



TL dose measurements on board the Russian segment of the ISS during Expedition-7 and -8

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The '*Pille*' space qualified TLD system

- small, portable**
- space-qualified**
- suitable for reading out the TLDs on board, so**
- a solution for EVA dosimetry as well**

used on board the

- Salyut-6 and -7 space stations by Hungarian and Soviet cosmonauts**
 - Mir space station by ESA and NASA astronauts**
 - ISS by NASA astronauts and Russian cosmonauts**
- ↳ service instrument**

Main Specifications of the '*Pille*' TLD System

Dosimeters

Type: bulb
Material: $\text{CaSO}_4:\text{Dy}$
Dimensions: f 20 mm * 60 mm
Mass: 70 g (with carrying case)



Reader

Measuring range ($s < 10\%$):	3 mGy , 10 Gy (CaSO₄:Dy)
TLD Efficiency $e = 1 \pm 10\%$	LET_¥H₂O < 10 keV/mm
Read-out precision:	3 digits + exp.
Accuracy (above 10 mGy):	d < 5%
Measuring modes:	manual / automatic read-out
Display:	8-digit alphanum. LED
Storage of information:	PCMCIA mem. card (> 4000 data sets)
Computer connection:	RS-232, CAN
Dimensions:	70 mm (H)* 190 mm (W) * 120 mm (D)
Mass:	1,400 g
Power consumption:	0.1 / 1 / 7 W (standby/ready/readout)



September 8-10, 2004

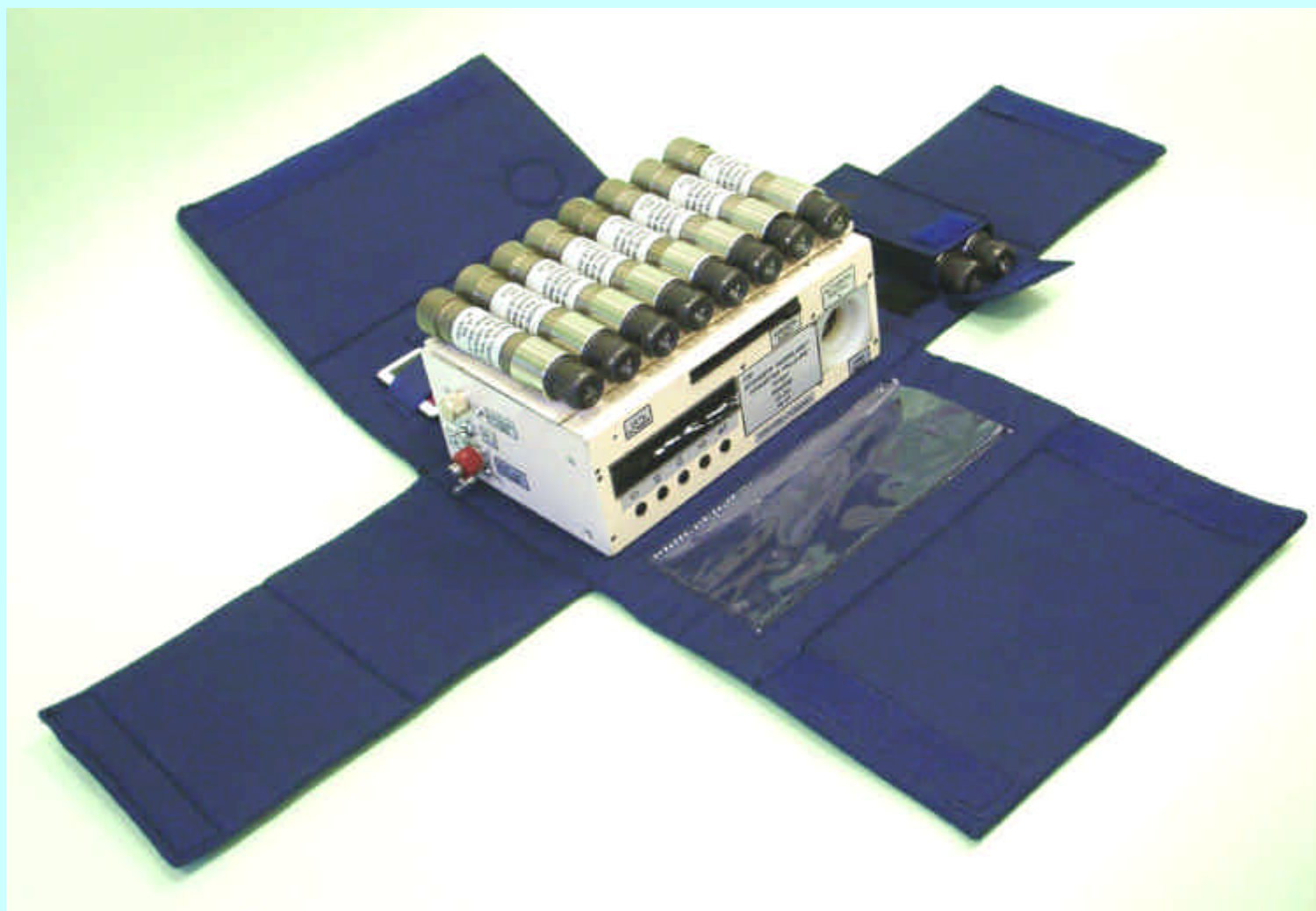
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***‘Pille-MKS’* on the Russian Service Module (Zvezda) of the ISS**

- **Consisting of**
 - 10 Dosimeters (Nº A0301-A0310)
 - Reader
- **Part of the service system**
- **Applied for**
 - routine and EVA individual dosimetry and
 - onboard experiments
- **Developed and manufactured by KFKI AEKI, Hungary**
- **Maintained by IBMP, Russia**
- **Launched on Progress-12 cargo S/C on 2003.08.29**

The '*Pille-MKS*' in its transporting case



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The Russian Service Module (Zvezda) before docking to the ISS

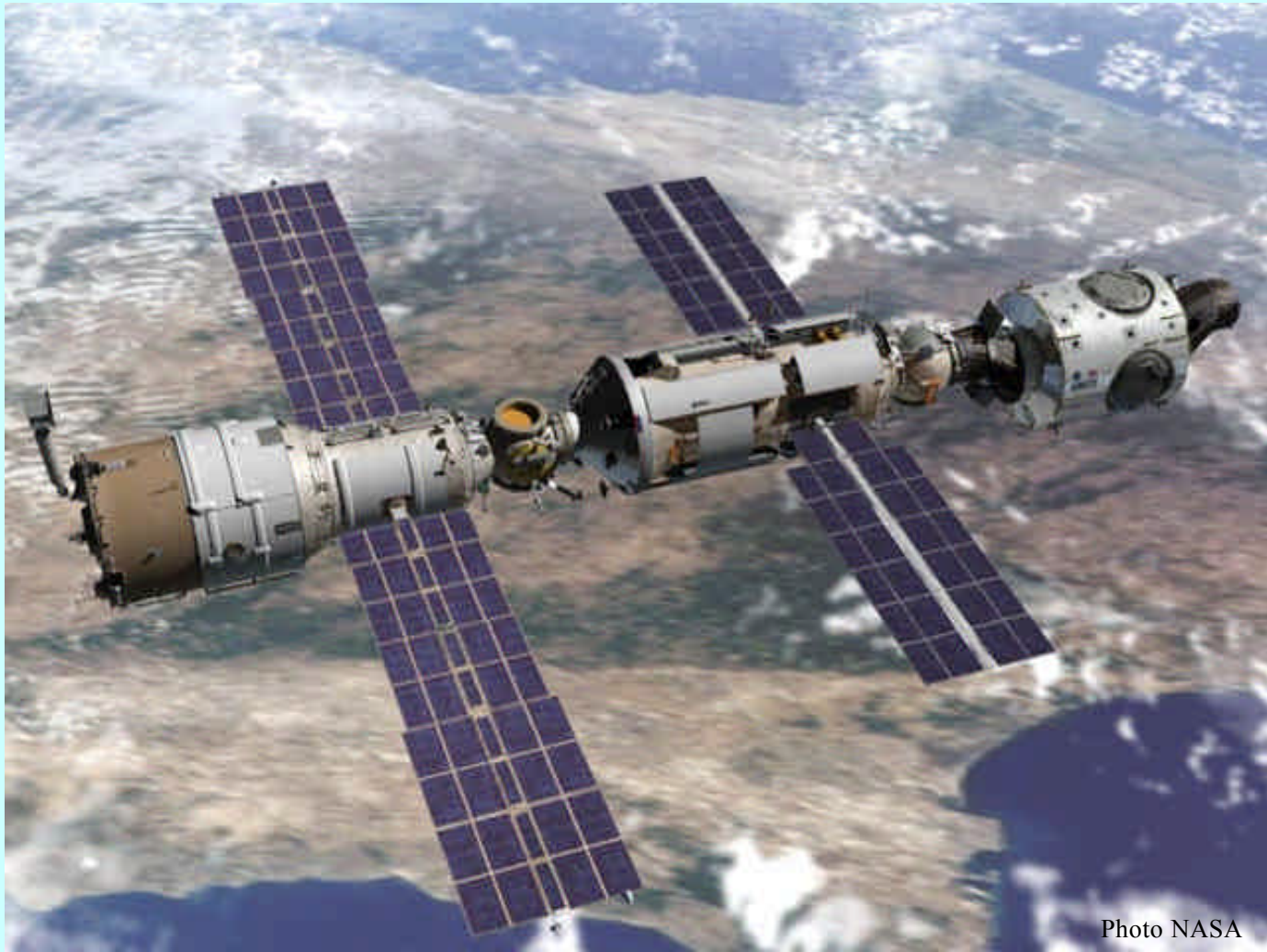


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The Russian Service Module (Zvezda) after docking to the ISS



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***Pille* TLD measurements during Expedition-7 and -8**

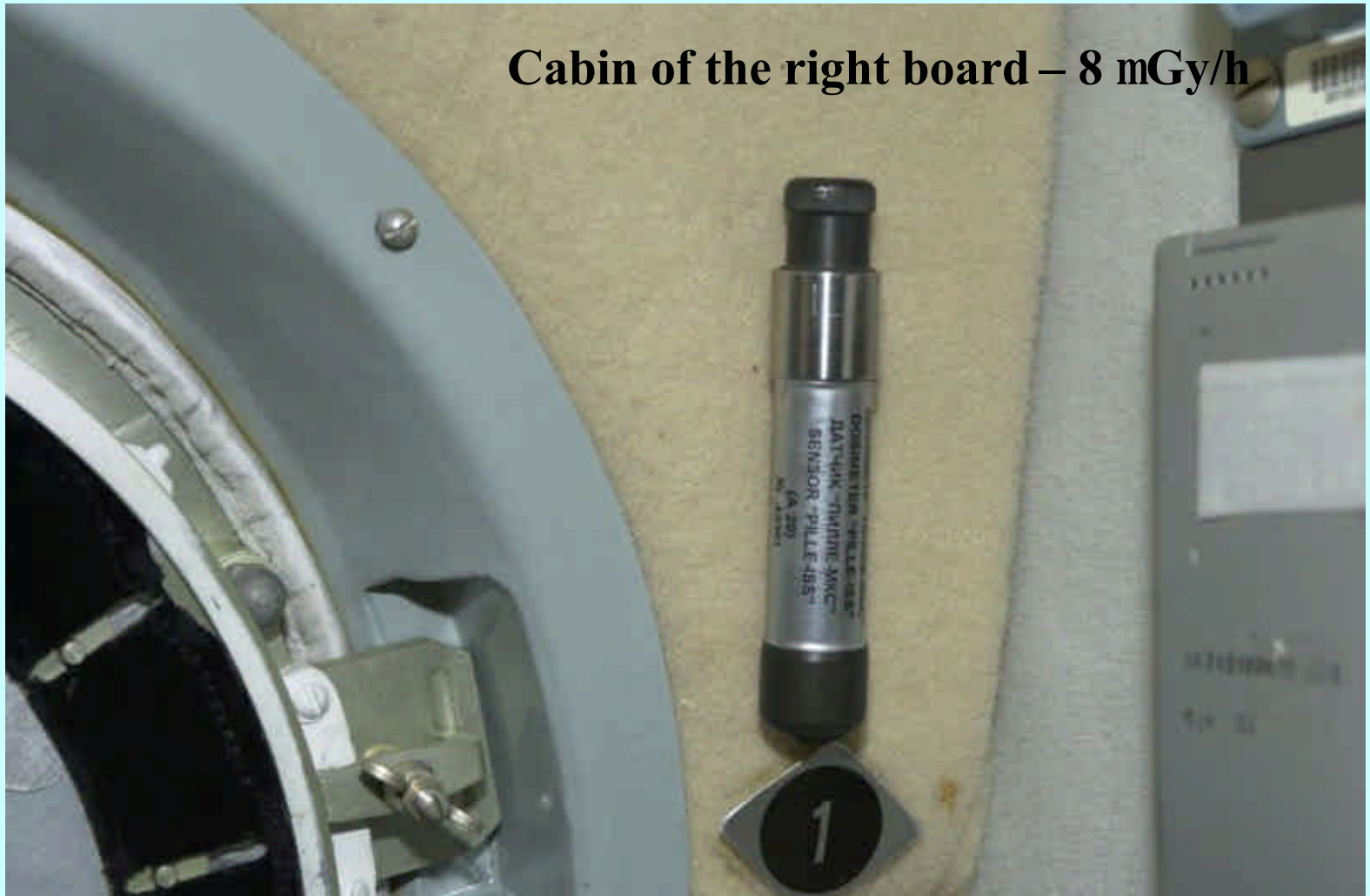
- **The *Pille-MKS* system was**
 - **installed and started up by Yuri Malenchenko**
(Exp.7, commander, on board 2003.04.28 – 2003.10.27)
 - **operated by Alexander Kaleri**
(Exp.8, board engineer, on board 2003.10.20 – 2004.04.29)
- **2822 measurements have been fulfilled until 2004.04.24**
- **Results of the measurements were**
 - **partly reported nearly realtime via radio to the Earth**
 - **completely transferred on memory card by S/C**
(Soyuz-TMA3) to the Earth

General location of the dosimeters

Dosimeter N°	Location in <i>Zvezda</i> module
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 <i>Dedicated for EVA reference measurement inside ISS</i>
A0308	Inserted in the Reader, which is fixed on the floor, right to illuminator N° 9 <i>Dedicated for automatic measurements</i>
A0309, A0310	In the transporting case of the Reader, left to illuminator N° 9 <i>Dedicated for EVA personal measurements</i>

Dosimeter № A0301

Cabin of the right board – 8 mGy/h



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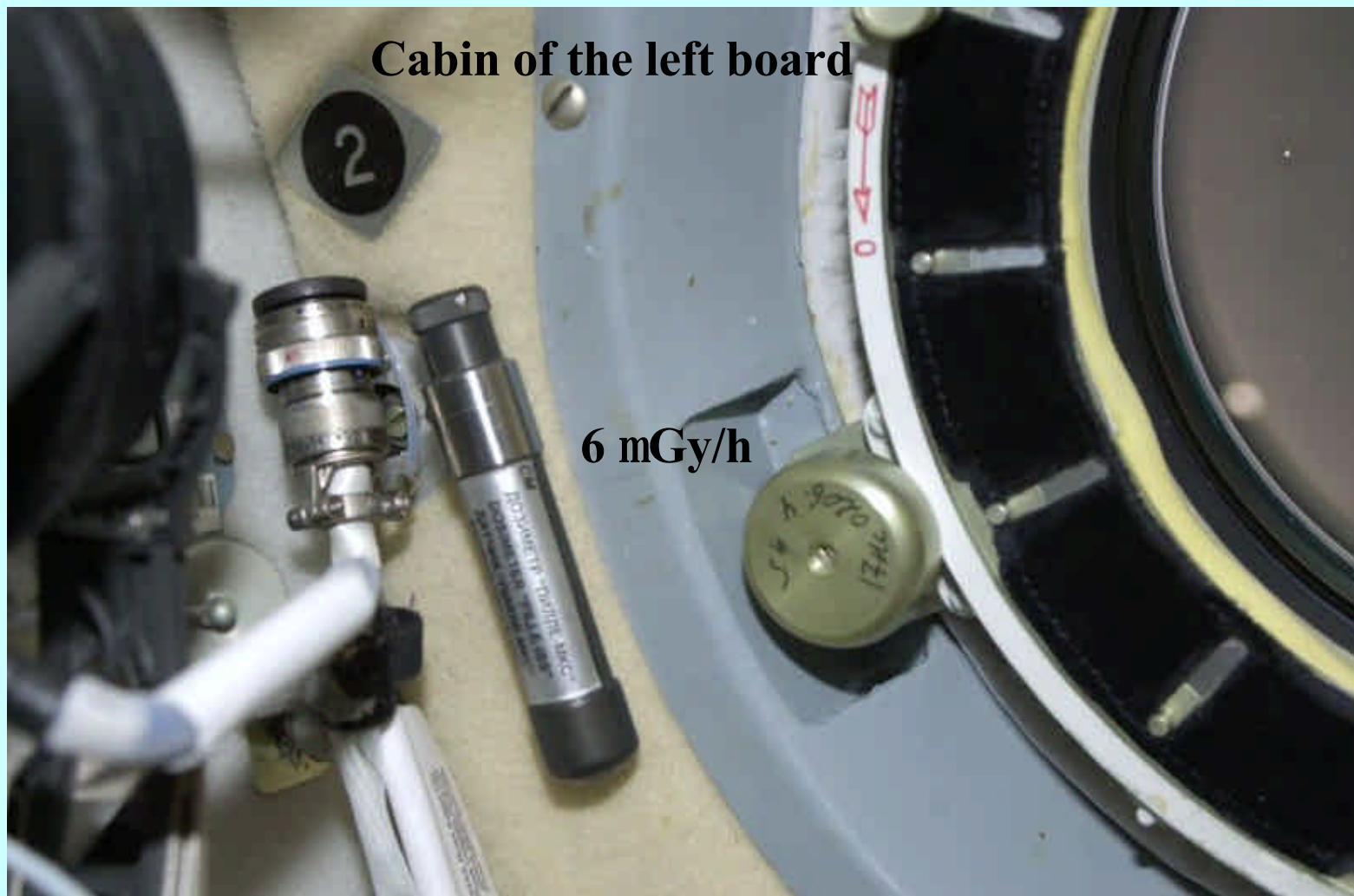
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Dosimeter № A0302



Dosimeter N^o A0303

Cabin of the left board



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Dosimeter № A0304

Cabin of the left board

9 mGy/h

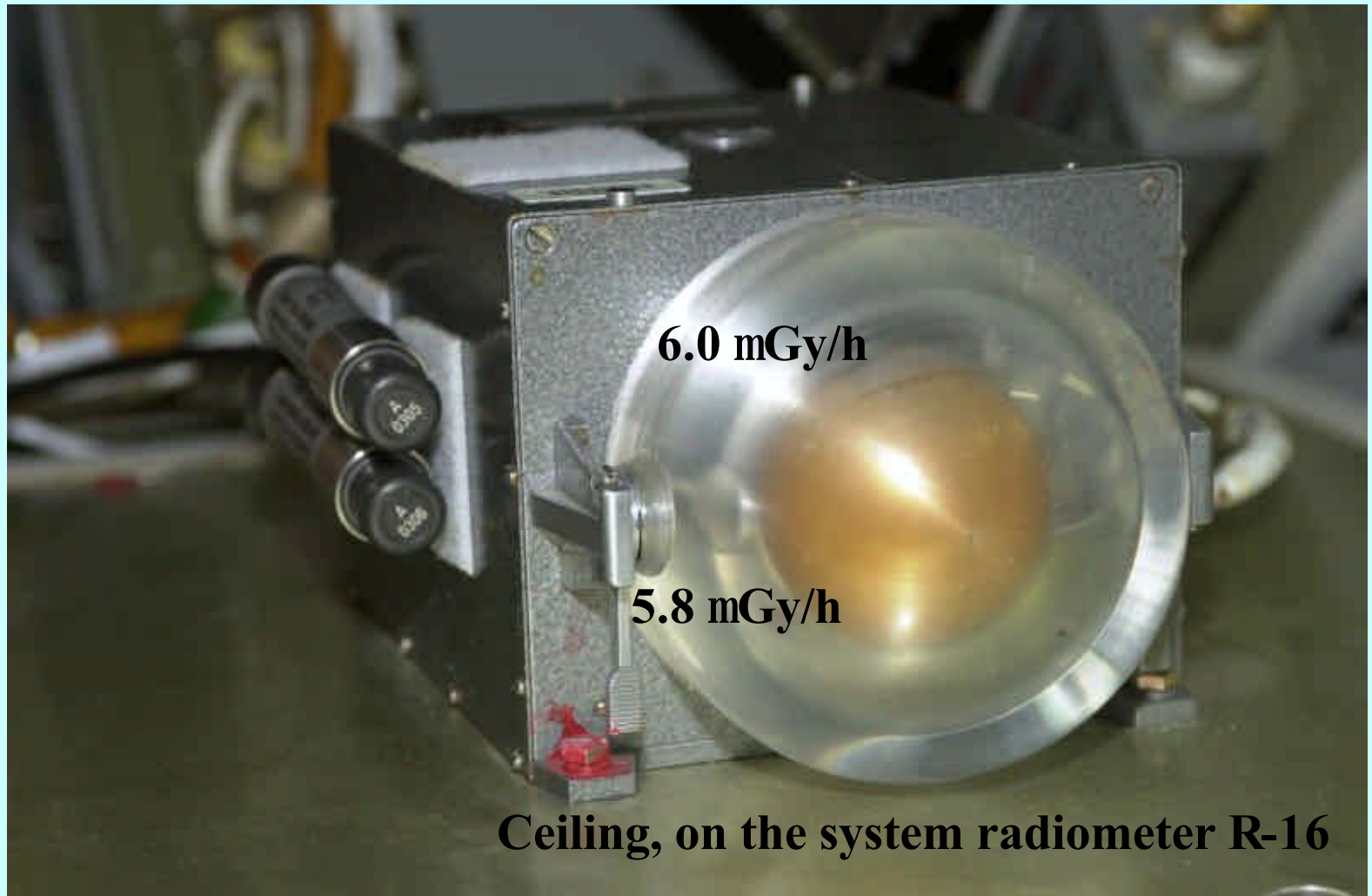


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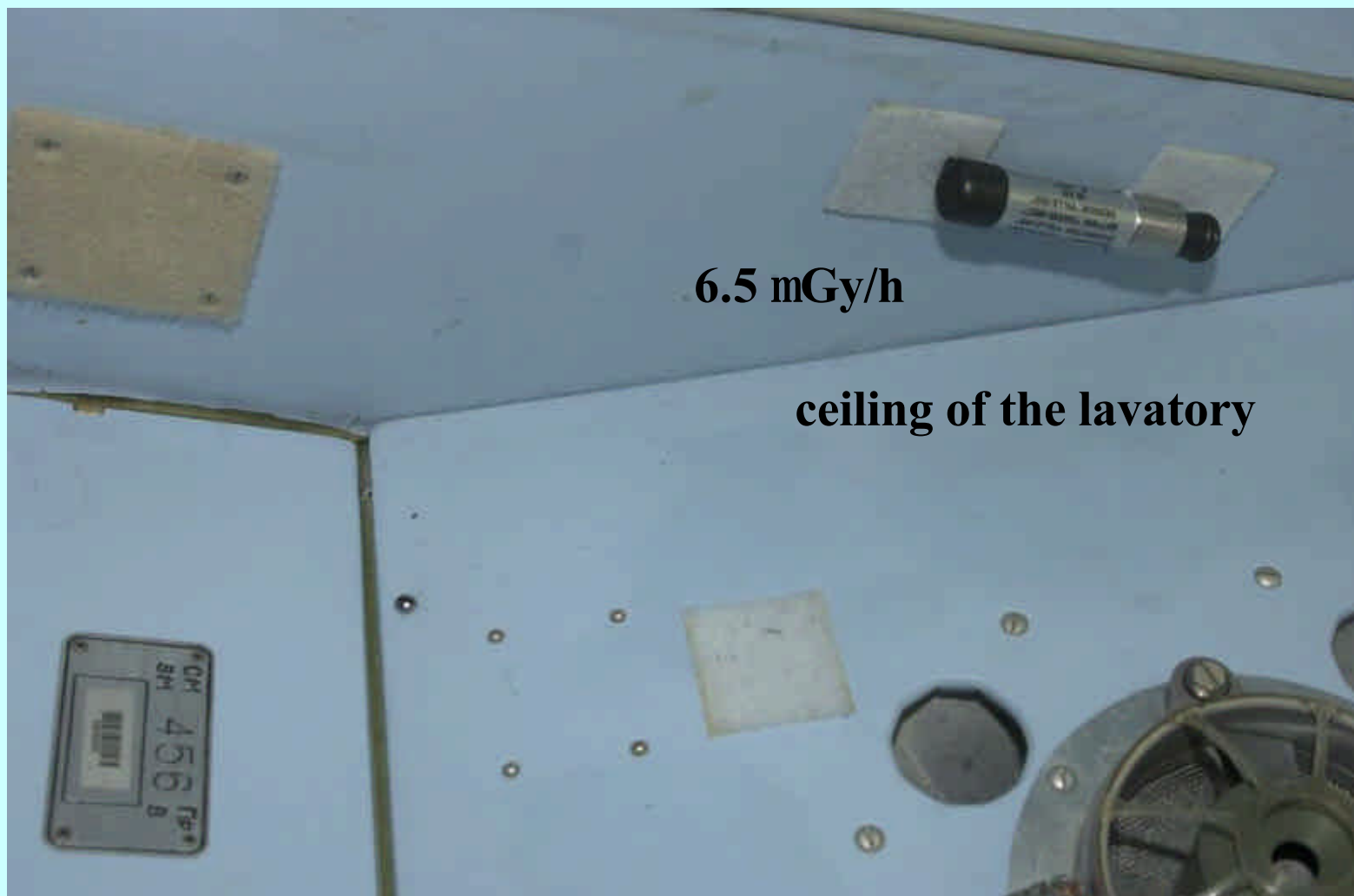
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Dosimeters N^o A0305 – A0306



Dosimeter N^o A0307



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Dosimeter N° A0308 and the Reader



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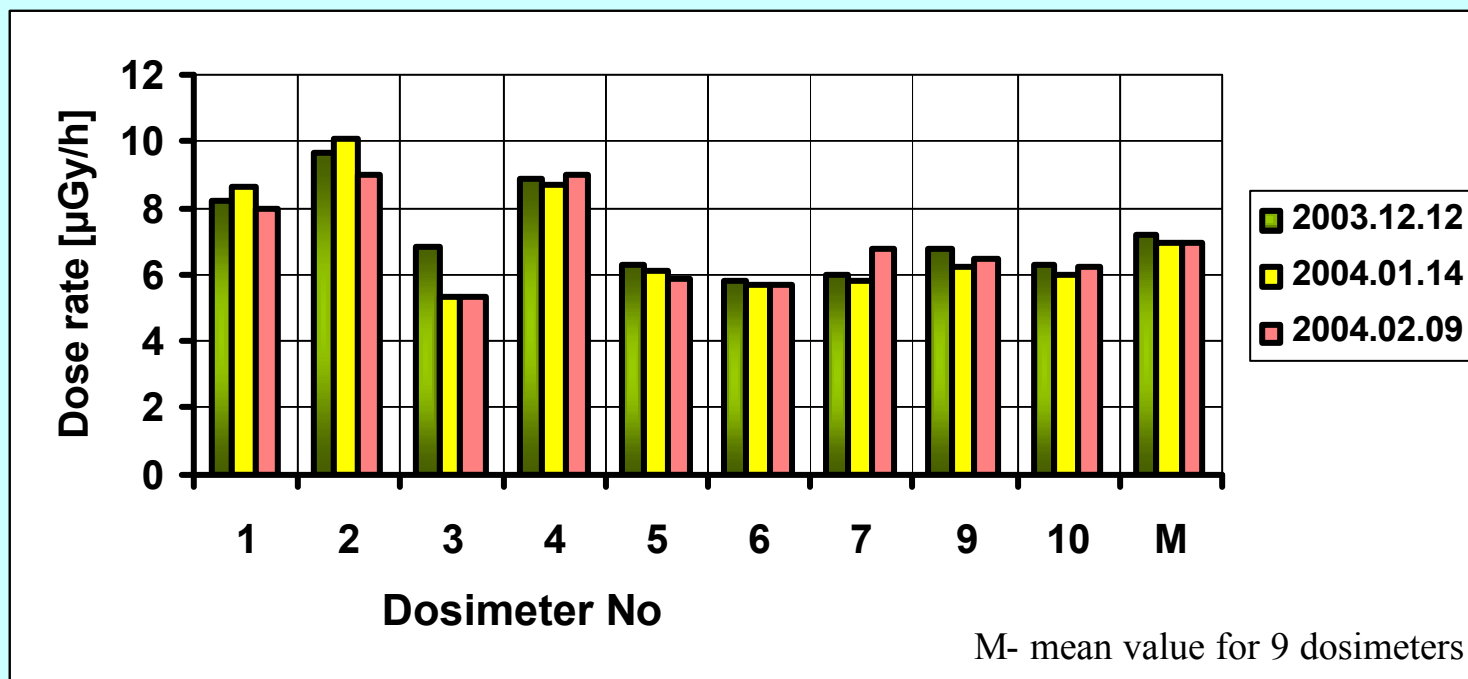
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Preliminary results of the '*Pille-MKS*' measurements

Dose rates of the single dosimeters

Readouts: 2003.12.12, 2004.01.14 and 2004.02.09

Average: ~ 6.5 mGy/h



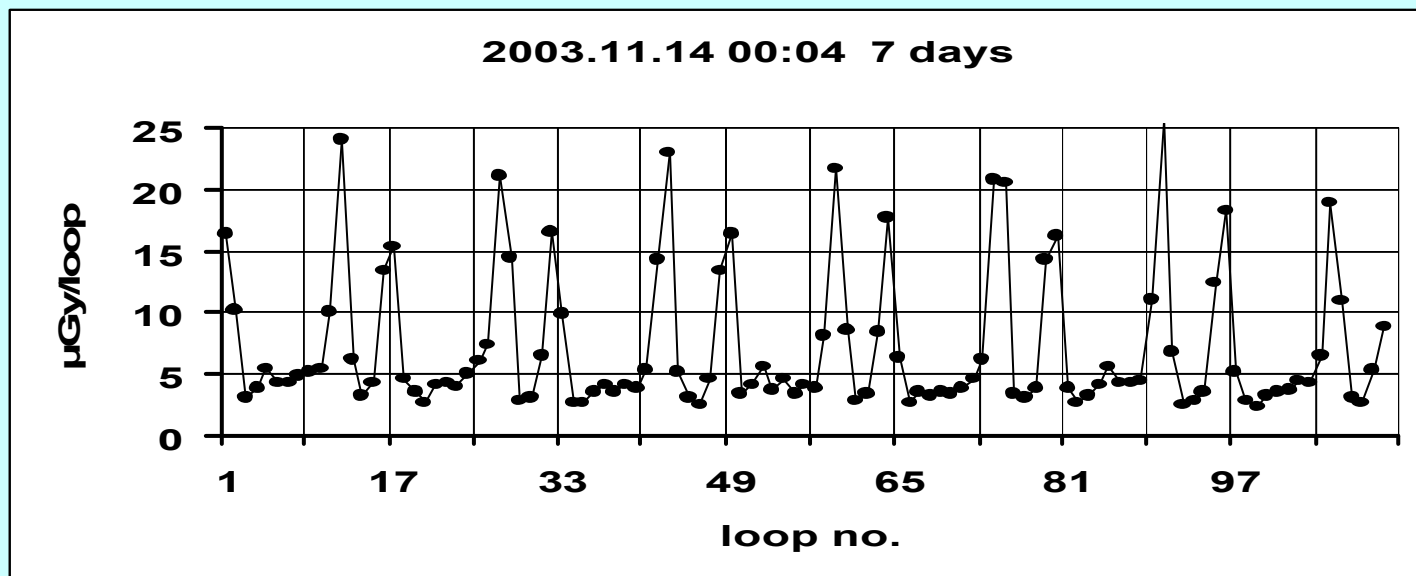
Chronology of the measurements

- **2003.10.28 – 2003.11.07 (11 days)**
 - **frequent readouts (twice daily) because of extreme solar activity**
 - **Nº ? 0304, A0307, A0308 and ? 0309 dosimeters were used**
 - **Nº A0307, A0308 used as personal dosimeters of the cosmonaut/astronauts**
- **2003.11.13 – 2004.04.24 (5 months)**
 - **regular (monthly) readout of all dosimeters (except Nº A0308)**
 - **Nº ? 0308 dosimeter read out every 1.5 hour automatically**
- **2004.02.25 (17:23) / 2004.02.24 (10:44) GMT**
 - **prior and post readouts of EVA (duration of 3 hours 55 minutes)**
 - **Nº A0309, A0310 personal EVA, Nº A0309 reference dosimeters**

Preliminary results of the '*Pille-MKS*' measurements

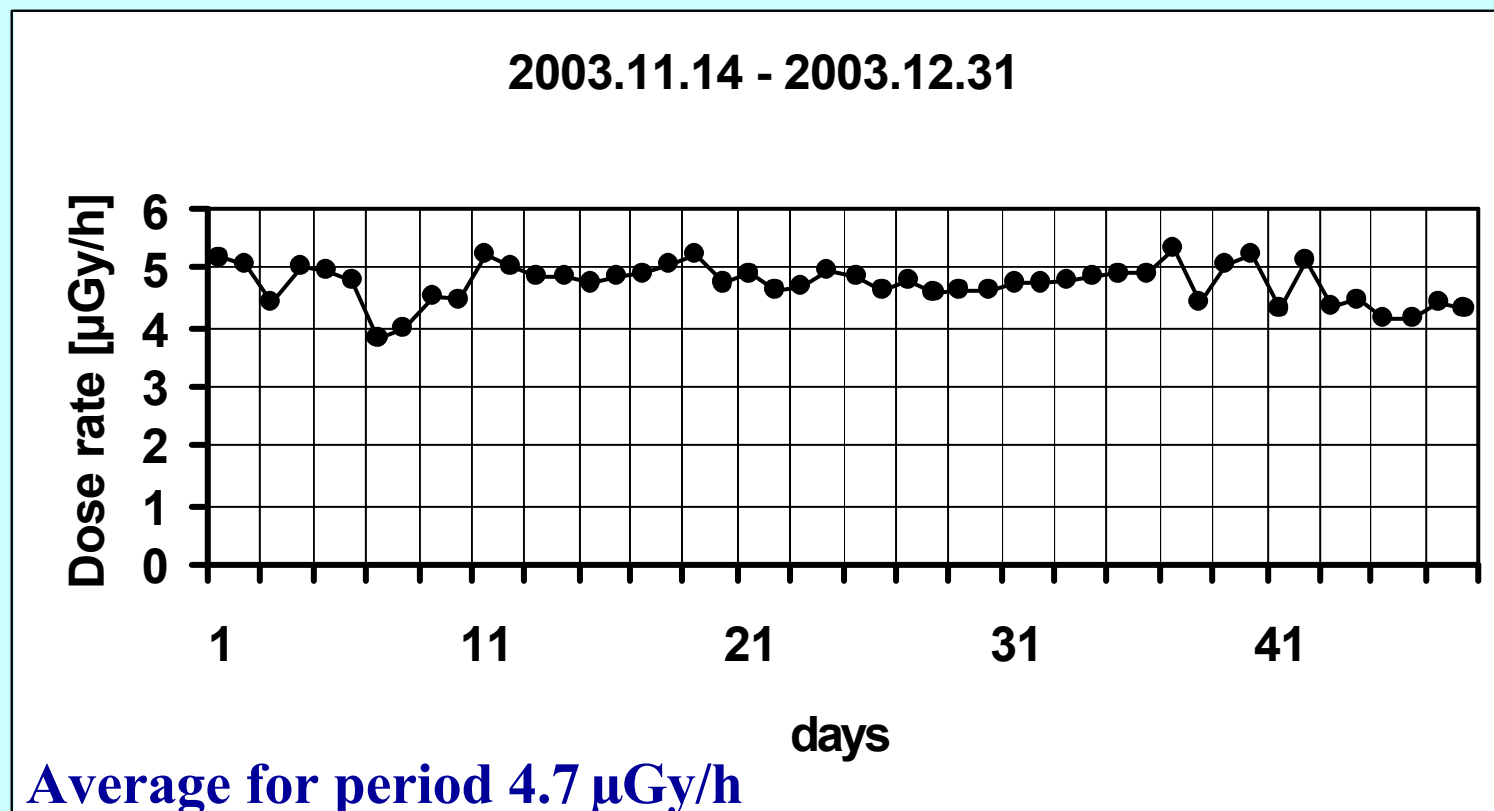
7-days sample of automatic measurements

Starting of readouts: 2003.11.14 00:04
Periodicity: 1:30 (90 minutes @ orbital time)
Interval of readouts: ~ 7 days
Average dose rate total: 4.9 $\mu\text{Gy/h}$
Average dose rate untrapped: 4 $\mu\text{Gy/orbit}$, 2.7 $\mu\text{Gy/h}$



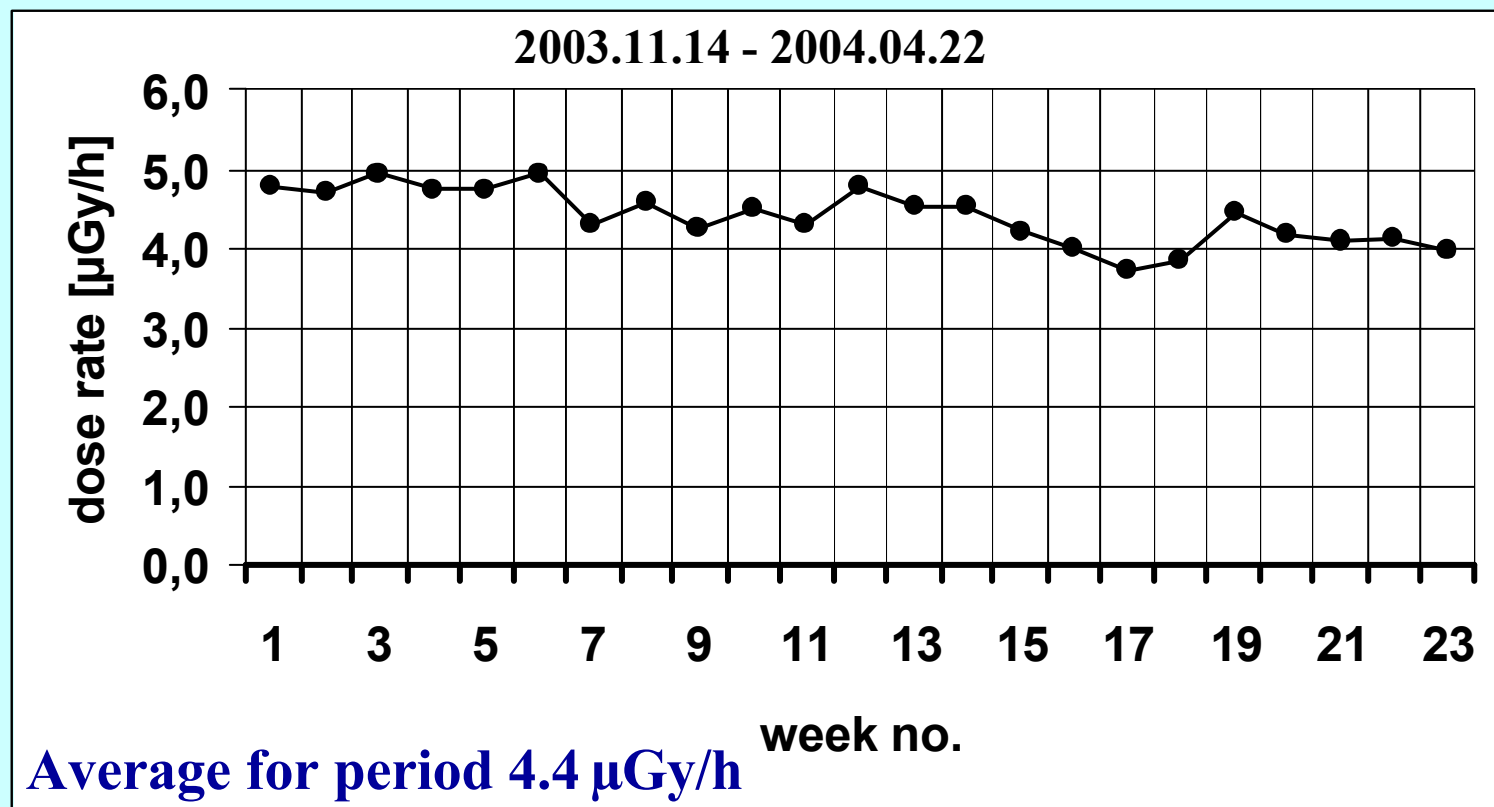
Preliminary results of the '*Pille-MKS*' measurements

Daily dose rates



Preliminary results of the '*Pille-MKS*' measurements

Weekly dose rates



Preliminary results of the '*Pille-MKS*' measurements

- **Sample from an increased solar activity period**
 - time interval: 2003.10.29-30
 - average dose rate: 15.5 $\mu\text{Gy/h}$
- **Dose measurement during EVA (2 astronauts)**
 - start of EVA: 2004.02.26 21:17 GMT
 - end of EVA: 2004.02.27 01:12 GMT
 - duration: 3 hours 55 minutes
 - dose rate: 38 $\mu\text{Gy/h}$ and 52 $\mu\text{Gy/h}$



**Location of the
'Pille' TLDs on the
'Orlan' spacesuit
during EVA**

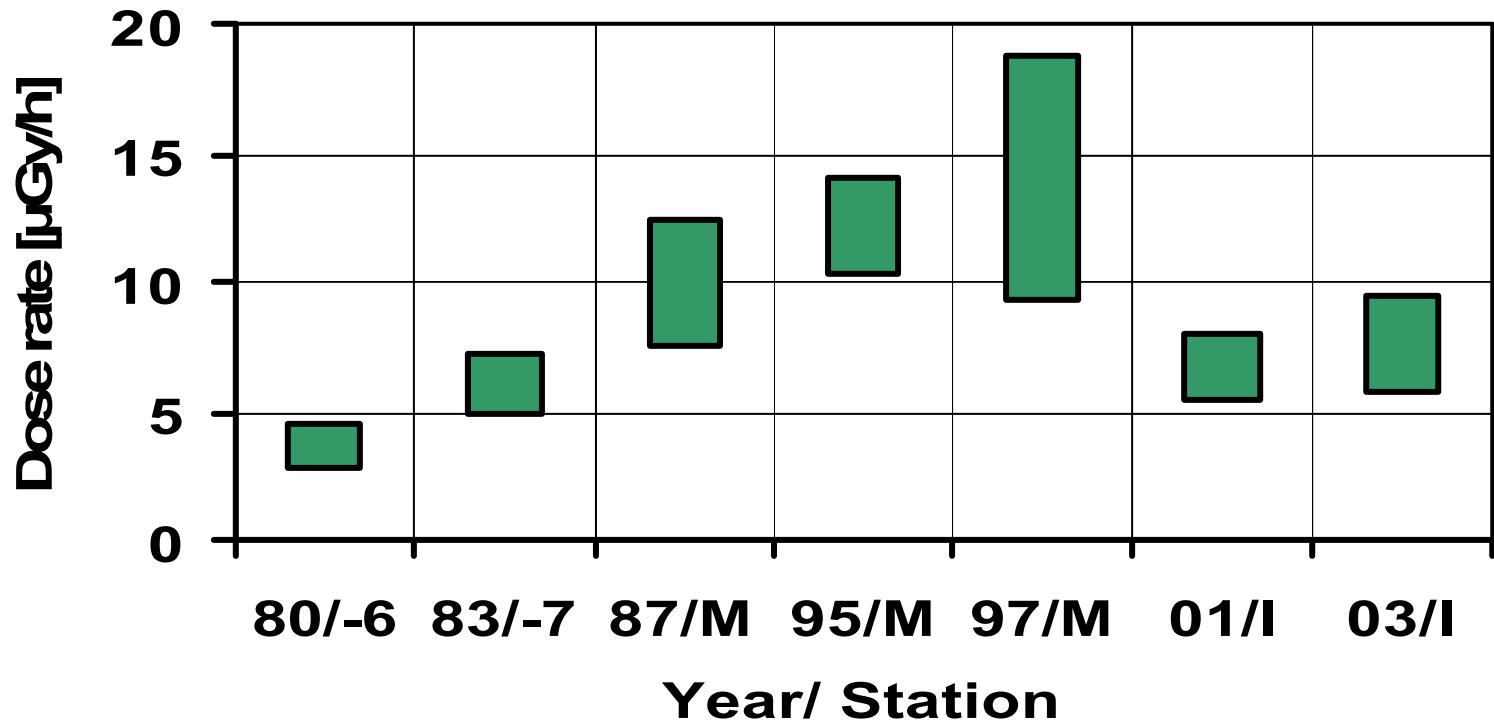
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Comparing dose rates measured by 'Pille' on different Space Stations

Salyut-6, -7, Mir, ISS



Special thanks to

- **Yuri Malenchenko**

Commander of ISS Expedition 7

for installing and starting up
the '*Pille-MKS*' system successfully



- **Alexander Kaleri**

Board Engineer of ISS Expedition 8

for operating the '*Pille-MKS*' system
during half a year so outstanding



Thank you for your attention!

PNTD Measurements

$\text{LET}_{\text{H}_2\text{O}} \approx 10 \text{ keV/mm}$

**TLD correction:
Efficiency +
High LET contribution**

ISS dosimeter + CR-39 PNTD-s (x-y-z)



Combined data

- **$12 \mu\text{Gy/h} \Rightarrow 25 \mu\text{Sv/h}$ Mir**
- **$8 \mu\text{Gy/h} \Rightarrow 16 \mu\text{Sv/h}$ ISS**

- *On-board TLD system is applicable for measurement of*
- **Dose map and personal dose**
- **EVA dose**
- **Trapped and Untrapped Dose Components**
but PNTD or other LET measurements are necessary for dose equivalent determination + phantom for effective dose evaluation

ISS / DOSMAP / 2001

Location of TLD-PNTD kits

Dosimeter	Location	Orientation
A0102	Node 1 (combined with MDU1 and NTDP4.F)	Zenith area of aft hatch, opposite of US Lab
A0103	US Lab	Any axis on BBND
A0104	Node 1	Zenith area of forward hatch
A0105	Node 1	Zenith area of starboard hatch
A0106	Node 1	Port side close to US Lab
A0107	US Lab (combined with NTDP5.F and MDU 4)	Opposite end of lab from Ku Band on Zenith area of aft hatch
A0108	Node 1	Nadir area on forward hatch
A0109	US Lab	Seat track on starboard side of US Lab close to forward hatch
A0110	US Lab	Seat track on starboard side of US Lab close to aft hatch
A0111	US Lab	Seat track on port side of US Lab close to forward hatch
A0112	US Lab	Seat track on port side of US Lab close to aft hatch