Attributes of Monte Carlo codes for calculation of shielding at high-energy accelerators

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Thanks

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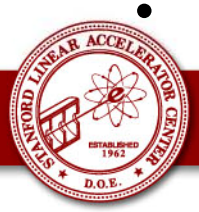
- Thanks to Alberto Fasso, Toshiya Sanami and Markus Brugger
- My views only

List of issues (E-mail on 3/24/2007)

- -General
- - Precision
- * Consistency
- - Physics
- * models
- * interactions
- * transport
- - multiple scattering
- - E-M fields
- - boundaries
- - time dependence
- - computer speed
- * settings
- - transport cut-offs
- - production cut-offs
- - defaults
- - Scoring
- * quantities
- * errors
- * space distributions ("color plots")
- * scoring independent of geometry



List of issues (E-mail on 3/24/2007)

- user-written scoring
- - Biasing
- * transport and production biasing
- * setting tools
- * checks of bad biasing
- - Geometry
- * accuracy
- * ease of preparation
- * debugging/checking
- * visualization
- * hierarchical structure
- * computer speed: minimum distance from boundary
- - Source
- Installing
- - need of external libraries, tools etc.
- - shared libraries vs. normal libraries
- - Multiplatform
- - Learning
- * Ease of use
- * Existing Community/Support
- * Documentation
- * Courses/tutorials
- - Safety against errors
- - Quality Assurance

General

- Limited number of High energy accelerator facailities (LHC, SNS,LCLS, JPARC, ILC, SuNumi)
- Many synchrotron light facilities operational or being designed
- Shielding, activation of environment and beam line components, residual radiation levels, radiation damage to critical components (beam stops, collimators)
- The quantities typically used for shielding and radiation protection are officially defined by (ICRU/ICRP)
  - radiometric quantities (fluence, current, dose, dose equivalent, activity) are required

General

- Shielding designers are mainly looking for solutions to the Boltzmann equation
- Many designers are not code experts, or advanced computer users
  - For radiation protection, a fully integrated "black-box" program, not easily tampered with by the user, has some advantageous
  - Defaults must be easily chosen according to the application of interest (shielding, activation, dosimetry)
  - For scoring a wide choice of well-tested options should be available
  - User-written sources are sometimes necessary to describe a complex particle field. However, this can also lead to errors which are difficult to find. A wide list of available pre-written and tested sources would be very useful.

Biasing

- It is a MUST for shielding calculations. It needs to be mathematically correct and easily defined by the user
  - transport biasing (deep penetration),
  - production biasing (leading particle biasing, biasing of the interaction length)
- Tools should be available to facilitate the setting of biasing parameters
  - the code should check against badly set biasing (e.g. excessive splitting) and correct it.

Benchmarking

- Models used should be well benchmarked, both at the microscopic and at the macroscopic level
- Codes should be benchmarked against shielding, (thin target and thick target), activation experiments
  - SATIF: Expert Group on Shielding Aspects of Accelerators,Targets and Irradiation Facilities
  - Modeling and design of accelerator shield systems including Electron Accelerators, Proton Accelerators, Ion Accelerators, Spallation Sources and the following types of facilities: synchrotron radiation facilities; very high energy radiation facilities; accelerator production of tritium; free electron lasers
  - http://www.nea.fr/html/science/egsaatif/index.html

Benchmarking

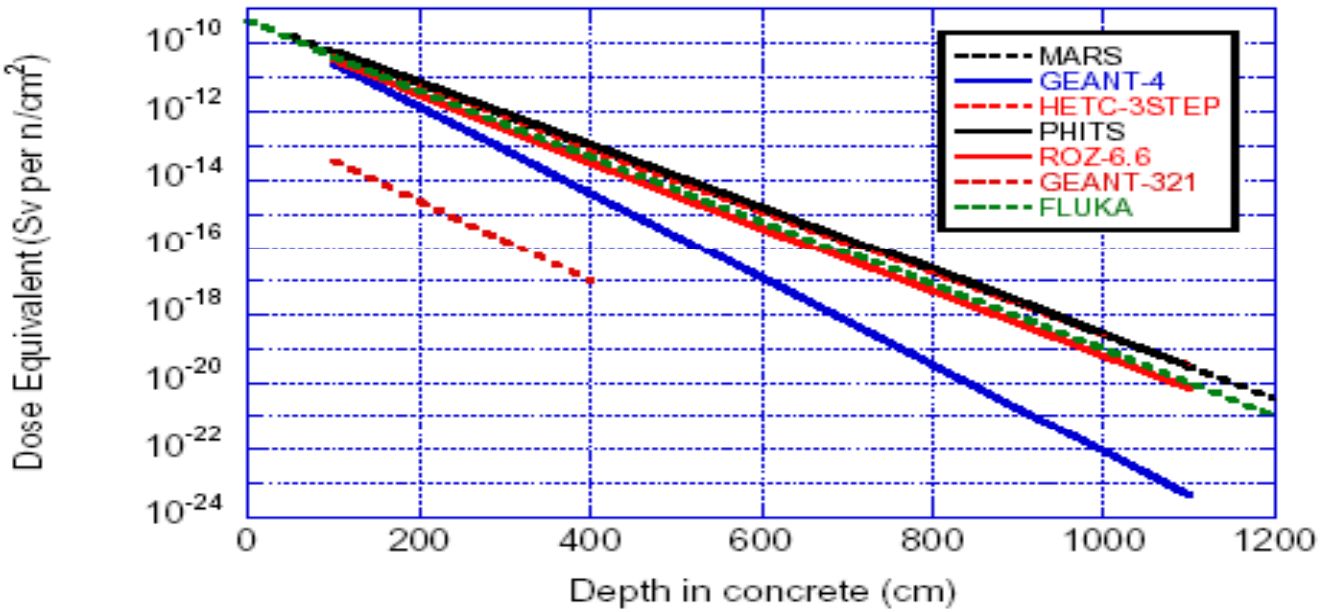


Fig. 18 Dose distribution inside concrete for secondary neutrons emitted to 90 degrees from an iron target with 1 GeV protons.

Benchmarking

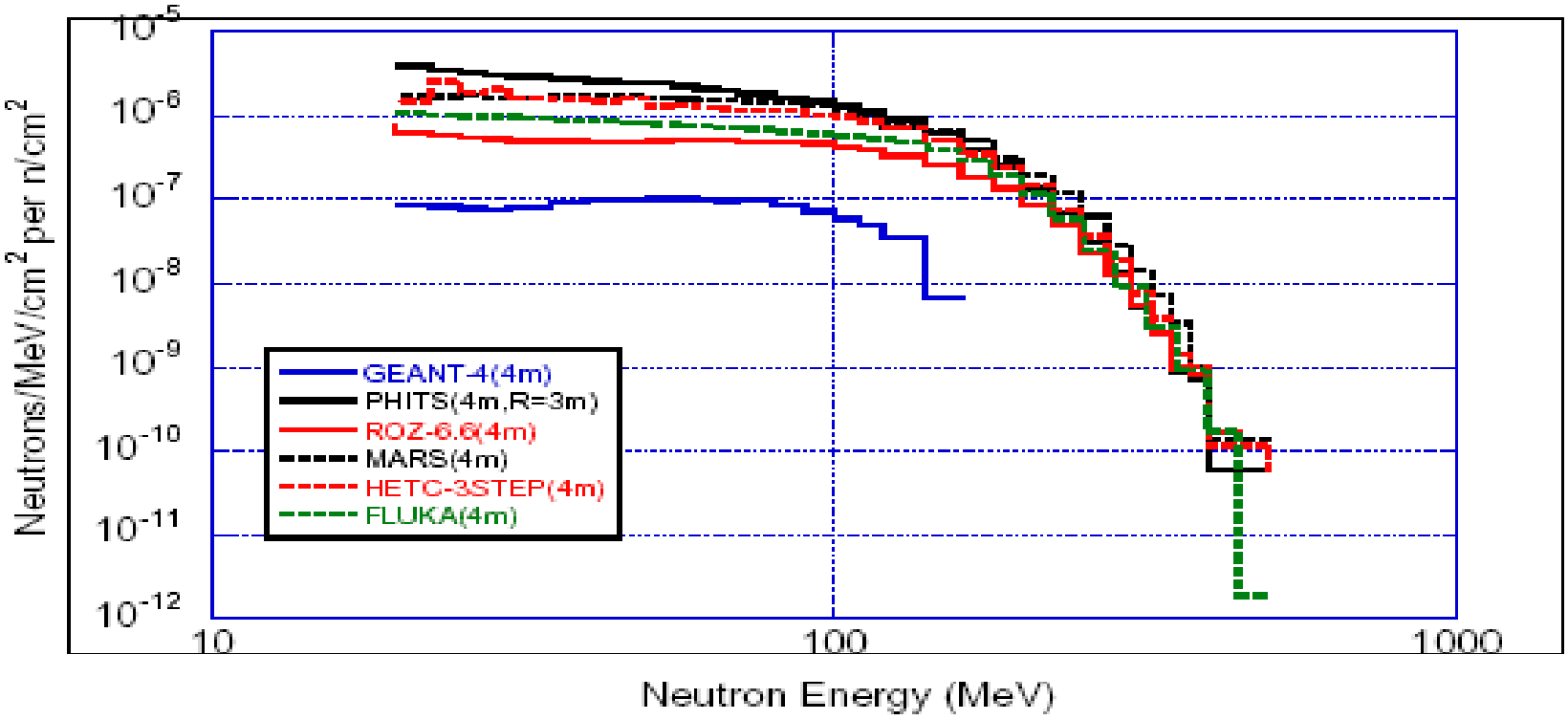


Fig. 20 Neutron spectraat 4m inside concrete for secondary neutrons emitted to 90 degrees from an iron target with 1 GeV protons.

THANK YOU