Treatment Planning for Breast Cancer: Contouring Targets

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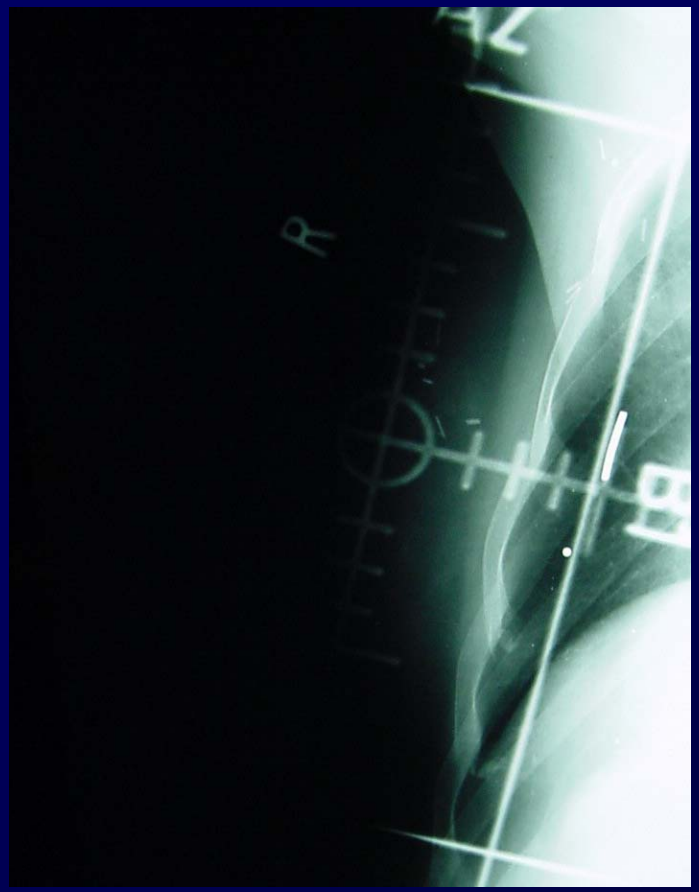
ASTRO 56TH ANNUAL MEETING
TARGETING CANCER: TECHNOLOGY & BIOLOGY

Outline

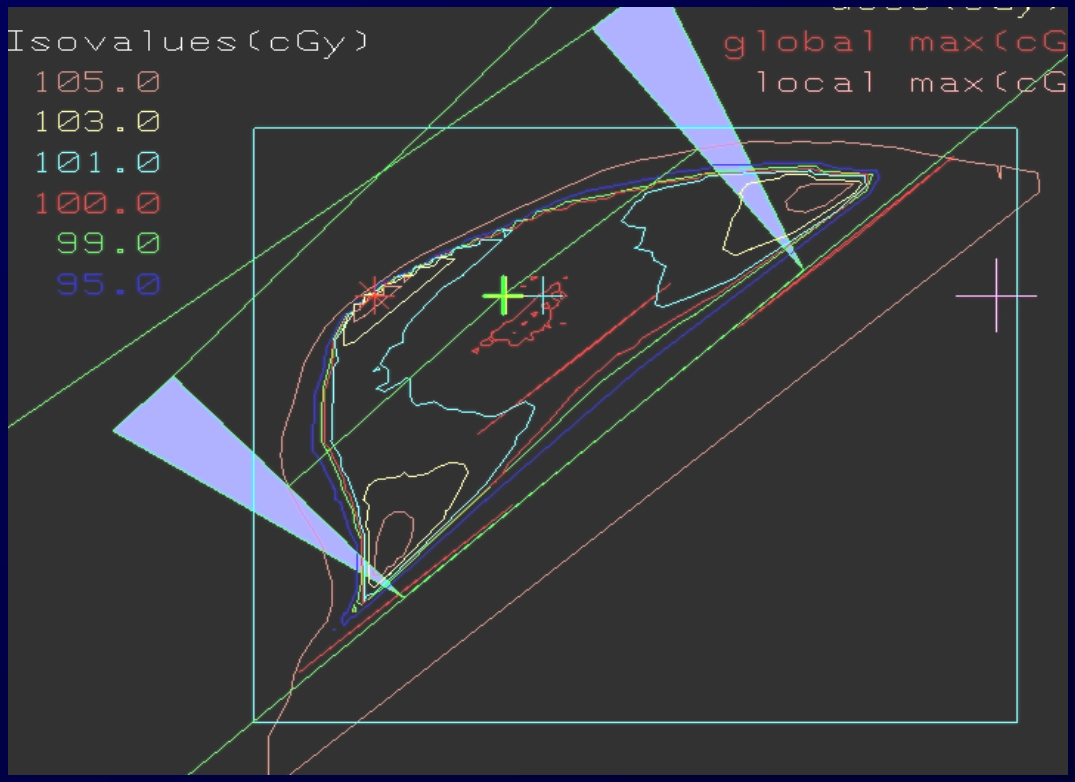
1. RTOG Breast Cancer Atlas
2. Target development on Clinical Trials

Whole Breast Irradiation
2-D Radiotherapy

Fluoroscopic simulation



Central plane dosimetry



American College of Radiology

Patterns of Care Study (PCS)

Quality Research in Radiation Oncology (QRRO)

Whole Breast Irradiation

Intact Breast	Central Plane	CT Scan	3-DCRT/ Multiple planes	IMRT	APBI
1984	98 %	-	-	-	-
1993-94	94.1%	5%	1%	-	-
1998-99	81%	16.6%	13%	-	-
2007-2008	0.23%	97%	79.7%	15.8%	4.5%

http://www.rtog.org/CoreLab/ContouringAtlases/BreastCancerAtlas.aspx

Breast Cancer Atlas for Radiation Therapy Planning:

Consensus Definitions

RTOG®
RADIATION THERAPY ONCOLOGY GROUP

Goals: Breast Cancer Atlas

1. Establishes initial consensus about anatomic delineation of target and normal tissue volumes for breast cancer radiation therapy
2. Intended as an anatomical reference to guide CTV definition
3. Provides a common denominator for breast cancer clinical trials when radiation therapy is to be delivered
4. Future goals include establishment of reporting parameters for target and normal tissue dose-volumes to compare outcomes from different clinical trials and institutional series

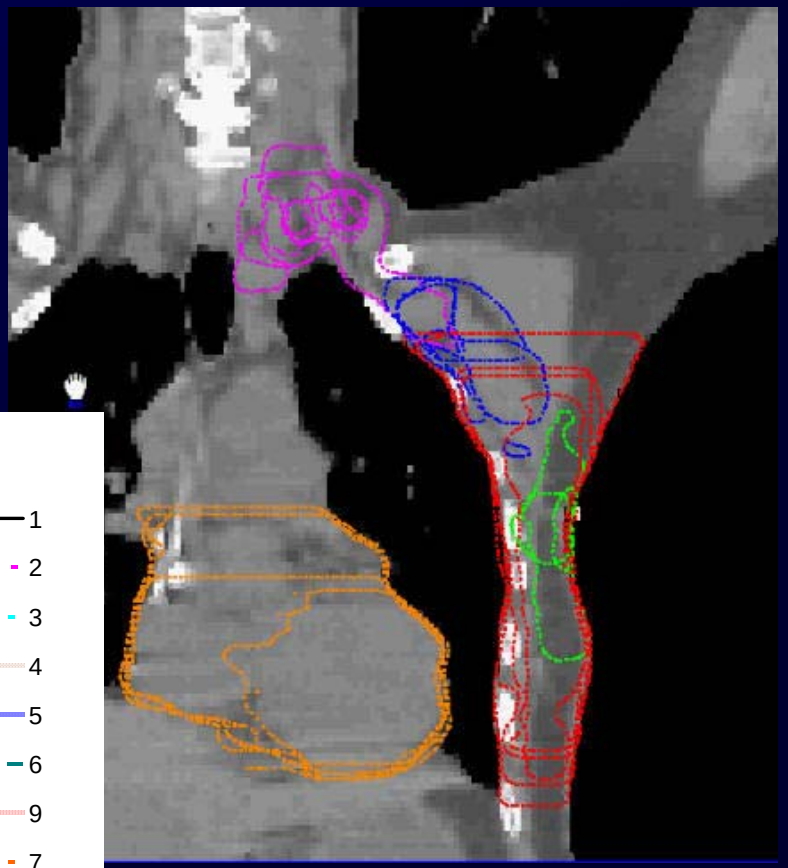
Atlas Development

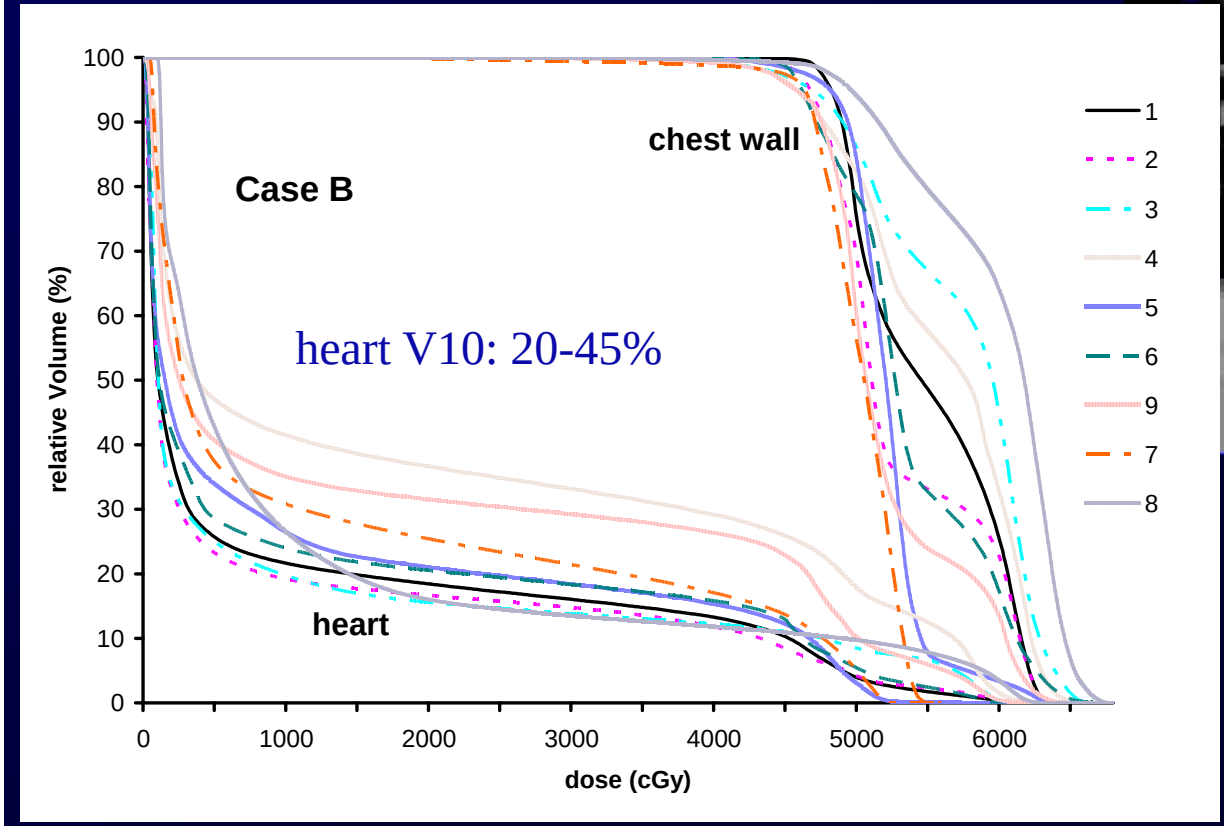
- 1**0** breast radiation oncologists from **9** institutions
- Independently delineated anatomic volumes on three representative CT cases - twice:

1. First: without any guidance/ instruction
2. Second: with written consensus guidelines developed after the first try

RTOG
RADIATION THERAPY ONCOLOGY GROUP

Variability of target and normal structure delineation





Targets: lumpectomy cavity, breast, chestwall, SCL nodes, axillary nodes, IMC nodes
OAR: heart, lung

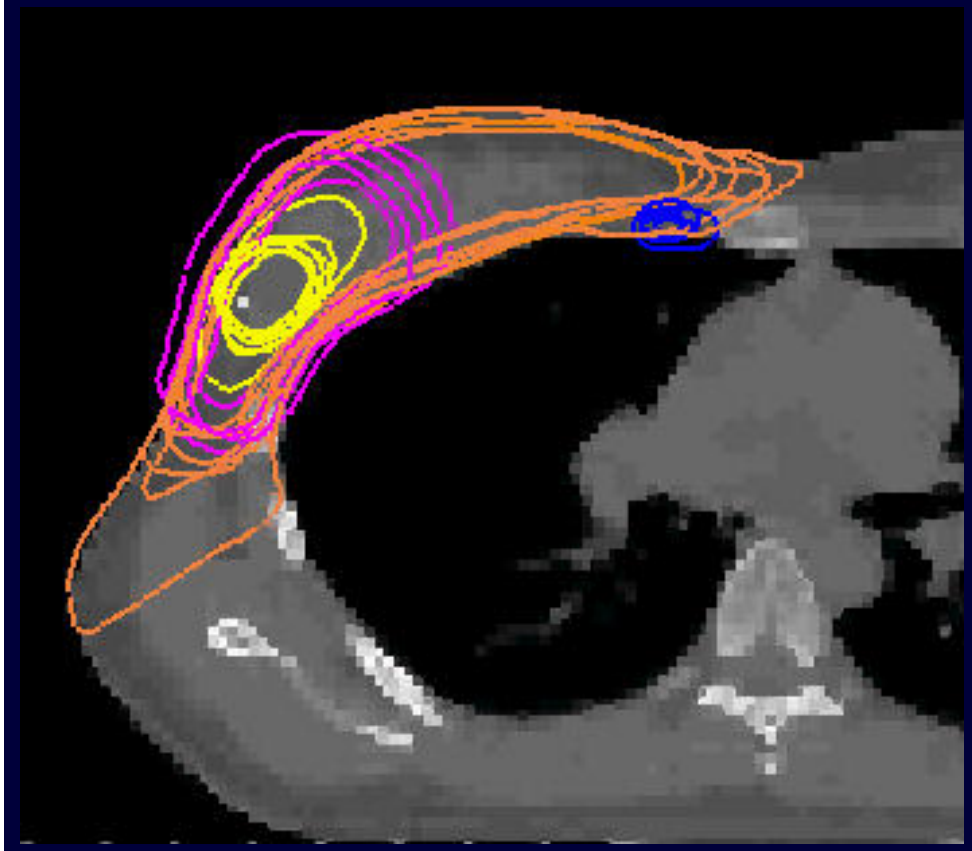
Li XA, et al, IJROPB 2009

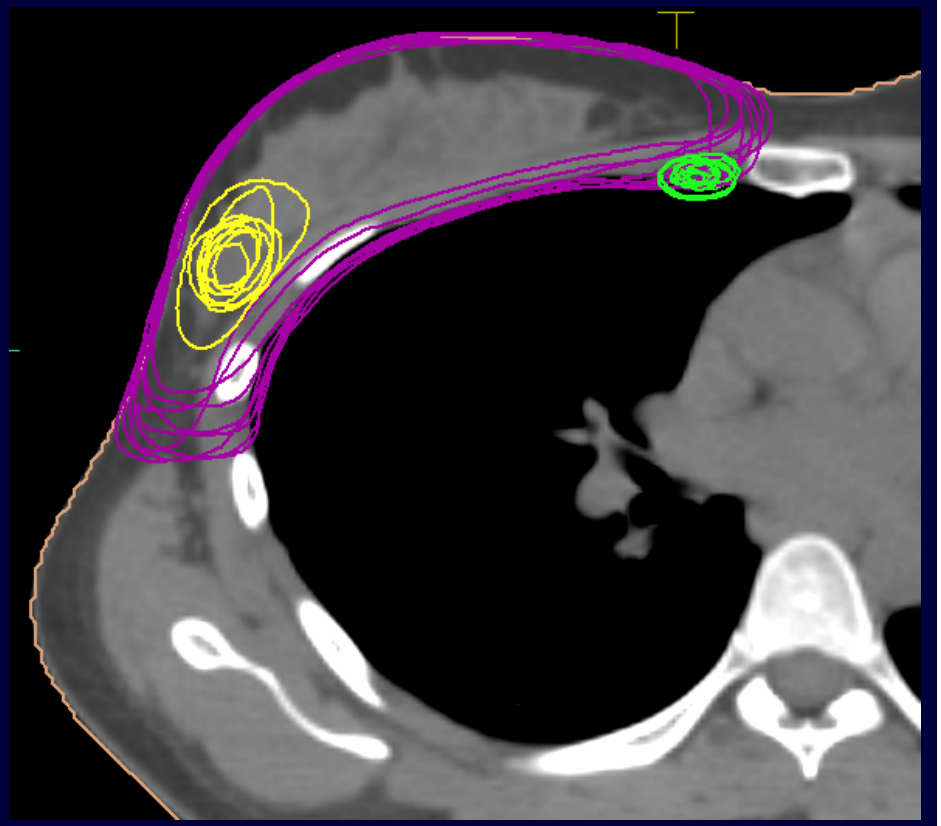
Comparison of the 1st and 2nd Runs

	Mean Volume Overlapping		Standard deviation for volume variation	
	1st Run	2nd Run	1st Run	2nd Run
Breast	85%	91%	16%	10%
Chestwall	72%	83%	38%	14%
Heart	86%	89%	24%	15%
Lumpectomy*	86%	90%	15%	16%
Axillary nodes*	51%	60%	41%	40%
Supraclav nodes	55%	58%	61%	42%

* Not significantly different

Case C: Stage IIIA (T2N2M0), 4/18 LN+
Left Nodal and Breast-Chestwall RT

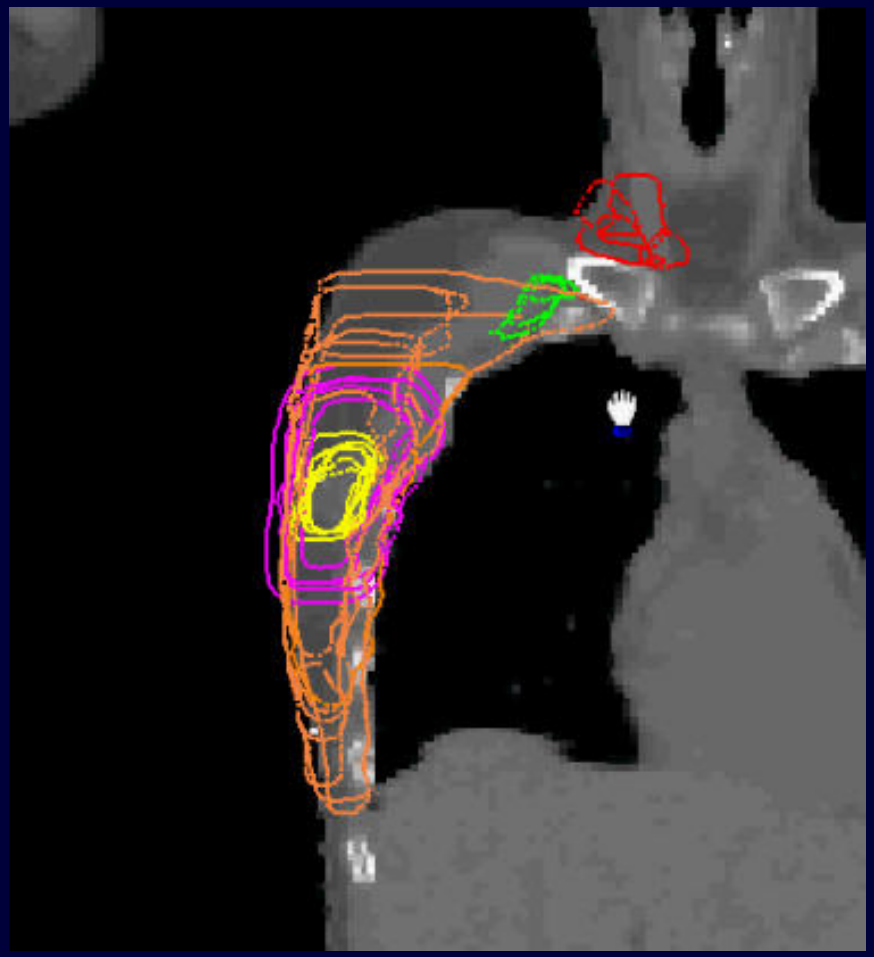




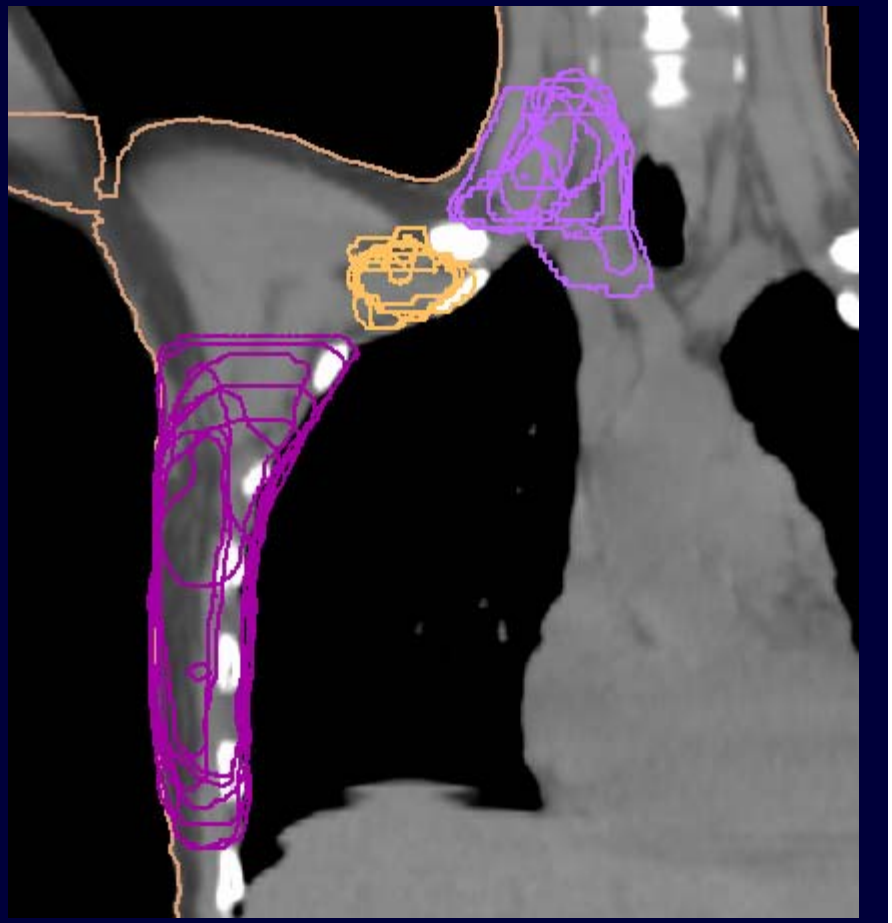
First Run

Second Run

Case C: Stage IIIA (T2N2M0), 4/18 LN+ Left Nodal and Breast RT



First Run

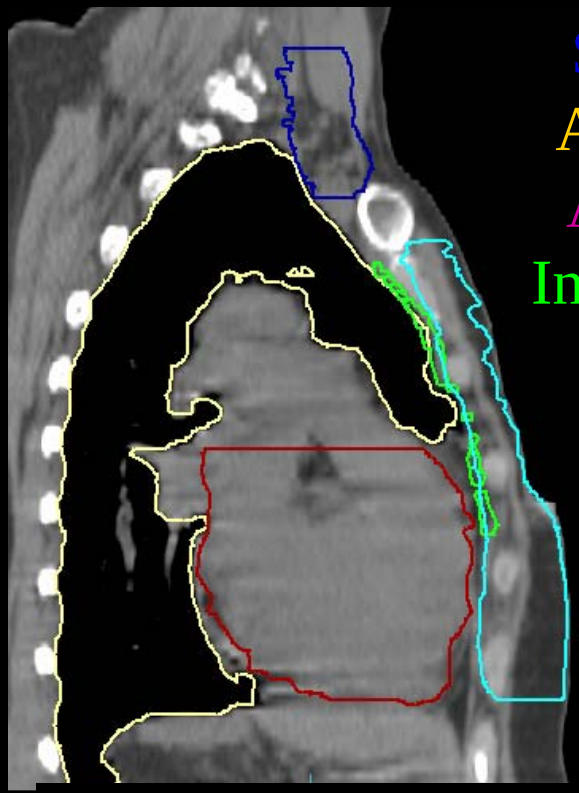


Second Run

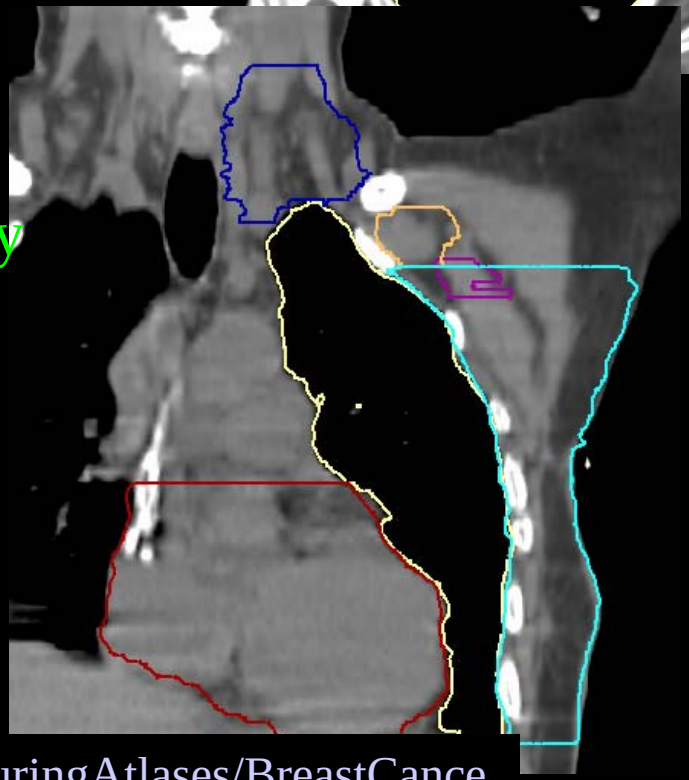
RTOG Breast Cancer Atlas

- Geometric Average (Example)
- Consensus Definitions

Case B:



Chestwall
Supraclavicular
Axillary level III
Axillary level II
Internal Mammary
Heart
Lung



http://http://http://www.rtog.org/CoreLab/ContouringAtlases/BreastCancerAtlas.aspx

Regional Nodal Contours: Anatomical Boundaries

	Cranial	*Caudal*	*Anterior*	*Posterior*	*Lateral*	*Medial*
Supra-clavicular	Caudal to the cricoid cartilage	Junction of brachioceph.-axillary vns./ caudal edge clavicle head [a]	Sternocleido mastoid (SCM) muscle (m.)	Anterior aspect of the scalene m.	Cranial: lateral edge of SCM m. Caudal: junction 1st rib-clavicle	Excludes thyroid and trachea
Axilla-Level I	Axillary vessels cross lateral edge of Pec. Minor m.	Pectoralis (Pec.) major muscle insert into ribs [b]	Plane defined by: anterior surface of Pec. Maj. m. and Lat. Dorsi m.	Anterior surface of subscapularis m.	Medial border of lat. dorsi m.	Lateral border of Pec. minor m.
Axilla-level II	Axillary vessels cross medial edge of Pec. Minor m.	Axillary vessels cross lateral edge of Pec. Minor m. [c]	Anterior surface Pec. Minor m.	Ribs and intercostal muscles	Lateral border of Pec. Minor m.	Medial border of Pec. Minor m.
Axilla-level III	Pec. Minor m. insert on cricoid	Axillary vessels cross medial edge of Pec. Minor m. [d.]	Posterior surface Pec. Major m.	Ribs and intercostal muscles	Medial border of Pec. Minor m.	Thoracic inlet
Internal mammary	Superior aspect of the medial 1st rib.	Cranial aspect of the 4th rib	- [e.]	- [e.]	- [e.]	- [e.]

Breast/ Chestwall Contour: Anatomical Boundaries

	Cranial	*Caudal*	*Anterior*	*Posterior*	*Lateral*	*Medial*
Breast	Clinical Reference + Second rib insertion[a]	Clinical reference + loss of CT apparent breast	Skin	Excludes pectoralis muscles, chestwall muscles, ribs	Clinical Reference + mid axillary line typically, excludes lattismus (Lat.) dorsi m. [b]	Sternal-rib junction [c]
Breast-Chestwall[2\]	Same	Same	Same	Includes pectoralis mucles, chestwall muscles, ribs	Same	Same
Chestwall[3]	Caudal border of the clavicle head	Clincial reference+ loss of CT apparent contralateral breast	Skin	Rib-pleural interface. (Includes pectoralis mucles, chestwall muscles, ribs)	Clinical Reference/ mid axillary line typically, excludes lattismus dorsi m [a]	Sternal-rib junction [b]

Nanoparticle-enhanced MRI To Evaluate Regional Lymphatics For Patients With Breast Cancer

- MGH: 23 patients
- LN-MRI: Lymphotrophic nanoparticle–enhanced MRI to identify benign versus malignant lymph nodes

→ No consistent relationship between malignant and/or benign lymph nodes and bony and/or vascular anatomy was determined.

MacDonald et al, IJROBP 77:2010

Red nodes: Metastatic
Green nodes: Benign

Nanoparticle-enhanced MRI To Evaluate Regional Lymphatics concordance with RTOG Contouring ATLAS

- Lymph node regions were contoured on CT according to RTOG guidelines
- % LN-MRI lymph nodes contained within these contours determined
- 86% of actual lymph nodes and 89% of sampled lymph nodes were within contoured RTOG consistent nodal volumes
- 99% of actual and sampled lymph nodes were included when a 5-mm expansion was added.

	Within contour	% Oustide contour
Malignant actual	82.40	17.60
Benign actual	87.70	12.30
Malignant sampled	85.50	14.50
Benign sampled	89.60	10.40
Total actual	86.30	13.70
Total sampled	88.60	11.40

MacDonald et al, IJROBP 77:2010

Contour Development and Clinical Trials

Year	Targets	Clinical Trial
2003 2005	• Lump CTV • Lump PTV • Lump PTV_eval	- RTOG 0319 - NSABP B39/RTOG 0413
2010	• Breast CTV • Breast PTV • Breast PTV_eval	- RTOG 1005
2013	• Chestwall CTV • Chestwall PTV • Chestwall PTV_eval • Axilla CTV • Axilla PTV • IMN CTV • IMN PTV • SCL CTV • SCL PTV	-NSABP B51/ RTOG 1304 - ALLIANCE A011202

NSABP B-39/RTOG 0413 Trial

Phase III

Stage 0, I-II breast cancer treated by lumpectomy

Randomization

WBI

- 50-50.4 Gy (1.8-2.0 Gy) Fractions to the whole breast followed by boost to 60 -66.6 Gy

APBI

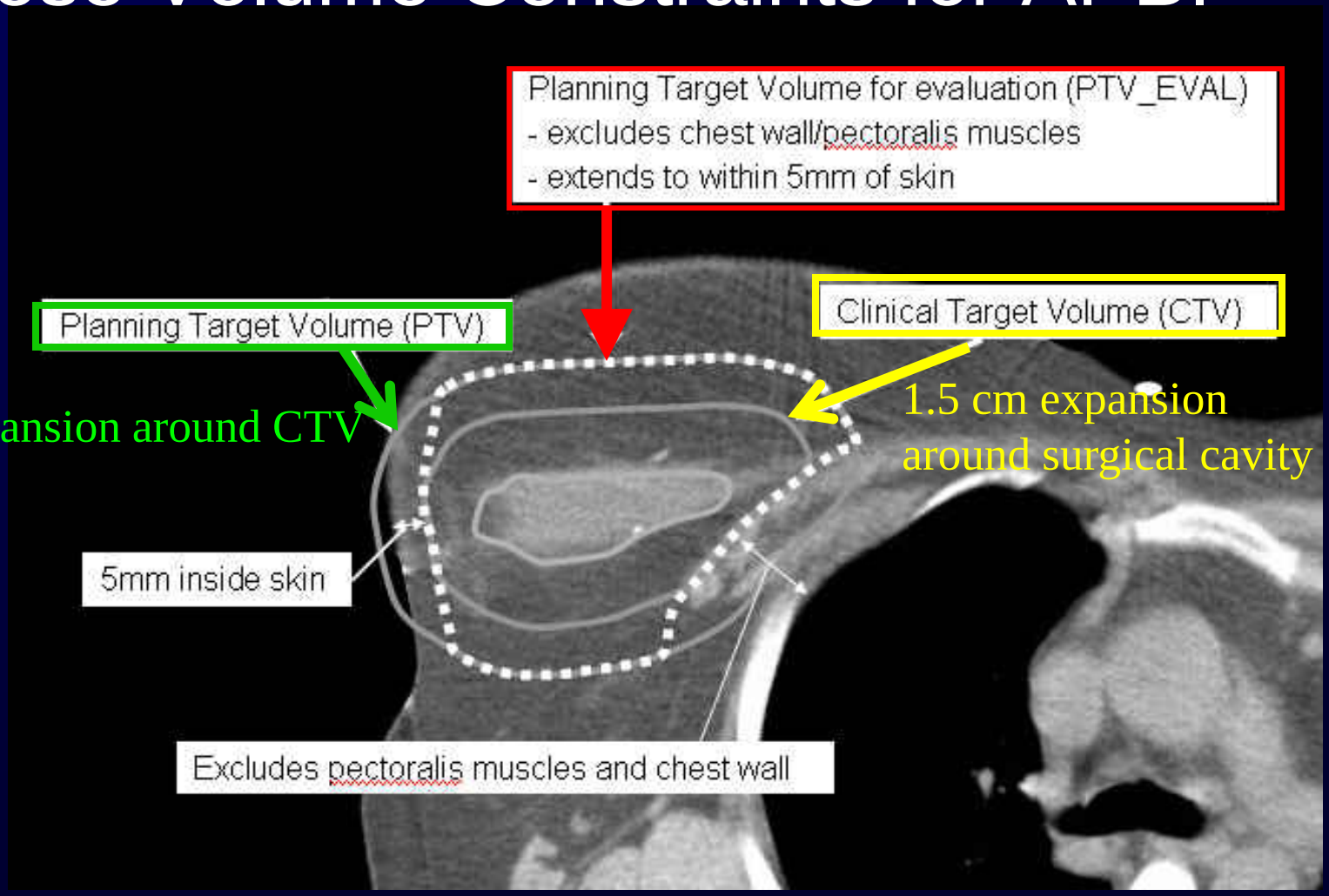
- 34 Gy in 3.4 Gy fxs bid Mammosite® , Contura, SAVI or Multicatheter brachytherapy

OR

- 38.5 Gy in 3.85 Gy fxs bid 3D-CRT

March 2005- April 2013 accrual = 4,216

NSABP B-39/RTOG 0413
Defined Lumpectomy Targets and Dose Volume Constraints for APBI



RTOG 1005

Phase III

STRATIFICATION:
Age: < 50 vs ≥ 50
Chemo: yes vs no
ER: + vs. -

"High risk" Stage 0, I-II, breast cancer treated by lumpectomy

Randomization

Standard WBI-Sequential boost

- WBI: 50 Gy (2.0 Gy)
  42.56 Gy (2.67 Gy)
- Boost: 12-14 Gy (2 Gy)
  22-33 Fractions

4.5-6.5 weeks

Hypofractionated WBI-Concomitant boost

- WB PTV: 40 Gy/ 2.7 Gy
- Lumpectomy PTV: 48 Gy/ 3.2 Gy

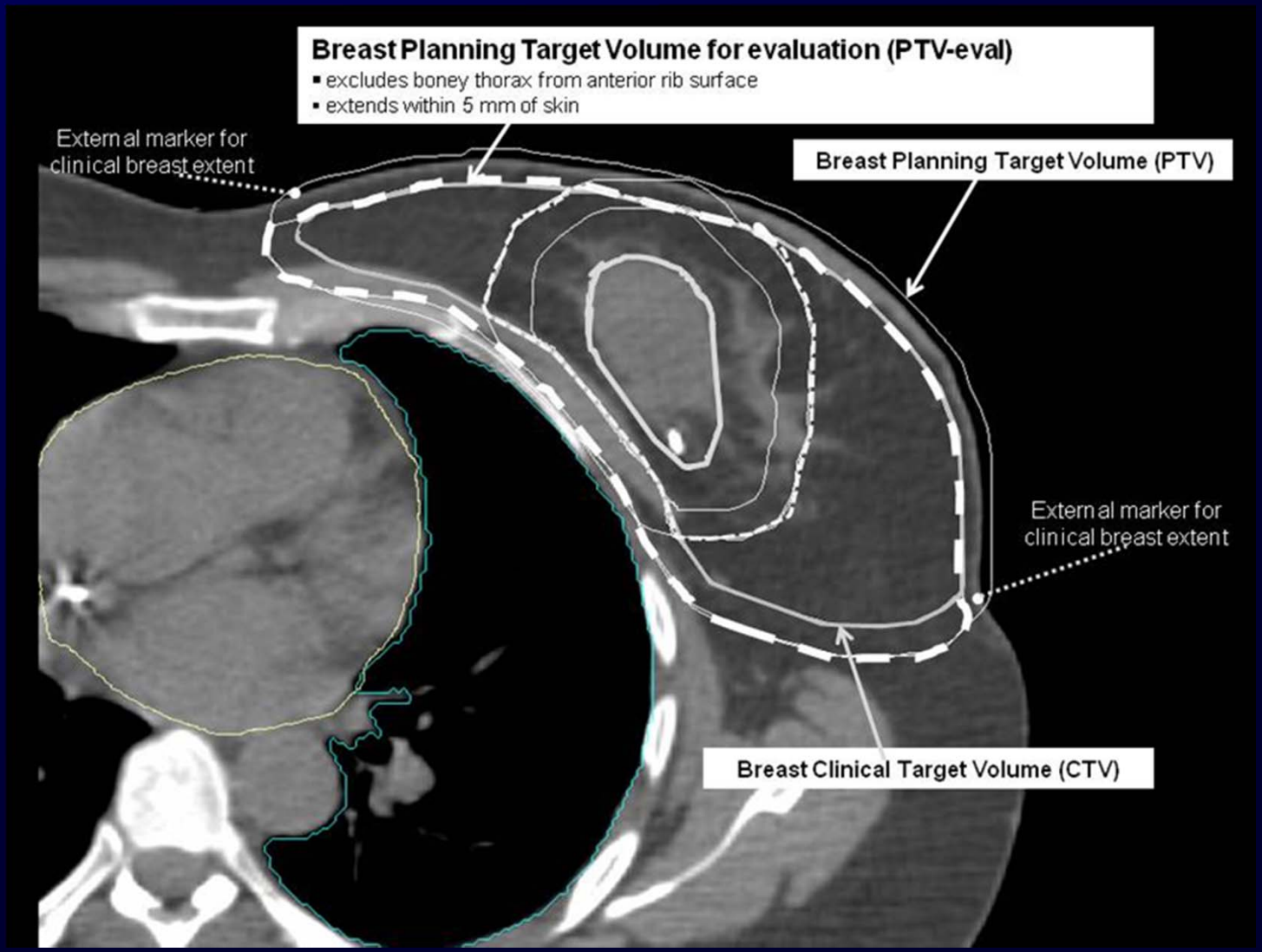
15 Fractions

3 weeks

Targeted accrual = 2312

Opened May 2011

RTOG 1005: Defined Breast Targets and Dose Volume Constraints



NSABP B-51/RTOG 1304 Trial Phase III

- Clinical T1-3N1M0 breast cancer
- Pathology positive axillary node (**FNA/Core**)
- Neoadjuvant CT ± anti HER2

ypN0 at definitive Breast Surgery + AND or SNB

Randomization

Arm 1

No Regional Nodal XRT

A. Lumpectomy: Breast XRT.
B. Mastectomy: Observation

Arm 2

Regional Nodal XRT

A. Lump.: Breast/Nodal XRT
B. Mast: Chestwall/ Nodal XRT

Targeted accrual = 1636

Opens8-2013

Stratification: Type of Surgery (Mast v. Lump) , ER-Status (+ v. –), HER2 Status (+ v. –), pCR in Breast (yes v. no)

Alliance A011202 Trial (select): Phase III

- Clinical T1-3N1M0 breast cancer
- Pathology positive axillary node (**FNA/Core**)
- Neoadjuvant CT ± anti HER2
- Surgery with sentinel lymph node biopsy

Positive Sentinel LN Identified

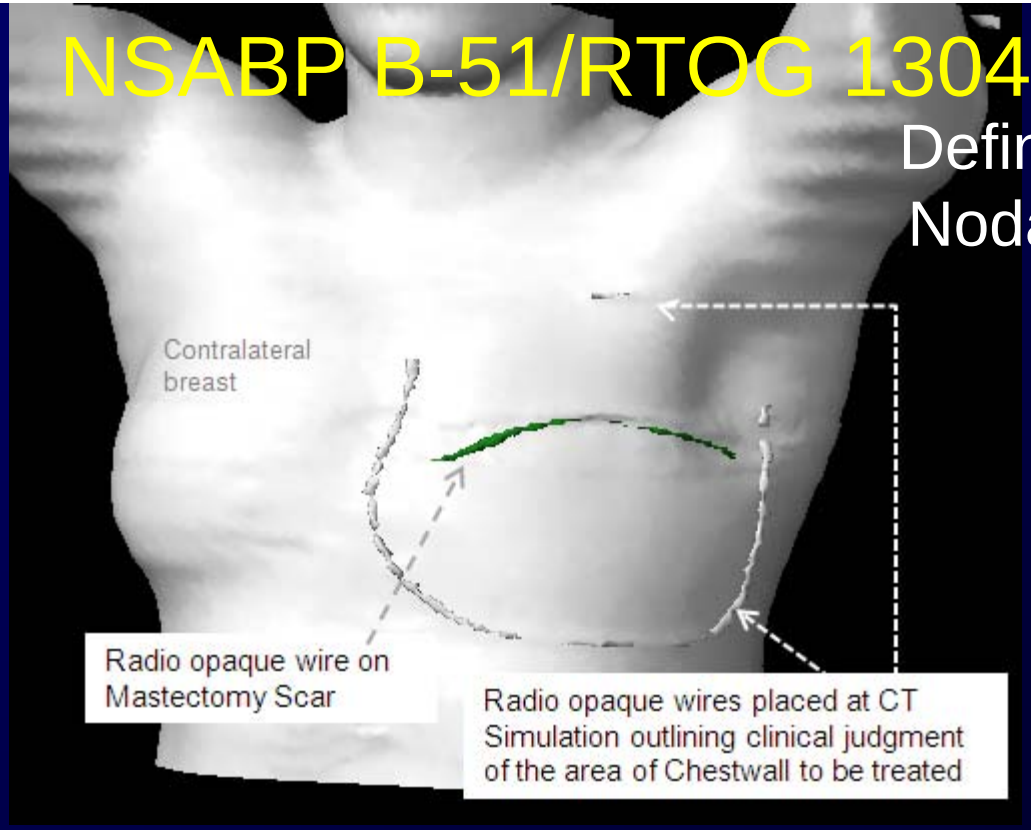
Intra OP Reg + Randomization

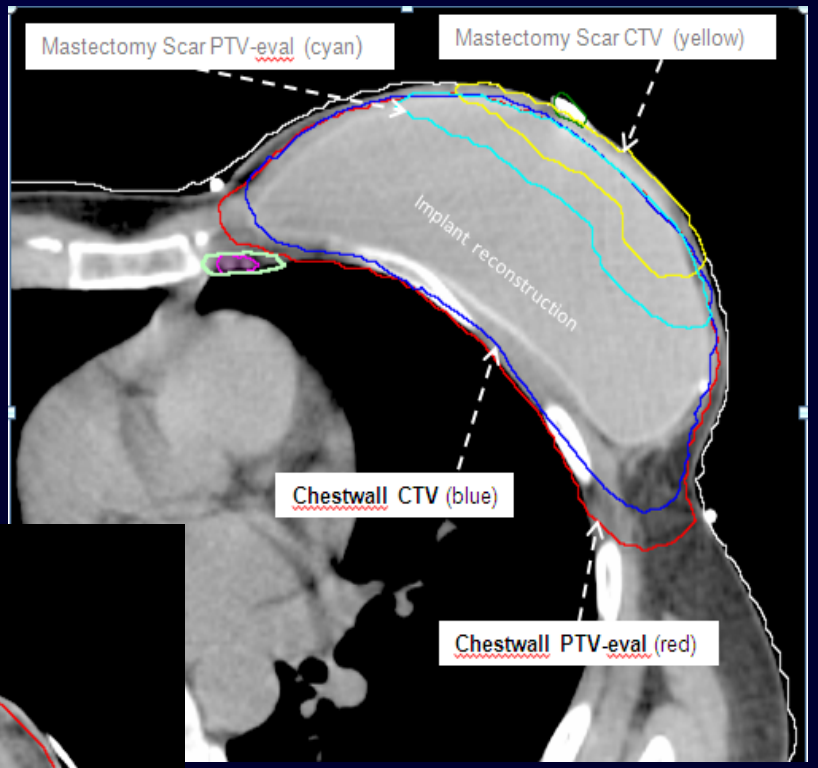
Arm 1	Arm 2
ALND + Nodal XRT	No ALND + Nodal XRT

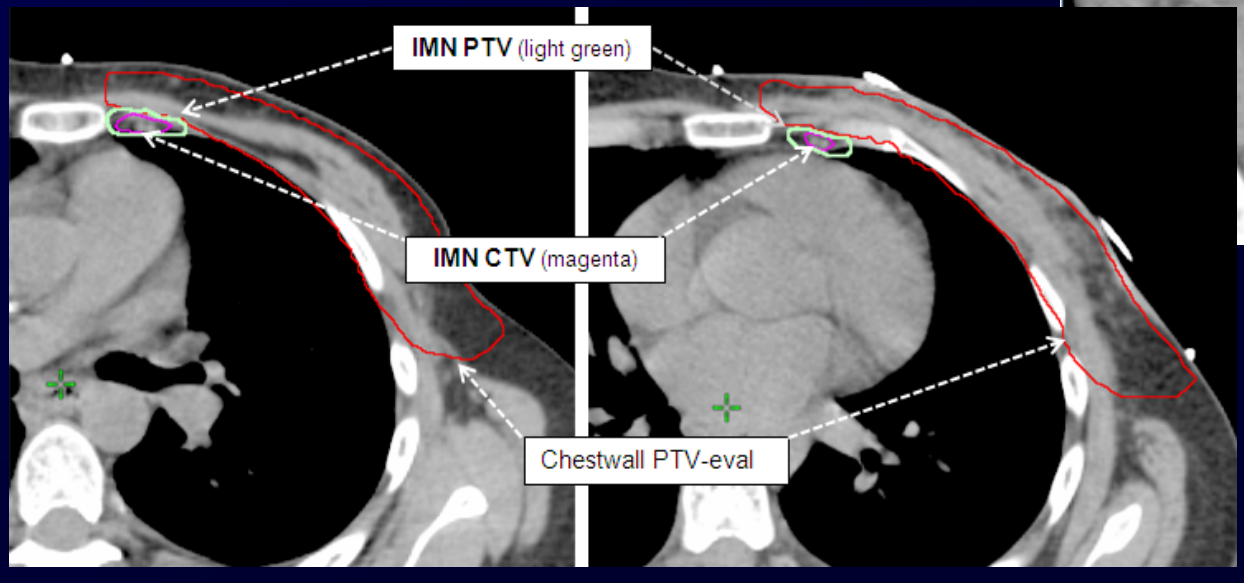
Targeted accrual = 1576

NSABP B-51/RTOG 1304

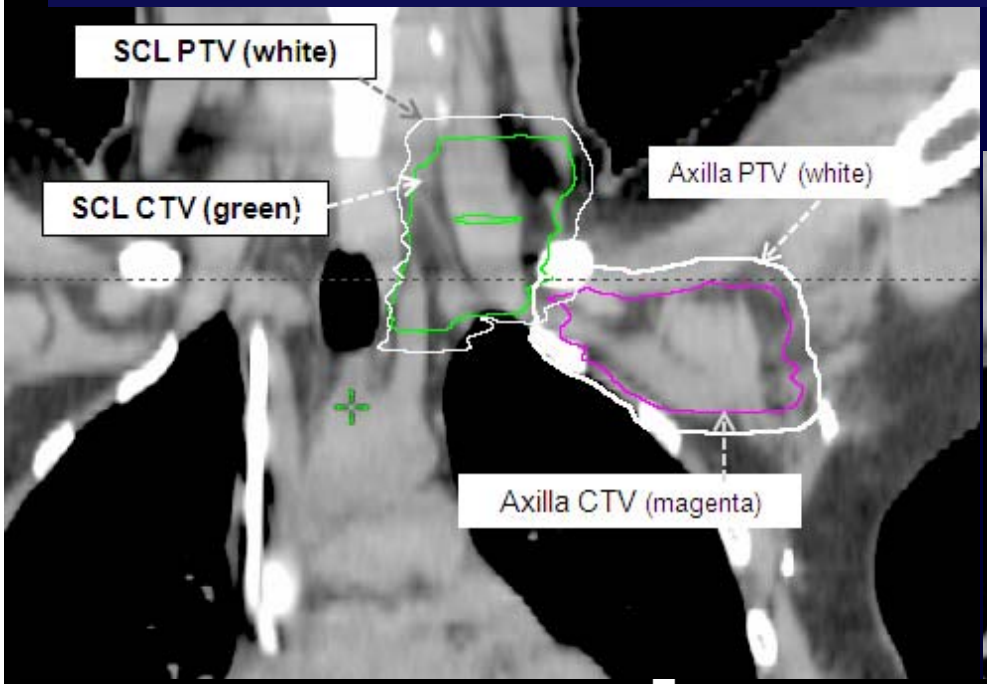
Defines Chest Wall And Regional Nodal Targets and Dose Volume Constraints

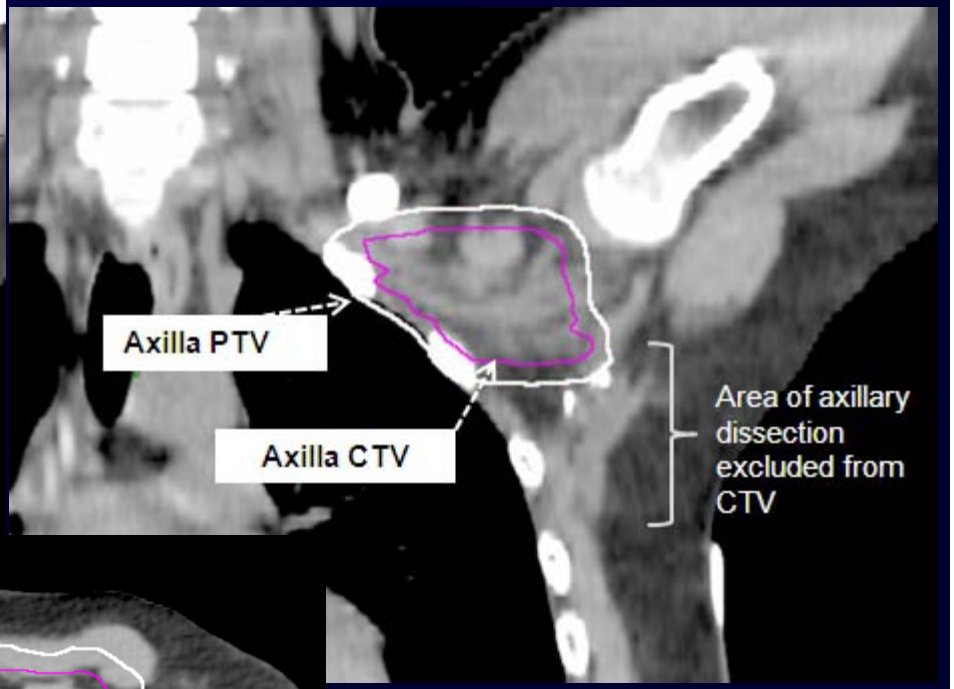


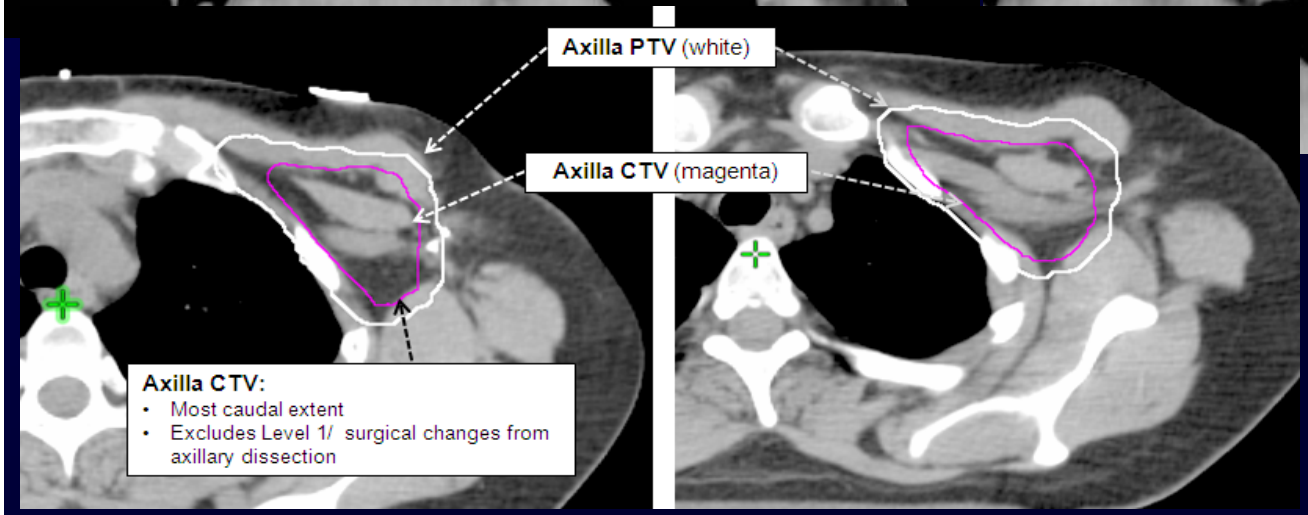




NSABP B-51/RTOG 1304: Contouring Appendix







Thank you!