WP1 Updates on TRiP98 side

Elettra V. Bellinzona

INFN - TIFPA Trento Institute for Fundamentals Physics Applications

elettra.bellinzona@tifpa.infn.it

Jan 19 2018

Overview

1. What
2. Consistency
   - RayStation LET maps
   - TRiP98 Beam model physics
3. Implementation of target fragments effects
   - Macroscopic approach
   - Microscopic approach

What

At this moment two[1] parallel works are conducted

1. Ensure consistency between TRiP98 Treatment Planning Systems (***GSI***) with Raystation one (***APSS Trento***)
2. Target fragmentation effects implementation in TRiP98

[1] mainly..

1. Consistency

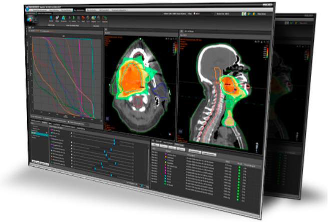
To reach the endpoint of making TRiP98 Treatment Planning Systems (TPS) consistent with RayStation TPS, two solutions are analysed:

1. fit beam data to reproduce RayStation beam (see Sebastian Hild's talk)
2. physical study of TRiP98 to include missing aspects

*LET based calculations

RayStation research 5.99.50, offers from short time ago, the possibility of printing LET maps, choosing between dose or track average LET.

This tool will be used to account for RBE by LET based biological dose calculation.
(See next talk)

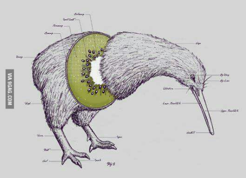


Beam model physics

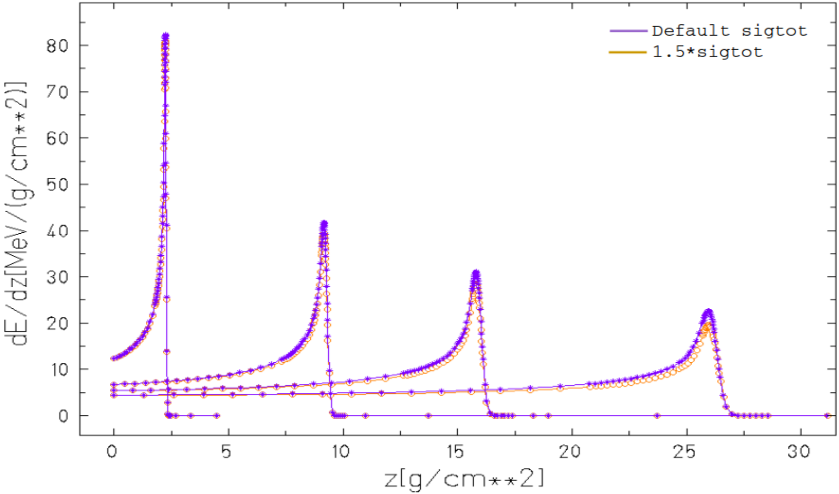
In order to understand the differences between TRiP98 beam model and RayStation one, different aspects of the physics have been investigated in TRiP98 like fragmentations models, singles and total cross sections

At the moment the most promising is this last one.

First results of the study on the variation of the *sigtot* table that indeed contains total reaction cross section of the desired particle, are shown



Beam model physics



2. Implementation of target fragments effects

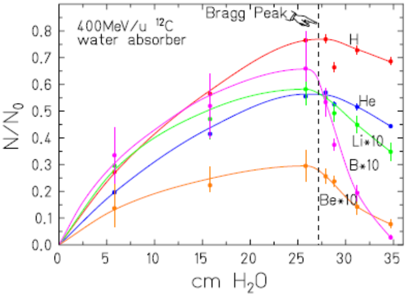
Two approaches:

1. ***Macroscopic-*** Primary protons fragments are considered as secondaries particles; each single spectra of thus fragments is evaluated separately, considering its impact on the RBE. The total RBE is evaluated by using mixed field algorithm and LEM IV model.

$$\overline{\alpha} = \left(\sum_l w_l \frac{\mathrm{d}E}{\mathrm{d}x}(l)\right)^{-1} \sum_l w_l \frac{\mathrm{d}E}{\mathrm{d}x}(l)\alpha_l$$

$$\sqrt{\overline{\beta}} = \left(\sum_l w_l \frac{\mathrm{d}E}{\mathrm{d}x}(l)\right)^{-1} \sum_l w_l \frac{\mathrm{d}E}{\mathrm{d}x}(l)\sqrt{\beta_l}$$

where w_l denotes the relative weight of the radiation component l and α_l, β_l are the α_D, β_d values in low dose approximation [1] [2].



Macroscopic approach

Monte Carlo

Simulations of proton in water saving fragments spectra separately

↓

TRiP98 TPS

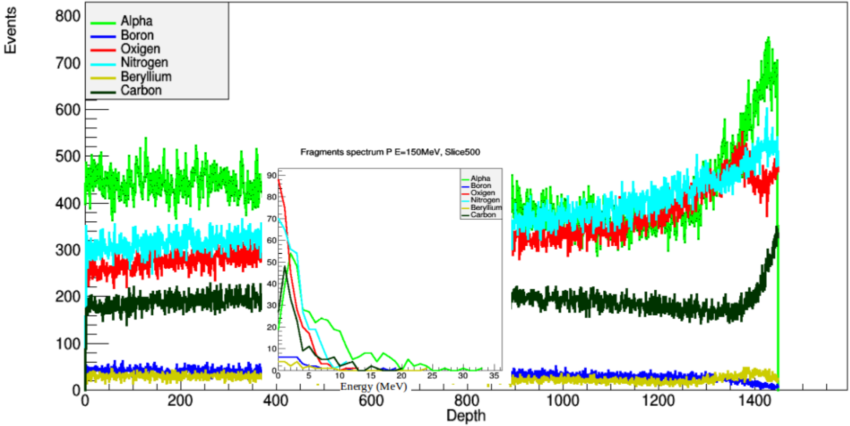
Implementation of the simulation results in dedicated TRiP98 format files

Macroscopic approach: Monte Carlo

We have started the analysis of the target fragments spectra simulating[2] a 150MeV proton beam in water with 10^7 particles.
The first binning configuration has been chose as
ΔZ=100μm, ΔE=1MeV

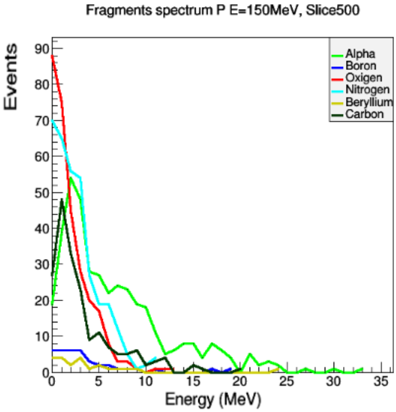
[2]thanks to Giada Petringa

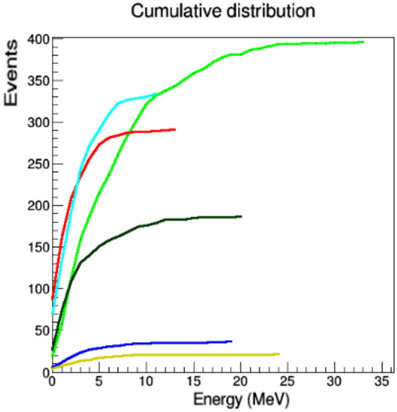
Macroscopic approach: Monte Carlo



$\Delta Z = 100\mu m$, $\Delta E = 1MeV$

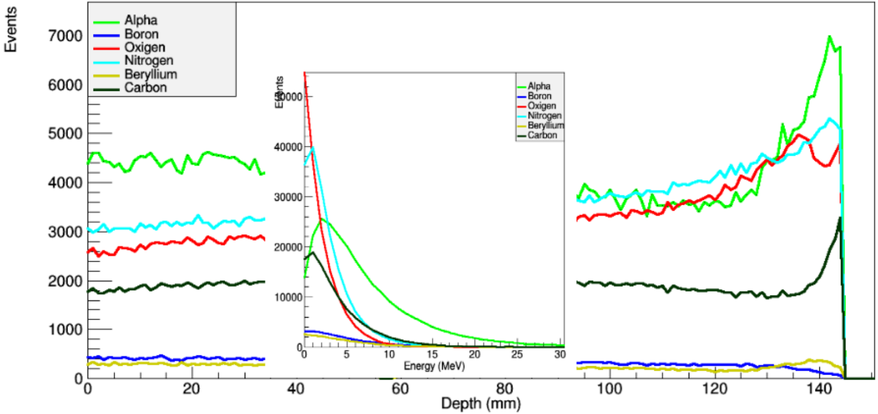
Macroscopic approach: Monte Carlo





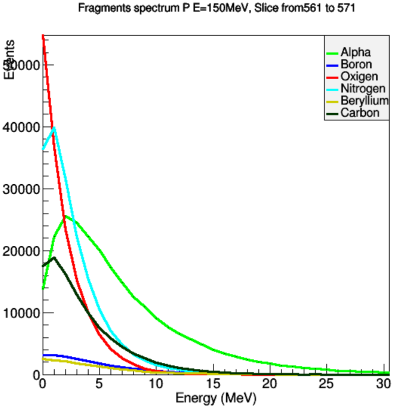
$\Delta Z = 100\mu m$, Z=5cm

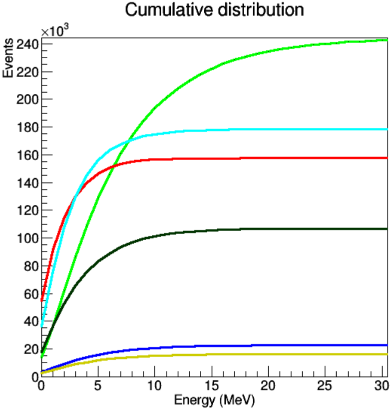
Macroscopic approach: Monte Carlo



$\Delta Z = 1mm$, $\Delta E = 1$MeV

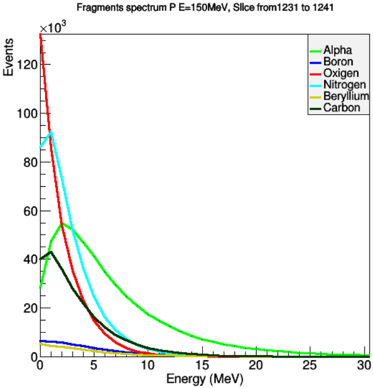
Macroscopic approach: Monte Carlo

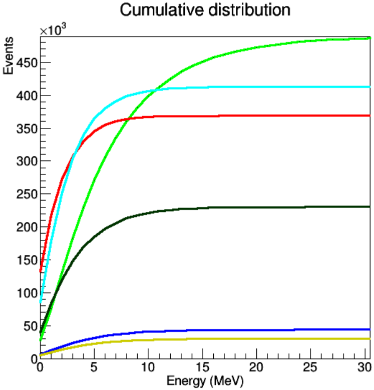




$\Delta Z = 1mm$, Z=5,61cm

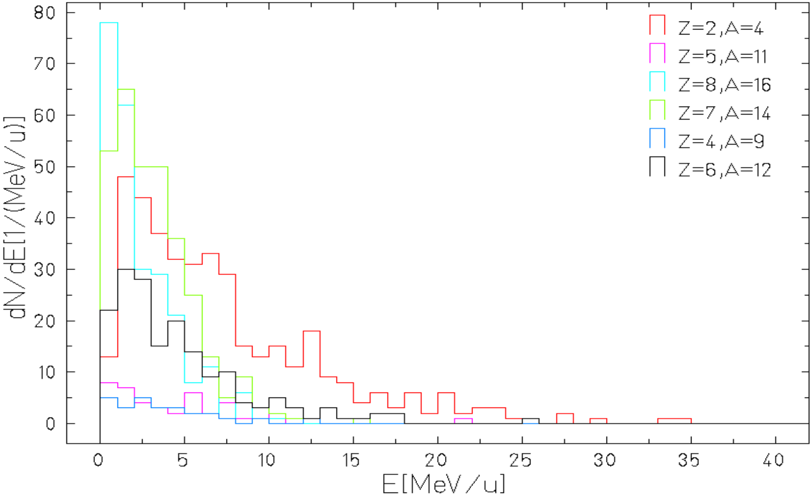
Macroscopic approach: Monte Carlo





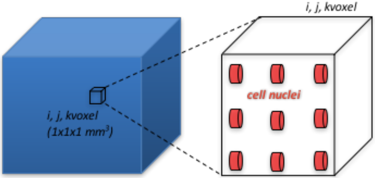
$\Delta Z = 1mm$, Z=12,3cm

Macroscopic approach: TPS implementation



Microscopic approach

2. ***Microscopic* -** Only one single voxel with the cell nucleus dimension ($10 \mu m$) is simulated. In this volume we score the dose, fluence and the residual energy of primaries and secondaries traversing particles . The description of the depth dependency will be described by iterating this process.



G.Petringa, F.Romano, F.Tommasino

References

[1] Zaider M and Rossi H H 1980 The synergistic effects of different radiations Radiat. Res. 83 732–9

[2] M Kärmer and M Scholz 2006 Phys. Med. Biol. 51 1959

Thanks
for your attention

Trento Institute for
Fundamental Physics
and Applications