September 2018

Detector Simulation Working Group (DeSi-WG)

EEE telescope simulation

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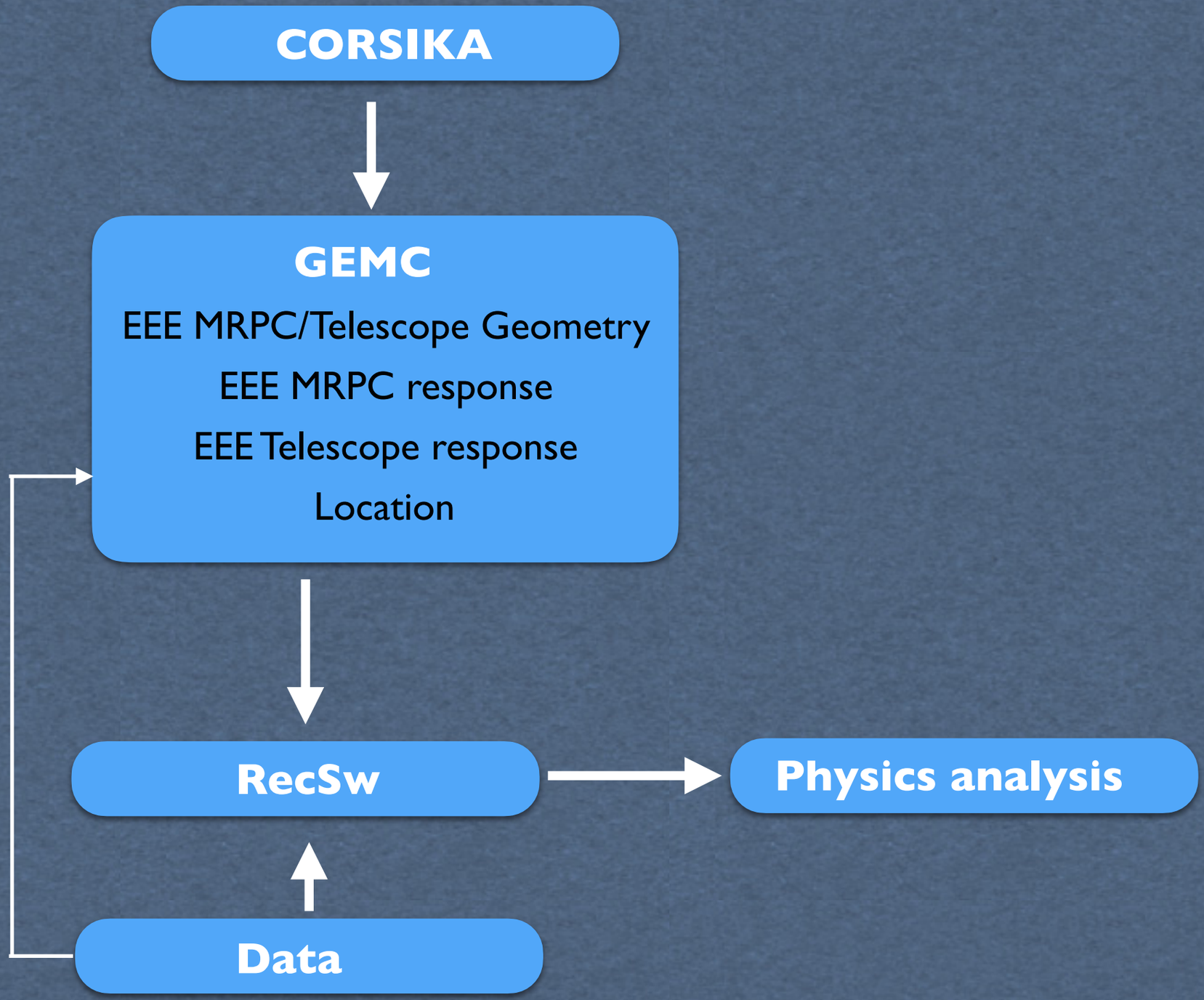
DEtector**SI**mulation**-WG**

Goal: generate pseudo data using GEANT4 to track CORSIKA generated particle



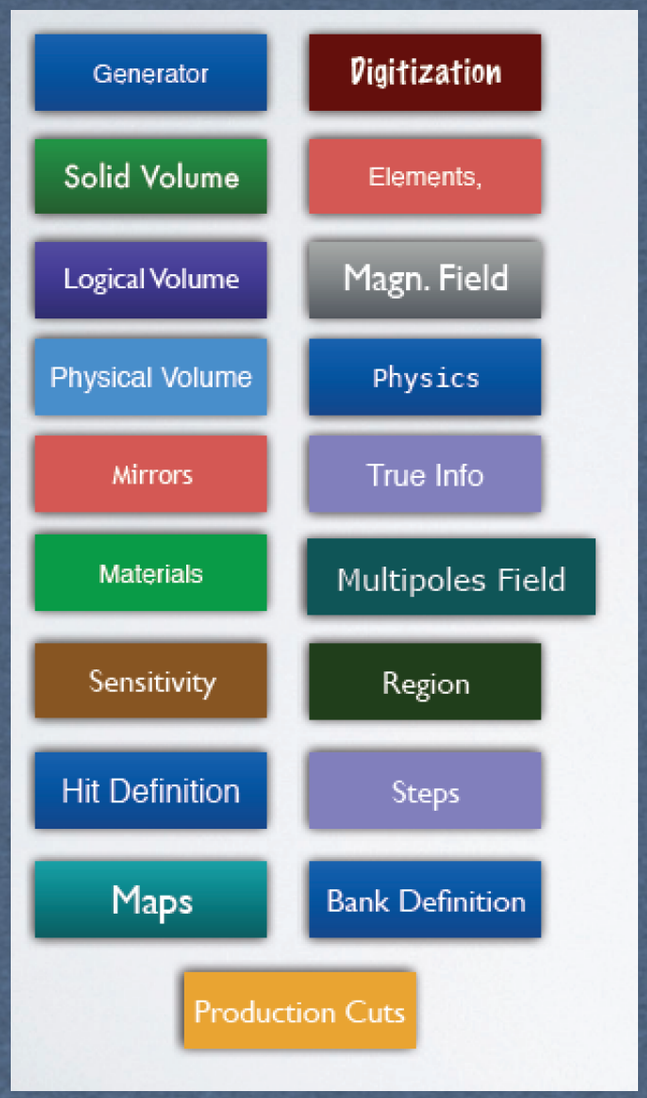
DeSi-WG: targets and work plan

✳ **EEE MRPC response to cosmic rays implementation in GEANT4**

- MRPC geometry: material, size, …
- MRPC response (parametrized)
- Telescope response: geometry, trigger, …
- Telescope location: effect of roof, walls, surrounding materials, …
- Telescope: muon rates for different multiplicities
- Multi-telescopes: coincidence rates
- Single/multiple telescope(s) studies: bottom-up muons, …

GEant4 Monte Carlo: GEMC

M.Ungaro

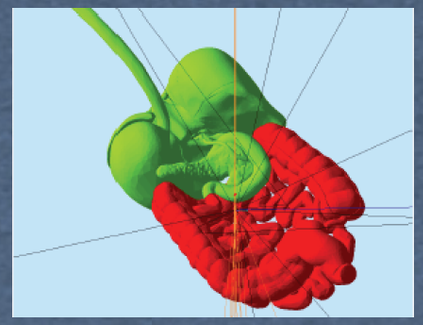


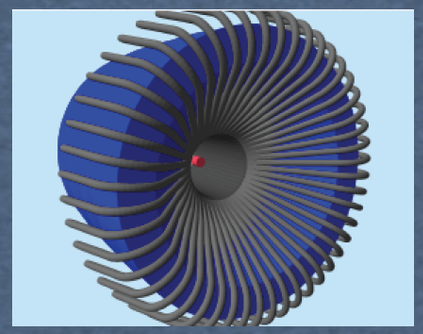
Realistic detector simulation

GEMC

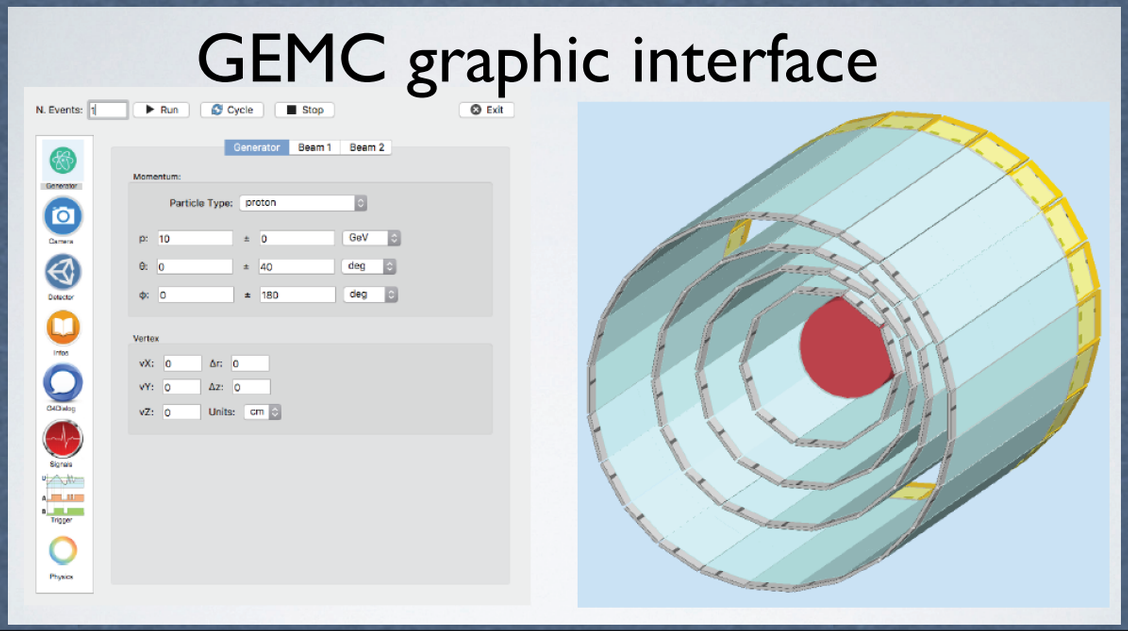
A GEANT4 librarys based simulation tools

- components description
- components interaction
- user-defined geometry and hit
- internal generator (included cosmic rays)
- multiple input/output format
- CAD geometry accepted
- interactive/batch mode
- source on GitHub





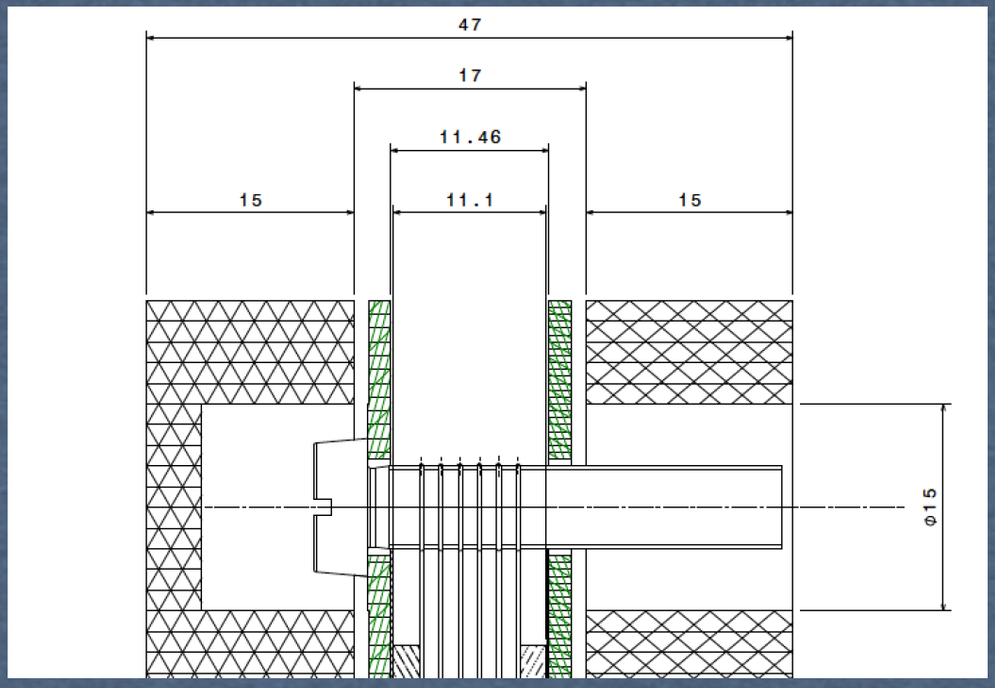
GEMC graphic interface

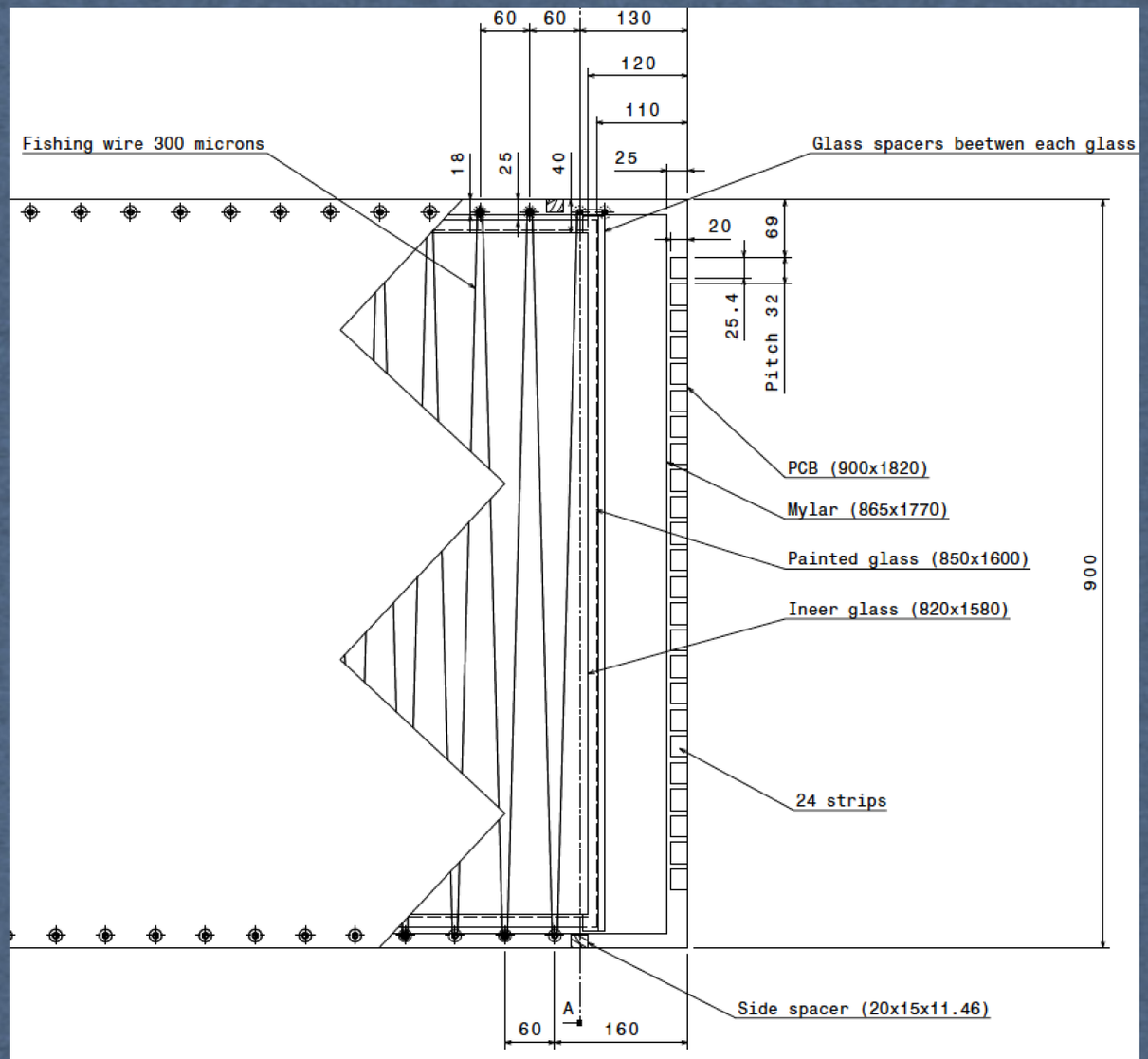


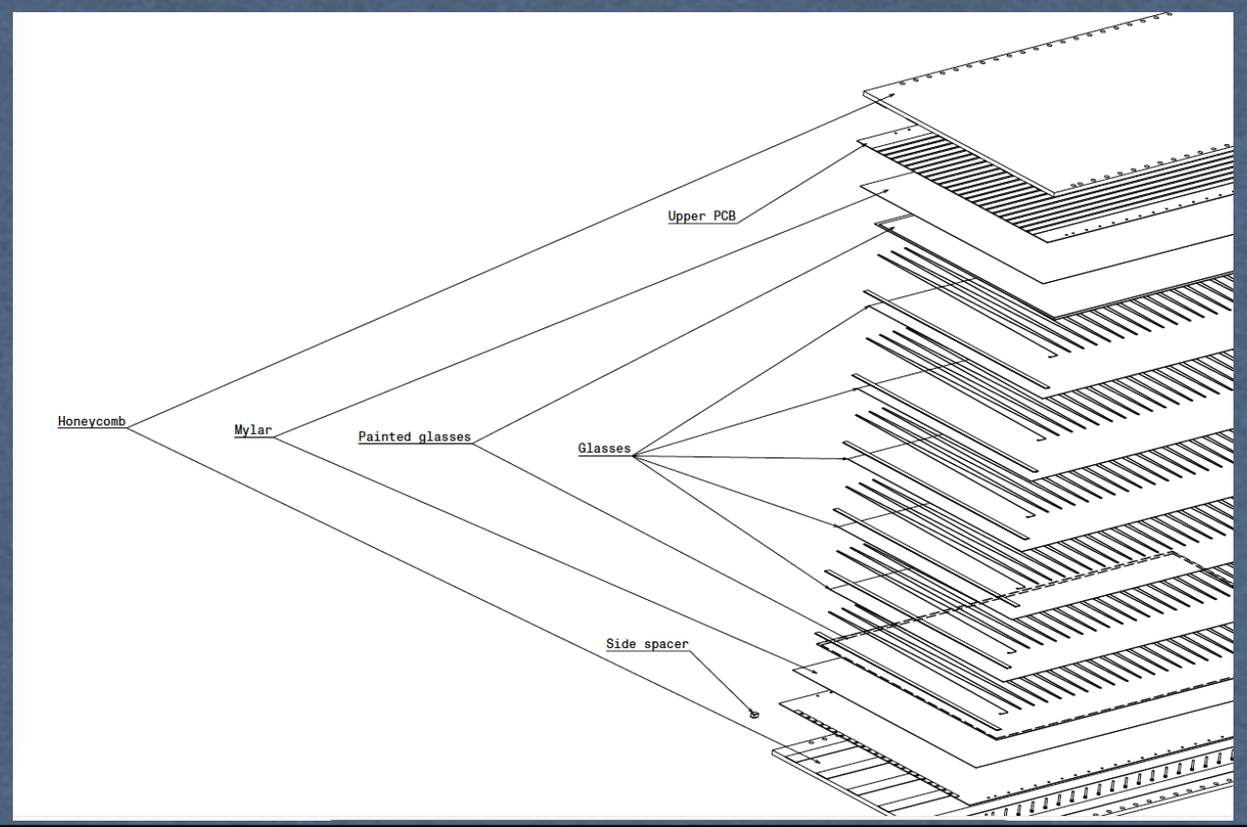
Installed (and now working!) in EEE cluster at CNAF!

EEE-MRPC simulation: geometry

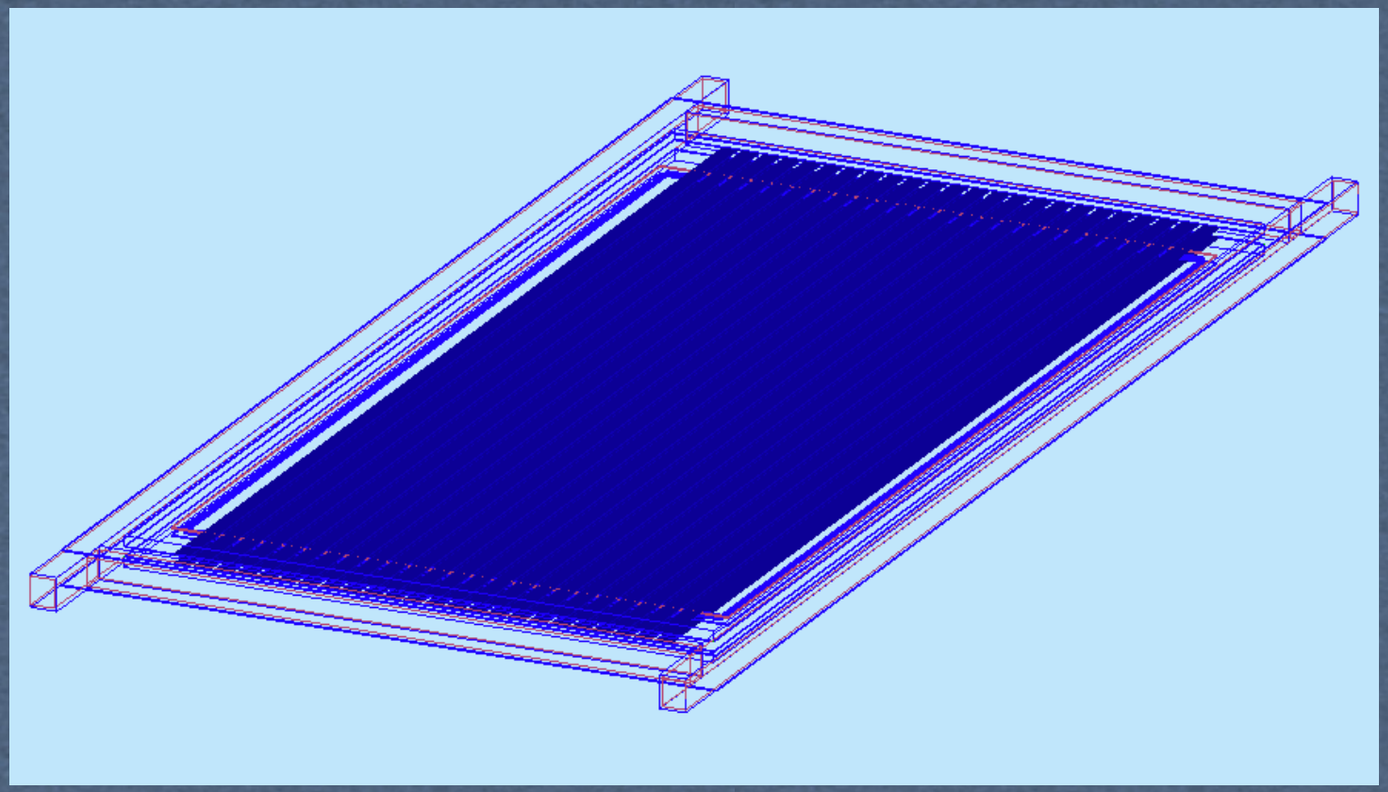
- Detailed drawings provided by R.Zuyeuski
- Geometry/materials verified during assembly of Genova telescope at CERN (March 2017)



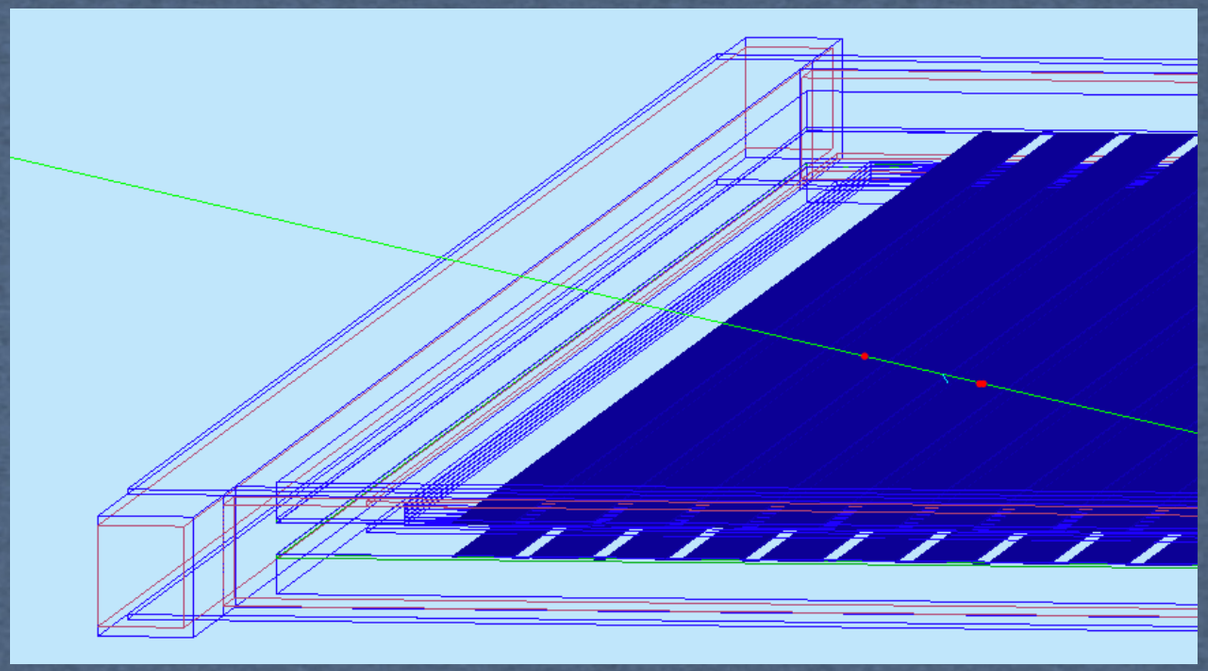


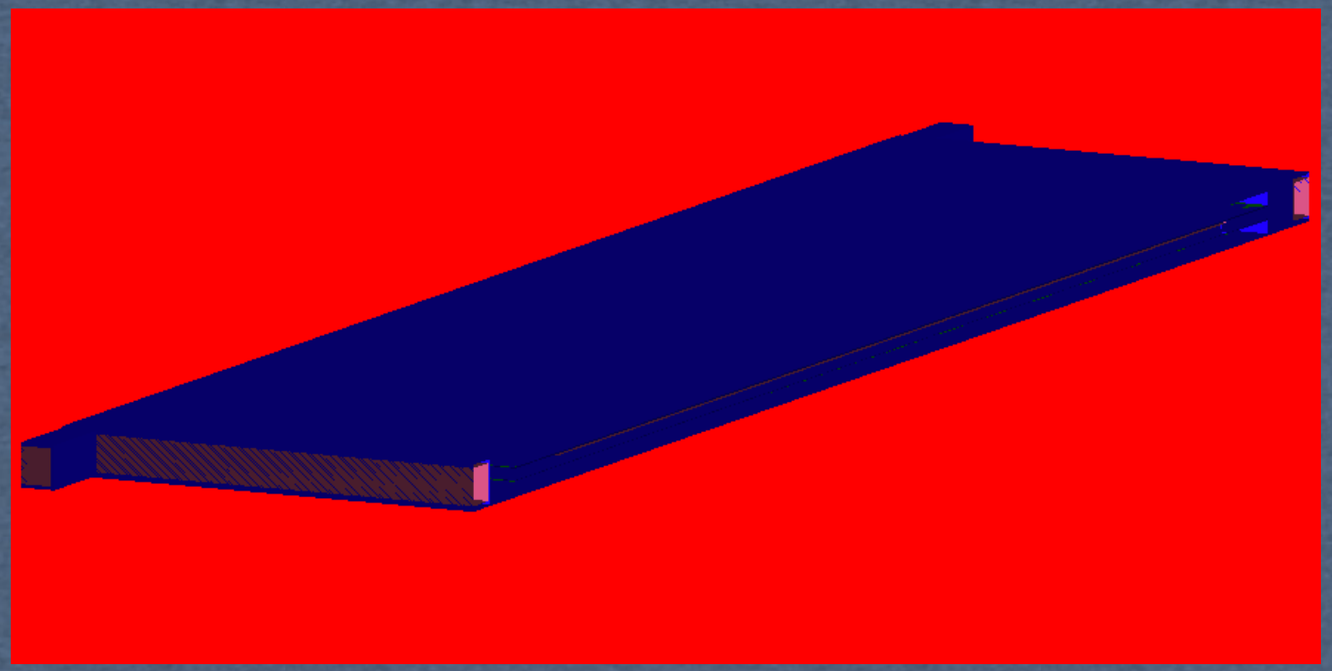


EEE-MRPC simulation: geometry



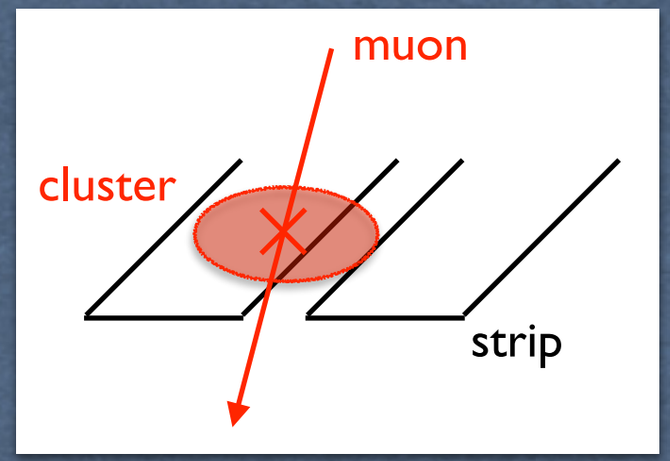
- ✳ Realistic geometry implemented in GEMC
  - materials (Al, Vetronite-G10, Cu, glass, Al-honeycomb, Gas
  - geometry
  - active layers (so far only bottom strips + gaps)





EEE-MRPC simulation: response

- No avalanche simulated in details
- Effective hit process:
  - Sample XY (and Z) muon hit on on bottom strip plane
  - Assume both strips and gaps are active
  - Apply a spread of σ=8.4mm (2σ) to account for multiple hits and spread position resolution both in X and Y
  - Apply a time spread (constant) σ=94ps



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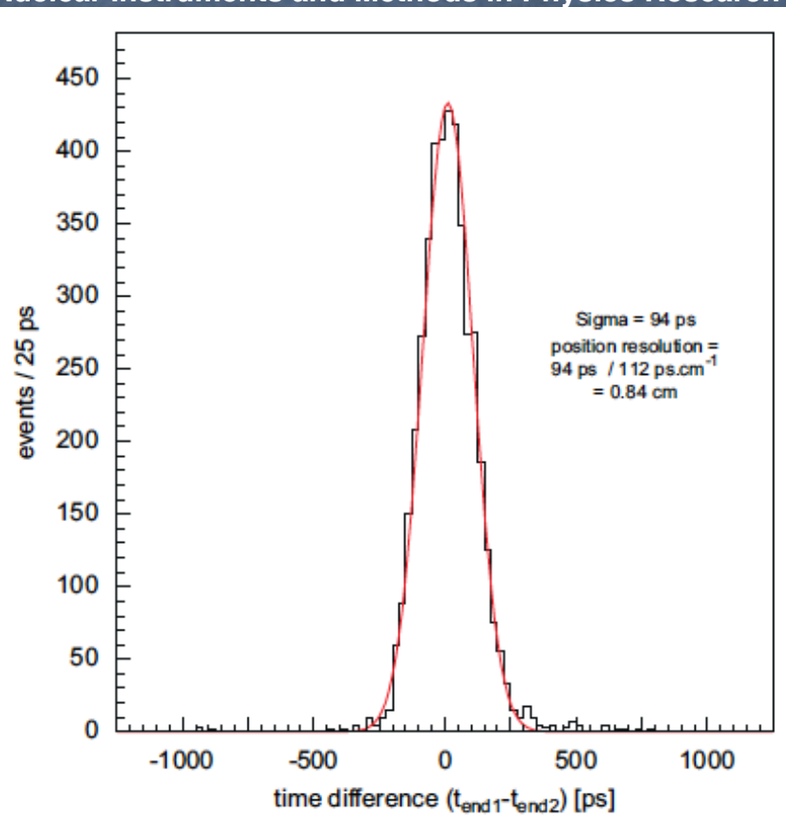
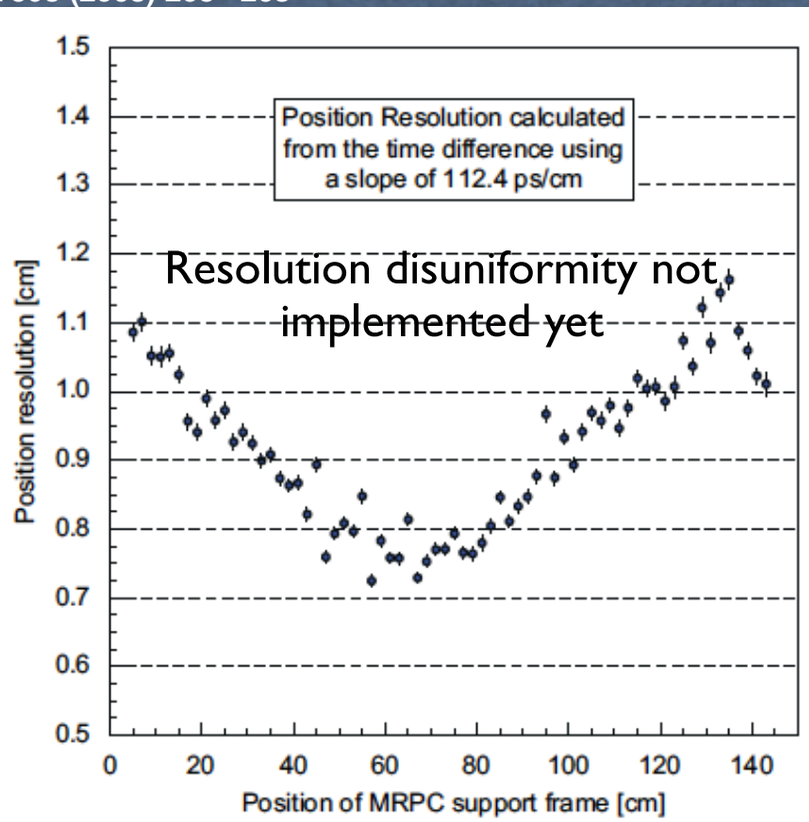
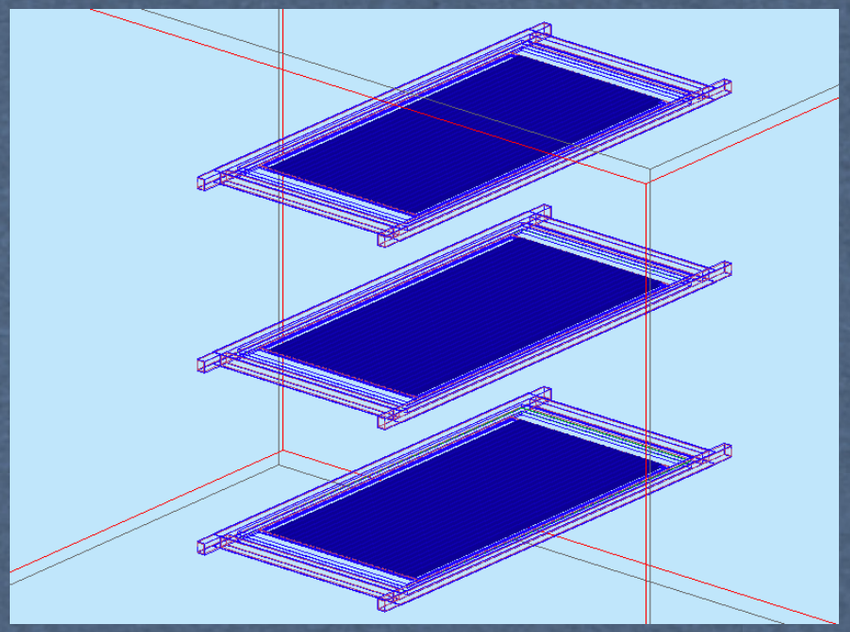




- MRPC parameters
  - 90x160 active area
  - Active: 2.5cm x 24 strips + 0.7cm x (24-1) gaps
  - Time spread: σ = 94ps
  - Cluster size: σ_X = 8.4 mm
  - Cluster size: σ_Y = 8.4 mm
  - HIT_{XY} is gaussian-spread and projected on the sensitive area to derive strip multiplicity

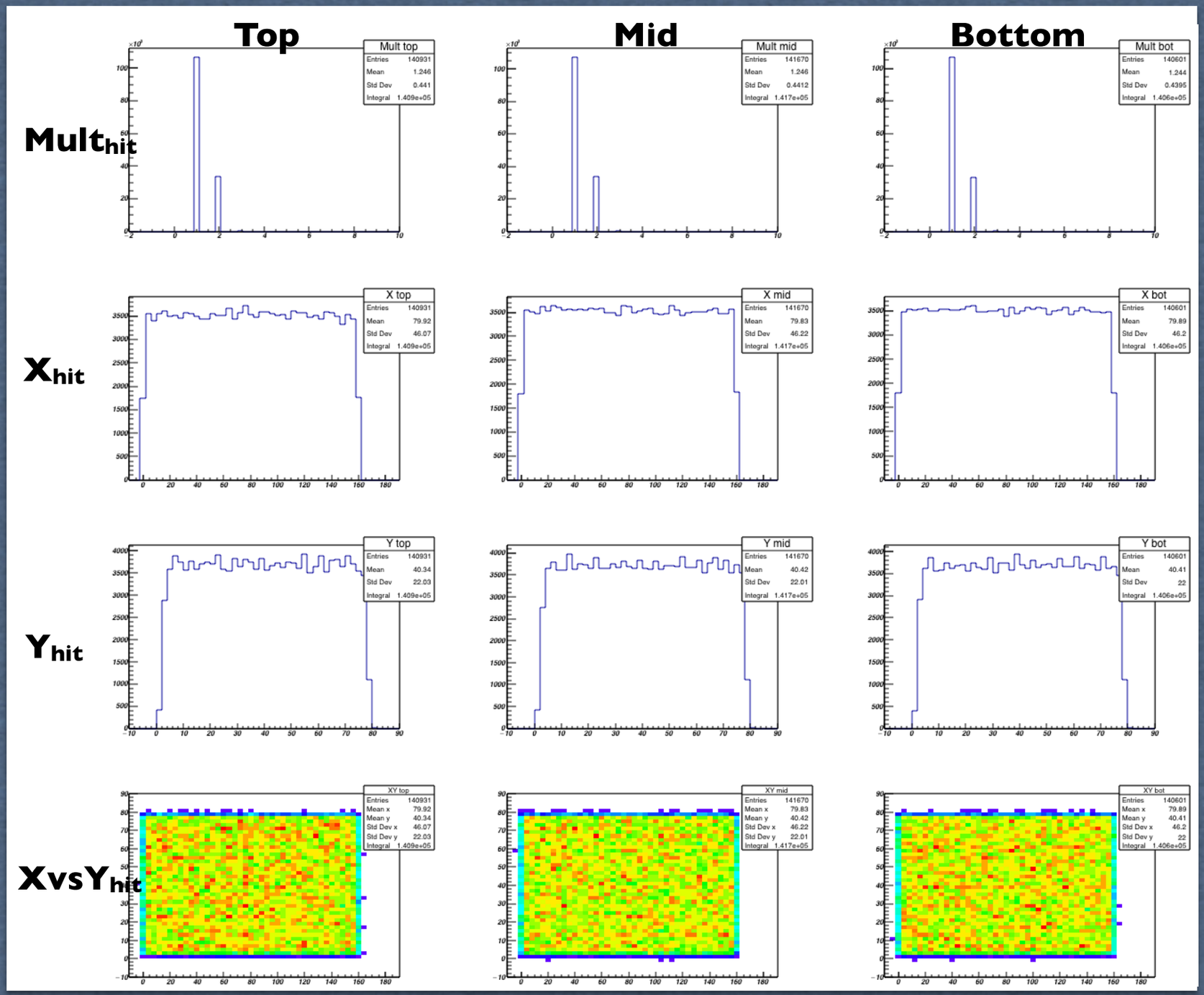
EEE-Telescope simulation: geometry



✳Telescope Parameters

- 3 chambers
- -50/0/+50 cm apart
- placed in a concrete box wall on all sides (30cm concrete)

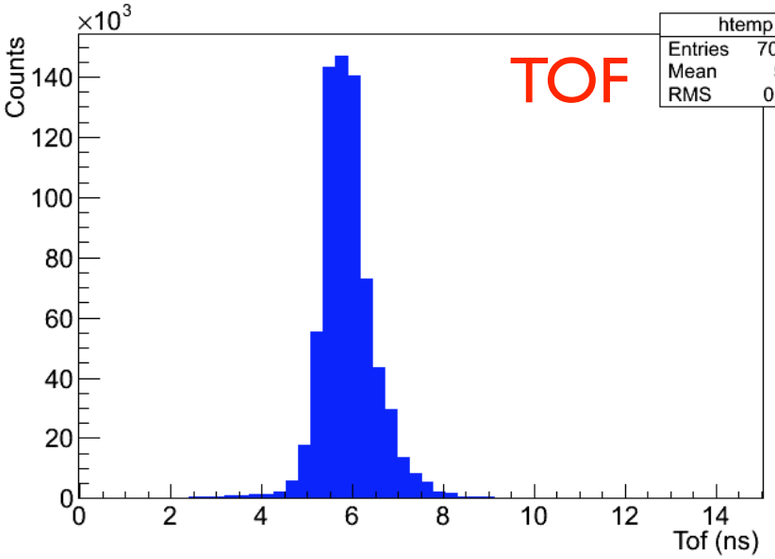
✳Individual response to cosmic muons (2-10 GeV) of the three chambers

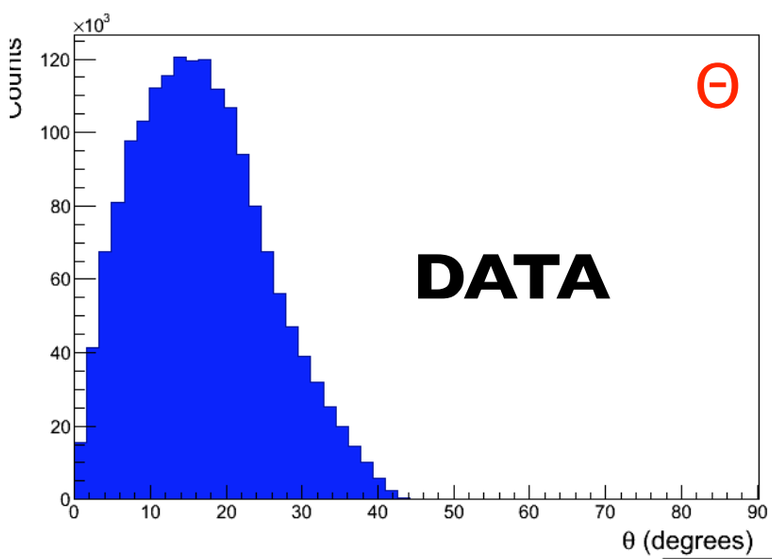


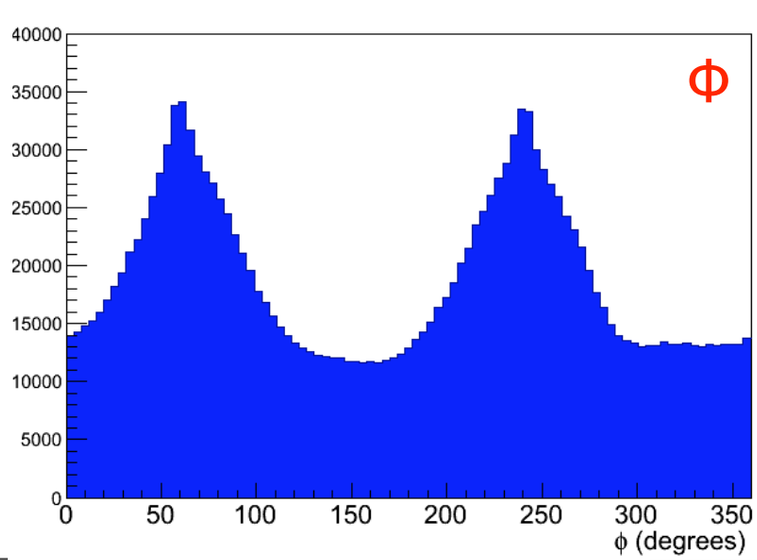
EEE-Telescope simulation: response

✳Comparison to data

EEE Report: *Description of the event reconstruction procedures for the EEE telescopes*

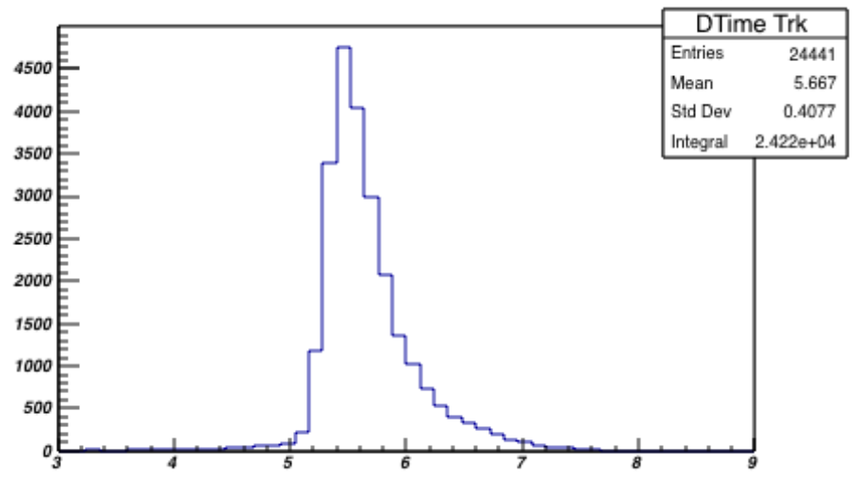


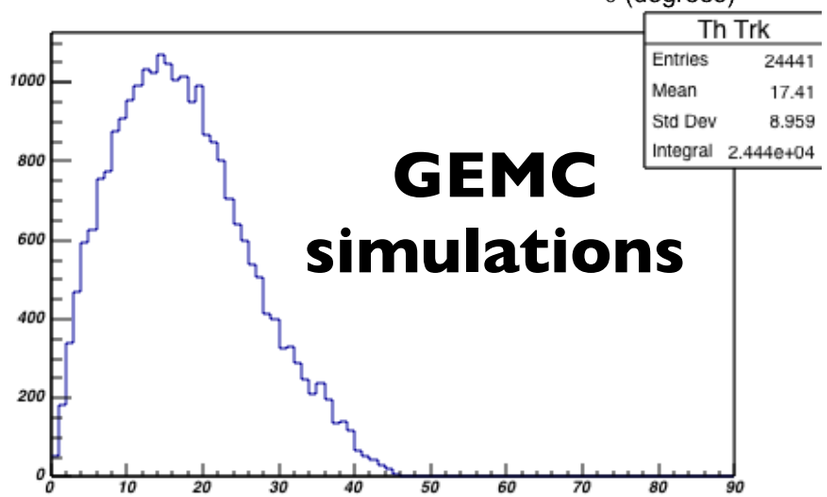


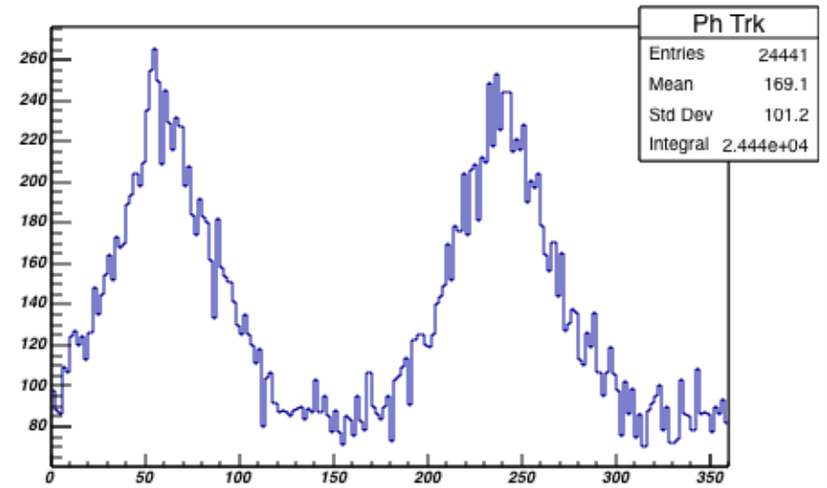


DATA

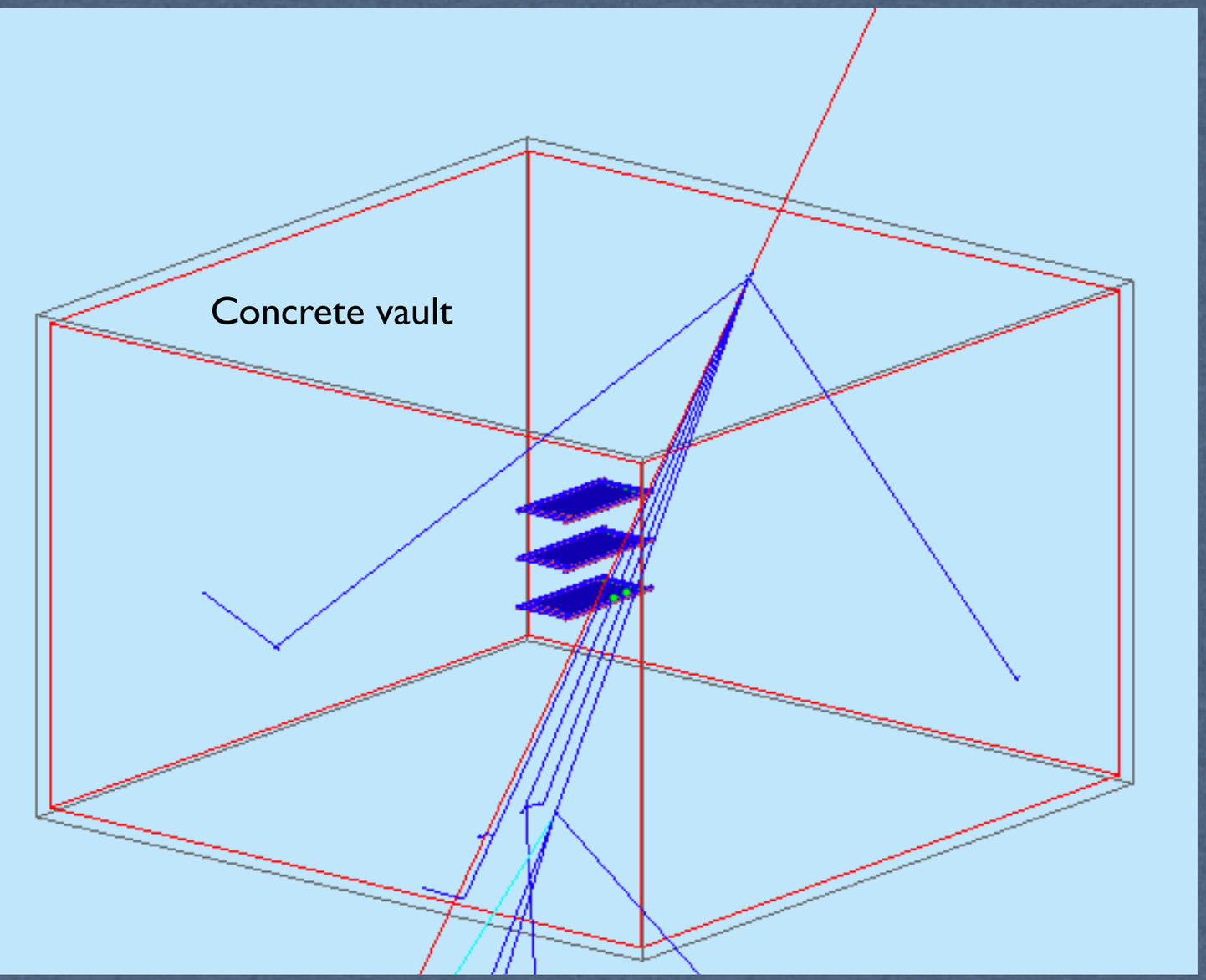
GEMC simulations



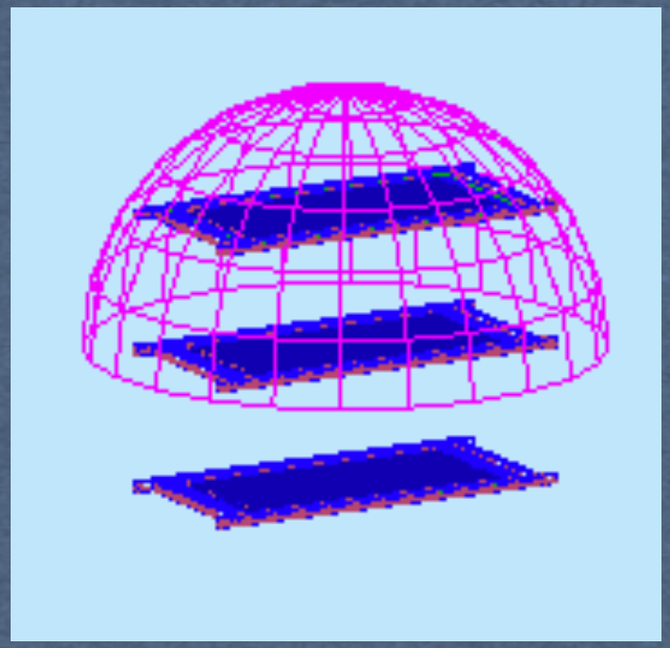


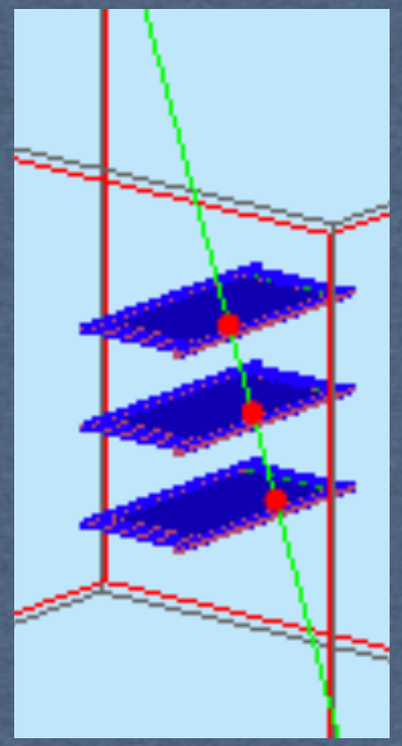


EEE-Telescope simulation: response to cosmic



- Muons gnerated on a sphere but with an uniform distribution on the plane
- Absolute rate calculation





Energy	fraction of the spectrum (%)	Rate 1248.8Hz * Rec/Gen	Rate -50cm/0/+50cm
0.2 - 2 GeV	44.5	60.1Hz	26.8Hz
2- 10 GeV	41	53.5Hz	22.0Hz
10- 100 GeV	14.2	38.7Hz	5.5Hz
100 - 500 GeV	0.3		
Tot	**100**		**54.3Hz**

- Current EEE-telescope geometry: -50/0/+50 cm apart
- Rates are obtained summing up muons generated in different energy intervals
- Values should be compared to Rate measured in a single-layer-roof EEE telescope

Summary and future plans

- EEE MRPC response implemented in GEANT4
- EEE data reconstruction program modified to process pseudo-data
- Simulations matches data angular and time distribution
- Absolute rates of single muon hits on the telescope (3 chambers) are comparable
- Fine-tuning of the simulations parameter (cluster size, time resolution, …) in progress
- Next steps:
  - use of CORSIKA to generate and propagate multi-muon hits (primary hadron in high atmosphere + shower propagation to the sea-level)
  - Sim/data for multi-telescopes correlation comparison