



Passive dosimetry in the Service (Zvezda) module: 2010-2014.

**J.K. Pálfalvi¹, J. Szabó¹, A. Strádi¹, I. Apáthy¹, P. Szántó¹,
Yu. Akatov², V.A. Shurshakov², R. Toloček²,
I. Ambrozova³, S. Kodaira⁴, T. Berger⁵, M. Hajek⁶**

1 HAS, Centre for Energy Research, Budapest, Hungary

2 RAS, Institute of Biomedical Problems, Moscow, Russian Federation

3 ASCR, Nuclear Physics Institute, Prague, Czech Republic

4 NIRS, National Institute of Radiological Sciences, Chiba, Japan

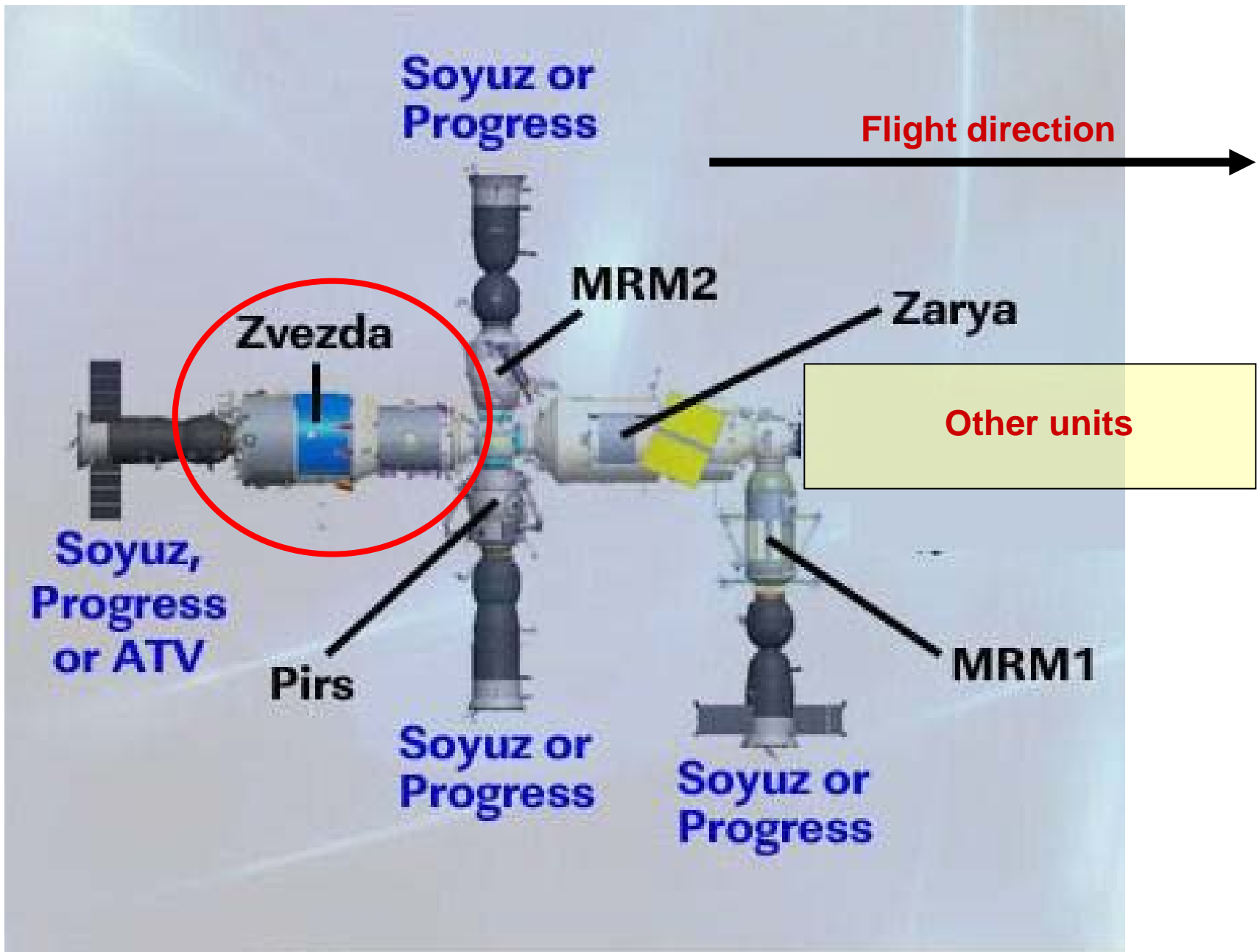
5 DLR, German Aerospace Center, Cologne, Germany

6 IAEA, International Atomic Energy Agency Vienna, Austria



SPD experiments

Experiment	Date		Vehicle	Duration, day
SPD-7	Launch	28.04.2010	Progress-05M/37P	211.5
	Landing	26.11.2010	Soyuz-TMA-19/24S	
SPD-8	Launch	04.04.2011	Soyuz-TMA-21/27S	231
	Landing	22.11.2011	Soyuz-TMA-02M/29S	
SPD-9	Launch	15.05.2012	Soyuz-TMA-04M/30S	364
	Landing	14.05.2013	Soyuz-TMA-07M/34S	
SPD-10	Launch	25.09.2013	Soyuz-TMA-10M/36S	231
	Landing	14.05.2014	Soyuz-TMA-11M/37S	



Sunday, February 22,
2015

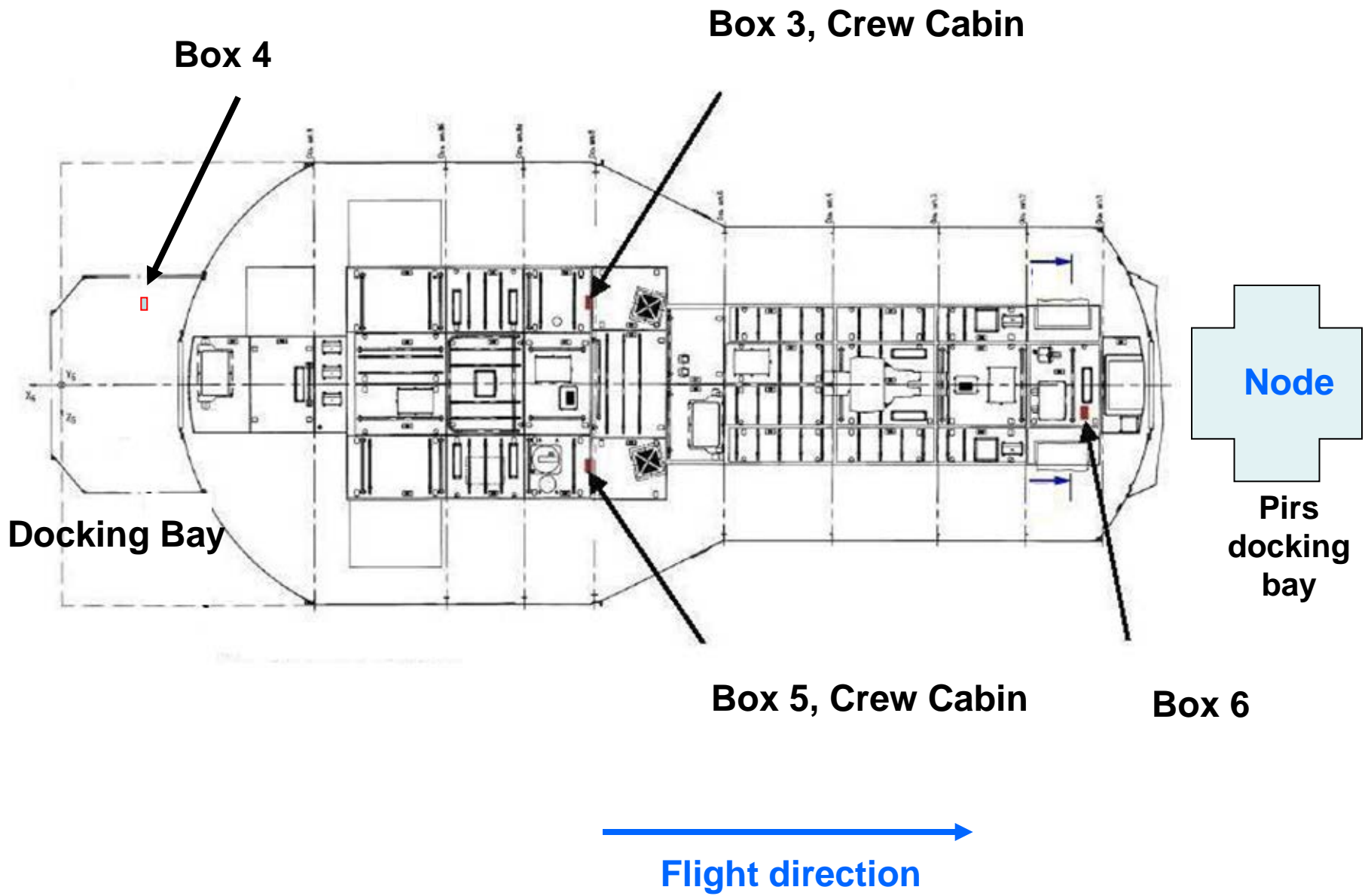
Russian units of ISS

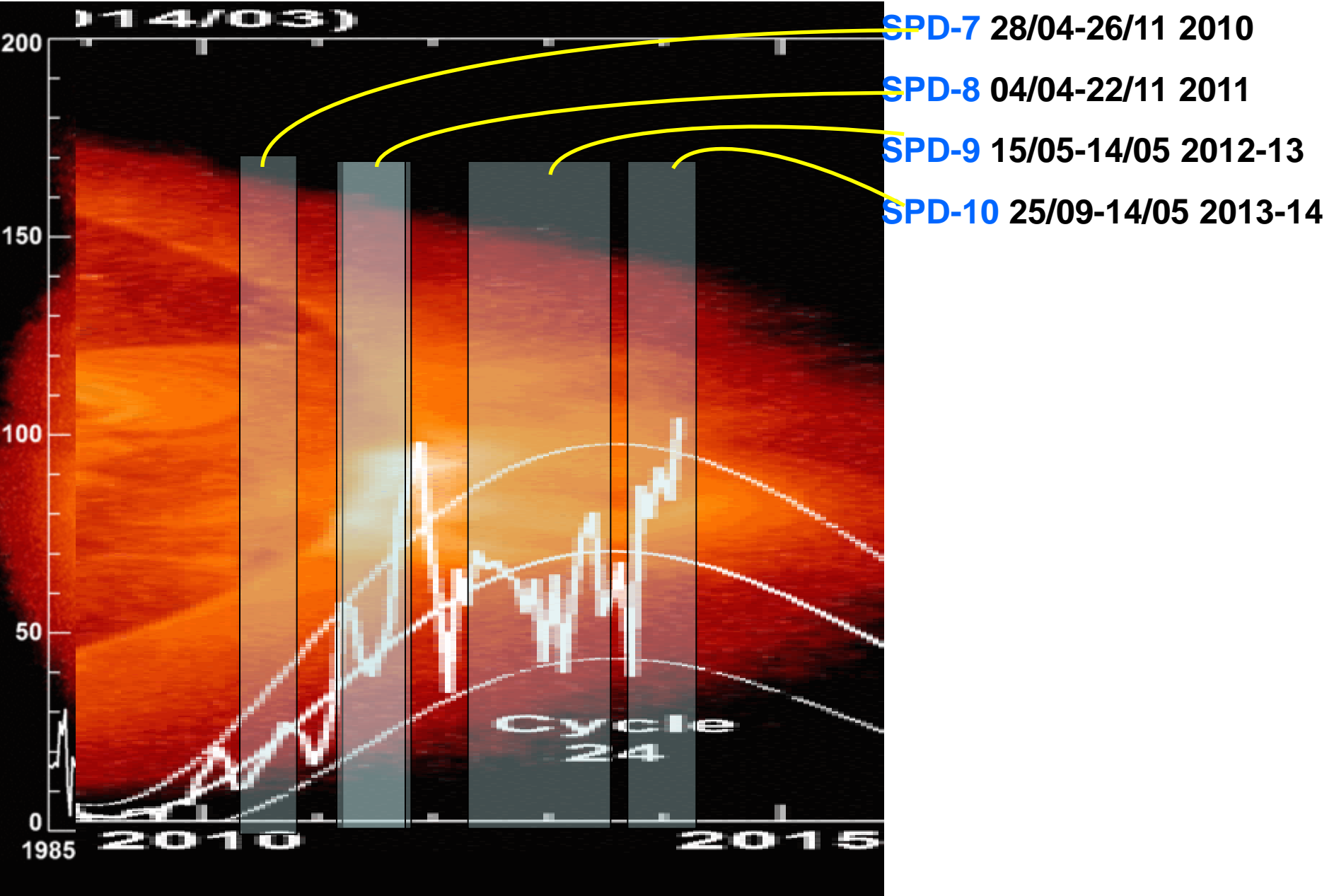
SPD boxes in Zvezda (Service) module

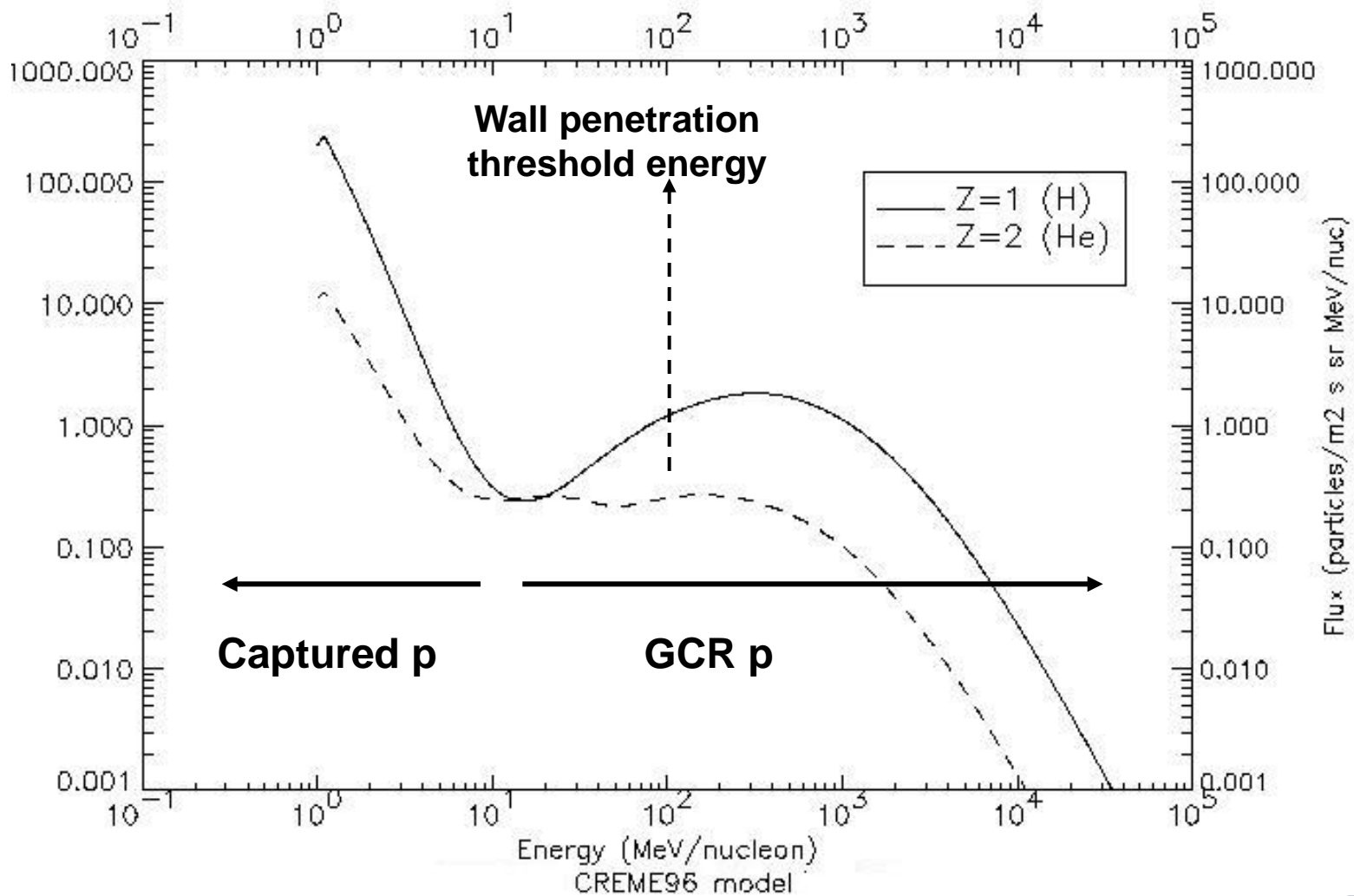
Box №	Panel № / Location
3	325 / SM CC left, overhead
4	461 / SM near Docking Bay left, starboard
5	323 / SM CC right, overhead
6	305 / SM near Pirs Docking Bay right, overhead

SM : Service Module

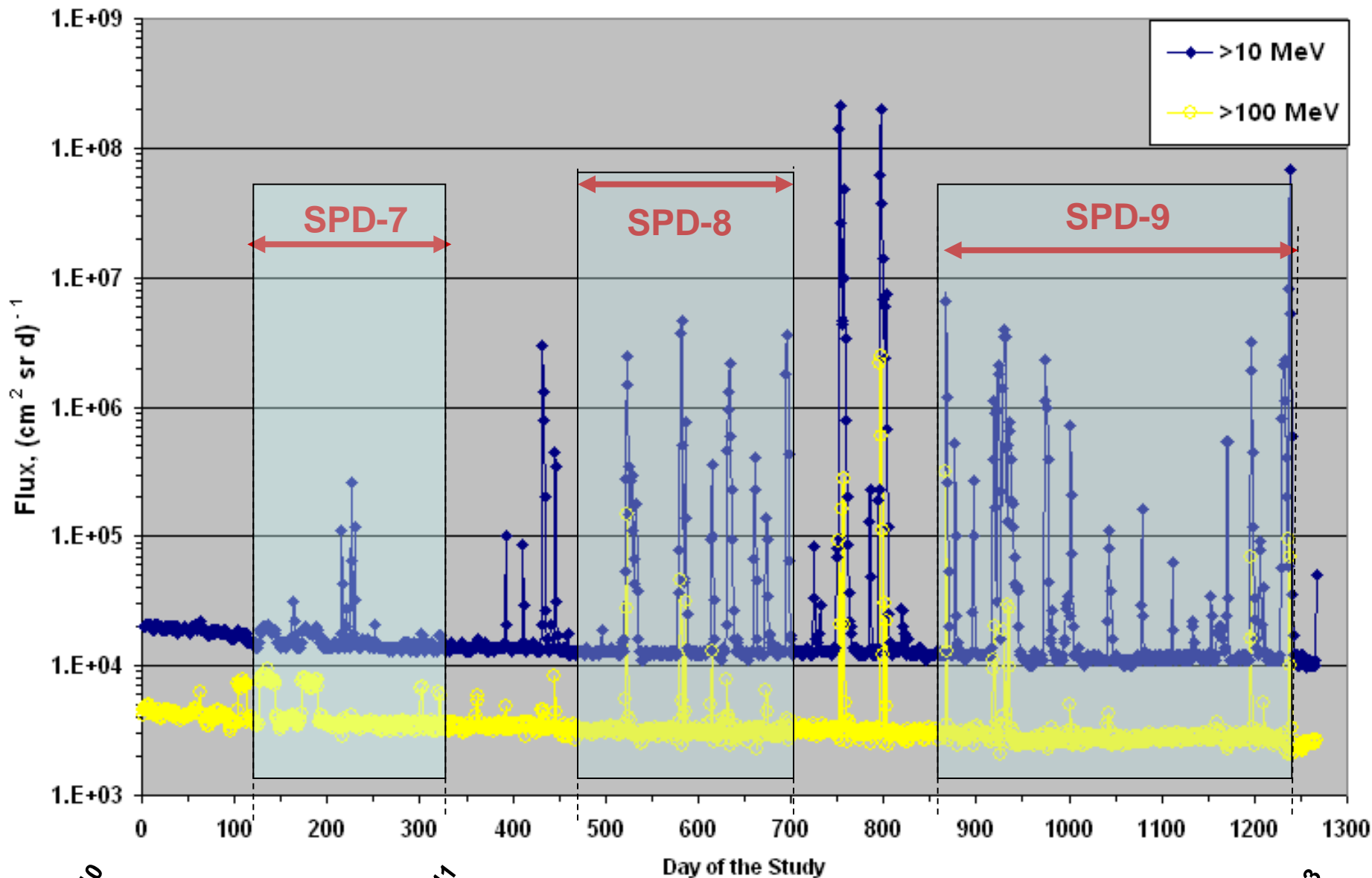
CC: Crew Cabin







GOES-13 Daily proton flux



01.01.2010
Sunday, February 22,
2015

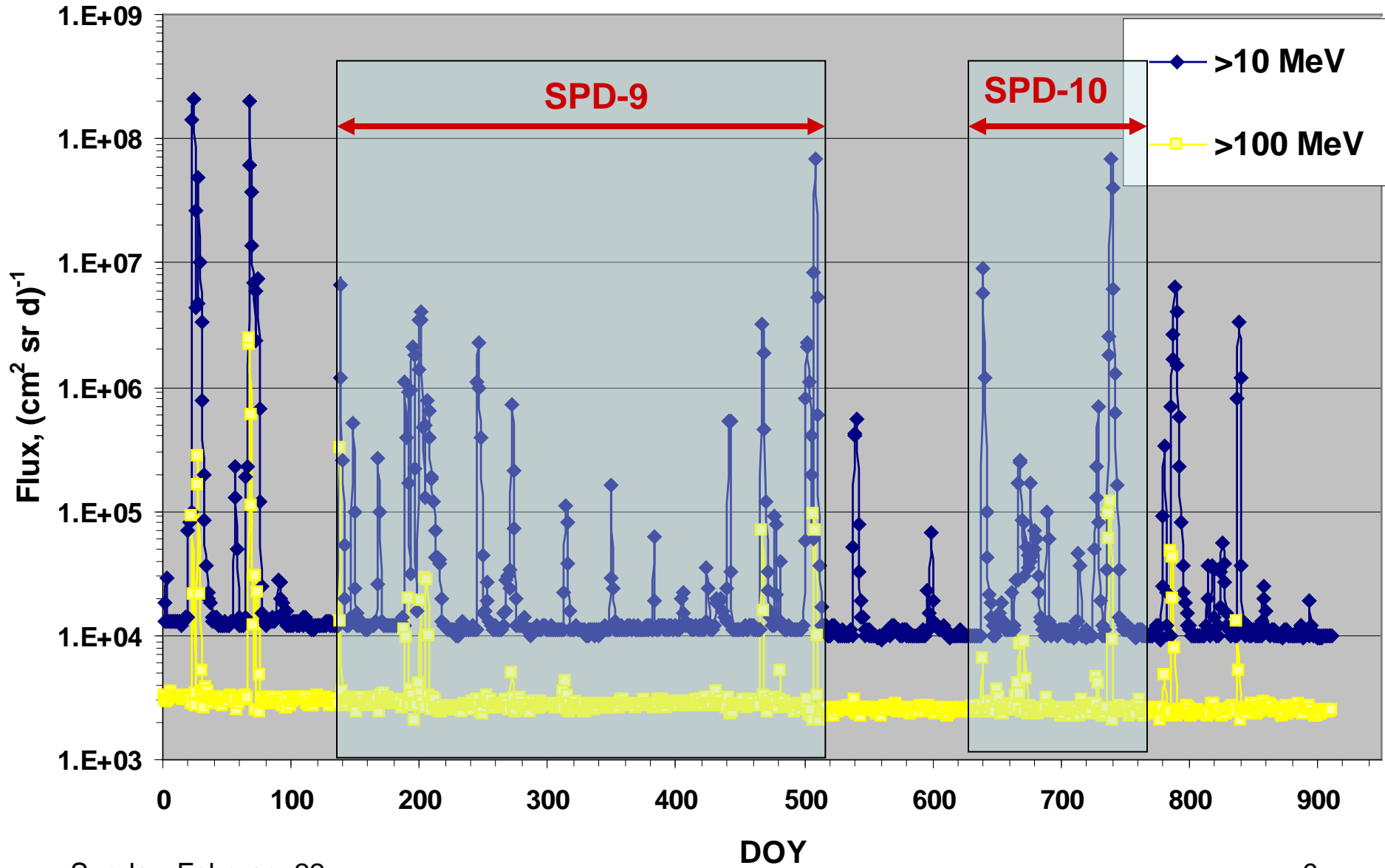
01.01.2011

Day of the Study
01.01.2012

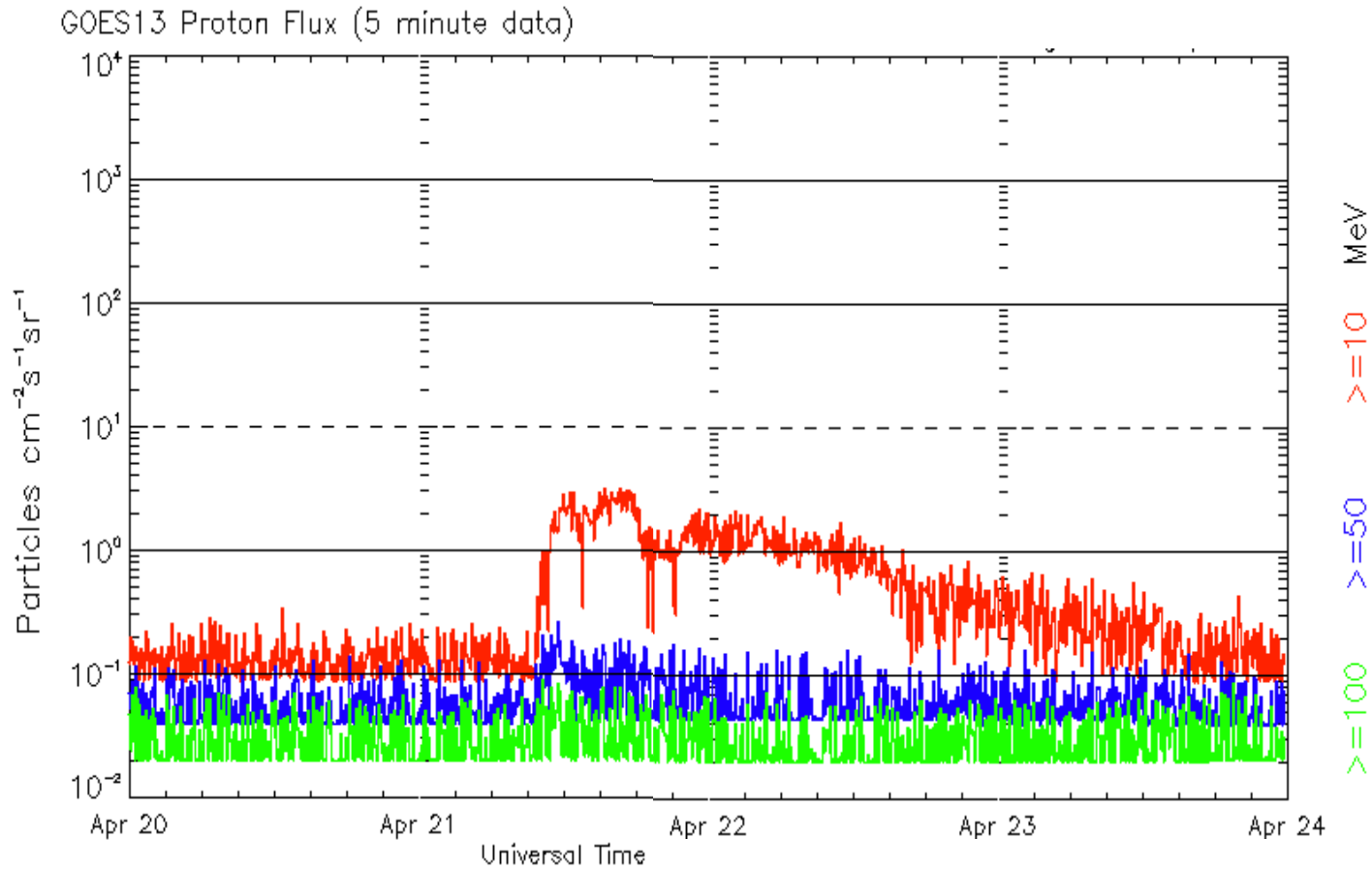
01.01.2013

21.06.2013
8

Daily proton flux (1 January, 2012 - 30 June 2014)

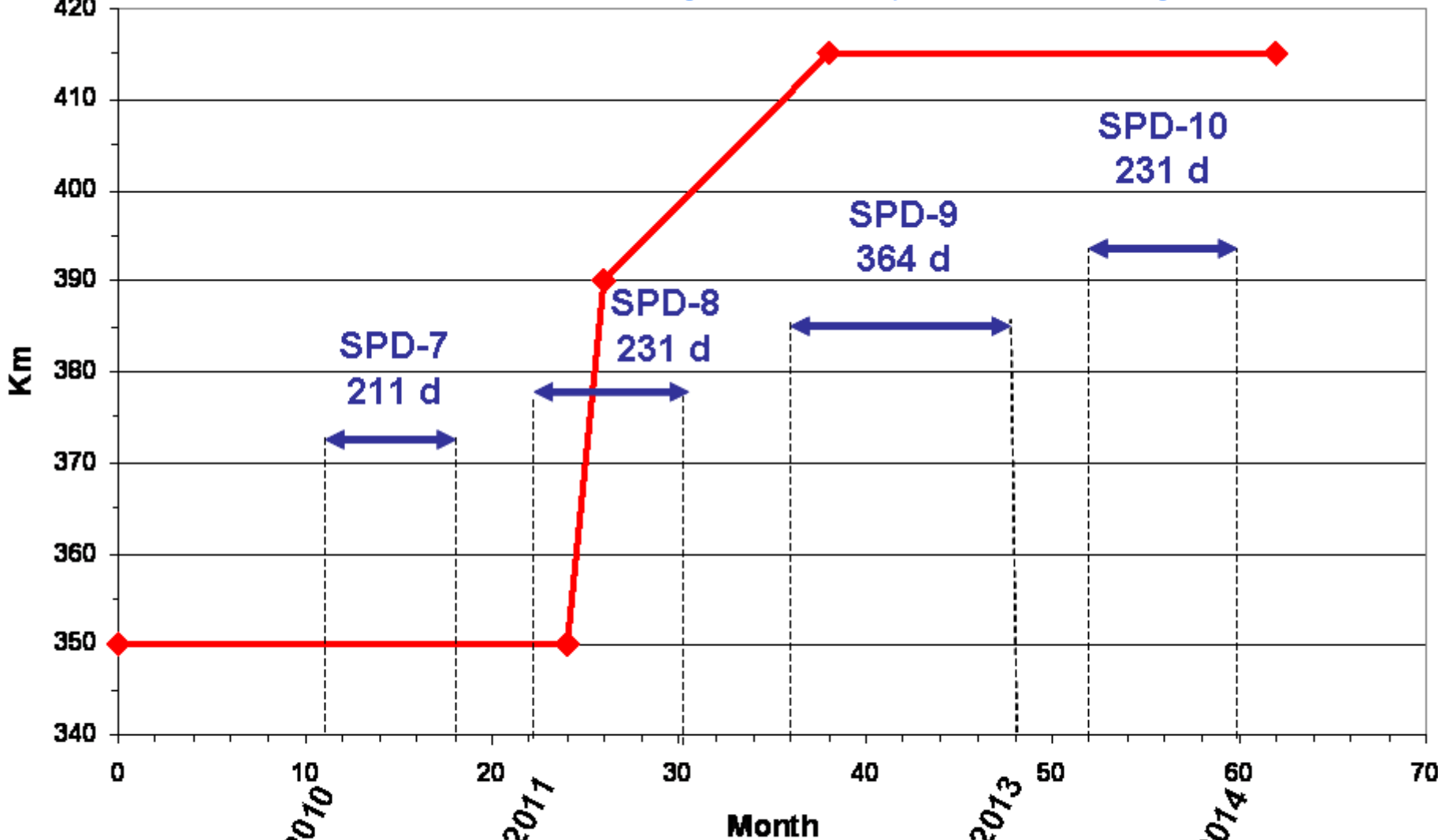


Proton Flux April 20 – April 24, 2013, During SPD-9



100 MeV protons can penetrate 3.6 cm Aluminum only !

ISS altitude elevation during 24th Sun cycle, increasing phase



01.05.2010

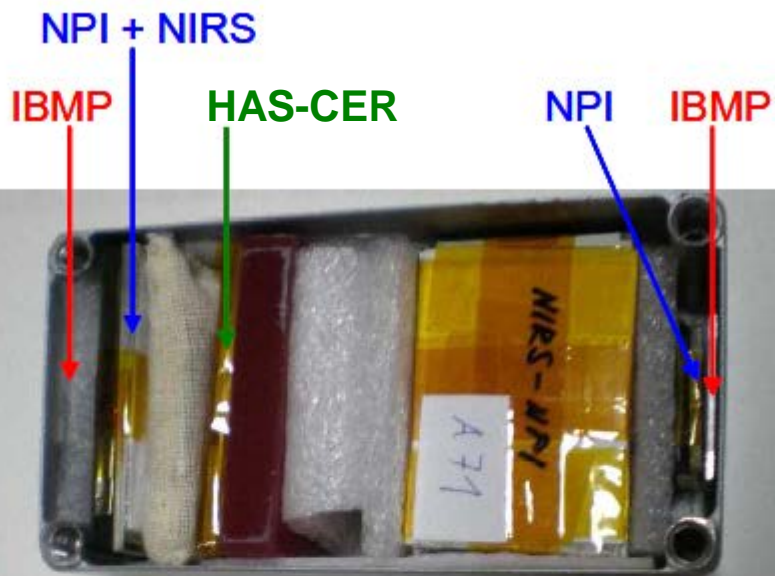
01.05.2011

01.05.2013

01.05.2014

Month





IBMP: mean values of two sides

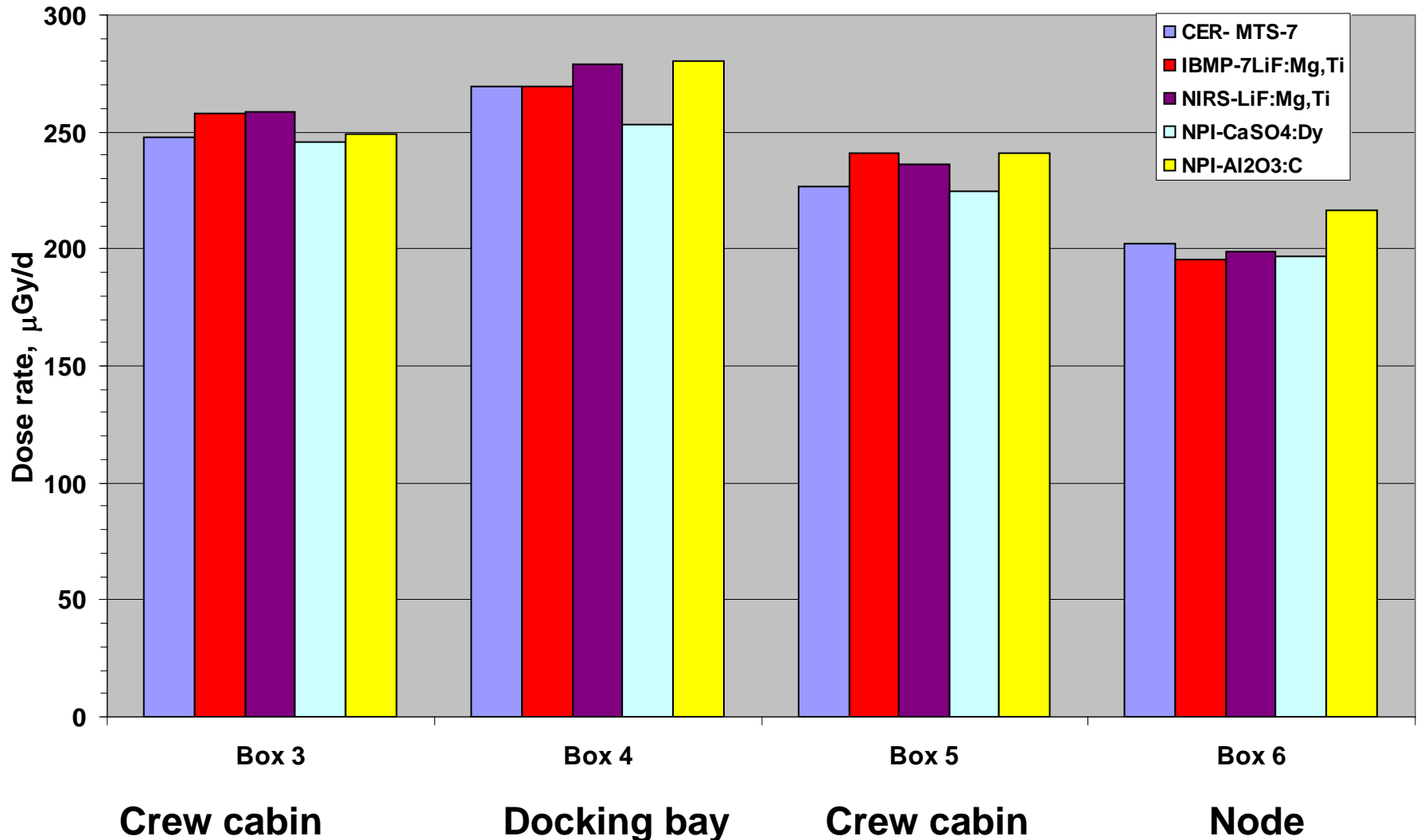


Detector arrangement of SPD Boxes

SPD-7, low LET radiation

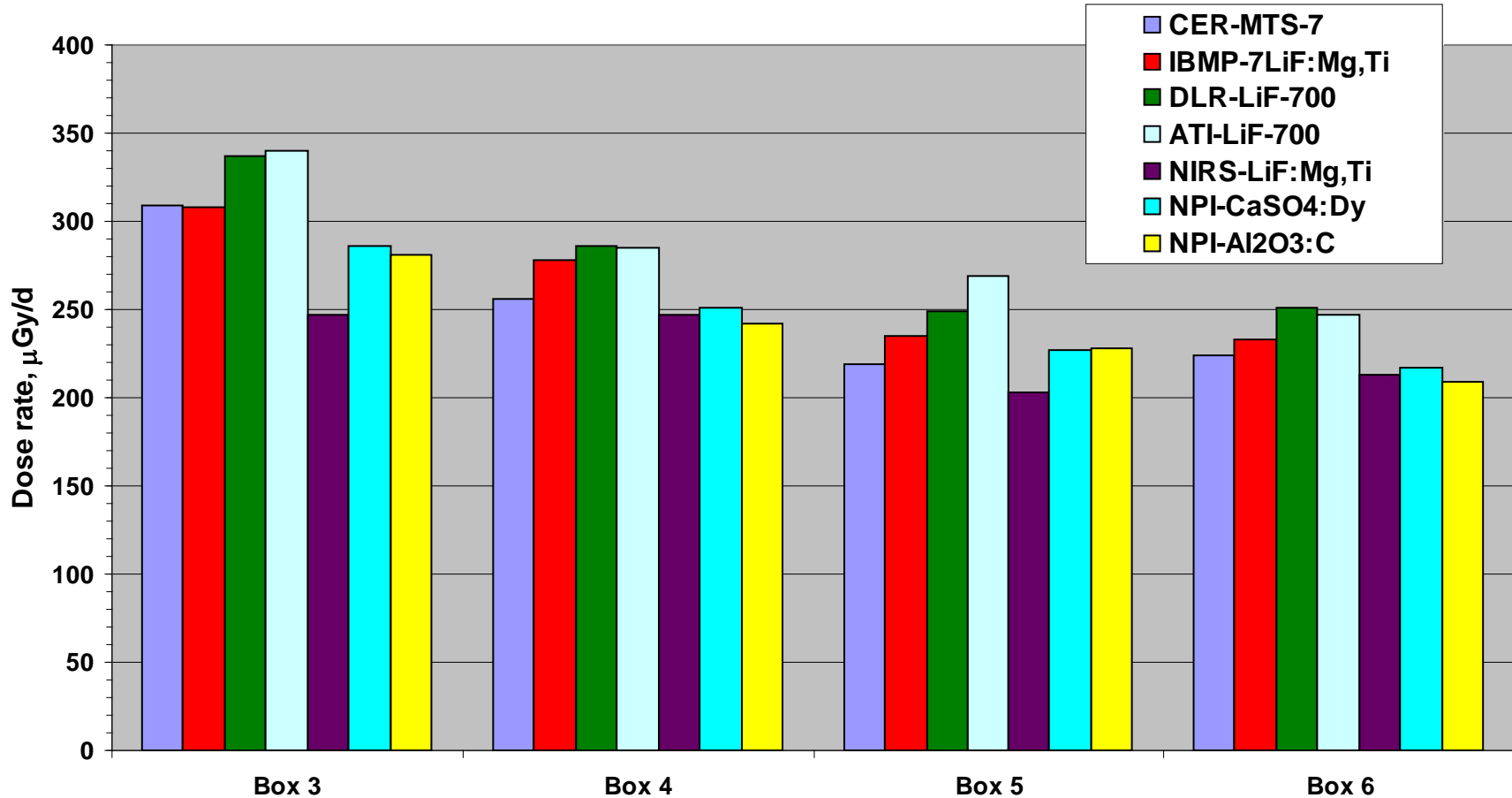
28/04-26/11 2010, lower flight altitude

In SM the dose rate varies between 200 and 270 $\mu\text{Gy/d}$



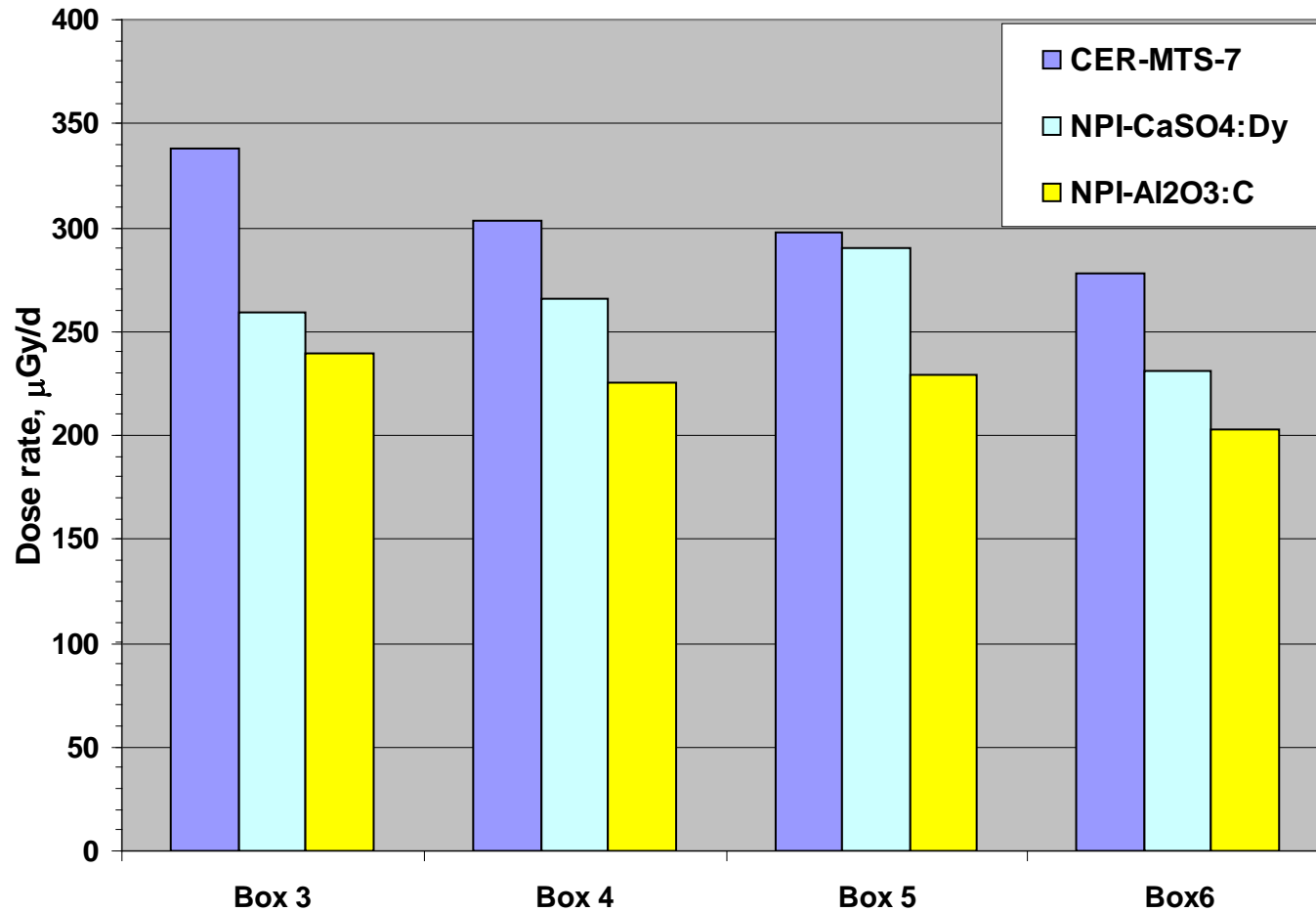
SPD-8, low LET radiation
04/04-22/11 2011, increasing flight altitude

In SM the dose rate varies between 230 and 320 $\mu\text{Gy/d}$



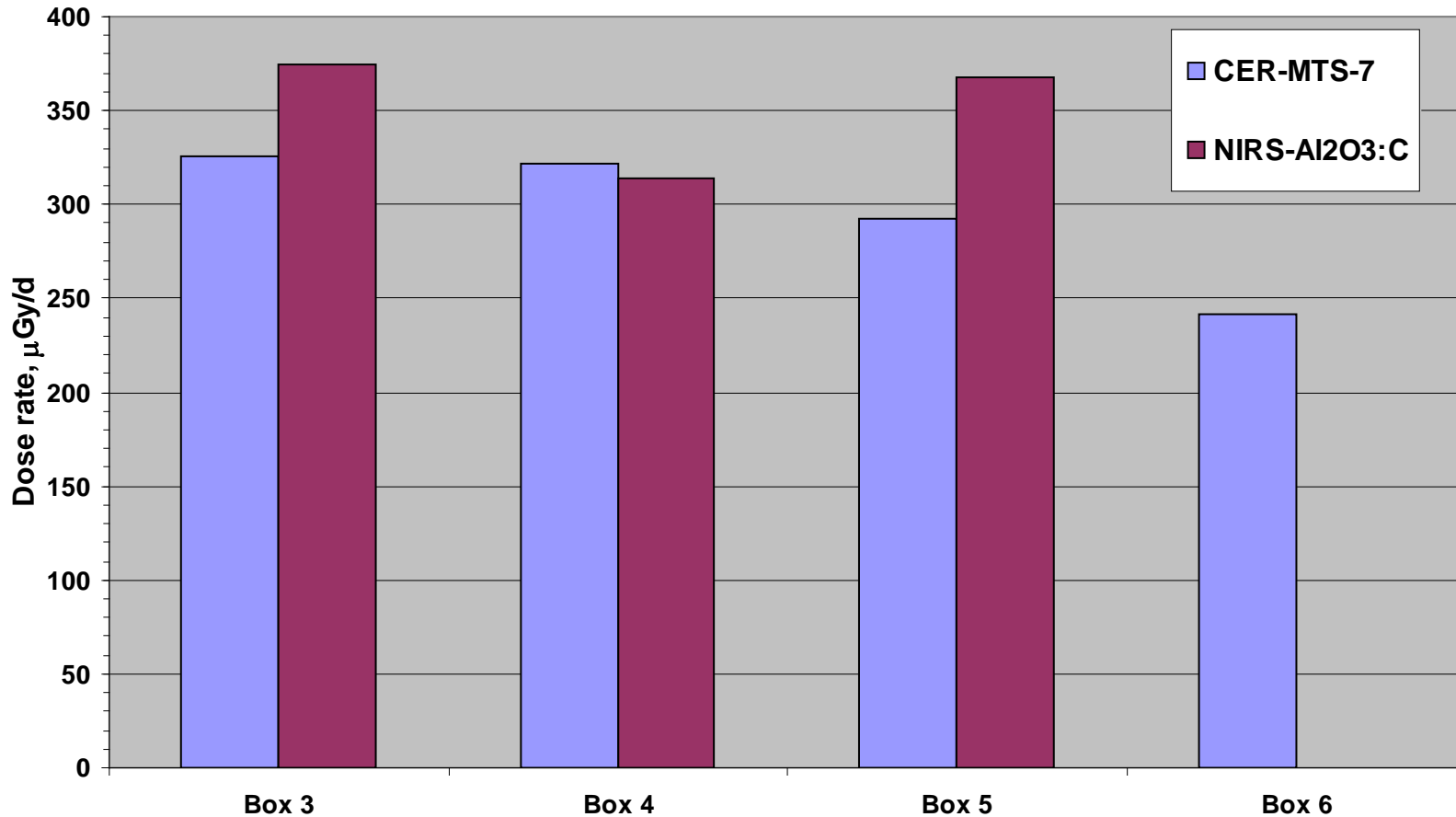
SPD-9, low LET radiation
15/05/2012-14/05/2013, high flight altitude

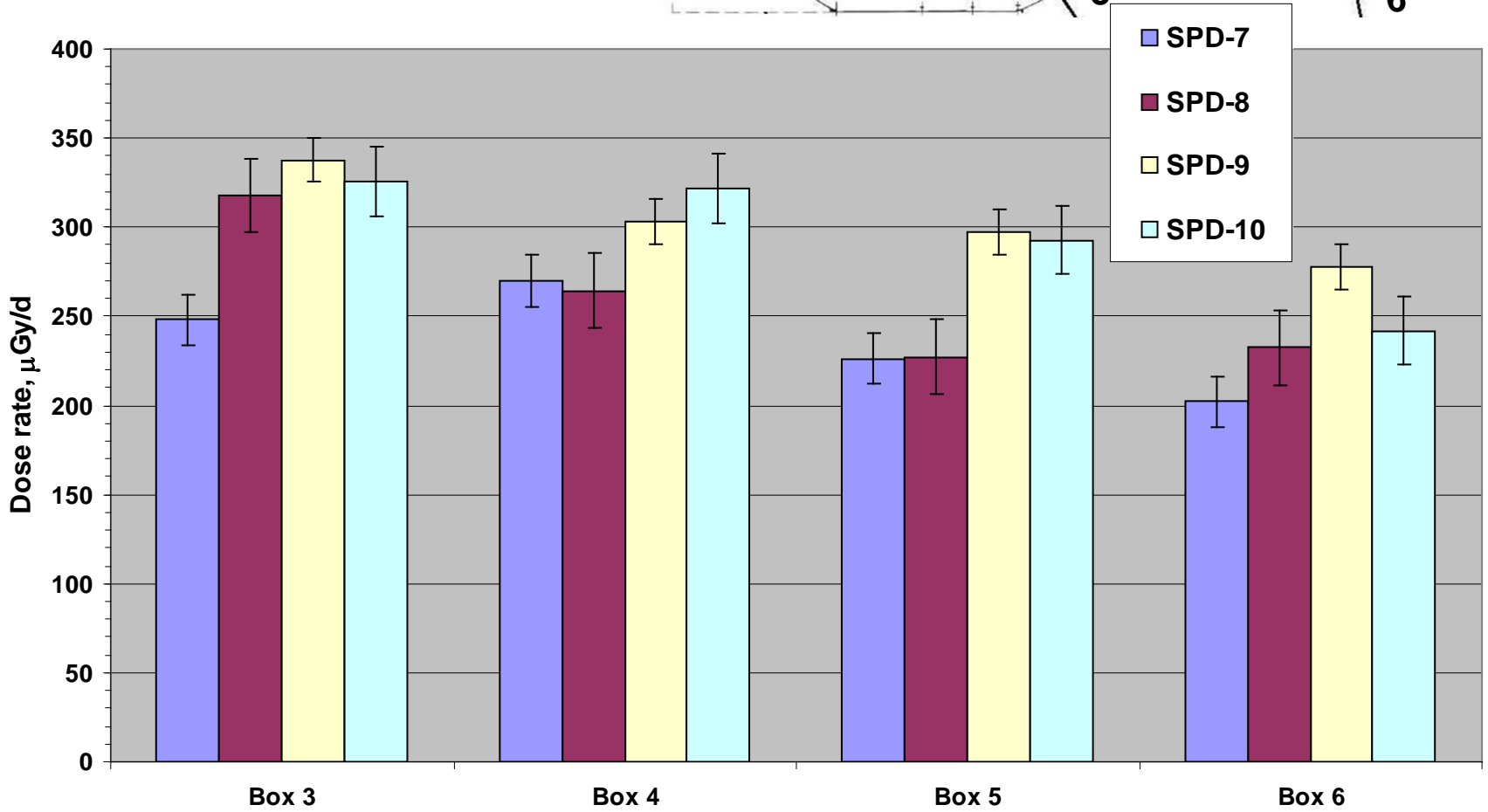
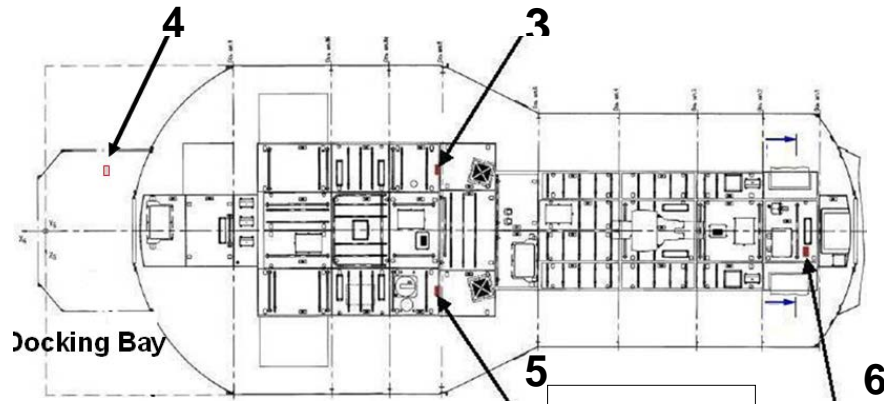
CER: In SM the dose rate varies between 270 and 330 $\mu\text{Gy/d}$



SPD-10, low LET radiation
25/09/2013-14/05/14, high flight altitude

CER: In SM the dose rate varies between 240 and 330 $\mu\text{Gy/d}$





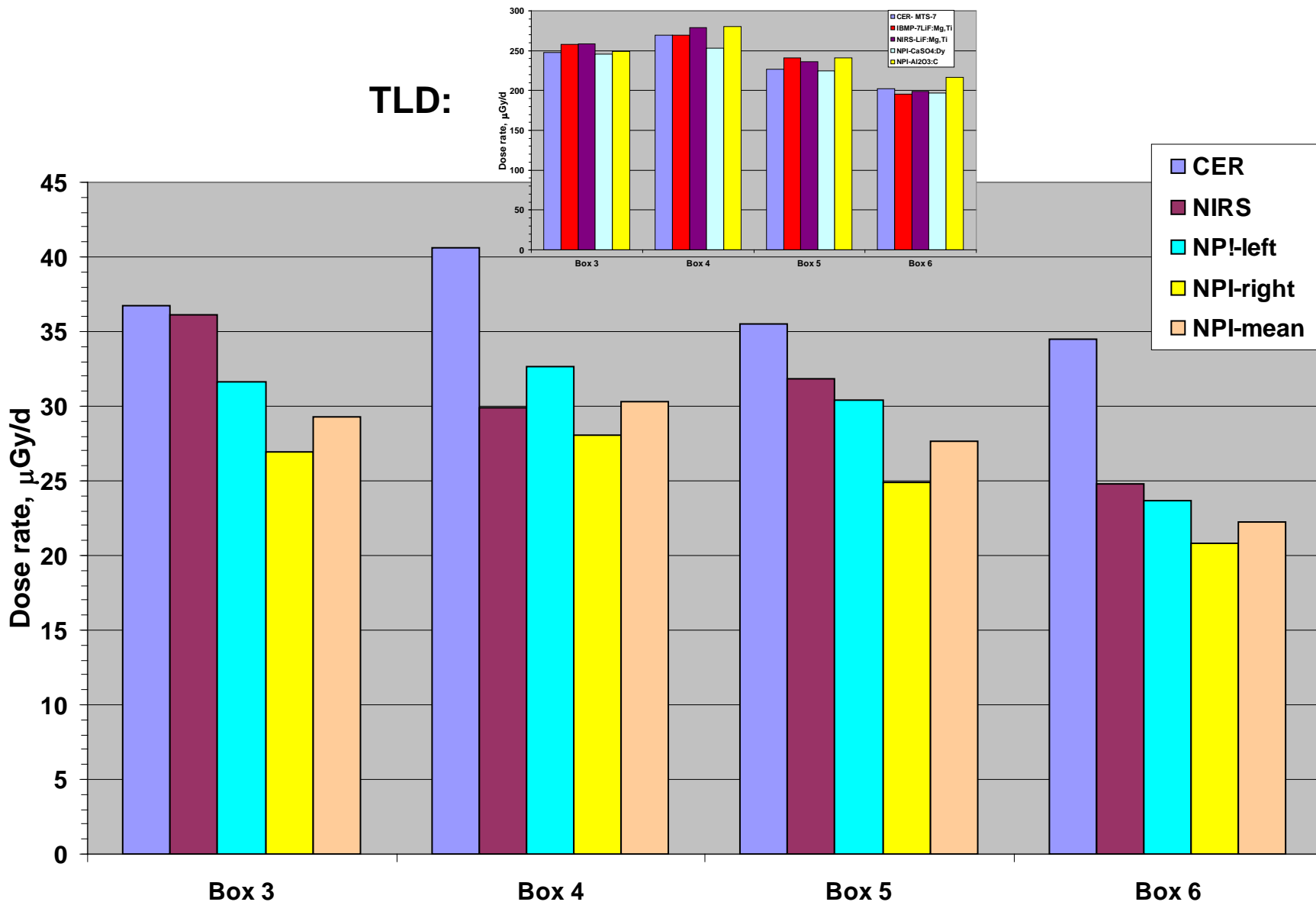
Sunday, February 22,
2015

PRELIMINARY RESULTS !

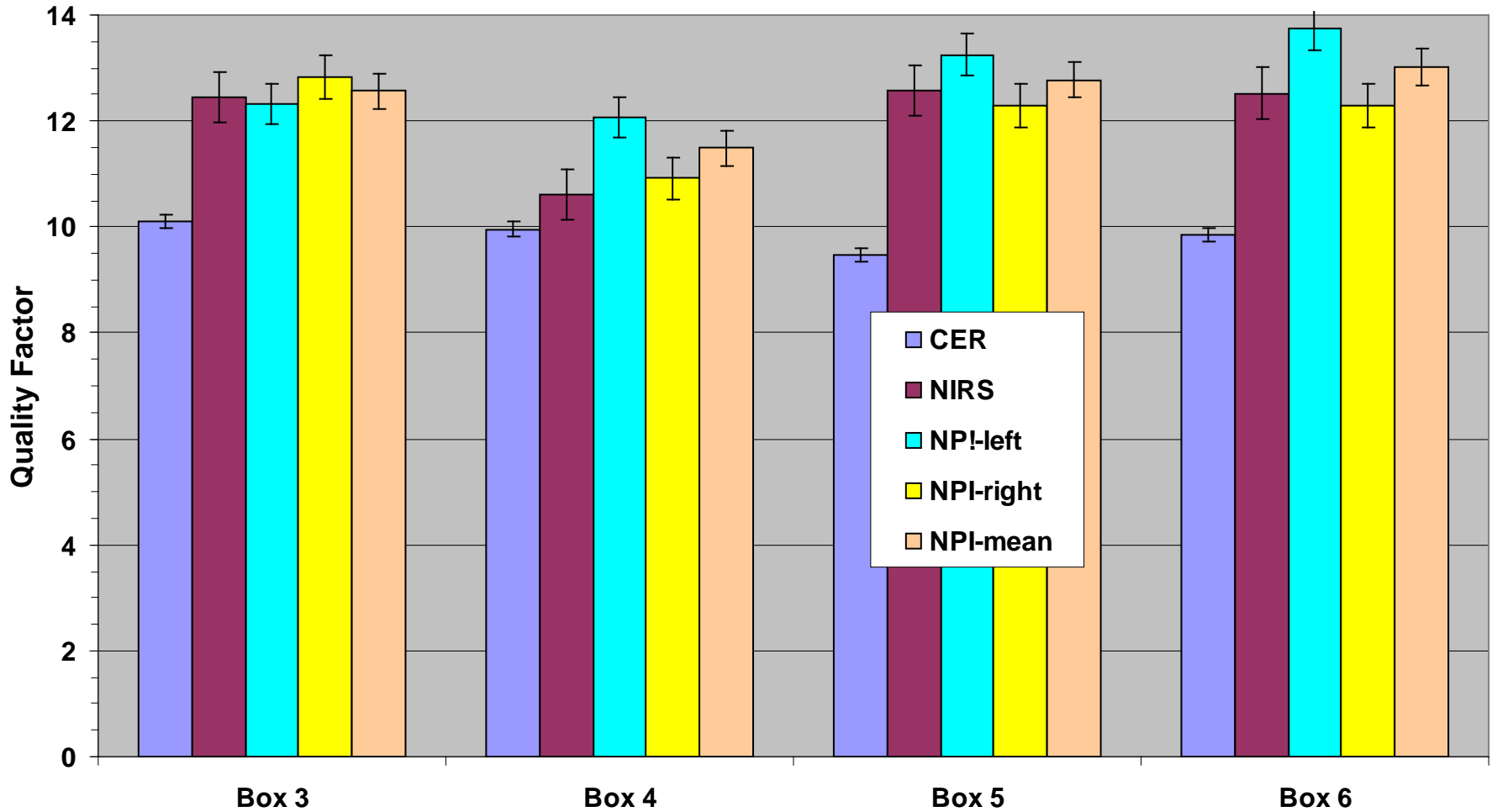
CER TLD results

SPD-7, LET > 10 keV/μm, absorbed dose rate 28/04-26/11 2010, lower flight altitude

TLD:

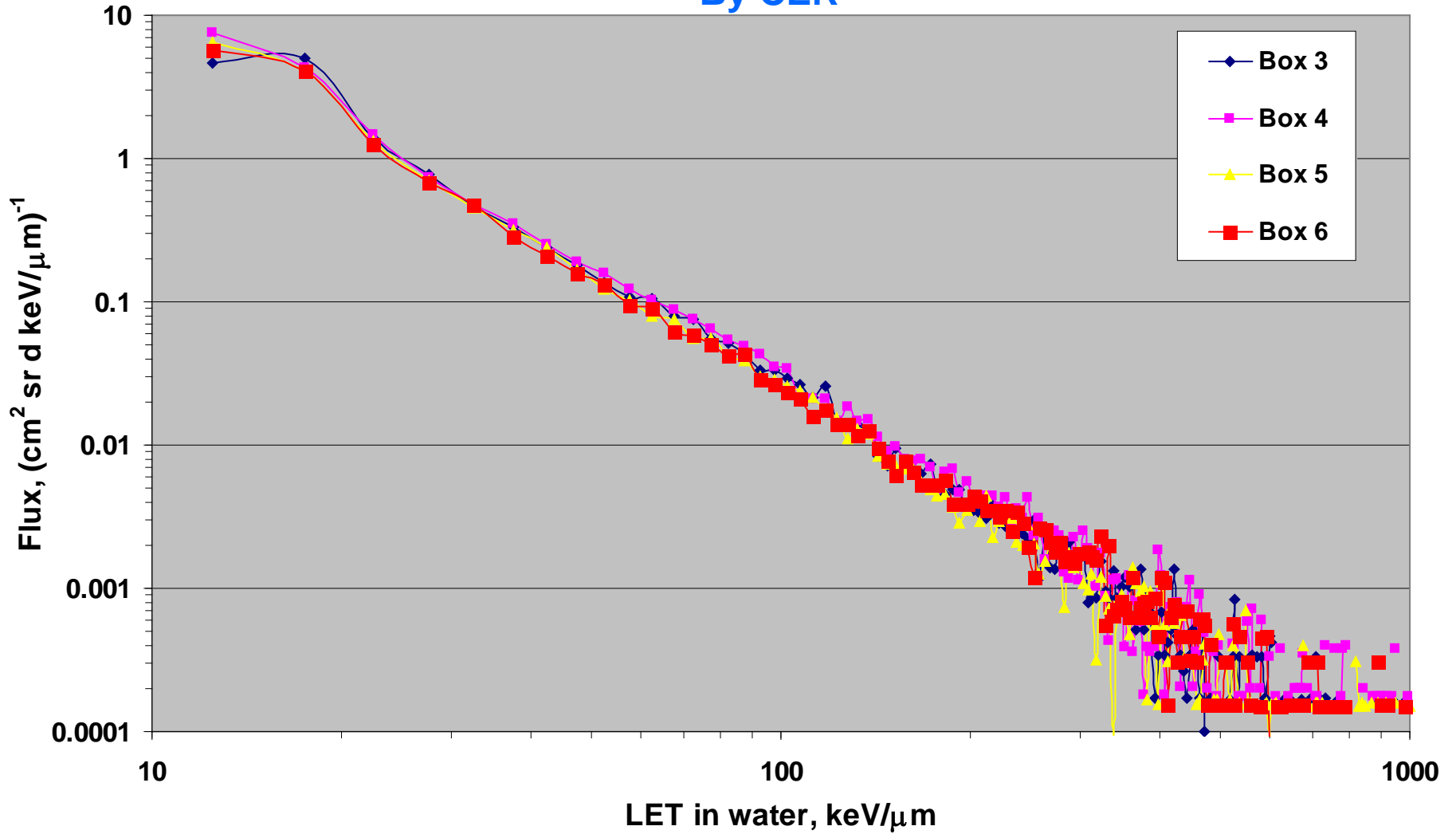


SPD-7, LET > 10 keV/μm, Quality factor
28/04-26/11 2010, lower flight altitude



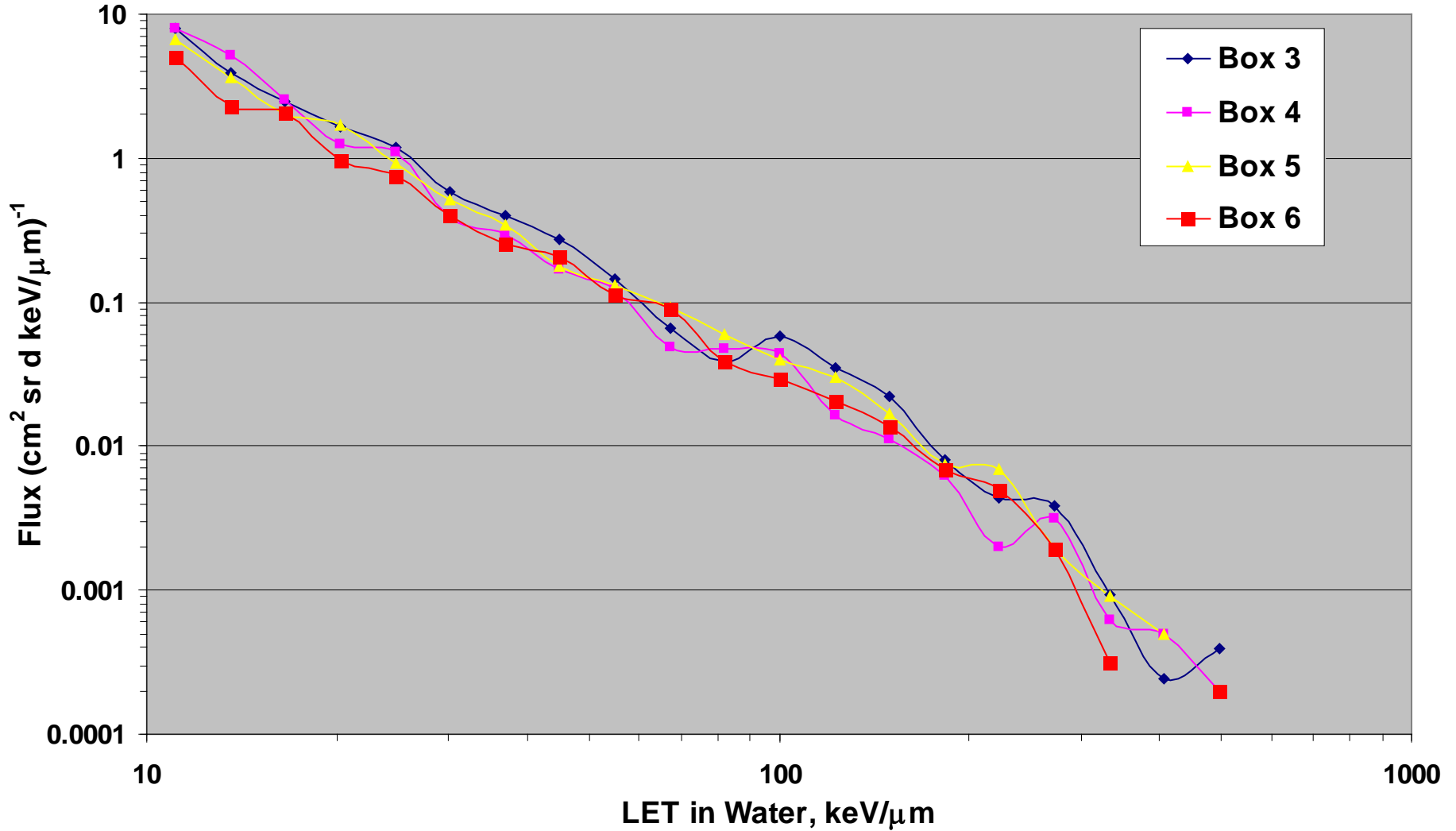
SPD-7 LET spectra

By CER

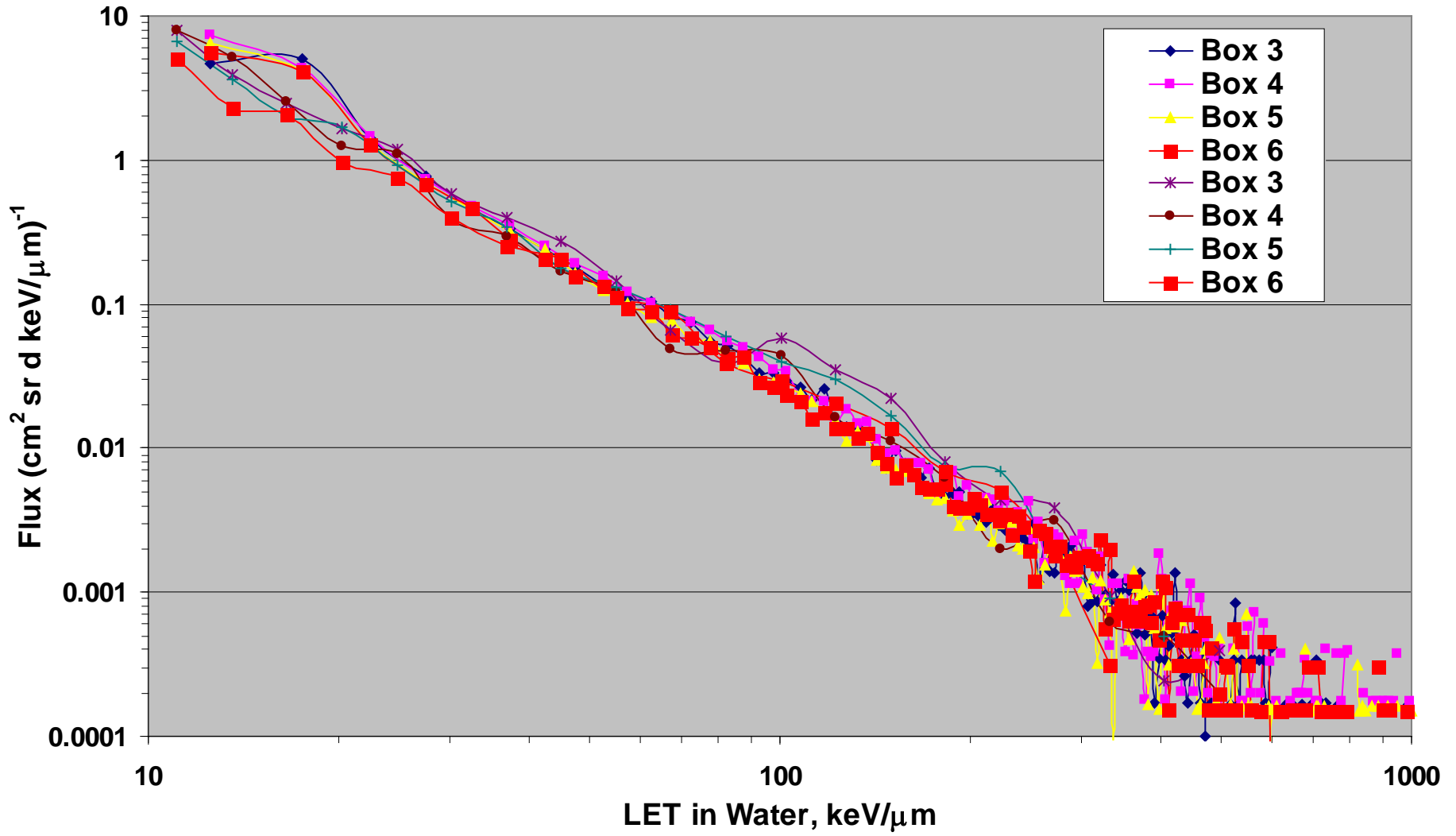


SPD-7 LET Spectra

By NIRS

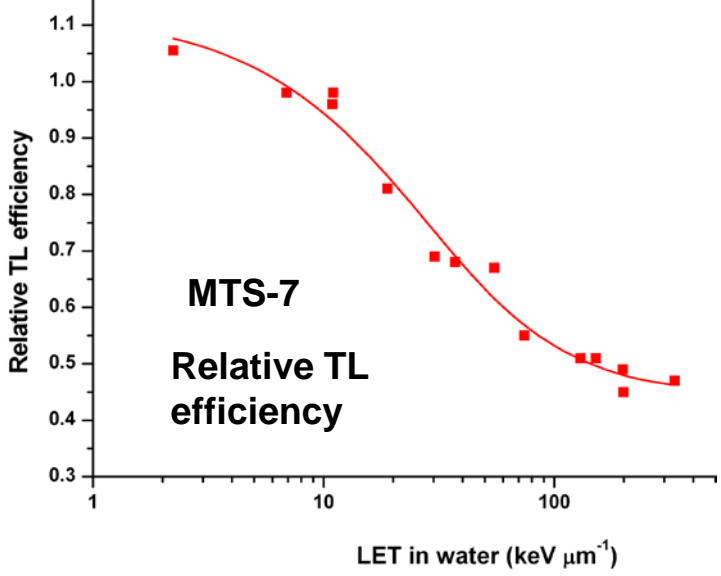


SPD LET spectra by CER & NIRS



Bilski, P., Berger, T., Hajek, M., Reitz, G., 2011. **Comparison of the response of various TLDs to cosmic radiation and ion beams: current results of the HAMLET project.** Rad.Meas. 46, 1680-1685.

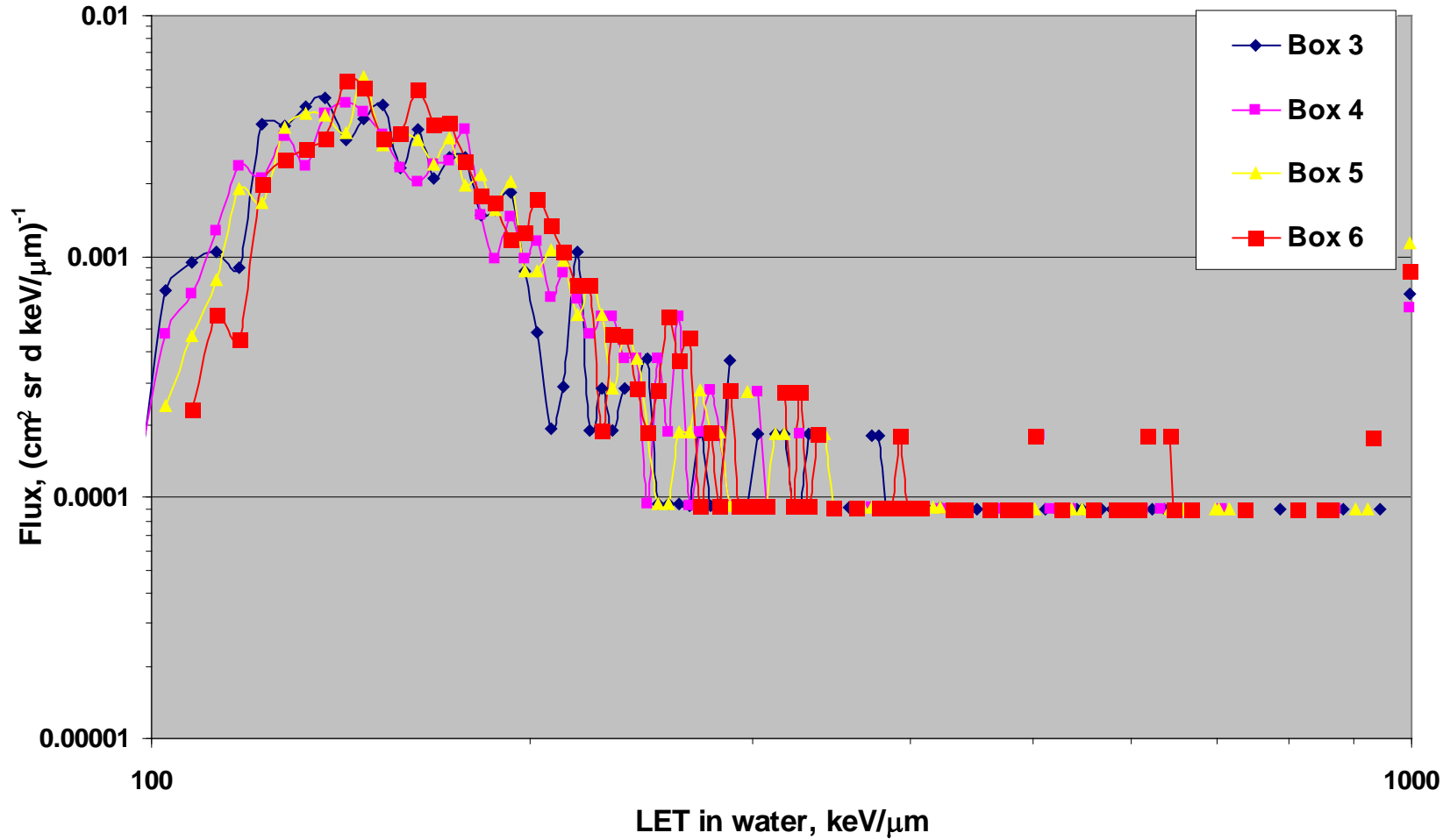
Hajek, M., Berger, T., Vana, N., Fugger, M., Pálfalvi, J.K., Szabó, J., Eördögh, I., Akatov, Y.A., Arkhangelsky, V.V., Shurshakov, V.A., 2008. **Convolution of TLD and SSNTD measurements during the BRADOS-1 experiment onboard ISS (2001).** Rad. Meas. 43, 1231-1236.



Box No.	Absorbed dose rate, measured by TLD ($\mu\text{Gy d}^{-1}$)	LET corrected absorbed dose rate below 10 keV μm^{-1} ($\mu\text{Gy d}^{-1}$)	Total absorbed dose rate: TLD + SSNTD ($\mu\text{Gy d}^{-1}$)	Total dose equivalent rate: TLD + SSNTD ($\mu\text{Sv d}^{-1}$)	Average quality factor
3	248.0	222.2	259.0	593.3	2.29
4	269.7	241.5	282.1	646.3	2.29
5	226.4	201.4	236.9	537.9	2.27
6	202.0	178.4	212.9	518.1	2.43

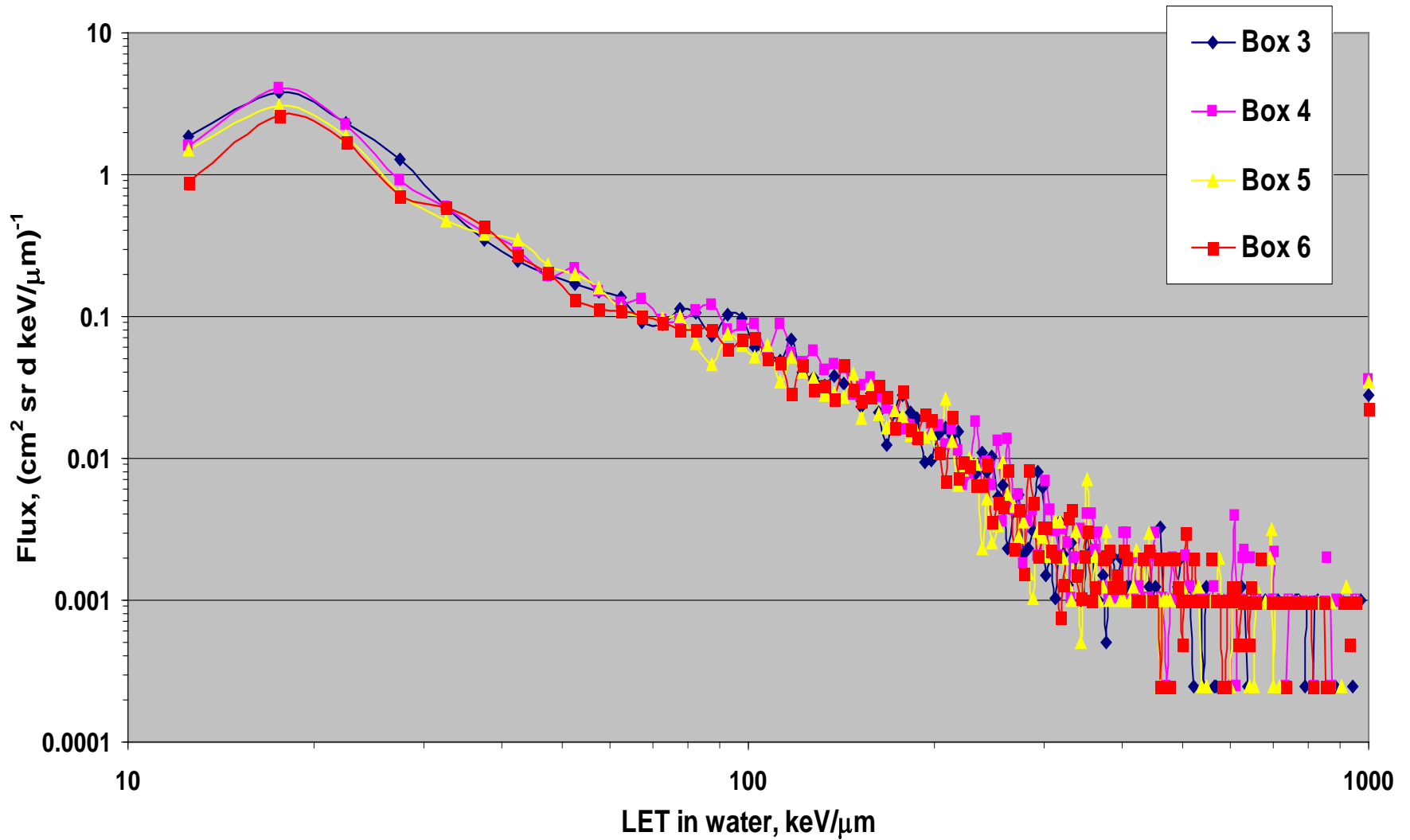
SPD-9 LET spectra of HZE particles

By CER



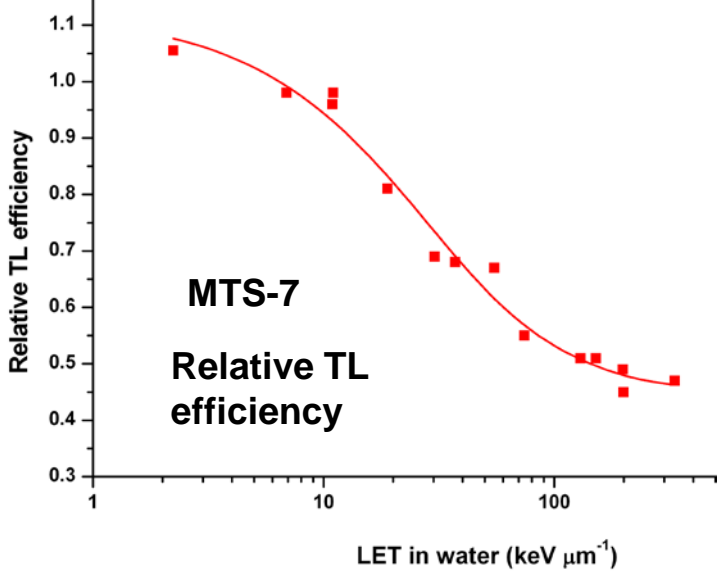
SPD-9 LET spectra

By CER

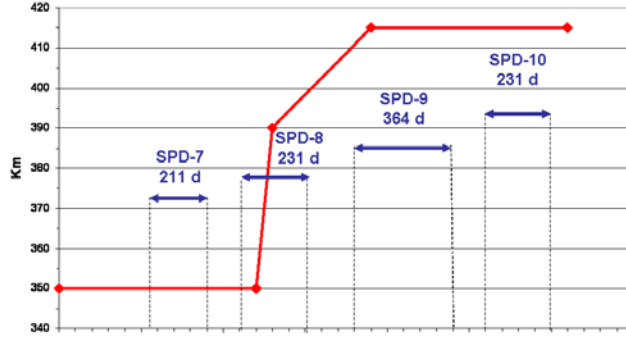


Bilski, P., Berger, T., Hajek, M., Reitz, G., 2011. **Comparison of the response of various TLDs to cosmic radiation and ion beams: current results of the HAMLET project.** Rad.Meas. 46, 1680-1685.

Hajek, M., Berger, T., Vana, N., Fugger, M., Pálfalvi, J.K., Szabó, J., Eördögh, I., Akatov, Y.A., Arkhangelsky, V.V., Shurshakov, V.A., 2008. **Convolution of TLD and SSNTD measurements during the BRADOS-1 experiment onboard ISS (2001).** Rad. Meas. 43, 1231-1236.



Box No.	Absorbed dose rate, measured by TLD ($\mu\text{Gy d}^{-1}$)	LET corrected absorbed dose rate below 10 keV μm^{-1} ($\mu\text{Gy d}^{-1}$)	Total absorbed dose rate: TLD + SSNTD ($\mu\text{Gy d}^{-1}$)	Total dose equivalent rate: TLD + SSNTD ($\mu\text{Sv d}^{-1}$)	Average quality factor
3	337.6	325.8	377.1	1021.6	2.71
4	303.3	291.8	346.6	1064.3	3.07
5	297.5	289.2	335.0	919.7	2.75
6	277.9	267.1	310.5	895.9	2.89



Box No.	Absorbed dose rate, measured by TLD ($\mu\text{Gy d}^{-1}$)	LET corrected absorbed dose rate below 10 keV μm^{-1} ($\mu\text{Gy d}^{-1}$)	Total absorbed dose rate: TLD + SSNTD ($\mu\text{Gy d}^{-1}$)	Total dose equivalent rate: TLD + SSNTD ($\mu\text{Sv d}^{-1}$)	Average quality factor
3	248.0	222.2	259.0	593.3	2.29
4	269.7	241.5	282.1	646.3	2.29
5	226.4	201.4	236.9	537.9	2.27
6	202.0	178.4	212.9	518.1	2.43
3	337.6	325.8	377.1	1021.6	2.71
4	303.3	291.8	346.6	1064.3	3.07
5	297.5	289.2	335.0	919.7	2.75
6	277.9	267.1	310.5	895.9	2.89

SPD7

SPD-9

