Update on Requirements

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CERN

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On behalf of the Geant4 Collaboration

Requirements Tracking System Page:
https://jira-geant4.kek.jp/secure/Dashboard.jspa?selectPageId=10000

Pending requests

Follow-up on "requests under clarifications" [1/2]

- Ability to set up physics processes without creating a G4RunManager
  - Requesters: ATLAS, LHCb, (CMS ?)
  - Understood, an example will be provided (Alberto)
  - Not a requirement.
- Ability to set a parametrised description of volumes
  - Requester: LHCb
  - On going (Witek)
- Review of hadronic cross sections for protons and anti-protons
  - Requester: LHCb
  - On going (Witek)
- Initialization in parallel mode
  - Requester: CMS
  - Understood, avoid having worker threads waiting for initialization by master.
    - With, notably, differential table for the e+e- pair production by muons and hadrons and PDF function for Glauber model of the hadron elastic scattering of pions.
  - Initializations partly pushed to worker thread in 10.6, more is possible but work required.
  - CMS will verify benefit of 10.6 initializations when moving to this release
  - On going (Vladimir)
- Improve Bertini cascade near kinematic endpoint of reactions at 4.5 GeV
  - Today unphysical and over-production of protons and neutrons in this region
  - Requested by EIC
  - Was assigned to Alberto, Dennis now taking care, on-going

Follow-up on "requests under clarifications" [2/2]

- Energy loss in volumes smaller than 10 nm
  - To properly take into account the small size parts in microelectronic in the Single Event Effect simulation
  - Requester : Robert Reed – Vanderbilt
  - On going (Mihaly)
- Electron transport down to ~10 eV
  - In view of giving an insight of the scales at which quantum effects become important
  - Requester : Robert Reed – Vanderbilt
  - On going (Mihaly)
- Existing possibilities of CAD interfaces
  - Requester to be informed.
  - Note : there is a possibility of NASA to fund a project for such interface
  - On Makoto (ongoing)
- Better visualization tools for debugging geometry
  - Currents tools not easy, produce too few details, and have no rendering
  - Requesters: Insoo Jun, Chad Lindstrom, Brian Zhu – JPL
  - Response to user under preparation.
  - On going (Laurent G.)

Open requirements

4702 : Inclusion of γ polarization effects in the high energy EM models

- Originator:
  - CMS
  - 47th Technical Forum (link)
- Scope:
  - Include Linear Polarization into HE γ Models
  - This has potential usage in the analysis of H → γ γ
    - Polarization planes of scalar (pseudo-scalar) particle to γ's are parallel (perpendicular)
    - Investigate the effect of polarization in the shower shape of photons
      - May give additional handles to distinguish direct γ's from H decay from BG
- Responsible:
  - Vladimir Ivantchenko
- Status:
  - In this year work plan.
    - Will likely extend to 2021
  - Open.

5001 : Hadronic physics processes for c-mesons and b-mesons

- Originator:
  - ATLAS, LHCb
  - Pages 3 & 5 of Requirements from energy frontier
- Scope:
  - Provide cross-sections and final state models for c- and b-mesons
- Responsible:
  - Alberto Ribon
- Status:
  - Significant fraction of work already done last year.
  - Expect a first release in 2020.
  - Open.

5002 : Support for "sub-event" parallelism across G4 threads

- Originator:
  - ALICE
  - Page 6 of Requirements from energy frontier
- Scope:
  - ALICE handles very big events
  - These would be processed faster if one event could be split into “sub-events” (= {subset of primary tracks}) -each processed on one thread- with merging back of sub-events into the event at the end
- Responsible:
  - Makoto Asai
- Status:
  - Partly in 2020 work plan
  - Started
  - Open.

5003 : Benefit from VecGeom & VecGeom Navigation

- Originator:
  - ALICE
  - Page 6 of Requirements from energy frontier
- Scope:
  - VecGeom solids already usable in Geant4
    - Under "standard" navigation
  - Request specialized navigation to be interfaced too
    - Similarly to what exists with TGeo
- Responsible:
  - Gabriele Cosmo
- Status:
  - Interface with navigation planned for 2020
  - Open.

5005 : Neutron self-shielding effect

- Originator:
  - LZ (LUX-ZEPLIN), SuperCDMS
  - Page 7 of Requirements from intensity frontier
- Scope:
  - Significant reduction of the neutron flux in material when neutron energy is in the resonance region
    - The capture process can reduce the flux at one position in a crystal creating a kind of shadow in which the downstream atoms see a reduced flux (a ~10% effect)
- Responsible:
  - Vladimir Ivanchenko
- Status:
  - Valid requirement but big work
  - Needs theoretician support as well as manpower.
  - Open.

5006 : Improve simulation of gamma induced neutron background

- Originator:
  - LZ (LUX-ZEPLIN), SuperCDMS
  - Page 7 of Requirements from intensity frontier
- Scope:
  - Low energy gammas producing neutrons in various materials can generate a significant background
  - But photo-nuclear process does not model this well below 30 MeV
  - Point that G4LEND gamma models might resolve the issue
- Responsible:
  - Vladimir Grichine
- Status:
  - Valid requirement and possible solutions under verification.
  - In 2020 work plan.
  - Open.

5007 : Improve electro-nuclear models

- Originator:
  - Markus Diefenthaler (EIC Center, EICUG) for:
    - JLAB 12 GeV Science program
    - Electron-Ion Collider (EIC)
  - Page 12 of Requirements from nuclear physics experiments
- Scope:
  - Electro-nuclear models rely on Weizsacker-Williams approximation.
  - Not sufficient for high-intensity and high precision electron scattering.
  - The full, off-shell electron scattering vertex must be implemented for nucleons within the nuclear target.
- Responsible:
  - Vladimir Grichine
- Status:
  - Big work
  - In work plan of Vladimir Grichine for 2020
  - Open.

5008 : Make EPICS2017 models (electrons, photons) as an alternative to Livermore

- Originator:
  - General demand
  - Page 11 of Requirements from Medical and bio science
- Scope:
  - EPICS2017 : Electron and Photon Interaction Cross Sections
    - Mention : these data supersede all earlier versions of the data libraries EADL, EEDL and EPDL
- Responsible:
  - Sébastien Incerti
- Status:
  - On-going in framework of thesis of Z. Li (CENBG+CERN EM group)
    - Thesis will end in 2022
  - Open.

5009 : Extend energy and material coverage of G4-DNA beyond DNA and liquid water

- Originator:
  - General demand
  - Page 11 of Requirements from Medical and bio science
- Scope:
  - Develop track structure models for specific materials (beyond liquid water and DNA)
  - Extend energy coverage of existing models
    - ex. option4 is limited to 10 keV for electrons
- Responsible:
  - Sébastien Incerti
- Status:
  - On-going.
  - Open.

5010 : Physics models for ions below 1 MeV/u for Boron Neutron Capture

- Originator:
  - General demand
  - Page 12 of Requirements from Medical and bio science
- Scope:
  - Allows usage of Geant4 in BNC therapy field
- Responsible:
  - Jose Ramos-Mendez (University of California, San Francisco)
    - Put Sébastien Incerti temporarily
- Status:
  - Work started with Naoki Domínguez (Ph.D. student at BUAP, México), and José Ramos (UCSF)
  - Open.

5011 : Provide "Independent Reaction Time" as an alternative to step-by-step approach

- Originator:
  - General demand
  - Page 12 of Requirements from Medical and bio science
- Scope:
  - Boost the damage calculation chemistry phase of the DNA of radiolysis simulation
  - Details at:
    - https://indico.cern.ch/event/825306/contributions/3561755/attachments/1916238/3168132/Parallel7B_Jose.pdf
- Responsible:
  - Jose Ramos-Mendez (University of California, San Francisco)
- Status:
  - Will be part of 2020 beta release
  - Already merged
  - To be closed.

5012 : Alternative (in)elastic cross-sections and models for systematic uncertainties

- Originator:
  - NA61/SHINE
- Scope:
  - Have at least one alternative hadron elastic treatment (including both cross-sections and final-state models) for any reference physics list, which can be enabled by users, without the need of modifying Geant4 source code.
  - Have at least one alternative hadron inelastic cross-section treatment for any reference physics list, which can be enabled by users, without the need of modifying Geant4 source code.
- Responsible:
  - Alberto Ribon
- Status:
  - In 2020 work plan.
  - Open.

Recently closed requirements

5004 : Precise calculation of the Fermi density effect using atomic data

- Originator:
  - NOvA
  - Page 6 of Requirements from intensity frontier
- Scope:
  - MC / Data differences on Fermi density effect can not be calibrated in neutrino experiments
    - Needs precise calculation
  - Suggests to perform density effect calculations "free" of approximations
    - following R.M. Sternheimer *et al.* "Density Effect For The Ionization Loss of Charged Particles in Various Substances" Atom. Data Nucl. Data Tabl. 30 (1984) 261-271
- Responsible:
  - Vladimir Ivanchenko
- Status:
  - Progress reported during JLab collaboration meeting
  - Implementation provided with help of requester
  - Closed.