EEE weekly meeting
Wednesday Nov 8 2017

Detector Simulation Working Group (DeSi-WG)

# Activity report update

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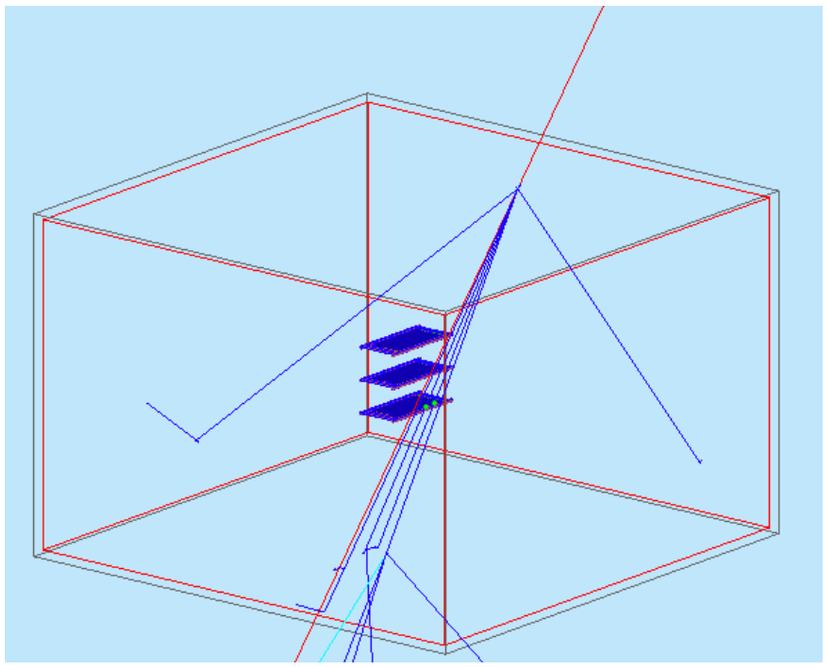
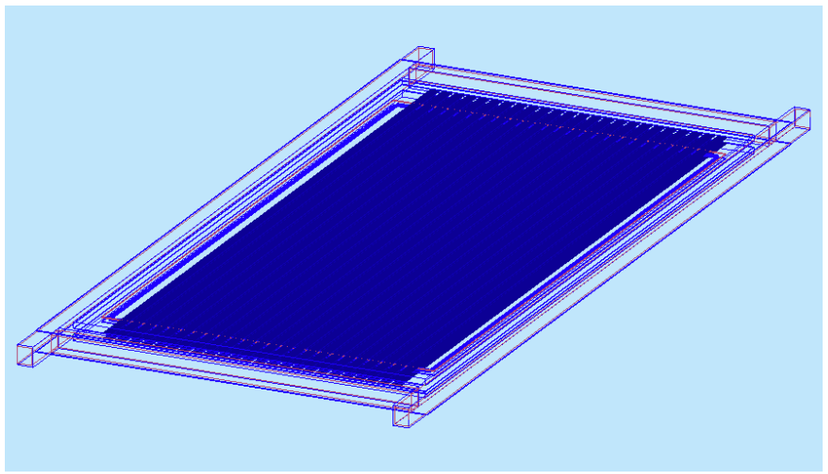
*F.Coccetti, F.Noferini, M.Ungaro*

## **DE**tector**SI**mulation**-WG**

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

**EEE telescope implementation in GEMC (GEANT4)**





**CORSIKA**

**GEMC**

EEE MRPC/Telescope Geometry

EEE MRPC response

EEE Telescope response

Location

**RecSw**

**Data**

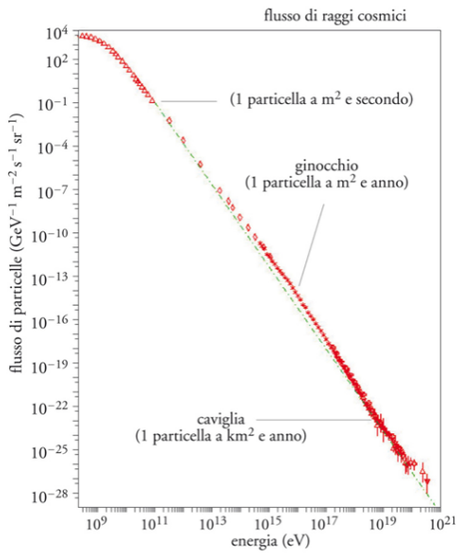
**Physics analysis**

**Further activities**

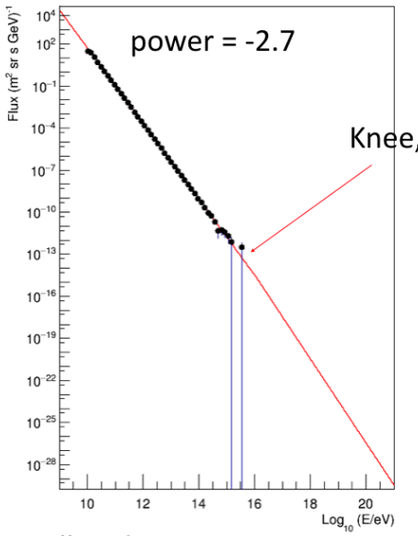
# Cosmic ray flux

We are simulating a cosmic ray flux accordingly to the one measured.

Measured




Simulated




Still under tuning

Red → current parameterization

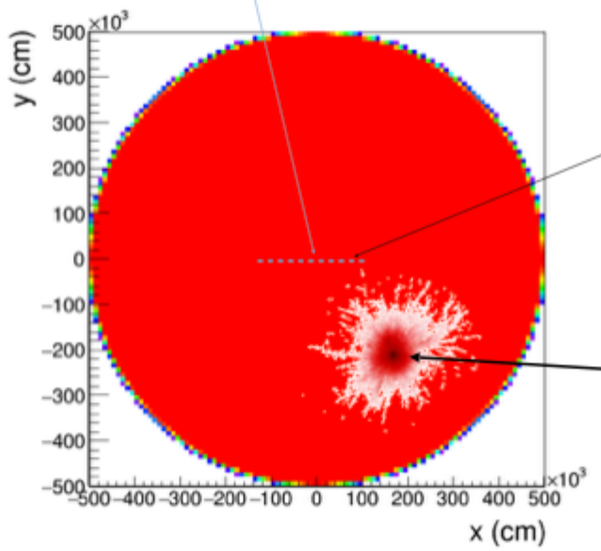
Black → From random sampling

# Generation: CORSIKA

## Simulation setup

- Many telescopes can be inserted as input of the simulation
- Cosmic ray flux simulated accordingly to the primary spectrum
- Showers simulated with Corsika
- Output: muon candidates (with a timestamp) for each telescope → Geant4

i.e. 11 telescopes setting




Shower generated randomly:

- Energy (previous slide)
- Direction (θ from Corsika,ϕ random)
- Position core (x,y) randomly generated in a large area

2

F.Coccetti, F.Noferini

# Feeding GEMC

## Corsika to lund conversion

LUND format is a typical ascii file fed as input to gemc

It is meant for fixed-target experiment: $e\ p\ \rightarrow e\ h_1\ h_2\ X$ and contains the relevant variables to describe the scattering event.

An «event» – i.e. a Deep-Inelastic Scattering of an electron off a target - is represented by

- a *header* part containing beam and target information (target atomic number, beam charge and polarization etc)
- a *body* composed of a line per track reporting information on the track kinematics and particle type (LUND ID)

To adapt this format to shower simulations, the following strategy has been followed.

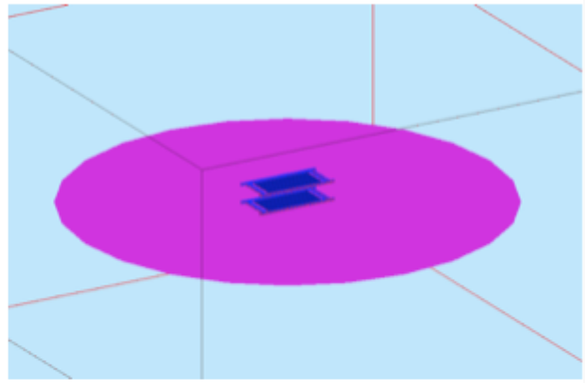
An «event» is now a secondary cosmic ray hitting a circular surface of $R = 5m$ (Corsika sampling area) centered on the bottom chamber:

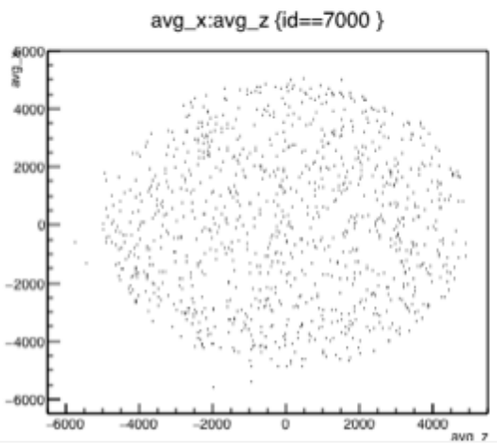
- the *header* is used to store *primary* information $(p, \vartheta, \varphi, (x, y)_{Core}$, Corsika ID, time); it replicated for any muon associated to the same primary
- the *body* contains the secondary information (kinematics, Lund ID)

## Technical aspects and tests

Secondary vertex definition:

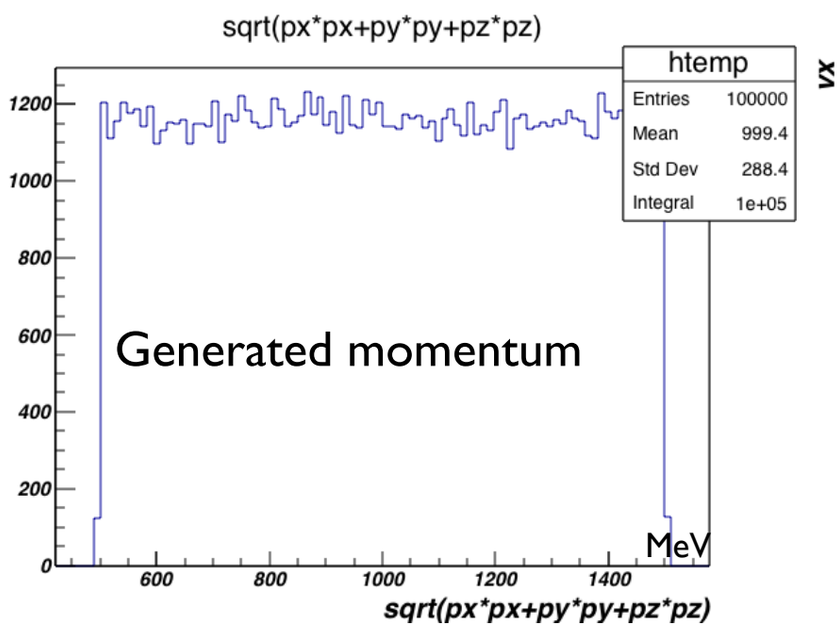
- In the Corsika output, the hit coordinates where the secondary reaches a circular area of $R = 5m$ centered on the bottom chamber are stored, together with its four-momentum
- However, gemc needs the **production** vertex: it is extrapolated to a surface of height = $t$ from the vertex and the momentum direction in a parametric way (different heights can be simulated to account for different school buildings)
- Reference frame has been changed to gemc one ($\hat{z}$ along the beam line)

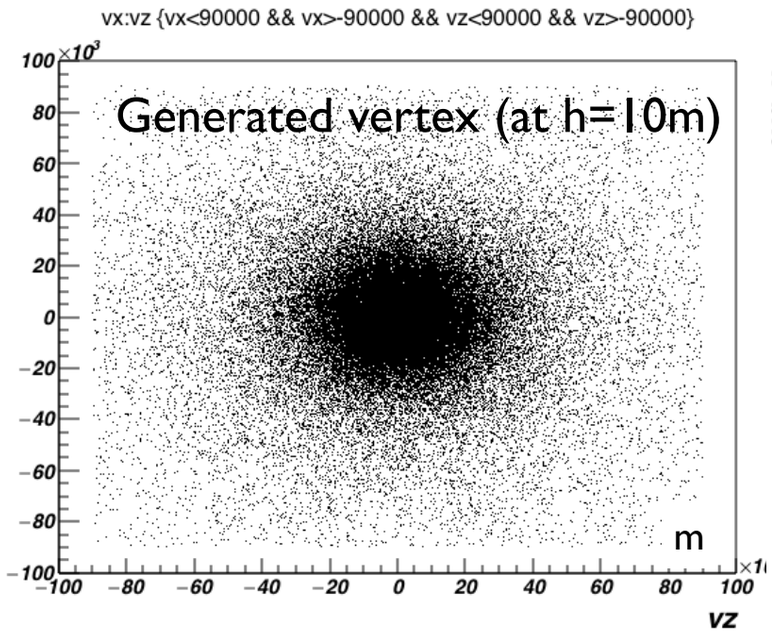


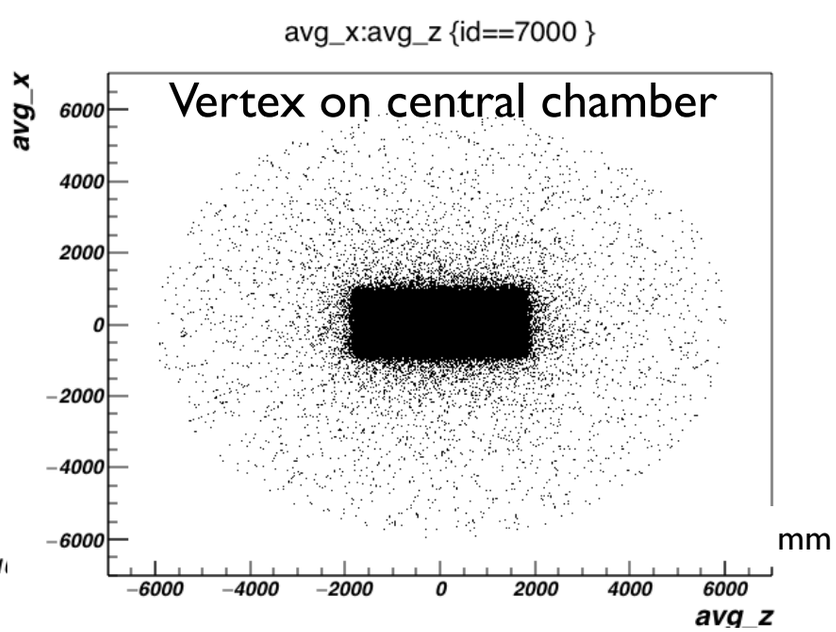


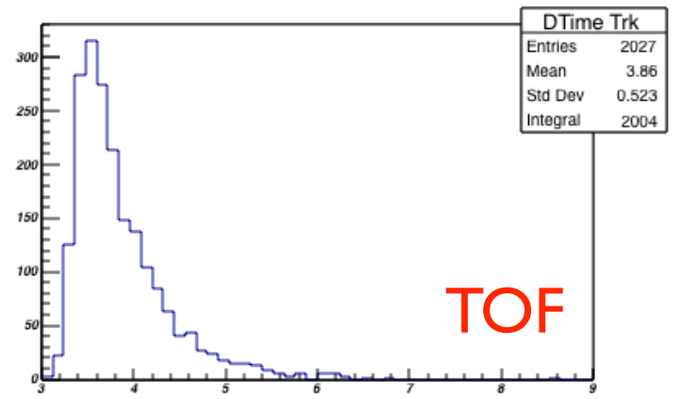

S.Pisano, F.Noferini

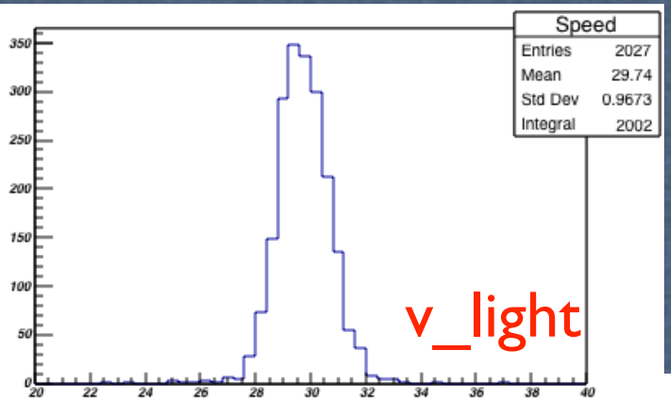
# Generated events (CORSIKA-like)



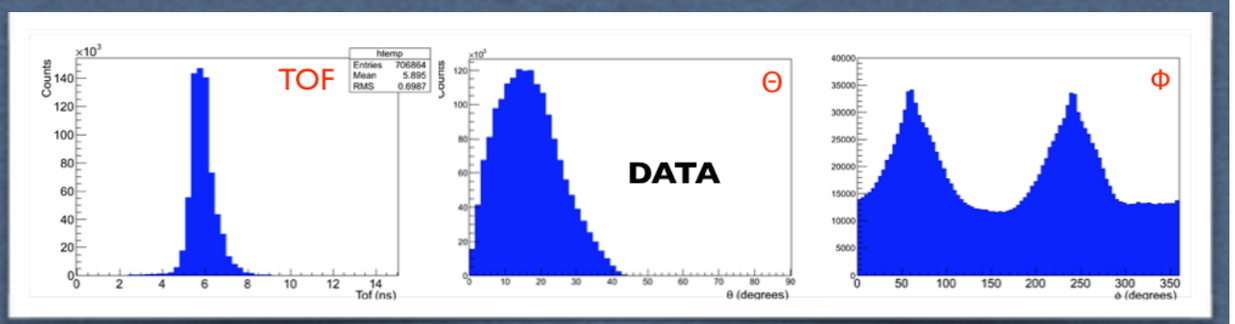



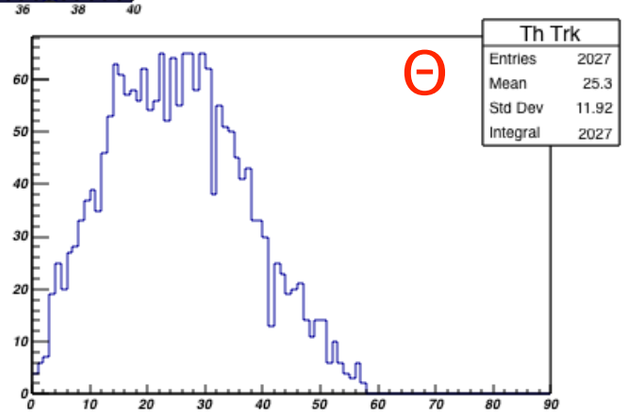



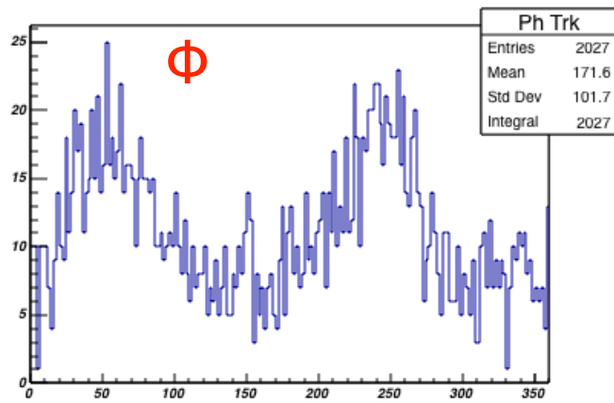




- "Poor man" reconstruction
- Gen/Rec variables shows a reasonable behaviour



# From EG+GEMC to EEE-reconstruction

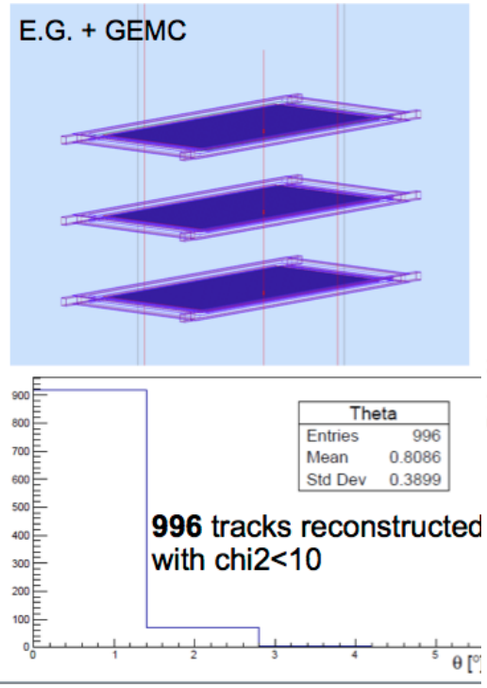
Interface between GEMC and EEE-reconstruction consists in a macro reading GEMC output and writing root file to be used as input for EEE-reconstruction.

Macro to run EEE-reconstruction provided by F. Noferini

The macro simulates a kind of trigger in order to have all hits time in the trigger window.

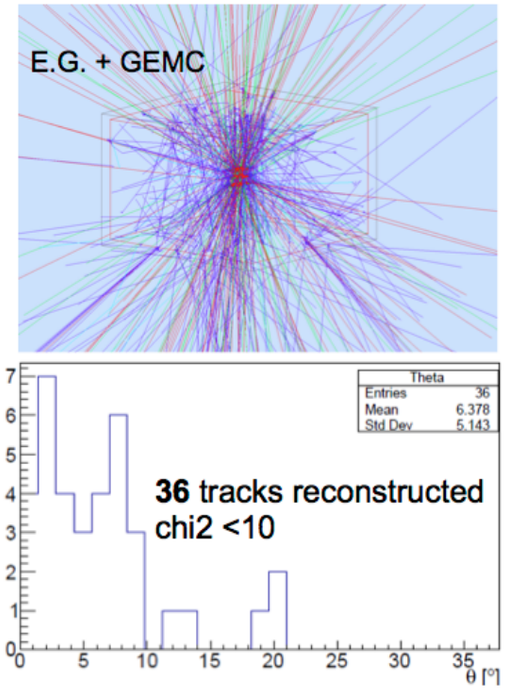
Macro and EEE-reconstruction tested on events at fixed angle (theta =0° and theta = 10°) and all direction at low statistics (1000 events).
(data by M. Battaglieri)

Macro and EEE-reconstruction tested on data sample at high statistics (100000 events), data generated by F. Noferini and processed with GEMC via lund by S. Pisano

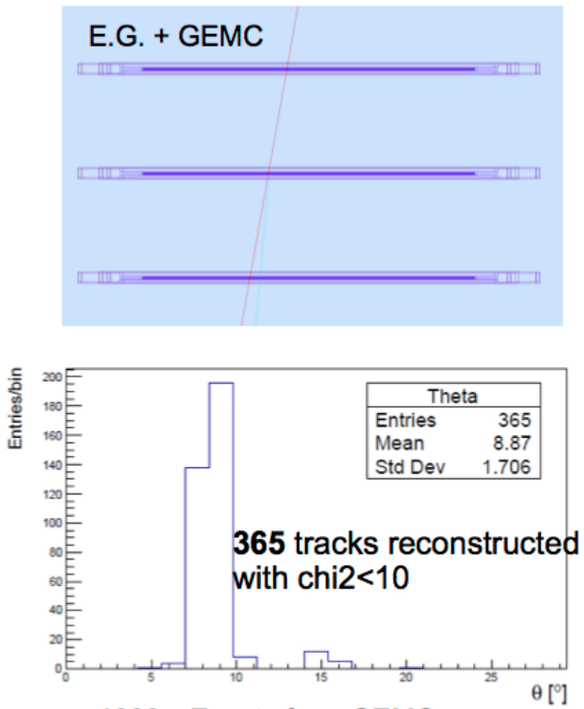



1000→Events from GEMC
inside the trigger =999

# From EG+GEMC to EEE-reconstruction



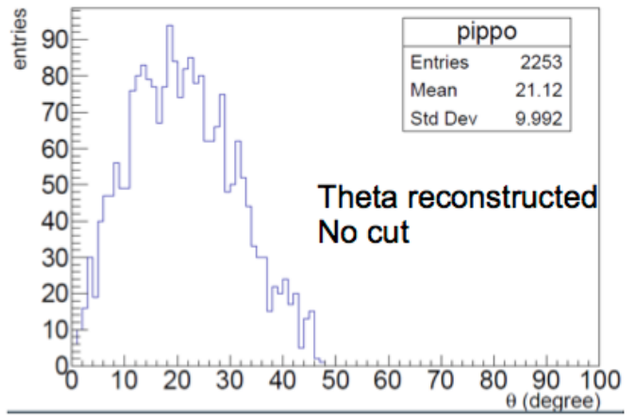

1000 →Events from GEMC
inside the trigger =308

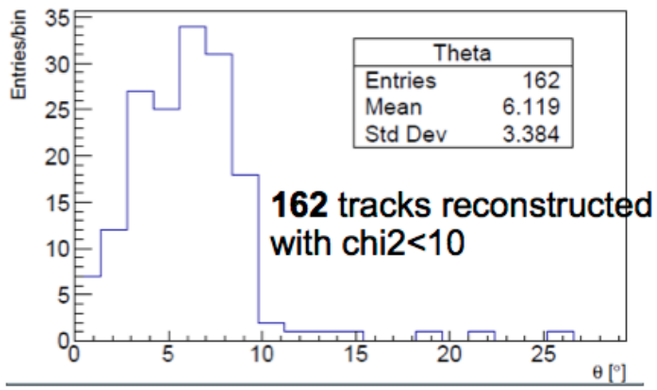



1000→Events from GEMC
inside the trigger =1000

- Full reconstruction tested on study cases
- HW trigger simulation implemented
- Tested on high stats file
- The full chain is in place
- Ready to process CORSIKA data

## High statistics data 100000 events




100000 →Events from GEMC
out of the trigger =97747
inside the trigger =2253

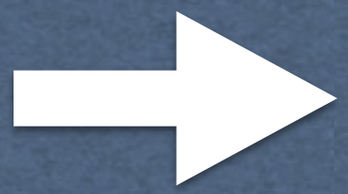
G.Mandaglio, F.Noferini

# Side-activity

- Installed a VM (eeevm01.ge.infn.it) with ROOT, GEMC and EEE data
- Granted access to teachers (SV, Recco, Voghera, Cinisello)
- WIKI page (https://wiki.ge.infn.it/eee )with detailed instruction on how to open an X-session
- Easy connection and display exported via  MobaXterm (Windows) or ssh (Mac/Linux)
- ROOT tutorial in preparation (D.Menasce)
- ROOT via WEB under investigation (D.Menasce)

**GEMC**

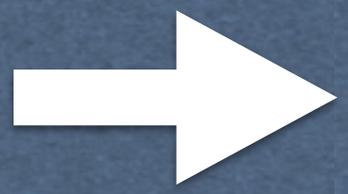
EEE configuration available and running



- Simple simulations
- Surrounding material effect
- EEE full simulations

**ROOT**

v6.0



- EEE data analysis
- GEMC pseudo-data analysis

# 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

# 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

## **DE**tector**SI**mulation**-WG**

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

**CORSIKA**

Silvia, Francesco,Fabrizio: 90%

**GEMC**

EEE MRPC/Telescope Geometry — done

EEE MRPC response — Marco/Stefano, 50% — schools

EEE Telescope response — Marco/Stefano, 50% — schools

Location

Carmelo/Giuseppe + Francesco 80%

Marco/Stefano, 30% Implementation
schools

Marco/Stefano, 30% Validation

**RecSw**

**Physics analysis**

**Further activities**

**Data**