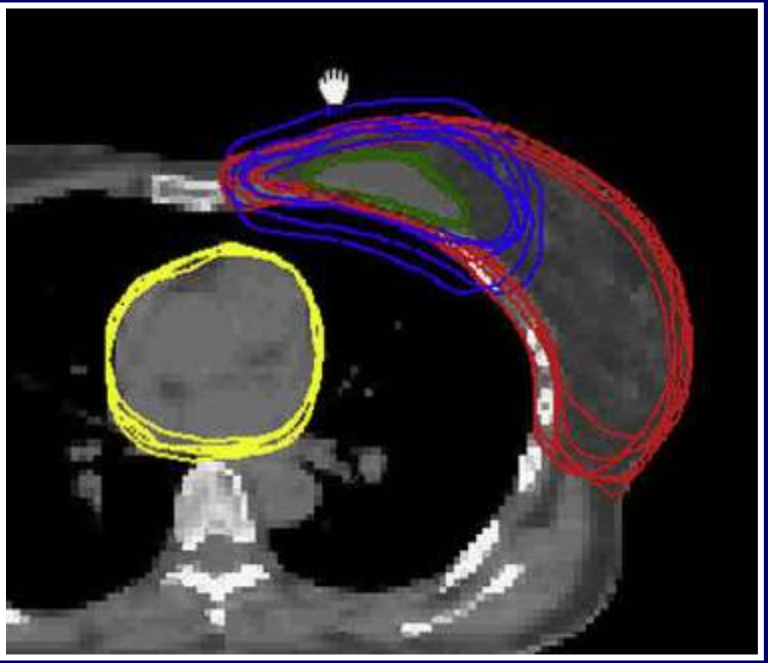
- **Contouring of structures is required for inverse planning which is still a change of practice at many centers**
- **There can be significant variability in the contours by practicioner**

Organs at risk

- Heart
- Contralateral breast
- Lungs
- Brachial Plexus
- Left anterior descending artery
  - Sensitive small volume to help push optimization



Radiation Therapy Oncology Group: Breast Group



Contours by 9 physicians from 8 institutions. Structure overlaps as small as 10%. Volumes with standard deviations as high as 60%.

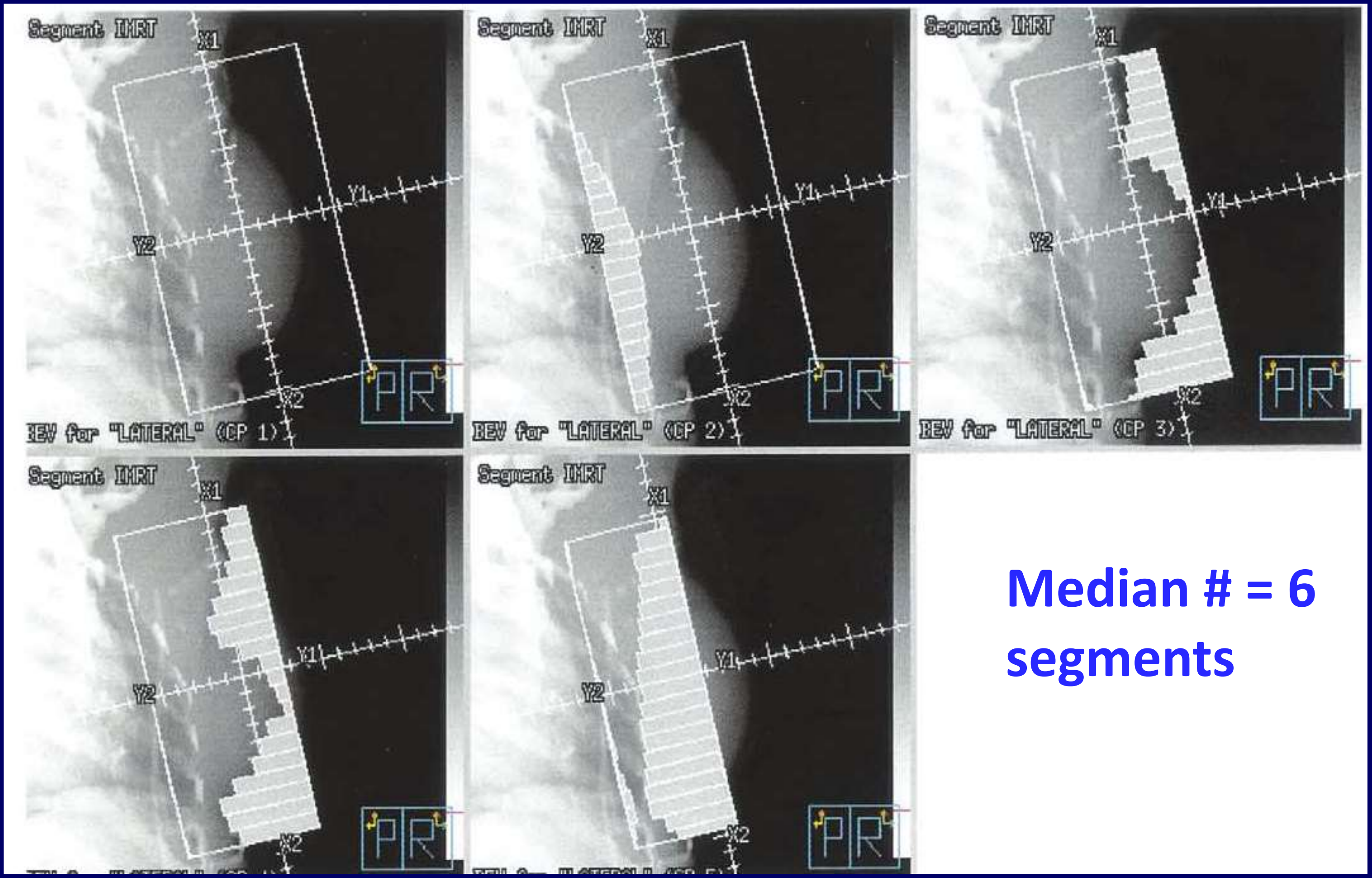
Li et al, IJROBP, 2009

Additional Considerations

- Spectrum of techniques
  - Simple IMRT (missing tissue compensation) to beamlet IMRT to VMAT
- Still need adequate flash
  - Jaws should be open for flash
  - Want intensity in air to be similar to intensity over the breast

Segmental or Field-in-Field Technique

Example lateral segments



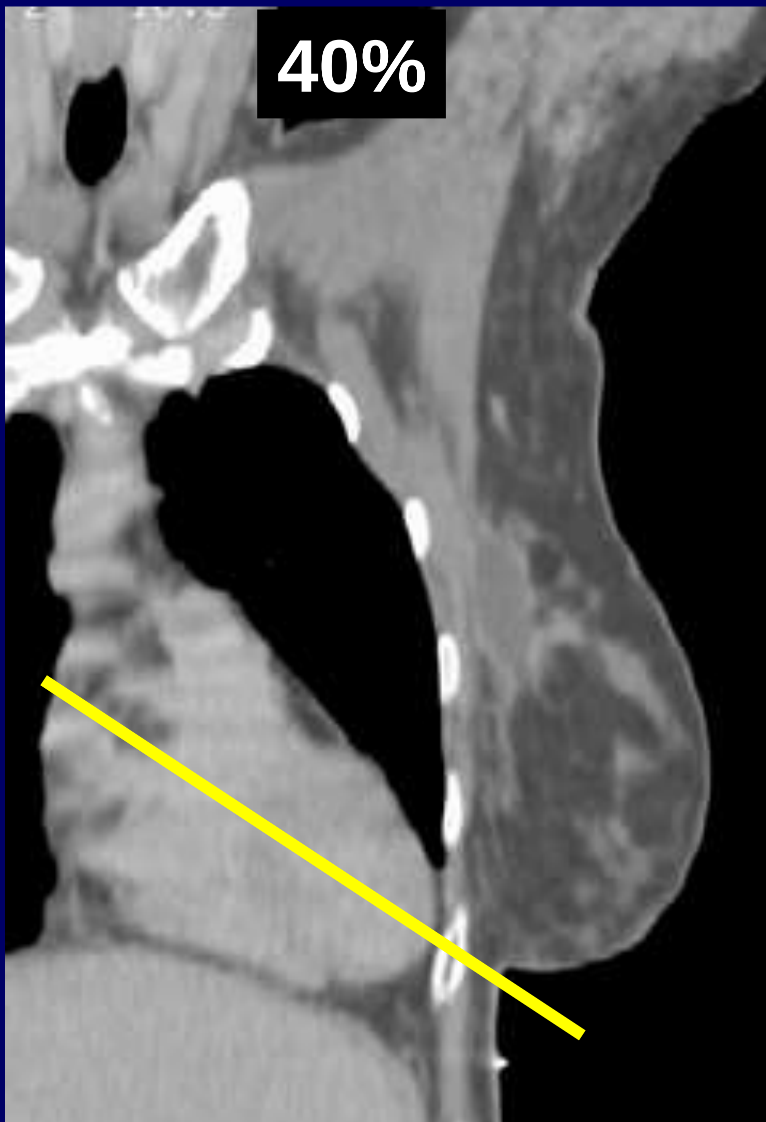
Median # = 6 segments

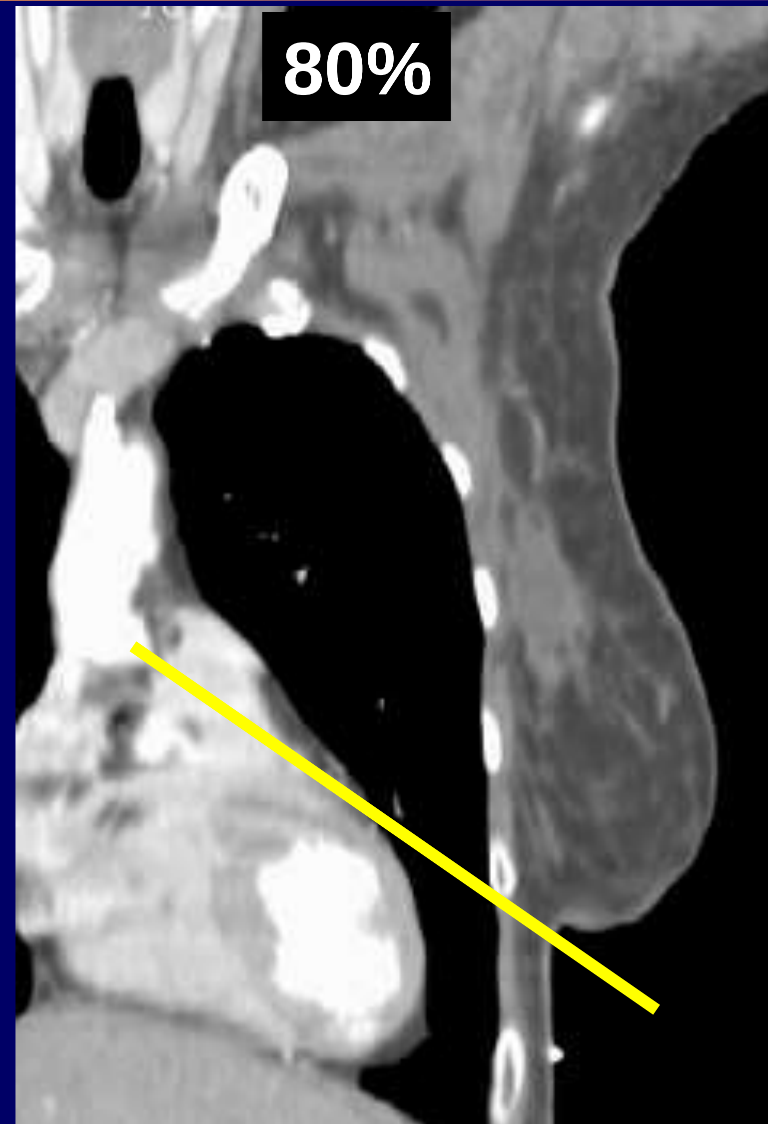
Vicini et al, IJROBP, 2002

Use of Deep Inspiration Breath hold

- Sixel et al IJROBP 2001
- Remouchamps et al 2003
- Dosimetric advantages when using deep inspiration breath hold
  - Move heart away from breast
  - Decrease amount of lung in the field

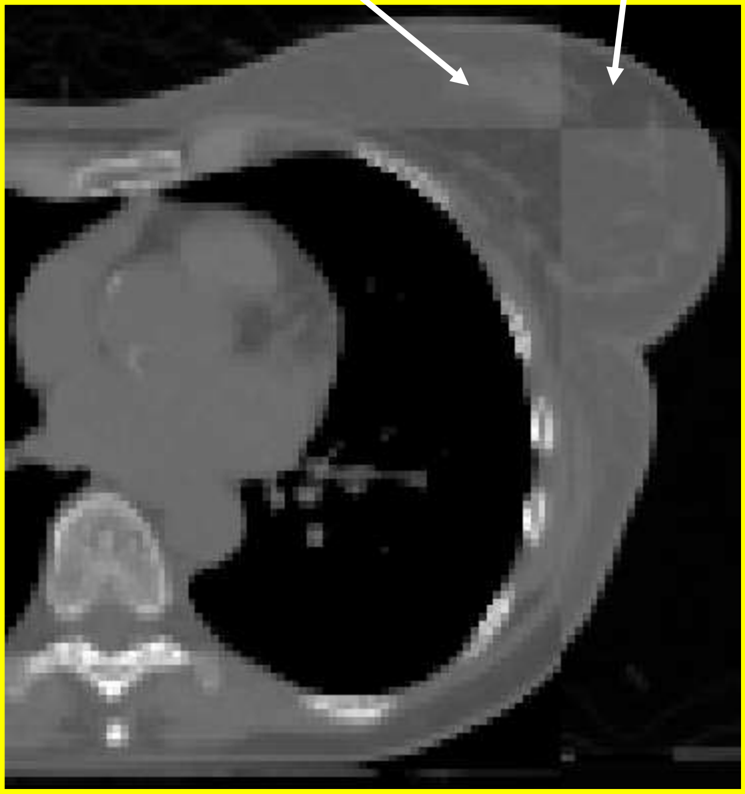
Effect of breathing on heart position





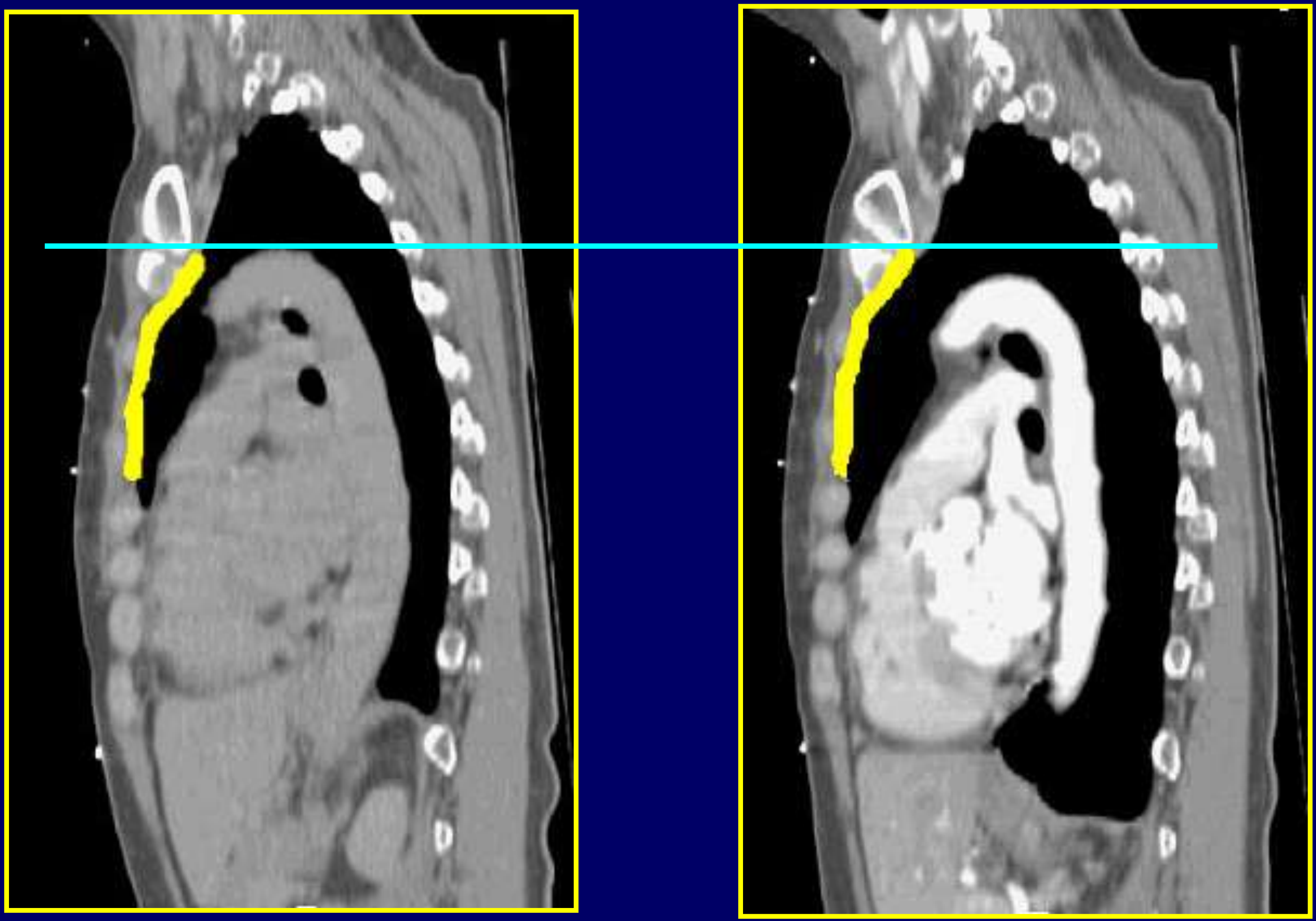
Moran, ASTRO, 2004

Example breast alignment



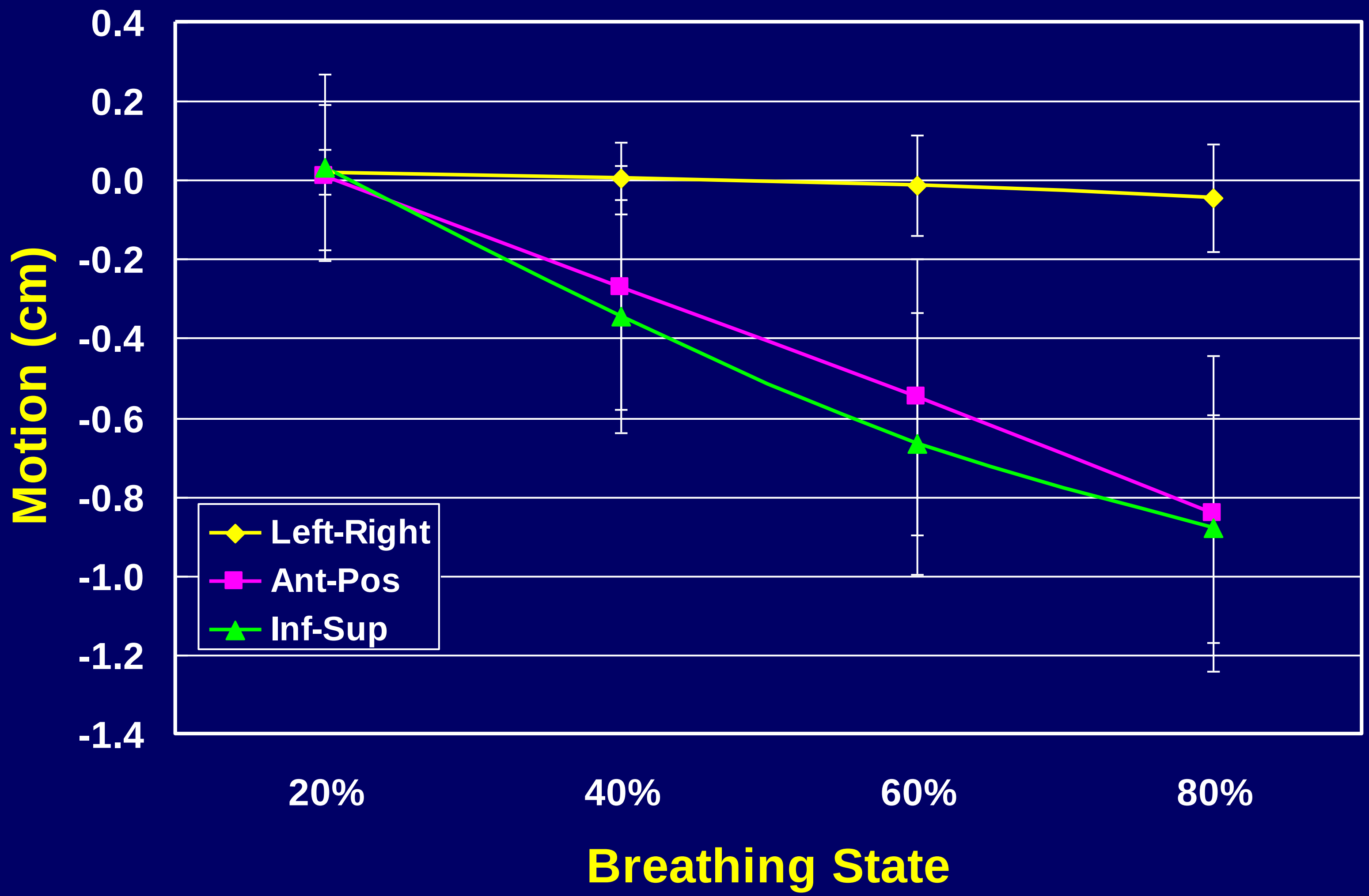
Moran et al. IJROBP 68: 541-546, 2007.

Change in Position of IM Nodes



Moran et al. IJROBP 68: 541-546, 2007.

Breast or Chestwall Motion



Adapted from Moran et al. IJROBP 68: 541-546, 2007.

Reproducibility of position with ABC

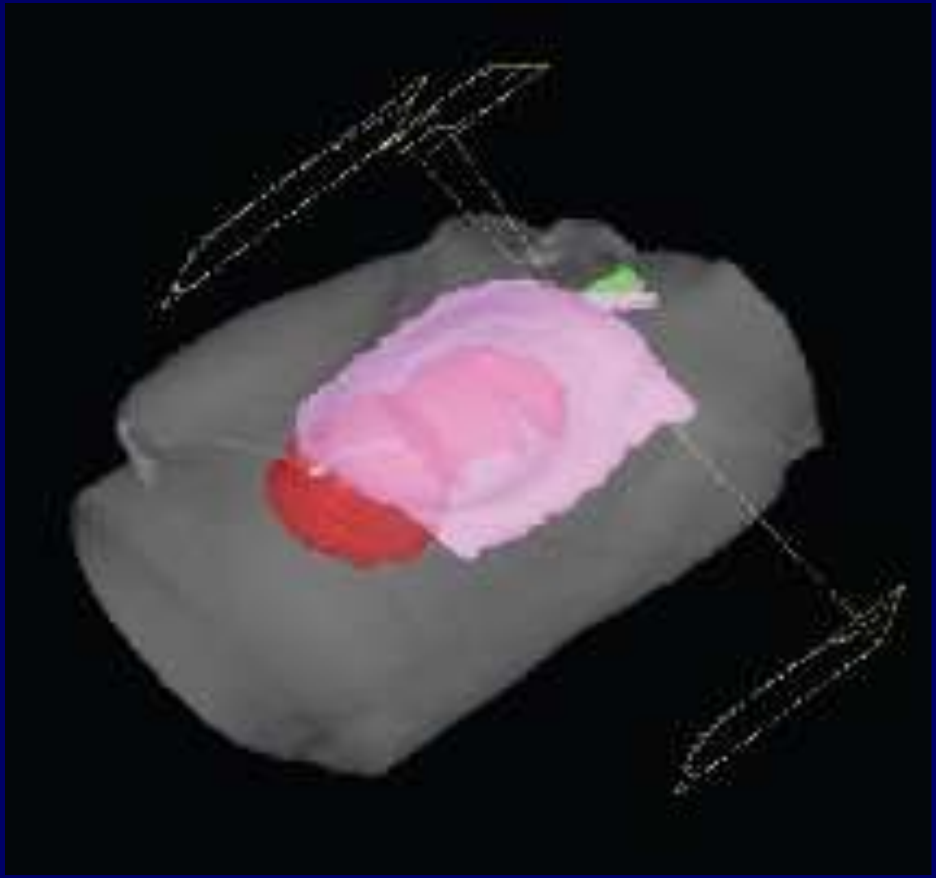
- Up to 0.8 cm movement anteriorly and superiorly of breast/chestwall, ICV, and IMN regions with respect to end exhale
- Individual patient variation was up to 1.3 cm
- The reproducibility with ABC (based on 3 scan sessions) was on the order of 3 mm for all breathing states and directions

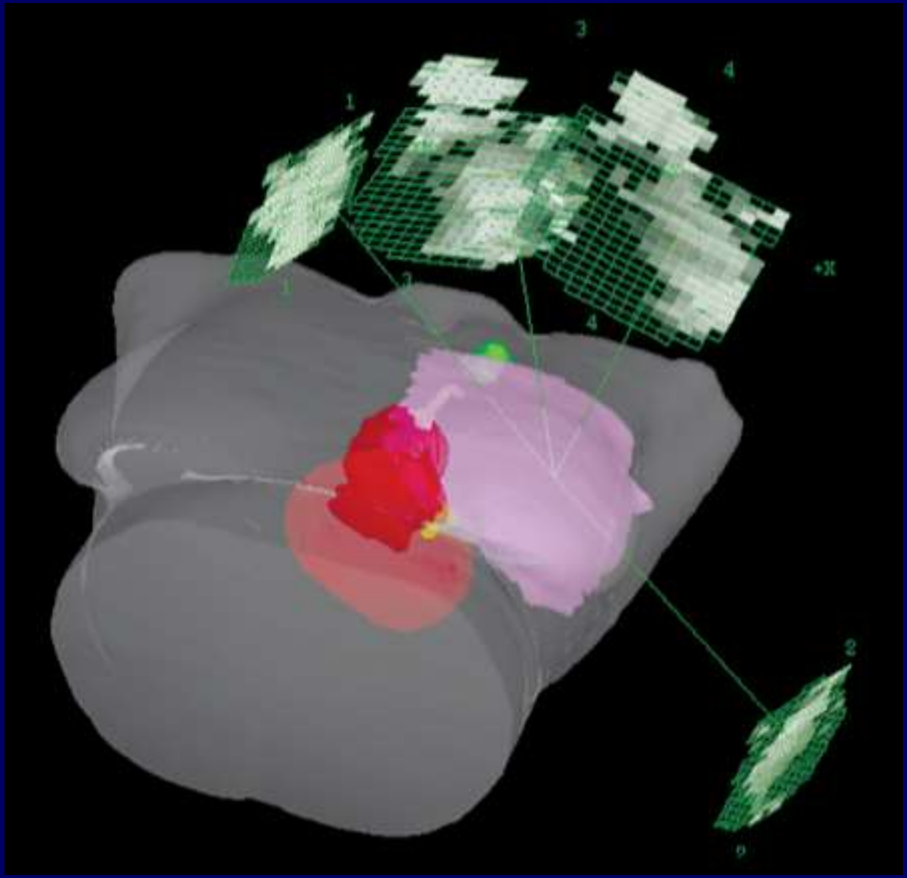
Treatment Planning Techniques

- IMRT and VMAT techniques have been applied to:
  - Whole breast
  - Whole breast + nodal
  - Accelerated partial breast
- Sequential or concurrent boost
- Electron beams can play a role when needing to spare organs-at-risk such as the heart and lungs

Whole breast and nodal irradiation

Tangential Technique
Partially Wide Static Fields vs. IMRT





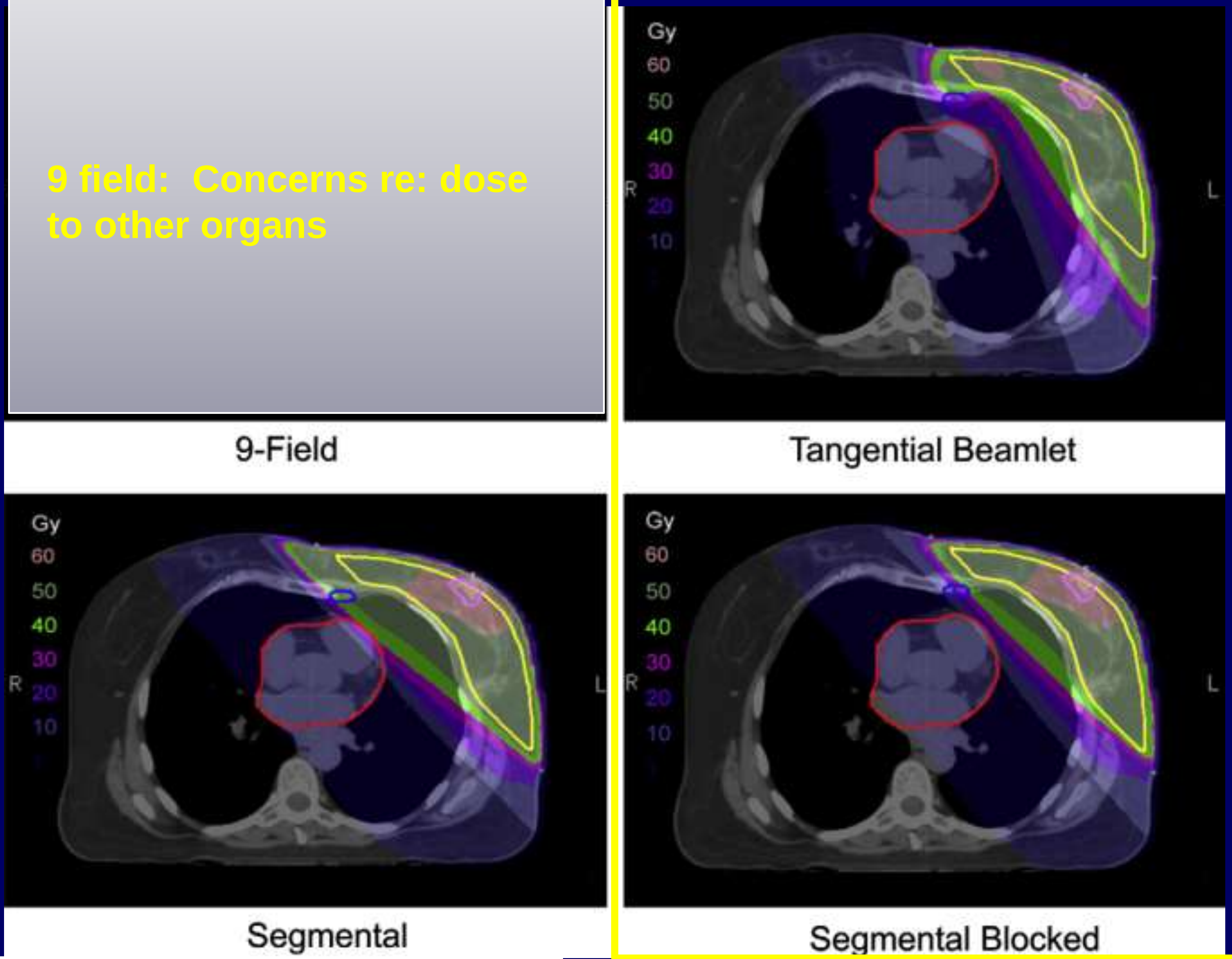
Objective Function for IMRT Plans

Structure	Dose/Volume Costs
Breast, Nodal regions (ICV, SCV, IMN)	95% volume, dose ≥ 52.2 Gy Min-Max Range: 49.6-60 Gy
Lumpectomy Cavity with margin	99% volume, dose ≥ 60 Gy 1% volume, dose ≤ 63 Gy
Heart and Left Anterior Descending Artery (LAD)	Mean dose ≤ 3 Gy Maximum dose < 15 Gy
Ipsilateral lung	<30% volume, dose ≥ 20Gy
Brachial plexus	Minimize dose
Contralateral breast and lung	Minimize dose

Dose Distributions

9 field: Concerns re: dose to other organs

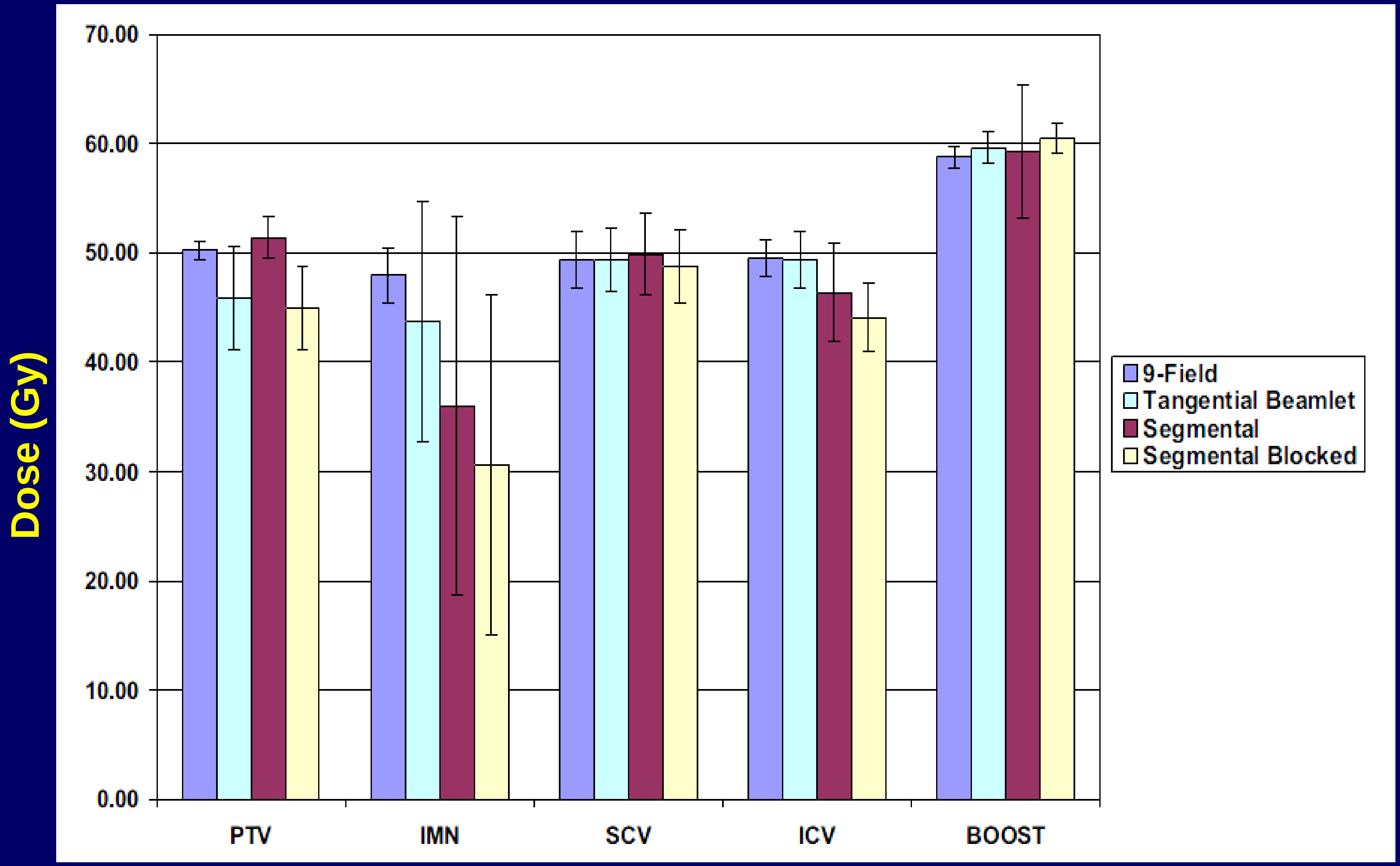
Clinical Practice at Our Center



6 MV photons
Electrons (6, 9, or 12 MeV) used as deemed necessary for normal tissue sparing or for nodal coverage

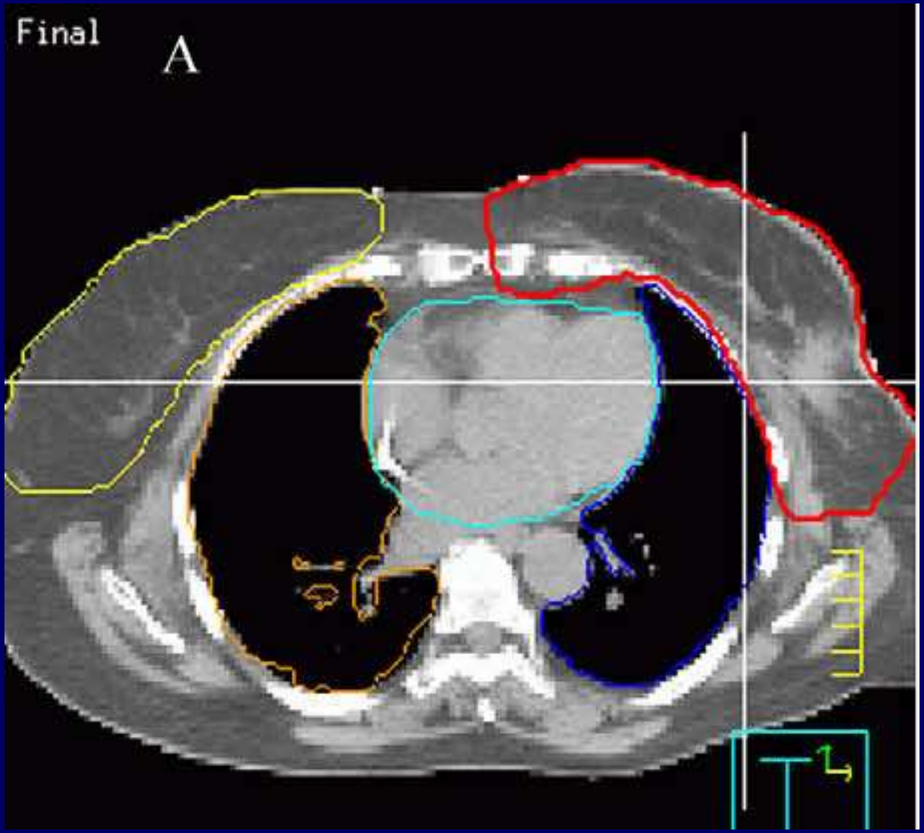
Jagsi et al, IJROBP 78: 2010.

Min Dose to 5% Volume - Targets



Jagsi et al, IJROBP 78: 2010.

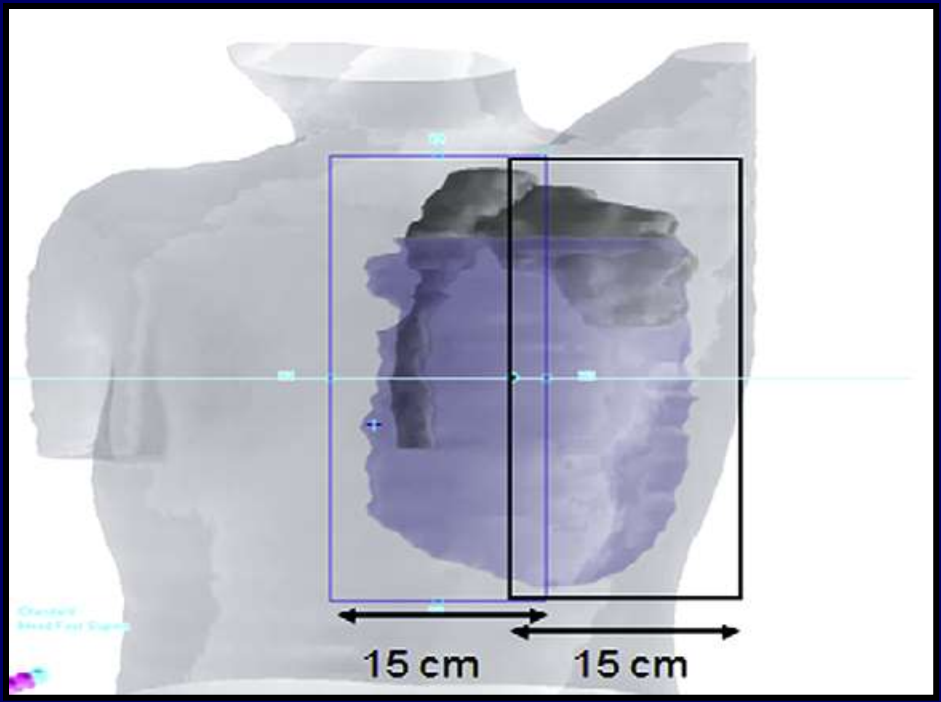
Rotational Techniques



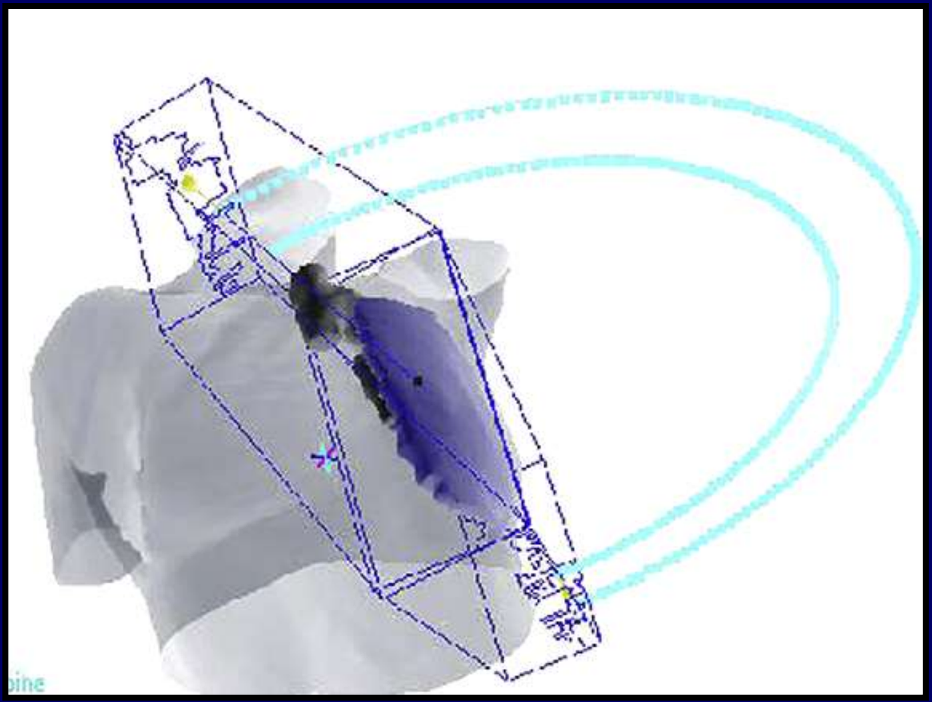
- Demonstrated improved minimum dose to the target with a TomoTherapy technique
- Also static gantry technique

Goddu et al, IJROBP 73: 1243-1251, 2009.

VMAT: Arc span + Field Considerations



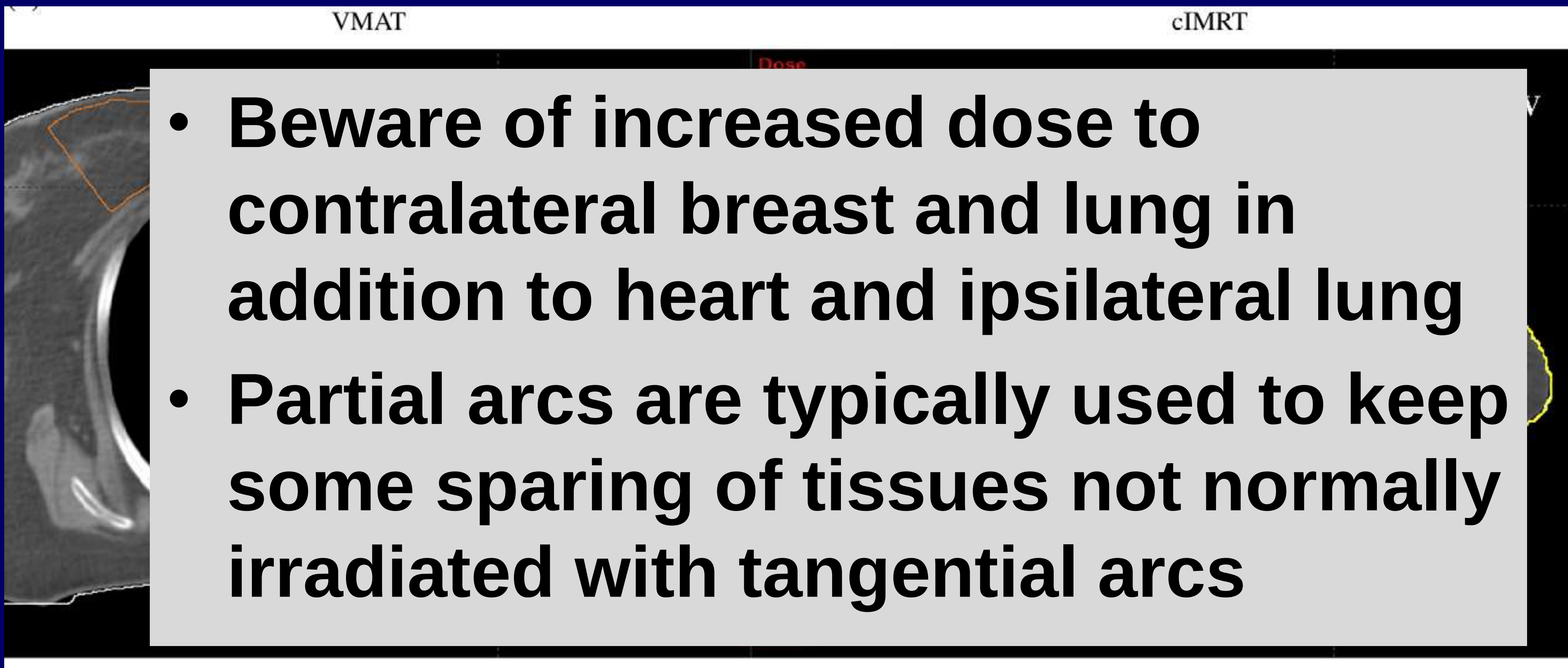
2 cm overlap to distribute dose for arcs so no sharp gradient or match



Two VMAT arcs of 190 deg:
CW: 300 to 130
CCW: 130-300

Fig. 2 Popescu et al, IJROBP 289, 2010.

VMAT – Breast + Nodes



- **Beware of increased dose to contralateral breast and lung in addition to heart and ipsilateral lung**
- **Partial arcs are typically used to keep some sparing of tissues not normally irradiated with tangential arcs**

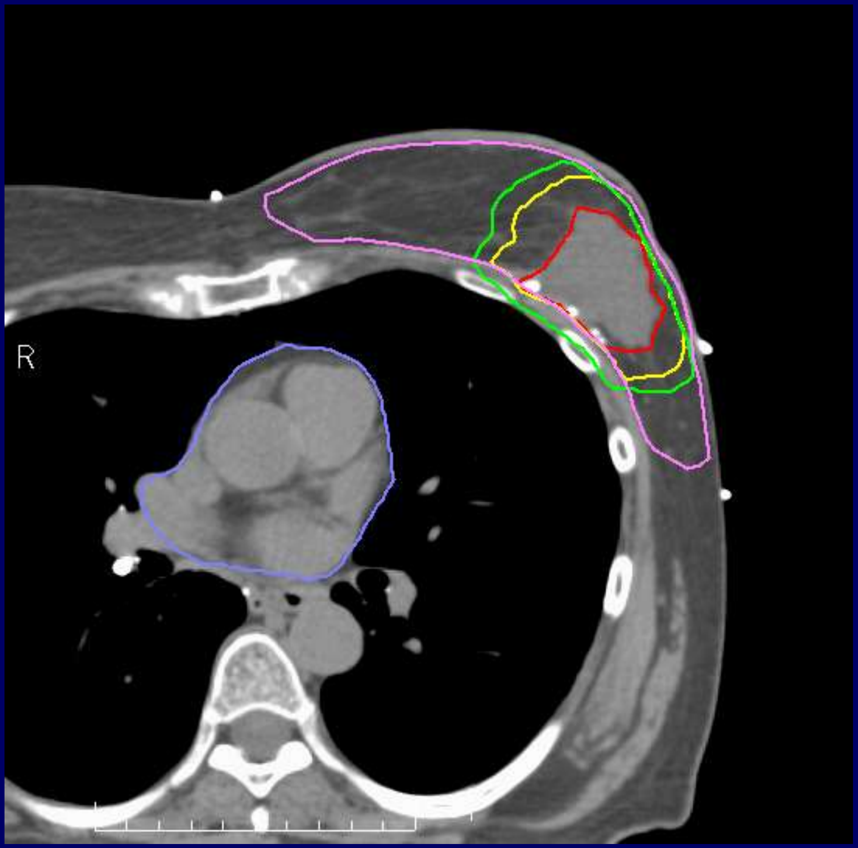
Popescu et al, IJROBP 287–295, 2010.

Accelerated Partial Breast Techniques

Volumes

- Expansion from Clinical Target Volume (CTV) to Planning Target Volume (PTV) depends on
  - Immobilization
  - Breath hold technique used
    - Device or voluntary?
  - Localization
  - Concerns re: seroma cavity position

Volumes



Lumpectomy cavity
Clinical Target Volume
Planning Target Volume

Breast contour

Additional contours:
Heart, lungs,
contralateral breast

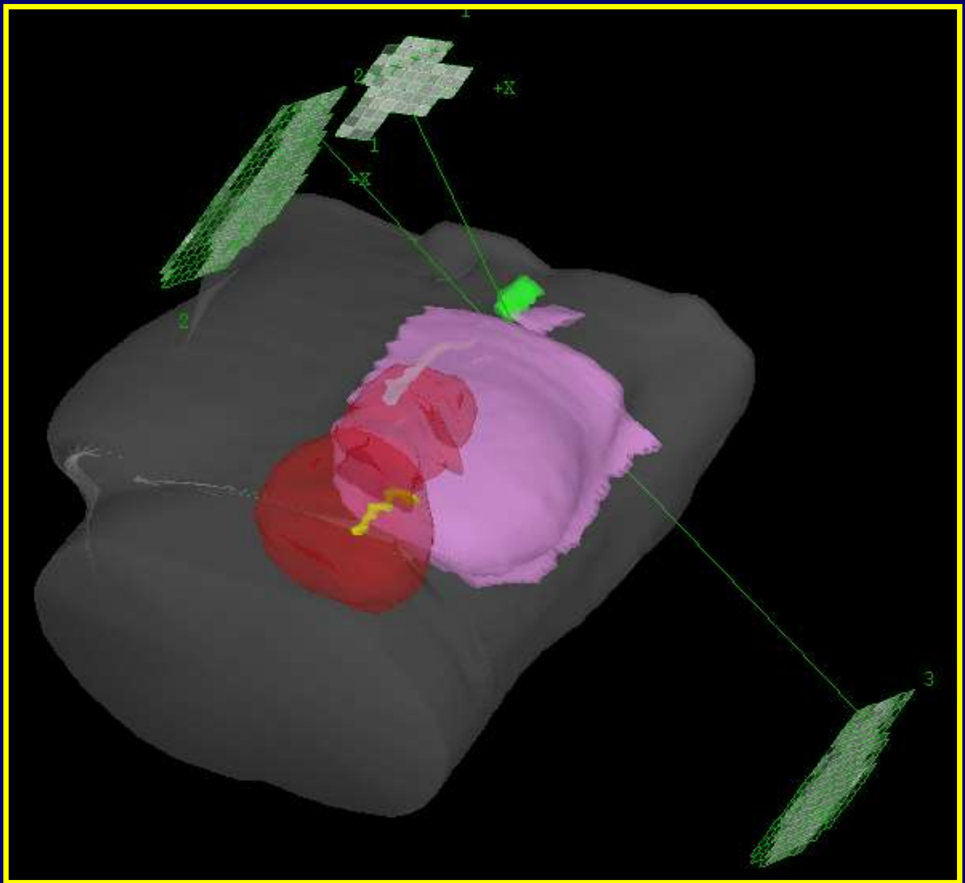
Excluded region 5 mm from surface for all volumes

Volumes – 10 patients

- Mean volume of the contoured breast (cc):
  - FB: 722±389
  - DIBH: 731±382
- Mean PTV volumes (cc)
  - FB: 202 cc
  - DIBH: 185 cc
  - Volumes are different because expansions are different

Moran et al. IJROBP 75: 294-301, 2009.

Example beam arrangement



Contoured breast, CTV, heart, LAD

- Technique: 3 or 4 beams per patient
- Mean PTV volumes in cc:
- FB: 202 cc
- DIBH: 185 cc

Cost Function for IMRT Plans: Treatment Planning Study

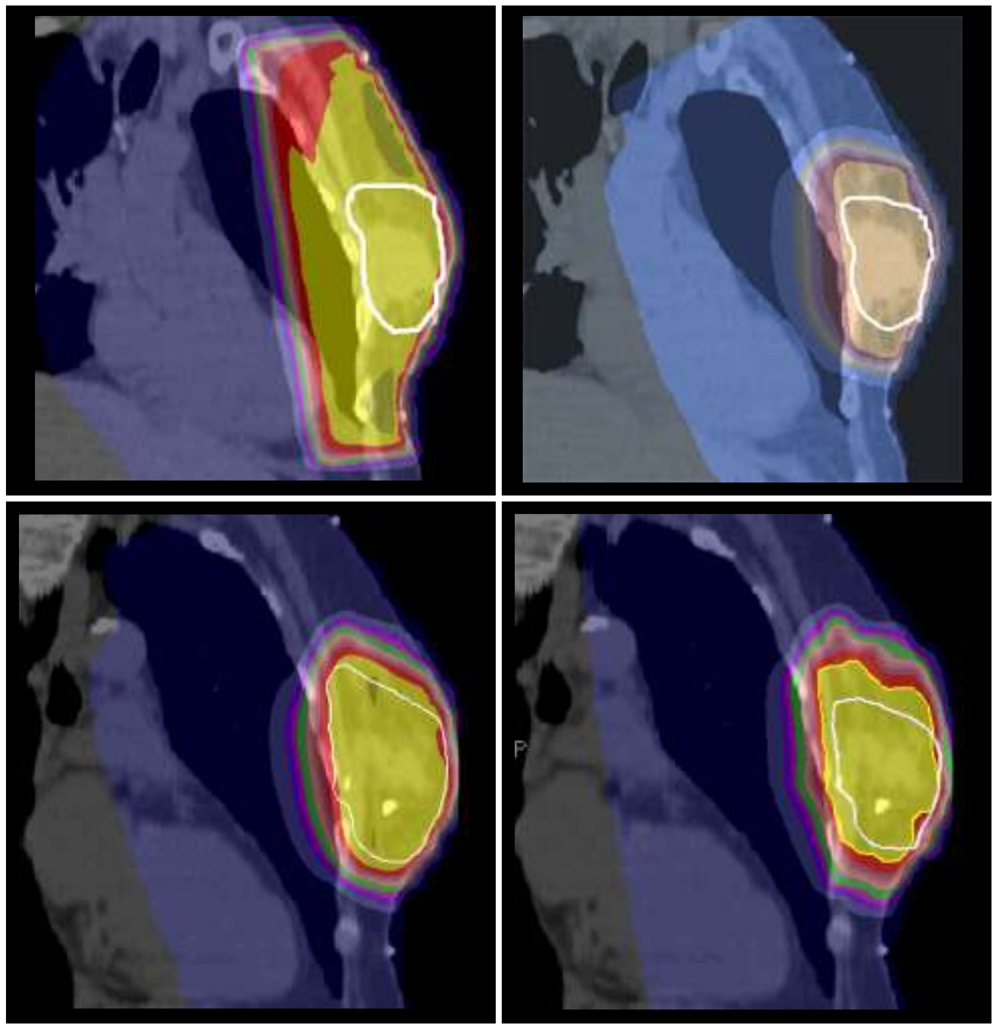
Structure	Dose/Volume Costs
CTV	100% volume, dose ≥ 38.5 Gy 99% volume, dose ≤ 40.4 Gy
PTV	95% volume, dose ≥ 38.5 Gy 99% volume, dose ≤ 40.4 Gy
Heart and LAD	Mean dose ≤ 3 Gy
Uninvolved ipsilateral breast	Minimize dose
Lungs	90% volume, dose ≤ 5 Gy

Moran et al. IJROBP 75: 294-301, 2009.

Example Oblique Dose Distributions

WBRT FB

38-42
34-38
31-34
27-31
23-27
20-23
16-20
12-16
8-12



3DCRT FB

3DCRT DIBH

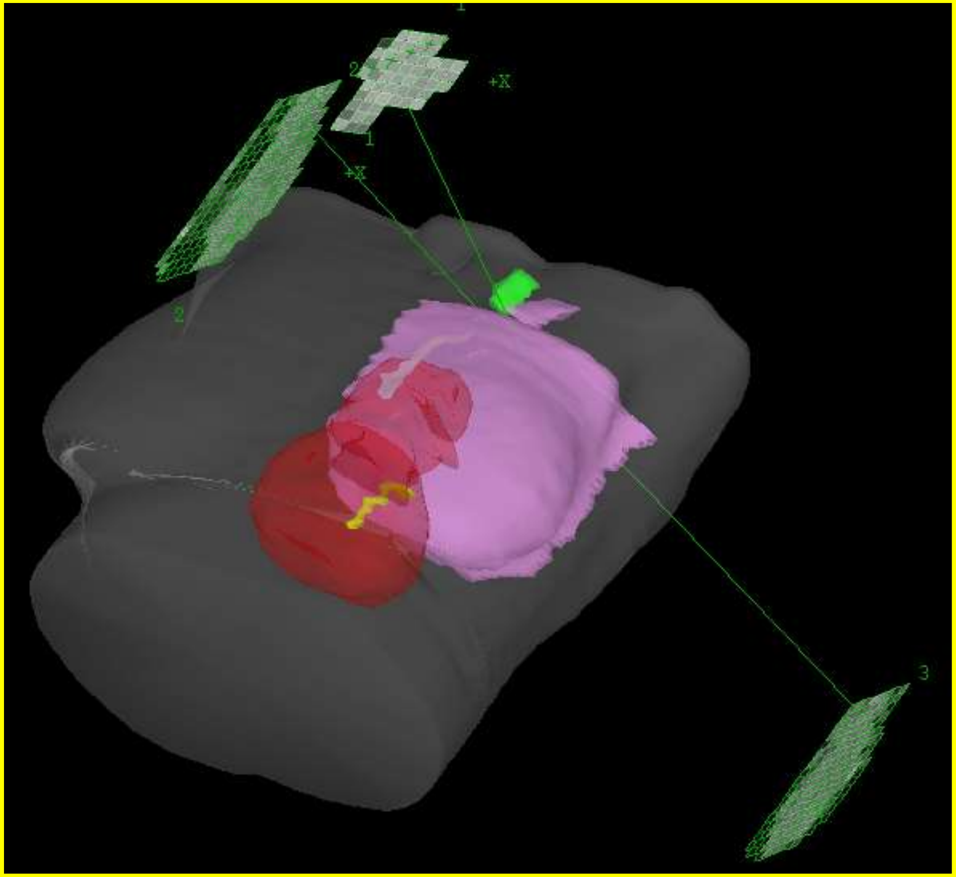
IMRT DIBH

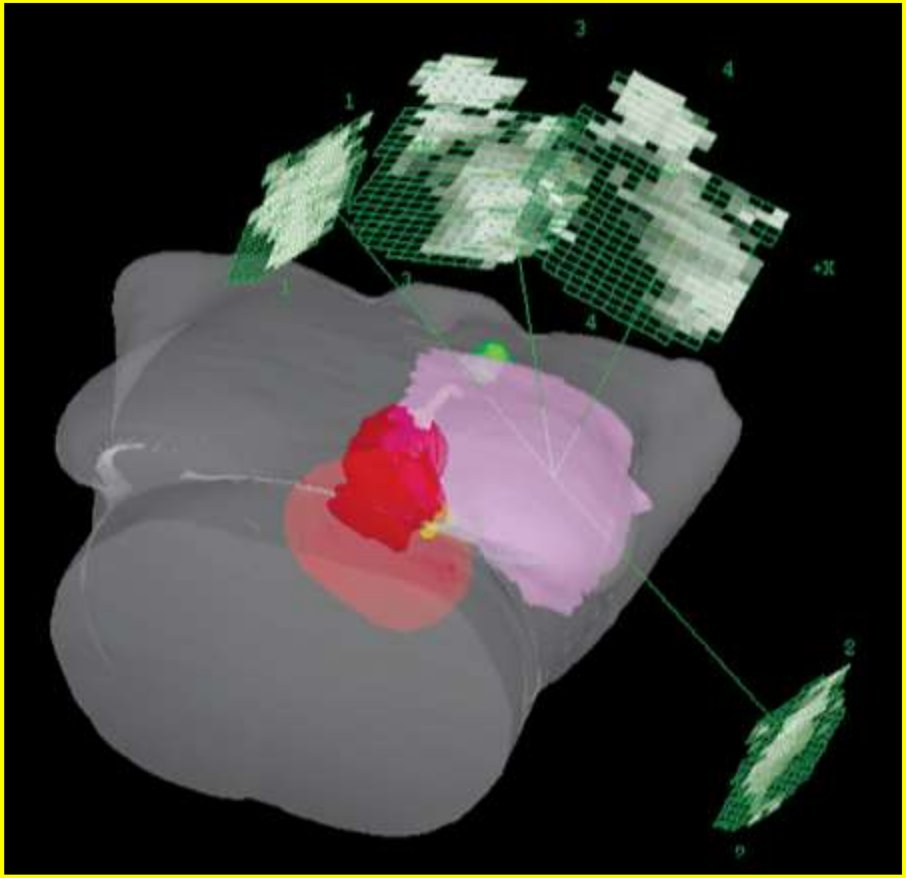
Moran et al. IJROBP 75: 294-301, 2009.

PBI Technique Comparison

- Acceptable target coverage with all PBI techniques
  - IMRT can be used improve dose homogeneity to the PTV and reduce the maximum dose
  - The use of DIBH result in further dose reductions of heart dose when compared to free-breathing 3DCRT
- Dose to uninvolved left breast can be reduced with IMRT

IMRT Techniques





Summary – Advanced Tx Planning

- Targets must be defined to use DVH constraints
  - Use RTOG atlas as a guide to improve consistency of targets
- Beware when using beam arrangements that involve irradiation of contralateral structures
  - Limit arc range to reduce likelihood of extraneous dose to contralateral structures
- When transitioning from previous techniques the treatment team must work together
  - Reproducibility of techniques, implementation of breath hold or gating technology, margin evaluation, assessment of patient changes

Acknowledgements

- Lori Pierce, MD
- Robin Marsh, CMD
- James Balter, PhD
- Kent Griffith, MS, MPH
- Reshma Jagsi, MD
- Jim Hayman, MD
- Chrissy Lockhart

NIH Grants R01 CA102435-01 and P01-CA59827