GRAN SASSO SCIENCE INSTITUTE
SCHOOL OF ADVANCED STUDIES
Scuola Universitaria Superiore

INFN
Istituto Nazionale di Fisica Nucleare

Particle Identification in Space Experiments with Scintillator Detectors

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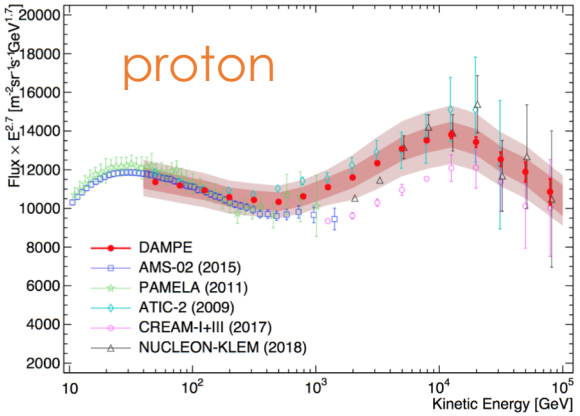
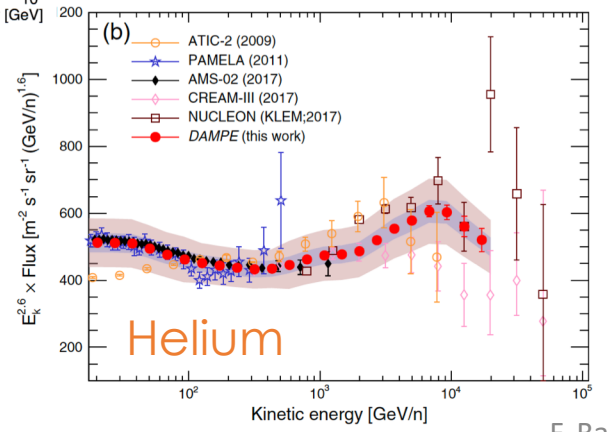
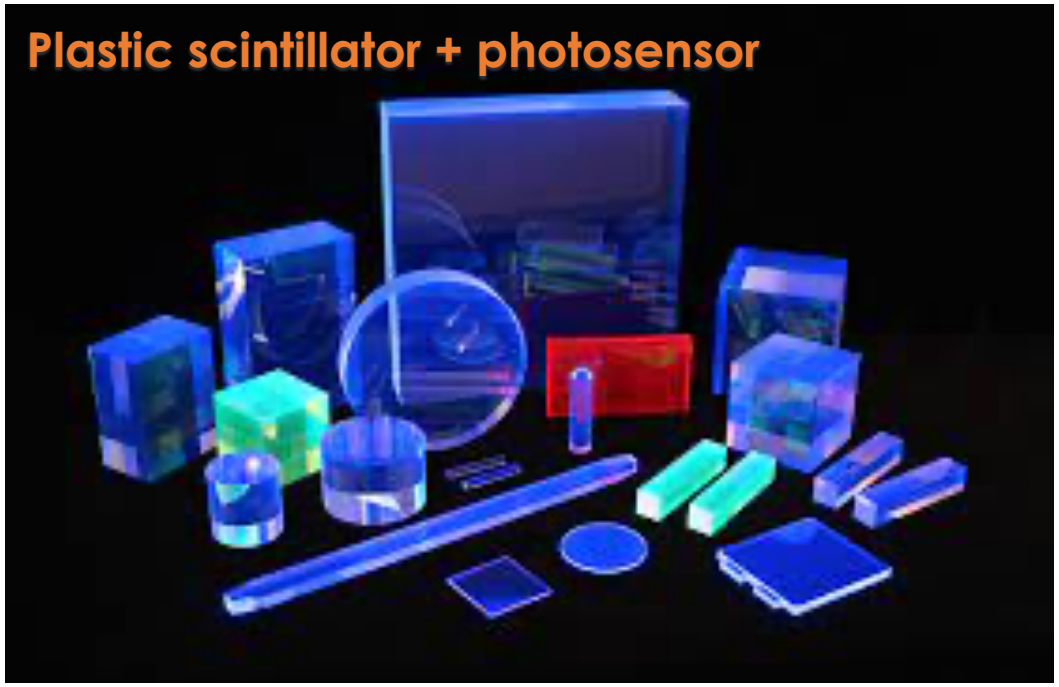
Charge Identification of cosmic rays

Motivation

Identify cosmic rays species to measure the flux and address origin, acceleration and propagation problem







Principle of operation

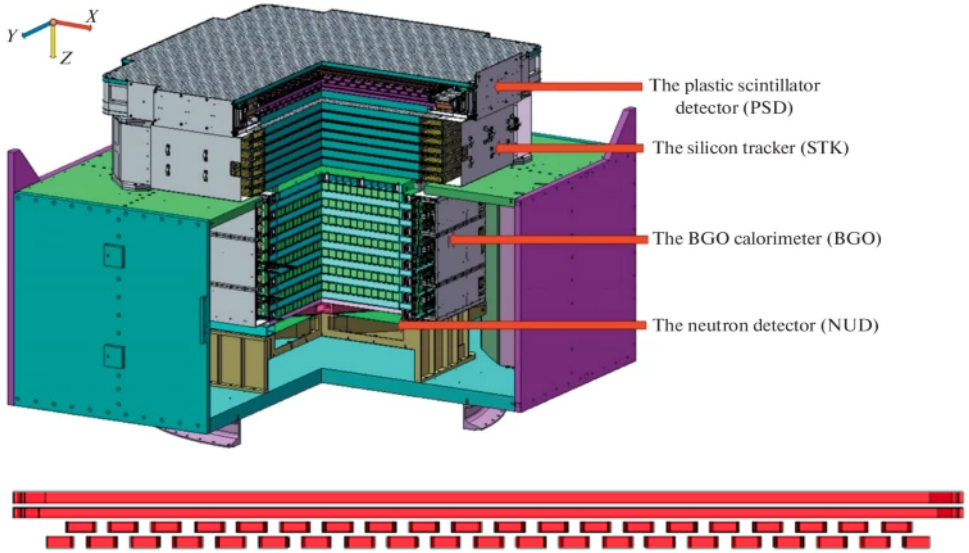
$$-\frac{dE}{dx} = \frac{4\pi e^4 z^2 NZ}{(4\pi\varepsilon_0)^2 M_e v^2}\left[\ln\left(\frac{2M_e v^2}{I}\right) - \ln(1-\beta^2) - \beta^2\right]$$

Bethe Bloch formula

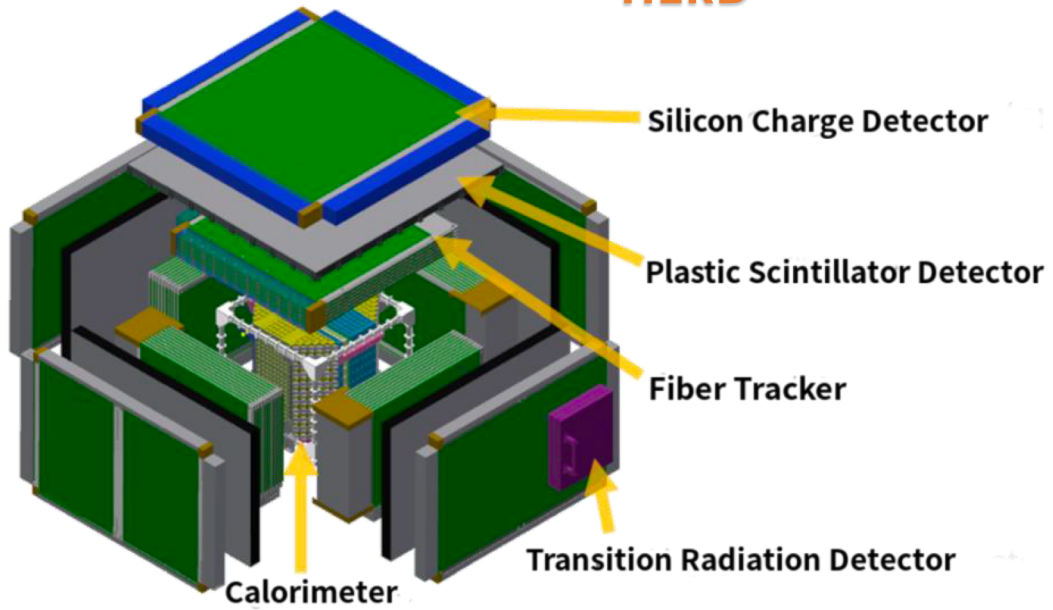
Ionization energy loss of charged particles

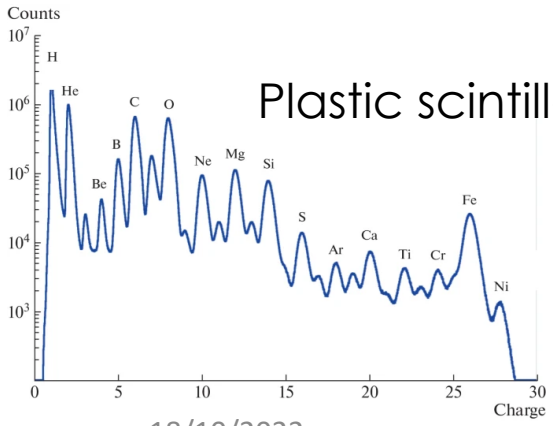
Plastic Scintillator Detector

DAMPE

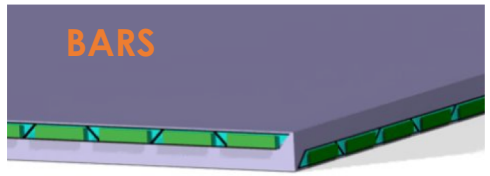


HERD

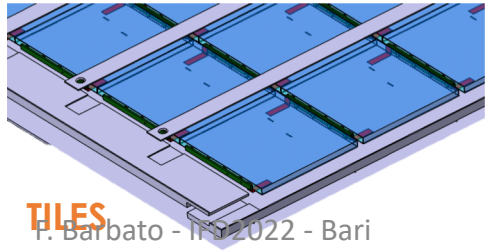


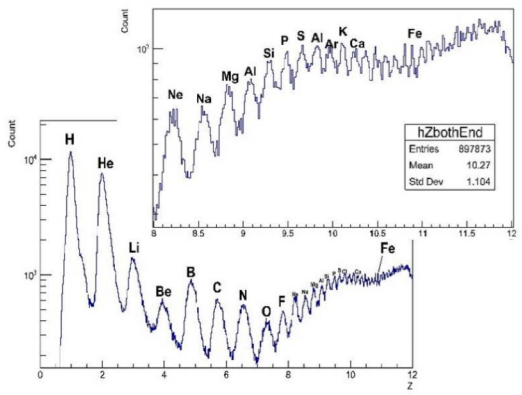


Plastic scintillator bars + PMTs

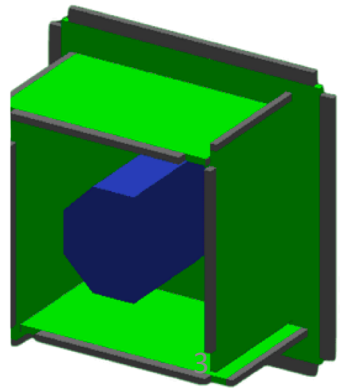


Plastic scintillator + SiPM



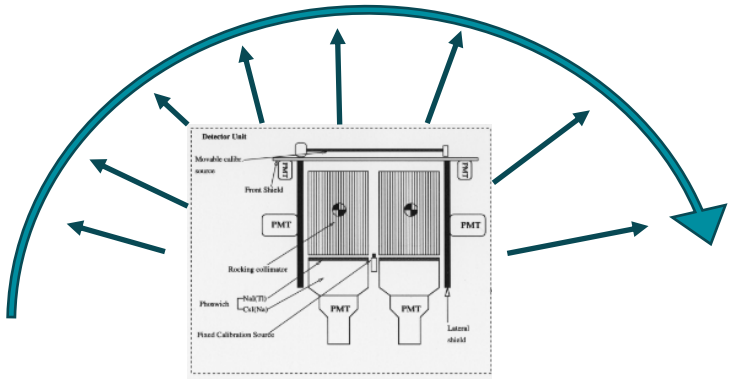


High hermeticity



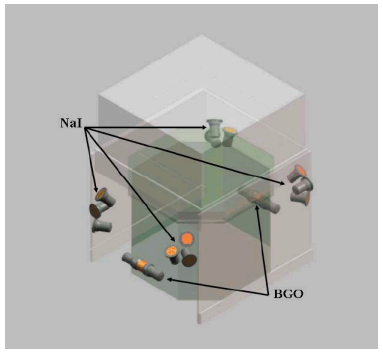
Gamma-ray identification

Beppo-Sax



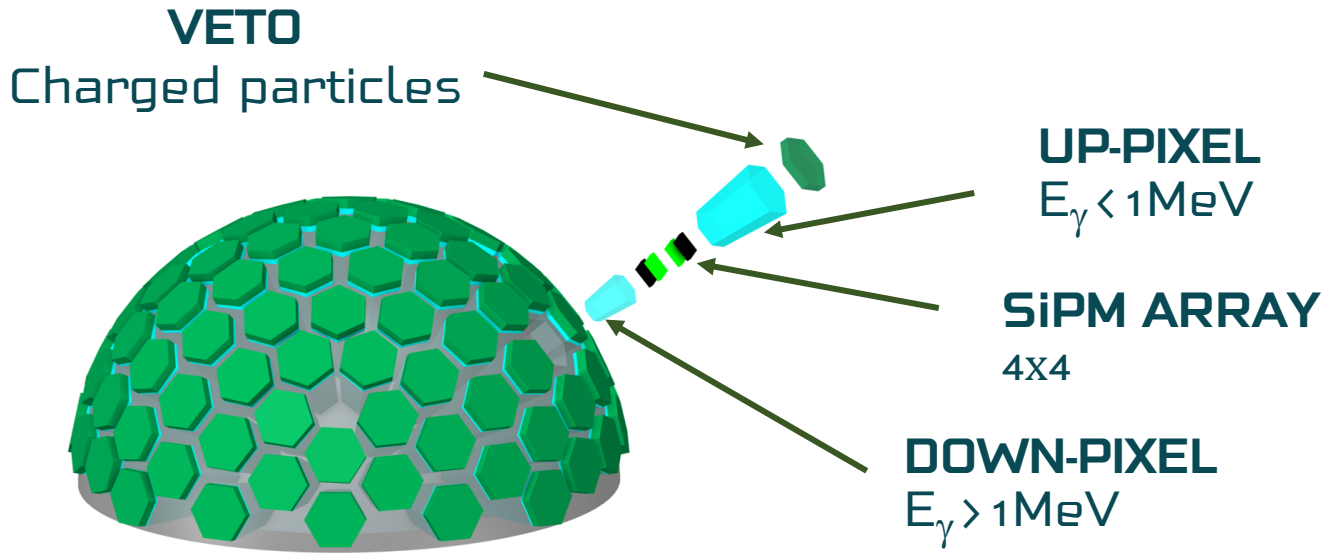
- Phoswich technique with collimators
- Orientable mechanics
- One module

Fermi-GBM

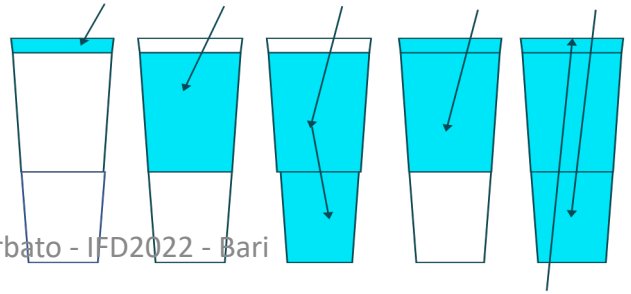


- Triangulation over 12 pixel (ø 12.7 cm)
- Different orientation
- One module

Crystal Eye

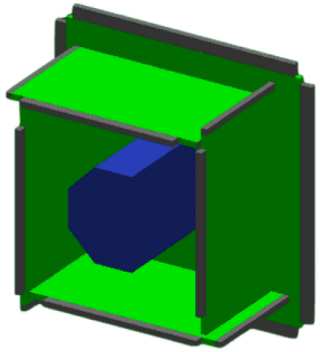


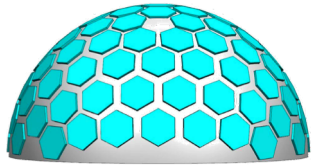
- Charge distribution over 112 pixel (ø ~ 5cm)
- Compact photosensors (simplified phoswich, no need for pulse shape discrimination)
- Compact hemispherical design (no need for orientable mechanics)



a – Down-going hard X-ray
b – Down-going LE g-ray
c – Down-going ME g-ray
d – Down-going LE charged particle
e – HE charged particle

Scintillators + SiPMs





PROS

- Compact design
- Low power consumption
- Easy redoundancy
- No sensitivity to magnetic fields

CONS

- Non space qualified
  - packaging issue
  - radiation damage
- high dcr

OPEN DISCUSSION ABOUT FUTURE