Update on Advanced Examples: summary

S. Guatelli and F. Romano

On behalf of the Geant4 Advanced Examples WG

Plan for 2020 (1)

- Maintenance and bug fixes (1,2)
  - Ongoing
- Code review (e.g. implementation of the extended examples coding guidelines) in selected examples (1,2)
  - Ongoing
  - Done in *brachytherapy*
  - Started in *radioprotection*

Plan for 2020 (2)

- Release of a new example for nanomedicine (gold nanoparticles in X-ray radiotherapy) (2)[*]

Example that show how to use Geant4-DNA physics models specialised for gold.

Authors: E. Engels[1,2], S. Bakr[1], D. Bolst[1], D. Sakata[1], N. Li[1,2], P. Lazarakis[1], S. McMahon[3], A. Rosenfeld[1,2], S. Incerti[4,5], I. Kyriakou[6], D. Emfietzoglou[6], M. Lerch[1,2], M. Tehei[1,2], S. Corde[1,7], S. Guatelli[1]

[1] Centre for Medical Radiation Physics, University of Wollongong, NSW, Australia, [2] Illawarra Health and Medical Research Institute, University of Wollongong, NSW, Australia, [3] Queens University, Belfast, Northern Ireland BT7 1NN, [4] Centre National de la Recherche Scientifique, [5] Universitie de Bordeaux, Bordeaux, France, [6] University of Ioannina, Ioánnina, Greece, [7] Prince of Wales Hospital, Randwick, Australia.

This has to be postponed to next year because the paper has been just accepted in Physics, Medicine and Biology.

Plan for 2020/2021 (3)

- Release of a new example showing how to import in Geant4 simulations IAEA Phase Space Files (2)[*]
  - Ongoing by M. Cortes-Giraldo and collaborators.
- Improvement of GammaRayTel example to deal with polarised processes (2)[*]
  - By F. Longo.
  - For the next december release the plan is to include a new polarised macro, parallel to the already existing one, that uses the "LowEnergy" polarised physics processes. This new macro is currently under testing.
  - The new macro will include particularly the 5D model of polarised Gamma ray pair production, and, possibly, some alternative polarised Compton models, available in the EM physics package.

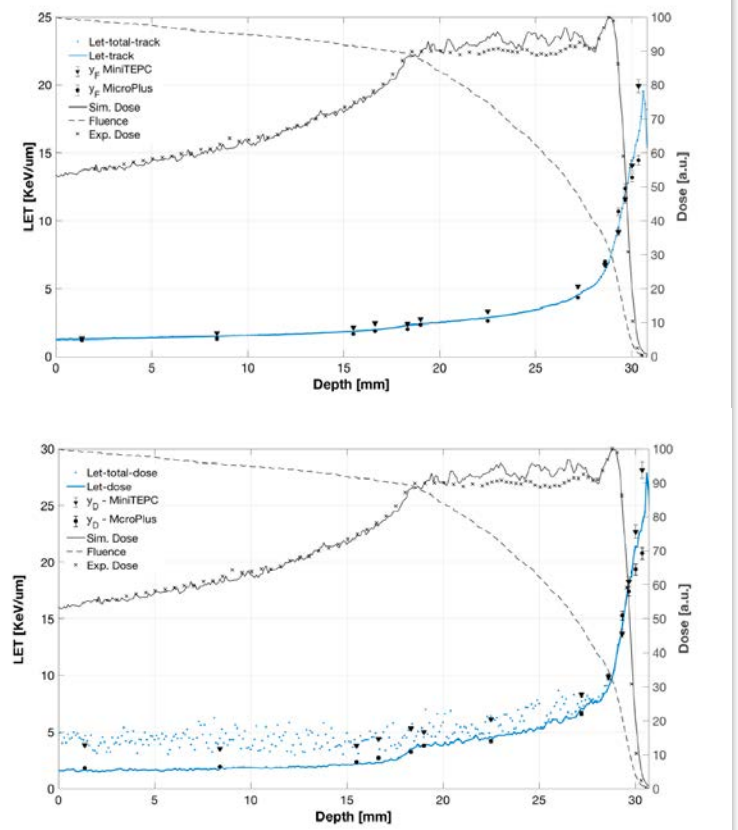
Plan for 2020/2021: Hadrontherapy

G. Petringa, P. Cirrone, L. Pandola, G. Miluzzo

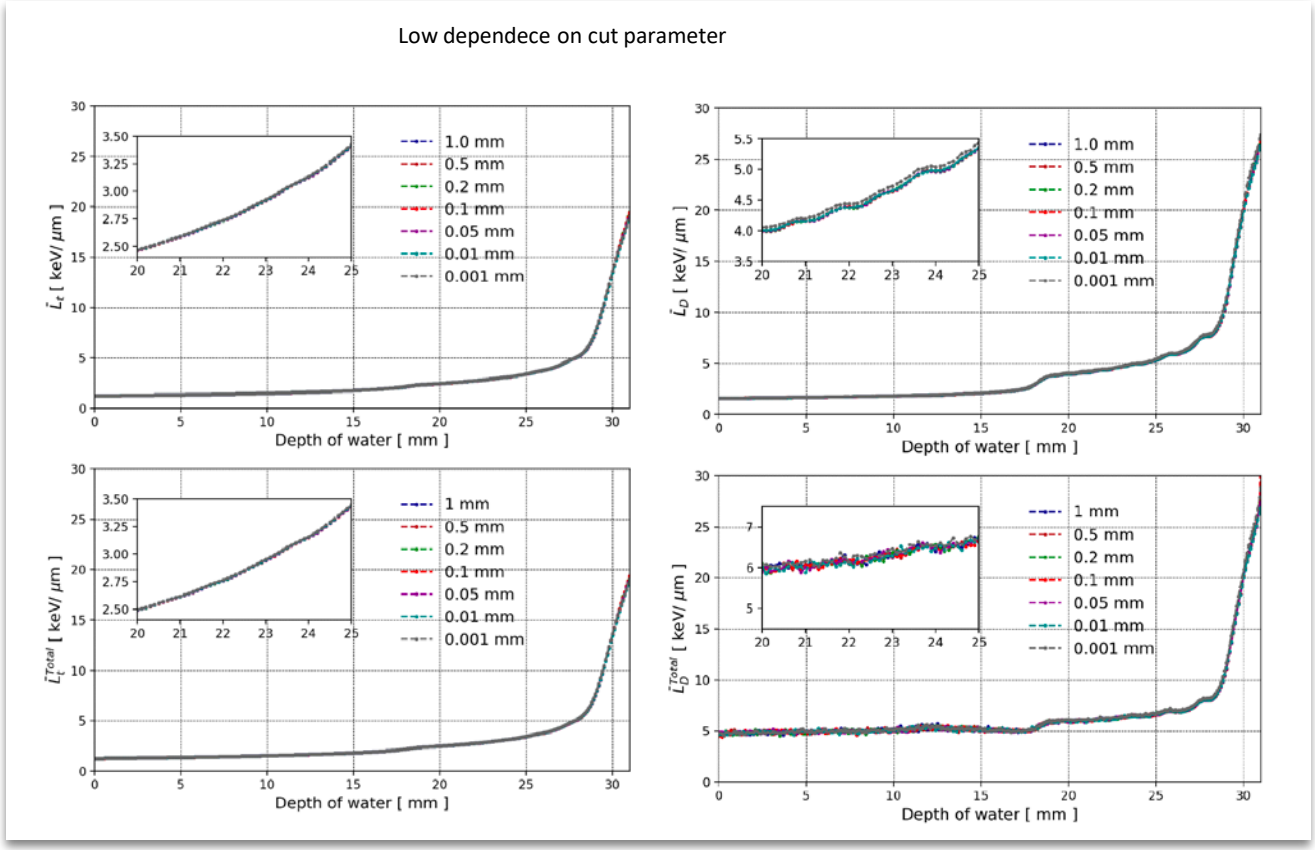
New developed and validated algorithms to compute the LET

Try to eliminate the crashes in system testing

Validation with microdosimetric spectra



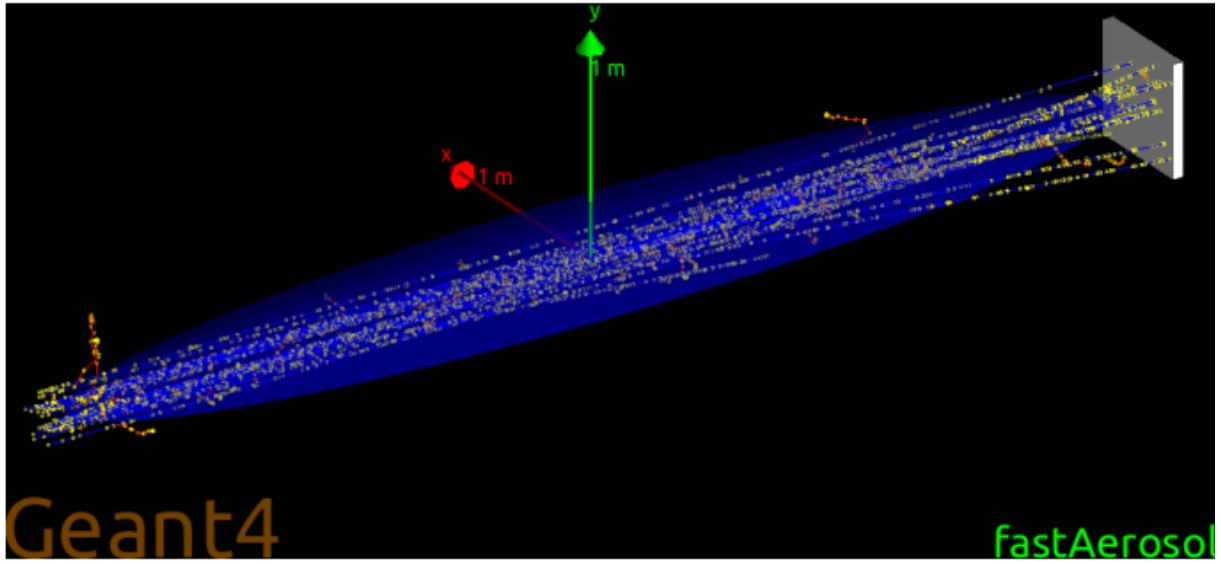
Low dependece on cut parameter



G. Petringa et al. “Study and validation of Monte Carlo methods for linear energy transfer calculation in voxelized geometries with clinical proton beams”, PMB, DOI: 10.1088/1361-6560/abaeb9 (2020)

New example modelling dust cloud: fastAerosol

- Authors: Ara Knaian and Nate MacFadden, NK Labs, LLC (http://www.nklabs.com), supported by Makoto Asai
- Nuclear energy application
- Modelling of aerosols with many droplets.
- It is possible to simulate clouds containing billions of randomly-positioned solid or liquid droplets
  - Arbitrary droplet and cloud shapes
- The example shoots a beam of protons through a rectangular section of atmospheric rain cloud, and measures the energy absorbed by a detector.



(figure from our associated preprint: arxiv 2008.01236)

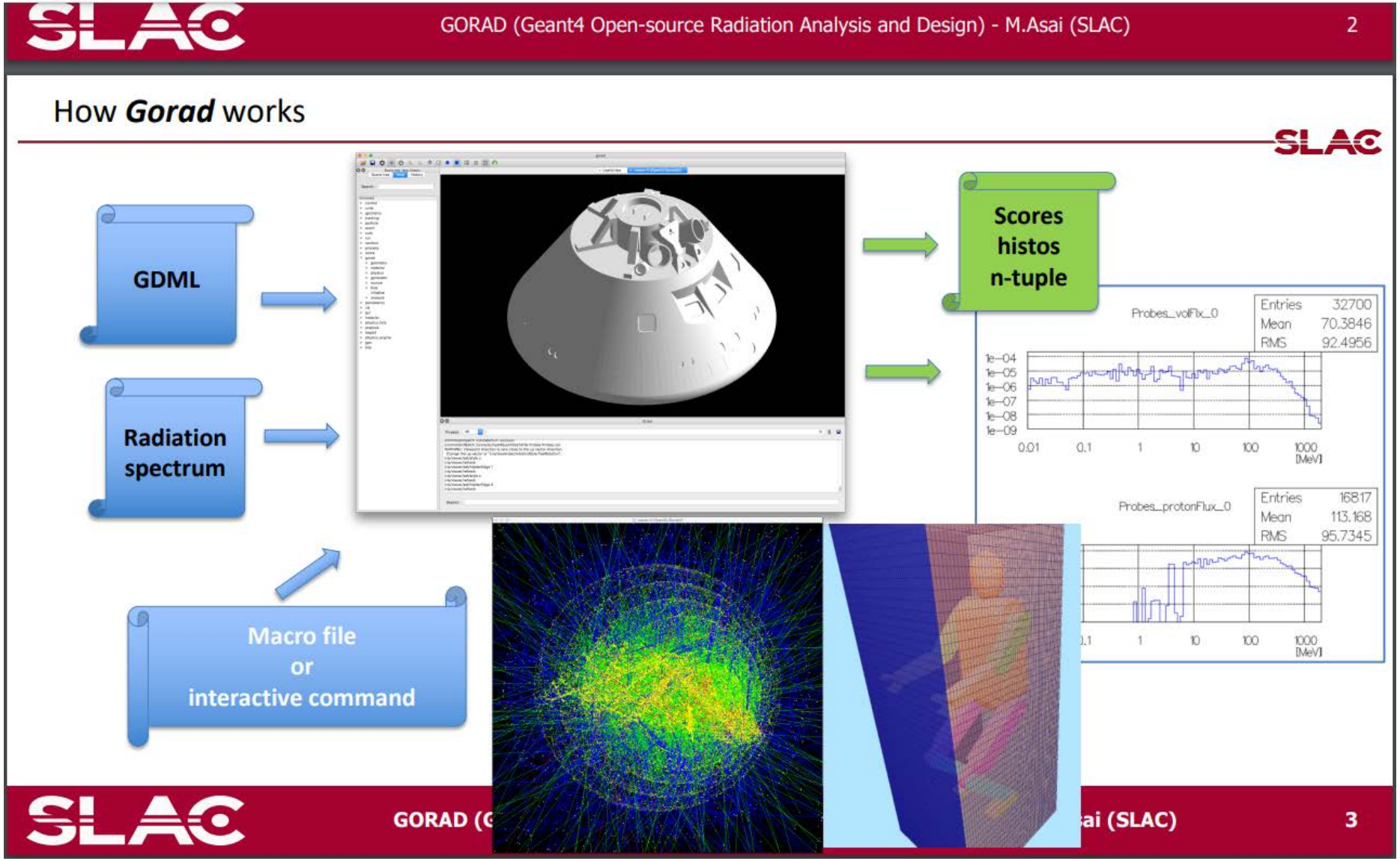
Available in Geant4 10.7

New example for space applications: Gorad

Developed by Makoto Asai under the NASA JSC contract NNJ15HK11B to be used primarily for radiation shielding studies of Orion spacecraft.

Gorad is developed as a turn-key application for radiation analysis and spacecraft design built on top of Geant4.

Available in Geant4 10.7



New example based on CMS HGCal test-beam

Developed By Anna Zaborowska

Main goal: physics validation of particle (EM and pion) shower development

Aimed to demonstrate high-end HEP test-beam setup simulation

Based on expertise of HGCal team and standalone application by Thorben Quast.

Updates on its development:

- Match standard of G4 examples structure, format;
- Fine tune materials, thicknesses;
- Change of physics lists;
- Updated simulation output;
- Developed analysis tools to study shower properties;

Plans:

- More sophisticated primary generator, necessary for the validation (particle gun will be default in the example);
- Make sure visualization still works as in the base application;
- Clean-up + documentation;
- After Vladimir Ivanchenko's comment: possibly implement few other details beneficial for validation for CMS
- MR to `examples/advanced` in coming months;
- Geant-val integration

Target: Geant4 10.7

New Advanced example: ICRP110Phantom

- Developers: M. Large, S. Guatelli, A. Malaroda (Wollongong University)
- Implementation in Geant4 of ICRP110 phantoms with the kind permission of the International Commission on Radiological Protection.
- Reference publication: Zankl M 2010 Adult male and female refence computational phantoms: ICRP Publication 110 Ann. ICRP vol 39 (Oxford: Elsevier) pp 1-165.
- Dosimetry in voxelised geometry
- It should be released in December 2020
- Of interest for dosimetry for radiotherapy and radiation protection, internal dosimetry

Target: Geant4 10.7

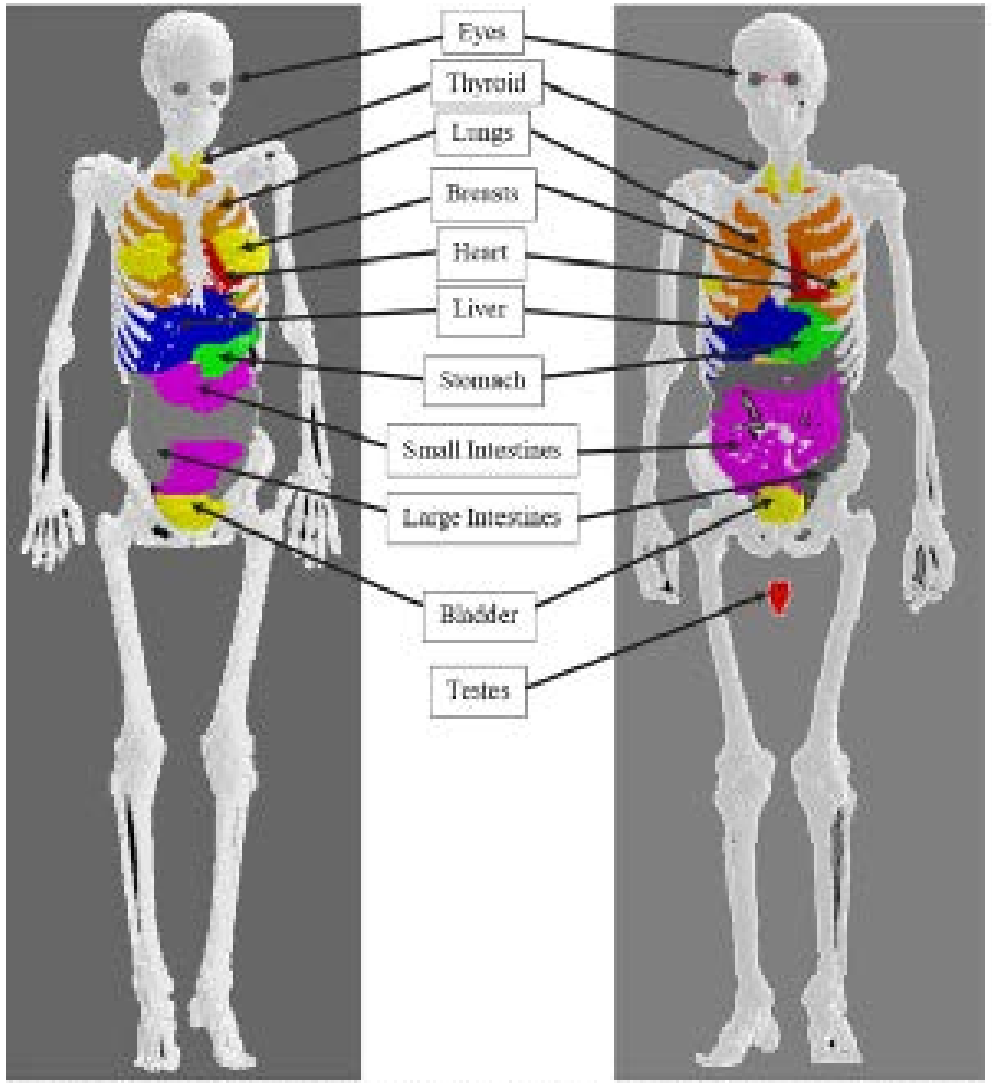


Figure 1. 3D rendering of whole body ICRP110 Reference Female (left) and Reference Male (right) voxel phantoms as modelled in the Geant4 application *ICRP110Phantoms*, in which skin, muscle, cartilage and adipose tissue are not visualised.

Other

- Current status: MT
  - Examples that need to be migrated to MT as soon as possible:
    - *ChargeExchangeMC*
    - *eRosita*
    - *iort_therapy*
    - *medical_linac*
- Migration to use *G4RunManagerFactory*
  - Wait for the successful migration of some categories of the extended examples
    - In the mean time check if there are any problems when adopting G4RunManagerFactory in some specific advanced examples
  - Then migrate the examples within 2021

Conclusions

In summary in 2020:

- Refinements in *brachytherapy*, *hadrontherapy* and *GammaRayTel* examples
- New examples already accepted in system testing for Geant4 10.7 public release: *fastAereosol* and *gorad*
- Other examples targeting 10.7 release: *CMS HGCal*, new example showing how to import in Geant4 simulations IAEA Phase Space Files and *ICRP110Phantom*
- This year no presentations in workshops and conferences (COVID)