Medium Energy Particle Spectrometer (MEPS) for ESA Lagrange Mission

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on behalf of the MEPS team

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Workshop on Instruments for Distributed Space Weather Sensor System (D3S)

C | A | U
Christian-Albrechts-Universität zu Kiel
Mathematisch-Naturwissenschaftliche Fakultät

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ESOC

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- Instrument concept
- Structural and Thermal design baseline
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MEPS key observational requirement (1)

- Ions with kinetic energy from 30 kev/nuc up to 8 MeV/nuc.

✓ **Space Weather**:

- They are abundant and their temporal increase can warn the arrival of a traveling shock

✓ **Science**:

- These measurements contribute to the important question of how particles are injected and accelerated at interplanetary shocks

MEPS key observational requirement (2)

- Electrons with kinetic energy in the range 30 keV to 0.6 MeV.

✓ **Space Weather**:

- 600 keV electrons travel at a significant fraction of the speed of light. Thus, they give early warning of solar eruptions („explosions”)

✓ **Science**:

- Electron-rich solar particle events are linked to solar flares in which enormous amounts of energy are released in a short time and these measurements helps better understanding them

MEPS key observational requirement (3)

- Particles: electrons, protons, helium, heavy ions.
  goal: resolve He3 and He4, C, N and O, Si/Ne, Fe, Ni, plus single a measure for heavier ions for energies larger than 1.5 MeV/nuc.

✓ **Space Weather**:

- Heavy ions deposit more energy along their tracks through a solid than protons or electrons, so their effect might be larger than their abundance suggests to the space weather. (SEE and secondaries)

✓ **Science**:

- Heavy ions provide important information about the coronal processes which accelerate particles to high energies.

MEPS instrument concept (1)

MEPS measures and separates electrons and ions using technique similar to STEREO/SEPT and EPT on Solar Orbiter, but adds 3rd detector.

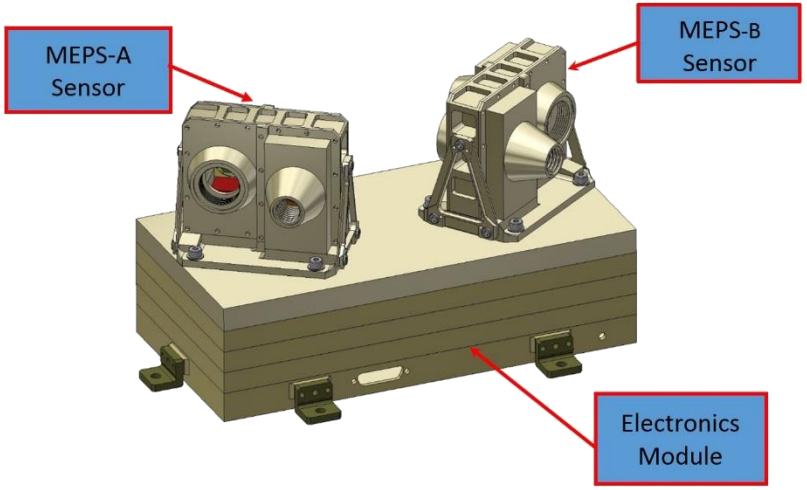
Budgets:

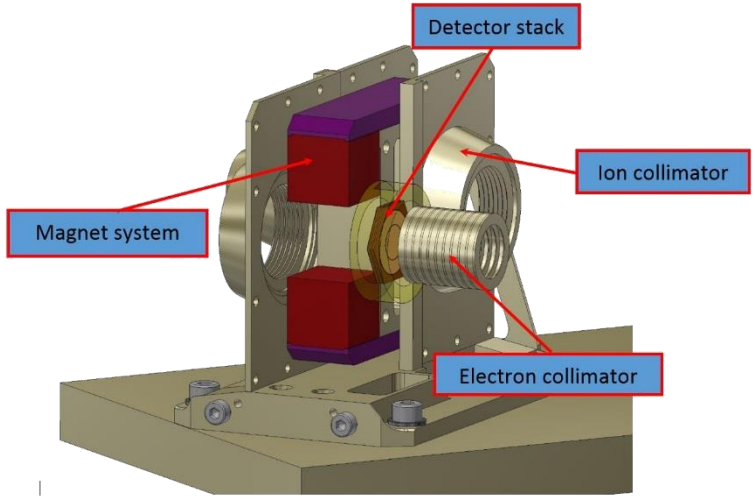
Mass: max. 3.5kg

Power: max. 5W

Volume: 30x20x20 cm^3

Two identical sensors + One Electronic box

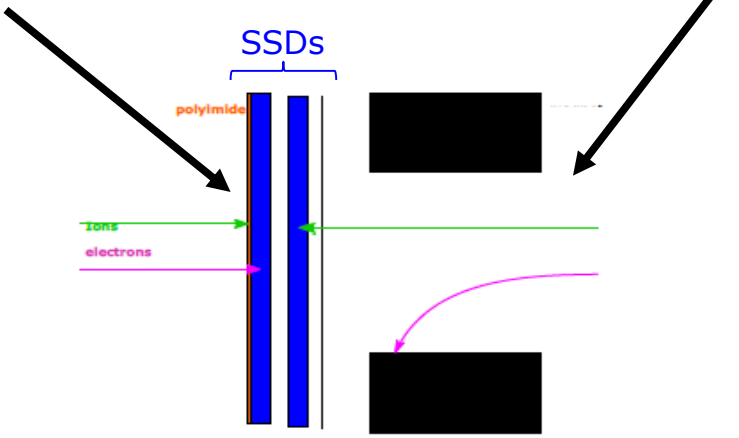




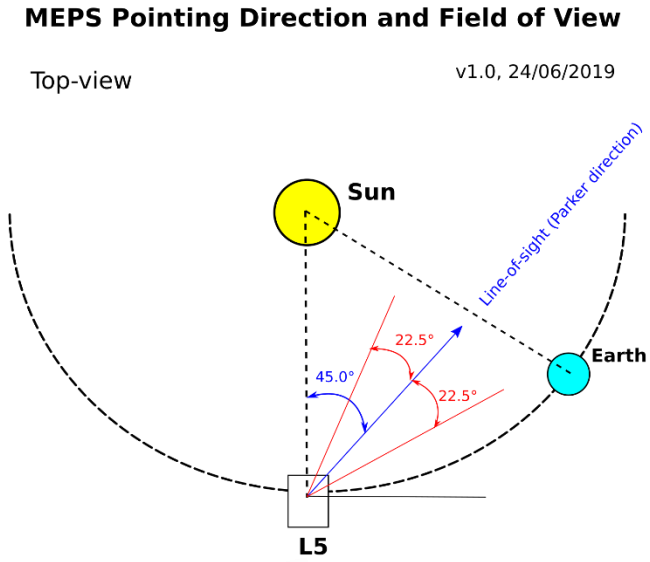
MEPS instrument concept (2)

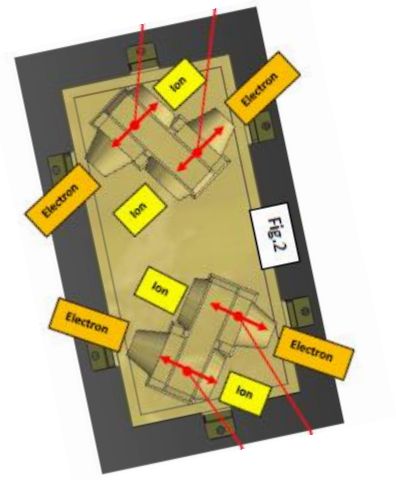
Foil-magnet technique
PI-foil stops 400 keV protons

Magnets reject
600 keV electrons



MEPS uses the dE/dx vs. total E method to measure composition.

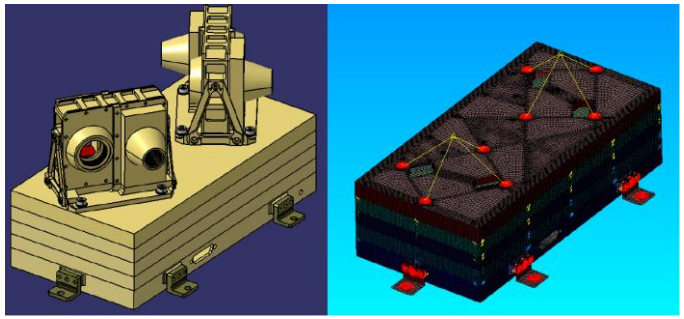


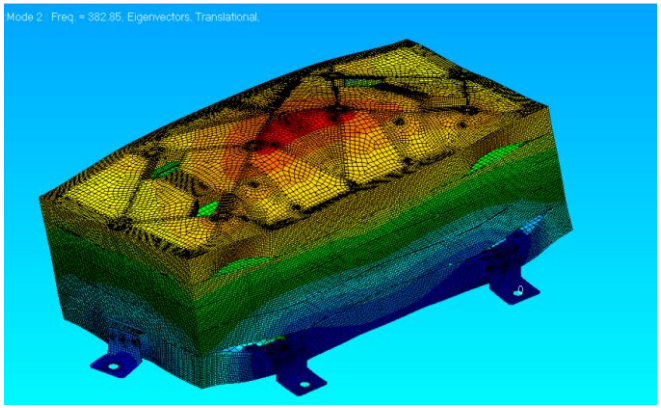


MEPS structural & thermal design

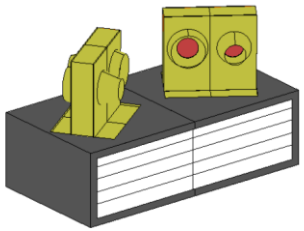
Design baseline FEM analysis

First natural frequency: 380 Hz
Stress MOS: positive





Design baseline Thermal analysis



MEPS GMM in ESATAN
Passive Thermal Control

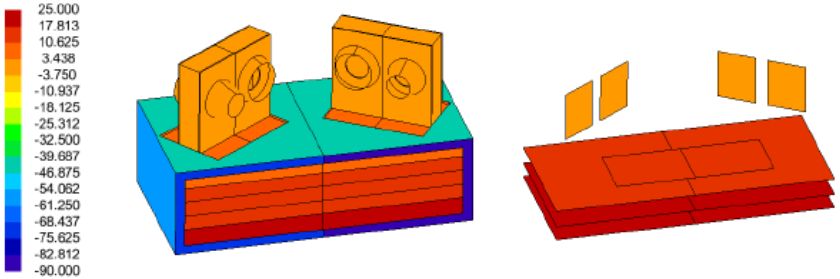


Figure 3-4: MEPS external (left) and internal (right) temperatures for hot operational case.

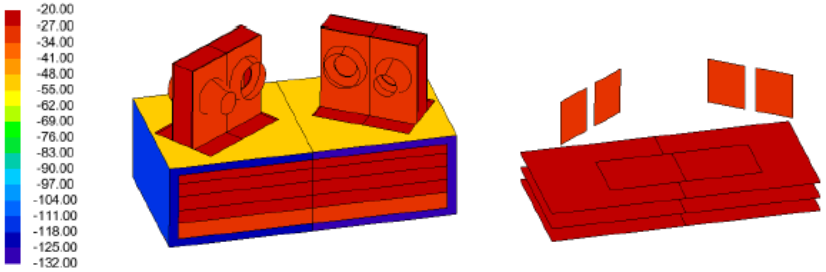
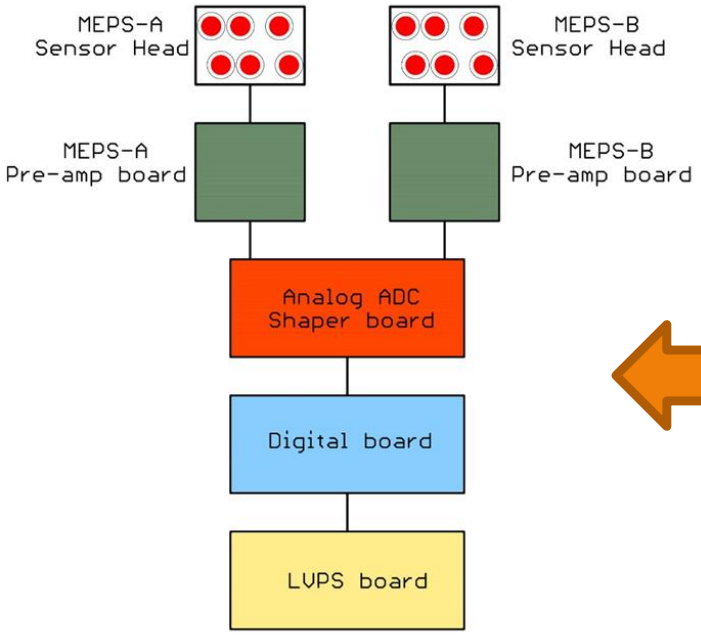
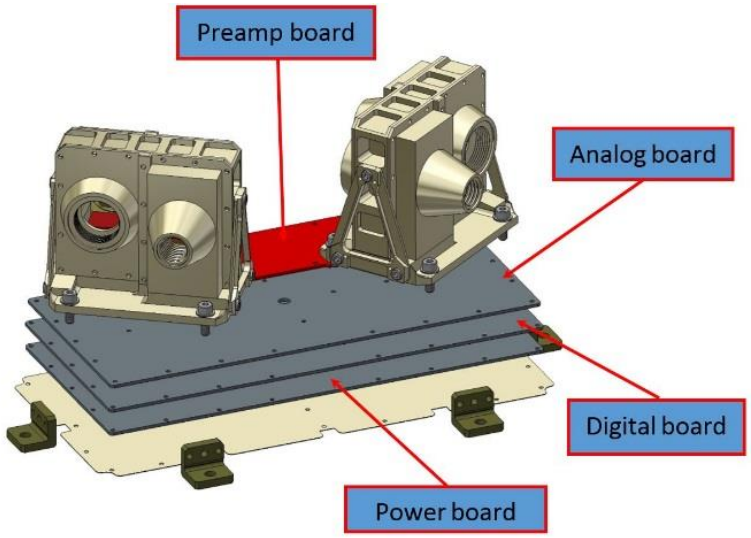


Figure 3-5: MEPS external (left) and internal (right) temperatures for cold operational case.

MEPS Electrical and data interface concept

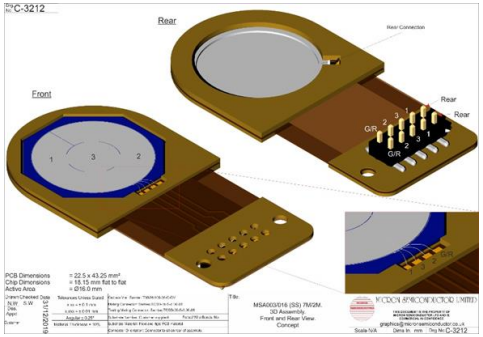
- The electronics design is based on SolO heritage.



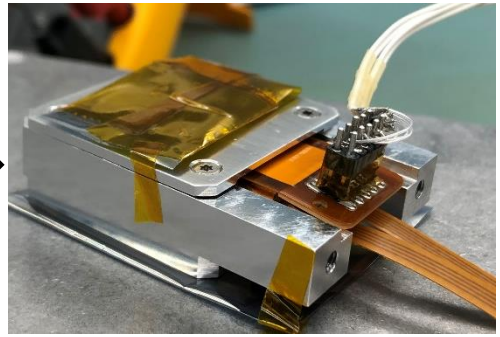


- SpaceWirewill be usedforthedata interface between the MEPS and the In-Situ DPU.

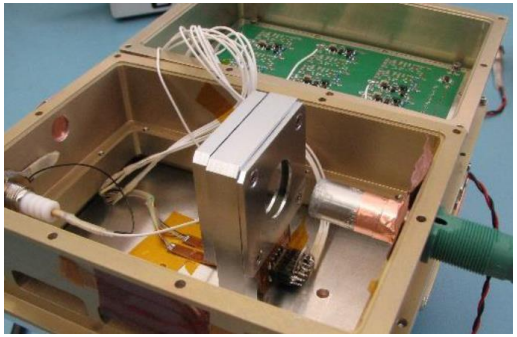
Characterization of thin front detector



Thin detector

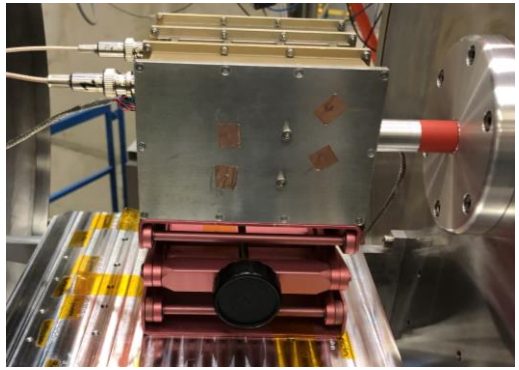


Detector stack 20-300-300µm



Demo model

Characterization at PTB



- 2018 (11-14 Nov): Demo model experiment with an old detector at PTB (Physikalisch-TechnischeBundesanstalt).
  - Proton energy: 1.2 to 10 MeV
  - Alpha energy: 6 to 20 MeV

- 2019 (7-8 Nov): to repeat alpha and proton measurements with new (better) thin detector.
  - Using lower energies <1.2 MeV/nuc

Current status end of B1 phase (end of ISRR)

- MEPS design baseline analysis show promising results regarding the mission requirements as well as instrument design requirements.
- MEPS accommodation is settled with both primes.
- Requirements engineering is in progress.
- MEPS thin detector characterization is in progress.
- The general development seems to be satisfactory considering schedule and cost.

Thank you very much for your attention!

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