

# VIS-IR imaging spectrometer for MARCO POLO



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And all the team members...

# Team members

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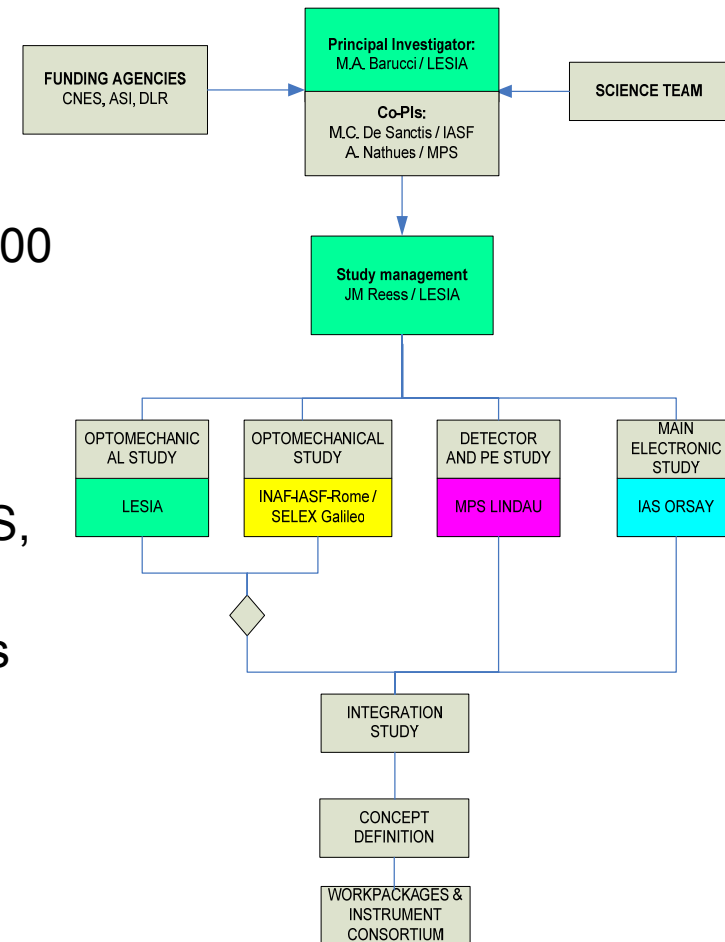
# Introduction

## Typical parameters

- VIS-IR Imaging spectrometer
- Band pass and resolution : [0.4 – 3.3 $\mu$ m] - R=100
- SNR > 100

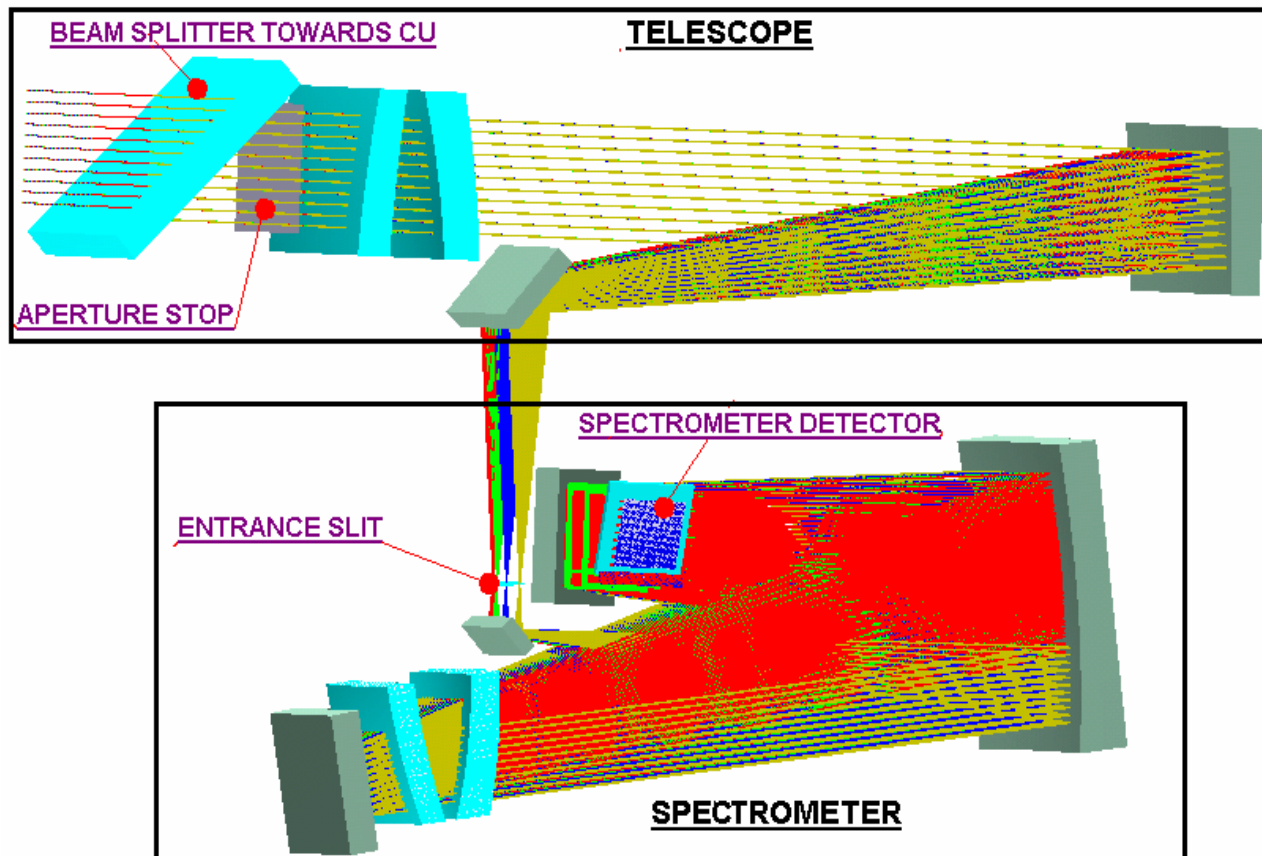
## Study organisation

- Study done by MAPIS consortium (LESIA, MPS, INAF-IASF, IAS)
- Opto-mechanical, thermal, detector, electronics studies
- End of study in august 2009



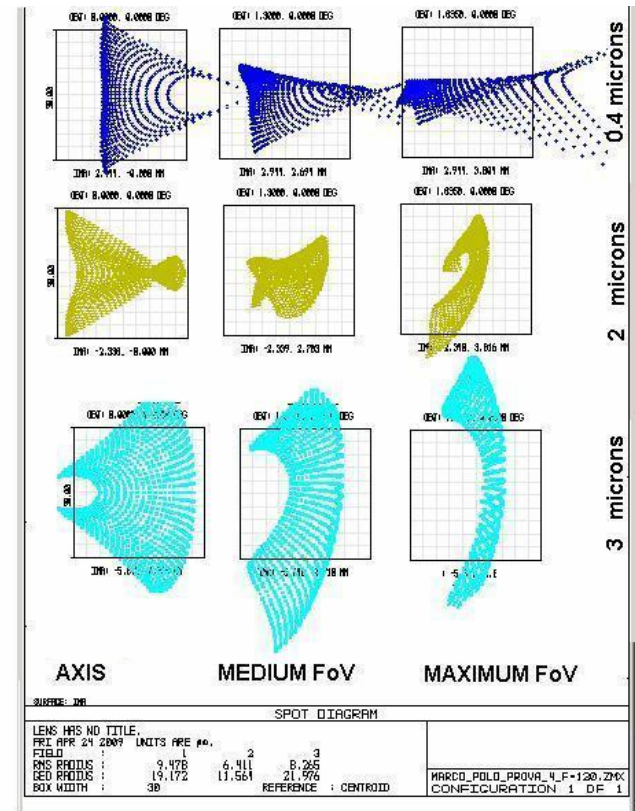
# SETA Optical configuration

- The optical scheme is based on a design derived from VIHI (Bepi-Colombo) and Jiram (JUNO) experiments.
- It uses a Schmidt telescope joined with a Spectrometer in Littrow configuration. The optical design foresees an Aspherical Correcting Plate with an Achromatic doublet to have all spherical elements with a resulting null optical power.
- Possibility to include a scanning mirror (if necessary)



# SETA Characteristics

Optical design	Schmidt telescope, Littrow spectrometer; magnification 1X; CaF2 corrective lenses
Entrance pupil	50x25 mm (across x along track) (40 mm equivalent)
F#	120 mm
FOV	0.014°x3.6° (across x along track)
Spectral range and sampling	0.4-3.5 µm; 9 nm/band
Focal plane	HgCdTe; 256x256 pixels; 30 µm pixel pitch
Optical performances	Slit curvature (smile) corrected at 2 µm; residual 1/10 pixel at shortest and longer wavelengths. Keyston: <1 pixel on overall spectrum



## Optical Head + FPA Mass Estimation (derived from VIHI)

Optical Head (with baffle) 1.2 kg

Margin+ FPA cooling and thermal control system(\*) 0.5 kg

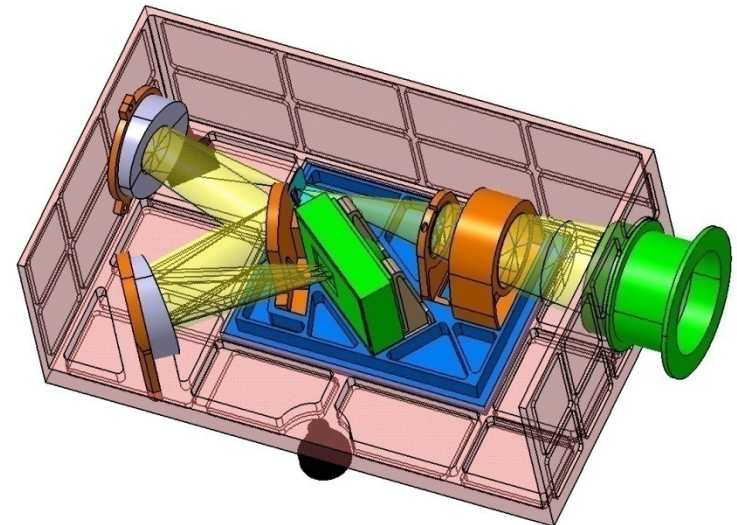
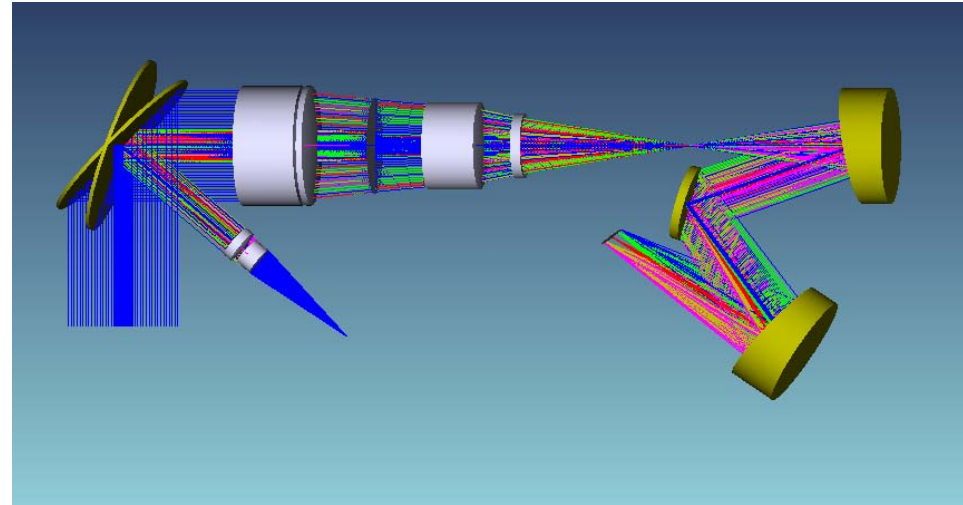
**TOTAL** 1.7 kg

(\*) provisional figure, depending by the selected thermal control of the FPA

Scan Unit (flat motor resolver + electronics) mirror (if needed) 0.6 kg

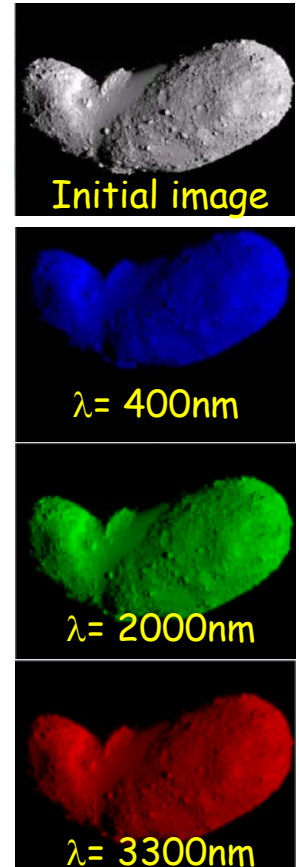
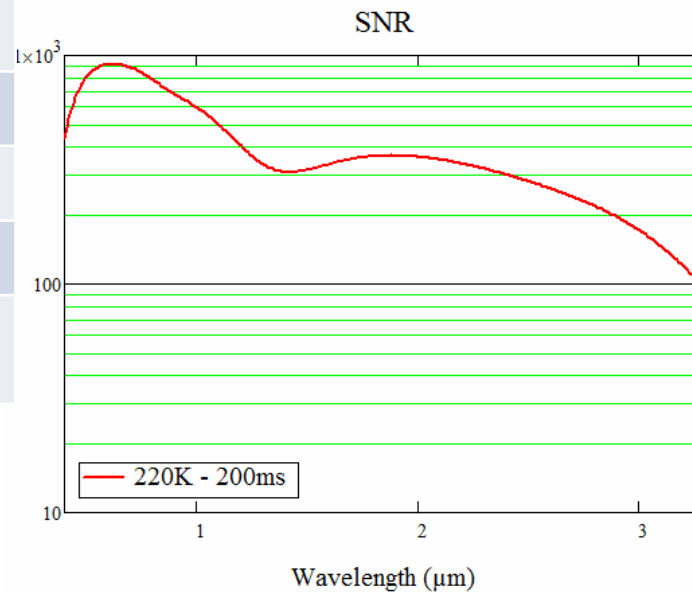
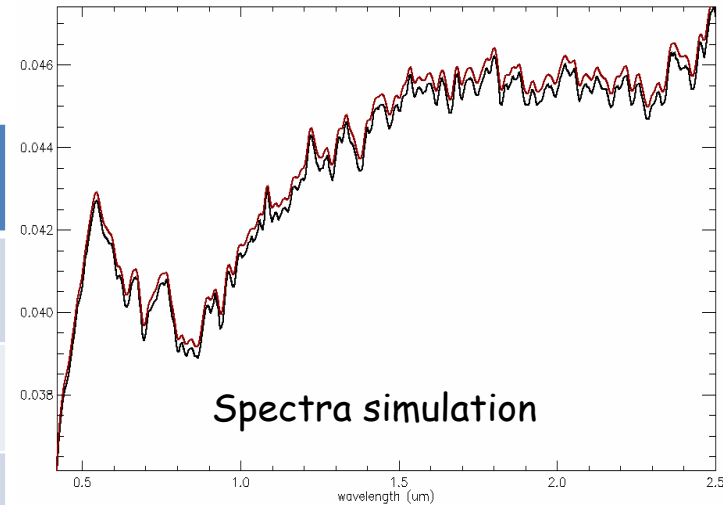
# MAPIS Optical configuration

General parameters	Value
Type	4-lens telescope & modified Offner spectrometer
Internal calibration	2-lens objective & FP system
Entrance pupil diameter	40mm
IFOV	0.25mrad
FOV	32mrad
Band pass	0.4 $\mu$ m – 3.3 $\mu$ m
Pixel pitch	30 $\mu$ m
Detector size	311x128
Spectrometer temperature	220K
Detector temperature	150K



# MAPIS performance

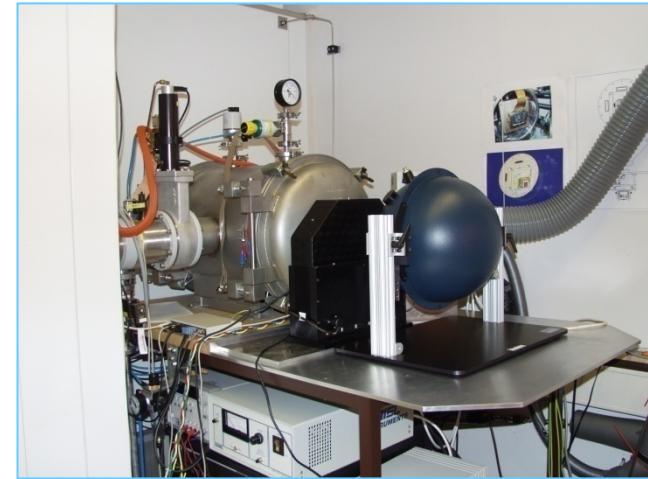
General parameter	Value
Slit spectral width (FWHM)	< 10nm full field
MTF (frequencies < pixel cut-off)	>10% full field
SNR	>100
Tolerance analysis	No major issue
Optical head mass	1.3kg
Cooling system mass	0.5kg
Dimension	240x128x81mm
Typical radiator surface	- 0.5m <sup>2</sup> (passive cooling) - 0.07m <sup>2</sup> (cryocoolers)



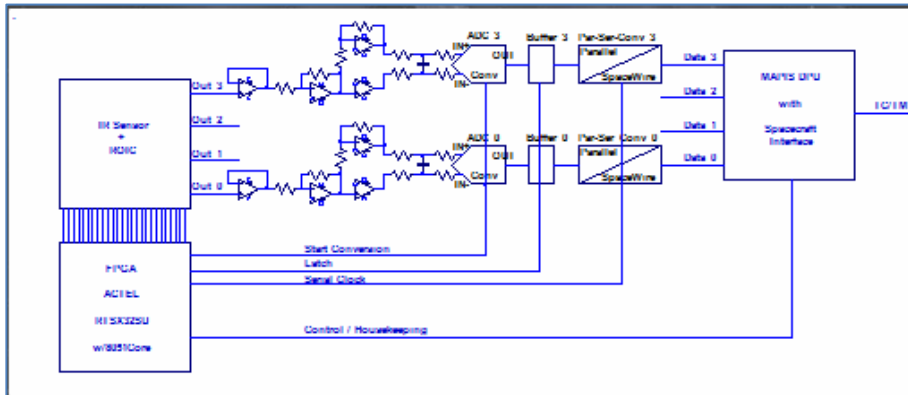
# MAPIS Detector Technology and Proximity Electronics



- Single HgCdTe detector
  - Substrate removed
  - Wavelength range: 0.4 to 3.45  $\mu\text{m}$
- Read Out Integrated Circuits
  - Multiple sampling prior and past exposure (Fowler Sampling)
  - Snapshot shutter
  - Multiple channel read out
- Pros and Cons of front-end electronics technology discussed: FPGA design with integrated processor kernel favored

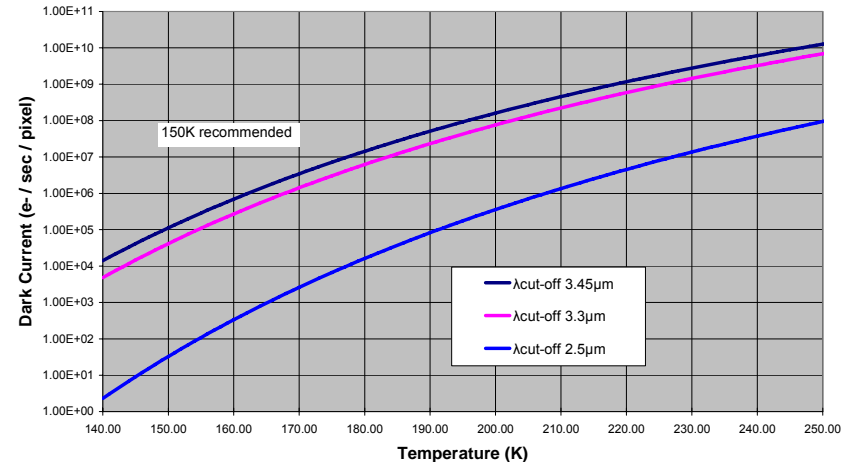


Detector calibration facility at MPS



MAPIS proximity electronics design schema

HgCdTe Sensors - Dark Current vs Temperature for 30 $\mu\text{m}$  x 30 $\mu\text{m}$  Pixel Size



Expected dark current for different detector cut-off wavelengths



# MAPIS Main Electronics



## MAPIS ME Architecture inheritance from the Simbio-sys ME:

➤ One CPCU including a SpW link for the TM-TC interface with the S/C

➤ One CU for the data compression

➤ One DCDC converter

## Main Characteristics:

➤ Wavelet Transform data compression

up to 2 Mpixel/s

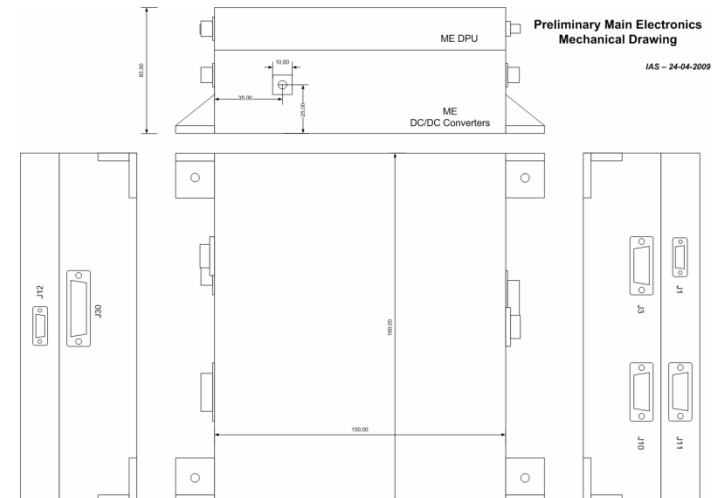
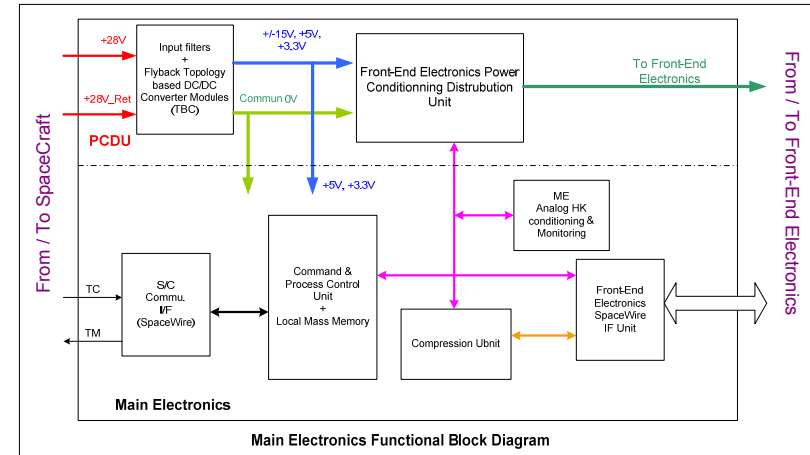
➤ SpaceWire links @ 100 Mbits/s

## Budgets:

➤ Power Consumption: 6W

➤ Dimension: 150x180x65 mm

➤ Mass: 1275g (including DCDC converters)



# Conclusion

- Preliminary studies show that proposed designs allow to reach scientific requirements
- Typical total mass: 3.6kg  
1.3kg (optical head) + 0.6kg (scanning device) + 0.5kg (cooling system) + 1.2kg (ME)
- TRL at this step, quite high (>4)
- Instrument design and preliminary cost assessment documentation to be written