cosine

Miniaturized Integrated Instrument Suites at Europa: Tools and Strategies for Operating in the Jovian Environment

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Presentation Agenda

- cosine Background
- Jupiter Instruments
  - SILAT
  - HIBRIS
  - MPS
- Remote Sensing Simulator
- Conclusions

cosine Background

Founded in 1998, located in Leiden

contract R&D in applied physics

Highly trained Research & Development team

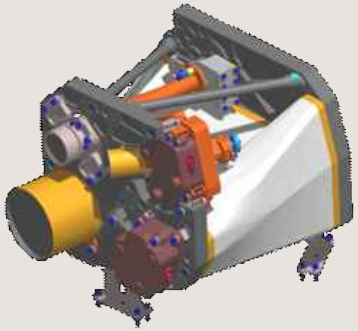
- Optical systems
- Industrial metrology
- Ionizing radiation
- Physics calculations and software

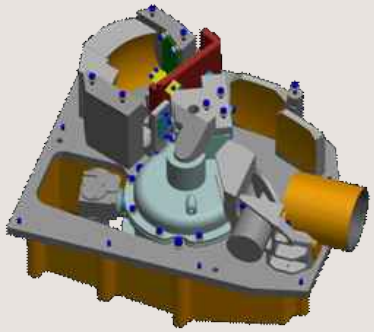
High quality internal laboratory facilities

- clean room
- laser laboratory
- radiation laboratory
- electronics laboratory

Europa-Jupiter Background

- cosine Micropayloads design program has generated two project payloads:
  - SILAT - Stereo Imaging Laser Altimeter
  - HIBRIS – Highly Integrated Broadband Hyperspectral Imager and Spectrometer

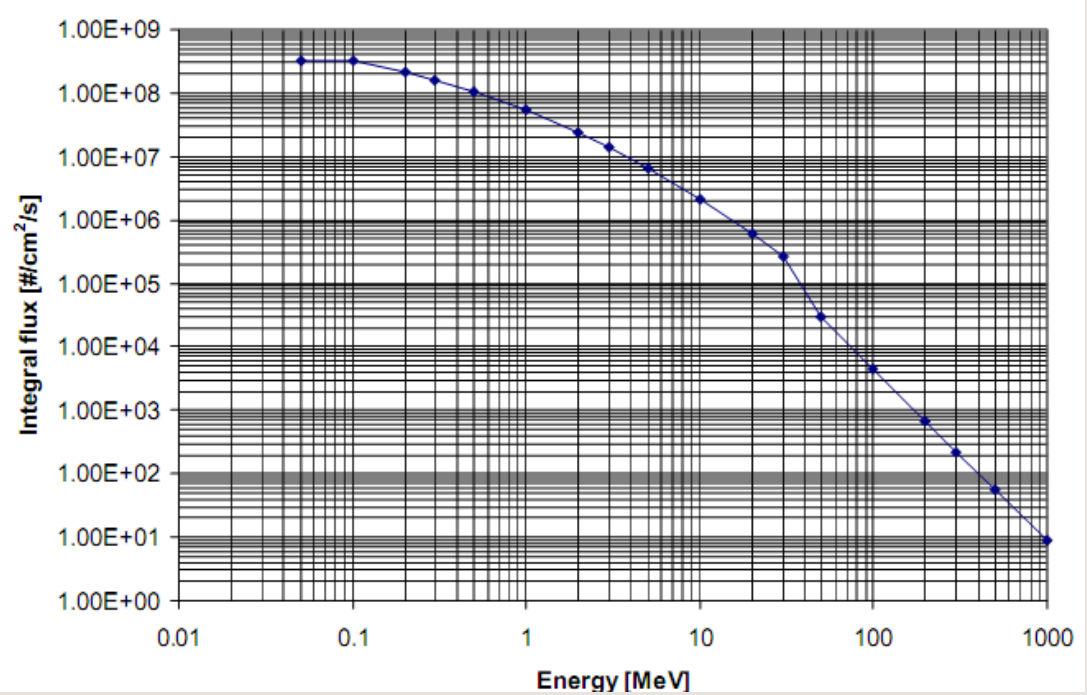




- Both studied as potential payload for 60 day Europa mission
  - Circular orbit @ 200km altitude

Jovian Mission

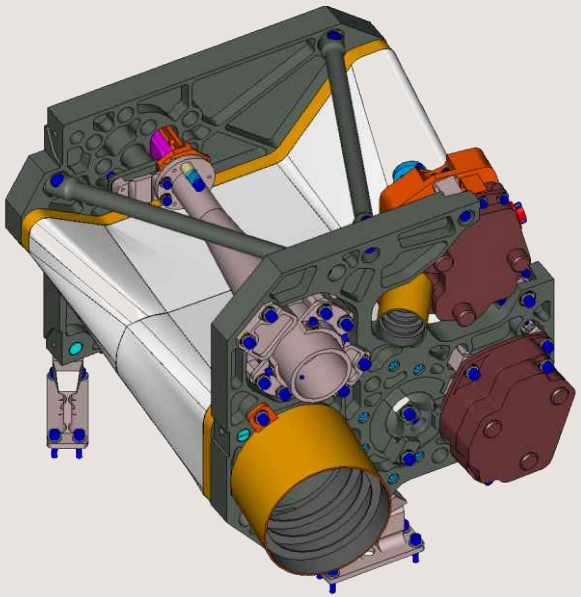
- Design using science requirements from Jupiter Minisat Explorer (JME)
  - Required redesign of payload packages for Europa environment
- Main redesign influence:
  - Thermal environment
  - Radiation
    - Type
    - Intensity

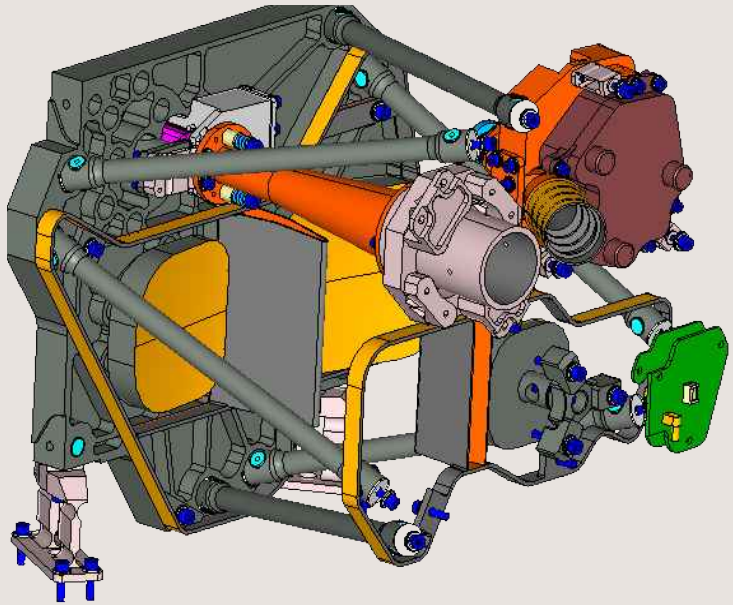


SILAT Overview

SILAT consists of:

- High Resolution Camera (HRC)
- Stereo Camera (S-CAM)
- Photon Counting Laser Altimeter (LAT-TX/RX)





SILAT: Features

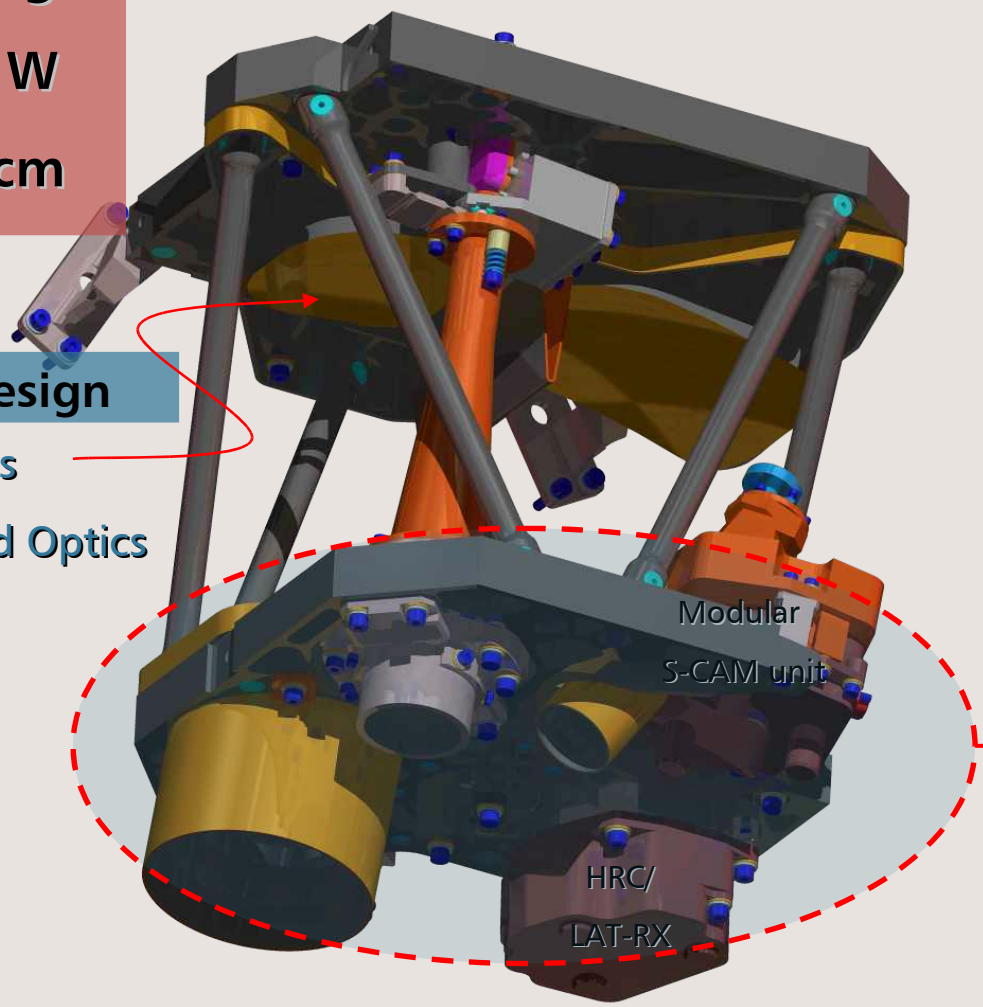
Mass: 7.6 kg

Power: 12 W

30x30x30 cm

Integrated Design

- Combined optics
- Diamond Turned Optics



Thermal Design

- Opto-mechanical alignment preserved

Science capabilities

- Water identification
- Stereoscopic Imagery
- High Accuracy Altimetry
- Topography
- Digital Elevation Map (DEM) data

SILAT Performance – HRC & S-CAM

HRC

- Signal-to-noise (SNR) ratio over 100
- 6.0 m Ground Sampling Distance
- 12.2 km swath
- 32 cm focal distance

S-CAM

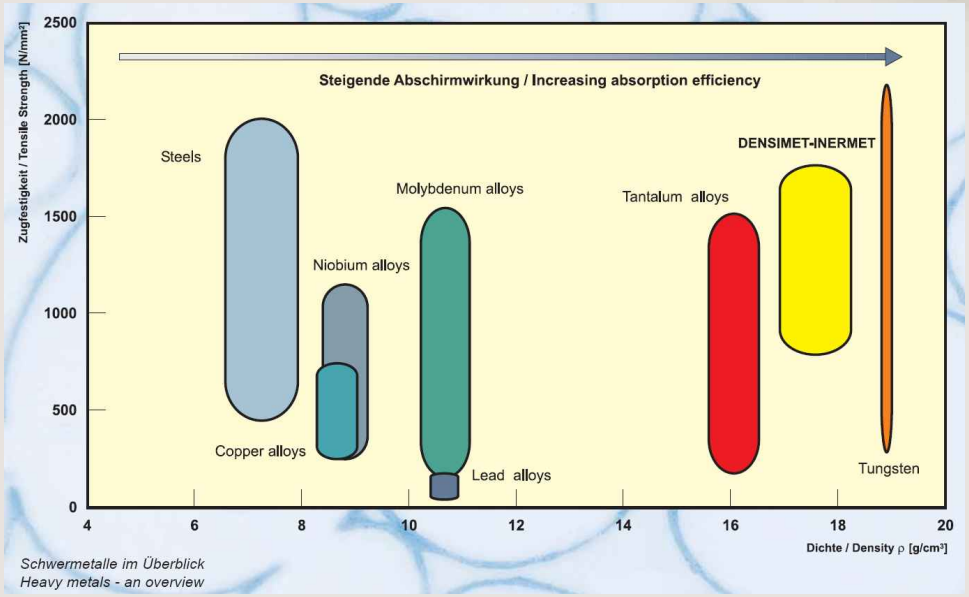
- SNR over 100
- 15.9 m GSD
- 16.1 km swath
- Same central wavelength as HRC Green channel

LAT

- Single-photon counting with 99.9% confidence
- 15 cm vertical resolution
- 10 kHz, 25 μJ microchip laser.

Jovian Considerations

- Radiation shielding
  - Stainless steel
  - Silicon carbide
  - Densiment
  - Shared systems
- Radiation Hard Electronics
  - Redundantly programmed FPGA control
- Opto-mechanical alignment
  - Low CTE, high conductivity materials

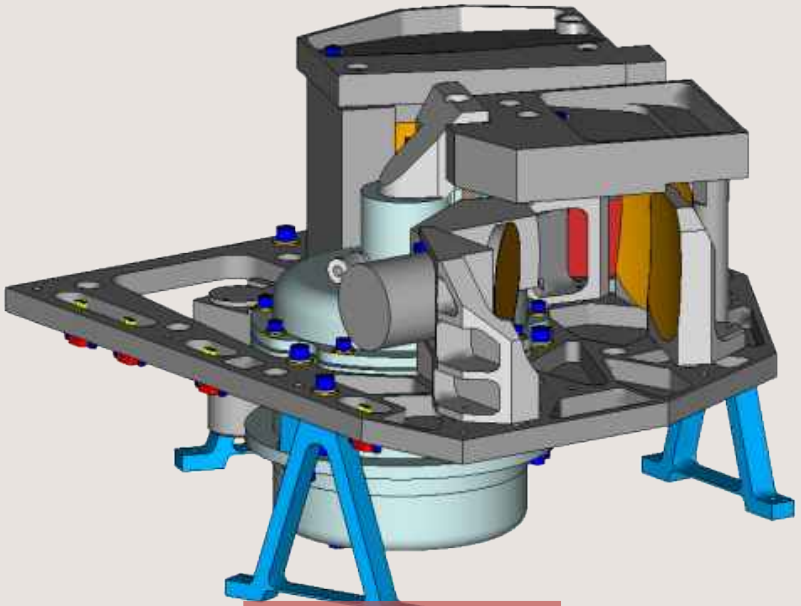


Current Status

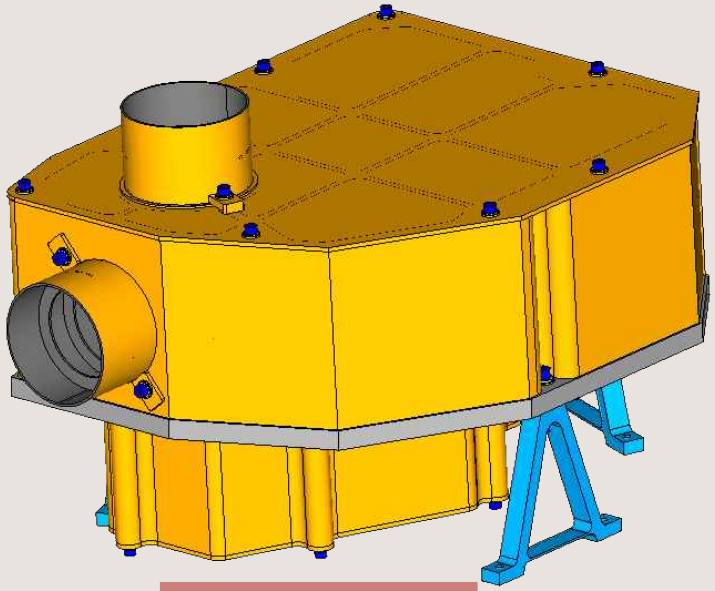
- Phase B complete
- Next step is engineering model
- Prototype critical components being developed with project partners
  - Aspherical diamond turned optics (with TNO)
  - Microchip lasers for LAT
  - Data analysis software for LAT

HIBRIS

- HIBRIS consists of:
  - Near Infrared Hyperspectral Imager (NSI)
  - Thermal Imager (TI)



Open case



Closed case

HIBRIS Features

Mass: 7.5 kg

Power: 4.2 W

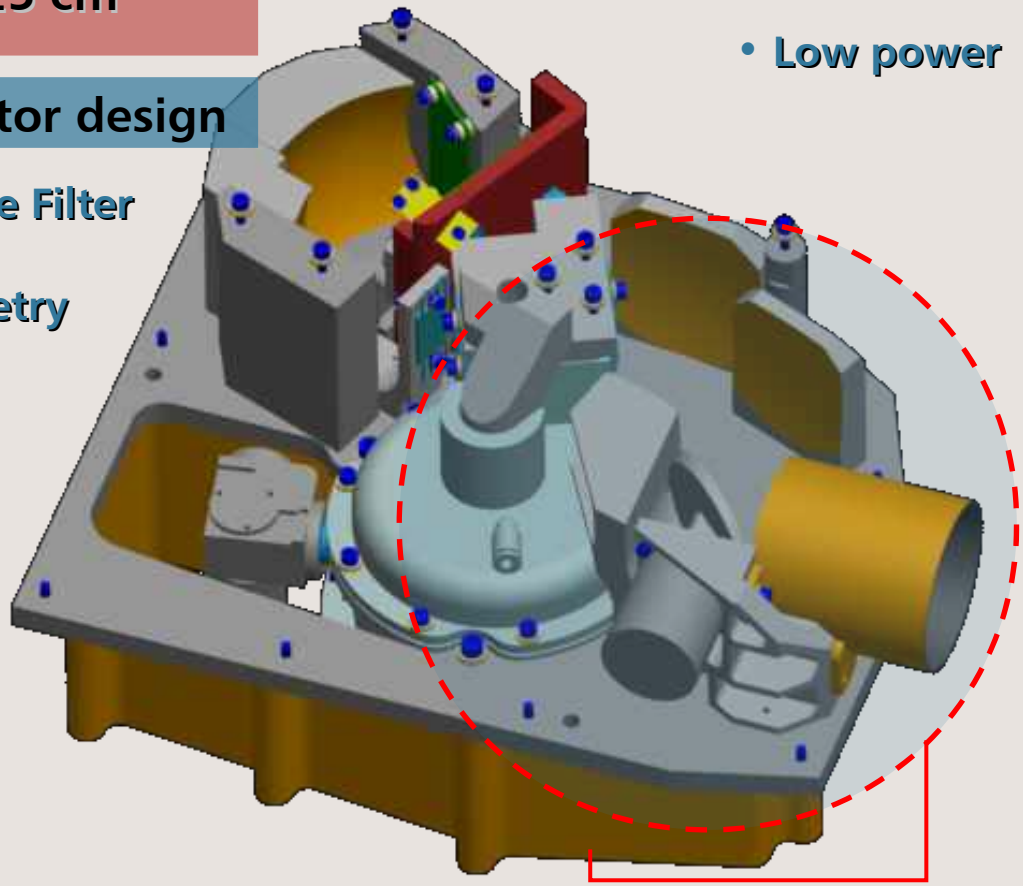
25x25x25 cm

Highly Optimized Electronics

- Shared FPGA
- Low power

Unique detector design

- Linear Variable Filter (LVF) for Hyperspectrometry
- HgCdTe Detector



Science capabilities

- Global Thermal Mapping
- Spectroscopy in the Infra-red regions
- Characterization of heat sources

Compact Optics

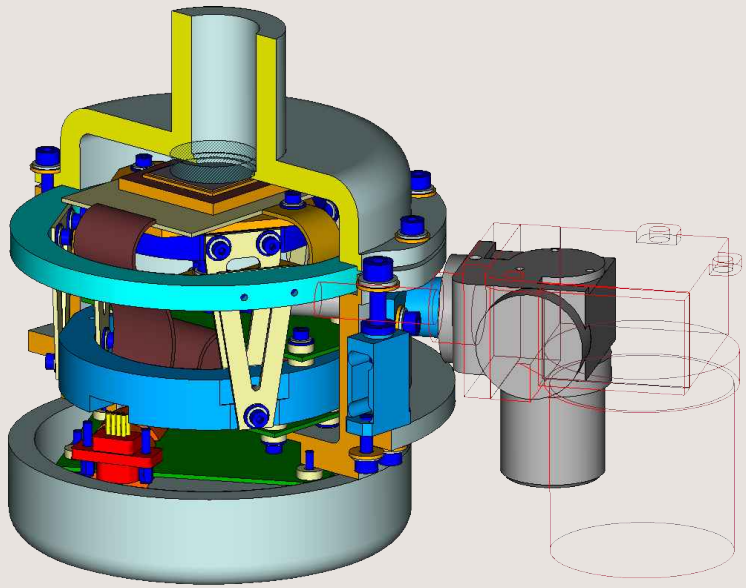
HIBRIS Performance – NSI, TI

NSI

- 50 m GSD
- 52 km swath
- 50 mm aperature
- MCT detector
  - cooled to 80-90 K
- LVF providing spectra between 800 nm and 5.2 μm

TI

- 143 m GSD
- 55 km swath
- 7 μm bands
- Broad total range

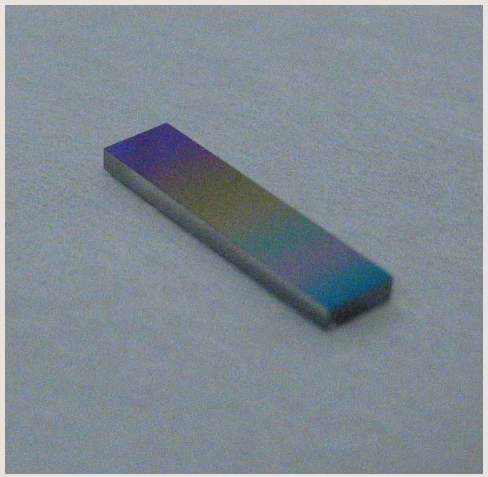


Jovian Considerations

- Radiation shielding
  - Stainless steel
  - Aluminium
  - Shared systems
- Radiation Hard Electronics
  - Redundantly programmed FPGA control
- Sectorial analysis for minimum and shared shielding

HIBRIS Status

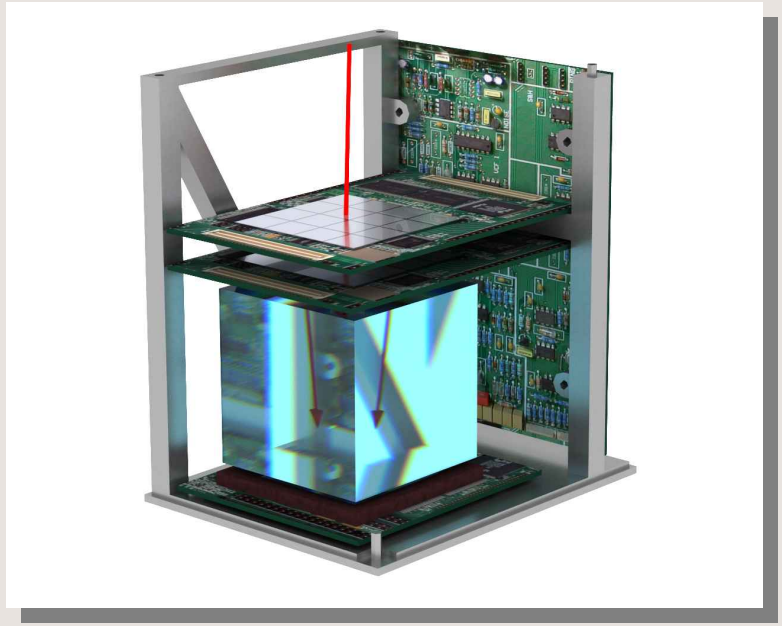
- Design Phase B complete
- Critical technologies under investigation at cosine
  - Infrared detectors
  - Linear Variable Filters (LVF)



Multi-functional particle spectrometer (MPS)

- Developed to provide better radiation monitors on exploration missions
  - Discriminates between 4 types of particles and determines angle of incidence
  - Provides continuous large energy range and good energy resolution
- Makes use of scintillator and detector technologies from nuclear and high energy physics
- Real time analysis

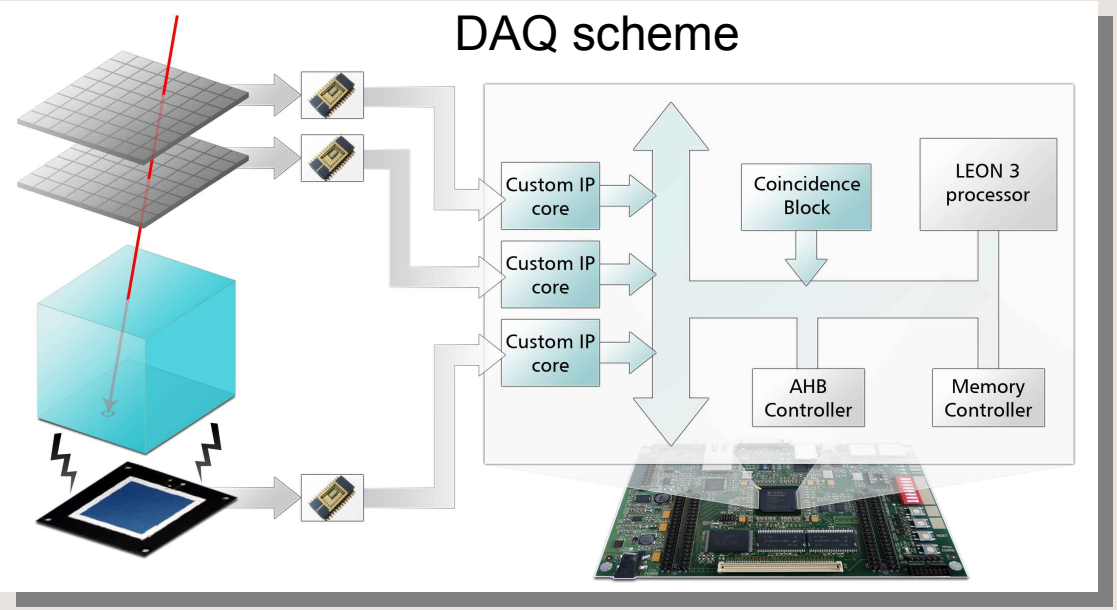
MPS overview (baseline)	
Mass	600 g
Power	< 2 W
Width	7.5 cm
Length	7 cm
Height	8.0 cm



Operating Parameters

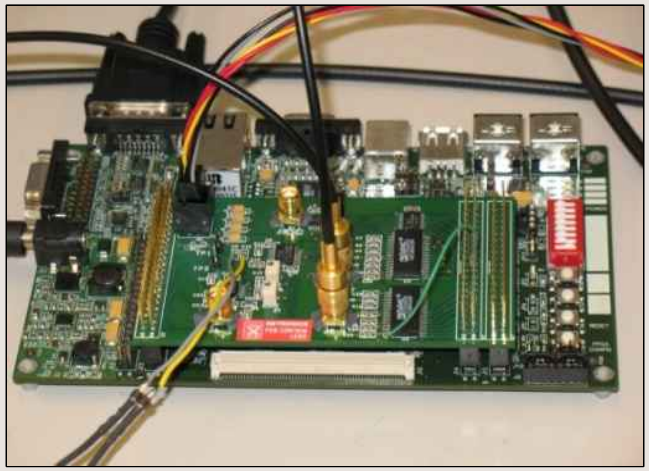
- Particles
  - Protons from 1 to 200 MeV
  - Ions from 5 to 400 MeV/n
  - Electrons from 1 to 10 MeV
  - Gamma from 0.1 to 3 MeV
- Angular Resolution
  - 10° resolution based on tracker separation
- Rate: up to 100 kHz

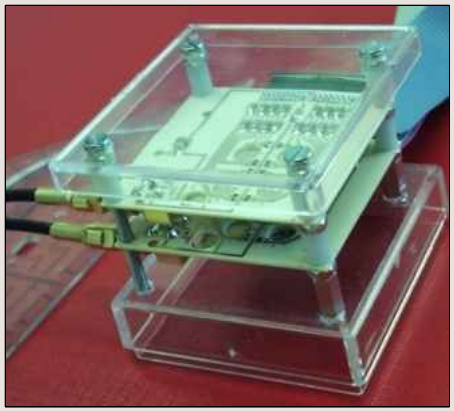
- Jupiter considerations
  - High rates, decrease sensor area
  - Redundant FPGA control
  - Couple with magnetic spectrometer for high energy electrons > 10 MeV



MPS Status

- Components prototyped
  - Scintillator and detector
  - Thin silicon trackers
  - Control and data analysis software
  - Electronics
- Full funcitonal system prototype under production





Remote Sensing Simulator RSS

- Mission Analysis and Simulation Tool
  - Used for SILAT, HIBRIS
- Models all bodies in Solar system
- Surface coverage evaluation
- Models expected performance of instrument and overall mission
- Future development:
  - Increased interactivity
  - Visualized output
  - Expansion of mission options

Thank You

Contact

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Key Performance Parameters

HRC	
Spatial Resolution	6.0 m
Focal Distance	320 mm
Swath Width	12.2 km
IFOV	31.25 μrad
Viewing Angle	Nadir

SCAM	
Spatial Resolution	15.9 m
Focal Distance	126 mm
Swath Width	16.1 km
IFOV	79.4 μrad
Viewing Angle	27°

LAT	
Vertical Resolution	0.15 m
Spatial Resolution	10 m
RX-IFOV	150 μrad
TX IFOV	50 μrad
Viewing Angle	0°
TX Wavlength	532 nm
Pulse Rate	10 kHz
Pulse Energy	25 μJ