# Update on Requirements

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Virtual Meeting

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On behalf of the Geant4 Collaboration

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

# New Requirements

# 5201 : To extend "force collision" biasing to charged particles

- Originator:
  - NA62
- Scope:
  - A "force collision" biasing scheme exists in Geant4, but is adapted to neutral particles.
  - NA62 uses a K+ beam
  - A biasing with forced collisions for charged particles would allow for generating samples of useful statistics within a reasonable time to study the rare inelastic interactions in thin material in more detail.
- Responsible:
  - Marc Verderi
- Status:
  - In 2021 work plan.
  - On-going
  - Open.

# 5202 : To have the Goudsmith-Sanderson MSC model in the default EM option Opt0

- Originator:
  - ATLAS, from 2020 LPCC workshop
- Scope:
  - Having the GS (Goudsmith-Sanderson) multiple scattering model as precise as in EM Opt4 (_EMZ), or close to this precision, with the default EM Opt0.
  - EM Opt4 helps to describe EM showers but at price of much slower simulations.
  - Many things in EM Opt4 (_EMZ) are not necessary for EM showers, whereas the GS multiple scattering model seems the only important piece of physics which is missing in the default, Opt0.
- Responsible:
  - Mihaly Novak
- Status:
  - In 2021 work plan.
  - On-going
  - Open.

# 5203 : Improve the inelastic cross sections of $\bar{d}$ and anti_He3 at low energies (< 1-2 GeV/c).

- Originator:
  - ALICE, from 2020 LPCC workshop
- Scope:
  - Inelastic cross-section of anti-deuteron and anti_He3 is too low at low enegies
  - Likely, the same is needed for anti_triton and anti_alpha cross sections.
- Responsible:
  - Vladimir Uzhinsky
- Status:
  - In 2021 work plan.
  - On-going
  - Open.

# 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 progress, continuing this year.
  - 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:
  - This comes along with the tasking model.
  - Reproducibility is the main issue
  - In this year work plan
  - 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:
  - Use of VecGeom navigation as option planned for this year.
  - In the plan of work & addressed.
  - Can be closed.

# 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.
  - Collection of publications and references on-going.
  - 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.
  - Alternative model to treat low-energy gamma-nuclear interactions is available in 10.7. Need to study its effect.
  - 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, but good progress
  - Note that new data-sets have been introduced in 10.7 : might bring some improvements also in this area, to be evaluated.
  - 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
  - Very good progress, needs to be polished for this year release.
  - 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.
  - Gold G4-DNA model will be included in 2021 beta release.
  - 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 taken care by Naoki Domínguez (Ph.D. student at BUAP, México), and José Ramos (UCSF)
  - Open.

# Recently closed requirements

# 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:
  - Work completed and included in Geant4 10.7.
  - Closed.

# 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
  - Provided in 10.7

# 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.
  - Work completed and included in release Geant4 10.7.