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Short description: This test calculates the main radiobiological quantities of interest in a clinical condition: Relative Biological Effectiveness, Linear Energy Transfer and Dose. The simulated geometry reproduces the CATANA facility. The RBE is compared with the clonogenic assay performed on the U87 cell line. The dose calculation is compared with the dose distribution measured by using a Markus chamber (mod 3002).

Reference publication:

- Cirrone G.A.P., Cuttone G. et al., Clinical and Research Activities at the CATANA Facility of INFN-LNS: From the Conventional Hadrontherapy to the Laser-Driven Approach, *Frontiers in Oncology*, 10, (2017)
- Cirrone G.A.P., Cuttone G. et al., Implementation of a new Monte Carlo GEANT4 simulation tool for the development of a proton therapy beam line and verification of the related dose distributions, *IEEE Transaction Nuclear Science*, 52, 1756-58 (2005)
- Cirrone G.A.P., Cuttone G. et al., Hadrontherapy: A 4-based tool for proton/ion-therapy studies, *Progress in Nuclear Science Technology*, 2, 207-212 (2011)
- Romano F., A Monte Carlo study for the calculation of the average linear energy transfer (LET) distributions for a clinical proton beam line and a radiobiological carbon ion beam line, *Physics in Medicine and Biology* 59(12):2863 (2014)
- Chaudhary P., Marshall T.I. et al., Relative Biological Effectiveness Variation Along Monoenergetic and Modulated Bragg Peaks of a 62-MeV Therapeutic Proton Beam: A Preclinical Assessment, *International Journal Radiation Oncology Biology Physics*, 90(1), 27-35 (2014)

Geant4 code: Advanced Example hadrontherapy

Geant-val layout: Radiobiology

Reference data:

- **Cells line:**
- **Description of experimental data:** reference data are located in the folder *referenceData* containing various .txt files. Each file contains two columns with the absorbed dose and corresponding survival fraction.-

Data are the following:

- U87_Pristine_P1.txt it contains the survival curve for U87 cells irradiated at the entrance position (P1) of a clinic proton spread out Bragg peak

Tested EM physics constructors: *G4EmStandardPhysics_option4*

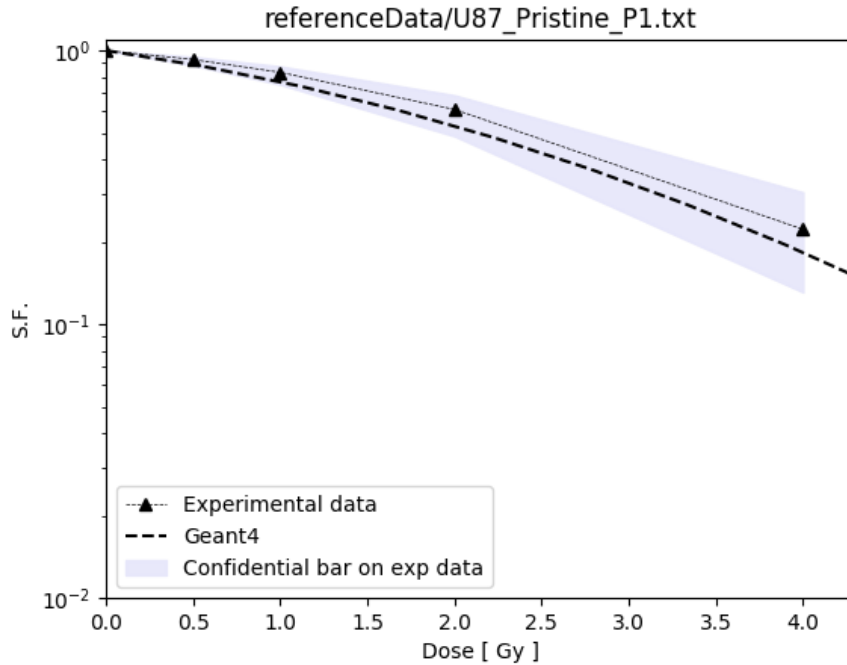
Tested Hadronic physics: *QGSP_BIC_HP*

Description of the analysis script

A python script is in preparation to perform data analysis and comparisons. The script performs the following steps:

- Read a reference experimental file from the *referenceData* folder. The file is an experimental survival curve expressing the survival fraction of a clonogenic assay as a function of the absorbed dose;
- Read the file AlphaBeta.out produced by the simulation. This file contains, at any depths, the values of the Alpha and Beta parameters of the linear-quadratic formula describing the cells Survival Fraction as a function of the dose

- An evaluated Survival curve is then reconstructed using the formula $S(D) = \exp(-\text{Alpha} \cdot D - \text{Beta} \cdot D^2)$
- The script then plots the experimental Survival curve (with a confidential bar representing the maximum and minimum expected values calculated on the basis of the errors on Alphas and Betas) and the Survival curve calculated with Geant4. An example of comparison plot is shown below.



Example of output

hadrontherapy-radiobiology

-- SusannaGuatelli - 2019-04-18

This topic: Geant4 > RadiobiologicalCalculations
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