

Pille Measurements on ISS (April 2015 – December 2015)

A. Hirn¹, I. Apáthy¹, V. A. Bondarenko², S. Deme¹, I. Fehér¹,
O. Ivanova², V. Mitrikas², I. V. Nikolaev³, T. Pázmándi¹,
V. A. Shurshakov², P. Szántó¹, V. V. Tsetlin²

¹MTA Centre for Energy Research, Budapest, Hungary

²Institute for Biomedical Problems, Moscow, Russia

³RSC Energia, Russia

hirn.attila@energia.mta.hu

Content

- The Pille TLD system
- Pille on the ISS
- Practice in reporting data
 - Decrease in sensitivity with high number of read-outs
 - Corrections
- Results of April 2015 – December 2015



The Pille thermoluminescent dosimeter system

Space qualified, on-board TLD system

Dosimeters and a reader device

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



Reader	
Measuring range ($s < 10\%$):	$3 \mu\text{Gy} \div 10 \text{ Gy}$ ($\text{CaSO}_4:\text{Dy}$)
TLD Efficiency ($\varepsilon = 1 \pm 10\%$):	$\text{LET}_{\infty}(\text{H}_2\text{O}) < 10 \text{ keV}/\mu\text{m}$
Accuracy (above $10 \mu\text{Gy}$):	$\delta < 5\%$



High sensitivity

Even hourly read-outs are possible



Pille on board ISS

On board every space station since Salyut-6

More than 50 000 comparable read-outs from different space stations

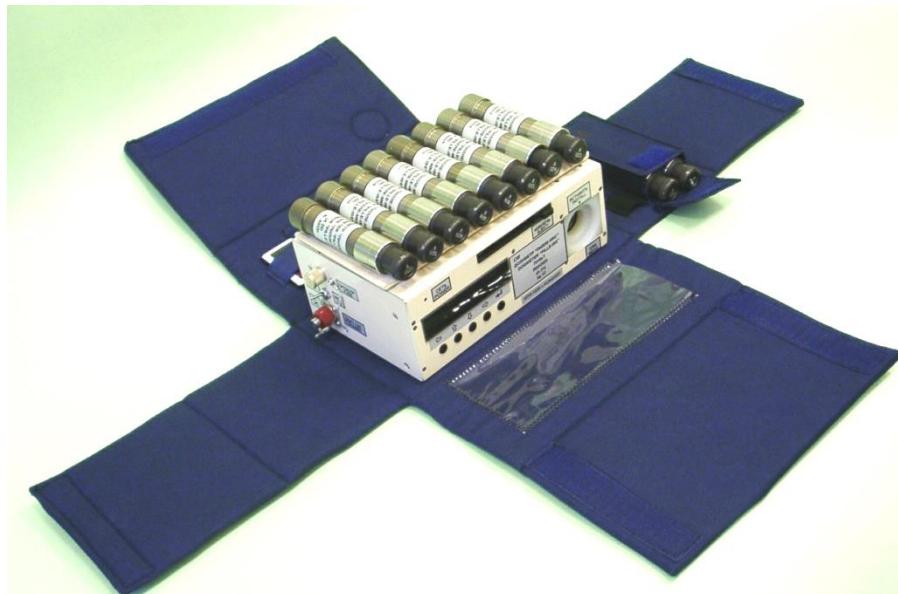
DOSMAP project

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

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

New dosimeters were delivered to ISS in 2009

- Currently 12 dosimeters on board



Accuracy and corrections

- Usual accuracy: $\pm 10\%$
- Bulbs are selected for flight for which the **reproducibility** is within an accuracy of **5%**.
- Dosimeters are calibrated with a standard ^{137}Cs source beam (gamma-rays) on ground (measure air kerma).
- Data presented are **not corrected for $\text{LET}_{\text{H}_2\text{O}} > 10 \text{ keV}/\mu\text{m}$** .
- **No conversion to absorbed dose in water** or tissue-equivalent material is applied.



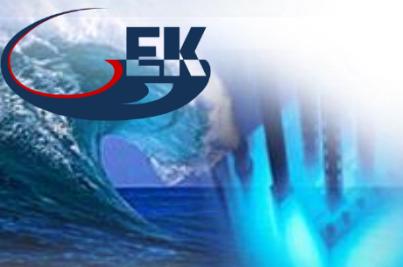
Experiences and corrections

- The only **correction** we perform is **based on the regular cross-calibration of the dosimeters on board**.
- Except from dosimeter A0303, none of the Pille dosimeters used exclusively for dose mapping or personal dosimetry showed any decrease in their sensitivity.
- „**Sudden**“ degradation in sensitivity was reported (see last year's presentation).
- But it is **NOT sudden** (in the past the frequency of cross-calibration measurements was inadequate).
 - It depends on the total **number of read-outs!**

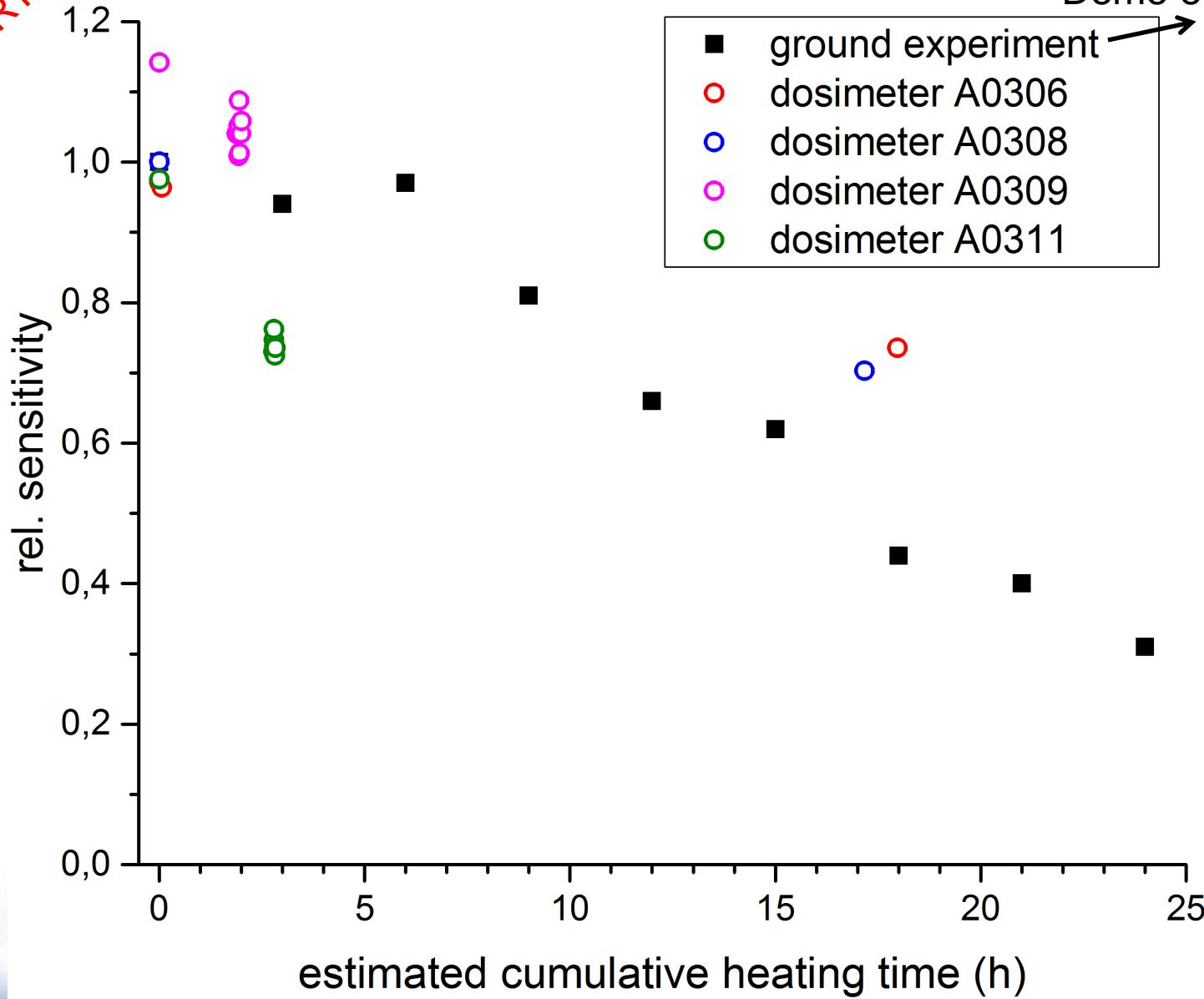


Dosimeters used for automated measurements

Dosi-meter	Period(s)	No. of read-outs	Rel. sensitivity
A0308	2003/09-2005/11 2006/06-2009/11	>20000	~70%
A0309	2005/11-2006/04	>2000	~100%
A0311	2009/11-2010/09	>3000	~74%
A0306	2010/09- ...	>20000	~74%



PRELIMINARY

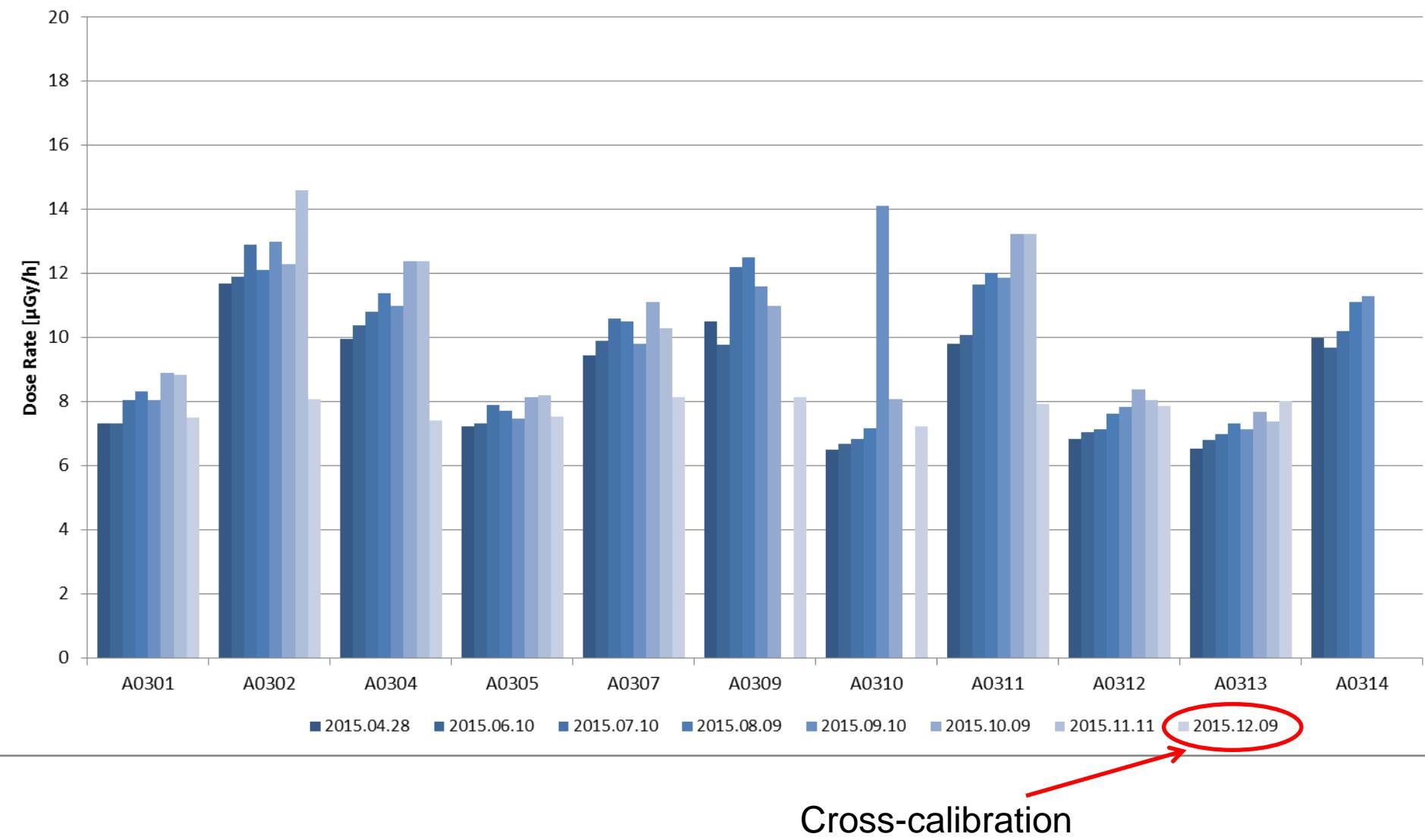


From 9 February 2015

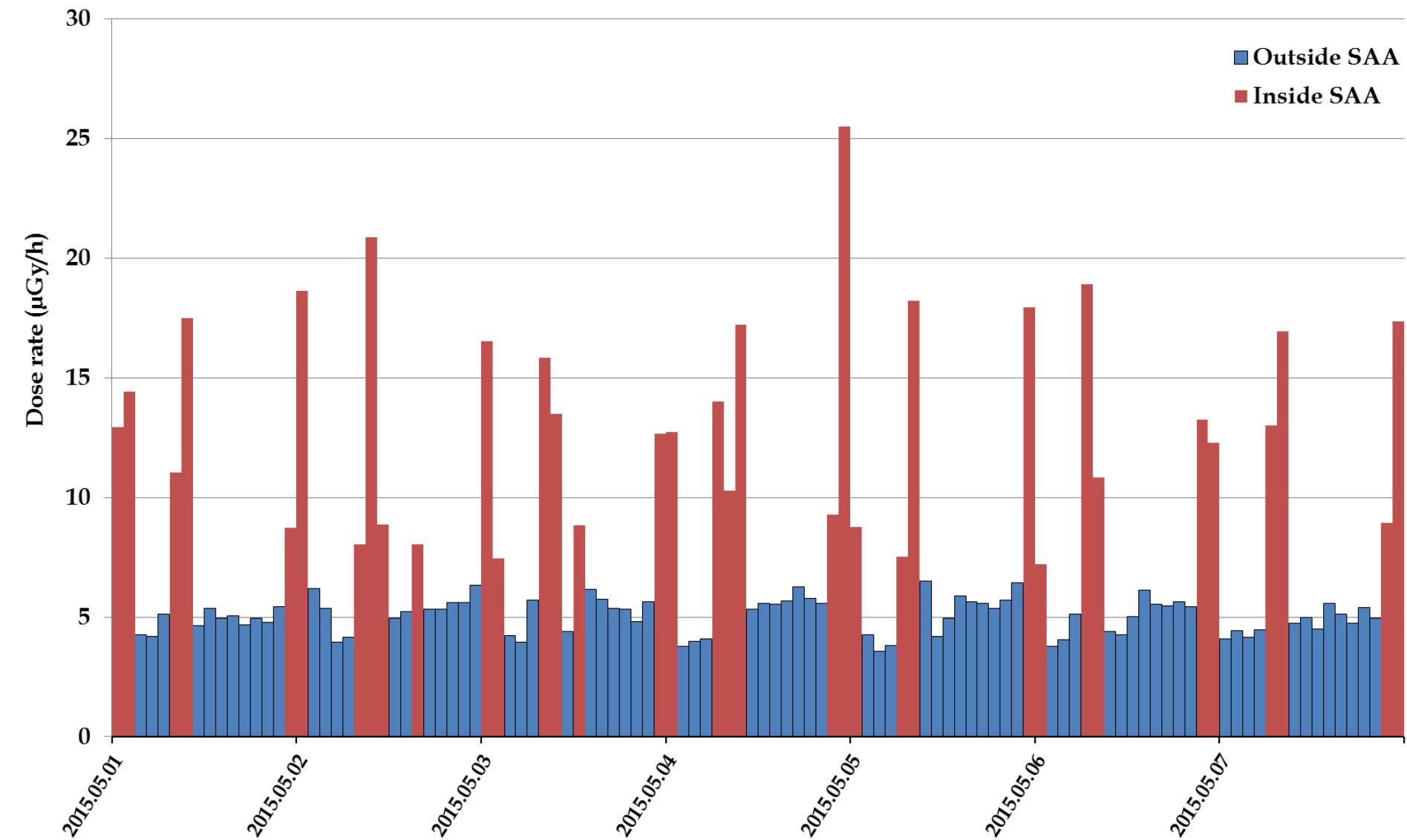
Dosimeter No.	Locations (except during cross-calibration measurement)
A0301	On Panel 406
A0302	Starboard (right side) crew quarters, left of window
A0304	MIM1 (Small Research Module Rassvet) , under Panel 204
A0305	In the saloon of large diameter on Panel 327
<u>A0306</u>	“Service” dosimeter, inserted in the Reader (fixed on the floor, right to illuminator № 9)
<u>A0307</u>	Docking port 1 (to module Pirs-1), hemisphere, on panel III, <i>RS EVA ref. dosim.</i>
<u>A0309</u>	MIM2 (Small Research Module Poisk), cylindrical part at the entrance (handrail 6111)
<u>A0310</u>	Behind panel 447 at detector DB-8 №.3
A0311	Port (left side) crew quarters, left of window
<u>A0312</u>	NODE2 of the Russian crew quarters; <i>US EVA ref. dosim.</i>
A0313	On panel 435 (table)
A0314	MIM2 (Small Research Module Poisk), cylindrical part on Plane III



Monthly manual read-outs, April 2015 - December 2015



Sample of the automatic measurements, dosimeter A0306 (2015. 05. 01 - 2015. 05. 07)



No signs of CME's in the automatic measurements in the period between
April 2015 and December 2015

EVA measurements

RS EVA-41; Aug. 10, 2015. 14:20–19:51 UTC; duration 5 hrs 31 min 

Reference dosimeter: A0307 (on top of the Reader, Zvezda Service Module)

Dosimeter	Total dose [μGy] / time [h]	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0307	499 (54.5)	50.5	-	9.2	-
A0309	922 (54.5)	474	423	85.8	76.6
A0310	1040 (54.5)	592	541	107	98.0

US EVA-32; Oct. 28, 2015. 12:03–19:19 UTC; duration 7 hrs 16 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μGy] / time [h]	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0312	440 (46.9)	68.2	-	9.4	-
A0309	498 (46.9)	126	58	17.4	8.0
A0310	394 (46.9)	22.2	-46	3.1	-6.3



EVA measurements

US EVA-33; Nov. 6, 2015. 11:22– 19:10 UTC; duration 7 hrs 48 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μGy] / time [h]	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0312	400 (47.0)	66.4	-	8.5	-
A0309	451 (47.0)	117	51	15	6.5
A0310	356 (47.0)	22.4	-44	2.9	-5.6

US EVA-34; Dec. 21, 2015. 13:45–16:01 UTC; duration 3 hrs 16 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μGy] / time [h]	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0312	312 (46.8)	21.8	-	6.7	-
A0307	424 (46.8)	134	112	40.9	34.3
A0309	342 (46.8)	51.8	30	15.8	9.2

PRELIMINARY



EVA measurements

PRELIMINARY

US EVA-35; Jan. 15, 2016. 12:48–17:31 UTC; duration 4 hrs 43 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μGy] / time [h]	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0312	439 (46.9?)	44.2	-	9.4	-
A0307	573 (46.9?)	178	134	37.8	28.4
A0309	502 (46.9?)	107	63	22.7	13.3

RS EVA-42; Feb. 3, 2016. 12:55–17:40 UTC; duration 4 hrs 45 min 

Reference dosimeter: A0307 (on top of the Reader, Zvezda Service Module)

Dosimeter	Total dose [μGy] / time [h]	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0307	521 (51.0)	48.5	-	10.2	-
A0309	1240 (51.0)	768	719	162	151
A0310	1120 (51.0)	648	599	136	126



PRELIMINARY



Thank you for your attention