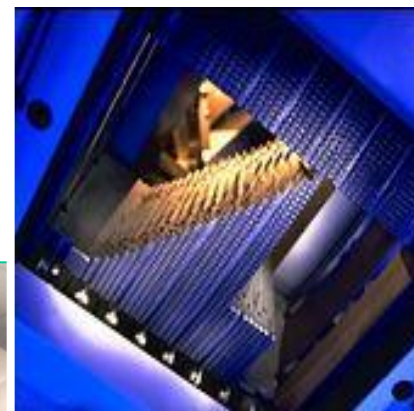
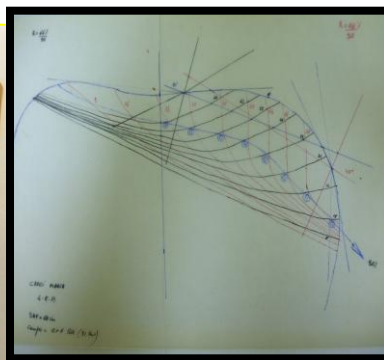




Tomotherapy: Lucca's experience in the management of metastases

U.O. Radioterapia P.O. Campo di Marte, Lucca

Lucca's technological equipment



Patients selection for Tomotherapy (July 2010-October 2010)

Curative treatments (17 pts): **Palliative treatments (8 pts):**

- HNC: 4 pts (1 reirradiation)
- Prostate cancer: 5 pts
- Thoracic neoplasms
 - thymus: 2pts
 - lung: 1pt
 - esophagus: 2pts
- Abdomen neoplasms
 - pancreas: 1pt
 - papilla di vater: 1 pt
 - cervico-vaginal local recurrence: 1pt
- Oligometastatic disease
 - Bone: 7pts
 - Lung: 1pt

Oligometastatic disease

(up to five localizations)

Physician focus on:

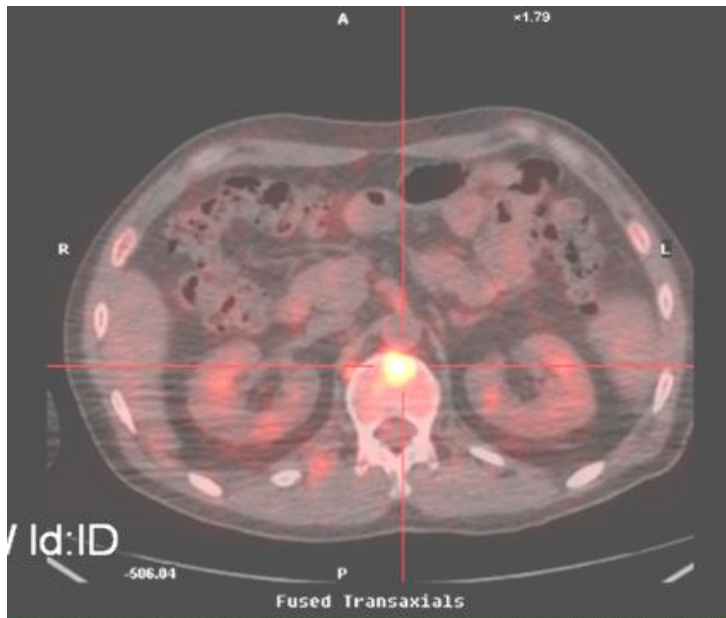
- Suitable patient
- Tumor shape
- Tumor site toward OAR
- Fractionation scheme
- PTV margin

Tomotherapy answers:

- Treatment time
- Dose distribution highly conformed with steep dose gradient

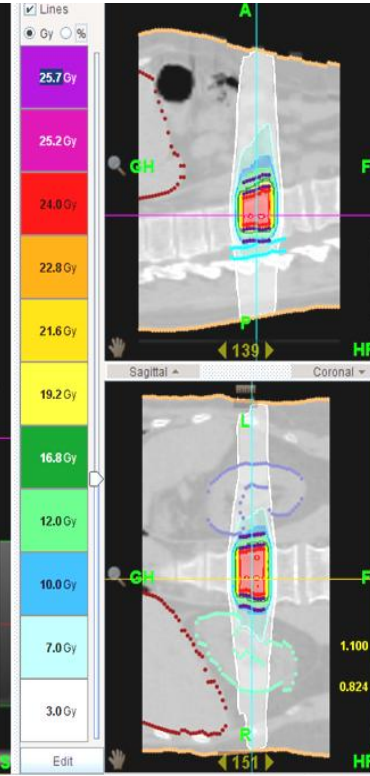
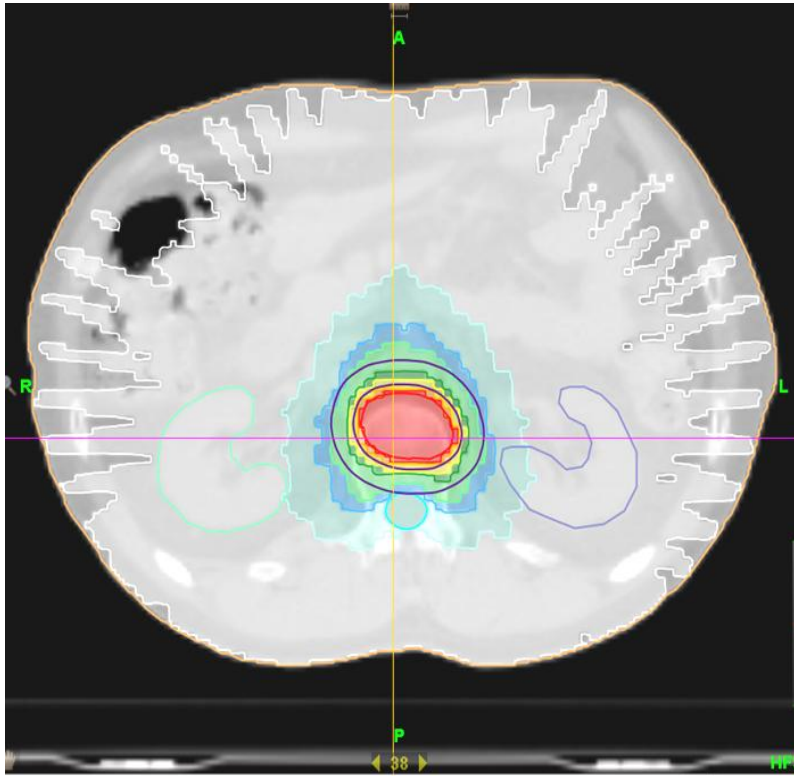
Preliminary study for bone metastases hypofractionation

- Male 61yrs
- Primary prostate cancer
- Painful bone metastases



- 24Gy single fraction
- 20Gy single fraction
- 10Gy x 3 fr DT 30Gy

24Gy Single fraction



Presets ▾

Lines

Gy %

Max Dose [Gy]	Max Dose Pen.	DVH Vol	DVH Dose [Gy]	Min Dose [Gy]	Min Dose Pen.
4.0	300	95.0	24.0	24.0	500

Distance	Max Dose [Gy]	Max Dose Pen.	DVH Vol	DVH Dose [Gy]	DVH Pt. Pen.
80	10.0	80	30.0	8.0	1
5	18.0	10	50.0	12.0	1
90	21.0	80	22.0	18.0	80
1	8.0	1	50.0	8.0	1
1	8.0	1	50.0	8.0	1

Receive 24.0 Gy in 1 Fractions

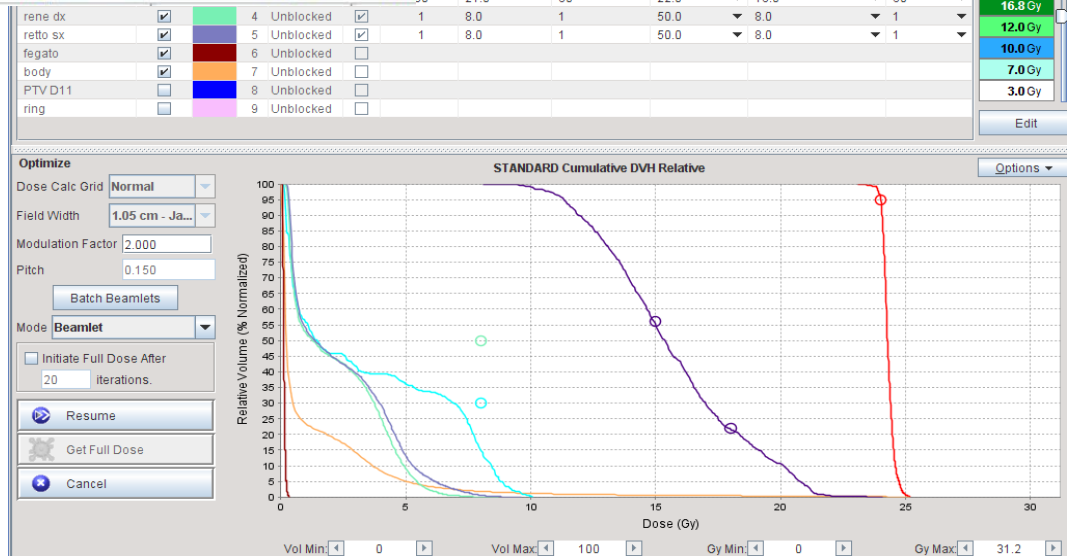
ROI contours have been resampled

Color	Dose [Gy]
25.7 Gy	25.7 Gy
25.2 Gy	25.2 Gy
24.0 Gy	24.0 Gy
22.8 Gy	22.8 Gy
21.6 Gy	21.6 Gy
19.2 Gy	19.2 Gy
16.8 Gy	16.8 Gy
12.0 Gy	12.0 Gy
10.0 Gy	10.0 Gy
7.0 Gy	7.0 Gy
3.0 Gy	3.0 Gy

Edit

- Modulation factor $\uparrow\uparrow$
- Field width 1 cm
- Pitch $\downarrow\downarrow$

Highly conformed dose distribution even for:
 Small target
 Extremely irregular shape



24Gy Single fraction

Prescription Summary

The plan has 1 fractions defined for a planned delivery of 24.00 Gy.
95.00% of the PTV L1 volume receives at least 24.00 Gy.
There is no modulation factor for this plan.

Unlock All Fractions

Presets ▾
 Lines
 Gy %

	Dose	Duration	Index	Locked	Planned Date	Dose	Duration
▼	24.00	47.3					

Fraction 1
Gantry Period: -- sec
Duration: 47.3 minutes (2,840.3 sec)
Duration estimate is based on most recent optimization.

47.3 minutes

25.7 Gy
25.2 Gy
24.0 Gy
22.8 Gy
21.6 Gy
19.2 Gy
16.8 Gy

Slowly Gantry rotation is not enough to deliver high dose to irregular target keeping steep dose fall-off

Prescription Summary

The plan has 1 fractions defined for a planned delivery of 24.00 Gy.
95.00% of the PTV L1 volume receives at least 24.00 Gy.
There is no modulation factor for this plan.

Unlock All Fractions

Planned Date	Dose	Duration	Index	Locked	Planned Date	Dose	Duration
2010	▼ 24.00	47.9					

Notice

The calculated gantry period for fractions having a dose of 24Gy exceeds the maximum available gantry period (60 seconds) by 54.5%.
Options: decrease the pitch or decrease the dose for those fractions having a dose of 24Gy.

Support ID: 3414663754

exceeds 54.5%

OK

20Gy Single fraction

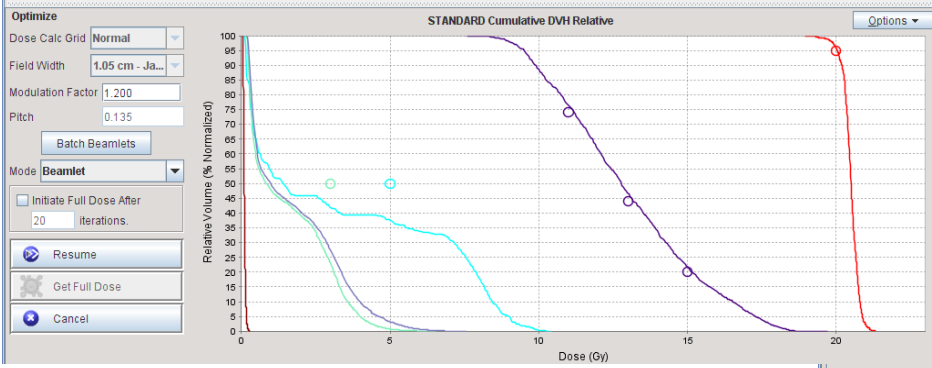
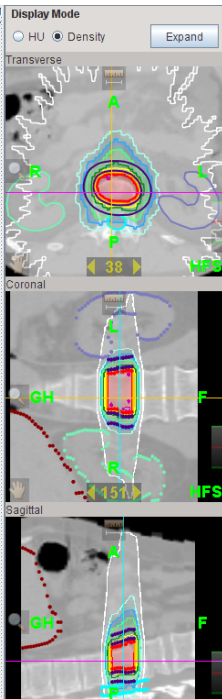
Prescription
 % Vol For: PTV L1 95.0 % will receive 20.0 Gy in 1 Fractions
 ROI contours have been resampled

Target Constraints

Name	Display Color	Blocked	Use	Importance	Max Dose [Gy]	Max Dose Pen.	DVH Vol	DVH Dose [Gy]	Min Dose [Gy]	Min Dose Pen.
PTV L1	Red	1 Unblocked	<input checked="" type="checkbox"/>	1000	20.0	2000	95.0	20.0	20.0	1800

Regions at Risk Constraints

Name	Display	Color	Blocked	Use	Importance	Max Dose [Gy]	Max Dose Pen.	DVH Vol	DVH Dose [Gy]	DVH Pt Pen.
midollo	<input checked="" type="checkbox"/>	Cyan	1 Unblocked	<input checked="" type="checkbox"/>	800	10.0	800	50.0	5.0	1
exp	<input checked="" type="checkbox"/>	Blue	2 Unblocked	<input checked="" type="checkbox"/>	5	15.0	10	50.0	12.0	1
don	<input checked="" type="checkbox"/>	Green	3 Unblocked	<input checked="" type="checkbox"/>	800	18.0	800	20.0	15.0	800
ren	<input checked="" type="checkbox"/>	Yellow	4 Unblocked	<input checked="" type="checkbox"/>	1	6.0	1	50.0	3.0	1
retto	<input checked="" type="checkbox"/>	Orange	5 Unblocked	<input checked="" type="checkbox"/>	1	6.0	1	50.0	3.0	1
feg	<input checked="" type="checkbox"/>	Light Green	6 Unblocked	<input checked="" type="checkbox"/>						
bdg	<input checked="" type="checkbox"/>	Light Blue	7 Unblocked	<input type="checkbox"/>						
PTV Volume	<input checked="" type="checkbox"/>	Red	8 Unblocked	<input checked="" type="checkbox"/>						
ring	<input type="checkbox"/>	Pink	9 Unblocked	<input type="checkbox"/>						



Prescription Summary

1 fractions defined for a planned delivery of 20.00 Gy. of the PTV L1 volume receives at least 20.00 Gy. ie modulation factor for this plan is 1.182.

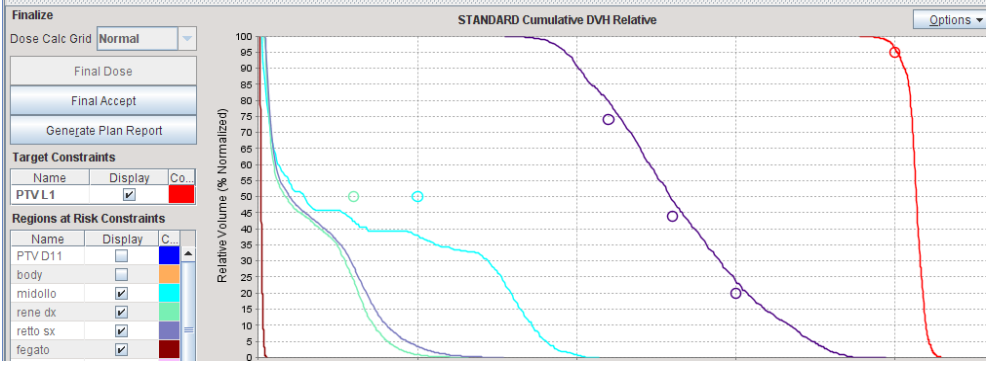
se	Duration	Index	Locked	Planned Date	Dose	Duration
0	23.9					

Fraction 1
 Gantry Period: 58.00 sec
 Duration: 23.9 minutes (1,431.8 sec)
 Duration estimate is based on Final Dose calculation (best estimate).

23.9 minutes

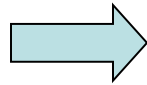
- Modulation factor ↑
- Field width 1cm
- Pitch ↓

Less conformed dose distribution



Choose fractionation

- High dose per fraction besides 24Gy not achievable



- technical Tomotherapy limits (table movement, gantry rotation time)
- coarse planning parameters (MF, FW, Pitch) reduce treatment quality

- Maximum dose per fraction achievable: 16-18Gy



- compromise between ability to paint the dose around target and Tomotherapy mechanism

**Lucca experience
on metastases
treated with Tomotherapy
July 2010-October 2010**

Margins applied to GTV:

- Thorax: 6mm in each direction but 10mm CC
- Pelvis or abdomen: 6mm isotropic expansion
- Bone: 4mm isotropic expansion
- Head & neck: 3mm “isotropic” expansion

Adequate immobilization devices:

- Abdomen compression
- Vacuum cushions
- thermoplastic mask, shoulder fixator

Fractionation schemes:

- Thorax 5Gy x 6 DT 30Gy: 1pt
- Bones 3Gy x 10 DT 30Gy: 2pts
 4Gy x 5 DT 20Gy: 1pt
 8Gy single fraction: 1pt
 10Gy x 3 DT 30Gy: 3pts

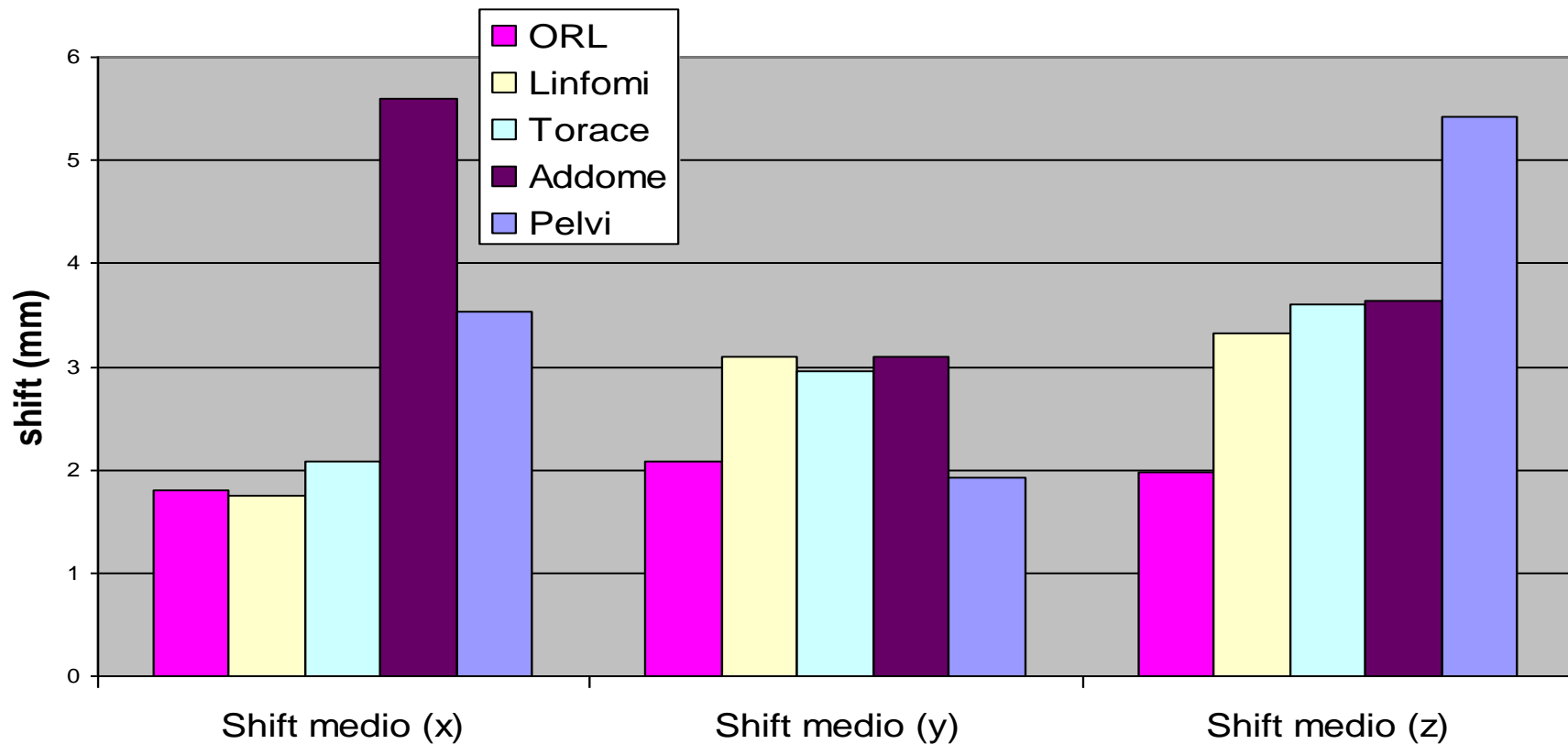
Mean coregistration shifts (mm):

curative and palliative treatments

Mean Roll correction 0.4°

sites	x	y	z
thorax	2.1	2.8	3.9
bone	1.8	3.2	3.1
pelvis	2.5	1.8	5.3
abdomen	2.8	5.4	1.8

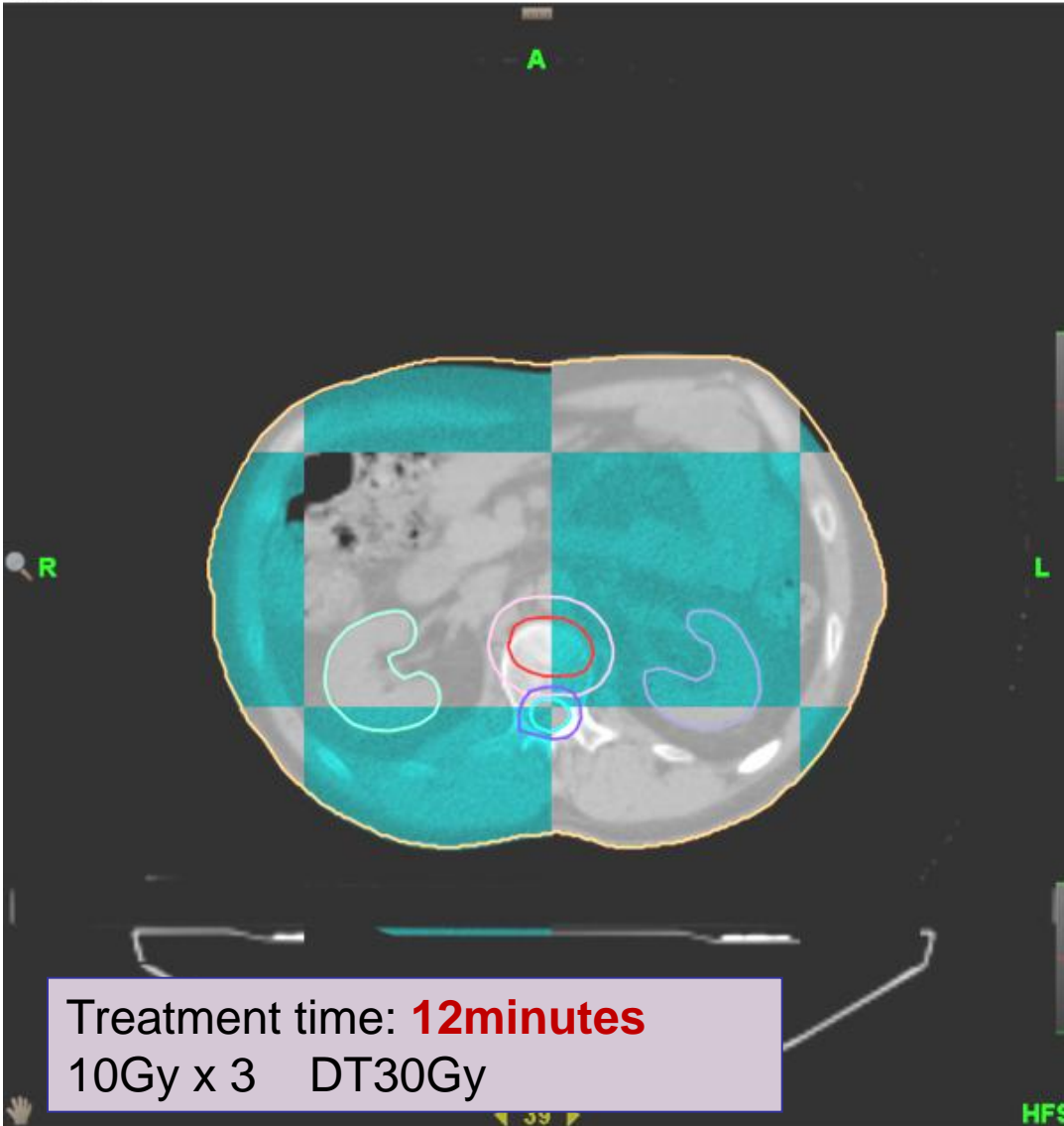
Mean coregistration shifts



Site	Mean Shifts (mm) (x)	Mean Shifts (mm) (y)	Mean Shifts (mm) (z)
Pelvi	3,5	1,9	5,4
ORL	1,8	2,1	2,0
Linfomi	1,8	3,1	3,3
Torace	2,1	3,0	3,6
Addome	5,6	3,1	3,6

Bone target #1

- Male 61yrs
- Primary prostate cancer
- Bone met (L1)



Automatic Registration Control

Bone Technique

Standard Resolution

Translations+Roll

Incomplete Field of View

Start

Scan Image Control

Checker & Balance CTrue Image Filter

Balance

Plan Plan Scan

Checker

Coarse Fine

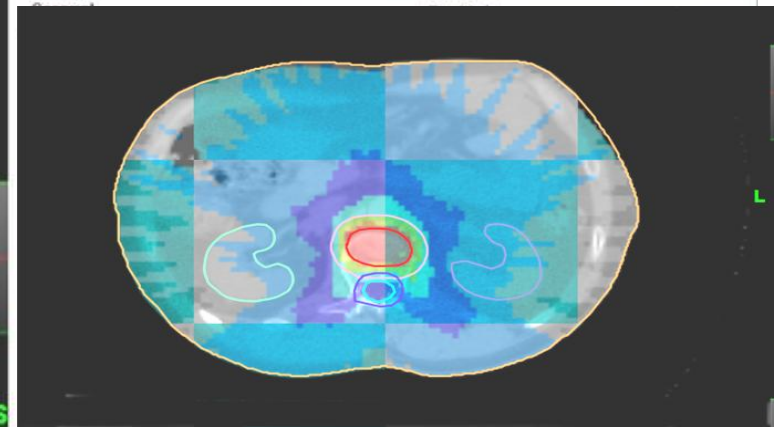
Switch

Translational Adjustments (mm)

Lateral	Long	Vert.
-2.6	-3.2	1.8

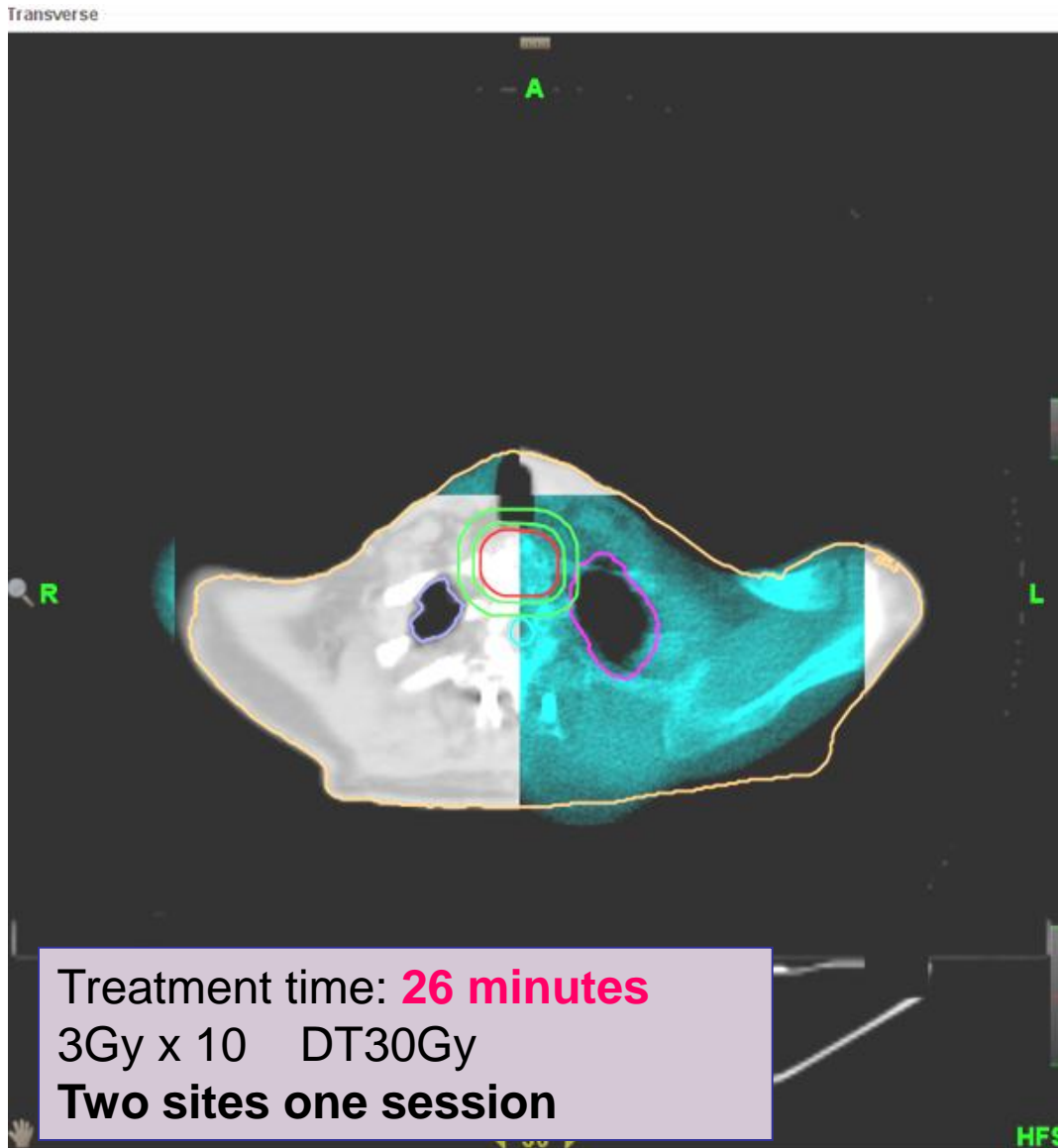
Rotational Adjustments (degrees)

Pitch	Roll	Yaw
0.0	0.3	0.0



HFS

Bone target #2



Automatic Registration Control

Bone Technique

Standard Resolution

Translations+Roll

Incomplete Field of View

Start

Scan Image Control

Checker & Balance CTrue Image Filter

Balance

Plan Plan Scan

Checker

Coarse Fine

Navigation buttons: Home, Up, Down, Left, Right, Switch, L, R, Refresh

- Male 46yrs
- Multiple myeloma
- bone
- (C7, D6)

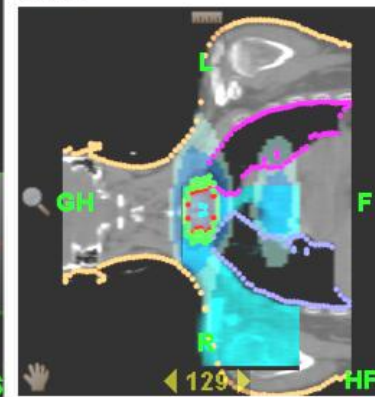
Translational Adjustments (mm)

Lateral	Long	Vert	
1.1	-3.2	-0.1	R

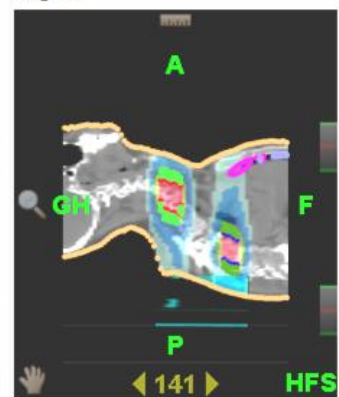
Rotational Adjustments (degrees)

Pitch	Roll	Yaw	
0.0	1.1	0.0	R

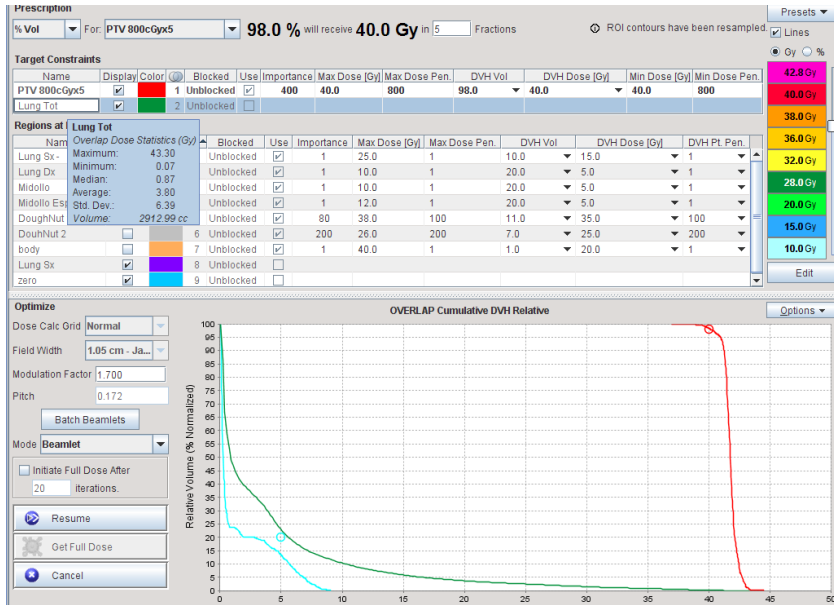
Coronal



Sagittal



Lung metastases

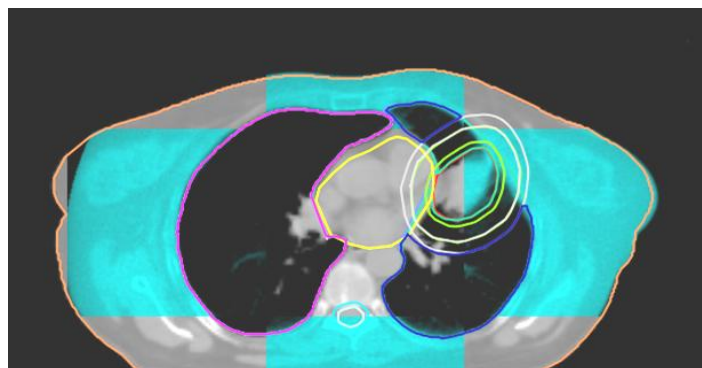
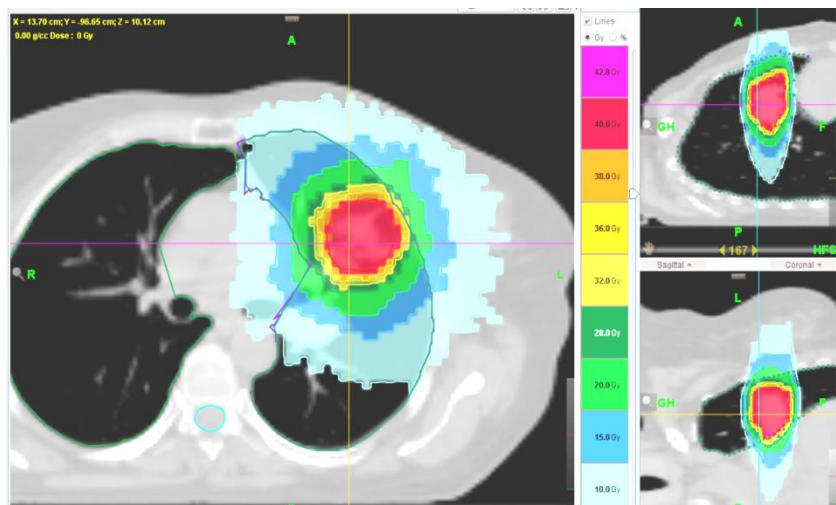


- Female 52yrs
- Primary colorectal cancer
- Lung metastases

Prescription Summary:

The plan has 5 fractions defined for a planned delivery of 40.00 Gy.
 98.00% of the PTV 800cGyx5 volume receives at least 40.00 Gy.
 The modulation factor for this plan is 1.597.

Planned Date	Dose	Duration	Index	Locked	Plan
2010	8.00	15.9			
2010	8.00	15.9			
2010	Fraction 1				
2010	Gantry Period: 37.00 sec				
2010	Duration: 15.9 minutes (951.1 sec)				
2010	Duration estimate is based on Final Dose calculation (best estimate).				



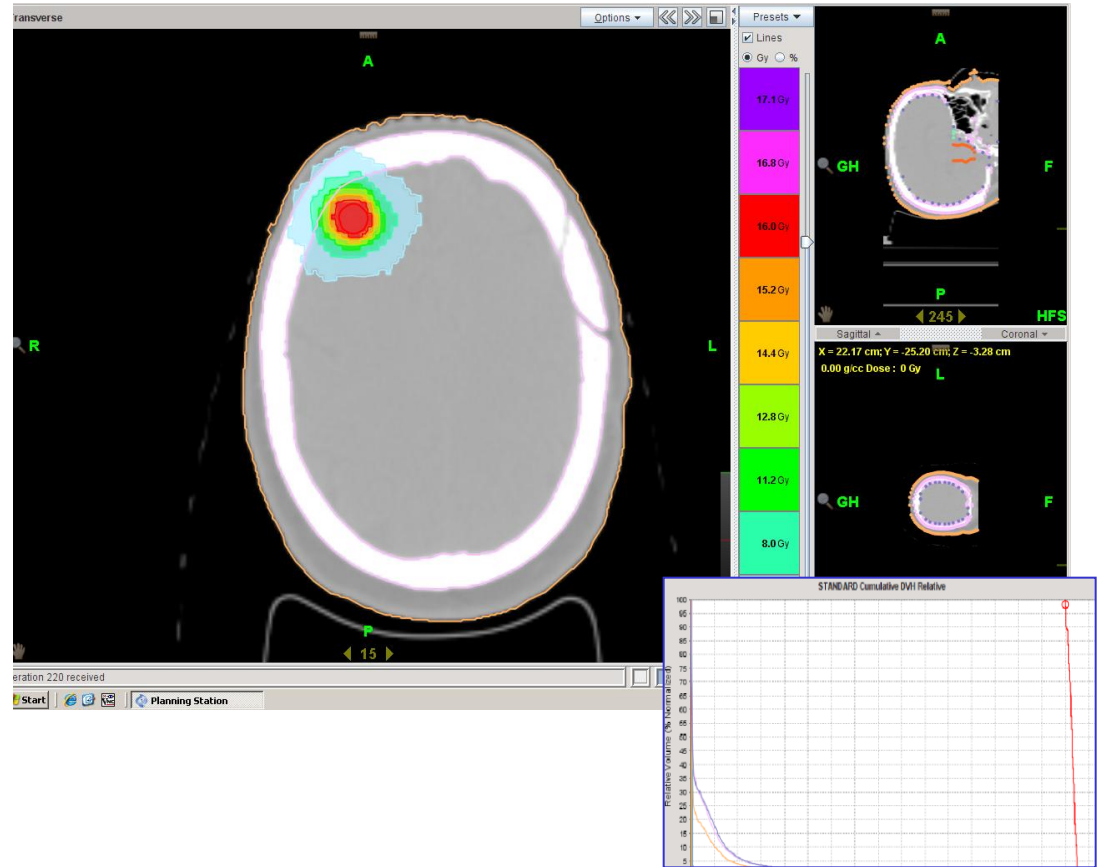
Treatment time: **16 minutes**
 5Gy x 5 DT 30Gy

Cranial stereotactic RT

- Male 48 yrs
- Primary lung cancer
- Prior RTWB
- relapse after 26 months
- single metastases
- 16Gy single fraction

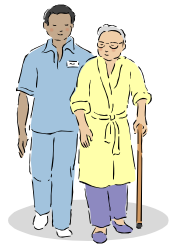
- Modulation factor ↑↑
- Field width 1cm
- Pitch ↓

Extremely high conformed dose distribution



Treatment time: **13 minutes**

Traditional Sim and Treat Workflow



patient



Immobilize and Scan patient



Transfer data to planning system



Import data for physician to define fields and/or contour



Patient now waits to be treated



Physician returns to review plan



Transfer plan data to R&V system



plan data in R&V system



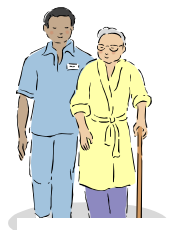
Import, assign and register DRR's



Therapist: "How much longer???"



Physician may check plan and R&V System



Bring patient in the room



Setup patient for treatment



Take X-rays to verify patient position



Physician reviews verification X-ray



Patient can now be treated!



StatRT™

Sim and Treat Workflow



Bring patient in the room



Immobilize and Scan patient on the TomoTherapy Hi-Art System



Contour Structures



Planner quickly optimizes plan



Physician approves Plan

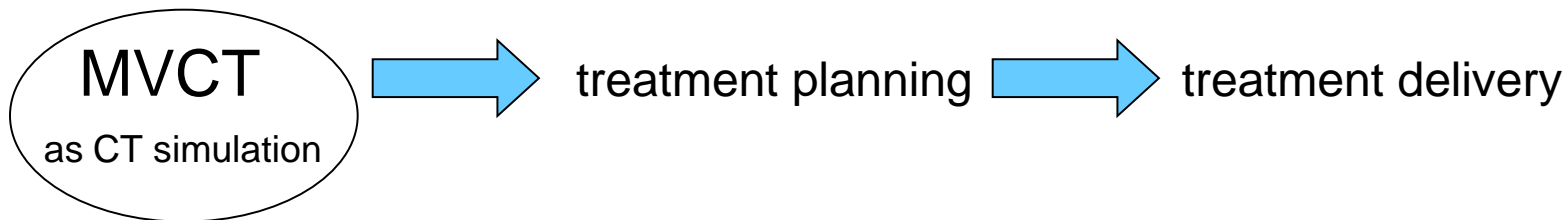


Treat!

Scan, plan, and treat in as little as 30 minutes

STAT RT

A software for rapid intensity-modulated treatment planning, enabling conformal radiation treatment plans to be generated on megavoltage computed tomography (MVCT) scans.



STAT RT allow to acquire scans, plan and deliver treatment in the same session within one hour.

Take home messages

PROs

- High dose conformity and dose gradient with excellent PTV coverage and adequate OAR sparing regardless of complexity
- Simultaneous treatment of multiple target in the same session
- SIB (WB+SRT)
- Re-treatment near critical structures
- Avoidance of junctions (up to 160cm)

CONs

- Treatment time could be too long even for fit patients
- Not reliable for dose per fraction higher than 18Gy

no way is too long for
a man who knows
where he wants
to go... →



←
... and who is very thirsty