THE HIGH ENERGY COSMIC RADIATION DETECTOR (HERD) TRIGGER SYSTEM

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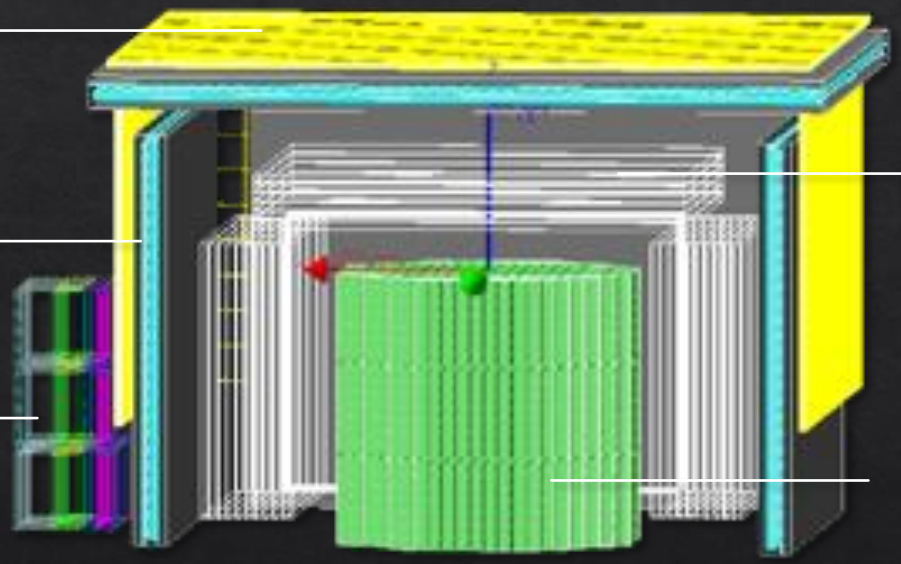
THE HERD DETECTOR

The High Energy cosmic Radiation Detector (HERD) is a future cosmic ray experiment planned to be installed onboard the Chinese Space Station (CSS) for a 10-year mission.

PSD
Gamma identification
Charge measurement

SCD
Charge measurement

TRD
TeV CR calibration



FIT
Charge measurement
CR trajectory
Gamma converting & tracking

CALO: 3-d imaging calorimeter:
Energy measurement
Particle identification

- Orbit inclination: ~41.5º
- Orbit altitude: 340 - 450 km
- Mass: < 4 t
- FOV: ~70º

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Scientific Goals

- Precise measurement of the CR spectra and composition up to knee
- Measurement of the electron spectra up to tens of TeV
- Indirect searches for DM
- Gamma ray astronomy and transients

Baseline Trigger Definitions

The trigger strategy is defined to fulfill the scientific goals of the HERD mission.

Science mode

High Energy (HE)	Low Energy Electron (LEE)	Low Energy Gamma (LEG)	Unbiased (UNB)
high energy deposition in CALO	low energy deposition in CALO	low energy deposition in CALO + PSD veto	low energy dep. in CALO, prescaled, for trigger efficiency studies

Standalone calibration mode

Calibration (CALIB): low energy deposition CALO trigger, for calibration with penetrating charged particles. Operated in a band of latitude between -20◦ and 20◦ around the Earth's Equator

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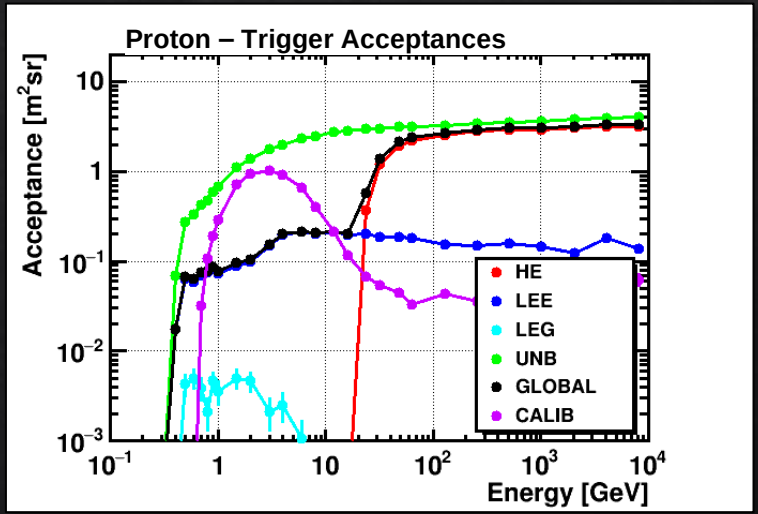
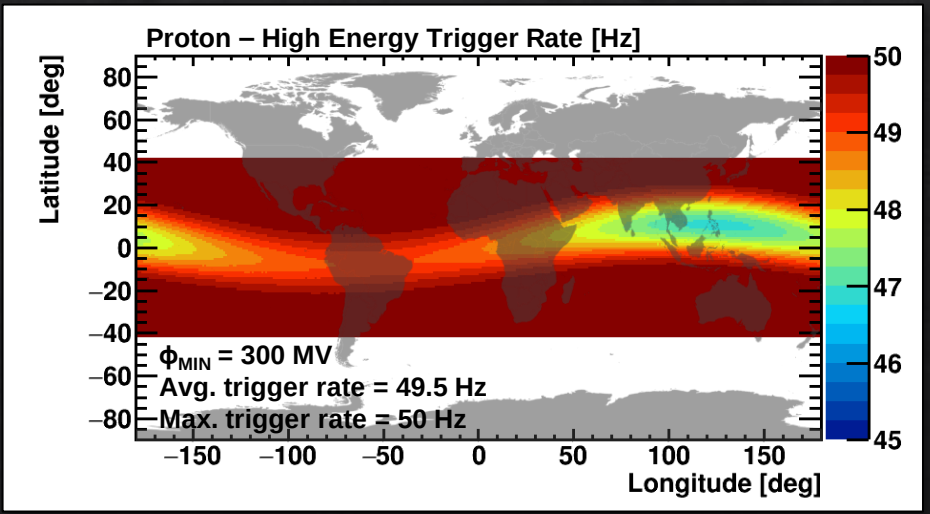
Study of the Trigger Performances

The performances of the sub-trigger definitions have been evaluated using Monte Carlo samples simulated and processed with the HerdSoftware framework based on Geant4 using a compact geometry of HERD detector.
The generated samples include different particle species (protons, electrons, helium, carbon and gammas) and energy points.
The trigger acceptances and expected trigger rates for down-going particles are calculated.





Expected proton trigger rates

ϕ_{MIN}=300 MV	Avg. [Hz]	Max. [Hz]
HE :	49.5	50.0
LEE :	72.5	311.2
LEG :	0.5	8.1
UNB :	0.9	3.6
GLOBAL :	123.1	372.5
CALIB :	26.4	94.3

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Feasibility of a Topological Trigger

The photodiode readout of the CALO LYSO crystals provides topological trigger capabilities that may complement the baseline sub-triggers based on the energy deposition in CALO.

A simple programmable logic (based on the total multiplicity or x,y,z-projection multiplicities) built from individual PD self-trigger signals provides enhanced particle identification as long as a low threshold (<~ 1 MIP) can be set. Based on this, different sub-triggers have been investigated:

- **Low Energy Electron Topological (LEET):** low energy electrons either for science/calibration
- **High Energy Topological (HET):** high energy CRs
- **High Energy Electron Topological (HEET):** for electrons at intermediate energies
- **MIP Topological (MIPT):** for MIP calibration