

Update on Advanced Examples: summary

S. Guatelli and F. Romano

On behalf of the Geant4 Advanced Examples WG

27 Advanced Examples

Coord.: S. Guatelli (UOW), Dep.: F. Romano (INFN)

air_shower	B. Tomè	Detection system for cosmic ray shower simulation
ams_Ecal	M. Maire	Simulation of an Electromagnetic calorimeter
brachytherapy	S. Guatelli	Dosimetry for endocavitary, interstitial and superficial brachytherapy
composite_calorimeter	A. Ribon	A composite electromagnetic and hadronic calorimeter
ChargeExchangeMC	A. Radkov	Simulation of charge exchange real experiment
doiPET	A. Ahmed , S. Guatelli , M. Safavi	Simulation of a detector system for PET
eRosita	F. Longo	PIXE simulation with Geant4
fastAerosol	A. Knaian, N. MacFadden	Modelling of particle interactions with
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 with advanced description of the detector response
gorad	M. Asai	Model of a NASA space mission
hadrontherapy	G.A.P.Cirrone	Simulation of a transport beam line for proton and ion therapy
HGCal_testbeam	A. Zaborowska	High-end High Energy Physics test beam setup, for the endcap electromagnetic calorimeter of the CMS detector [CERN-LHCC-2017-023]
human_phantom	S: Guatelli	Dosimetry in analytical anthropomorphic phantoms
ICRP110_HumanPhantoms	S. Guatelli	Dosimetry in the ICRP110 Phantom
lort_therapy	F. Romano	Simulation of a IORT device
lAr_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 purging magnet in a radiotherapy treatment head
radioprotection	S. Guatelli, F. Romano	Microdosimetry with diamonds and silicum detectors for radioprotection in space missions
STCyclotron	F. Poignant, S. Guatelli	Modelling the production of radio-isotopes
underground_physics	A. Howard	A simplified typical dark matter detector (such as the Boulby Mine experiment)
xray_fluorescence	A. Mantero	Elemental composition of material samples through X-ray fluorescence spectra
xray_telescope	G. Santin	A simplified typical X-ray telescope (such as XMM-Newton or Chandra)

Plan for 2021 (1)

- Maintenance and bug fixes (1,2)
 - Ongoing
- Code review in selected examples (1,2)
 - Ongoing
 - Done in *microbeam*, *ICRP110Phantom*, *brachytherapy*
 - On-going in *radioprotection*, *eRosita*
- Migration to C++11/14/17 (1,2)
 - In the initial phase
- Release of a new example for nanomedicine (gold nanoparticles in X-ray radiotherapy) (2)[*]
 - The example will be released as an Extended Example of Geant4 in the next public release (*AuNP*)

Plan for 2021: Hadrontherapy

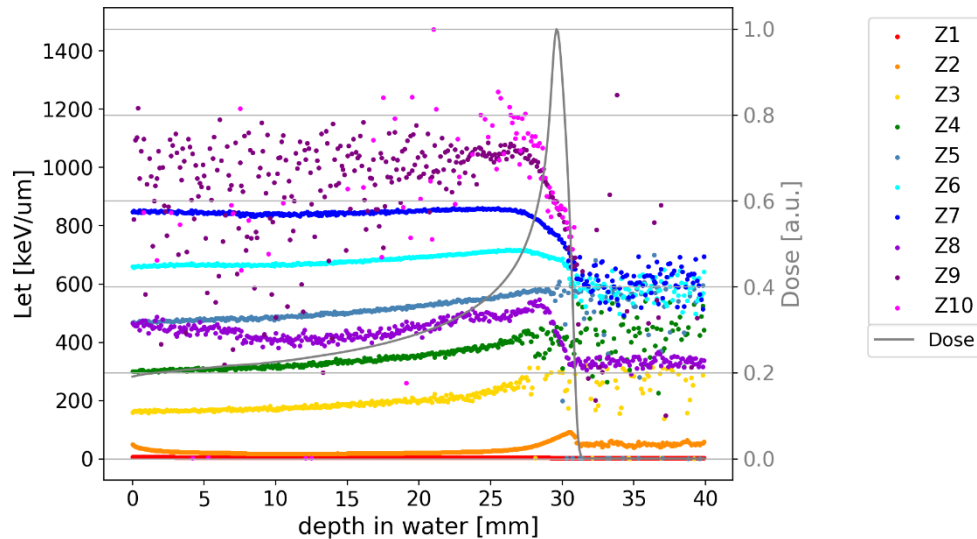
G. Petringa, P. Cirrone, L. Pandola,
G. Miluzzo, S. Fattori

New developed algorithms to compute the LET

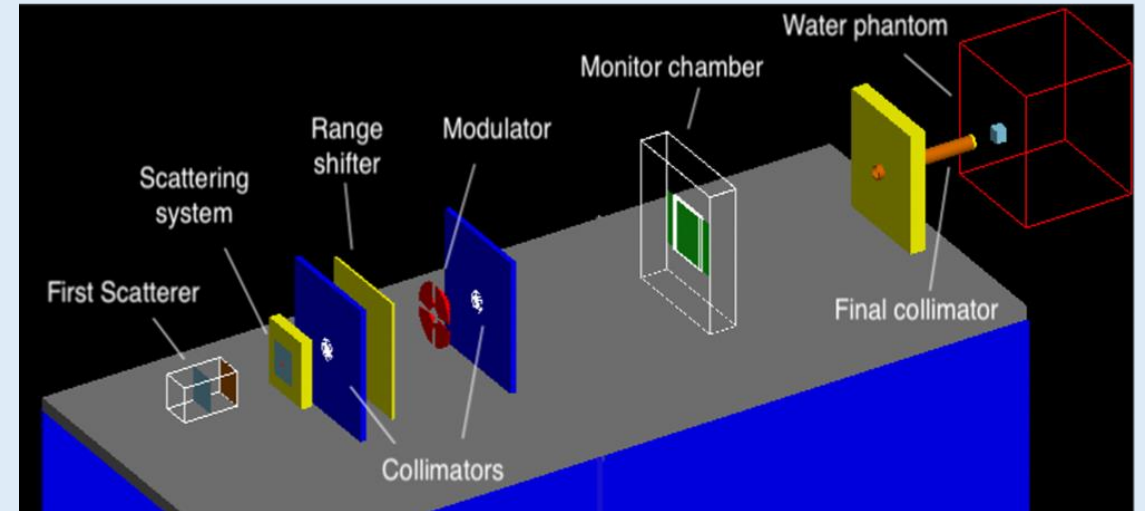
- Validation done with clinical proton beams:

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)

- On going validation with ions:



A new geometry : Best-Cyclotron beam line

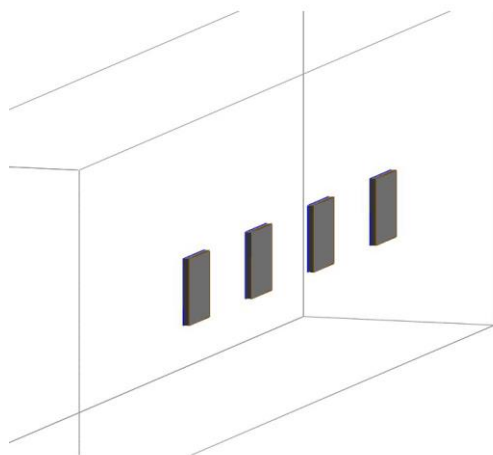


	Best Cyclotron source parameters
Energy	70MeV
Energy spread (sigma)	300keV
Spot dimension (FWHM of a gaussian distribution)	3mm-5mm (sigma)
Spatial distribution type	Circular
Angular distribution type	Gaussian
Angular divergency	~ 0.16 ° (sigma)

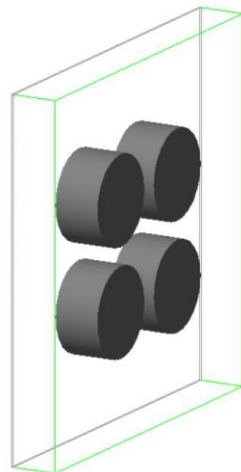


Radioprotection advanced example

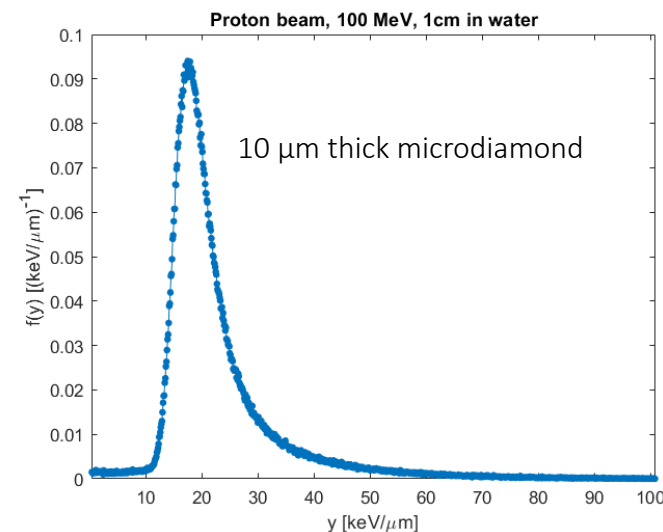
- Responsible developers:
S. Guatelli (University of Wollongong, Australia) and F. Romano (INFN - Catania Division, Italy)
- New implementation of diamond microdosimeters (produced by University of Rome “Tor Vergata”):
collaboration between INFN-Catania and University of Surrey (J. Magini, G. Parisi, G. Schettino and F. Romano)
→ **completed**
- Implementation of simple macro commands for easy management of the geometrical configuration from Users:
 - Possibility of changing the different simulated microdosimeters (Silcon vs microdiamond) via → **completed**
- Cross-comparison with experimental data → **completed/in progress** (data acquired with low energy ion beams)
- Simulation of double-stage microdiamond for particle identification → **in progress**
- Python scripts for microdosimetric spectra and data analysis (first version) → **in progress**



Diamond microdosimeters



Silicon microdosimeters



see talk on the
«Radioprotection example»

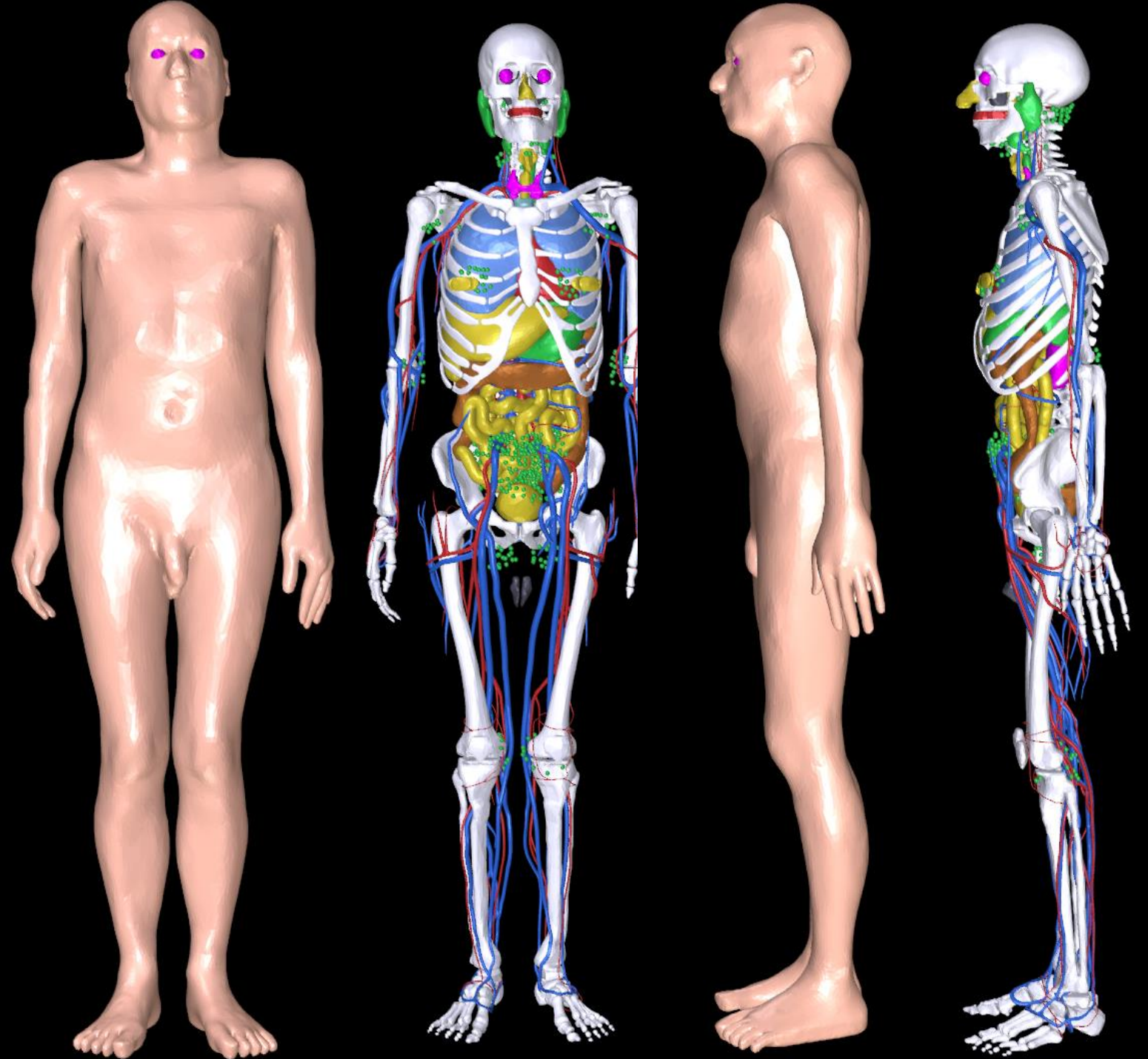
New Advanced example: ICRP145Phantom

ICRP Publication 145 on Adult
Mesh-type Reference
Computational Phantoms

Ann ICRP . 2020 Oct;49(3):13-201. doi:
10.1177/0146645319893605.

Calculation of the dose in the
organs of the phantoms

To be released in Geant4 11, in
agreement with the original
developers of the models.



Plan for 2021: Other

- Current status: MT

- Examples that need to be migrated to MT :
 - *ChargeExchangeMC*
 - *iort_therapy*
 - *medical_linac*

- Migration to G4RunManagerFactory

- **Migrated examples:** in *air_shower*, *amsEcal*, *composite_calorimeter*, *eRosita*, *fastAerosol*, *gammaknife*, *gammaray_telescope*, *gorad*, *hadrontherapy*, *HGCal_testbeam*, *human_phantom*, *ICRP110Phantoms*, *microbeam*, *microelectronics*, *nanobeam*, *radioprotection*
- **To migrate:** *ChargeExchangeMC*, *doiPET*, *iort_therapy*, *lAr_calorimeter*, *medical_linac*, *purging_magnet*, *x_rayfluorescence*

Plan for 2021: Other

- Remove eRosita, which is no longer maintained, with no Geant4 Collaborator responsible for it (2)
 - F. Longo kindly agreed to maintain the example
- Release of a new example showing how to import in Geant4 simulations IAEA Phase Space Files (2)[*]
 - Ongoing by M. Cortes-Giraldo and collaborators
- Measurements and statistical analysis of size, McCabe, Halstead, Chidamber and Kemerer software metrics over at least 50% of the advanced examples; explication of the results in relation to ISO/IEC 9126 and ISO/IEC 25000 (1,2)
 - No update
- Improvement of the webpage and documentation (1,2)
 - Started but in stand-by to see how the Geant4 webpage will evolve

- That's all, thank you