

Updates on requirements from previous TF meetings

Geant4 Technical Forum
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M. Asai (SLAC), M. Verderi (IN2P3/LLR)
on behalf of Geant4 collaboration

Outline and links

Outline

- Update on requirements for which the status has recently changed
- Open requirements: previous **update** March 2009
- Long-term requirements: previous **update** July 2008

Some links

- Previous updates at Technical Forums can be found at http://cern.ch/geant4/technical_forum/
- Updated work plans and expected release schedules available at http://cern.ch/geant4/support/planned_features.shtml

Recent requirements

2801: Anti-ion interactions

- Responsibles: D. Wright / V. Uzhinskiy
- Requestor: ALICE (A. Morsch)
- Light Anti-Ion Transport with Geant4. Scope
 - Light anti-ions: anti-deuteron, anti-triton, anti-He3 and anti-He4 •
 - Energy loss, absorption, (quasi)elastic scattering •
 - Materials: H, C, N, O, Si, Al, ...
 - Momentum range 0.1 – 4 GeV
- Update (Nov 2010)
 - Anti-proton cross-sections from “Simplified Glauber”
 - total , inelastic, production, elastic and quasi-elastic.
 - Calculated cross sections anti-d, anti-t and anti-He with fuller Glauber approach
 - Coding of both is (just) done – plan to include in release 9.4.

2801 (continued)

Improved calculation for anti-d, -t, -He

Used approach of

- Generator of inelastic nucleus-nucleus interaction diagrams
 - Computer Physics Communications, V 54, 1989, Pages 125-135, S. Yu. Shmakov, V. V. Uzhinskii, A. M. Zadorozhny

And cross sections from Kossov/CHIPS (2010) and

- Cross Sections of Various Processes in Pbar P-Interactions, V.V. Uzhinsky, A.S. Galoyan
 - <http://arxiv.org/abs/hep-ph/0212369v1>

Cross sections for anti-d, -t, -He

$$R = (1.113A^{1/3} - 0.277A^{-1/3}) \text{ fm,}$$

$$a = 0.45 \text{ fm} \quad (d = 0.4 \text{ fm}),$$

- Used

- Nuclear density of W. Broniowski, M.Rzyczynski, P. Bozek, CPC, 180, (2009), 69

- Result

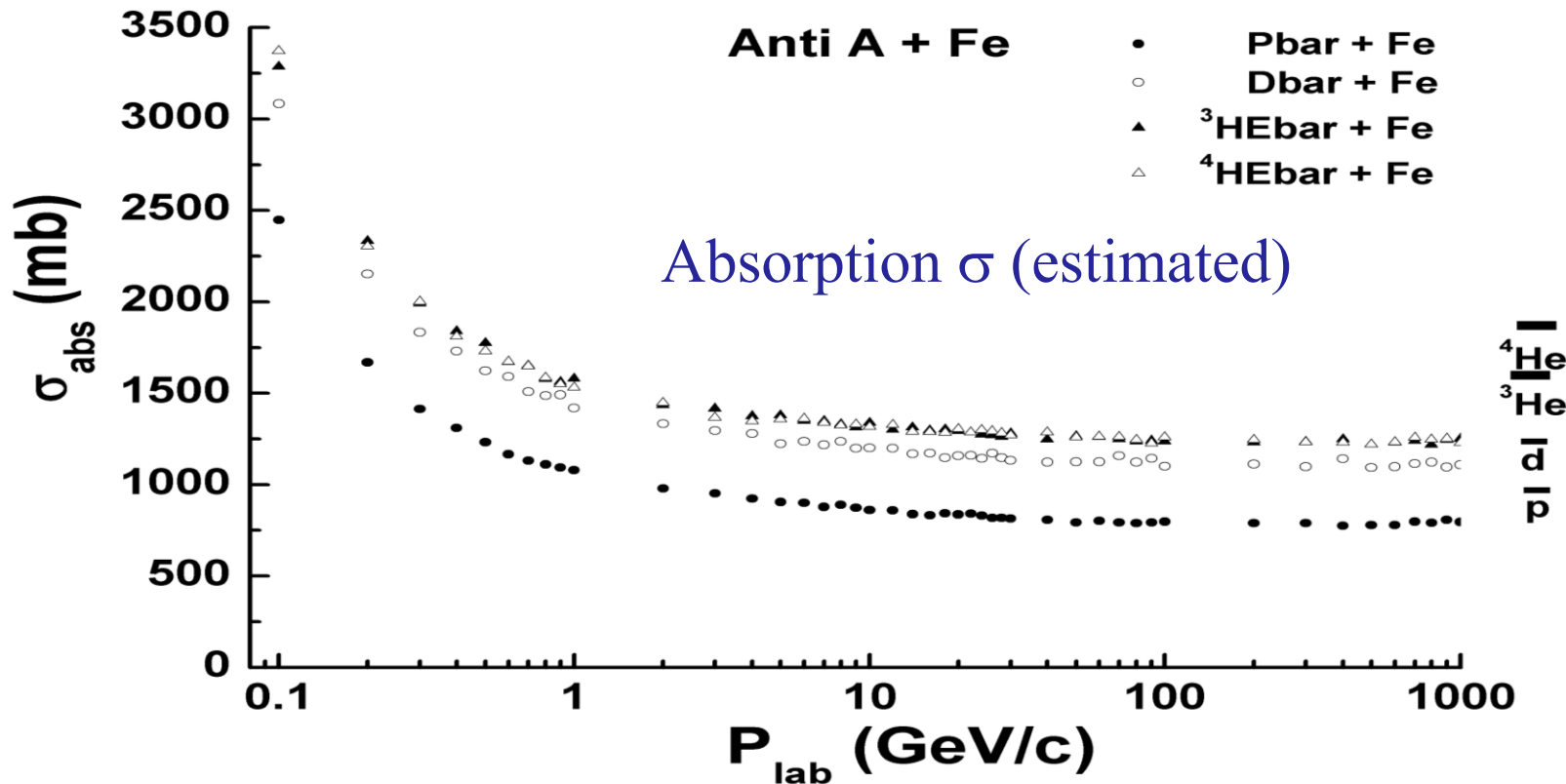
- Total, elastic, absorption cross section for any nucleus

$$n_e(r) = c \frac{4\pi r^2 (1 + W_e \frac{r^2}{R_e^2})}{1 + \exp(\frac{r-R_e}{a_e})},$$

$$R(\text{He3}) = 1.81 \text{ fm,}$$

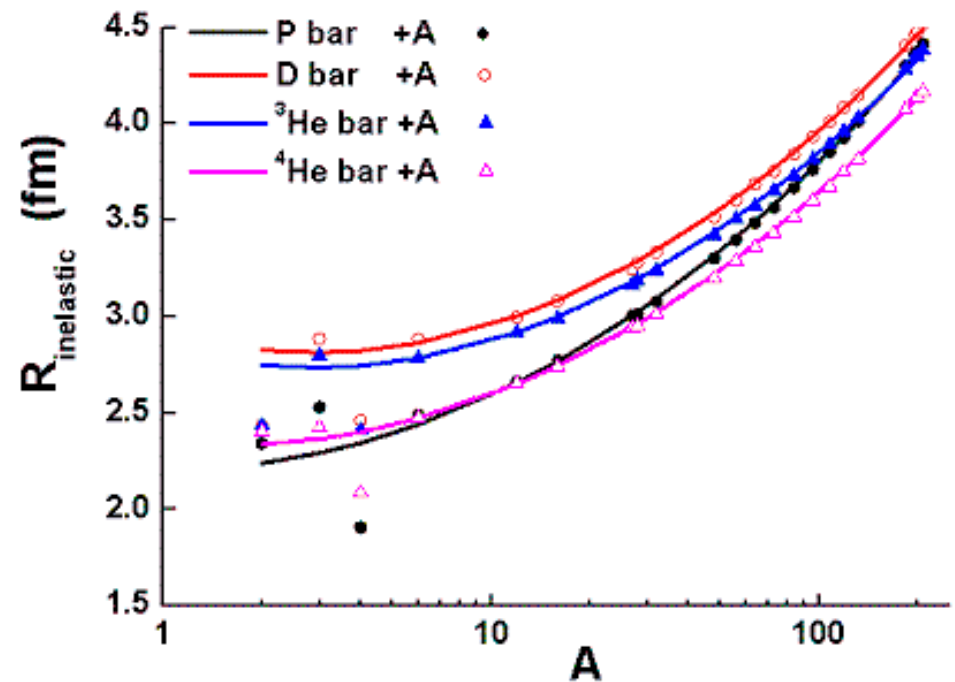
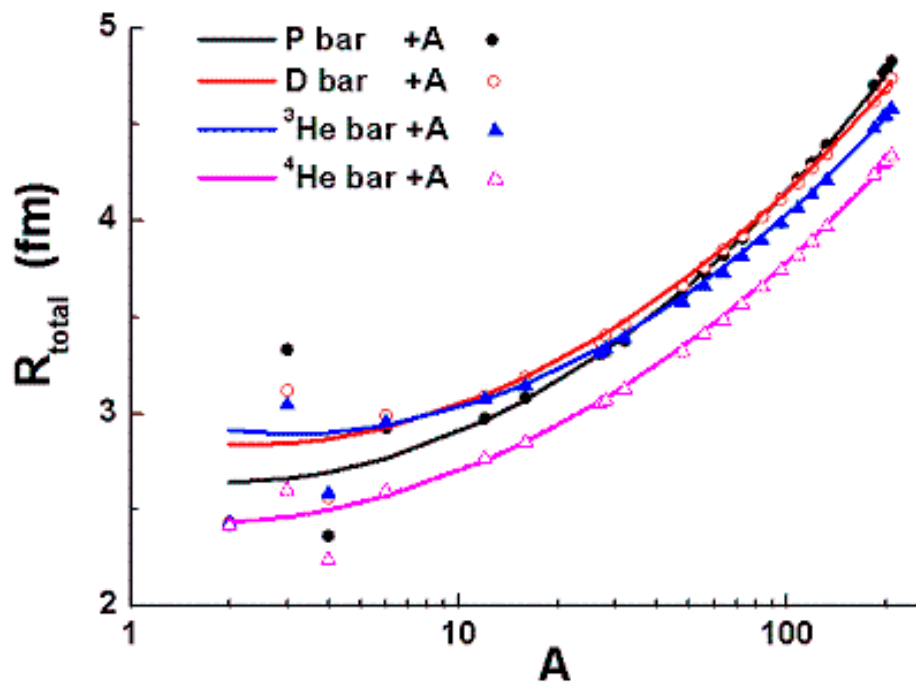
$$R(\text{He4}) = 1.37 \text{ fm}$$

Deuteron: Hulthen wave function.



Cross section implementation

- Seek to reuse formula of simplified Glauber model
 - Created parameterisation of radii (fitting the previous calculations)
 - Use table for smallest nuclei.



(2801) Interaction: Physics modeling

- Hadronic interaction using DPM model implementation by Galoyan and Uzhinsky
 - From $\sim 50 \text{ MeV} \cdot A$ – 100s GeV
 - Annihilation/absorption, binary channels and diffractive interactions
- Status: In preparation

2703: Regularize error messages

- Originators: (LHCb, Gloria Corti) – March 2010

- Responsible(s):

Context: Need to create scripts to extract G4 errors from 50K job files/day.

Requests

- A unique way of messaging errors/warnings to enable a generic script to find ALL of them
- And/or a summary of error messages

Status (Nov 2010)

- Requirement is acknowledged and accepted
- Analysis: Potential implementation would be
 - One format for the ‘header’/first line of errors/warnings
 - One format for the last line of errors/warnings.
- Open – will include it in plans for 2011.

2701: Cross-sections for K-/K+

- **Originators: (LHCb, Gloria Corti) – March 2010**
- **Responsible: M. Kossov / G. Folger (tbc)**
 - Identified significant differences between charged Kaon cross sections and PDG values. This has impact on LHCb measurements.
 - Physics lists QGSP_BERT still utilises Gheisha cross-section for K+/K-
 - Request
 - **hadronic physics builder with well-modeled Kaon interactions**
- **Previous update (Sept 2010)**
 - Physics builders and QGSP_BERT_CHIPS physics list provided in 9.4 beta (June 2010)
 - Kaon cross-sections use revised CHIPS parameterisations
 - Kaon interactions unchanged (Bertini < 9.9 GeV, 9.5 < LEP < 25, QGSP > 12)
 - Note: K0/K0bar oscillations not modelled.
- **Status (Nov 2010)**
 - Feedback is awaited.

2702: Interfaces of Physics Builders

- Originators: (LHCb, Gloria Corti) – March 2010
- Responsible(s): V. Ivantchenko

Need to allow the full set of G4 constructors arguments to be passed. Context: LHCb customises physics list, using physics builders as components.

Requests

A. rationalize the constructors of the PL builders

- Make regular the order and types of arguments

B. create an extender of G4VPhysicsConstructor to allow the setting of class arbitrary parameters.

Last update (Sept 2010)

- A: Additional interface of physics builders were created and made in 9.4-beta (Jun 2010). These are to be included in 9.4.

Status (Nov 2010)

- Feedback (on A) is awaited.
- B: Open

Recent updates

2501: Choices of physics processes (or options) per region

- **Originators:** (CMS, Fabio Cossutti)
- **Responsible:** V. Ivantchenko
 - Refinements of physics lists by G4Region
 - Use case: a mixture of homogeneous (e.g. ECAL) and sampling (e.g. HCAL) calorimeters
 - The optimal balance between EM physics accuracy and performance is different
 - QGSP_BERT_EMV (ECAL) vs QGSP_BERT (HCAL)
 - At present only one choice (physics list, in particular EM 'option') can be made for the whole setup
- **Status (Sept 2009)**
 - Specific use case for EM processes demonstrated with existing G4 toolkit code – and CMS guided in its use.
 - Example provided in G4 distribution which uses PAI model for gases.
 - General case: under analysis (preliminary stage)
 - **Update (March 2010) – EM part is part of plan of 2010**
 - Are there use cases which require full-flexibility (beyond EM options) or benefit significantly from it?
 - Potential impact of new degree(s) of freedom for varying (pseudo-tuning) the physics results.
 - Status (Sept 2010)
 - After a few tests at CMS they see no clear benefit of different options in ECAL and HCAL, so likely the requirement is no longer valuable.
 - **Propose to close after confirming to requester**

Req.1202: Alternative models for intermediate energies – 1/2

Responsible (new): D.Wright (hadronics)

Requestor: HARP

Description: “HARP requests additional hadronic models in the energy range of 1-15 GeV, as alternative to the parameterised (LEP) models.

Status (July 2008)

-June 2008:The **FTFP** model was extended and refined for proton and pion-incident interactions starting from **~3 GeV**

- **Re-parameterization of the LEP models is suspended**

- New name: **RPG = Re-Parameterised Gheisha models.**
 - Development stopped due to lack of resources
 - Not seen as 1st or high priority - currently.

Update (March 2010)

- New CHIPS hadronic interaction developed (validation underway).
- Further improvement of FTF model undertaken in 2009
 - Improved model included in Geant4 9.3

Req.1202: Alternative models for intermediate energies – 2/2

Update (September 2010)

- RPG is the direct alternative to the LEP models, but its development is still on hold until it assumes a higher priority.
- CHIPS in this energy range is still being validated and has some significant problems, both in physics performance and speed.
- Recent improvements (9.4 beta) in Bertini go a long way toward answering the HARP request, but still more validation is required. It even does a reasonable job in the 10-15 GeV range.
- The improved FTF model can go down to 3 GeV, but still needs some tuning.

In short, we think the HARP request for a new model is no longer relevant, unless they were referring specifically to an LEP/RPG style model. Their request is probably better satisfied by the existing but improved Bertini and FTF models. By the next release we hope to have a physics list which combines them smoothly.