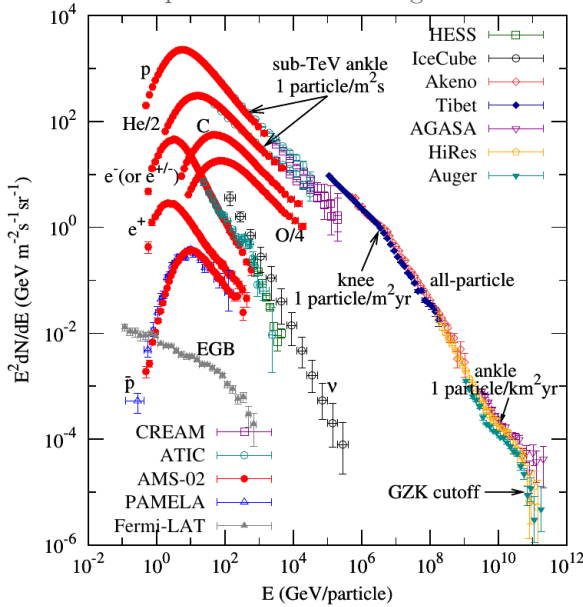


## The Plastic Scintillator Detector of the HERD space mission

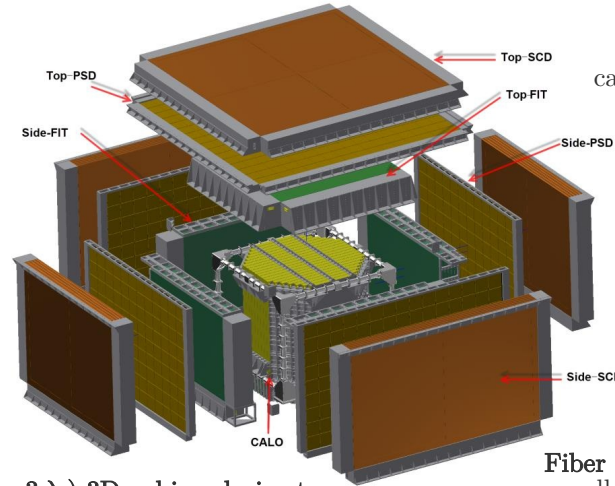
Dimitrios Kyratzis  
for the HERD collaboration

Due to rapidly falling intensity of CR fluxes with energy, experiments with large acceptances, operating over several years are needed to explore the CR spectrum at PeV energies.



## Scientific goals

- Cosmic Rays: Precise CR spectra and mass composition up to the PeV range
- Gamma – ray astronomy and transient studies (e.m. counterpart of GW)
- Electron spectra (and anisotropy) up to tens of TeV (nearby sources, ...)
- Indirect Dark Matter searches with high sensitivity



A deep ( $\sim 55 X_0$ ,  $3 \lambda_I$ ) 3D cubic calorimeter (CALO), forming an octagonal prism.

A **Transition Radiation Detector (TRD)** placed on one of the lateral faces in order to provide energy calibration of nuclei in the TeV region.

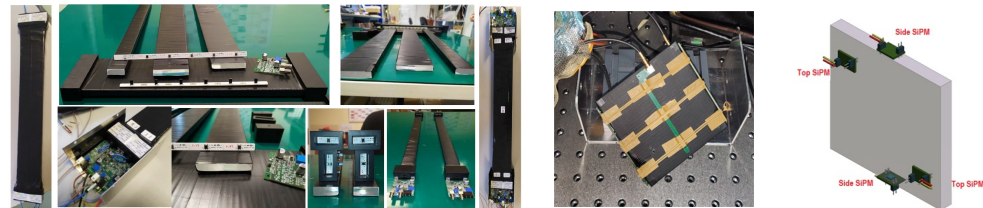
A **Silicon Charge Detector (SCD)** that envelops all sub-detectors, ensuring an additional determination of the charge.

A **Plastic Scintillator Detector (PSD)** covering the calorimeter and tracker, providing gamma-ray and charged particle triggers, with an additional level of charge measurement.

**Fiber Trackers (FiTs)**, situated on all active sides, determining tracks of impinging particles

The PSD of HERD will operate as an anti-coincidence providing charge measurement of incoming cosmic-ray nuclei in a range of  $Z = 1 - 26$ .

Main requirements: high detection efficiency, broad dynamic range & good energy resolution.



PSD of the HERD space mission

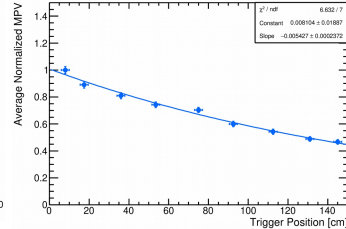
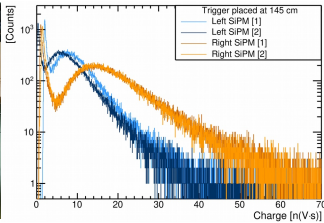
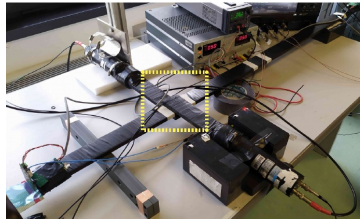
Two design layouts are currently investigated, one based on long scintillator bars while the other on square (or rectangular) tiles, both coupled with Silicon Photomultipliers (SiPMs).

## PSD: Bar option

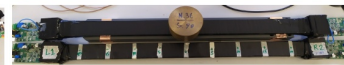
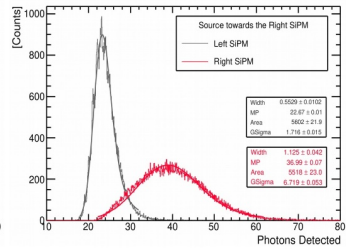
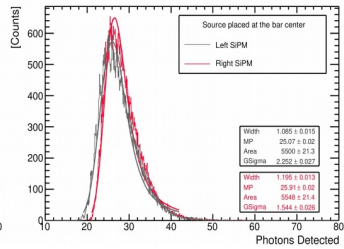
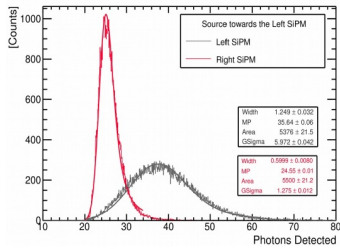
The proposed bar layout consists of long scintillator slabs. Main advantages of this layout concern the optimal number of readout channels and ease of instrumentation.

CR muons

Light attenuation length

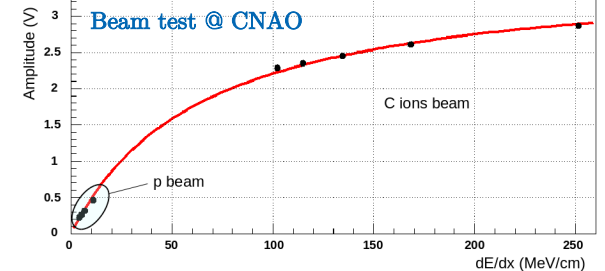
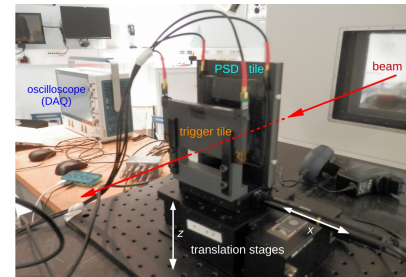
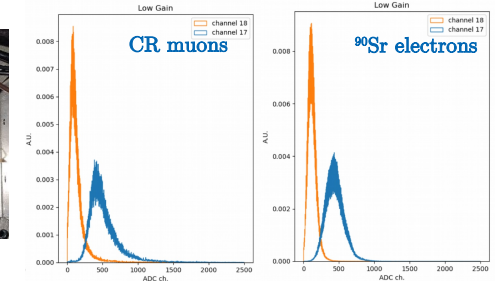
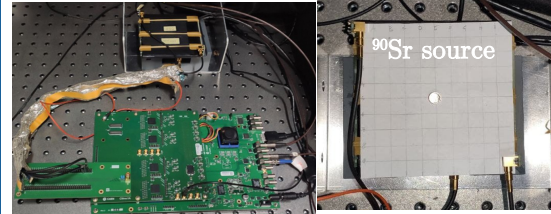


<sup>90</sup>Sr electrons



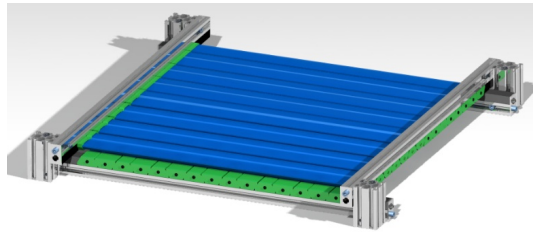
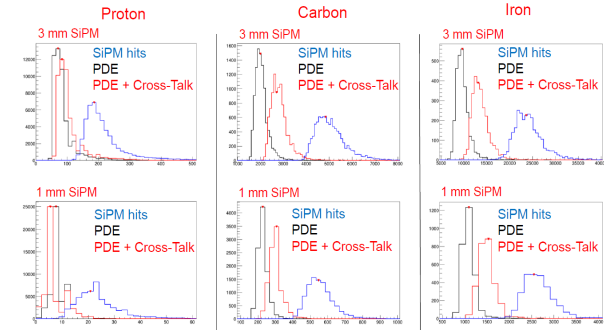
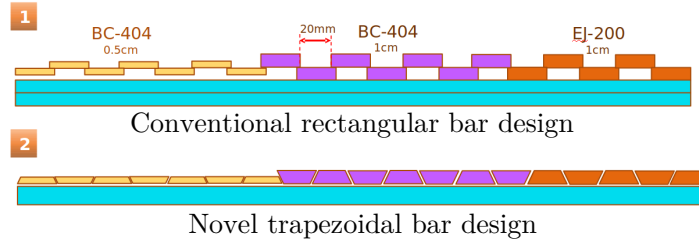
## PSD: Tile option

In the tile configuration, rectangular scintillators are being tested in order to cover both top and lateral faces of the instrument, adopting similar instrumentation technique to Fermi-LAT that provided satisfactory results in reducing back-splash effects.



## PSD: Simulation Activities

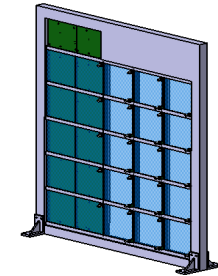
A dedicated GEANT4 – based simulation software is developed with customized tile/bar layouts, in order to evaluate performances of various configurations and their inherent properties, along with their response to different particles & nuclei.



Preliminary bar prototype

## HERD Beam Test @ CERN

Of great importance in evaluating and determining the optimal PSD layout (along with HERD as a whole), will be the **upcoming test beam campaign, taking place at CERN SPS** and scheduled for Oct/Nov 2021. Such an endeavor will lead to **systematic performance tests of PSD bar and tile prototypes**, being a **collective effort of mechanical, software and hardware groups** inside the collaboration.



Preliminary tile prototype

## Conclusions

The **High Energy cosmic-Radiation Detector (HERD)** is one of the prominent space – borne instruments to be installed on-board China's Space Station (CSS), with an expected lifetime of 5–10 years. In this work, the **Plastic Scintillator Detector (PSD)** was illustrated along with a brief presentation of its ongoing and upcoming activities.

