

Hadron Therapy Workshop: status and perspectives, plans for next generation facilities 18-19 October 2024

Oct 18, 2024, 8:00 AM → Oct 19, 2024, 11:30 PM Europe/Zurich

Zoom

# Carbon Programme in MedAustron

## MedAustron

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&

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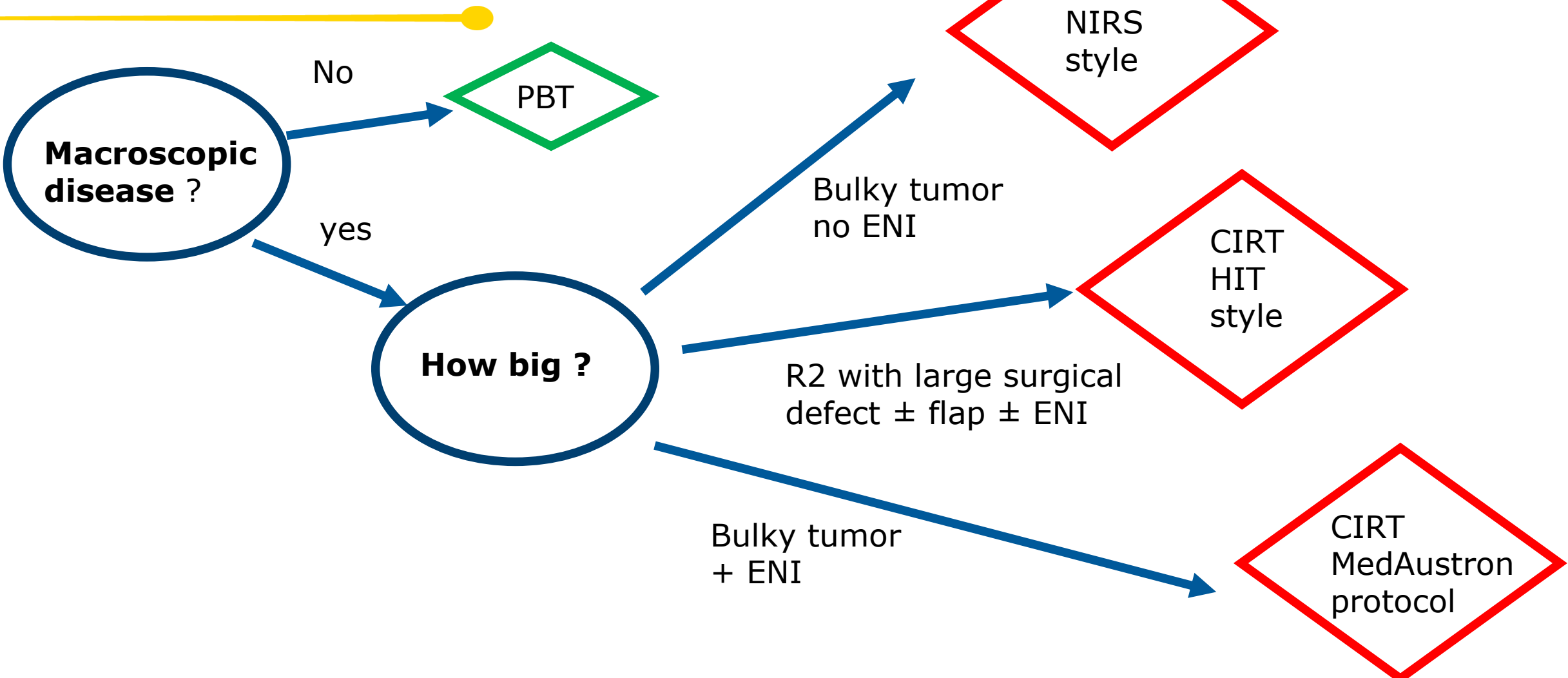
# Carbon Why?

- **Radioresistant histology**
- **Early in field recurrence after adequate dose**
- **Sharper penumbra**

# RADIORESISTENT HISTOLOGY

1. Sarcoma
2. Non SCC H&N Cancer
3. Kidney cancer
4. High risk prostate cancer ?
5. Local recurrence of rectal adn carcinoma

# HEAD AND NECK



Male 43 YO

Initial symptom : closed nose

**Diagnosis**

Adenoid cystic carcinoma  
cT4b cN0

**Prescription:**

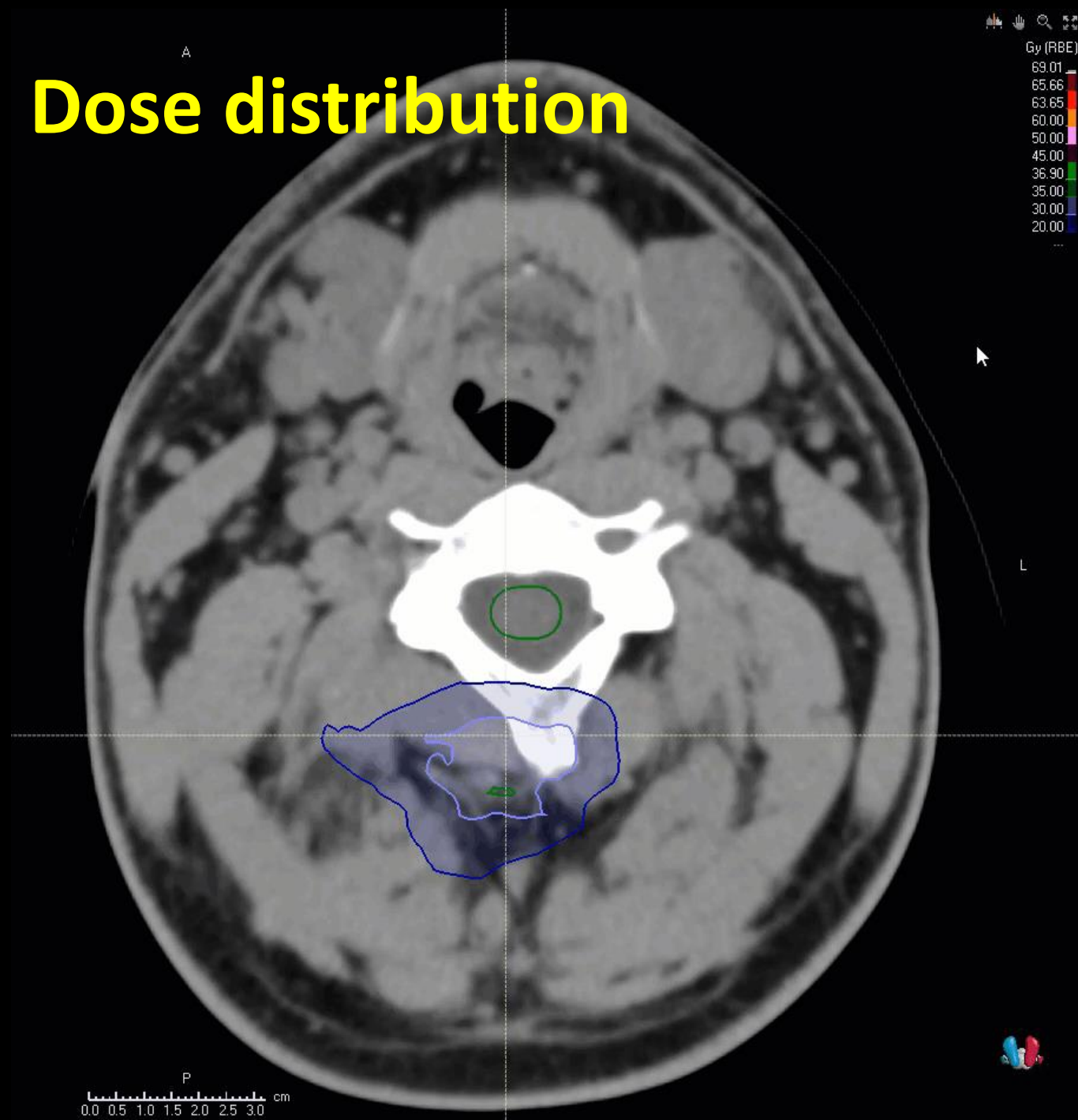
exclusive CIRT

4.1 Gy RBE x 9 to PTV1  
(36.9 Gy RBE )

4.3 Gy RBE x 7 to PTV2  
(30.1 Gy RBE)

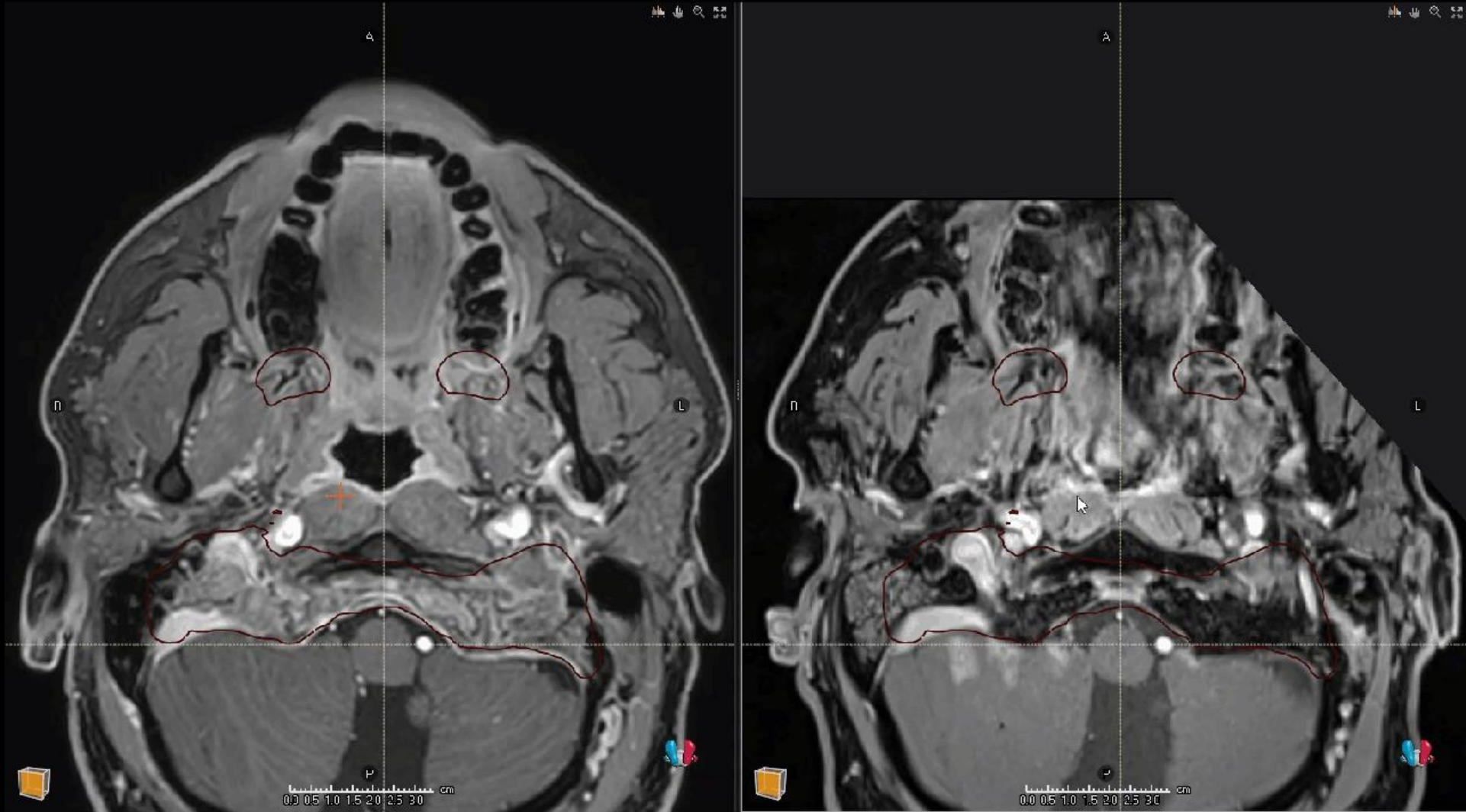
Total dose 67 Gy RBE in  
16 fr in 4 weeks

# Dose distribution

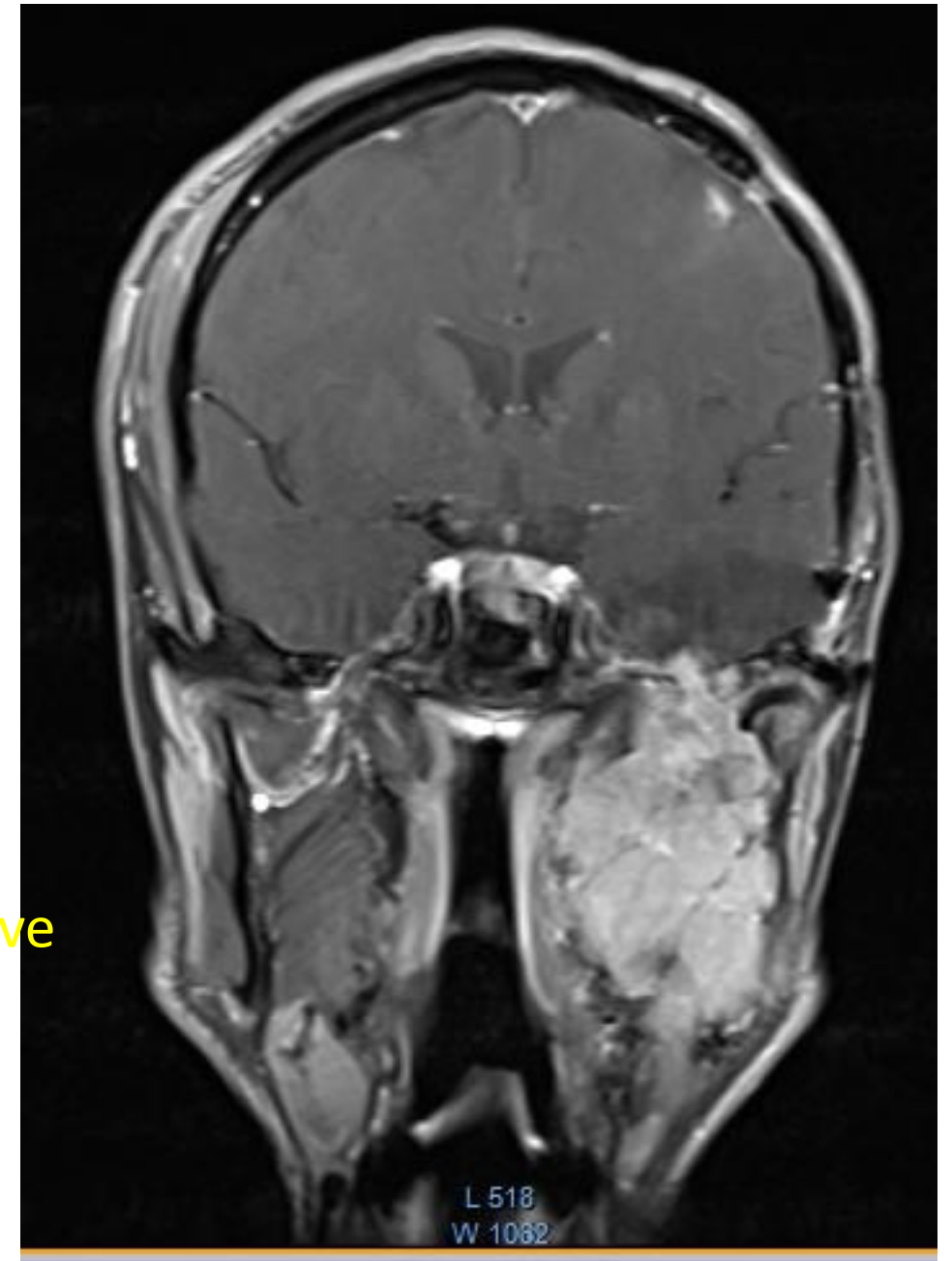
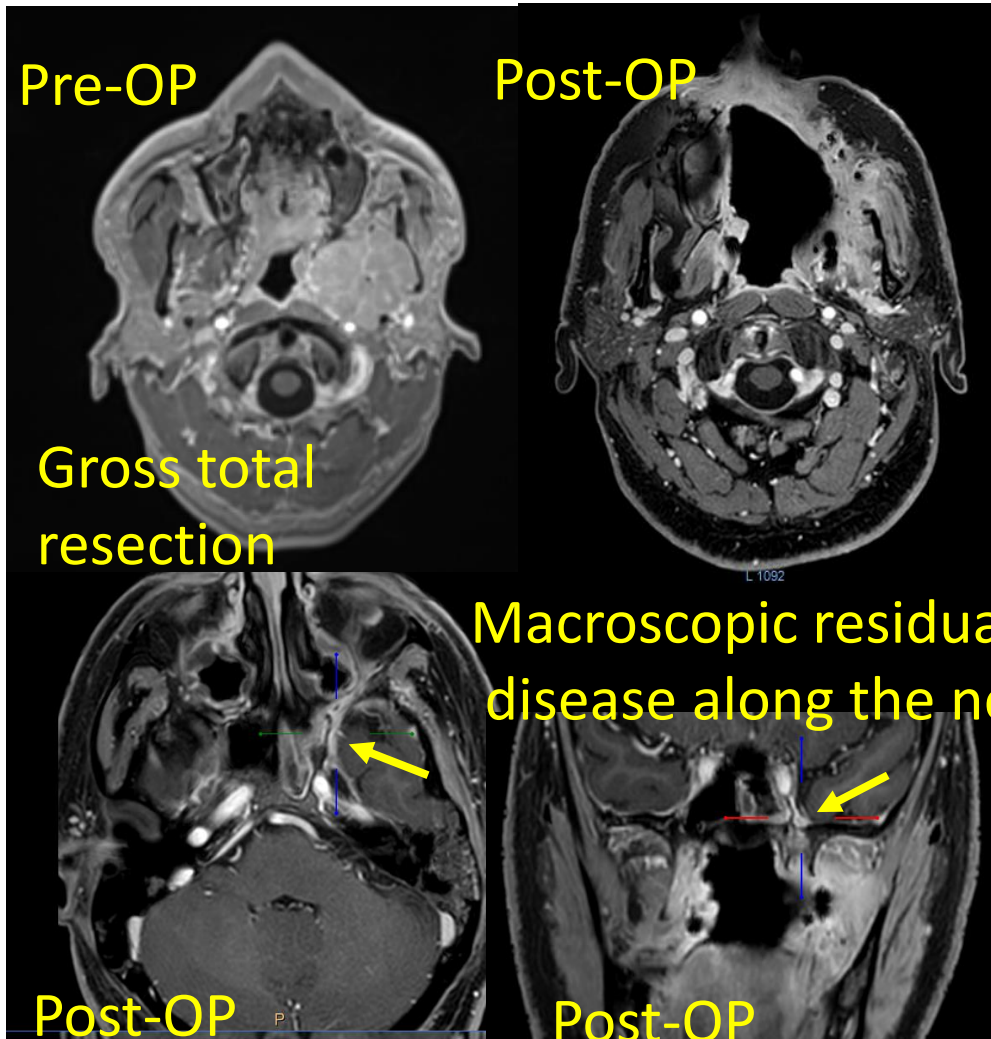


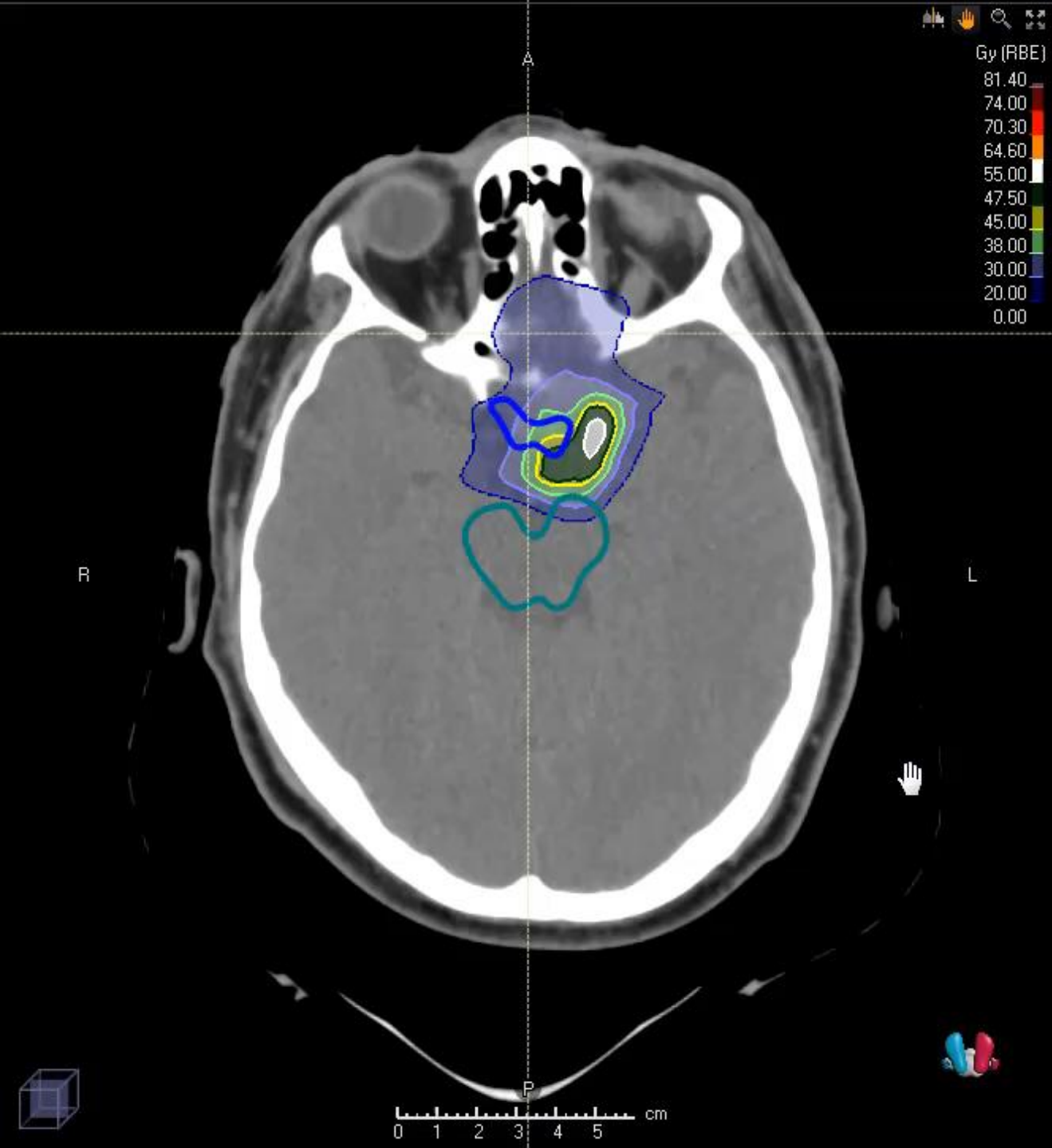


# Response at 12 Mo.



- HEMI MAXILLECTOMY 10/2019
- ACC, post. margin positive
- Perineural involvement
- PT4 N0 M0
- Post-op MRI: perineural invasion including Meckel's cave





## Prescription

PTV3	74 Gy(RBE)
PTV2	68 Gy(RBE)
PTV1	50 Gy(RBE)

- PTV1 = Protons, 50 Gy (RBE) / 25 x 2 Gy (RBE) fractions
- PTV2 = Carbons, sequential boost 6 Gy (RBE)/2 x 3 Gy (RBE) fractions
- PTV3 = Carbons, sequential boost 18 Gy (RBE) / 6 x 3 Gy (RBE)
- **Total cumulation dose:**  
74 Gy (RBE) at 2 and 3 Gy (RBE) per fractions



# GERMANY

# JAPAN

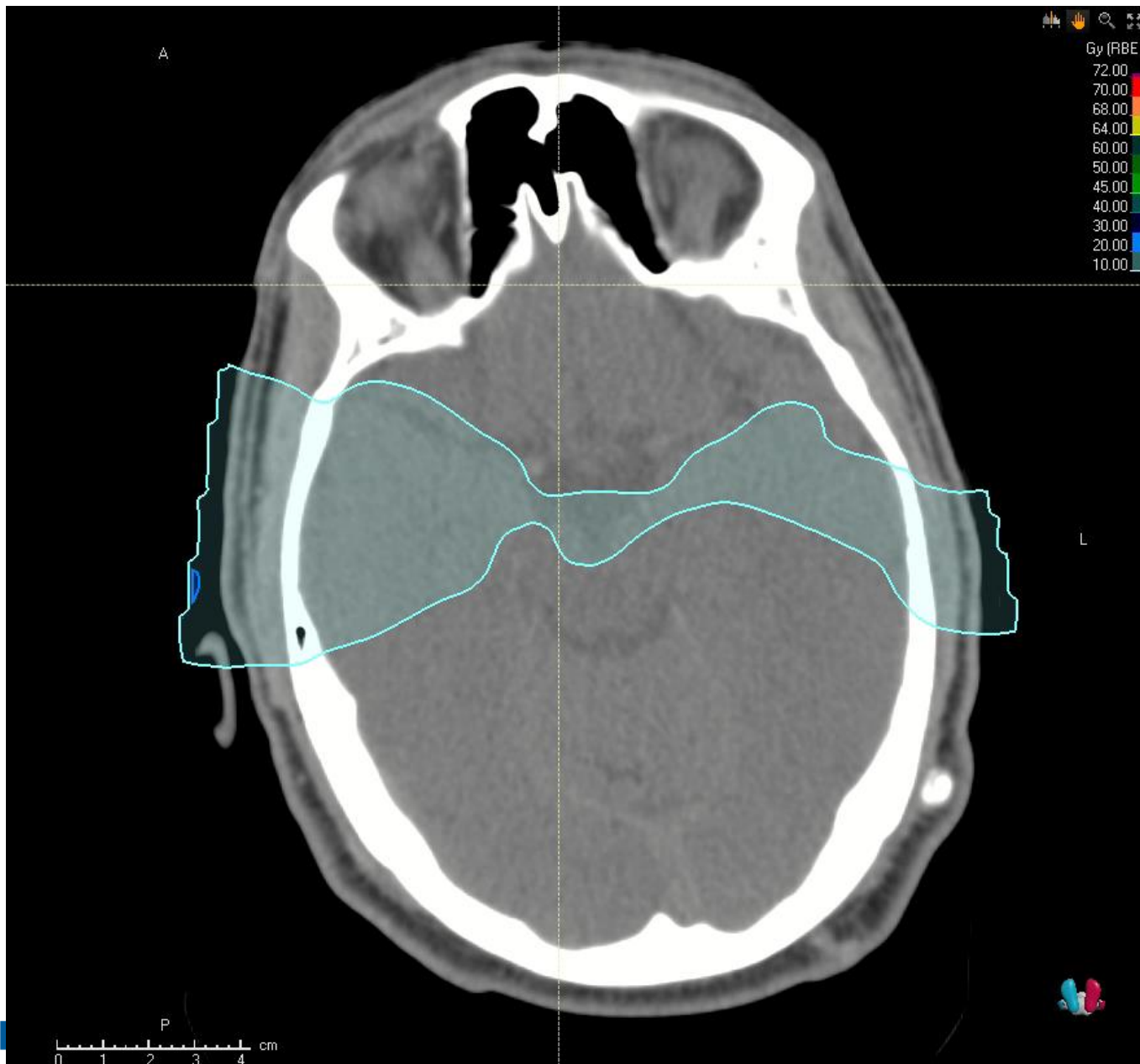
WORLD CUP  
2022

VS





# TRYING TO GET THE BEST OF BOTH WORLDS



- ACC of the base of tongue
- Bulky GTV ( 118 ml)
- Macroscopic nerve infiltration
- Non negligible risk of lymph node mets

- **PTV1 = Protons, 30 Gy (RBE) / 15 x 2 Gy (RBE) fractions**
- **PTV1 = Carbons, 18 Gy (RBE) / 6 x 3 Gy (RBE) fractions**
- PTV2 = Carbons, sequential boost 6 Gy (RBE)/2 x 3 Gy (RBE) fractions
- PTV3 = Carbons, sequential boost 18 Gy (RBE) / 6 x 3 Gy (RBE)

# Carbon How?

- **Optimize with LEM, check with MKM, iterate until both RBE models are good enough**
- **Be mindful of LET**

# Sacral Chordoma

## One RBE model is not enough

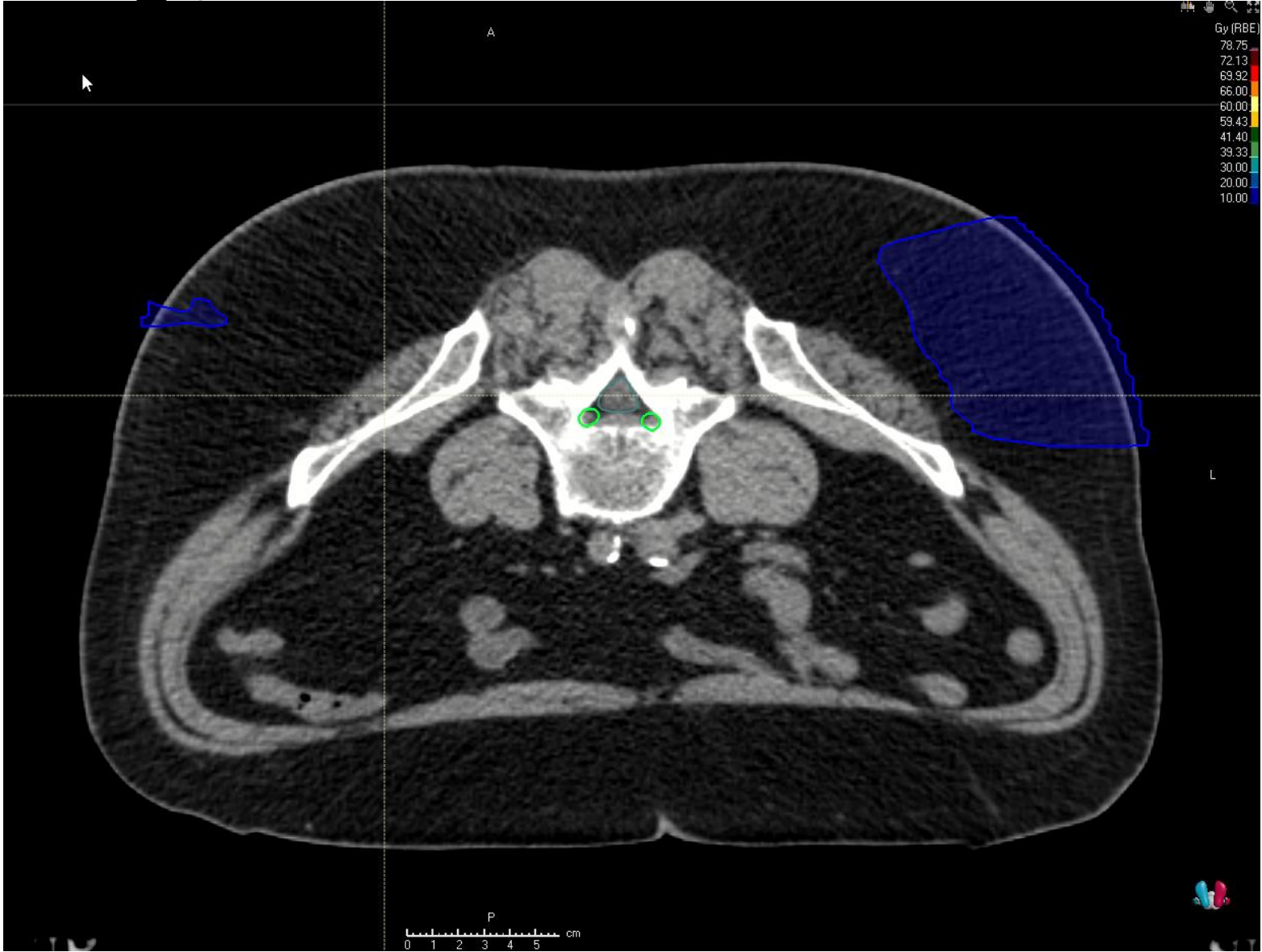
Target volume	n	d LEM-I / mMKM		D LEM-I / mMKM		Total D LEM-I / mMKM	
PTV1	9	4.6	4.2	41.4	37.8	41.4	37.8
PTV2	7	4.6	4.2	32.2	29.4	73.6	67.2



# OARs constraints:

OARs	LEM-I constraint	mMKM constraint
<b>Recto-sigmoid colon</b>	D 1 cc < 66 Gy RBE D 5 cc < 60 Gy RBE	D 1 cc < 60 Gy RBE D 5 cc < 54 Gy RBE
<b>Urinary bladder</b>	D 1 cc < 66 Gy RBE D 50 cc < 50 Gy RBE	<b>Not used</b>
<b>Small bowel</b>	D 0.1cc < 45 Gy RBE D 1cc < 40 Gy RBE	D 0.1cc < 40 Gy RBE D 1cc < 30 Gy RBE
<b>Cauda Equina</b>	D 0.1 cc < 66 Gy RBE	D 0.1 cc < 60 Gy RBE
<b>Nerve roots inside CTV2</b>	D2% < 73 Gy RBE (avoid hot spots)	D2% < 66 Gy RBE (avoid hot spots)
<b>Nerve roots outside CTV2</b>	D5% < 69 Gy RBE	D5% < 62 Gy

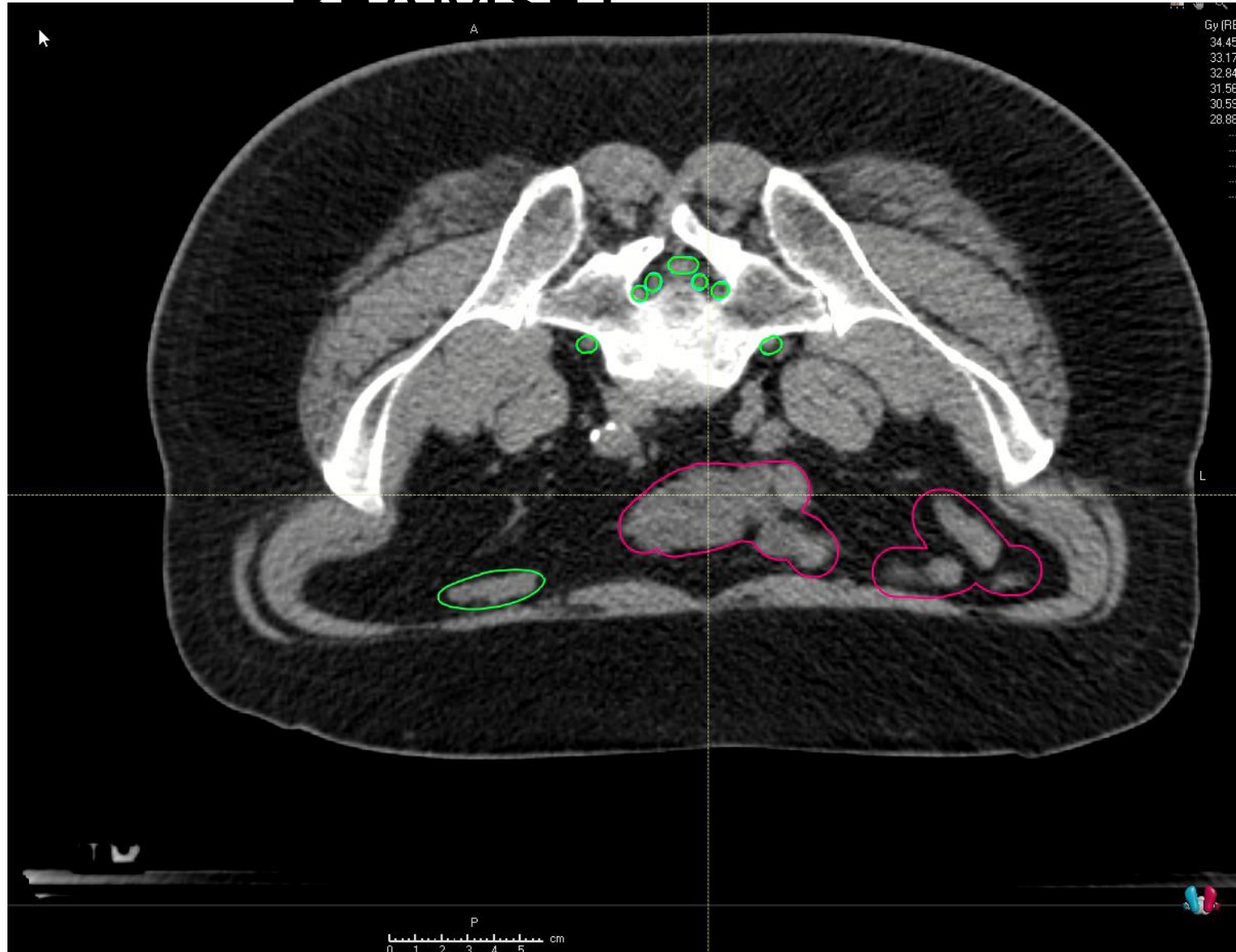
# Planning / PLAN EVALUATION 3: SUM PLAN



# Planning / PLAN EVALUATION 5: HOT SPOT IN 1

## BEAMSET

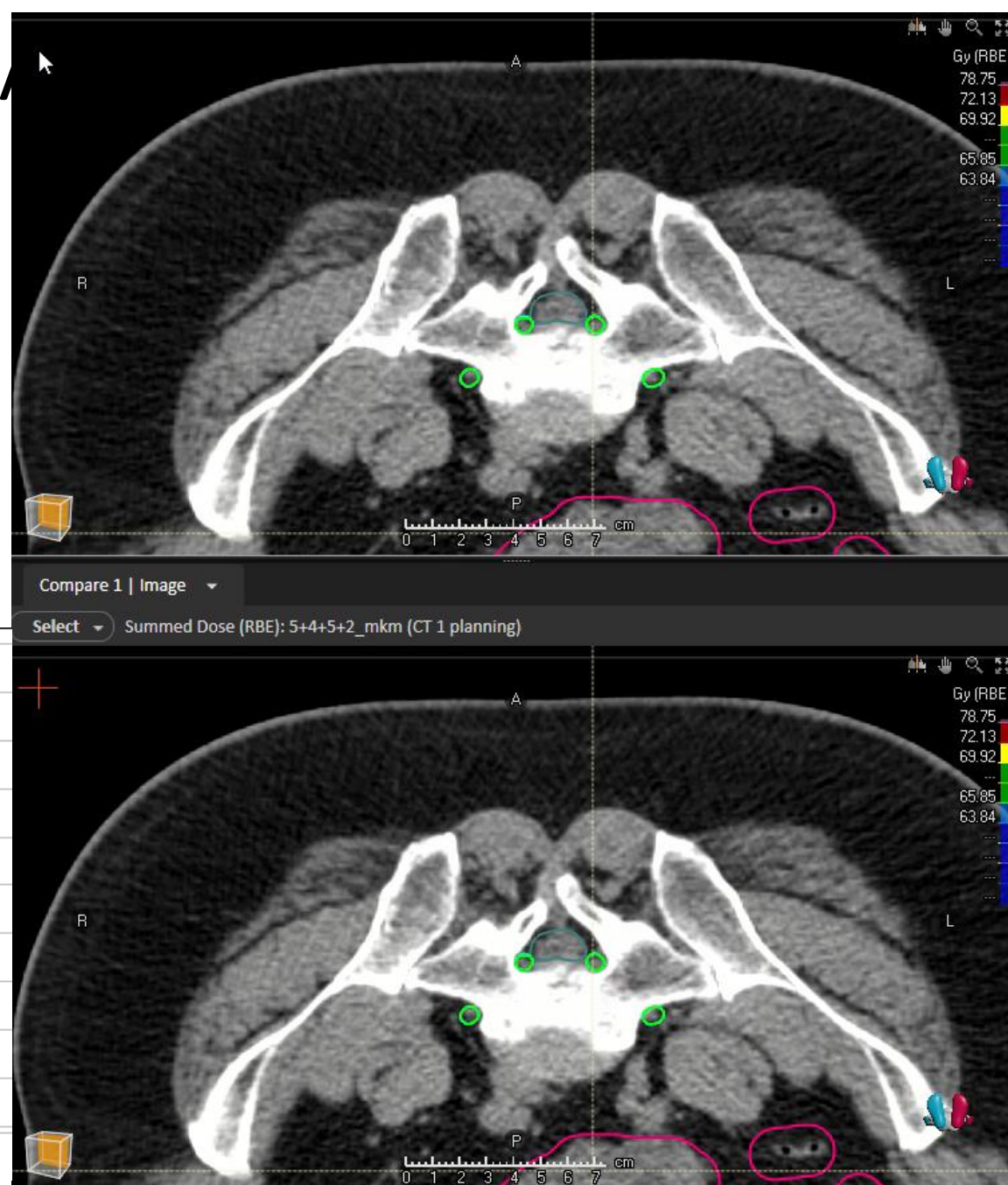
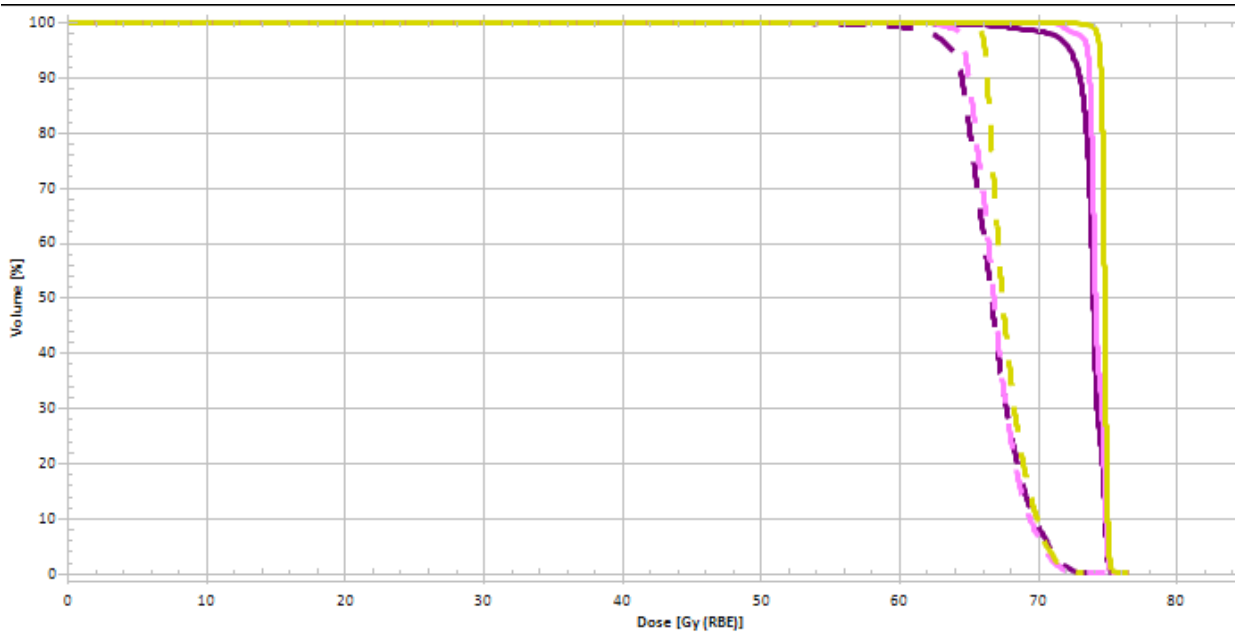
**RED 98%**  
**YELLOW 95%**  
**BLUE 102%**  
Green 103%



# Planning TARGET COVERAG

**RED 98% of LEM**  
**YELLOW 95% of LEM**

**GREEN 98% of MKM**  
**BLUE 95% of MKM**





# Planning / OAR rectum

The image displays two axial CT scan slices of a patient's pelvis, showing the rectum and surrounding tissues. The left image shows a dose distribution with a red contour (66.00 Gy) and a yellow contour (60.00 Gy). The right image shows a similar distribution with a different contour configuration. Below the images is a DVH plot and a clinical goals table.

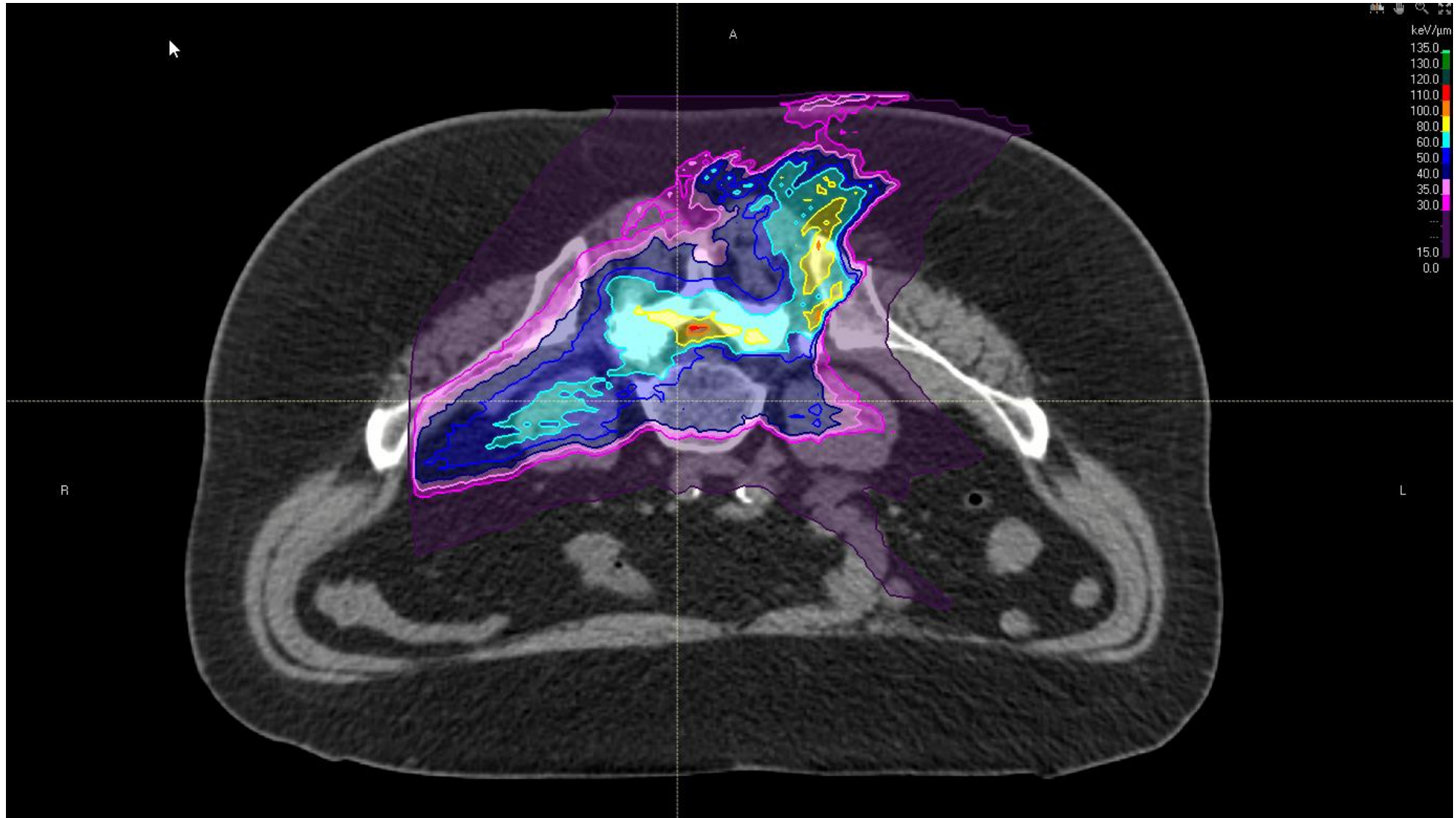
**DVH Plot:** The DVH plot shows Volume [cm<sup>3</sup>] on the y-axis (0 to 9) and Dose [Gy (RBE)] on the x-axis (45 to 65). Two curves are shown: a solid green line and a dotted green line. Two points on the dotted line are circled in black, corresponding to the clinical goals in the table below.

**Clinical Goals Table:**

Priori	Dose	ROI/POI	Clinical goal	Value	Result	% out
<b>LEM</b>						
1	Summed Dose (...)	sigma	At most 66.00 Gy (RBE) dose at 1.00 cm <sup>3</sup> volume	65.60 Gy (RBE)	✓	
1	Summed Dose (...)	sigma	At most 60.00 Gy (RBE) dose at 1.00 cm <sup>3</sup> volume	58.45 Gy (RBE)	✓	
<b>MKM</b>						

**Legend:**  
 Dose axis:  Absolute  Relative max  Relative dose [Gy (RBE)]  
 Volume axis:  Relative  Absolute

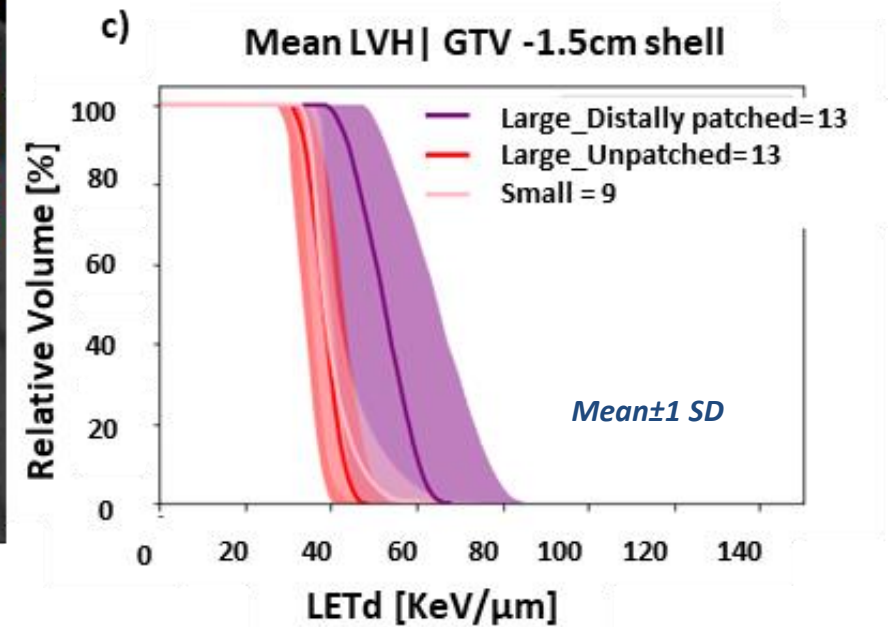
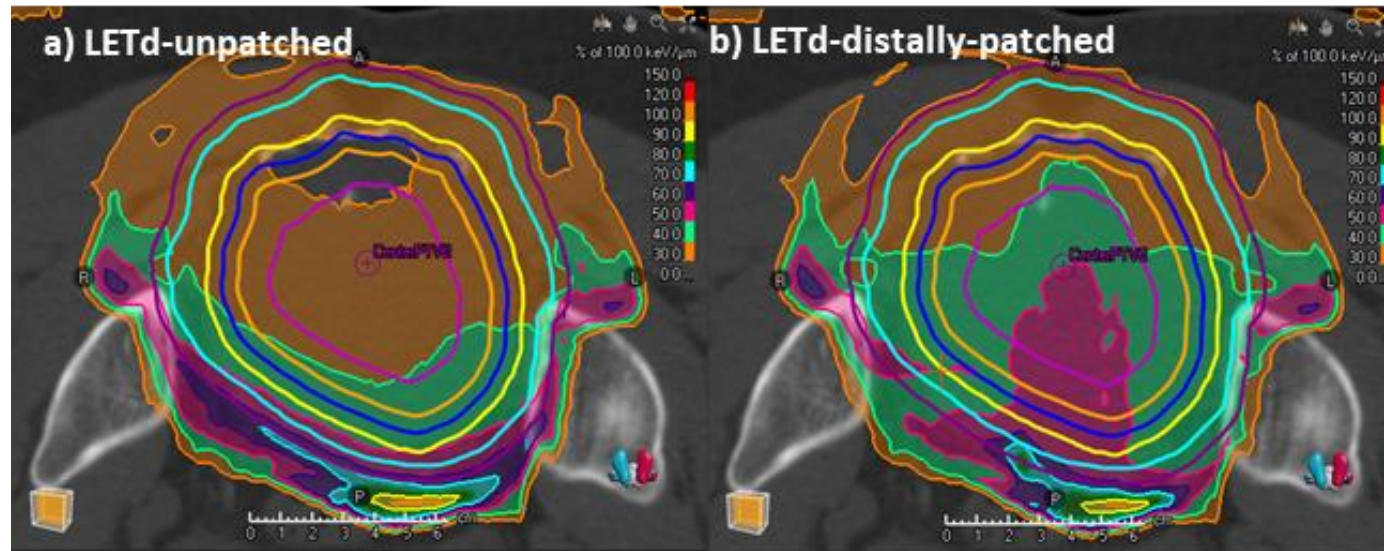
# Treatment planning : LET distribution



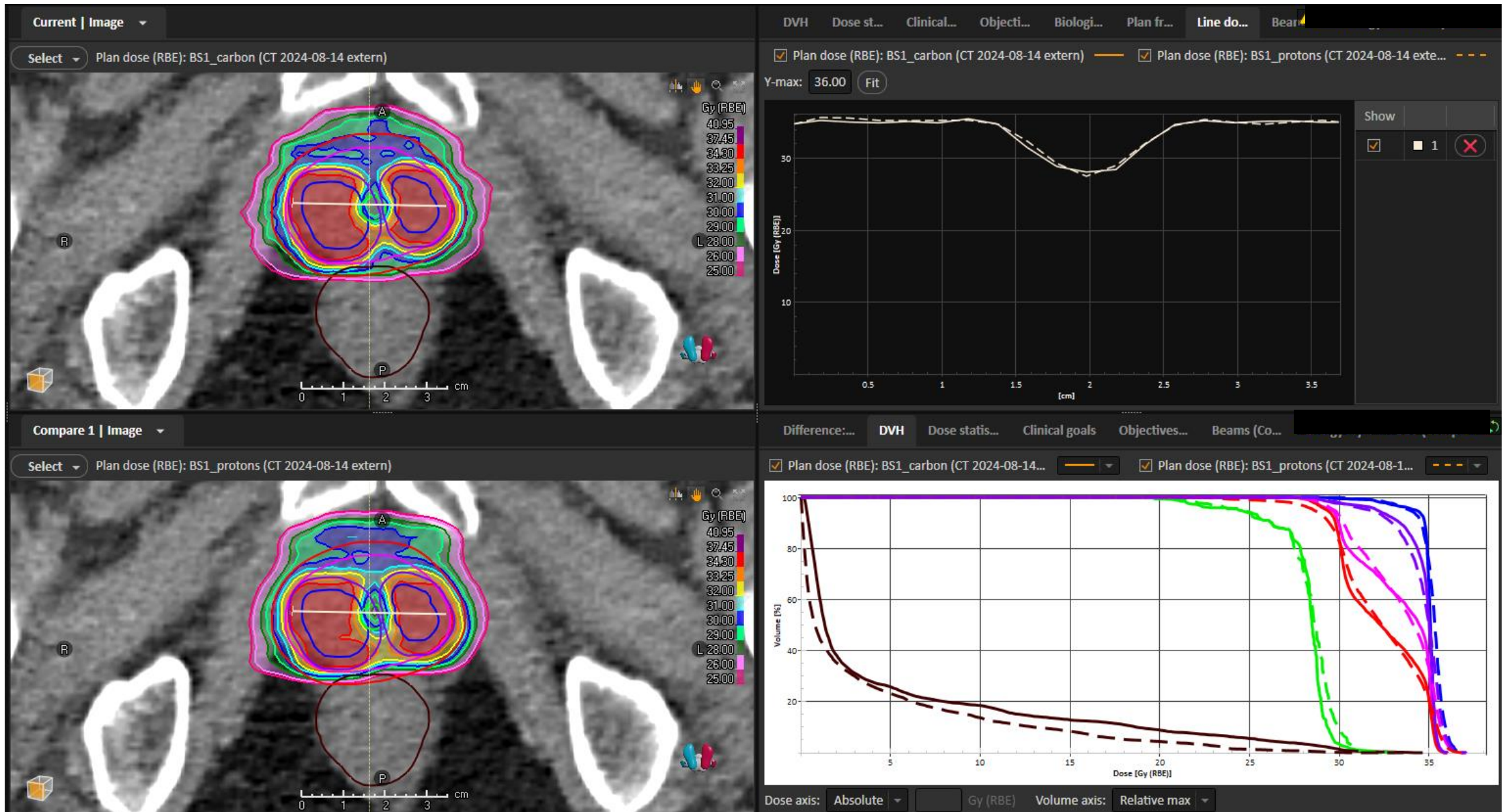


# LETd Redistribution | central portion of GTV

Distal patching → Redistribution of high LETd component from periphery to the center of GTV



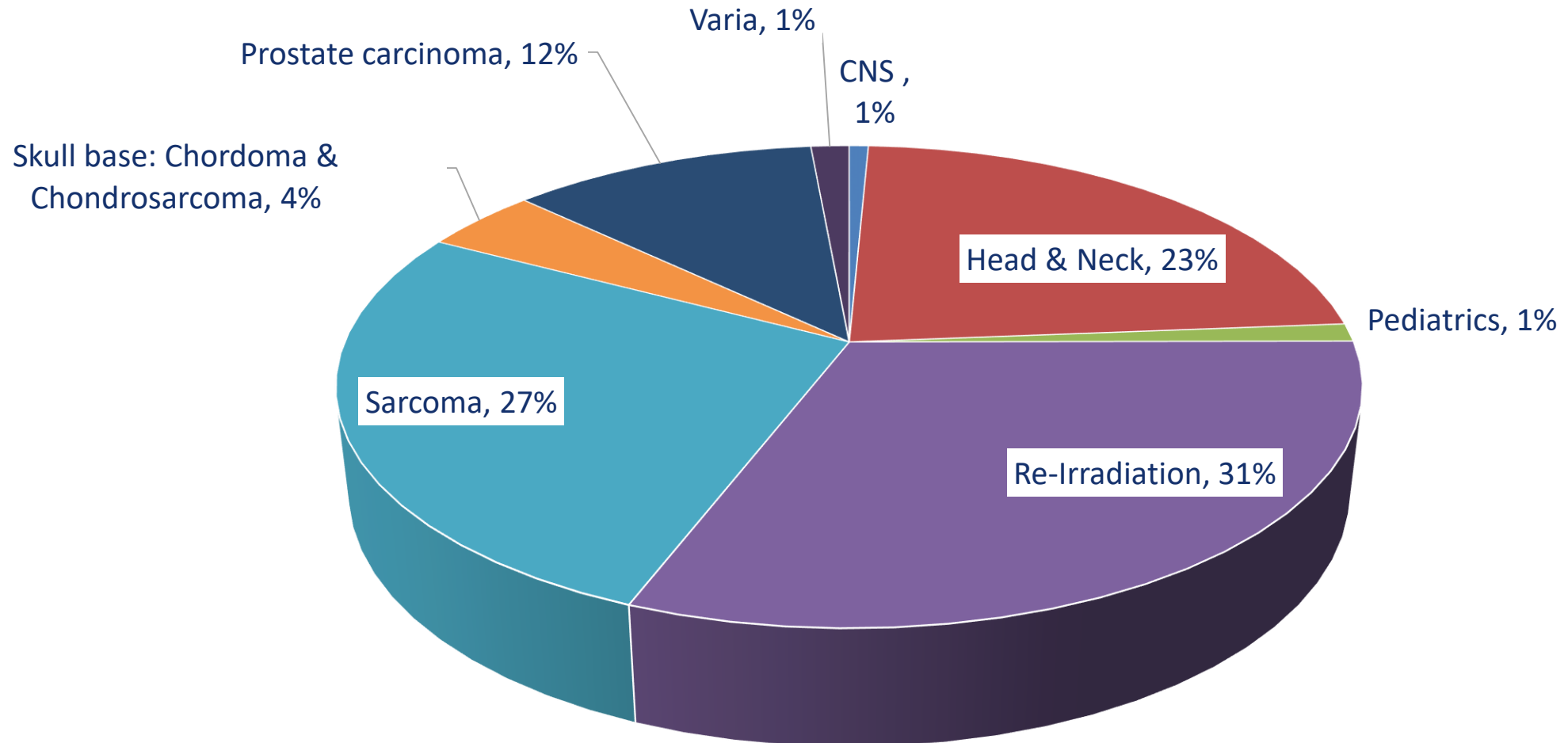
# Sharper penumbra ?





# 420 Carbon ion Treatments

JUL 2018 – Nov 2023



Female 81 YO

RCC operated, M1 (skull) at diagnosis

Previous RT 50 Gy with photons

### Diagnosis

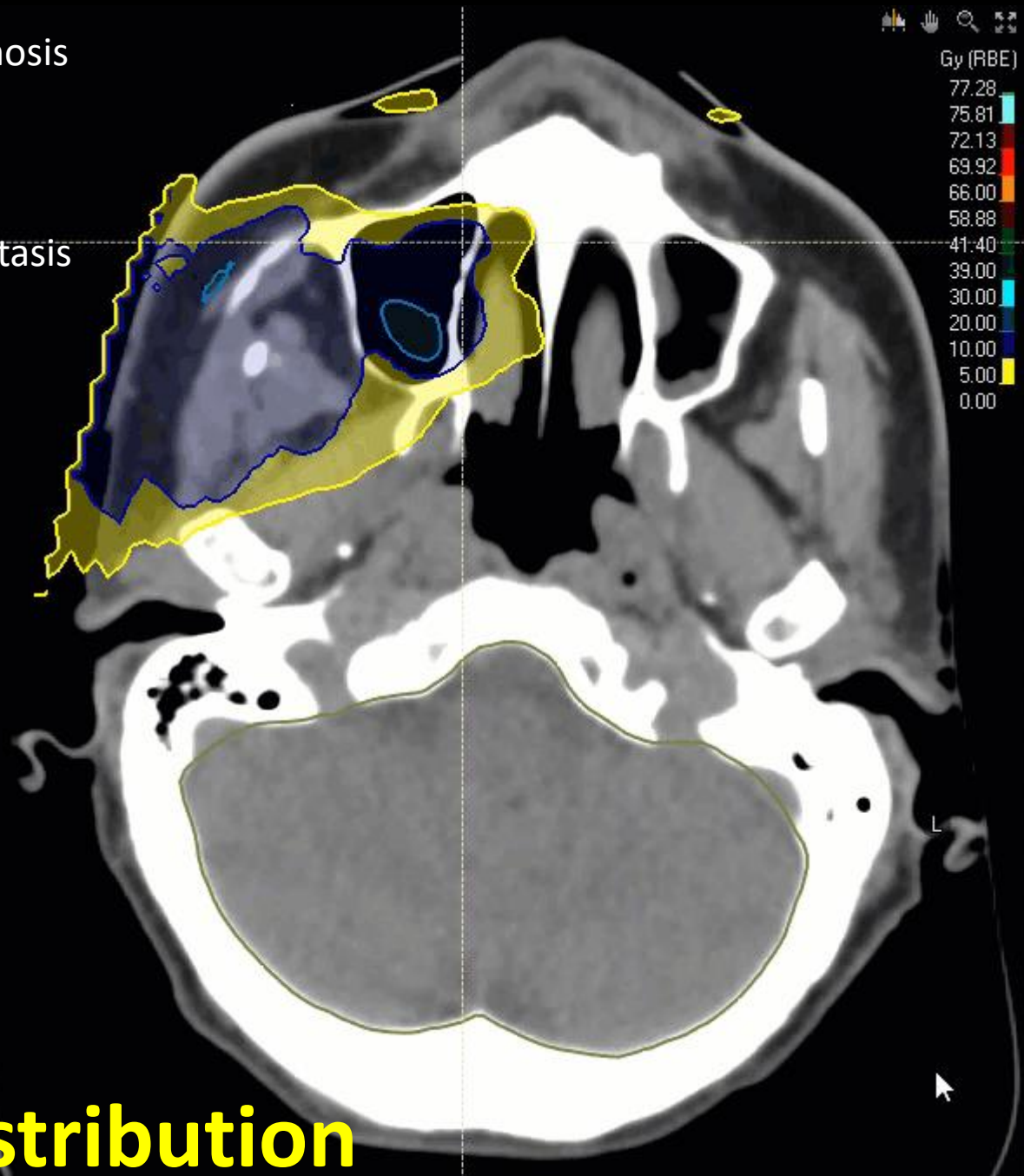
Symptomatic progression of  
previously irradiated skull metastasis  
from renal cancer

After 2 years SD with systemic  
therapy

### Prescription:

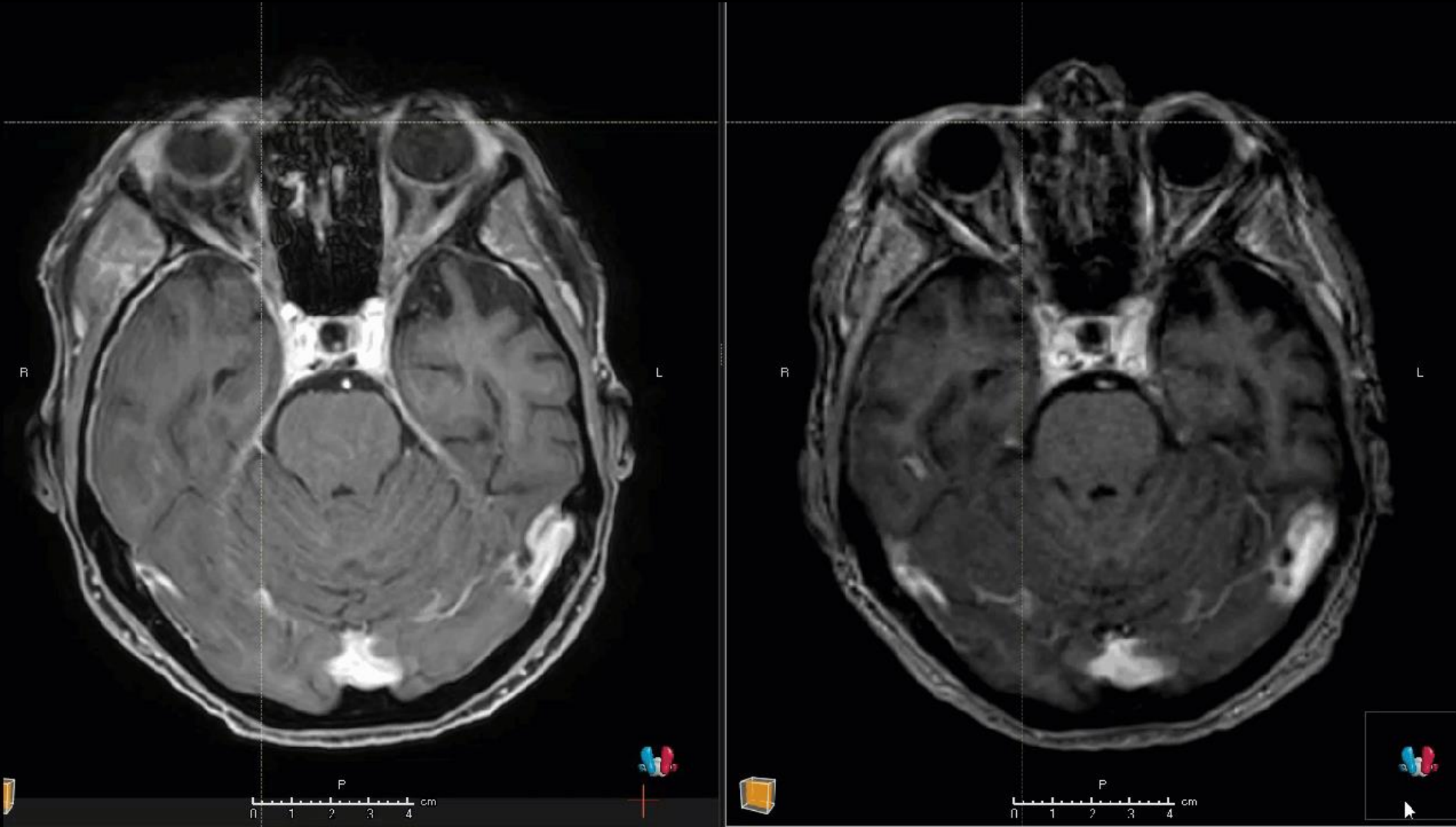
exclusive CIRT

4.6 Gy RBE x 16 (73.6 Gy RBE )



**CIRT**  
**Dose distribution**

# Response at 10 Mo.

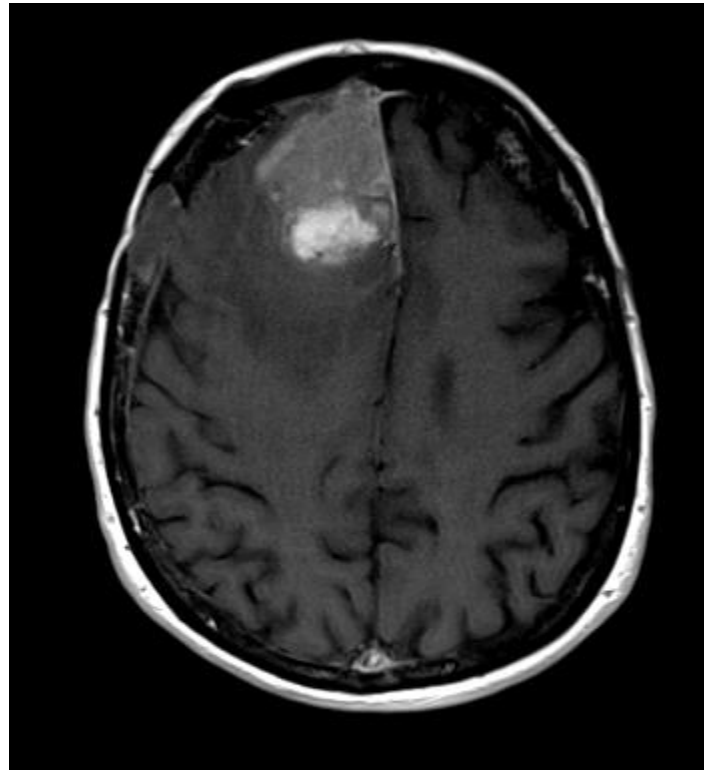


## **Toxicity at 18 Mo:**

Complete resolution of diplopia

RT induced Tox G0 ( no CNS toxicity)

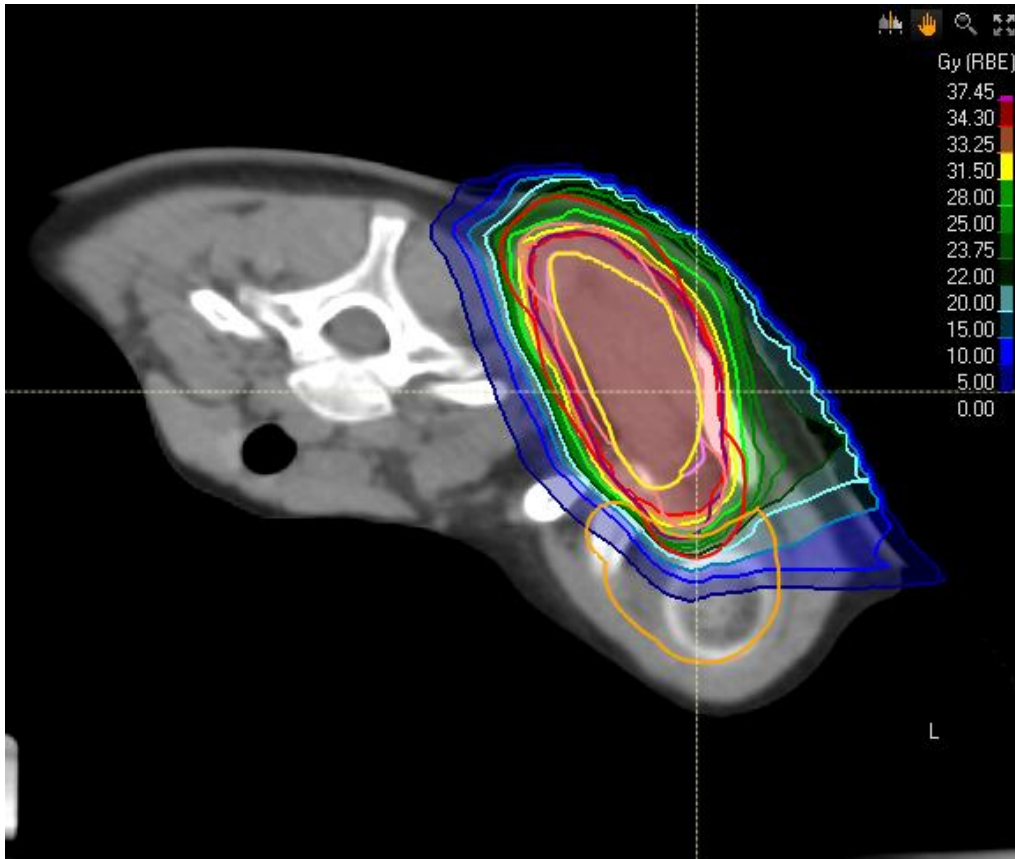
**Unfortunately at 18 local PD of the falx nodule  
(neurosurgery is planned in 2 weeks)**



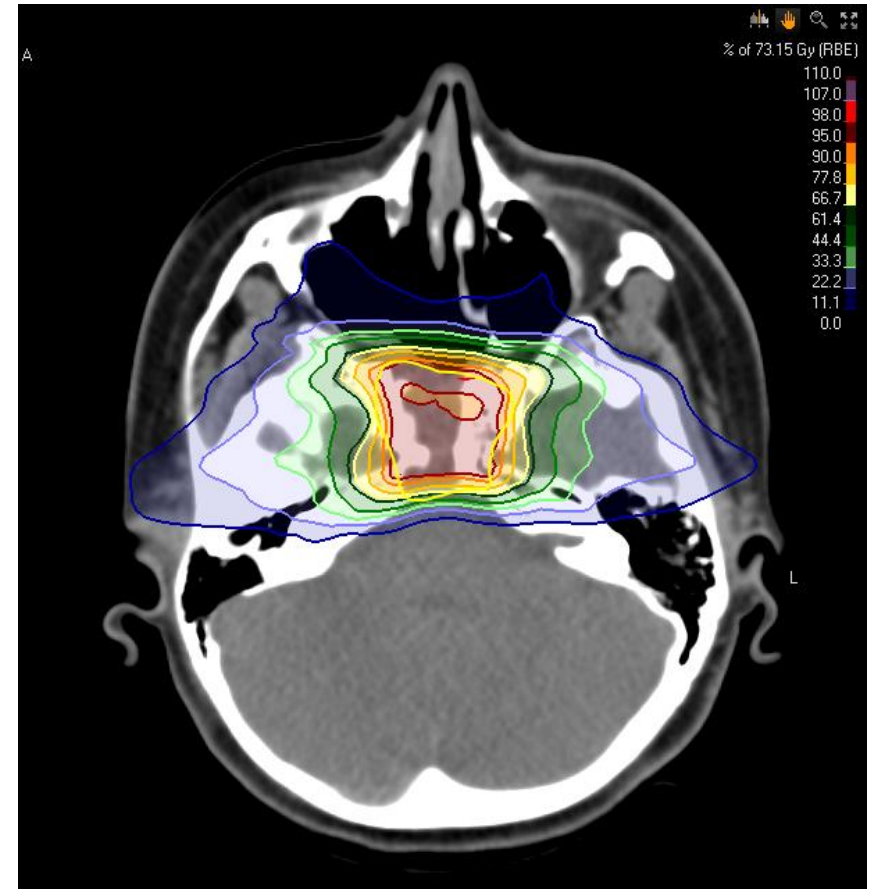


# CIRT AND PEDIATRICS ?

- Osteosarcoma



- Sarcoma recurrences



DANKE FÜR IHRE AUFMERKSAMKEIT

