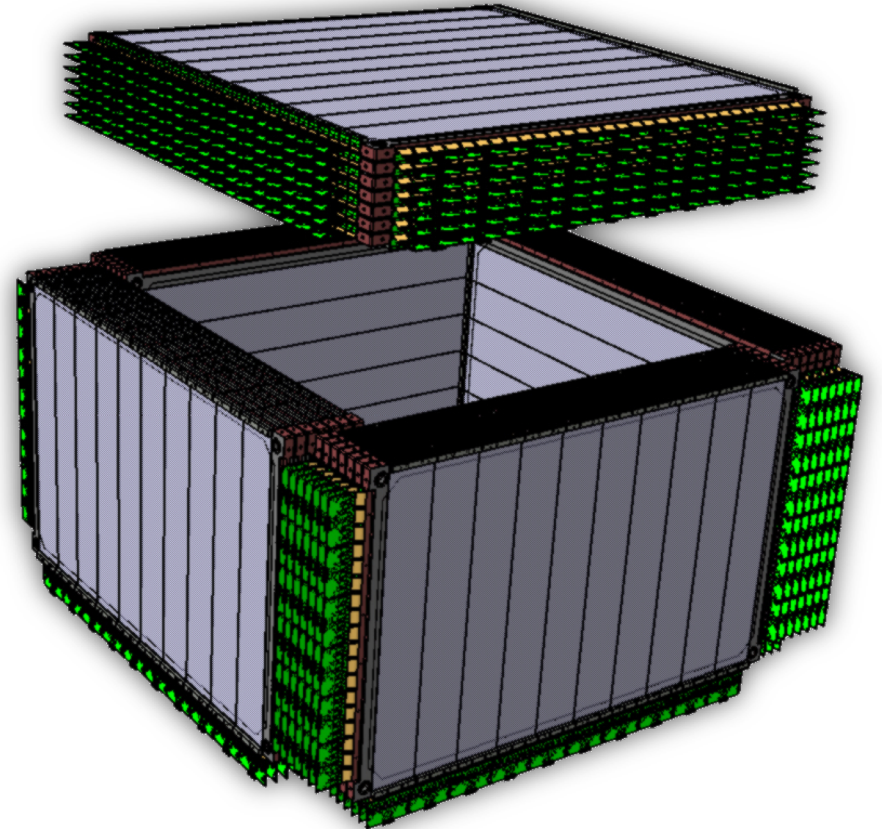


FIT: the scintillating fiber tracker of the HERD space mission

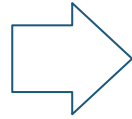
C. Perrina on behalf of the HERD Collaboration

Chiara.Perrina@epfl.ch

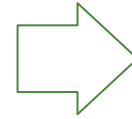


HERD

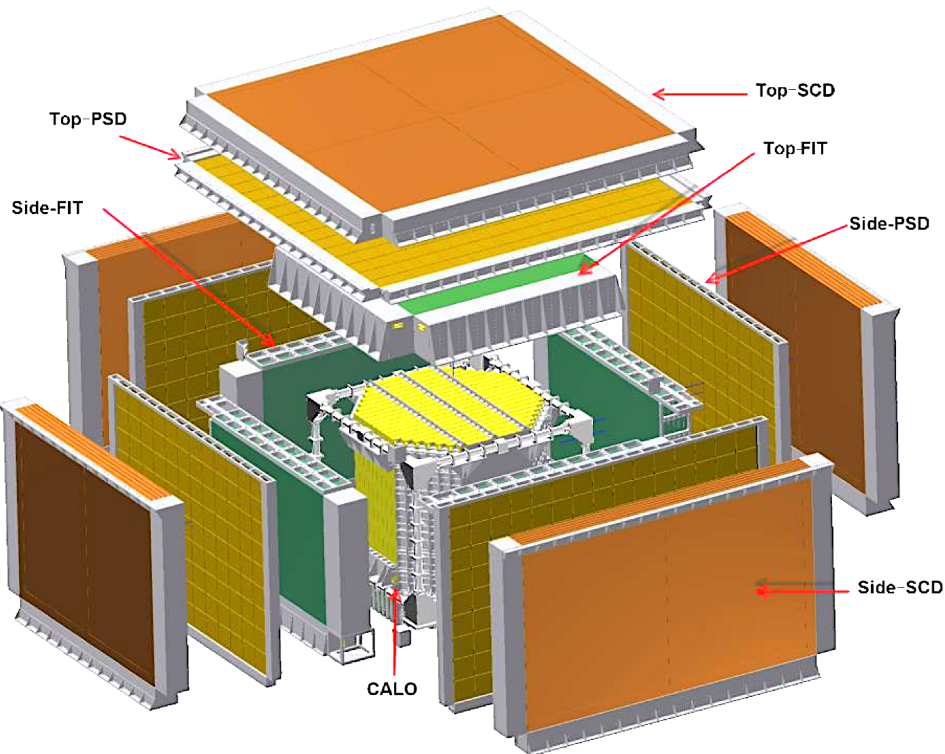
High
Energy
cosmic-Radiation
Detection
facility



Planned to be
operational on the
China's space station
from 2027, for more
than 10 years



Goals: measurement of the
energy spectrum and
composition of cosmic rays up
to the "knee", indirect search
for dark matter and monitoring
of the γ -ray sky



CALO: CALOrimeter

- Energy measurement
- Electron/proton separation

FIT: Fiber Tracker

- Track reconstruction
- Charge measurement ($|Z|$)
- Low energy gamma ray conversion ($\gamma \rightarrow e^+ e^-$)

PSD: Plastic Scintillator Detector

- Charge measurement ($|Z|$)
- Gamma ray identification

SCD: Silicon Charge Detector

- Charge measurement ($|Z|$)

TRD: Transition Radiation Detector

- Energy calibration of TeV nuclei

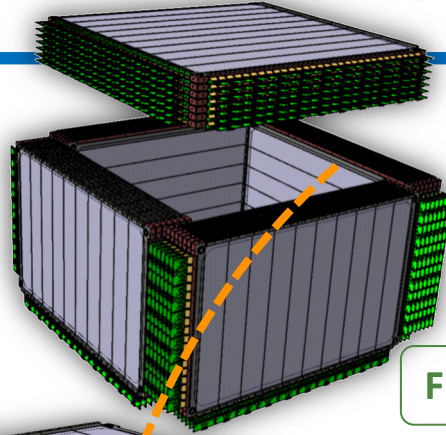


FIT: Fiber Tracker

Design

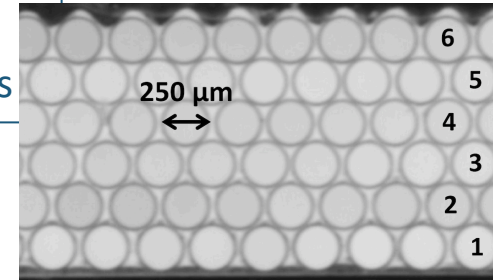
Simulation

Prototype



FIT = 5 sectors

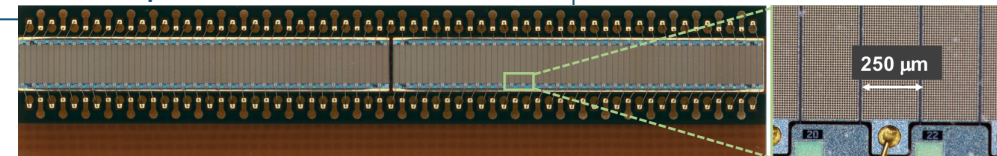
- Fiber mat: 6 layers of fibers
- Fiber type: **KURARAY SCSF-78MJ**
 - round section with, diameter = 250 μm
 - peak emission at λ : 450 nm
- Titanium dioxide coating to avoid cross-talk between fibers
- Mat width \cong 97.80 mm to match 3 SiPM arrays



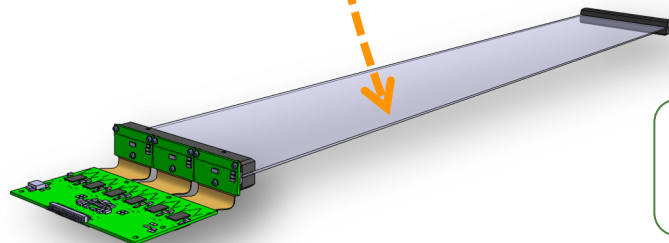
Sector = 7 x-y planes

- SiPM array: 2 chips with 64 channels
- Channel size: 230 μm \times 1630 mm
- Pixel size: 10 μm \times 10 μm
- 23 \times 163 pixels/channel
- Gap between channels: 20 μm \rightarrow pitch: 250 μm
- Gap between chips: 220 μm
- 105 μm epoxy resin on top

Plane (side) = 6x + 10y modules
Plane (top) = 10x + 10y modules



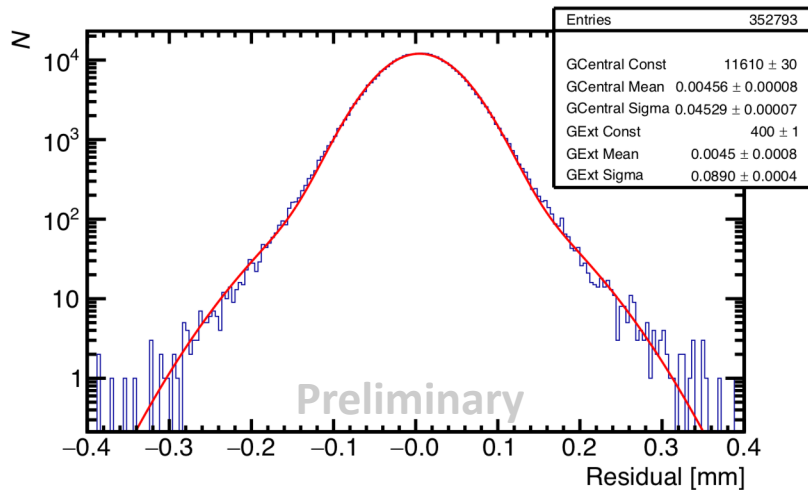
Module = 1 fiber mat +
3 SiPM arrays



Performance of the FIT module

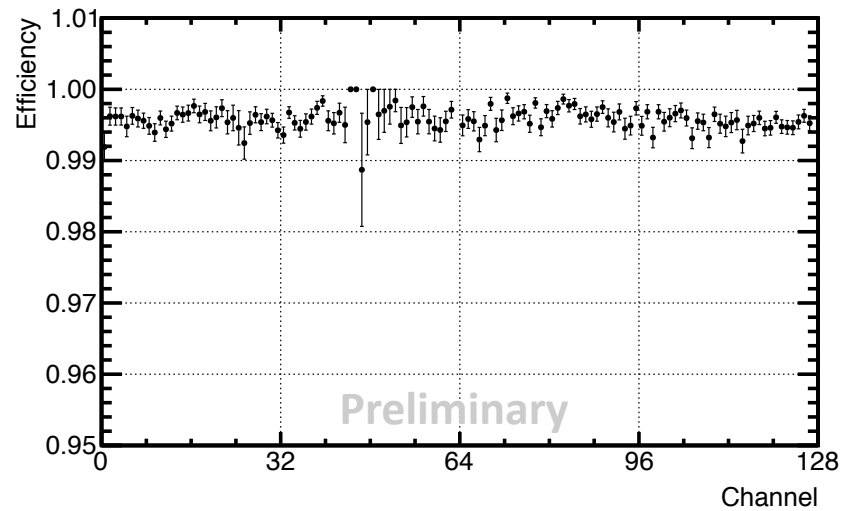
Proton beam test results

Position residual distribution:

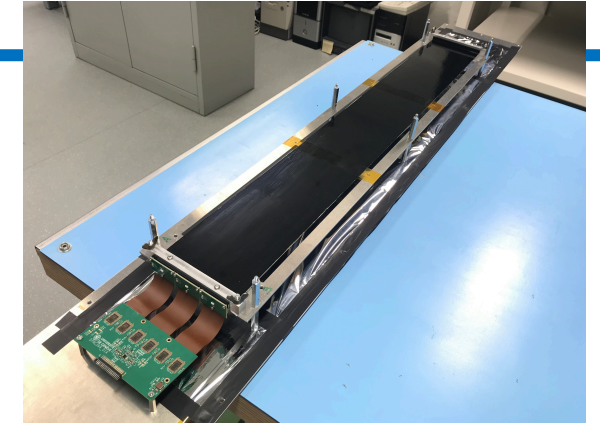


Spatial resolution = $(45.0 \pm 0.1) \mu\text{m}$
(taking into account the external beam telescope resolution)

Hit detection efficiency



Mean efficiency = 99.6 %



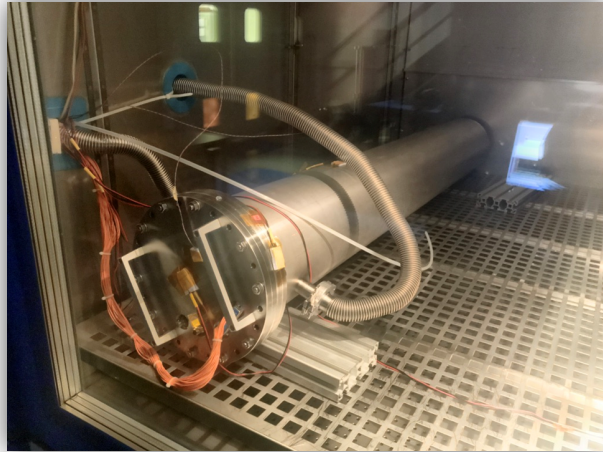
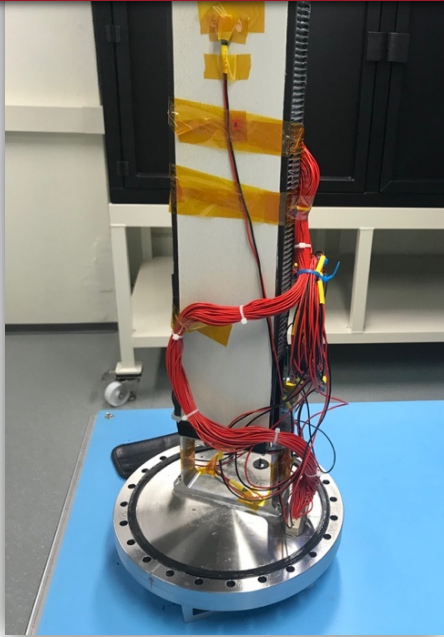
Nuclei beam test results

Charge resolution for nuclei heavier than p

Z	μ_z	σ_z	σ_z/μ_z
2	1.99	0.31	15 %
3	3.07	0.40	13 %
4	4.01	0.51	12 %

Thermal-vacuum test of a FIT module

FIT module in a vacuum cylinder inside a thermal chamber



- Vacuum cylinder (5×10^{-6} mbar)
- Chamber temperature set from -20 °C to 30 °C, with steps of 10 °C.
- Scintillators were placed on the top and the bottom of the chamber, to have cosmic triggers.

- The cluster length distribution is uniform and independent on the temperature.
- This is a sign of the mechanical stability.

