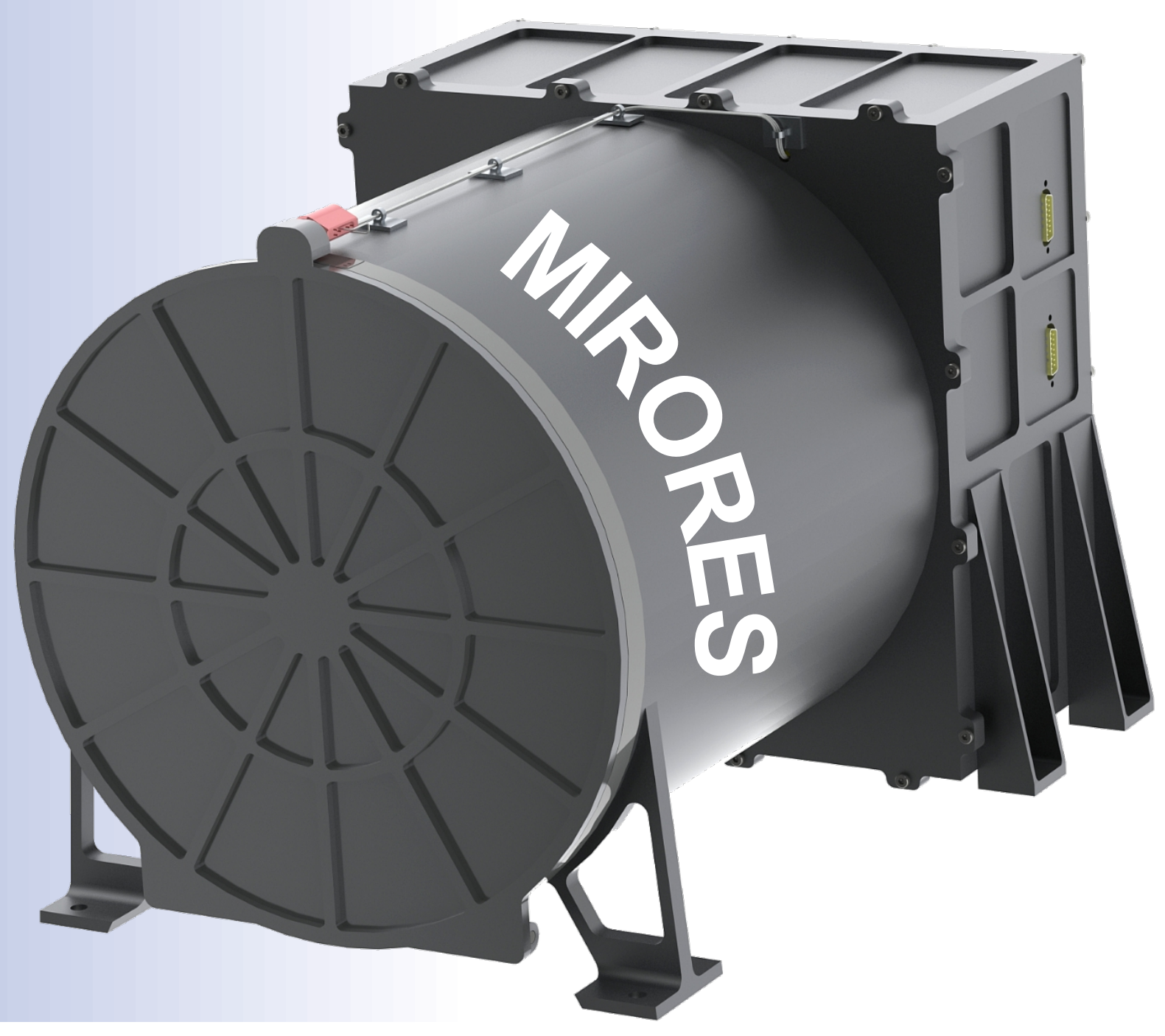
Design of the Martian far-IR ORE Spectrometer MIRORES



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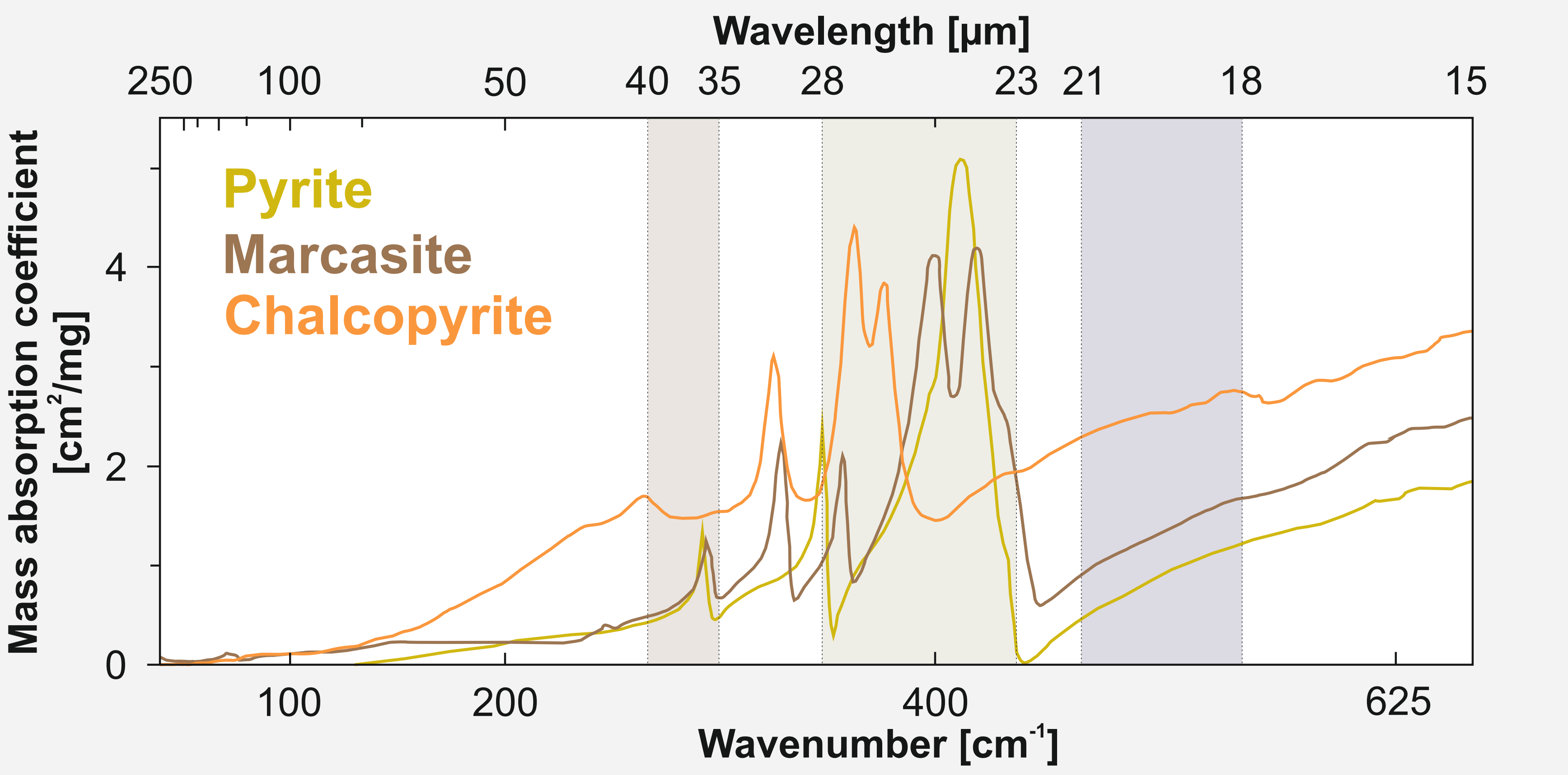
1 Introduction:

Identification of sulfide ores, being a major source of **noble metals** (Au, Ag, Pt) and **base metals** (Cu, Pb, Zn, Sn, Co, Ni, occasionally Fe), will be vital to self-sustainment of future Mars colonies. Martian meteorites are rich in sulfides[1,2], which reflects in recent findings from Martian rovers[3,4,5]. Yet the only high resolution (18 m/px) infrared spectrometer orbiting Mars, CRISM (Compact Reconnaissance Imaging Spectrometer for Mars) on board Mars Reconnaissance Orbiter (MRO), struggles to detect sulfides on the martian surface. Spectral interferences with silicates impede sulfide detection in the 0.4-3.9 µm CRISM range. In contrast, at least four common sulfides on Earth and Mars (pyrite, chalcopyrite, marcasite, pyrrhotite) possess prominent absorption peaks in a narrow far-infrared (FIR) wavelength range of 23-28 µm. Providing global distribution and chemical composition of sulfide ores would help to choose useful targets for future Mars exploration missions. Therefore, we are starting to design a relatively **inexpensive and simple pyroelectric detector-based Martian far-IR ORE Spectrometer (MIRORES).**

Pyrite, Navajun, Spain; John Harrison

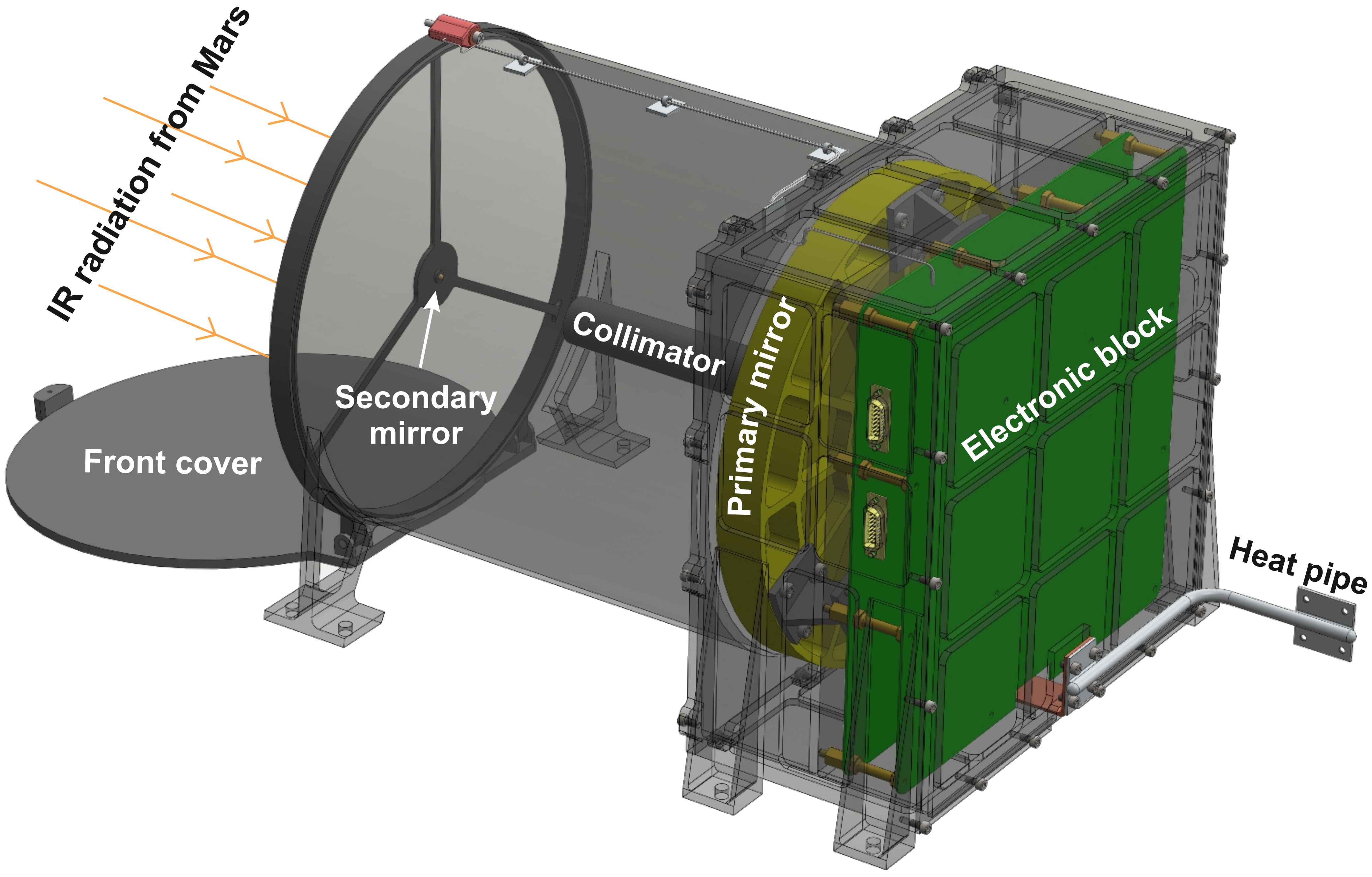
Sulfide spectra:



adapted from Brusentova et al., 2012

2 Design:

We propose a relatively **inexpensive, simple instrument** measuring only limited 18-40 µm range of the FIR spectrum. The **middle band** is 23-28 um, where we expect absorption peak for ore minerals. **Additional bands**, 18-21 and 35-40 um, will allow intrapolating the background level of radiance at the middle band, which varies as a function of incidence angle, emission angle, atmospheric H_2O and other factors. **Dimensions are reduced to a size (47 x 32 x 32 cm) and mass (~10 kg) of a microsatellite.**



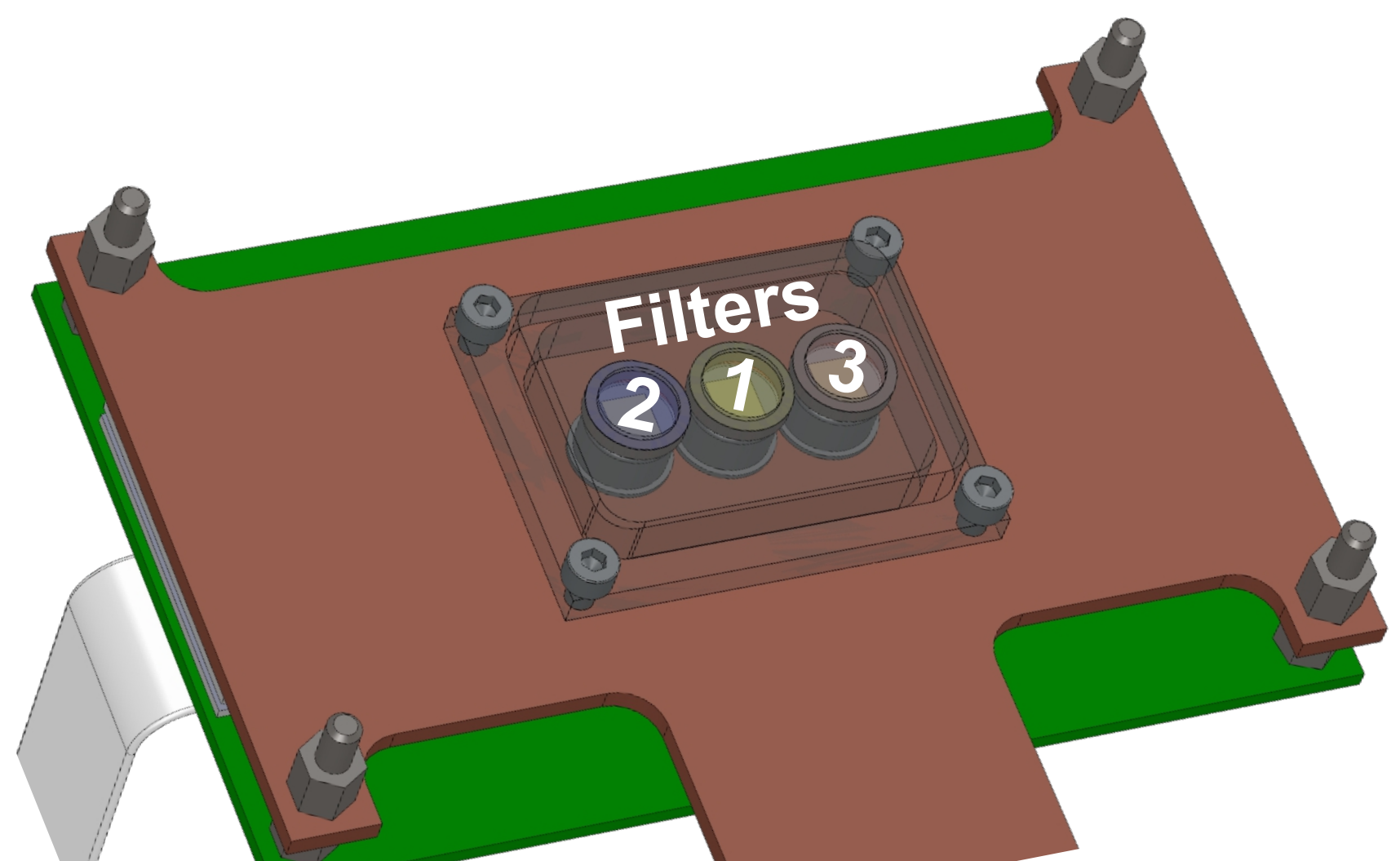
Detection system:

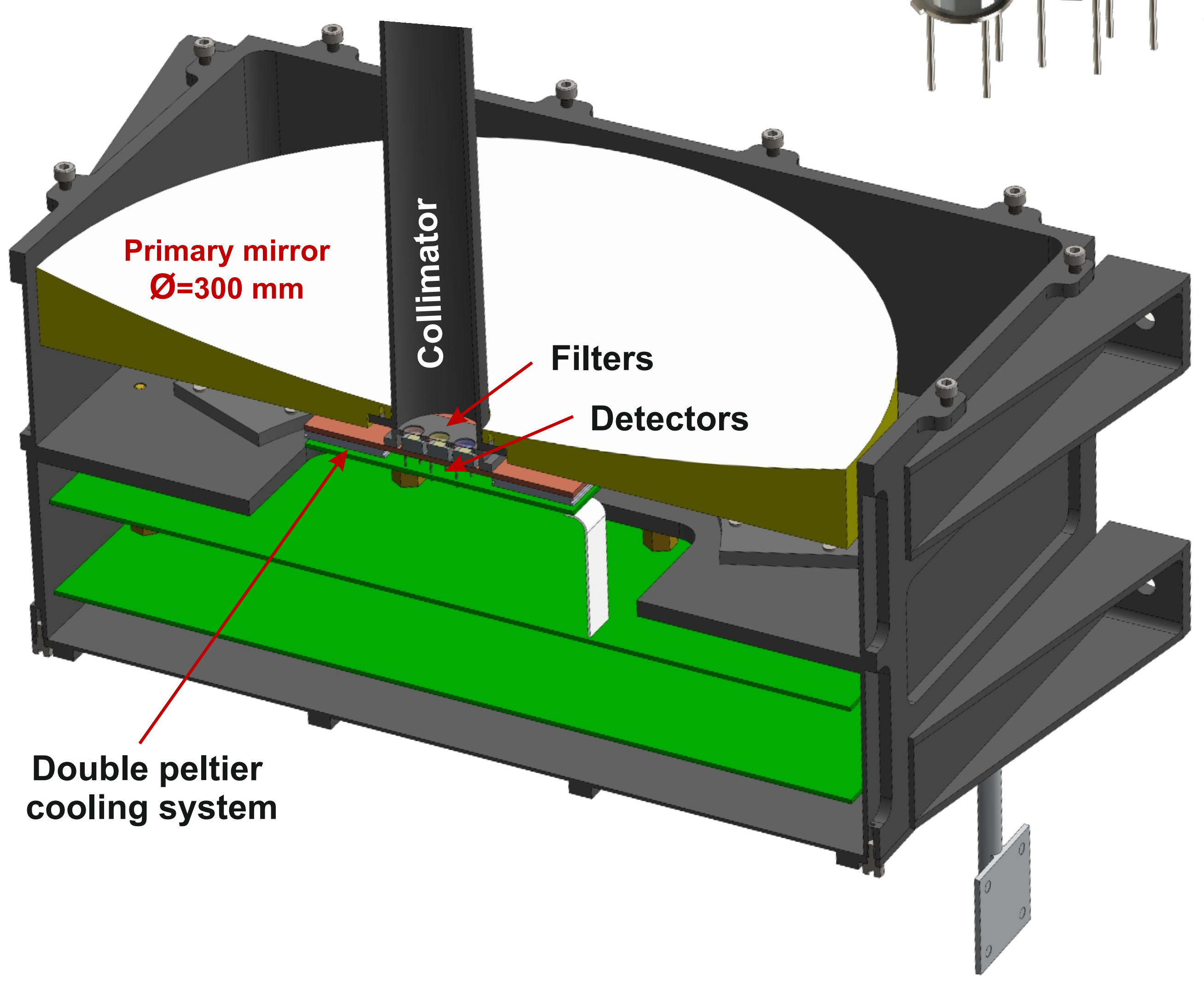
Three filters:

- **(1)** one for the main band of **23-28 µm**
- **(2,3)** two for reference bands at **18-21 µm** and **35-40 µm**

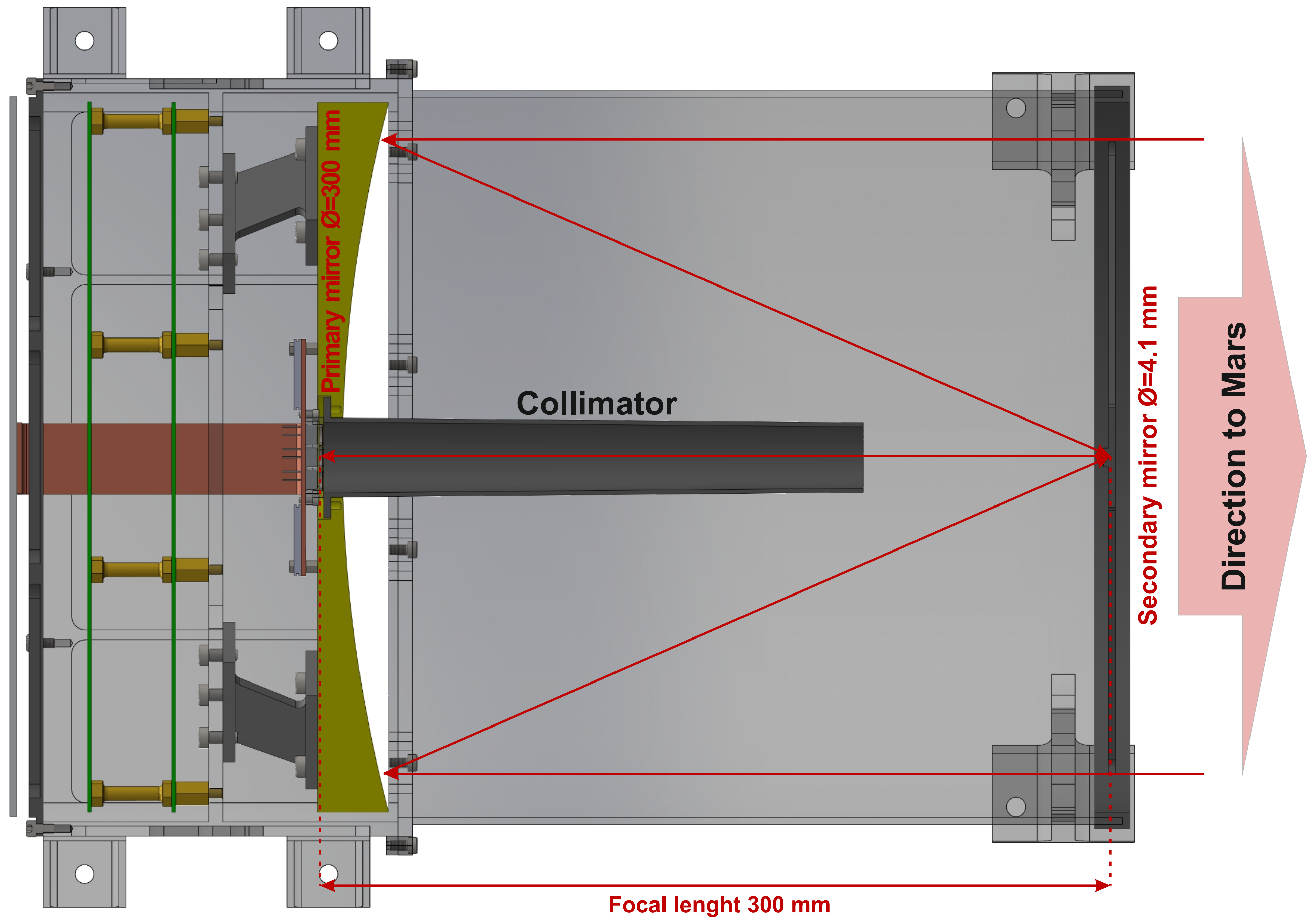
Detector parameters:

- responsivity 1.3 V/W
- incident power limit 5 W/cm^2
- operating temperature from -55 to +125°C





Optical system:



Cassegrain optical system with large primary and small secondary mirrors

3 Summary:

The largest challenge related to this design is the small field of view conditioned by high resolution required for this study (10-20 m/px), which in limited space can be only achieved by the use **of the Cassegrain optical system.** The probe may be launched as a piggyback mission with a larger satellite between 2026 and 2030, for example **Japanese Martian Moons Exploration satellite** of **JAXA (2024/26)** or **Mars Sample Return Mission (HX-2) of CNSA (2028/30).**

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