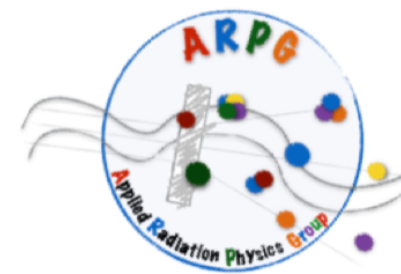




SAPIENZA
UNIVERSITÀ DI ROMA



CENTRO RICERCHE
ENRICO FERMI

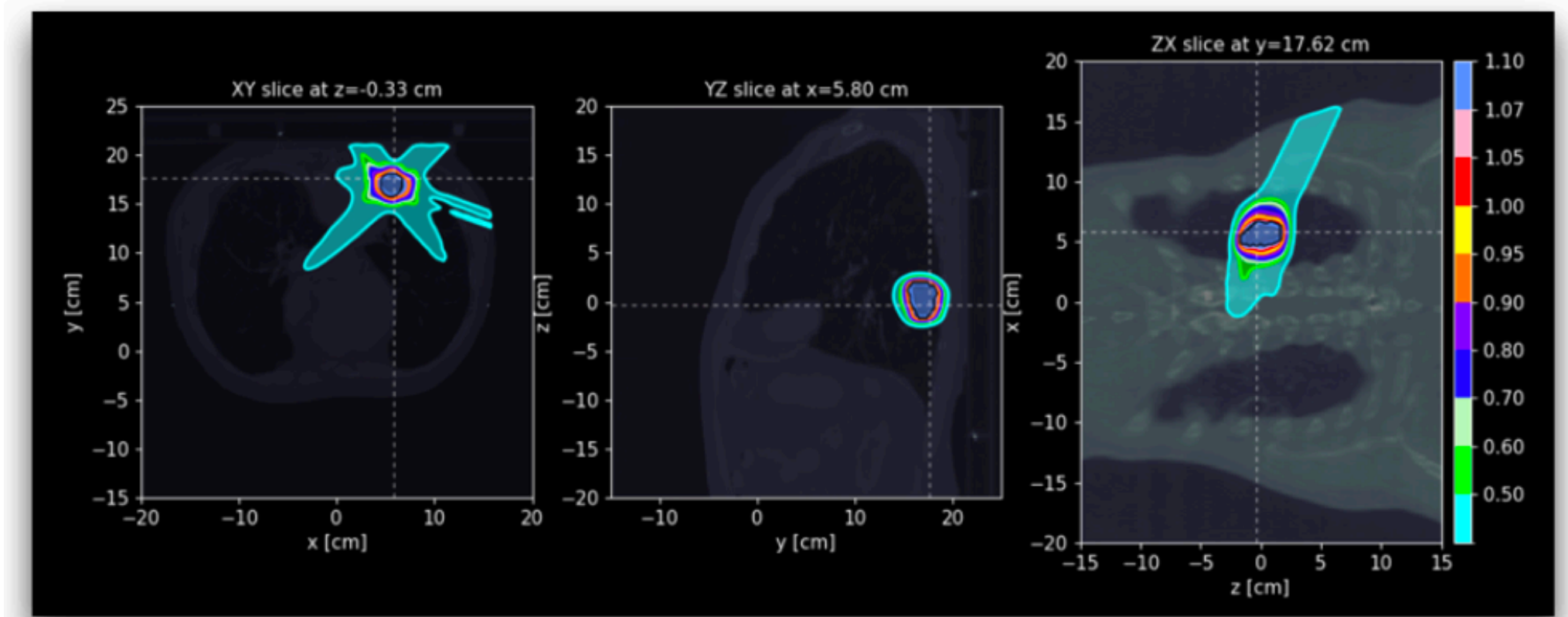
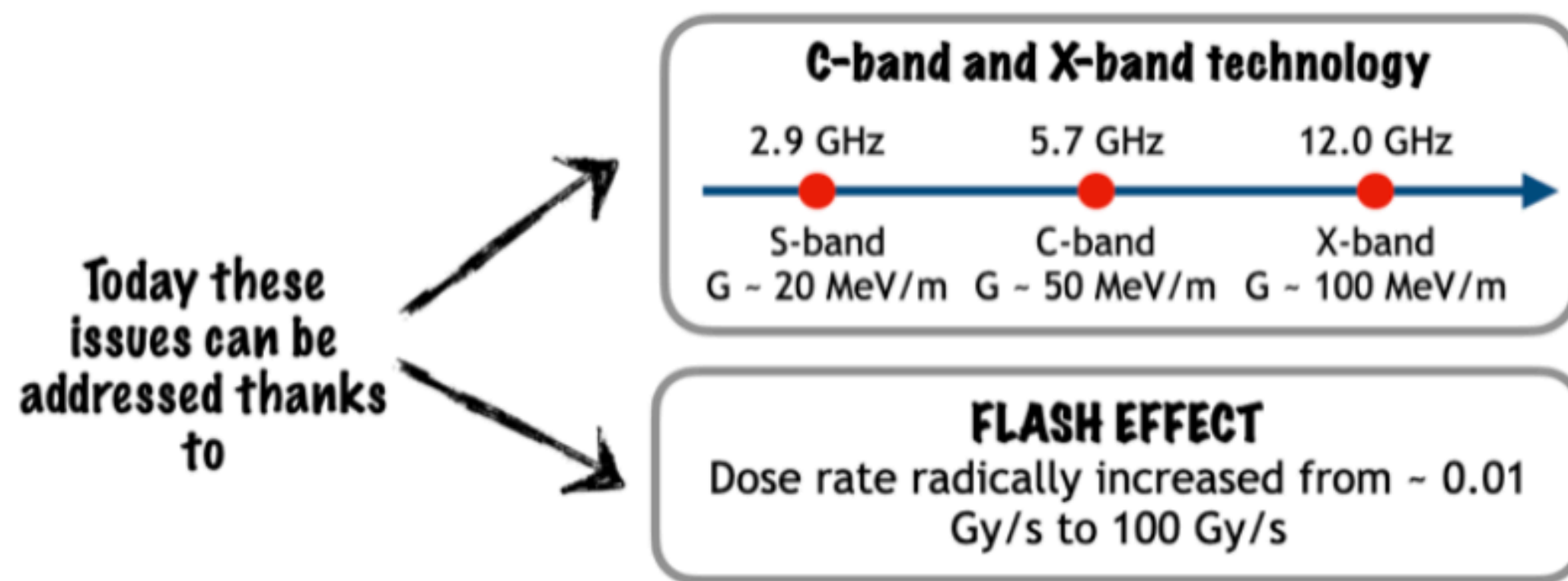
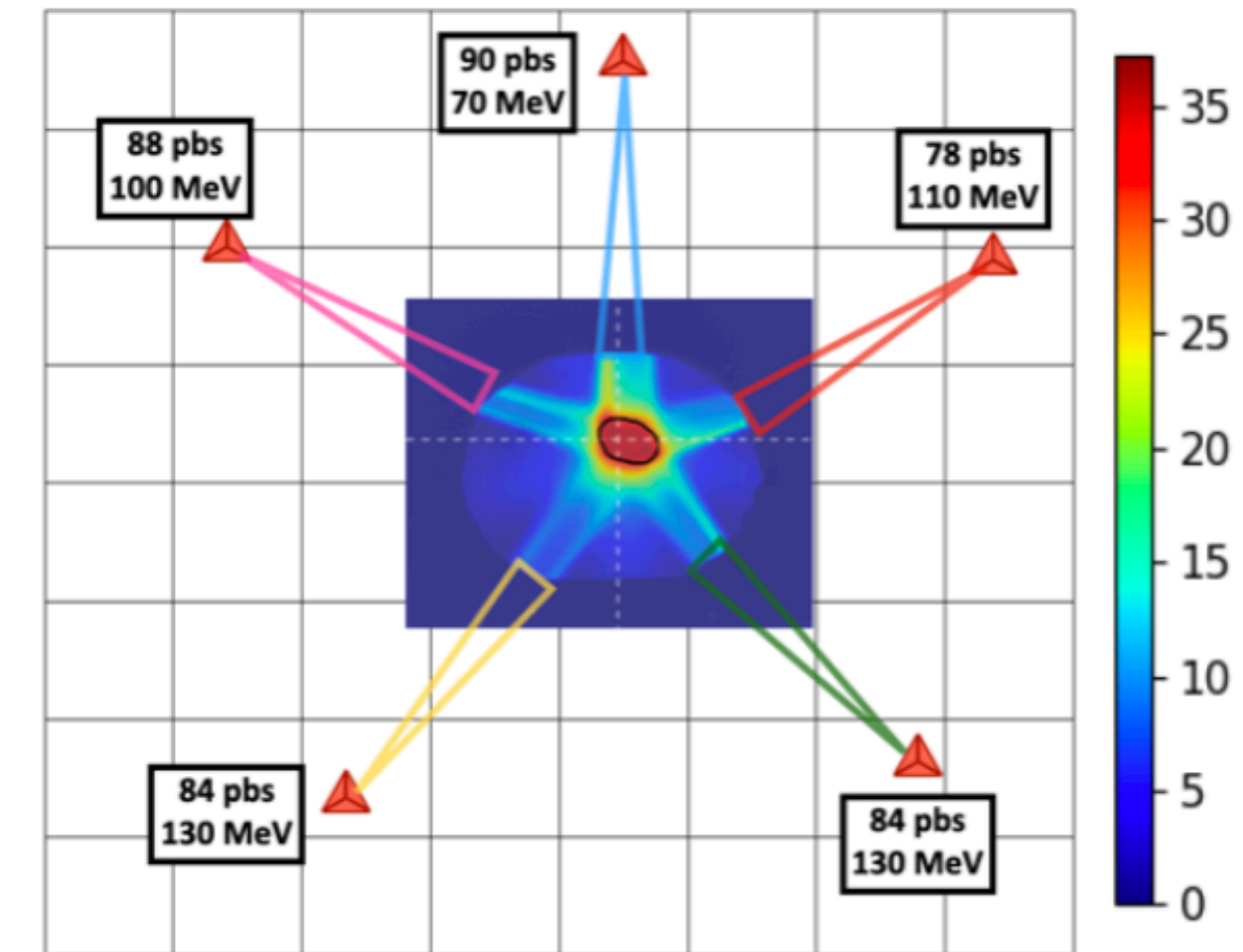
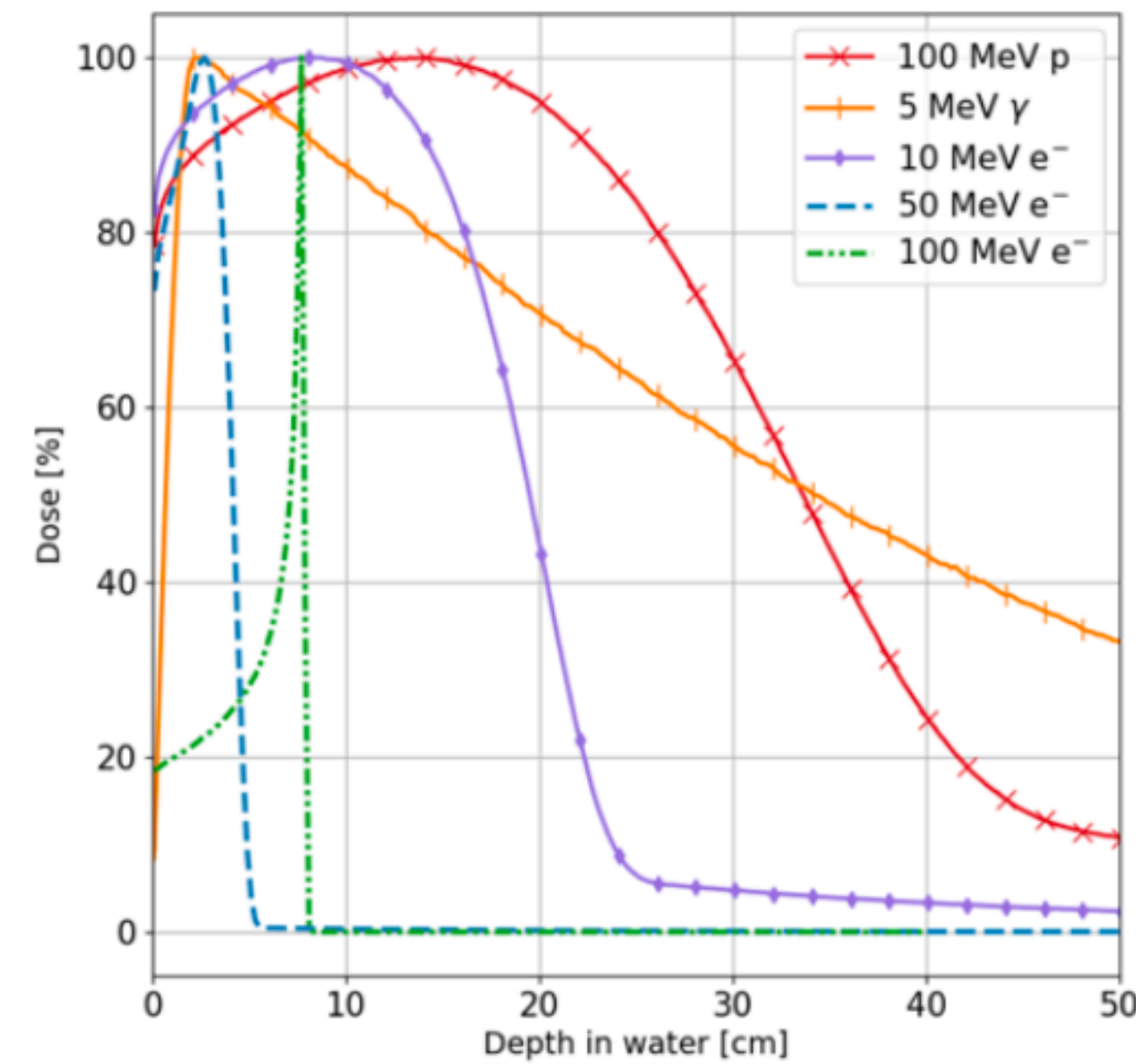


Treatment Planning System VHEE FLASH

What?

Electrons with $E > 70$ MeV have been considered in the past as an alternative to protons and RT due to their better longitudinal sparing of the OARs with respect to photons (charged \rightarrow BP) and reduced impact of the range uncertainties with respect to protons (broader BP).

Due to cost, complexity and space encumbrance (long accelerating system) VHEE have not yet reached the clinical stage.



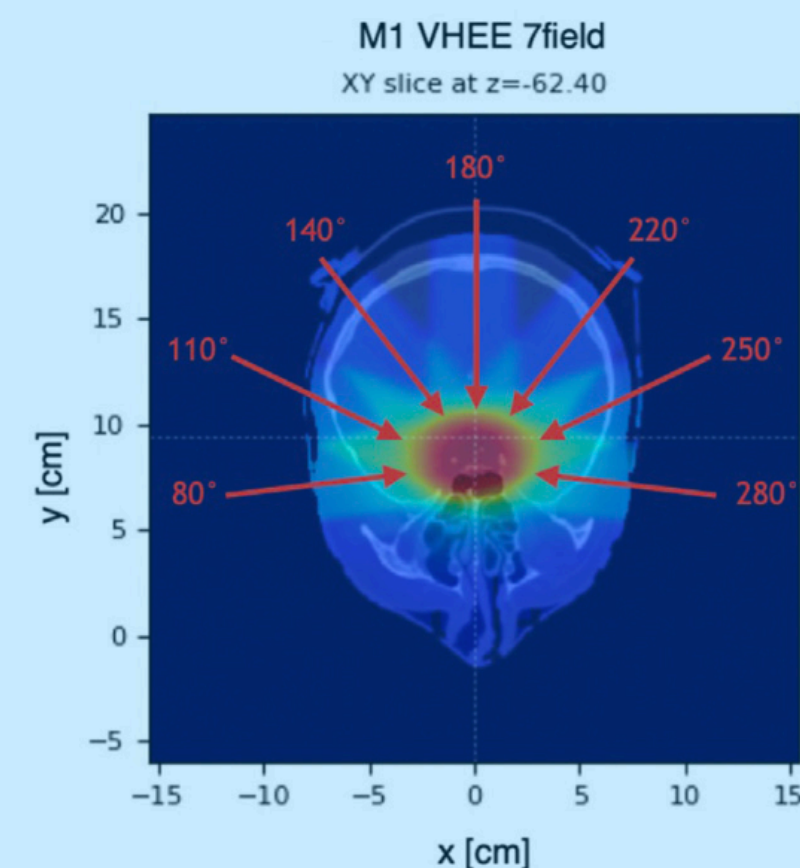
How?

START

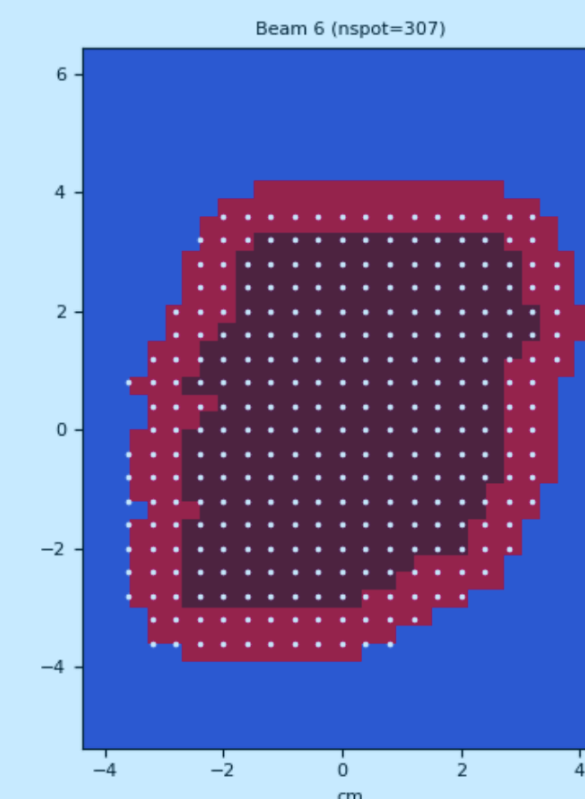
Real clinical treatments
provided by hospitals

1. Prostate cancer (1) @ Policlinico Umberto I
2. Head&Neck lesions (2) @APSS Trento
3. Pancreatic cancers (3) @ Campus Biomedico
4. Lung cancers (2) @ Campus Biomedico

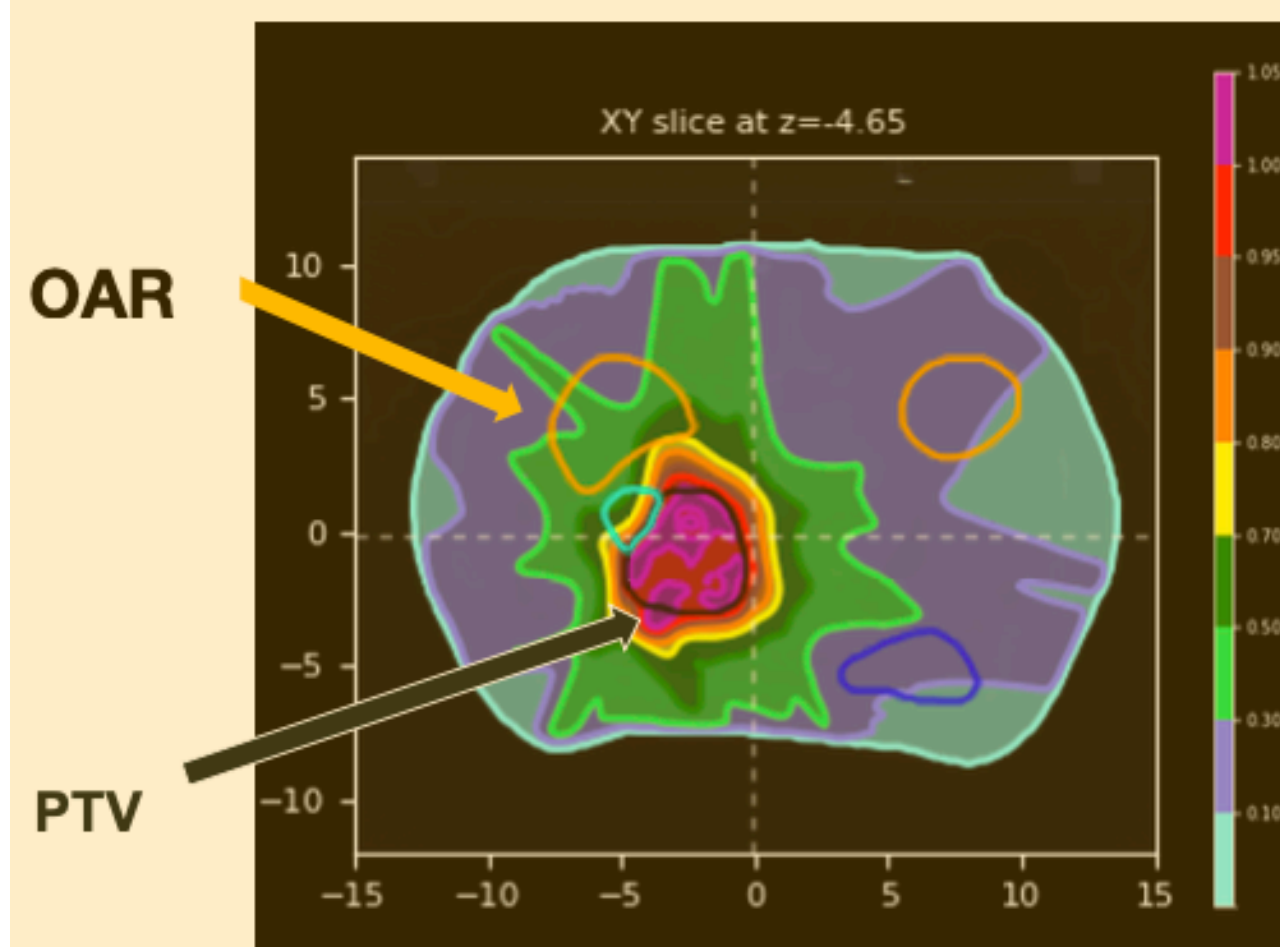
Multi field irradiation



PB active scanning



Optimization process



Cost Function evaluation

$$\chi^2 = \sum_{i \in PTV} \omega_i \frac{(d_i - D_{PTV})^2}{D_{PTV}^2} + \sum_{i \in OAR} \omega_i \frac{(d_i - D_{OAR})^2}{D_{OAR}^2} * g(d_i - D_{OAR})$$

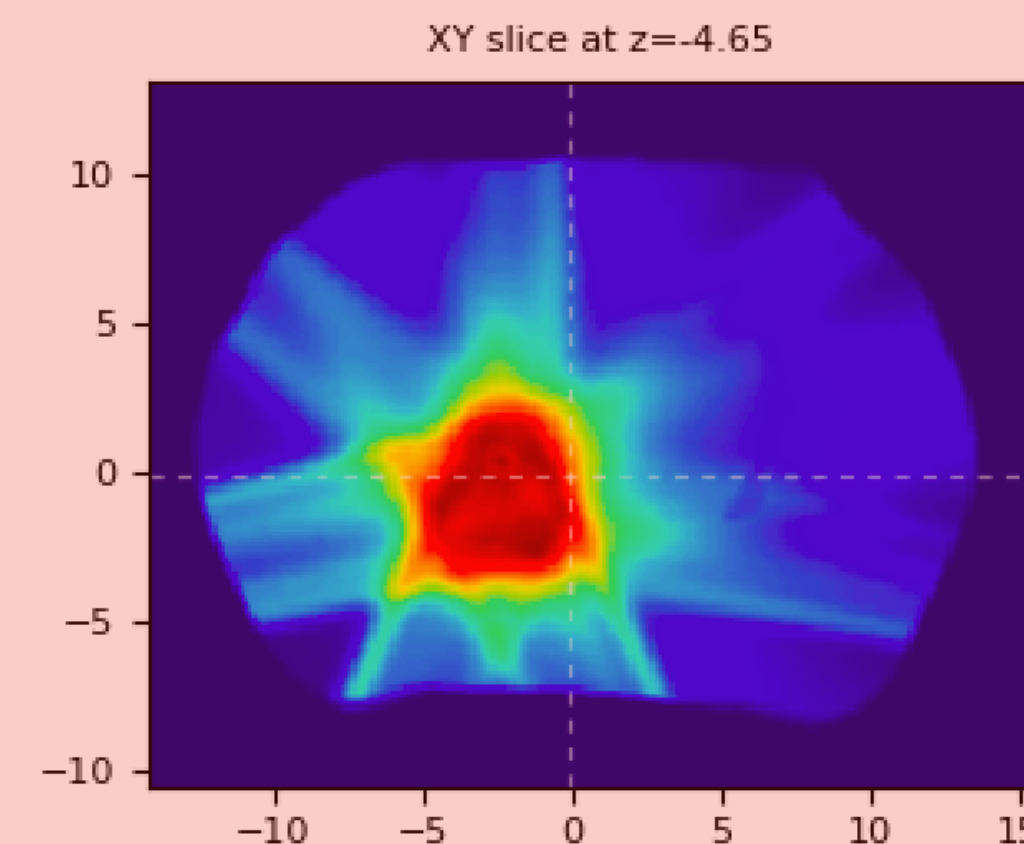
Voxel based

$$d_i = \sum_{j=1}^{N_j} N_j D_{ij}$$

FLASH effect parametrization

$$FMF = \begin{cases} 1 & \text{if } D \leq D_T \\ (1 - FMF^{min}) \frac{D_T}{D} + FMF^{min} & \text{if } D > D_T \end{cases}$$

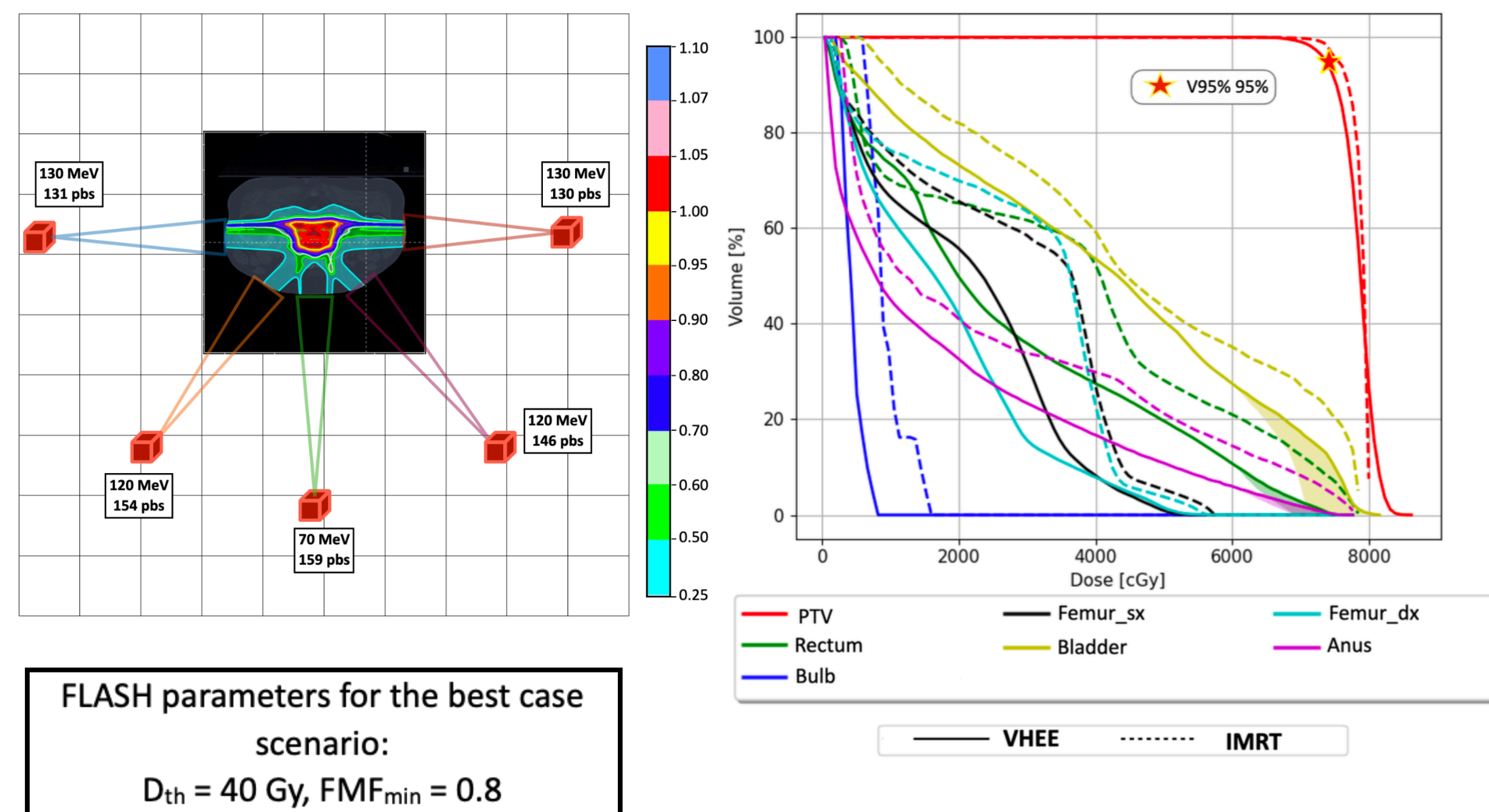
Dose evaluation with FRED



Results

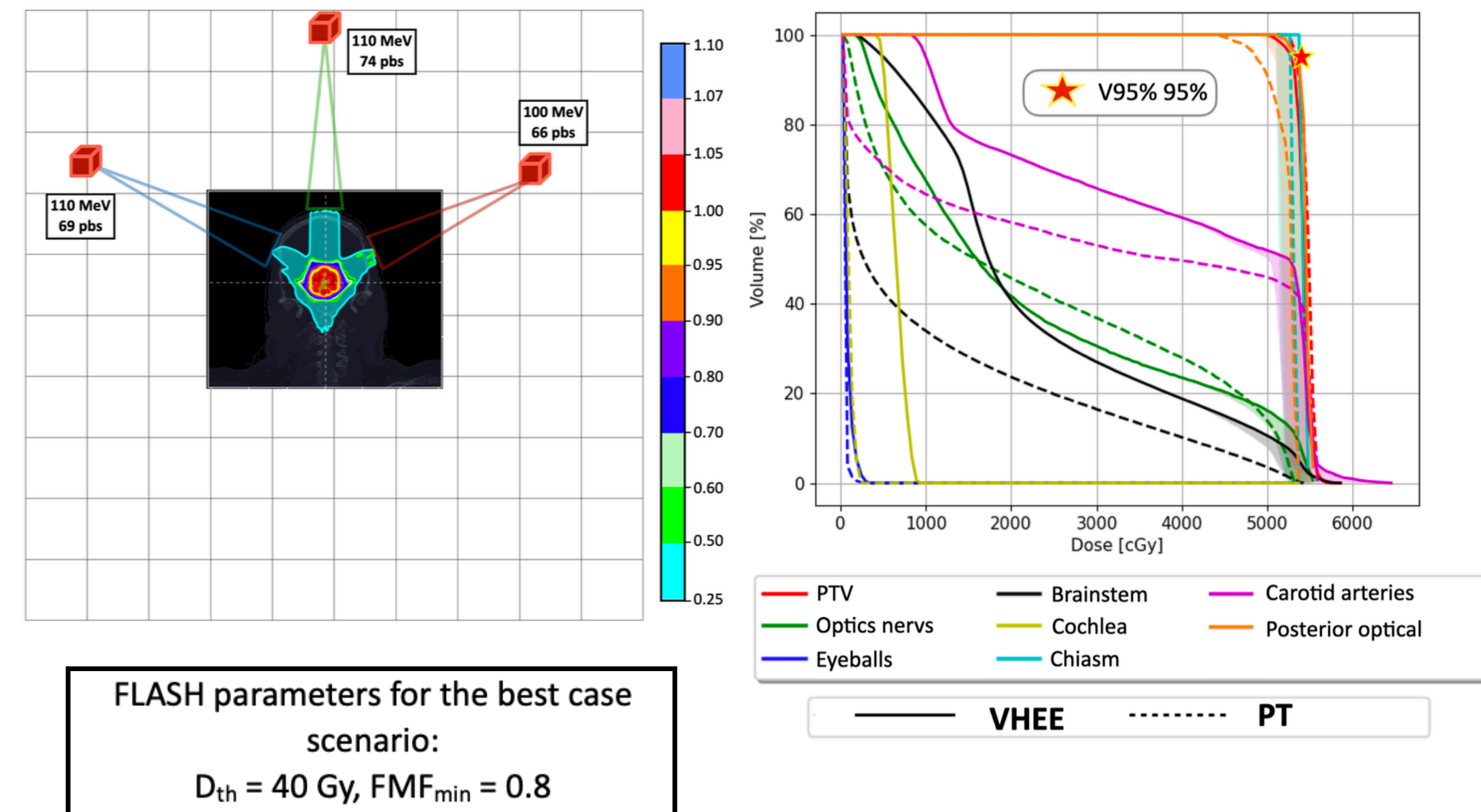
Prostate

- Patient treated at Policlinico Umberto I using **photons** with a prescription to the PTV of **78 Gy in 39 fractions**;
- VHEE plan simulated considering the same 5 fields used for **IMRT** treatment.



Head&Neck

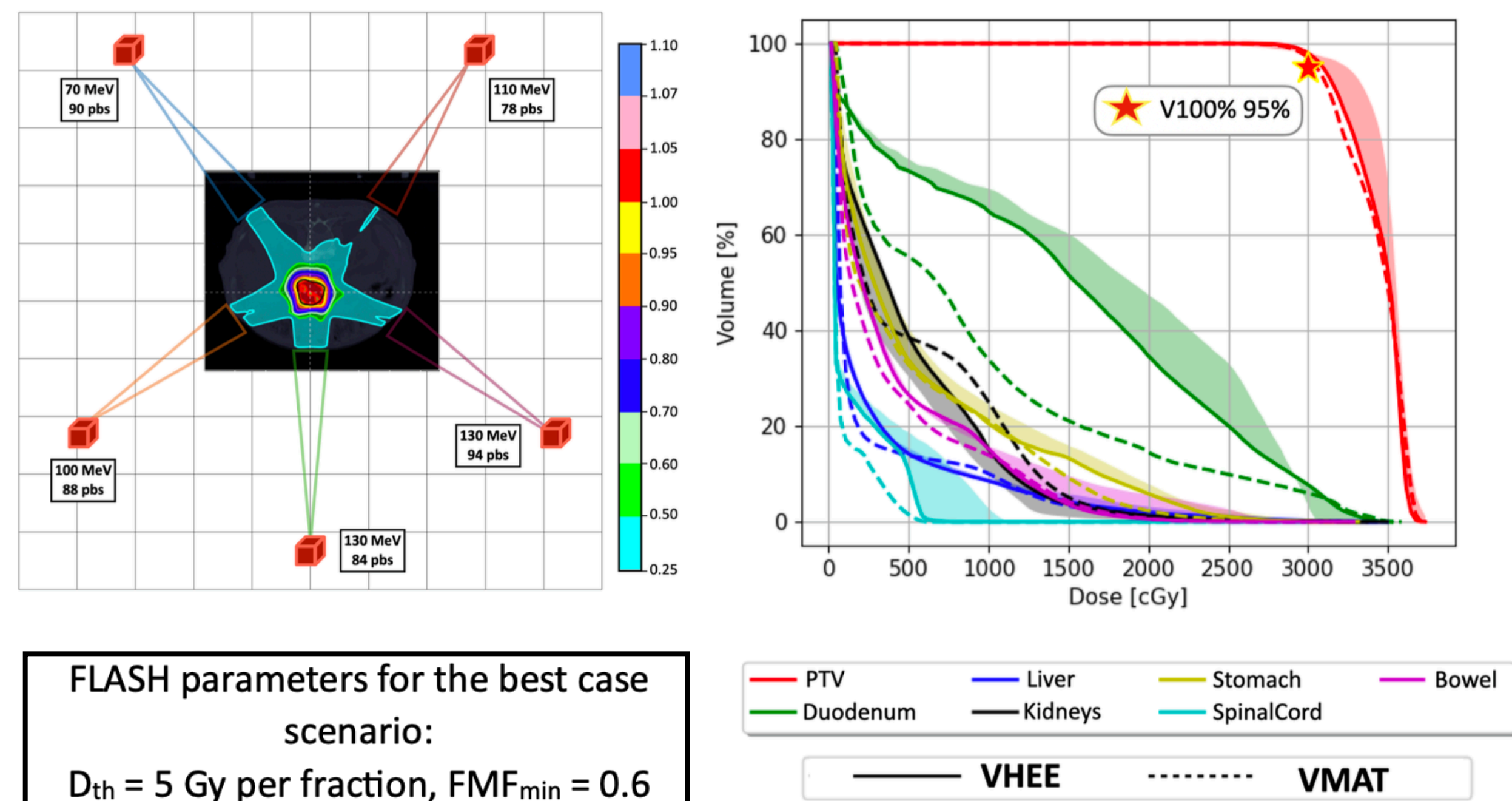
- Patient treated at APSS of Trento using **protons** with a prescription to the PTV of **54 Gy(RBE) in 27 fractions**;
- VHEE plan simulated considering the same 3 fields used for proton treatment.



Results

Pancreas

- Patient treated at Campus Biomedico using **photons** with a prescription to the PTV of **30 Gy in 5 fractions**;
- VHEE plan simulated considering the same 5 fields used for **VMAT** treatment.



Lung

- Patient treated at Campus Biomedico using **photons** with a prescription to the PTV of **45 Gy in 3 fractions**;
- VHEE plan simulated considering the same 5 fields used for **VMAT** treatment.

