

# Planowanie i realizacja radioterapii: QA / IGRT

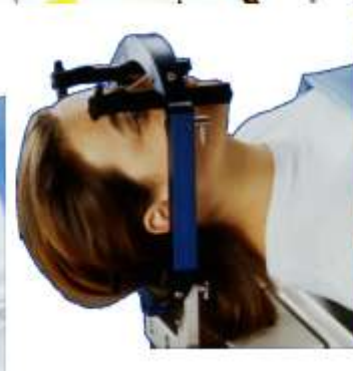
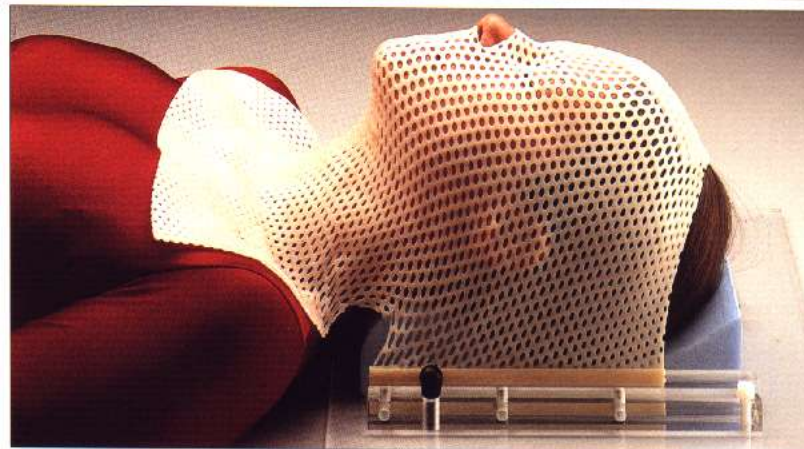
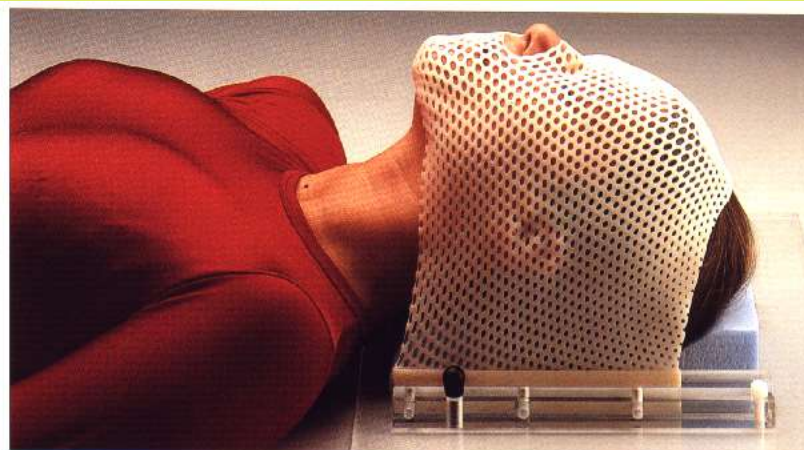
**Krzysztof Ślosarek,**  
Centrum Onkologii – Instytut MSC, Oddział Gliwice,  
Wyższa Szkoła Humanitas, Sosnowiec

# Zagadnienia

1. Systemy stabilizacji pacjenta
2. Obrazowanie dedykowane radioterapii
3. Systemy planowania leczenia, algorytmy
4. Techniki napromieniania
5. Systemy komputerowe administrujące ruchem chorych
6. Aparaty terapeutyczne
7. Weryfikacja dawki w czasie prowadzonej terapii
8. Weryfikacja graficzna prowadzonej terapii

# Systemy stabilizacji pacjenta w czasie seansu napromieniania

## Unieruchamianie chorego w czasie leczenia





# Systemy stabilizacji



# TT treatment



# Obrazowanie dedykowane radioterapii



Resp 5.0 B30f 100% In (100% 198bpm)  
Centrum Onkologii - Instytut Gliwice  
Sensation Open  
12-May-2008 11:58:14  
CT

A GT 0.0  
KV 120  
mA 80  
LD WX 0.84x0.84x1.17  
LD 256x256x178 [12 bit]  
SL 5  
SP 5  
PX 0.84  
512x512x60 [12 bit]



WW 990  
C -391

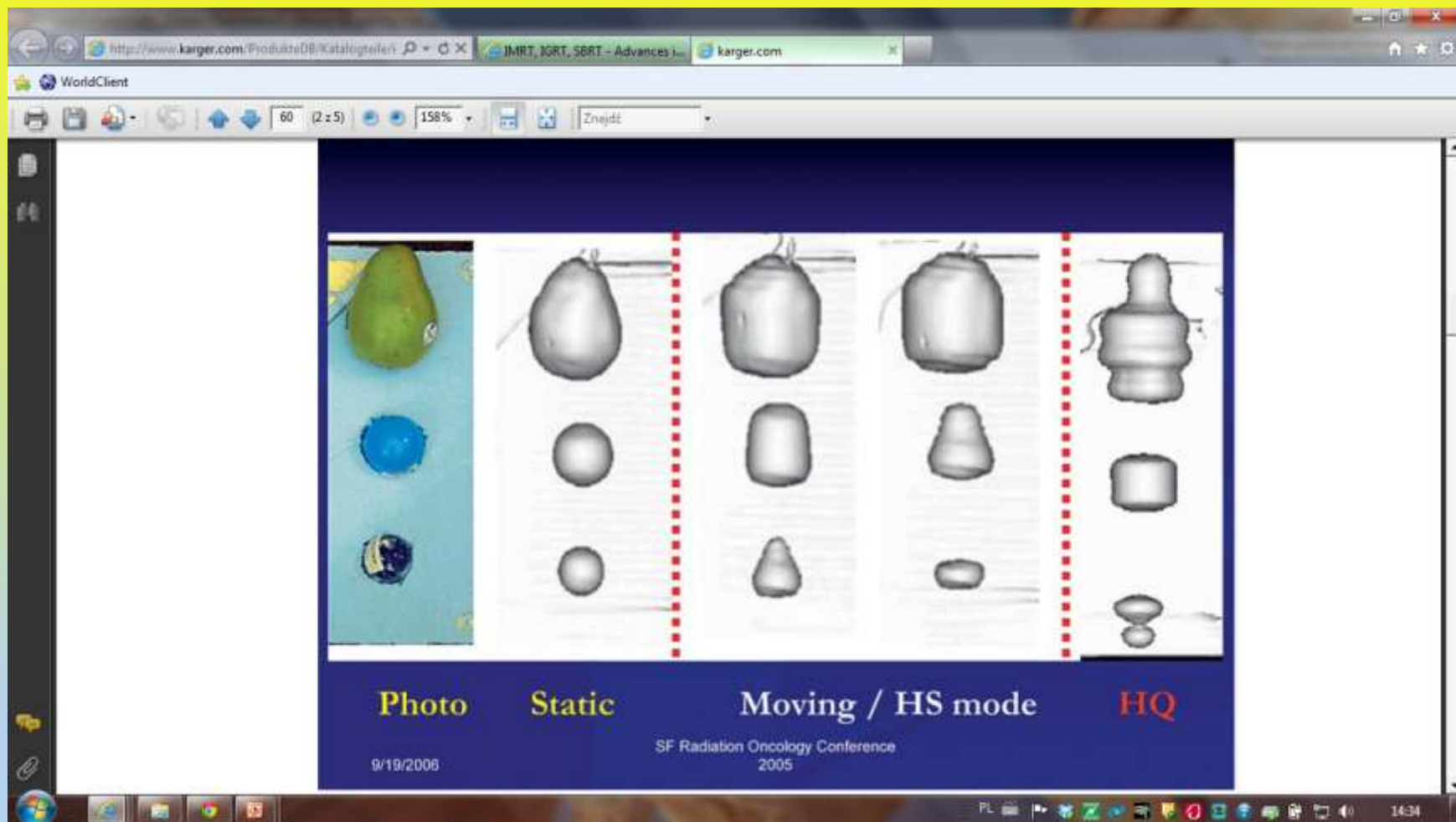
Resp 5.0 B30f 100% In (100% 198bpm)  
Centrum Onkologii - Instytut Gliwice  
Sensation Open  
12-May-2008 11:58:16  
CT

P A GT 0.0  
KV 120  
mA 80  
LD WX 0.84x0.84x1.19  
LD 256x256x181 [12 bit]  
SL 5  
SP 5  
PX 0.84  
512x512x61 [12 bit]



WW 990  
C -391

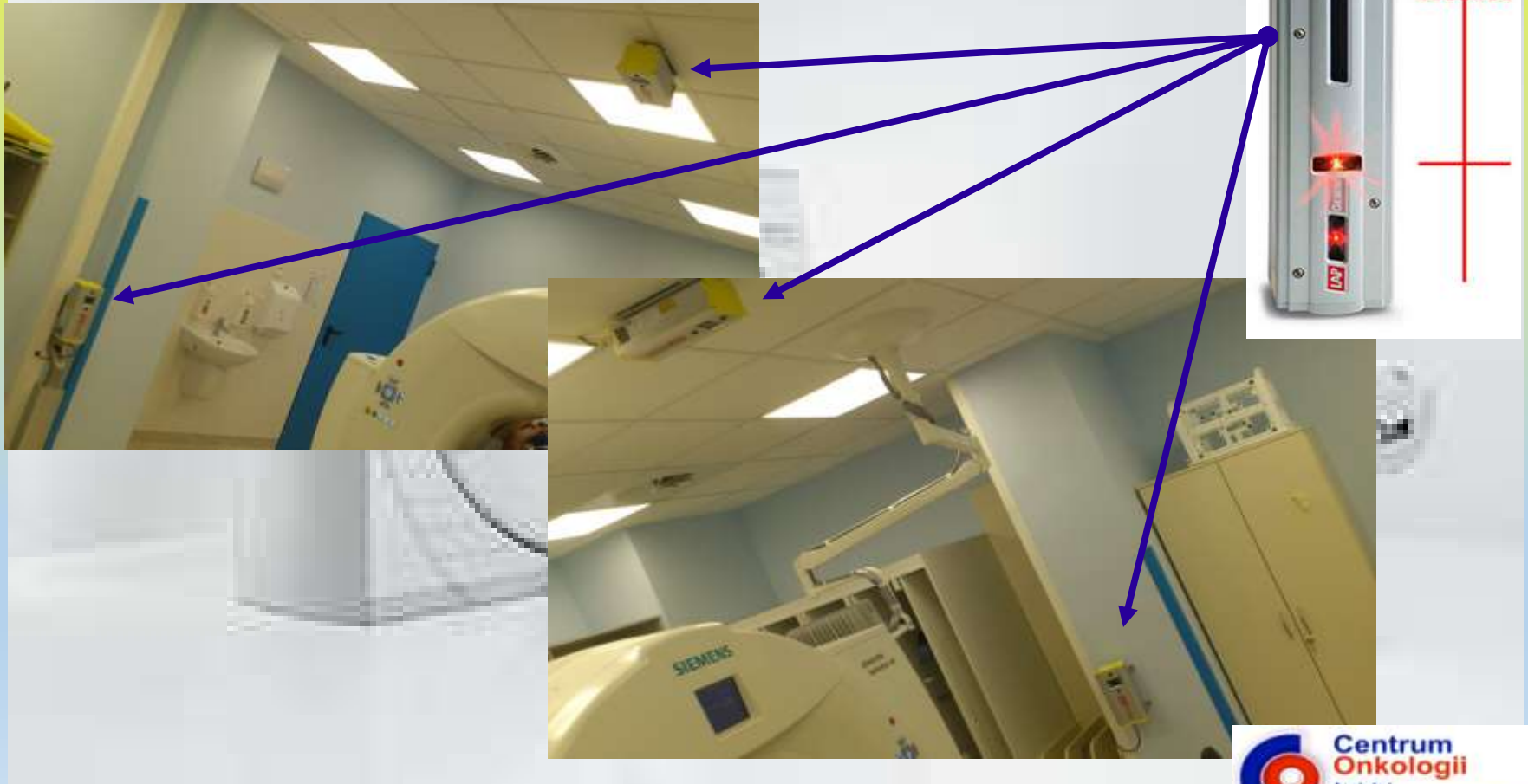


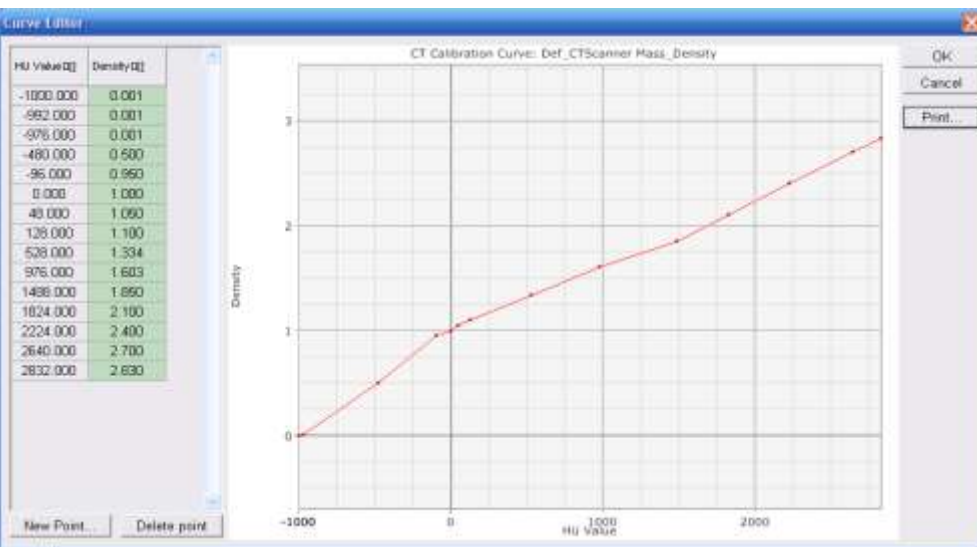
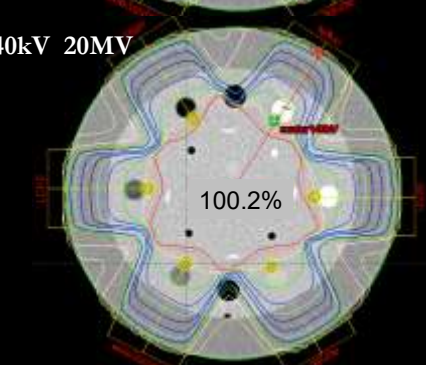
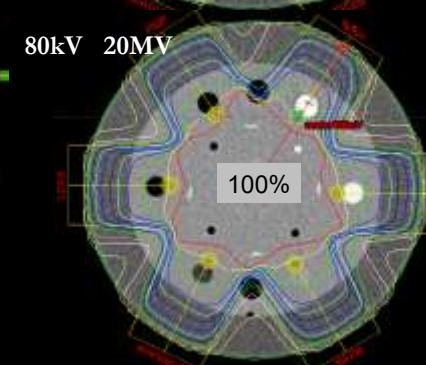
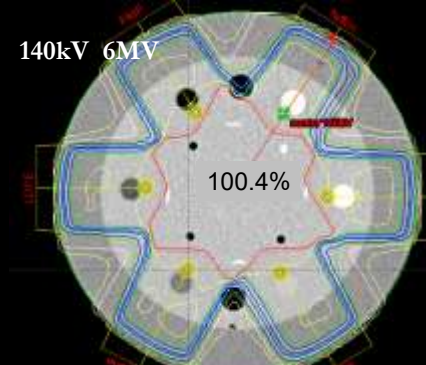
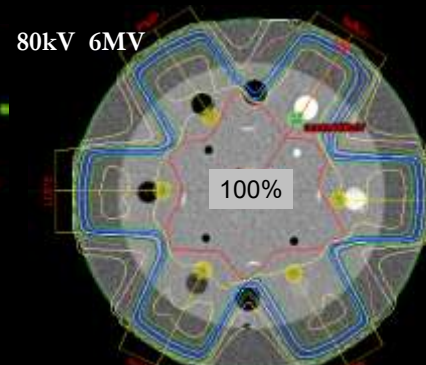
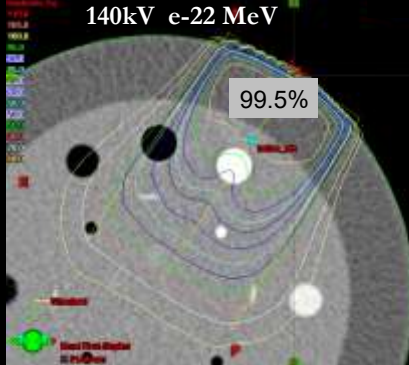
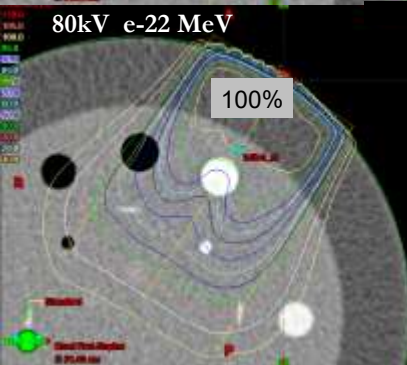
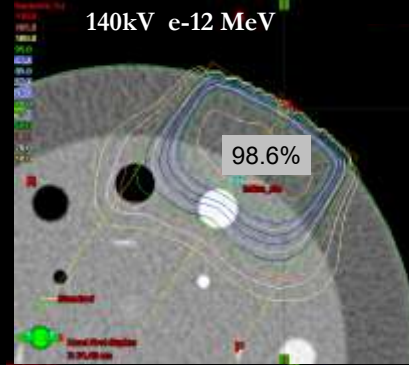
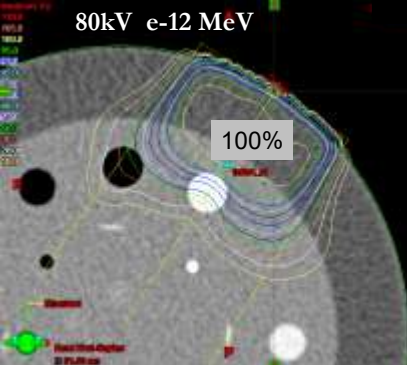




# Imaging procedures – laser's set

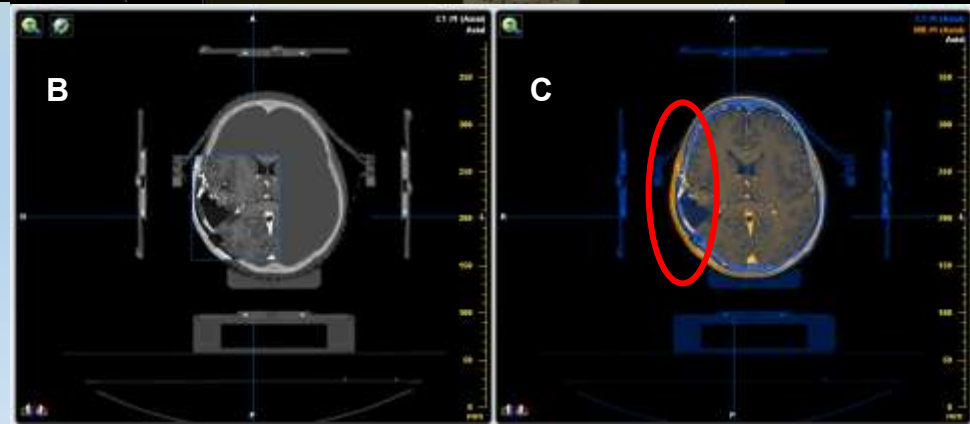
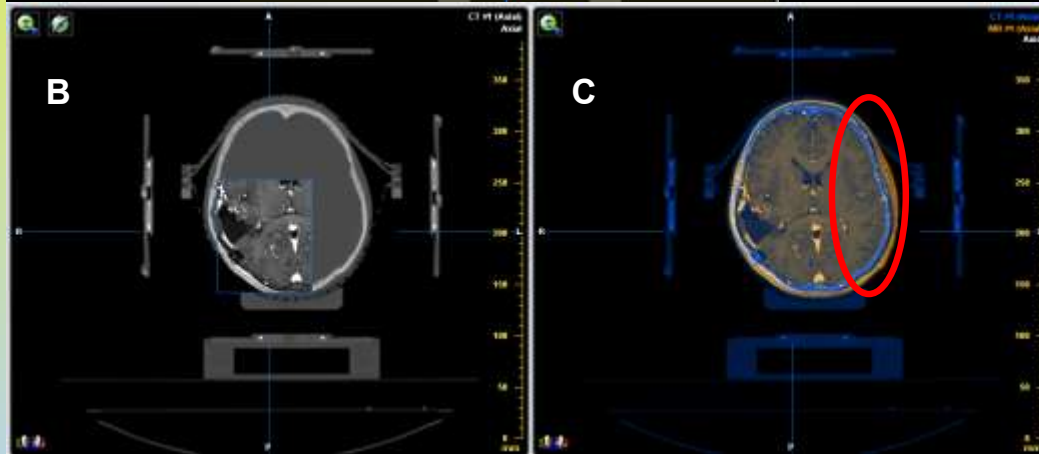
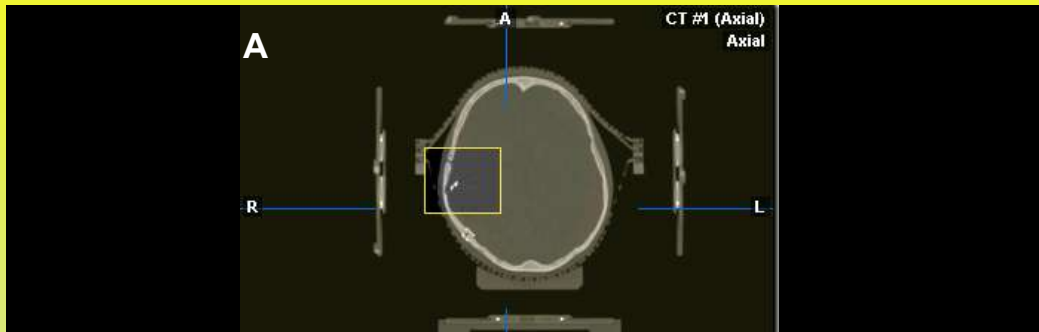
Virtual simulation



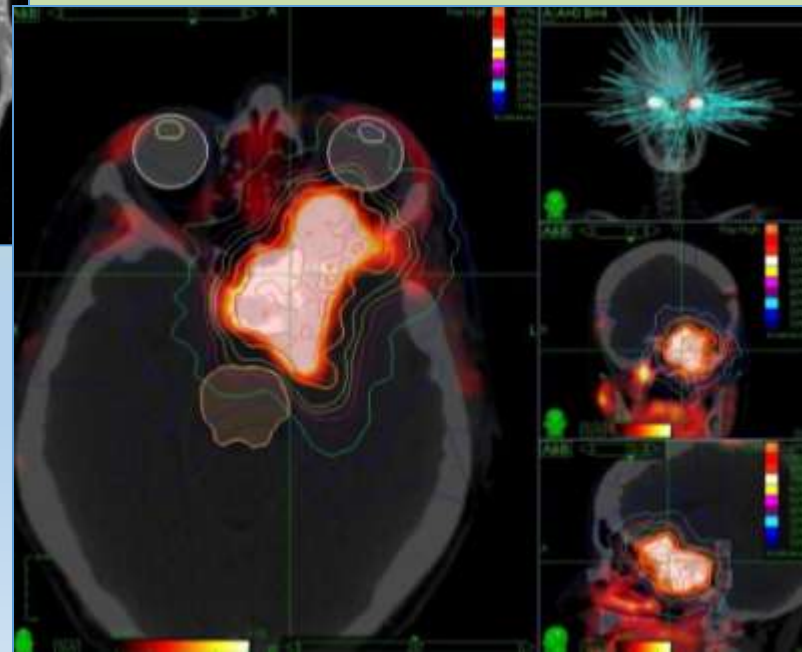
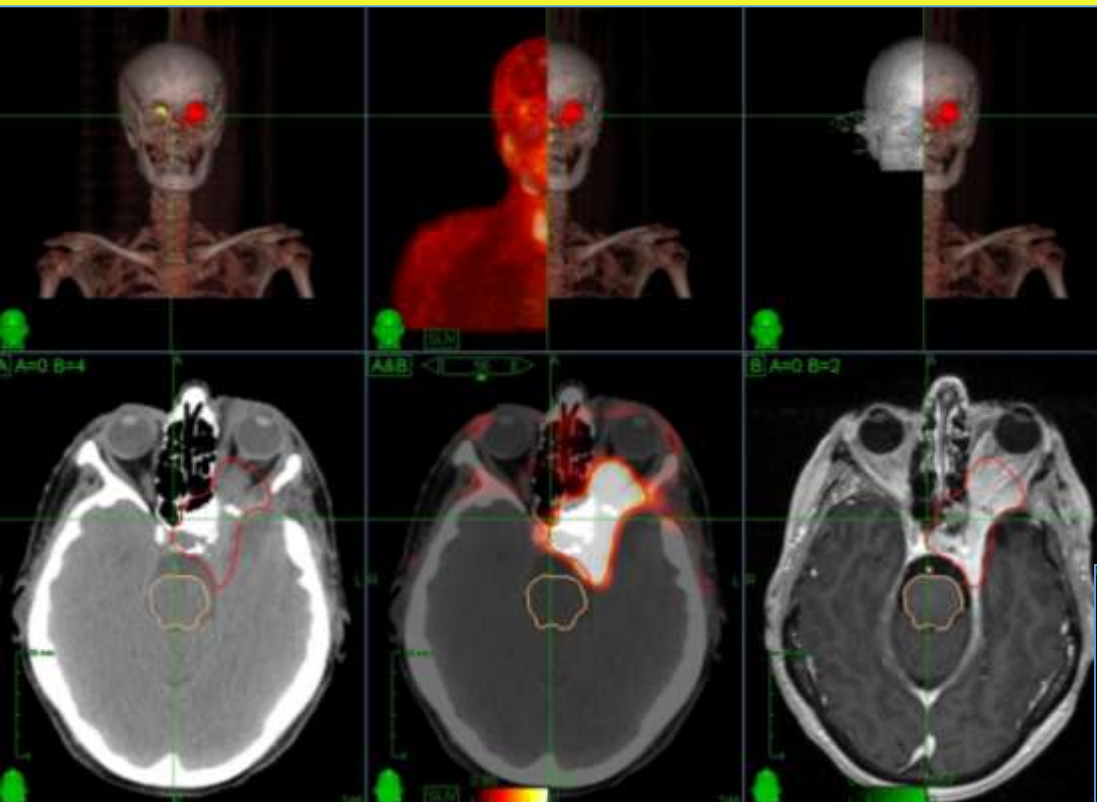


$$HU_{obiekty} = k \frac{\mu_{obiekty}(E) - \mu_{wody}(E)}{\mu_{wody}(E)} \cdot 1000$$

# Definition of PTV: fusion



# Definition of PTV: fusion: CT / NMR / PET





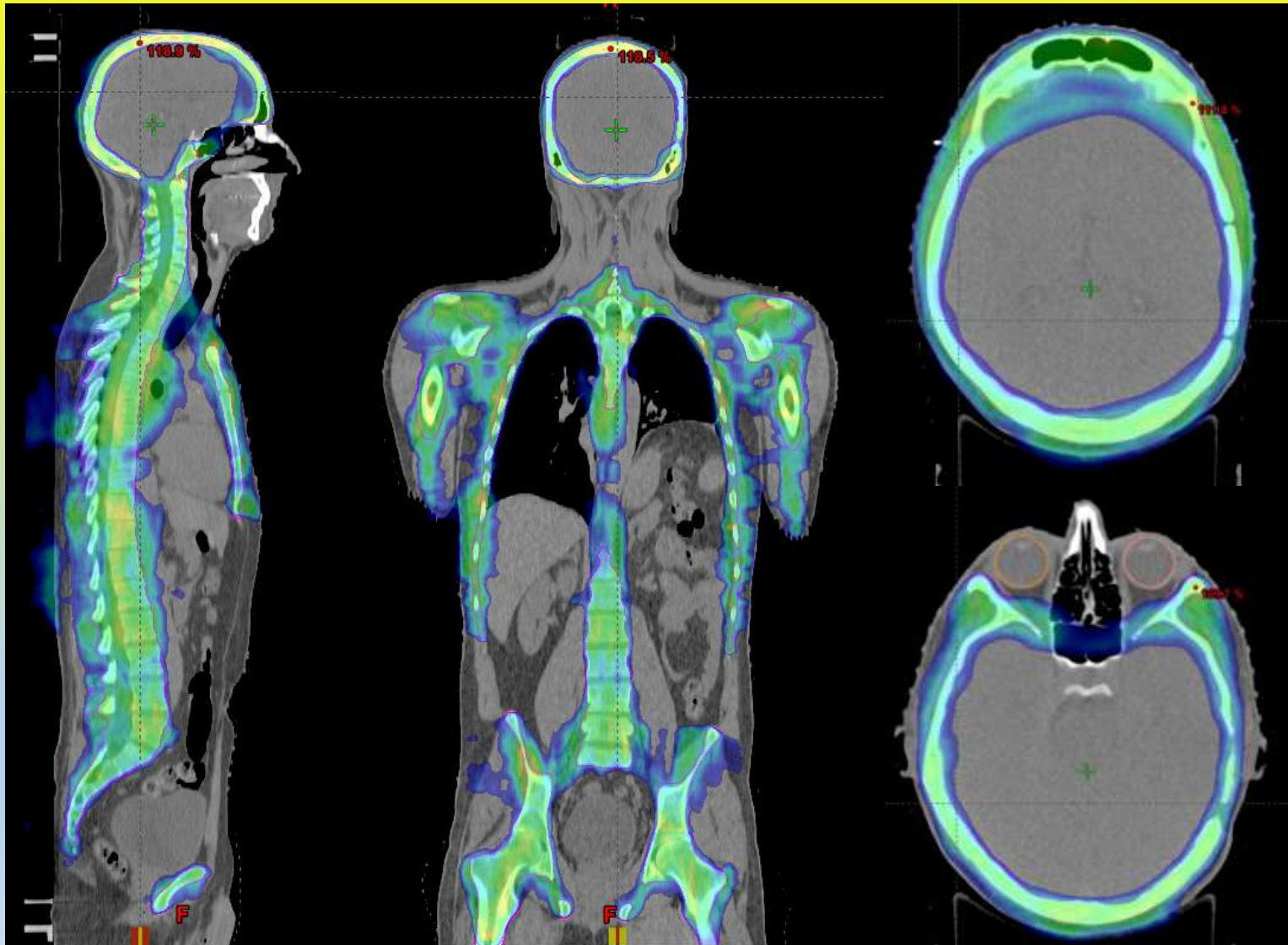
# Systemy planowania leczenia, algorytmy

- dedykowane do aparatu terapeutycznego
- związane z producentem aparatu terapeutycznego – ale „otwarte”
- niezależne od producenta aparatu terapeutycznego
  
- Algorytmy stosowane do obliczeń dawek i ich rozkładów:
  - dwu składnikowe
  - Pencil Beam
  - Analityczne
  - Monte Carlo

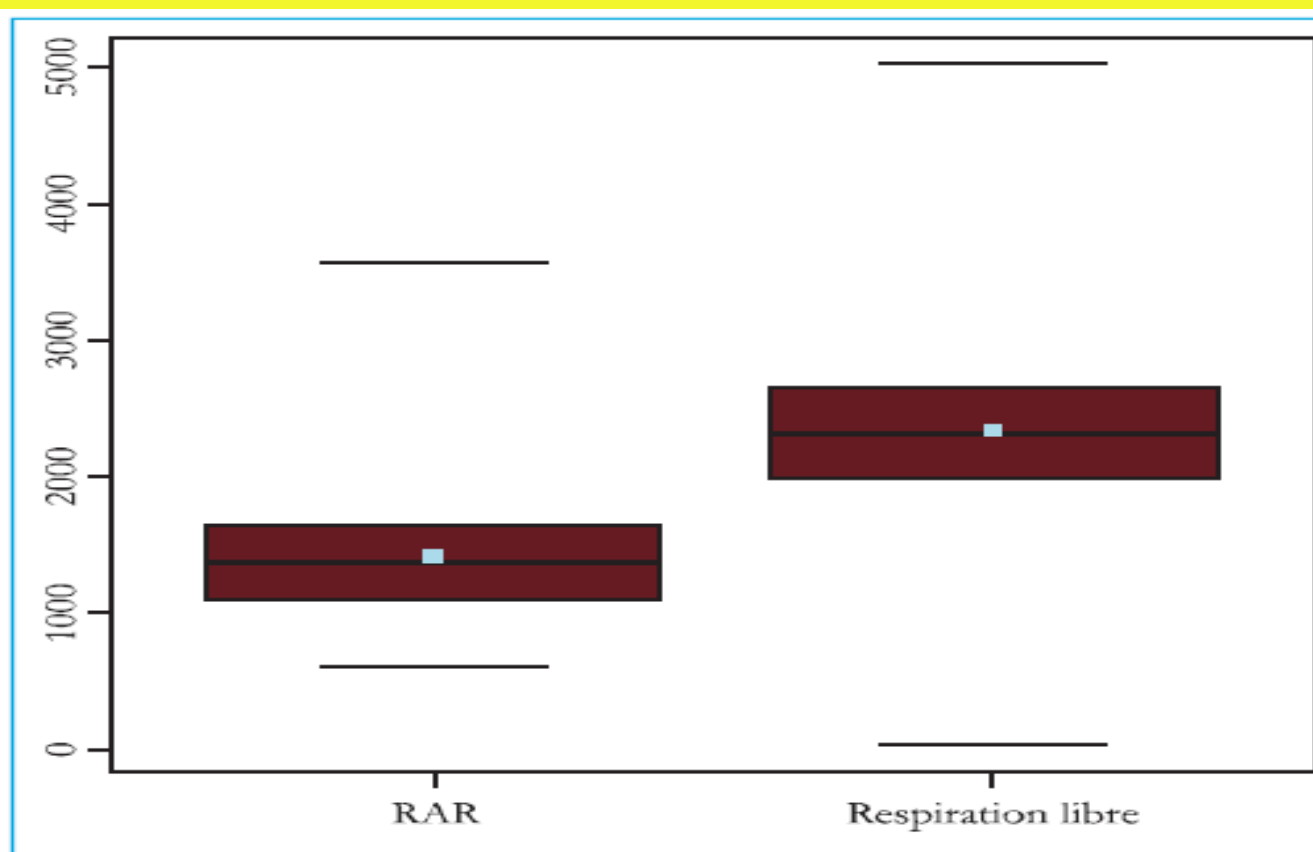
# Techniki napromieniania

- 2D - ?????
- 3D:
  - CRT
    - Statyczne
    - Dynamiczne
      - Kształt pola wiązki
      - Ruch źródła promieniowania
- Źródła
  - Zewnętrzne
  - Wewnętrzne (?)
- Techniki wielkopolowe np. TBI, TMI
- Stereotaktyczne,
- Z bramkowaniem oddechowym

# TMI



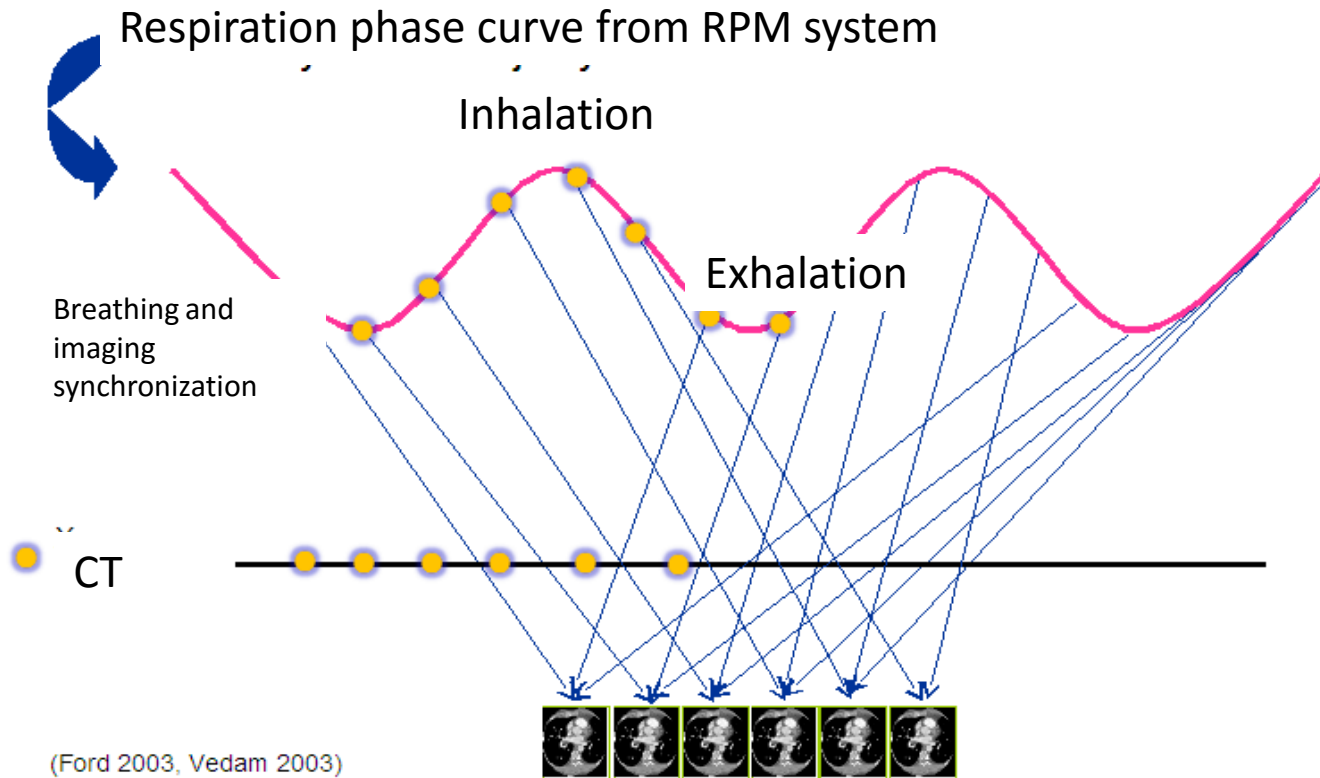
# Bramkowanie oddechowe



**Figure 4.** Comparaison des distributions du volume pulmonaire recevant au moins une dose de 25 Gy ( $V_{25}$ ) entre une technique de radiothérapie avec (RAR) ou sans (respiration libre) contrôle de la respiration dans la population de patients traités pour un cancer du sein.



# Retrospective examination



VARIAN Medical Systems

# Systemy komputerowe administrujące ruchem chorych

- Oferowane przez producenta aparatu terapeutycznego, integrujące wszystkie elementy „linii” terapeutycznej (TPS, symulatory, aparat terapeutyczny, ....).
- Niezależne od producenta, łączące używane urządzenia terapeutyczne, diagnostyczne
- Administracja zasobami systemu: użytkownicy, sprzęt, prawa dostępu
- Konfiguracja aparatury terapeutycznej

System Setup

Hospitals & Departments

Department Details

Lists

User Defined Patient Labels

User Defined Activity Attributes

Global Settings

Patient IDs

Staff & Resource IDs

Code Scheme

Select a hospital to edit the "Details" below.

Hospital Name	Organization
Instytut Onkologii	

Name
Department

# Aparaty terapeutyczne

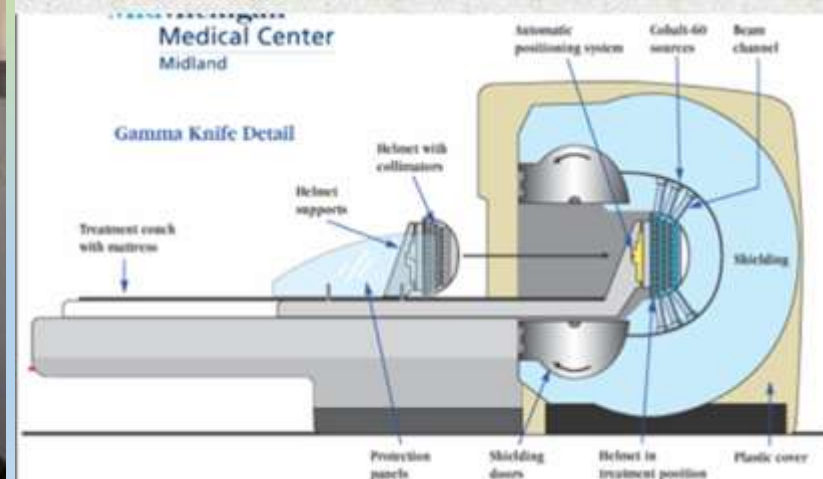
- Gamma Knife
- CyberKnife
- Klasyczne akceleratorzy biomedyczne:
  - zintegrowany kolimator wielolistkowy
  - dodatkowy kolimator wielolistkowy
  - dodatkowe kolimatory kołowe
- Tomoterapia
- Protonoterapia / ciężkie jony



# Aparaty terapeutyczne

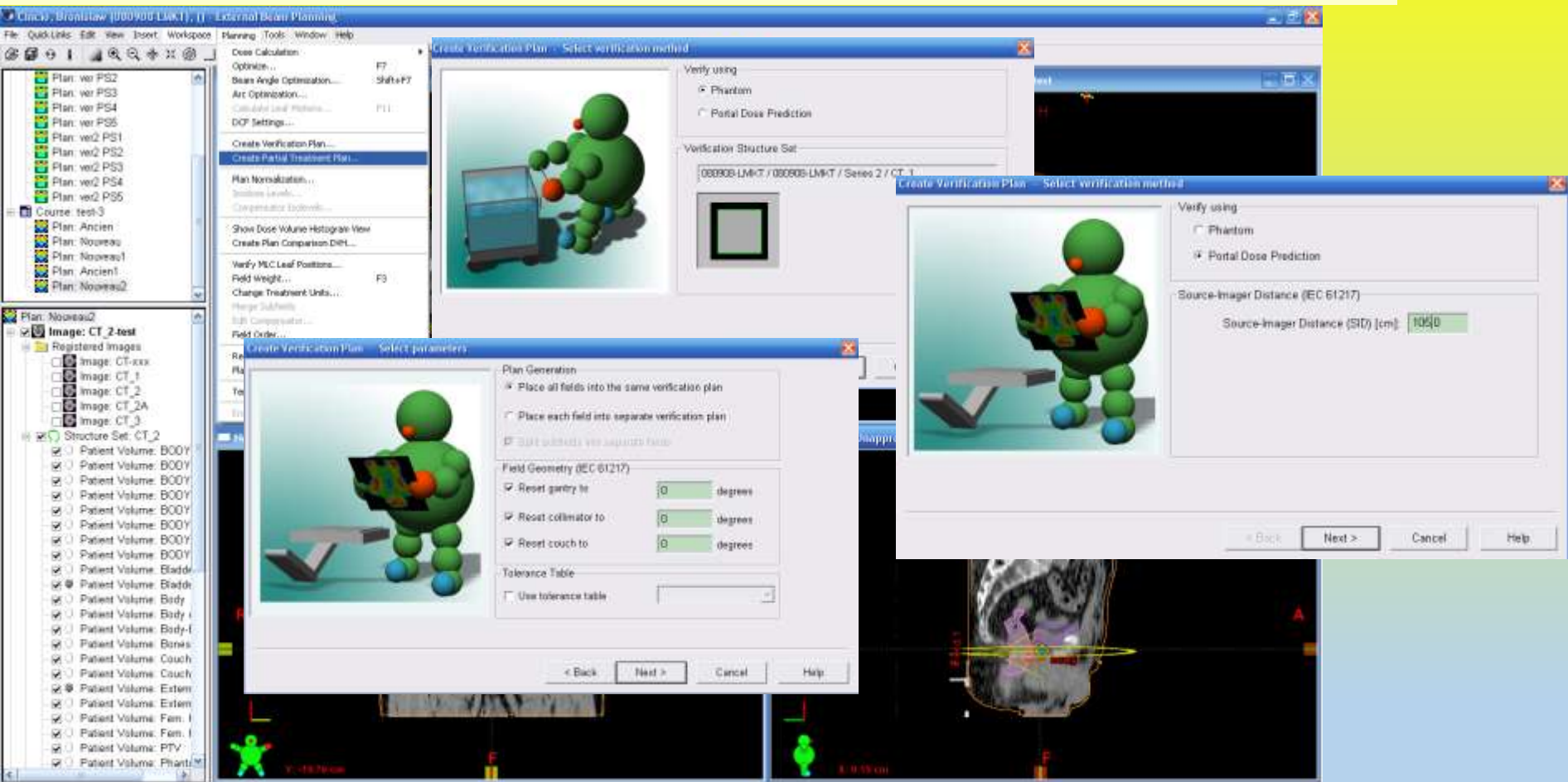


## Radiochirurgia: Gamma Knife



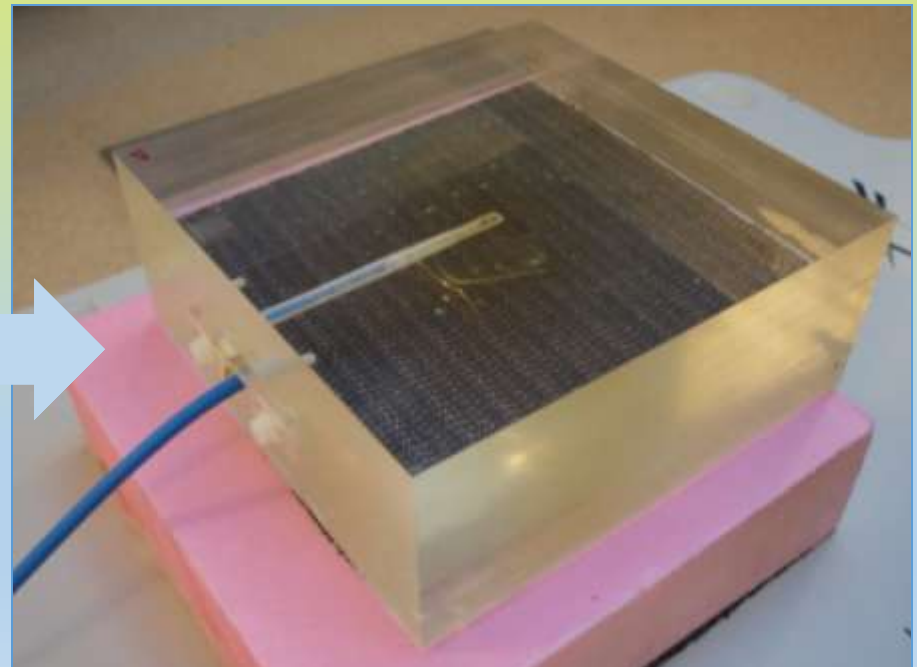
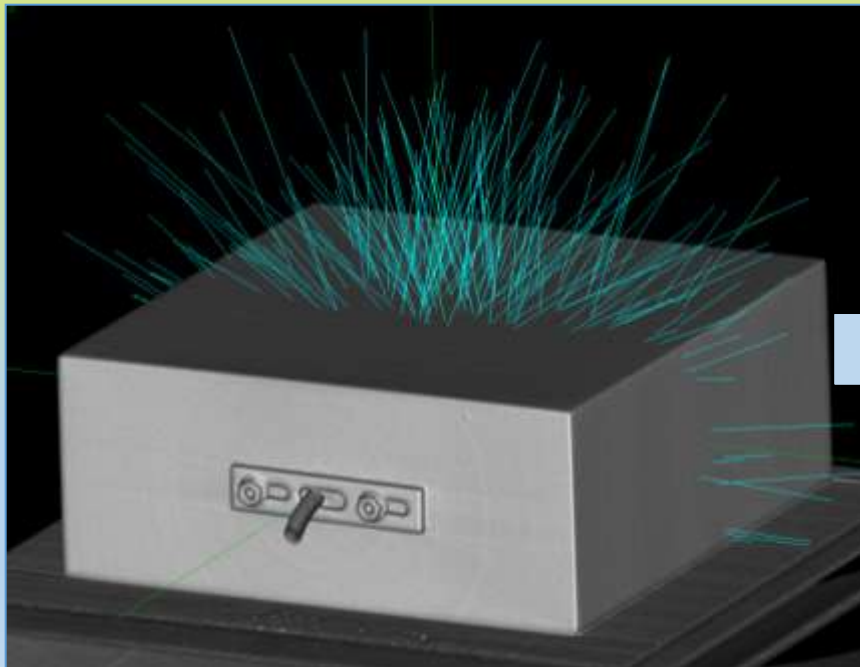
Weryfikacja dawki w czasie prowadzonej terapii

# 1. Plan for verification



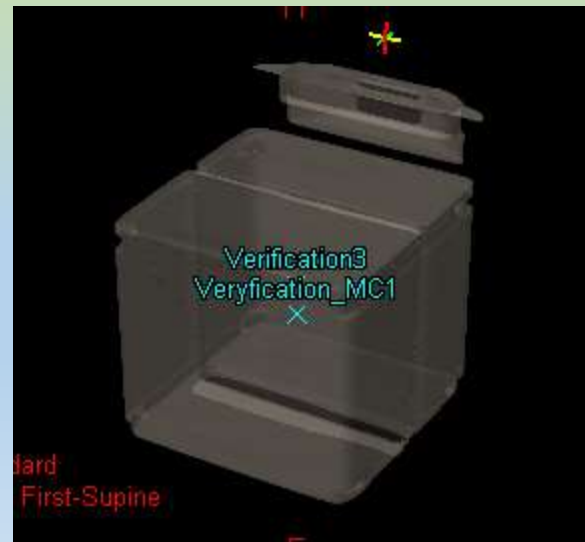
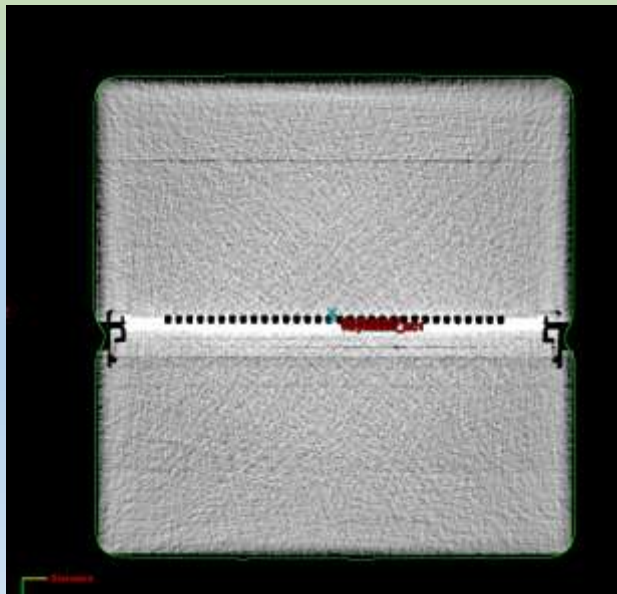
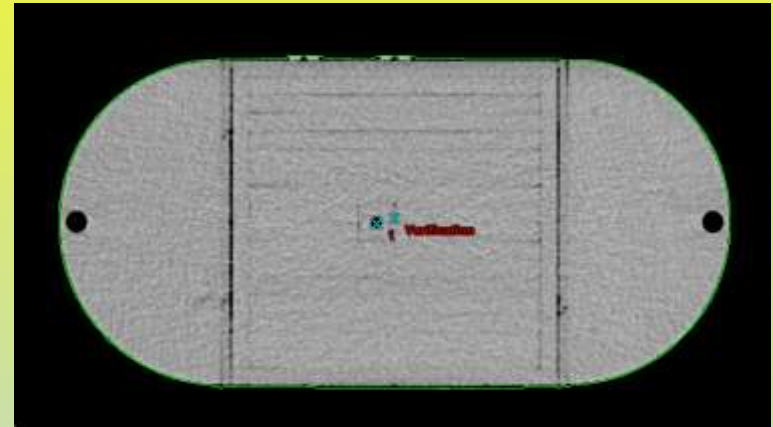
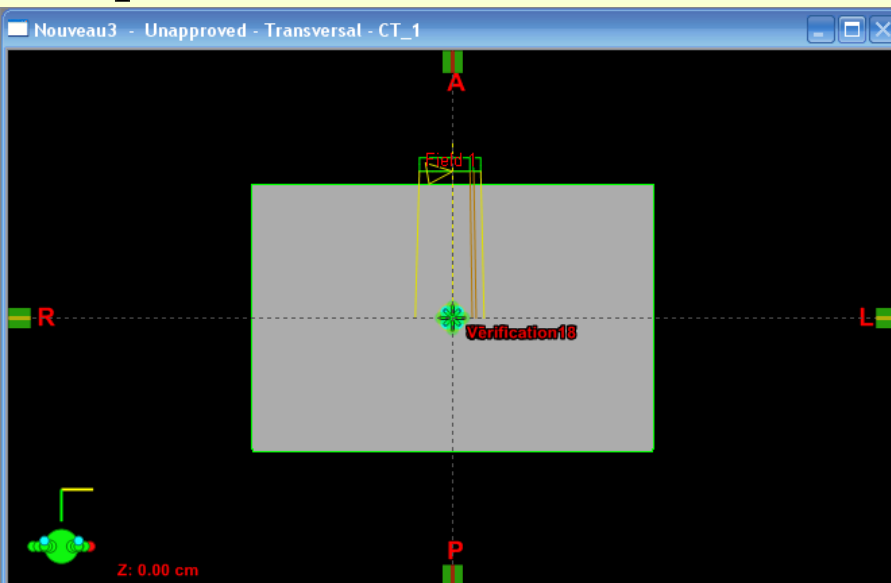
Fields	Dose Prescription	<input type="checkbox"/> Field Alignments	<input type="checkbox"/> Plan Objectives	<input type="checkbox"/> Optimization Objectives	Dose Statistics	Calculation Models	Plan Sum		
Fractionation Id	Dose / Fraction [Gy]	Number of Fractions		Total Dose [Gy]	Primary Reference Point	Total Dose at Primary [Gy]	Relative Dose at Primary [%]	Prescribed Percentage [%]	Plan Normalization Mode
F1	2.000	10		20.000	nowy			100.0	No plan normalization

# Plan QA

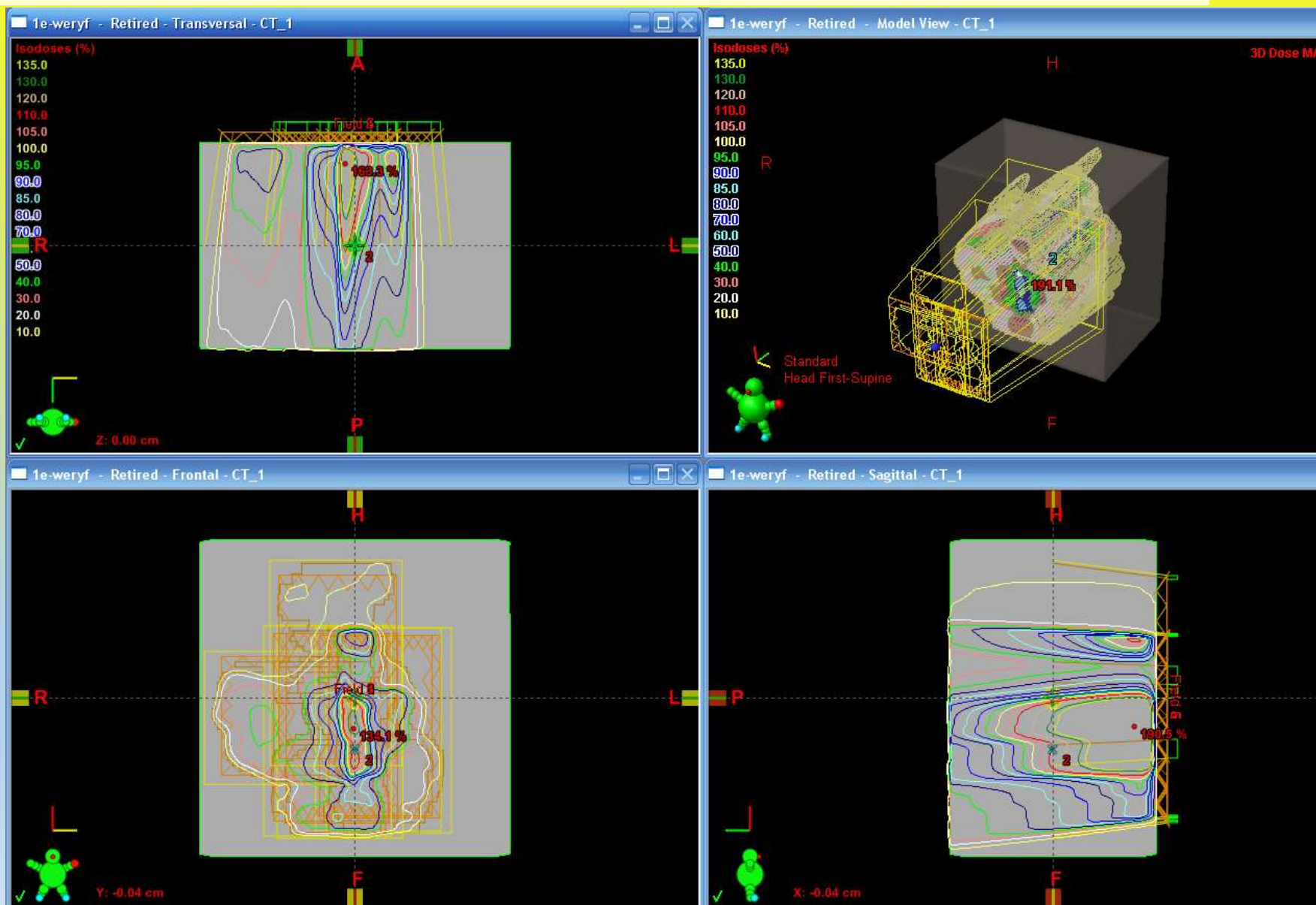




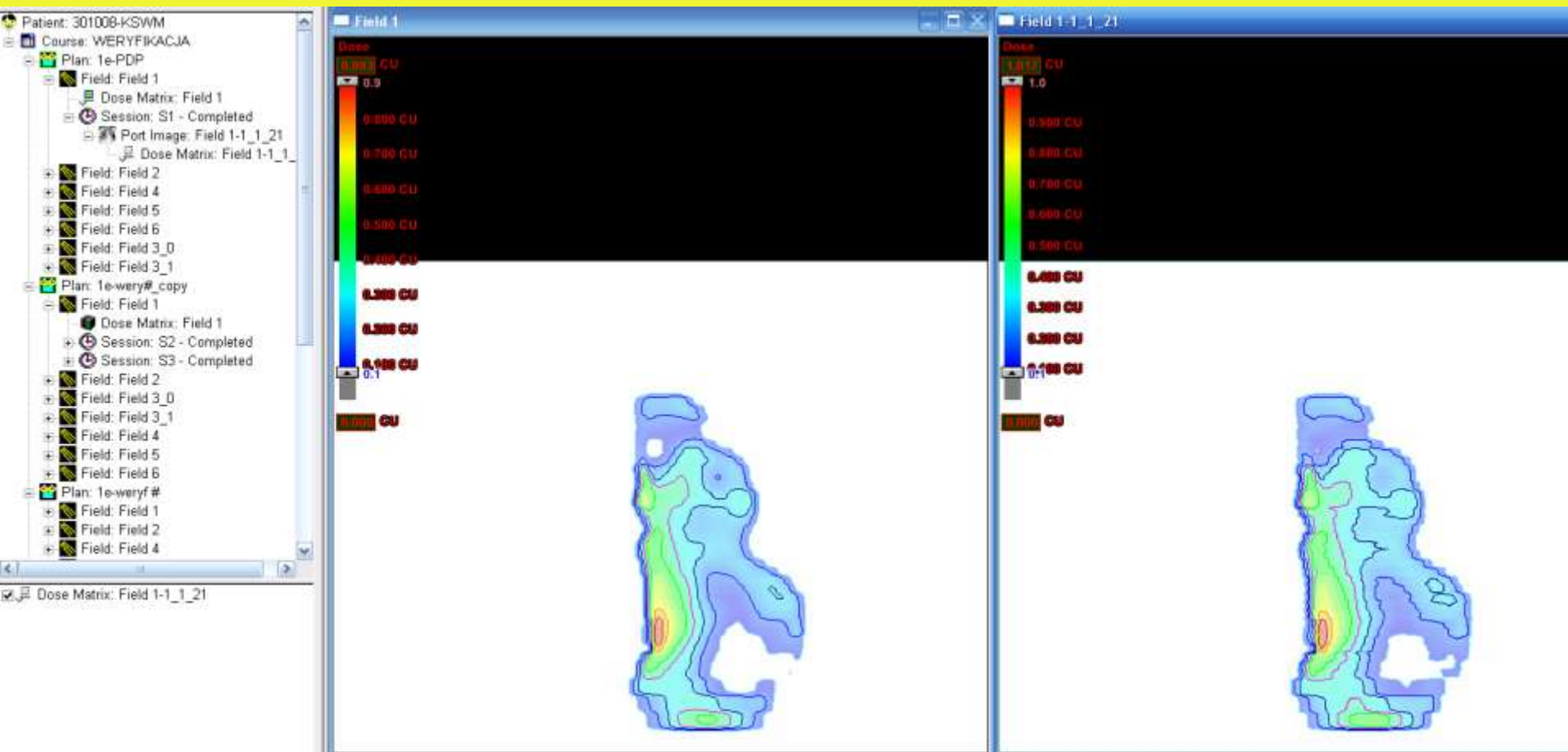
# 1. plan for verification



# Ionization chamber measurements

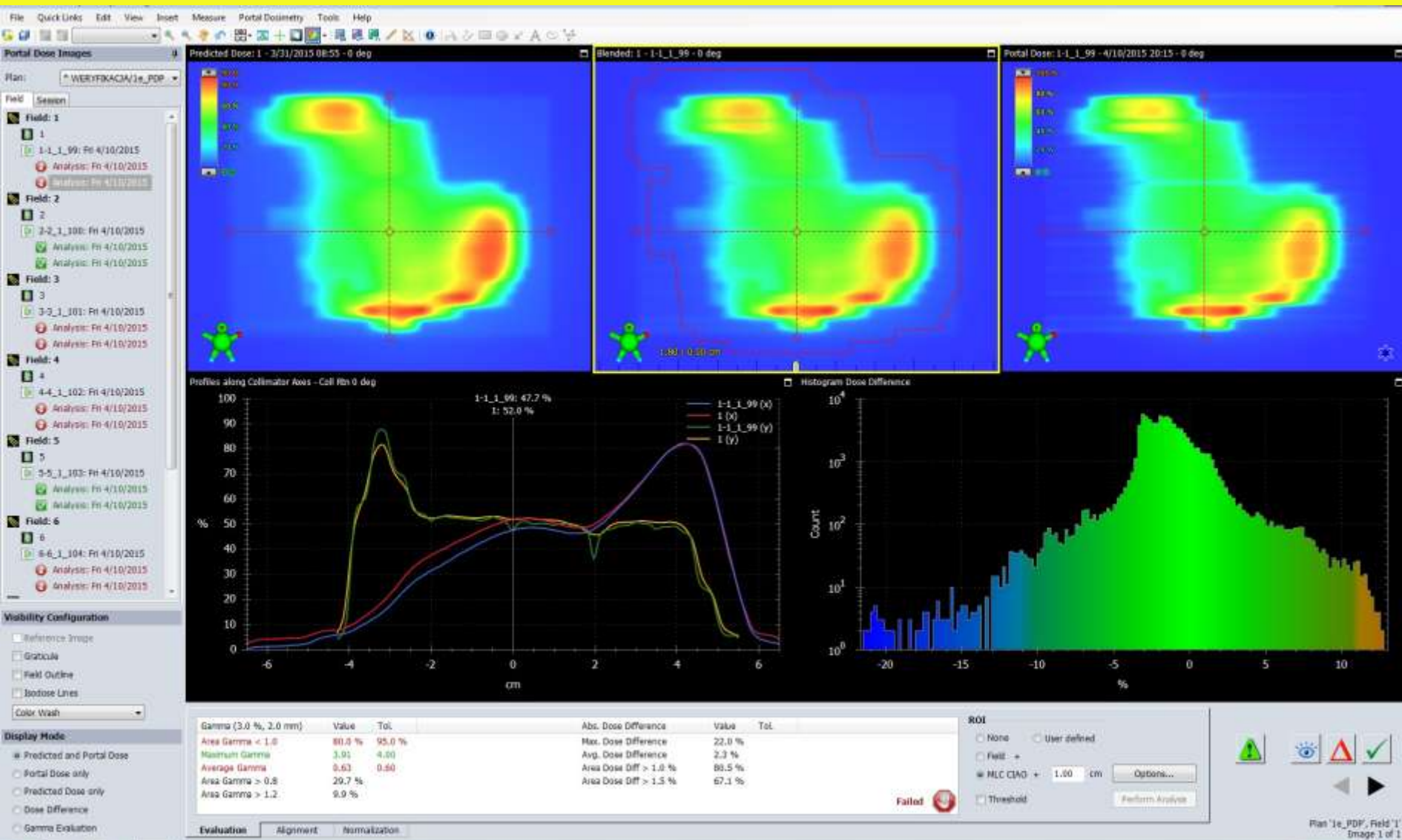


# EPID measurements



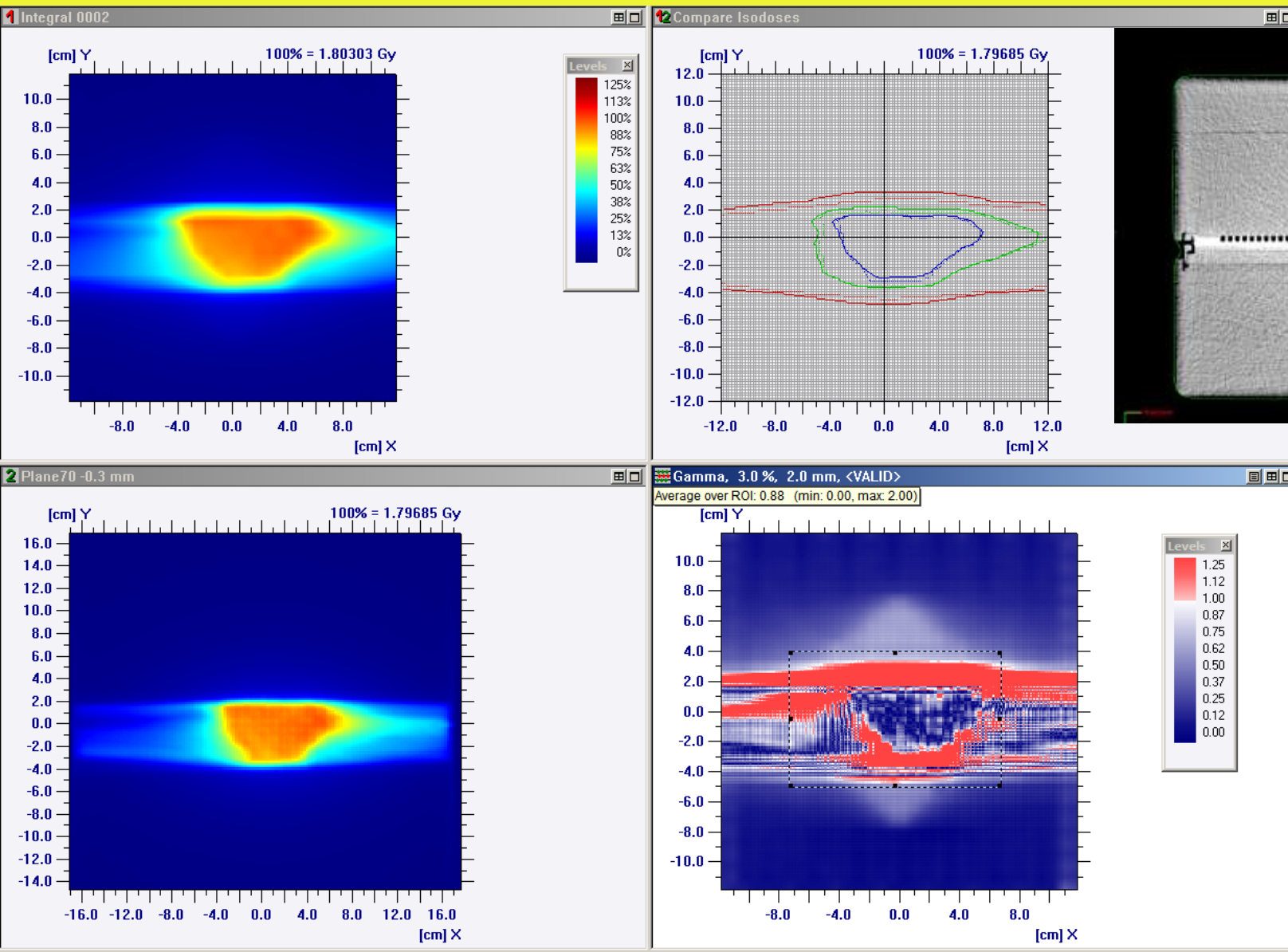
Label	Value
Dose difference criterion [%]	3.000000
DTA criterion [mm]	2.000000
Threshold (fraction of max. dose)	0.000000
Maximum gamma	4.776624
Average gamma	0.395652
Area gamma > 1.0 [%]	11.173162

# EPID

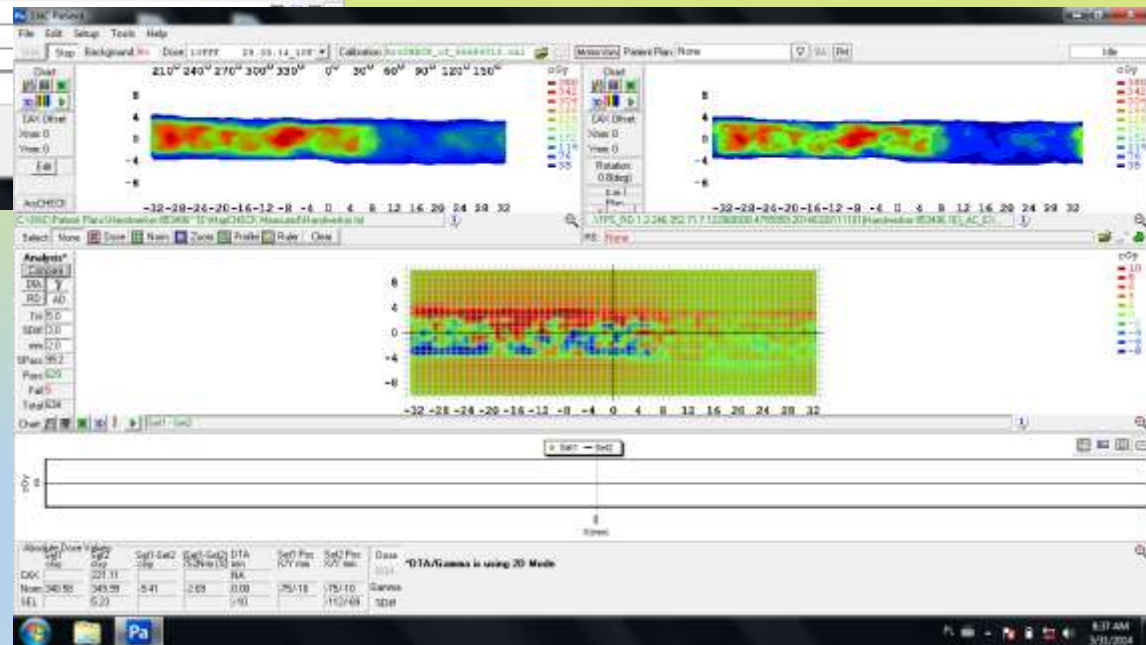
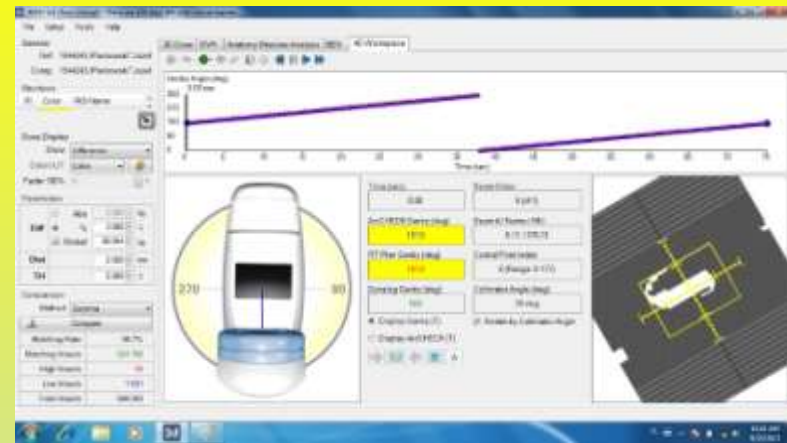
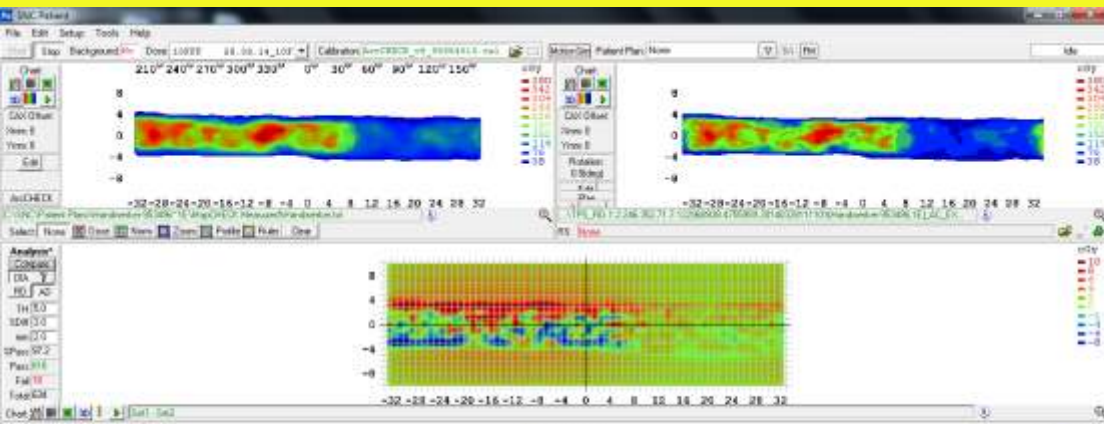




# RapidArc: Matrix measurements

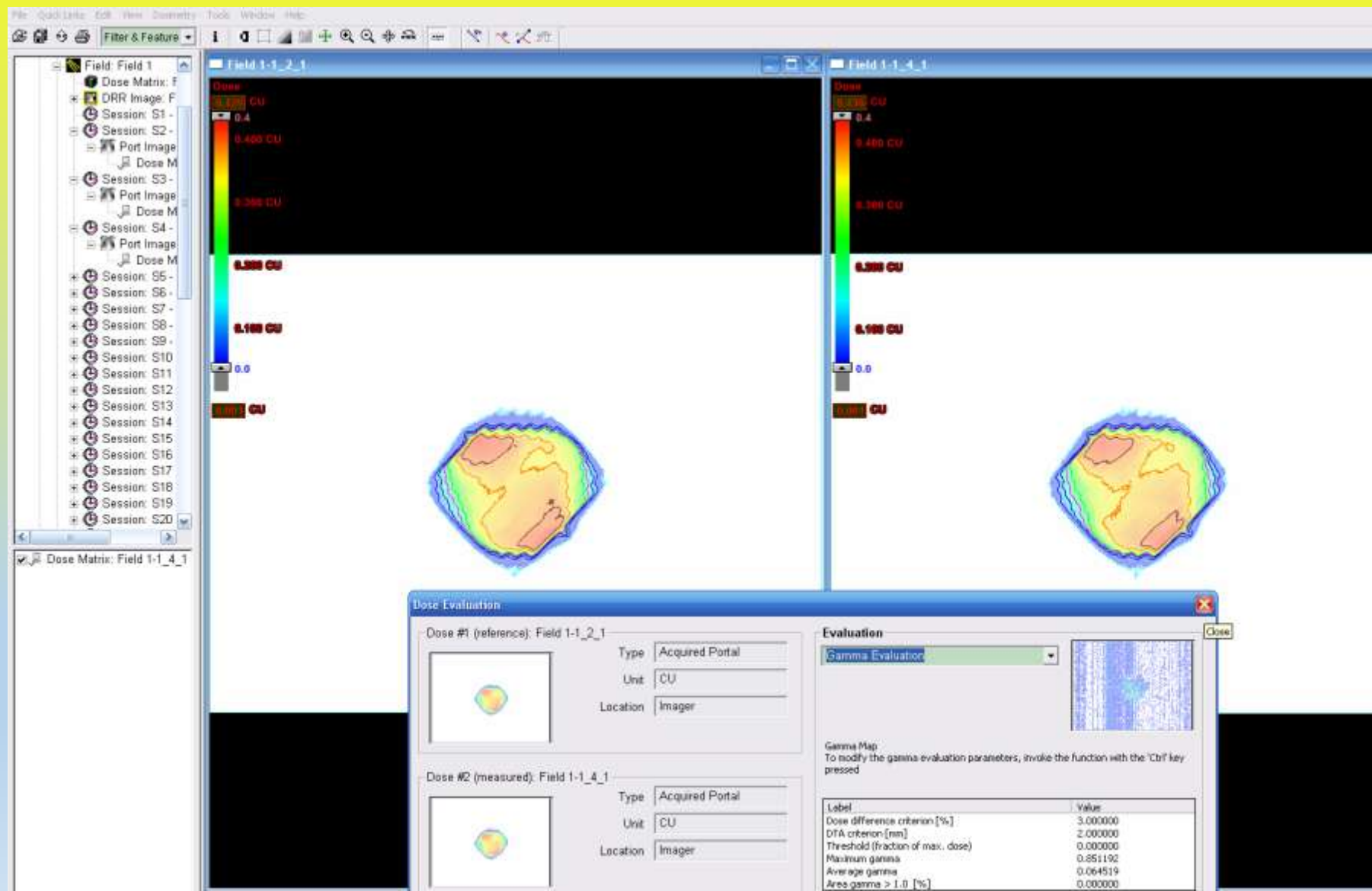


# Fluence map verification





# RapidArc: with patient



# Dose reconstruction proces (home made software)

## Accelerator



Export of DynaLog.dlg or  
Trajectory log file  
in real time

## TPS- ECLIPSE workstation



Export of  
RTplan.dcm



Importing of new RTplan.dcm  
to the TPS and calculating  
reconstructed dose  
distribution

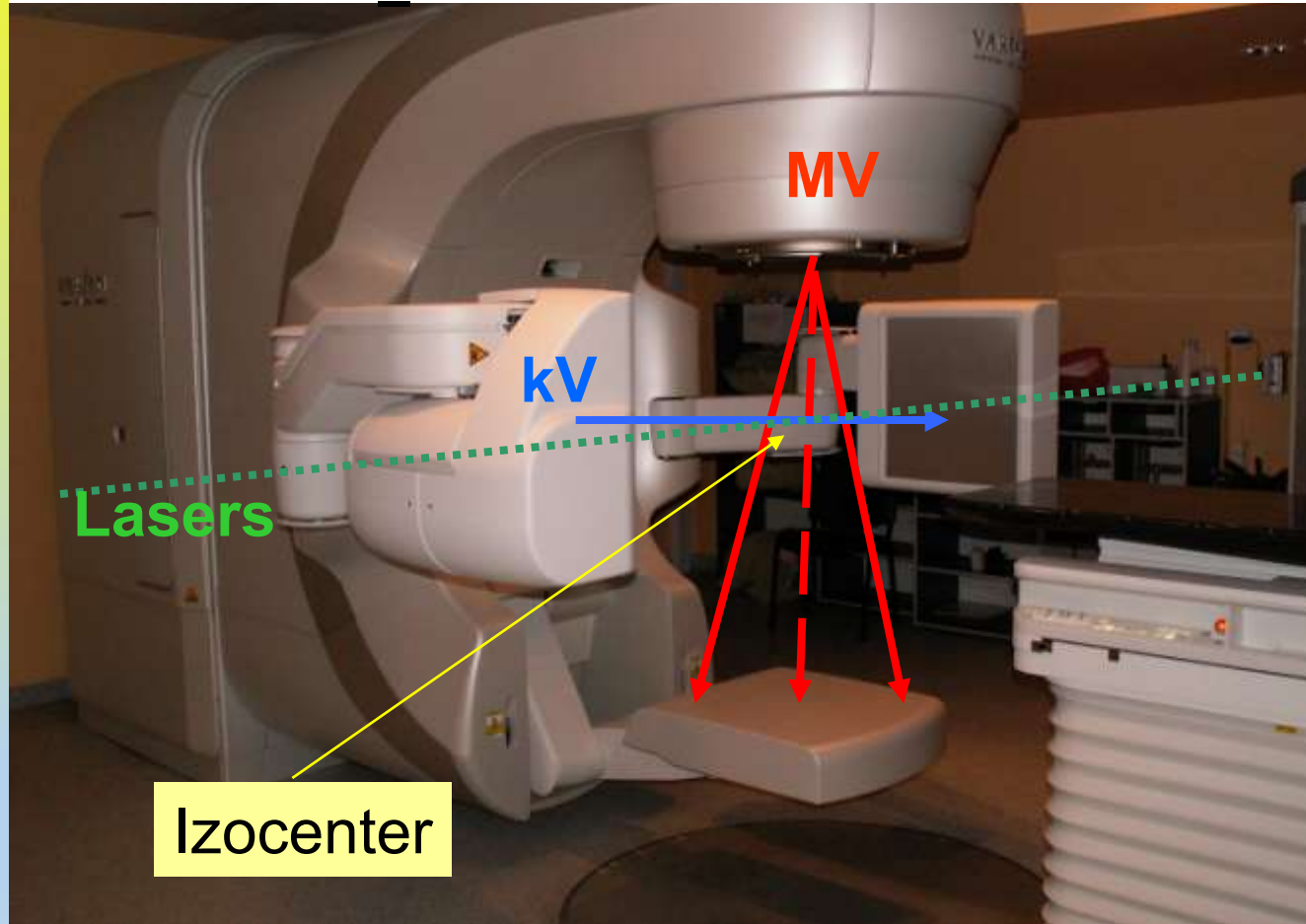
Creating new RTplan.dcm file based on log files and original RTplan.dcm file  
– DDcon.exe software –

# Weryfikacja graficzna prowadzonej terapii

- EPID
- kV – imaging 2D
- CB/CT: (3D)
  - kV
  - MV
- optical systems
- ultrasound

# Izocenter: kV & MV & lasers

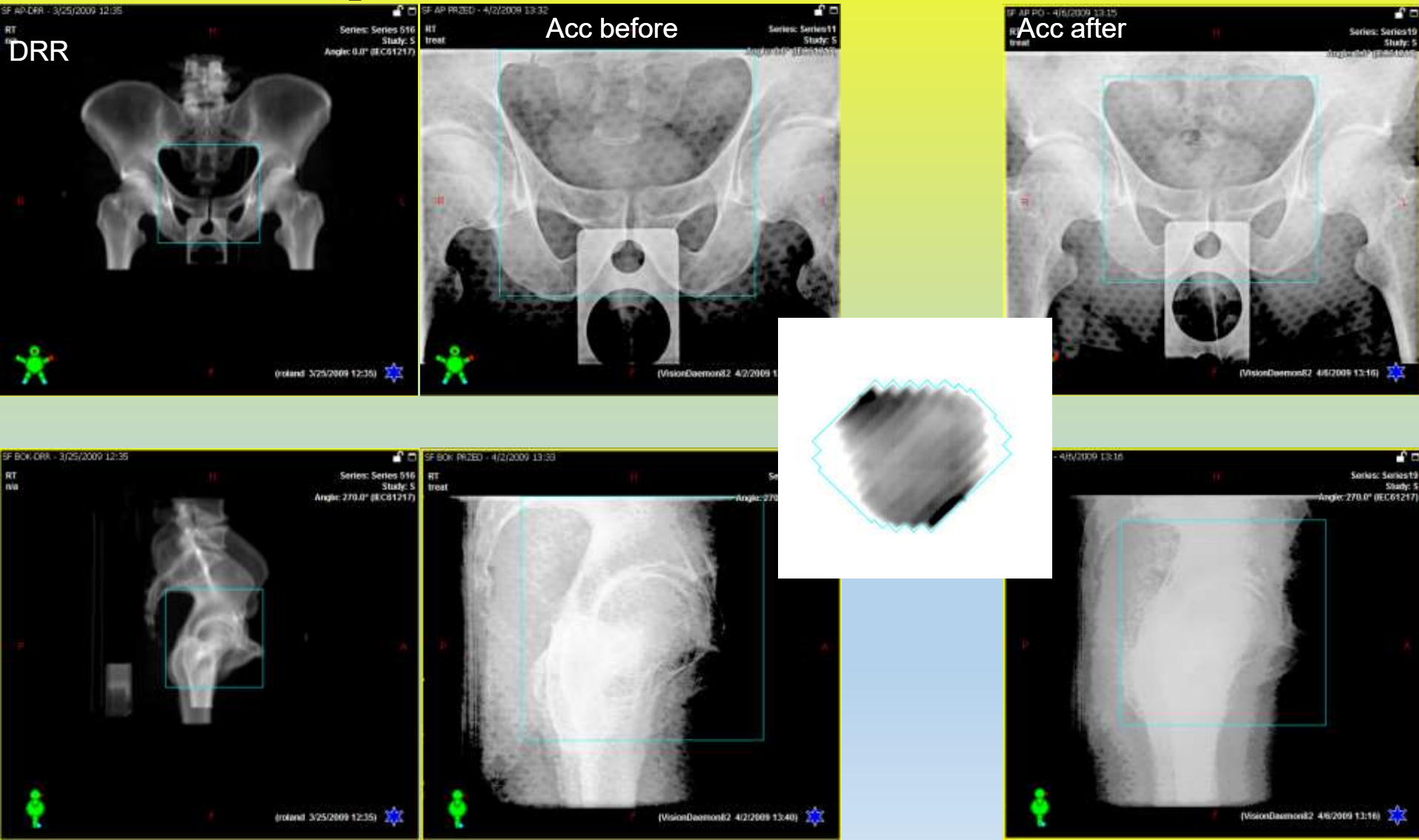
$$(X,Y,Z)_{\text{IZO\_kV}} = (X,Y,Z)_{\text{IZO\_MV}}$$



# Verification of IMRT during treatment

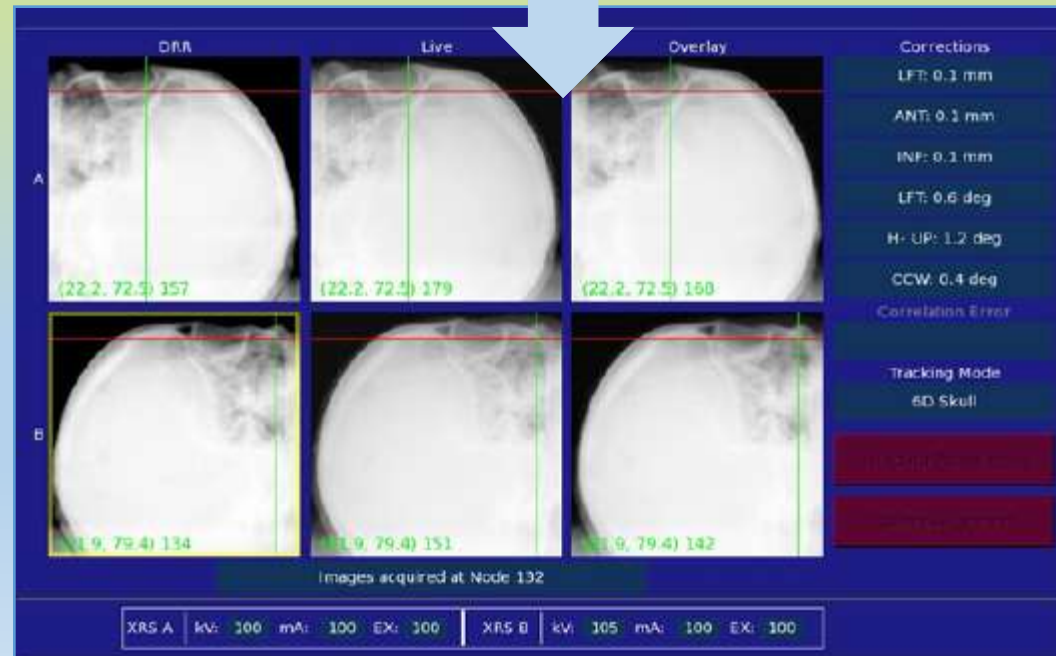
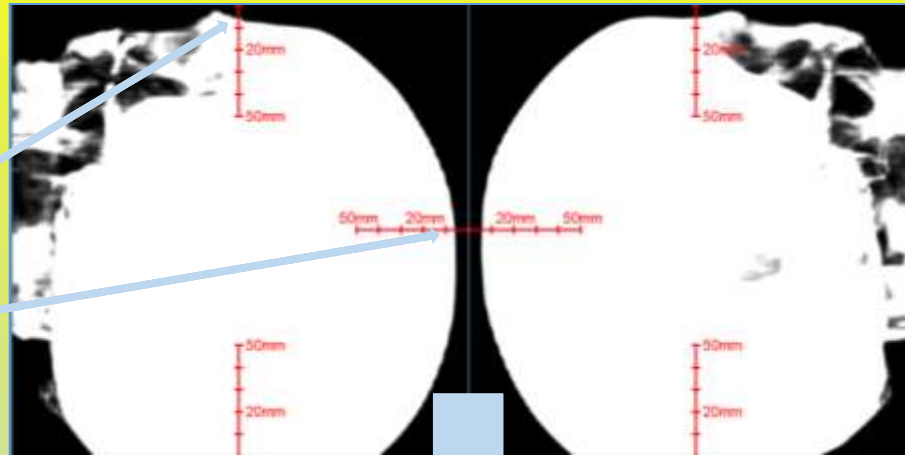
## RapidArc: with patient

# verification of patients stabilization: intra, inter fractions



## 6D Skull

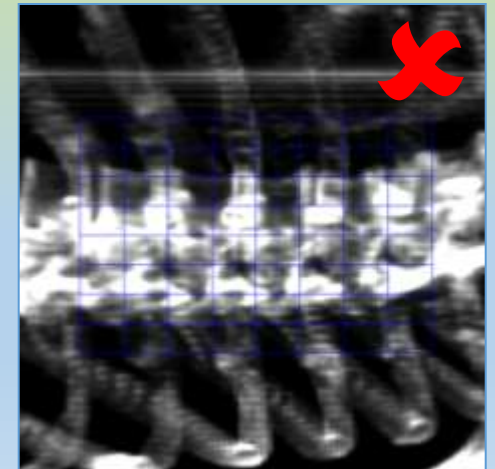
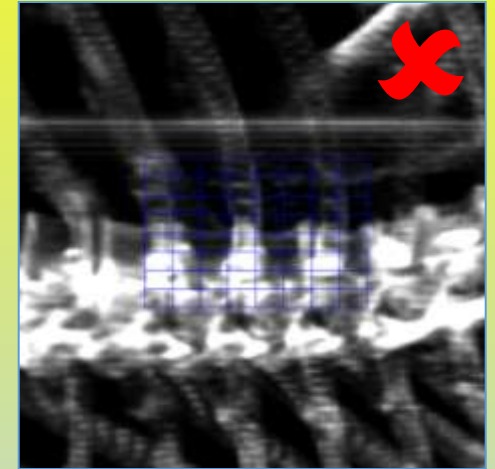
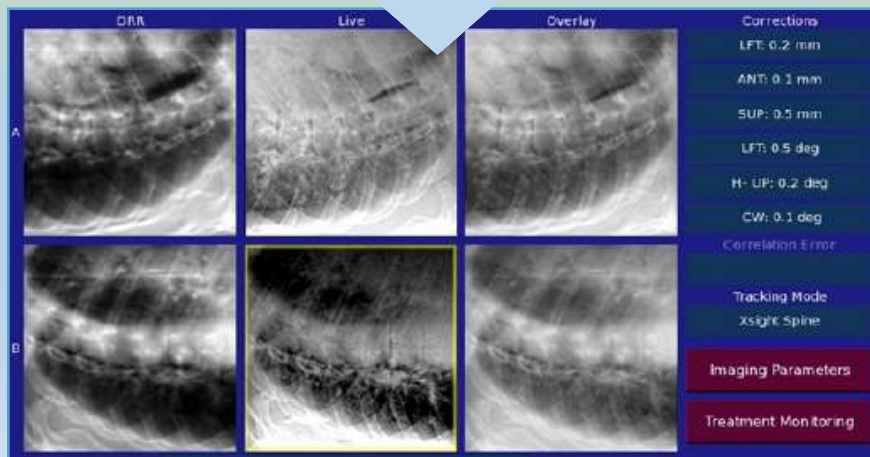
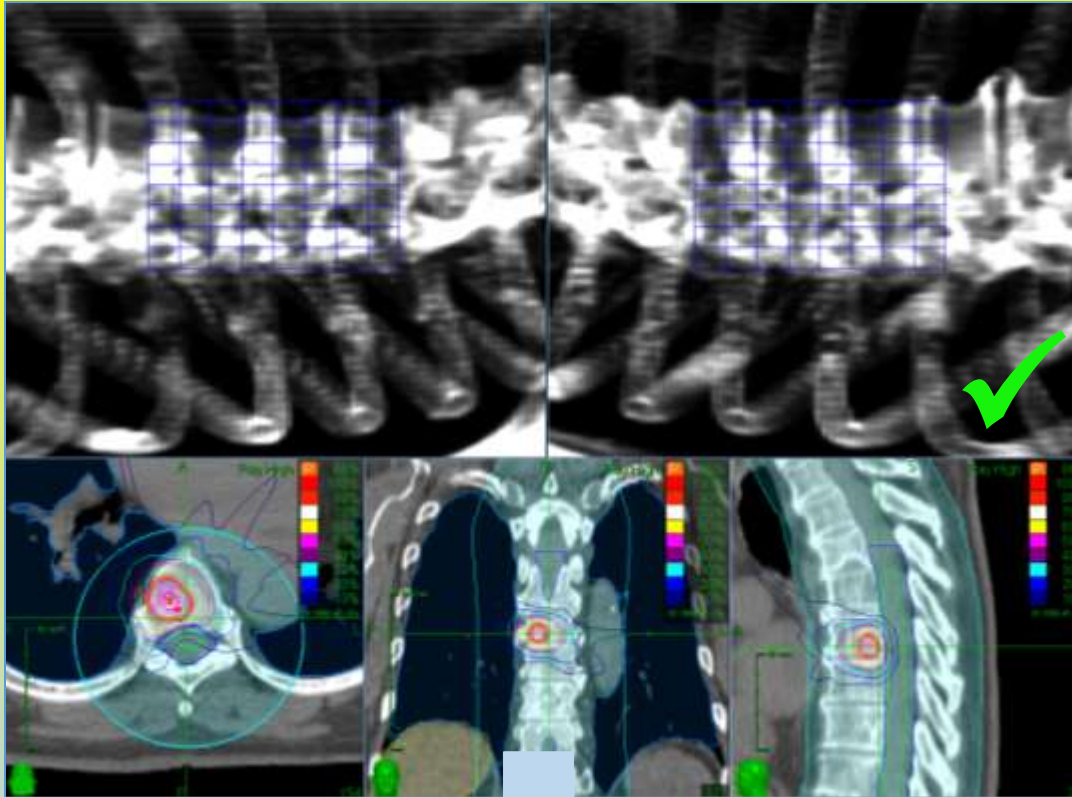
0-10mm



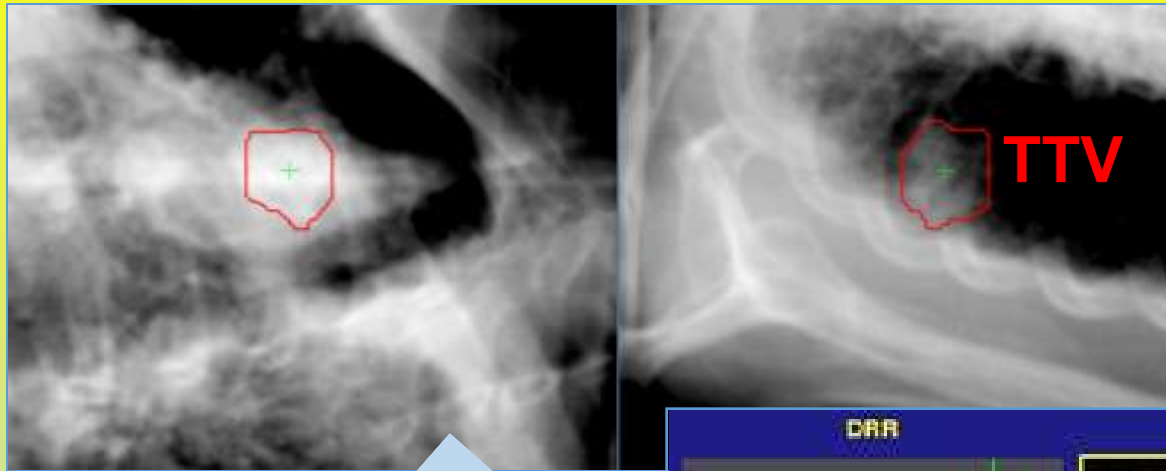


# Planowanie leczenia – MultiPlan – METODA ŚLEDZENIA

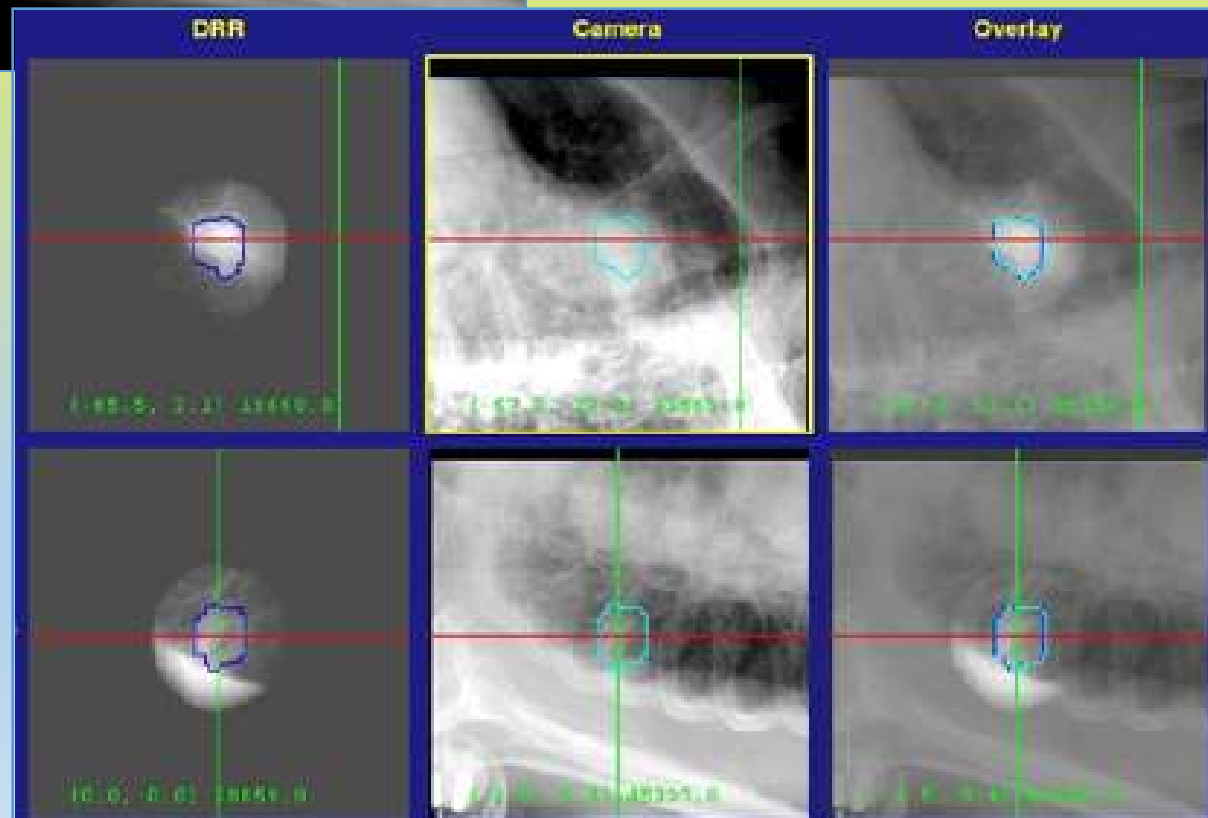
## Xsight Spine

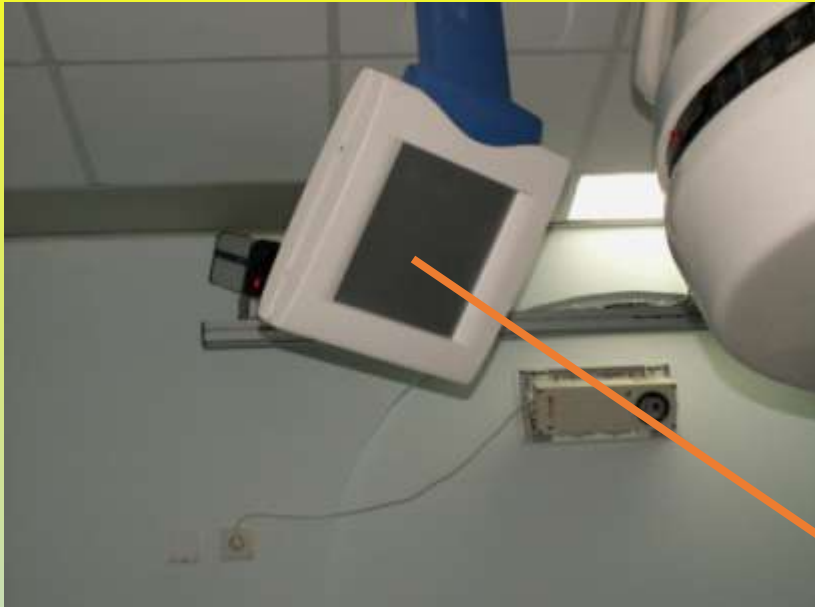


# Xsight Lung



**TTV**  
+  
**Xsight Spine**





# Patient positioning verification: X-ray / InfraRed



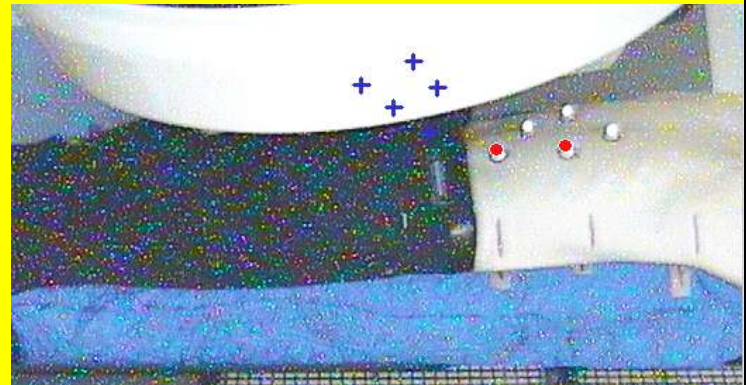
A



C



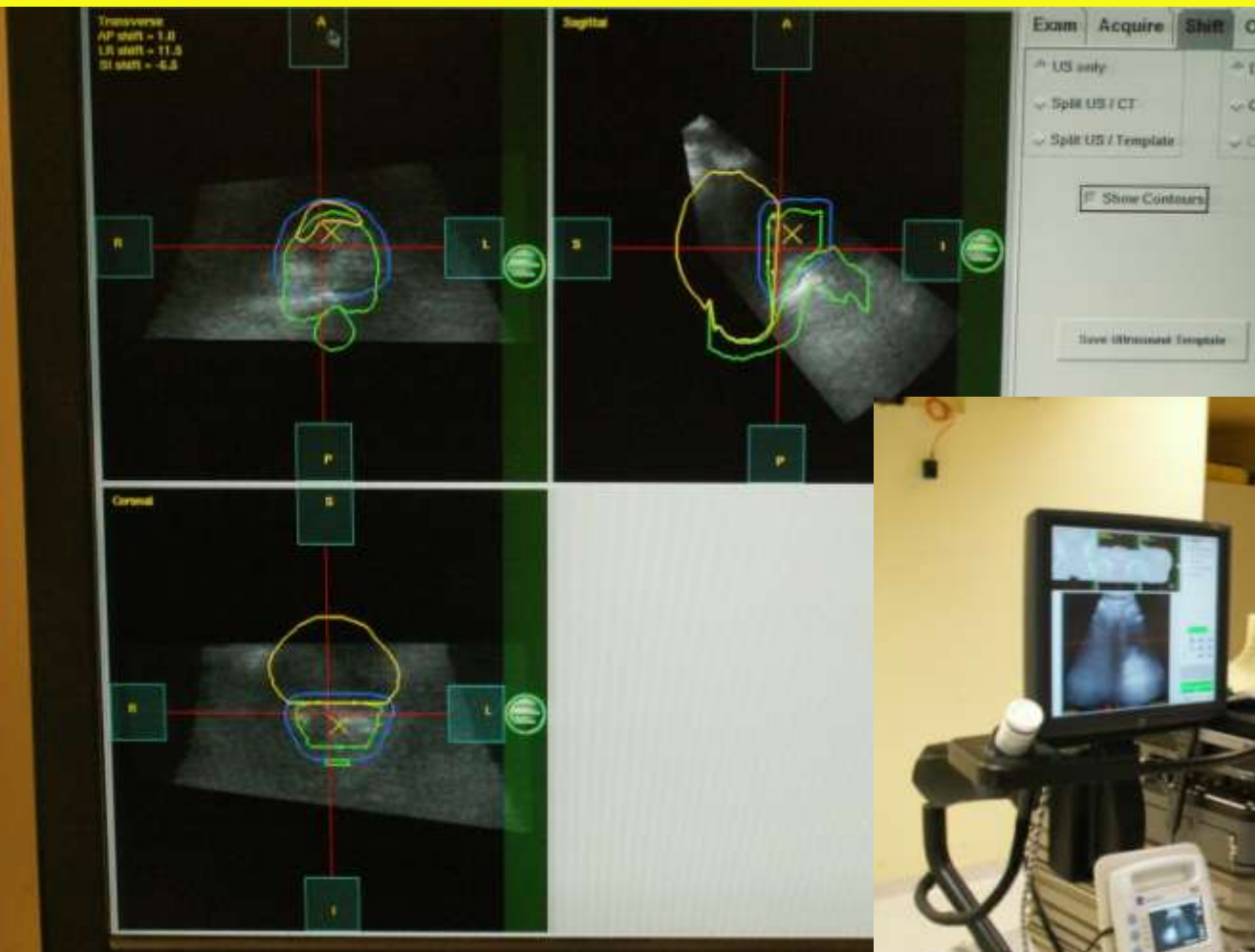
B



D

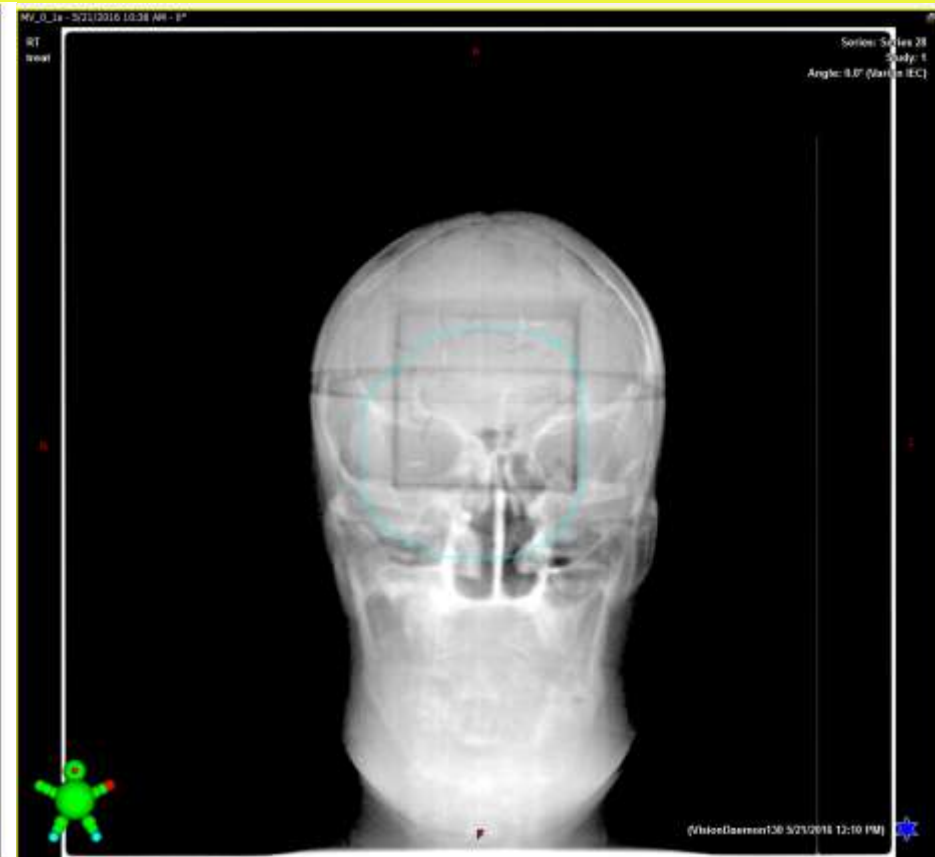
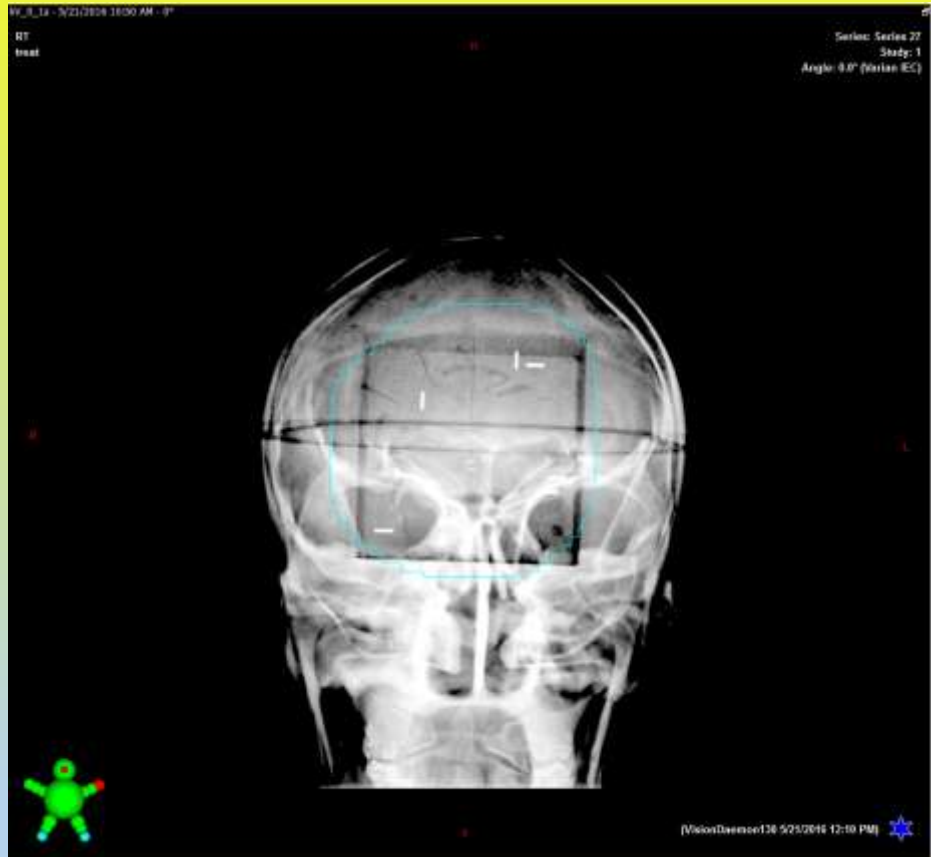


# Ultrasound

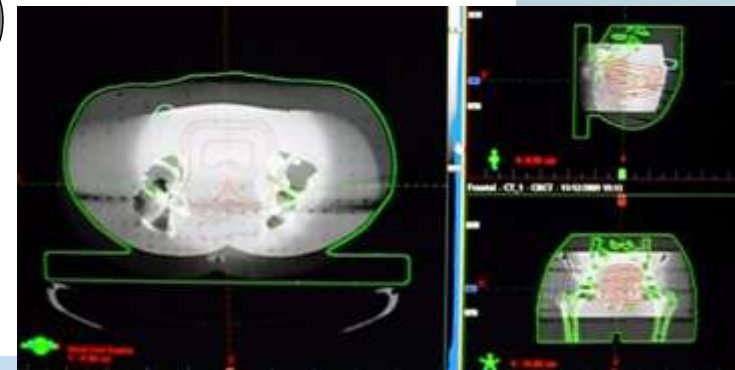
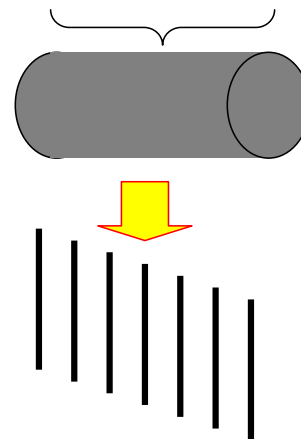
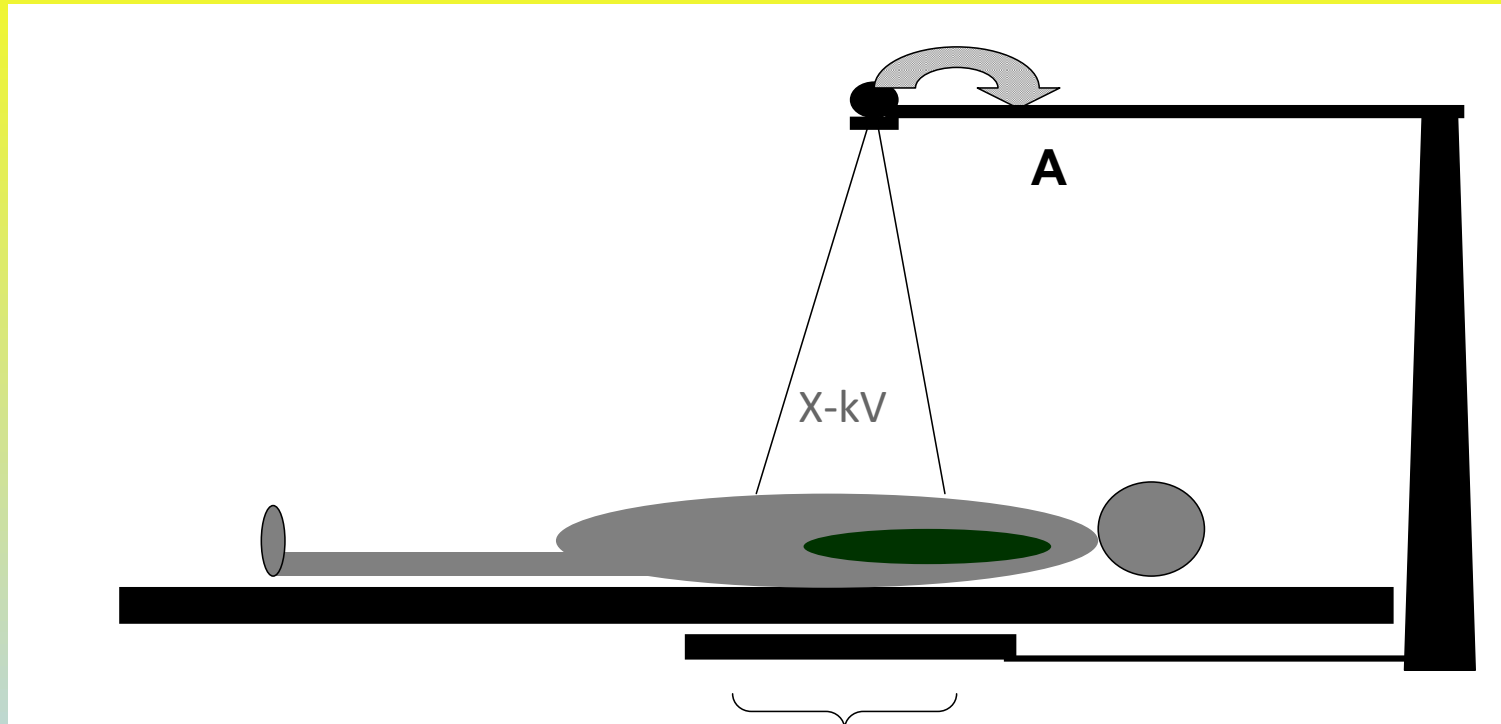




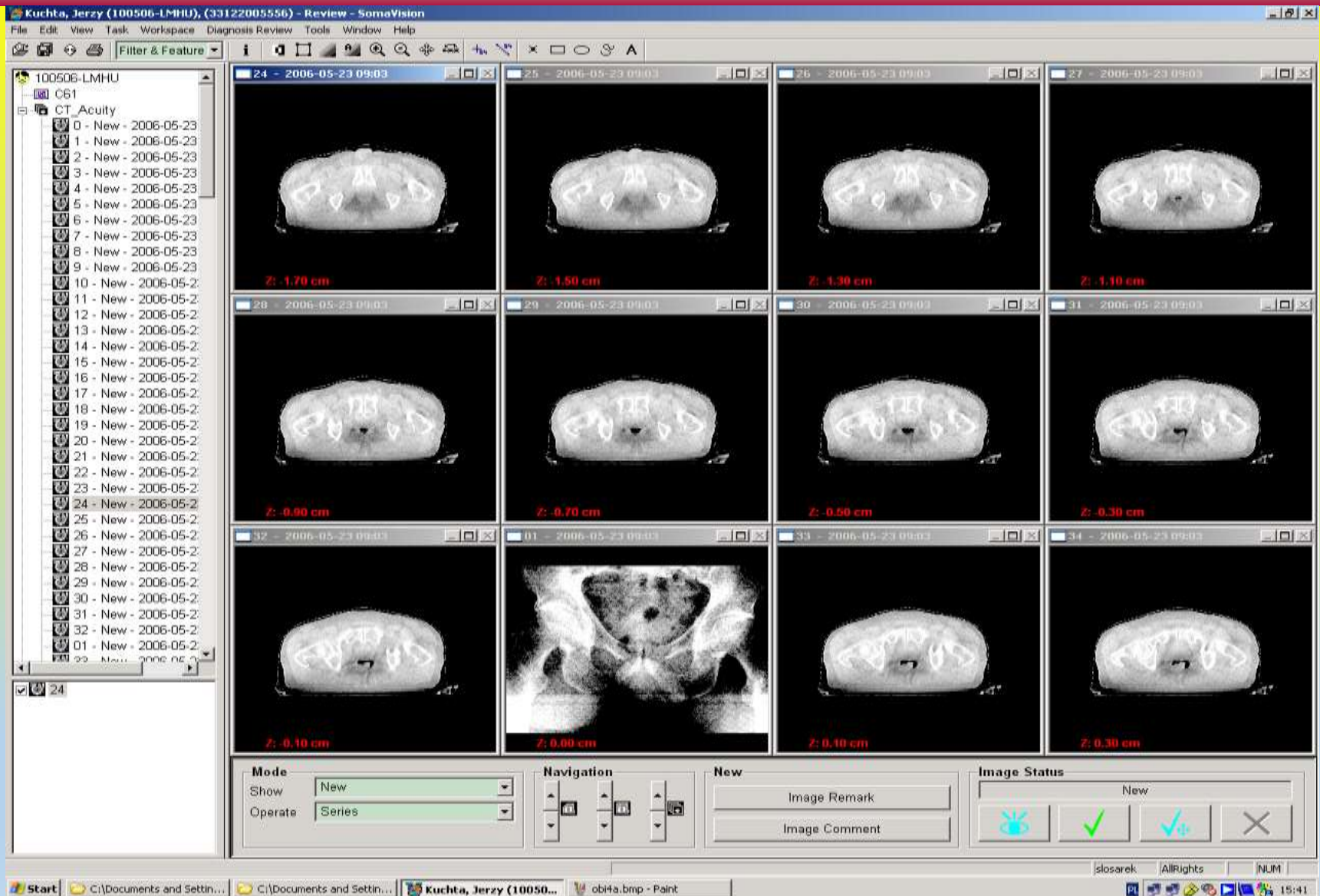
# kV vs MV



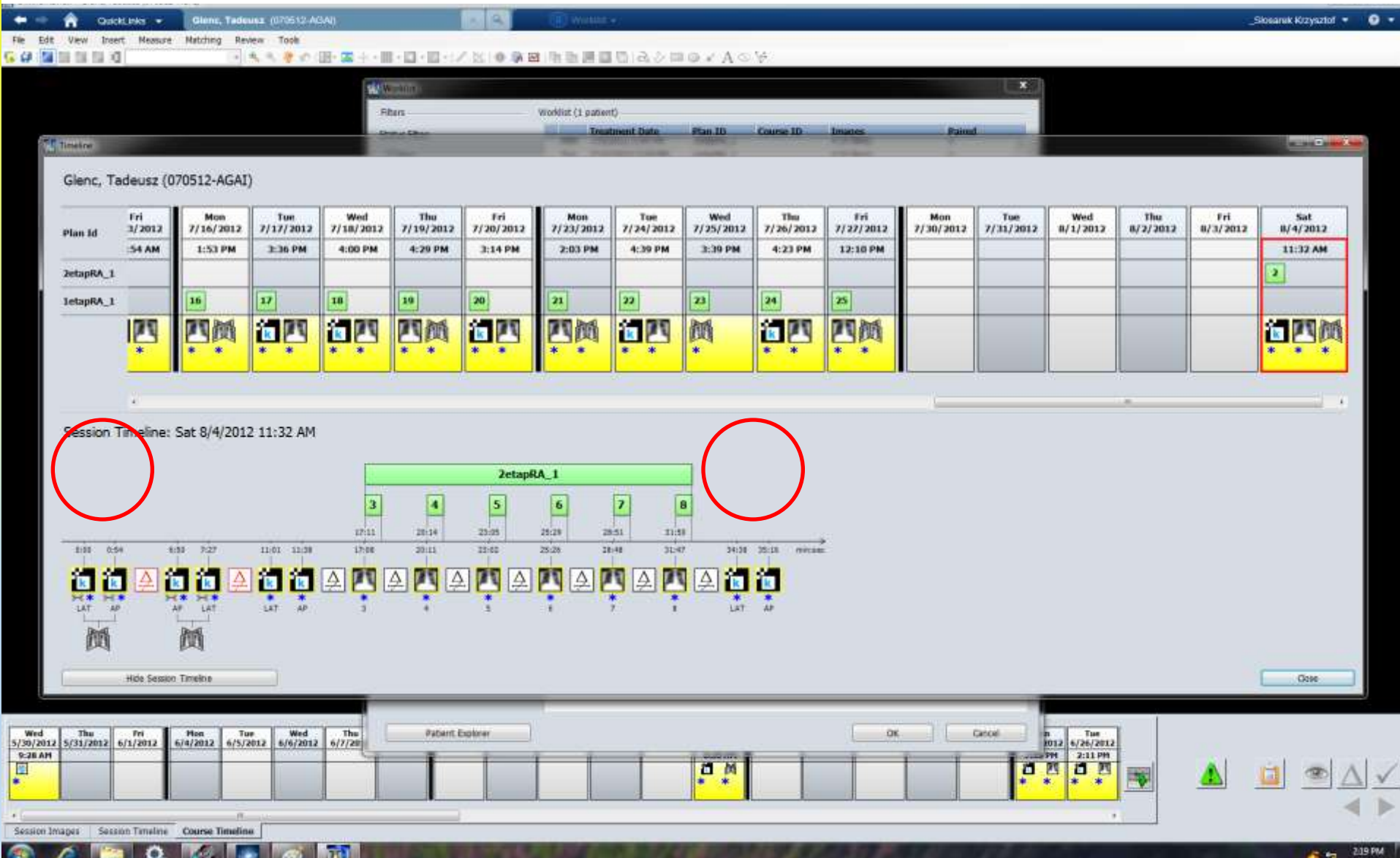
# CBCT: (3D) kV



# CBCT



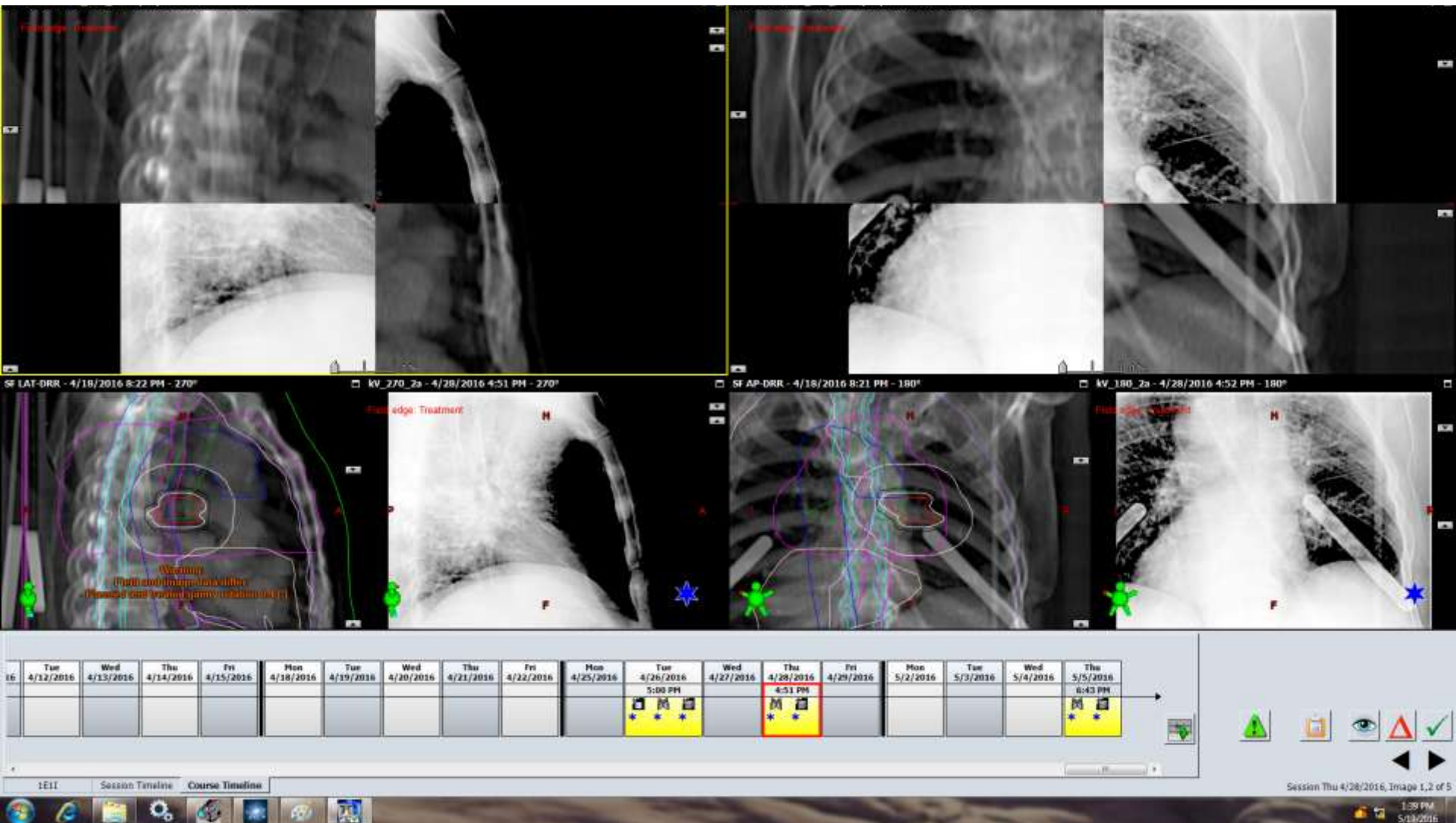
## Verification of patient and organs position: before the fraction **and** after the fraction







# Verification of patient and organs position: before the fraction **or** after the fraction

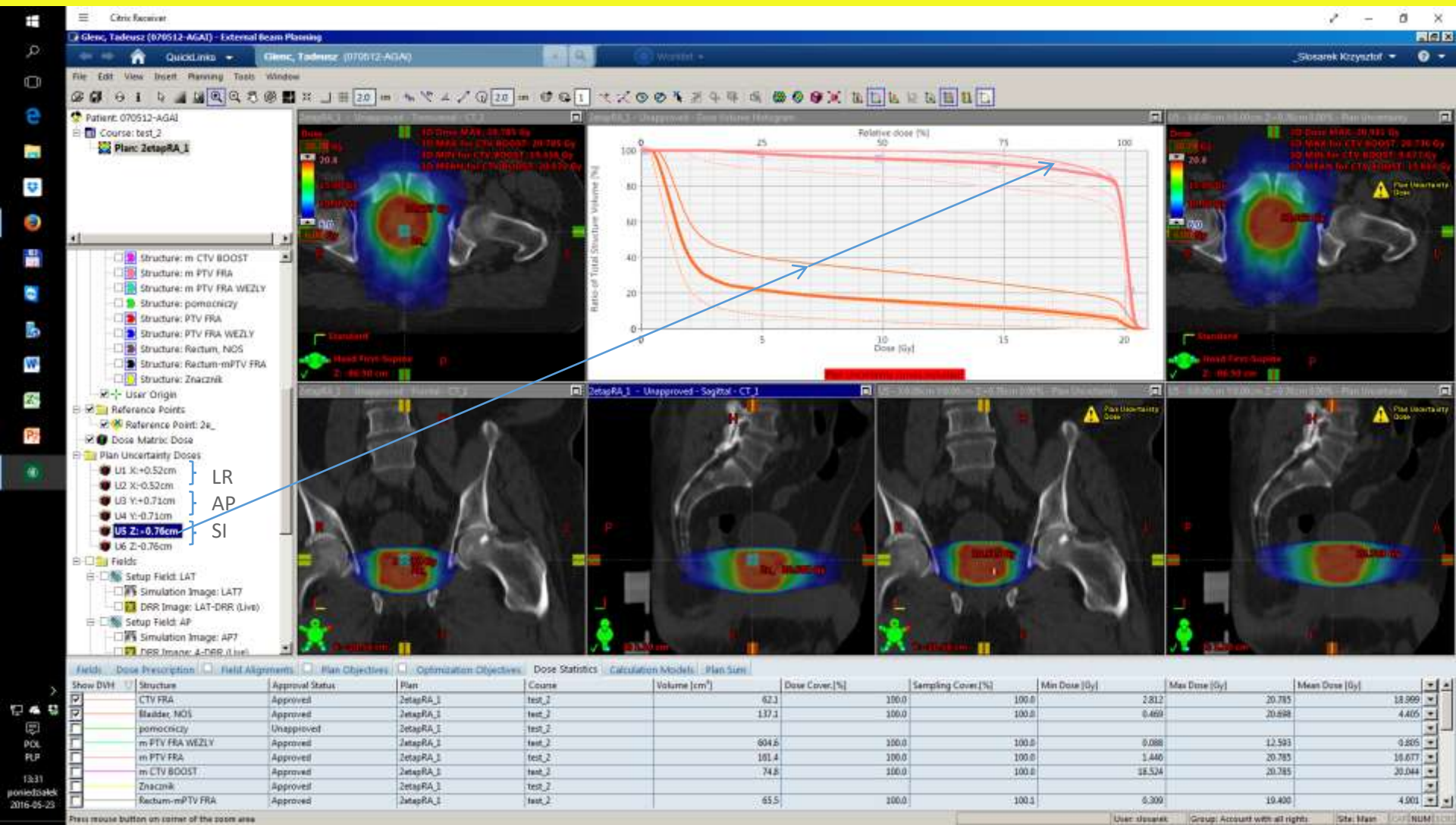


# Plan uncertainty





# Plan uncertainty



# Devices for IGRT

**Table 1.** Comparison of tomographic guidance systems

Specification	In-room CT	MV CT (tomotherapy)	MV cone beam CT	kV cone beam CT
Energy	80–140 kV	approx. 3.5 MV	2–6 MV	80–140 kVp
Resolution (min., aperture based) mm <sup>3</sup>	0.5	1 × 1 × 2	<0.5	<0.5
Soft tissue imaging	Y	Y	Y	Y
Dose	no minimum	no minimum	no minimum	no minimum
Typical dose, cGy	5–10	1–3	4–8	1–3
Physical aperture, cm	70	85	90	90
Maximum FOV, cm	XY: 50 Z: 2 × N	XY: 40 Z: 0.2-5 × N	XY: 30 Z: 30	XY: 50 Z: 26
Scan time for Z: 15 cm, sec	<10	15×10/rot: 150	60	60

*IMRT IGRT SBRT Meyer J, Karger, 2007*

# Deformacje: objętości i dawki

Object Explorer - Jach, Grazyna (2043254), (64101205645)

Patient: 2043254

- Course: Velocity
- Course: DDcon C3 Nad
- Course: WER\_C3 Nad
- Course: C3 Nad
- Course: WER\_G2 P
- Course: G2 P
- Course: wer G1 P
- Course: G1 P
- Course: C2
- Course: C1
- 4D Image: 4D\_CT1
- 4D Image: 4D\_CT2
- 4D Image: 4D\_CT3
- 4D Image: 4D\_CT4
- All Diagnostic Images
- All Structure Sets
- DICOM View
  - Study: 2043254
  - Study: 3
  - Study: C1
  - Study: C2
  - Study: Id2639412
  - Study: Id2639660
  - Study: Id2786816
  - Study: Id2799450
  - Study: Id2811510
  - Study: S
  - Study: S1
  - Study: S2
  - Study: WER\_C3 Nad
  - Study: WER\_G2 P
- Diagnosis: C34.9

ID	Clinical Status	Intent	Start Date	Comment	Name	Type
Velocity	ACTIVE	Unknown	4/8/2016			
DDcon C3 Nad	ACTIVE	Unknown	4/5/2016			
WER_C3 Nad	ACTIVE	Unknown	4/4/2016			
C3 Nad	ACTIVE	Unknown	3/30/2016			
WER_G2 P	ACTIVE	Unknown	3/7/2016			
G2 P	ACTIVE	Unknown	3/3/2016			
wer G1 P	ACTIVE	Unknown	7/31/2015			
G1 P	ACTIVE	Unknown	7/28/2015			
C2	ACTIVE	Unknown	7/23/2015			
C1	ACTIVE	Unknown	7/9/2015			
4D_CT1					4D_CT1	4D Image
4D_CT2					4D_CT2	4D Image
4D_CT3					4D_CT3	4D Image
4D_CT4					4D_CT4	4D Image
C34.9						

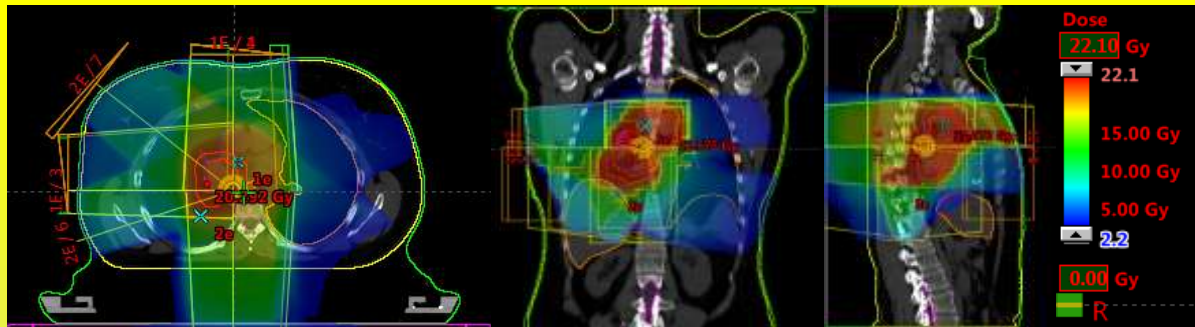
3 x 10 Gy the adrenal gland

1 x 20 Gy lung L

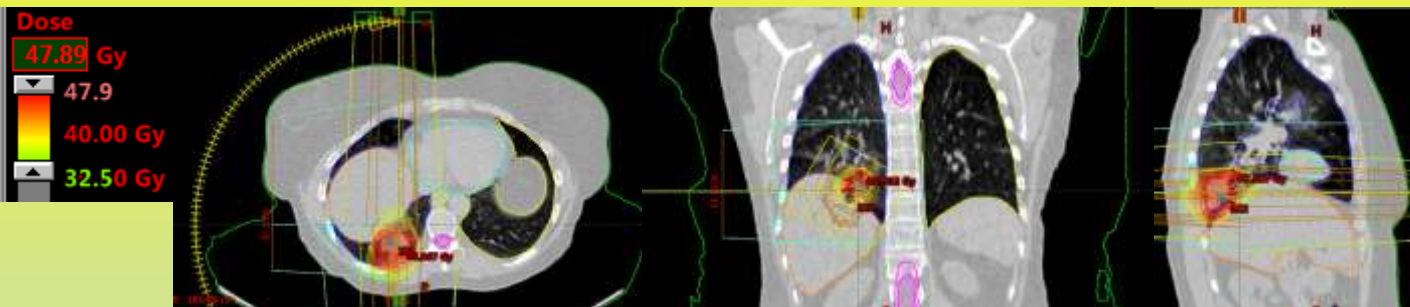
3 x 15 Gy lung R

4 x 5 Gy mediastinum

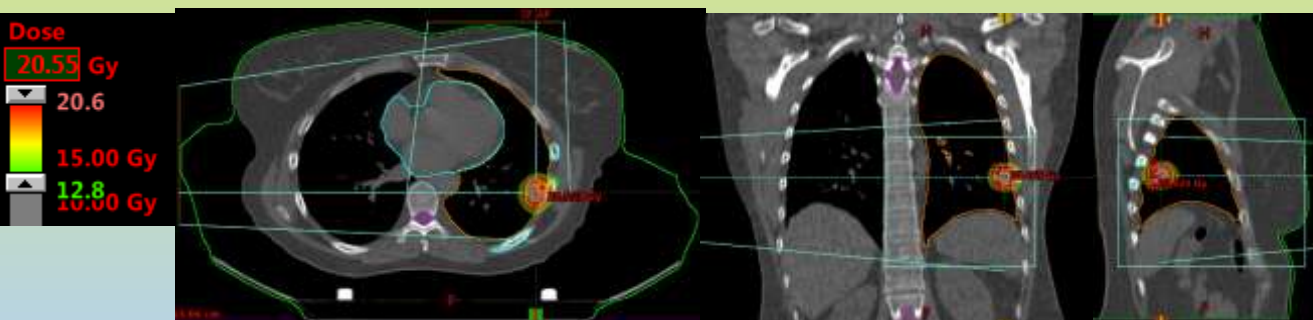




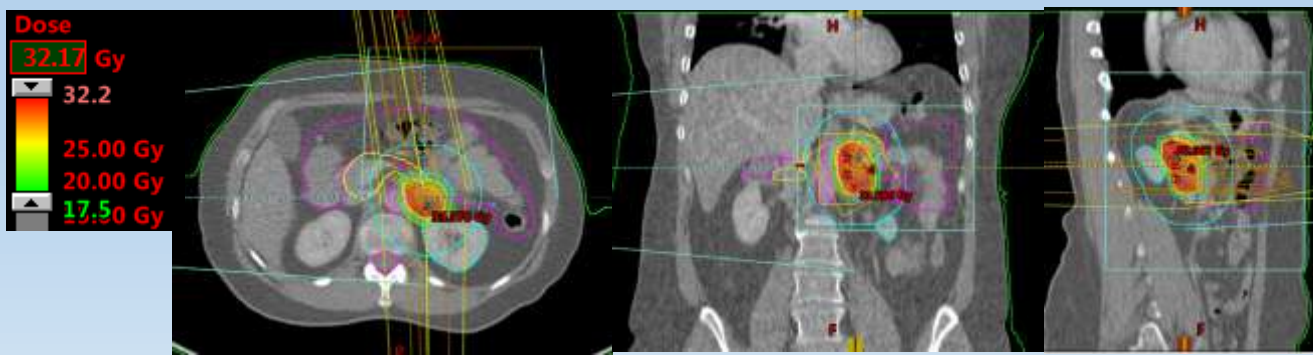
4 x 5 Gy mediastinum



3 x 15 Gy lung R

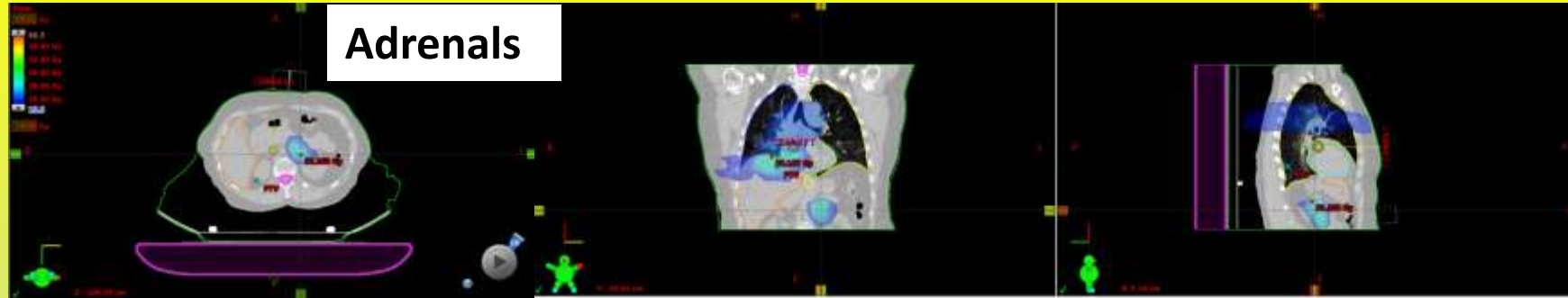


1 x 20 Gy lung L



3 x 10 Gy the adrenal gland

# SUM: all stages of treatment, 3D set ( deformation ) – programme VELOCITY (VMS)



dziękują za uwagę.

ytania ?



[Krzysztof.Slosarek@io.gliwice.pl](mailto:Krzysztof.Slosarek@io.gliwice.pl)

[www.io.gliwice.pl](http://www.io.gliwice.pl)