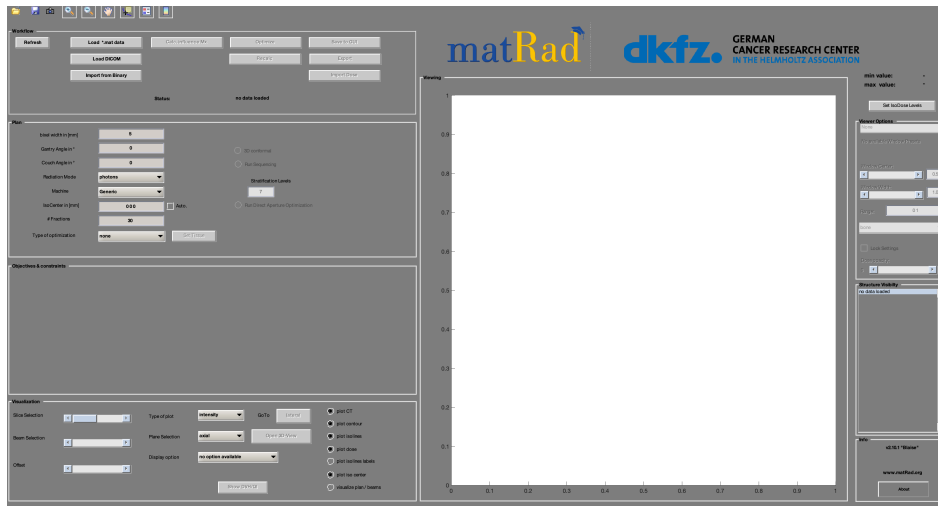


Hands-On Treatment Planning Basics: Hands-On Biological/Carbon Planning

20.05.2021

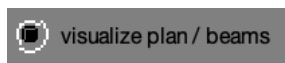
Task 1: Comparison between Protons and Carbon Ions

1.) Open the matrad User Interface

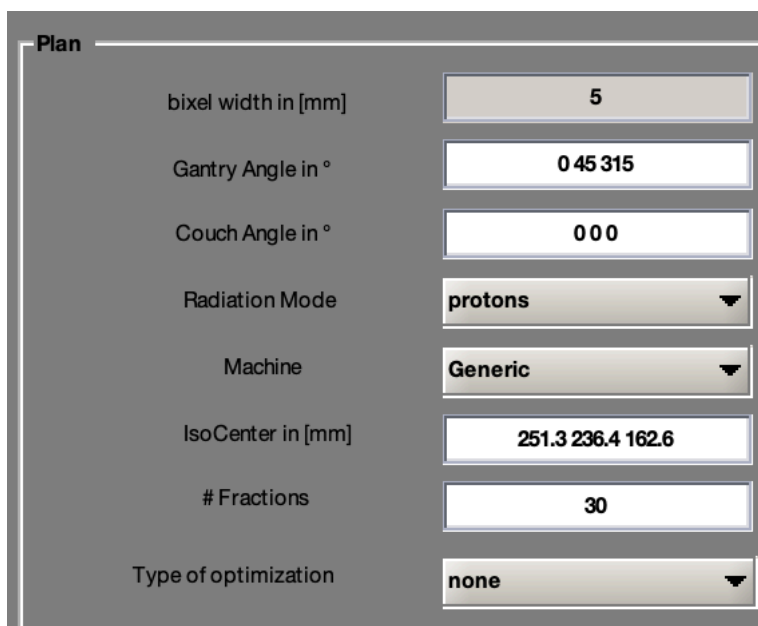


2.) Load *.mat data and choose TG119.mat

3.) Enable the visualization of the beam angles.



4.) Choose the following plan parameters



5.) Choose the following objectives

Objectives & constraints						
+/-	VOI name	VOI type	OP	Function	p	Parameters
-	Core	OAR	2	Squared Overdosing	300	d^{max} : 25
-	OuterTarget	TARGET	1	Squared Deviation	2000	d^{ref} : 60
-	BODY	OAR	3	Squared Overdosing	100	d^{max} : 30
+	Core					

6.) Calculate the dose influence matrix by clicking **Calc influence Matrix**

7.) Then click **Optimize**

8.) Save your dose to the list with **Save to GUI** and choose a name (e.g. **proton3beamNone**). You can export an image using the screenshot button:

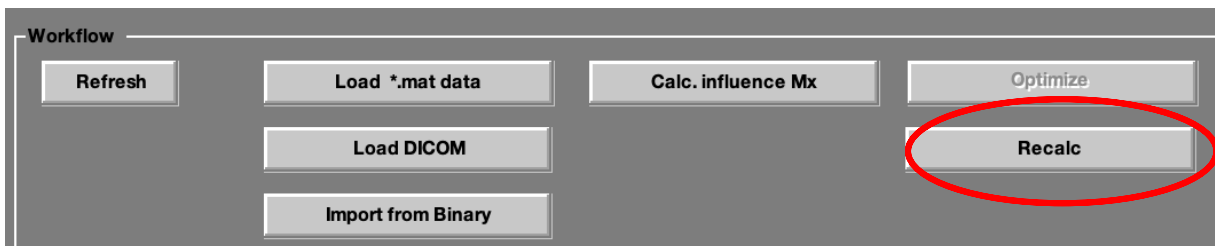


9.) Change the Type of optimization of 'none' to const_RBExD

Type of optimization:

Type of optimization:

10.) And then recalculate the dose



11.) Save your dose to the list with **Save to GUI** and choose a name (e.g. **proton3beamConstRBE**).


12.) Go to the **Display option** and compare physicalDose and RBExD. What differences can be seen between these two distributions ?

Display option:

13.) Compare the D95 dose and the DVH for the target and the core (OAR) for these two dose distributions

- 14.) Change the radiation mode to carbon and select type of optimization 'none', which indicates a physical dose optimization.

Plan	
bixel width in [mm]	5
Gantry Angle in °	0 45 315
Couch Angle in °	0 0 0
Radiation Mode	carbon ▼
Machine	Generic ▼
IsoCenter in [mm]	251.3 236.4 162.6
# Fractions	30
Type of optimization	none ▼

- 15.) Calculate the dose influence matrix by clicking [Calc influence Matrix](#) and then click [Optimize](#). This may take a while ...
- 16.) Save the treatment plan [Save to GUI](#) (e.g. **carbon_physicalOpt**)
- 17.) What difference can you immediately observe in the dose distribution?
- 18.) Change the Type of Optimization to LEM_IV
- 
- 19.) Press the Recalc Button to calculate the RBE weighted dose (=biological effective dose) for the previously physically optimized treatment plan. Save the treatment plan with plan [Save to GUI](#) (e.g. **carbon_recalcBioDose**)
- 20.) Inspect the resulting treatment plan and compare the two carbon ion dose distribution (physicalDose vs. RBExD) in the Viewing pane as well as with DVH and quality metrics.
- 21.) Perform a full biological optimization for carbon ions by leaving the settings as they are ([Type of Optimization: LEMIV_effect](#)) and press the button [Calc influence Matrix](#) and then click [Optimize](#).
- 22.) Save the treatment plan with [Save to GUI](#) button (e.g. **carbon_bioOpt**) and compare the result to the previous result. Use the display option to switch between RBExD and physical dose.
- 23.) What did change in the physical dose when compared to the biological optimization result (LEMIV_effect).

Task 2: Boxphantom case -Different tissue type

- 1.) Click on **Load *.mat data** and load the boxphantom.mat case and select the following settings:

Plan

bixel width in [mm]	5
Gantry Angle in °	0
Couch Angle in °	0
Radiation Mode	carbon
Machine	Generic
IsoCenter in [mm]	240 240 240
# Fractions	30
Type of optimization	LEMIV_RBExD

- 2.) Save the treatment plan (e.g **carbon_ab2**).
- 3.) Click the **Set Tissue** button

Type of optimization: LEMIV_RBExD **Set Tissue**

- 4.) And change the alphaX betaX values of all structures to **0.5 0.05. AB ratio of 10** and click on **Save&Close**.

	VOI	alphaX	betaX	alpha	beta	ratio
1	BODY	0.5	0.05			10
2	OuterTarget	0.5	0.05			10

Cancel&Close **Save&Close**

- 5.) Now perform a new biological optimization with a different reference tissue. Click on Calc **influence Matrix** and then click **Optimize**.
- 6.) Compare the two dose distributions. What differences can be observed, especially in the physical dose?

Task 3: LIVER case

7.) Click on **Load *.mat data** and load the LIVER.mat case and select the following settings:

Plan

bixel width in [mm]	5
Gantry Angle in °	330
Couch Angle in °	0
Radiation Mode	carbon
Machine	Generic
IsoCenter in [mm]	265.8 296.7 316.4
# Fractions	30
Type of optimization	LEMIV_effect

8.) Select at least the following objective functions for optimization:

Objectives & constraints

+/-	VOI name	VOI type	OP	Function	p	Parameters
-	Skin	OAR	2	Squared Overdosing	300	d^{\max} : 25
-	PTV	TARGET	1	Squared Deviation	1000	d^{ref} : 60
+	GTV					

9.) Inspect the treatment plan using the Viewing pane, the display options and the DVH/QI button.

10.) Save the treatment plan using **Save to GUI** and give it a name like **carbon_1Beam_ab2**

11.) Click the **Set Tissue** button

Type of optimization: LEMIV_RBExD

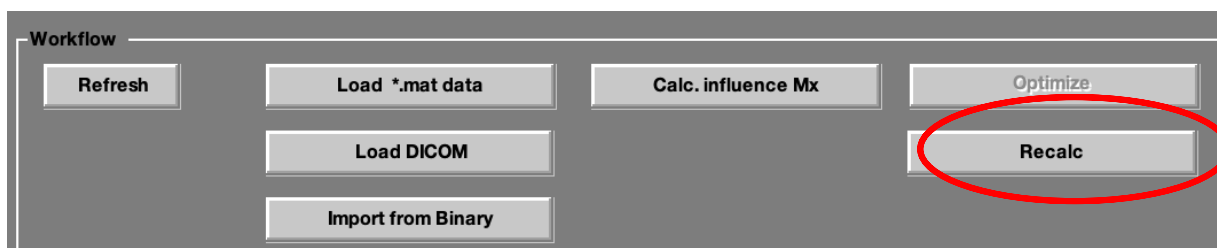
Set Tissue

12.) And change the alphaX betaX values for the PTV to **0.5 0.05. AB ratio of 10**. By this, the radio-sensitivity parameters of our tumor change.

Treatment planning practical

	VOI	alphaX	betaX	alpha beta ratio
1	GTV	0.1	0.05	2
2	Kidney_R	0.1	0.05	2
3	Kidney_L	0.1	0.05	2
4	Stomach	0.1	0.05	2
5	SmallBowel	0.1	0.05	2
6	LargeBowel	0.1	0.05	2
7	Celiac	0.1	0.05	2
8	SMA_SMV	0.1	0.05	2
9	Liver	0.1	0.05	2
10	Heart	0.1	0.05	2
11	SpinalCord	0.1	0.05	2
12	DoseFalloff	0.1	0.05	2
13	duodenum	0.1	0.05	2
14	CTV	0.1	0.05	2
15	Skin	0.1	0.05	2
16	PTV	0.5	0.05	10
17	cord+5mm	0.1	0.05	2
18	clip1	0.5	0.05	2
19	clip2	0.1	0.05	2
20	clip3	0.1	0.05	2
21	clips	0.1	0.05	2
22	entrance	0.1	0.05	2
23	Liver-CTV	0.1	0.05	2
24	combinedKid...	0.1	0.05	2
25	CT Reference	0.1	0.05	2
26	ISOCENTER	0.1	0.05	2

13.) Recalculate the treatment plan and save using [Save to GUI](#) (e.g. carbonab10)



14.) Inspect the resulting treatment plan. What differences can be observed ?

Treatment planning practical

- 15.) OPTIONAL: Uncheck the auto-box in the Plan pane and define manually a new shifted iso center and click on the Recalc button. By this you now additionally simulate a shifted patient geometry during treatment.