

1st Symposium on Space Educational Activities
Padova, 09-11 December 2015



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MISSUS EXPERIMENT SENSORS DATA ANALYSIS

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Overview



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- **Introduction**
- **Background & objectives**
- **MISSUS Experiment**
- **Launch campaign**
- **Relevant results**
- **Conclusions**

MISSUS Team 2011/2012



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BS in Aerospace Engineering



Marco



**Dr. Giacomo
Colombatti**
MarsTem Lead Co-I



Francesca
PhD in Space
Measures, Sciences &
Technologies



Prof. Stefano Debei

MS in Aerospace Engineering



Veronica

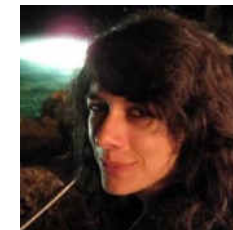


Emanuele

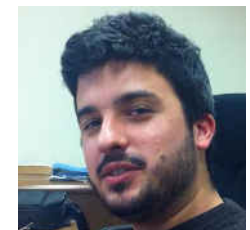
BS in Information Engineering



Davide & Davide



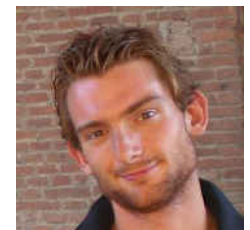
Chiara



Sebastiano



Giovanni



Ireneo

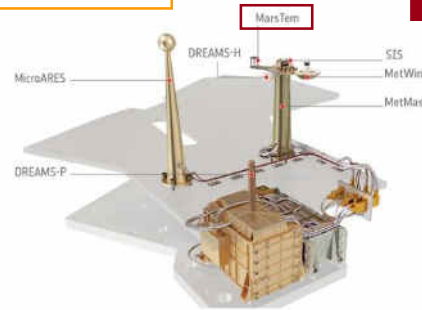
Background & motivations



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DREAMS



Copyright: ESA/ATG medialab



TECHNICAL GOALS

- Integrated multi-sensor scientific payload design and realization.
- Design, development, calibration and test of an innovative temperature sensor (**MarsTEM prototype**).
- Design and development of a system for the impact detection of the gondola with ground.

ExoMars 2016



EDM

- Landing technology demonstrator
- Atmosphere characterization

SCIENTIFIC GOALS

- Environment characterization up to **20-30 km**.
- Validation of **atmospheric models**.
- Comparison between Earth thin atmosphere and **Mars ground environment**.
- **Attitude and trajectory** reconstruction.



Meteorological Integrated Sensor **SU**ite for
Stratospheric analysis

Experiment overview



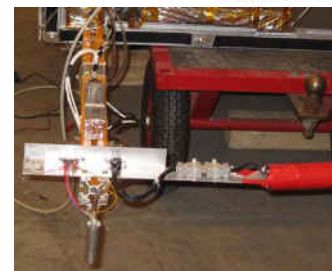
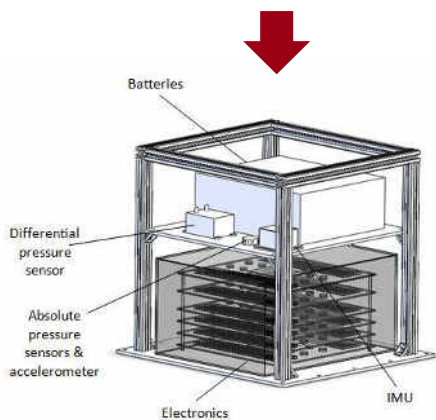
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EXPERIMENT CONFIGURATION

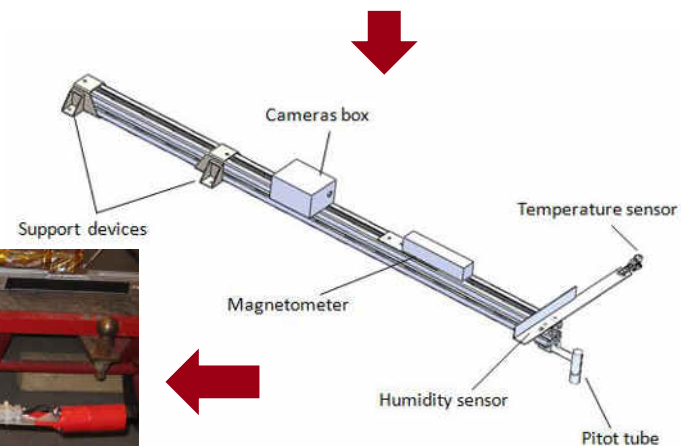
Inside the gondola

- IMU
- Triaxial accelerometer
- Absolute pressure sensor
- Differential pressure sensor
- Electronics
- Batteries
- Housekeeping sensors



Outside the gondola

- MarsTem prototype
- Magnetometer
- Pitot tube
- 2 webcams



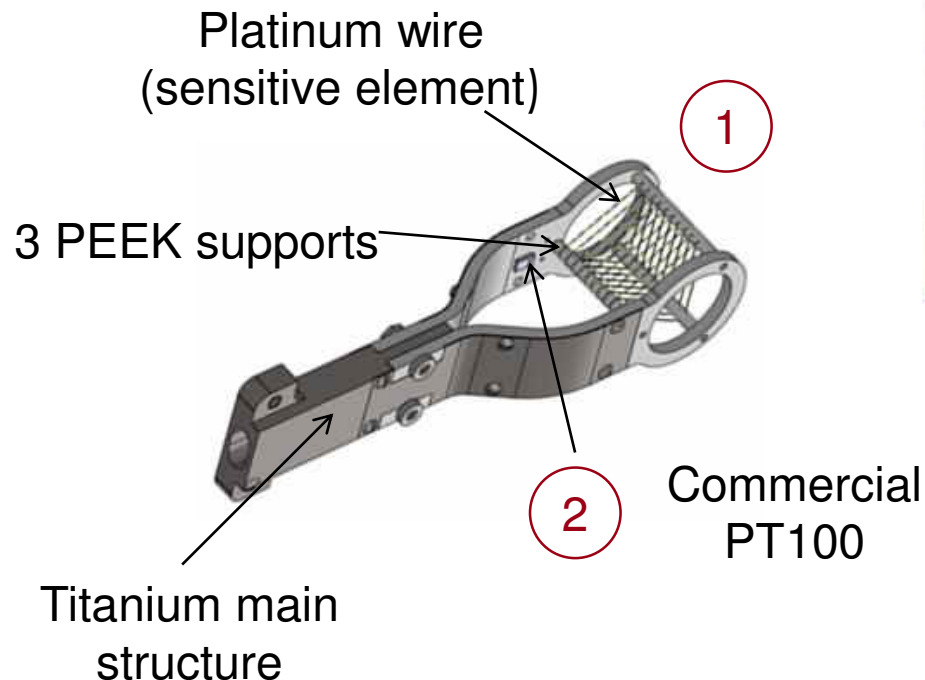
Temperature sensor MarsTEM prorotype



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1. Innovative temperature sensor (RTD – Resistance thermometer)
2. Reference PT100



Launch campaign



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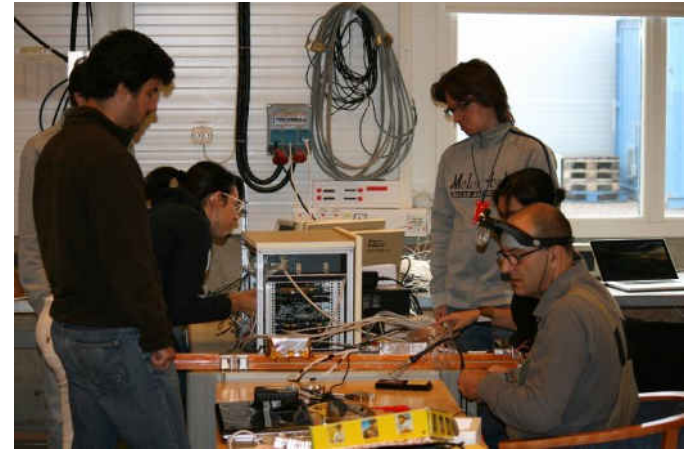


Esrange Space Center in Kiruna, Sweden:

- Final assembly
- Functional tests
- Sensors calibration
- Integration on the gondola
- RF Interference tests
- **FRR**



READY FOR FLIGHT!



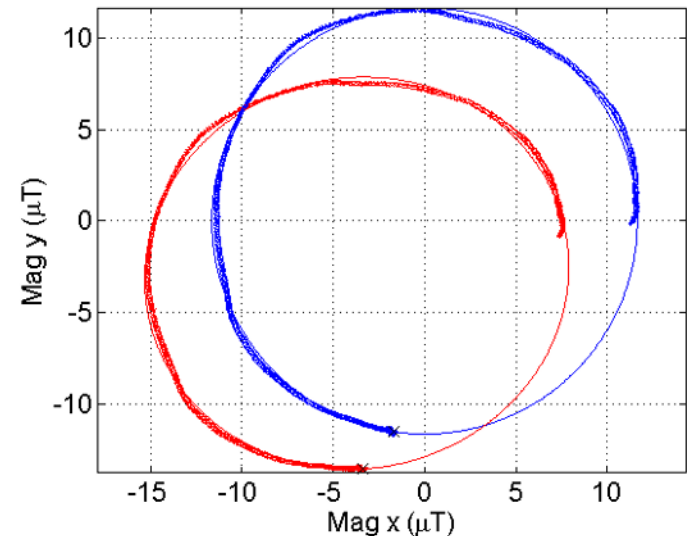
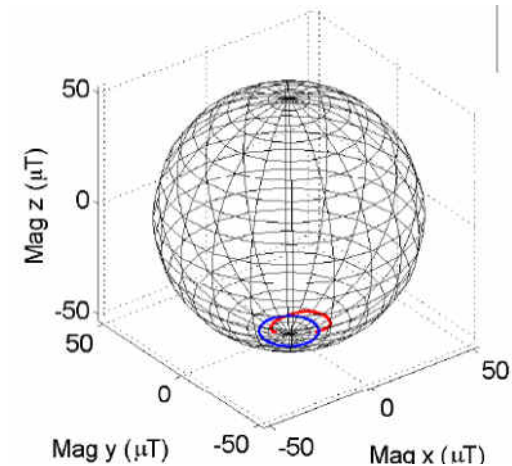
Launch campaign



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- Soft and Hard Iron calibration - Required for attitude reconstruction
- Disturbances:
 - Hard iron: generated by magnetic field sources not related to Earth's magnetic field
 - Soft iron: caused by ferromagnetic materials, they produce a distortion of existing field lines existing



Rotation of the gondola needed for magnetometer calibration

Detected & calibrated magnetic field data

BEXUS 15 flight



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Lift off: 12:30 LT
25/09/2013

MISSUS works &
transmits data

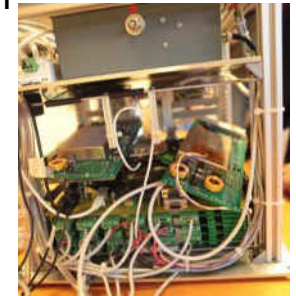


Ascent phase: 1h 40'
Max altitude: ~25500
m

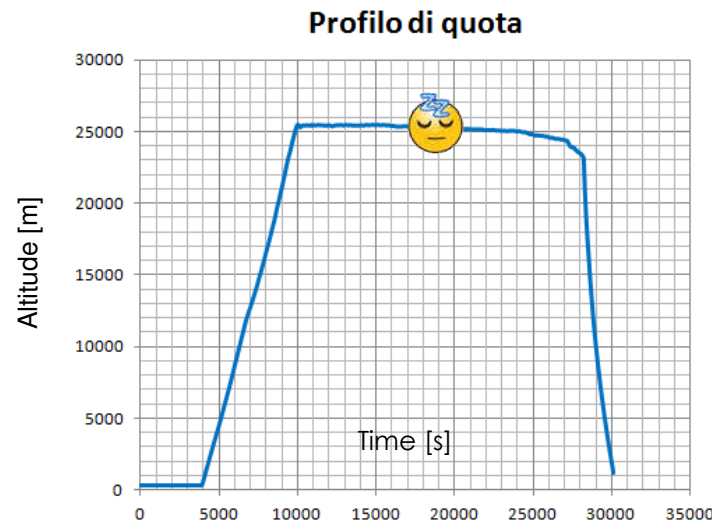
Cruise phase: 5h 20'
(Very long flight
respect to mean BX
flights)

Cut down: 18:30 LT

Hard landing: 19:00
LT



Luckily **Tem** perfectly
undivided
and reusable

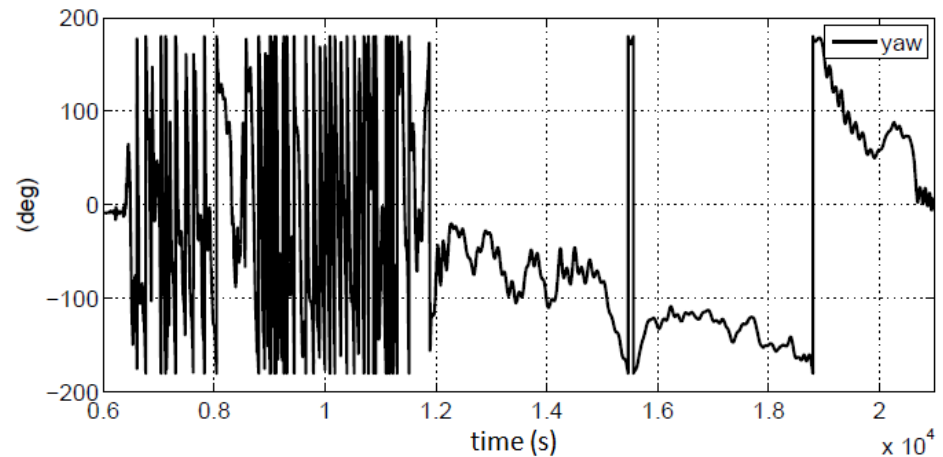
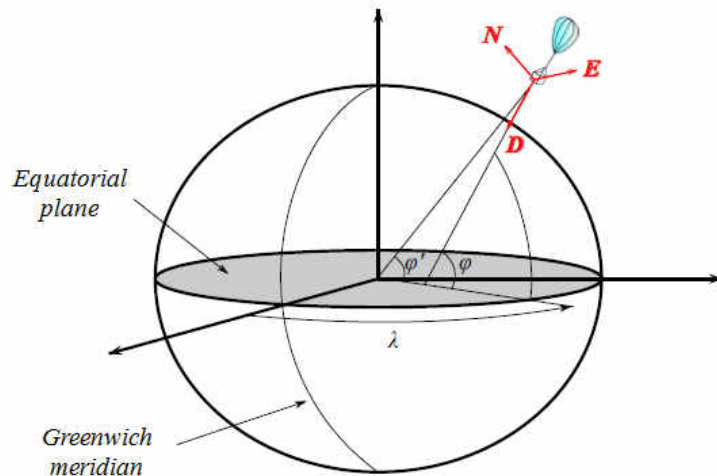
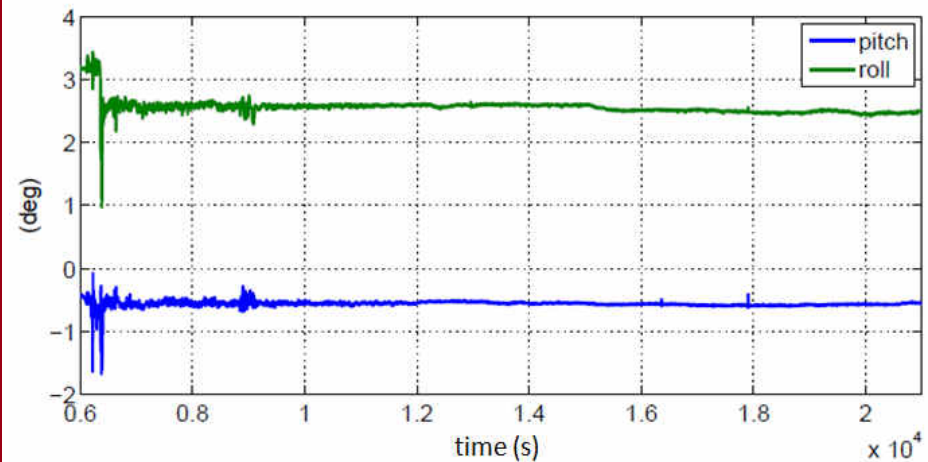


+04:06:00
Lost contact
PC onboard has shut
down

Attitude reconstruction



- Deeper understanding of the observed phenomena
- TRIAD algorithm for attitude reconstruction:
 - Gravity vector
 - Magnetic vector from WMM2010
- Euler angles in NED reference frame



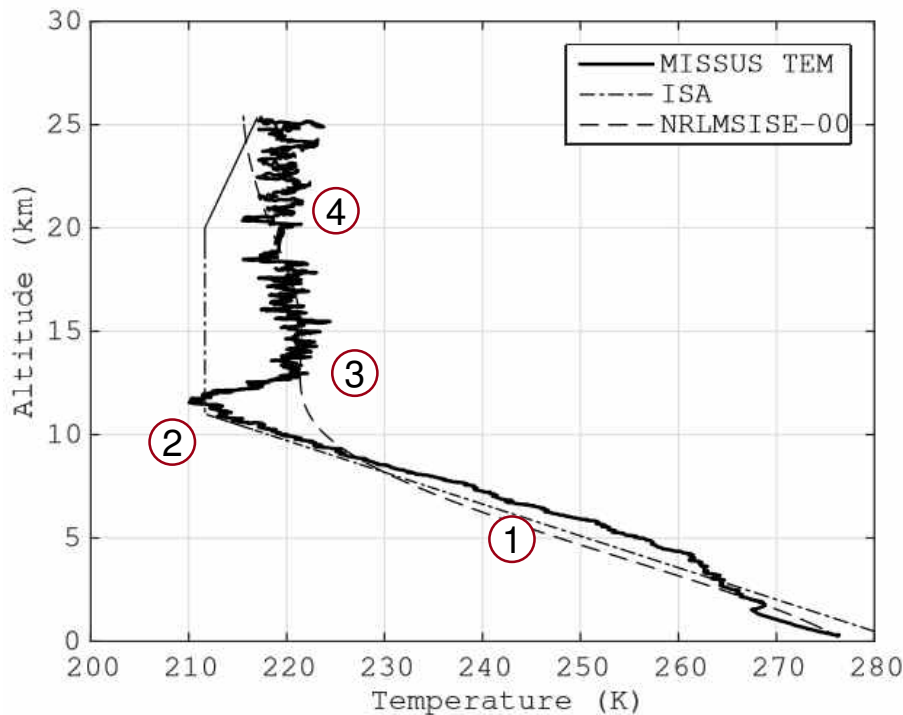
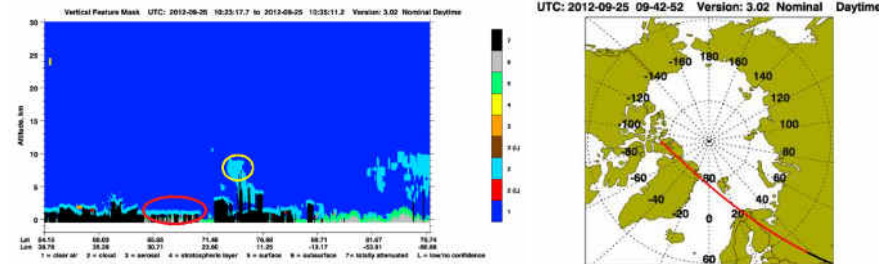
Temperature sensor data analysis (ascent phase)



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- Atmosphere thermo-structure compared with:
 - **ISA model**
 - **NRLMSISE-00 model**
- Unexpected local variation related to presence of **cirrus clouds**



- Comparison with CALIPSO clouds profile

1. Mean trend compatible with models
2. Temperature drop: 10°C @10-13 km
3. Tropopause over 12 km: positive lapse rate not expected
4. Stratosphere layer compatible with NRLMSISE-00

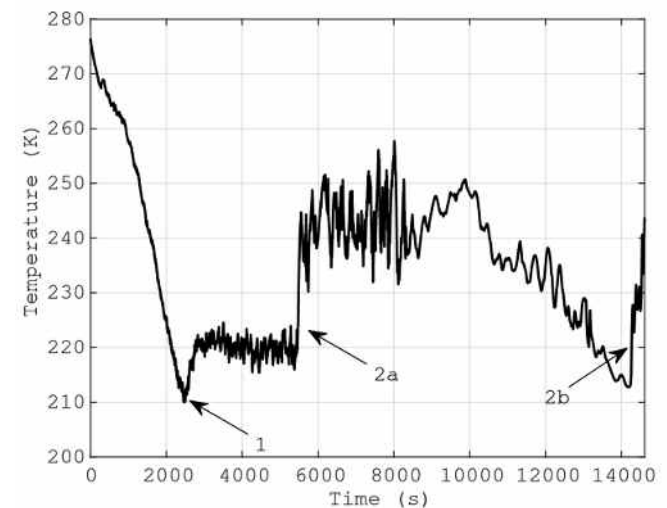
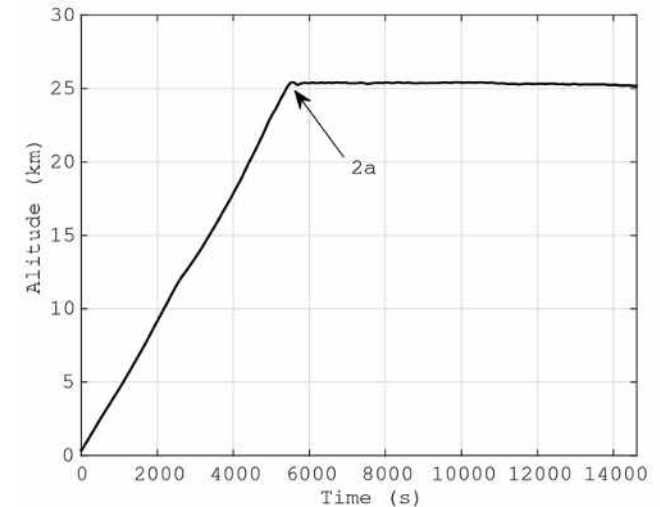
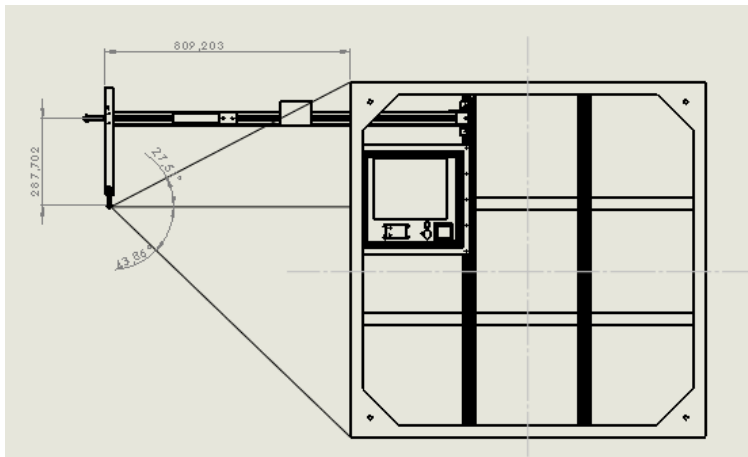
Temperature sensor data analysis (floating phase)



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- An increase in temperature of **20 °C** has been detected at the beginning of the **floating phase**.
- A second relevant **temperature increase** has been detected at 14200 s.
- **Solar radiation influence** on temperature measurements has been evaluated.
- Evaluation of **shadow zone** vs RTD sensor position ($N_{geo}=0^\circ$):
 - Sun Azimuth (207° - 242°)



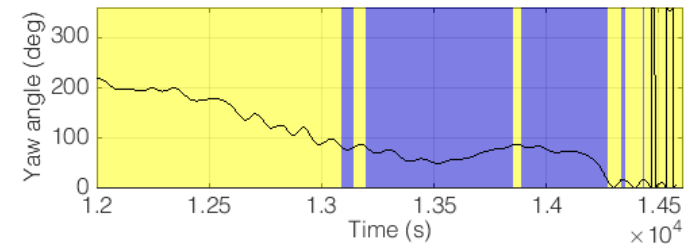
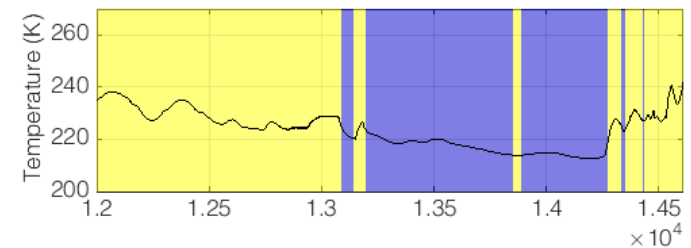
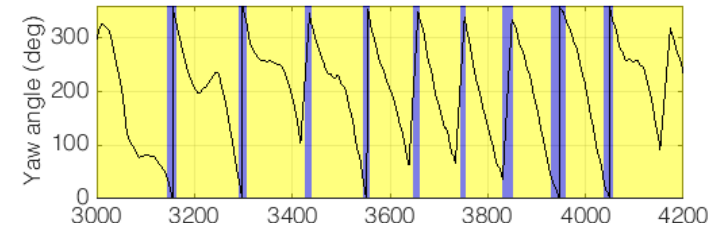
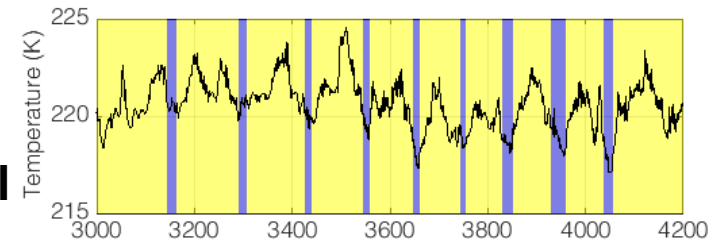
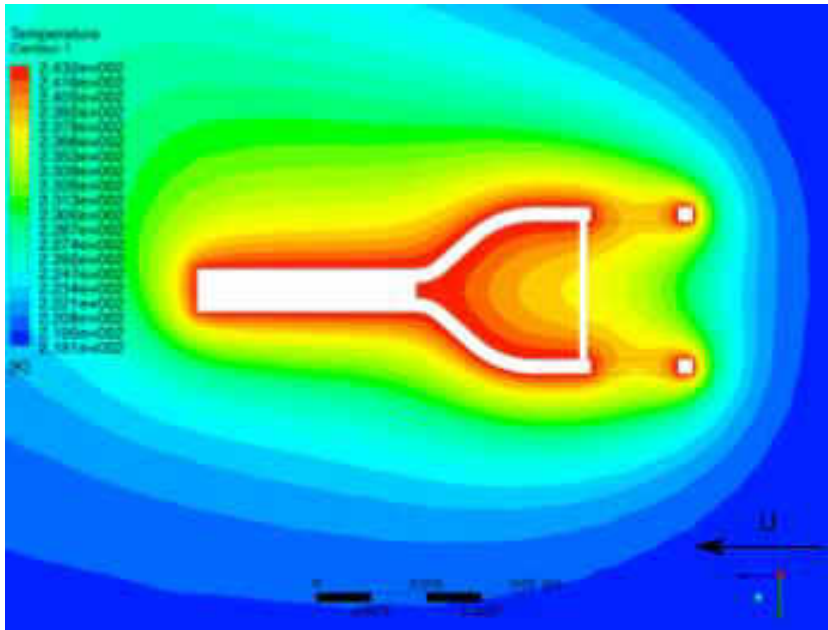
Temperature sensor data analysis (floating phase)



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- Clear correlation between **sensor heating** and **solar radiation**.
- Sensor structure, influences RTD sensor **thermal boundary layer** measurements (CFD simulations).



Conclusions



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- An **integrated sensor suite** has been designed and realized for **stratospheric balloon flights**.
- **Cross-correlation** of different kind of data in order to obtain a deeper understanding of the observed phenomena.
- Test of the **MarsTEM prototype** on Mars-like environment.
- **Improvement** of MarsTEM flight model in order to reduce the sensor structure thermal boundary layer.



Conclusions



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Thanks for your attention! Questions? ☺