POLARIS EXPERIMENT: DATA COLLECTED DURING THE STRATOSPHERIC FLIGHT ON THE BALLOON BEXUS18

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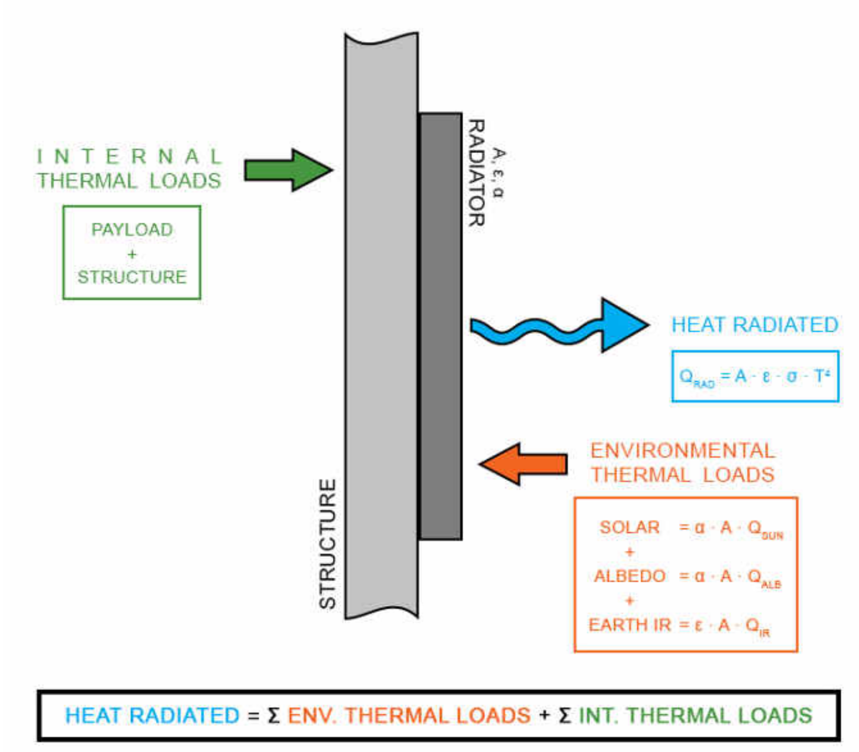
F. Branz, L.Olivieri, F. Sansone, A, Francesconi

PRESENTATION OVERVIEW

RADIATOR CONCEPT

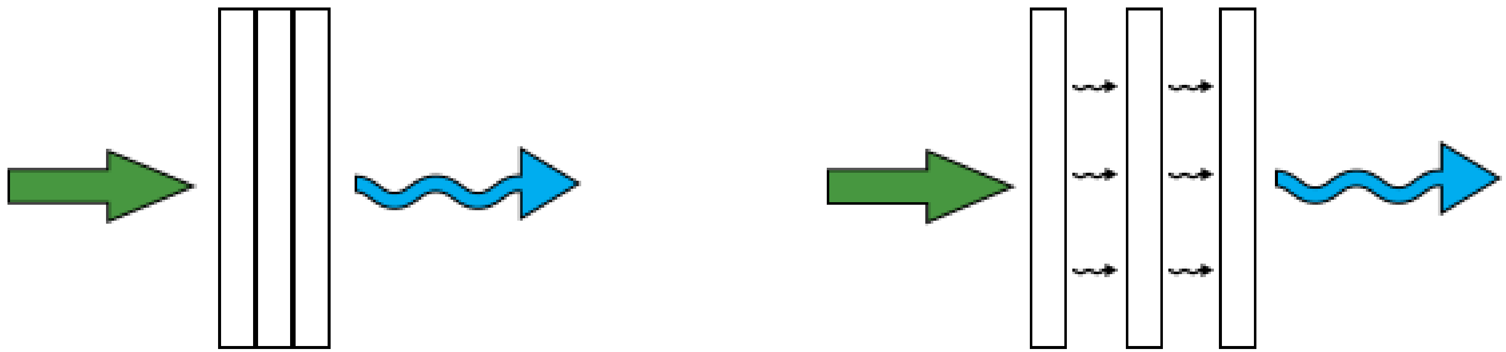
Heat radiators are designed to manage the heat of P/L Internal Generation



Variable P/L activity and Environment heat fluxes require FLEXIBILITY & CONTROL on RADIATORS PERFORMANCE

RADIATOR CONCEPT

The radiator is composed by three metallic plates linked together so that an actuation system can put them in good thermal contact or separate them



TWO GEOMETRY CONFIGURATIONS

RADIATOR CONCEPT

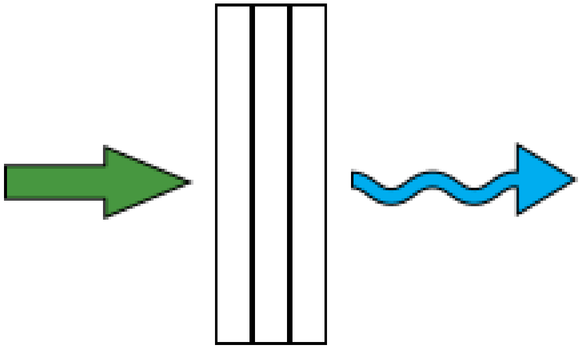
The radiator is composed by three metallic plates linked together so that an actuation system can put them in good thermal contact or separate them

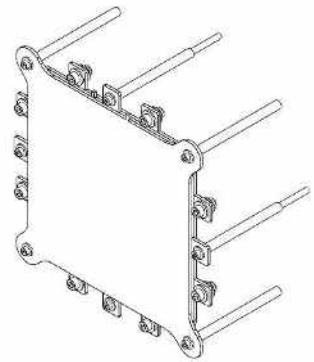
TIGHENED CONFIGURATION

CONDUCTIVE LINK
BETWEEN THE PLATES

LOWER EQUIVALENT
THERMAL RESISTANCE

MAXIMUM HEAT EXCHANGE





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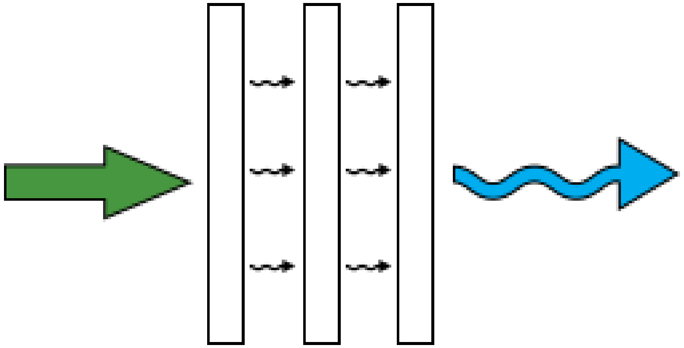
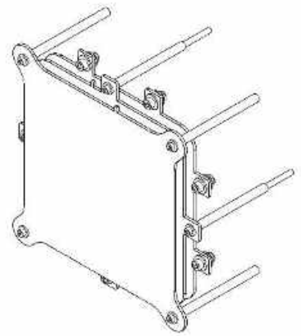




OPEN CONFIGURATION

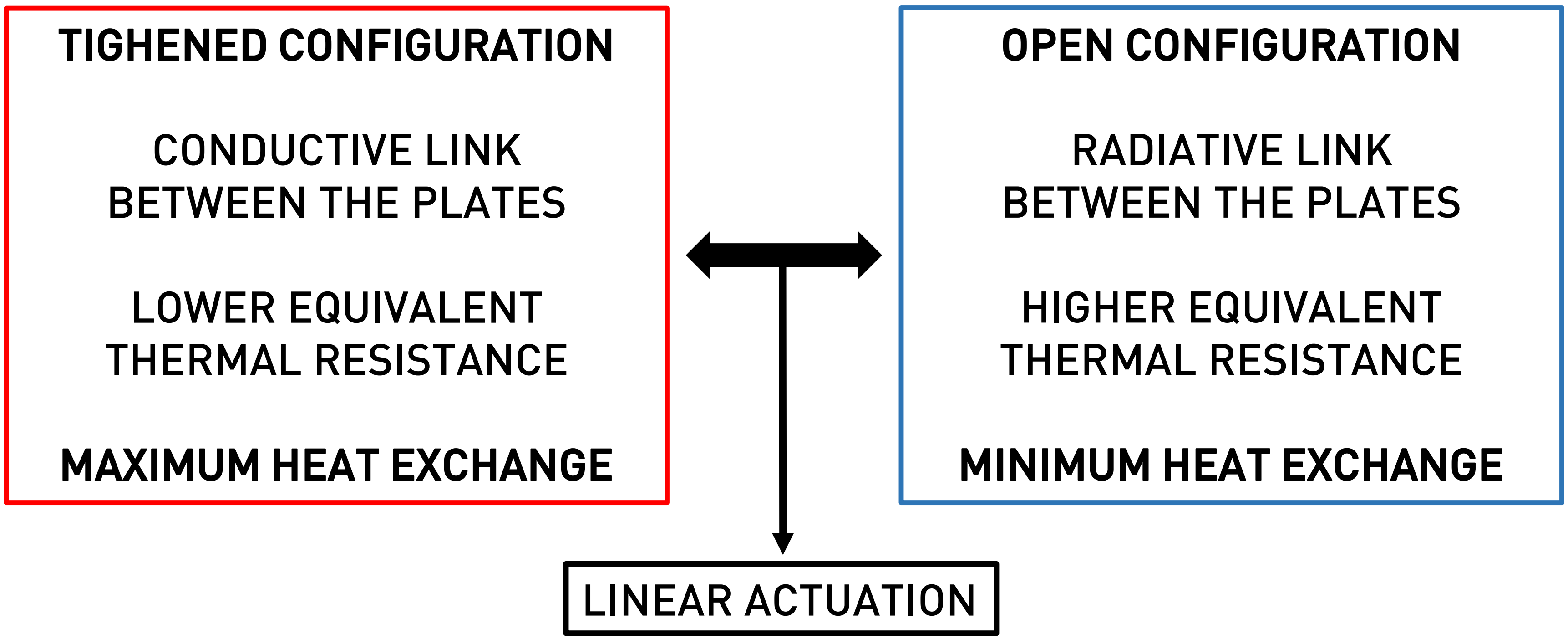
RADIATIVE LINK
BETWEEN THE PLATES

HIGHER EQUIVALENT
THERMAL RESISTANCE

MINIMUM HEAT EXCHANGE

RADIATOR CONCEPT

The radiator is composed by three metallic plates linked together so that an actuation system can put them in good thermal contact or separate them



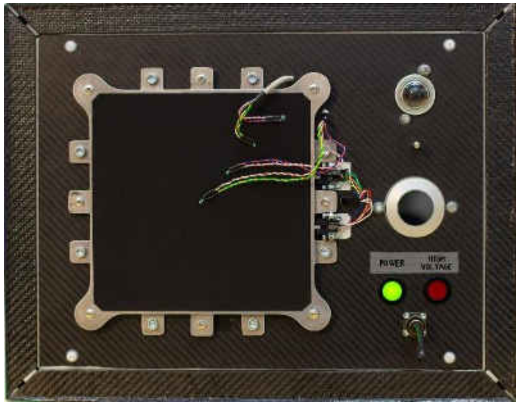
PRESENTATION OVERVIEW

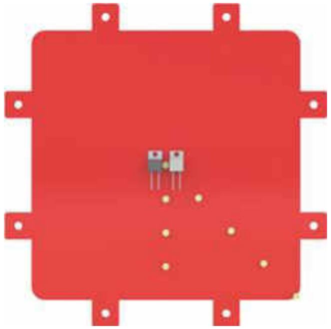
1. RADIATOR CONCEPT
2. POLARIS EXPERIMENT
3. SETUP EVOLUTION DURING RX/BX PROGRAMME
4. FLIGHT DATA
5. LESSONS LEARNED & CONCLUSIONS

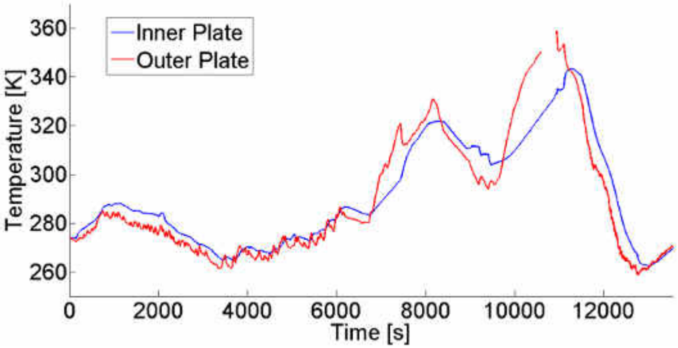
POLARIS EXPERIMENT

POLymer Actuated Radiator with Independent Surfaces

1. Test a new concept of heat radiator in variable environmental conditions
2. Control the radiator to guarantee the thermal steadiness of a dummy payload
3. Compare the numerical thermal model with the measured data

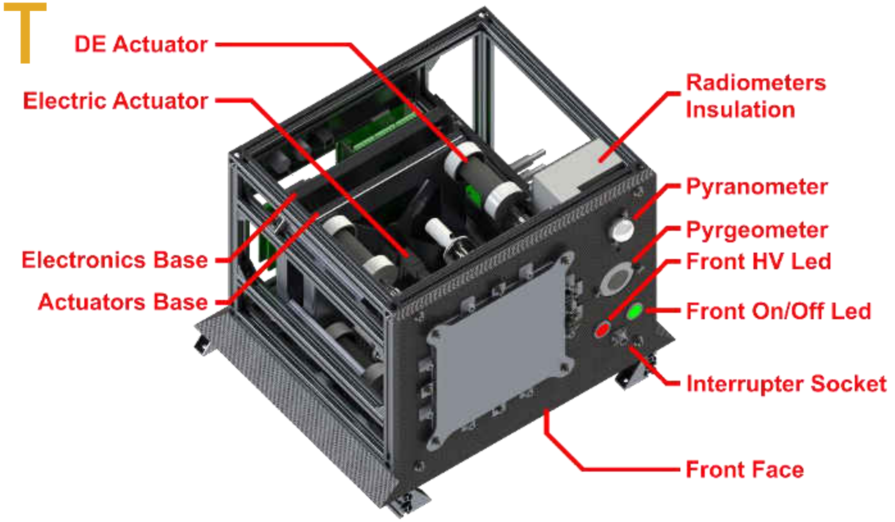


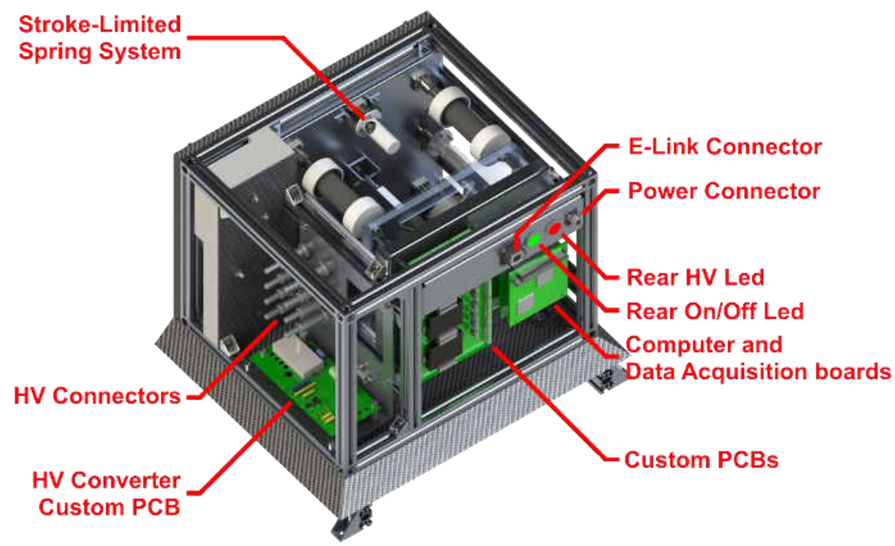




POLARIS EXPERIMENT

- POLARIS Setup flew into stratosphere on October 2014
- Aluminium Radiator Prototype
- Two Independent Actuation Systems for the radiator movement
- Set of sensors for full radiator performance evaluation





POLARIS EXPERIMENT

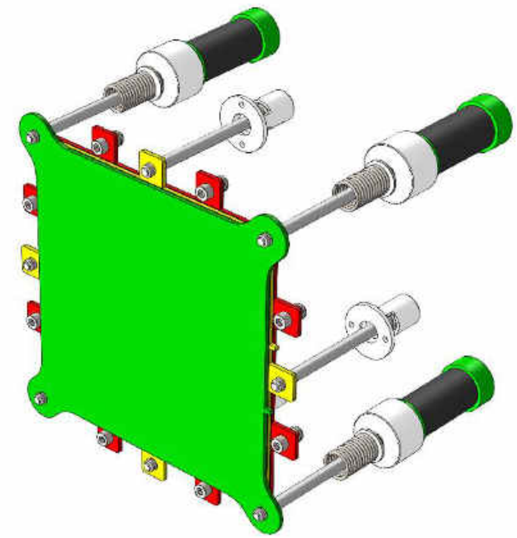
LINEAR ACTUATION

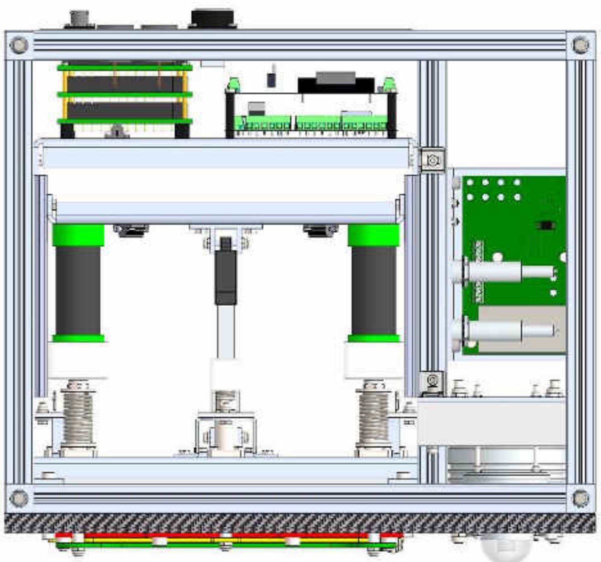
DIELECTRIC ELASTOMER ACTUATORS

ELECTRIC LINEAR ACTUATOR

Reliable and Accurate

Completely manufactured in the University facilities





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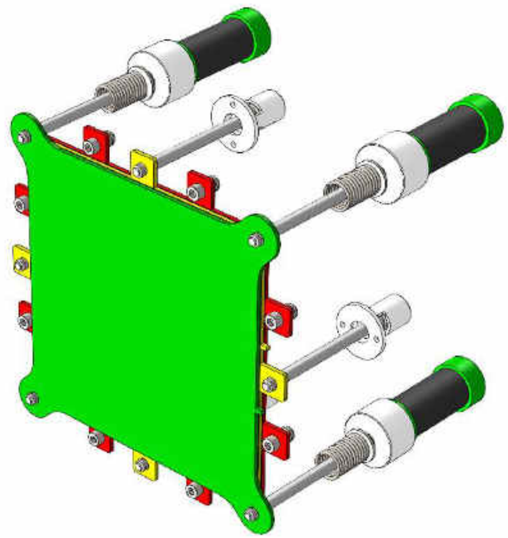
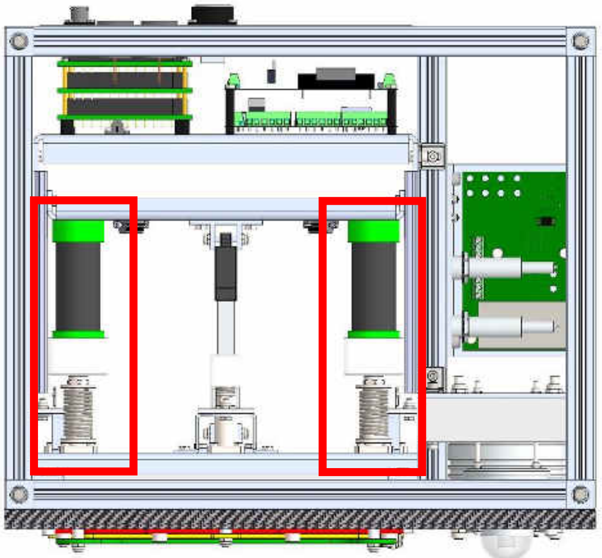
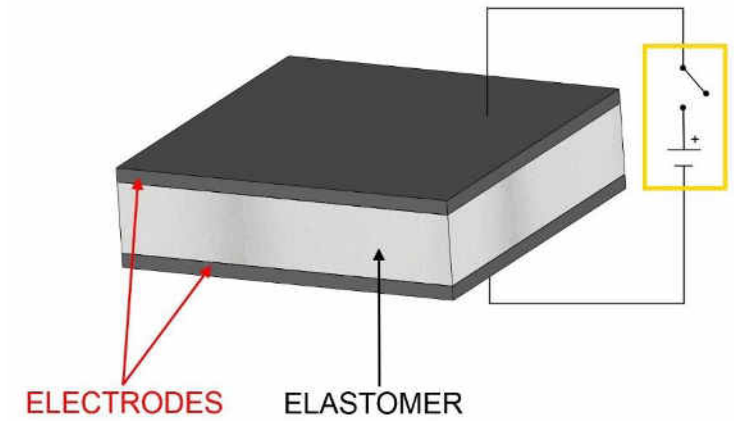




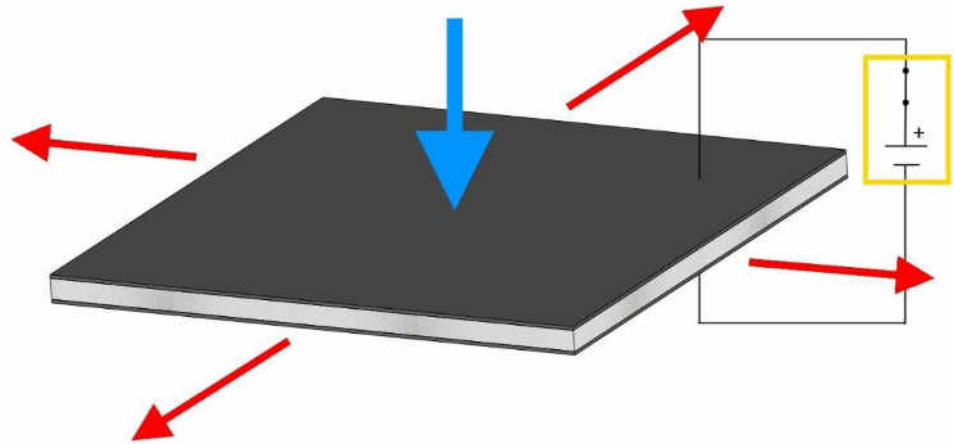
POLARIS EXPERIMENT

Basically they are **COMPLIANT CAPACITORS**

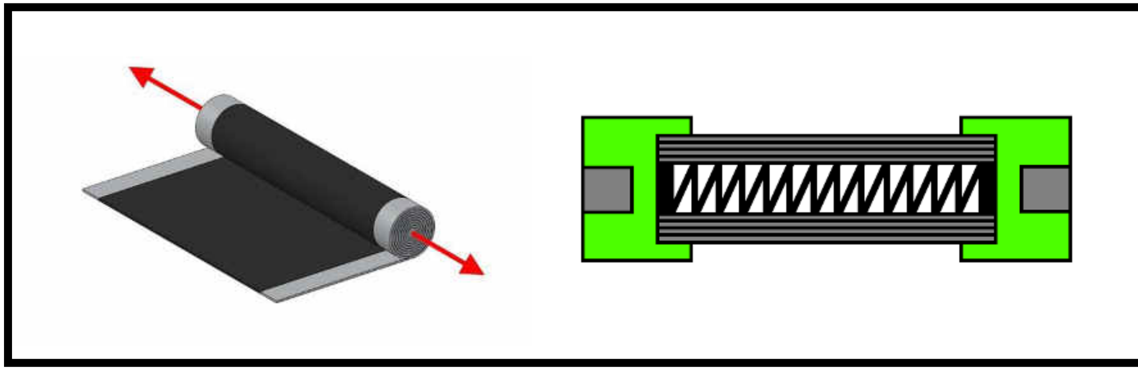
High Voltage OFF



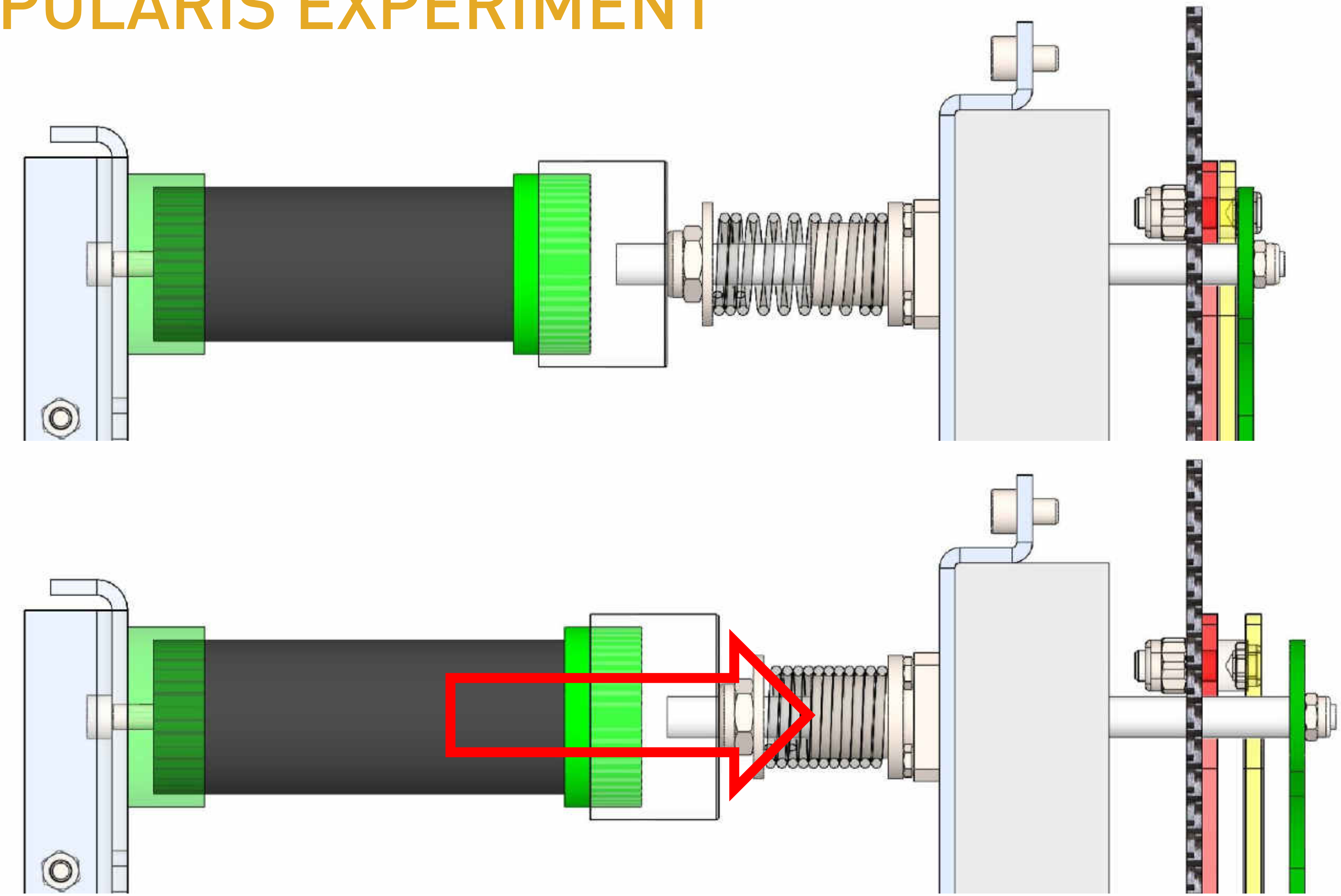
High Voltage ON



Wrapping it around a compressed coil spring is possible to obtain a **LINEAR ACTUATOR**



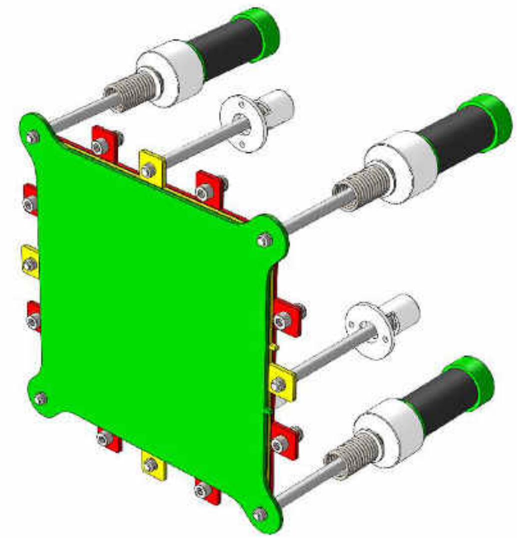
POLARIS EXPERIMENT

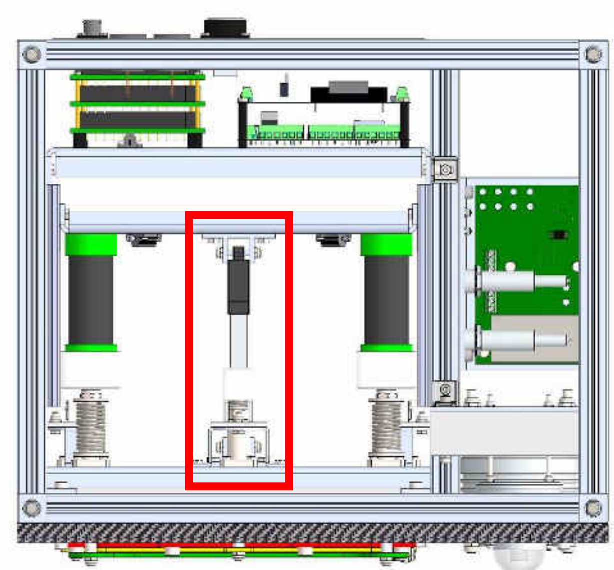


POLARIS EXPERIMENT

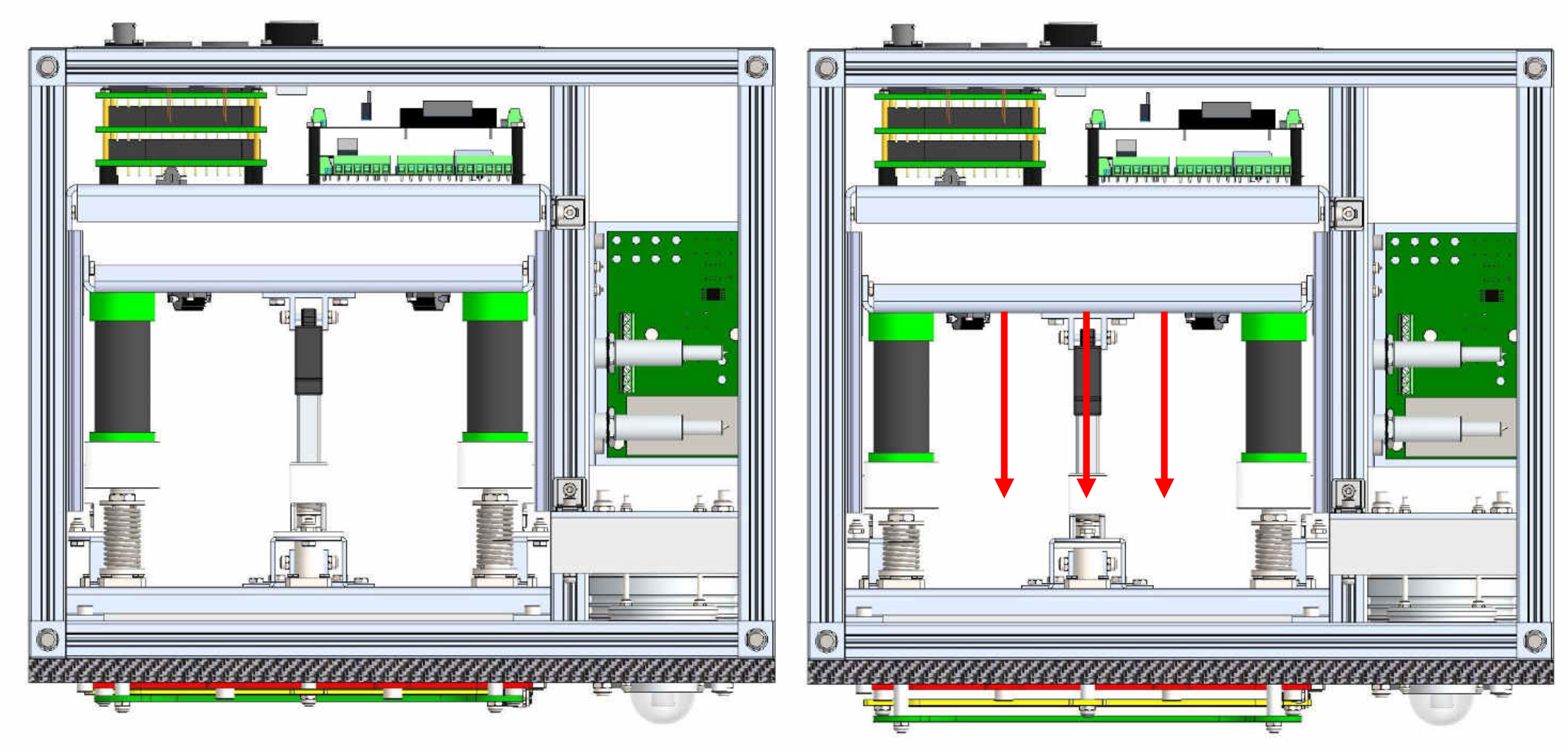
LINEAR ACTUATION

- DIELECTRIC ELASTOMER ACTUATORS → Completely manufactured in the University facilities
- ELECTRIC LINEAR ACTUATOR → Reliable and Accurate





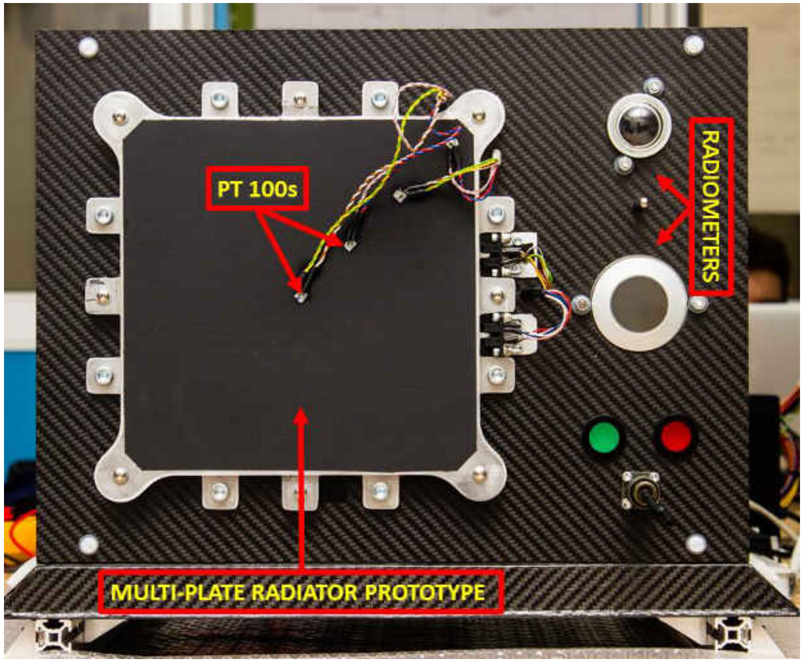
POLARIS EXPERIMENT



POLARIS EXPERIMENT

A complete set of sensors was included in the setup, monitoring both radiator temperatures and environment boundary conditions

SPOT	MEASURE
Dummy Payload	Temperature Voltage Amperage
Inner Radiator Plate	Temperature and its spatial distribution
Outer Radiator Plate	Temperature and its spatial distribution
Plates Supports	Plates position
Environment Boundary Condition	Pressure Incoming Visible Radiation Incoming IR Radiation Temperature



PRESENTATION OVERVIEW

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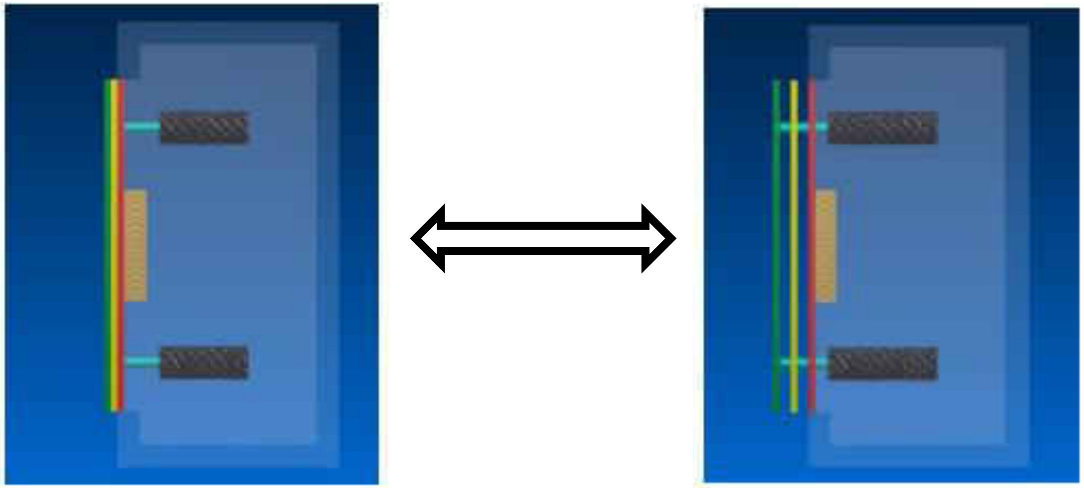
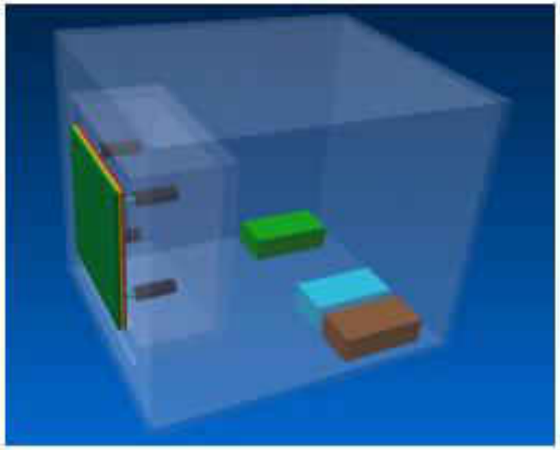
DURING RX/BX (PROPOSAL)

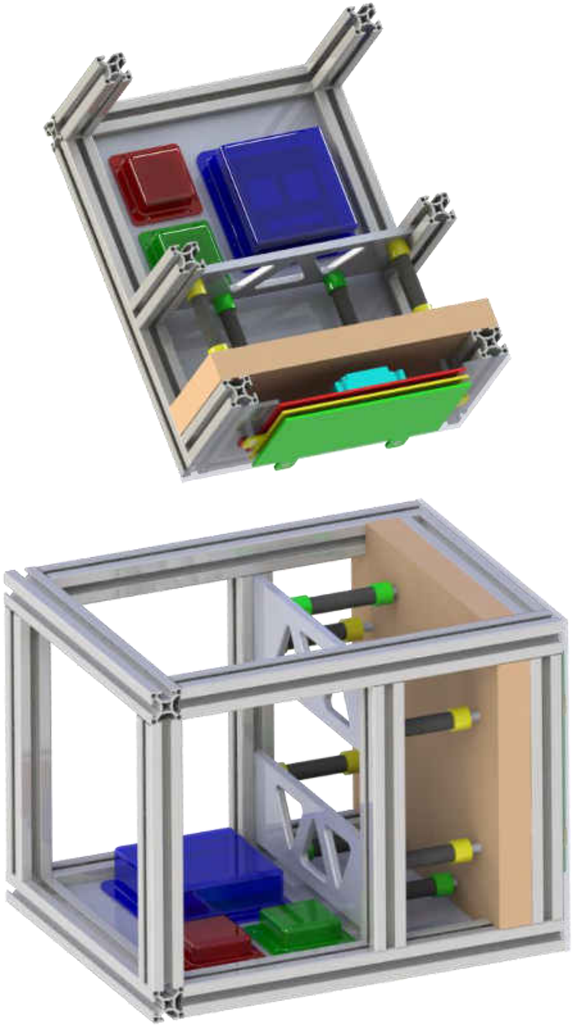




- ✓ Mission Concept
- ✓ Mission Objectives

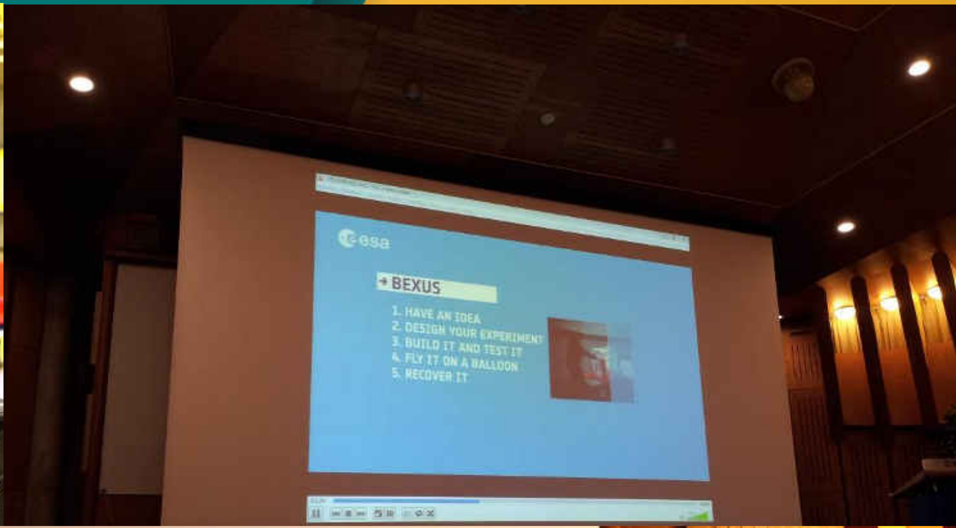
Experiment MASS: 4 Kg
Experiment DIMENSIONS: 30 X 30 X 30 cm

DURING RX/BX (SW)



- ✓ Preliminary WBS
- ✓ 8 DE Actuators configuration
- ✓ Experiment divided in 3 main sections

Experiment MASS: 5 Kg
Experiment DIMENSIONS: 40 X 30 X 30 cm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BEXUS
1. HAVE AN IDEA
2. DESIGN YOUR EXPERIMENT
3. BUILD IT AND TEST IT
4. FLY IT ON A BALLOON
5. RECOVER IT


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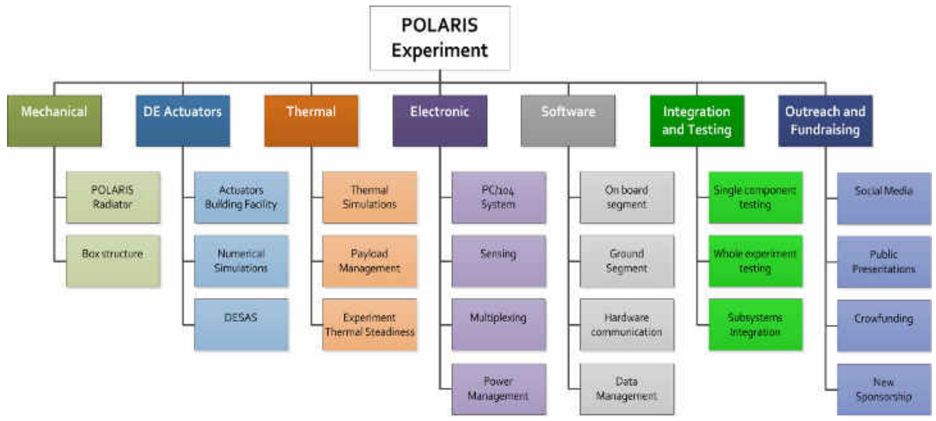
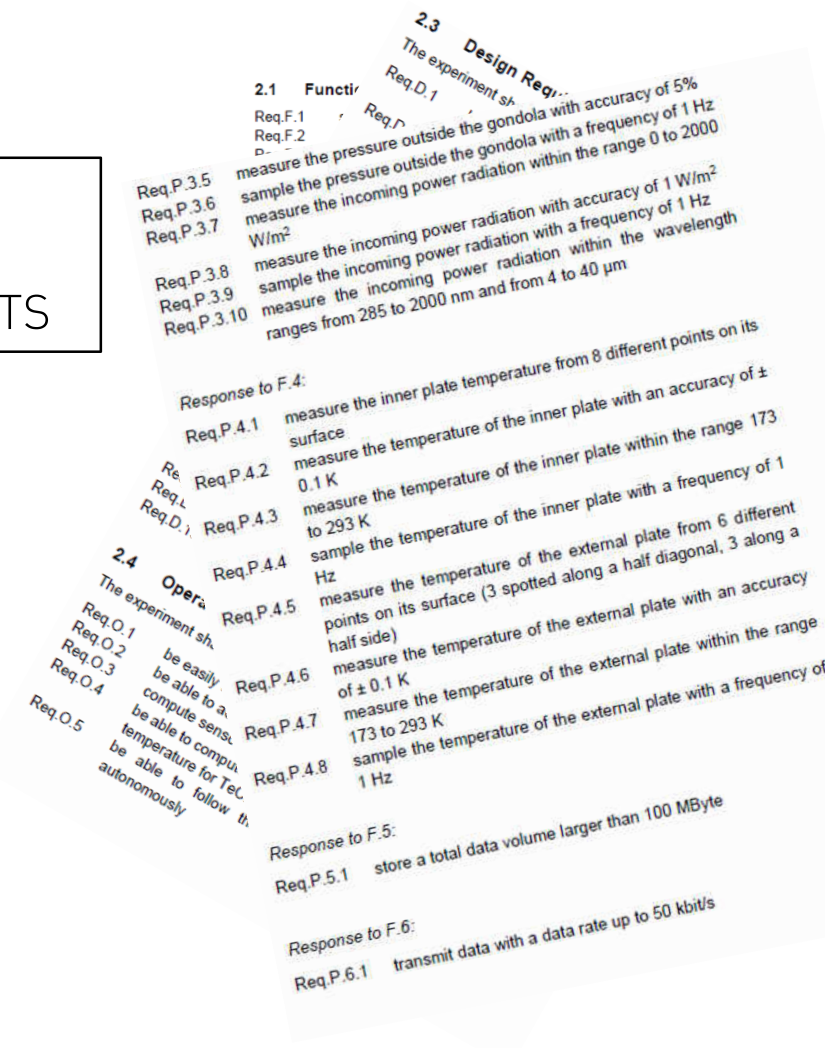
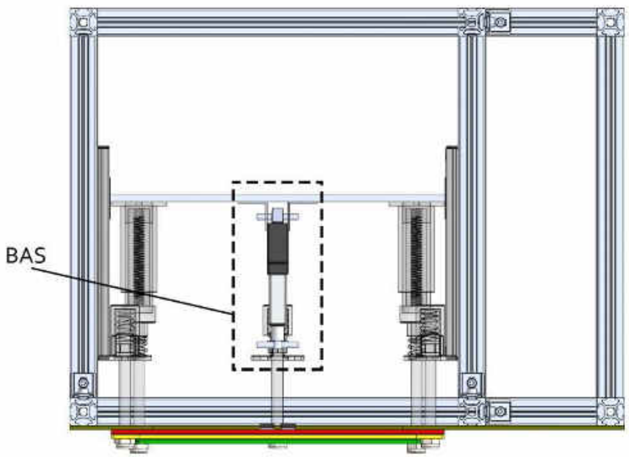
DURING RX/BX (PDR)

- ✓ First version of the S.E.D.
- ✓ Definition of the WBS
- ✓ Definition of the Experiment REQUIREMENTS



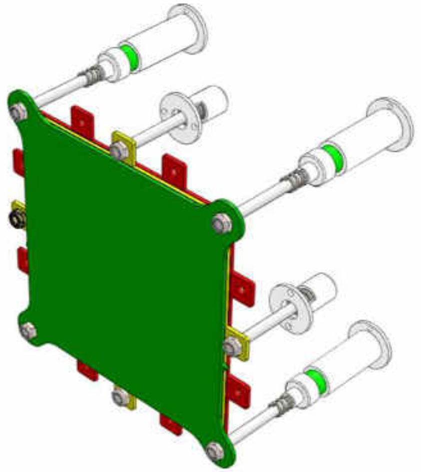


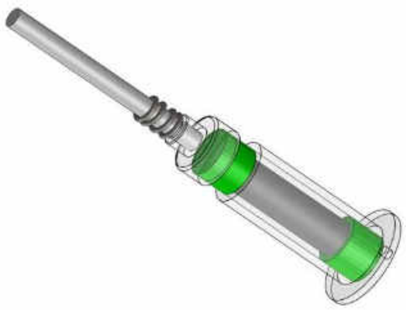
DURING RX/BX (PDR)

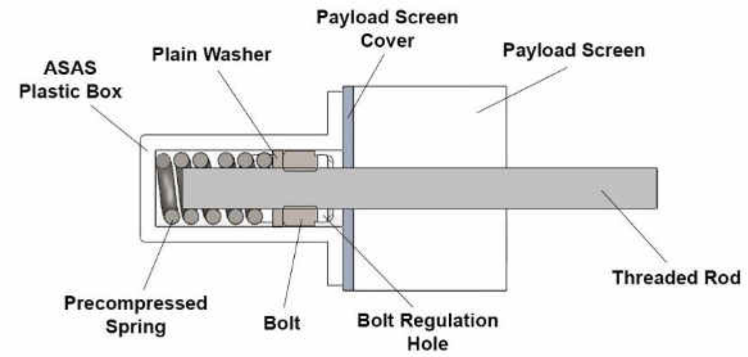


- ✓ Design of the Radiator Assembly
- ✓ Preliminary Design of the Actuation System
- ✓ Preliminary Design of the Backup A.S.

Experiment MASS: 12 Kg
Experiment DIMENSIONS: 46 X 34 X 36 cm





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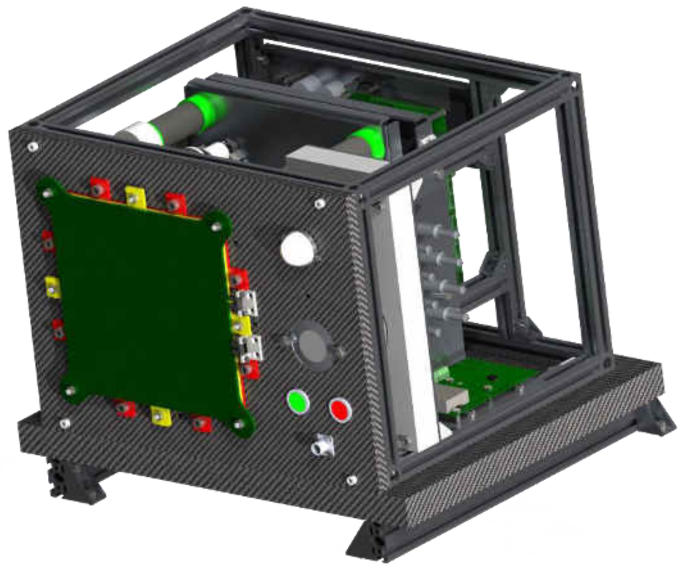
DURING RX/BX (CDR)



POLARIS Experiment DESIGN completed

Experiment MASS: 15 Kg
Experiment DIMENSIONS: 46 X 38 X 40 cm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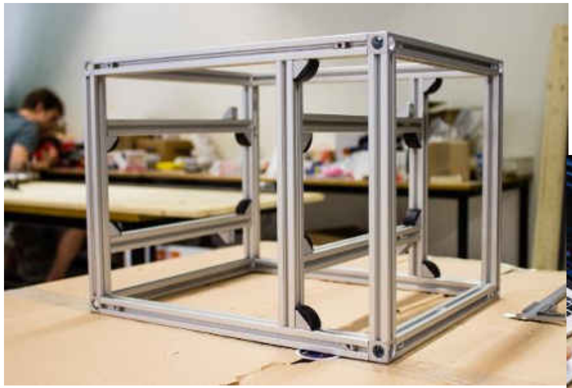
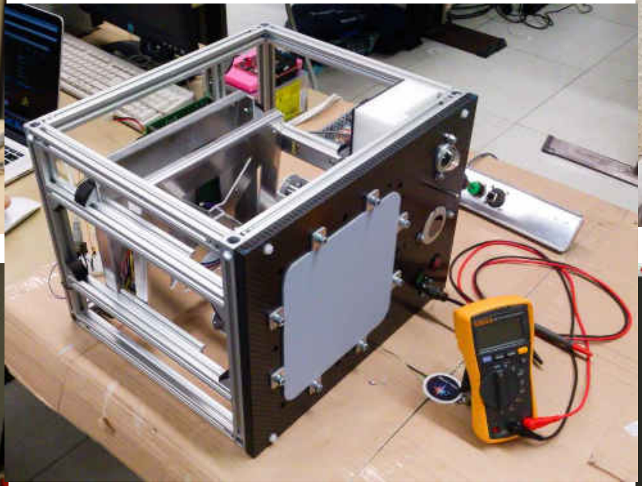
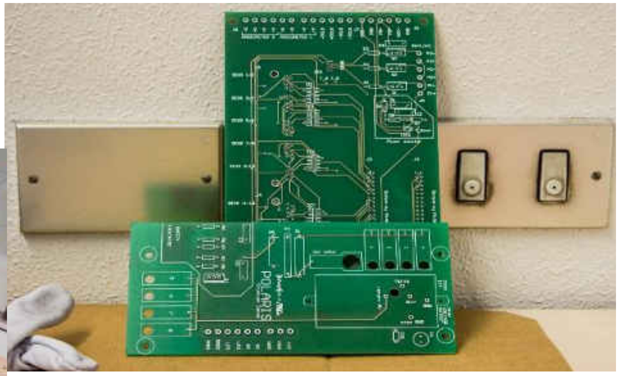
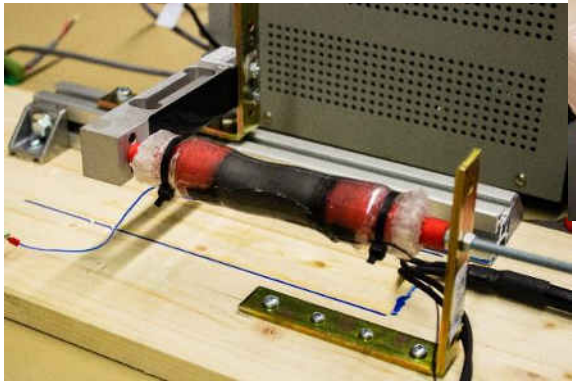
OUTDOORS

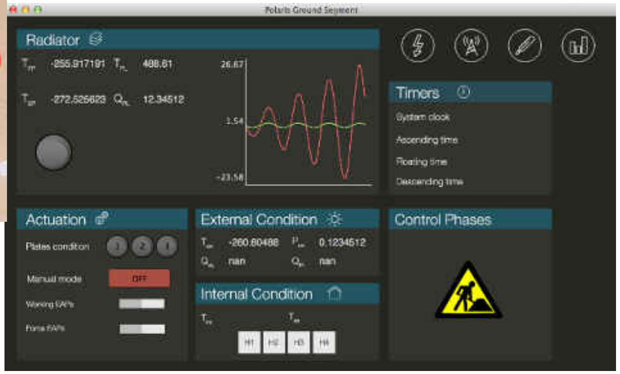
DURING RX/BX (IPR)





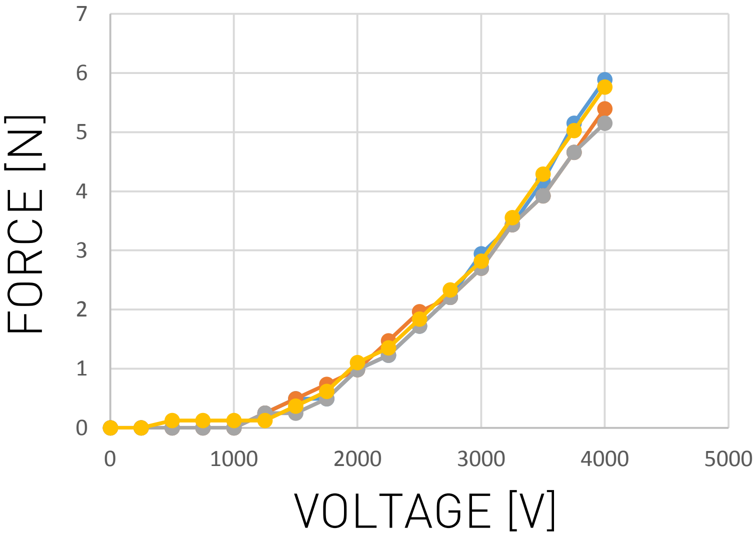




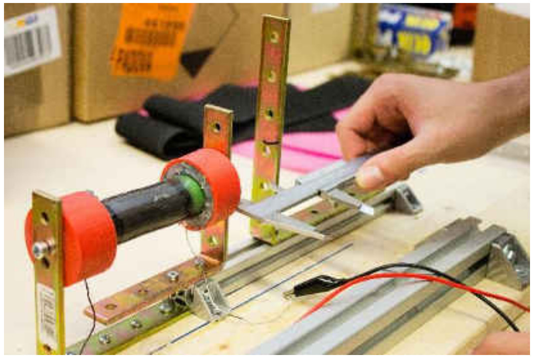


DURING RX/BX (IPR)

FORCE

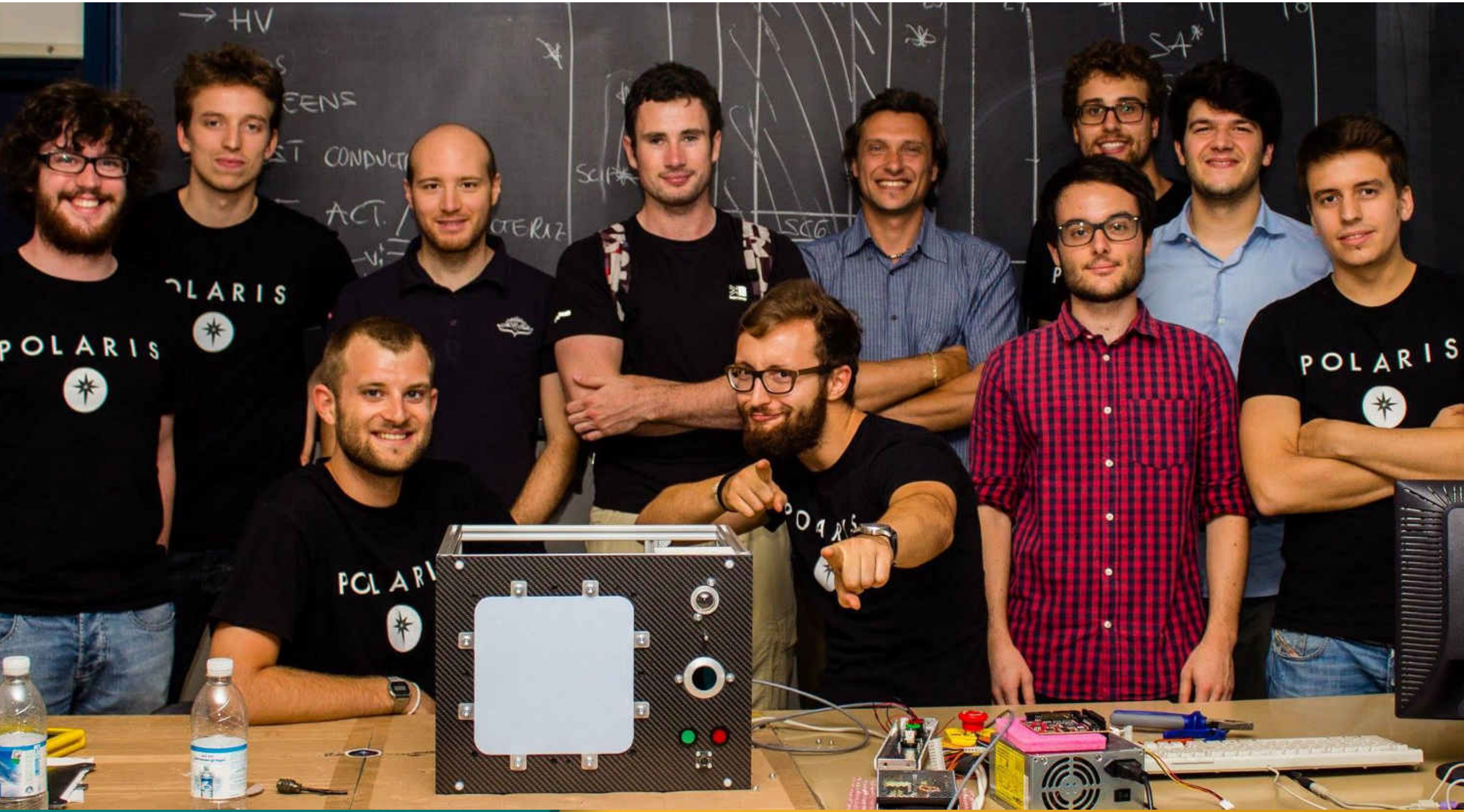


DEFORMATION

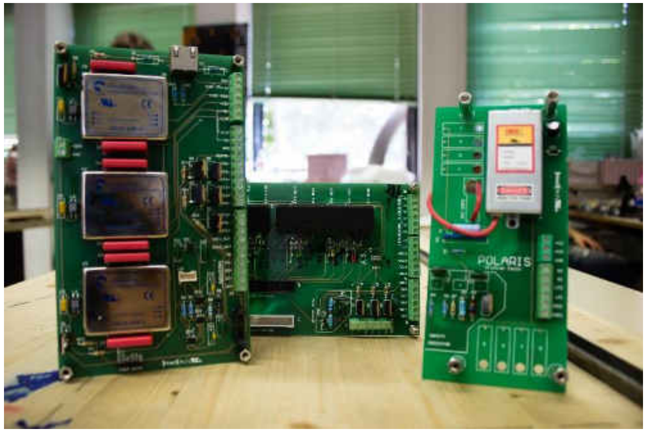


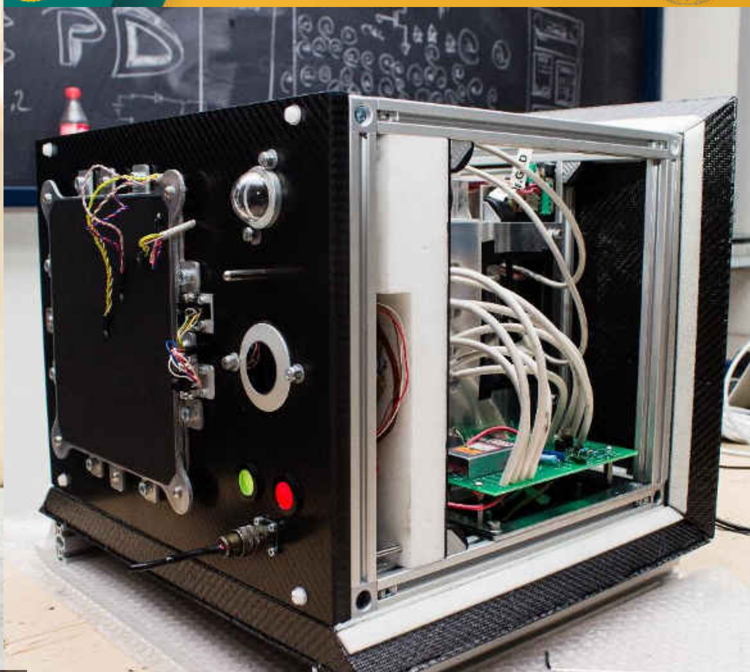
All the tested actuators show maximum **DEFORMATIONS OF 5 MM,** but limited performance for the mechanism requirements

DURING RX/BX (IPR)

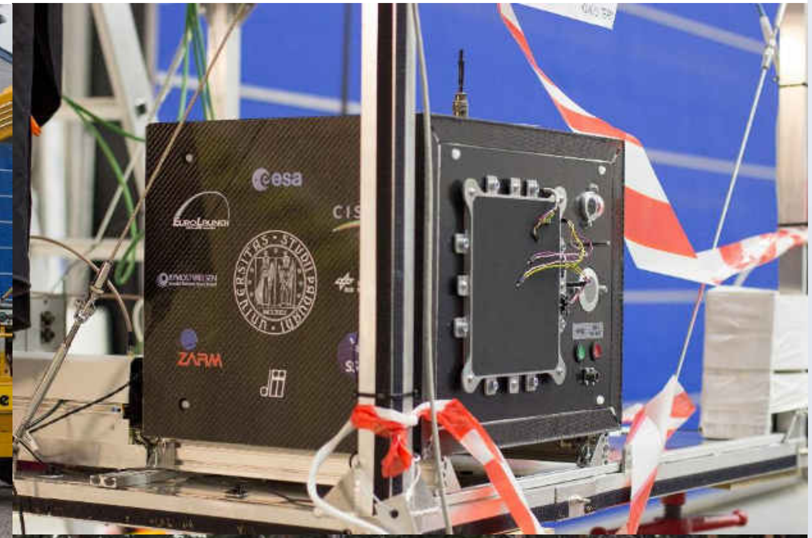


DURING RX/BX (EAR)





DURING RX/BX (LAUNCH CAMPAIGN)

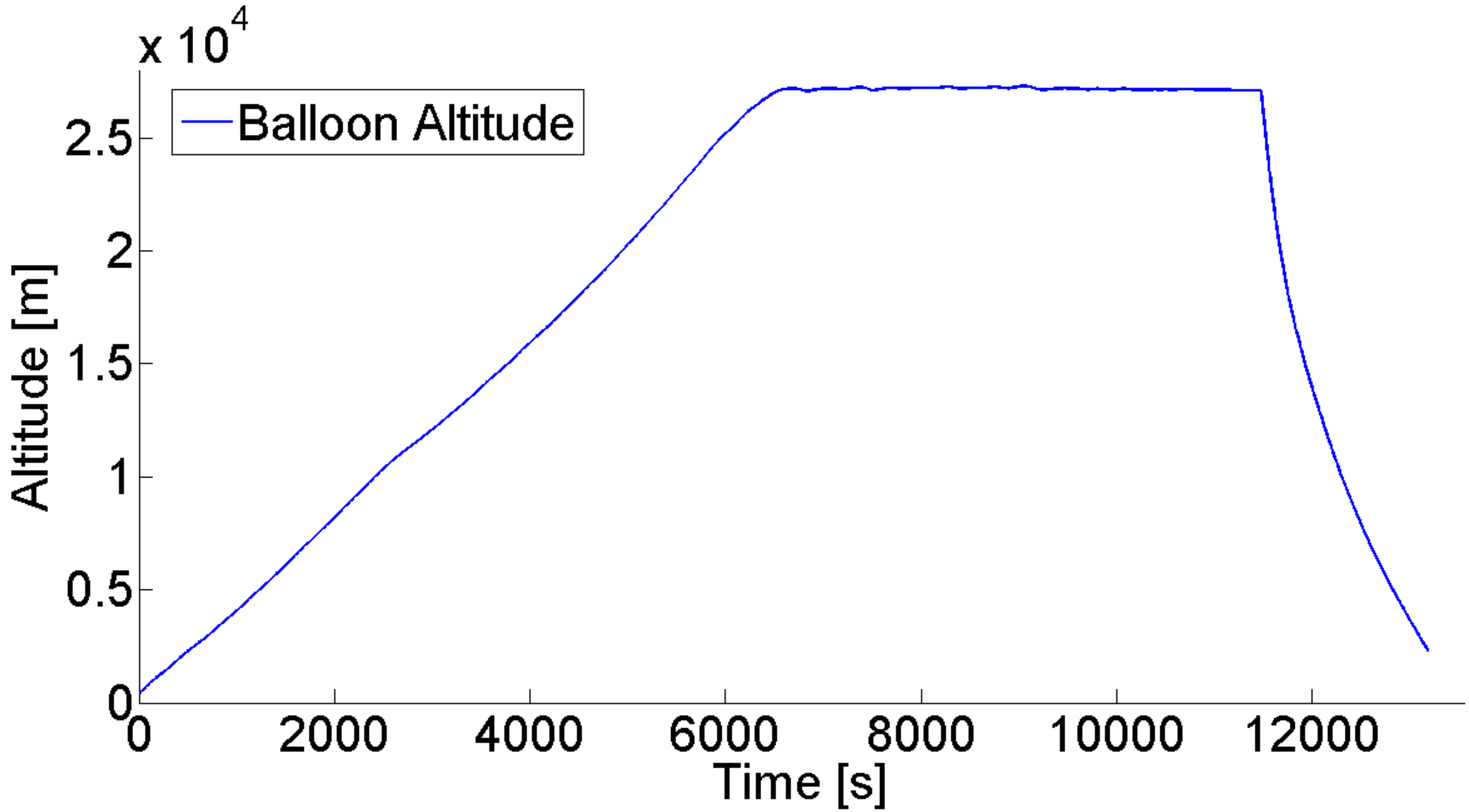


PRESENTATION OVERVIEW

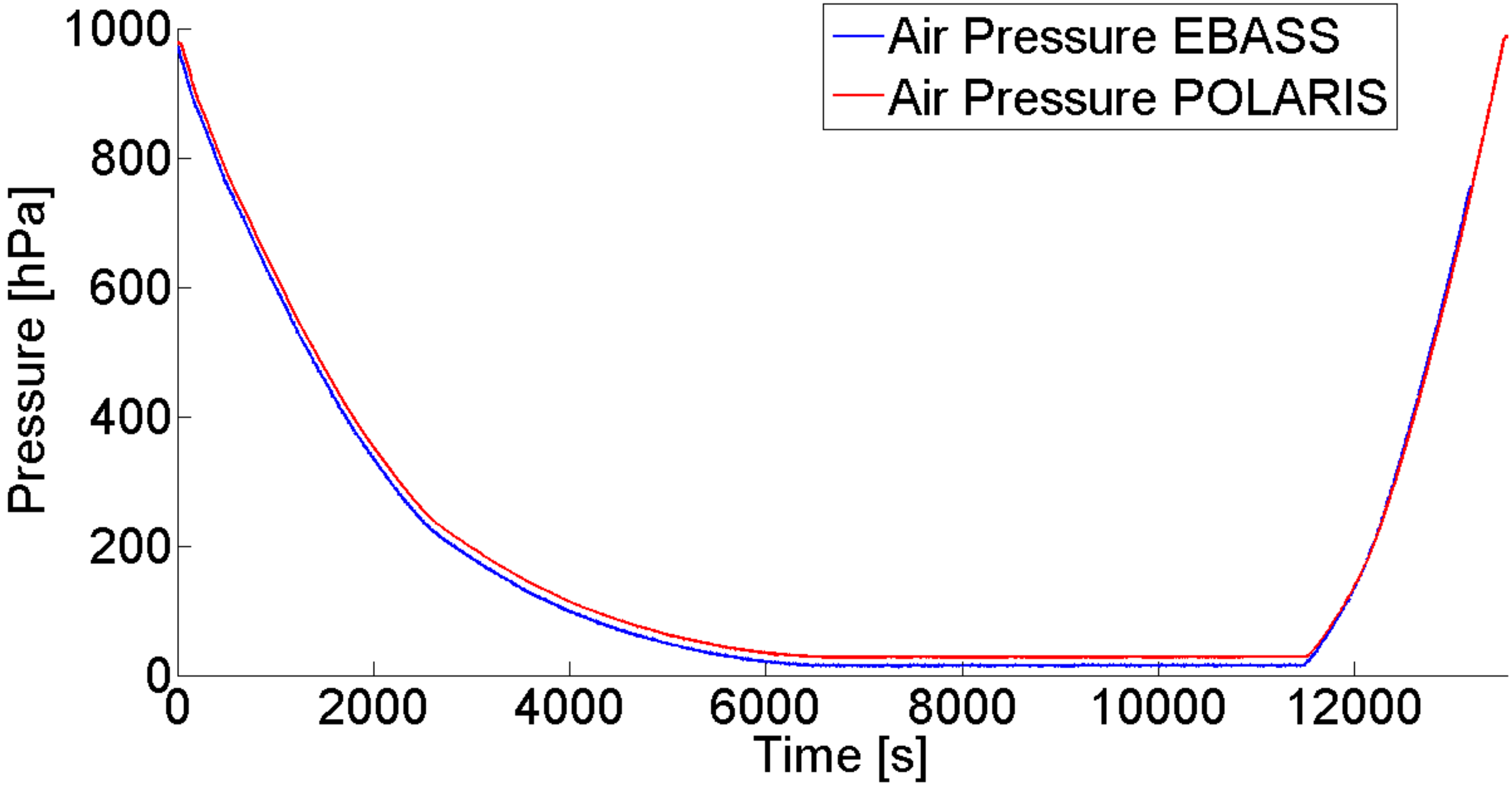
FLIGHT DATA

The setup flew into stratosphere on-board the balloon BEXUS18 from the ESRANGE Space Center (9 October 2014)

FLIGHT DATA - ENVIRONMENT



FLIGHT DATA - ENVIRONMENT



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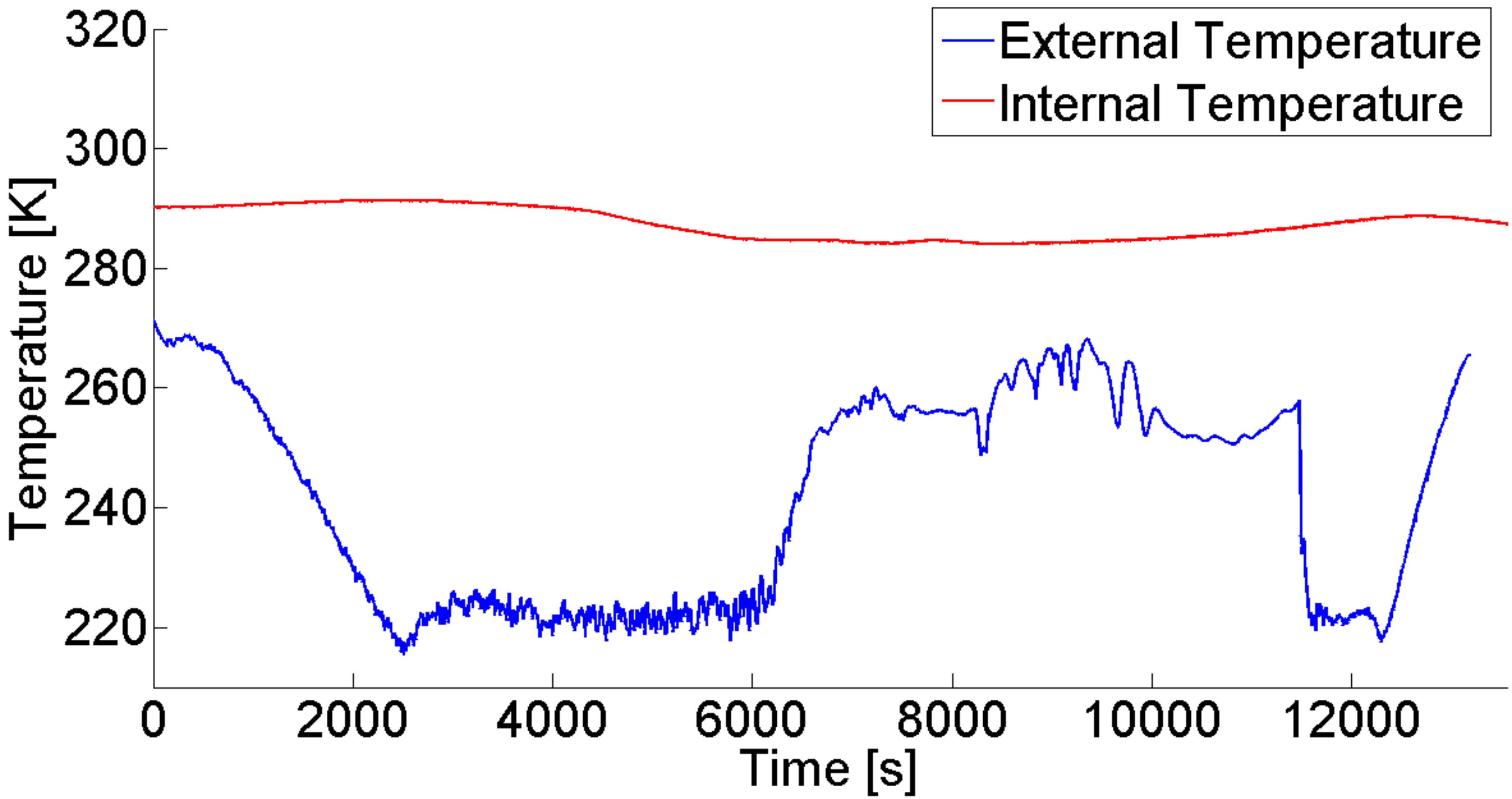
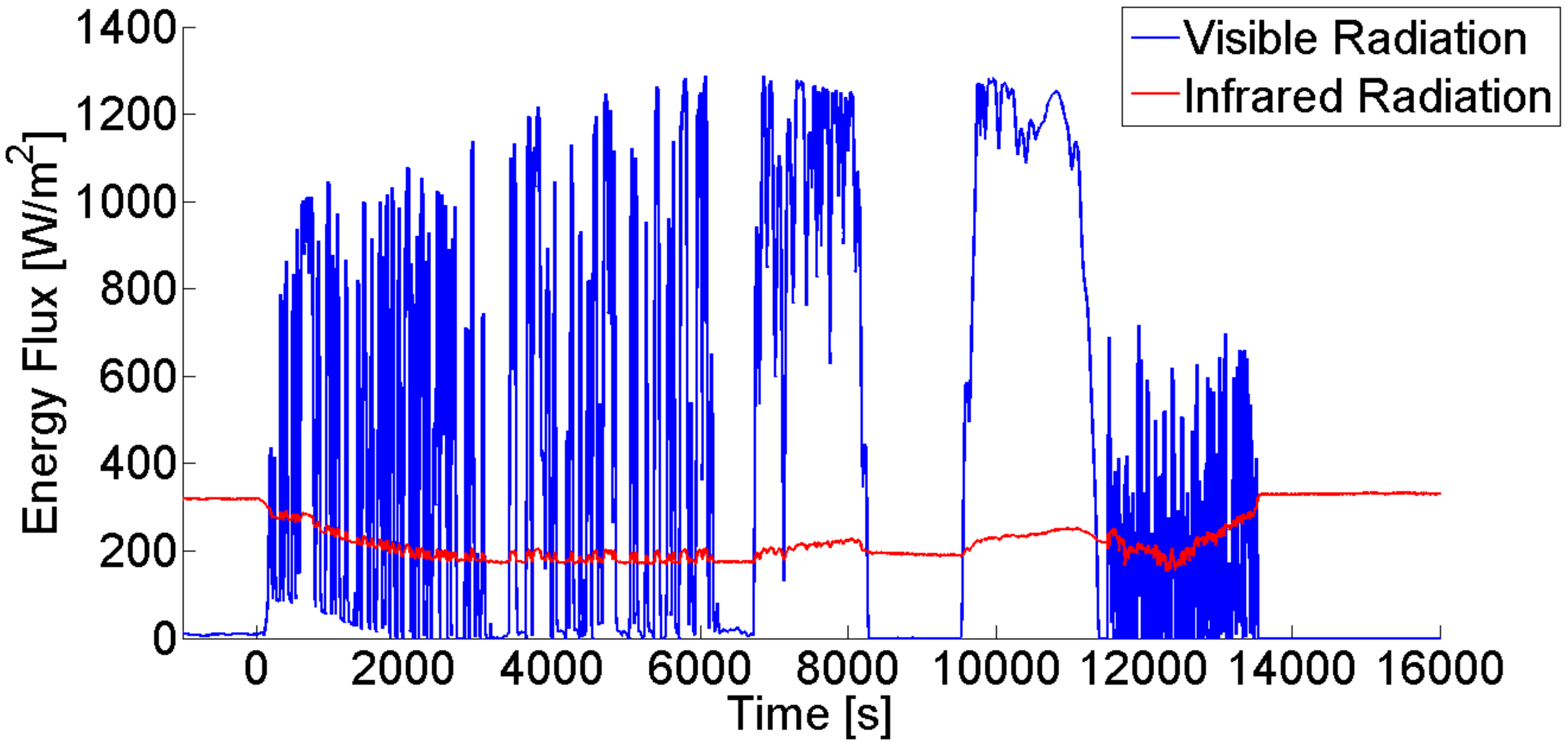
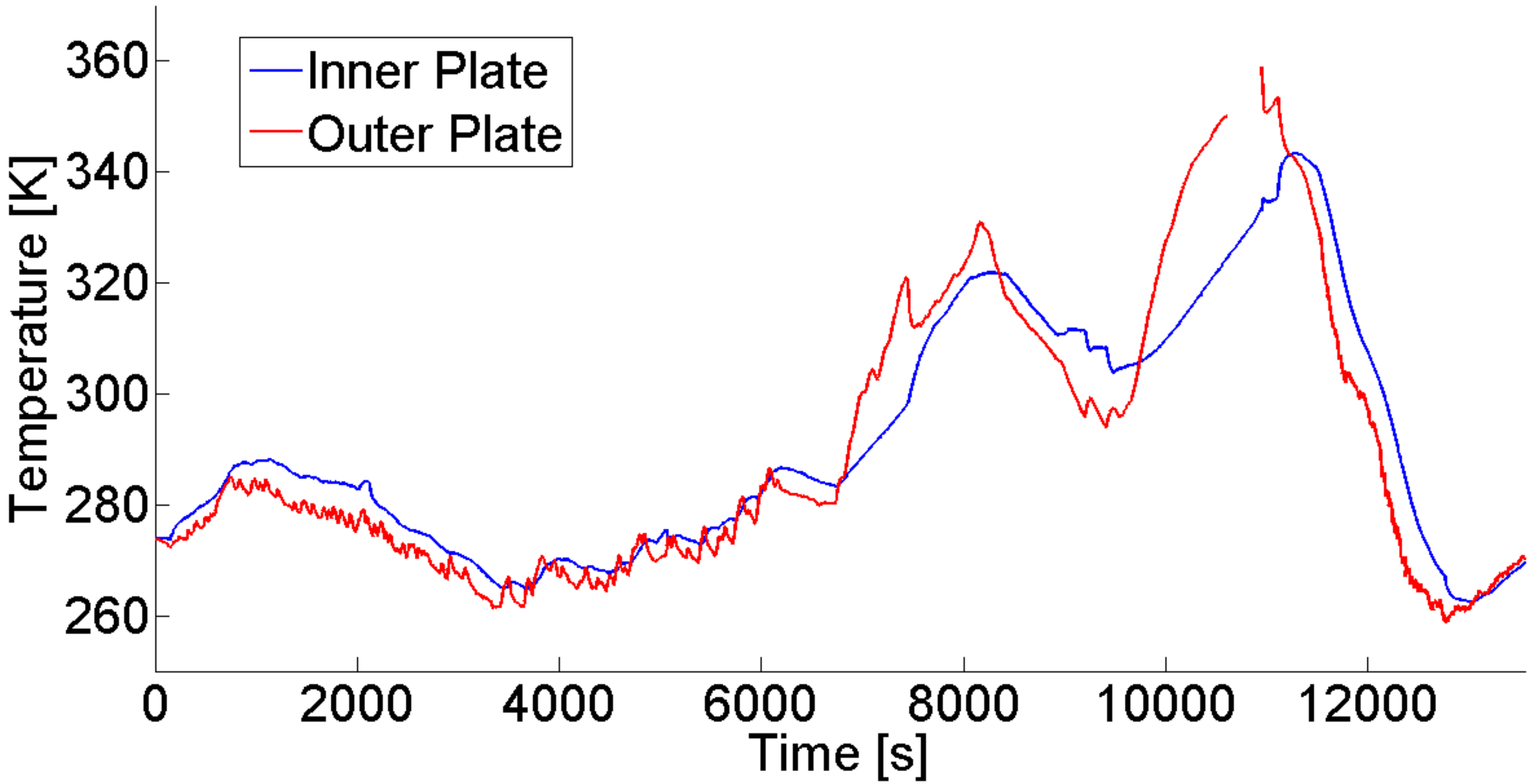


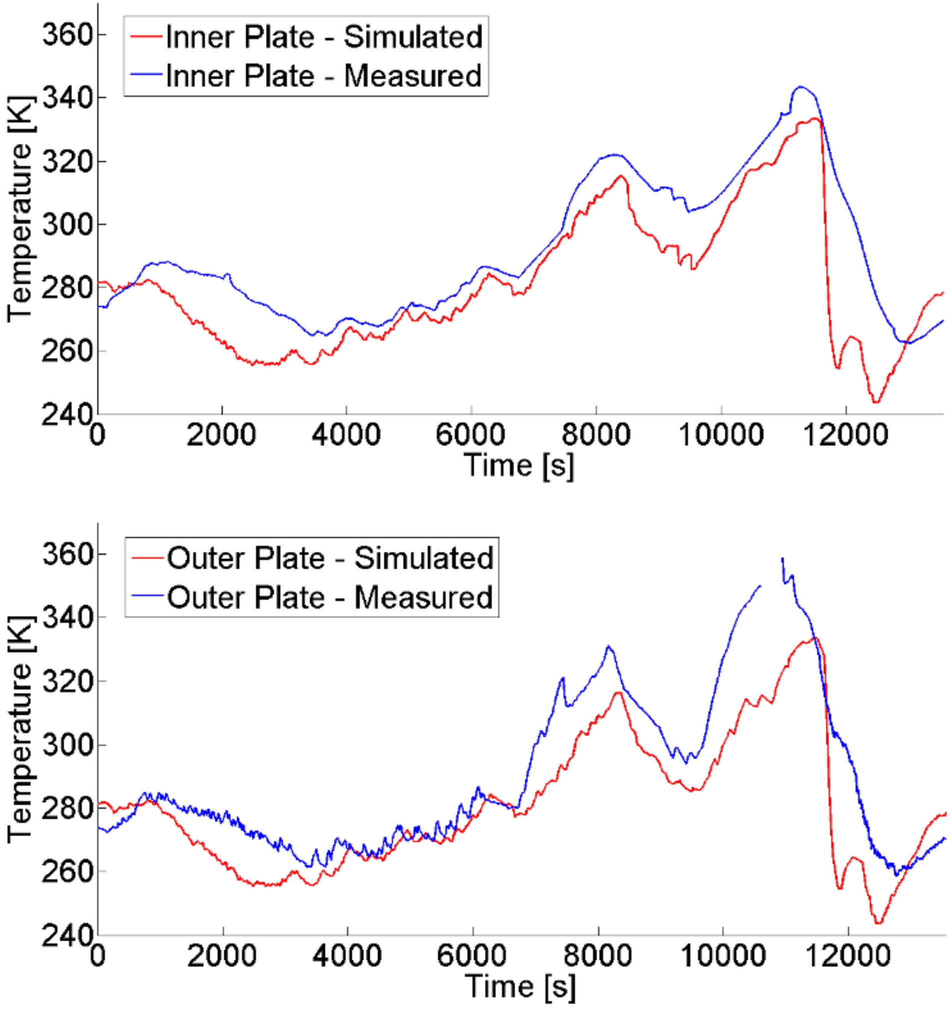
FLIGHT DATA - ENVIRONMENT

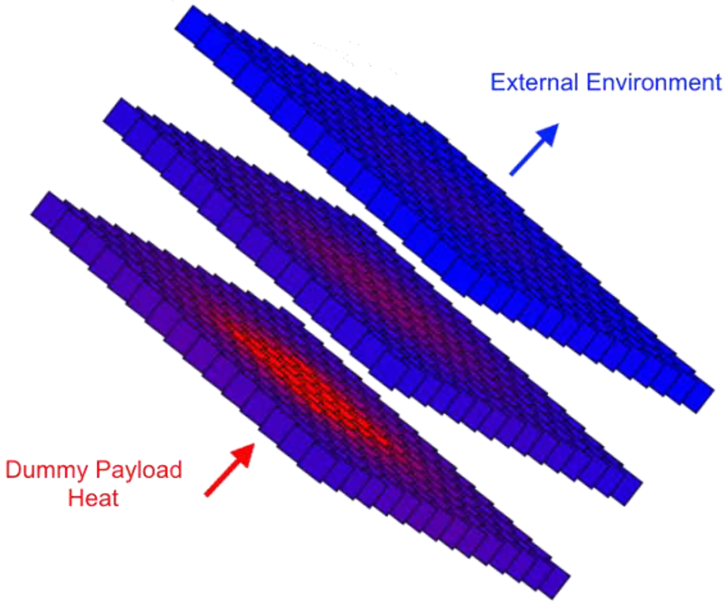


FLIGHT DATA - RADIATOR



FLIGHT OUTCOMES





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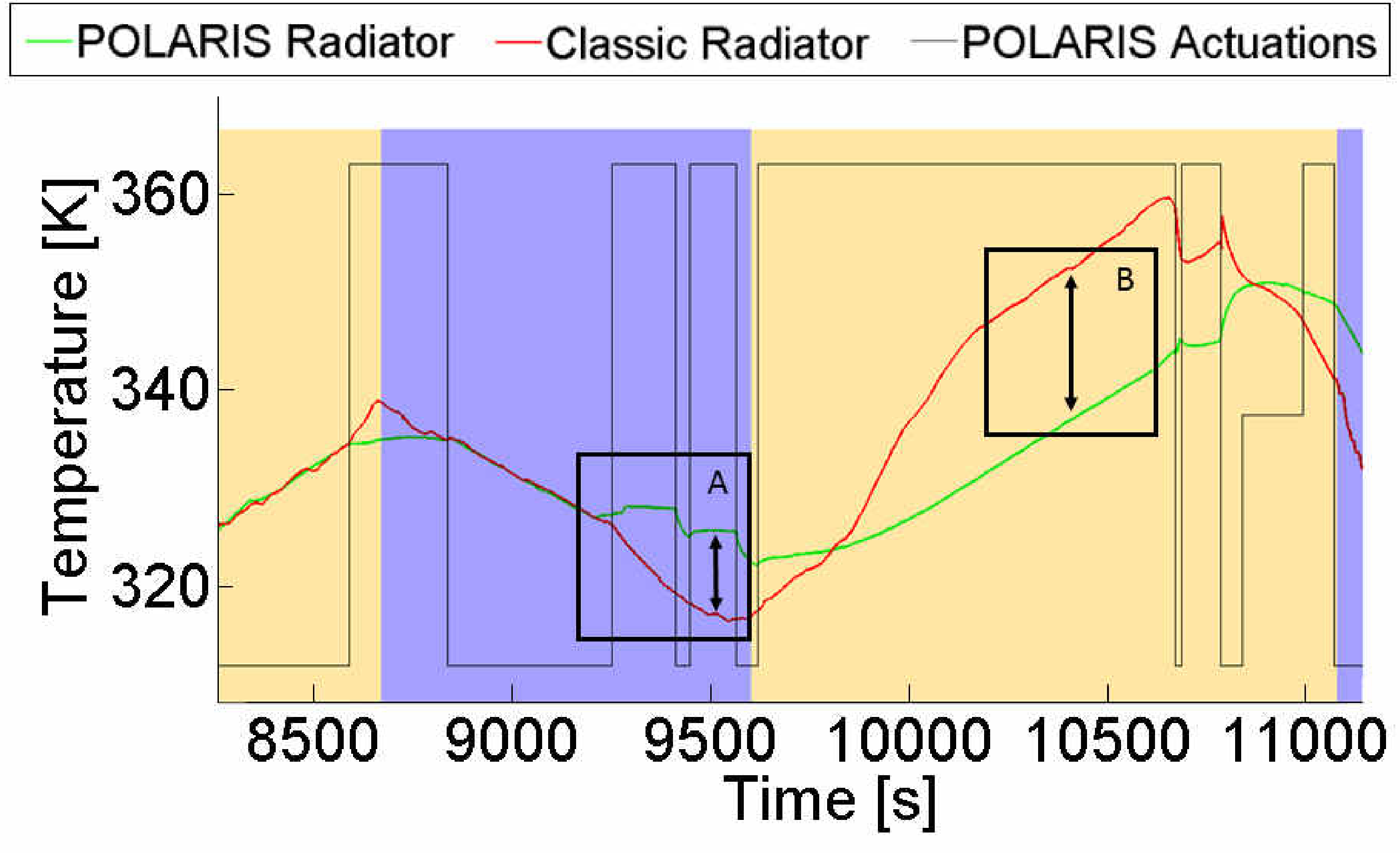

PRESENTATION OVERVIEW

LESSONS LEARNED & CONCLUSIONS

- Despite of an unexpected flight condition, it was possible to prove functionality and potentialities of this concept of radiator
- Experiment bus & software were perfectly functional during the whole flight
- Dielectric Elastomers Actuators manufacturing process was developed, even though the DEs performance were not enough to fulfill the experiment requirements
- New model was developed and post flight work was focused on vacuum test to characterize the radiator performance in a more stable environment

LESSONS LEARNED & CONCLUSIONS

- How to deal with the shipment and procurement of the experiment components: the experiment manufacturing (and thus all the following phases) should be carefully planned
- How to deal with the development of new technologies without extensive literature references (i.e. Dielectric Elastomers): the technology development should not be absolutely underestimated
- KEEP IT SIMPLE
- Define your objectives, state the requirements you need in order to fulfill them and then base your design choice on them. Once you froze your design (CDR) don't change desing!

ACKNOWLEDGEMENTS

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- **Prof. Alessandro Francesconi**
- **Dr. Francesco Branz**
- **Dr. Lorenzo Olivieri**
- **Dr. Francesco Sansone**

THANK YOU

Questions?

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