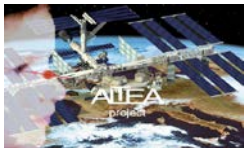
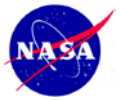


ALTEA: results and perspectives

L. Narici, L. Di Fino, M. Larosa, V. Zaconte, M. Casolino, P. Picozza

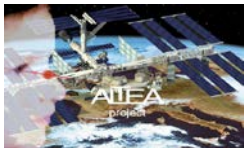
Department of Physics University of Rome Tor Vergata and INFN Tor Vergata



University of Rome
"Tor Vergata"

Space Radiation and Plasma Monitoring Workshop 2014

13-14 May 2014
European Space Research and Technology Centre (ESTEC)
Europe/Amsterdam timezone



Why radiation measurements on the ISS?

A detailed knowledge of the radiation environment is required

to **validate models** for future extrapolations in outer space.

[available simulations must be further validated to reach confidence in the extrapolation to outer space]

for **accurate risk assessments**

[increasing evidence for the importance of *radiation quality* (i.e. Z, E_{in}, rate)]

And the ISS is the best test bed we have available for measurements in outer space-like radiation environment

What is unique in ALTEA?

Real time radiation monitoring with several unique features:

Trajectory and directions

Nuclear estimation (Z)

Input energy estimation (E_{in})

Real time analysis

ALTEA Heritage

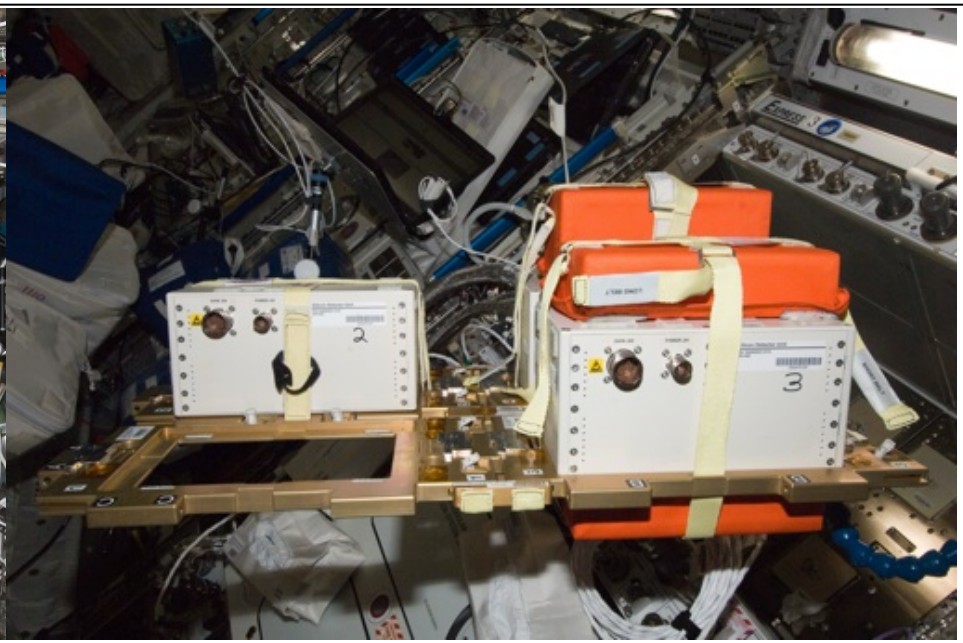
Satellite detectors

- Nina
- Nina 2
- Pamela

Human exploration detectors

- SilEye
- SilEye2
- Alteino
- ALTEA

ALTEA: the detector

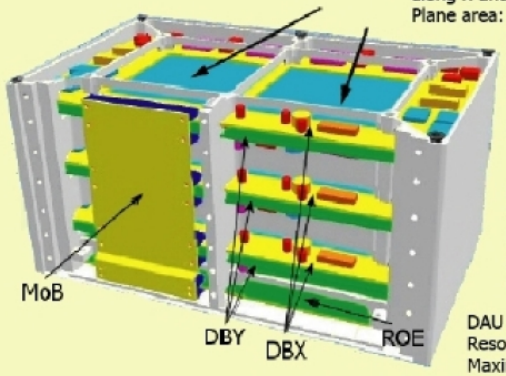


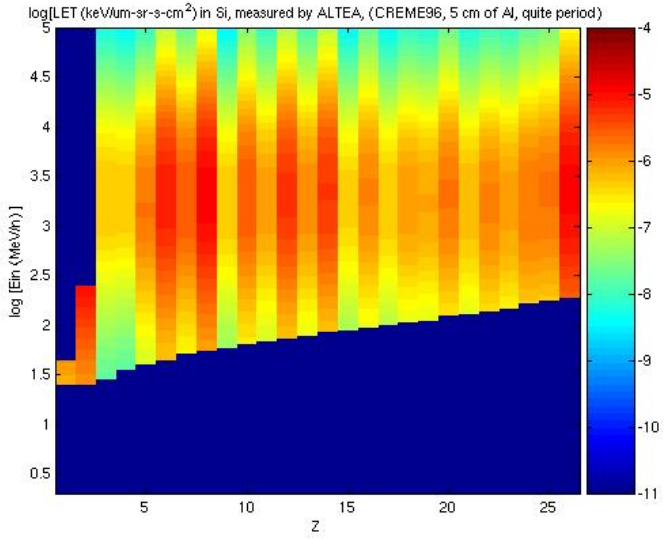
SDU: Silicon Detector Unit

DETECTORS: 6 double strip silicon layers arranged alternately-along X and Y directions
Plane area: 2 x (8x8) cm^2
Thickness: 380 μm
Distance X-Y planes: 3.75 cm
Maximum error of angular reconstruction: 1.8°
Geometric Factor (bidirectional): 200 cm^2 sr

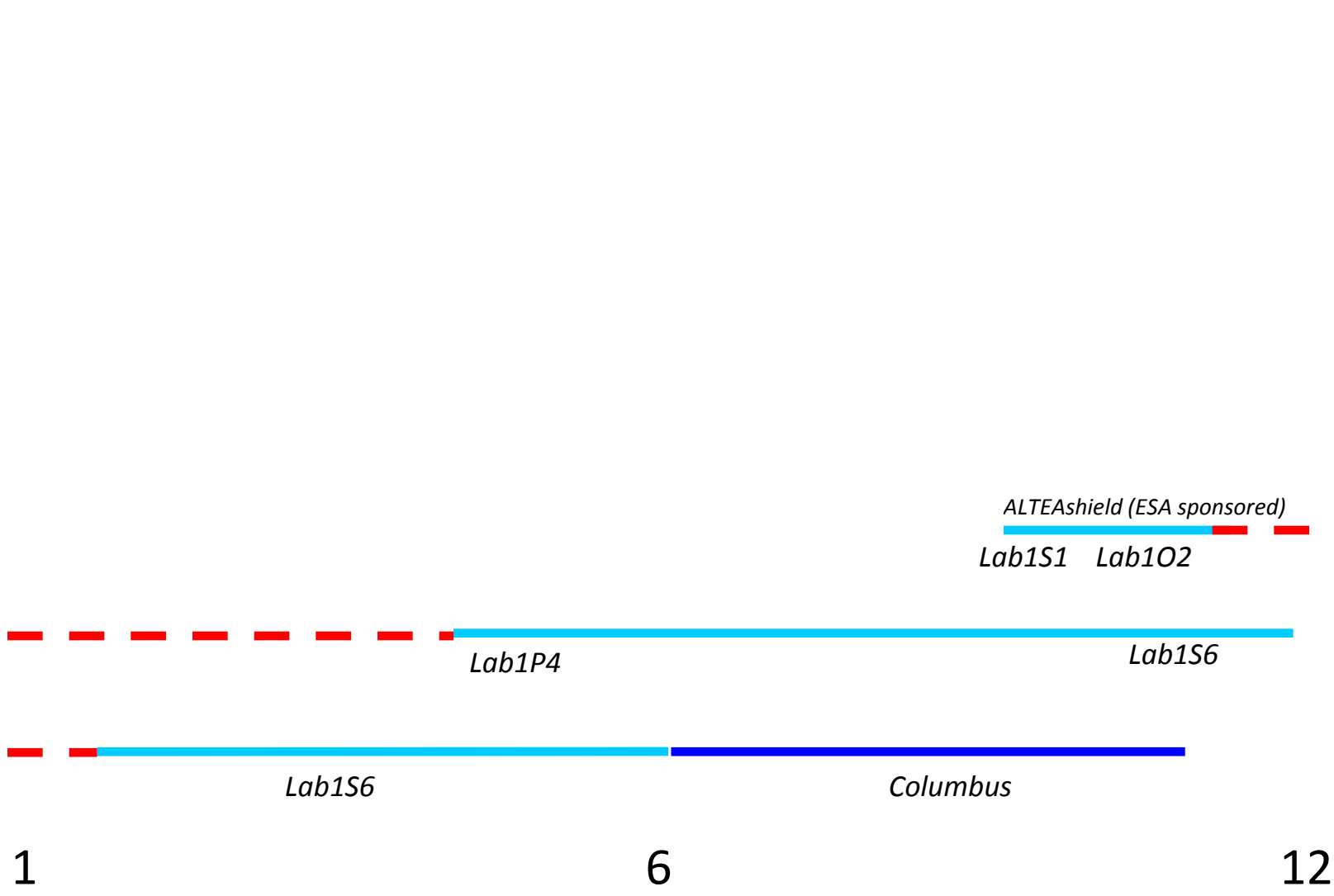
PERFORMANCES:
Threshold: 5 -33 MIP
Saturation: 2400 MIP
(1 MIP=109 KeV/plane)
ADC: 12 bit

DAU SOFTWARE PARAMETERS:
Resolution: 0.64 MIP/ADC ch
Maximum Acquisition Rate: 700 Hz
Autotrigger (logic OR or logic AND of X planes, software switchable)

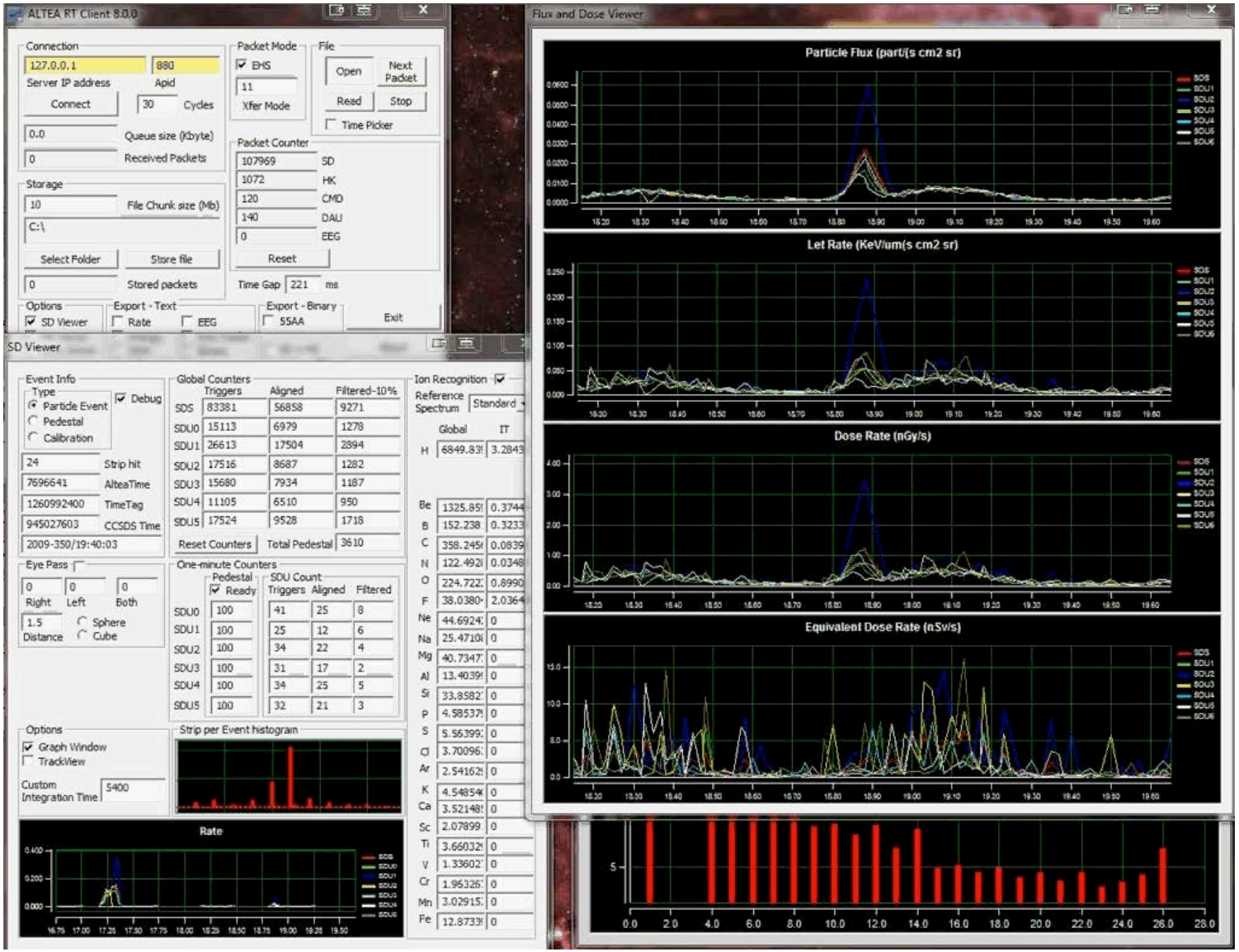




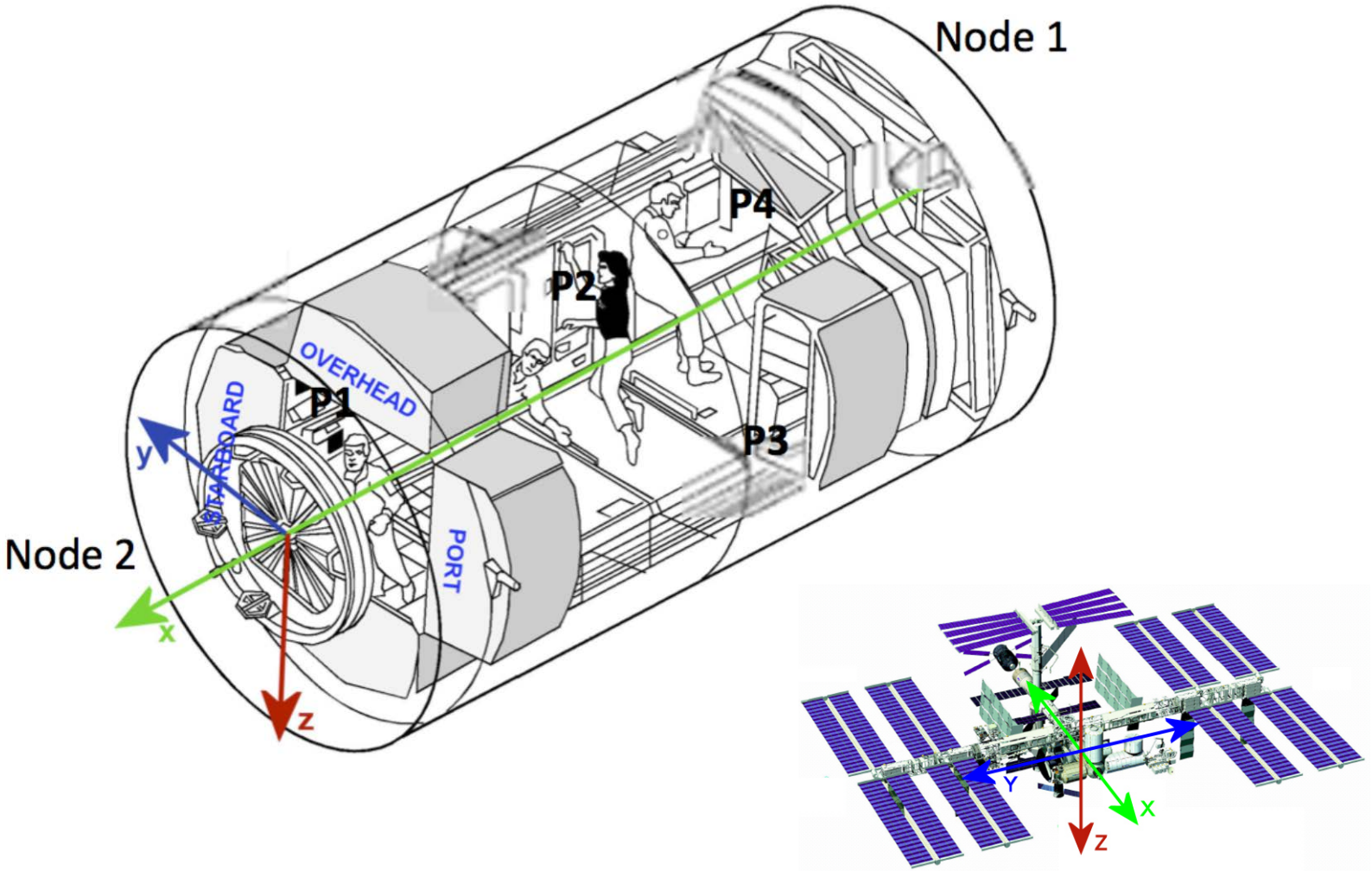
ALTEA: running times



ALTEA: real time in Rome UHB

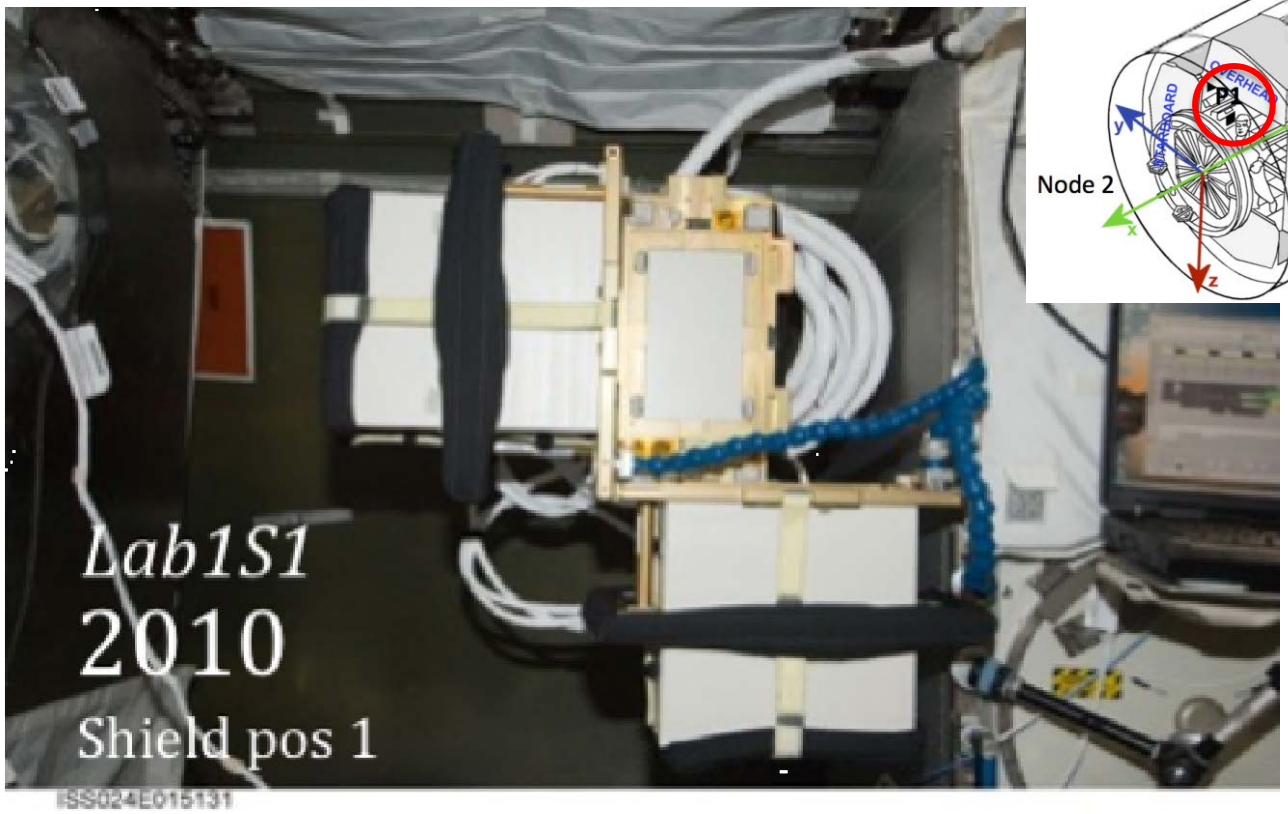


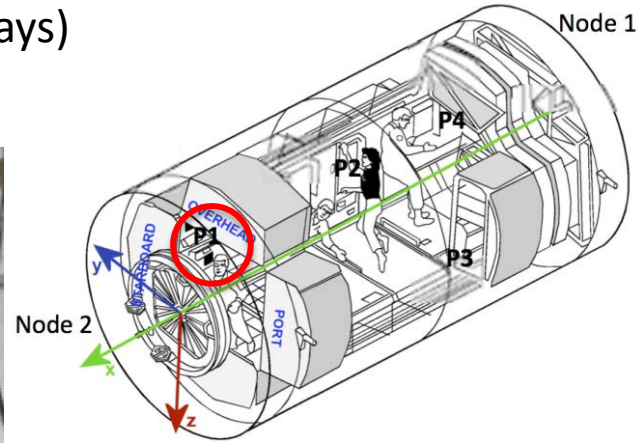
ALTEA – shield / Survey: siti di misura



First site: Lab1S1

This is a peculiar site: we have been able to insert two SDUs ('Y') in a free space with no rack. In this way Y radiation was shielded only by the USLab hull (≈ 12 days)





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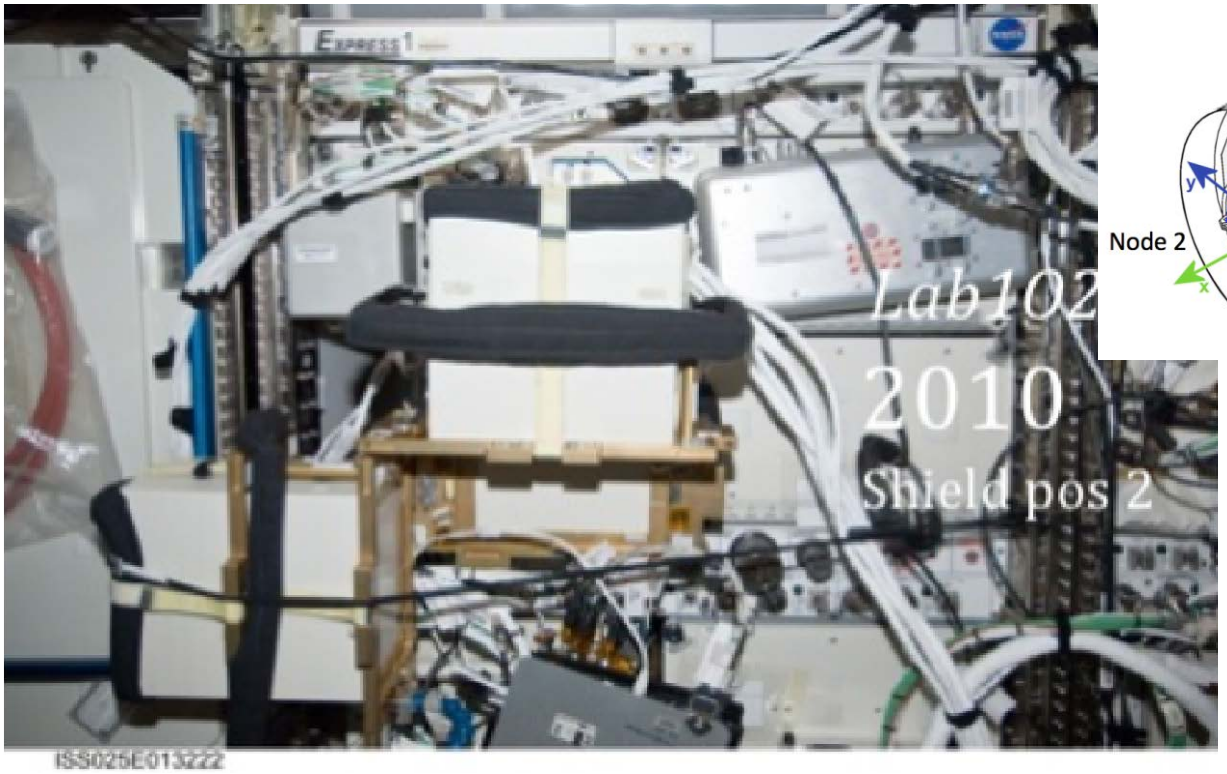
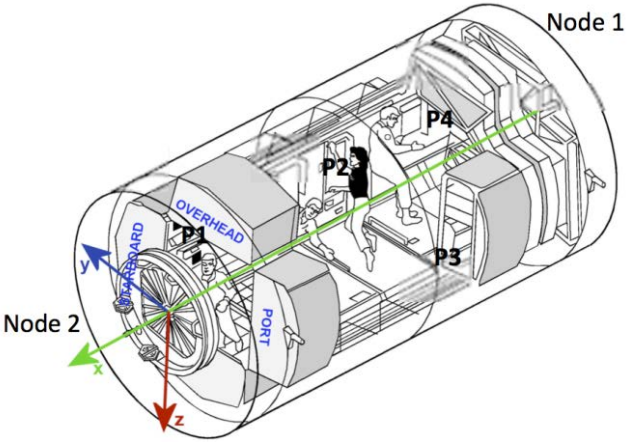
Second site: Lab1O2

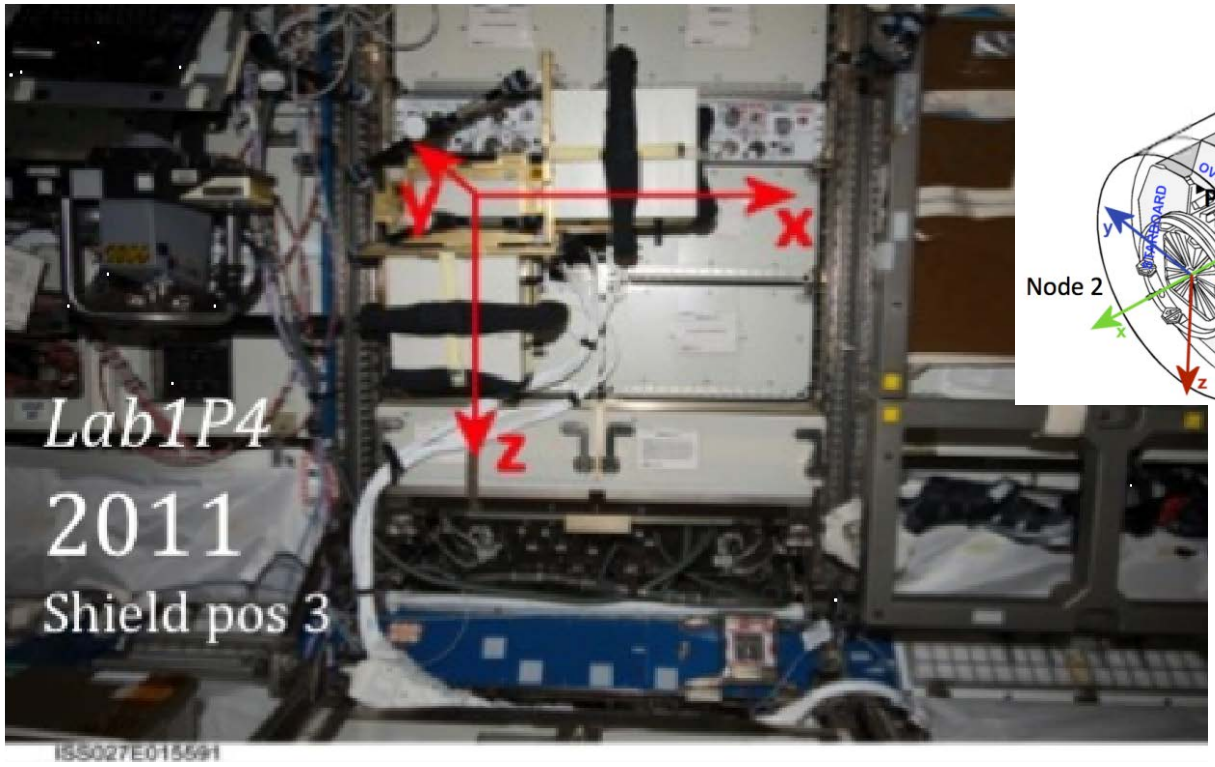
In this second site, instead, the two ‘Y’ SDUs are inserted in one rack (≈35 days)

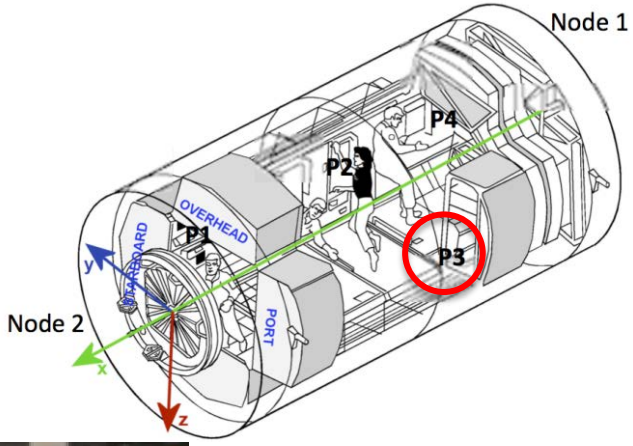




Third site: Lab1P4

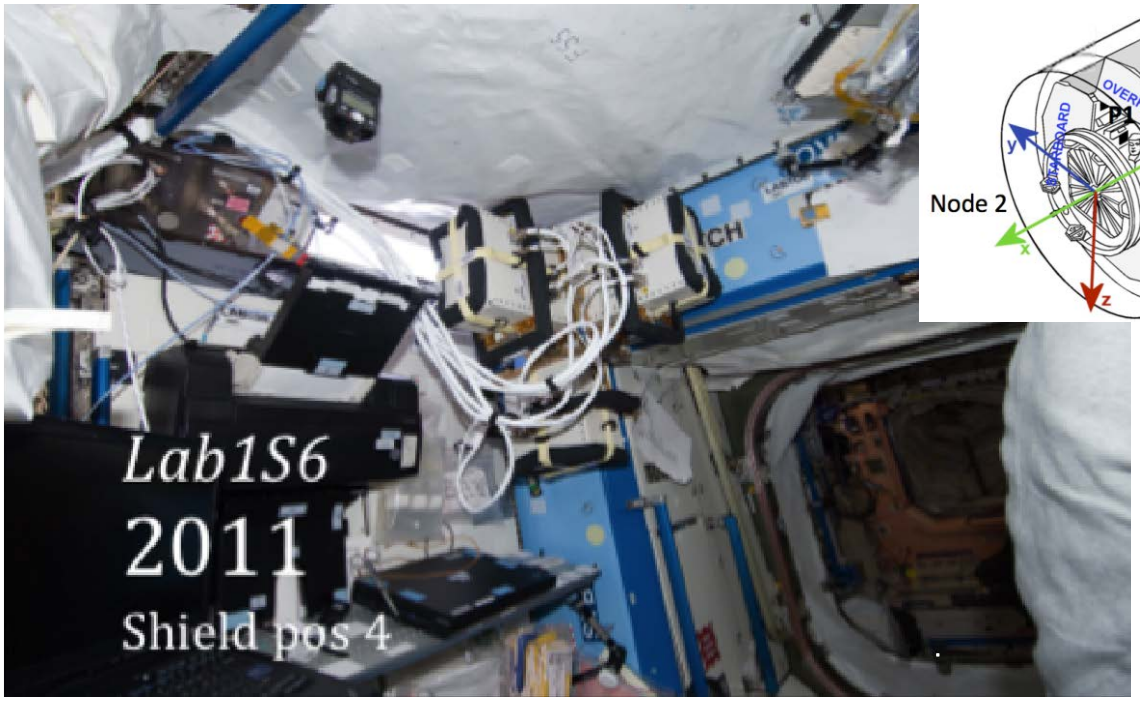
Also in this site the two ‘Y’ SDUs are inserted in one rack (≈ 90 days)

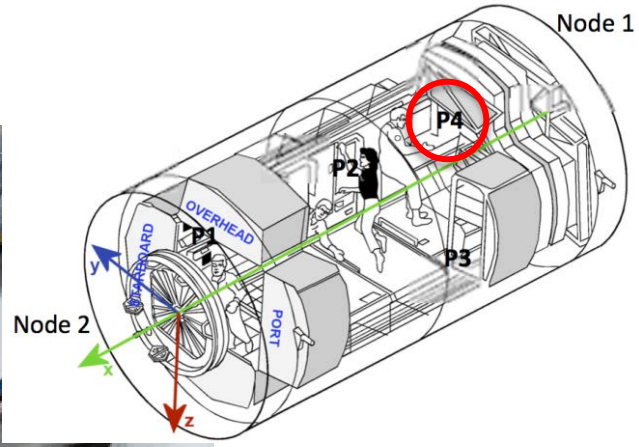




Fourth site: Lab1S6

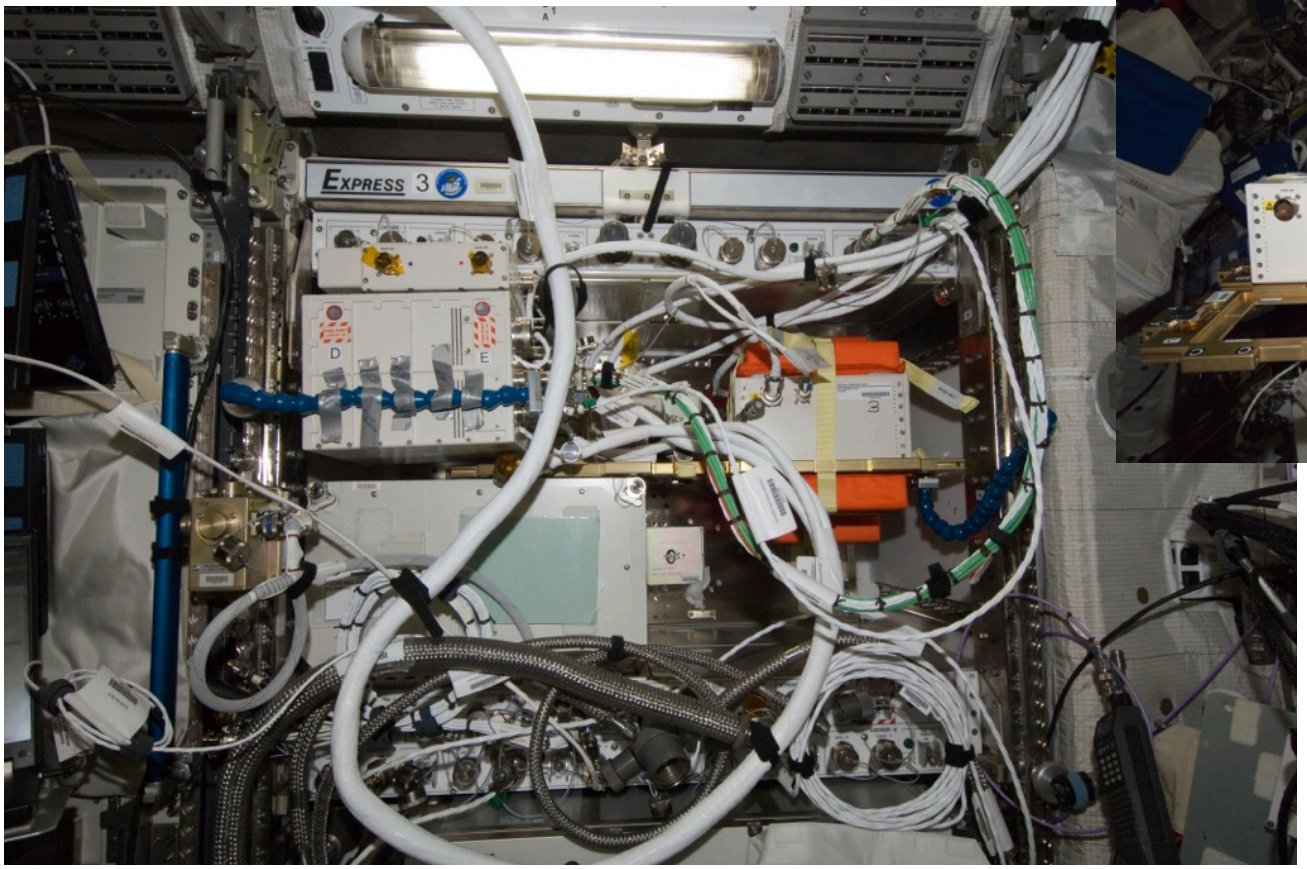
In this last Survey site we have all three directions outside of racks. This is the site with the longest measurement time (≈ 230 days)

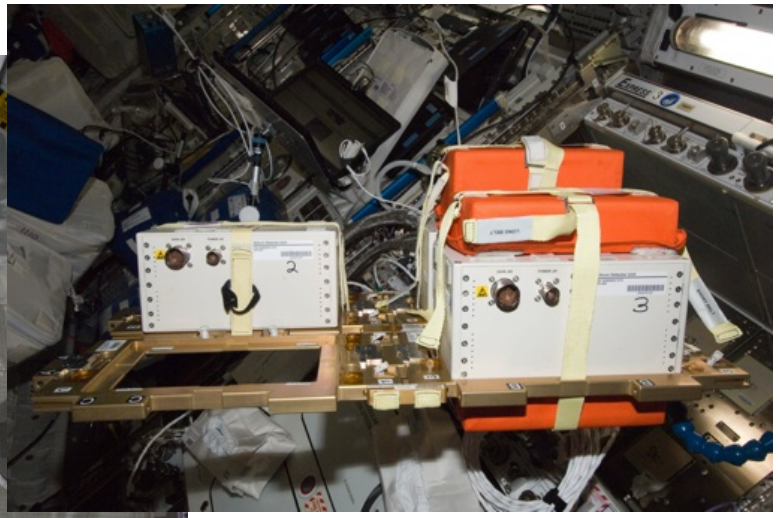




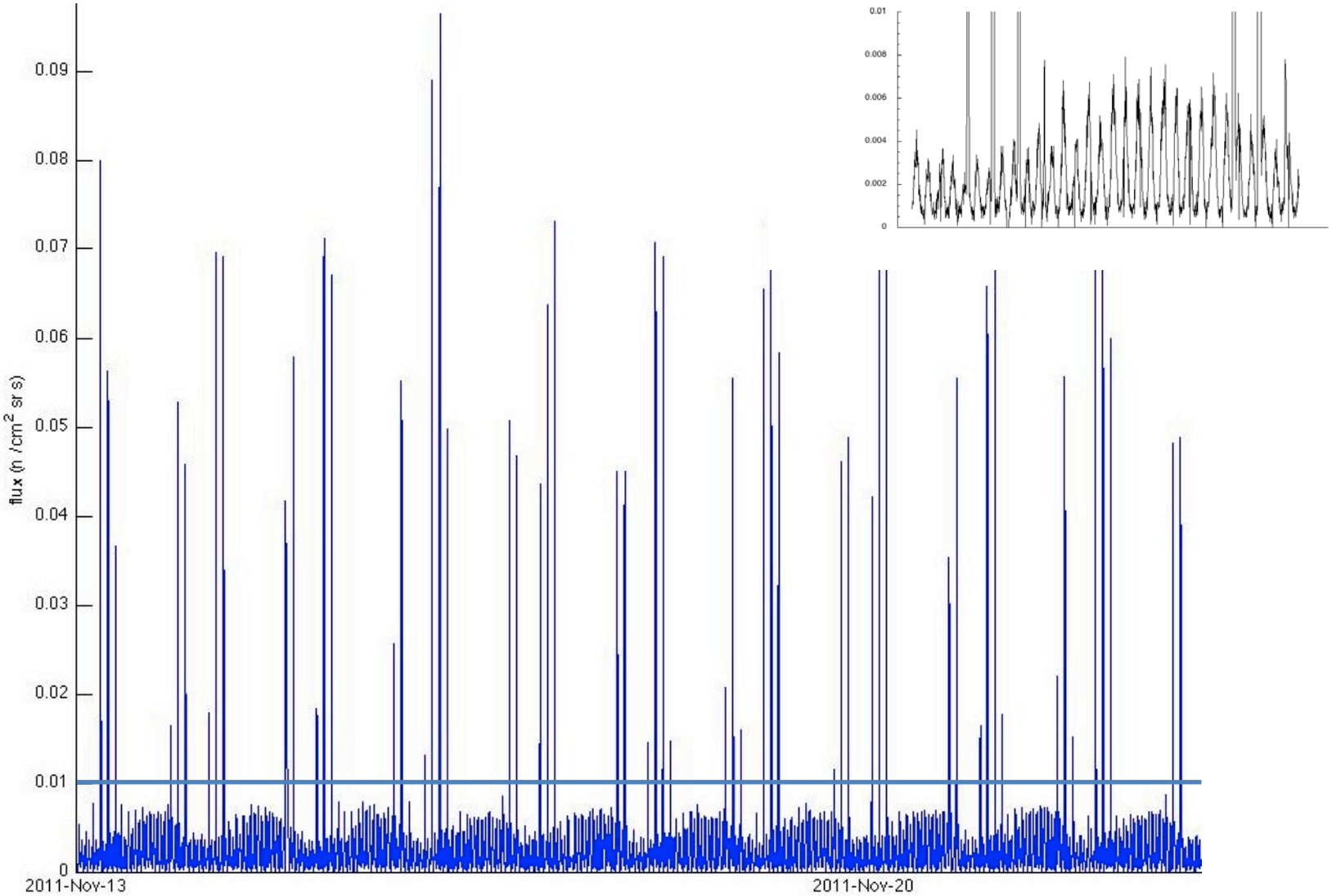
‘Fifth’ site: Columbus Express Rack 3

The measurements in this site belongs to the second part of ALTEA-shield, devoted to the characterization of Kevlar an Polyethylene. The reference SDU has been measuring with no added shield (‘Z’ direction) and was inserted in the rack facing upward. We can use these measurements to extend our survey (≈ 150 days)

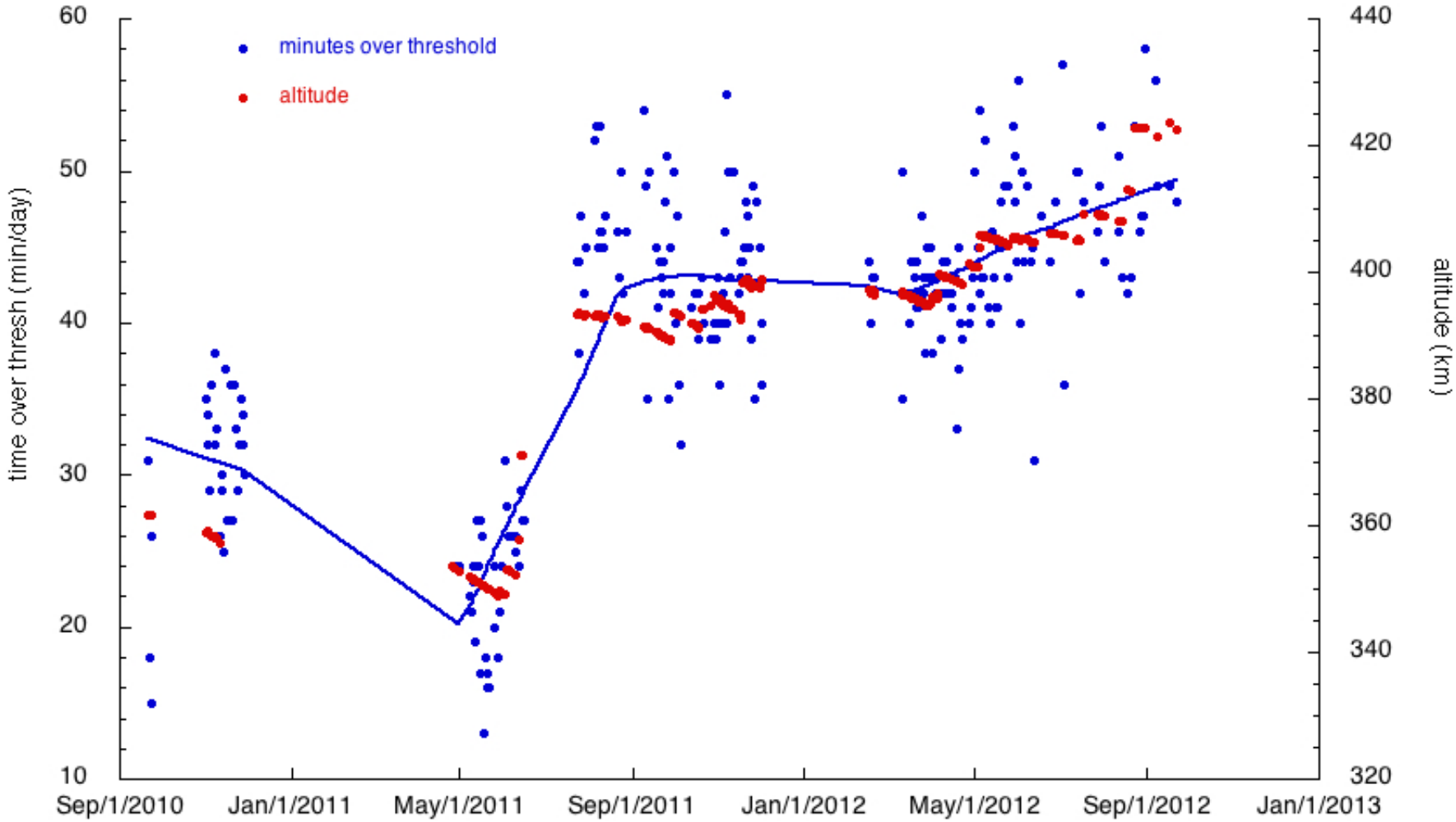




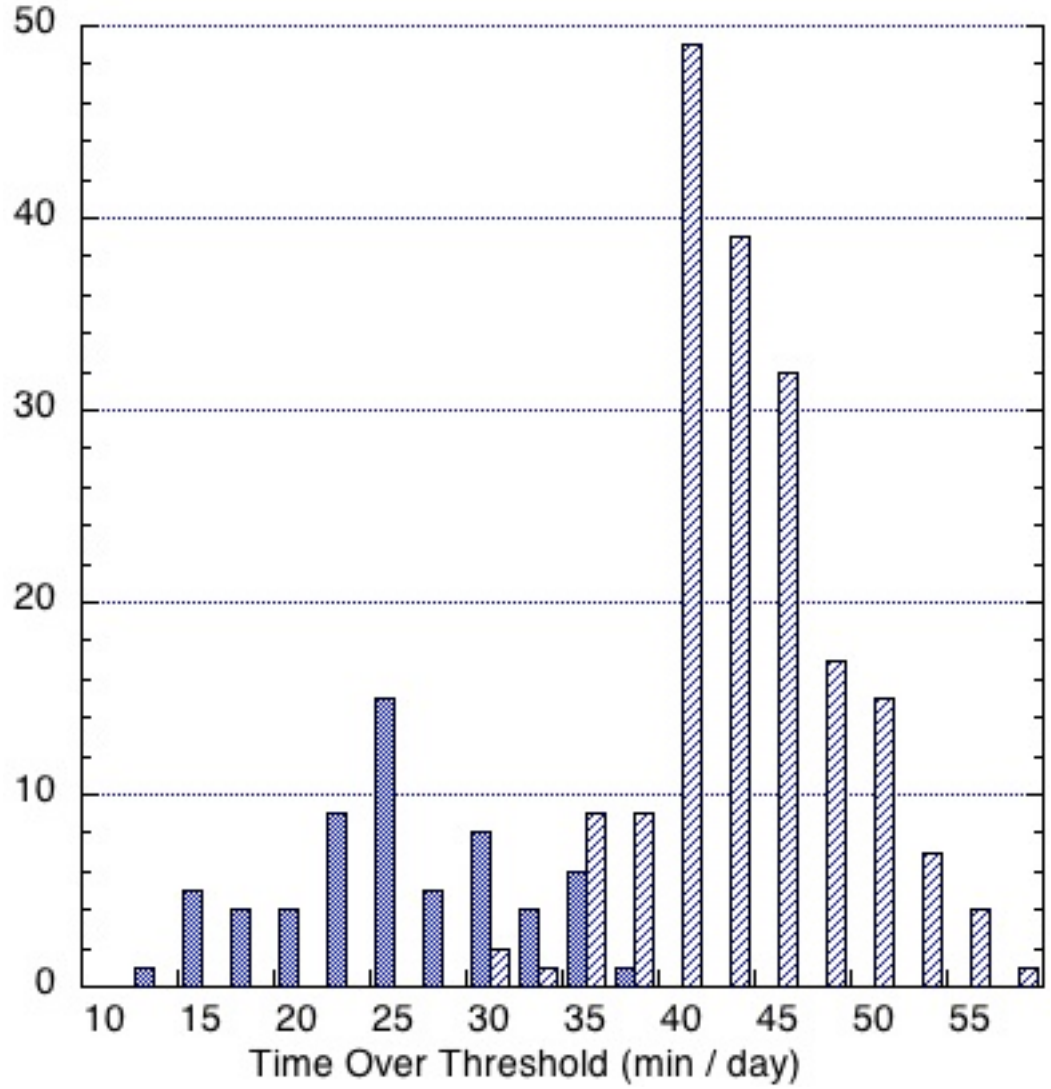
The different zones



Passages in the SAA – 1



Passages in the SAA – 2



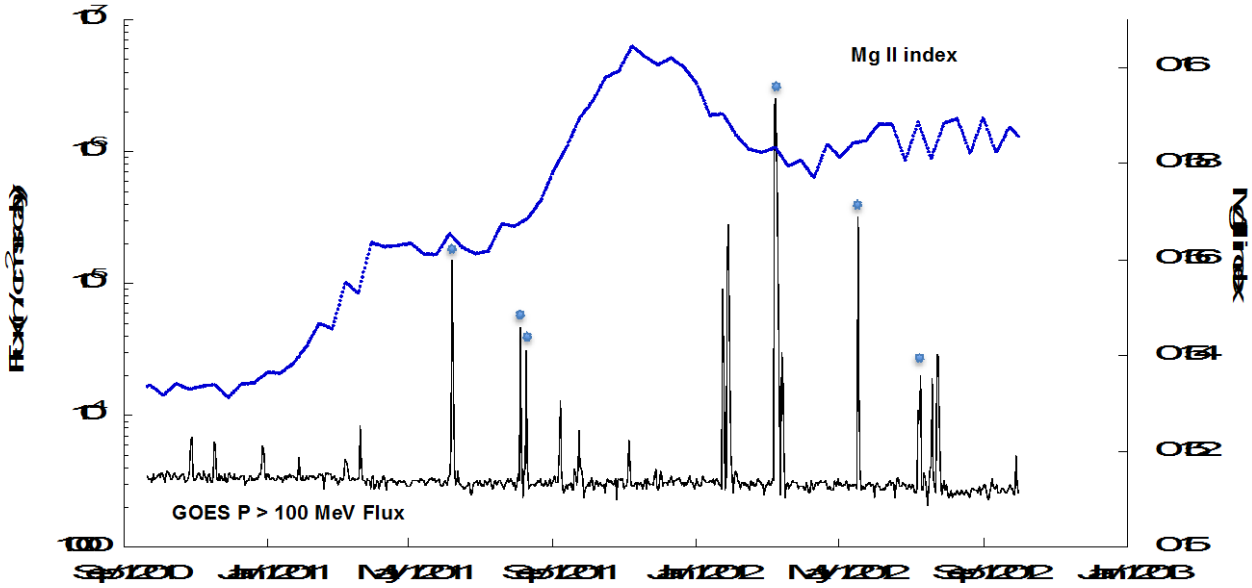
Before June 20th

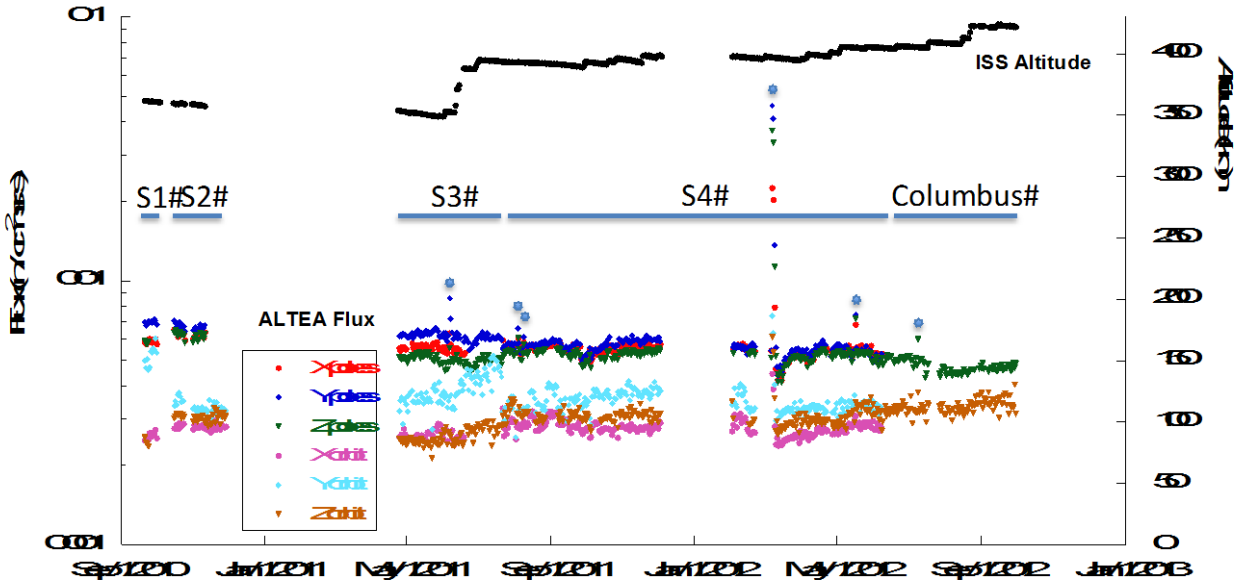
27 ± 6 min/day

After Jun 22nd

44 ± 5 min/day

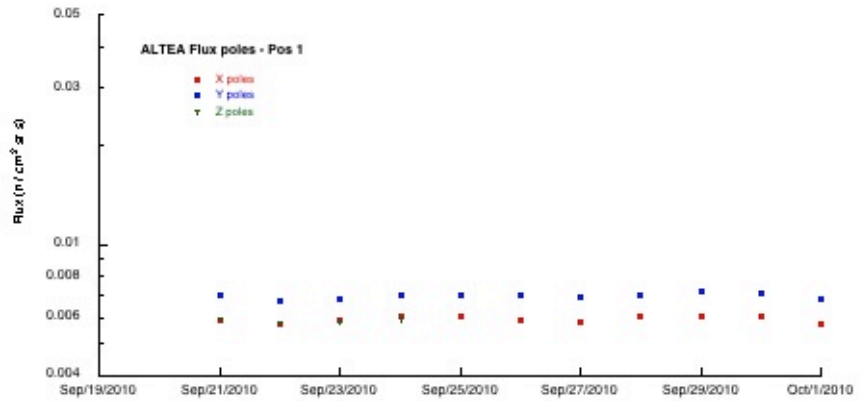
ALTEA survey results – flux

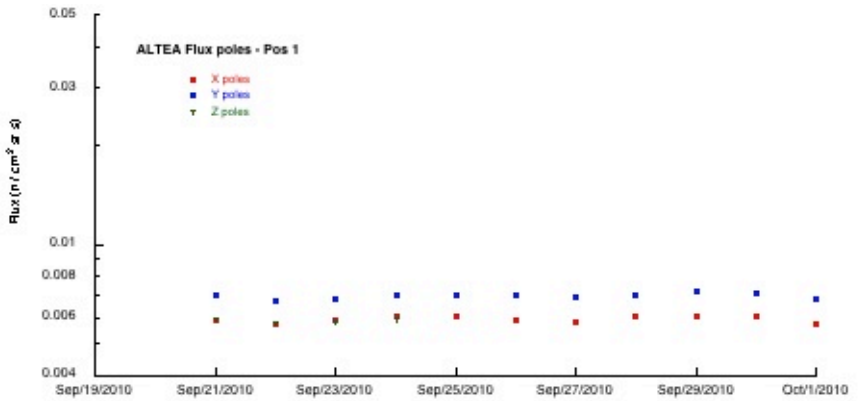


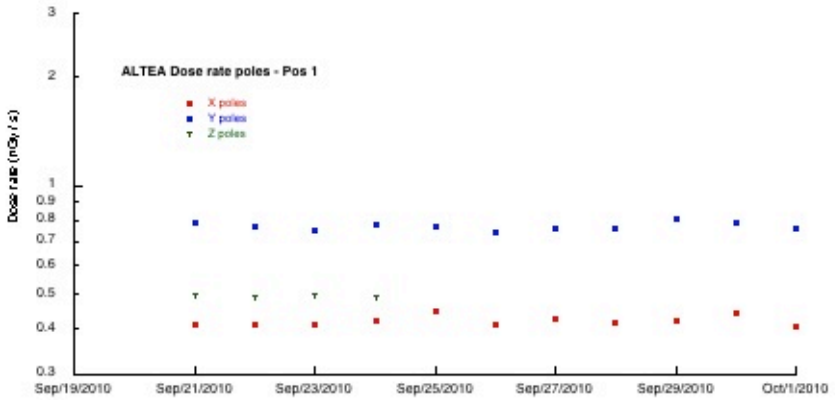


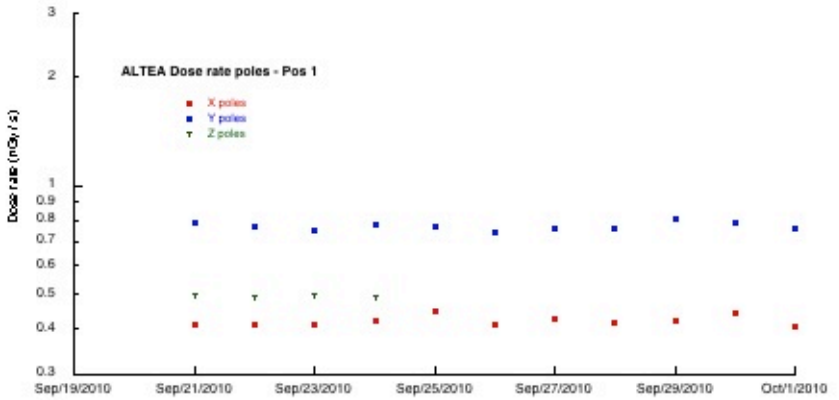
ALTEA survey results – Dose / Dose Equivalent rates

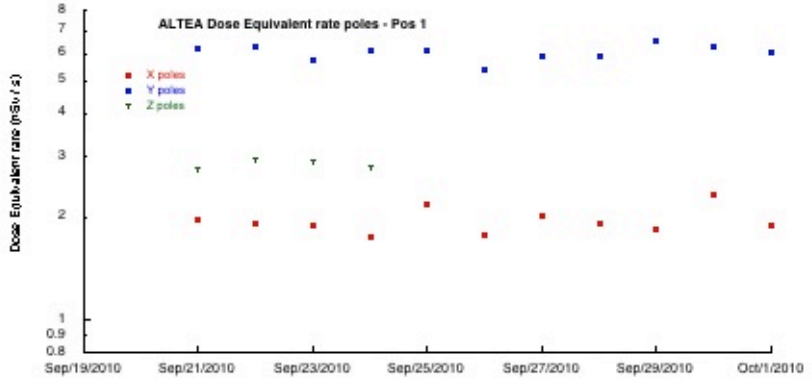
ALTEA survey results – closer look at the 5 positions

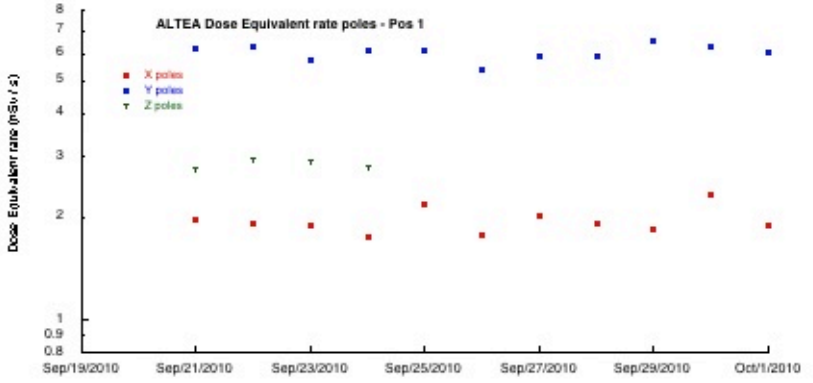




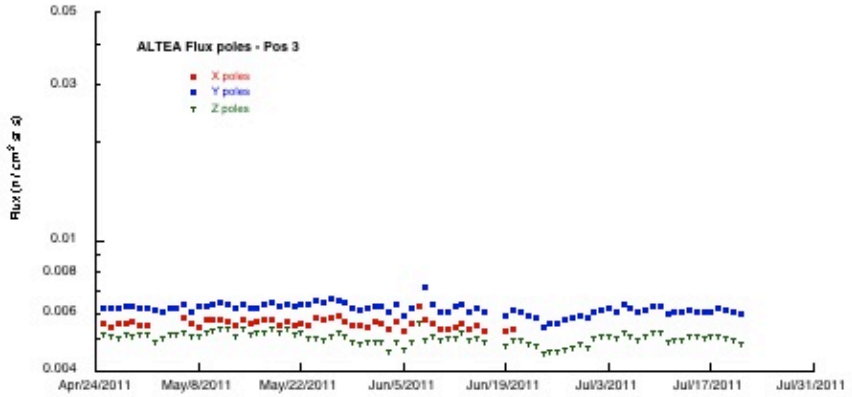


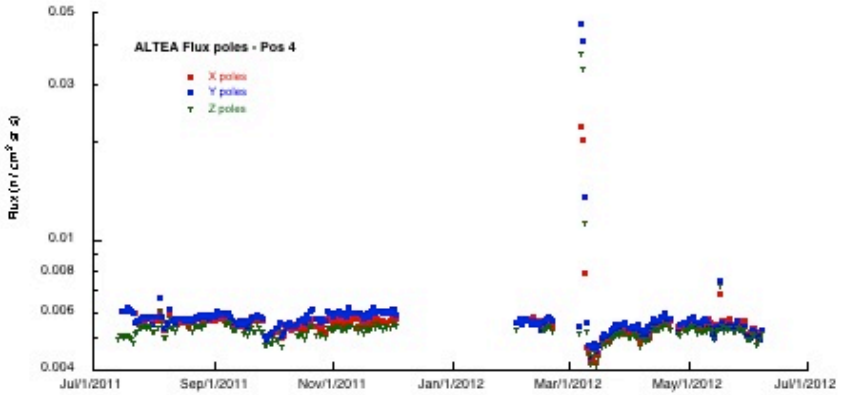


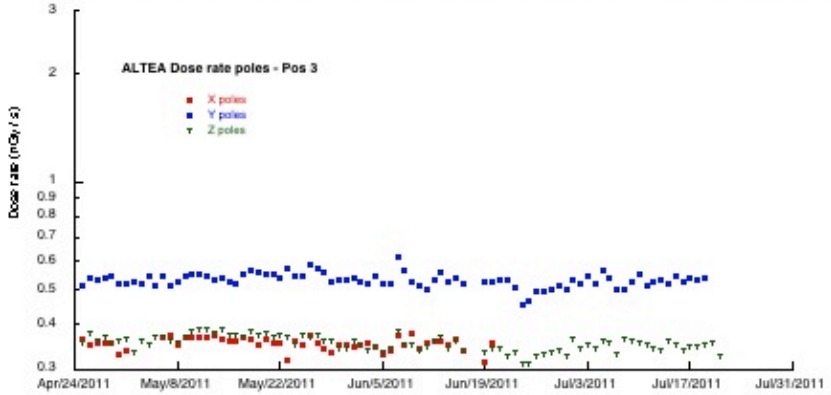


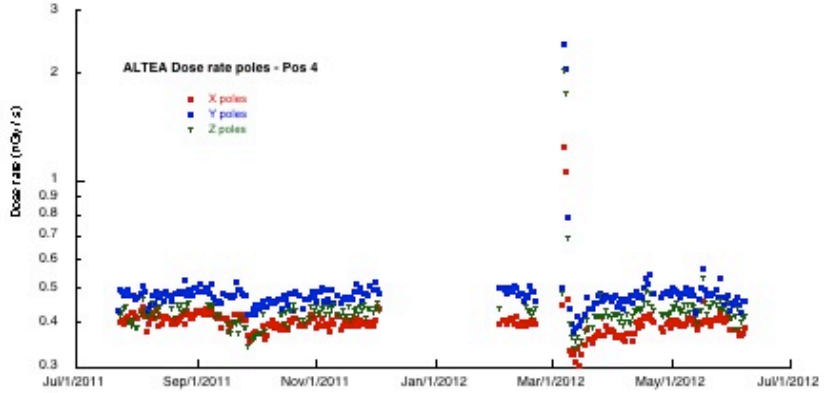


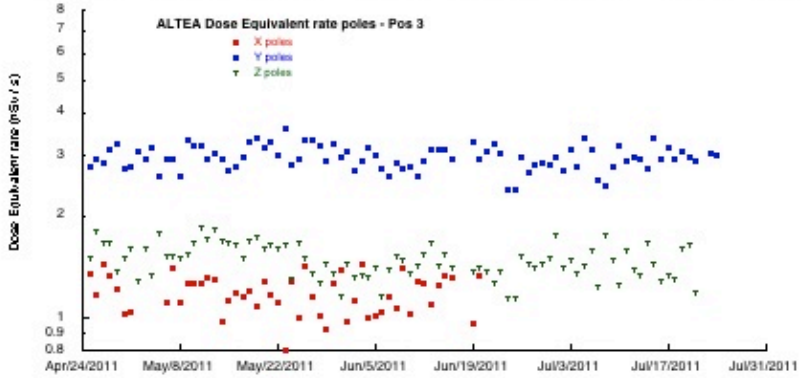
ALTEA survey results – closer look at the 5 positions

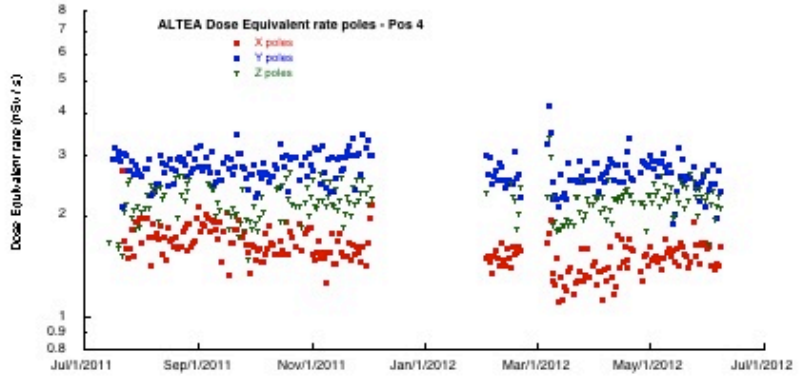




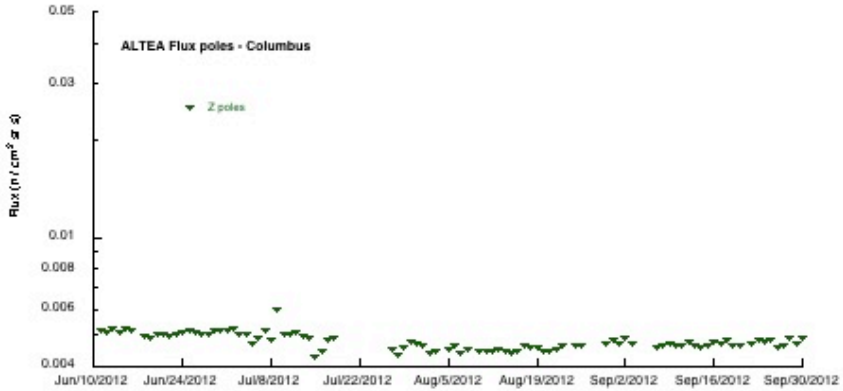


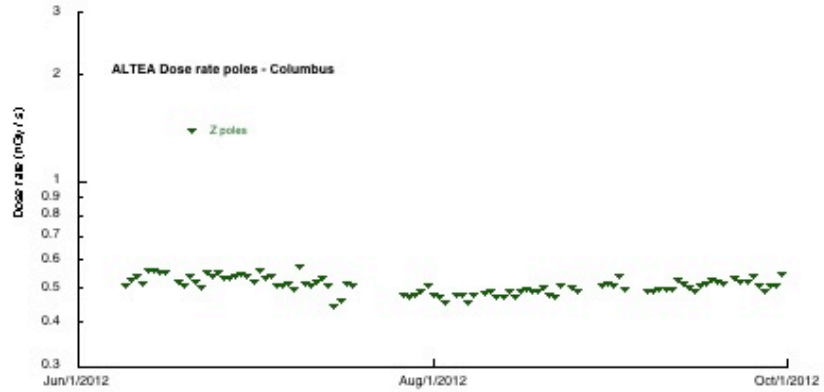


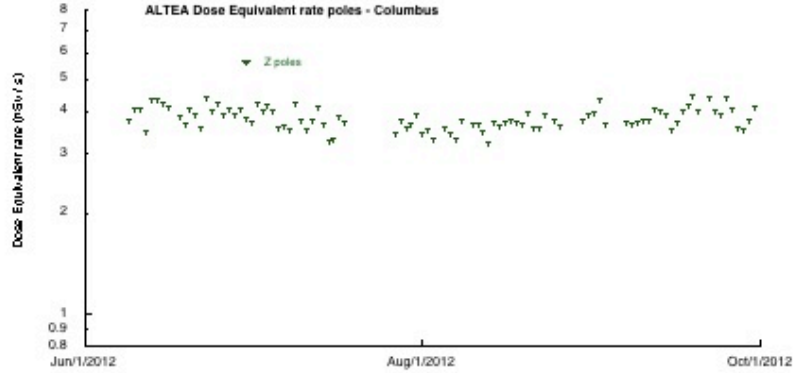




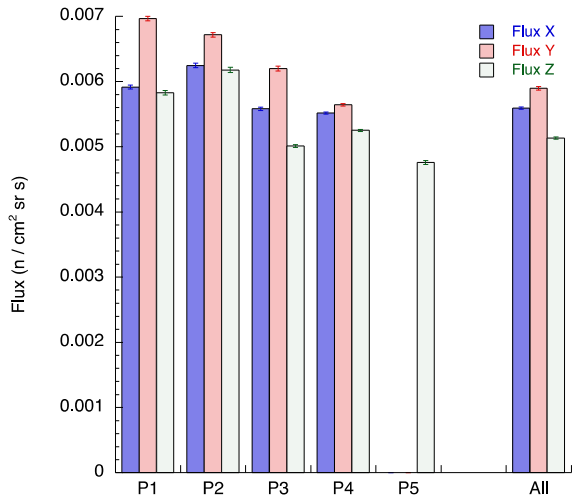
ALTEA survey results – closer look at the 5 positions

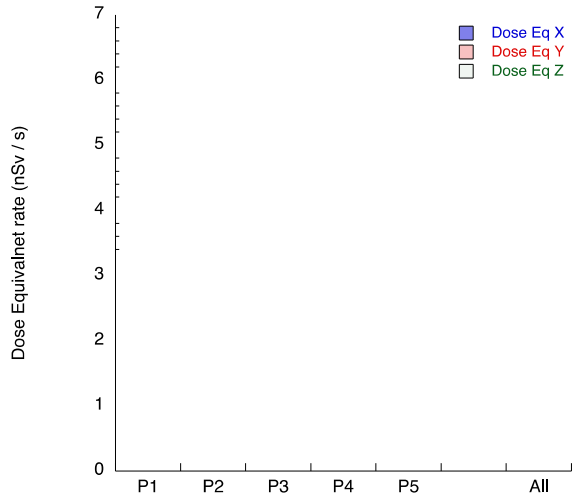


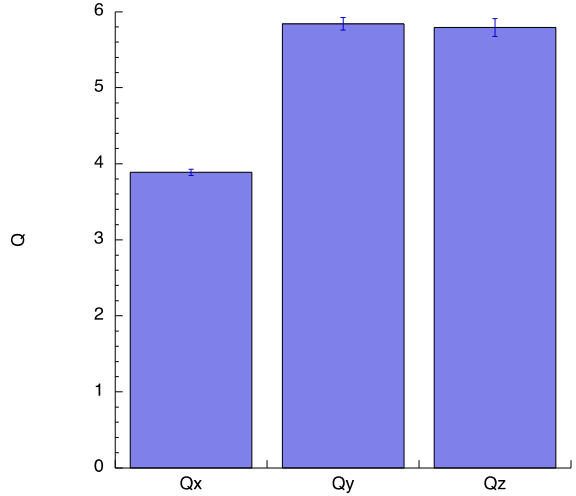




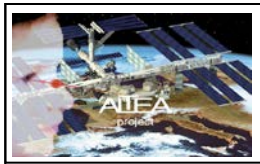
ALTEA survey results – averages for positions/directions

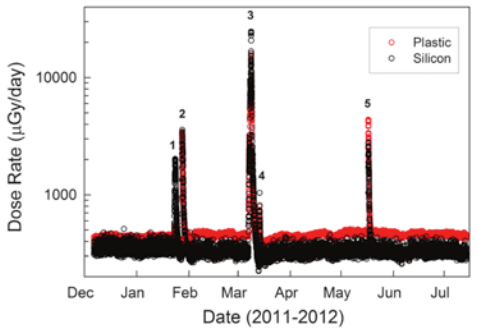






The March 2012 SPE





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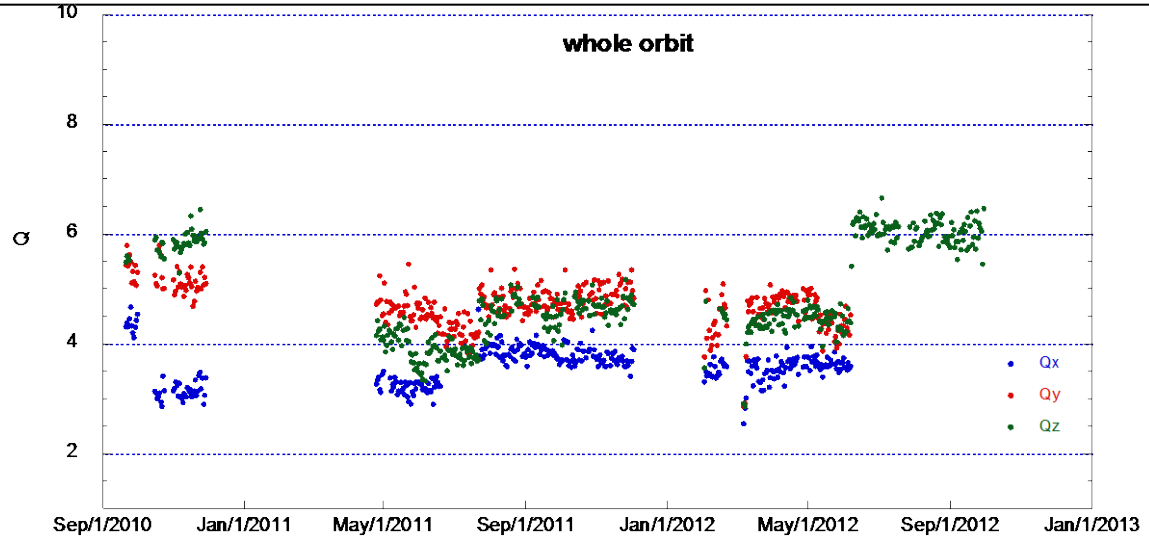
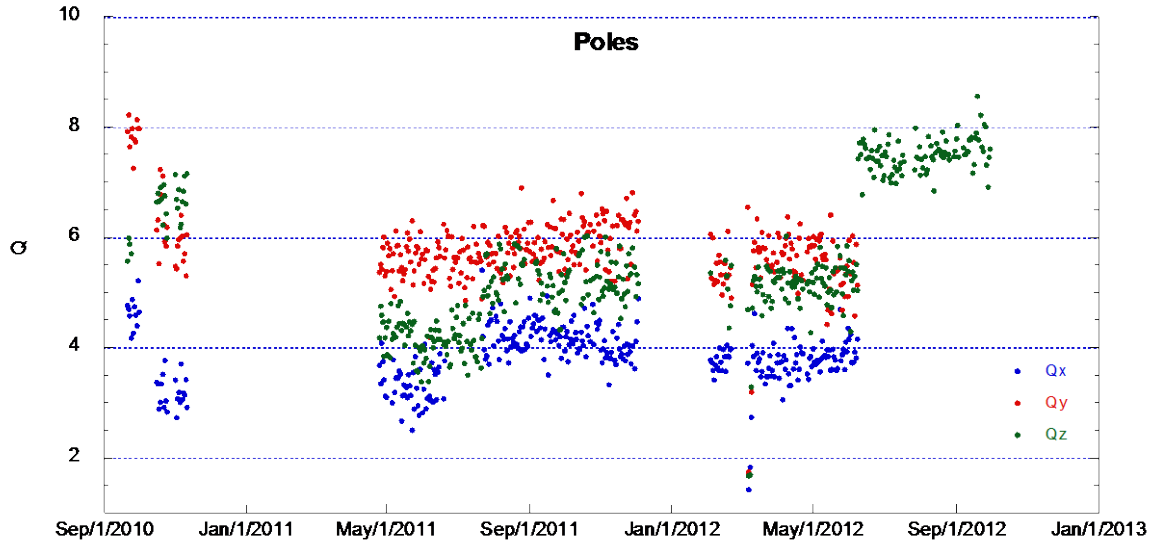
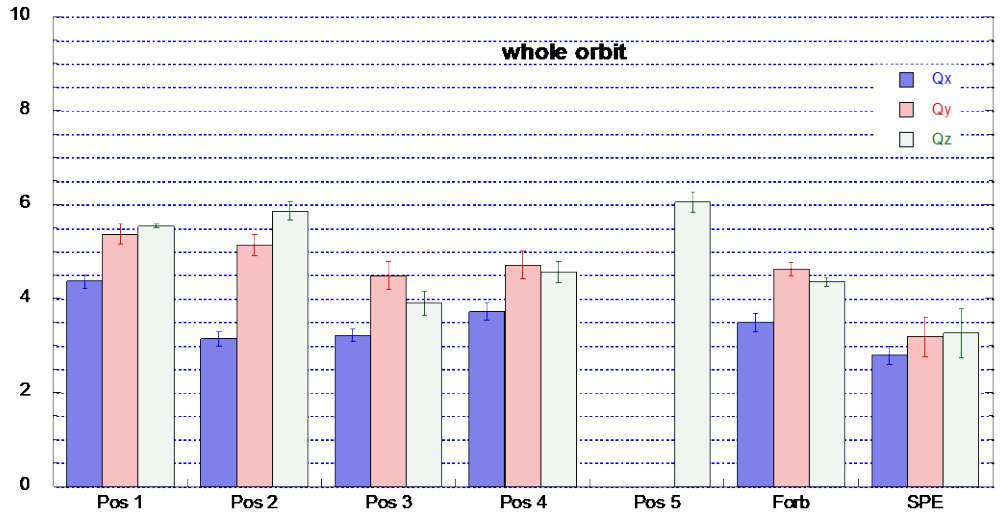
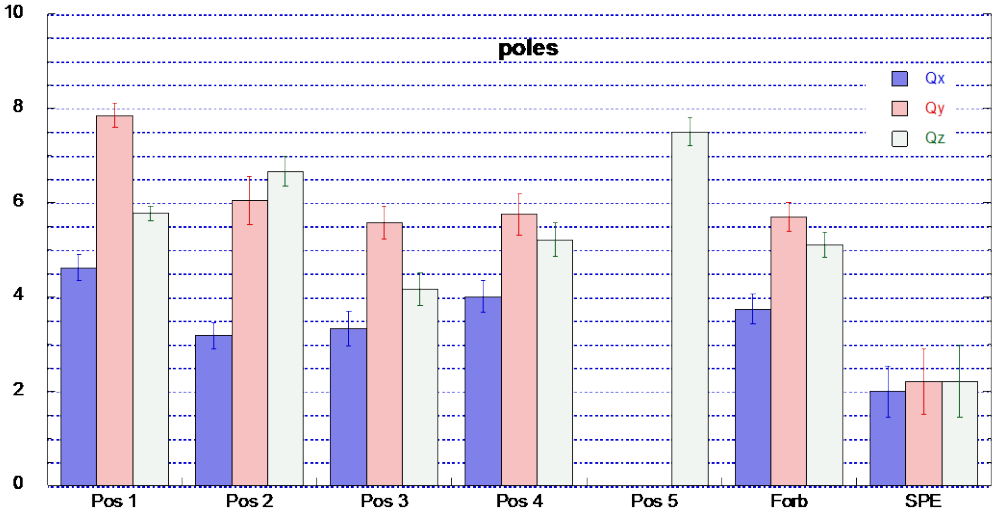
Q during the whole measurement period



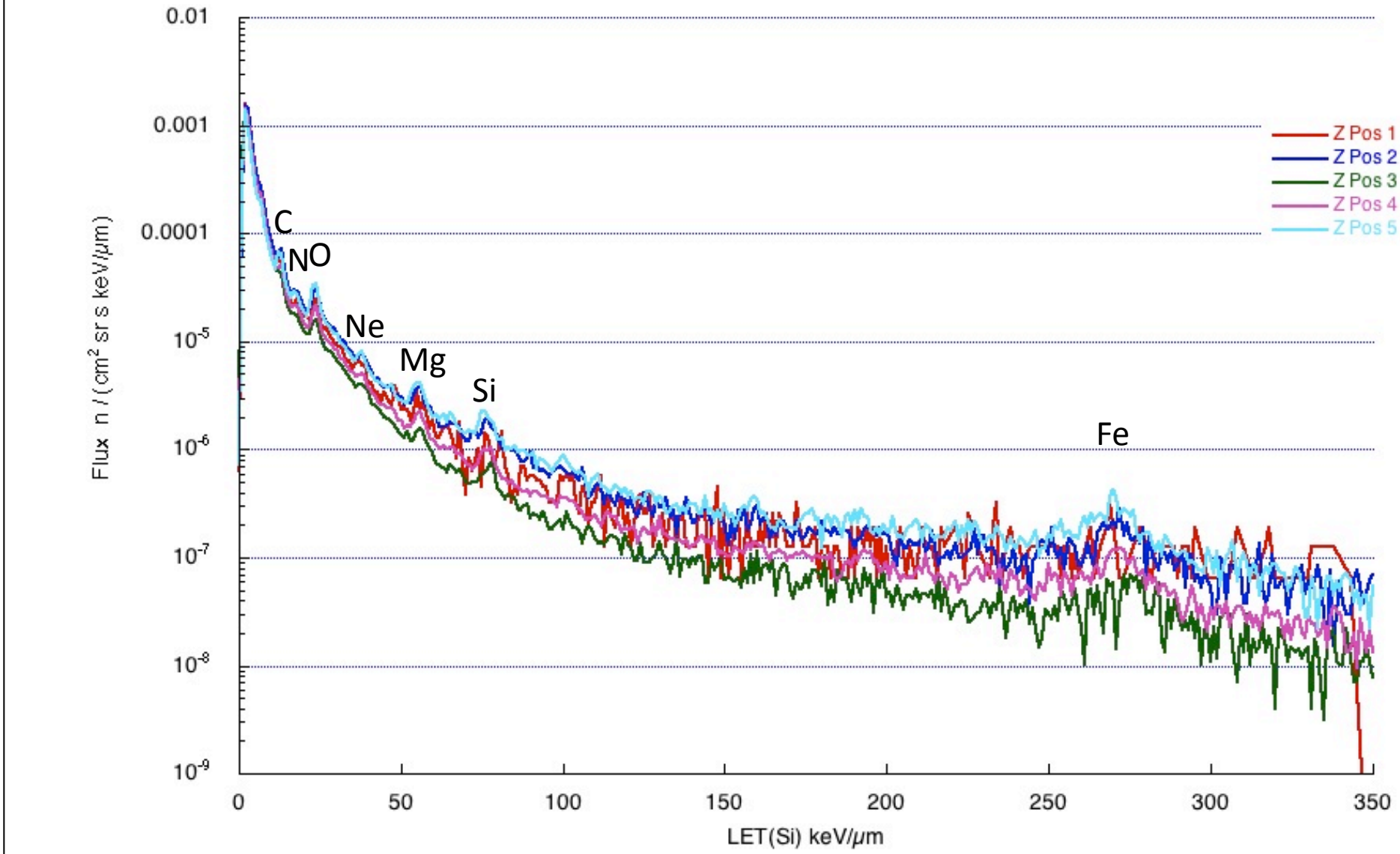


Q during the whole measurement period: the different sites

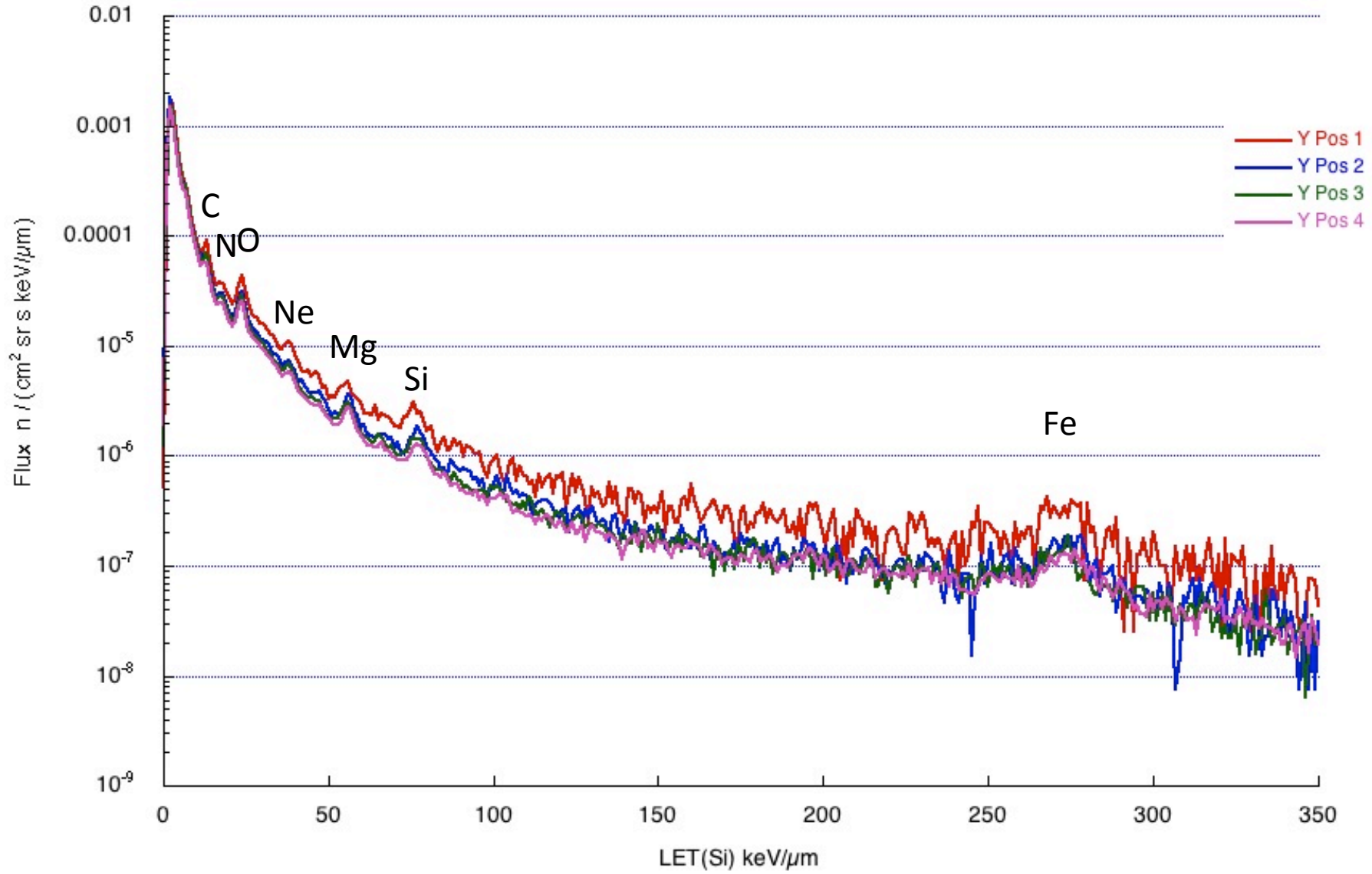




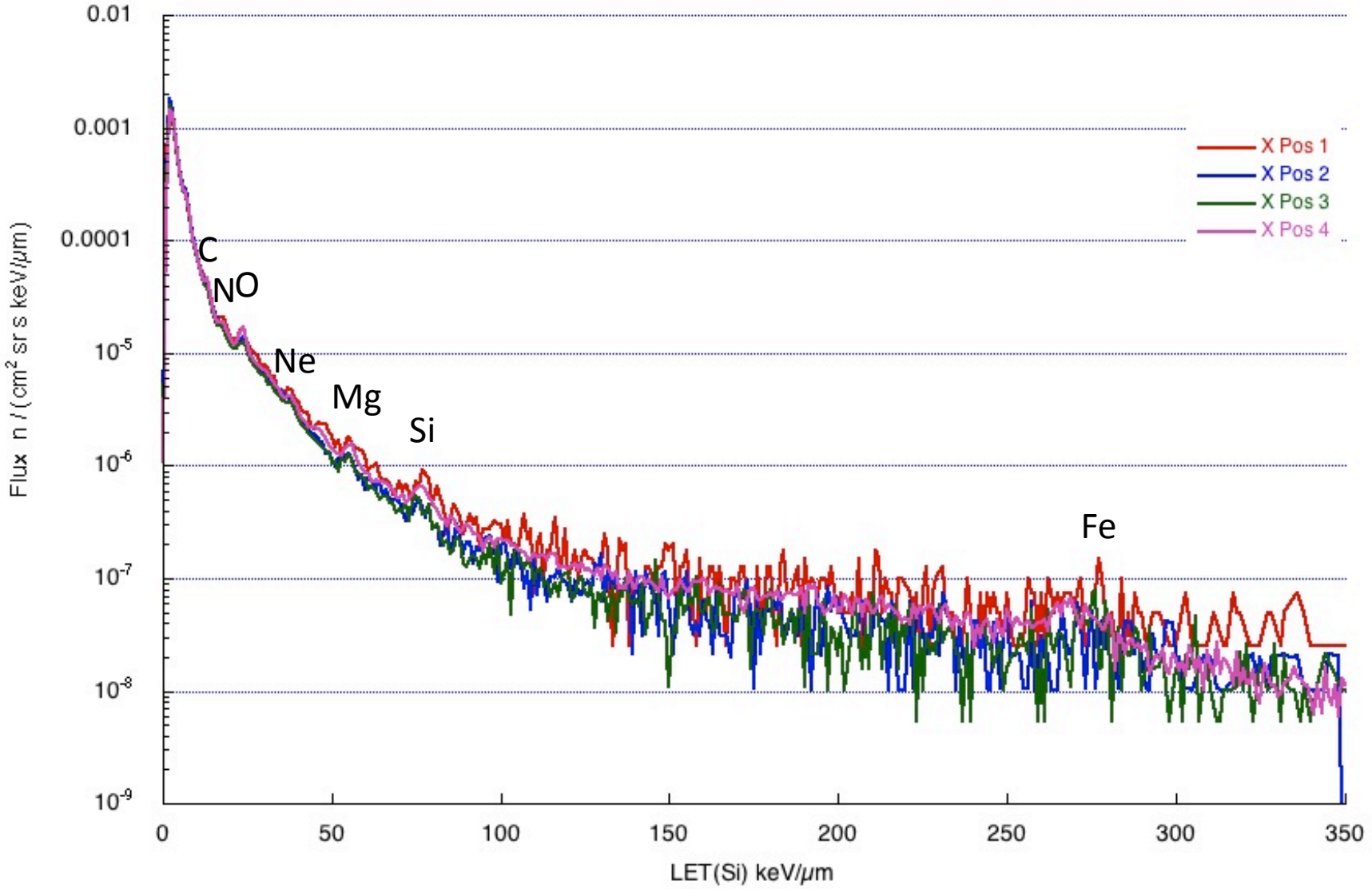
Spectrum in Z in the five positions

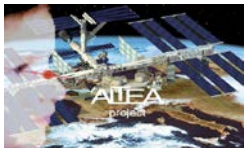


Spectrum in Y in the four positions

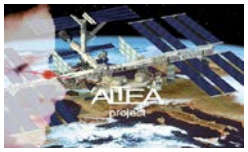


Spectrum in X in the four positions





Coming up …

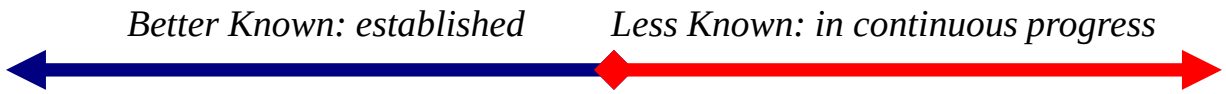


The logic of an adaptable “risk monitor”

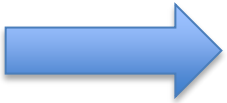
Measure Energy Loss, LET, Z & Ein.

From these transform to risk using the most recent available knowledge
(Risk intended as a full spectrum word: for humans, plants, devices …)

The transformation performed in software / firmware directly on the device,
with a *great flexibility for upgrading/changing even in orbit*
[we demonstrated this is possible with our real time software in ALTEA]



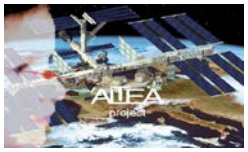
Energy Loss
E input
LET
Z



Radiobiology
Engineering

ALTEA estimates Ein and Z because it does not have an independent measure of E
ALTEA measures H in a limited band and not all the He

LIDAL



The ALTEA upgrade: LIDAL

Light Ion Detector for ALTEA: LIDAL *(selected by ASI)*

LIDAL will be a fast scintillator detector to be coupled to ALTEA
and providing ToF, wider acceptance window, (also as trigger):

- Two Detector Units (DUs) to be positioned at the end of a Silicon Telescope (1, 2 or more SDUs)
- Each DU made of thin plastic scintillators (full ST field of view covered)
- Scintillators will be segmented in the two orthogonal directions (provide first position/tracking)
- Scintillators read by Silicon Photomultiplier (SiPM)
- ToF esolution aimed to be better then 100 ps

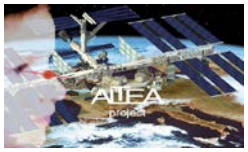
Upgrade rationale:

1) include the missing H and He in the acceptance window, covering the entire Z spectrum
2) include an independent measurement of input energy (Time of Flight, ToF)

Background:
ToF design and prototype ready as output of a just ended National Research Project
'New' Photomultiplier SiPM with several appealing features already tested in the ISS (program *Lazio*)

-ToF measurements provide energy determination
-Signal from DUs can be used also as ALTEA trigger

On the ISS NET 2016



ALTEA's results toward a µdetector

• Results from ALTEA and LIDAL can be used for testing configurations and software for a miniaturized device

• We already proposed a few years ago (***ESA Call For Ideas 2010***) the personal detector LORE (presented at this workshop 2 years ago) and the use of ALTEA's results to define its minimal required parameters.

• The proposed device was based on square scintillating fibers read out by an array of SiPM and on single element crystal/silicon.

The objective is now a further step towards miniaturization and modularity.

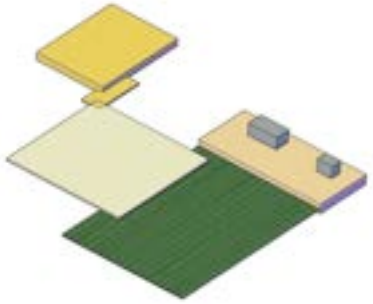
• Miniaturizing decreases performances and the compromise could come from modularity

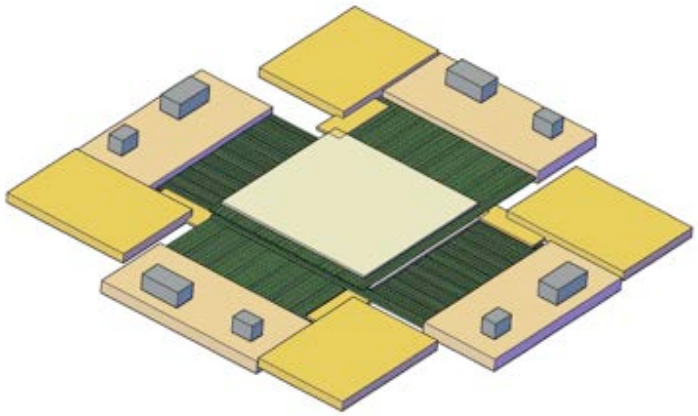
• ALTEA's (or LIDAL's) results and software could be used to help assessing the smallest configuration to achieve a µdetector with the minimal required performances

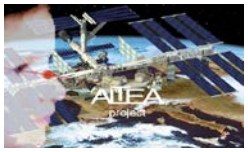
• A combination of these µdetectors (modularity) would improve performances if/when needed

LORE

- Based on the logic of separating physics from biology
- Smallest single package possible compatible with physics requirements
- Modularity to increase performances
- Upgradable software-firmware for conversion to riskS

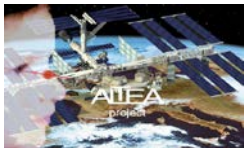






Final comments

- ALTEA provides results satisfying (almost) the most recent requirements for radiation quality
- Using ALTEA results with ISS CAD and radiation models is a needed step toward a model validation
- ALTEA (and even more LIDAL) with the help of the radiobiology community can become the first real time alarming radiation risk monitor
- ALTEA results can be used towards the optimization of µdetector characteristics
- hardware modularity and real time software-based conversion to risk are needed features for a µdetector featuring flexibility and upgradability (LORE)



ALTEA the international team

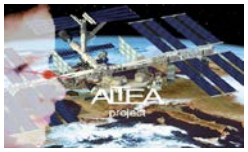
Dept. di Physics, Univ. of Rome "Tor Vergata" and INFN Sect. Roma2 , Roma
Dept of Physics, Univ. of Pavia, Pavia
Dept of Physics, Univ. of Milan, Milan
DISM-Univ. of Genoa, Genoa
L.N.F. - INFN, Frascati (Rome)
CERN - INFN
Dept. of Physics,Univ. e Sect. INFN of Trieste, Perugia, Firenze
Dept. of Sc. and Chemical Tec., Univ. of Rome "Tor Vergata"
Dept. of STB - Univ. of L'Aquila, L'Aquila
Univ. Paris Sud, 91406 Orsay Cedex, France
GSI - Biophysik, Darmstadt, Germany
Royal Institute of Technology, Stockholm, Sweden
Chalmers University of Technology, Sweden

Institute for BioMedical Problems, Moscow, Russia.
Russian Space Corporation "Energia" by name Korolev, Korolev, Moscow region, Russia
Moscow State Engineering Physics Institute, Moscow, Russia

JAERI, Japan

Johnson Space Center, NASA, Houston TX, USA
Goddard Space Flight Center, NASA, USA
Brookhaven National Laboratory, NY, USA
Lawrence Berkeley National Laboratory, CA, USA
Loma Linda University, CA, USA
Cole Eye institute, The Cleveland Clinic, Cleveland, OH, USA
Wyle Laboratories, TX, USA
Eril Research, CA, USA

+ others joining in



Thank you for your attention