

IMAGING TECHNIQUES
in
RADIOTHERAPY

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ACIBADEM
SISTINA

University hospital radiotherapy service



University hospital radiotherapy service



- 2 simulators - 1 classic, 1 CT
- 3 Varian linacs
- + 2 Electra linacs

Private hospital radiotherapy service



Private hospital radiotherapy service

- MR, PET-CT
- CT simulator
- 2 Varian IX linacs



INTRODUCTION

- Imaging modalities used in medicine
 - Radiography
 - Ultrasound
 - Computer Tomography
 - Magnetic Resonance Images
 - Positron Emission Tomography

INTRODUCTION

- Radiotherapy treatment goal
 - deliver as high as possible dose to the volume of interest
 - spare the surrounding healthy tissues as much as possible

INTRODUCTION

The delivered dose should be the same as the predicted one.

That dose should be delivered on the certain volume (PTV)

Q1: How we are sure that the delivered dose is the same as the predicted one

Delivered dose accuracy depends on:

- machine functionality,
- beam calibration errors
- calculation algorithm uncertainty

Q2: How we are sure that the dose is delivered at the right place?

Delivered dose accuracy depends on:

- patient position errors
- volume of interest delineation precision

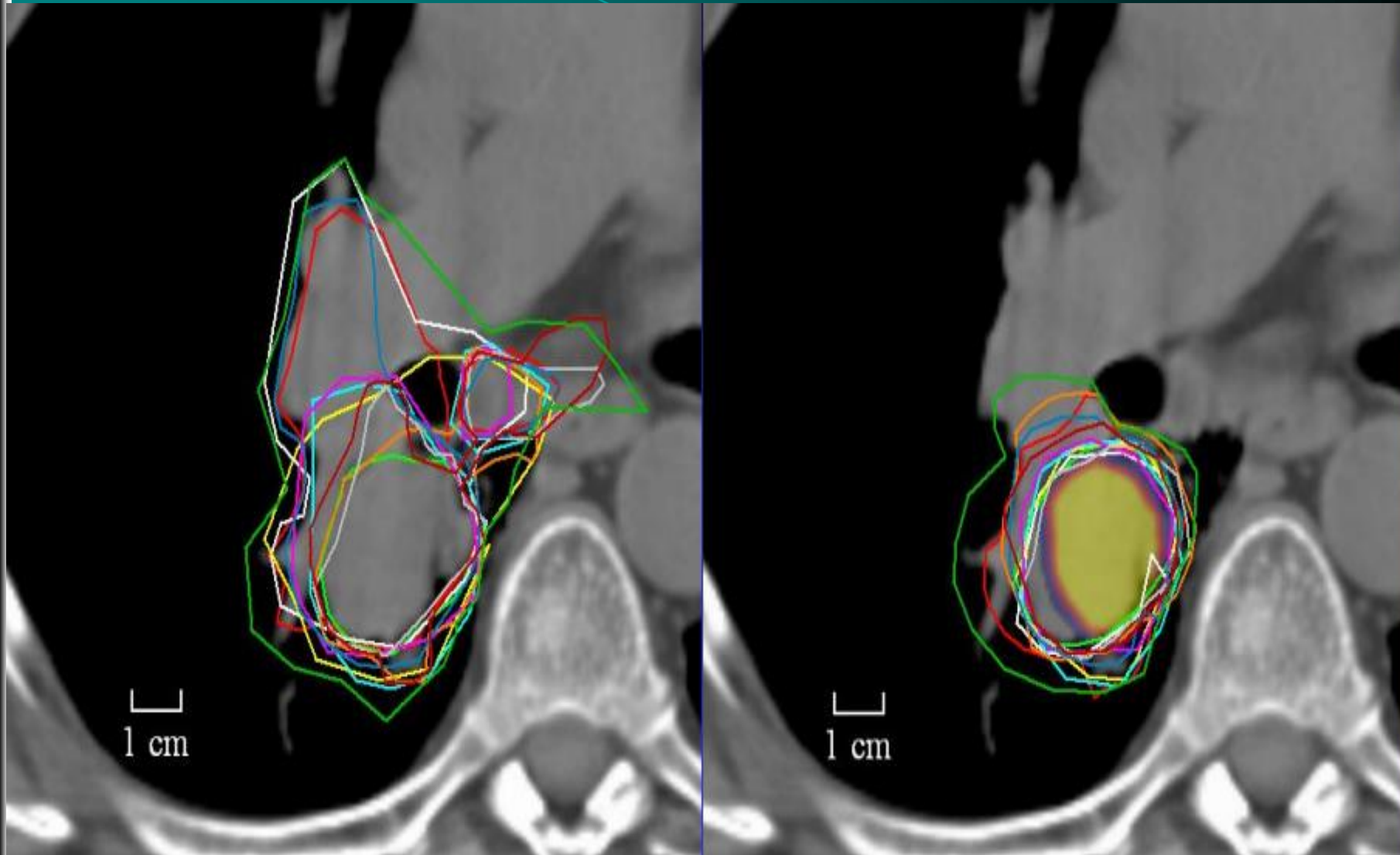
Medical IMAGES are necessary for structures contouring and patient position following

How we are sure that the delineation is correct?

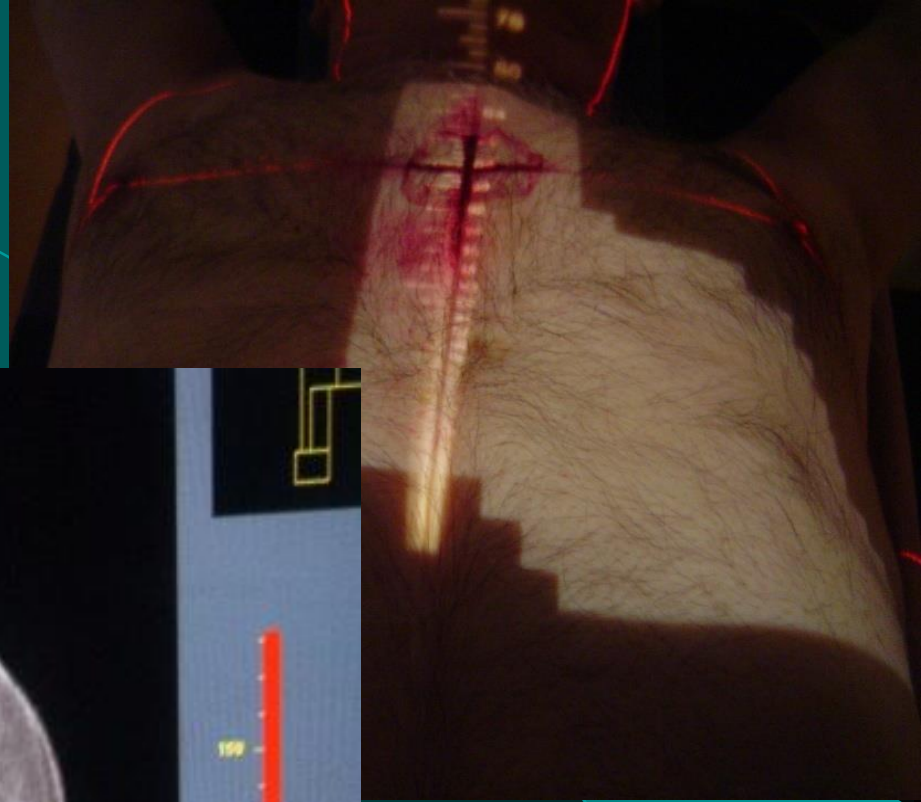
Delineation accuracy depends on:

- tumor tissue visibility
- radiation oncologist experience

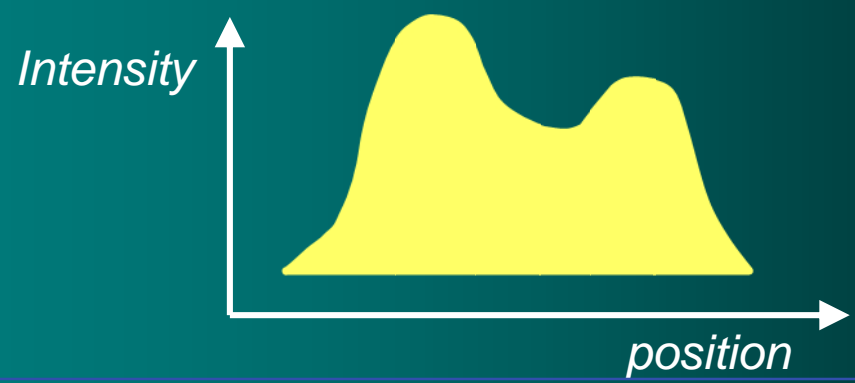
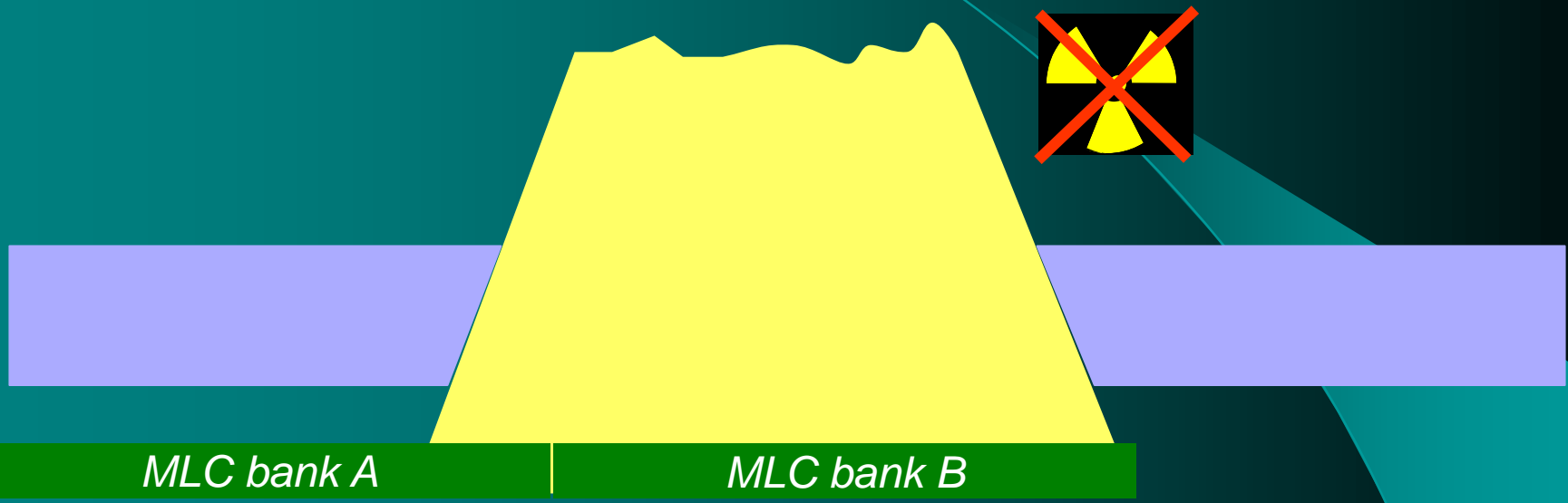
IMAGING



IMAGING





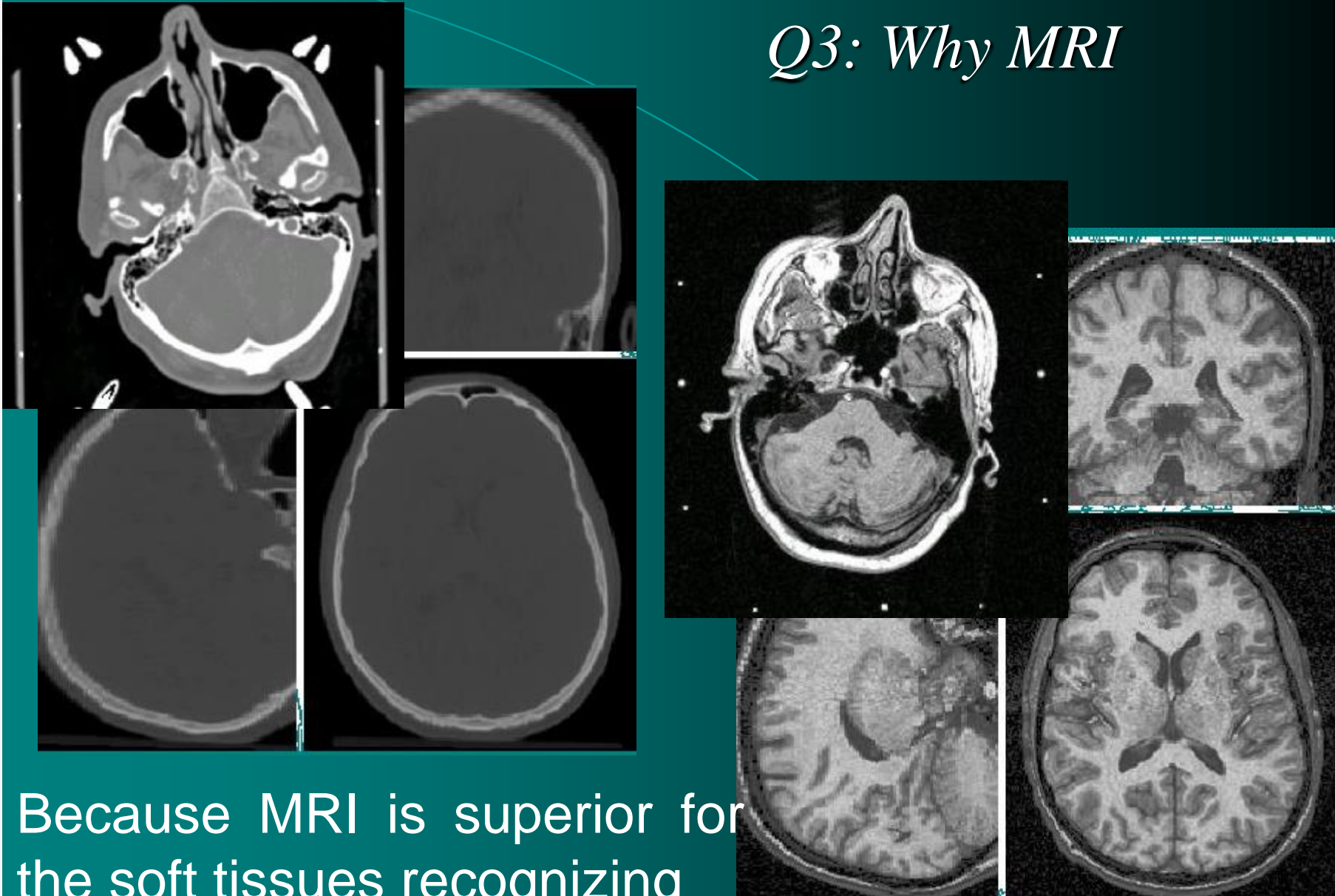


IMAGING

Integration of multimodality imaging data for radiotherapy treatment planning is beneficial and indispensable for perfect delineation.

- *CT* *for planning*
- *MRI* *for registration*
- *PET-CT*

Q3: Why MRI

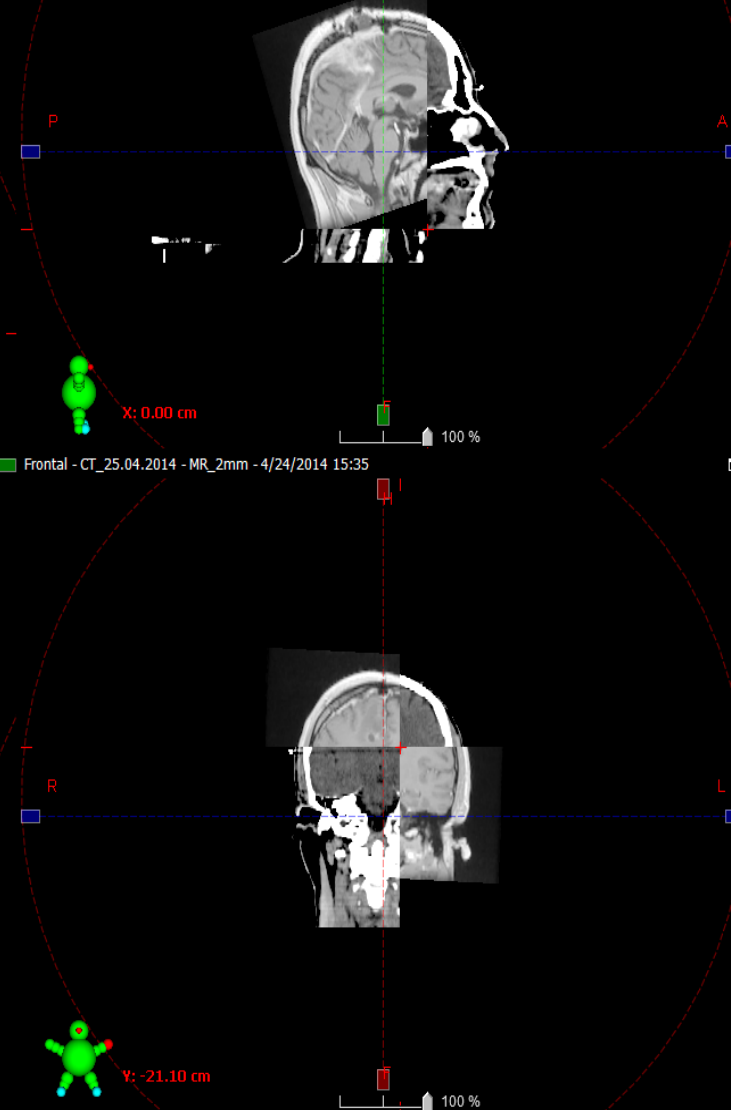
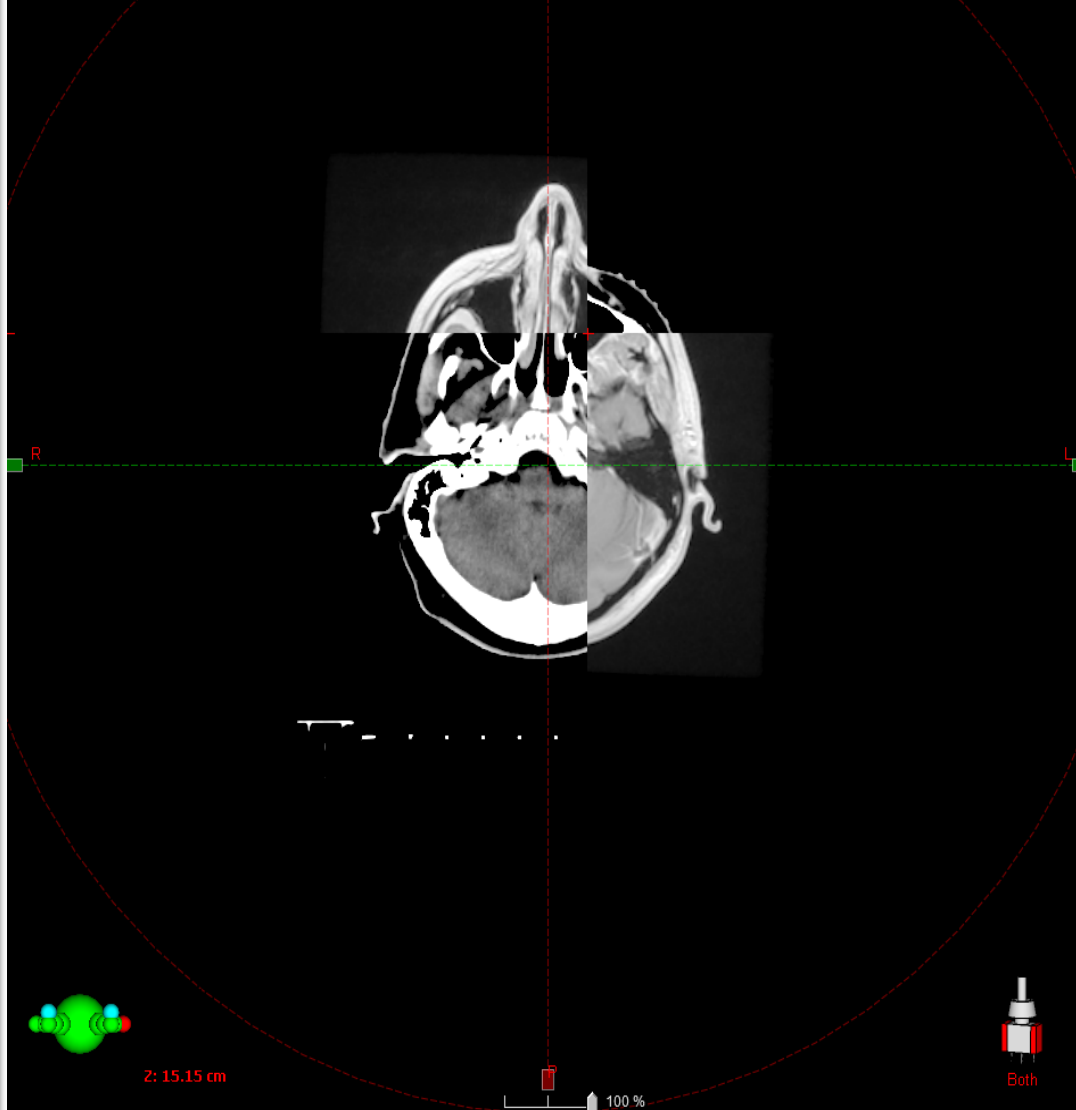


Because MRI is superior for
the soft tissues recognizing

CT - MRI registration

REGISTRATION

CT Image CT_25.04.2014 4/24/2014	MR Image MR_2mm 4/24/2014	1/7/2014 CT	3/28/2014 MRI	3/28/2014 MRI	3/28/2014 MRI	4/24/2014 CT	4/24/2014 CT	4/24/2014 MRI	4/24/2014 MRI	4/24/2014 MRI
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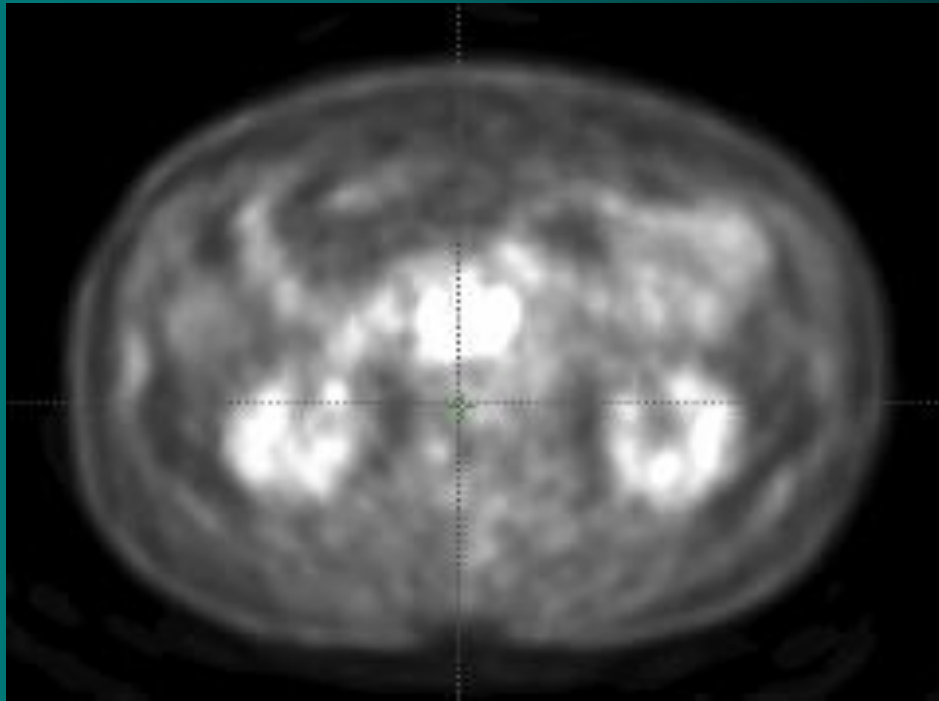


Q4: Why PET/CT

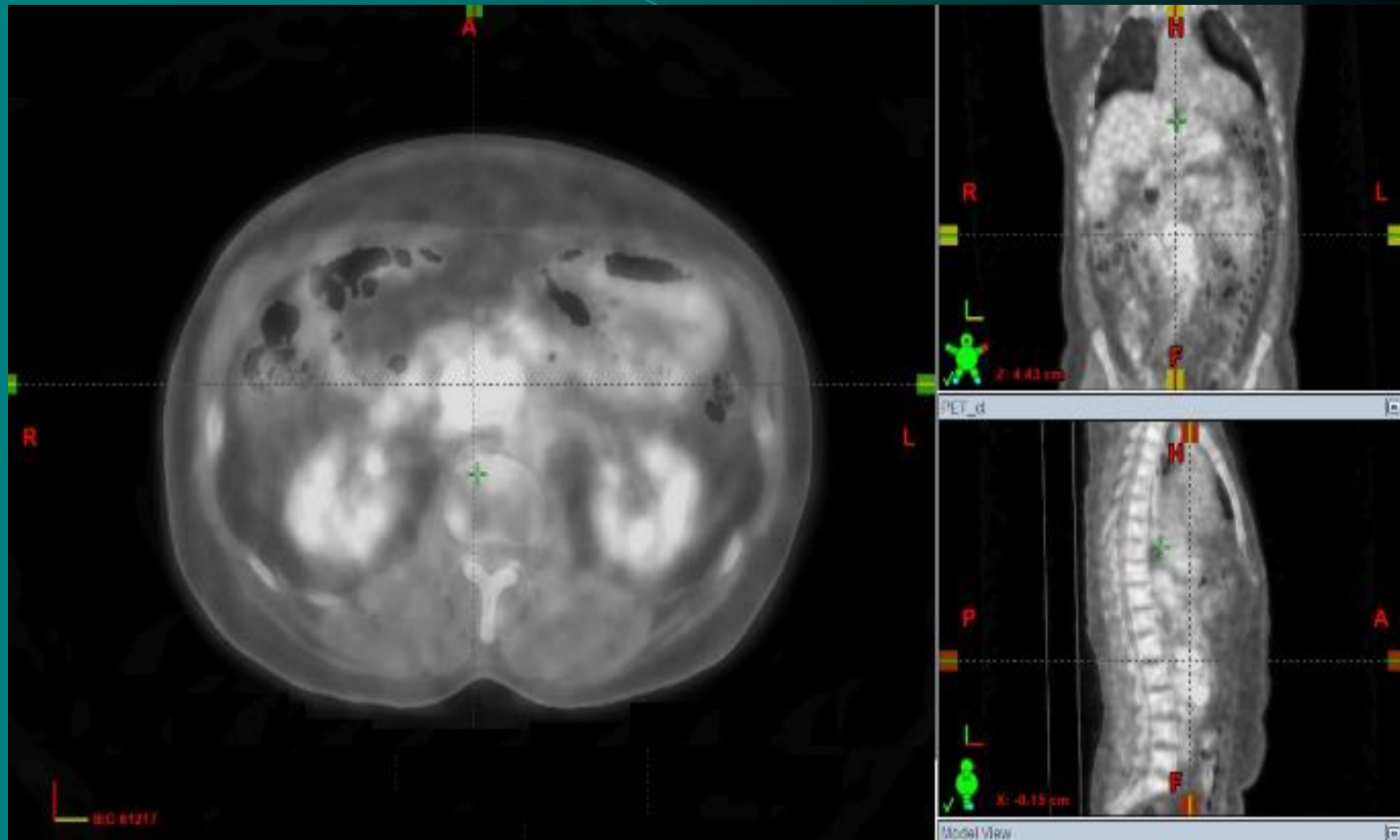


Q4: Why PET/CT

Functional imaging with PET can provide information that can influence RT planning, it can reveal targets that are not well visualized by CT/magnetic resonance (MR) structural imaging.

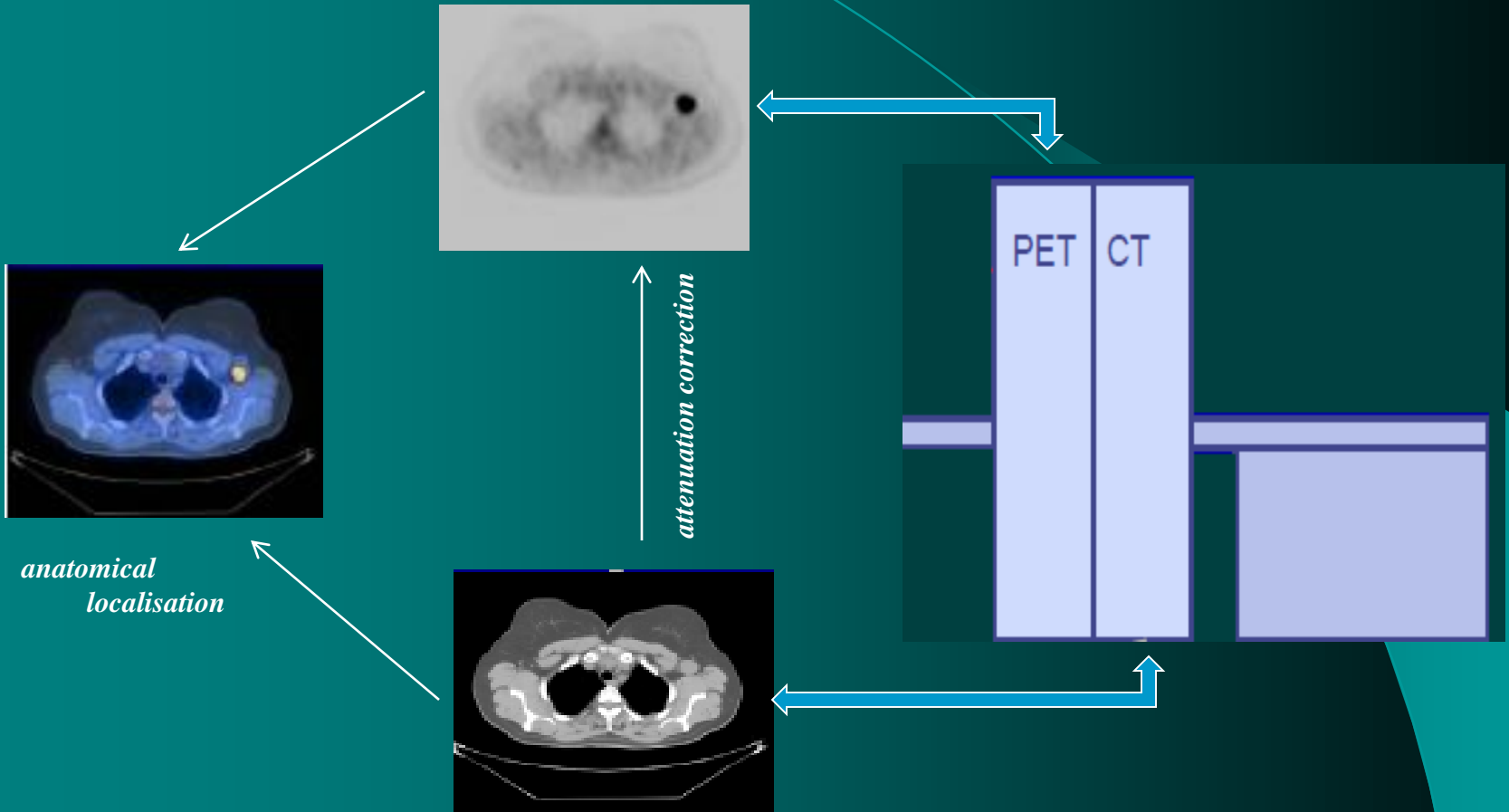


PET/CT registration



Integrated PET/CT Imaging System

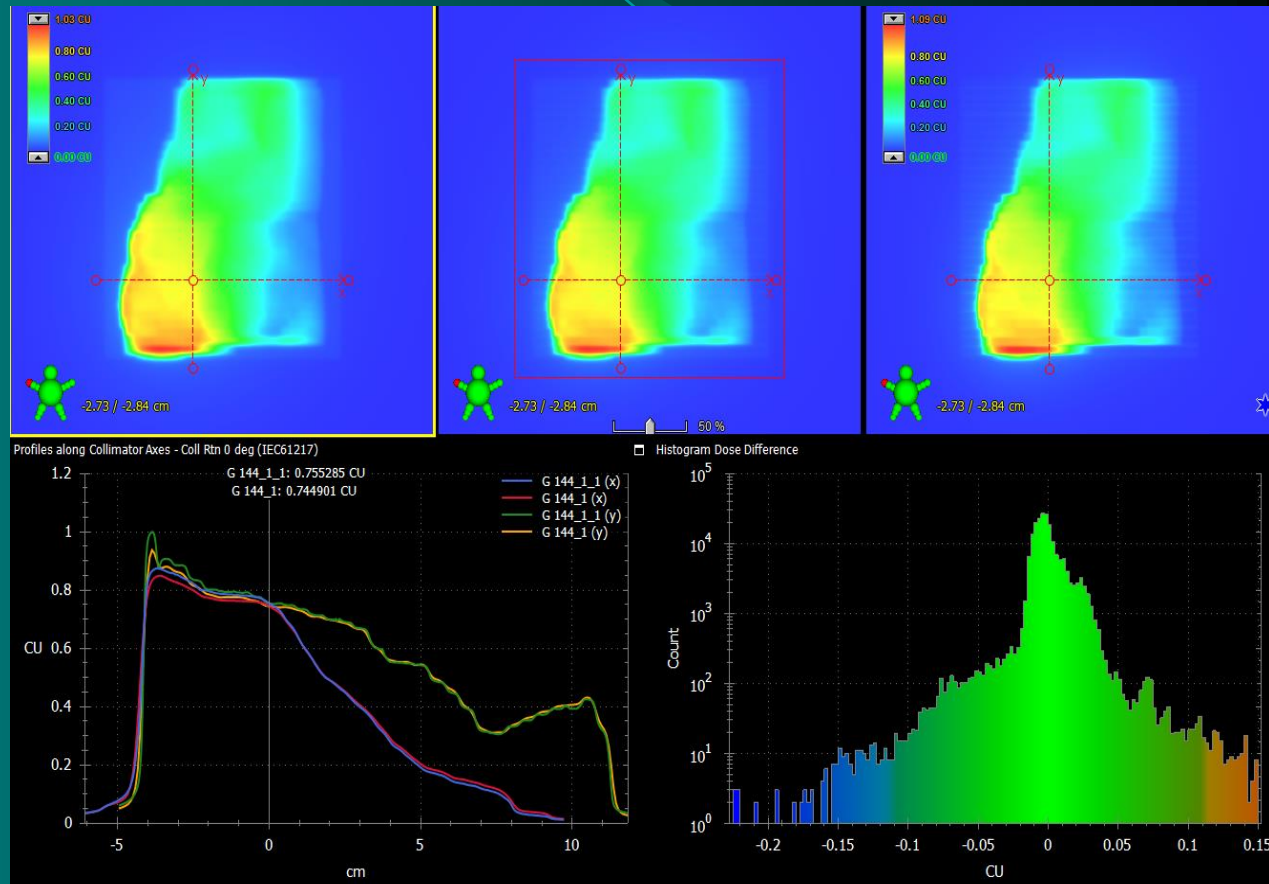
BENEFITS of COMBINED TECHNIQUE



Imaging for treatment verification

On-board MV imaging capabilities:

- EPID for pretreatment plan verification
(without patient)



Imaging for treatment verification

On-board kV imaging capabilities:

- Radiography (2-D), fluoroscopy (2-D),
(on site patient positioning)
- cone-beam CT (3 beam CT (3-D)
(on site tumor positioning)

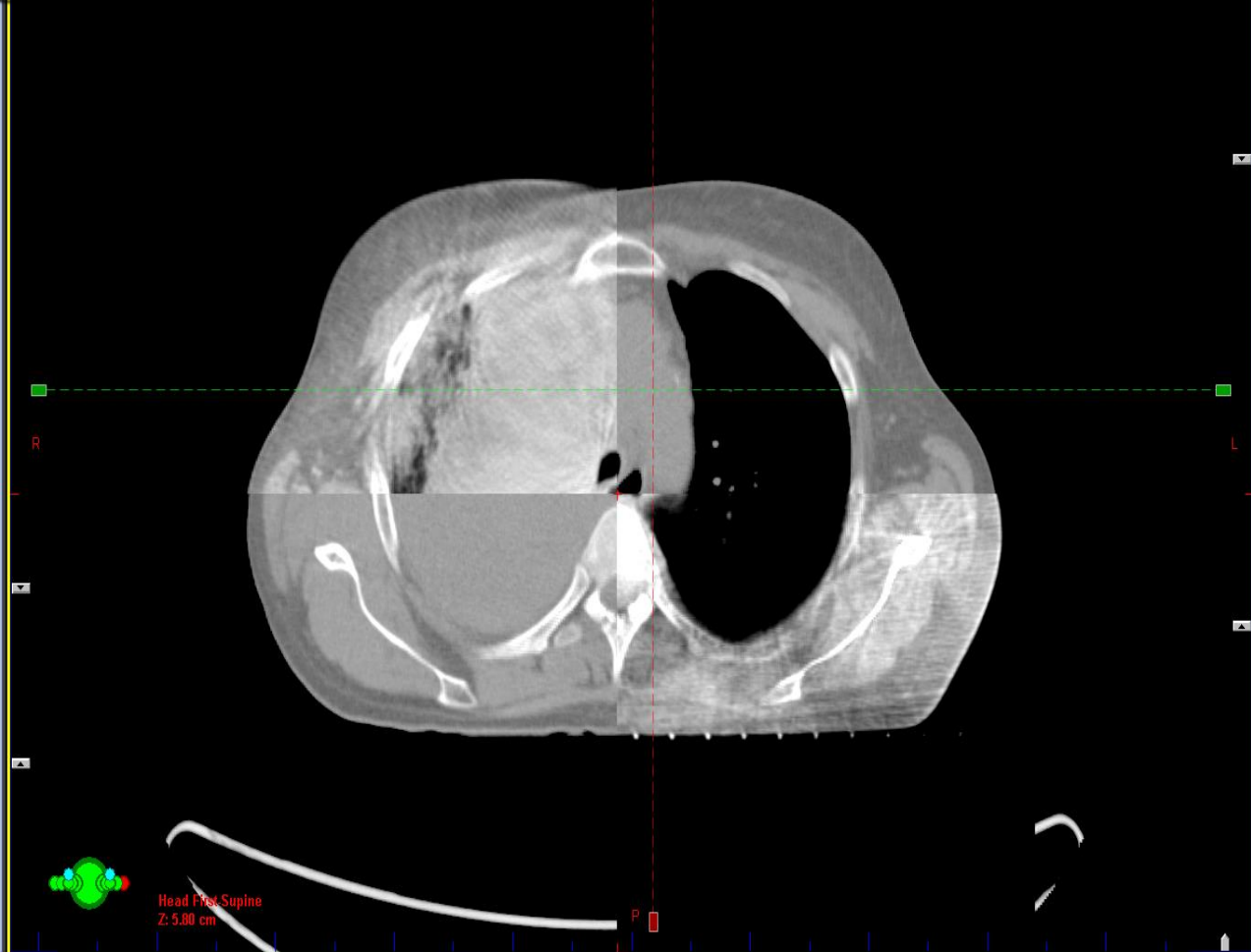


Imaging for treatment verification

- LUNG
- kV
- CE

Plan Tree Image Gallery

Transvers 1 - CT 1 - CBCT 1 - 2/12/2014 13:35

Reference:
setupCBC...

Couch Position (IEC 61217 Scale) and Shift

	TARGET	ACTUAL	SHIFT		TARGET	ACTUAL	SHIFT	
Couch Vrt	-8.5	-8.9	+0.4	<input checked="" type="checkbox"/> Include	Couch Lat	+4.3	+4.2	+0.1 <input checked="" type="checkbox"/> Include
Couch Lng	131.9	131.8	+0.1	<input checked="" type="checkbox"/> Include	Couch Rtn	359.9	359.9	0.0 <input type="checkbox"/> Include

Reset Shift

Save Match

Apply Shift

Imaging for treatment verification

- CBCT verification plan

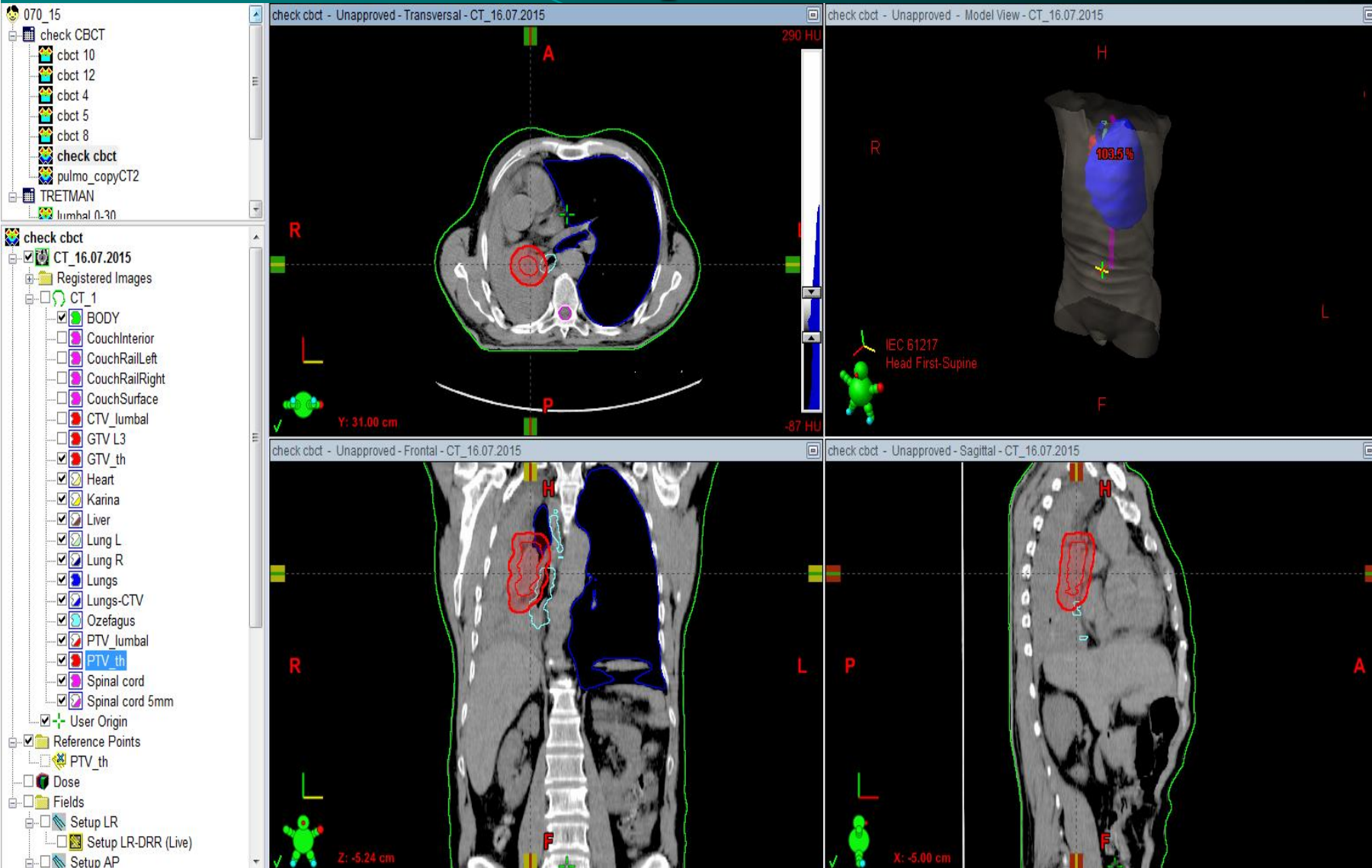


IGRT in practice

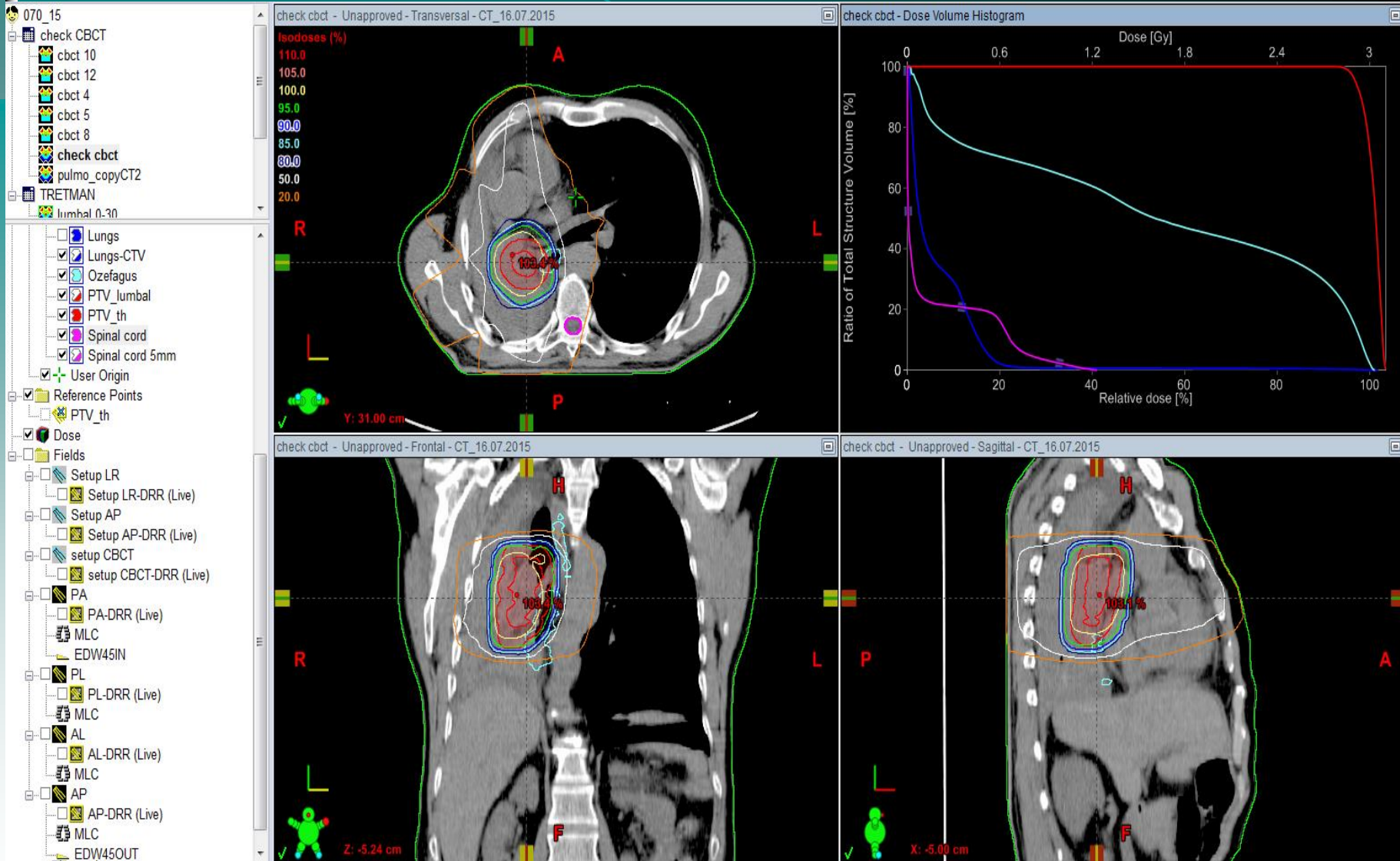
The screenshot displays a medical software interface for IGRT (Image-Guided Radiation Therapy) in practice. The interface is divided into several panels:

- Left Panel (Tree View):** A hierarchical list of objects and treatment plans. The object **check cbct** is expanded, showing a sub-entry **CT_16.07.2015** which is circled in red. Other objects include **cbct 10**, **cbct 12**, **cbct 4**, **cbct 5**, **cbct 8**, **check cbct**, **pulmo_copyCT2**, **TRETMAN**, and **lumbal 0-30**. Under **check cbct**, there are sections for **Registered images** (containing **CT_1** with sub-items like **BODY**, **CouchInterior**, etc.), **Reference Points** (containing **PTV_th**), **Dose**, and **Fields** (containing **Setup LR**, **Setup LR-DRR (Live)**, and **Setup AP**).
- Top-Left Panel:** **check cbct - Unapproved - Transversal - CT_16.07.2015**. Shows a transverse CT slice with a green contour around the body and a blue contour around the lungs. A red arrow points to a specific area. A vertical scale on the right shows **290 HU** at the top and **-87 HU** at the bottom. A coordinate indicator shows **Y: 31.00 cm**.
- Top-Right Panel:** **check cbct - Unapproved - Model View - CT_16.07.2015**. Shows a 3D model of the patient's torso with a blue lung volume. A red arrow points to the lung volume, which is labeled **103.5 %**. A coordinate indicator shows **IEC 61217 Head First-Supine**.
- Bottom-Left Panel:** **check cbct - Unapproved - Frontal - CT_16.07.2015**. Shows a frontal CT slice with a green contour around the body and a blue contour around the lungs. A red arrow points to a specific area. A coordinate indicator shows **Z: -5.24 cm**.
- Bottom-Right Panel:** **check cbct - Unapproved - Sagittal - CT_16.07.2015**. Shows a sagittal CT slice with a green contour around the body and a blue contour around the lungs. A red arrow points to a specific area. A coordinate indicator shows **X: -5.00 cm**.

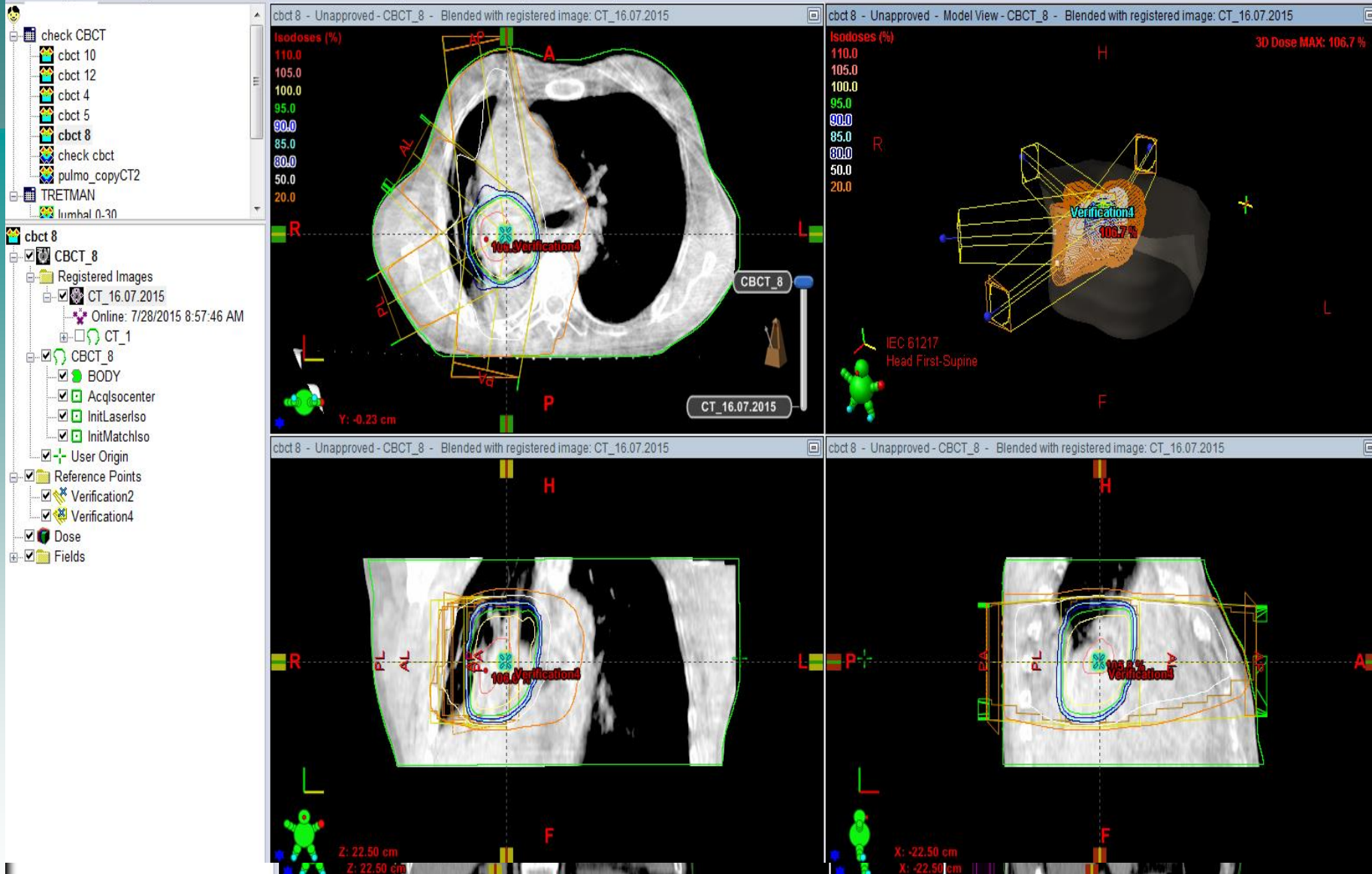
IGRT in practice



IGRT in practice



IGRT in practice



IGRT in practice

check CBCT
cbct 10
cbct 12
cbct 4
cbct 5
cbct 8
check cbct
pulmo_copyCT2
TRETMAN
lumbal 0-30

cbct 12
CBCT_12
Registered Images
CT_29.07.15
Online: 8/5/2015 8:14:47 AM
CT_2
BODY
CouchInterior
CouchRailLeft
CouchRailRight
CouchSurface
ezofagus
GTV 1
GTV p
GTV2
Lungs
Ozefagus
PTV 50
PTV2
Spinal cord

CBCT_12
BODY
AcqIsocenter
InitLaserIso
InitMatchIso
User Origin
Reference Points
Verification5
Dose
Fields

cbct 12 - Unapproved - CBCT_12 - Blended with registered image: CT_29.07.15
Isodoses (%)
110.0
105.0
100.0
95.0
90.0
85.0
80.0
50.0
20.0
109.9%
Verification5
CBCT_12
CT_29.07.15
Y: -0.15 cm

cbct 12 - Unapproved - Model View - CBCT_12 - Blended with registered image: CT_29.07.15
Isodoses (%)
110.0
105.0
100.0
95.0
90.0
85.0
80.0
50.0
20.0
3D Dose MAX: 110.2%
Verification5
110.2%
IEC 61217
Head First-Supine

cbct 12 - Unapproved - CBCT_12 - Blended with registered image: CT_29.07.15
Verification5
109.9%
Z: 22.50 cm

cbct 12 - Unapproved - CBCT_12 - Blended with registered image: CT_29.07.15
Verification5
109.4%
X: -22.50 cm

CONCLUSION

Radiotherapy uses image guidance procedures to:

- ❖ delineate target volume and organs at risk
- ❖ Identify and correct problems arising from inter- and intra-fractional variation in patient setup, anatomy, target volume, and organs at risk

CONCLUSION

Excessive dose from intensive imaging procedures could be a limitation in IGRT

- ❖ Imaging doses must be balanced with demonstrable improvements in the delivery of therapeutic dose.
- ❖ Team: radiotherapist – physicist - technologists is crucial in IGRT using and developing

