NINE YEARS OF THE RADIATION MONITORING SYSTEM OPERATING IN SERVICE MODULE OF ISS

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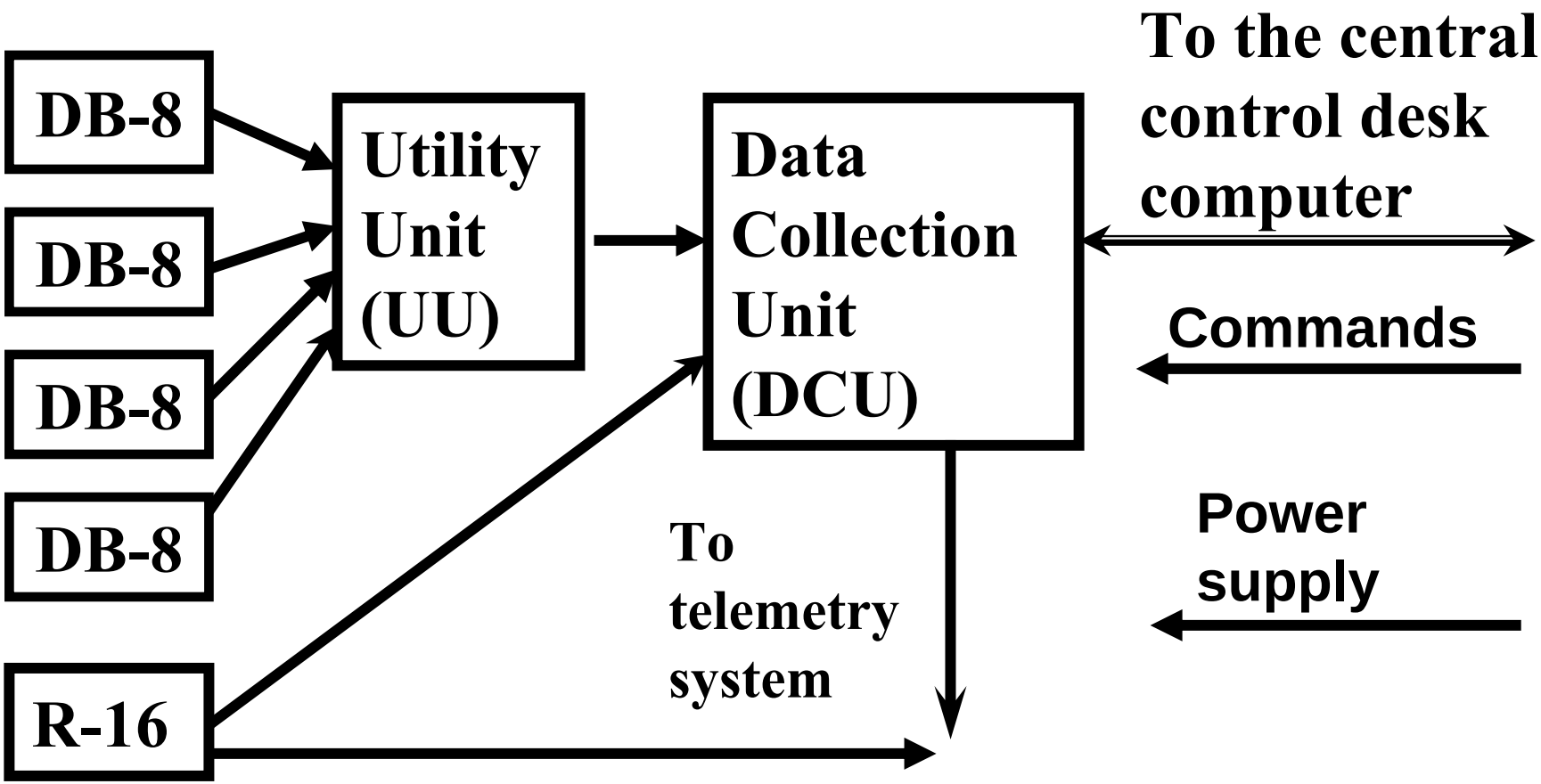
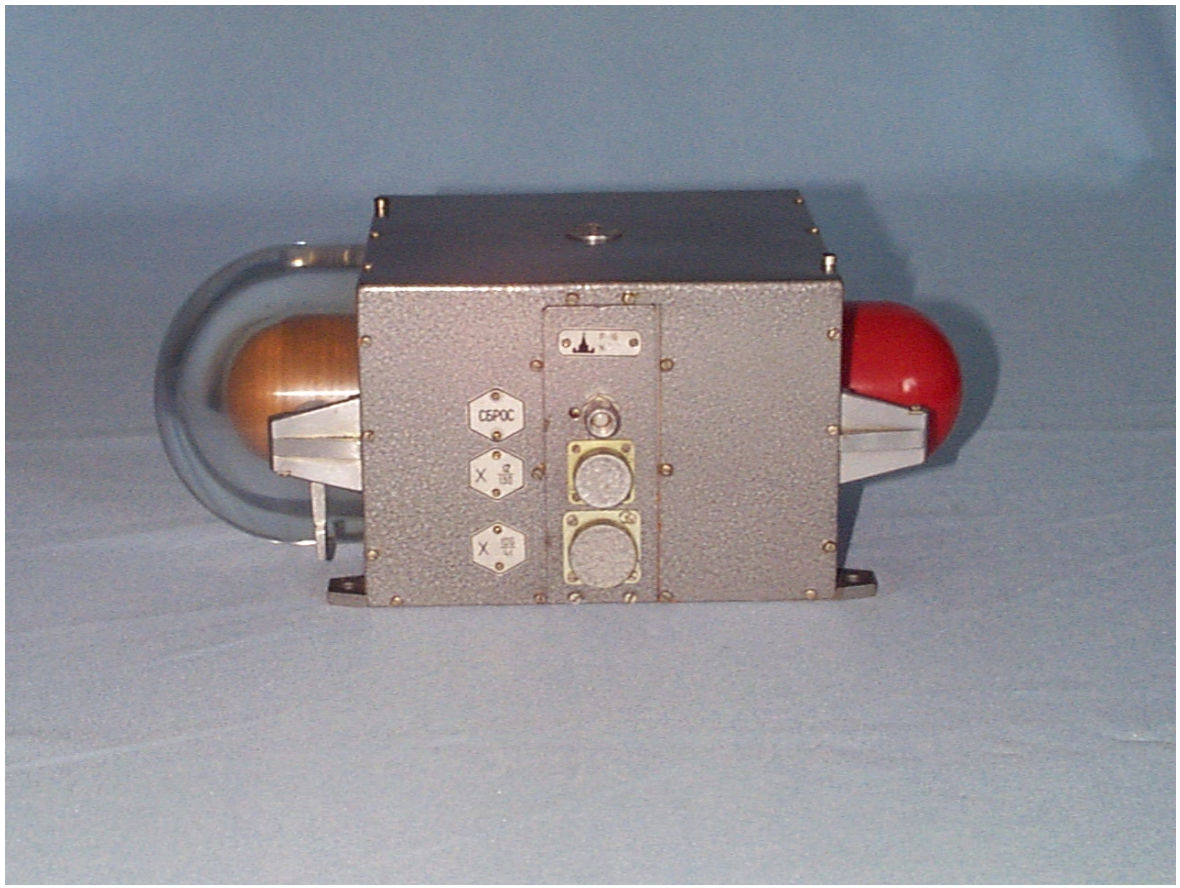
Configuration of the Radiation Monitoring System (RMS)



R-16 dosimeter

Two argon filled ionisation chambers are sensitive elements of the R-16 dosimeter.
One of the chambers has an additional plastic shielding 3 g/cm^2.



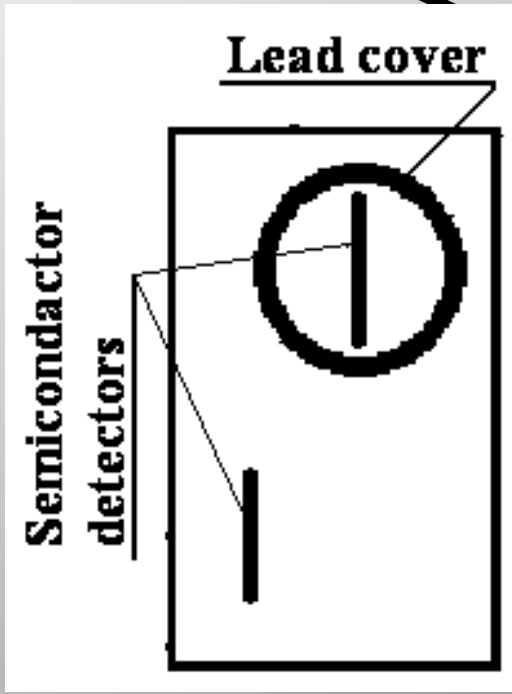
Pulses from ionisation chambers are counted up. The number of the pulses is transferred directly to the telemetry system of RS ISS.

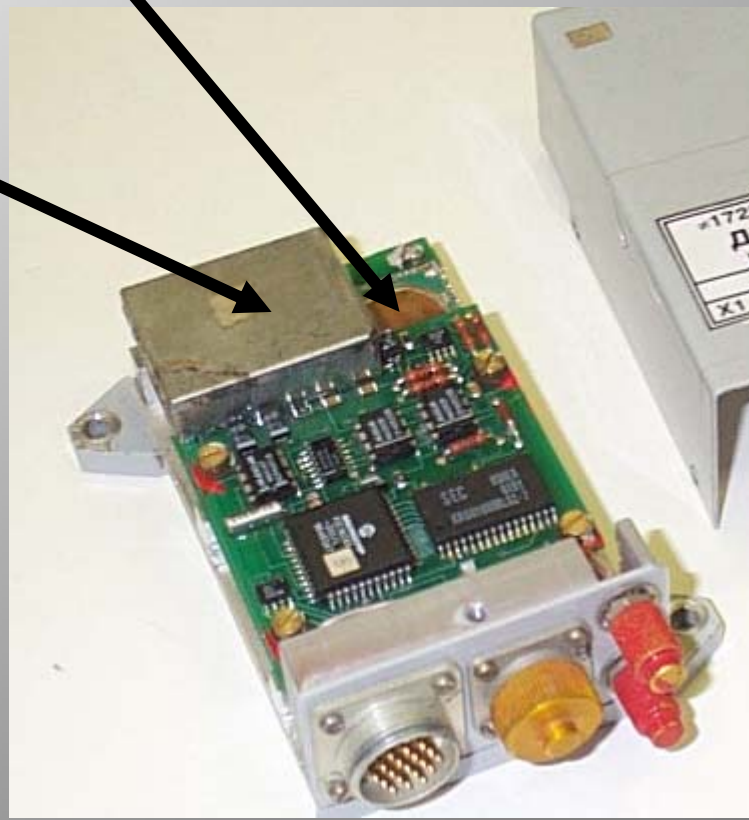
DB-8 unit without cover

Shielded detector **Unshielded detector**

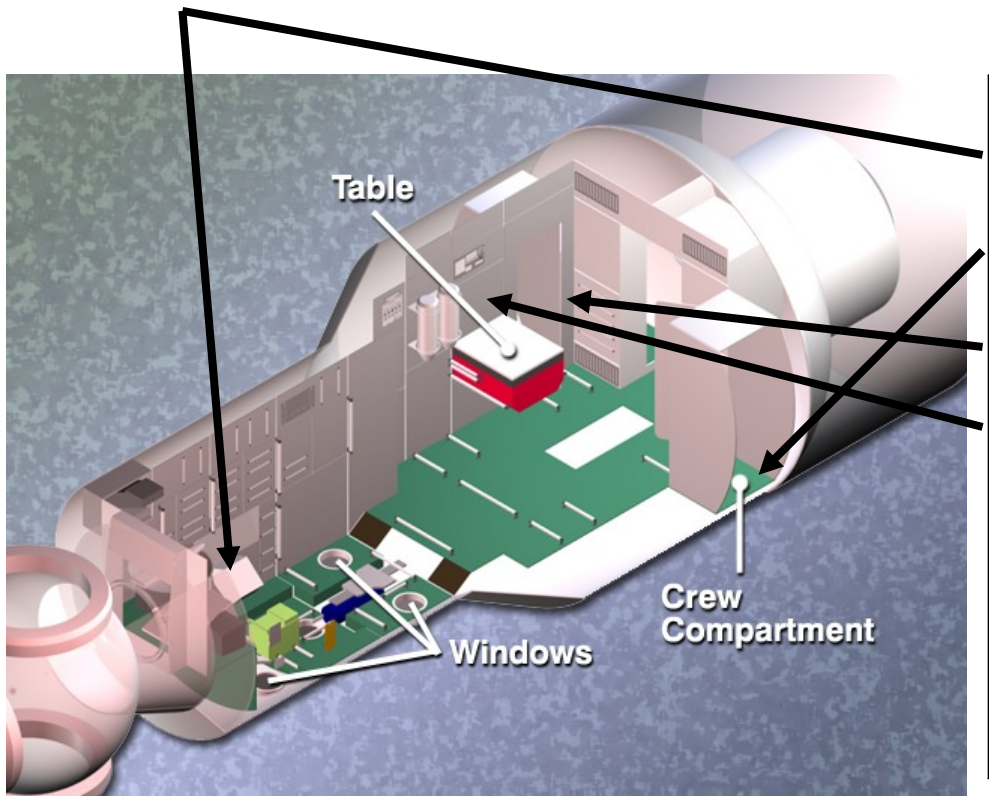
The difference between the two channels is that one of the detectors has an additional lead shielding. The shielding is a sphere surrounding the detector.

The sphere wall thickness is 3 g/cm^2 Pb



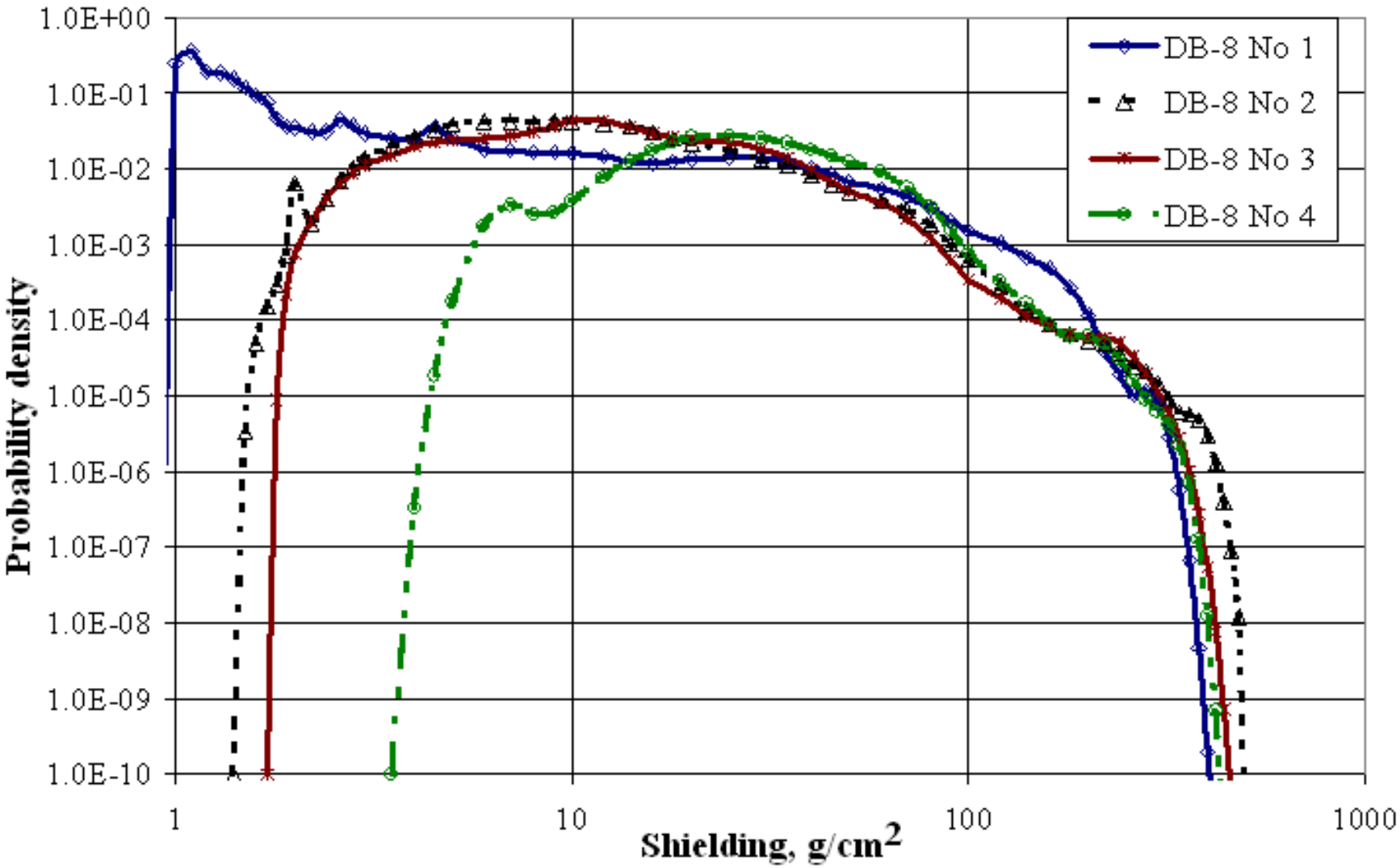


Locations of the RMS units

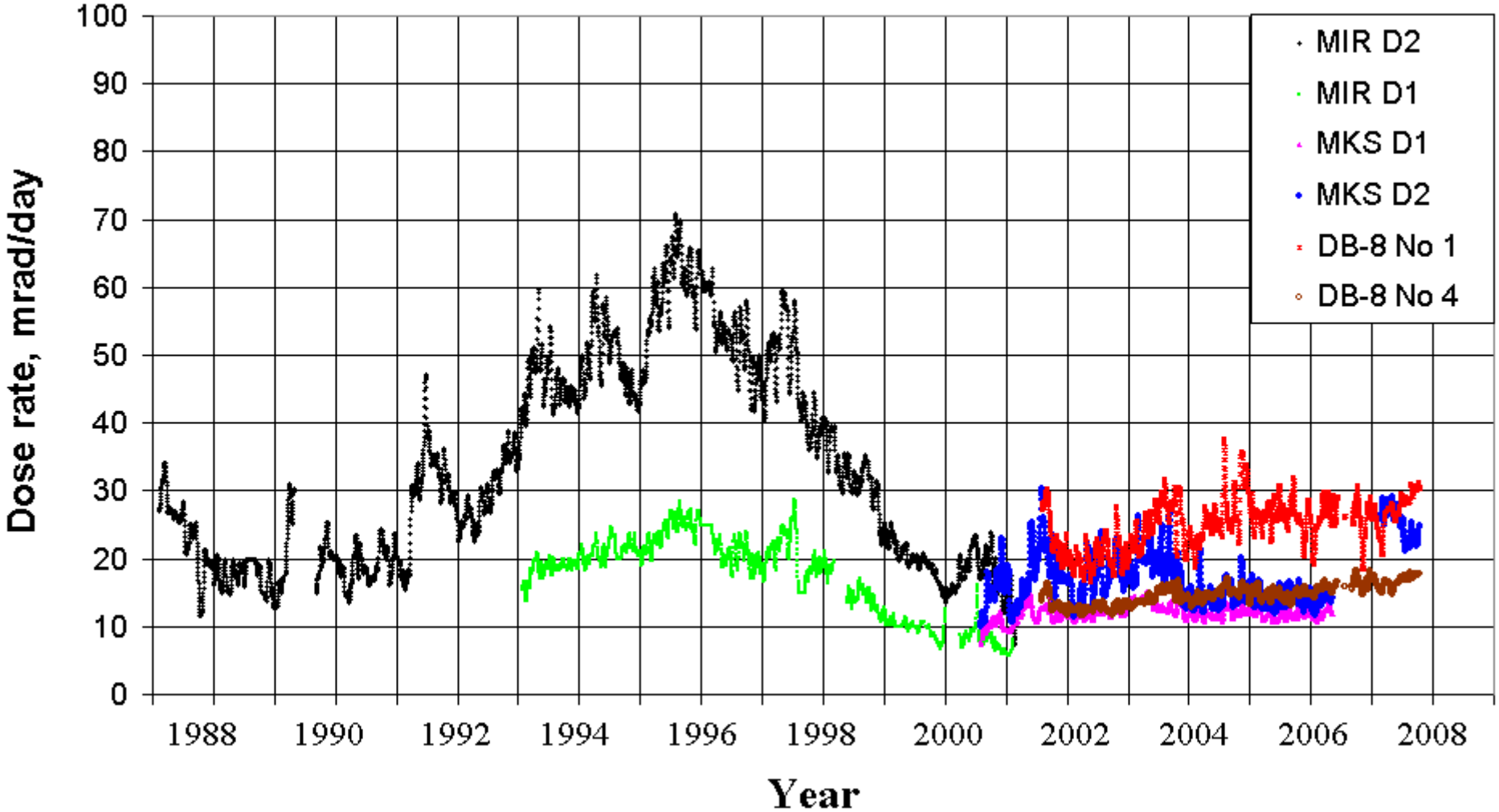


Unit	Location
DB-8 No 1	Starboard side, behind board № 410
DB-8 No 2	Port side, behind board № 244 (cabin)
DB-8 No 3	Starboard side, behind board № 447 (cabin)
DB-8 No 4	Starboard side, behind board № 435
R-16	Ceiling of Big diameter bay, behind board № 327
UU	Starboard side, behind board № 447 (cabin)
DCU	starboard side, behind board № 447 (cabin)

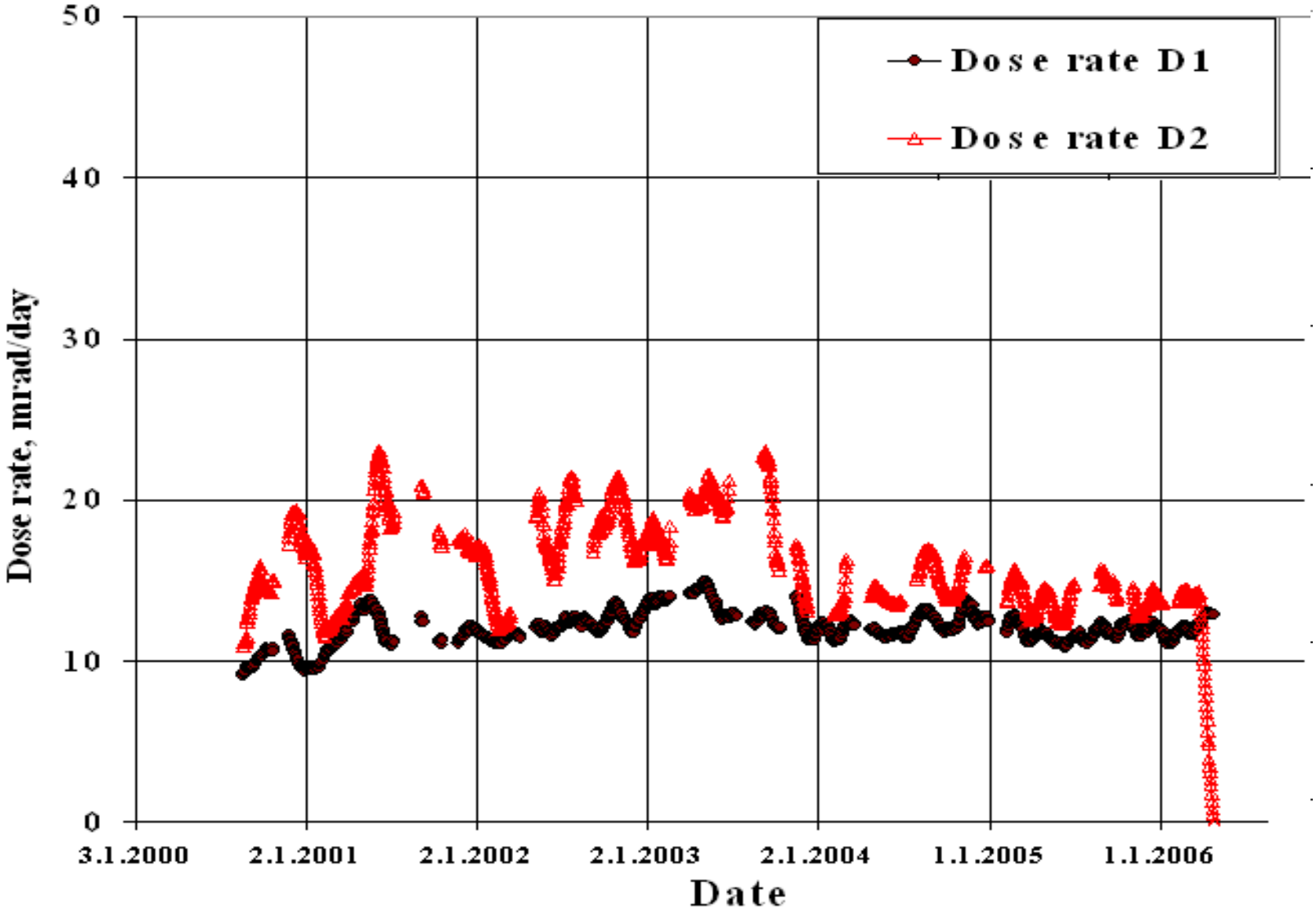
Shielding functions of DB-8 detectors



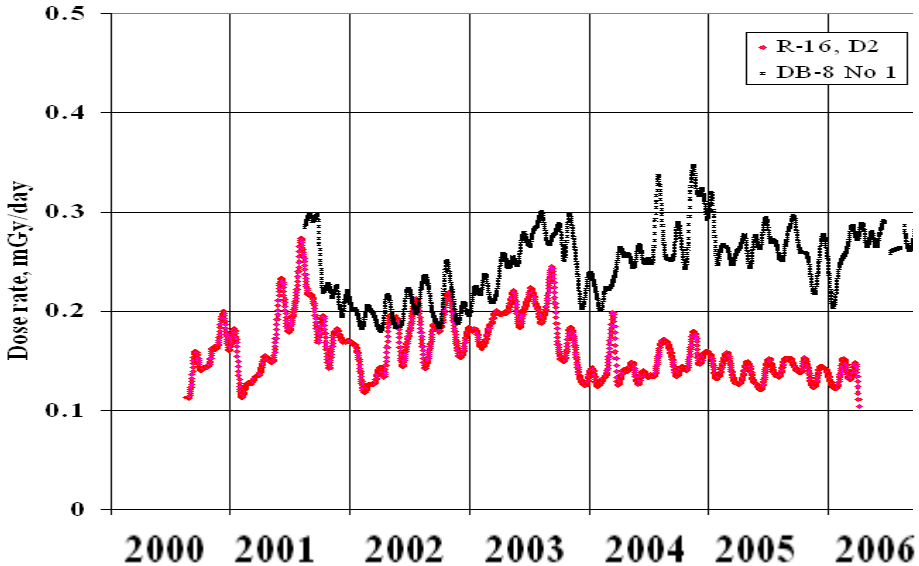
Daily doses measured with R-16 on MIR and ISS

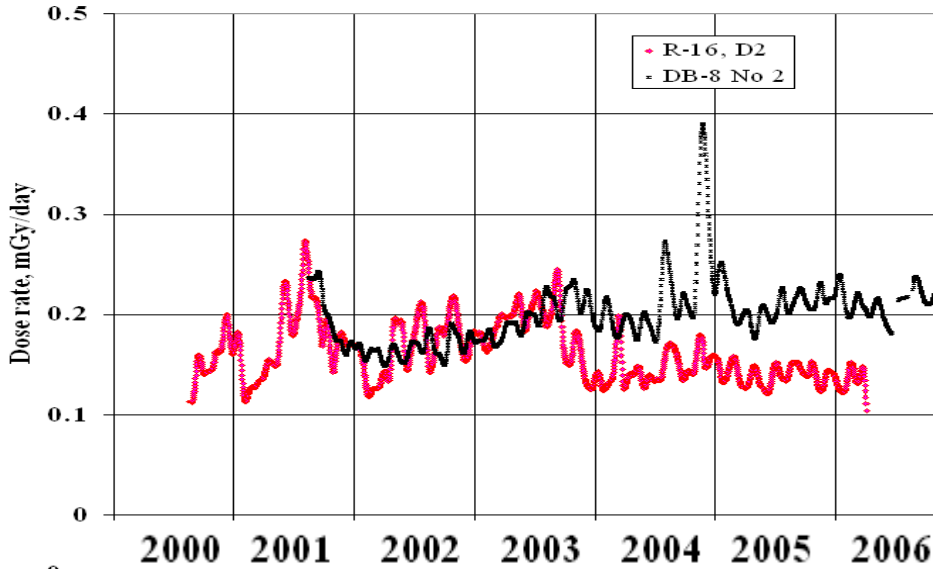


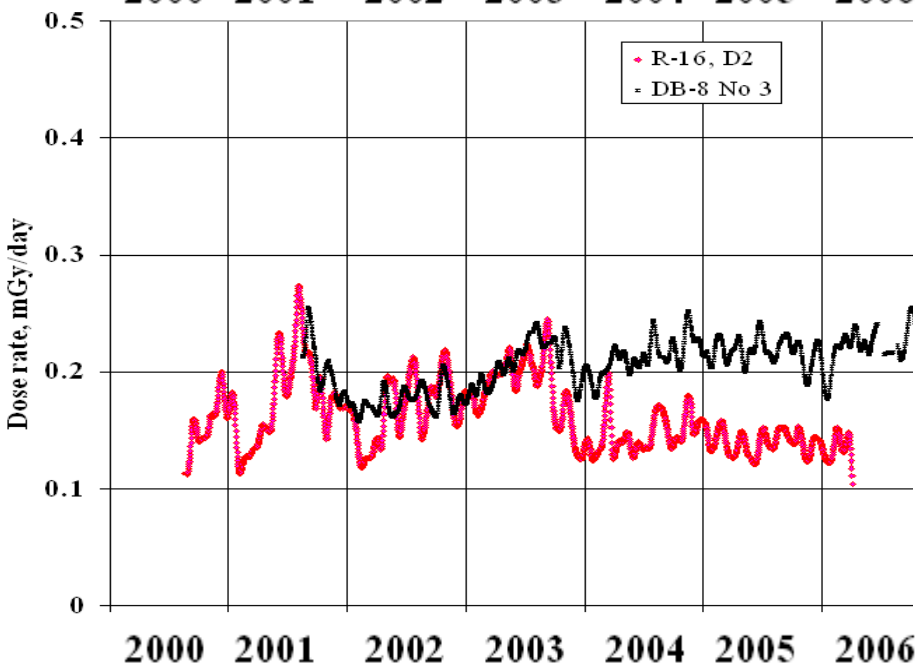
R-16 daily doses measured on ISS

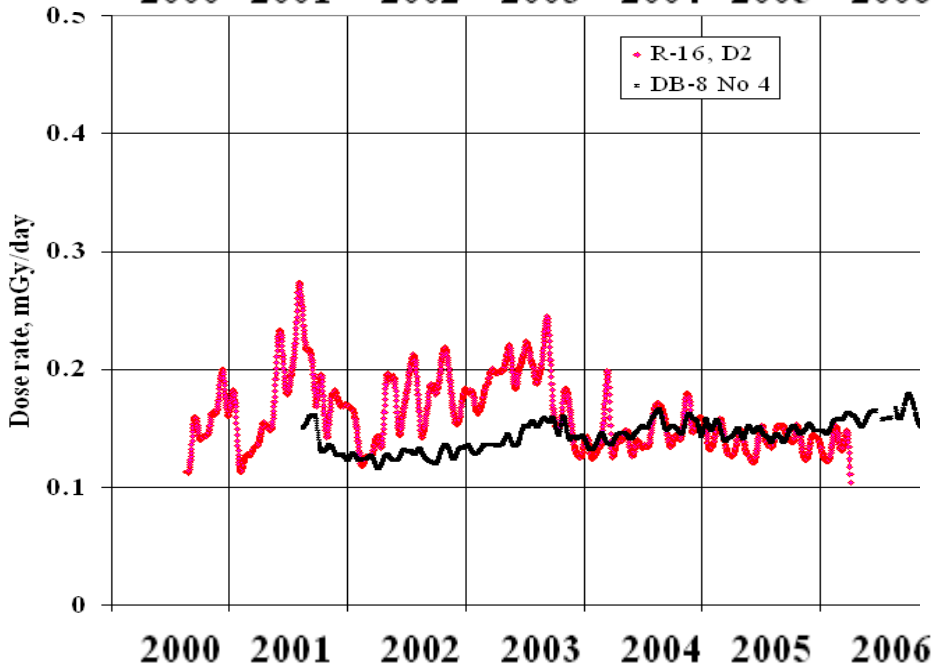


Comparision of «smoothed» measurements of the R-16 device D2 ionisation chamber and measurements of unshielded DB-8 detectors (also «smoothed»).

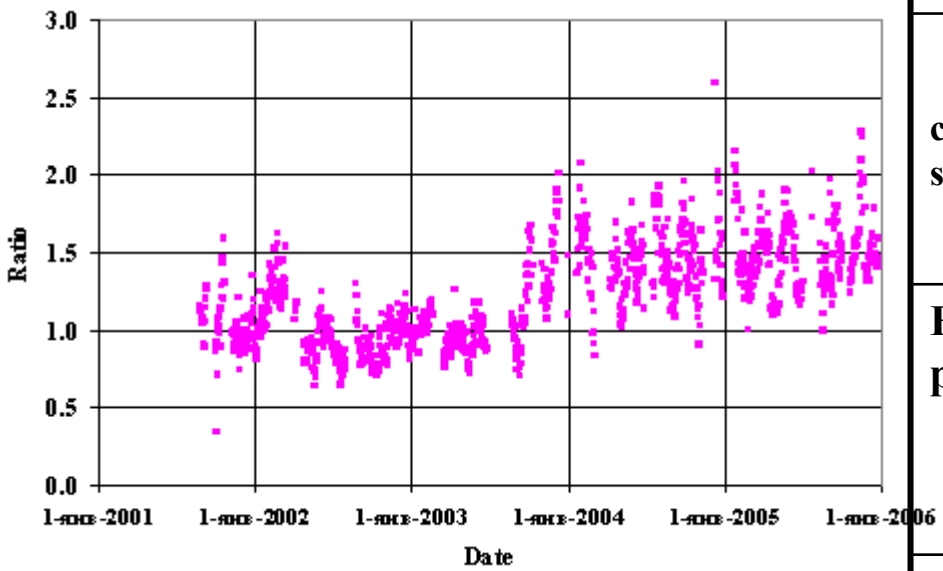




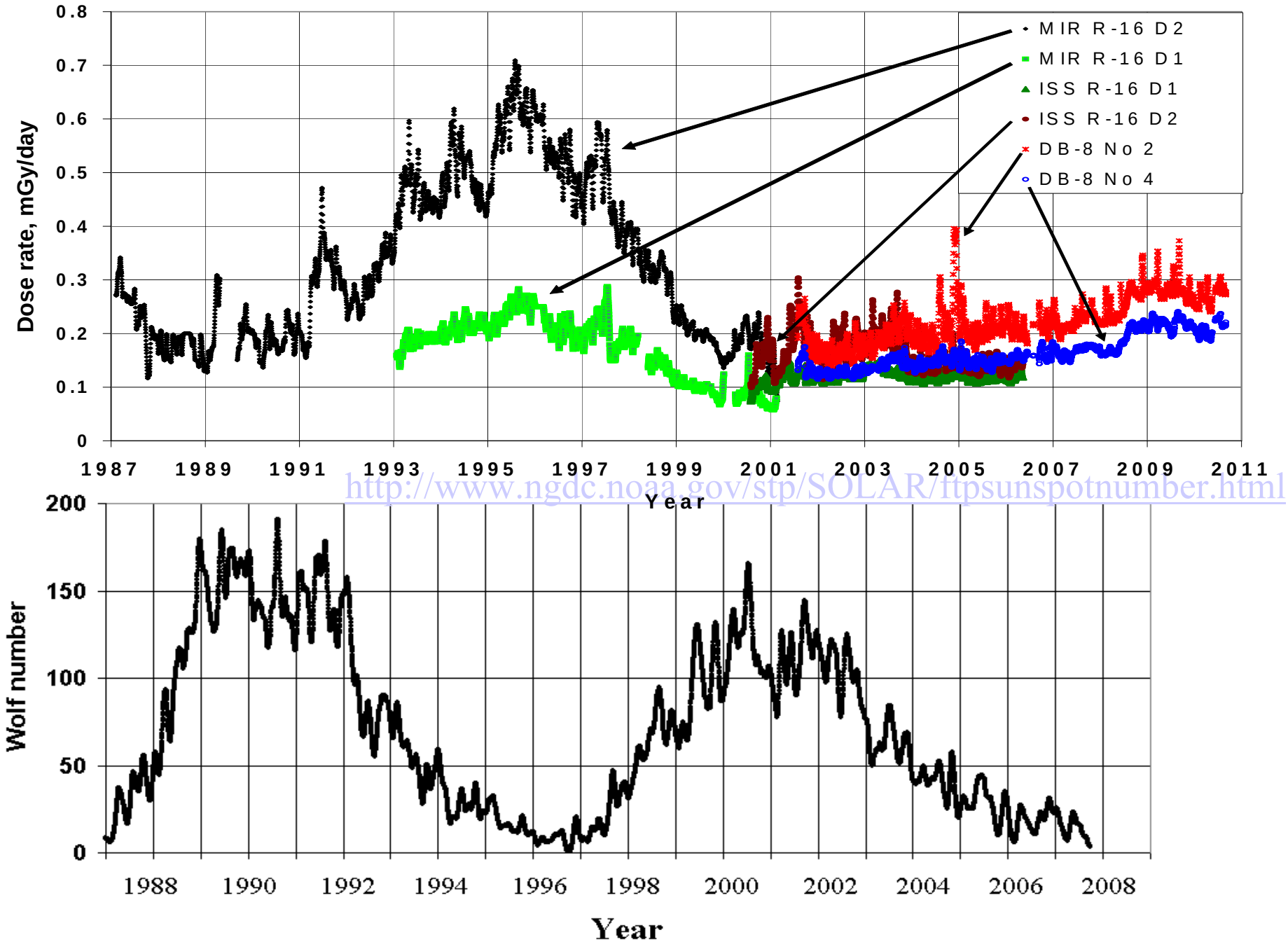




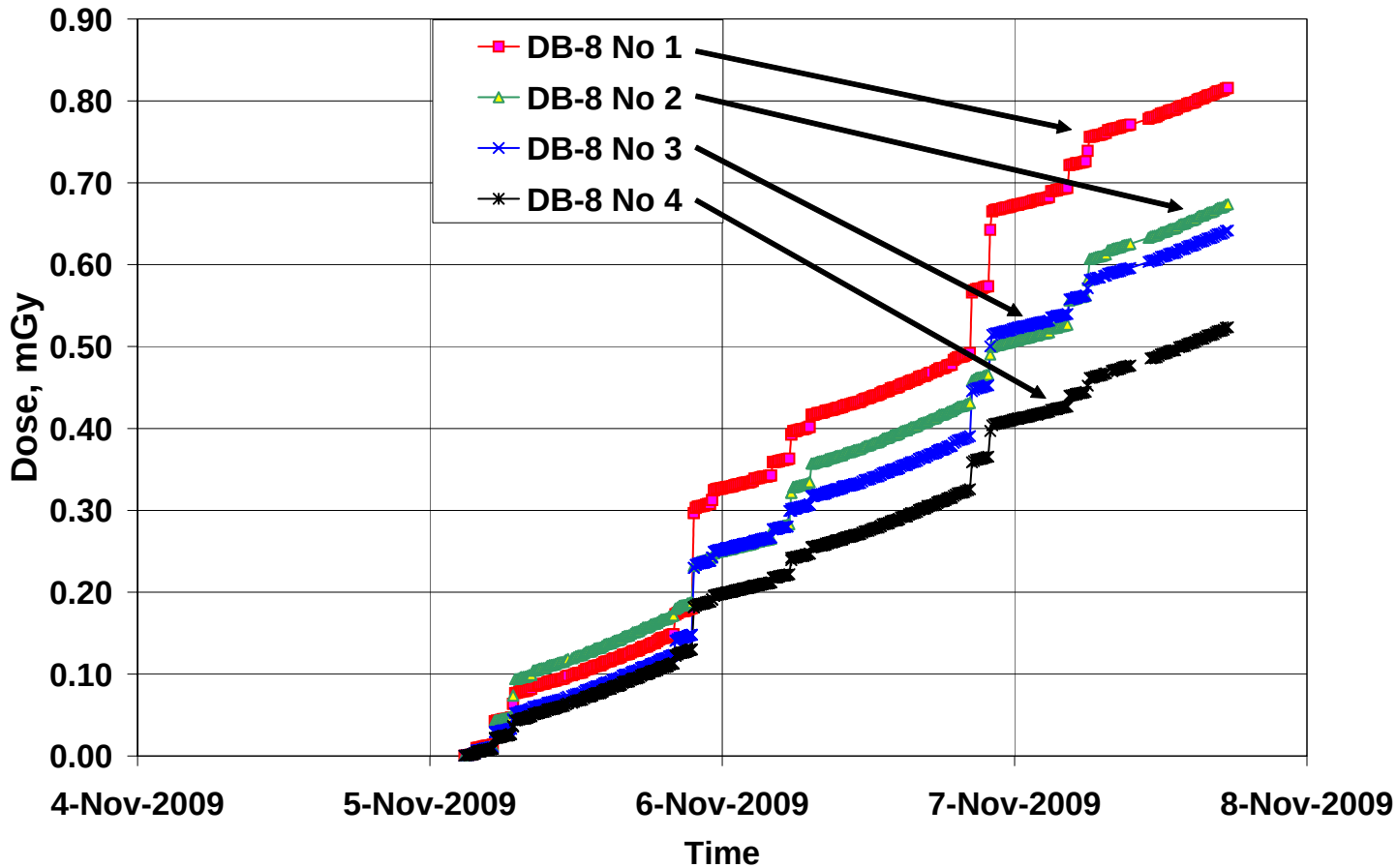
The ratio of the dose rate measured by DB-8 No 2 unshielded detector to the dose rate measured by the R-16 dosimeter D2 ionization chamber (not smoothed data)



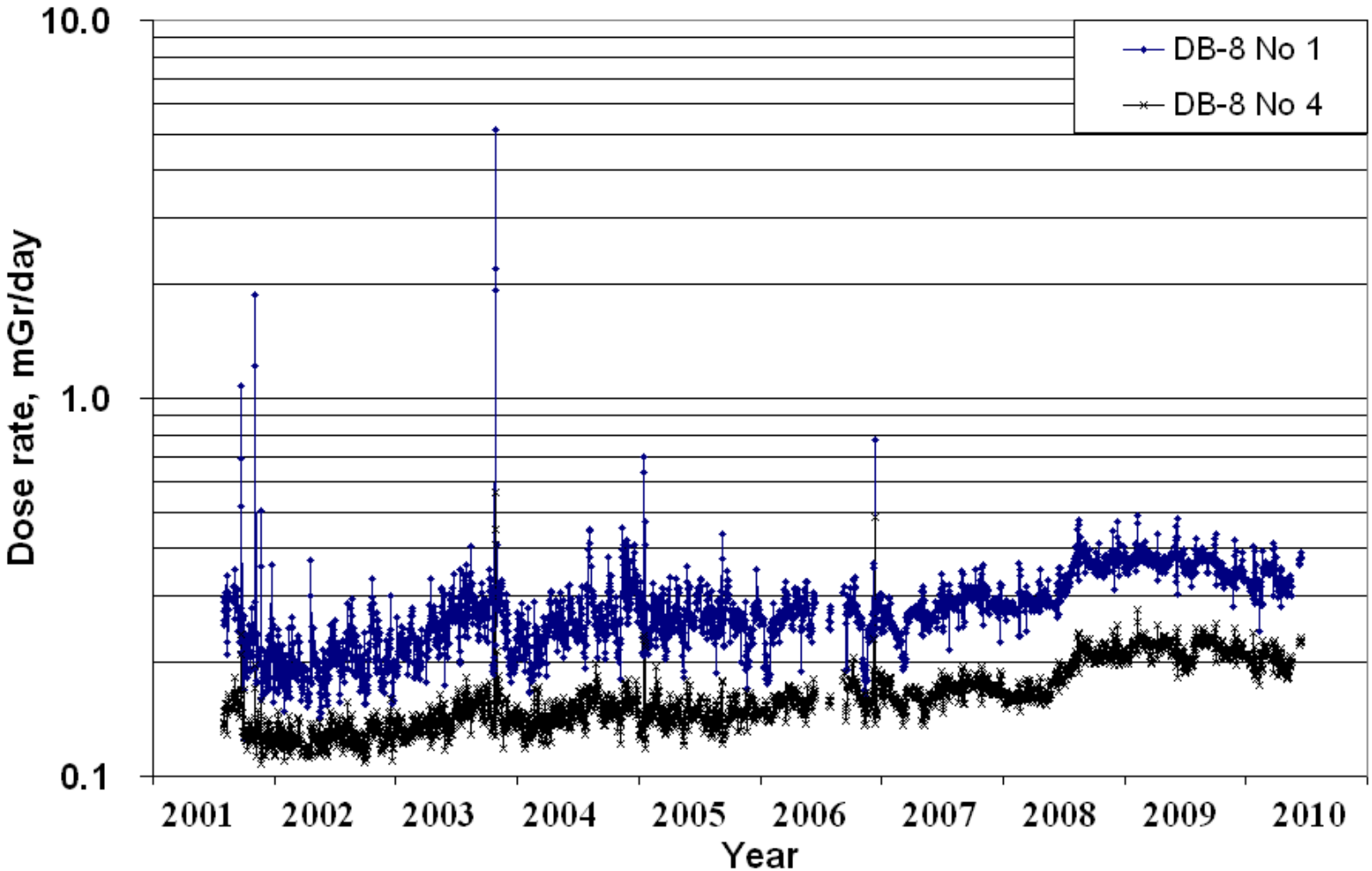
		DB-8 No 1	DB-8 No 2	DB-8 No 3	DB-8 No 4
complete sample	mean	1.531	1.230	1.271	0.887
	mean-root square	0.394	0.317	0.294	0.184
First part	mean	1.218	0.982	1.035	0.735
	mean-root square	0.220	0.166	0.181	0.115
Second part	mean	1.825	1.467	1.495	1.032
	mean-root square	0.280	0.238	0.187	0.105


Dose rate, mGy/day
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
MIR R-16 D2
MIR R-16 D1
ISS R-16 D1
ISS R-16 D2
DB-8 No 2
DB-8 No 4
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
Year
http://www.ngdc.noaa.gov/stp/SOLAR/ftpsunspotnumber.html
Wolf number
200
150
100
50
0
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Year

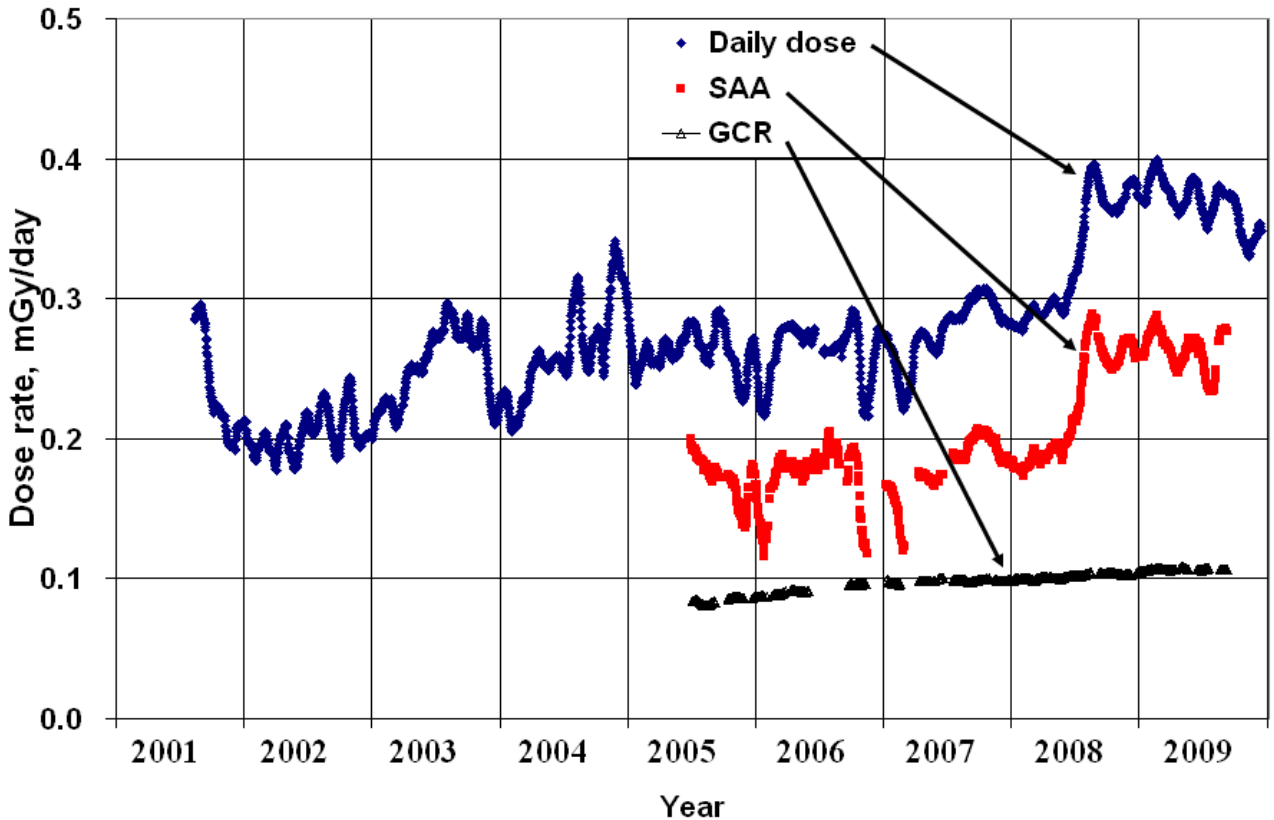
The dose accumulation in the locations of DB-8 detectors.



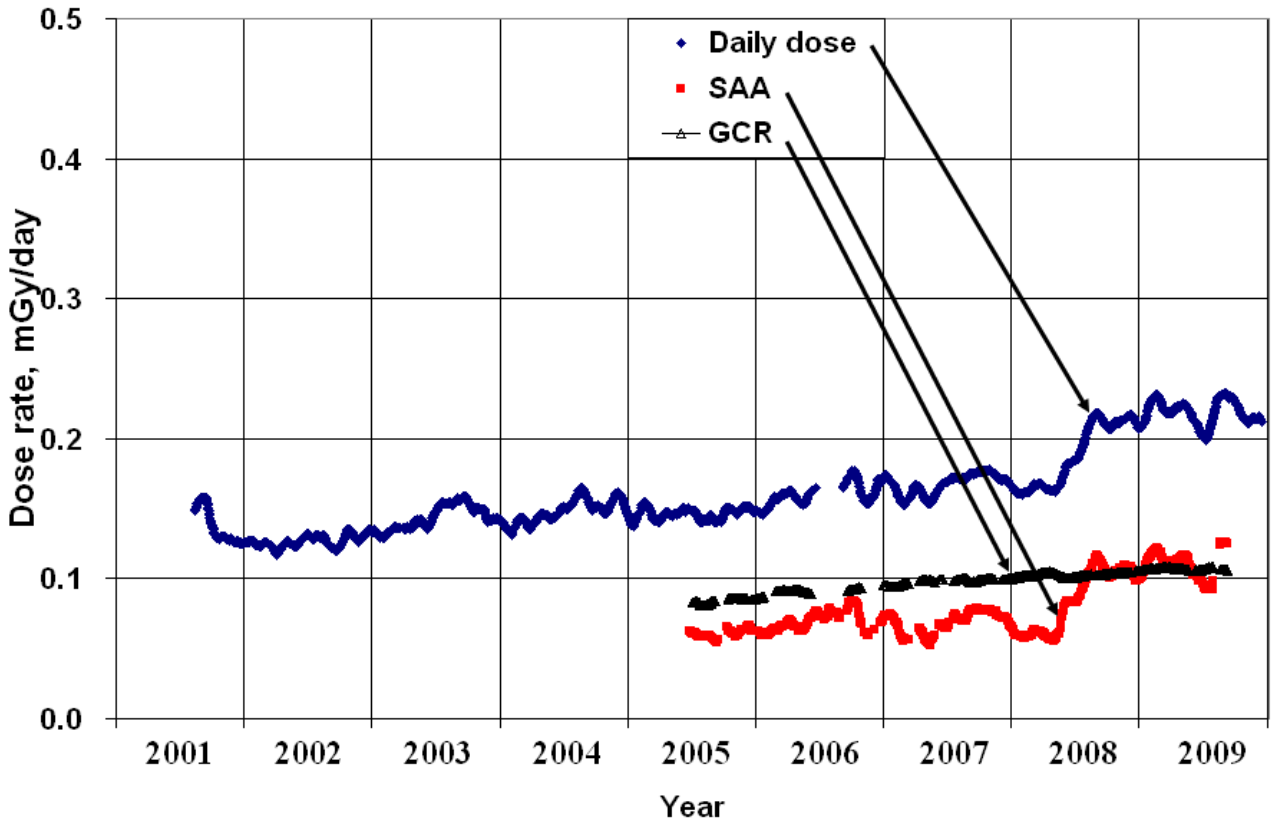
Daily doses measured with unshielded detectors of the first and fourth DB-8 units since August 2, 2001



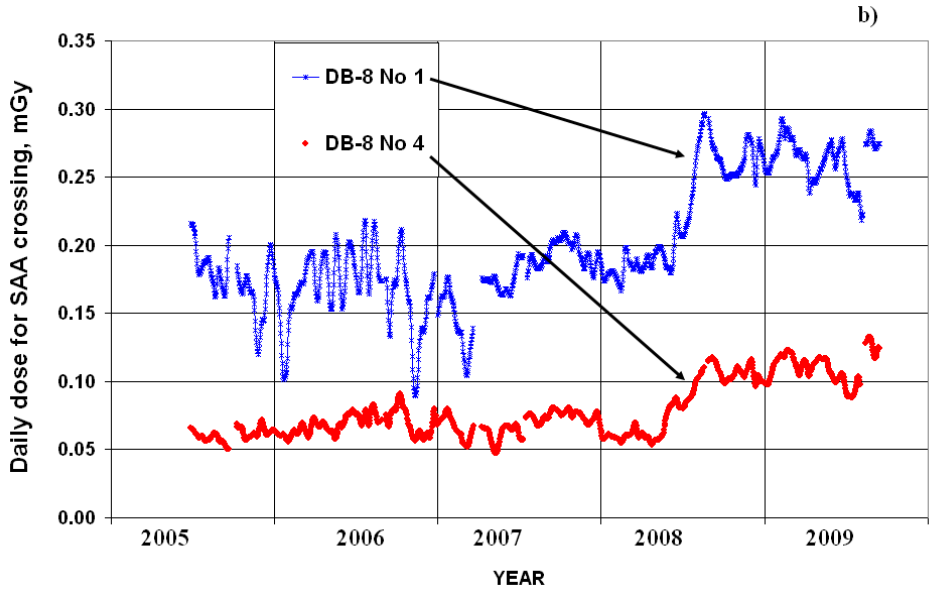
Daily dose measured with unshielded detectors of the DB-8 No 1. Contribution to the daily dose caused by ERB and GCR



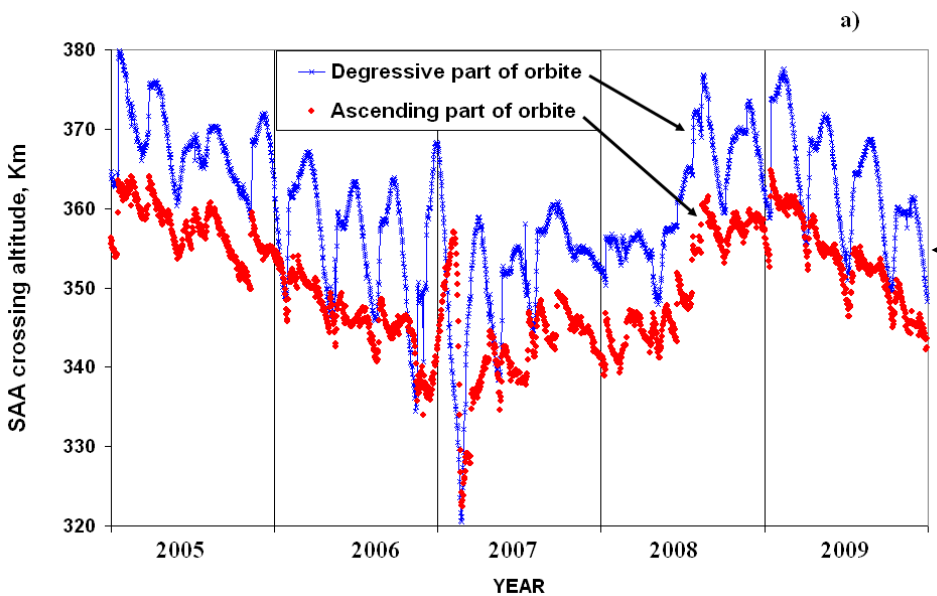
Daily dose measured with unshielded detectors of DB-8 No 4. Contribution to daily dose caused by ERB and GCR



ERB contribution to daily doses versus altitude of SAA crossing

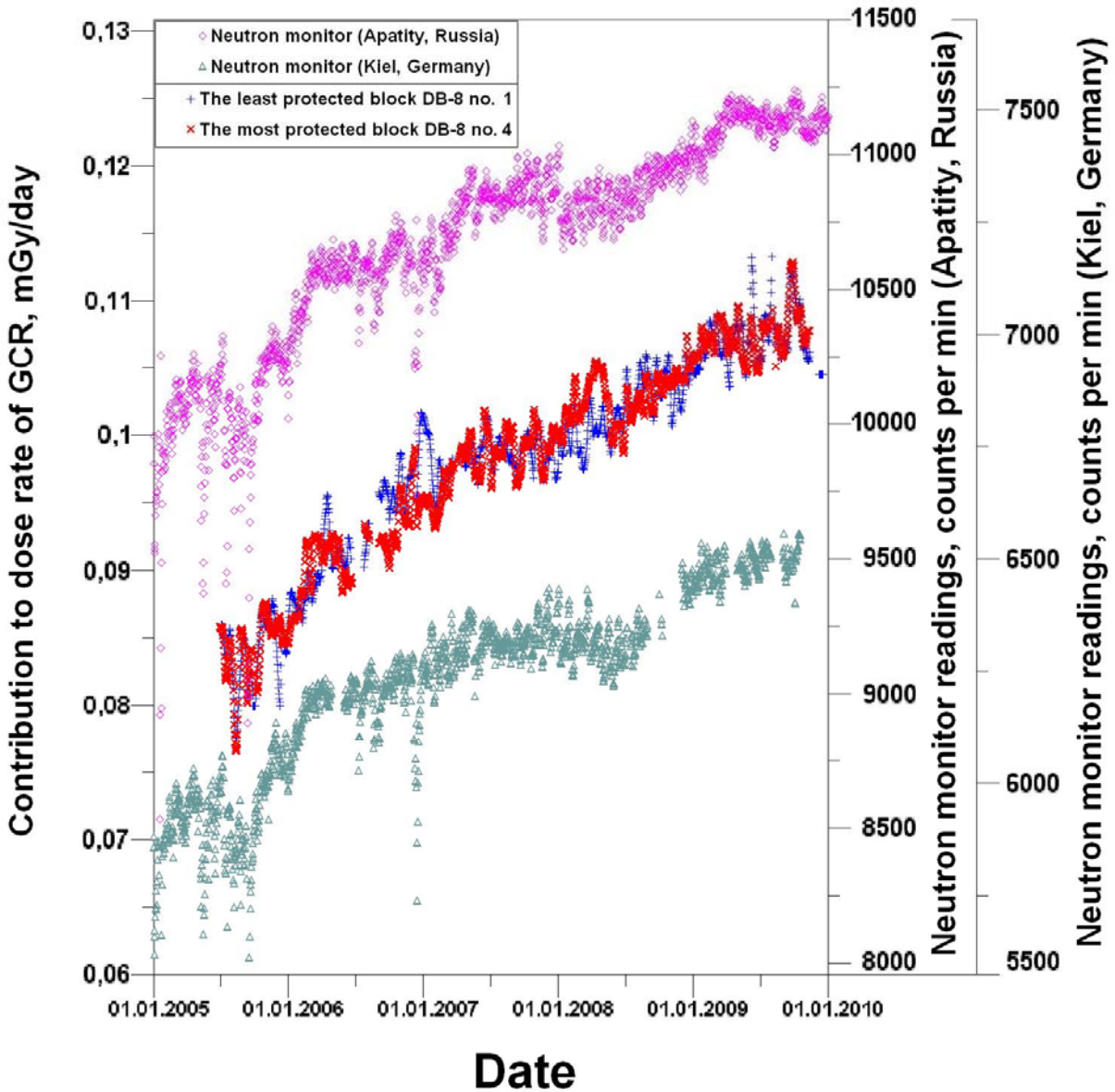


The ERB contribution to daily doses



Altitude of SAA crossing by ISS

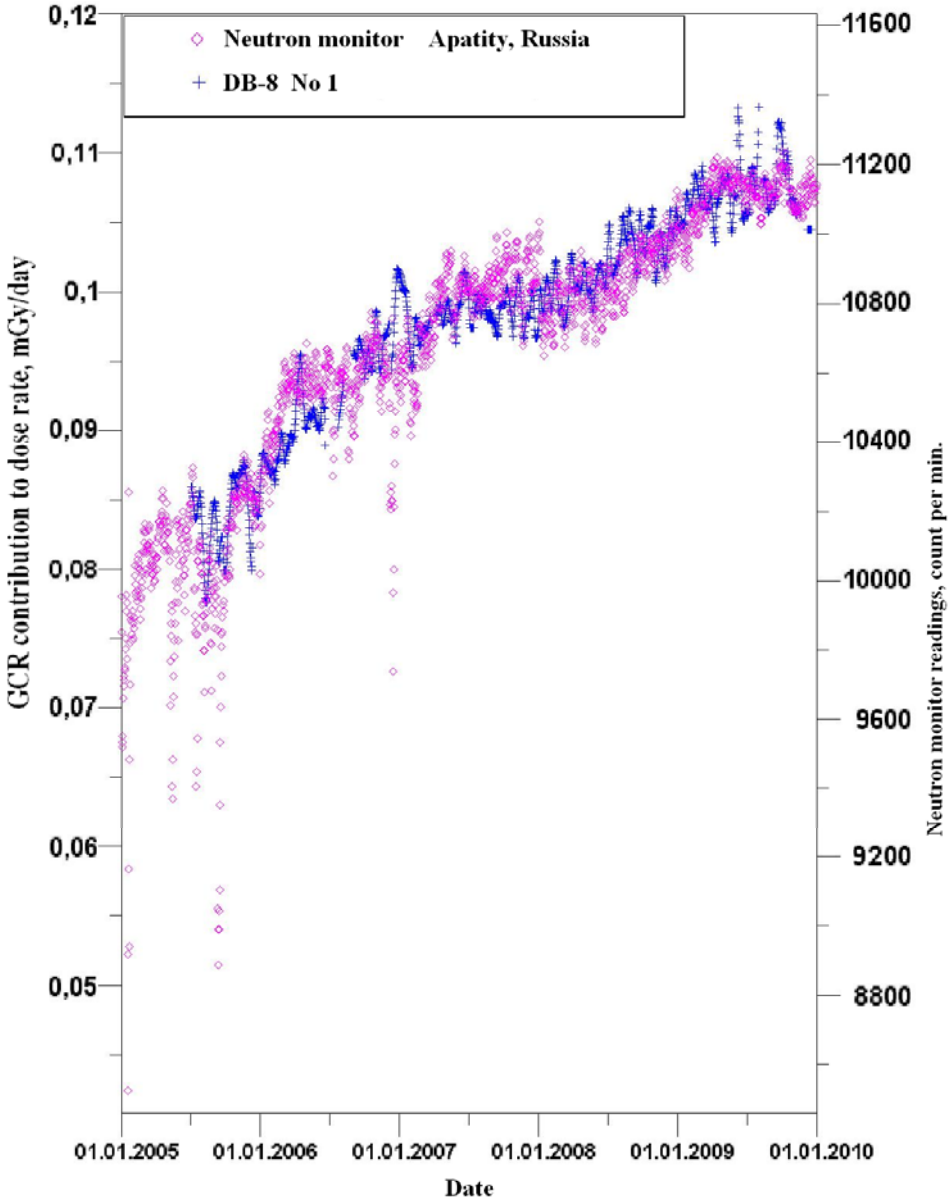
Comparison of GCR contribution to daily dose with the data of neutron monitors



Value of GCR contribution to daily dose for period from middle of 2005 until middle of 2009 increased from 0.08 to 0.11 mGy/day.

The variations of neutron monitor data and GCR contribution to daily dose are similar

Comparison of GCR contribution to daily dose with the Apatity neutron monitor data



A special scale for Apatity neutron monitors data is used

Range of neutron monitor data variation is 6% - 10% against 30% variations of GCR contribution to daily dose on ISS

SPE doses obtained with R-16 and DB-8

SPE	MIR, mGy	ISS, mGy	MIR, mrad	ISS, mrad		Date of the event	ISS, mGy	ISS, mrad
07.03.1989	0.35		35.			18.04.2001	0.16	15.
23.03.1989	0.20		20.			25.09.2001	2.78	278.
28.09.1989	4.65		465.			04.11.2001	4.08	408.
19.10.1989	27.20		2720.			22.11.2001	0.46	46.
23.10.1989	3.00		300.			26.12.2001	3.22	322.
25.10.1989	1.70		170.			21.04.2002	1.32	132.
24.05.1990	0.20		20.			28.10.2003	6.37	637.
23.03.1991	2.45		245.			29.10.2003	7.90	790.
04.06.1991	0.60		60.			04.11.2003	0.56	56.
11.06.1991	2.05		205.			10.11.2004	0.26	26.
15.06.1991	0.75		75.			16.01.2005	2.67	267.
20.04.1998	0.35		35.			20.01.2005	1.86	186.
14.07.2000	7.80		780.			08.09.2005	0.83	83.
08.11.2000	2.80	1.40	280.	140.		06.12.2006	6.65	665.
02.04.2001		0.17		17.		13.12.2006	8.02	802.
15.04.2001		0.50		50.				

SPE doses obtained with DB-8, mGy

Date	DB-8 # 1		DB-8 # 2		DB-8 # 3		DB-8 # 4	
	Unshiel	Shielded	Unshiel	Shielded	Unshiel	Shielded	Unshiel	Shielded
2001/09/24	1.57	0.99	1.25	0.96	0.54	0.21	0.19	0.15
2001/11/04	2.66	1.31	1.18	0.49	0.84	0.54	0.08	0.04
28.10.2003	1.71	1.19	0.82	0.52	0.87	0.69	0.31	0.30
2003/10/29	6.82	3.14	3.00	1.18	2.11	1.35	0.67	0.52
2005/01/17	0.81	0.67	0.31	0.55	0.63	0.29	0.18	0.10
2005/01/20	0.21	0.18	0.13	0.14	0.13	0.14	0.08	0.07
2005/09/08	0.33	0.28	0.20	0.24	0.26	0.20	0.09	0.08
2006/12/13	0.51	0.47	0.67	0.67	0.43	0.42	0.32	0.32

Conclusion

- The radiation monitoring system has been in operation aboard ISS since August, 2001 and provides Radiation safety service with operative dosimetric information.
- The RMS data set obtained up to now covers more than 9 years.
- The difference of daily doses measured in the ISS Service Module in undisturbed conditions is obtained to be about factor of 2
- Analysis of contribution to daily dose from ERB and GCR for the period since middle of 2005 showed that daily dose variations are caused mainly by variations of ERB contribution as dependent on the ISS orbit altitude changes.
- The contribution to the daily dose from GCR is slightly different in locations of the RMS detector in the ISS Service module. The GCR daily dose for considered period increased on 30%. Variations of GCR contribution to daily dose measured aboard ISS are similar to variations measured with the Apatity neutron monitor.
- During SPE the difference in daily doses onboard the ISS can be as much as a factor of 10. However, during January 20, 2005 SPE characterized by very hard energy spectrum the difference was only 3 times
- The highest daily dose measured with the less shielded DB-8 detector during October 29, 2003 SPE was 30 times above the mean daily dose measured with the same detector in undisturbed conditions

Thank you for your attention!