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Next Generation Radiation Monitor NGRM

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Next Generation Radiation Monitor - NGRM

Compact, light instrument for ESA missions and exploration of radiation environment

Mass < *1 kg; Volume* < *1 dm^3, Power* < *1 W*

Electron detector

Spectral range 100 keV – 7 MeV

peak flux 10^9 e/cm^2/s

Proton heavy ion detector

Spectral range 2 MeV – 200 MeV

peak flux 10^8 p/cm^2/s

Heavy ion detection

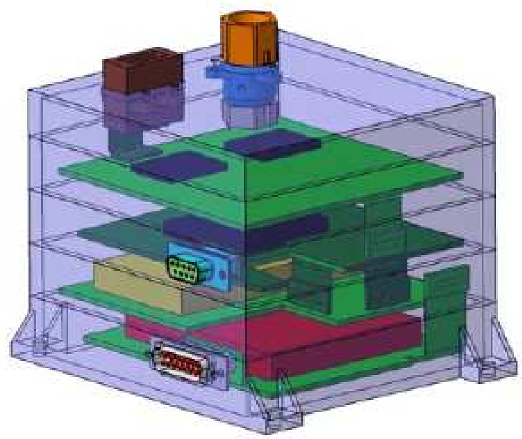
Let 0.1 – 10 MeV/cm^2/mg

Radiation hard

dose determination and alarm function

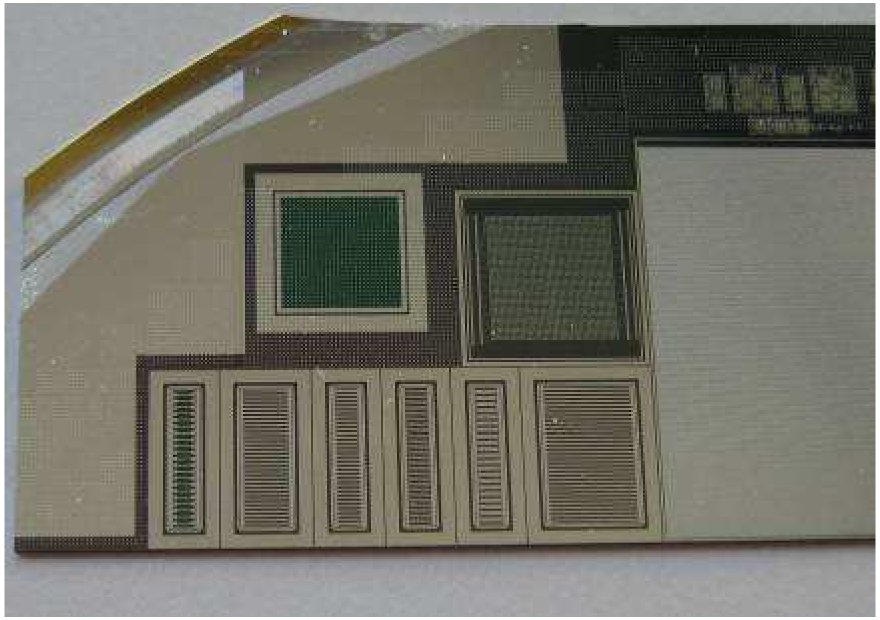
Particle separation

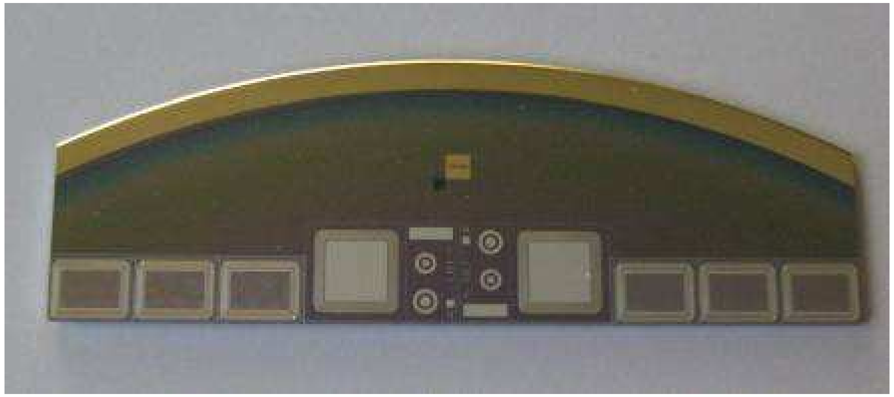
Data storage (1 month, 5 min cadence)



Electron Detector Concept / Detection technology

- Detector based on circular Si-diode with 16 readout rings (analogue to microstrip)
- Various concepts for production studied (1 or 2 metal layers, signal pads in vertical slice etc.)
- Energy separation with properly shaped mechanical degrader (no magnets)
- Energy determination through event position readout
- Further verification with amplitude analysis
- Low noise frontend ASIC in vicinity of the sensor





Electron Detector – Mechanics

Degrader concepts elaborated and studied

Final version confirmed by MC simulations

Critical low energy part

PCB with detector sensor directly under degrader

Sufficient shielding for background suppression

Short distance to FE ASIC

Electron Detector – Breadboard

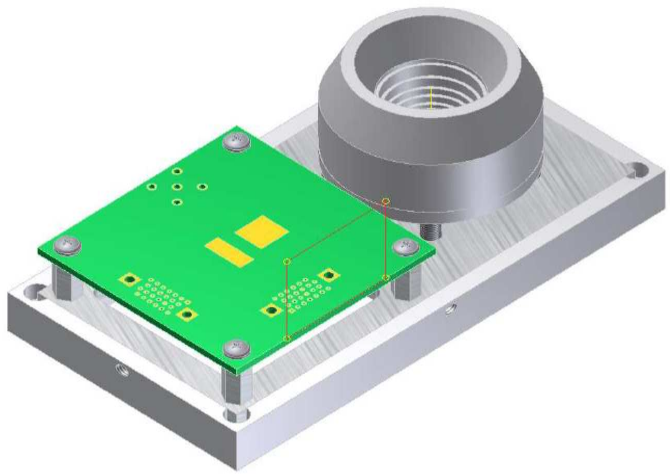
Extended Breadboard of NGRM constructed

Support for Frontend electronics manufactured

BB version based on milling of Aluminum layers as degrader under construction

PCB design for microstrips sent to manufacturer

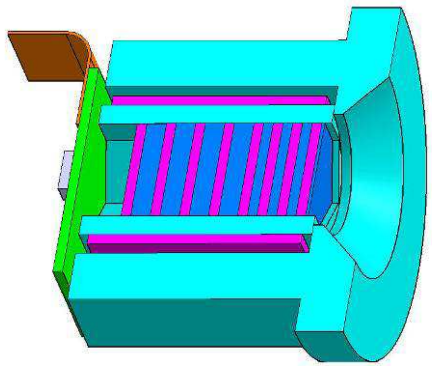
readout electronics EGSE based on modified RADEM/HEP – ready to use



NGRM

Proton Telescope Concept / Detection technology

- Arranged as particle telescope (similar to HEP-RADEM)
- Fully depleted Si-diodes as sensors
- Range shifters (degraders) for energy threshold in bins
- Energy separation with properly shaped mechanical degrader und readout of hit pattern
- Further verification with amplitude analysis
- Low noise frontend ASIC in vicinity of the sensor



NGRM

Proton Telescope – Mechanics

Arranged as particle telescope

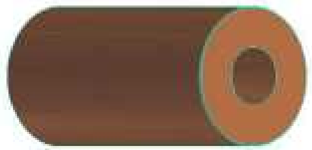
Energy range 2 MeV – 200+ MeV

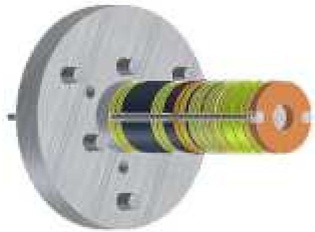
Energy resolution – 8 bins equally spaced on log-scale

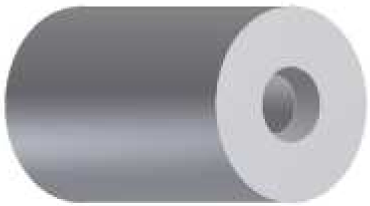
Fully depleted Si-diodes as sensors

Range shifters (energy degraders) for energy threshold

Fast, low power, radiation hard readout ASIC (A/D)







Proton Telescope – Breadboard

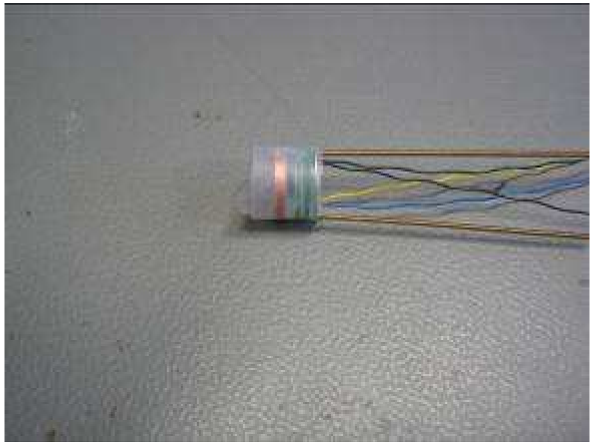
Extended Breadboard of NGRM constructed

Mechanical support for Frontend electronics manufactured

BB version based on Al+Cu degraders

Inner and outer cylinder of telescope ready

readout electronics EGSE based on modified RADEM/HEP – ready to use



Detector Manufacturing

Dedicated set of detectors for whole NGRM batch

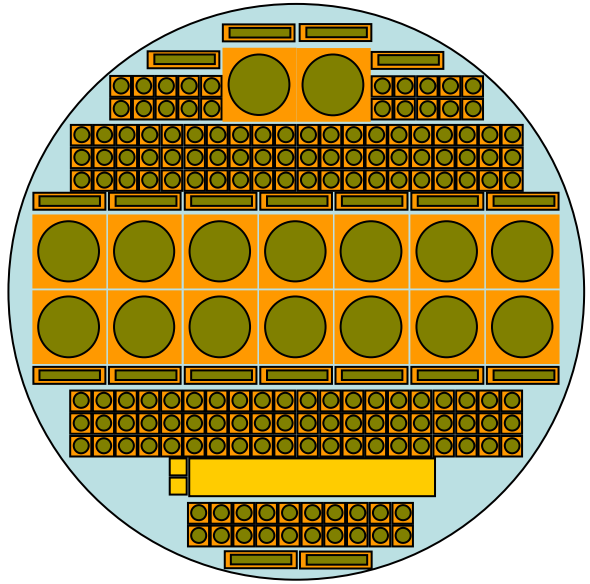
Team from PSI SLS Detector Technology group

3 types of sensors under design:

- large area diodes
- microstrip
- circular ring detector

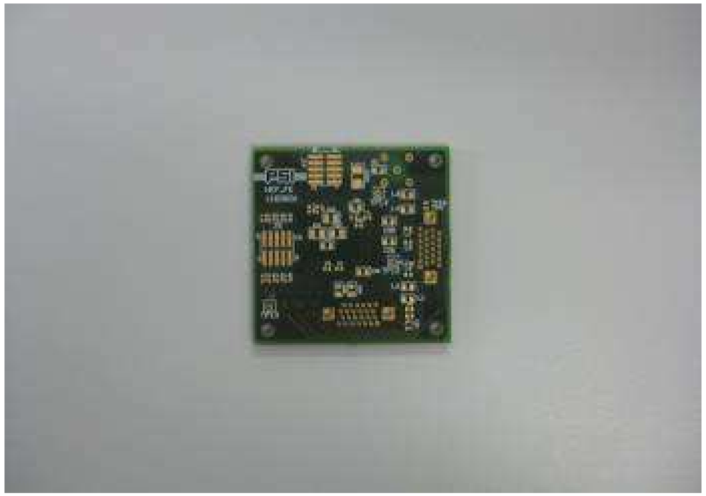
Manufacturers offers requested

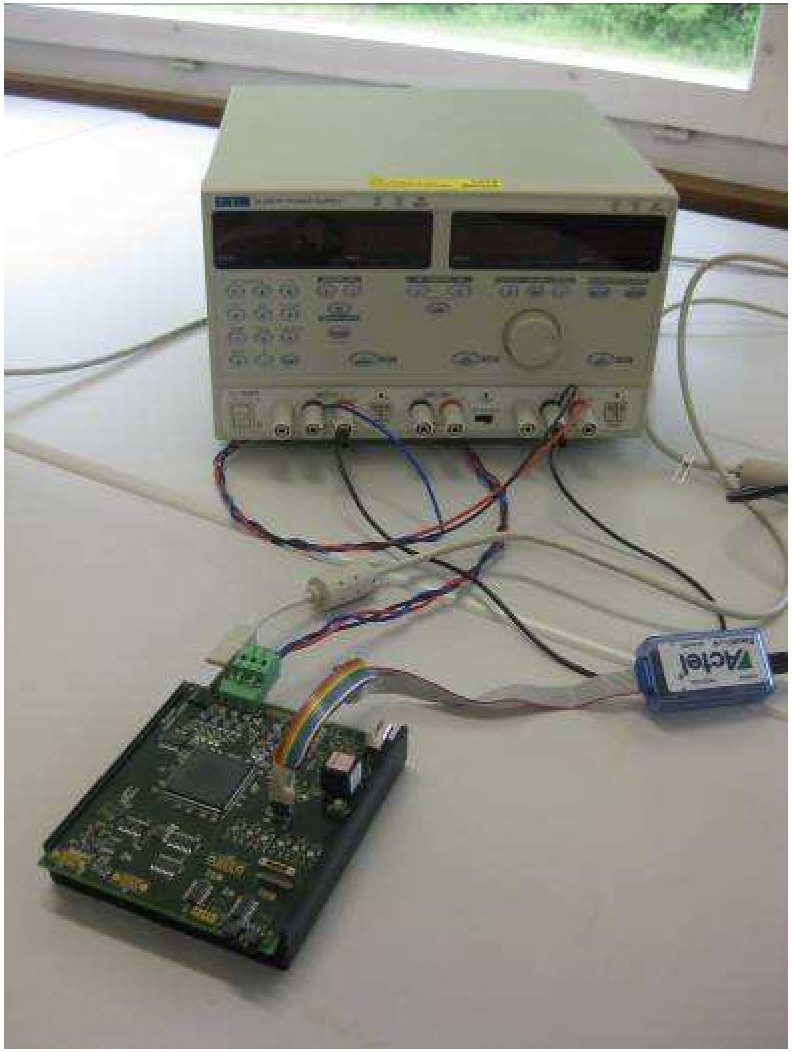
Cutting, bonding and qualification at PSI nanotech-labs



NGRM Readout / Frontend Electronics

- BB is based on solution for HEP
- BB FE uses VA64TAP ASIC applied for both e/p sensors
- BB EGSE solution is adapted from RADEM. It is ready to use
- For DM/EQM the Readout and Frontend will use dedicated ASIC (under construction)





Particle Energy, Identification and Separation

For fast detection the energy is determined via position of the event

In electron detector the particle identification uses energy loss analysis for various threshold settings.

Higher depositions belong to heavier particles (HLD)

In telescope the threshold settings cut-off electron events (LLD)

Pattern analysis and amplitude verification identifies proton events and their energy

Very high energy depositions together with hit pattern identify heavy ions HI. Energy (LET) possible via amplitude analysis.

Special ASIC inputs and readout channels are dedicated for HI

Mass Model for Monte Carlo Simulations

Full mass model constructed with GIANT and GRAS

Input based on Breadboard CAD drawings

Lab responses with protons and electrons computed

Results used for optimization of both detector units

Mass models of HEP adapted for NGRM while electron detector is constructed anew

NGRM

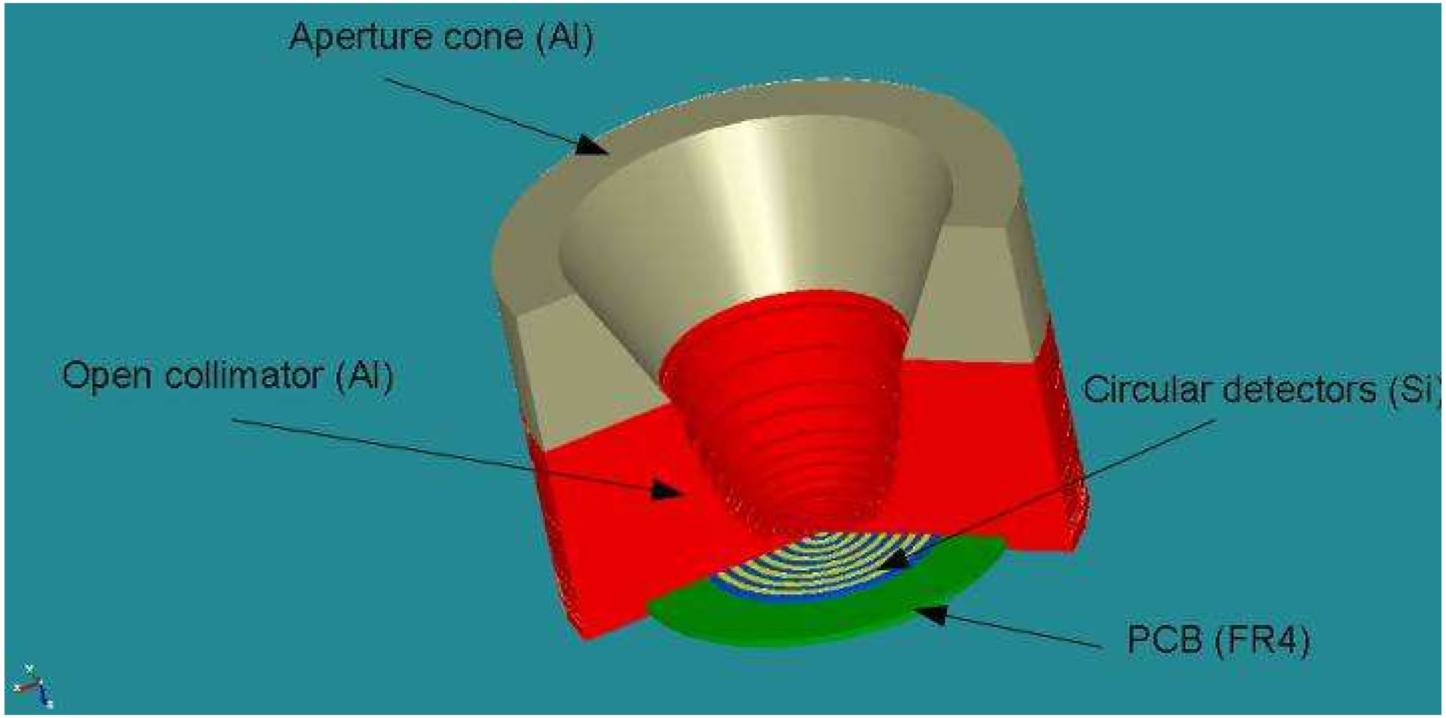
Simulations of Electron Detector

Simulations performed with electrons and protons

Response from front and all direction determined

Specifications for electrons are kept

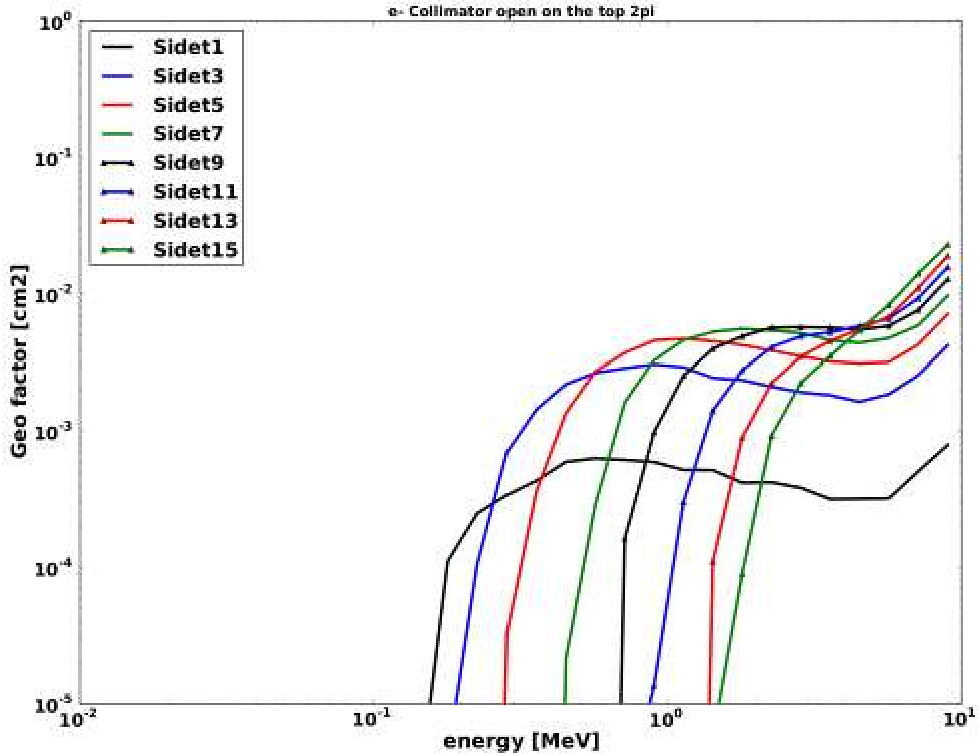
Side electron background needs extra shielding



E-Detector – Electron Response Function

Response from front and all direction determined

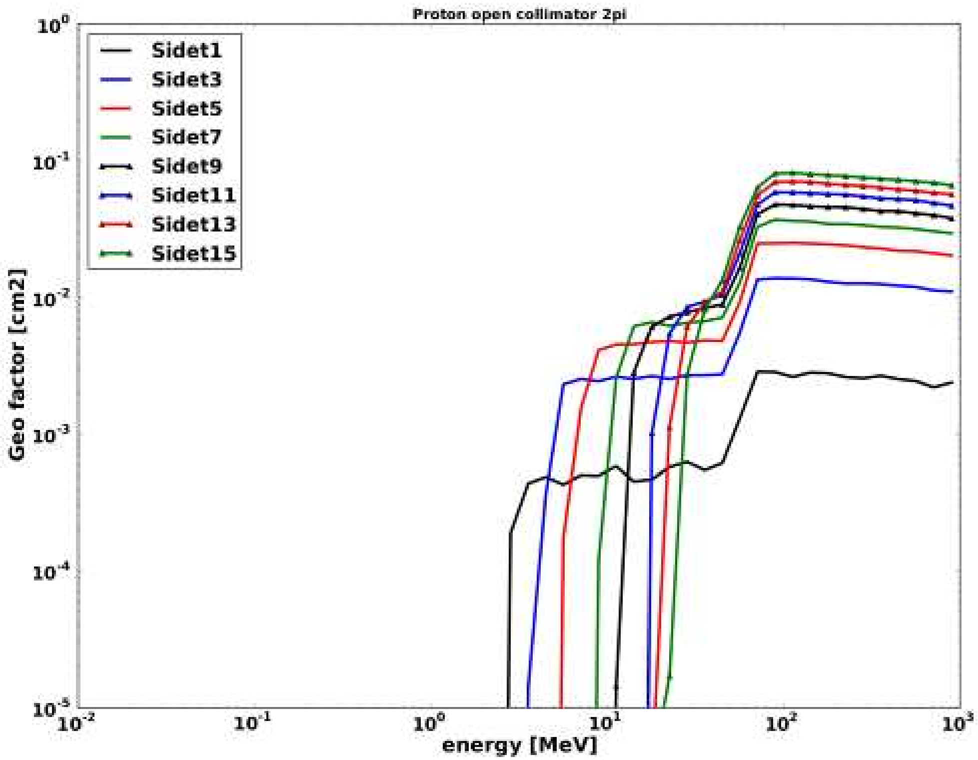
Specifications for electrons are kept – design concept feasible



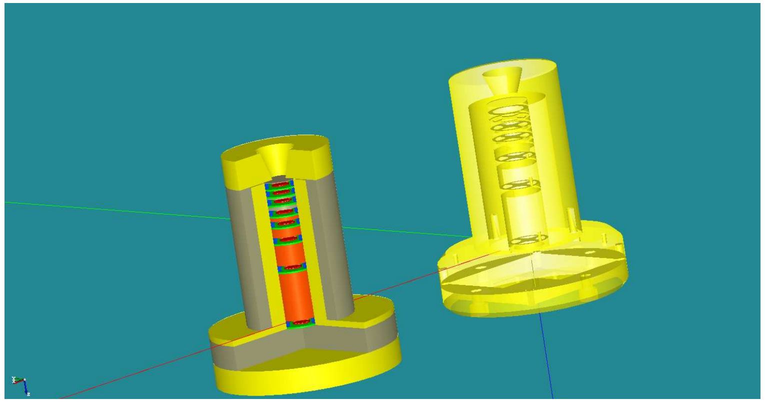
NGRM E-Detector – Response Function for protons

Design of electron detector also allows for proton measurements

Detector provides spectral determination potential with good energy resolution for front detection



Simulations of Telescope Response



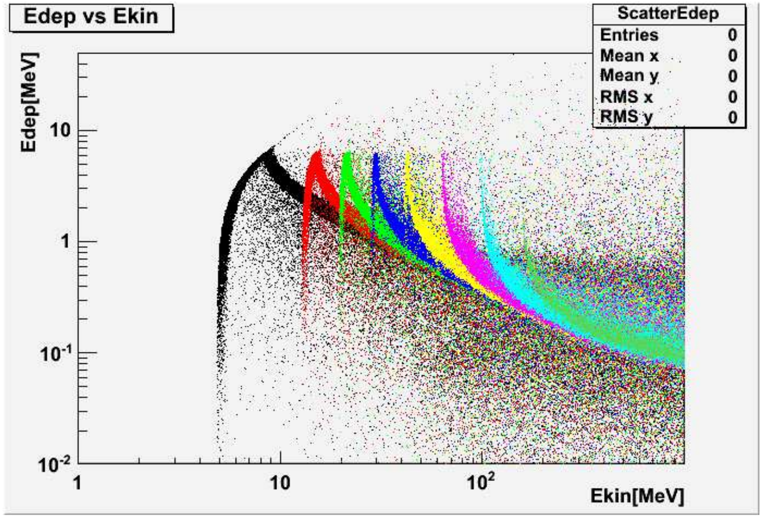
Results as for HEP in RADEM with modification of cylinders and absorbers

Simulations performed with protons and electrons

Response from front and all direction determined

Specifications for protons are kept

Electron background discrimination via threshold



NGRM

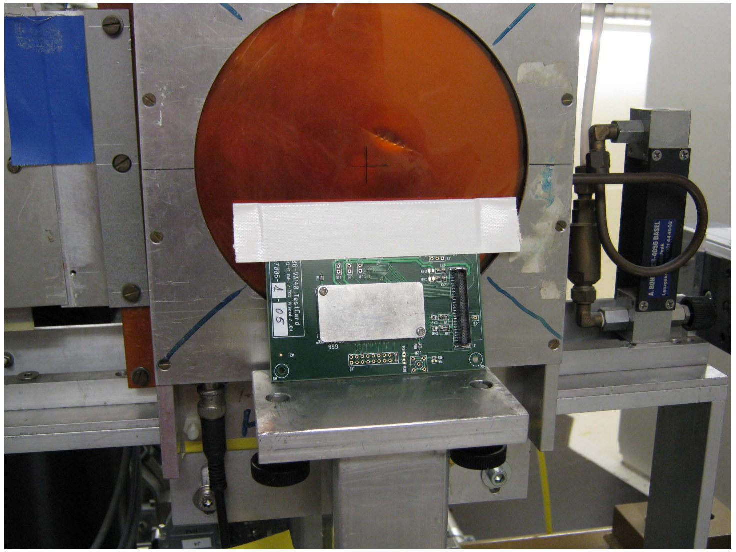
Test of ASIC for Single Event Latchups

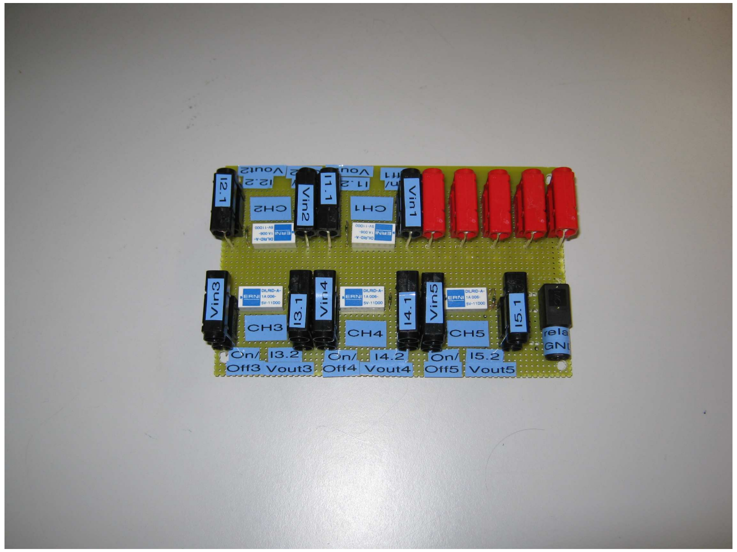
Both VA64TAP ASIC and technologically equivalent ASIC for EQM tested for SEL

Proton tests at PIF PSI revealed no latch-ups for 230 MeV and 60 MeV

Further tests with HI performed in HIF facility in Belgium on Tuesday night

(Setup equipment, HW and SW from PIF PSI)





Summary

Next Generation Radiation Monitor NGRM designed as standard instrument for measurement of e/p/HI onboard of spacecraft

Concept feasibility tested and optimized using simulations as well as physical and mechanical analysis

Electronics and detection sensor concepts elaborated for manufacturing of dedicated ASIC and detectors

Breadboard model construction about finished starting first laboratory and radiation tests

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Thank You