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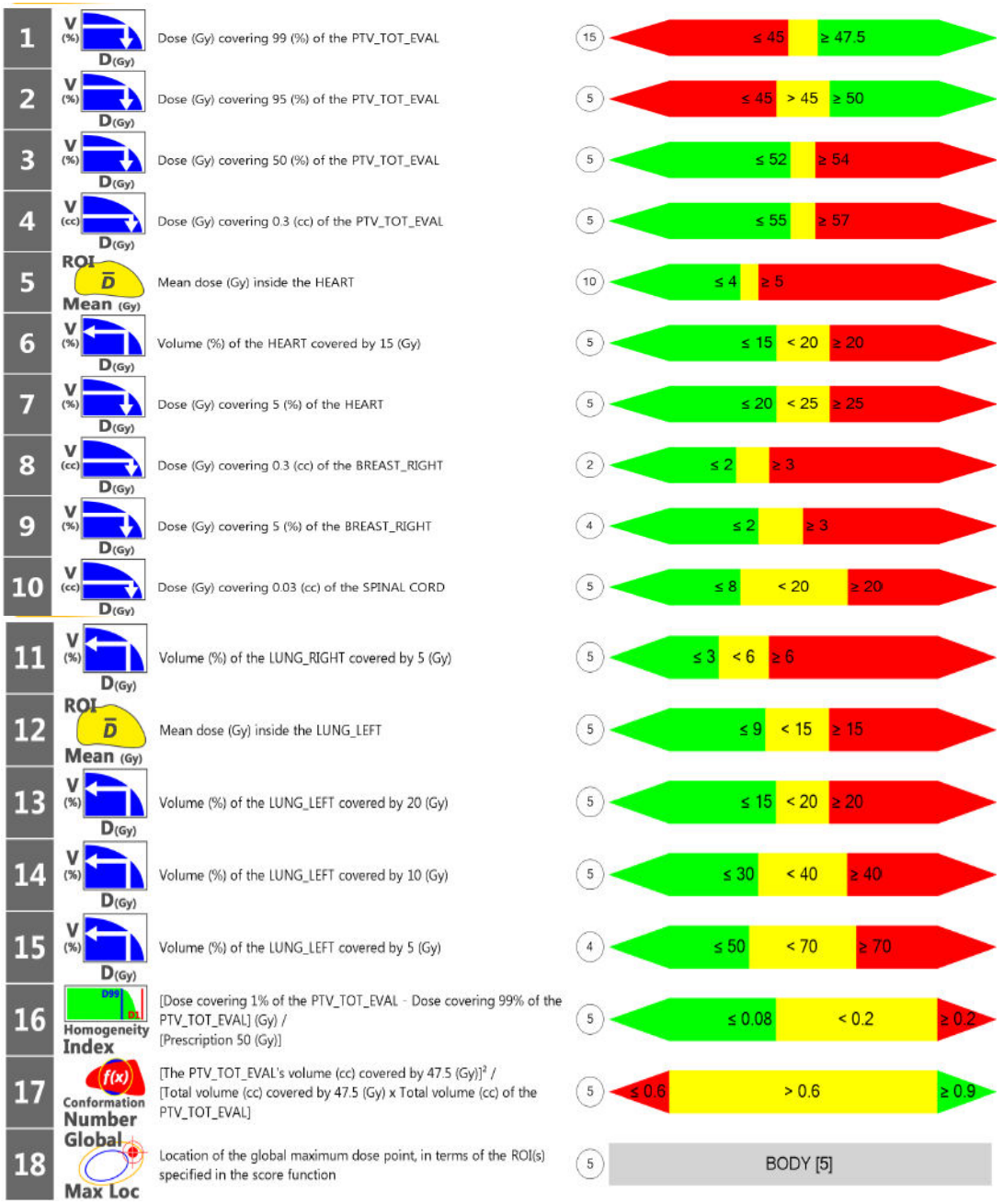
Delhi State Cancer Institute, Delhi, India.

Lt Breast Case

- Close proximity to OARs
- Large Target volume
- Peripheral target closer to skin
- Inhomogeneity involved

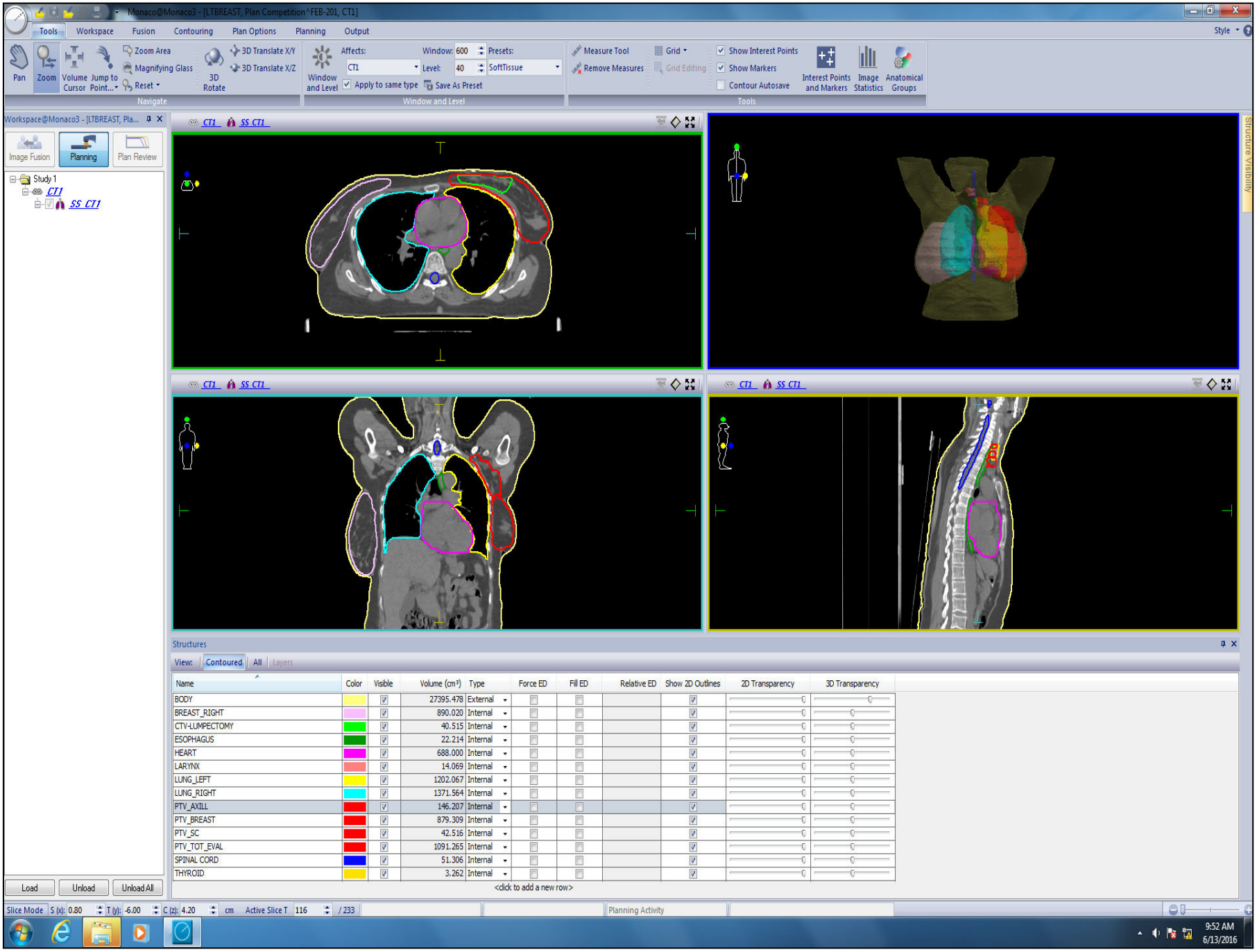
Criteria to achieve for

1. PTV_TOT_EVAL
2. Heart
3. Left Lung
4. Right Lung
5. Right Breast
6. Spinal Cord
7. Homogeneity index
8. Conformation number
9. Global maximum dose location



Equipment and method used

- ONCOR expression Linear Accelerator (Siemens AG, Germany)
- OPTIFOCUS^{TM} Multileaf collimator with 41 leaf pairs
- Leaf size 1cm (outer leaf pair 0.5cm)
- 6MV Photon Energy
- Step and Shoot IMRT Technique
- Monaco TPS version 5.10.02 from IMPAC Medical Systems, Elekta, USA.
- Algorithm used – Monte Carlo
- Nine coplanar beams


Monaco@Monaco3 - [LTBREAST, Plan Competition^FEB-201, CT1]
Tools
Workspace
Fusion
Contouring
Plan Options
Planning
Output
Style
Pan
Zoom
Volume Cursor
Jump to Point...
Zoom Area
Magnifying Glass
Reset
3D Rotate
3D Translate X/Y
3D Translate X/Z
Navigate
Window and Level
Affects:
CT1
Window: 600
Level: 40
Presets:
SoftTissue
Apply to same type
Save As Preset
Measure Tool
Remove Measures
Grid
Grid Editing
Show Interest Points
Show Markers
Contour Autosave
Interest Points and Markers
Image Statistics
Anatomical Groups
Tools
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BREAST_RIGHT 890.020 Internal
CTV-LUMPECTOMY 40.515 Internal
ESOPHAGUS 22.214 Internal
HEART 688.000 Internal
LARYNX 14.069 Internal
LUNG_LEFT 1202.067 Internal
LUNG_RIGHT 1371.564 Internal
PTV_AXILL 146.207 Internal
PTV_BREAST 879.309 Internal
PTV_SC 42.516 Internal
PTV_TOT_EVAL 1091.265 Internal
SPINAL CORD 51.306 Internal
THYROID 3.262 Internal
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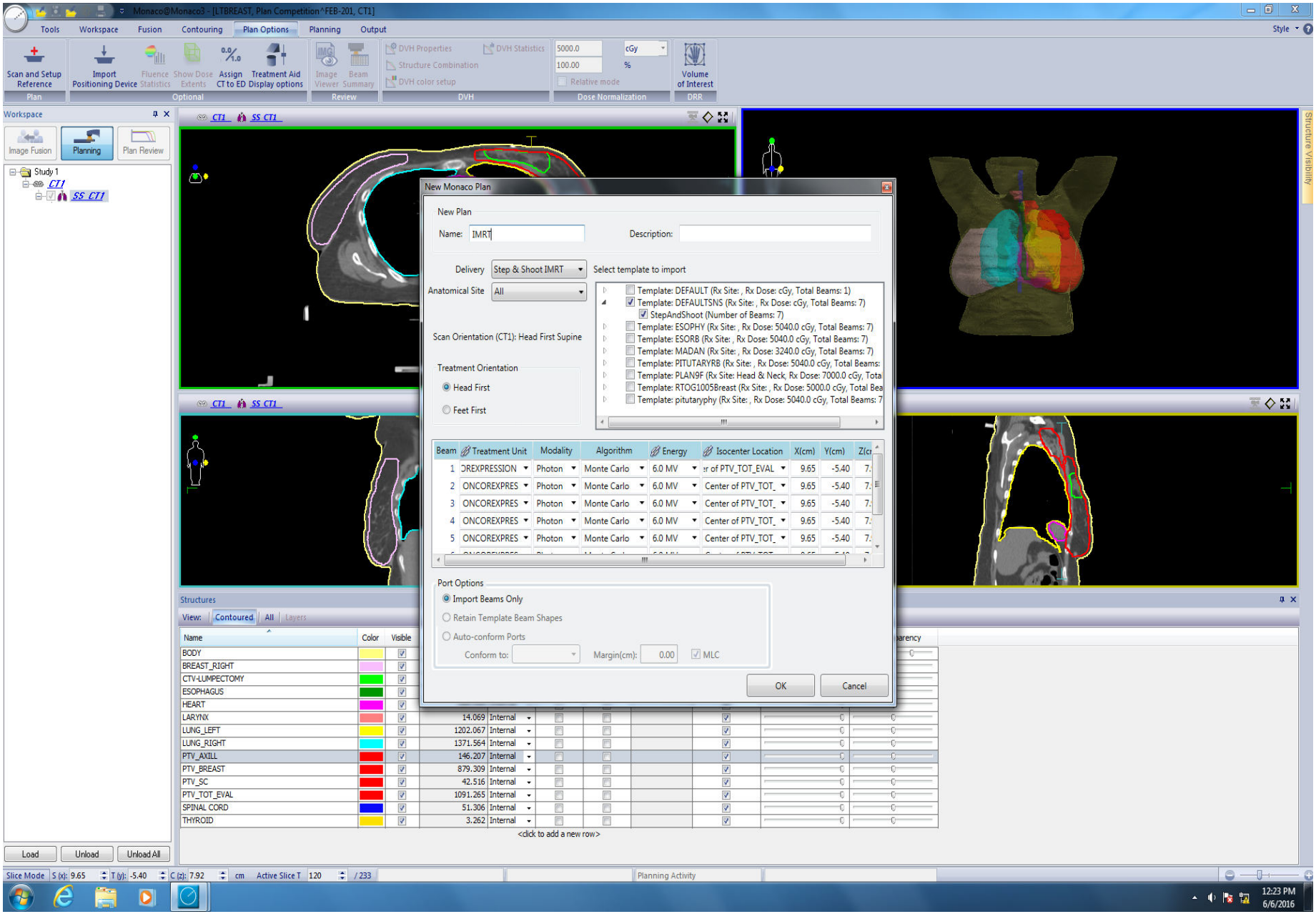
/ 233
Planning Activity
9:52 AM
6/13/2016

Creating Plan in Monaco TPS



Beam 1

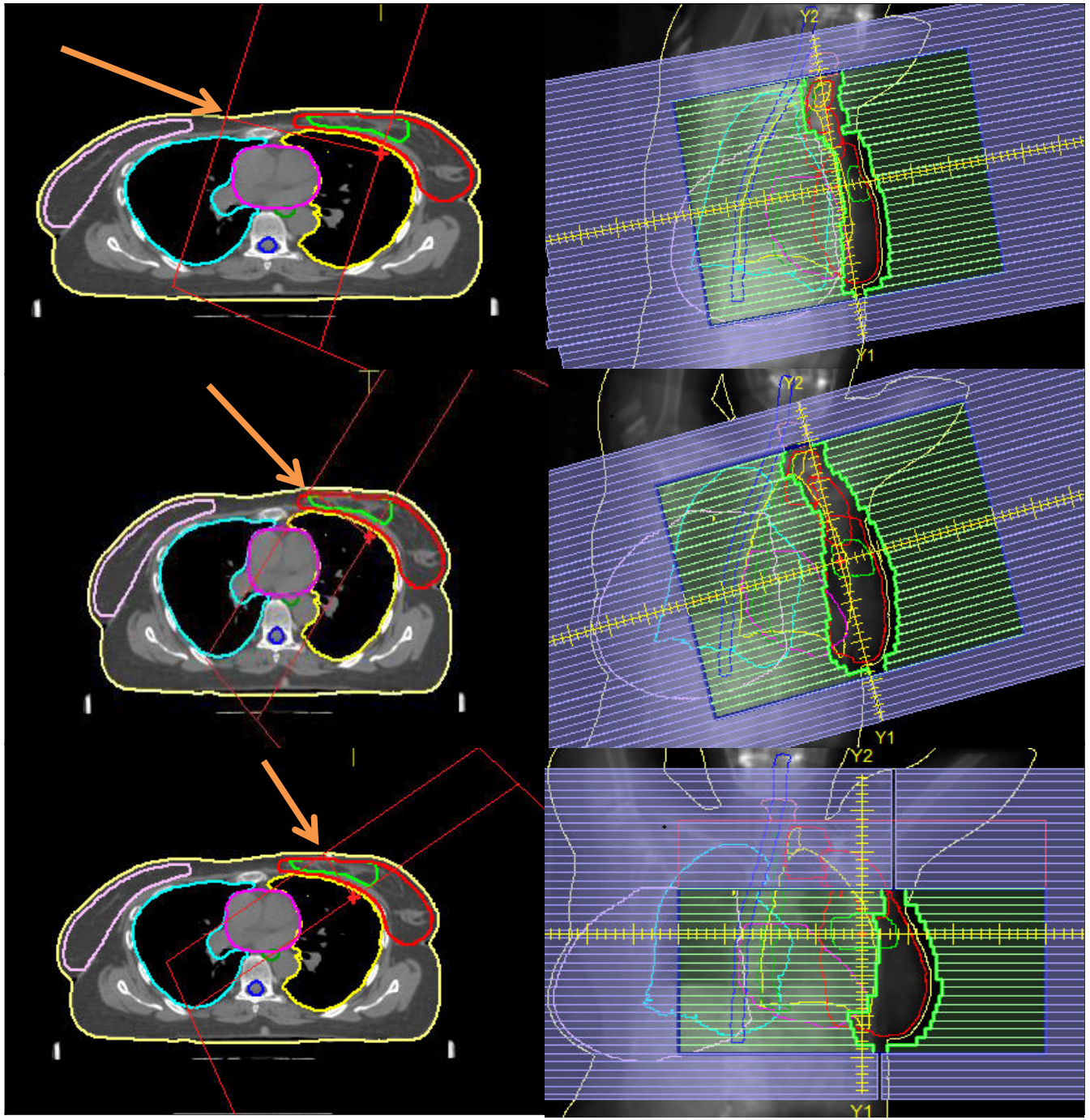
Gantry angle 285°
Collimator angle 10°

Beam 2

Gantry angle 305°
Collimator angle 15°

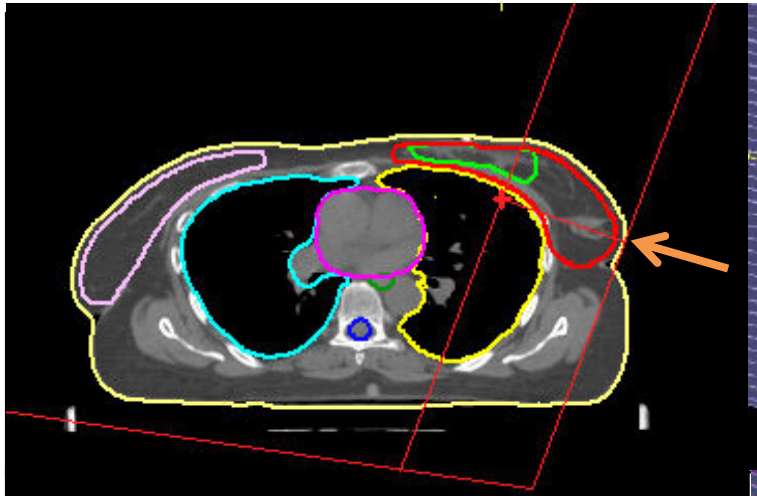
Beam 3

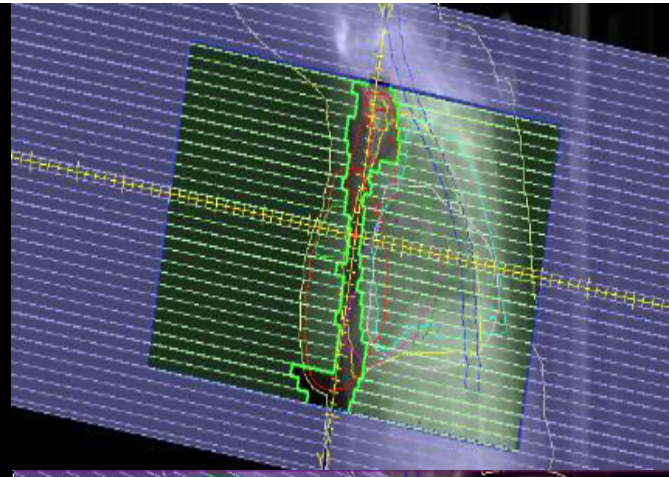
Gantry angle 325°
Collimator angle 0°



Beam 4

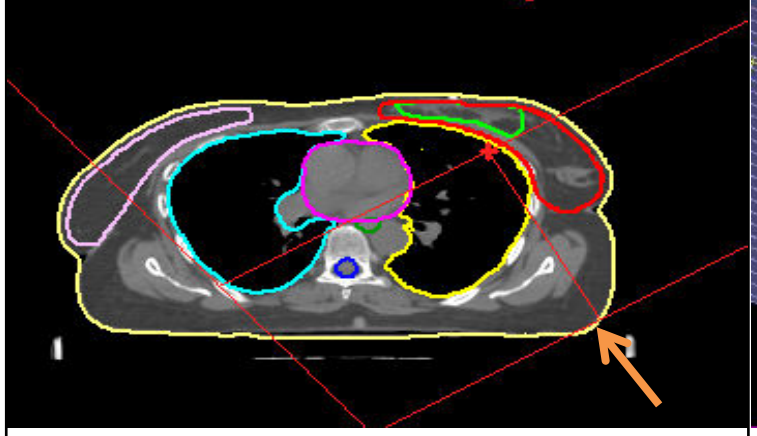
Gantry angle 110˚
Collimator angle 350

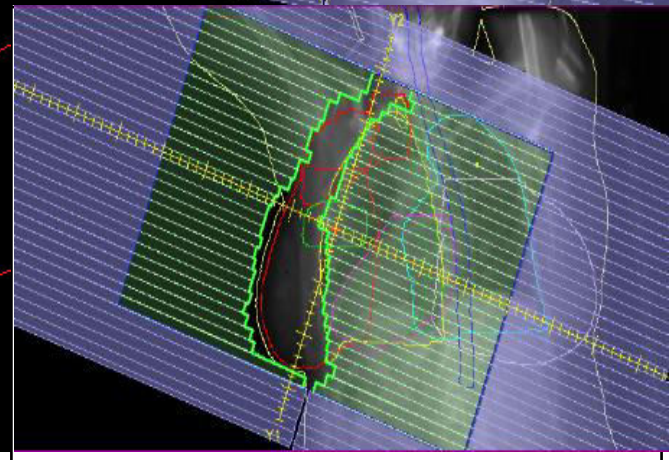




Beam 5

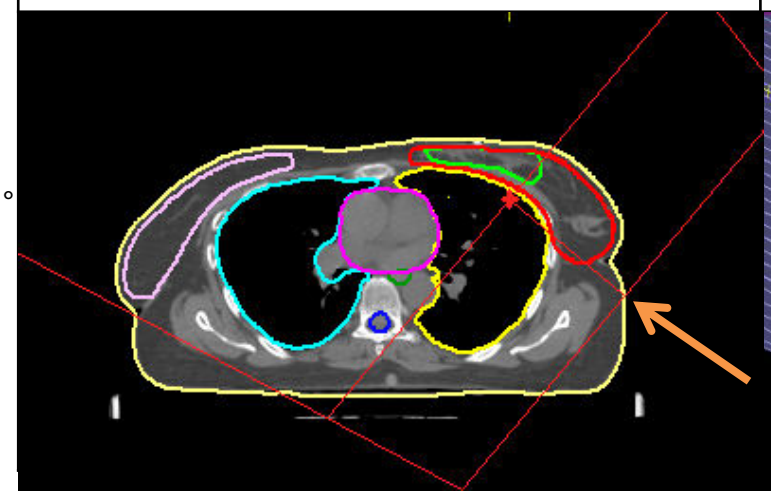
Gantry angle 150˚
Collimator angle 340˚

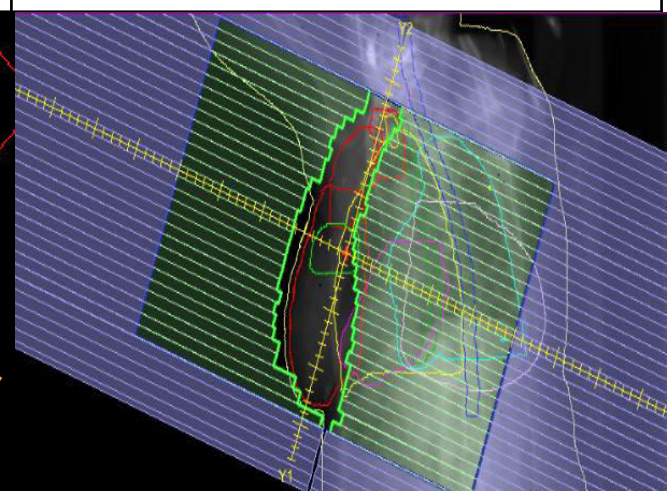




Beam 6

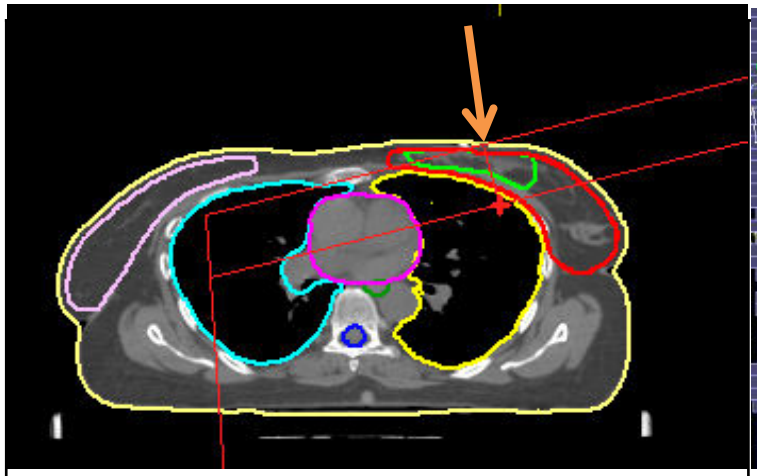
Gantry angle 130˚
Collimator angle 340˚

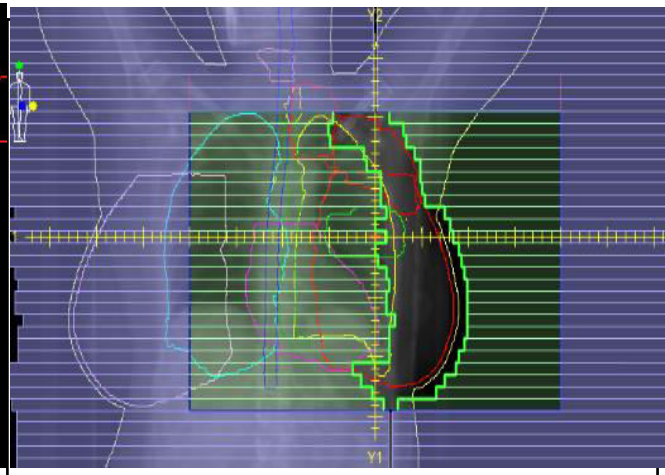




Beam 7

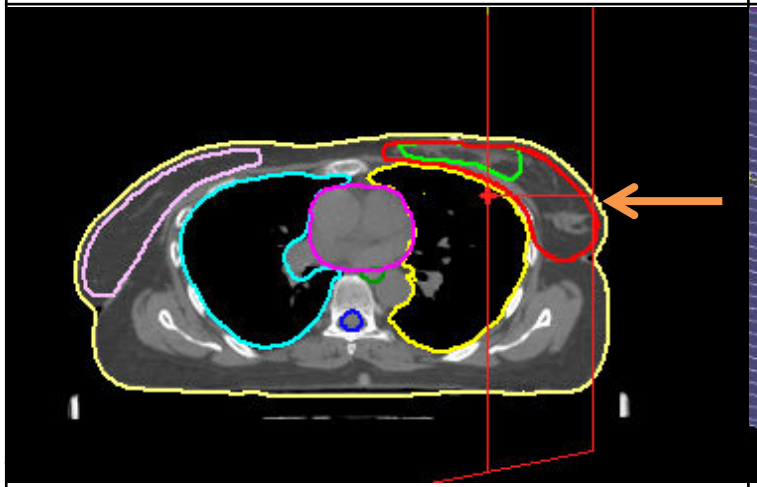
Gantry angle 345˚
Collimator angle 0

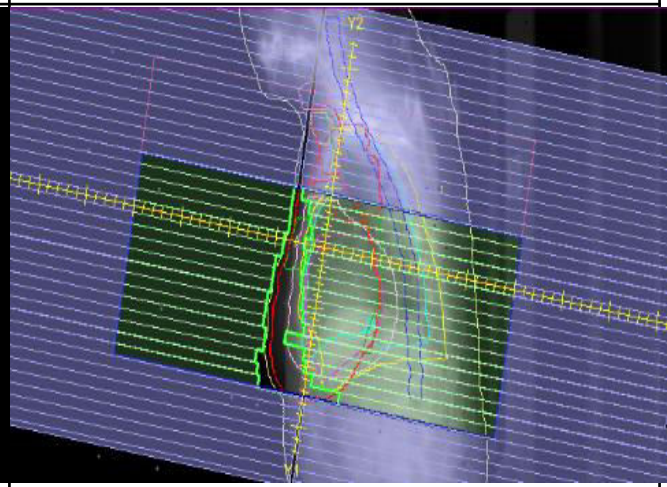




Beam 8

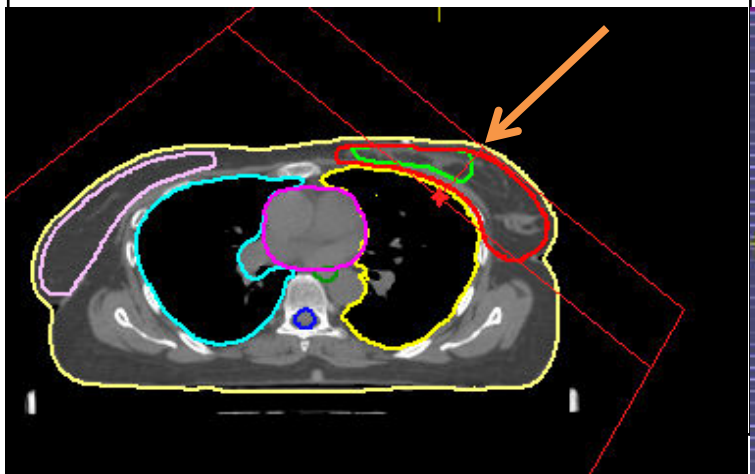
Gantry angle 90˚
Collimator angle 350˚

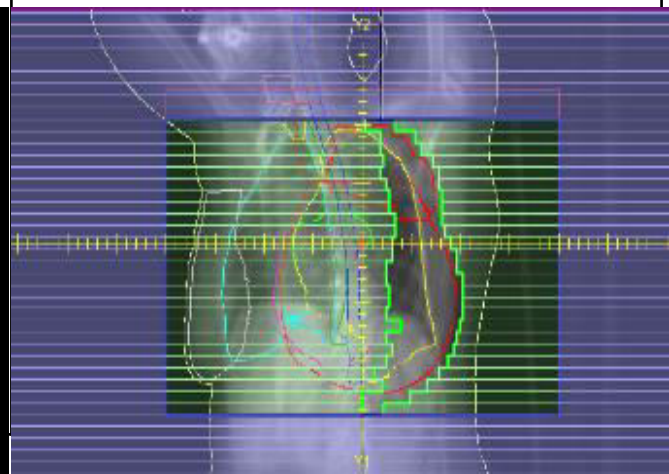


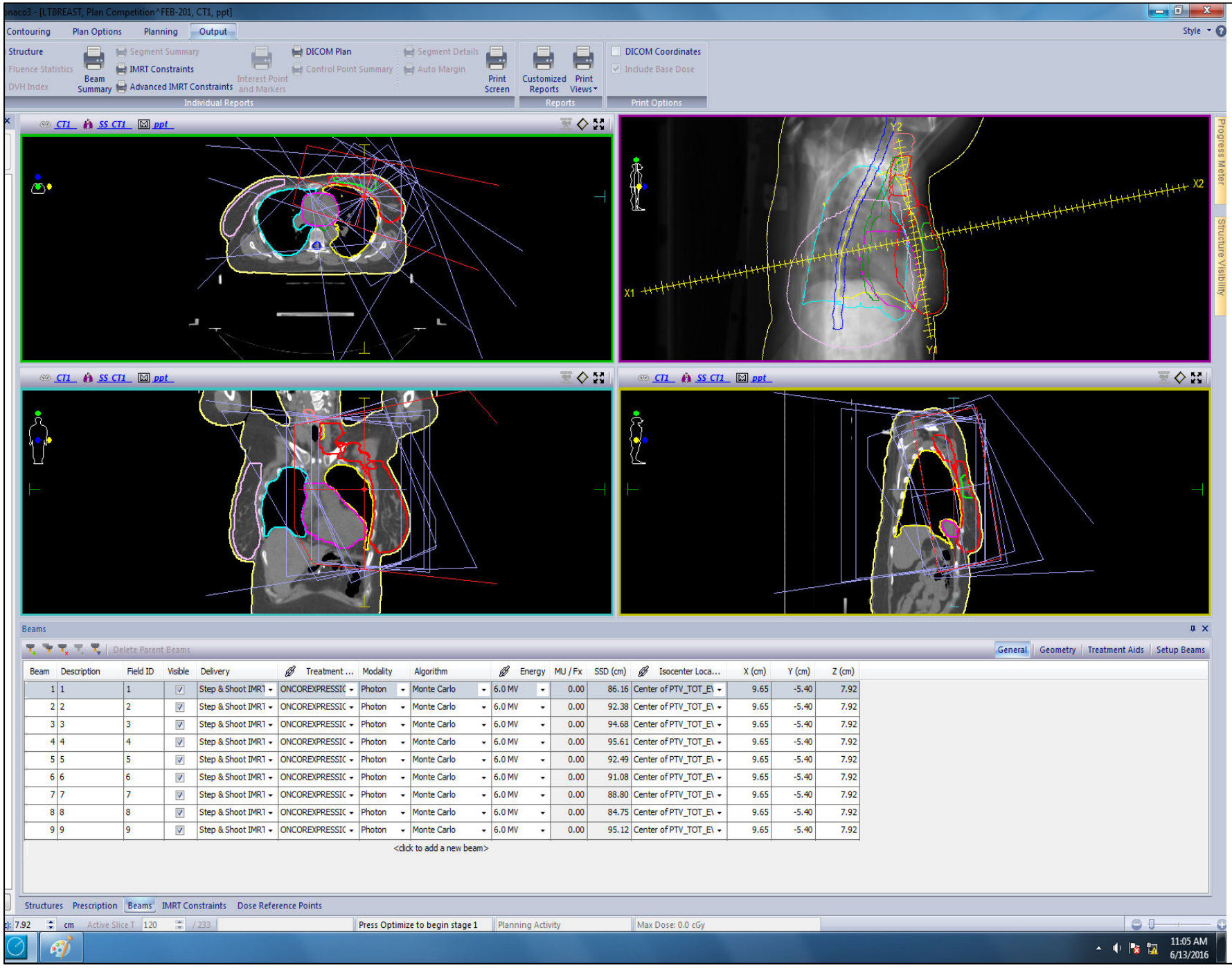


Beam 9

Gantry angle 40˚
Collimator angle 0˚






naco3 - [LTBREAST, Plan Competition^FEB-201, CT1, ppt]
Contouring
Plan Options
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Beam Summary
Segment Summary
IMRT Constraints
Advanced IMRT Constraints
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Segment Details
Auto Margin
Print Screen
Individual Reports
Customized Reports
Print Views
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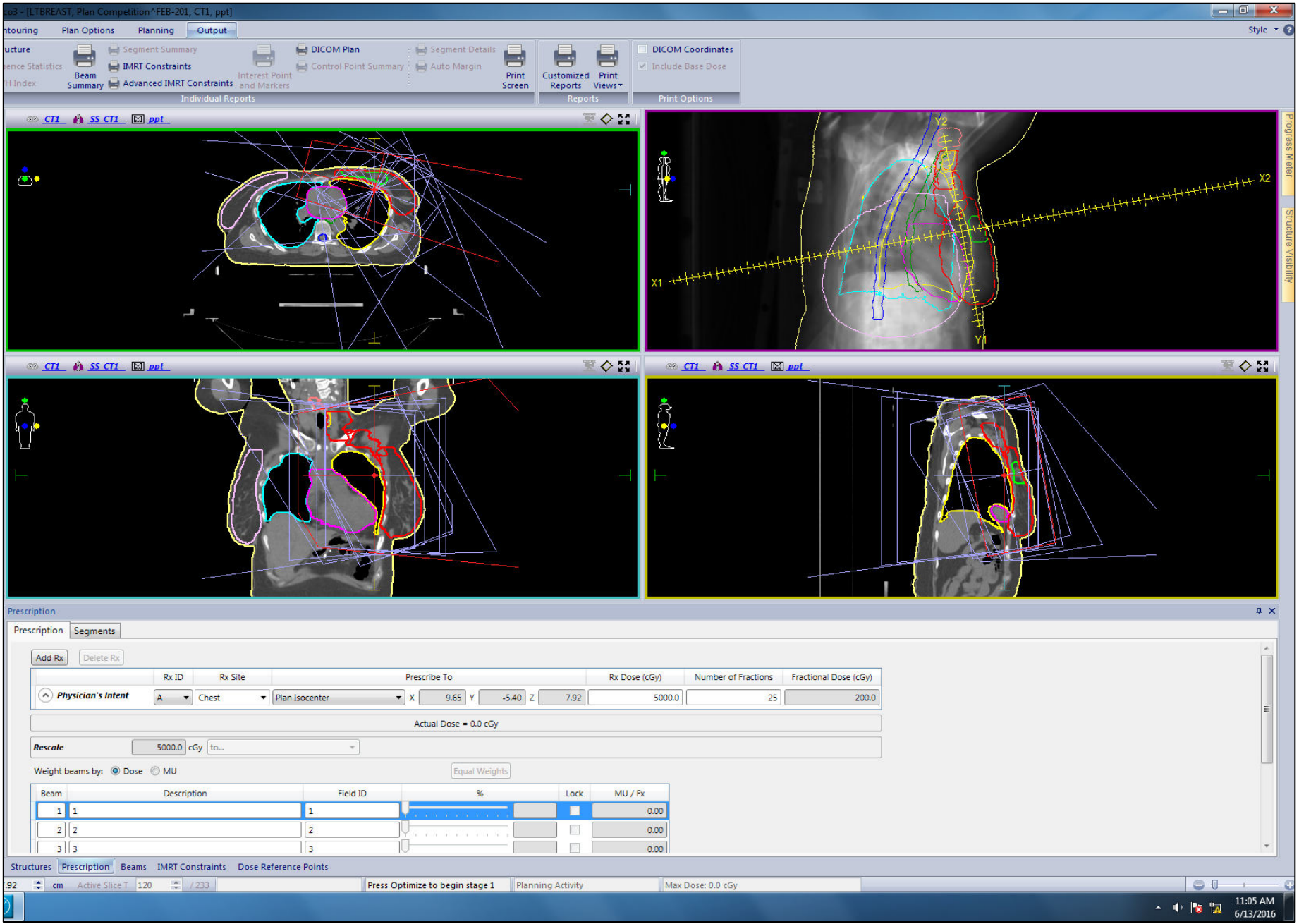
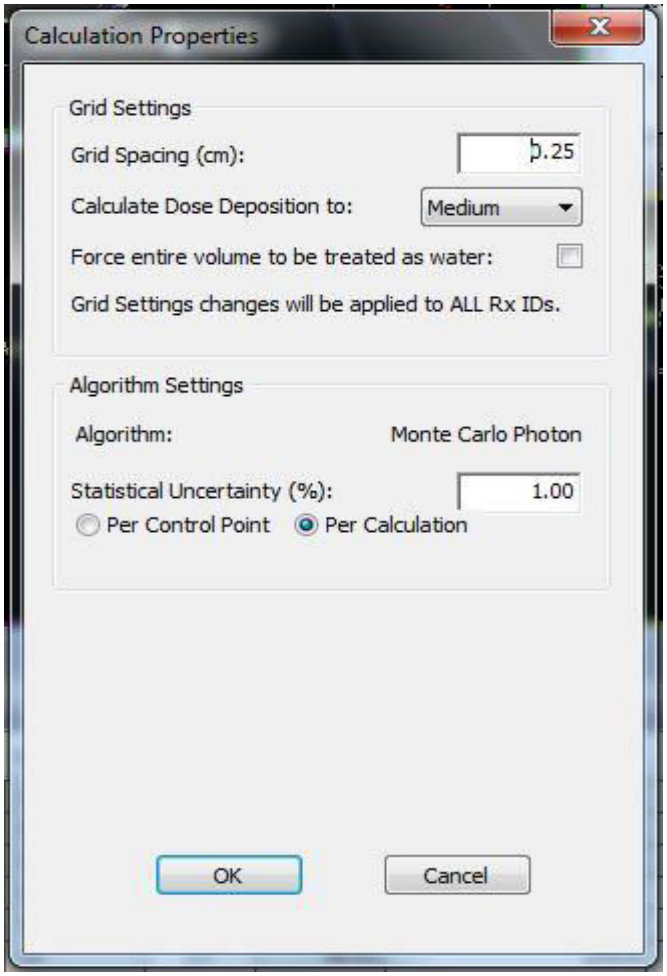
Dose Prescription

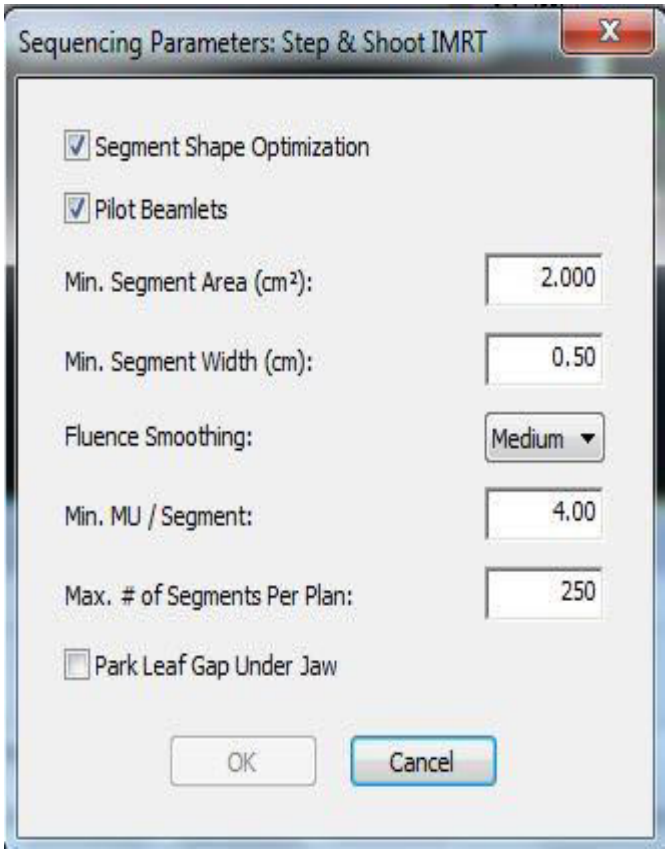


Plan Parameters

Define Calculation properties



Define sequencing parameters



Optimization Process

- Two stage process
  - Phase I: beamlet weights are optimized using the PB Algorithm.
  - Phase II: segment weights are optimized using MC Algorithm.
- Layering of structures/OARS (Monaco uses layering order to determine voxel ownership)
- Heart, Left Lung, Right Breast, Spinal cord, Right Lung defined all above the body but below target
- Define objectives for target and constraint for OARs
- Start optimization with PTV and Body first
- Add OARs constraint one by one in optimization
- Analyze the results of optimization using relative impact tab as well as dose statistics.

Optimization constraints

IMRT Constraints

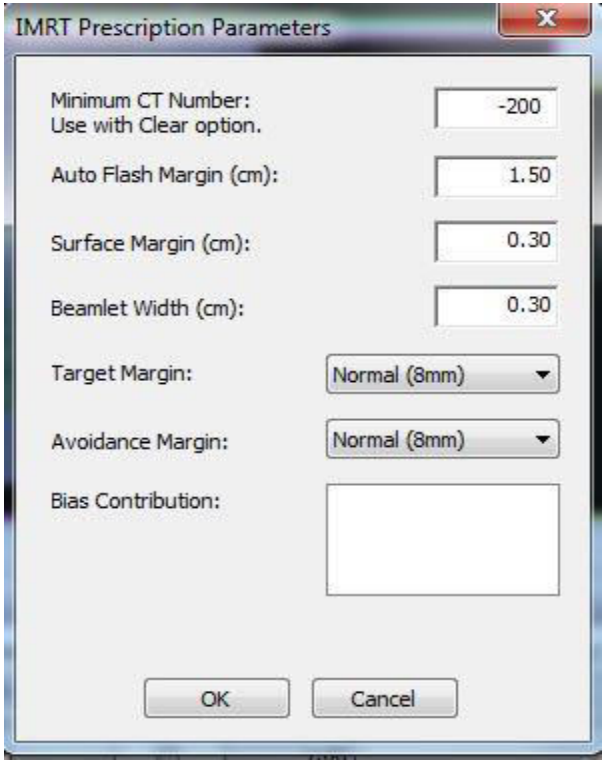
Pareto | Constrained | IMRT Parameters

Structure	Cost Function	Enabled	Status	Manual	Weight	Reference Dose (cGy)	Multicriterial	Isoconstraint	Isoeffect	Relative Impact
PTV_TOT_EVAL	Target EUD	☑	On	☐	1.00			5000.0	0.0	
	Quadratic Overdose	☑	On	☐	0.01	5200.0		100.0	0.0	
	Target Penalty	☐	Off	☐	1.00			5000.0	0.0	
HEART	Parallel	☐	Off	☐	0.08	1900.0	☐	5.00	0.00	
	Parallel	☐	Off	☐	0.01	1500.0	☐	15.00	0.00	
	Parallel	☐	Off	☐	48.61	270.0	☐	29.00	0.00	
LUNG_LEFT	Parallel	☐	Off	☐	27.76	800.0	☐	33.00	0.00	
	Parallel	☐	Off	☐	315.87	2000.0	☐	14.00	0.00	
	Parallel	☐	Off	☐	0.02	1000.0	☐	40.00	0.00	
BREAST_RIGHT	Parallel	☐	Off	☐	0.01	300.0	☐	5.00	0.00	
	Serial	☐	Off	☐	0.05		☐	158.0	0.0	
SPINAL CORD	Serial	☐	Off	☐	0.01		☐	750.0	0.0	
LUNG_RIGHT	Parallel	☐	Off	☐	0.02	500.0	☐	6.00	0.00	
BODY	Quadratic Overdose	☑	On	☐	0.01	5000.0	☐	30.0	0.0	
	Quadratic Overdose	☑	On	☐	0.01	3333.0	☐	30.0	0.0	
	Maximum Dose	☑	On	☐	9.95			5550.0	0.0	
	Conformality	☑	On	☐	28.79		☐	0.70	0.00	

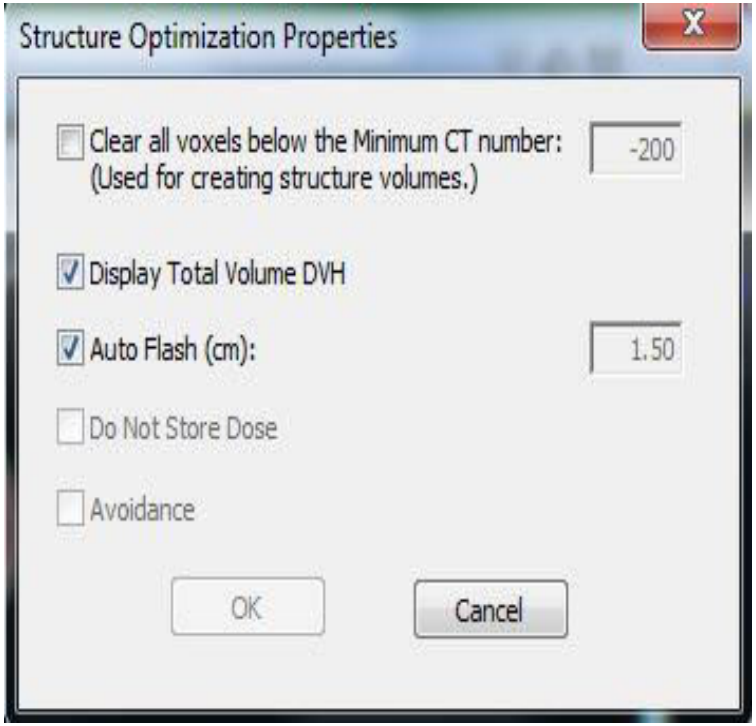
<click to add a new structure>

Target Objectives

IMRT Parameters



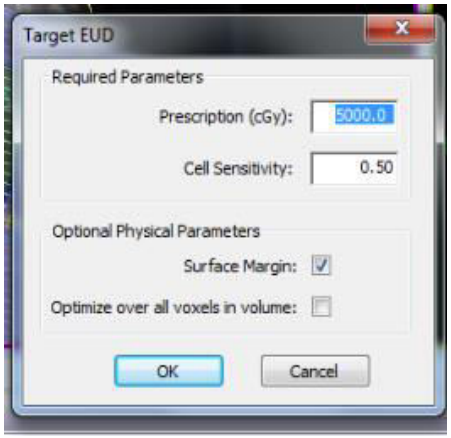
In PTV Structure optimization properties use Auto Flash Margin



Target Objectives

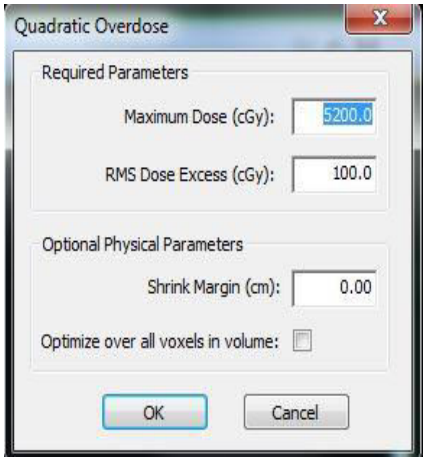
Biological cost function → Target EUD

Dose (Gy) covering 99 (%) of the PTV_TOT_EVAL



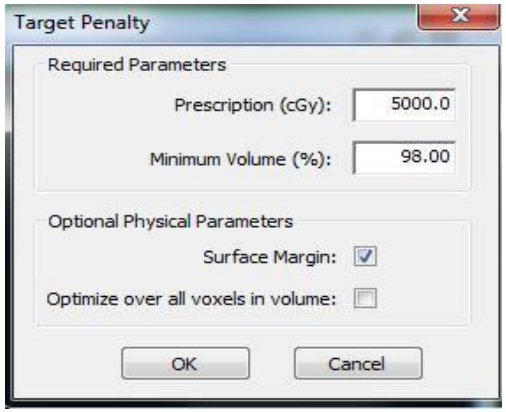
Physical cost function → Quadratic Overdose

Dose (Gy) covering 0.3 (cc) of the PTV_TOT_EVAL



One more physical cost function used → **Target penalty** (to force the min. dose coverage)

Dose (Gy) covering 95 (%) of the PTV_TOT_EVAL

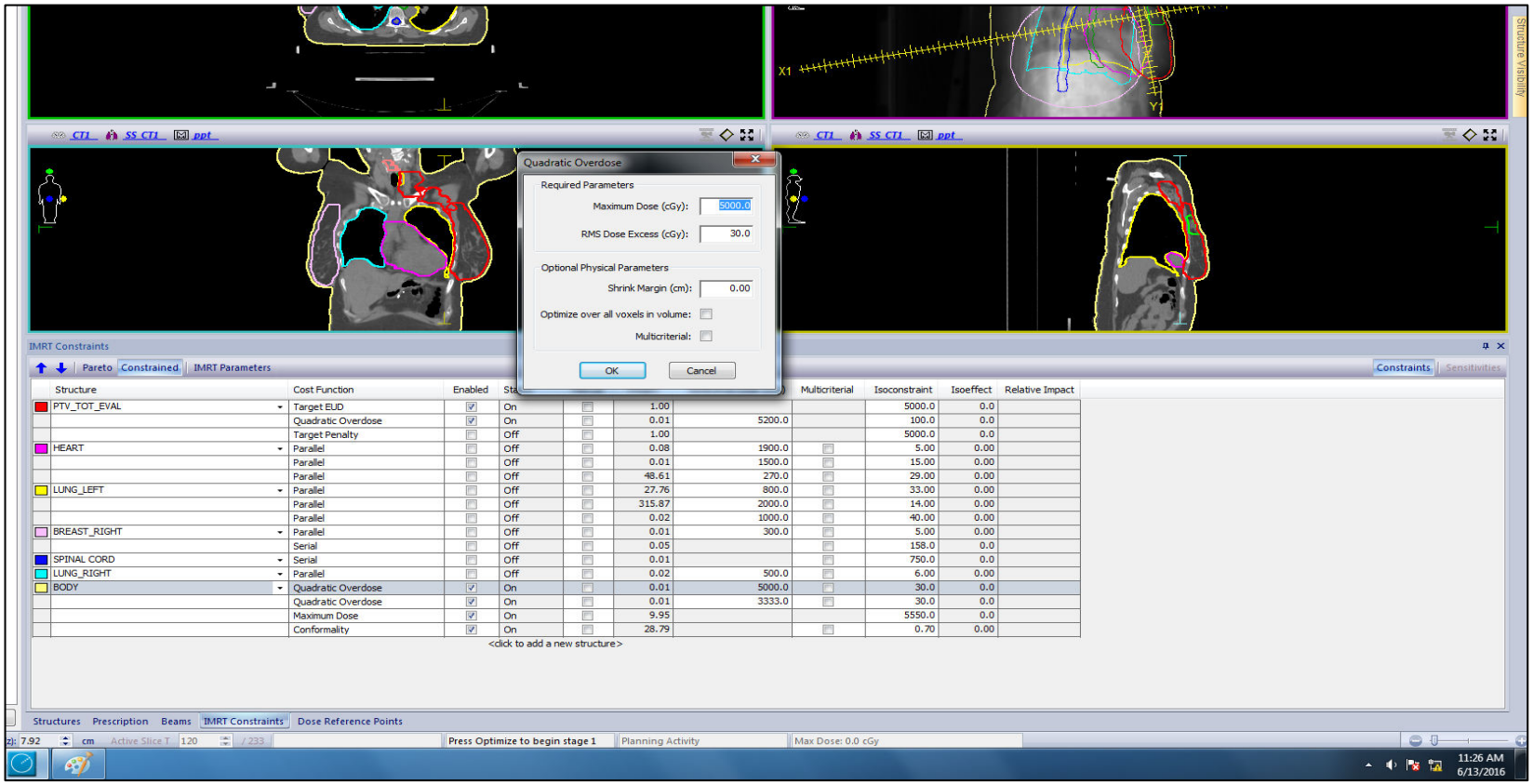


Define cost functions for body

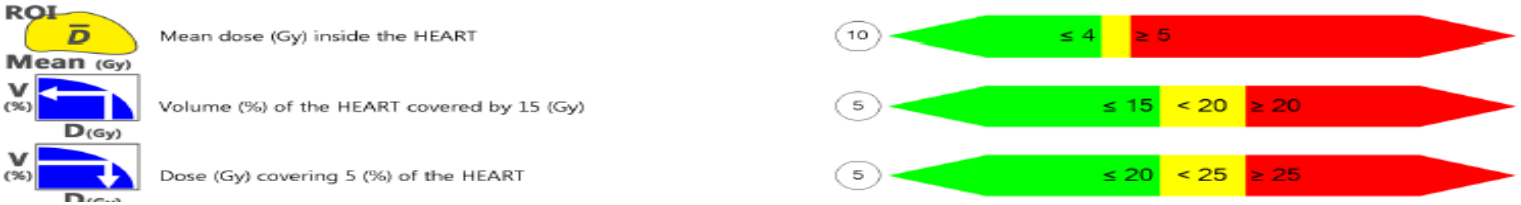
- First quadratic overdose function
- Second quadratic overdose function

} To limit spillage of dose

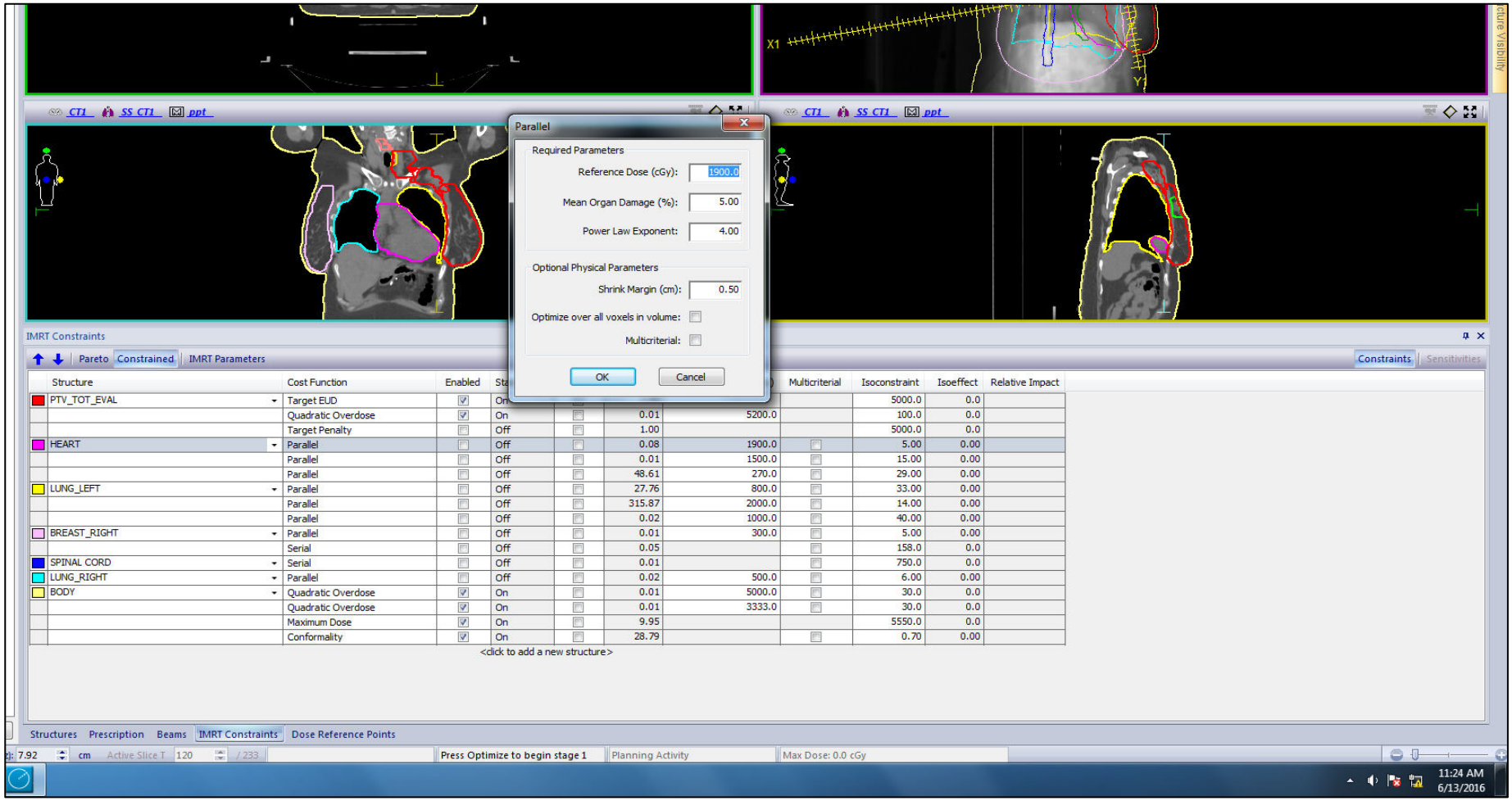
- Maximum dose cost function
- Conformality cost function



Constraints defined for heart



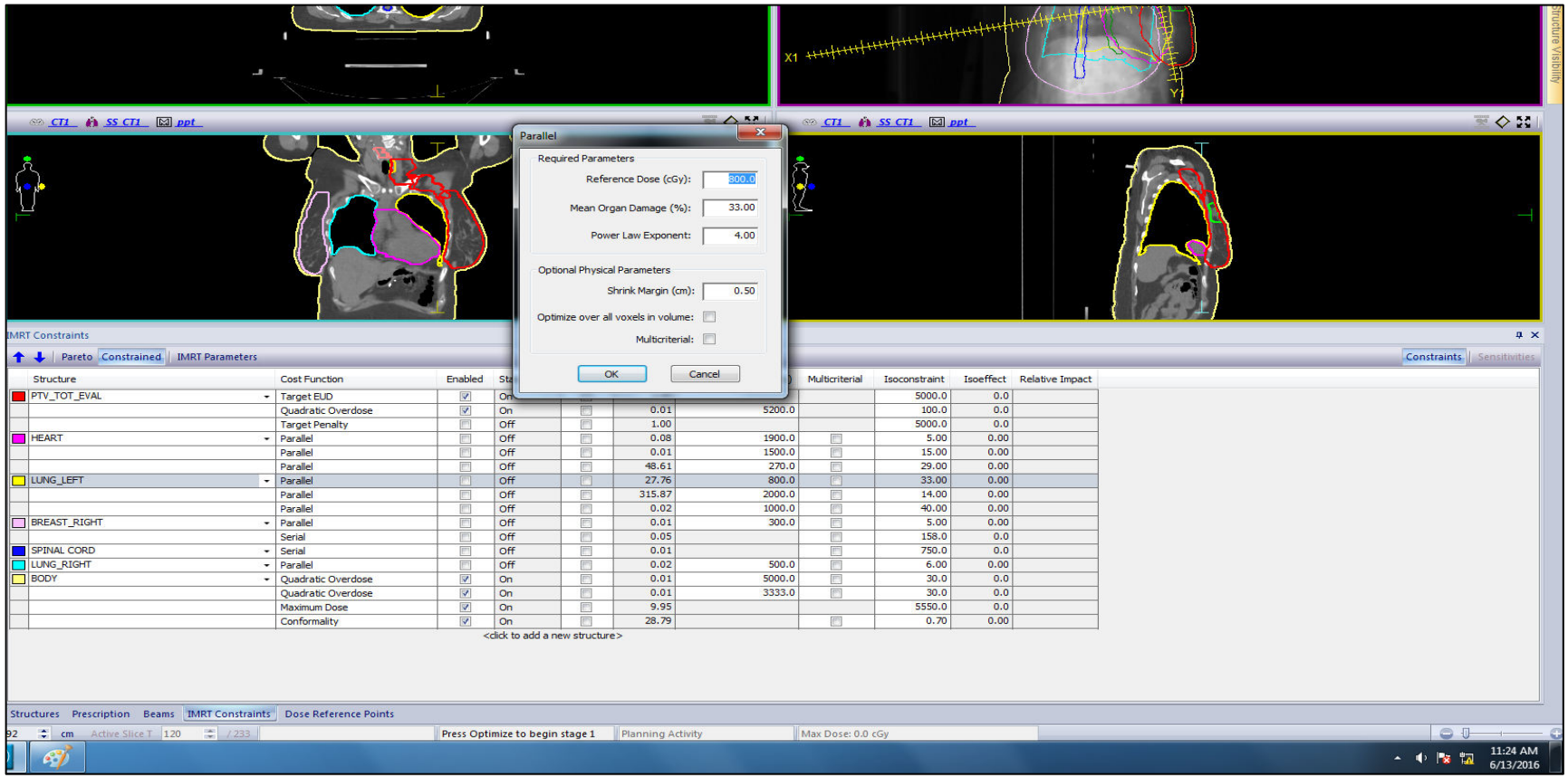
Biological cost function used – Parallel cost function



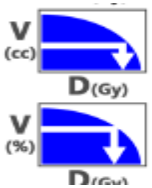
Constraints defined for Left Lung

ROI Mean (Gy)	Mean dose (Gy) inside the LUNG_LEFT	5	≤ 9	< 15	≥ 15
V (%) D (Gy)	Volume (%) of the LUNG_LEFT covered by 20 (Gy)	5	≤ 15	< 20	≥ 20
V (%) D (Gy)	Volume (%) of the LUNG_LEFT covered by 10 (Gy)	5	≤ 30	< 40	≥ 40
V (%)	Volume (%) of the LUNG_LEFT covered by 5 (Gy)	4	≤ 50	< 70	≥ 70

Biological cost function used – Parallel cost function



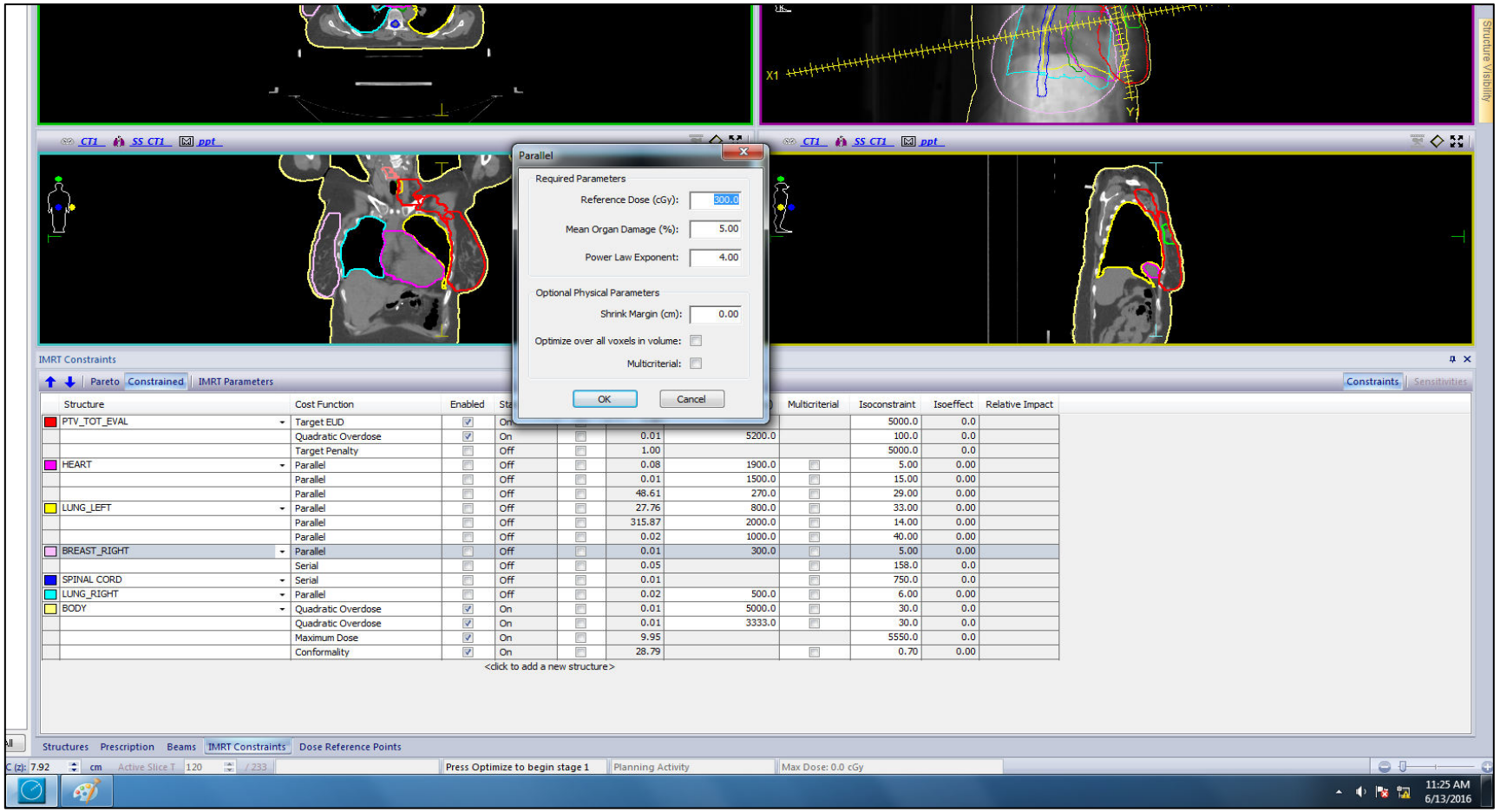
Constraints defined for Right Breast



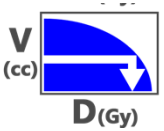
Dose (Gy) covering 0.3 (cc) of the BREAST_RIGHT

Dose (Gy) covering 5 (%) of the BREAST_RIGHT

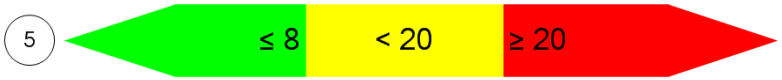
Biological cost function used – Parallel and Serial cost function



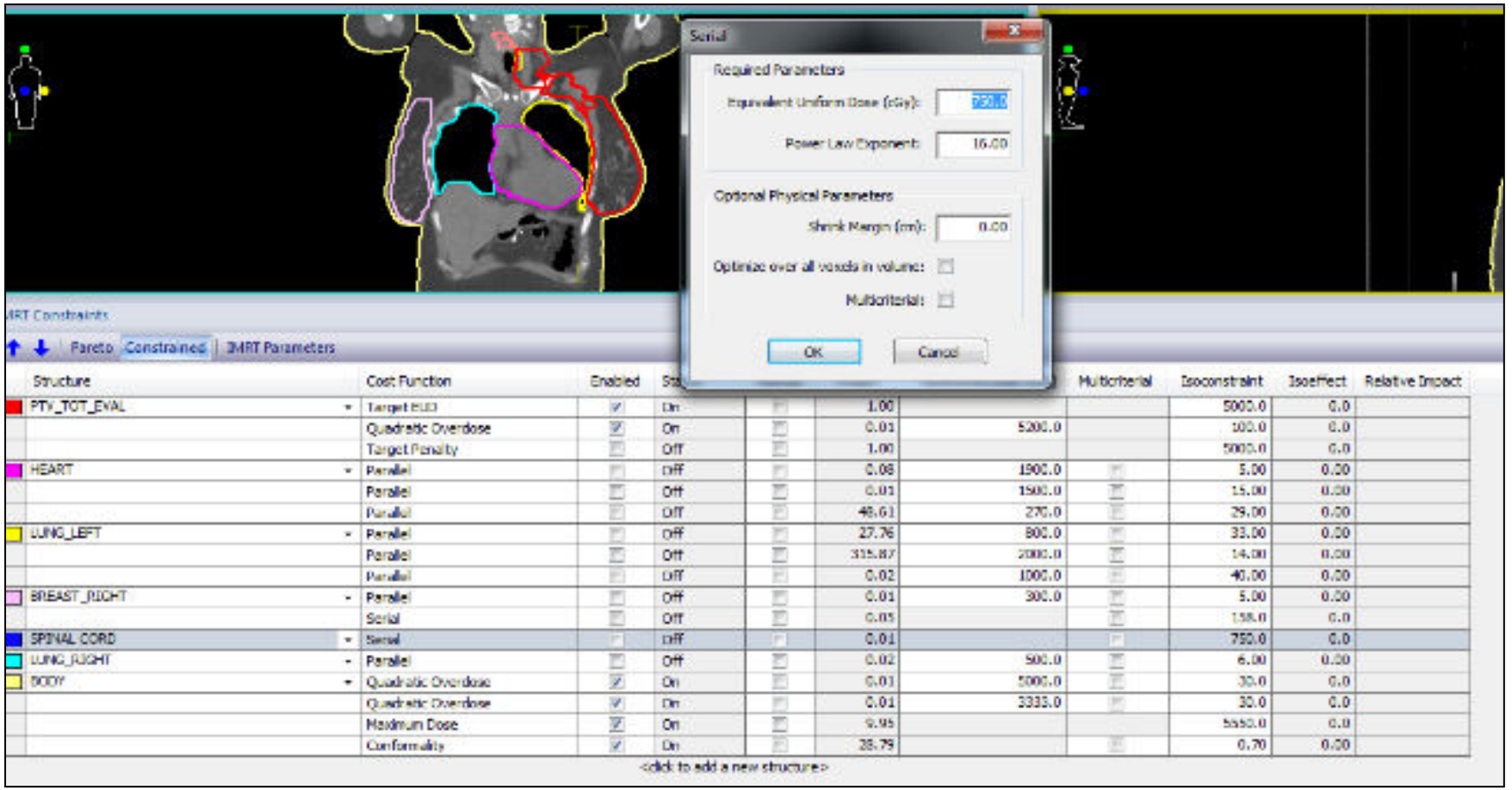
Constraints defined for Spinal Cord



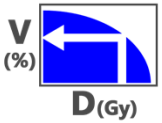
Dose (Gy) covering 0.03 (cc) of the SPINAL CORD



Biological cost function used – Serial cost function

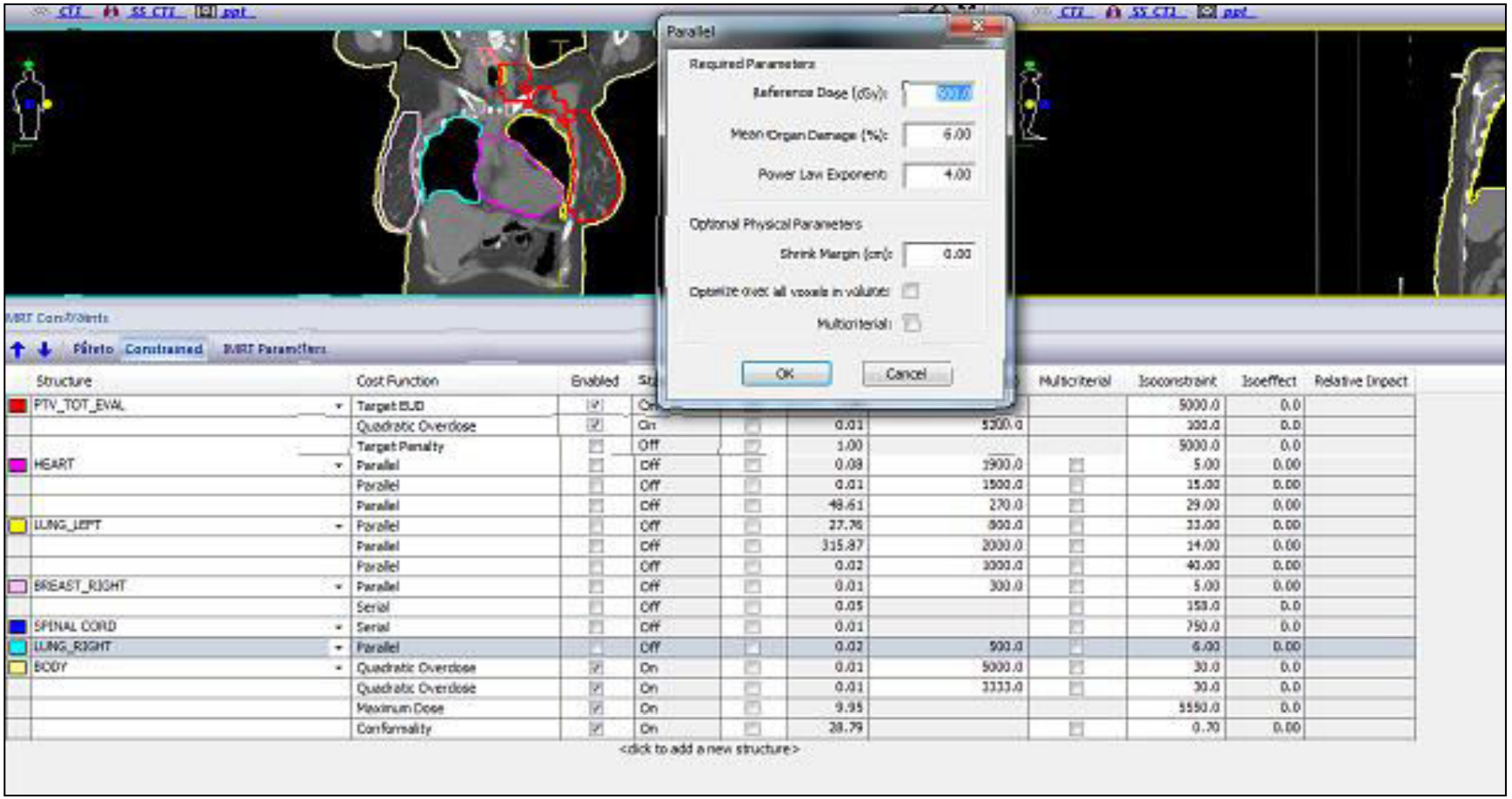


Constraints defined for Right LUNG

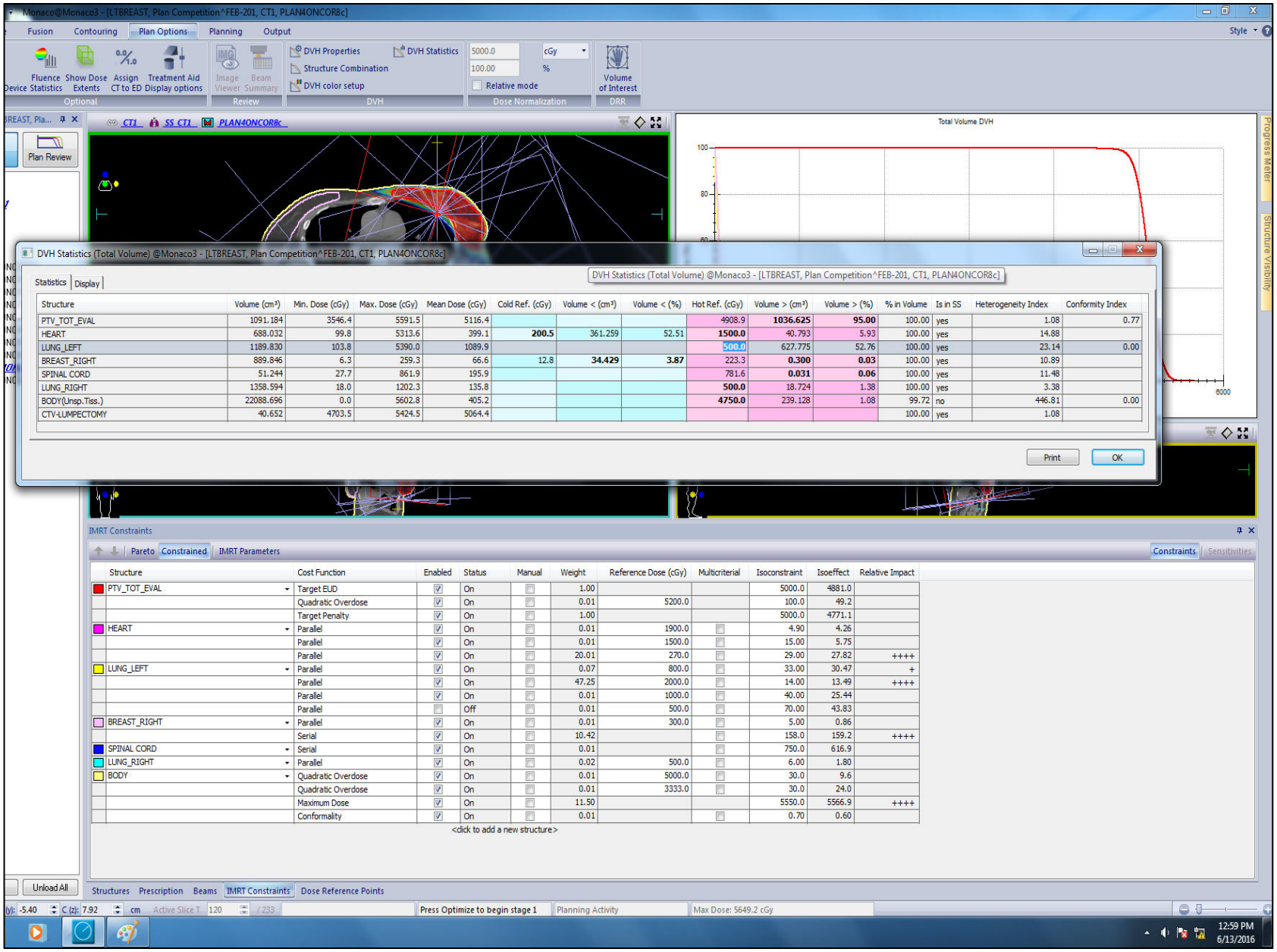


Volume (%) of the LUNG_RIGHT covered by 5 (Gy)

Biological cost function used – Parallel cost function



Dose Statistics from TPS



DVH Statistics (Total Volume) @Monaco3 - [LTBREAST, Plan Competition^FEB-201, CT1, PLAN4ONCOR8c]

Structure	Volume (cm³)	Min. Dose (cGy)	Max. Dose (cGy)	Mean Dose (cGy)	Cold Ref. (cGy)	Volume < (cm³)	Volume < (%)	Hot Ref. (cGy)	Volume > (cm³)	Volume > (%)	% in Volume	Is in SS	Heterogeneity Index	Conformity Index
PTV_TOT_EVAL	1091.184	3546.4	5591.5	5116.4				4908.9	**1036.625**	**95.00**	100.00	yes	1.08	0.77
HEART	688.032	99.8	5313.6	399.1	**200.5**	361.259	52.51	**1500.0**	40.793	5.93	100.00	yes	14.88	
LUNG_LEFT	1189.830	103.8	5390.0	1089.9				**500.0**	627.775	52.76	100.00	yes	23.14	0.00
BREAST_RIGHT	889.846	6.3	259.3	66.6	12.8	**34.429**	**3.87**	223.3	**0.300**	**0.03**	100.00	yes	10.89	
SPINAL CORD	51.244	27.7	861.9	195.9				781.6	**0.031**	**0.06**	100.00	yes	11.48	
LUNG_RIGHT	1358.594	18.0	1202.3	135.8				**500.0**	18.724	1.38	100.00	yes	3.38	
BODY(Unsp.Tiss.)	22088.696	0.0	5602.8	405.2				**4750.0**	239.128	1.08	99.72	no	446.81	0.00
CTV-LUMPECTOMY	40.652	4703.5	5424.5	5064.4							100.00	yes	1.08	

Structure	Cost Function	Enabled	Status	Manual	Weight	Reference Dose (cGy)	Multicriterial	Isoconstraint	Isoeffect	Relative Impact
PTV_TOT_EVAL	Target EUD	☑	On	☐	1.00			5000.0	4881.0	
	Quadratic Overdose	☑	On	☐	0.01	5200.0		100.0	49.2	
	Target Penalty	☑	On	☐	1.00			5000.0	4771.1	
HEART	Parallel	☑	On	☐	0.01	1900.0	☐	4.90	4.26	
	Parallel	☑	On	☐	0.01	1500.0	☐	15.00	5.75	
	Parallel	☑	On	☐	20.01	270.0	☐	29.00	27.82	++++
LUNG_LEFT	Parallel	☑	On	☐	0.07	800.0	☐	33.00	30.47	+
	Parallel	☑	On	☐	47.25	2000.0	☐	14.00	13.49	++++
	Parallel	☑	On	☐	0.01	1000.0	☐	40.00	25.44	
	Parallel	☐	Off	☐	0.01	500.0	☐	70.00	43.83	
BREAST_RIGHT	Parallel	☑	On	☐	0.01	300.0	☐	5.00	0.86	
	Serial	☑	On	☐	10.42		☐	158.0	159.2	++++
SPINAL CORD	Serial	☑	On	☐	0.01		☐	750.0	616.9	
LUNG_RIGHT	Parallel	☑	On	☐	0.02	500.0	☐	6.00	1.80	
BODY	Quadratic Overdose	☑	On	☐	0.01	5000.0	☐	30.0	9.6	
	Quadratic Overdose	☑	On	☐	0.01	3333.0	☐	30.0	24.0	
	Maximum Dose	☑	On	☐	11.50		☐	5550.0	5566.9	++++
	Conformality	☑	On	☐	0.01		☐	0.70	0.60	

<click to add a new structure>

Plan report

Rx A: Plan Report

Hospital/Clinic:	DELHI STATE CANCER INST.	Doc Number:	Rx A: 19220160218.111316.001	Monaco 5.10.02
Patient Name:	Plan Competition^FEB-201	Save Plan Date/Time:	Jun 13, 2016 13:40:11	
Patient ID:	LTBREAST	Print Date/Time:	Jun 14, 2016 11:42:46	
Plan Name:	CT1:SS_CT1:PLAN4ONCOR8c	Workstation ID:	Monaco3 198.169.120.124	
Description:				
Comment:				

StudySet Information

Studyset ID: CT1 **# of Slices:** 233 **Pixel Size:** 0.14 **Scan Orientation:** Head First Supine

Plan Information

Treatment Orientation: Head First Supine

Max Dose in Plan (cGy): 5649.2

Max Dose Location (cm): X = 4.61 Y = 1.60 Z = 8.76

Grid Information

Grid Spacing (cm): 0.28 **Assigned CTtoED File:** DICOM3.rocsboard02

Calculate Dose Deposition to: Medium **# of Calculation Points:** 3369392

Force entire volume to be treated as water: No

Prescription Information: [A]

Rx Site	Prescribe To:	Rx Dose (cGy)	Fractional Dose (cGy)	Number of Fractions
Chest	Plan Isocenter	5000.0	200.0	25

Actual Dose(cGy): 3900.2

Rescale: No user normalization applied

Algorithm: Monte Carlo Photon

Statistical Uncertainty (%) per Calculation: 1.00

Delivery Mode: Step & Shoot IMRT

Beam Information

Scan Reference Coordinates (cm): No Scan Reference Point has been selected

Beam #	Description	Treatment Unit	Modality	Energy	Gantry (deg)	Coll. (deg)	Couch (deg)	Isocenter X(cm)	Y(cm)	Z(cm)	# of Segs	MU/Fx
1	1	ONCOREXPRESS	Photon	6.0 MV	285.0	10.0	0.0	9.65	-5.40	7.92	22	163.62
2	2	ONCOREXPRESS	Photon	6.0 MV	305.0	15.0	0.0	9.65	-5.40	7.92	18	130.51
3	3	ONCOREXPRESS	Photon	6.0 MV	325.0	0.0	0.0	9.65	-5.40	7.92	22	157.85
4	4	ONCOREXPRESS	Photon	6.0 MV	345.0	0.0	0.0	9.65	-5.40	7.92	15	119.04
5	5	ONCOREXPRESS	Photon	6.0 MV	90.0	350.0	0.0	9.65	-5.40	7.92	13	82.15
6	6	ONCOREXPRESS	Photon	6.0 MV	110.0	350.0	0.0	9.65	-5.40	7.92	17	96.45
7	7	ONCOREXPRESS	Photon	6.0 MV	130.0	340.0	0.0	9.65	-5.40	7.92	17	98.20
8	8	ONCOREXPRESS	Photon	6.0 MV	150.0	340.0	0.0	9.65	-5.40	7.92	17	99.54
9	9	ONCOREXPRESS	Photon	6.0 MV	40.0	0.0	0.0	9.65	-5.40	7.92	14	114.66
										Total:	155	1062.02

Approved by:

Name:_____ Signature:_____ Date:_____

Results Summary

Plan Quality Metric Component	Objective(s)	Result	Raw Score	Max Score	Performance
[PTV_TOT_EVAL] D[99.0%] (Gy)	> 45 [≥ 47.5]	47.6849	15.00	15.00	100.0%
[PTV_TOT_EVAL] D[95.0%] (Gy)	> 45 [≥ 50]	48.9114	3.91	5.00	78.2%
[PTV_TOT_EVAL] D[50.0%] (Gy)	< 54 [≤ 52]	51.2424	5.00	5.00	100.0%
[PTV_TOT_EVAL] D[0.3cc] (Gy)	< 57 [≤ 55]	55.5935	3.52	5.00	70.3%
[HEART] Mean dose (Gy)	< 5 [≤ 4]	4.0248	9.75	10.00	97.5%
[HEART] V[15.0Gy] (%)	< 20 [≤ 15]	6.0442	5.00	5.00	100.0%
[HEART] D[5.0%] (Gy)	< 25 [≤ 20]	19.6966	5.00	5.00	100.0%
[BREAST_RIGHT] D[0.3cc] (Gy)	< 3 [≤ 2]	2.2540	1.49	2.00	74.6%
[BREAST_RIGHT] D[5.0%] (Gy)	< 3 [≤ 2]	1.4801	4.00	4.00	100.0%
[SPINAL CORD] D[0.03cc] (Gy)	< 20 [≤ 8]	7.8581	5.00	5.00	100.0%
[LUNG_RIGHT] V[5.0Gy] (%)	< 6 [≤ 3]	1.3995	5.00	5.00	100.0%
[LUNG_LEFT] Mean dose (Gy)	< 15 [≤ 9]	11.1194	3.23	5.00	64.7%
[LUNG_LEFT] V[20.0Gy] (%)	< 20 [≤ 15]	18.7632	1.24	5.00	24.7%
[LUNG_LEFT] V[10.0Gy] (%)	< 40 [≤ 30]	29.4110	5.00	5.00	100.0%
[LUNG_LEFT] V[5.0Gy] (%)	< 70 [≤ 50]	53.8121	2.86	4.00	71.4%
[PTV_TOT_EVAL] Homogeneity Index [50.0Gy]	< 0.2 [≤ 0.08]	0.1316	2.23	5.00	44.5%
[PTV_TOT_EVAL] Conformation Number [47.5Gy]	> 0.6 [≥ 0.9]	0.7891	3.67	5.00	73.5%
Global Max Location (ROI)	[BODY]	BODY	5.00	5.00	100.0%
Total [18 Metrics]			85.90	100.00	85.9%

Monaco results vary from Sun Nuclear Score

		Sun Nuclear result	Monaco TPS result
[PTV_TOT_EVAL] D[99.0%] (Gy)	> 45 [≥ 47.5]	47.6849	47.845
[PTV_TOT_EVAL] D[95.0%] (Gy)	> 45 [≥ 50]	48.9114	49.089
[PTV_TOT_EVAL] D[50.0%] (Gy)	< 54 [≤ 52]	51.2424	51.216
[PTV_TOT_EVAL] D[0.3cc] (Gy)	< 57 [≤ 55]	55.5935	54.935
[HEART] Mean dose (Gy)	< 5 [≤ 4]	4.0248	3.991
[HEART] V[15.0Gy] (%)	< 20 [≤ 15]	6.0442	5.93
[HEART] D[5.0%] (Gy)	< 25 [≤ 20]	19.6966	19.118
[BREAST_RIGHT] D[0.3cc] (Gy)	< 3 [≤ 2]	2.2540	2.233
[BREAST_RIGHT] D[5.0%] (Gy)	< 3 [≤ 2]	1.4801	1.49
[SPINAL CORD] D[0.03cc] (Gy)	< 20 [≤ 8]	7.8581	7.816
[LUNG_RIGHT] V[5.0Gy] (%)	< 6 [≤ 3]	1.3995	1.38
[LUNG_LEFT] Mean dose (Gy)	< 15 [≤ 9]	11.1194	10.899
[LUNG_LEFT] V[20.0Gy] (%)	< 20 [≤ 15]	18.7632	18.35
[LUNG_LEFT] V[10.0Gy] (%)	< 40 [≤ 30]	29.4110	28.8
[LUNG_LEFT] V[5.0Gy] (%)	< 70 [≤ 50]	53.8121	52.76
[PTV_TOT_EVAL] Homogeneity Index [50.0Gy]	< 0.2 [≤ 0.08]	0.1316	
[PTV_TOT_EVAL] Conformation Number [47.5Gy]	> 0.6 [≥ 0.9]	0.7891	
Global Max Location (ROI)	[BODY]	BODY	


THANK
YOU