Next Generation Radiation Monitor (NGRM)

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Overview

- NGRM Project Introduction
- RUAG Heritage with Radiation Monitors
- Key Requirements
- Design Challenges
- Design Approach
- Design Status
- Conclusion

NGRM Project Introduction

- Successor of the Standard Radiation Environment Monitor (SREM)
  → Generic multi-use radiation monitor

- Contract between RSSZ and ESA under co-funded GSTP

- International consortium
  - PSI (CH) → Detectors' sizing / rad. analysis
  - IDEAS (N) → Read-out ASIC
  - EREMS (F) → Controller Electronics Unit
  - Onera (F) → Radiation analysis

- Development started in Q3 2011
- Model philosophy: EM, EQM, PFM
- PFM to be embarked on EDRS-C

RUAG Heritage with Radiation Monitors

- SREM
  - Aim: support scientific missions and provide valuable radiation data for future missions (eg Giove)
  - Status: operating since more than a decabe onboard STRV-1c, Proba-1, Integral, Rosetta, Giove-B, Herschel and Planck
  - Developed by RSSZ and PSI

RUAG Heritage with Radiation Monitors

- Environmental Monitor Unit (EMU)
  - Aim: characterize the radiation environment of the Galileo orbits.
  - Developed by RSSZ and Qinetiq.
  - Status:
    - 2 EMU units embarked on Galileo FOC satellites to be launched in tbd
    - Additional EMU on Galileo tbd
    - 2 EMU / SEDA on Japanese Himawari mission

NGRM Key Requirements

- Electrons energy range: 100keV - 7 MeV
  - Classification in 8 quasi-logarithmic channels
  - Peak flux of 10^9 and 10^7 particles/cm^2/s for 0.1 and 1 MeV electrons, respectively
- Protons energy range: 2MeV - 200MeV
  - Classification in 8 quasi-logarithmic channels
  - Peak flux of 10^8 and 10^6 particles/cm^2/s for 2 and 20 MeV protons, respectively
- Heavy Ions: LET (ΔE) spectrum: 0.1 to 10 MeV.cm^2/mg, measurable in 8 quasi-logarithmic channels
- Discrimination of electrons vs. protons

NGRM Key Requirements

- Volume: 1 litre
- Mass: 1 kg
- Average power consumption: 1 W
- Lifetime: 15 years in GEO, 12 years in MEO
- Operating temperature range (qualif.): -40° C to +65° C

NGRM Key Requirements

- Reconfigurable TM/TC IF
  - MIL-STD-1553B (implementation baseline for EQM and PFM)
  - CAN
  - SpaceWire
  - RS-422 (optional)
- Primary bus voltage: +28 V or +50 V
- Time resolution: 30 sec to 1 hour
- Data autonomy: 1 month at 5 minutes time resolution
- In-orbit patchable software

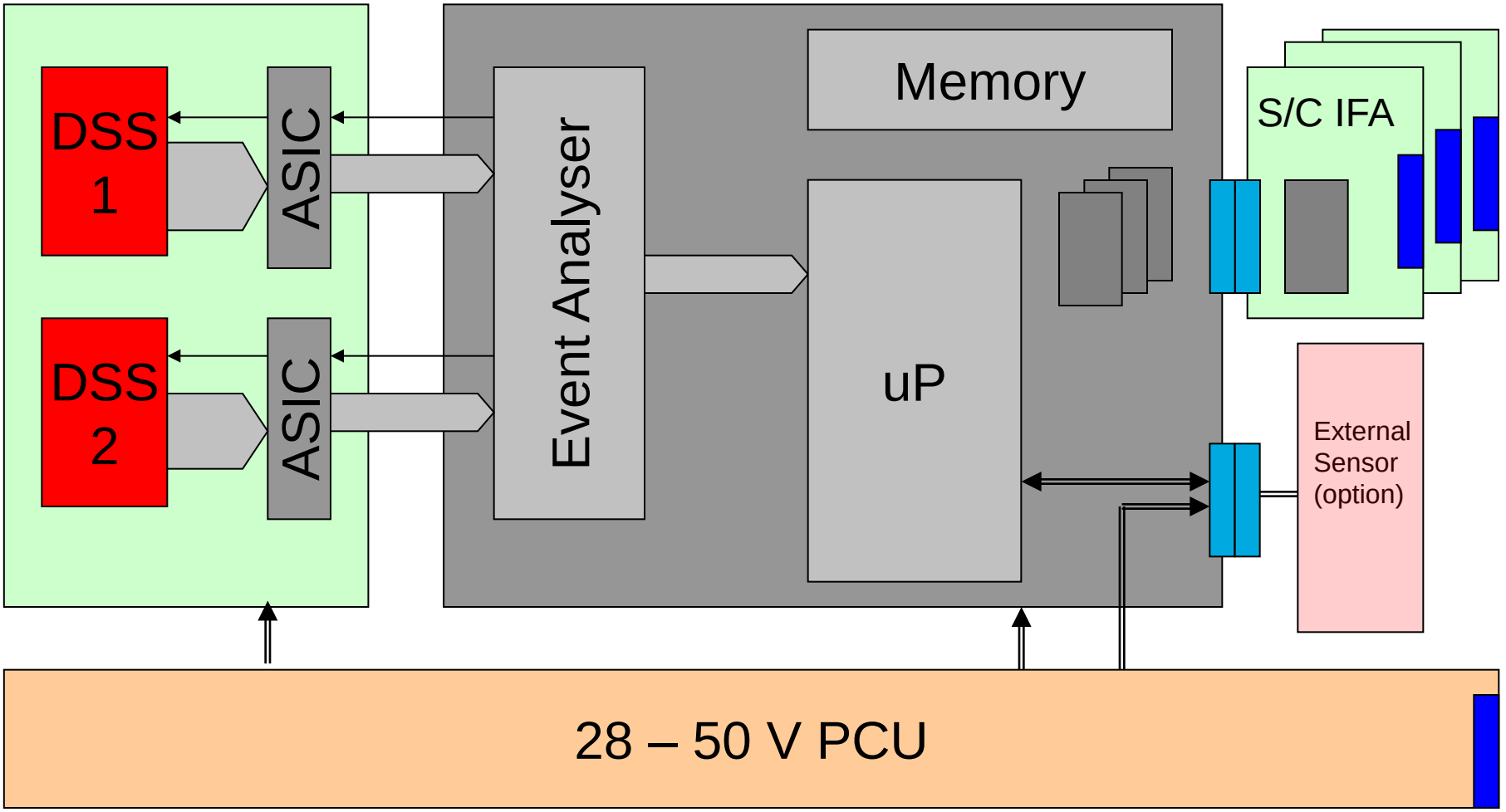
Design Challenges

- Several challenging requirements
  - Also when compared to recent developments like EMU

- Achieving all requirements simultaneously is extremely challenging as most are «competing requirements»

Example of competing requirements
Radiation meas. requirements ⇔ mass, volume, power consumption
Volume ⇔ radiation meas. requirements
Power consumption ⇔ radiation meas. requirements
Reconfigurable TM/TC IF ⇔ mass, volume and cost
Primary bus voltage ⇔ power consumption
Lifetime ⇔ mass, power consumption

Design Approach



Design Approach

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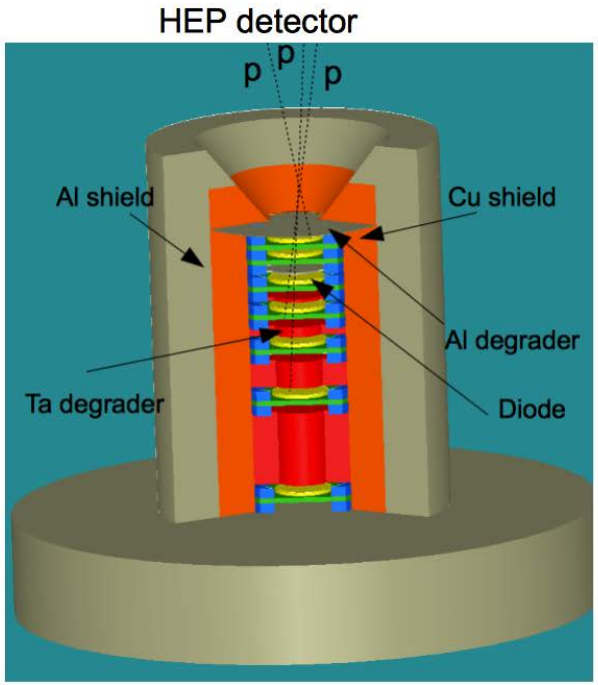
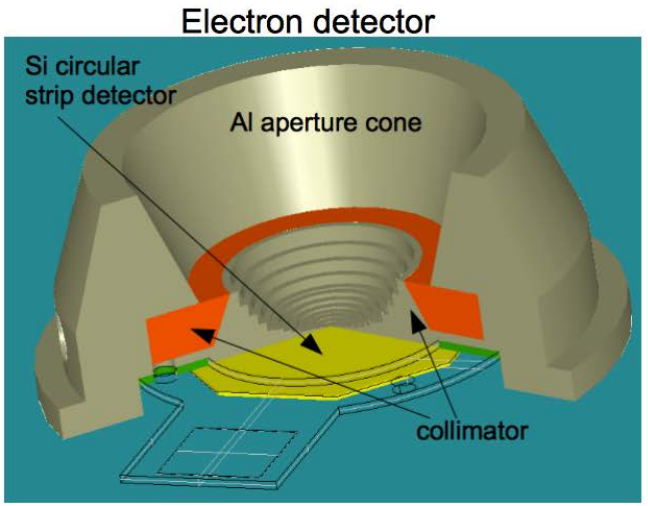
Design Approach

- Detectors' design:
  - compact and integrated with RO ASIC while achieving radiation measurement requirements
  - allows reducing mass & volume



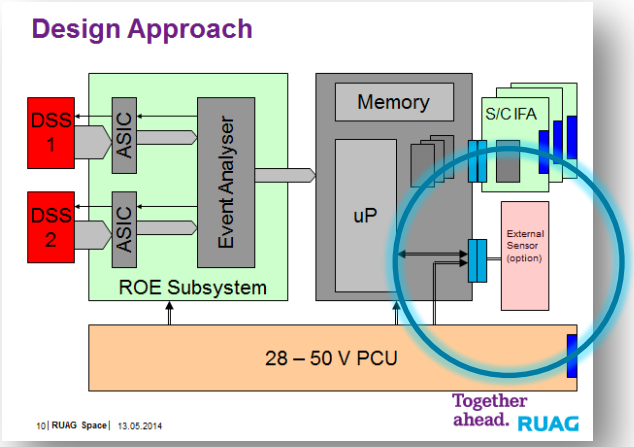


Design Approach

- Read-out ASIC: integrates 20 channels within a single die
  - allows reducing mass, volume & power consumption
- Use of radiation hard components
  - allows reducing mass (by reducing required shiedling)
- System architecture
  - allows reducing power consumption
  - allows changing the TM/TC IF by only changing a single board implementing the TM/TC IF physical layer only

Design Approach

- Design compliant with listed requirements except for:
  - Mass: 1.35 kg (but incl. MLI)
  - Average power consumption: approx. 1.8 W (MIL bus !!)
- The design approach also implements the possibility to supply and control an external sensor and use NGRM as host.



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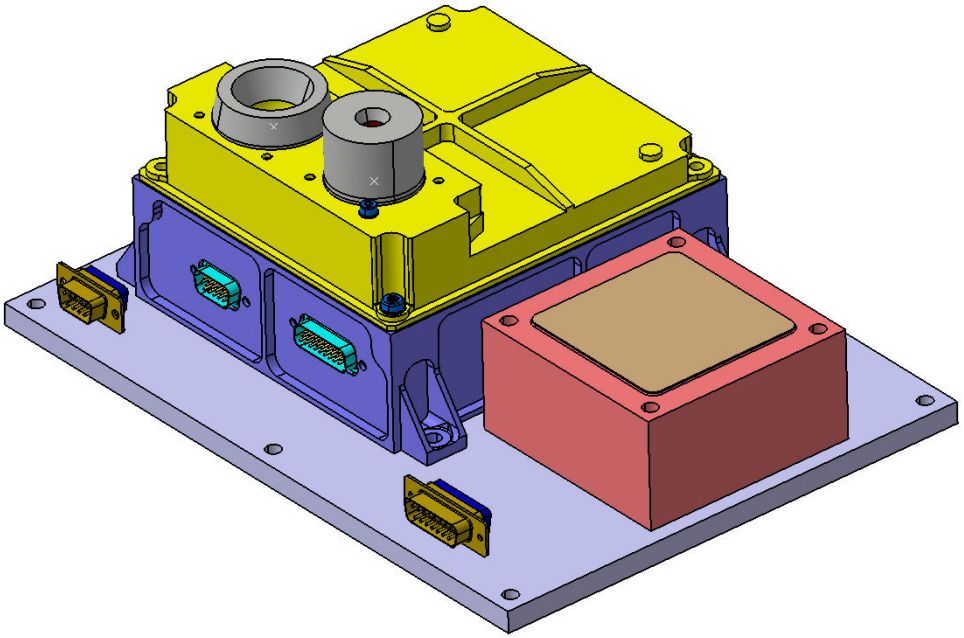
External sensor on NGRM (conceptual view)

- NGRM mounted on interface plate to allow …
  - 1:1 mechanical interface to EMU
  - 1:1 electrical interface (power and data, data frames tbc)
  - Adjust CoG and MoI
  - Accomodate and interface an external sensor for special ranges via the NGRM data stream (→ NGRM as firewall to S/C)
    → Baseline studied in frame of SW study: NGRM + HMRM



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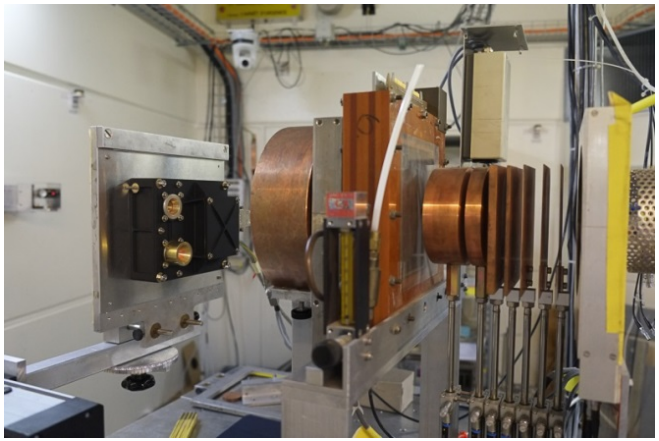
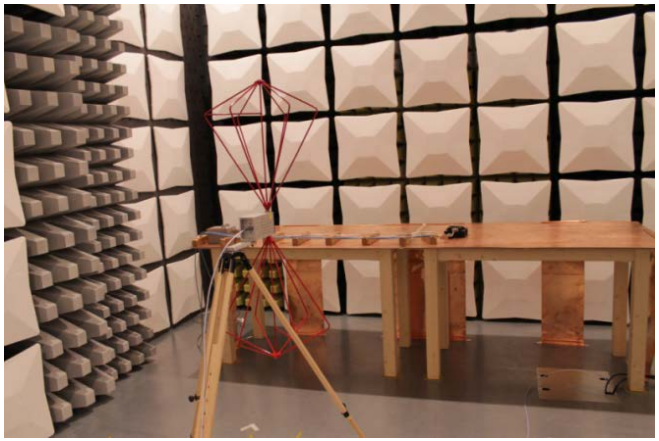
Development Status

- End of EM-plus test phase
  - ✓ EMC test
  - ✓ Thermal test
  - ✓ Electron test at PSI Monochromator
  - ✓ Proton test at PSI PIF

- Additional electron and proton tests required at PSI to complete the measurement campaign
- Dedicated papers on radiation performance were presented by PSI in the frame of related conferences (e.g. RADECS 2013)





EQM / PFM Status

- Update of EM design to EQM/PFM (minor modifications)
- EQM AIT expected to start Aug 2014
- PFM DRB planned for late Q4 2014

  Note: EQM and PFM quasi parallel

Conclusion

- NGRM was and still is challenging
- The consortium is on good way to achieve the requirements in-line with customer needs by end of this Year
- NGRM is able to measure the radiation environment for most missions, incl. long MEO missions
- The design allows for easy accommodation on upcoming missions
  - Low S/C resource requirement (power, mass, footprint)
  - Flexible TM/TC interface
  - Patchable / configurable software
  - Environmental conditions
- NGRM can be used as host / controller for additional external sensors / detectors

Standard Radiation Monitor
→ see SREM

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Thank you for your attention!