Prone Intact Breast Treatment: The OSU Approach

Lee Culp, M.S. CMD, RT(T)
Karla Kuhn, CMD, RT(R)(T)

September 2016

The James

THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER

Creating a cancer-free world. One person, one discovery at a time.




Disclosures

- I have no disclosures relative to the presented material
- The following presentation is a reflection of studies, protocols, and opinions
- No Honorarium has been received in regards to the subsequent material
- Eclipse v.13.5

Meet the Speaker

- Lee Culp, M.S CMD RT(T)
- Dosimetrist at OSU - SSCBC
- Originally from Buffalo, NY
- Masters in Dosimetry from University of Wisconsin – La Crosse
- Therapy Degree at ECC
- Business & Communication BS from University at Buffalo

The James

The Ohio State University
Wexner Medical Center

Radiotherapy at OSU

- The “New” James Cancer Hospital
  - All sites except Breast
  - 7 Vaults
  - 1 PET/CT
  - 1 CT
  - 1 MRI
  - 1 HDR Unit
  - 1 Gamma Knife Unit
  - 13 Radiation Oncologists
  - 12 Radiation Physicists
  - 11 Medical Dosimetrists
  - 36 Radiation Therapists

The James

The Ohio State University
Wexner Medical Center

Radiotherapy at OSU

- SSCBC
  - All Breast and Breast mets
  - 2 Vaults
  - 1 CT
  - 4 Radiation Oncologists
  - 1-2 Radiation Physicists
  - 2 Medical Dosimetrists
  - 8 Radiation Therapists
  - 3 Nurses

The James

The Ohio State University
Wexner Medical Center

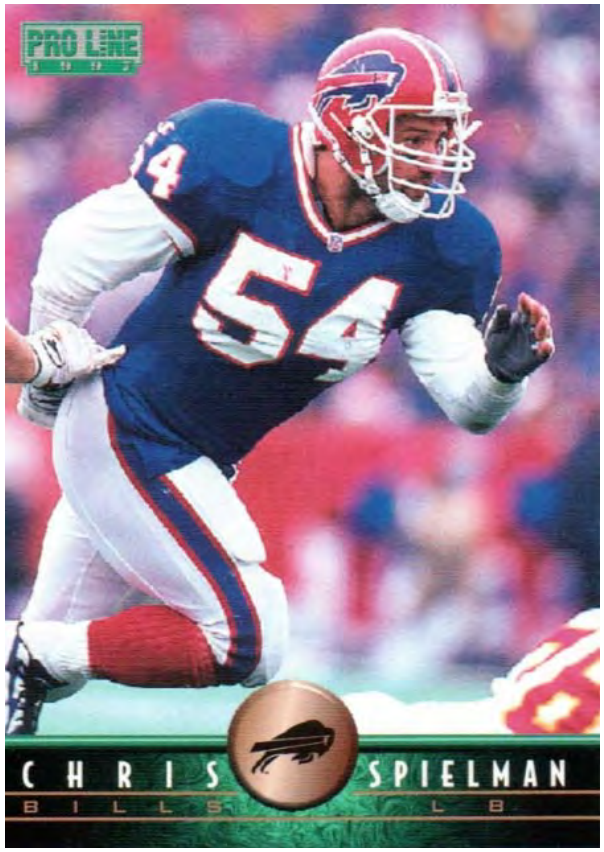
Our Clinic

The Stefanie Spielman Comprehensive Breast Center (SSCBC) at the Ohio State University

Opened in January 2011

The James
THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER

SSCBC – Stefanie Spielman Comprehensive Breast Center



1996-1997

The James
The Ohio State University
Wexner Medical Center

Evolution of Breast Planning

Supine 2D – The Past

- Done by Simulator
- Borders marked visually by MD with wire
- Used borders to indicate field size using half-beam blocked technique
- Gantry angle chosen from crossing of medial and lateral wires
- Standard of 2 cm of lung treated
- Used mobile contour plotter to achieve a 2D treatment plan

Evolution of Breast Planning at SSCBC

3D – The Present

- Free Breathing → DIBH → Prone
- Done by CT Simulator
- Border is marked visually by MD with wires to use as a guide when contouring
- Dosimetrist contours Organs at Risk; MD contours target volumes
- Dosimetrist utilizes all 3D tools: Conformal, and if necessary, IMRT planning to achieve our Dosimetric goals

Evolution of Breast Planning (cont'd)

- Post-Op External Beam Partial Breast Irradiation
- IORT & HDR Partial Breast Irradiation

The Future of Breast Planning:

Protocol OSU 13282 – Feasibility of assessing Radiation Response with MRI/CT Directed Pre-Op Accelerated Partial Breast Irradiation in the Prone Position for Hormone Response early stage Breast Cancer

Indications for Prone Breast Radiotherapy

- Patients with larger and/or pendulous breasts to reduce the toxicity and improve breast appearance long term
- Left sided breast cancer patients to avoid the heart & lung
- Small Breast benefits due to decrease in lung dose
- Cases where maximal lung avoidance is desirable such as smokers, severe COPD

- Approximately 60% of patients at SSCBC undergoing post-lumpectomy breast radiotherapy are treated in prone position

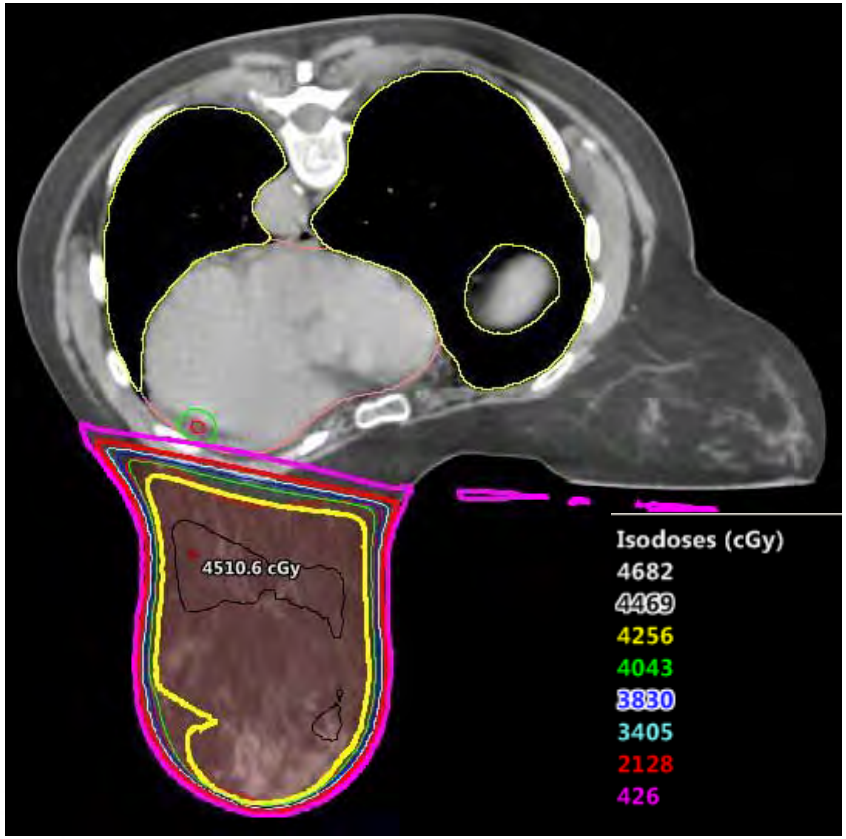
Expertise in prone WBRT varies widely between institutions, resulting in mixed findings regarding the degree of heart sparing with this technique[3,4]

[3] Kirby et al. *Radiother Oncol* 96: 178-84, 2010.
[4] Bartlett et al. *Radiother Oncol* 114: 66-72, 2015

The James
The Ohio State University
Wexner Medical Center

Indications for Prone Breast Radiotherapy (Cont'd)

- Better dose homogeneity due to smaller separation
- Reduces skinfolds
- Distances the breast from the chestwall
- Reduction in chestwall Motion



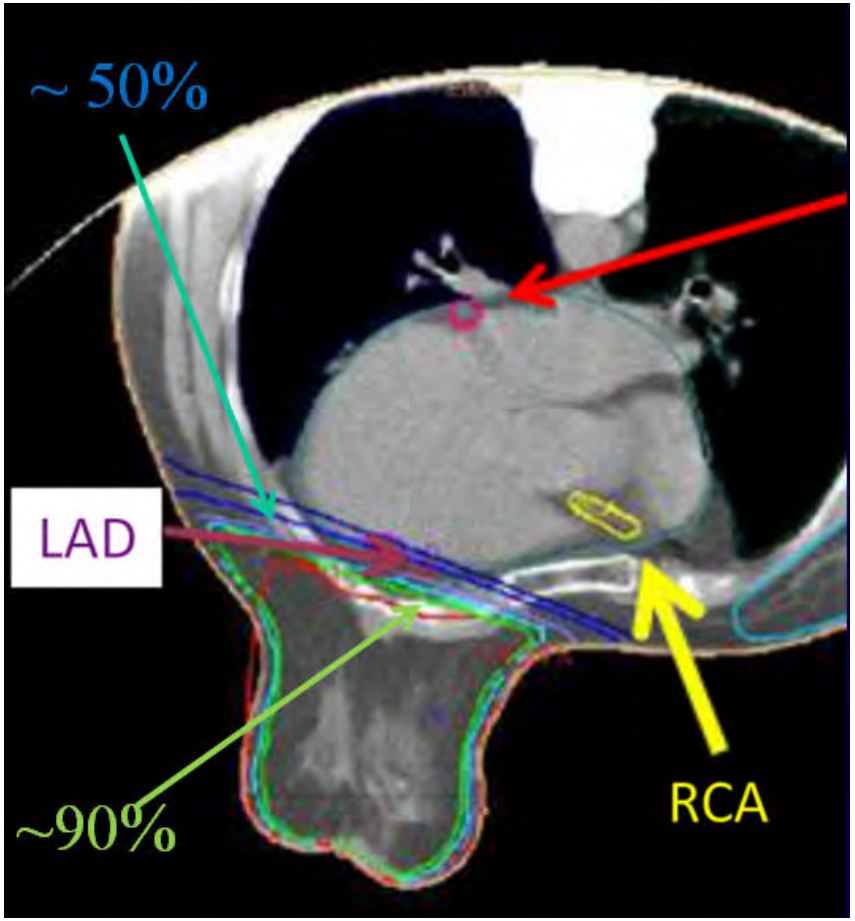
However, WBRT has also been associated with excess non-breast cancer mortality, predominantly related to ischemic cardiac disease*

[5] EBCTCG. *Lancet* 378(9804): 1707-16, 2011.

The James
The Ohio State University
Wexner Medical Center

Incidental Dose to Coronary Arteries is Higher in Prone Than in Supine Whole Breast Irradiation

- n = 46
- WBI – Field-in-field (5-6)
  - WB dose: 50.4 Gy/1.8 Gy/28 fx
  - boost: supine
- Left Anterior Descending Artery (LAD) dose:
  - V20 & V40 significantly higher in the prone position versus supine



[6] Wurschmidt et al, *Strahlenther Onkol* 2014 Aug;190(8):777

Retrospective SSCBC study on the Learning Curve in Cardiac Sparing with Prone left Whole Breast Radiotherapy

- Patient population: women diagnosed with stage I-II invasive carcinoma or DCIS of the left breast who received WBRT in the prone position post-lumpectomy

a) Cohort 1: first 20 patients treated consecutively beginning in January 2014

b) Cohort 2: last consecutive 20 patients treated prior to August 2015

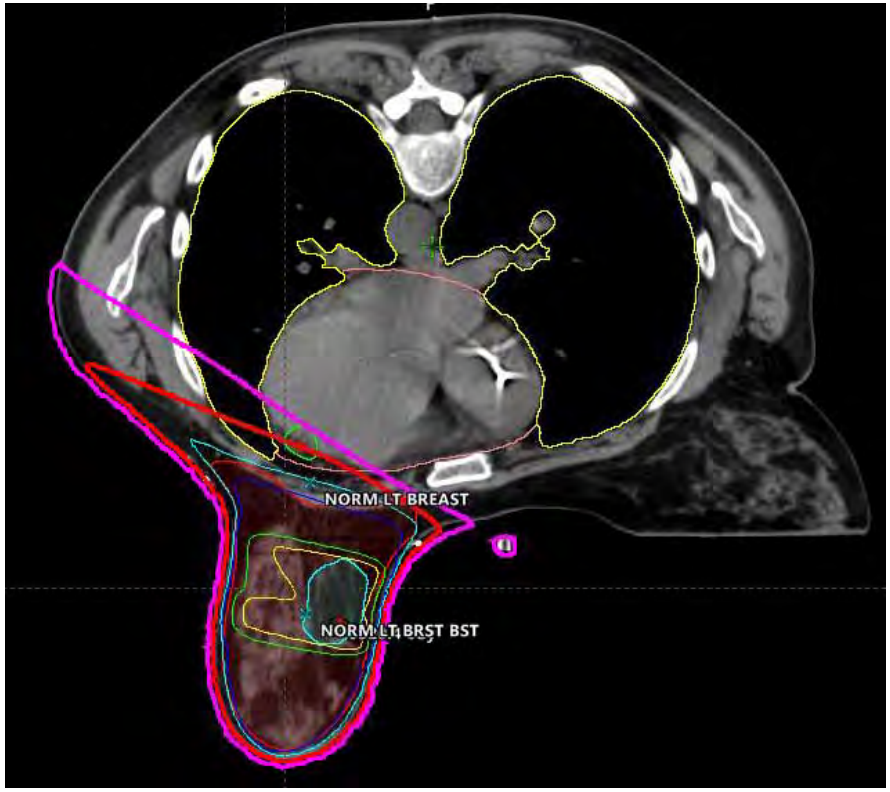
- Breast and lumpectomy target volumes, heart, and lungs contoured following CT simulation
- LAD contoured retrospectively on each case

Results	Cohort 1	Cohort 2	p-value
Mean Heart Dose (Gy)	1.5	1.1	0.007
Mean LAD Dose (Gy)	9.6	5.5	0.01
Mean Lung Dose (Gy)	5.0	3.8	0.12
Ipsilateral Lung V(20) (%)	0.29	0.18	0.43

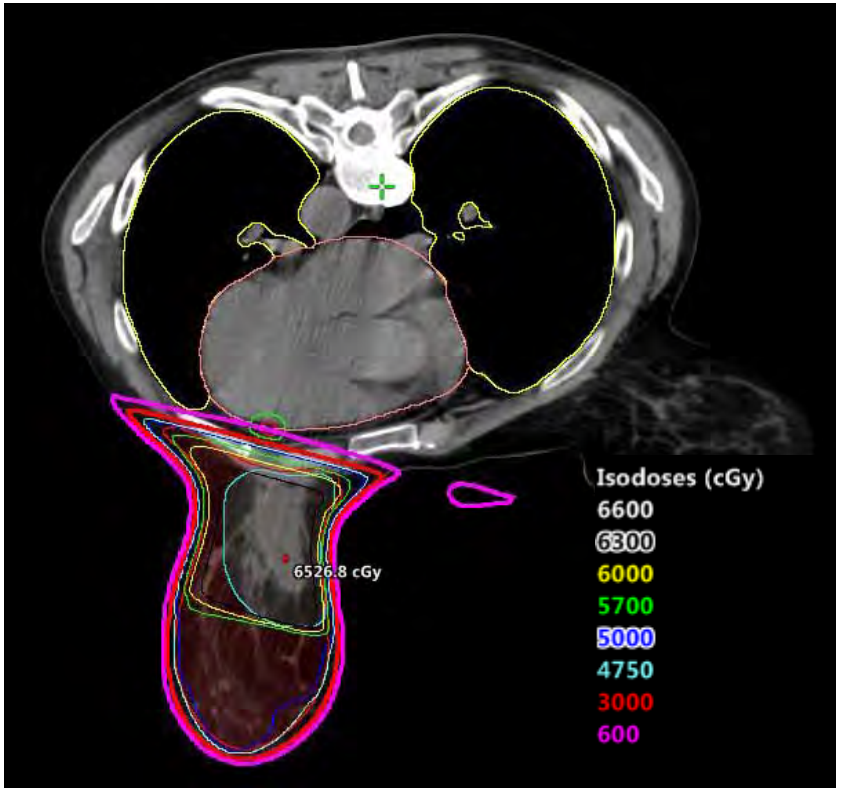
The James

The Ohio State University
Wexner Medical Center

Cohort 1



Cohort 2



Stage IA (pT1cN0) ER+/PR+/Her2- G1 IDC
BMI = 31
Breast PTV (cm^3) = 710
Dose: 50 Gy + 10 Gy boost

The James
The Ohio State University
Wexner Medical Center

RTOG 1005 & 1304; Organs at Risk

- Heart
- Left Lung
- Right Lung
- Contralateral Breast
- Sternum
- Thyroid

RTOG 1005 & 1304; Expansions & Evals

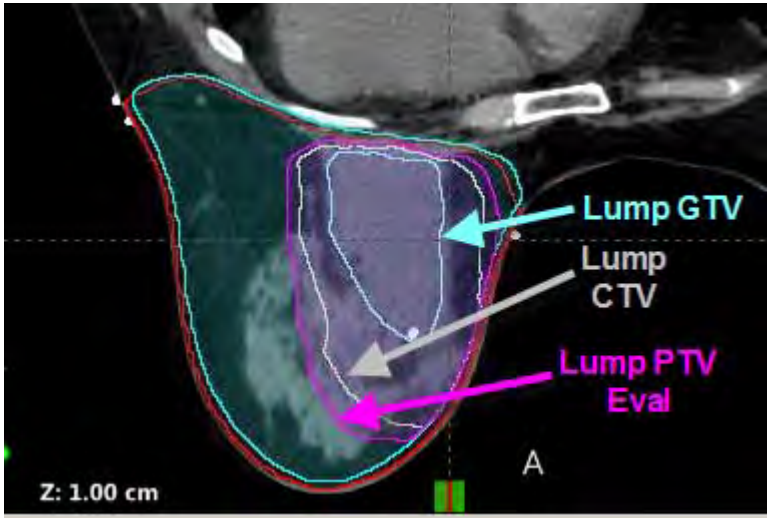
- Breast CTV – Includes palpable breast tissue demarcated with radio-opaque markers at CT simulation, the apparent CT glandular breast tissue visualized by CT, consensus definitions of anatomical borders, and the Lumpectomy CTV from the breast cancer atlas.
- Breast PTV – Breast CTV + 7mm 3D expansion (exclude heart and does not cross midline)
- Breast PTV Eval – Edited copy of Breast PTV limited anteriorly to exclude the part outside the patient and the first 5 mm of tissue under the skin and posteriorly is limited no deeper to the anterior surface of the ribs

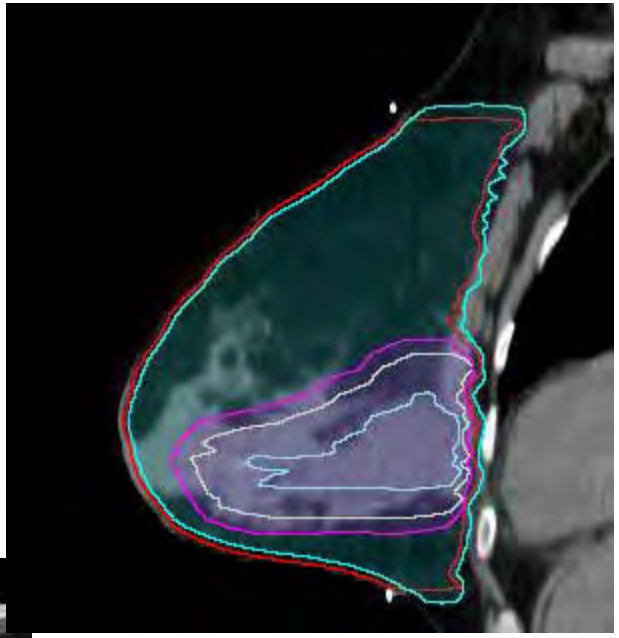
*In Prone (and Supine DIBH) at SSCBC the CTV to PTV expansion is reduced to 5mm due to limited chestwall motion

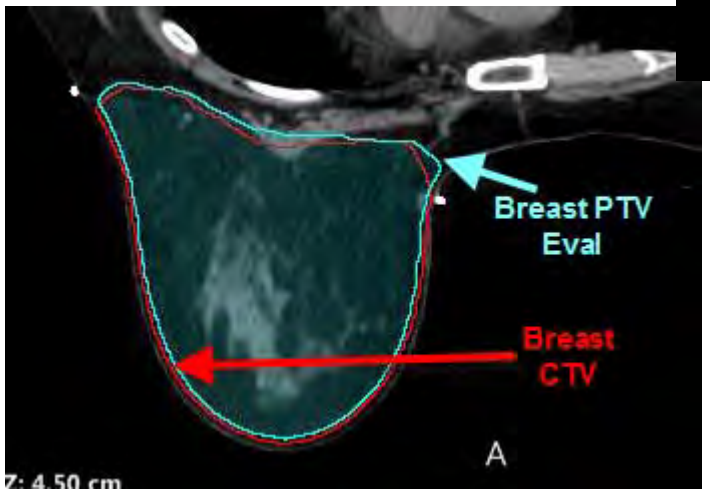
RTOG 1005 & 1304; Expansions & Evals

- Lumpectomy GTV – Includes excision cavity volume, architectural distortion, lumpectomy scar, seroma and/or extent of surgical clips
- Lumpectomy CTV – Lump GTV + 1cm 3D expansion
- Lumpectomy PTV – Lump CTV + 7mm 3D expansion (excludes heart)
- Lump PTV Eval – Copy of Lump PTV which is edited. Limited to exclude the part outside the ipsilateral breast and the first 5mm of tissue under the skin.

Targets Contoured:







The James

The Ohio State University
Wexner Medical Center

Constraints & Goals

RTOG 1005 & 1304

	Ideal	Acceptable
Breast PTV Eval	95%/95%	90%/90%
Lump PTV Eval	95%/95%	90%/90%
50% Breast PTV Eval	<108%	<112%
VBreast Receiving Boost Dose	30%	35%
Heart Mean	<400cGy	<500cGy
Lung V20	15%	20%
Contra Breast Max	<300cGy	<330cGy

SSCBC

	Ideal	Acceptable
Breast PTV Eval	95%/95%	90%/90%
Lump PTV Eval	100%/100%	100%/95%
50% Breast PTV Eval	<108%	<112%
VBreast Receiving Boost Dose	30%	35%
Heart Mean	<200cGy	<200cGy
Lung V20	10%	15%
Contra Breast Max	<300cGy	<330cGy

*Boost (when indicated) & Whole Breast planned simultaneously in Prone Position. Constraints & Goals evaluated in Plan Sum.

To Boost, or Not to Boost?

Guidelines for SSCBC Boost:

- Any Stage
- No Lymph Nodal Involvement
- Hormone Receptor positive
- <50+ years old
- No prior chemotherapy

Hypofractionated/Canadian Fractionation

- SSCBC Guidelines for Hypofractionation
- Stage 1 or 2
- No Lymph Nodal Involvement
- Hormone Receptor positive
- 60+ years (sometimes women 50+ years)
- No prior chemotherapy

Standard Fractionation
2.0Gy * 25 FX = 50.0 Gy

VS.

Hypofractionated Prescription:
2.66Gy * 16 FX = 42.56Gy

The James
The Ohio State University
Wexner Medical Center

Prone with Boost

- Boost is planned at time of Initial plan
- Boost is in Prone position as well
- Plan evaluated in Plan Sum
- Ski slope
- V54

  108% dose <

  50% volume
- “Simultaneous Boost”

  hotspot placed in the

  Lump PTV Eval

Boost is planned & treated Prone as well

The James

The Ohio State University

Wexner Medical Center

Dr. White original Breast Board – The Past

Evolution of SSCBC
Breast Board

The James

The Ohio State University
Wexner Medical Center

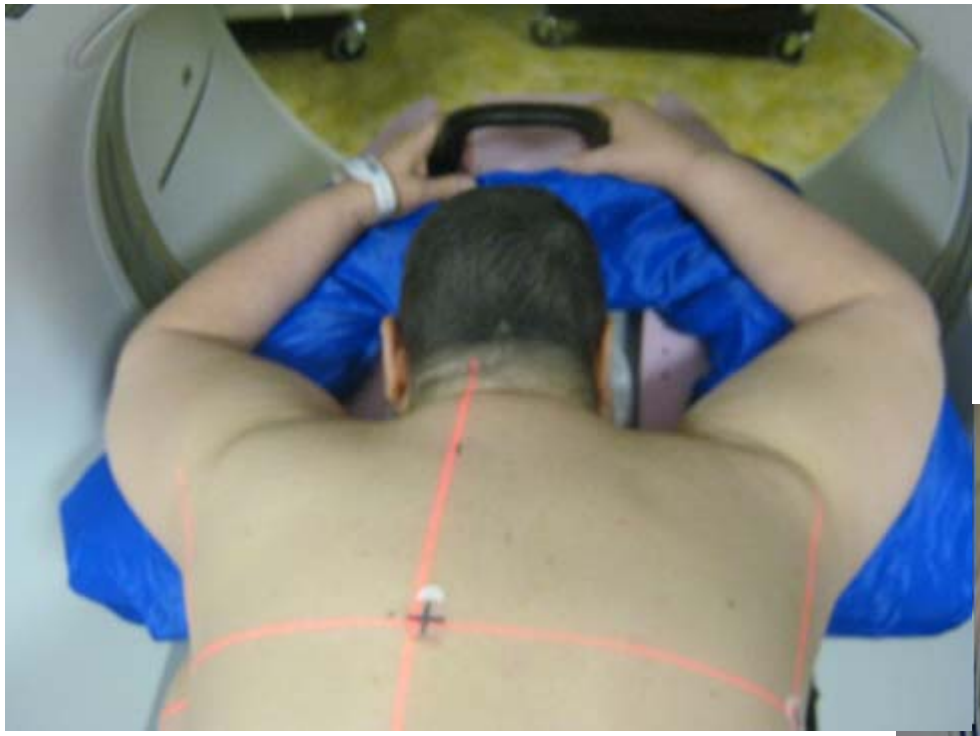
Vendor Manufactured Breast Board v.1 - The Present

Extra mobilization devices are used for patient comfort

The James

The Ohio State University
Wexner Medical Center

Face Down Option



The James

The Ohio State University
Wexner Medical Center

Vendor Manufactured Breast Board v.2 (Access 360) – The Future

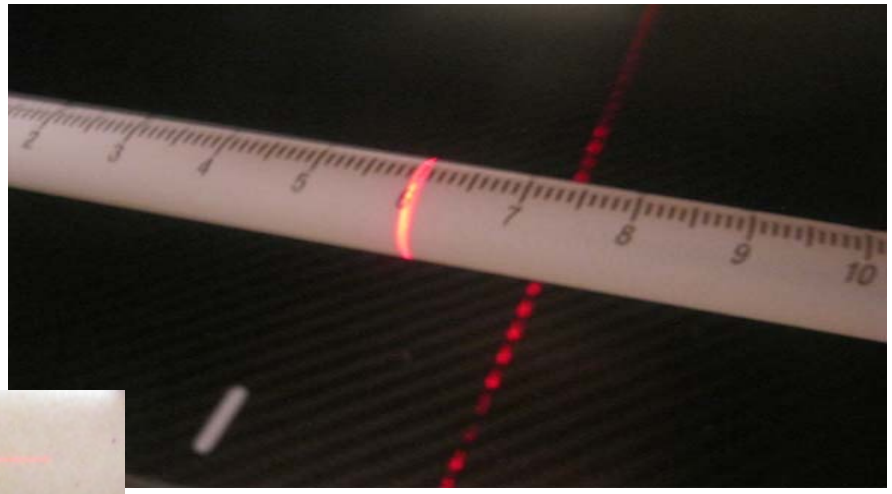
Custom designed by Manufacturer for SSCBC

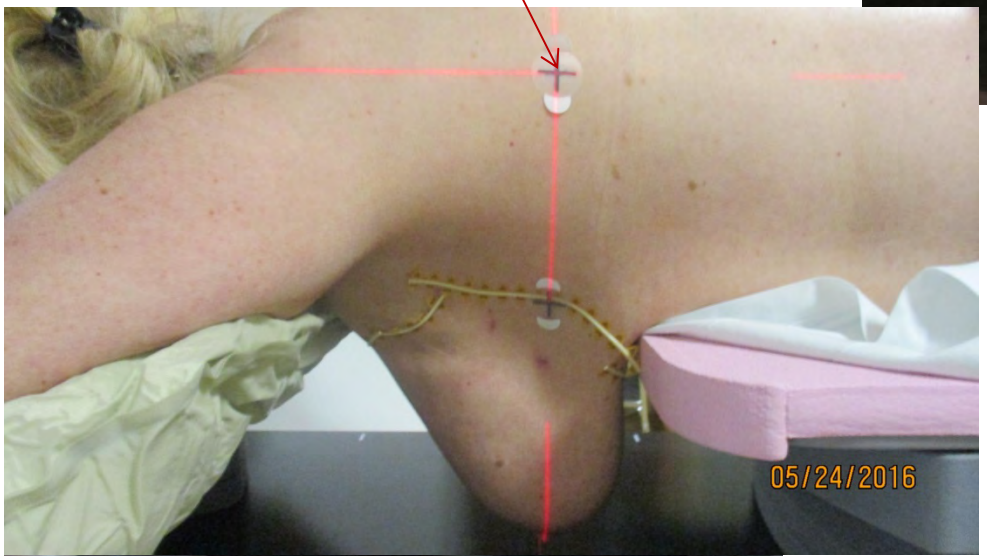
CT Prone Positioning

- Index Immobilization
- MD wires Lumpectomy scar & Breast Borders
- Patient starts low on hands & knees before laying down. Inframammary fold should fall just above the inferior opening of the insert
- Smoothing of the belly tissue may be needed
- Elbows bent in Vac-bag to ensure arm reproducibility & comfort. Location of headrest is marked
- Contra breast should be gently pulled “down & out” and rest on the sternal sponge
- Head turned toward the contra side
- Back should be as flat as possible with shoulders relaxed

5 Tattoos

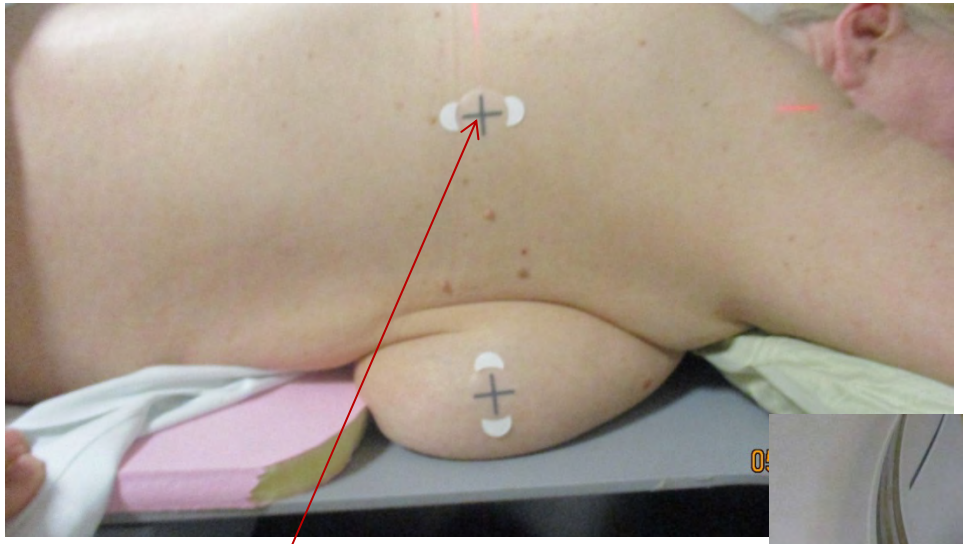
Ipsilateral Tattoo





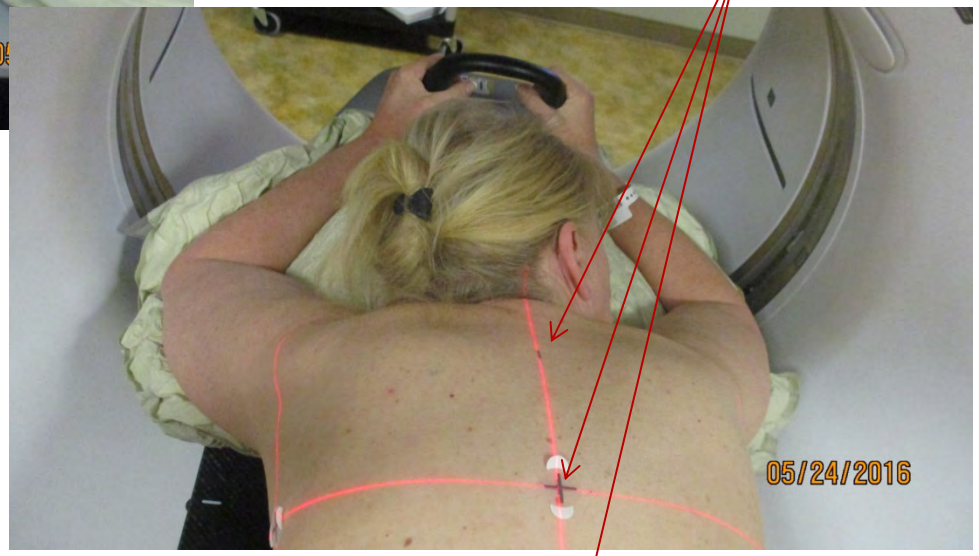
Board number on index bar in line with mid-nipple or other designated breast mark

5 Tattoos (cont'd)



Contralateral Tattoo

3 PA Tattoos

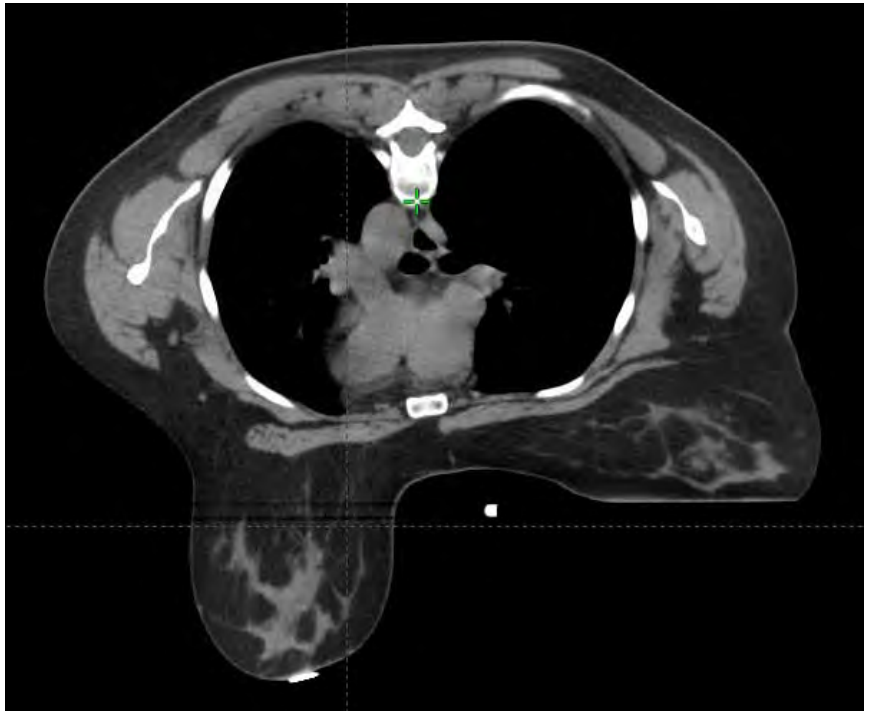


The James

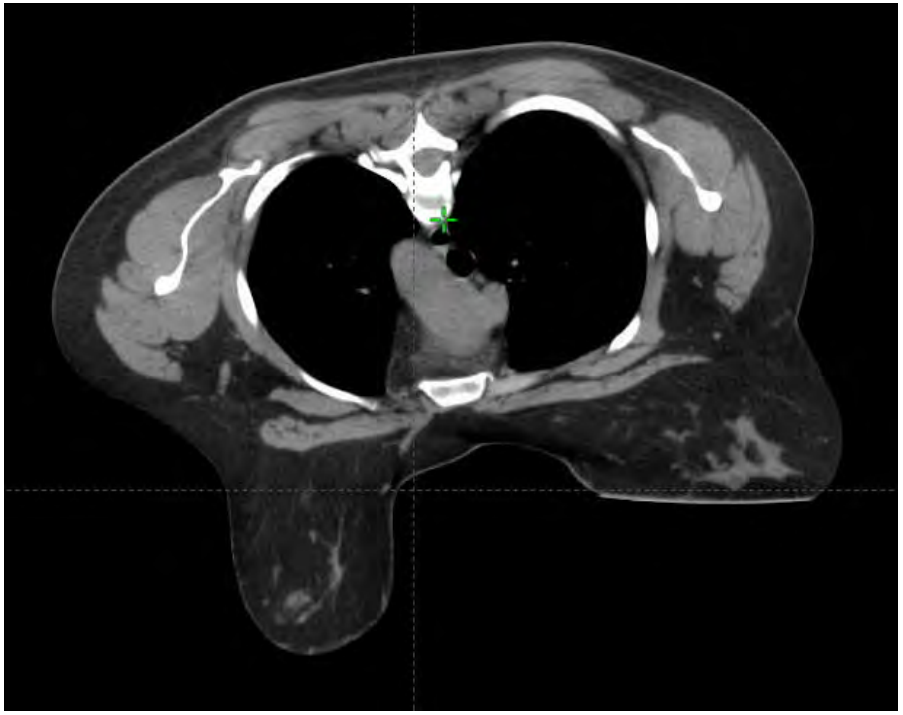
THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER

CT Setup: Ideal VS. Not

Ideal



Not

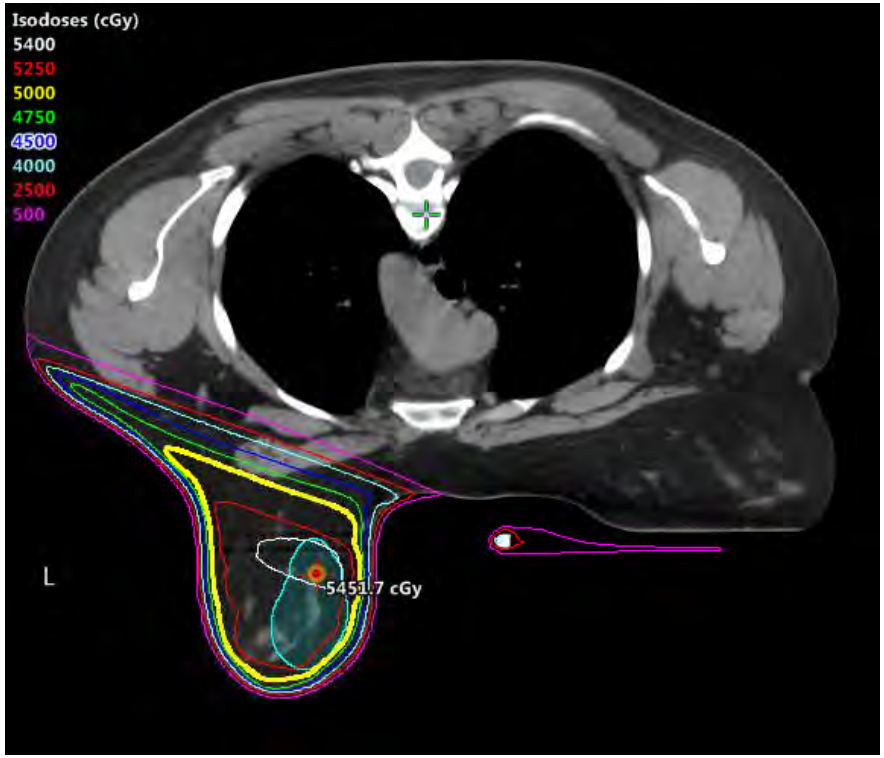


The James

The Ohio State University
Wexner Medical Center

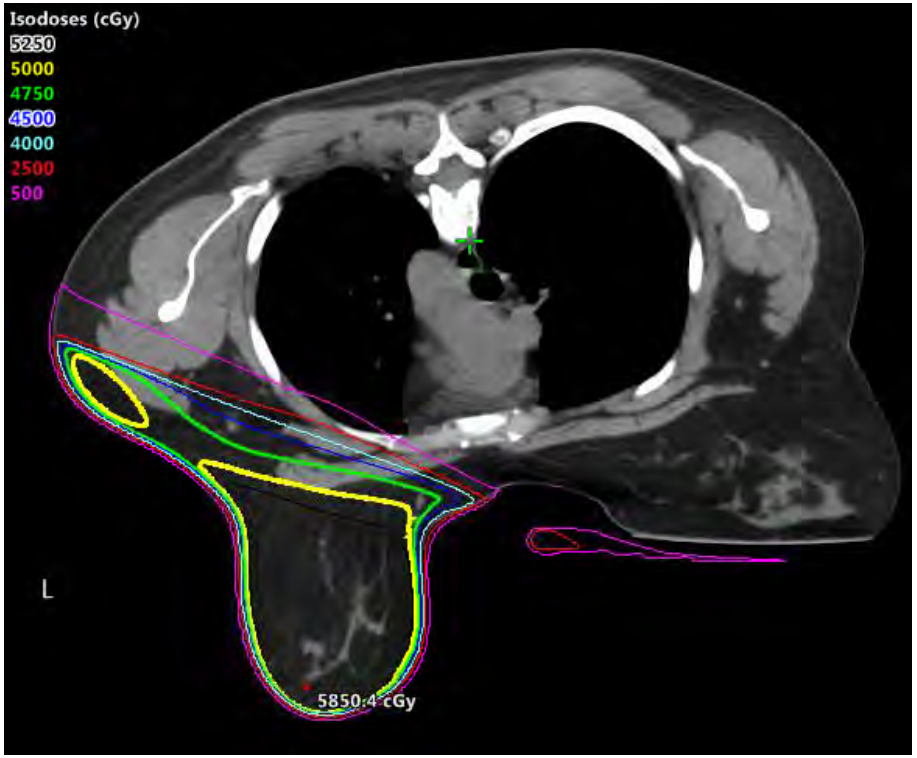
Plan from CT Setup: Ideal VS. Not

Ideal



Heart Max: 1039.8
Heart Mean: 96.1

Not



Heart Max: 4493.4
Heart Mean: 304.9

The James

The Ohio State University
Wexner Medical Center

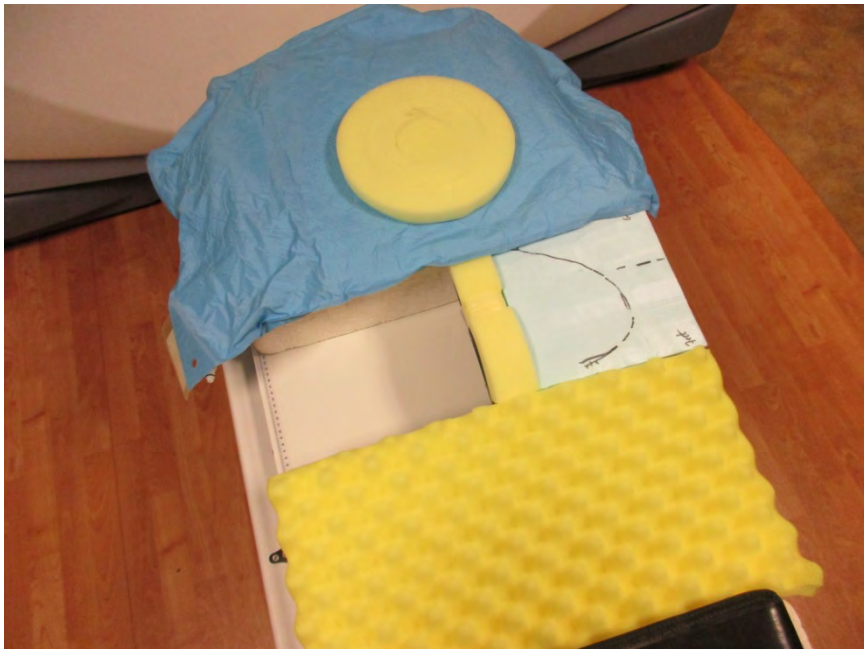
Belly Board Technique

Egg crate opening reduces pressure to the abdomen

The James

The Ohio State University
Wexner Medical Center

Custom Styrofoam Insert



- May be used to keep contralateral breast out of treatment field
- Contralateral breast is marked on Styrofoam insert
- Used when necessary

Improves set-up of contralateral breast
Also reduction in roll of patient

The James
The Ohio State University
Wexner Medical Center

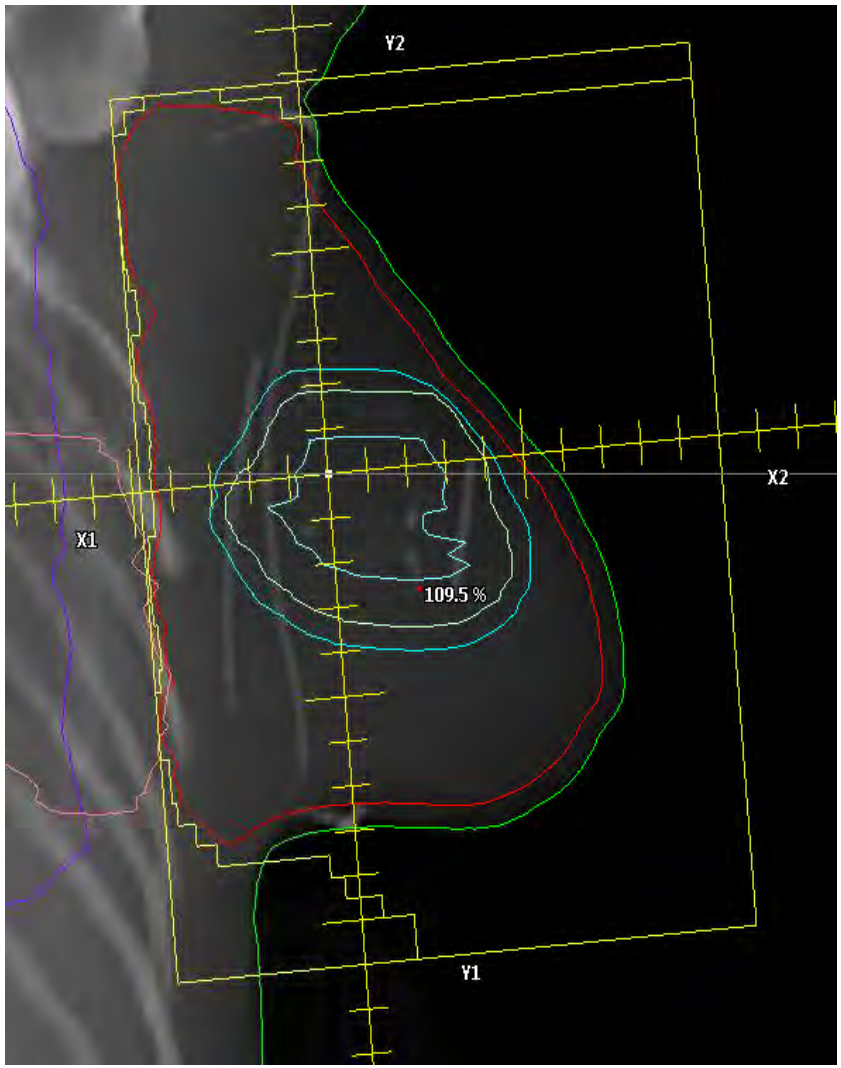
Prone Breast Planning

- Posterior Oblique Field (#1)
- Each angle for each patient different
  - Not True tangents
    - Slight divergence
- Medial field edge at least ~1cm from contra breast
- Include minimal heart
- 2-3cm of Flash (ANT & INF)
- MLC's brought up to PTV Eval edge

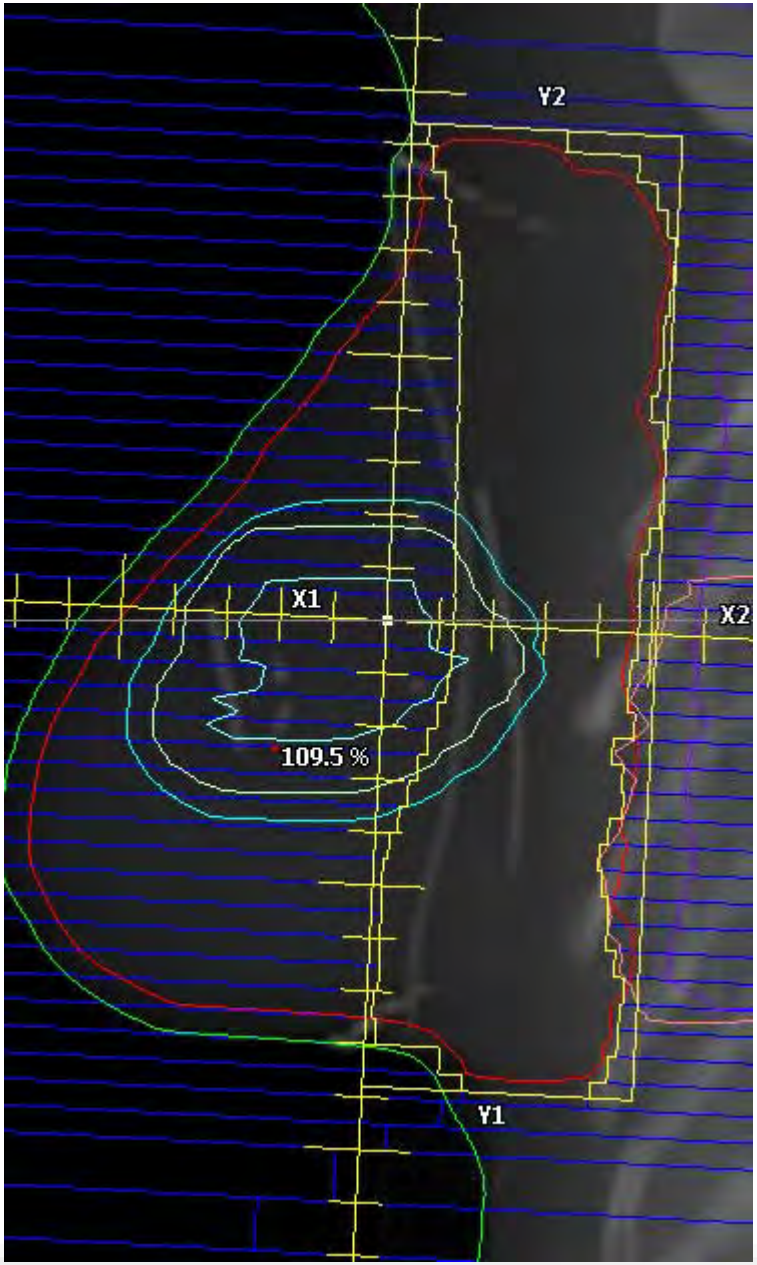
The James

The Ohio State University
Wexner Medical Center

Prone Breast Planning



- Anterior Oblique Field (#2)
- Each angle for each patient different
- Collimator angle adjusted to use primary jaw with limited MLC leakage
- Medial field edge at least 2cm from contra breast
  - Minimizes contra breast dose
- Include minimal heart
- 2-3cm of Flash (ANT & INF)
- MLC's brought up to PTV Eval edge



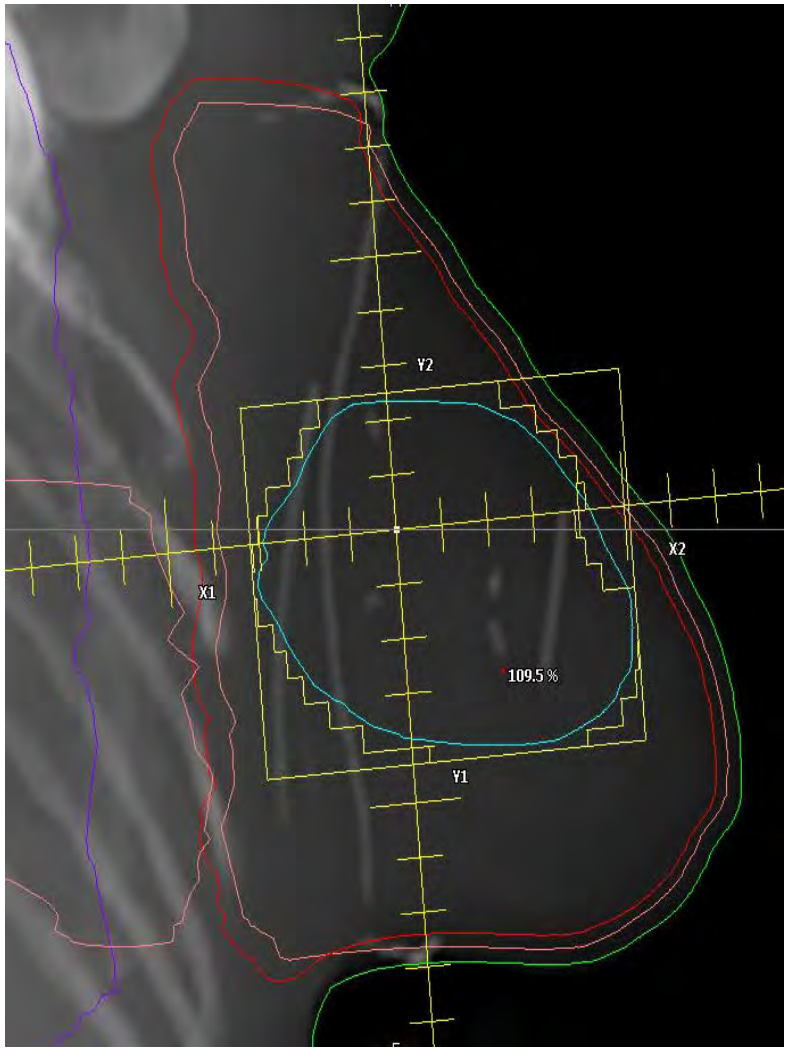
Prone Breast Planning

- Reduced fields (2-3)
- Begin with side opposite Lumpectomy site. Use High Energy
- Block out 108-110%, depending on coverage
- Block heart in Reduced Fields
- Close Jaws down

The James

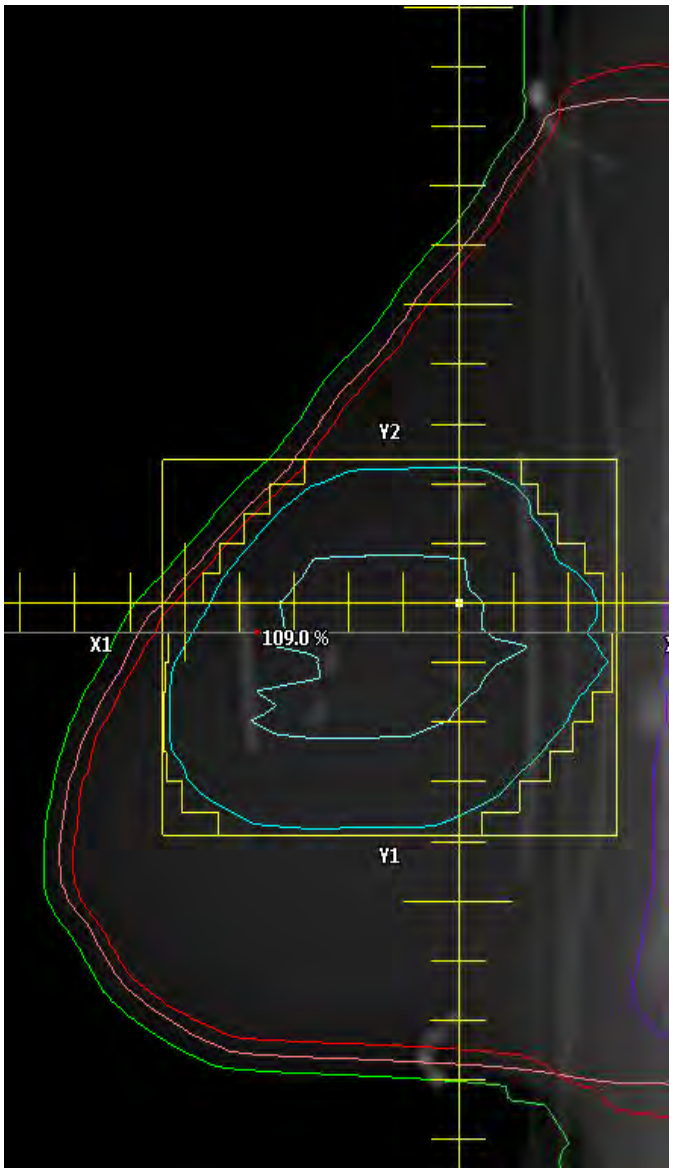
The Ohio State University
Wexner Medical Center

Prone Breast Planning

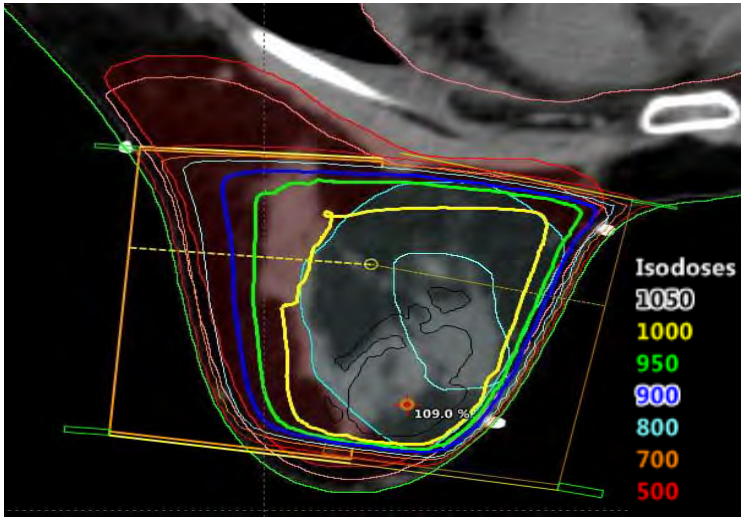


- Reduced fields (cont'd)
- Side with Lumpectomy cavity, use Low Energy
- Trick to getting the hotspot in the Lump cavity, as well as the 105% around the lumpectomy site, is to add a reduced field just around the lumpectomy.
- Reduced fields receiving at least 3% weighting

Prone Boost Breast Planning



- 1-2 Fields
- Place beams avoiding contra Breast and heart
- Again, Slight divergence
- Shape MLCs to the Lumpectomy edge, 2cm flash on skin surface may be necessary if lump is at skin surface



The James

The Ohio State University
Wexner Medical Center

Side Points

- Volume Based
- We plan to a Normalization VALUE, not a point
- This is the only way to get the plan hot in the Lumpectomy cavity, and cool in the rest of the breast throughout
- Our Physicians draw volumes and we come up with a plan
- If the Physician insists on placing the beams the Dosimetrist cannot come up with an ideal plan.
  - Dosimetrist is completely limited

How Large?

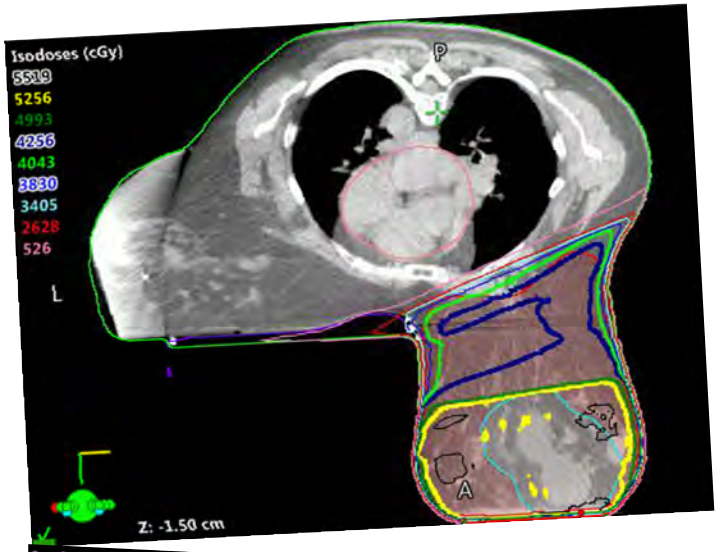
You may be asking yourself, “How large of breasts have we treated in the Prone position?”

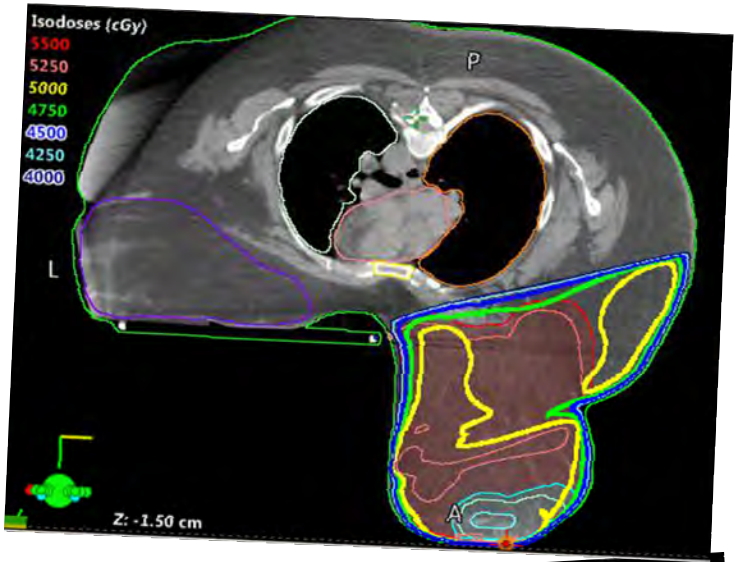
Pretty large.

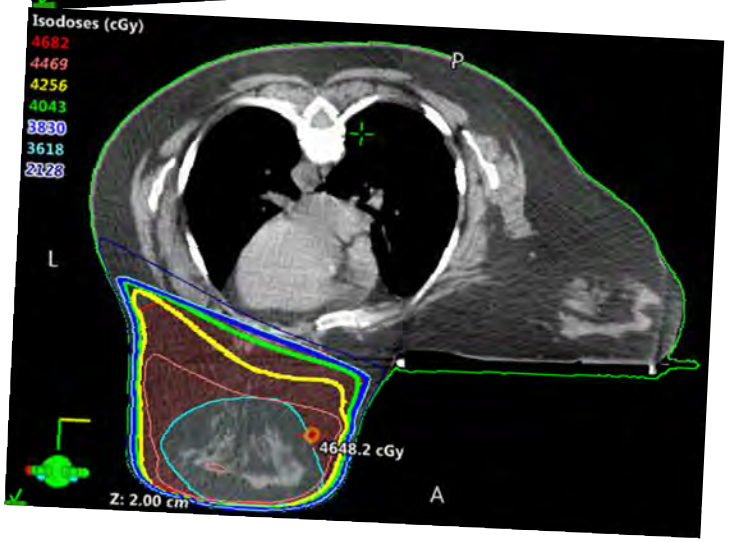
But.

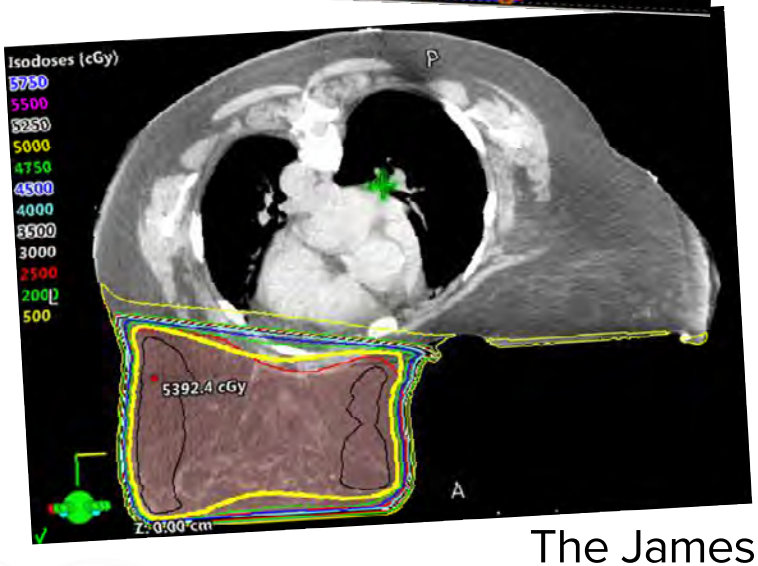
Whenever we say “This is the largest,” we always get a larger one.

Largest of the Large









The James

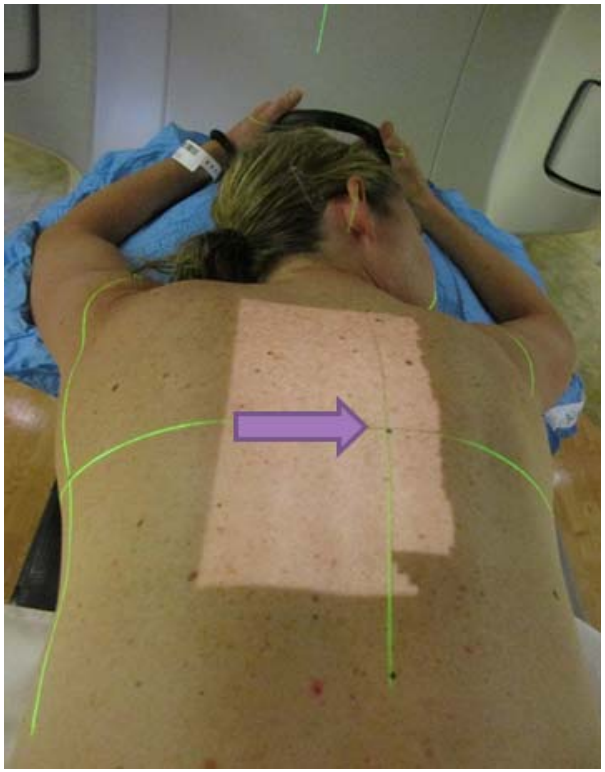
THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER

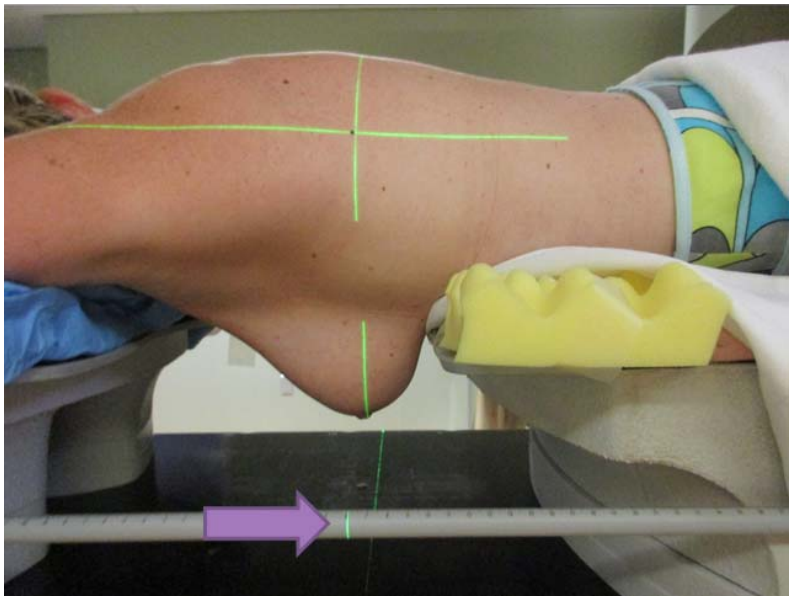
Verification Simulation

- Always performed with physician present
- Orthogonal films taken for isocenter verification
- Double exposure of each treatment field is acquired
- PA, lateral, and treatment SSDs are verified
- Physician clinically visualizes treatment fields on the patient

Treatment Setup

- Patient adjusted Right to Left, Sup and Inf, and rolled to align tattoos to lasers.



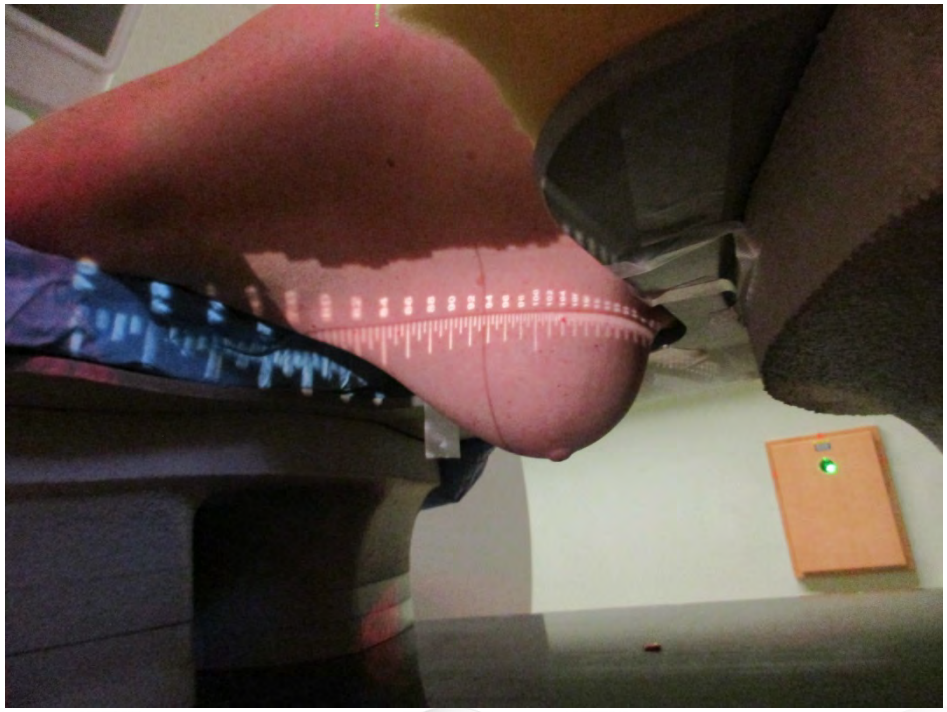


Board number on index bar in line with mid-nipple or other designated breast mark

*important to leave Lateral table position at 0

Treatment Setup (cont'd)

- Daily Shifts are made to isocenter
- PA and Lateral SSD is checked



Lateral SSD is checked DAILY to verify how tight the contralateral breast is pulled and verifies correct lateral position

What about Nodal Patients??

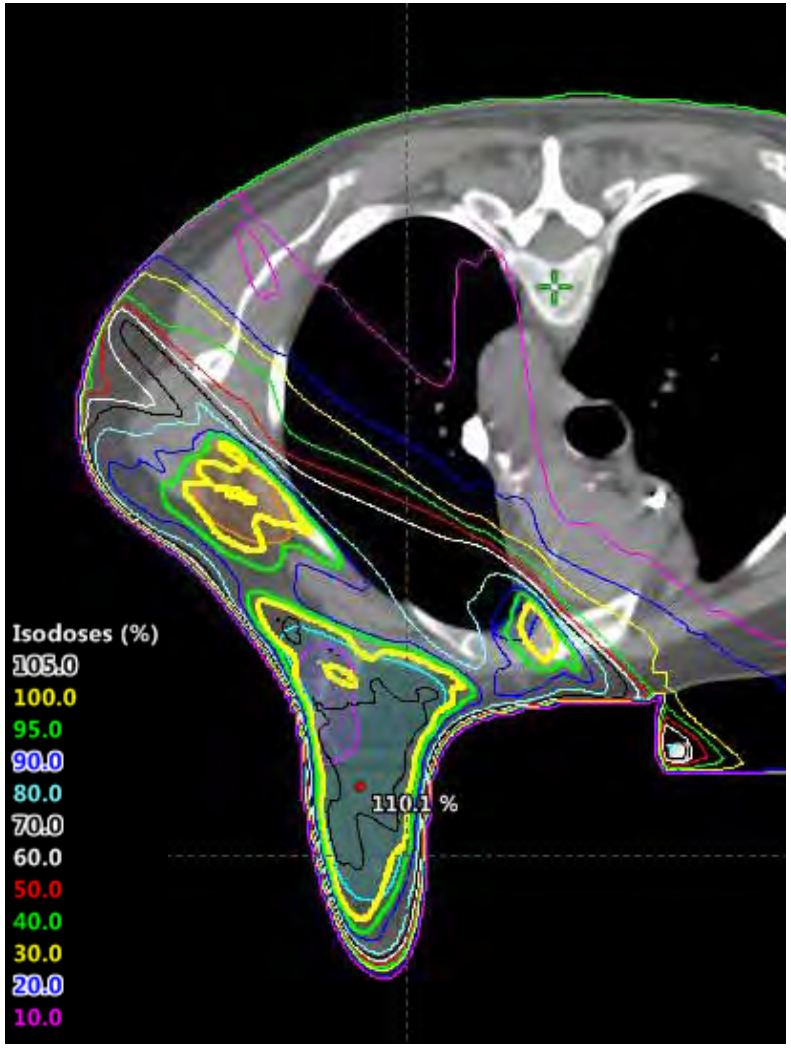
We see all this benefit treating patients Prone, have we ever treated Nodal patients in the Prone position?

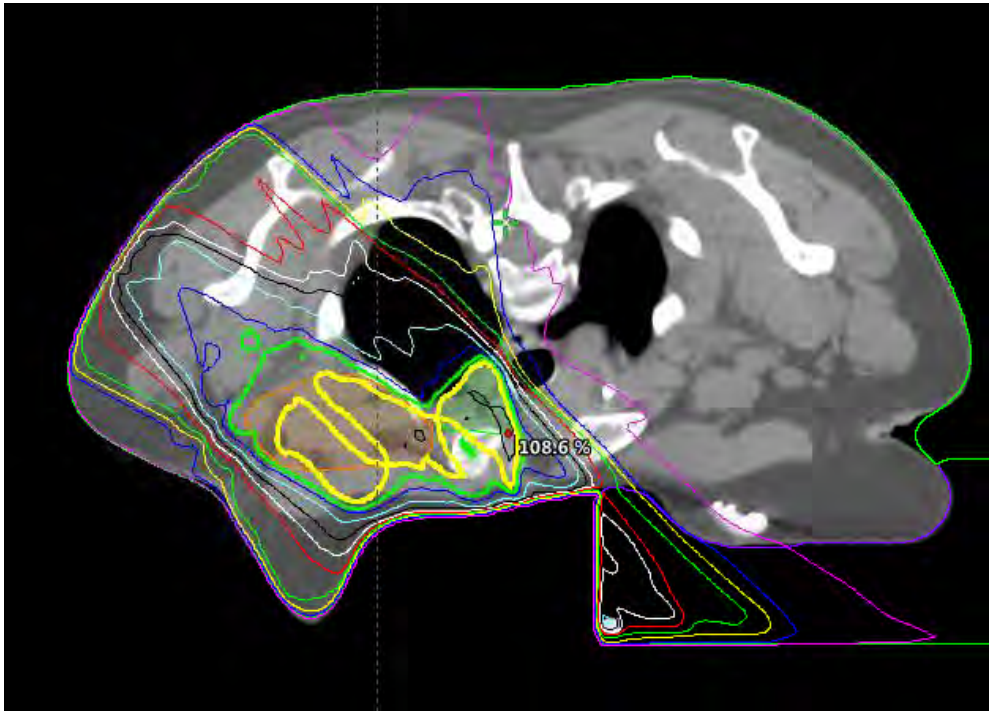
YES

Conformal to get the high Axilla

IMRT to include Axilla, SupraClav, & IMN

Prone IMRT Technique



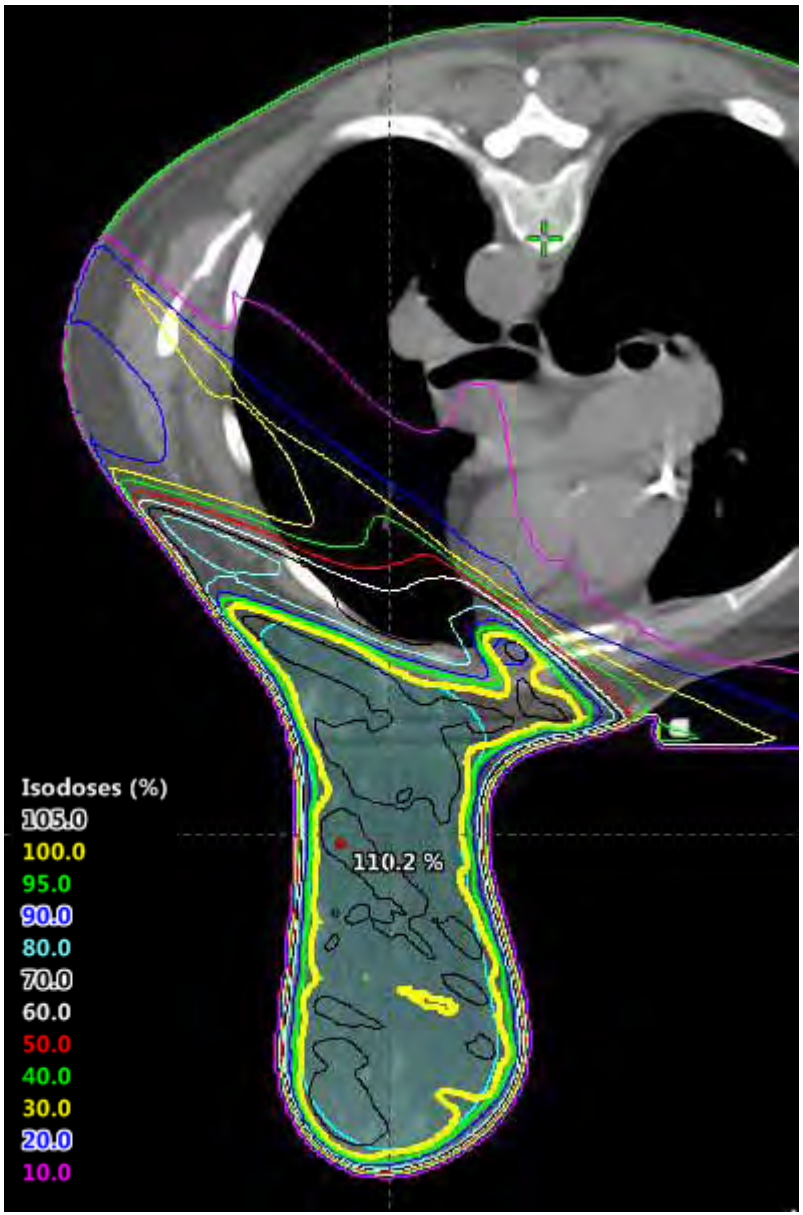


Conformality is much tighter, therefore requiring daily IGRT CBCT

The James

The Ohio State University
Wexner Medical Center

Prone IMRT Planning



- 7-9 Beams
- No Beams through the contralateral side
- Boost is done in Prone as well
- Boost is planned same as in Conformal Breast
- Plan is evaluated in the Plan Sum
- Evaluate using RTOG 1304 criteria
- Paint Flash

The James

The Ohio State University
Wexner Medical Center

The Future

Protocol OSU 13282 – Feasibility of assessing Radiation Response with MRI/CT Directed Pre-Op Accelerated Partial Breast Irradiation in the Prone Position for Hormone Response early stage Breast Cancer

The James

The Ohio State University
Wexner Medical Center

Protocol OSU 13282- Design

- Use MRI to define extent of disease for radiotherapy targeting, the PTV
- Determining tumor response following preoperative APBI
- Correlating MRI with pathologic findings from resection

Primary Hypothesis: that MRI will improve RT targeting, planning and delivery, and that MRI features can be identified to correlate with pathologic radiation response.

Protocol OSU 13282 - Eligibility

- Invasive Breast Cancer
  - Stage I
  - Hormone Positive
    - Pre-surgery
  - OK with receiving MRI with contrast
  - No Prior malignancy
- No previous hormonal therapy for current Breast Cancer
- No co-existing medical conditions with less than 2 years life expectancy

Protocol OSU 13282 - cont'd

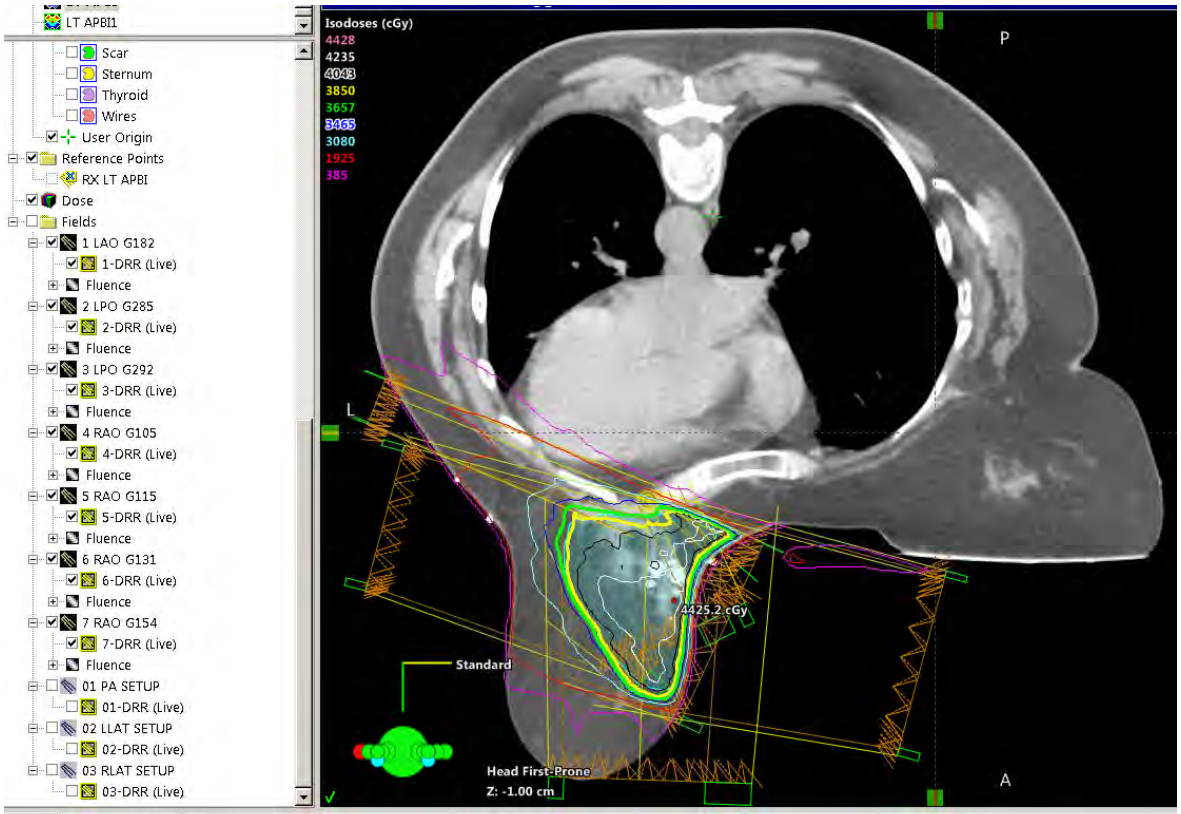
- 33 Patients
  - Cohort 1: 3 patients to verify flow between MRI and CT
  - Cohort 2: 30 patients receive radiation treatment

- Prescription Dose 3.85 Gy BID for 5-8 days
- Total Dose of 38.50 Gy using IMRT
- Follow up MRI completed 4 weeks post radiation and before surgical resection to assess response

Protocol OSU 13282 – cont'd

- CT scan with patient in prone position
- MRI scan with patient in same prone position as CT
  - MRI & CT fused together
- Dosimetrist contours OAR
- Physician contours Lumpectomy from fused MRI/CT
  - GTV: MRI defined tumor + 10mm margin
  - CTV: uniform expansion of lumpectomy cavity of 15mm
  - PTV: 5mm expansion of CTV
    - Excluding chest wall musculature, and cropped 5mm from skin

Protocol OSU 13282 – 1st Planned Patient



Fields | Dose Prescription | Field Alignments | Plan Objectives | Optimization Objectives | Dose Statistics | Calculation Models | Plan Sum

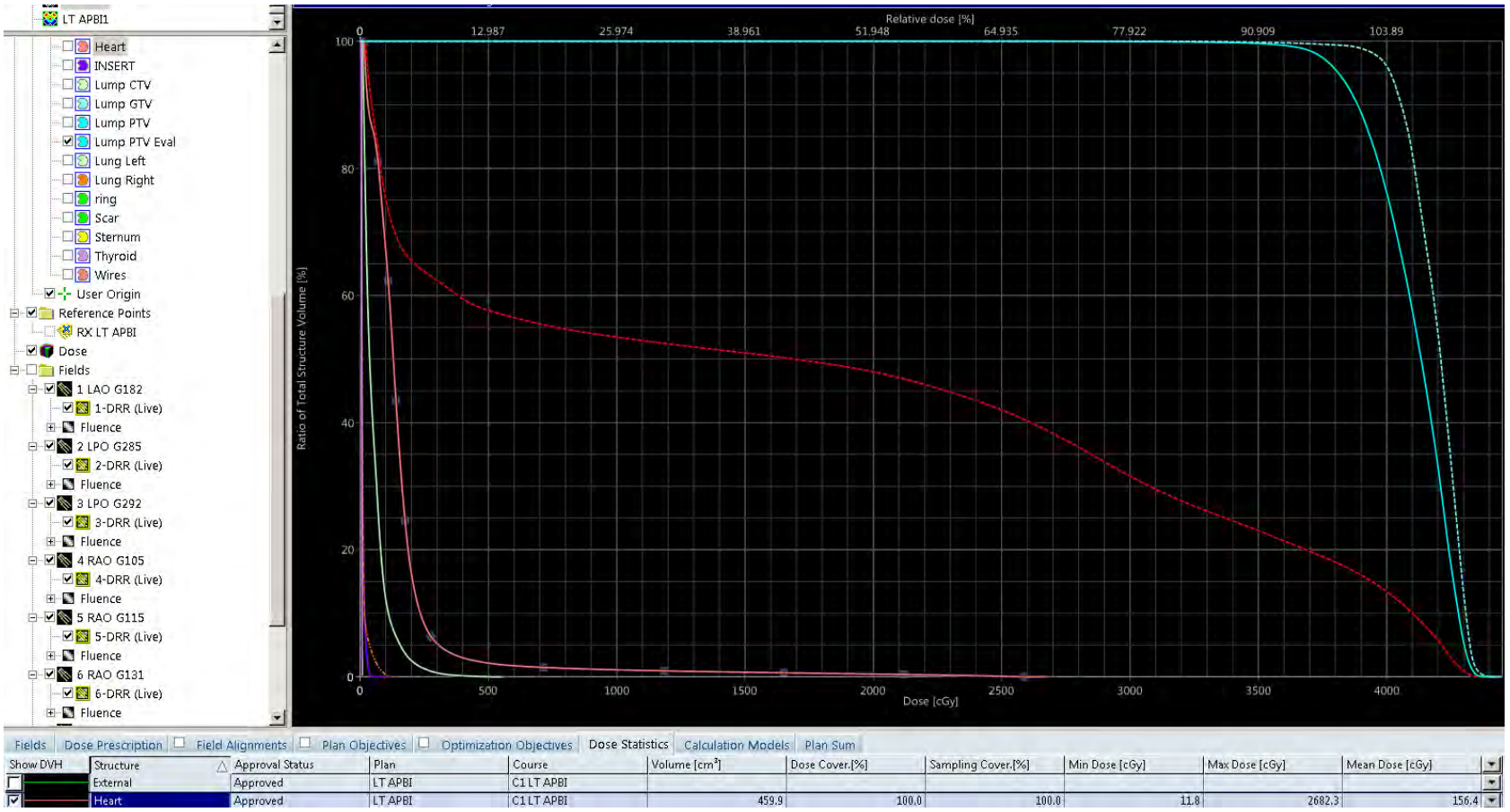
Group	Field ID	Technique	Machine/Energy	MLC	Field Weight	Scale	Gantry Rtn [deg]	Coll Rtn [deg]	Couch Rtn [deg]	Wedge	Field X [cm]	X1 [cm]	X2 [cm]	Field Y [cm]
☑	1 LAO G182	STATIC-I	TrueB1 - 6X	Dose Dynamic	1.000	Varian IEC	182.0	303.0	0.0	None	8.0	+4.0	+4.0	9
☑	2 LPO G285	STATIC-I	TrueB1 - 6X	Dose Dynamic	1.000	Varian IEC	285.0	352.0	0.0	None	7.8	+8.3	-0.5	7
☑	3 LPO G292	STATIC-I	TrueB1 - 6X	Dose Dynamic	1.000	Varian IEC	292.0	346.0	0.0	None	2.5	+1.8	+0.8	7
☑	4 RAO G105	STATIC-I	TrueB1 - 6X	Dose Dynamic	1.000	Varian IEC	105.0	12.0	0.0	None	10.0	+0.5	+9.5	9
☑	5 RAO G115	STATIC-I	TrueB1 - 6X	Dose Dynamic	1.000	Varian IEC	115.0	12.0	0.0	None	9.5	+0.5	+9.0	9
☑	6 RAO G131	STATIC-I	TrueB1 - 6X	Dose Dynamic	1.000	Varian IEC	131.0	285.0	0.0	None	8.8	+3.8	+5.0	7
☑	7 RAO G154	STATIC-I	TrueB1 - 6X	Dose Dynamic	1.000	Varian IEC	154.0	282.0	0.0	None	8.3	+3.8	+4.5	7

Followed Protocol for partial Breast but had Lumpectomy

This is how we will approach planning for patients on this protocol

Tried RapidArc; too much spillage in the heart

Protocol OSU 13282 – 1st Planned Patient



Well under Protocol requirements for amount of normal breast tissue receiving 50% and 100% of prescription dose

The James

The Ohio State University
Wexner Medical Center

Key Components for Successful Prone Treatments

- Integrated Team of Specialists
- Full Patient Compliance and Understanding
- Proper Equipment
- Established Policy & Procedure

References/Contributions

- Dr. Julia White
- Dr. Jose Bazan
- Dr. Jessica Wobb
- Dr. Ashley Sekhon
- Steven Kalister (Administrator SSCBC)
- Tina LaPaglia (Lead Therapist SSCBC)
- Kristen Krupela (Dosimetrist at OSU)

Radiation Oncology Training Center

The James

THE OHIO STATE UNIVERSITY
WEXNER MEDICAL CENTER