

Status and recent developments in the Geant4 Advanced Examples: summary

S. Guatelli and F. Romano

On behalf of the Geant4 Advanced Examples WG

Snapshot

- Members (census 2020): 16 Geant4 Collaborators
- 25 Advanced Examples
 - Medical physics: 12
 - Space science: 9
 - HEP: 4

https://geant4.web.cern.ch/collaboration/working_groups/advanced_examples

Examples and responsables (I)

Example	Responsible	Description
air_shower	B.Tomè	Detection system for cosmic ray shower simulation
amsEcal	M.Maire	Simulation of an Electromagnetic calorimeter
brachytherapy	S.Guatelli	Dosimetry for endocavitary, interstitial and superficial brachytherapy
ChargeExchangeMC	A. Radkov	Simulation of charge exchange real experiment performed at the Petesburg Nuclear Physics Institute (PNPI, Russia)
composite_calorimeter	A.Ribon	A composite electromagnetic and hadronic calorimeter
doiPET	A. Ahmed, S. Guatelli, M. Safavi	Simulation of a typical a positron emission tomography (PET) scanner with depth-of-interaction detectors
eRosita	M.G.Pia, et el.	PIXE simulation with Geant4
fastAerosol	A. Knaian	Simulation of a custom geometry class for accurately and efficiently simulating aerosols with many droplets.
gammaknife	F. Romano	A device for Stereotactic Radiosurgery with Co60 sources for treatment of cerebral diseases
gammaray_telescope	F.Longo	A simplified typical gamma-ray telescope (such as GLAST), with advanced description of the detector response
gorad	M. Asai	Application developed for radiation analysis and spacecraft design built on top of Geant4, with the simulation geometry provided in the form of GDML.
hadrontherapy	G.A.P.Cirrone	Simulation of a transport beam line for proton and ion therapy

Examples and responsables (II)

Example	Responsible	Description
human_phantom	S. Guatelli	Internal dosimetry
lort_therapy	F. Romano? S. Gutelli ?	Simulation of a IORT device
IAr_Calorimeter	A.Dotti	Simulation of the Forward Liquid Argon Calorimeter of the ATLAS Detector at LHC
medical_linac	B. Caccia, G.A.P. Cirrone	A typical LINAC accelerator for IMRT,
microbeam	S.Incerti	Simulation of a cellular irradiation microbeam line using a high resolution cellular phantom
microelectronics	M. Raine	Simulation of tracks of few MeV protons in silicon
nanobeam	S.Incerti	Simulation of a nanobeam line facility
purging_magnet	J.Apostolakis	Electrons travelling through the magnetic field of a strong purging magnet in a radiotherapy treatment head
radioprotection	S.Guatelli	Microdosimetry with diamonds and silicum detectors for radioprotection in space missions
STCyclotron	F. Poignant, S. Guatelli	Simulation of cyclotron radioisotope production in a solid target
underground_physics	A.Howard	A simplified dark matter detector (such as the Boulby Mine experiment)
xray_fluorescence	A.Mantero	Elemental composition of material samples through X-ray fluorescence
xray_telescope	G.Santin	A simplified typical X-ray telescope (such as XMM-Newton or Chandra)

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*
 - To be started in *purging_magnet*

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. Bakr¹, D. Bolst¹, D. Sakata¹, N. Li^{1,2}, P. Lazarakis¹, S. McMahon³, A. Rosenfeld^{1,2}, S. Incerti^{4,5}, I. Kyriakou⁶, D. Emfietzoglou⁶, M. Lerch^{1,2}, M. Tehei^{1,2}, S. Corde^{1,7}, S. Guatelli¹

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 Universit e de Bordeaux, Bordeaux, France, ⁶ University of Ioannina, Ioannina, 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.

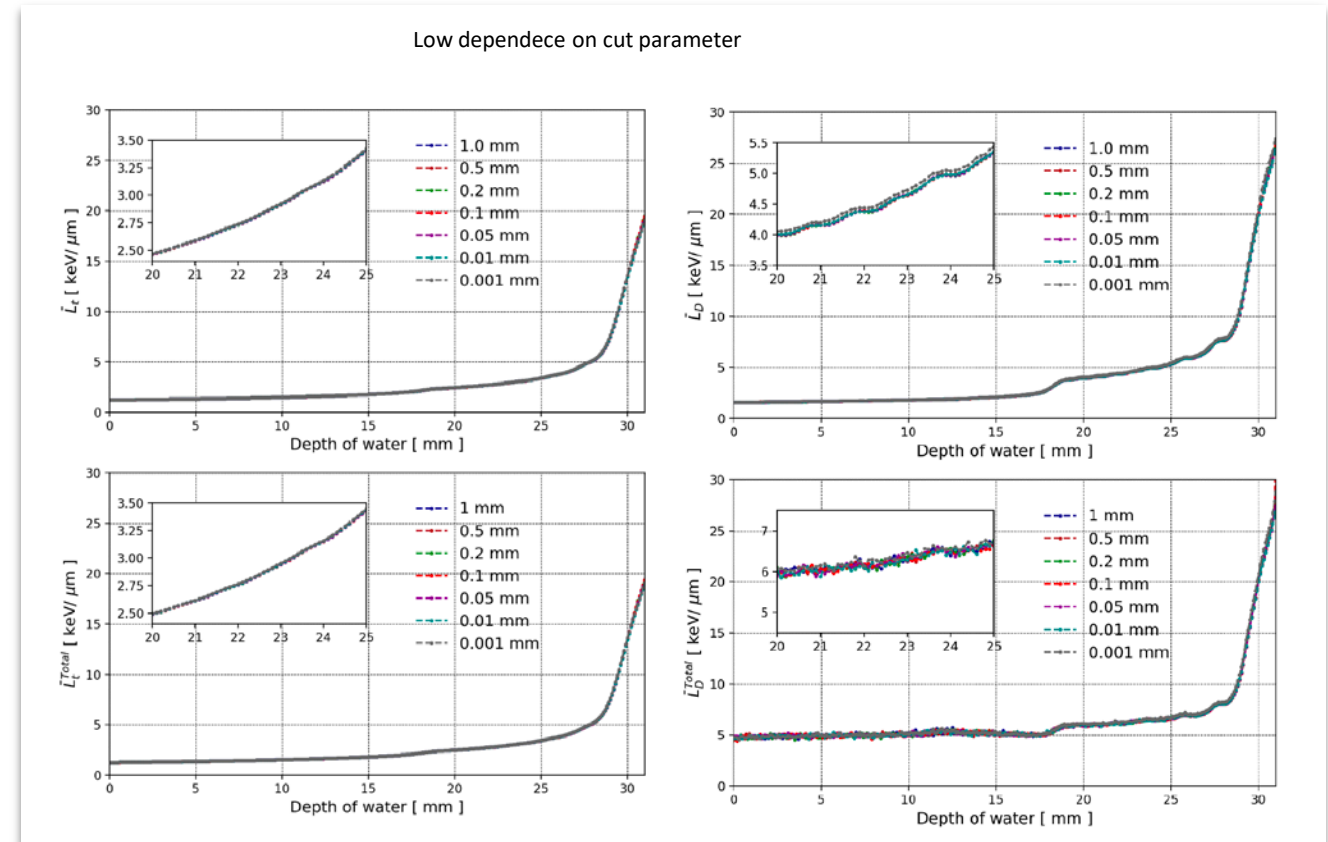
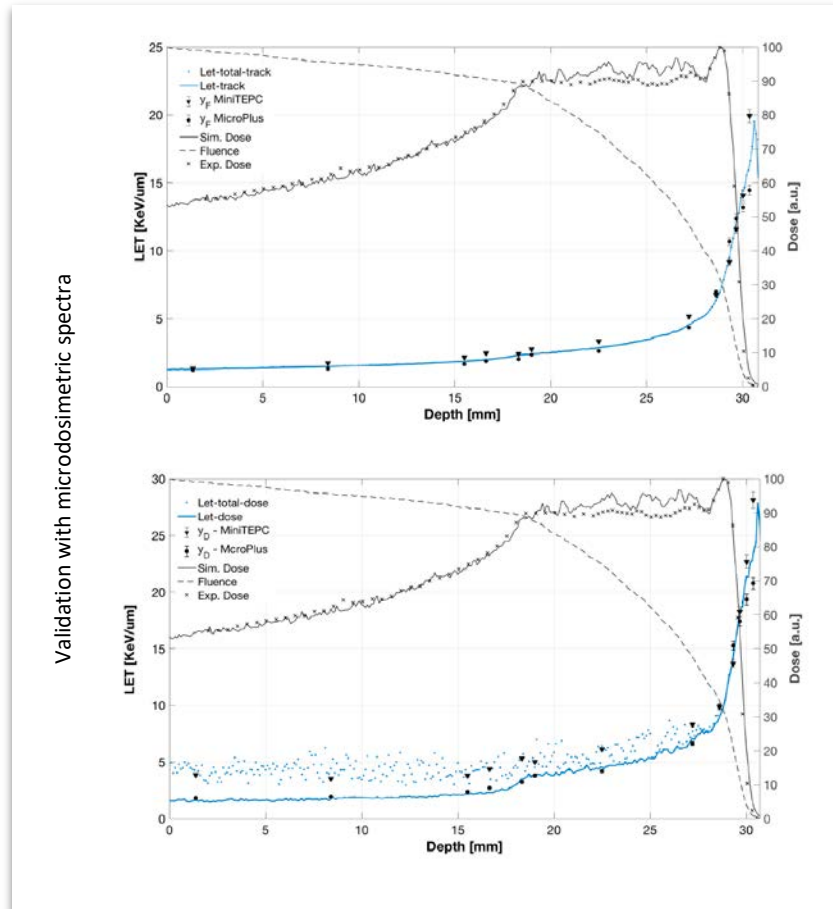
Plan for 2020/2021 (3)

- Release of a new example showing how to import in Geant4 simulations IAEA Phase Space Files (2)[*]
 - M. Cortes-Giraldo and collaborators are extending the Geant4 extended example GammaTherapy to read IAEA phase space files. Testing against potential MT issues is ongoing.
- Improvement of GammaRayTel example to deal with polarised processes (2)[*]
 - 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 and P. Cirrone

New developed and validated algorithms to compute the LET



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](https://doi.org/10.1088/1361-6560/abaeb9) (2020)

Plan for 2020 (5)

- Release of a new example modelling dust cloud: fastAerosol
 - Done
 - Authors: Ara Knaian and Nate MacFadden, NK Labs, LLC (<http://www.nklabs.com>), supported by Makoto Asai
 - Related Publication: MacFadden, N., Knaian, A., 2020, "Efficient Modeling of Particle Transport through Aerosols in GEANT4", Manuscript in preparation.
 - See talk by Ara Knaian and Nate MacFadden

Plan for 2020/2021 (6)

- Release of a new CMS example
 - See talk by Anna Zaborowska
- Release of GORAD (Geant4 Open-source Radiation Analysis and Design)
 - See talk by Makoto Asai

New Advanced example: ICRP110Phantom

- Developers: M. Large, S. Guatelli, A. Malaroda (Wollongong University)
- The Advanced Example implements in Geant4 ICRP110 phantoms with the kind permission of the International Commission on Radiological Protection.
- Reference publication: Zankl M 2010 Adult male and female reference 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

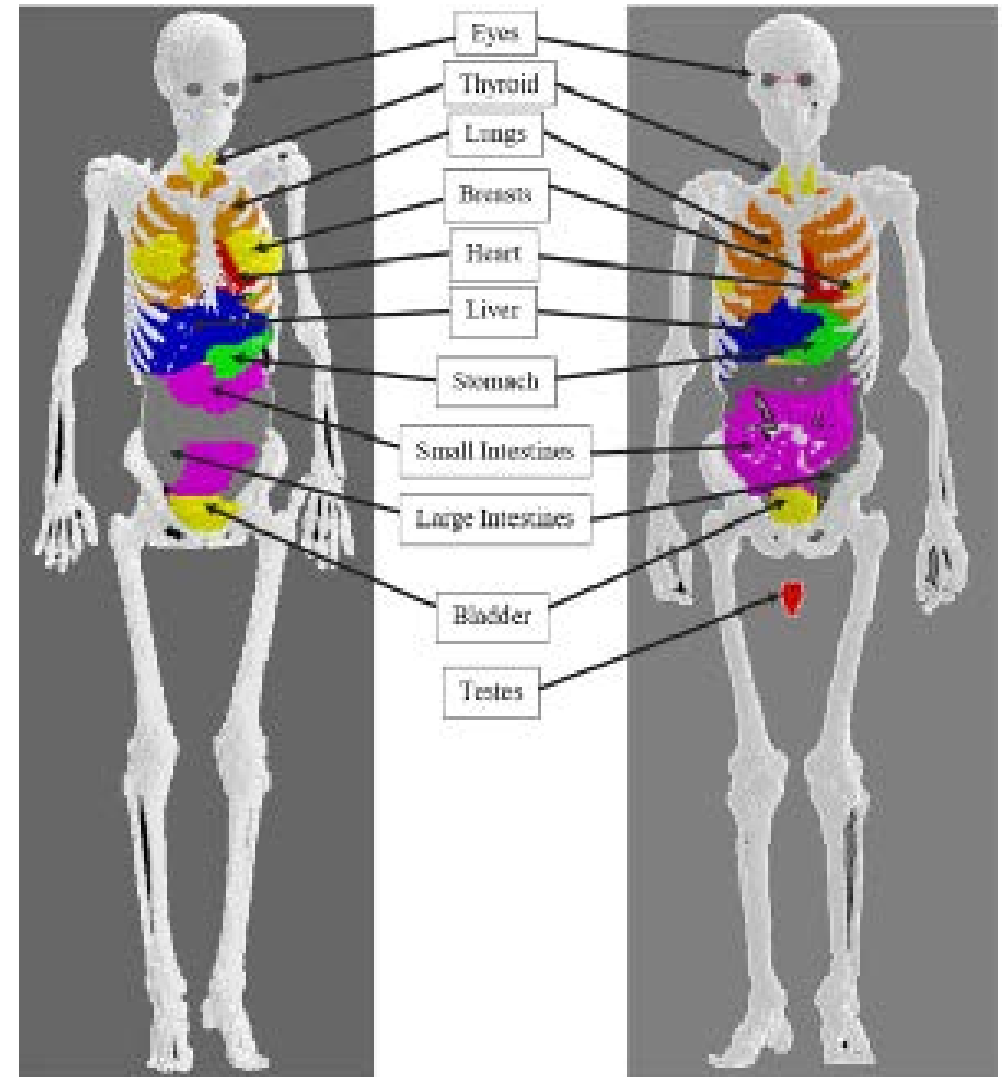


Figure 1. 3D rendering of whole body ICRP110 Reference Female (left) and Reference Male (right) voxel phantoms as modelled in the Geant4 application ICRP110Phantoms, in which skin, muscle, cartilage and adipose tissue are not visualised.

Other

- Current status: MT

- Examples that need to be converted to MT as soon as possible:

- *ChargeExchangeMC*
- *eRosita*
- *iort_therapy*
- *medical_linac*

- The developers/maintainers of the codes have been contacted

- Migration to use *G4RunManagerFactory*

- The plan is to do it within 2021

- *iort_therapy* won't be maintained anymore by the current developer in 2021

- F. Romano and S. Guatelli willing to maintain it and happy to share the responsibility with anyone interested.

Conclusions

- Maintenance and code reviews are on-going
- New examples released in 2020 so far: *fastAereosol* and *gorad*
- This year no presentations in workshops and conferences (COVID)