

A Infrastructure for technological development of aero-space systems:

The experience of the LNTS

Di Stefano - Iarocci



• Scientific Rationale

- We have proposed a module with reference to the Technological Development of electronic and electromechanical systems, subsystems, microsystems and sensors for aerospace and ground-based technologies to support space observation.
- The module proposes technological ideas (es. new sun sensors, power management) to be integrated on small satellites or aero platform, starting from current experiences and knowledge, or collaborate on projects with other institutions or partnerships.
- The goal is to implement a transversal infrastructure, starting of the LNTS (New Technology and Instruments Laboratory - INGV - ROMA1), for the development of aerospace tools and to train a group of skills also to support other modules for the study of technical solutions

• Project of Reference and Experiences

Past and current projects in collaborations with ASI, Physics Department (Univ. La Sapienza) and DLR

- FASA
- PEGASO (LDB program and pathfinder)
- STRADIUM
- Winter long duration stratospheric balloons
- OLIMPO
- BOOMERANG
- HERMES (project under the european program HEMERA)

• Project FASA: Development of an Automatic Calibrator for FTIR

FASA - Fire Airborne Spectral Analyser

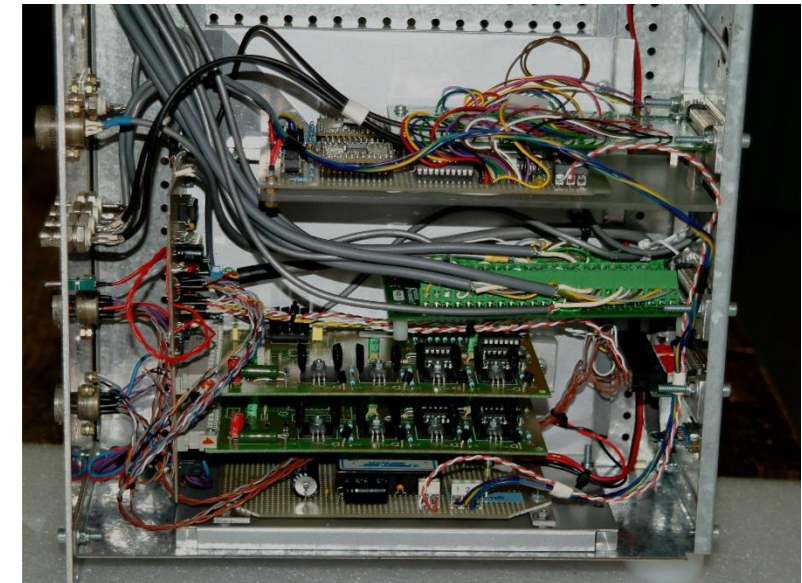
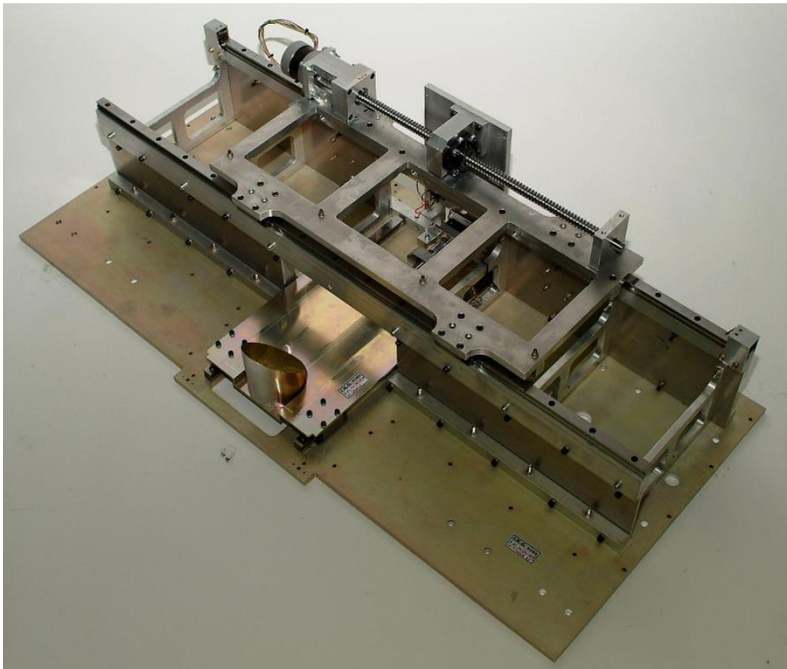
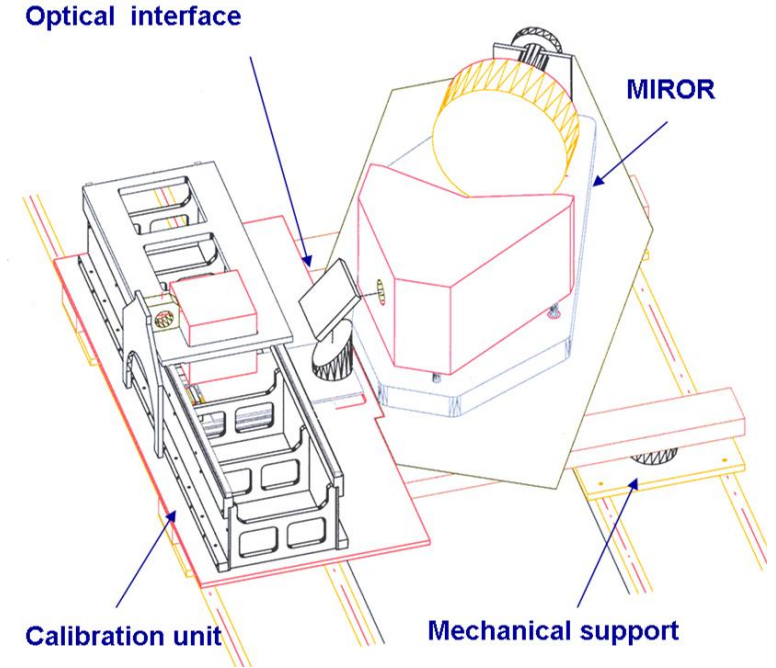
- FASA combines high-resolution spectra (MIROR) and thermal images (ABAS) in order to investigate the earth surface, gas composition related wildfires and/or volcanic phenomena.
- The system combines two different instruments: a bi-spectral image cameras and an high-resolution FTIR- spectrometer (MIROR) in the IR range (3-16 μ m), designed to operate onboard on Donier 228 aircraft.



• Project FASA: Development of an Automatic Calibrator for FTIR

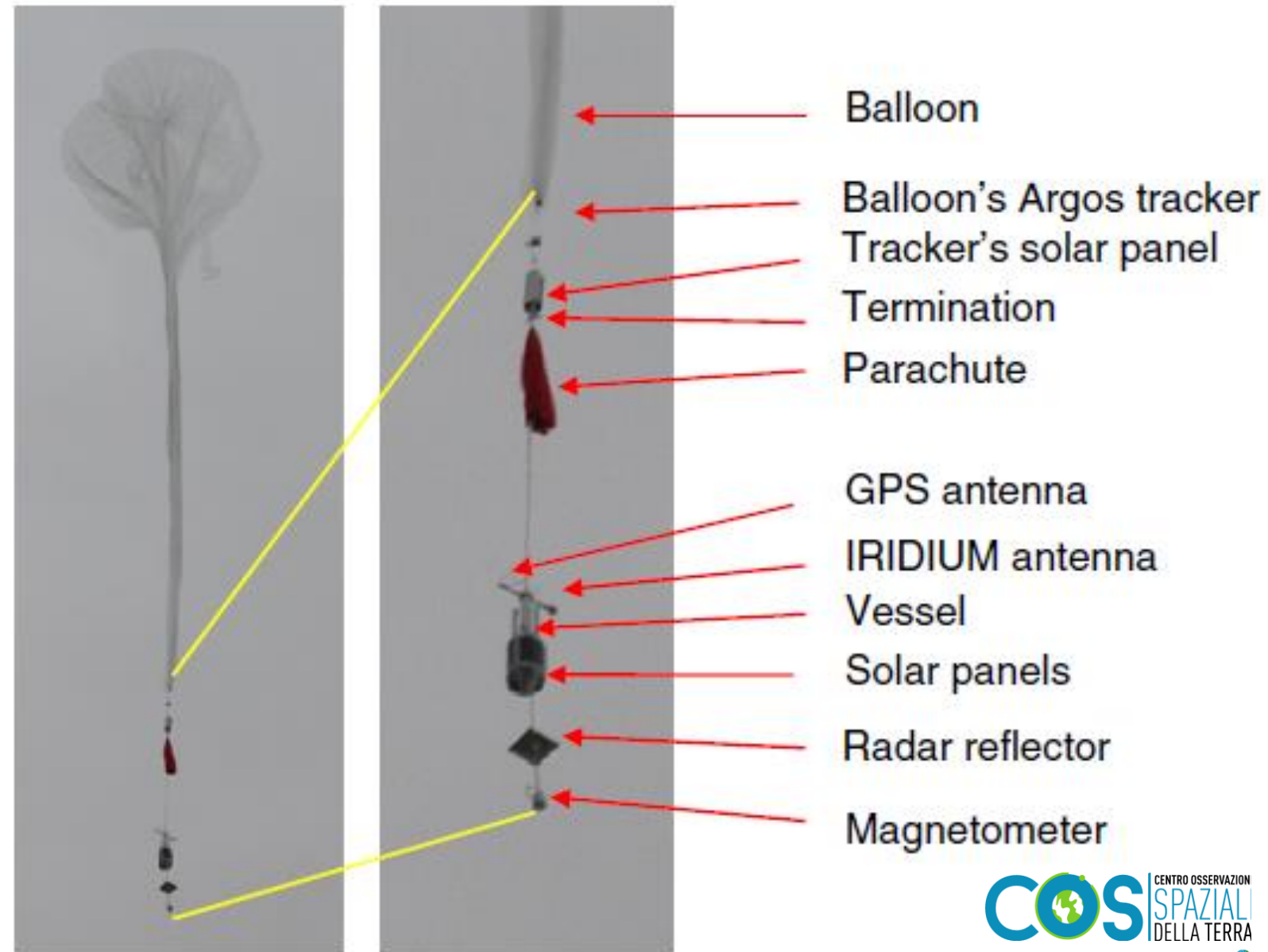
What was done at the LNTS - INGV:

- Design and implementation of the calibrator mechanics
- Frame and mechanical interface of the interferometer/calibrator for the Dornier 228 airplane
- Thermal covers
- Calibrator drives and electronic interfaces
- Development of control system for the movement of mirrors and black bodies, thermal control of the interferometer and black bodies.
- Software for automatic in-flight calibration and interferogram acquisition



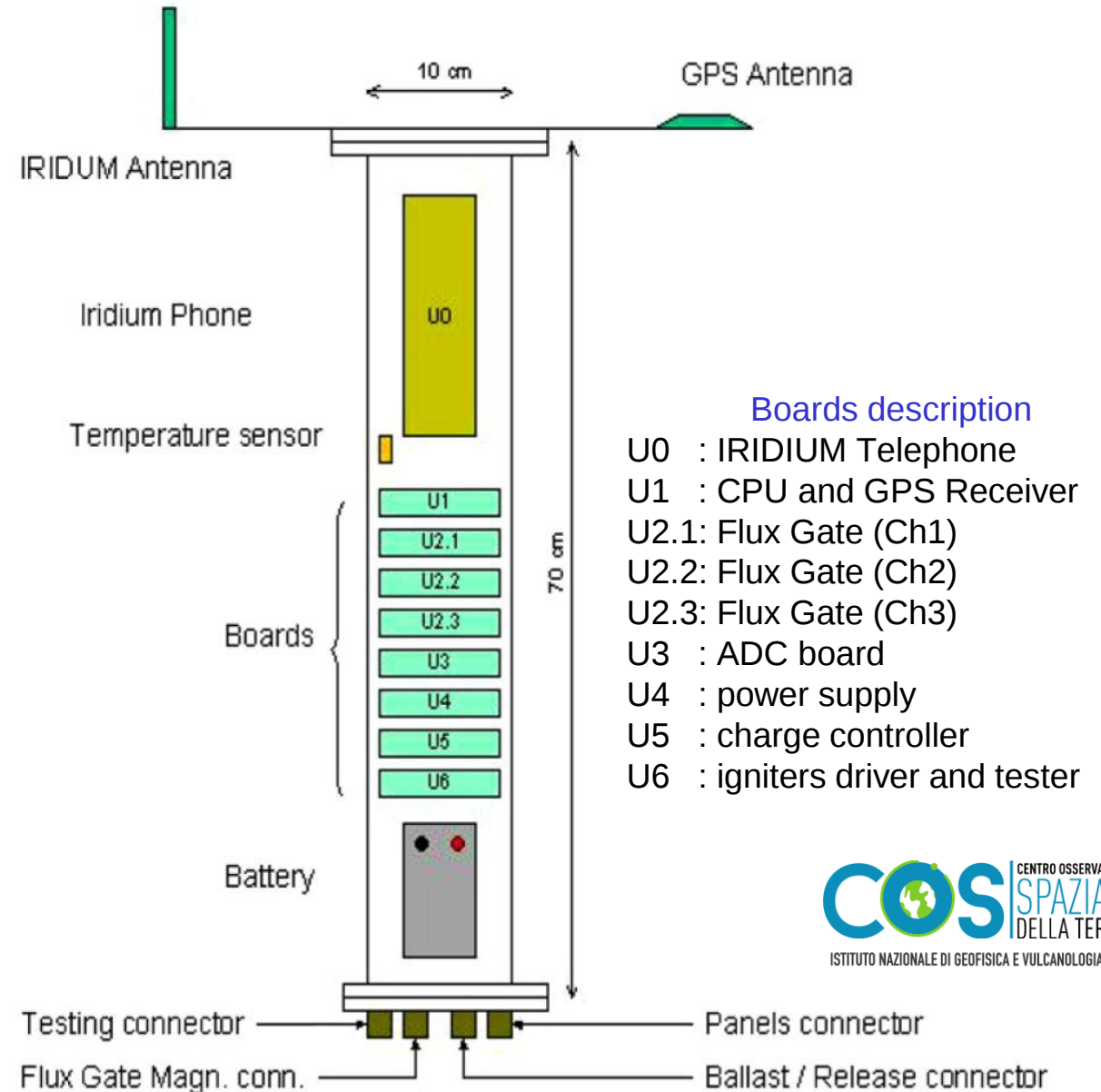
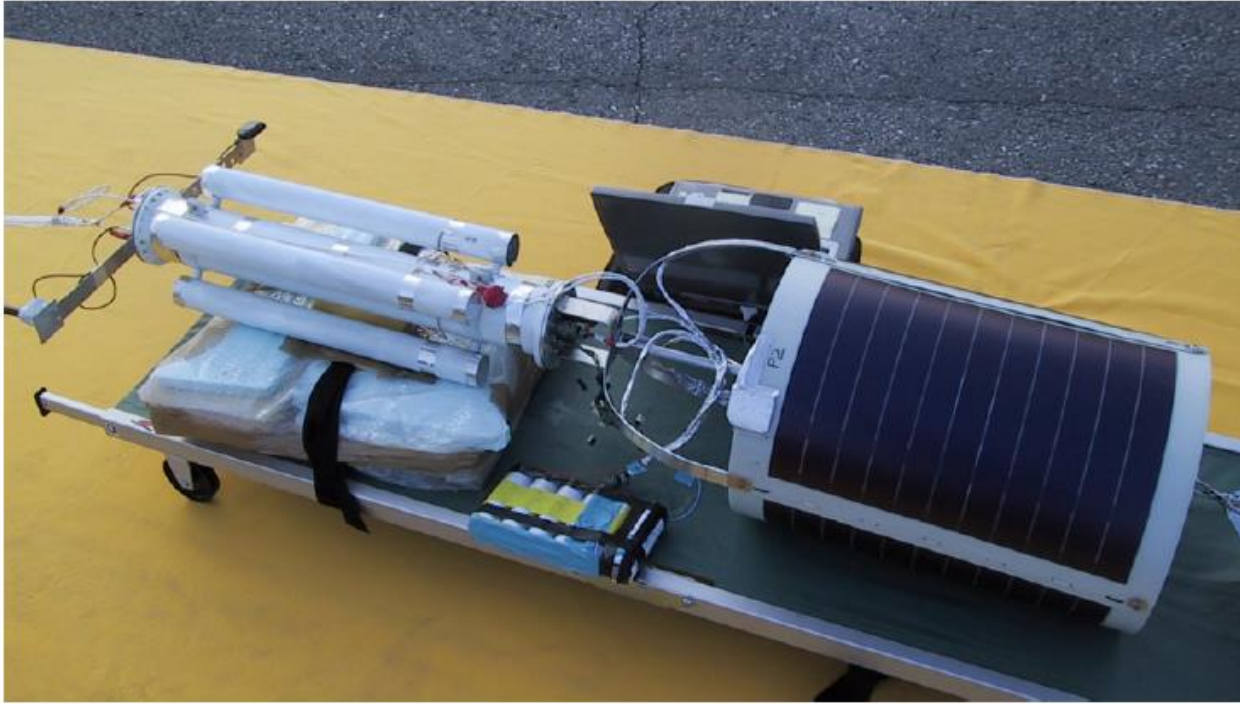
- Project PEGASO: Development a stratospheric payloads for LDB

PEGASO (Polar Explorer for Geophysics And Scientific Experiments) is a project in the framework of LDB program



A. Iarocci, et al - *PEGASO: An ultra light long duration stratospheric payload for polar regions flights* -
Advances in Space Research 42 (2008) 1633–1640

• Project PEGASO: Development a stratospheric payloads for LDB



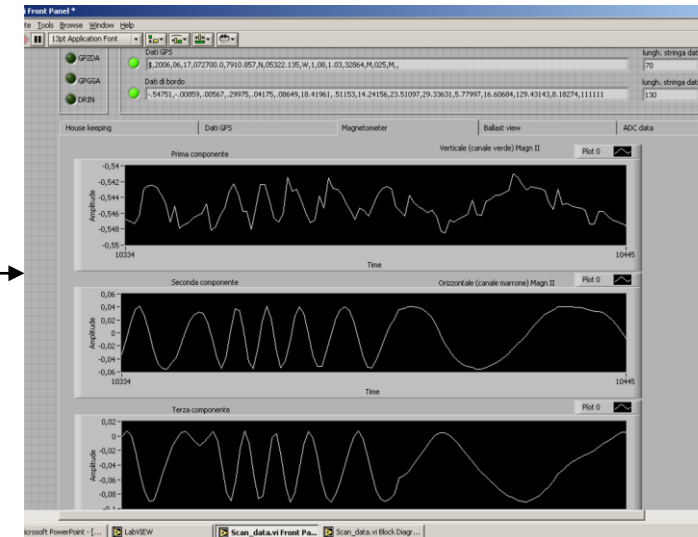
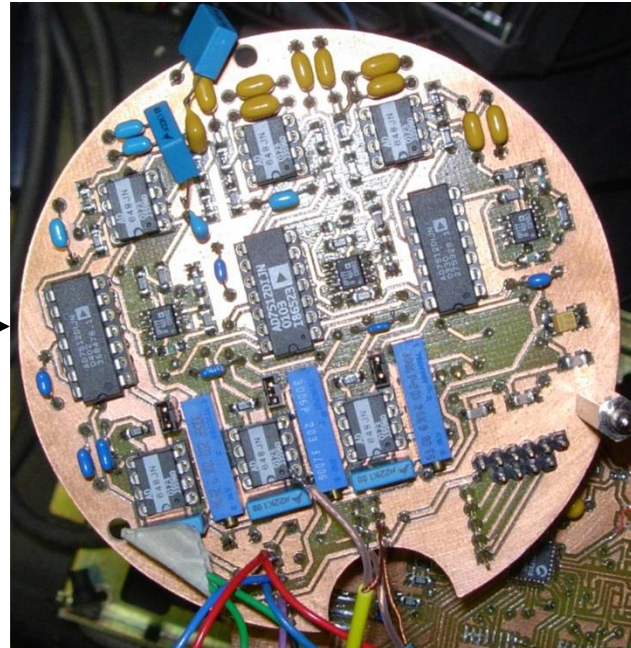
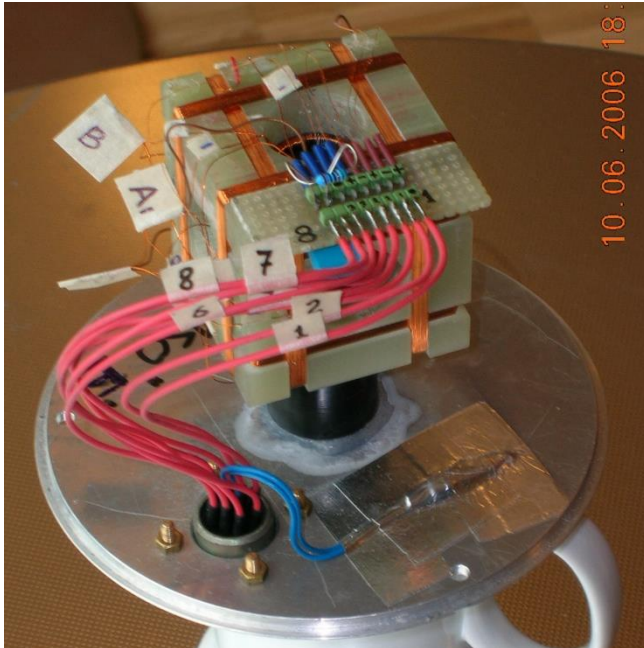
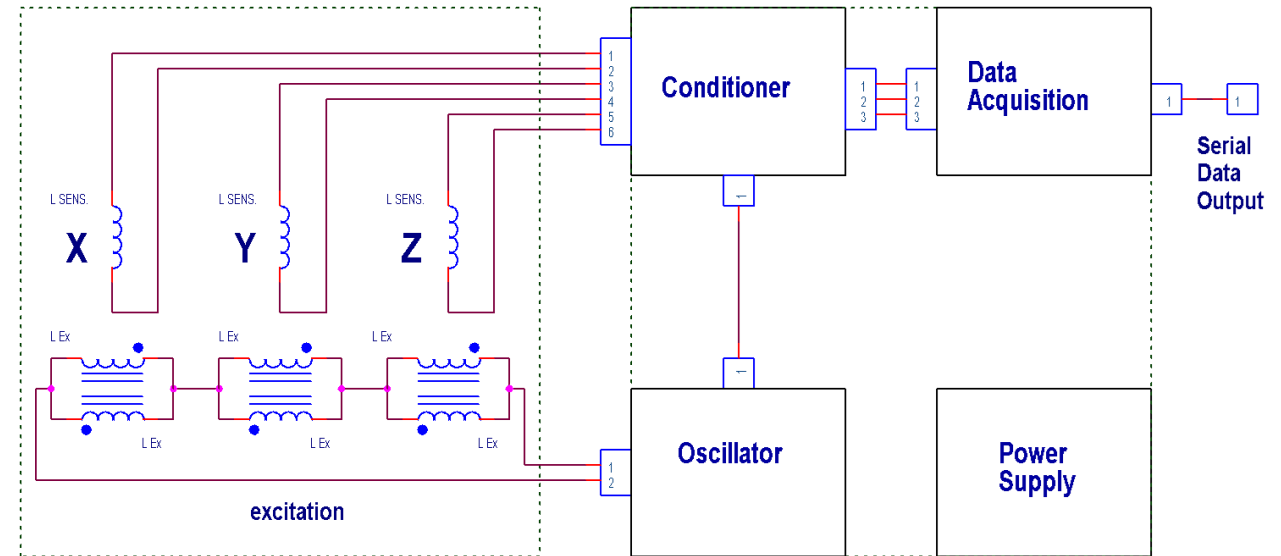
Activity in the LNTS:

- Developed all components of small payloads (~5kg)
- Iridium Telemetry
- Power system from solar energy
- Release system
- Termination system
- Magnetometer

• Project PEGASO: Development a stratospheric payloads for LDB

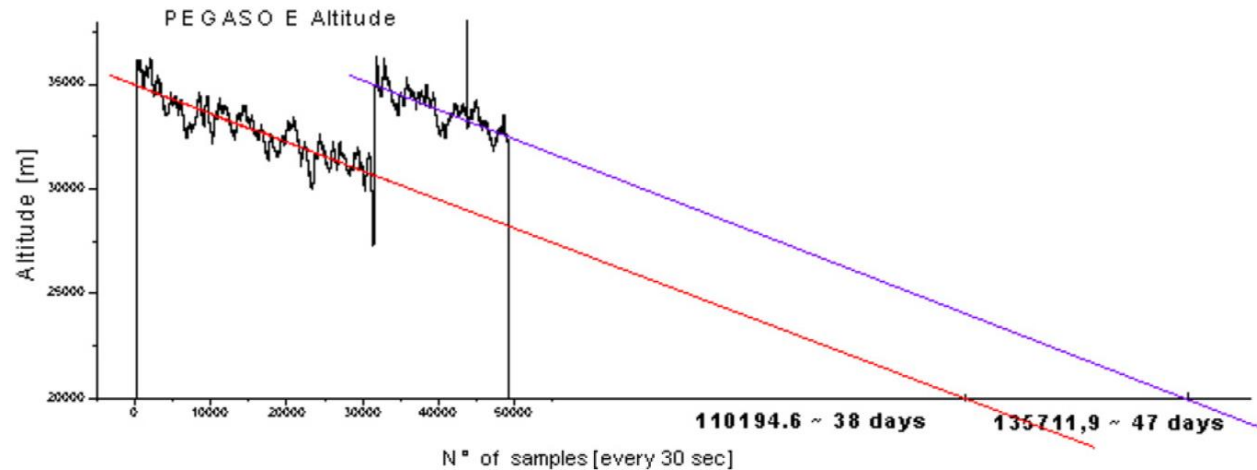
3 Axis fluxgate magnetometer for stratospheric payload (project PEGASO)

Experimental Specifics	
Power Supply	10 ÷ 20 VDC
Current (No telemetry)	200 ÷ 250 mA
Weigh	≈ 600g
Size	10x10x30cm
Accuracy	< 1 nT



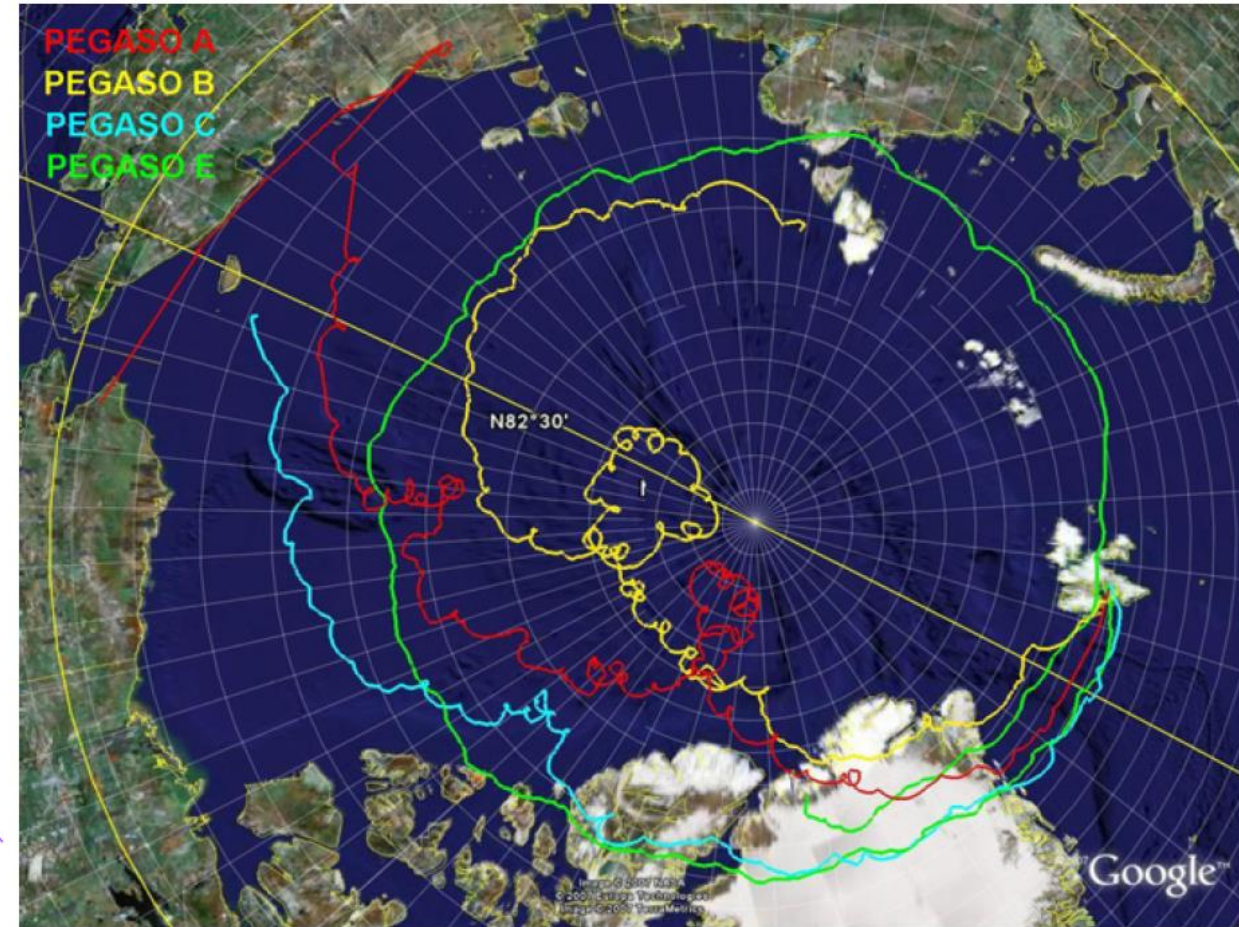
- Project PEGASO: Development a stratospheric payloads for LDB

Trajectory of the stratospheric flights of PEGASO over the north pole, launched from LongYearByen (Svalbard).



PEGASO missions table

PEGASO	Pole	Launch date	Termination date	No. of flight days	KM covered	Magnetometer
A	N	24 July 2004	31 August 2004	39	12,624	No
B	N	29 June 2005	23 July 2005	25	9966	Yes
C	N	5 July 2005	18 July 2005	13	6317	No
D	S	1 February 2006	7 March 2006	35	13,978	Yes
E	N	14 June 2006	2 July 2006	18	10,193	Yes



- Project: HERMES

The HERMES (HEmera Returning MESsenger) experiment (ASI, INGV, “La Sapienza” University)

HERMES is a framework of the HEMERA European Program

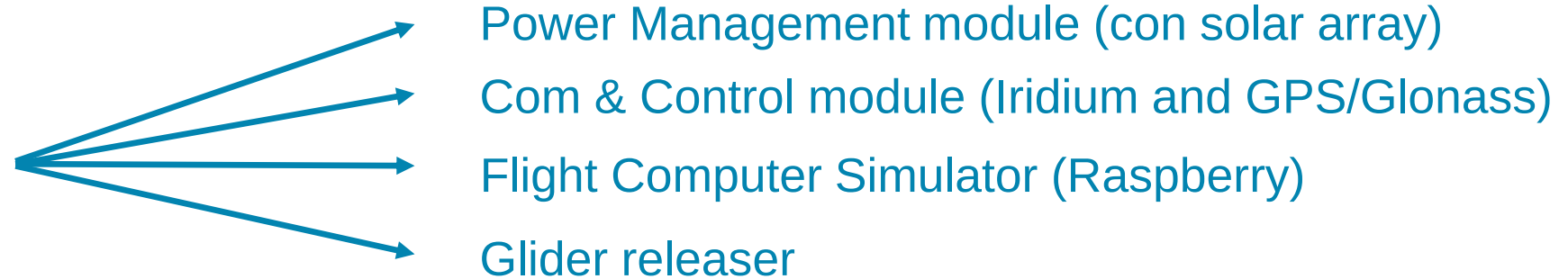
Technological objective of the project

- Transfer large amounts of data from a long-lasting stratospheric balloon (LDB balloon) to a Ground Station (in cosmological payloads about 5 GB / day);
- Achieve the goal by using an autonomous **glider** capable of physically carrying the data (stored in solid state memory) from the stratospheric platform to a recovery point on the ground. The glider is also able to carry test tubes on board for sampling in the stratosphere.

- Project: HERMES

The HERMES experiment consist of ...

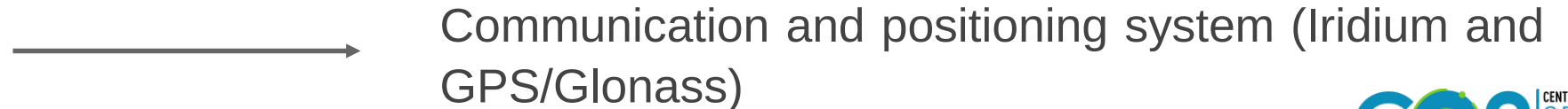
- Payload



- Glider



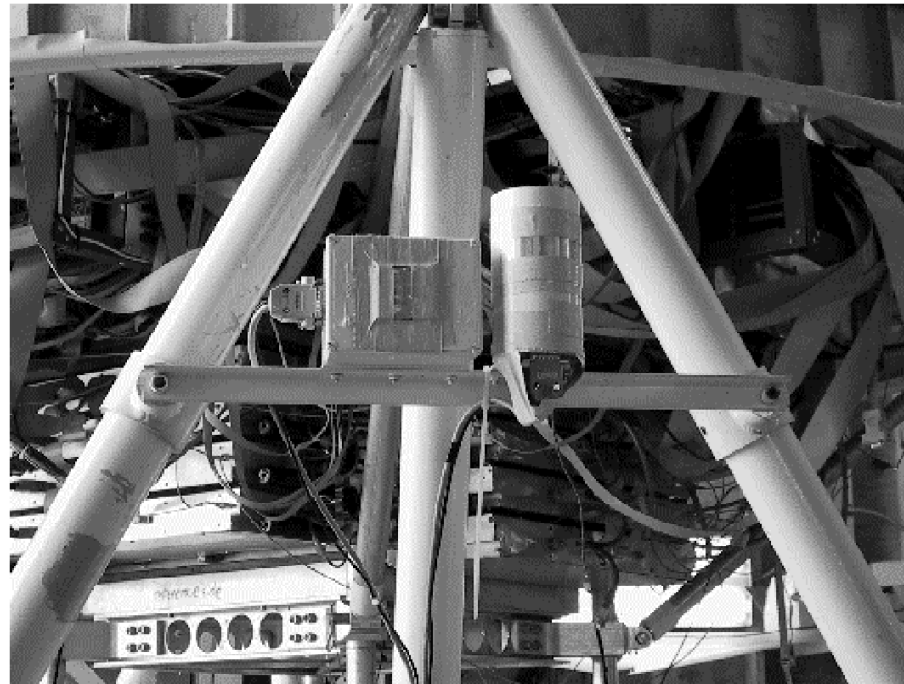
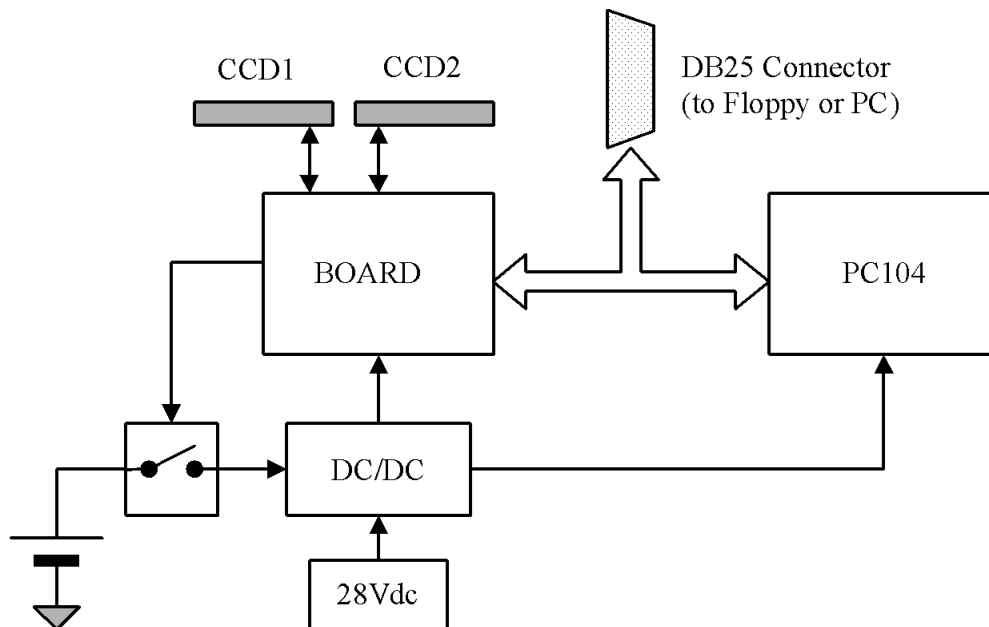
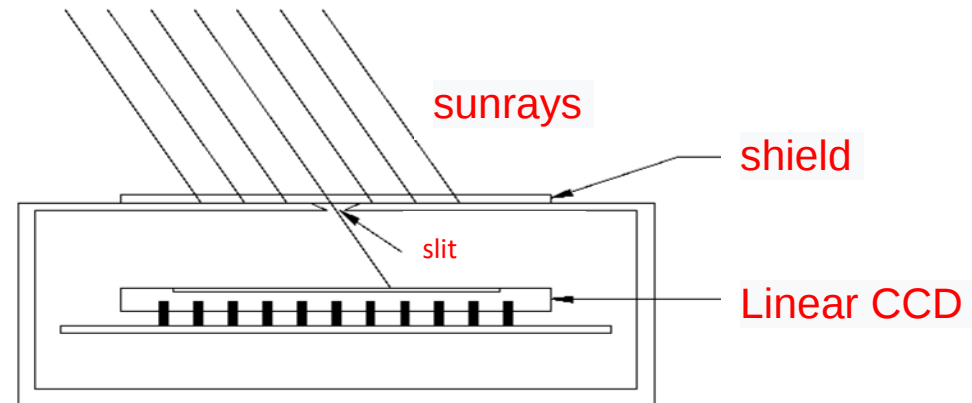
- Ground Station



- Product Developed: Fine Solar Compass

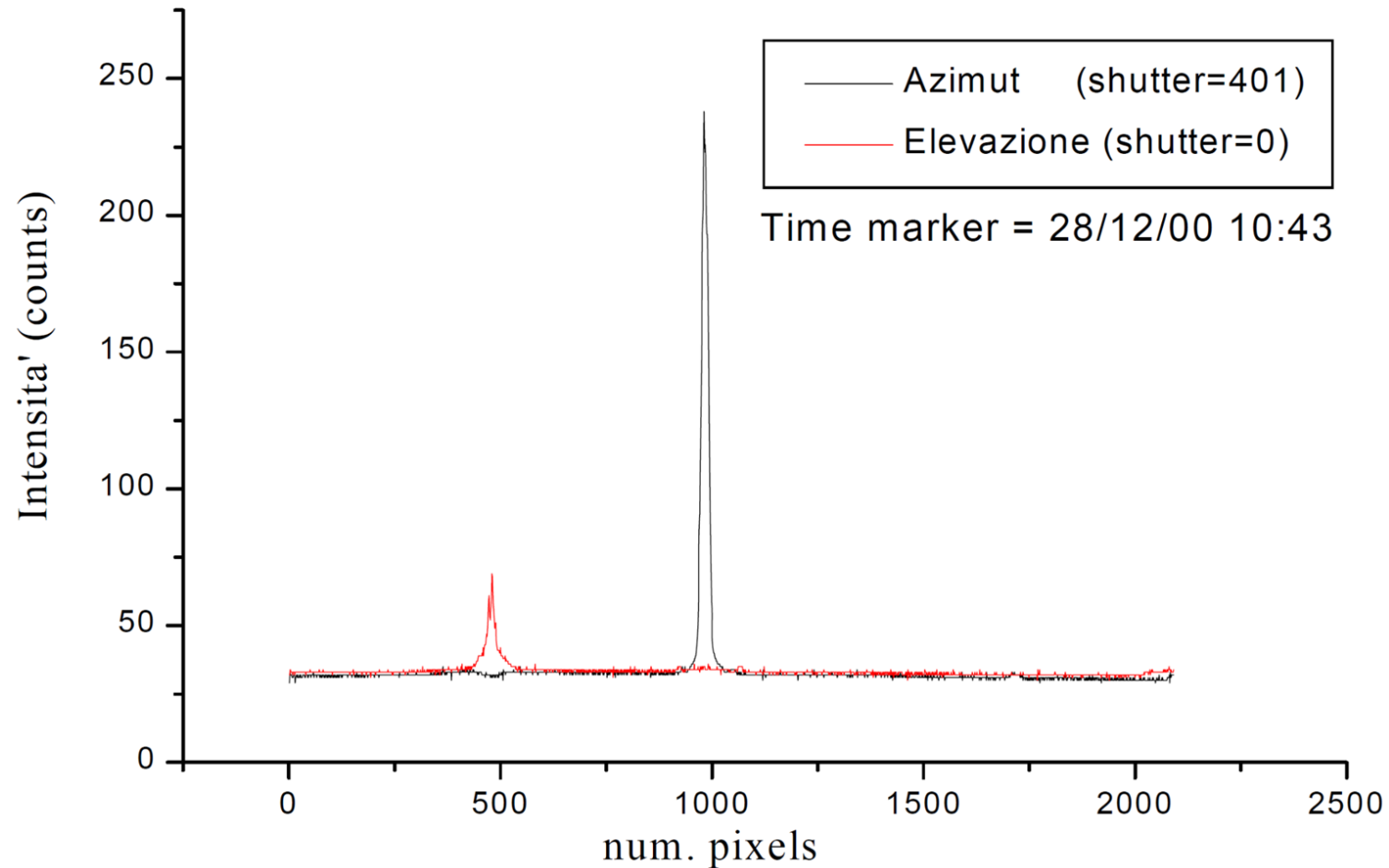


Linear CCD sensor

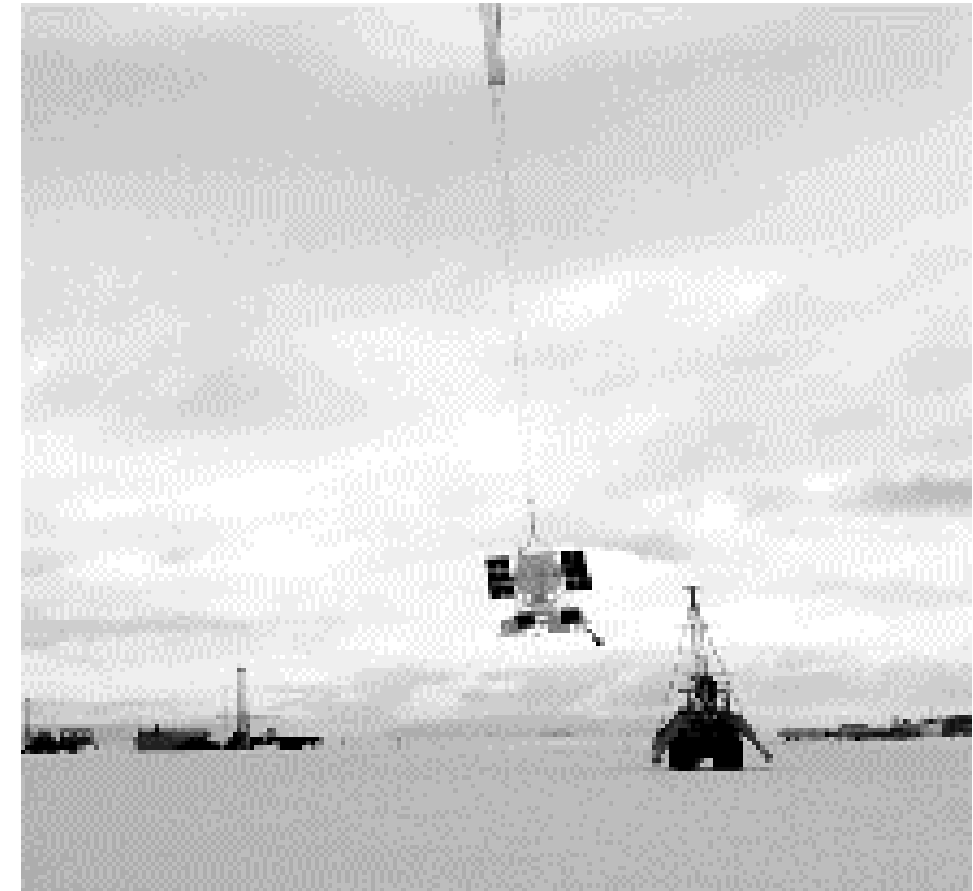


Two CCDs
(Azimuth and
Elevation)
hosted on board
the ATIC gondola

- Product Developed: Fine Solar Compass

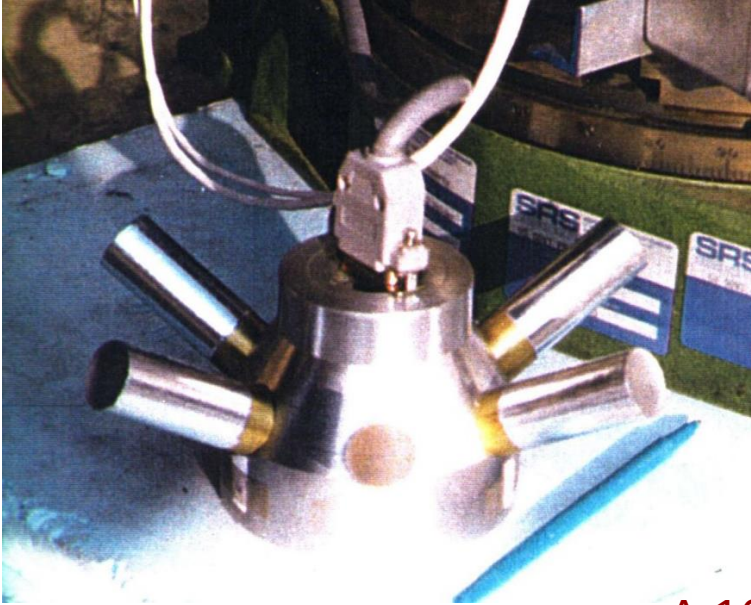


One Shot Frame of Azimuth and Elevation CCD



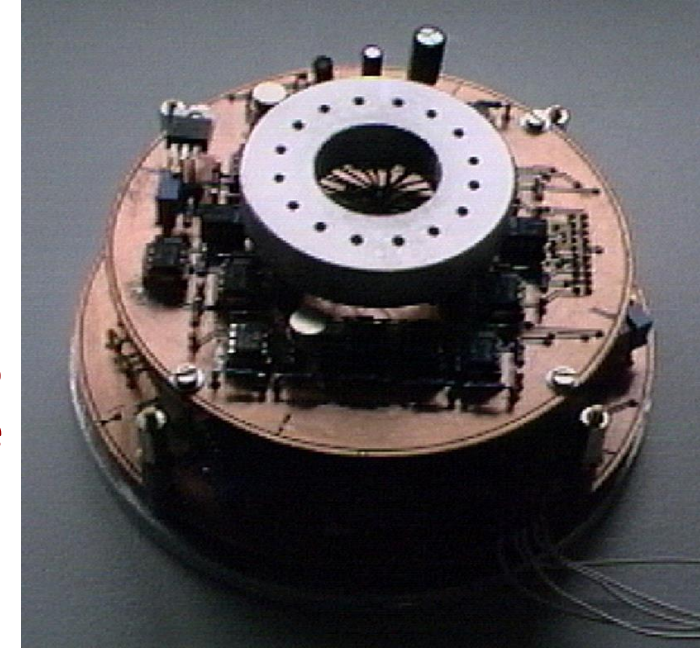
Launch of the gondola from Mc Murdo

• Product Developed: Coarse Solar Compass

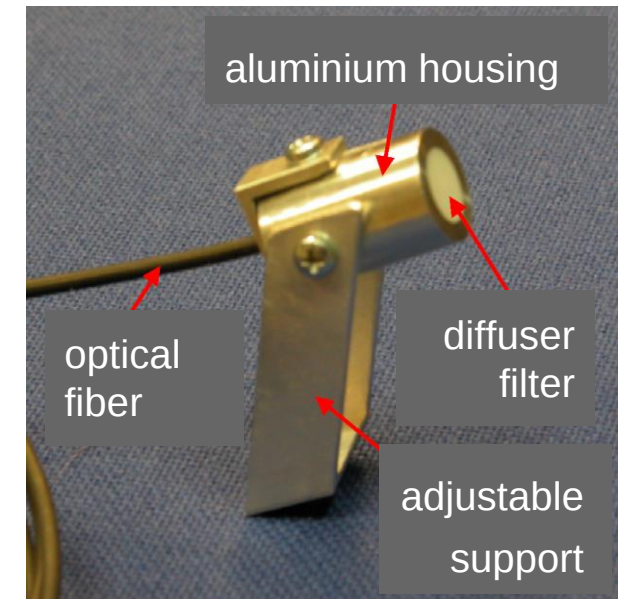
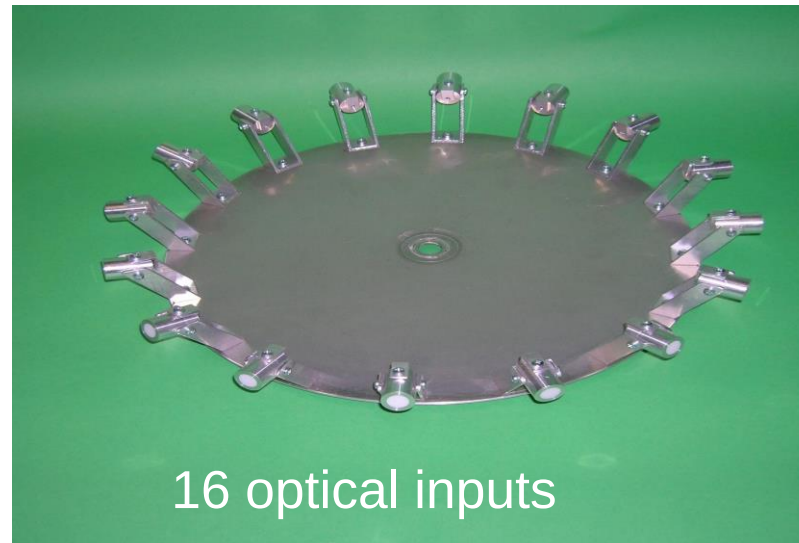
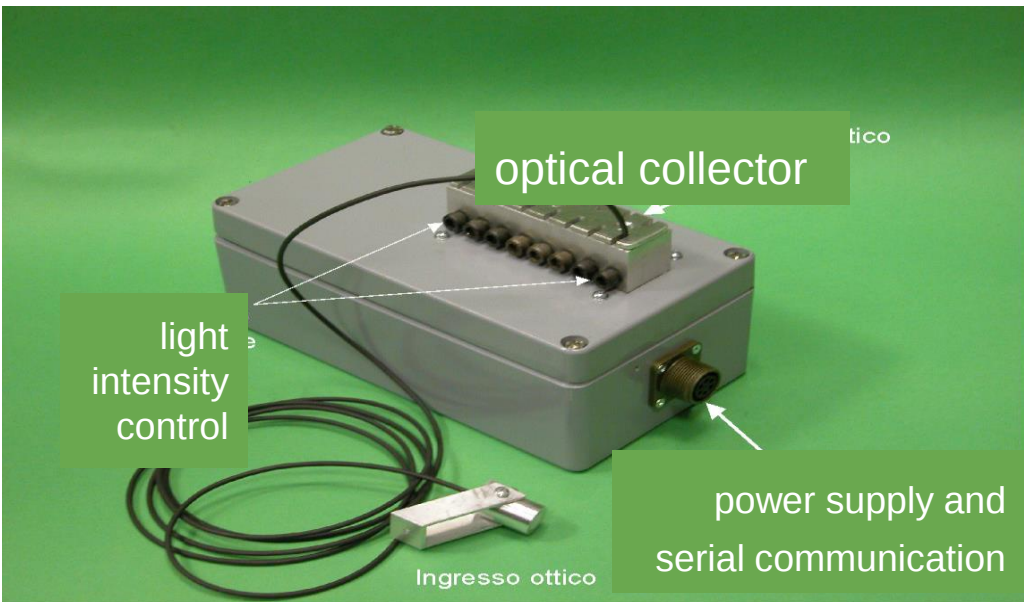


A six cells assembly used in the BOOMERanG flight (1998), made by the collaboration of Physics Depart. Univ. La Sapienza and LNTS-INGV.

A 16 cells compass. Photocells are inside the aluminium ring. The 16 holes are for optical inputs, where are inserted optical fibres.



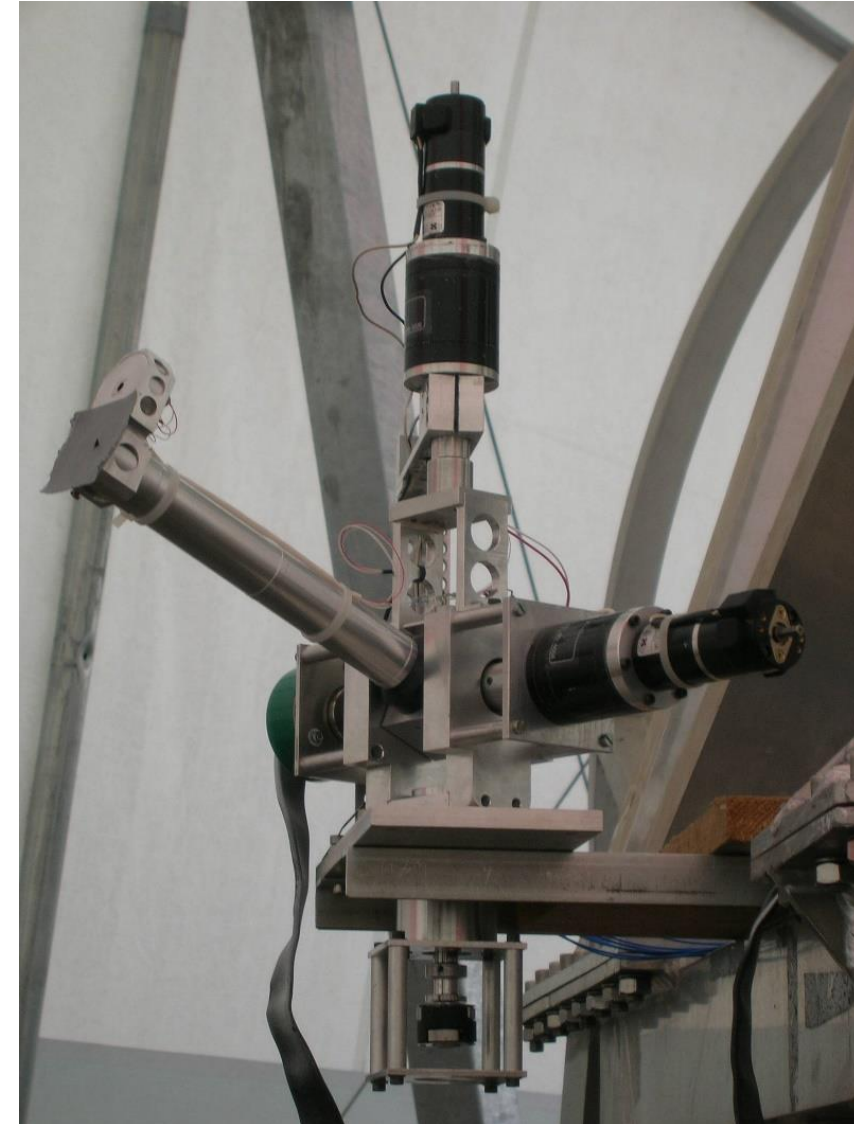
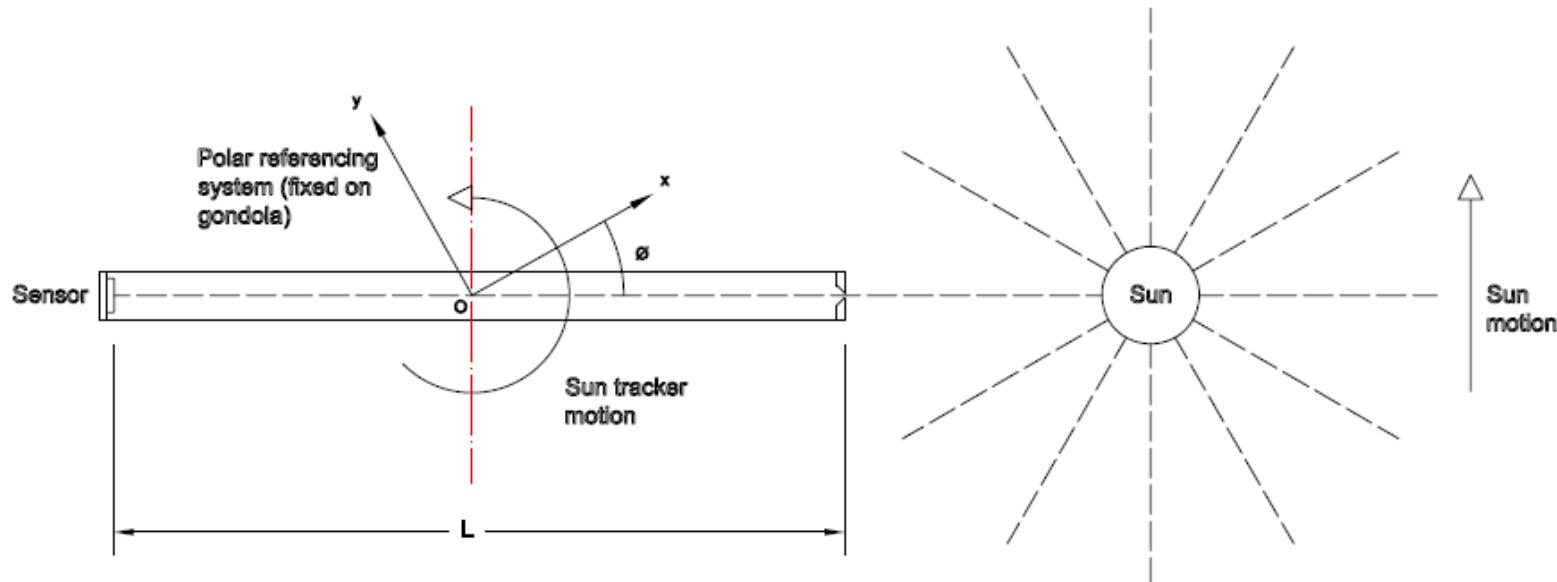
A 16 cells assembly cosine detector, used for the OLIMPO flight (2018).



• Product Developed: Analog controlled Sun Tracker

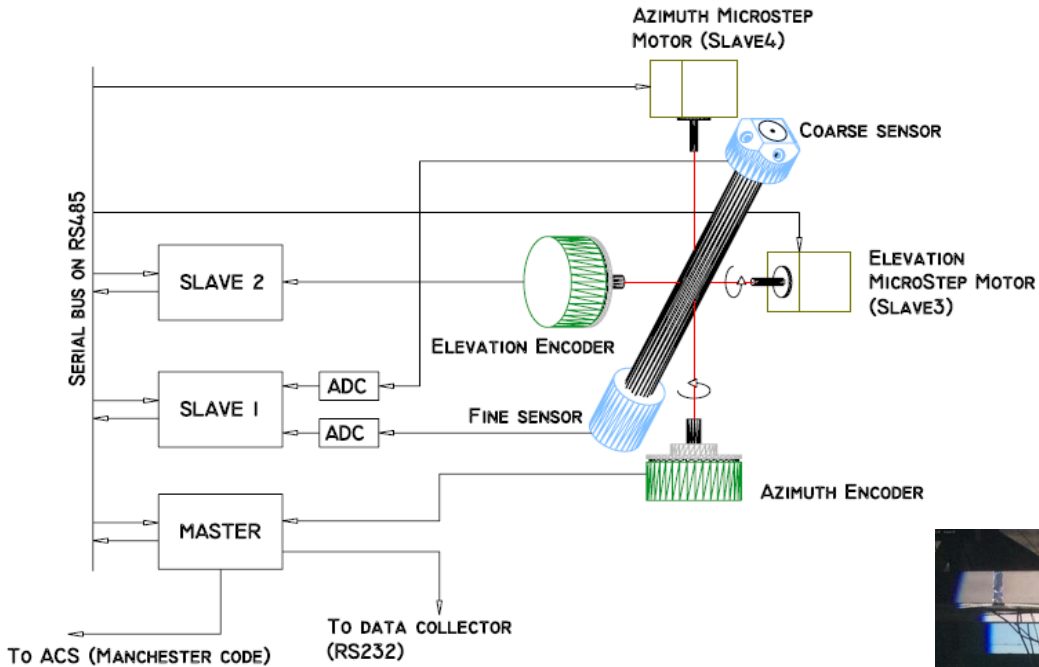
The *sun tracker* is an electro-mechanical device used on board of a gondola, carried by the stratospheric balloon for conducting earth and space observations at stratospheric altitude.

When the stratospheric fly has a place over the polar region during the summer, the sun tracker determines the polar coordinates of the sun position on the local reference system fixed on the gondola.

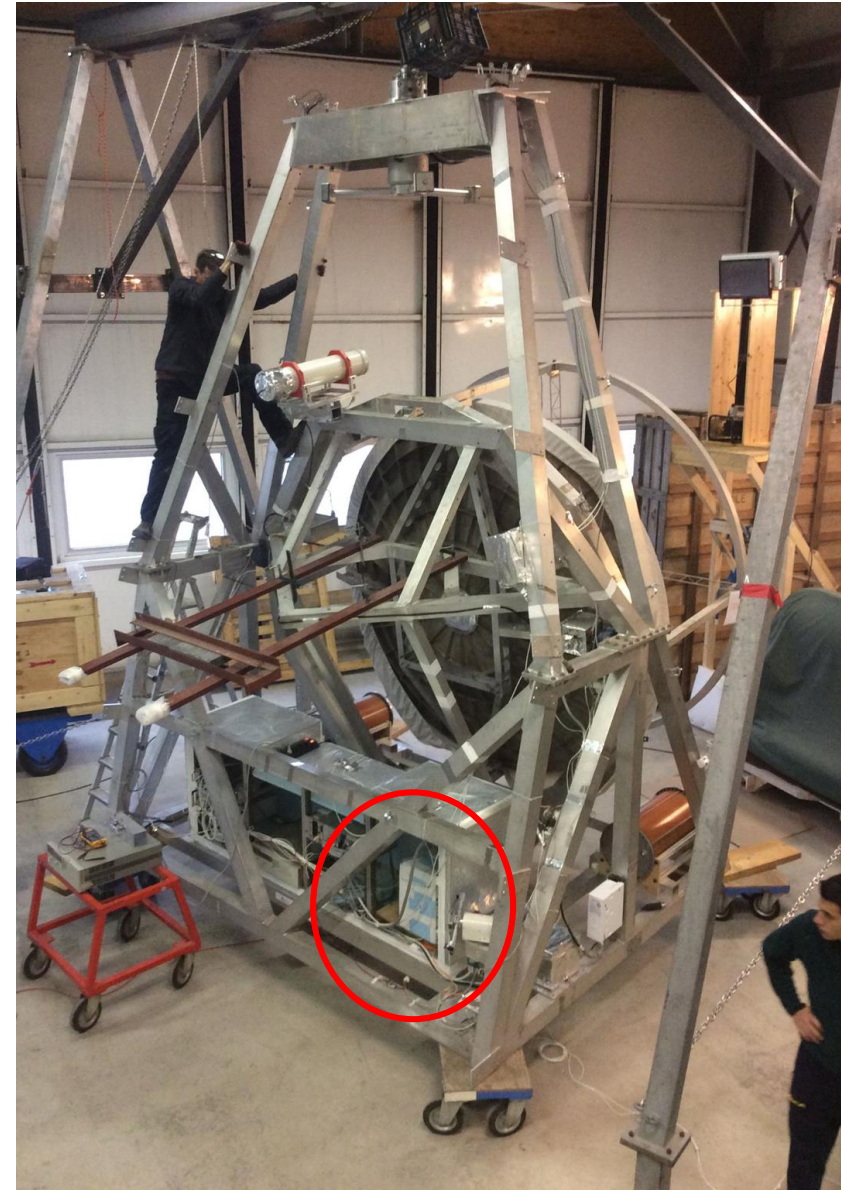
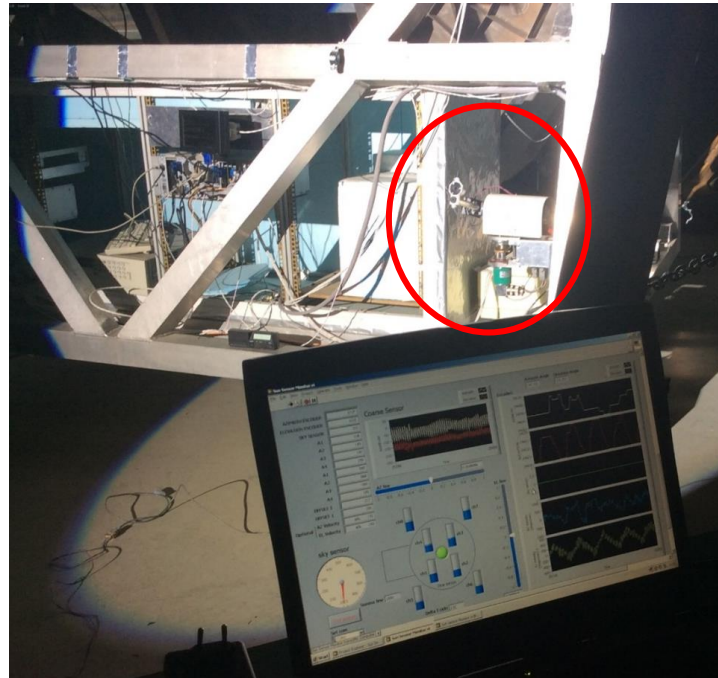
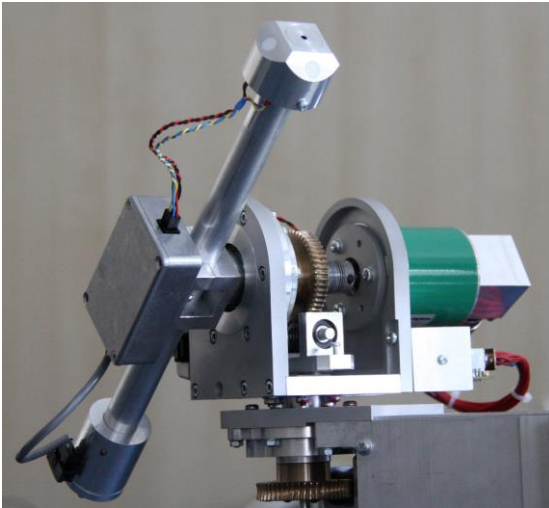


Analog Sun Tracker installed on BOOMERANG gondola

- Product Developed: Digital Controlled Sun Tracker



Sun Tracker installed
on OLIMPO gondola
during a test



- Product Developed: MPPT to power supply payloads

STRADIUM: power management for stratospheric payloads

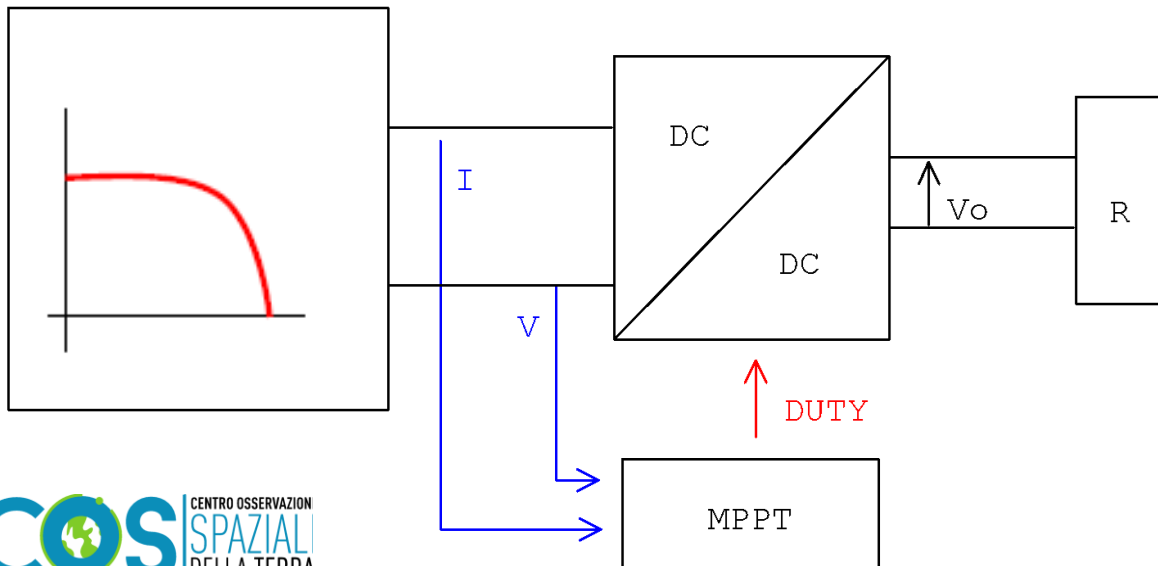
Features:

- power board with microcontroller;
- MPPT working in order to get max efficiency;
- output voltage regulation by means of PWM technique;
- power: 10W;
- safe mode guaranteed by flexible handling of load and batteries.

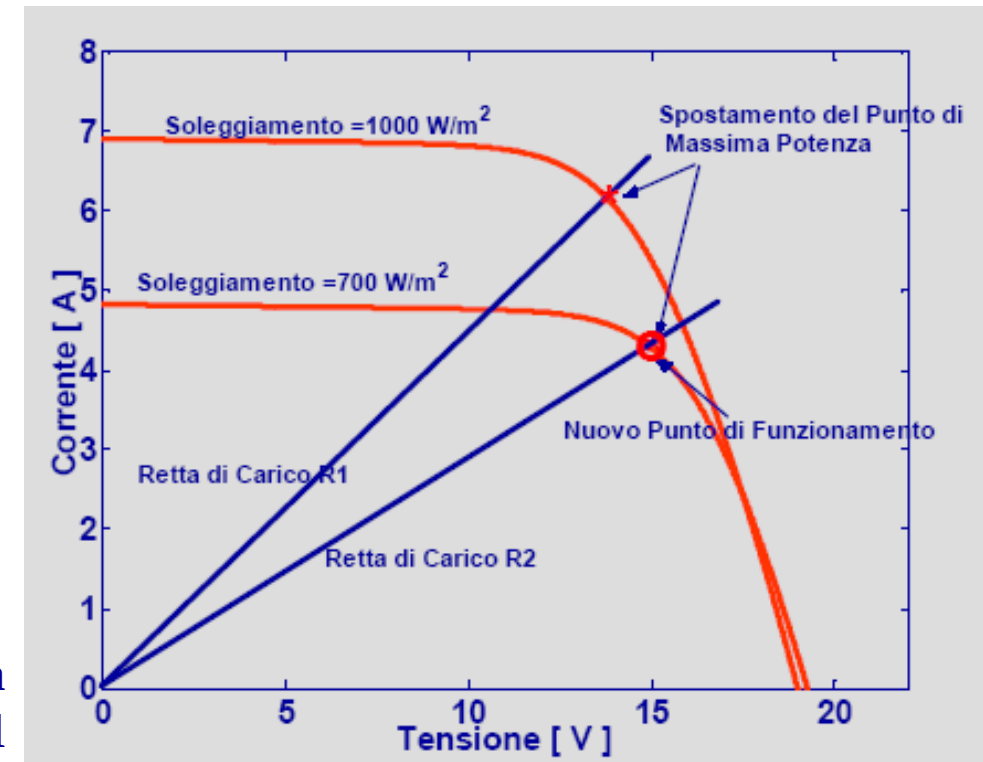
• Product Developed: MPPT to power supply payloads

Goal: MPPT working....

- the output power is maximum at a single operating point. This is known as the Maximum Power Point;
- the MPP changes continuously due to: radiation level, sun angle, temperature;
- if one is to get the most out of their solar cells, it is essential to operate around the MPP.



I vs. V for a
basic solar cell



- Team and Affiliations

Actual proposed
team

Giuseppe Di Stefano
Alessandro Iarocci
Francesco Pongetti
Massimiliano Vallocchia
Massimo Mari
Giuseppe Spinelli
Marcello Silvestri

LNTS - ROMA1 - INGV

Massimo Orazi
Francesco Liguoro

OV - INGV

• Infrastructures for instruments development

- Actually we have available of:
 - the LNTS - New Technologies and Instruments Laboratory (INGV-Roma1) - that consists in an Electronic Laboratory and a Mechanical Shop.
 - Electronic Laboratory of Vesuvian Observatory (INGV-OV).

Needs ...

- Enhance laboratory instrumentation (e.g. simulators, development systems, etc ...) for the development of electronic and mechanical equipment.
- Increase the staff
- Favorite the integration into the world of aerospace technologies as technical workshop, conference, fairs ...