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A proposal for a multiPMT detector in the Southern hemisphere wide field of view gamma-ray observatory (SWGO)

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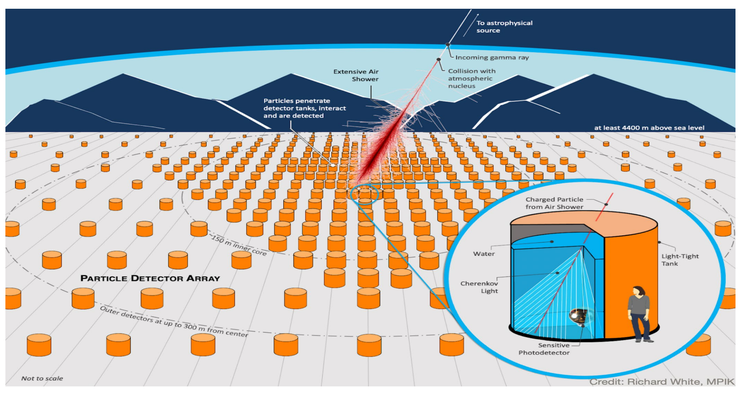
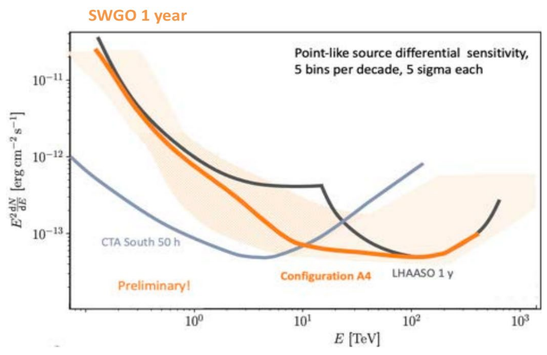
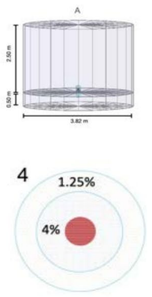
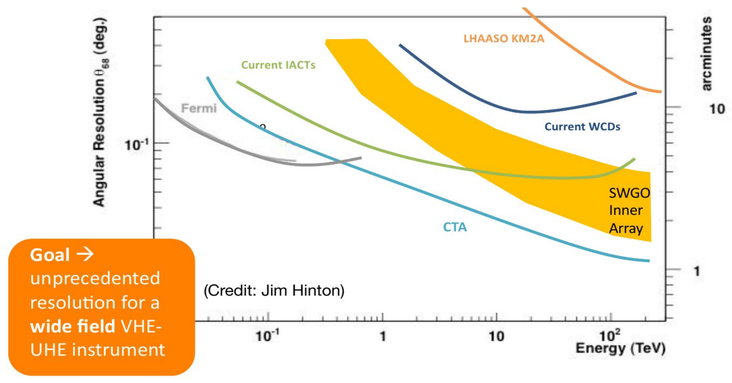
SWGO will be a new ground-based gamma-ray observatory in the southern hemisphere. It will be based on water Cherenkov detectors andi t is proposed to complement existing Northern instruments like HAWC, Tibet-ASg, and LHAASO. The selected site is Pampa la Bola in Chile, at 4770 m, in the Atacama Astronomical Park, featuring a high fill-factor core detector with enhanced sensitivity and a low-density outer Array. This observatory will cover energies from 100s of GeV to PeV, offering near 100% duty cycle and wide field of view. This includes mapping large-scale gamma-ray emissions, accessing the Galactic Centre, and supporting transient and multi-messenger astronomy, with significant potential for cosmic-ray studies and anisotropy detection.



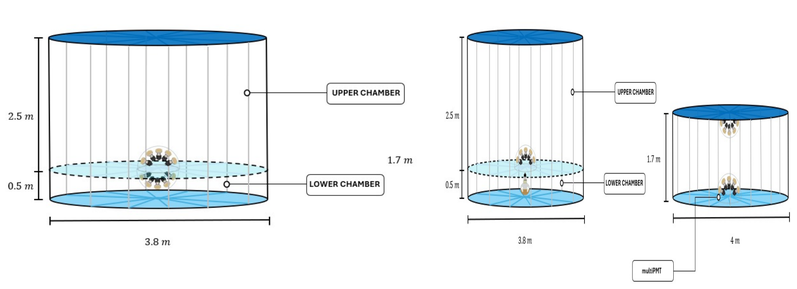




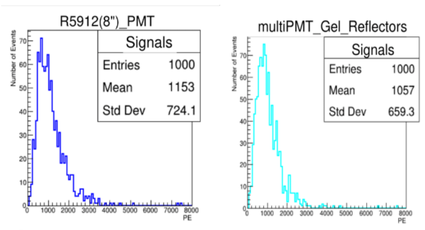


Based on the experience of KM3NeT and Hyper-Kamiokande we **proposed a multiPMT detector in SWGO**:

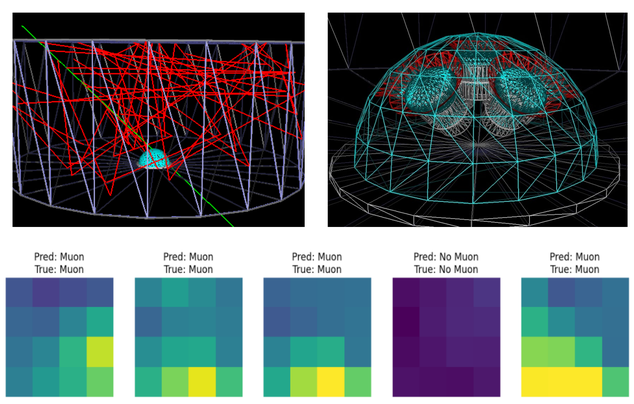
- Seven 3'' R14374 Hamamatsu PMTs;
- Components enclosed in a watertight vessel with only digital cables going out;
- Intrinsic directional sensitivity;
- Modular design, with enhanced reliability at a competitive cost.



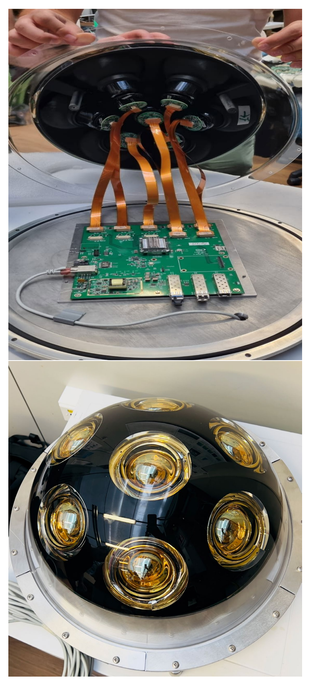
Simulation models have been developed to test the detector in any of the SWGO tank design.



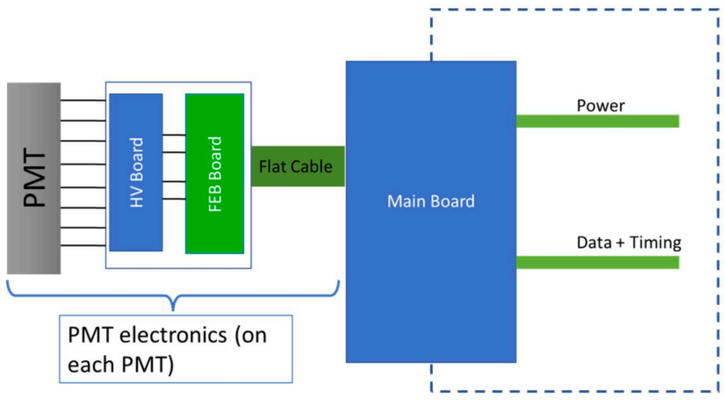
Comparison between the performances of the 8'' Hamamatsu R5912 PMT (baseline) and the multiPMT inside a SWGO tank.



Output of a CNN algorithm for muon identificationn at tank level exploiting muon directionality. Input from CORSIKA showers. Promising results.

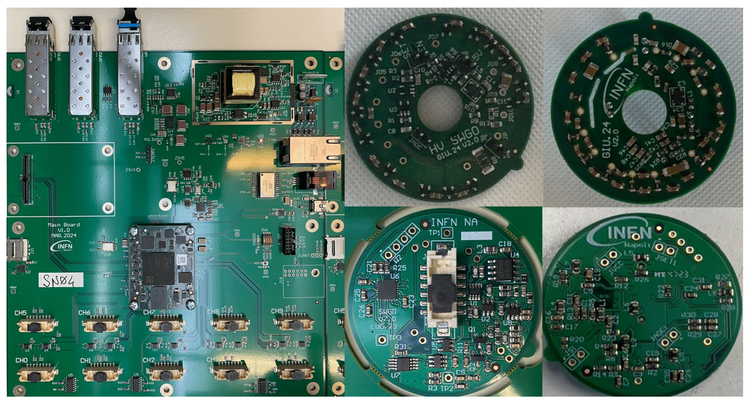


A complete electronics system has been developed and produced to operate the first prototypes.



Each multiPMT is composed by:

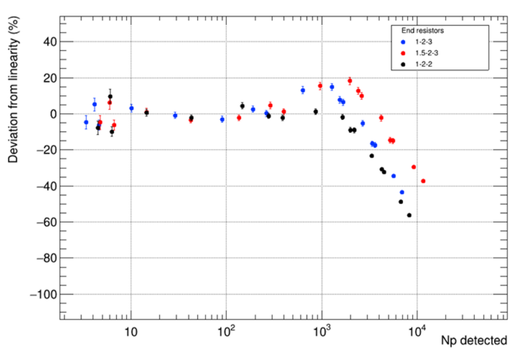
- Active HV board to generate up to 1500 V;
- Front End Board to digitalise the signal;
- Main Board to collect the signal and send them on Ethernet.

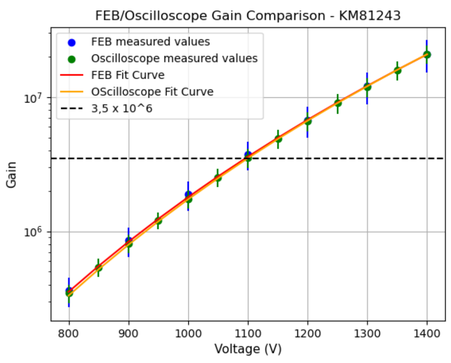


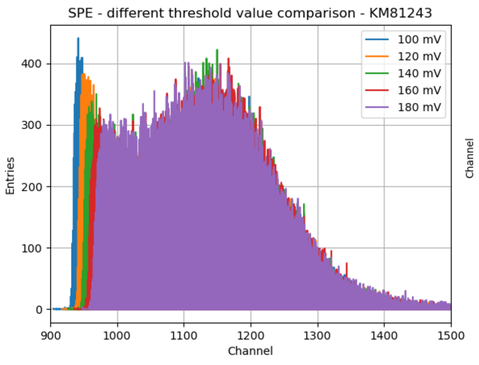
- HV board is based on a Cockcroft–Walton voltage multiplier
- Tapered voltage multiplier to increase linearity of R143734 PMT.

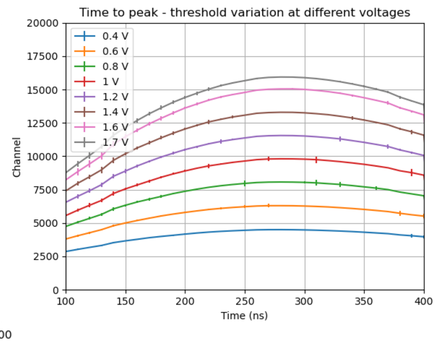
- FE based on a slow shaper integrator to get charge and fast amplifier to get timing of the hit
- Prototypes tested in the first multiPMT built to validate the design

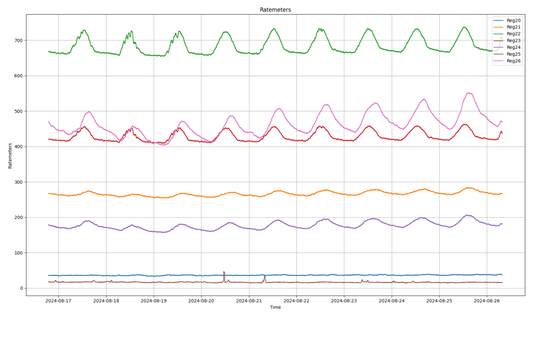
- Main Board based on a Trenz System on Module
- The board embeds Ethernet on both copper and fiber, custom timing link on copper and fiber and also a White Rabbit node hardware











The first full chain has been tested and validated. We produced the necessary electronics for 5 multiPMT prototypes and we plan to test them in **selected sites**, like CBPF in Brasil, Auger site, HAWC site and in **Pampa la Bola**, where we plan to install prototypes by next spring.