Mars MetNet Mission and Payload Precursors

Martian In Situ Investigations

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MetNet

Atmospheric science network for Mars

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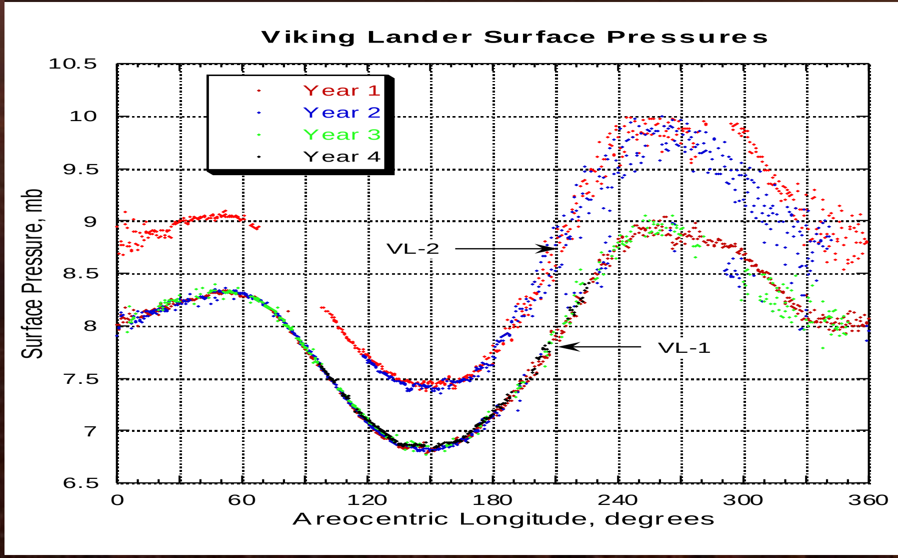
The Mars MetNet Mission concept

- Goal: wide-spread surface observations network around Mars to investigate atmospheric physics, meteorology and planetary interior and crust.
- Secondary goal: Landing safety of future missions.
- Protype development performed in 2001 -2004
- Entry, descent and landing system qualified for Mars (2003-2005)
- Precursor mission and a series of missions to start in 2016+ and to extend over several subsequent launch windows.

- ”Successor” of the Netlander Mission’s atmospheric leg.
- Mission lead : FMI
  Systems lead : LA
  Payload lead : FMI / IKI
  Payload : INTA
- **Other collaborators are invited to join the mission efforts**

MetNet Network Science Objectives

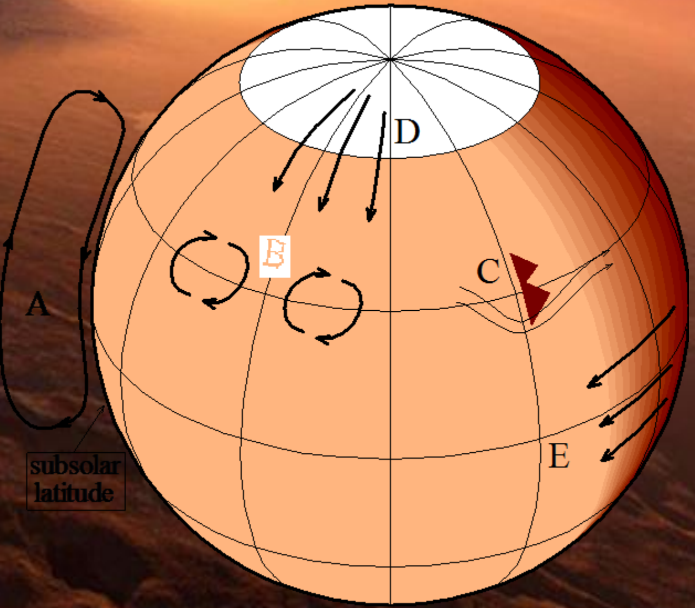
- Atmosphere
  - Surface to Atmosphere interactions & the Planetary Boundary Layer (PBL)
  - Atmospheric dynamics and circulation
  - Cycles of CO_2, H_2O and dust.
  - Dust raising mechanisms
- The evolution of Martian climate



Network missions / Proposals:

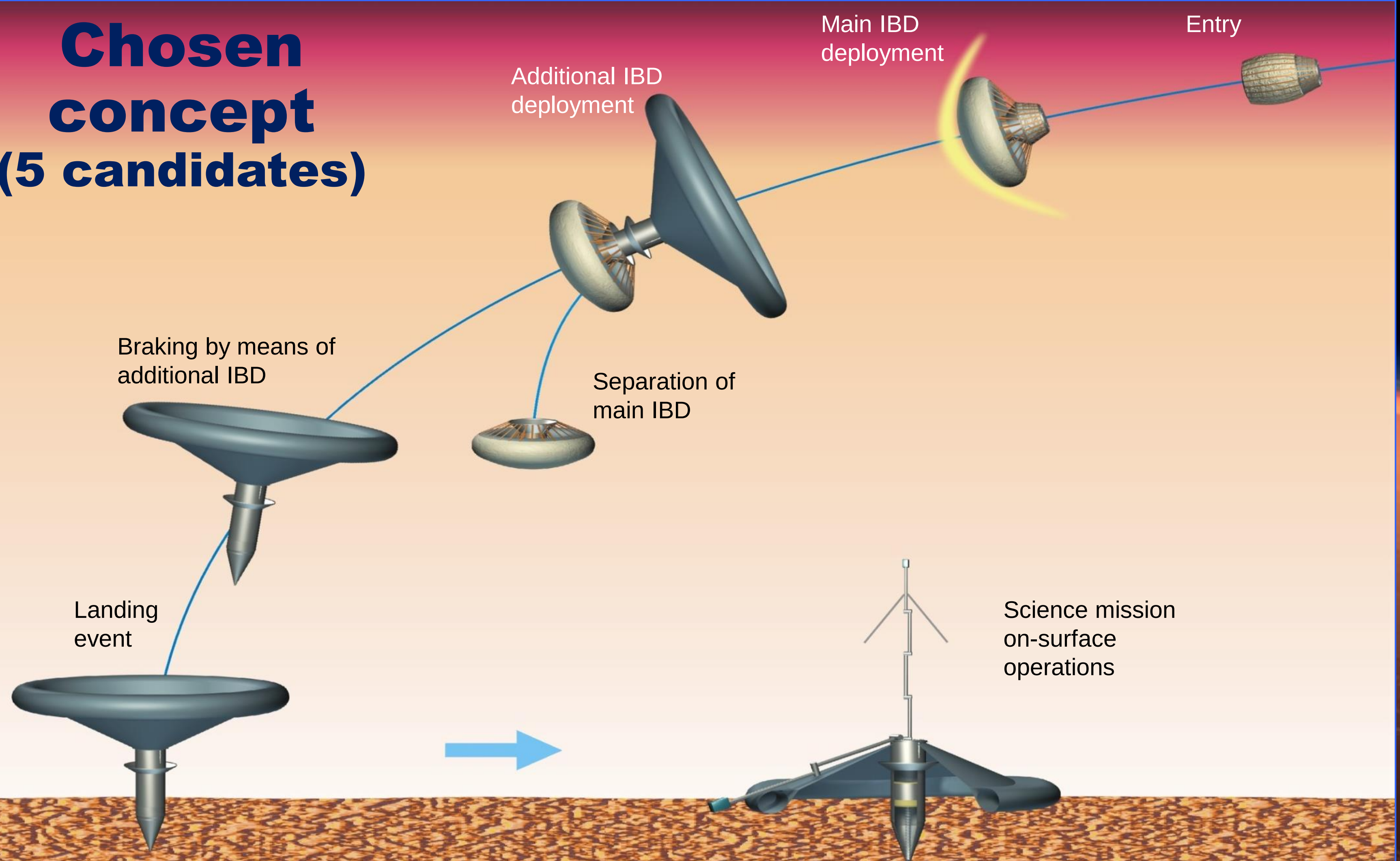
Mars-92/96
Marsnet
Intermarsnet
NetLander

MESUR
PASCAL
METNET

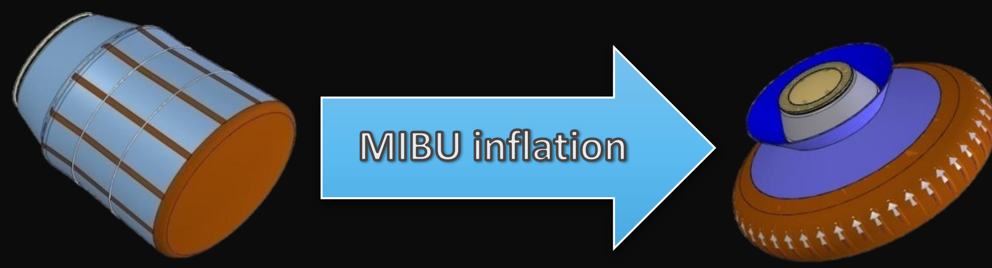


MetNet – Mission For Mars

Chosen concept (5 candidates)

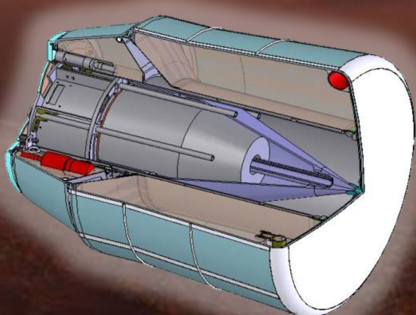


Mars MetNet Lander



Main Parameters of the MetNet Lander

PARAMETER	VALUE
Vehicle mass	22.2 kg
Payload mass	4.0 kg
Landing speed	50-70 m/s
Diameter of MIBU	1m
Diameter of AIBU	2m



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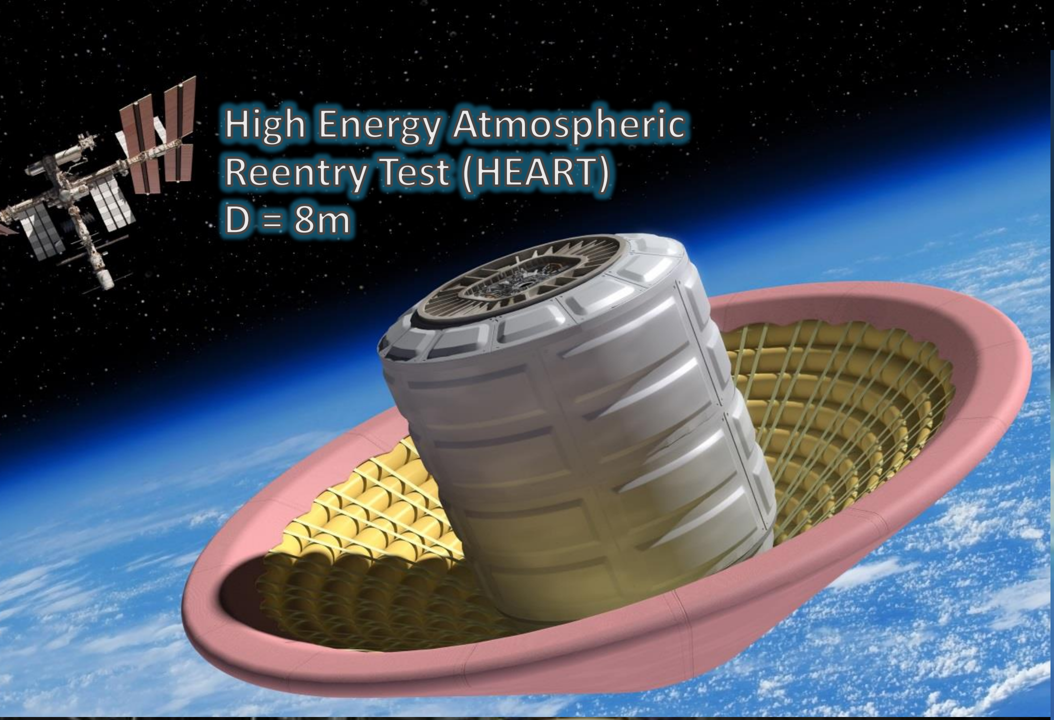
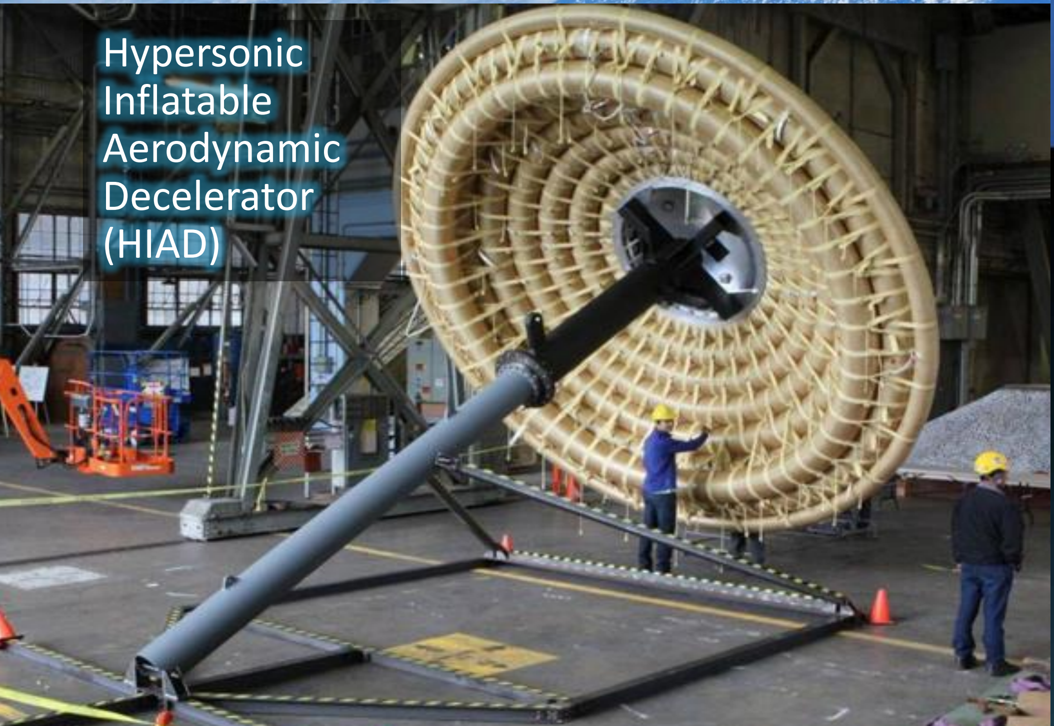
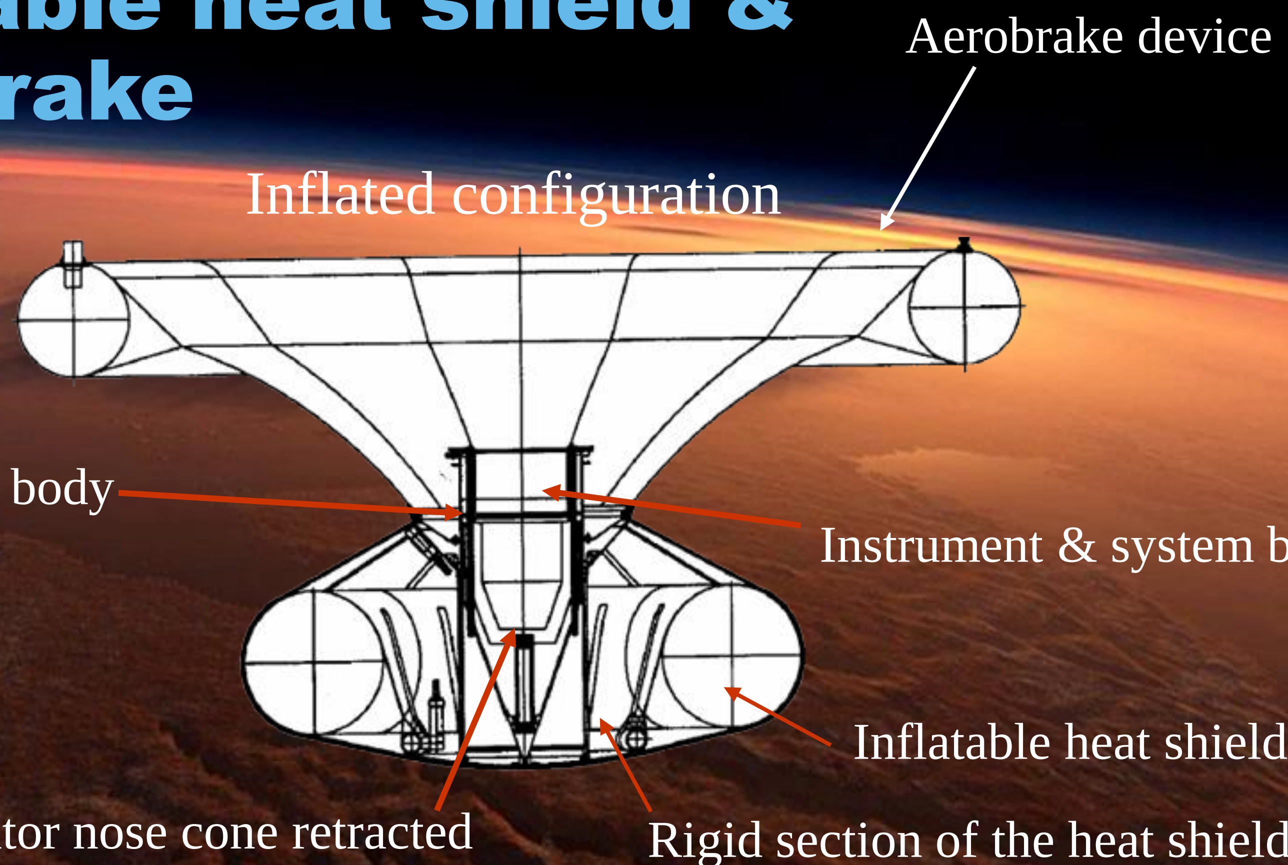

High Energy Atmospheric
Reentry Test (HEART)
D = 8m

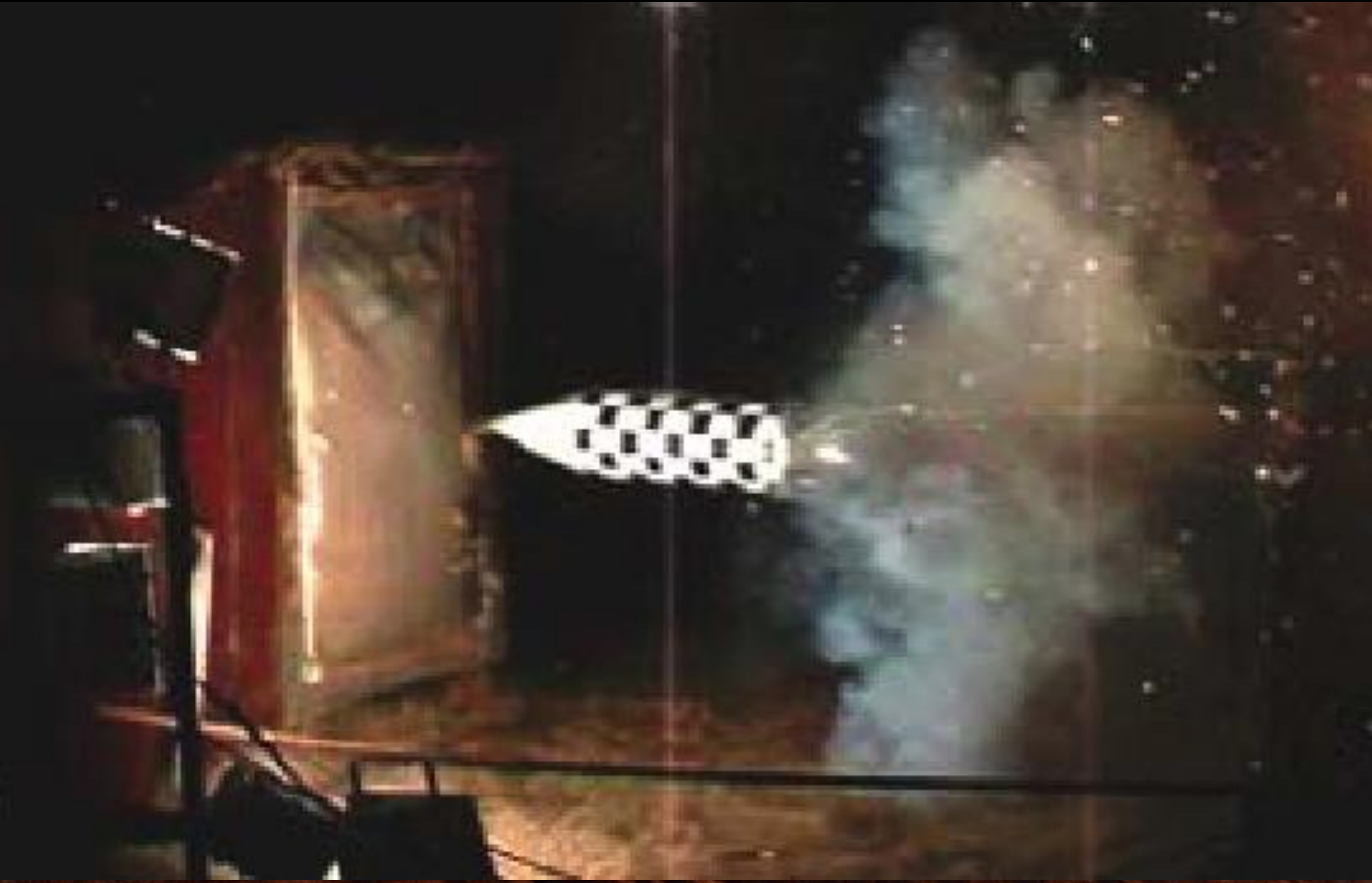

HIAD/IRVE-3
Dimensions: 56 cm x 3000 cm (cylinder)
Diameter (infl.): 3m
Total mass: 100 kg


Hypersonic
Inflatable
Aerodynamic
Decelerator
(HIAD)

MetNet penetrator with inflatable heat shield & aerobrake

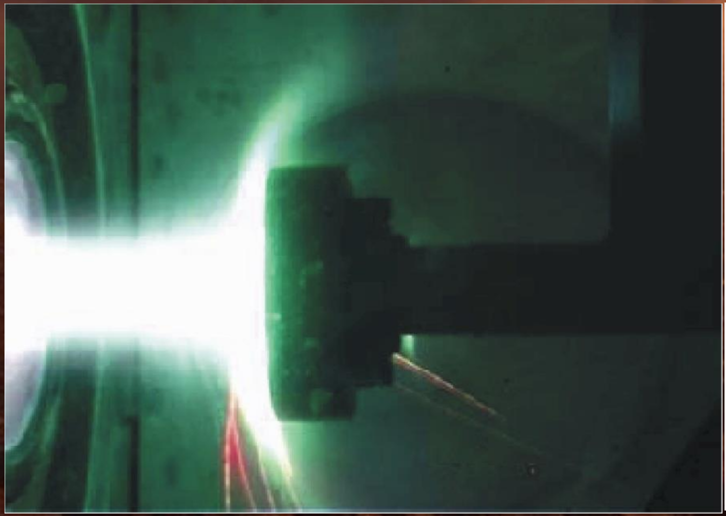


MetNet – Mission For Mars



MetNet – Mission For Mars

Thermal protection system tests



Low altitude drop test

Event	Time of test cyclogram, sec	Real time, sec	Note
Timer activation	0	0	Standard Moscow time 17h 25 min
Separation from the carrier	5-10	7.8	
AIBD deployment	25	25.0	
AIBD inflation system activation, start of AIBD inflation	27	27.0	
Stop of AIBD inflation, cutting of tube and AIBD inflation system pyro-cartridge cable	127	127.0	
Cutting of front shield connections, front shield separation	130	130.0	
Front shield lowering	-	133.2	
Landing	191	182.8	

MetNet Mars Precursor Mission (MMPM)

MMPM Primary Goals

- Carry out the MMPM flight to Mars
- Demonstrate the feasibility and robustness of the MetNet concept
- Prove that MetNet is capable of operating at Mars incl high latitudes
- Carry out scientific observations at the Martian surface

MMPM Mass budget

MMPM Mass		Kg
EDLS		12.0
Landing Module		13.2
Lander body	9.2	
P/L Module	4	
Total Entry Mass		22.2

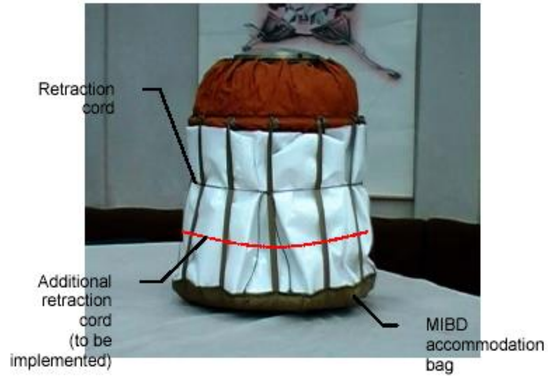


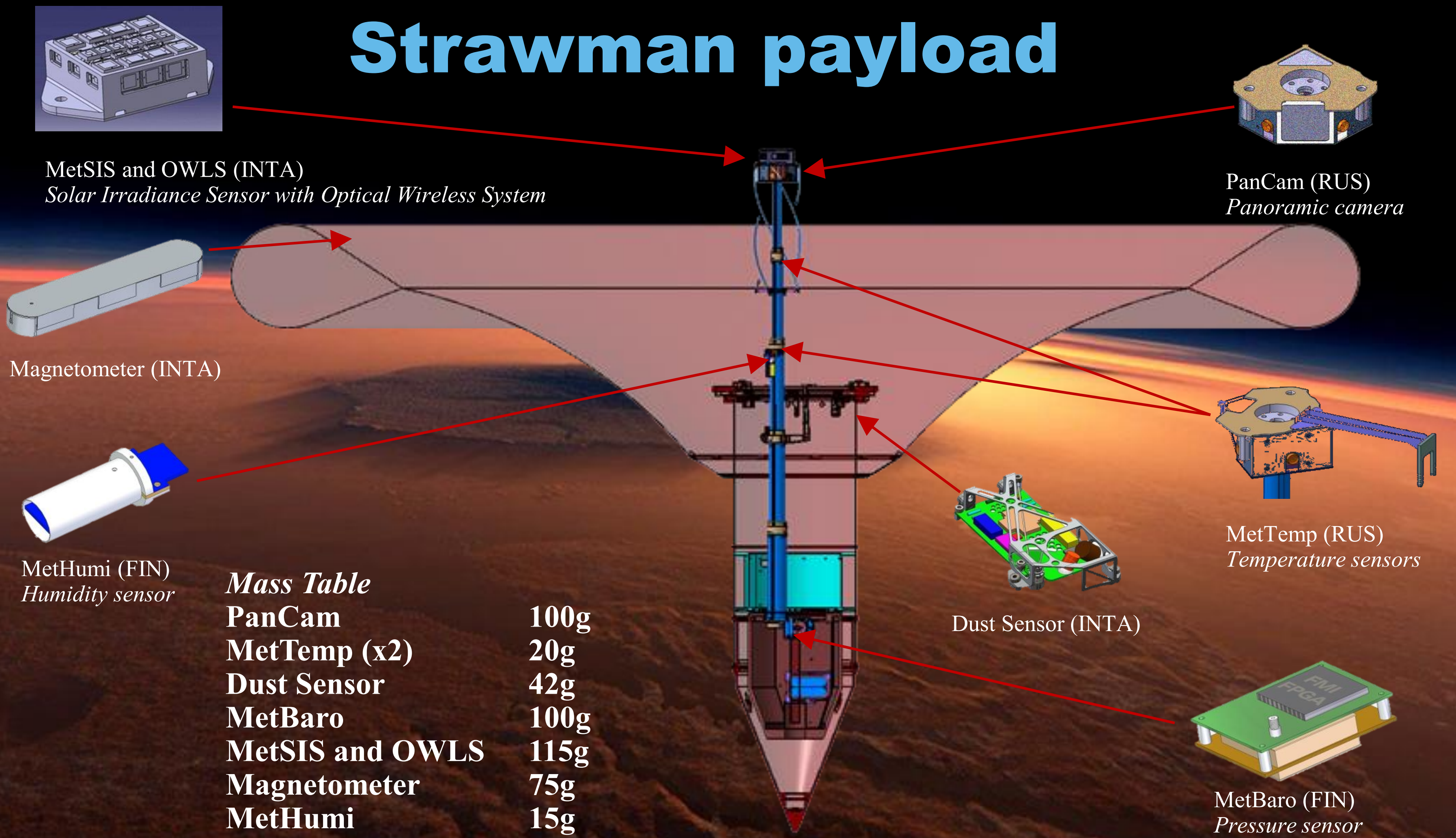
Figure 3-5 MML prototype (folded)


Figure 3-6 MIBD is being inflated


Figure 3-7 MIBD and AIBD fully inflated


Figure 3-8 MML's landing configuration

Strawman payload

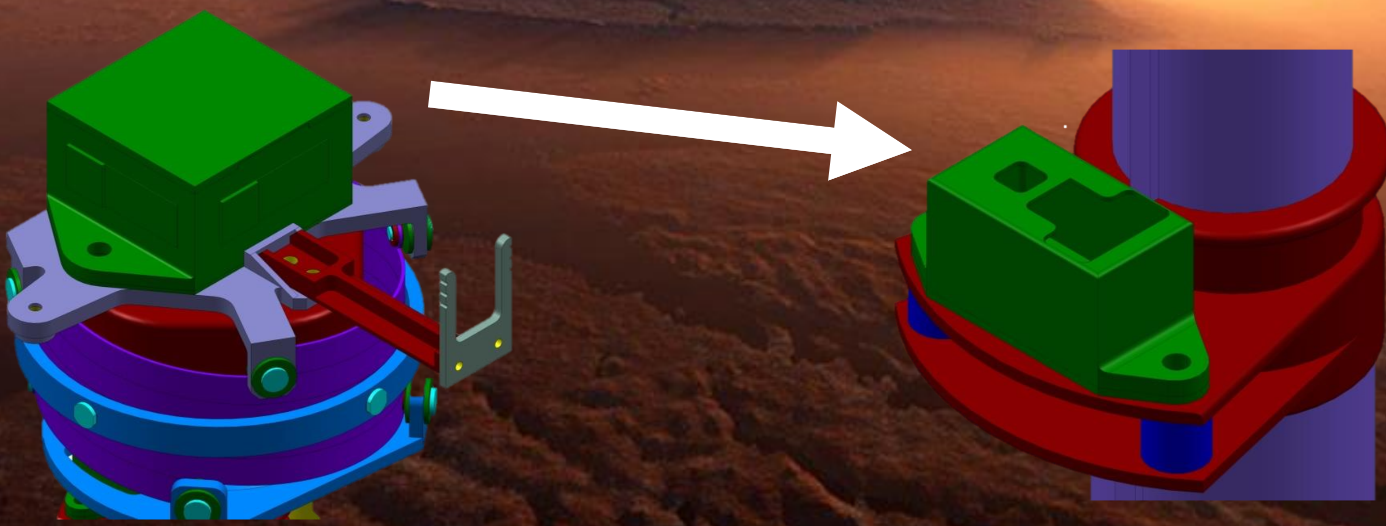


Mass Table

PanCam	**100g**
MetTemp (x2)	**20g**
Dust Sensor	**42g**
MetBaro	**100g**
MetSIS and OWLS	**115g**
Magnetometer	**75g**
MetHumi	**15g**
Instrument reserve	**42g**
Total	**509g**

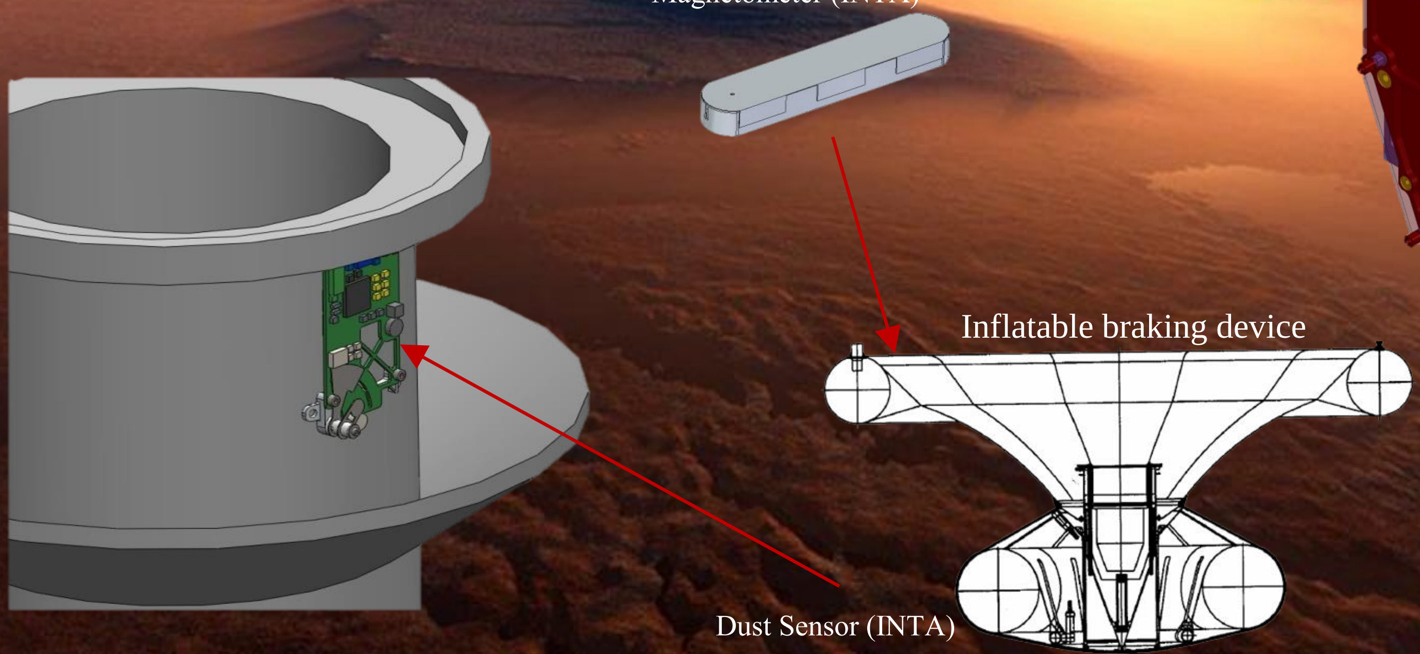
MetNet – Mission For Mars

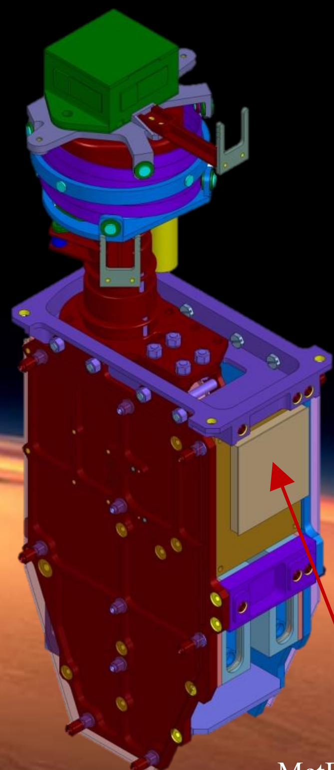
- SIS, PanCam, Temperature sensors and Humidity device are located in the boom.
- SIS communicates with DPU by using the optical link (OWLS)
- All the payload is designed to withstand the landing shock of 500 g in the payload bay and about 1000 g outside the payload bay.



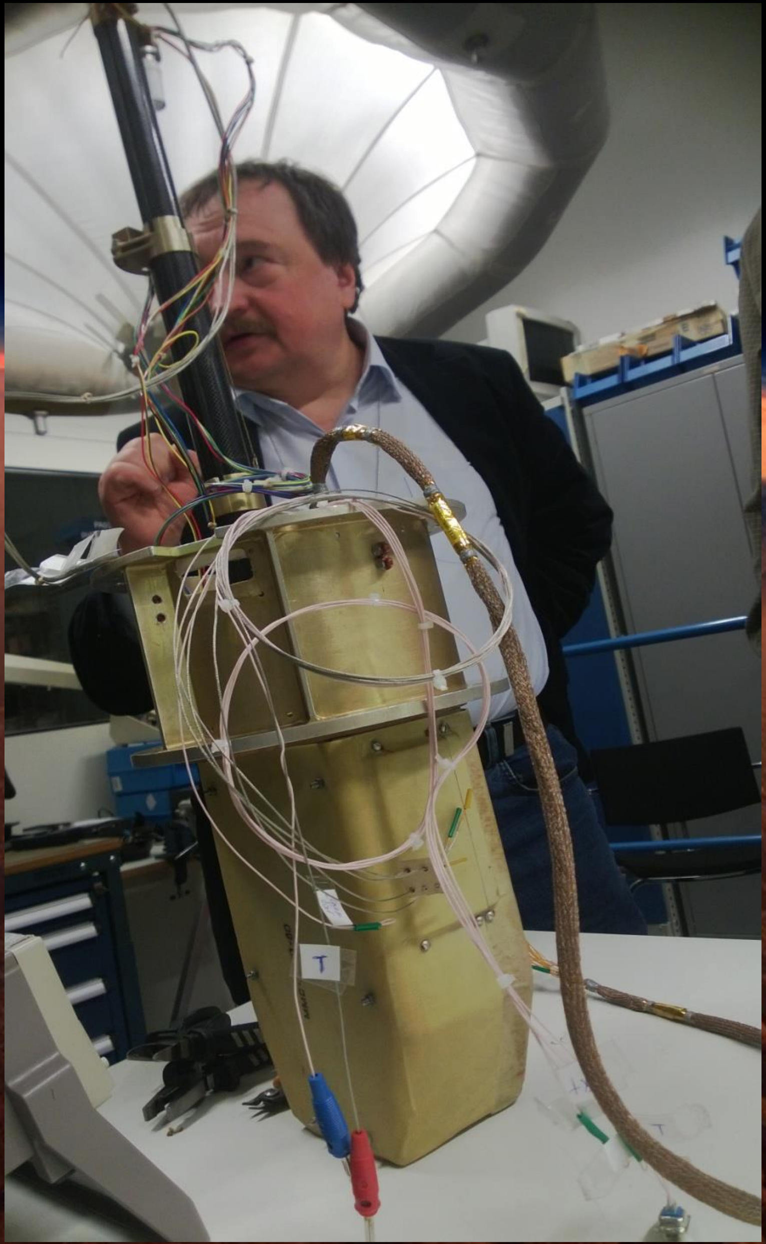
MetNet – Mission For Mars

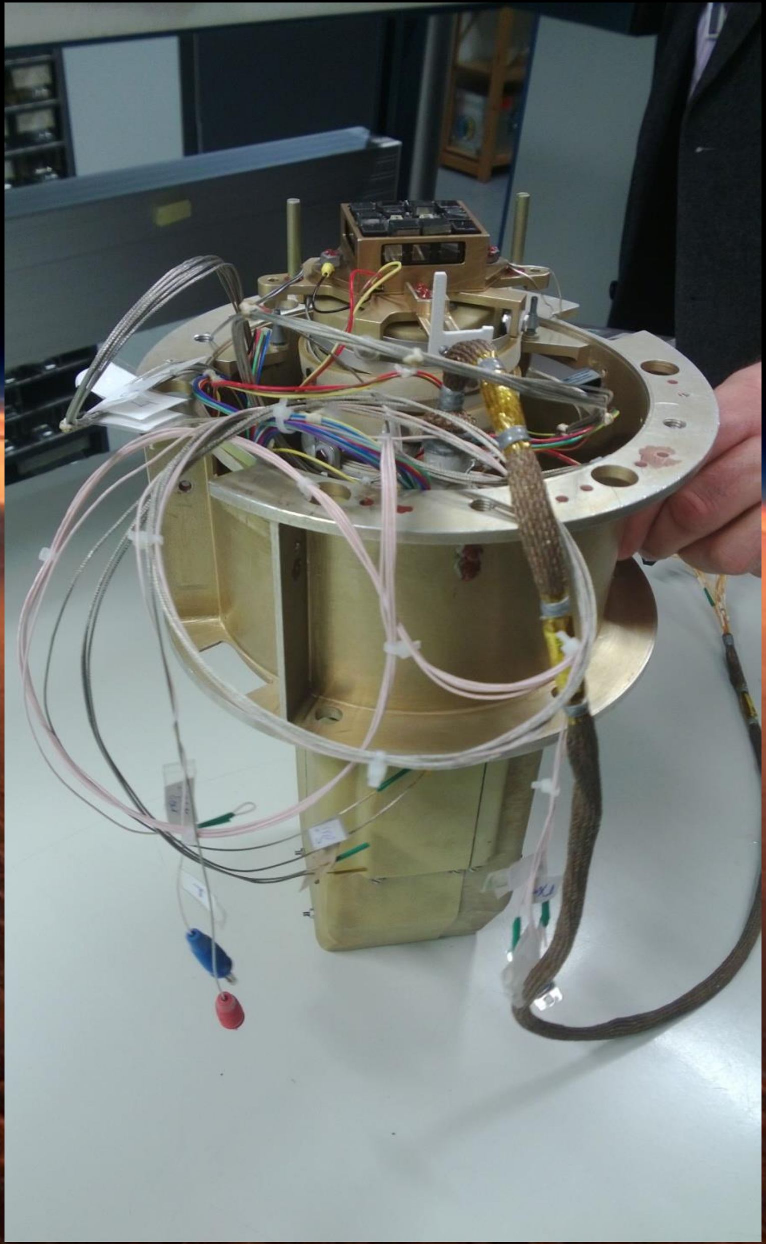
- MetBaro Pressure sensor is located inside he MNL payload bay
- The magnetometer and dust sensor, are located in the payload bay inside the MNL.
    - DS is mounted on the frame of the MNL
    - MAG is mounted on the inflatable braking device



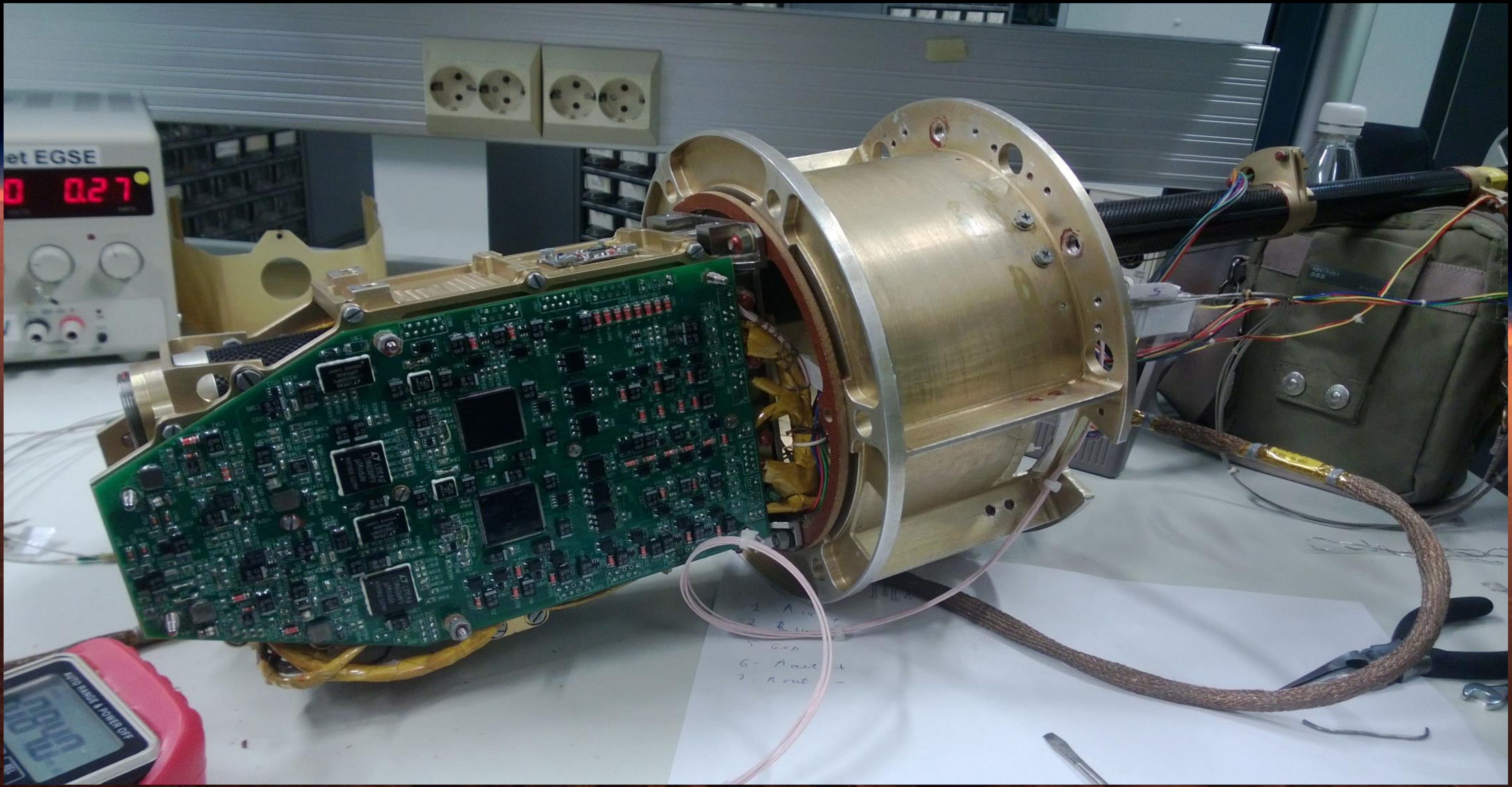


MetNet – Mission For Mars





MetNet – Mission For Mars



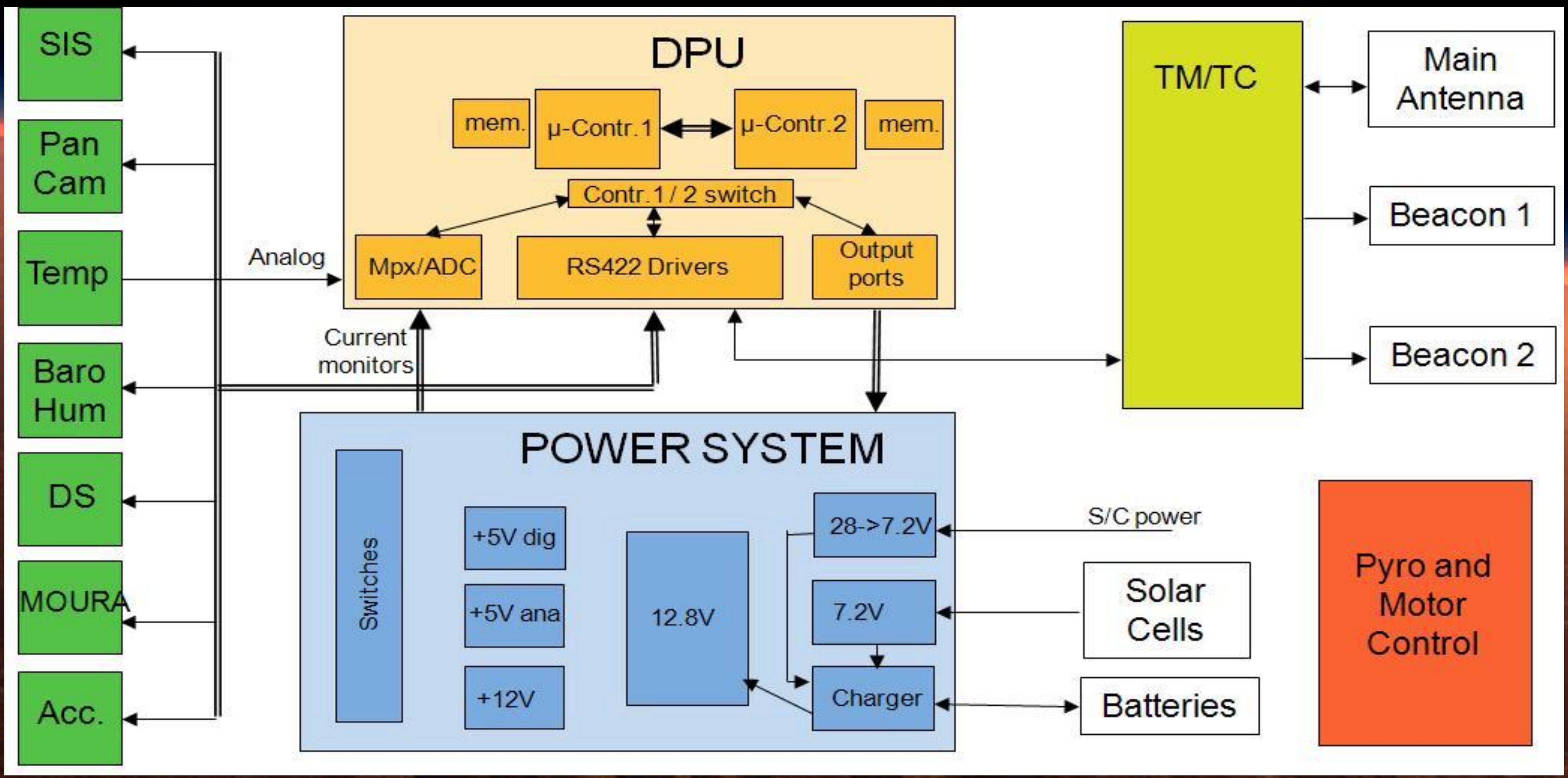
MMPM-1 Mission resources: systems

- Mass
  - The overall Payload bay mass is now tight
  - INTA instrument allocation has not changed

- Energy
  - MMPM-1: Solar cells and pre-charged (no RTG)
  - Availability of RTGs was low for MMPM-1 schedule
  - Solar cells mounted on the fabric of the inflatable system (up to 500 mw permanent)

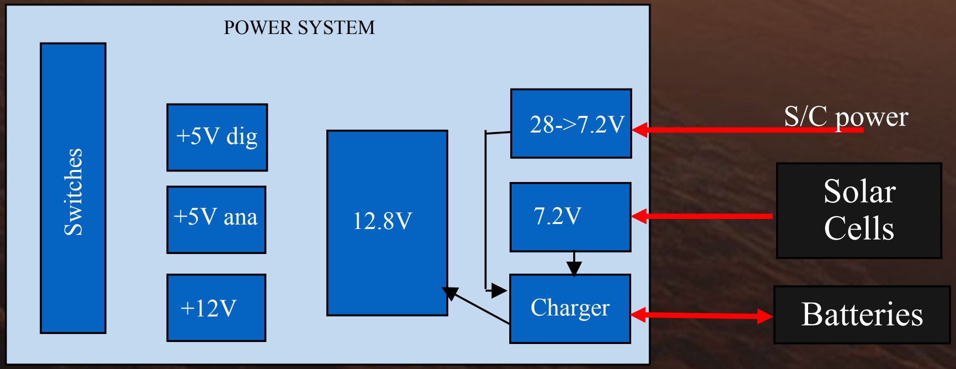
- Command and data systems
  - Freescale – controller based system
  - Results in mass savings
  - More flexible design cycle gives more speed after the initial design

MetNet Conceptual System Structure

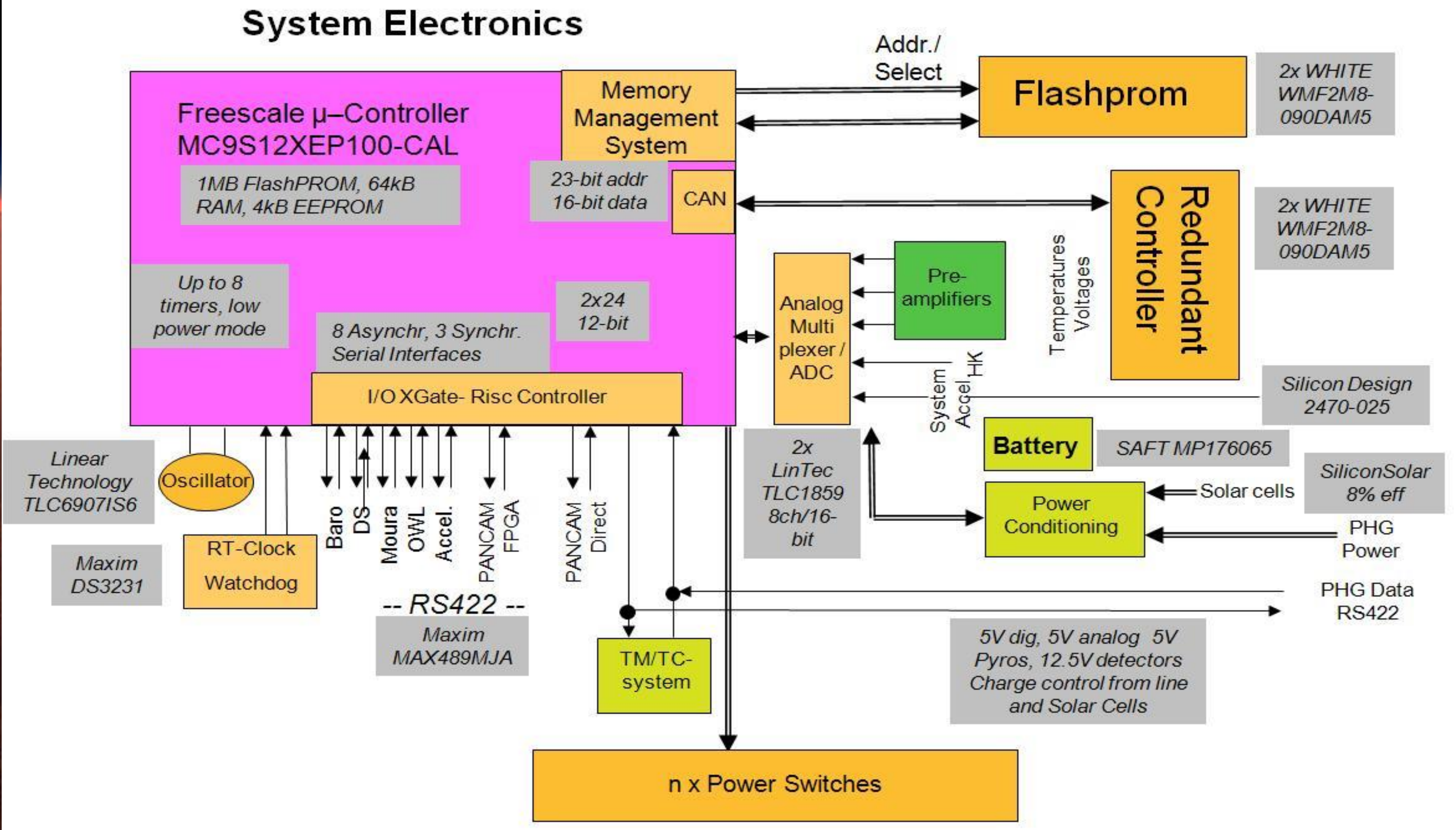


MetNet MMPM-1 Power Supply

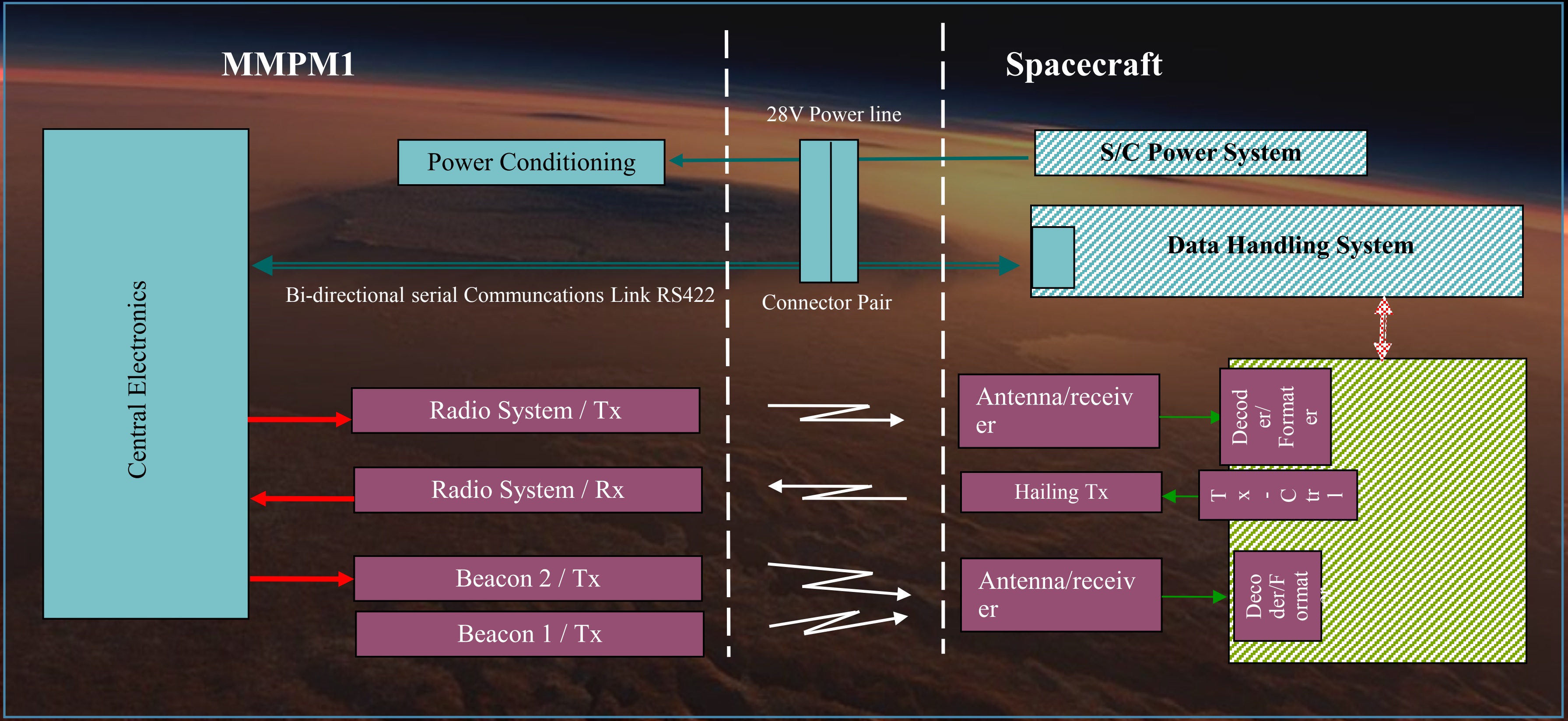
- MNL power supply is implemented by using very *flexible solar cells* mounted on the lander additional braking unit, *rechargeable batteries* and *non-rechargeable batteries*.
- Due the general low power level requirement, the instruments are specially designed to operate with very low power.
- Power system will provide +5V ± 0,25V digital and +12V ± 0,15V analog power lines for the instruments.



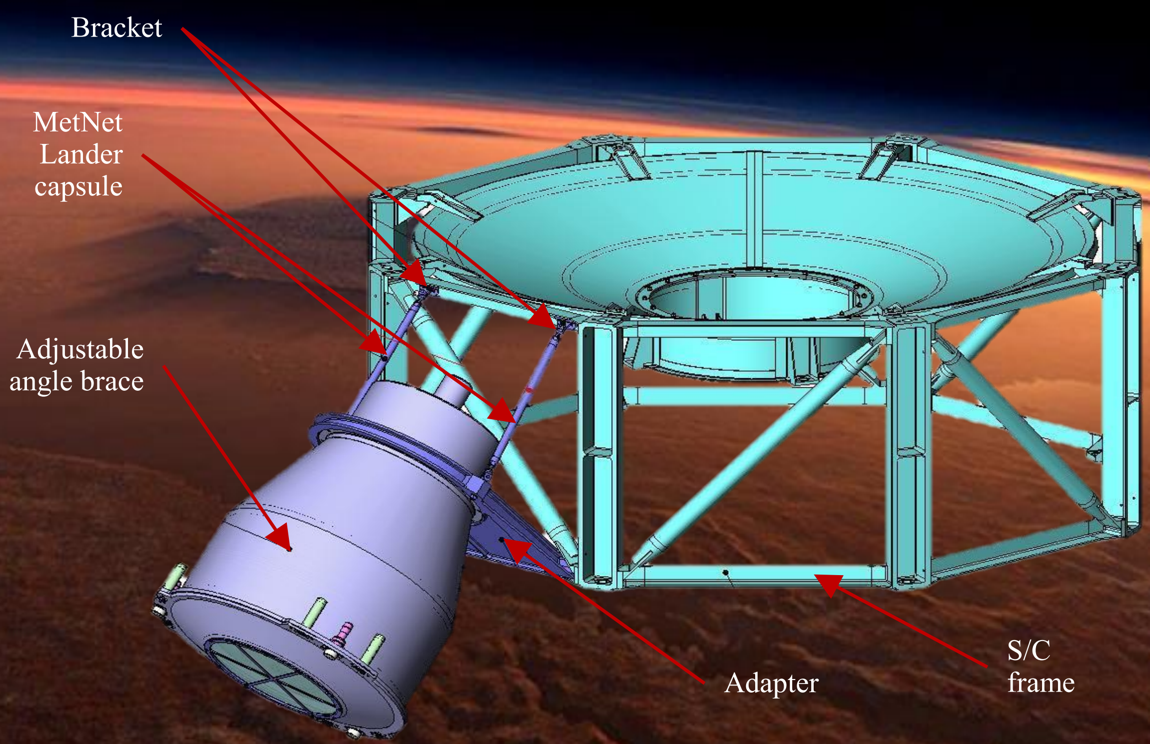
MetNet MMPM-1 System Electronics



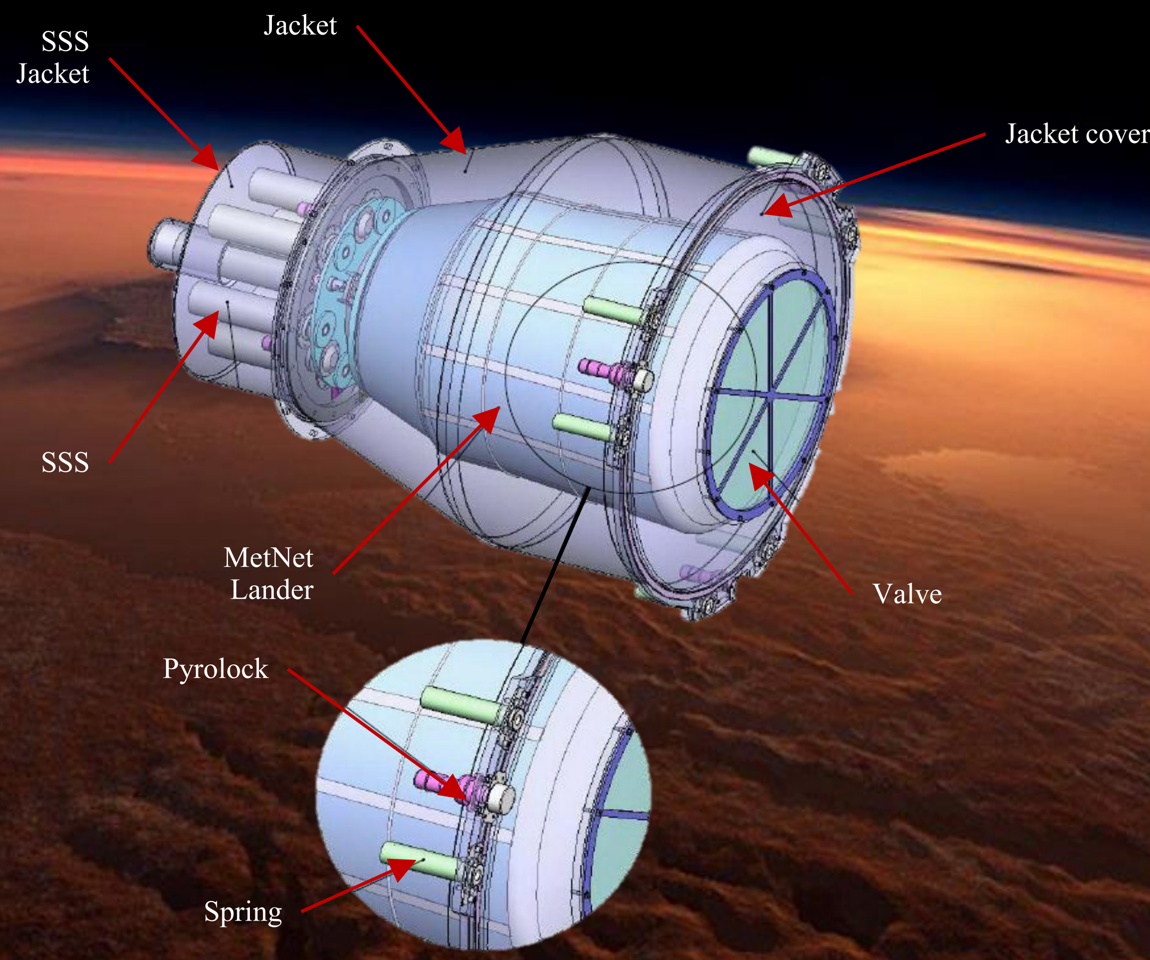
MetNet MMPM-1 Radio System and SC Connection



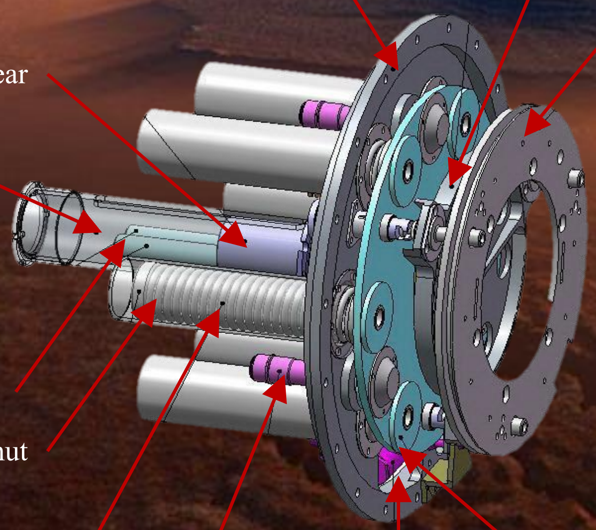
Mounting the MetNet Lander on S/C

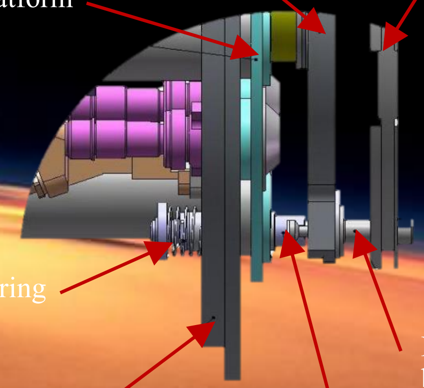


MetNet Lander capsule



Preliminary separation and spinning system



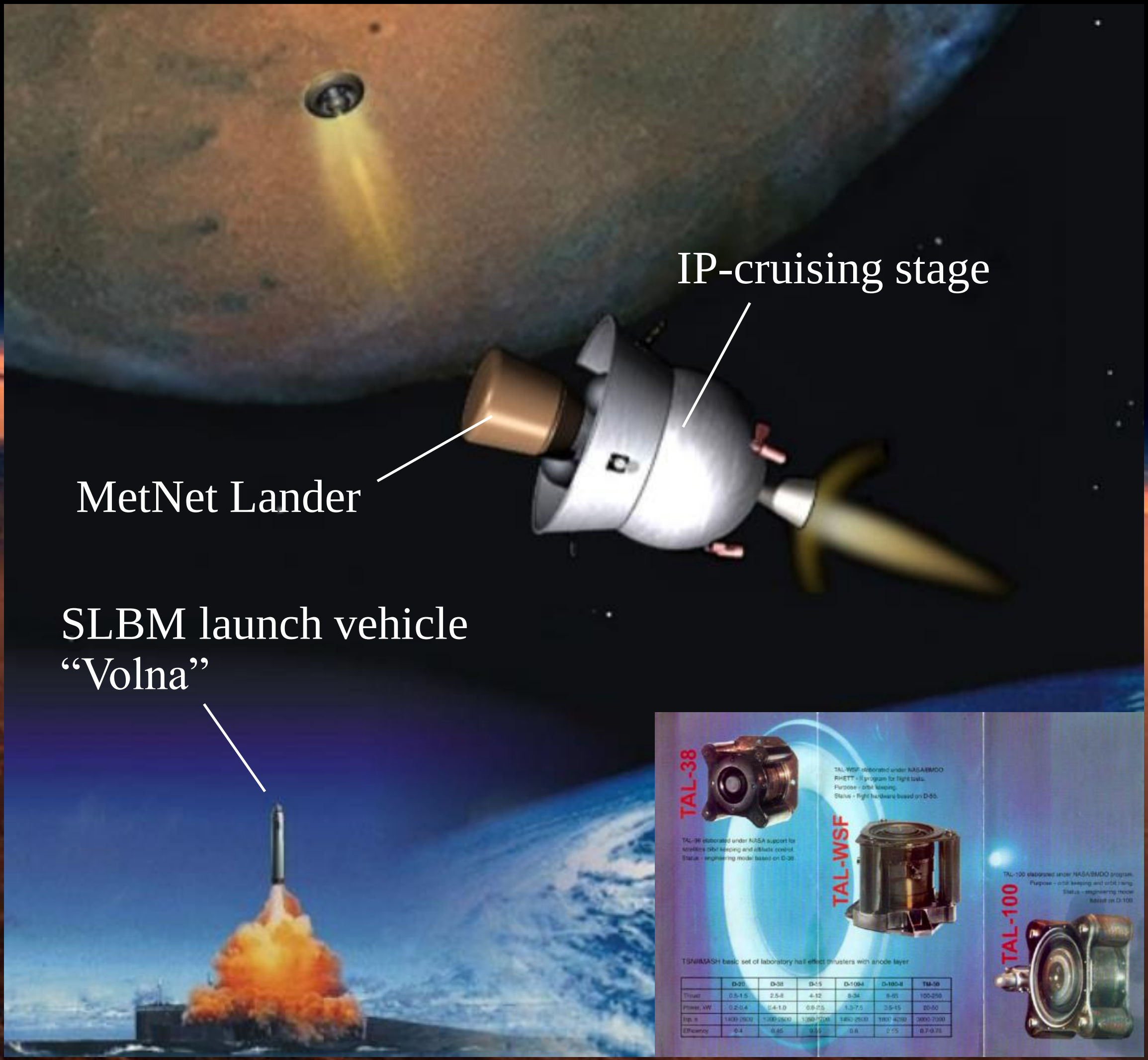


Separation System Parameters

Rate of rotation, deg/s	150
Separation force, N	5300-5900
Force duration, s	0.05
Rate of separation, m/s	7

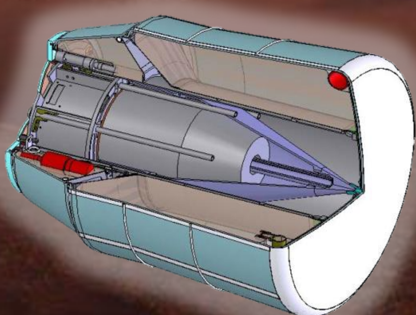
Option: Low-lift Mars MetNet Mission Precursor

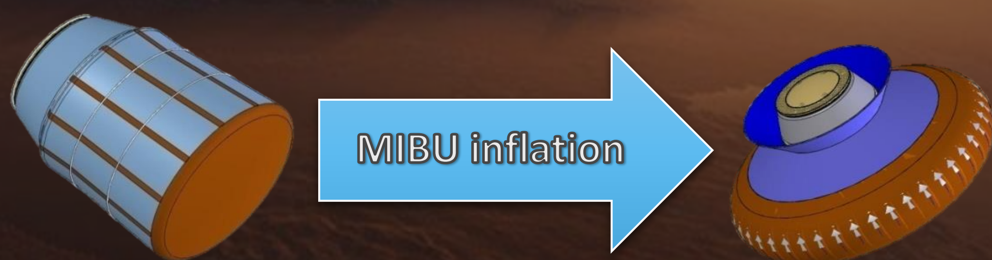
- A single MetNet Lander could be sent to Mars using SLBM LV
- Acceleration from LEO by electric propulsion engine (used for more than decade)
- Small interplanetary cruise stage (heritage from earlier missions)
- <u>Low cost</u>
- Requires communications satellite around Mars (MEX, NASAs orbiters, special comsat)



Mars MetNet Lander Network

- Network the next step in Mars research
- Could fly onboard any mission
- Could use even a missile launch
- Precursor mission (1-2 landers)





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METNET Payload Precursors

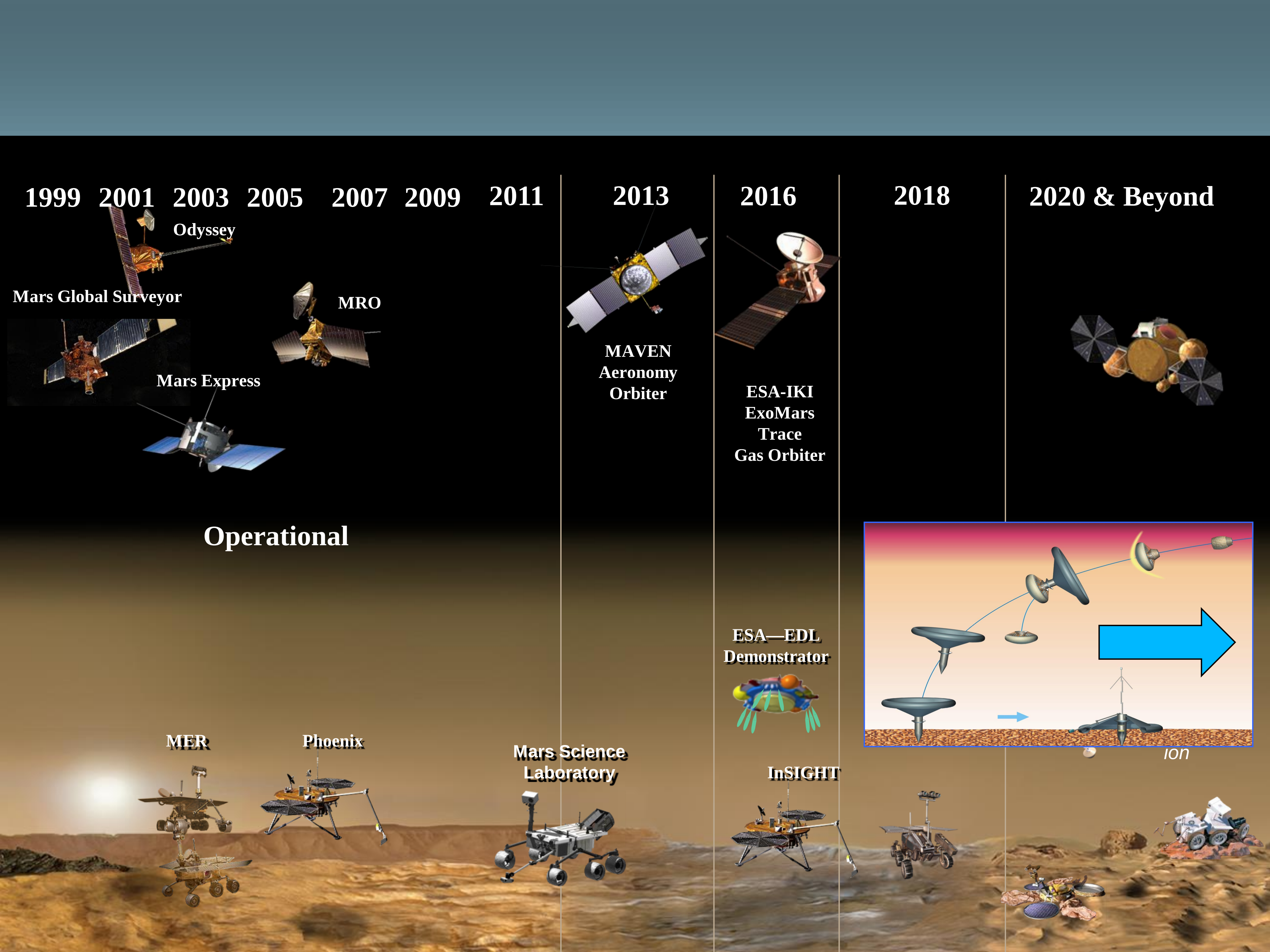
ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

- **REMS / Mars Science Laboratory (2012 →)**
- **DREAMS / ESA ExoMars-2016 (EDM & TGO)**
- **METEO / ESA ExoMars-2018/2020 (Rover)**
- **MEDA / NASA Mars-2020 (Rover)**

- **These science payloads are Precursors for MetNet science investigations**
- **First short-term ”network” with DREAMS to take place during the EDM mission (EDM/EXO-16 + REMS/MSL)**
- **MetNet investments are paying off in advance**

Concluding remarks

- **METNET Mission development continues – Payload Precursors paving the way**
- **MSL / REMS performs well and is providing an unprecedented data record – DREAMS on its way**
- **Diurnal cycle investigations require additional modelling efforts combined with observations**
- **Surface-atmosphere exchange processes currently under investigation**
- **METNET Mission elements have already taken the first steps at Mars**



1999 2001 2003 2005 2007 2009 2011
2013
2016
2018
2020 & Beyond
Odyssey
Mars Global Surveyor
MRO
Mars Express
MAVEN
Aeronomy
Orbiter
ESA-IKI
ExoMars
Trace
Gas Orbiter
Operational
ESA—EDL
Demonstrator
MER
Phoenix
Mars Science
Laboratory
InSIGHT
ion