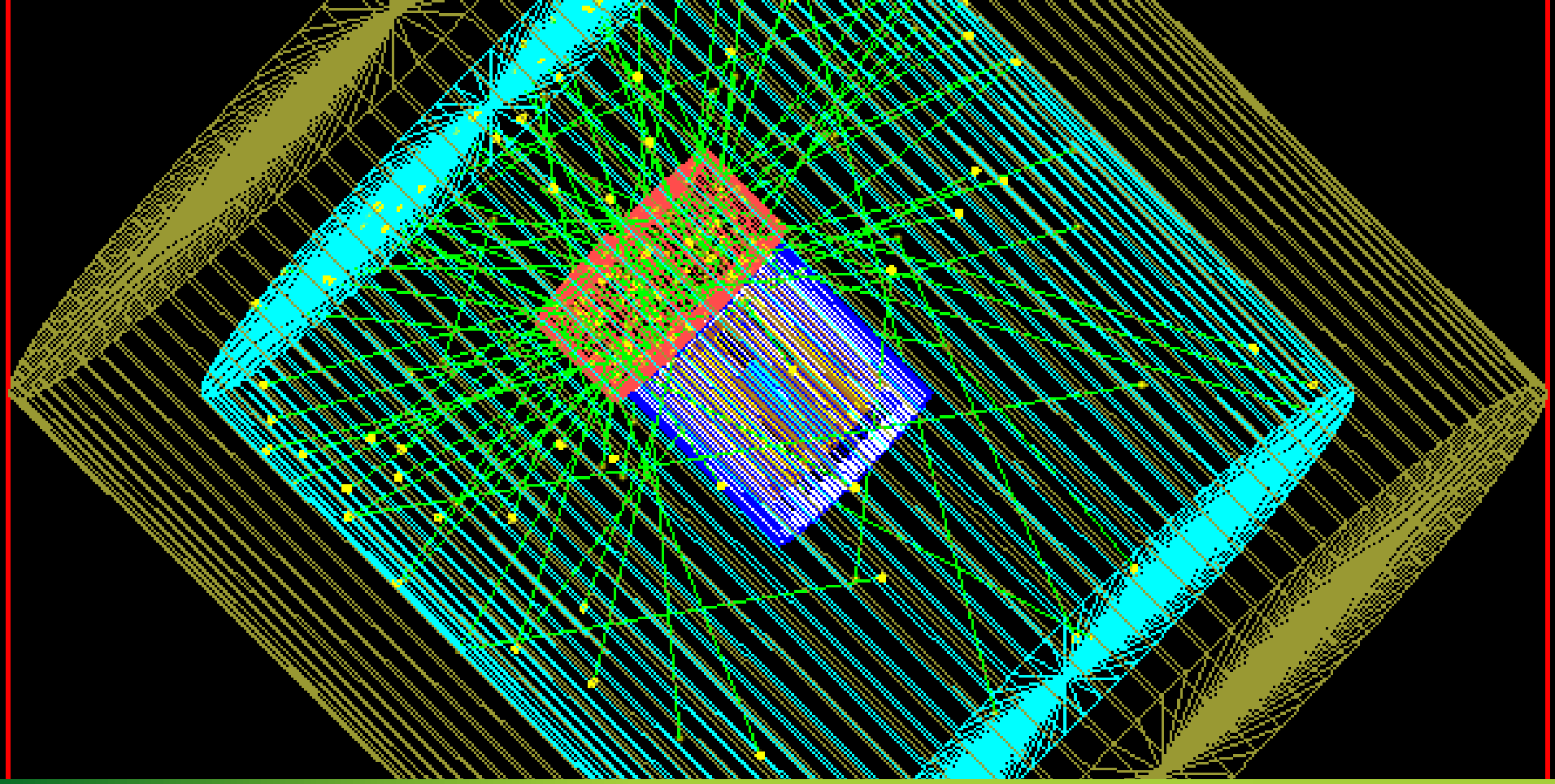


ICRM GS WG : ACTION TO FACILITATE THE USE OF GEANT4 IN GAMMA–SPECTROMETRY

LNHB
Laboratoire National Henri Becquerel

ICRM GS WG meeting | 29-30 Oct 2020 | Cheick THIAM

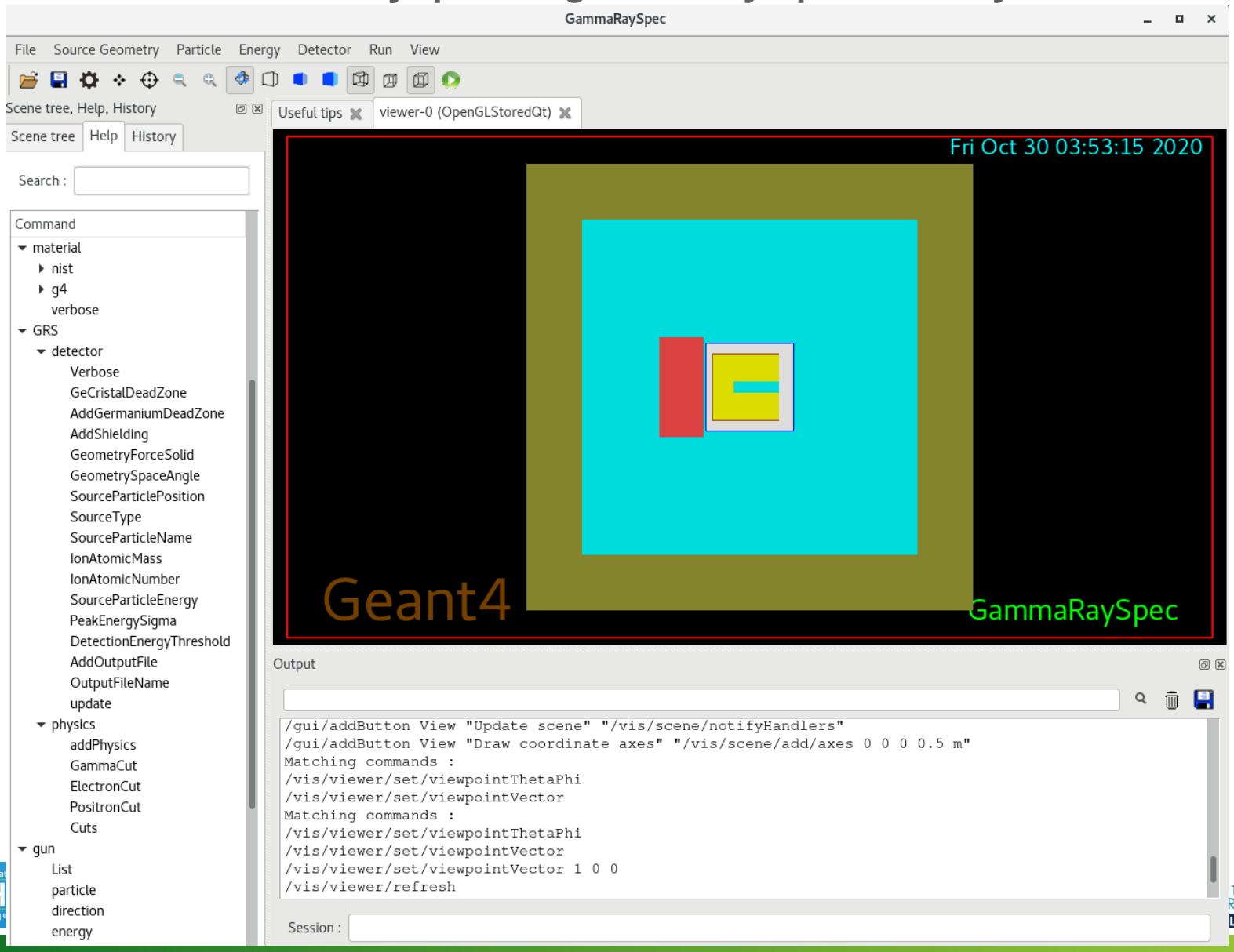
SHORT DESCRIPTION OF GEANT4

- **Geant4 is a toolkit:**
  - for simulating the passage of particles through matter and interacting with it
  - toolkit i.e. there is no main program
  - provides all the necessary components needed to describe and to solve particle transport simulation problems
    - tools to define/describe: geometry, materials and properties, particles and physical processes governing particles interactions, scoring, etc.
  - problem solution: step-by-step particle transport computation
  - while providing interaction points for the user

- **Build and implement simulation:**
  - user must build his own application by selecting the Geant4 components
  - either selecting ready to use tools in form of interfaces (called actions in Geant4 terminology)
  - or building his own from the base abstract classes
  - need a minimal knowledge of the Geant4 structure and base classes
  - need a basic knowledge in Linux and C++ programming
  - several examples are available within the code

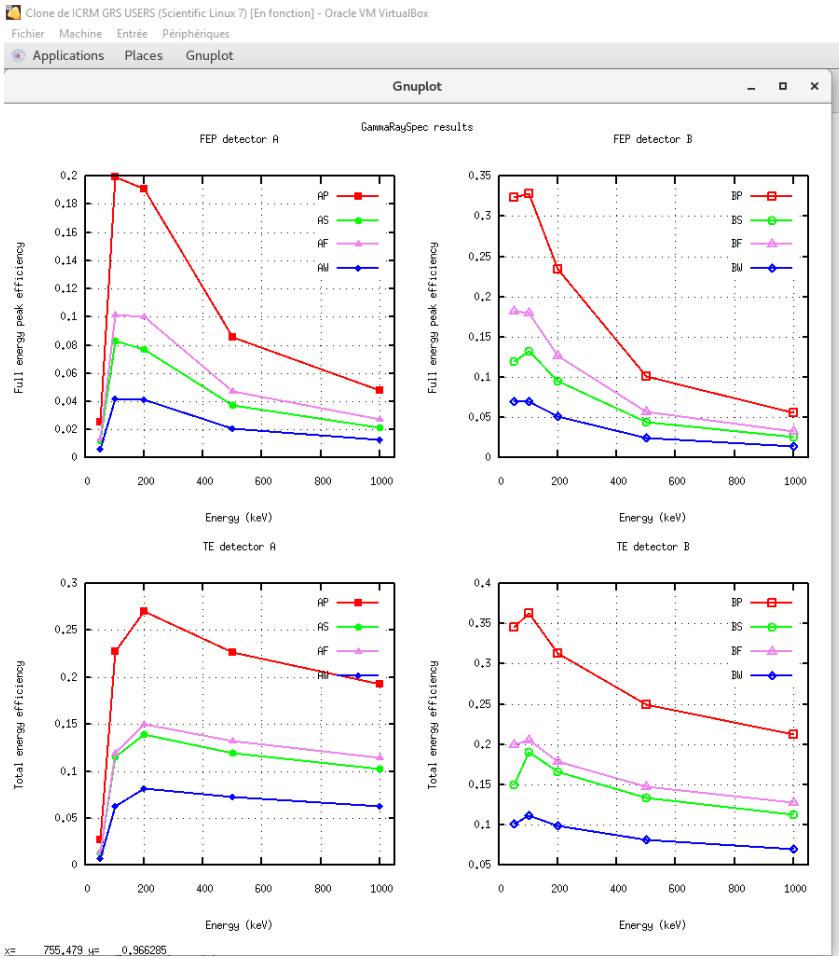
GAMMA-RAY SPECTROMETRY BENCHMARK

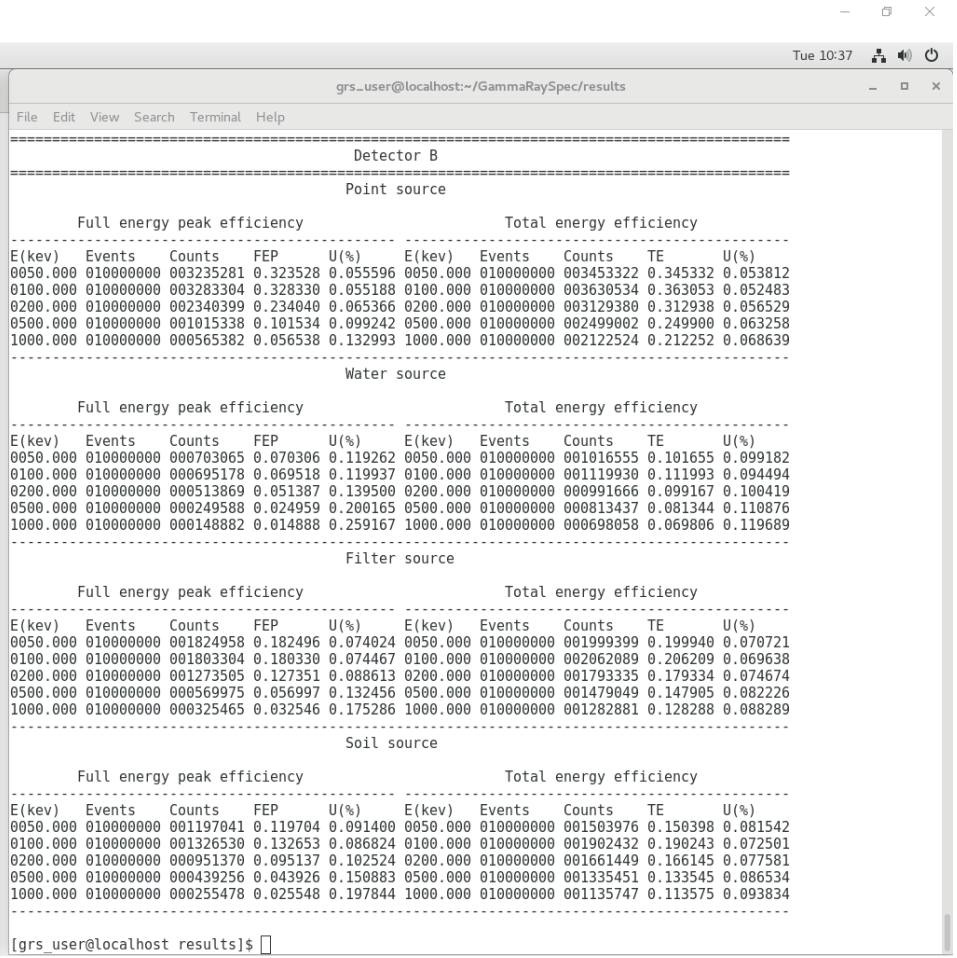
« G4/GammaRaySpec » : gamma-ray spectrometry benchmark



GAMMA-RAY SPECTROMETRY BENCHMARK

- « G4/GammaRaySpec » : γ-ray spectrometry dedicated benchmark





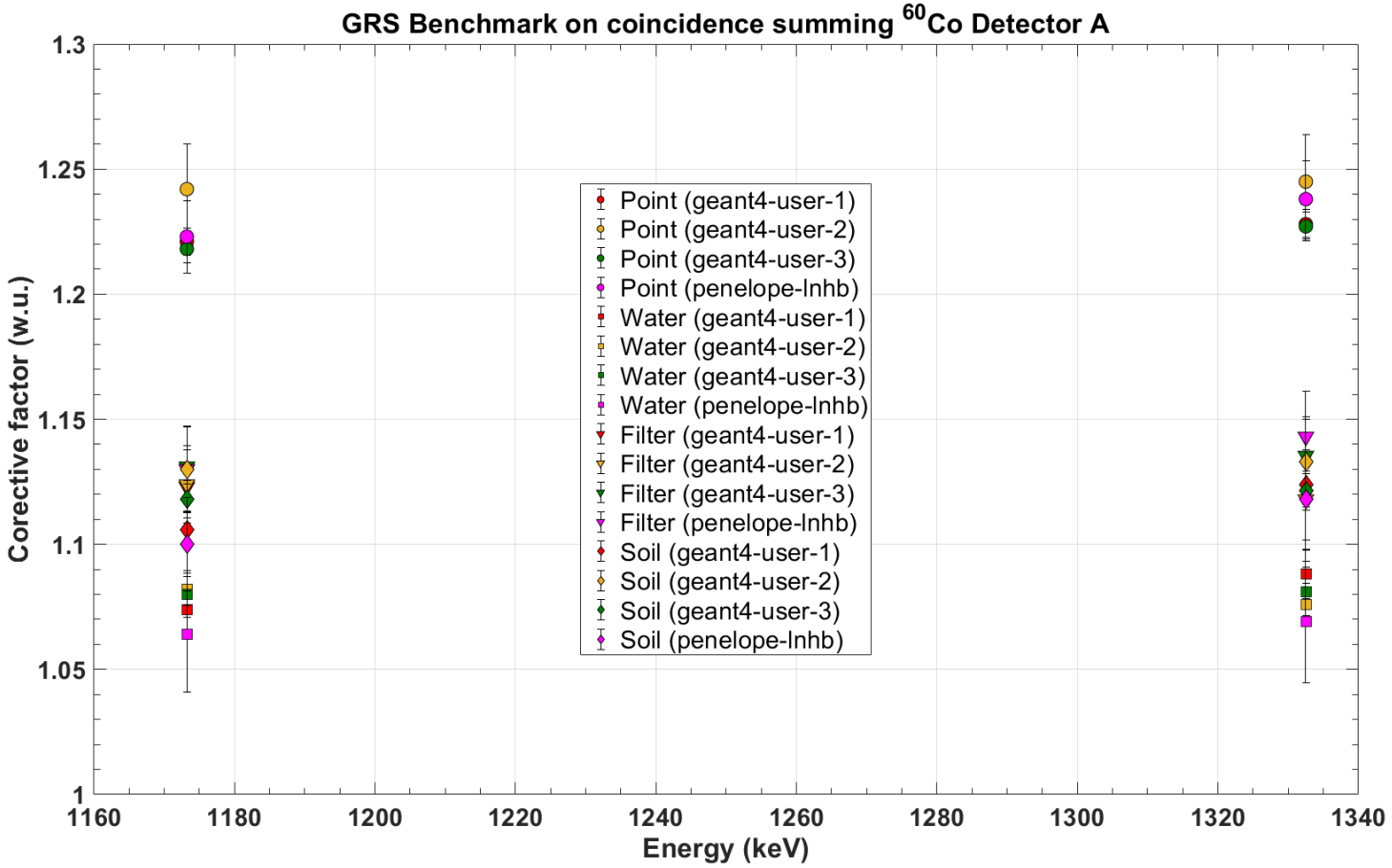
GAMMA-RAY SPECTROMETRY BENCHMARK

- **« G4/GammaRaySpec » : γ-ray spectrometry dedicated benchmark**
  - **On-going exercise:** Extension to coincidence-summing corrections

Participant name	Santiago Hurtado-Bermúdez (CIEMAT)	Stefan Röttger (PTB)	Cheick Thiam (LNHB)
Code	Geant4	Geant4	Geant 4
Version	10.6	10.6.p02	10.6.p02
Radionuclide database	ENSDF	ENSDF	DDEP
Number of channels	8192	8192	1024
Detection threshold	1 keV		1 keV
E cut for secondary particles (photons) E cut for secondary particles (electrons) E cut for secondary particles (positrons)	250 eV 250 eV 250 eV	0.1 eV 0.1 eV 0.1 eV	250 eV 250 eV 250 eV
Number of generated events	1E7 to 3E7	1.00E+07	1.E+07
Peak energy sigma (if applicable)	2 keV		2 keV

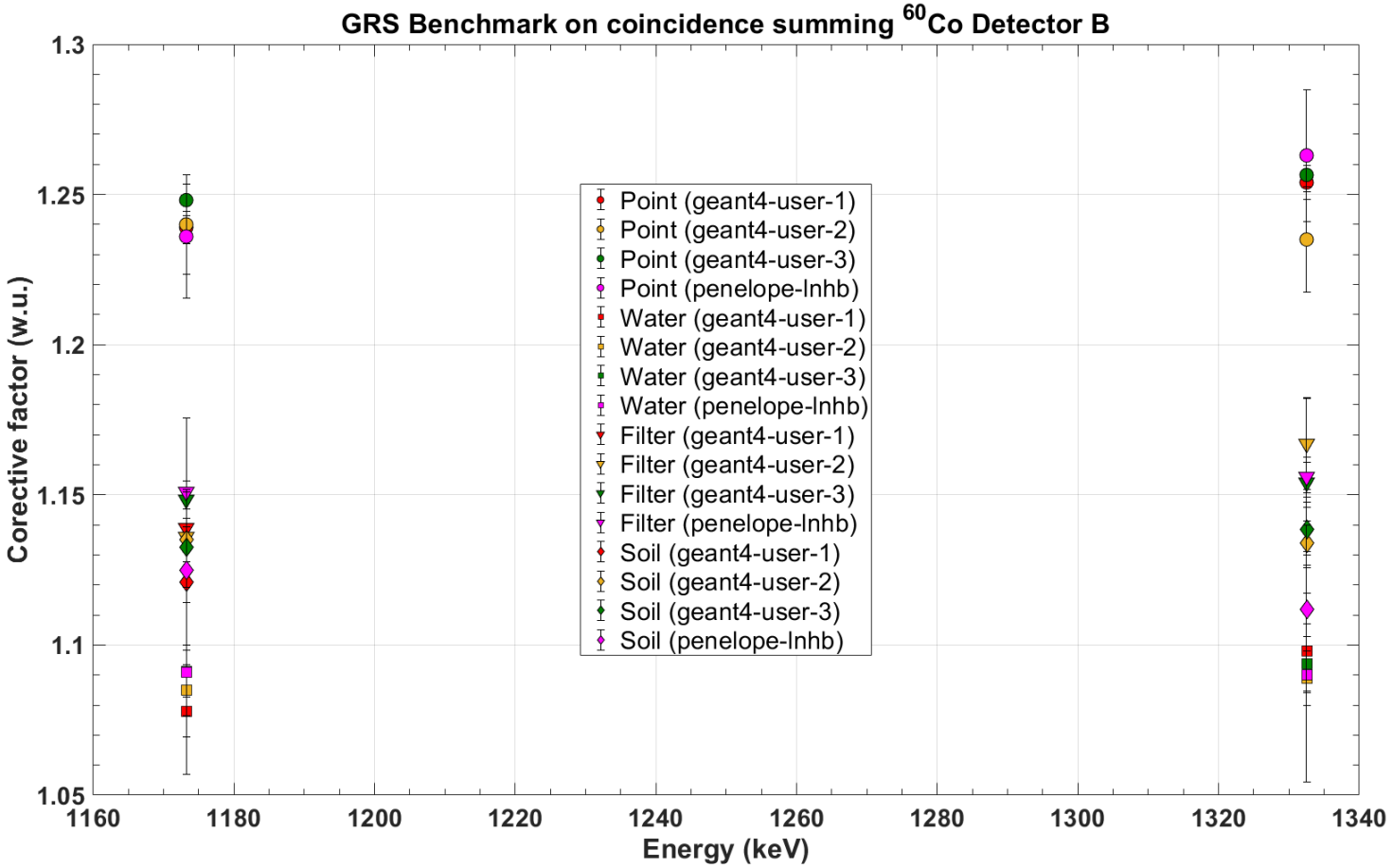
GAMMA-RAY SPECTROMETRY BENCHMARK

- Determination of corrective factors: comparisons between users
- Co-60, detector A



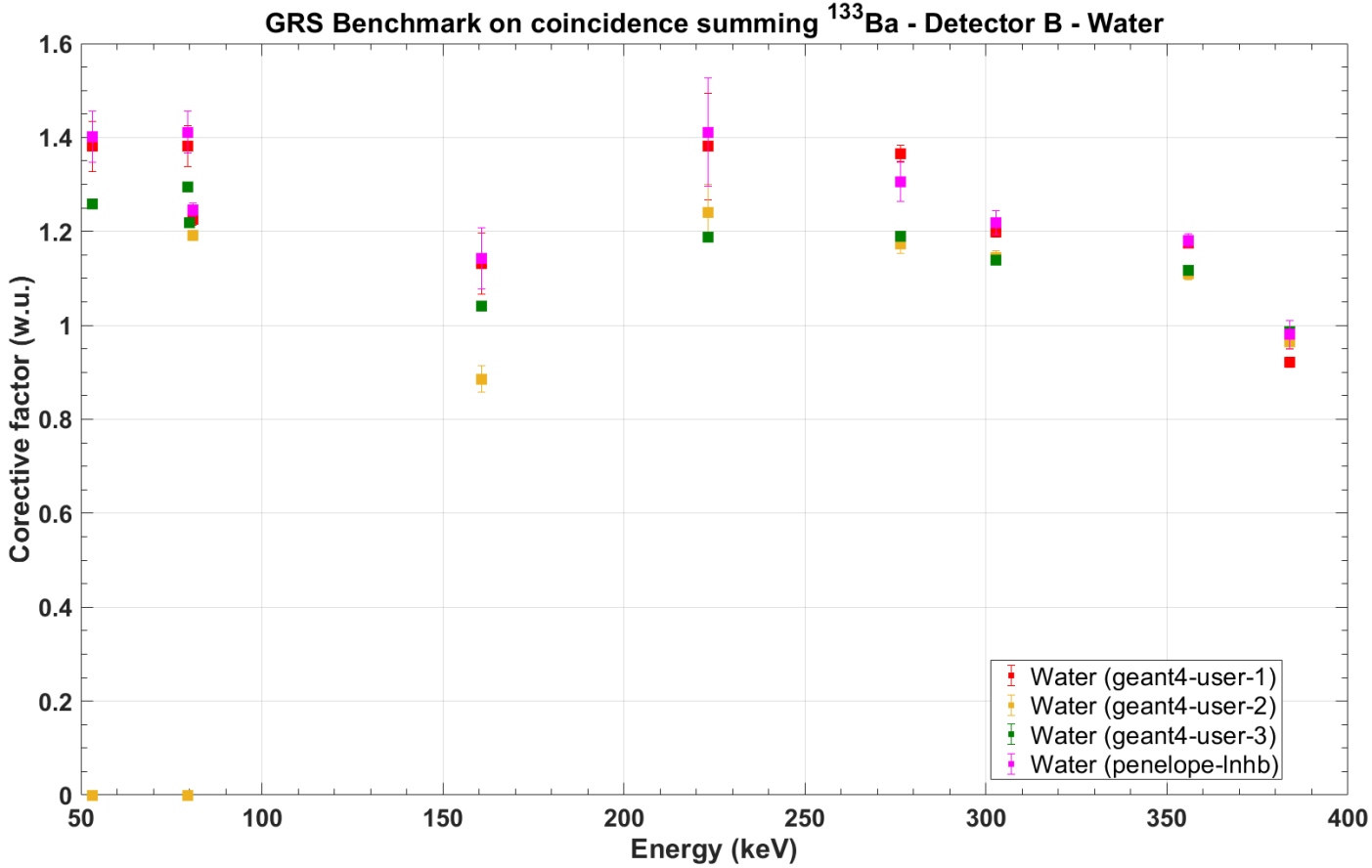
GAMMA-RAY SPECTROMETRY BENCHMARK

- Determination of corrective factors: comparisons between users
- Co-60, detector B



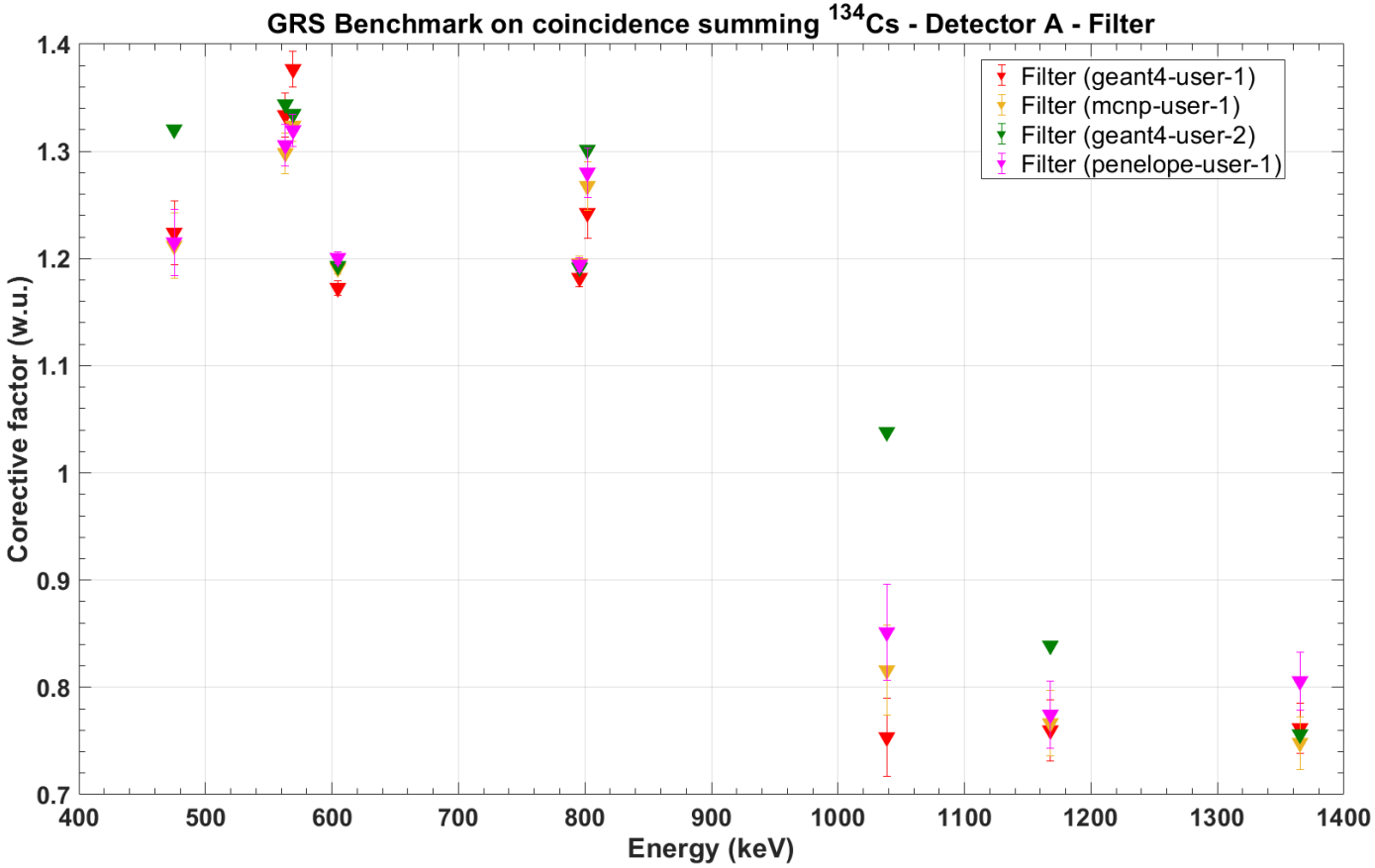
GAMMA-RAY SPECTROMETRY BENCHMARK

- Determination of corrective factors: comparisons between users
- Ba-133, detector B, Water



GAMMA-RAY SPECTROMETRY BENCHMARK

- Determination of corrective factors: comparisons between users
- Cs-134, detector A, Filter



GAMMA-RAY SPECTROMETRY BENCHMARK

- **Conclusion/Discussion on corrective factors calculation using MC tools**
  - Geant4 and other codes give good results if the problem is well described
  - Users have to pay attention to the radioactive decay simulation
    - The energy spectrum obtained in sensitive detector depend a lot on decay data used
  - Geant4: a specific module, Radioactive Decay Module (*G4RadioactiveDecay*), with associated classes, allows to simulate the decay of radioactive nuclei by alpha, beta plus and beta minus emission and electron capture
  - The simulation model is empirical and data-driven, and uses the ENSDF data for information on nuclear half-lives, nuclear level structure for the parent or daughter nuclide, decay branching ratios and the energy of the decay process
    - Data are not always complete and some emissions may not be considered in the decay process due to low intensity or low energy emitted, which can be problematic in simulation applications concerning in particular the metrology of the radionuclides
  - Alternative to Geant4 Radioactive Decay Module:
    - User can set his own radionuclide decay input (with N numbers of events)
    - Interface other decay module (ex. Nuclide++ is ongoing development at LNHB)

Commissariat à l'énergie atomique et aux énergies alternatives
Institut List | CEA SACLAY NANO-INNOV | BAT. 861 – PC142
91191 Gif-sur-Yvette Cedex - FRANCE
www-list.cea.fr

Établissement public à caractère industriel et commercial | RCS Paris B 775 685 019

CERN Accelerating science

GEANT4
A SIMULATION TOOLKIT

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Contact Us | Bug Reports

Geant4

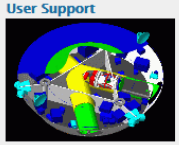
Overview

Geant4 is a toolkit for the simulation of the passage of particles through matter. Its areas of application include high energy, nuclear and accelerator physics, as well as studies in medical and space science. The three main reference papers for Geant4 are published in Nuclear Instruments and Methods in Physics Research A 506 (2003) 250-303, IEEE Transactions on Nuclear Science 53 No. 1 (2006) 270-278 and Nuclear Instruments and Methods in Physics Research A 835 (2016) 186-225.

Applications

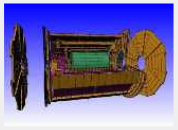
A sampling of applications, technology transfer and other uses of Geant4

User Support



Getting started, guides and information for users and developers

Publications



Validation of Geant4, results from experiments and publications

Collaboration

Who we are: collaborating institutions, members, organization and legal information

News

2020-06-26
Release 10.7-BETA is available from the BETA Download area.

2020-05-29
Patch-02 to release **10.6** is available from the download area.

2020-03-13
2020 planned developments.

Events

[Virtual] 4th LPCC Detector Simulation Workshop, CERN (Geneva), **2-3 November 2020**.

[Virtual] 2nd HSF/WLCG Virtual Workshop, **19-25 November 2020**.

[Virtual] IN2P3 & PHENICS Geant4 School, Orsay (France), **23-27 November 2020**.

Past events

➔ https://geant4.web.cern.ch