

PILLE MEASUREMENTS ON ISS

(April 2017 – February 2018)

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Outline

- The Pille TLD system
- Pille on the ISS
- Practice in reporting data
- Results of April 2017 – February 2018
- Solar Particle Event of September 2017
- Brief status on the new Pille Reader on board
- Modernized Pille sensors → next talk

The Pille TLD system

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 $10 \mu\text{Gy}$):	$\delta < 5\%$

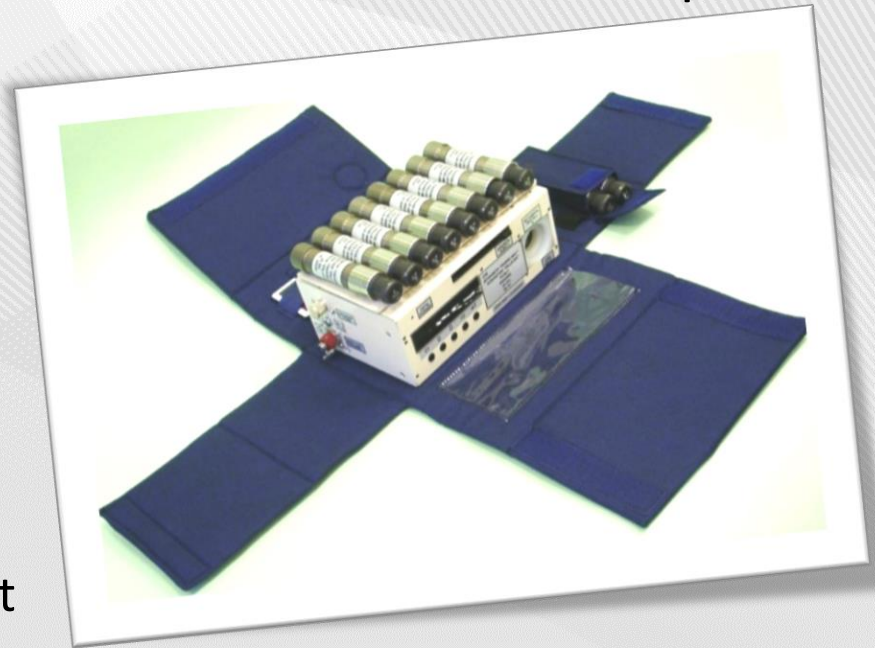


- High sensitivity → Even hourly read-outs are possible

Pille on board ISS

Pille on board the ISS (in the reporting period)

- On board every space station since Salyut-6
- More than 60 000 comparable read-outs from different space stations
- DOSMAP project in 2001
- Service dosimetry system on Zvezda since 2003 (Exp. #8)
 - Dose mapping
 - Personal dosimetry during SPE-s
 - Personal dosimetry during EVA-s
 - Automatic read-out on every orbit
- 4 new dosimeters were delivered to ISS and 2 old ones retrieved in 2009



Practice in reporting data

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 (air kerma).
- Data presented by MTA EK 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 by MTA EK. Russian specialists use a conversion factor of 1.1.

Experiences and corrections

- The only correction MTA EK performs is based on the regular cross-calibration of the dosimeters on board.



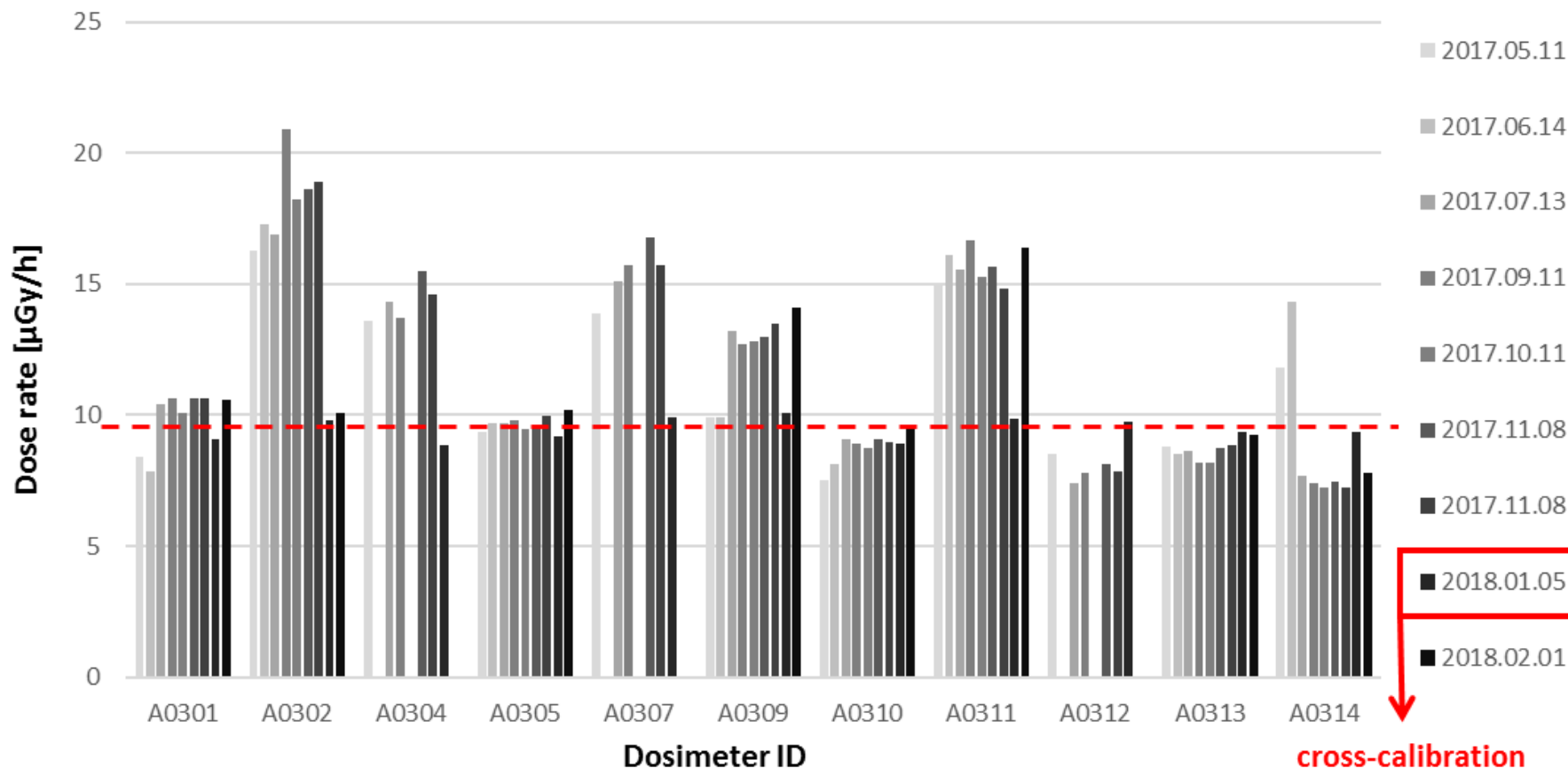
Credits: RSC Enyergia/Roskosmos

Results of April 2017 – February 2018

From 27 September 2016

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)
<i>A0307</i>	Docking port 1 (to module Pirs-1), hemisphere, on panel III, <i>RS EVA ref. dosim.</i>
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
<i>A0312</i>	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 (05/2017–02/2018)



EVA measurements

US EVA-42; May 12, 2017. 13:08–17:21 UTC; duration 4 hrs 13 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μ Gy] (time [h])	Total EVA dose [μ Gy]	Extra EVA dose [μ Gy]	Total EVA dose rate [μ Gy/h]	Extra dose rate [μ Gy/h]
A0312	379 (47.9)	33.4	-	7.9	-
A0304	563 (47.9)	217	184	51.5	43.6
A0307	681 (47.9)	335	302	79.5	71.6

US EVA-43; May 23, 2017. 12:20–14:06 UTC; duration 2 hrs 46 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μ Gy] / time [h]	Total EVA dose [μ Gy]	Extra EVA dose [μ Gy]	Total EVA dose rate [μ Gy/h]	Extra dose rate [μ Gy/h]
A0312	307 (43.1)	19.7	-	7.1	-
A0304	390 (43.1)	103	83	37.1	30.0
A0307	510 (43.1)	223	203	80.4	73.3

EVA measurements

RS EVA-43; Aug. 17, 2017. 14:36–22:10 UTC; duration 7 hrs 34 min 

Reference dosimeter: A0307 (Pirs)

Dosimeter	Total dose [μGy] (time [h])	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total EVA dose rate [$\mu\text{Gy/h}$]	Extra dose rate [$\mu\text{Gy/h}$]
A0307	558 (47.2)	89.5	-	11.8	-
A0310	891 (47.2)	422	333	55.8	44.0
A0313	1210 (47.2)	741	652	98.0	86.1

US EVA-44; Oct. 5, 2017. 12:05–19:00 UTC; duration 6 hrs 55 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μGy] / time [h]	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total EVA dose rate [$\mu\text{Gy/h}$]	Extra dose rate [$\mu\text{Gy/h}$]
A0312	363 (44.2)	56.8	-	8.2	-
A0306	247 (44.1)	38.8	-	5.6	-
A0304	465 (44.2)	159	102	23.0	14.7
A0307	590 (44.3)	284	227	41.0	32.8

EVA measurements

US EVA-45; Oct. 10, 2017. 12:56–19:22 UTC; duration 6 hrs 26 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μGy] (time [h])	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total EVA dose rate [$\mu\text{Gy/h}$]	Extra dose rate [$\mu\text{Gy/h}$]
A0312	432 (47.6)	58.4	-	9.1	-
A0306	289 (47.6)	39.0	-	6.1	-
A0304	464 (47.6)	90.4	32	14.1	5.0
A0307	572 (47.7)	198	140	30.8	21.8

US EVA-46; Oct. 20, 2017. 12:46–19:36 UTC; duration 6 hrs 49 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μGy] / time [h]	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total EVA dose rate [$\mu\text{Gy/h}$]	Extra dose rate [$\mu\text{Gy/h}$]
A0312	400 (46.0)	59.3	-	8.7	-
A0304	441 (46.0)	100	41	14.7	6.0
A0307	532 (46.0)	191	132	28.1	19.4

EVA measurements

US EVA-47; Jan. 23, 2018. 11:49–19:13 UTC; duration 7 hrs 24 min 

Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μ Gy] (time [h])	Total EVA dose [μ Gy]	Extra EVA dose [μ Gy]	Total EVA dose rate [μ Gy/h]	Extra dose rate [μ Gy/h]
A0312	422 (48.5)	64.4	-	8.7	-
A0306	365 (48.5)	55.7	-	7.5	-
A0304	589 (48.5)	231	167	31.3	22.6
A0307	734 (48.5)	376	312	50.9	42.2

RS EVA-44; Feb. 2, 2018. 15:34–23:47 UTC; duration 8 hrs 13 min 

Reference dosimeter: A0317 (Pirs)

Dosimeter	Total dose [μ Gy] / time [h]	Total EVA dose [μ Gy]	Extra EVA dose [μ Gy]	Total EVA dose rate [μ Gy/h]	Extra dose rate [μ Gy/h]
A0307	588 (53.1)	91.0	-	11.1	-
A0306	397 (53.6)	60.9	-	7.4	-
A0310	1150 (53.2)	653	562	79.4	68.4
A0313	1280 (53.2)	783	692	95.3	84.2

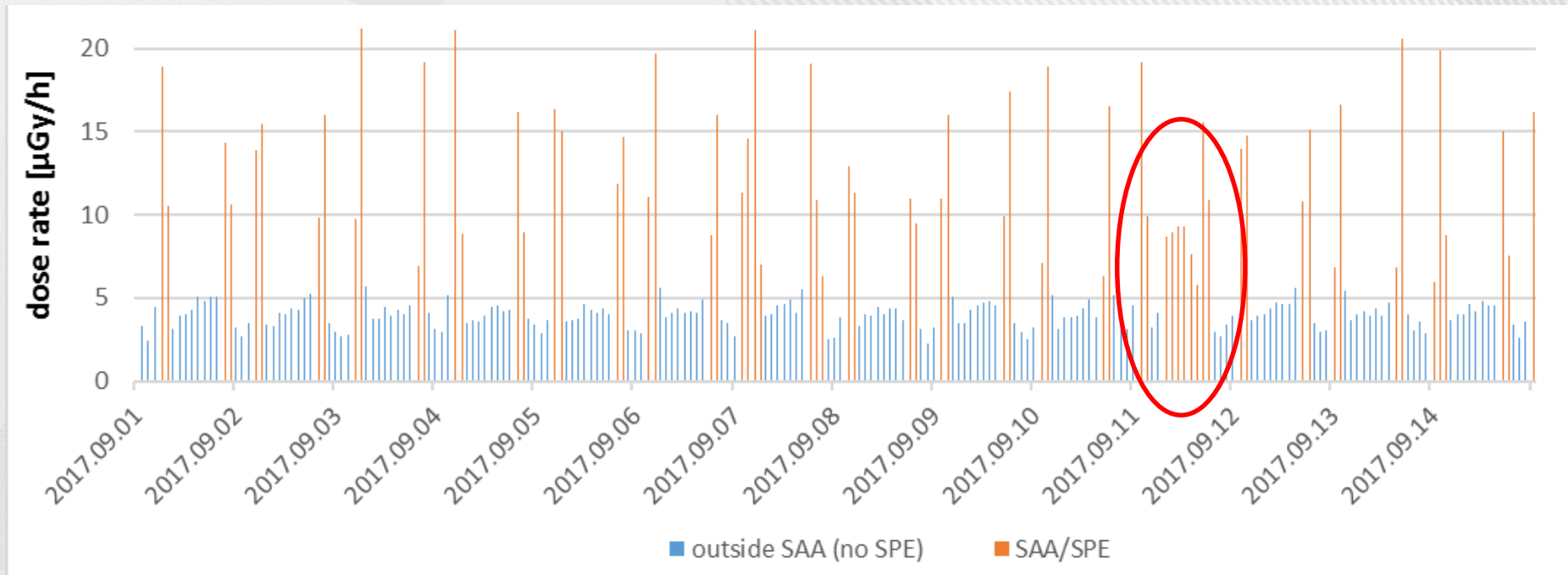
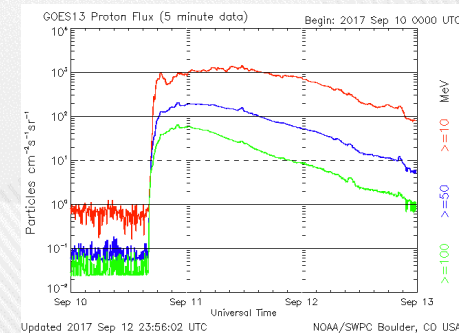
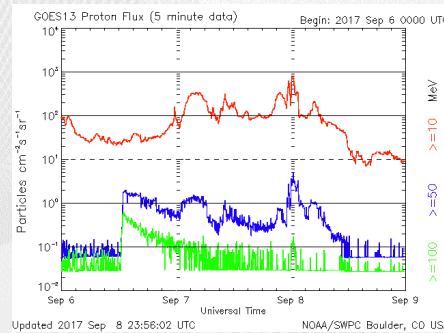
EVA measurements

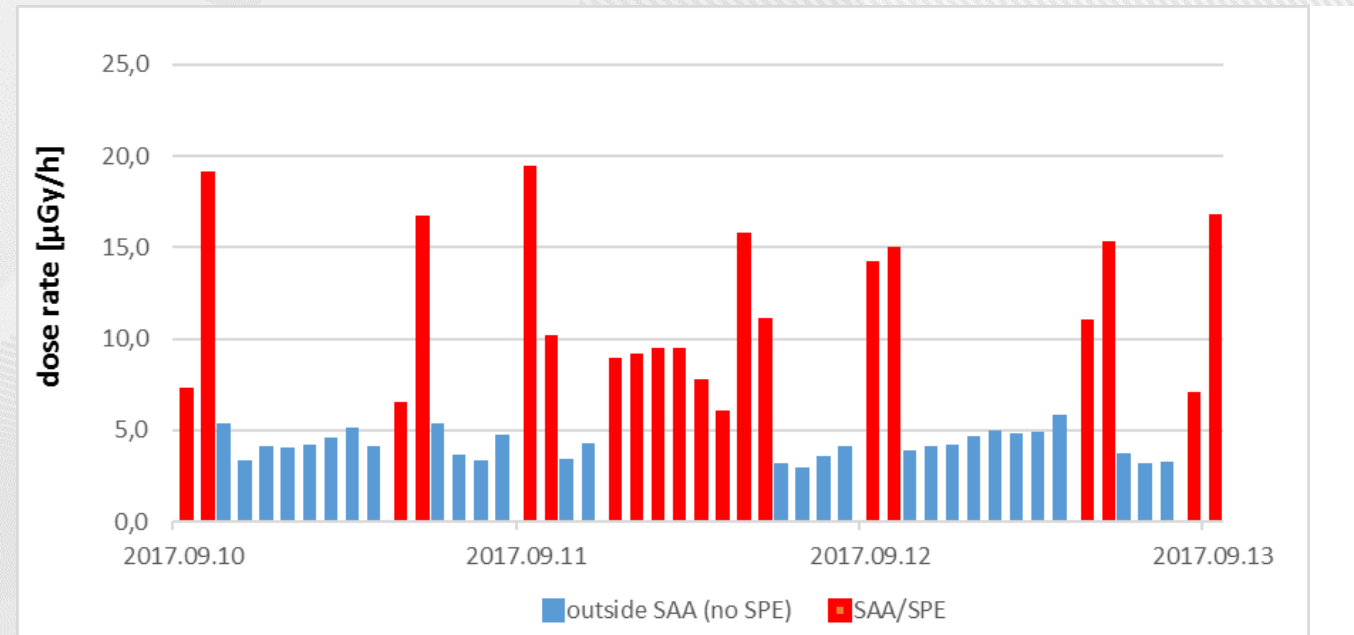
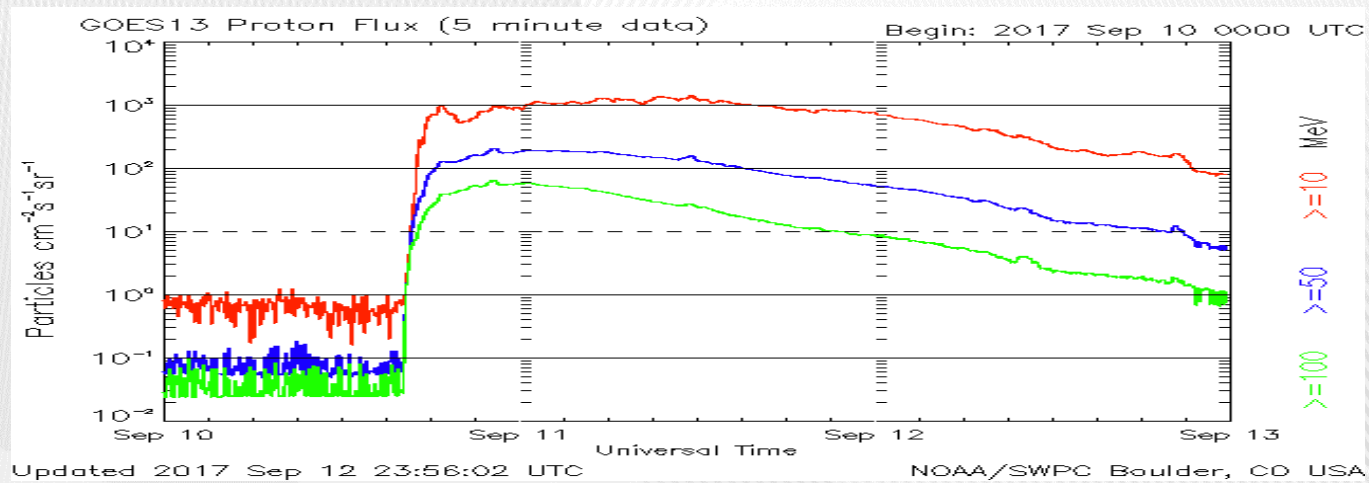
US EVA-48; Feb. 16, 2018. 12:00–17:57 UTC; duration 5 hrs 57 min 

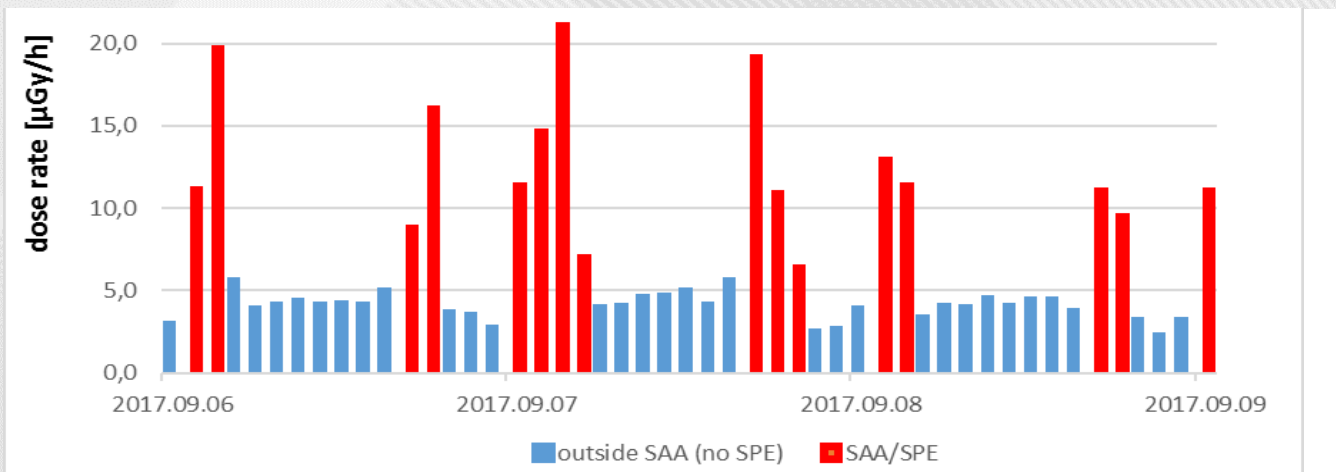
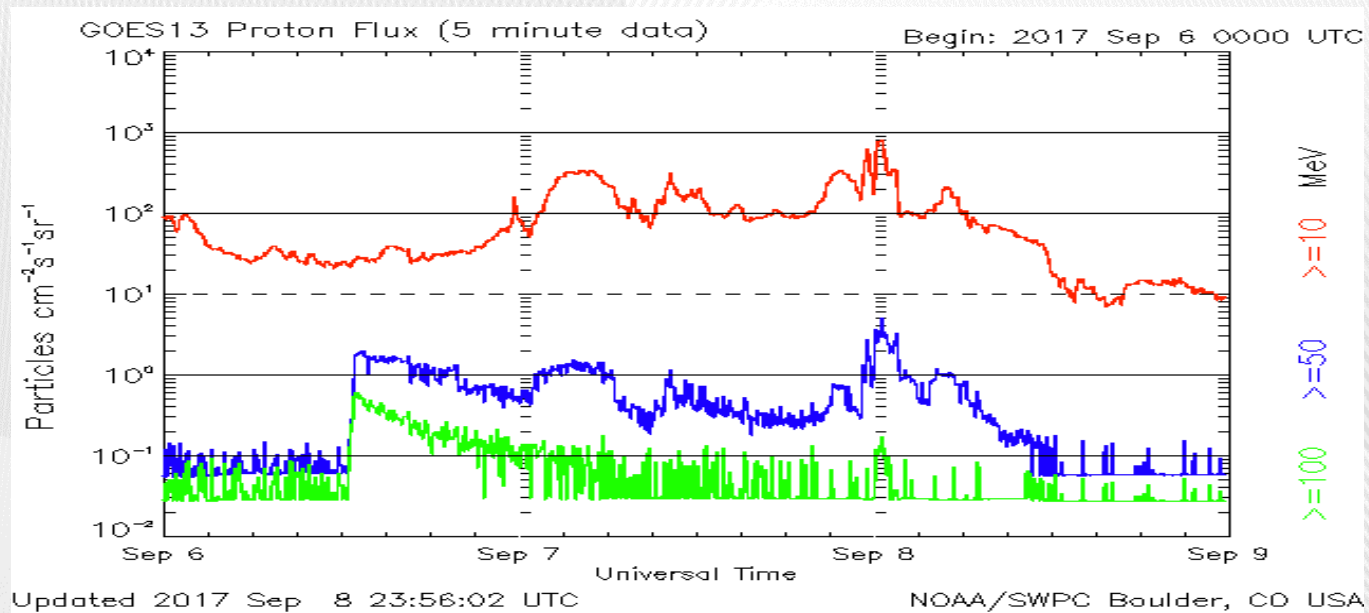
Reference dosimeter: A0312 (NODE-2)

Dosimeter	Total dose [μGy] (time [h])	Total EVA dose [μGy]	Extra EVA dose [μGy]	Total EVA dose rate [$\mu\text{Gy/h}$]	Extra dose rate [$\mu\text{Gy/h}$]
A0312	473 (51.4)	54.8	-	9.2	-
A0304	500 (51.5)	81.8	27.0	13.7	4.5
A0307	624 (51.4)	206	151	34.6	25.4

Pille A0306 automatic measurements during SPE







Brief status on the new Pille Reader on board

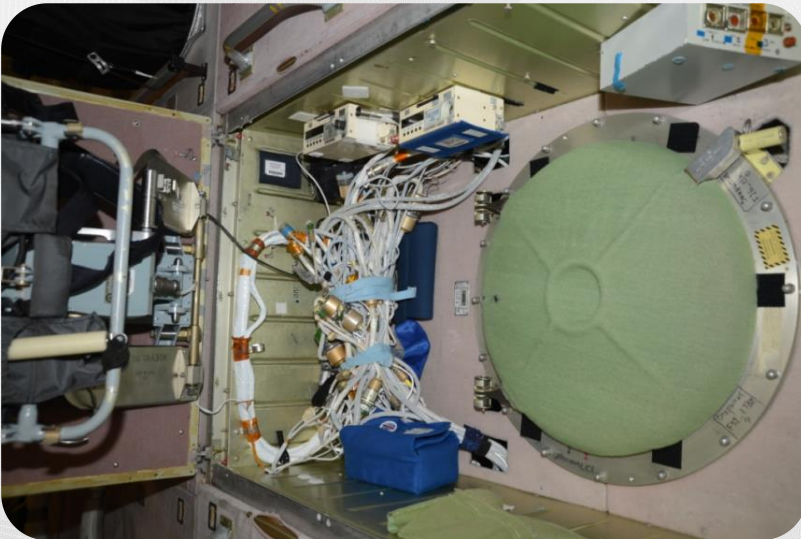
New Pille Reader on ISS

- Warranty period of the Pille reader is over
- FM2 reader + 8 additional dosimeters passed acceptance tests
- Delivery to ISS with Soyuz MS-09 in June 2018



New Pille Reader on ISS

- Currently 12 + 8 dosimeters (and 1+1 readers) on board
- Cross-comparison of old/new dosimeters & readers ongoing



Credits: RSC Enyergia/Roskosmos



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Thank you for your attention!

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