DOSE MEASUREMENTS ON BOARD THE ISS WITH THE PILLE TL SYSTEM

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Outline

The Pille TLD System

Position of the dosimeters

Results of Exp. 17-18. (2008. 05. 01. – 2009. 03. 28.)

Measurements by Charles Simonyi (2009. 03. 25. – 2009. 04. 03.)

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 (s<10%):	3 μGy ÷ 10 Gy ($CaSO_4$:Dy)
TLD Efficiency (ε=1±10%):	$LET_\infty(H_2O)$ < 10 keV/μ_m
Accuracy (above 10 μGy):	δ < 5%

High sensitivity

Even hourly read-outs are possible

On board of every space station since Salyut-6

More than 20 000 comparable read-outs from different space stations

Position of the dosimeters

A0301: on the right handrail of phantom-torso Matroshka, attached by Velcro

A0302: Starboard crew quarters, left of window

A0303: on the left handrail of phantom-torso Matroshka, attached by Velcro

A0304: Port crew quarters, left side of window

A0305, A0306: Ceiling, on the system radiometer R-16

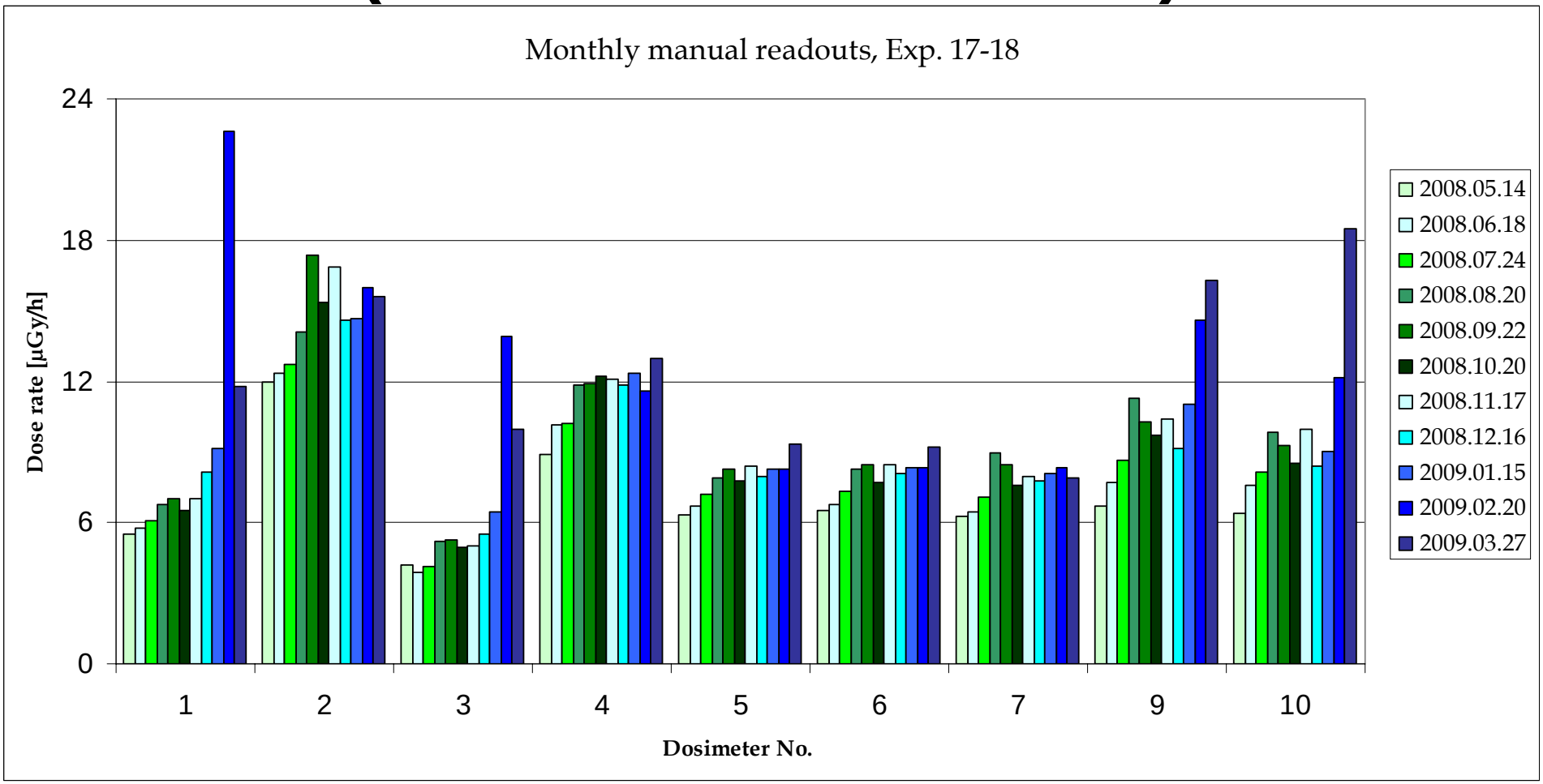
A0307: Right board, beside of the cabin, on ceiling of the lavatory
2008. 07. 24: near TEPC detector (sensor)
Dedicated for EVA reference measurement inside ISS

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
2008. 07. 24. – 08. 20: ATV, in FE-1 sleep station
Dedicated for EVA personal measurements

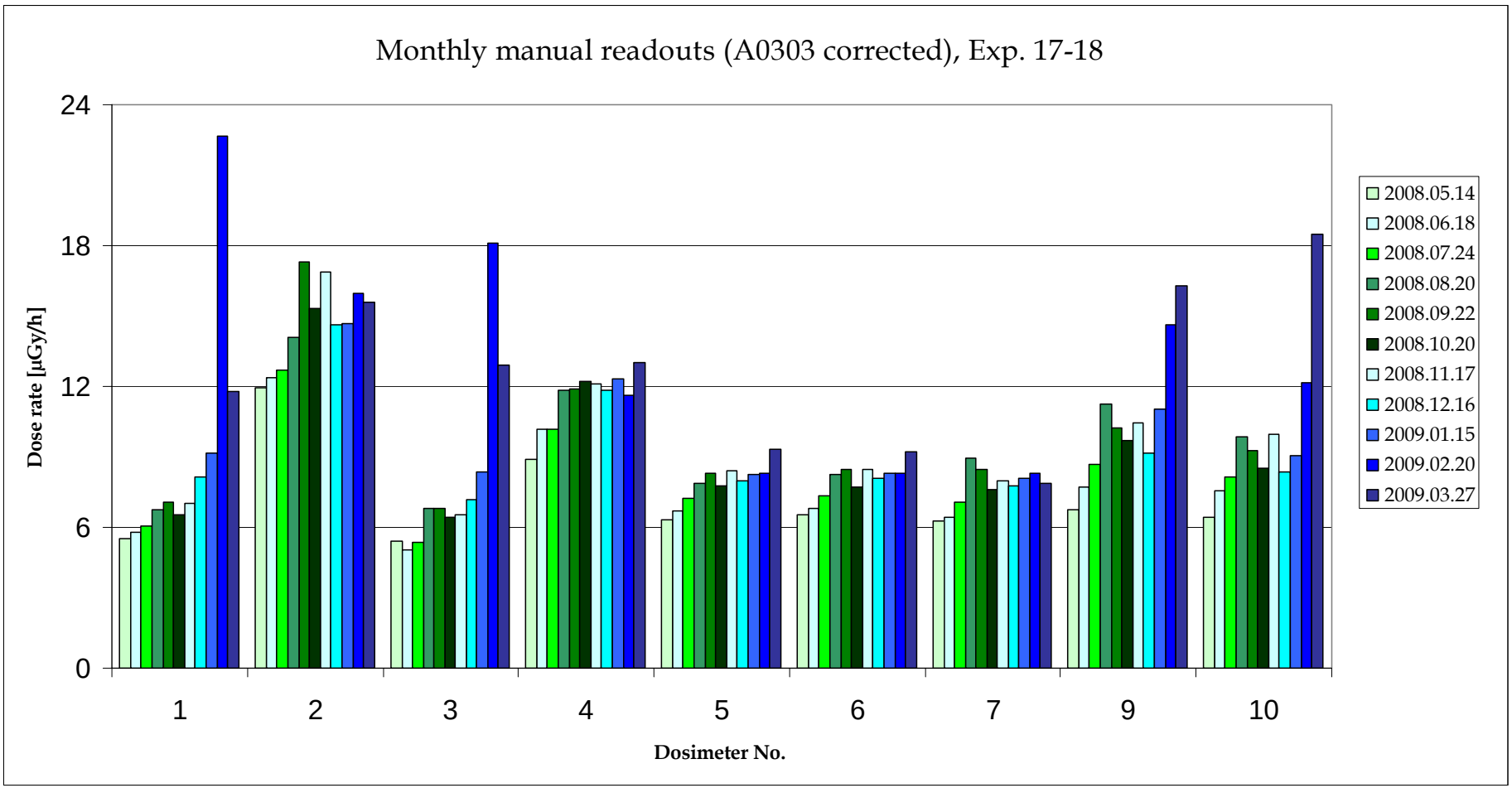
A0311, A0312, A0313, A0314: 4 recently calibrated dosimeters launched in March 2009

Monthly manual readouts, Exp. 17-18. (2008. 05. 01. – 2009. 03. 28.)



Monthly manual readouts, Exp. 17-18. (2008. 05. 01. – 2009. 03. 28.)

A0303 corrected by 30%



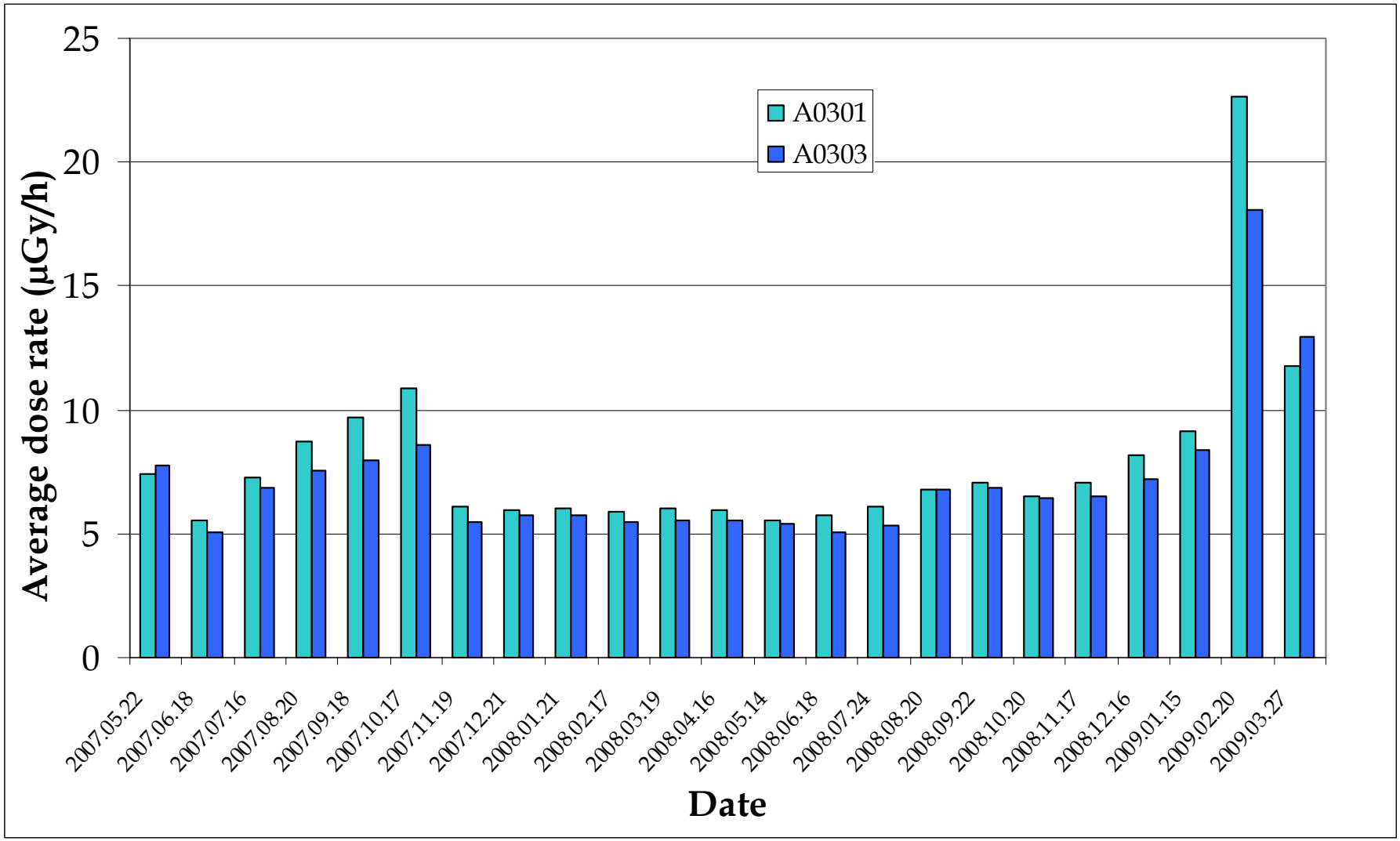
Matroshka measurements

A0301: on the right handrail of phantom-torso Matroshka, attached by Velcro

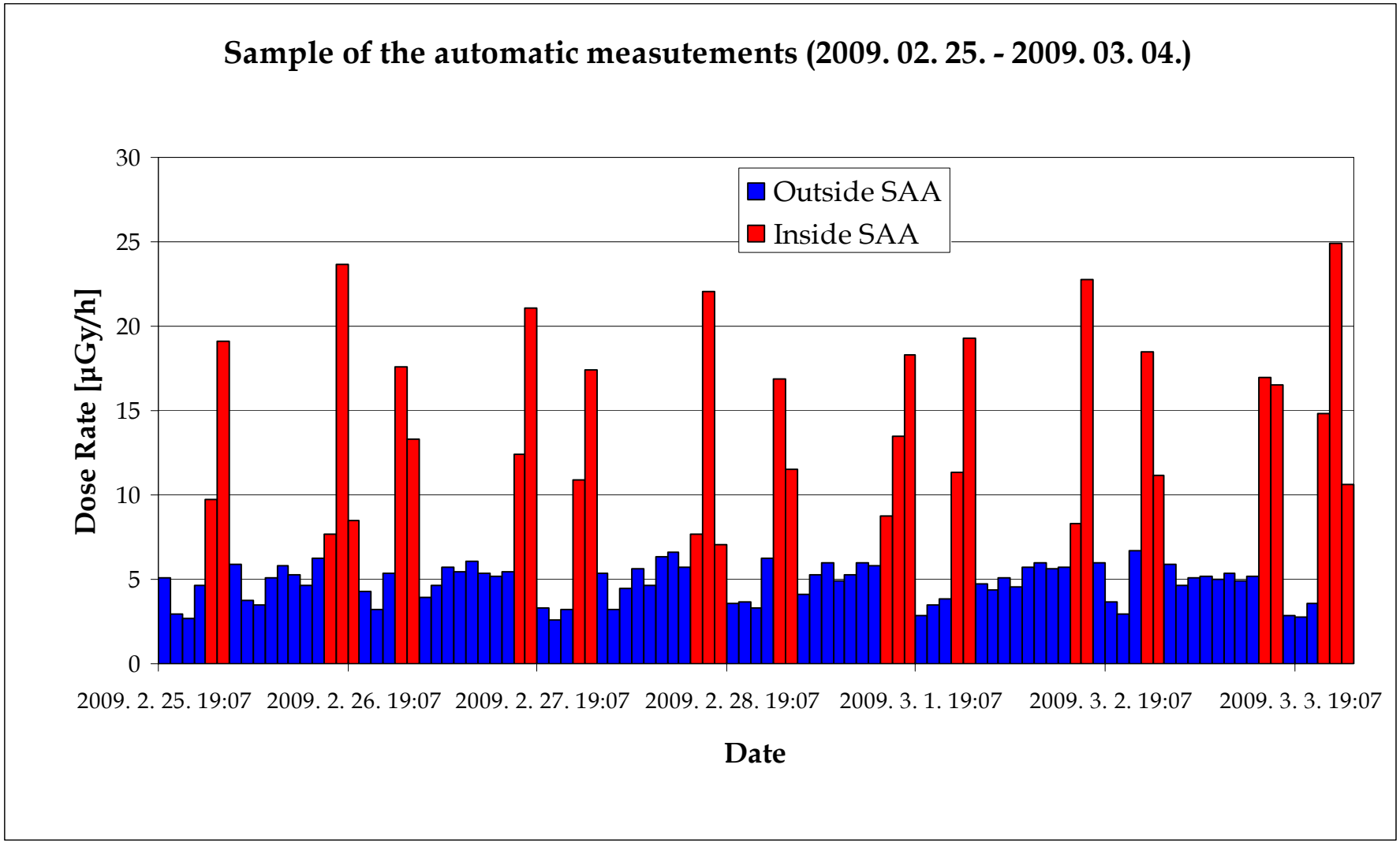
A0303: on the left handrail of phantom-torso Matroshka, attached by Velcro

23 monthly readouts between 2007. 05. 22. and 2009. 03. 27.

Matroshka measurements



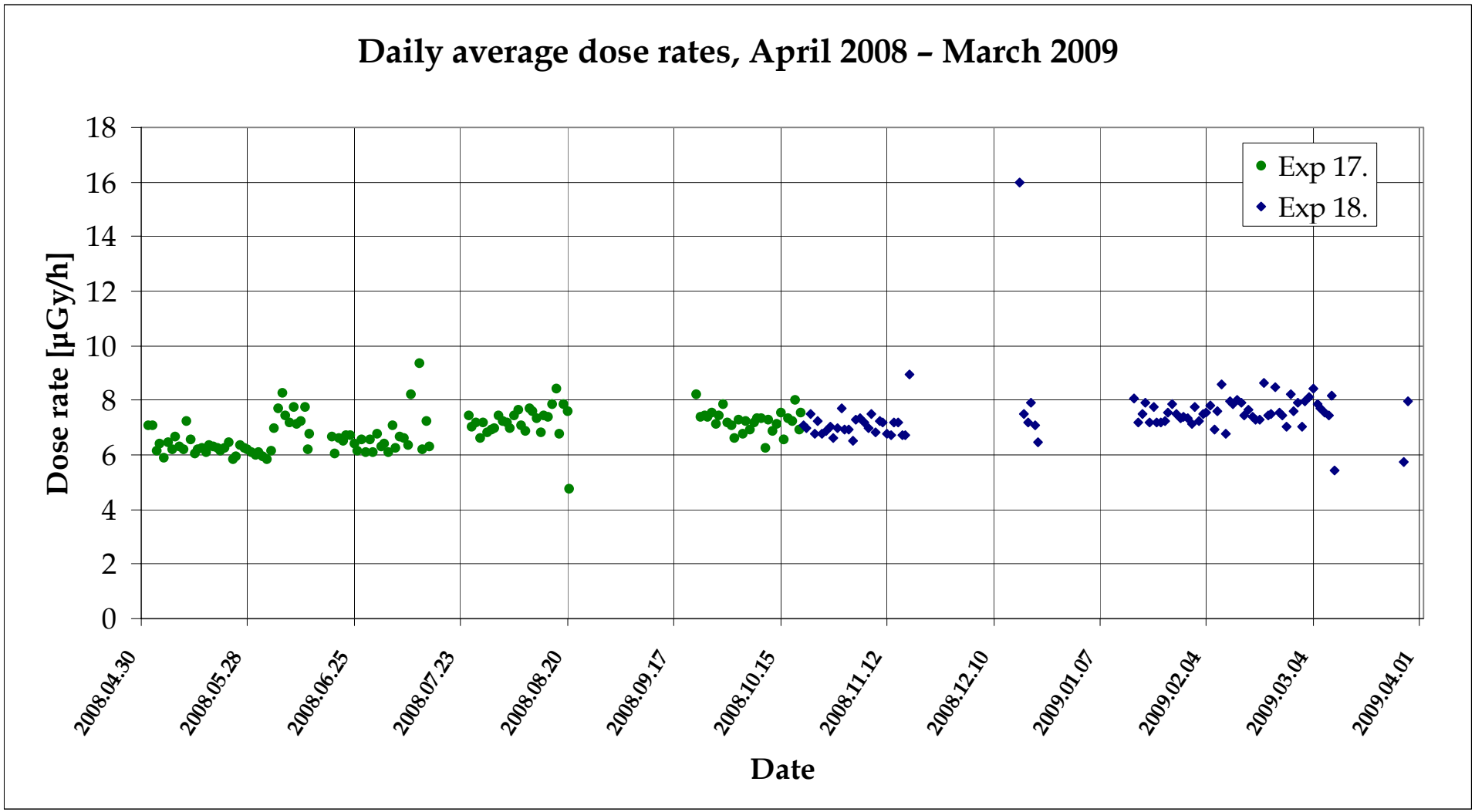
Sample from the automatic measurements, Exp. 17-18.



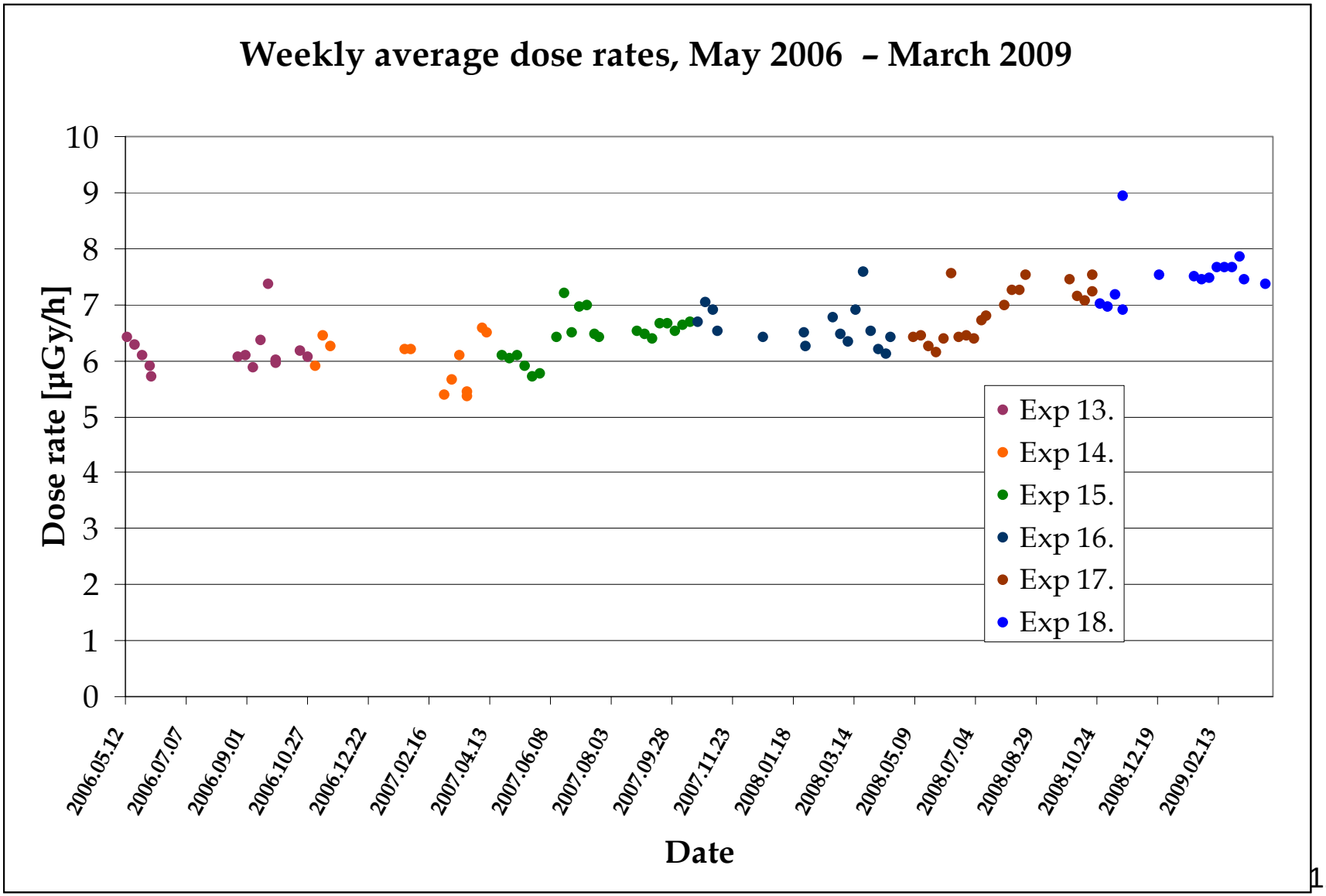
One third of the dose of the astronauts are caused by the South Atlantic Anomaly.

No solar acivity was detected by Pille during Exp. 17 and 18.

Daily average dose rates, Exp. 17-18.



Weekly average dose rates, Exp. 13-18.



EVA measurements

EXP. 17

2 EVAs were measured

EVA date	Extra dose [µGy]	Extra dose rate [µGy /h]	Extra dose [µGy]	Extra dose rate [µGy /h]
2008. 07. 10.	424	67.3	450	71.4
2008. 07. 15.	433	73.4	436	73.9

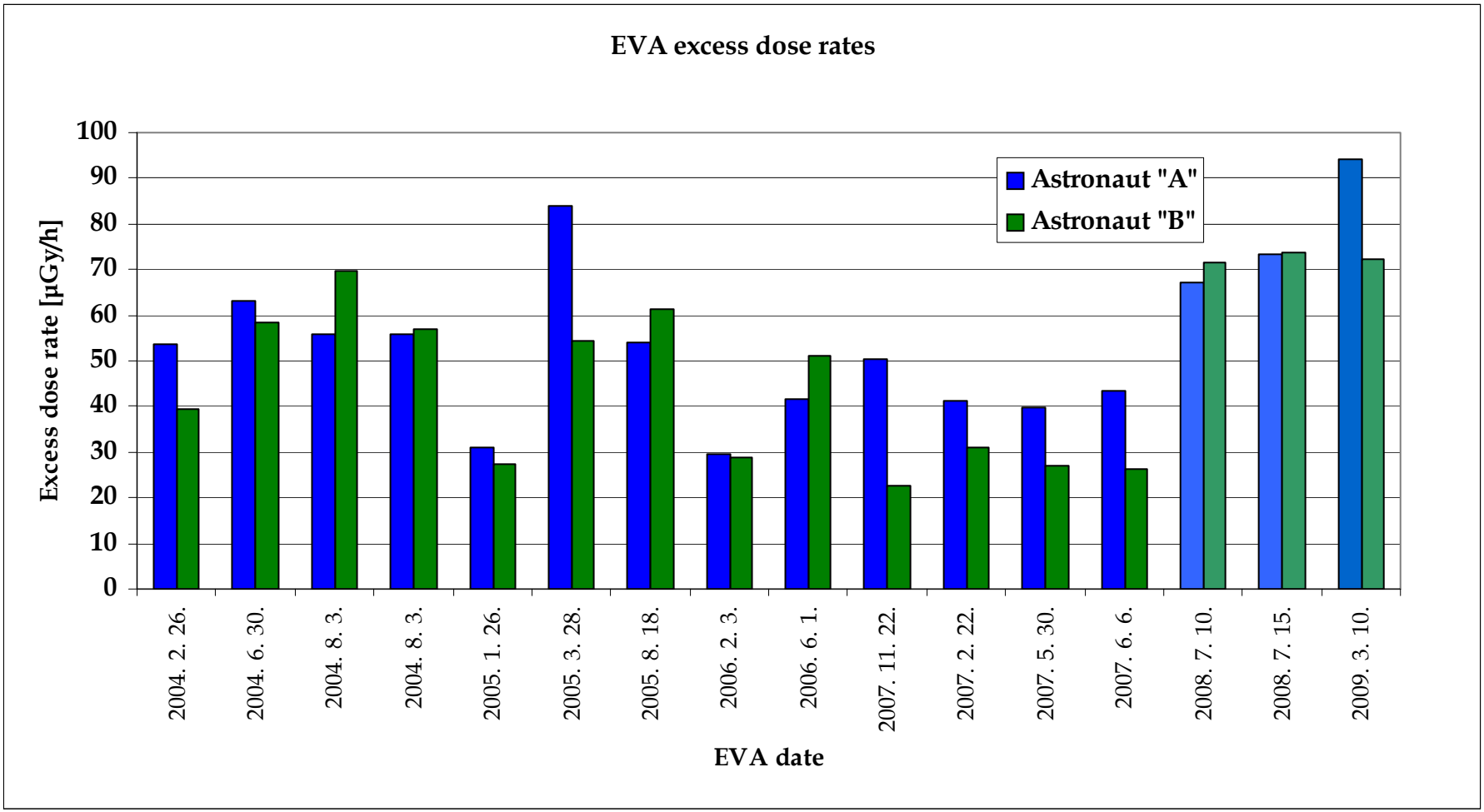
EXP. 18

2 EVAs were measured, BUT

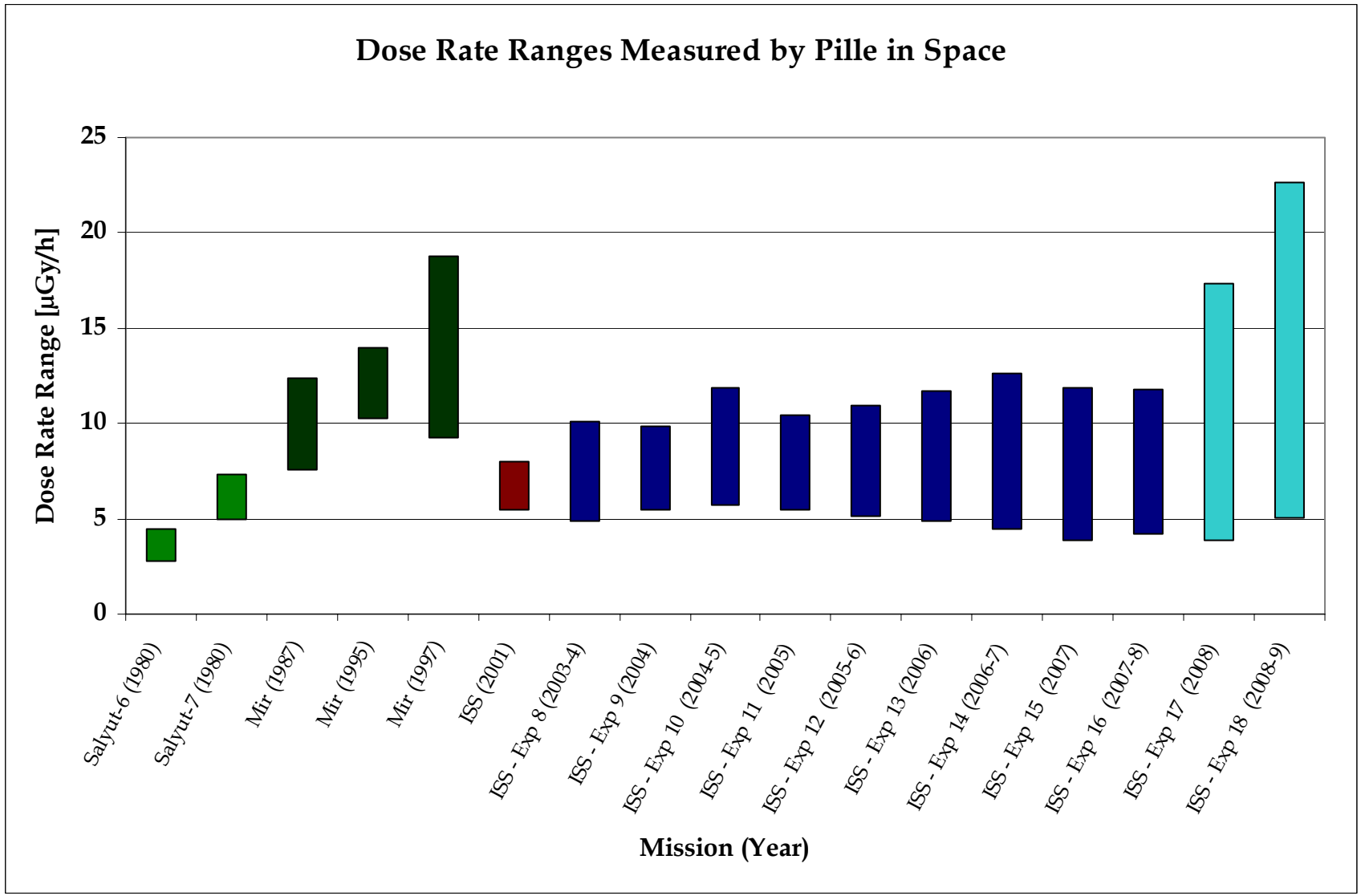
- In December no reference dosimeter was used
- In March dosimeter No. A0305 and A0306 were used as EVA dosimeters

EVA date	Extra dose [µGy]	Extra dose rate [µGy /h]	Extra dose [µGy]	Extra dose rate [µGy /h]
2009. 03. 10.	454	438	94.2	72.2

EVA excess dose rates



Dose ranges measured by Pille



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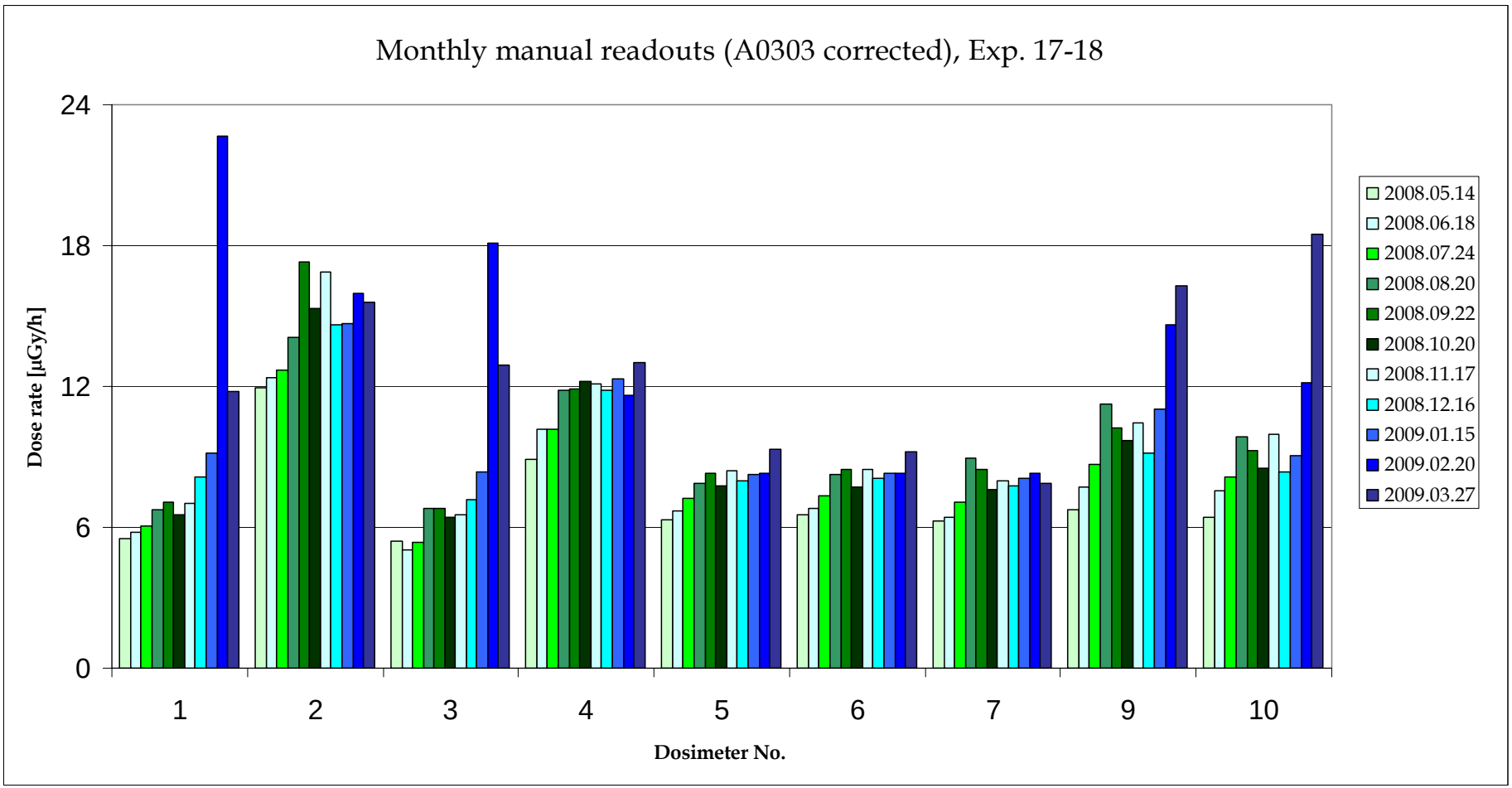
A0303 corrected by 30%



Measurements by Charles Simonyi

Aims

- to check the sensibility of the Pille reader
- to check the sensibility of the Pille dosimeters
- to send additional 4 dosimeters to the ISS
- to measure Simonyi's personal dose

Measurements by Charles Simonyi

Launch dose

- Personal dosimeter No. A0311
- Time of 1st readout: 2009.03.25. 20:52
- Time of launch: 2009.03.26. 11:49
- Time of docking: 2009.03.28. 13:05
- Time of 2nd readout: 2009.03.28. 21:28
- Dose measured: **596 μGy**
- Estimated dose from launch to docking: **532 μGy**
- Estimated average dose rate from launch to docking: **10.8 μGy/h**

Launch dose rate is 10% higher than Simonyi's personal dose rate on ISS.

Measurements by Charles Simonyi

Reader sensitivity

Dosimeters A0312, A0313 and A0314 were irradiated at AEKI on 2009.01.28. by 10 mGy γ-dose of ^{137}Cs source.

Dosimeters were read out after docking

Expected dose rate:

- ground irradiation and 2% fading:	9.8 mGy
- ground dose:	0.125 mGy
- launch dose:	0.596 mGy
SUM (expected value):	**10.52 mGy**

Measured dose rates

- A0312:	10.5 mGy (-0.2%)
- A0313:	9.95 mGy (-5.4%)
- A0314:	10.5 mGy (-0.2%)
Average:	**10.32 mGy (-1.9%)**

The reader sensitivity is correct.

The new dosimeters have survived the launch in excellent shape.

Measurements by Charles Simonyi

Dosimeter sensitivity

New and old dosimeters were cross-calibrated (panel 321).

Exposure time: 62.8 h and 75.2 h

Measurements by Charles Simonyi

Dosimeter sensitivity

New and old dosimeters were cross-calibrated (panel 321).

Exposure time: 62.8 h and 75.2 h

1st set of calibration			2nd set of calibration		
Dosimeter No.	Dose (μGy)	Relative sensitivity (1)	Dosimeter No.	Dose (μGy)	Relative sensitivity (2)
A0303	345	0.68	A0301	494	0.90
A0305	473	0.93	A0302	558	1.02
A0306	481	0.94	A0304	526	0.96
A0308	351	0.69	A0307	565	1.03
A0311	487	0.95	A0309	562	1.03
A0312	507	0.99	A0310	521	0.95
A0313	515	1.01	A0312	536	0.98
A0314	532	1.04	A0314	559	1.02

The sensitivities of all dosimeters except A0303 and A0308 are in the range of ±10% of the sensitivity of the new, recently calibrated dosimeters

The sensitivity of dosimeters A0303 and A0308 are 30% lower.

Measurements by Charles Simonyi

Shielding effect of the reader

Dosimeter A0304 and A0305 were irradiated in the reader

Dosimeter A0309 and A0311 were irradiated near the reader

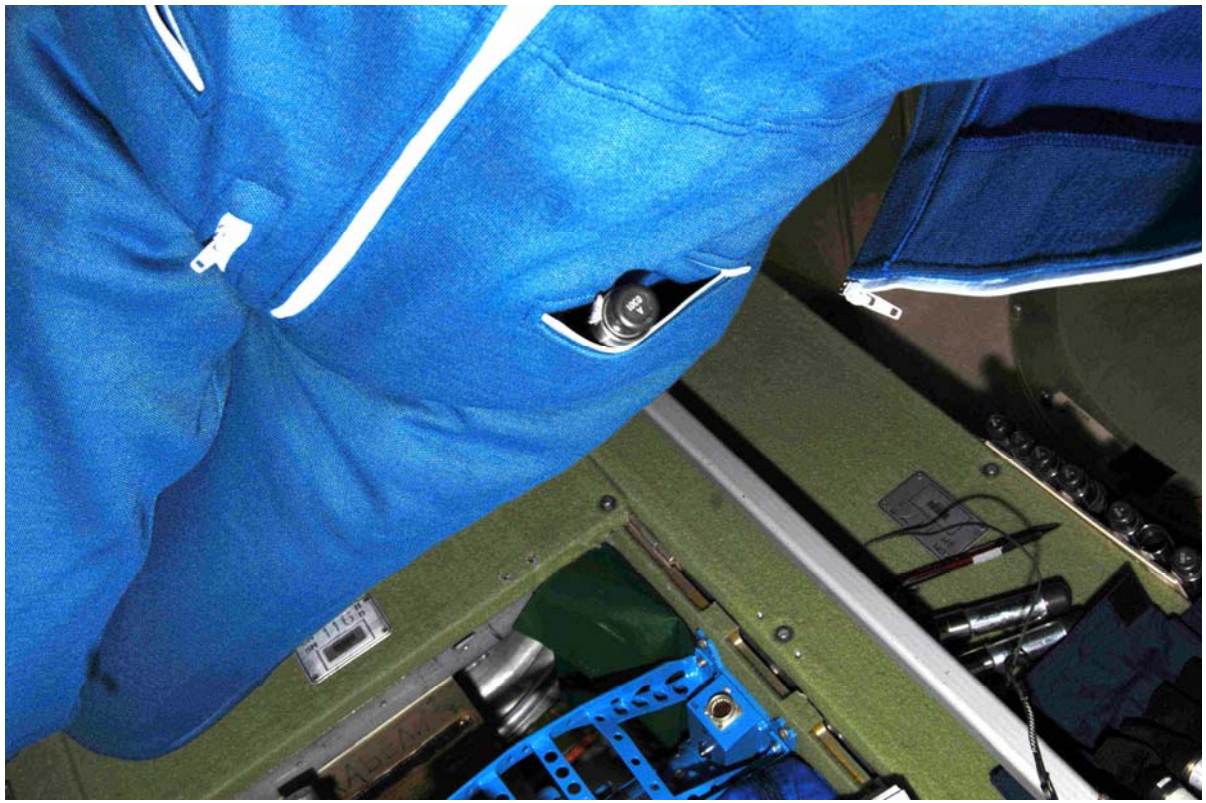
Exposure time 46.6 h (A0304 and A0309) and 75.2 h (A0305 and A0311)

The shielding effect of the Pille reader is ~10%.

Measurements by Charles Simonyi

Personal dose rate of Simonyi

Dosimeter A0311 was located in the lower pocket of Simonyi's suit



Measurements by Charles Simonyi

Personal dose rate of Simonyi

Dosimeter A0311 was located in the lower pocket of Simonyi's suit

Dose rate of his sleeping place was also measured (A0302, A0313)

Measurements by Charles Simonyi

Personal dose rate of Simonyi

Dosimeter A0311 was located in the lower pocket of Simonyi's suit

Dose rate of his sleeping place was also measured (A0302, A0313)

The mean personal dose rate of Charles Simonyi on the ISS was 9.6 μGy/h – a little bit higher than during his previous flight in 2007 (8.3 μGy/h)

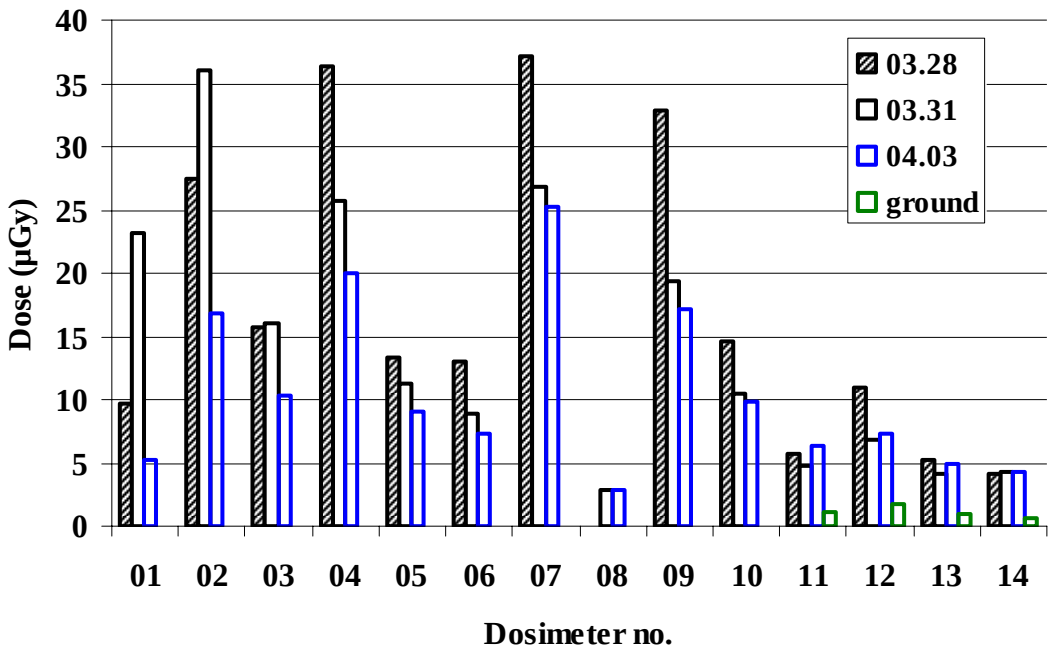
The dose rate at Simonyi's sleeping place on the ISS was 15 μGy/h, ~150% of his personal dose rate and ~190% of the dose rate at panel 321

Measurements by Charles Simonyi

Background of dosimerers

All dosimeters were read out on 03.28., 03.31. and 04.03., each time twice

The results of the second readouts:



The background values of the dosimeters are generally less than 50 µGy so at the regular monthly readouts second readouts for corrections are not necessary.

Summary

Higher dose rates were measured (A0309, A0310, Matrioshka)

- exact position of the dosimeters needed

4 new, recently calibrated dosimeters carried to the ISS

The sensitivity of the Pille reader is correct

The sensitivity of the Pille dosimeters were measured.

- the sensitivities of dosimeters A0303 and A0308 are ~30% lower.

The background of the Pille dosimeters are still negligible at the monthly readouts.

The personal dose of Charles Simonyi was measured

Launch dose was measured

The shielding effect of the Pille reader was measured

(2 oldtimers)

Thank you for your attention