3D-CRT Breast Cancer Planning

Tips and Tricks

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3D-CRT – Obsolete or not?

- There are more advanced techniques than 3D-CRT, but 3D-CRT has some advantages:

- Availability and price
- Forward planning - better plan understanding
- Easier plan verification

- You can not compare an average 3D-CRT plan with good VMAT plan, but in many cases, a good 3D-CRT plan can be as good as average VMAT plan (or even better)

- Maybe 3D-CRT is obsolete, but it’s still alive and it can do a great job for us;)

Radiotherapy planning basics

- Every percent and every millimeter is important
- 1% of irradiated volume means up to 3% TCP/NTCP

- What happens, if we would take away just 1mm from this tennis ball?

- We will decrease its volume by …

10% !!!

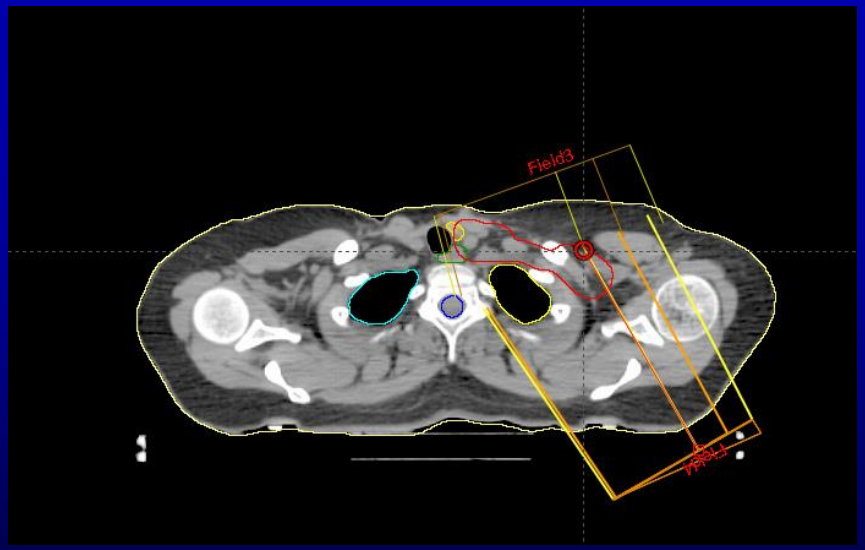
3D-CRT of breast cancer

- In 3D-CRT of breast cancer, we hardly find something special (and useful), but we may (or should):
  - Really know our linac and TPS
  - Get most of every beam we use
  - Get most of every MU we irradiate
  - Save every millimeter we can save
  - Save every percent we can save
  - Use proper plan normalization
  - Think about plan robustness and technical realization

…and our plans will be better…

Field arrangement

- Basic field geometry is always the same
  - Using half beams (1 isocenter) or beam matching (2 isocenters)
  - Two tangential fields for breast
  - Two fields for axilla and supraclavicular nodes
  - And some low-weight fields for dose distribution improvement

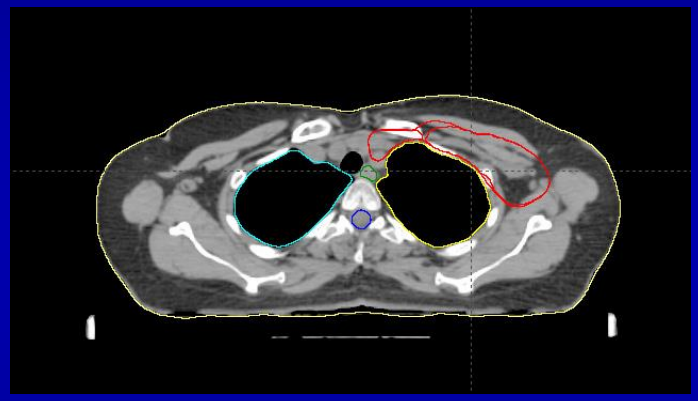


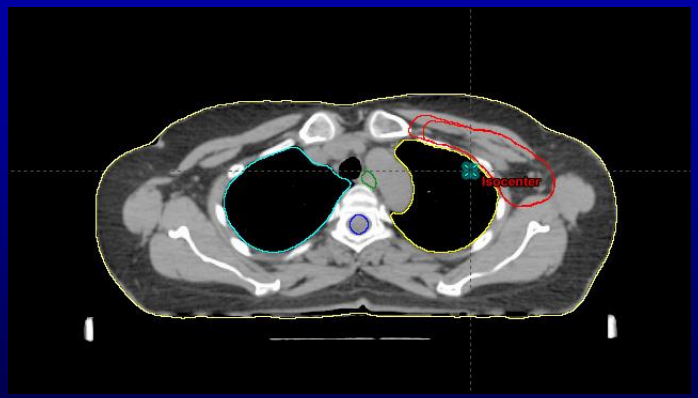
The competition case

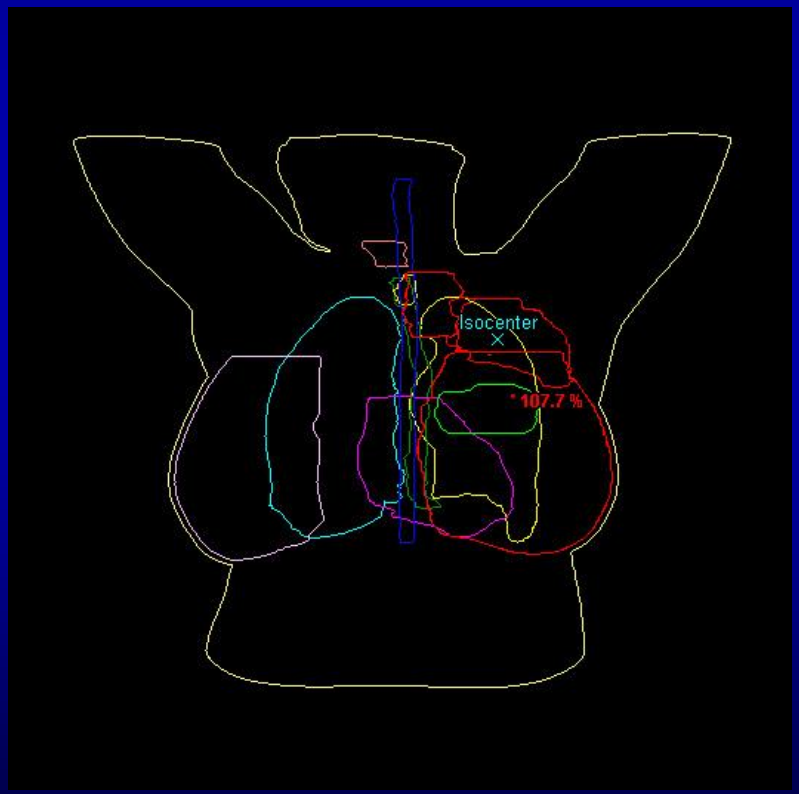
- Used equipment:
  - TPS Eclipse 8.6, AAA algorithm
  - Clinac 600C (X 6MV), MARK52 MLC
- Following the competition criteria (1 isocenter), I was not able to use my MLC because of insufficient range, so I used blocks
- In practice, I use 2 isocenters and non-coplanar fields as a simple way to extend my MLC range
- You can use standard 80 or 120 leafs MLC with similar results as I have got with blocks, just use the MLC instead of blocks
- I don't think the presented plan is a good plan, it is just a plan that tries to meet the competition criteria – and there are no criteria for plan robustness, dose to larynx, integral dose…, however you can simply modify it to meet your own criteria

Isocenter position

- Find out the plane, where PTV shape changes significantly
- Usually few millimeters below supraclavicular nodes

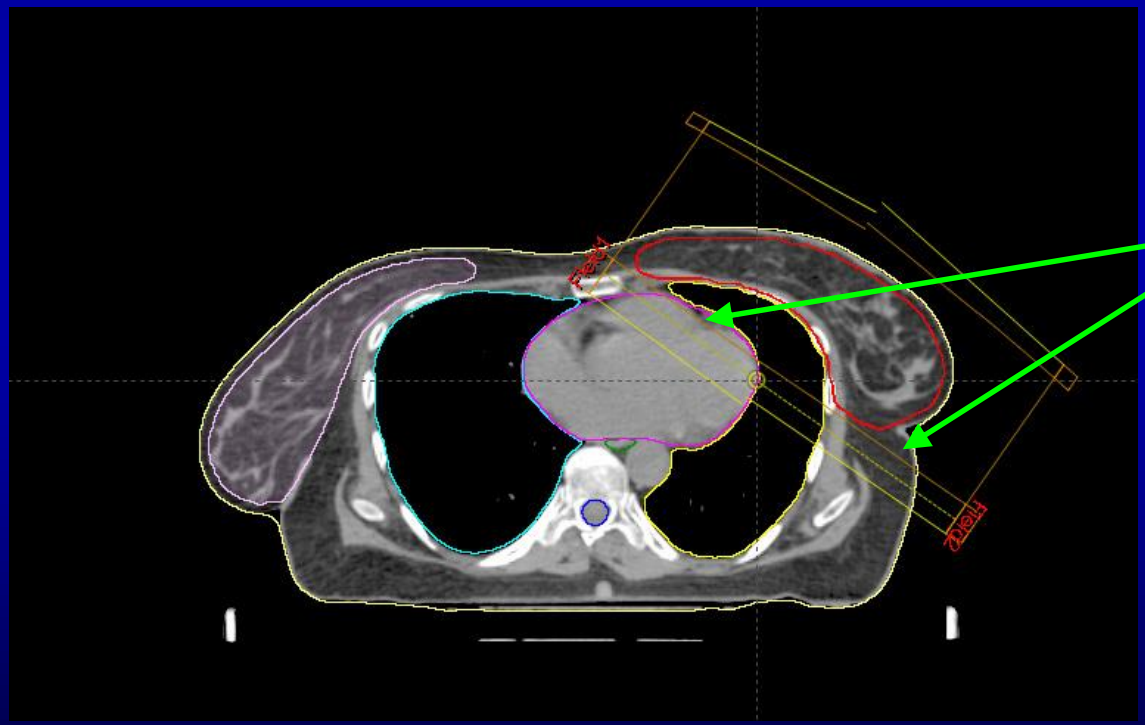






Tangential fields

- Gantry angles –minimize irradiated lung volume

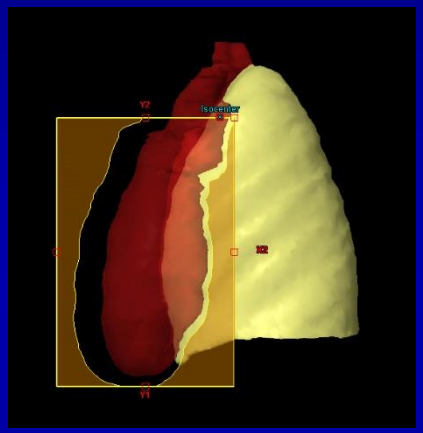


These lines should be matched

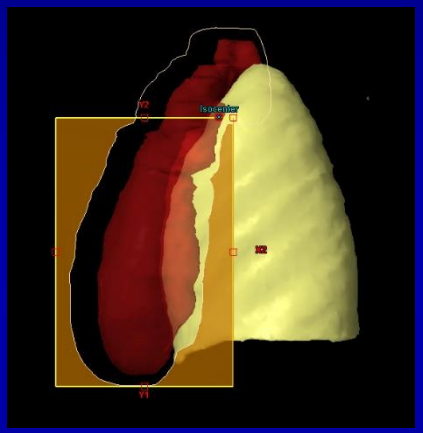
Tangential fields

- To find optimal gantry angles, show only PTV and left lung in BEV

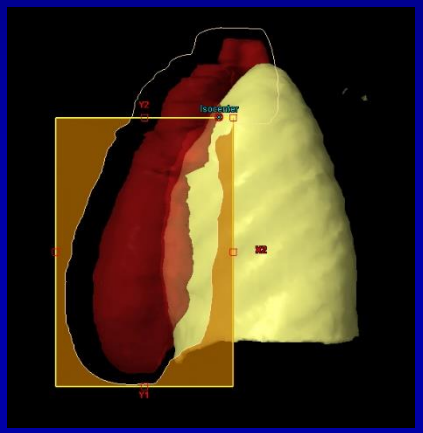
G120



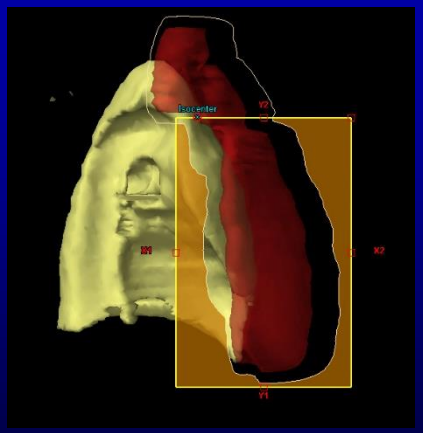
G125



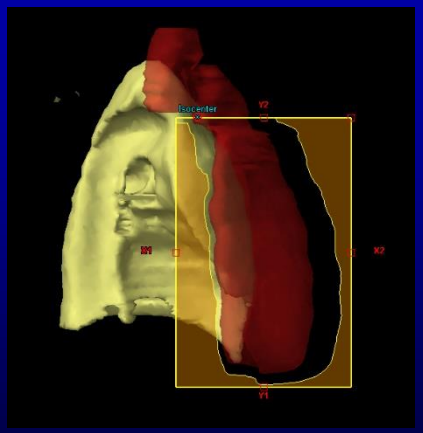
G130



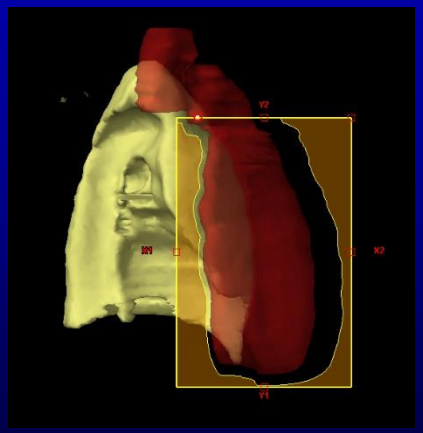
G300



G305



G310



Supraclavicular and axillar fields

- Show OARs (structure outlines only) in BEV
- Find the best gantry angles, minimize irradiated volume of OARs

G305

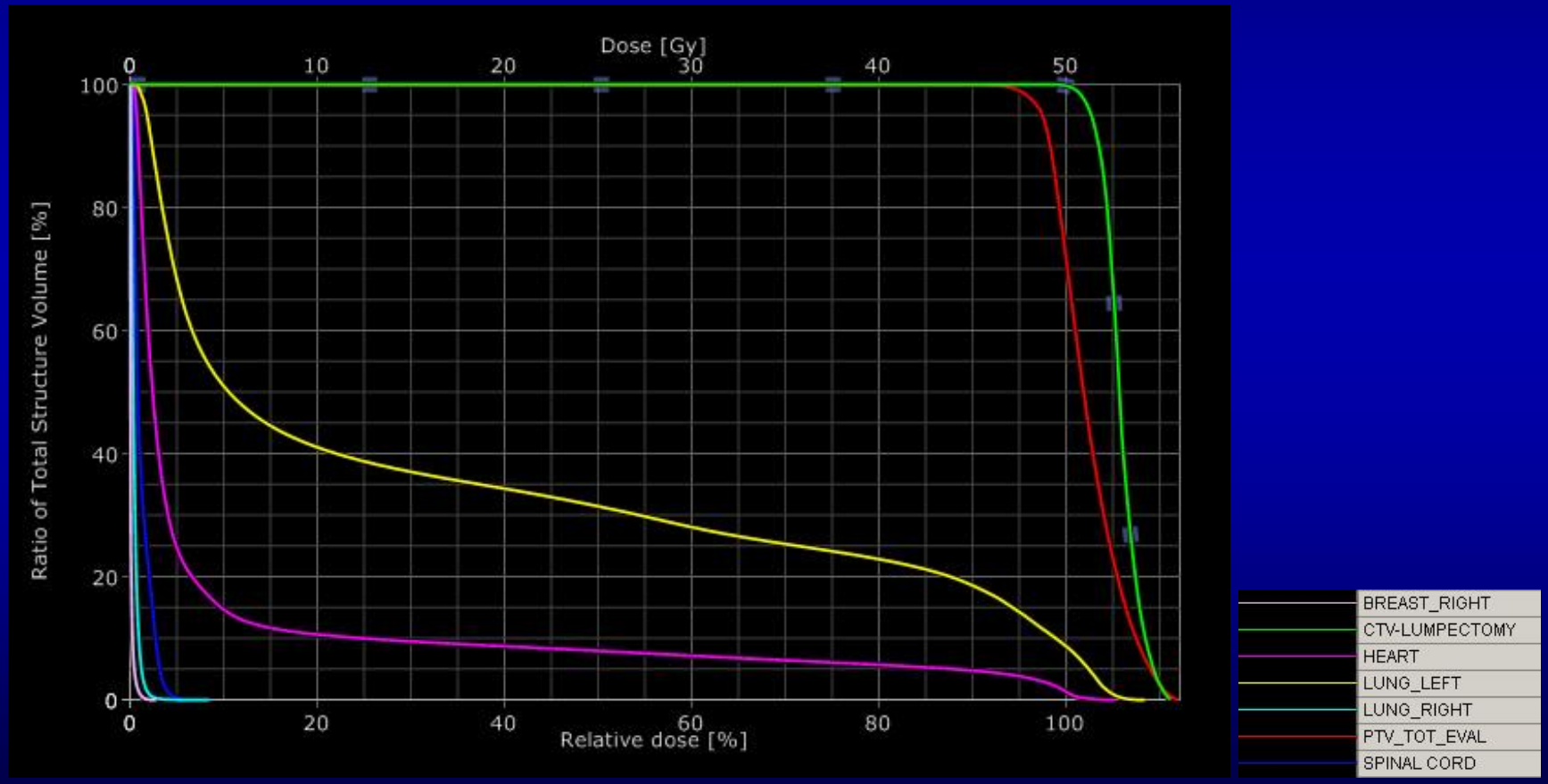
G125

Completing the plan

- Add some wedges
  - Usually 15° for breast tangential fields
  - Wedges for supraclavicular/axillar fields are strongly dependent on gantry angles
- Adjust field weight
  - Just by your experience
- Choose the right plan normalization
  - In this case, $D_{99\%}$=95% means 15 points for you;)
- Calculate the dose distribution

First look to dose distribution

- Oh no, it's terrible ;(

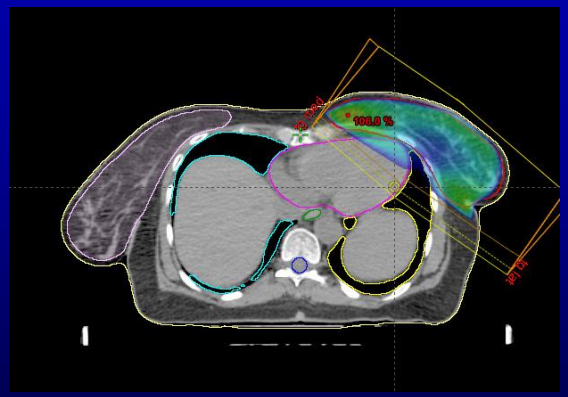


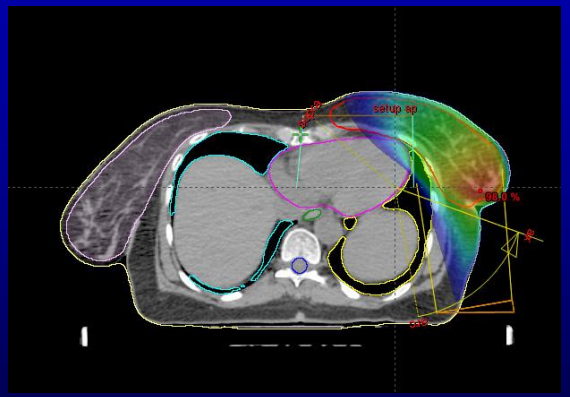
What to improve?

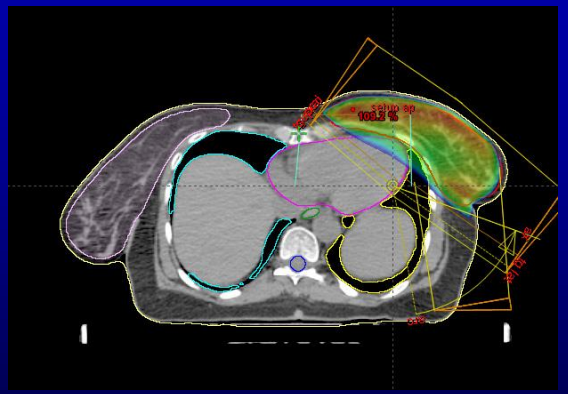
Volume	Points total	Points	Criteria	full points	no points	
PTV	45	15	D99%	>95%	90%	15
		5	D95%	>100%	90%	4
		5	D50%	<104%	108%	5
		5	D0,3cc	<110%	114%	2
		5	HI (D1%-D99%)	<8%	20%	1
		5	Conf. num.	>0,9	0,6	0
		5	Global max.	inside CTV_LUMP.		0
Lung L	19	5	Mean	<18%	30%	0
		5	V40%	<15%	20%	0
		5	V20%	<30%	40%	0
		4	V10%	<50%	70%	4
Lung R	5	5	V10%	<3%	6%	5
Heart	20	10	mean	<8%	10%	0
		5	V30%	<15%	20%	5
		5	D5%	<40%	50%	0
Breast Right	6	2	D0,3ccm	<4%	6%	2
		4	D5%	<4%	6%	4
Spinal Cord	5	5	D0,03ccm	<16%	40%	5
Sum						**52**

Decreasing dose to the left lung and heart

- In the end, we will precisely fit collimator and save few percent
- Sometimes, you can save a little volume of irradiated heart and lung using asymmetric arc field
- The more asymmetric this arc is, the more concave shape of dose distribution you get (but there are usually hardware limits)
- Balance the field weight to get uniform dose distribution



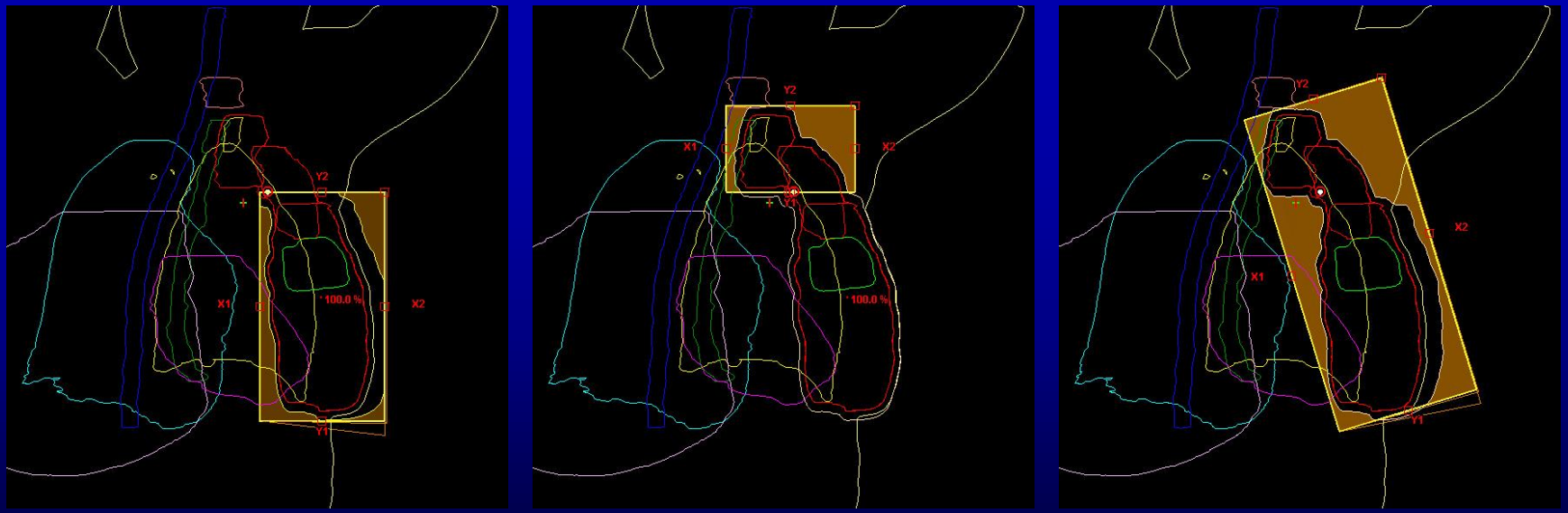




Plan consolidation

- Look at the plan, and…

…yes, there are 2 fields with the same gantry angle and the similar weight. You can merge them and save some MU, treatment time and scattered radiation dose



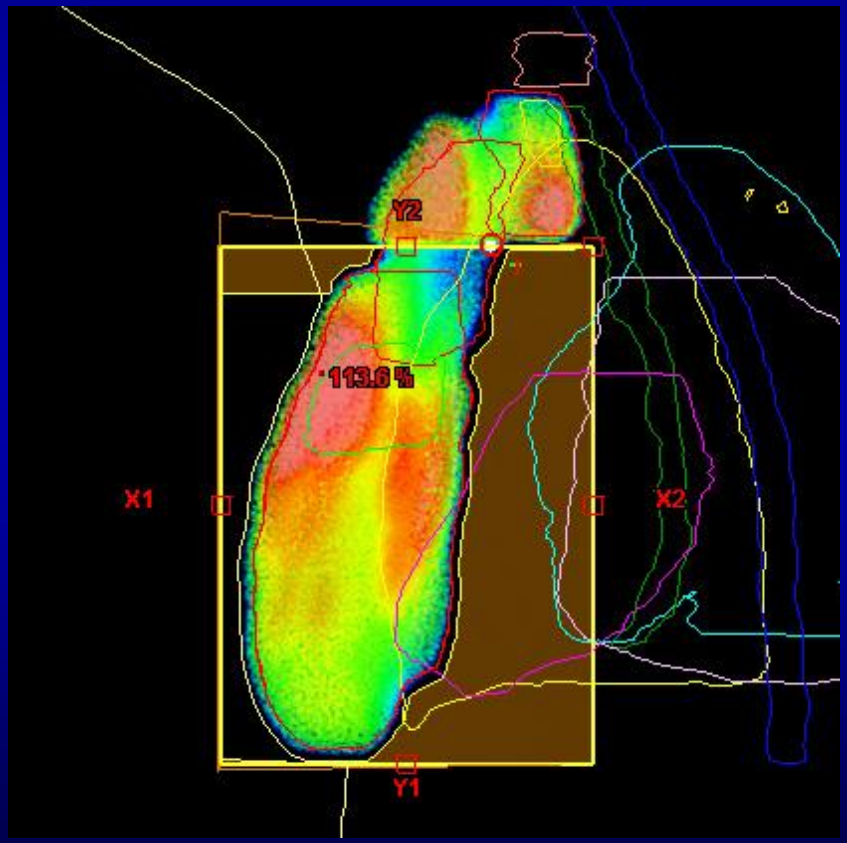
Homogeneity improvement

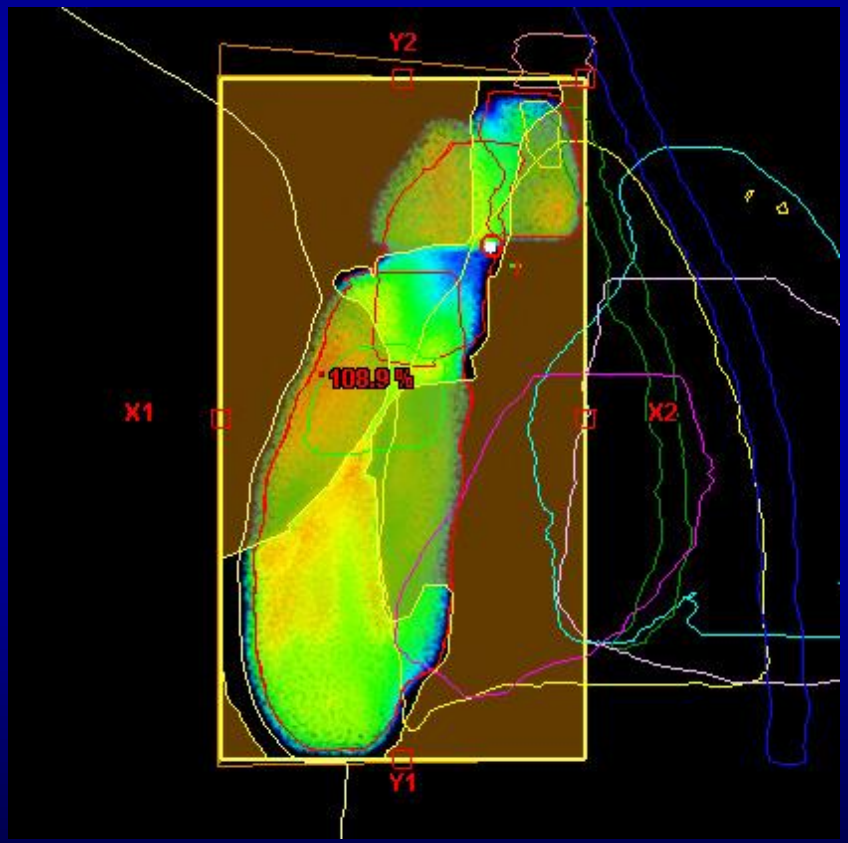
- Use support fields with low weight (~12% of main fields)
- If the support fields have the same gantry and collimator angle and beam modifiers (wedges) as main fields, these support fields would not induce significant treatment time prolongation and therapists work
- Using “persistent dose” in Eclipse allows you to see the dose while editting fields in BEV – excellent feature
- Set required dose range you would like to view (e.g. 95% - 110%)
- You can add the dose where you need to

- Add another support field, balance the weight of fields again and again
- Shape the dose distribution as you like, take advantage of intentional inhomogeneity

Homogeneity improvement

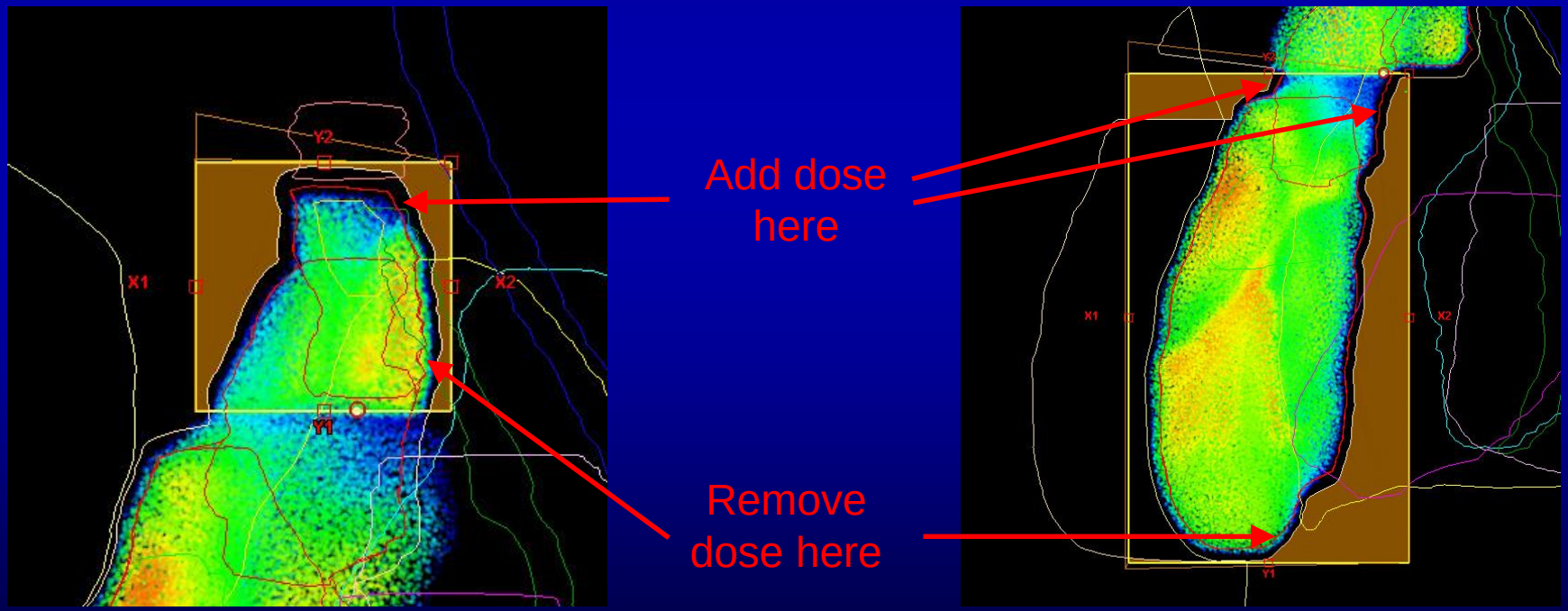
- Effect of the support field





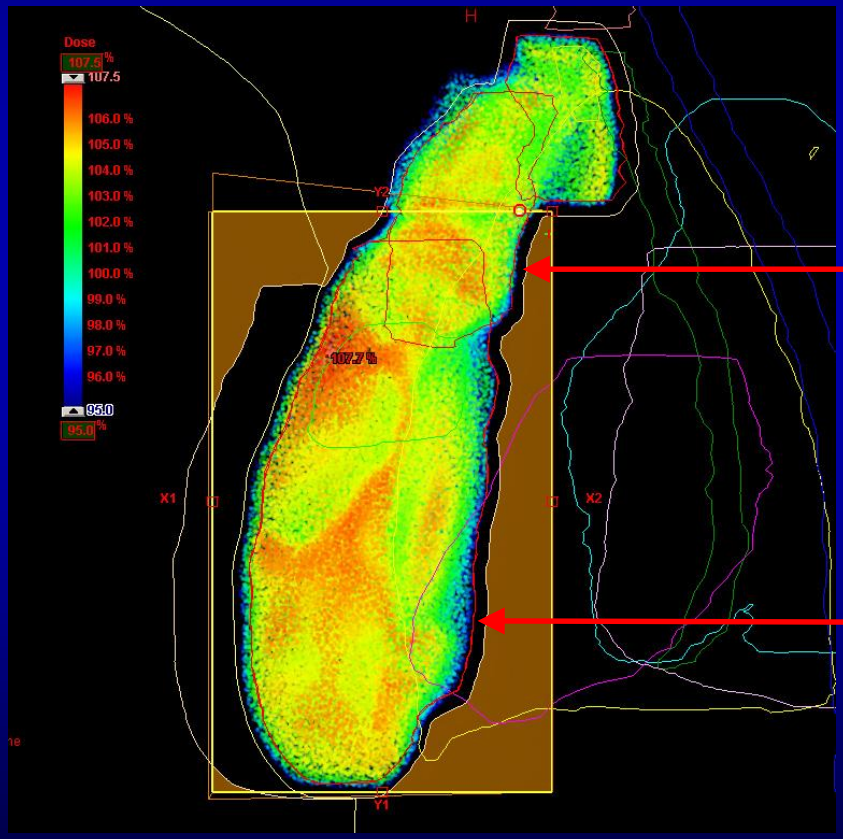
Conformity improvement

- Carefully look all fields and shield every irradiated millimeter you don’t need to irradiate



Next dose to OARs reduction

- Compromise between dose to OARs and PTV coverage



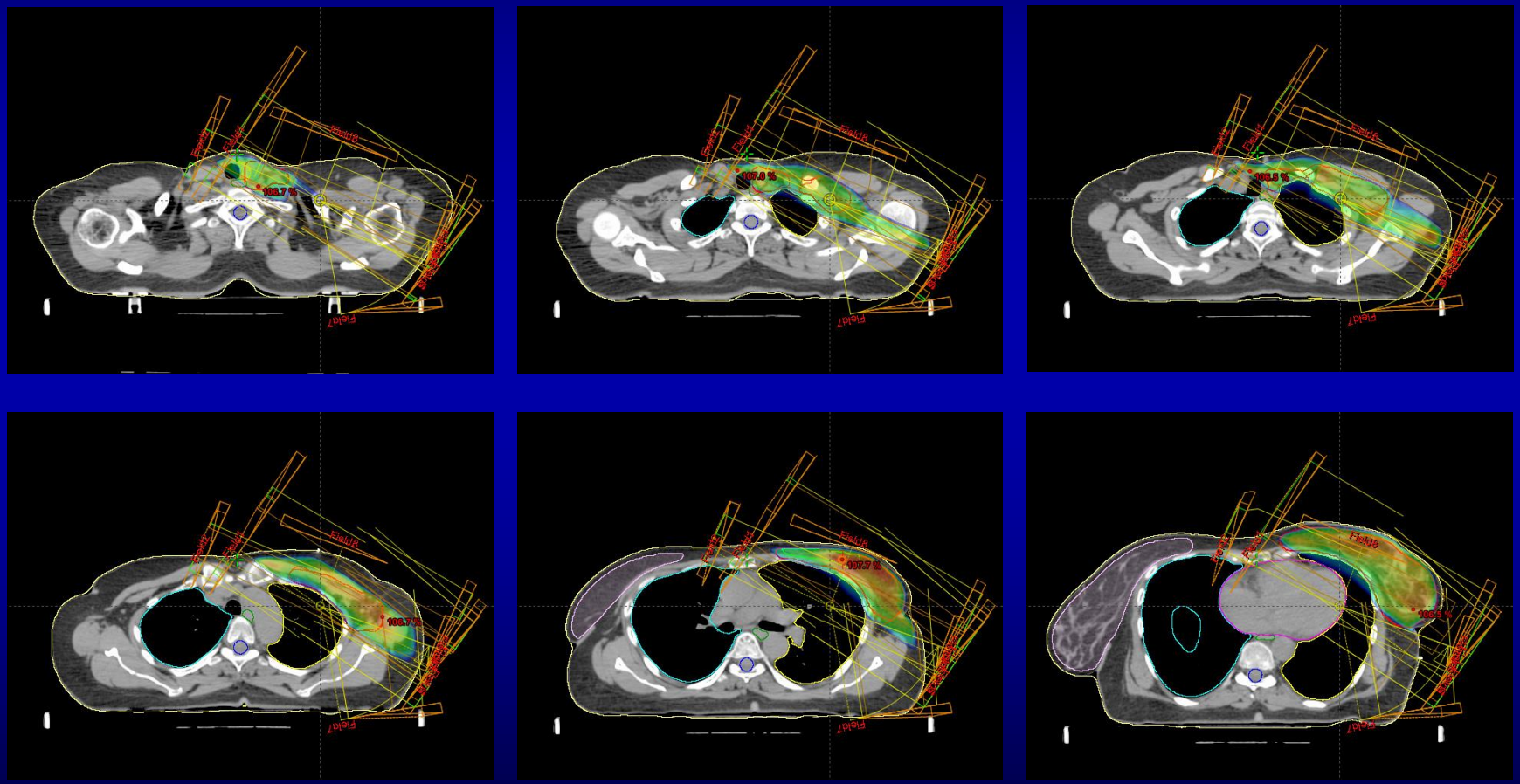
Don’t shield here – you just shield PTV and minor volume of lung

Shield here – you shield remarkable part of lung and heart at once

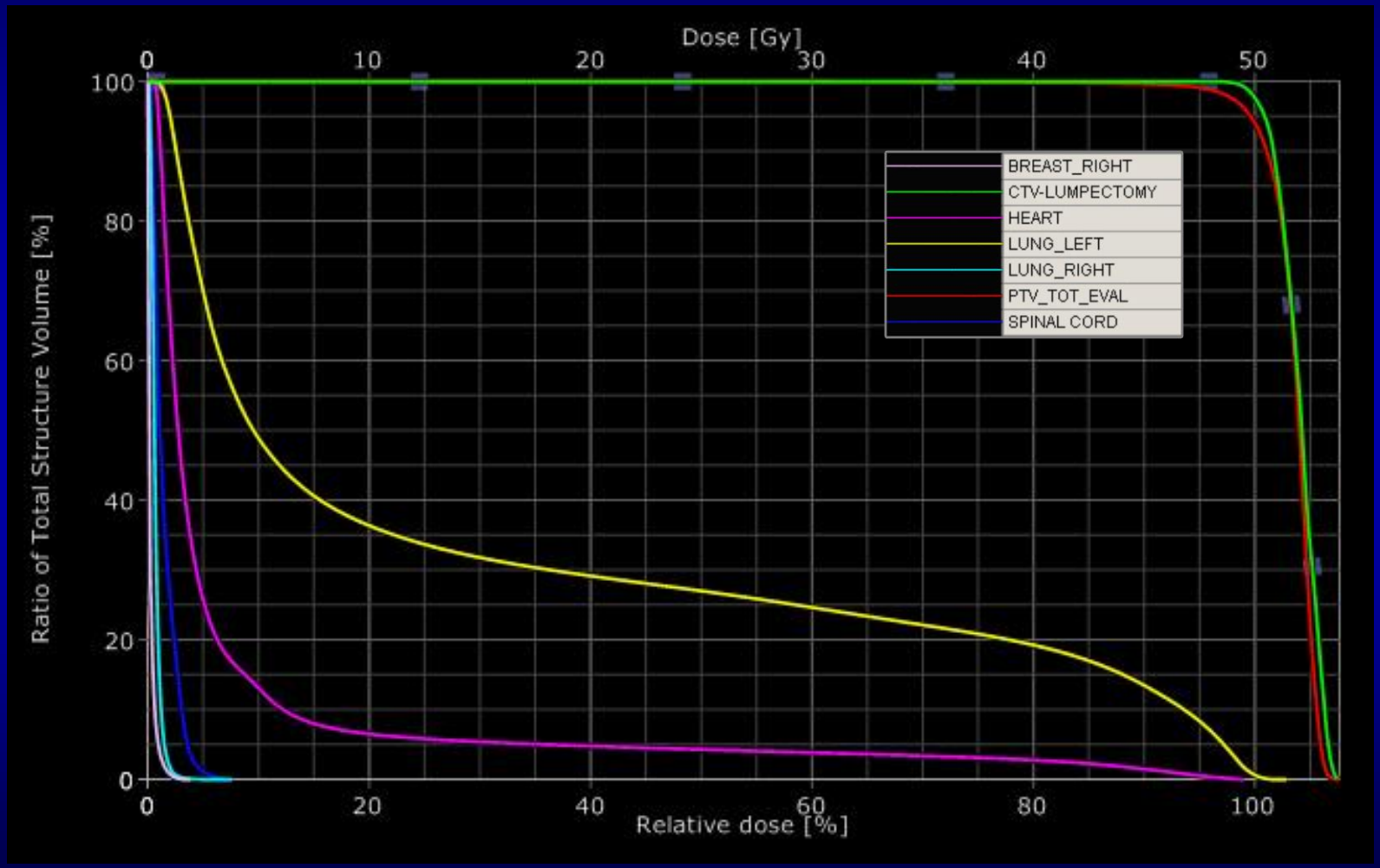
Plan revision

- Carefully view the dose distribution
- Find and fix weak points
- Review, weight and shape field by field
- Think about next improvement

Final plan



Final plan

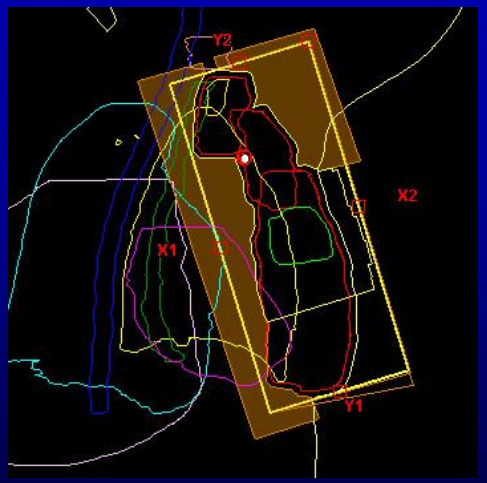

Dose [Gy]
0
10
20
30
40
50
100
80
60
40
20
0
Ratio of Total Structure Volume [%]
0
20
40
60
80
100
Relative dose [%]
BREAST_RIGHT
CTV-LUMPECTOMY
HEART
LUNG_LEFT
LUNG_RIGHT
PTV_TOT_EVAL
SPINAL CORD

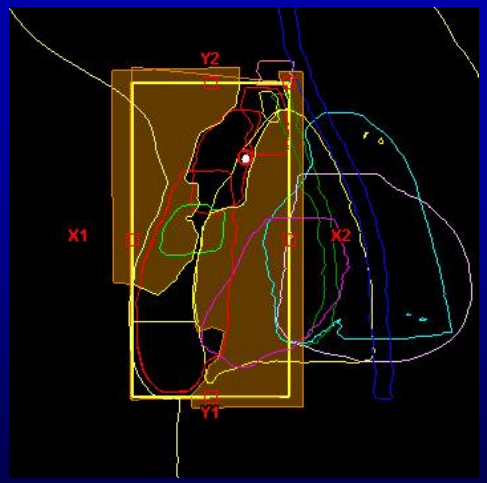
Final plan

Volume	Points total	Points	Criteria	full points	no points	
PTV	45	15	D99%	>95%	90%	15
		5	D95%	>100%	90%	4.9
		5	D50%	<104%	108%	5
		5	D0,3cc	<110%	114%	5
		5	HI (D1%-D99%)	<8%	20%	3.7
		5	Conf. num.	>0,9	0,6	0.4
		5	Global max.	inside CTV_LUMP.		5
Lung L	19	5	Mean	<18%	30%	0
		5	V40%	<15%	20%	0
		5	V20%	<30%	40%	1.8
		4	V10%	<50%	70%	4
Lung R	5	5	V10%	<3%	6%	5
Heart	20	10	mean	<8%	10%	10
		5	V30%	<15%	20%	5
		5	D5%	<40%	50%	5
Breast Right	6	2	D0,3ccm	<4%	6%	2
		4	D5%	<4%	6%	4
Spinal Cord	5	5	D0,03ccm	<16%	40%	5
Sum						**80.8**

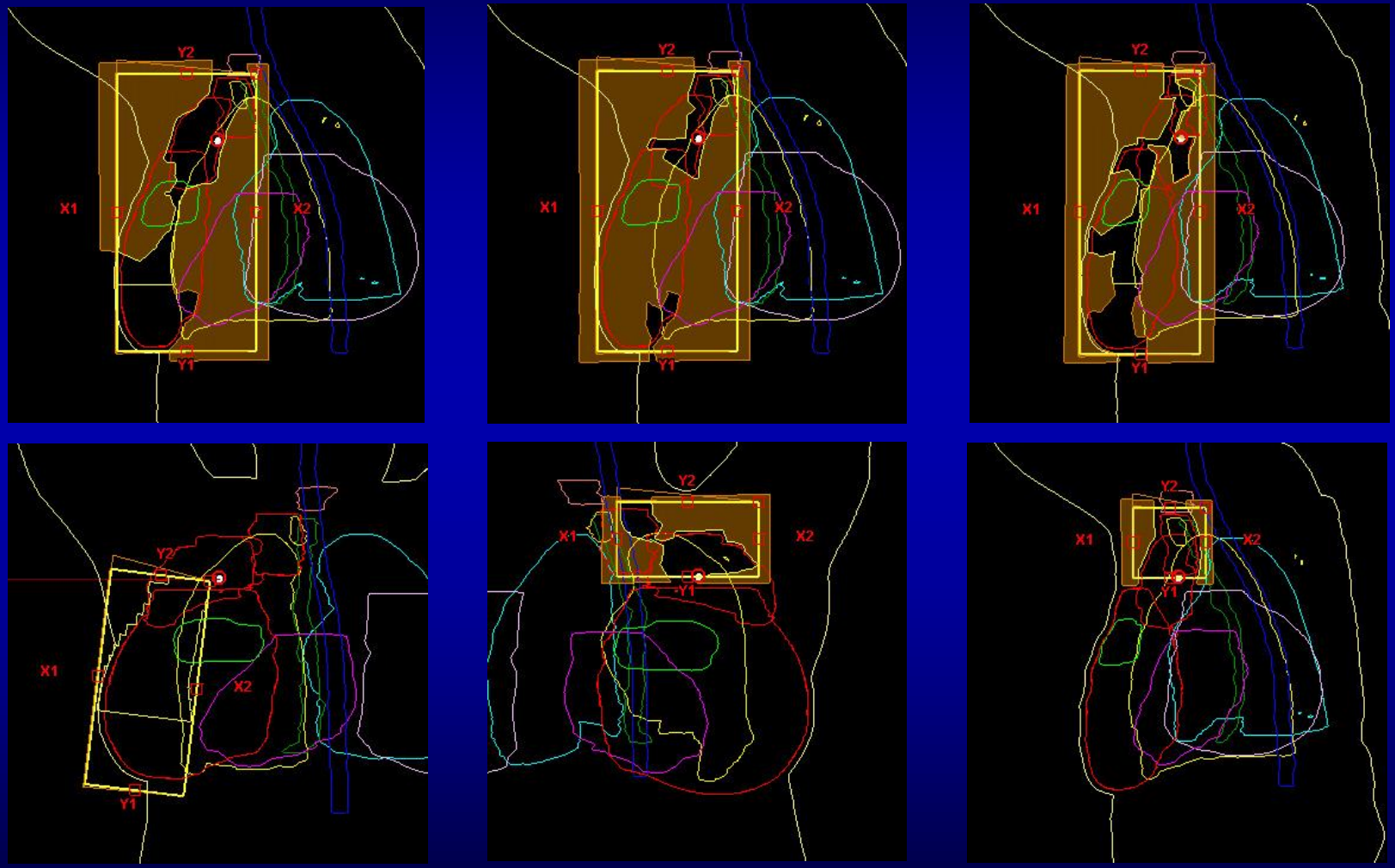
Final plan

Field ID	Technique	Machine/Energy	MLC	Field Weight	Gantry Rtn [deg]	Coll Rtn [deg]	Couch Rtn [deg]	Wedge	MU
Field1	STATIC-I	CLINAC1 - 6X	Static	11.60	305.0	17.0	0.0	W15R20	164
Field2	STATIC-I	CLINAC1 - 6X	Static	1.00	295.0	13.0	0.0	W15R20	14
Field3	STATIC-I	CLINAC1 - 6X	Static	6.10	125.0	0.0	0.0	W30L20	108
Field4	STATIC-I	CLINAC1 - 6X	Static	1.00	125.0	0.0	0.0	W30L20	18
Field5	STATIC-I	CLINAC1 - 6X	Static	0.60	125.0	0.0	0.0	W30L20	11
Field6	STATIC-I	CLINAC1 - 6X	Static	0.40	115.0	0.0	0.0	W30L20	7
Field7	ARC-I	CLINAC1 - 6X	Static	0.19	170.0	353.0	0.0	W15L20	51
Field8	STATIC-I	CLINAC1 - 6X	Static	1.10	20.0	0.0	0.0	W45L20	24
Field9	STATIC-I	CLINAC1 - 6X	Static	9.10	110.0	0.0	0.0	W45L20	202





Final plan




Yes, I did it!
I WILL DO IT
I CAN DO IT
I'LL TRY TO DO IT
HOW DO I DO IT?
I WANT TO DO IT
I CAN'T DO IT
I WON'T DO IT
WHICH STEP HAVE YOU REACHED TODAY?
Thank you for your attention.