

Gamma-ray performance of the GAMMA-400 detector

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GAMMA-400 is a new space mission, designed as a dual experiment, capable to study both high energy gamma-rays (from ~100 MeV to few TeV) and cosmic-rays (electrons up to 20 TeV and nuclei up to ~ 10^{15} - 10^{16} eV). The full simulation framework of GAMMA-400 is based on the Geant4 toolkit. The details of the gamma-ray reconstruction pipeline in the three main instruments (Tracker, Preshower and Calorimeter) as well as the trigger simulation are outlined. The performance of GAMMA-400 (PSF, effective area and energy resolution) have been obtained using this framework. The most updated results on them are shown.

Reconstruction:

Overall Reconstruction

Requirements: 3 consecutive planes hit in each view

Low energy (< 10 GeV):

- Information only from the tracker
- Kalman filter
- Energy estimation from the multiple scattering
- One track per particle reconstructed in each view, combined in a 3d view

High energy (>10 GeV):

- Combination of information from the tracker, CC1 and CC2
- Use of the reconstruction in the CC1 and CC2 to estimate the energy and suppress the signal from backslash
- Fit using the points in the tracker and in the CC1

CC1 Only Reconstruction

Requirements: hit on both planes

- Weighted median on each plane to find the barycenter
- Fit using the found points
- Exclusion of the points outside a cylinder around the found direction
- Iteration reducing the cylinder radius

CC2 Only Reconstruction

Requirements: 3 planes hit

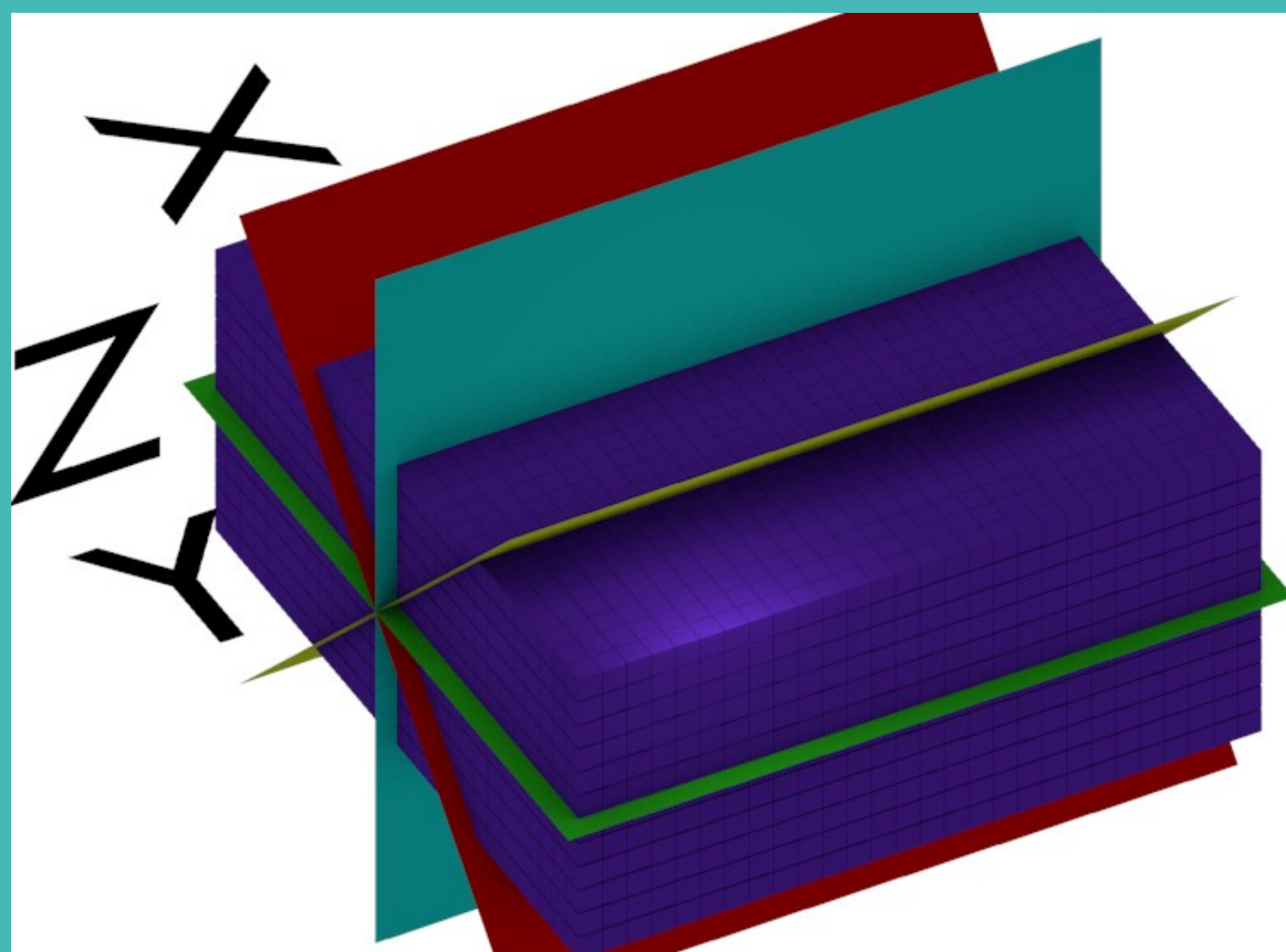
Reconstruction of the direction of particles coming also from the side of the detector.

Need to define the inclination of the planes:

- Fit using the 3 cubes with the highest energy release
- Definition of planes as perpendicular to the found direction with $\pi/4$ steps

Once the plane are found:

- Weighted average to find the barycenter on each plane
- Fit using the found points
- Exclusion of the points outside a cylinder around the found direction
- Iteration reducing the cylinder radius



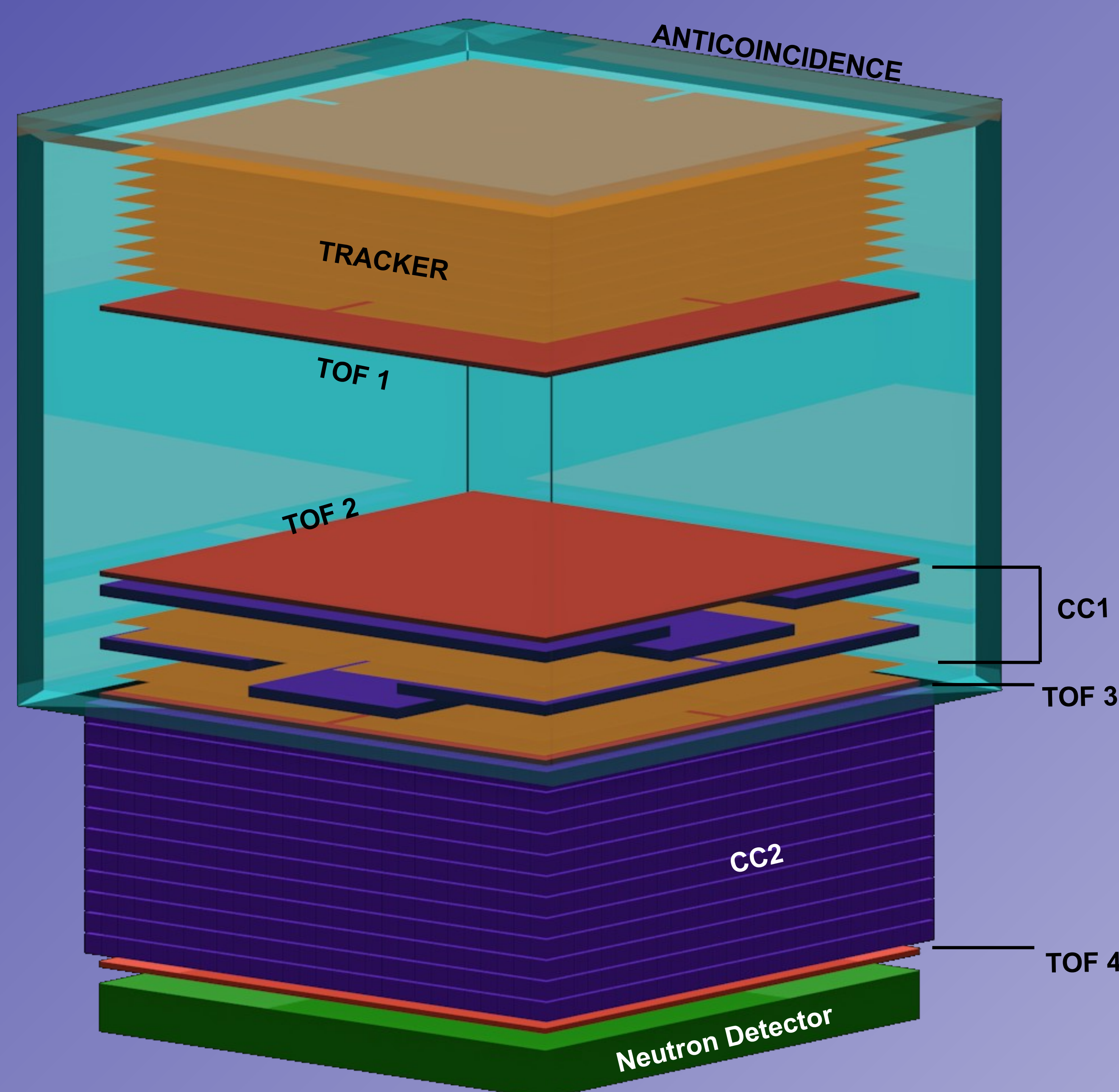
Some of the possible inclination of the planes used in the fit for the CC2 only reconstruction

PERFORMANCE PRELIMINARY

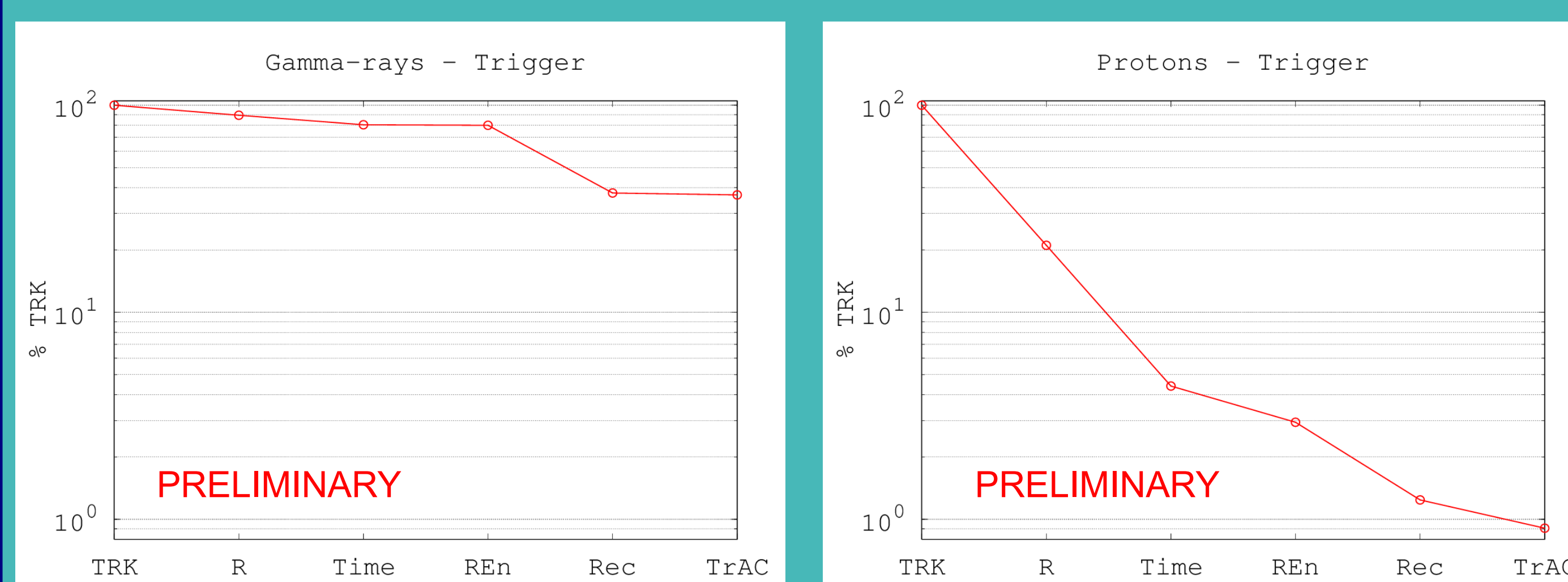
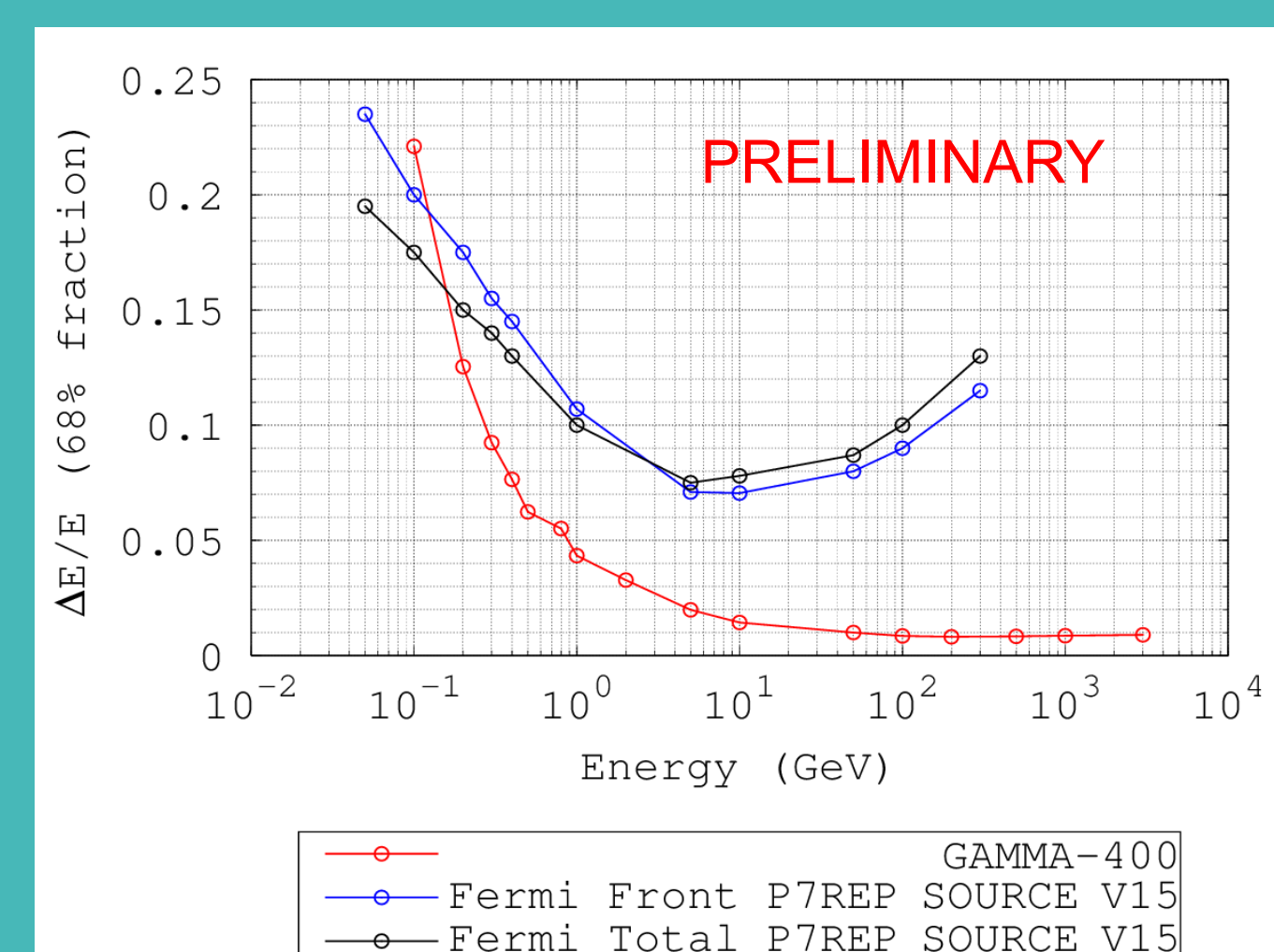
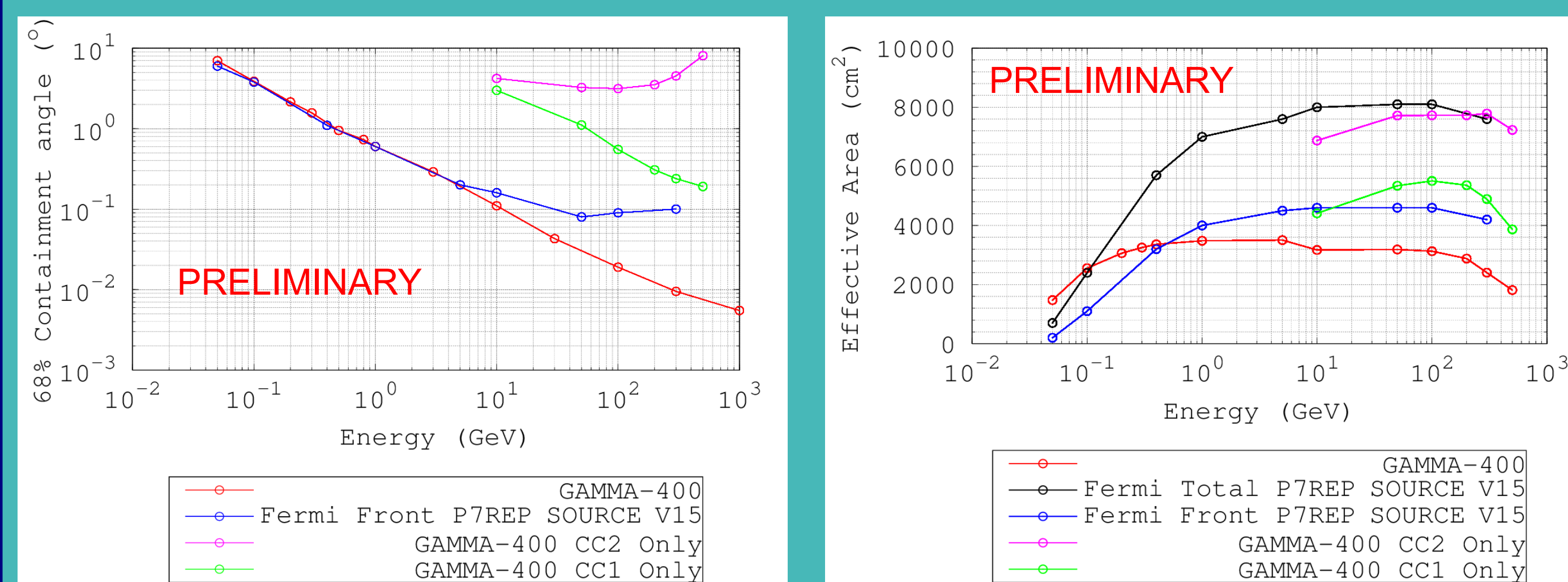
Energy range	100 MeV – 3 TeV
Angular resolution (E>100 GeV)	~ 0.01°
Energy resolution (E>100 GeV)	1%

Framework:

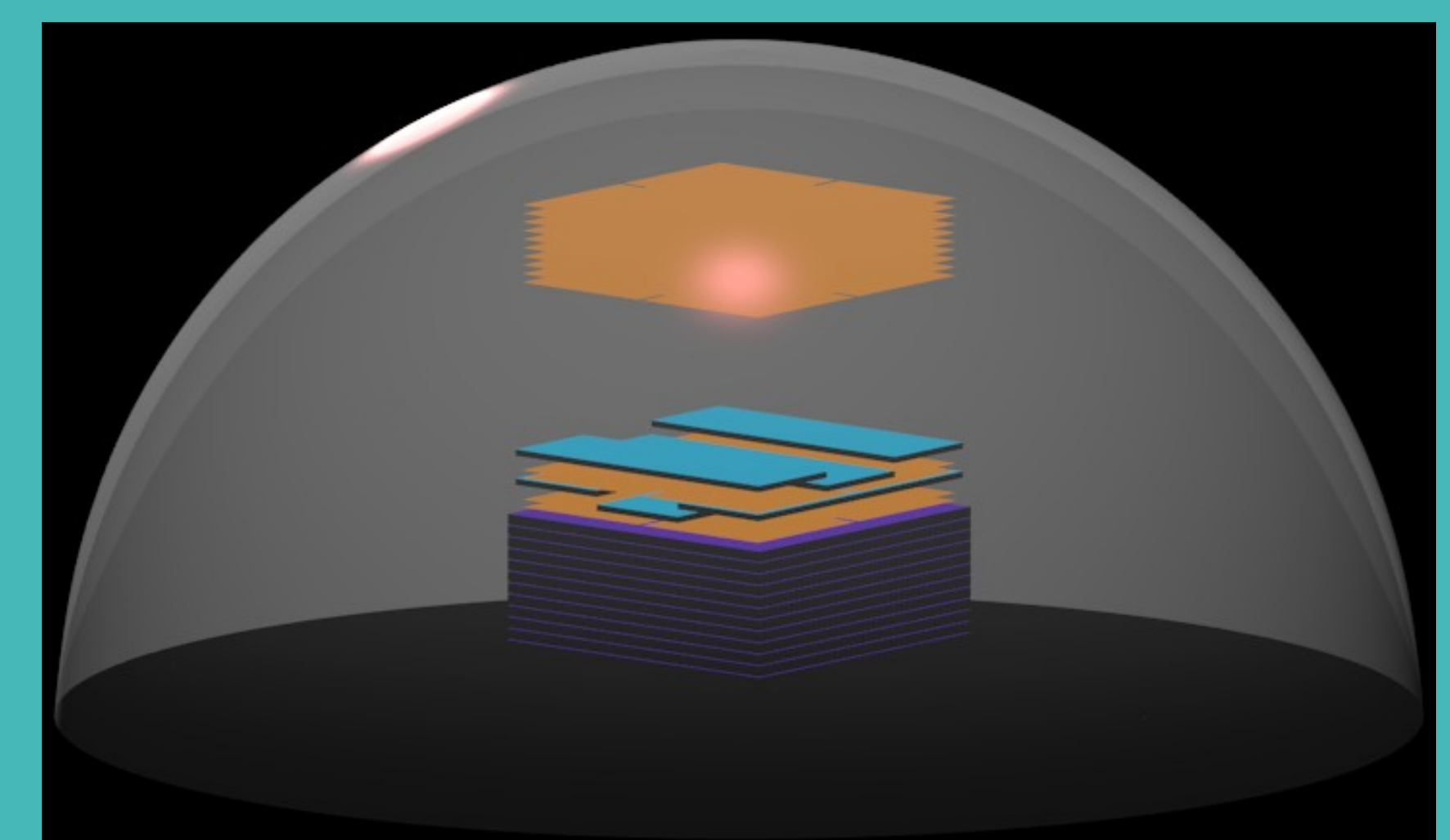
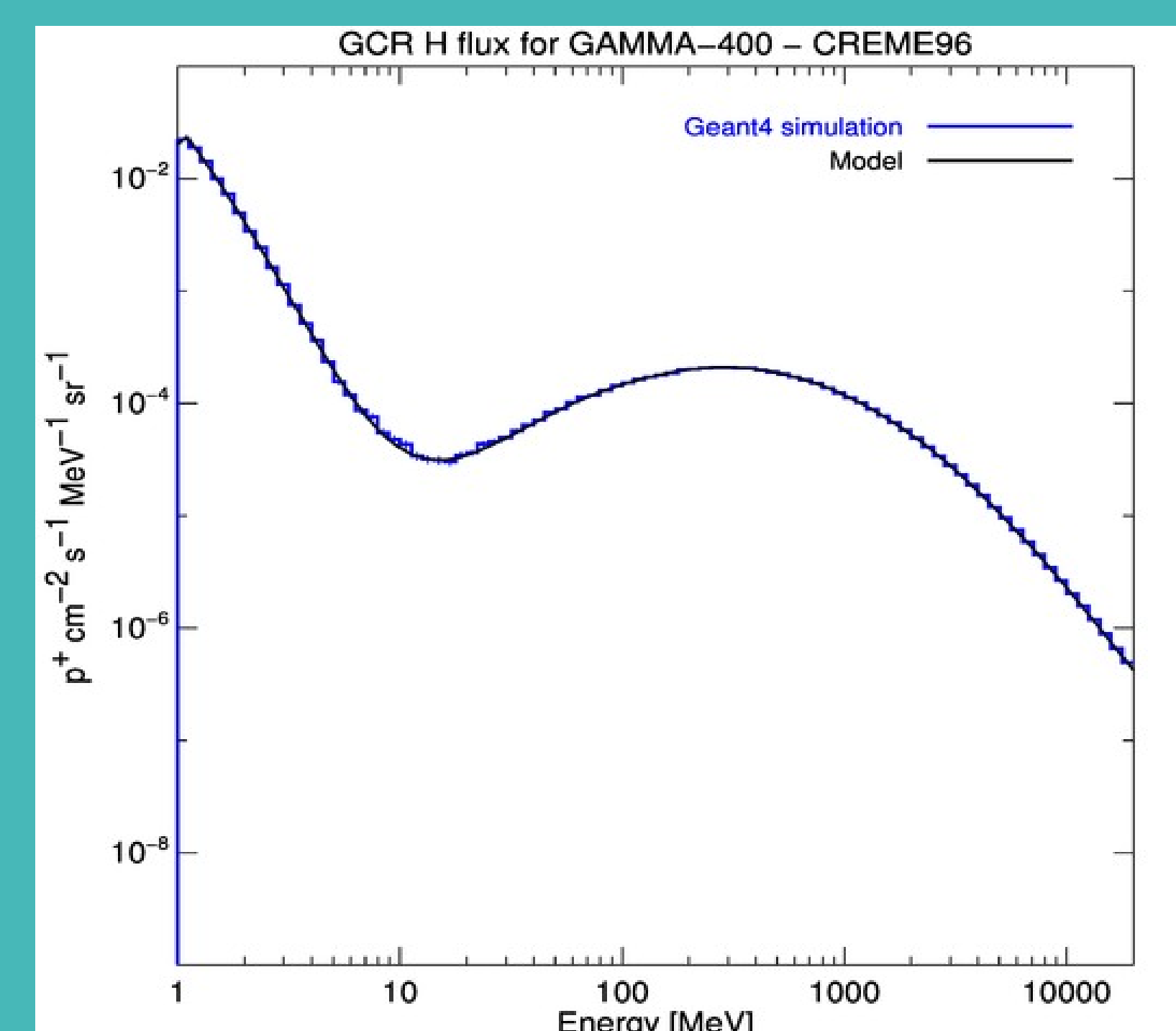
- Based on the Geant4 toolkit (Geant4 9.6 patch 03)
- Contain tools to:
 - Create the geometry
 - Simulate particle interaction
 - Digitize the output of the simulation
 - Analyze the results (reconstruction and trigger)



Results:



Trigger for gamma-ray observation using the tracker:



Spectrum (up) and source distribution (down) used in the simulation of the background. The starting points of all the protons are uniformly distributed on the glass-like hemisphere centered at the bottom of the instrument and encompassing it all. All the particles are directed inside the hemisphere with random theta and phi.

Conditions:

On board:

- TRK: 3 consecutive planes hit in each view
- $R = N_{\text{clusters}} / N_{\text{firedviews}} > 1.1$
- Time: use timing information from TOF and AC to reject charged particles coming from the outside and upgoing particles
- $\text{Ren} = N_{\text{clusters}} (E > 3 \text{ MIP}) / N_{\text{clusters}} < 0.6$

On the ground:

- Rec: direction reconstruction
- TrAC: Check if the fired ACT tile lies along the reconstructed track

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Events that passes the trigger on-board (% over the total that passes the TRK condition)	2.9 %	80.1 %
Events that passes the trigger on the ground (% over the total that passes the TRK condition)	0.9 %	37 %