Contribution ID: **378** Type: **Poster**

The X-γ detector onboard the POMMA-Balloon with Radio payload

The POEMMA-Balloon with Radio (PBR) is a NASA mission designed to study Ultra-High-Energy Cosmic Rays (UHECRs) and Very-High-Energy Neutrinos (VHENs) from a balloon platform. Serving as a precursor to the planned POEMMA (Probe of Extreme Multi-Messenger Astrophysics) satellite mission, PBR will be launched aboard a NASA Super Pressure Balloon for a targeted flight as long as 50 days at an altitude of 33 km. The launch is planned for Spring 2027 from Wanaka, New Zealand. The unique conditions of low pressure and high altitude will enable in-situ observations of High-Altitude Horizontal Air Showers (HAHAs), a poorly understood class of nearly horizontal Extensive Air Showers (EASs) induced by cosmic rays skimming the Earth's atmosphere without reaching the ground. Due to the reduced atmospheric grammage at these altitudes, HAHAs develop more gradually compared to typical downward-going EASs, with interaction lengths on the order of 100 km. This slow development allows balloon-borne instruments to probe the early stages of cosmic ray shower evolution.

At these early stages, high-energy electrons and positrons from the electromagnetic component of the shower can generate X-rays and gamma rays via synchrotron radiation. The X-γ detector onboard PBR is designed to measure these photons across a broad energy range. The instrument consists of four sub-detectors, each optimized for different overlapping energy bands: X-ray (10–30 keV), X-γ (30–300 keV), and γ-ray (100–4000 keV, with two detectors). The current design utilizes CsI(Tl)/NaI(Tl) scintillating crystals coupled with Silicon Photomultipliers (SiPMs) for photon detection. To suppress background noise, all detectors—except for the X-ray entrance window—are enclosed within an anti-coincidence system composed of plastic scintillators, also read by SiPMs, to reject charged particle events.

The X-γ detector is aligned with PBR's primary instruments—the Fluorescence Camera and the Cherenkov Camera—within a 30° field of view, overlapping with both imaging cameras. It can operate in a triggered mode, receiving signals from the other instruments, as well as autonomously, also during daylight hours, to maximize data collection.

This contribution will summarize the scientific objectives of the X-γ detector and provide an overview of its design, functionality, and current development status.

Collaboration(s)

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Session Classification: PO-2

Track Classification: Gamma-Ray Astrophysics