PARTICLE THERAPY MASTERCLASS

Hands-On Treatment Planning with matRad

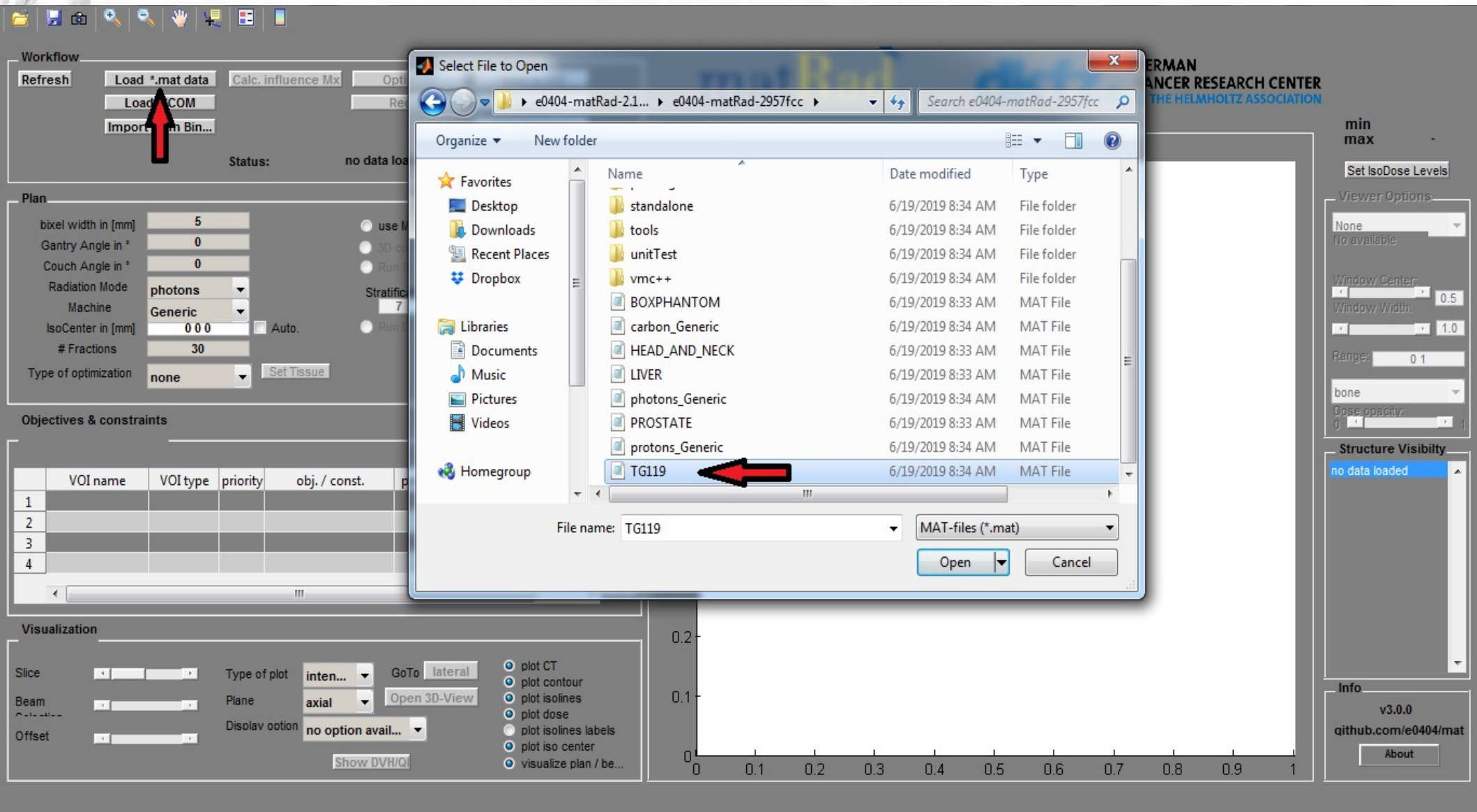
Workflow step by step instructions

Slides courtesy of Amila Avdić

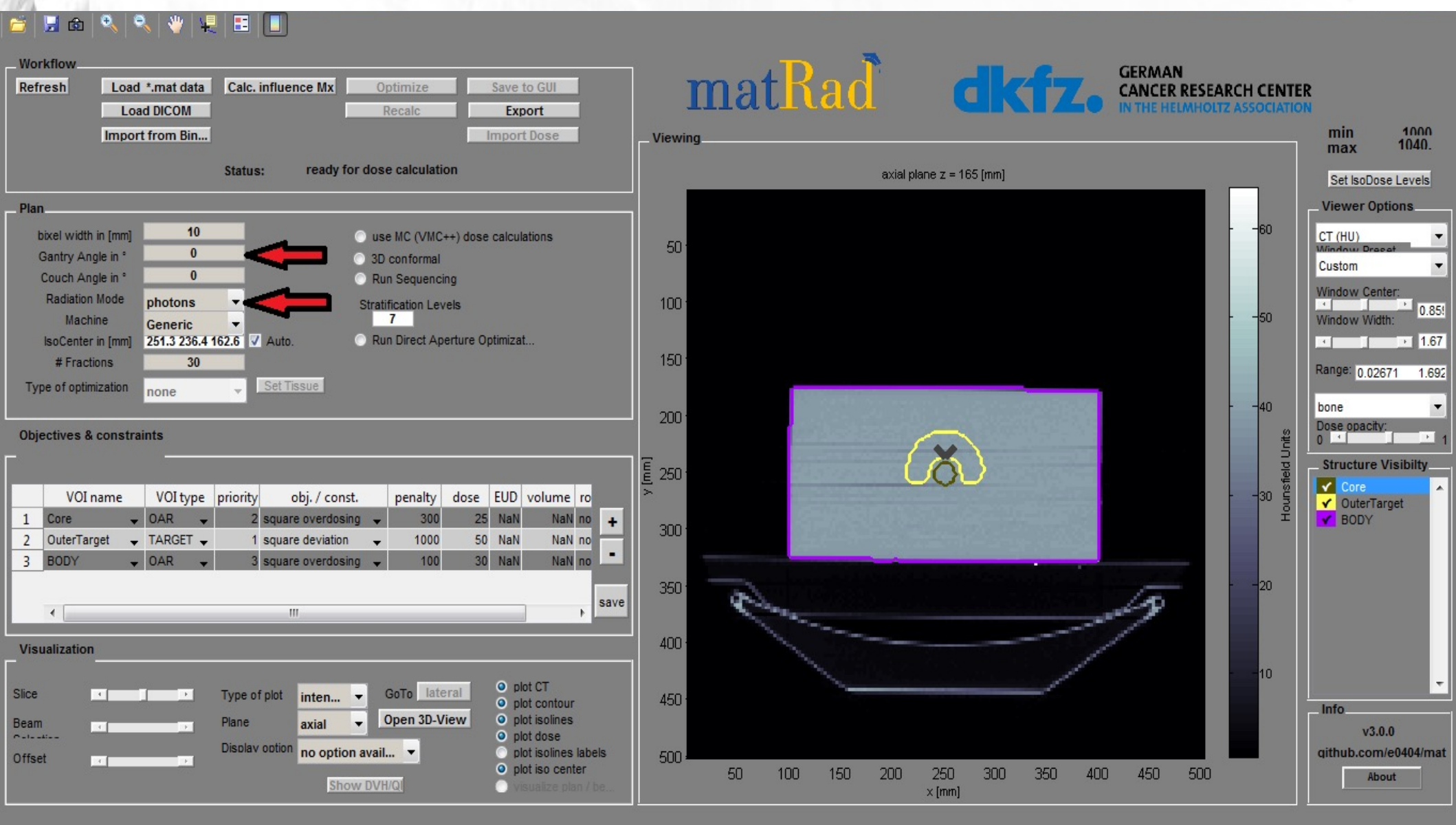
1st Exercise

- First steps on the TG119 phantom
- Radiotherapy treatment - photons vs. protons vs. carbon ions
- Analysing and comparing results

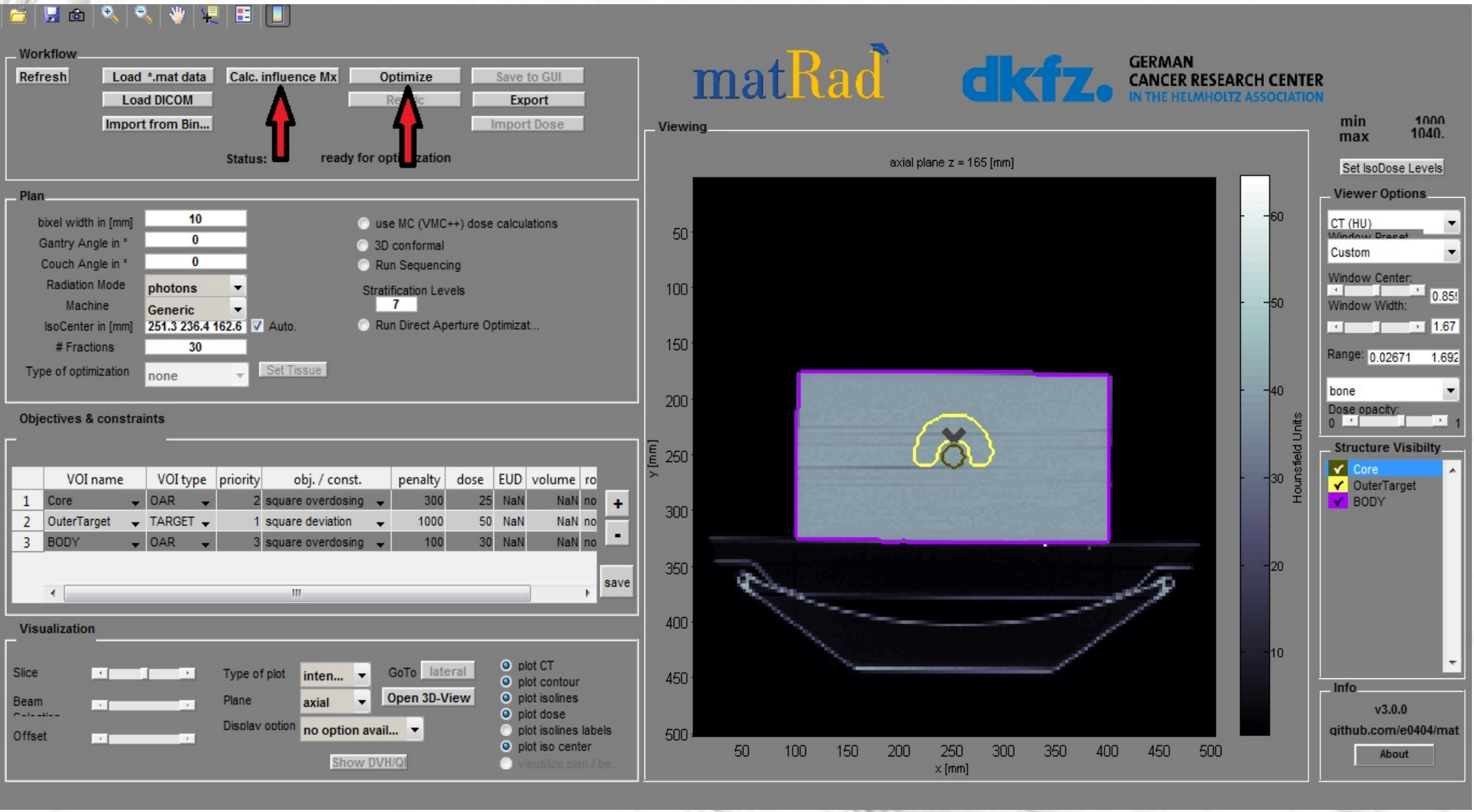
1. Load the TG119 phantom via the Load *.mat button (TG119.mat).



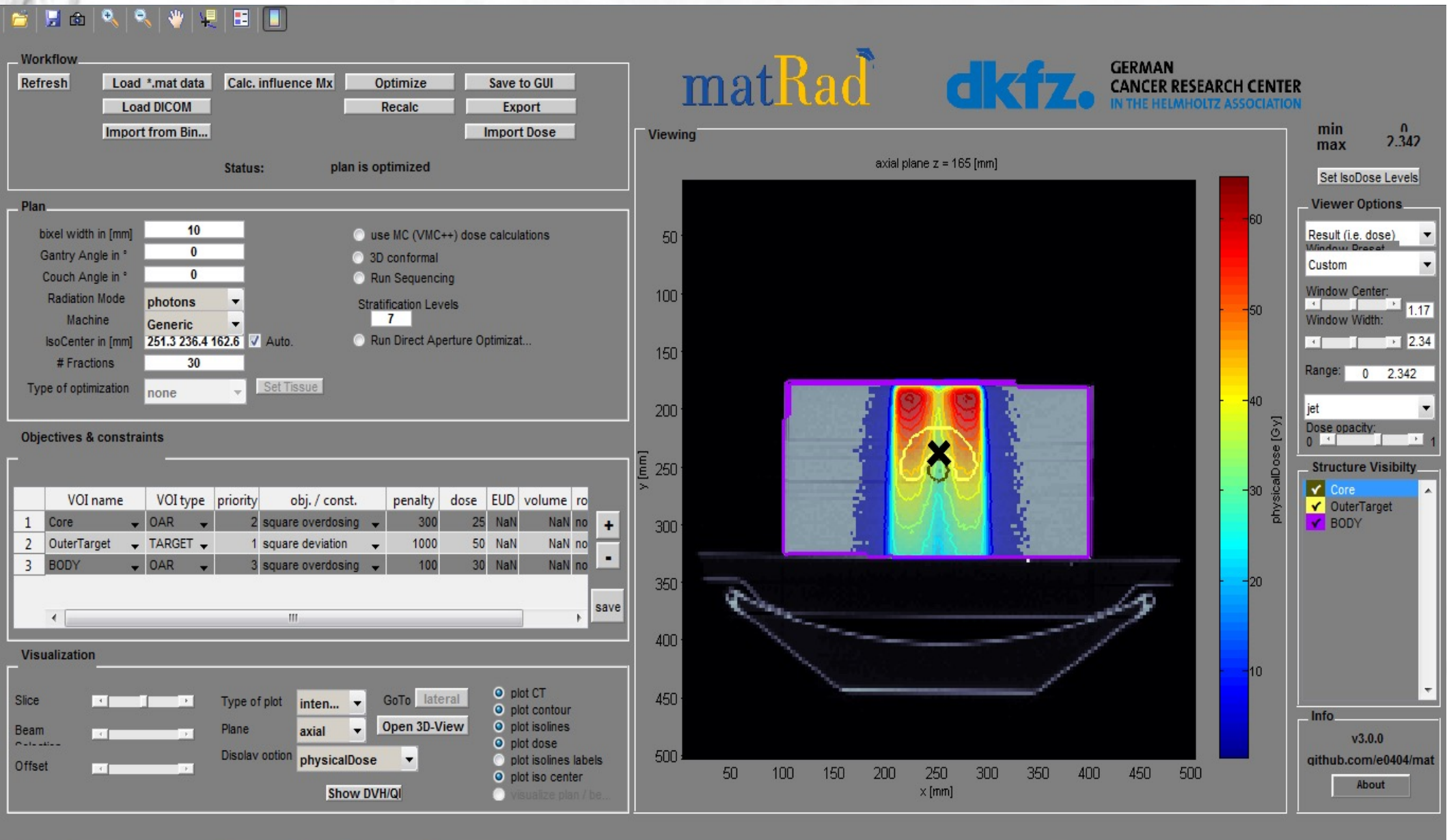
2. Set radiation modality to Photons and define one beam angle (gantry angle).



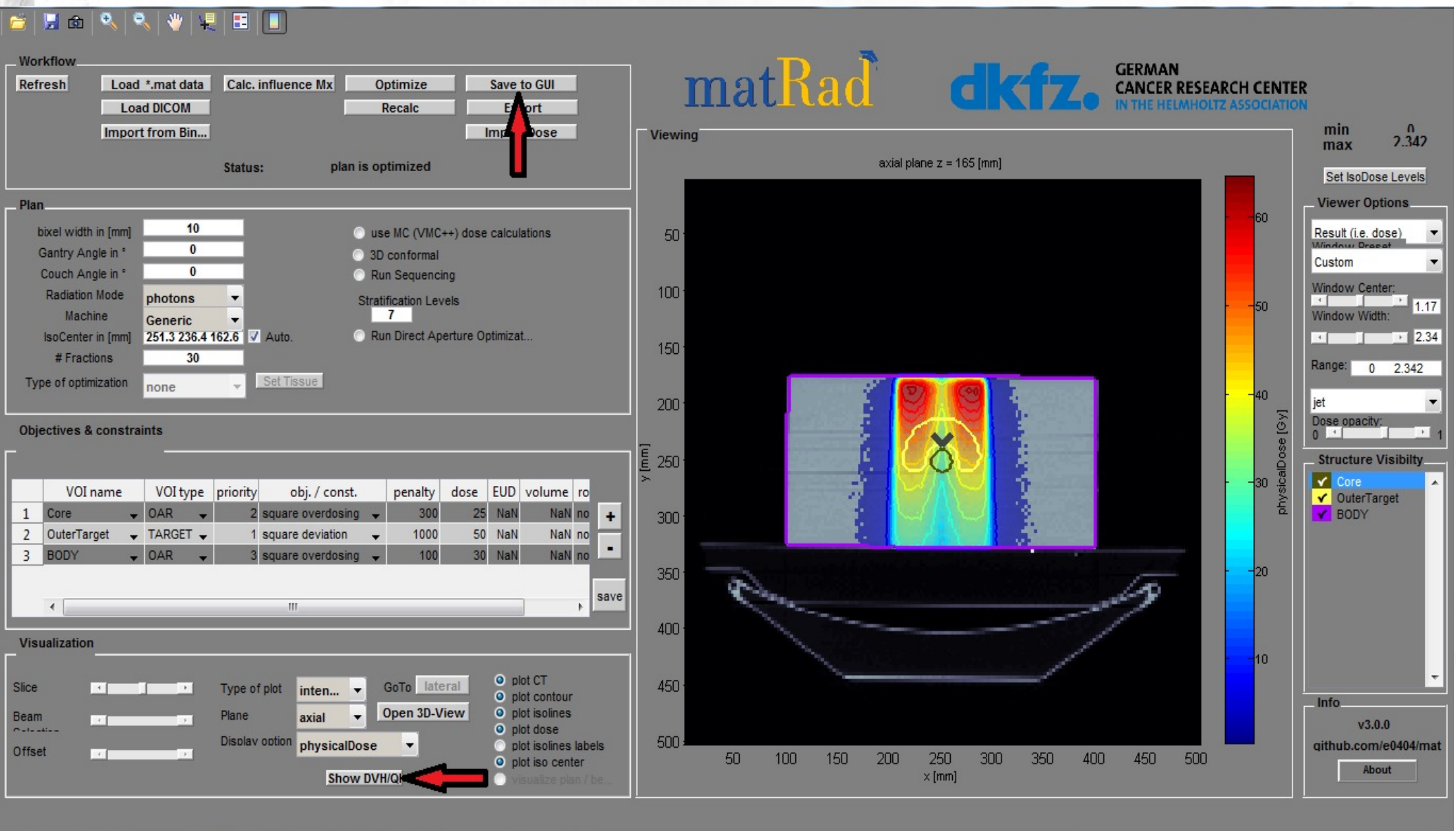
3. Trigger dose calculation viabutton („Calc. Influence Mx“) and start inverse optimization by clicking on („Optimize“).

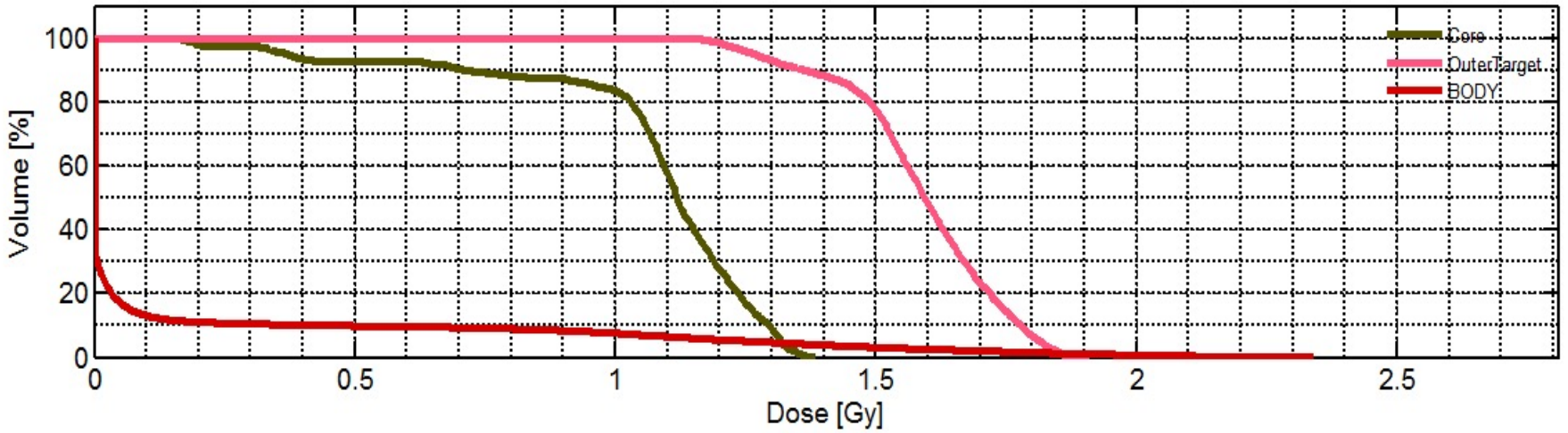


4. Analyze the resulting dose distribution.



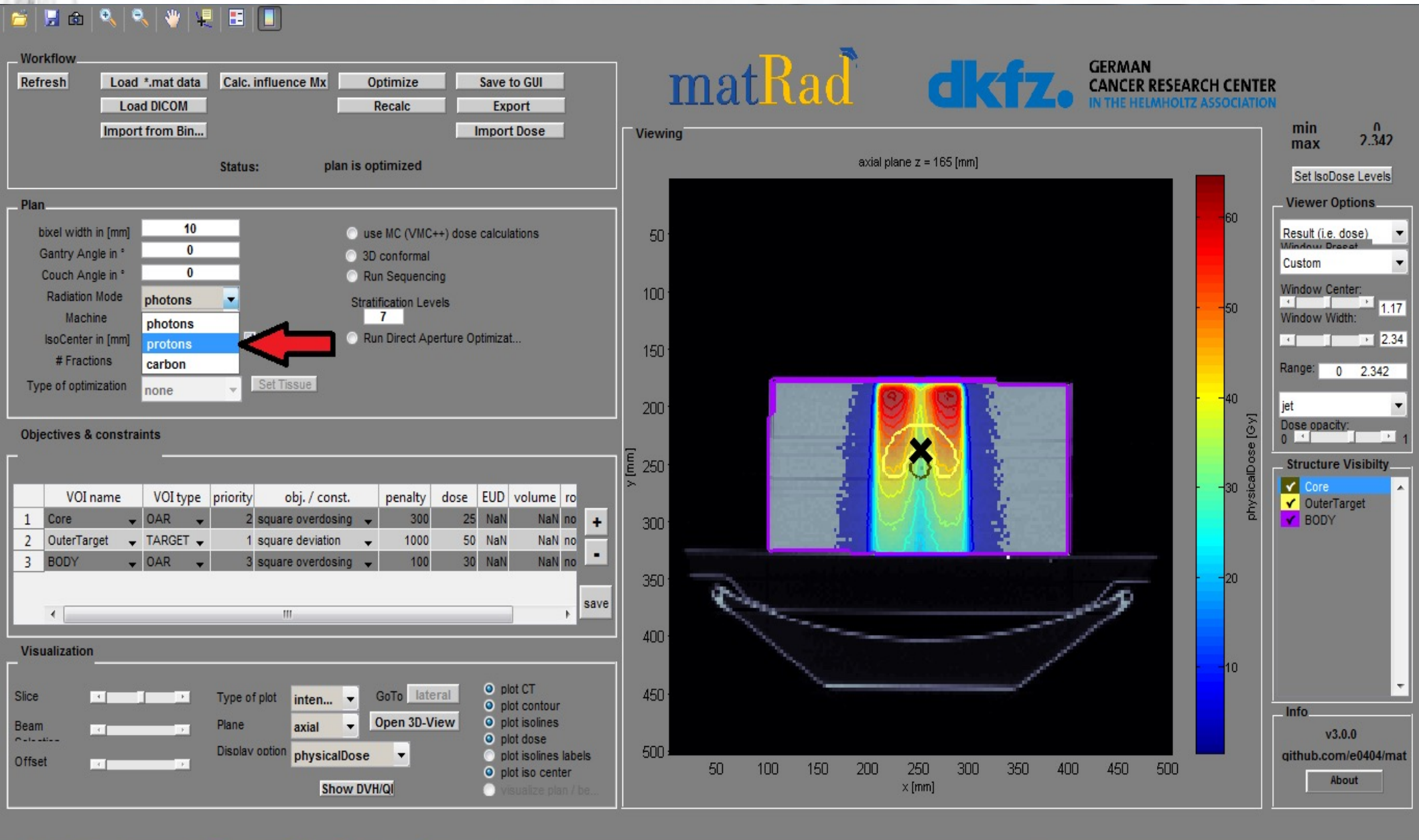
5. Save the optimization result via („Save to GUI“). Next, show the DVH by („Show DVH/QI”).



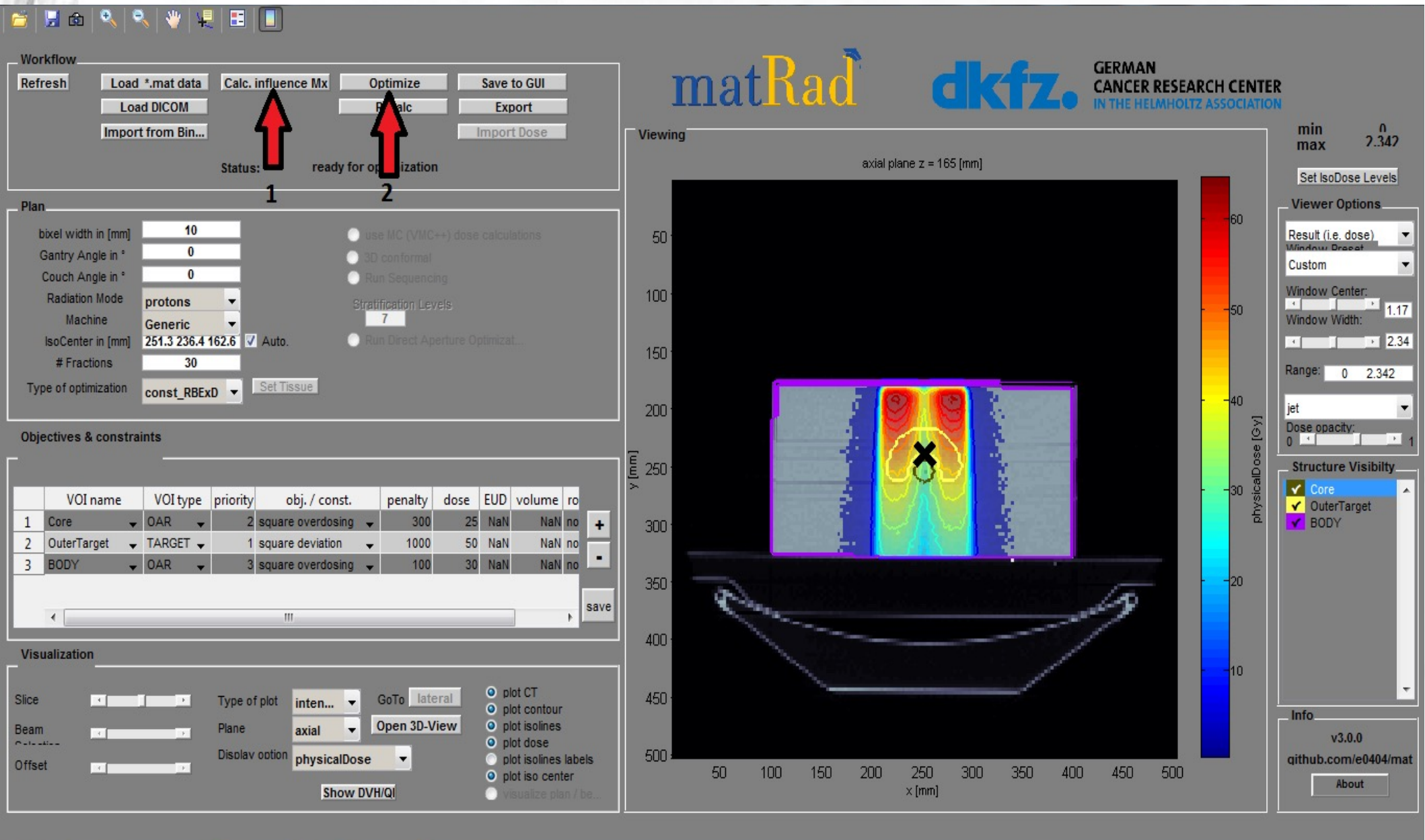


	mean	std	max	min	D_2	D_5	D_50	D_95	D_98	V_0Gy	V_0.4Gy	V_0.9Gy	V_1.4Gy	V_
Core	1.0665	0.2554	1.3860	0.1329	1.3434	1.3187	1.1183	0.3706	0.1988	1	0.9341	0.8727	0	
OuterTarget	1.5852	0.1536	1.9115	1.0935	1.8453	1.8153	1.5941	1.2663	1.2077	1	1	1	0.8824	
BODY	0.1443	0.4168	2.3420	0	1.7203	1.2694	0	0	0	1	0.1019	0.0846	0.0393	

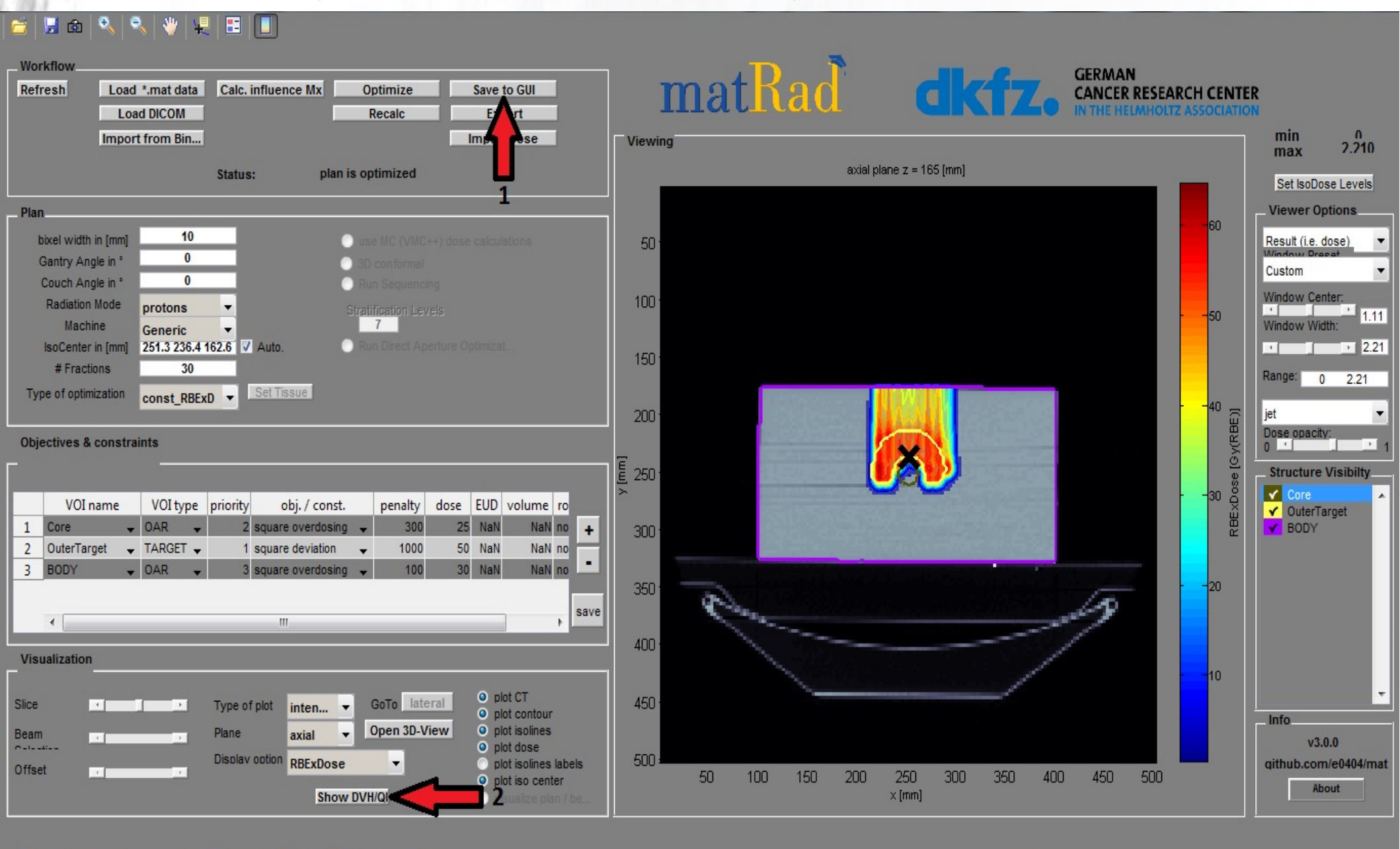
6. Change the radiation modality to: Protons and leave the beam angles unchanged.

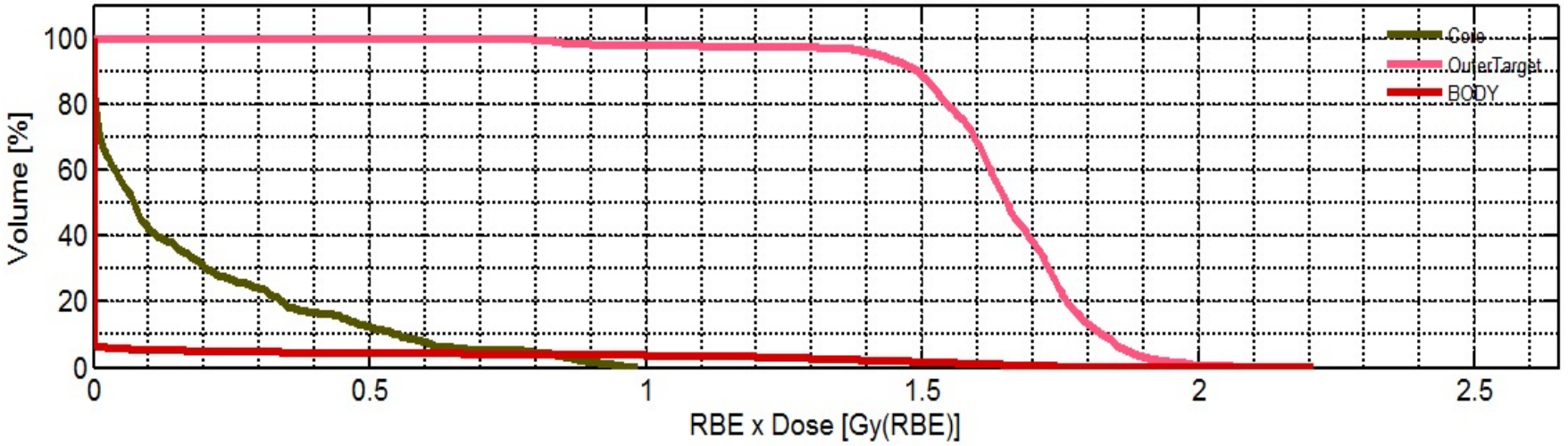


7. Trigger dose calculation viabutton („Calc. InfluenceMx“) and start inverse optimization by clicking on („Optimize“).



8. Save the optimization result via („Save to GUI“). Next, show the DVH by („Show DVH/QI”). Analyze the dose distribution.





	mean	std	max	min	D_2	D_5	D_50	D_95	D_98	V_0Gy	V_0.4Gy	V_0.8Gy	V_1.3Gy	V_
Core	0.1815	0.2396	0.9866	2.0386e-09	0.8909	0.7849	0.0744	2.4933e-05	6.0723e-07	1	0.1682	0.0470	0	
OuterTarget	1.6449	0.1770	2.1789	0.7475	1.9408	1.8726	1.6533	1.4205	0.9187	1	1	0.9949	0.9722	
BODY	0.0640	0.2912	2.2101	0	1.4572	0.2364	0	0	0	1	0.0462	0.0405	0.0282	

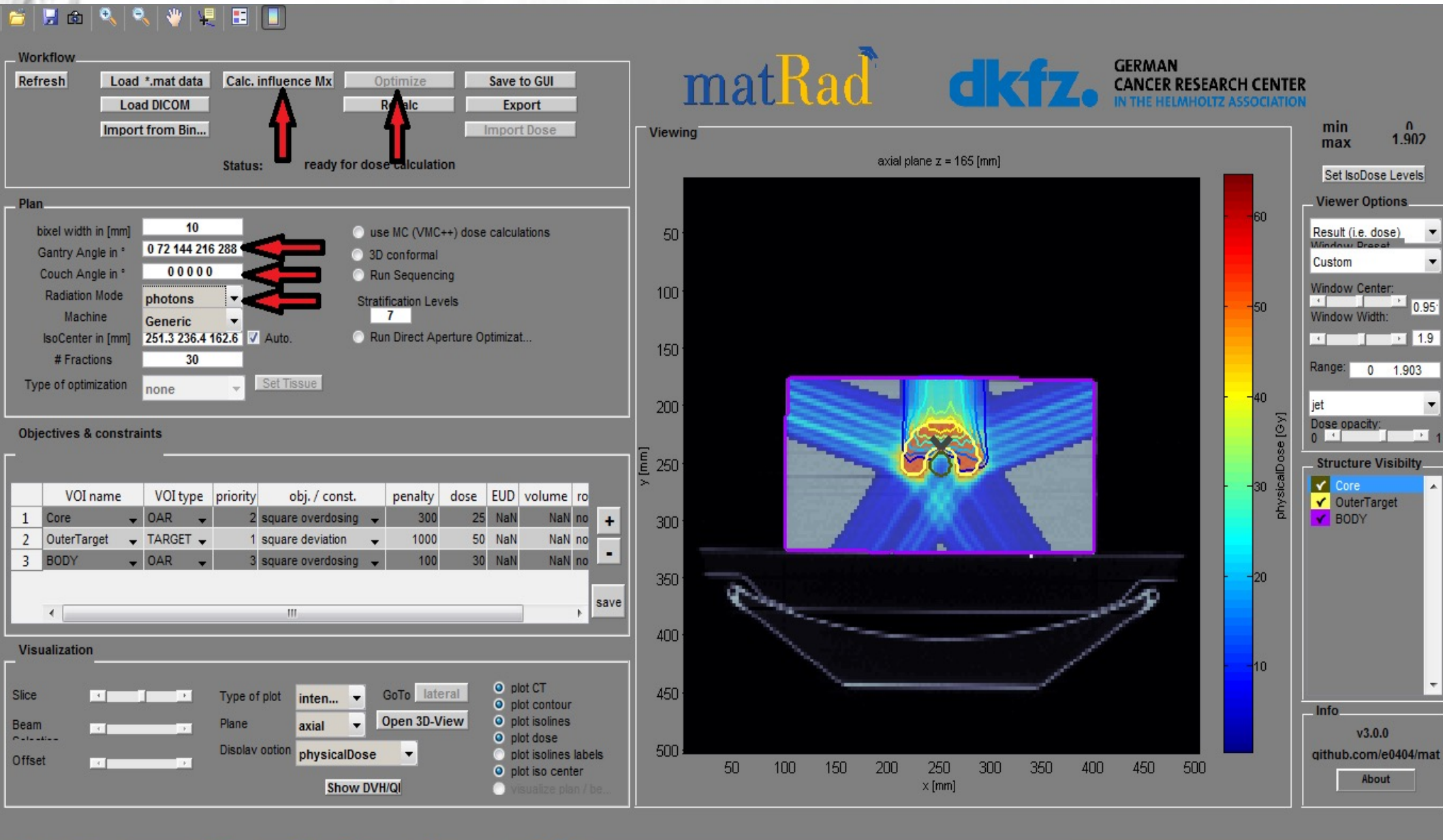
Results

- Mean doses for different regions (Gy):

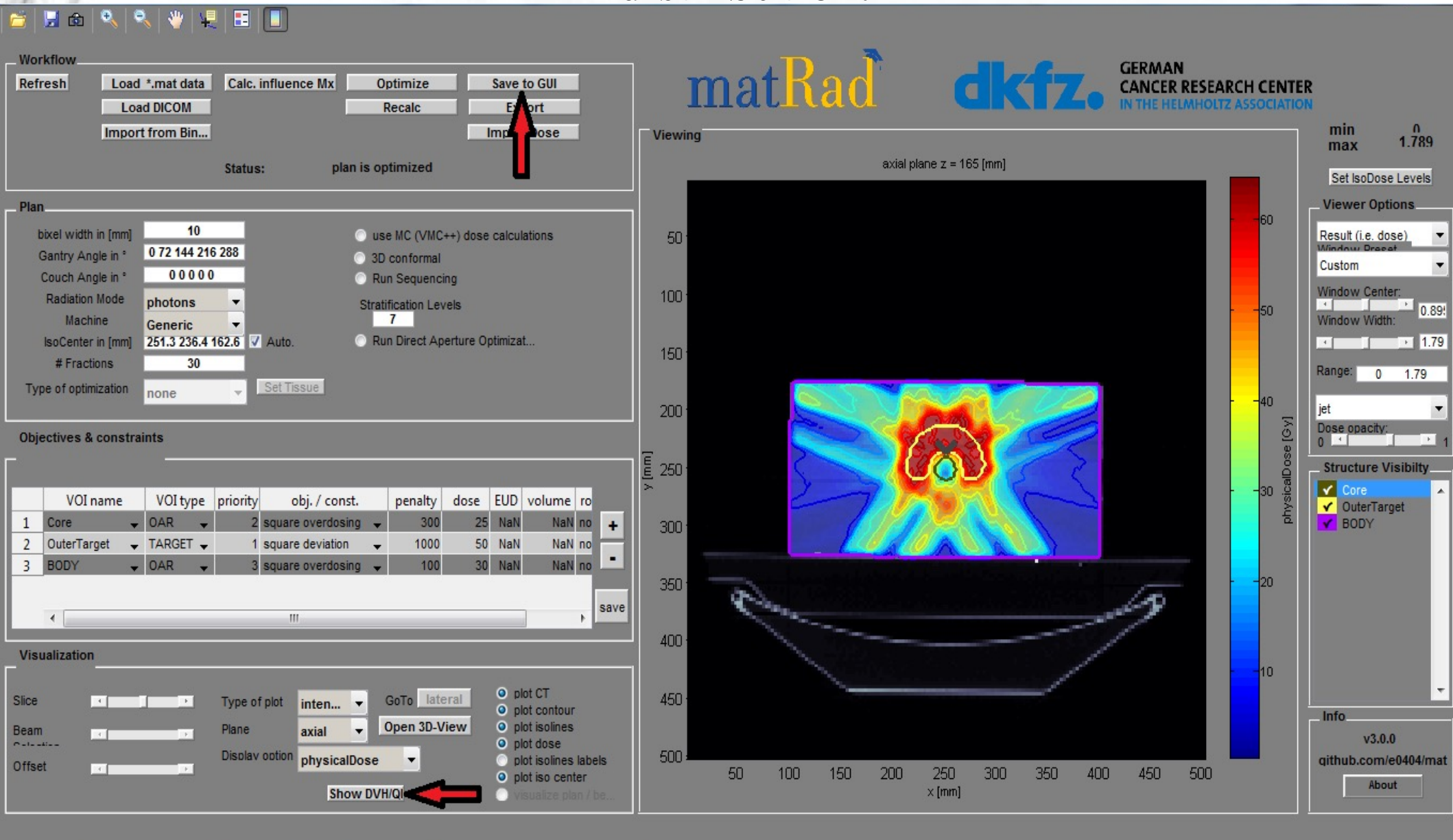
Region/Radiation	Photons	Protons
Core	1.0665	0.1815
Outer Target	1.5852	1.6449
Body	0.1443	0.0640

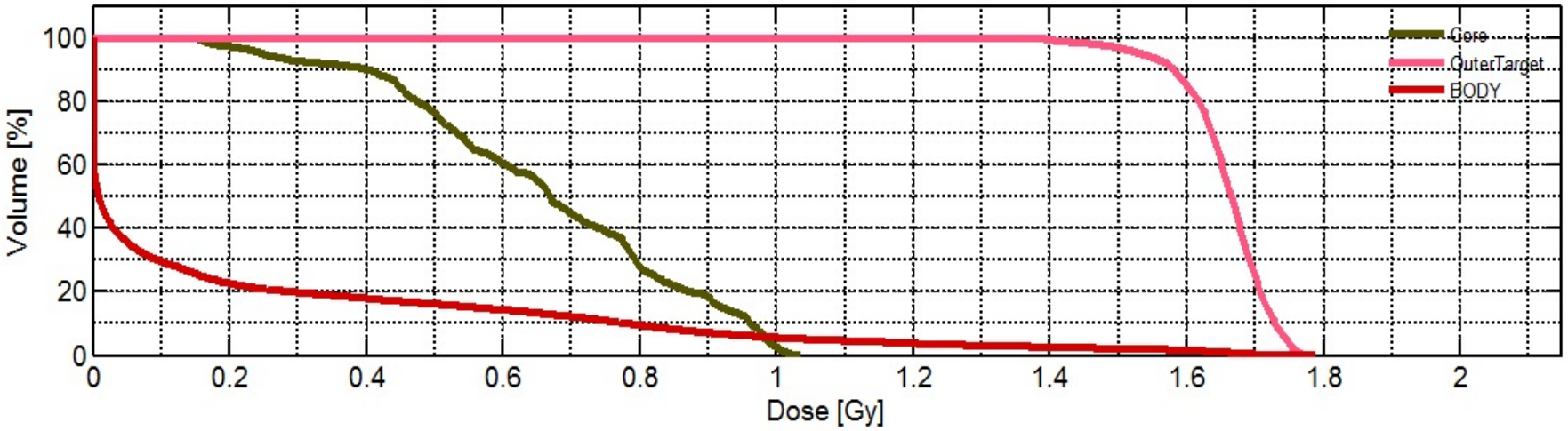
- Photons deliver highest dose at the surface
- Protons deliver highest dose at the target (tumor) and protect sensitive organs

9. Try to define a better photon treatment plan by defining more beam angles (e.g. [0, 72, 144, 216, 288]). Trigger dose calculation („Calc. Influence Mx“) and start inverse optimization („Optimize“).



10. Save the optimization result via („Save to GUI“). Show the DVH by („Show DVH/QI”). Analyze resulting dose distribution.





	mean	std	max	min	D_2	D_5	D_50	D_95	D_98	V_0Gy	V_0.3Gy	V_0.7Gy	V_1Gy	V_
Core	0.6625	0.2176	1.0370	0.1450	1.0030	0.9853	0.6686	0.2460	0.1755	1	0.9265	0.4477	0.0250	
OuterTarget	1.6563	0.0659	1.7897	1.2866	1.7566	1.7450	1.6652	1.5323	1.4636	1	1	1	1	
BODY	0.1968	0.3777	1.7897	0	1.5510	1.0629	0.0091	0	0	1	0.1986	0.1230	0.0568	

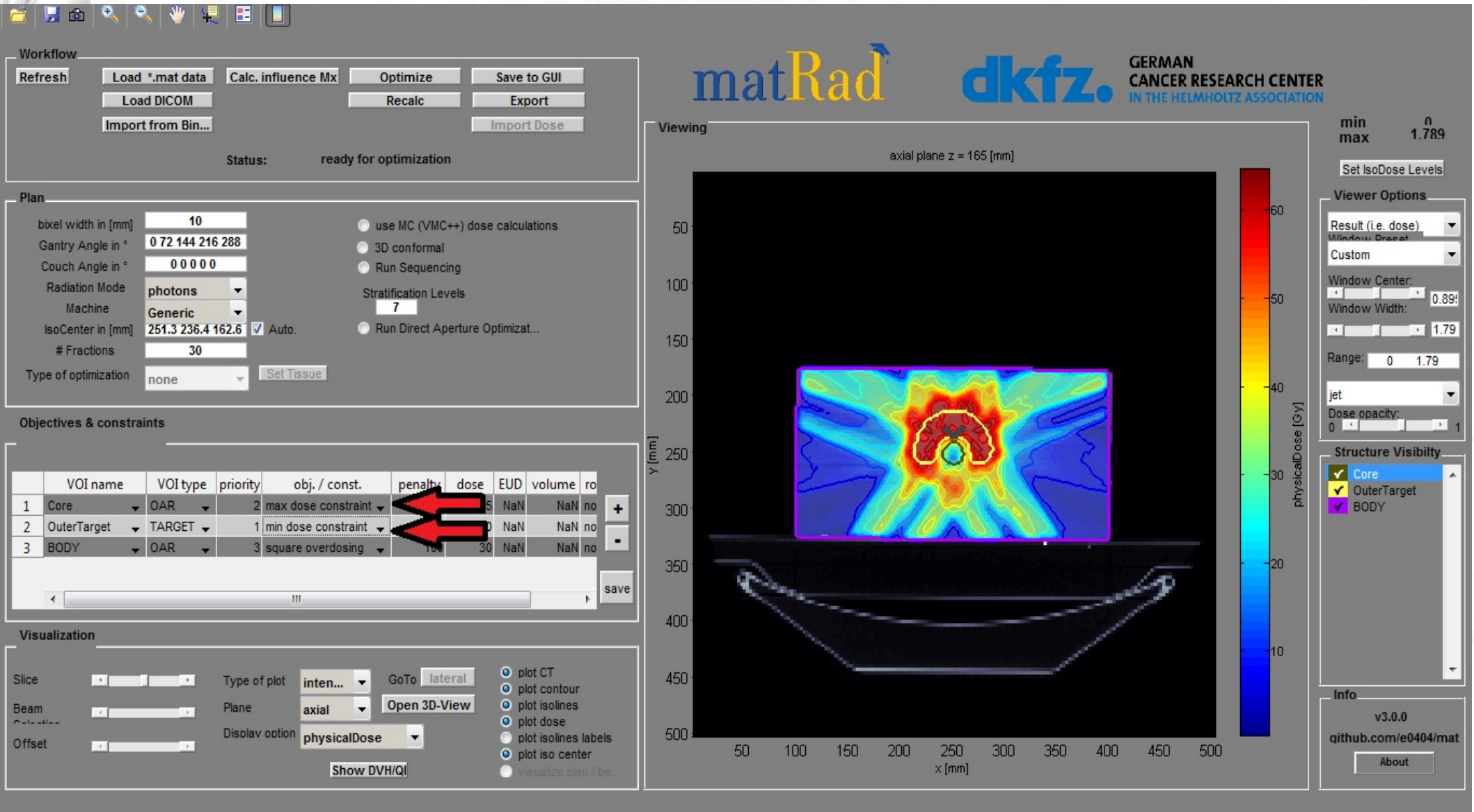
Results

- Mean doses for different regions (Gy):

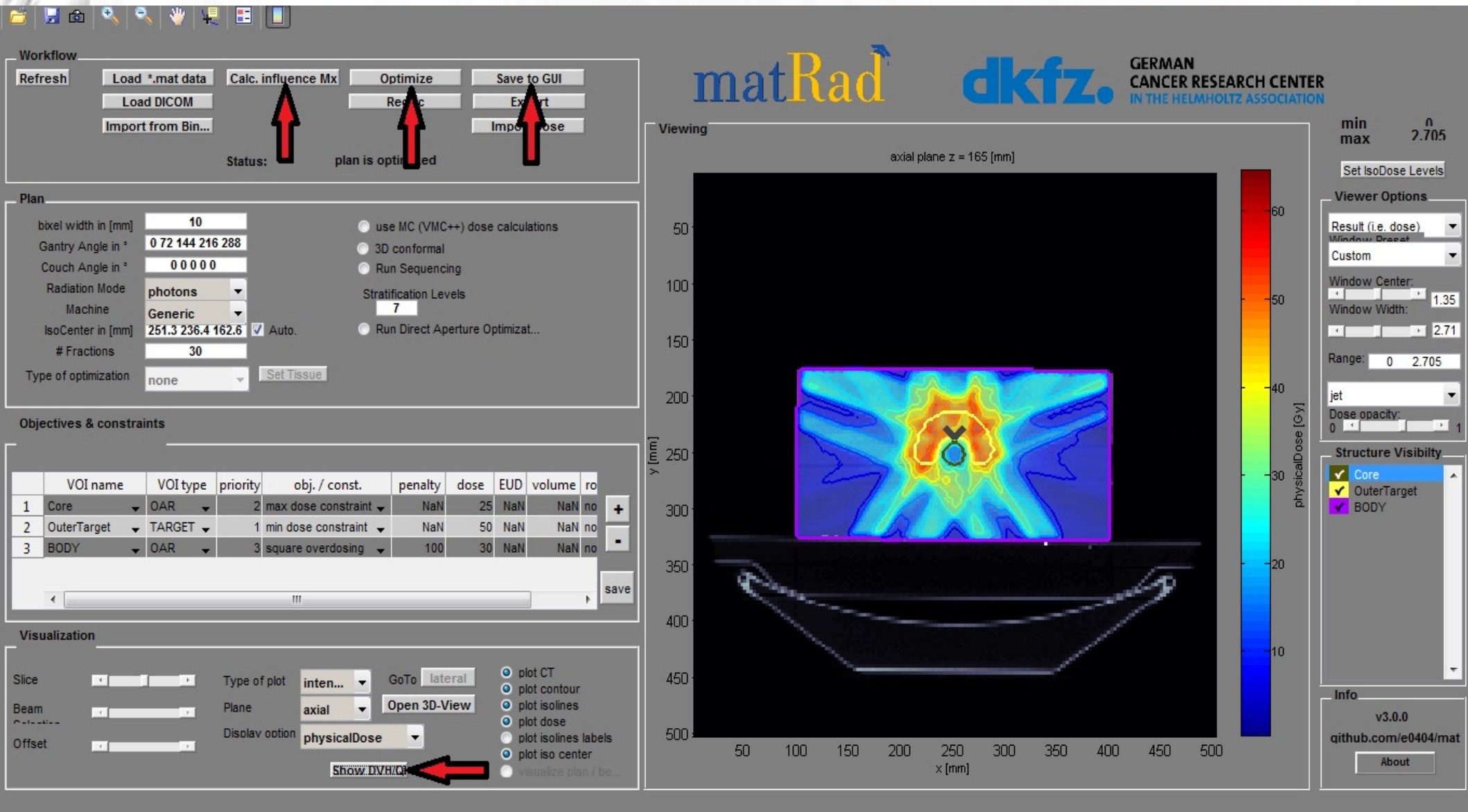
Region/Radiation(angles)	Photons(0)	Protons(0)	Photons (0,72,144,216,288)
Core	1.0665	0.1815	0.6625
Outer Target	1.5852	1.6449	1.6563
Body	0.1443	0.0640	0.1968

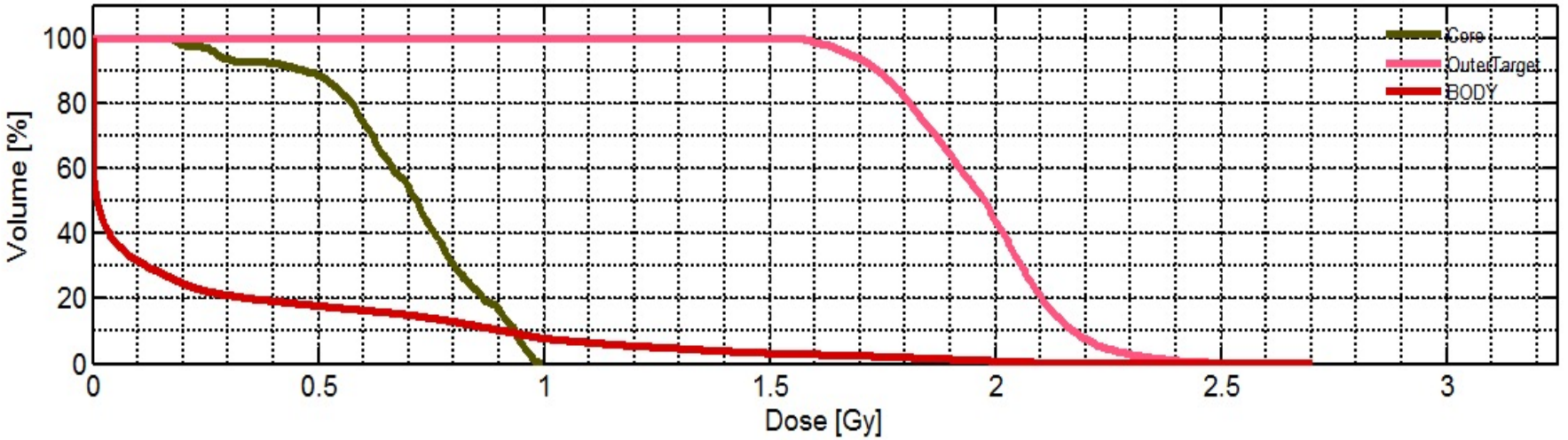
- Treatment plan using multiple photon beams gives better results than single photon beam.
- Best results are obtained using protons.

11. Change optimization objective to improve the photon treatment plan. Use Table („Objectives &constraints“) and add for e.g. maximal dose for the core or minimal dose for the outer target.



12. Trigger dose calculation („Calc. Influence Mx“) and start inverse optimization („Optimize“). Save the optimization result via („Save to GUI“). Next, show the DVH by („Show DVH/QI”).





	mean	std	max	min	D_2	D_5	D_50	D_95	D_98	V_0Gy	V_0.5Gy	V_1Gy	V_1.6Gy	V_
Core	0.6974	0.1876	0.9986	0.1704	0.9743	0.9563	0.7189	0.2781	0.1981	1	0.8848	0	0	
OuterTarget	1.9652	0.1732	2.7054	1.5511	2.3409	2.2397	1.9766	1.6761	1.6190	1	1	1	0.9857	
BODY	0.2343	0.4481	2.7054	0	1.7993	1.2658	0.0110	0	0	1	0.1780	0.0784	0.0288	

Results

- Mean doses for different regions (Gy) using 5 beams with and without constraints:

Region/Radiation	With constraints	Without constraints
Core	0.6625	0.6974
Outer Target	1.6563	1.9652
Body	0.1968	0.2343