2018 AAMD PLAN STUDY
5 FIELD BREAST CASE

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OUTLINE

1. HISTORY
2. PURPOSE
3. WHAT ARE WE STUDYING?
4. METHODS
5. COMPLEXITIES AND CONSIDERATIONS
6. RESULTS AND DISCUSSIONS
7. CONCLUSIONS

History

2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016



RADIATION ONCOLOGY RESOURCES

Goshen Hospital (IN)

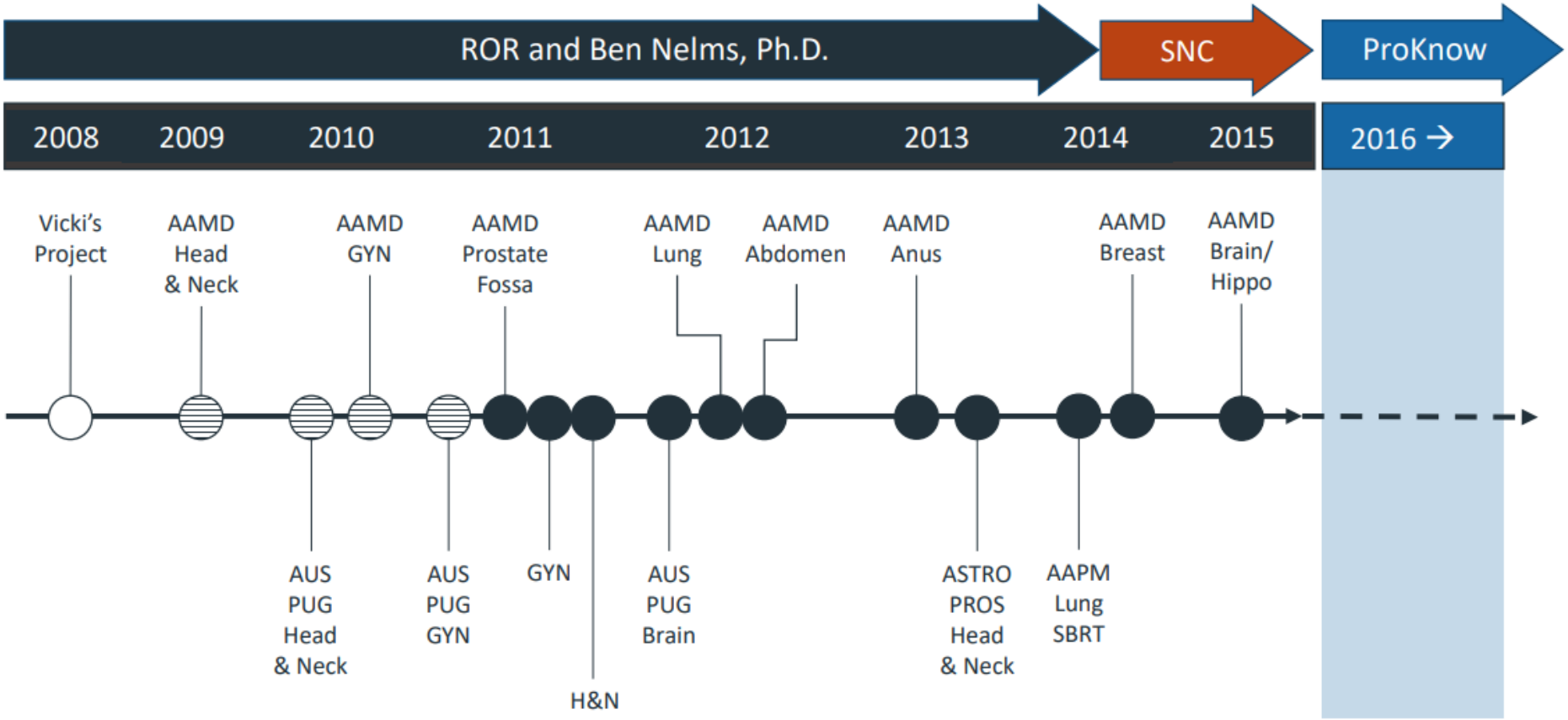
SUN NUCLEAR corporation

Vicki LaCerba, CMD

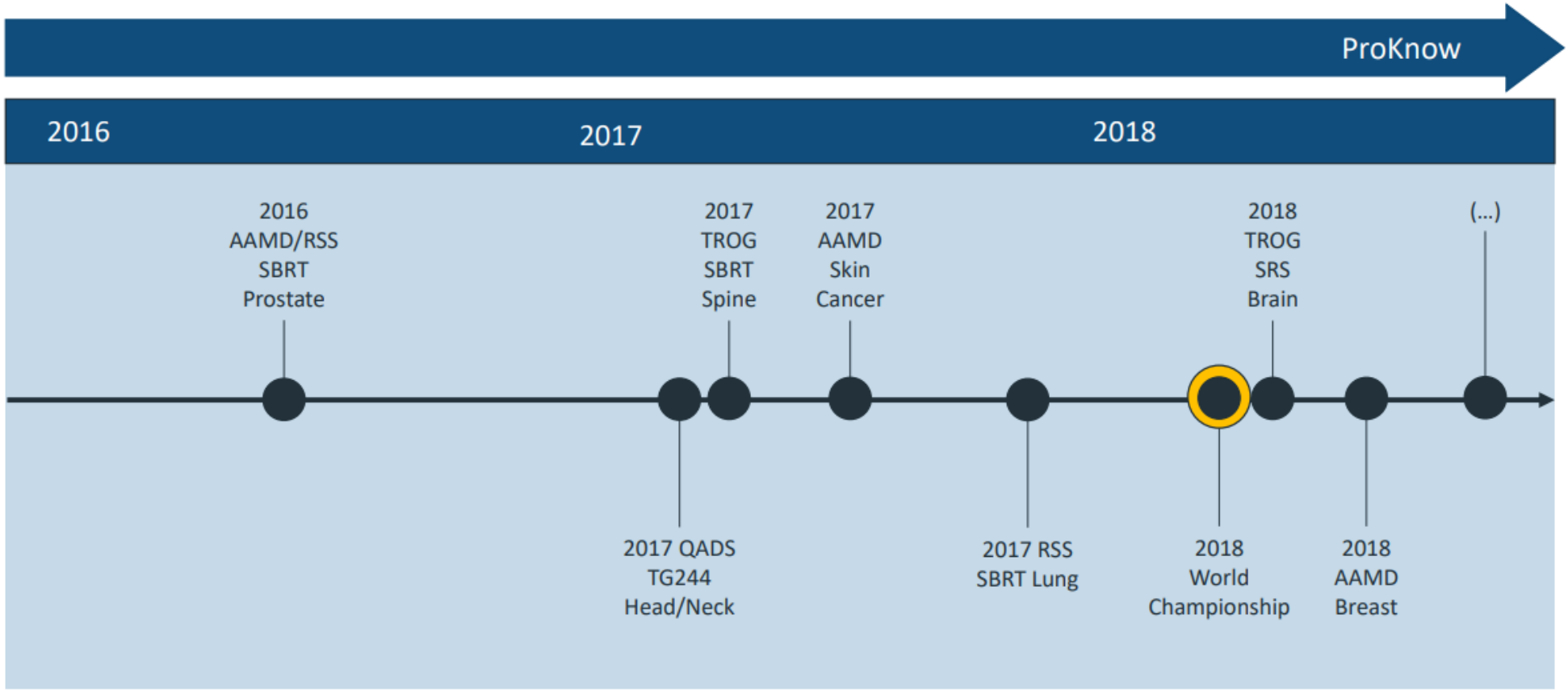
(pictured here with husband Matt)

Ben Nelms / Canis Lupus LLC

HISTORY


ROR and Ben Nelms, Ph.D.
SNC
ProKnow
2008
2009
2010
2011
2012
2013
2014
2015
2016 →
Vicki's Project
AAMD Head & Neck
AAMD GYN
AAMD Prostate Fossa
AAMD Lung
AAMD Abdomen
AAMD Anus
AAMD Breast
AAMD Brain/ Hippo
AUS PUG Head & Neck
AUS PUG GYN
GYN
H&N
AUS PUG Brain
ASTRO PROS Head & Neck
AAPM Lung SBRT

HISTORY


ProKnow
2016
2017
2018
2016
AAMD/RSS
SBRT
Prostate
2017
TROG
SBRT
Spine
2017
AAMD
Skin
Cancer
2018
TROG
SRS
Brain
(...)
2017 QADS
TG244
Head/Neck
2017 RSS
SBRT Lung
2018
World
Championship
2018
AAMD
Breast

HISTORY PROVIDES US WHAT?

Studying **history can provide us** with insight into our cultures of origin as well as cultures with which we might be less familiar, thereby increasing cross-cultural awareness and understanding.

What have other Plan Studies shown us?

1. No correlation with:
   - Certification
   - Education Level
   - Experience
   - Confidence
2. No major significance on TPS
3. No dependency of plan complexity
4. Dependency is more on Planner Skill

PURPOSE

HISTORICALLY:

- COMPARE DIFFERENT SYSTEMS
- COMPARE MODALITIES
- IDENTIFY BEST PRACTICES
- SHARE INFORMATION WITH THE WORLD

NEW CONSIDERATIONS:

- ESTABLISH CLINICAL STANDARDS
- LEARN PROCESSES

ULTIMATE GOAL = DRIVE OUT VARIATION AND IMPROVE PLAN QUALITY

WHAT ARE WE STUDYING: VARIATION

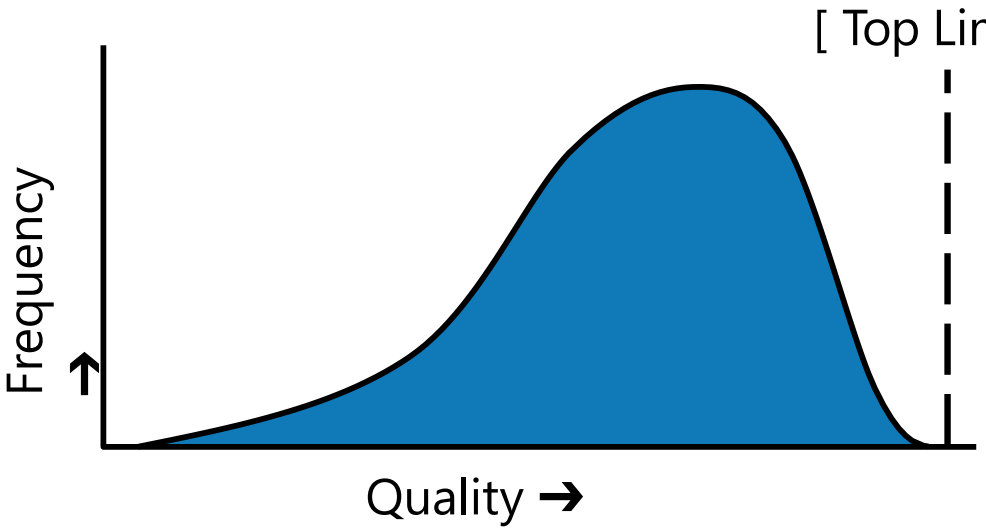
VARIATON IN TREATMENT PLANNING IS NOT GOOD

Within A System
Within A Center
Within a Planner

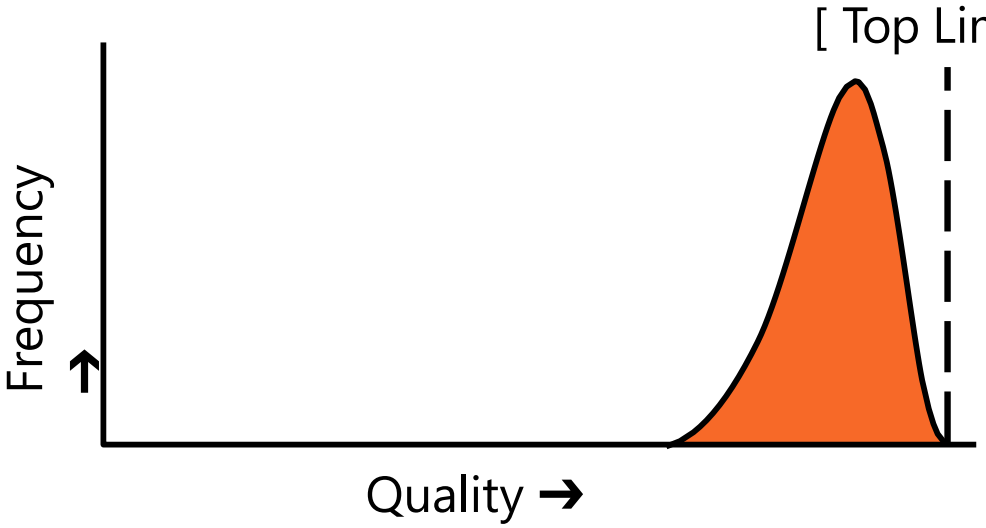
VARIATION IS A BY PRODUCT OF IMPERFECT METHODS AND/OR PROCESSES

Dosimetry is an ART but we need Standards and Processes

VARIATION: MEASURED QUALITY

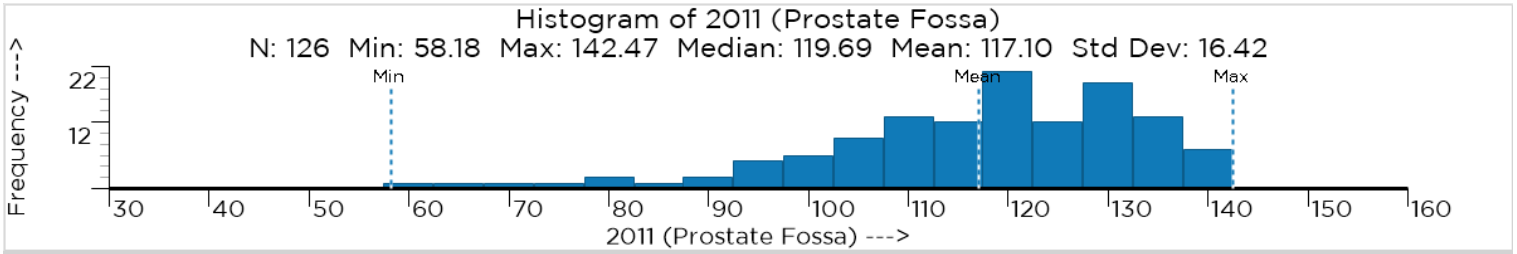


- High variation
- Average quality is low
- Lots of low quality items
- Few high quality items

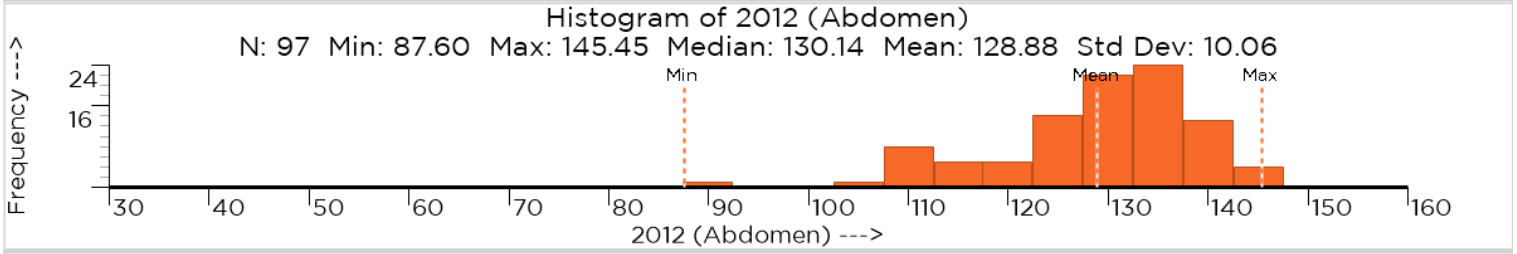


- Lower variation
- Average quality is higher
- Fewer low quality items
- More high quality items

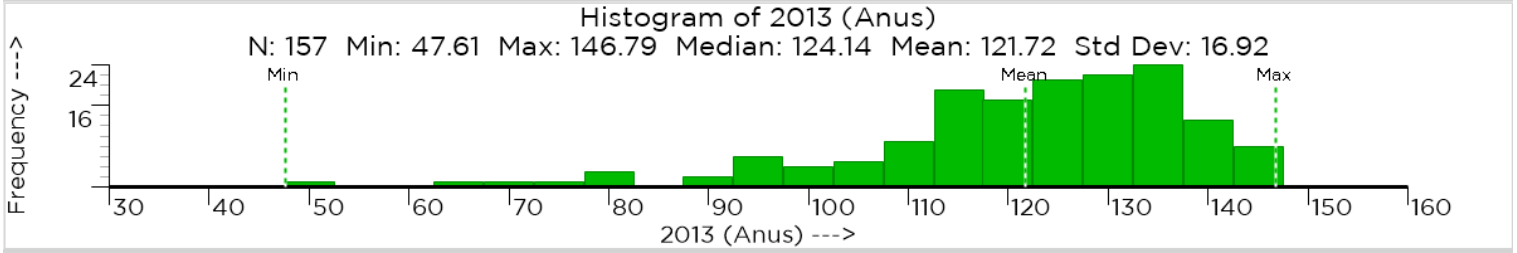
2011



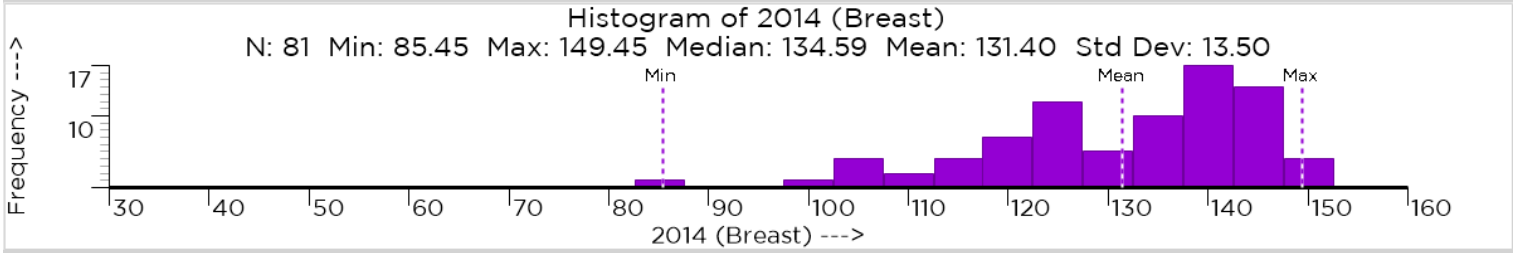
2012



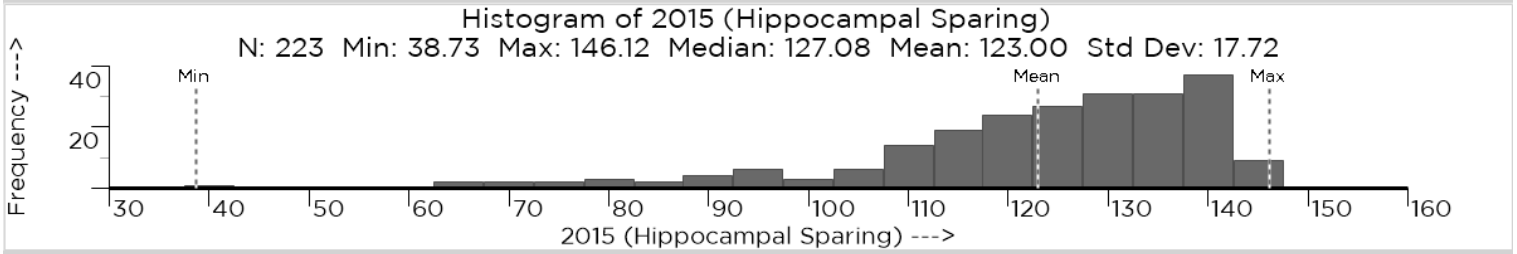
2013



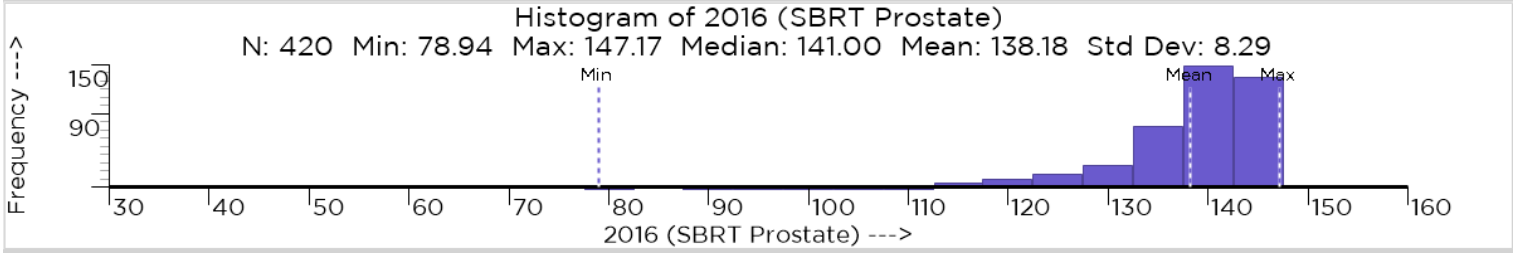
2014



2015



2016



Are We Lowering Variance?

Plan Studies Suggest We Are Lowering Variance! That's Good.

But are we really?

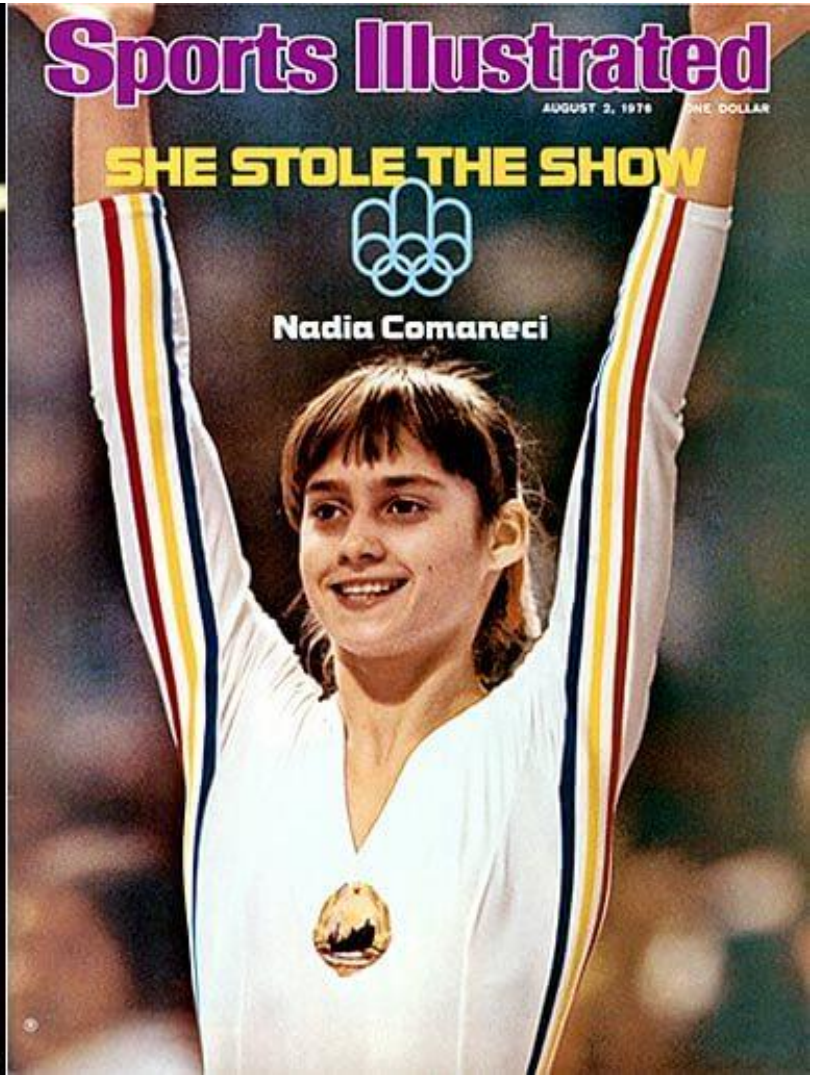
200 – 400 planners per study
8,000 planners worldwide
That is 2.5% - 5% Participation
What would the distribution of scores really look like? I strongly suspect a LARGE VARIATION.

Continue the Push!

Sharing is Caring. Education is Key.
We need to find the time!

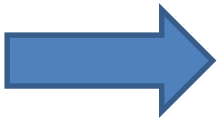
WHAT DOES IT MEAN TO GET A MAX SCORE?





What Does It Mean to Score a 150 on the Plan Study?

1. Were the constraints of the study to easy?
   Answer
2. Are the planners just getting better?
   Answer
3. Is a score of 150 better than 145? Answer
4. Is this difference clinically relevant? Answer



Need for New Protocols
Need to Tie Score to Toxicity
Need for Physician Engagement

METHODS: PROJECT PLANNING TEAM

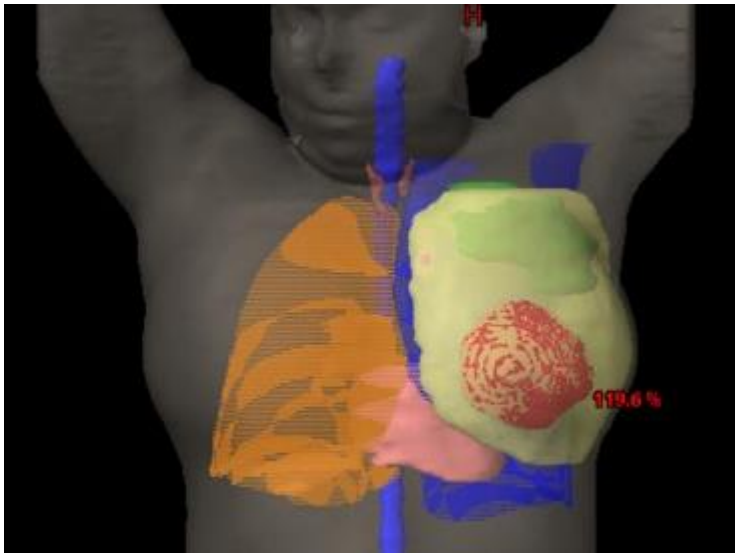
TEAM MEMBER	AFFILIATION
JAMES WHEELER, MD, PHD	CENTER FOR CANCER CARE, GOSHEN HEALTH
BRUCE PHILLIPS, CMD	RTU INSTRUCTOR / TA
THOMAS COSTANTINO, MS, CMD	RTU FACULTY
SANJEEL PATEL, MS, CMD	RTU INSTRUCTOR / TA
BRENT MURPHY, MS, DABR	RTU FACULTY
DAVID LITTLEJOHN, CMD	RTU INSTRUCTOR / TA

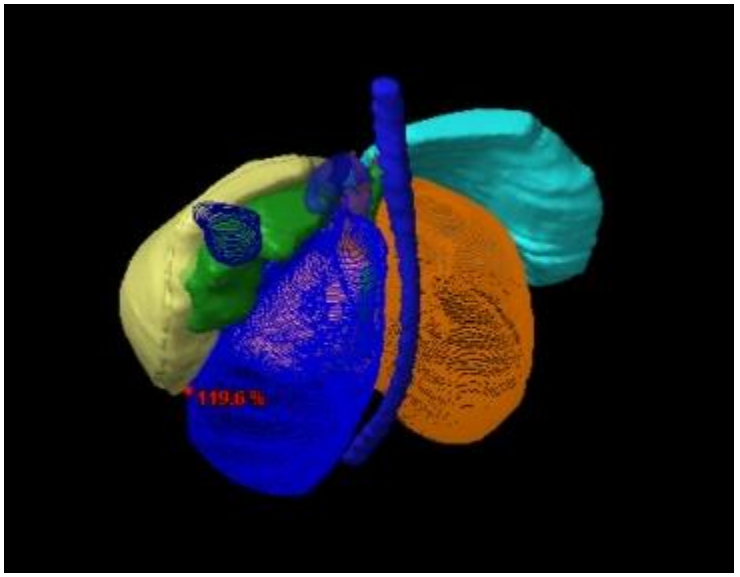


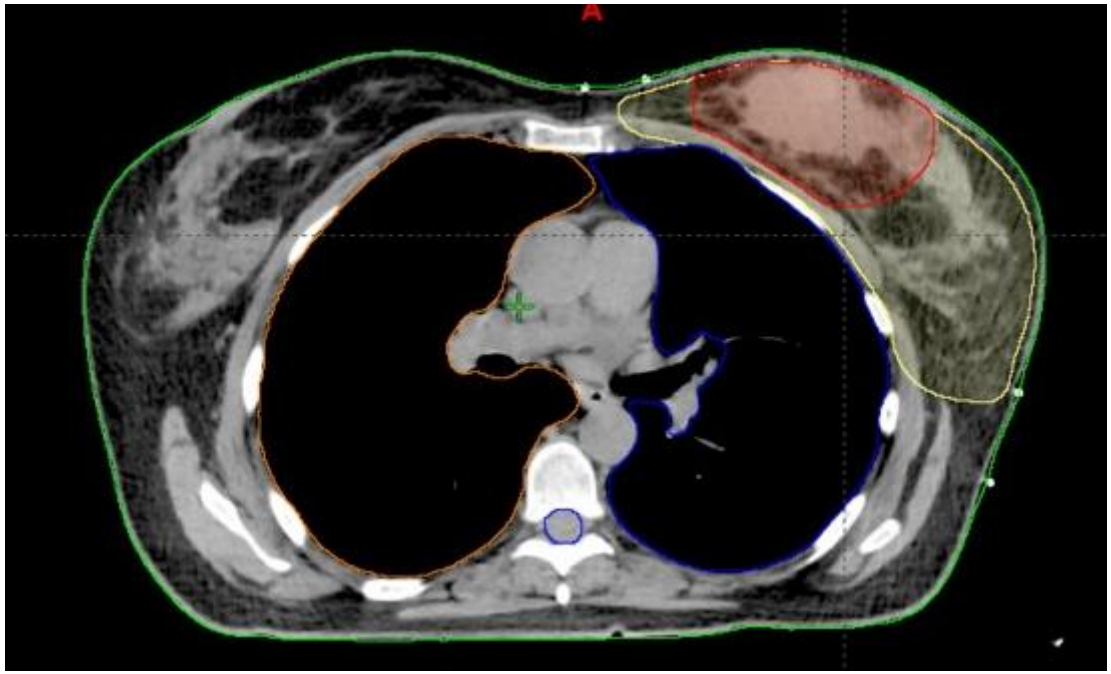





METHODS: THE DATASET







METHODS: The Prescription

1. RX Dose: 5 Targets: 25 fx x 2 Gy/fx
2. Decision to Not Include the Boost
3. Variability in Boost
    * Integrated vs Successive
    * VMAT, IMRT, Other
    * Photons, Electrons, Mix
4. Ultimately, the composite plan is most important

COMPLEXITIES AND CONSIDERATIONS

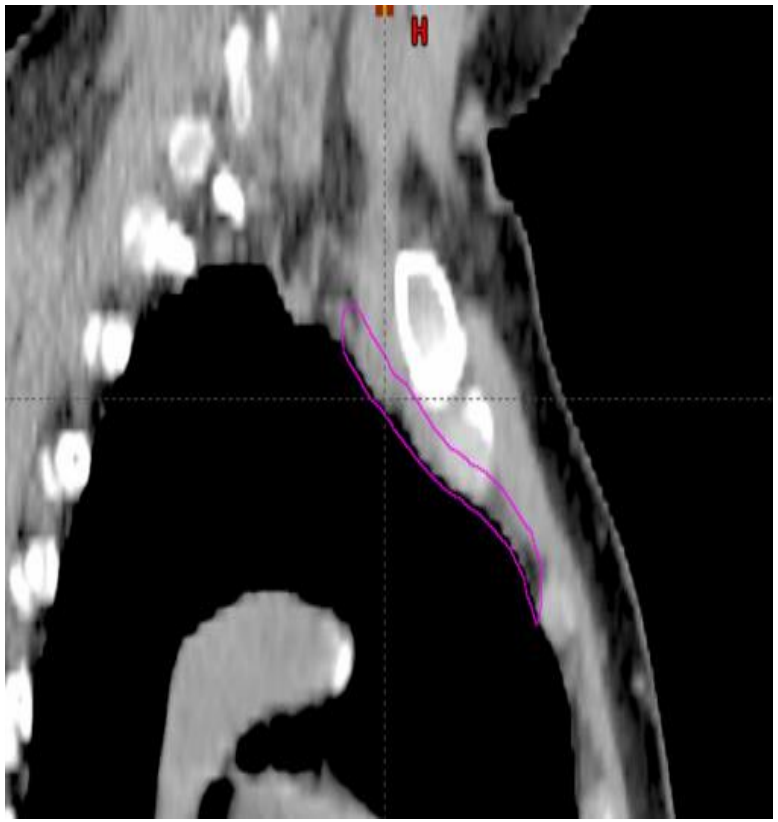
1. Variation of Technique
2. Inclusion of IMN
3. Hot Spots / Cold Spots
4. Skin Dose
5. Integral Dose

VARIATION OF TECHNIQUE

1. Modality
   - Photon
   - Proton
2. Techniques
   - VMAT / IMRT
   - VMAT / IMRT with 3D
   - Electronic Compensation
   - 3D Field in Field
   - 3D Wedges

INCLUSION OF IMN

1. Controversy
2. Length: Depends on protocol.
3. How do you treat?



HOT SPOTS / COLD SPOTS

1. Hot Spots
   * Physicians are now pushing more for homogeneity of breast cases.
   **Hot Spots created by weighting, wedging, modulation, other.
   *** Moving from no breast target to Breast PTV target (contouring)
2. Cold Spots
   * Historical Matching
   * Skin / Build Up Area

SKIN DOSE

1. Definition of the Skin
2. Skin Dependency
3. What affected skin dose:
   - PTV defined
   - Modulated beams
   - Mixed Energies
   - Obliquity Effect



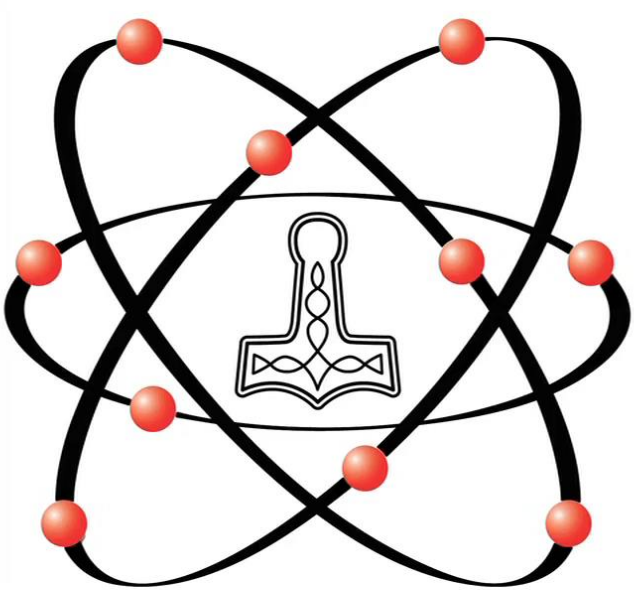
INTEGRAL DOSE

1. Integral Dose Defined
2. General Concept: Lower Integral Dose is Better.
3. Should it be limited?
4. How do we monitor over 15-20 years?

MD Concerns (Dr. Wheeler)

1. Target Coverage: 5 Targets
2. Heart Dose: Mean Dose, Vessels
3. Lung Dose
4. Rib Dose
5. Esophagus
6. Skin Dose: Definition
7. Other Metrics
    * Conformation
    * Dose Homogeneity
    * Integral Dose

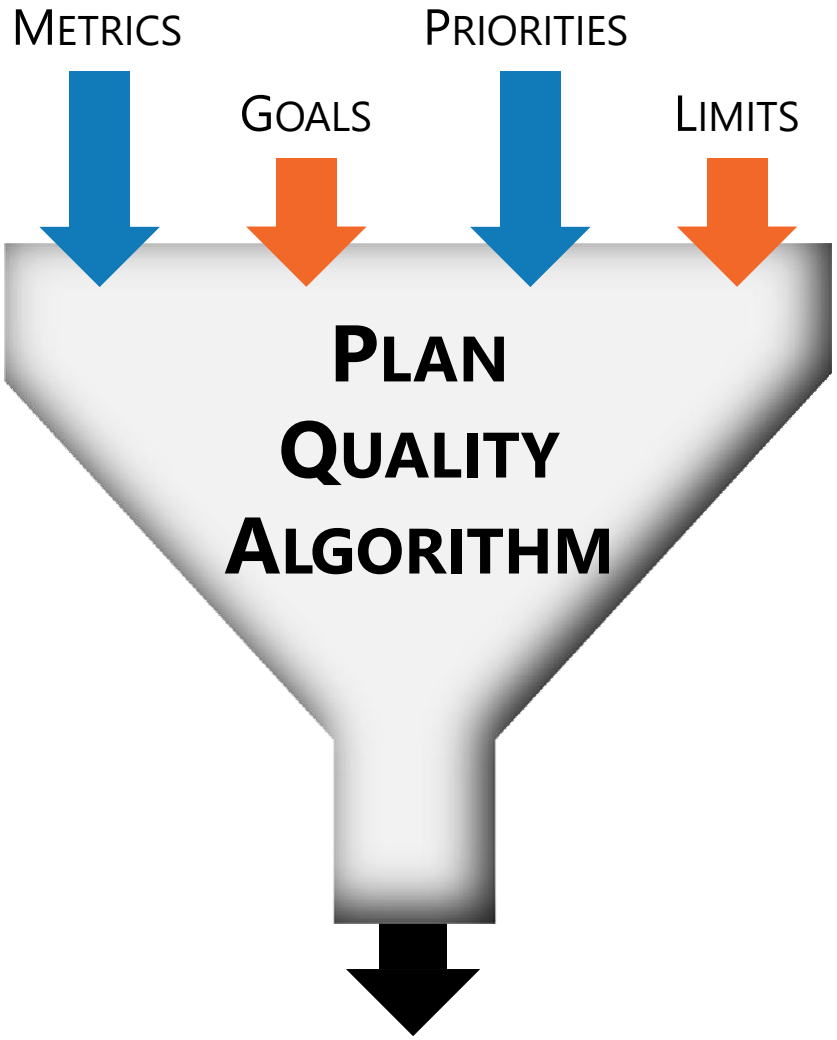
A PHYSICIAN'S PERSPECTIVE



Radiological Technologies University VT

METHODS: PLAN SCORING

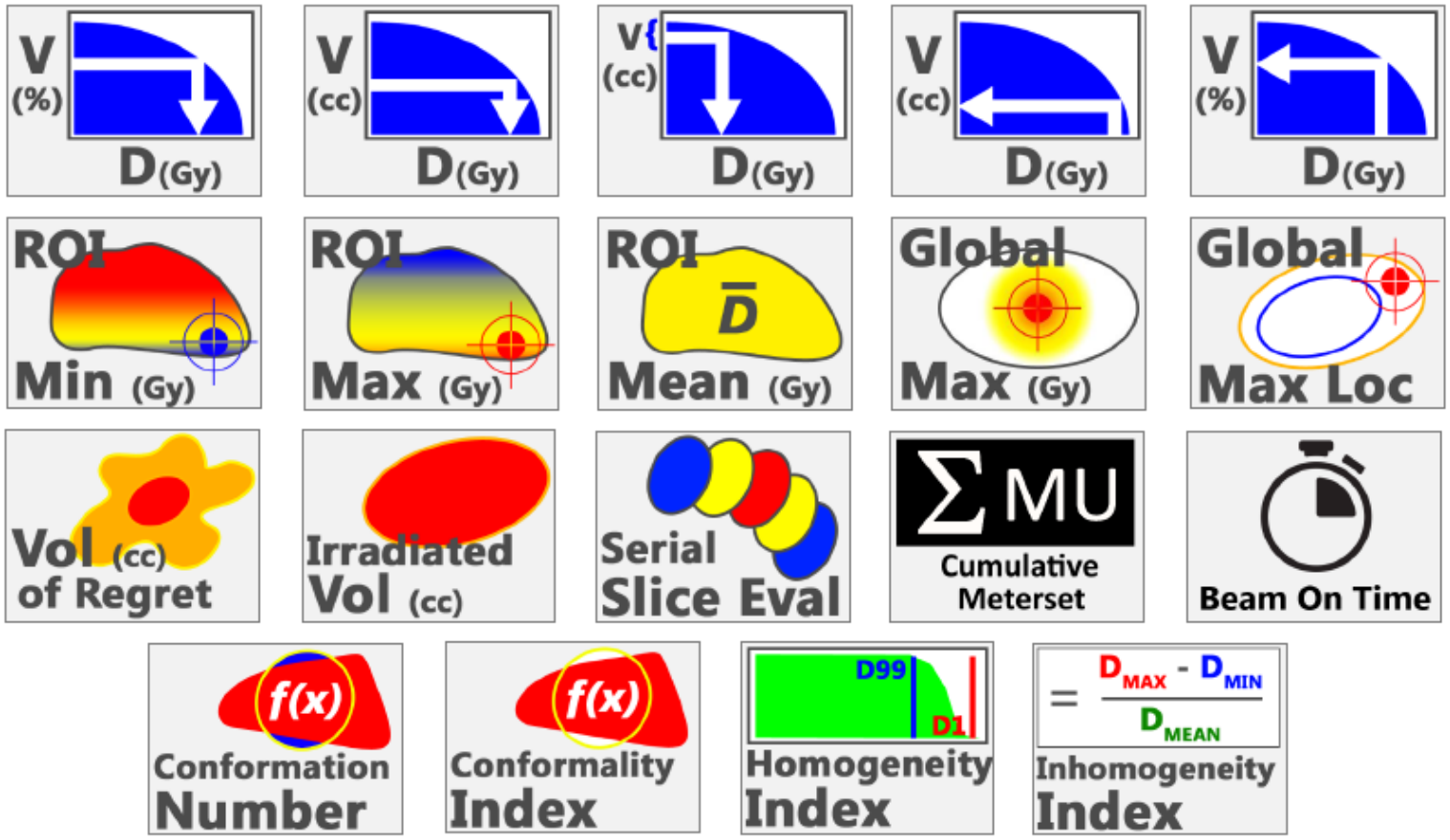
- **IDENTIFY CRITICAL METRICS.** Dose, DVH, or formulaic metrics selected from a vast library of options.
- **DEFINE EACH METRIC'S PARAMETERS.** Select applicable structure, dose- or volume- levels, or other input parameters to derive the metric result.
- **DEFINE EACH METRIC'S SCORING.** For each metric, capture what defines success, i.e. specify priority along with: 1) minimally required result, 2) ideal result, and 3) variable scoring in between.



COMPOSITE PLAN SCORE
USING **PLANIQ** SCORING METHODOLOGY

A REVIEW OF PLAN METRICS

Library of Available Metrics



METHODS: THE PLAN OBJECTIVES

24 Key Metrics Total Points **150**

ProKnow

Scoring powered by PlanIQ™
Sun Nuclear Corporation

50 Gy (25 x 2 Gy) to the target volumes detailed in the plan metrics.

#	METRIC ID (28 Total Metrics)	MIN REQ	IDEAL	WEIGHT (150)
[01]	Volume (%) of the BREAST_PTV_EVAL covered by 47.5 (Gy)	90	97	20 points
[02]	Dose (Gy) covering 50 (%) of the BREAST_PTV_EVAL	54	52	3 points
[03]	Dose (Gy) covering 0.03 (cc) of the BREAST_PTV_EVAL	57	56	2.5 points
[04]	Volume (%) of the LUMPEC_PTV_EVAL covered by 47.5 (Gy)	95	99	20 points
[05]	Dose (Gy) covering 50 (%) of the LUMPEC_PTV_EVAL	54	52	3 points
[06]	Dose (Gy) covering 0.03 (cc) of the LUMPEC_PTV_EVAL	57	56	2.5 points
[07]	Structure(s) containing the global max dose point	BREAST_PTV_EVAL	LUMPEC_PTV_EVAL	3 points
[08]	Volume (%) of the SUPRACLAV_PTV covered by 47.5 (Gy)	90	97	15 points
[09]	Dose (Gy) covering 0.03 (cc) of the SUPRACLAV_PTV	55	53.5	2.5 points
[10]	Volume (%) of the AXILLARY_PTV covered by 47.5 (Gy)	90	97	15 points
[11]	Dose (Gy) covering 0.03 (cc) of the AXILLARY_PTV	55	53.5	2.5 points
[12]	Volume (%) of the IMN_PTV covered by 47.5 (Gy)	90	97	15 points
[13]	Dose (Gy) covering 0.03 (cc) of the IMN_PTV	55	53.5	2 points
[14]	Dose (Gy) covering 5 (%) of the BREAST_CONTRA	3	2	5 points
[15]	Dose (Gy) covering 0.03 (cc) of the BREAST_CONTRA	7	5	3 points
[16]	Dose (Gy) covering 5 (%) of the HEART	20	5	2 points
[17]	Dose (Gy) covering 30 (%) of the HEART	10	5	5 points
[18]	Mean dose (Gy) to the HEART	3	2	5 points
[19]	Volume (%) of the LUNG_IPSI covered by 20 (Gy)	37	20	5 points
[20]	Volume (%) of the LUNG_IPSI covered by 10 (Gy)	55	30	5 points

Plan Quality Algorithm

- **24 Scored Metrics**
  - 150 Point Totals
  - Target Coverage accounted for 103 of 150 points
  - 24 of 24 used advanced, non-linear scoring
- **4 Unscored Metrics**
  - Conformation Number (PTV All)
  - Homogeneity Index (PTV All)
  - Integral Dose to Body
  - Cumulative Meterset

METHODS: EXAMPLE PLAN SCORESHEET

ProKnow

Scoring powered by PlanIQ™
Sun Nuclear Corporation

METRIC	RESULT	MIN REQ	IDEAL	POINTS	WEIGHT
Volume (%) of the BREAST_PTV_EVAL covered by 47.5 (Gy)	97.029	90 ✓	97 ✓	20.00	20.00
Dose (Gy) covering 50 (%) of the BREAST_PTV_EVAL	50.720	54 ✓	52 ✓	3.00	3.00
Dose (Gy) covering 0.03 (cc) of the BREAST_PTV_EVAL	56.031	56 ☐	55 ☐	0.00	2.00
Volume (%) of the LUMPEC._PTV_EVAL covered by 47.5 (Gy)	99.603	90 ✓	97 ✓	20.00	20.00
Dose (Gy) covering 50 (%) of the LUMPEC._PTV_EVAL	50.841	54 ✓	52 ✓	3.00	3.00
Dose (Gy) covering 0.03 (cc) of the LUMPEC._PTV_EVAL	55.491	56 ✓	55 ☐	1.51	2.00
Volume (%) of the SUPRACLAV._PTV covered by 47.5 (Gy)	97.830	90 ✓	97 ✓	15.00	15.00
Dose (Gy) covering 0.03 (cc) of the SUPRACLAV._PTV	53.067	55 ✓	53.5 ✓	2.00	2.00
Volume (%) of the AXILLARY_PTV covered by 47.5 (Gy)	98.744	90 ✓	97 ✓	15.00	15.00
Dose (Gy) covering 0.03 (cc) of the AXILLARY_PTV	54.281	55 ✓	53.5 ☐	1.74	2.00
Volume (%) of the IMN_PTV covered by 47.5 (Gy)	99.249	90 ✓	97 ✓	15.00	15.00
Dose (Gy) covering 0.03 (cc) of the IMN_PTV	53.035	55 ✓	53.5 ✓	2.00	2.00
Dose (Gy) covering 5 (%) of the BREAST_CONTRA	2.201	3 ✓	2 ☐	4.60	5.00
Dose (Gy) covering 0.03 (cc) of the BREAST_CONTRA	4.896	7 ✓	5 ✓	3.00	3.00
Dose (Gy) covering 5 (%) of the HEART	3.144	20 ✓	15 ✓	5.00	5.00
Dose (Gy) covering 30 (%) of the HEART	1.466	15 ✓	10 ✓	5.00	5.00
Mean dose (Gy) to the HEART	1.292	3 ✓	2 ✓	5.00	5.00
Volume (%) of the LUNG_IPSI covered by 20 (Gy)	18.352	37 ✓	20 ✓	5.00	5.00
Volume (%) of the LUNG_IPSI covered by 10 (Gy)	28.529	55 ✓	30 ✓	5.00	5.00
Volume (%) of the LUNG_IPSI covered by 5 (Gy)	45.925	70 ✓	50 ✓	5.00	5.00
Volume (%) of the LUNG_CONTRA covered by 5 (Gy)	0.521	10 ✓	5 ✓	5.00	5.00
Mean dose (Gy) to the HUMERAL_HEAD_LT	11.775	15 ✓	10 ☐	1.82	2.00
Mean dose (Gy) to the THYROID	22.826	25 ✓	20 ☐	1.72	2.00
Integral dose (Gy cc) to the BODY	192263.719	---	---	---	---
TOTALS		22 (of 23)	17 (of 23)	144.39	148.00

SANITY CHECK: HIGH QUALITY VMAT/IMRT

METRIC	RESULT	MIN REQ	IDEAL	POINTS	WEIGHT
Volume (%) of the BREAST_PTV_EVAL covered by 47.5 (Gy)	94.433	90	97	17.09	20.00
Dose (Gy) covering 50 (%) of the BREAST_PTV_EVAL	51.104	54	52	3.00	3.00
Dose (Gy) covering 0.03 (cc) of the BREAST_PTV_EVAL	56.741	56	55	0.00	2.00
Volume (%) of the LUMPEC._PTV_EVAL covered by 47.5 (Gy)	98.427	90	97	20.00	20.00
Dose (Gy) covering 50 (%) of the LUMPEC._PTV_EVAL	52.059	54	52	2.94	3.00
Dose (Gy) covering 0.03 (cc) of the LUMPEC._PTV_EVAL	55.971	56	55	1.03	2.00
Volume (%) of the SUPRACLAV._PTV covered by 47.5 (Gy)	95.086	90	97	13.09	15.00
Dose (Gy) covering 0.03 (cc) of the SUPRACLAV._PTV	53.868	55	53.5	1.88	2.00
Volume (%) of the AXILLARY_PTV covered by 47.5 (Gy)	94.922	90	97	12.95	15.00
Dose (Gy) covering 0.03 (cc) of the AXILLARY_PTV	54.531	55	53.5	1.66	2.00
Volume (%) of the IMN_PTV covered by 47.5 (Gy)	90.102	90	97	10.06	15.00
Dose (Gy) covering 0.03 (cc) of the IMN_PTV	52.938	55	53.5	2.00	2.00
Dose (Gy) covering 5 (%) of the BREAST_CONTRA	2.623	3	2	3.75	5.00
Dose (Gy) covering 0.03 (cc) of the BREAST_CONTRA	6.382	7	5	1.96	3.00
Dose (Gy) covering 5 (%) of the HEART	6.113	20	15	5.00	5.00
Dose (Gy) covering 30 (%) of the HEART	3.404	15	10	5.00	5.00
Mean dose (Gy) to the HEART	2.978	3	2	3.04	5.00
Volume (%) of the LUNG_IPSI covered by 20 (Gy)	19.884	37	20	5.00	5.00
Volume (%) of the LUNG_IPSI covered by 10 (Gy)	38.210	55	30	4.18	5.00
Volume (%) of the LUNG_IPSI covered by 5 (Gy)	65.227	70	50	3.32	5.00
Volume (%) of the LUNG_CONTRA covered by 5 (Gy)	9.803	10	5	3.05	5.00
Mean dose (Gy) to the HUMERAL_HEAD_LT	9.028	15	10	2.00	2.00
Mean dose (Gy) to the THYROID	18.384	25	20	2.00	2.00
Integral dose (Gy·cc) to the BODY	212283.359	---	---	---	---
TOTALS		22 (of 23)	8 (of 23)	124.00	148.00

Modality	VMAT*1st Pass
Summary	4 Arcs
Total Score	**124.00**/ 150.0
Min. Req. Met	23 / 24

METRIC	RESULT	MIN REQ	IDEAL	POINTS	WEIGHT
Volume (%) of the BREAST_PTV_EVAL covered by 47.5 (Gy)	97.029	90	97	20.00	20.00
Dose (Gy) covering 50 (%) of the BREAST_PTV_EVAL	50.720	54	52	3.00	3.00
Dose (Gy) covering 0.03 (cc) of the BREAST_PTV_EVAL	56.031	56	55	0.00	2.00
Volume (%) of the LUMPEC._PTV_EVAL covered by 47.5 (Gy)	99.603	90	97	20.00	20.00
Dose (Gy) covering 50 (%) of the LUMPEC._PTV_EVAL	50.841	54	52	3.00	3.00
Dose (Gy) covering 0.03 (cc) of the LUMPEC._PTV_EVAL	55.491	56	55	1.51	2.00
Volume (%) of the SUPRACLAV._PTV covered by 47.5 (Gy)	97.830	90	97	15.00	15.00
Dose (Gy) covering 0.03 (cc) of the SUPRACLAV._PTV	53.067	55	53.5	2.00	2.00
Volume (%) of the AXILLARY_PTV covered by 47.5 (Gy)	98.744	90	97	15.00	15.00
Dose (Gy) covering 0.03 (cc) of the AXILLARY_PTV	54.281	55	53.5	1.74	2.00
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Dose (Gy) covering 5 (%) of the HEART	3.144	20	15	5.00	5.00
Dose (Gy) covering 30 (%) of the HEART	1.466	15	10	5.00	5.00
Mean dose (Gy) to the HEART	1.292	3	2	5.00	5.00
Volume (%) of the LUNG_IPSI covered by 20 (Gy)	18.352	37	20	5.00	5.00
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Mean dose (Gy) to the THYROID	22.826	25	20	1.72	2.00
Integral dose (Gy·cc) to the BODY	192263.719	---	---	---	---
TOTALS		22 (of 23)	17 (of 23)	144.39	148.00

Modality	IMRT
Summary	11 Beams
Total Score	**144.39**/ 150.0
Min. Req. Met	23 / 24

RESULTS

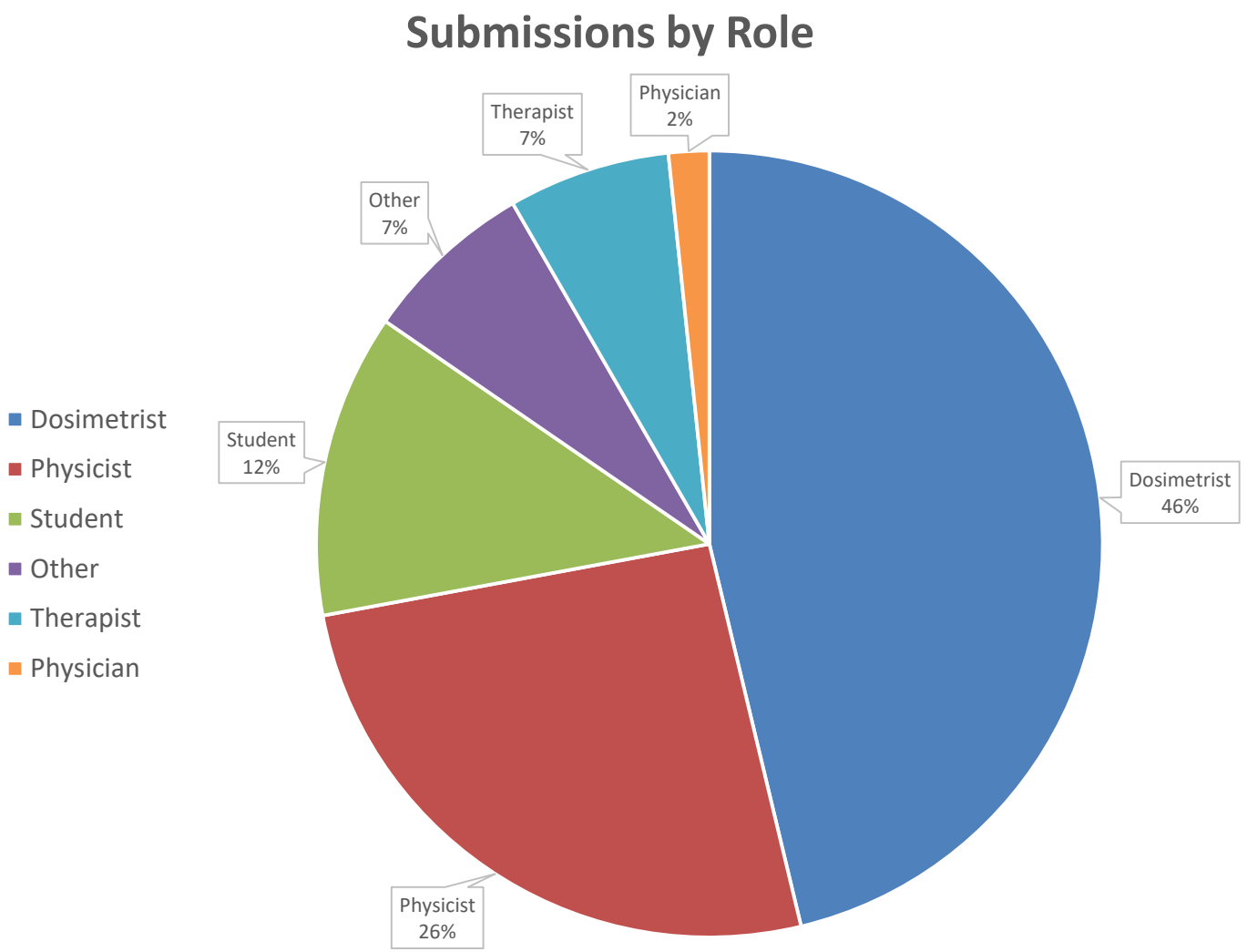
If You Don’t Measure It, You Can’t Manage It

RESULTS

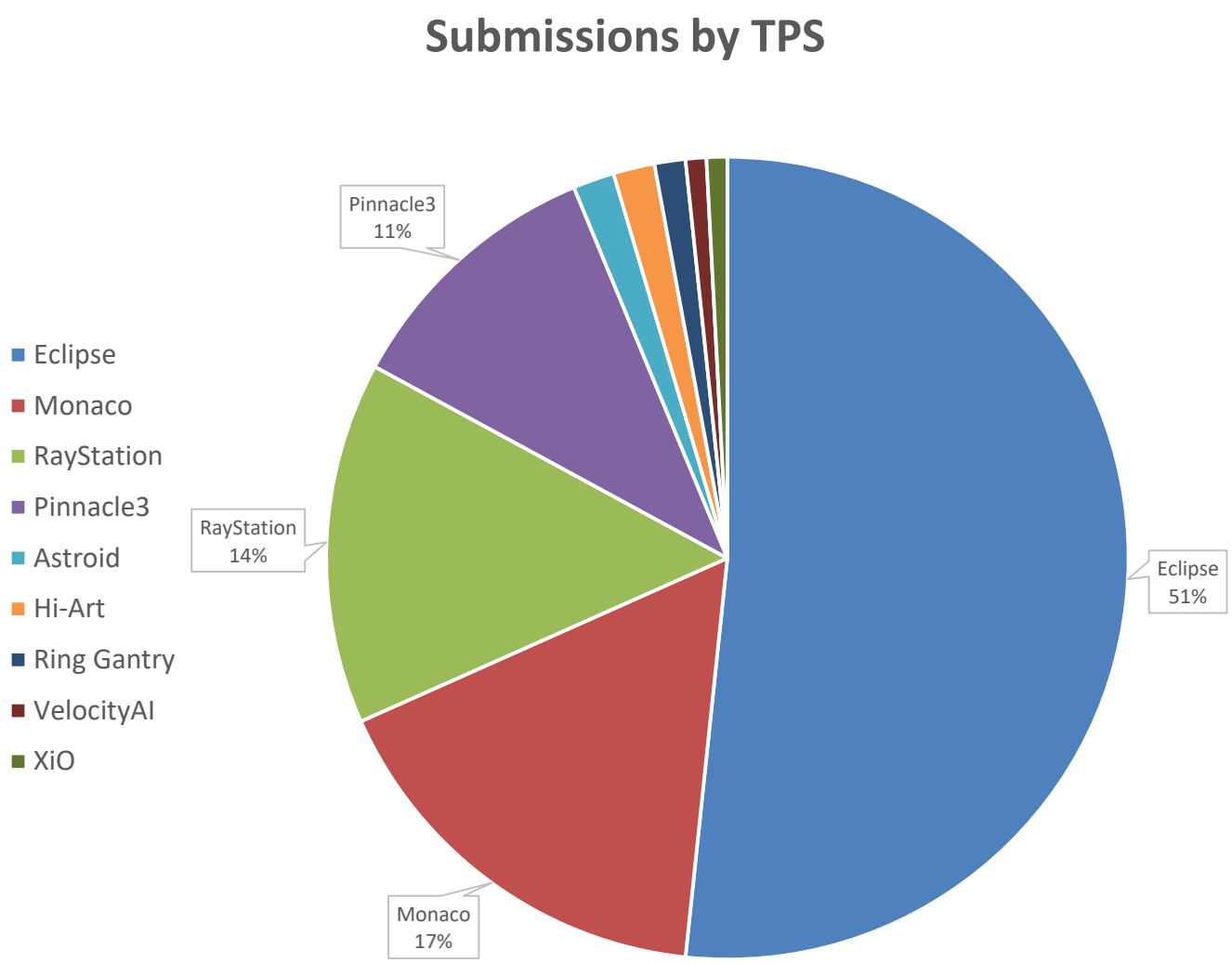
Learning Objectives

- Participation
- Overall Score Distribution
- Ideal VS. Minimum Metrics
- Individual Metrics
- Photons vs. Protons

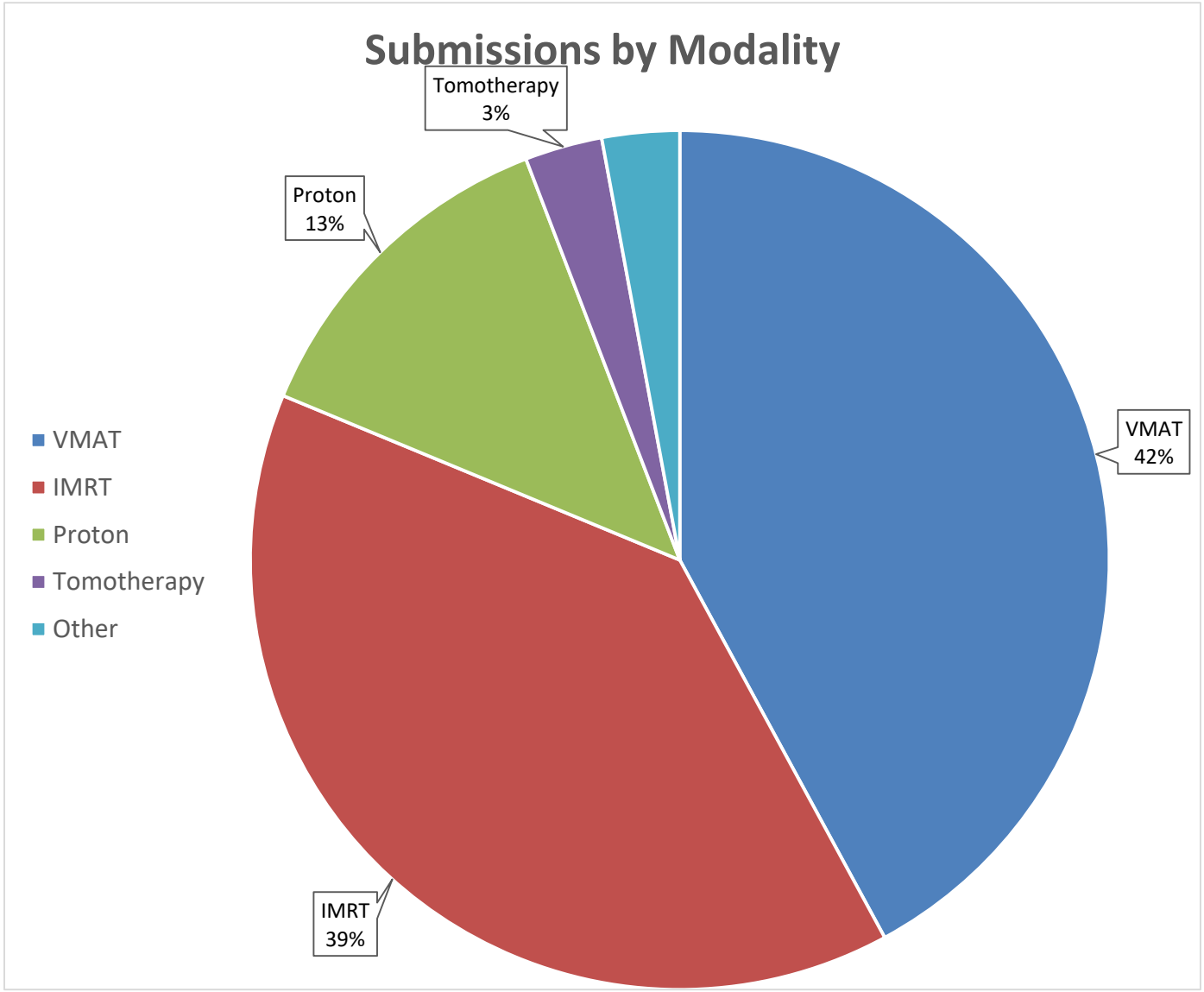
RESULTS: PARTICIPATION BY ROLE



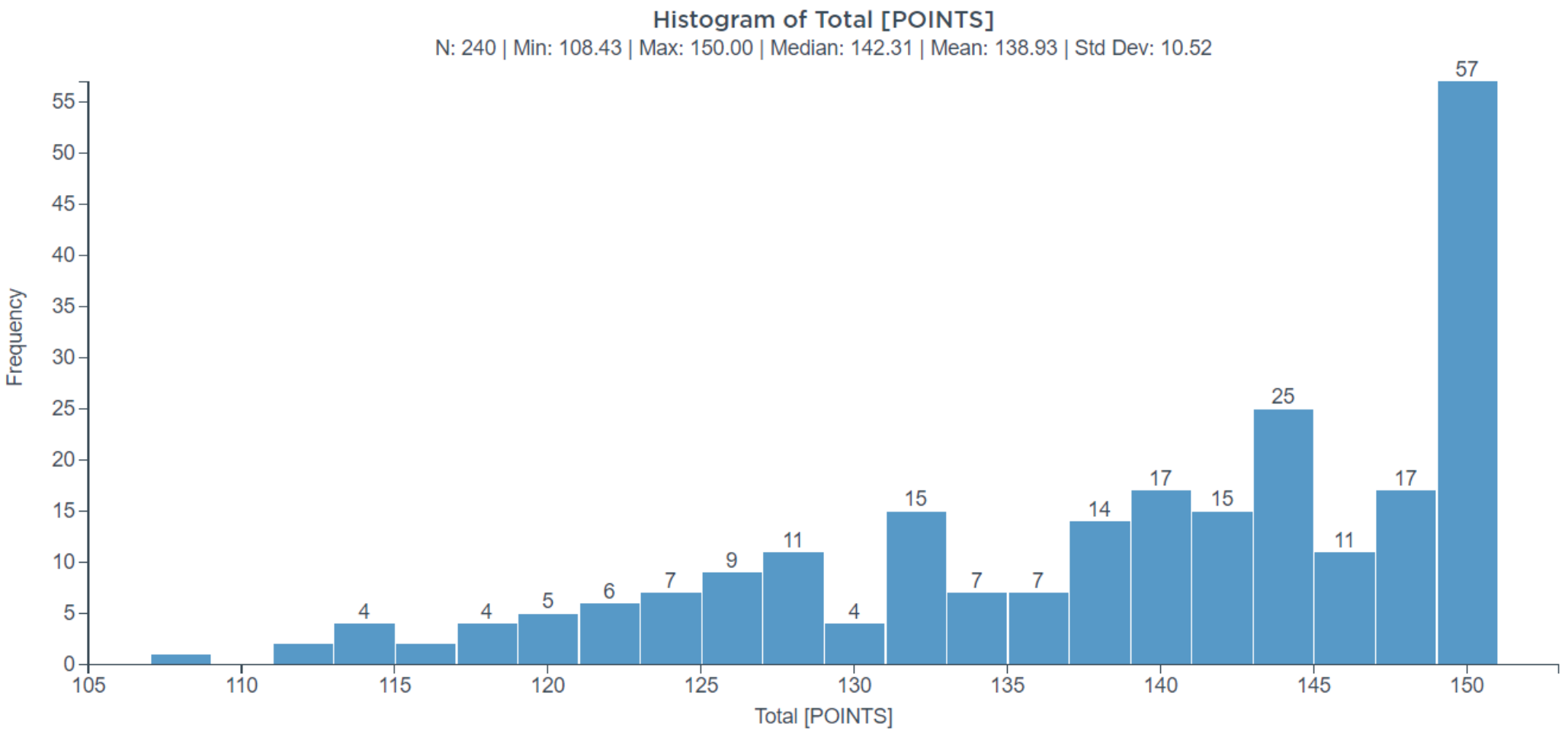
RESULTS: PARTICIPATION BY TPS



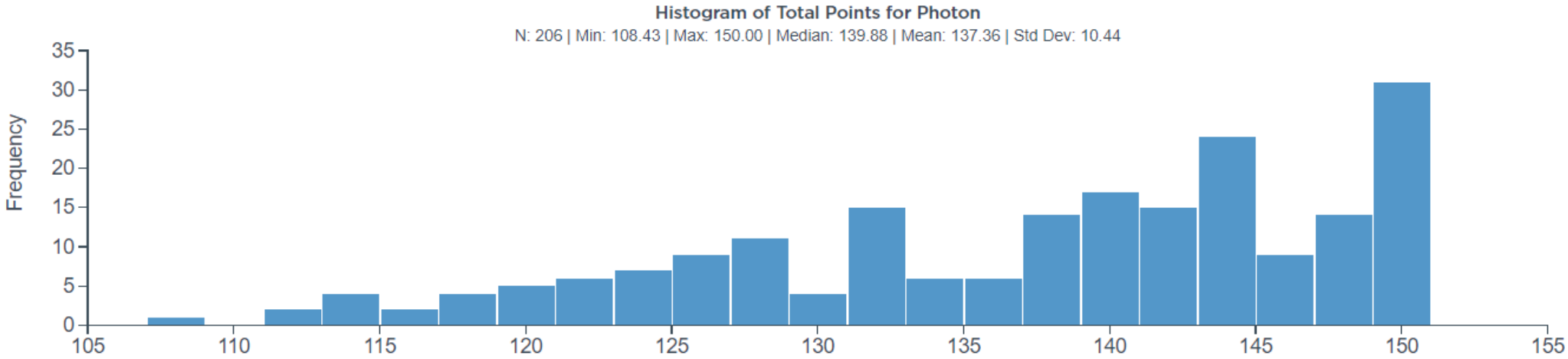
RESULTS: PARTICIPATION BY MODALITY

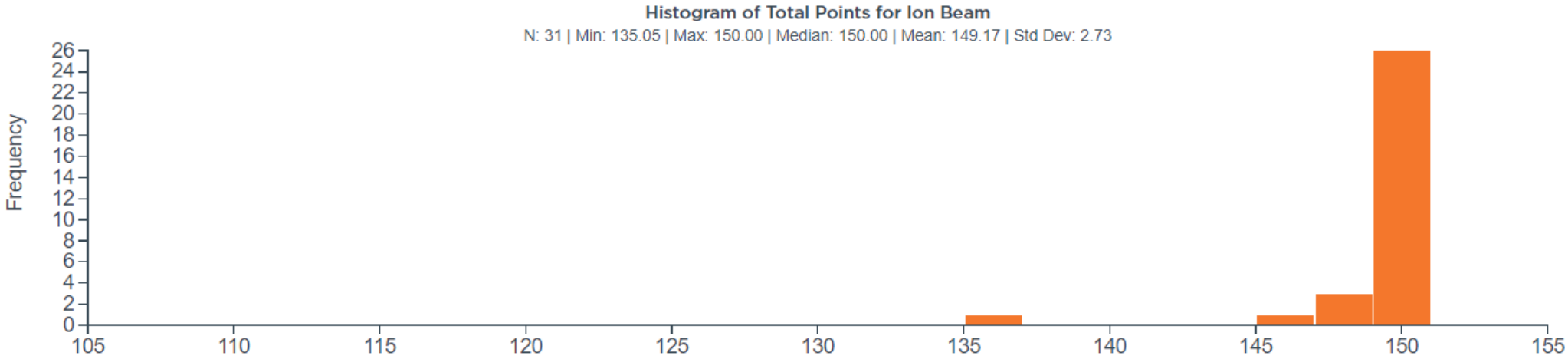


RESULTS: SCORE DISTRIBUTION (ALL)

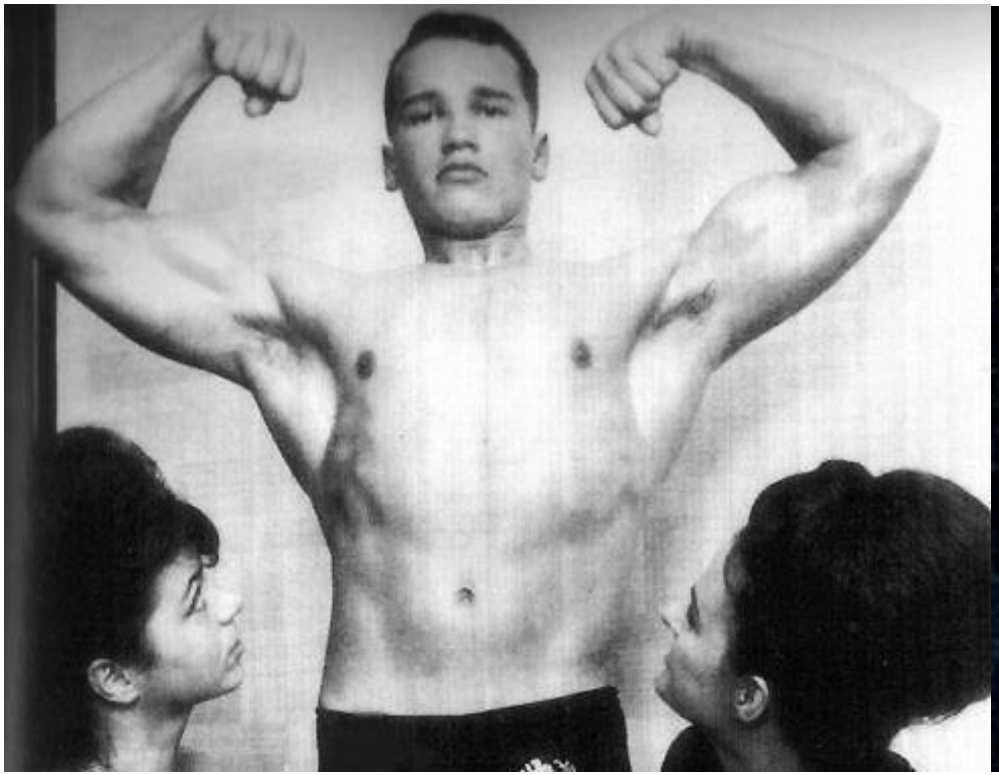


RESULTS: Photons VS Protons





If You Don't Measure It, You Can't Manage It





RESULTS: MEETING IDEAL REQUIREMENTS

# Ideal Requirements Achieved	N	%
24 (out of 24)	37	15.4
23	4	1.7
22	10	4.2
21	4	1.7
20	7	2.9
19	6	2.5
< 19	172	71.6

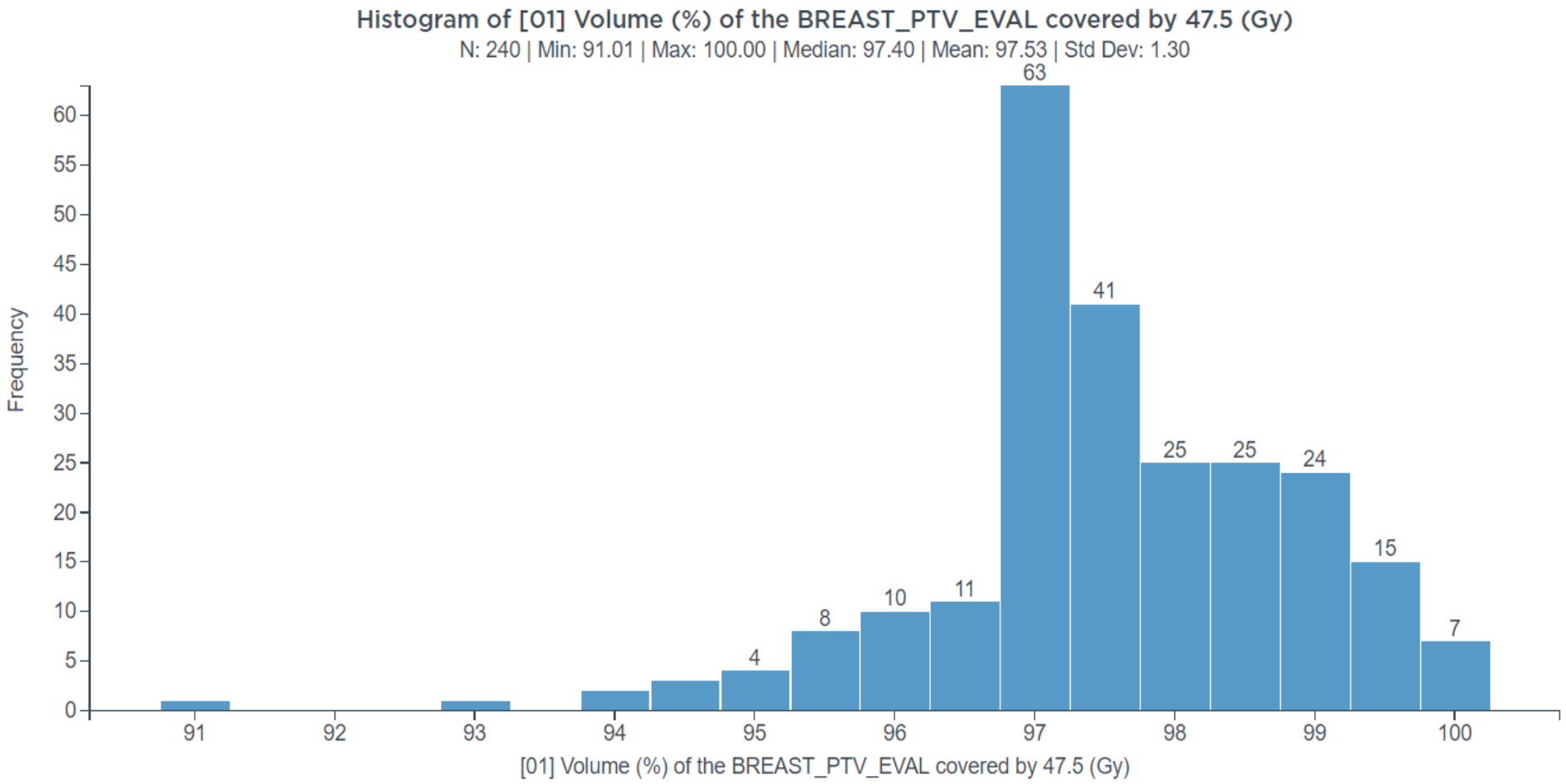
RESULTS: MEETING MIN REQUIREMENTS

# Min Requirements Achieved	N	%
24 (out of 24)	130	54.2
23	30	12.5
22	14	5.8
21	20	8.3
20	14	5.8
19	9	3.8
< 19	23	9.6

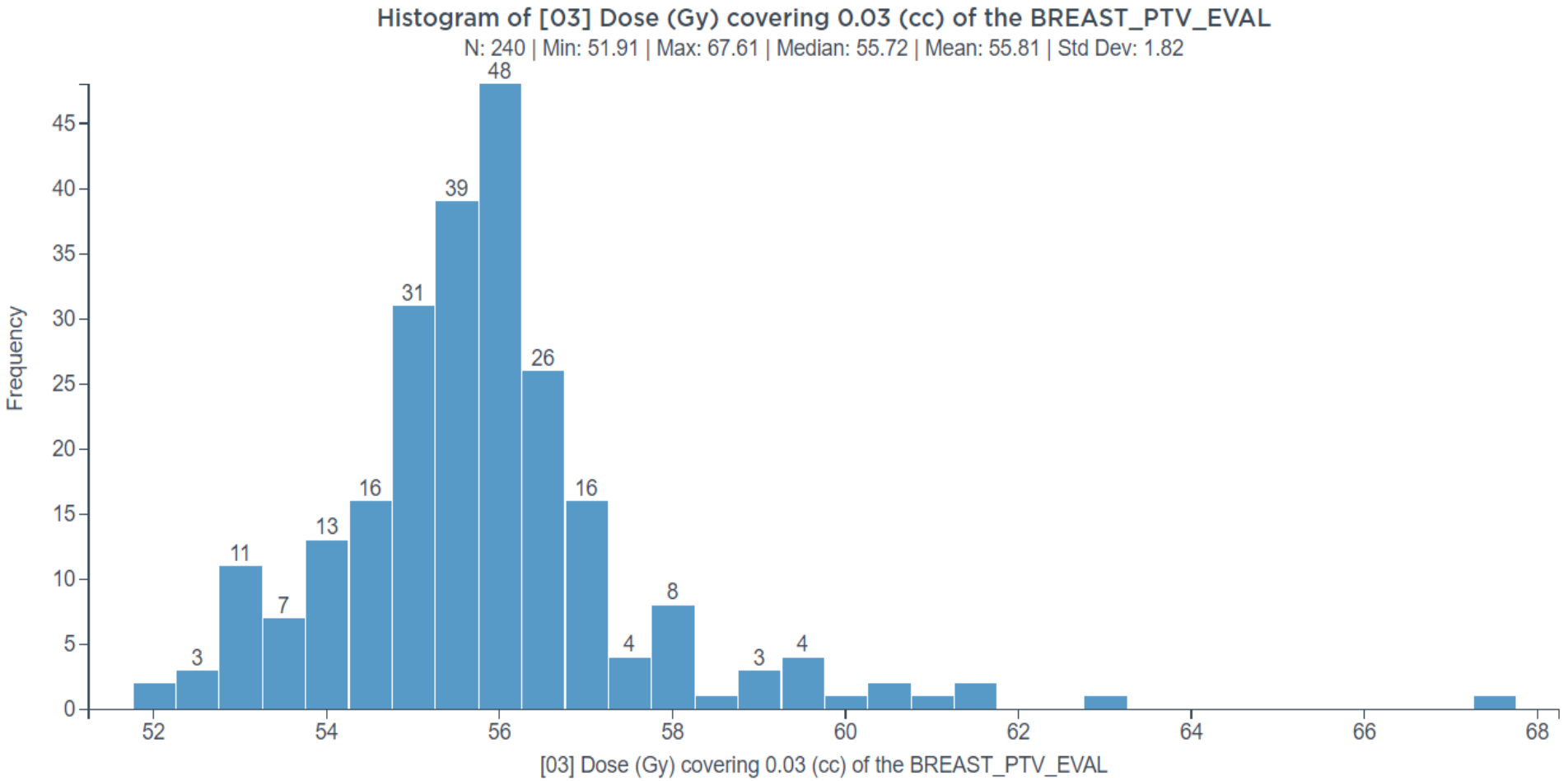
RESULTS: MEETING MIN REQUIREMENTS



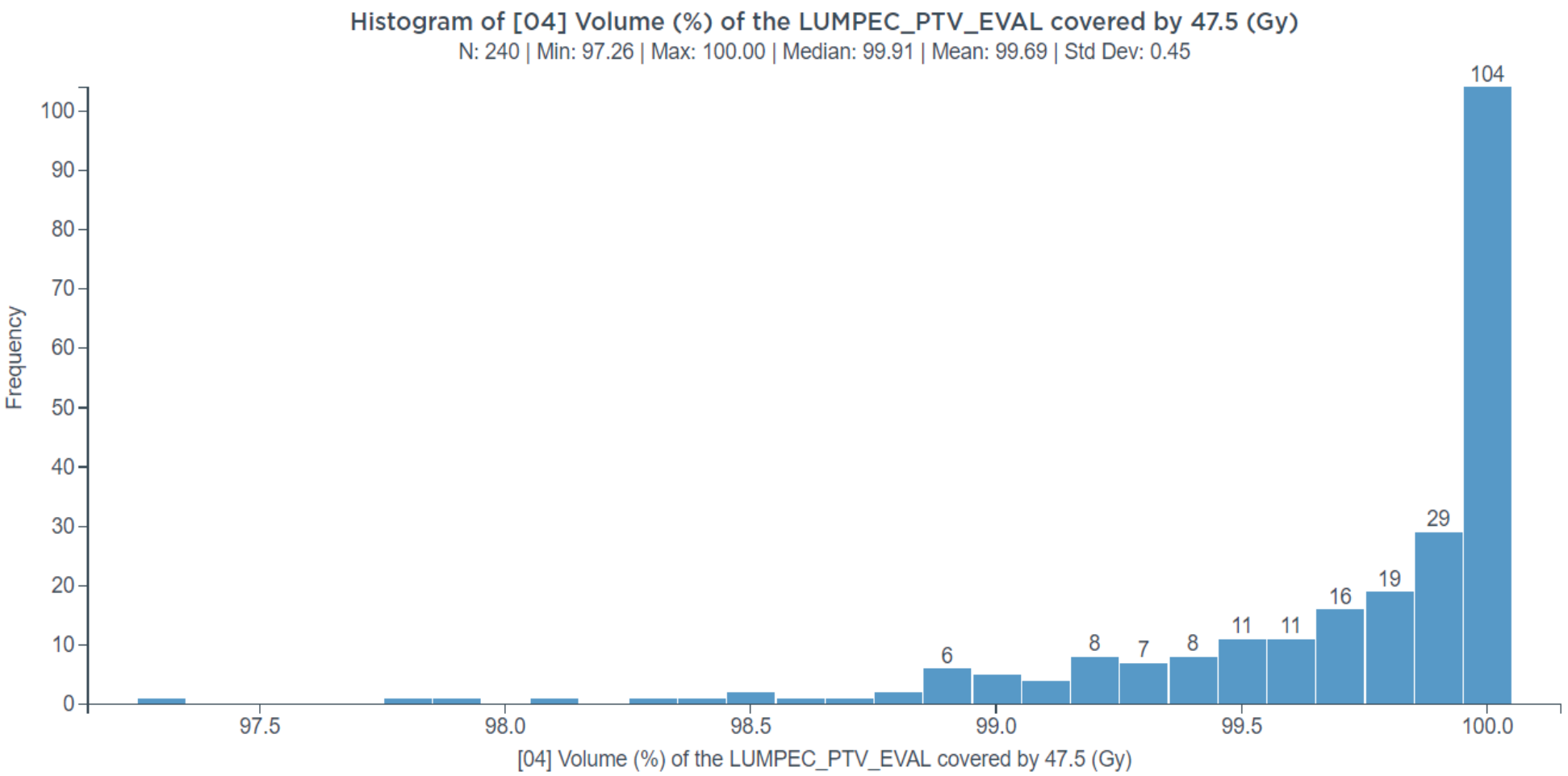
METRIC: BREAST_PTV_EVAL



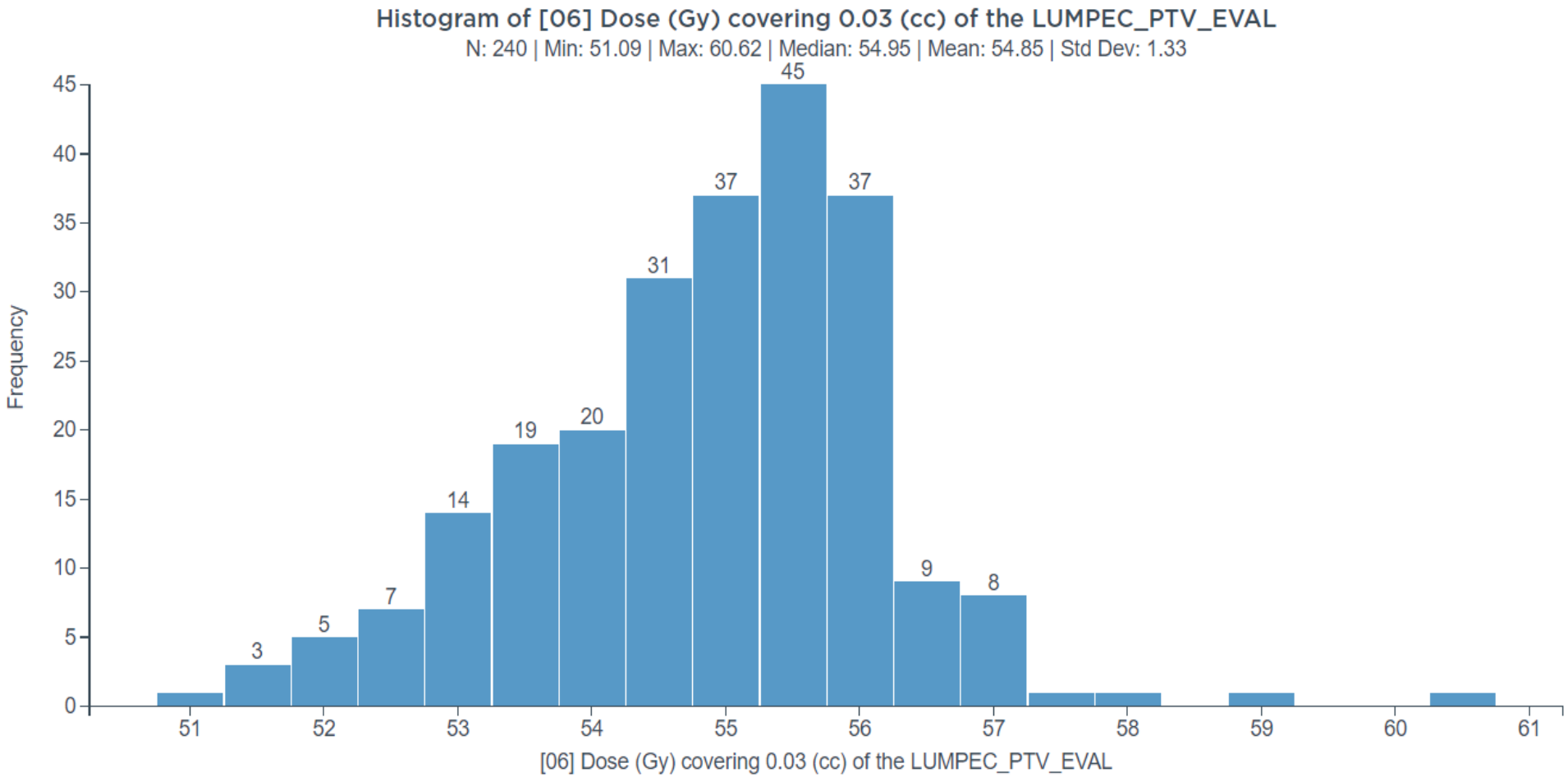
METRIC: BREAST_PTV_EVAL



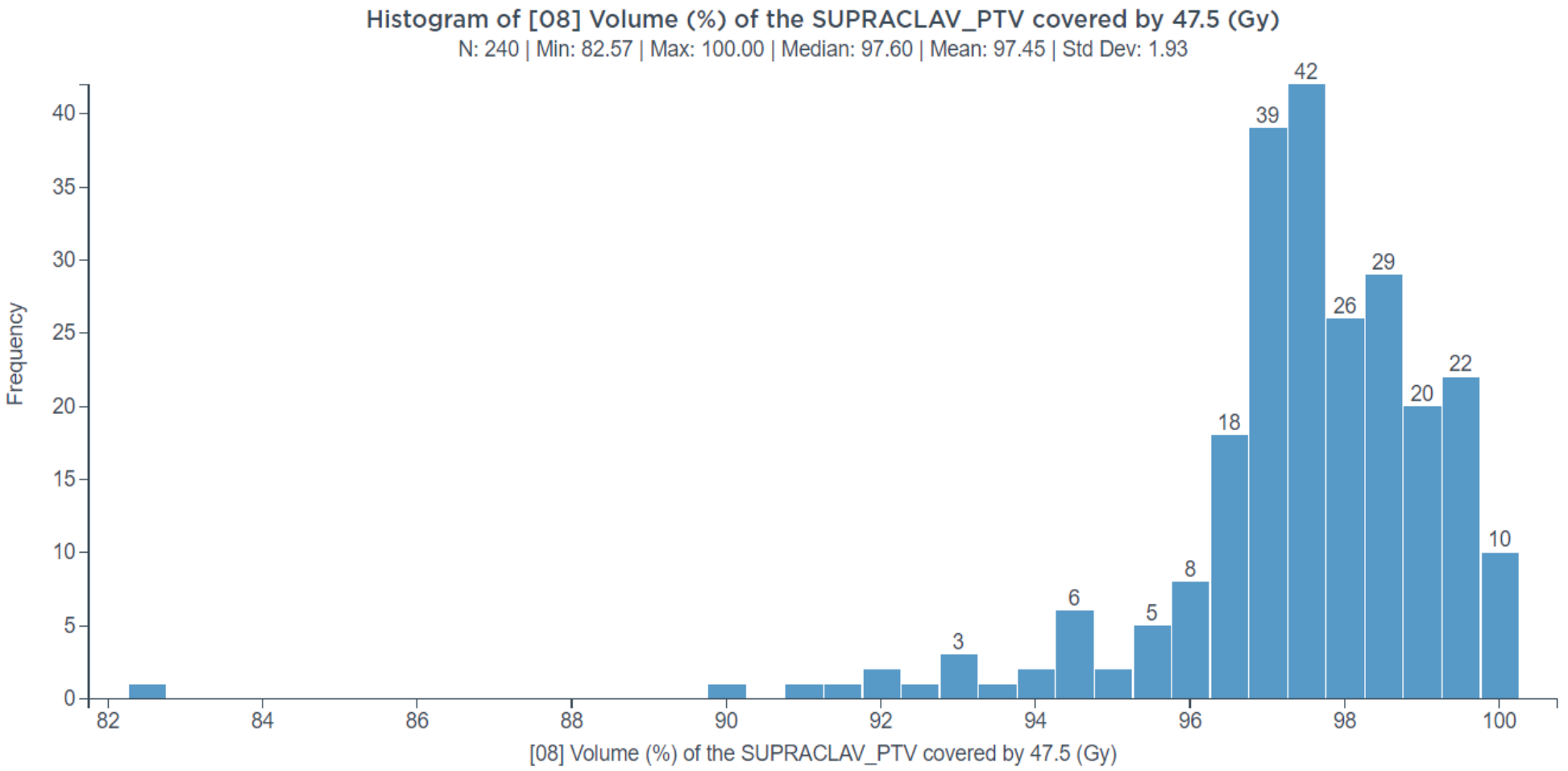
METRIC: LUMPEC_PTV_EVAL



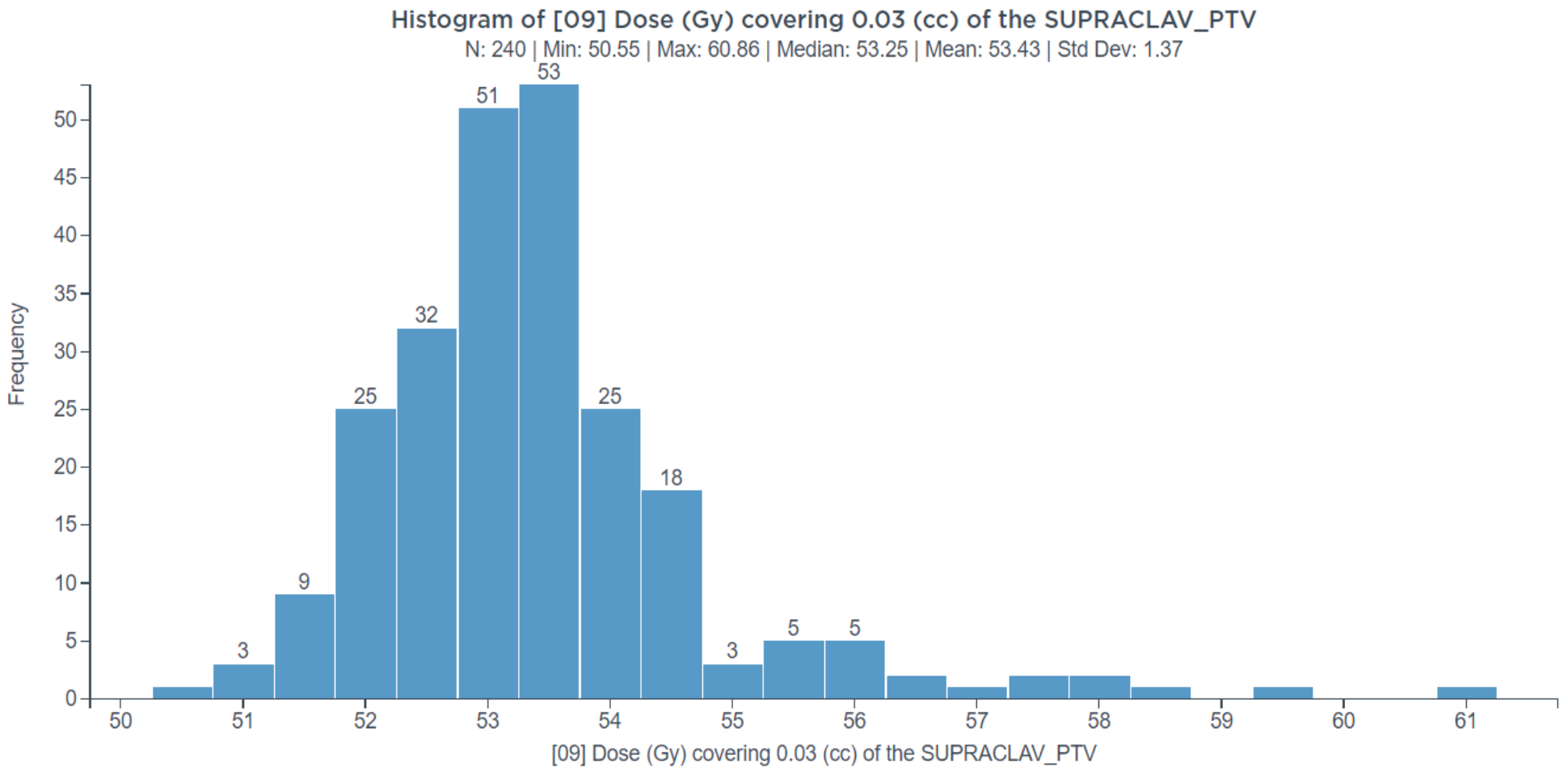
METRIC: LUMPEC_PTV_EVAL



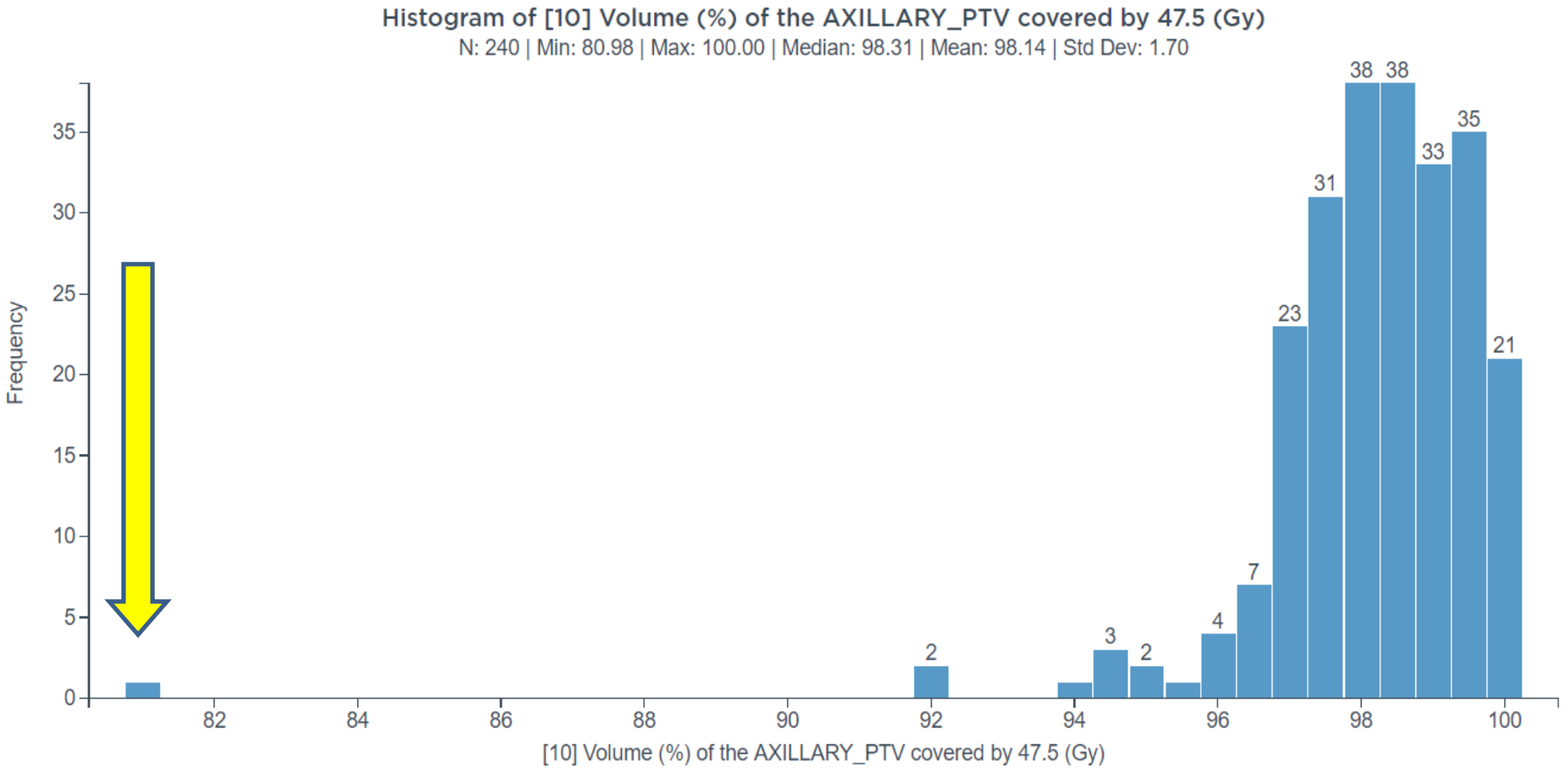
METRIC: SUPRACLAV_PTV



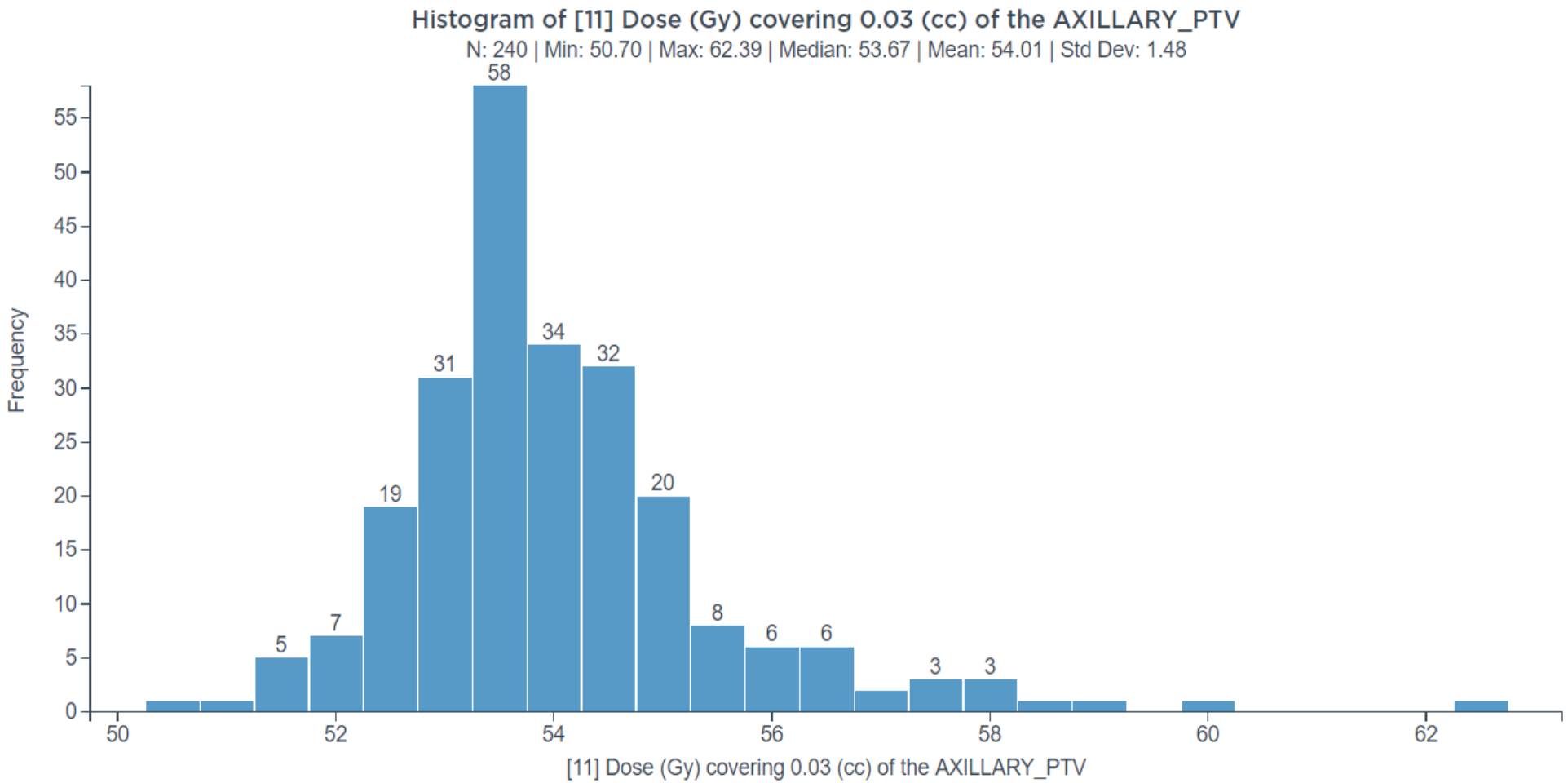
METRIC: SUPRACLAV_PTV



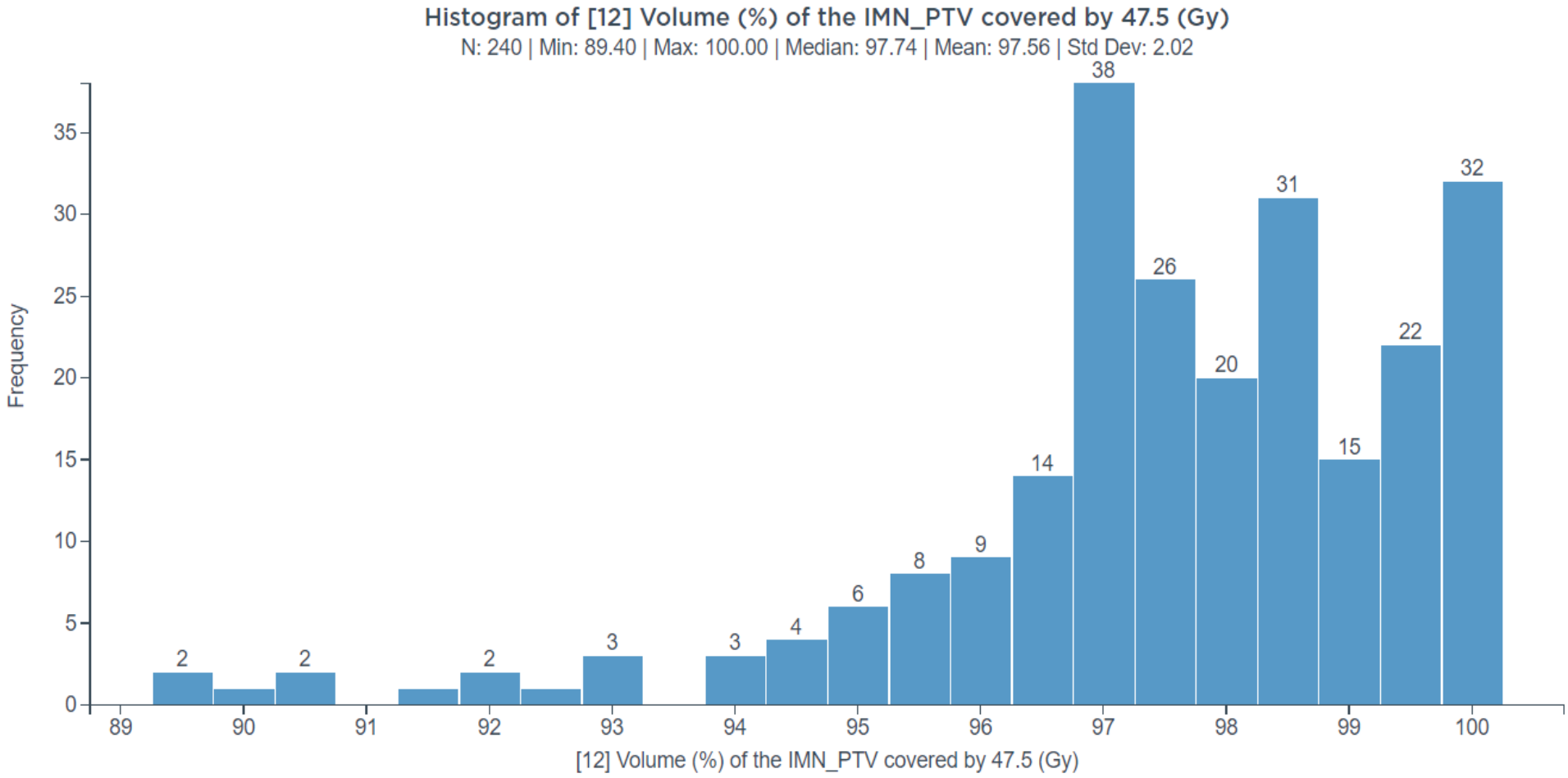
METRIC: AXILLARY_PTV



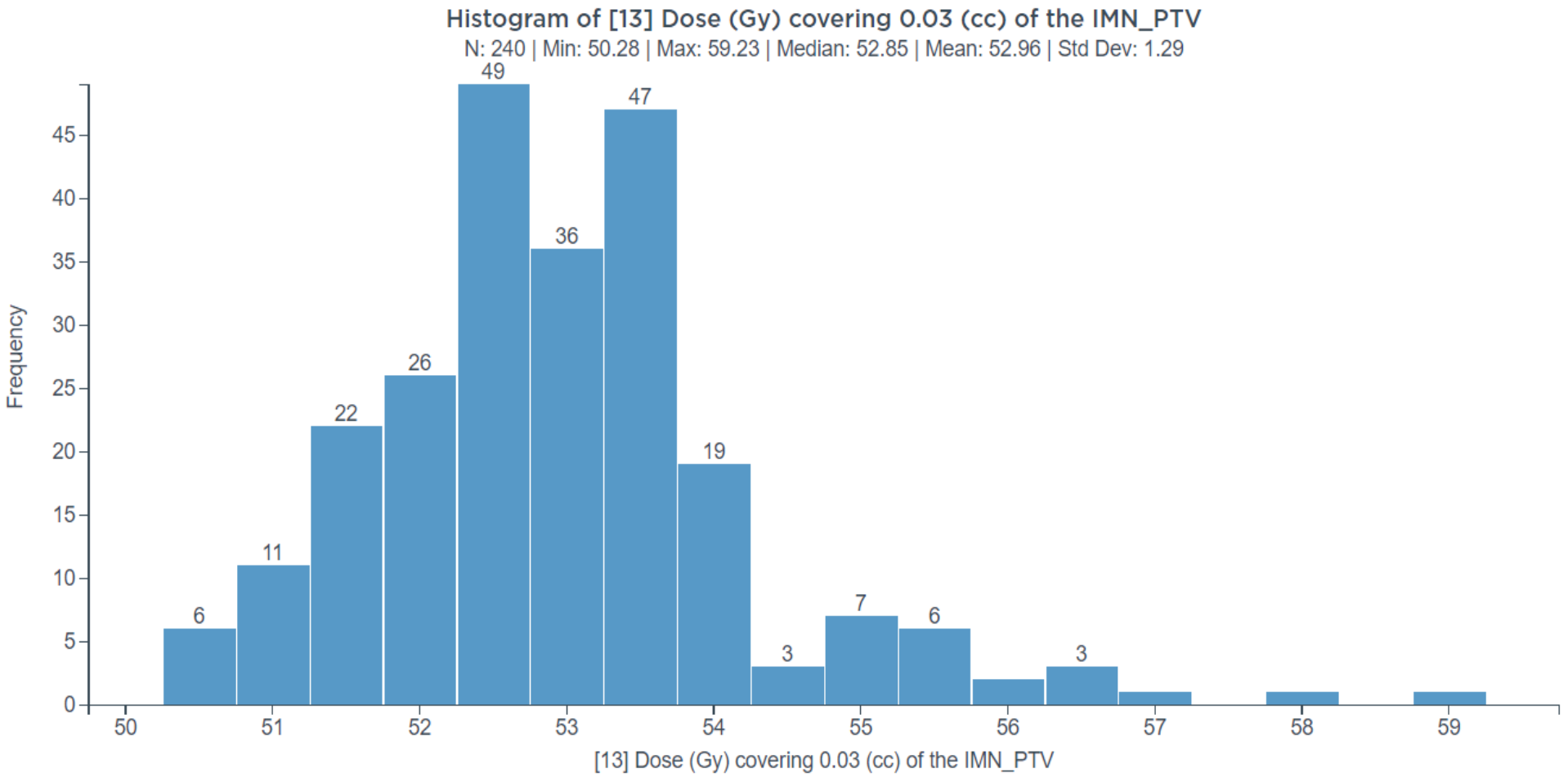
METRIC: AXILLARY_PTV



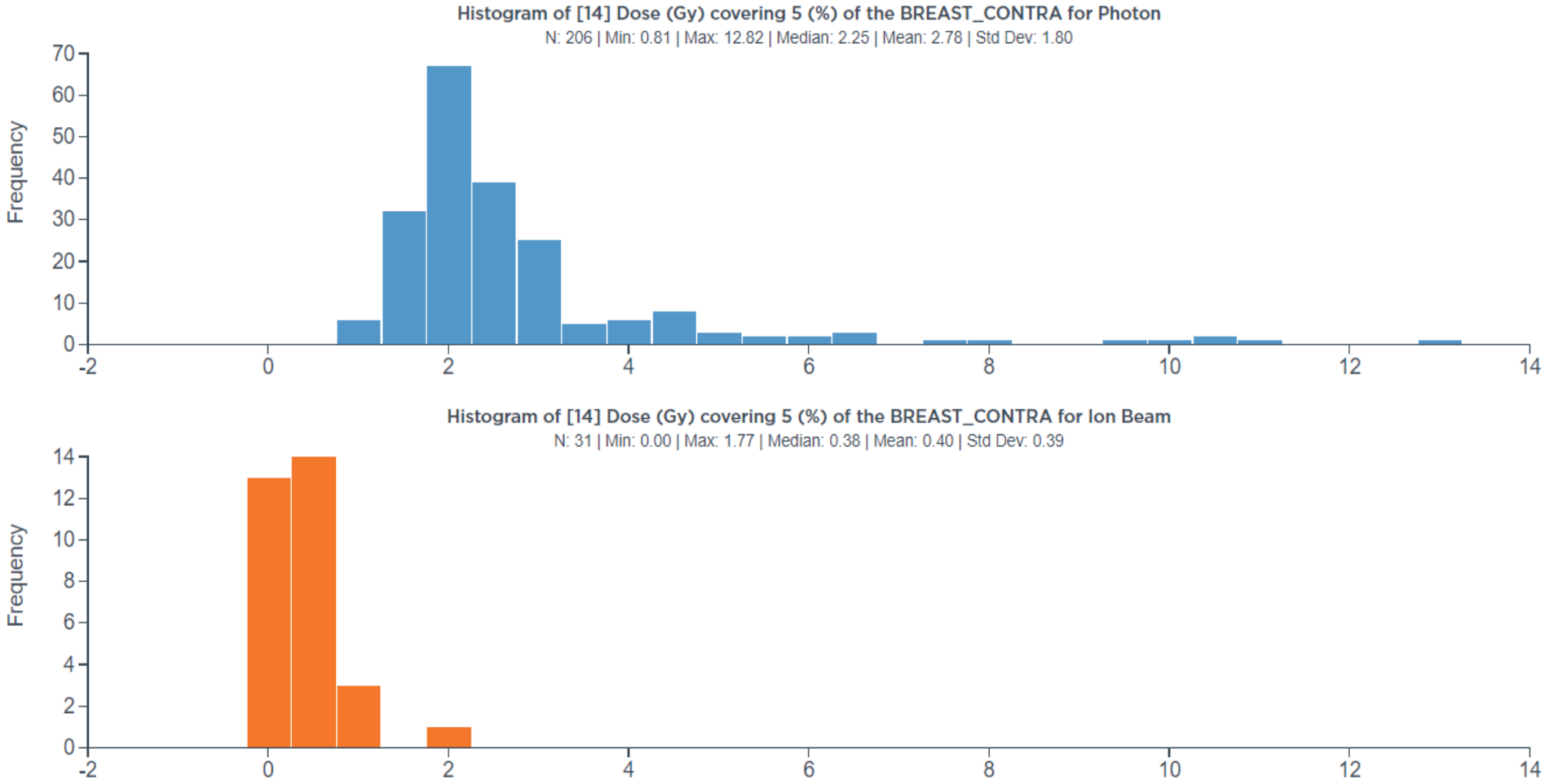
METRIC: IMN_PTV



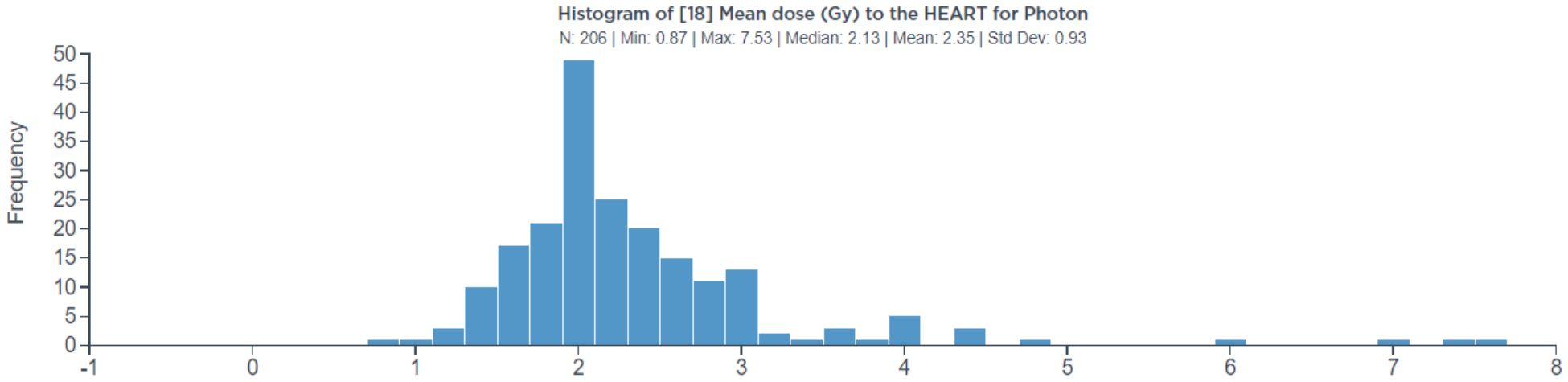
METRIC: IMN_PTV

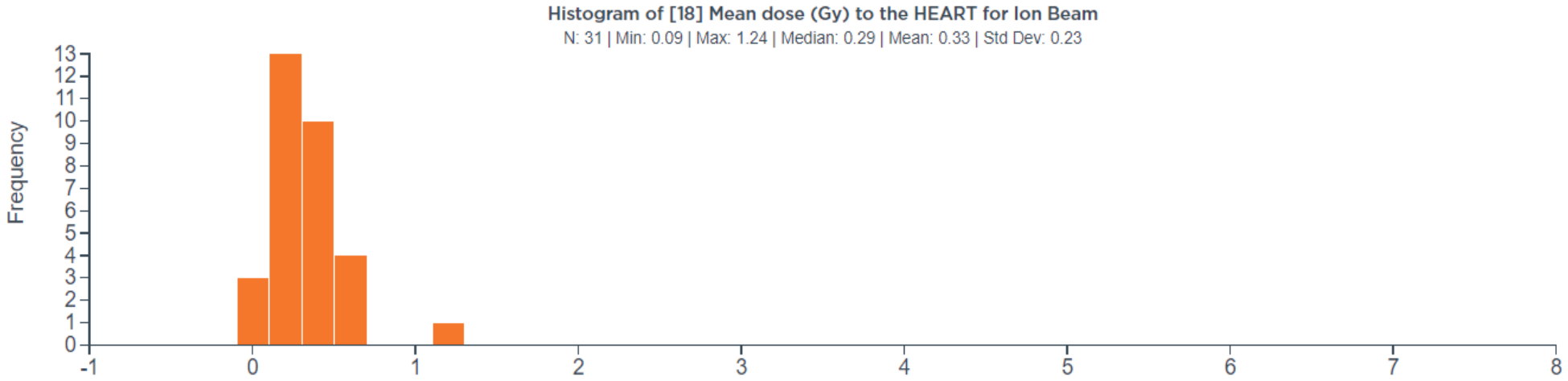


BREAST_CONTRA: Photons vs Protons

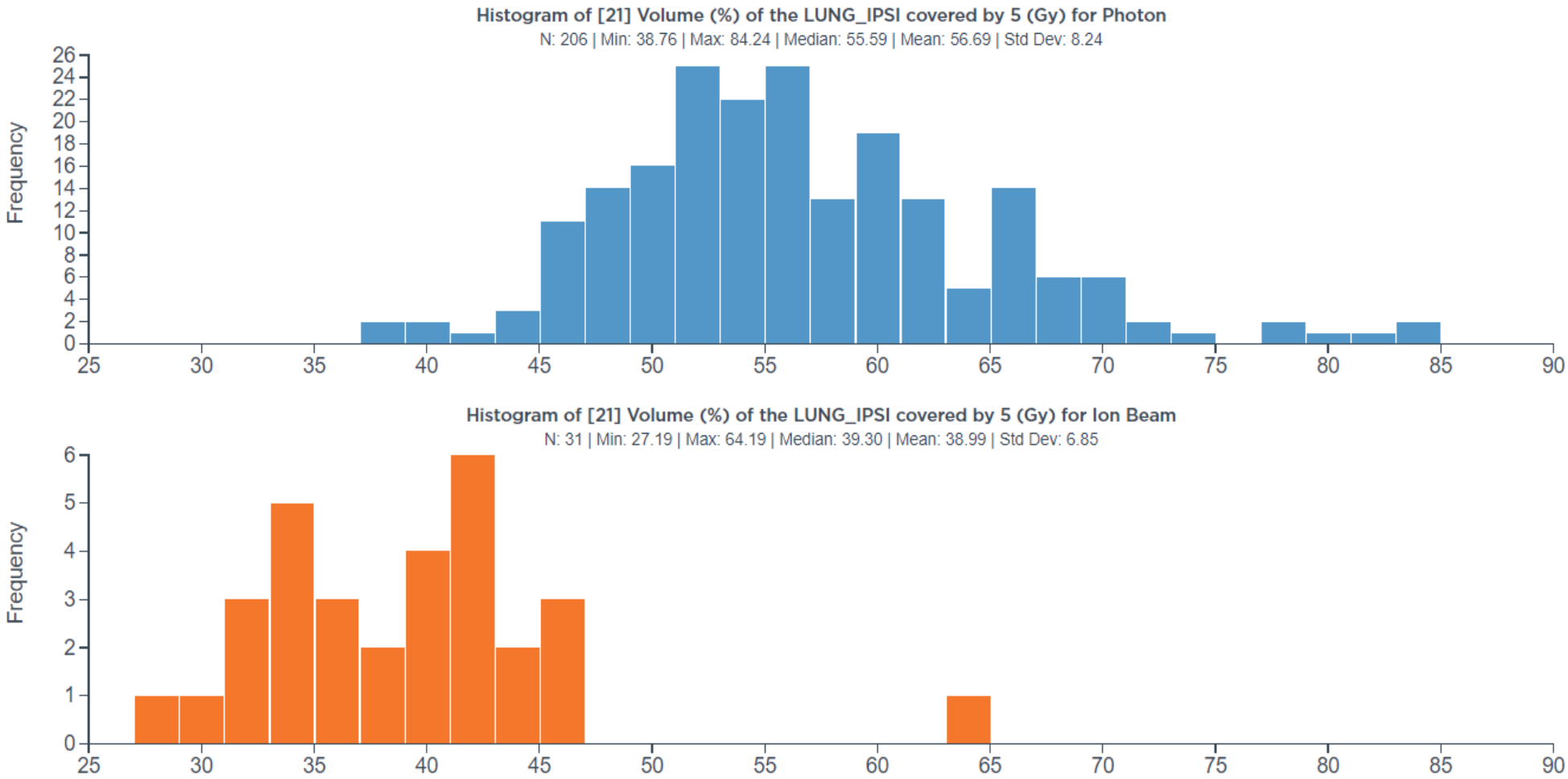


METRIC: HEART: Photon vs Proton

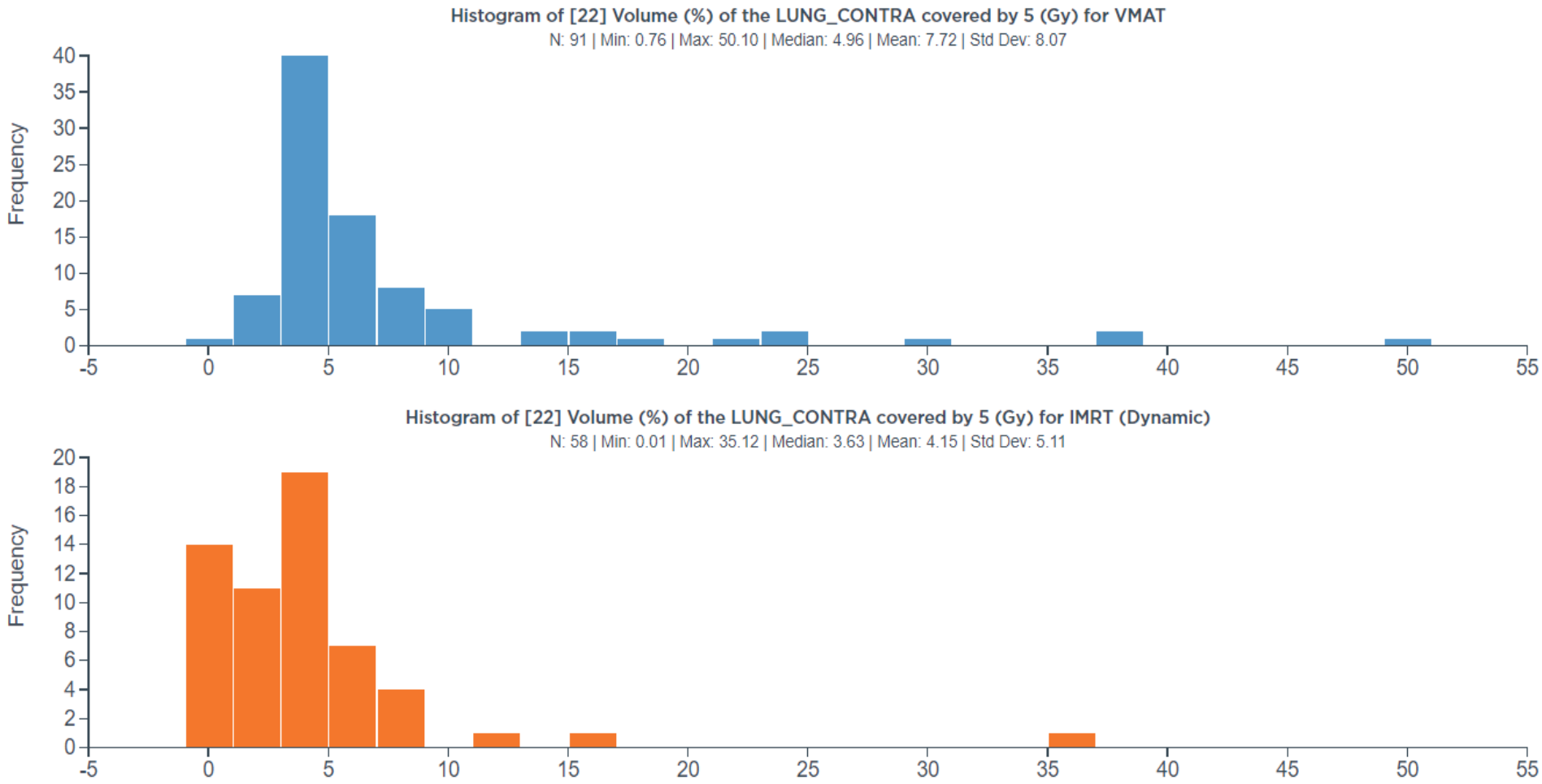




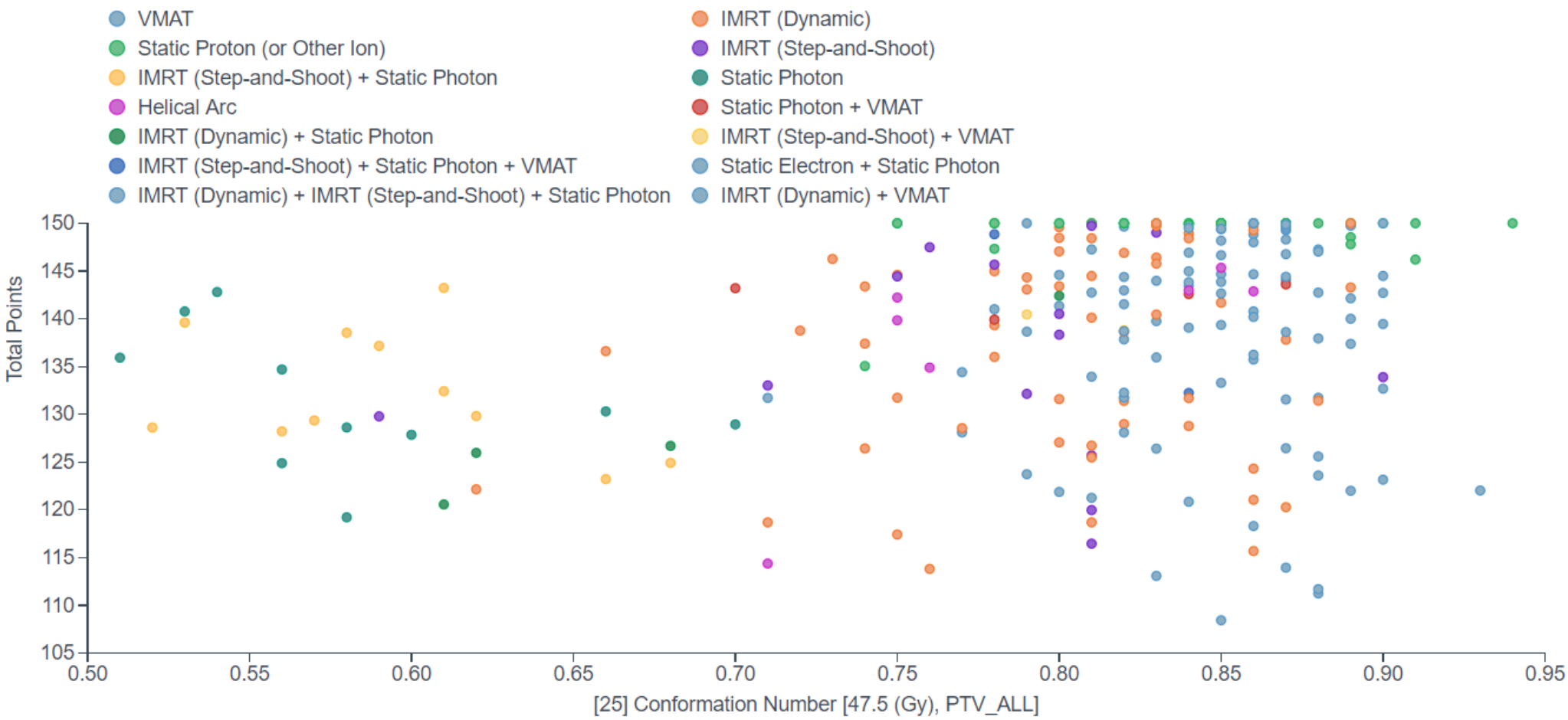
METRIC: LUNG_IPSI : Photon vs Proton



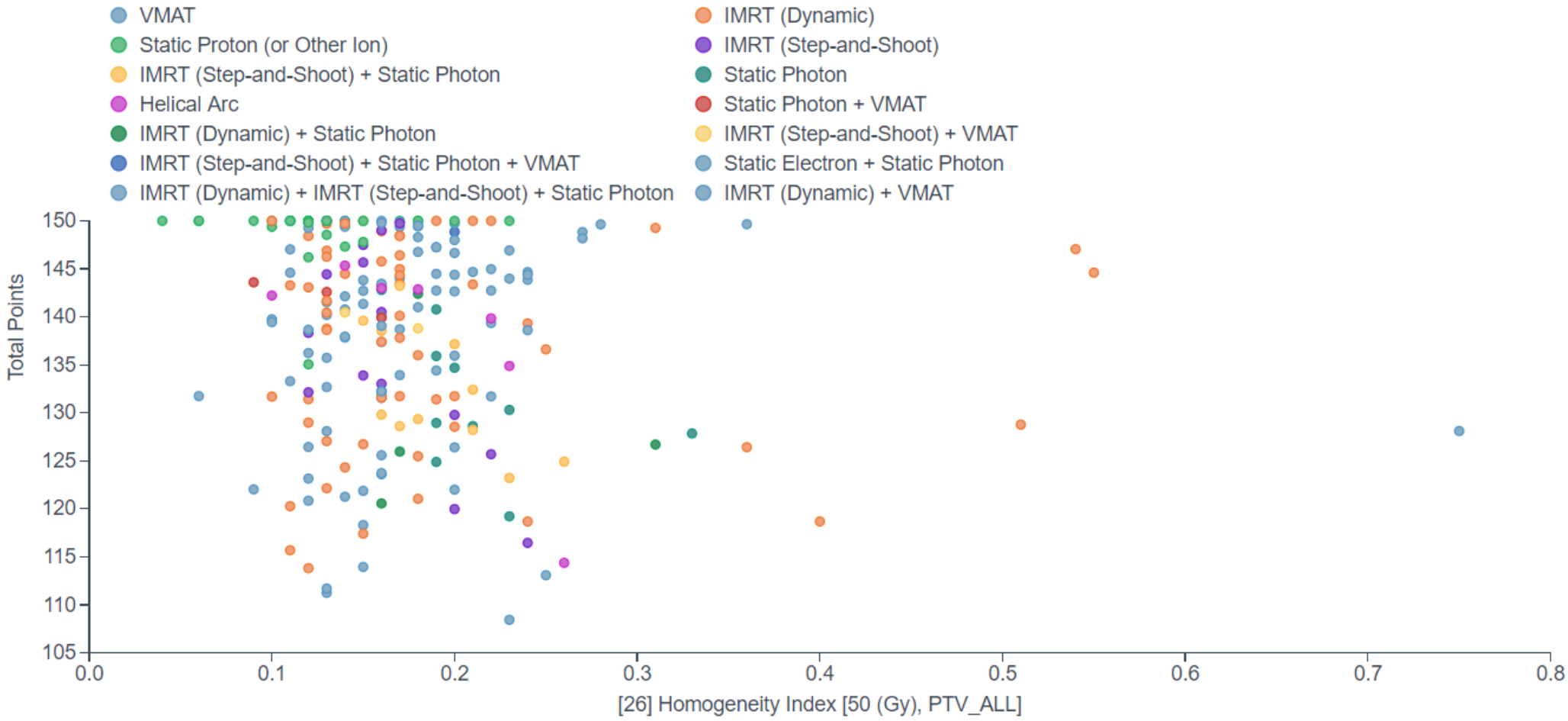
POPULATION DVH: LUNG_CONTRA



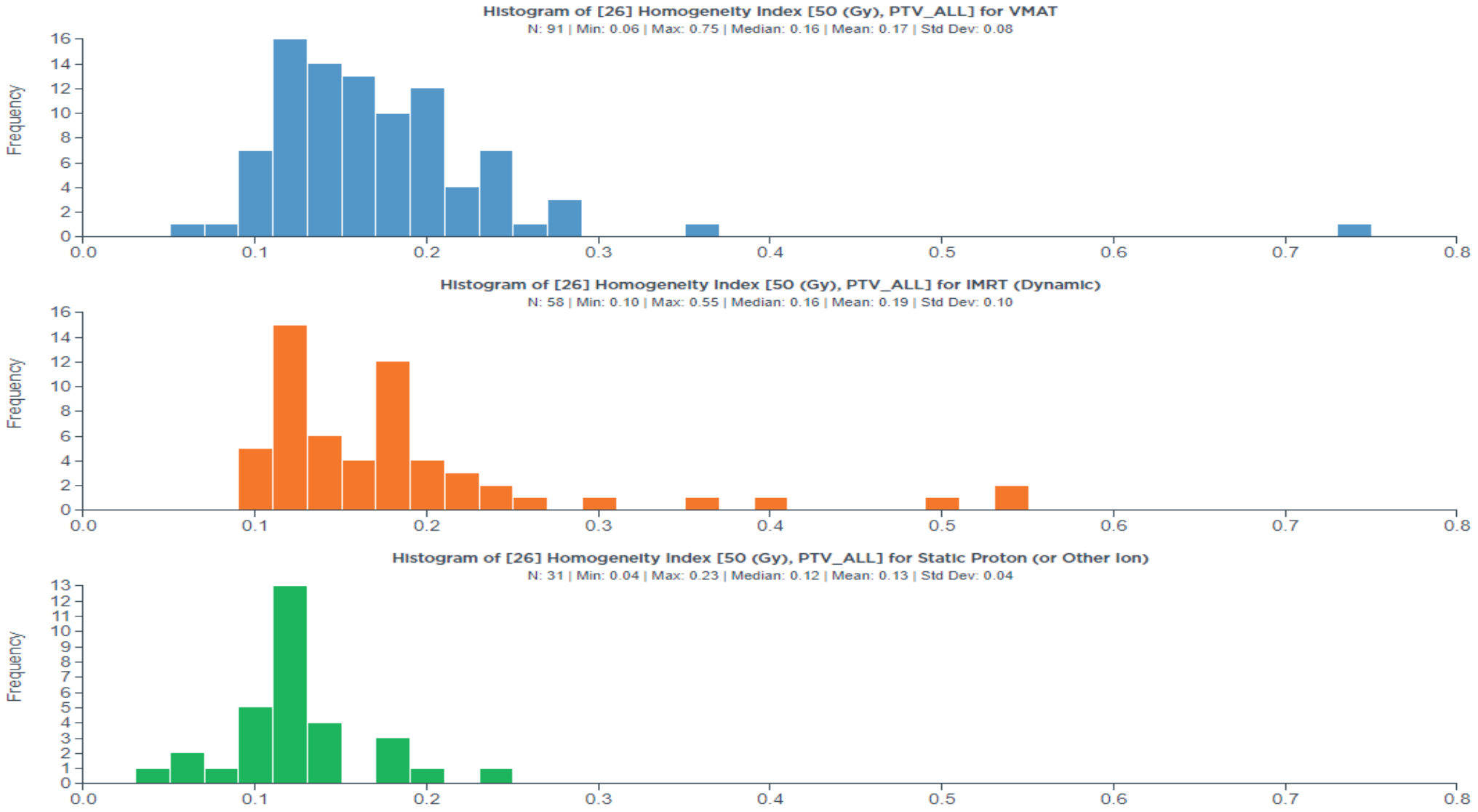
CONFORMATION NUMBER



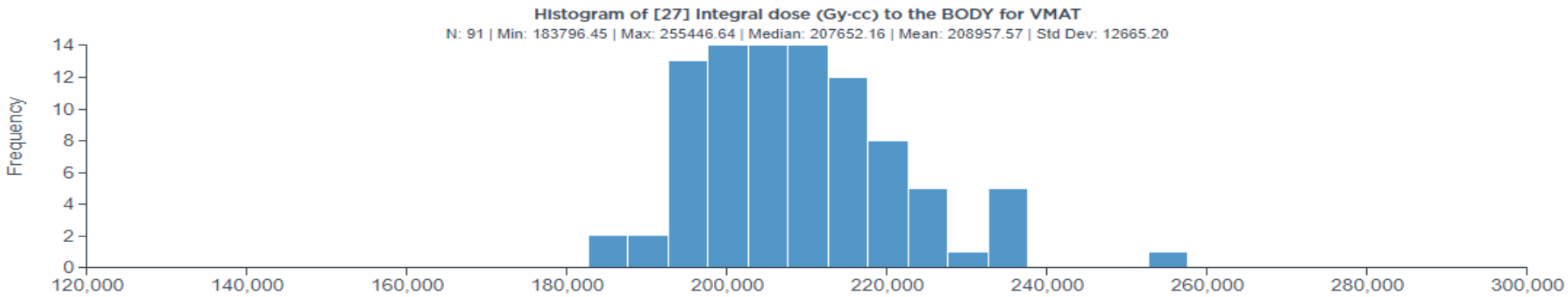
HOMOGENEITY INDEX (PTV ALL)

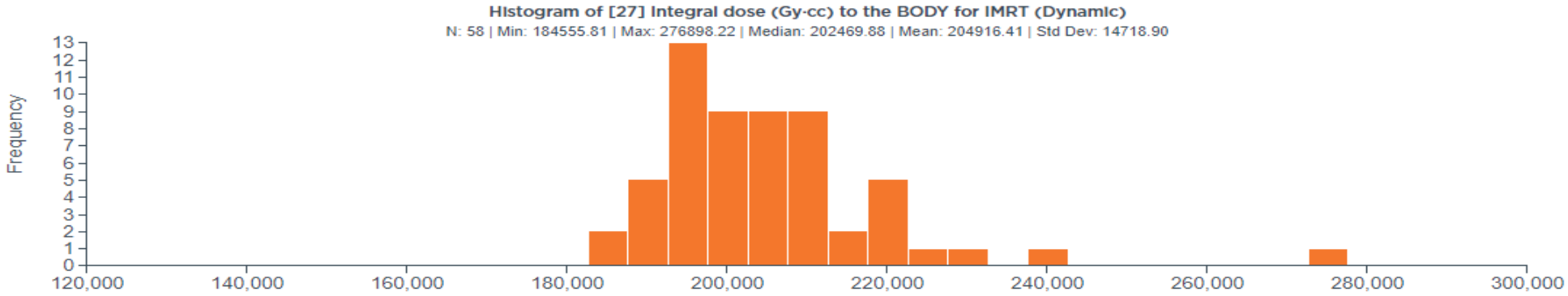


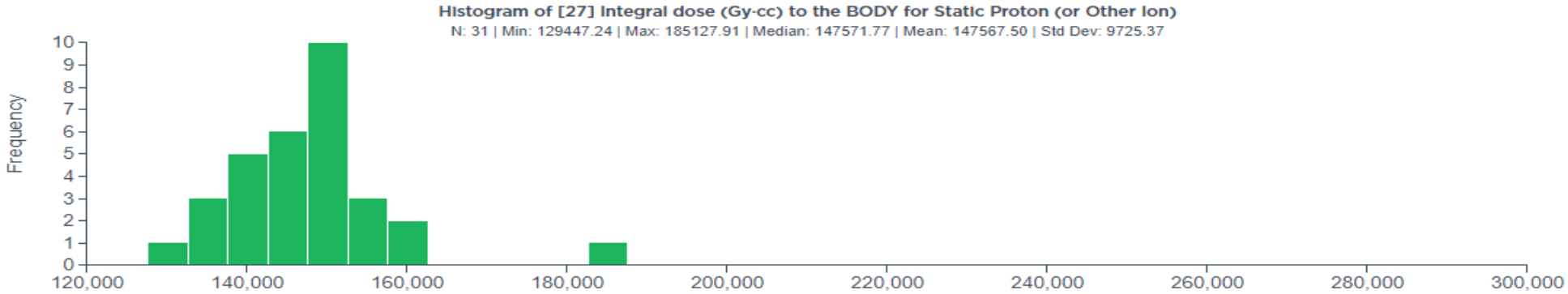
HOMOGENEITY INDEX (PTV ALL)



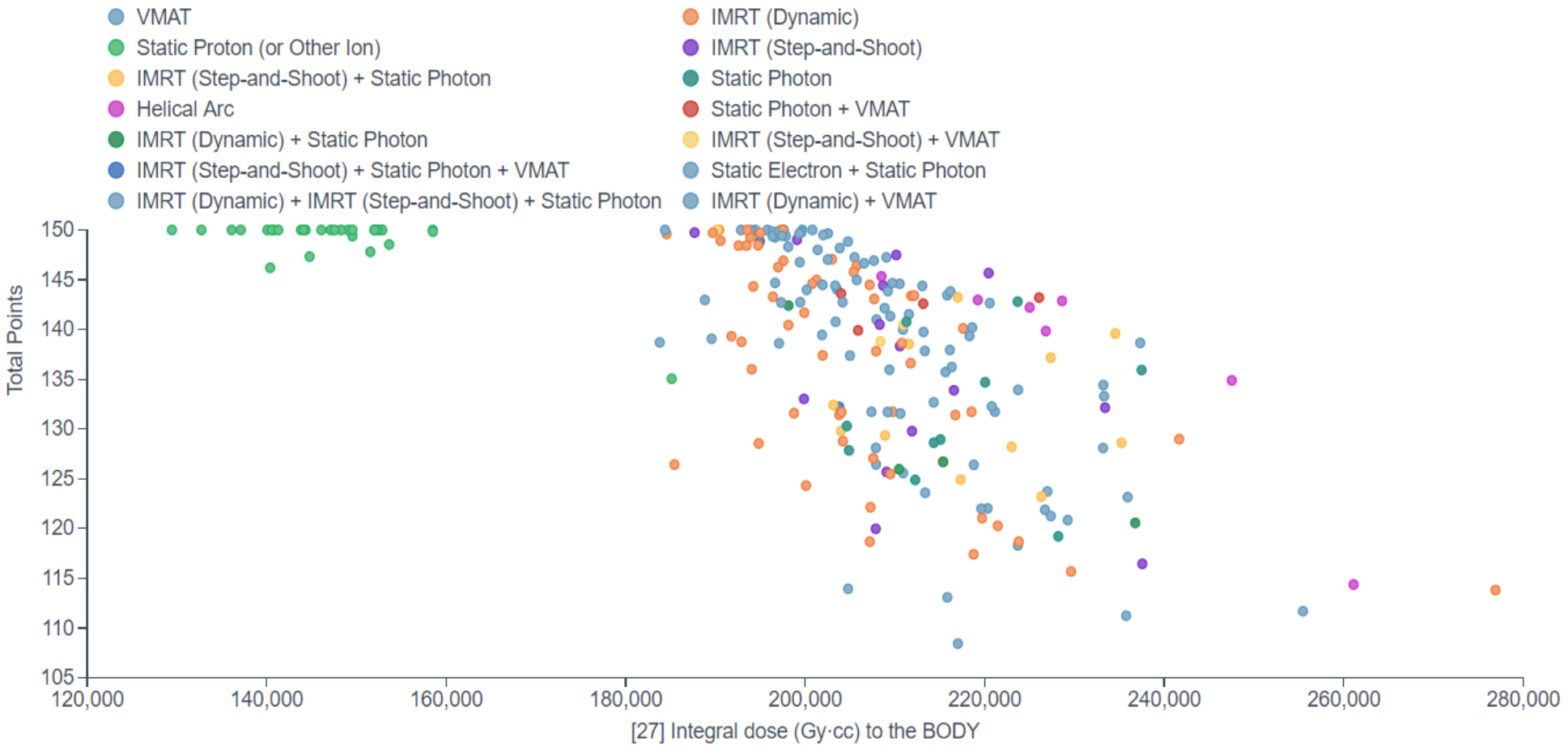
INTEGRAL DOSE TO BODY







INTEGRAL DOSE TO BODY



If You Don’t Measure It, You Can’t Manage It



RESULTS: INDIVIDUAL

- First, a word about individual recognition.
- **List of high performers**
- **“Best in Class” mentions**

Results: High Performers (145+)

Rolland Julien
Drew Granatowicz
Louis Genet
Charbel Attieh
Irina Fotina
William Starbuck
Charbel Attieh
Sergey Rusetskiy
Paul Barry
Luke Mackowiak
Wanglu
Wesley Zoller
Alex Goughenour
Amber Bryant
Anthony Magliari
Ben Robison
Brent Bachmann
Brian Neal
Dennie Fransen
Erin Gittings
James Henry
Jeff Stamper
Jennifer Sillings
Joakim Nilsson
Joe Simmons
Karla Leach
Keitt Mobile
Kevin Erhart
Kevin Sine
Laura Cutler
Nicolas Depauw
Reynald Vanderstraeten
Scott Petro
Shae Gans
Valerie Coffman
Wuyifan
Brandon Stone
Tiffany Shieder
David Ly
Hongdong Liu
Yuriy Filippov
Richard “Able” Shores
Norifumi Mizuno
Daniel Eiler
Ian Zoller
Nguyen Daniel
Mok To Wing
AdriÃ MarÃ
Caocan
Tongkaize
Kirsten
Nick Hutchinson
Chavanon Apinoraethkul
Roberto Pellegrini
Timothy Hancock
Takuya Ito
Mark Addington
Kirby DeLozier
Jonathan Stenbeck
Ontida Apinorasethkul
Alejandro
Wesley Groves
Adalicia DeGroff
Juan Maria Perez Moreno
Khaled Khatib
Yasuyuki Nakagawa
Ted Hoene
Shaomin Zhang
Hilarie Simpson
Shane Hagler
Kai Leung Li
Dalibor Lojko
Mary Headley
Angel
Megan Tattersall
Jason Edwards
Yuuta Miyake
Hadouane
Ruth Crawford
Lauren
Anthony Magliari
Mikhail Kuznetsov
Rachel
Nathan Corradini

Results: "Top 10 Students"

Name	Program	TPS	Modality	Score
Amber Bryant	RTU-VT	Ray Station	Proton	150.00
Erin Gittings	RTU-VT	Ray Station	Proton	150.00
Laura Cutler	RTU-VT	Ray Station	Proton	150.00
Hongdong Liu	Univ of Sci/Tech of China	Ray Station	Proton	149.83
Shane Hagler	MD Anderson	Pinnacle	VMAT	147.25
Ruth Crawford	SIU	Eclipse	IMRT	146.20
Rachel	Thomas Jefferson	Pinnacle	IMRT S/S	145.67
Praveen Kumar Nukasani	RTU-VT	Eclipse	IMRT	144.26
Sarena Eves	SIU	Pinnacle	VMAT	143.82
Benjamin Mowbray	SIU	Eclipse	STATIC	142.80

RESULTS: "BEST IN MU EFFICIENCY"

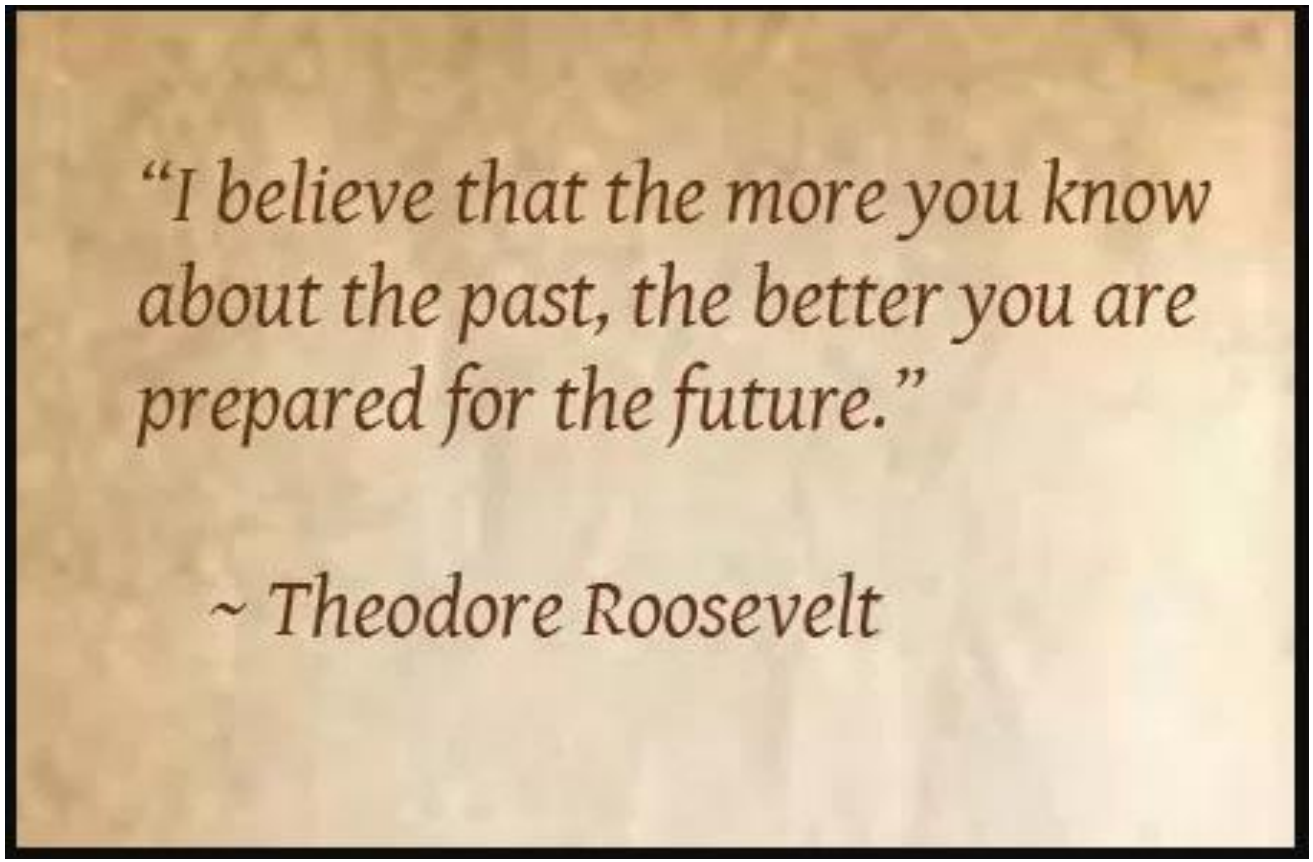
Name	Site	Technique & MU	Score
ROLLAND Julien	IPC CHICAS	VMAT 566 MU	150
Drew Granatowicz	Nebraska Medicine	IMRT (Step-and-Shoot) + VMAT 812 MU	150
Louis Genet	Elekta	VMAT 842 MU	150
Charbel Attieh	KHUH	IMRT (Dynamic) 869 MU	150

RESULTS: INDIVIDUAL DATA ANALYSIS

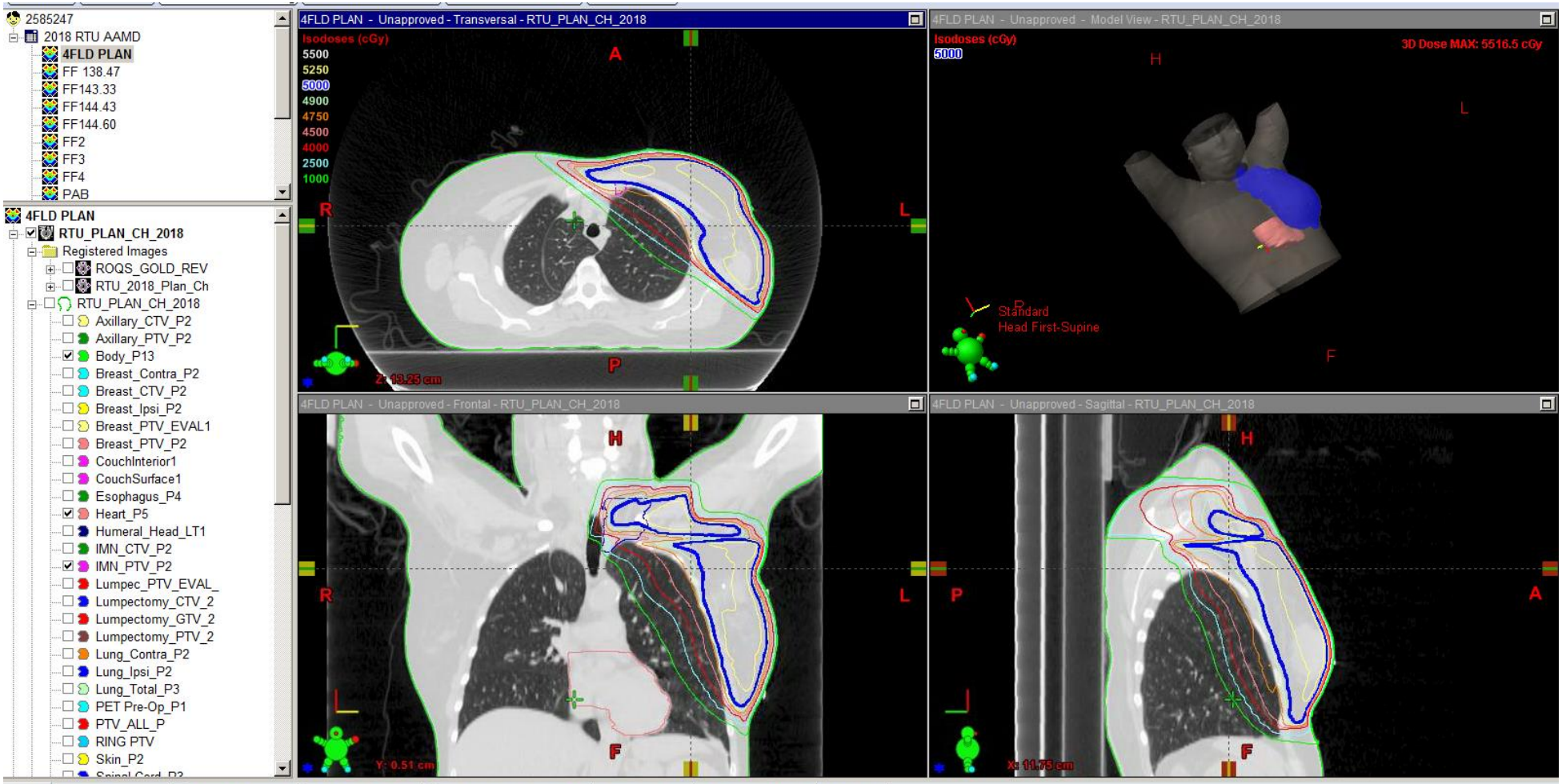
1. Sign in to www.proknowsystems.com
2. Go to “Plan Studies” (top menu)
3. Select Organization: AAMD
4. Select the 2018 AAMD/RSS Plan Study
5. Select the “Population Results” tab
6. Interactively study your plan’s result relative to the entire population of your peers (anonymous, of course).
    - Distributions (histograms)
    - Correlations (scatterplot)
    - Select any metric you want, not limited to the composite plan score

What does all this “BIG DATA” mean?

Historical Perspective



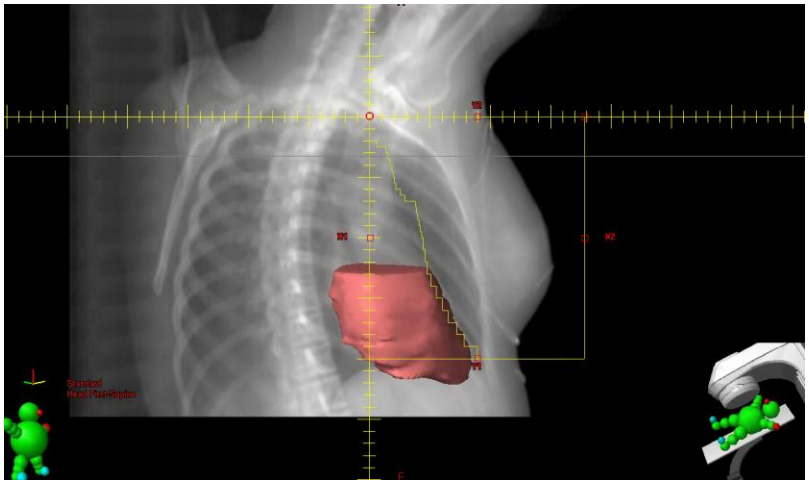
Traditional 4 field mono-isocentric breast



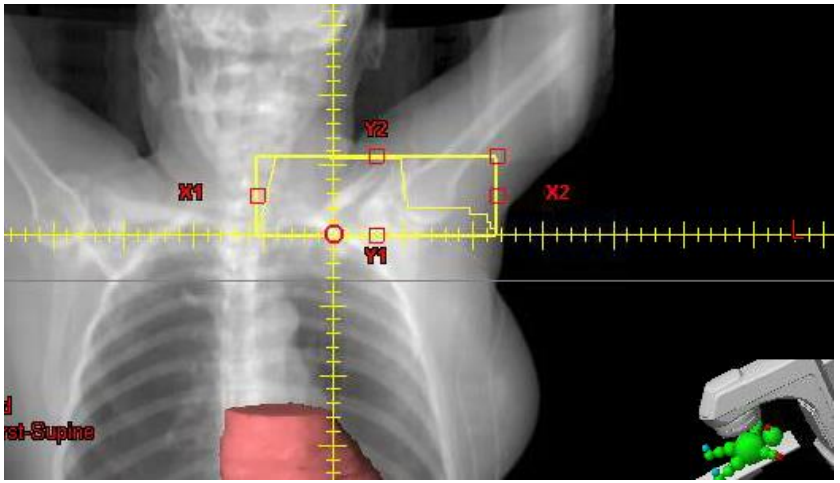
Fields | Dose Prescription | Field Alignments | Plan Objectives | Optimization Objectives | Dose Statistics | Calculation Models | Plan Sum

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]	Y1 [cm]	Y2 [cm]	X [cm]	Y [cm]	Z [cm]	SSD [cm]	MU	Ref. D [cGy]
☑	Field 1	STATIC-I	BHC-Trilogy - 6X	Dose Dynamic	1.000	Varian IEC	306.9	0.0	0.0	None	16.0	+0.0	+16.0	20.0	+20.0	+0.0	7.87	4.02	16.50	85.0	246	
☑	Field 2	STATIC-I	BHC-Trilogy - 23X	Static	1.000	Varian IEC	306.9	0.0	0.0	None	17.8	+0.0	+17.8	20.0	+20.0	+0.0	7.87	4.02	16.50	85.0	49	
☑	Field 3	STATIC-I	BHC-Trilogy - 6X	Dose Dynamic	1.000	Varian IEC	126.9	0.0	0.0	None	16.0	+16.0	+0.0	20.0	+20.0	+0.0	7.87	4.02	16.50	88.2	182	
☑	Field 4	STATIC-I	BHC-Trilogy - 23X	Static	1.000	Varian IEC	126.9	0.0	0.0	None	17.8	+17.8	+0.0	20.0	+20.0	+0.0	7.87	4.02	16.50	88.2	49	
☑	Field 5	STATIC-I	BHC-Trilogy - 23X	Static	3.270	Varian IEC	345.0	0.0	0.0	None	17.1	+5.5	+11.6	5.6	+0.0	+5.6	7.87	4.02	16.50	90.9	175	
☑	Field 6	STATIC-I	BHC-Trilogy - 6X	Static	0.330	Varian IEC	180.0	0.0	0.0	None	10.5	+9.6	+0.9	5.6	+0.0	+5.6	7.87	4.02	16.50	91.1	23	

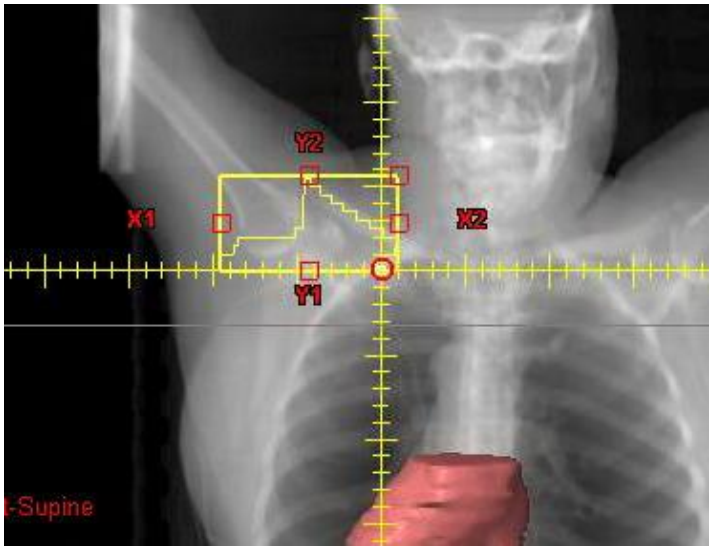
Beams Eye View



Typical high tangent with iso just inferior to humeral head

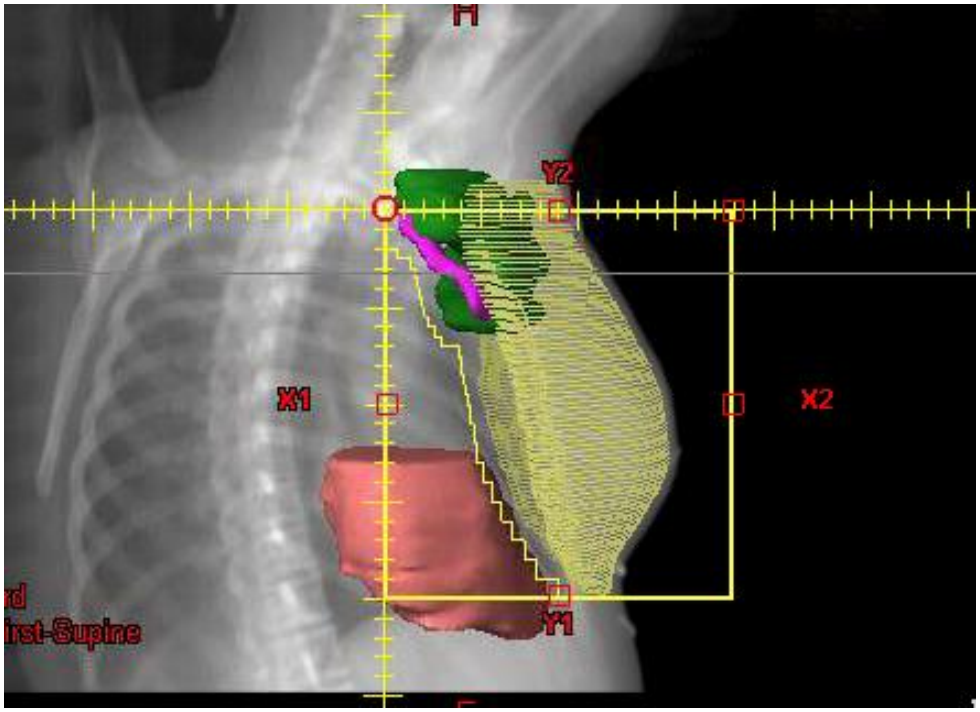


Scf field 15 degree angle with humeral head blocked



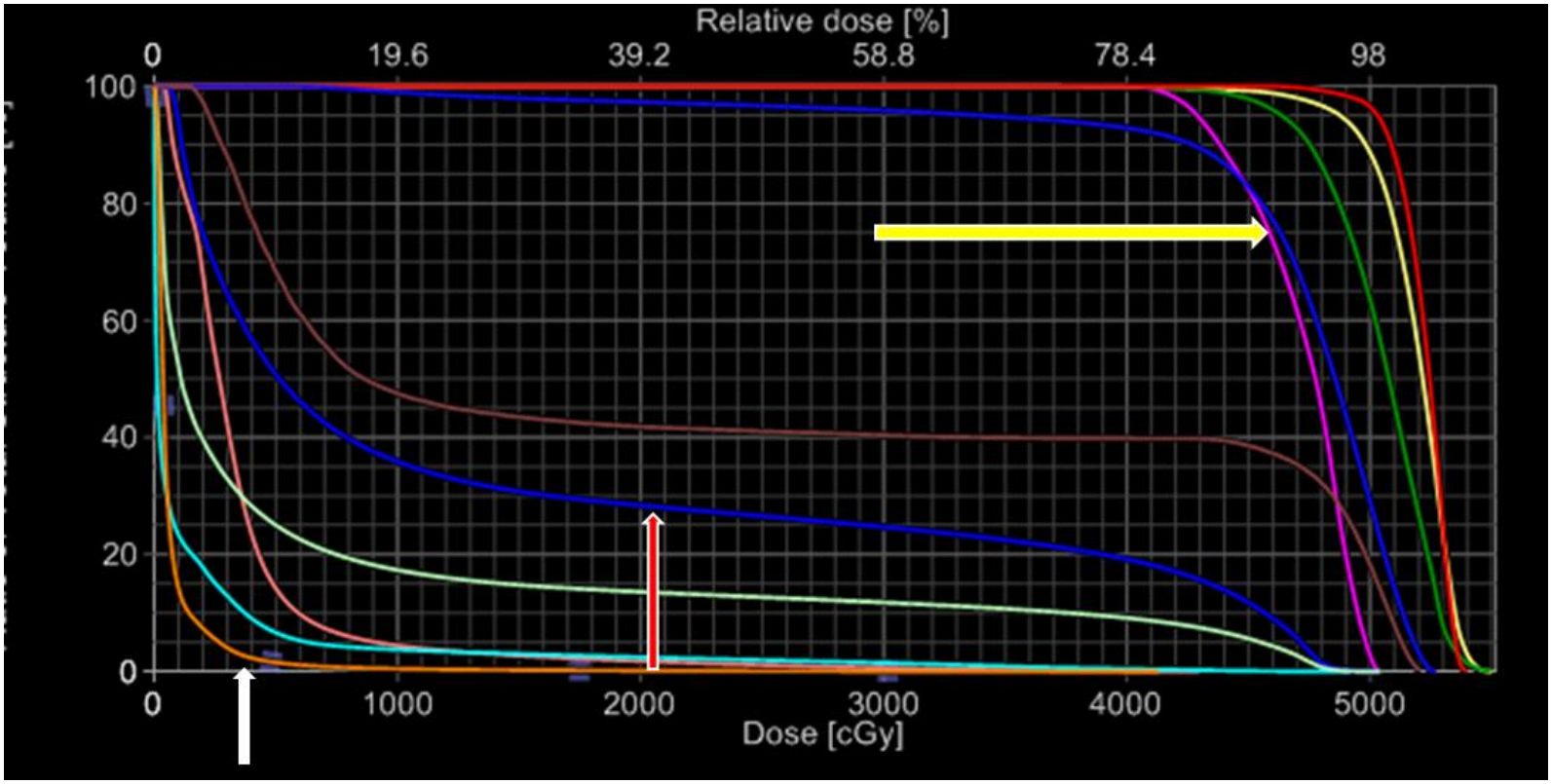
Traditional PAB with 20 cGy added per fraction to achieve 45 Gy at axillary fossa

Field Placement



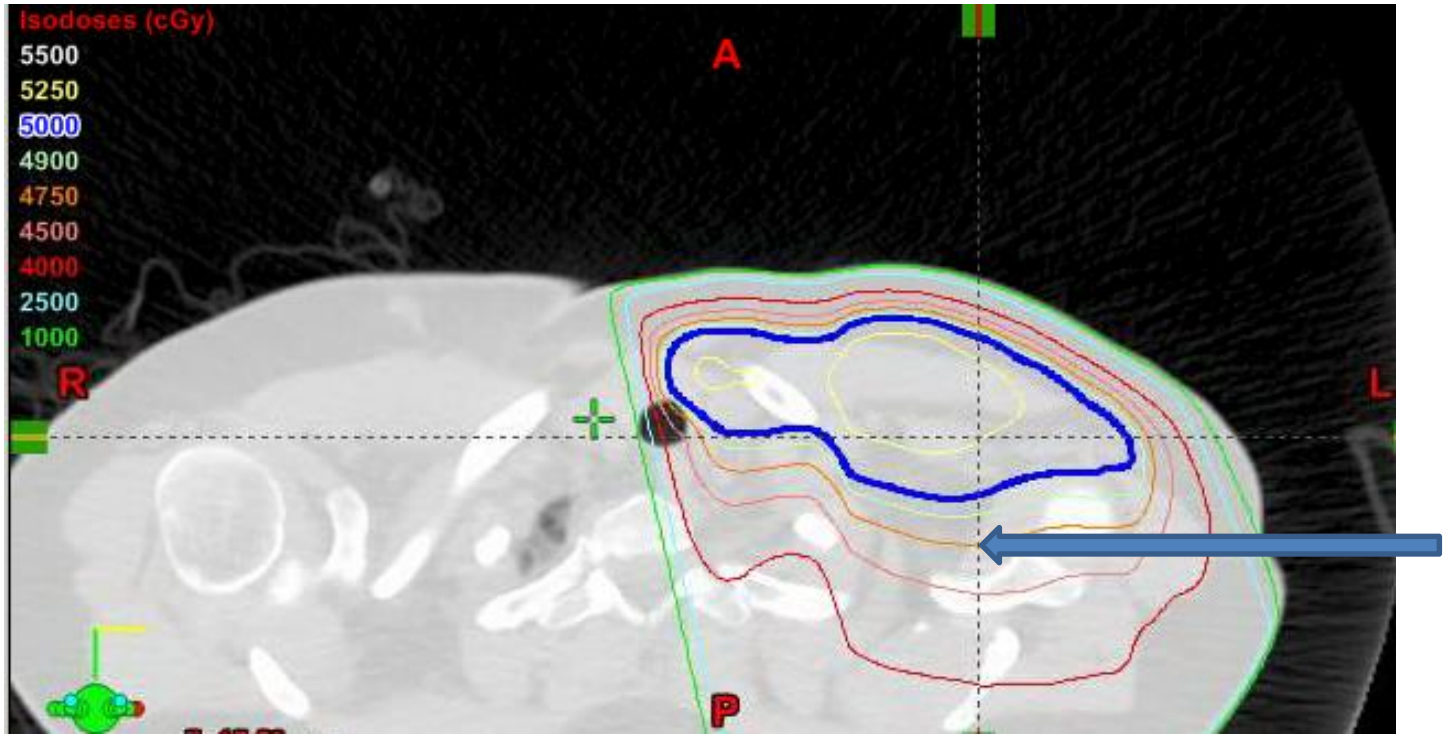
Ports designed to pick up contoured PTV's while still maintaining the traditional setup

Resultant DVH



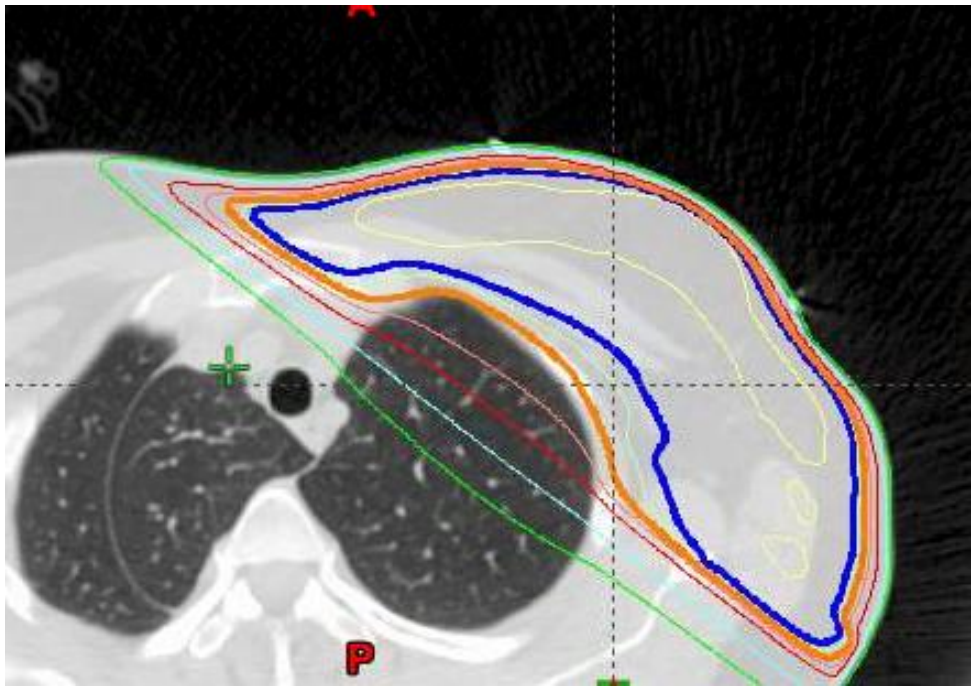
Although there is good coverage of the breast tissue, the SCF, IMN, and Axillary volumes do not receive the full dose. (Yellow Arrow) Also ipsilateral lung dose is high due to inclusion of IMN in the tangent ports. (Red arrow) Contra-lateral lung dose is very low with no beam exit (white arrow)but contra-lateral breast is partially included in the deep tangent medially to pick up the IMN.

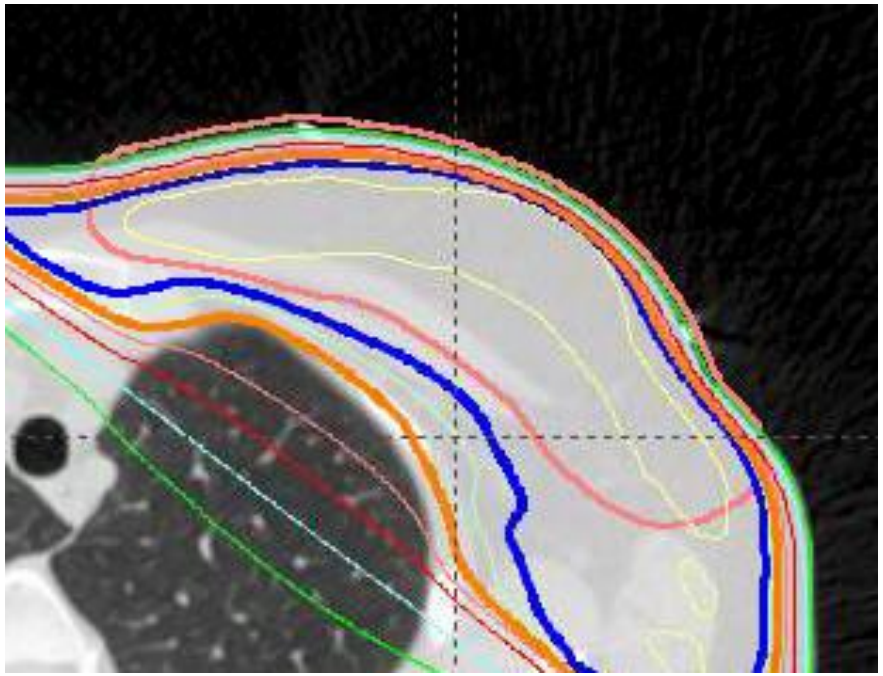
Dose at axillary fossa



Dose at axillary fossa visually is 45-47.5 Gy.

Homogeneity and conformality





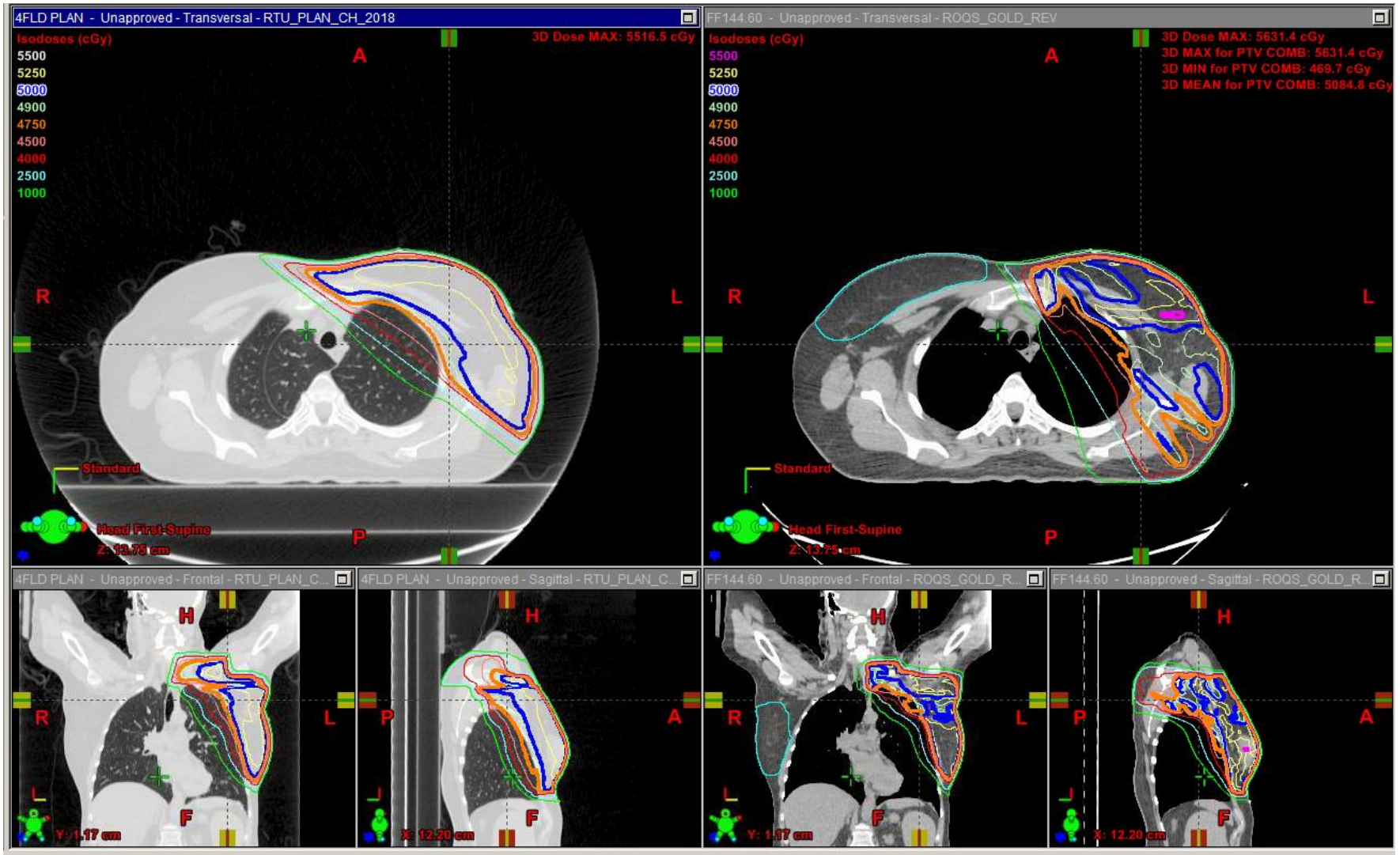
Dose is homogenous but not very conformal to the contoured targets due to use of tangential ports only.

Plan Study Score = 83.26

METRIC	RESULT	MIN REQ	IDEAL	POINTS	WEIGHT
Volume (%) of the BREAST_PTV_EVAL covered by 47.5 (Gy)	97.584	90	97	20.00	20.00
Dose (Gy) covering 50 (%) of the BREAST_PTV_EVAL	52.182	54	52	2.82	3.00
Dose (Gy) covering 0.03 (cc) of the BREAST_PTV_EVAL	55.121	57	56	2.50	2.50
Volume (%) of the LUMPEC_PTV_EVAL covered by 47.5 (Gy)	99.636	95	99	20.00	20.00
Dose (Gy) covering 50 (%) of the LUMPEC_PTV_EVAL	52.463	54	52	2.54	3.00
Dose (Gy) covering 0.03 (cc) of the LUMPEC_PTV_EVAL	54.021	57	56	2.50	2.50
Structure(s) containing the global max dose point	(4 values)	BREAST_PTV_EVAL	LUMPEC_PTV_EVAL	1.00	3.00
Volume (%) of the SUPRACLAV_PTV covered by 47.5 (Gy)	63.200	90	97	0.00	15.00
Dose (Gy) covering 0.03 (cc) of the SUPRACLAV_PTV	52.595	55	53.5	2.50	2.50
Volume (%) of the AXILLARY_PTV covered by 47.5 (Gy)	89.997	90	97	0.00	15.00
Dose (Gy) covering 0.03 (cc) of the AXILLARY_PTV	55.031	55	53.5	0.00	2.50
Volume (%) of the IMN_PTV covered by 47.5 (Gy)	53.961	90	97	0.00	15.00
Dose (Gy) covering 0.03 (cc) of the IMN_PTV	50.305	55	53.5	2.00	2.00
Dose (Gy) covering 5 (%) of the BREAST_CONTRA	6.370	3	2	0.00	5.00
Dose (Gy) covering 0.03 (cc) of the BREAST_CONTRA	49.161	7	5	0.00	3.00
Dose (Gy) covering 5 (%) of the HEART	8.872	20	5	1.23	2.00
Dose (Gy) covering 30 (%) of the HEART	3.585	10	5	5.00	5.00
Mean dose (Gy) to the HEART	3.559	3	2	0.00	5.00
Volume (%) of the LUNG_IPSI covered by 20 (Gy)	28.302	37	20	3.72	5.00
Volume (%) of the LUNG_IPSI covered by 10 (Gy)	35.766	55	30	4.42	5.00
Volume (%) of the LUNG_IPSI covered by 5 (Gy)	50.738	70	50	4.85	5.00
Volume (%) of the LUNG_CONTRA covered by 5 (Gy)	1.537	10	5	5.00	5.00
Mean dose (Gy) to the HUMERAL_HEAD_LT	14.404	15	10	1.56	2.00
Mean dose (Gy) to the THYROID	23.767	25	20	1.62	2.00
Conformation Number [47.5 (Gy), PTV_ALL]	0.671	---	---	---	---
Homogeneity Index [50 (Gy), PTV_ALL]	0.215	---	---	---	---
Integral dose (Gy·cc) to the BODY	210363.719	---	---	---	---
Cumulative meterset over all treatment beams	723.221	---	---	---	---
TOTALS		17 (of 24)	8 (of 24)	83.26	150.00

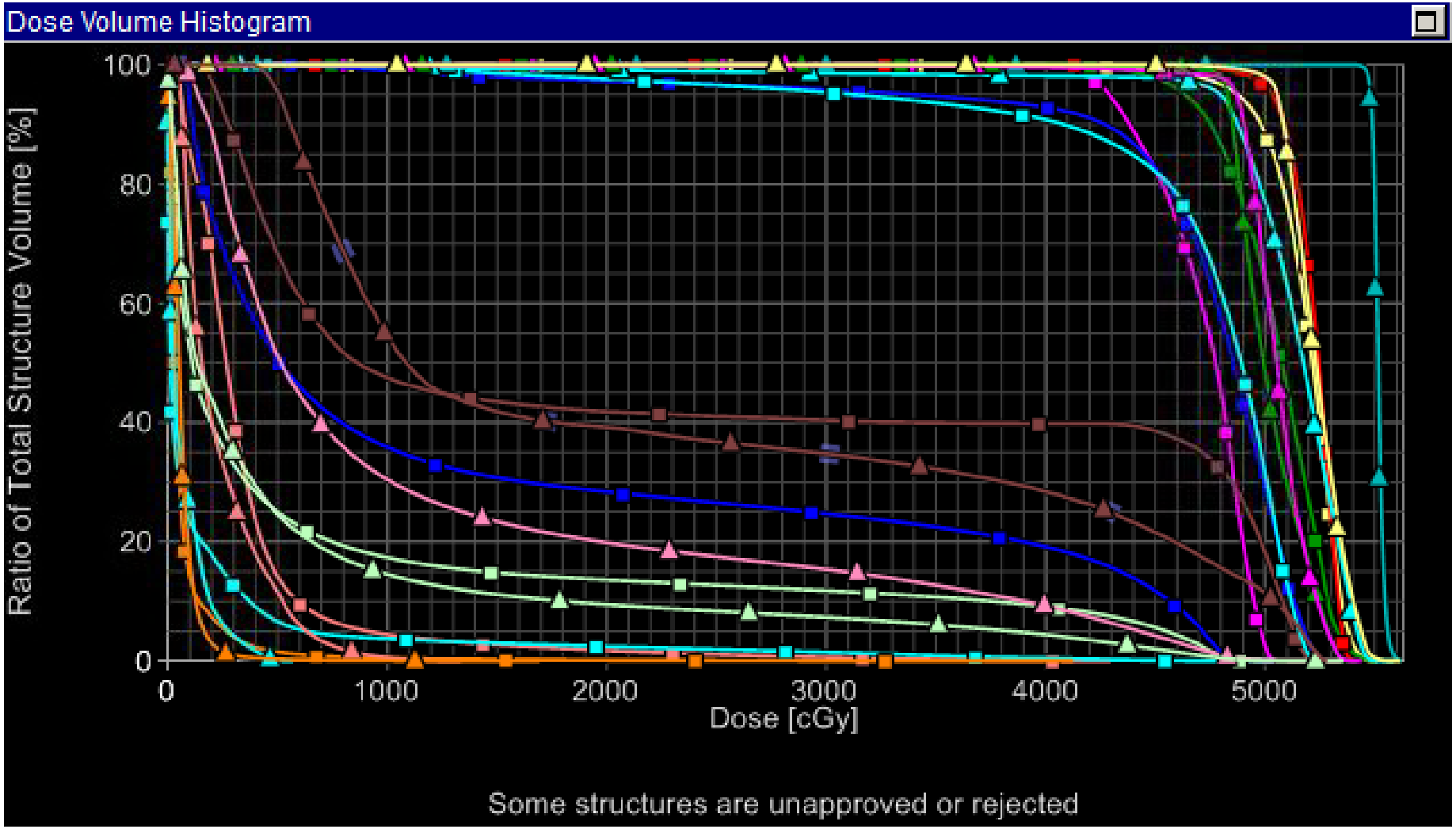
Score for the traditional plan is very low at 83.26 as the IMN, SCF, and Axillary contours were not covered. Also ipsilateral lung , heart, and contralateral breast minimums were not achieved for this study.

Comparison traditional to IMRT multi-field



The multi-field IMRT plan on the right is not very homogeneous or conformal. The traditional plan is more visually appealing.

Comparison DVH traditional to IMRT multi-field



Comparison traditional to IMRT multi-field

View	DVH Line	Structure	Approval Status	Plan	Course	Volume [cm³]	Dose Cover.[%]	Sampling Cover.[%]	Min Dose [cGy]	Max Dose [cGy]	Mean Dose [cGy]
☑		IMN_PTV_P2	Unapproved	4FLD PLAN	2018 RTU AAMD	5.0	100.0	99.4	3966.8	5046.4	4716.1
☑		Lumpec._PTV_EVAL	Unapproved	FF144.60	2018 RTU AAMD	274.3	100.0	100.0	4416.9	5631.4	5234.6
☑		Lumpec_PTV_EVAL_	Unapproved	4FLD PLAN	2018 RTU AAMD	249.5	100.0	99.9	4524.1	5406.5	5222.6
☐		Lumpectomy_CTV_2	Unapproved	4FLD PLAN	2018 RTU AAMD						
☐		Lumpectomy_CTV_P	Unapproved	FF144.60	2018 RTU AAMD						
☐		Lumpectomy_GTV_2	Unapproved	4FLD PLAN	2018 RTU AAMD						
☐		Lumpectomy_GTV_P	Unapproved	FF144.60	2018 RTU AAMD						
☐		Lumpectomy_PTV_2	Unapproved	4FLD PLAN	2018 RTU AAMD						
☐		Lumpectomy_PTV_P	Unapproved	FF144.60	2018 RTU AAMD						
☑		Lung_Contra_P	Unapproved	FF144.60	2018 RTU AAMD	2380.5	100.0	100.0	0.4	1697.6	65.1
☑		Lung_Contra_P2	Unapproved	4FLD PLAN	2018 RTU AAMD	2380.4	100.0	100.0	0.0	4134.7	72.6
☑		Lung_Ipsi_P	Unapproved	FF144.60	2018 RTU AAMD	2169.8	100.0	100.0	51.7	5357.8	1174.2
☑		Lung_Ipsi_P2	Unapproved	4FLD PLAN	2018 RTU AAMD	2169.8	100.0	100.0	36.2	5044.1	1477.6
☑		Lung_Total_P1	Unapproved	FF144.60	2018 RTU AAMD	4558.2	100.0	100.0	0.4	5357.8	594.2
☑		Lung_Total_P3	Unapproved	4FLD PLAN	2018 RTU AAMD	4558.2	100.0	100.0	0.0	5047.2	742.7
☐		PET Pre-Op1_P	Unapproved	FF144.60	2018 RTU AAMD						
☐		PET Pre-Op_P1	Unapproved	4FLD PLAN	2018 RTU AAMD						
☐		PTV COMB	Unapproved	FF144.60	2018 RTU AAMD						
☐		PTV_ALL_P	Unapproved	4FLD PLAN	2018 RTU AAMD						
☐		RING PTV	Unapproved	4FLD PLAN	2018 RTU AAMD						
☐		SKIN_P	Unapproved	FF144.60	2018 RTU AAMD						
☐		SPINAL CORD_P1	Unapproved	FF144.60	2018 RTU AAMD						
☐		Skin_P2	Unapproved	4FLD PLAN	2018 RTU AAMD						
☐		Spinal Cord_P3	Unapproved	4FLD PLAN	2018 RTU AAMD						
☐		Supraclav._CTV_P	Unapproved	FF144.60	2018 RTU AAMD						
☐		Supraclav._PTV_P	Unapproved	FF144.60	2018 RTU AAMD						
☑		Supraclav_CTV_P	Unapproved	4FLD PLAN	2018 RTU AAMD	22.3	100.0	100.0	765.2	5238.4	4670.3
☑		Supraclav_PTV_P	Unapproved	4FLD PLAN	2018 RTU AAMD	57.3	100.0	100.0	509.7	5274.8	4673.2
☑		THYROID_P	Unapproved	FF144.60	2018 RTU AAMD	5.4	100.0	99.9	382.5	5296.1	2212.7
☑		Thyroid_P2	Unapproved	4FLD PLAN	2018 RTU AAMD	5.4	100.0	100.4	138.3	5220.9	2347.0
☐		WIRE_P	Unapproved	FF144.60	2018 RTU AAMD						
☐		Wire_P2	Unapproved	4FLD PLAN	2018 RTU AAMD						
☑		push hot	Unapproved	FF144.60	2018 RTU AAMD	1.4	100.0	99.7	5417.3	5631.4	5517.3

Comparison traditional to IMRT multi-field

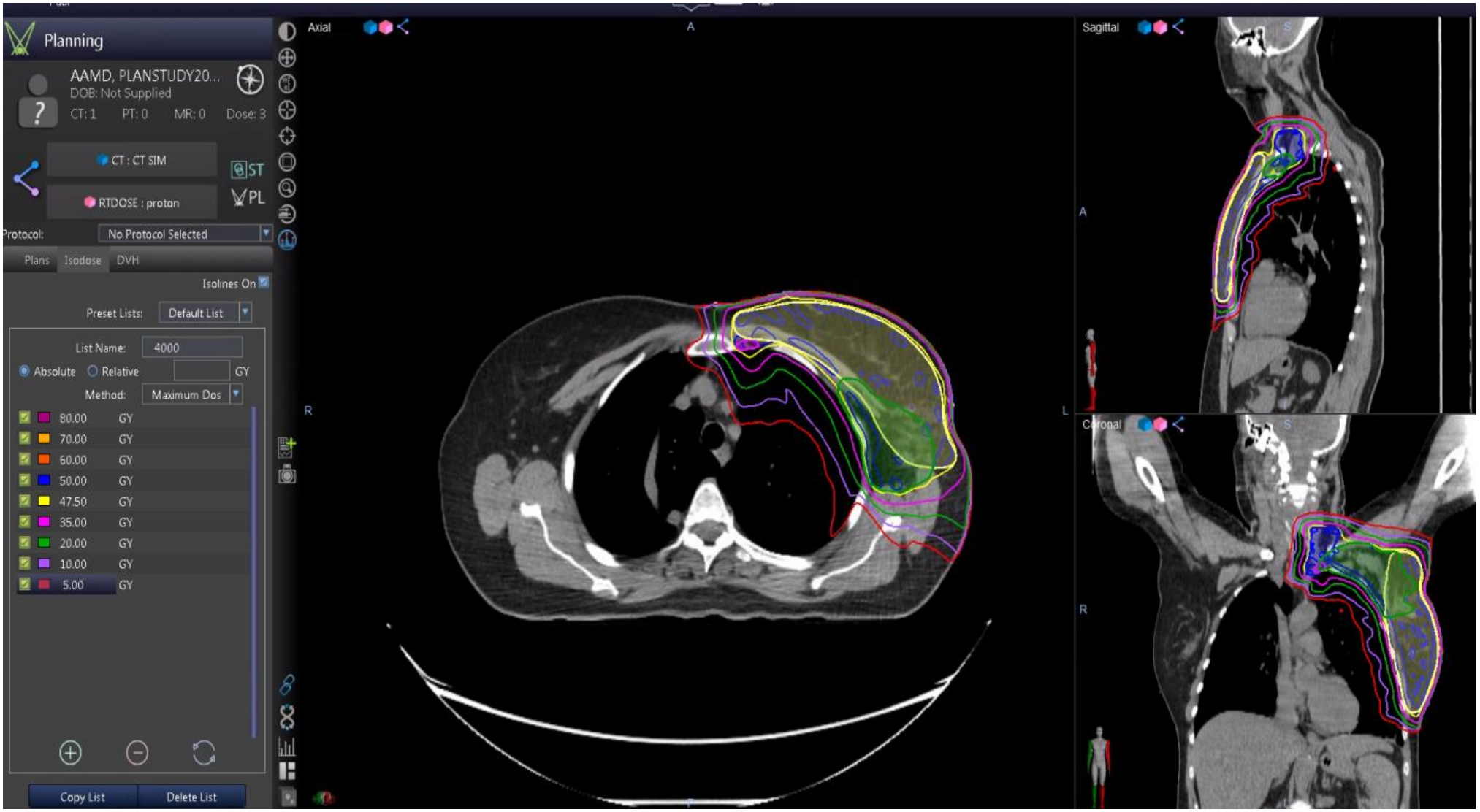
METRIC	RESULT	MIN REQ	IDEAL	POINTS	WEIGHT
Volume (%) of the BREAST_PTV_EVAL covered by 47.5 (Gy)	97.584	90	97	20.00	20.00
Dose (Gy) covering 50 (%) of the BREAST_PTV_EVAL	52.182	54	52	2.82	3.00
Dose (Gy) covering 0.03 (cc) of the BREAST_PTV_EVAL	55.121	57	56	2.50	2.50
Volume (%) of the LUMPEC_PTV_EVAL covered by 47.5 (Gy)	99.636	95	99	20.00	20.00
Dose (Gy) covering 50 (%) of the LUMPEC_PTV_EVAL	52.463	54	52	2.54	3.00
Dose (Gy) covering 0.03 (cc) of the LUMPEC_PTV_EVAL	54.021	57	56	2.50	2.50
Structure(s) containing the global max dose point	(4 values)	BREAST_PTV_EVAL	LUMPEC_PTV_EVAL	1.00	3.00
Volume (%) of the SUPRACLAV_PTV covered by 47.5 (Gy)	63.200	90	97	0.00	15.00
Dose (Gy) covering 0.03 (cc) of the SUPRACLAV_PTV	52.595	55	53.5	2.50	2.50
Volume (%) of the AXILLARY_PTV covered by 47.5 (Gy)	89.997	90	97	0.00	15.00
Dose (Gy) covering 0.03 (cc) of the AXILLARY_PTV	55.031	55	53.5	0.00	2.50
Volume (%) of the IMN_PTV covered by 47.5 (Gy)	53.961	90	97	0.00	15.00
Dose (Gy) covering 0.03 (cc) of the IMN_PTV	50.305	55	53.5	2.00	2.00
Dose (Gy) covering 5 (%) of the BREAST_CONTRA	6.370	3	2	0.00	5.00
Dose (Gy) covering 0.03 (cc) of the BREAST_CONTRA	49.161	7	5	0.00	3.00
Dose (Gy) covering 5 (%) of the HEART	8.872	20	5	1.23	2.00
Dose (Gy) covering 30 (%) of the HEART	3.585	10	5	5.00	5.00
Mean dose (Gy) to the HEART	3.559	3	2	0.00	5.00
Volume (%) of the LUNG_IPSI covered by 20 (Gy)	28.302	37	20		
Volume (%) of the LUNG_IPSI covered by 10 (Gy)	35.766	55	30		
Volume (%) of the LUNG_IPSI covered by 5 (Gy)	50.738	70	50		
Volume (%) of the LUNG_CONTRA covered by 5 (Gy)	1.537	10	5		
Mean dose (Gy) to the HUMERAL_HEAD_LT	14.404	15	10		
Mean dose (Gy) to the THYROID	23.767	25	20		
Conformation Number [47.5 (Gy), PTV_ALL]	0.671	---	---		
Homogeneity Index [50 (Gy), PTV_ALL]	0.215	---	---		
Integral dose (Gy-cc) to the BODY	210363.719	---	---		
Cumulative meterset over all treatment beams	723.221	---	---		
TOTALS		17 (of 24)	8 (		

METRIC	RESULT	MIN REQ	IDEAL	POINTS	WEIGHT
Volume (%) of the BREAST_PTV_EVAL covered by 47.5 (Gy)	96.917	90	97	19.92	20.00
Dose (Gy) covering 50 (%) of the BREAST_PTV_EVAL	51.842	54	52	3.00	3.00
Dose (Gy) covering 0.03 (cc) of the BREAST_PTV_EVAL	56.081	57	56	2.40	2.50
Volume (%) of the LUMPEC_PTV_EVAL covered by 47.5 (Gy)	99.837	95	99	20.00	20.00
Dose (Gy) covering 50 (%) of the LUMPEC_PTV_EVAL	52.318	54	52	2.68	3.00
Dose (Gy) covering 0.03 (cc) of the LUMPEC_PTV_EVAL	56.081	57	56	2.40	2.50
Structure(s) containing the global max dose point	(10 values)	BREAST_PTV_EVAL	LUMPEC_PTV_EVAL	3.00	3.00
Volume (%) of the SUPRACLAV_PTV covered by 47.5 (Gy)	96.778	90	97	14.78	15.00
Dose (Gy) covering 0.03 (cc) of the SUPRACLAV_PTV	53.971	55	53.5	2.30	2.50
Volume (%) of the AXILLARY_PTV covered by 47.5 (Gy)	98.810	90	97	15.00	15.00
Dose (Gy) covering 0.03 (cc) of the AXILLARY_PTV	54.261	55	53.5	2.18	2.50
Volume (%) of the IMN_PTV covered by 47.5 (Gy)	96.971	90	97	14.97	15.00
Dose (Gy) covering 0.03 (cc) of the IMN_PTV	53.394	55	53.5	2.00	2.00
Dose (Gy) covering 5 (%) of the BREAST_CONTRA	2.803	3	2	3.39	5.00
Dose (Gy) covering 0.03 (cc) of the BREAST_CONTRA	5.801	7	5	2.40	3.00
Dose (Gy) covering 5 (%) of the HEART	6.352	20	5	1.73	2.00
Dose (Gy) covering 30 (%) of the HEART	2.750	10	5	5.00	5.00
Mean dose (Gy) to the HEART	2.328	3	2	4.34	5.00
Volume (%) of the LUNG_IPSI covered by 20 (Gy)	19.797	37	20	5.00	5.00
Volume (%) of the LUNG_IPSI covered by 10 (Gy)	30.431	55	30	4.96	5.00
Volume (%) of the LUNG_IPSI covered by 5 (Gy)	51.309	70	50	4.74	5.00
Volume (%) of the LUNG_CONTRA covered by 5 (Gy)	0.309	10	5	5.00	5.00
Mean dose (Gy) to the HUMERAL_HEAD_LT	13.415	15	10	1.66	2.00
Mean dose (Gy) to the THYROID	22.565	25	20	1.74	2.00
Conformation Number [47.5 (Gy), PTV_ALL]	0.751	---	---	---	---
Homogeneity Index [50 (Gy), PTV_ALL]	0.553	---	---	---	---
Integral dose (Gy-cc) to the BODY	200775.469	---	---	---	---
Cumulative meterset over all treatment beams	3664.283	---	---	---	---
TOTALS		24 (of 24)	8 (of 24)	144.60	150.00

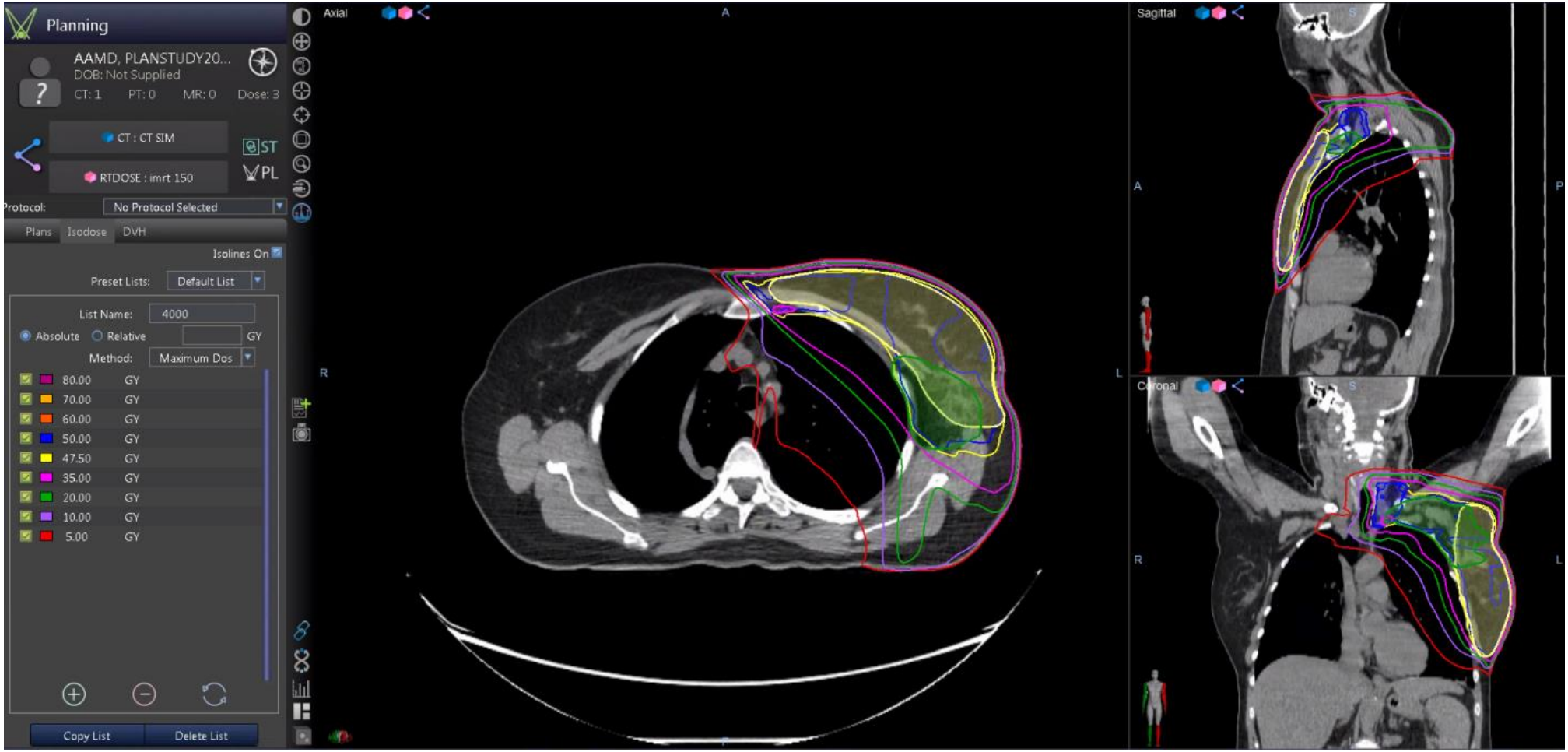
Other modalities:

Proton, VMAT, IMRT
all had a perfect score utilizing the same treatment planning system

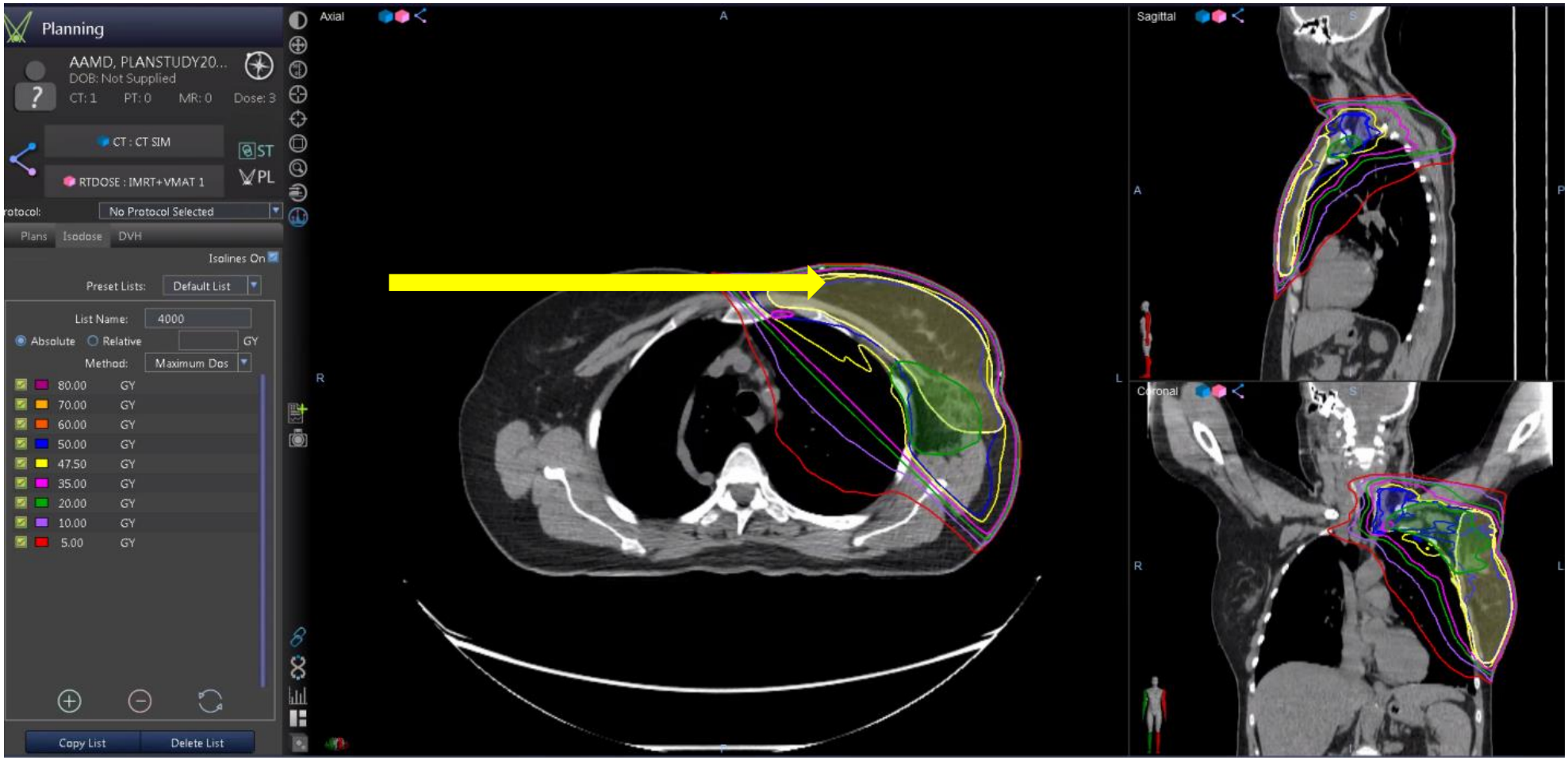
PROTON 4 beam



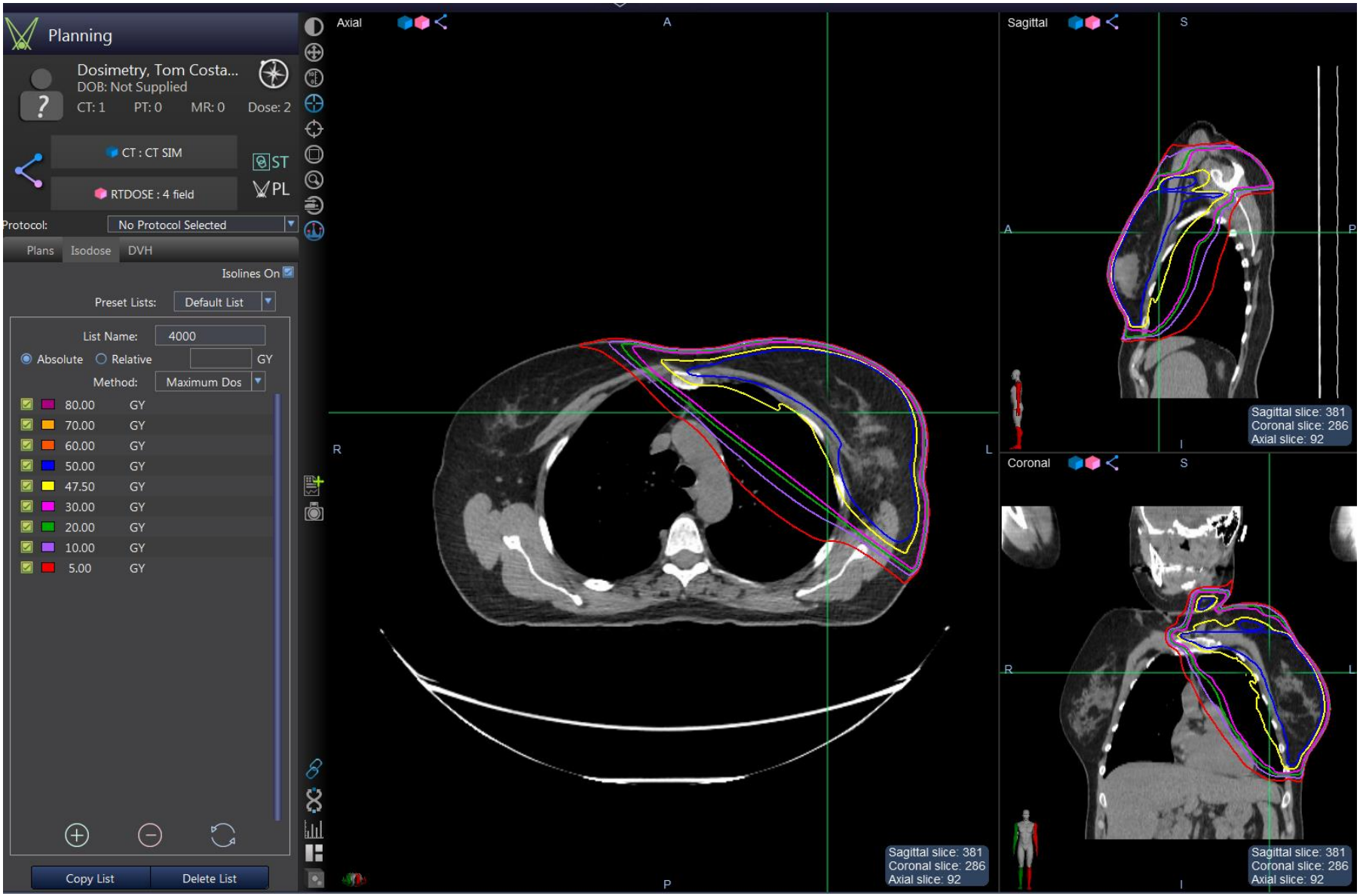
IMRT 9 fields



VMAT 2 ARCS


Planning
AAMD, PLANSTUDY20...
DOB: Not Supplied
CT: 1 PT: 0 MR: 0 Dose: 3
CT : CT SIM
RTDOSE : IMRT+VMAT 1
No Protocol Selected
Plans Isodose DVH
Isolines On
Preset Lists: Default List
List Name: 4000
Absolute Relative GY
Method: Maximum Dos
80.00 GY
70.00 GY
60.00 GY
50.00 GY
47.50 GY
35.00 GY
20.00 GY
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Copy List
Delete List
Axial
Sagittal
Coronal

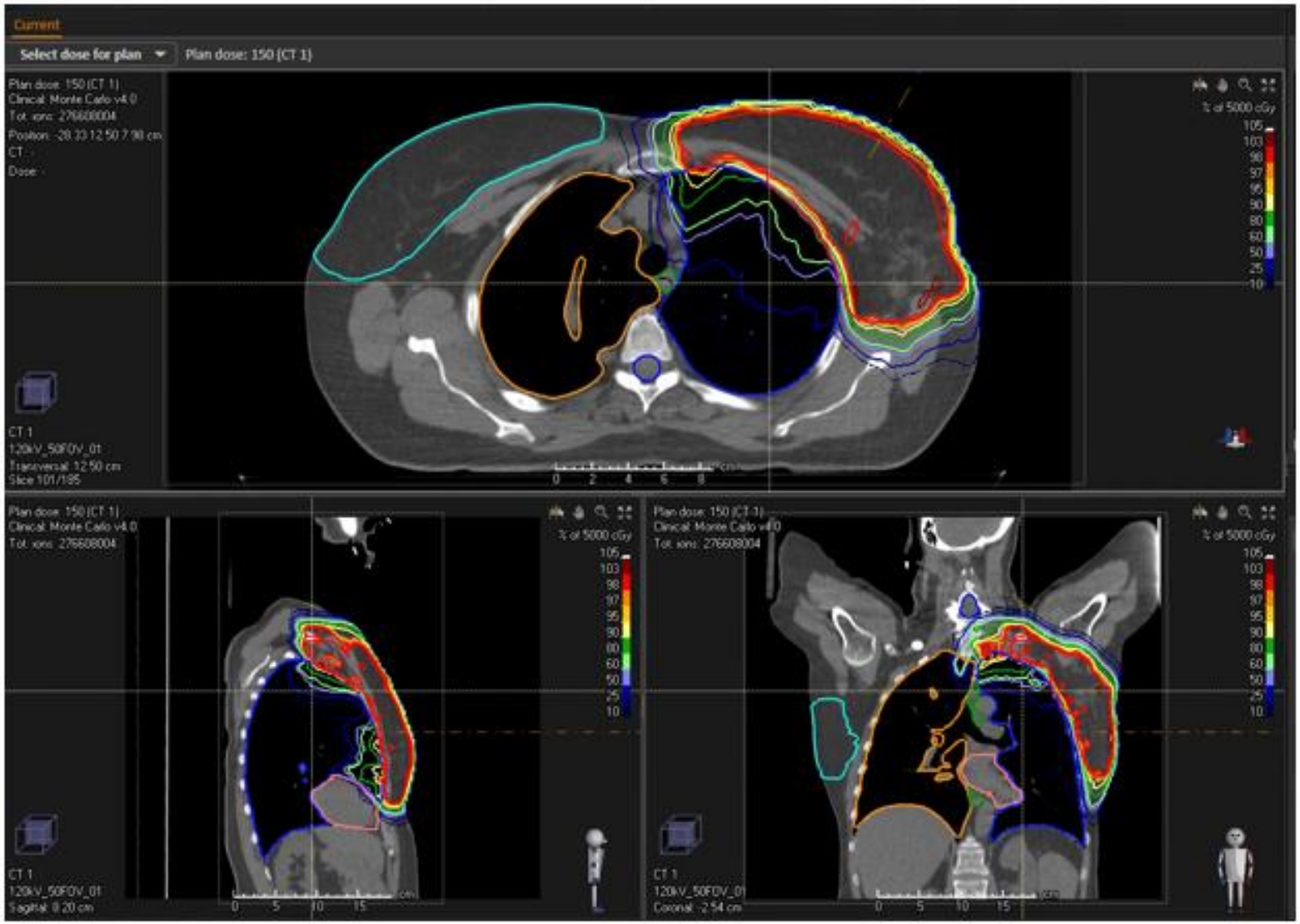
Traditional 4 field



Does number of proton beams make a visual difference?

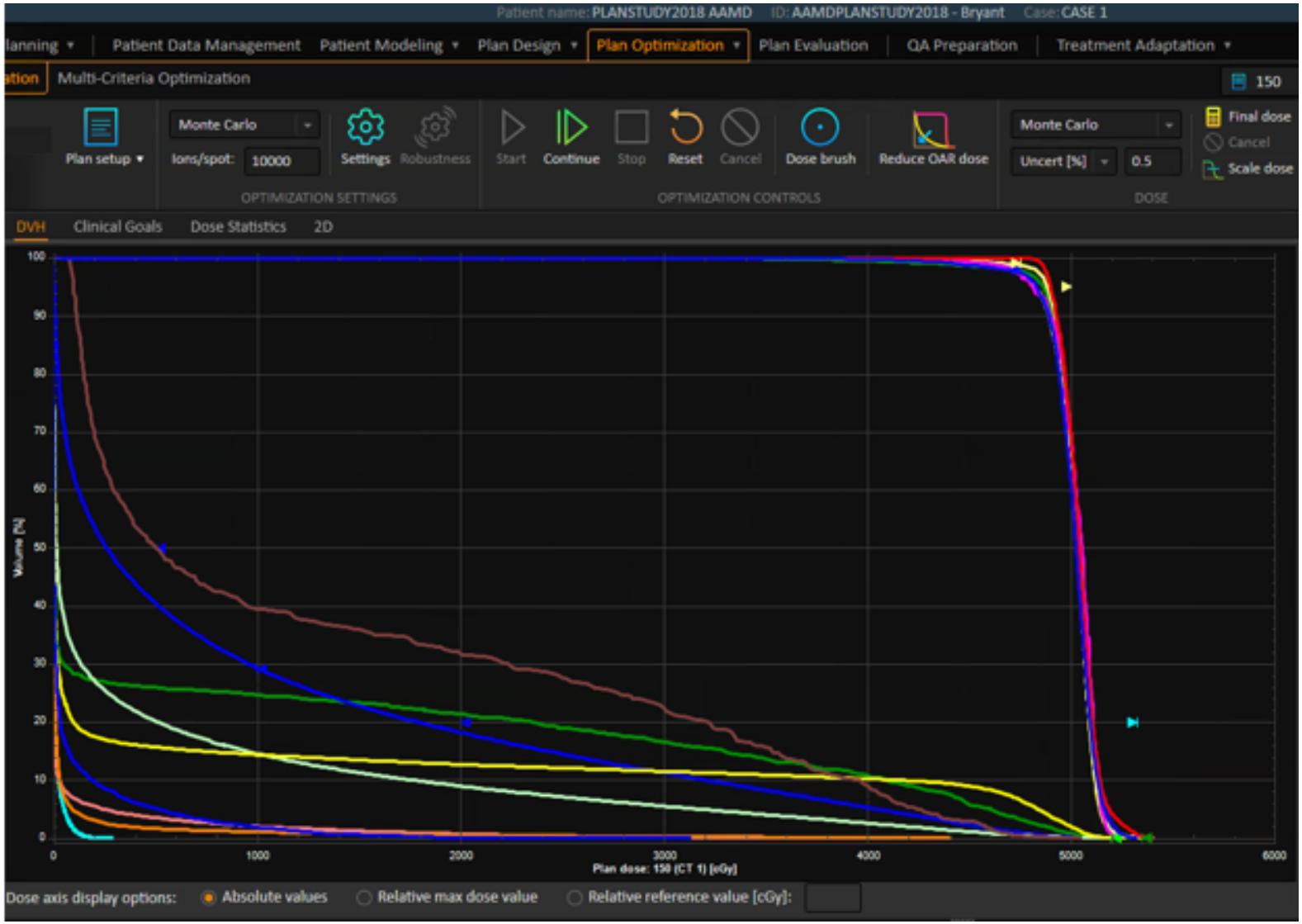
Proton 1 beam

Single Beam: ~120 seconds beam on time (includes layer switching): G=30, T=0



Amber Bryant, Erin Gittins, and Laura Cutler RTUVT

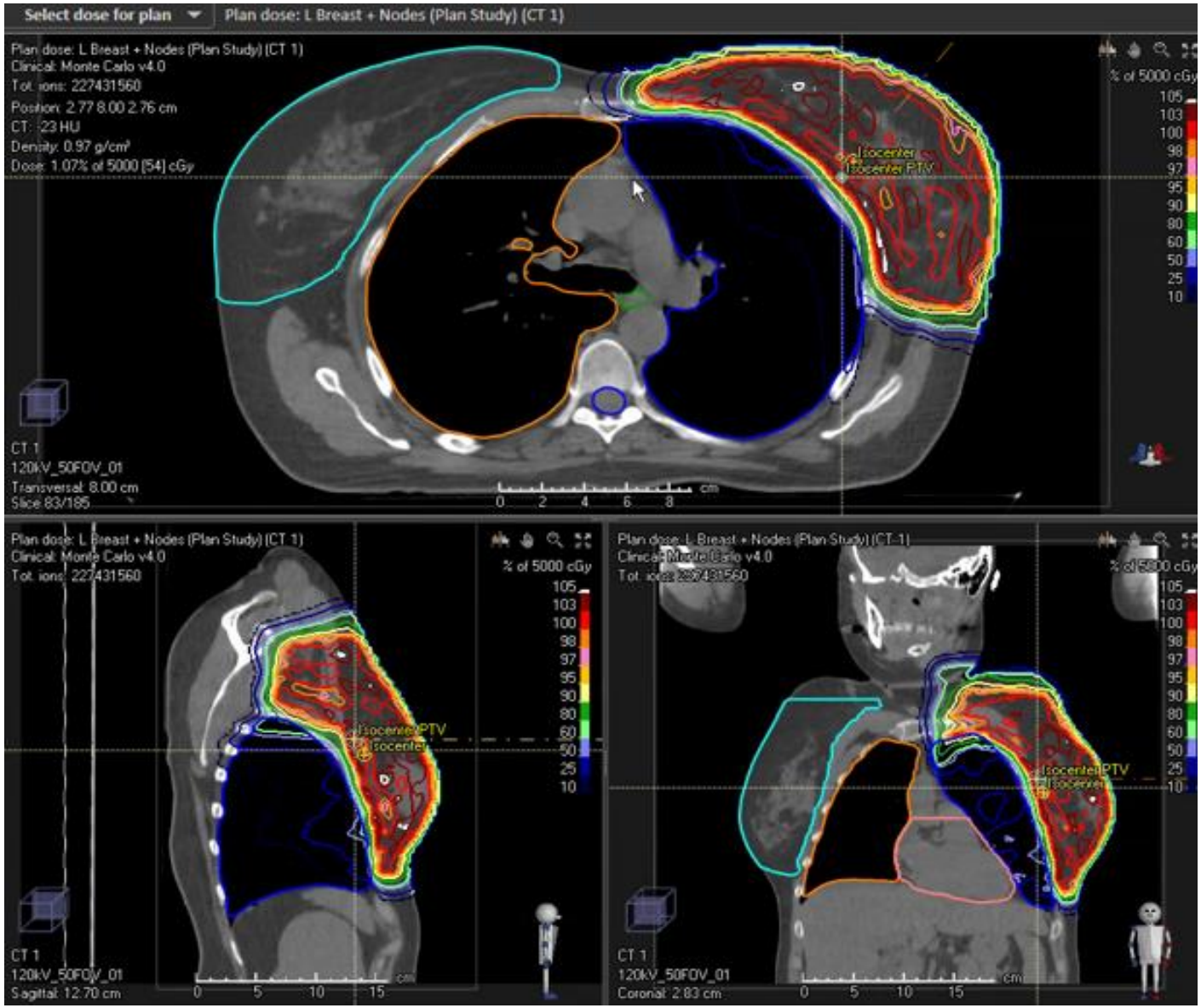
Proton 1 beam



Amber Bryant, Erin Gittins, and Laura Cutler RTUVT

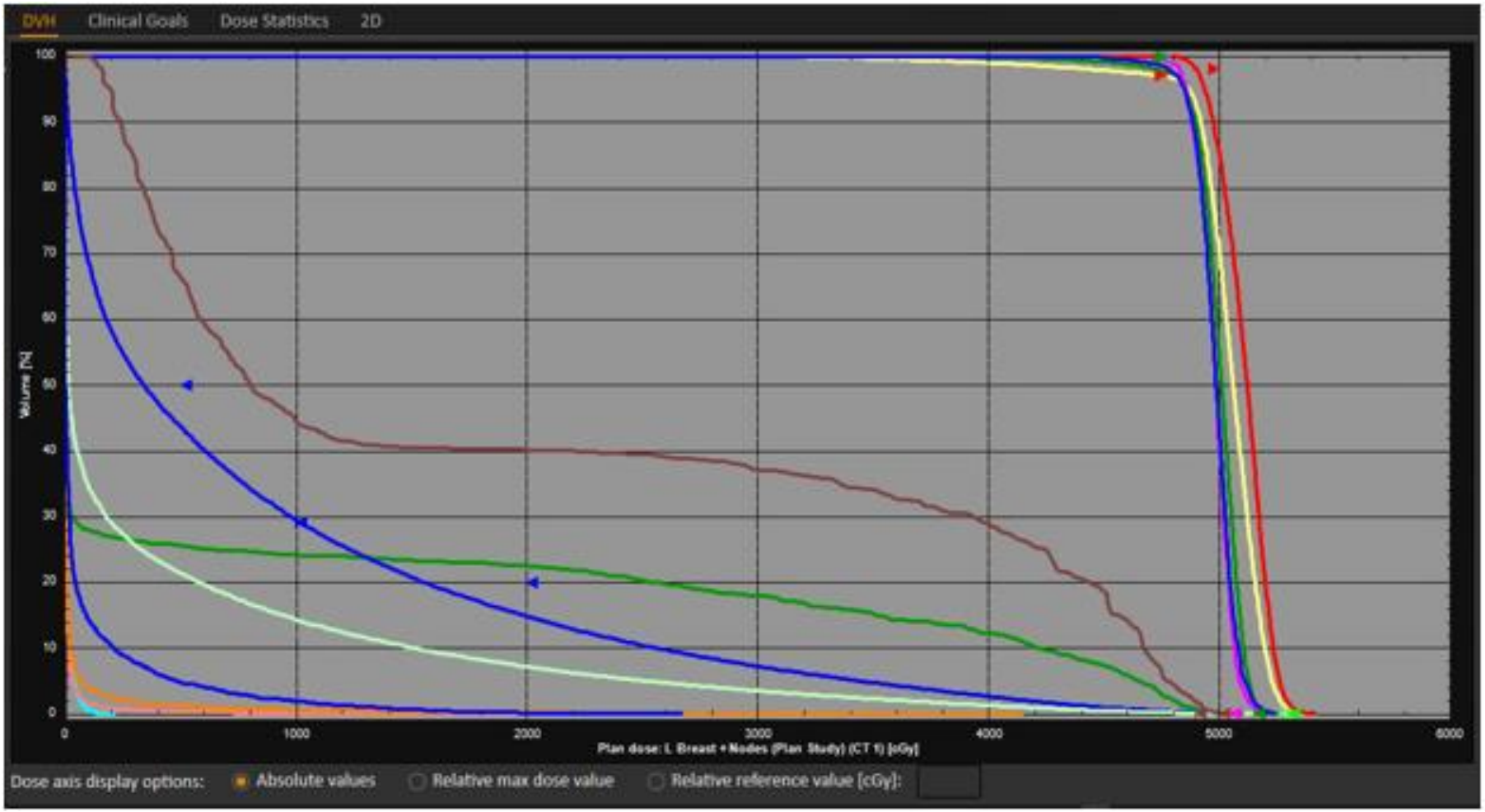
Proton 2 beam

2 Beam Plan: ~250 seconds beam on time (includes layer switching):
Beam 1: G=0, T=0: Beam 2: G=38, T=0



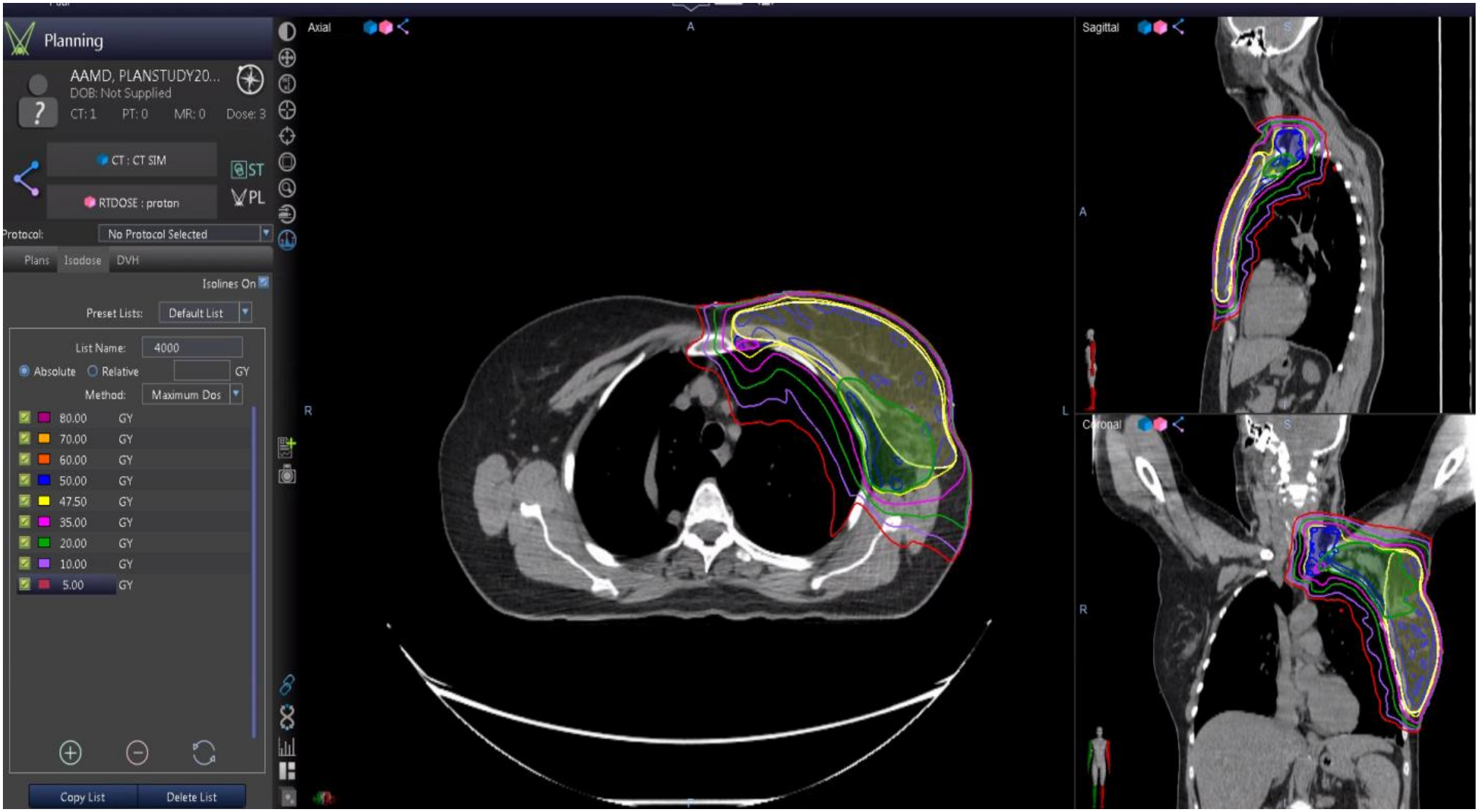
Amber Bryant, Erin Gittins, and Laura Cutler RTUVT

Proton 2 beam



Amber Bryant, Erin Gittins, and Laura Cutler RTUVT

PROTON 4 beam



Motion and practicality

1. Use of breath hold and importance with modulation

2. Practical treatment times considering motion management techniques.

3. Planning time

Conclusions and more questions

Based on the outcomes of this small study N=240 It is clear dosimetrically, that modulated fields which ever modality, can achieve better target coverage as well as OAR sparing when compared to traditional approaches.

So why are we still using the old techniques?

Do these new abilities translate to better clinical outcomes?

This study based on NSABP-B51.

Maybe a new study utilizing the latest techniques with a higher metric standard should be initiated.

Conclusions and more questions

This can be very difficult!

Phase III randomised trial

Ten years results of the Canadian breast intensity modulated radiation therapy (IMRT) randomized controlled trial

Jean-Philippe Pignol [a], Pauline Truong [b], Eileen Rakovitch [c], Margriet G. Sattler [a], Timothy J. Whelan [d], Ivo A. Olivotto [e]

Conclusions

Breast IMRT cannot be recommended for all patients to reduce long-term side effects. However, late toxicities were significantly correlated with acute side effects, which are increased in patients having poor dose distribution. Breast IMRT may hence be useful for selected patients.

ELSEVIER

Radiotherapy and Oncology

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Conclusions and more questions

Insurance and resistance to payments

- Comparison plans? Really needed?
- Proof needed?
- Challenge ASTRO and physicians
- Accepting technology and using it to our patient's advantage



CONCLUSIONS: What Do We NEED?

- More Participation of Planners
  - Drive Out Variation
- Physician Input
- Tools for Benchmarking
  - New Protocols
  - Repository of Data / Plans
- Constant Communication / Training
  - Big Data Analytics (how to utilize)

Tips & Techniques

- Interviews of High Performers to be conducted and shared On-Line on the ProKnow Website

Thanks

- AAMD
- MDCB
- ProKnow

Questions and Answers

- Questions and Answers
- Share Your Physician's Opinion
- Share Your Tips / Tricks

- HOW DO YOU TREAT?