From 2D to 3D

3D planning in breast cancer

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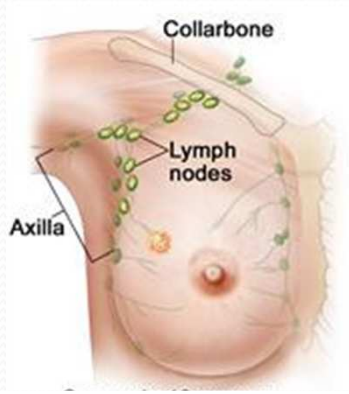
Road map of the talk

- Should we change from 2D to 3D planning
- What are its advantages
- Review of literature
- How do we do it? – Steps
- Types of 3D planning
- Conclusion

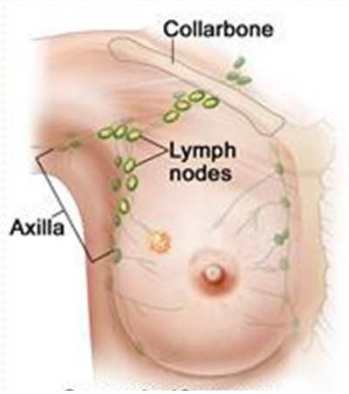


Should we change to 3D planning

YES?

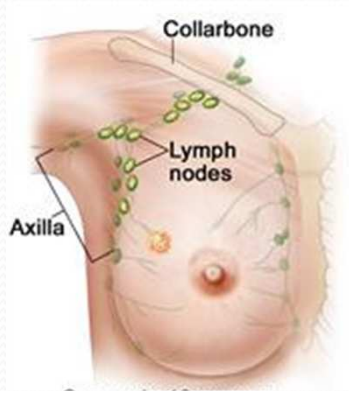
Indications

- Following neo-adjuvant chemotherapy
- As a part of Breast conservation therapy.
- Post mastectomy RT
    1. Positive nodes: >4 ; (?)1-3
    2. Large tumors:T3 +
    3. Skin involvement



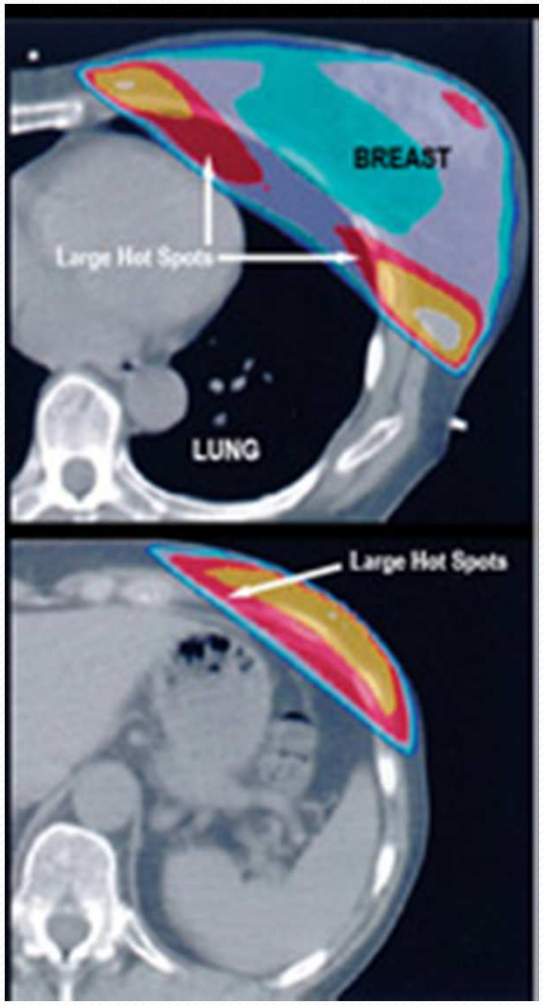
What are its advantages

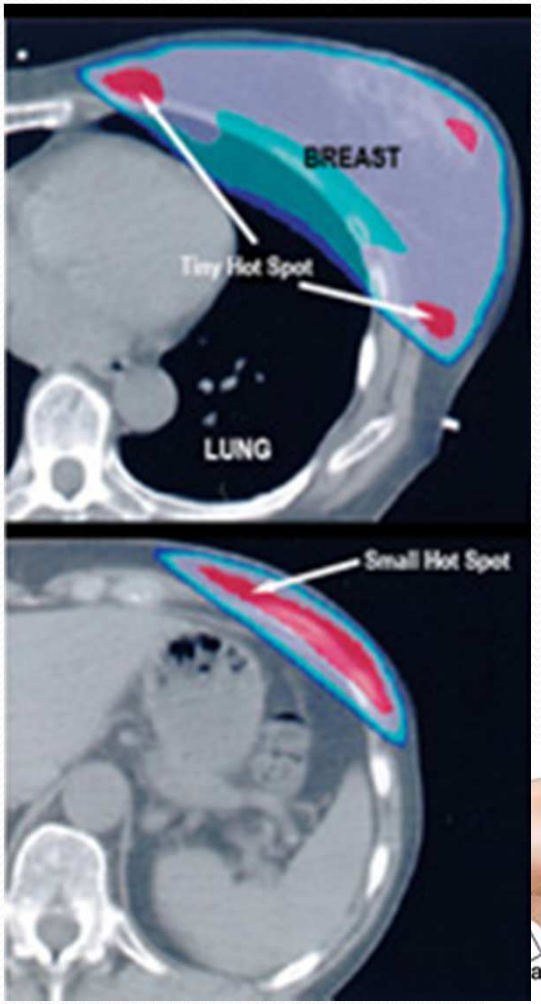
- **Dosimetry**
  - Better Dose Homogenicity
  - Better Dose Conformality
  - SIB – Feasible
- **Clinical**
  - Dose to Heart & Lung can be minimized.
  - Better Cosmetic Outcome ?

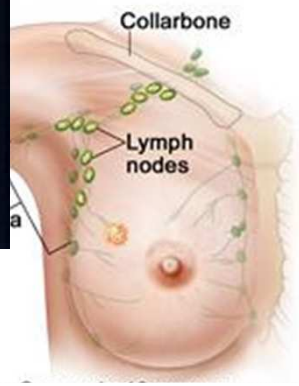


2D

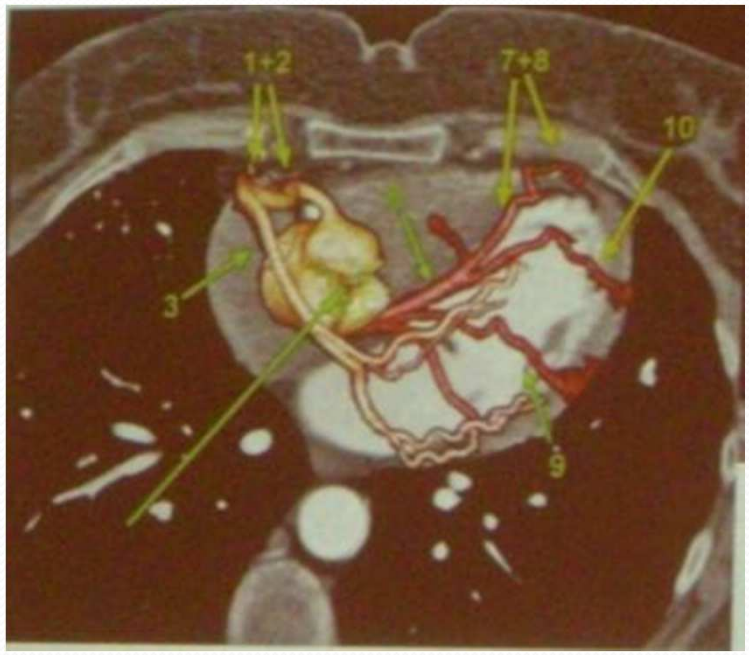
IMRT

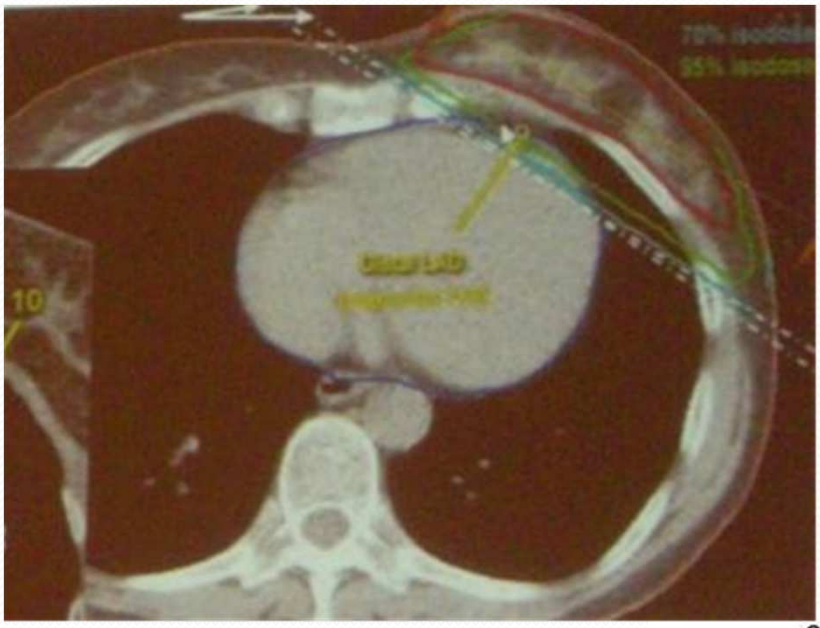

BREAST
Large Hot Spots
LUNG
Large Hot Spots


BREAST
Tiny Hot Spot
LUNG
Small Hot Spot

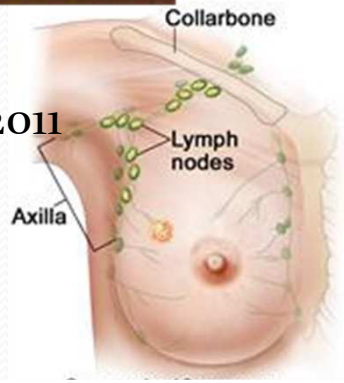

Collarbone
Lymph nodes

Cardiac injury in breast RT



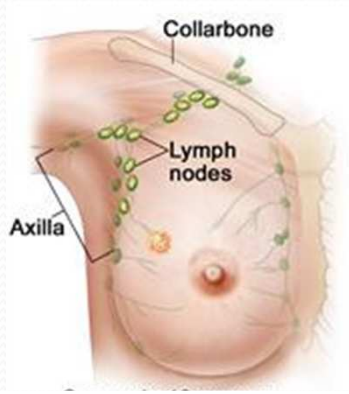


Nilsson et al JCO 2011



Review of Literature

- William Beaumont Hospital
- Ontaria Phase 3 Multicenter trial
- Royal Marsden Hospital



William Beaumont Hospital

2D (wedges) vs IMRT

- N = 172, CT plan,
- 1.8 Gy X25

+ 2 GyX 8 photons.

Toxicity	IMRT (%)	Wedges	p
Acute Grade >2			
Dermatitis	**41**	**85**	**<0.001**
Breast edema	**1**	**28**	**<0.001**
Pain	8	8	0.78
Hyperpigmentation	**5**	**50**	**<0.001**
Chronic Grade >2			
Hyperpigmentation	7	17	0.06
Breast edema	**1**	**25**	**<0.001**
Fat Necrosis	0	1	0.46
Induration/fibrosis	0	6	0.11
Good/excellent fibrosis	99	97	0.60

Harsolia et al. IJROBP 68-5 (2007)

Ontario phase III multicentre trial

2D (wedges) vs 3D IMRT

- N = 331, CT plan
- 2GyX 25

+2 Gy x 8 elec.

Toxicity	IMRT (%)	Wedges	p
Skin Toxicity 3-4	**27.1**	**36.7**	**0.06**
Moist desquamation, all breast	**31.2**	**47.8**	**0.002**
Moist desquamation, Inframammary crease	26.5	43.5	0.001
Pain grade 2-4	26.5	25.5	0.68

Grading NCI CTC 2.0

Pignol et al. JCO 26-13

Royal Marsden phase III randomised trial

2D (wedges) vs 3D IMRT

- N= 240
- Single contour plan
- 25x2 Gy+5x2Gy electrons.

- Reduced late effects
  - change in breast appearance from 58% to 40%
  - Reduction of induration

Toxicity	STD	IMRT (%)	p
	Year 5 Assessment		
Center of the breast	37/117(32%)	25/118(21%)	0.02
Pectoral fold	34/118 (29%)	26/119 (22%)	0.006
Inframammary Fold	28/116 (24%)	20/117(17%)	0.009
Boost site	70/114(61%)	43/115(61%)	<0.001

Donovan et al. R&O 82 (2007)

RCT Analysis – FIMRT in EBC

- 1145 – trial plans
- Standard plans Vs FIMRT plans

	FIMRT	2D	p value
V>107% & V<95%	34cm3 (26.4-41.6)	48.1 cm3 (34.4-61.9)	<0.0001

- Confirmed FIMRT improved breast dosimetry
- More likely dosimetric benefit – large breasts

IMRT for BCT

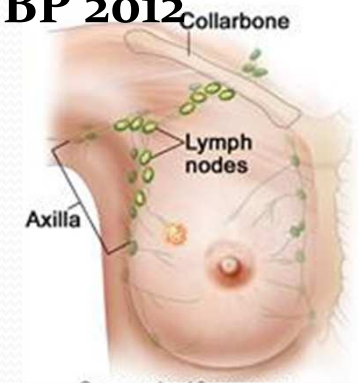
Cosmesis:

	Physician	Patient
Excellent	63%	33%
Good	33%	50%
Fair/Poor	<1.5%	17%

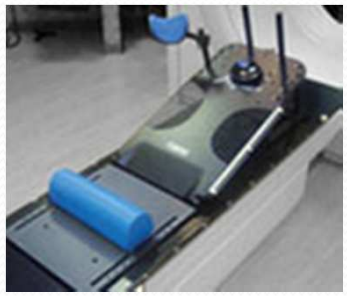
Predictors :

1. Increased Boost volume
2. Breast tumor ratio
3. Erythema
4. Telangiectasia

Kelle et al IJROBP 2012



Steps



Patient positioning

Volumetric Data acqusition

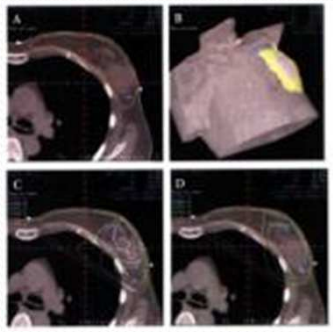
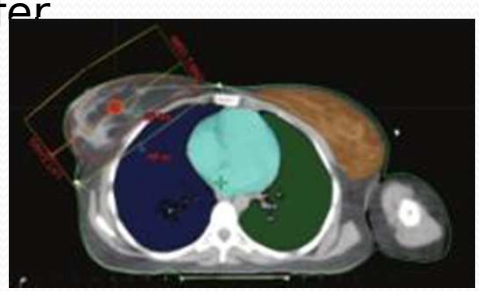
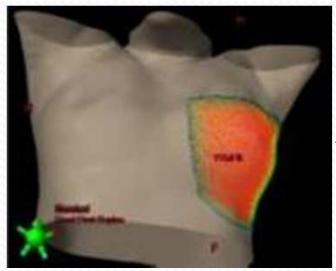


Image Transfer to the TPS



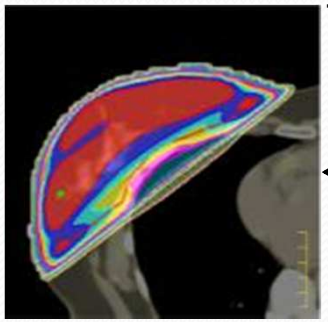
Target Volume Delineation



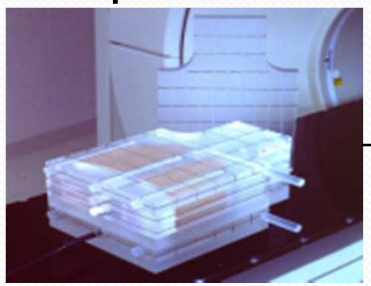
3D Model generation

Forward Planning

Inverse Planning



Dose distribution Analysis



Treatment QA

Treatment Delivery

Physics of FIMRT

CT based

- 75% of dose with open fields
- 8 extra segments
- Min. segment size 9 cm2
- Simple planning objectives

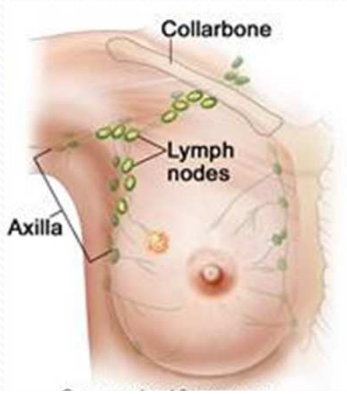
Additional benefits

- Less MU, less scatter
- Decreased planning time
- Decreased beam-on time
- Less susceptible to breast deformations.

Breast Contouring

- Breast Contour
  - Consider referred clinical breast at time of CT
  - Includes the apparent CT glandular breast tissue
  - Incorporates consenses definations of anatomical borders
  - Includes the lumpectomy CTV

- Lumpectomy CTV
  - Includes seroma & surgical clips where present

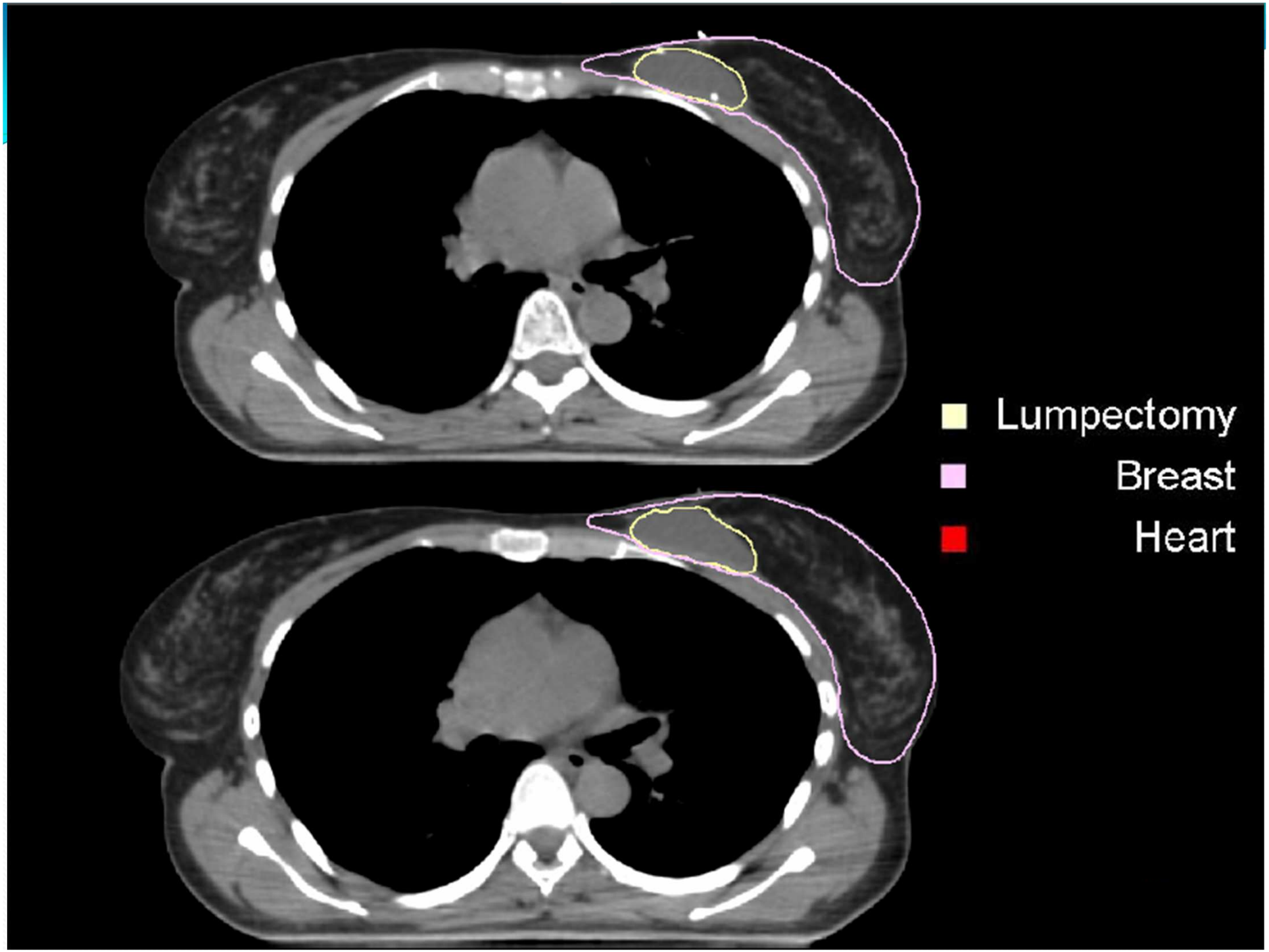


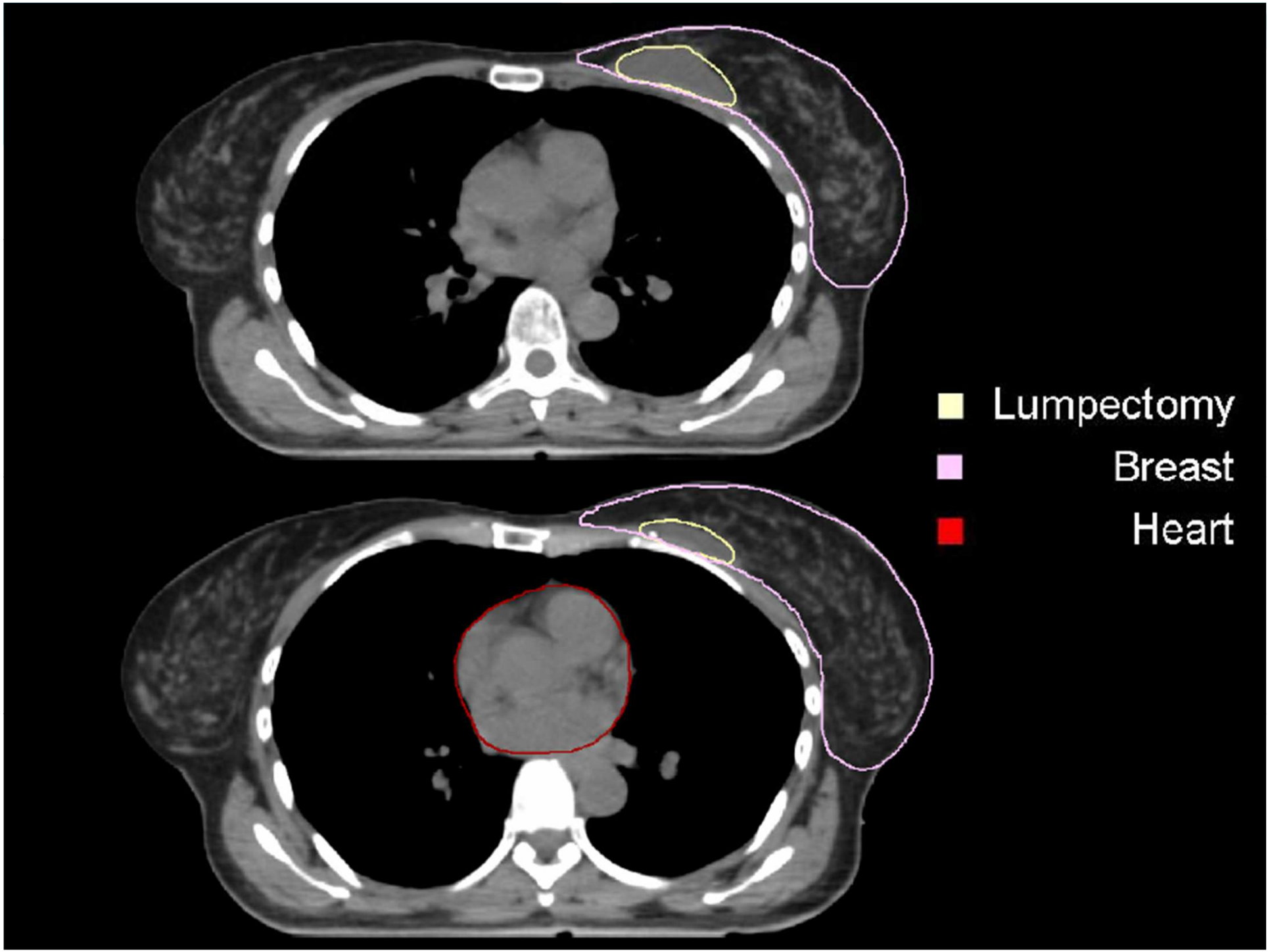
Breast CTV

- The target volume must include all the total glandular breast tissue
- Borders are not clearly visible
- Radio opaque wire around the breast tissue to help guide the approx borders of breast tissue (do not represent the true borders)

Breast Contour – Anatomical Boundaries

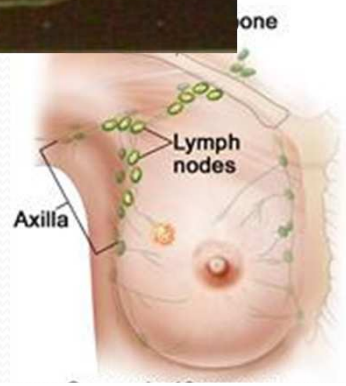
Cranial	Caudal	Anterior	Posterior	Lateral	Medial
Clinical Reference + Second rib insertion	Clinical reference + loss of CT apparent breast	Skin	Excludes pectoralis muscles, chestwall muscles, ribs	Clinical Reference + mid axillary line typically, excludes latissimus (Lat.) dorsi m	Sternal-rib junction


Lumpectomy
Breast
Heart


Lumpectomy
Breast
Heart

Chest wall delineation

- All borders of the CTV thoracic wall are usually considered to be identical to the CTV breast
- In post MRM radio opaque wires should be positioned around the imaginary original site of the breast & on the scar
- Careful palpation of the thoracic wall & the position of the mastectomy scar should be used well.



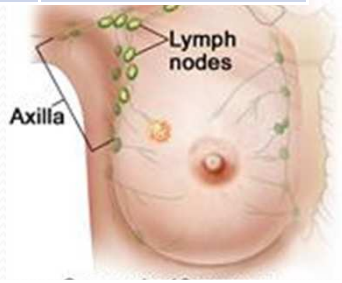
CHEST Wall - special

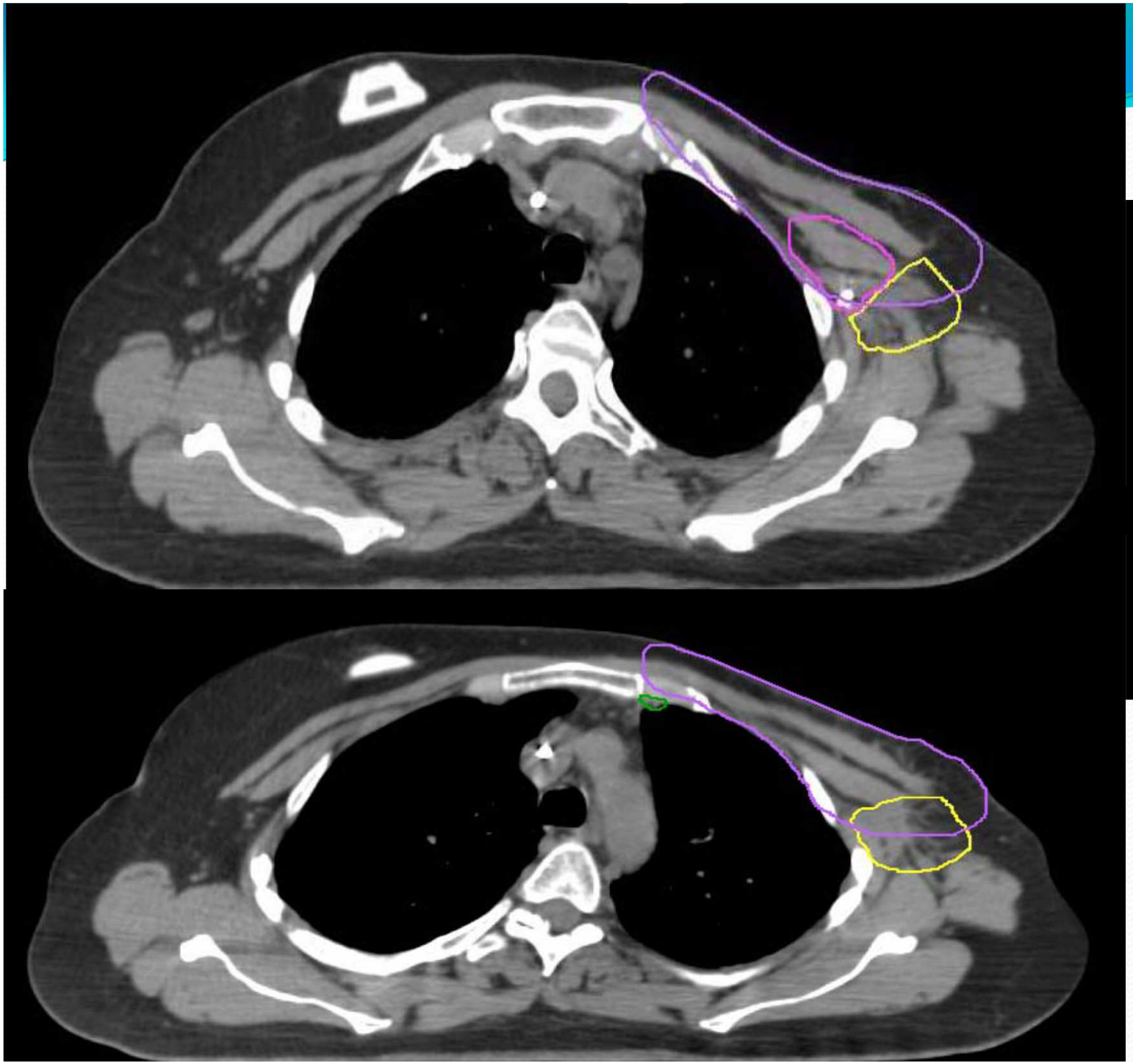
- Most cases the tissue upto the skin is removed and skin is adherent to the thoracic wall.

- Use bolus in such cases to deliver dose to the skin and the thoracic wall.

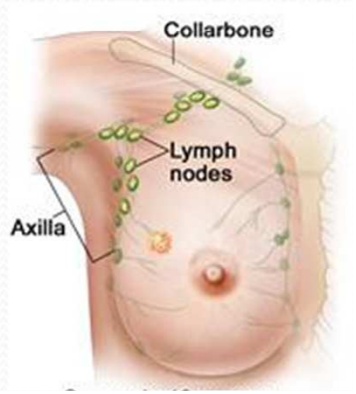
Chest wall contour-Anatomical Boundaries

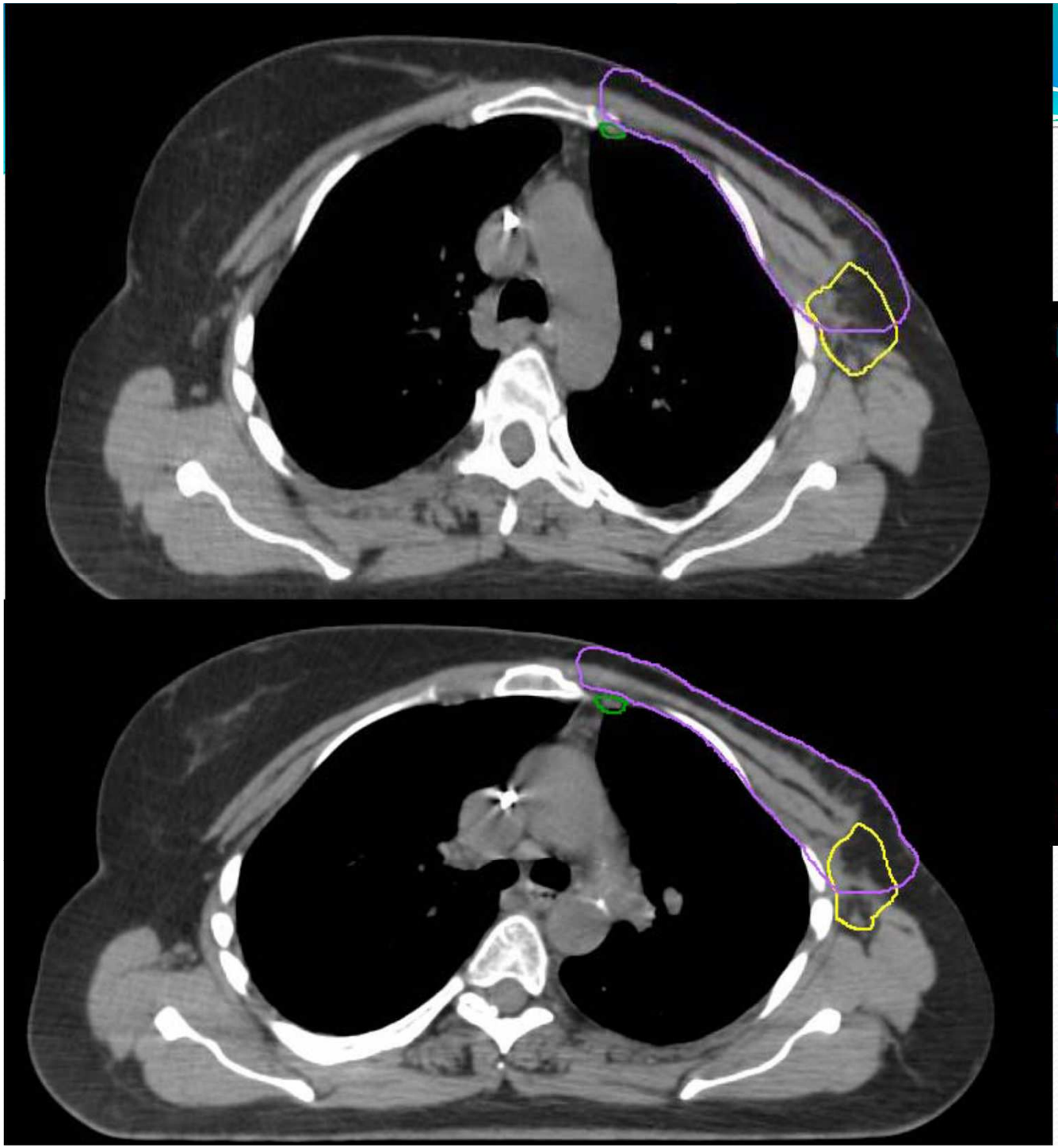
Cranial	Caudal	Anterior	Posterior	Lateral	Medial
Caudal border of the clavicle head	Clinical reference+ loss of CT apparent contralateral breast	Skin	Rib-pleural interface. (Includes pectoralis muscles, chestwall muscles, ribs)	Clinical Reference/ mid axillary line typically, excludes lattismus dorsi m.	Sternal - rib junction



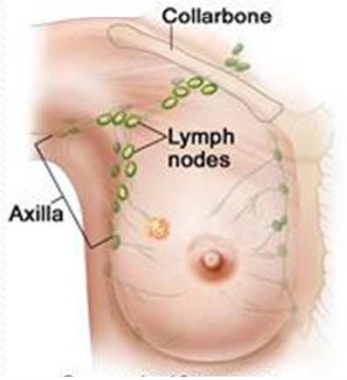


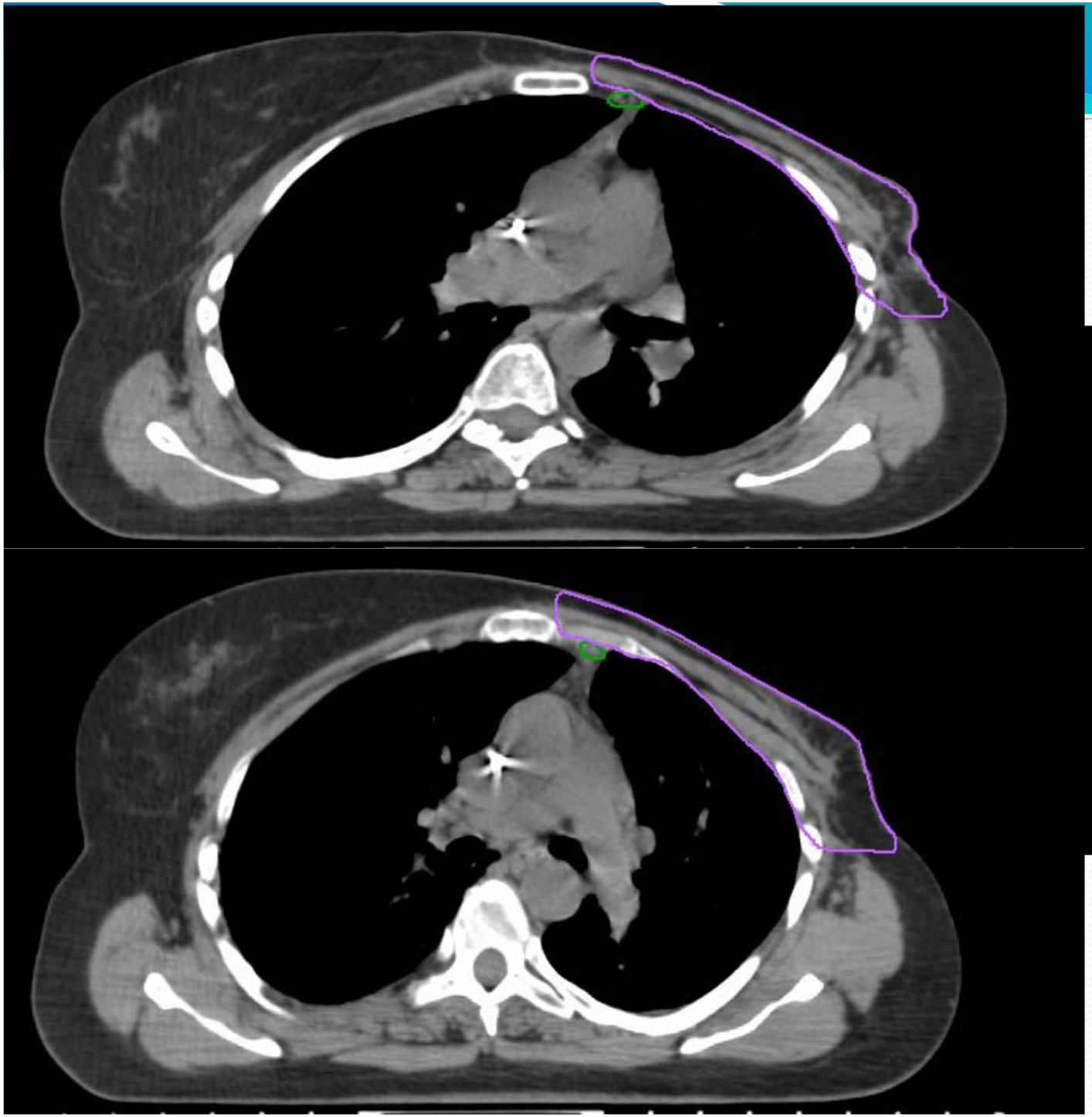
Supraclavicular
Axilla level 3
Axilla level 2
Axilla level 1
Chestwall
Heart





Supraclavicular
Axilla level 3
Axilla level 2
Axilla level 1
Chestwall
Heart





Supraclavicular
Axilla level 3
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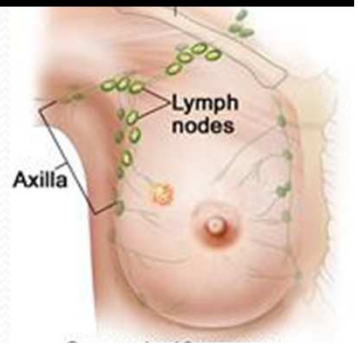
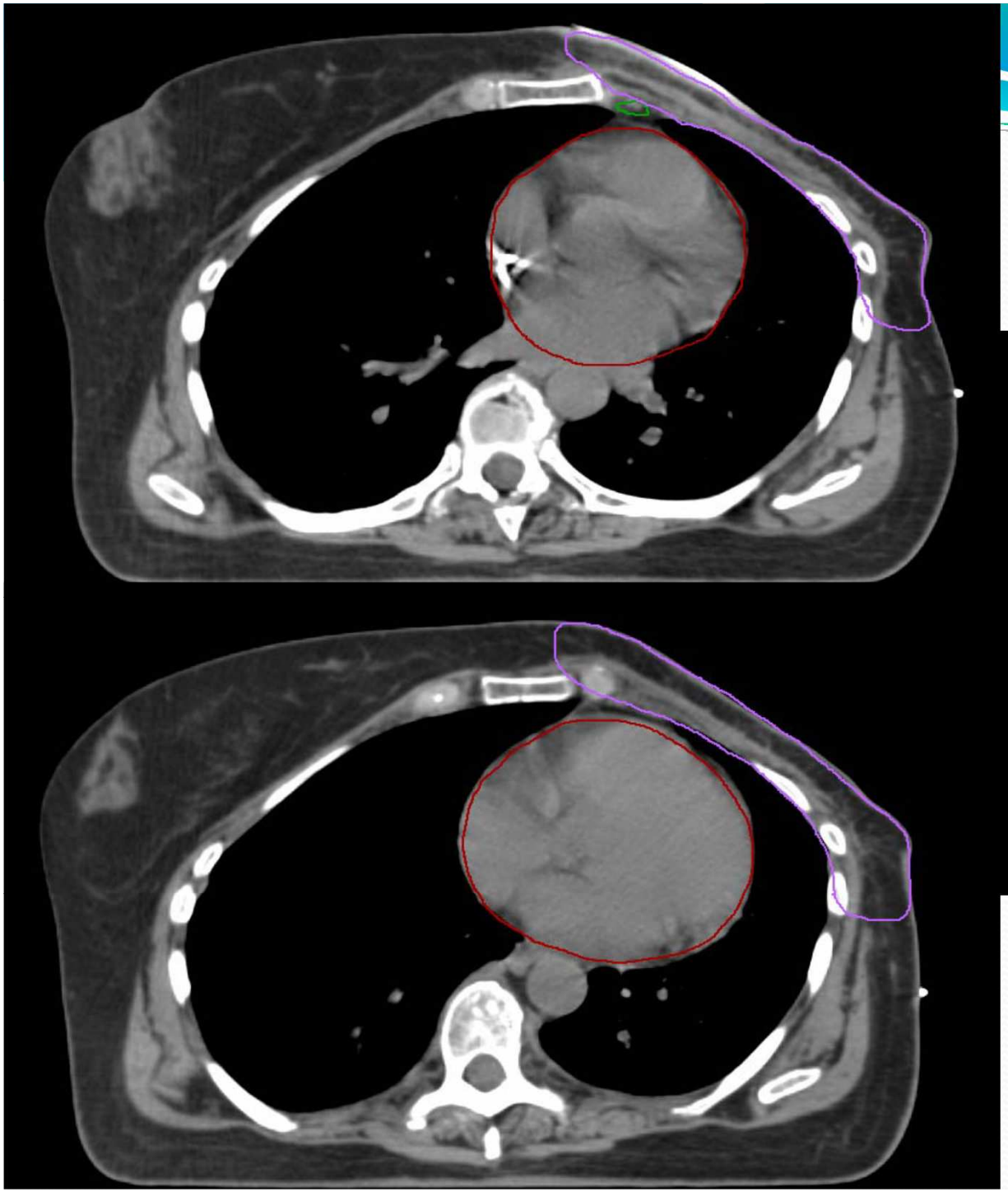
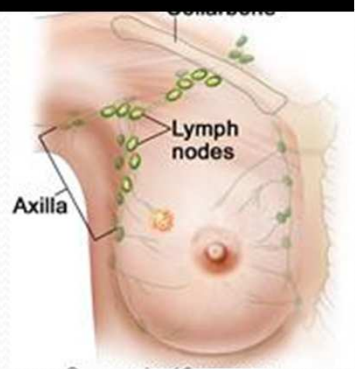
Chestwall
Heart





Supraclavicular
Axilla level 3
Axilla level 2
Axilla level 1

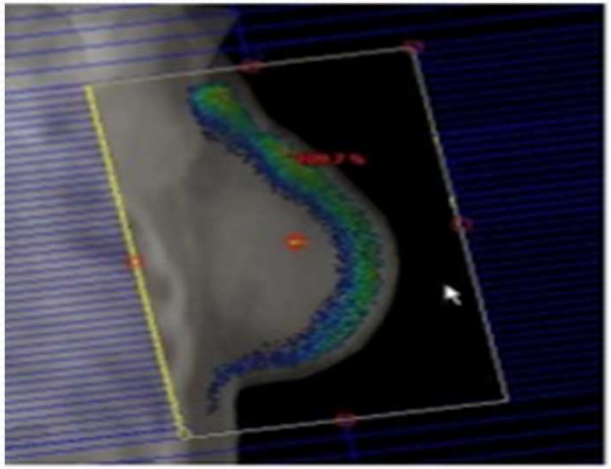
Chestwall
Heart

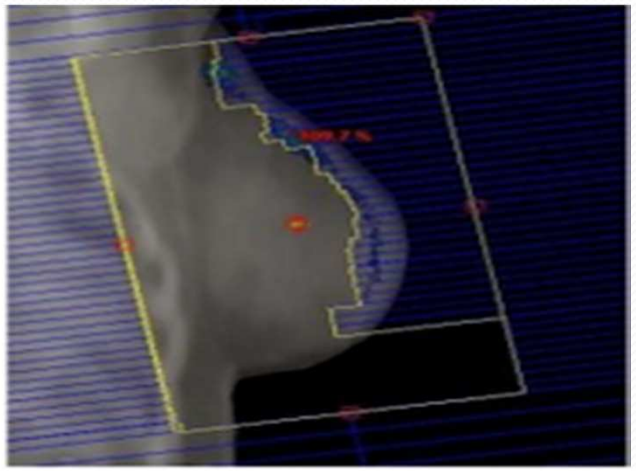


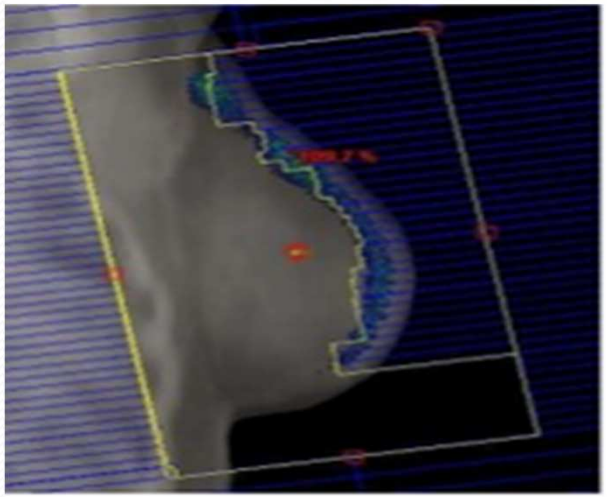
Types of IMRT

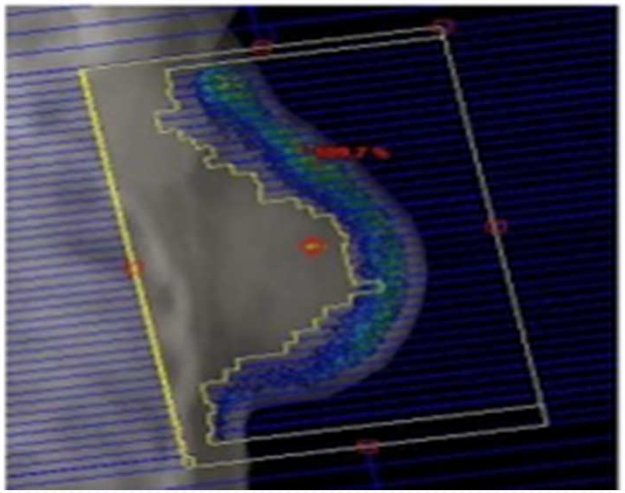
- FIMRT
  - Beams parameters specified / manually changed as reqd.
  - Dose distribution computed
  - Manual iterations
  - Time consuming
  - Subjective function
- Inverse IMRT
  - Dose distribution specified
  - Computerised beam parameters
  - Auto iterations
  - Quicker
  - Objective function

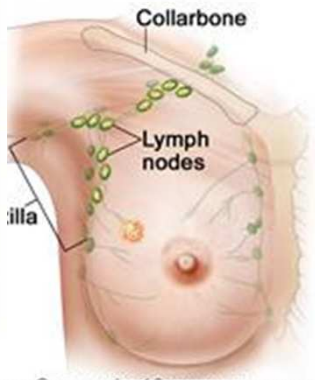
Forward plan IMRT



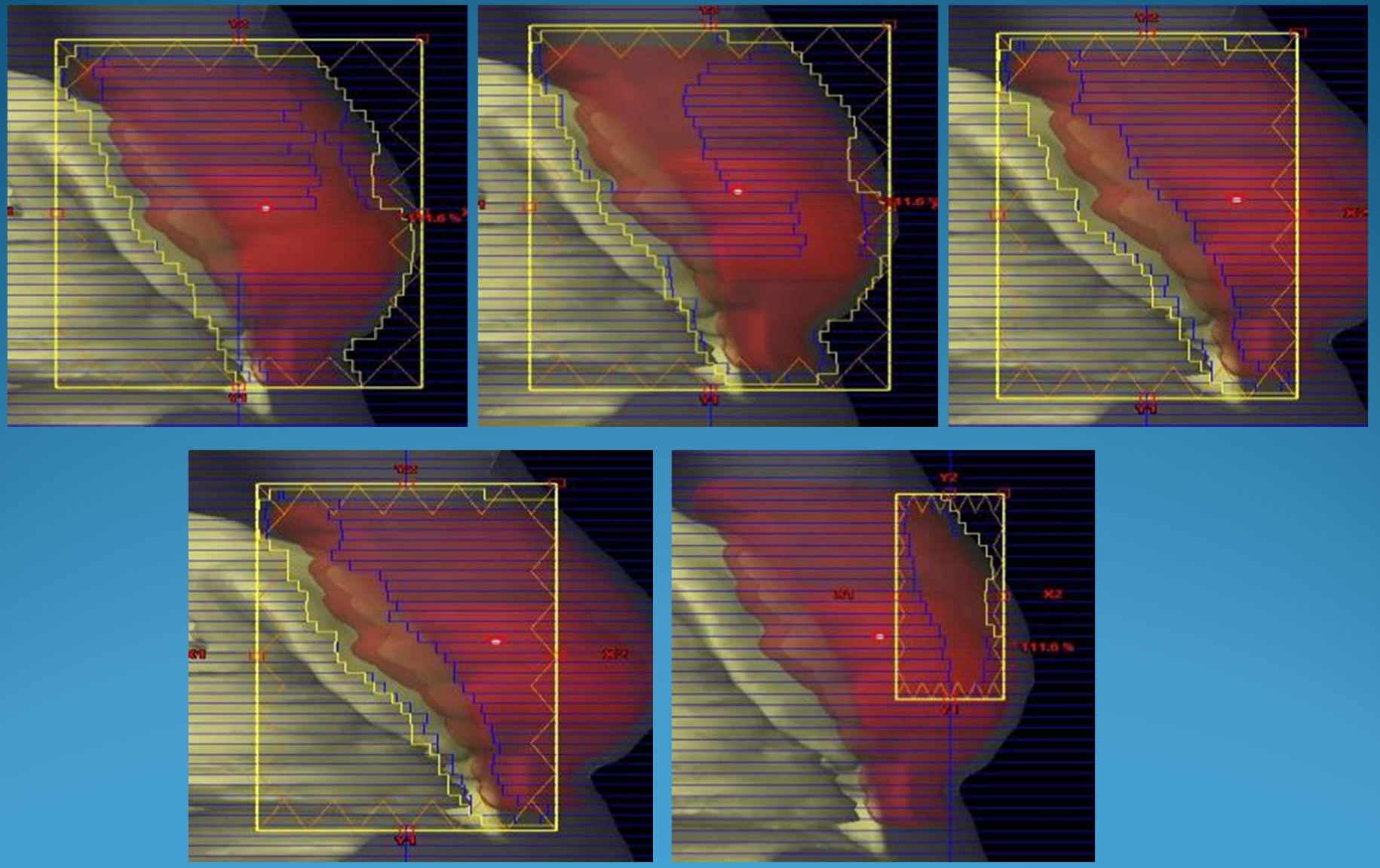




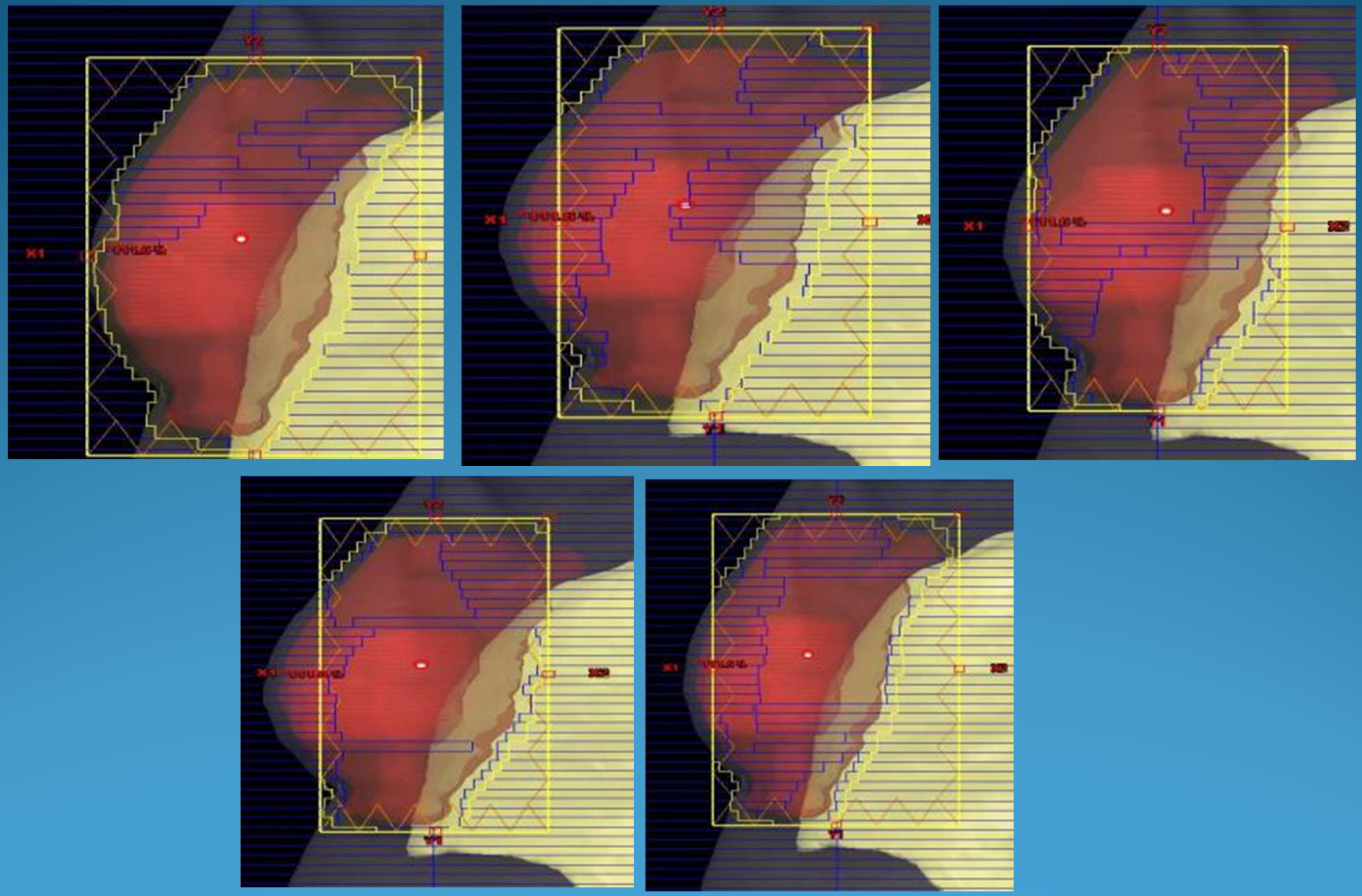




Medial Tangential Segments

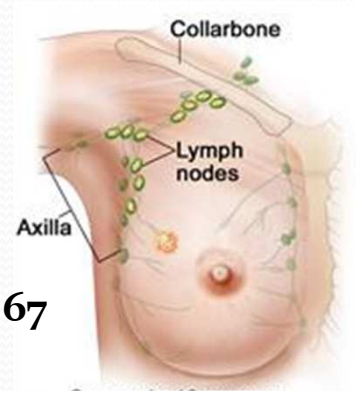


Lateral Tangential Segments



Plan Evaluation

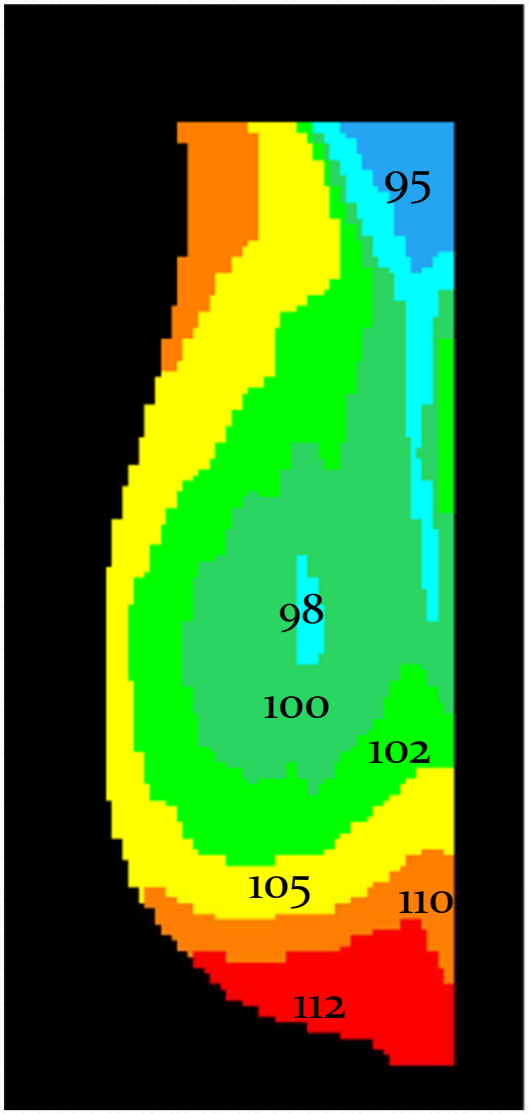
- Target coverage
- Homogeneity of dose distribution
- Dose distribution on all slices
- Dose to organs at risk
  1. Opposite breast
  2. Lungs : Ipsilateral and combined
  3. Heart : Especially in Left sided



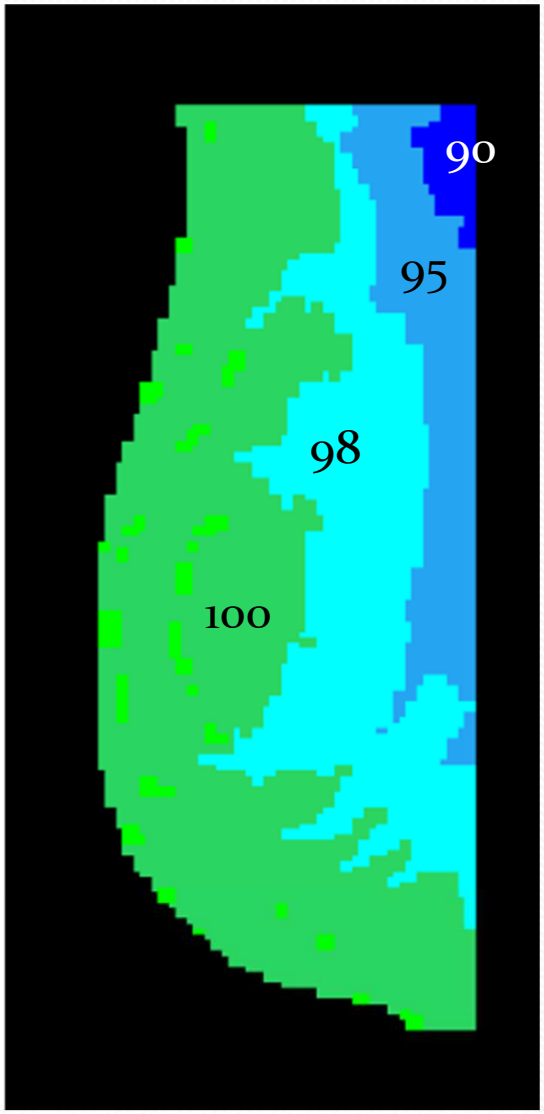
Nguyen et al. Radiation Oncology 2013, 8 : 67

Plan goals

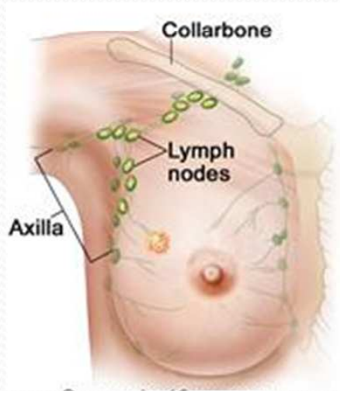
PTV	
V95	≥ 95%
V107	< 2% or 2 cc
Lung V 20 Gy	<15%
Heart V 50	≤ 1 cc



Open fields

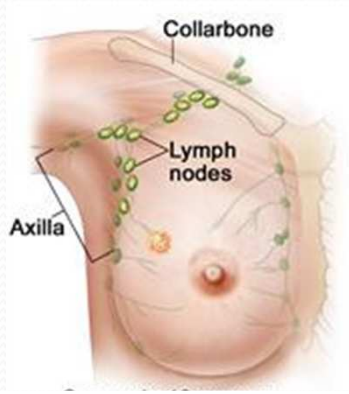


F IMRT



Prone IMRT at MSKCC

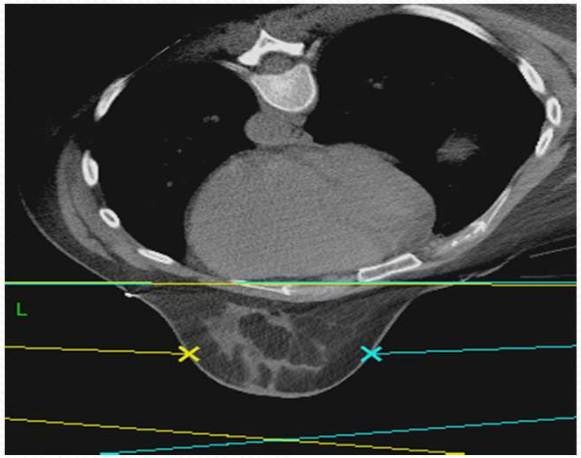
- Minimize radiation to the heart and lungs by utilizing gravity effect on mobile breast
- Specify beam direction (Two tangent fields) before inverse planning process to avoid an increase in integral dose
- Bring dose intensity pattern to field edge to account for minimal edema through treatment.

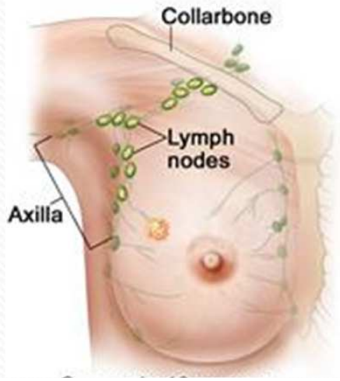


Breast board

Patient in Position

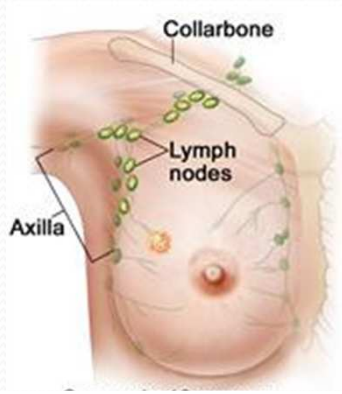
CT scan





Conclusion

- Reduce Acute Toxicity
- Late effects – Data Awaited
- No increased survival benefit
- IMRT feasible for Intact Breast



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