

DOSE MEASUREMENTS ON BOARD THE RUSSIAN SEGMENT OF THE ISS BY THE PILLE TL SYSTEM

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Outline

The Pille TLD System

Pille on ISS

Position of the dosimeters

Measurements by Charles Simonyi

Results of Exp. 15-16.

Summary

The Pille thermoluminescent dosimeter system

Space qualified, on-board TLD system

Dosimeters and the reader device

Dosimeters	
Type:	bulb
Material:	CaSO ₄ :Dy
Dimensions:	φ 20 mm * 60 mm
Mass:	70 g (with carrying case)

Reader	
Measuring range ($\delta < 10\%$):	3 μGy ÷ 10 Gy (CaSO ₄ :Dy)
TLD Efficiency ($\epsilon = 1 \pm 10\%$):	LET _∞ (H ₂ O) < 10 keV/ μm
Accuracy (above 10 μGy):	$\delta < 5\%$



High sensitivity

Even hourly read-outs are possible

On board of every space station since Salyut-6

More than 17 000 comparable read-outs from different space stations

Pille on ISS

DOSMAP project

Service dosimetry system on Zvezda since 2003. (Exp. 8.)

- Dose mapping
- Personal dosimetry during CME-s
- Personal dosimetry during EVA-s
- Automatic read-out in every orbit

Result presented on WRMISS

Exp. 15-16.



Position of the dosimeters 1/2

Original positions

- A0301, A0302: Cabin of the right board, on both sides of the illuminator
- A0303, A0304: Cabin of the left board, on both sides of the illuminator
- A0305, A0306: Ceiling, on the system radiometer R-16
- A0307: Right board, beside of the cabin, on ceiling of the lavatory
Dedicated for EVA reference measurement inside ISS
- A0308: Inserted in the Reader, which is fixed on the floor,
right to illuminator N° 9
- A0309, A0310: In the transporting case of the Reader, left to illuminator N° 9
Dedicated for EVA personal measurements
-
- A0301, A0303: Removed from original position for Matroshka project

Position of the dosimeters 2/2

Exp 15, Charles Simonyi (spaceflight participant, docked to the ISS on April 9, 2007 and returned to the Earth on April 21)

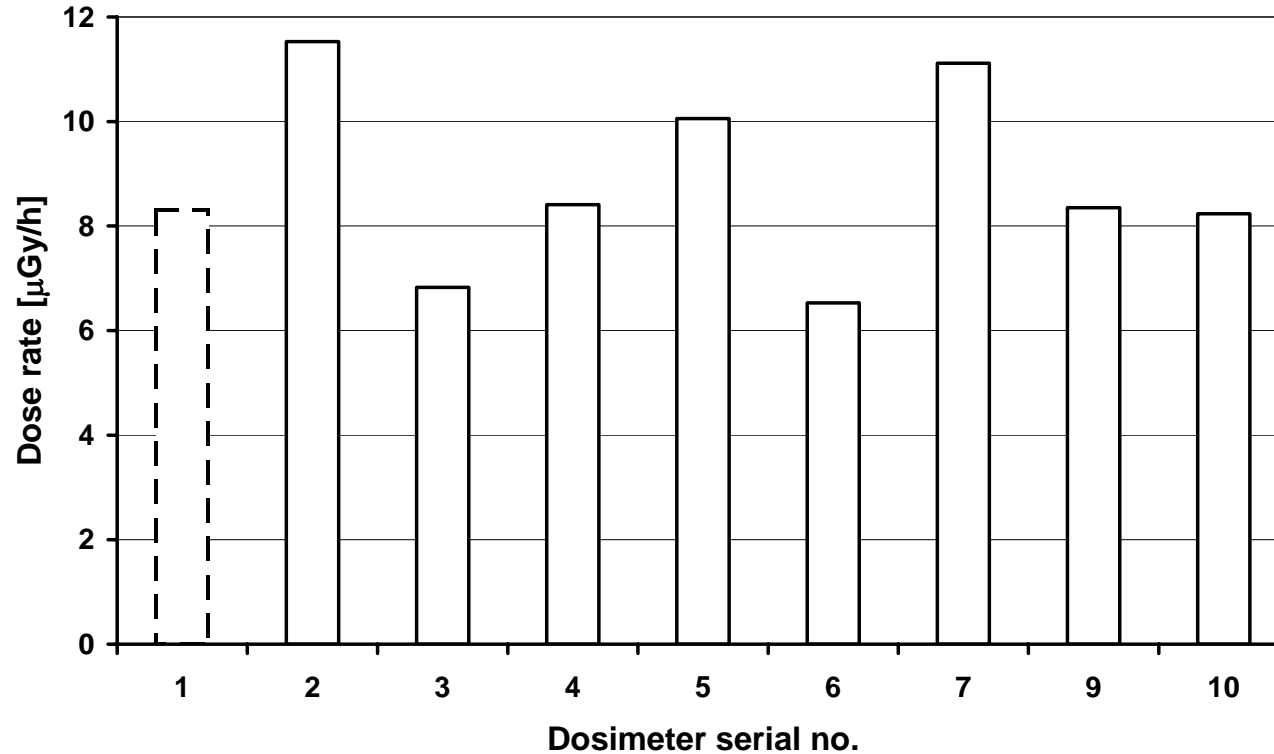
A0301:	Pocket of Simonyi's shorts just wearing (personal dosimeter)
A0302:	Attached to the sleeping-bag (in Living Compartment of the Suyuz until 14th, in Docking Compartment later on)
A0303:	Panel 410 at detector DB-8 No.1
A0304:	Panel 244 at detector DB-8 No.2
A0305:	Panel 447 at detector DB-8 No.3
A0306:	Panel 435 at detector DB-8 No.4
A0307:	Cabin of the right deck, left to the window
A0308:	Service dosimeter used for automatic measurement
A0309:	Cabin of the left deck, right to the window
A3010:	Panel 111 at window No.6, floor

Current position

No data about the current position of the dosimeters

Measurements by Charles Simonyi 1/3

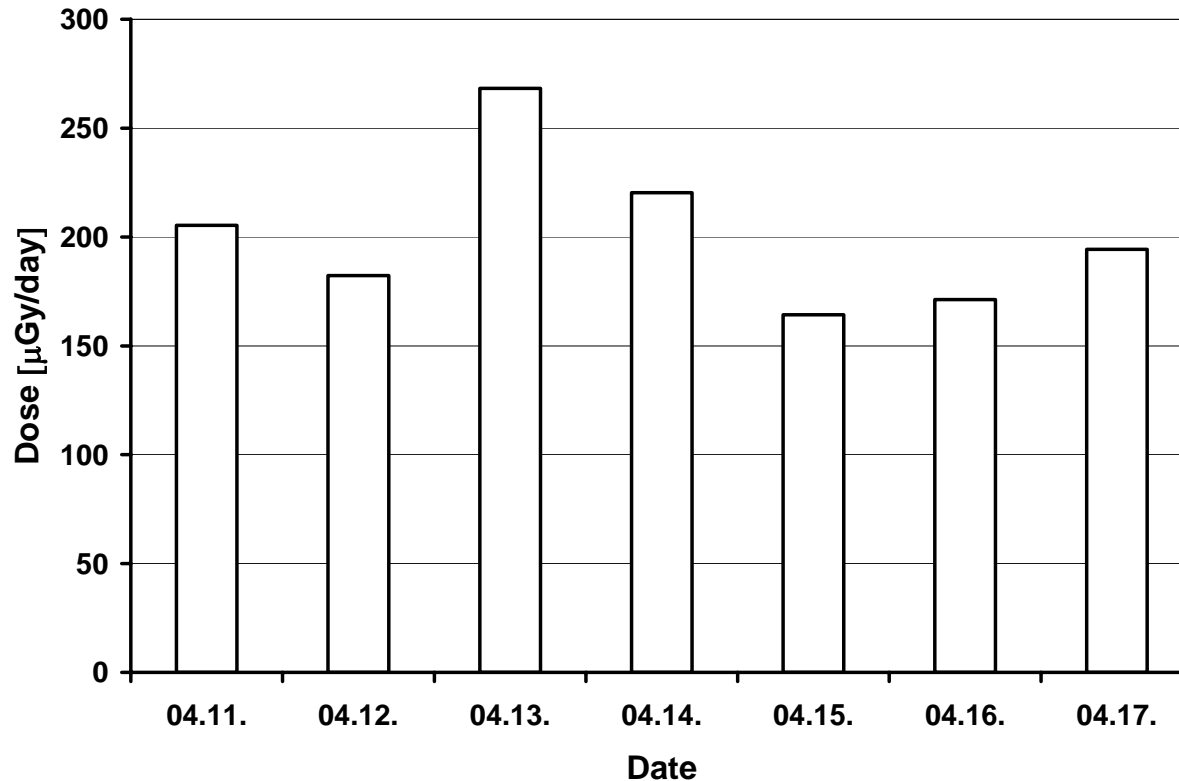
Dose mapping



Relatively high dose rate at the sleeping place (2)

Measurements by Charles Simonyi 2/3

Personal dosimetry



04. 13.: Simonyi spent 10-11 hours in the sleeping compartment

Measurements by Charles Simonyi 3/3

Other measurements

Dosimeter backgrounds

- Second read-outs were performed for each dosimeters by Simonyi
- The dosimeters background have not changed since 2003

Automatic measurements were carried on as normally

- No extra events were detected

Conclusions

The highest dose rate was measured at the sleeping place

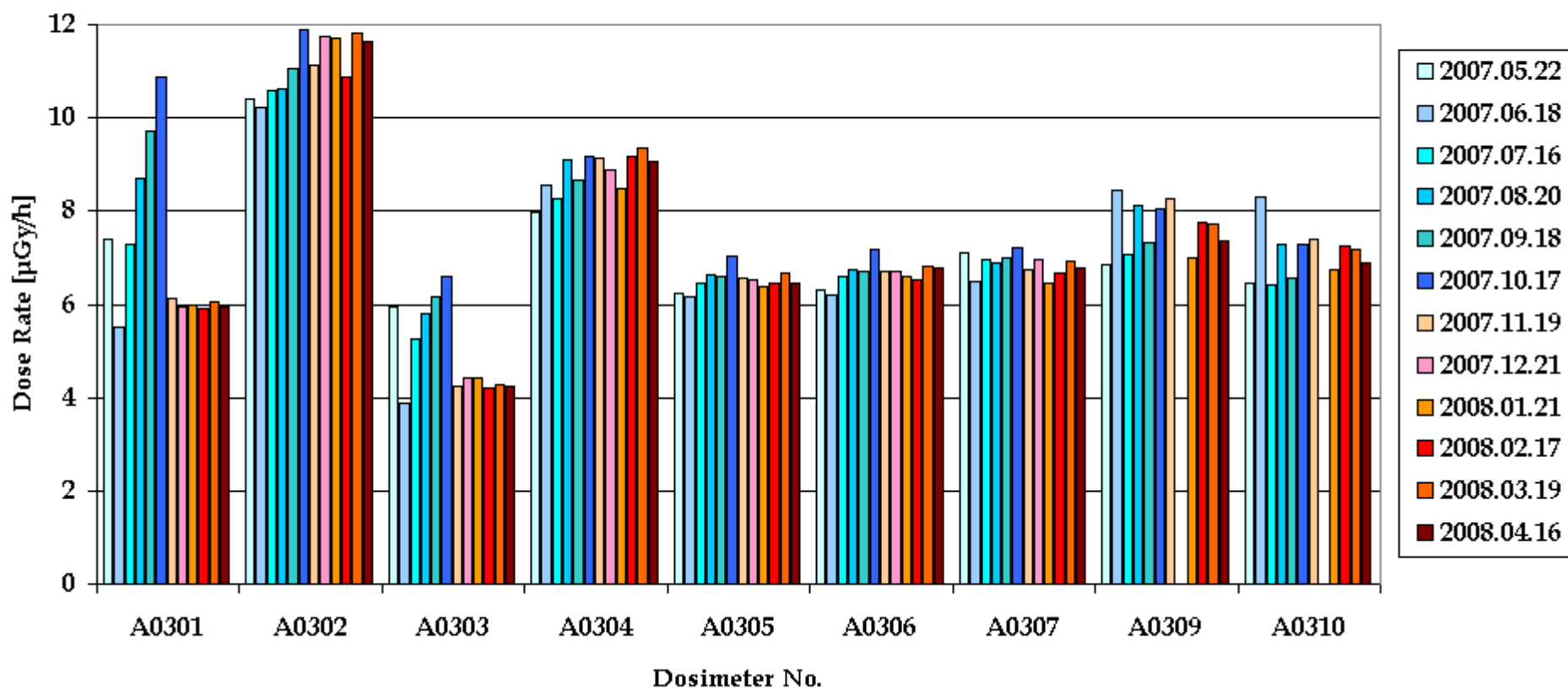
- *Relocating sleeping places on spacecraft may reduce the personal dose of the astronauts*

The background of the Pille dosimeters have remained constant

No solar particle events were detected

Monthly manual read-outs, Exp. 15-16.

Dose rates on the ISS, Exp 15-16.



Sensitivity of dosimeter A0308

Dosimeter A0308 is dedicated for the automatic measurements

- Read-out in every 1.5 hours
- More than 15 000 read-outs until now

The average dose rate measured by dosimeter A0308 is ~30% lower than dose rate measured by other dosimeters

- Integrated automatic measurements compared to monthly read-outs: ~30% lower
- Once, during an EVA, both A0308 and A0307 were used as reference dosimeter: ~30% lower
- A0309 was used for automatic measurements for several months: ~30% lower

The effect exists since 2003, the beginning

Possible cause:

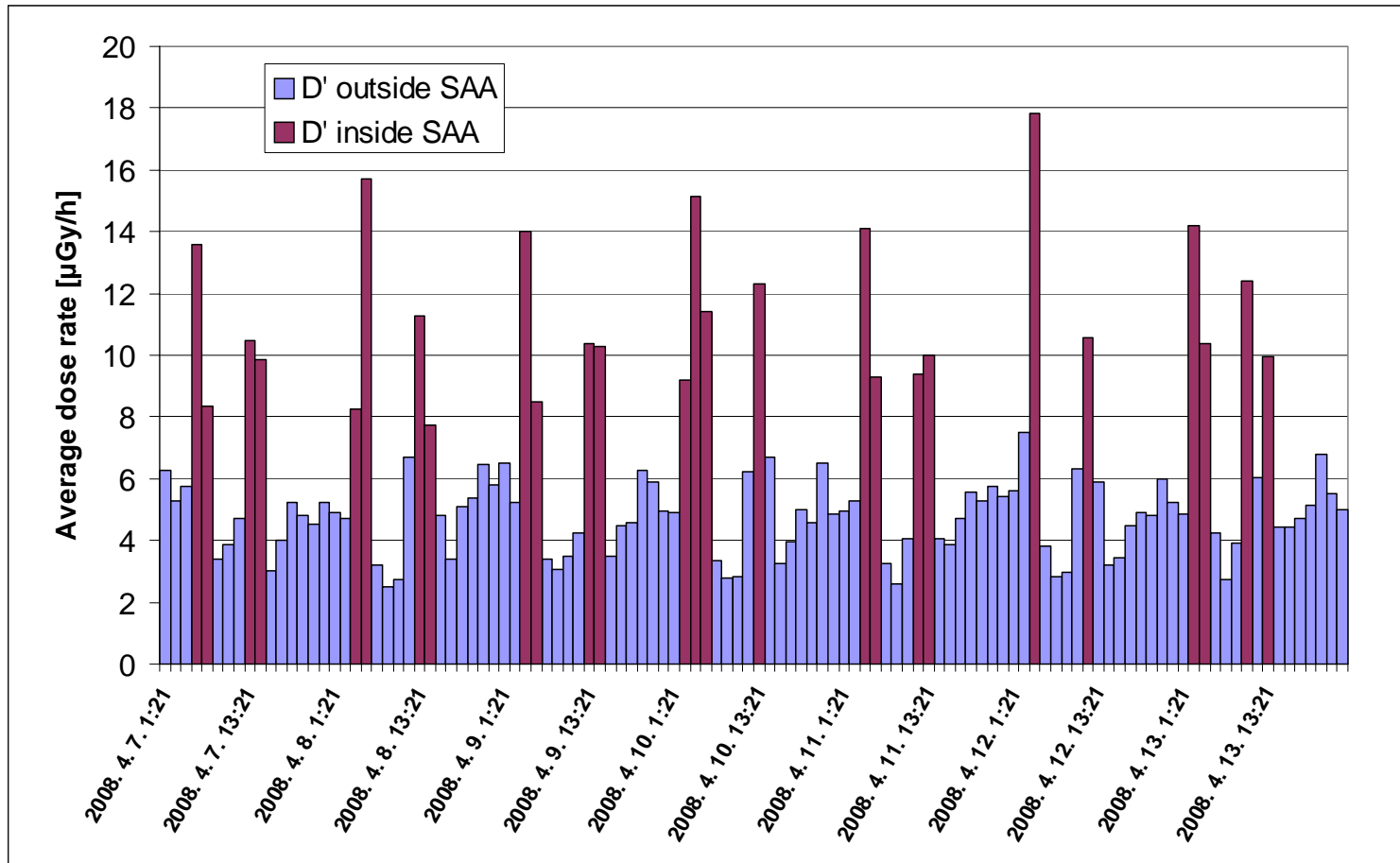
- A0308 is more efficiently shielded inside the reader: calculations against this
- The dosimeter is getting old: no changing was observed in the last 5 years
- Some CaSO_4 crystals fell during launch

Onboard cross-calibration needed

- can be easily done e.g. during EVA-s with A0307

Replace the dosimeters

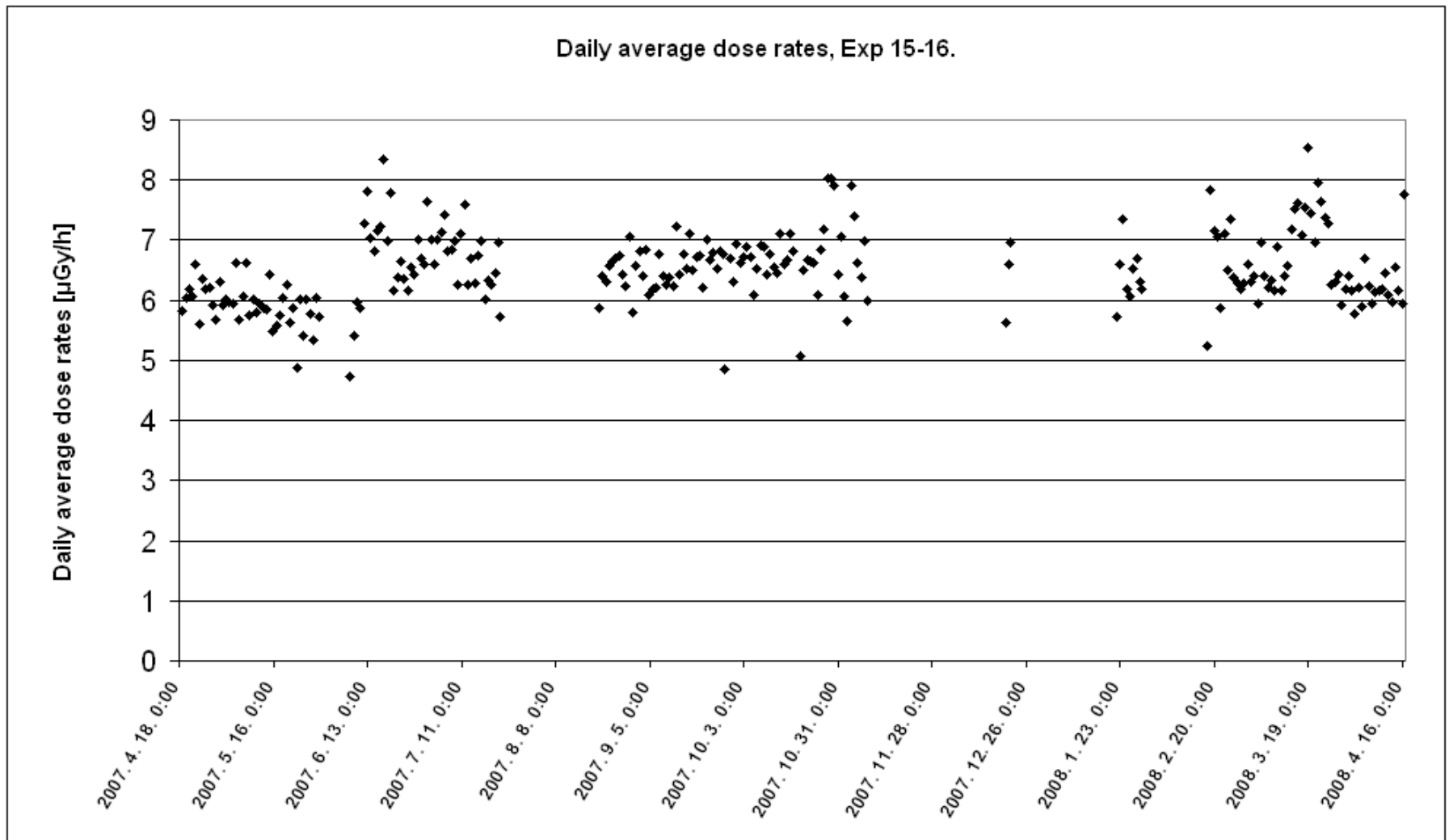
Sample from the automatic measurements, Exp. 15-16.



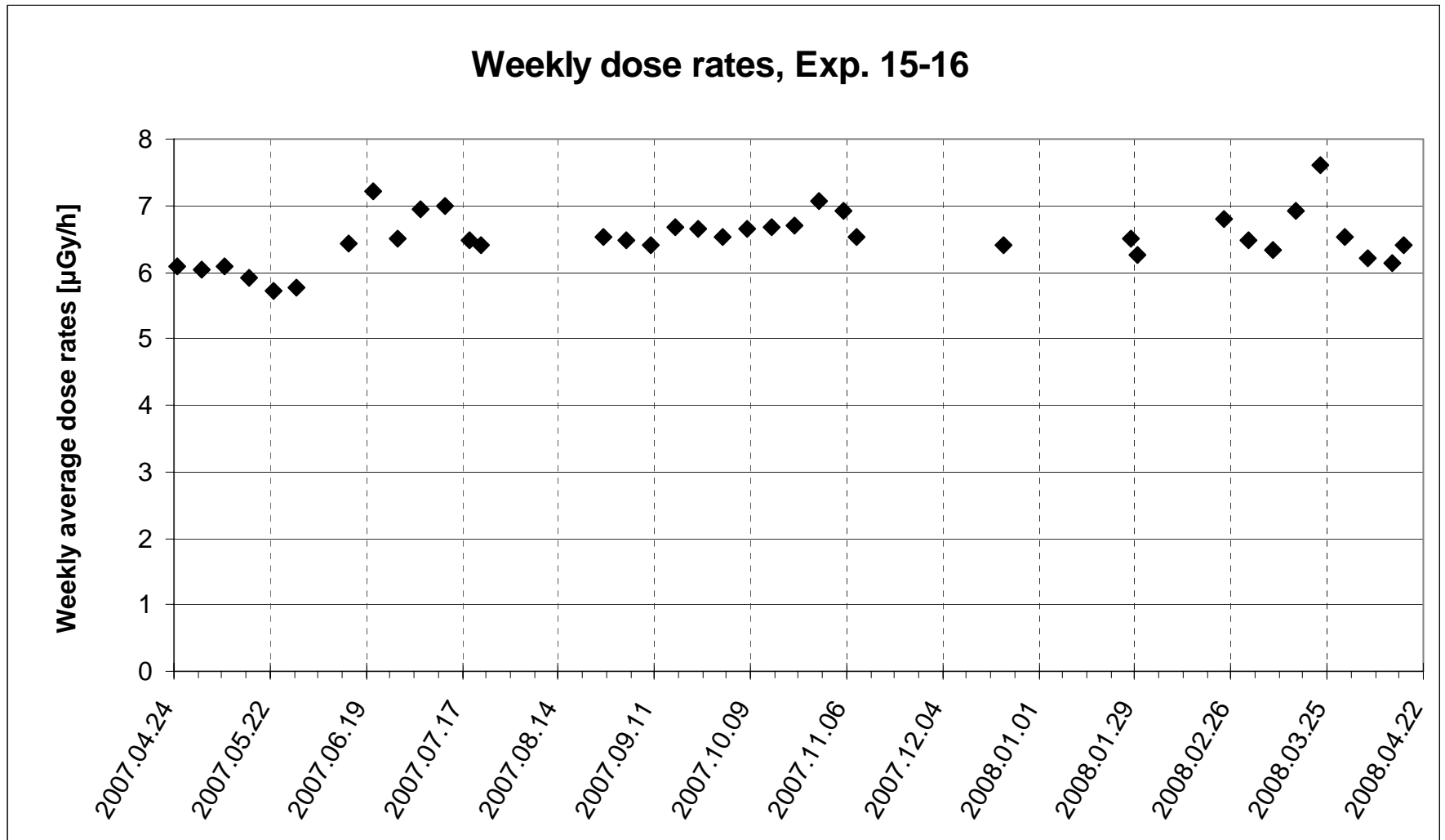
One third of the dose of the astronauts are caused by the South Atlantic Anomaly.

No solar activity was detected by Pille during Exp. 15 and 16.

Daily average dose rates, Exp. 15-16.



Weekly average dose rates, Exp. 15-16.



EVA measurements

EXP. 15.

2 EVAs were measured

EVA date	Extra dose [μGy]	Extra dose rate [$\mu\text{Gy} / \text{h}$]	Extra dose [μGy]	Extra dose rate [$\mu\text{Gy} / \text{h}$]
2007. 05. 30.	215	39.7	147	27.1
2007. 06. 06.	244	43.4	147	26.2

EXP. 16.

4 EVAs were measured, BUT

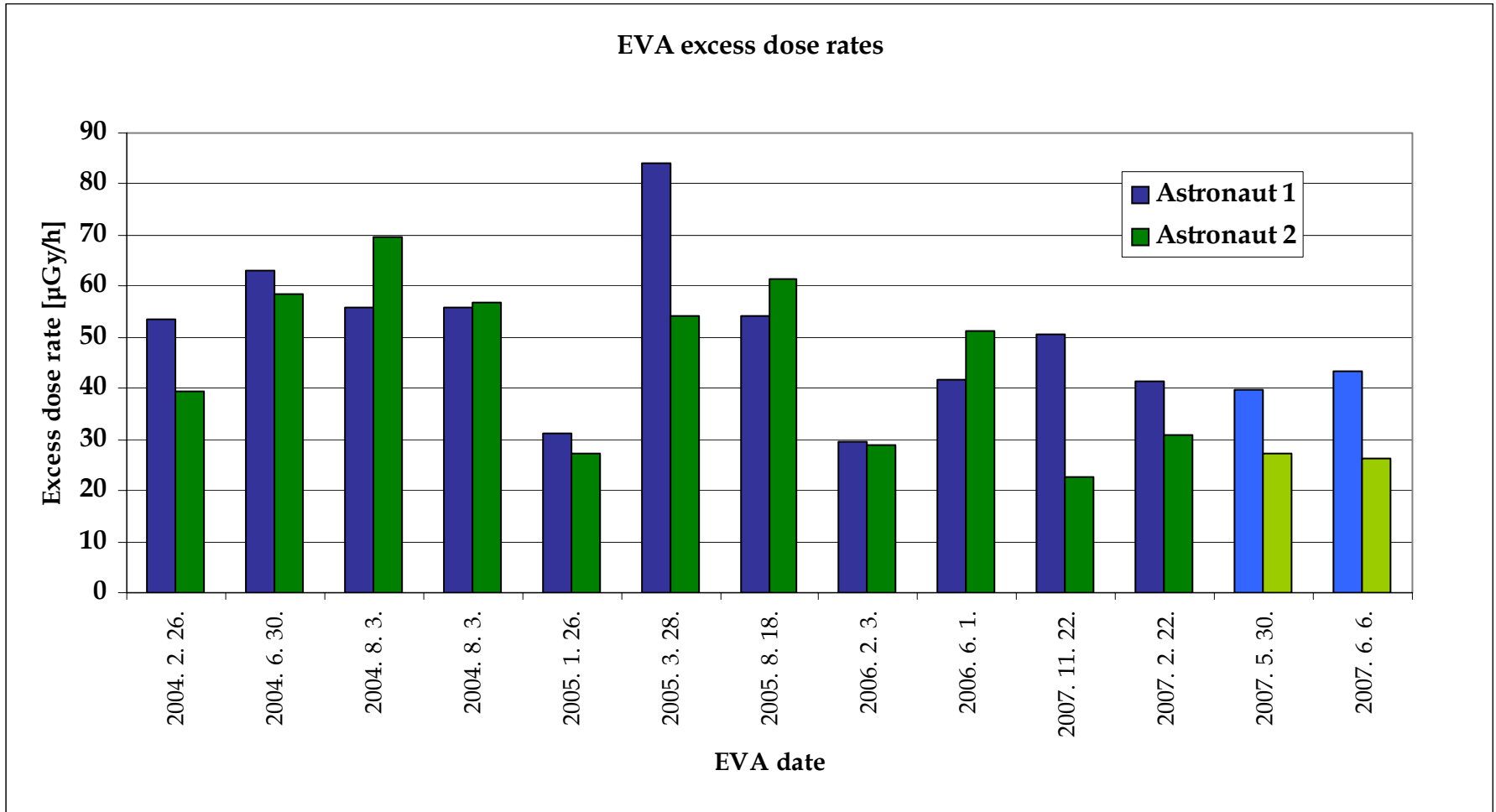
A0308 was used for reference dosimeter

- No automatic measurements during EVA (unfortunately that is usual)
- A0307 is dedicated and should be used as reference dosimeter

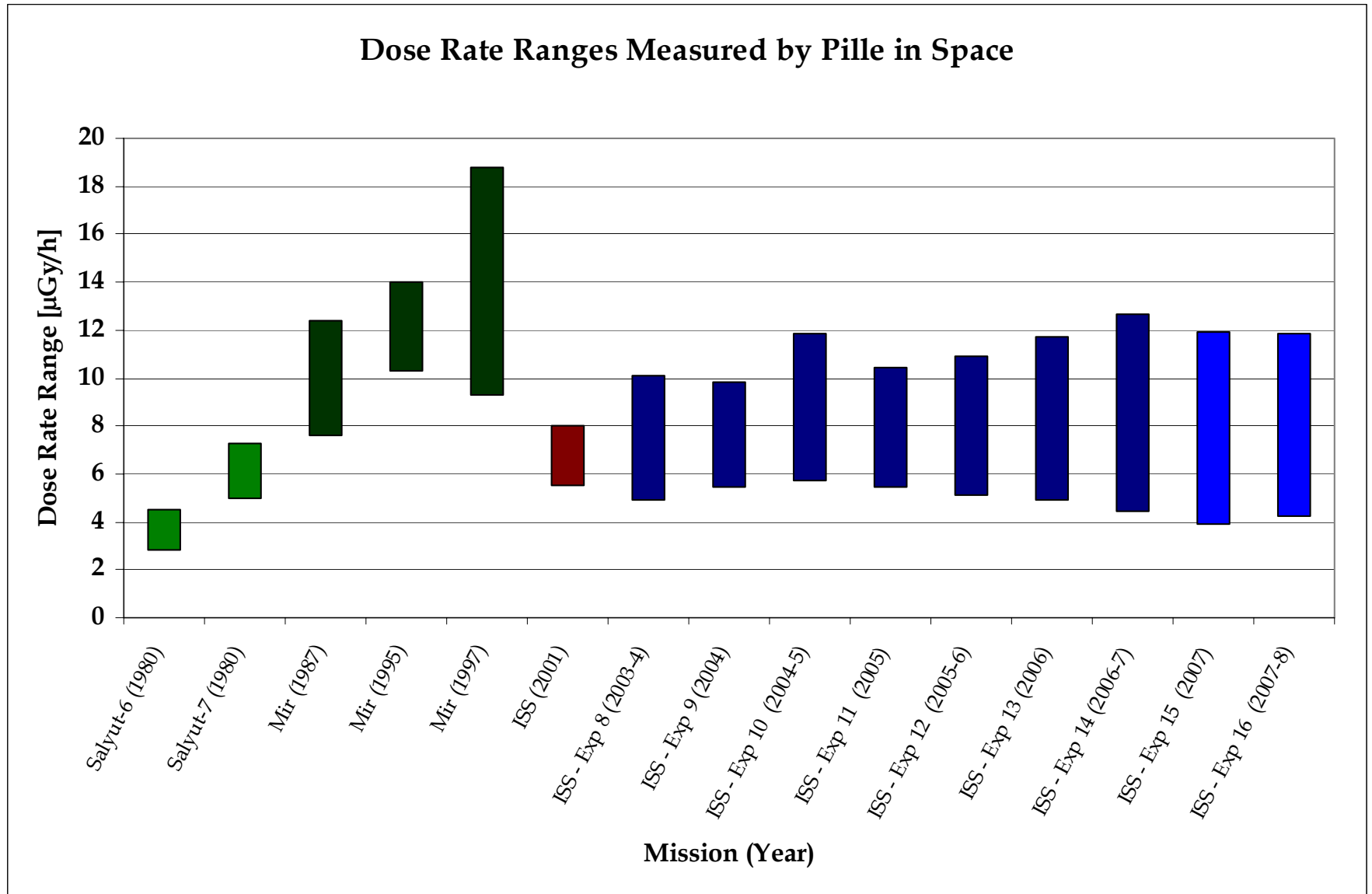
No extra dose measured during the EVA-s

- Assumably, the EVA dosimeters were not used

EVA excess dose rates



Dose ranges measured by Pille



Further work and summary

Latest developments

2 Pille dosimeters inside ATV (No. A0309, A0310)

Pille dosimeters in JEM in the future

Summary

The Pille TLD system is in good shape, has been providing data since 2003

The present position of the dosimeters is unknown, unfortunately

The highest measured dose rates are at the sleeping place of the astronauts

Dose rates of Exp. 15-16. were similar to the previous measurements

EVA extra dose rates during Exp. 15. were measured, Exp 16. no valuable data

Automatic measurements with A0308 were revised

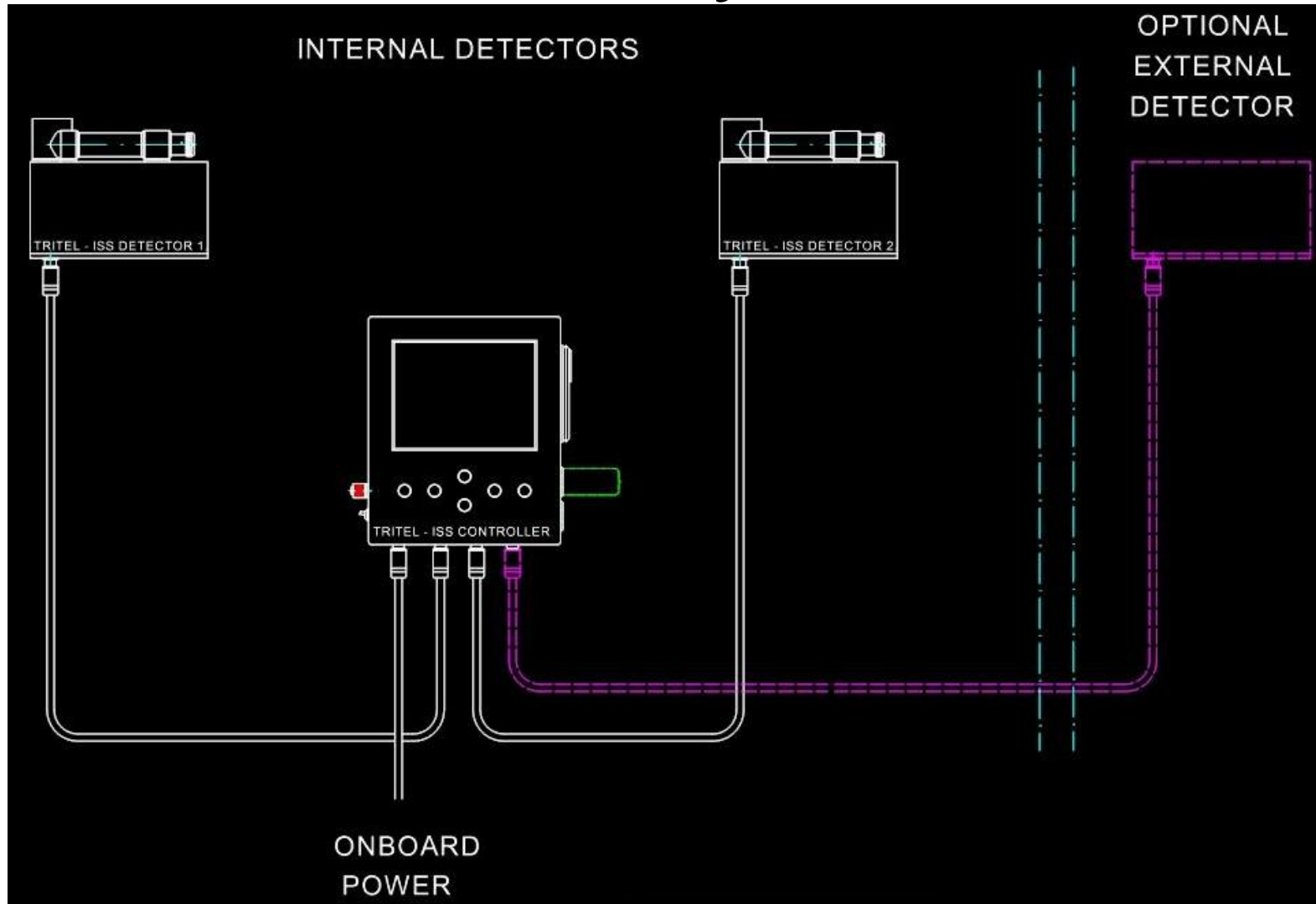
(2 oldtimers)



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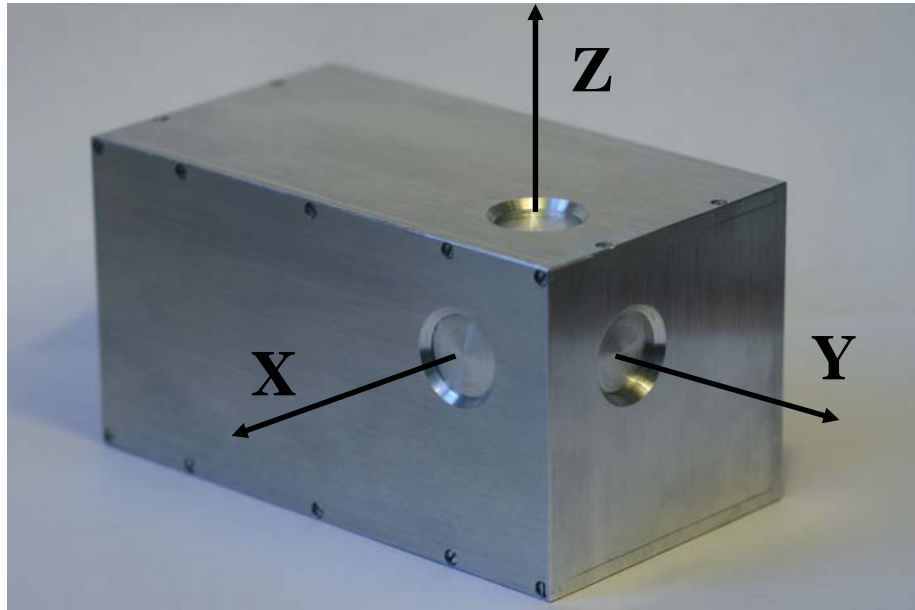
TriTel – Recent Developments

TriTel system

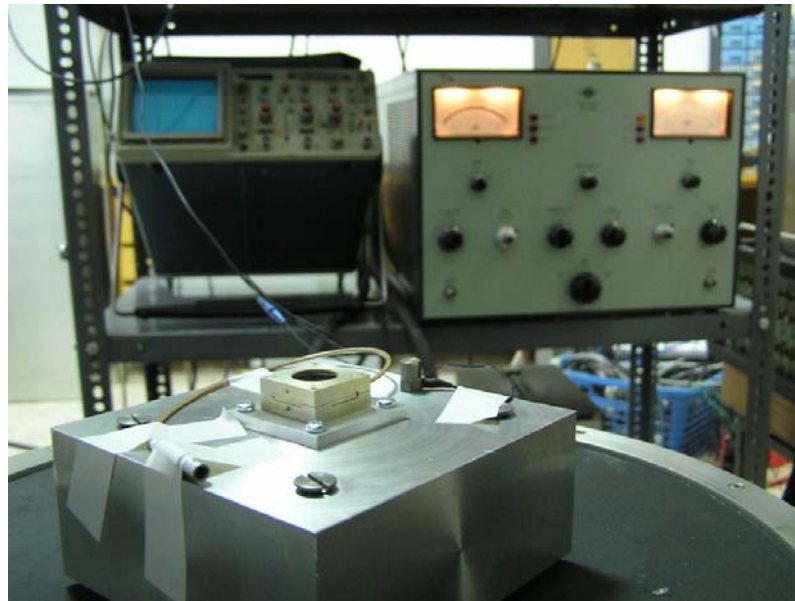
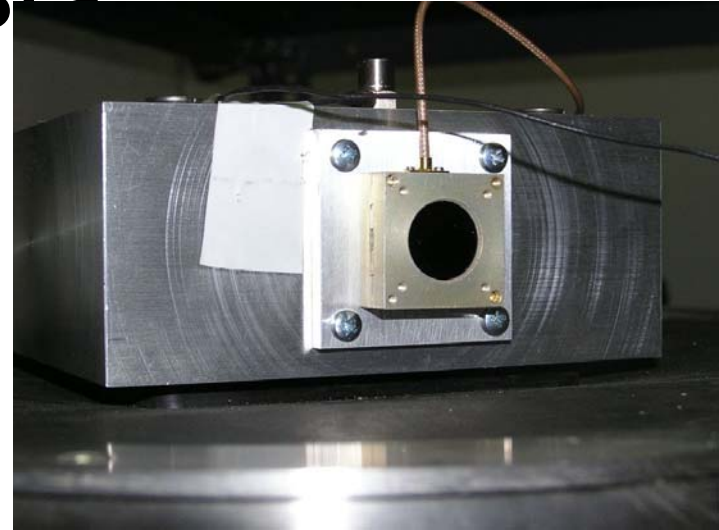
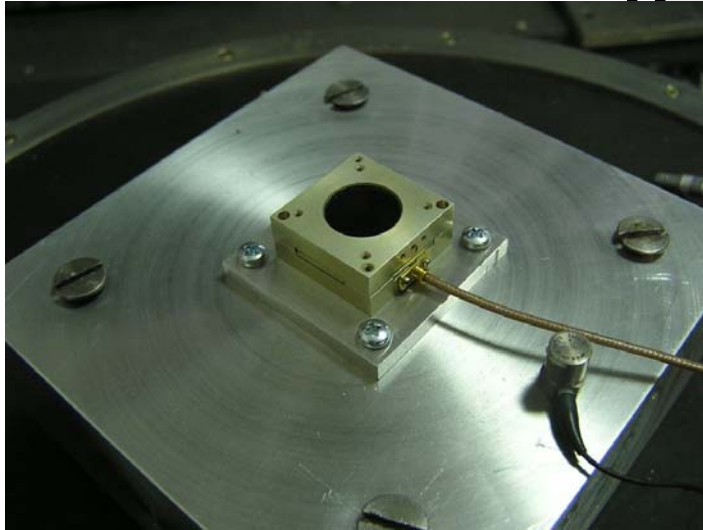


TriTel projects are at an advanced stage

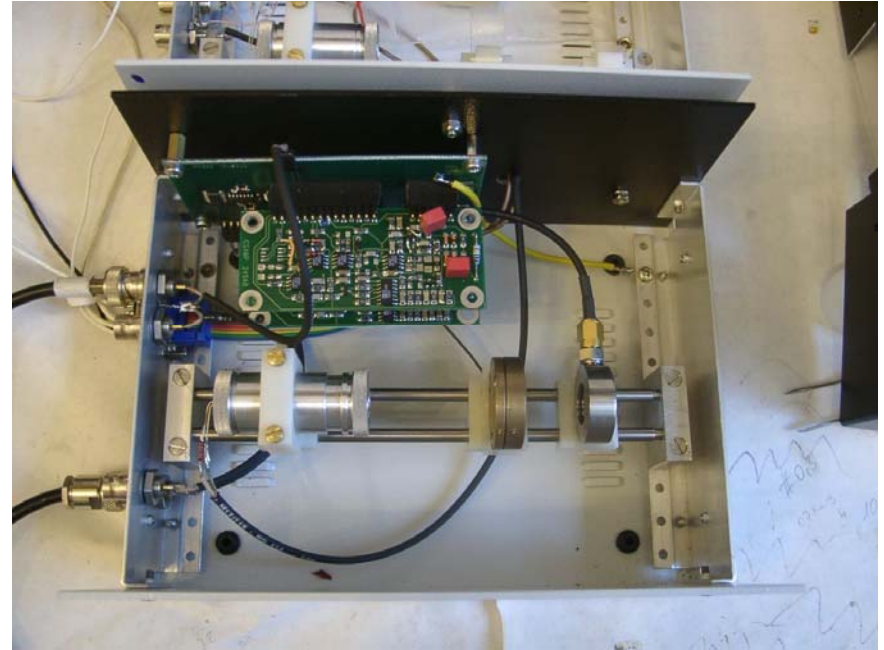
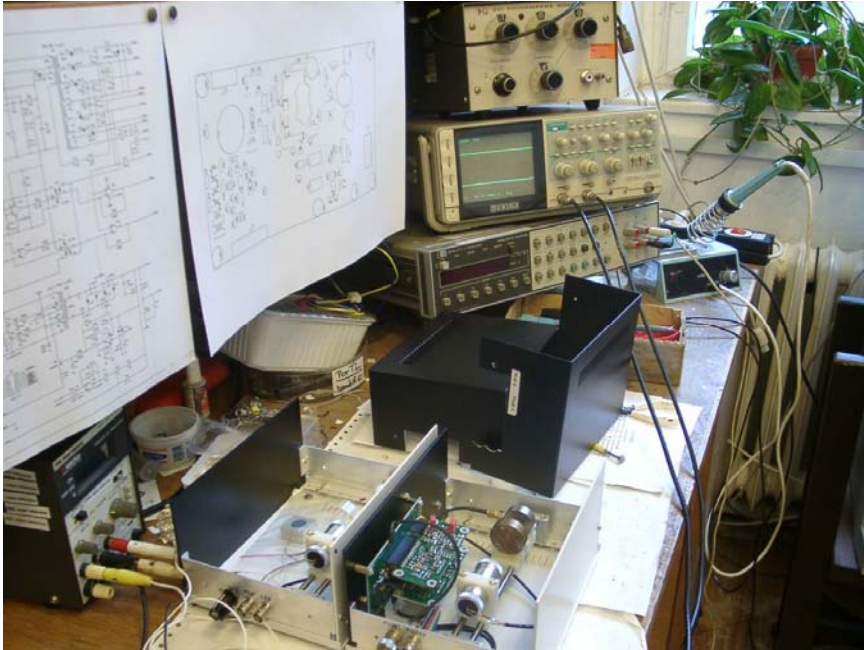
Detector unit



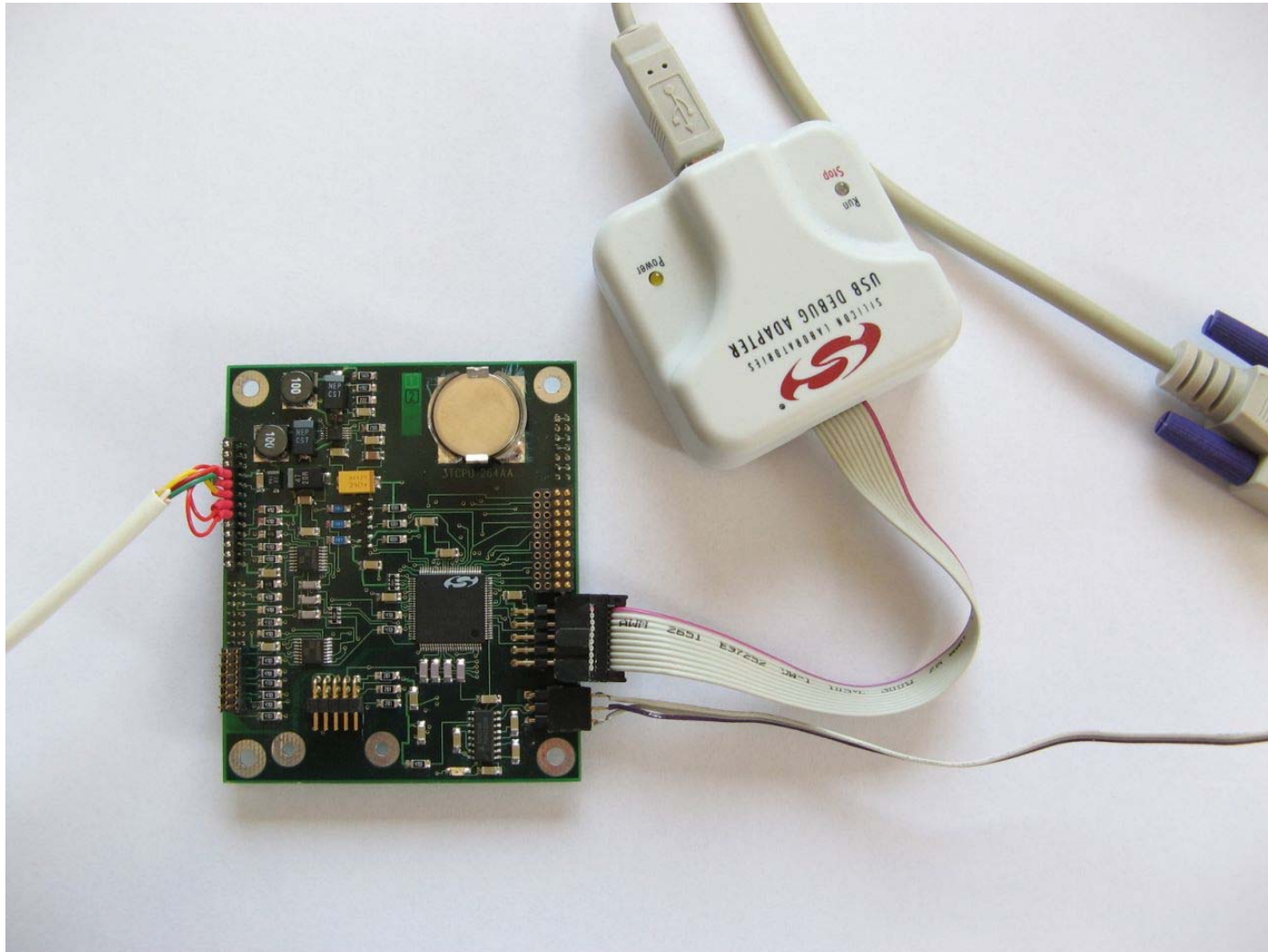
Telescope under vibration tests



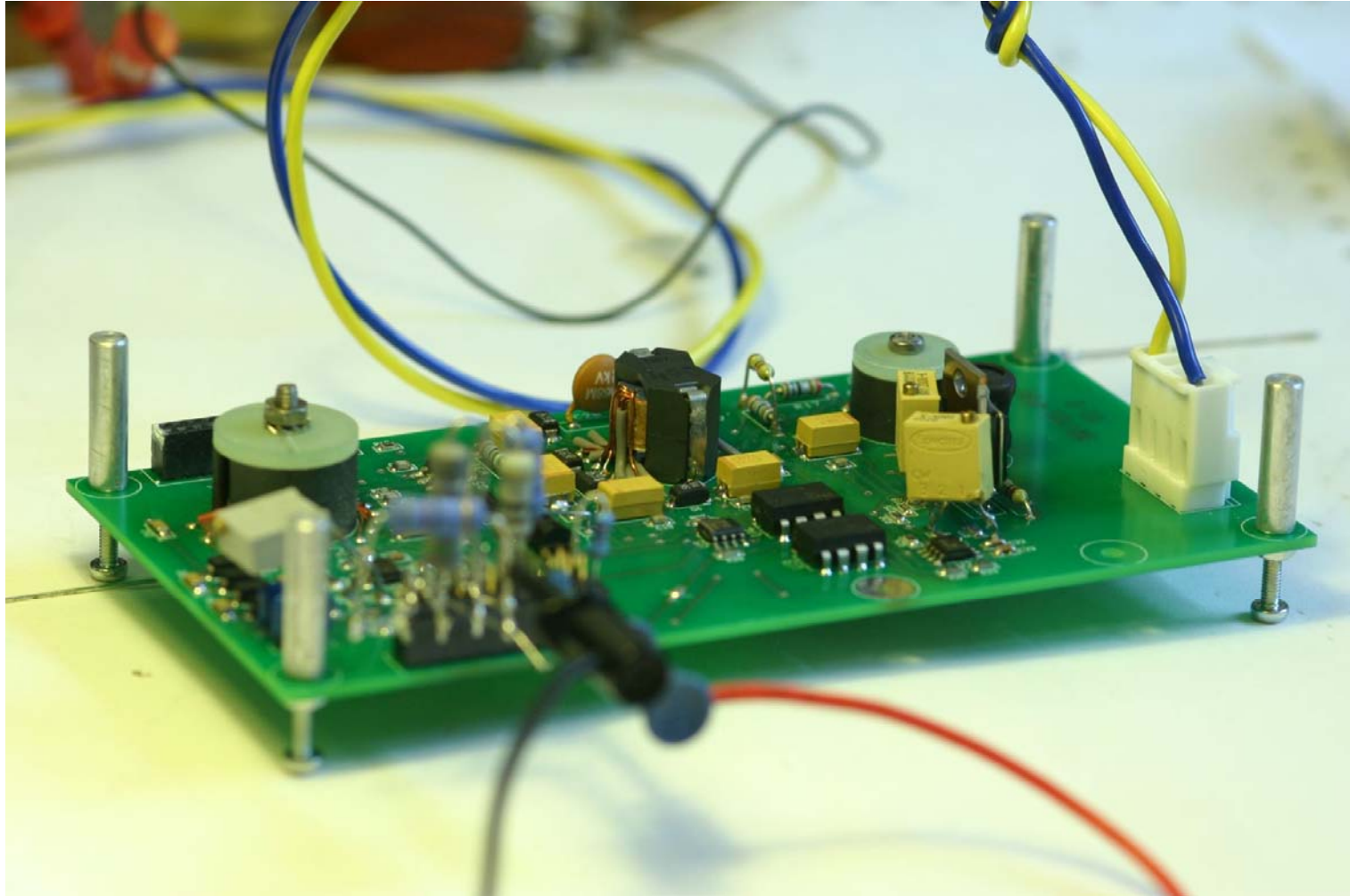
Testing of the analog electronics



Microprocessor card of the detector unit



Power supply card of the detector unit

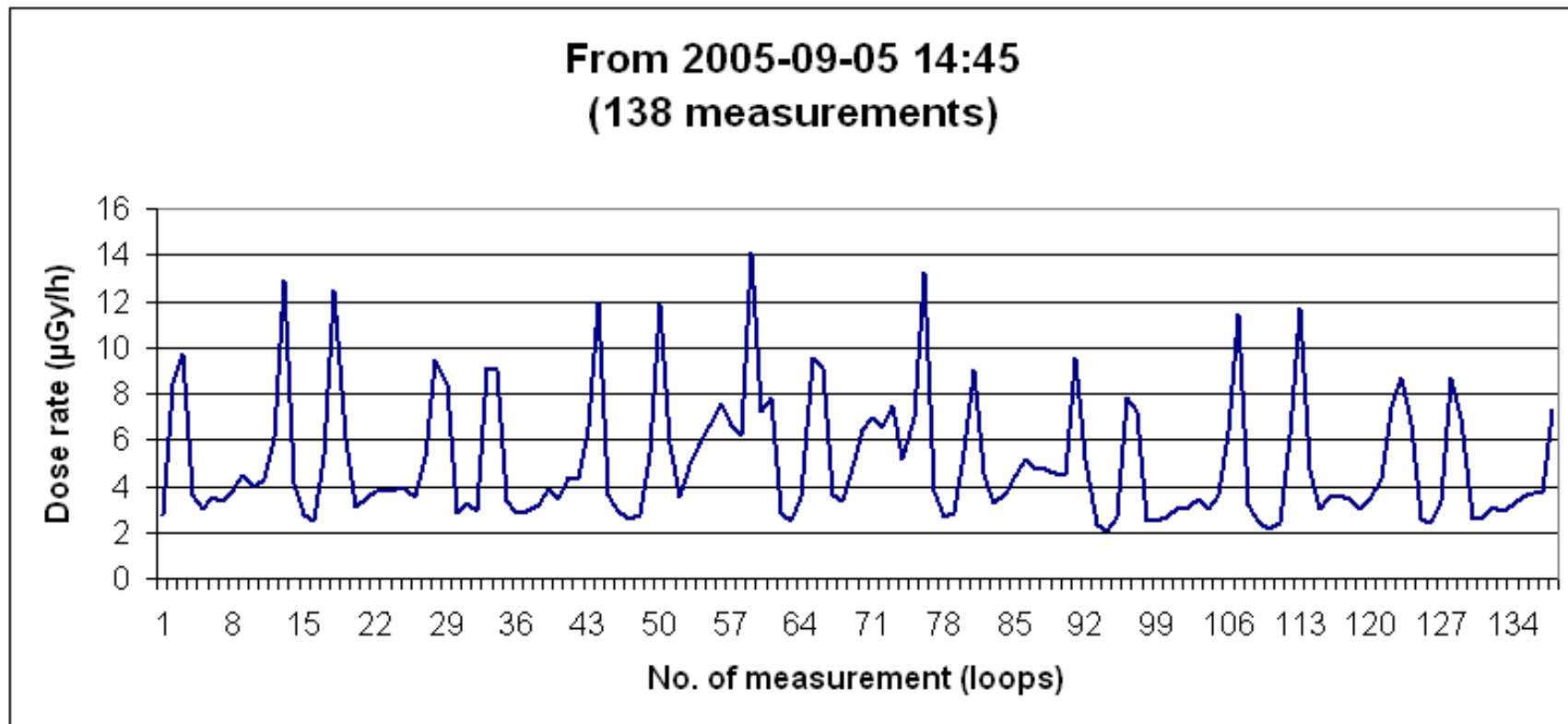


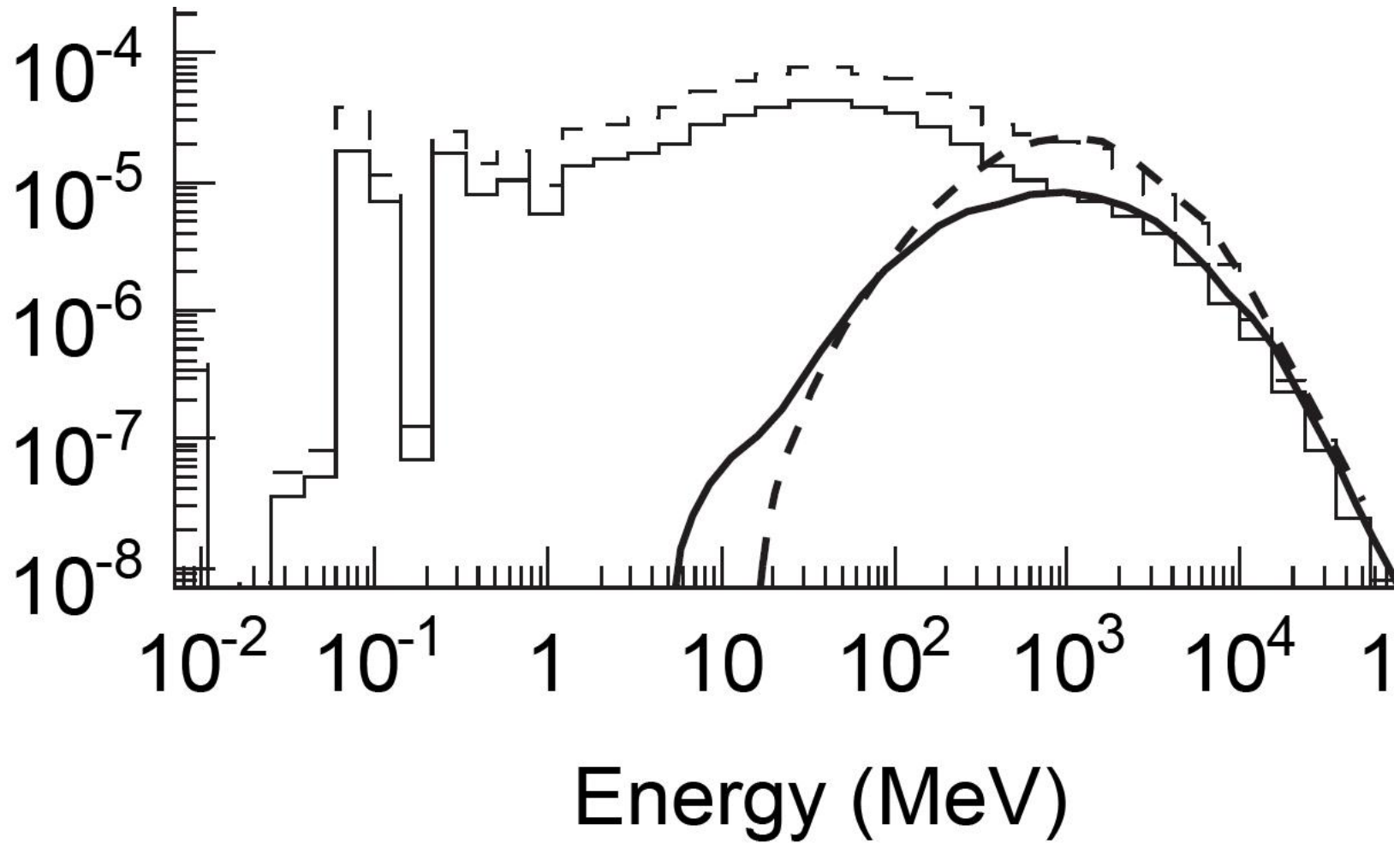
Central unit

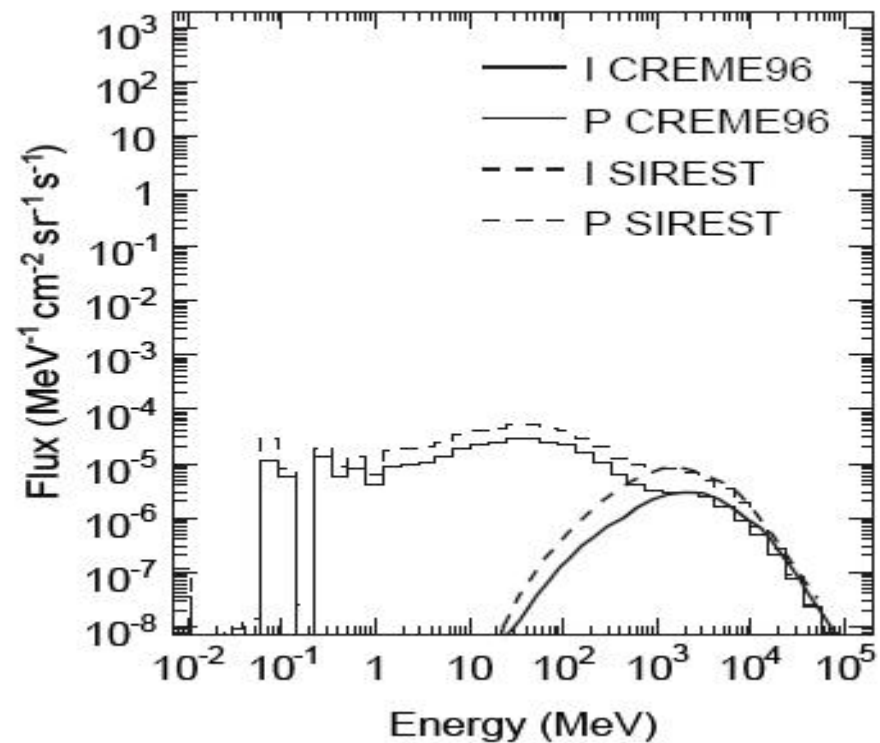
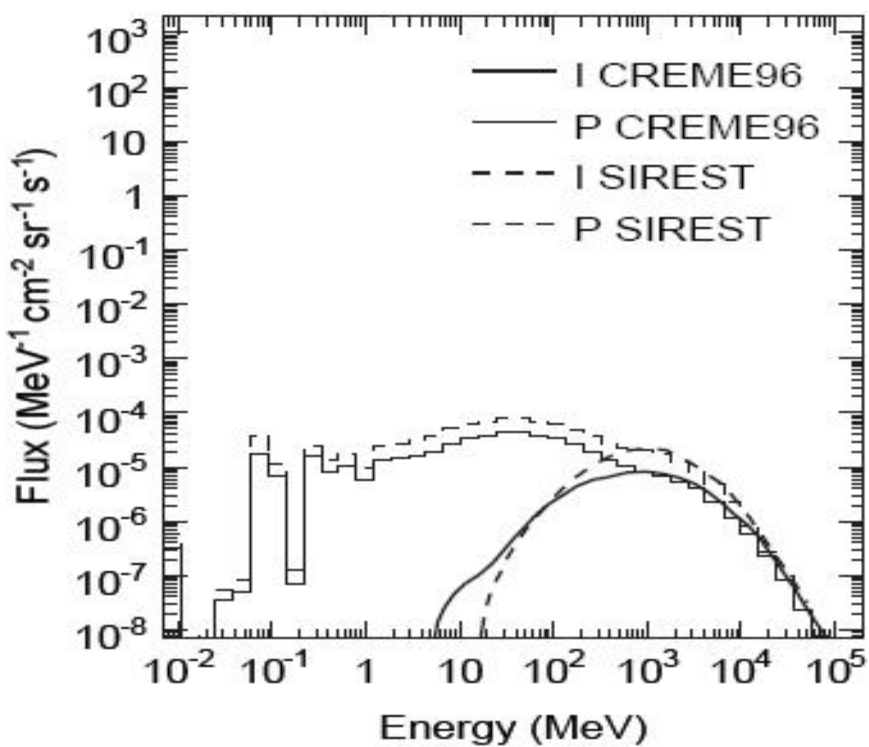


Thank you for your attention

Solar activity (Exp. 11.)







(a) Protons entering Columbus (solar minimum).

