DOSIS & DOSIS 3D onboard the ISS
Status and Science Overview from 2009 - 2019

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DOSIS & DOSIS 3D: Science Team

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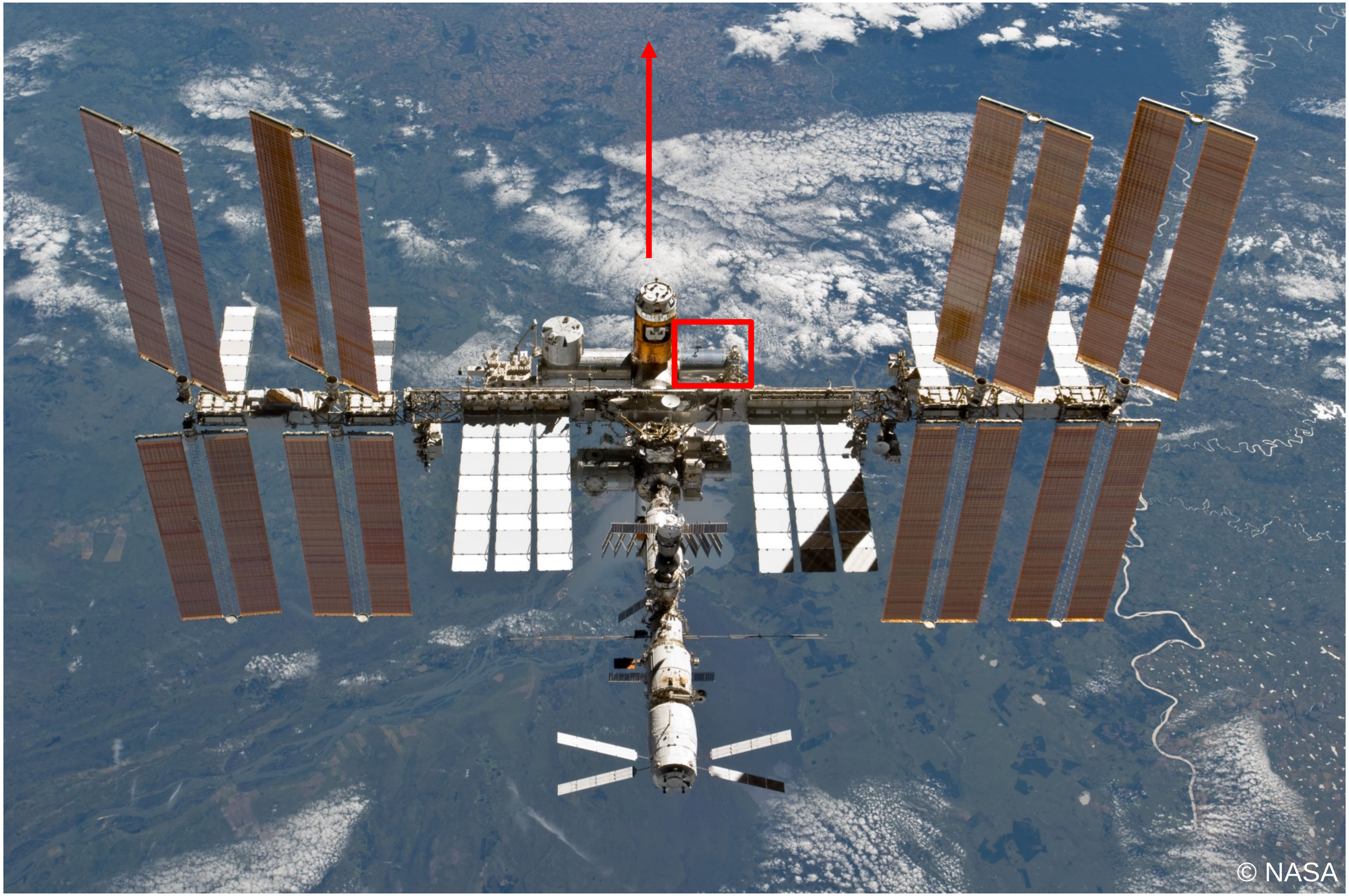
[1]DLR	German Aerospace Center	Cologne, Germany
[2]CAU	Christian Albrechts Universität zu Kiel	Kiel, Germany
[3]IFJ	Institute of Nuclear Physics	Krakow, Poland
[4]IAEA	International Atomic Energy Agency	Vienna, Austria
[5]ATI	Technical University Vienna	Vienna, Austria
[6]MTA EK	Centre for Energy Research	Budapest, Hungary
[7]NPI	Nuclear Physics Institute	Prague, Czech Republic
[8]SCK•CEN	Belgian Nuclear Research Center	Mol, Belgium
[9]NASA	Space Radiation Analysis Group	Houston, United States
[10]OSU	Oklahoma State University	Stillwater, United States
[11]NIRS	National Institute of Radiological Sciences	Chiba, Japan
[12]IMBP	Russian Academy of Sciences	Moscow, Russia
[13]JAXA	Japan Aerospace Exploration Agency	Tsukuba, Japan
[14]OHB System AG	OHB System AG	Bremen, Germany
[15]Leidos	Leidos Innovations Corporation, Houston, TX, USA	Houston, United States
[16]ESA-ESTEC	European Space Agency	Noordwijk, The Netherlands

DOSIS & DOSIS 3D: Columbus

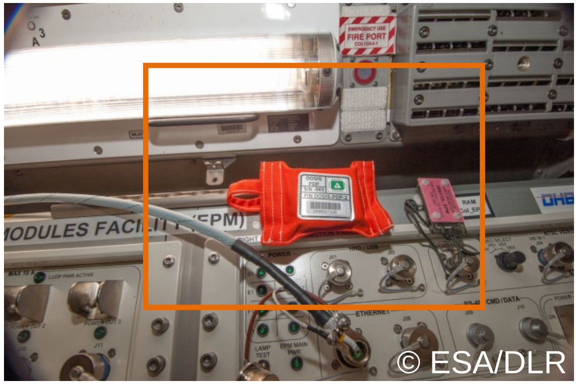


DOSIS & DOSIS 3D: Scientific Goals

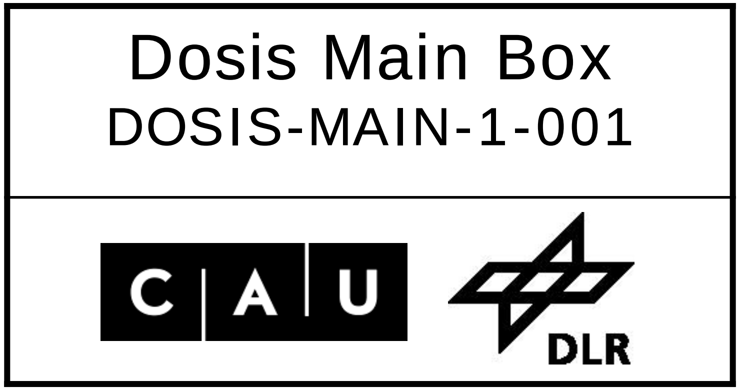
The main objective of the **DOSIS & DOSIS 3D** experiment is the determination of the absorbed dose and dose equivalent using a variety of active and passive radiation detector devices distributed throughout the ISS.

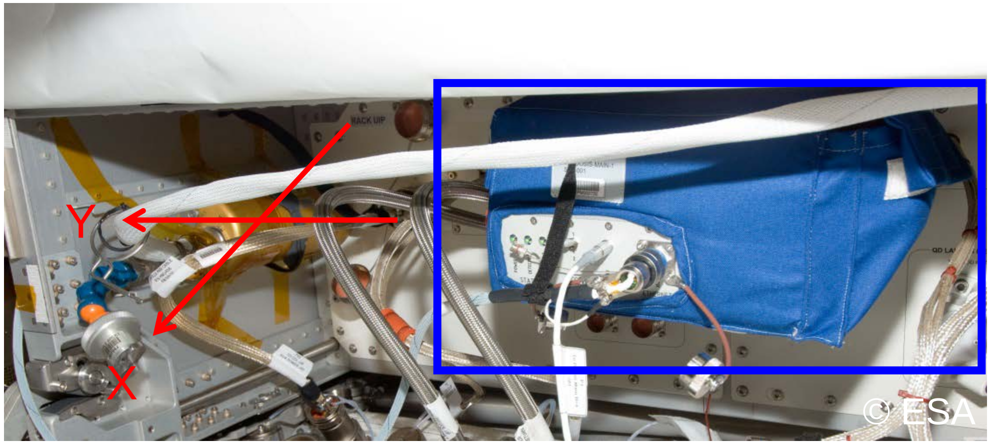
- Monitor the radiation environment inside Columbus with **active** and **passive** radiation detectors for the determination of the temporal and spatial dose distribution

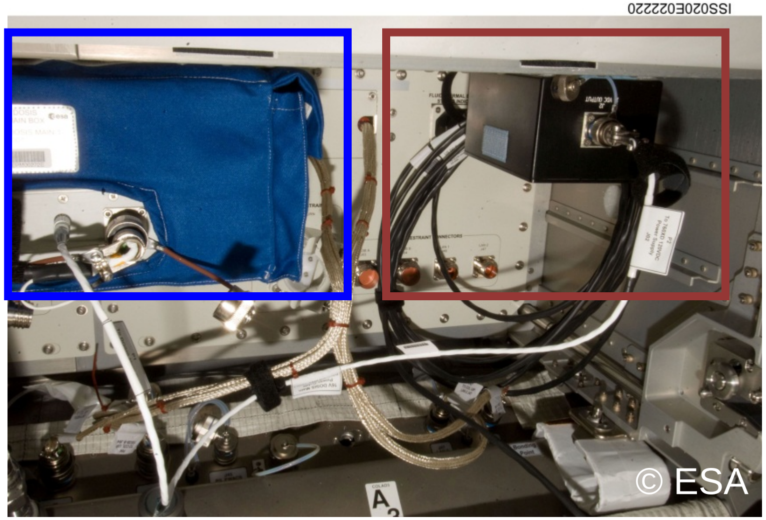
- Combine data gathered by NASA, JAXA, IMBP into a 3D radiation map of the International Space Station



DOSIS & DOSIS 3D: Active detectors (2 x DOSimetry TELescope)

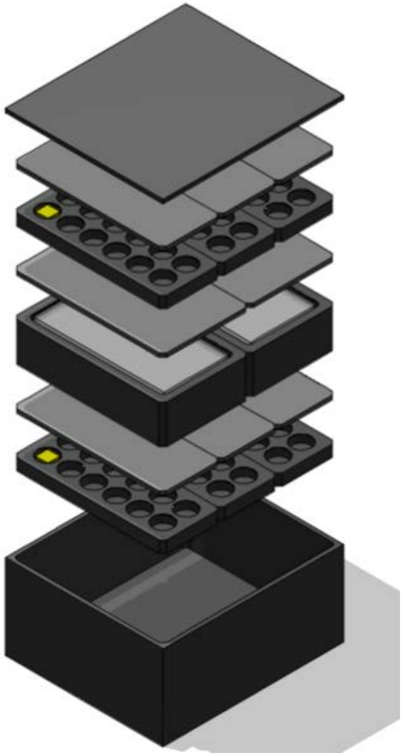


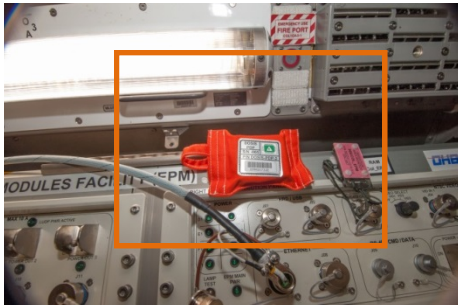


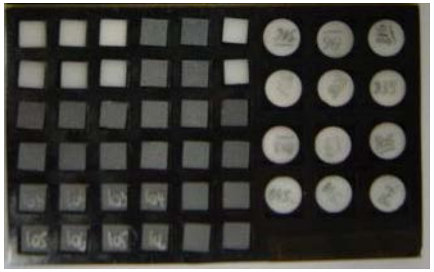


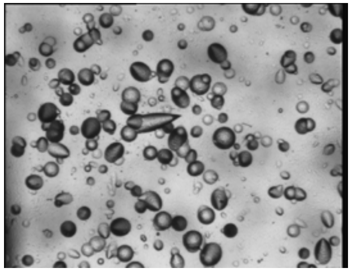
- Ethernet connection to EPM rack "Right Utility Distribution Panel“
- DOSIS-MAIN-BOX connected to EPM LAN like an external EPM instrument
- Data downlink is an EPM operation from ground performed once per month over CADMOS – COLCC – MUSC – Scientists
- Up to 28th August 2019: 85 data downlinks (**DOSIS 3D**)

DOSIS & DOSIS 3D: Passive Detector Packages (PDP)









Thermoluminescence detectors (TLD) / OSLD

First usage of LiF (Lithiumfluoride) for the measurement of radiation following an atomic weapon test

Measurement of internal radiation dose received by cancer patients treated with radioactiv isotopes at Oak Ridge Institute for Nuclear Studies

F. Daniels *Science* 117, 343, 1953

Nuclear Track Etch Detectors (CR-39)

Material : CR-39 = allyl diglycol carbonate

Heavy charged particles break chemical bonds in the material.This trail can be made visible by etching the material.

R. P. Henke and E. V. Benton, Nucl.Instr.Meth. 97 (1971) 483-9

TLD/OSLD + CR-39 → Absorbed dose + Dose Equivalent

DOSIS & DOSIS 3D: PDP Positions

PDP Nr	Columbus Location	Related Rack	Position		Columbus coordinate system [cm]		
					X	Y	Z
1	Star Cone	-	Behind bend in right cone structure	Aft	681	-57	0
2	A4 UIP	HRF 2	Left side on UIP next to Vacuum connector	Aft	665	-123	-93
3	F4 UIP	HRF 1	Left side on UIP next to Vacuum connector	Forward	570	123	-93
4	B1 HRF 1	HRF 1	Front panel of Cooling Stowage Drawer	Forward	600	104	60
5	A3 EPM	EPM	410 mm left from upper right edge	Aft	463	-104	93
6	A2 UIP	BLB	Left side on UIP next to Vacuum connector	Aft	436	-123	-93
7	O2 UIP	-	Left side on UIP next to Vacuum connector	Aft	436	-101	106
8	F1 UIP	EDR	Left side on UIP next to Vacuum connector	Forward	243	123	-93
9	F1 EDR	EDR	77 mm left from upper right edge	Forward	333	104	93
10	End Cone	-	On PBA Cover	Forward	221	95	85
X	DOSIS-MAIN-BOX	EPM	On the left side of the DOSIS-MAIN-BOX	Aft	516	-116	-60

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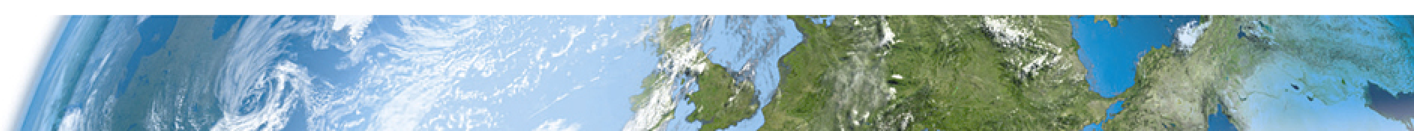
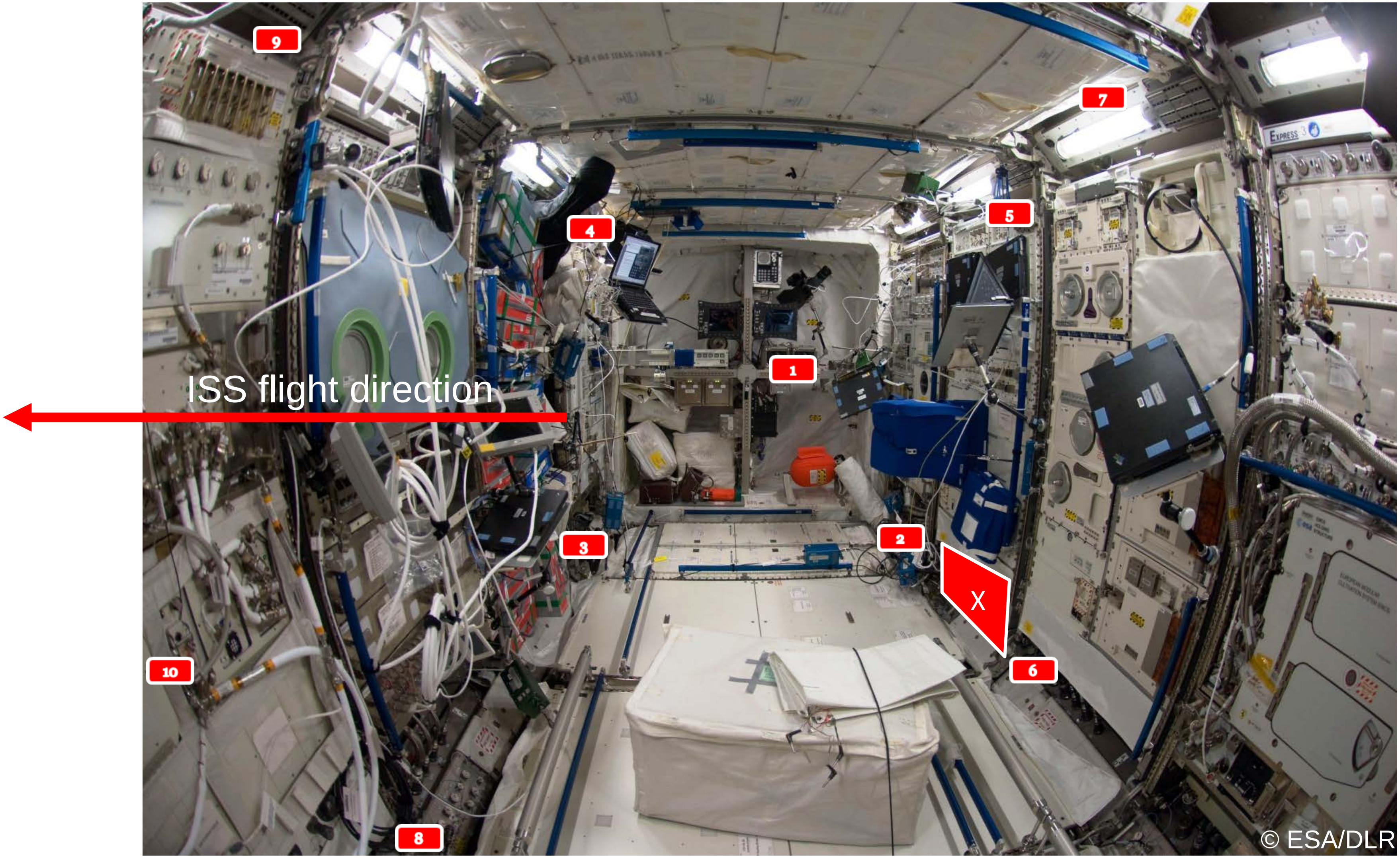
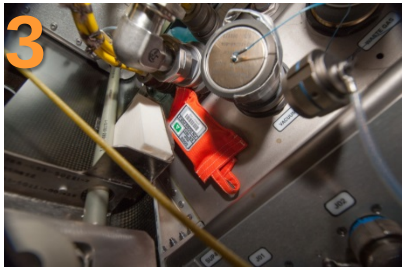
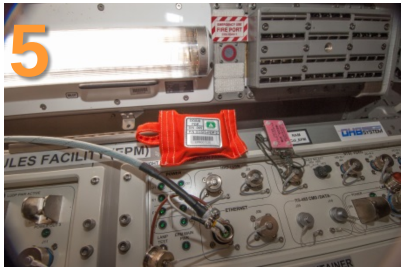


DOSIS & DOSIS 3D: PDP Positions

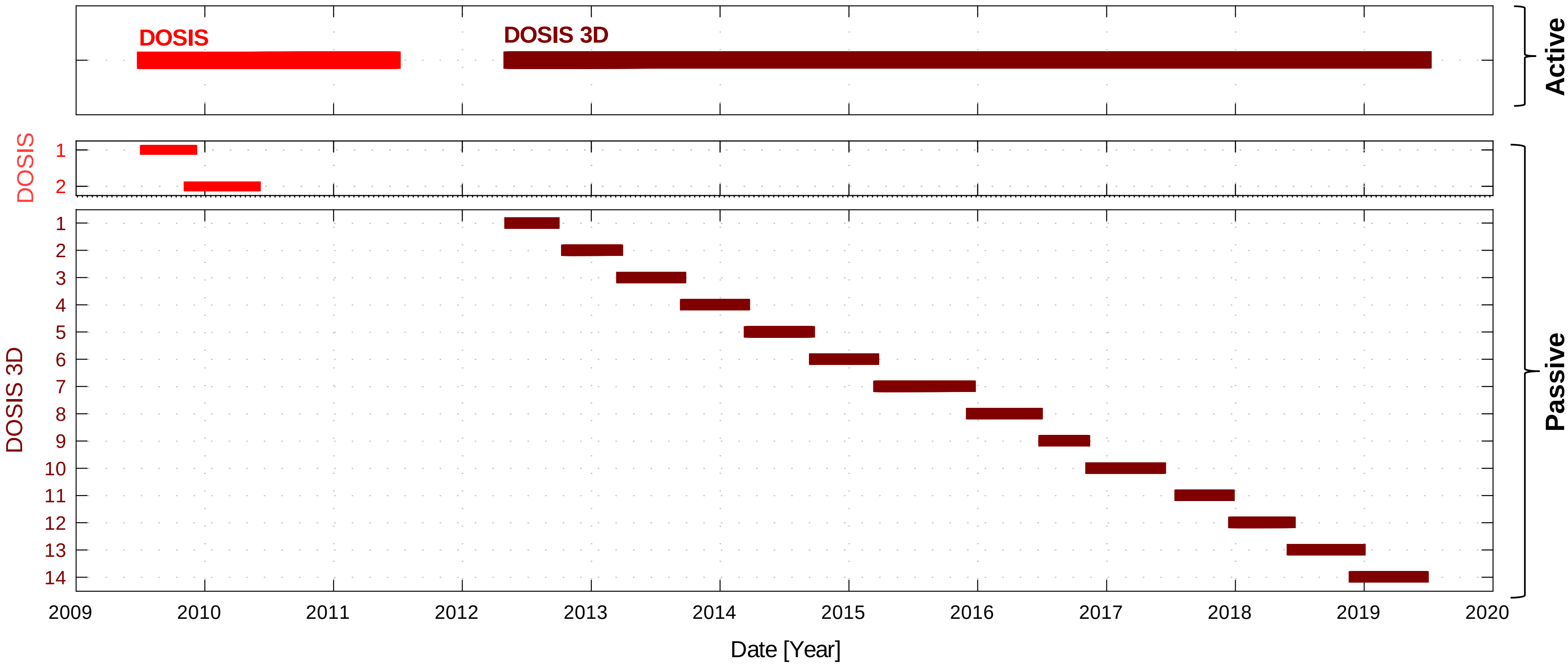


DOSIS & DOSIS 3D: PDP Positions





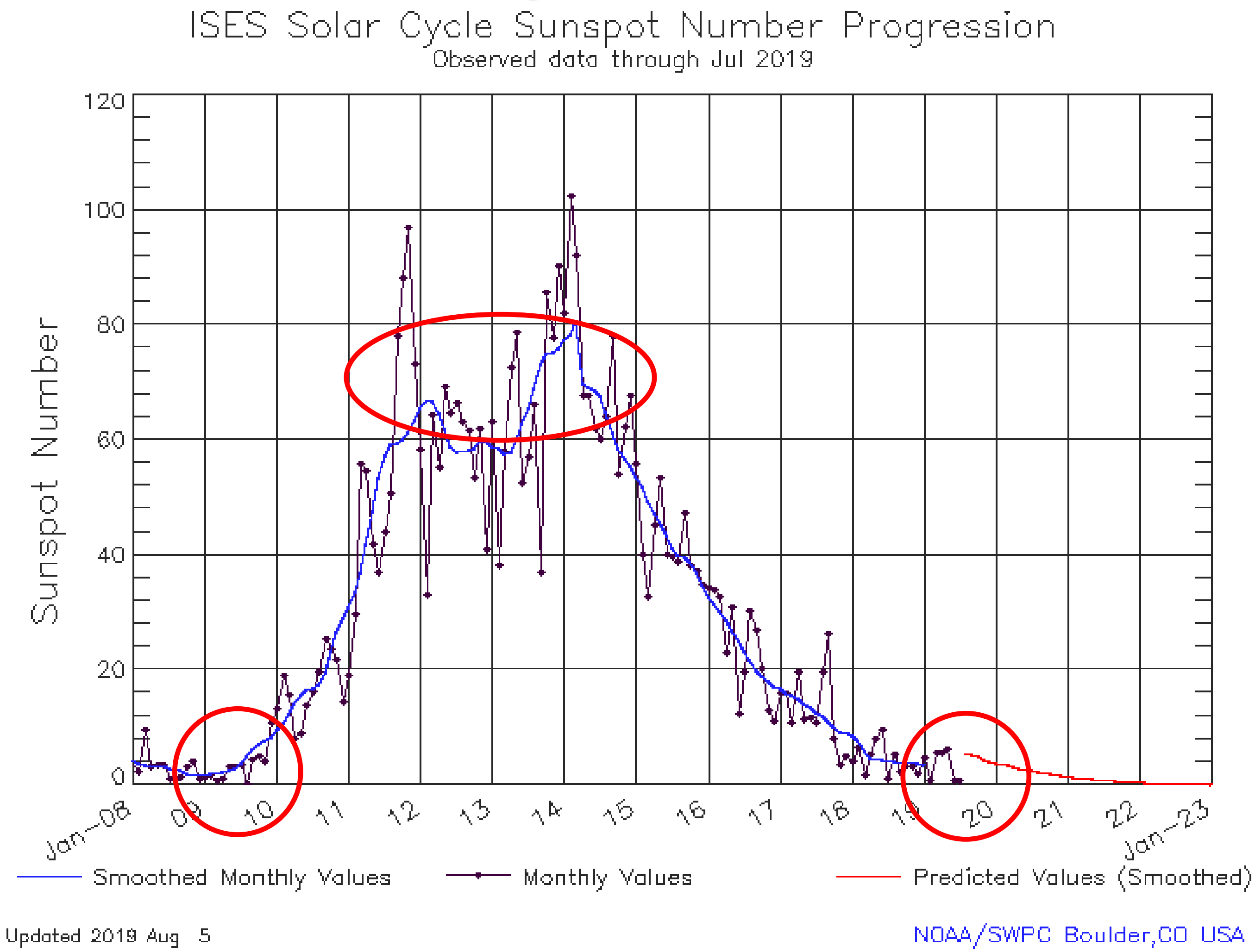
DOSIS & DOSIS 3D: Timeline



DOSIS 3D: Timeline → Passive

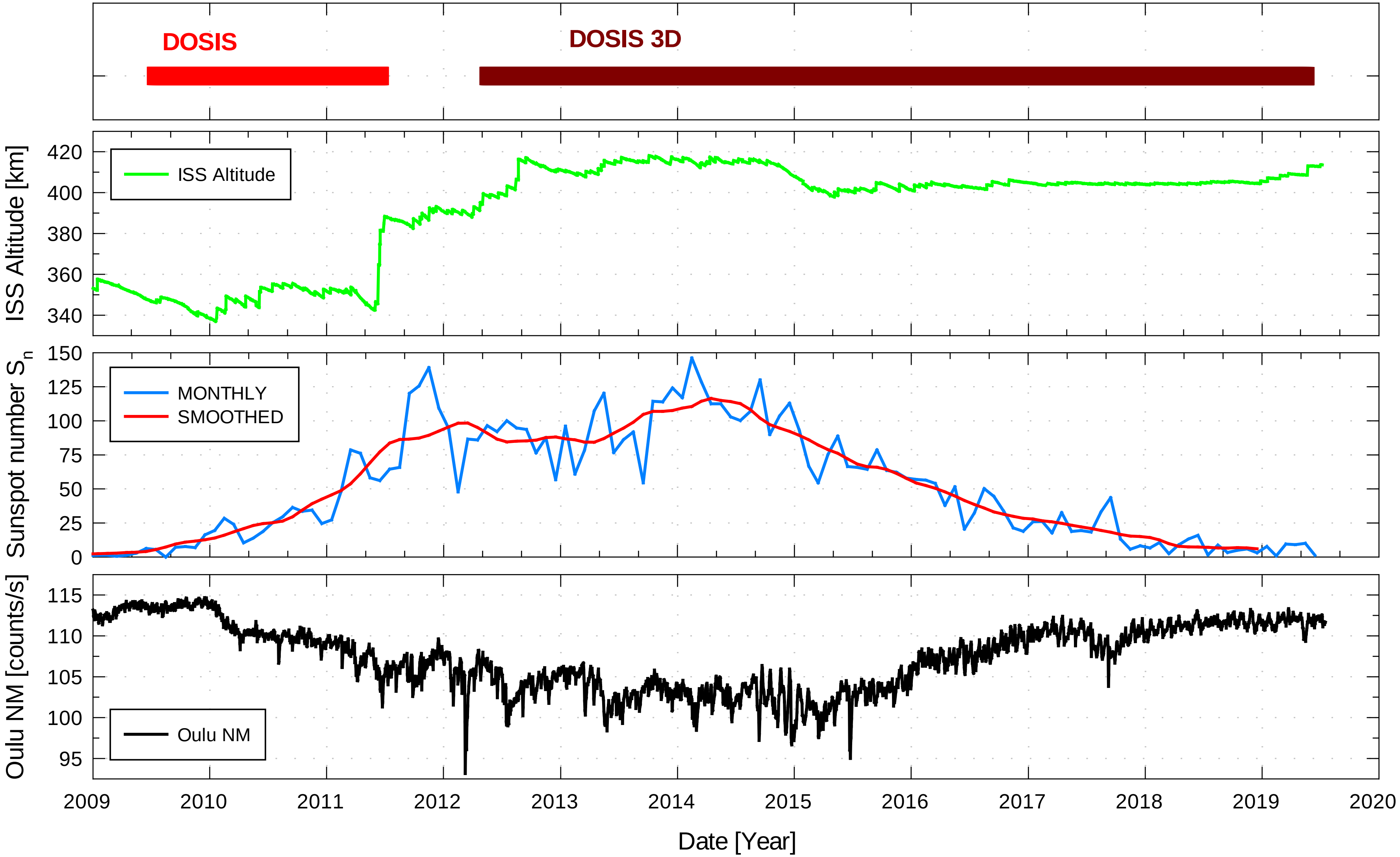
DOSIS 3D	Soyuz	Launch	Docking	Installation	Crew Member	Deinstallation	Crew Member	Landing	Mission duration	PDP installed	Percentage
1	30S	15.05.2012	17.05.2012	21.05.2012	Andre Kuipers	11.09.2012	Joe Acaba	17.09.2012	125	113	90,40
2	32S	23.10.2012	25.10.2012	27.10.2012	Sunita Williams	13.03.2013	Chris Hadfield	16.03.2013	144	137	95,14
3	34S	28.03.2013	29.03.2013	03.04.2013	Chris Cassidy	06.09.2013	Luca Parmitano	11.09.2013	167	156	93,41
4	36S	25.09.2013	26.09.2013	01.10.2013	Michael Hopkins	06.03.2014	Rick Mastracchio	11.03.2014	167	156	93,41
5	38S	25.03.2014	27.03.2014	28.03.2014	Koichi Wakata	05.09.2014	Alexander Gerst	11.09.2014	170	161	94,71
6	40S	26.09.2014	27.09.2014	29.09.2014	Alexander Gerst	09.03.2015	Samantha Cristoforetti	12.03.2015	167	161	96,41
7	42S	27.03.2015	28.03.2015	29.03.2015	Samantha Cristoforetti						
	43S					10.12.2015	Scott Kelly	11.12.2015	259	256	98,84
8	45S	15.12.2015	15.12.2015	18.12.2015	Scott Kelly	15.06.2016	Timothy Peake	18.06.2016	186	180	96,77
9	47S	07.07.2016	09.07.2016	09.07.2016	Jeffrey Williams	26.10.2016	Takuya Onishi	30.10.2016	115	109	94,78
10	49S	17.11.2016	19.11.2016	21.11.2016	Thomas Pesquet	01.06.2017	Thomas Pesquet	02.06.2017	197	192	97,46
11	51S	28.07.2017	28.07.2017	30.07.2017	Jack Fischer	12.12.2017	Mark Vande Hei	14.12.2017	139	135	97,12
12	53S	17.12.2017	19.12.2017	20.12.2017	Norishige Kanai	30.05.2018	Andrew Feustel	03.06.2018	168	161	95,83
13	55S	06.06.2018	08.06.2018	11.06.2018	Alexander Gerst	03.12.2018	Alexander Gerst	20.12.2018	197	175	88,83
14	57S	03.12.2018	03.12.2018	04.12.2018	Alexander Gerst	19.06.2019	Nick Hague	24.06.2019	203	197	97,04
15	59S	20.07.2019	21.07.2019	22.07.2019	Luca Parmitano						
	61S							01.04.2020	256		

DOSIS & DOSIS 3D: Solar Cycle

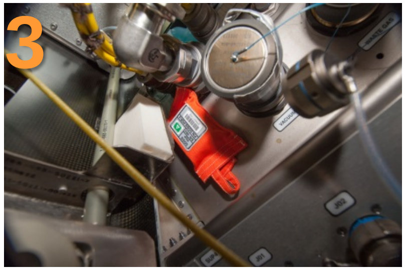


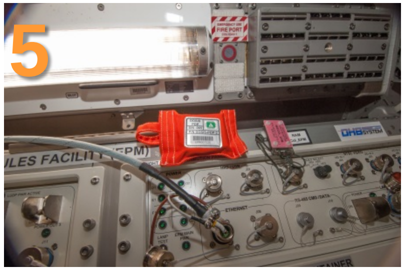
http://www.swpc.noaa.gov/products/solar-cycle-progression

DOSIS & DOSIS 3D: Timeline / ISS Altitude / S_n / Oulu NM



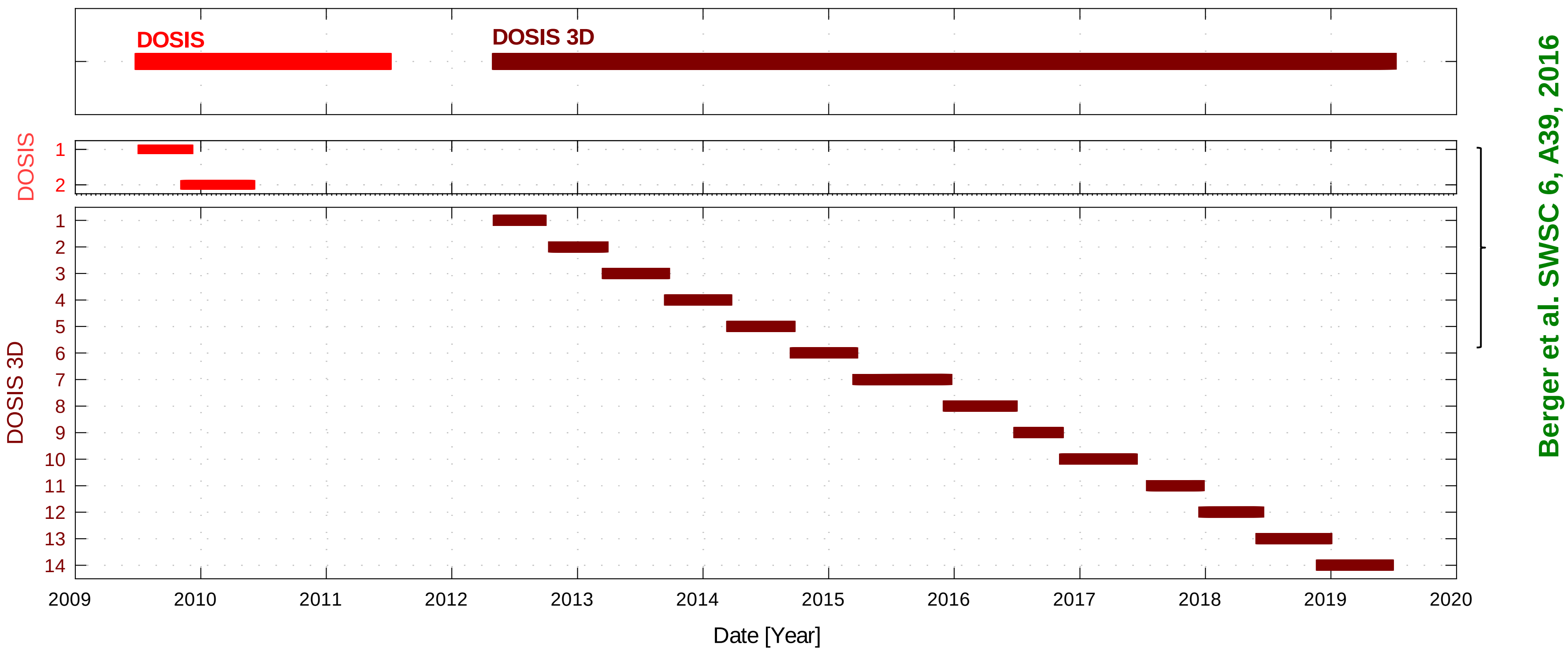
DOSIS & DOSIS 3D: PDP – Results





DOSIS & DOSIS 3D: PDP – Results

Published: D1-D2 & D3D1 – D3D6 (July 2009 – March 2015)



DOSIS & DOSIS 3D: PDP – Results → Publication

J. Space Weather Space Clim., 6, A39 (2016)
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SWSC

RESEARCH ARTICLE — OPEN ACCESS

DOSIS & DOSIS 3D: long-term dose monitoring onboard the Columbus Laboratory of the International Space Station (ISS)

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https://www.swsc-journal.org/articles/swsc/full_html/2016/01/swsc160033/swsc160033.html

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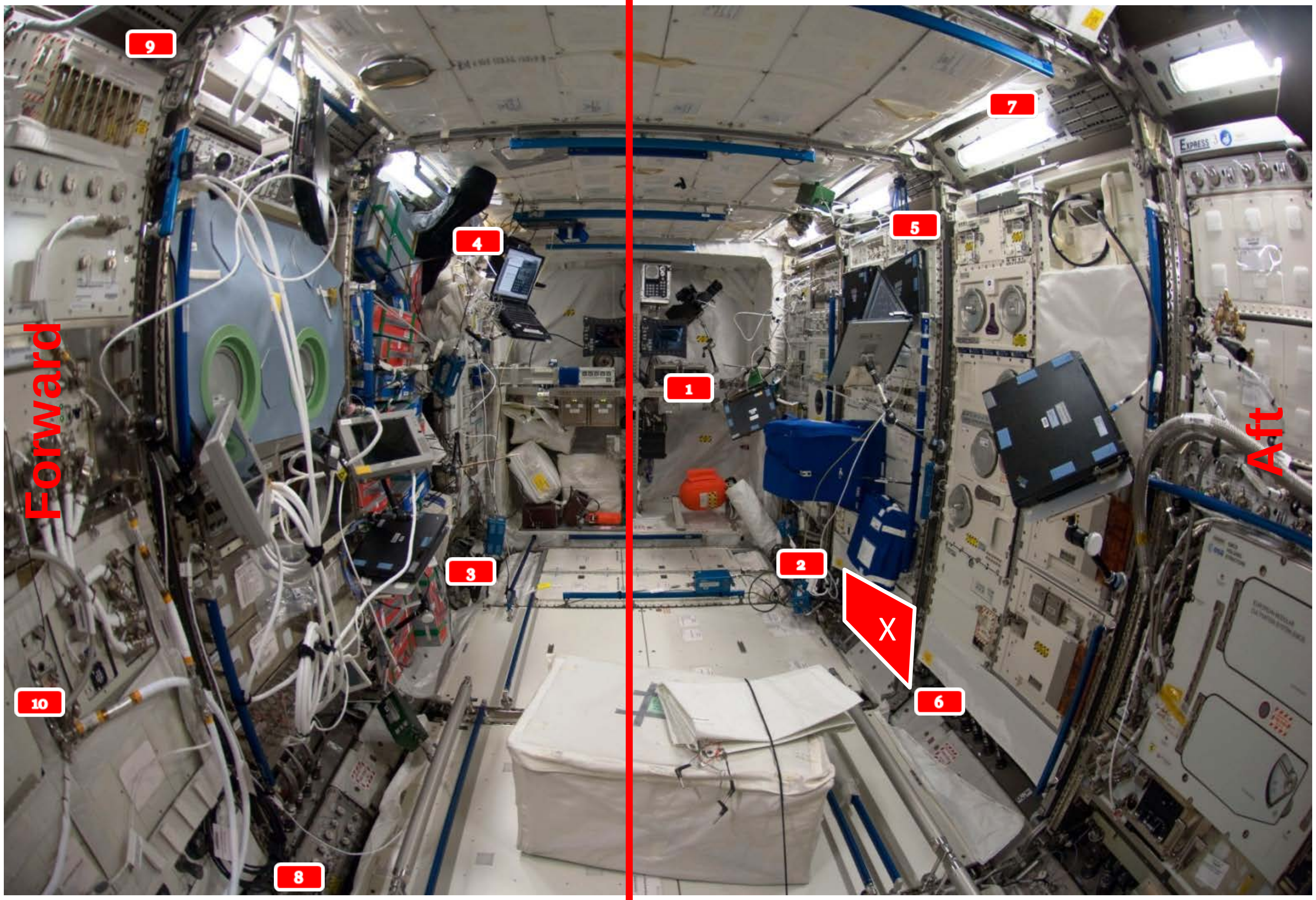
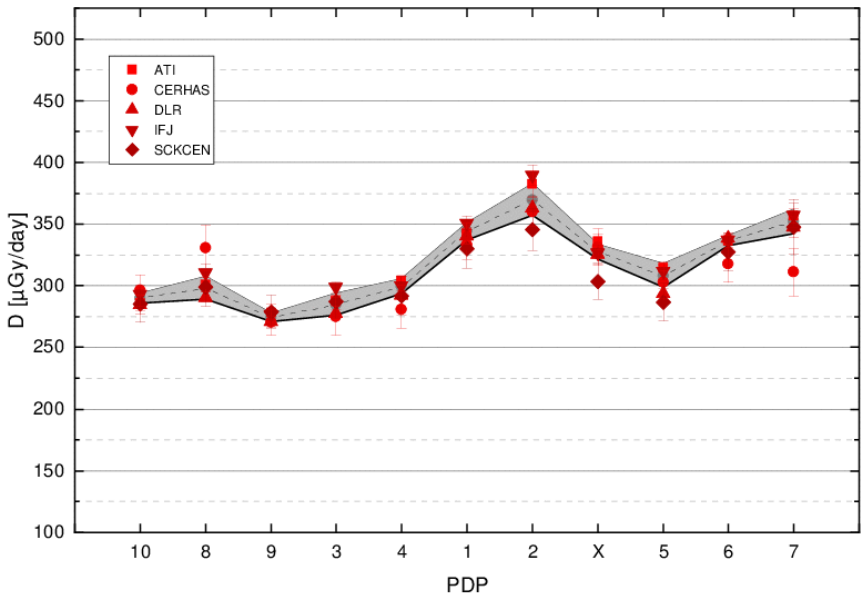
DOSIS & DOSIS 3D: PDP – Results (Selected TLD)

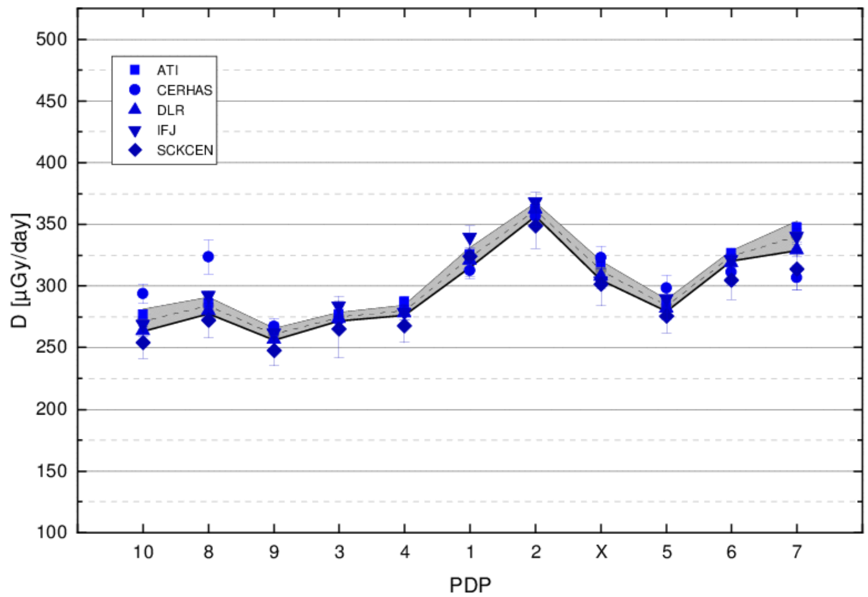


DLR ATOMINSTITUT SCK•CEN mtaEK NIRS OKLAHOMA STATE UNIVERSITY NASA Nuclear Physics Institute of the CAS public research institution

DOSIS 3D: PDP – Results (D3D#1 to D3D#14)

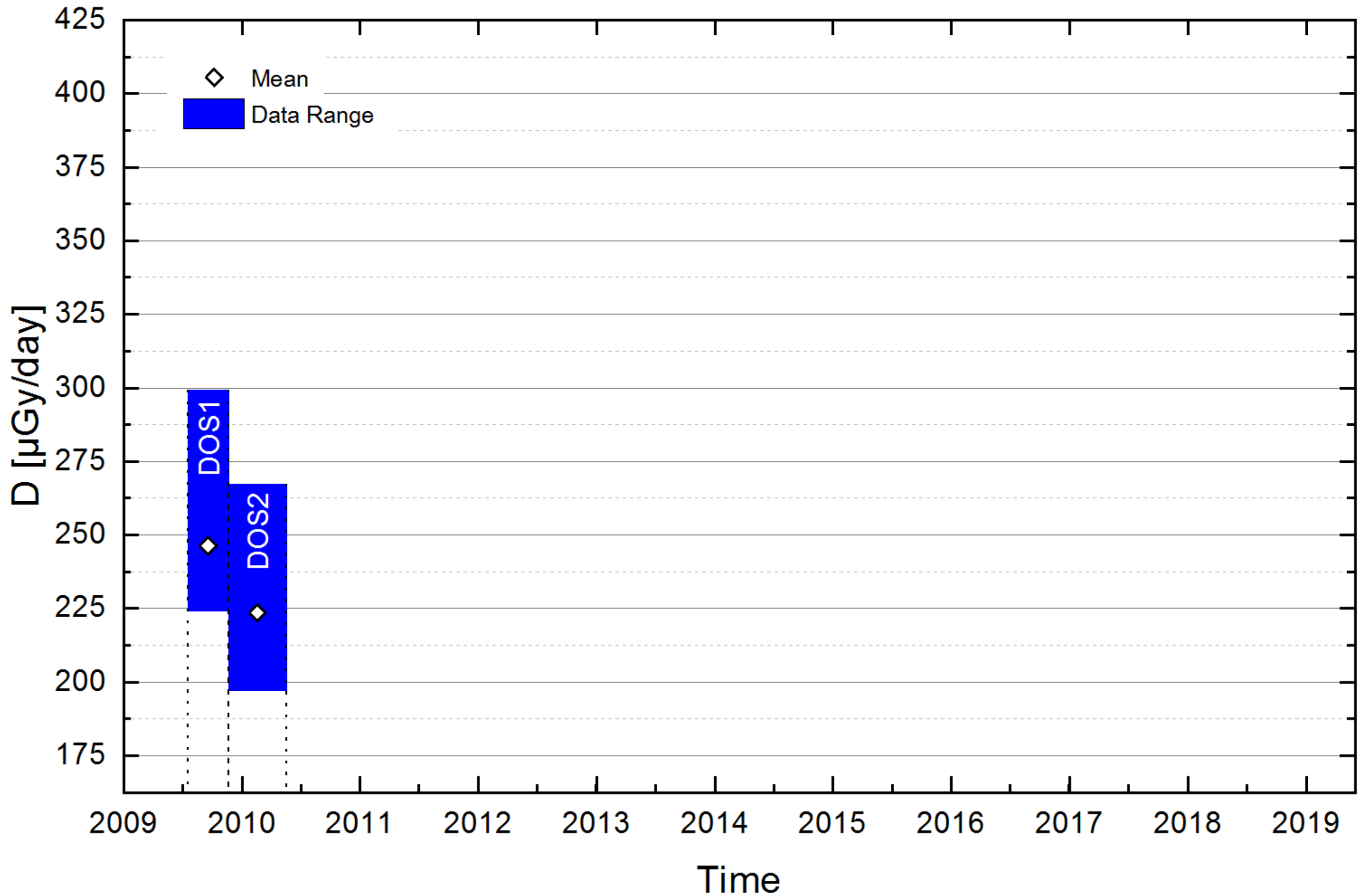


^{6}LiF:Mg,Ti

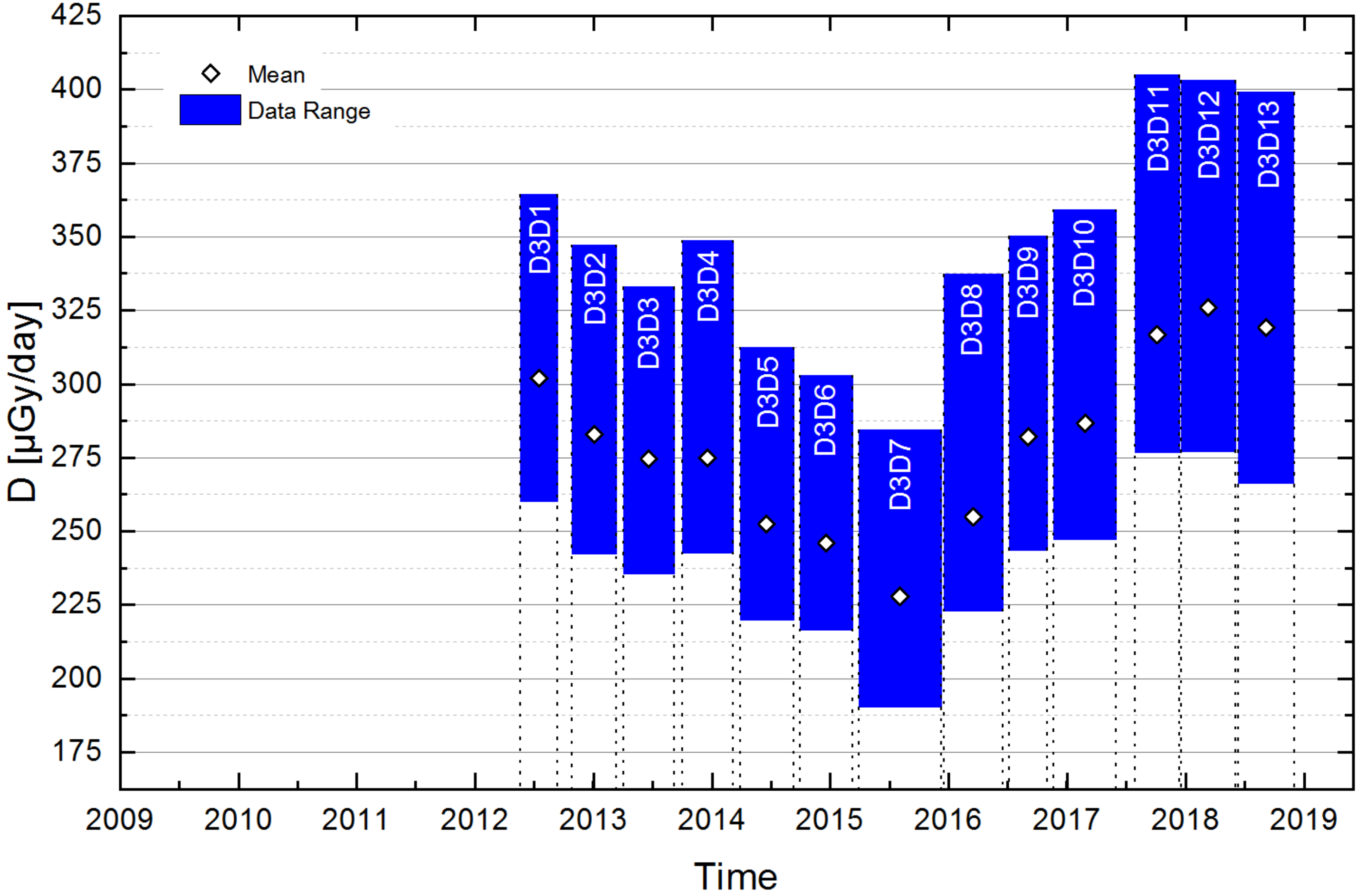


^{7}LiF:Mg,Ti

DOSIS & DOSIS 3D: PDP – Results



DOSIS & DOSIS 3D: PDP – Results



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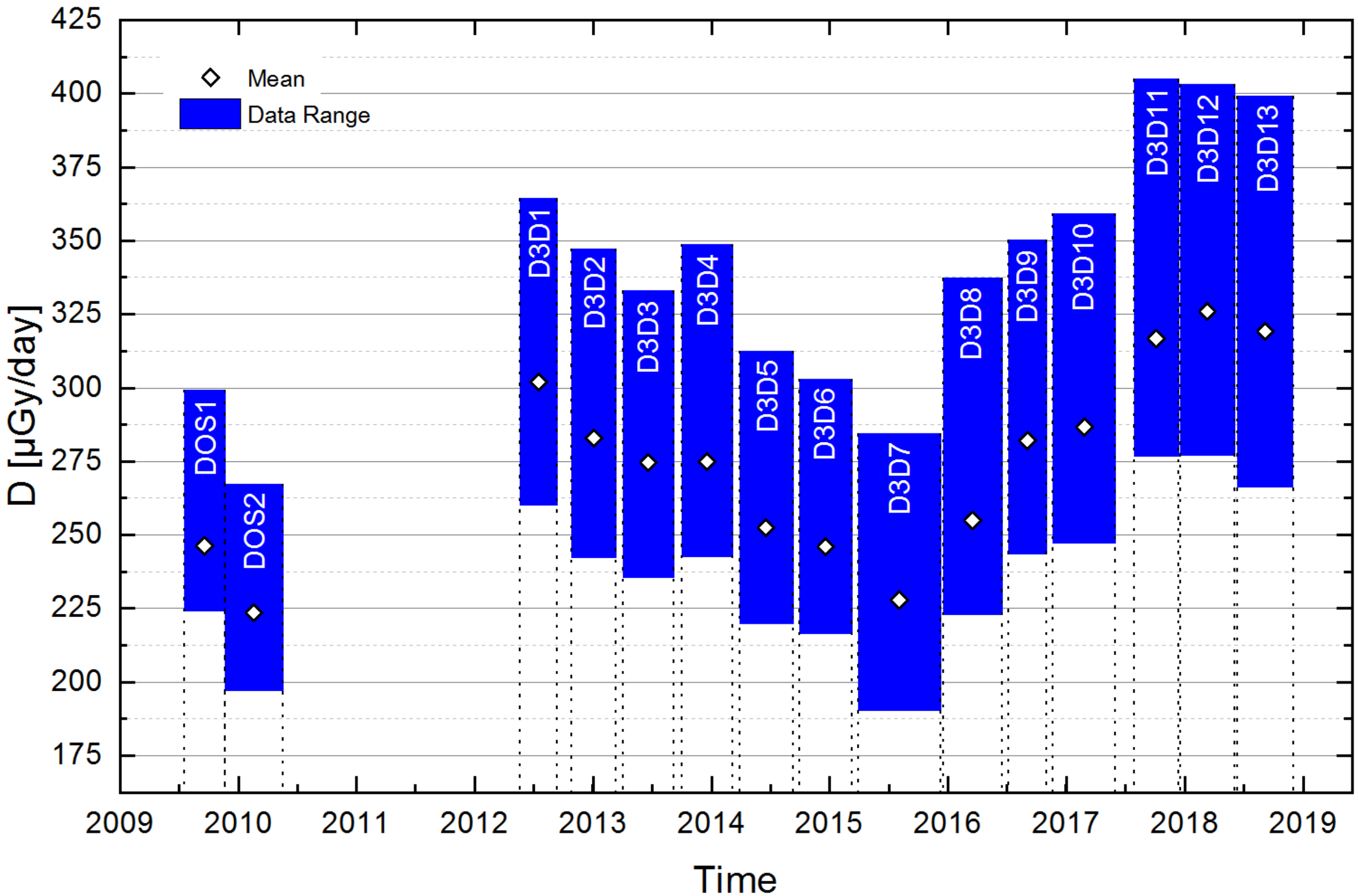
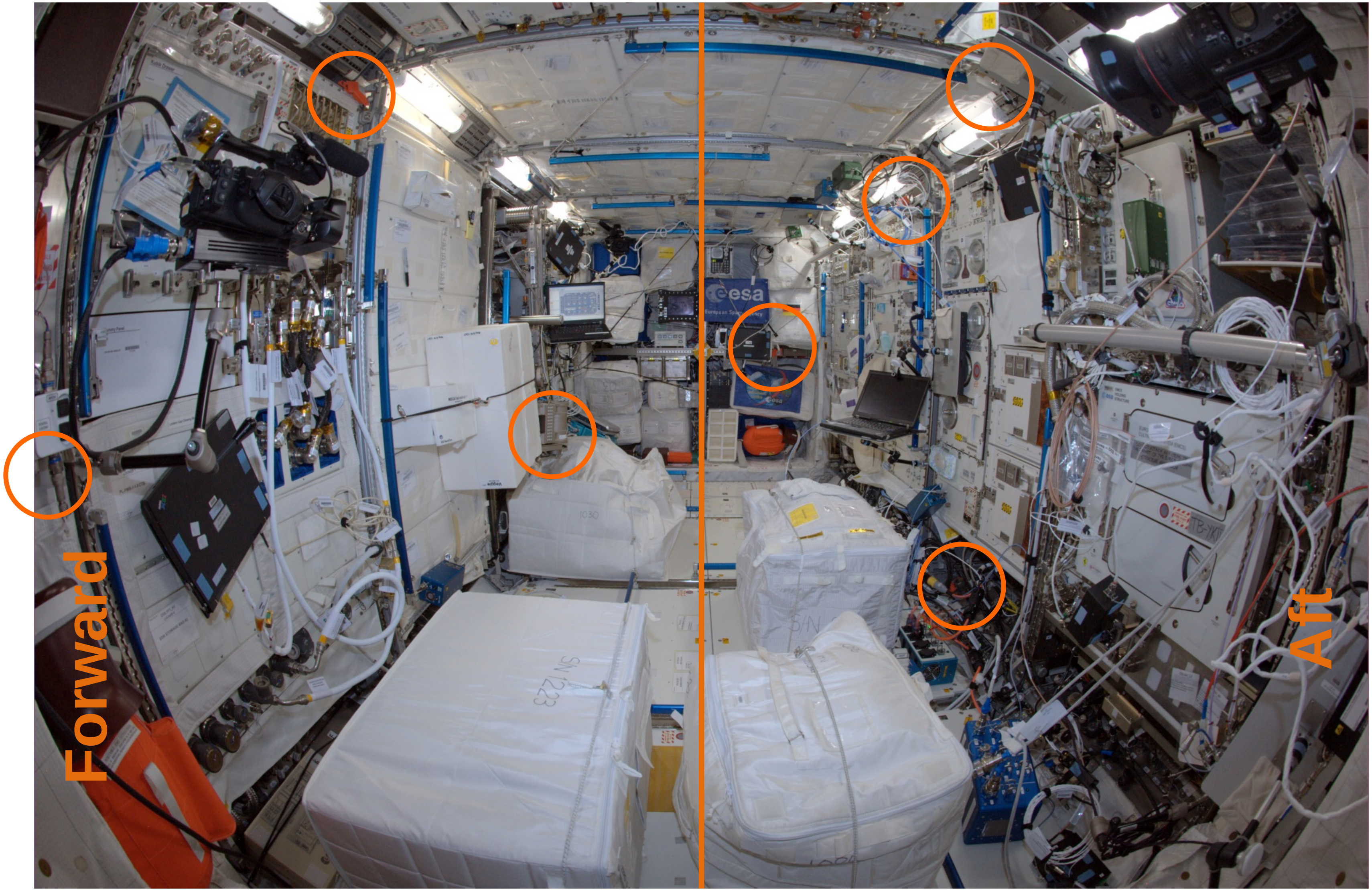
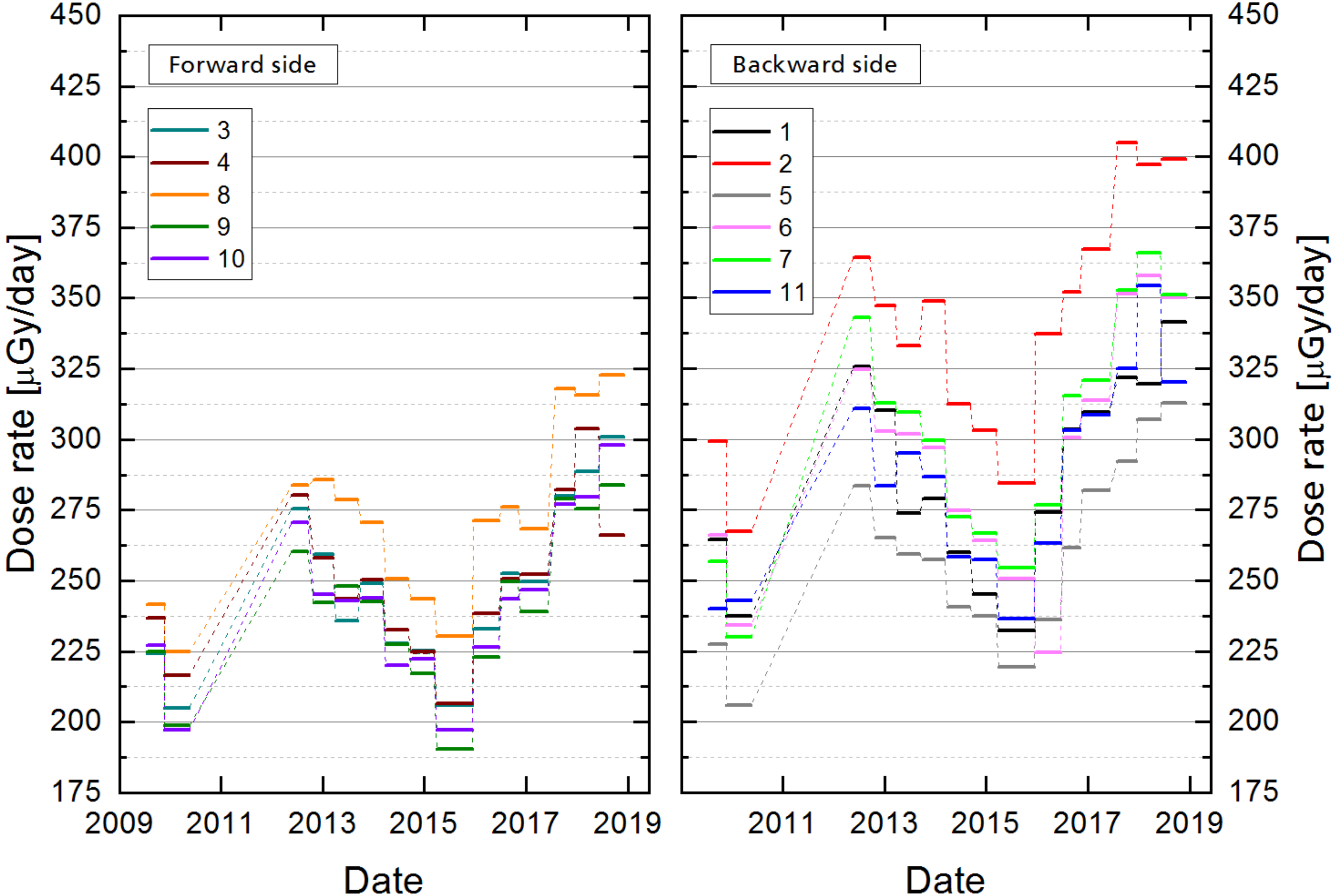
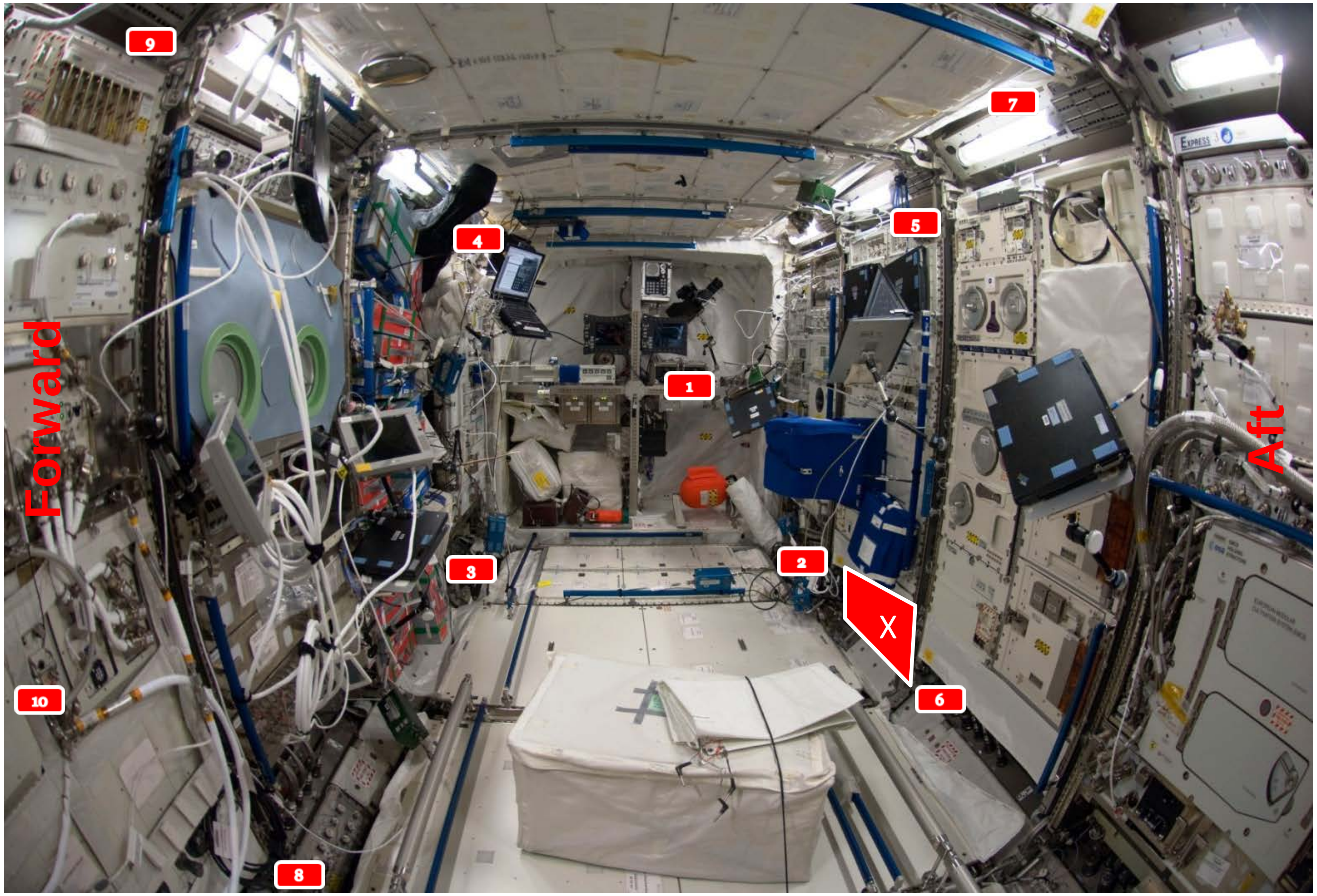


DOSIS & DOSIS 3D: PDP – Results (Selected TLD II)




Forward side
3
4
8
9
10
Dose rate [µGy/day]
Date
2009
2011
2013
2015
2017
2019
175
200
225
250
275
300
325
350
375
400
425
450
Backward side
1
2
5
6
7
11
Dose rate [µGy/day]
Date

DOSIS & DOSIS 3D: PDP – Results (Selected CR-39)



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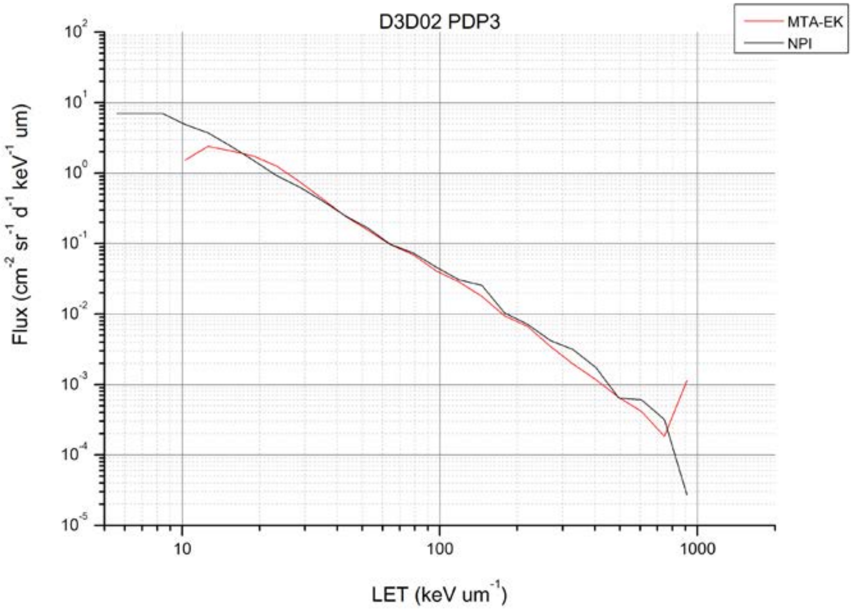
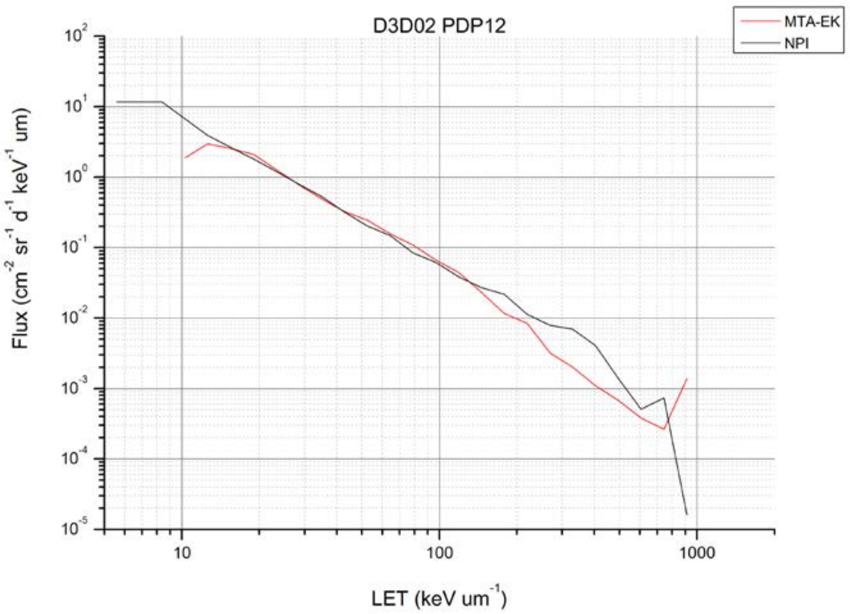
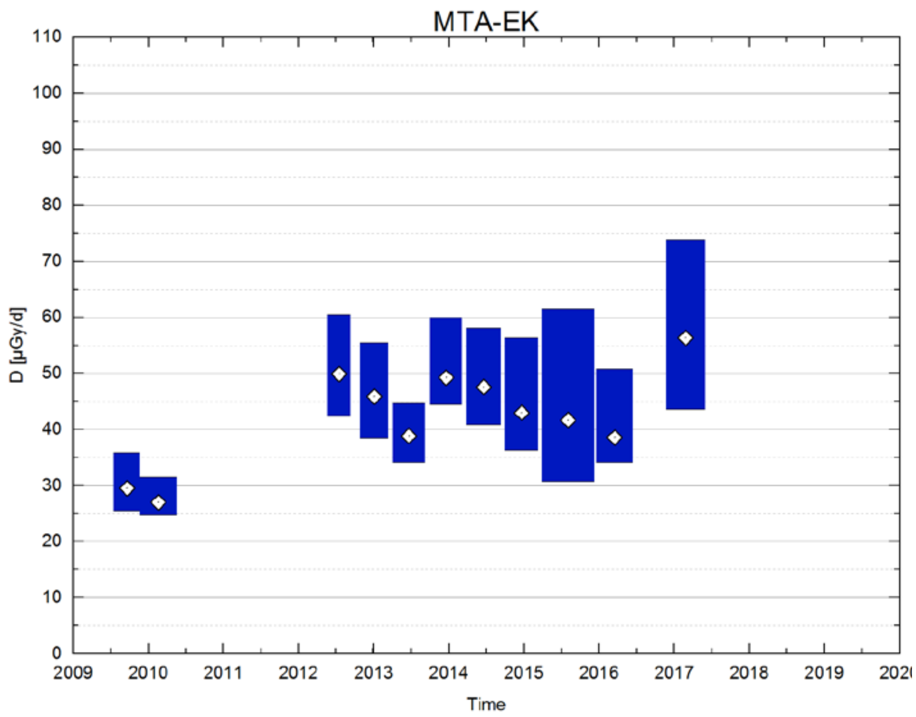
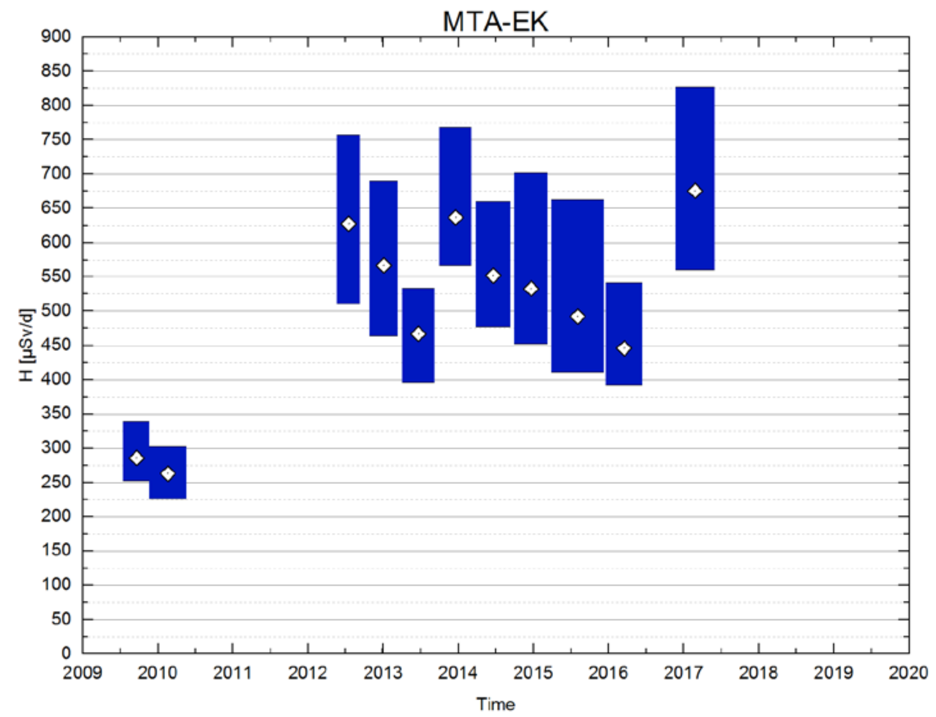
DOSIS & DOSIS 3D: PDP – Results (Selected CR-39)



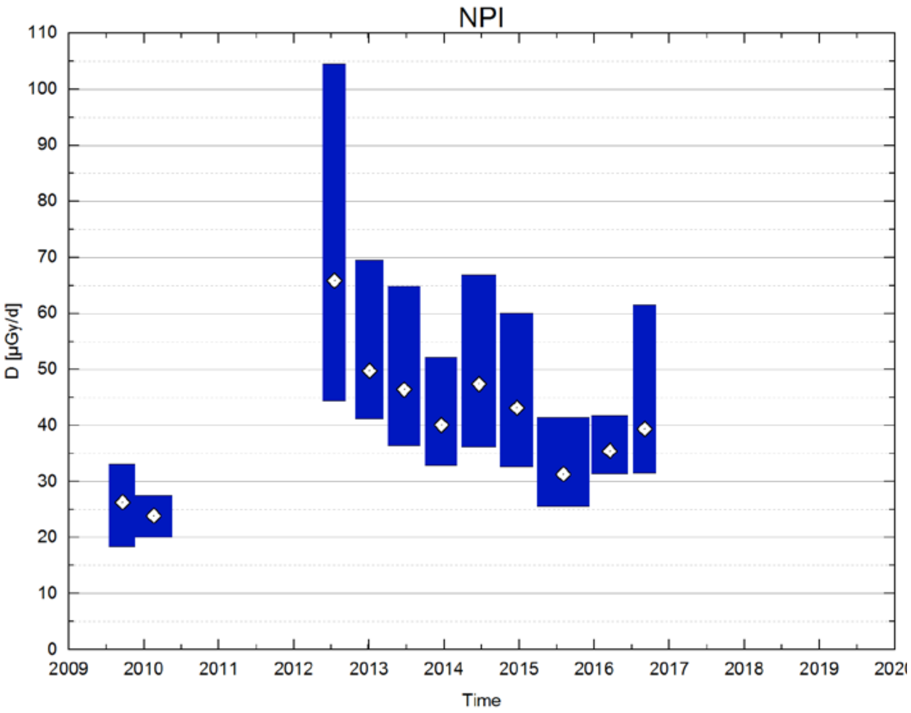


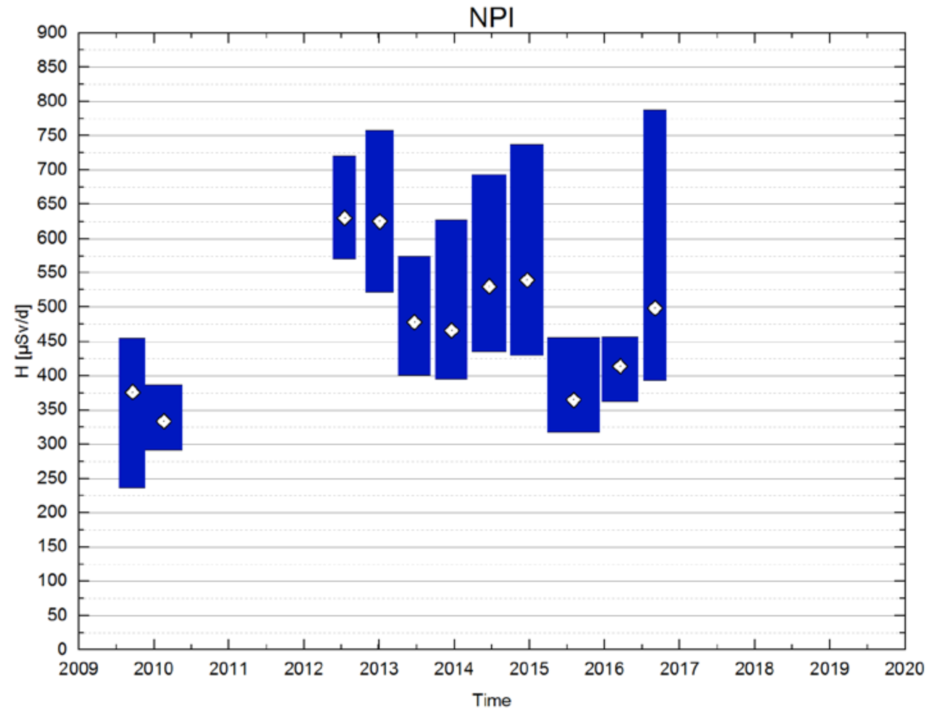
DOSIS & DOSIS 3D: PDP – Results (Selected CR-39)





DOSIS & DOSIS 3D: PDP – Results (Selected CR-39)





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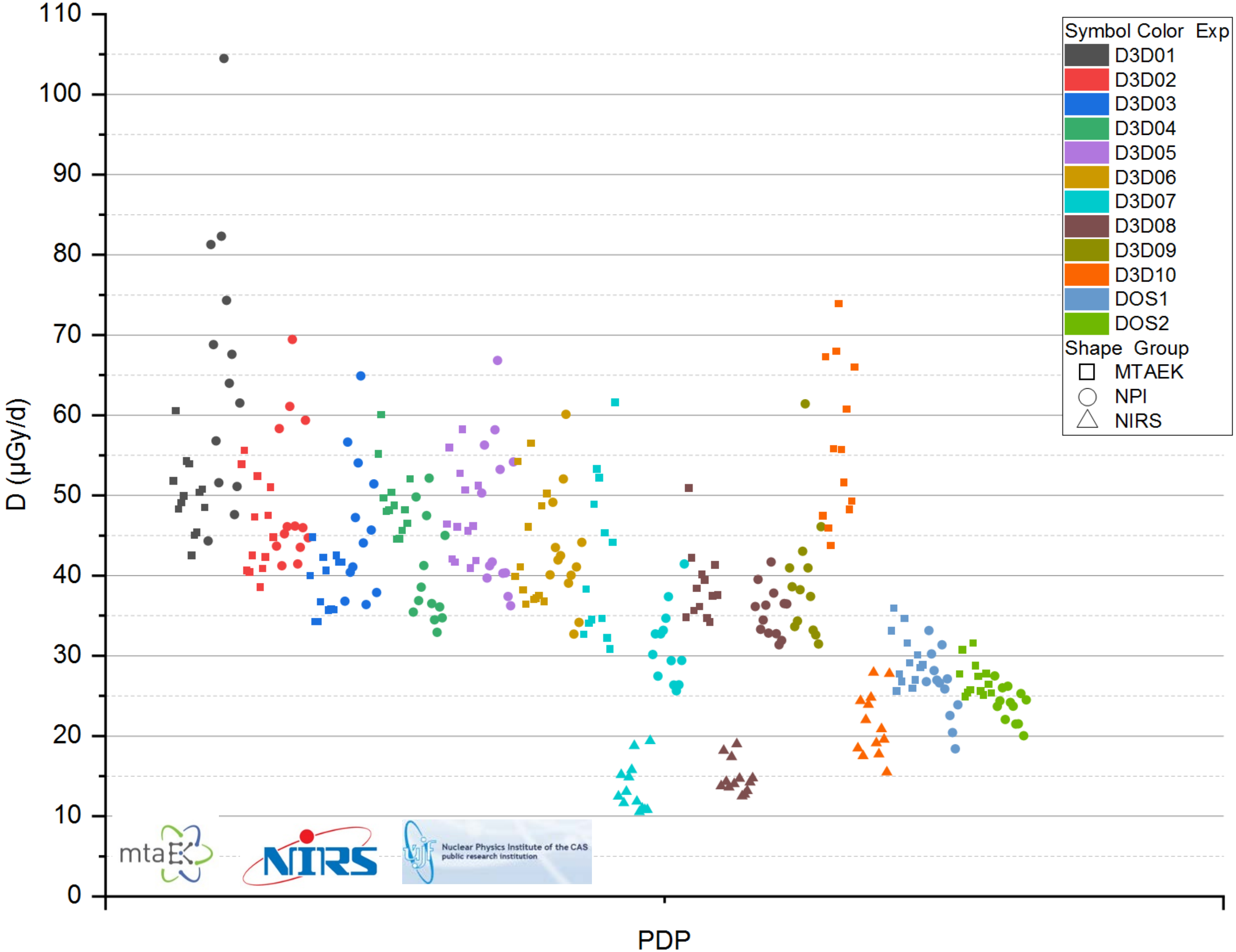
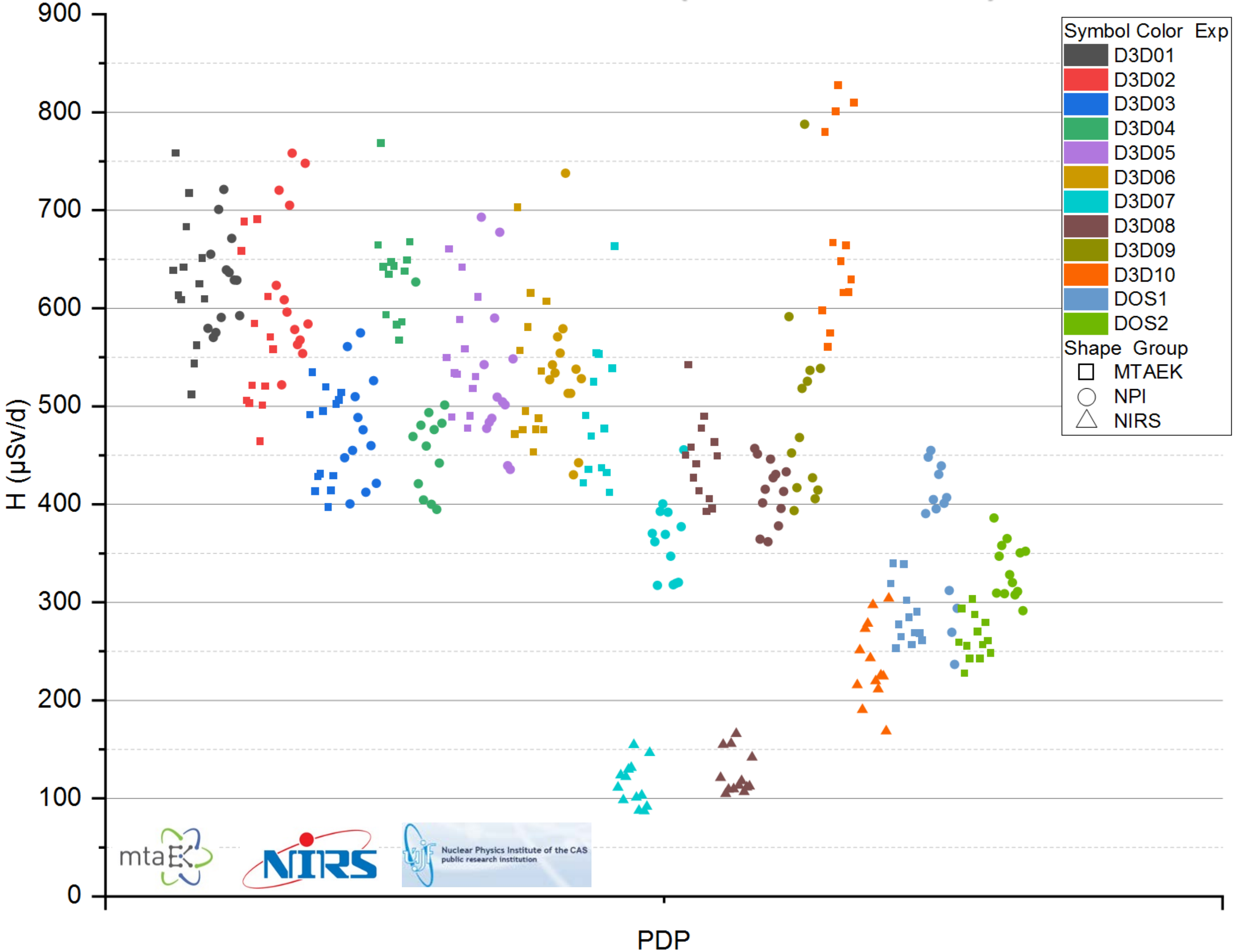
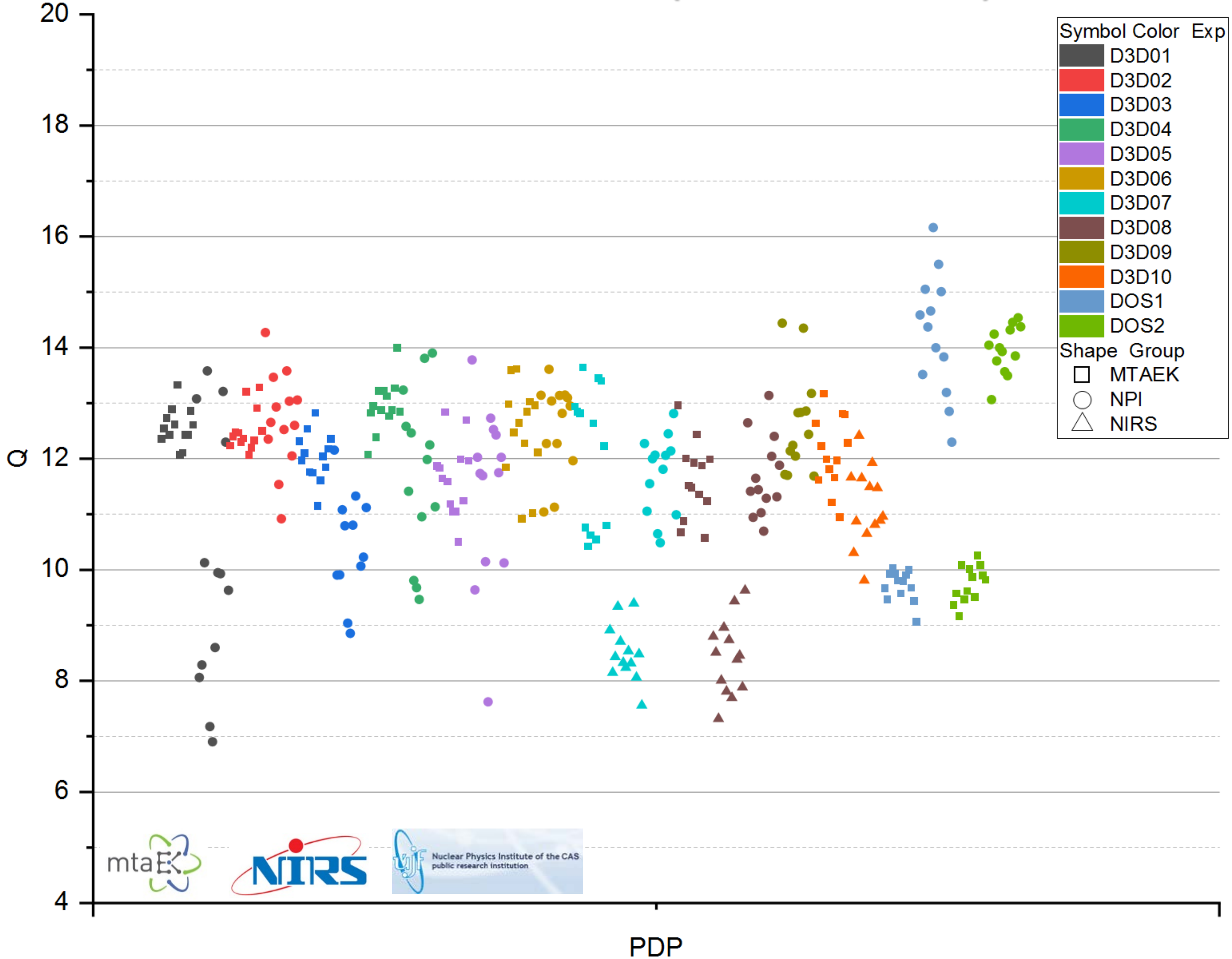
DOSIS & DOSIS 3D: PDP – Results (Selected CR-39)



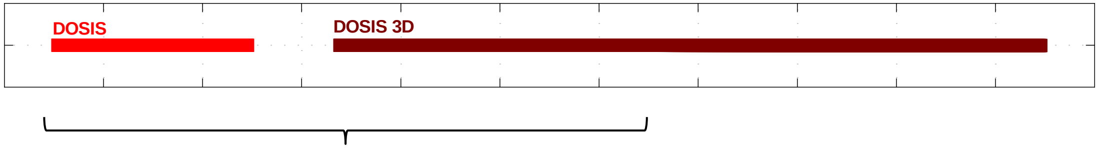
DOSIS & DOSIS 3D: PDP – Results (Selected CR-39)



DOSIS & DOSIS 3D: PDP – Results (Selected CR-39)



DOSIS & DOSIS 3D: DOSTEL – Results
Published: D1-D2 & D3D1 to 6 (July 2009 – March 2015)



Berger et al. SWSC 7, A8, 2017

DOSIS & DOSIS 3D: DOSTEL – Results → Publication

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DOI: 10.1051/swsc/2017005

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RESEARCH ARTICLE — OPEN ACCESS

DOSIS & DOSIS 3D: radiation measurements with the DOSTEL instruments onboard the Columbus Laboratory of the ISS in the years 2009–2016

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10 NASA, Space Radiation Analysis Group (NASA/SRAG), Houston, TX 77058, USA
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14 OHB System AG, Universitätsallee 27-29, 28359 Bremen, Germany

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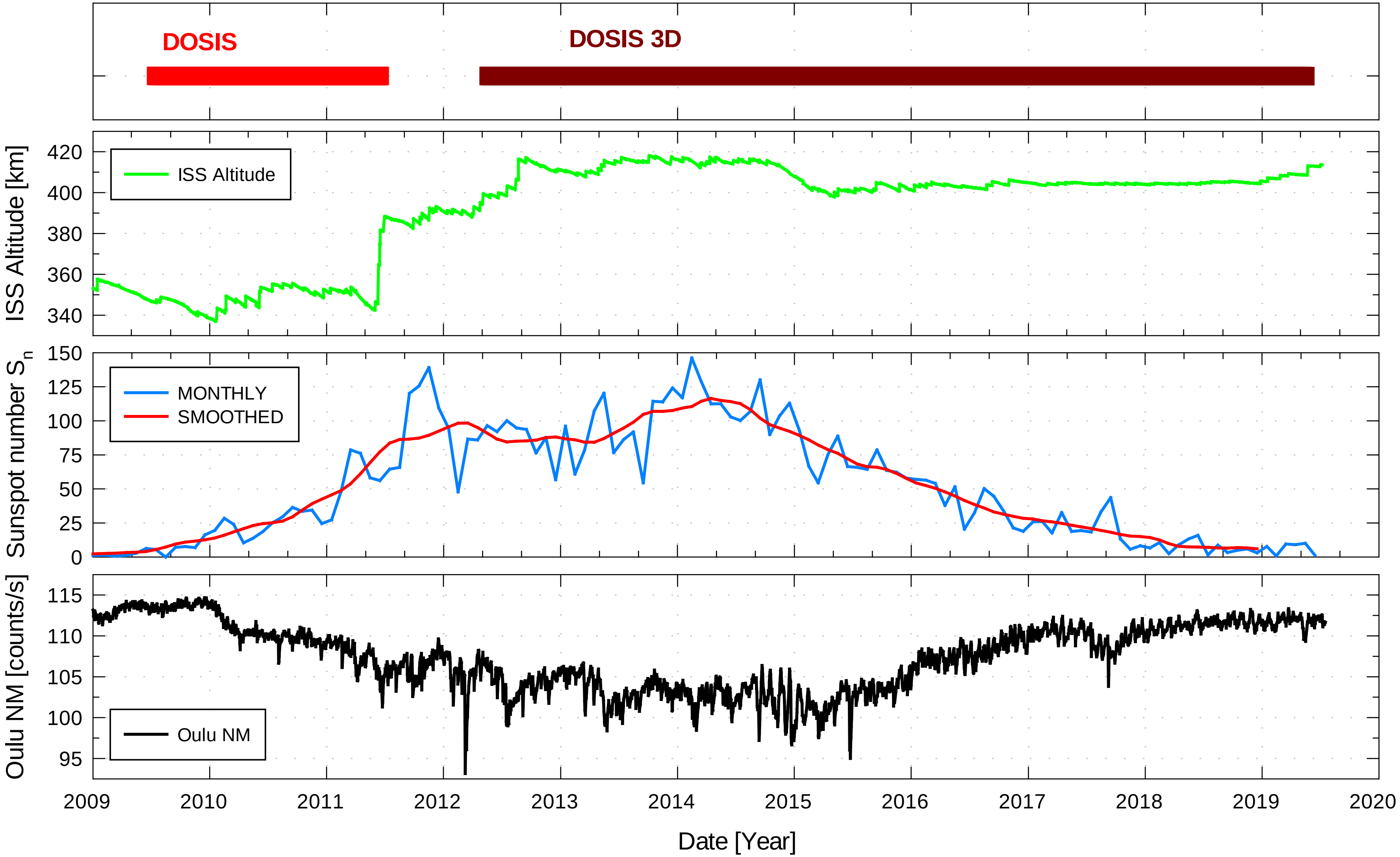
https://www.swsc-journal.org/articles/swsc/full_html/2017/01/swsc160046/swsc160046.html

DLR C|A|U

DOSIS & DOSIS 3D: Timeline / ISS Altitude / S_n / Oulu NM



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C | A | U

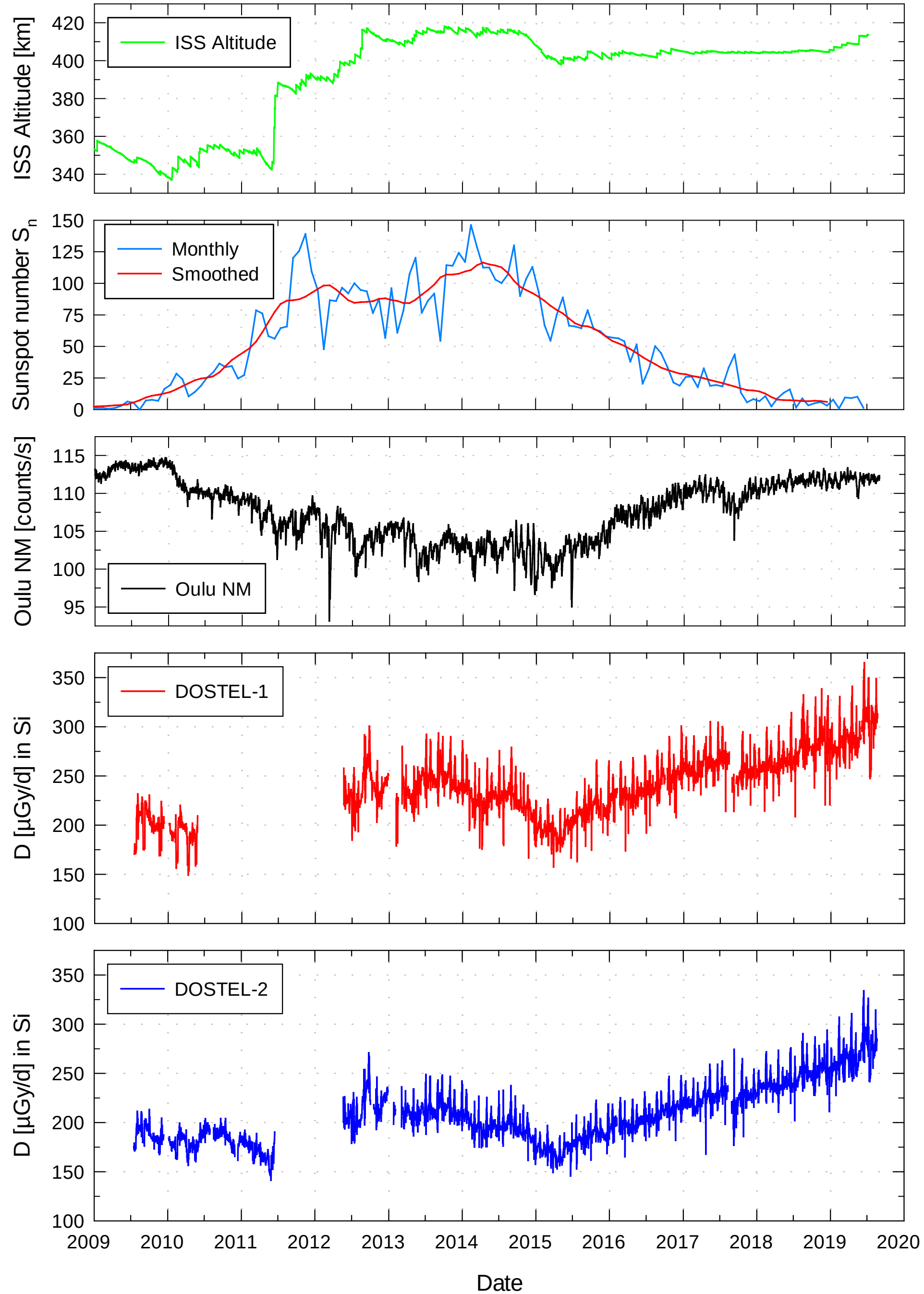
DOSIS & DOSIS 3D
DOSTEL-1 & DOSTEL-2

Data: Dose in Si

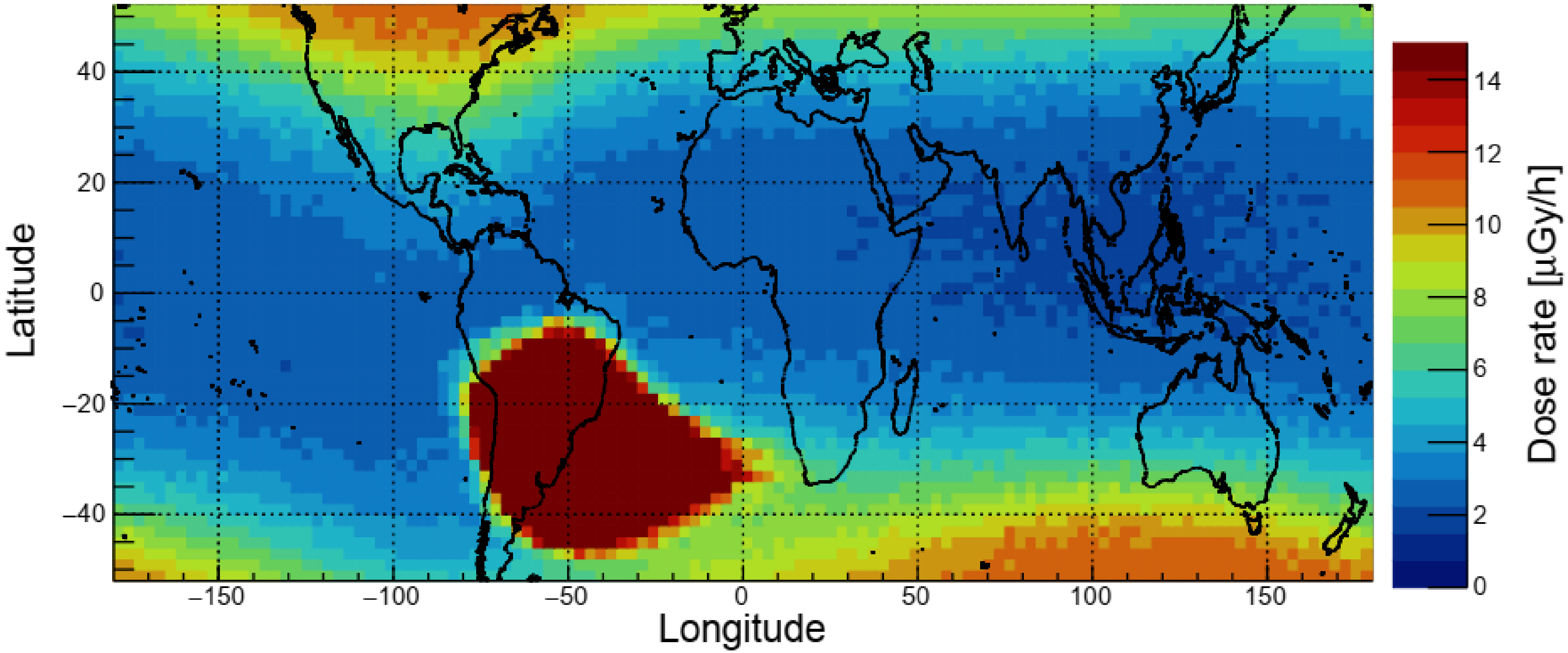
DOSIS: July 2009

DOSIS 3D: August 2019

→ 10 years covered

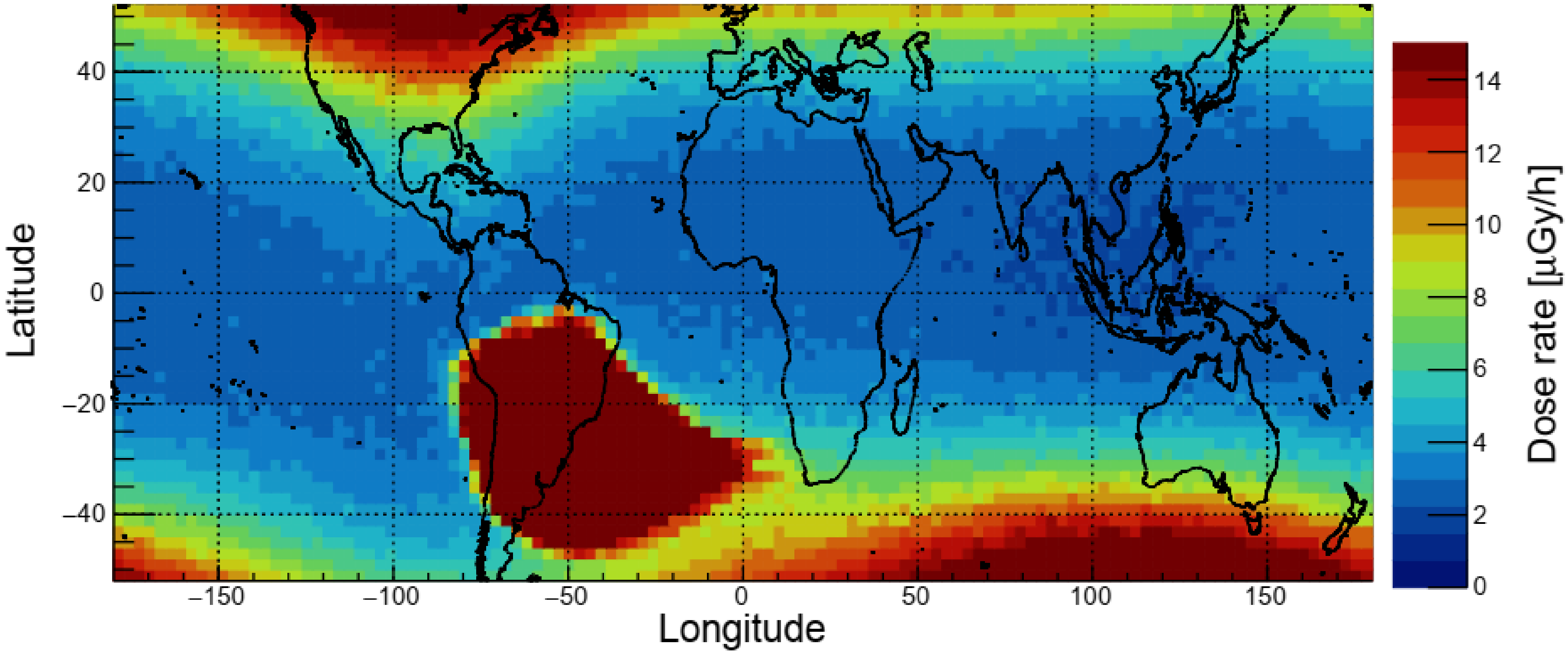


DOSIS 3D: DOSTEL-1 GCR



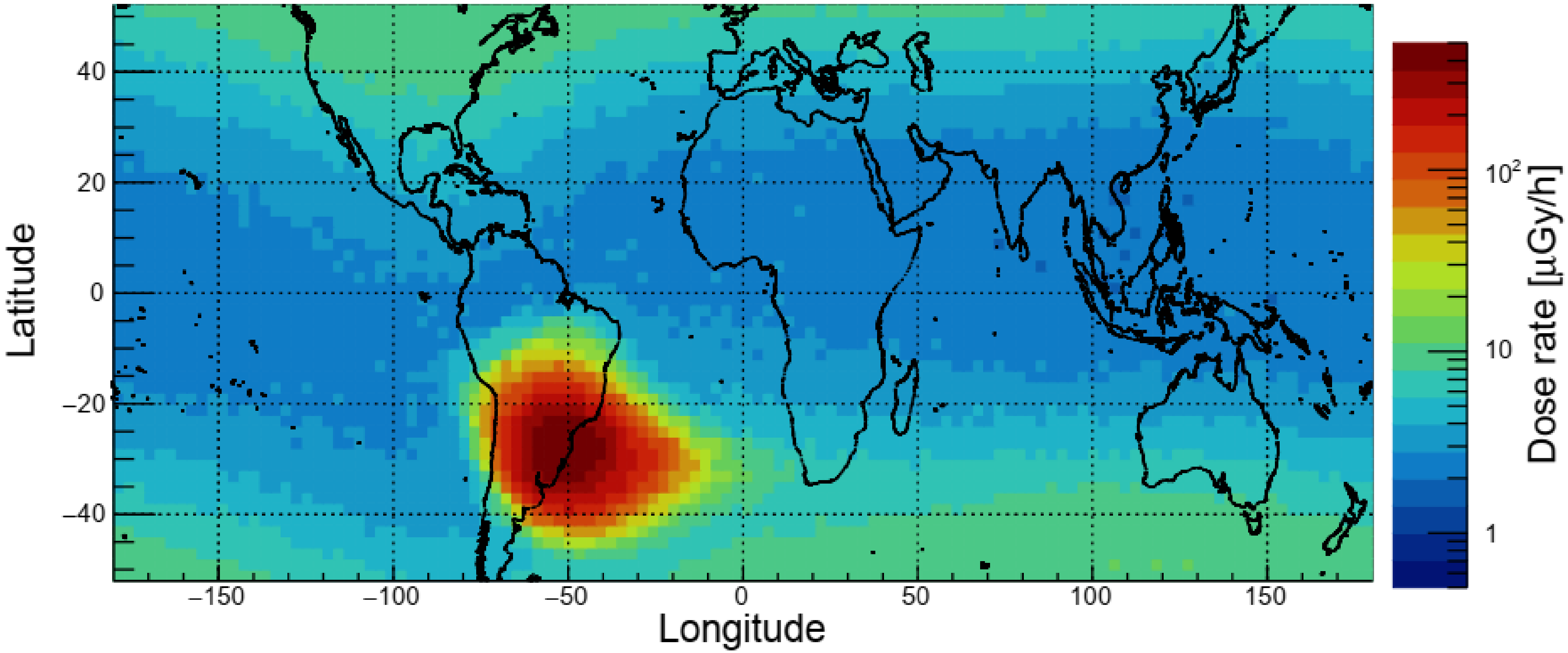
01/07/2014 – 31/12/2014

DOSIS 3D: DOSTEL-1 GCR



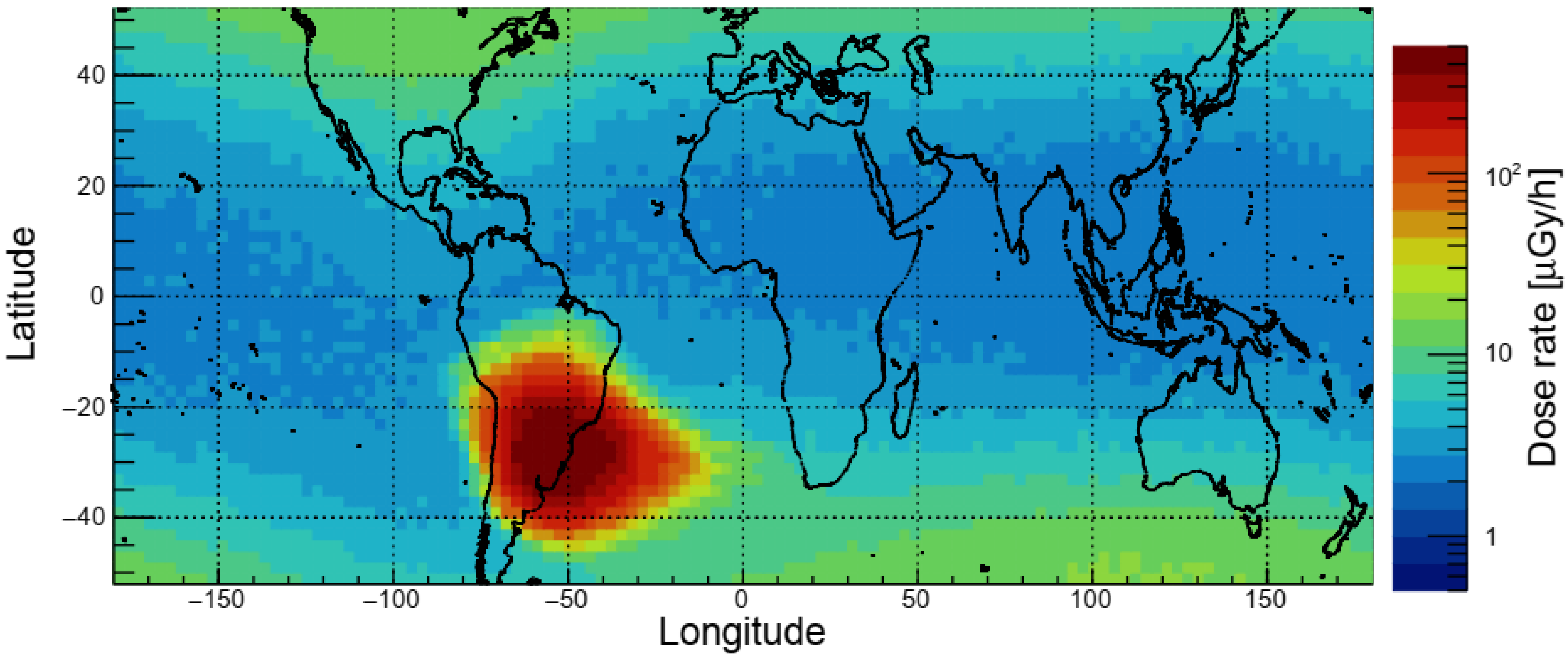
01/07/2018 – 31/12/2018

DOSIS 3D: DOSTEL-1 SAA



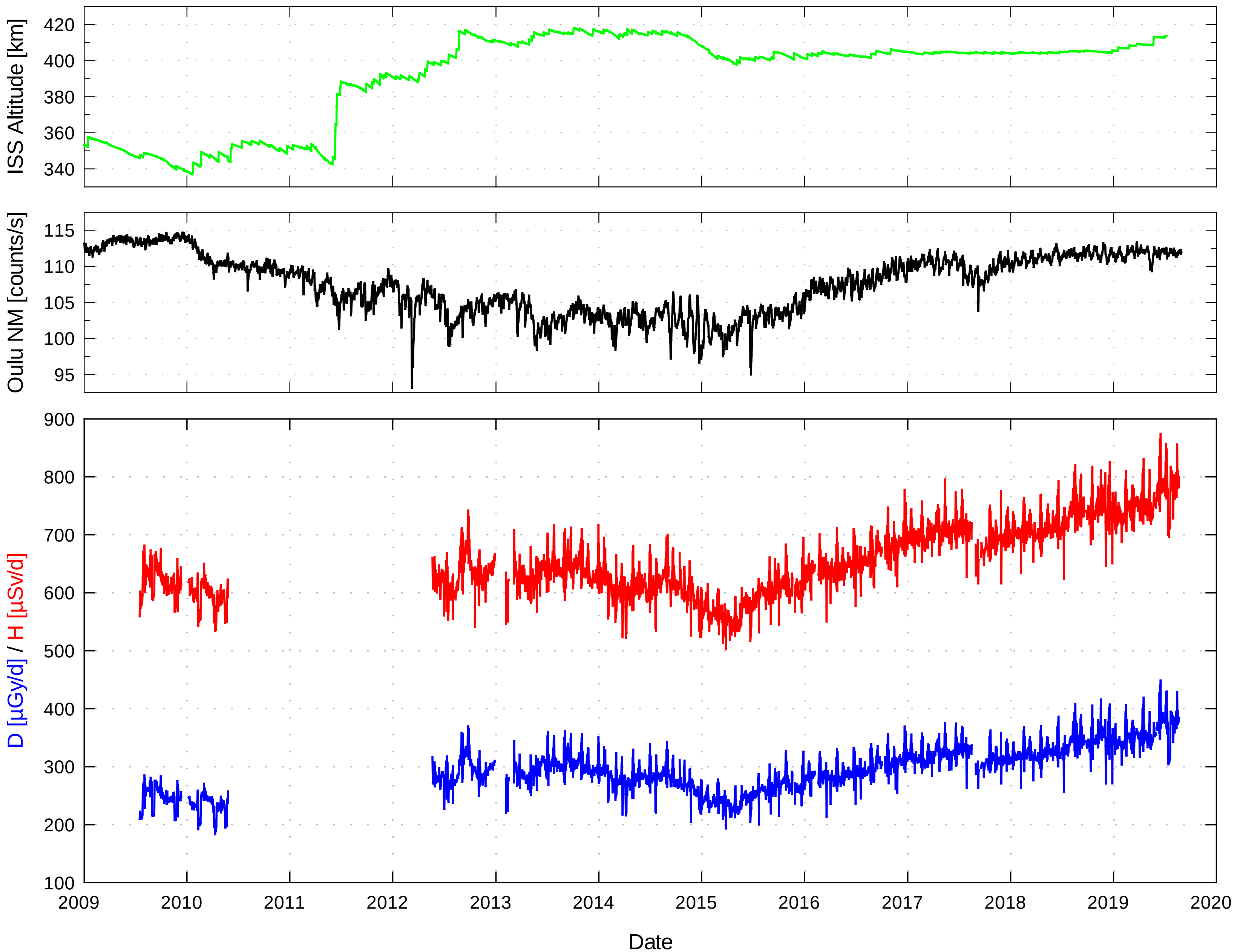
01/07/2014 – 31/12/2014

DOSIS 3D: DOSTEL-1 SAA

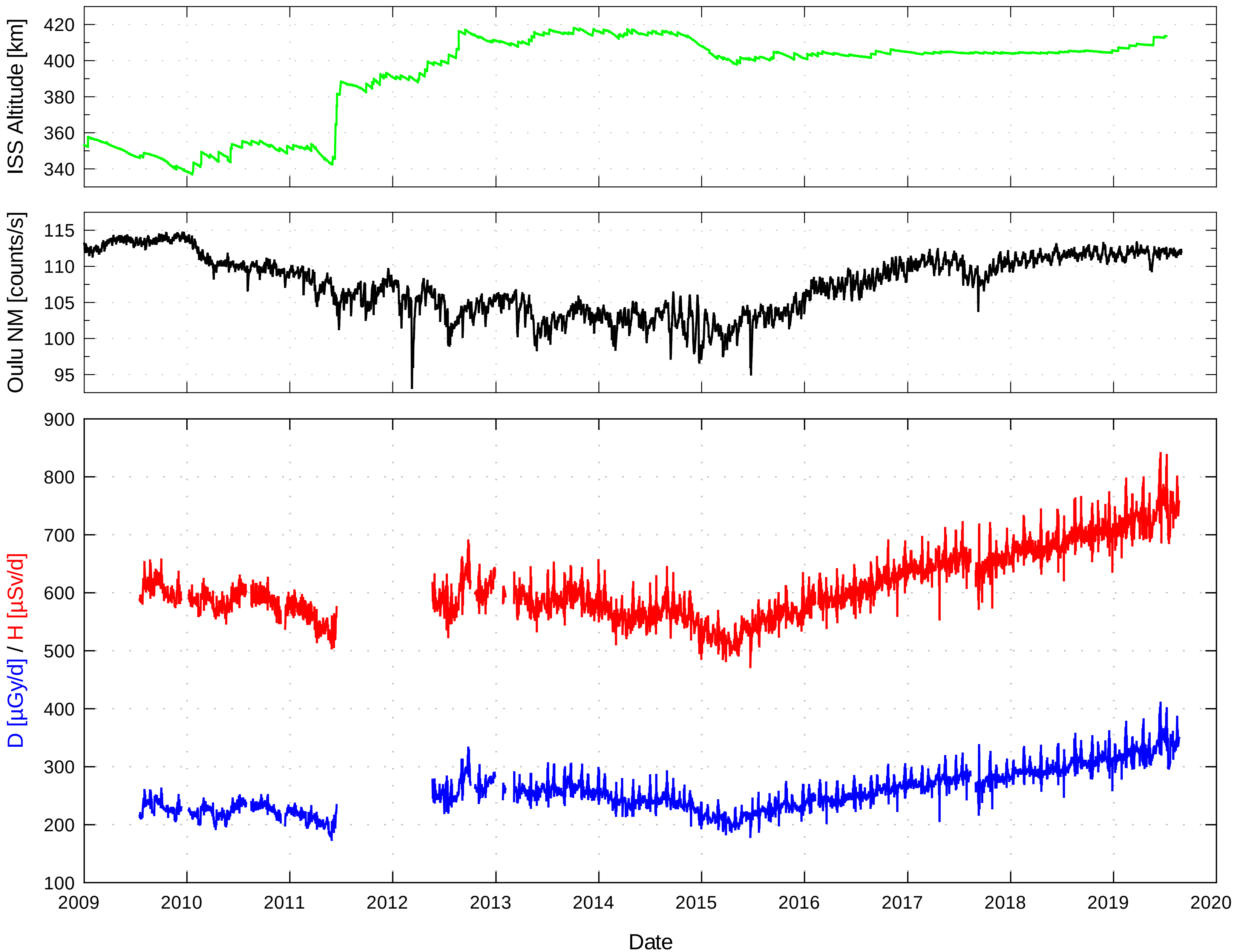


01/07/2018 – 31/12/2018

DOSTEL-1


ISS Altitude [km]
420
400
380
360
340
Oulu NM [counts/s]
115
110
105
100
95
D [µGy/d] / H [µSv/d]
900
800
700
600
500
400
300
200
100
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Date

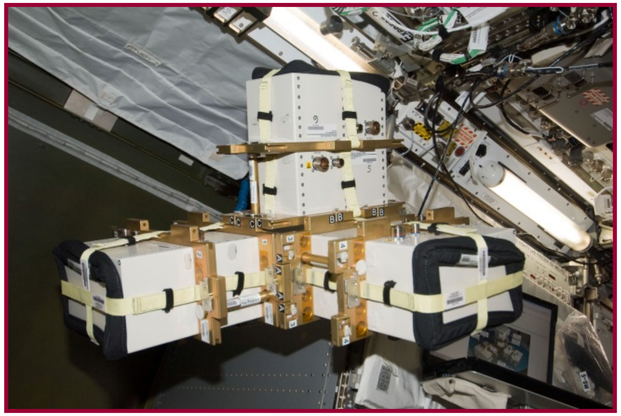
DOSTEL-2



ISS Altitude [km]
420
400
380
360
340
Oulu NM [counts/s]
115
110
105
100
95
D [µGy/d] / H [µSv/d]
900
800
700
600
500
400
300
200
100
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Date

DOSIS & DOSIS 3D:
Active Detector Comparison

DOSIS & DOSIS 3D: Comparison → ALTEA / D3D-DOSTEL



J. Space Weather Space Clim., 7, A18 (2017)
DOI: 10.1051/swsc/2017016

SWSC

RESEARCH ARTICLE — OPEN ACCESS

Exploiting different active silicon detectors in the International Space Station: ALTEA and DOSTEL galactic cosmic radiation (GCR) measurements

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ABSTRACT

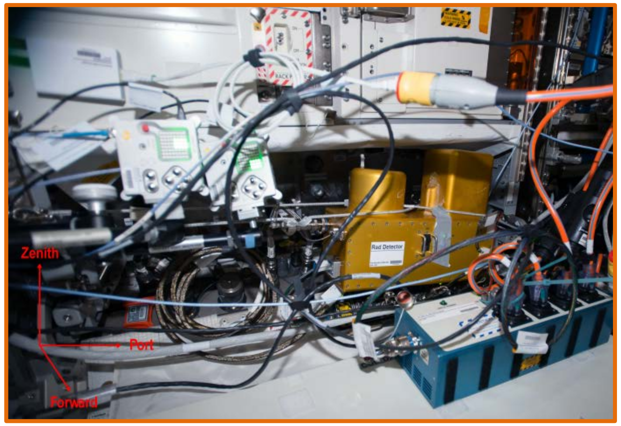
The solar system exploration by humans requires to successfully deal with the radiation exposition issue. The scientific aspect of this issue is twofold: knowing the radiation environment the astronauts are going to face and linking radiation exposure to health risks. Here we focus on the first issue. It is generally agreed that the final tool to describe the radiation environment in a space habitat will be a model featuring the needed amount of details to perform a meaningful risk assessment. The model should also take into account the shield changes due to the movement of materials inside the habitat, which in turn produce changes in the radiation environment. This model will have to undergo a final validation with a radiation field of similar complexity. The International Space Station (ISS) is a space habitat that features a radiation environment inside which is similar to what will be found in habitats in deep space, if we use measurements acquired only during high latitude passages (where the effects of the Earth magnetic field are reduced). Active detectors, providing time information, that can easily select data from different orbital sections, are the ones best fulfilling the requirements for these kinds of measurements. The exploitation of the radiation measurements performed in the ISS by all the available instruments is therefore mandatory to provide the largest possible database to the scientific community, to be merged with detailed Computer Aided Design (CAD) models, in the quest for a full model validation. While some efforts in comparing results from multiple active detectors have been attempted, a thorough study of a procedure to merge data in a single data matrix in order to provide the best validation set for radiation environment models has never been attempted. The aim of this paper is to provide such a procedure, to apply it to two of the most performing active detector systems in the ISS: the Anomalous Long Term Effects in Astronauts (ALTEA) instrument and the DOSimetry TELescope (DOSTEL) detectors, applied in the frame of the DOSIS and DOSIS 3D project onboard the ISS and to present combined results exploiting the features of each of the two apparatuses.

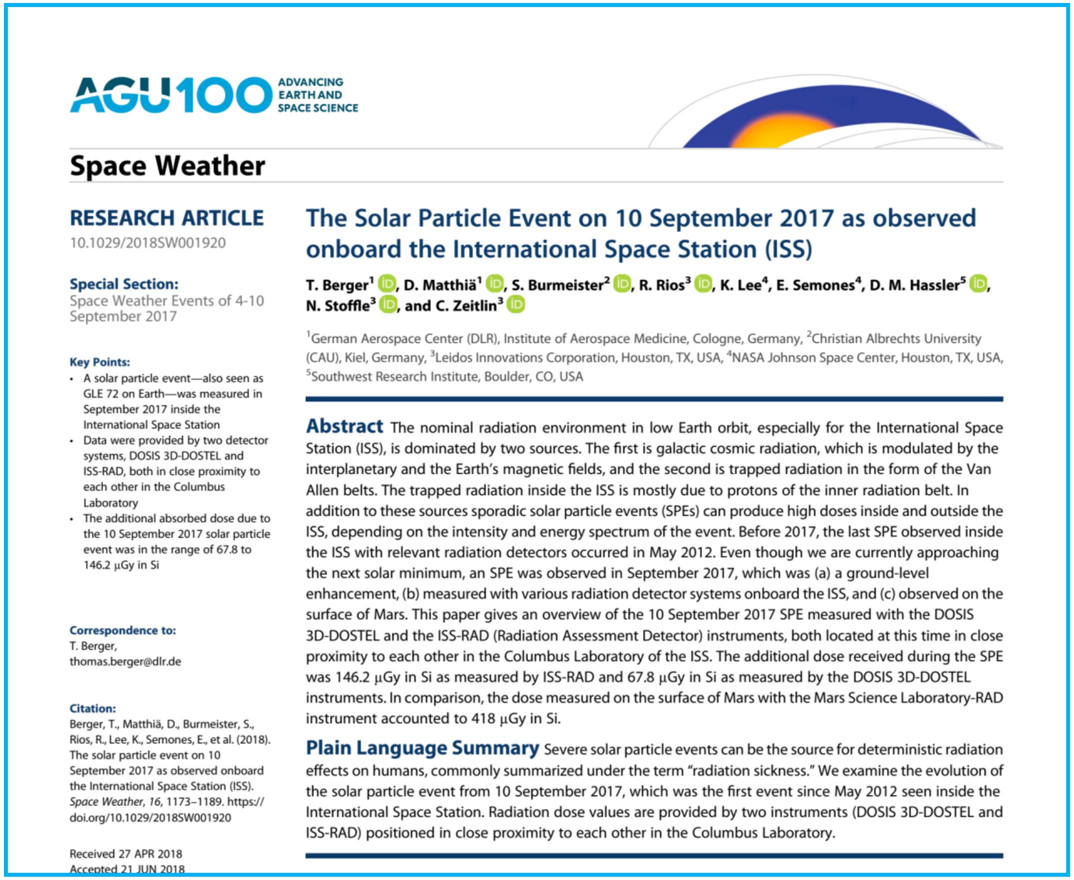
Key words. International space station – ALTEA – DOSTEL – Galactic cosmic radiation – Space radiation measurements

Narici, L., Berger, T., Burmeister, S., Di Fino, L., Rizzo, A., Matthiä, D., Reitz. G., (2017) Exploiting different active silicon detectors in the International Space Station: ALTEA and DOSTEL Galactic Cosmic Radiation (GCR) measurements. J. Space Weather Space Clim. 7, A18, https://doi.org/10.1051/swsc/2017016

DLR

DOSIS & DOSIS 3D: Comparison → ISS-RAD / D3D-DOSTEL




AGU100 ADVANCING EARTH AND SPACE SCIENCE

Space Weather

RESEARCH ARTICLE
10.1029/2018SW001920

Special Section:
Space Weather Events of 4-10 September 2017

Key Points:
- A solar particle event—also seen as GLE 72 on Earth—was measured in September 2017 inside the International Space Station
- Data were provided by two detector systems, DOSIS 3D-DOSTEL and ISS-RAD, both in close proximity to each other in the Columbus Laboratory
- The additional absorbed dose due to the 10 September 2017 solar particle event was in the range of 67.8 to 146.2 μGy in Si

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T. Berger,
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Citation:
Berger, T., Matthiä, D., Burmeister, S., Rios, R., Lee, K., Semones, E., et al. (2018). The solar particle event on 10 September 2017 as observed onboard the International Space Station (ISS). *Space Weather, 16*, 1173–1189. https://doi.org/10.1029/2018SW001920

Received 27 APR 2018
Accepted 21 JUN 2018

The Solar Particle Event on 10 September 2017 as observed onboard the International Space Station (ISS)

T. Berger[1], D. Matthiä[1], S. Burmeister[2], R. Rios[3], K. Lee[4], E. Semones[4], D. M. Hassler[5], N. Stoffle[3], and C. Zeitlin[3]

[1]German Aerospace Center (DLR), Institute of Aerospace Medicine, Cologne, Germany, [2]Christian Albrechts University (CAU), Kiel, Germany, [3]Leidos Innovations Corporation, Houston, TX, USA, [4]NASA Johnson Space Center, Houston, TX, USA, [5]Southwest Research Institute, Boulder, CO, USA

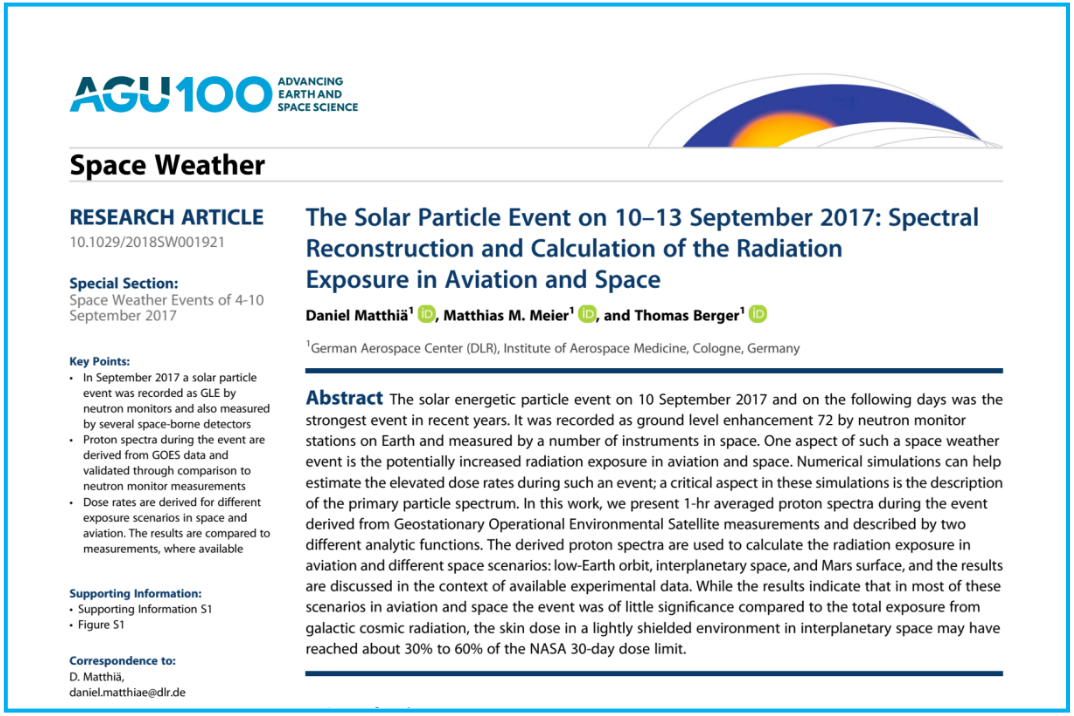
Abstract The nominal radiation environment in low Earth orbit, especially for the International Space Station (ISS), is dominated by two sources. The first is galactic cosmic radiation, which is modulated by the interplanetary and the Earth's magnetic fields, and the second is trapped radiation in the form of the Van Allen belts. The trapped radiation inside the ISS is mostly due to protons of the inner radiation belt. In addition to these sources sporadic solar particle events (SPEs) can produce high doses inside and outside the ISS, depending on the intensity and energy spectrum of the event. Before 2017, the last SPE observed inside the ISS with relevant radiation detectors occurred in May 2012. Even though we are currently approaching the next solar minimum, an SPE was observed in September 2017, which was (a) a ground-level enhancement, (b) measured with various radiation detector systems onboard the ISS, and (c) observed on the surface of Mars. This paper gives an overview of the 10 September 2017 SPE measured with the DOSIS 3D-DOSTEL and the ISS-RAD (Radiation Assessment Detector) instruments, both located at this time in close proximity to each other in the Columbus Laboratory of the ISS. The additional dose received during the SPE was 146.2 μGy in Si as measured by ISS-RAD and 67.8 μGy in Si as measured by the DOSIS 3D-DOSTEL instruments. In comparison, the dose measured on the surface of Mars with the Mars Science Laboratory-RAD instrument accounted to 418 μGy in Si.

Plain Language Summary Severe solar particle events can be the source for deterministic radiation effects on humans, commonly summarized under the term "radiation sickness." We examine the evolution of the solar particle event from 10 September 2017, which was the first event since May 2012 seen inside the International Space Station. Radiation dose values are provided by two instruments (DOSIS 3D-DOSTEL and ISS-RAD) positioned in close proximity to each other in the Columbus Laboratory.

Berger, T., Matthiä, D., Burmeister, S., Rios, R., Lee, K., Semones, E.; Hassler, D.M., Stoffle, N., Zeitlin, C. (2018). The Solar Particle Event on 10 September 2017 as observed on-board the International Space Station (ISS). *Space Weather, 16*, https://doi.org/10.1029/2018SW001920

DLR

DOSIS & DOSIS 3D: Comparison → D3D-DOSTEL GEANT4



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Space Weather

RESEARCH ARTICLE
10.1029/2018SW001921

Special Section:
Space Weather Events of 4-10 September 2017

Key Points:
- In September 2017 a solar particle event was recorded as GLE by neutron monitors and also measured by several space-borne detectors
- Proton spectra during the event are derived from GOES data and validated through comparison to neutron monitor measurements
- Dose rates are derived for different exposure scenarios in space and aviation. The results are compared to measurements, where available

Supporting Information:
- Supporting Information S1
- Figure S1

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The Solar Particle Event on 10–13 September 2017: Spectral Reconstruction and Calculation of the Radiation Exposure in Aviation and Space

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[1]German Aerospace Center (DLR), Institute of Aerospace Medicine, Cologne, Germany

Abstract The solar energetic particle event on 10 September 2017 and on the following days was the strongest event in recent years. It was recorded as ground level enhancement 72 by neutron monitor stations on Earth and measured by a number of instruments in space. One aspect of such a space weather event is the potentially increased radiation exposure in aviation and space. Numerical simulations can help estimate the elevated dose rates during such an event; a critical aspect in these simulations is the description of the primary particle spectrum. In this work, we present 1-hr averaged proton spectra during the event derived from Geostationary Operational Environmental Satellite measurements and described by two different analytic functions. The derived proton spectra are used to calculate the radiation exposure in aviation and different space scenarios: low-Earth orbit, interplanetary space, and Mars surface, and the results are discussed in the context of available experimental data. While the results indicate that in most of these scenarios in aviation and space the event was of little significance compared to the total exposure from galactic cosmic radiation, the skin dose in a lightly shielded environment in interplanetary space may have reached about 30% to 60% of the NASA 30-day dose limit.

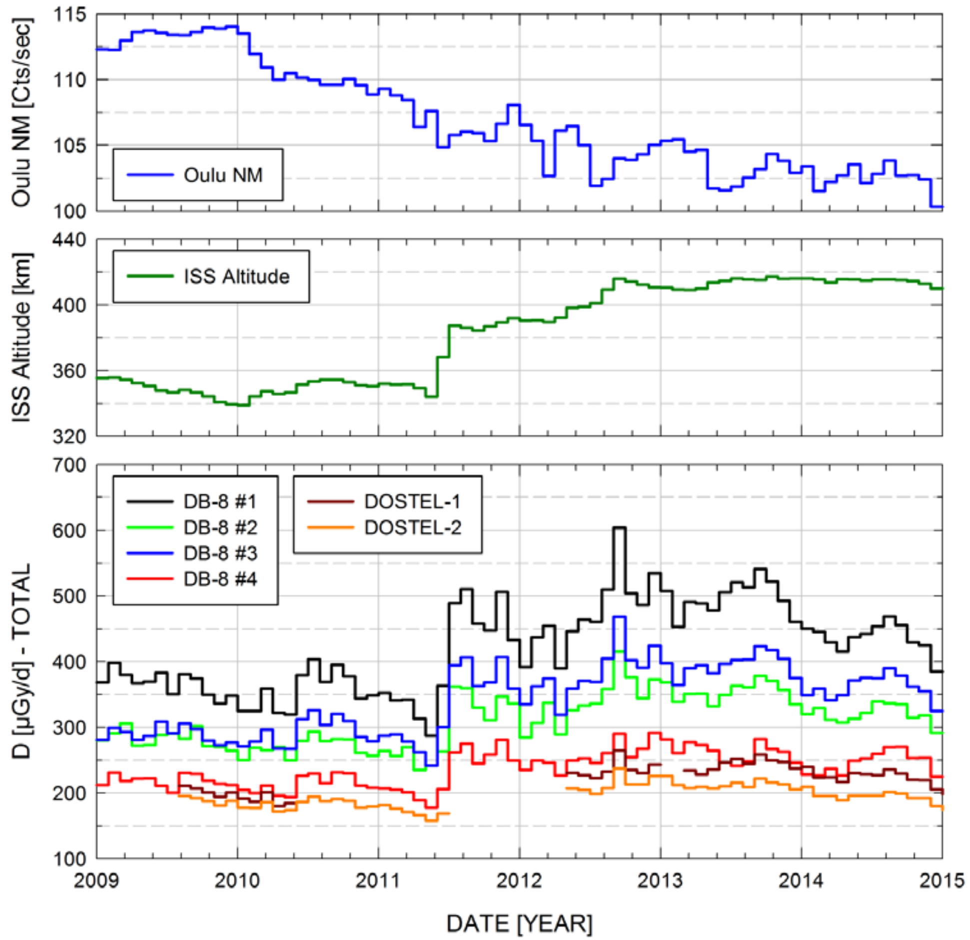
Matthiä, D., Meier, M. M., Berger, T., (2018). The solar particle event on 10-13 September 2017 – Spectral reconstruction and calculation of the radiation exposure in aviation and space. Space Weather,16, 977-986. https://doi.org/10.1029/2018SW001921

Table 1
Event Integrated Dose Values Calculated for Interplanetary Space, Mars Surface, and Aviation Altitudes

			Interplanetary space		Mars surface
			$1\ g/cm^2$	$30\ g/cm^2$	
Power law	Si	mGy	6,136.0	4.7	1.1
	Skin	mGy	1,070.0	3.5	1.0
	Skin	mSv	3,128.0	8.7	2.2

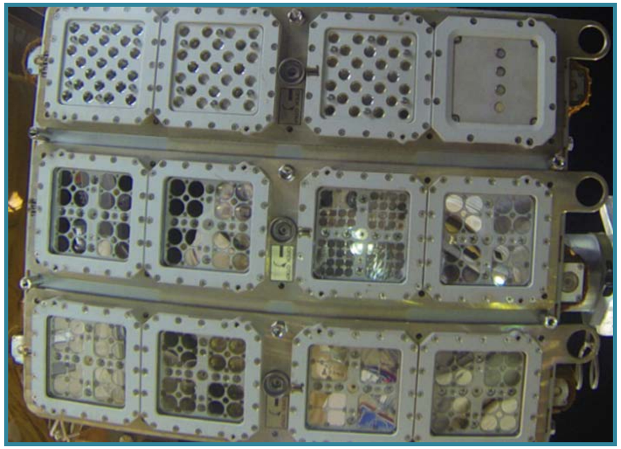
DLR

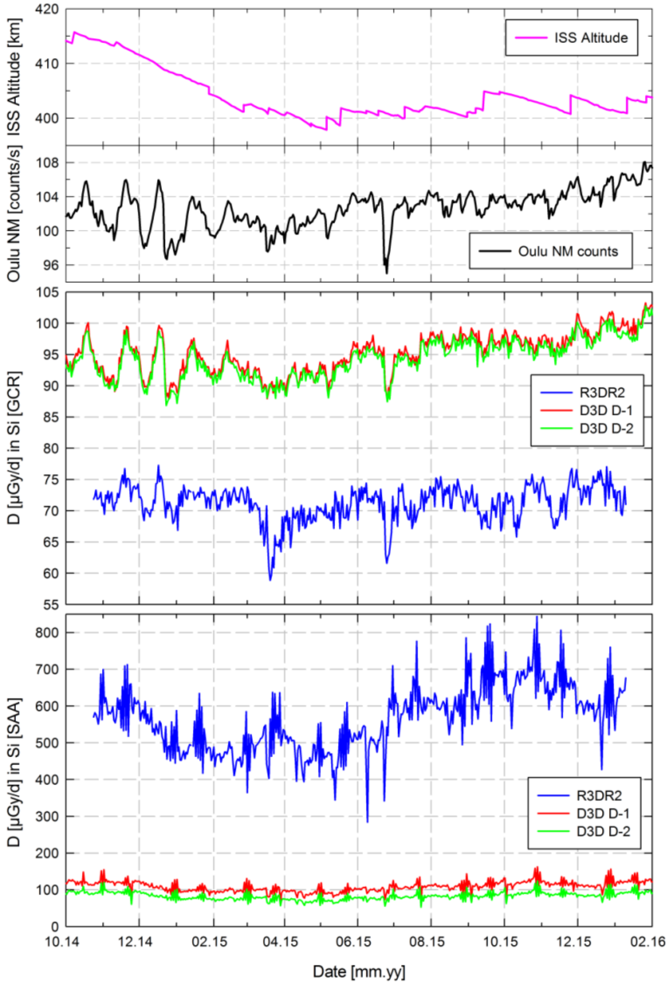
DOSIS & DOSIS 3D: Comparison → DB-8 / D3D-DOSTEL



Berger, T., et al. *A comparison of radiation measurements performed with the DOSTEL and the DB-8 silicon detector systems onboard the International Space Station* In preparation for re-submission to Life Sciences in Space Research

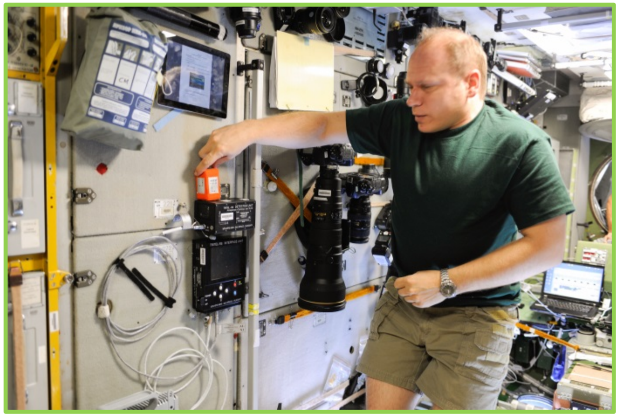
DOSIS 3D: Comparison → R3DR2 / D3D-DOSTEL





Berger, T., Dachev, T.P., Burmeister, S., Matthiä, D., Przybyla, B., et al. *On the comparison of radiation measurements outside and inside the International Space Station (ISS)* In preparation for Life Sciences in Space Research

DOSIS 3D: Comparison → TRITEL / D3D-DOSTEL



WORK IN PROGRESS

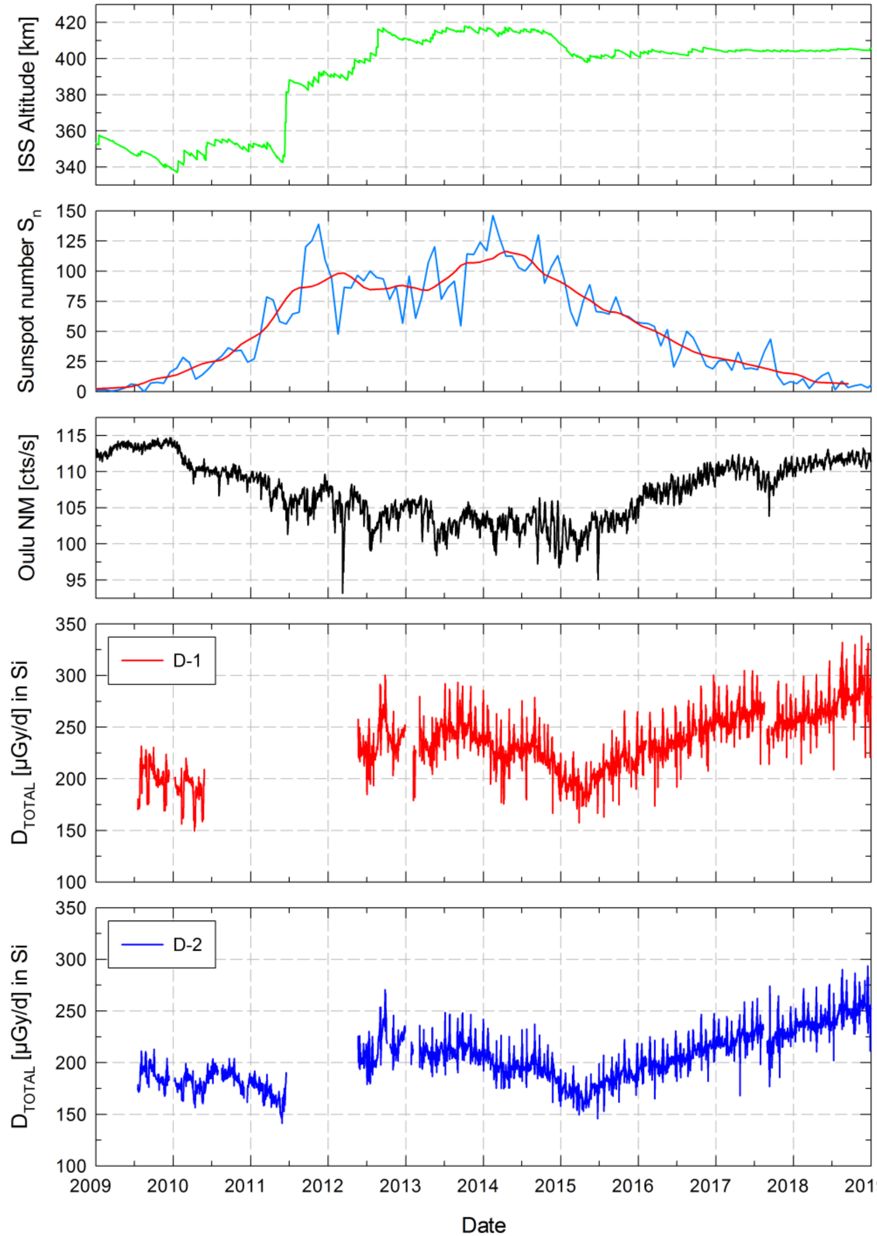
See: Stradi et al. WRMISS (2019)

DOSIS & DOSIS 3D:

On the long term GCR variations
… and some L value cuts …
… and some MSL-RAD data …
… and some CRaTER data …
… and more work to do …

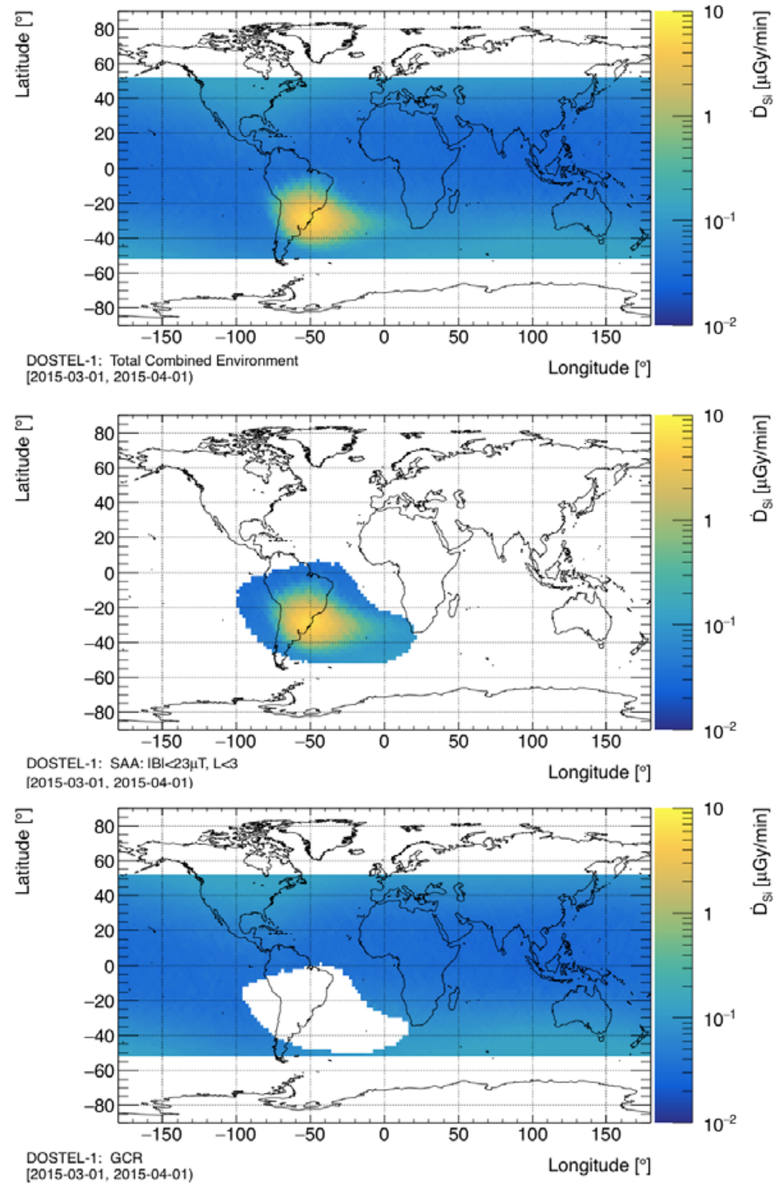
Berger, T., Matthiä, D., Burmeister, S., Rios, R., Stoffle, N., Zeitlin, C. and more (2019). 10 years of GCR – a full solar cycle

DOSIS & DOSIS 3D: 1 Baseline Data – DOSIS & DOSIS 3D



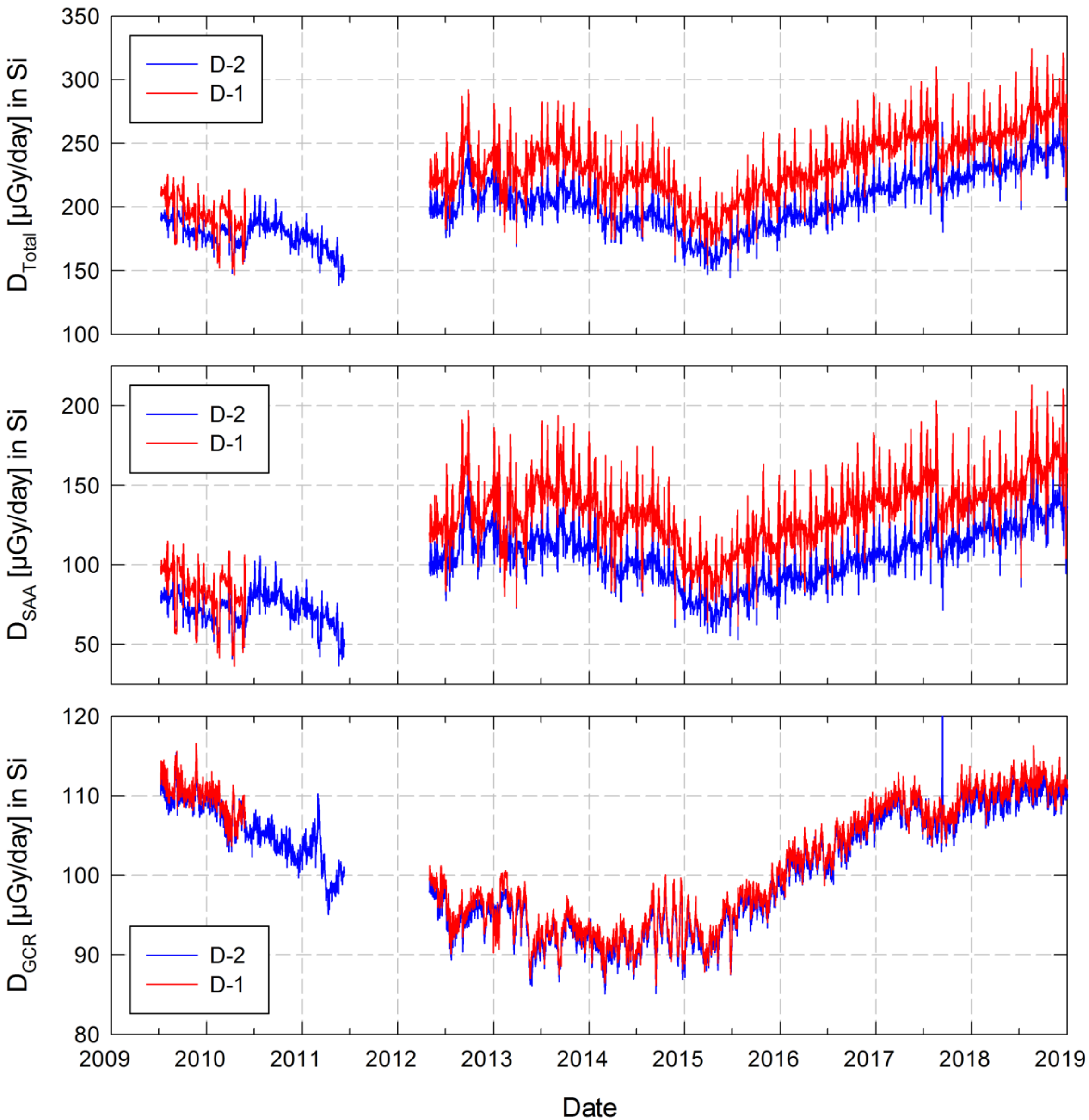
DOSIS & DOSIS 3D: 2 GCR/SAA Separation - NASA

We use a model-based definition, thereby preventing any sensitivity to localized shielding inside or outside the vehicle that utilizes the geomagnetic field intensity (B) and Mc Ilwain L-shell parameter (L) as attributed to ISS's trajectory. We have categorized the SAA using |B| < 23 µT and L < 3; (Rios, 2017) the remaining environment is thereby categorized as GCR. ISS trajectory has been calculated using the instruments' timestamps and SGP4 (Simplified General Perturbation model); for improved accuracy, we calculate the geomagnetic field using IGRF-12 (International Geomagnetic Reference Field) (Thébault et al., 2015) and L-shell at each point in the trajectory.



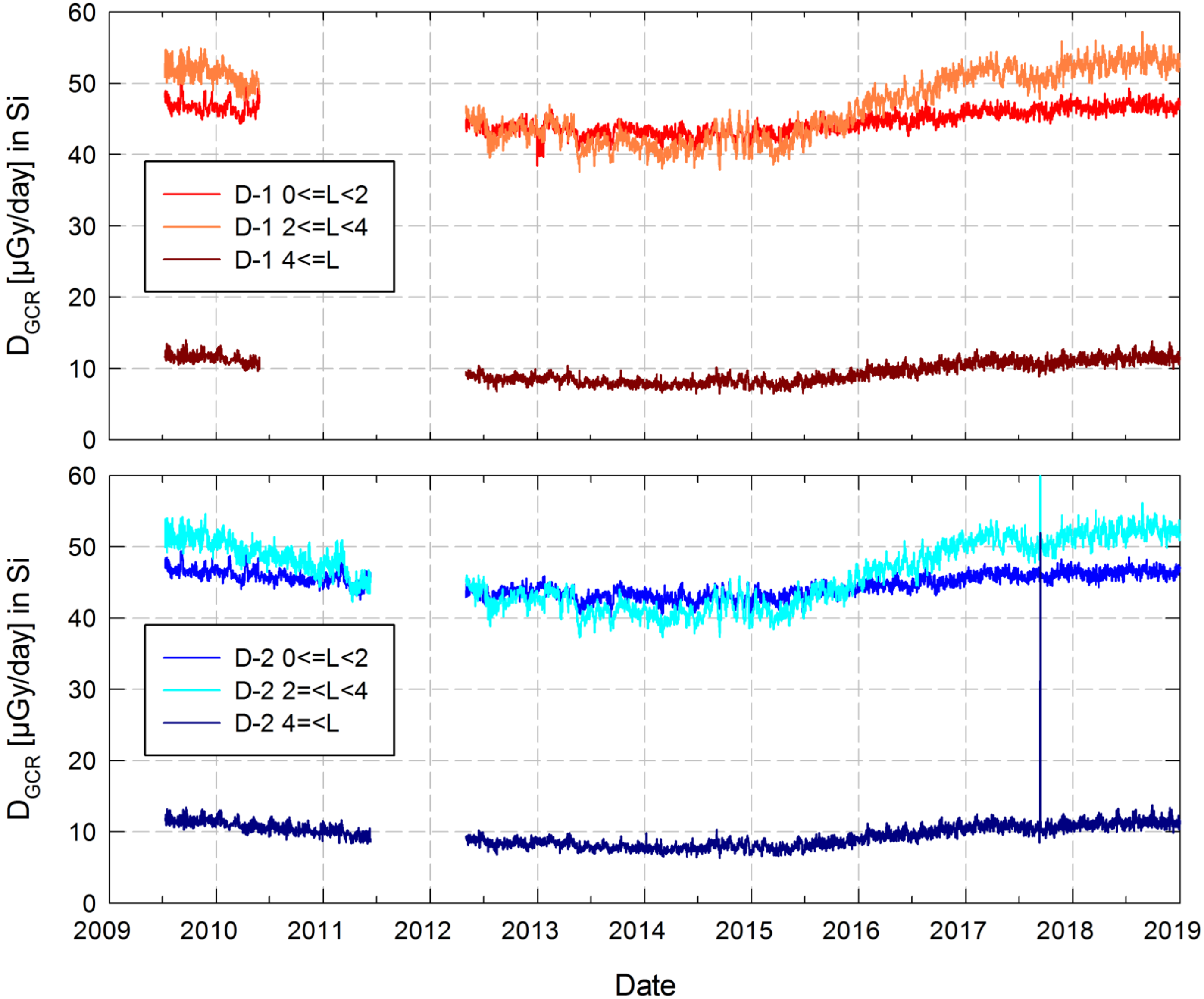
Berger, T., Matthiä, D., Burmeister, S., Rios, R., Lee, K., Semones, E.; Hassler, D.M., Stoffle, N., Zeitlin, C. (2018). The Solar Particle Event on 10 September 2017 as observed on-board the International Space Station (ISS). *Space Weather, 16*, https://doi.org/10.1029/2018SW001920

DOSIS & DOSIS 3D: 3 GCR/SAA Separated – Data for B/L cut

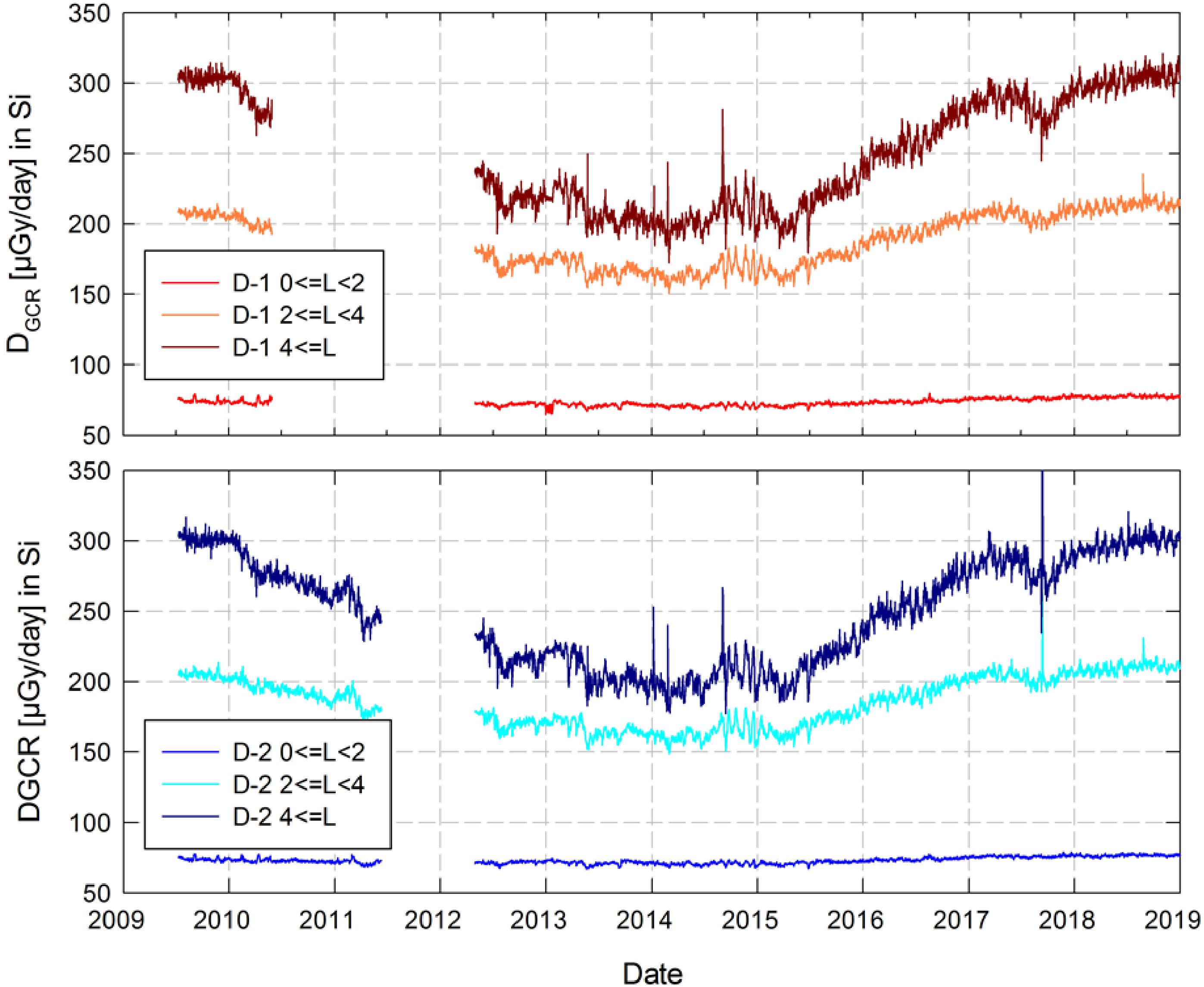


DOSIS & DOSIS 3D: 4 GCR Separated – L cut

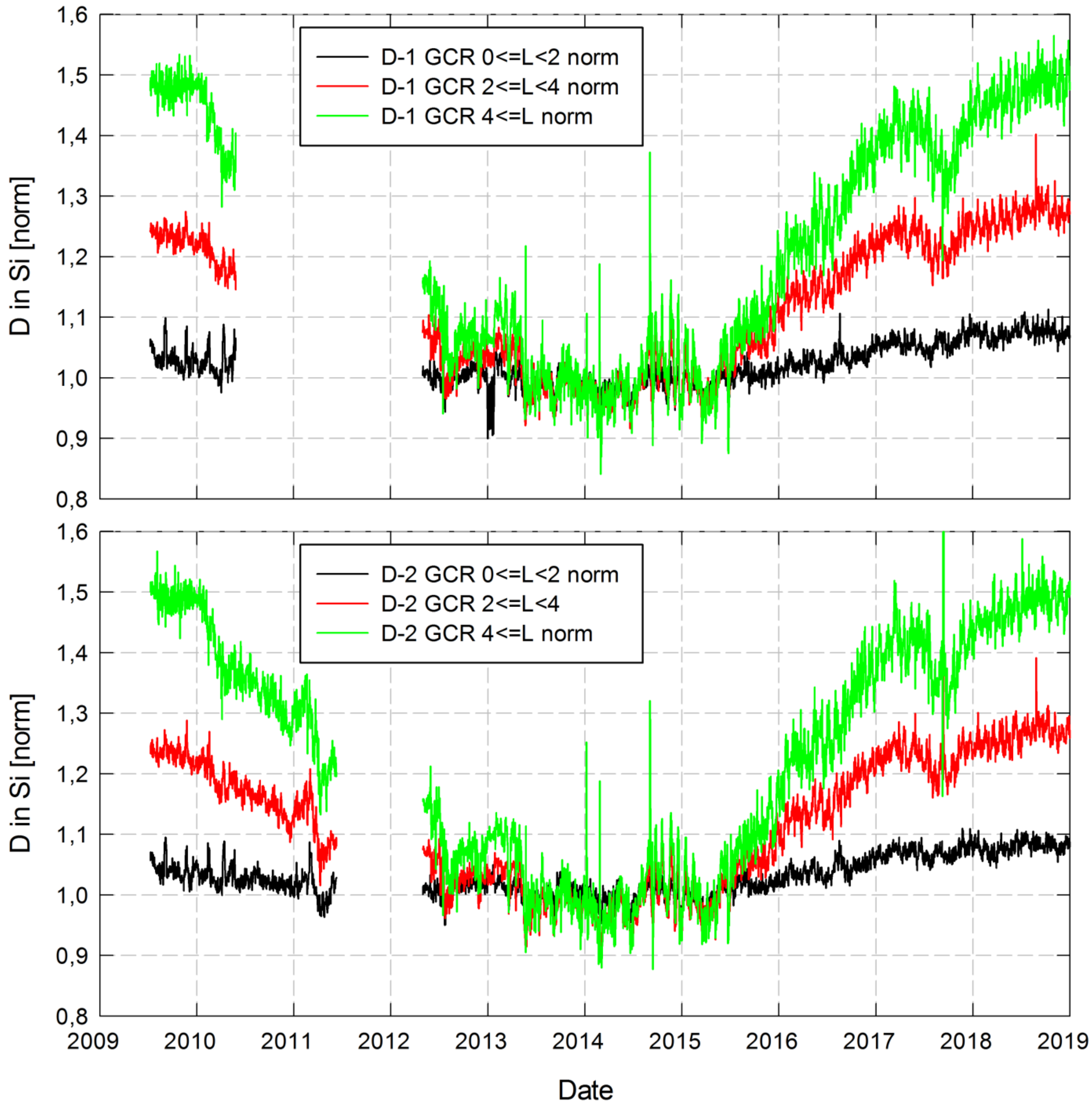
DOSIS & DOSIS 3D: 5 L value cut – 0≤L<2 / 2≤L<4 / 4≤L



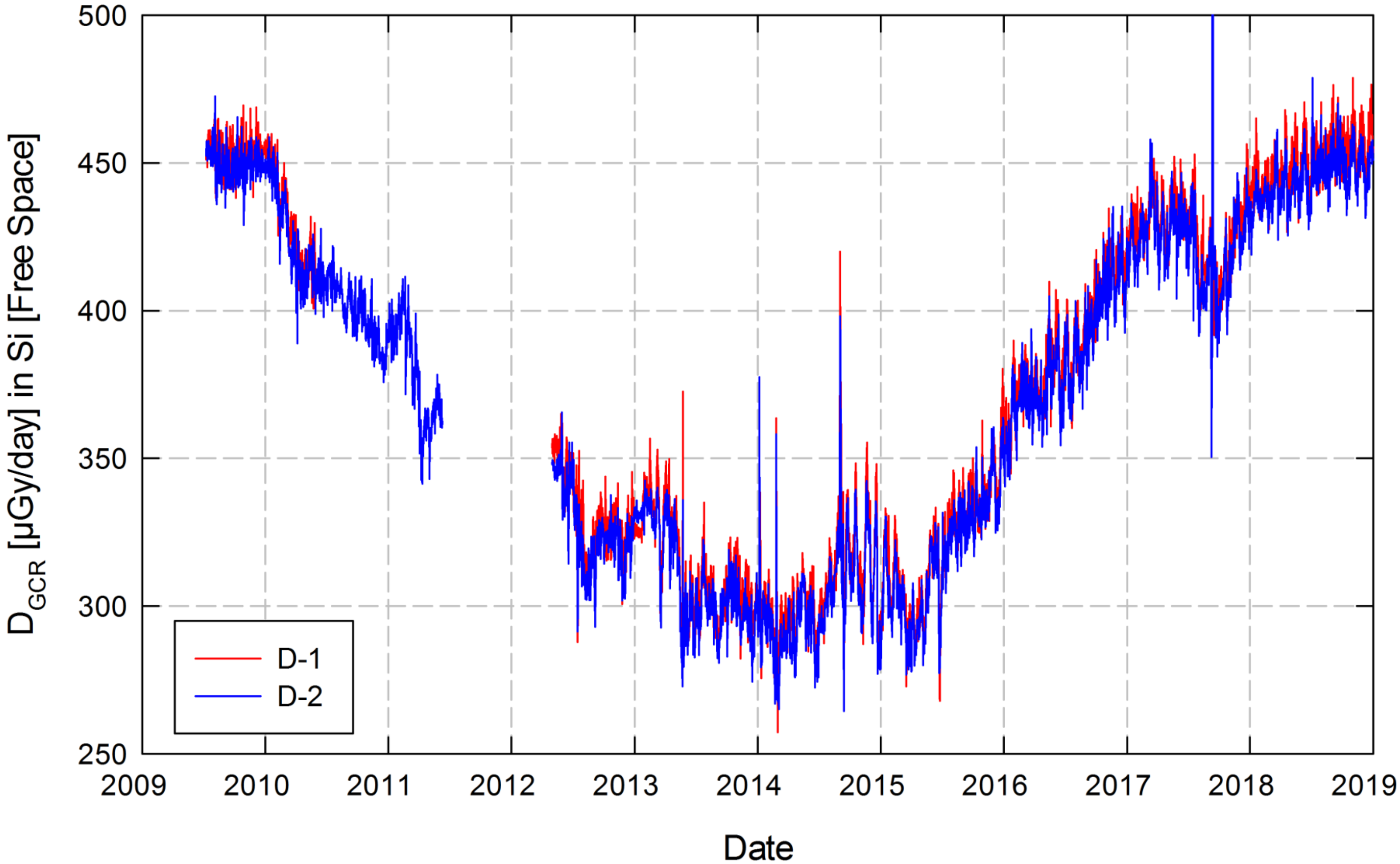
DOSIS & DOSIS 3D: 6 L value cut full day at 0≤L<2 / 2≤L<4 / 4≤L



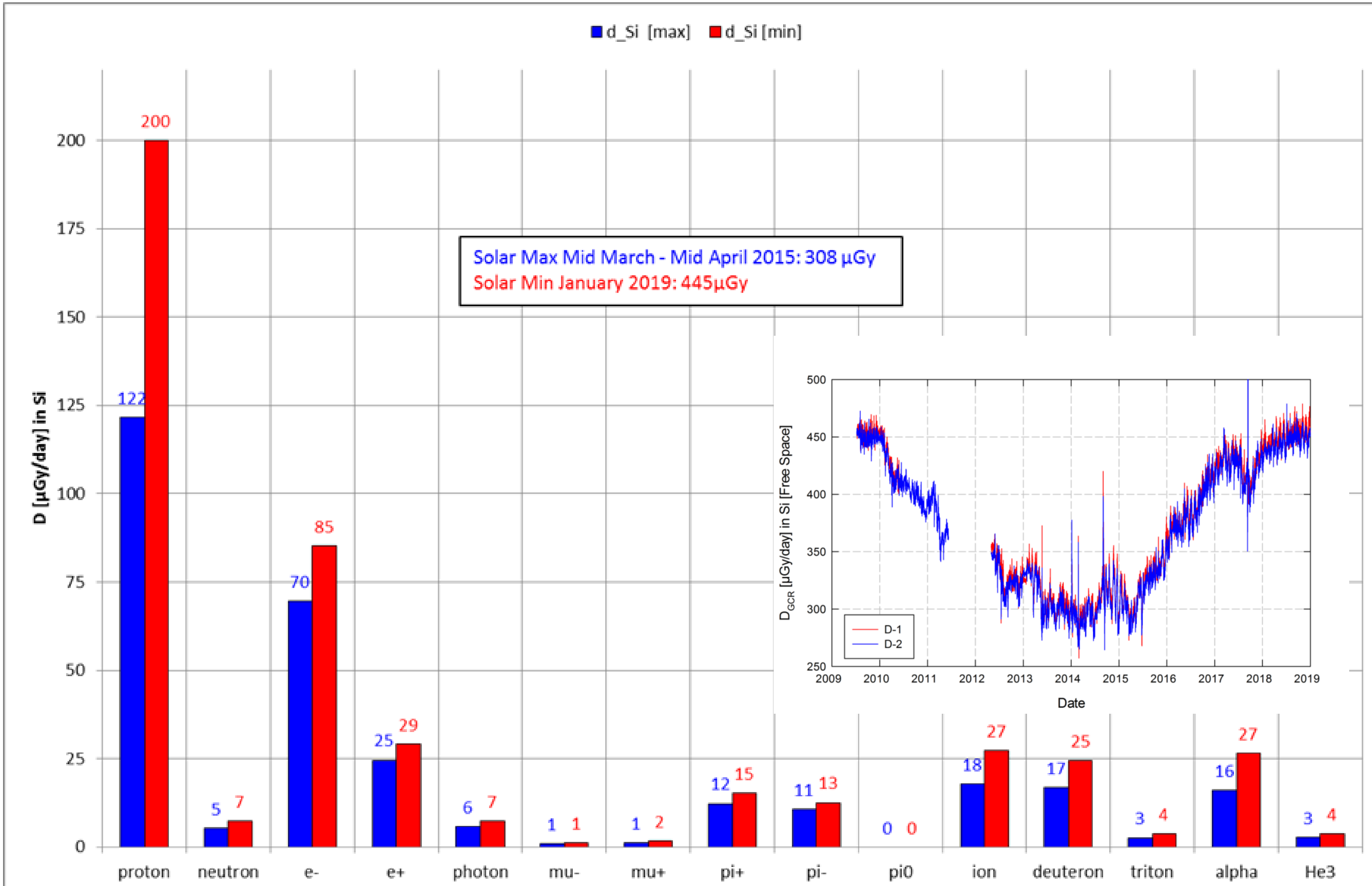
DOSIS & DOSIS 3D: 7 L value cut ratios – 0≤L<2 / 2≤L<4 / 4≤L



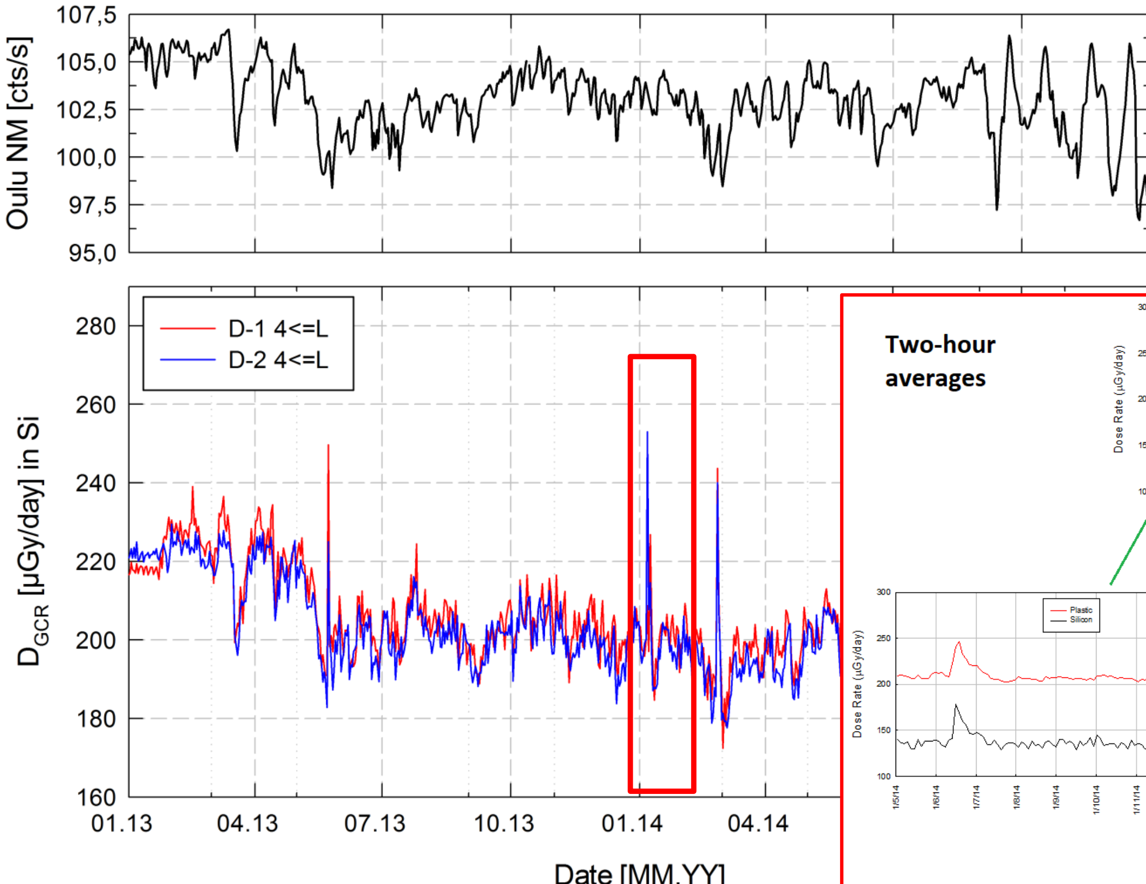
DOSIS & DOSIS 3D: 8 L value cut free space full day 4≤L



DOSIS & DOSIS 3D: 9 L value cut free space 4≤L (DLR GEANT4)



DOSIS & DOSIS 3D: 10 „NEW“ SPE Events

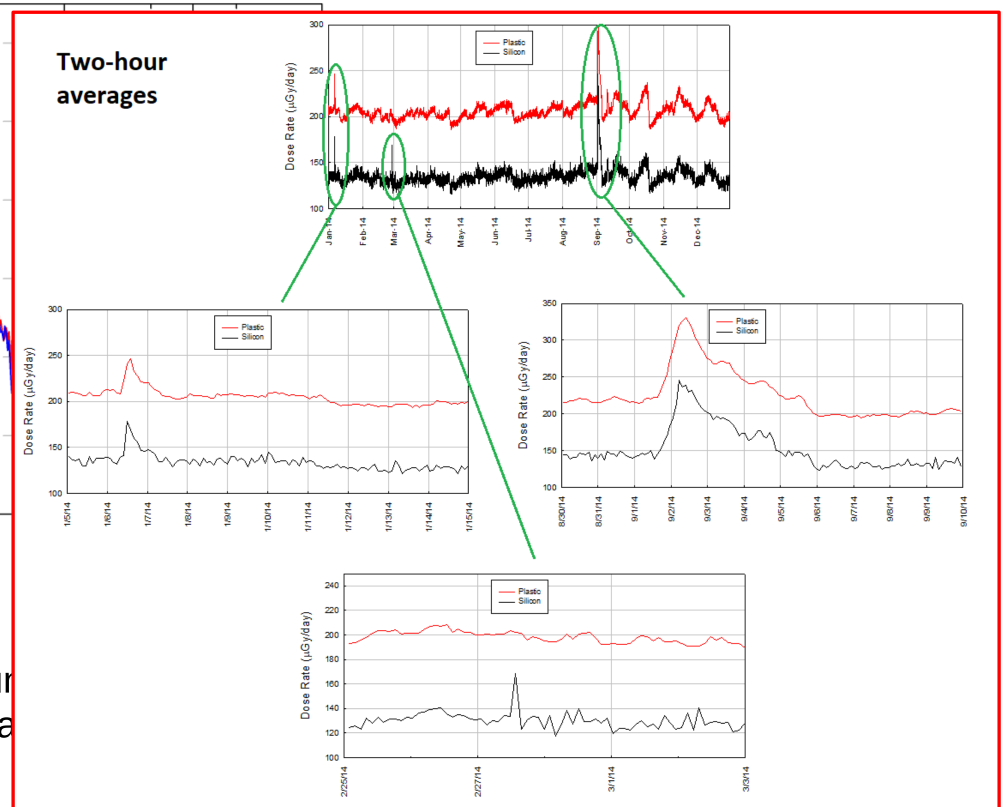


23 May 2013

6 – 8 January 2014 (DoY 6 – 8)

25 February 2014 (DoY 56)

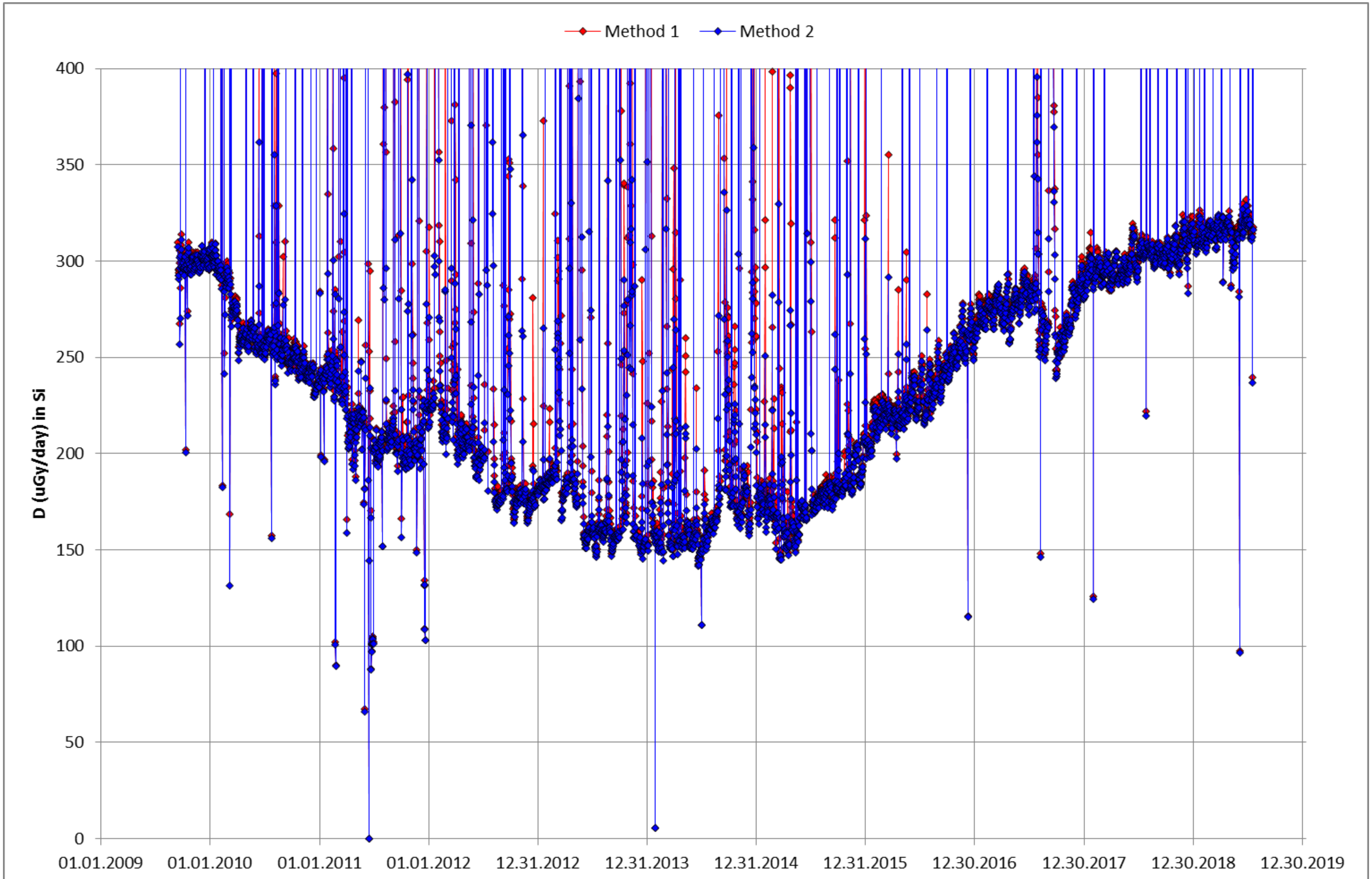
2 – 3 September 2014 (DoY 245 – 246)



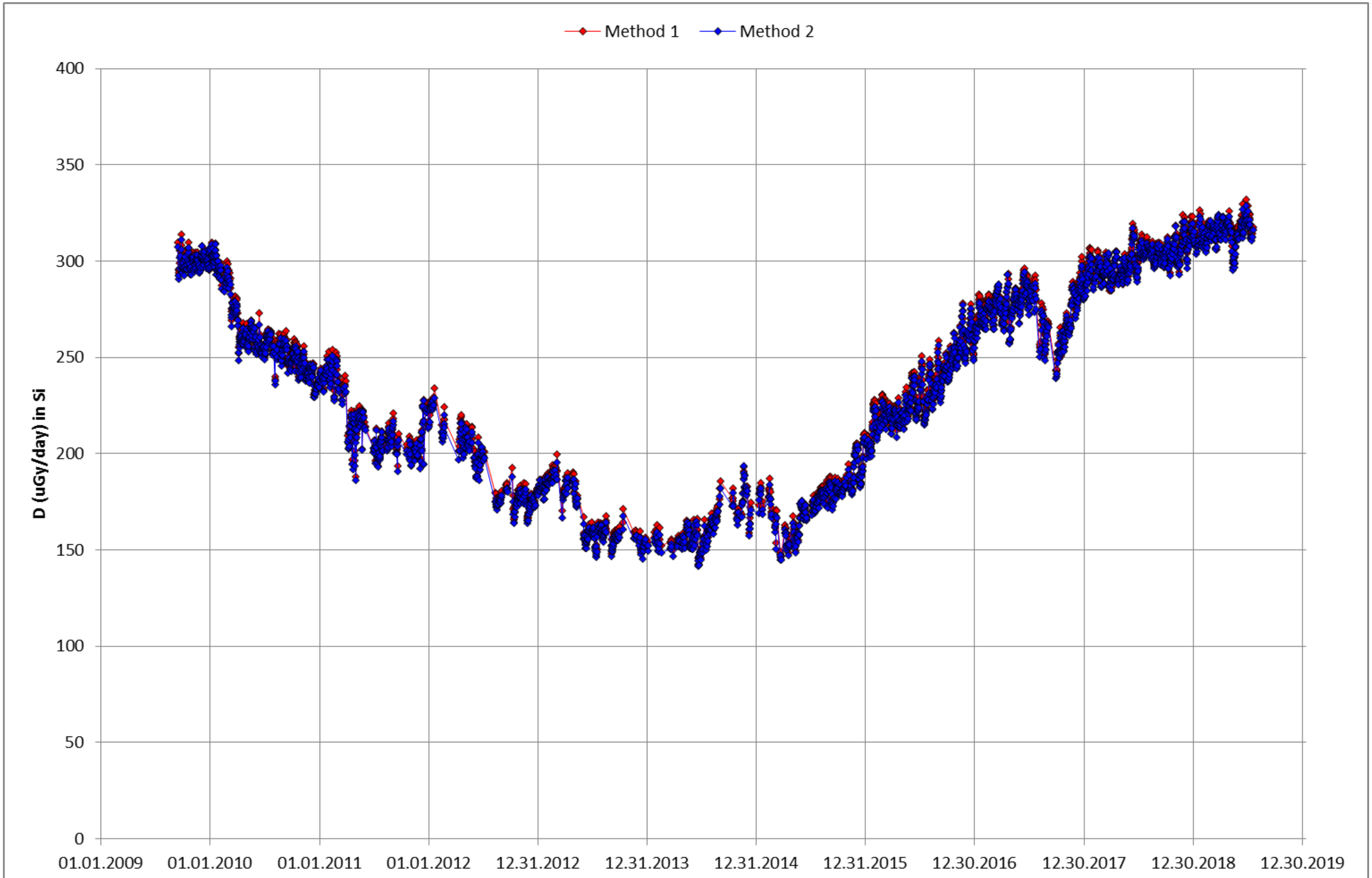
Cohen, C. M. S., & Mewaldt, R. A. (2018).The grour
large solar energetic particle events of cycle24. Spa
https://doi.org/10.1029/2018SW002006

CRaTER: Thanks to Cary !!!

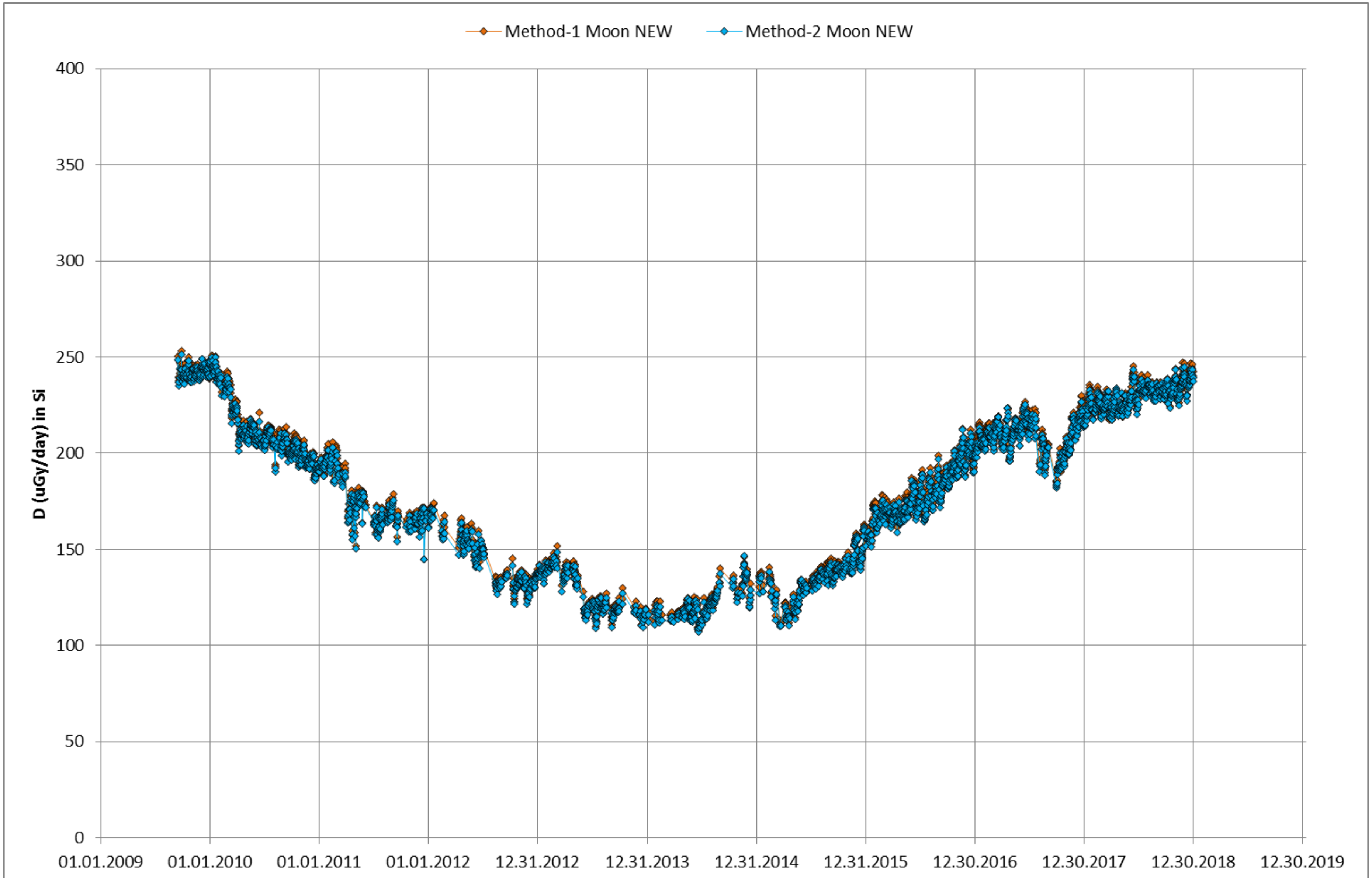
CRaTER: Data re-evaluation D1/D2



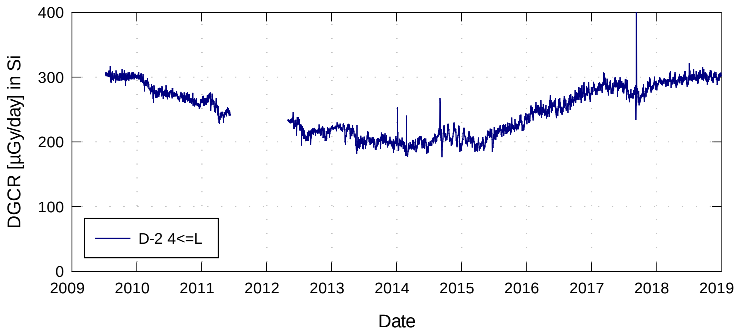
CRaTER: Data re-evaluation D1/D2



CRaTER: Data re-evaluation D1/D2

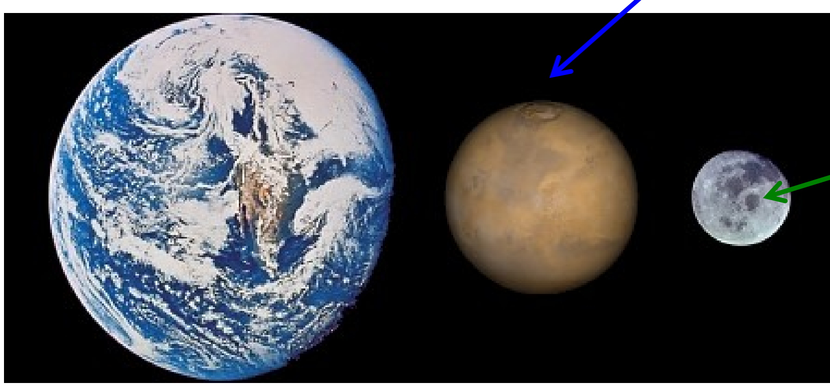


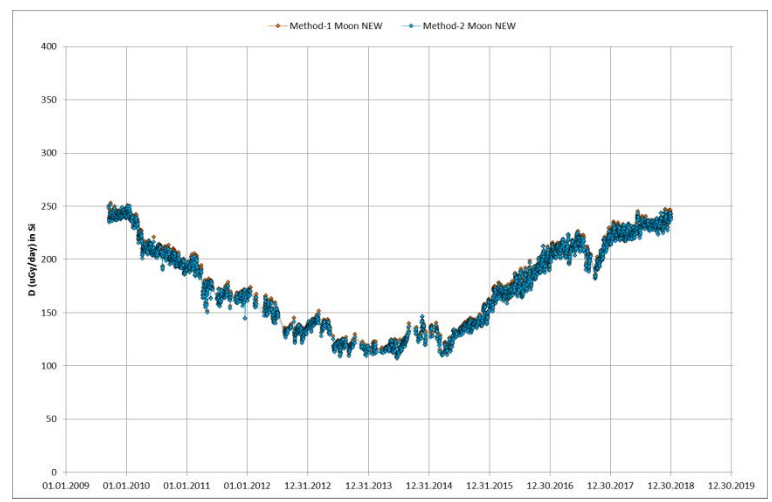
ISS / The Moon / Mars: 2009 …



DOSIS 3D DOSTEL

MSL-RAD

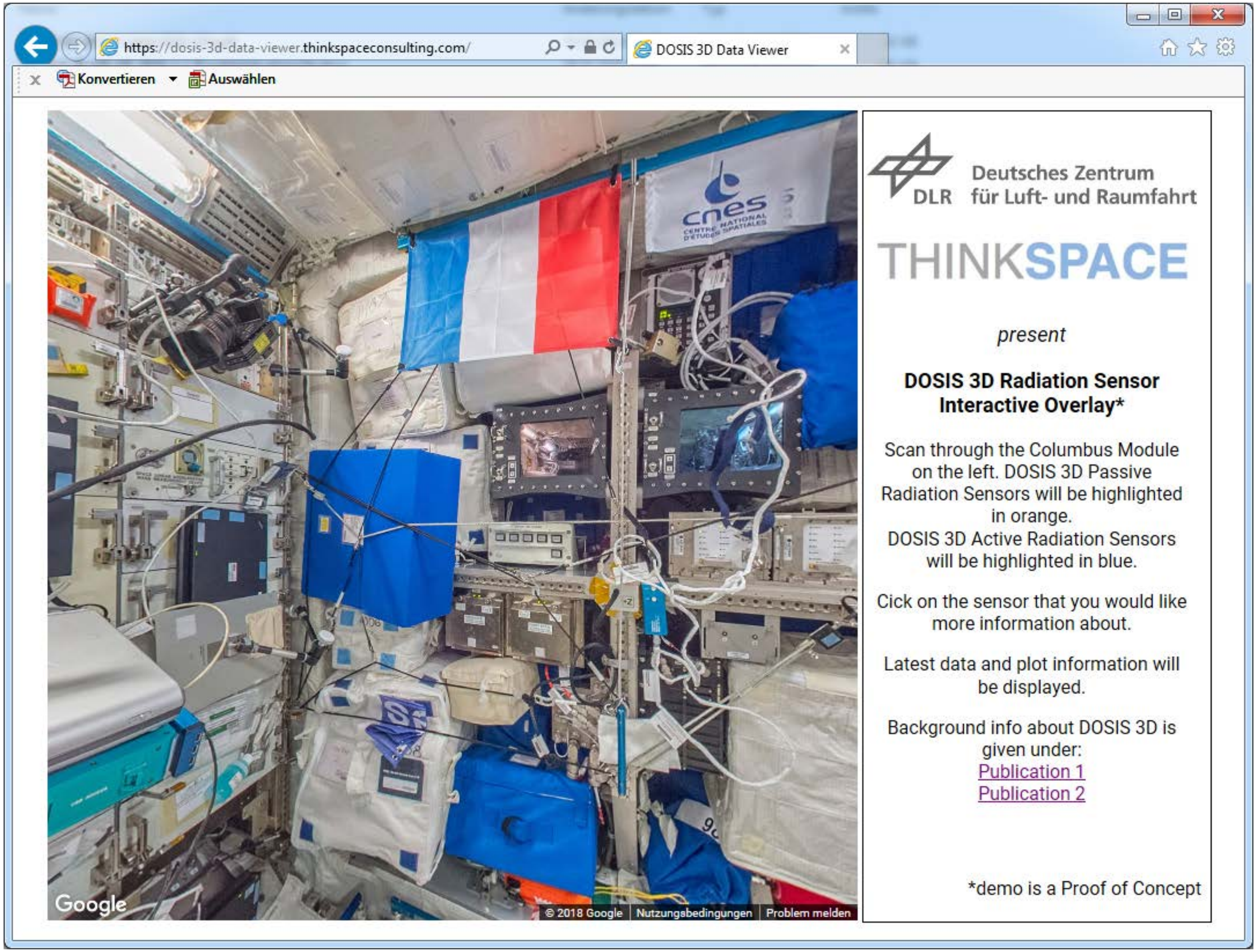




CRaTER

DOSIS & DOSIS 3D:
DATA VIEWER

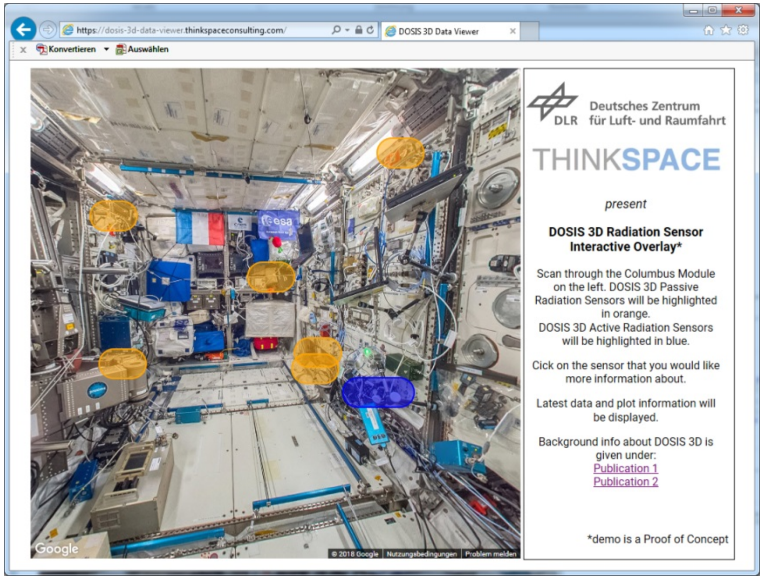
DOSIS & DOSIS 3D: Data Viewer

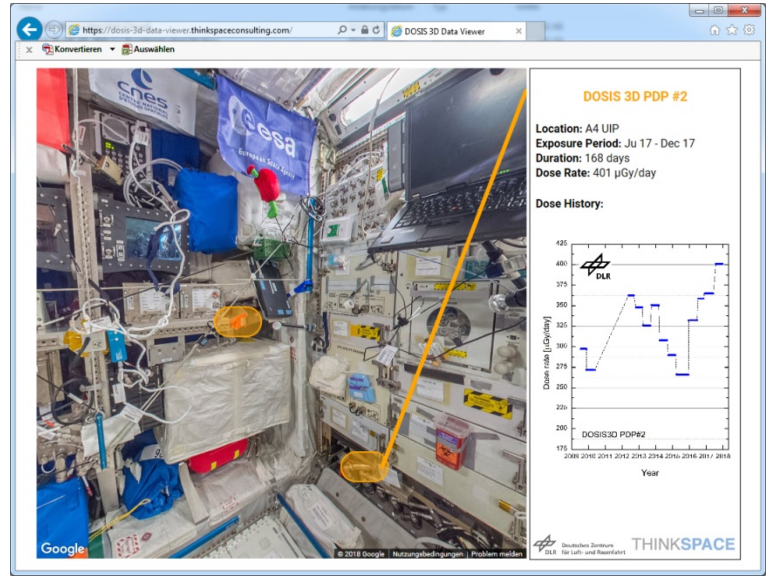


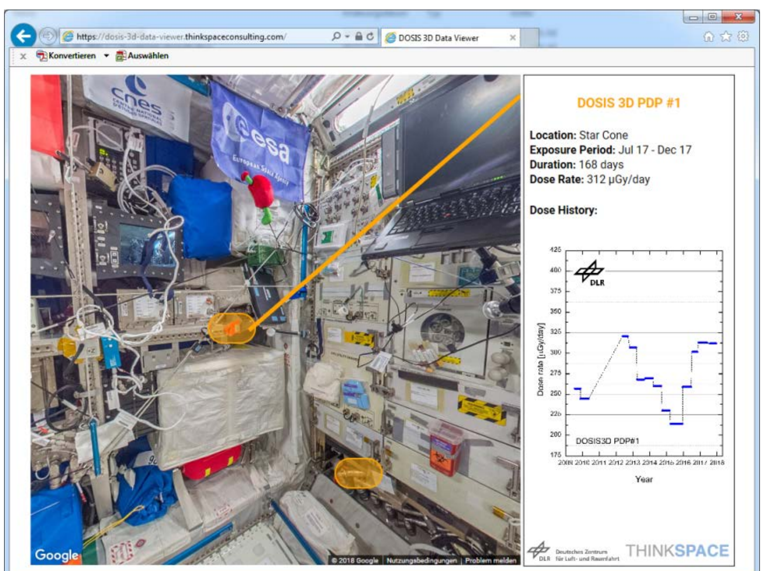
https://dosis-3d-data-viewer.thinkspaceconsulting.com/

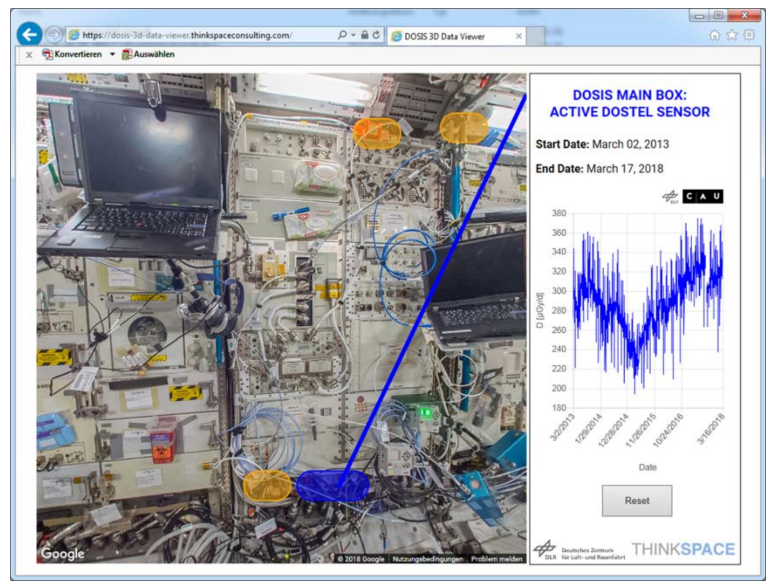
DLR

DOSIS & DOSIS 3D: Data Viewer









https://dosis-3d-data-viewer.thinkspaceconsulting.com/

DOSIS & DOSIS 3D: Summary and Outlook

- Data from 2009 -2019
- Data comparison with active detectors onboard ISS, Moon and Mars ongoing
- Data evaluation for TLD + CR-39 soon ready to be published
- … a lot more to do…

DOSIS & DOSIS 3D: Acknowledgements

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