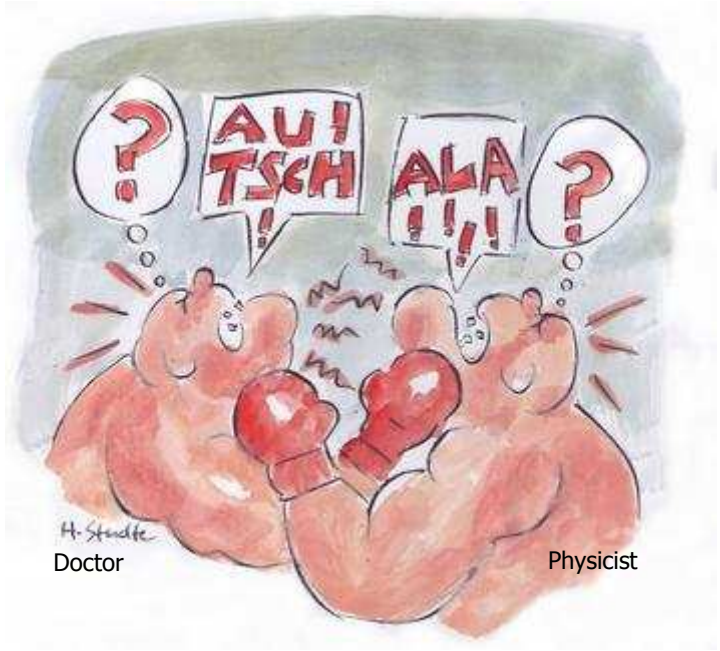
FISICA E RADIOTERAPIA
NUOVE FRONTIERE TRA HIGH TECH E POST GENOMICA
- TOMOTHERAPY: NUOVE POSSIBILITÀ TECNICHE PER NUOVE RISPOSTE A QUESITI CLINICI -

G.Guidi, et.al – Medical Physics Dpt.
Azienda Ospedaliero - Universitaria di Modena - Policlinico



Doctor Physicist

"Fight" with the doctor...

...with Tomo will be possible?

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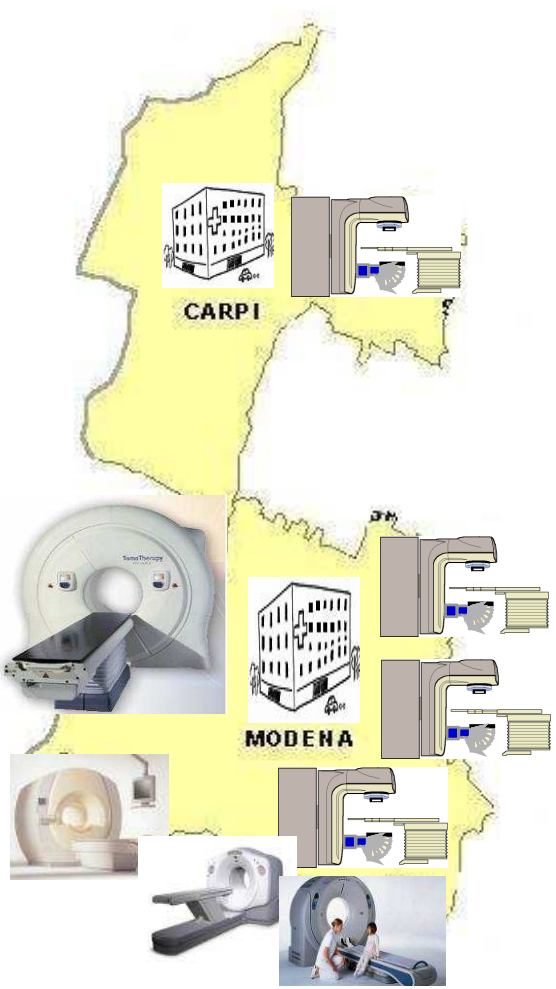
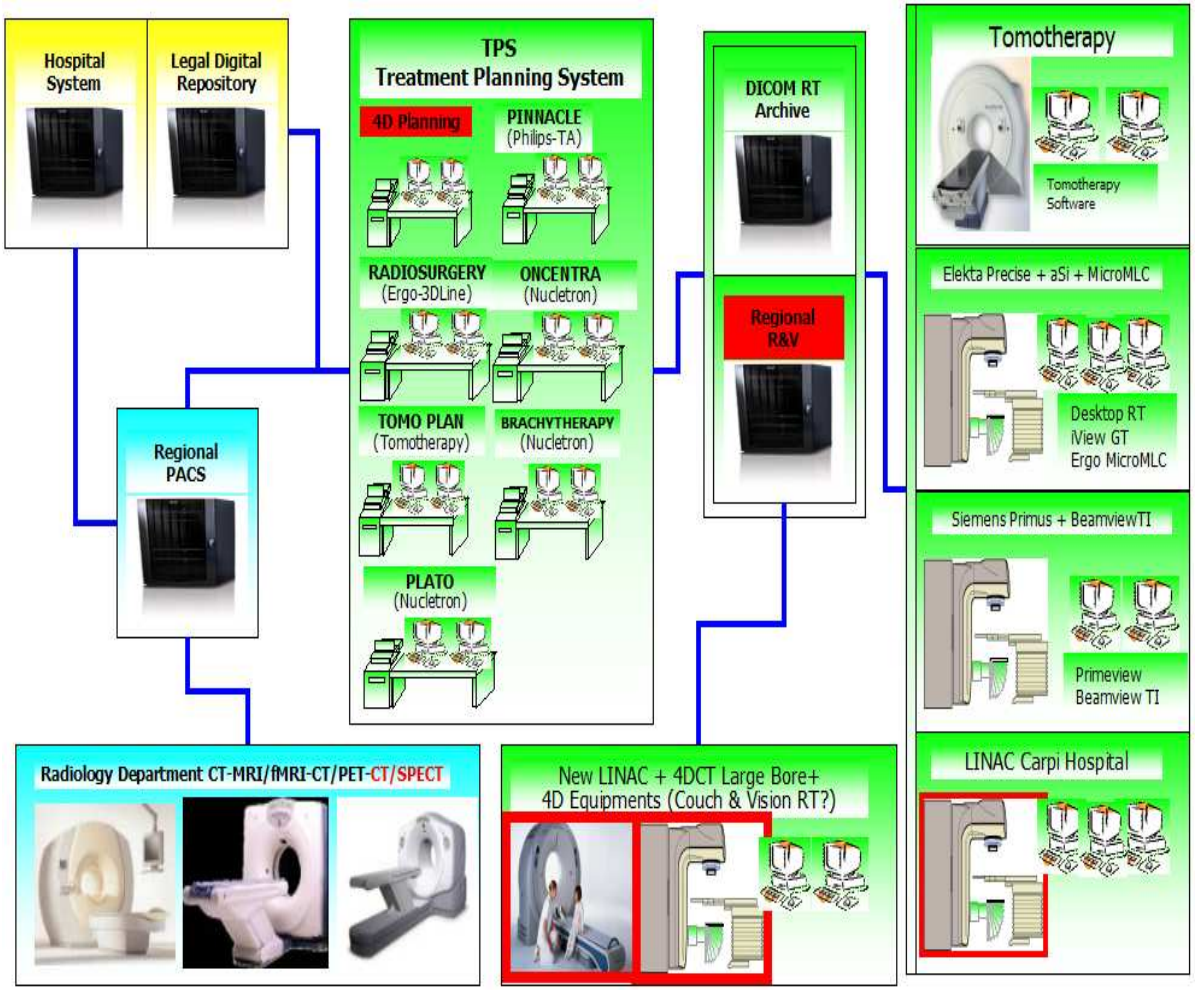
Phone: +390594225699

Special Thanks to Dr.Amadori for part of this presentation
…and the good friendship during this years….

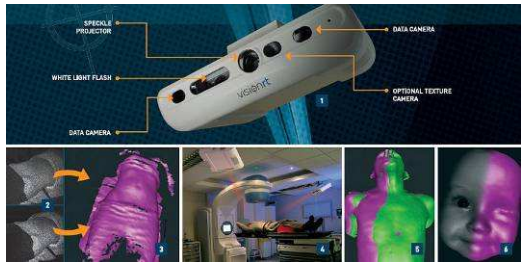
MODENA HUB-SPOKE PROJECT
(RADIATION ONCOLOGY HEALTH SERVICES)

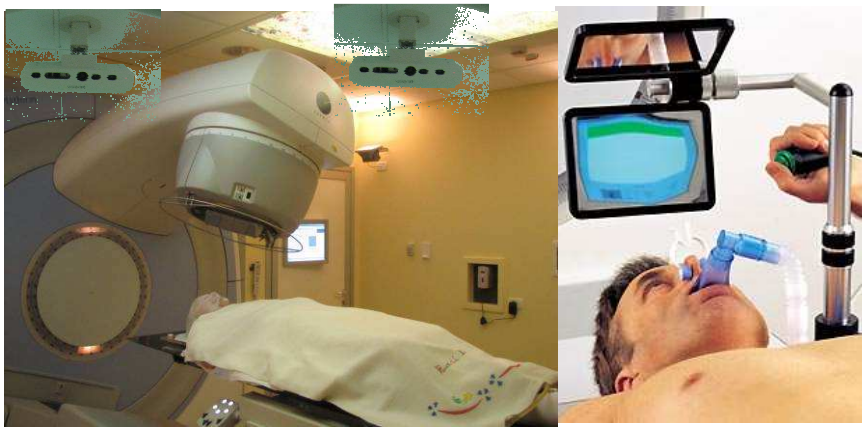




4D RADIATION THERAPY .... VISION
(4DRT & 4D TOMOTHERAPY)

TOSHIBA 4D LARGE BORE + VISION RT





4D LINAC + ABC (ACTIVE BREATHING CONTROL)

TOMOTHERAPY + VISIONRT

6 Clinical Research Program to acquire Tomotherapy

1. **NSCLC** : Efficacy and tolerances of exclusive and post-surgery radiation therapy treatments with/without chemo association, using CT-PET and Dynamic IMRT. Patients survival and/or time to progression analysis. Procedures and cost-benefit evaluation. (Prof. L.Fabbri, Prof. U.Morandi, Prof. B.Bagni, Dr. F.Bertoni, Dr. C.Danielli)
2. **H&N** : Radical treatments with concomitant chemotherapy using SIB, Dynamic IMRT, IGRT and Adaptive Radiation Therapy. Treatment conformity index, patients tolerance, efficacy and cost-benefit evaluation using Tomotherapy (Prof. P.F.Conte, Prof. A.Falchi, Dr. F.Bertoni, Dr. C.Danielli)
3. **TBI** (National Health Research - PIO V): Clinical and dosimetric evaluation of Total Body Irradiation using Tomotherapy. Transplant procedure, adequacy and safety evaluations of the treatments using Tomotherapy. Problem solving, efficacy and efficiency. (Prof. G.Torelli, Dr. F.Bertoni, Dr. C.Danielli)
4. **PAEDIATRIC** : Clinical evaluation of paediatric treatments. Paediatric patients management and performance assessment for high conformal and complex treatment using Tomotherapy. Clinical advantages and disadvantages. (Prof. P.Paolucci, Dr. F.Bertoni, Dr. C.Danielli)
5. **BRAIN** : Clinical study for brain tumors using Tomotherapy. Clinical advantages and disadvantages, cost-benefit impact and patient management (Prof. G.Pinna, Dr. L.Mavilla, Prof. B.Bagni, Dr. F.Bertoni, Dr. C.Danielli)
6. **TECHNOLOGY ASSESSMENT**: Technical, dosimetric and cost-benefit evaluation of a Tomotherapy Unit. Routine applicability in a Public Hospital of high conformal, IGRT and Adaptive Radiation Therapy treatments. Develop and optimization of treatment delivery, commissioning and Quality Assurance procedures. Time estimation and requirements to implement protocols and techniques (Dr. F.Bertoni, Dr. C.Danielli, Dr. Eng. M.Lugli)

Research supported by Fondazione Cassa di Risparmio di Modena

3D-IGRT HEALTH TECHNOLOGY ASSESSMENTS (13 REGIONAL RADIATION THERAPY CENTERS COLLABORATION)

Regione Emilia-Romagna

Osservatorio regionale per l'innovazione

Osservatorio Regionale per l'Innovazione

Osservatorio Regionale per l'Innovazione

Image Guided Radiation Therapy (IGRT) in Oncologia

HEALTH TECHNOLOGY ASSESSMENT

3D Image Guided – Intensity Modulated Radiotherapy

Systematic review of literature on technical performance, safety and clinical effectiveness

RECOMMENDATIONS FOR FUTURE RESEARCH

1) To assess whether radical radiation treatment with IGRT/IMRT in patients with low and intermediate risk prostate cancer improves disease specific survival, compared to treatment with 3D-CRT/IMRT
2) To assess whether radical radiation treatment with IGRT/IMRT in patients with primary lung cancer increases local and loco-regional control, compared to treatment with 3D-CRT/IMRT
3) To assess whether radical radiation treatment with IGRT/IMRT in patients with head & neck cancer decreases incidence or grade of xerostomy, compared to treatment with 3D-CRT/IMRT

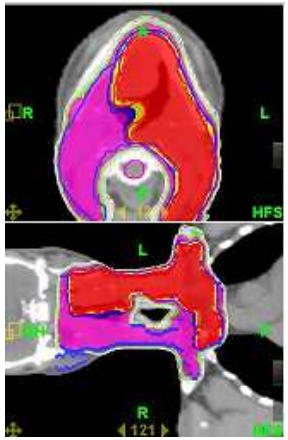
FROM TRUCK (WITH TRICK) …. TO CLINICAL USE

….. 1 Month

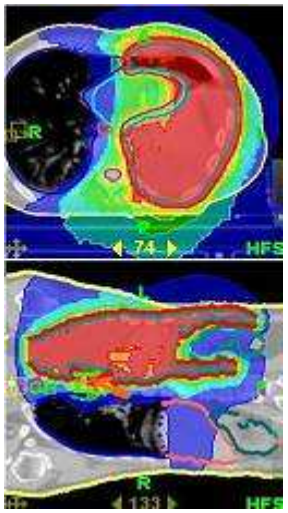
"....Thanks to the perfect cooperation and planning between the hospital and TomoTherapy, we took delivery of our TomoTherapy system and just 30 days later we were already imaging and treating our first patient." (S. Cencetti - MO)

MADISON, Wis.--(BUSINESS WIRE)--Sept. 10, 2008—
TomoTherapy Incorporated (NASDAQ: TOMO)

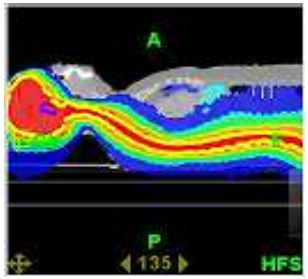
CLINICAL PRACTICE & RESEARCH AREA



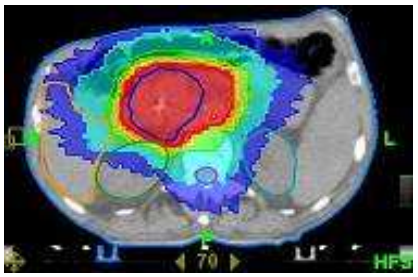
H-N



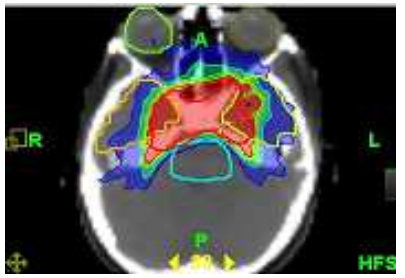
Mesothelioma



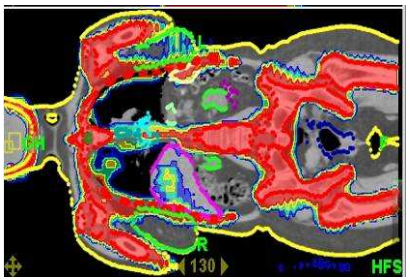
Craniospinal



Pancreas

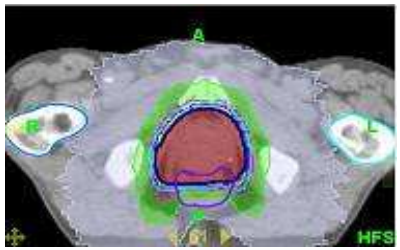


Re-Irradiation

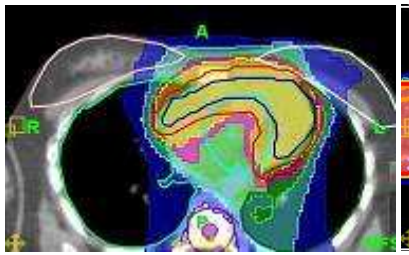


Total Lymphoid Irradiation

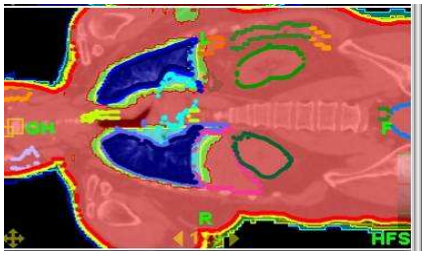
Lung



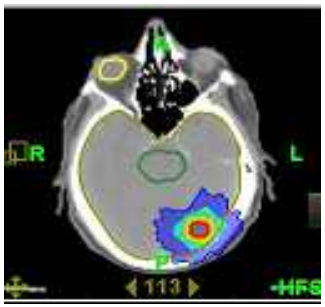
Prostate



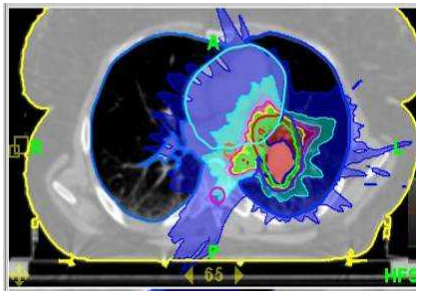
Lymphoma



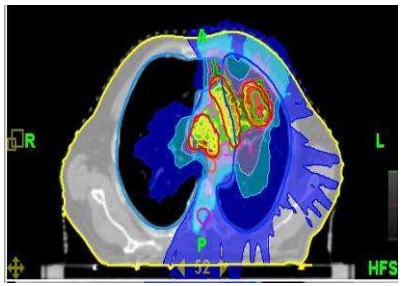
Total Body Irradiation



Radiosurgery



Lung - SBRT



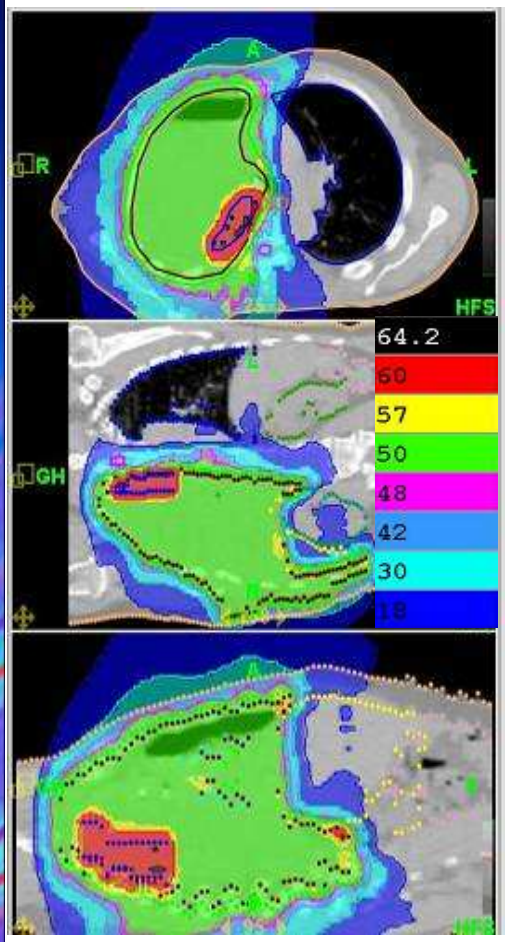
Multiple Lesions

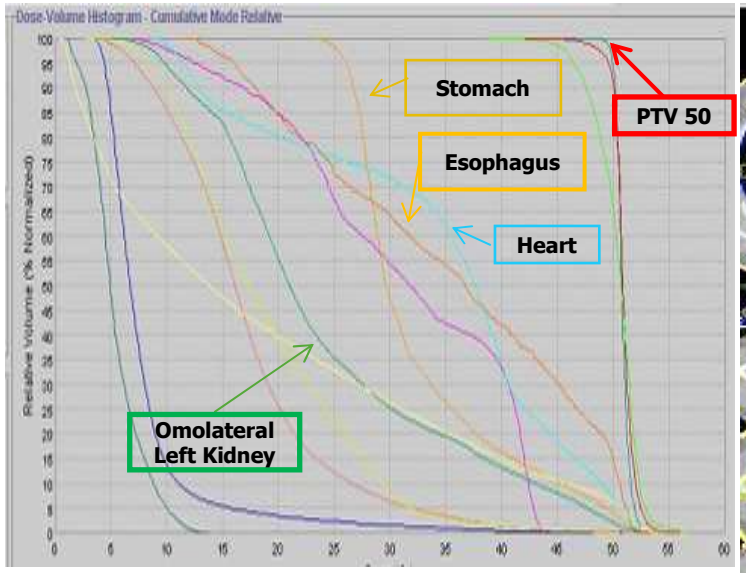
Bilateral Breast

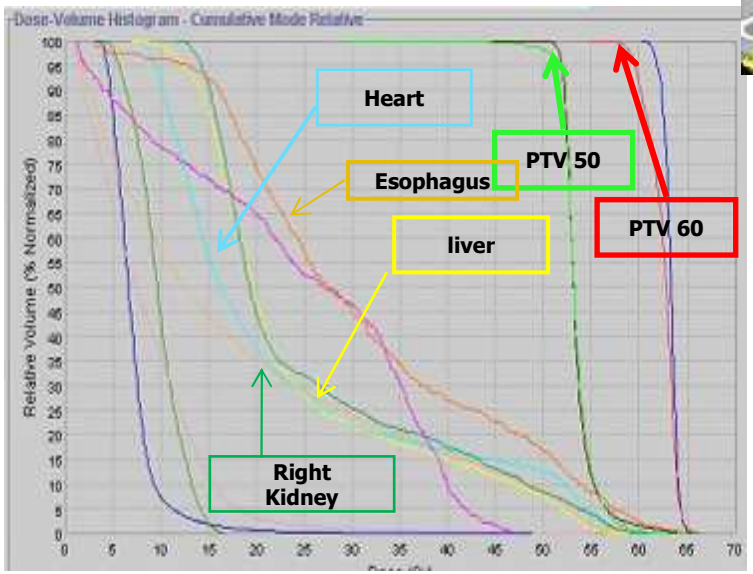
…… preliminary data are consistent with a better tolerance and lower acute toxicity of Tomotherapy treatment compared with other standard treatments using LINAC (3DCRT – IMRT – RCS - SBRT)

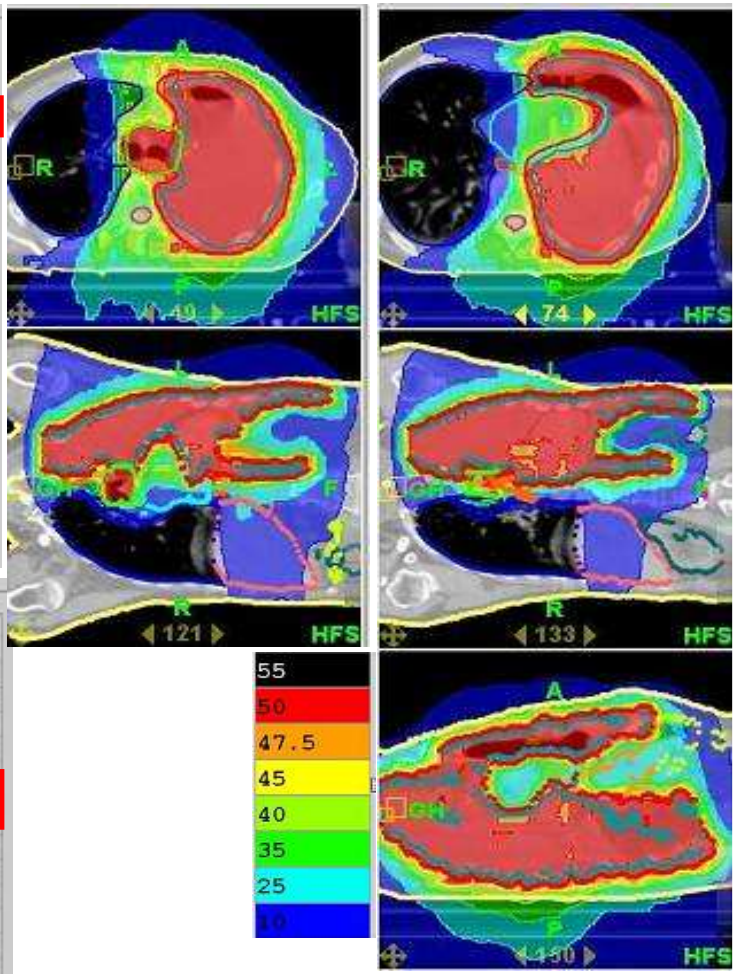
MESOTHELIOMA
(SIB: PTV1 60 : 2,4Gy / Fx 25 - PTV2 50 : 2,0Gy / Fx 25) or (Standard: PTV 50 : 2.0 Gy / Fx 25)

Collaboration with aTrep (Proton Center), Brescia and Florence



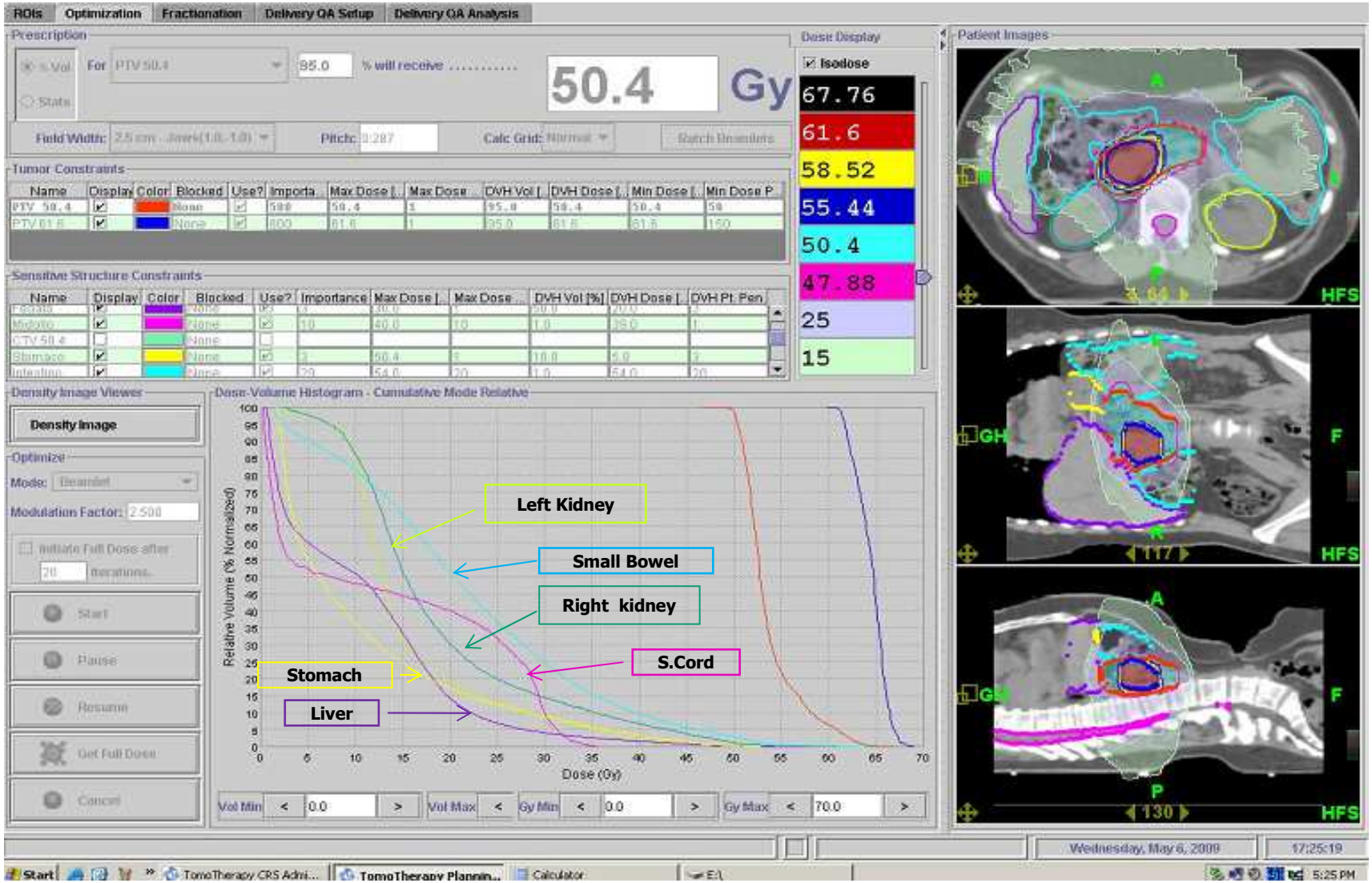




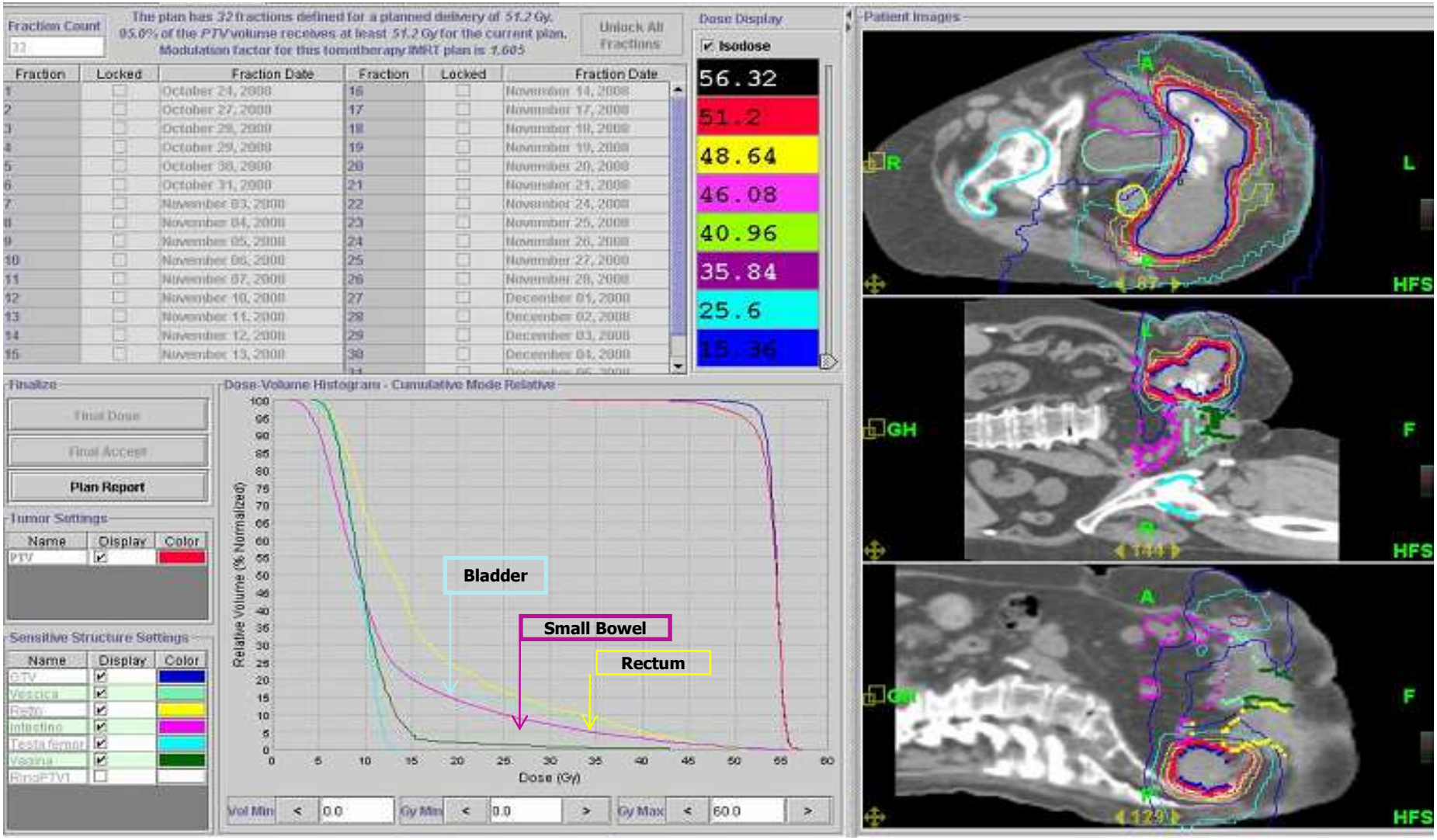


Muticenter Intercomparison for Treatment of the Mesothelioma with IMRT and Tomotherapy.
G. Guidi, et al Med. Phys. Vol. 36, Issue 6, pag.2666, (June 2009)

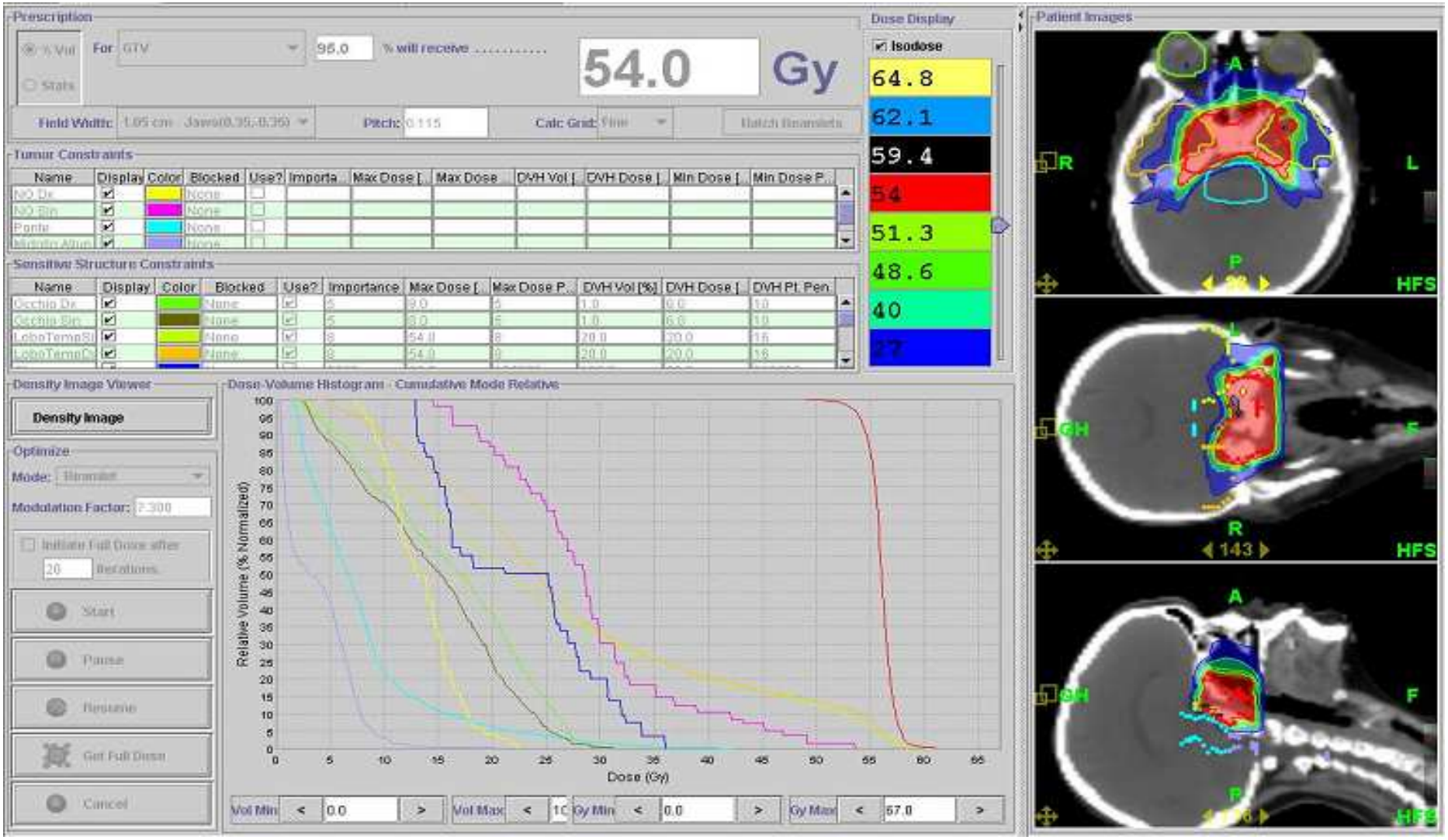
UNRESECATBLE PANCREATIC CANCER
SIB: PTV 61,6 : 2,2 Gy / Fx 28 - PTV 50,4 : 1,8 Gy / Fx 28



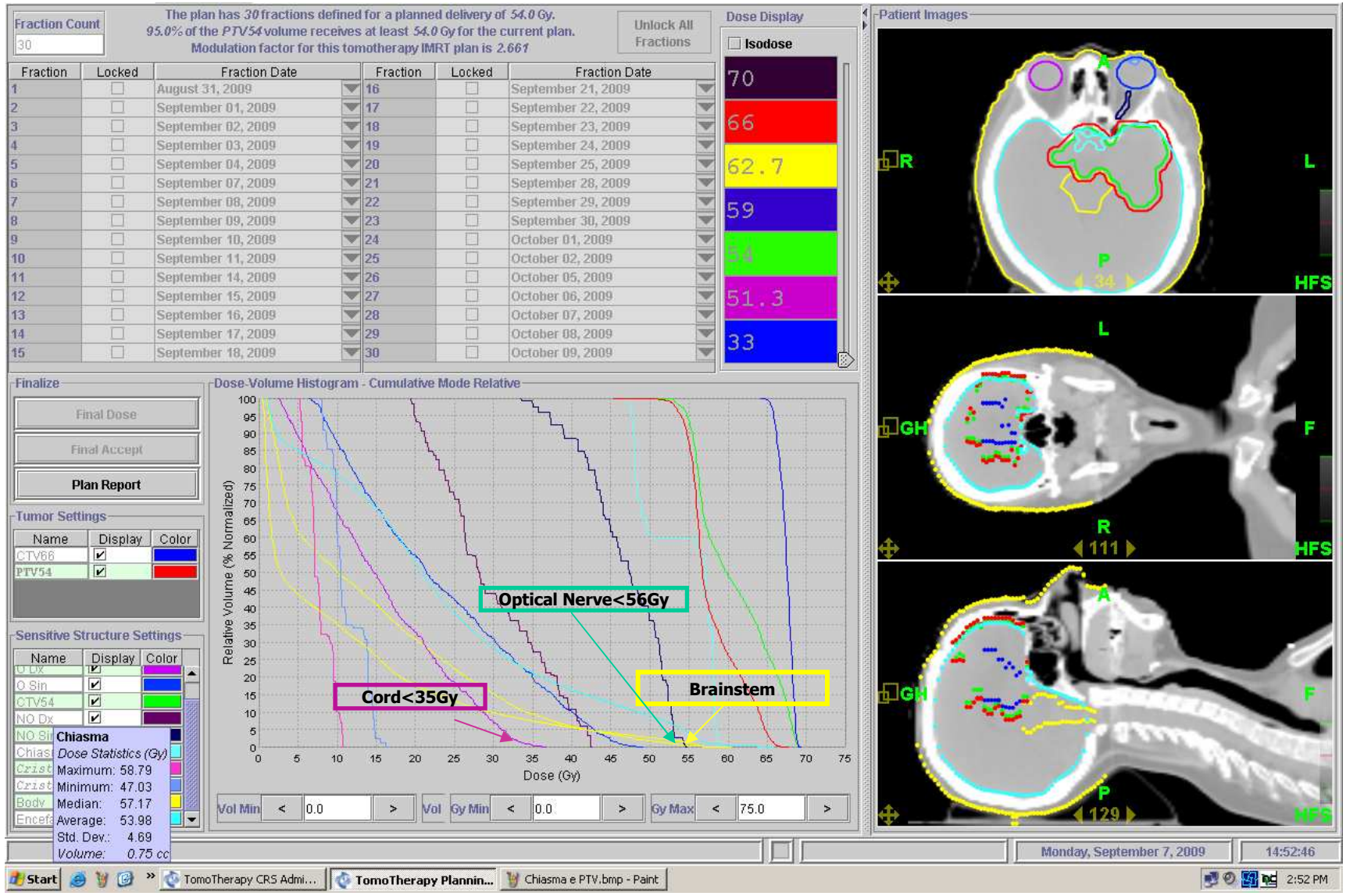
RE-IRRADIATION: PELVIS SARCOMA PREVIUSLY TREATED (3DCRT : 50 Gy / 25 Fx + HDR Brachytherapy : 10 Gy / 2 Fx) FOR ENDOMETRIAL CARCINOMA



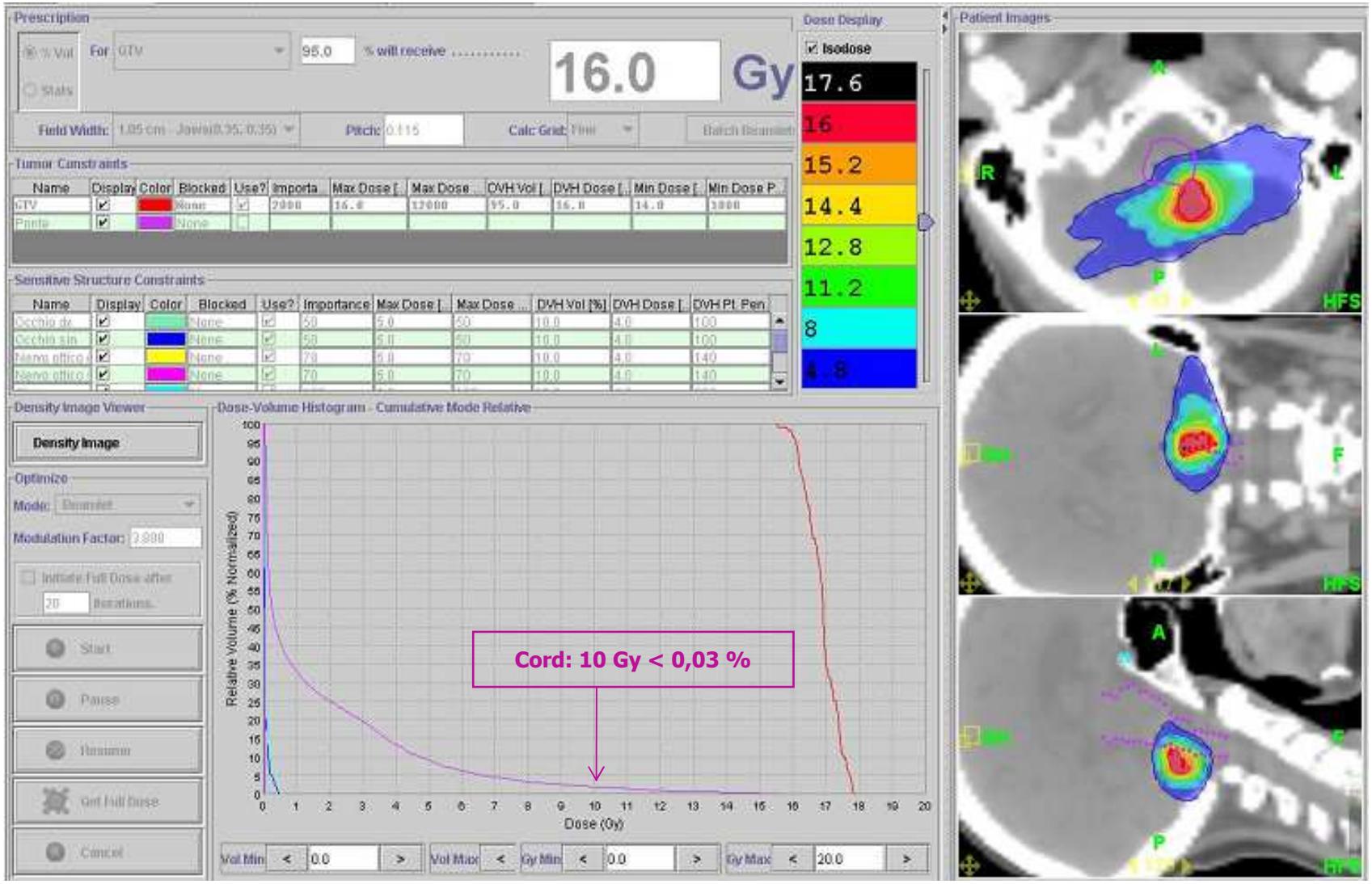
RE-IRRADIATION: HEAD & NECK
(Standard: 54 Gy / 27 Fx - Hyper-fractionation: 54Gy / 36Fx)



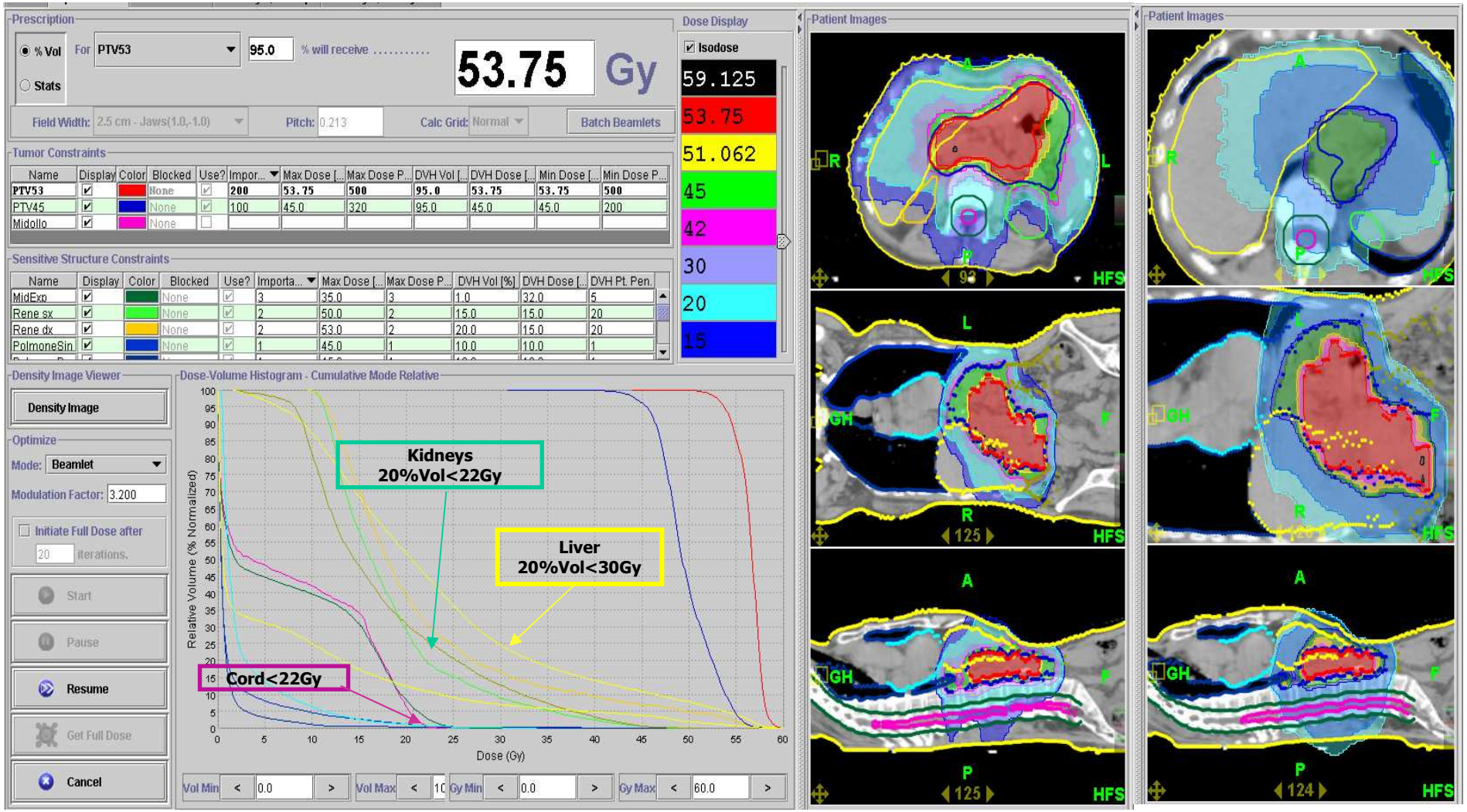
TEMPORAL LESIONS CLOSE TO VITALS OAR (PTV1:55GY/30FX - PTV2 :66GY/30FX)



RADIOSURGERY RE-TREATMENT (16-22Gy / Fx @ 95% of the Volume)
(PREVIOUS WBRT 30 Gy / 10 FX + RS WITH MicroMLC+LINAC 18 Gy /1 Fx – CORD DOSE : 42 Gy)

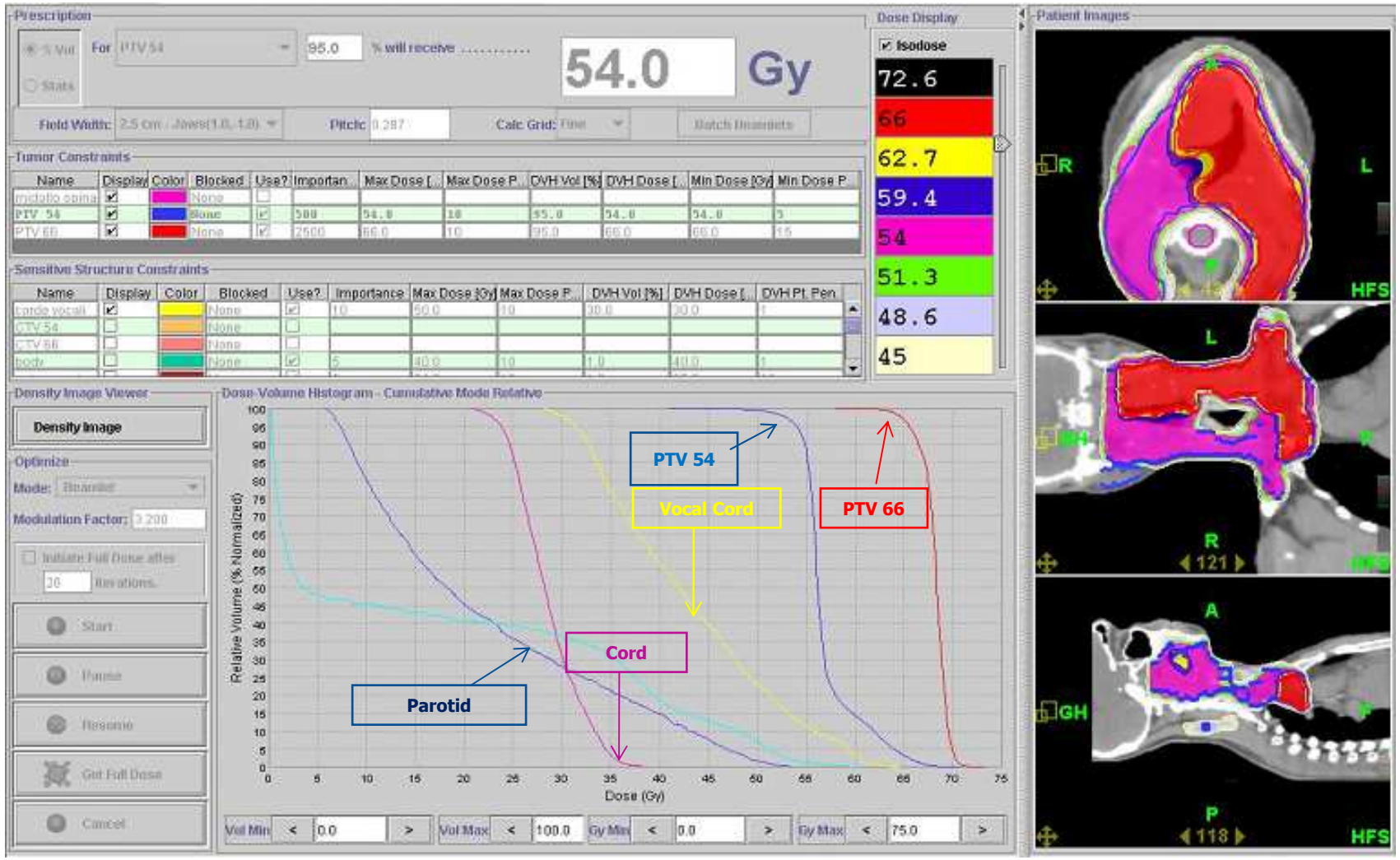


STOMACH
(PTV1: 53.75GY/ 25FX – PTV2: 45GY/25FX)

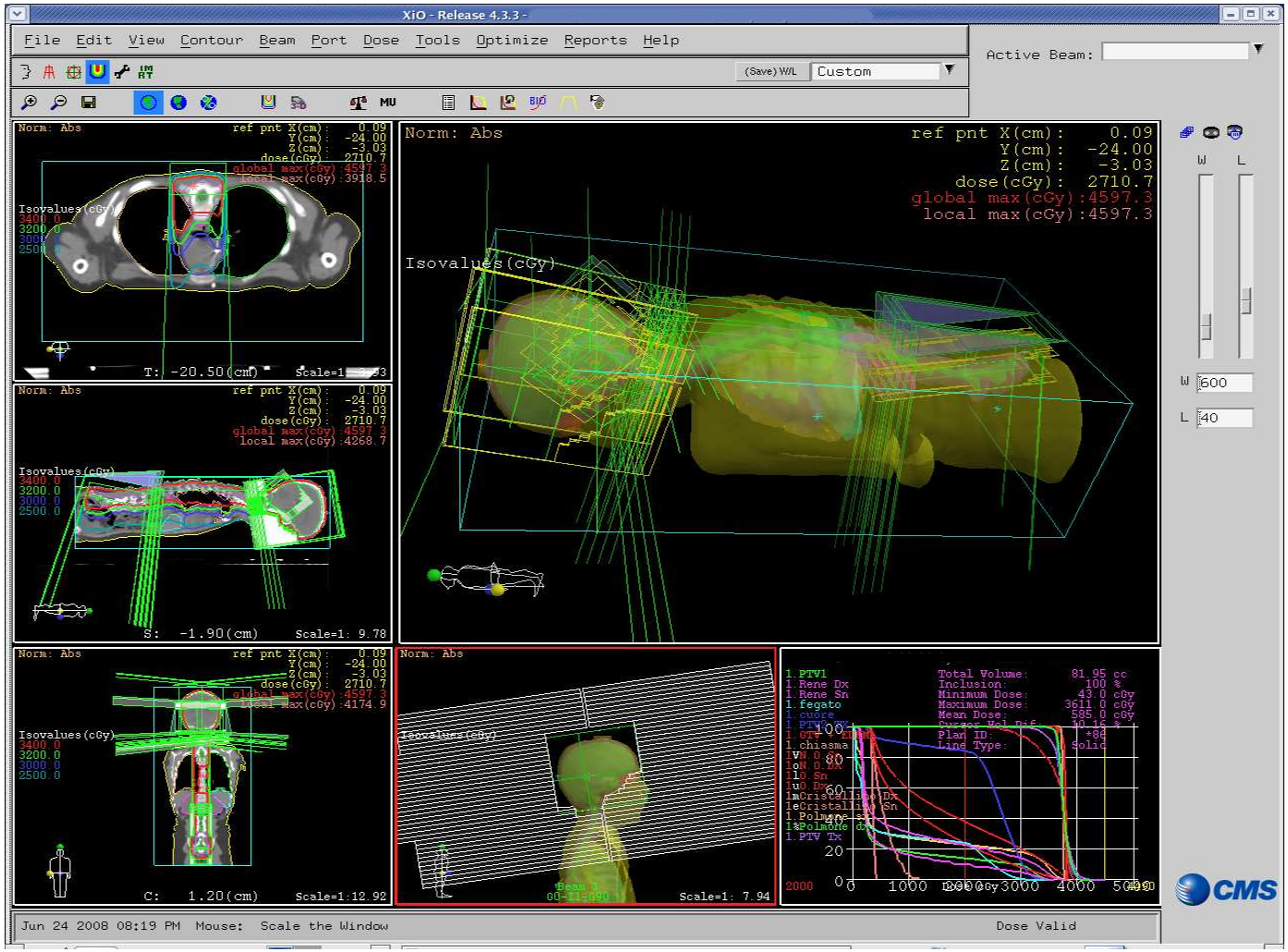


HEAD & NECK WITH CONCOMITANT CHT + RT (SIB)
66 Gy IN 30 / Fx (2,2 Gy/Fx) TO T AND N+ 54 Gy IN 30 / Fx (1,8 Gy/Fx) TO RIGHT CERVICAL NODES

RELAPSE TO ORIGINAL SITE AND TO LEFT CERVICAL NODES FROM SQUAMOS CARCINOMA OF LEFT BODY TONGUE (R C T2 N2B M0) PREVIUSLY MANAGED WITH SURGERY ALONE



PAEDIATRIC CRANIO – SPINAL (Linac)

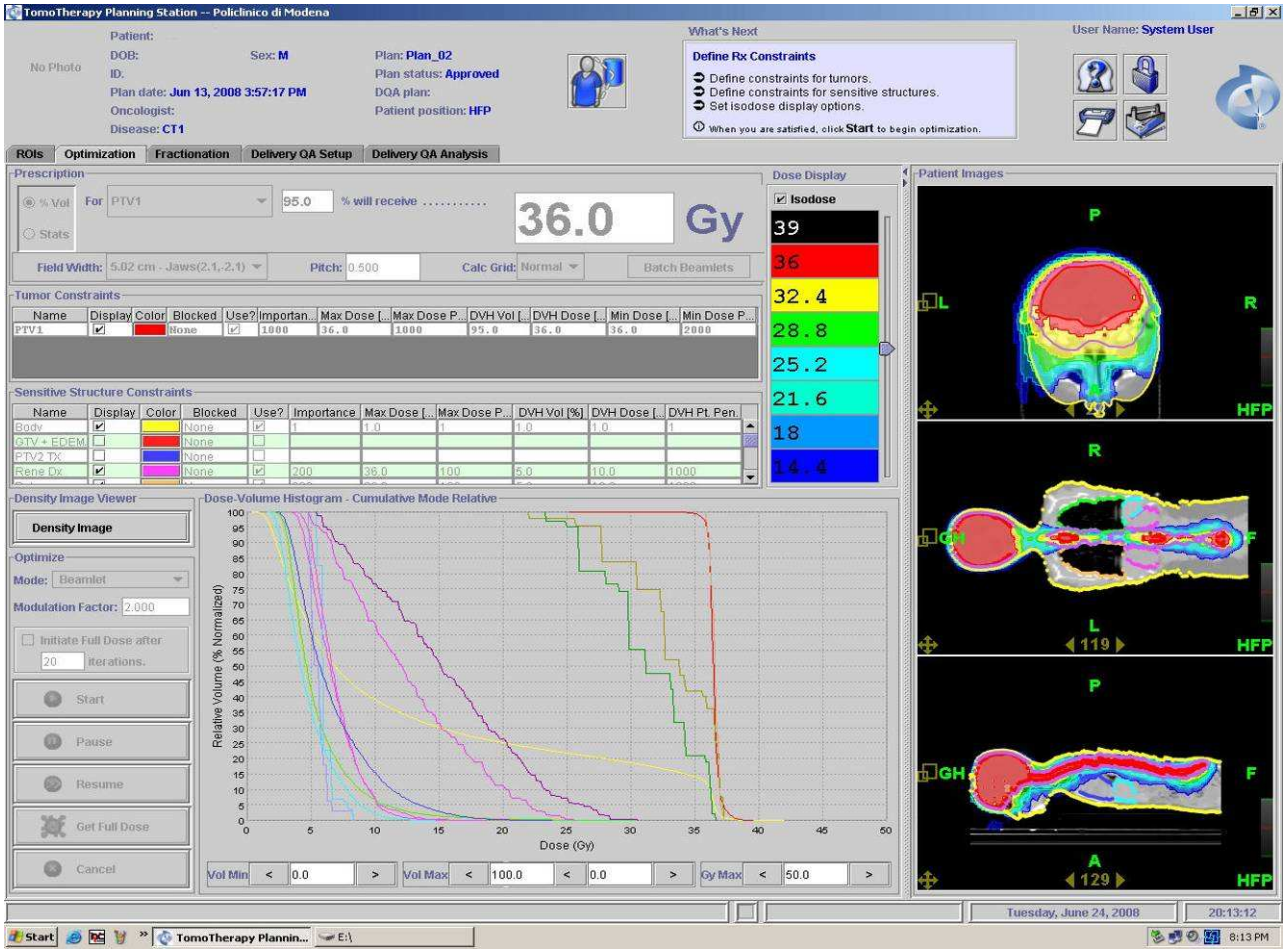


Standard Treatment @ Modena

1. Linac 6MV
2. Prone Position
3. Multiple field junction
4. 3 Split-beam (1cm for each day)
5. No-Coplanar Beam
6. Multiple Isocenter (no SSD=100cm)
7. PTV Margin 1cm
8. Conformal field
9. Portal verification of each junction
10. Procedure time 35 - 45min

..not anymore used after the Tomotherapy installation..

PAEDIATRIC CRANIO – SPINAL (Tomotherapy)



Tomotherapy Simulation

1. Prone Position
2. No Multiple field junction
3. No Split-beam
4. No-Coplanar Beam
5. No Multiple Isocenter
6. PTV Evaluation
   i. Margin 1cm
   ii. Margin 0cm
7. High Conformal
8. MVCT verification and adjustment
9. Procedure time 20-30min

TOMOTHERAPY VS. LINAC

Lung, Hearth, Liver, Eyes, and Kidneys less dose/volume; for Hearth and Liver decrease the DMax

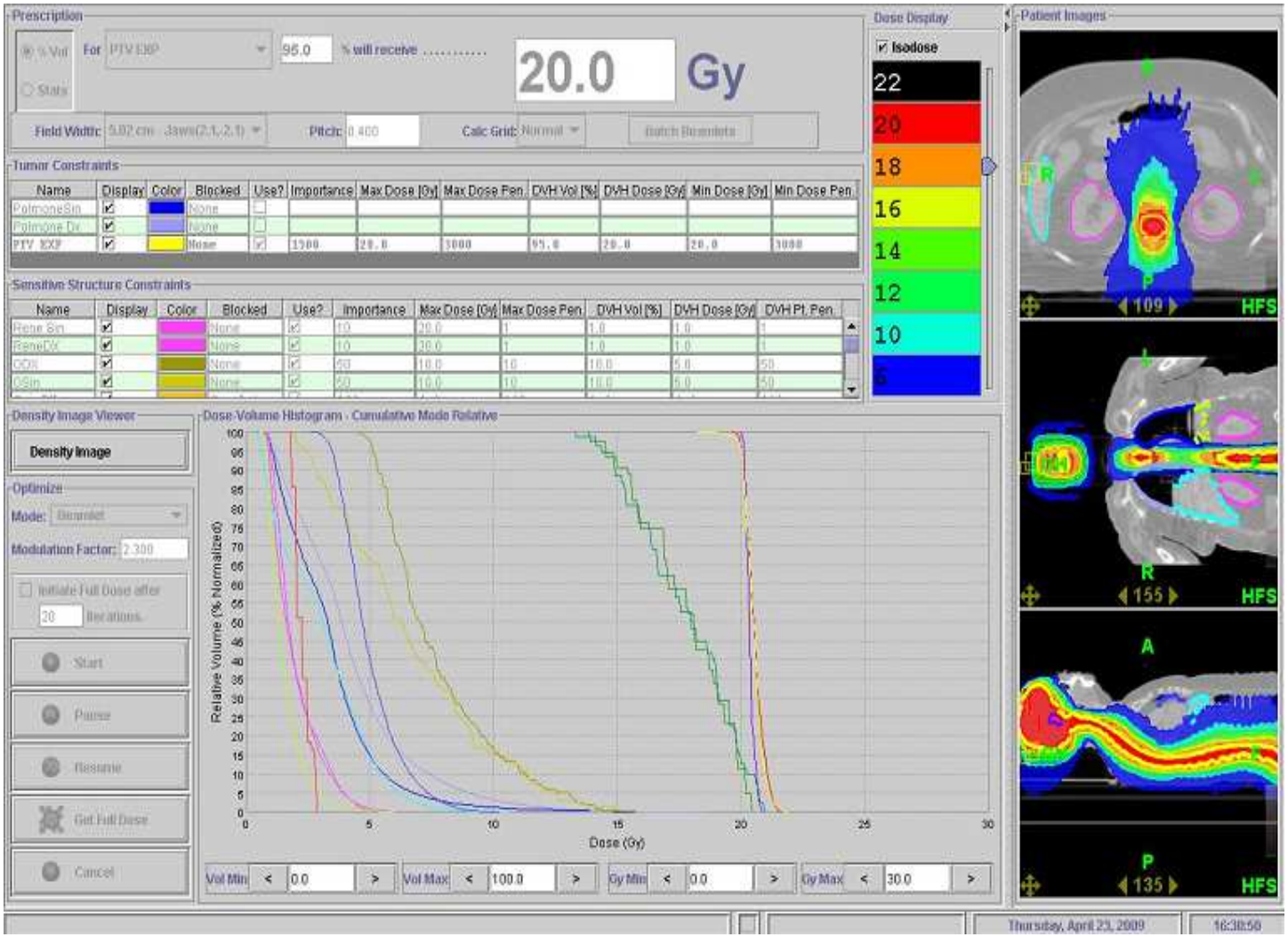
•Optical Nerve : same Dmax but less dose/volume

•Lens: increase the Dmax Dose, but under the max toxicity value (also with Complete Block Option)

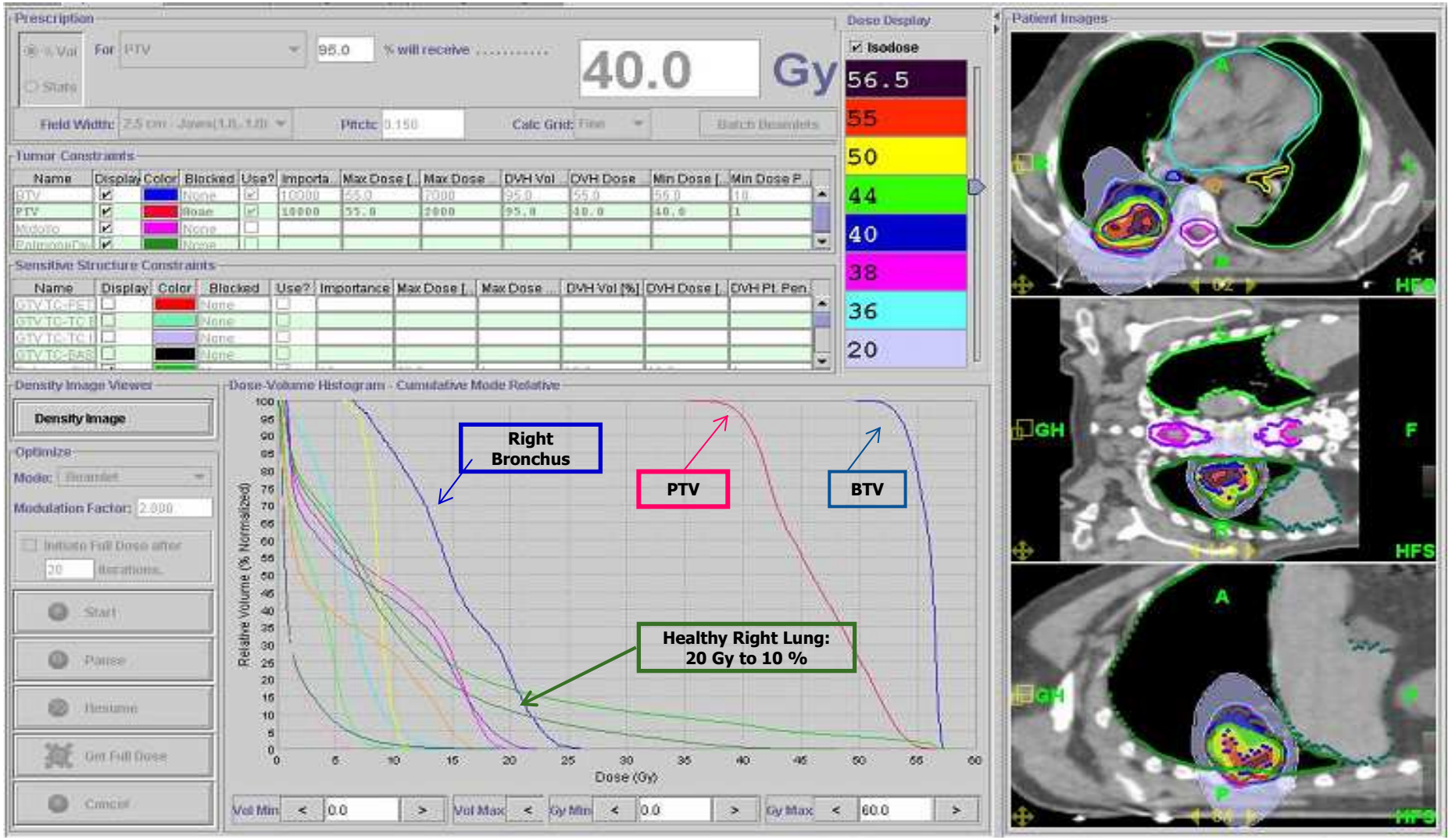
CRANIO SPINAL TODAY (20-36Gy)

Cranio Spinal - Clinical Tx

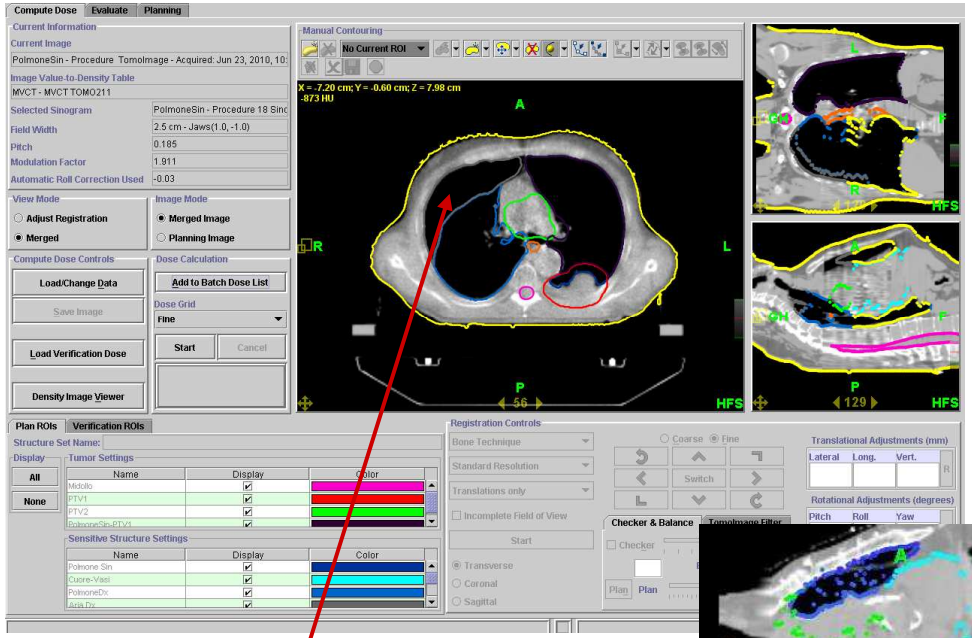
- Supine position
- Immobilization device (Mask)
- Target and Margin definition
- OAR objective
- Optimize verification time
- Optimize treatment time
- Analyze dosimetric accuracy
- **Treat patients**

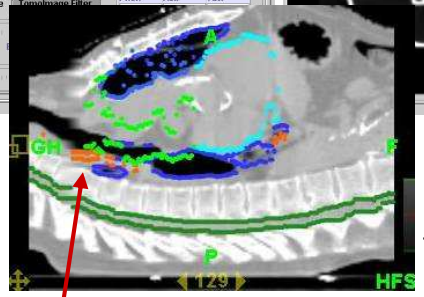


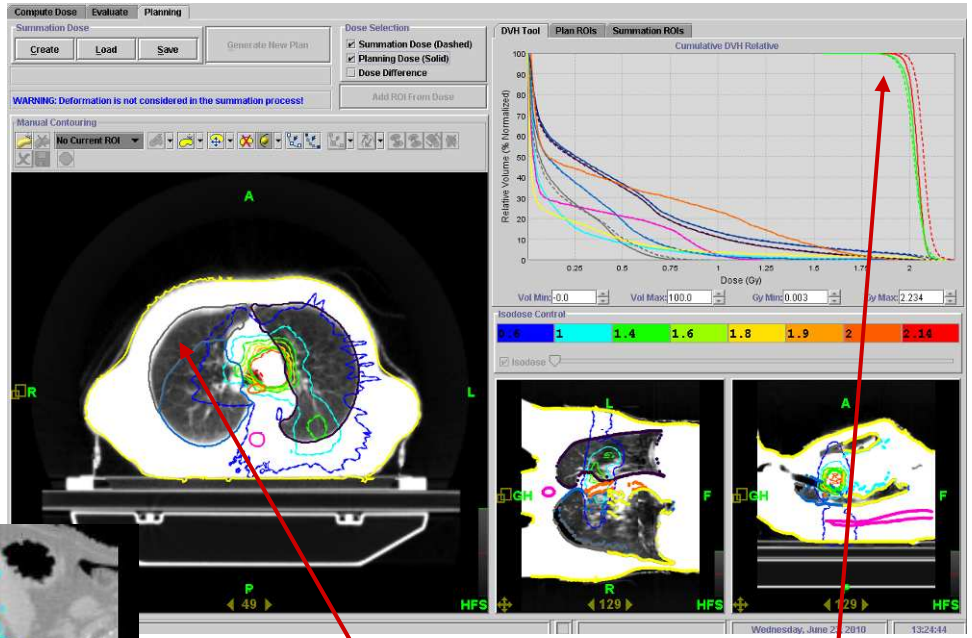
SECONDARY LUNG CANCER RELAPSED AFTER RFA
MULTIMODALITY IMAGE FUSION (SIB: BTV 55 Gy / 5 Fx - PTV 40 Gy / 5 Fx)



AIR CAVITY EFFECTS VS. ADAPTIVE RADIATION THERAPY VS. MOTION EFFECT







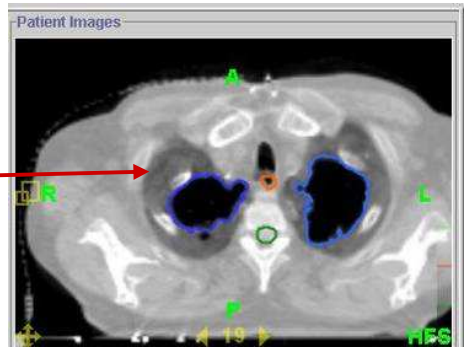
Air Cavity: Density equal 0 g/cm^3

Can create problem to the calculation?

During the treatment cycle can change the anatomy

Results?

The previous plan can be different than the current delivery

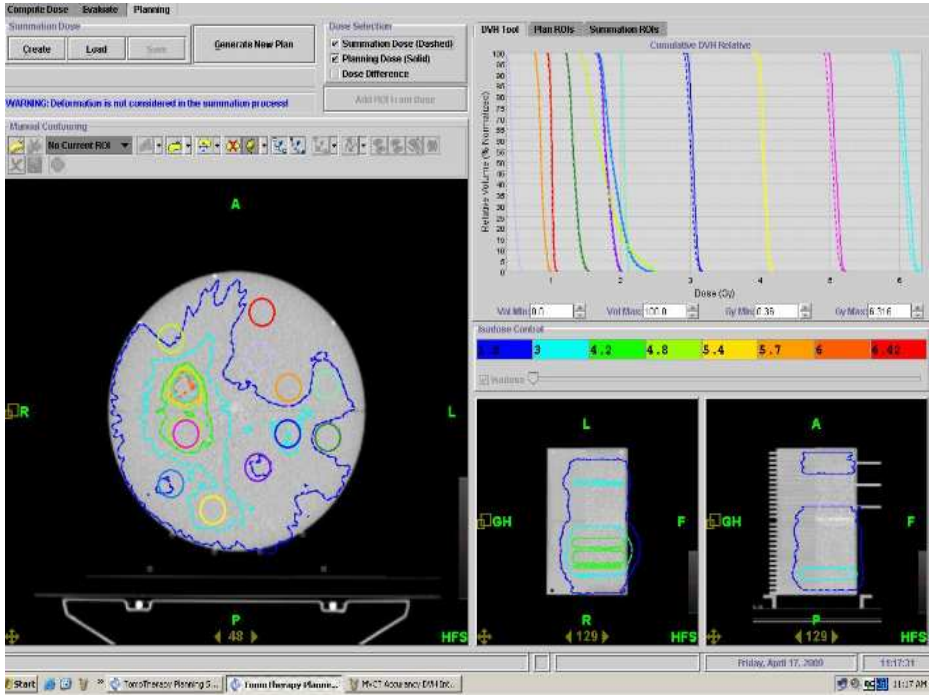


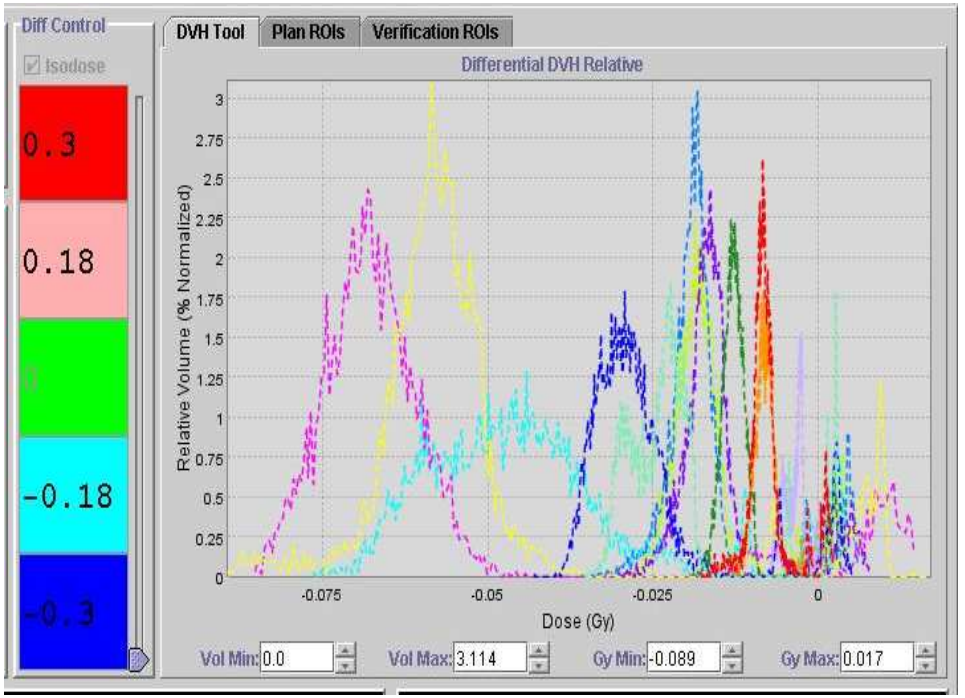
Using an Adaptive RT approach and a DVH analysis can show an idea of the current mistake and possible missing.

Be careful, could be not perfect!!!!

- Breathing cycle effects and artifact – Organ deformation
- MVCT density table modification due to the target degradation
- Fusion algorithm (mutual information) can smooth some effect due the voxel volume considered
- Some software trick of image concatenation

MVCT SUITABLE FOR ADAPTIVE RT : DOSIMETRIC EVALUATIONS





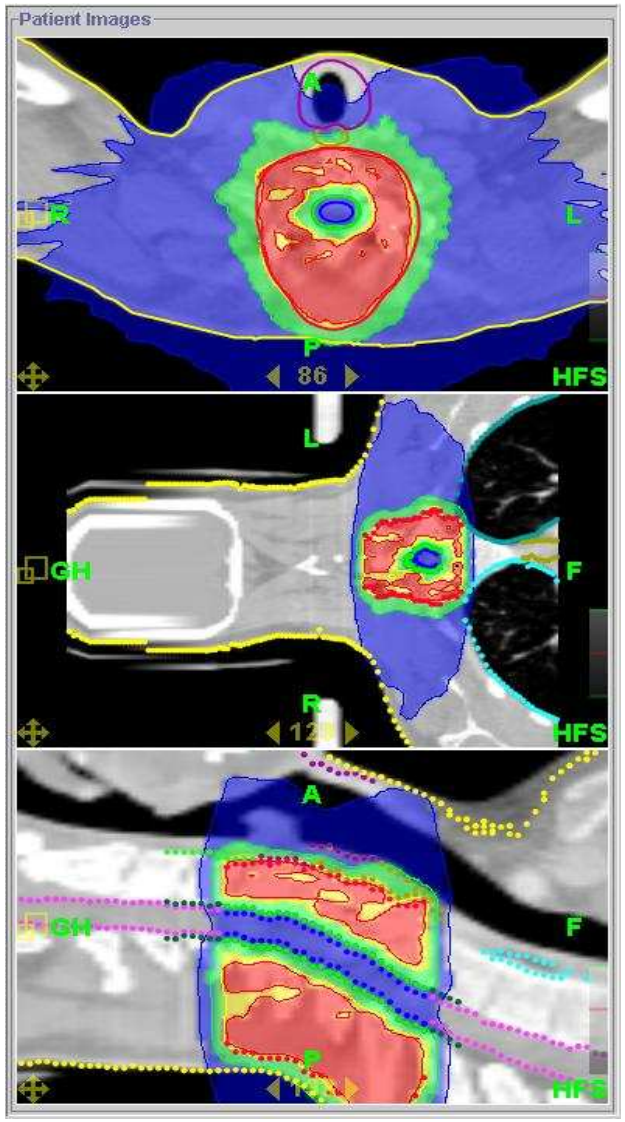
Result : difference of 0.08Gy (1%) for one fraction of 5Gy

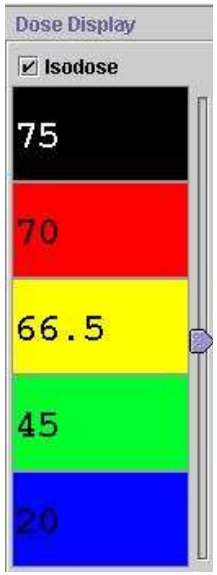
The problem is the reliability and stability of the MVCT during the time…
The degradation of the target can change the data…
(UNDER INVESTIGATION)

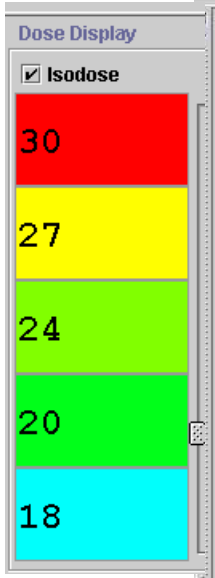
SPINAL SARCOMA (PTV 70 Gy / 35 FX)

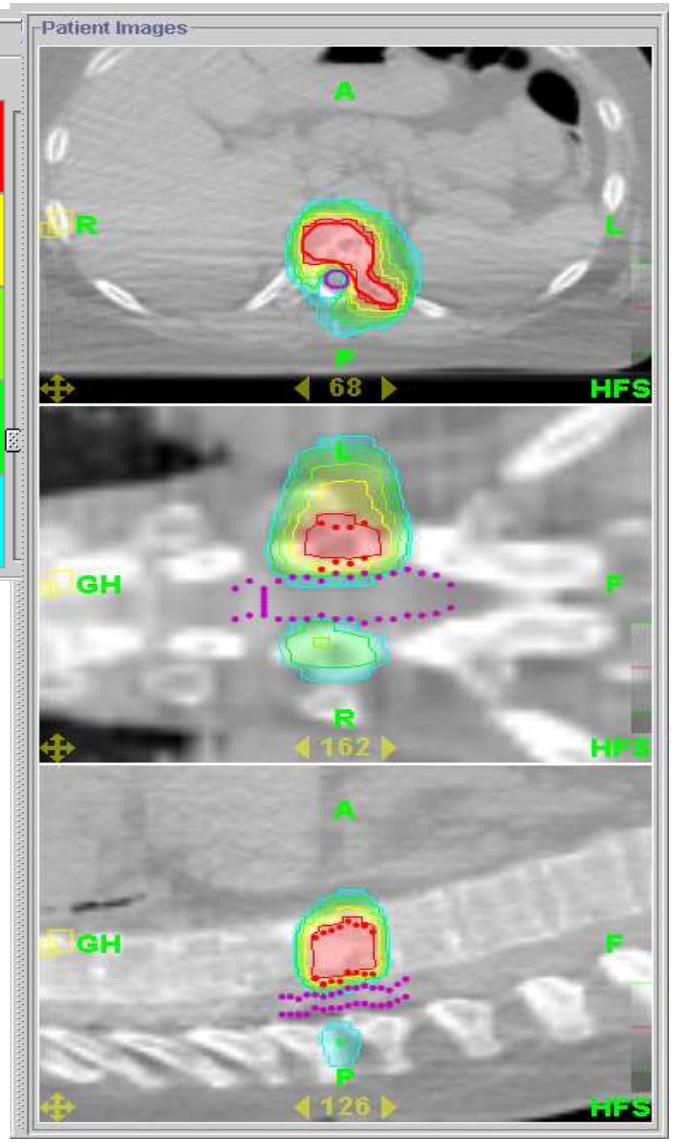
PALLIATIVE CASES

VERTEBRA (PTV 30Gy)

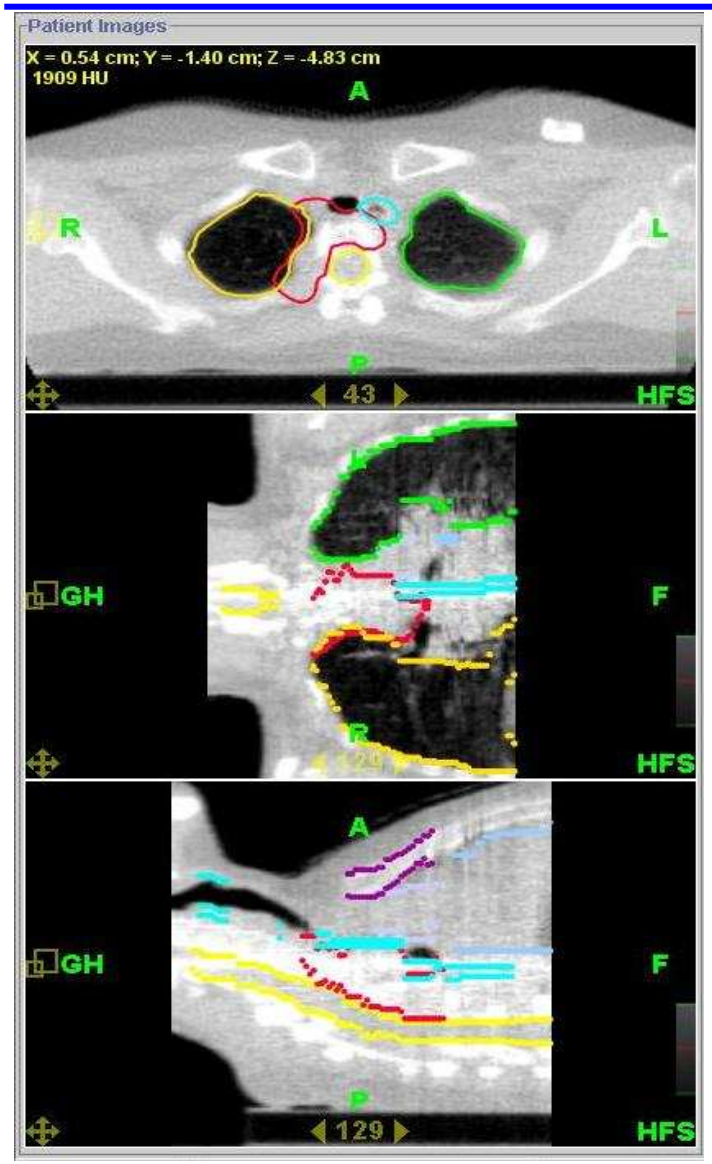




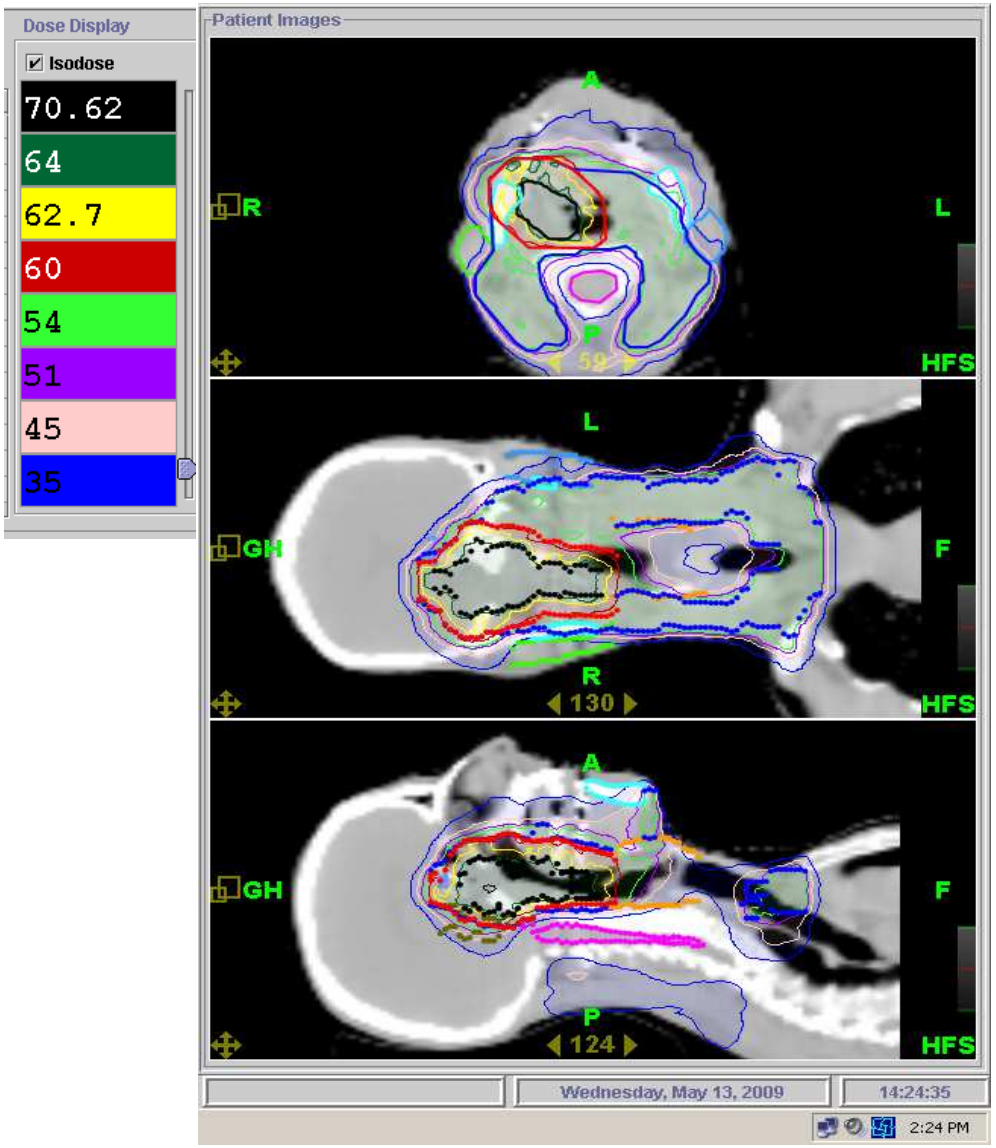




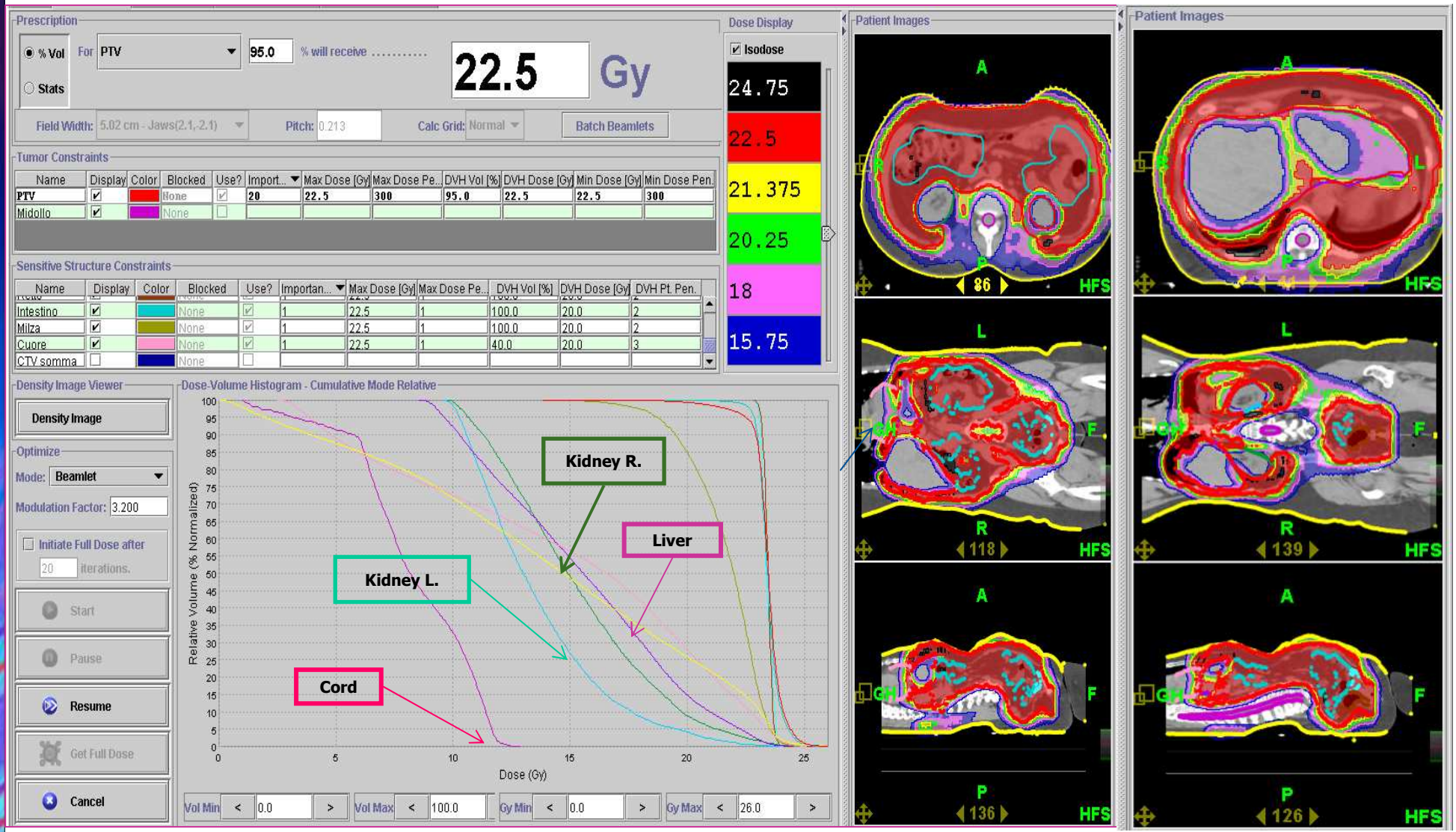
SPINAL METAL PROSTHESIS (Using MVCT)



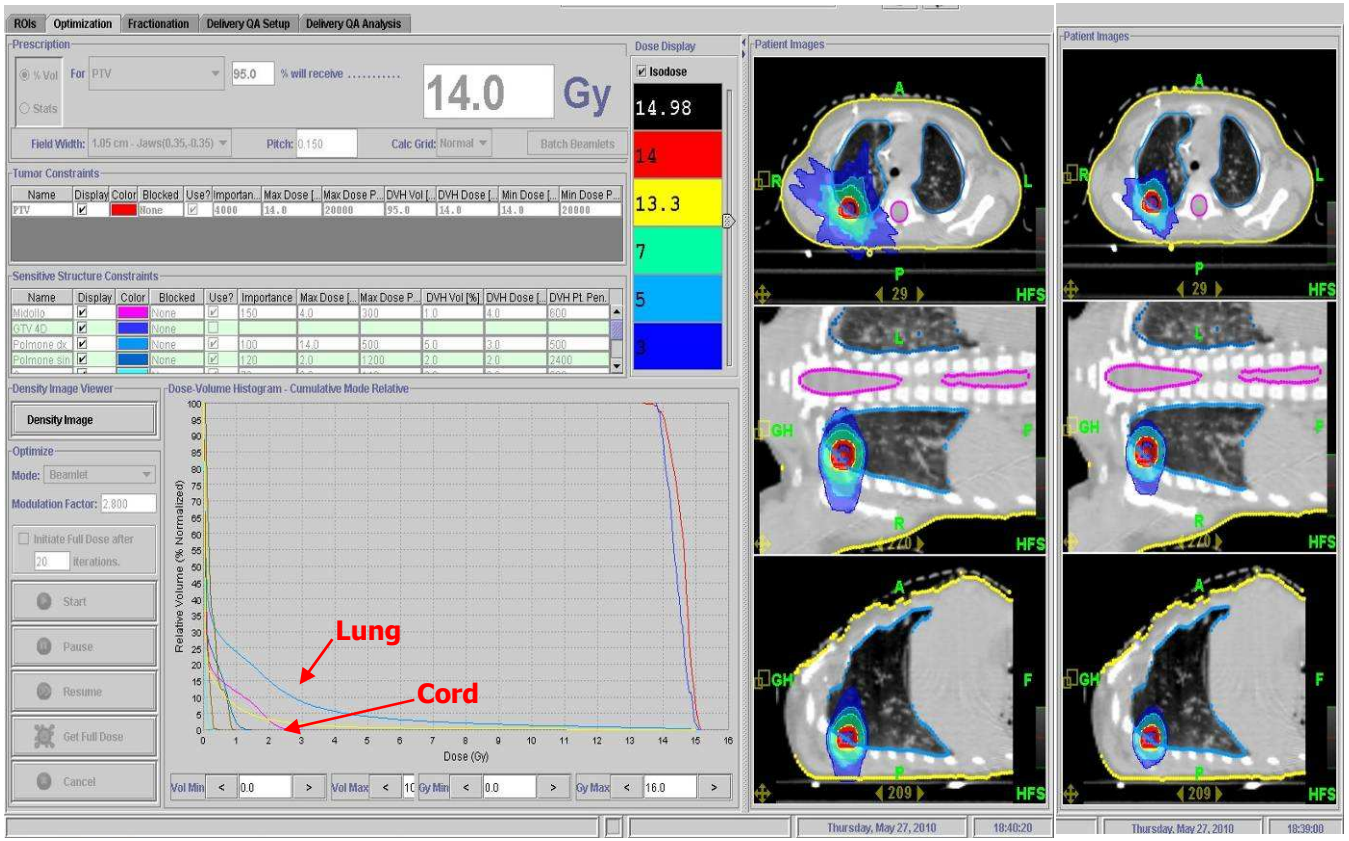
H&N in 30Fx (PTV1:70Gy - PTV2:64 Gy - PTV3:54 Gy)

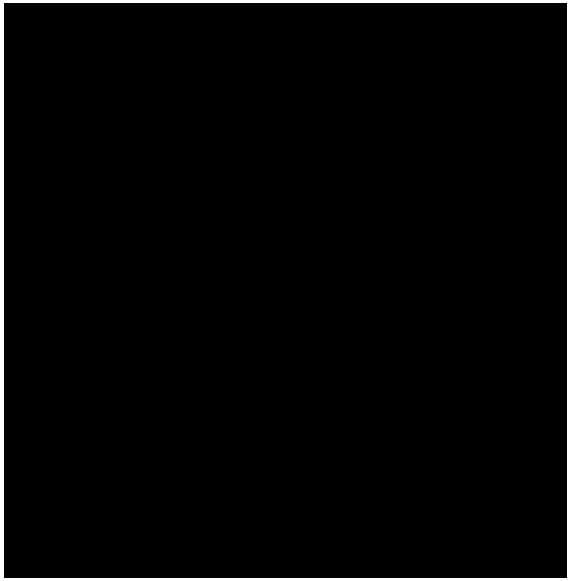


ABDOMINAL TREATMENT
(PTV 22,5 GY / 15 FX)



PAEDIATRIC TREATMENTS (14 Gy / 2 Fx) – 2 YEARS OLD
REDUCE THE NUMBER OF ANESTHESIA



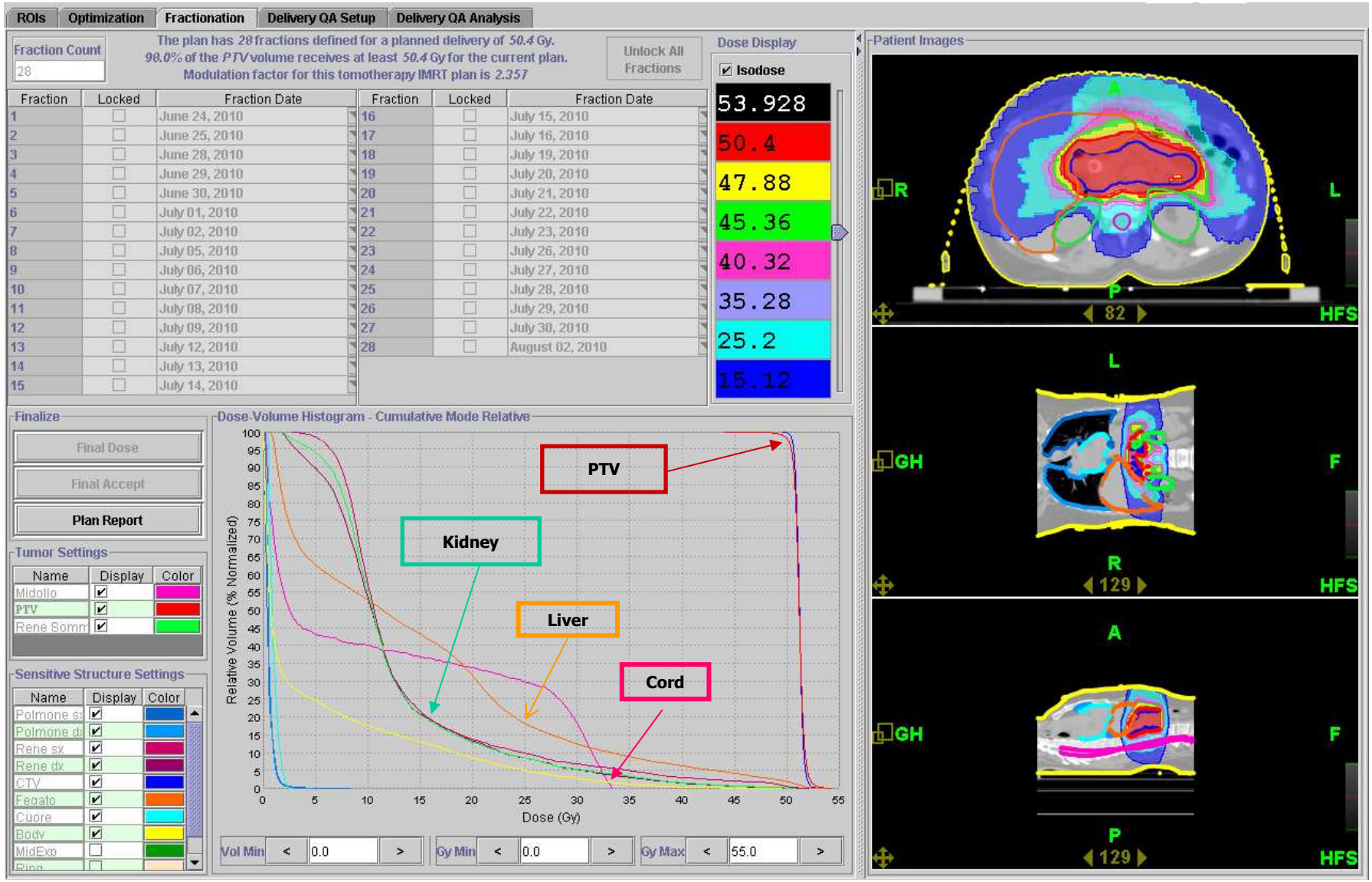


Breathing effect during 3DCRT and MicroMLC treatment

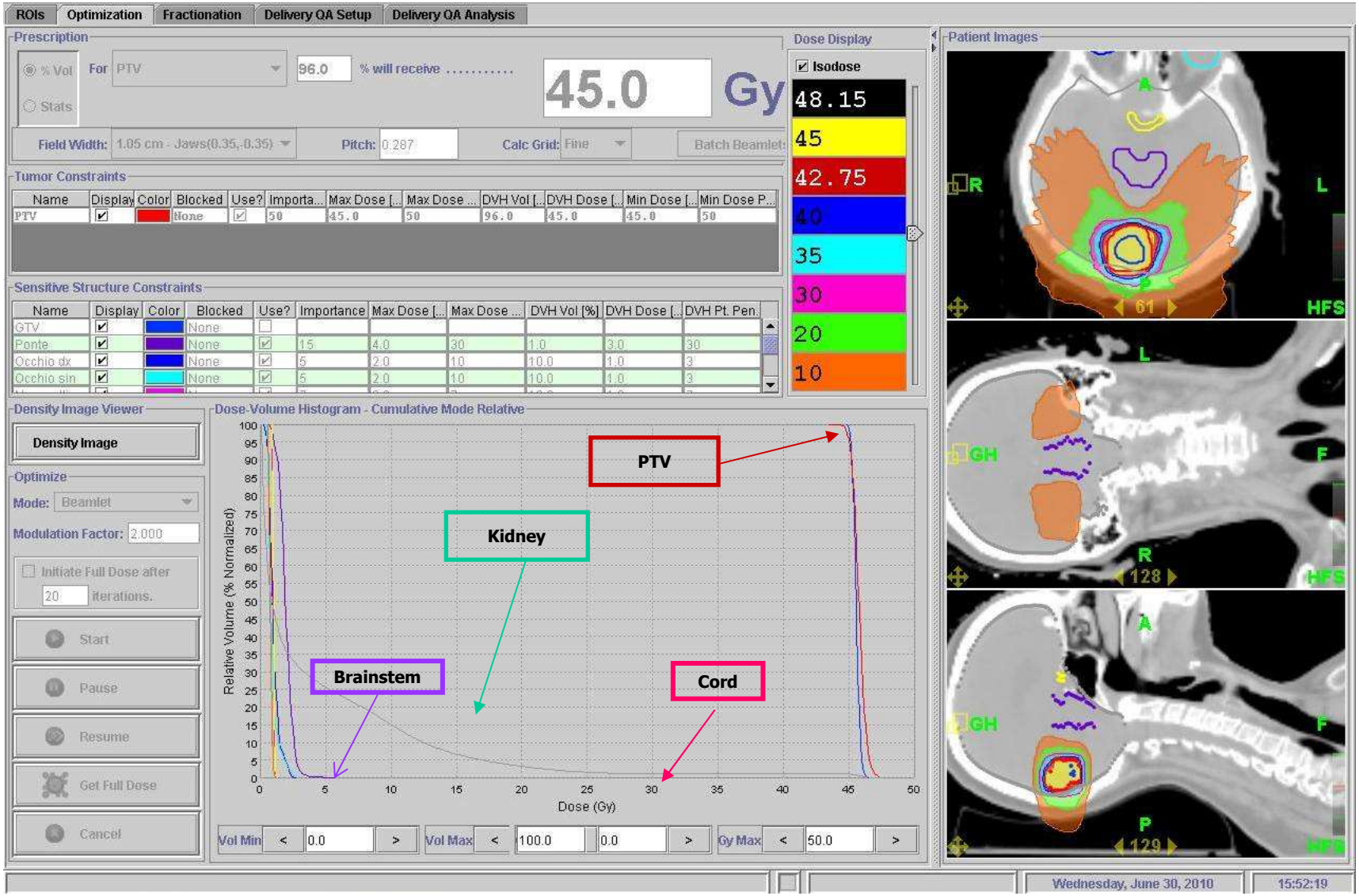
Tomotherapy advantages vs. MicroMLC or Cone systems

- No systems collision
- Low integral dose (3 Gy dose is showed)
- Concomitant anesthesia and patient monitoring very easy
- No dose at the contra lateral lung (trick during planning)
- Fast treatment (20minutes)
- Easy spare of the organ at risks

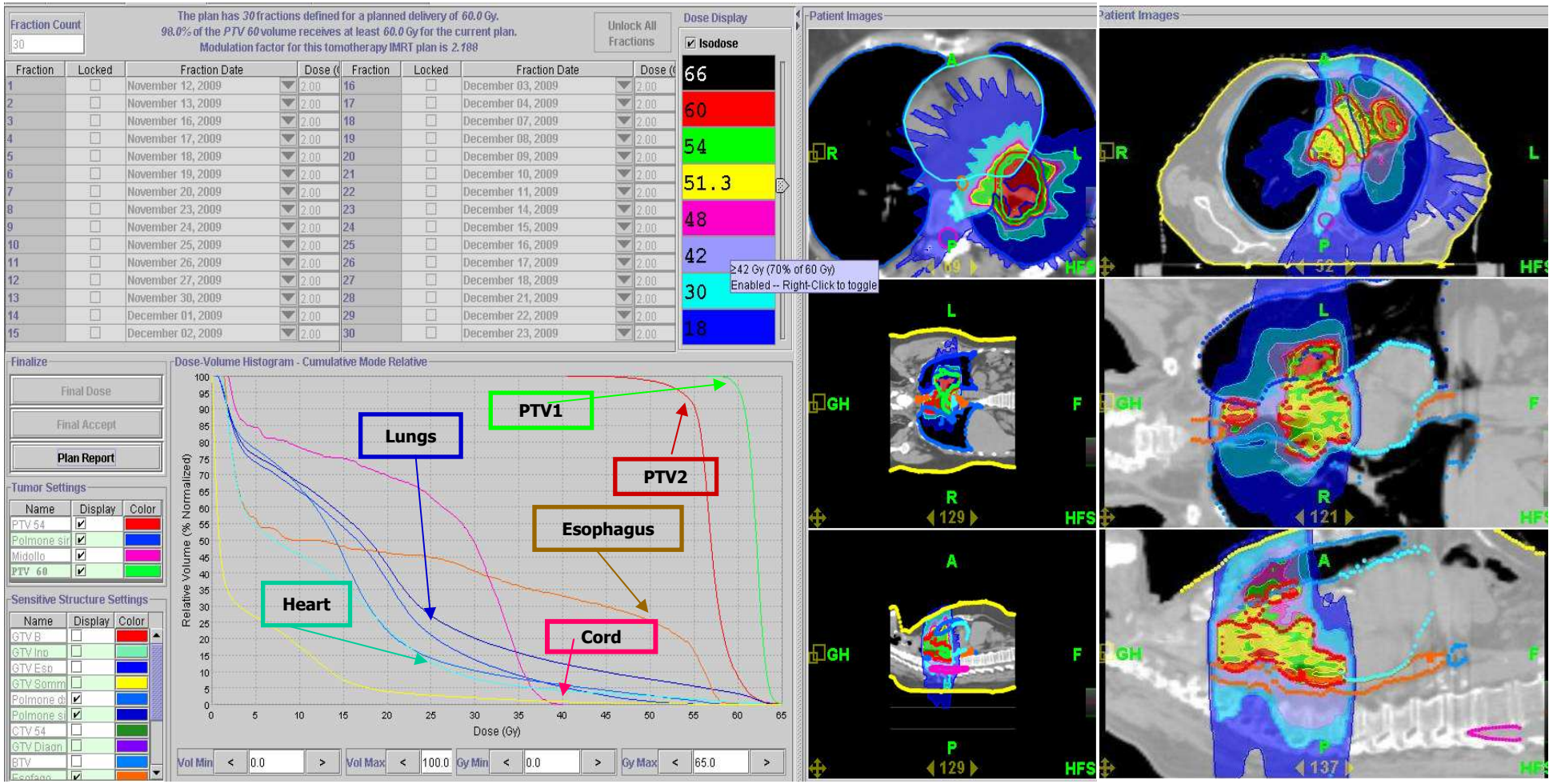
PANCREAS (50.4 Gy / 28 Fx)



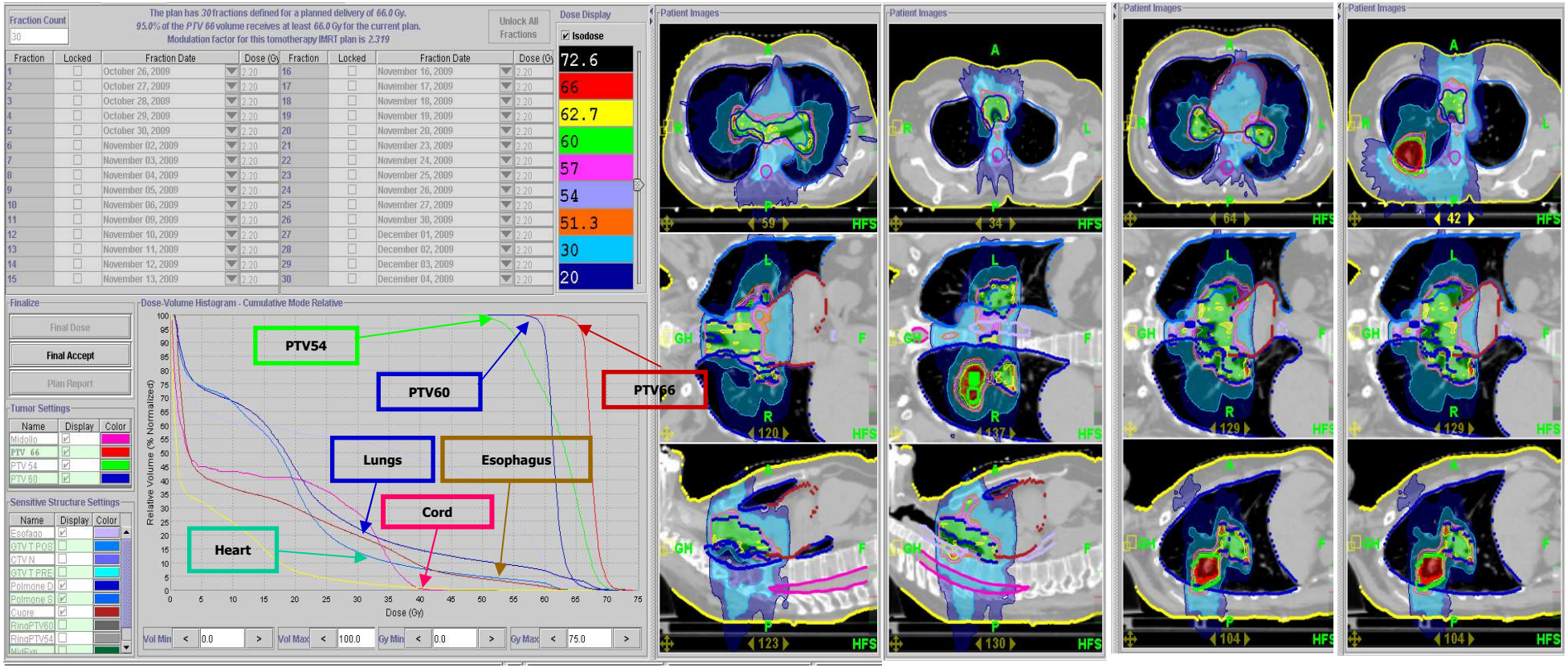
RECURRENT MENINGIOMA - RS 45 Gy /3 Fx – BRAINSTEM : 3 Gy (PREVIOUS TREATMENT 54 Gy – BRAINSTEM 54 Gy)



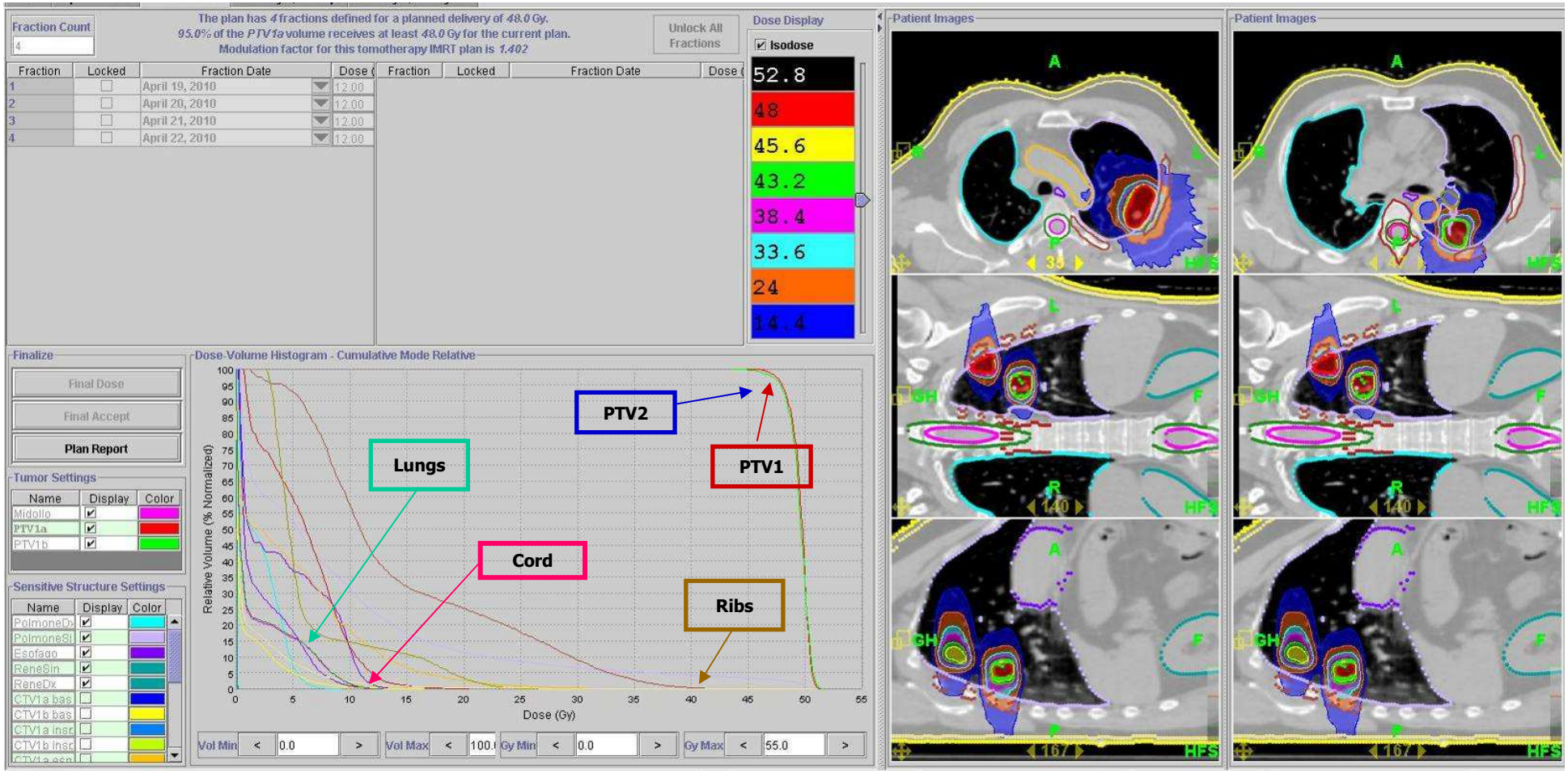
LUNG LESION (PTV1: 60 Gy / 30Fx – PTV2: 54Gy / 30 Fx)



LUNG LESION + BILATERAL ILA + MEDIASTINUM
(PTV66 Gy /33 Fx – PTV60 Gy / 33 Fx – PTV54 Gy /33Fx)

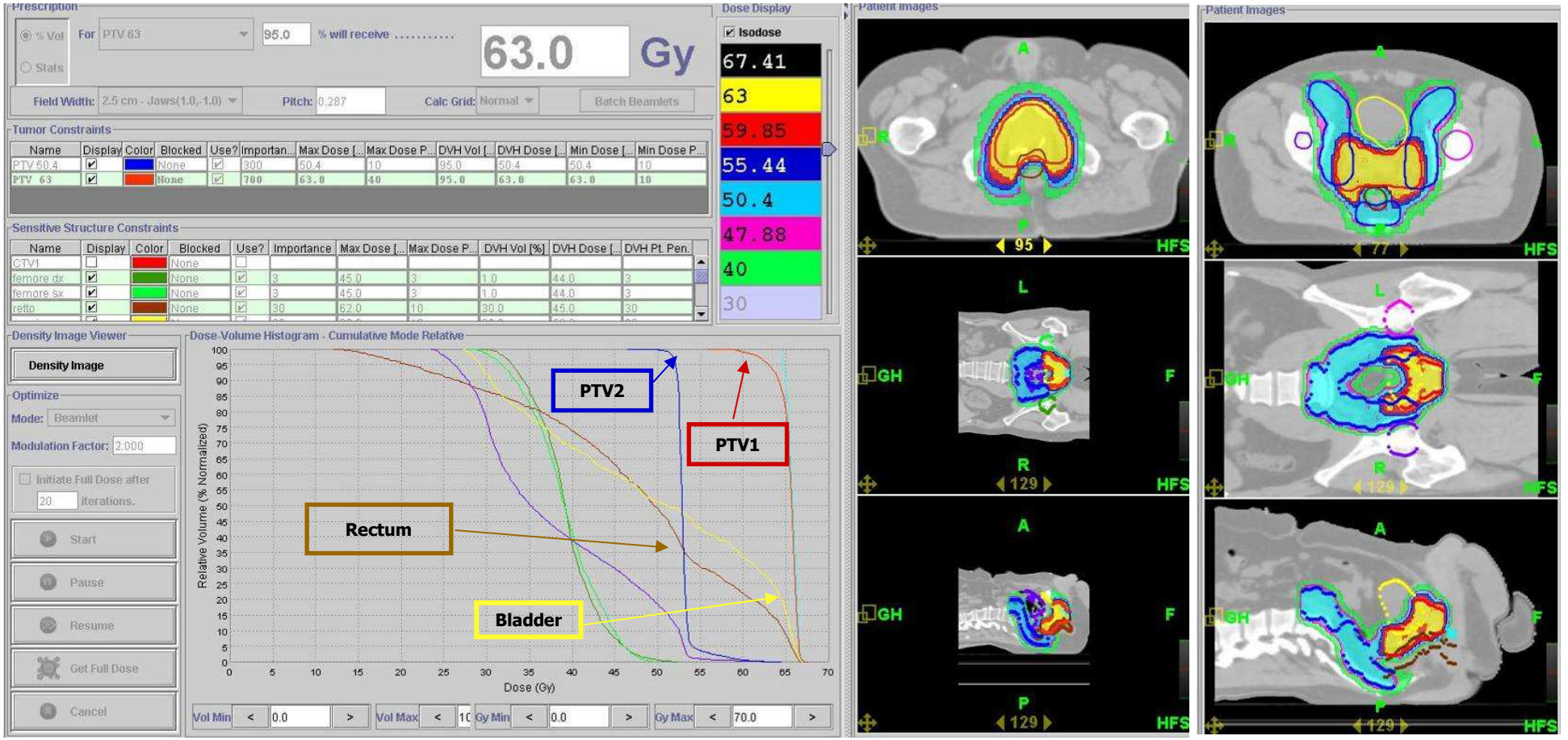


SBRT MULTIPLE LUNG LESIONS (48 GY / 4FX)

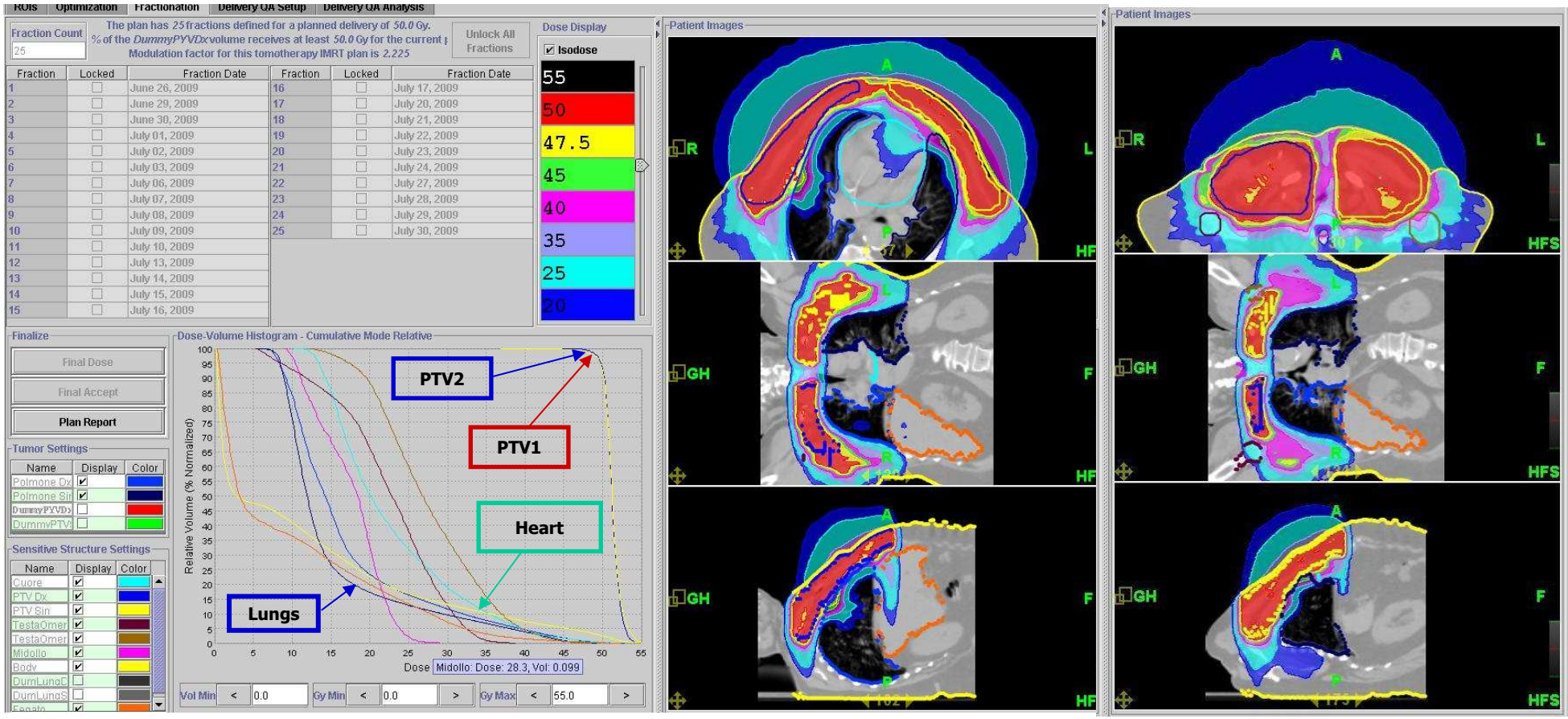


PELVIS
(PTV1 63Gy – PTV2: 50.4Gy / 28 Fx)

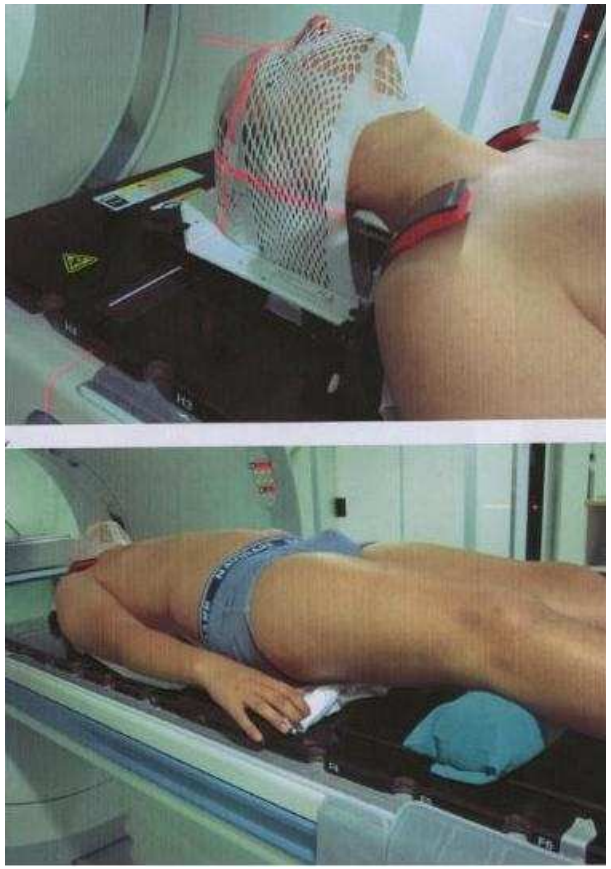
Prostate
(PTV1 54Gy – PTV2: 70Gy / 28 Fx)

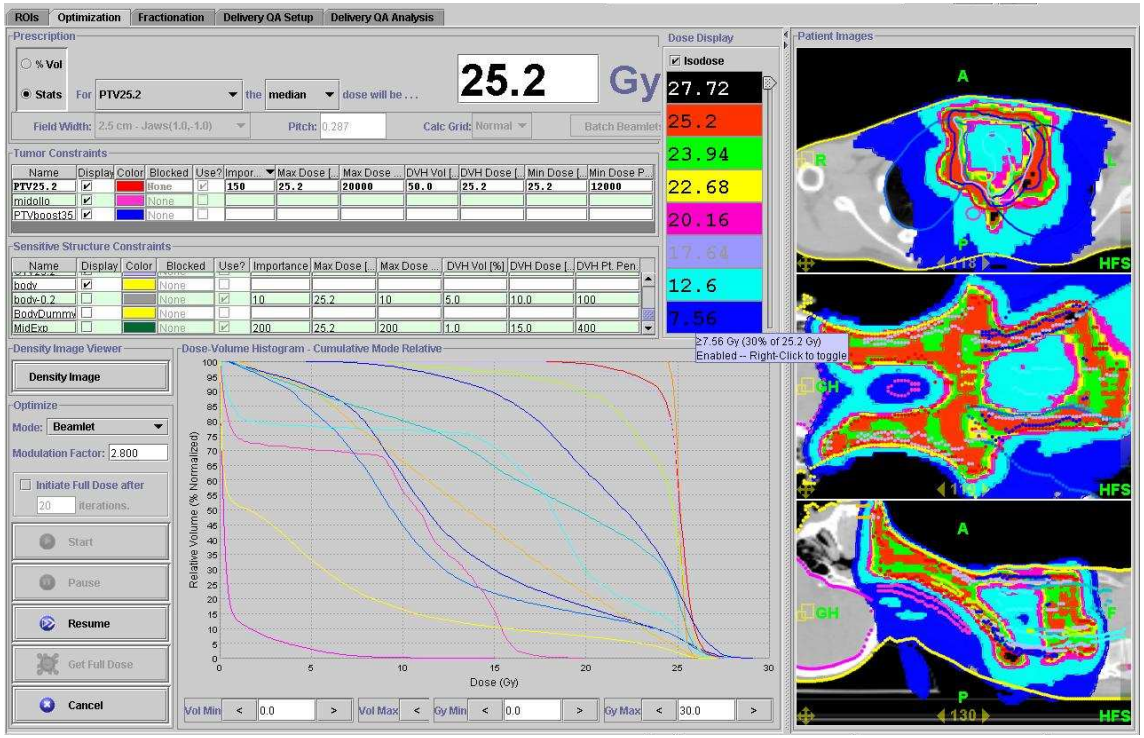


BILATERAL CHEST WALL + SUVRACLAVEAR (50 Gy /25 Fx)



BAD SETUP IMMOBILIZATION – BAD PLAN APPROACH





Bad overlap priority of the structures consideration can create unexpected error during treatment and DVH could not show this error

Tomotherapy use a rotational delivery treatment, everything must be where is suppose to be during the planning

- Arms effect on the attenuation and improper dose at soft tissue
- Thorax bad fixation and breathing influences
- Leg and longitudinal alignment (MVCT correction could be complicate between upper and lower movement)
- Shoulder movement during the treatment or day by day positioning

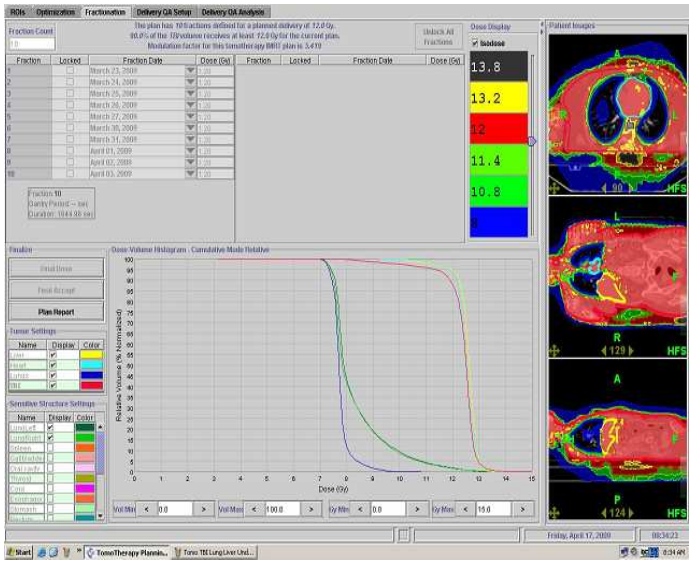
JUST FOR TRAINING !!! NOT REAL CASES

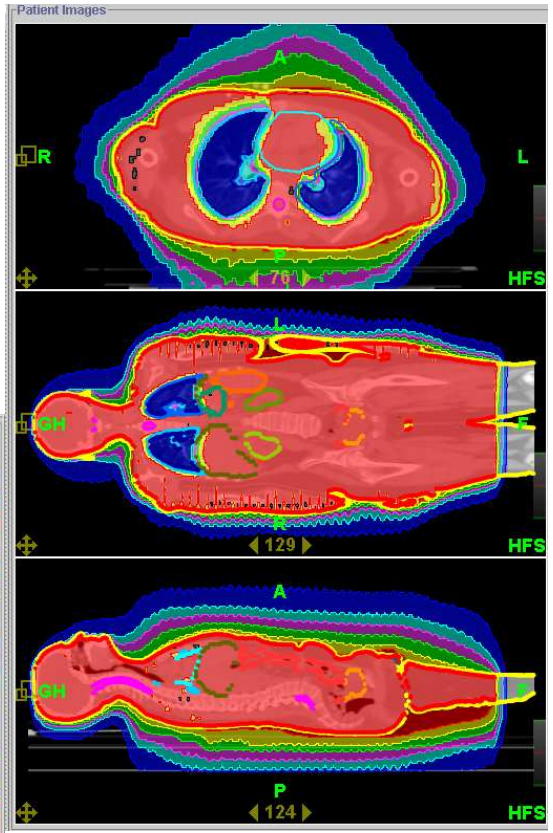
National Research and Collaboration (Project N°5 : Program PIO V)

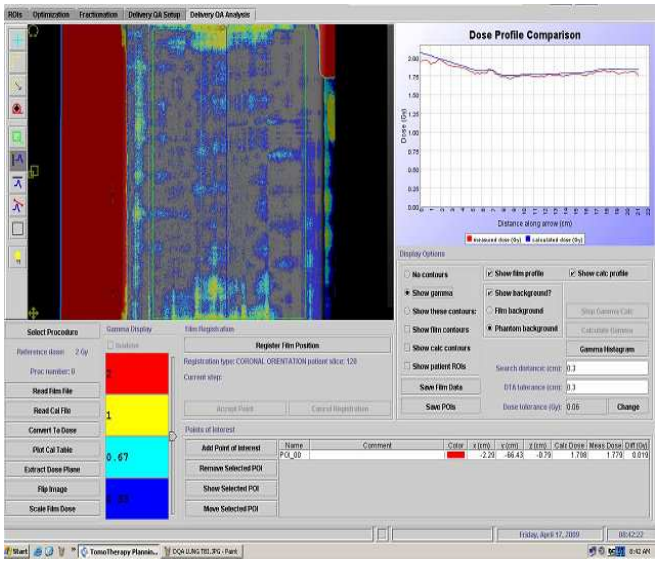
Evolution of the Image Guided Radiation Therapy (IGRT) using Tomotherapy: feasibility and efficacy of Adaptive Radiation Therapy Techniques (ART), Hypo-Fractionation (HF), Target Biological Definition (BTV) and Total Body Irradiation (TTBI)

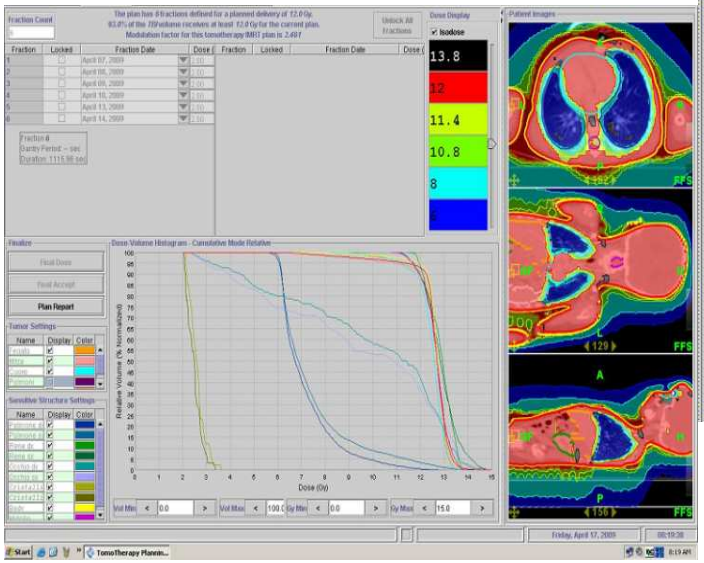
- MAIN RESEARCH CENTER
  - IRCCS – Centro di Riferimento Oncologico di Aviano (1)
- MULTI-CENTER COLLABORATION:
  - IRCCS – Ospedale S. Raffaele di Milano (2)
  - Regione Emilia Romagna - Arcispedale S. Maria Nuova di Reggio Emilia (3)
  - Regione Emilia Romagna - Azienda Ospedaliero Universitaria Policlinico di Modena (4)
- Objective
  1. Efficacy, efficiency and clinical evaluation of Adaptive Radiation Therapy system using multiple national health institutions, where Tomotherapy units are installed
  2. Prostate hypo-fractionated techniques evaluation to reduce the treatment time and assessment of dose escalation program to reduce the dose per fraction for adjuvant treatments after surgery. Local – Regional control and toxicity evaluation.
  3. Evaluation and definition of multi-modal imaging techniques for radiotherapy biological target definition (BTV). Clinical application and dose distribution optimization using physics and radio-biological parameter to improve clinical treatment efficacy
  4. **Clinical and dosimetric evaluation of Total Body Irradiation using Tomotherapy. Treatment and transplant procedure, adequacy and safety evaluations using Tomotherapy. Problem solving, efficacy and efficiency for human and paediatric treatments.**

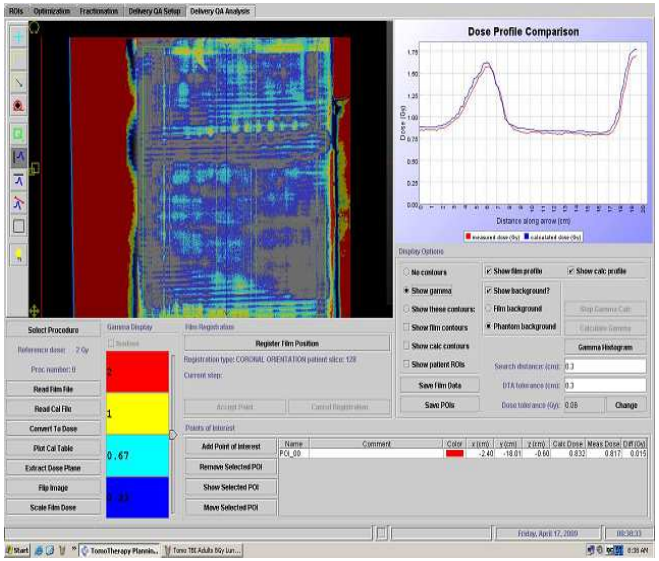
RESEARCH
RESULTS: TOTAL BODY IRRADIATION USING TOMOTHERAPY





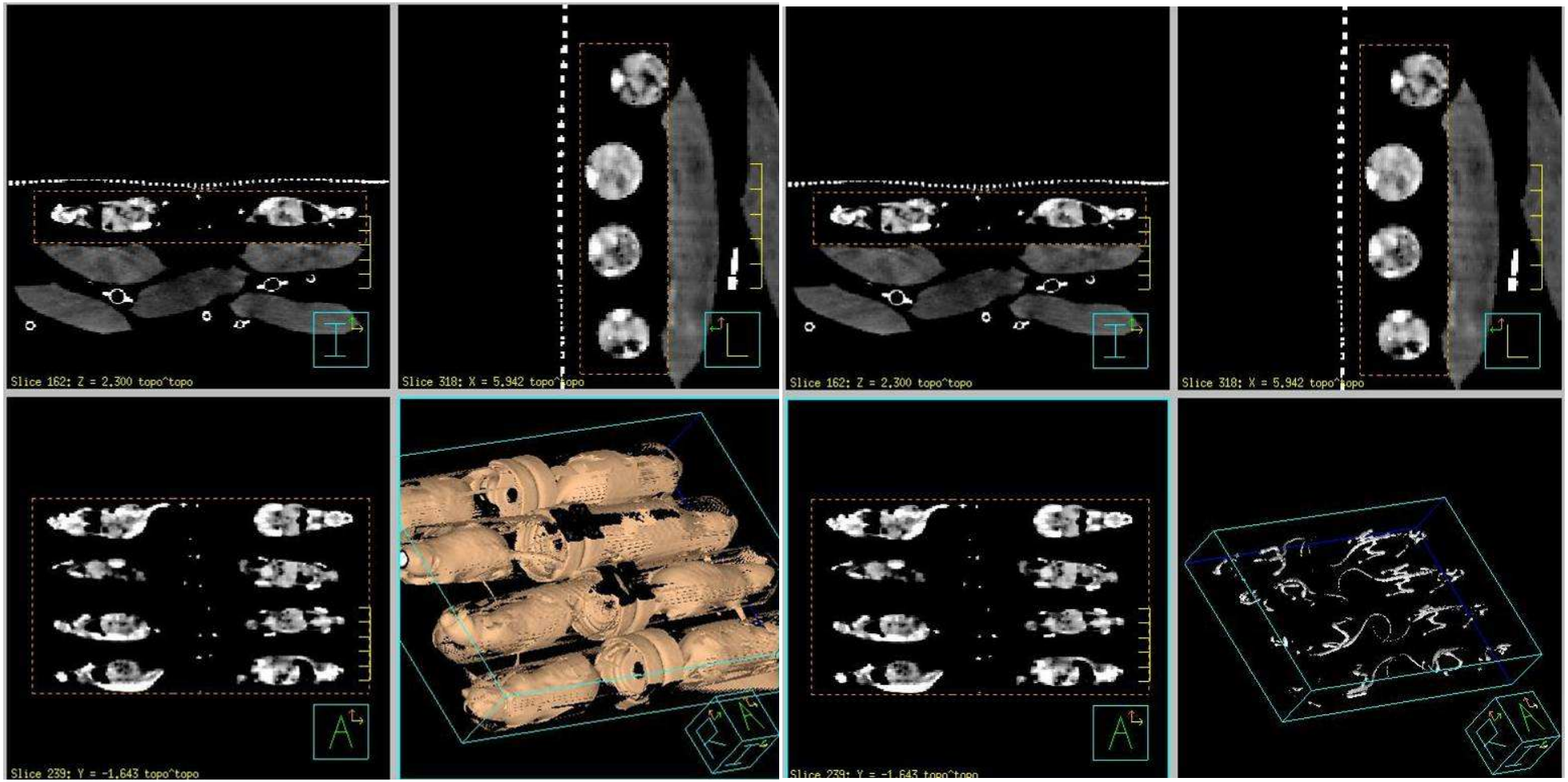






In memory of Marco Corni (2008)

TBI RESEARCH: HIGH DOSERATE EFFECT IN MICE (TOMOTHERAPY 880-900cGy/min) (STUDY UNDER DEFINITION)

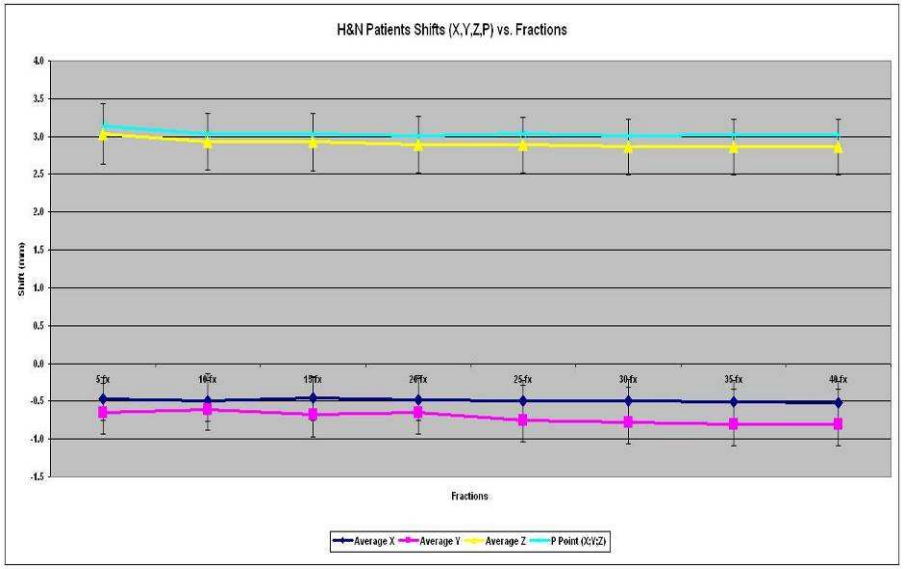


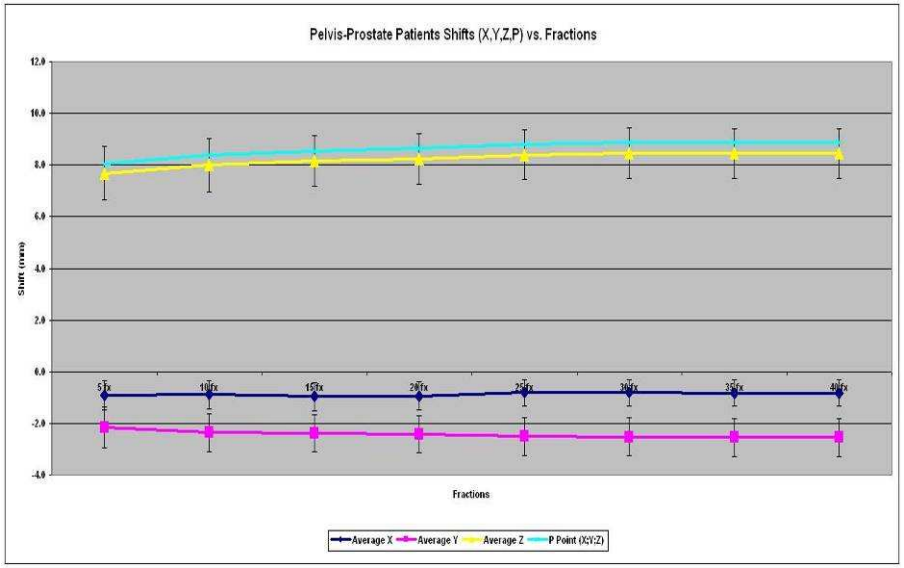
Idea by G.Guidi, F.Bertoni 2008, 2009, 2010

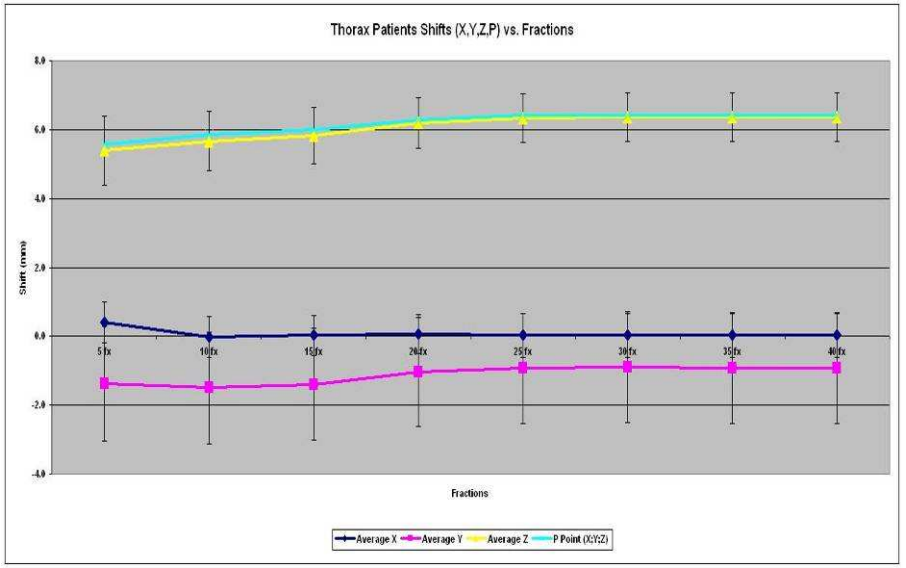
IMMOBILIZATION SYSTEM AND SET-UP ERRORS

Our data analysis shows that:

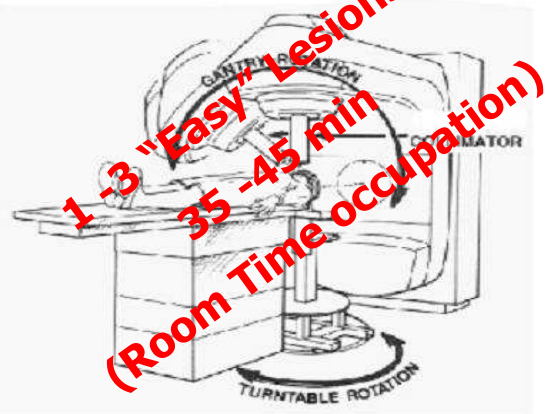
- Immobilization systems are adequate:
  - 3-fixing point thermoplastic masks for brain treatments (no invasive devices)
  - 5-fixing point masks with shoulder immobilization for head & Neck treatments
  - Thermoplastic masks with abdominal compression for thorax & abdomen treatments
- Reduced margins of CTV-PTV may be proposed with very low risk of geographic missing:
  - < 3 mm for brain
  - < 5 mm for head & neck
  - < 10 mm for thoracic & abdominal
- Senseless reduction of the margin could be very dangerous for the future outcomes of the patients



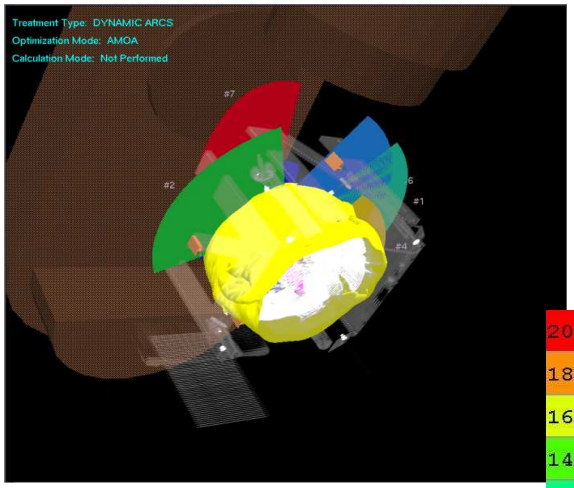


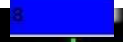


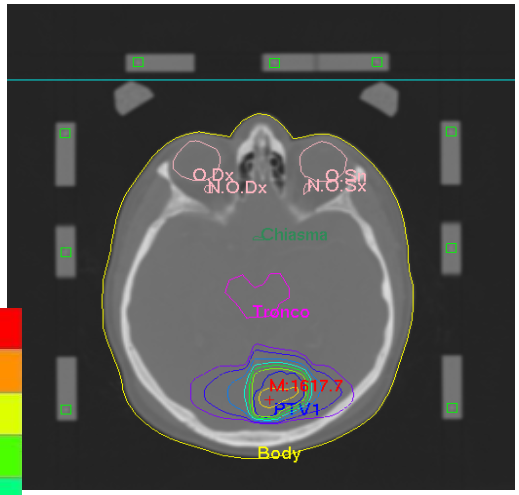
MANAGEMENT AND OPTIMIZATION
HOW CAN I SAVE TIME …… (RADIOSURGERY)



adapted from A. T. Villavicencio,
Duke University Medical Center





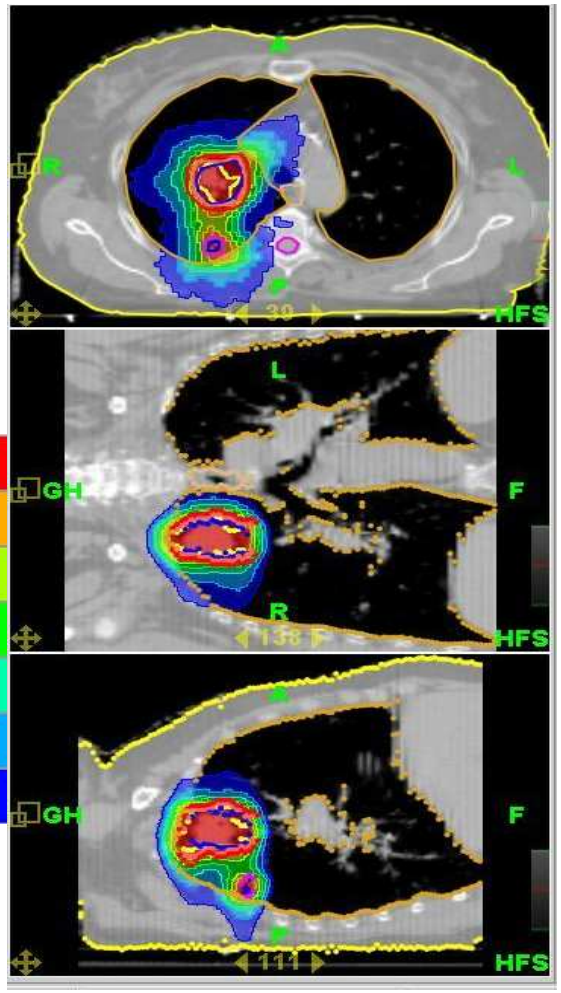


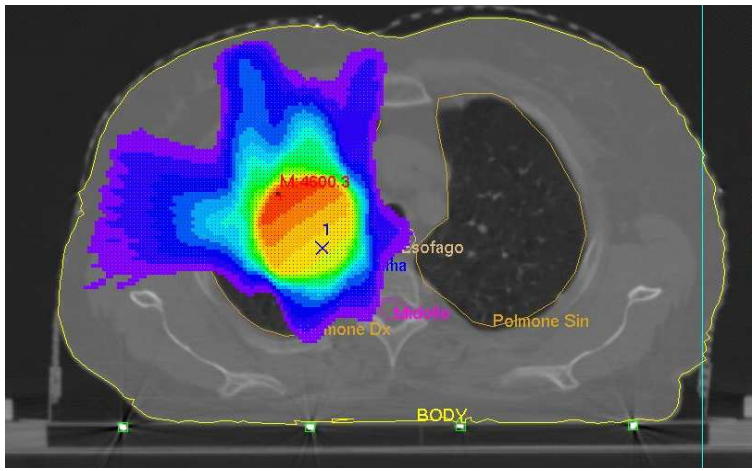
Equivalence???

2 Radiosurgery using Tomotherapy = Same LINAC Occupation Time = 40 minutes at the LINAC available for 3DCRT = 4 Patients?

6 Patients (2 RS+4 pts. 3DCRT) treated at the center vs. 2 RS using 2 LINACs during the same time

MANAGEMENT AND OPTIMIZATION
HOW CAN I SAVE TIME …… (STEREOTACTIC BODY RADIATION THERAPY)





Equivalence???

2 SBRT using Tomotherapy = Same LINAC Occupation Time = 50 minutes at the LINAC available for 3DCRT = 5 Patients?

7 Patients (2 SBRT+5 pts. 3DCRT) treated at the center vs. 2 SBRT using 2 LINACs during the same time

MACHINE TIME MANAGEMENT

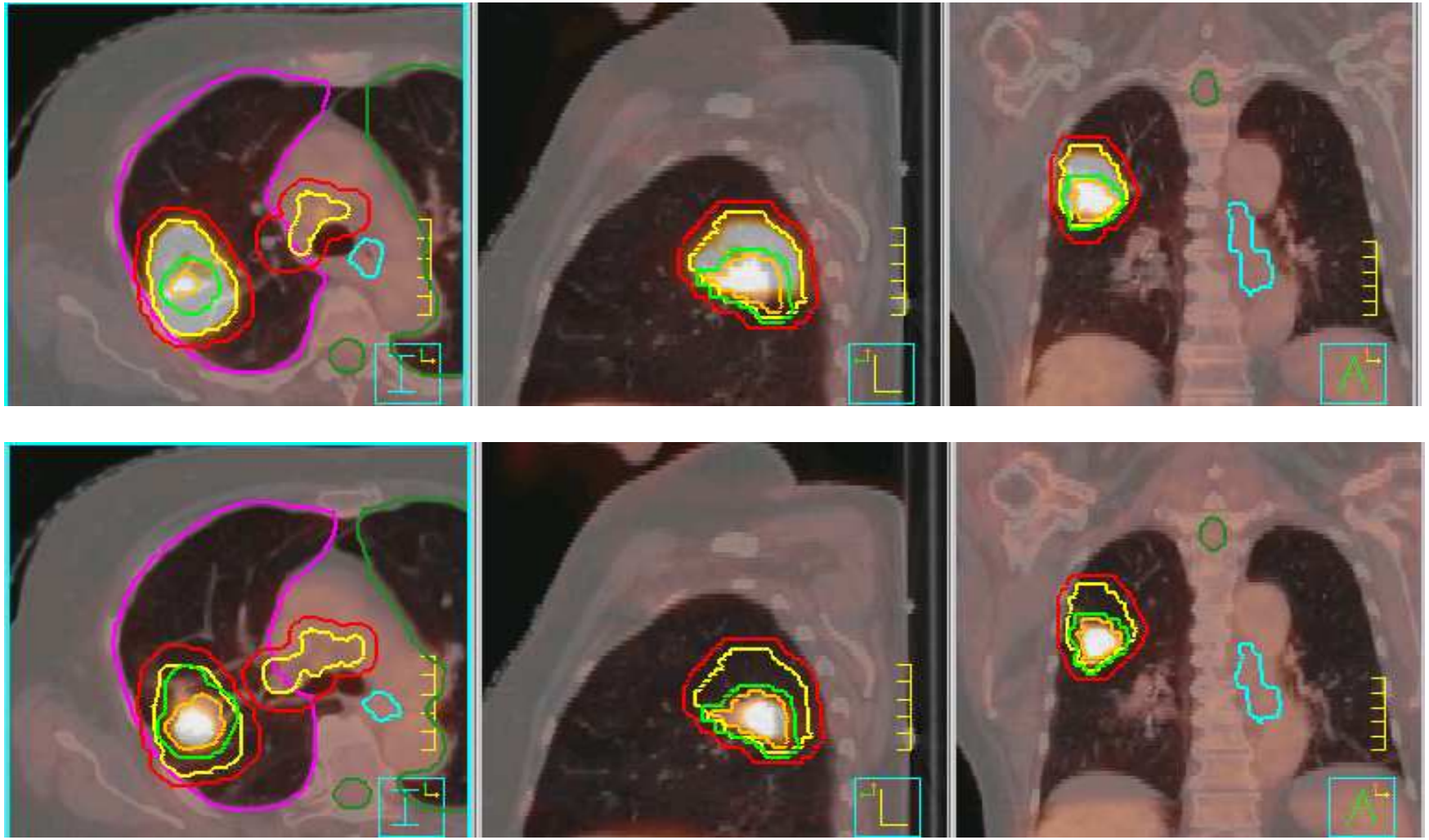
Site	Room Time			MVCT Time			Beam-On Time		
	Average	Min	Max	Average	Min	Max	Average	Min	Max
H-N	26,2	13	53	3,2	1,4	6,7	8	3,4	14
Thorax	35	23	50	3,5	2,5	6,2	11	7,6	15,6
Prostate	23	13	40	2,3	1,3	5,3	8,2	3,2	14,8
Global Average: 25,6 ± 8,7 minutes									

PHILOSOPHY OF THE CLINICAL AND TIME MANAGEMENT

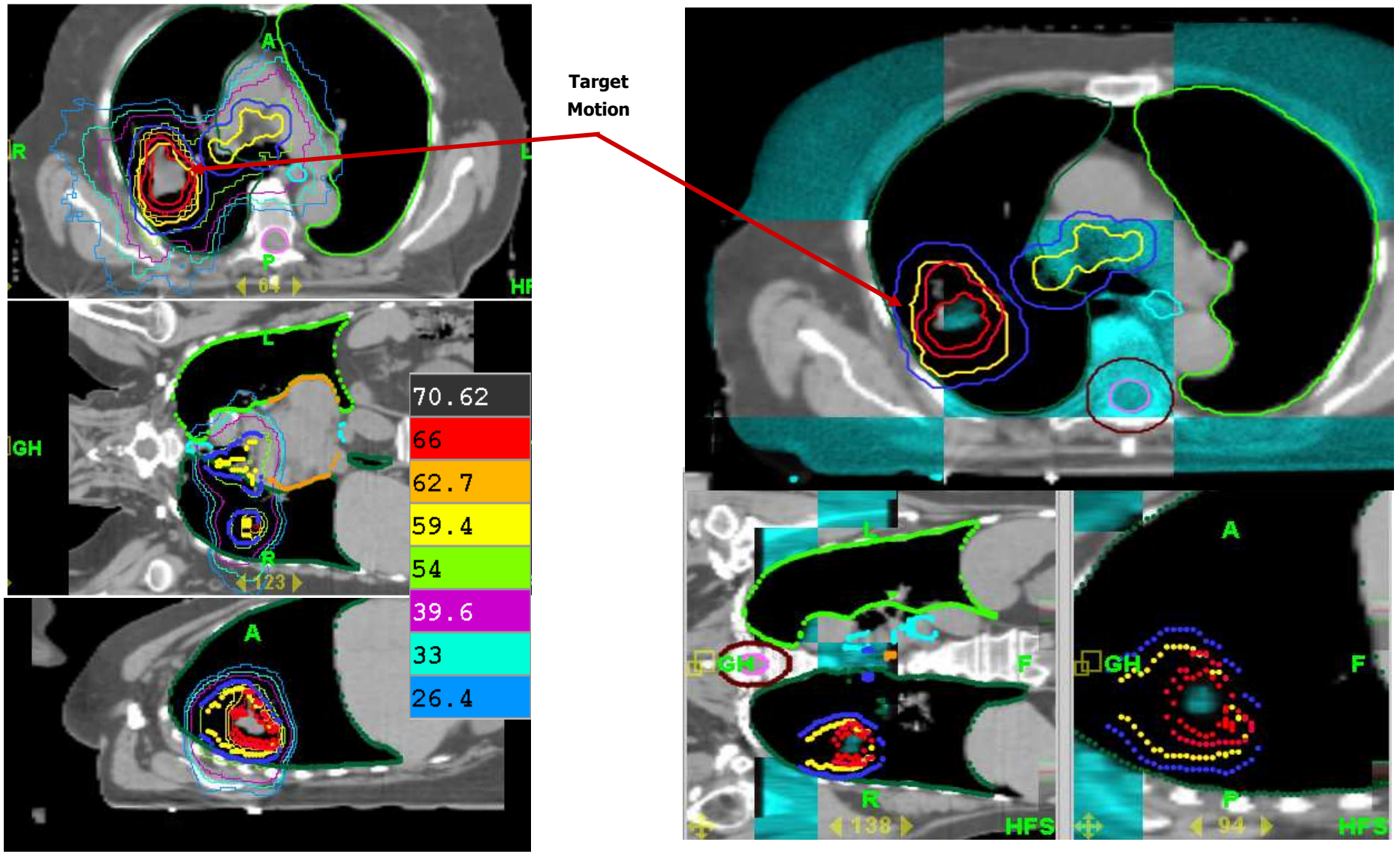
Complex cases treated at the Tomotherapy Unit…..
….Treatment time is not a must…
…Room time occupation is not a must….
…Plan must cover the clinical requirements….
… with Tomo I have to obtain something otherwise complicate at the LINACs

By G.Guidi, F.Bertoni 2008

4DCT - MOTION MANAGEMENT
4DPET - MULTI MODALITY IMAGE FUSION

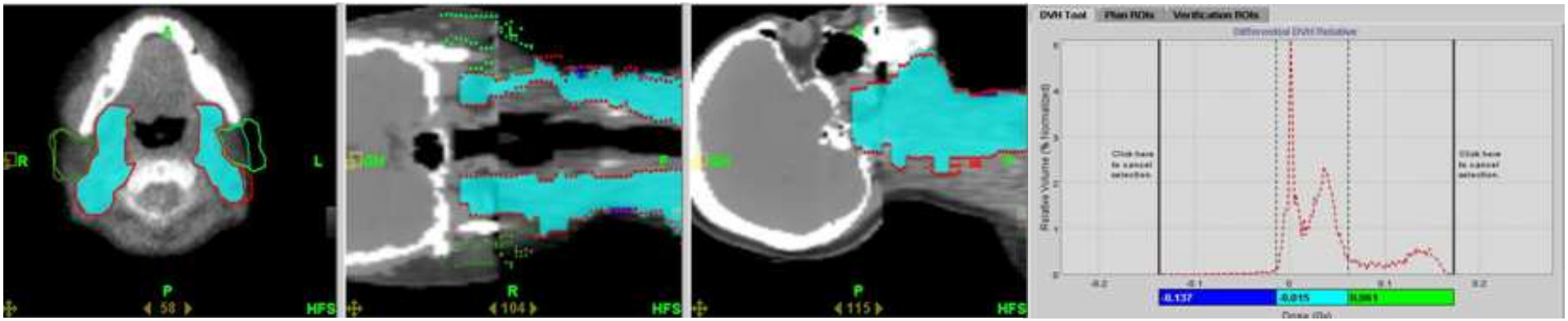


ADAPTIVE RADIATION THERAPY AND MOTION MANAGEMENT (4D-ART: RESEARCH AREA)

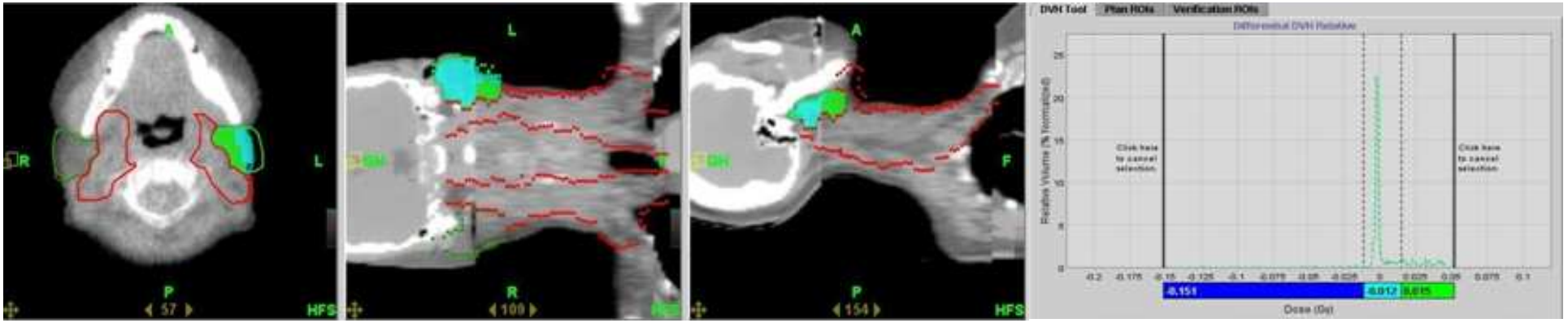


H&N ADAPTIVE CALCULATION STRATEGIES (Case I)

……During treatment, the weight loss of 11 kg has changed the anatomy…….
The dosimetric evaluation calculated for re-contoured volumes on MVCT shows…..



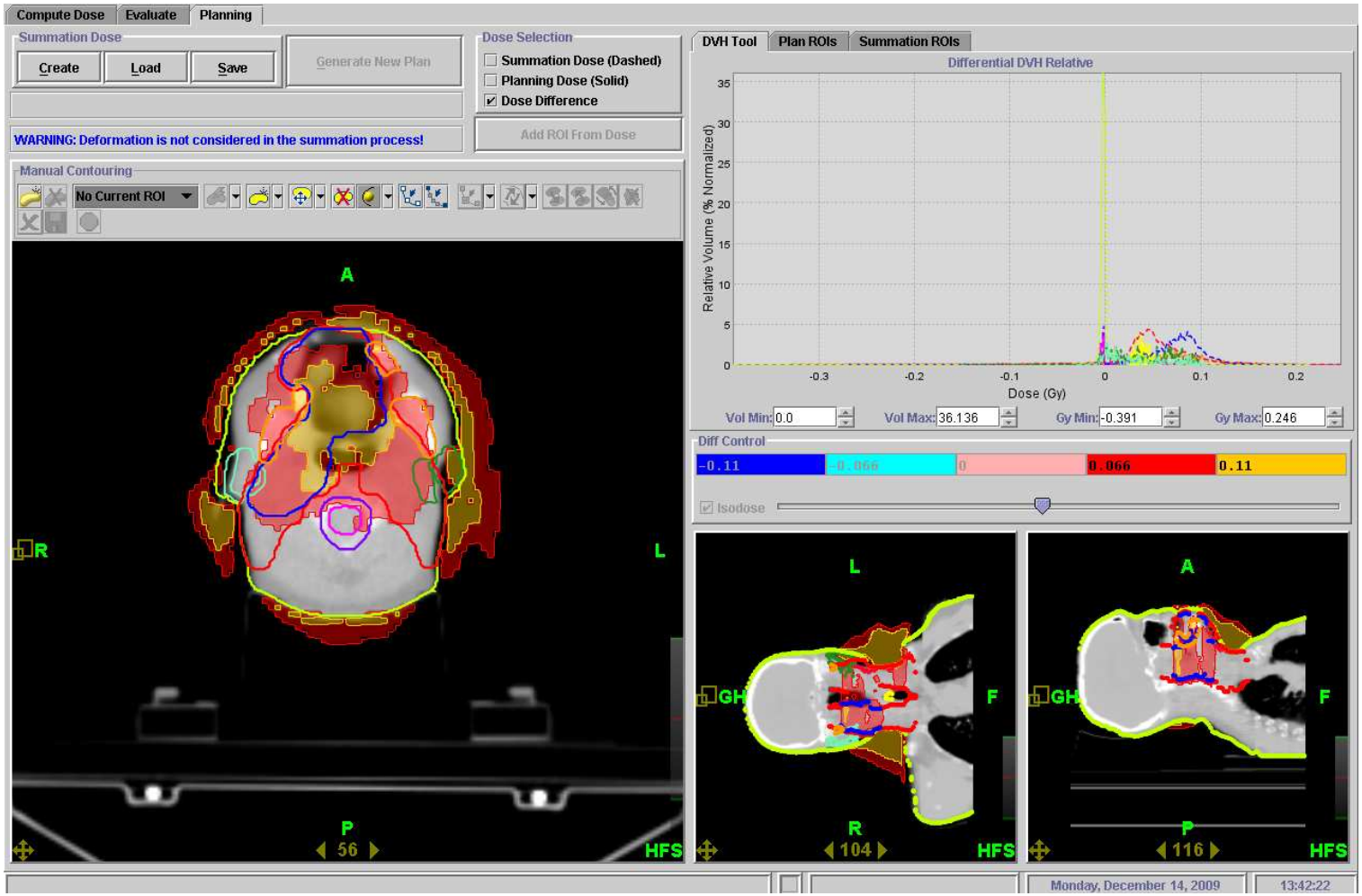
5% of PTV vol. received 0,01 Gy /F less and a maximum of 0,06 Gy /F more (~1%Vol)



20 % of left parotid gland vol. received 0,01 Gy / Fx less

H&N ADAPTIVE CALCULATION STRATEGIES (Case II)

……During treatment, the weight loss of 15 kg has changed the anatomy…….
The dosimetric evaluation shows high dose increase anywhere…
…The MVCT Daily check can guaranties the quality of the treatment changing and re-planning before any dosimetric error

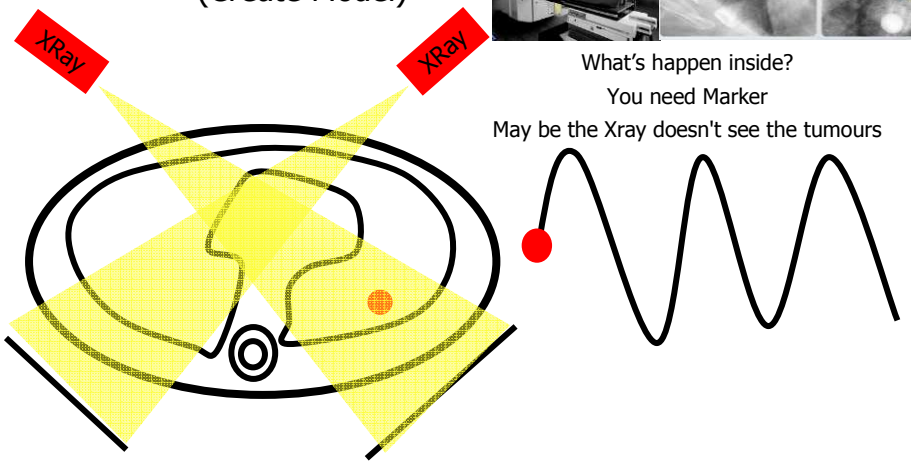


5% of PTV vol. received from 0.06 to 0,1 Gy /Fx anywhere

GATING vs. TRACKING (Breathing Model)

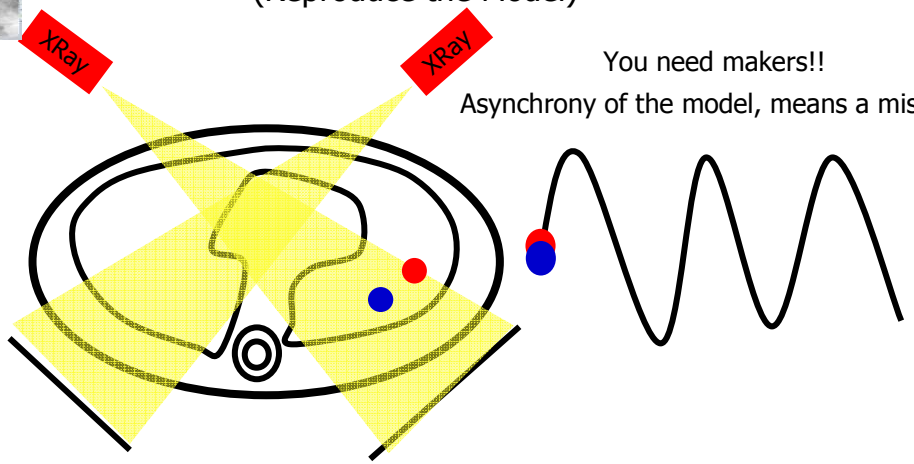
1° Point Of View
(Create Model)

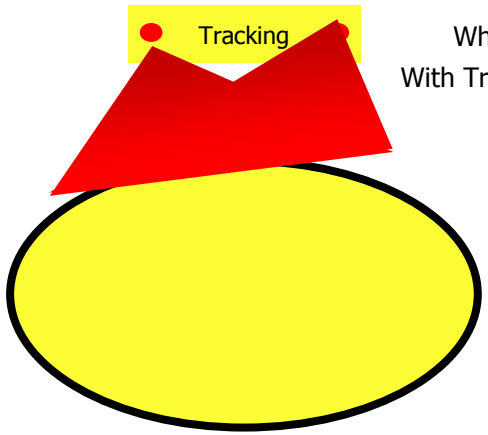
What's happen inside?
You need Marker
May be the Xray doesn't see the tumours



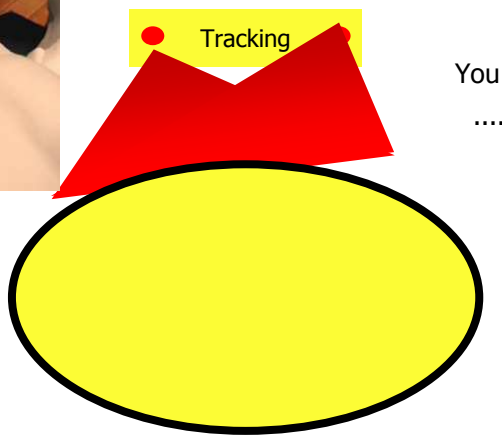
2° Point Of View
(Reproduce the Model)

You need makers!!
Asynchrony of the model, means a mistake





What's happen inside?
With Tracking, you don't know!

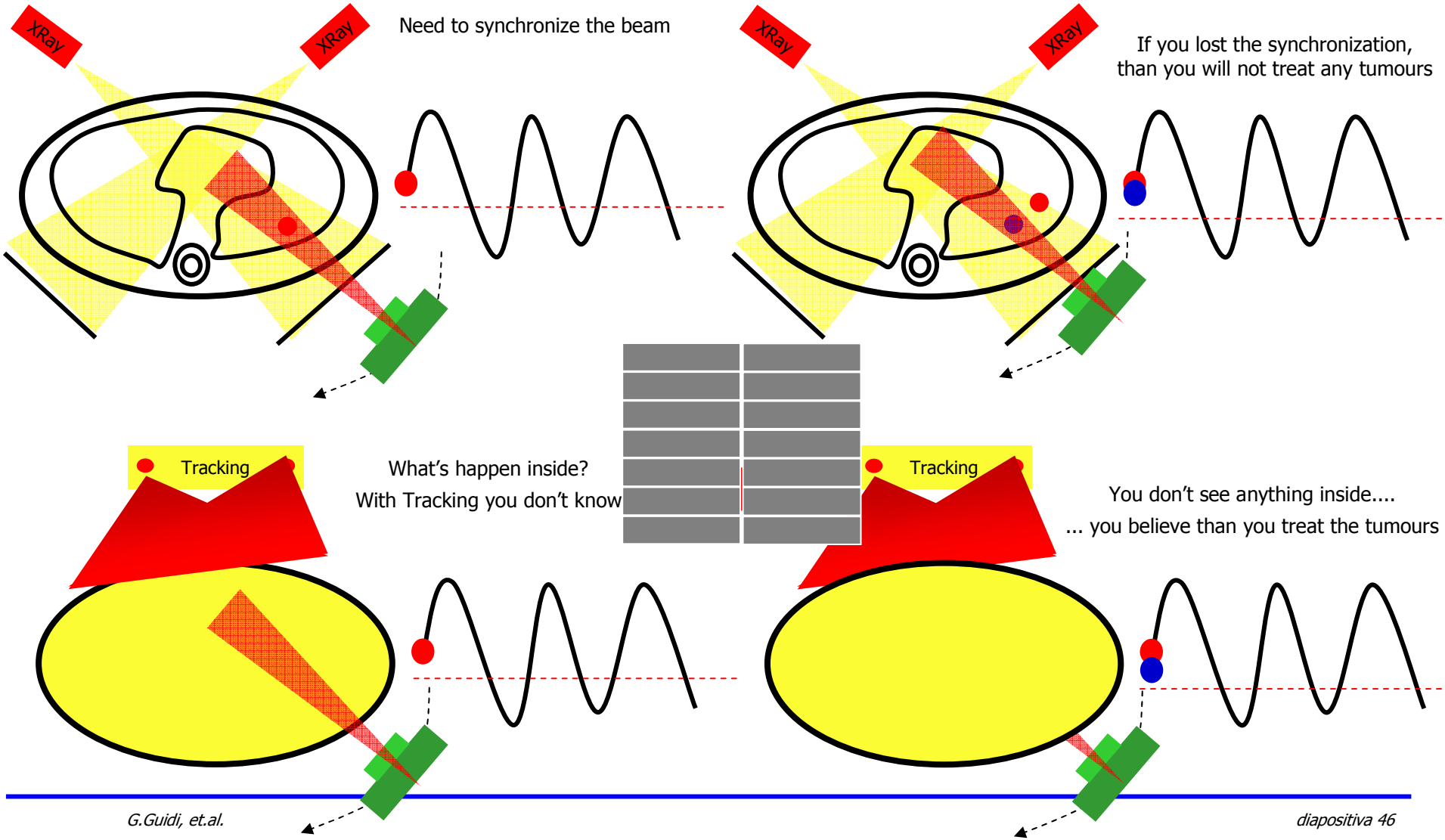


You don't see anything inside....
.....you believe in your model

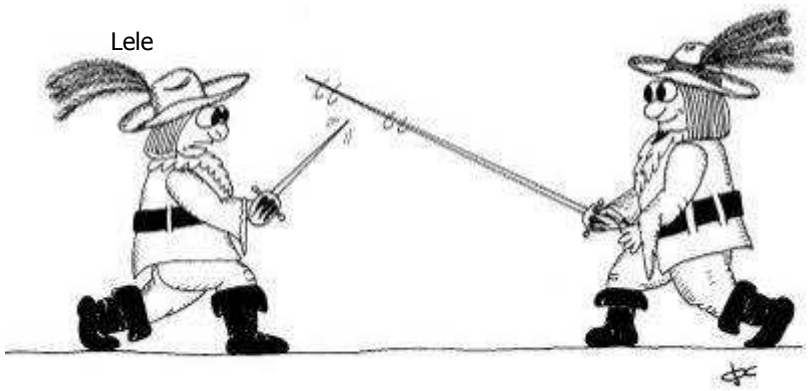
GATING VS. TRACKING
Breathing Surrogates are the worst way to treat patients

Outside Point Of View

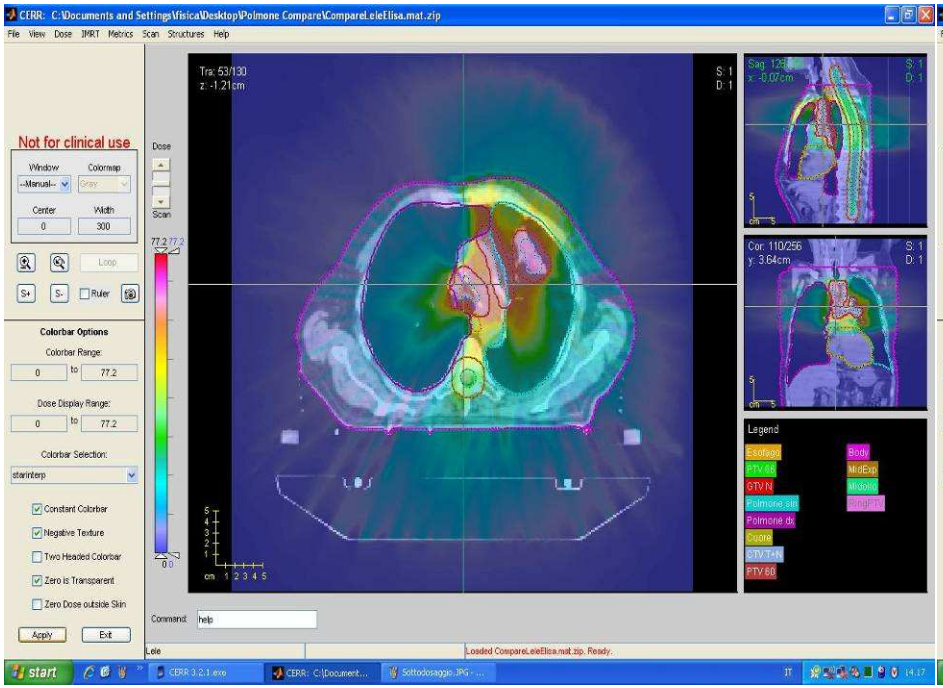
Inside Point Of View

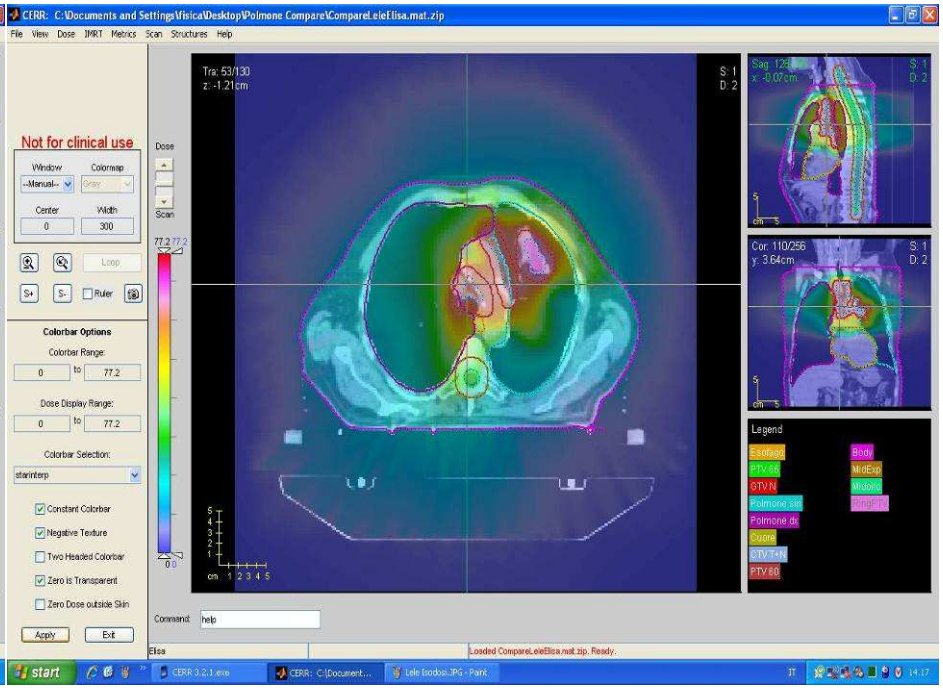


THE DUEL……

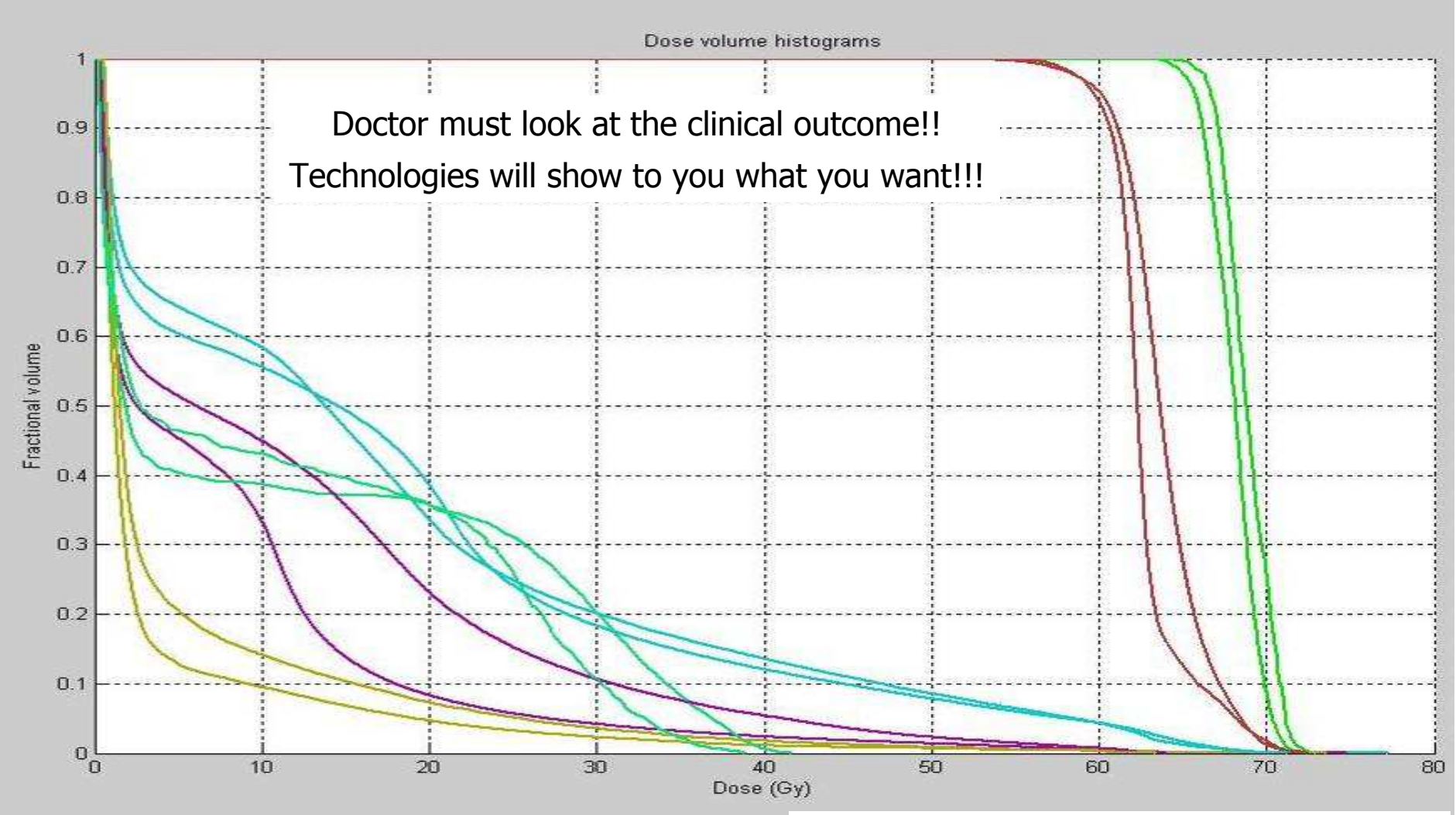


1. Same Patients
2. Same Doctor
3. Same Contours
4. Same Constrains
5. Same Target Objectives
6. Different Point of View
7. Which is the best plan?





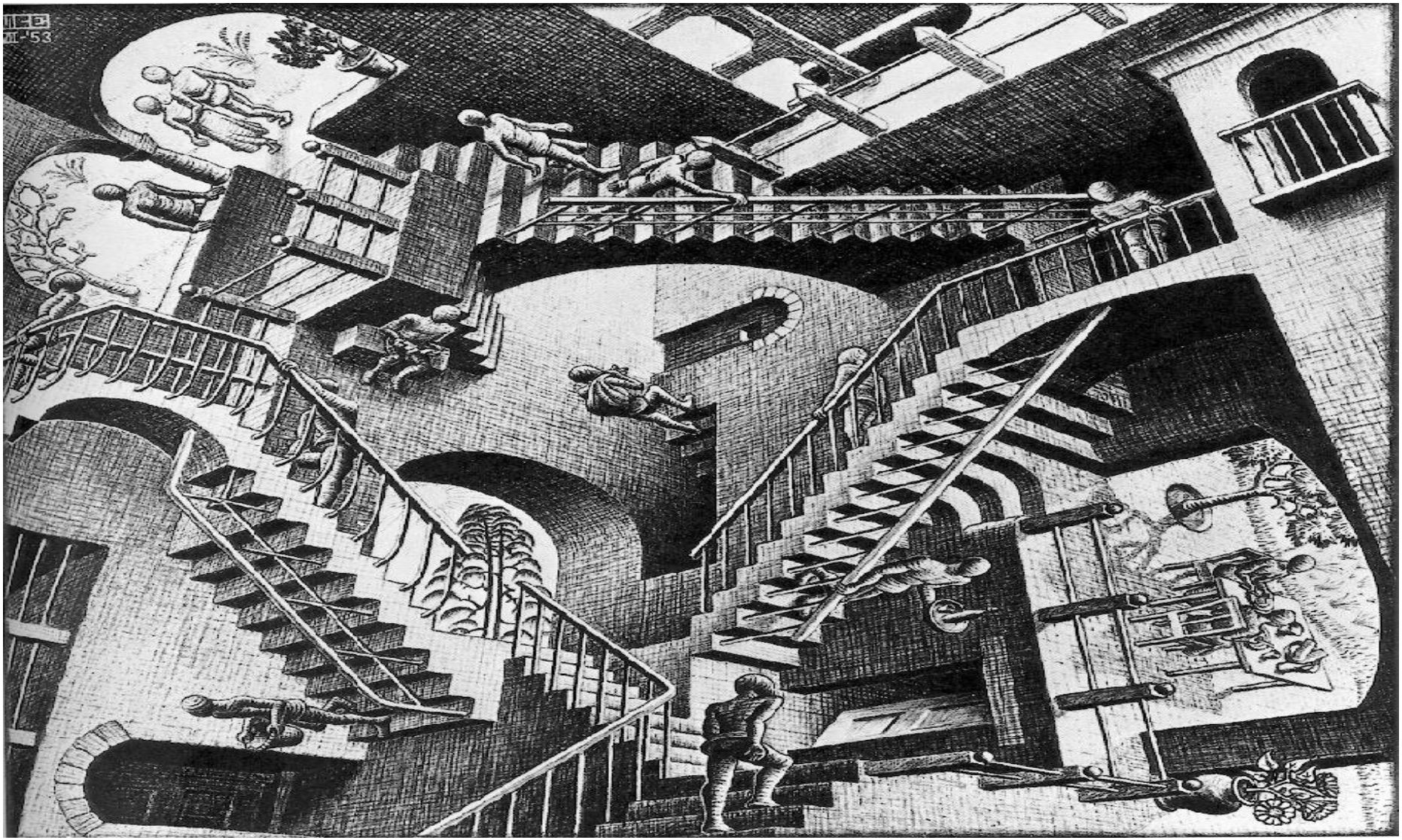
DVHs COMPARISON (AHHGGGG!!!!.....)



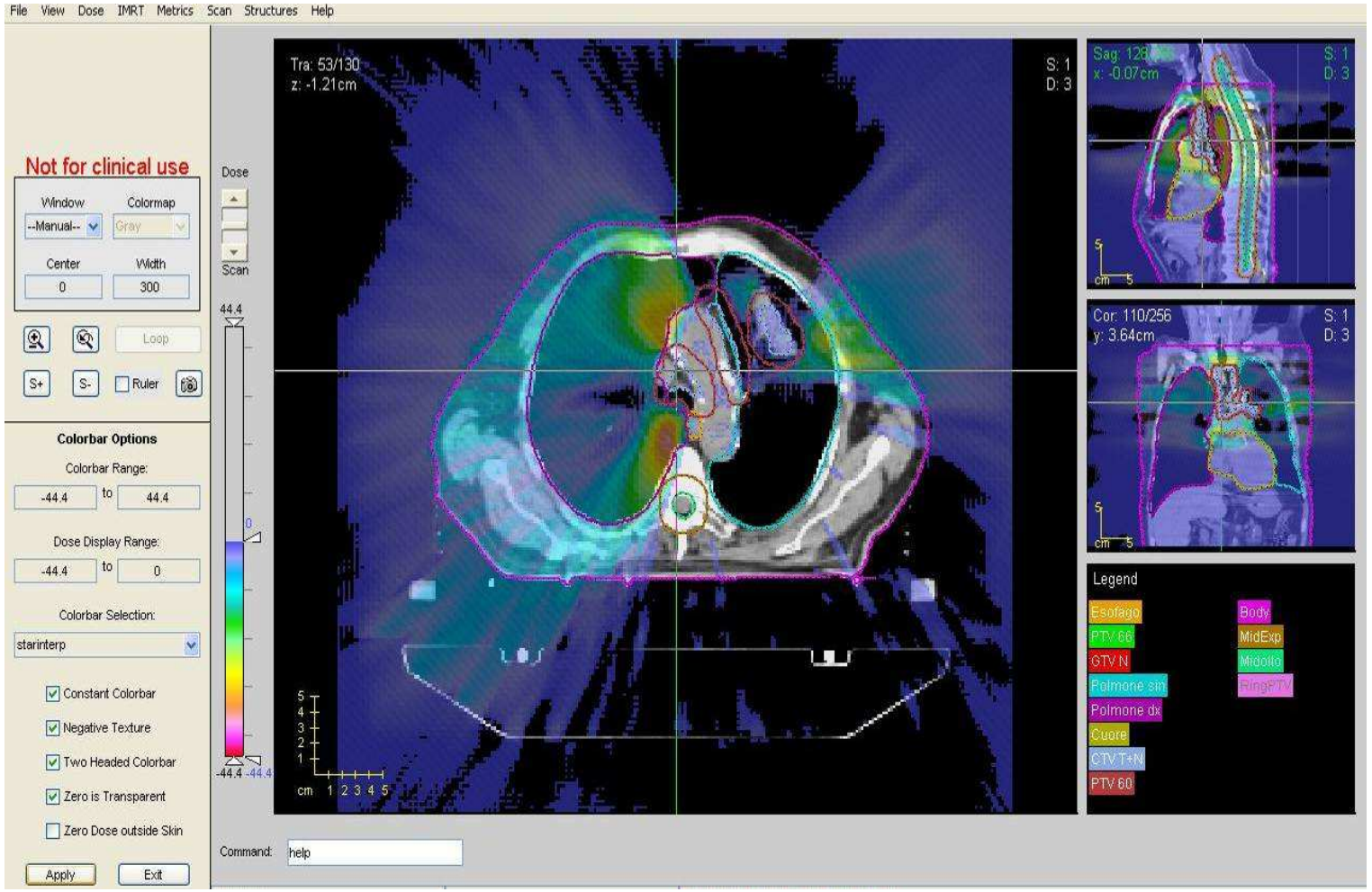
May be, compare DVH is not the best way to compare technologies...

....and for sure is not the right way to compare the clinical outcome

ESCHER : DIFFERENT POINT OF VIEW



OVERDOSED – UNDERDOSED (LOW DOSE LEVEL)



Objectives (1°PoV)

- Save Healthy Lung
- Minimize Integral Dose
- OARs Objectives
- Treat Target

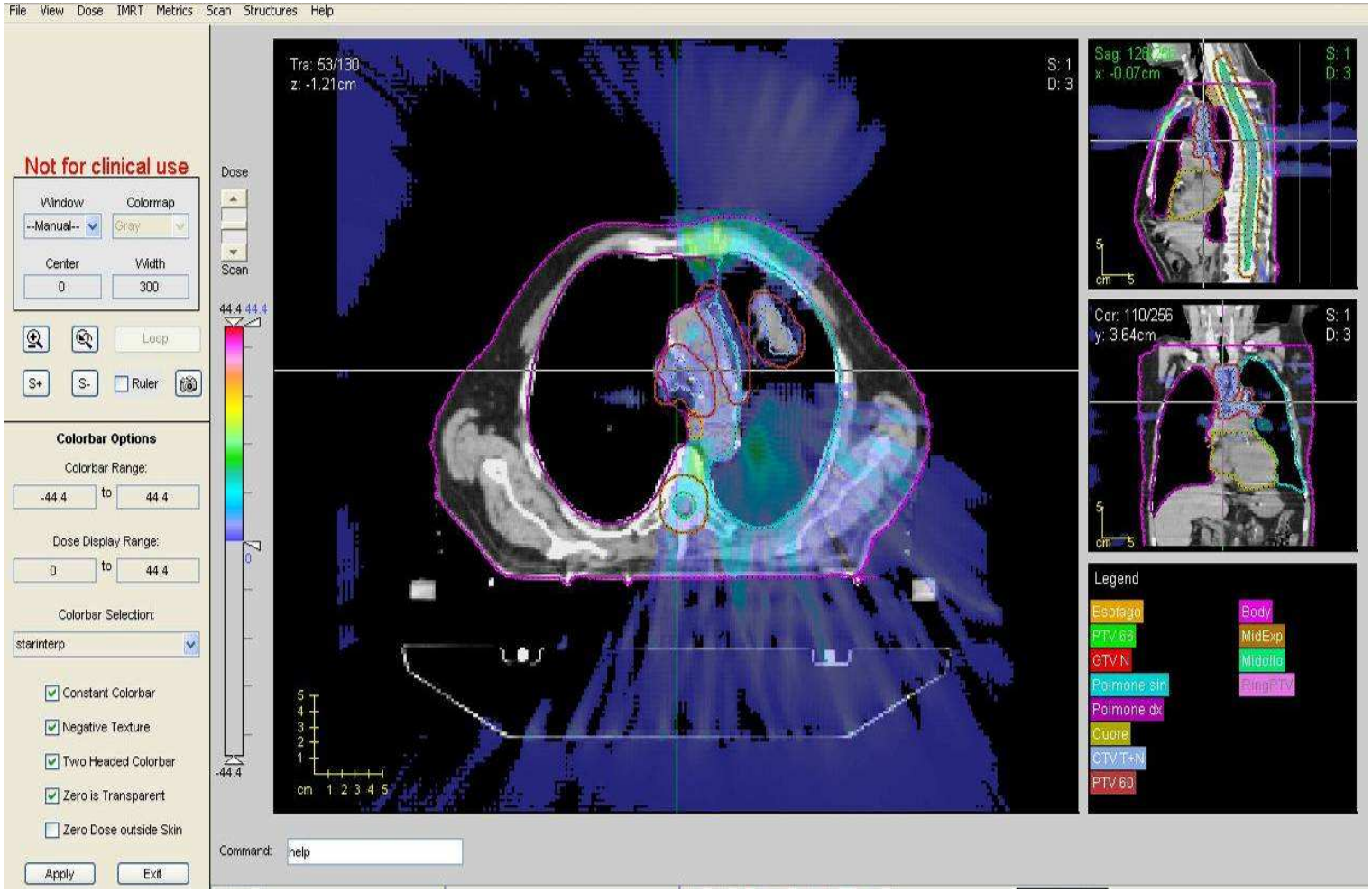
Objectives (2°PoV)

- Target Objectives
- OARs Objectives
- Save Healthy Lung
- Minimize Integral Dose

Lung Dx: Overdosed

Target: Underdosed

OVERDOSED – UNDERDOSED (HIGH DOSE LEVELS)



Objectives (1°PoV)

- Save Healthy Lung
- Minimize Integral Dose
- OARs Objectives
- Treat Target

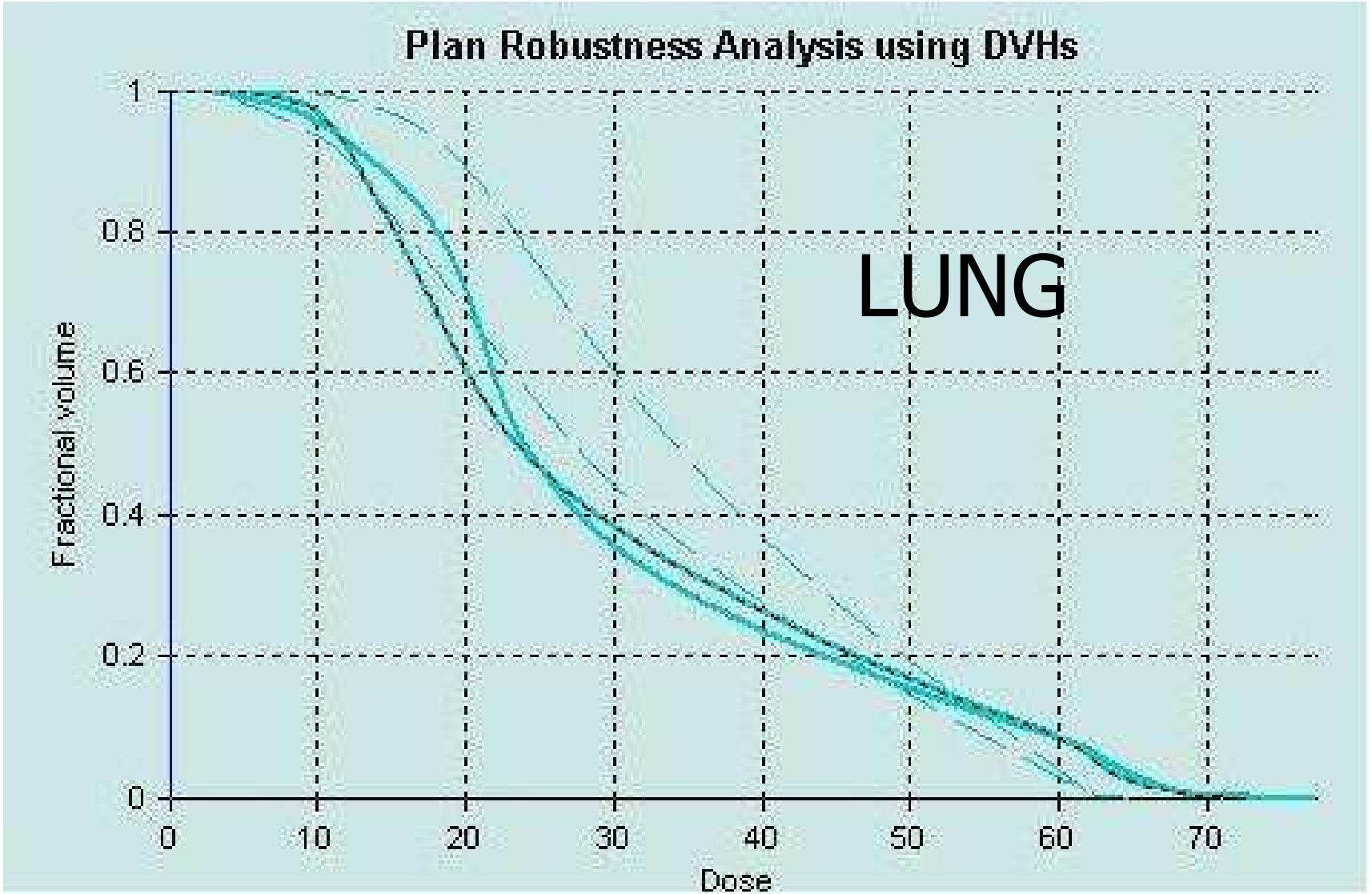
Objectives (2°PoV)

- Target Objectives
- OARs Objectives
- Save Healthy Lung
- Minimize Integral Dose

Lung Sin: Overdosed

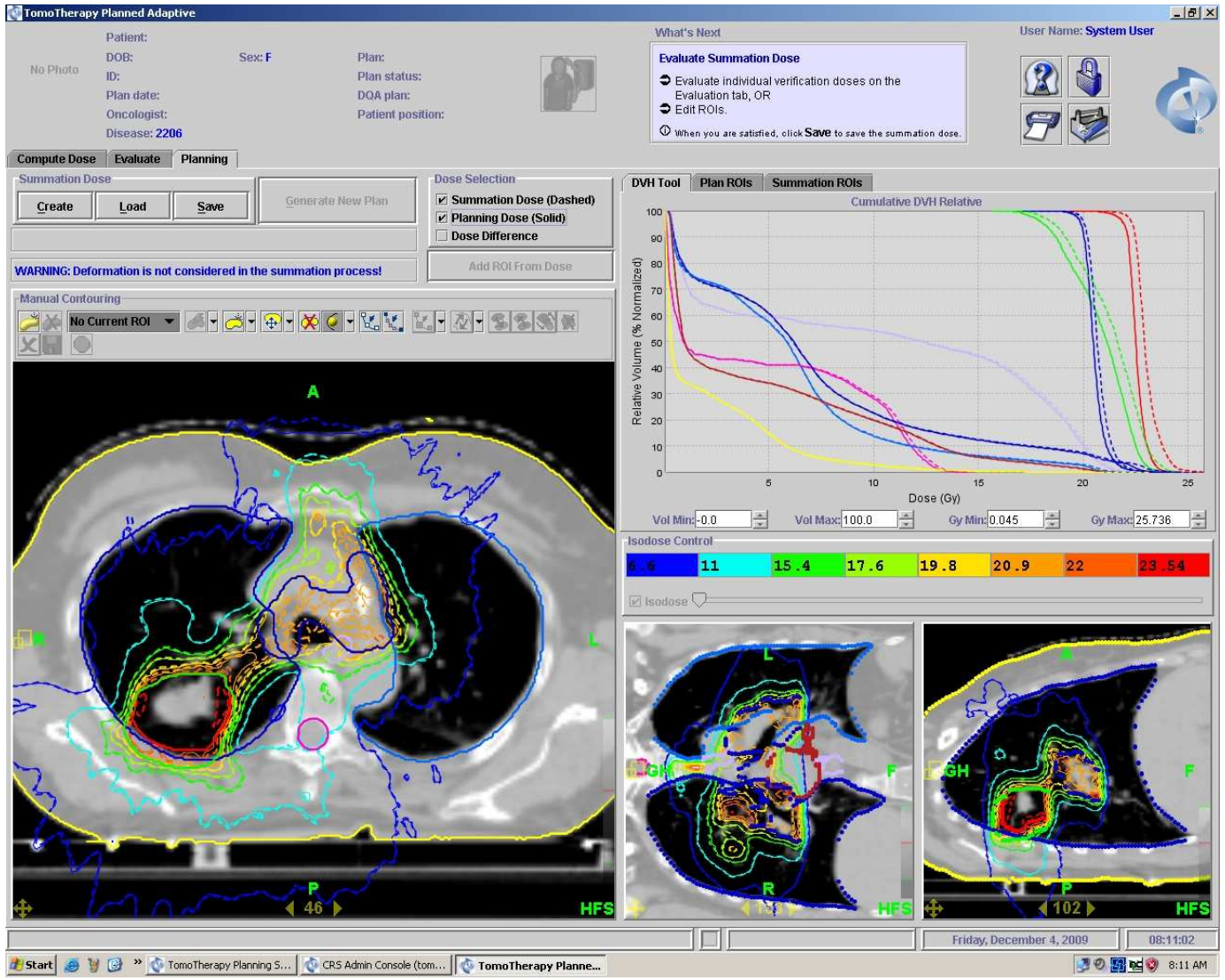
Target: Underdosed

PATIENT SYSTEMATIC & RANDOM SETUP ERROR EFFECT (2mm of shift close to the tumours)



LUNG ADAPTIVE DOSE CALCULATION

(… NOT EVERYTHING IS PERFECT…)

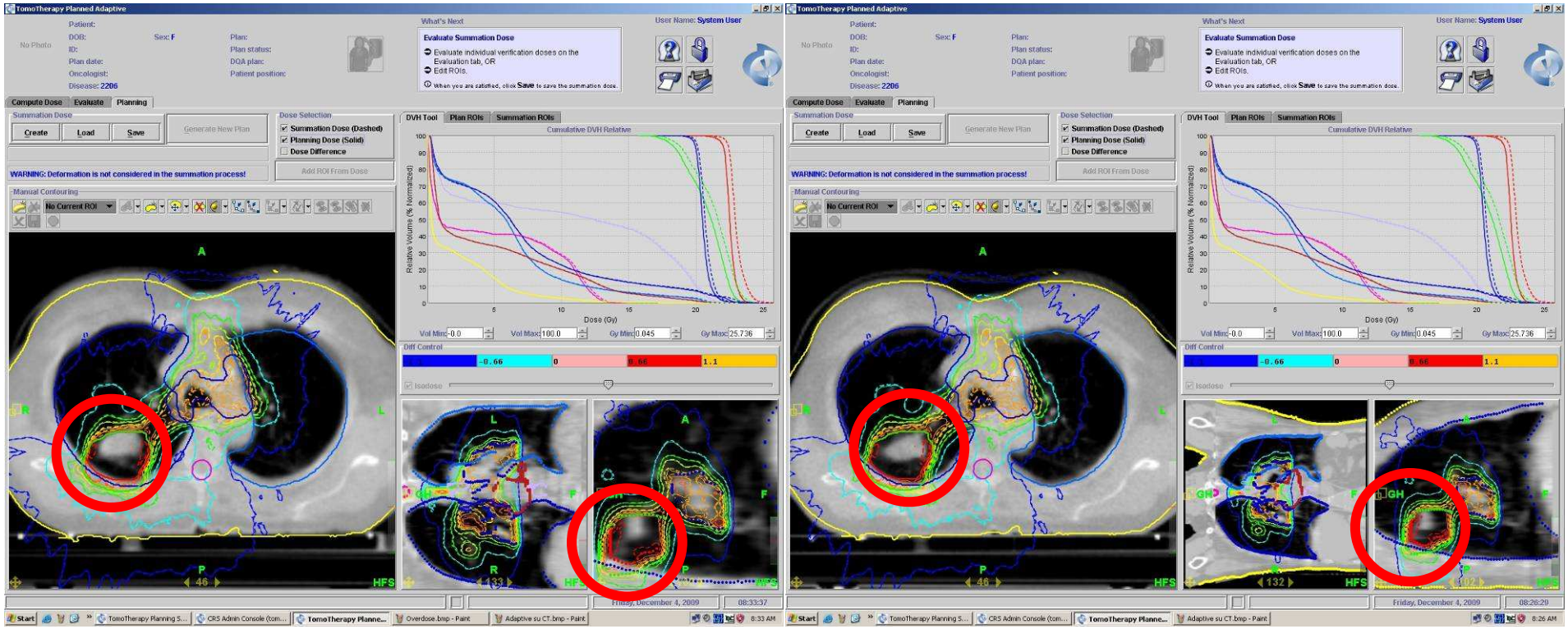


ISSUE UNDER INVESTIGATION:

1. Dosimetric error due to the algorithm?
2. Target delineation
3. Target Movement (Intra/Inter fraction)
4. Dose Lung Estimation
5. Dose at the interface (Bone/Lung/Fat)
6. Volume effect (image down sampling)
7. MVCT vs. kVCT
8. Treatment Dose Output
9. Plan Optimization and Parameters?
10. Operators
    - Doctor
    - Physicist
    - Therapist

… but the patient can have daily dose check of the dose delivered and the plan can be optimized during the cycle…

MVCT1 vs. MVCT2



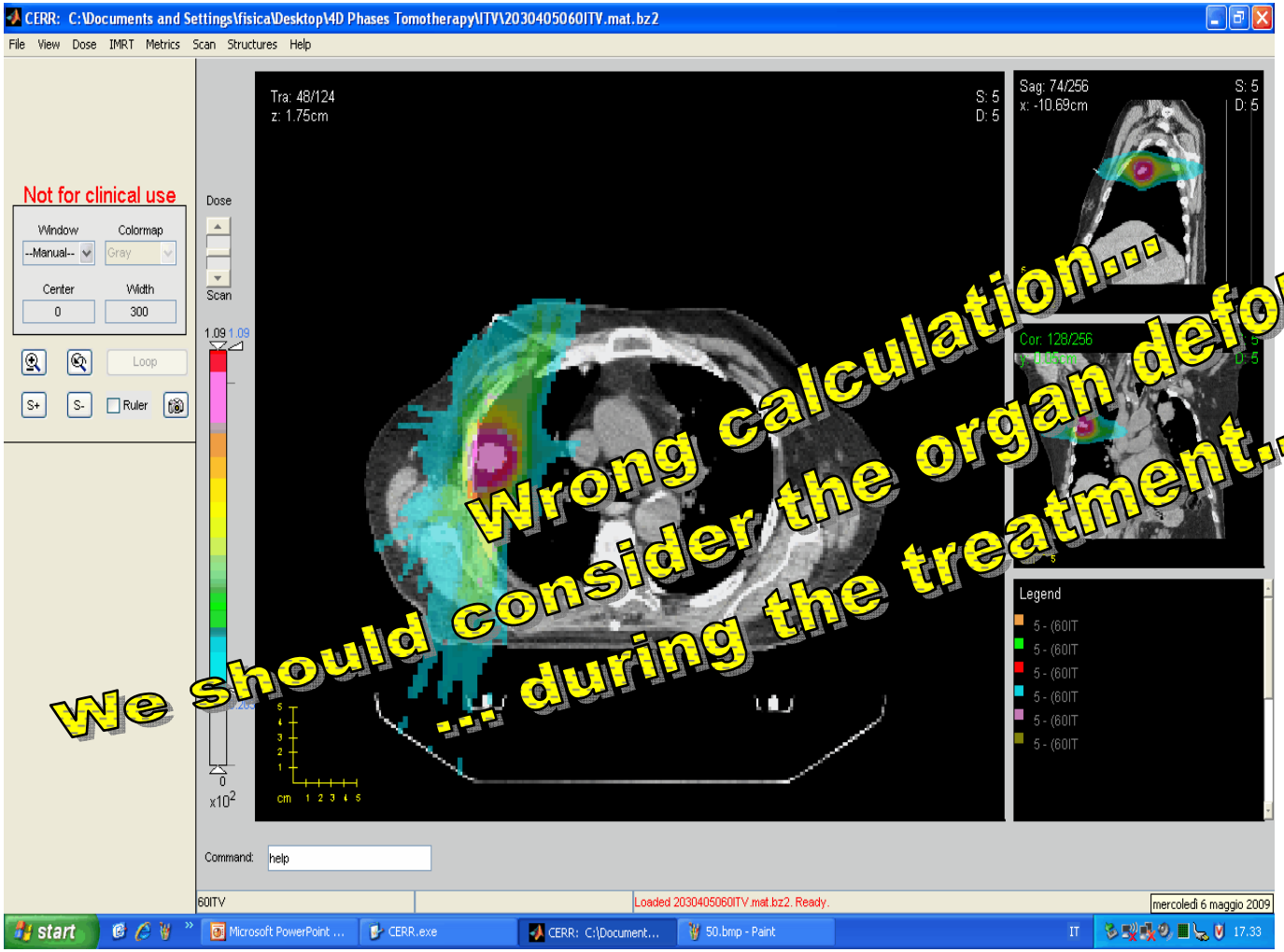
- Different target dimension?

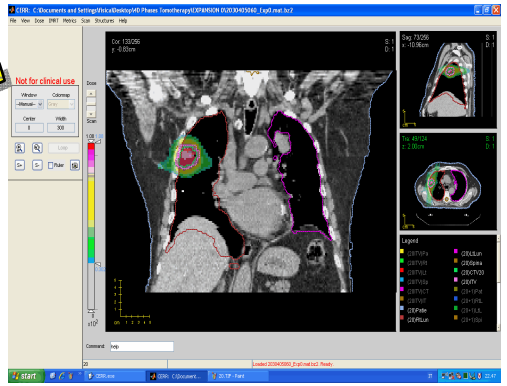
- Is Day1 vs. Day2? (Interfraction)
- Is Time1 vs. Time2 (Intrafraction)
- Is the tumor shrinkage ?
- Is the duty cycle? (Breathing)
- Different dose calculation ?
  - Where? In tumour or OAR?

1. Change the dose due to the OARs or Tumour position?
2. Isn't it during the respiration breathing?
3. Why should i do a MVCT before and after the treatment?
4. Why should I believe at the MVCT of multiple days?
5. Is important the Volume effect for goals of the entire treatment?

… may be the best way to care the patient, is check every day using a easy way

ORGAN MOVEMENT INFLUENCES & 4D-DOSE ACCUMULATION (RESEARCH AREA)



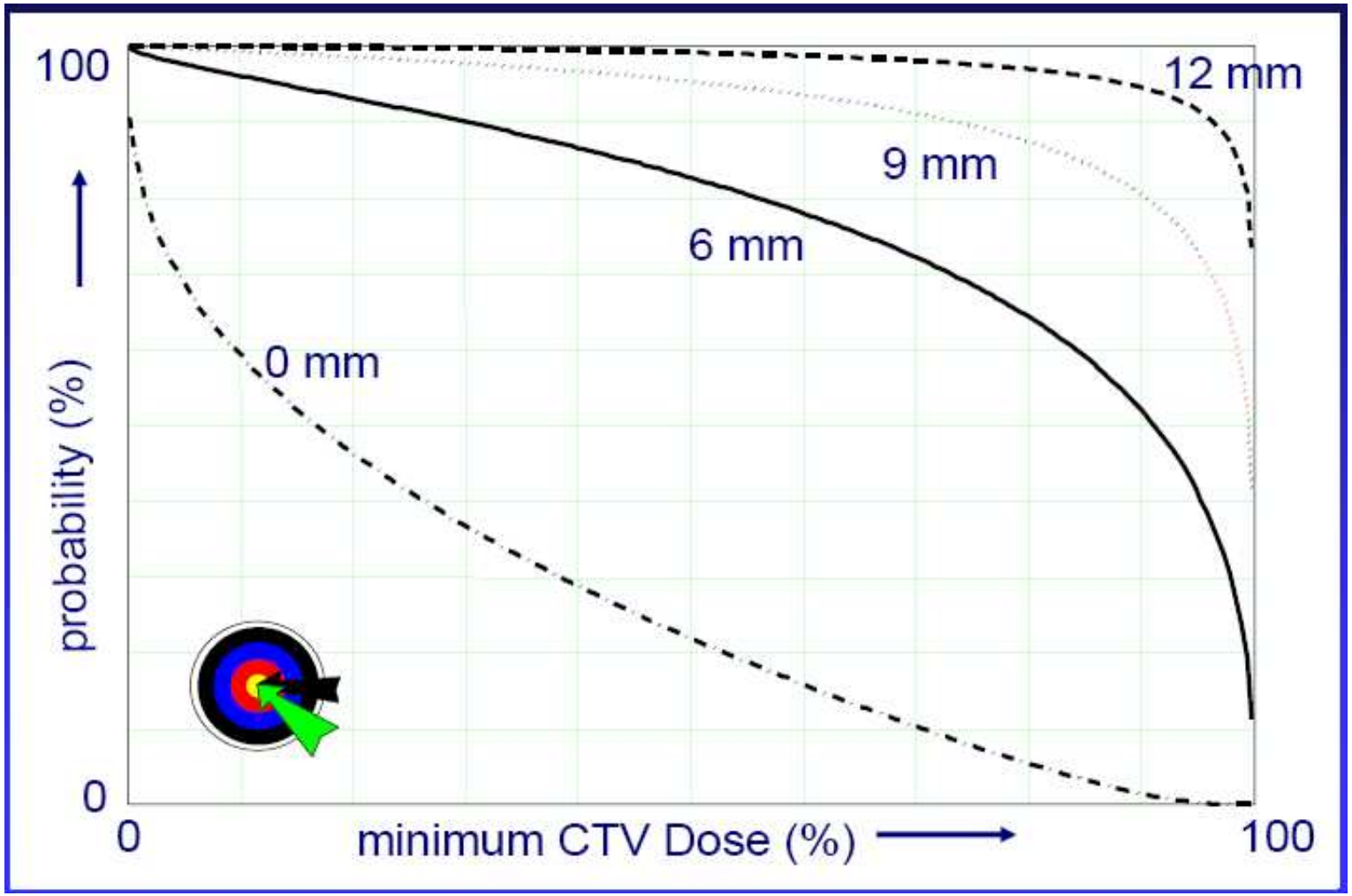


Dose Matrix (Phase 20%) +
Dose Matrix (Phase 30%) +
Dose Matrix (Phase 40%) +
Dose Matrix (Phase 50%) +
Dose Matrix (Phase 60%) +

4D Dose Reconstruction

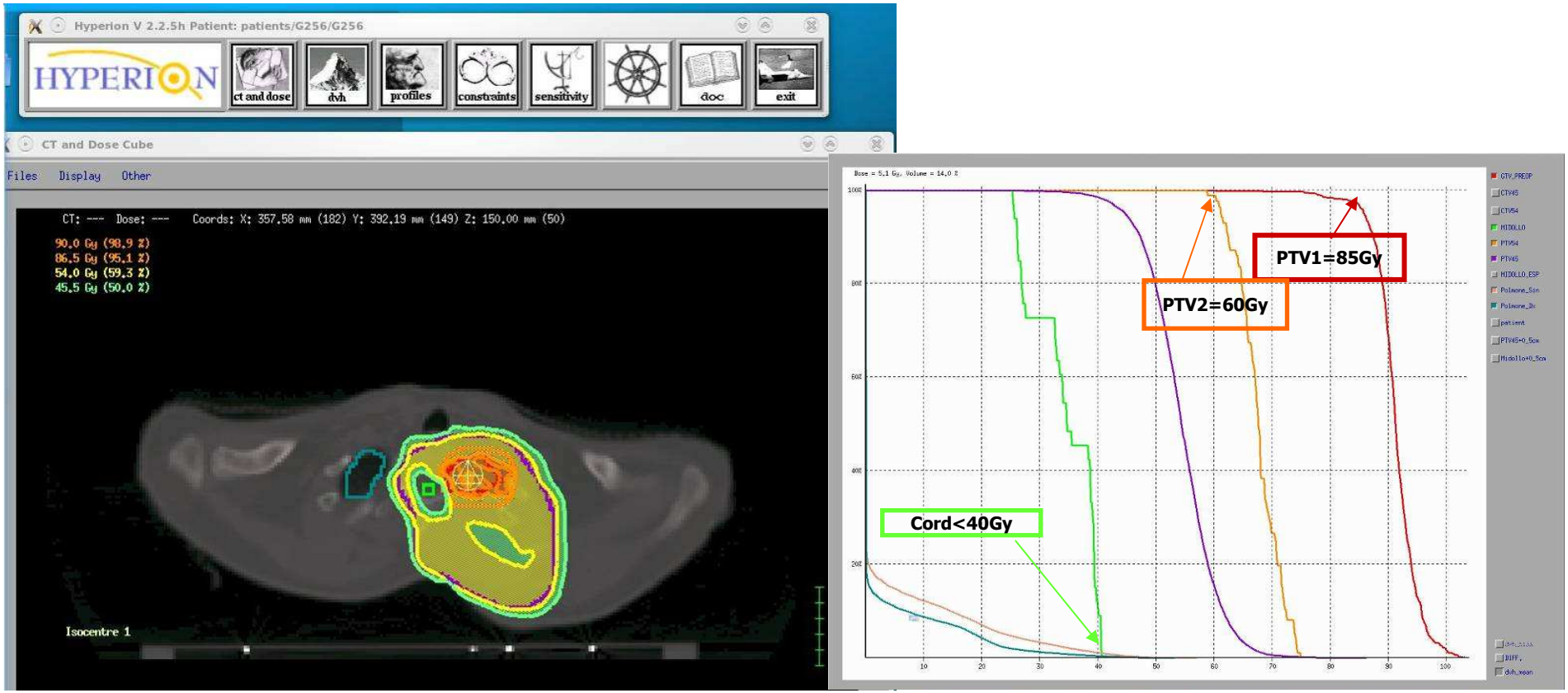
- 4D DOSE RECONSTRUCTION OF THE RESPIRATORY PHASES
- The Dose accumulation must include the organs deformation.... ADAPTIVE is not correct!!
- DVH is a Dose "reconstruction" of the Volume... DVH is not a clinical outcome!!

CAN I REDUCE THE MARGIN ?
(WITH TOMOTHERAPY FOR US IS LIMITED AND UNDER INVESTIGATION)



Courtesy of Marcel van Herk – ESTRO 2009

PROTON - THERAPY ..... (Proton-Tomo?)



Simulation of Protons Treatment with multiple gantry angles between -20 to 120°(by G.Guidi 2009)

Few questions in my mind.....may be I need to change my mind!!!
...are we sure about the dose calculation? Is there any clinical impact or benefit vs. Tomotherapy with Photons
...we will try to investigate the problems comparing photon (using Tomo) and proton (collaboration with CNAO and ATrep)

I hope, one day, to work with Protons (by G.Guidi 2010)

TAKE HOME MESSAGES

- Tomotherapy
  - Innovative machine
  - Faster and relatively easily to implement
  - Flexible for clinical routine and requirements
  - Easy way to treat complex cases
- Morphological area have not or few limitations
  - Target Delineation
  - Organ Movement (Interfraction – Intrafraction)
  - Organ Constrains
  - Fractionation based on Evidence Base Medicine data
- Multiple approach can be done and can be found
  - Different plan optimization parameters (Point of View)
  - Clinical objectives
  - 4D Tracking / Gating (Research area)
  - TBI and TLI (Research area)
- Doesn't exist a best plan or a best machine
  - DVH is not the "absolute true"
  - Plan can not be robust due to the setup and organ movement (dose can change)
    - Daily patient check should be a must for the future (Setup, dose and adaptive re-plan)
  - Many issues for the physicist and physicians
    - Dose calculation
    - Algorithm
    - Adaptive strategies....
- Integral dose and prescription must be consider and evaluated
  - Woman fertility (Breast and contra lateral breast)
  - Second cancer induction
  - Paediatric patient
  - ....
  - IGRT Dose is a problem, but anyone should consider the same problem for the ARC Therapy with LINAC
- Management
  - Full optional should be a must also for Tomotherapy Inc.
  - Service out of clinical time (21.00-6.00)
  - Service full risk also for upgrade and update

It is not perfect, but it's a "good" technology to try to fight the cancer!!

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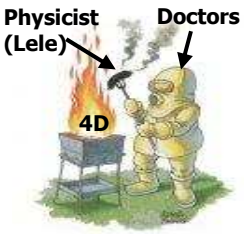
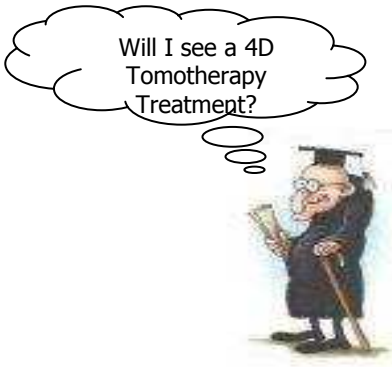
- G.Tolento
- E.Turco
- All thereapist





In my mind: "Thank you guys, without you would not been possible this!

Special Thanks to
Elisa, Luciano & Luca

"... under the "Ghirlandina" Tower....
.....new opportunities and ideas are growing ...
...and many people are working on it"

THANK YOU FOR YOUR ATTENTION AND INVITATION

"That's too much!!!"

(Praha 2009)