

# RADIATION MONITORS - OUTLOOK

EXISTING AND NEW INSTRUMENTS FOR D3S



# FROM PAST TO PRESENCE



Delivering Radiation Monitors for many years

## SREM / EREM

- General purpose RM for several ESA missions
- Strv-1c, Proba-1, Integral, Rosetta, Giove-B, Herschel, Planck

## EMU / SEDA RM for Galileo Mission

- 15 Y MEO / MIL1550
- 1 kg, 1.5 W, 1lt
- Galileo, Himawari

## RMU / NGRM (15 Y MEO / MIL1550)

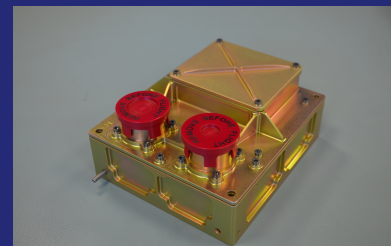
- EDRS-C (IOD),
- 7 Units on MTG
- 6 Units on MeTop-SG
- 2 Units for Sentinel-6



SREM  
1999 - 2003

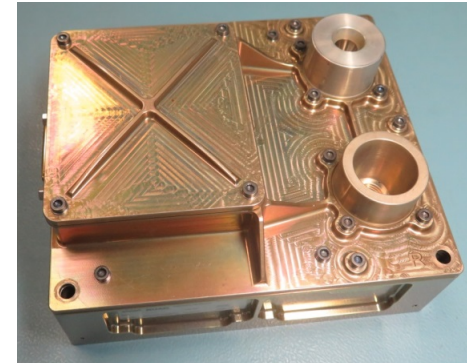


EMU  
2007 - 2009



RMU/NGRM  
since 2013

# FROM PAST TO PRESENCE – RMU / NGRM



Measurement	EMU	New Generation
Electron fluxes/charging	100keV – 5 MeV	100 keV – 7 MeV
Proton fluxes	15 – 100 MeV	2 – 200 MeV
Heavy ion measurement	0.5 - 33 MeV mg <sup>-1</sup> cm <sup>2</sup>	0.1 - 10.0 MeV cm <sup>2</sup> /mg
Total dose (TID)	4 RadFETs, 500 krad(Si) capability (different shielding depths)	Not available – derived from measurements

# THE PRESENCE

/// RMU / NGRM Unit

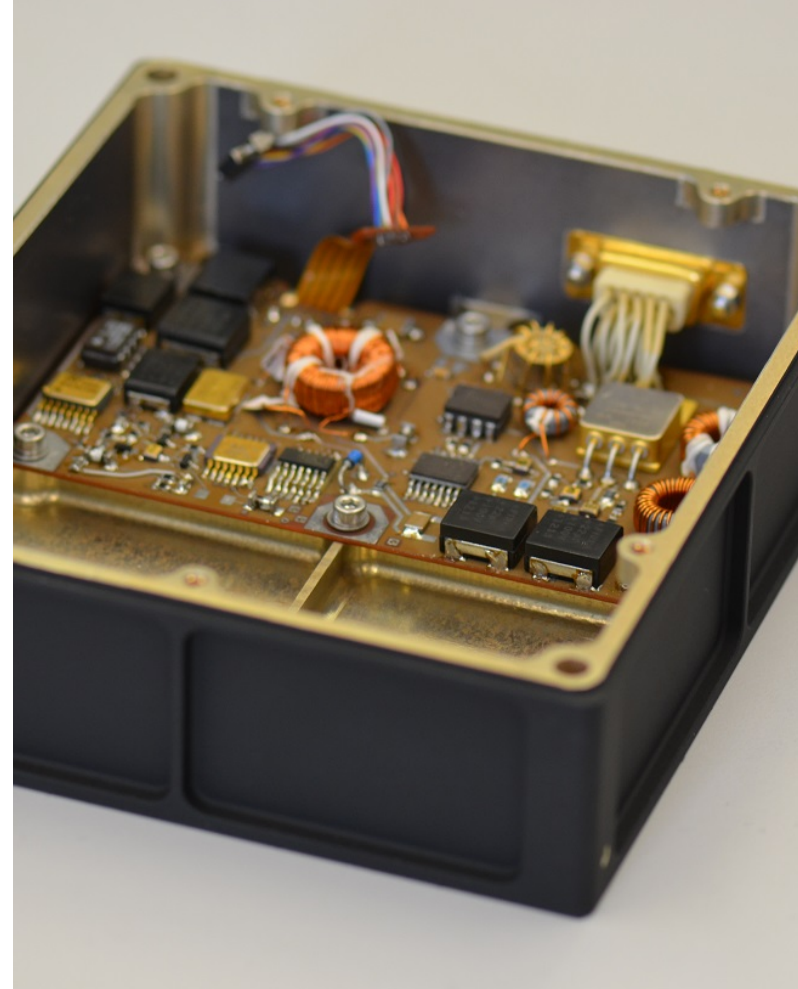
/// Versatile Radiation Monitor for various mission profiles to measure Electrons, Protons & Heavy Ions

## MONITORING

Alert & Saving function  
Support to the platform  
Science & Space Weather  
Information

## IMPLEMENTATION

Started in Q3 2010  
PFM delivered Q4 2016  
**First Mission on EDRS-C**  
16 Units in production for MTG,  
MOS and S-6



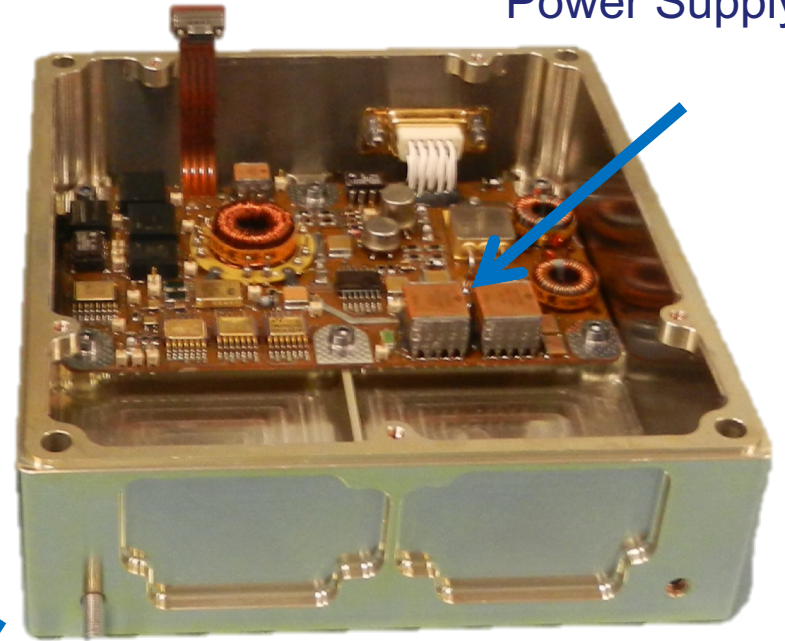
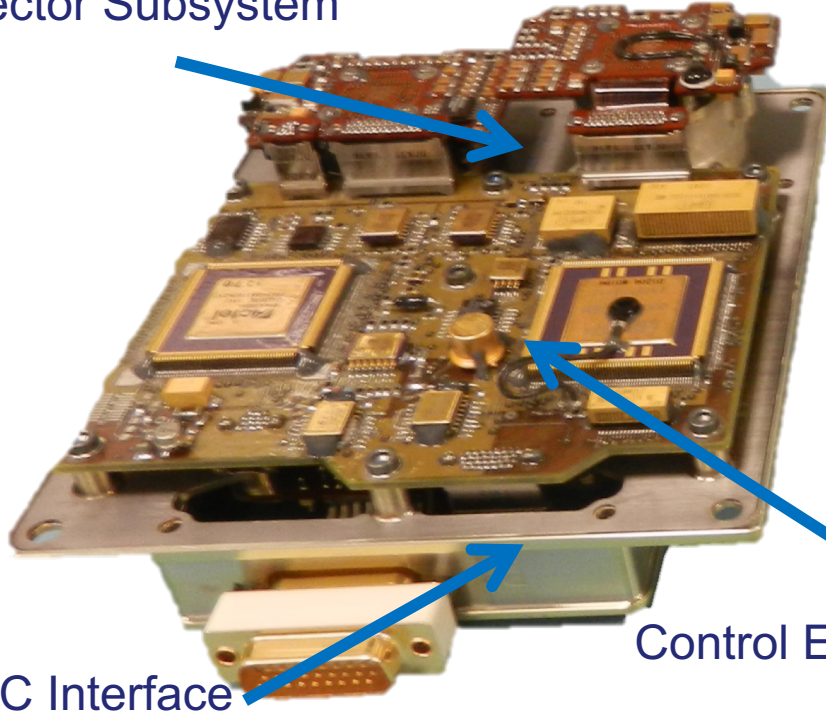
# THE PRESENCE – RMU / NGRM

Item	Range
<b>Particle Electrons</b>	
Minimum / Maximum Energy	100 keV – 7 MeV
Log Energy Bins	8
Maximum Flux	$10^9 \text{ cm}^{-2} \text{ s}^{-1}$ (at 100 keV)
<b>Particle Protons</b>	
Minimum / Maximum Energy	2 – 200 MeV
Log Energy Bins	8
Maximum Flux	$10^8 \text{ cm}^{-2} \text{ s}^{-1}$ (at 2 MeV)
<b>Particle Heavy Ions (Cosmic Rays and Solar Events Ions)</b>	
Minimum / Maximum LET	0.1 - 10.0 MeV cm <sup>2</sup> /mg
Log Energy Bins	8
Identification	Particle discrimination between electrons, protons and heavy ions
Total dose	Up to 100 krad(Si)
Non ionizing dose	Derive from particle spectra

# THE PRESENCE –RMU / NGRM UNIT IN DETAIL

Detector Subsystem

Power Supply



Control Electronics Unit

S/C Interface

# RMU/NGRM FOR D3S

/// Many reasons

- / FLIGHT PROVEN SOLUTION
- / BENEFIT FROM LESSONS LEARNT FROM ON-GOING PROGRAMS
- / AND ....

EXTERNAL SENSOR PORT

RMU/NGRM offers the capability to connect an additional sensor

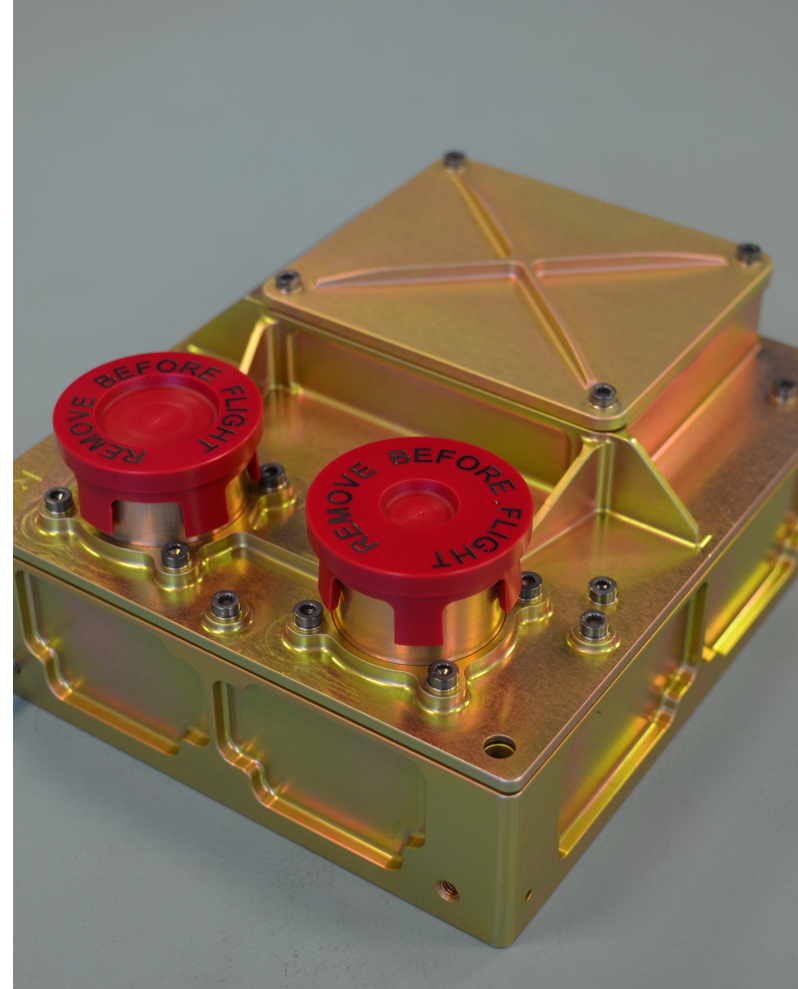
RMU/NGRM provides power and space craft interface

Sensor connects to RMU

Opportunity to reduce cost

Focus development efforts on “intelligent sensor” but not on S/C interfaces and power supply → Get those off-the-shelf plus some measurements ...

MAY BE A CONCEPT FOR D3S?



# WHY TO CONTINUE TO DEVELOP NEW MONITORS

/// Space Situation Awareness is becoming increasingly a topic of concerns for society, governments and companies

**/ INCREASED DEPENDENCY ON SPACE INFRASTRUCTURE**

/// Measurement Data is the foundation of any Space Weather System

**/ SENSORS ARE A KEY ASPECT TO DEVELOP A SUITABLE SERVICE**

**/ DEPLOY MANY SENSORS IF POSSIBLE**

**/ GOOD CALIBRATION, RELIABLE MEASUREMENT**

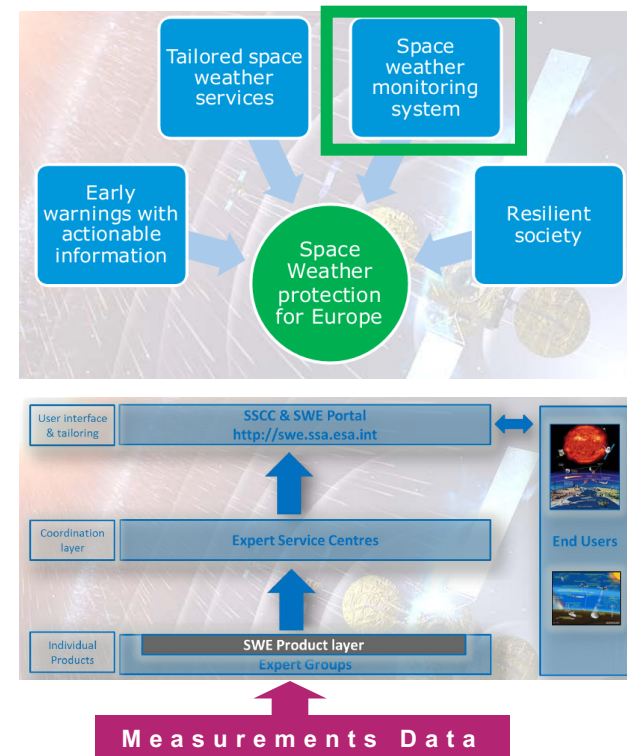
/// Market Expectations on Space Weather Sensors

**/ CHEAP – MANY SHALL BE DEPLOYED**

**/ VERSATILE - SHALL FLY ON MANY MISSIONS AS HOSTED PAYLOAD**

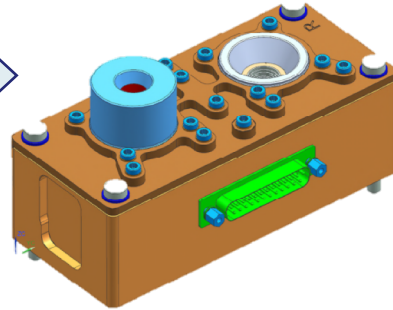
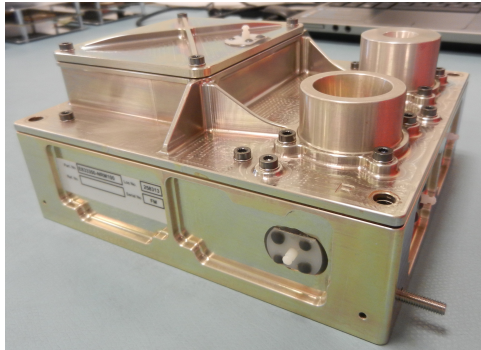
**/ SMALL / LOW FOOTPRINT – HOSTED PAYLOADS AND CUBESATS**

**/ AVAILABILITY – NOW AND IN-TIME EVOLUTIONS FOR GALILEO TB / 2G, SMALL SAT MISSION, D3S, ....**





# FROM PRESENCE TO THE FUTURE

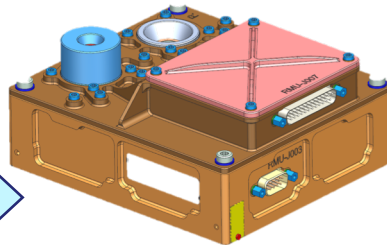
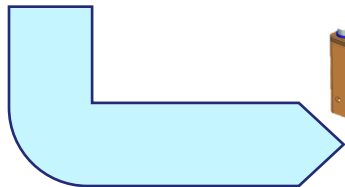


## miniRMU

close integration into S/C  
avionics

### / TECHNOLOGY PUSH

- Miniaturization / packaging
- COTS processes
- COTS components / up-screening
- Smart-COTS



## RMU V2

self standing monitor  
Reduced functionality  
compared to RMU/NGRM

# THE FUTURE –PART 1 - MINI-RMU

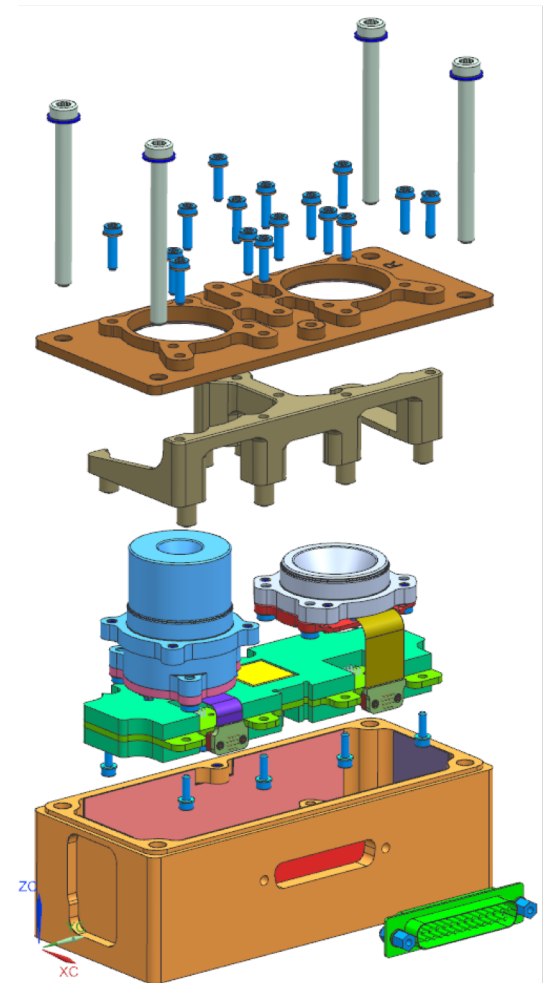
## /// Concept

- / USE SPACECRAFT RESOURCES (OBC, MASS MEMORY, ...) TO REDUCE UNIT COST
- / RE-USE QUALIFIED AND PROVEN SENSORS FROM RMU/NGRM PRODUCT LINE.

### KEY ELEMENTS

- **Detector Subsystem**
- **Standard Power Converter (5V)**
- **Configuration and data read-out via the SPI interface implemented in the ASIC**

**COST/MASS/POWER EFFICIENT SOLUTION**



# MINI-RMU - DETECTOR SUBSYSTEM



Provide same detectors as RMU/NGRM to allow continuity of measurements

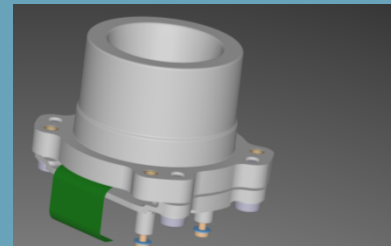
## / DETECTOR SUBSYSTEM

- **Electron Detector (ED)** optimized for the detection of electrons
- **Stack Detector (SD)** optimized for the detection of protons and heavy ions (HI)
- The detectors have been designed by the Paul Scherrer Institute (PSI),

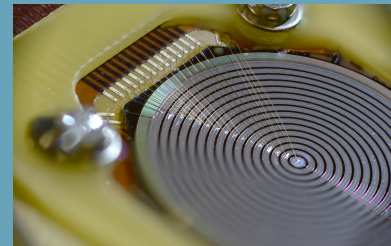
## / MODIFICATION COMPARED TO RMU/NGRM

- the Field of View of the ED and SD has been updated to  $+30^\circ$  and  $+20^\circ$  half angle, respectively.

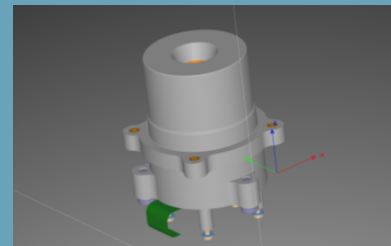
Electron  
Detector



Si-Strip  
Detector



Stack  
Detector



# THE FUTURE – PART TWO – RMUV2

## /// Concept

- / FULLY SELF-STANDING UNIT
- / SAME DETECTOR SUBSYSTEM AS RMU/NGRM & MINI-RMU
- / COST REDUCTION BY HIGHER INTEGRATION OF SUBSYSTEMS

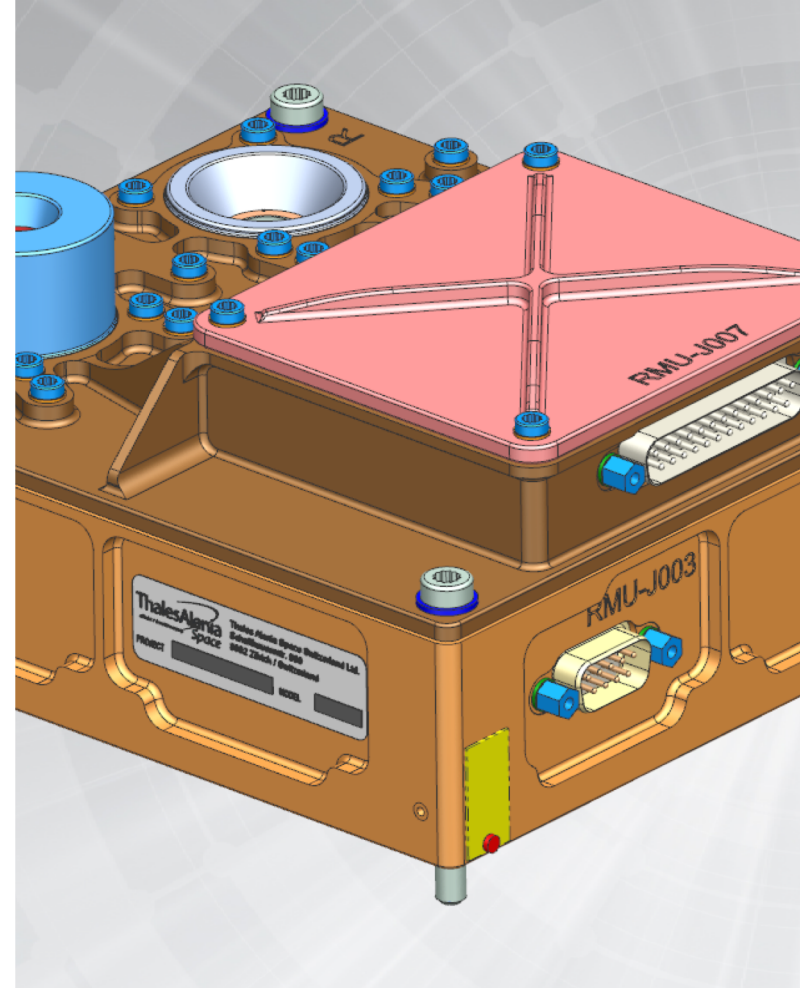
### MAIN SUBSYSTEMS

Detector Subsystem  
Power Supply Subsystem  
Digital Processing Unit

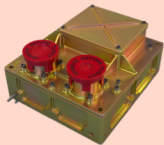
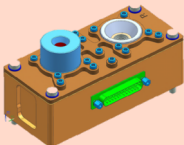
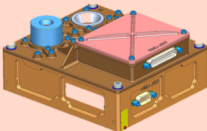
### MAIN CAPABILITIES

Radiation Measurement  
S/C Interfacing via MIL-1553B  
Detector Subsystem configured via  
 $\mu$ controller in unit  
Science Data read-out managed by unit  
Input Voltage ranges 28V-100V

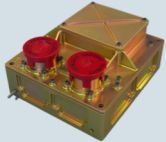
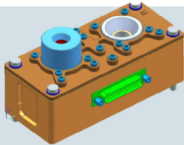
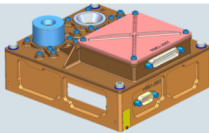
**FLEXIBLE SOLUTION, ESPECIALLY SUITED AS HOSTED PAYLOAD**



# OVERVIEW

Item	RMU/NGRM	miniRMU	RMUv2
			
Power	2W (peak 6W) 28 – 50V	0.5W (peak 0.8W) 5V	2W (peak 6W) 28V, 50V, 100V
Mass [kg]	1.4	<1kg	1.4
Size (w x l x h) [mm]	132x150x68	1/3 of RMUv2	132x150x68
Measurement Ranges			
Electrons		100keV-7MeV	
Protons		2MeV – 200MeV	
Heavy Ions (cm <sup>2</sup> /mg)		0.1MeV – 10 MeV	

# SUMMARY

Item	RMU/NGRM	miniRMU	RMUv2
			
Characteristics	Self Standing Unit High Flexibility Available now	Reduced function	Self-Standing Unit More Flexibility
Customer Segment	Operational Missions Short Term, High TRL	Cost sensitive Early in development cycle Flexibility on platform, CubeSats, SmallSat missions, Constellations	Hosted Payload market less impact / adaptation on platform
Why?	High TRL – Flight proven True off-the-shelf External Sensor	Low Cost Limited resources on platform	Easy integration, no dedicated modifications on platform Can be integrate late in the dev cycle
Status	In production	In Development	Concept Finished

# SUMMARY

/// TAS is moving from single instrument to a product group

**/ IMPLEMENTATION OF VARIOUS PRODUCT VARIATIONS TO SERVE DIFFERENT NEEDS**

/// Reliable and flight proven sensors in various “Form Factor” to have high flexibility on hosting and mission Options

/// Built on heritage / experience but not be blocked by it

**/ MAINTAIN HERITAGE WHERE USEFUL AND BENEFICIAL**

**/ APPLY LESSONS LEARNED**

**/ USE NEW COMPONENTS / TECHNOLOGIES TO IMPROVE (MASS / POWER / COST) THE PRODUCTS**

/// Being part of TAS group, TAS in Switzerland can also facilitate to find hosted payload opportunities on commercial missions

# OUR PARTNERS

## / LONG STANDING PARTNERS

- PSI (CH): Detector Design & Radiation Tests
- IDEAS (NO): Read-out ASICs

## / ADDITIONAL PARTNERS OF RMU/NGRM DEVELOPMENT TEAM

- EREMS (FR): Controller Board
- ONERA (FR): Radiation Analysis

## / ESA

- D-TEC Team
- EDRS-C Project
- SSA-SWE Team
- Swiss Space Office for providing the necessary funding

New and additional partners are always welcome  
We cannot do it alone !





**THANK YOU VERY MUCH FOR YOUR ATTENTION**  
QUESTIONS?

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PROPRIETARY INFORMATION  
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