

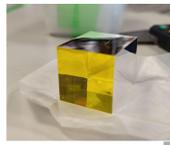
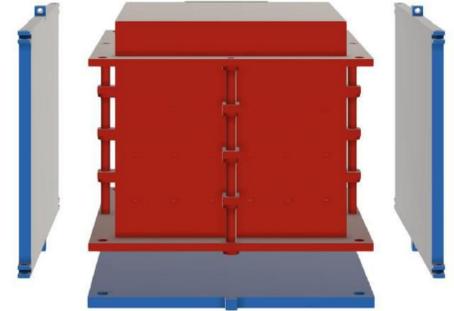
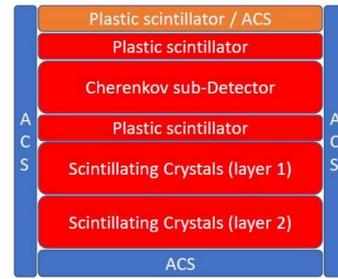
A compact detector for the measurement of ionizing radiation in space

Target measurements:

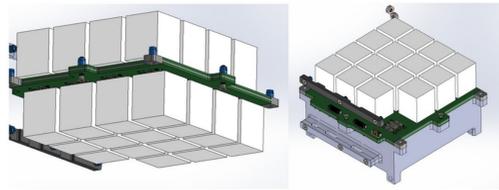
- Photons (0.1-10 MeV) : gamma transients, Terrestrial Gamma Ray Flashes, etc.
- Electrons and Protons below 100-200 MeV: space weather, solar flares, magnetosphere-ionosphere-lithosphere coupling, etc.

Detector innovations with new solutions for:

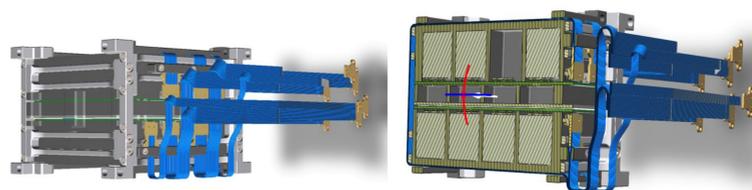
- Silicon Photomultipliers (SiPMs) for light readout in space
- Particle identification: Cherenkov detection for electron tagging
- Photon tagging: duly segmented active veto systems
- Optical coupling: space qualified materials
- Low power electronics tailored for space applications
- Radiation hardness and damage mitigations
- Characterization of crystal and plastic scintillators and TRL assessment, quality controls, procedures



Crystal assembly



Detector layout



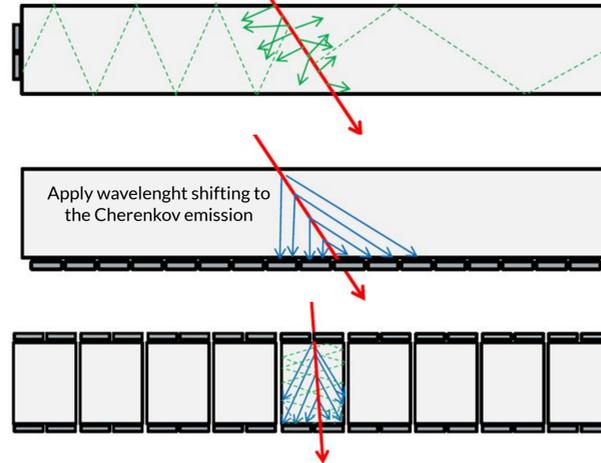
Electron Tagging with Cherenkov light

Typical plastic scintillator (e.g. EJ-200)
Light Yield (LY) $\sim 10^4$ photons / MeV
Emission: visible range
1 mip $\sim 2 \cdot 10^4$ photons / cm

Transparent medium with $n \sim 1.5$
No scintillation
Cherenkov light if $\beta > 1/n \sim 0.7$
Forward emission, but mostly UV

Emission in the visible range: $\sim 1\%$ of the typical scintillation
Apply wavelength shifting to maximize the number of detected Cherenkov photons by using:
Optically independent WLS PMMA elements

Maximize thickness / surface
Use SiPM arrays in the upper and lower surfaces
Also exploit a possible residual up/down asymmetry



Scintillators

BGO

- High density (7.13 g/cm³)
- Better stopping power for gamma rays
- Radiation hard
- Non-hygroscopic

-Moderate-Low light yield
-Slow decay time

GAGG

- High density (6.63 g/cm³)
- Excellent light yield
- Good energy resolution
- Non-hygroscopic

-Lower density than BGO

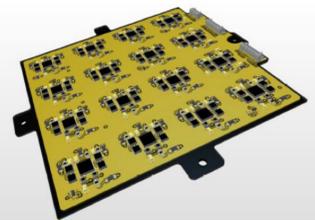
LYSO

- High density (7.1 g/cm³)
- Better stopping power for gamma rays
- Good light yield
- Fast decay time
- Non-hygroscopic

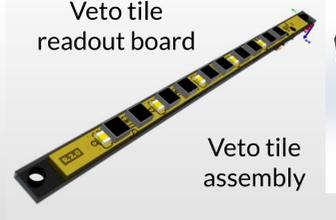
-Intrinsic radioactivity

Readout and DAQ electronics

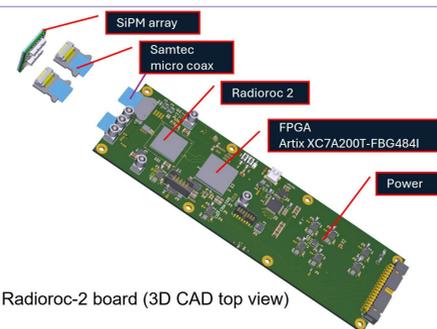
Crystal readout board



Veto tile readout board



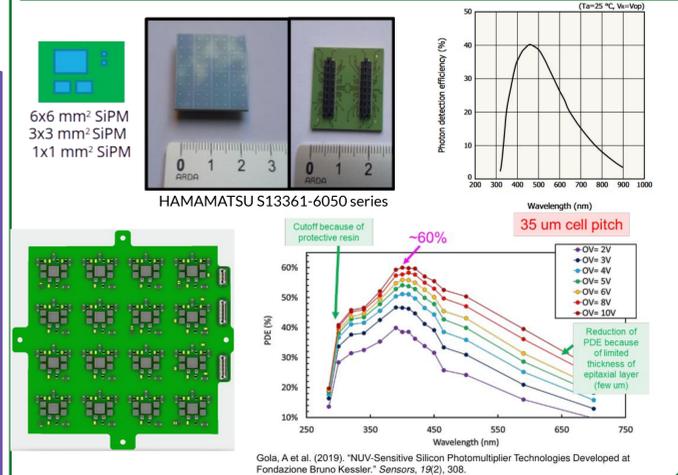
Veto tile assembly



See poster by F. Peretto on WP4.3 electronics. In synergy with SPOKE 5, WP 5.3.

Radioroc-2 board (3D CAD top view)

Silicon PhotoMultiplier sensors



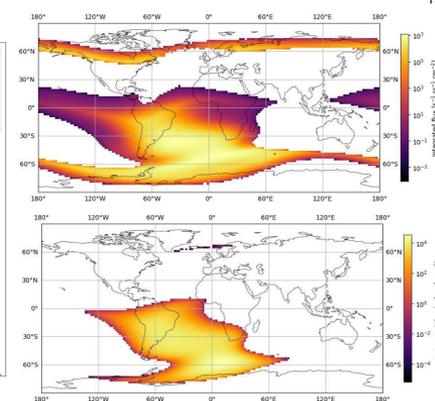
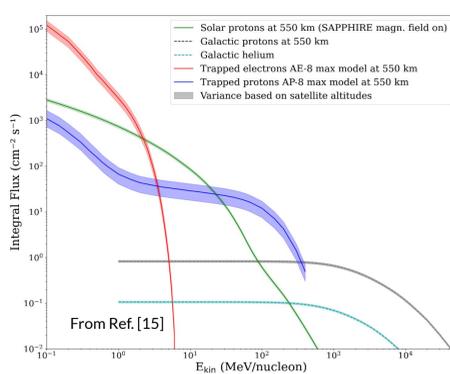
LEO radiation environment & damage studies

Energetic particles in Low Earth Orbit degrade SiPM performance, mainly increasing the dark count rate due to ionizing and non-ionizing radiation.

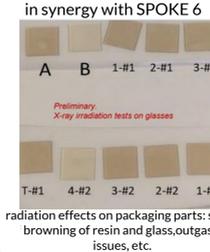
Mission effects will be evaluated through proton and gamma irradiations up to mission-equivalent doses with safety margins, defining performance limits, mitigation strategies, and supporting component qualification.

Outgassing tests will verify contamination compliance.

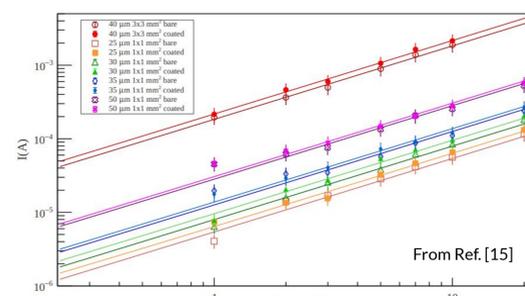
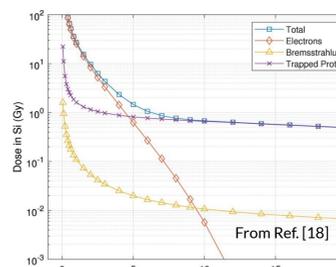
Annealing studies will explore recovery of SiPM/MPPC performance, focusing on dark count rate reduction



See poster by S. Bez Baruah in synergy with SPOKE 6



radiation effects on packaging parts: study of browning of resin and glass, outgassing issues, etc.



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