Simultaneous Investigation of Galactic Cosmic Rays on Aircrafts and on International Space Station

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Outlook

- International Space Station GCR Radiation Environment
- Aircraft instrumentation and results
- Long-term variations of aircraft doses and fluxes
- Forbush decrease study on aircrafts and on International Space station
- Future space experiments
- Conclusions

International Space Station GCR Radiation Environment

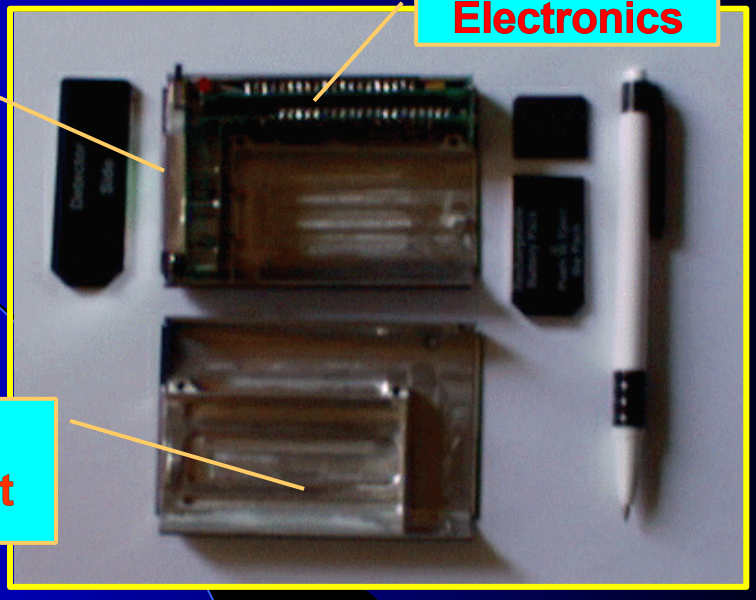
Liulin-Mobile Dosimetry Unit (MDU) at ISS

External view of MDU

Detector + preamp.

Battery compartment

Internal view of MDU



SPECIFICATIONS OF MDU

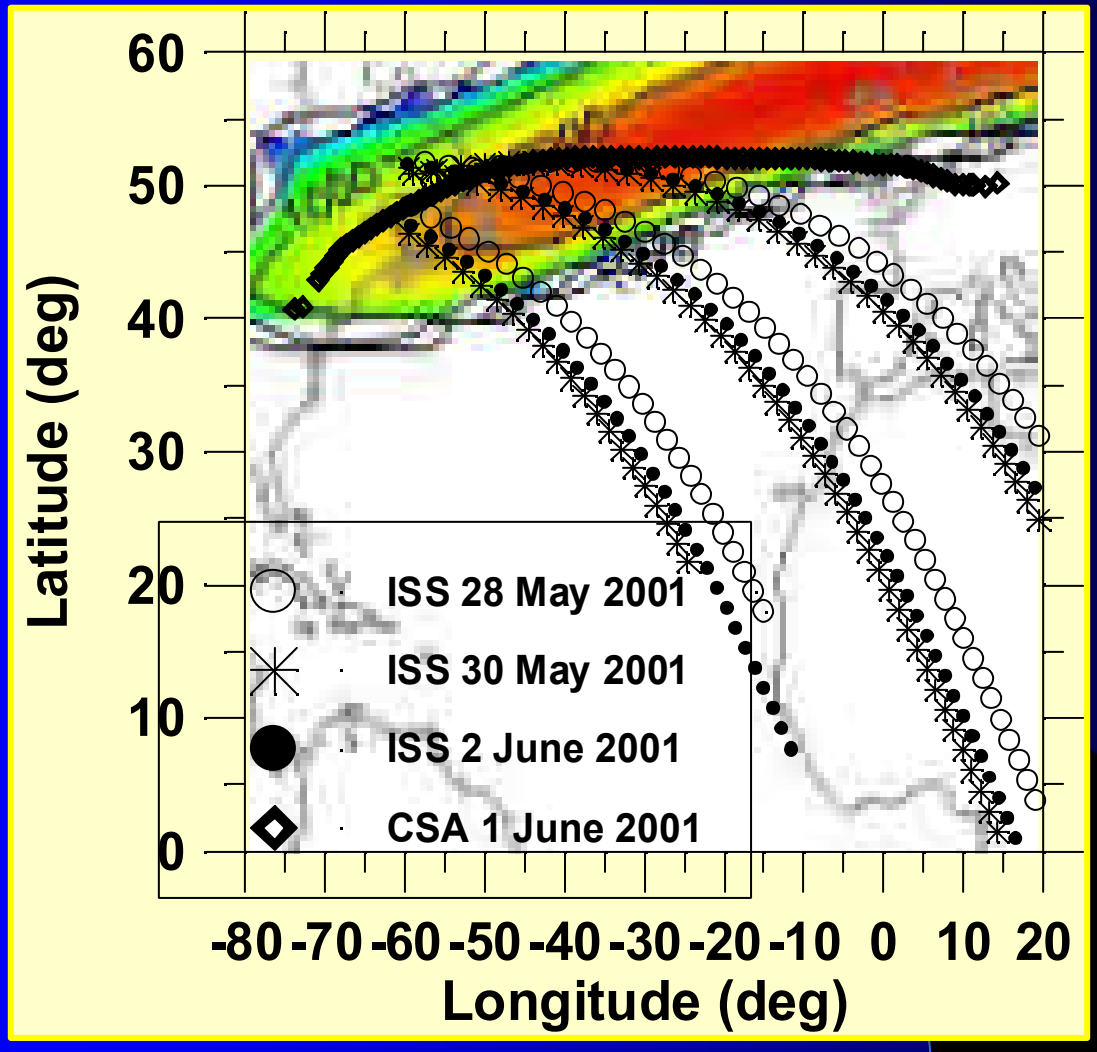
- *Dose range: 0.093 nGy – 1.56 mGy;*
- *Flux range: - 0.01 - 1250 part/cm²s;*
- *Energy loss range: - 0.0407 – 20.83 MeV;*
- *Pulse height analysis range: - 19.5 mV – 5.0 V;*
- *LET range: 0.27- 69.4 keV/㎛;*
- *Temperature range: 0°C - +40°C;*
- *Power consumption: typically 72 mW;*

-*Size (including 70x38x20 mm battery pack of SONY NP-F550 type): 100x64x24 mm;*

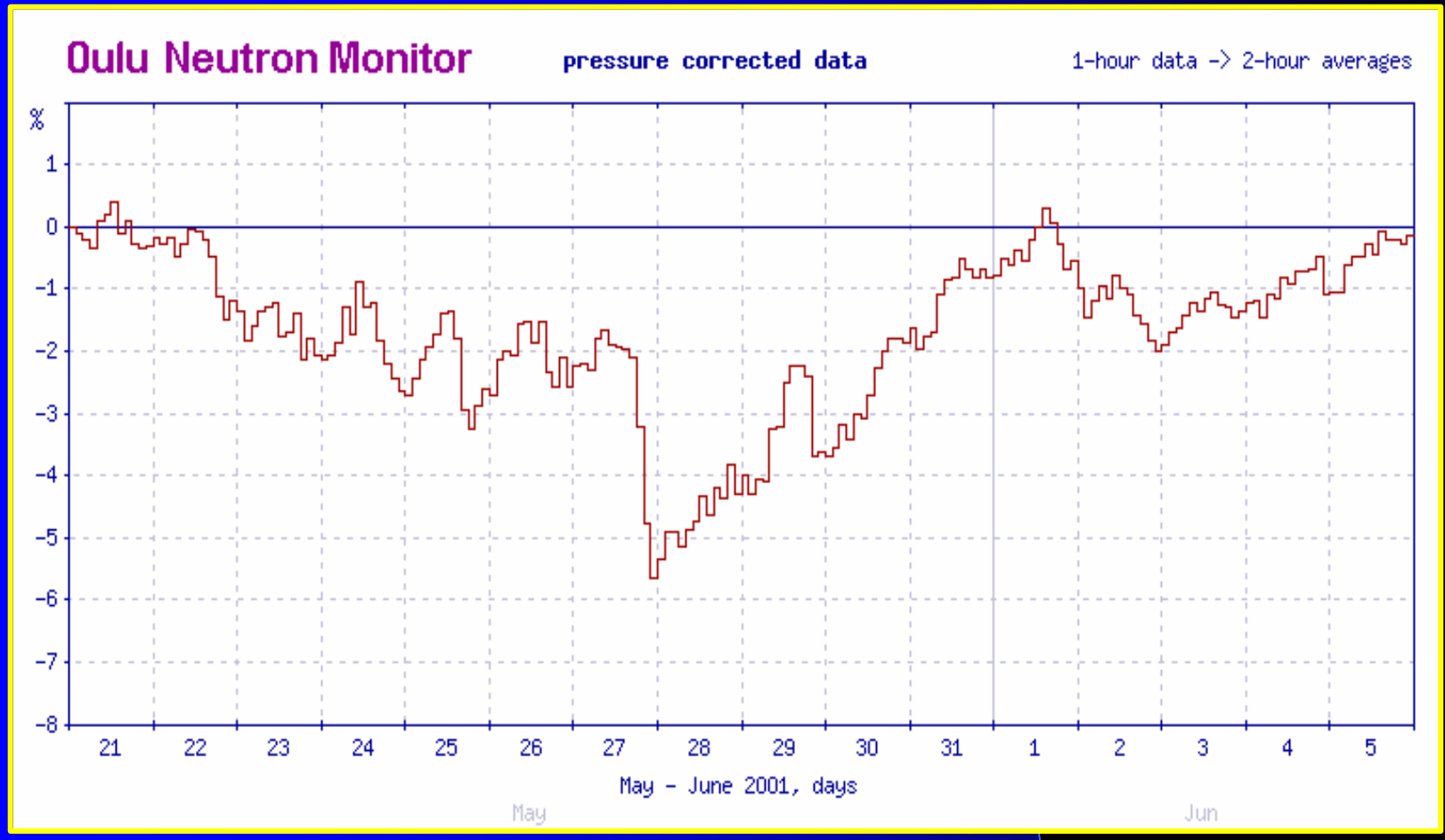
-Total mass (including 0.08 kg battery pack): 0.23 kg.

- Operation time 5 days

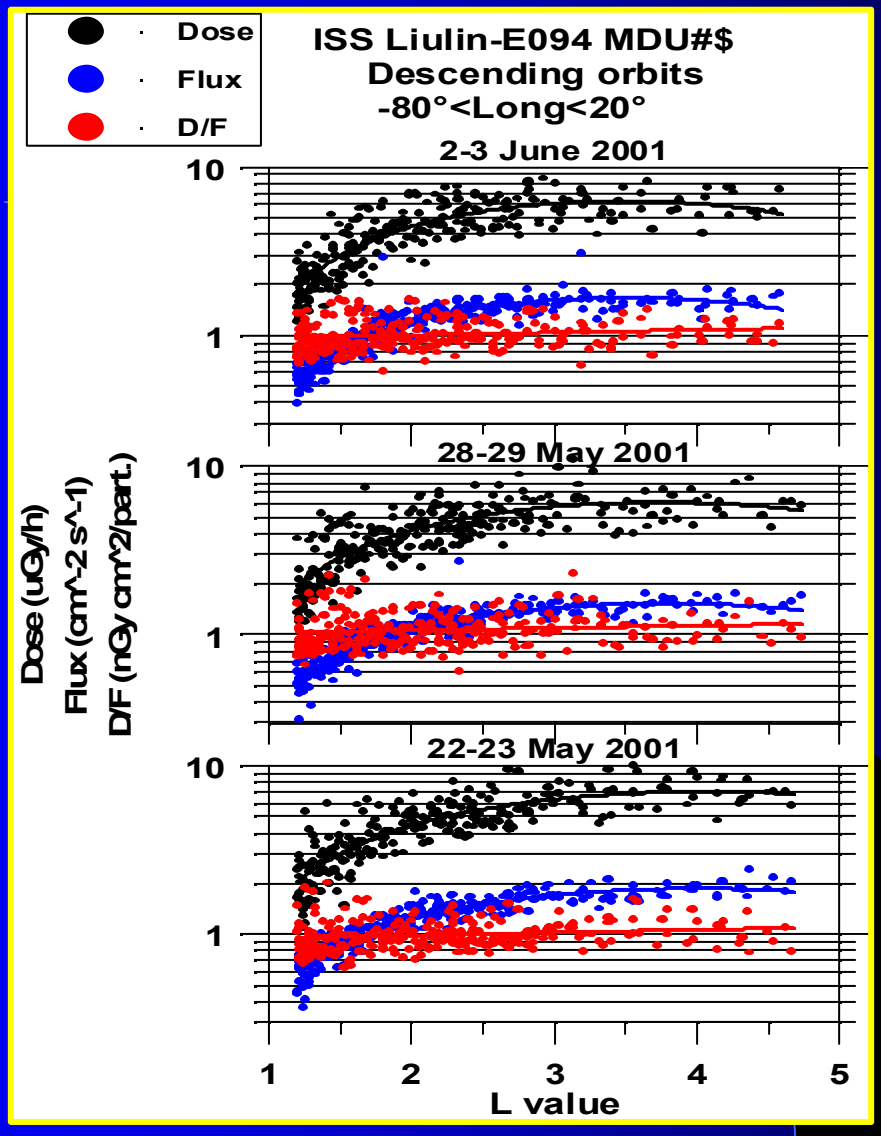
Configuration of ISS and CSA aircraft orbits



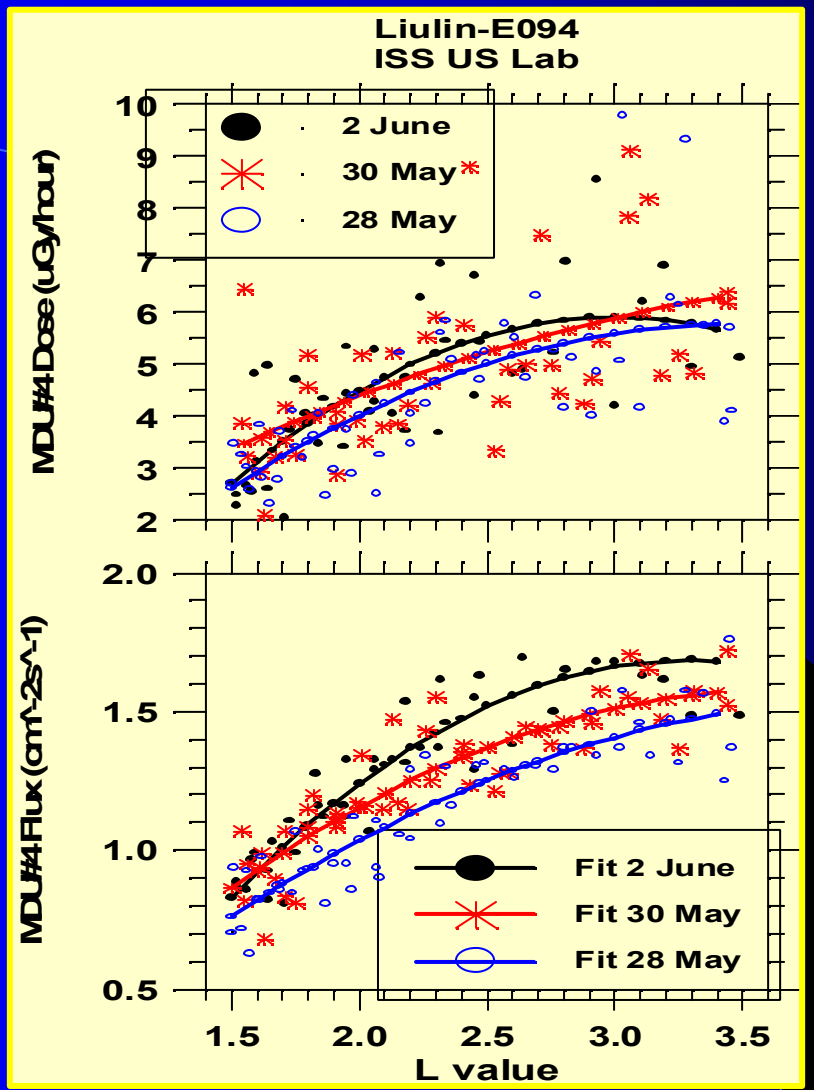
Oulu Neutron Monitor Data



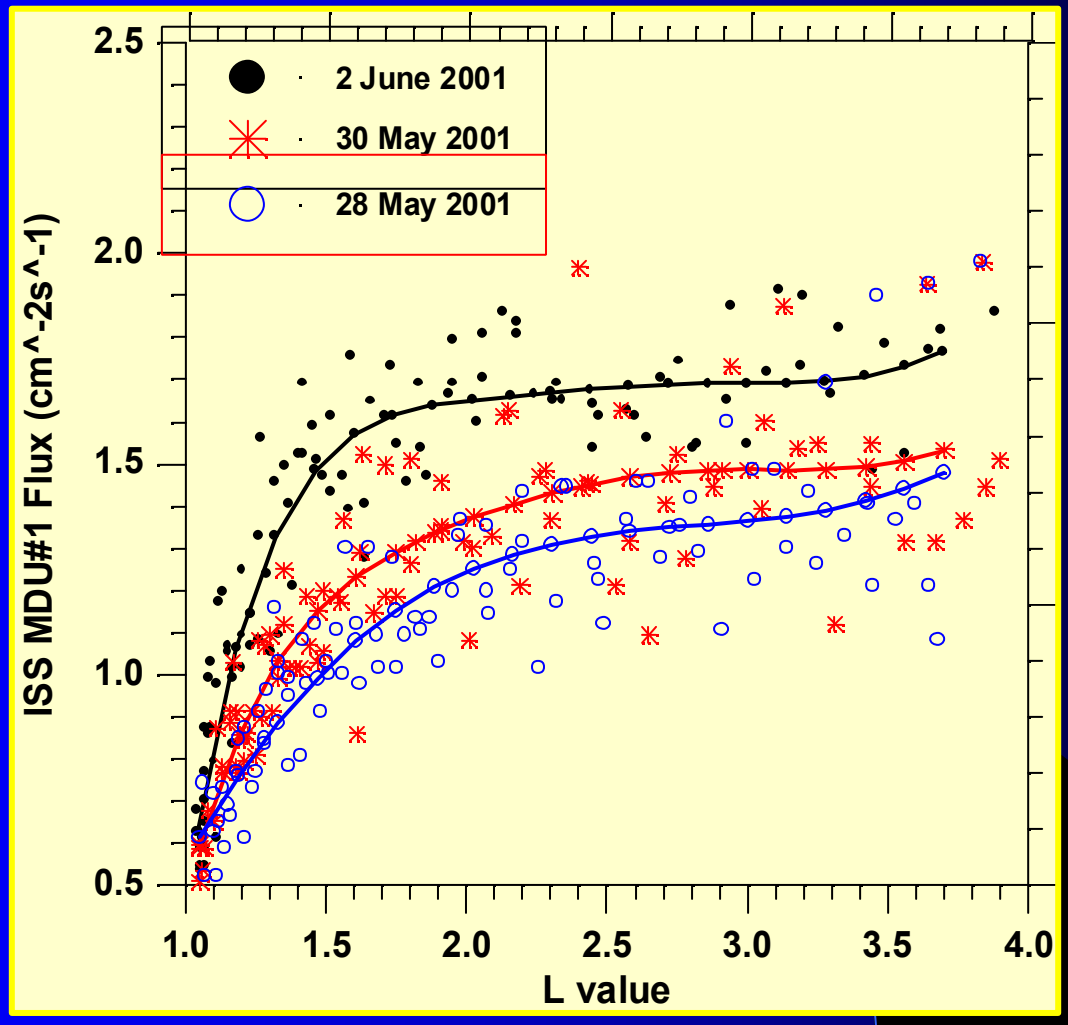
Presentation of the ISS data



Variations of the GCR in dependence of L value as observed by MDU#4 on ISS.



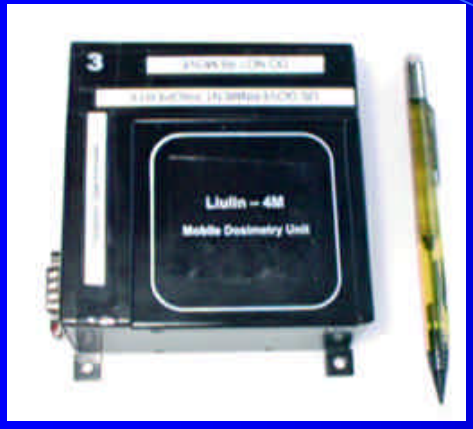
Same as previous for MDU#1, which is less shielded



Aircraft instrumentation and results

Liulin-Spectrometer for more than 100 days monitoring of the space radiation at aircraft altitudes

External view of LS



Internal view of LS

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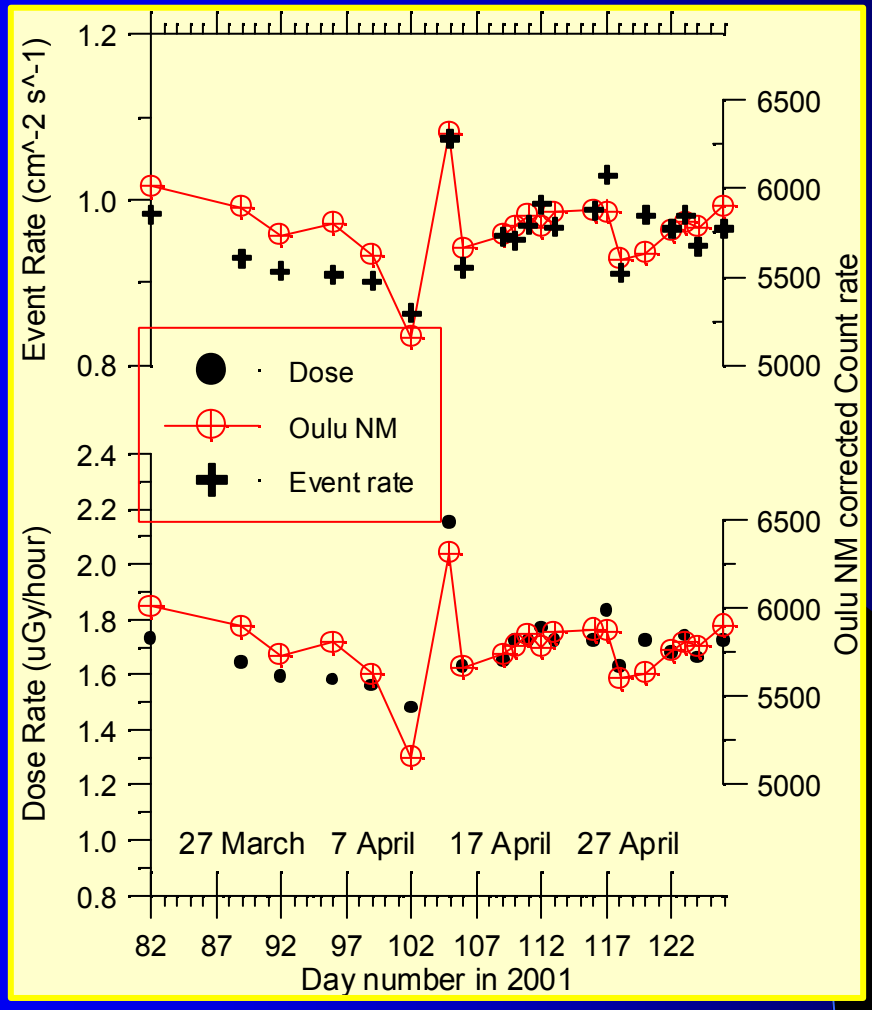
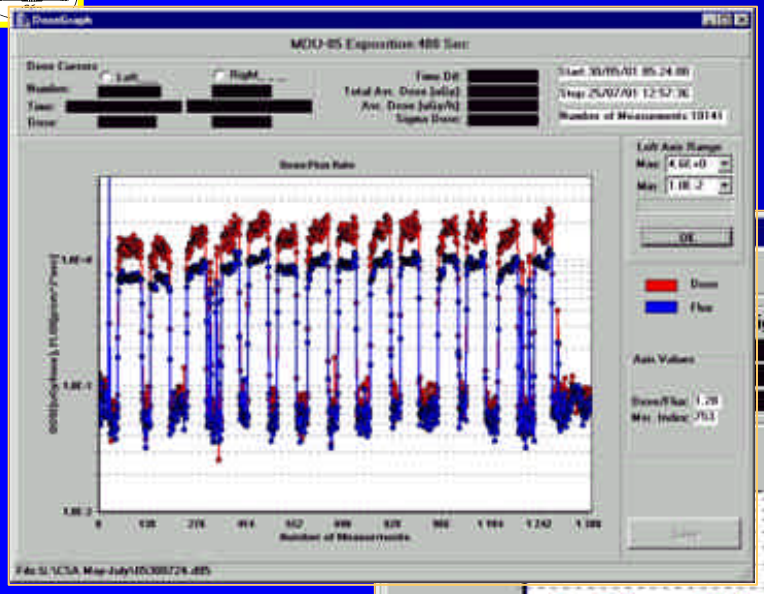
- Flux range: - 0.01 - 1250 part/cm2s;
- Energy loss range: - 0.0407 – 20.83 MeV;
- Pulse height analysis range: 19.5 mV – 5.0 V;
- LET (Si) range: 0.27- 69.4 keV/m;
- Temperature range: 0oC - +40oC;
- Power consumption: typically 52 mW;

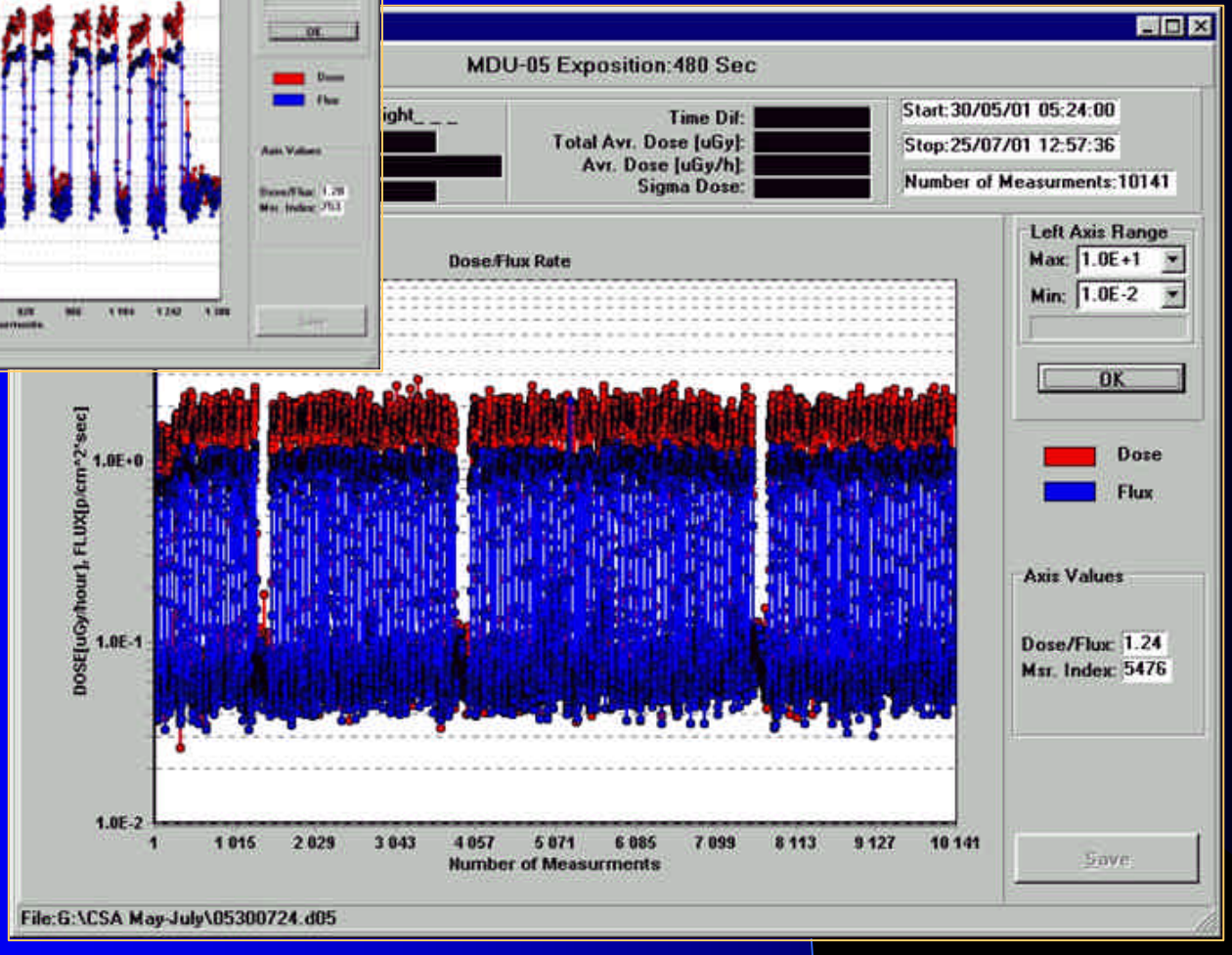
-Size: 100x100x50 mm;
-Total mass: 0.33 kg. (including 2x 0.1 kg SAFT LSH20 3.6 V Li-ion batteries);
- Operation time 110 days

Long term variations including Forbush decreases and GLE#60 as seen on Liulin data on CSA aircraft for the mean doses and fluxes on Prague New-York routes for 22 March – 7 May 2001

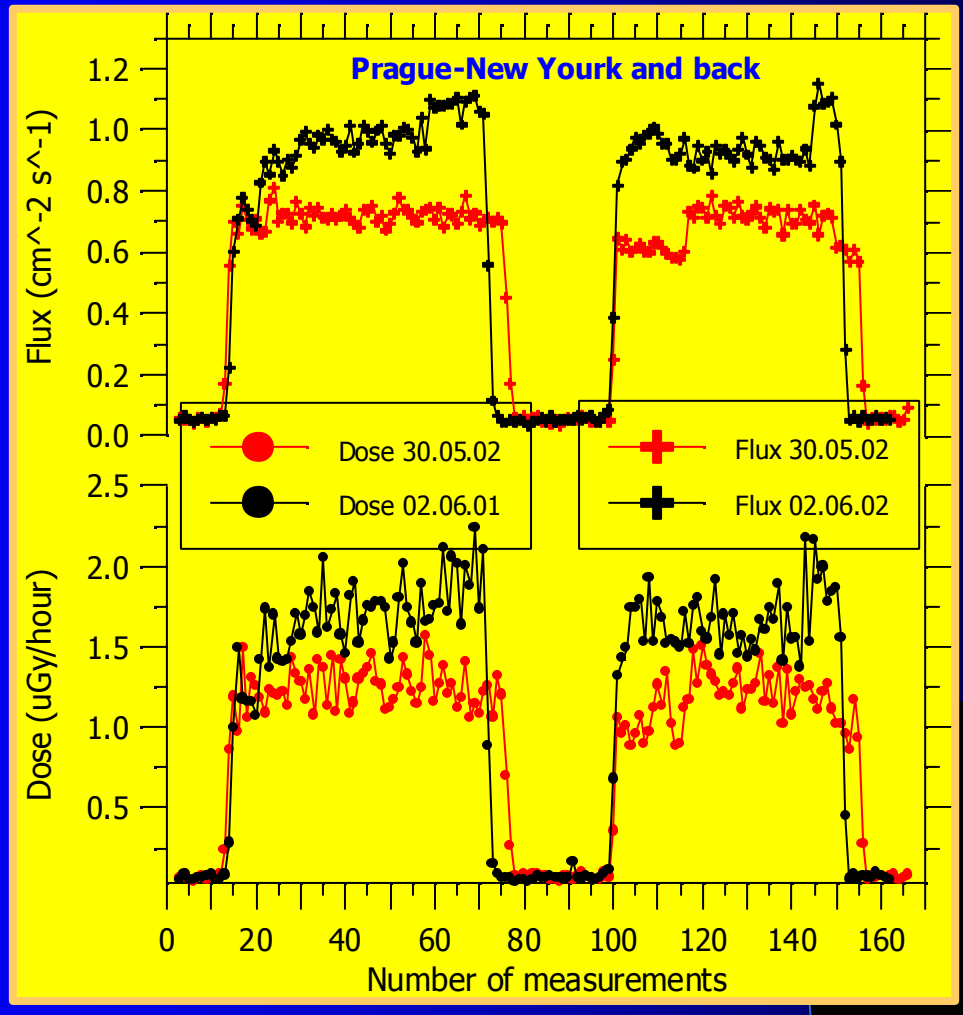


Aircraft data

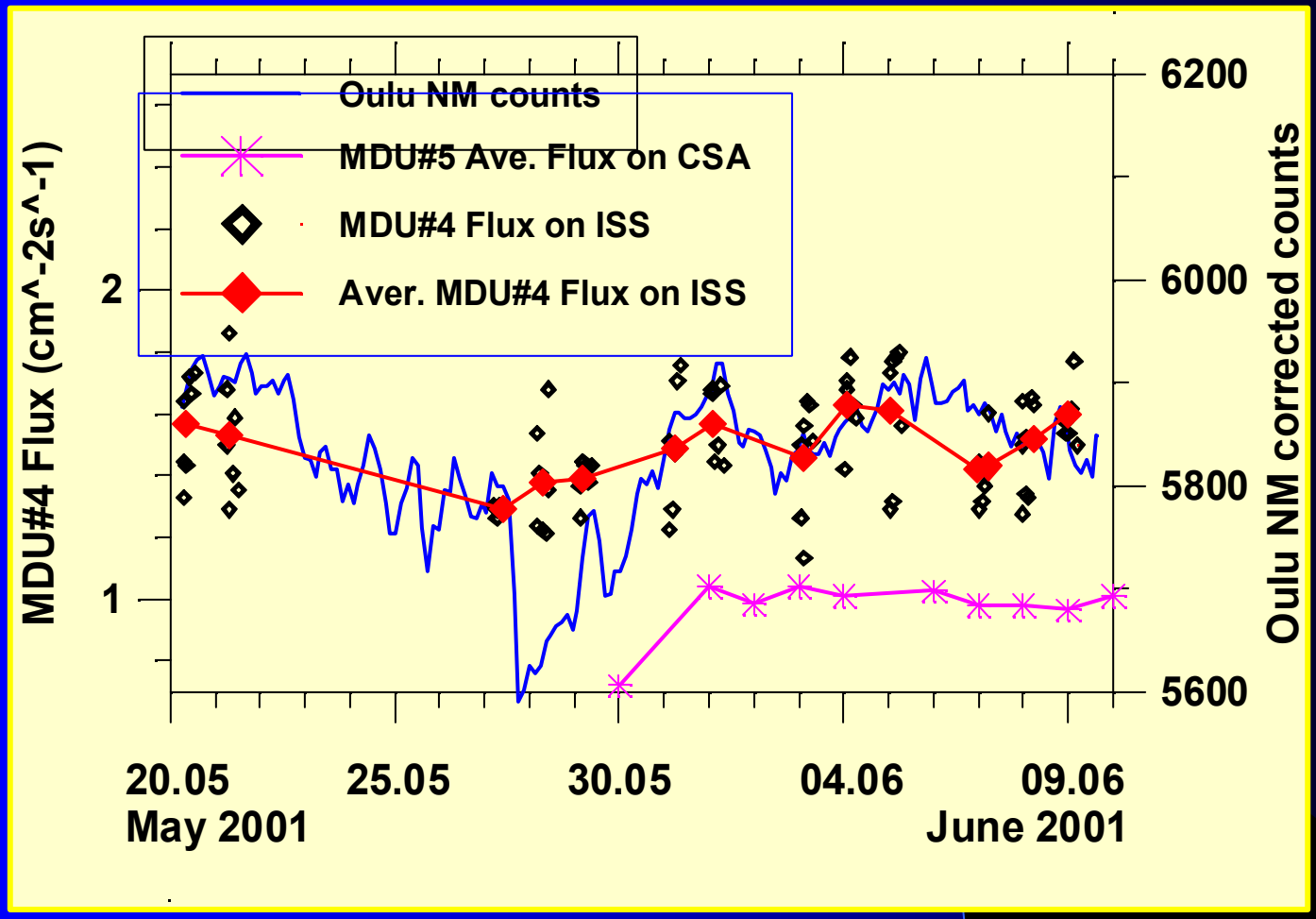




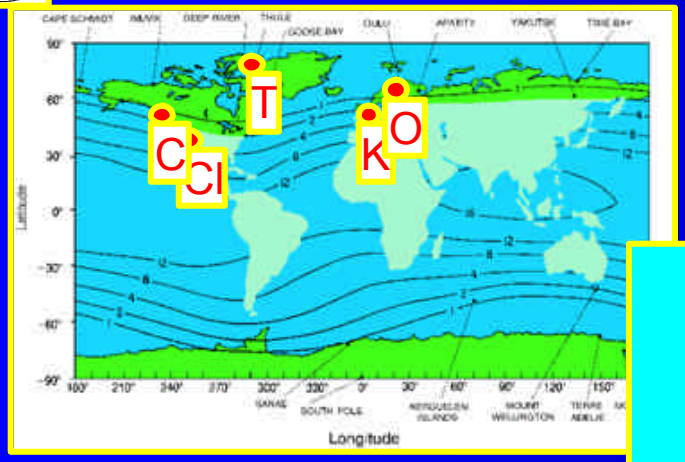
Variations of the CSA aircraft dose and flux data for 30 May and 2 June 2001 on the route Prague-New York and back



Simultaneously plotted Flux data from MDUs on CSA and on ISS from 21 May to 10 June 2001



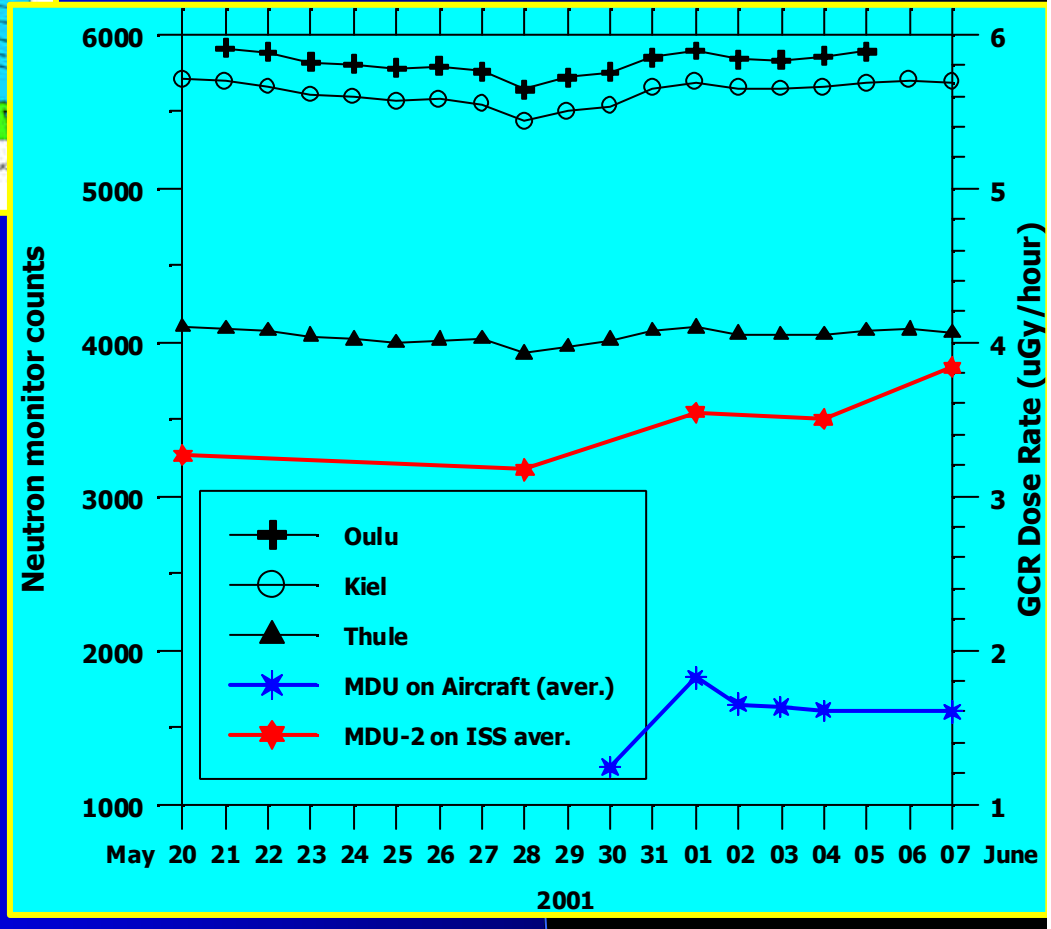
Comparison of ISS and aircraft dose and NM data



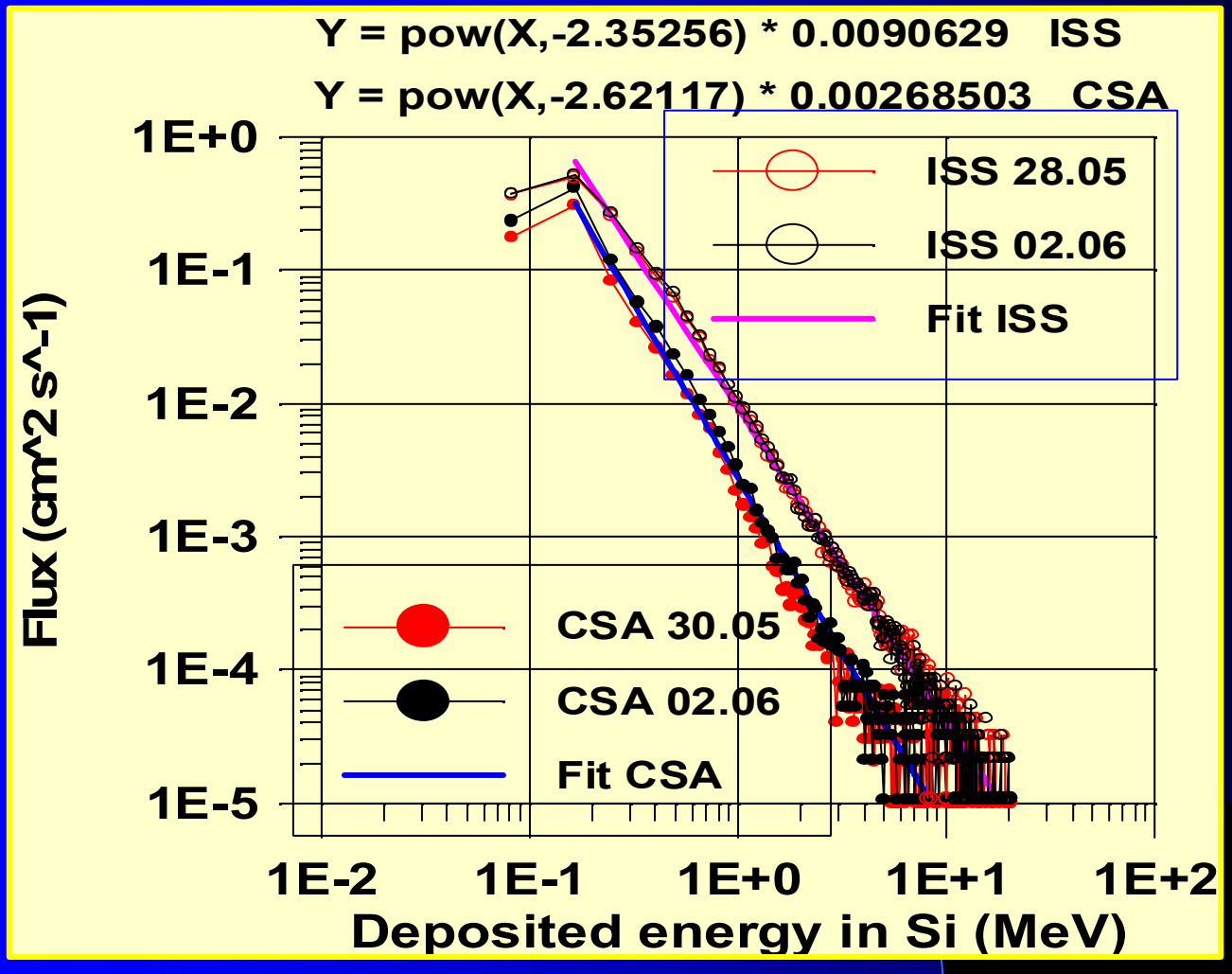
Normal to Forbush Ratios

On CSA aircraft: N/F=1.29

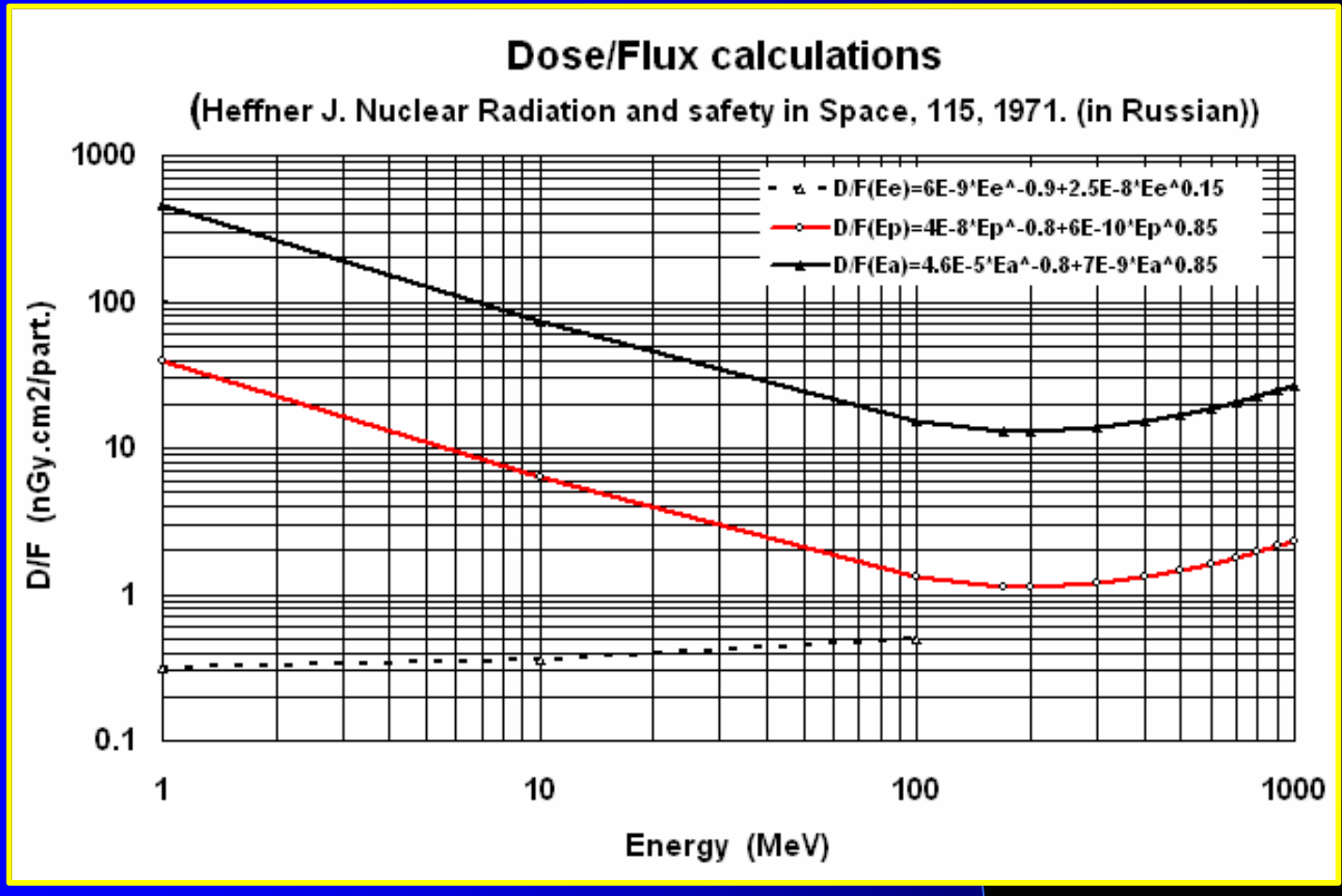
On ISS: N/F=1.21



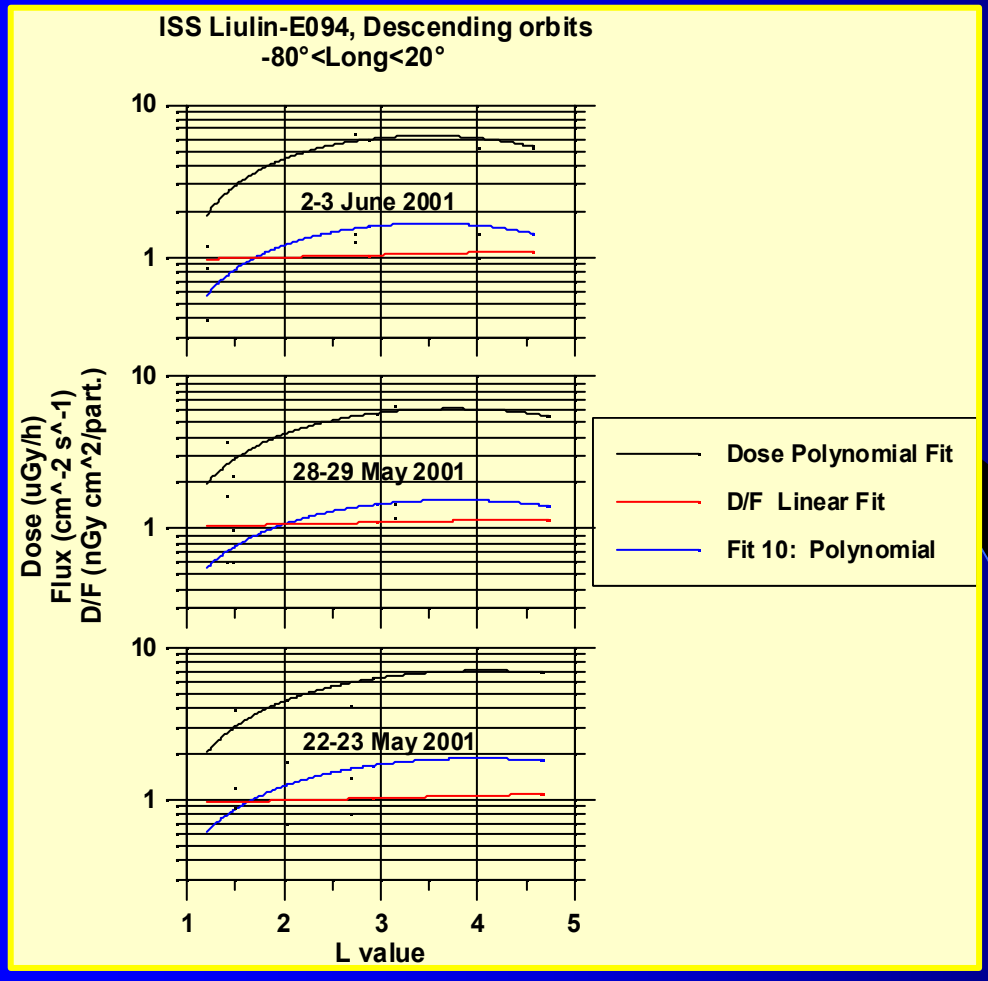
Comparison of the spectra obtained on ISS and on CSA aircraft for the time before and after Forbush Decrease



Dose to flux calculations according to Heffner, 1991



Fitting curves of the Dose, Flux and dose to flux ratio from MDU#4 on ISS for 3 different periods before, during and after the Forbush decrease on 27 May 2001



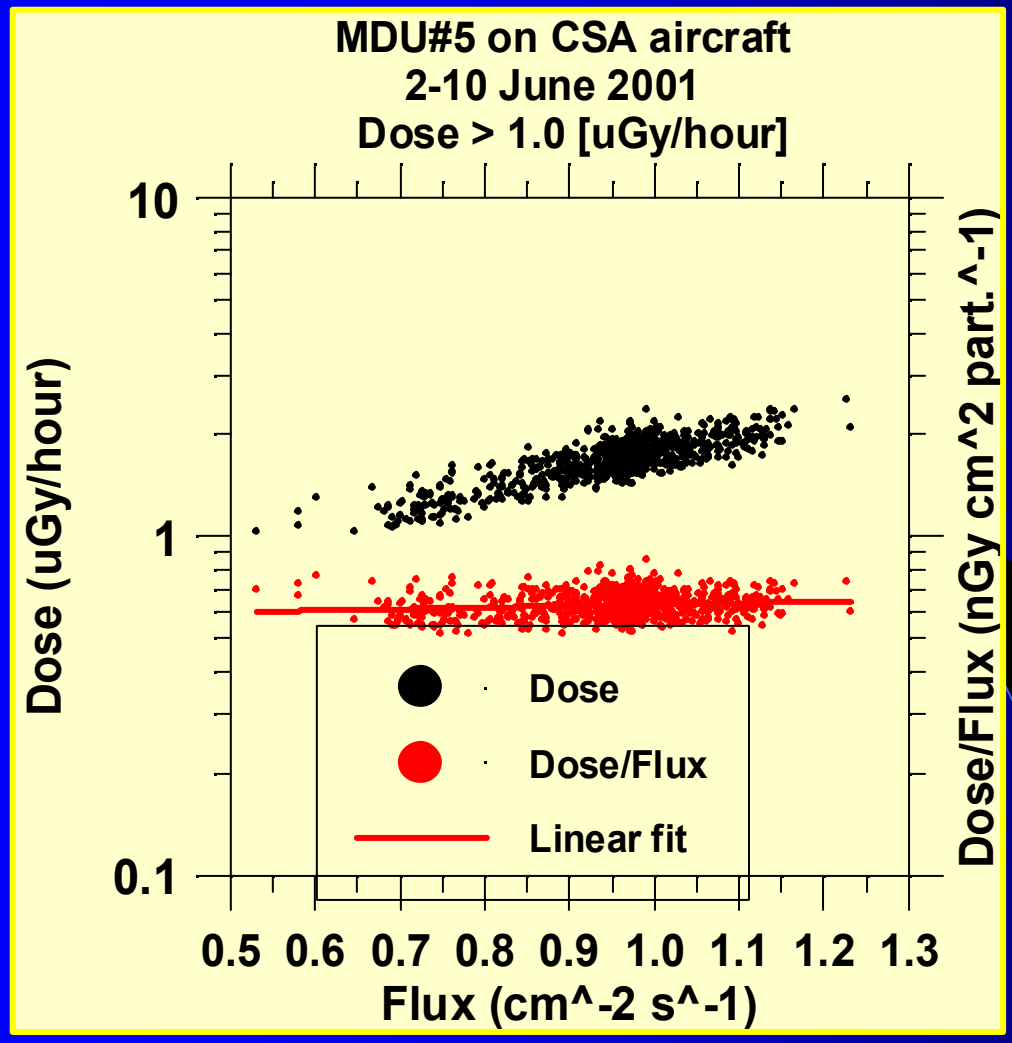
Note:

- Dose/Flux ratio being almost constant about 1.08 [mGy cm^2 p^{-1}];

- Average Dose L>2,5 is 5.28 [mGy/h];

-Average Flux is 1.62 [cm^{-2} s^{-1}]

Dose and dose to flux ratio from MDU#5 on CSA for 2-10 June 2001



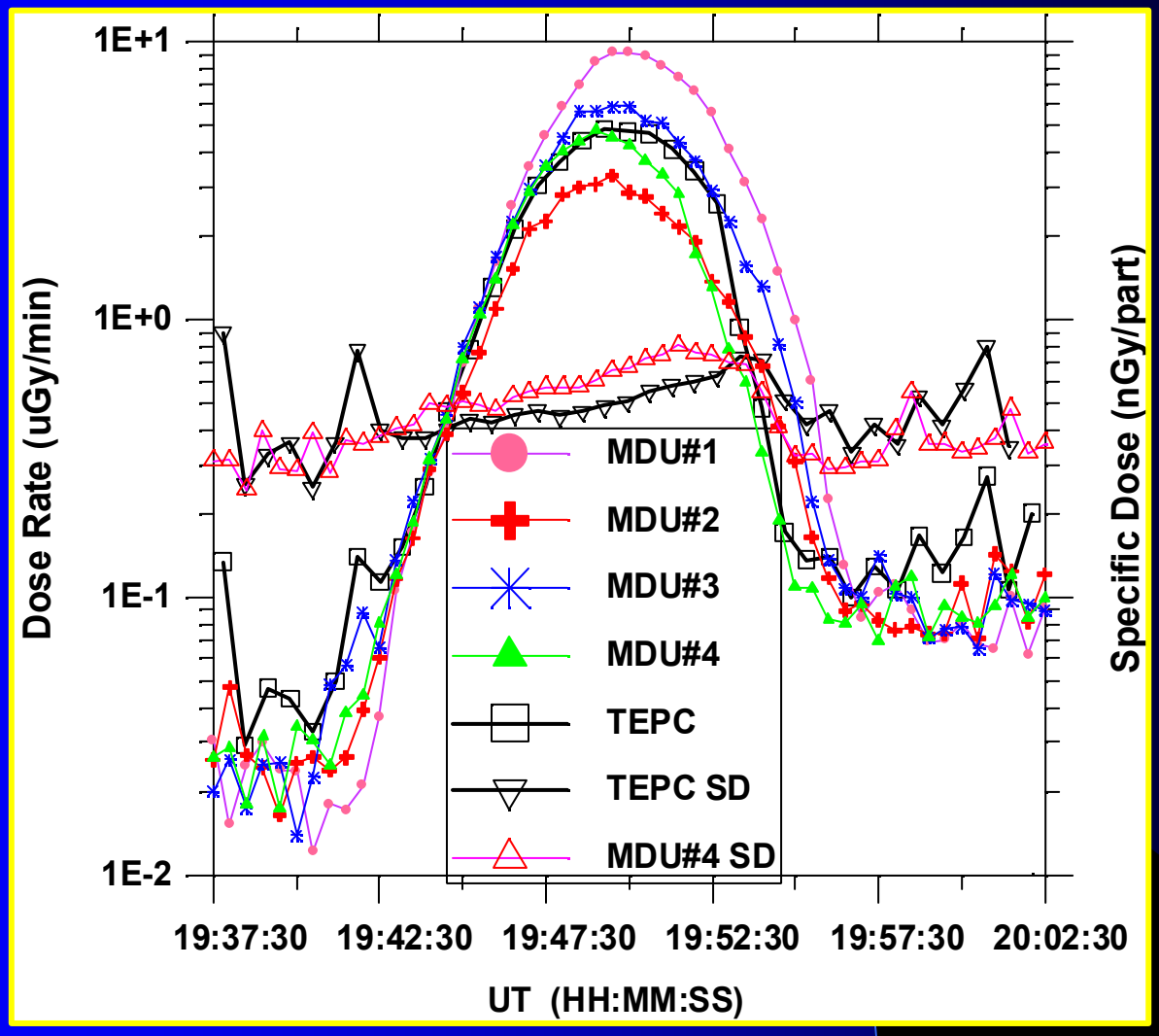
Note:

- Dose/Flux ratio being almost constant about 0.63 [mGy cm^2 p^{-1}];

- Average Dose is 1.68 [mGy/h];

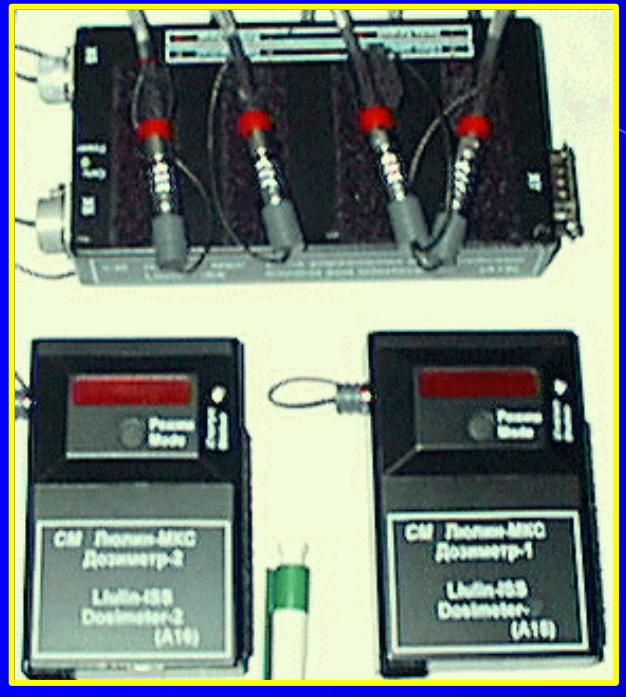
-Average Flux is 0.95 [cm^{-2} s^{-1}]

Comparison between Liulin MDUs and TEPC data



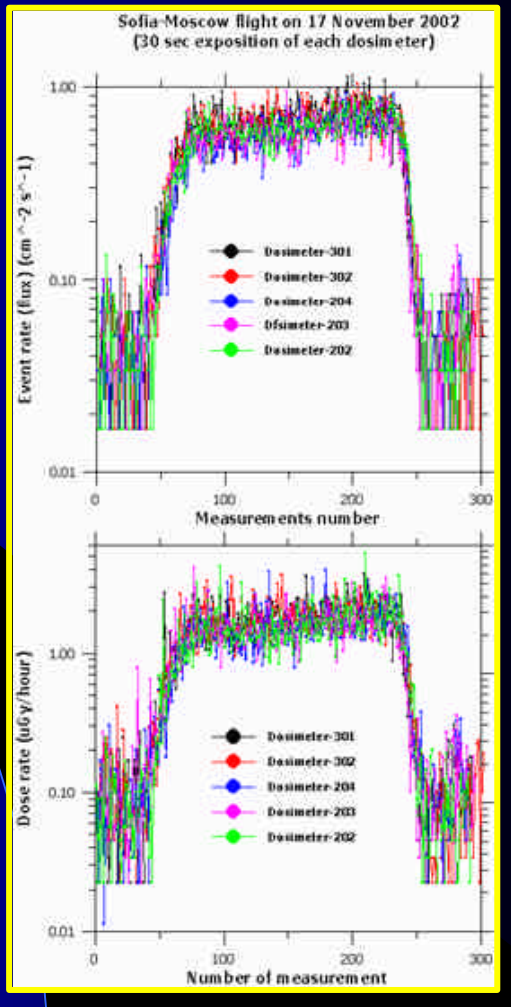
Future space experiments

Liulin-ISS Instrument is a part of Russian segment service dosimetric system and will work on ISS for 15 years since beginning of 2004



Liulin-ISS, MDU DIMENSIONS:

Weight: 229 g incl. 80 g battery
Size: 110x80x25 mm
Consumption: 84 mW



R3D-B instrument for ESA Biopan-4 facility outside of Foton M1 satellite. On 15 October 2002 it was unsuccessfully launched. The mission will be repeated in 2005 and 2006. The spectrometer is mutually developed with the University in Erlangen, Germany.

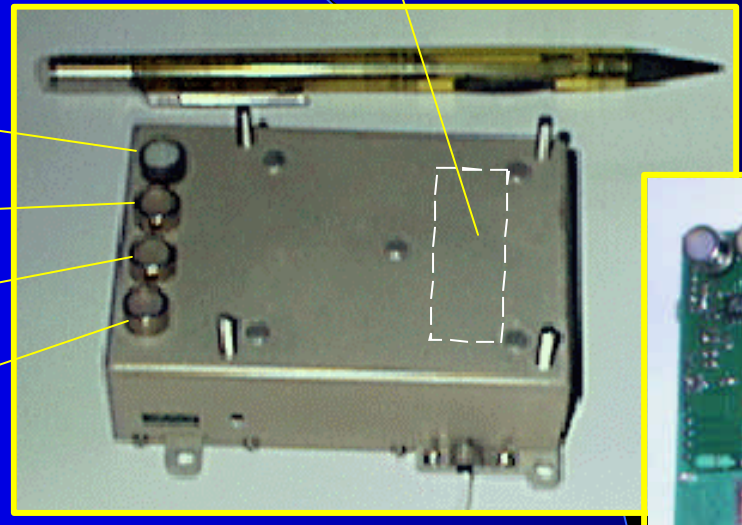
256 Channels
LET spectrometer

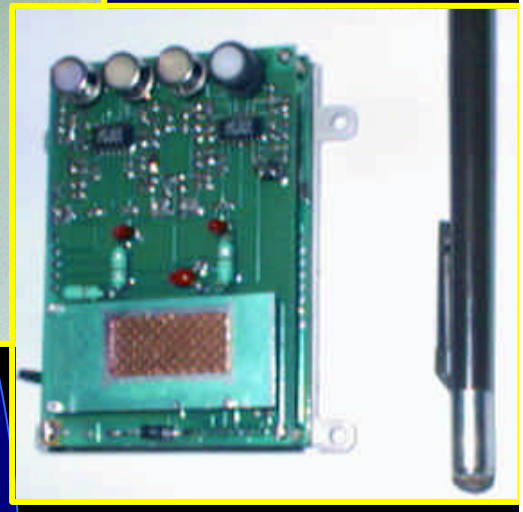
UV-C channel

UV-B channel

UV-A channel

PAR channel





R3D-B DIMENSIONS:

Weight: 129 g
Size: 82x57x25 mm
Consumption: 84 mW

R3D instrument for EXPOSE facility outside of Columbus on ISS. The spectrometer is mutually developed with the University in Erlangen, Germany and is expected to be launched in 2004/2005.

256 Channels
LET spectrometer

EXPOSE

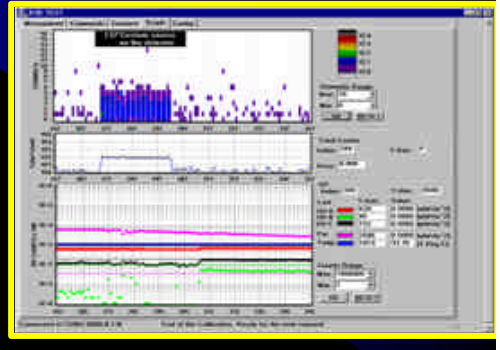
PAR channel

UV-A channel

Flight unit mounted in the EXPOSE facility (May 2003)

Columbus

UV-B channel



UV-C channel

R3D DIMENSIONS:

Weight: 189 g
Size: 76x76x36 mm
Consumption: 120 mW

Quick look data analysis panel

Conclusions

- Liulin spectrometers proved its possibility to characterize complex radiation fields and their variations in the International space station and on aircrafts;
- Future experiments in space are under development and will be performed up to 2019;
- Additional efforts are needed to present and analyze all the obtained results.

Thank you for your attention