Crystal Eye & WINK

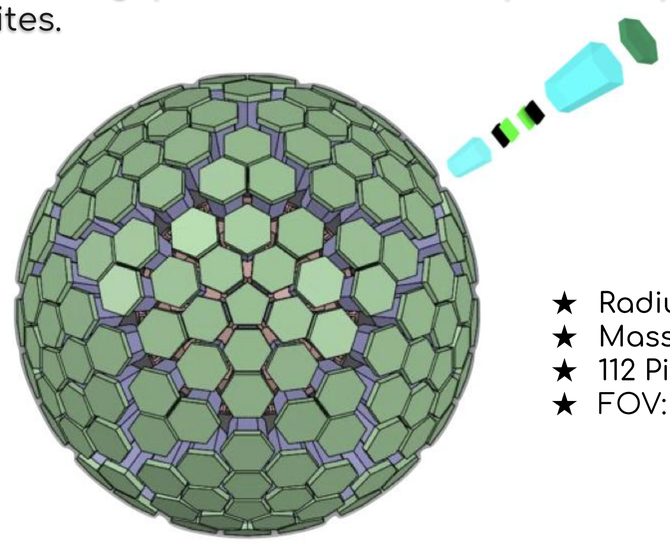
Innovating Hardware for the Space Detection of X and Gamma Rays

Felicia Barbato, Adriano Di Giovanni, Ivan De Mitri, Roberto Aloisio, Matteo Tambone, and Melissa Baiocchi on behalf of the HE-Exp group

Gran Sasso Science Institute, Istituto Nazionale di Fisica Nucleare, Universita Federico II

Crystal Eye

Crystal Eye (CE) is a space-based X- and γ- ray detector conceived as an all-sky monitor in the energy range of 10 keV - 30 MeV, which would address a gap that is still unexplored by other satellites.



- ★ Radius: 14 cm
- ★ Mass: ~50 kg
- ★ 112 Pixels
- ★ FOV: ~6sr

Pixel

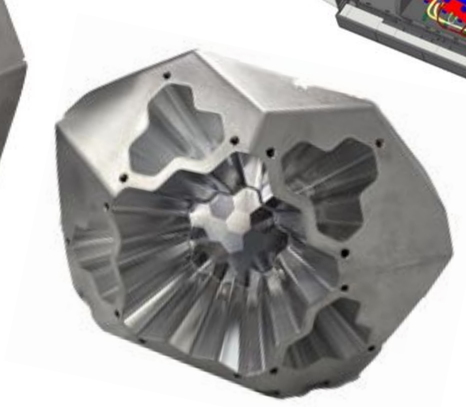
Each pixel is composed of two scintillating crystals sandwiching two arrays of SiPM photo-detectors and closed on each end with anti-coincidence tiles.

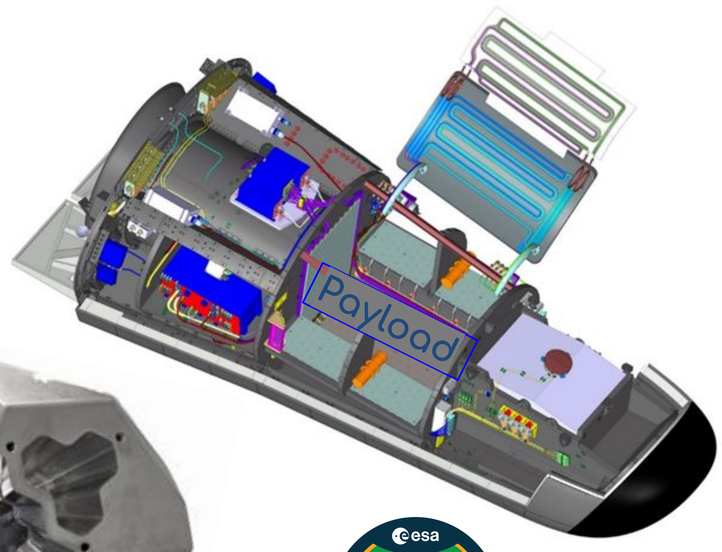
WINK

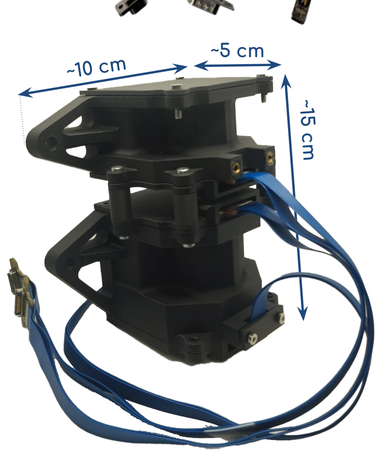
WINK is a pathfinder designed to test, optimize, and validate the Crystal Eye Technology. It is made of three complete pixels mounted with SiPMs mounted onto custom PCB's.

- ★ Connected to DAQ boards with SAMTEC cables
- ★ ASIC CITIROC 1A from Weeroc
- ★ Two HV CAEN SiPM power supply modules
- ★ Two 1 Tb SSDs

Crystal Eye Inner and Outer Shell



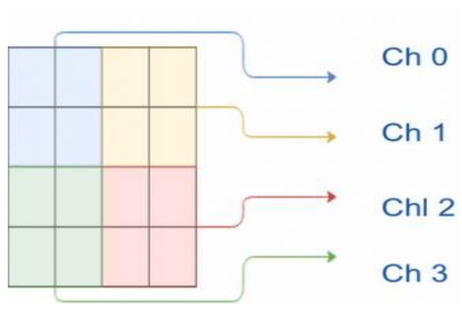




WINK on Board the Space Rider Mission

Trigger Logic

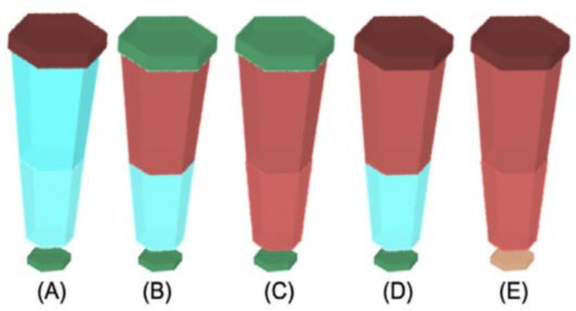
Each SiPM array is divided into 2X2 subarrays giving them redundancy with four channels each.



Two trigger combinations:
- ★ L0 + L1: Particle Detection
- ★ L0 + T_{cal}: Calibration

where T_{cal} is a configuration for which pixels are "free running". The whole system is read out in "OR" logic.

Two levels of trigger: crystal and detector



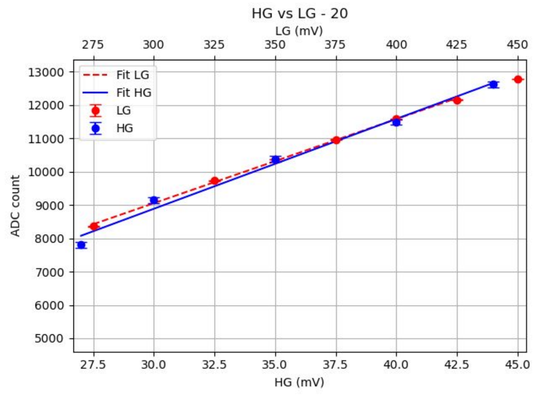
- ★ A) Down-going hard-X (E<30KeV)
- ★ B) Low-energy down-going γ (30KeV<E<1 MeV);
- ★ C) Medium-energy down-going γ (E>1MeV);
- ★ D) Low-energy down-going charged particle;
- ★ E) Charged particle

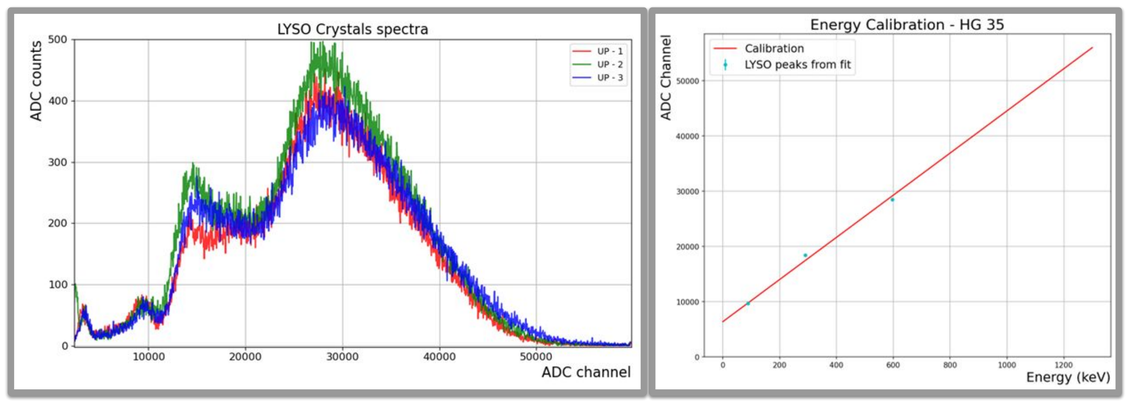
The WINK Engineering Qualification Model (EQM) uses LYSO crystals as scintillators. This allows the detector to be calibrated uses the auto-emission of the Lutetium decay. LYSO crystals also feature a high light yield, a high density for gamma-attenuation, and a short decay time of ~6.65 days.

Hardware Characterization

ADC characterization to prove the correct functioning of the CITIROC1A Asic

Detector Characterization by fitting the LYSO self-emission - due to the Lu-176 isotope - to perform the energy calibration





The primary goal of WINK is to study currently available technology for future use in main detector while characterizing cosmic background

References

- 🚩 Crystal Eye: Aloisio, R. et al. Astroparticle Physics, Vol 174, 2026, 103171.
- 🚩 WINK: Tambone, M., et al. "WINK: Advancing X and Gamma Ray Detection Technology for Space Observations," in PoS, vol. ICRC2025, pp. 857, 2025.
- 🚩 Also see the poster by Barbato, Sarkar et al.

Research Opportunities

- ☆ Crystal Eye angular resolution and optimization of the localization algorithm (possible advisors Barbato-Sarkar).
- ☆ Crystal Eye design optimization and test on 20 pixel prototype (co-working with engineers design/simulations)