The EUSO-BALLOON project @ CNES: The JEM-EUSO pathfinder and its infrared camera funded by MULTIDARK

IX MULTIDARK CONSOLIDER WORKSHOP @ Alcalá de Henares, November 7th 2013

Luis Ramírez, José Santiago Pérez Cano. Orbital Aerospace, Madrid, Spain.
Héctor Prieto, José Alberto Morales, L. Del Peral & M. D. Rodriguez Frias. UAH, Madrid, Spain. **http://spas.uah.es**

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THE EUSO-BALLOON MISSION

JEM-EUSO (Japanese Experiment Module - Extreme Universe Space Observatory) will be based on the Japanese Experiment Module (JEM) on the International Space Station.

JEM-EUSO is a new type of observatory that will utilize very large volumes of the Earth's atmosphere as a detector of the most energetic particles in the Universe (up to $10^{20}\ eV$).

EUSO-BALLOON is a partnership project of the international consortium JEM-EUSO (space mission scheduled for 2017) and CNES that aims to fly over several campaigns in 2013, a prototype fluorescence telescope aboard a stratospheric balloon.

THE EUSO-BALLOON MISSION

WHAT FOR?

- **To test all the technologies developed for JEM-EUSO under very severe operating conditions (stratosphere), partly representative of some conditions that would have to meet any telescope fluorescence light space (accommodated on the ISS or in free flight on a satellite) → <u>TECHONLOGICAL DEMONSTRATOR</u>**

- **To measure the intensity of the atmospheric airglow with an appropriate angular resolution for JEM-EUSO, this continuous background requiring to be subtracted to any measured signal**

- **To highlight the ability of such an instrument to detect air showers from space (above the measured background level from the Airglow)**

THE EUSO-BALLOON MISSION

INTERNATIONAL PARTICIPATION

Over 50 people from Japan (RIKEN), France (LAL, OMEGA, APC, IRAP and CNES), Poland (NCBJ), South Korea (SKKU), Italy (INFN Napoli and Frascatti), Mexico (UNAM), Spain (UAH, IAC, INTA, MULTIDARK) and Germany (IAAT and KIT) are involved in the EUSO-Balloon mission, led by CNES.

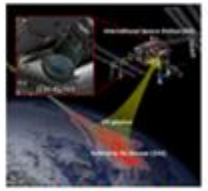
RIKEN

EUSO BALLOON

LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

irap astrophysique & planétologie

cnes CENTRE NATIONAL D'ÉTUDES SPATIALES



JEM-EUSO

UNIVERSIDAD NACIONAL AUTÓNOMA DE MÉXICO

SUNG KYUN KWAN UNIVERSITY 1398 성균관대학교

INFN Istituto Nazionale di Fisica Nucleare

KIT Karlsruhe Institute of Technology

INSTITUTO DE ASTROFISICA DE CANARIAS · IAC ·

INTA

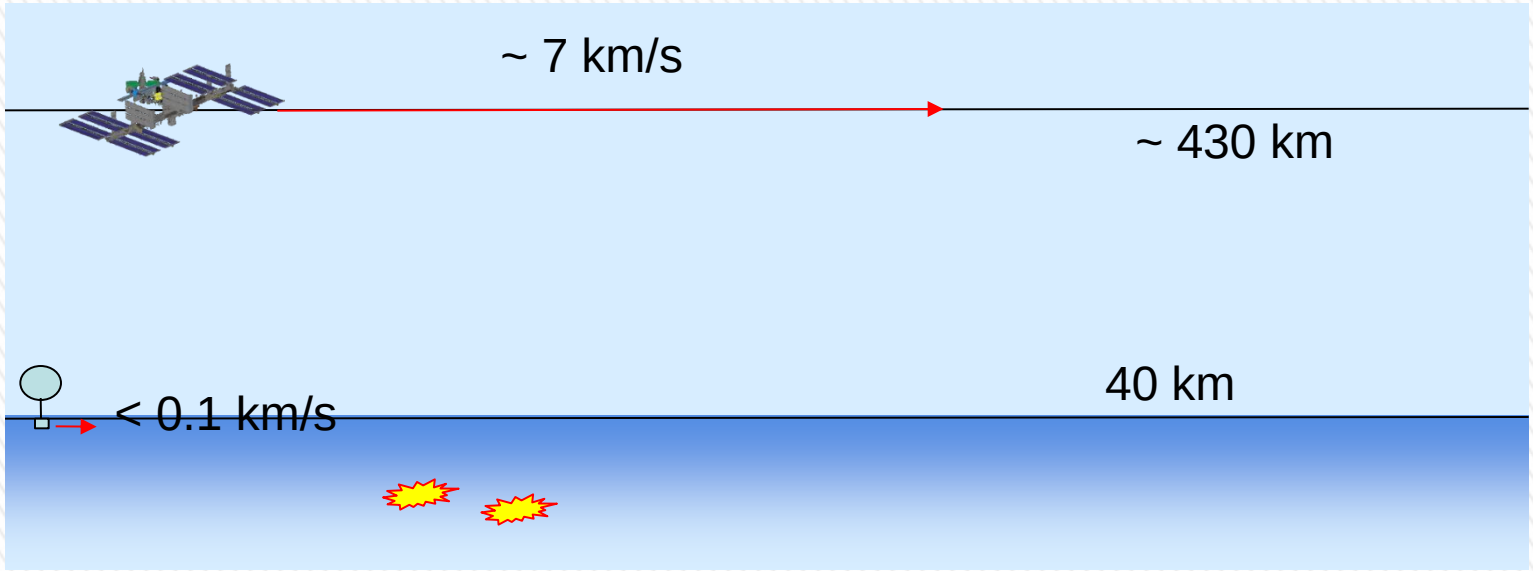
EBERHARD KARLS UNIVERSITÄT TÜBINGEN

UNIVERSIDAD DE ALCALÁ

MultiDark
Multimessenger Approach for Dark Matter Detection

Why an IRCamera is needed?

It is very important to bear in mind that is going to study the radiation at night time from a considerable height (400 Km from the ISS and 40 Km from the stratospheric balloon), and it is very important to know and discriminate if there are clouds, and measure its radiation, in order to retrieve its parameters and asses how it could affect to the JEM-EUSO telescope Cosmic Rays measurements.



EUSO-BALLOON IRCAMERA 1st Flight Mission Objectives

- To validate the IR camera mission concept
- To obtain real data with ULIS UL 04171 micro bolometer IR camera
- To assess the wavelength bands and filters selection
- To validate and optimize Temperature Retrieval Algorithms
- To validate and optimize Stereo Vision Technique
- To validate and assess part of Calibration Strategy (μShutter)

General Technical Specifications

Factor	Value
Altitude	40km
Pressure	3mbar
Energy Range	Thermal Infra Red (TIR)
Optical Subsystem	Devoted for missions objectives
Frame Rate	0.1 Hz
Wavelength Range	(10-12.5)μm
IR Bands	10.8 & 12 μm
FoV	75º
Power	30 W
Digitalization	16 Bits
Operating Duty Cycle	1 day
Mass Memory	Solid State memory
Power Supply	IR Camera Battery pack 28V
Size	350x350x300 mm
Weight	27 kg
Data Link	Internal storage/external test connection

IR Camera

Detector (UL 04171)

Technology: α-Si
Manufacturer: ULIS
Resolution: 640x480-25μm, 16bits
NETD < 120mK
Frame Rate: up to 60 Hz
Power consumption: <300 mW (without TEC)

IR Camera

Operational Bands

Band 1: **FOV≈75°**

CWL: 10.80 μm

FWHM: 0.85 ± 0.1 μm

Transmittance > 80;

Transmittance Rejection Band: 7 to 10.0 μm <0.01; 11.4 to 20 μm < 0.01

Band 2:

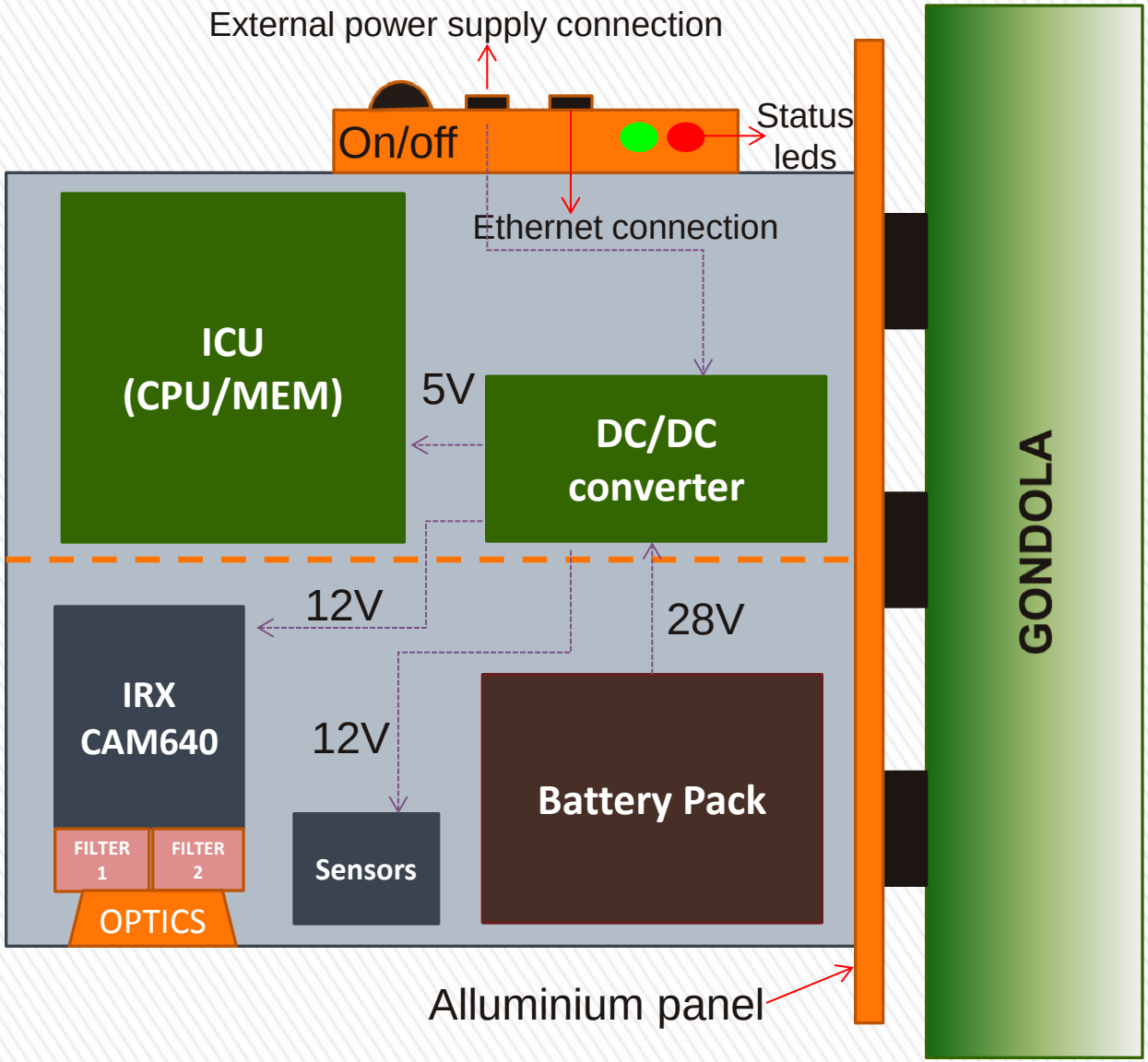
CWL: 12 μm

FWHM: 0.85 ± 0.1 μm

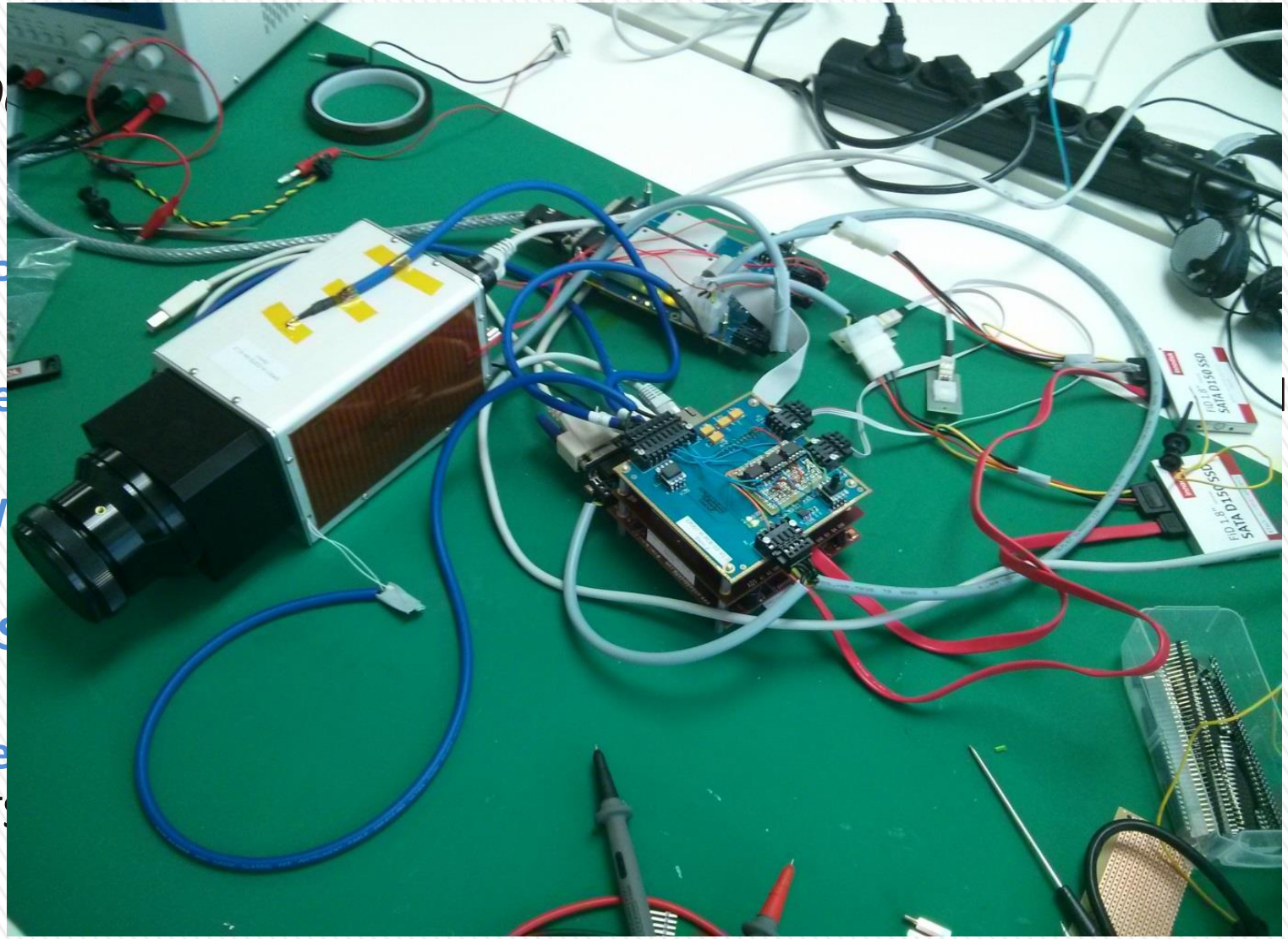
Transmittance > 80

Transmittance Rejection Band: 7 to 11.3 μm <0.01; 12.7 to 20 μm < 0.01

IR Camera block diagram



IR Camera




BenQ
Adler

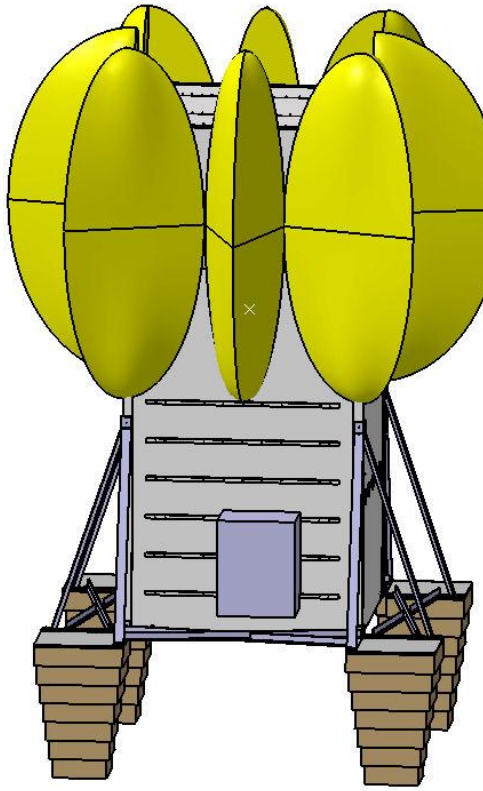
Mechanical Configuration

EUSO IR Camera accommodation

- ❑ *Located on the external side of the Gondola*
- ❑ *Totally isolated*
- ❑ *Autonomous batteries (ad-hoc power System developed, DC/DC converter Board…)*

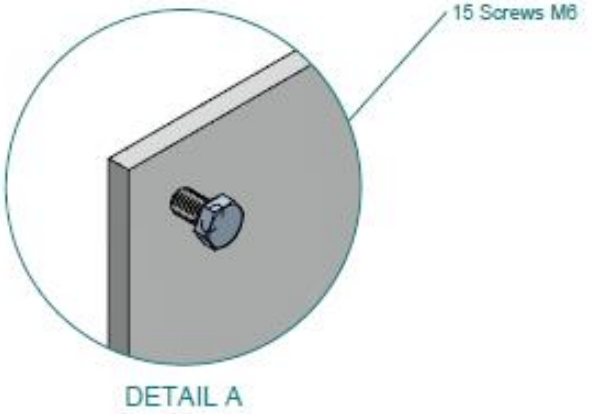
EUSO IR Camera mechanical booth

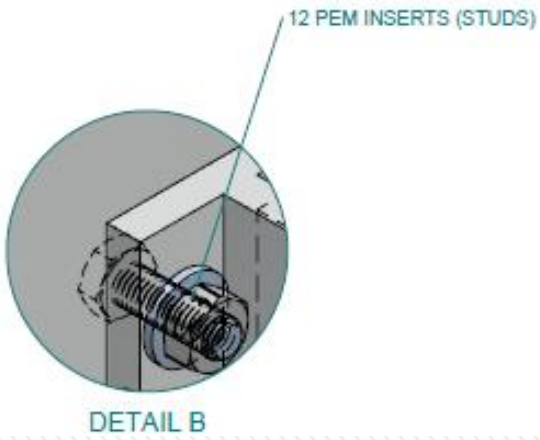
- ❑ *Withstand environmental conditions*
- ❑ *Water proof*
- ❑ *Passive (aluminum panel radiator) and active thermal control (2x4W heaters)*

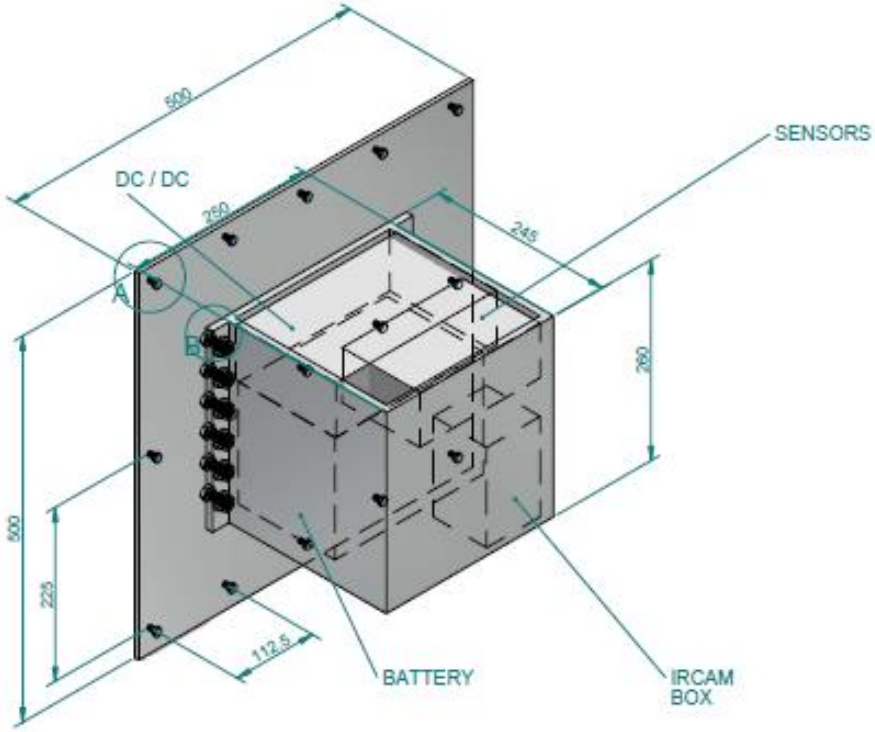


EUSO Balloon Gondola

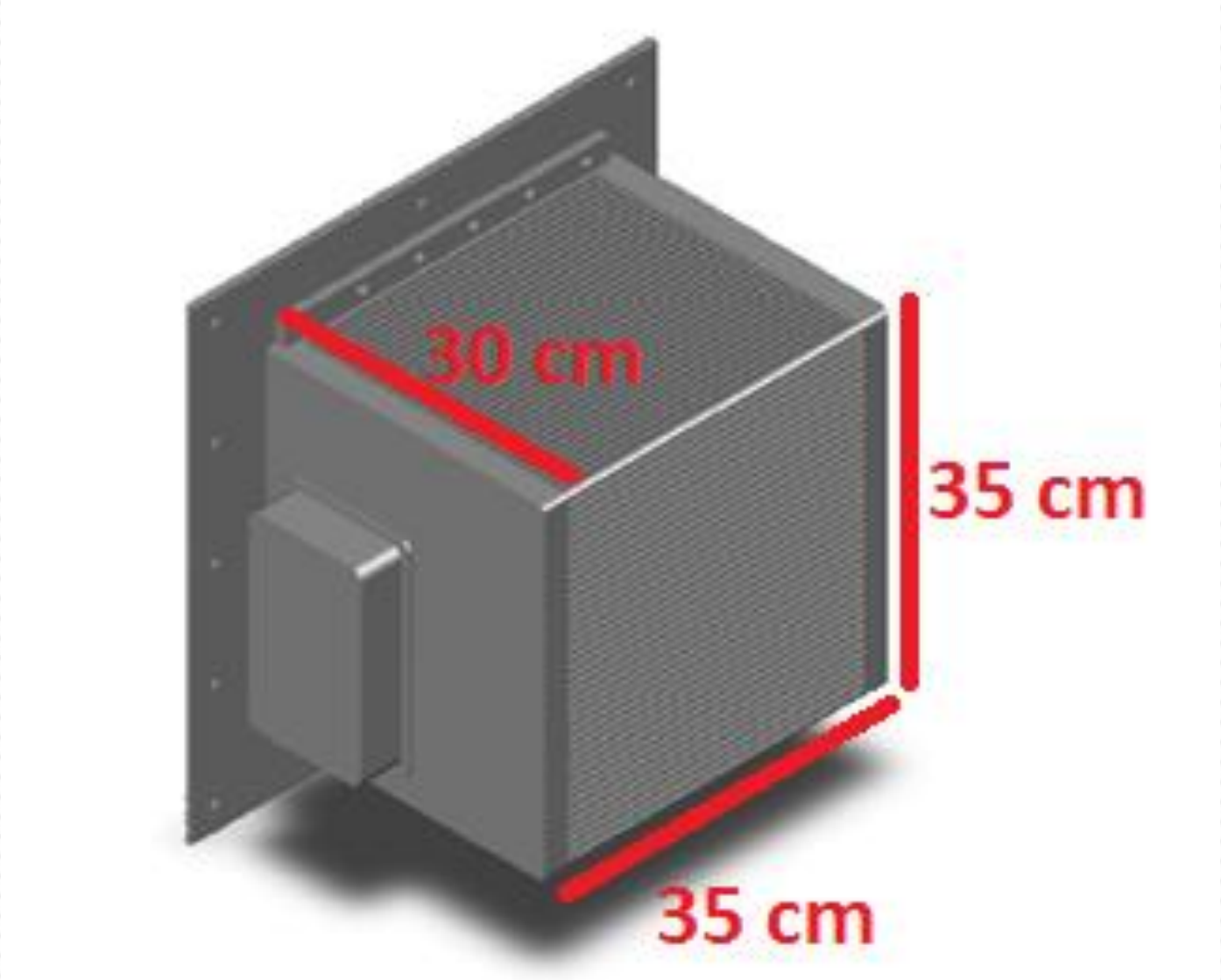
Mechanical Configuration







Mechanical Configuration



Thermal Configuration

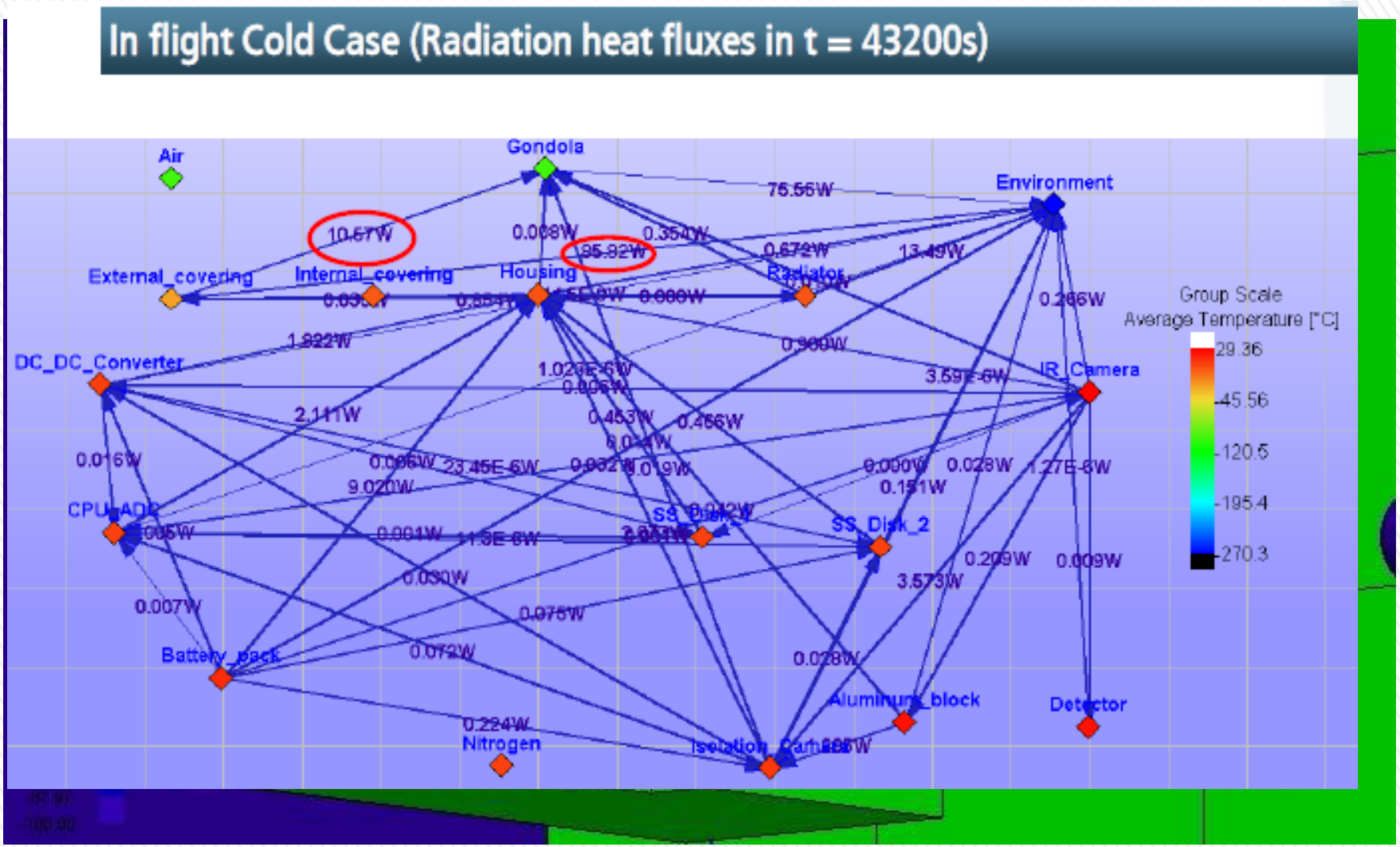
A thermal study has been done, obtaining these results:

Passive thermal control: **2 cm width styrofoam IRCam coverage and 4 cm external mechanical box envelope.**

Active thermal control: **2 heaters of 4W are used to control the shutter thermal stability**

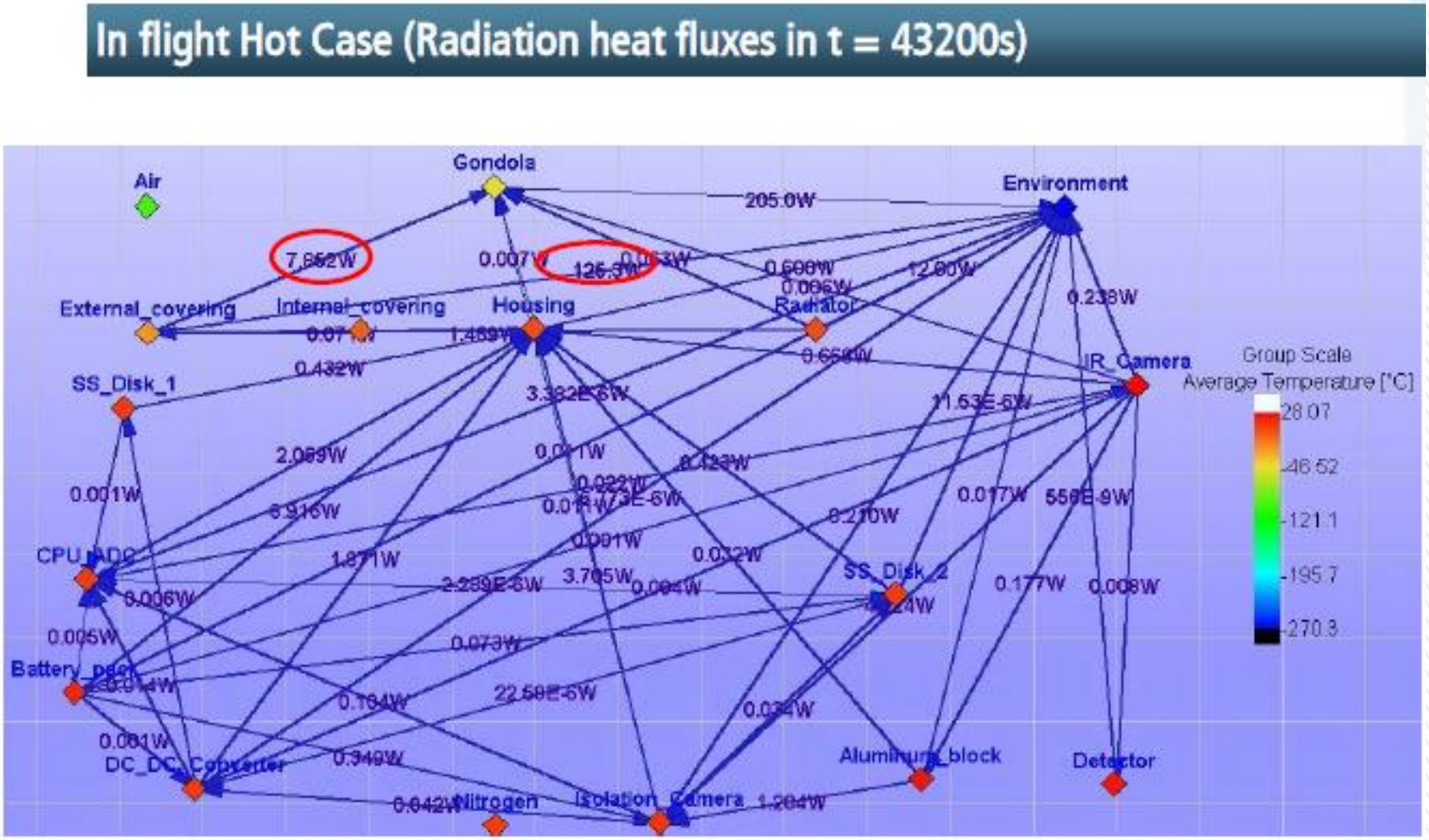
Thermal Configuration

Cold Case:



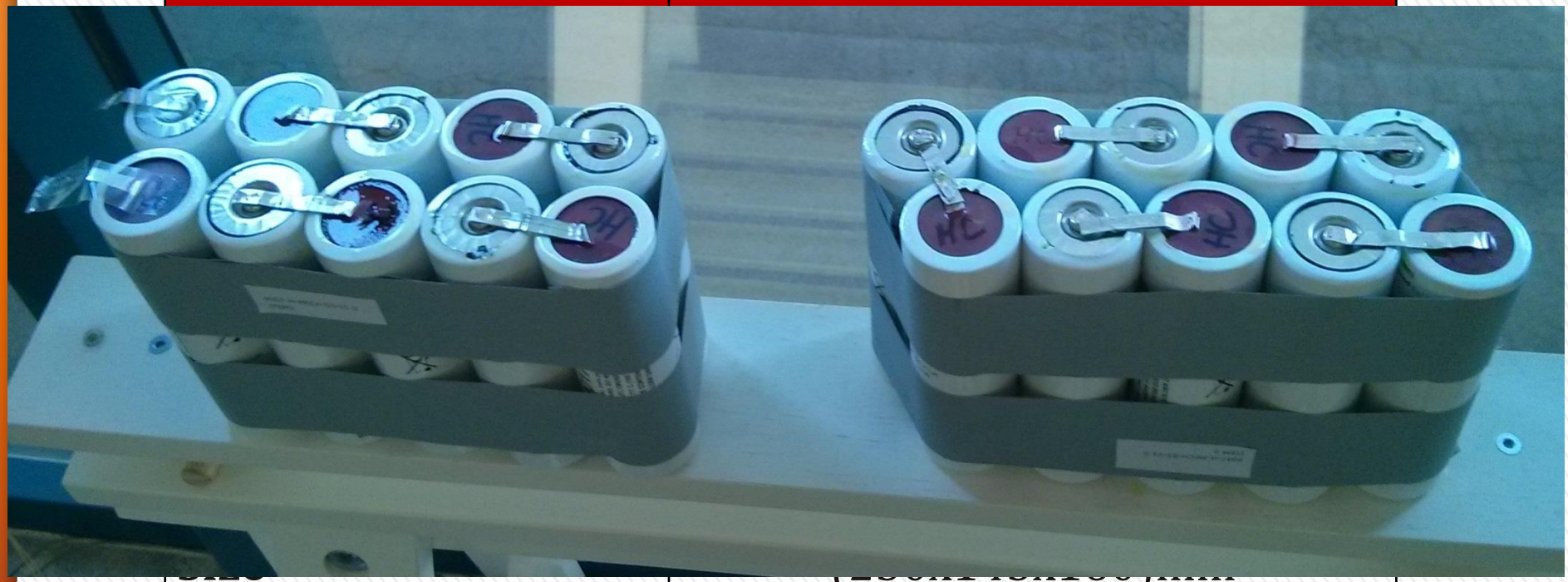
Thermal Configuration

Hot Case:



IR Camera Battery Pack technical specifications

	IR Camera PWP 24h
Size	(250mm x 154mm x 90)mm
Mass	5kg

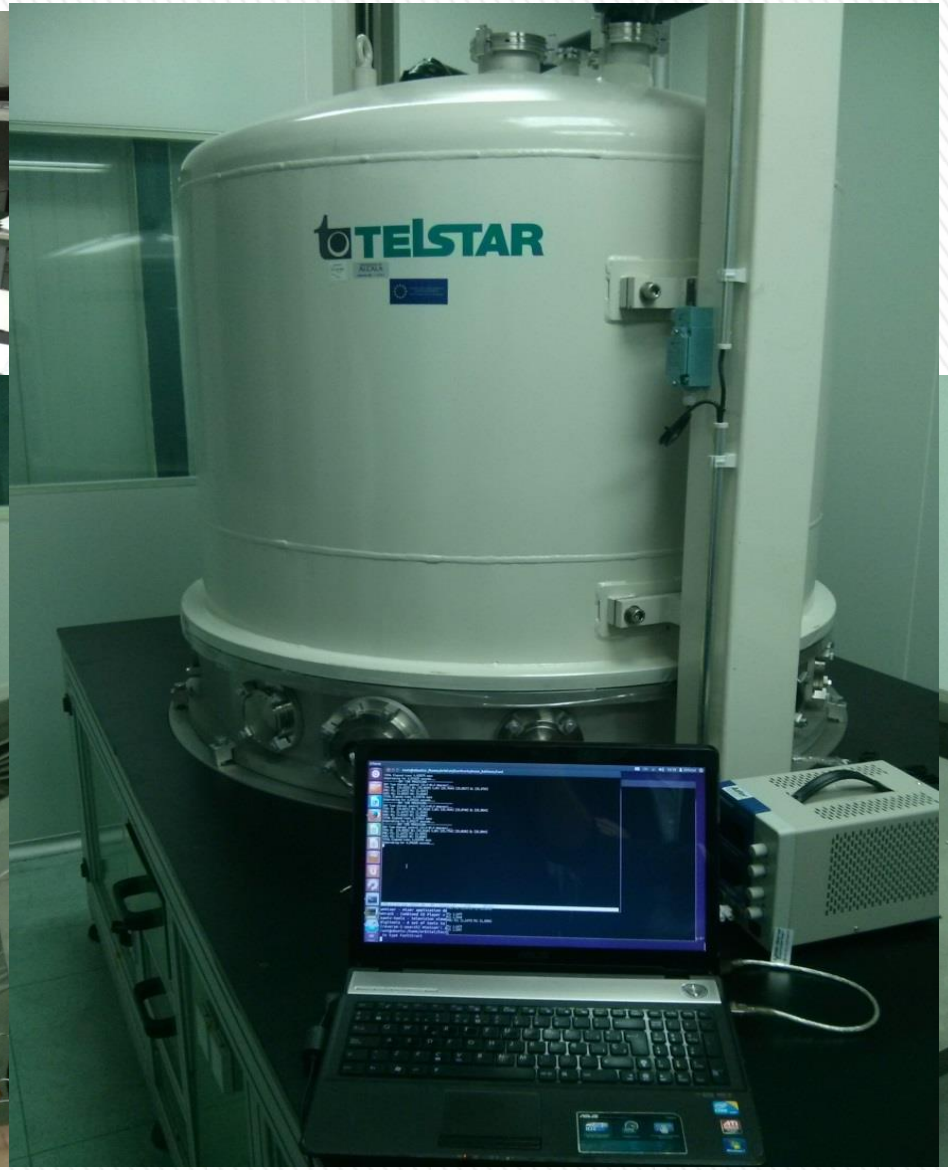


IR CAMERA Testing

A test campaign was performed at UAH/CATECHOM facilities in October 2013:

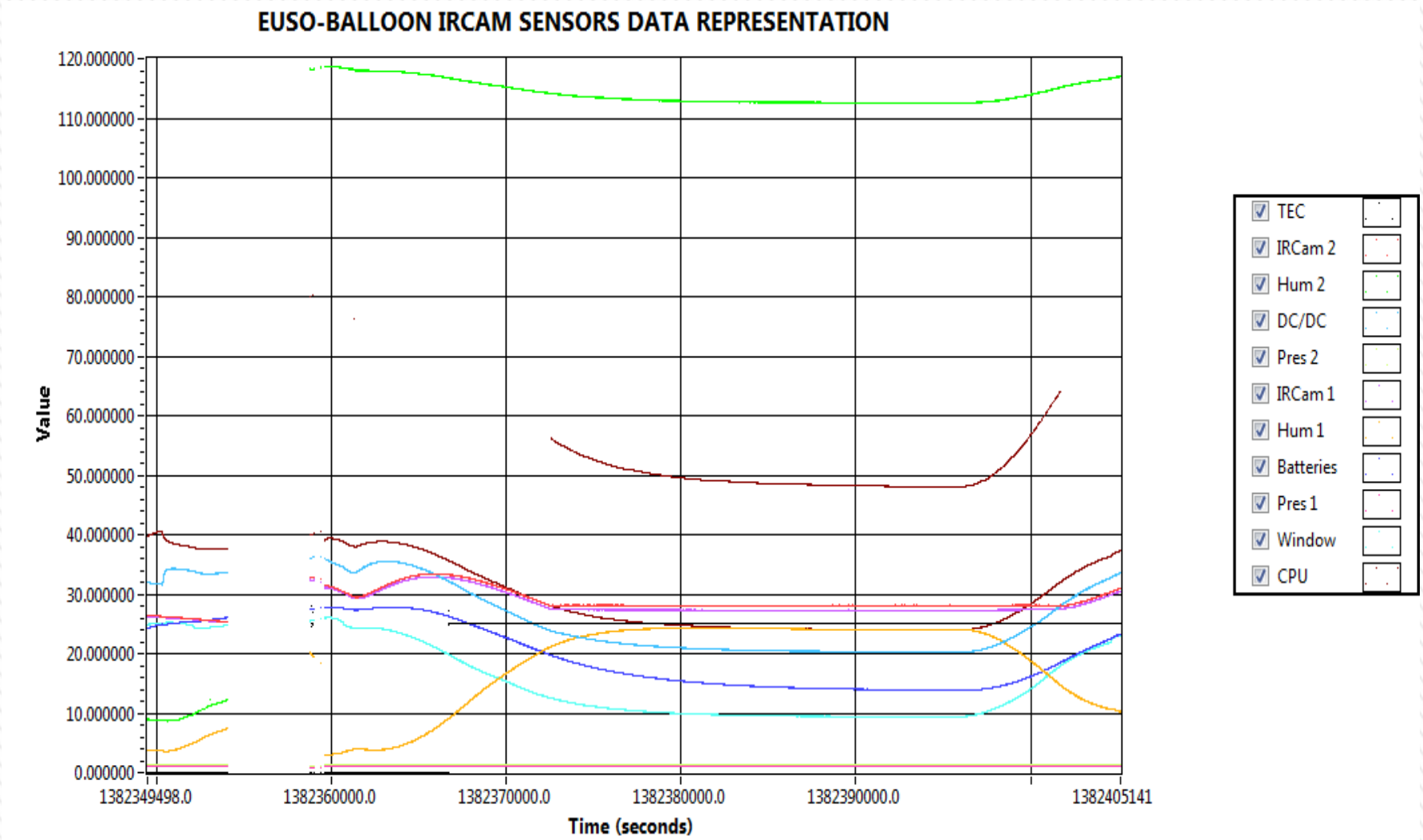
- **To characterize IRCAM thermal NTC sensors**
- **To test the tightness of the system (withstand operation in a vaccum environment)**
- **To validate the operation of the system in a similar temperature and pressure environment**

IR CAMERA Testing



IR CAMERA Testing

RESULTS



IR CAMERA CALIBRATION

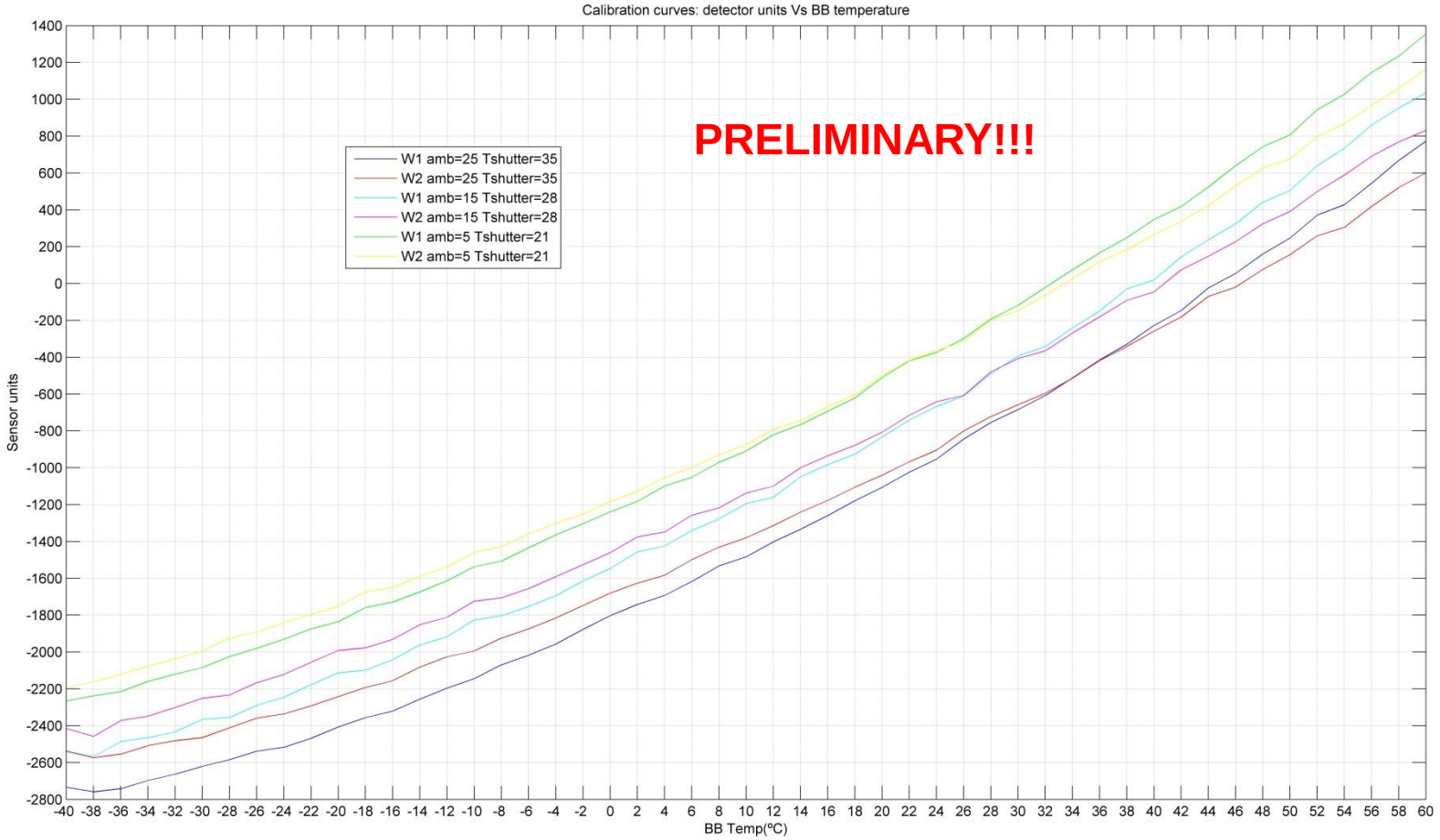
Calibration has been performed at IAC facilities in Tenerife from October 25th to November 7th 2013:

- **IRCam gain and voltages values are improved and fitted to the system with filters, Non Uniformities Corrections, Gain and Offset.**
- **Germanium window contribution is obtained in the final NETD contribution**
- **Calibration curves are perfomed with a Black Body to go from detector counts to temperature**
- **IRCam temperature sensores are fine calibrated with a Black Body**
- **NETD assessment with filters**

Sincere appreciation to the IAC team for their great support

IR CAMERA CALIBRATION

RESULTS



IR CAMERA Budget

Preliminary estimation has been done and reported:

- ***SIZE*** 350 x 350 x 300 mm3
- ***MASS*** 27.6 Kg
- ***POWER*** 30W

Functional Requirements

The EUSO Balloon IR camera subsystem has been designed to be ***reusable*** for all the balloon campaign opportunities.

IR Camera Schedule

IR CAM MILESTONES	DATE
PDR/CDR	December 18th @ CNES
Testing	October 2013
FM delivery	February 28th 2014
FIRST EUSO-BALLOON FLIGHT	September 2014 @TIMMING, ONTARIO (CANADA)

MultiDark
Multimessenger Approach for Dark Matter Detection
UNIVERSIDAD DE ALCALÁ
INSTITUTO DE ASTROFÍSICA DE CANARIAS · IAC
INTA
Orbital
AEROSPACE SYSTEMS

THIS EUSO-BALLOON IRCAMERA HAS BEEN FUNDED BY MULTIDARK AS WELL AS SOME OF THE EUSO-BALLOON PMTs.

FOR THIS REASONS THE EUSO-BALLOON SPANISH TEAM WOULD LIKE TO TAKE THIS OPPORTUNITY TO SHOW A SINCERE APPRECIATION TO MULTIDARK FOR THIS SUPPORT.