

# Open and new requirements - Space science and engineering



26<sup>th</sup> Geant4 Collaboration Meeting

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# Neutron physics

## Material data, access to cross sections



- **New:** A total re-write of the cross section classes to enable variance reduction (next event estimator) techniques and the ability to pass data to physics classes
  - Essentially getters/setters and a redo of public/protected/private
  - One user suggested that all private variables have getters
- **New:** Actually using the function `IsAlsoApplicable` in the cross section data classes.
- **New:** As of 10.6, the HP particle data does not make a cut on the bounds of the measured data and extrapolates the last point between 0 and 150-200 MeV. Not sure if this has been fixed ...
- **New:** Better  $S(a, \beta)$  models for thermal neutron physics,
- **Open:**  $S(a, \beta)$ : more materials relevant to space
- **New:** From the particle builders (NeutronBuilder, etc.), provide getters/setters to change the high and low energy thresholds. This would allow for the generation of custom physics lists without copying source code.
- **New:** Interrogating the cross-sections
  - a way to easily print what cross-sections are being used, not only the source, but also the value
  - the limits for various standard physics list be documented better. There appear to be a number of places that listed them as different values.

**Source: Karl Smith  
@LANL Space Science  
and Applications**

**Encouraged to use User Forum**



LRO/CRaTER project (charged-particle sensor aboard Lunar Reconnaissance Orbiter)

- **Interest in neutron production from cosmic-ray** impact on the lunar surface and Earth's atmosphere for future space neutron-detection hardware – neutron production, down to thermal energies
- **Physics lists: documentation** or recommendations for neutron physics and sensor response: Shielding\_EMZ ?
- **Thanks for Ion-Ion nuclear reaction** developments: have improved cosmic-ray sensor response and background (DOI 10.1029/2020SW002543)
- Comparison of secondary particles from cosmic-ray impact on the lunar surface using Geant4, FLUKA, HETC-HEDS, MCNP6, and PHITS (submitted to Space Weather)
  - They all **agree surprisingly well**; **Geant4 demonstrates superior completeness** in several areas
  - Geant4 produces more low-energy electrons (from Compton scattering) than the other codes;  
“I suspect that **we're the outlier because we're right...**”

**Source: Mark D. Looper  
@ The Aerospace  
Corporation**

**Open (?)** ROSSINI 3 project (GCR innovative shielding materials - TAS-I, GSI, UniTo, ESA R&D)

- Fe 1GeV/n Bragg peak in Paraffin (Geant4 10.6, reported in 2015 & 2020): **only CS** in \*INCLXX physics lists reproduce data – Req: check CSs, add this exp dataset to validation suite

**Source: L.Bocchini,  
M.Giraud @ Thales  
Alenia Space Italia**

**Open (?)** Electronic component tests at CERN SPS with Xe 40GeV/n and Pb 150GeV/n

- EM, 2020, v10.5.p1: discrepancies in **dE/dx in Si**: DOI:10.1109/TNS.2019.2958746

**Source: S.Gerardin,  
M.Bagatin @DEI UniPd**

**New: Biasing:** plans for implementation of **(cross-section) biasing for charged particles?**

A lot of interest in protons and heavier ions for simulations of thin targets (science and electronic components)

*Geant4 doc: For now, we discuss only the case of neutral particles, i.e., having no continuous energy loss along a step.*

*The case of charged particles is expected to be treated in later releases.*

**New:** Complete lack of reasonable **distribution of ion charged states** after thin targets

**Source: M.Kokkoris,  
@NTU Athens**

- e.g. 10 MeV O<sup>4+</sup> through ultra thin Al layer? codes such as LISE++, ETACHA etc. can model this. Why not G4?

**Source: P. Truscott**

**Open:** better model for nuclear fragments from **nucl-nucl interactions <50MeV/n regime** **@Kallisto**

## GDML

- **New:** Fixing xml parser warnings when using GDML (warnings on material and naming definitions that run fine)
- **Open:** Colours as part of core GDML standard
- **Open:** SPENVIS user point of view: free and easy to use geometry (GDML) editor
  - Simple old Java geometry definition tool for SPENVIS outdated / not working
  - Convert CAD/STEP files to GDML. Some interesting tools around (e.g. EDGE) but commercial
  - (GS: FreeCAD plugin: any development ?)
- **New:** Database with existing GDML models (spacecraft, instruments, etc.) available to users.
  - Columbus ISS module, Lunar/Martian surface etc.
  - Simplified models (no confidential information) including electronic components to simulate TID/SEEs(GS: TAS-I ROSSINI3 models: working on licence / distribution)

**Source: Karl Smith  
@LANL**

**Source:  
P. Truscott / GS**

**Source: N. Messios @BISA**

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**Open (?)** Fix for visualisation of G4 Boolean Solids (often only ray-tracing works)

**Source: P. Truscott @Kallisto**

# Geant4-based applications and interfaces



**Open:** Installation / distribution

- Docker: scripts / guidelines for
  - Geant4 install
  - Packaging Geant4 with space applications
  - Running the Docker-apps

**Source: Dávid  
Lucsányi @Puli Space  
Tech & CERN R2E,  
Neophytos Messios  
@BISA, ESA projects**

**New:** A standard tool to create space radiation inputs using models like SPENVIS in a more automated way

- à la MEGAlib – MEGAlib helps to simulate backgrounds from activation in space

**Source: Karl Smith  
@LANL Space Science  
and Applications**

**Open:** GPS: Improvement in internal treatment of user spectrum

- Interpolation, differentiation / integration
- Computational accuracy issues

**Source: Brian Xiaoyu  
Zhu @JPL (+GS@ESA,  
User forum)**

# Summary and Workshop



## Summary

- Heavy ions: biasing, cross sections and  $dE/dx$
- Cross sections: doc / data access
- Neutrons: guidelines, models, more materials
- Usability: geometry, radiation environment sources, installation

Finally, it would be nice to have a *Geant4 Space Users' Workshop* in 2022 and get the chance to meet in person!

I hoped that it would be an announcement of the restart of the *Space Users' Workshops*.  
Oh well, next year, we can hope.

## Space users' workshop:

Lots of enthusiastic users and plenty of new ideas

A lot of interest in getting the community together again, in a physical meeting

