TL dose measurements on board the Russian segment of the ISS during Expedition-11 and -12

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The Pille 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 (from 1980) 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: CaSO₄:Dy
Dimensions: φ 20 mm * 60 mm
Mass: 70 g (with carrying case)
Reader

Measuring range (s<10%): \(10 \, \mu\text{Gy} \div 10 \, \text{Gy (CaSO}_4\text{:Dy)}\)

TLD Efficiency \(\varepsilon=1\pm10\%\)

\(\text{LET}_\infty \text{H}_2\text{O} < 10 \, \text{keV}/\mu\text{m}\)

Read-out precision:

3 digits + exp.

Accuracy (above 10 \(\mu\text{Gy})\):

\(\delta < 5\%\)

Measuring modes:

manual / automatic read-out

Display:

8-digit alphanum. LED

Storage of information:

PCMCIA mem. card (> 4000 data)

Computer connection:

RS-232

Dimensions:

70 mm (H)*190 mm (W)*120 mm (D)

Mass:

1,400 g

Power consumption:

0.1 / 1 / 7 W (standby/ready/readout)
Pille TLD System

11th WRMISS      September 6 - 8,
2006, Oxford, UK
‘Pille-MKS’ on the Russian Service Module (Zvezda) of the ISS

• Consisting of
  – 10 Dosimeters (№ 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
Pille TLD measurements during Expedition-11 and -12

- The *Pille-MKS* system was operated by
  - Sergei Krikalev (Exp.11, Commander)  
    2005.05.13 – 2005.09.16
  - Valery Tokarev (Exp.12, Flight Engineer)  
    2005.10.18 – 2006.02.02

- 4691 measurements from 2005.05.13 until 2006.02.02

- Results of the measurements were transferred on memory card by to the Earth
## General location and designation of the dosimeters

<table>
<thead>
<tr>
<th>Dosimeter №</th>
<th>Location in Zvezda module</th>
</tr>
</thead>
<tbody>
<tr>
<td>A0301, A0302</td>
<td>Cabin of the right board, on both sides of the illuminator</td>
</tr>
<tr>
<td>A0303, A0304</td>
<td>Cabin of the left board, on both sides of the illuminator</td>
</tr>
<tr>
<td>A0305, A0306</td>
<td>Ceiling, on the system radiometer R-16</td>
</tr>
<tr>
<td>A0307</td>
<td>Right board, beside of the cabin, on ceiling of the lavatory</td>
</tr>
<tr>
<td></td>
<td><em>Dedicated for EVA reference measurement inside ISS</em></td>
</tr>
<tr>
<td>A0308/A0309</td>
<td>Inserted in the Reader, which is fixed on the floor, right to</td>
</tr>
<tr>
<td>05.11.06/05.11.18</td>
<td>illuminator № 9</td>
</tr>
<tr>
<td></td>
<td><em>Dedicated for automatic measurements</em></td>
</tr>
<tr>
<td>A0309, A0310</td>
<td>In the transporting case of the Reader, left to illuminator Nº 9</td>
</tr>
<tr>
<td></td>
<td><em>Dedicated for EVA personal measurements</em></td>
</tr>
</tbody>
</table>
Dose rates of the single dosimeters (Exp. 11)

![Graph showing dose rates of dosimeters over different dates.]

11th WRMISS     September 6 - 8, 2006, Oxford, UK
Dose rates of the single dosimeters (Exp. 12)
Dosimeter No. A0301

Cabin of the right board (Exp.9/10/11/12):
7.8 / 10.3/ 7.8/ 9.2 $\mu$Gy/h
Dosimeter No. A0302

Cabin of the right board (Exp.9/10/11/12):
8.4 / 10.6 / 8.6 / 9.3 μGy/h
Dosimeter No. A0303

Cabin of the left board (Exp.9/10/11/12):
6.3 / 7.2 / 5.4 / 6.3 μGy/h
Dosimeter No. A0304

Cabin of the left board (Exp.9/10/11/12):
9.1 / 10.8/ 8.7/ 8.3 µGy/h
Ceiling, on the radiometer R-16 (Exp.9/10/11/12):
6.0 / 6.6/ 5.2, 5.4/ 6.3, 6.2 µGy/h
Dosimeter No. A0307

Ceiling of the lavatory (Exp.9/10/11/12):
7.3 / 8.3/ 5.6/ 7.9 µGy/h
Dosimeter No. A0308 in the Reader

Right to illuminator Nº 9 (Exp.9/10/11/12):
4.7 / 5.2 / 4.0/ 4.0? µGy/h
6-days sample of automatic measurements (No. A0308)

Starting of readouts: 2005.05.13 19:15    Range of time: 6 days
Orbit: 90 minutes ≲ orbital time
6-days sample of automatic measurements (No. A0308)

Ratio trapped/untrapped 0.33/0.67
full mean 3.84 µGy/h

Dose rate [µGy/h]

outside SAA
inside SAA
untrapped aver.

Orbits

11th WRMISS    September 6 - 8, 2006, Oxford, UK
6-days sample of automatic measurements (No. A0309)

Starting of readouts: 2005.11.20 17:45  Range of time: 6 days
Orbit: 90 minutes ≅ orbital time

![Graph showing dose rate over orbits]

11th WRMISS    September 6 - 8, 2006, Oxford, UK
Automatic measurements (No. A0308 -12 days - A0309)

11th WRMISS  September 6 - 8, 2006, Oxford, UK
Automatic measurements (No. A0309)

\[ y = 8.223x^{-0.0733} \]

Dose rate [µGy/h]

Orbits
Daily dose rates (dosimeter No. A0308 and No. A0309 without correction)
Daily dose rates (dosimeter No.8 and No. 9, with correction)

![Graph showing daily dose rates (µGy/h)](image)

11th WRMISS   September 6 - 8, 2006, Oxford, UK
Weekly dose rates without correction

Mean dose rate [\mu Gy/h]

week
Weekly dose rates with correction
EVA excess dose rates
Duration of EVAs 4.3...5.5 hours

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Dose rate ranges measured by Pille’s on different Space Stations (1980-2006)

Year/Station (6:Salyut-6; 7:Salyut-7; M:Mir; I:ISS)
Thank you for your attention!