RadCube: The Space Weather Monitoring Satellite

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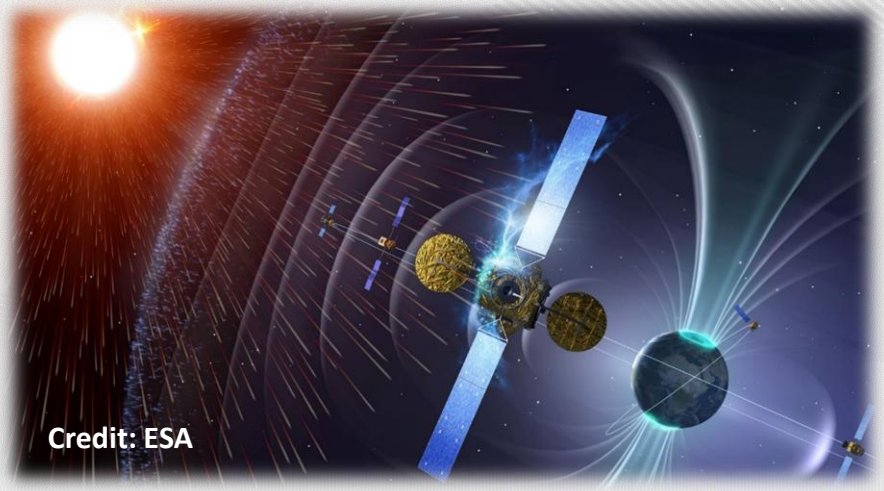
MTA Centre for Energy Research

C3S Electronics Development LLC

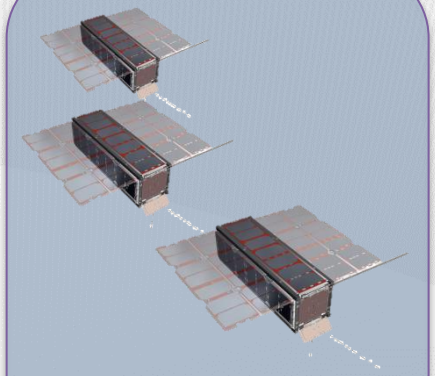
Technology dependence in the space age

- Space weather influences
  - Satellite services
  - Ground infrastructures
  - Manned space flights
  - Future Lunar/Mars missions


Credit: ESA


Credit: Wikipedia

We need space weather monitoring services!
→ cost–effective solution: fleet of CubeSats



Fleet of CubeSats and Ground Stations

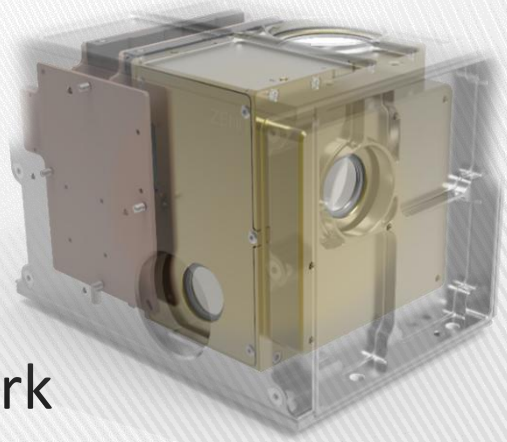
Cosmic ray environment information system

Space weather/ radiation damage related database

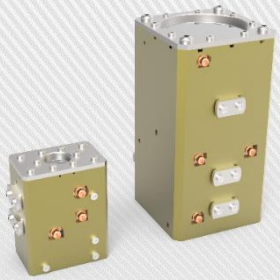
Space weather/ radiation damage forecast services

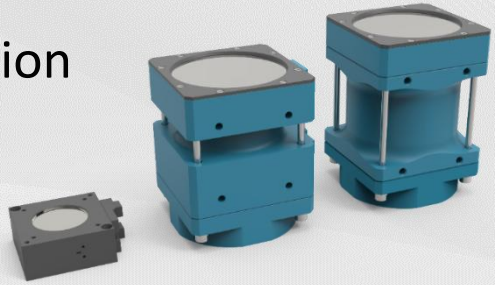
Users

Similar missions

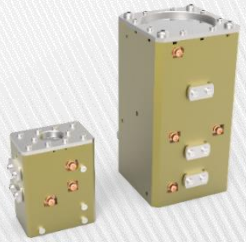


- Mainly big science satellite missions
- No existing space weather monitoring network
- No instrumentation with the following capabilities:
  - Measuring cosmic rays and magnetic field at the same time
  - Including a small boom system to support the magnetic field measurements
  - Including radiation hardness test capabilities
  - Realised within the constraints of a 3U CubeSat mission

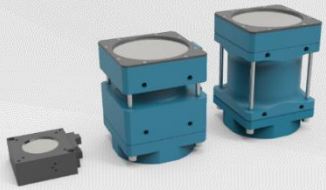




RadMag instrument concept



- ***RadMag = Cosmic Radiation and Magnetic Field Instrument Package***
- **Space weather monitoring by combination of cosmic ray and magnetic field measurements into one instrument**
- Specification is reflecting to ESA SSA SWE product requirements
- Cosmic ray measurements by silicon based telescopes: proton, electron, HZE spectra separately
- In-board and outboard 3-axis magnetoresistive sensor
- Built-in boom system to support the magnetic field measurements
- Built-in dose rate monitoring and Radiation Hardness Assurance (RHA) capabilities
- Small size to fit for CubeSat/SmallSat missions (fitting ~1.2U CubeSat standard)
- **Low-cost alternative in future space weather studies and forecast services and in general radiation damage monitoring for commercial use**
- Instrument development within ESA GSTP programme



Radiation Sensor System specification

Parameter	Values, ranges
Particle types	electrons, protons, heavy ions
Minimum electron energy	100 keV
Electron energy range	0.3 MeV – 8.0 MeV Channel number: 2-5 Contamination: <10 %
Minimum proton energy	1 MeV
Proton energy range	4 MeV – 1 GeV Channel number: 11-18 Contamination: <10 %
Heavy ion energy range (He&C&N&O&Fe)	100 MeV/n – 1 GeV/n Channel number: 4 Contamination: <10 %
Field of view for electron and proton measurement (half-angle)	31°
Field of view for heavy ion measurement (half-angle)	46°

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Magnetometer specification

Parameters	Mode	
	Nominal	High resolution
Range	± 60,000 nT	
Sampling rate	1.0 Hz	10 Hz
Orthogonal directions	3	
Orthogonality error	≤0.1°	
Noise limit	≤500pTrms/√Hz (at 1Hz at 25°C)	
Temperature coefficient	≤±1 nT/°C	
No. of sensors	2 (1: inboard, 1: outboard)	

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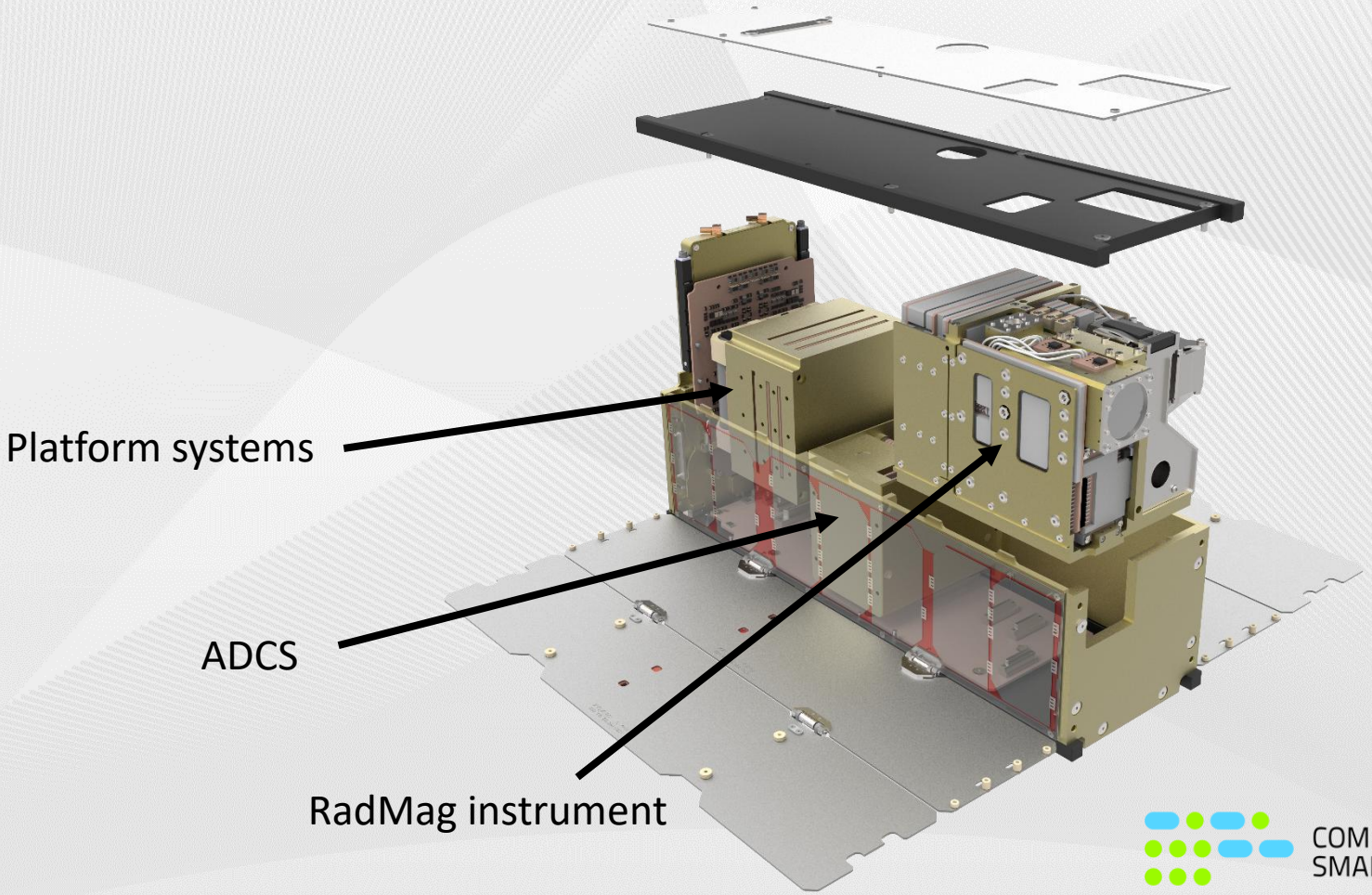
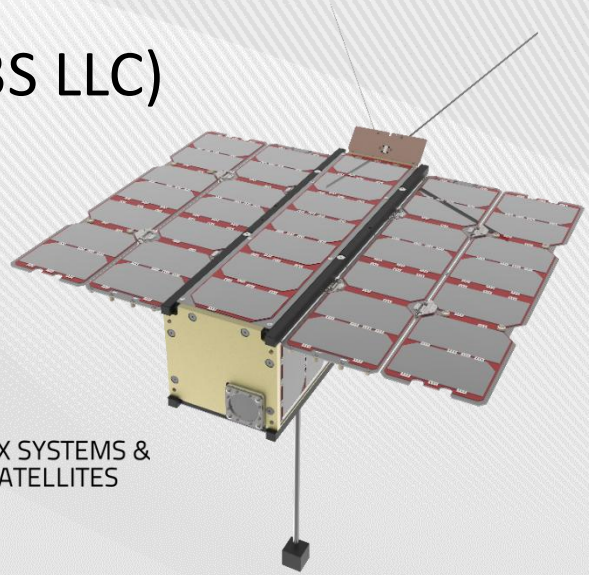
RADCUBE mission



COMPLEX SYSTEMS & SMALL SATELLITES

RADCUBE in-orbit demonstration mission

- In-orbit demonstration 3U CubeSat mission within ESA GSTP 6.3 programme
- Lead by a Hungarian CubeSat Company (C3S LLC)
- Project is reaching the CDR
- Expected launch: Q1 of 2020

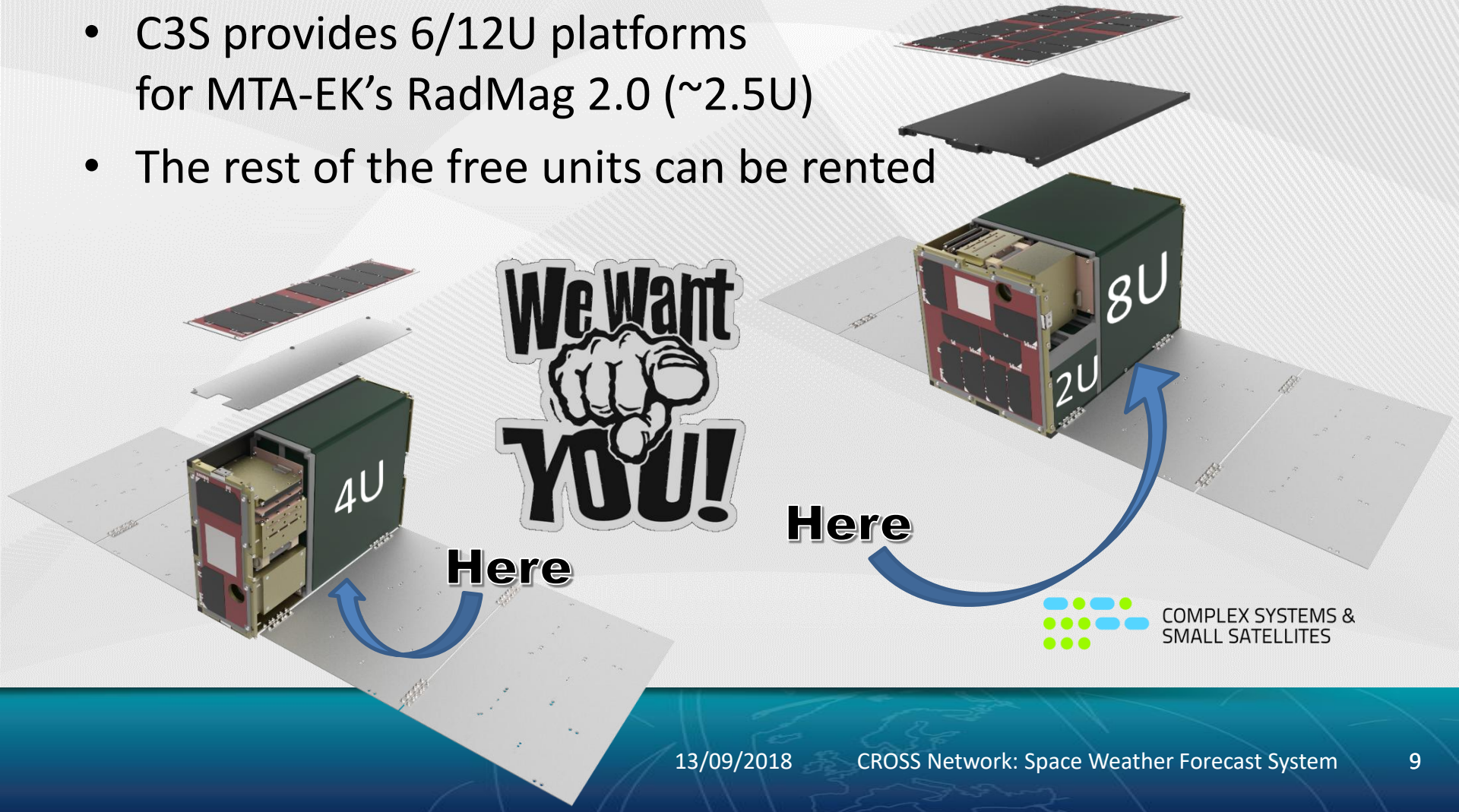


COMPLEX SYSTEMS & SMALL SATELLITES

- **Future vision: CROSS Network = Cosmic Ray Observatory Satellite System**

CROSS Network = Cosmic Ray Observatory Satellite System

- Multi-Payload and Multi-Sat concept
- C3S provides 6/12U platforms for MTA-EK's RadMag 2.0 (~2.5U)
- The rest of the free units can be rented



COMPLEX SYSTEMS & SMALL SATELLITES

Summary

- New space weather monitoring instrument development: RadMag
- Unique combination of cosmic ray and magnetic field measurements into one instrument
  - Very small size to fit for CubeSat/SmallSat missions (fitting ~1.2U CubeSat standard)
  - Built-in boom system to support the magnetic field measurements
  - **Relatively low-cost alternative for future space weather studies and in general radiation damage monitoring for commercial use**
- Instrument development just now passed PDR and moving into phase C
- 1st IOD Mission: RADCUBE 3U CubeSat
  - Expected launch is Q1 2020
- **Future vision (CROSS Network): CubeSat/SmallSat constellation for space weather and radiation damage monitoring services**

Thank you for your attention!

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