Extreme Energy Events: requests for the INFN station

47 telescopes in High Schools

+ 2 telescopes at CERN
+ 4 telescopes in INFN Units
[Bologna (2), Catania, Pisa]

Total: 53 telescopes

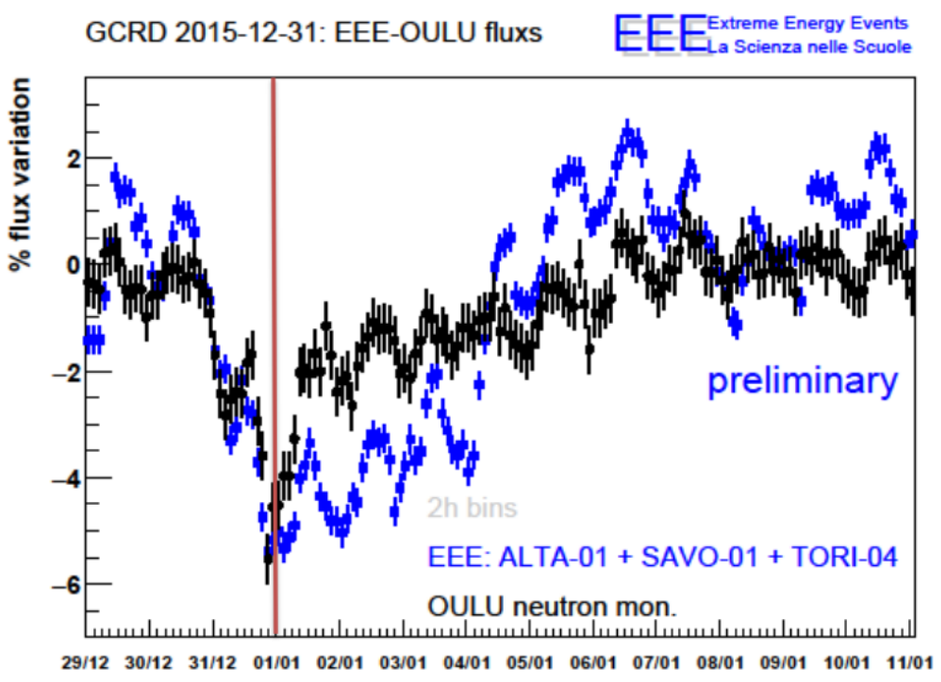
Mostly distributed in clusters over the whole Italian territory (+ Geneva)

… 49 Italian High Schools participating without telescopes
+ 1 in Korçë, Albania

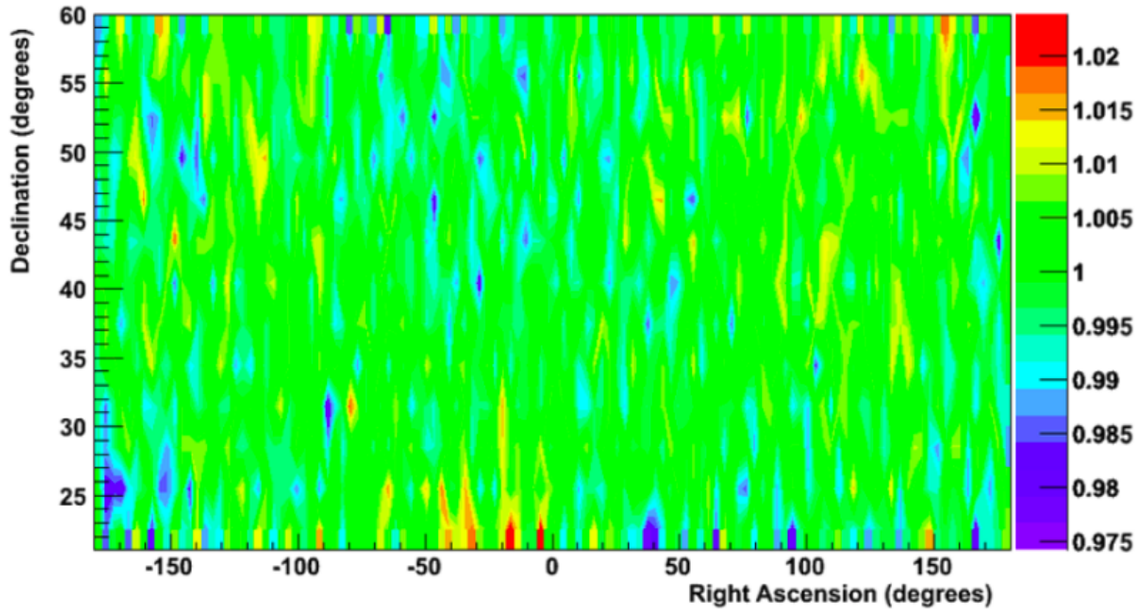
- *Telescopes in operation in High Schools*
- *Telescopes in operation in Research Labs*
- *High Schools without telescopes*

Telescopes are arranged in clusters
with typical distances
100 m to 6 km.
Each cluster size shows
different energy thresholds:
i.e. 3 station - 1 km clusters
$E_{th} \sim 10^{17}$ eV.
Clusters are 30 - 1000 km far away.

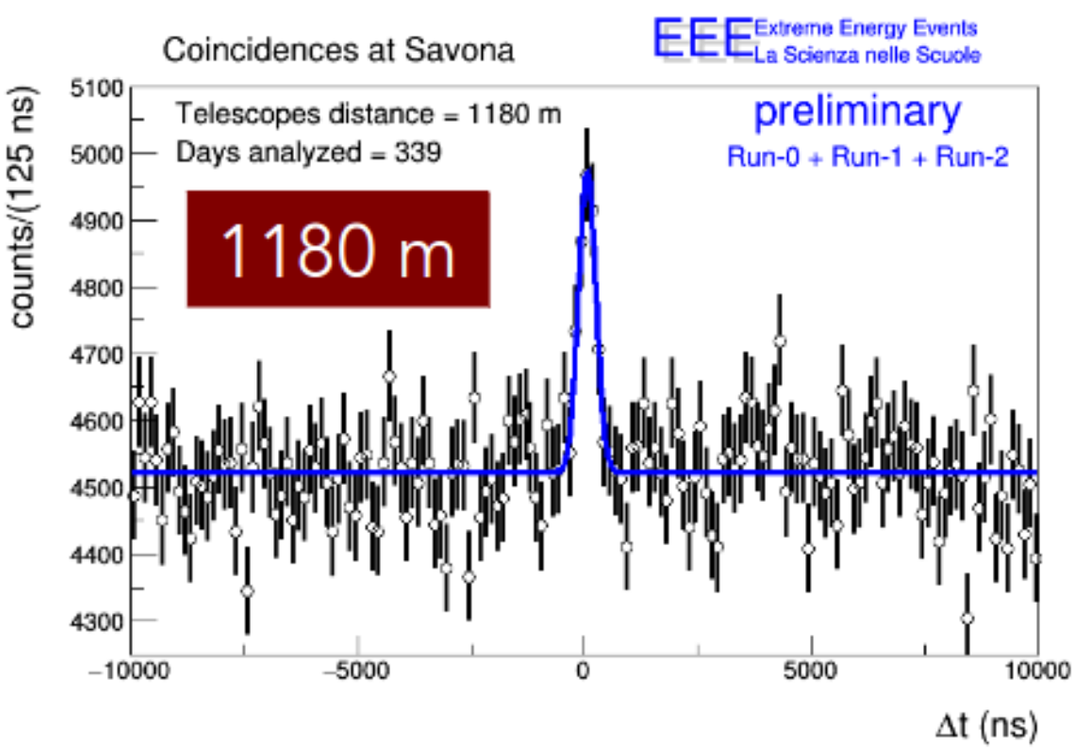
Solar activity Survey

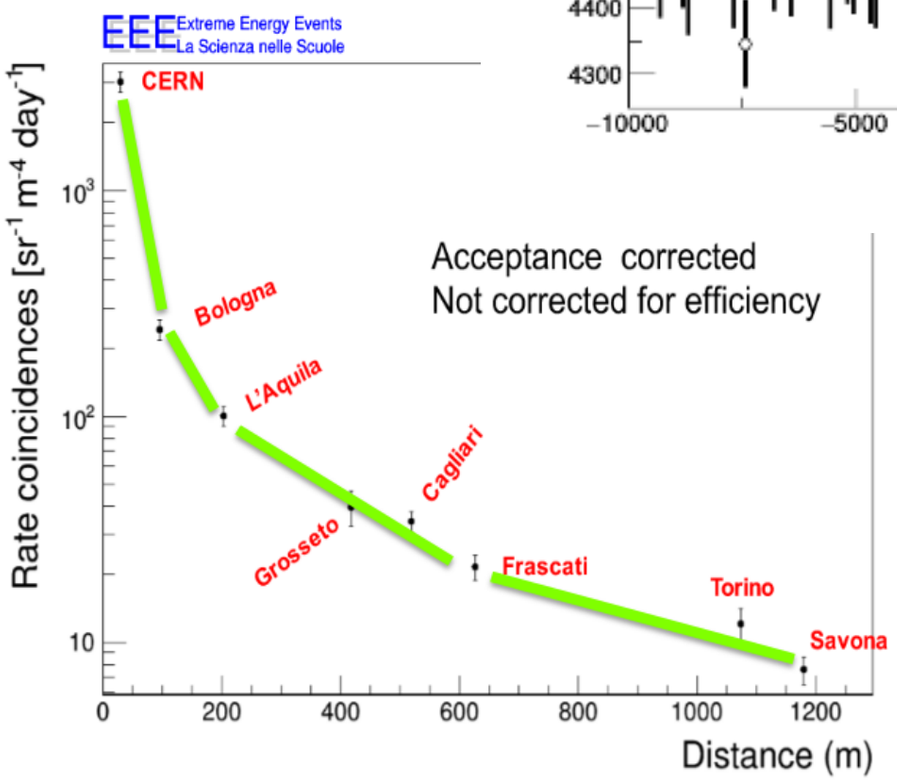


CR anisotropies

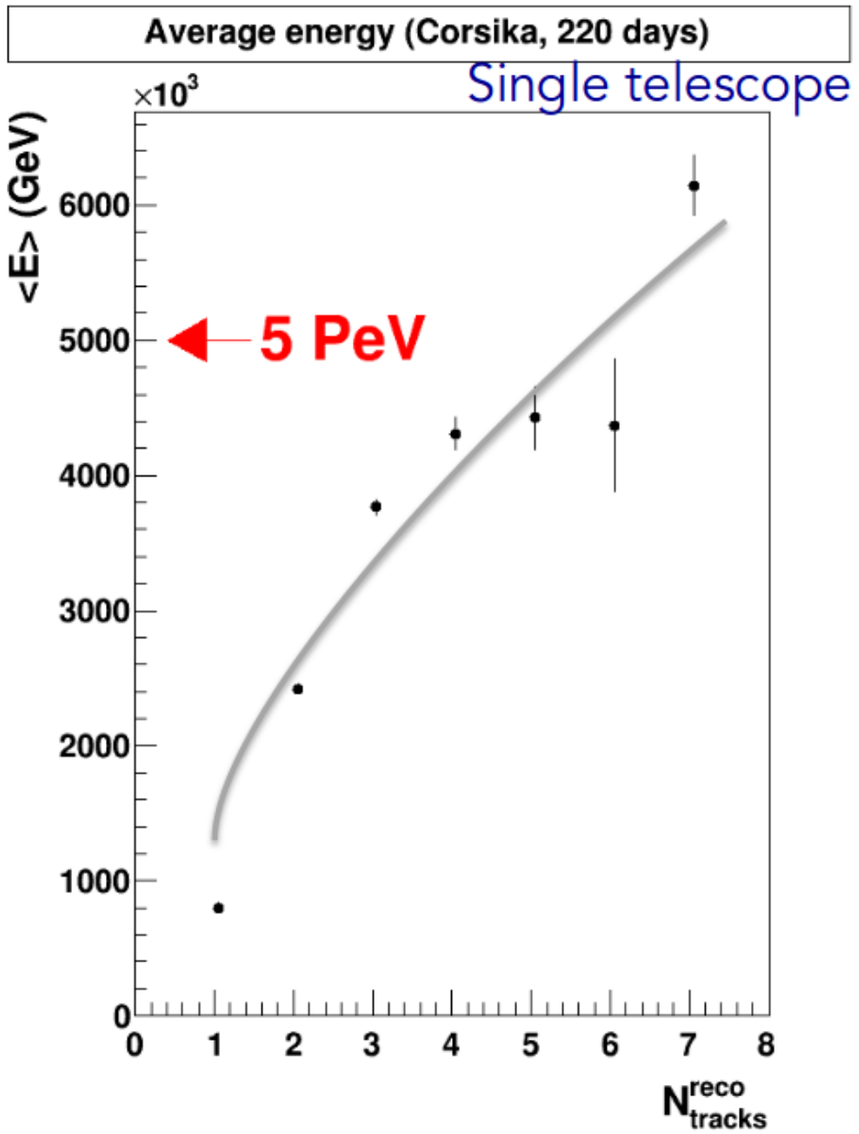


EAS





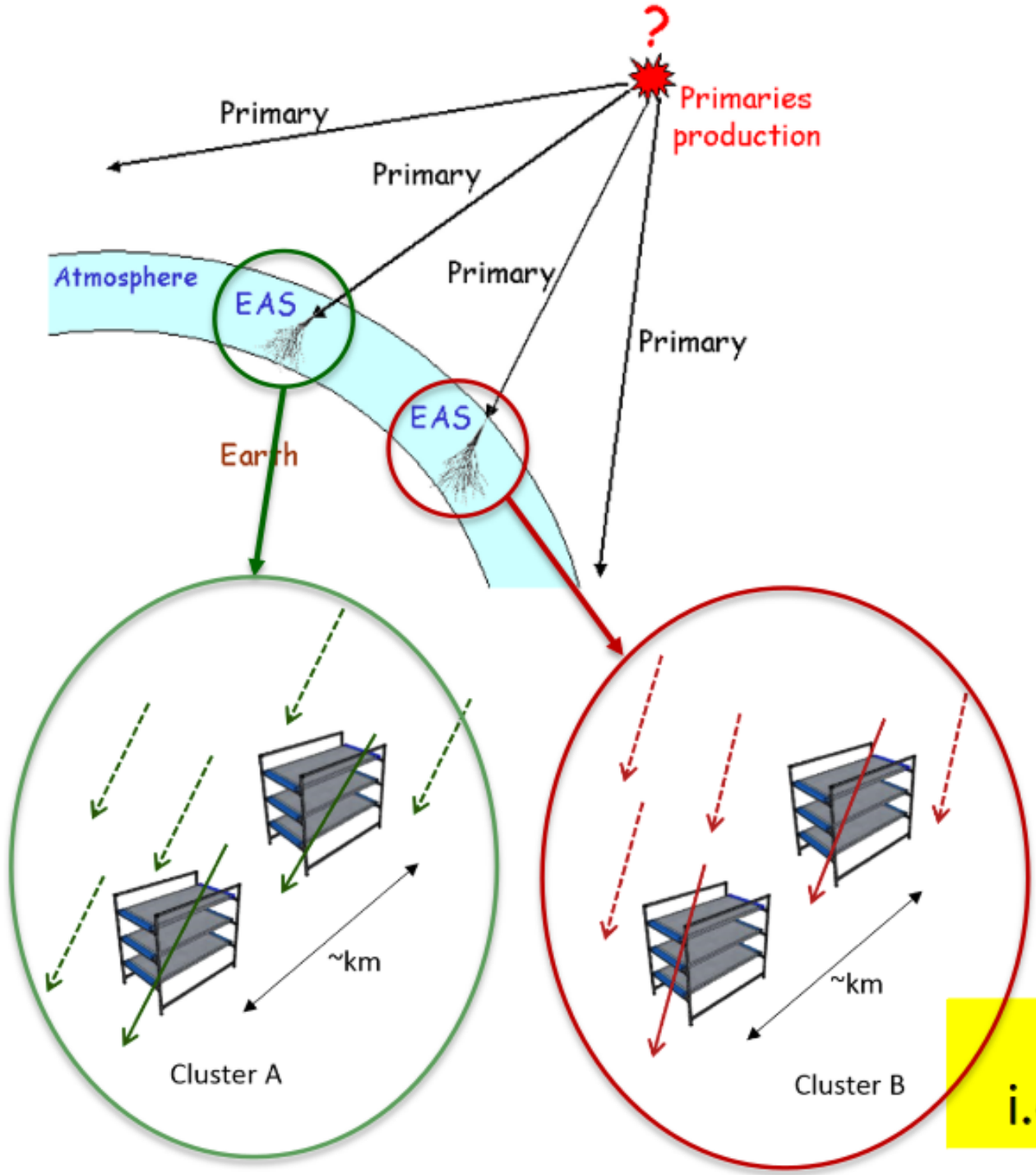
EAS coincidence peaks at different distances



First trials in primary energy estimation

Large distance shower correlations

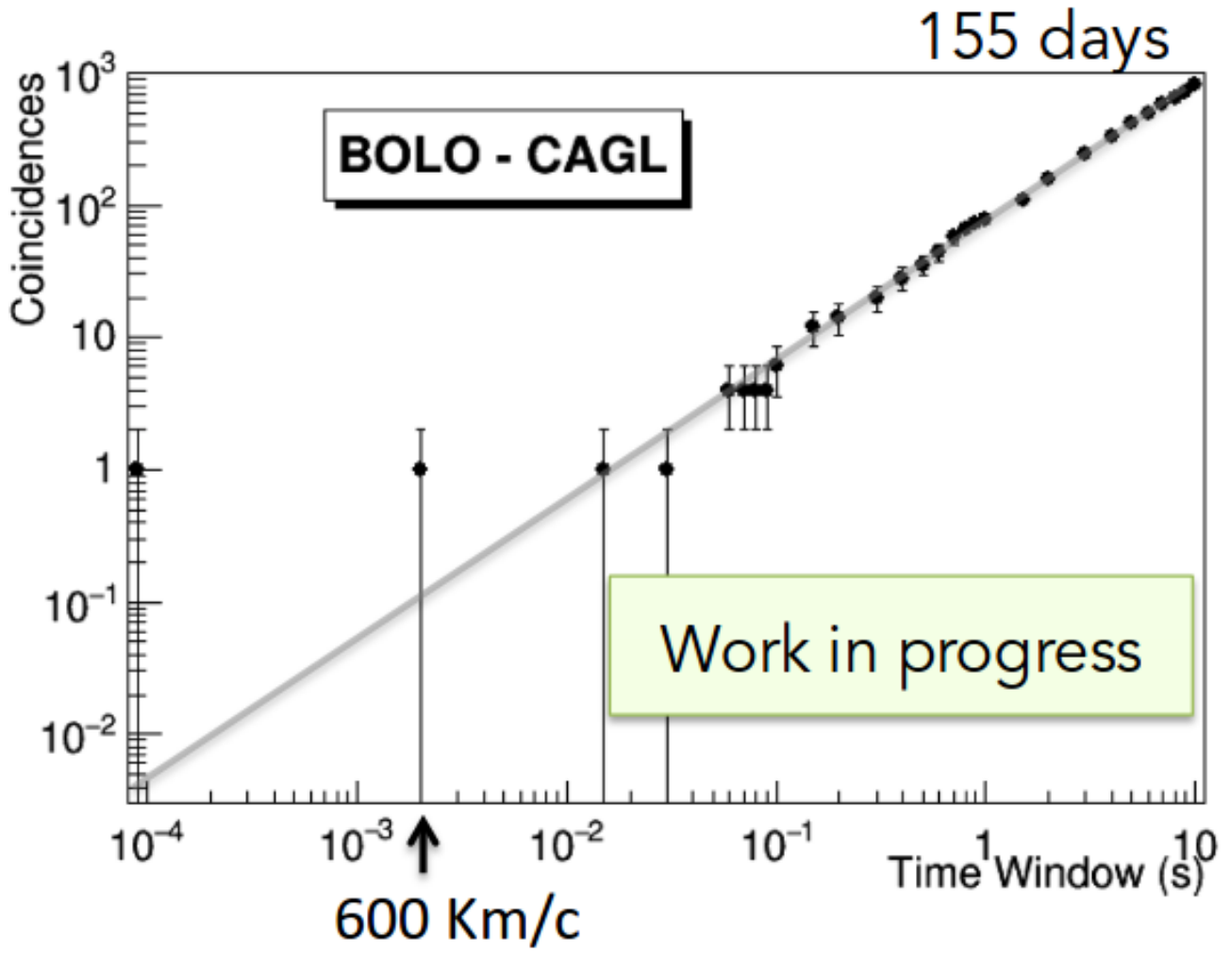
Extensive Air Showers (EAS) reconstructed via clusters (2-telescope coincidences)



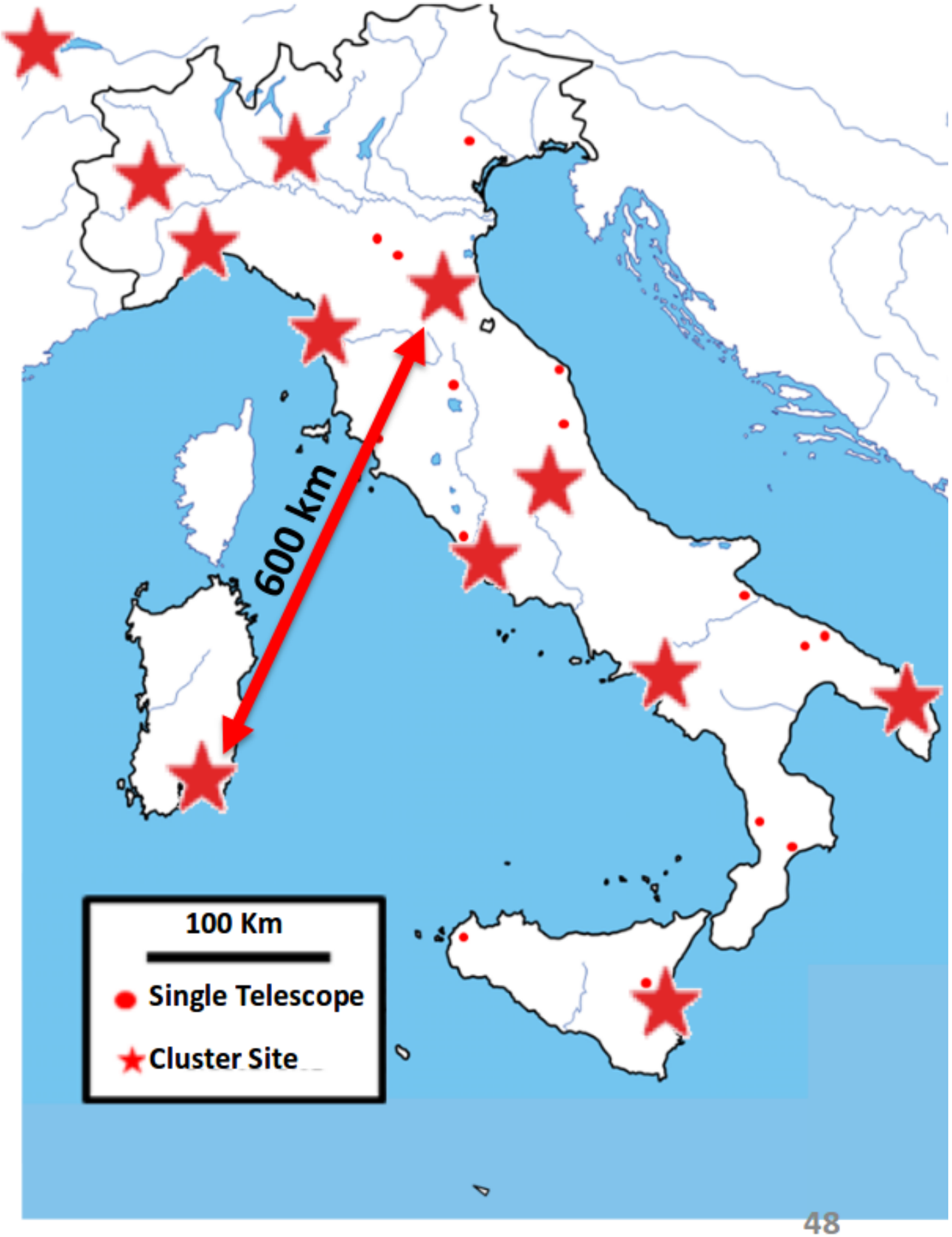
Search for coincidences of 2 showers
i.e. 2 clusters = 2 x (2-telescope coincidences)

Large distance shower correlations

2-cluster coincidence for decreasing time window



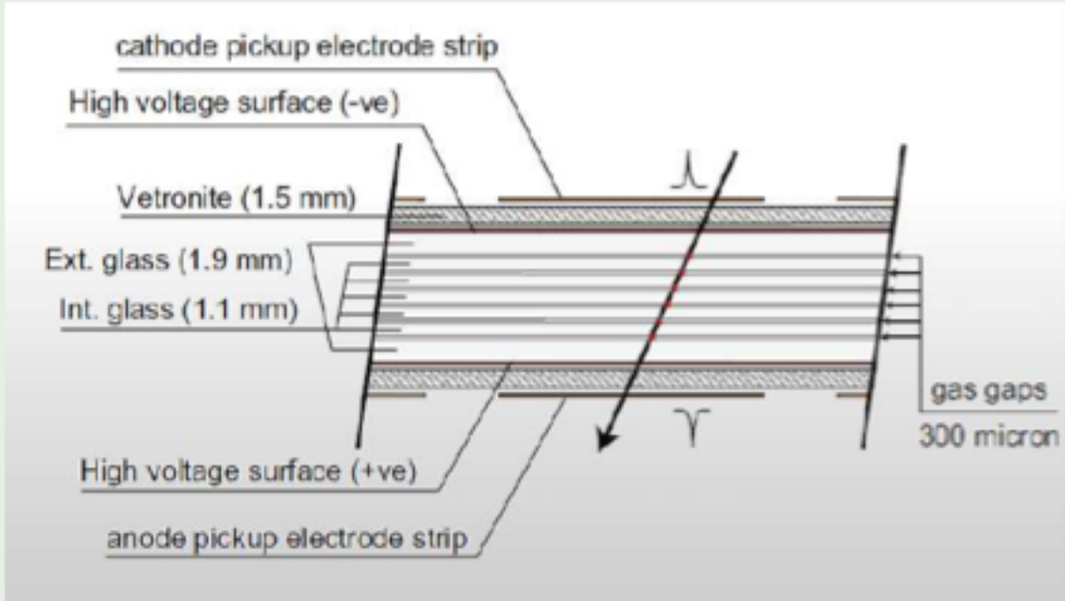
No direction correlation between clusters
(latitude correction needed ≈ 7° North-South)



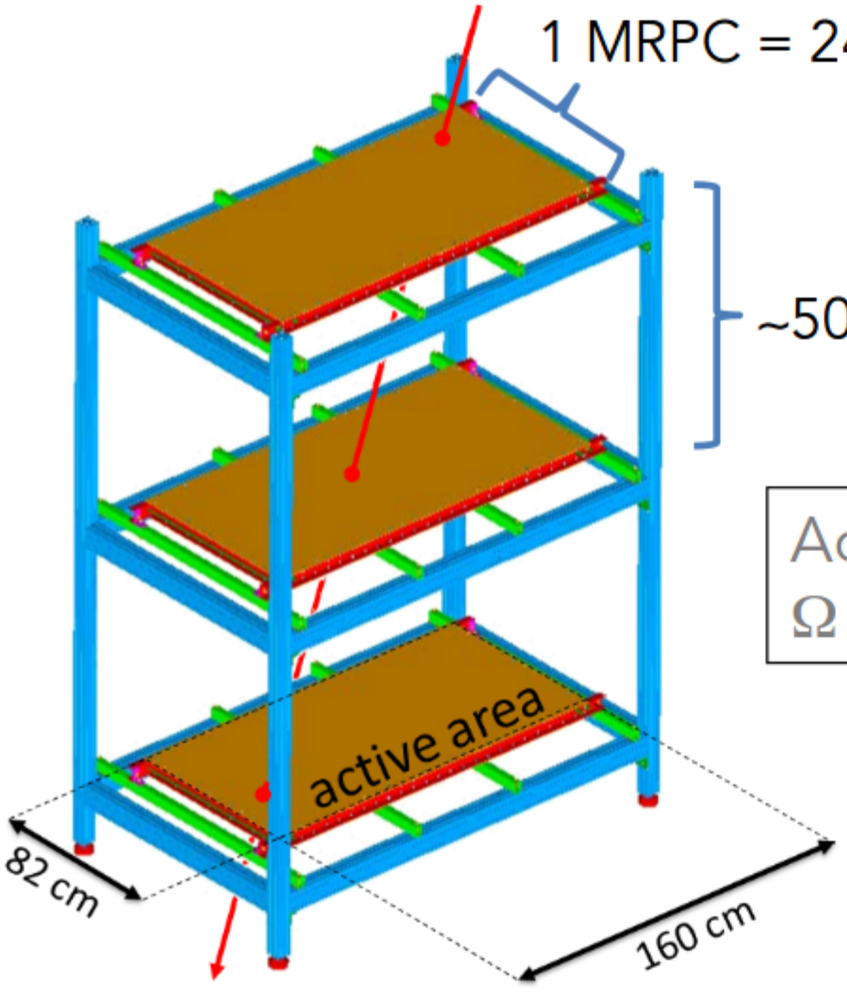
The Multigap Resistive Plate Chambers

EEE chamber is an extended version of ALICE TimeOfFlight modules

- 6 gas gaps: 2 glass plates with their external surfaces painted with resistive paint; 5 floating glass plates (spaced by 300 μm)
- $C_2H_2F_4$ (98%) and SF_6 (2%) continuously fluxed by (3l/h)

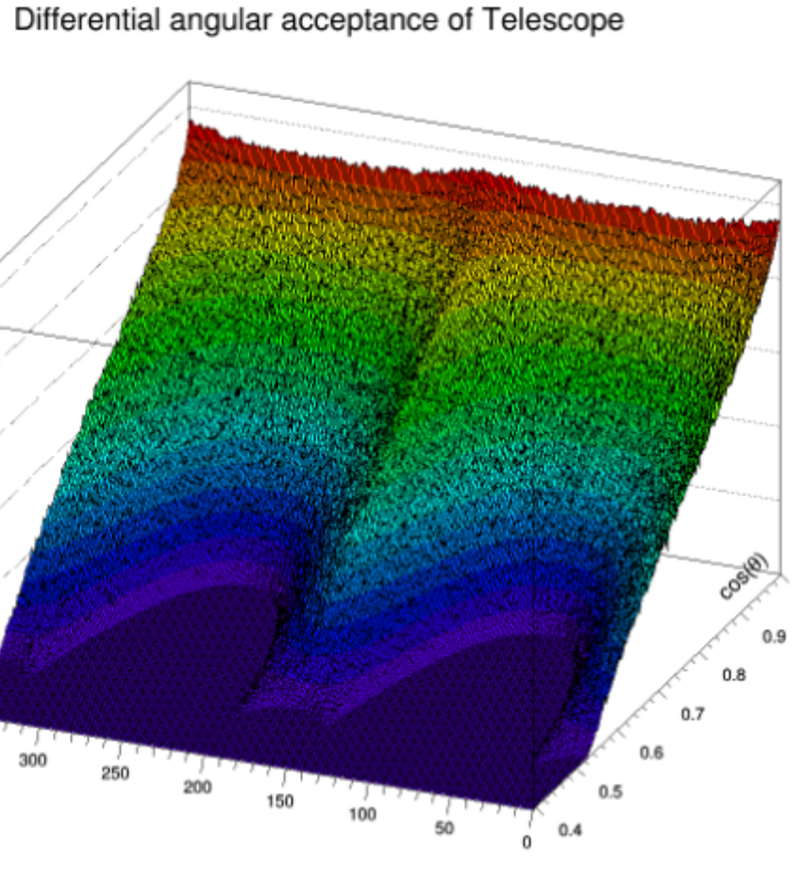


The EEE telescope



MRPC chambers are built by High School students at CERN (starting from 2004) and maintained by them under the supervision of EEE researchers

Acceptance
Ω = 1.6 sr

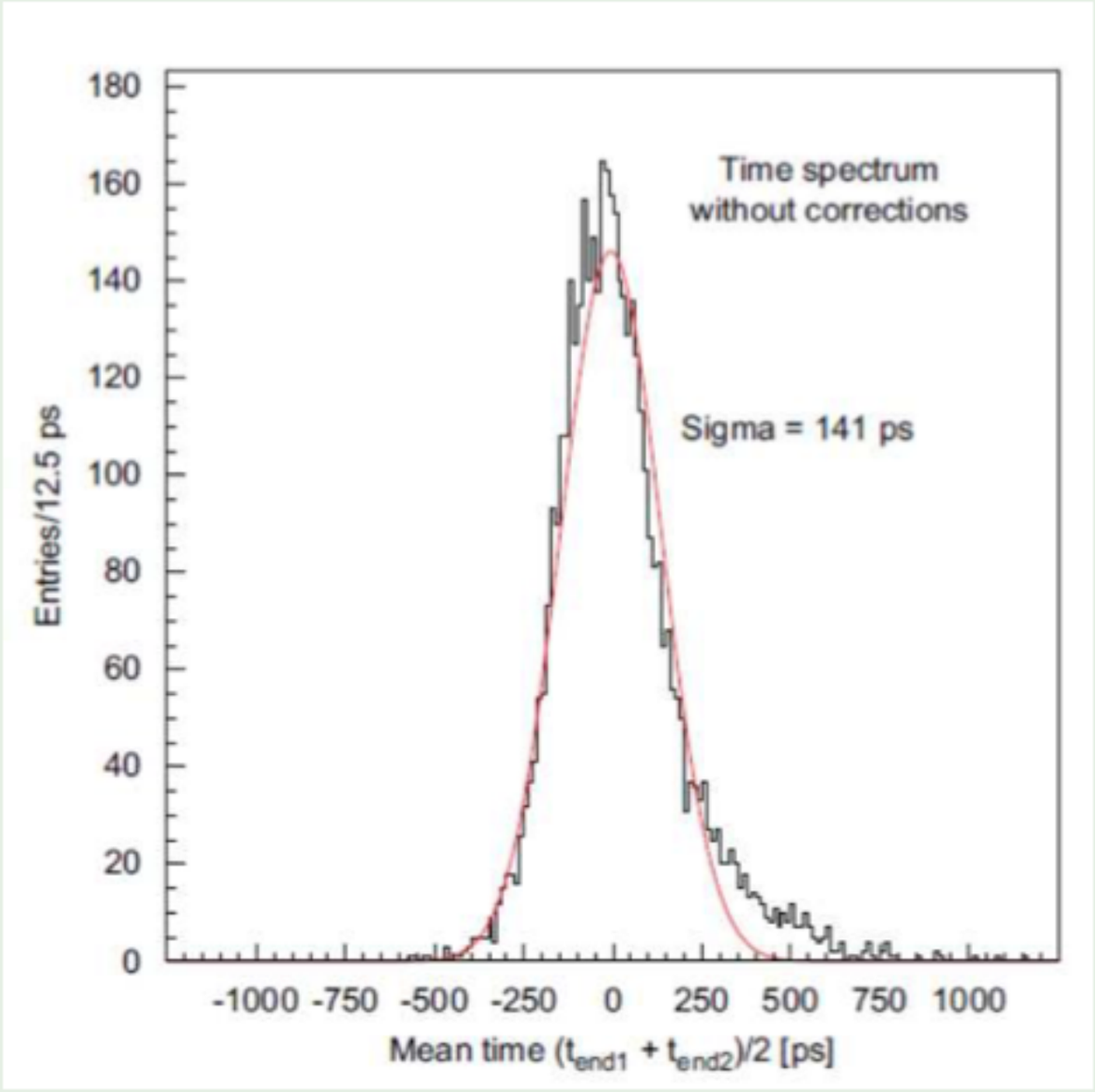


3 MRPC planes with 24 strips each read at both ends → **144 readout channels**

- The trigger requires a hit signal on each end of the 3 MRPCs **within a ±500 ns window**
- Cosmic muons are **tracked** & reconstructed

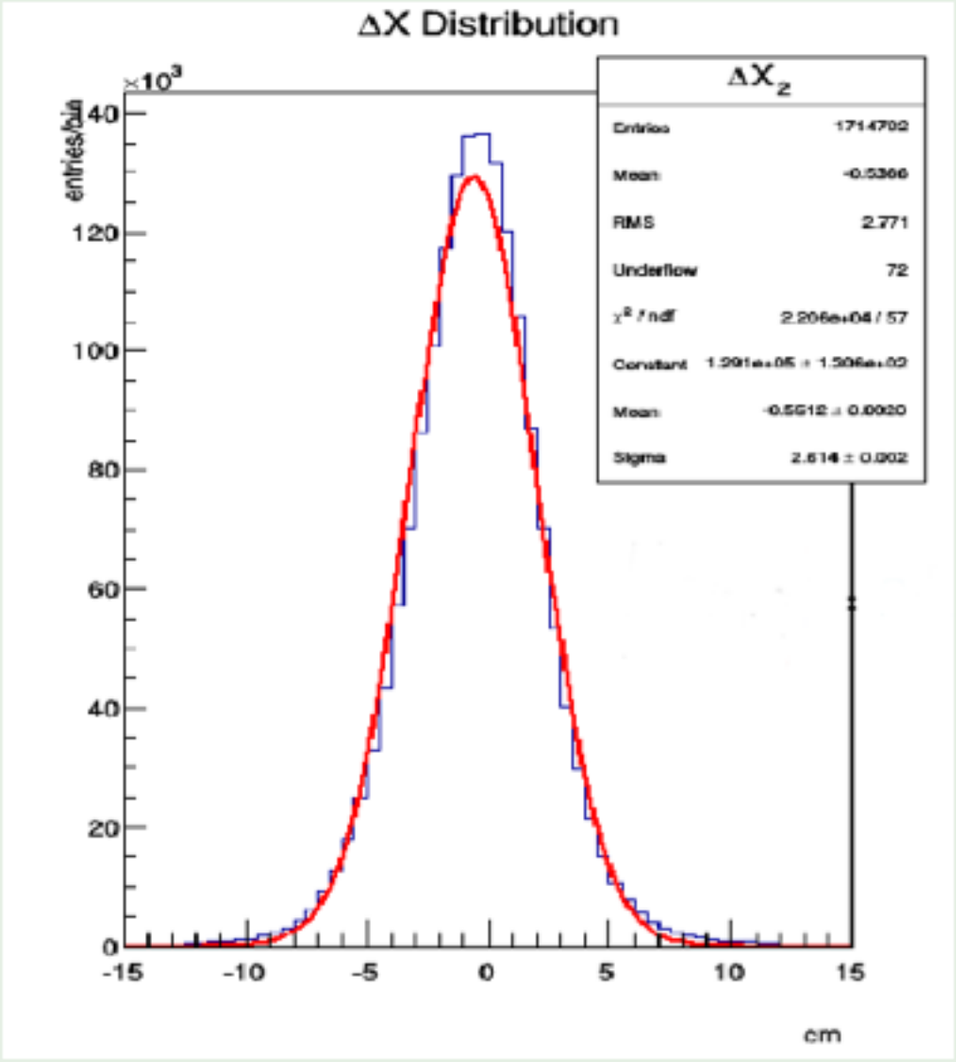
Time Resolution

@ CERN Test Beam



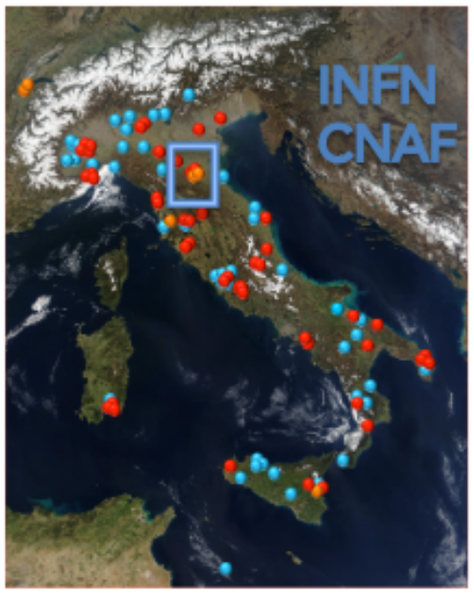
$\sigma_X \sim 141$ ps

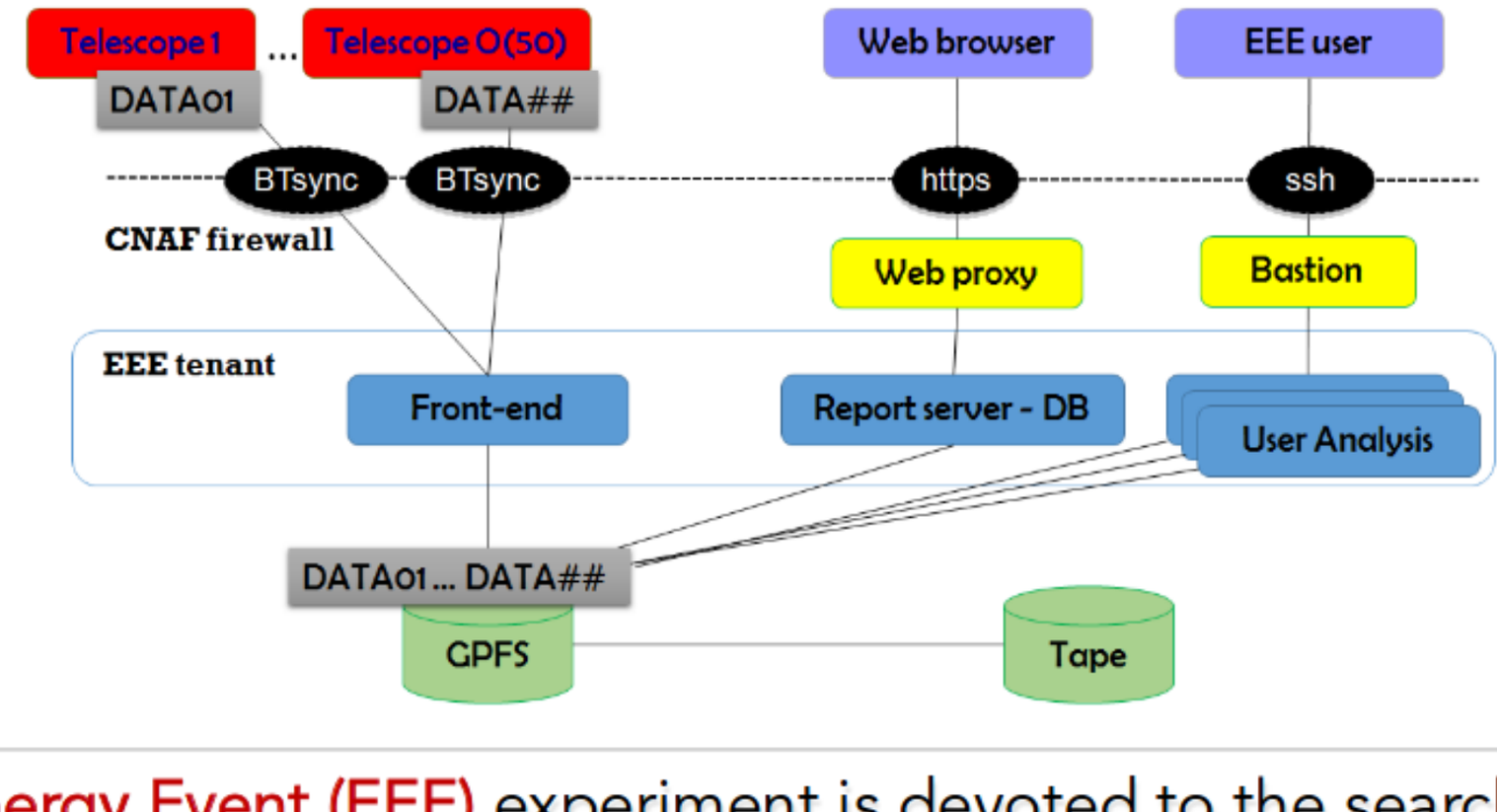
with Cosmic Rays



$\frac{2}{3}\sigma_X \sim 210$ ps

The computing and data infrastructure to interconnect EEE telescopes





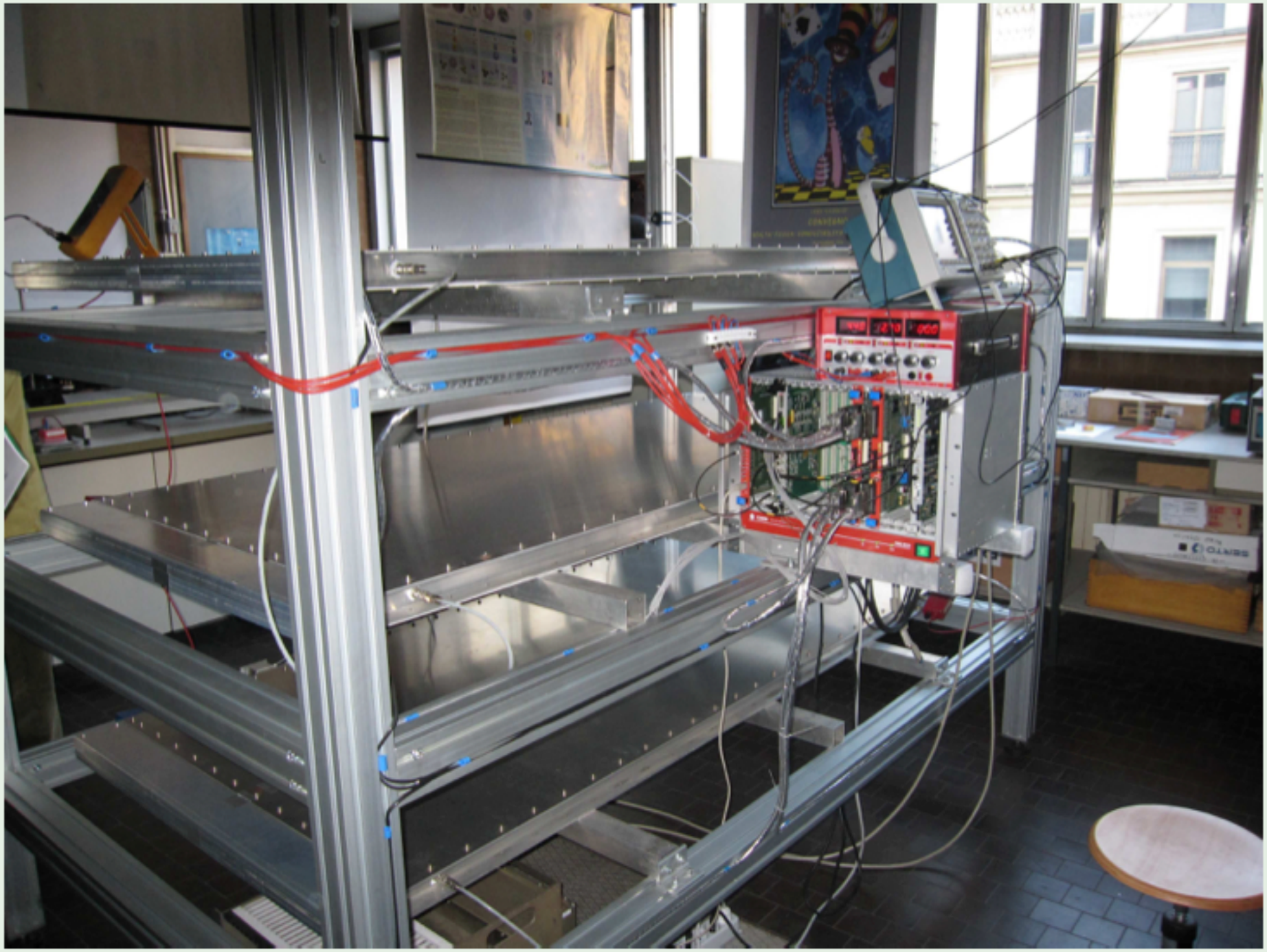
The Extreme Energy Event (EEE) experiment is devoted to the search of high-energy cosmic rays through a network of telescopes installed in about fifty High Schools distributed throughout the Italian territory.

One of the main goals of the project is to involve young students in a high-level scientific enterprise.

Therefore the experiment is very peculiar and requires new solutions for the data management.

Data are collected (all Schools → CNAF) and automatically reconstructed

The telescope equipment



The new station at INFN.
The first EEE 4-cluster

The 4th telescope would allow

- first estimate trials of EAS primary energy

And for EAS correlations

- background reduction

- 4 triplets
- 6 doublets

at present EEE got

~50 2telescope-cluster pairs
~1200 telescope pairs

The new station will be installed at the IV floor N.E.

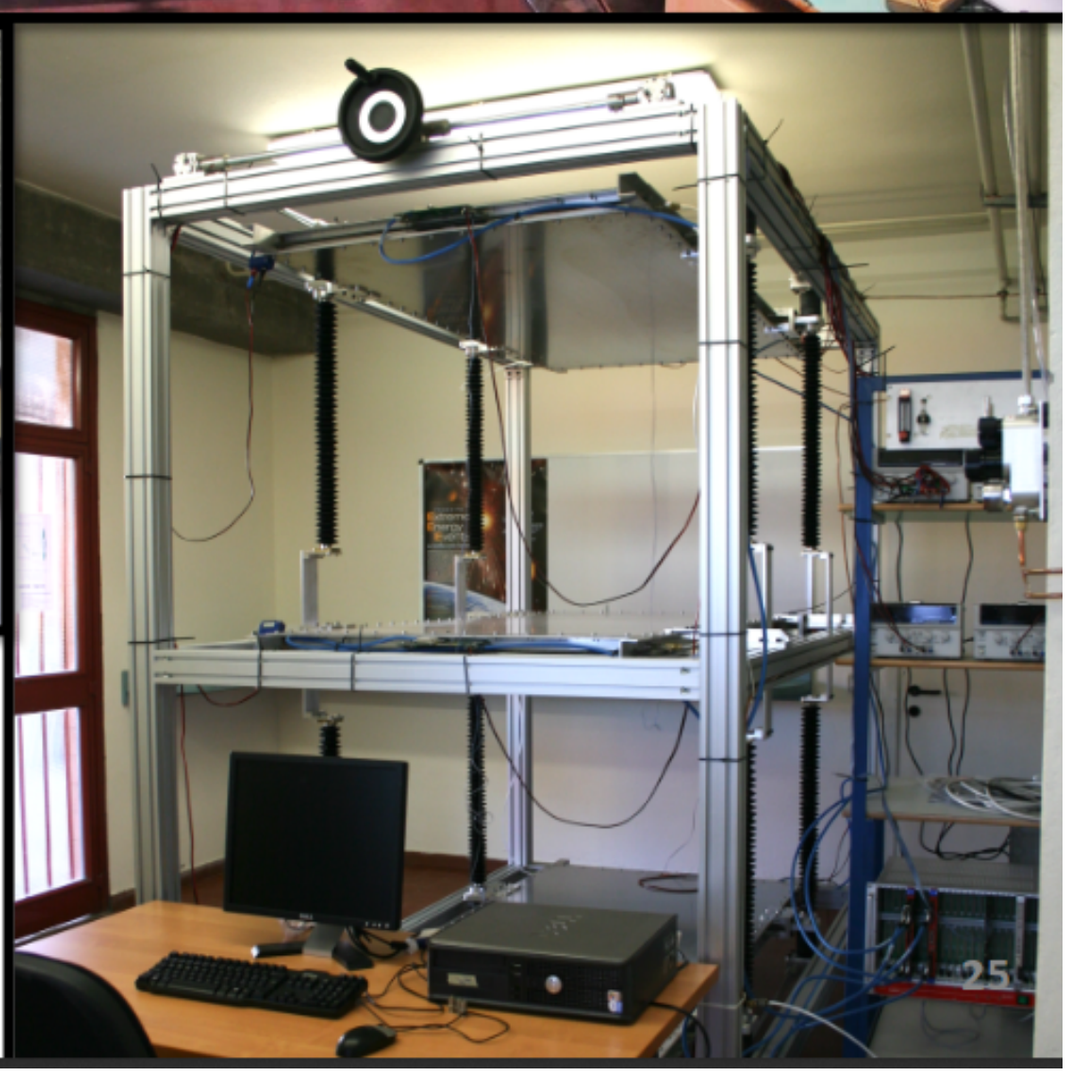
Requests:

1 MU for the telescope frame design and construction

(metal frame 2X1 m X 1.5 height)

1 MU for

- cabling (HV,LV,data,GPS)
- installation of electronics
- gas system pipes and safety



PolarQuEEEst

Extreme Energy Events

@

Extreme Weather Conditions !

POLARQUEST

1928
2018

EXTREME.....

EXPLORATION
A complete circumnavigation of the Svalbard islands investigating on heroes of the past

SCIENCE
An international team of researchers looking for great enigmas, from climate changes and human footprint, paleoclimate and cosmic rays

A MESSAGE FOR THE PLANET
A Voyage to the last wilderness on the Earth, looking for our Planet fate

PolarQuEEEst

3 portable
CR detectors,
1 onboard + other 2
in italian and
norwegian schools
Studying Cosmic Rays
at extreme Latitudes
and their connection
with climate
and environment,
EEE extends
to POLE!

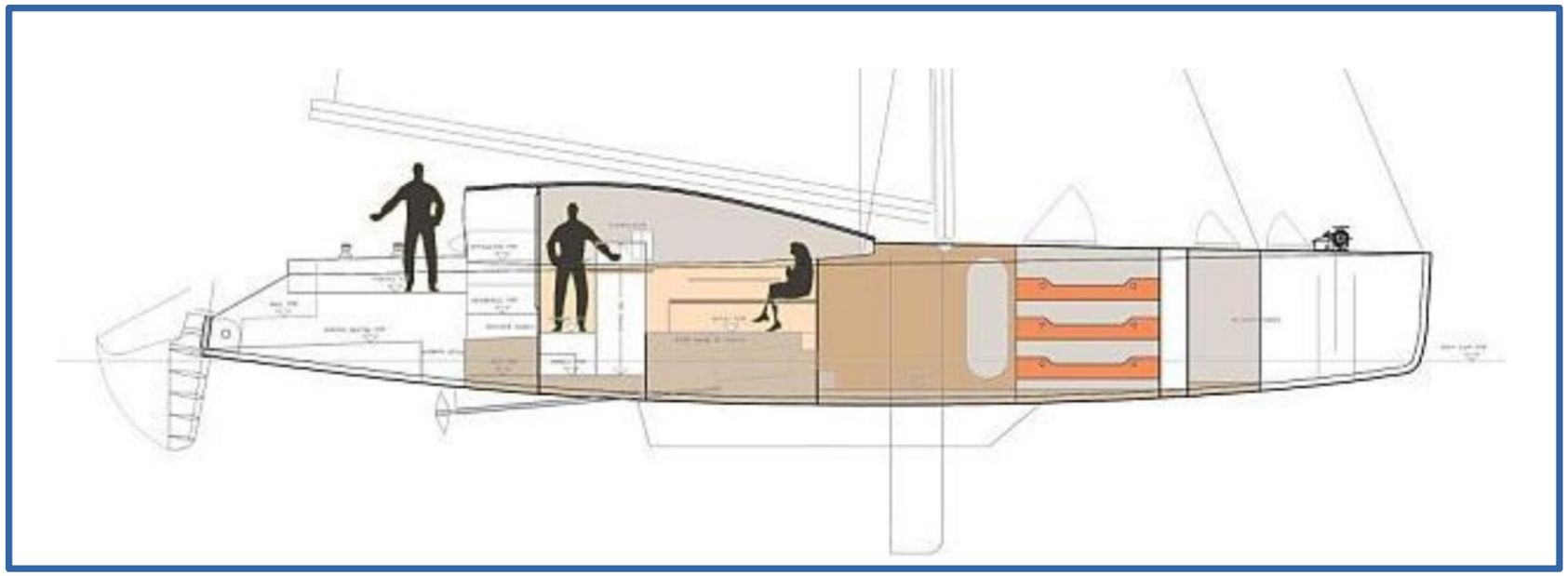
Nanuq Mantanet

The first study of
Microplastics
pollution
above 78°
to understand
The effects and size
of plastic
accumulating
at Poles
harming
Earth environment

ARARAT Arctic Research Aerial Reconnaissance and Transport

The first test of the use of drones
for gathering samples of waters, ice, air and pollution
for climate related scientific research

The BOAT and the IGLOO



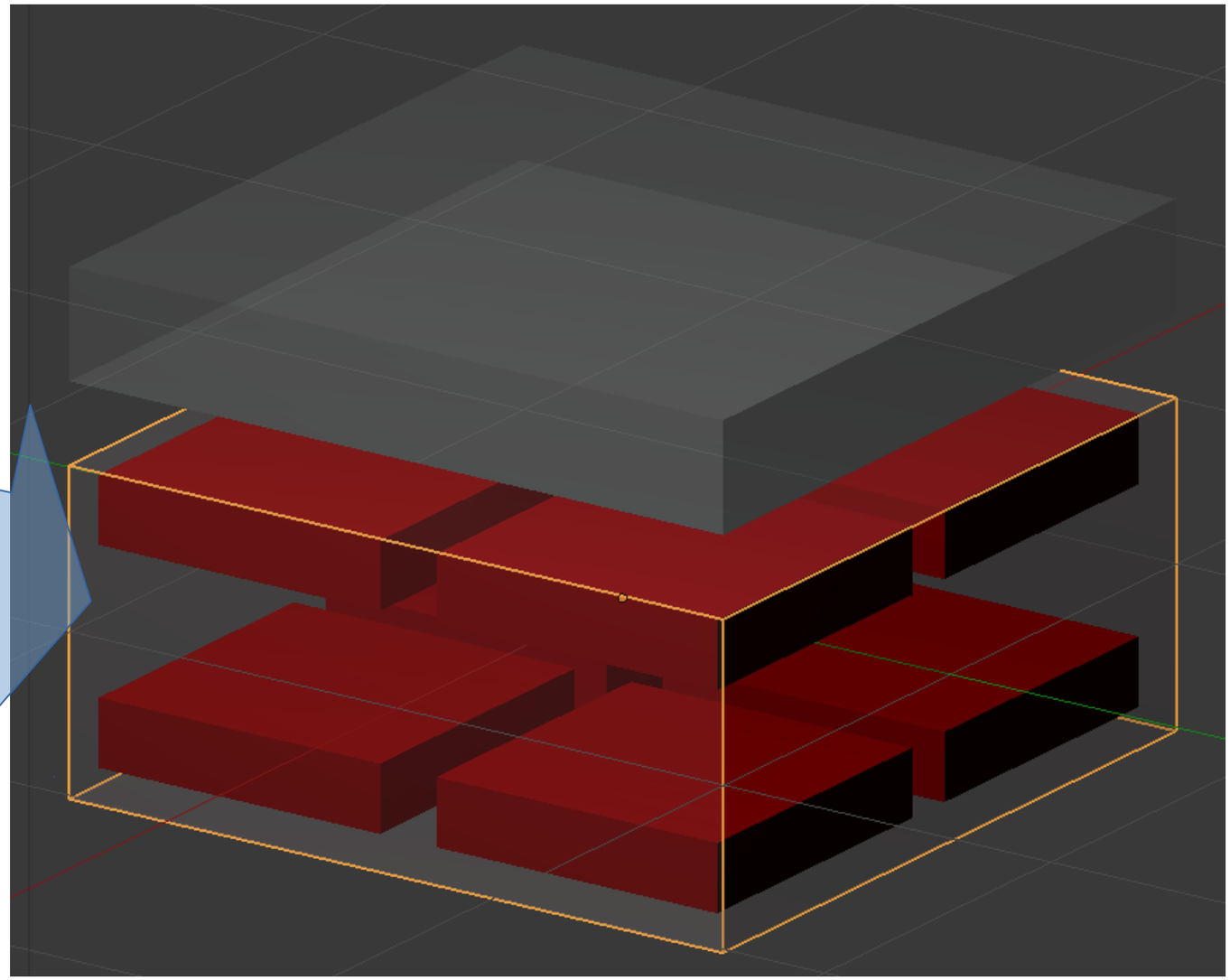
- 2 double cabins with bunk for extra crew plus cabin with 6 berths
- Engine: inboard Diesel 85cv
- Fresh water tank: 800l
- Diesel tank: 1200l

- Type: Integral 60
- Launched 2014
- Lenghth: 17.80 m
- Beam: 4m70
- Sail area: 165m^2 jib, main and mizzen
- Displacement: 18t

The PolarQuEEEst Detector

The detector case:

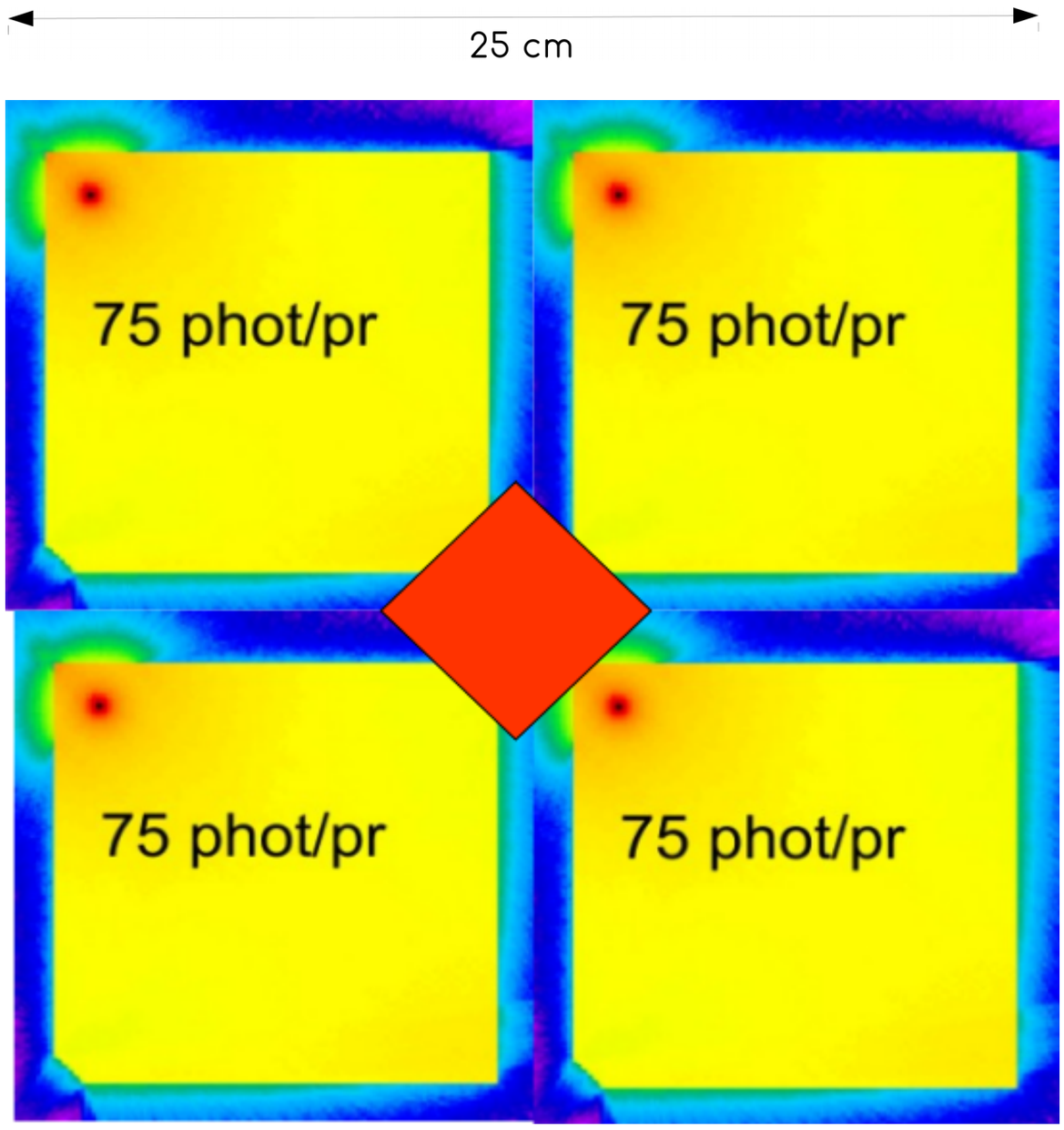
- Size 55X55X25 cm3
- Weight: 7 kg
- Shielding container:
  - Water tight / Air tight
  - Plexiglass or plastic + glass fiber
  - Atmosphere: Nitrogen
  - Light tight (black)
- Very low transmittance (<0.1 W/m2K) or trasmittance adapted to electronics power absorption

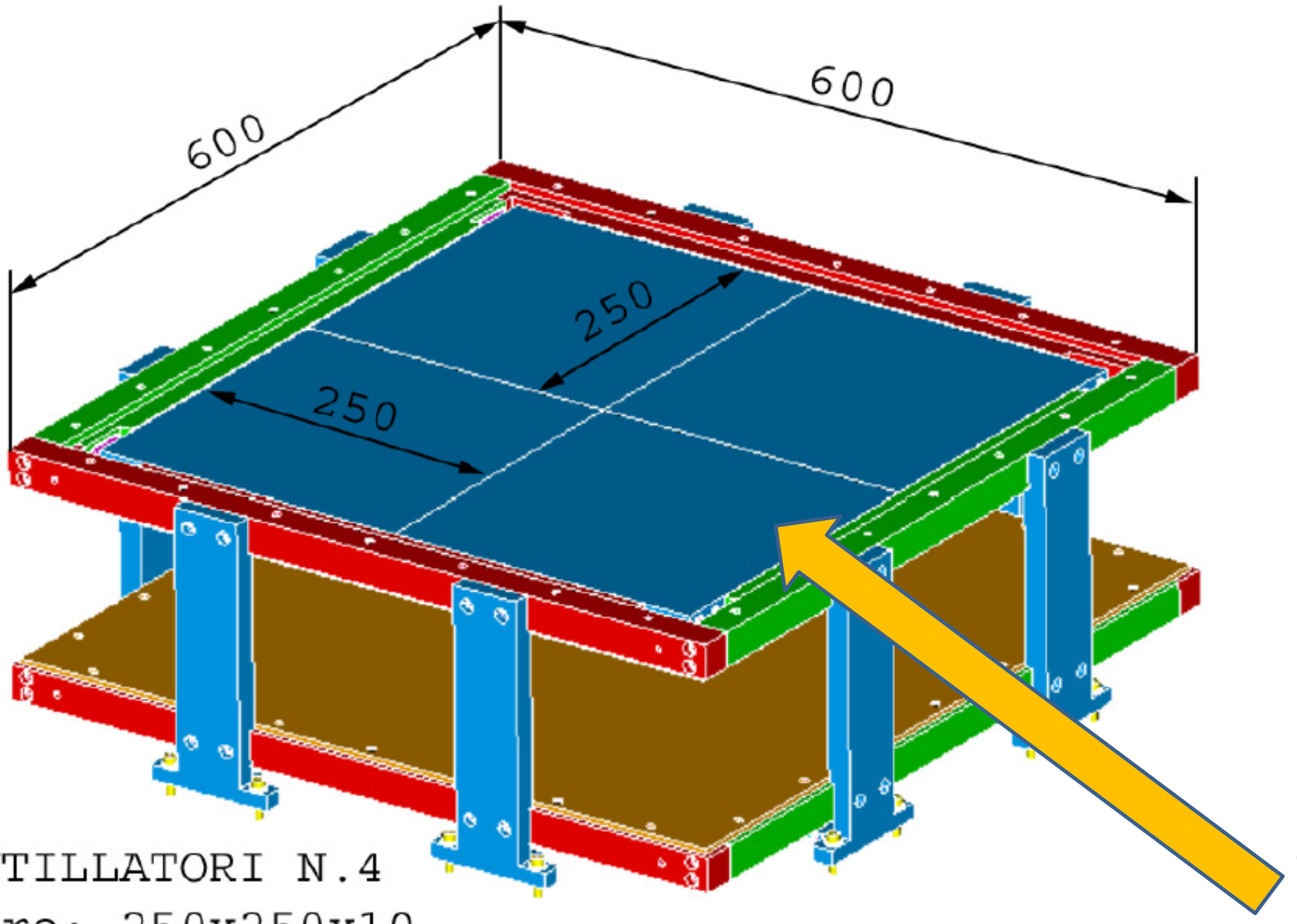


The PolarQuEEEst Detector

The detector

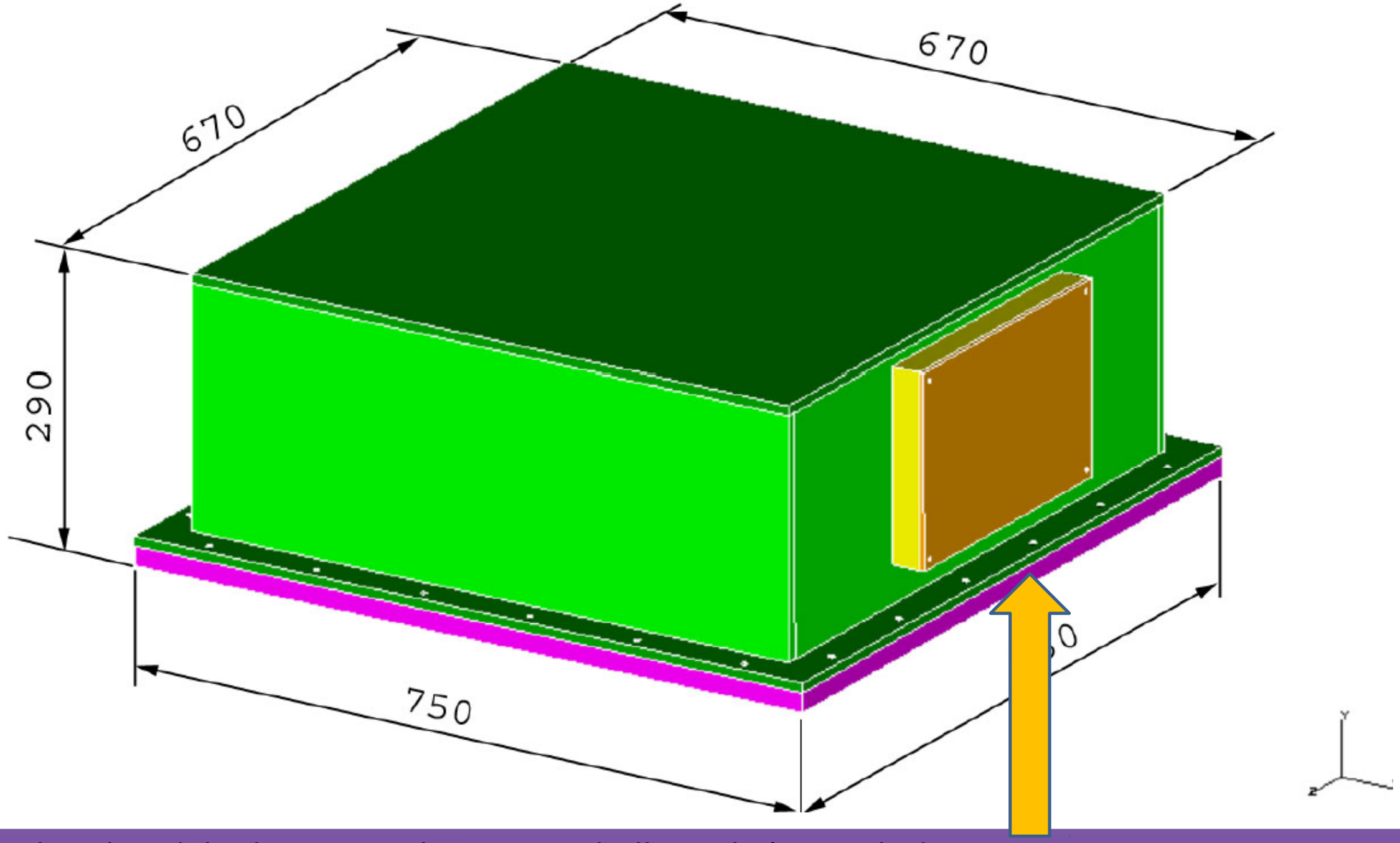
- 2 Detector Surface 50X50 cm
- Distance between planes: 22 cm
- 4 tiles per plane
- Each tile 2 SiPM
- Efficiency > 96% (overall)
- Trigger: AND among 2 planes
- Each plane: OR among 4 tiles
- Muon rate: 10-15 Hz
- Dark rate per 3 plane (4 tiles): 3 10^{-4} Hz
- S/N ~ 5 10^{4}





SCINTILLATORI N.4
misure: 250x250x10
DISTANZA TRA I PIANI: 150 mm

- 4+4 Scintillators on two planes
- Each Scintillator is read by 2 Photodiodes



- Readout box (The box named Detector-dedicated electronics)
- The electronics is outside the box thus does not contribute to the internal heating
- Other possible electronics case displacement: on top of chassis

External PTH

GPS Unit

Signal Processing/
DQM/Storage

(RaspberryPi)

Gyroscope+
accelerometers

SSD storage

WiFi to onboard
laptop

Trigger signal + SiPM
configuration

Power
supplies

Trigger Logic

8 LVDS signals from
SiPM

FrontEnd

Scintillators Upper
plane

Internal PTH probes

Mechanical
structure

PTU probes
Analog signal cables

SiPM
Analog signal
cables

Front-End
Electronics

Insulating chassis

External PTH

GPS Unit

Signal Processing/
DQM/Storage

(RaspberryPi)

INFN BARI

Gyroscope+
accelerometers

SSD storage

WiFi to onboard
laptop

INFN Bologna

Scintillators Upper
plane

Internal PTH probes

Mechanical
structure

PTU probes
Analog signal cables

SiPM
Analog signal
cables

Front-End
Electronics

Insulating chassis

Trigger signal + SiPM
configuration

Power
supplies

Trigger Logic

INFN TORINO

FrontEnd

8 LVDS signals from
SiPM

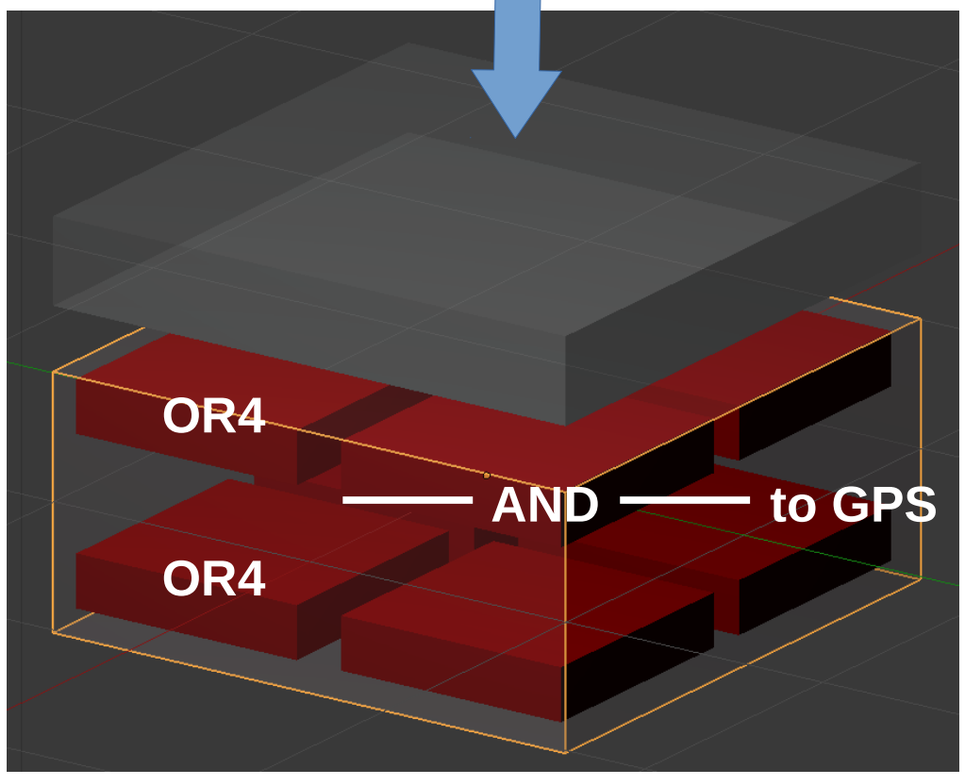
Requests for The PolarQuEEEst Detector

1.5 MU electr. Lab

for the modifications to the already existing FE for 2 SiPM readout
- Adding TOT measurements

For the design of the trigger card
- Simple OR4 AND OR4 card for triggering the GPS

–



Calibration and monitor
(to be used only one time,
During the set-up phase)