28th Geant4 Collaboration Meeting
26 sept. 2023, Hokkaido University, Japan

New advanced examples:
X-ray Silicon Pore Optics
X-ray TES detector

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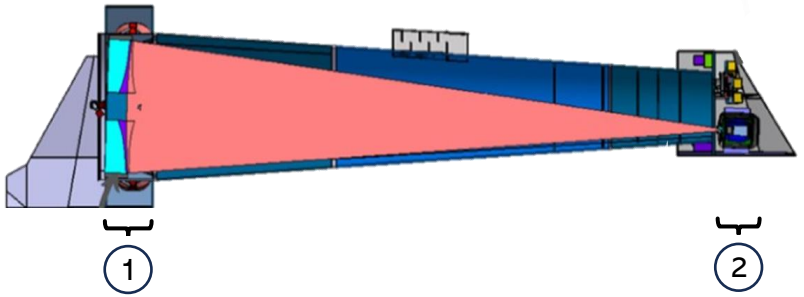
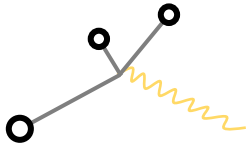
GENERAL CHARACTERISTICS

ATHENA OBSERVATORY, human for scale



Two **independent** examples (*) based on simplified geometries derived from the ATHENA telescope (thanks to INAF Rome and Bologna in defining the simplified geometries)



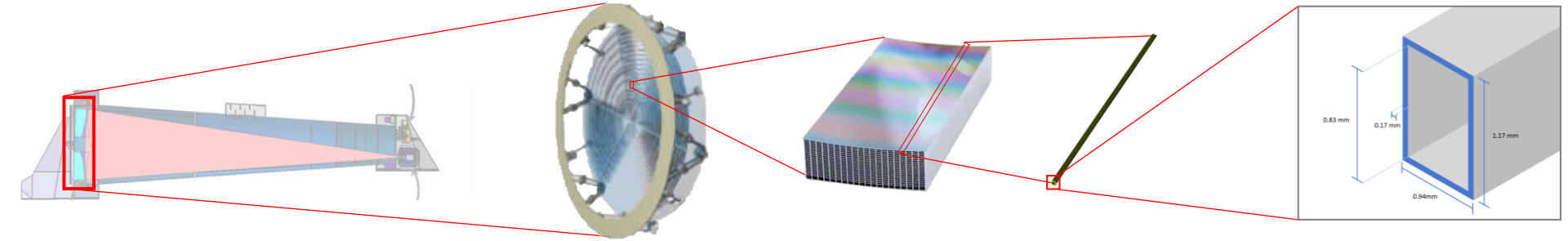
Application of Geant4 in a space environment: these examples includes the **Space Physics List (SPL)**, developed within the ESA AREMBES project.

*example developed within the ESA AREMBES Project, Contract n. 4000116655/16/NL/BW.

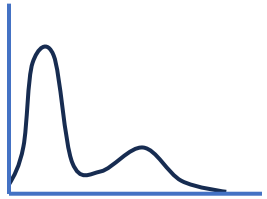
First example: **X-RAY Silicon Pore Optics**

GEOMETRY

Based on the **Silicon Pore Optics** (SPO) mass model given by V. Fioretti (INAF Bologna).
One single pore in the first version, with the possibility to include a section of the Mirror Module (simulation of the entire structure) in a future commit.
Dummy volumes at the pore entrance and exit to count the number of particles entering and exiting.



SOURCE



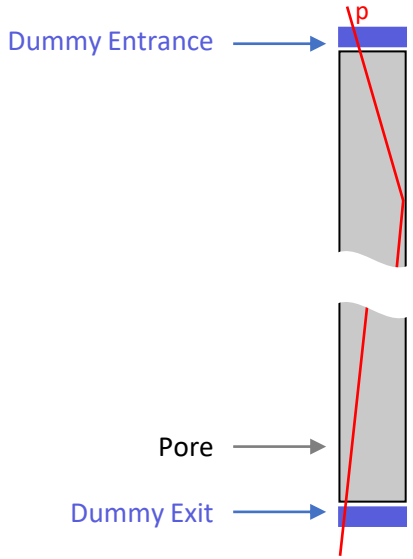
- Evaluate the impact of **low energy protons** scattering on the ATHENA mirror surface and focussing on the X-Ray detector for the evaluation of the induced residual background level
- **Planar source** of **100 keV protons** with a cosine-law distribution within a cone of +-1 deg on both Theta and Phi (polar angles from the axis of the detector).

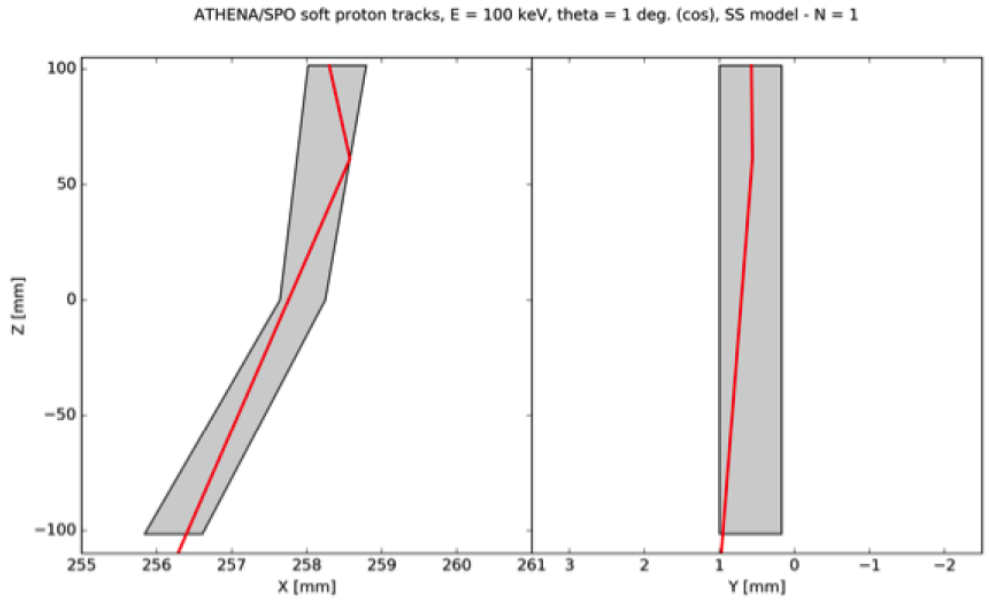
First example: **X-RAY Silicon Pore Optics**

OUTPUT

Use of the SS processes **reflections** to evaluate:

- the **number** of reflections inside the pore
- the **transmission efficiency**: the angular distribution of the exiting protons, normalized over the total entering particles.





From previous studies SS appears to be the best model so far to reproduce scattering at **grazing incidence** angle (detailed comparisons were carried on with G4 msc models and alternative models like Firsov and Remizovich).

First example: **X-RAY Silicon Pore Optics**

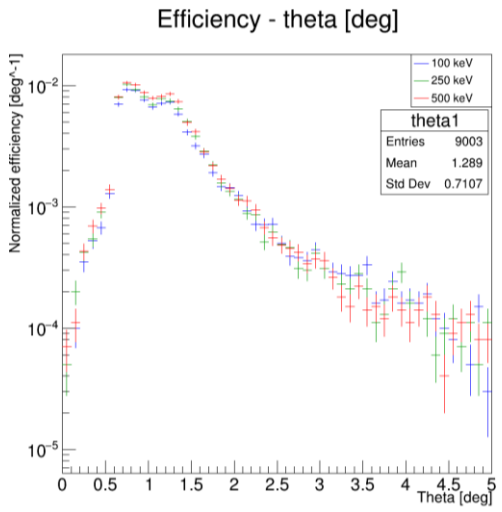
ANALYSIS

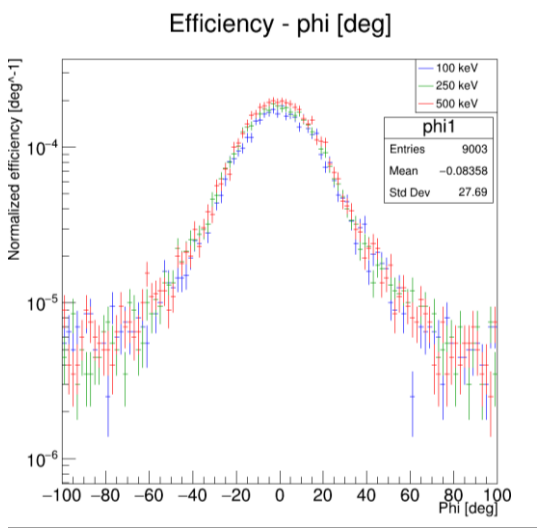
Output in **ROOT** format**,** data saved in **ntuples** containing**:**

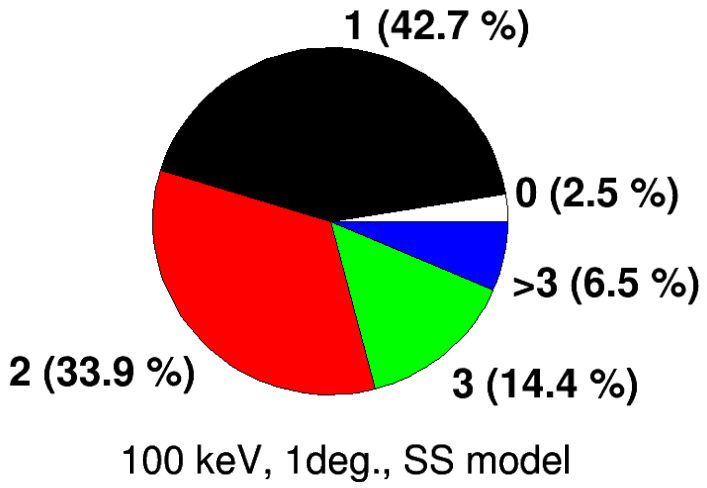
- **basic quantities:** event ID, volume name, track ID, coordinates (x,y,z), angles (theta, phi), process name, parent ID;
- number of **internal reflections** whenever the particle reaches the end of the pore.

XRAYoptics provides a C++ analysis macro example (analysis.C) to visualize data in the following representations:

- a histogram for the normalized efficiency for Theta and Phi;
- a pie chart for the number of reflections inside the pore.





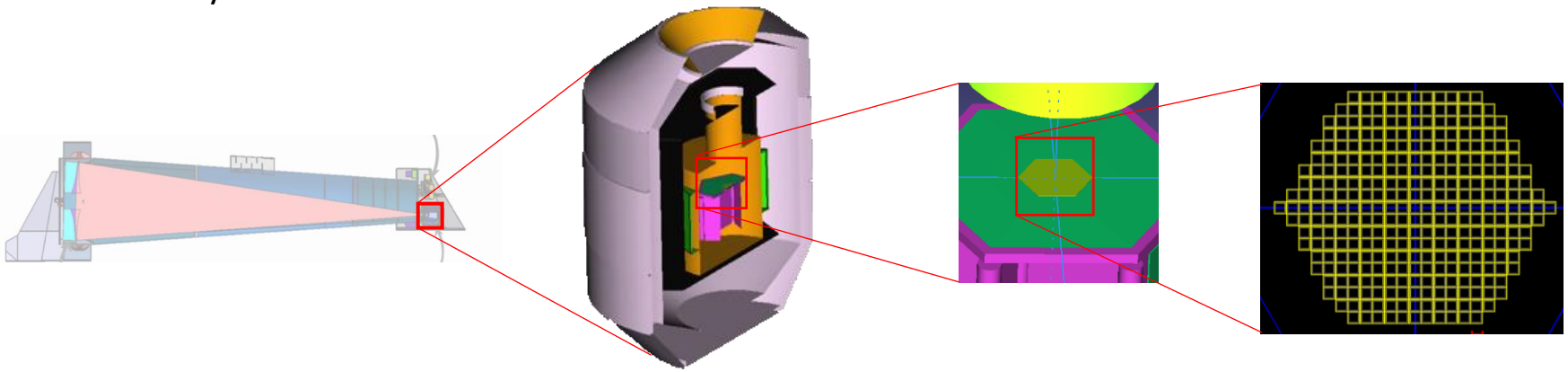


100 keV, 1deg., SS model

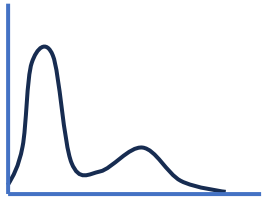
Second example: **X-RAY TES detector**

GEOMETRY

- Based on a simplified geometry derived from the **X-ray Integral Field Unit** (X-IFU), a Transition-edge sensor (TES) composed of 317 Bi-pixels.
- Geometrical model and the incident spectrum given by S.Lotti (INAF, Rome)
- Work focused on define a simplified but representative geometry and decrease simulation time
- Geometry in GDML



SOURCE



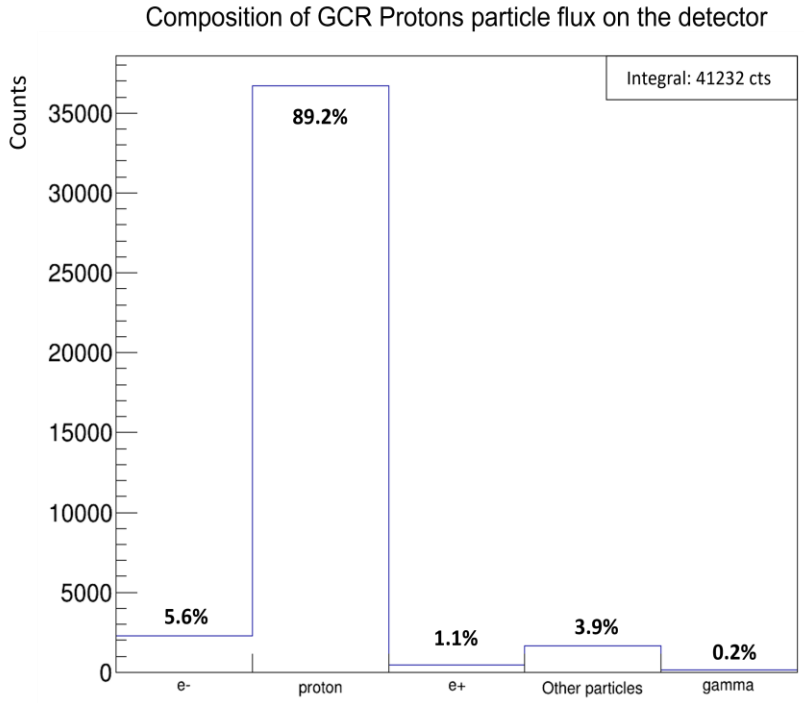
Galactic cosmic rays (GCR) high energy protons (10MeV - 100 GeV), generated isotropically on a 27cm-radius sphere right outside an Al sphere surrounding the geometry which represents the full satellite. Randomized direction toward the interior of the sphere.

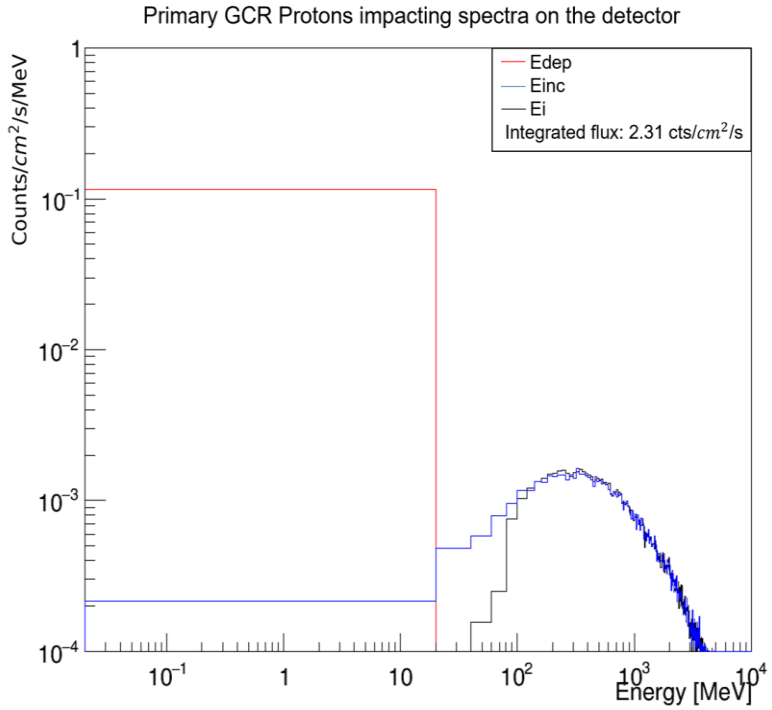
Second example: **X-RAY TES detector**

OUTPUT & ANALYSIS

Plots and histograms for data visualization and analyzing the spectra impacting on the detector.
Data is stored in **ROOT** files with ntuples containing **basic quantities** (e.g., event ID, volume name, process name) and **pixel number** (TES array).
A C++ **analysis macro** is included to plot:

- Energy deposit on the detector;
- Count per pixel;
- Spectra for primary GCR protons and for all particles





Release

11.1.2

underground_physics	Import Geant4 11.2.0.beta source tree
xray_SiliconPoreOptics	Import Geant4 11.2.0.beta source tree
xray_TESdetector	Import Geant4 11.2.0.beta source tree
xray_fluorescence	Import Geant4 11.2.0.beta source tree

Included in the Geant4

11.2beta release (June)

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Thank you!

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