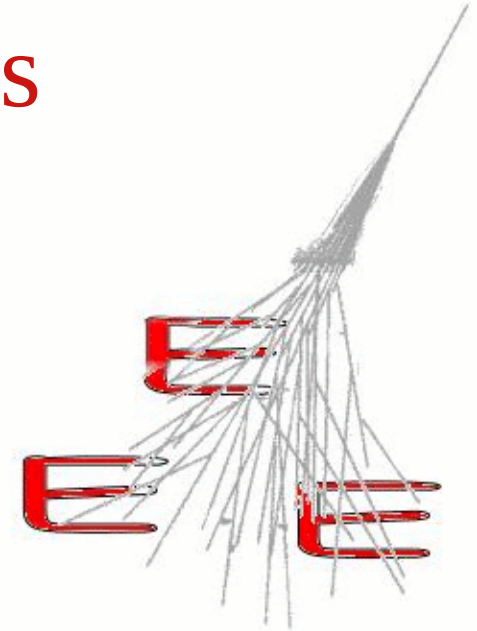
CENTRO FERMI
Museo Storico della Fisica e
Centro Studi e Ricerche Enrico Fermi

# The Extreme Energy Events experiment:

## ✓ The future



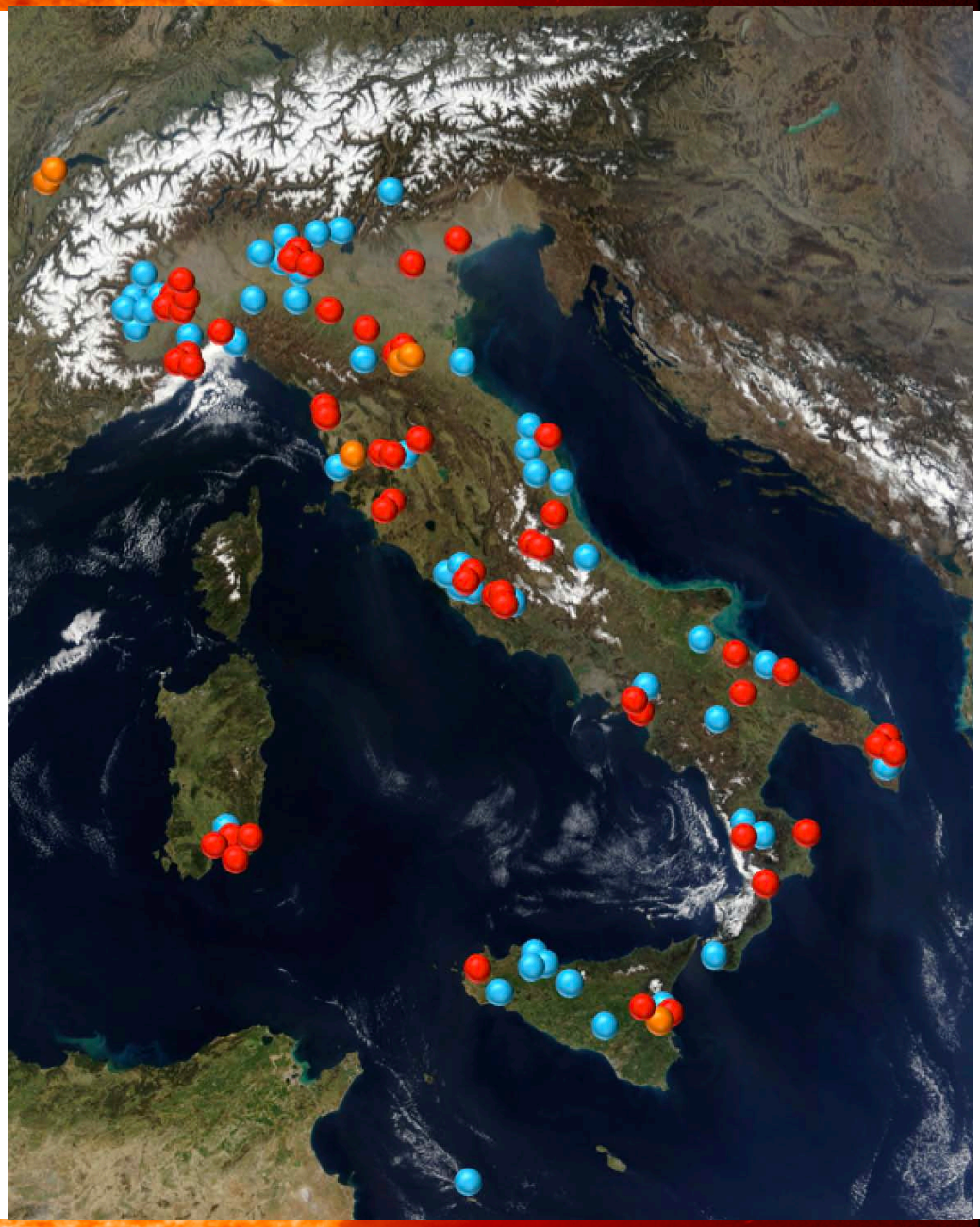
**M. Abbrescia for the**
**Extreme Energy Events collaboration**

# Present status

50 telescopes at High Schools
+ 2 telescopes at CERN
+ 4 at INFN Units
Total: 56 telescopes
+ ≈ 50 schools on the waiting list

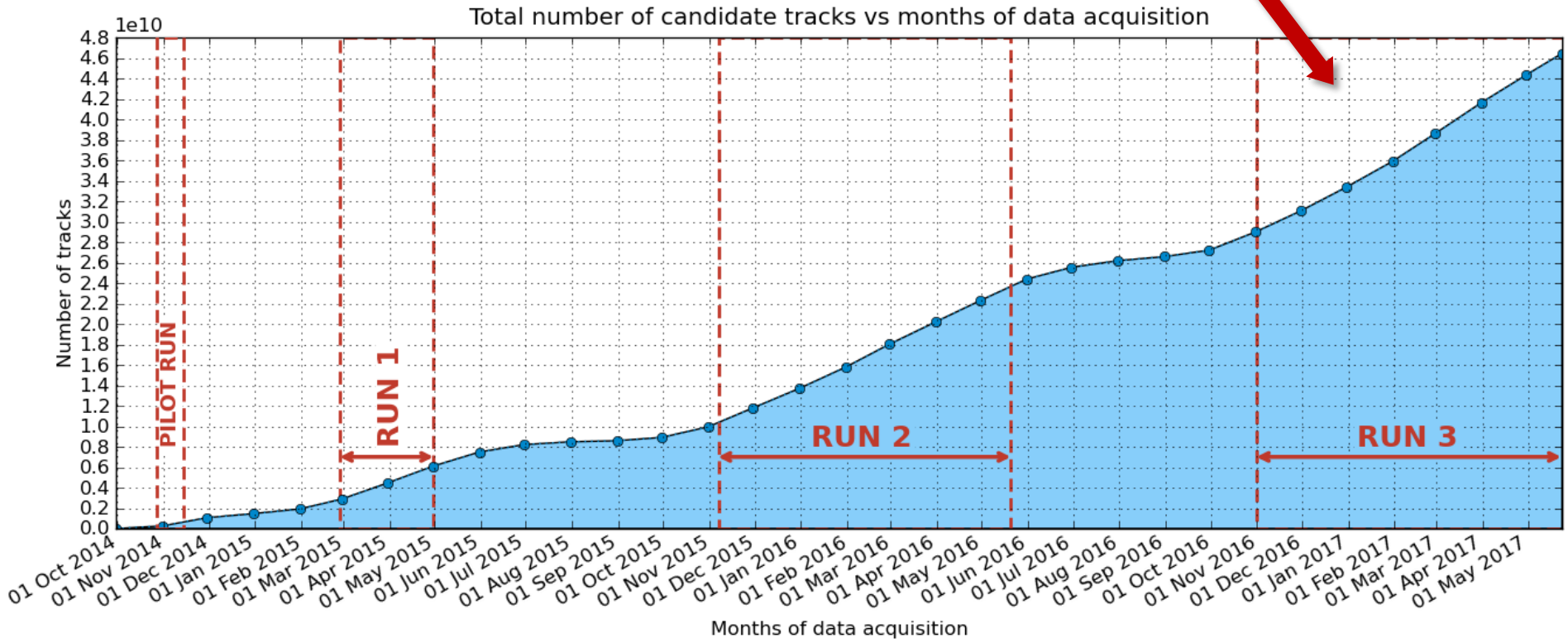
✓Largest (in terms of area) system using MRPCs
✓Largest cosmic rays experiment in Europe
✓ Four new stations in the last six months!

- *Stations in operation at schools*
- *Stations in operation at research centers*
- *Schools on the waiting list*

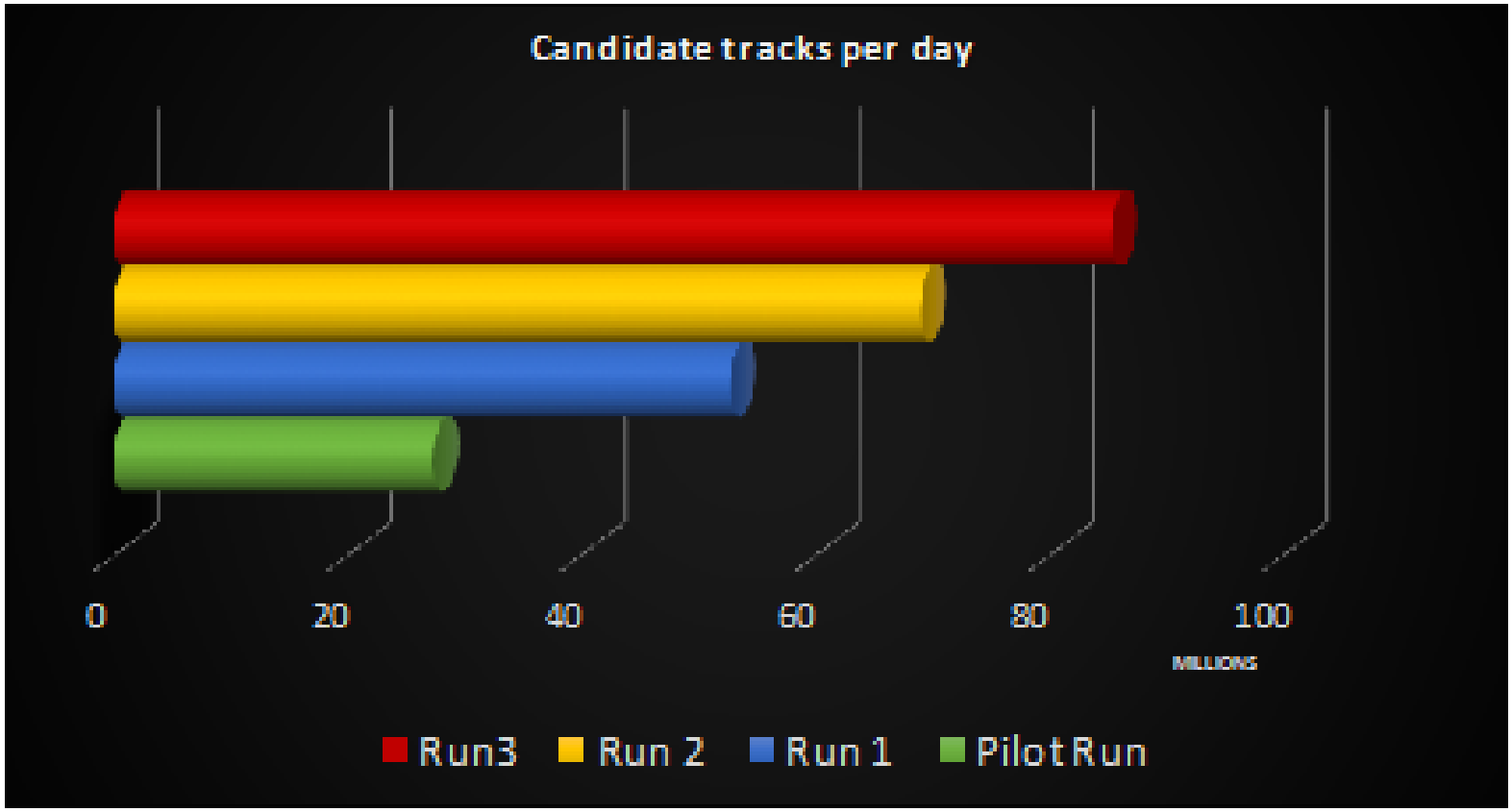


# Data taking

- ✓Almost 55 billion events collected since the start of organized data taking
- ✓More than 20 billion events collected during Run-3 only!
- ✓Plan to take another 20 billion events during Run-4



# Improvements in the data flow




- ✓Overcome the100 MEvents/day threshold (during March and April)
- ✓New reconstruction algorithm: Analyzer v.2.0
- ✓New data transfer tool: SyncThing
- ✓New automatic elog

# EEE MONITOR - DQM

*[ Web address: http://eee.centrofermi.it/monitor ]*

CENTRO FERMI — MUSEO STORICO DELLA FISICA E CENTRO STUDI E RICERCHE ENRICO FERMI

**Ultimo aggiornamento: ore 09:45 - venerdì 08 dicembre 2017 [by e3monitor]**

EEE Home Page | Connectivity Report

***[EEE Monitor] Back from the abyss of the waters...***
***[EEE Monitor]... running in ReCas - Bari***
***[EEE Monitor] Start of RUN4: October 2, 2017***
***[EEE Monitor] RUN 4 - Data Taking - Day number: 68***

**Total number of candidate tracks (X^2<10) in this database: 4307311741**

Questa tabella mostra la situazione dei telescopi in acquisizione:
In **verde** sono indicati i telescopi in presa dati e trasferimento nelle ultime 3 ore e con parametri di acquisizione ragionevoli nell'ultimo run analizzato.
In **giallo** sono indicati i telescopi in cui trasferimento e/o acquisizione sono sospesi da più di 3 ore o con tracce (X^2<10) minori di 10 Hz nell'ultimo run analizzato.
In **rosso** sono indicati i telescopi in cui trasferimento e/o acquisizione sono sospesi da più di due giorni o con tracce (X^2<10) minori di 5Hz nell'ultimo run analizzato.

| School | Day | Time | Name of the last trasferred File | Number of Files trasferred today | Name of the last File analyzed by DQM | DQM daily report | RATE of Triggers for the last Run | RATE of Tracks for the last Run | Link DQM |
|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | report | in DQM | in DQM | |
| | | | | | | | | | | | | |

✓Incredible effort done by Francesco, Fabrizio, Carmelo and people at ReCas

# The EEE crew…

Corrado, Daniele, Edoardo, Federico, Fabrizio, Francesca, Francesco Nof., Francesco Noz., Giovanni, Ivan, Laura, Luca, Marco B., Marco G., Marco P., Marco S., Marcello, Maria Paola, Nicola, Paola, Rosario, Silvia M., Silvia P., Stefano…

# EEE network upgrade

✓Plan to build another 20 telescopes

✓Will increase the capability of the EEE network to study the high-energy part of the cosmic rays spectrum

✓Huge effort for 2017-18!

## First bunch already almost completed

✓20-27 February → Lampedusa

✓12-18 March → Genova

✓23-29 April → SIEN-02

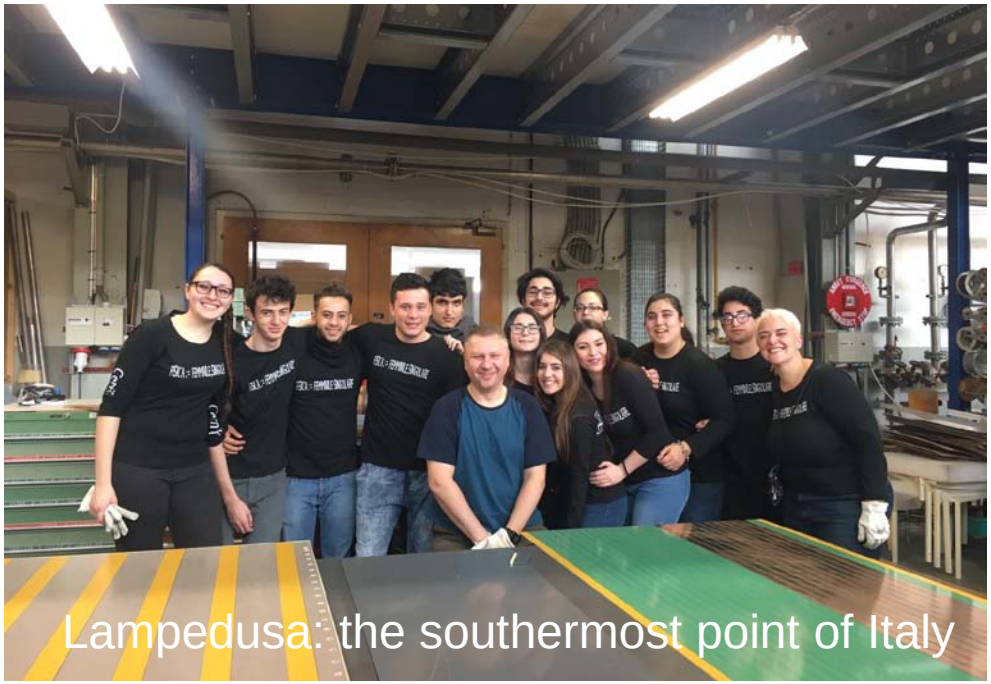
✓7-13 May → TORI-05 + Moscow

✓21-27 May → LODI-03

✓10-14 July → LODI + Korca (spare chambers)

✓25-29 September → CAGL-04

✓21-24 Novermber → BOLO-05

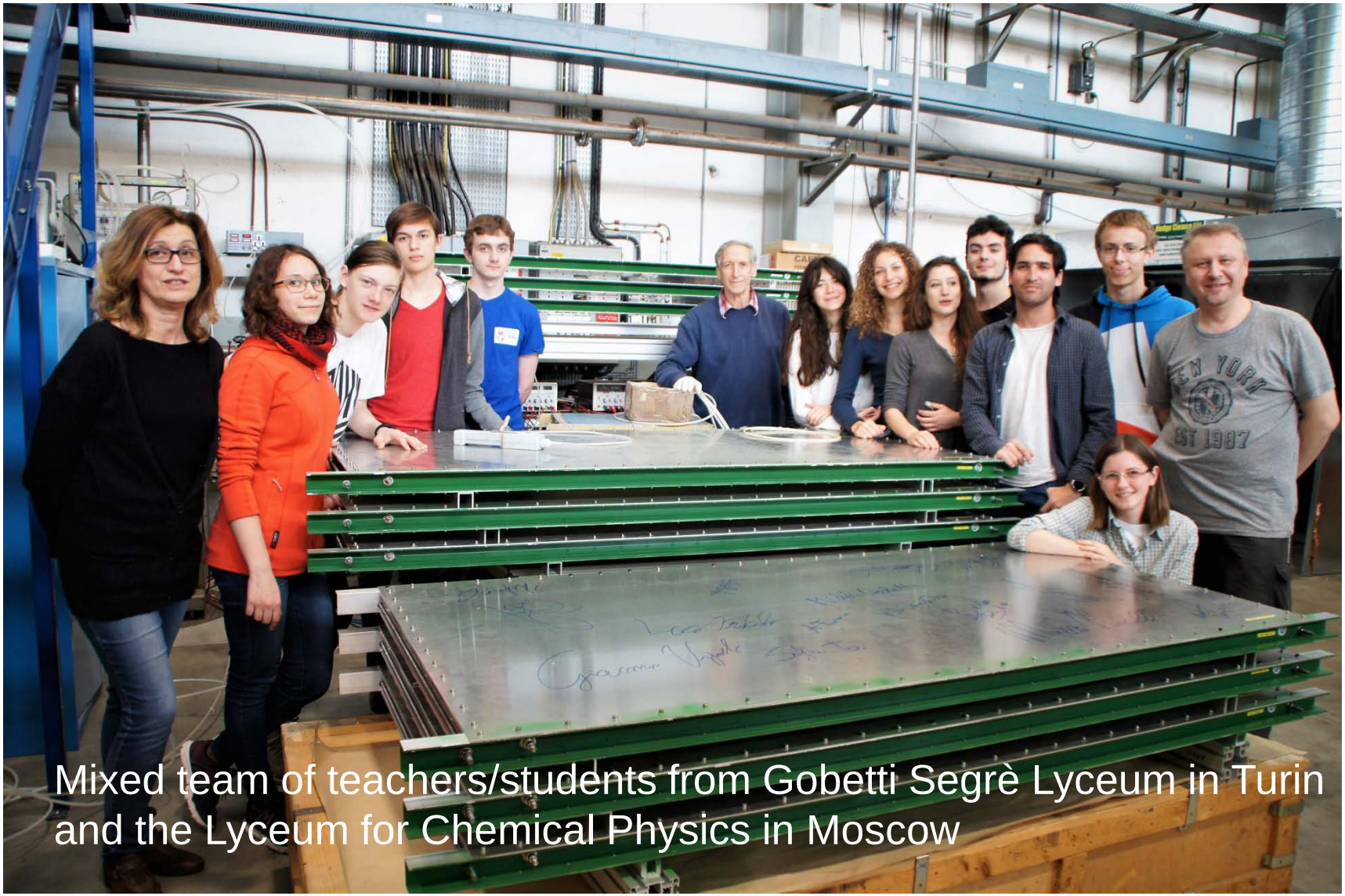


Lampedusa: the southermost point of Italy

# EEE smallest (but great) town


Liceo Scientifico “Patrizi” di Cariati

# EEE arrives to Moscow




Mixed team of teachers/students from Gobetti Segrè Lyceum in Turin and the Lyceum for Chemical Physics in Moscow

# Toward the first EEE Italy-Russia school


Invited to go to a location close to Moscow next February **(-25C!!!)**

# External collaborations

- EGO-VIRGO collaboration interested in having one (or more) EEE telescopes hosted at their lab in Cascina
- As a veto for cosmic ray showers in coincidence with possible signals coming from gravitational waves
  - There is a similar device at LIGO
  - There is some literature on that
- Possibility to sign up an agreement

EGO - Virgo

- University of Santiago de Compostela (Spain) interested in anaylizing EEE data looking for correlations between the cosmic rays flux and temperature and pressure conditions in the throposphere
- ✓ An agreement has been signed up


And, of course, Polar QuEEEst!

# POLAR QUEST 1928 2018

## EXTREME ADVENTURE

Complete circumnavigation of the Svalbard archipelago with a sailing boat.

## EXTREME SCIENCE

An international team of arctic researchers, today's explorers of the unknown, looking for answers to some of the great enigmas of science, from climate change to measuring the impact of human pollution at extreme latitudes, from the study of paleoclimate to the origin of high energy cosmic rays.

## EXTREME EXPLORATION

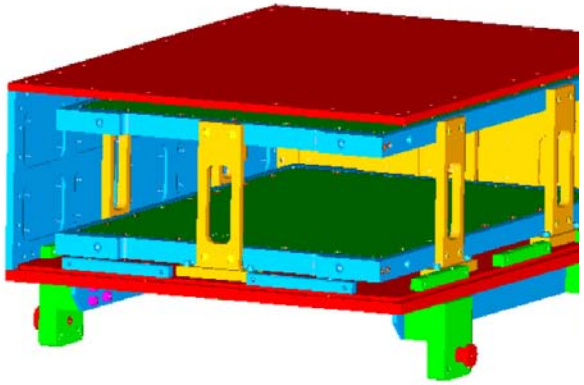
A quest for the wreck of the Italia airship on the 90th anniversary of the crash which made the history of polar exploration.

## A MESSAGE FOR THE PLANET

A voyage to the last untouched wildernesses on earth, to convey the importance of the Arctic for our sustainable future.


http://www.polarquest2018.org/

# Polar QuEEEst



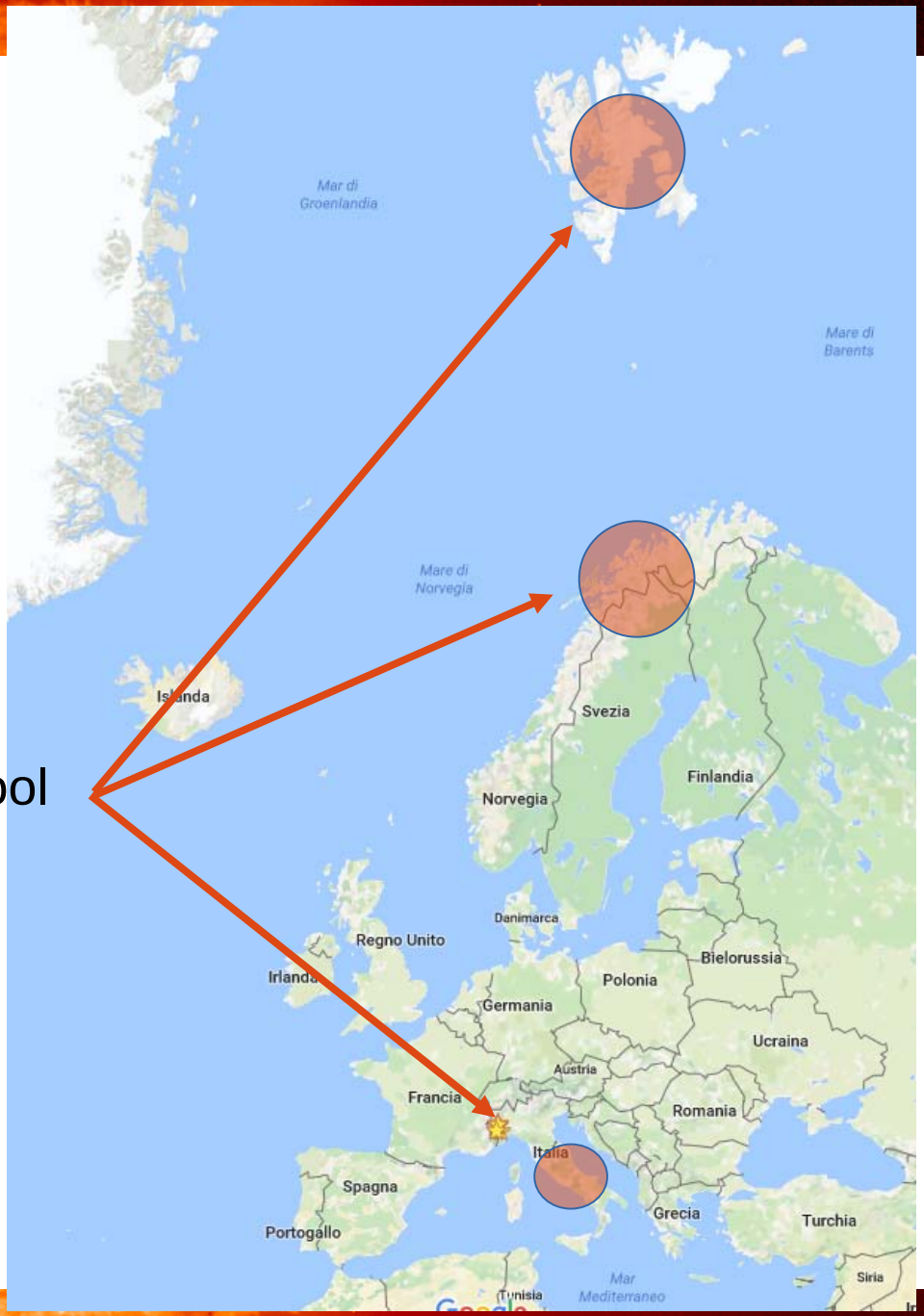
**3 PolarQuEEEst detectors**

- ✓ onboard on Polar Nanuq
- ✓ installed in a Norwegian High School
- ✓ installed in an Italian High School

Mounted by students as EEE tradition

**45° in latitude - 5000 km**

**Interesting technical problems**



# New chambers for new telescopes

## 250 μm gap chambers

✓Conceived for new eco-friendly gases

✓Reduce operating voltage

## Improved front-end boards

✓Amphenol cables and connectors replaced by Nugent ones

✓Pre-production boards under test

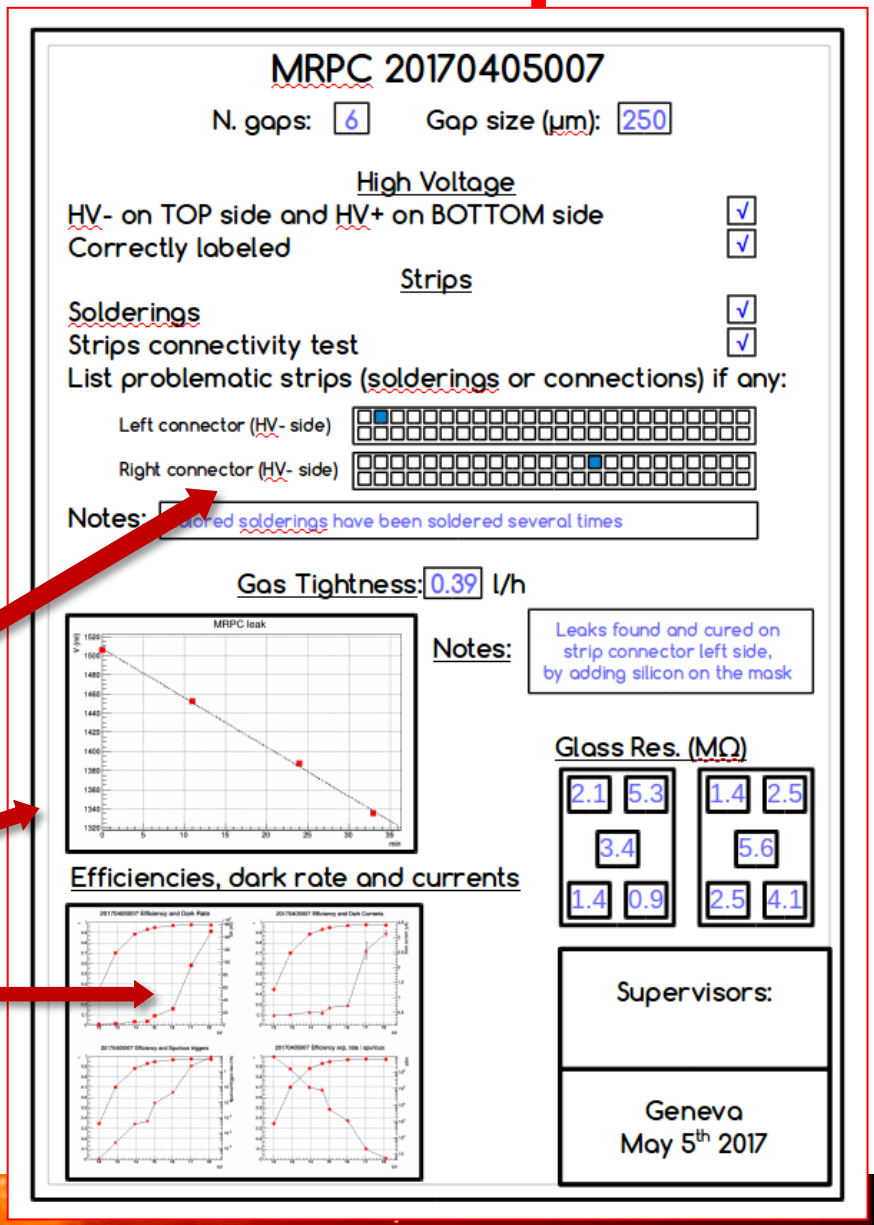
## New test protocol at CERN

✓Tests on electrical (strip) connectivity

✓Tests on gas tightness

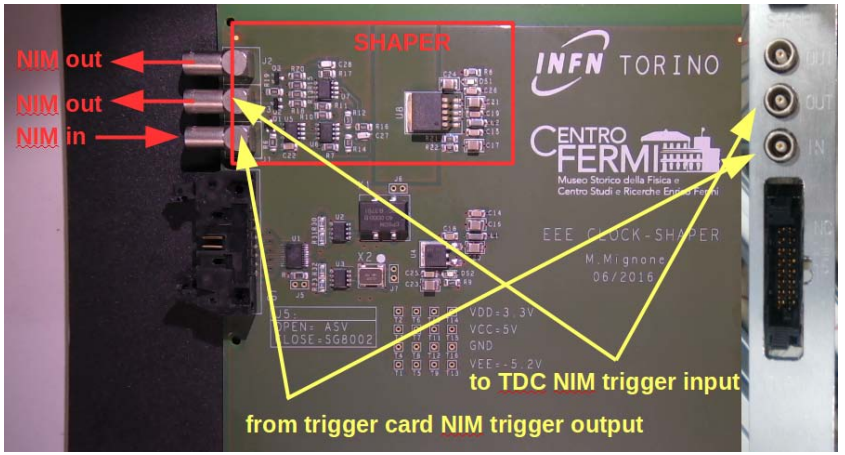
✓Tests on current, rate and efficiency

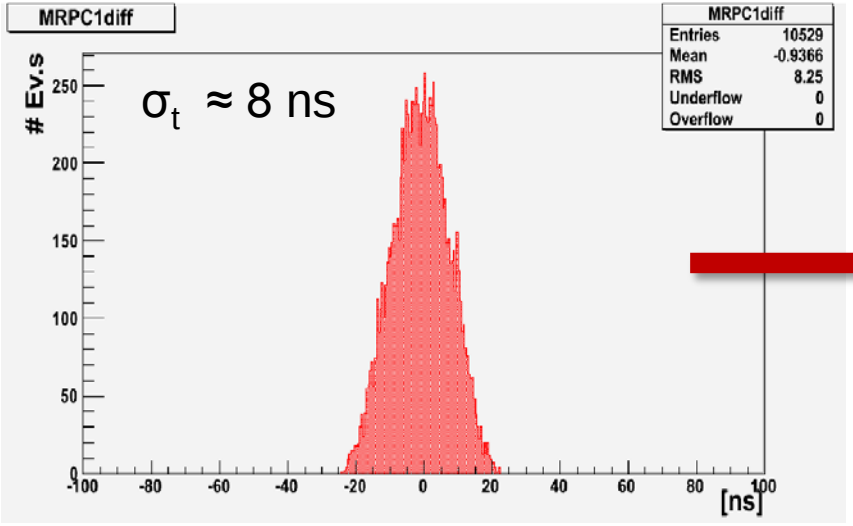
✓Everything stored in a dedicated DB

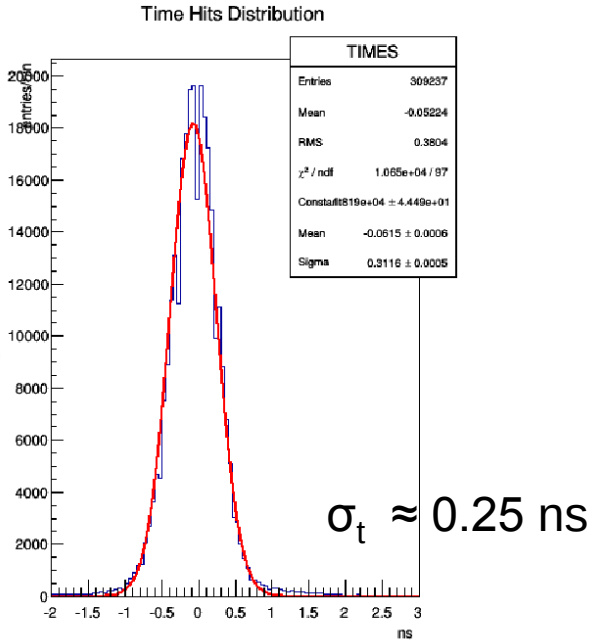


# EEE clock distribution card

- ✓Designed at INFN Torino
- ✓Distributed the same clock to the two TDCs of the EEE readout
- ✓Essential to exploit time info from the middle chamber
- ✓Built and installed in all EEE telescopes




Tres =254 ps

# New trigger/GPS cards

✓Developed between Bari and Lecce INFN sections

✓Joins the functionalities of the present trigger and GPS boards (+ GPS interface)

✓Additional functionalities:

-clock distribution

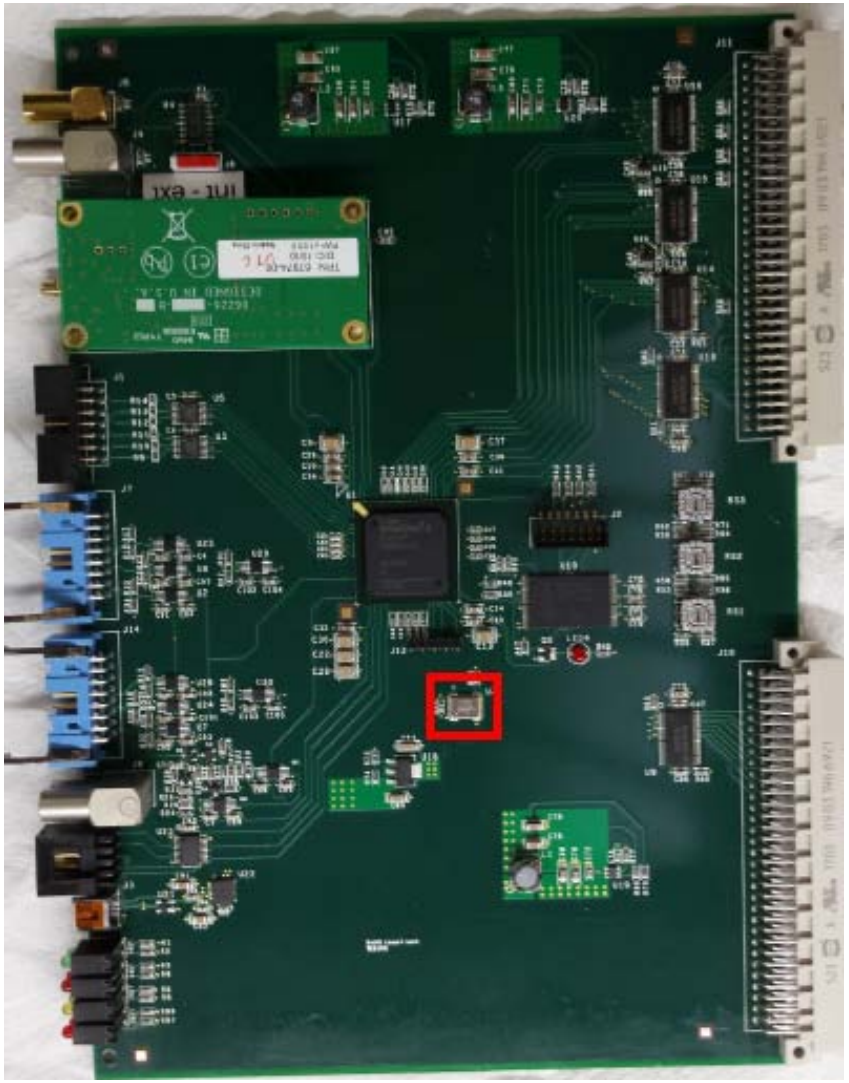
-counters accessible via VME

- trigger logic programmable via VME

✓Already installed at:

LODI-02, VICE-01, TORI-01…

✓Going into production now



# EEE: the taskforce

➢ A task force of hardware experts, to intervene where setting up/commissioning/reparation of an EEE telescope is needed

✓Started activity at beginning of 2017


Already interventions at:

➢TREV-01 (commissioning, now telescope taking part to the data taking)

➢VICE-01 (telescope set-up, now taking part to Run-4)

➢ROMA-01, ROMA-02 (testing and repairs)

➢VICE-01 (telescope set-up, now taking part to Run-4)

➢FRAS-02, FRAS-03 (some repairs)

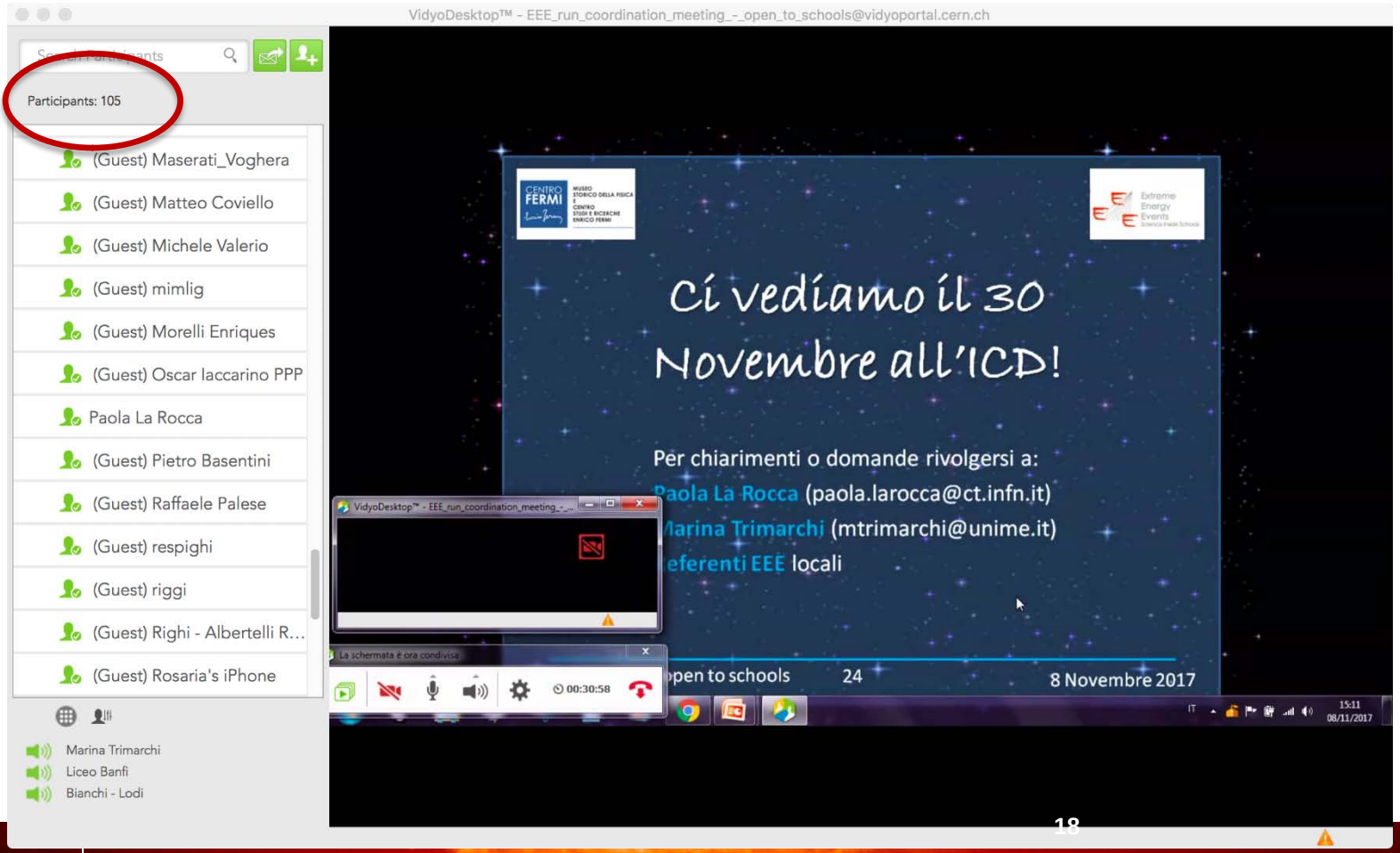
➢Programming interventions at LECCE, ROME, etc.

# EEE meetings with schools

- Since end of 2016 monthly EEE run coordination meetings open to schools

✓Using dedicated Vidyo virtual rooms

✓Around 100 schools connected → hundreds of participants!

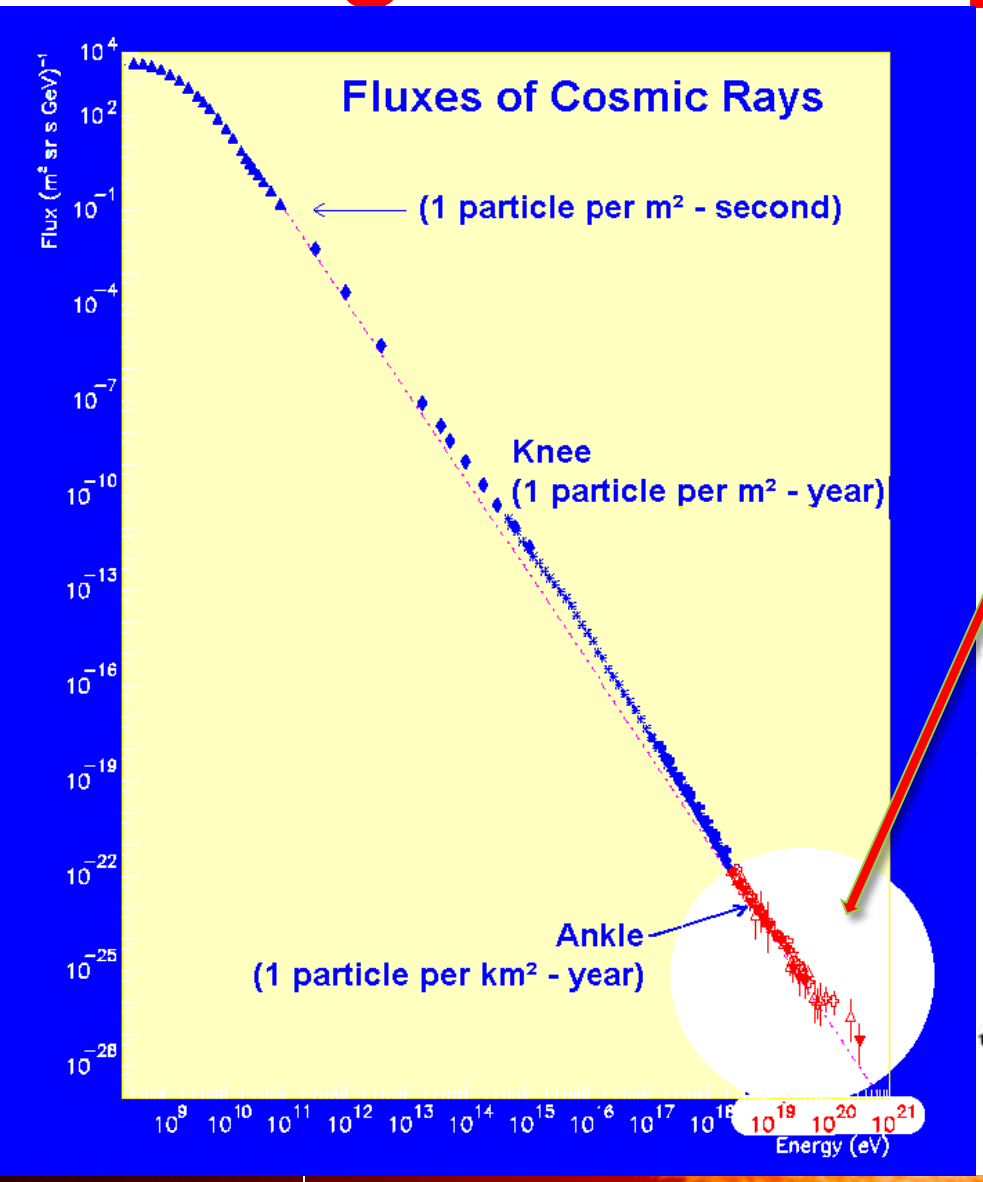


# EEE plenary meetings

- ✓Bologna, November 6-7
  North Italy schools
- ✓Grosseto, April 15-16
  Center Italy schools
- ✓Bari, October 13-14
  South Italy schools

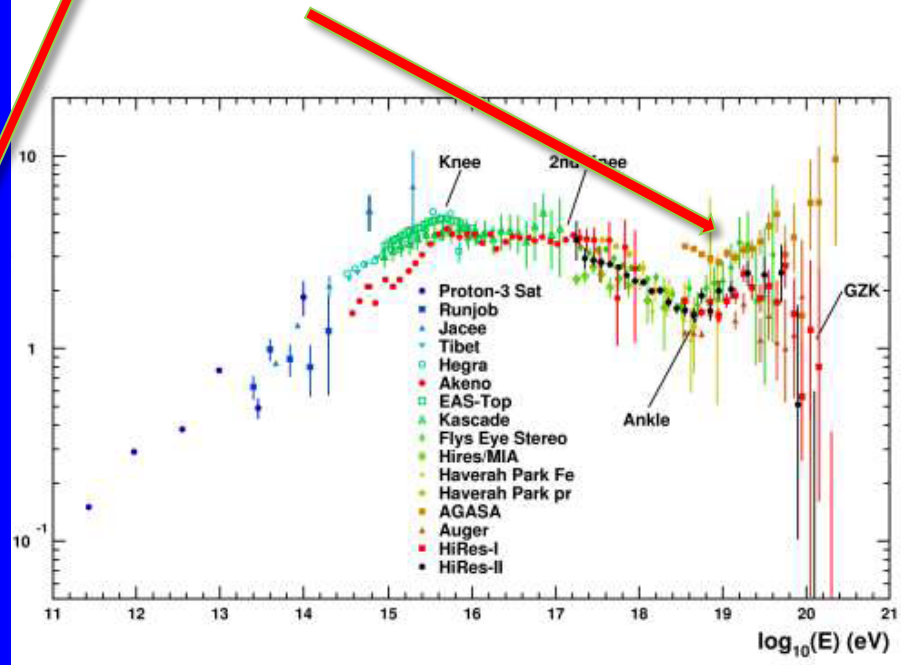

Erice 2017:
- ✓May, 29, 30 and 31
- ✓December, 6, 7 and 8

# EEE: goal of the project




Aims at covering the most interesting, and still unexplored, region of the cosmic ray spectrum:

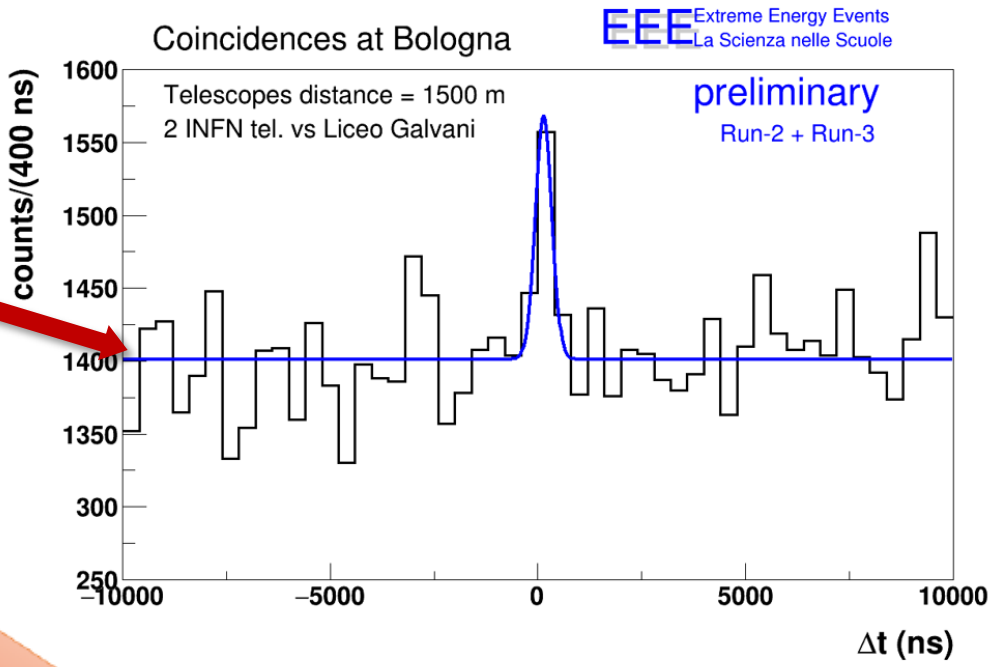
- ✓$E > 10^{18}$ eV
- ✓Extragalactic sources
- ✓GZK cutoff
  (Greisen, Zatspein and Kuz'min)



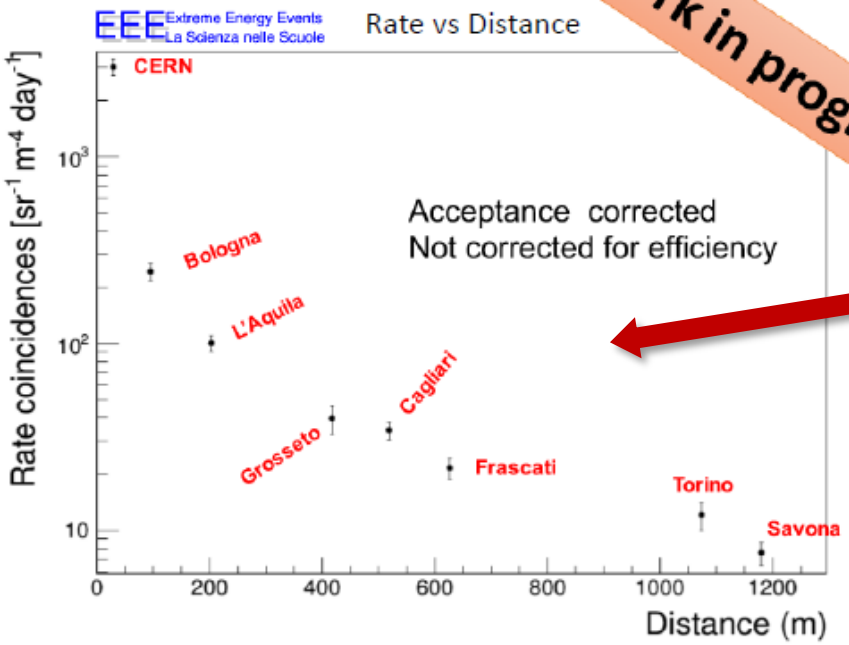
# EEE coincidences searches

➢Detected coincidences at 1.5 km

✓Higher distance → higher energy




work in progress




➢Coincidence rate vs. distance

✓Each cluster is sensitive to showers of Energy high enough to involve both stations

➢Need an accurate Monte Carlo

✓Simulate shower development

✓Simulate environmental effects

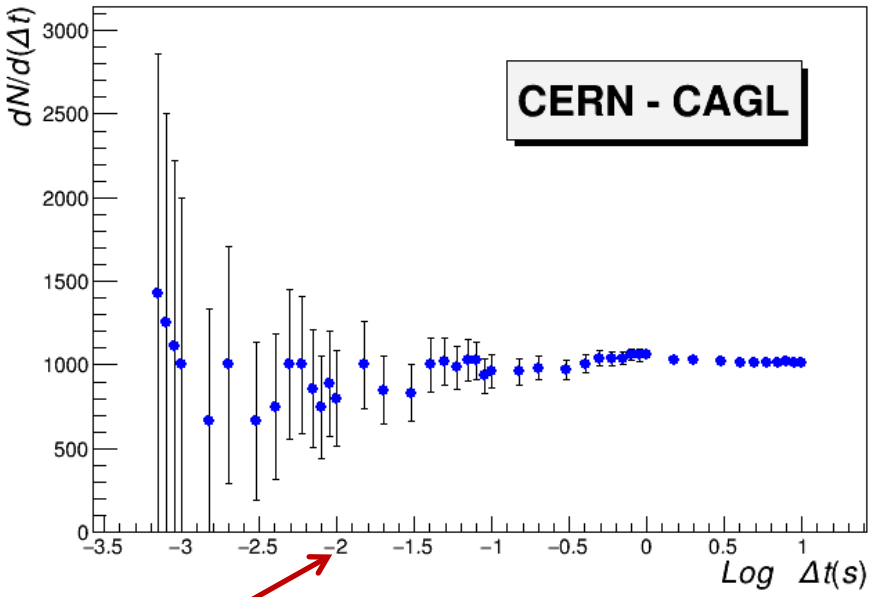
# EEE: long distance correlations

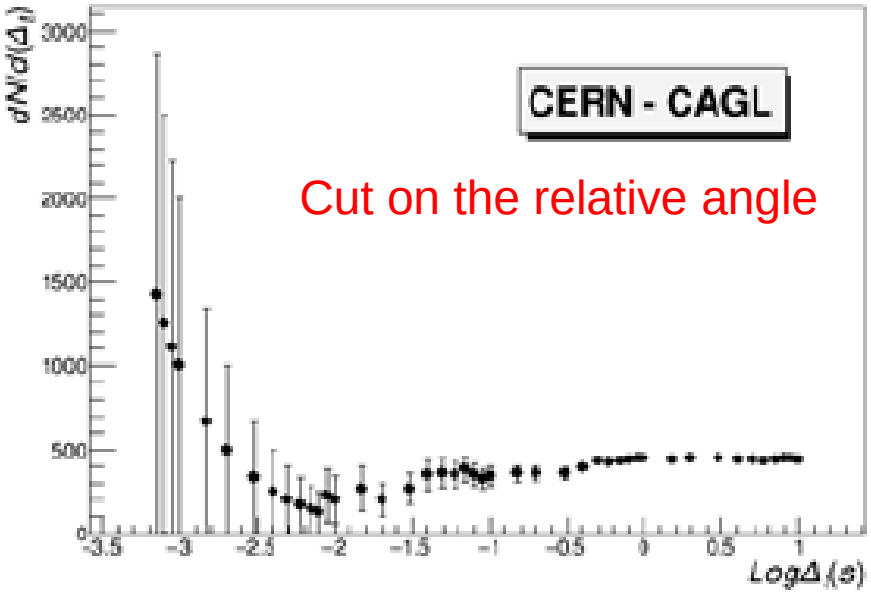
➢Strategy: correlations between individual showers in telescopes clusters

✓Shower rate: 0.001 - 0.04 Hz (depending on cluster and S/N ratio)

✓Spurious rate in 1 ms: $10^{-8}$ - $10^{-7}$ Hz (0.001 - 0.01/day)

Number of events dN/d(Δt) for decreasing time window




10 ms

Not the same results for all pairs of clusters: studies ongoing!

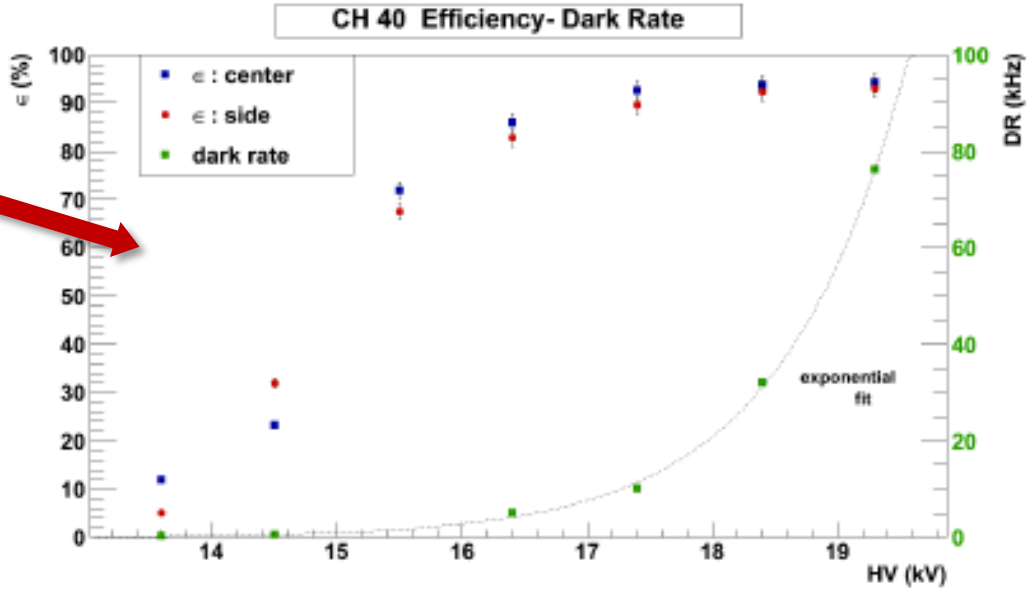
# EEE chamber performance

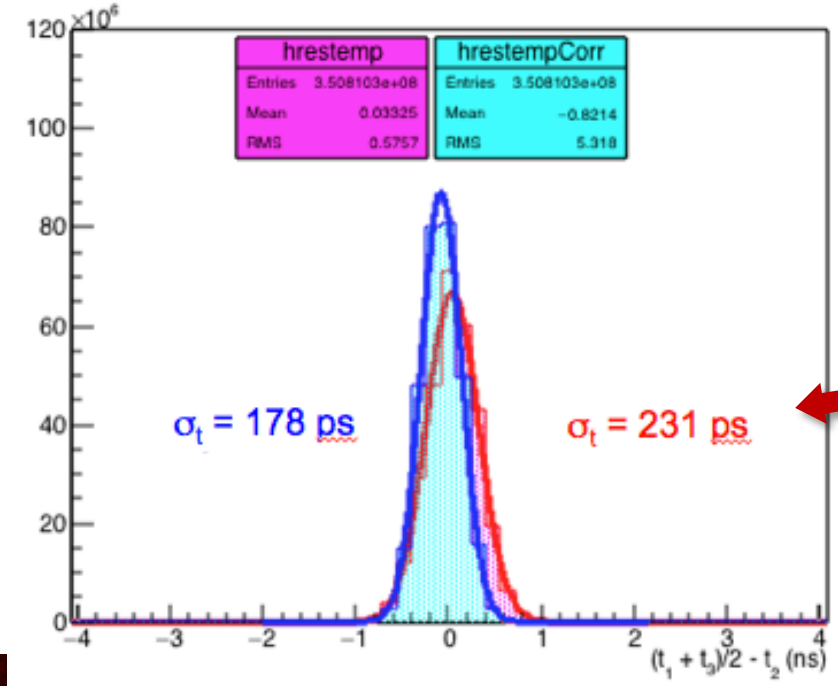
➢Efficiency measurements

✓…and counting rate

➢Efficiency HV scan performed last year (middle chamber)

✓To be repeated for all chambers

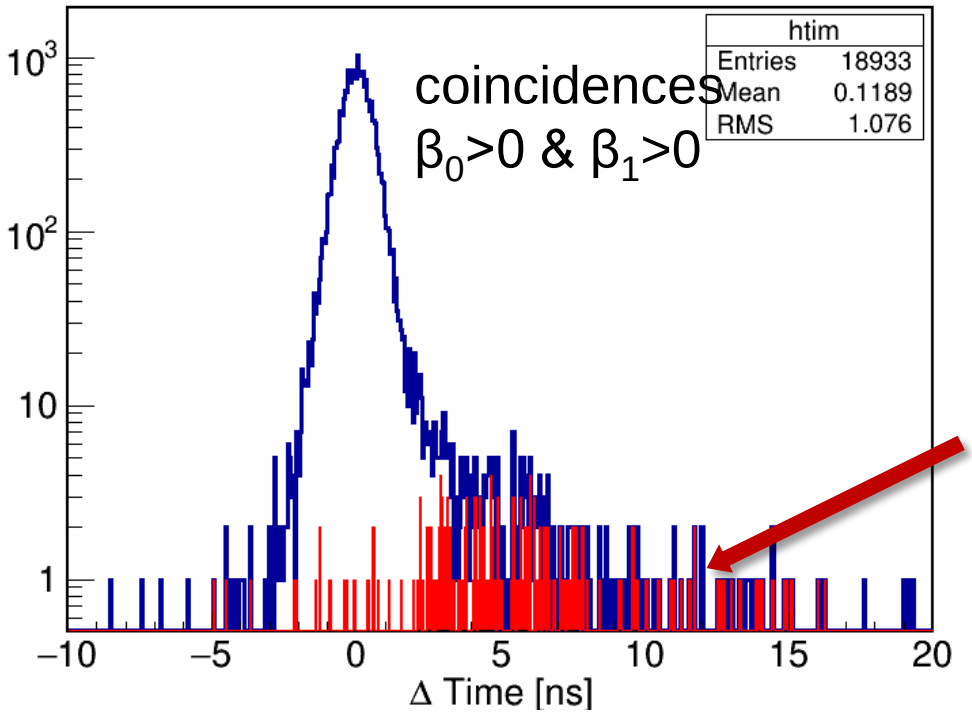


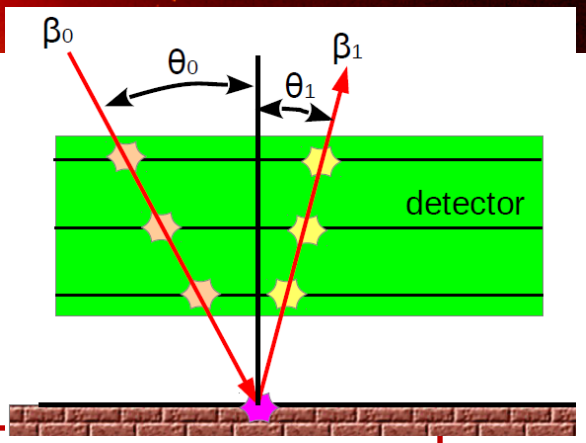




➢Time resolution measurements

✓With time slewing corrections, improving time resolution about 20%

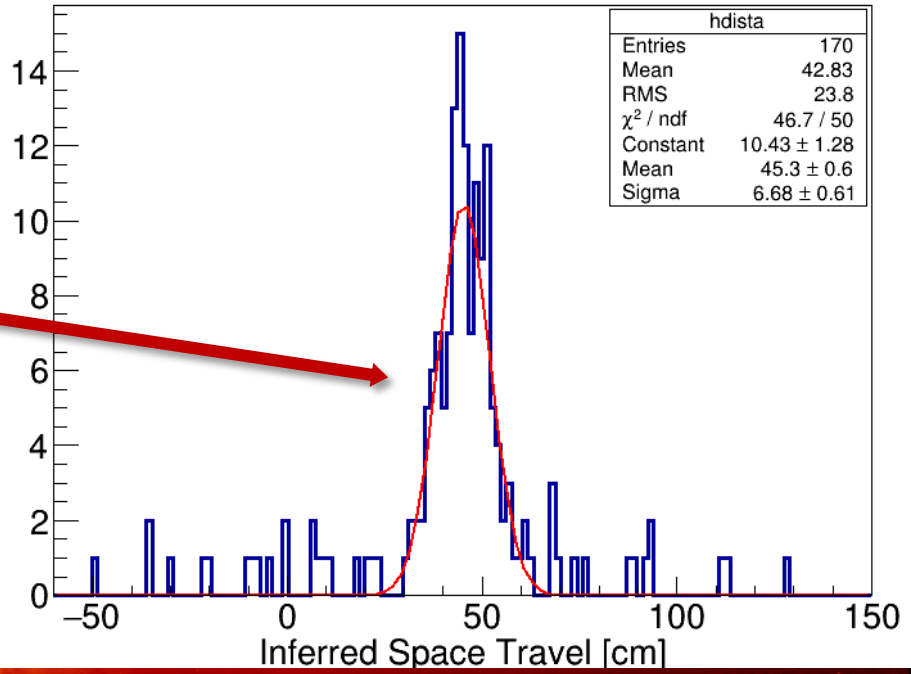
# Backscattered events



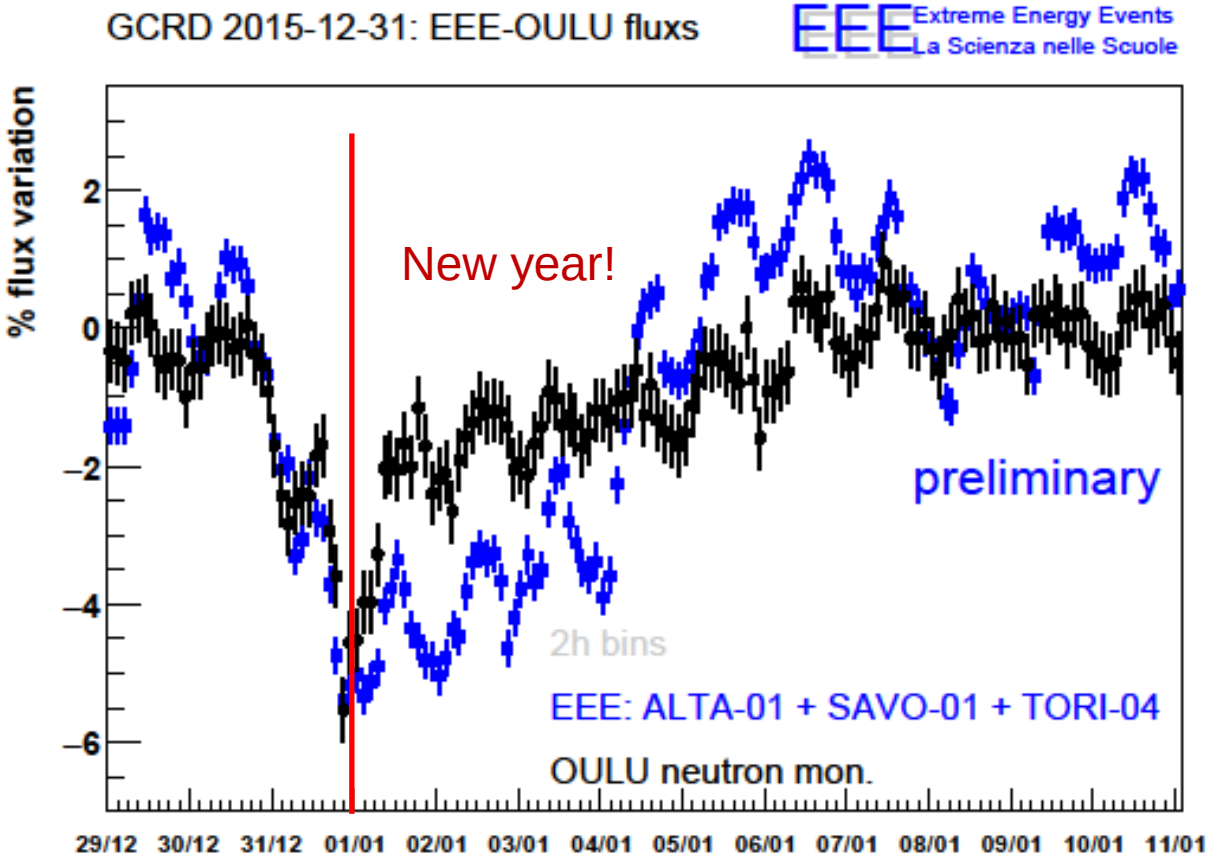

170 Backscattering events:
$\beta_0>0$ && $\beta_1<0$
Large time difference due to Time Of Flight

Inferred distance to the ground:
46 cm below the telescope



# Being up h24...


The 2016 new year Forbush: at 24.00 of 31/12/2015 our telescopes **-in schools-** were up and running!




All EEE papers: http://eee.centrofermi.it/collaboration/pubblicazioni

# The future is now: Run-4


➢Start: 2 October 2017 – End: 31 May 2018

✓Commissioning week: 25 September 2017 – 1 October 2017

Schools are called to:

- fix all issues in their telescopes
  - ✓ 50 cm distance between chambers
  - ✓ 2 l/h gas flow
- Complete the measure of the telescope angle wrt. North
- Start measures of the gas consumption
- Telescope startup and shutdown responsibility of the schools

Read emails, diffuse them and react

Take part and present to the EEE Run meetings open to schools

Keep the telescope in operation

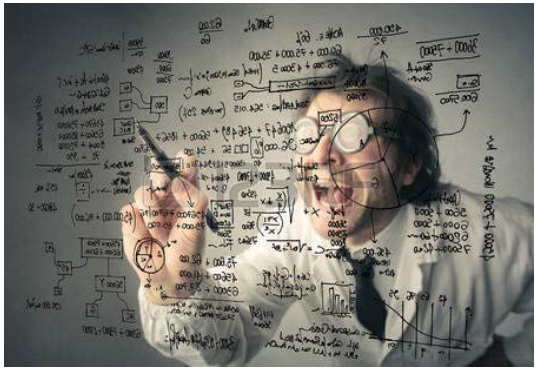
Monitor the telescopes (ALL)

# Conclusions


- The EEE experiment is an innovative approach to:
  - ✓ scientific research + scientific communication

- Its stations, <u>located in high schools</u>, take data almost continuosly
  - ✓incredible enthusiasm by students and teachers

- EEE produces <u>-a lot of-</u> physics!
  - ✓detectors performance similar to LHC
  - ✓very interesting observations of cosmics phenomena



But, above all…


… it is a lot of fun!

**… it is a lot of fun!**

# The End:

- ✓ Thanks for the attention
- ✓ Questions?