Pille Measurements on ISS (May 2014 – March 2015)

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Content

- The Pille TLD system
- Pille on the ISS
- Practice in reporting data (correction)
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The Pille thermoluminescent dosimeter system

Space qualified, on-board TLD system

Dosimeters and a 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/μm
Accuracy (above 10 μGy):	δ < 5%

High sensitivity

Even hourly read-outs are possible

Pille on board ISS

On board every space station since Salyut-6

More than 47 000 comparable read-outs from different space stations

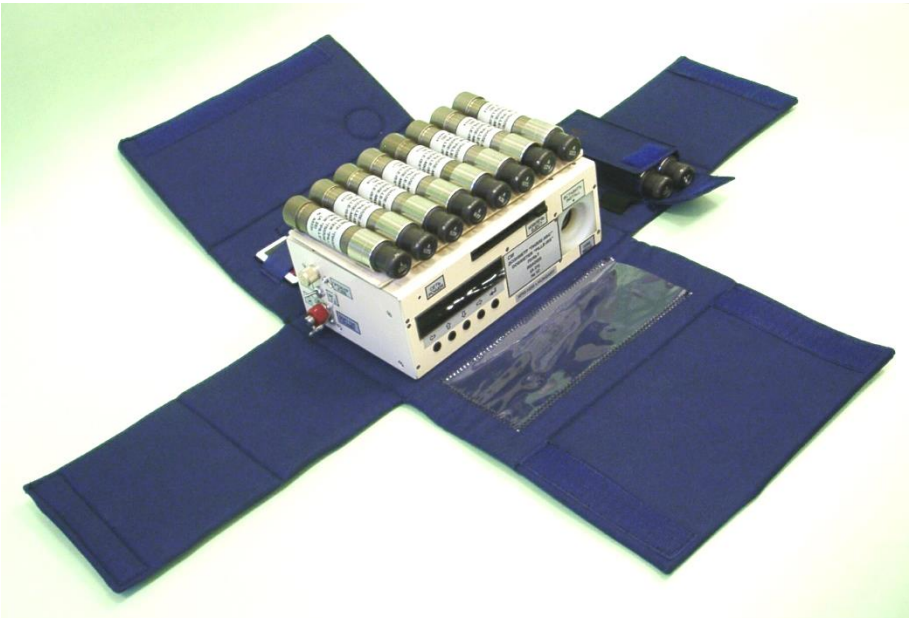
DOSMAP project

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: ±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 LET_{H2O}>10 keV/µm**.
- **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**.
- Sensitivity: very **stable**; does not degrade over time or with the number of readouts.
- But **sometimes sudden degradation** → reason is investigated.
- After degradation: **stable** and may be used for further measurements by taking into account the value of degradation → correction based on cross-calibration.

Experiences and corrections

Dosimeter ID	Relative sensitivity	
	30/03/2009-03/04/2009 Zvezda, Panel 321	07/11/2014-09/12/2014 Zvezda, Panel 121
A0301	0.90	0.91
A0302	1.02	1.01
A0303	0.68	*Retrieved*
A0304	0.96	0.94
A0305	0.93	0.94
A0306	0.94	*Retrieved*
A0307	1.03	1.01
A0308	0.69	*No data*
A0309	1.03	1.01
A0310	0.95	0.91
A0311	0.95	0.70
A0312	0.99	1.00
A0313	1.01	0.99
A0314	1.02	0.98

From 9 October 2013

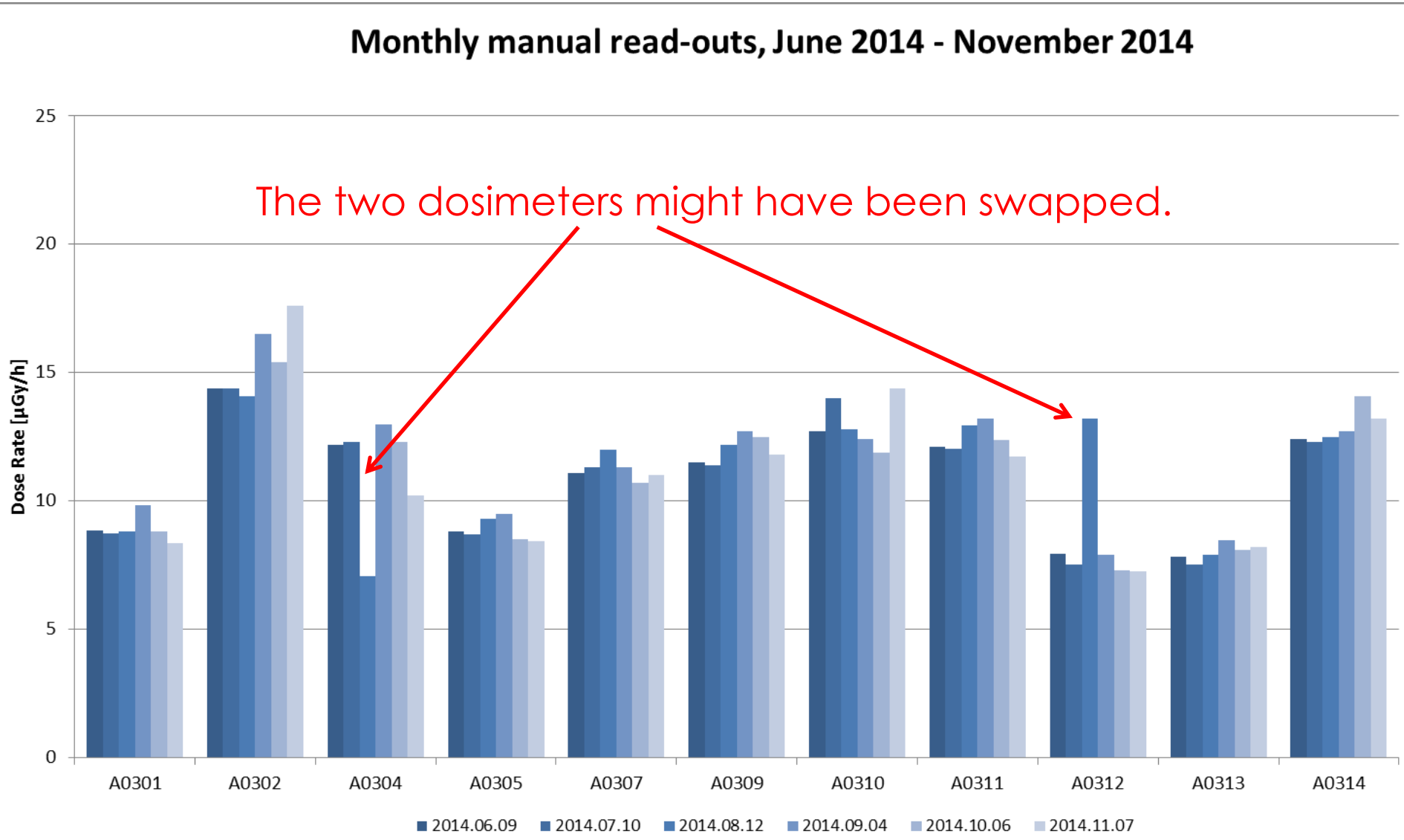
Dosimeter No.	Locations (except during cross-calibration measurement)
A0301	On Panel 406
A0302	Starboard (right side) crew quarters, left of window
A0304	MIM1 (Small Research Module Rassvet) , under Panel 204
A0305	In the saloon of large diameter on Panel 327
A0306	“Service” dosimeter, inserted in the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

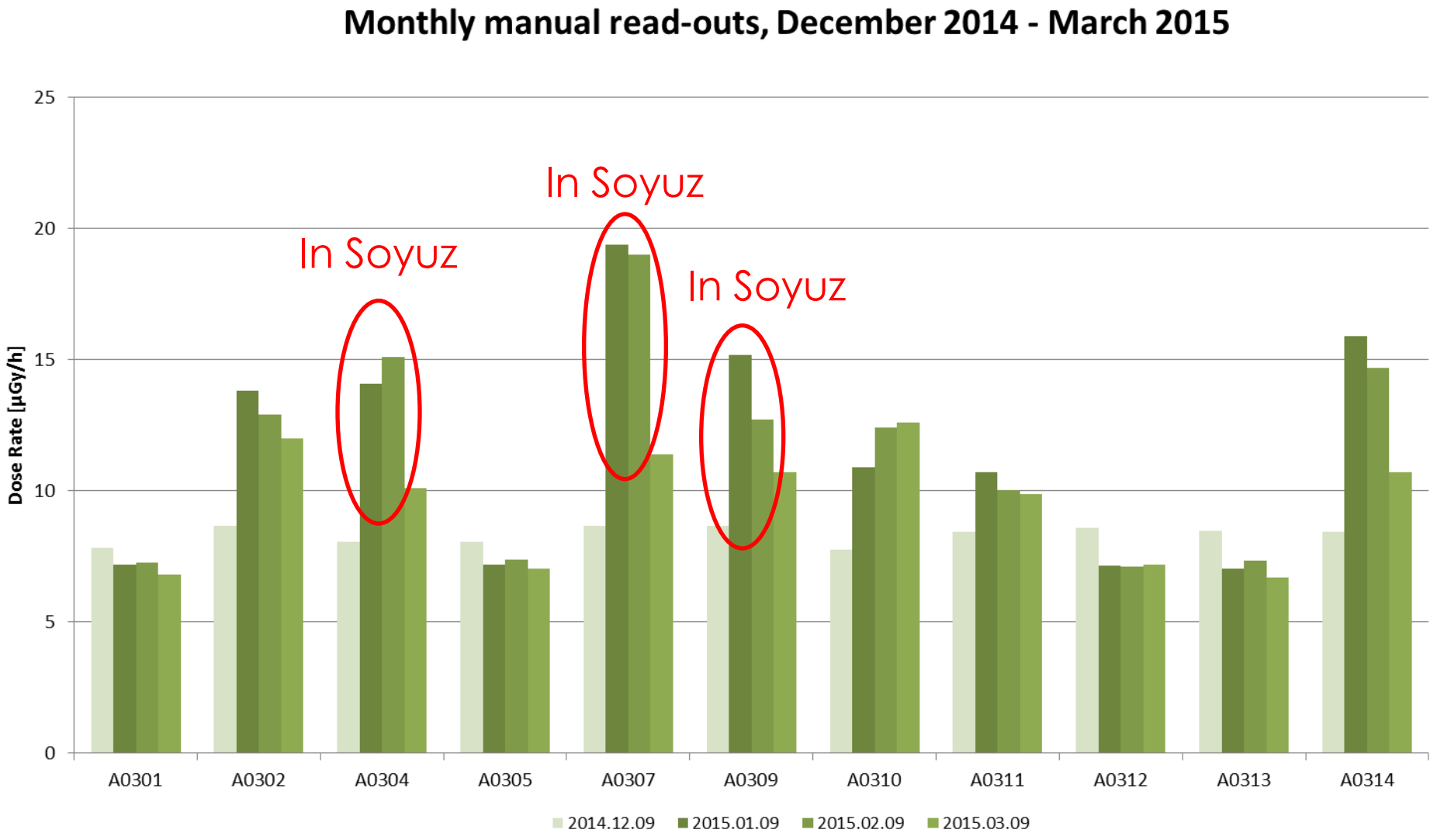
From 9 December 2014

Dosimeter No.	Locations (except during cross-calibration measurement)
A0301	On Panel 406
A0302	Starboard (right side) crew quarters, left of window
A0304	Soyuz-TMA-14M, middle seat
A0305	In the saloon of large diameter on Panel 327
A0306	“Service” dosimeter, inserted in the Reader (fixed on the floor, right to illuminator № 9)
A0307	Soyuz-TMA-14M, right seat
A0309	Soyuz-TMA-14M, left seat
A0310	Behind panel 447 at detector DB-8 No.3
A0311	Port (left side) crew quarters, left of window
A0312	NODE2 of the Russian crew quarters
A0313	On panel 435 (table)
A0314	MIM2 (Small Research Module Poisk), cylindrical part on Plane III

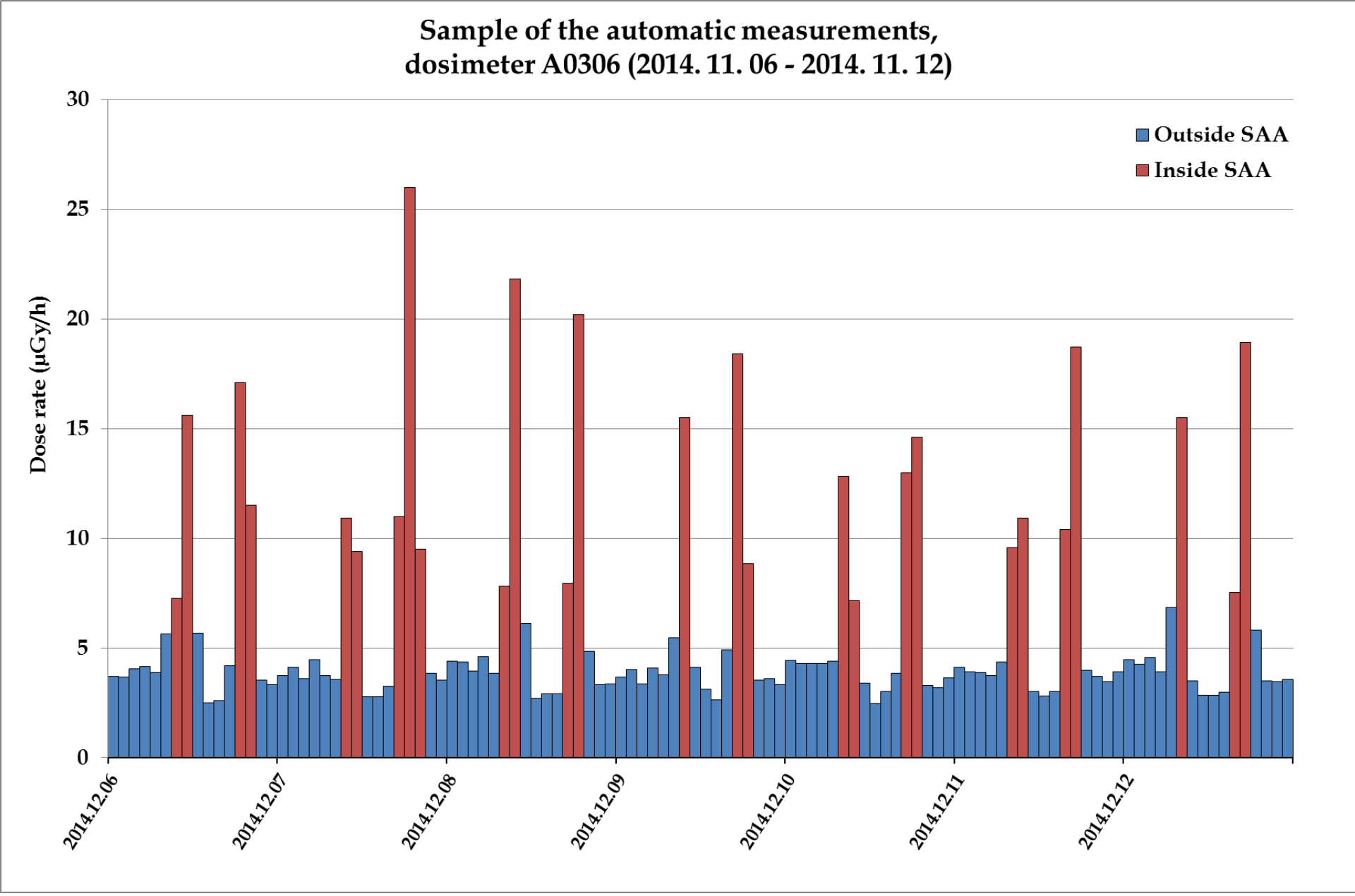
From 9 February 2015

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
A0306	“Service” dosimeter, inserted in the Reader (fixed on the floor, right to illuminator № 9)
A0307	Docking port 1 (to module Pirs-1), hemisphere, on panel III
A0309	MIM2 (Small Research Module Poisk), cylindrical part at the entrance (handrail 6111)
A0310	Behind panel 447 at detector DB-8 No.3
A0311	Port (left side) crew quarters, left of window
A0312	NODE2 of the Russian crew quarters
A0313	On panel 435 (table)
A0314	MIM2 (Small Research Module Poisk), cylindrical part on Plane III

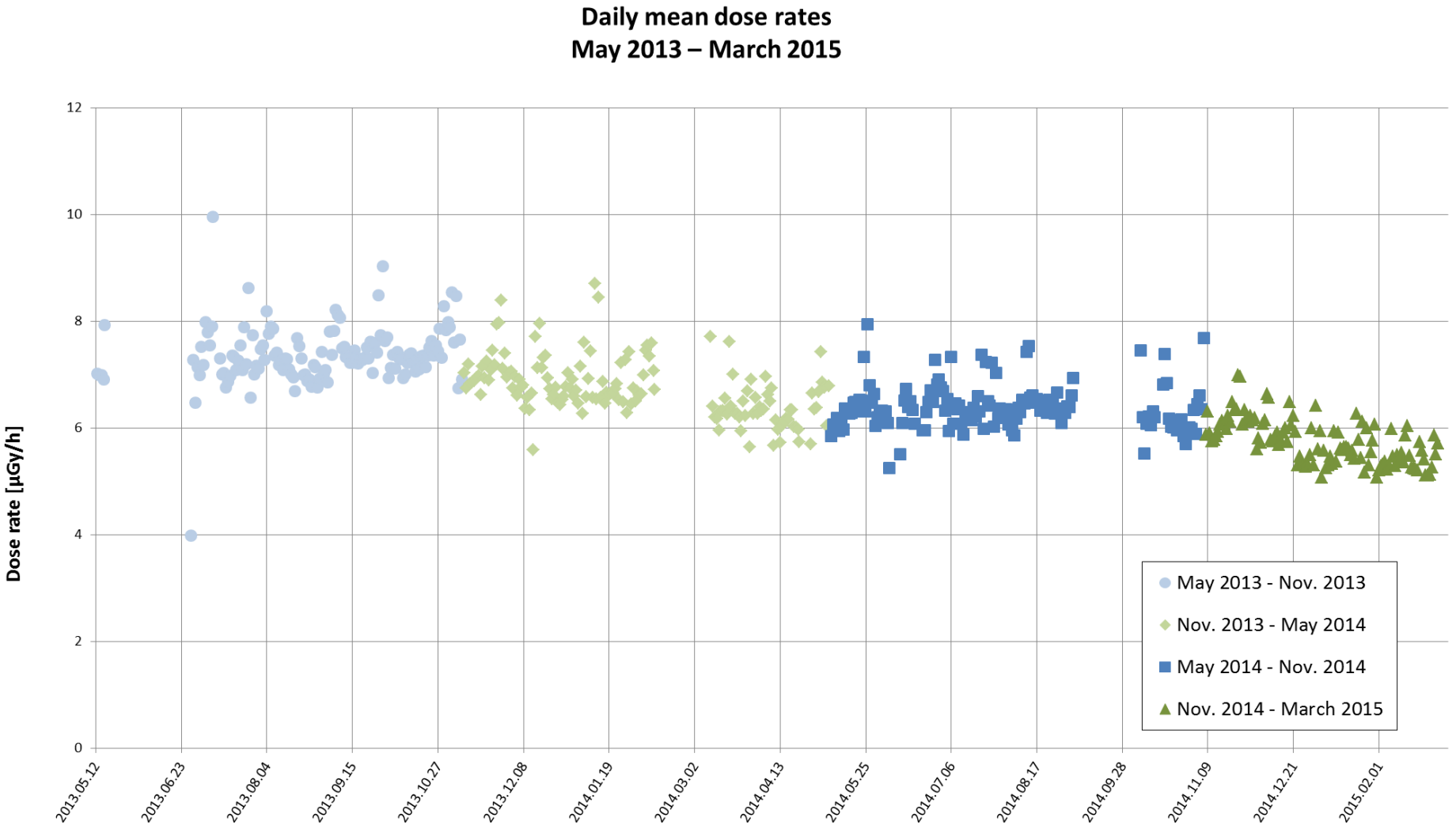

Monthly manual read-outs, June 2014 - November 2014
The two dosimeters might have been swapped.
Dose Rate [µGy/h]
25
20
15
10
5
0
A0301
A0302
A0304
A0305
A0307
A0309
A0310
A0311
A0312
A0313
A0314
2014.06.09
2014.07.10
2014.08.12
2014.09.04
2014.10.06
2014.11.07

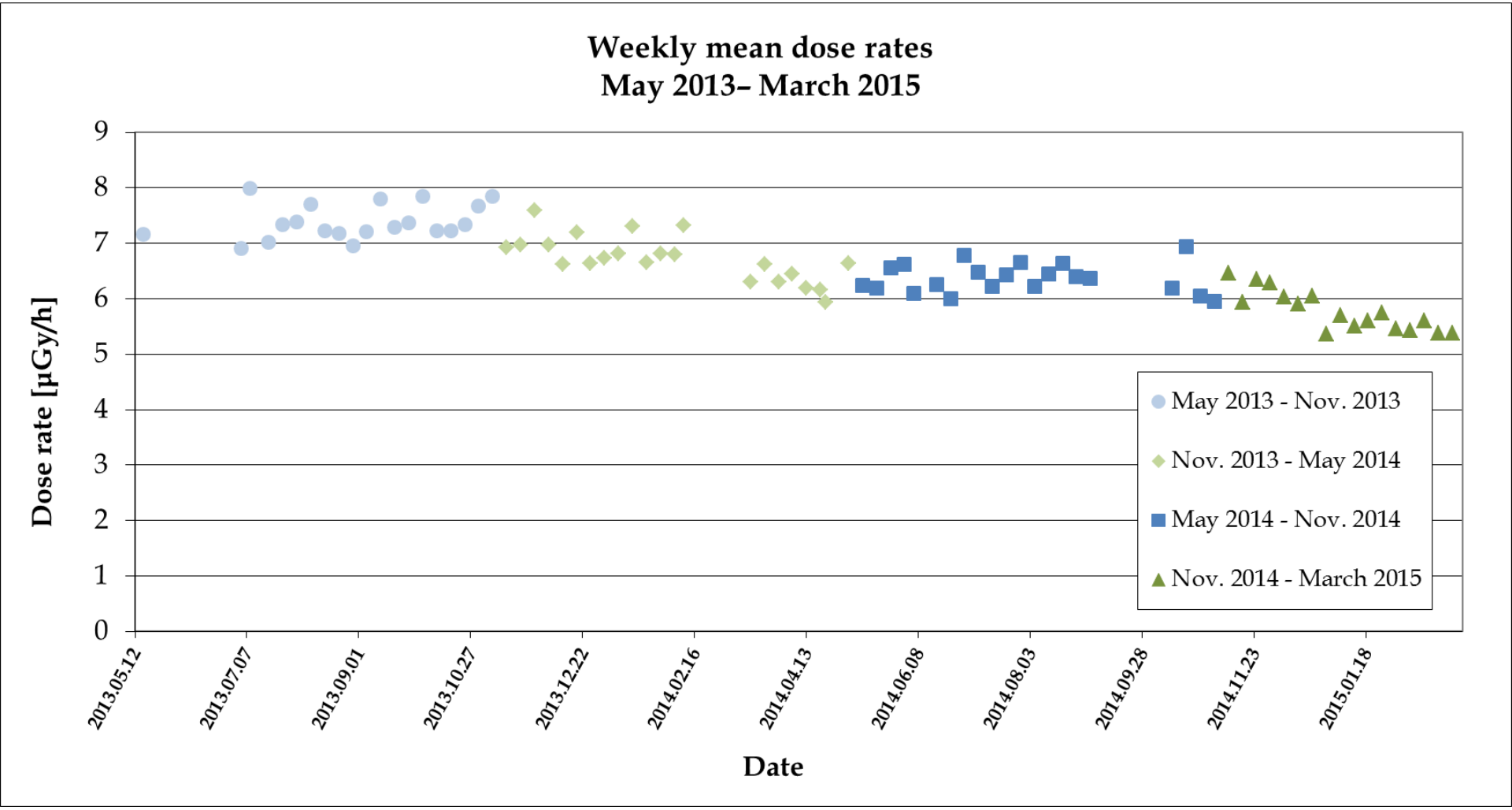


First columns: results of the cross-calibration close to the Pille Reader



No signs of CME's in the automatic measurements in the period between May 2014 and March 2015


Daily mean dose rates
May 2013 – March 2015
Dose rate [µGy/h]
0
2
4
6
8
10
12
2013.05.12
2013.06.23
2013.08.04
2013.09.15
2013.10.27
2013.12.08
2014.01.19
2014.03.02
2014.04.13
2014.05.25
2014.07.06
2014.08.17
2014.09.28
2014.11.09
2014.12.21
2015.02.01
May 2013 - Nov. 2013
Nov. 2013 - May 2014
May 2014 - Nov. 2014
Nov. 2014 - March 2015


Weekly mean dose rates
May 2013– March 2015
Dose rate [µGy/h]
9
8
7
6
5
4
3
2
1
0
2013.05.12
2013.07.07
2013.09.01
2013.10.27
2013.12.22
2014.02.16
2014.04.13
2014.06.08
2014.08.03
2014.09.28
2014.11.23
2015.01.18
Date
May 2013 - Nov. 2013
Nov. 2013 - May 2014
May 2014 - Nov. 2014
Nov. 2014 - March 2015

EVA measurements

RS EVA-38; Jun. 19, 2014. 14:10– 21:33 UTC; duration 7 hrs 23 min

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

Dosimeter	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0307	73	-	9.9	-
A0309	557	484	75.5	65.6
A0310	348	275	47.2	37.3

RS EVA-39; Aug. 18, 2014. 14:02–19:13 UTC; duration 5 hrs 11 min

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

Dosimeter	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0307	52.5	-	10.1	-
A0309	607	554	117	107
A0310	501	448	96.6	86.5

EVA measurements

US EVA-27; Oct. 7, 2014. 12:30–18:43 UTC; duration 6 hrs 13 min

Reference dosimeter: A0312 (NOD-2 Cabine)

Dosimeter	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0312	54.4	-	8.75	-
A0309	40.4	-14.0	6.5	-2.25
A0310	129	75.0	20.8	12.1

US EVA-28; Oct. 15, 2014. 12:16–18:50 UTC; duration 6 hrs 34 min

Reference dosimeter: A0312 (NOD-2 Cabine)

Dosimeter	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0312	56.1	-	8.5	-
A0309	303	247	46.1	37.6
A0310	90.1	34	13.7	5.2

EVA measurements

RS EVA-40; Oct. 22, 2014. 13:28–17:06 UTC; duration 3 hrs 38 min

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

Dosimeter	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0307	38.7	-	10.7	-
A0309	514	475	142	131
A0310	479	440	132	121

US EVA-29; Feb. 21, 2015. 12:45–19:26 UTC; duration 6 hrs 41 min

Reference dosimeter: A0312 (NOD-2 Cabine)

Dosimeter	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0312	48.2	-	7.2	-
A0309	28.2	-20.0	4.2	-3.0
A0310	19.2	-29.0	2.9	-4.3

EVA measurements

US EVA-30; Feb. 25, 2015. 11:51–18:34 UTC; duration 6 hrs 43 min

Reference dosimeter: A0312 (NOD-2 Cabine)

Dosimeter	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0312	46.5	-	6.9	-
A0309	56.5	10.0	8.4	1.5
A0310	52.5	6.0	7.8	0.9

US EVA-31; March 1, 2015. 11:52–17:30 UTC; duration 5 hrs 38 min

Reference dosimeter: A0312 (NOD-2 Cabine)

Dosimeter	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total Dose rate [μGy/h]	Extra dose rate [μGy/h]
A0312	38.7	-	6.9	-
A0309	61.7	23.0	13.5	4.1
A0310	26.7	-12.0	7.3	-2.1

Thank you for your attention