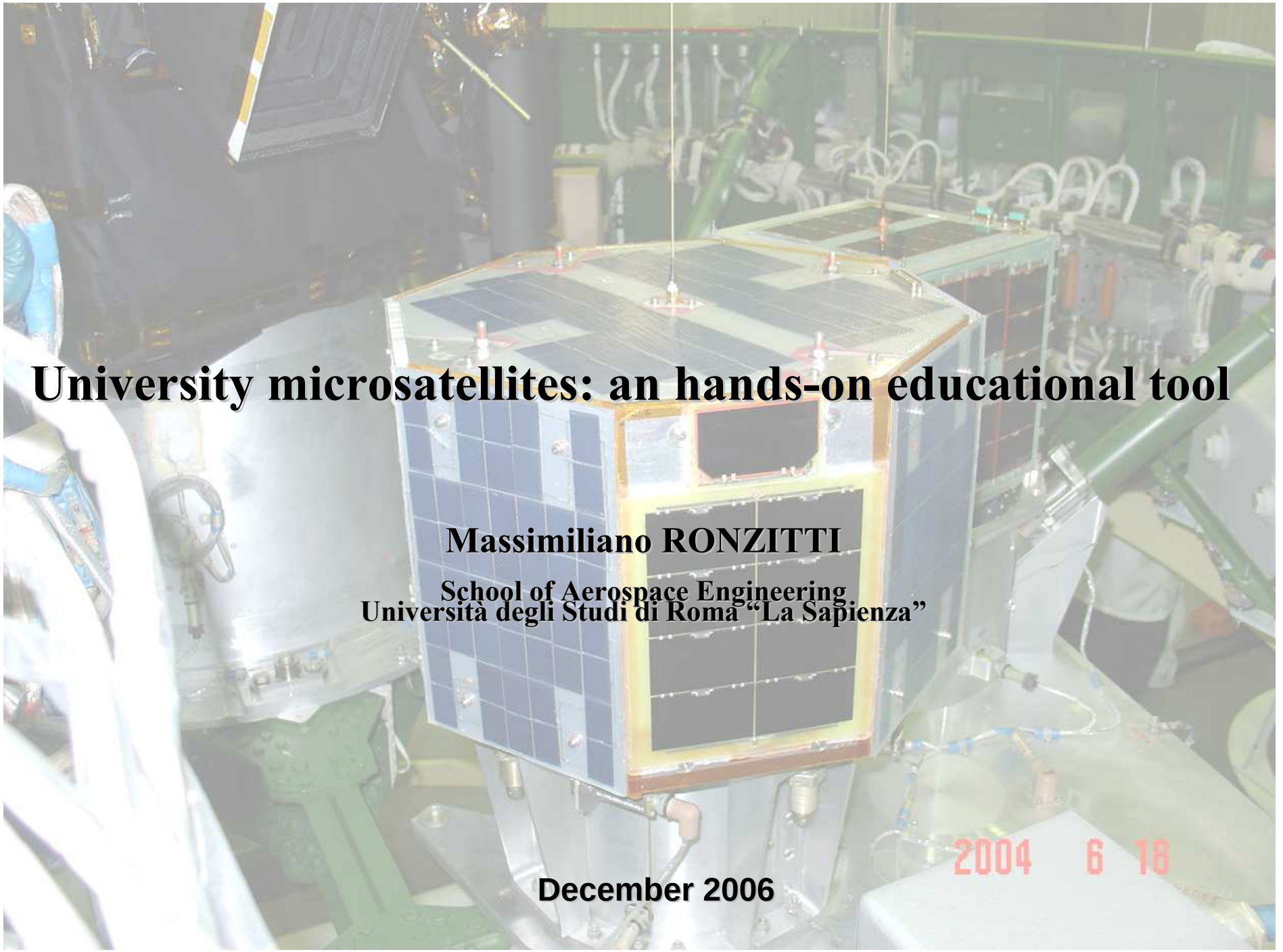

University microsatellites: an hands-on educational tool

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December 2006

The content of this presentation is the result of didactical activity at Scuola di ingegneria Aerospaziale by Group of Astrodynamics of University of Rome “La Sapienza” (G.A.U.S.S)

Small Satellites for Space Education

- ***Practical Training of Whole Cycle of Space Development***

– Mission conceptualization, satellite design, fabrication, ground test, modification launch and operation

– Know what is important and what is not.

- ***Importance for Engineering Education***

– Synthesis (Not Analysis) of an effective system

– Feedbacks from the real world to evaluate design, test, etc.

- ***Education of Project Management***

– Four Managements: time, human resources, cost and risk

– **Team work, conflict resolution**

– Effective discussion, documentation

– International cooperation, negotiation, mutual understanding

Shinichi Nakasuka
Department of Aeronautics and Astronautics
University of Tokyo

“Hands-on” space education

Objectives

- Improving students training courses
- Stimulating interest and creativity
- Enriching imagination
- Promoting space culture

Methods

- Team work (work together)
- Interactive work (exchange information)
- Multidisciplinary work (have a global view)
  space engineering is system engineering
- Practical work (put in practice theoretical knowledge)
- Challenging work (link to the “state-of-the-art” technology and scientific challenges)

A short history of UNISAT program

1990 -Theoretical studies on building low-cost microsatellites at university

A few people trusted it was possible that students could design realize microsatellites using commercial off-the-shelf components)

1995 – First founding of UNISAT program from Italian Minister of University

Building of ground station (SPIV)

researchers from University of Rome at Stanford University

1997 – Starting design and realization of UNISAT

2000 – Launch of UNISAT

2002 – Launch of UNISAT-2

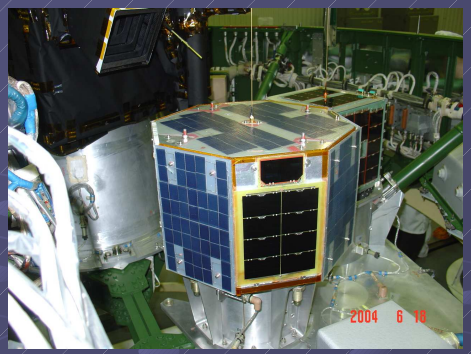
2004 – Launch of UNISAT-3

2006 – Launch of UNISAT-4

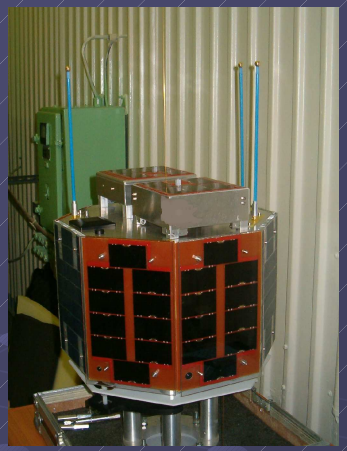
I microsatelliti UNISAT

Unisat
26 Settembre 2000

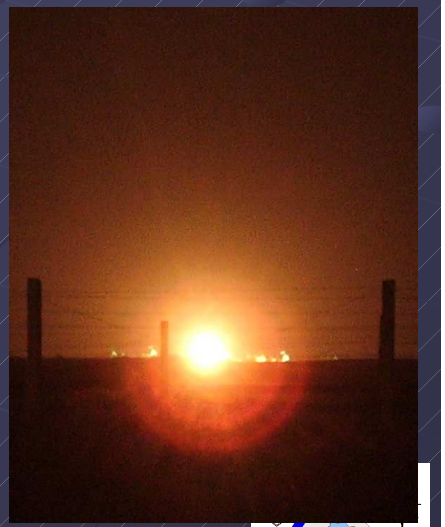
Unisat-2
20 Dicembre 2002



Unisat-3
29 Giugno 2004



Unisat-4
26 Luglio 2006



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AUSS

Lessons Learned

UNISAT

University-Microsatellite
alization and launch

Satellite structure

University ground
ation implementation

Solar cell lamination
nd array assembling
rocess

Test Campaign

Launch Campaign

Students can design realize and launch into orbit a small, low-cost university microsatellite !

UNISAT-2

• Electronic Laboratory establishment

•On Board Data Handling System development

•Payload design (spectrometer, camera)

Enviromental test campaign is "a must"

UNISAT-3

• Power system control and management

•On Board Data Handling System Improvement

•Attitude sensors (Magnetoresistive magnetometer, solar cells)

Low cost university microsatellite life-time can be longer than one year

UNISAT-4

•S-band transmitter

•Payloads:

Camera

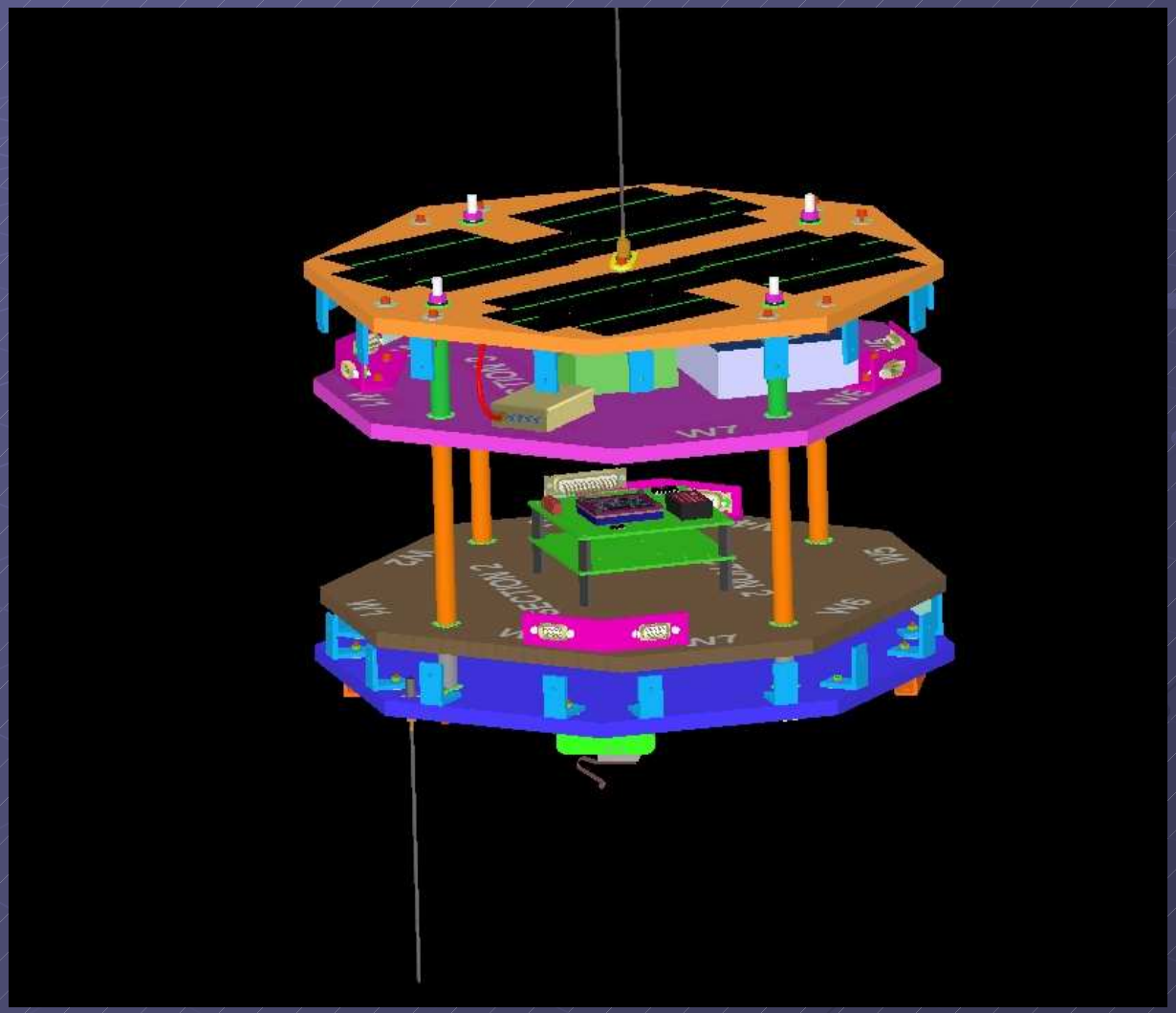
GPS receiver

Langmuir probe

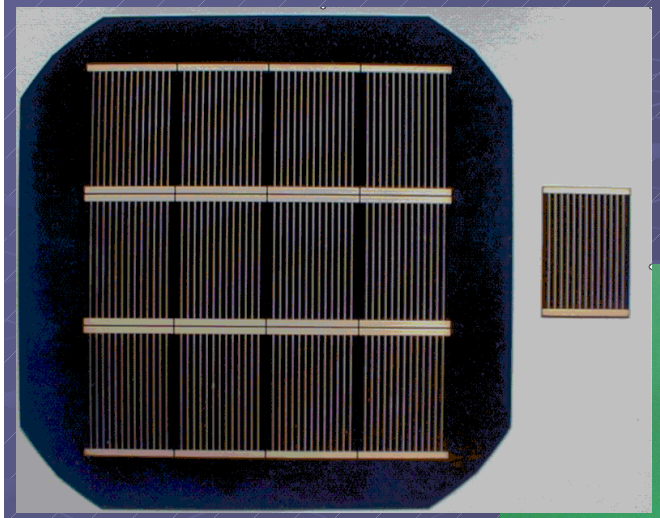
•Deorbiting device (SIRDARIA)

Building of back-up flight unit microsatellite

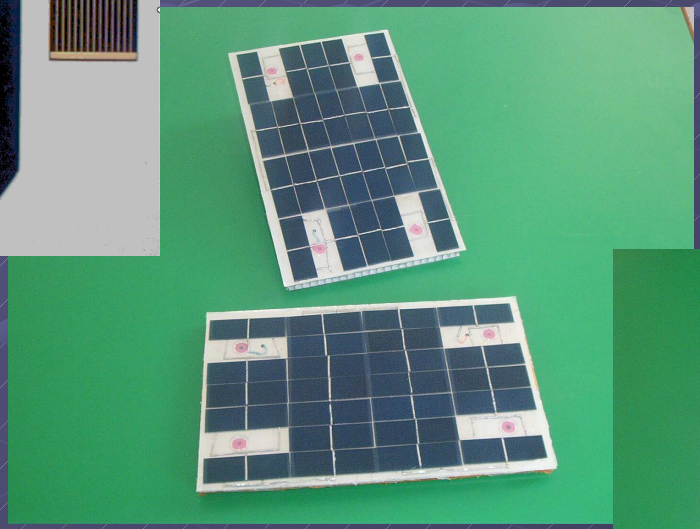
Spacecraft configuration



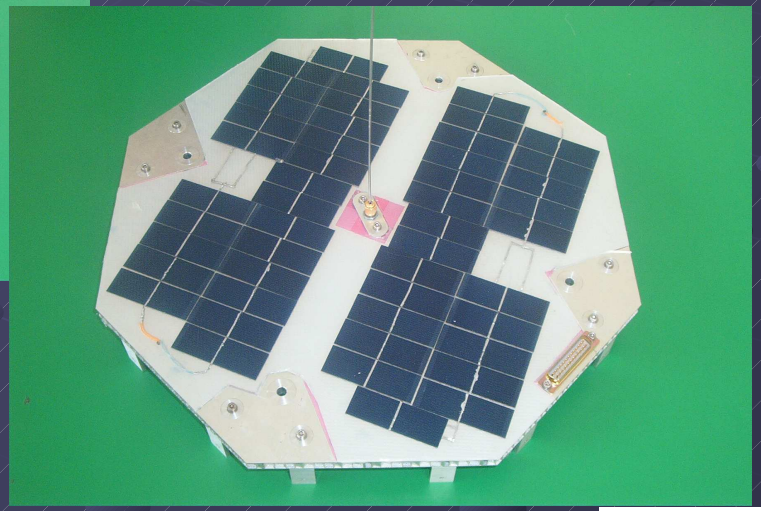
Solar Arrays



Terrestrial Si solar cell



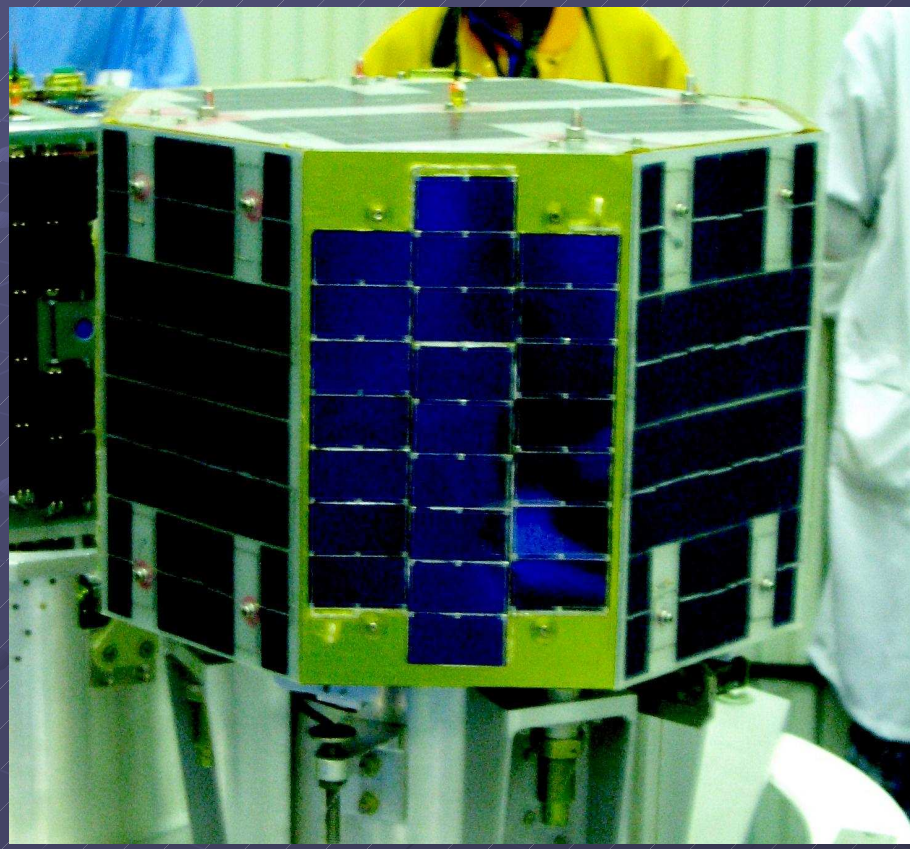
Lateral solar panels



Upper solar panel

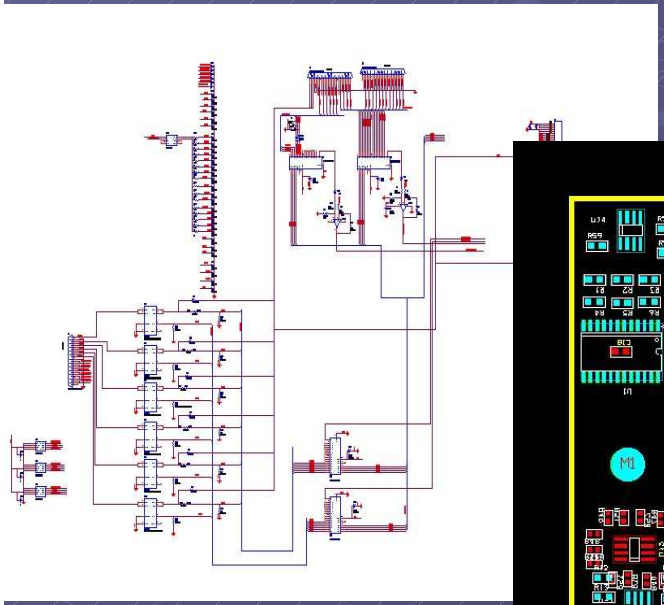
Solar Arrays

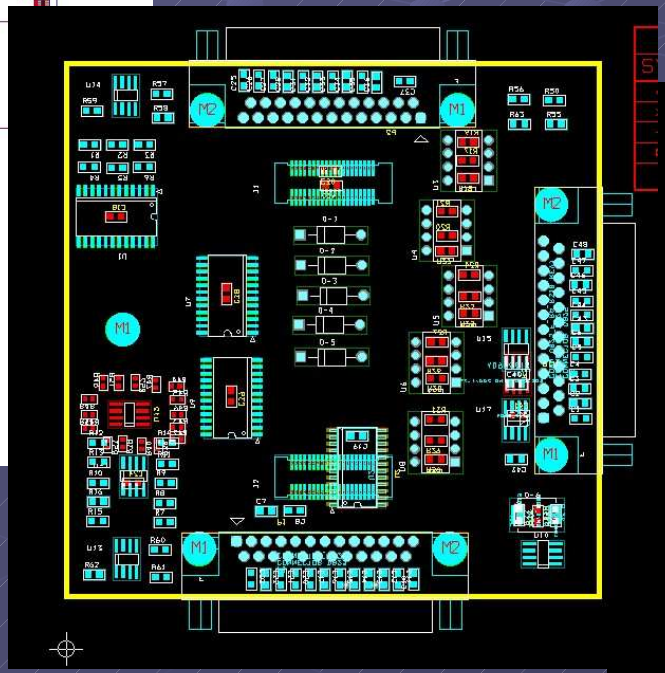
GaAs triple junction Solar Array

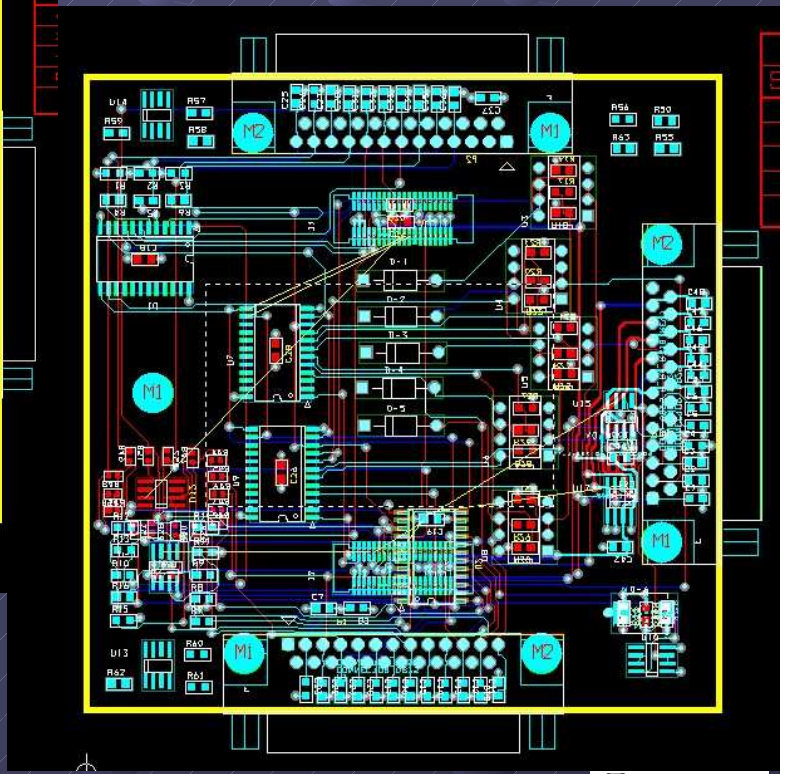


Solar Array made by Kiev Polytechnic Institute (Silicon)

Design and realization of electronic boards







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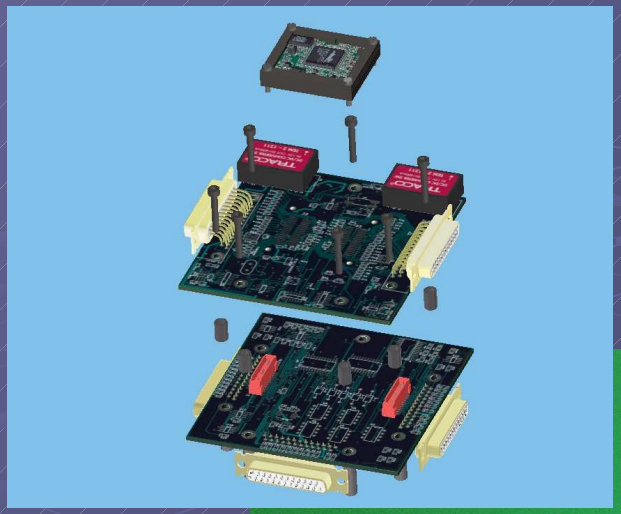
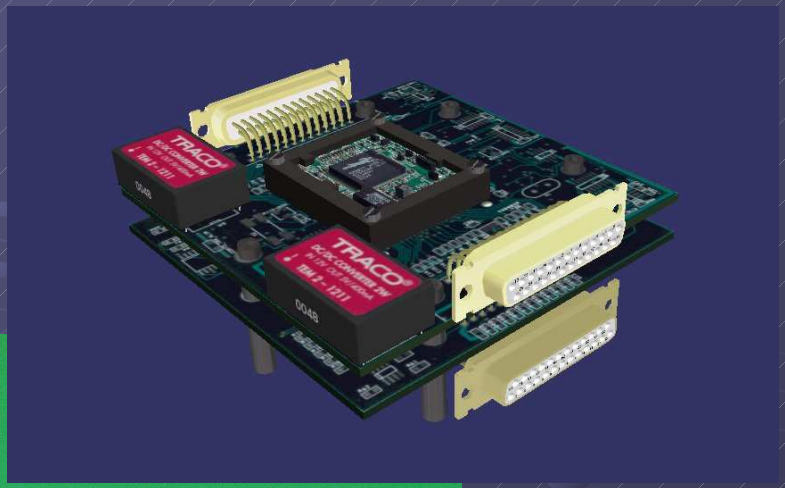
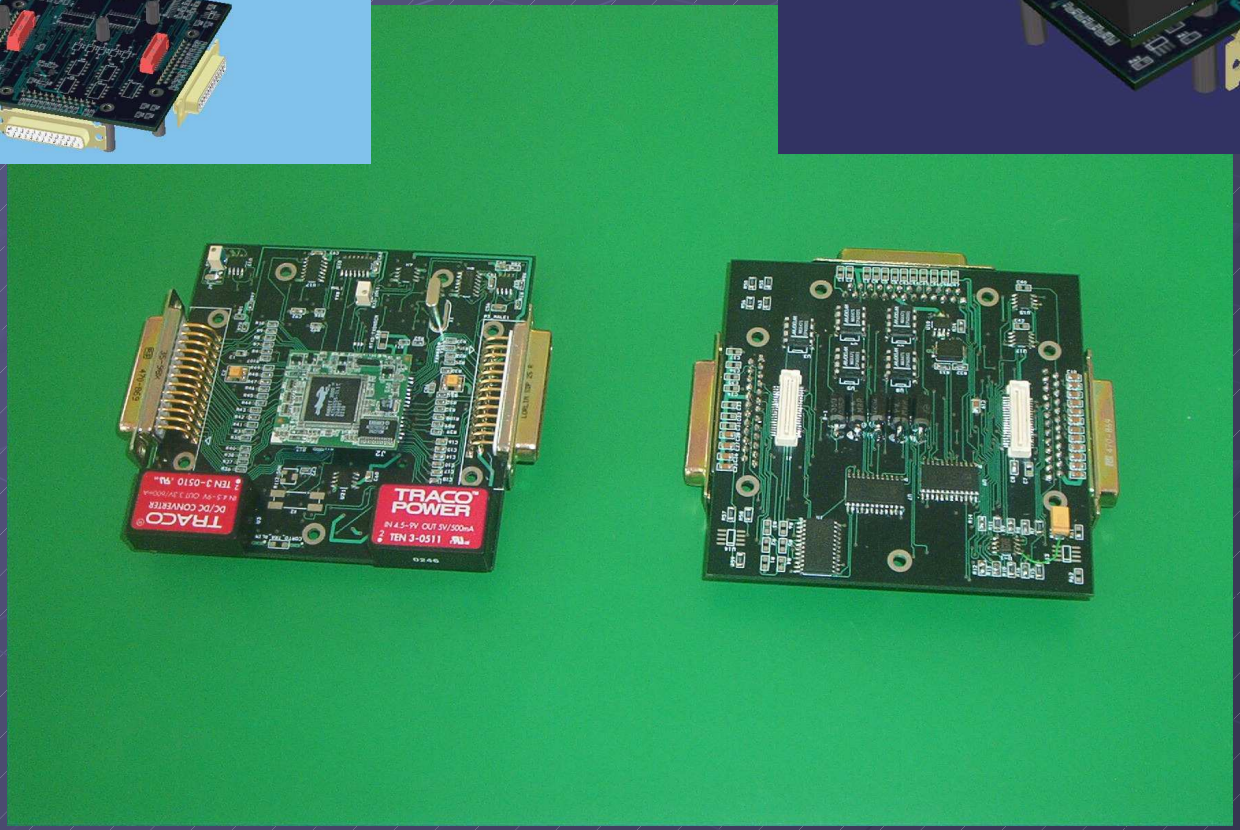
Electronic boards



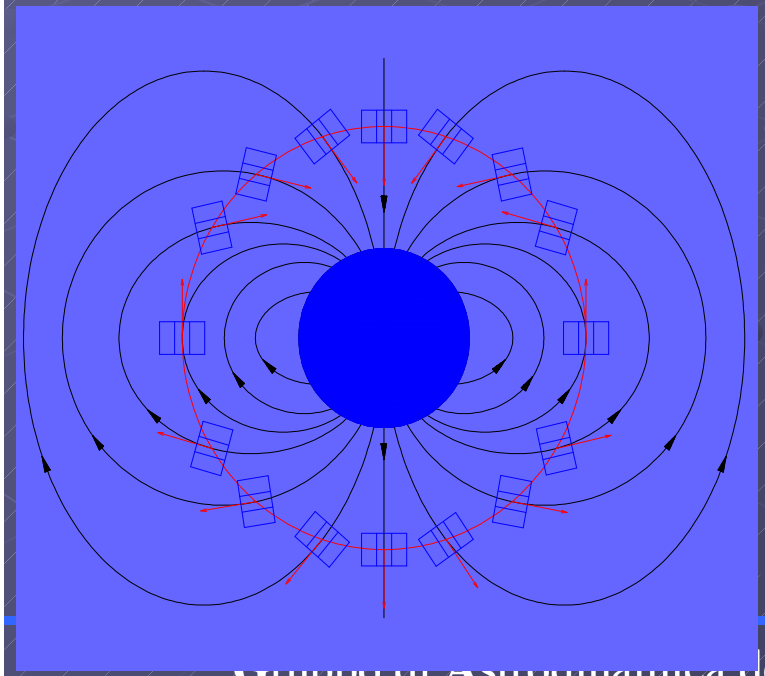




UNISAT-3 Attitude

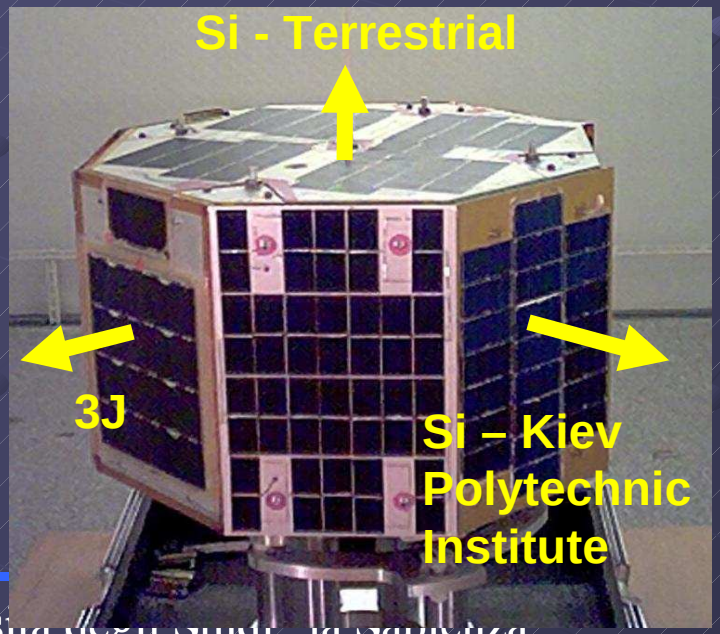
Attitude Stabilization

- A permanent magnet installed on the satellite follows the Earth magnetic field lines
- Accuracy on the order of 10°
- Low realization cost
- No software development



Attitude Determination

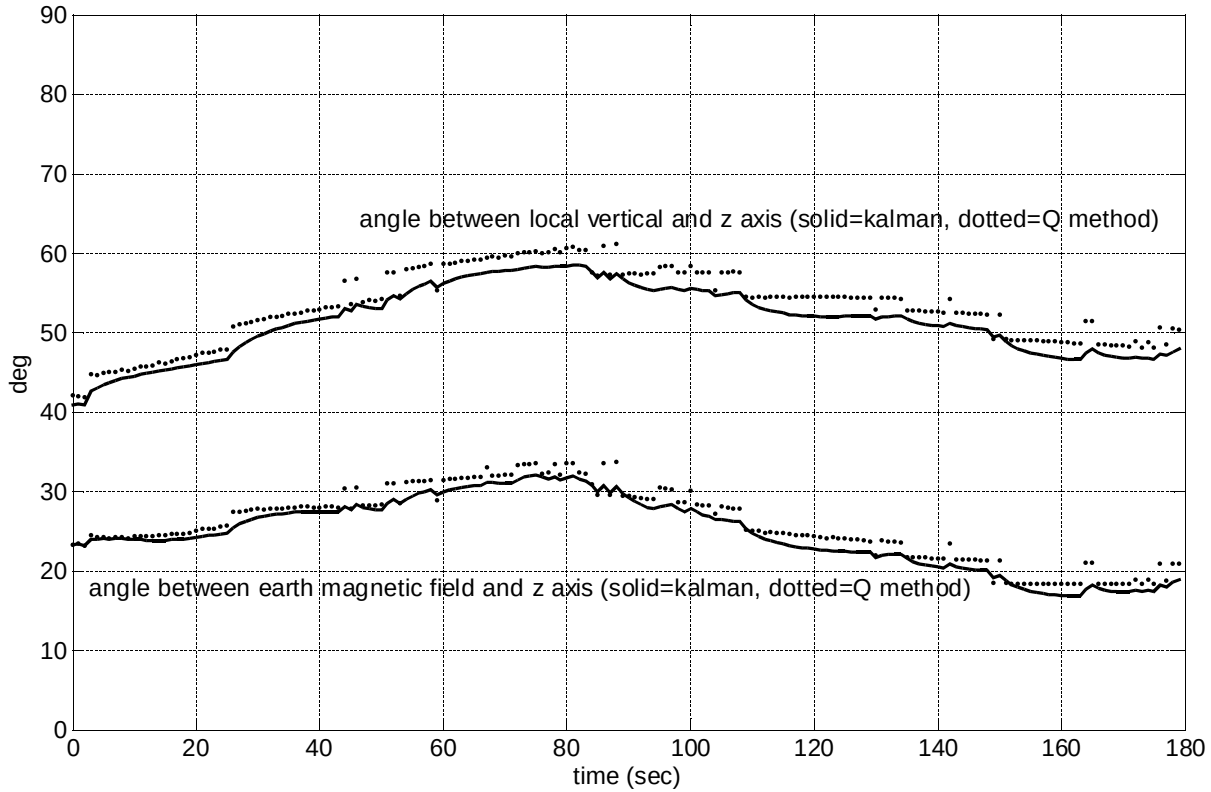
- Attitude sensors:
  coarse sun sensor (3 solar array currents)
  3 axes solid state magnetometer
- Attitude determination achieved by comparison of Sun-Satellite and Geomagnetic field theoretical direction (from ephemeris) with on board measures



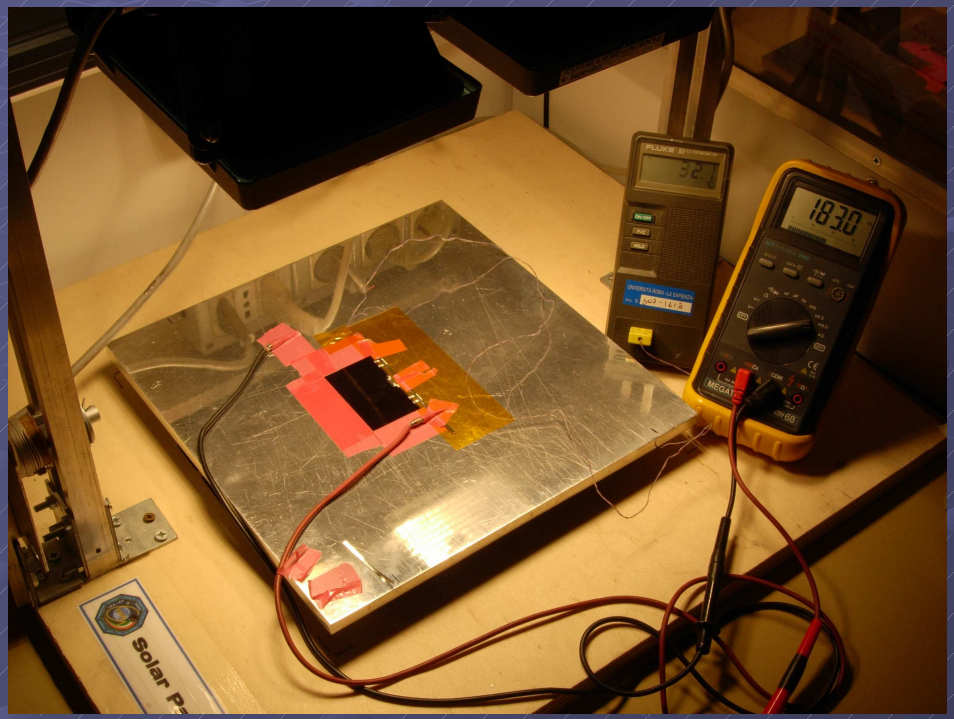
UNISAT-3 attitude determination: results

UNISAT-3 Z-Axis angles with respect to Geomagnetic Field and Local vertical

June 28th 2005

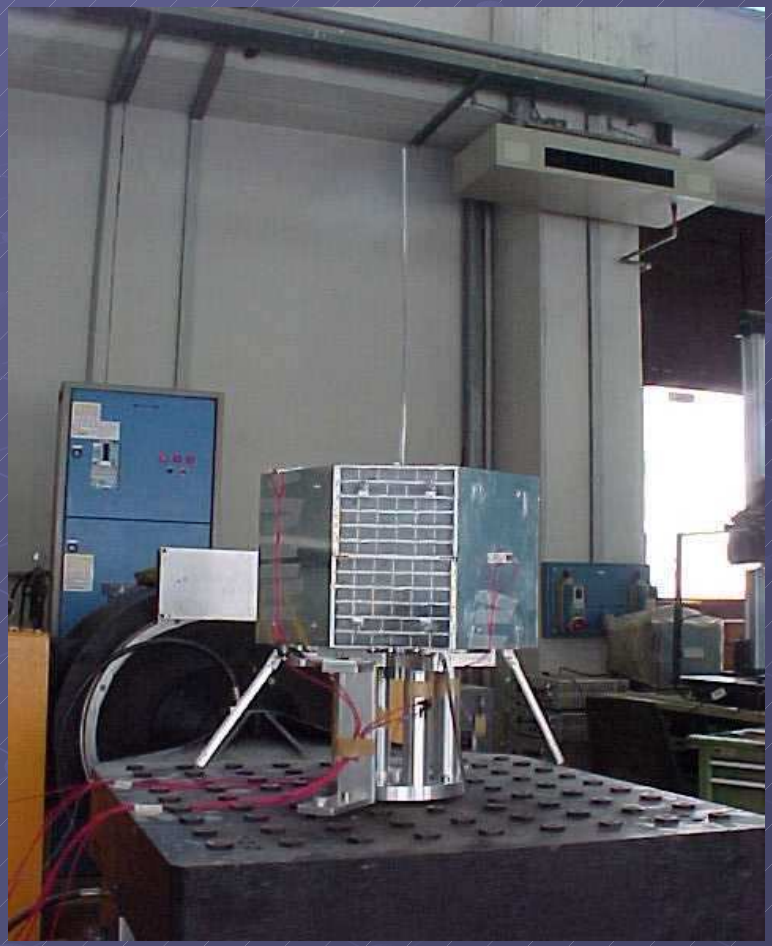


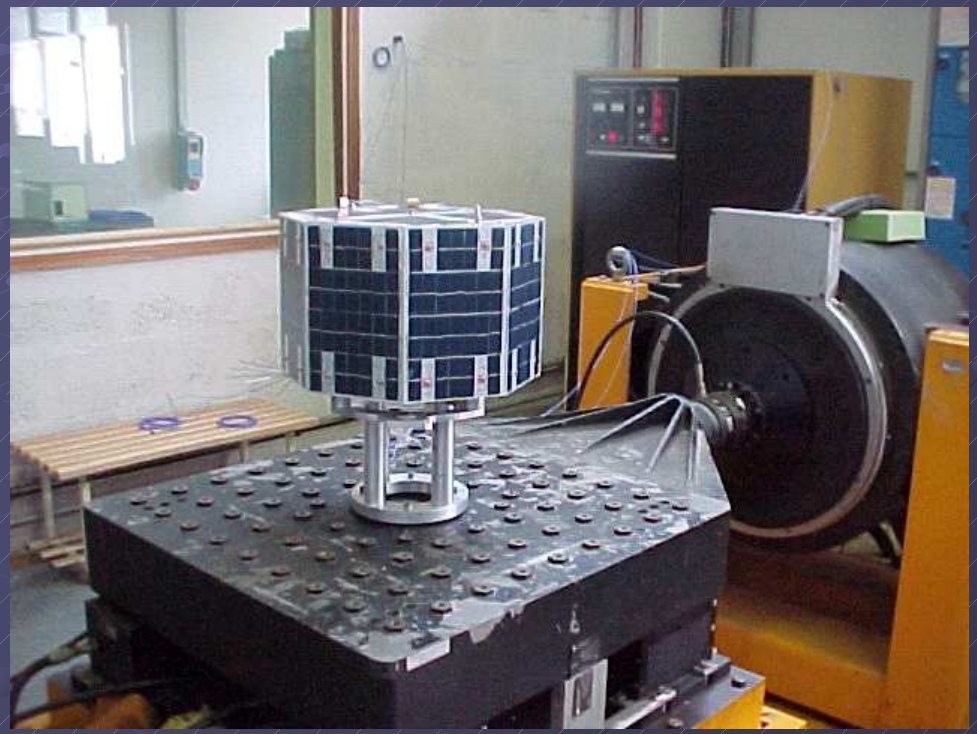
Triple Junction Solar Cells Tests



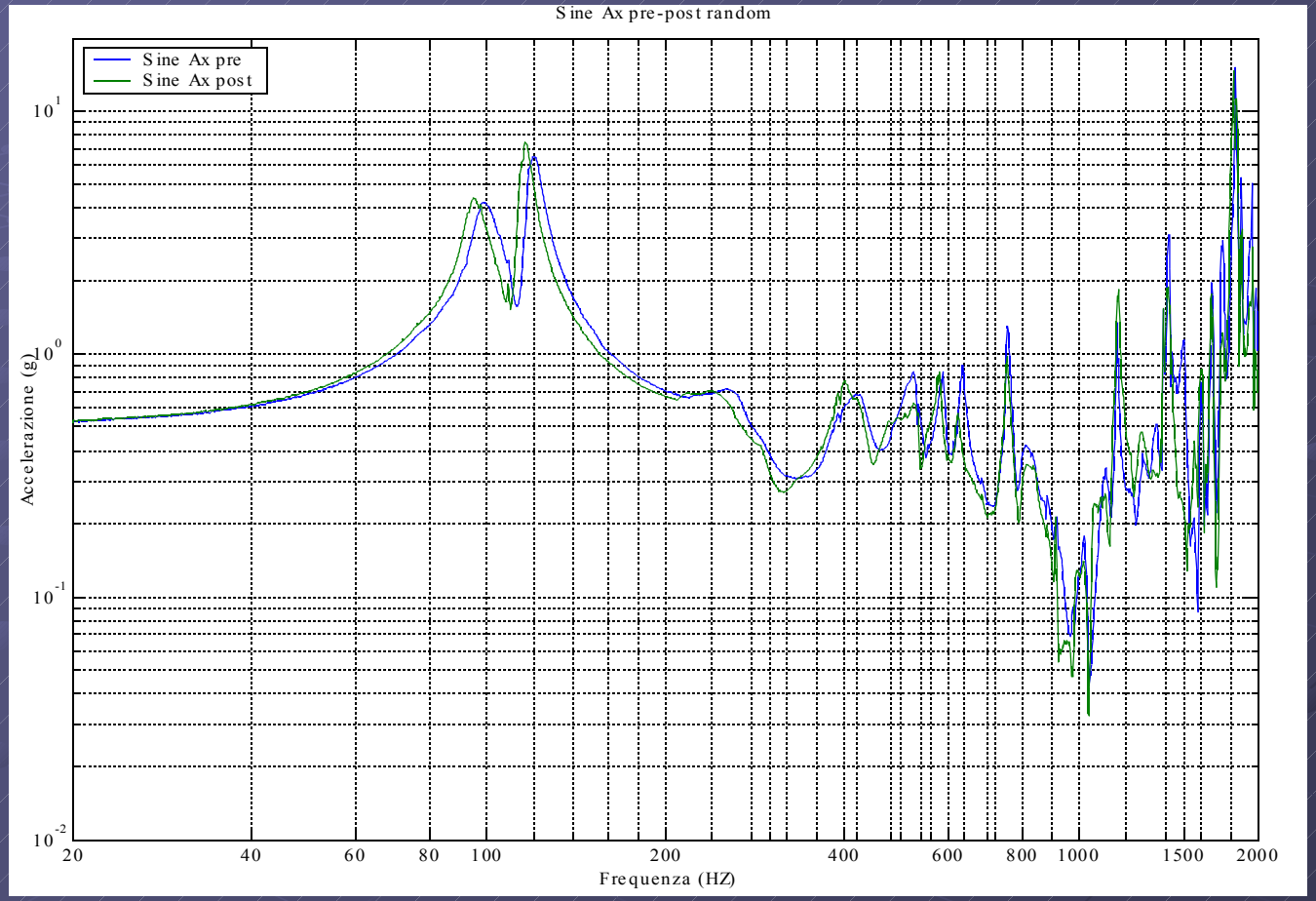
SUN SIMULATOR

Vibration Test (OCI, Roma)





Vibration Test Results

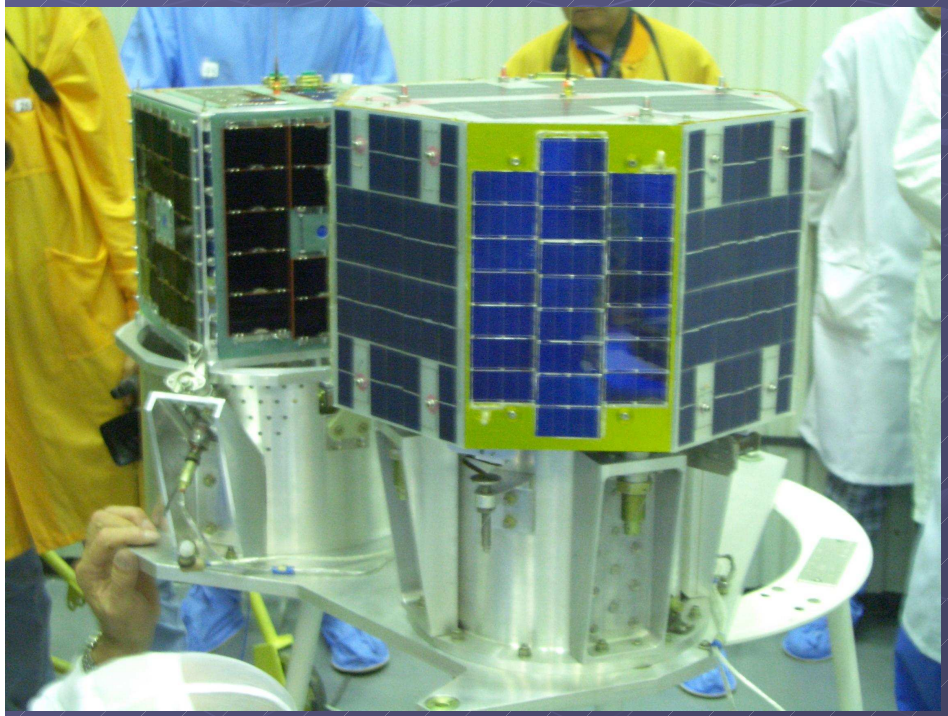


Frequency response before (blue) and after (green) random signal test

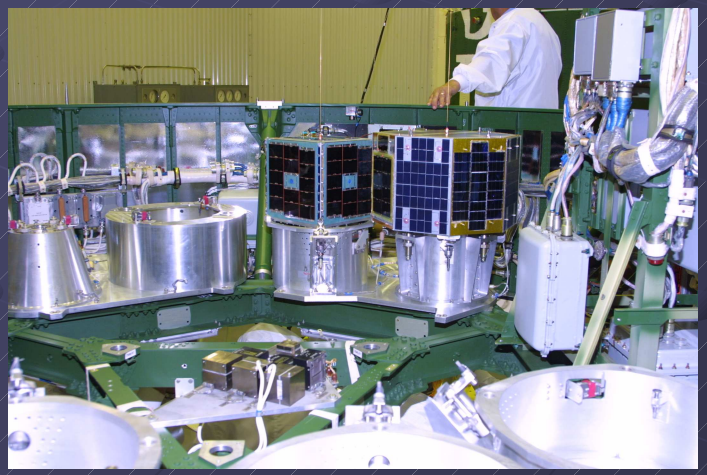
Vibration test (Dnepropetrovsk)

Separation test (Dnepropetrovsk)

Integration on the DNEPR launcher (Baikonour)



UNISAT-3 launch team



UNISAT-3 Launch

Launched from Baikonour using DNEPR LV on 29th June 2004

Sunsynchronous Orbit

Inclination: 98°

Altitude: 710-780 km