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Introduction to the use of MatRad software for treatment planning

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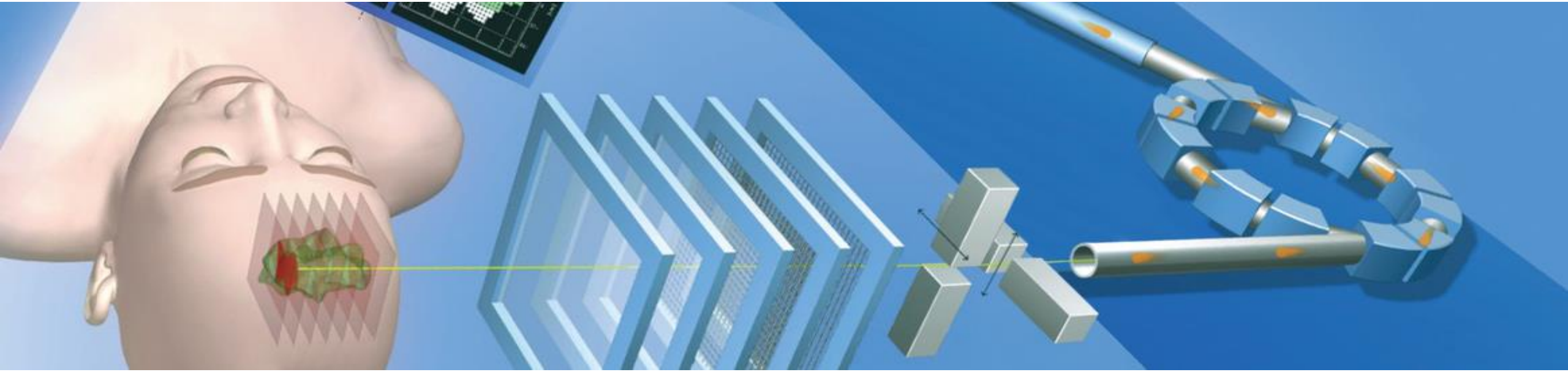
How is a treatment plan designed?

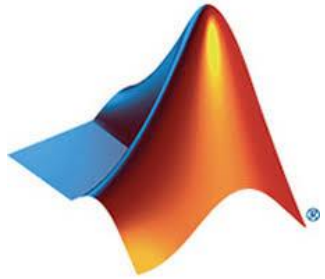


matRad

What is MatRad?

- MatRAD is an open source software tool for designing radiation therapy plans with a modulated beam of photons, protons and carbon ions.

- Its name derives from the combination of two words:



Source: http://bit.ly/3sX756v

MatLab + Radiation = MatRad

- Developed by scientists at the German Cancer Research Center, DKFZ in Darmstadt.

dkfz. GERMAN CANCER RESEARCH CENTER IN THE HELMHOLTZ ASSOCIATION

Source: http://bit.ly/3uXfNDt

- Use exclusively for research and educational purposes.

Where is MatRad used today?

+30 INSTITUTES

matRad – community

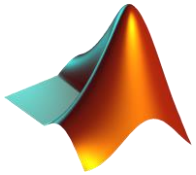
- With thousands of users worldwide.
- For more information visit the map at the following link:

Link: https://bit.ly/MatRadUsers

How can I use the software?

➢For research purposes:

- The program gives the possibility to use many parameters, for more realistic simulations.
- Uses the complete Mat Lab code for detailed analysis.
- Requires more computing power.



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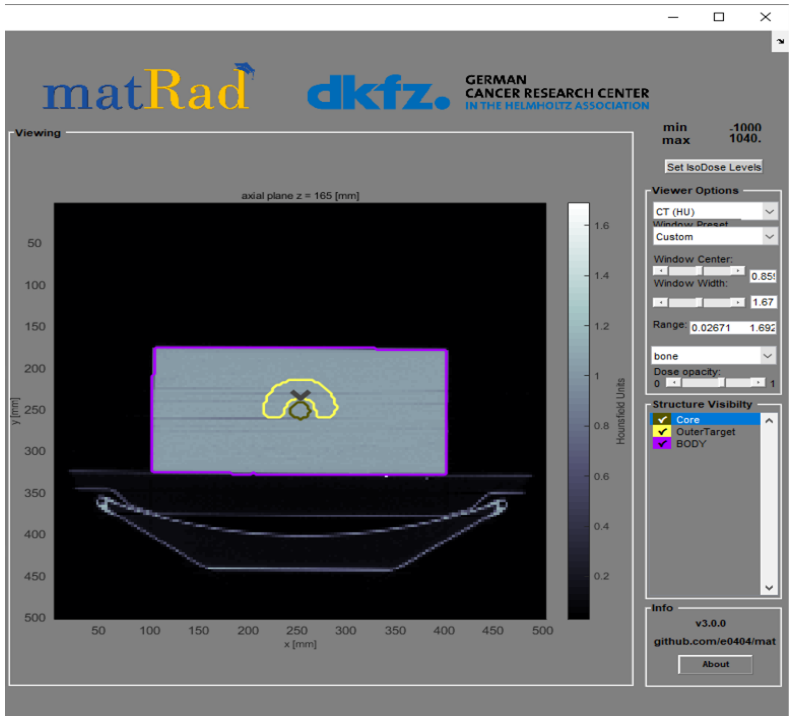
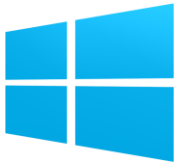
+Computing Power



➢For educational purposes:

- For educational use, the simplified form of the software on Windows, Linux, Mac is recommended.
- Requires less storage space and computing power.
- Does not require IDE (integrated development environment) for the use of the software.



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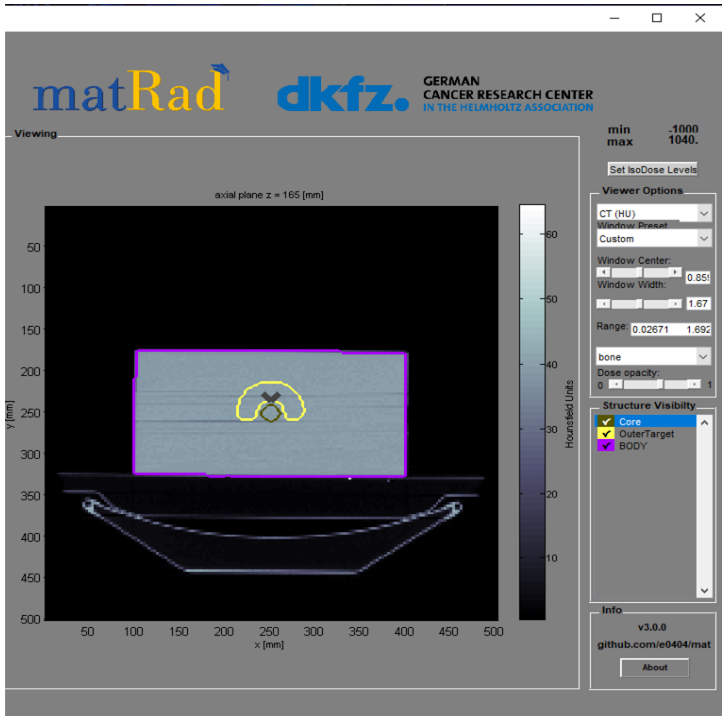
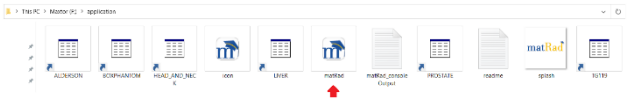
-Computing Power



How does MatRad work?



Data files:

I. Test Sample (C-phantom)
II. Liver
III. Head n Neck

We enter the patient data

We set the parameters of the treatment plan (Radiation geometry etc.)

We calculate the dose of distribution to the cancerous tissue through algorithms

$$d(x,y,z_{rad}) = \sum_i Z_i(z_{rad}) \iint dx'dy'\ \Psi(x',y')F(x',y')\ K_i(x'-x,y'-y)$$

Visualization of the plan with the reverse planning technique (Inverse planning)

$$\min f(d(w)), w \in \mathbb{R}^n$$

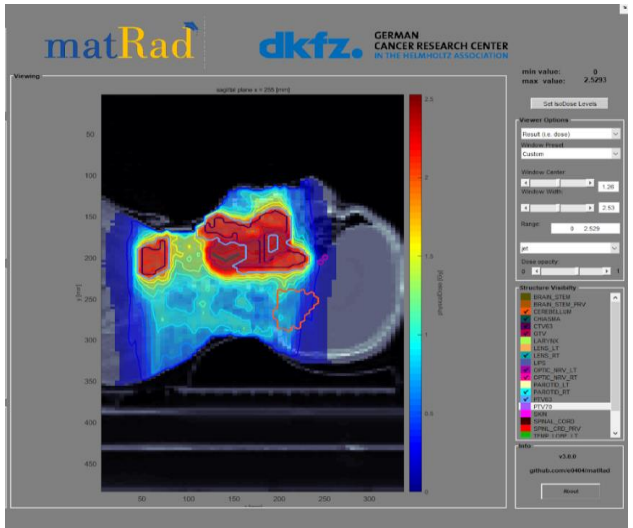
$$f = \sum_i p_i f_i$$

$$s.t. \quad d = Dw$$
$$c_l \leq c(w) \leq c_u$$
$$w_l \leq w \leq w_u$$

$$f(w): \mathbb{R}^n \rightarrow \mathbb{R} \quad , c(w): \mathbb{R}^n \rightarrow \mathbb{R}^m$$

Completion of Simulation

Procedure



Fundamental definitions used by MatRad

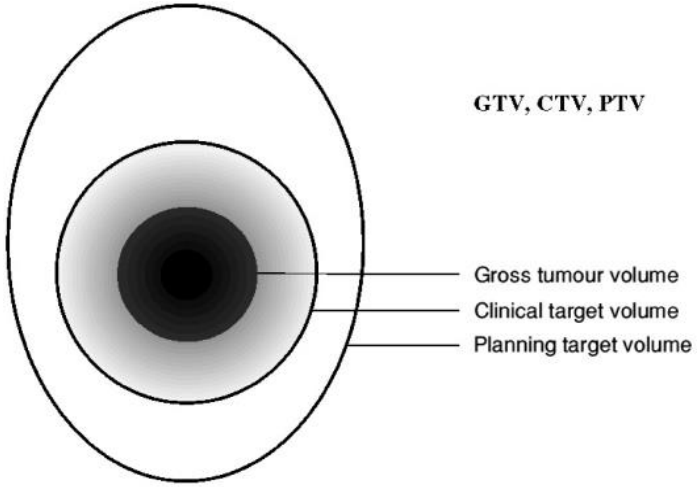
- **GTV** or gross tumor volume is defined as the macroscopic target tumor and is the exact location of the malignancy, as evidenced by imaging methods. It may consist of the initial tumor, metastatic lymphadenopathy or other metastases.

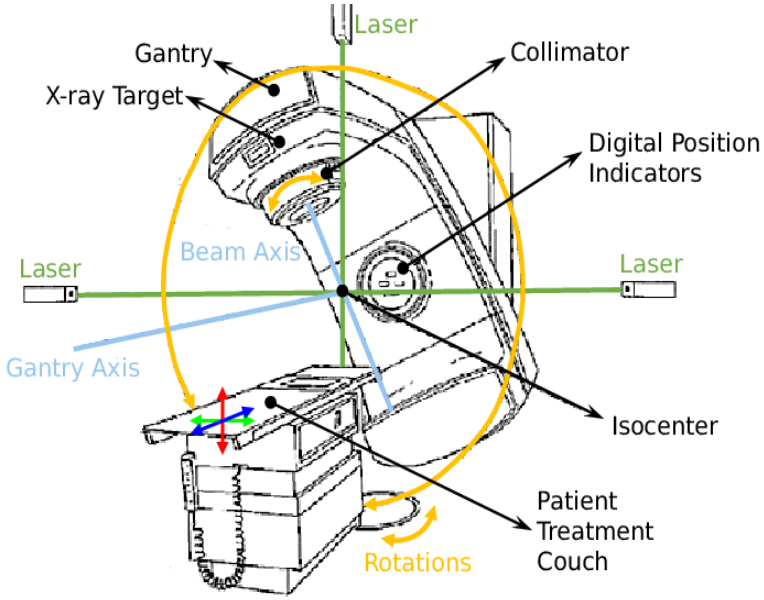
- **CTV** or clinical target volume is defined as the target clinical tumor (where the radio physicist assumes that cancerous tissue is still present). It consists of the tumor that is shown, if there is any, and any tissue with suspected tumor. It is designed with the requirement that cancer cells should not be located outside its region.

- **PTV** or "Planning Target Volume" is defined as the target volume for design. Includes CTV with an internal margin (IM) and an additional margin for placement (setup margin (SM)), which refers to patient movement and placement error.

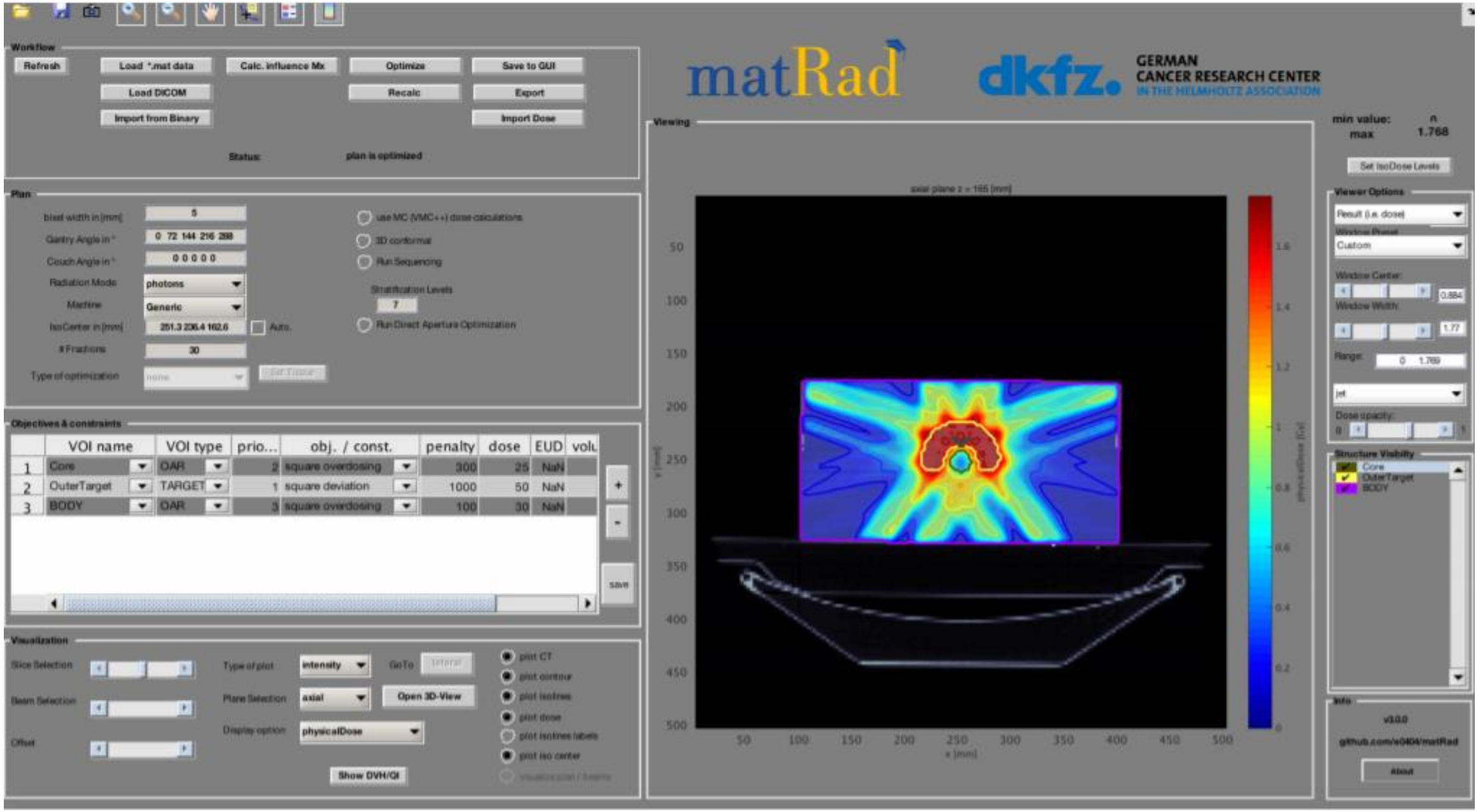
- **OAR** or “Organs At Risk", which are the organs that are more sensitive compared to healthy tissue. Organs in danger need adequate protection. Once the endangered organs are identified, an extra safety margin should be added to include their movement.

- **Gray** (Gy) is a unit of measurement of energy absorption derived from ionizing radiation. Is equal to the energy absorption of one joule of matter with a mass of one kilogram, 1 $\frac{Joule}{kg}$.



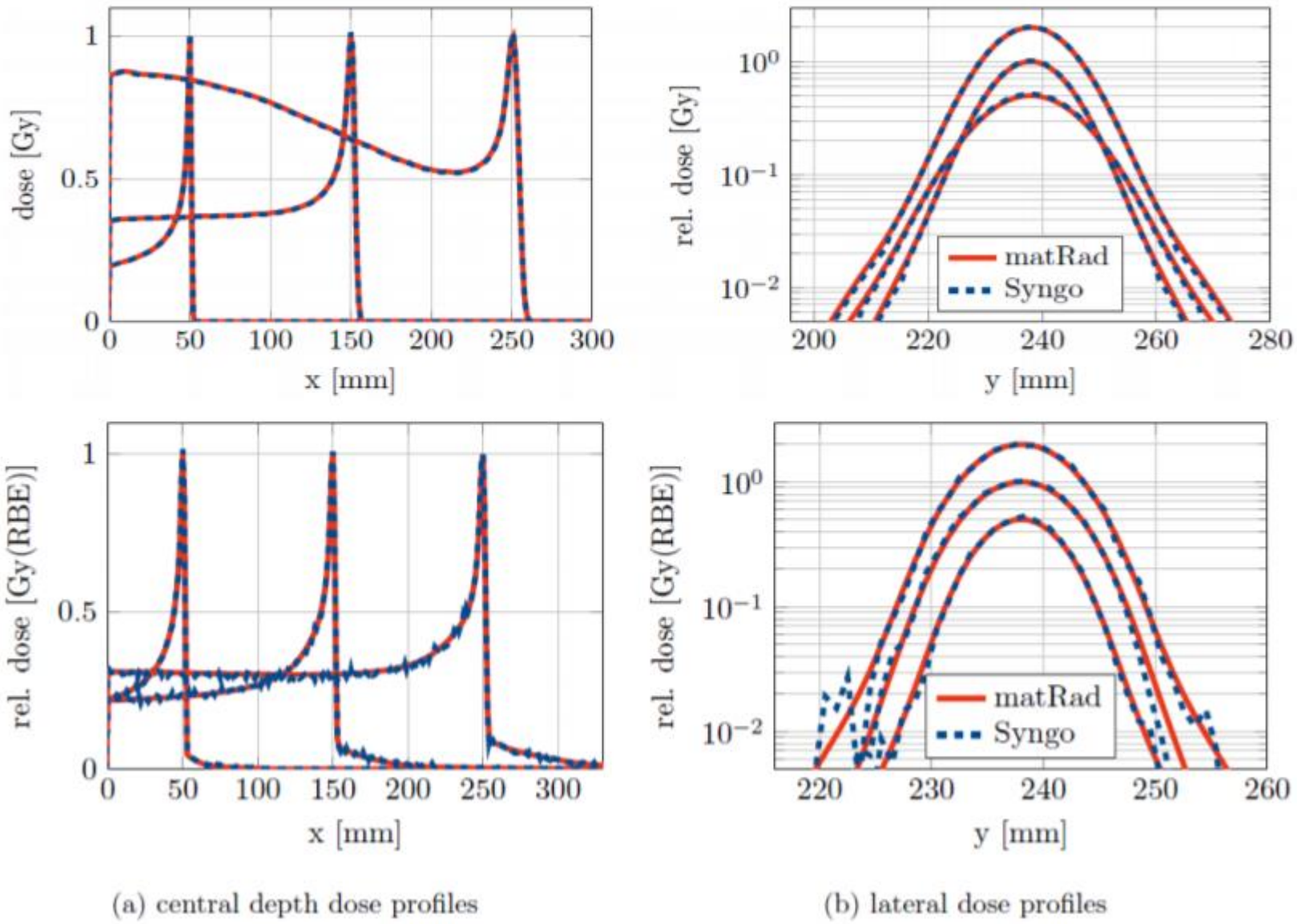


The graphical interface of MatRad



Comparison of MatRad with Syngo clinical software

- ✓ Syngo software is used clinically in Heidelberg (HIT).
- ✓ Display of the relative dose in Gray (Gy) as a function of the depth of the beam in human tissue in millimeters (mm).
- ✓ The results are almost identical !!!



(a) central depth dose profiles

(b) lateral dose profiles

Source: https://bit.ly/3sWzzwT

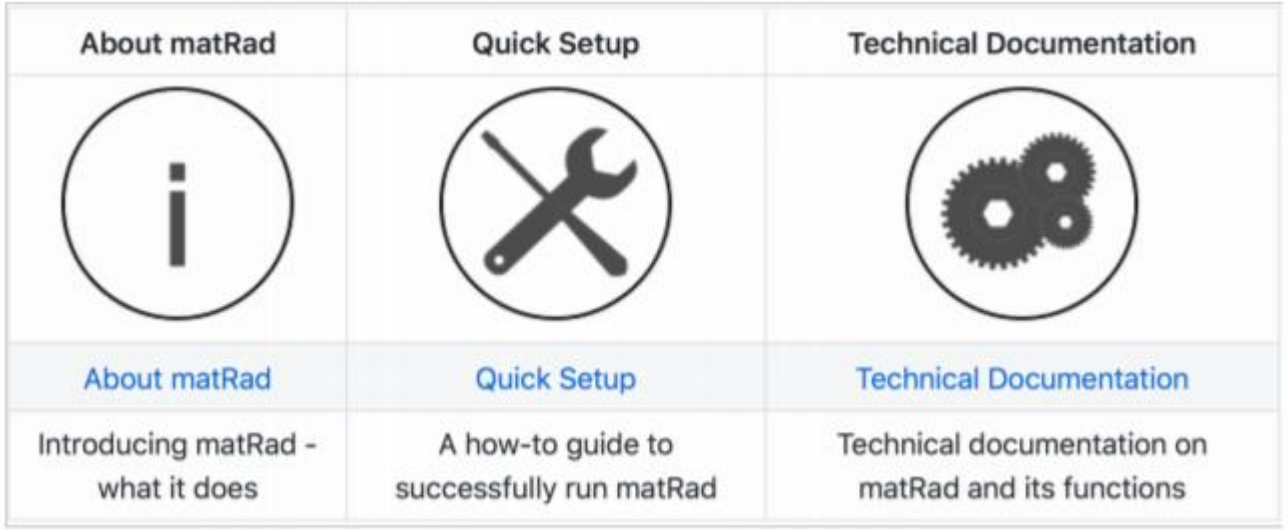
MatRad features

- Open source software and access to real life patient data. Widespread use in the Medical Physics community.
- Standalone (matRad.exe) can be used without permission.
- User friendly and provides easy data visualization functions.
- Convenient and fast debugging.
- Simple syntax compared to more abstract programming languages (e.g. C ++).

More information about the software

- Many functional examples of the software are available as well as enough educational material.

- 29 pages available at Wiki: https://github.com/e0404/matRad/wiki



- The official page of the software is given at the following link: https://e0404.github.io/matRad/

Thank you very much for your attention

And

I am waiting for you to study them in more detail in the hands on session!