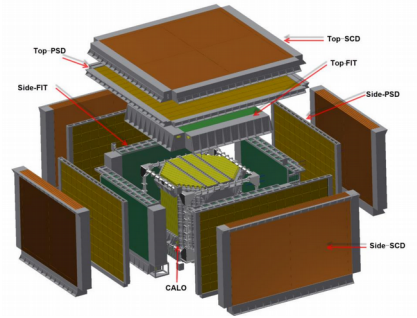
Design and expected performances of the large acceptance calorimeter for the HERD space mission.

Lorenzo Pacini et al., for the HERD collaboration

The HERD calorimeter

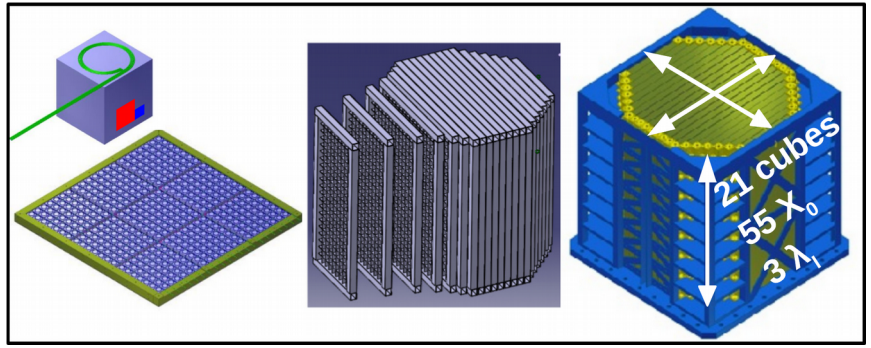
The High Energy cosmic-Radiation Detection (HERD):

- Space mission that will be installed aboard the Chinese Space Station (CSS) around 2027.
- Main goal: extend the measurement of cosmic ray spectra up to the knee region.



The main detector is the calorimeter (CALO):

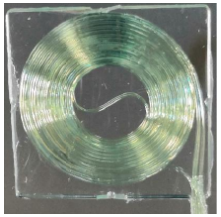
- It is an homogeneous, isotropic, 3D segmented calorimeter.
- It consists of ~ 7500 LYSO cubes
- It accepts particles coming from each surface.
- Effective geometrical factor (GF) few m^2sr.

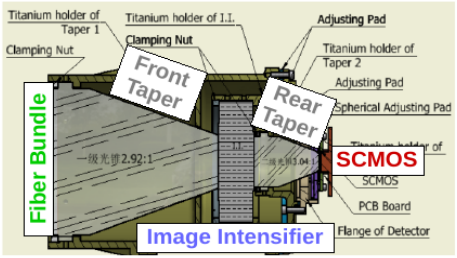


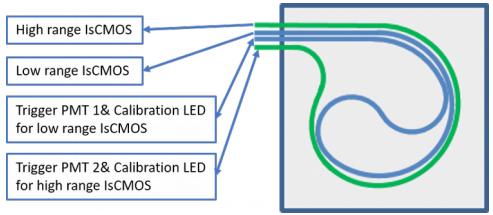
Double read-out system.

It allows the cross-calibration of the energy scale and two independent fast triggers.

- WaveLength Shifting fibers (WLS).
- Image Intensified scientific CMOS.
- Frame rate: > 800 frames/sec.
- Low read-out noise (< 1.5e).

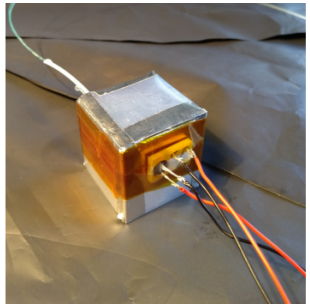


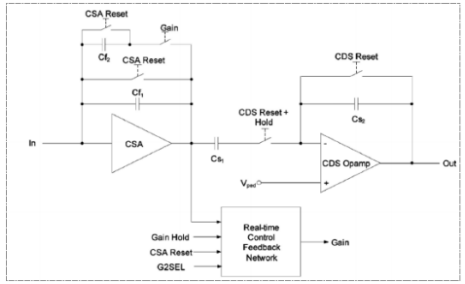




(b) IsCMOS.

- Photo-diodes with different active areas connected to HIDRA chips.
- The S/N ratio for MIP is $>= 4$.
- Expected saturation level ~ 250 TeV.





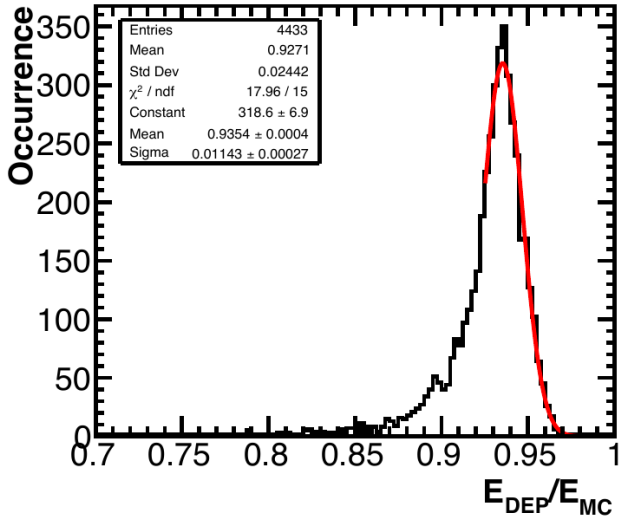
See the CaloCube project

Performance: MC simulation

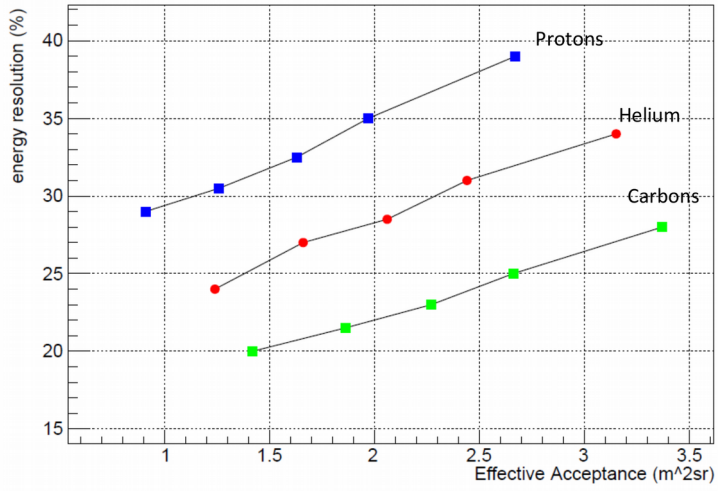
Few results obtained with MC simulation based on GEANT4.

Particle.	Energy.	Effective acceptance	Energy resolution
Proton	**<= 1 PeV**	**> 1 m2sr**	**~ 30%**
Electron	**<= 10 TeV**	**~ 2 m2sr**	**~ 2%**

Fraction of energy deposited by 10 TeV electrons: energy resolution ~ 2%



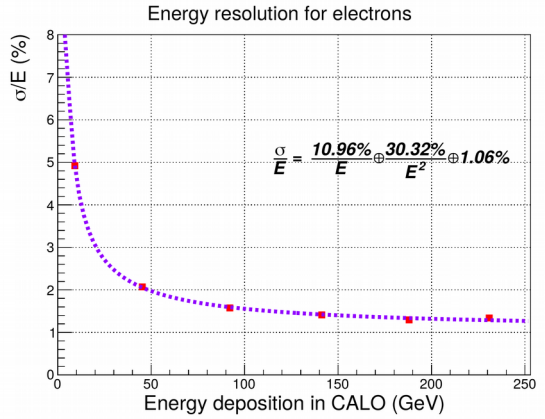
Nuclei @ 10 TeV: energy resolution vs effective GF.

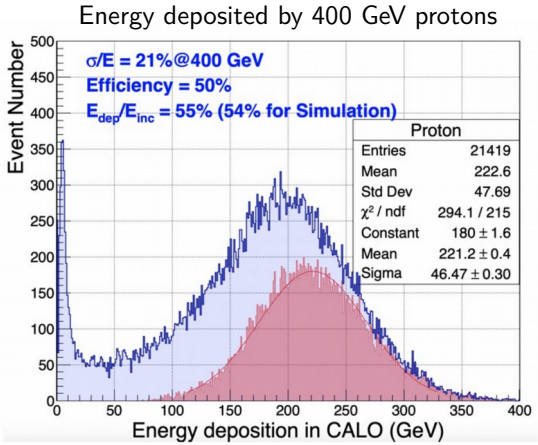


Performance: beam tests

Beam test results confirms the MC expected performance. Here few examples:

Prototype made by 5x5x20 LYSO cubes read-out with the WLS-IsCMOS system was tested at the CERN SPS.





The PD-HIDRA system was tested with a prototype made by hundreds of CsI(Tl) cubic crystals.