EEE analysis meeting
Friday, July 14 2017
Centro Fermi - Roma

Detector Simulation Working Group (DeSi-WG)
Activity report

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DeSi-WG: targets and work plan

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

- MRPC geometry: material, size, …
- MRPC response (parametrized)

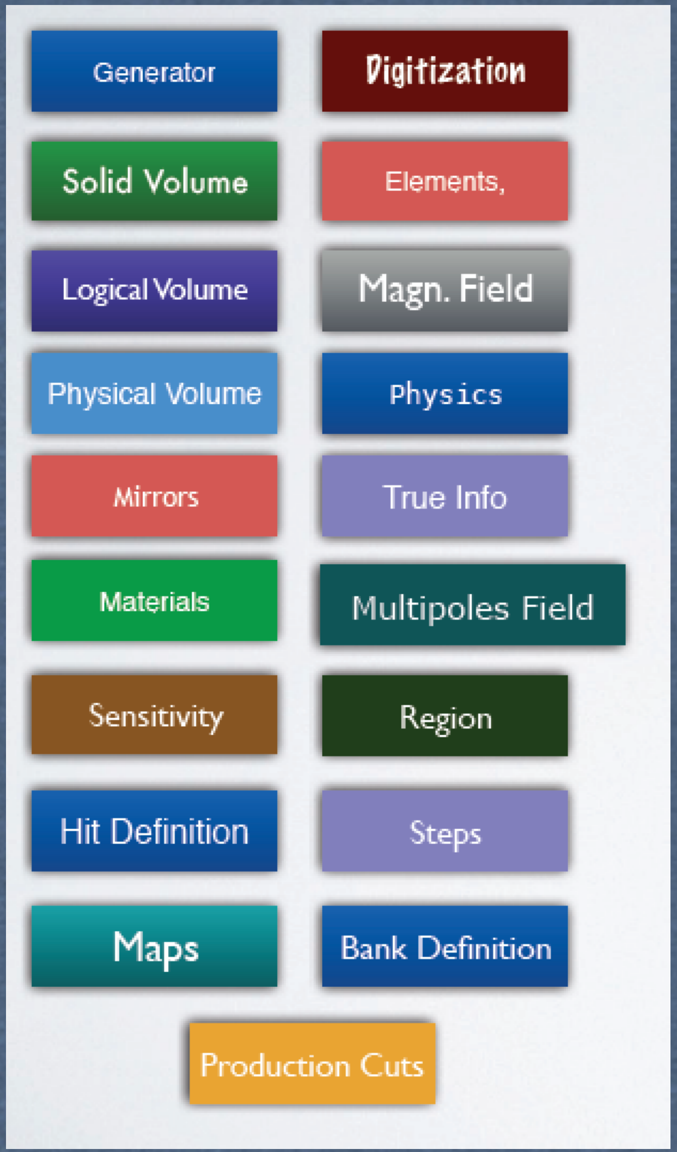
- Telescope response: geometry, trigger, …
- Telescope location: effect of roof, walls, surrounding materials, …
- Telescope: muon rates for different multiplicities

- Multi-telescopes: coincidence rates

- Single/multiple telescope(s) studies: bottom-up muons, …

GEant4 Monte Carlo: GEMC

M.Ungaro

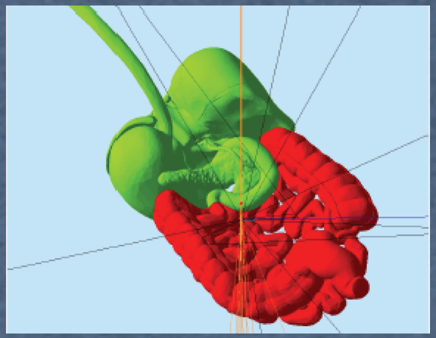


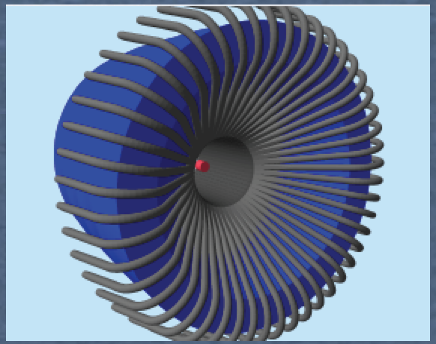
Realistic detector simulation

GEMC

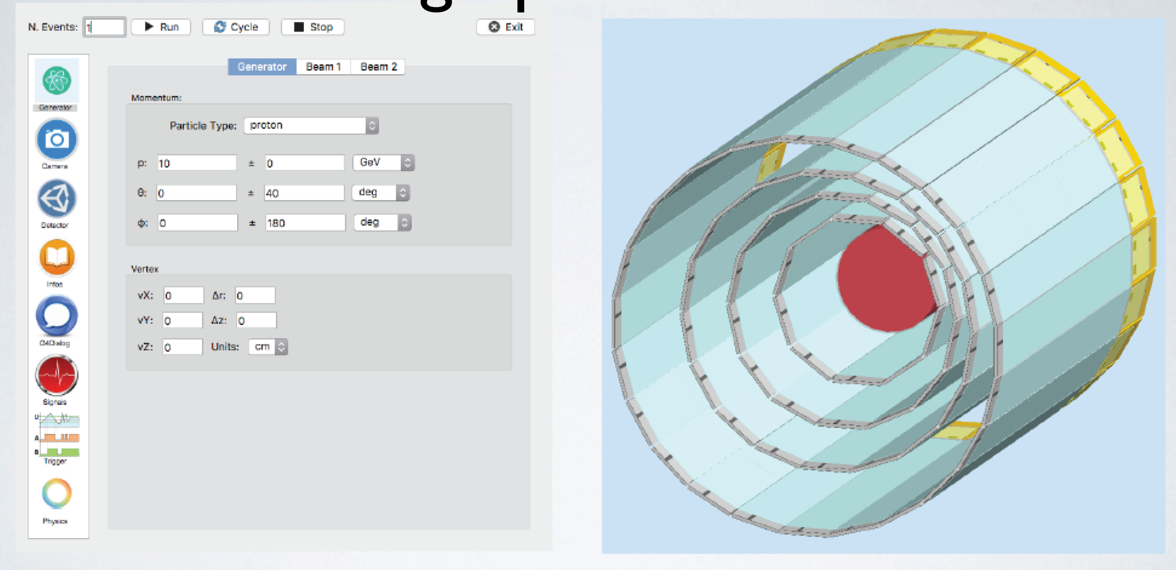
A GEANT4 librarys based simulation tools

- 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





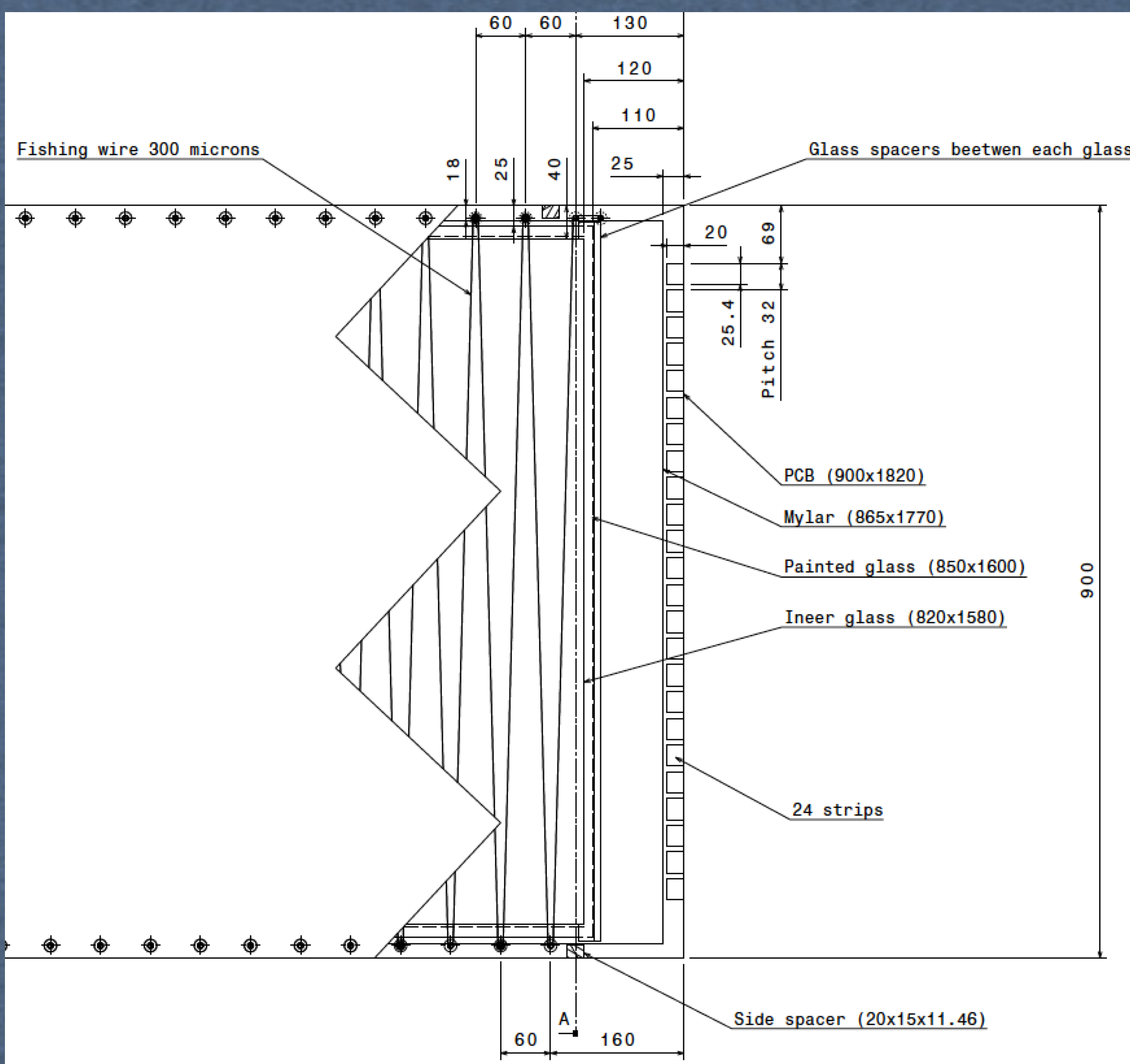
GEMC graphic interface

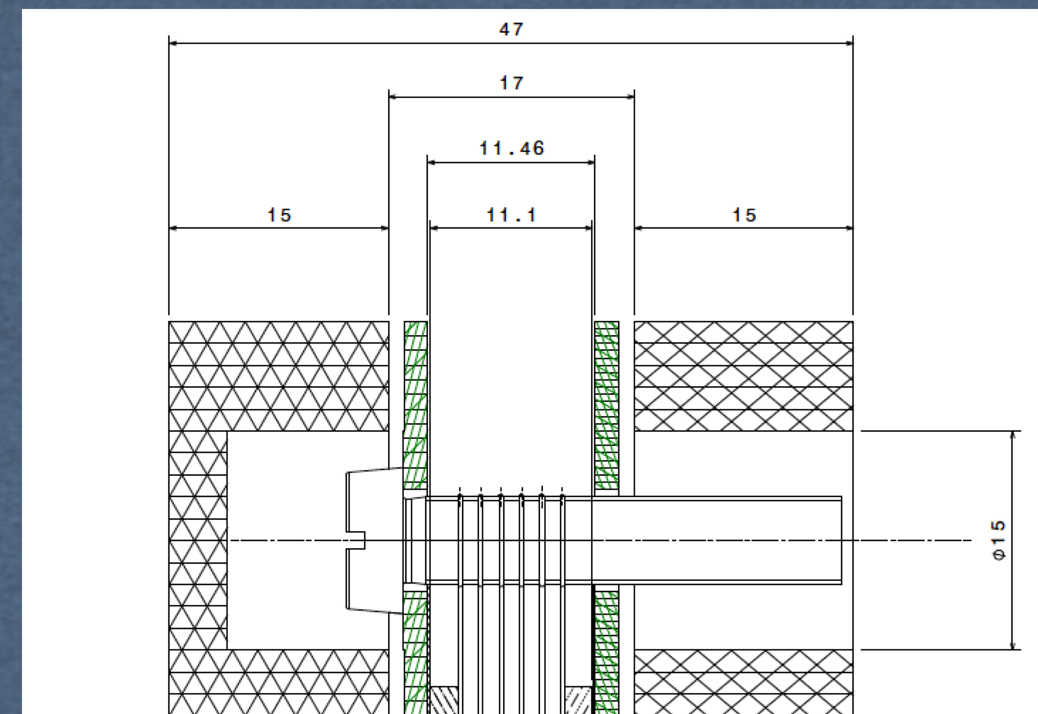


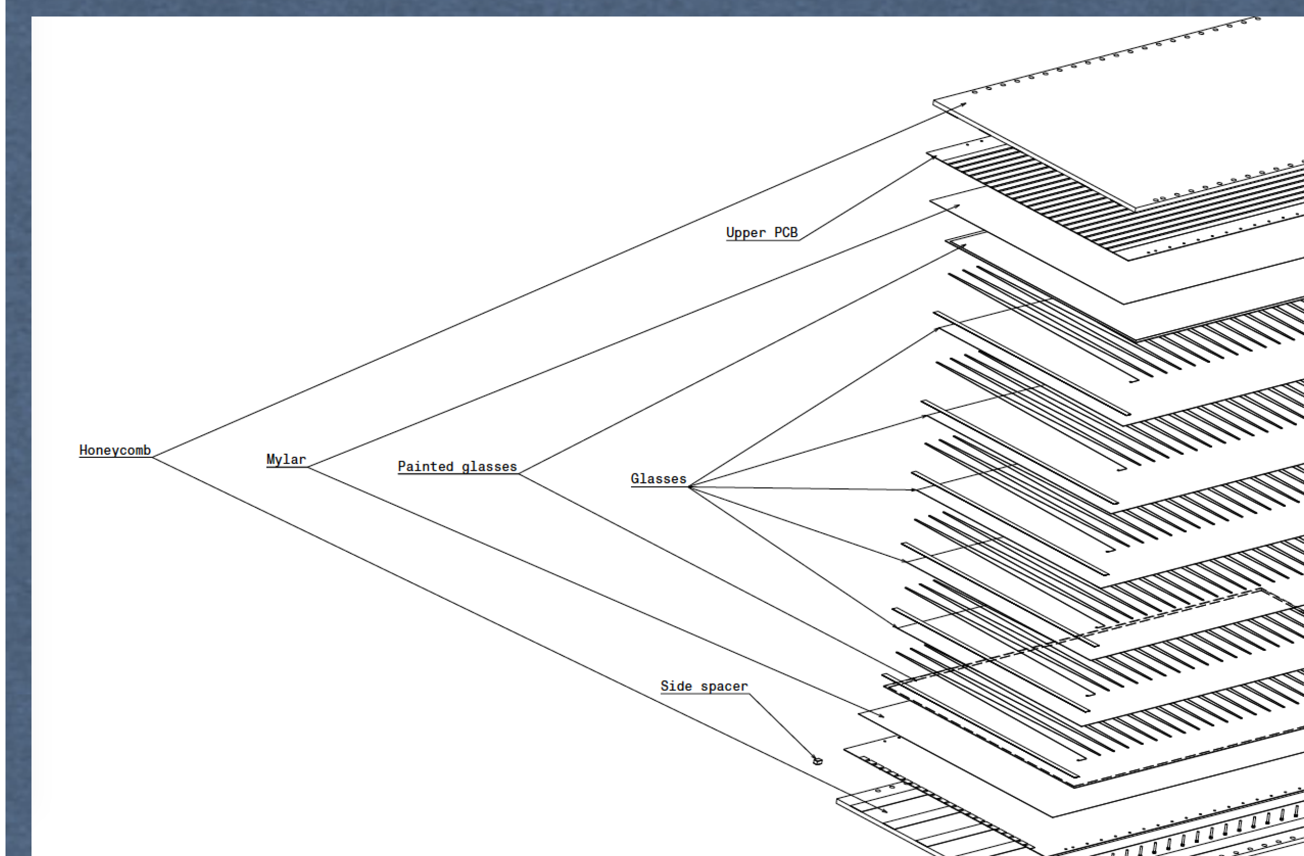
Installed (and now working!) in EEE cluster at CNAF!

EEE-MRPC simulation: geometry

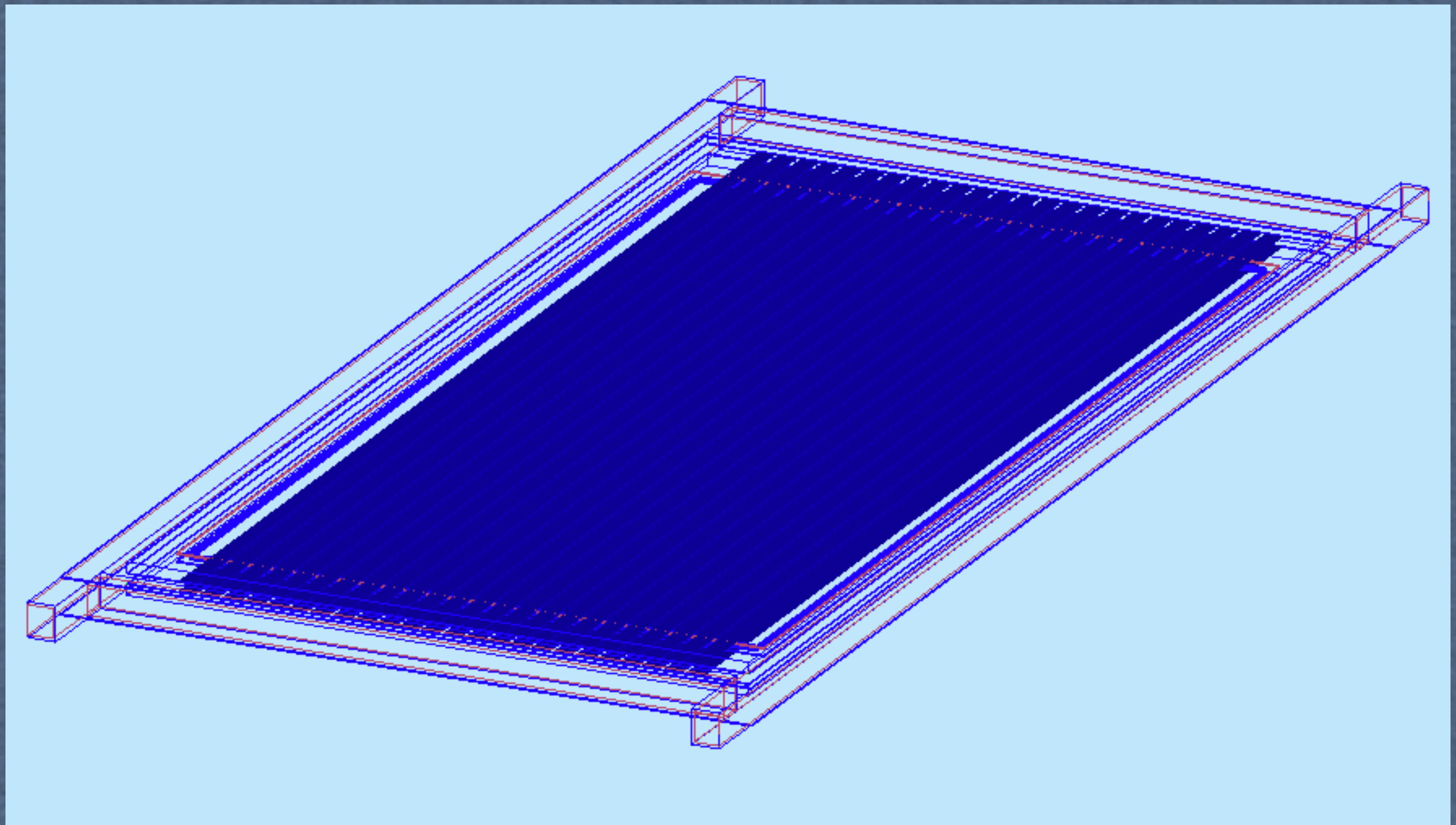
- ✳ Detailed drawings provided by R.Zuyeuski
- ✳ Geometry/materials verified during assembly of Genova telescope at CERN (March 2017)



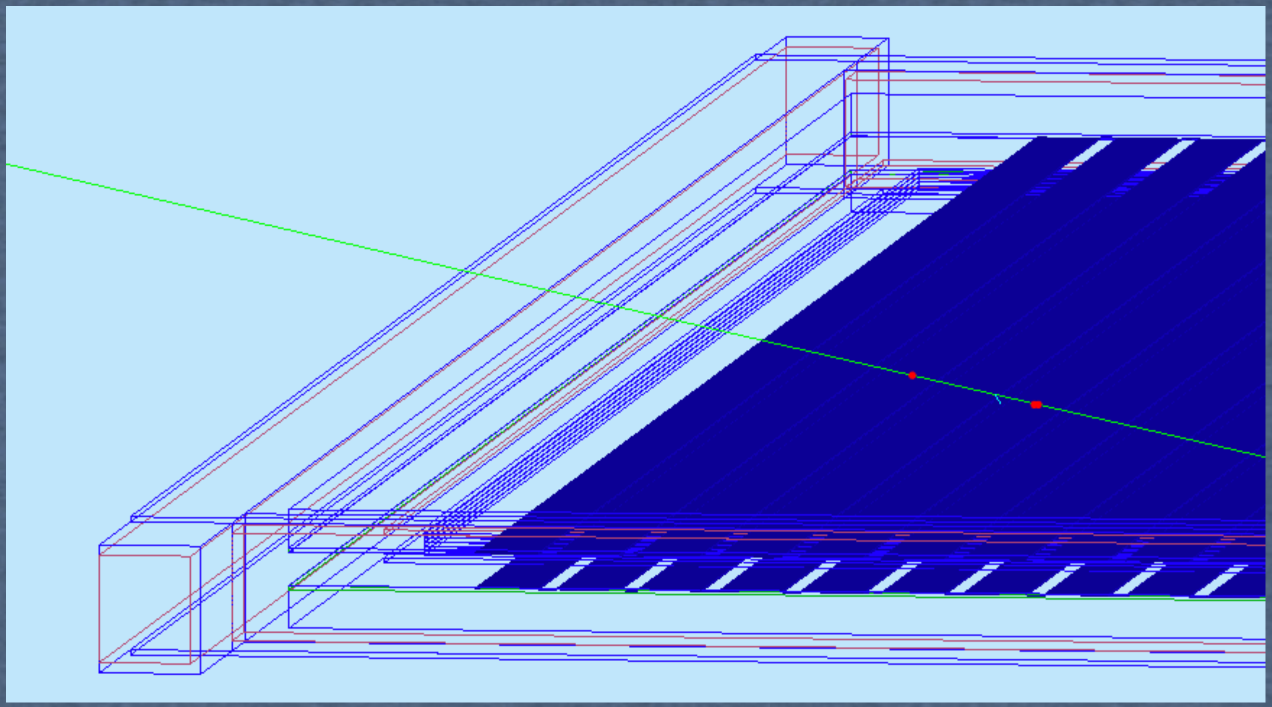


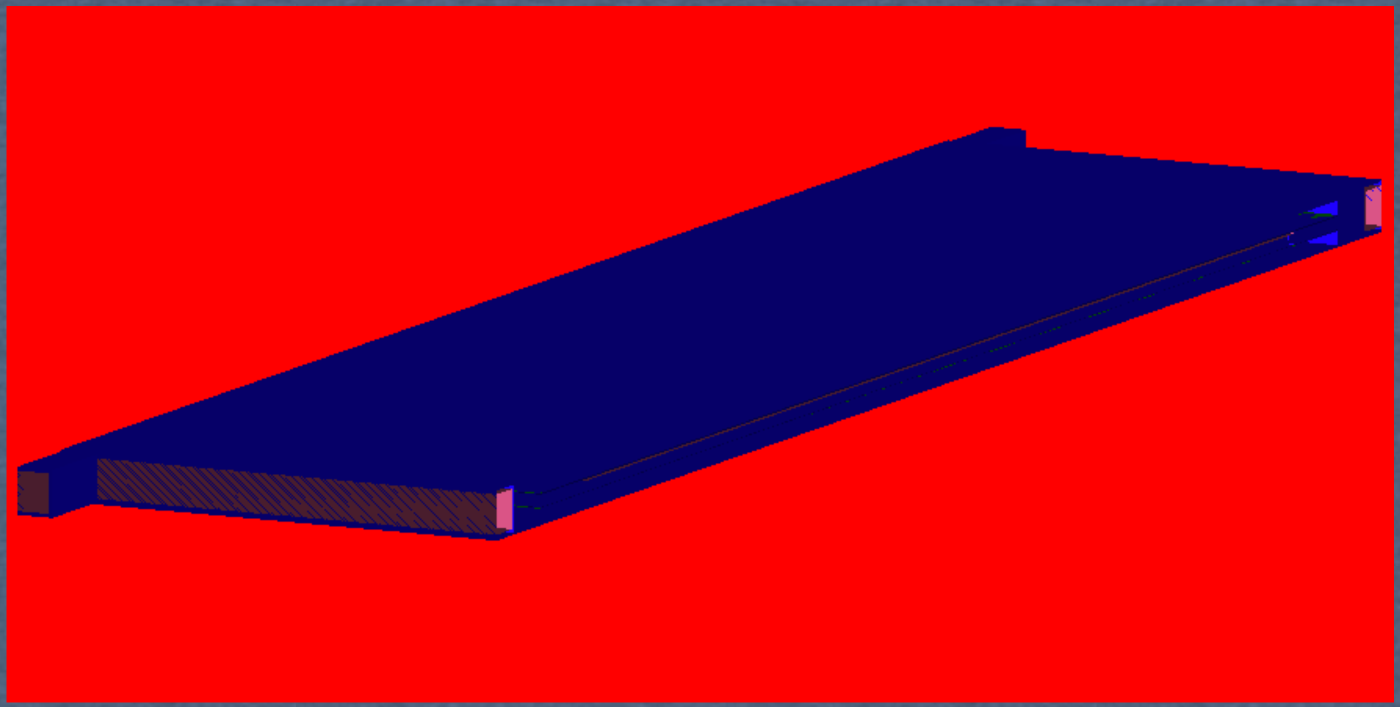


EEE-MRPC simulation: geometry



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



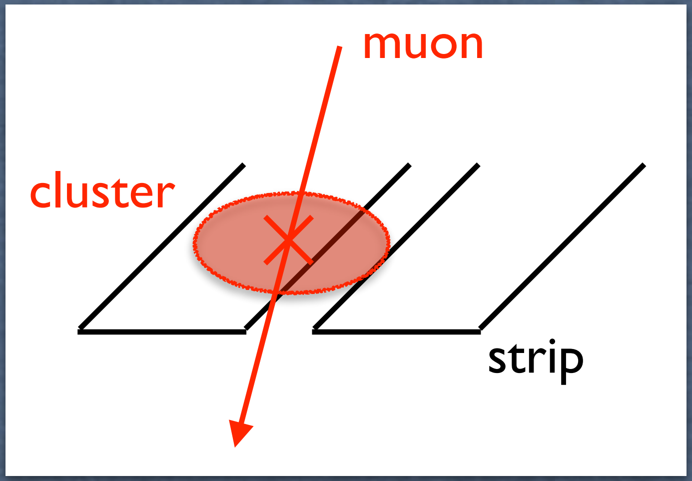


EEE-MRPC simulation: response

✳ 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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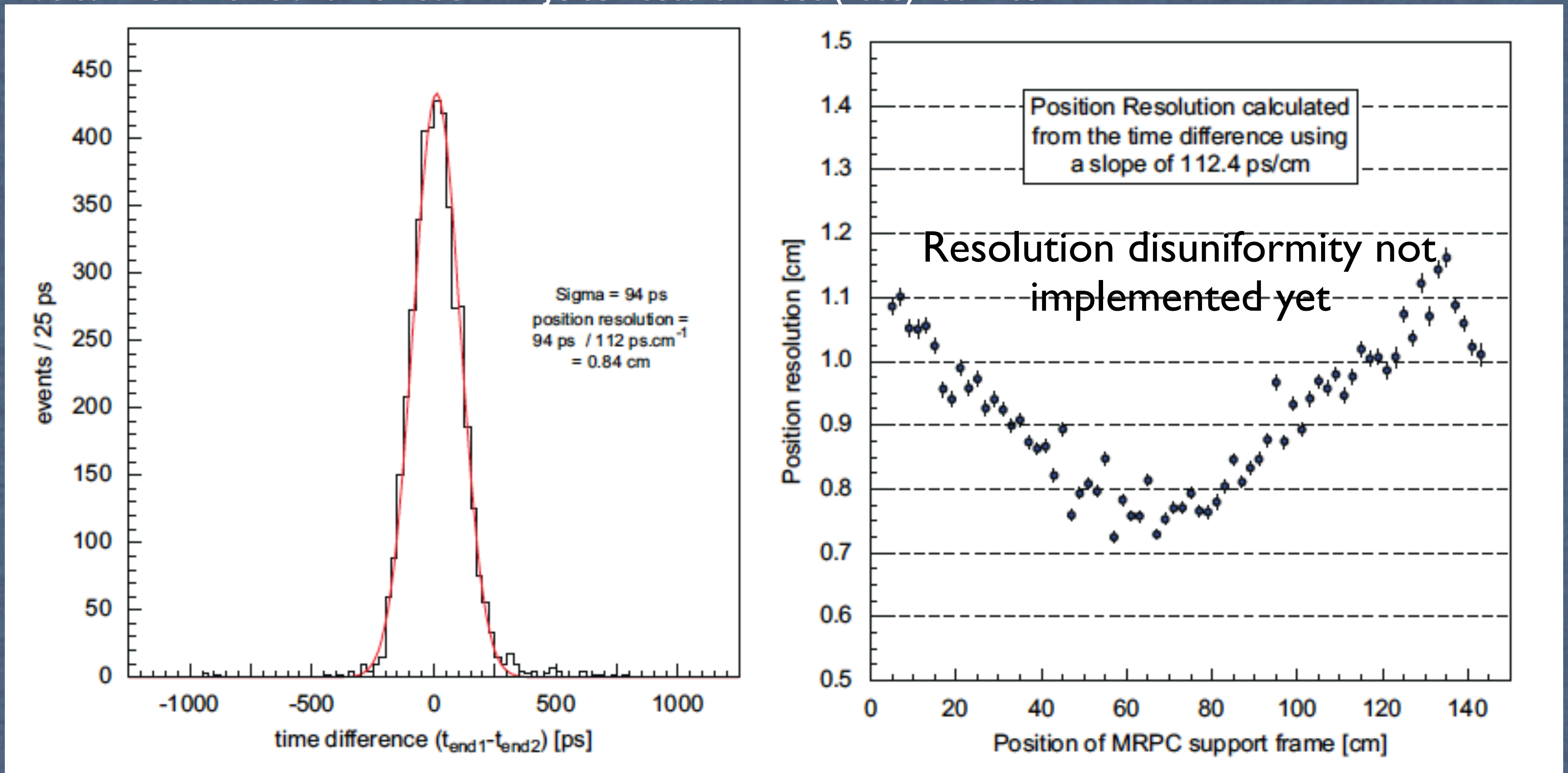
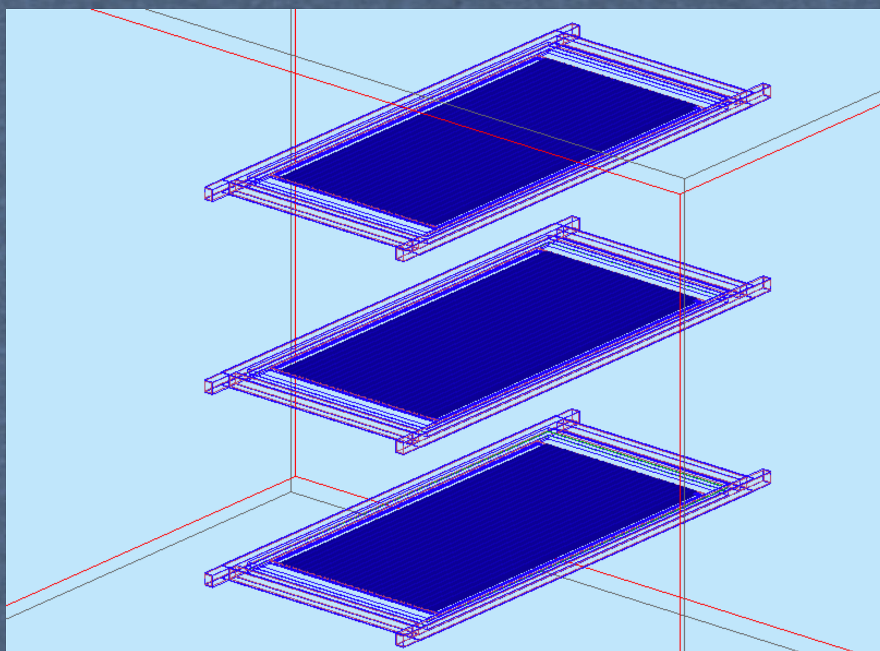
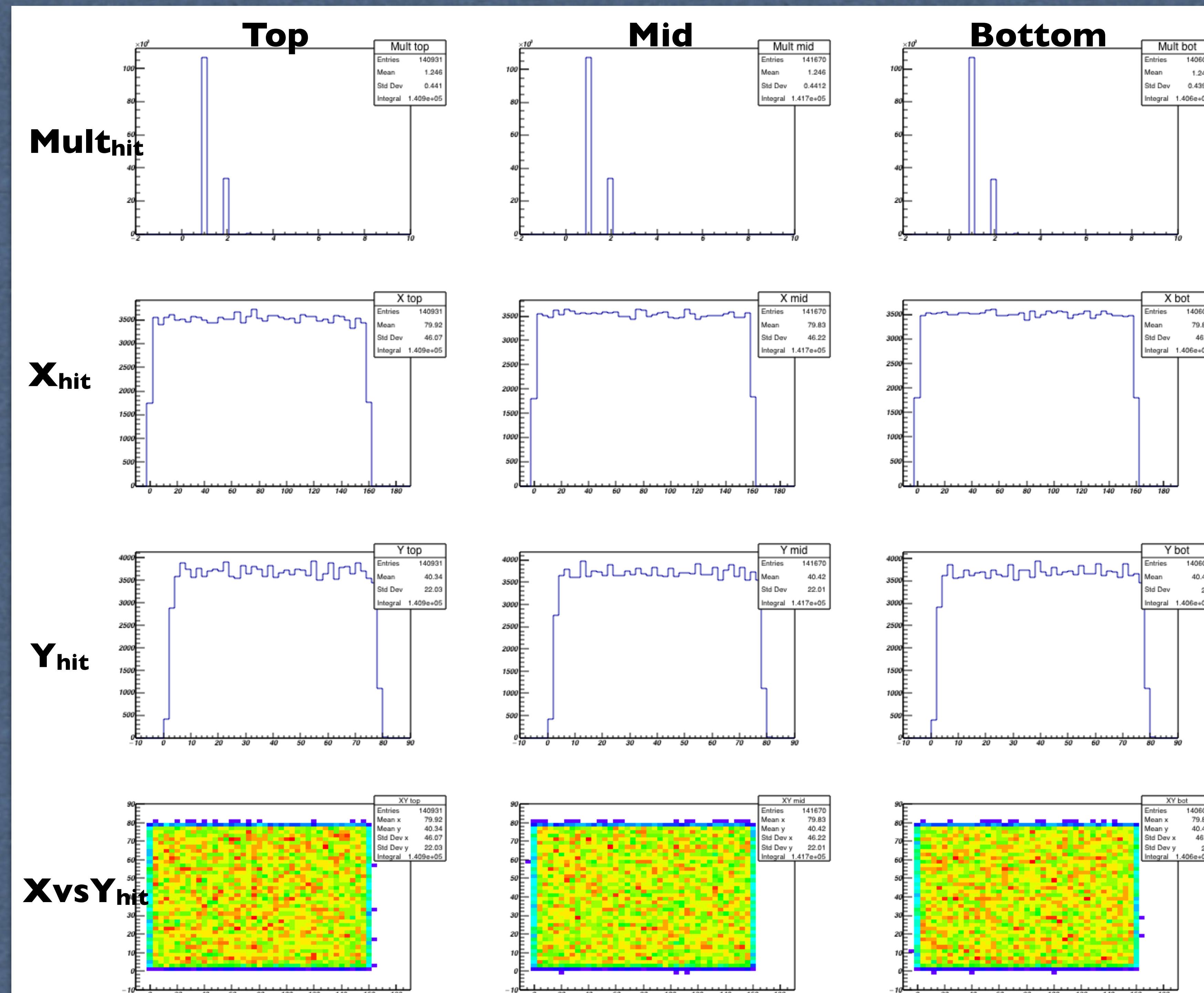


✳MRPC parameters

- 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

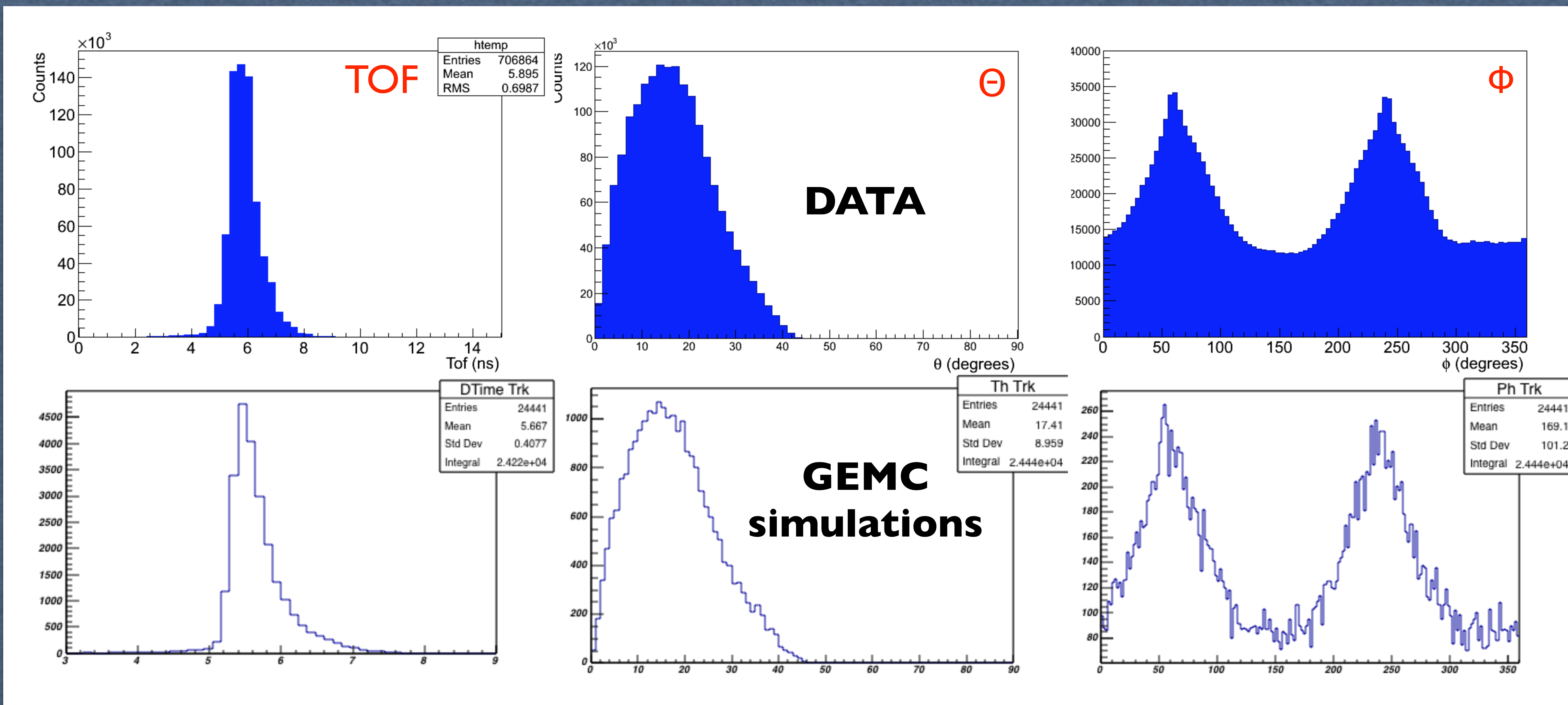
- 3 chambers
- -80/0/+80 cm apart
- placed in a concrete box wall on all sides (30cm concrete)

✳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*



EEE-Telescope simulation: response

Work plan

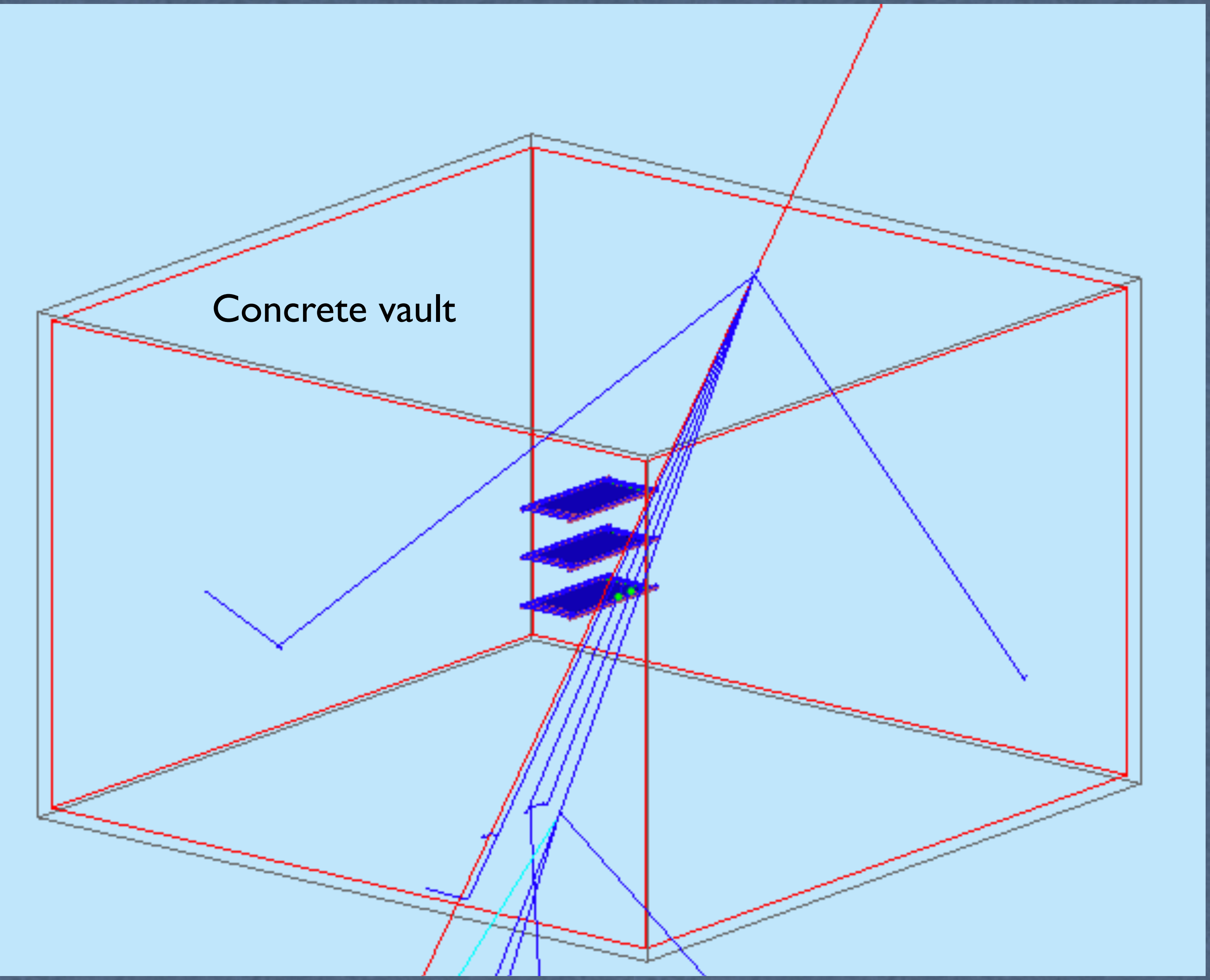
- Define critical parameters in MRPC response: timing, efficiency, strip multiplicity, …
- Define a measurement procedure to asses parameters (eg. scintillator hodo for efficiency, top/bottom chambers for precise track determination, …)
- Test the characterization procedure on a telescope (as a template)
- Implement the response in GEMC
- Check results sensitivity to details of the new response
- Define a subset of few (important) parameters
- Define a simplified characterization procedure that could be extended to the other telescopes
- Identify tasks for schools (Alternaza Scuola Lavoro) and tasks requiring EEE-experts
- Document the procedure writing a note
- Distribute to other schools

EEE-Telescope simulation: response to cosmic validation

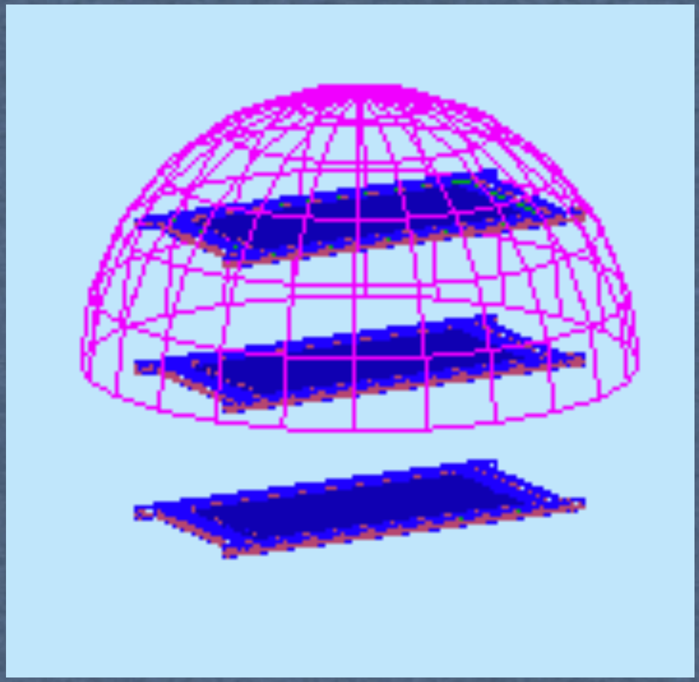
Work plan

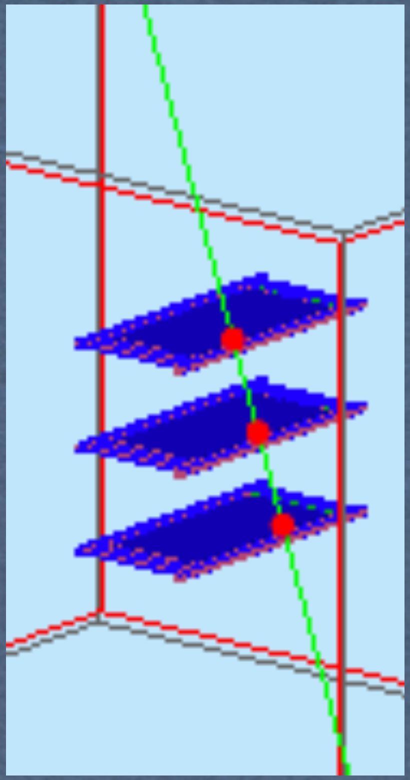
- Single hit: GEMC produces already reasonable distributions and absolute rates
- For detailed comparison we need to implement the same analysis chain used to process data
- Implement in GEMC output necessary information to feed to the RecSW
- Establish at which level of details pseudo-data have to be similar to data
- Identify variables (multeplicity, angular distribution, timing, …) to be used to validate simulations
- Validate simulations comparing variables and rates
- No interaction with school for this task (Too difficult!)
- Write a note for internal use

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

EEE-Telescope simulation: location

Work plan

- GEMC infrastructure is ready for precise surrounding geometry/material description
- Use SV-Chiabrera as a template (simple geometry, single layer roof + walls and windows)
- Coordinate with teacher how to obtain construction details (drawings, wall/roof size, composition,…)
- Implement information in GSIM
- Test results looking at absolute rate variation
- Teach/show students the effect of surrounding materials running GEMC with different parameters
- Define the full characterisation procedure and write a note
- Distribute to other schools

EEE-Telescope simulation: CORSIKA

Work plan

- Feed CORSIKA output to GEMC replacing the internal muon generator
- Generate a shower form a high energy primary with CORSIKA and sample the particle flux at sea level
- Convert info (4-momentum, particleId, vertex, time,…) from CORSIKA to LUND
- Feed LUND to GEMC to replace the internal cosmic generator
- Repeat validation comparing sim to data
- Start physics analysis: multiple coincidence, long-range coincidence, …
- No interaction with school for this task (Too difficult!)
- Write a note for internal use

Further activities

- When all set, use simulation for further studies such as muon decay life time (bottom-up tracks)
- Master Class: identify which part of the simulation chain can be implemented
- Master Class: GEANT, MC, Simulation tools
- Master Class: CORSIKA
- Stage: analysis tools (root)
- Stage: identify some simple simulation activities: run the code with different parameters (eg distance between chambers) and check the effect on some parameters (eg angular distributions, efficiency)

DeSi-WG: people and responsibility

✳ The core team:
- Marco Battaglieri (INFN-GE): Coordinator, SIM implementation
- Giuseppe Mandaglio (UniMessina): SIM-to-REC
- Carmelo Pellegrino (CNAF): SIM-to-REC
- Silvia Pisano (INFN-LNF): CORSIKA-to-SIM
- Stefano Sgrazzi (CF): Detector response measurement, telescope location

✳ Consultants:
- Fabrizio Coccetti (CF): CORSIKA expert
- Francesco Noferini (CNAF): REC expert
- Maurizio Ungaro (JLab): SIM expert

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

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