# Agenzia Spaziale Italiana

# *The Italian Stratospheric Balloon Program*

Enrico Flamini - Domenico Spoto
CSA Workshop on ‘Suborbital Platforms and Nanosatellites
Montreal 2010

# Main Activities

The stratospheric balloon activities in Italy started in 1975.

Main researches have been made in astrophysics:

- X Ray
- I R radiation
- Cosmic Rays
- Cosmic Ray effect on biological structure
- Biological experiments
- Planetary instruments and probe tests

And also in Technological tests :

- Preliminary test of satellite equipments and sub-systems
- A.R.D. Atmospheric Reentry Demonstrator (capsule rescue qualification)
- Flight control technique: balloon guidance using wind altitude dependency

# MOST IMPORTANT EXPERIMENTS LAUNCHED 1975-2003

| | | |
|---|---|---|
| *Milo1* | *Cosmic particles* | *Bristol University* |
| *Milo2* | *X Sources and C.B.R.* | *CNR and Washington University* |
| *Milo3* | *$\gamma$ ray Astronomy* | *IFCTR (CNR) and Max Plank inst.* |
| *Odissea1* | *Cosmic particles* | *CONIE SPAIN* |
| *Odissea2* | *$\gamma$ ray Astronomy* | *IFCTR - GIFCO - ITESRE (CNR)* |
| *PAF* | *Radio Astronomy* | *IROE - GIFCO (CNR)* |
| *CAESAR* | *$\gamma$ ray Astronomy* | *CERS/CEN CNES* |
| *CELIMENE* | *X Astronomy* | *IAS (CNR)* |
| *AGLE* | *IR Astronomy* | *CERS - CEN (CNES)* |
| *CIRCE* | *X Astronomy* | *IAS (CNR)* |
| *ULISSE* | *IR Astronomy* | *IROE (CNR)* |
| *ENEA* | *X Astronomy* | *IAS (CNR)* |
| *POKER* | *X Astronomy* | *IAS (CNR)* |
| *TELEMACO* | *IR Astronomy* | *IROE (CNR)* |
| *ELENA* | *$\gamma$ Astronomy* | *ITESRE (CNR)* |

# MOST IMPORTANT EXPERIMENTS LAUNCHED 1975-2003

| | | | |
|---|---|---|---|
| *FIGARO* | *$\gamma$* | *Astronomy* | *CERS (CNES) IFCAI/IAS (CNR)* |
| *PALLAS* | *X* | *Astronomy* | *IAF/IAS (CNR) -Southampton Univ.* |
| *ARGO* | *IR* | *Astronomy* | *IROE/IFA (CNR)* |
| *MINITIR* | *IR* | *Astronomy* | *ROME UNIV. IRE/CAISMI/IAS(CNR)* |
| *MINIZEBRA* | *X* | *Astronomy* | *CNR -Southampton Univ.* |
| *PHOSWICH* | *X* | *Astronomy* | *ITESRE(CNR) - Univ.* |
| *AROME* | *IR* | *Astronomy* | *CNES* |
| *LAPEX* | *X* | *Astronomy* | *ITESRE/IAS (CNR) CERS (FR)* |
| *ARD* | *Technologic* | | *ESA* |
| *S.Q.M.* | *Nuclear research CNR(TO) & TOKIO University* | | |
| *HASI* | *Huygens Atmospheric Structure Instr. CISAS/Padova* | | |
| *Univ. BIRBA* | *Collection of biological exp. Italian Labs & Univ.* | | |
| *BABY* | *UV Observation BAckground BY-pass IASF-CNR* | | |
| *SAFIRE – B* | *Atmospheric study –Envisat IFAC-CNR (FI)* | | |

# 2002-2009 Last Flights

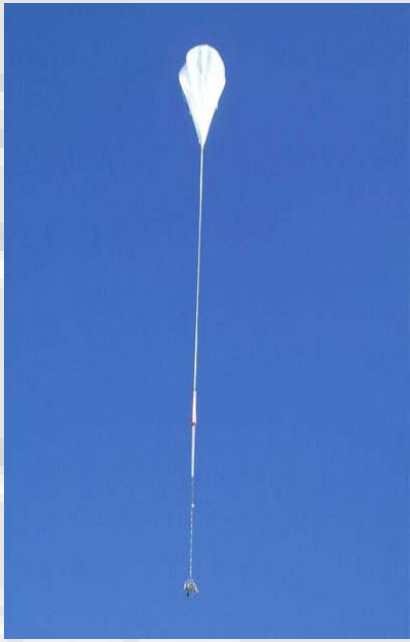
| Year | Launches | In co-operation with |
|---|---|---|
| 2009 | a) SoRa ( including 3 piggy back experiments) Svalbard | CISAS- Univ. Padova, Univ. Chieti, Univ. Napoli, Univ Bologna, INAF, CORISTA- Thalesaleniaspace |
| 2008 | a) Duster Andoya | Univ. Napoli |
| 2007 | a) USV-DTFT0 (2006 Summer Local Flight- ready to fly postponed to February 2007 due to meteo conditions) | a) CIRA |
| 2006 | a) 1 Flight from Antarctica<br>b) 1 Flight from Svalbard | a) PNRA, INGV,Ph. Dept University "La sapienza" , CNR/ISTI<br>b) ARR, INGV,Ph. Dept "La Sapienza", CNR/ISTI |
| 2005 | a) 2 Flights from Svalbard (PEGASO B & C) | a) ARR, INGV,Ph. Dept "La Sapienza", CNR/ISTI |
| 2004 | a) PEGASO Svalbard | a) ARR, INGV,Ph. Dept "La Sapienza", CNR/ISTI |
| 2003 | a) HASI From Milo<br>b) 4 Flights Trailblazer from Svalbard | a) CISAS_Univ. Padova – Obs. Paris Meudon- ESA<br>b) ARR, INGV,Ph. Dept "La Sapienza", CNR/ISTI |

# Trapani Milo: L. Broglio Base Location


# Main Buildings & Infrastructures

# LOCATION & SAFETY

Near the sea, minimum time in land over-flight
Water/Land recovery option
Main infrastructures and commerce (Airport,-Harbour-Highway)



Low population density during territory over-flight
Several areas for safety landing and recovery

# On Site Facilities…

600 m diameter Launch-Pad

Integration facilities able to accommodate up to 3 scientific payload at the same time

Launch vehicle capacity up to 2.500 Kg

Mechanical workshop & Electronic Laboratory

Thermo & Vacuum test equipments

Meteo station

# On Site Facilities

UHF telemetry / telecommand ground station and on-board equipment (equipped with a mobile station)

S Band telemetry / telecommand ground station and on-board equipment (equipped with a mobile station)

Iridium based TM/TC system for LDB flight

Flight control and balloon tracking system

Real time flight data Digital/Analog recording

High bit rate real time data acquisition system

Flight dynamics support and operations

Meteo forecasting and Vaisala sounding station

UHF on Board Avionics

# Trapani Balloon Control Center

# ASI Balloon Launch Facility
# Main support equipments


Launch Spool Machine


Wind measurement


UHF Mobile Station

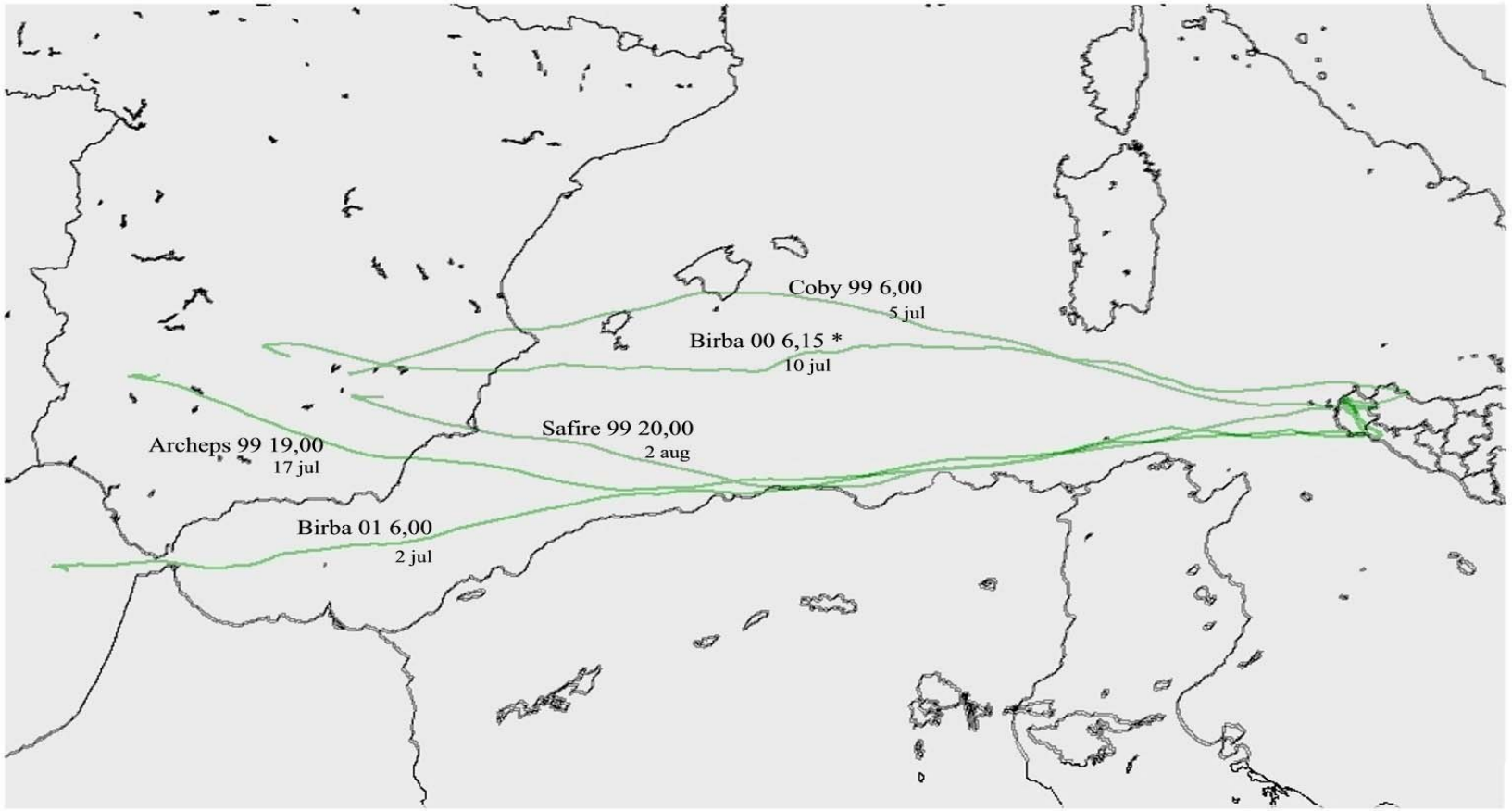

S band -Antenna & Mobile Station

# General Description

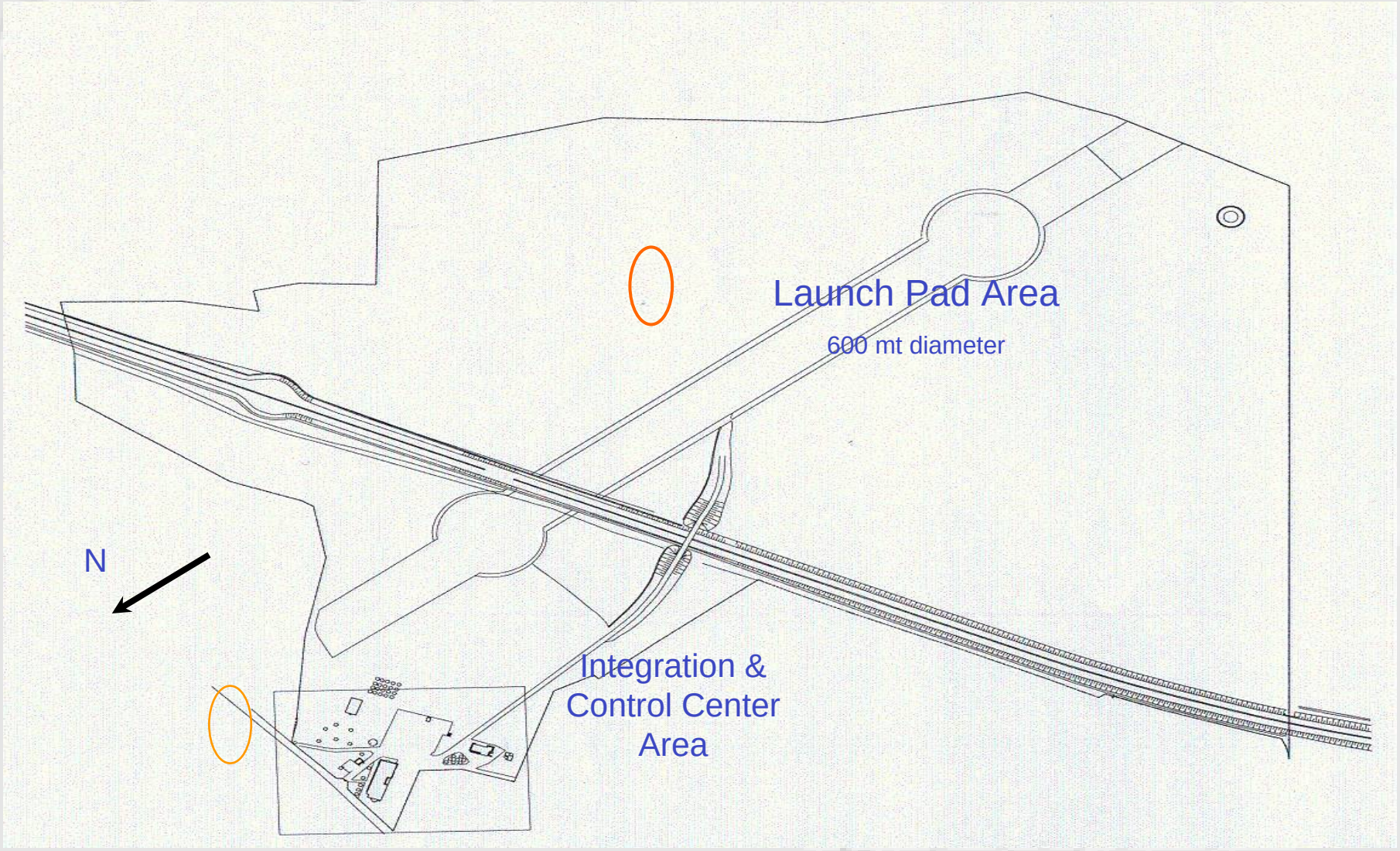
| | |
|---|---|
| Established: | 1975 |
| Geographic coordinates: | 38 01’ N, 12 35’ E |
| Flight statistics: | over 120 launches<br>over 85 % successfully concluded<br>4 flight/year |
| Payload Weight: | max 3.5 ton (h=30 Km)<br>max 2.5 ton (h=42 Km) |
| Flight duration: | > 20 Hours (Trans-Mediterranean) |

# TRAJECTORY

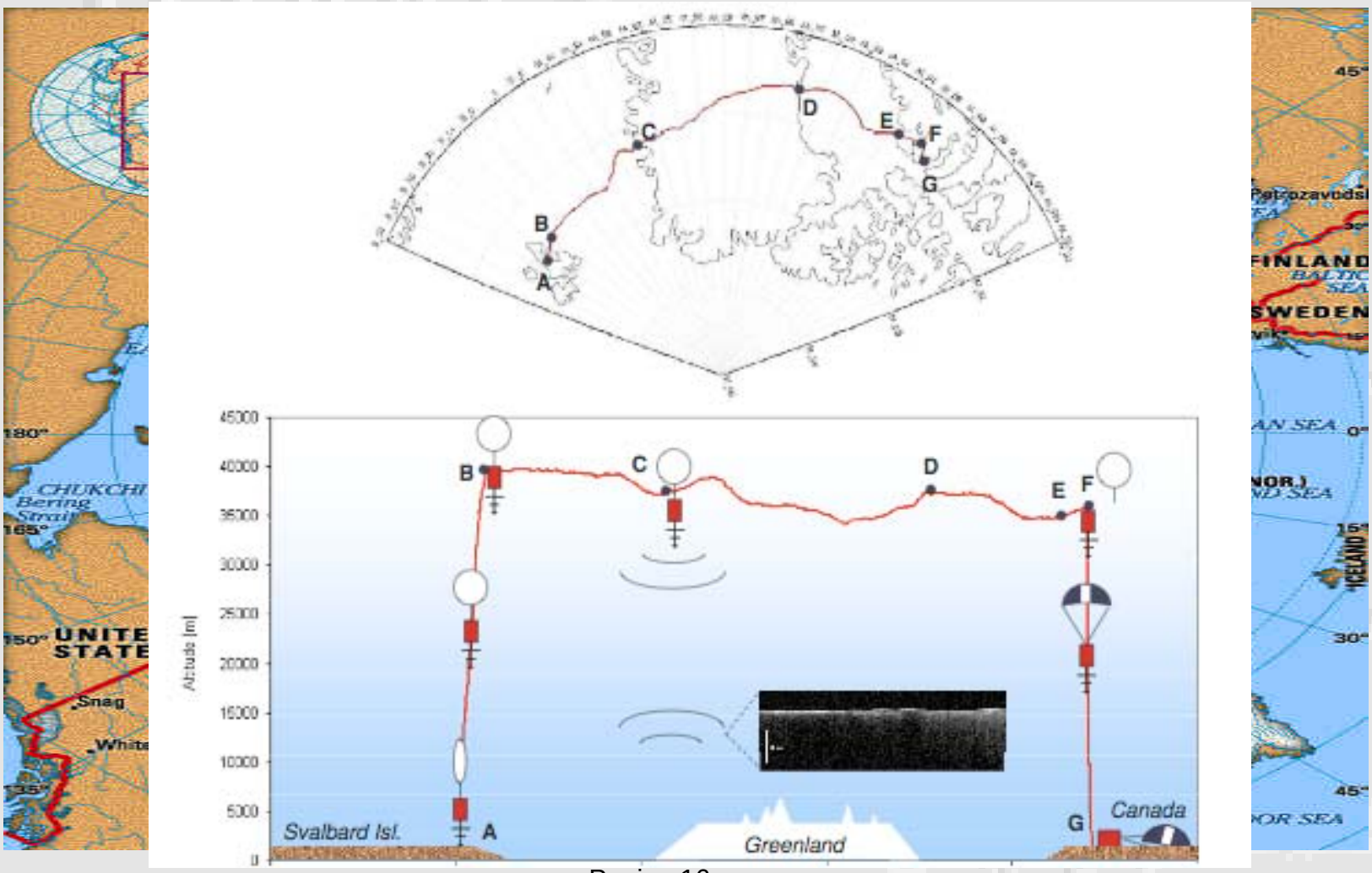
An average of 20 hours for a Trans-Mediterranean flight



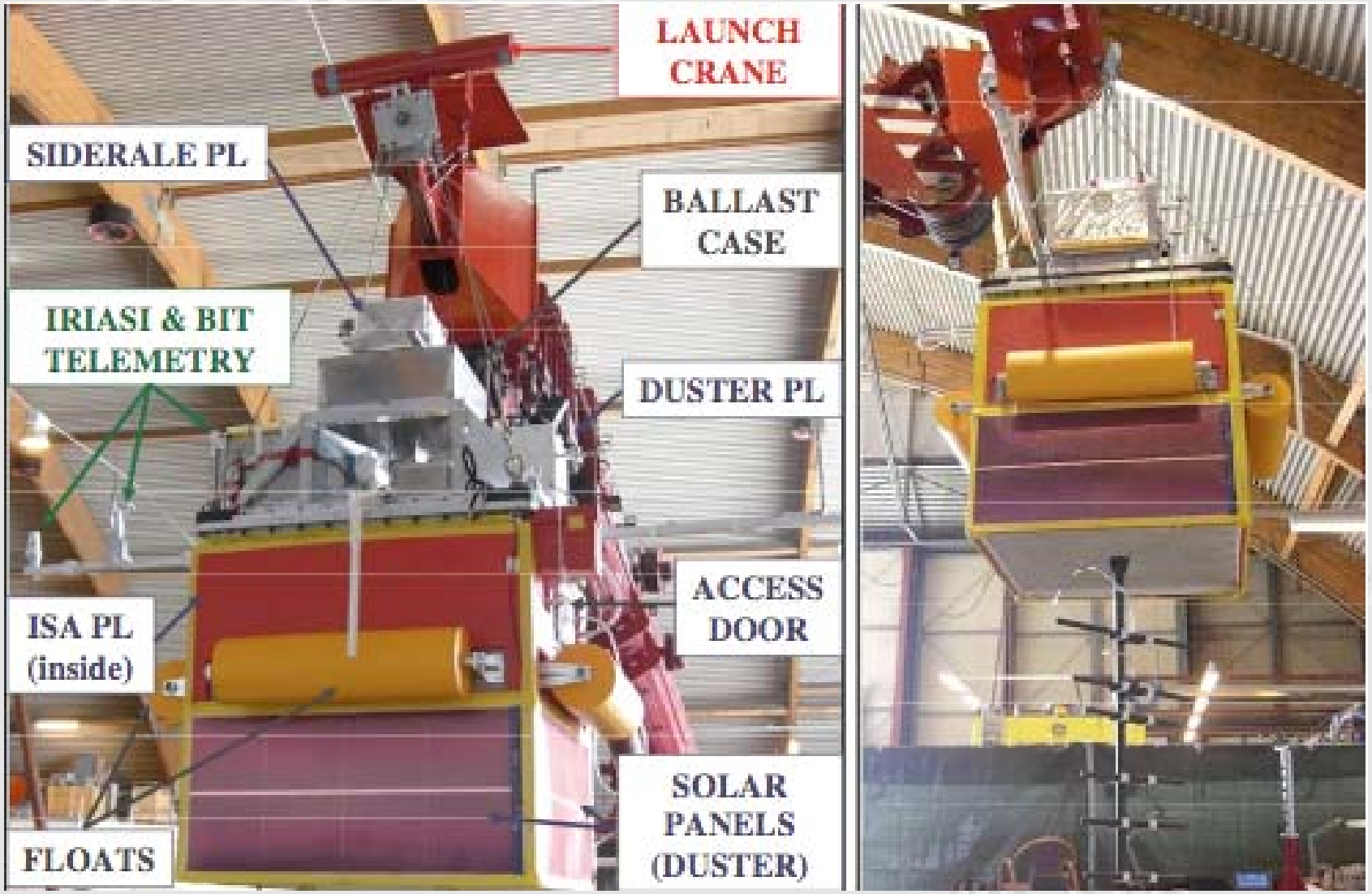
# Site Map
# 95 Ha overall area



# Longyearbyen Svalbard Norway
# Andoya Rocket Range



# *SoRa- Sounding Radar Experiment*



# Longyearbyen Svalbard Norway
# Andoya Rocket Range

| | |
|---|---|
| Geographic coordinates: | 78° 14’ N, 15° 30’ E |
| Site management | Andoya Rochet Range (Norway) |
| Launch season window | 30-50 Days June-August ; 30 Days Dec.-Jan. |
| Flight direction | West (Summer) East (Winter) |
| Flight duration | from 1 week- to 1 month and over |
| Launch Pad | Airport |
| Assembly buildings | Yes |
| Flight authorization | Yes |
| Overflight permissions | (Agreement finalized for Russian Territory) |
| TM/TC to be used | Satellite |

First flight for LDB Heavy payload from Svalbard accomplished

Next experiments

* OLIMPO 1&2 (Univ. La Sapienza + FR + UK)
* BOOMERanG (Univ. La Sapienza + FR + UK)
* SORA2 (Univ. Padova + FR + UK)


*New site of the*
*Nobile / Amundsen Stratospheric Balloon Center*
*Svalbard*

# Malindi Kenya
# ASI Space Centre

# Malindi Kenya
# ASI Space Centre

| | |
|---|---|
| Geographic coordinates: | 2.99 S, 40.19 E |
| Site management | Italian Space Agency (ITALY) |
| Launch season window | Study in progress ( summer-winter) |
| Flight direction | East – West Study in progress |
| Flight duration | Local flight or LDB |
| Launch type | Low weight, Auxiliary balloon, Dynamic launch |
| Launch pad | Design in progress |
| Assembly buildings | Yes |
| Flight authorization | Under definition (DoD Kenya) |
| Overflight permissions | TBI (DoD Kenya) |
| TM/TC to be used | LoS for local flight or Satellite Iridium |
| On site support equipment | Workshops (Electronic and Mechanical) |

# ANTARCTICA
## Terra Nova Bay – Base M. Zucchelli

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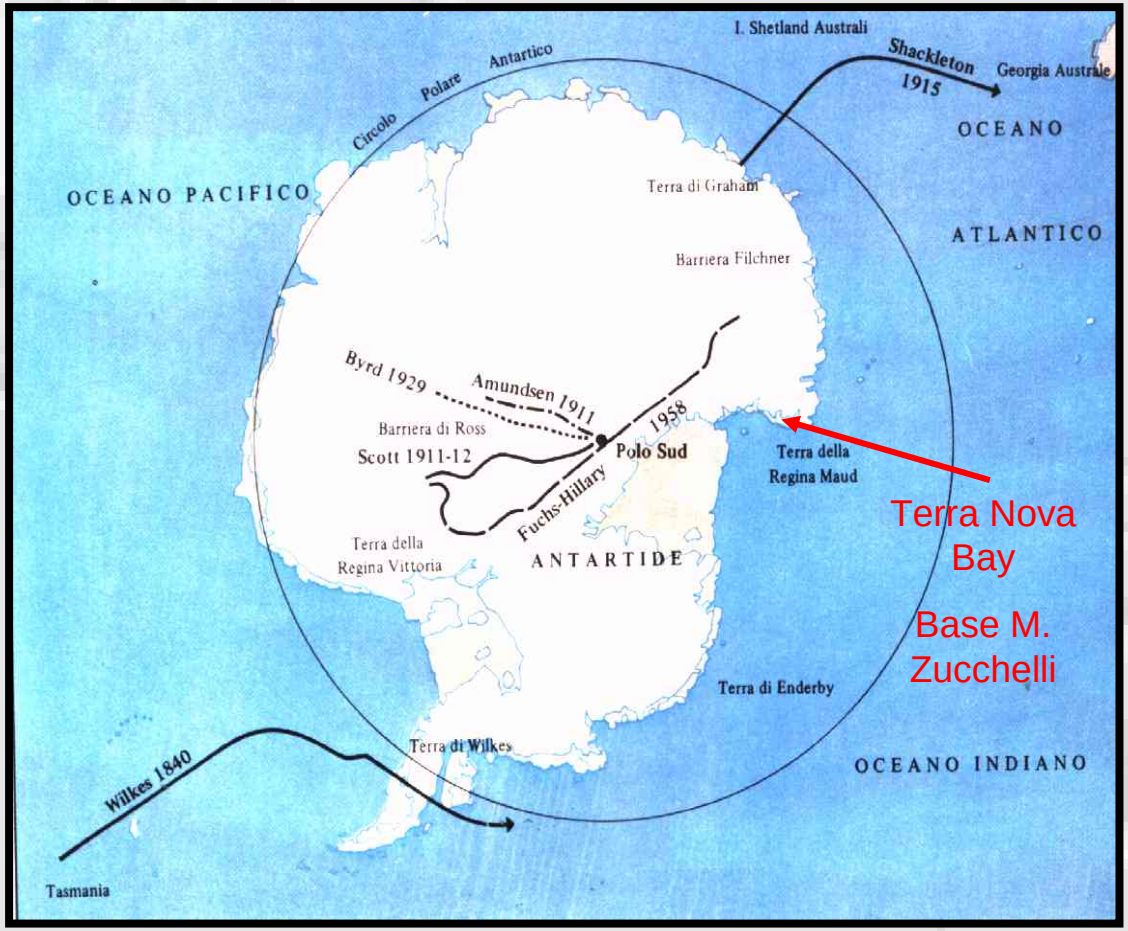


# ANTARCTICA
## Terra Nova Bay – Base M. Zucchelli

| | |
|---|---|
| Geographic coordinates: | 74° 41’ S, 164° 05’ E |
| Site management | Progetto Nazionale Ricerche Antartide (ITALY) |
| Launch season window | 30 Days December-February |
| Flight direction | West |
| Flight duration | Some weeks or Local flight |
| Launch type | Low weight, Auxiliary balloon, Dynamic launch |
| Launch pad | On the ice-pack |
| Assembly Buildings | Yes PNRA |
| Flight authorization | Yes PNRA |
| Overflight permissions | Yes PNRA |
| TM/TC to be used | Satellite – LoS if local flight |
| On site support equipment | Workshop (Electronic & Mechanical) |
| Other topics | The operations must start almost 1 year before the launch |

# USV Flight Test – Sardinia range

# Improvement of Stratospheric Services

To provide a wider opportunity to science community

Improve operations at the Nobile/Amundsen Stratospheric Balloon Center – Svalbard (NASBC)

Start the stratospheric flight activities (Pathfinders) in order to set-up a permanent launch facility in BSC-Malindi- Kenya

Reinforcing ASI participation to European-international stratospheric interoperability activities

# Techonological Development

Upgrading of advanced azimuthal gondola pointing systems (pivot)

Development of on board power supply system based on Fuel Cells ( activities in progress )

Upgrading and test a TM/TC system for Long Duration Balloon Missions and remote control of ground stations (composite satellite-line of sight control)

Development of non-dynamic launch systems (auxiliary balloon)

Development of non-conventional parachutes and separation device

Continuous upgrading of flight dynamics and trajectories forecast tools

Integrated control system for PL ( Command and Data processing, Data storage, attitude knowledge, GPS )

# *Techonological Development*

*STRADIUM – (IASF-INAF, INGV, LEN, Un. La Sapienza, Telespazio)*

*Science and Husekeeping Gondola TM/TC using IRIDIUM for LDB applications*

*Combined power supply module for LBD flight*

*HIPEG - ( IASF-INAF - Bologna)*

*High performance gondola azimuth pointing system*

*IRIASI ( by ELTA)*

*Science and Husekeeping Gondola TM/TC using IRIDIUM fo LDB applications*

*IRILASI – ( by ELTA)*

*High performance Science and Husekeeping Gondola TM/TC using combined Line of sight L band link and IRIDIUM for LDB applications*

# Agreements & Cooperations

Agreement ASI-Andoya Rocket Range for LDB North Pole flights

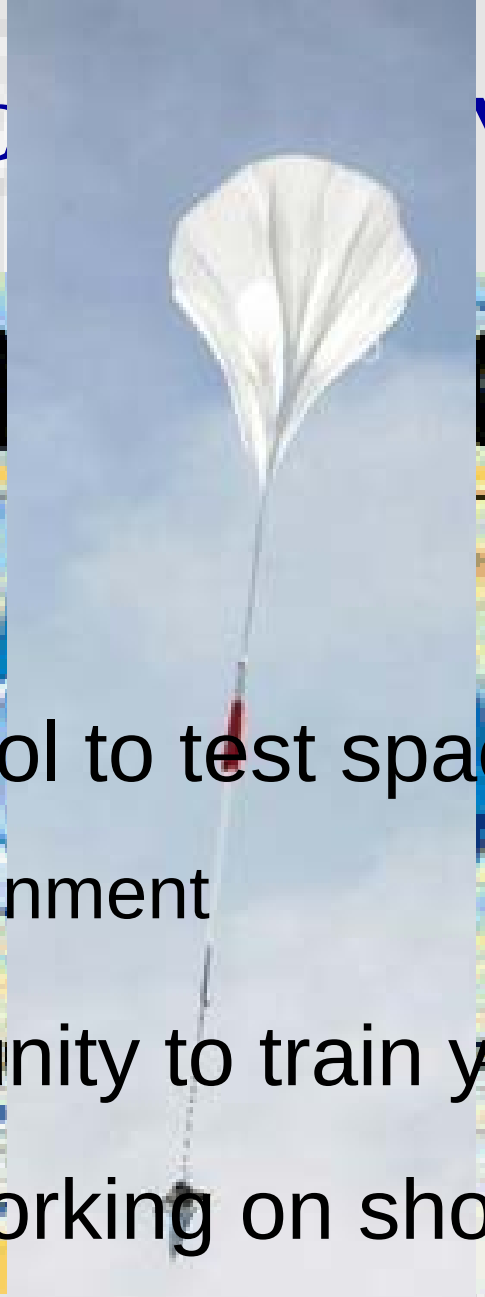
Agreement ASI-INTA for transmediterranean flights

Agreement ASI- Roskosmos in the frame of LDB North Pole flights

Agreement ASI-CSA for receiving ground stations ILIASI and …. ( in progress)

Cooperation with Italian schools (MIUR) to promote knowledge about space activities through educational stratospheric flights

# C VS



Stratospheric ful tool to carry on fi

A very useful tool to test space projects in a analogue environment

A unique opportunity to train young scientist and engineers working on short term schedules

# Thanks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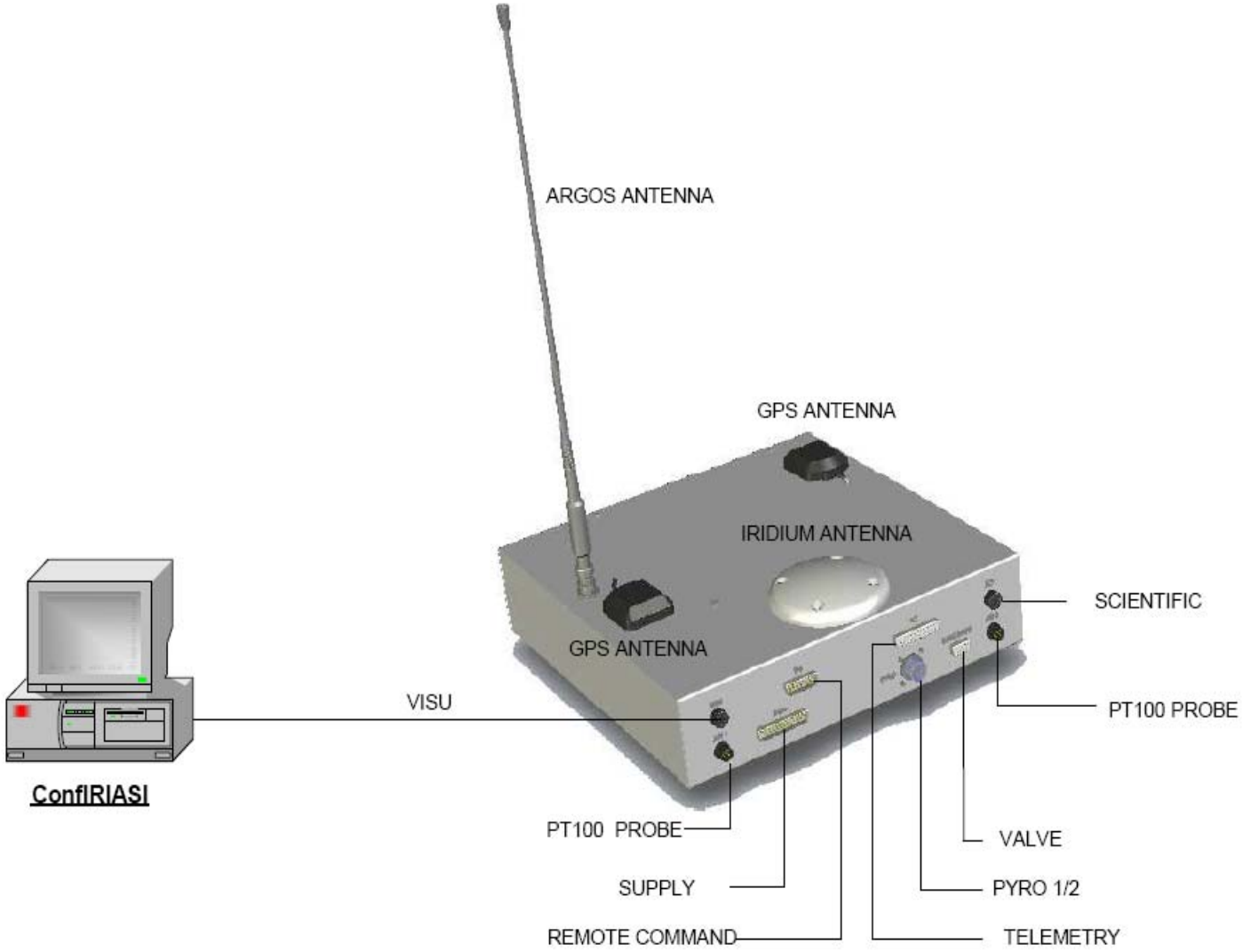
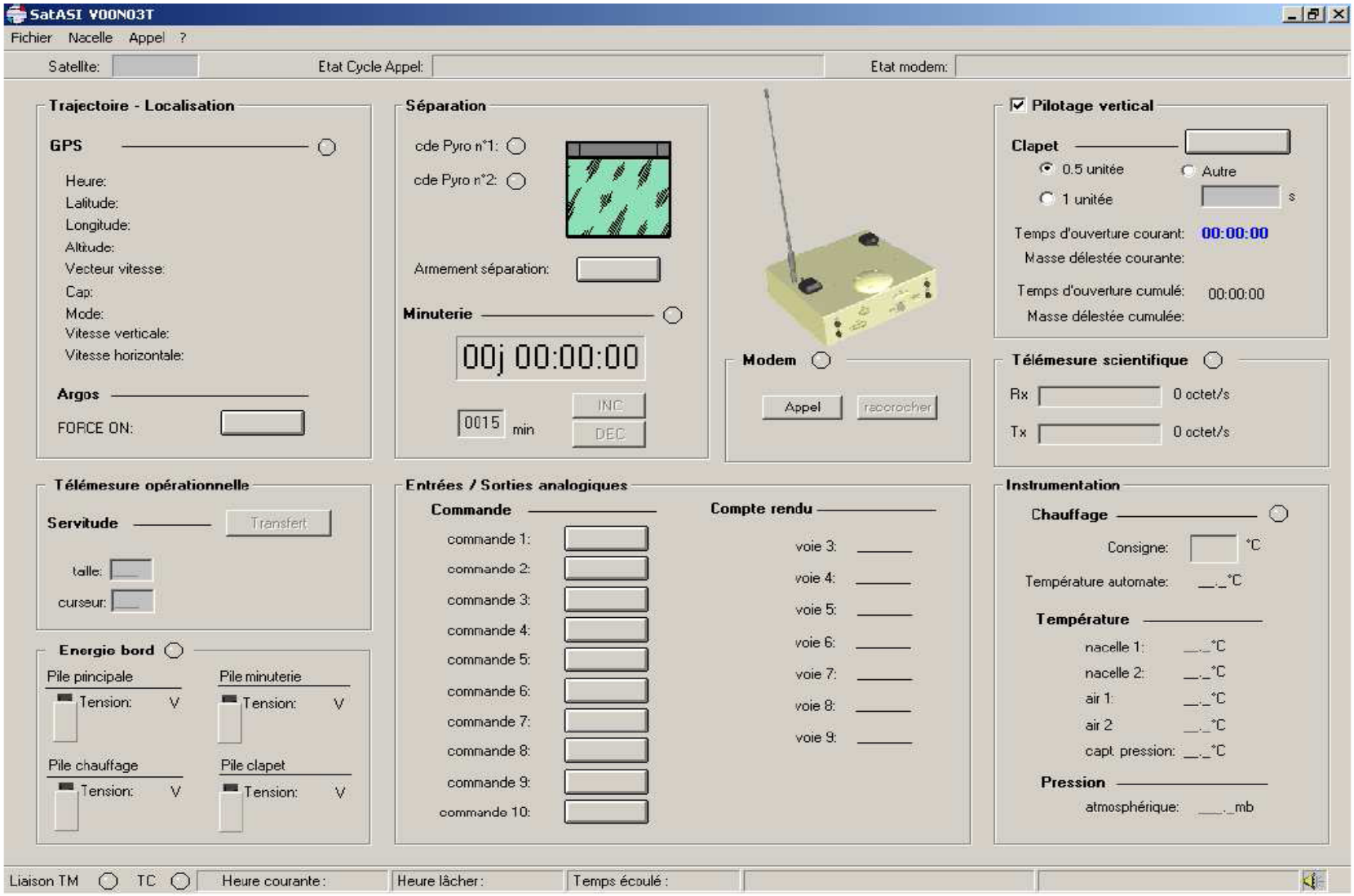
# Back Up

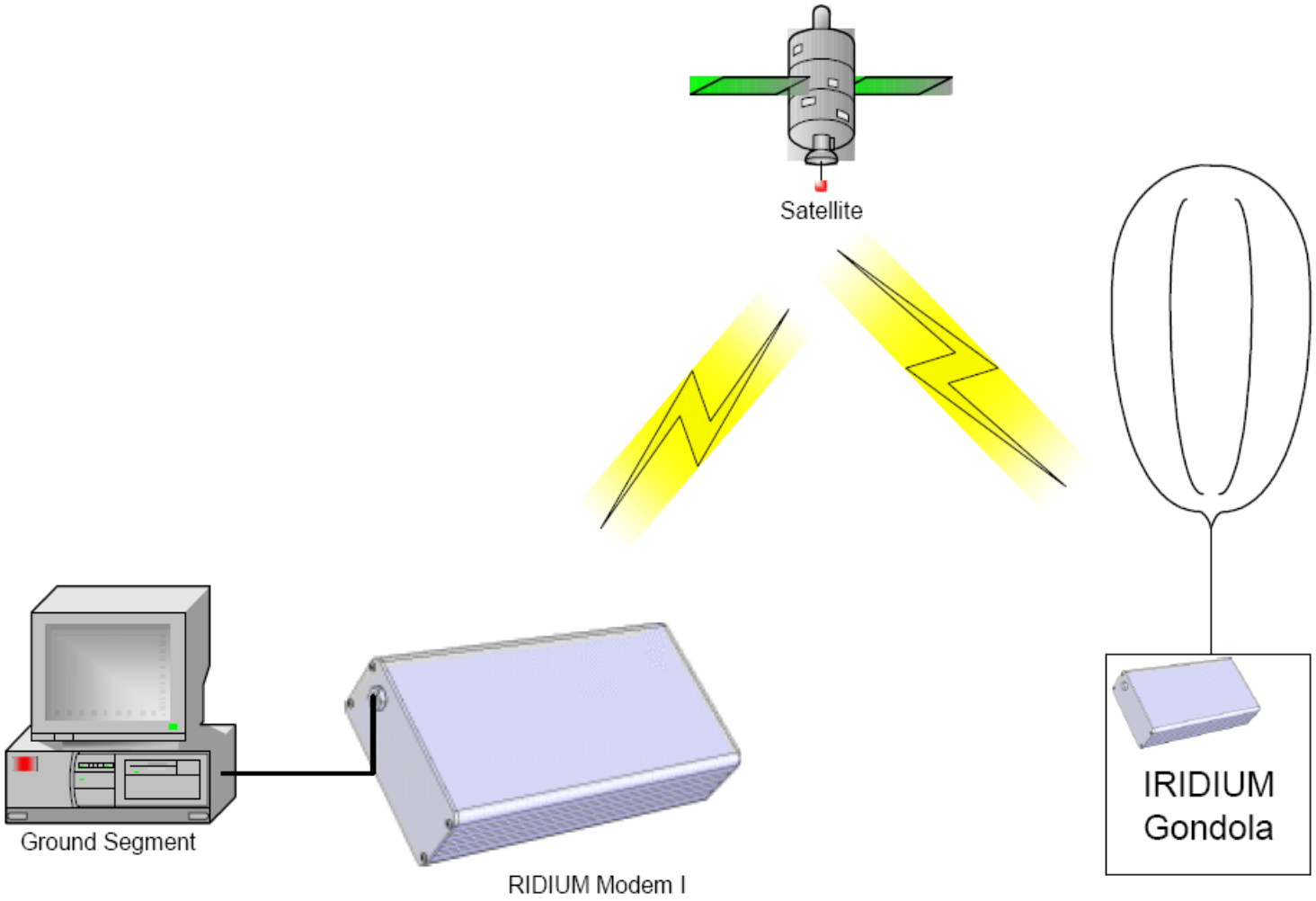
# ON Board IRIASI/TM/TC



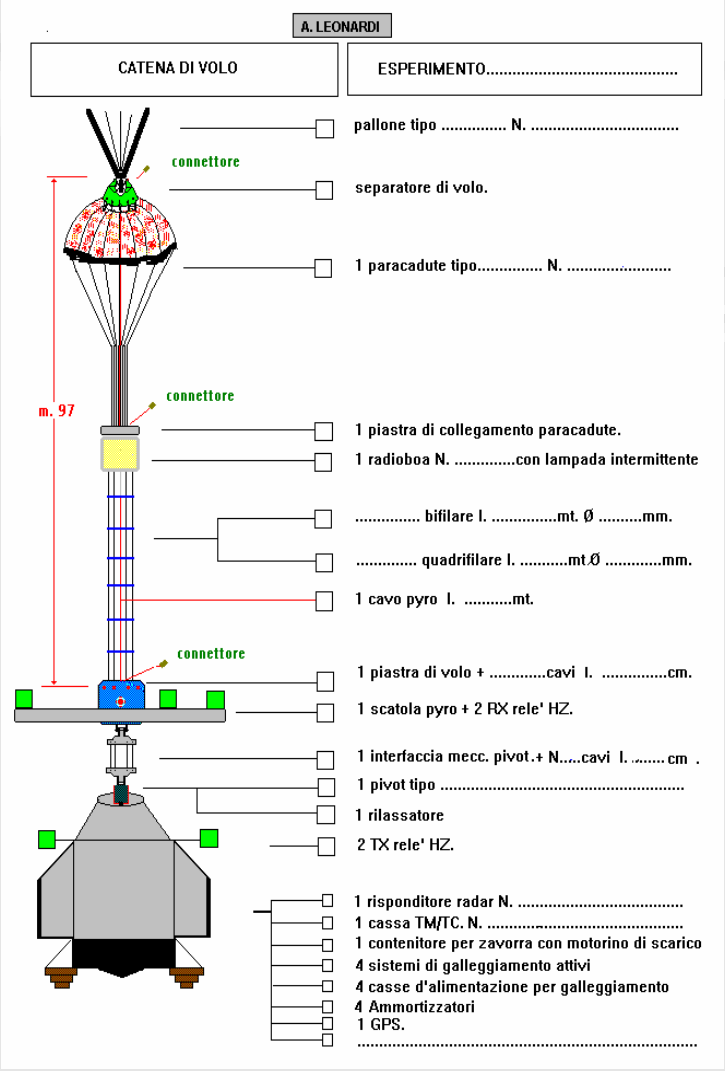
# IRIASI –Main Window



# LDB Ground TM/TC
# IRIDIUM



# ASI Balloon Launch Facility
# Main support equipments




*Fligth Train and*

*Safety & Recovery S/S*

*Radio Beacon along the flight train*

*Argos in LDB flight*

*GPS in LoS flight*

*Radar Transpoder with altimeter (OACI – TCRBS mode C)*