10th WRMISS
Workshop on Radiation Monitoring for the International Space Station
September 7 (Wed) - 9 (Fri), 2005 Chiba, Japan

Status and results of the LAZIO-Sirad and Sileye3/Alteino experiments board the ISS

M. Casolino, Sileye-3/LAZIO collaborations

INFN Roma2 & University of Roma Tor Vergata

Tor Vergata

INFN
Istituto Nazionale di Fisica Nucleare

Sileye/Alteino institutions

V. Bidoli[1], M. Casolino[1], M. P. De Pascale[1], M. Minori[1], A., L. Narici[1], P. Picozza[1], E. Reali[1], R. Sparvoli[1], V. Zaconte, A. Galper[2], A. Popov[2], S. Avdeev[3], M. Boezio[4], W. Bonvicini[4], A. Vacchi[4], G. Zampa[4], N. Zampa[4], G. Mazzenga[5], M. Ricci[5], P. Spillantini[6],G. Castellini[7], P. Carlson[8], C. Fuglesang[8], V. Benghin[9], V. P. Salnitskii[9], O. I. Shevchenko[9], V. Shurshakov[9], V. P. Petrov[9], K.A.Trukhanov[9]

[1] Dept. of Physics, Univ. of Rome "Tor Vergata" and INFN Sez. Rome2 , Italy; [2] Moscow State Engineering Physics Institute, Moscow, Russia;[3] Russian Space Corporation "Energia" by name Korolev, Korolev, Moscow region, Russia [4] Dept. of Physics of Univ. and Sez. INFN of Trieste, Italy; [8] Dept. of Physics of Univ. and Sez. INFN of Perugia, Italy; [5] L.N.F. - INFN, Frascati (Rome), Italy; [6] Dept. of Physics of Univ. and Sez. INFN of Florence, Italy; [7] IROE of CNR, Florence, Italy; [8] Royal Institute of Technology, Stockholm, Sweden;
[9]IMBP, Institute of BioMedical Problems,Moscow, Russia

LAZIO-SIRAD Collaboration

INFN

University and INFN "Tor Vergata" - Rome

University and INFN - Rome Tre

University and INFN - Perugia

University and INFN "Federico II" - Napoli

MEPhI - Russia

Laboratorio S.E.R.M.S. - Terni

Filas

Finanziaria laziale di sviluppo

Filas

Nergal

ESA

ASI

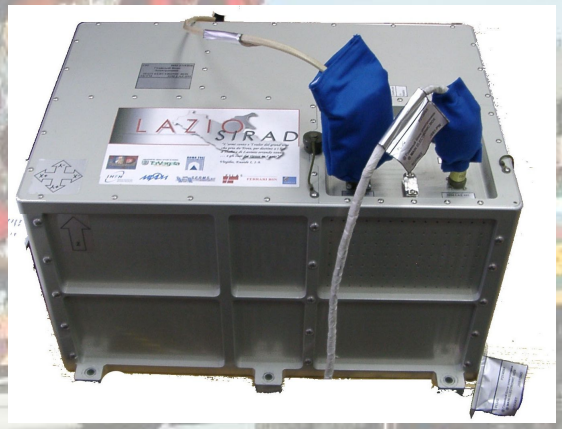
Alenia SPAZIO

Italian Soyuz Mission-2 (Eneide)

- Flight opportunity in July 2004
- Acceptance tests in January 2005
- Launch on Progress on February 2005
- Measurements during Soyuz-10S taxi flight, April 2005

LAZIO - Sirad experiment

Technological demonstrator → science

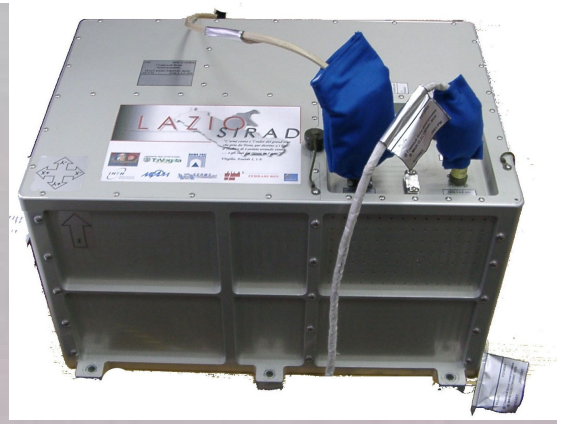


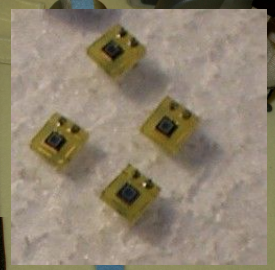
- New "Lazio" detector
- Light Flash observations
- Alteino + shielding material
- User centre in Tor Vergata → Altea

Lazio-Sirad

- 28 kg payload.
- 6 different experiments/detectors linked together involving:

  - Technology demonstration (SI-PM, Magnetometer)
  - Life science
  - Radiation environment
  - Relationship between seismic phenomena and radiation belts.





Lazio-MEB

Silicon-Scintillator Tracking Calorime

- ***Study of nuclear (>40MeV/n) and elec components inside ISS.***
- ***Study of spatial, angular dependence a (in long term) of magnetic perturbations***

40cm^2 sr

3 scintillators

4 double sided microstrip detectors 16*7 cm

16 Silicon Photomultiplies Tiles

One-axis magnetometer (EGLE)

PC-104 acquisition with PCMCIA cards

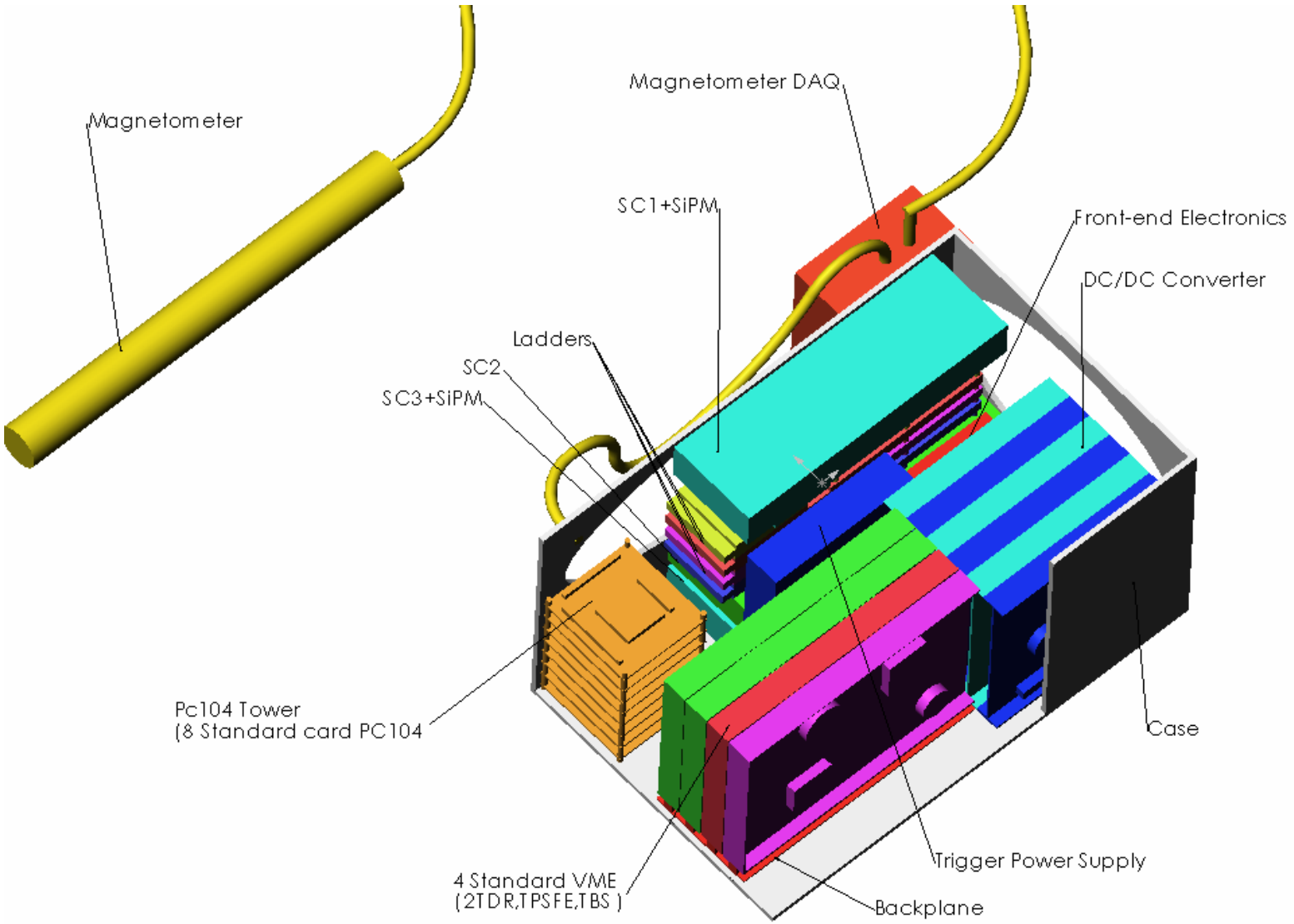
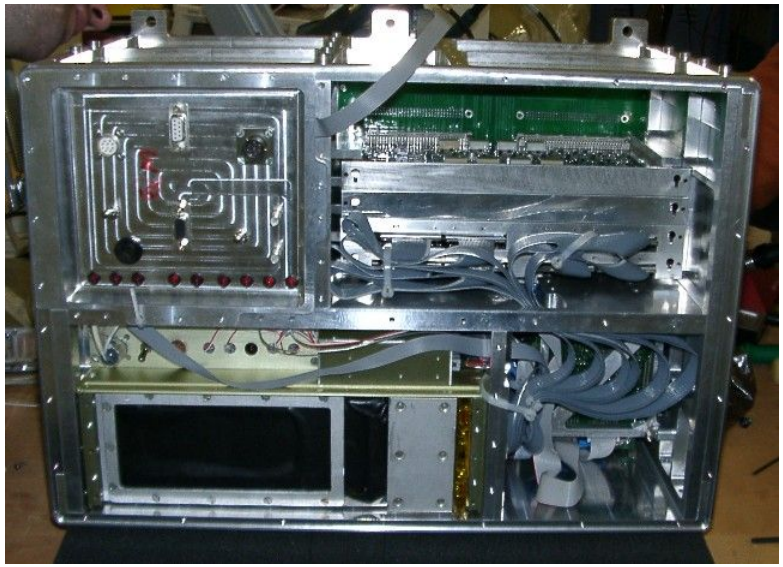
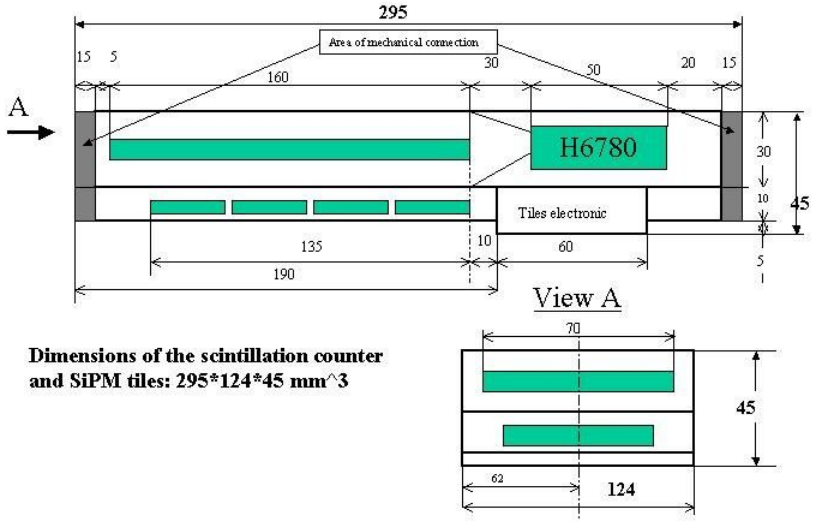


Figure 1: Lazio Detector assembly

Lazio-MEB

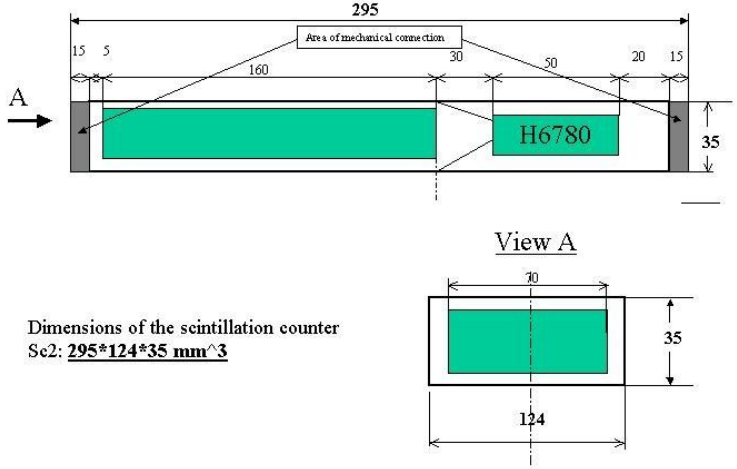


Scintillators and tiles



Dimensions of the scintillation counter and SiPM tiles: 295*124*45 mm^3

Scintillator SC2



Dimensions of the scintillation counter Sc2: **295*124*35 mm^3**

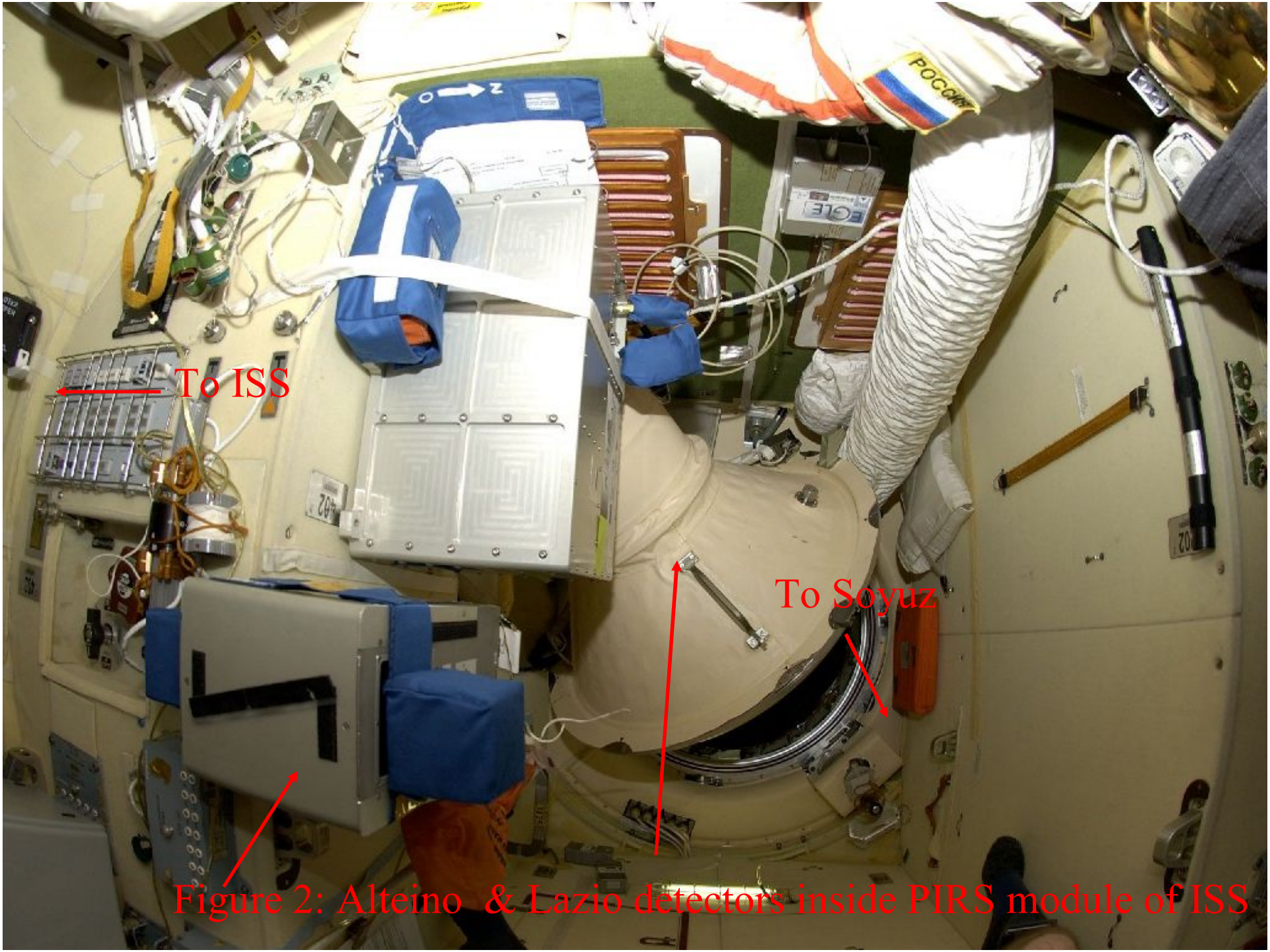


Figure 2: Alteino & Lazio detectors inside PIRS module of ISS

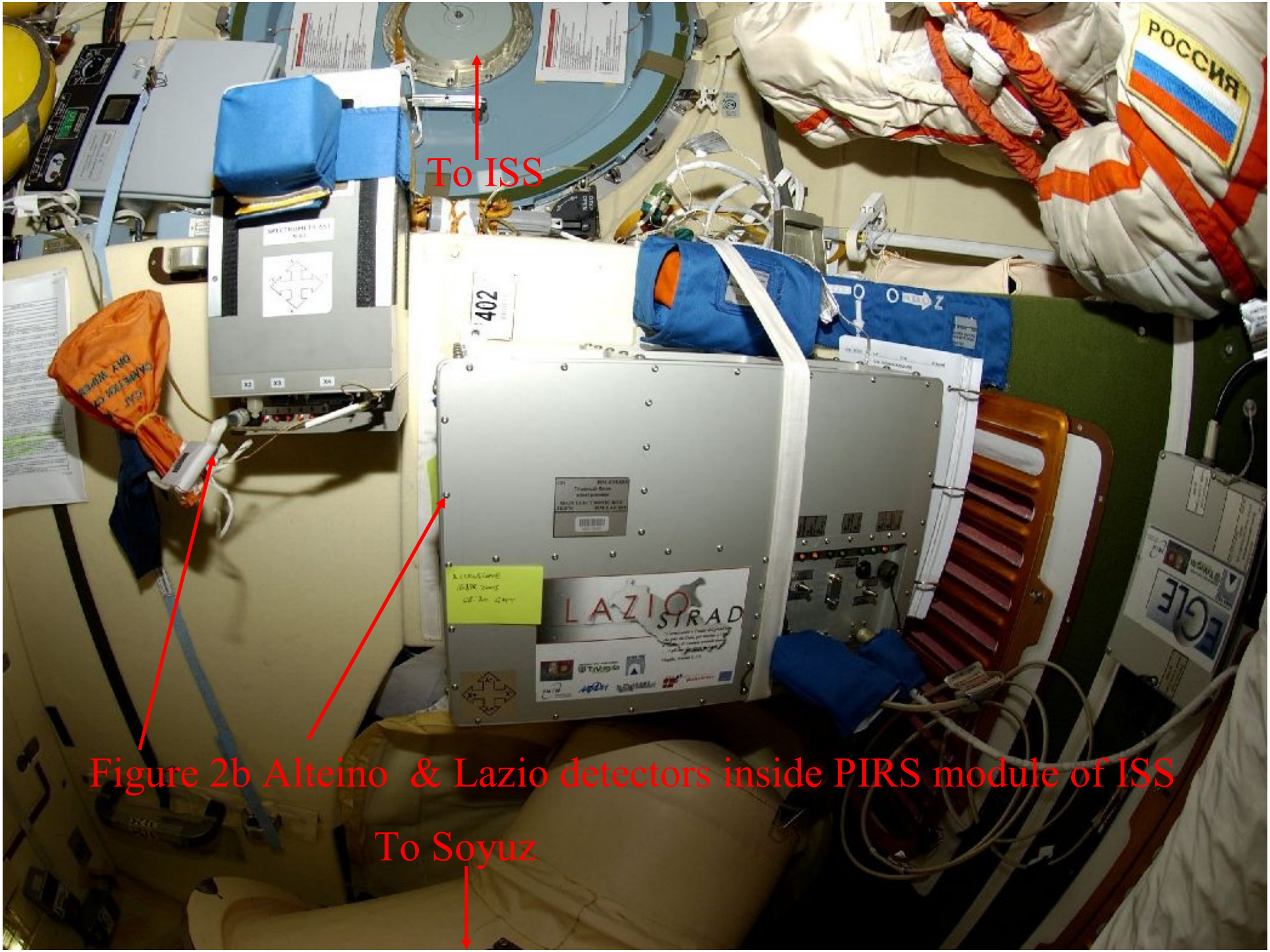
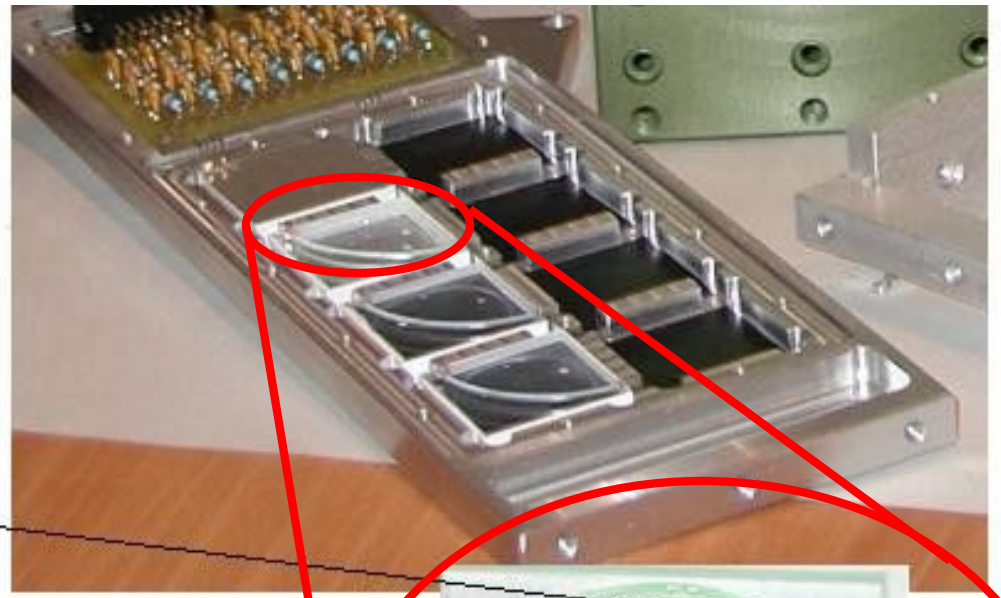


Figure 2b Alteino & Lazio detectors inside PIRS module of ISS

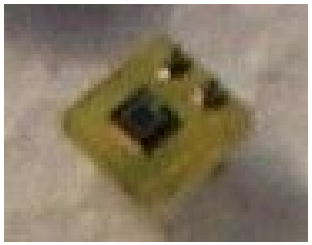
Lazio-Silicon Photomultipliers:

16 detectors with plastic tiles placed in two layers of the detector

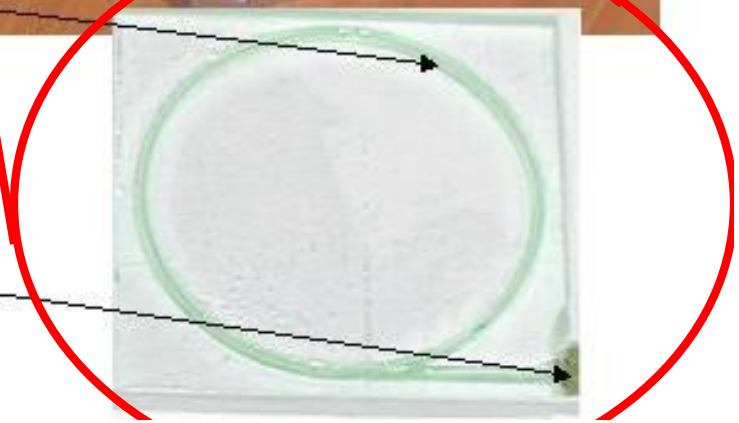
Tile:
Plastic scintillator
3x3x0.5 cm^3



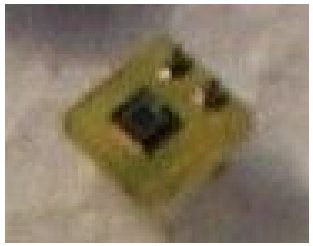
Shifter



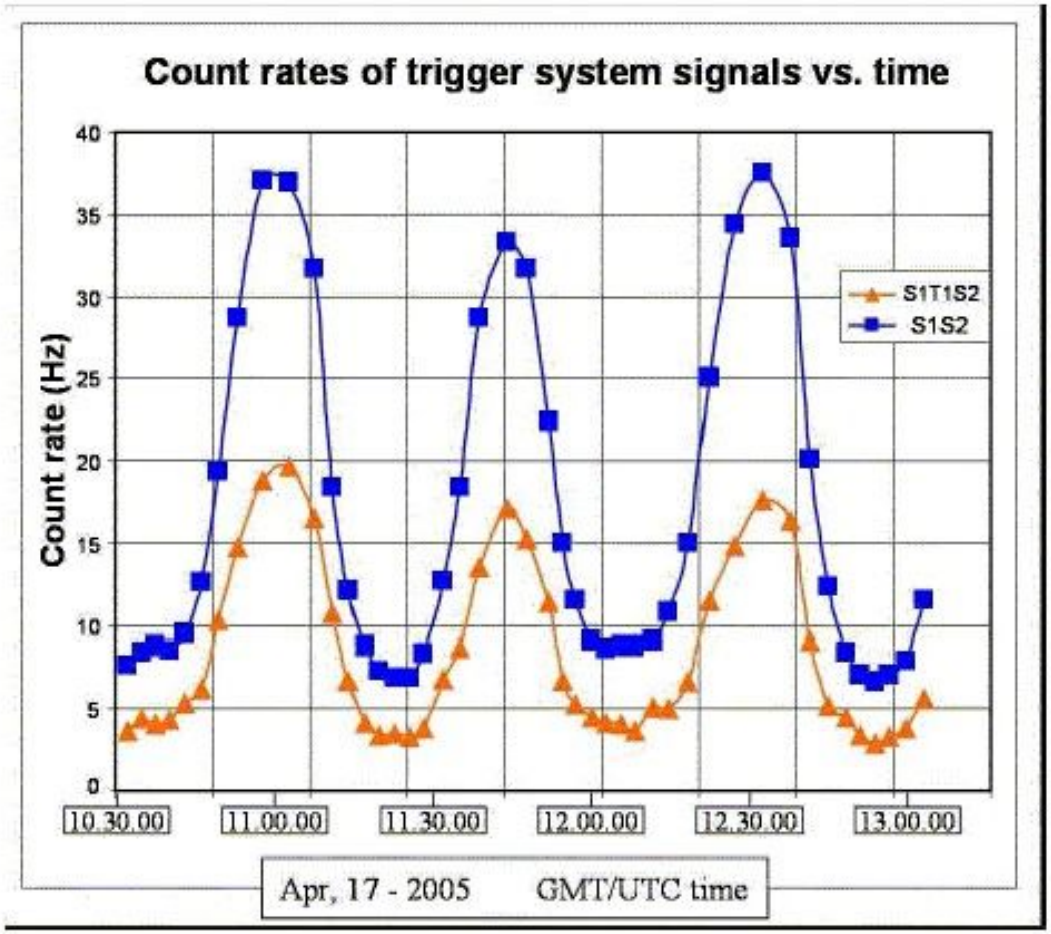
SiPM



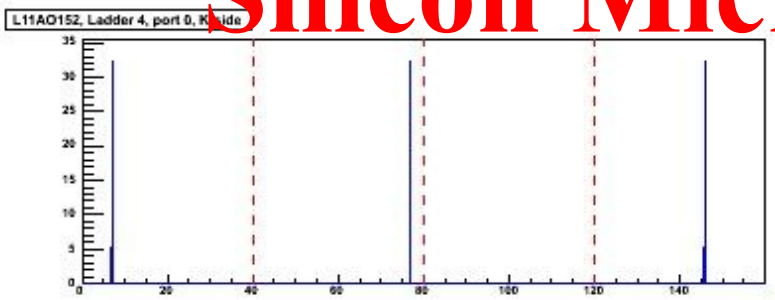
SI-PM

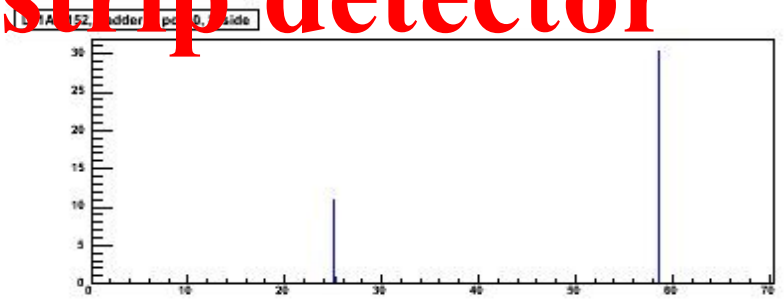


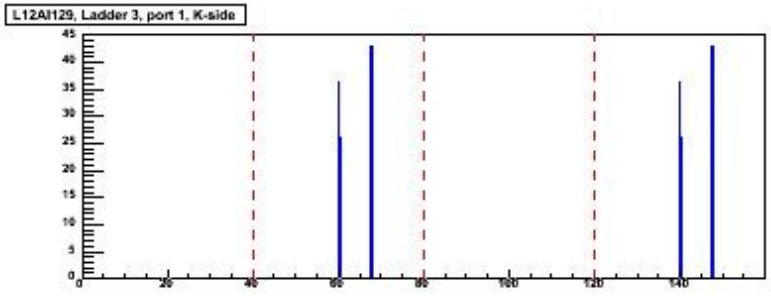
- First operation of SI-PM in space
- 1*1 mm^2, now 3*3 and 5*5 mm^2
- Low power consumption, small occupation
- Good detection efficiency (in accordance with geometrical dead area)
- Fast response (0.5 ns, in this case >3 ns due to wavelenght shifter)

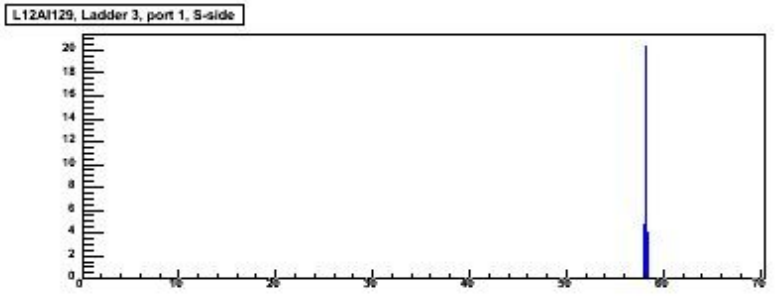


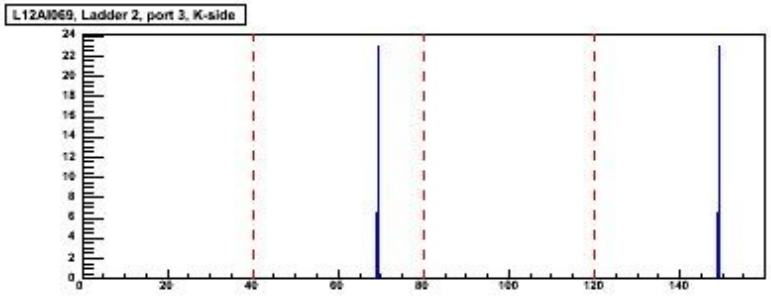
Silicon Microstrip detector

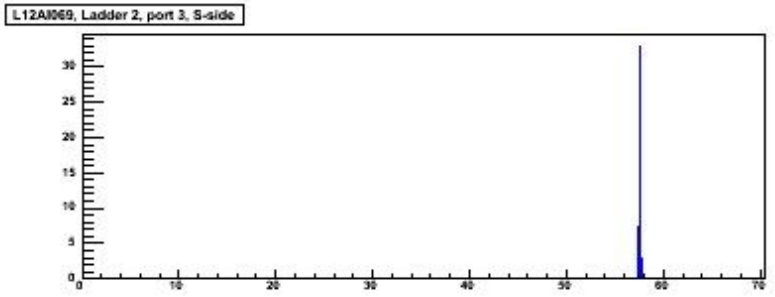


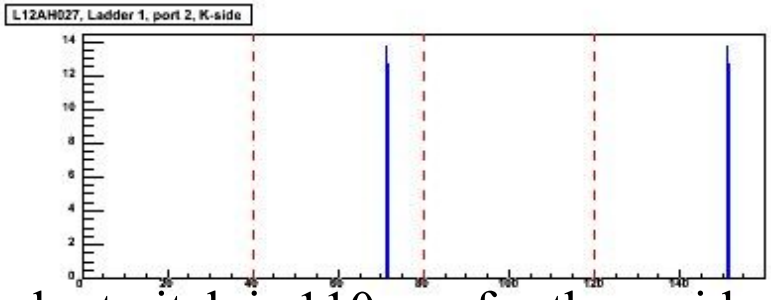


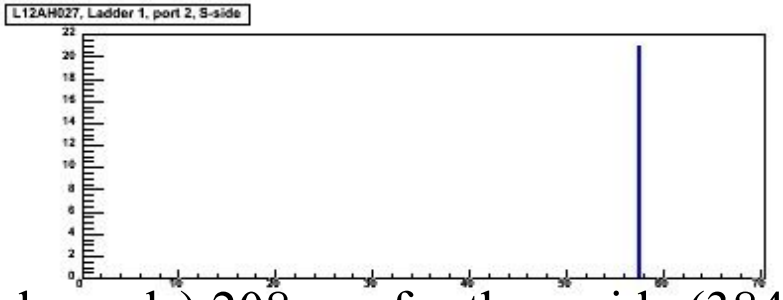






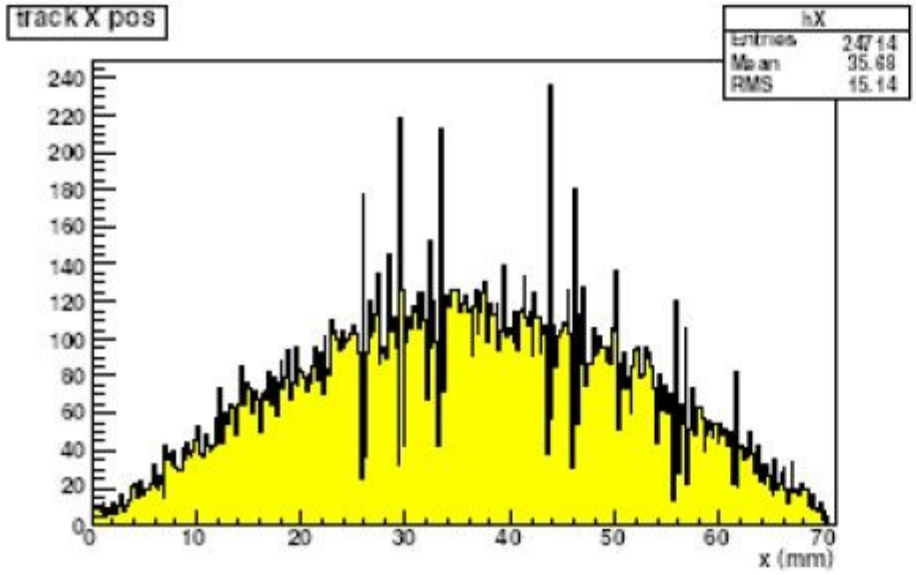


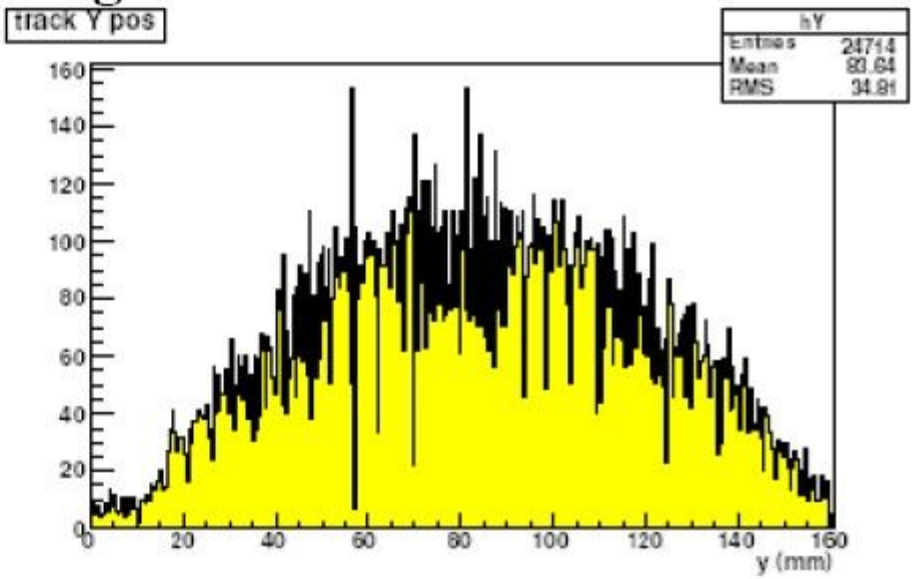


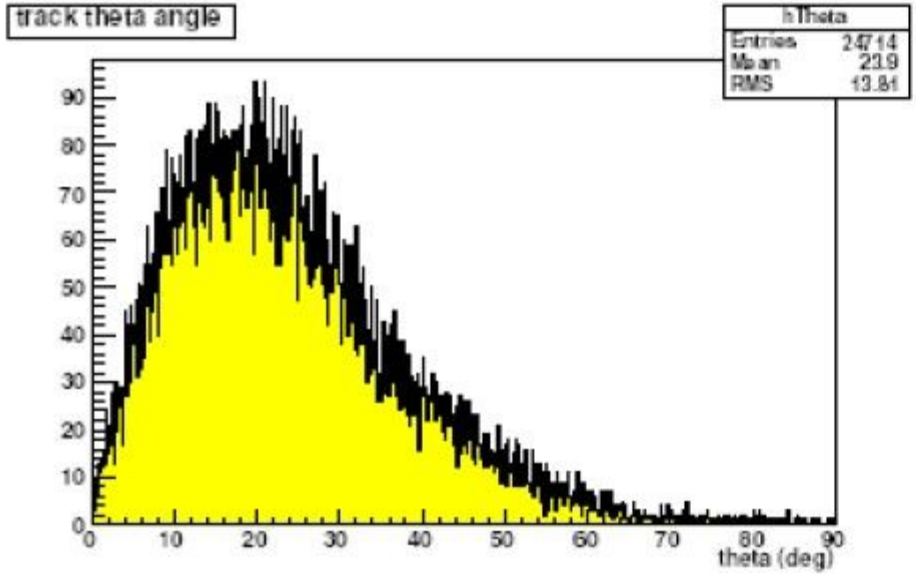


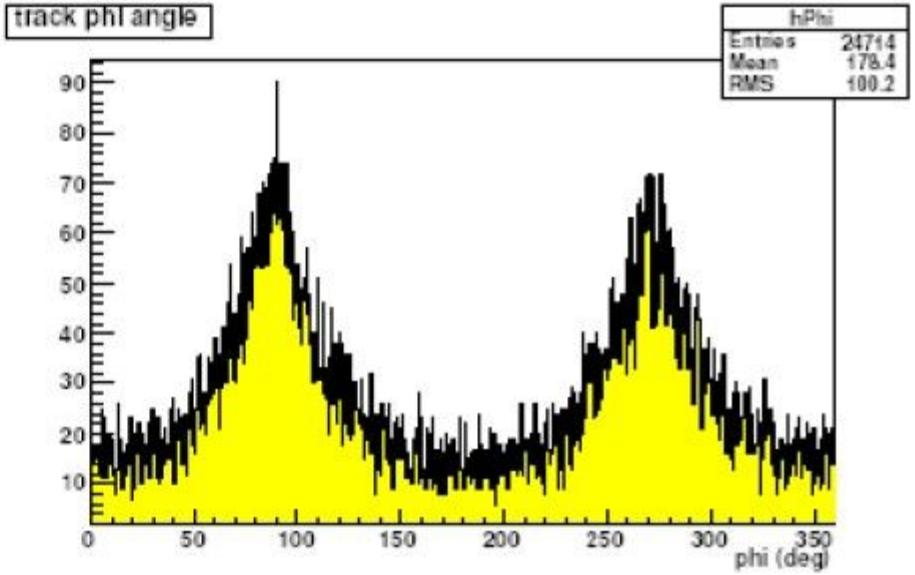
Readout pitch is 110 μm for the p-side (640 channels) 208 μm for the n-side (384 ch)

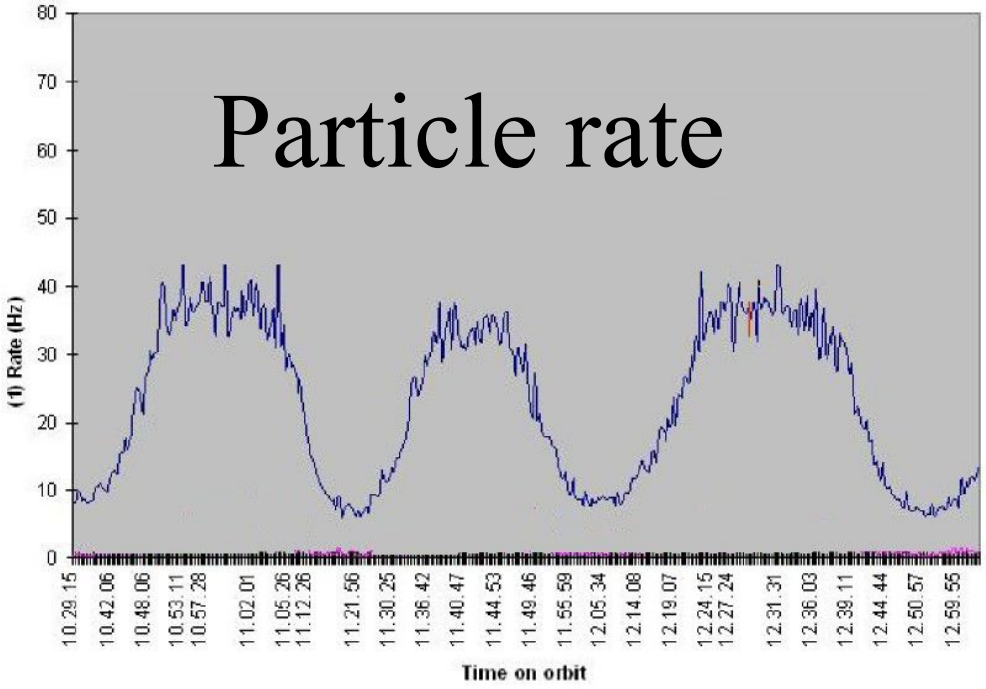
LAZIO-SiRad flight data







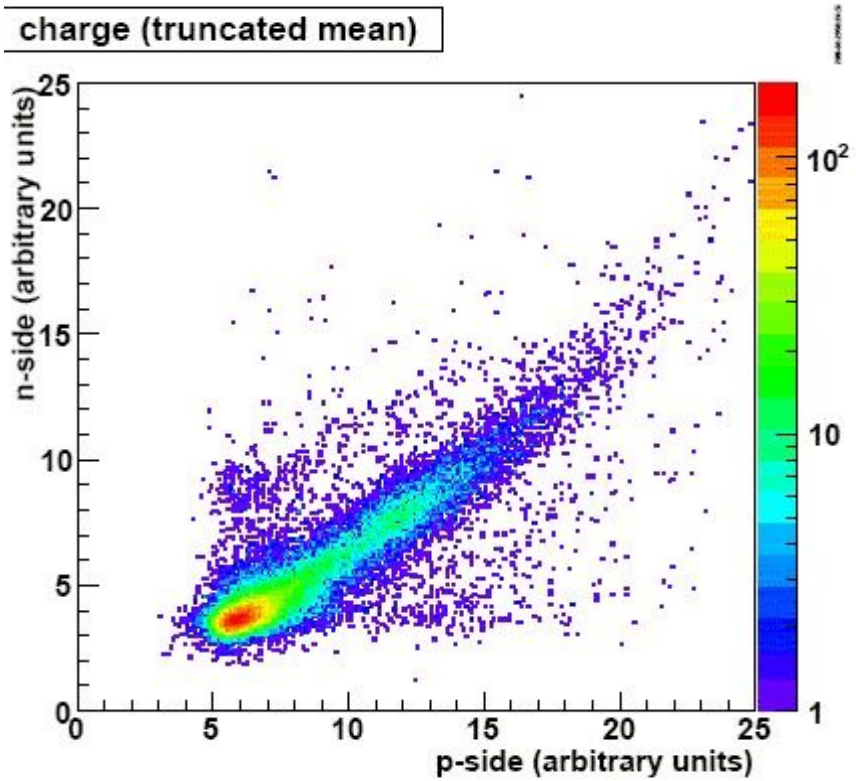




2.5 hours data before failure

Energy release

- Good linearity between two channels
- Proton peak evident

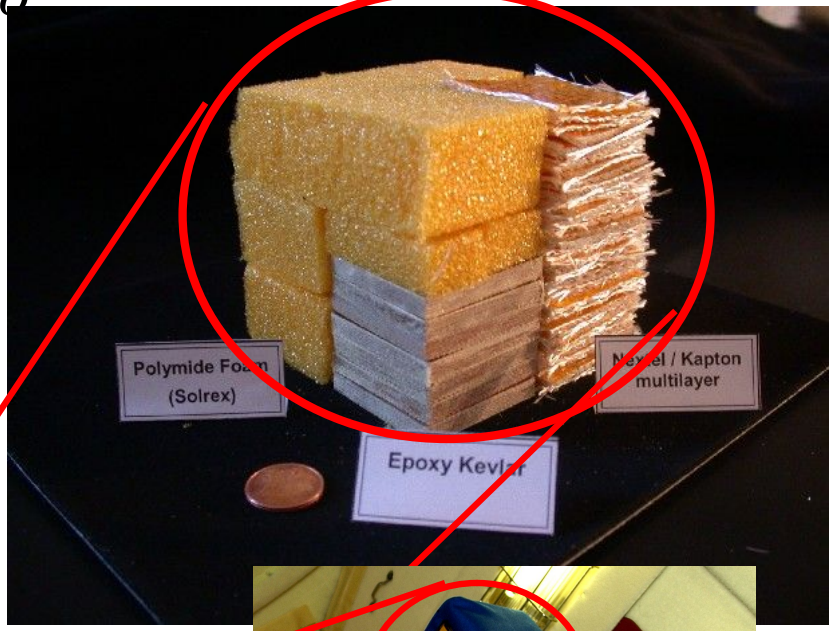


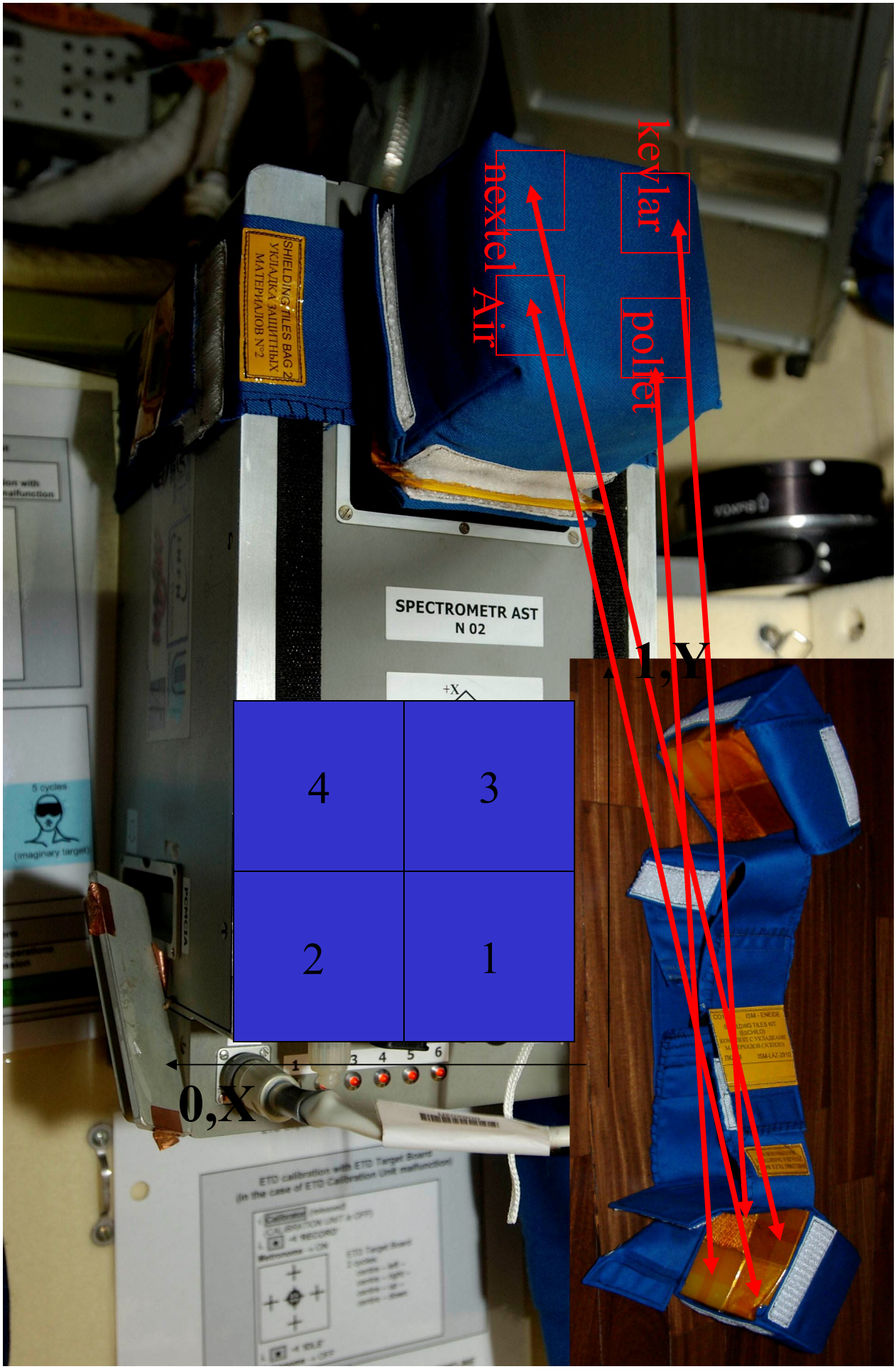
Lazio-Eschilo

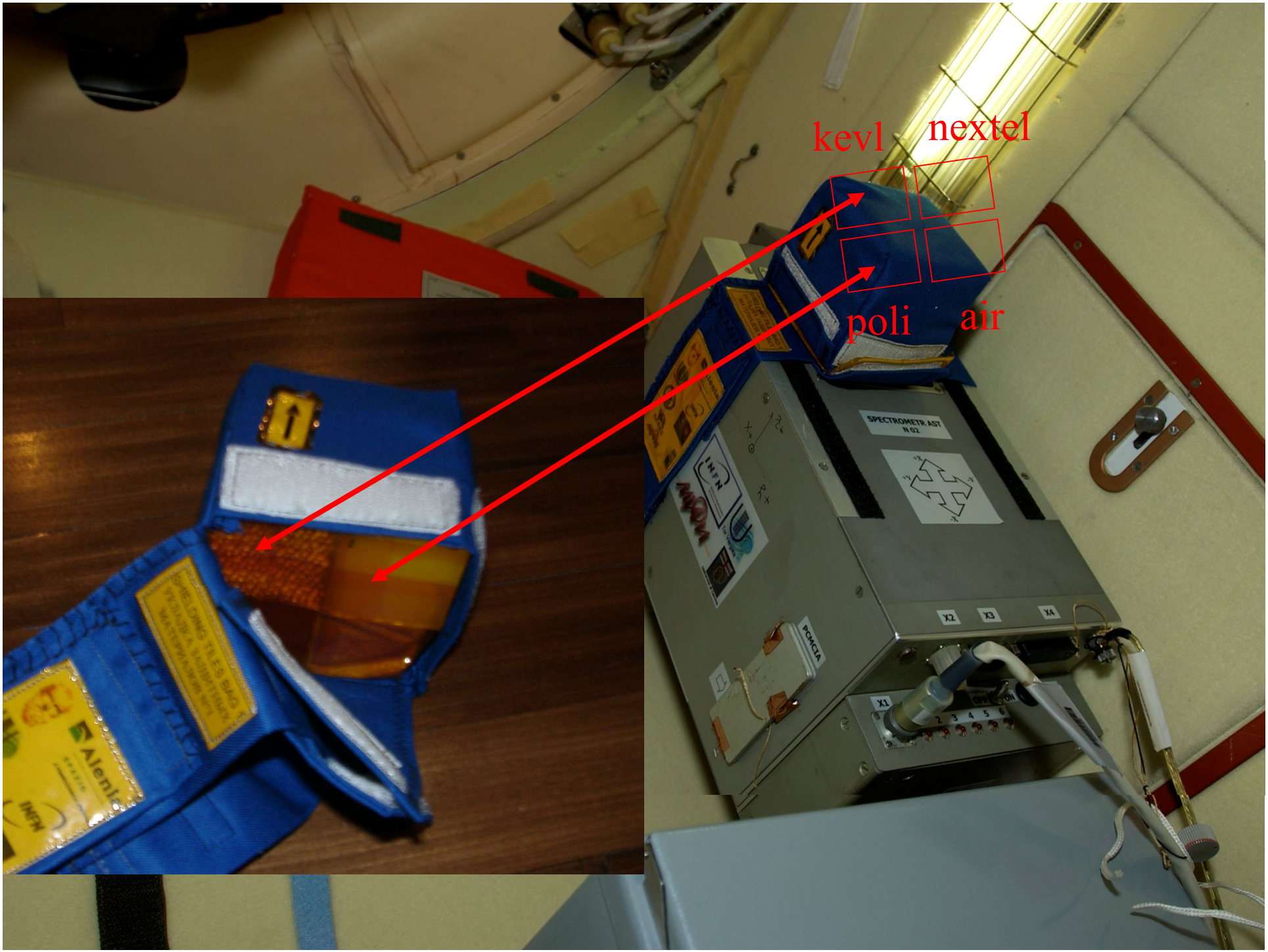
(Esperimento di Schermatura in Low earth Orbit)

With University of Naples Aleniaspazio

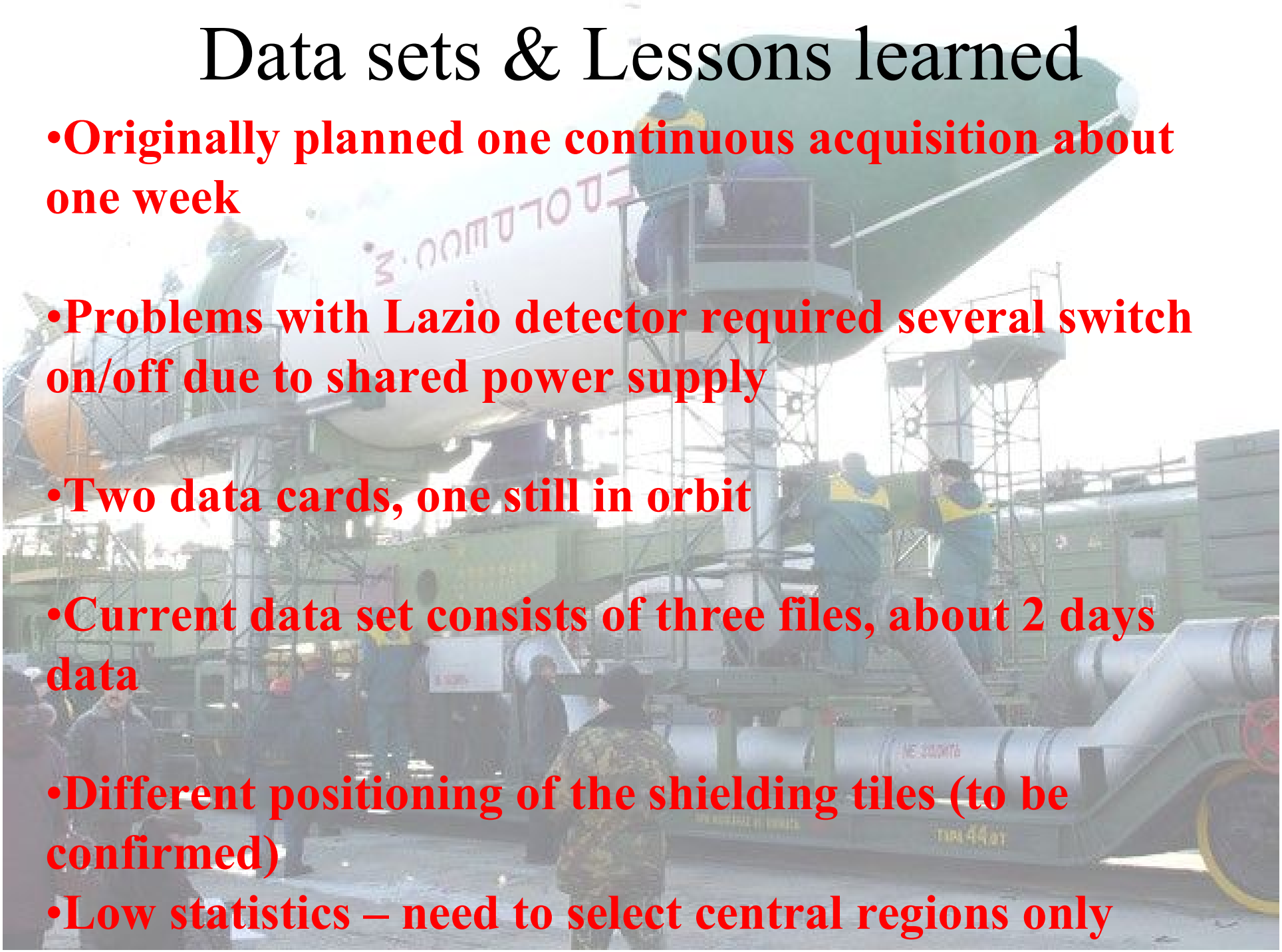
- Study of the effect of different shielding materials on the cosmic radiation
- 4 different shielding materials (5g/cm^2):
  - Air, Kevlar, Poliethilene, Nextel/Kapton
- Dosemeters for active/passive comparison
- Comparison with Montecarlo




kevlar
polyet
nextel
Air
SHIELDING TILES BAG 2
УКЛАДКА ЗАЩИТНЫХ МАТЕРИАЛОВ N°2
SPECTROMETR AST
N 02
+X
4
3
2
1
0,X
1,Y

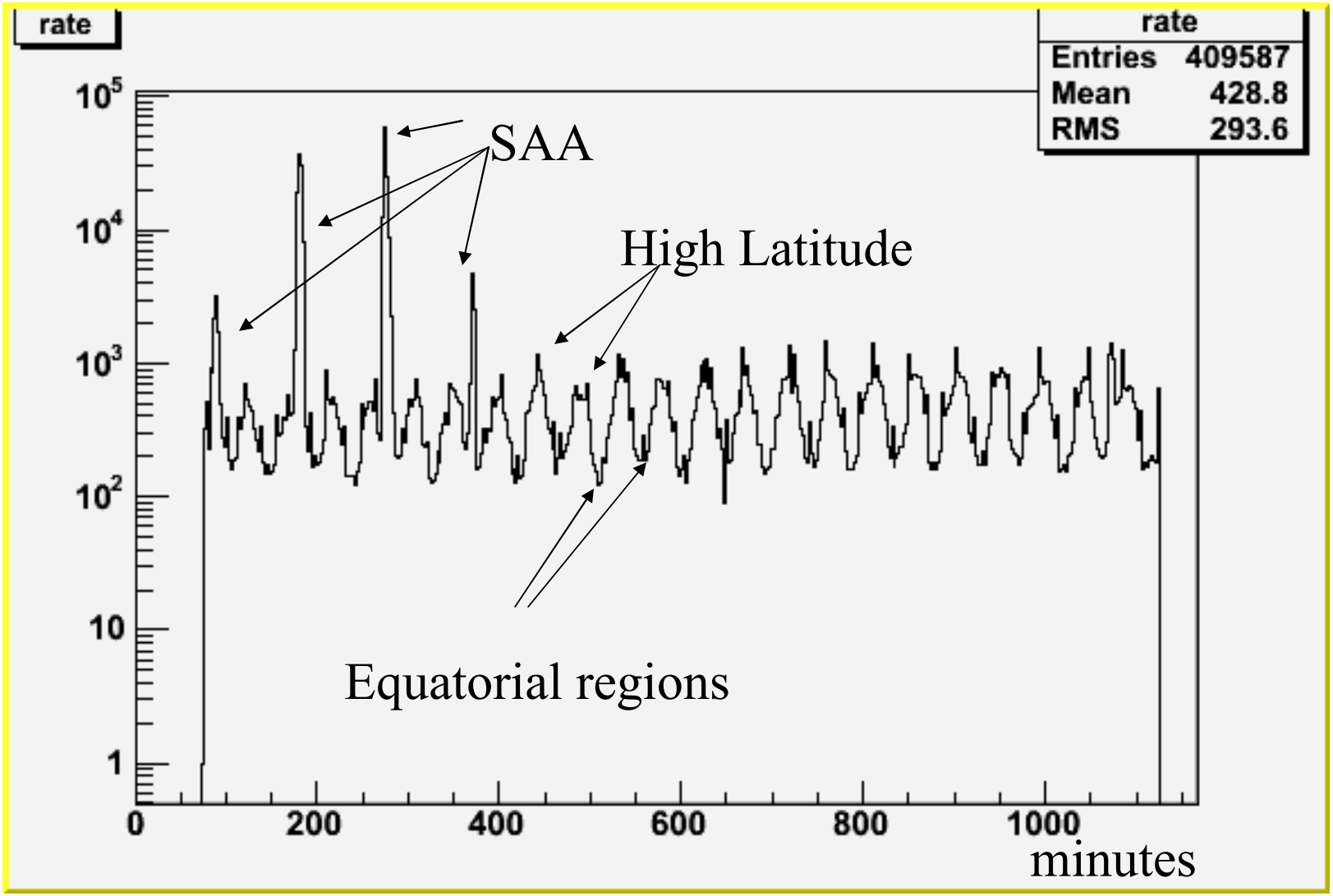

kevl
nextel
poli
air
SPECTROMETR AST
N 02
PCMCIA
X1
X2
X3
X4

Data sets & Lessons learned

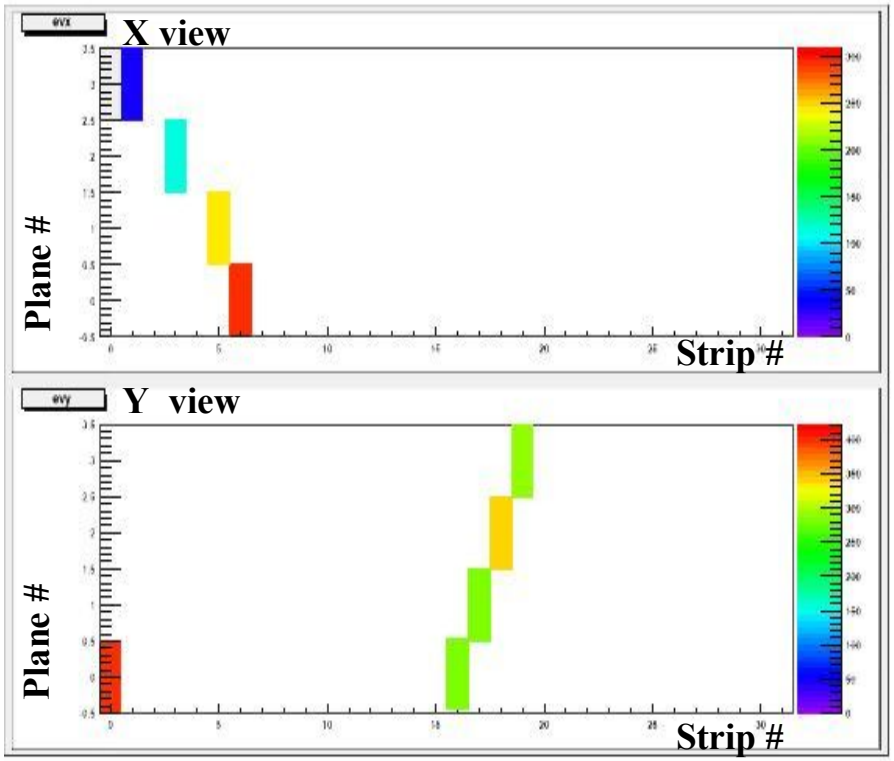


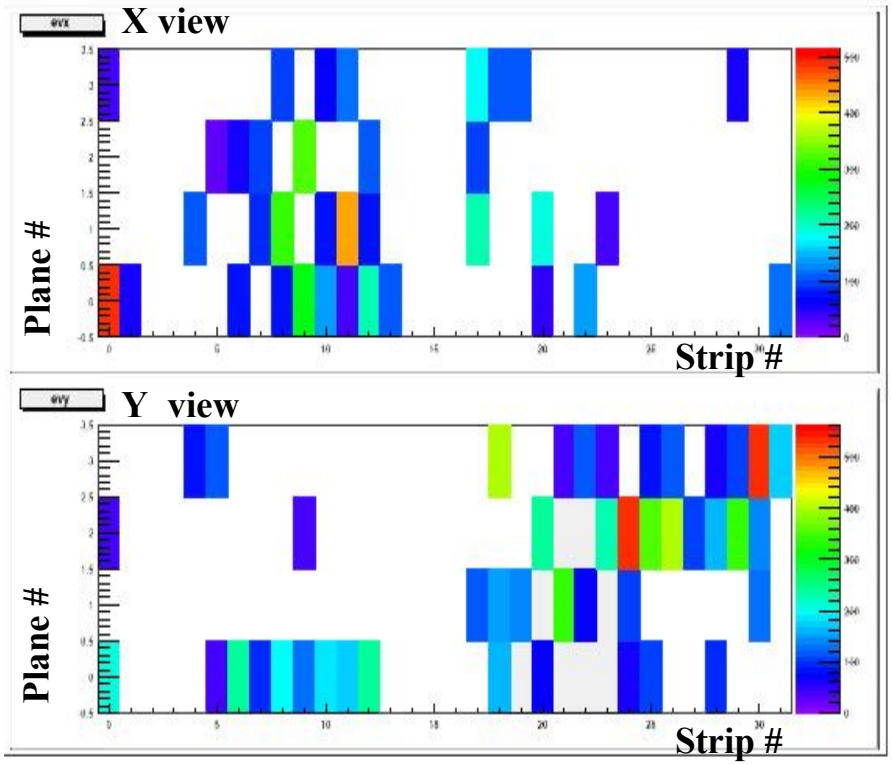
- **Originally planned one continuous acquisition about one week**
- **Problems with Lazio detector required several switch on/off due to shared power supply**
- **Two data cards, one still in orbit**
- **Current data set consists of three files, about 2 days data**
- **Different positioning of the shielding tiles (to be confirmed)**
- **Low statistics – need to select central regions only**

Sileye3/Alteino data

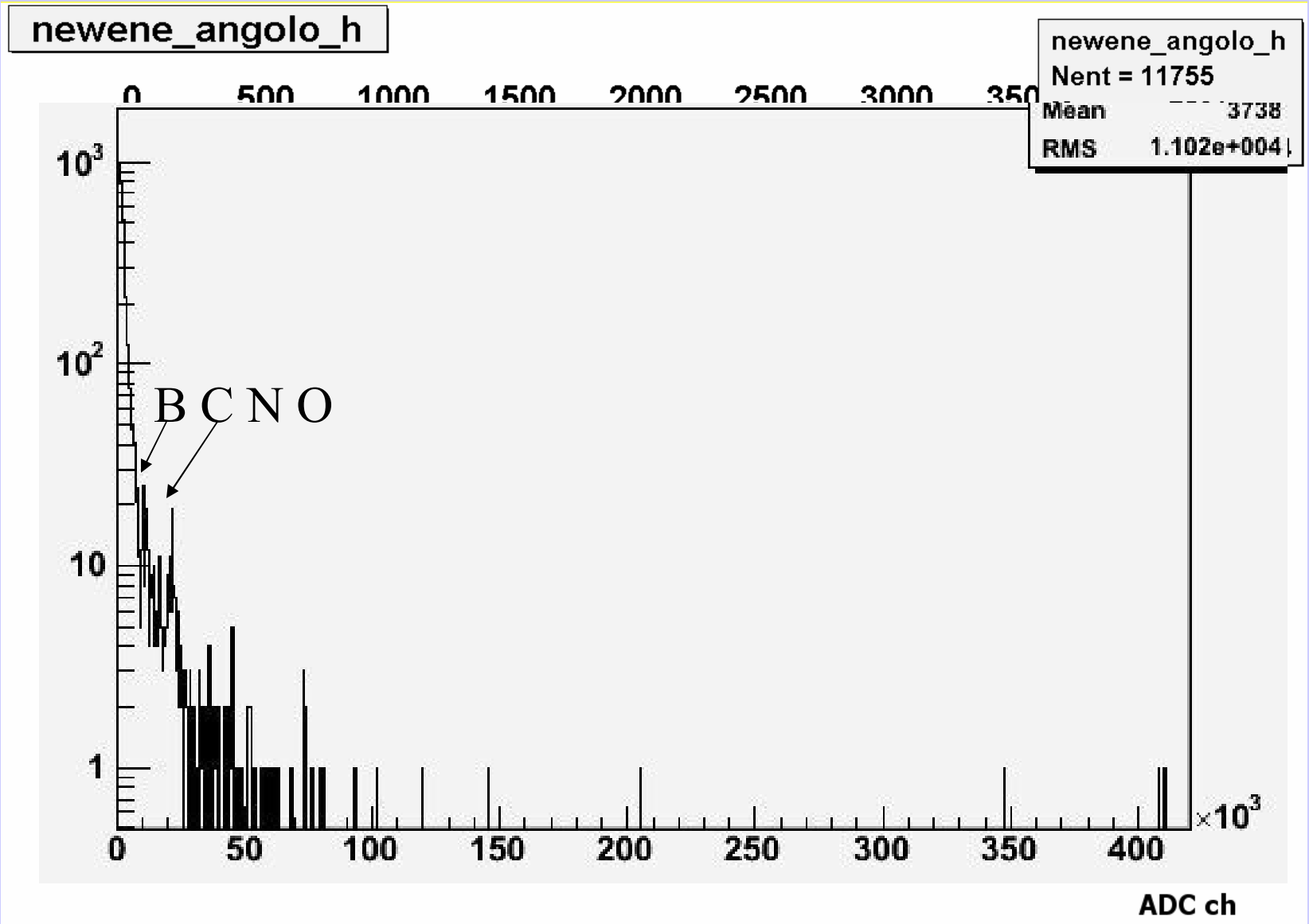


Sample events

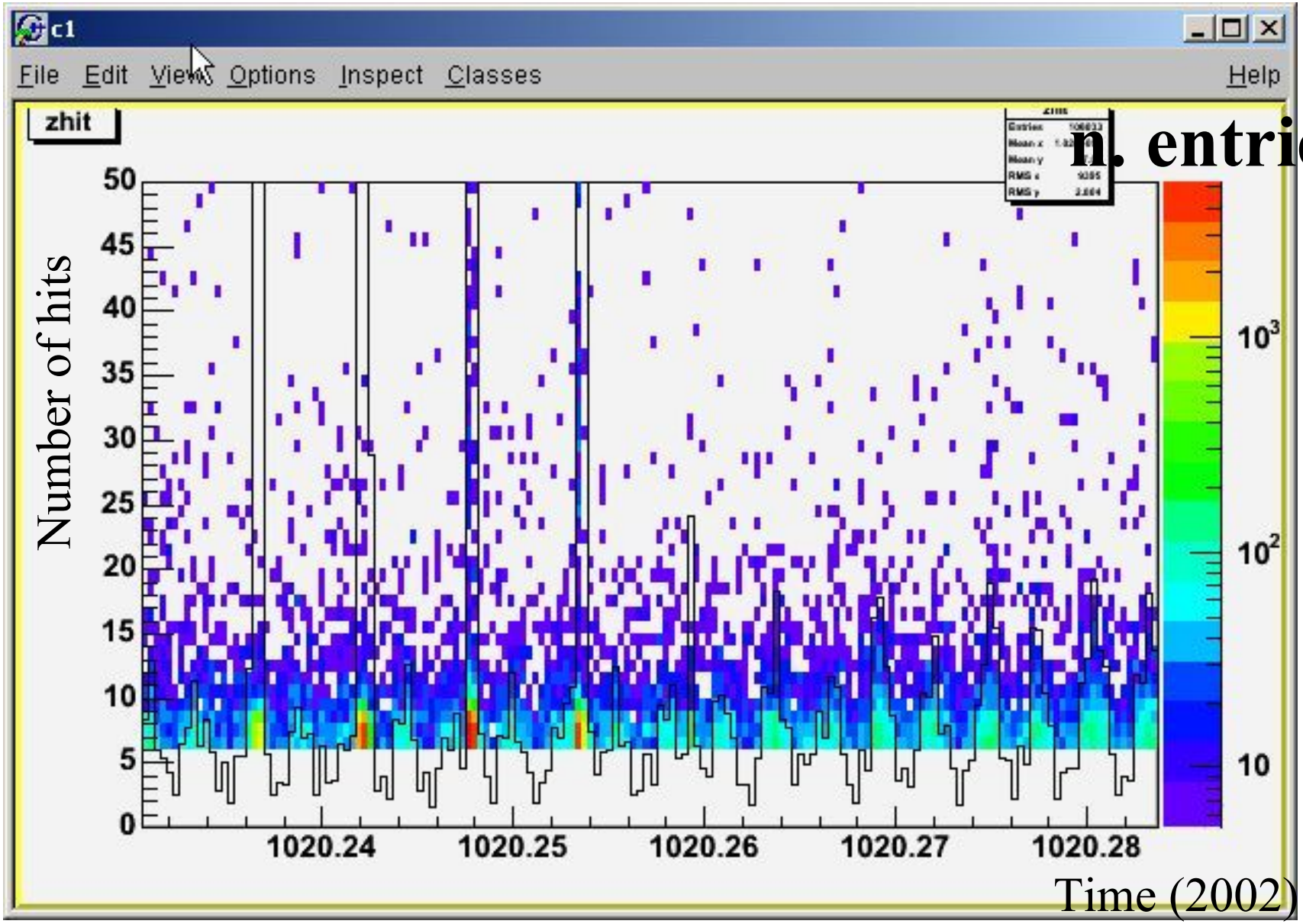




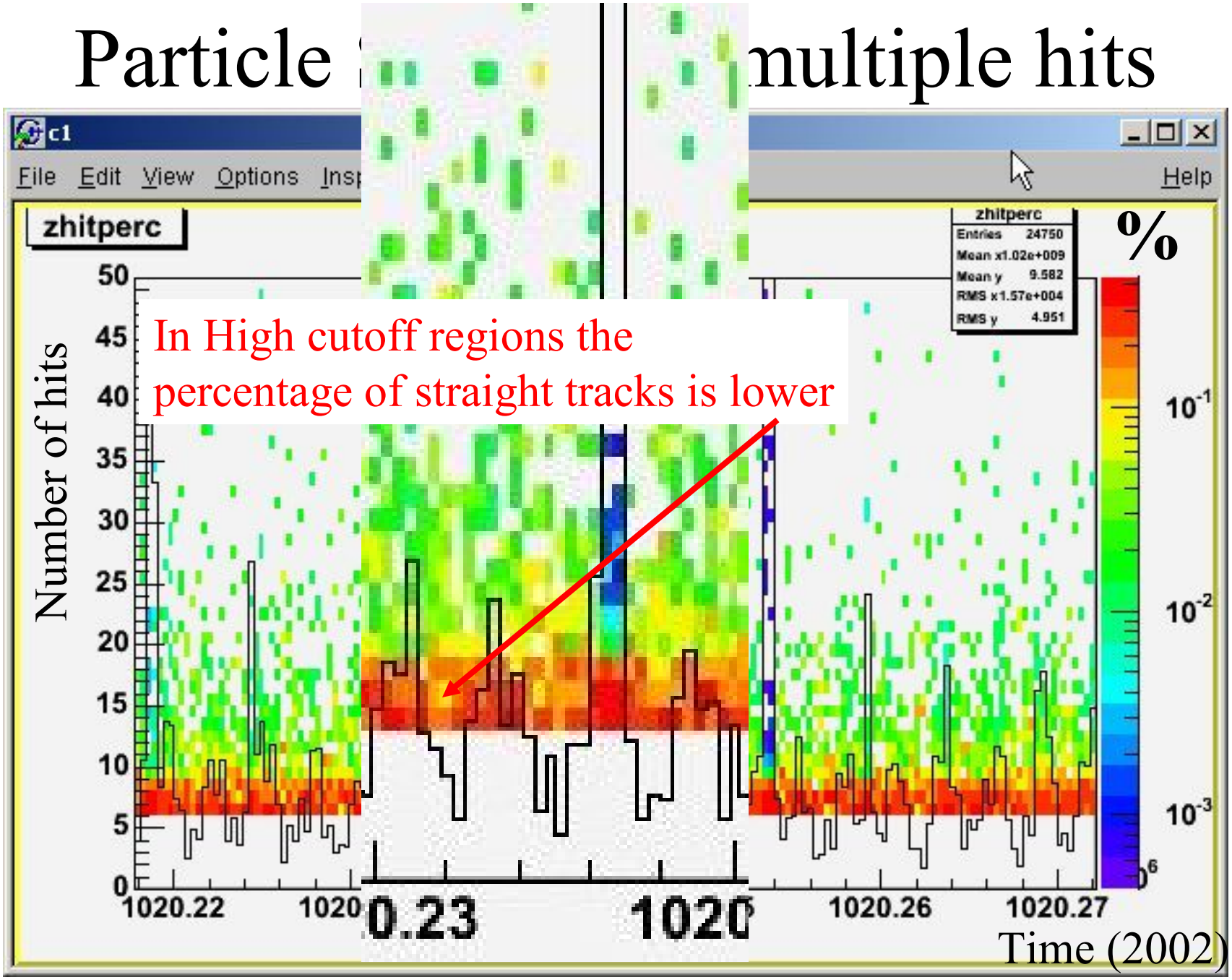
2002 data: particle identification



Number of hits distribution - 2002



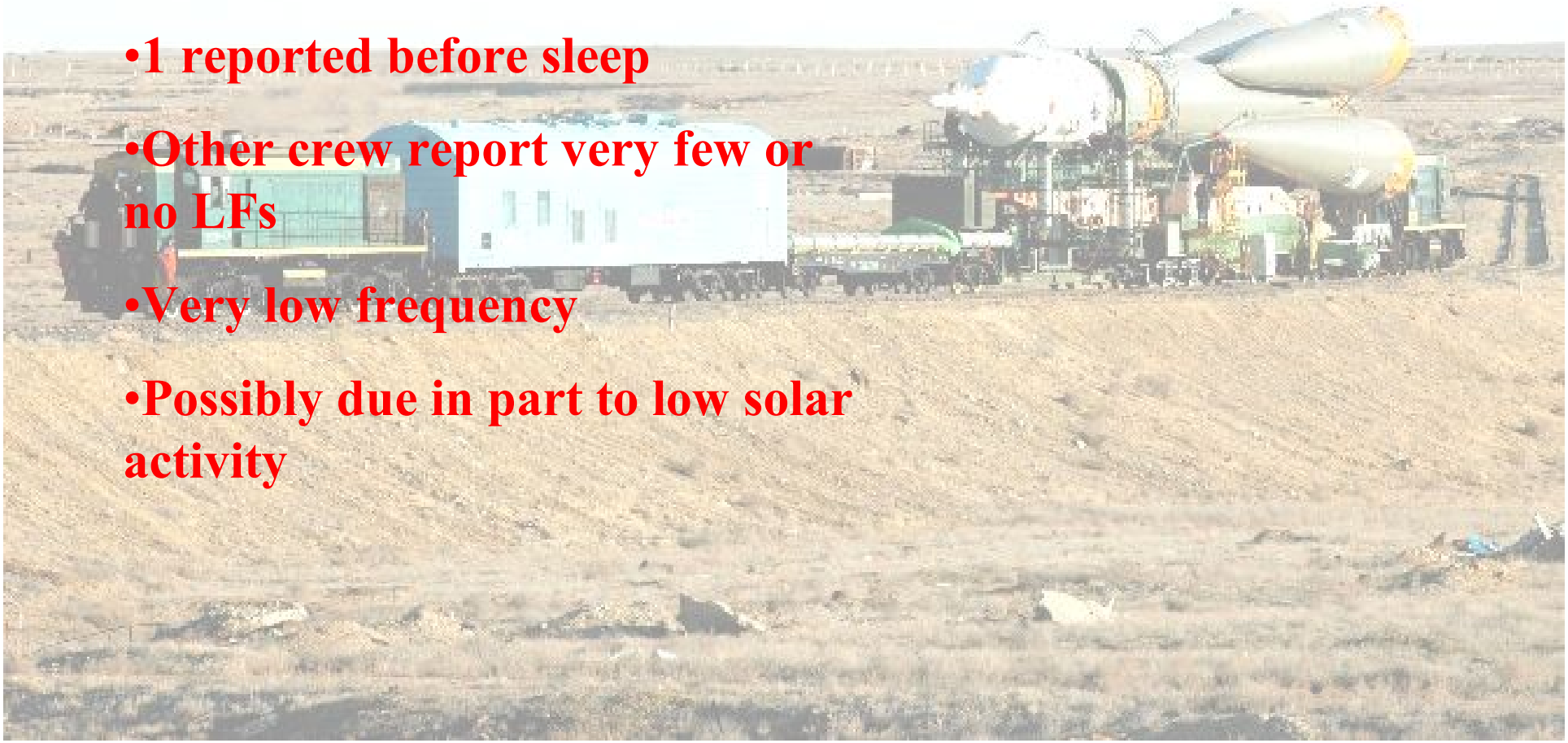
Particle multiple hits



Lazio-Light Flashes

- 5 – 1 hour LF observation sessions (about 200min time after dark adaptation).
- Analog tape recorder for time, comments and LF observations
- Altea precursor

Light Flash data



- **No LF seen during sessions**
- **1 reported before sleep**
- **Other crew report very few or no LFs**
- **Very low frequency**
- **Possibly due in part to low solar activity**

Current & future work…

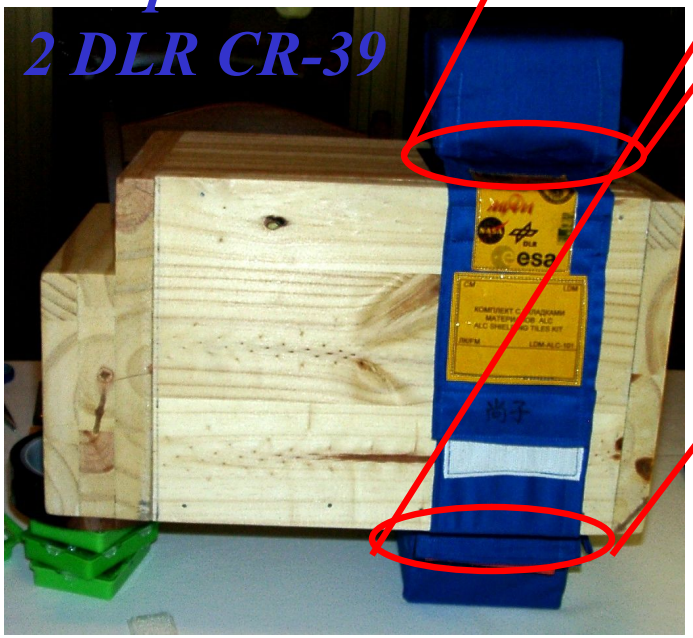
- Data analysis of Alteino
- Measurements inside ISS in the framework of Matroska-II / Altcriss ESA projects
- LAZIO reswitch on (magnetometer only)
- Altea
- Pamela
- Si-Rad (under development)

ALTCRISS

- **Long term monitoring inside ISS using Alteino**
- **Selected by ESA in the Life Science AO**
- **"Anticipated" to ESA Long Duration Mission of Thomas Reiter**
- **Intercomparison with other detectors in the framework of Matroska II**
- **Curently 6 month mission: 3 locations with and without shielding (Polyethilene shielding only on top of Alteino detector – 5g/cm^2)**
- **Various dosemeters: Napoli + DLR**
- **Comparison with ground data & simulations**

Active + Passive detector measurement

Active: Sileye-3
Passive:
Each Package:
2 Napoli TLD
6 DLR TLD (diff. Material)
1 Napoli CR-39
2 DLR CR-39



SHIELD1

SHIELD2

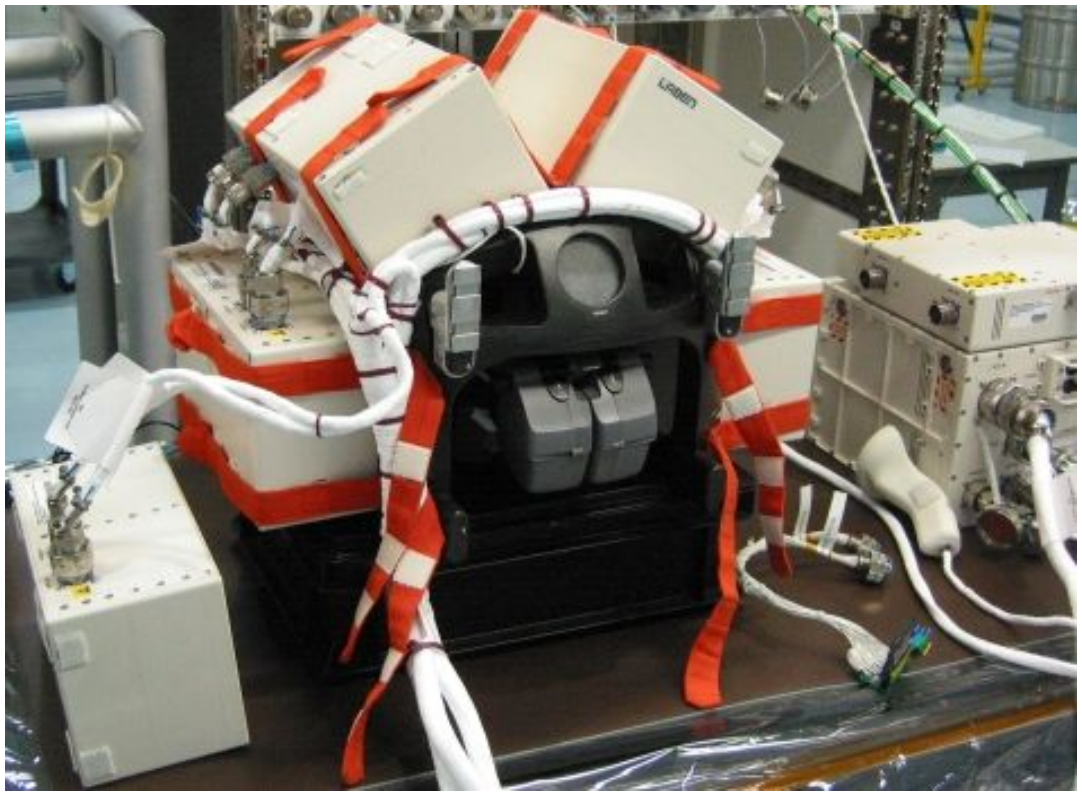
CNTRL (SPACE)

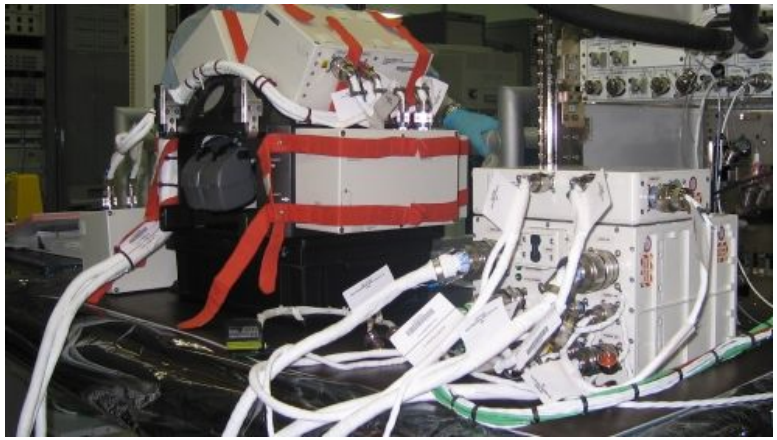
ESCHILO (SPACE

CNTRL GROUND

ALTEA

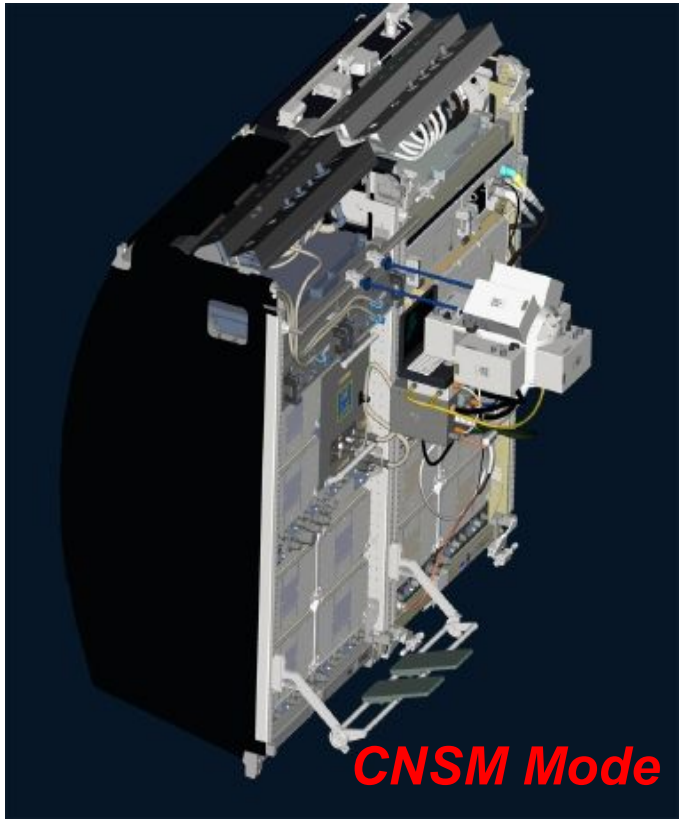
- Currently at JSC
- Scheduled for next Shuttle launch
- 6 Light Flash Sessions with astronauts
- Standalone mode: three axis detector
- Shielding studies





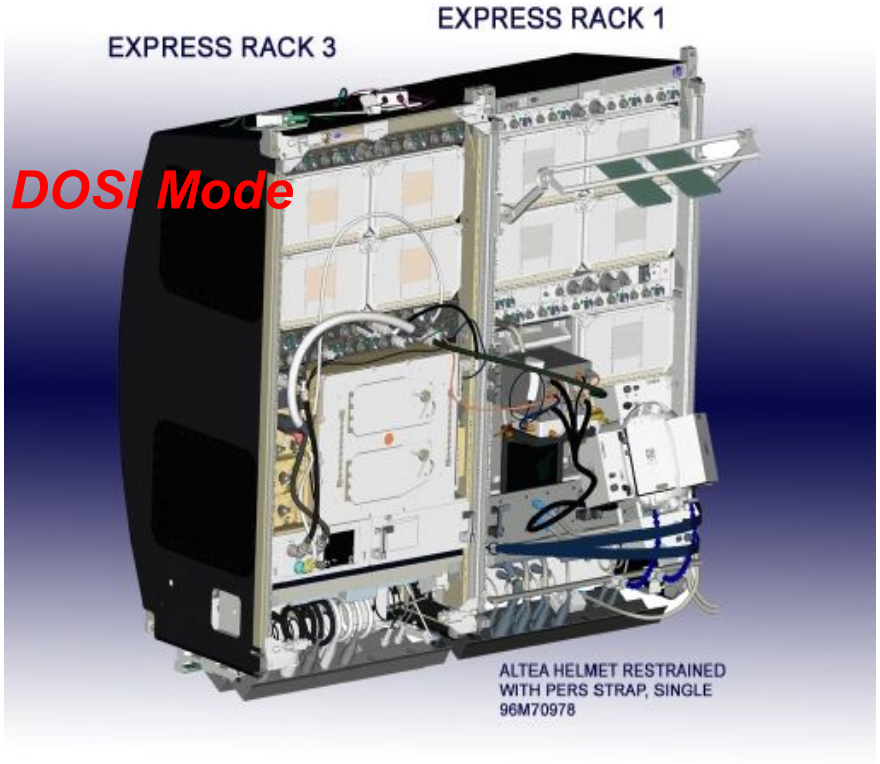
ALTEA - space

Experimental protocols



Manned: 6 sessions

the astronaut's electrophysiological activity is measured concurrently with the particles passing through her/his retina/cortex (energy released, trajectory, Z)



Unmanned:

The detectors are tilted 90° downwards to minimize protrusion.

The detectors are 'on' continuously.

Data is downlinked in real time

Pamela

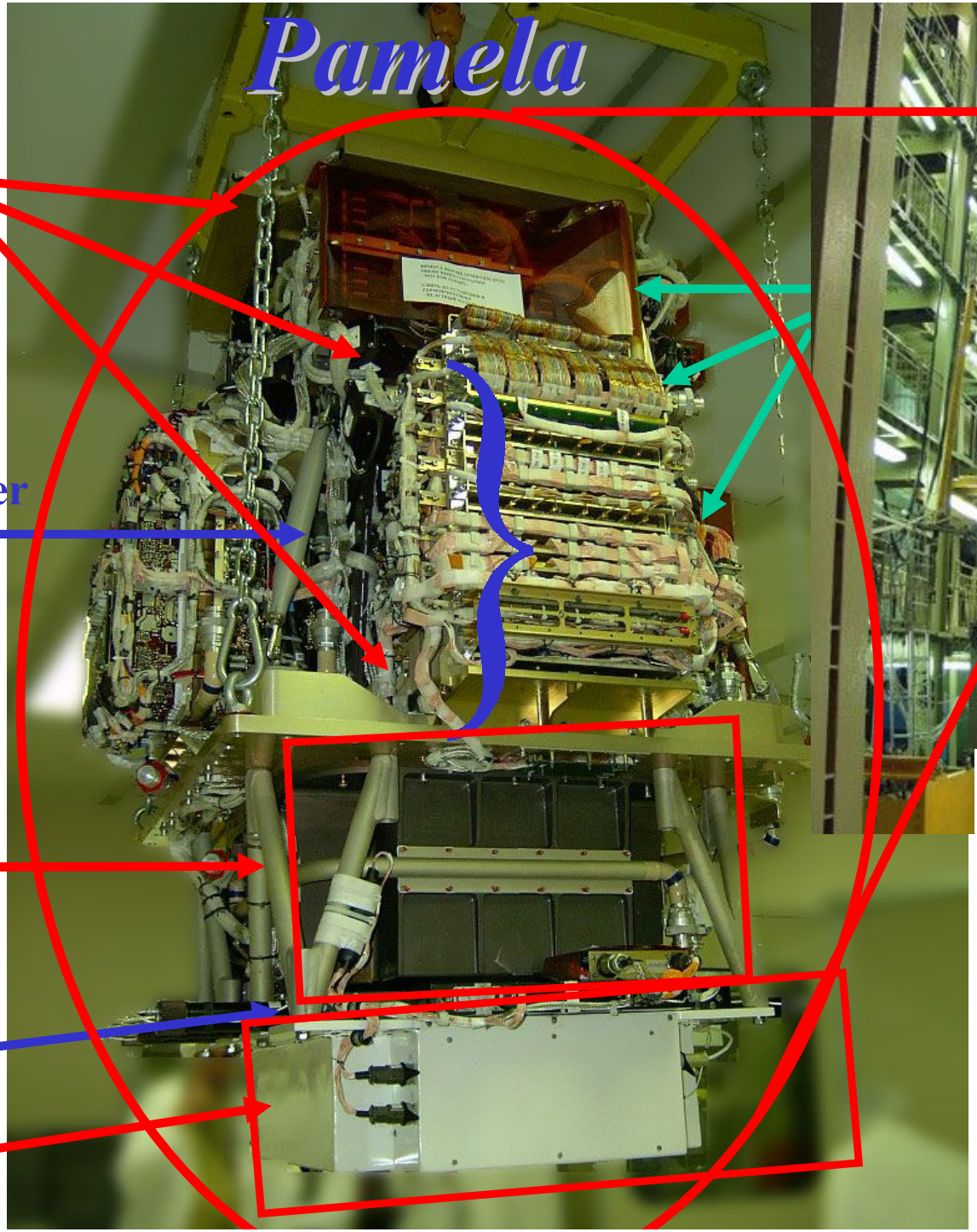
Time of Flight

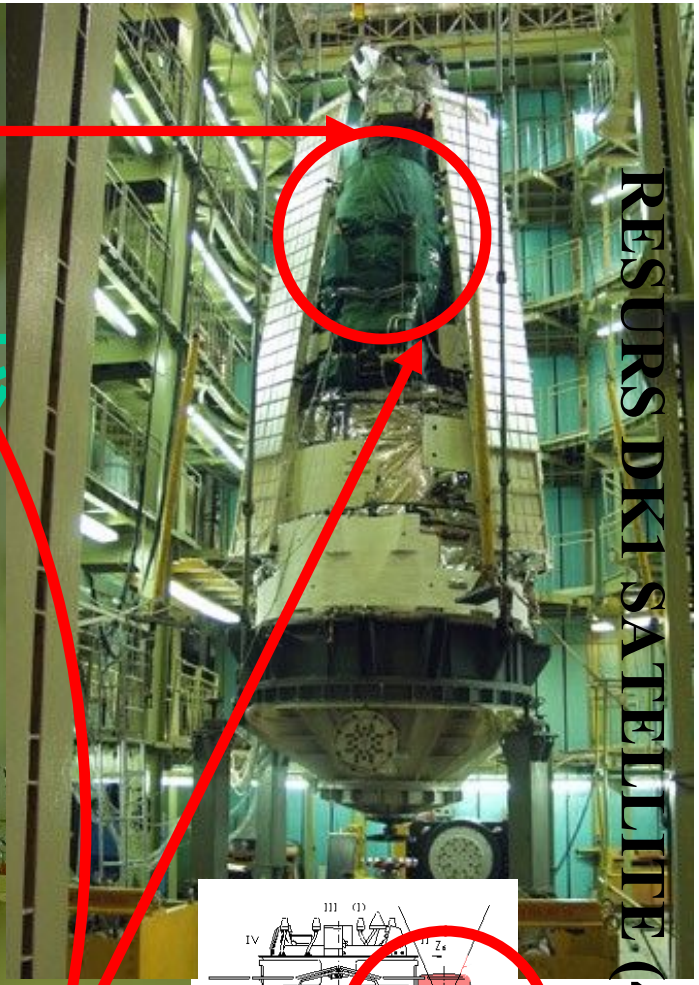
Magnetic Spectrometer Microstrip detector

Silicon Tungsten Tracking calorimeter

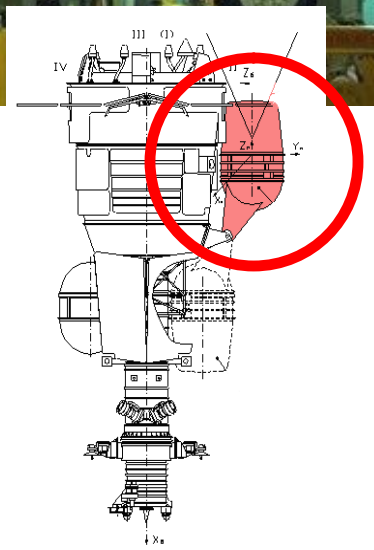
Shower Catcher Scintillator

Neutron Detector

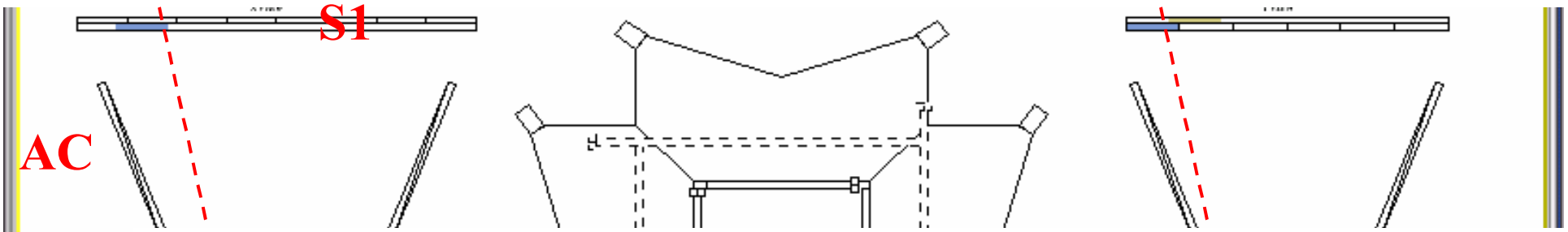




RESURS DK1 SATELLITE (4.5T)



X View Top View Y View



- 450 kg detector devoted to research of antimatter component in cr
- Protons + nuclei up to O
- Polar orbit
- Currently integration in Russia,
- Launch foreseen by Dec 2005