MC simulations of energy losses of protons and heavy ions - S. P. Merts

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MC simulations of energy losses of protons and heavy ions

Outline

1. *FLUKA and GEANT4*
2. *Results*
3. *High Performance Computing*
4. *Plans*

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FLUKA

FLUKA is a general purpose tool for calculations of particle transport and interactions with matter.[1,2]

Set of Fortran77 subroutines

Operating System: Linux

GEANT4

Geant4 is a toolkit for the simulation of the passage of particles through matter.[3]

Library of C++ classes

Operating System: Linux/Windows

The main fields of application:

- **dosimetry**;
- **cosmic rays**;
- **radiotherapy**;
- **accelerator shielding design**;
- **calorimetry**.
- **etc**

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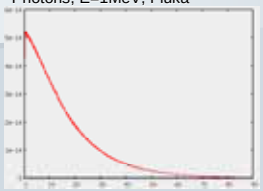
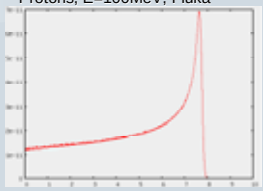
Examples of energy losses of some types of particles in water

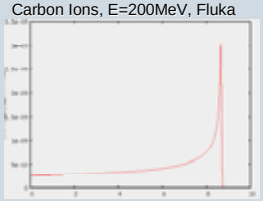
Photons, E=1MeV, Fluka



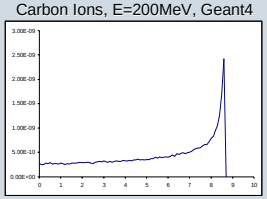
Protons, E=100MeV, Fluka



Carbon Ions, E=200MeV, Fluka



Carbon Ions, E=200MeV, Geant4



abscissa axis: depth , sm

ordinate axis: energy losses

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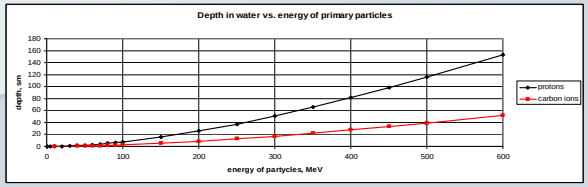
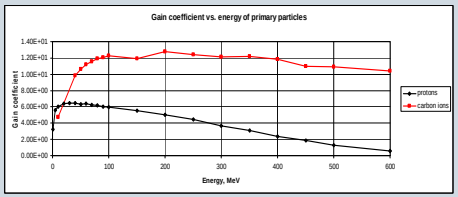
Depth vs. energy of primary particles



Gain coefficient for protons and C12 ions vs. energy



Gain coefficient is the ratio of total energy losses in the Bragg peak to total energy losses before the peak

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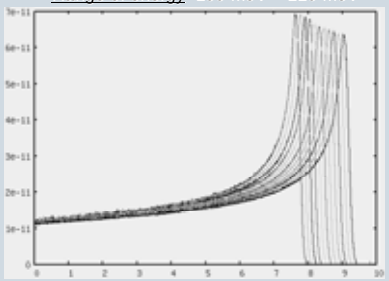
Spread Out Bragg Peak

Range of energy: 100 MeV – 110 MeV



abscissa axis: depth ordinate axis: energy losses

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High Performance Computing

Our interest is in the developing of the problem-oriented grid-service based on a Grid Programming Environment from Intel.[4]

Grid Programming Environment is an Open Source technology that provides a full Grid software stack ready to be used out-of-the-box. It enables the development of Grid–enabled applications that are independent of the underlying Grid middleware, and includes powerful graphical user interfaces for Grid experts, administrators and "ordinary" end users.

GPE provides components at the application, service and utility levels

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Plans for 2009 - 2011

Physics.
MC simulations using GEANT4 and FLUKA codes and further study of propagation of high-energy charged particles and gamma rays using some models of biological tissues for different human organs.

Optimization.
We plan to get a solution of the multiparametric problem in order to obtain a uniform (or any required) distribution of the Spread Out Bragg Peak. Optimization of the conformal treatment plan (or maximal ratio of the doze in the irradiated volume to the total doze)

High Performance Computing.
We plan to use the methods of high performance computing with the goal to optimize computations. Our special interest is in the developing of the problem-oriented grid-service based on a Grid Programming Environment from Intel and ARC-NorduGRID.

3D Visualization.
3D visualization may be useful for preliminary analysis of modeling results.

Verification.
We plan to compare results of our model simulations based on FLUKA and GEANT4 codes with the available experimental results.

Practical aspects (tasks) of the High Performance Computing GEANT4 and FLUKA MC simulations and GRID applications could be done in close cooperation with the ENLIGHT++

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References

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3. Official site of GEANT4 package – http://geant4.cern.ch
4. Official site of GPE project – http://gpe4gtk.sourceforge.net
5. S.S. Ananko, S.P. Merts, S.N Nemnugin, "Simulation of strong electromagnetic radiation transfer through matter with Fluka", collected articles "Mathematical modeling of systems and processes", Perm, 2007 (in Russian)
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