18-th Workshop on Radiation Monitoring for the International Space Station. 3 - 5 September 2013, Budapest, Hungary

RESULTS OF THE RADIATION MONITORING SYSTEM MEASUREMENTS ON SERVICE MODULE OF ISS DURING 2009 -2013

V.V. Benghin [1)], V.M. Petrov [1)], M.I. Panasyuk[2)],
O.Yu. Nechaev [2)] , I.V. Nikolaev [3)] , A.N. Volkov [3)] ,
V.I. Liagushin [3)] , A.E. Lishnevskii [2)]

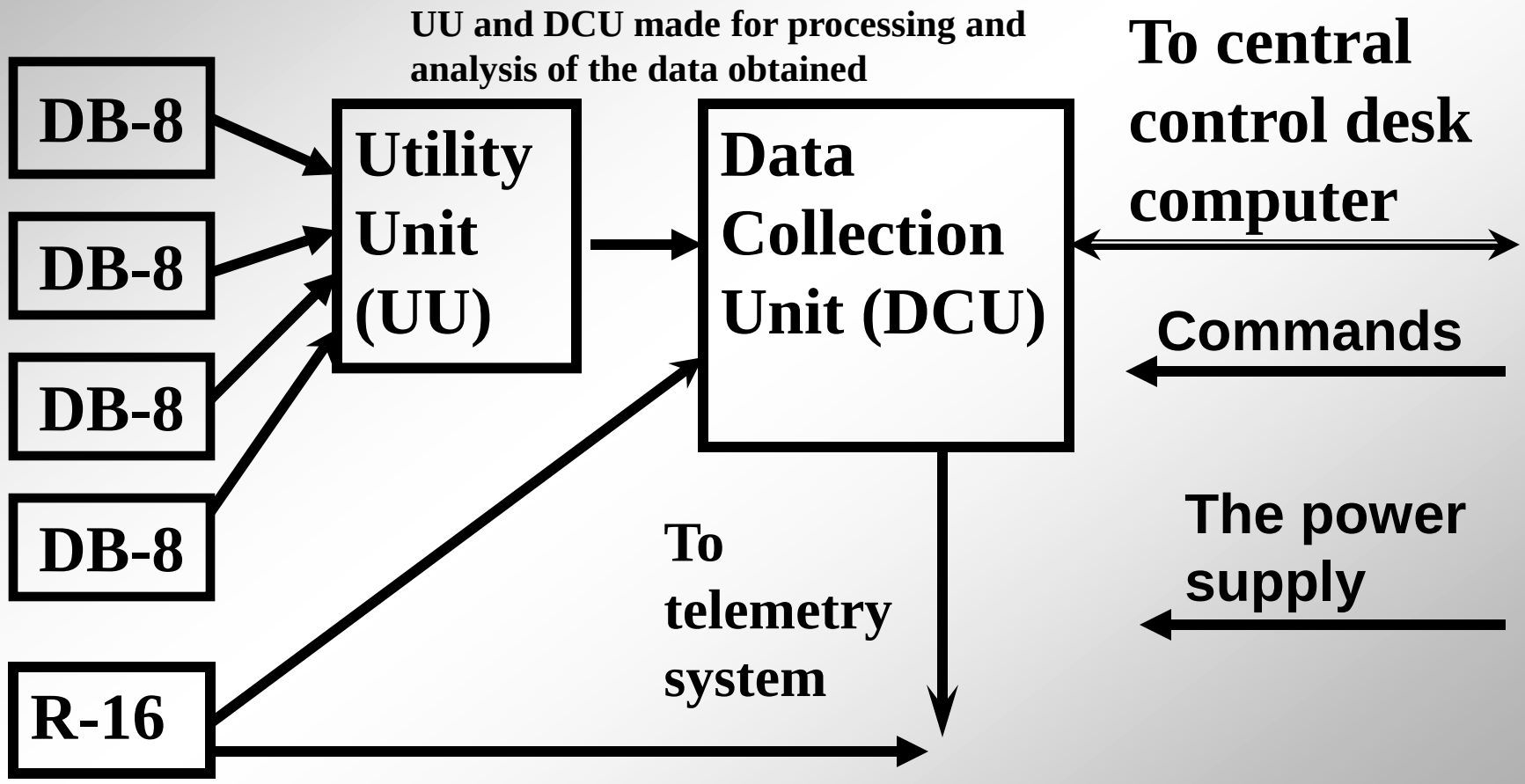
[1)] Scientific Research Centre of the RF – Institute for Biomedical Problems, Russian Academy of Sciences, Moscow, Russia

[2)] Skobeltsyn Institute of Nuclear Physics of Moscow State University Moscow, Russia

[3)] Rocket-space corporation "Energiya", Korolev, Russia

Configuration of the Radiation Monitoring System (RMS)

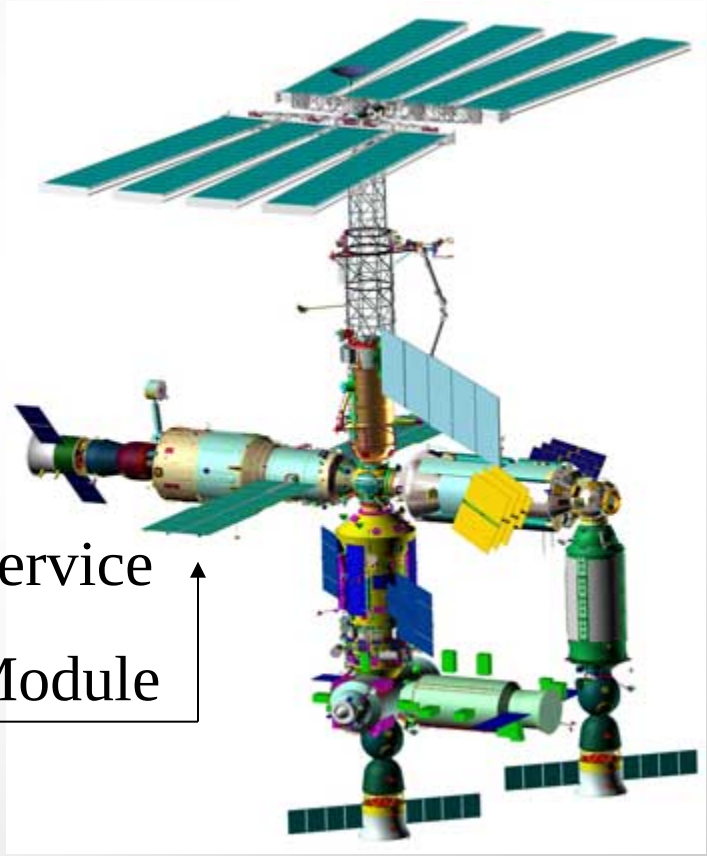
Each DB-8 unit consist of two dosimeters with semiconductor radiation detectors



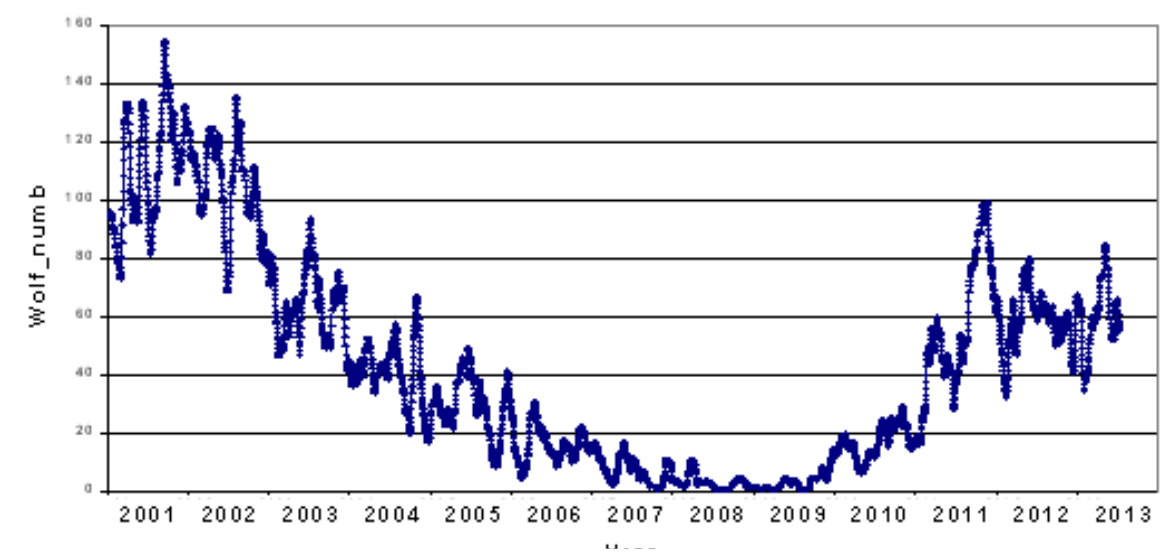
The Russian segment of the ISS

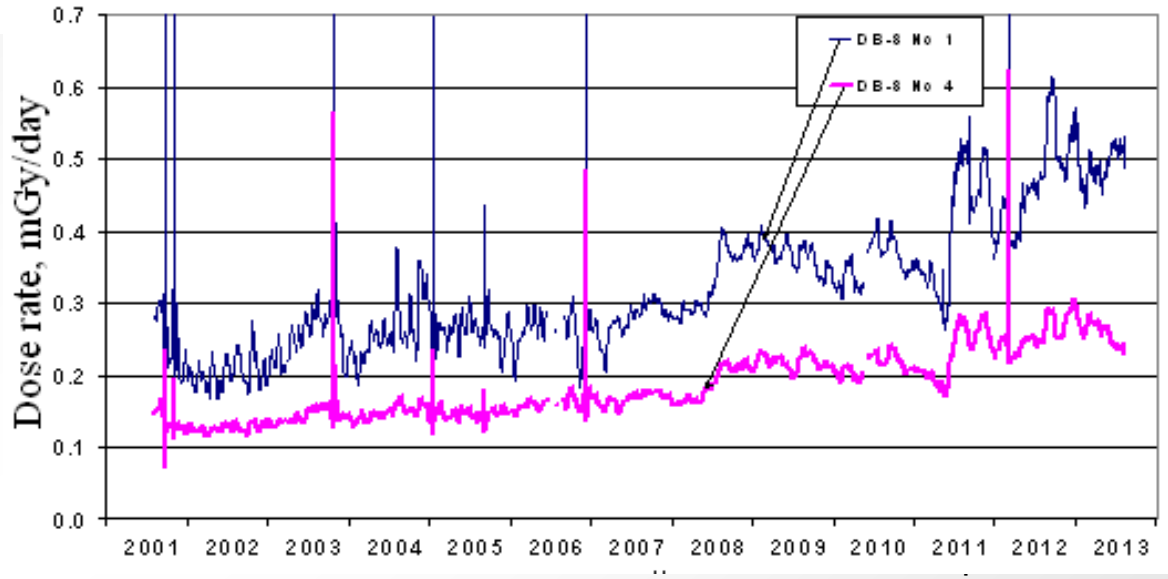
The R-16 device has been operating on the ISS since summer, 2000.
Four DB-8 units, Utility Unit and Data Collection Unit, were delivered to the ISS by "Progress M 1-6" on May 23, 2001.
On the 27th of July, 2001 the crew of the 2nd ISS mission mounted the blocks on board of the Service Module and connected up the cables.

The RMS has been operating since August 1, 2001 12:42 UT.



Dose rate measured from August 2001 to August 2013 with DB-8 units # 1 and # 4 unshielded detectors





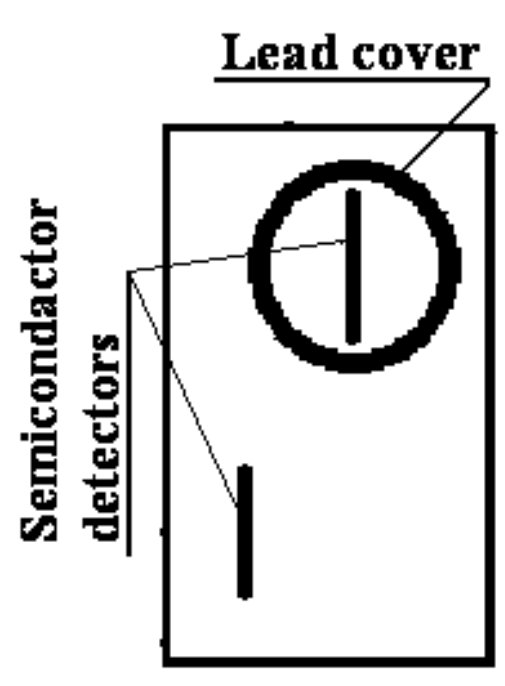
ftp://ftp.ngdc.noaa.gov
/STP/space-weather
/solar-data/solar-indices
/sunspot-numbers
/international/tables
/daily-sunspot-numbers

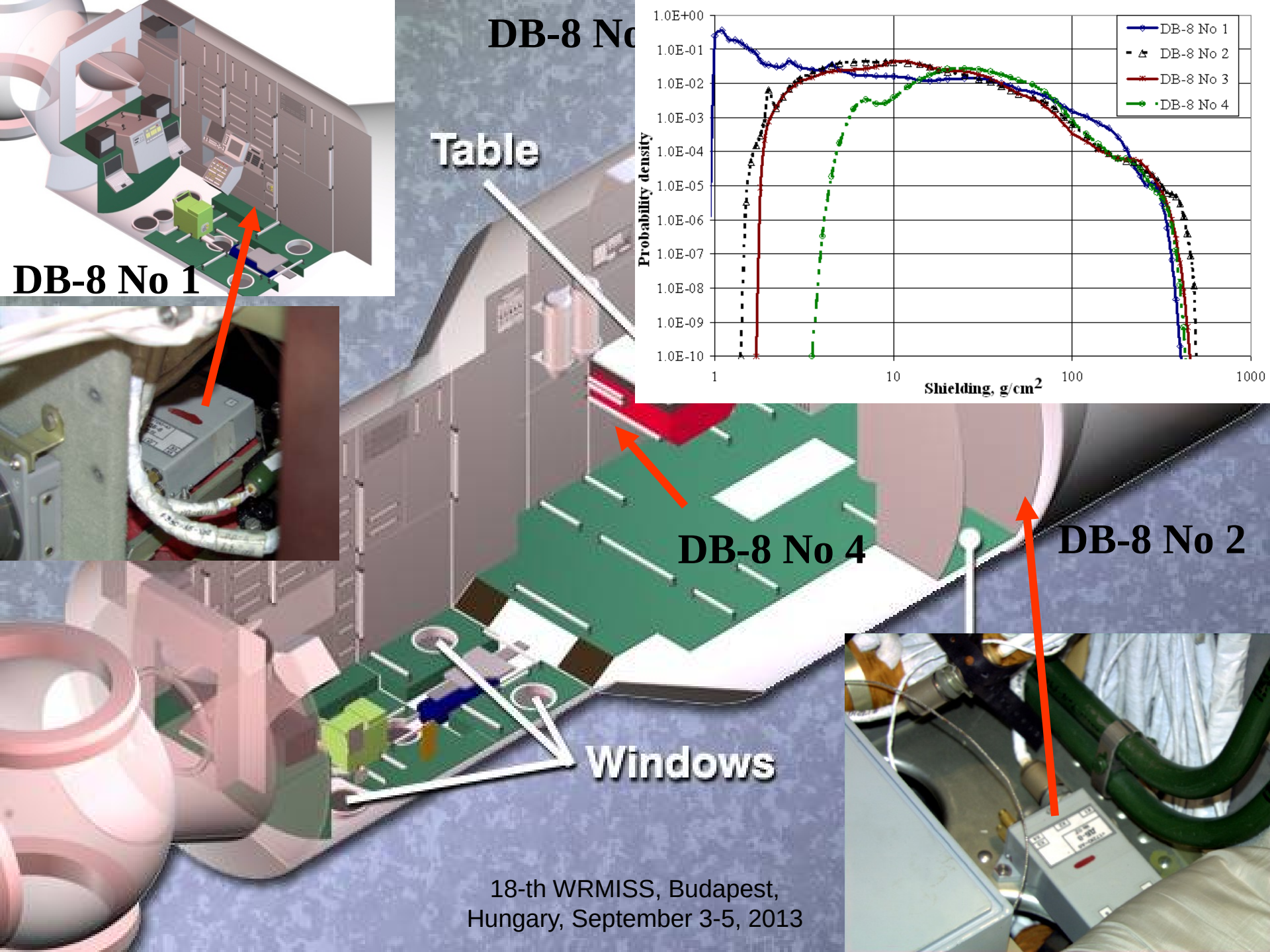
DB-8 unit without cover

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.

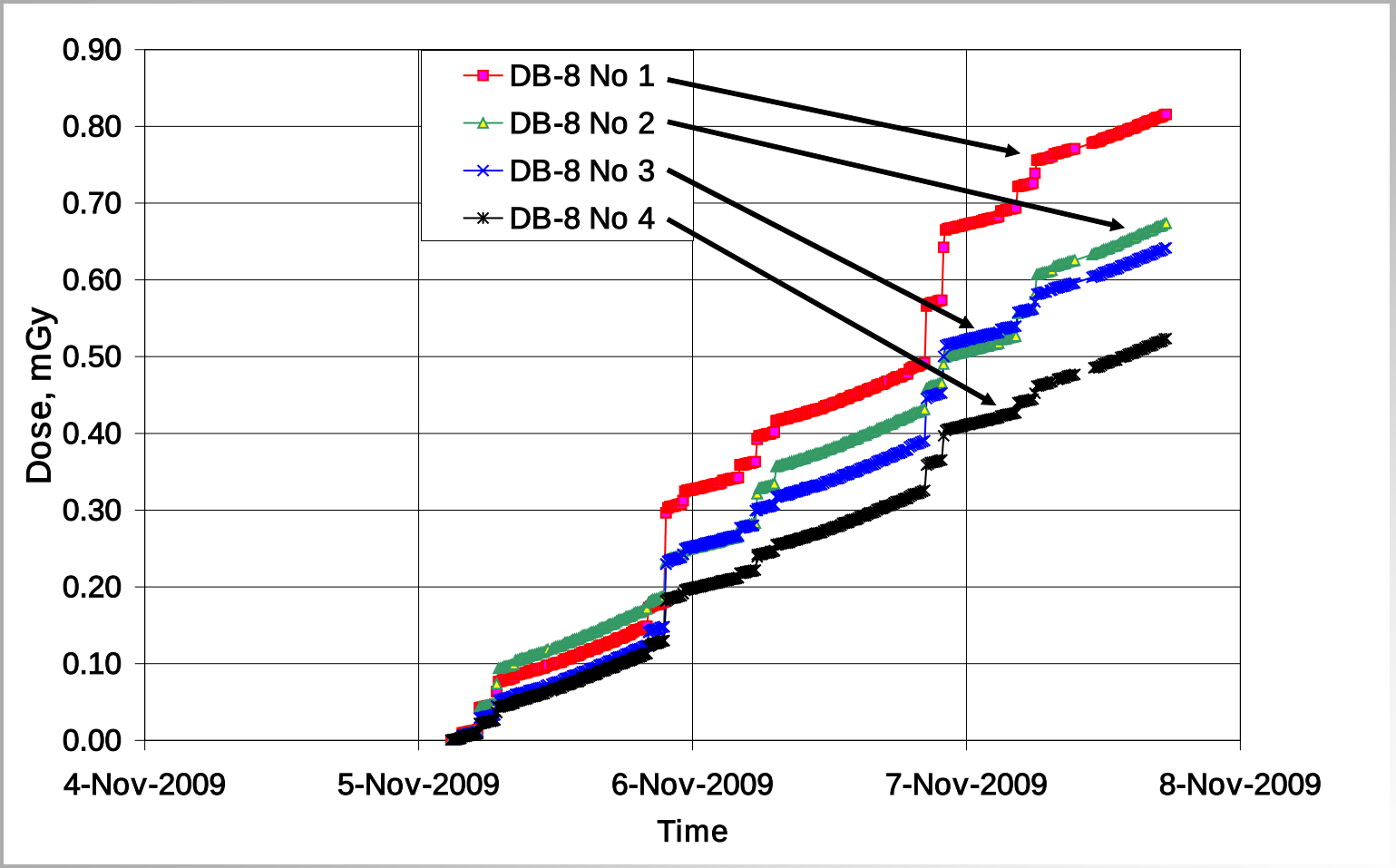
The sphere wall thickness is 3 g/cm^2 Pb



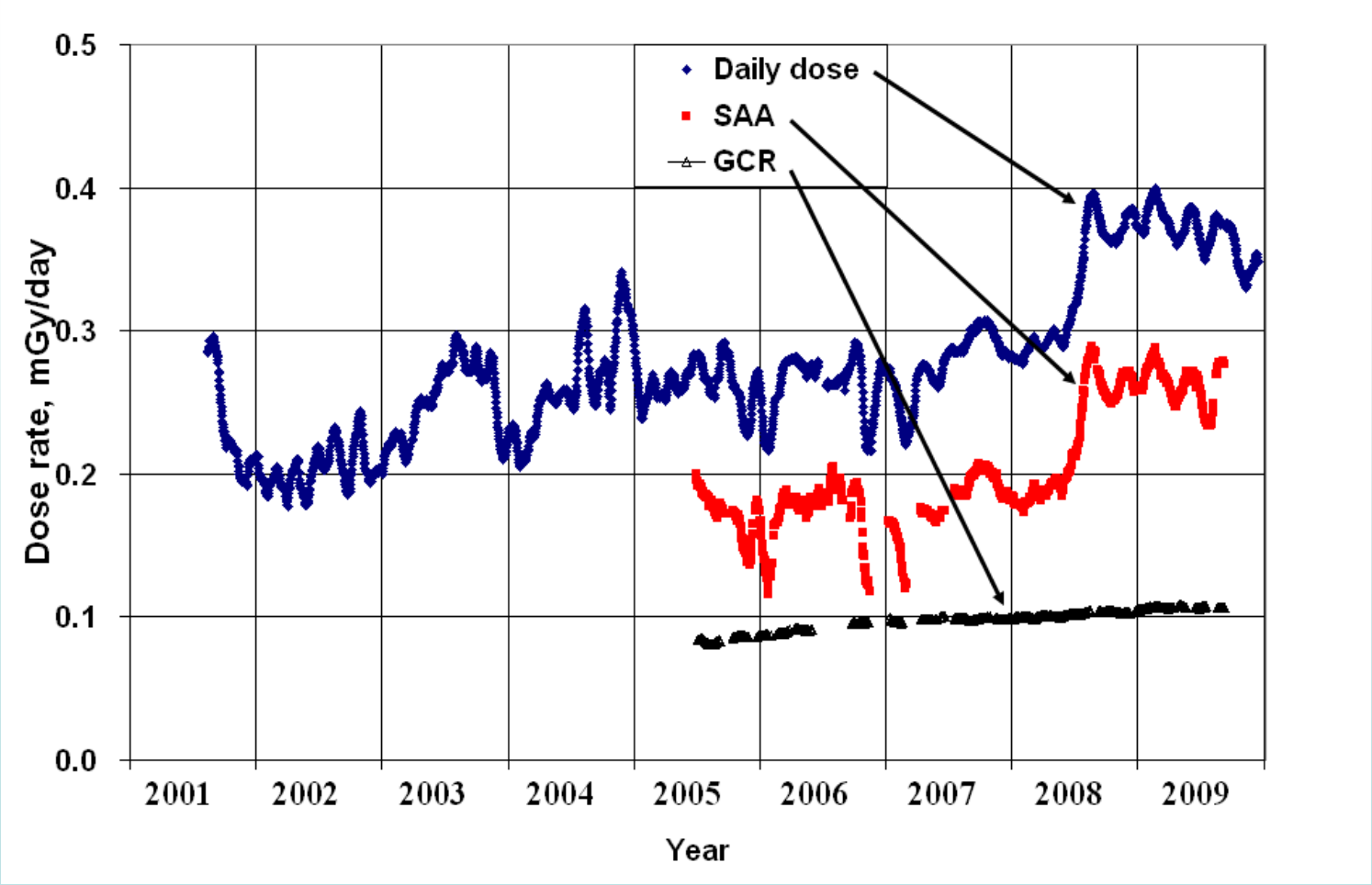


18-th WRMISS, Budapest,
Hungary, September 3-5, 2013

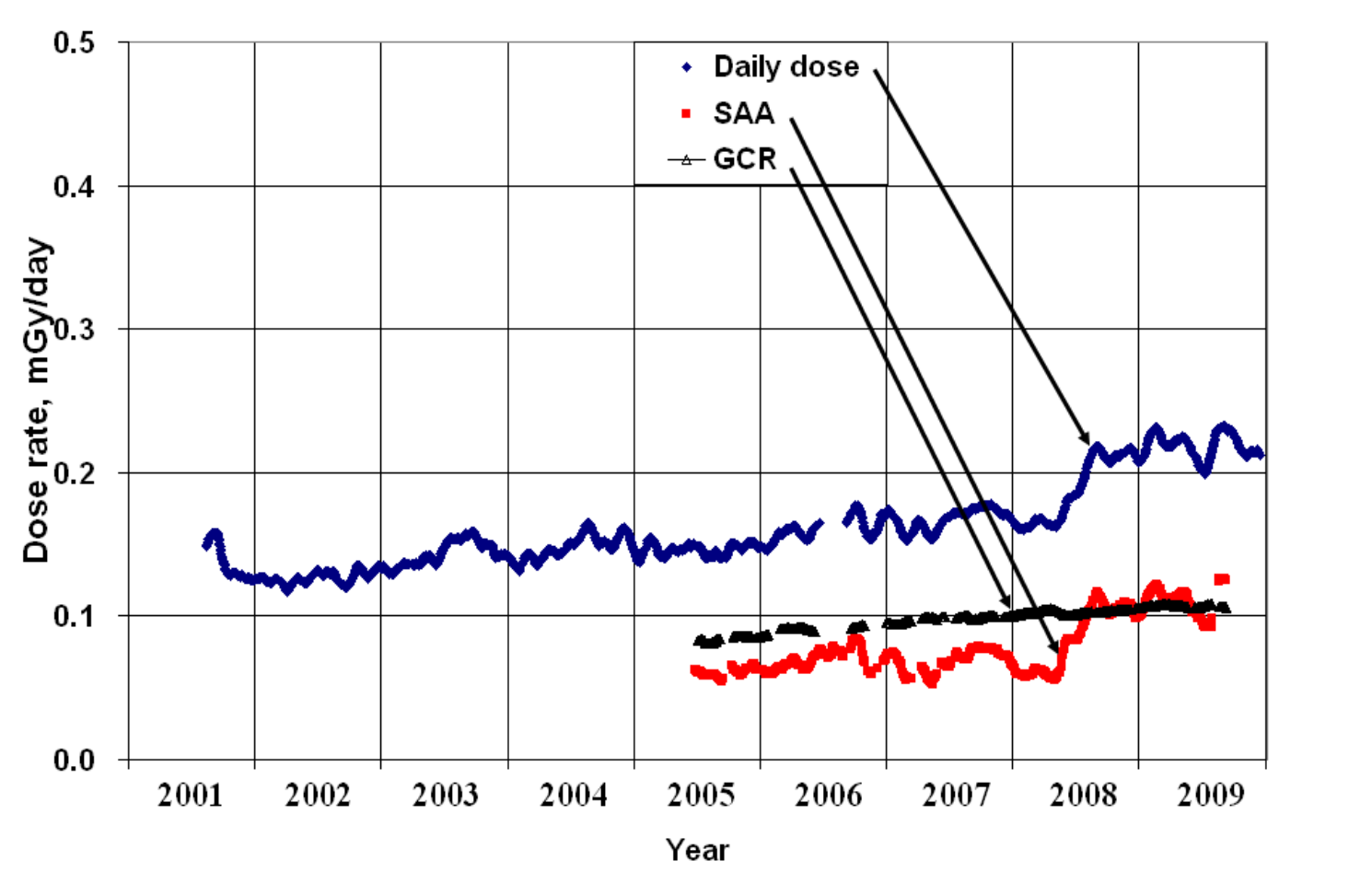
The dose accumulation in the locations of DB-8 detectors.



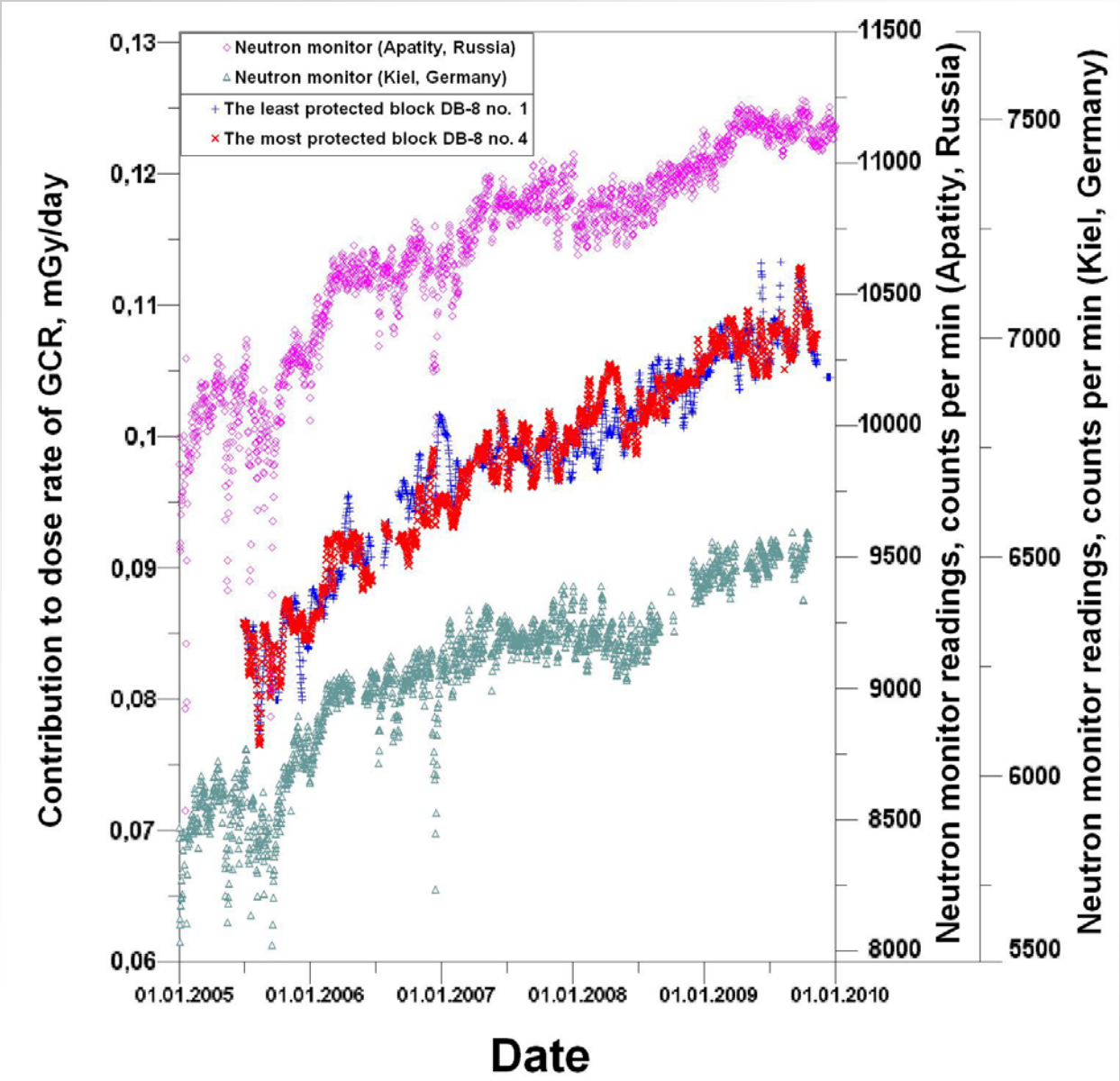
Daily dose measured with unshielded detectors of the DB-8 No 1. Contribution to the daily dose caused by ERB and GCR



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



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



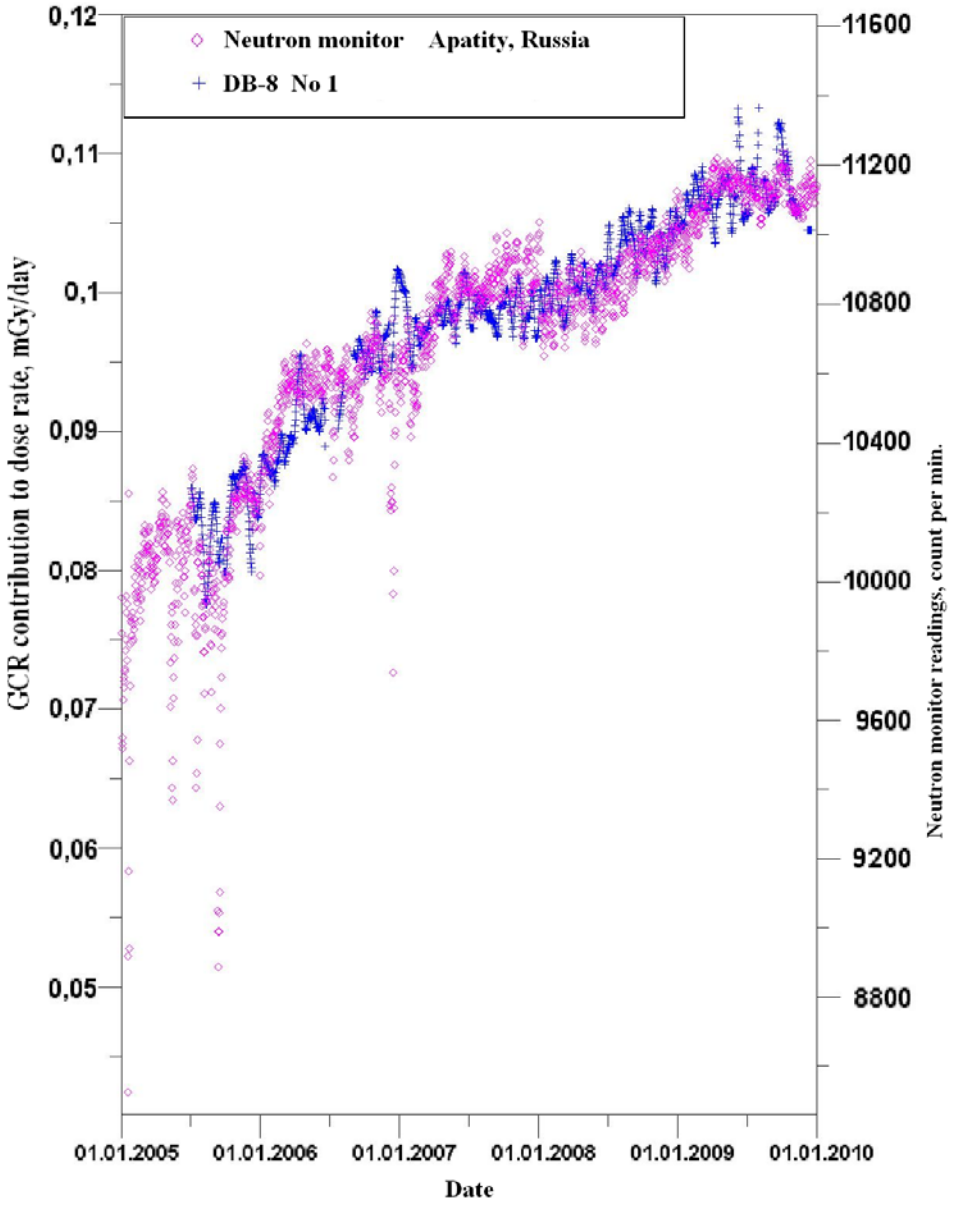
Value of GCR contribution to daily dose for period from middle of 2005 until middle of 2009 increased from 0.08 to 0.11 mGy/day.

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

http://pgia.ru/data/nm/

http://cr0.izmiran.rssi.ru/kiel/main.htm

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



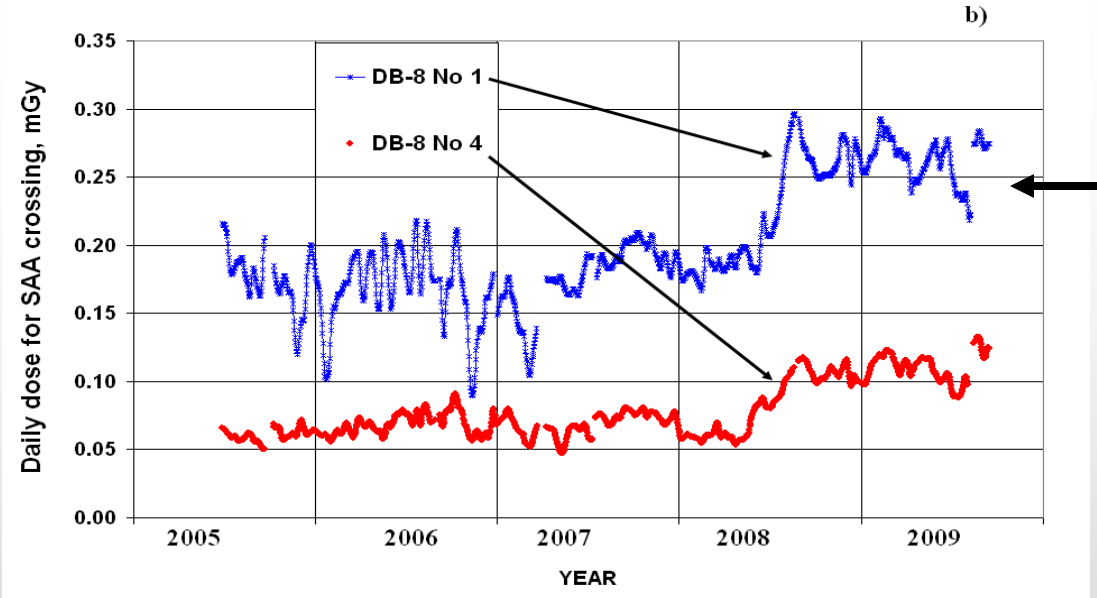
A special scale for Apatity neutron monitors data is used

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

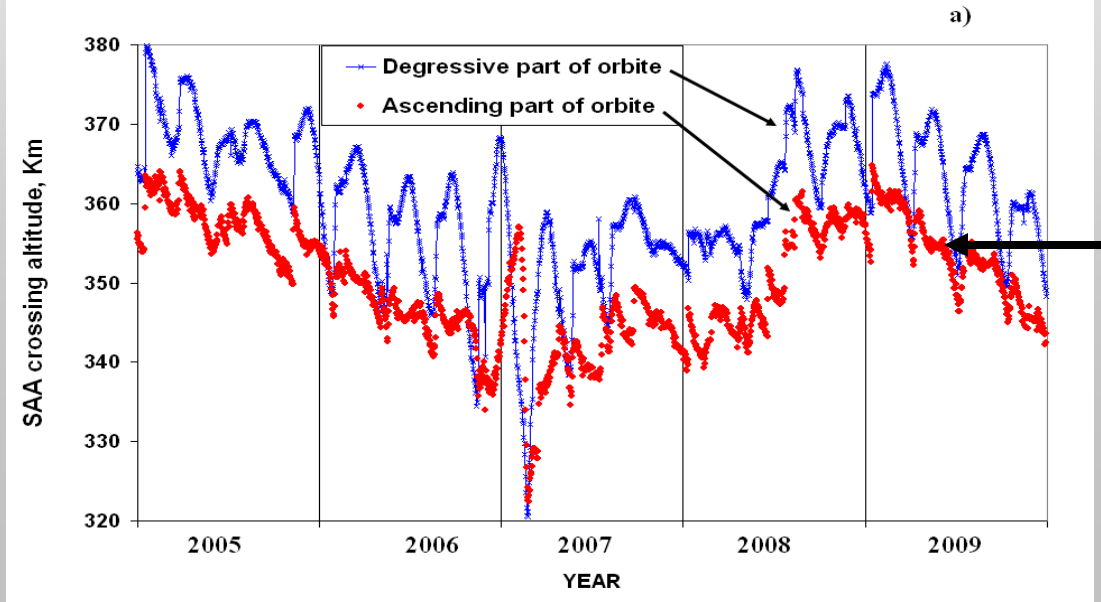
GCR contribution to absorbed dose in range **0.08 – 0.11 mGy/day in Si** is in a tolerable accordance with absorbed dose rates calculation about **0.085 mGy/day in water** / D. Matthia, T. Berger, G. Reitz, Organ shielding and doses in Low-Earth orbit calculated for spherical and anthropomorphic phantoms, Advances in Space Research 52 (2013) 528–535

st,
2013

ERB contribution to daily doses versus altitude of SAA crossing

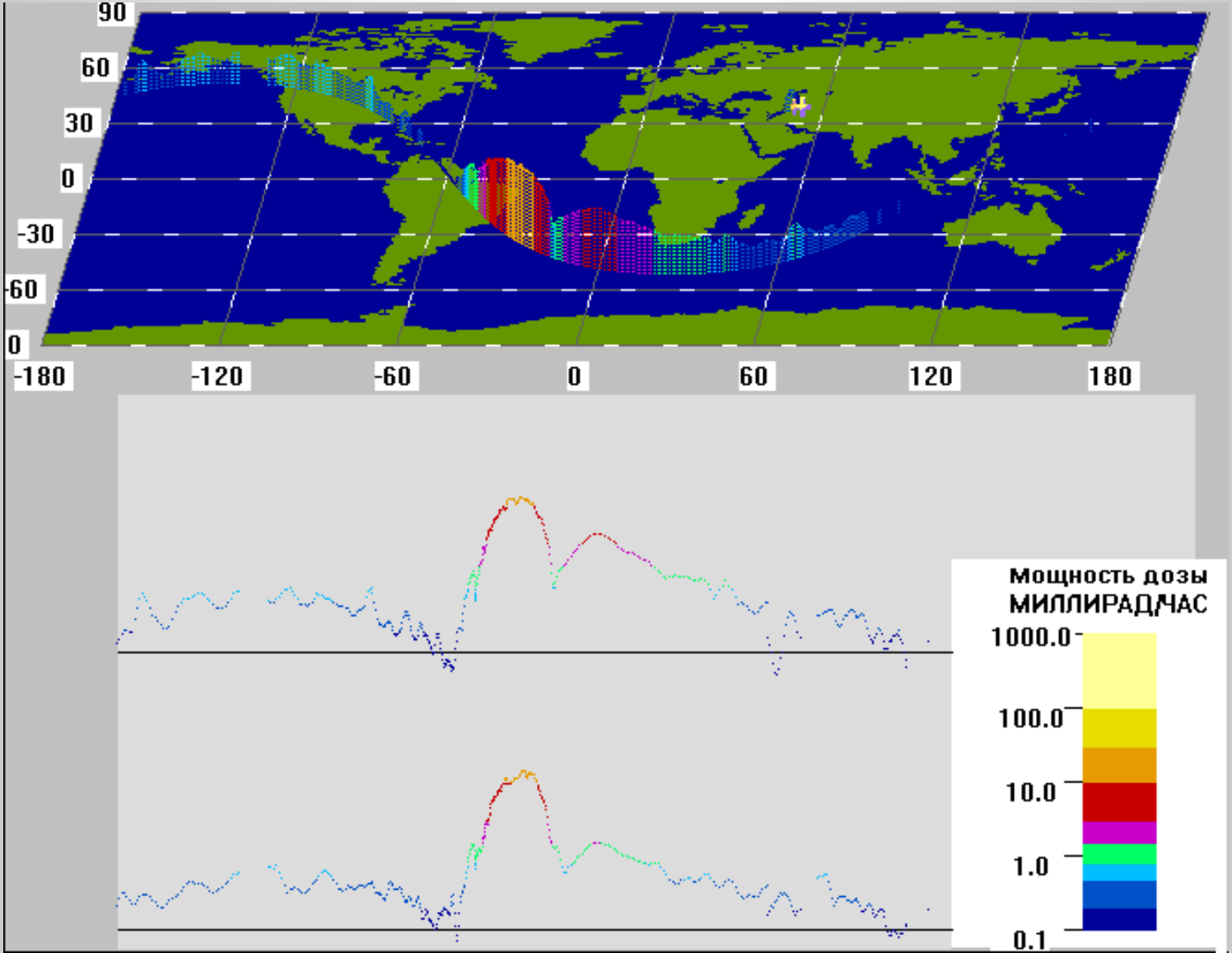


The ERB contribution to daily doses

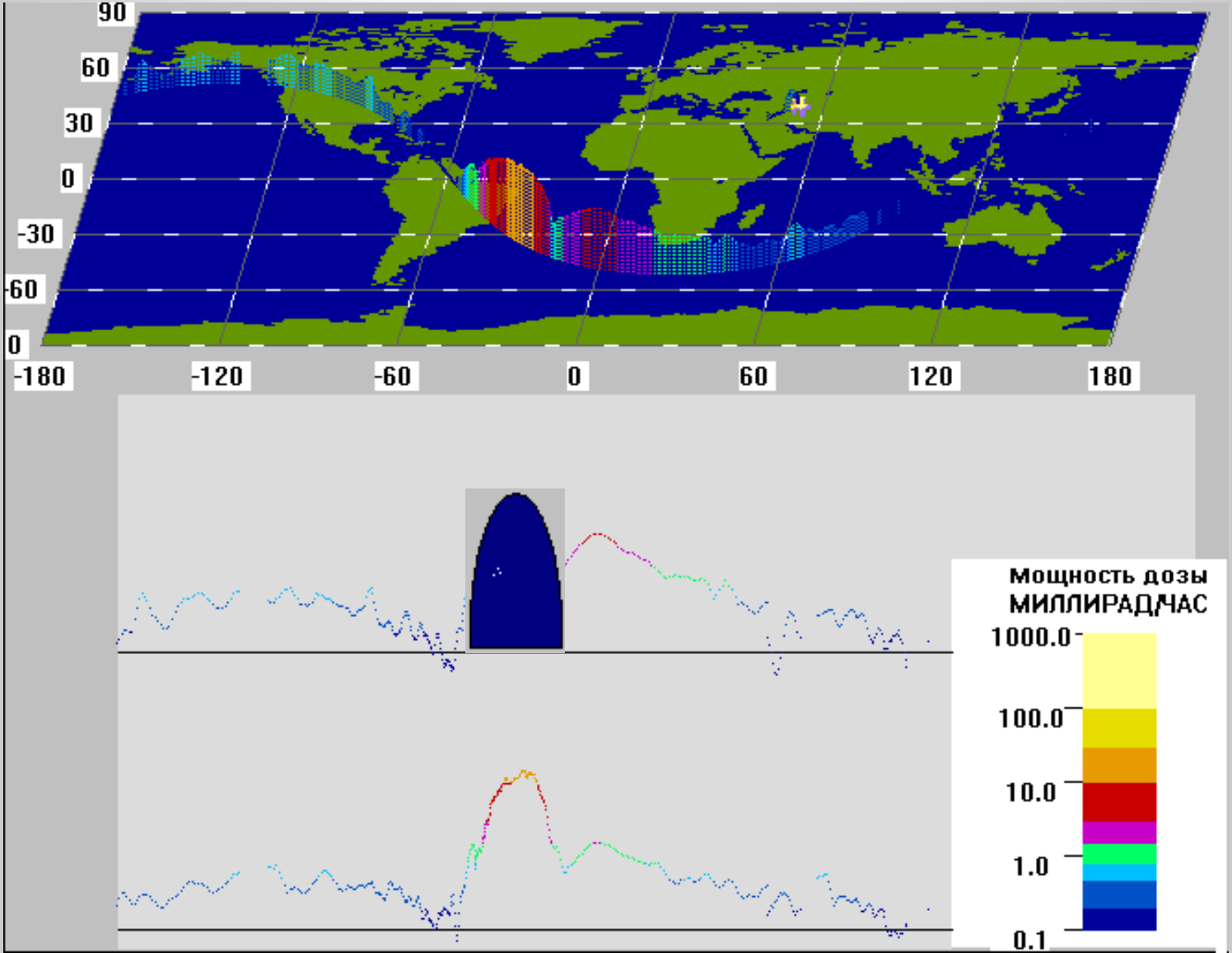


Altitude of SAA crossing by ISS

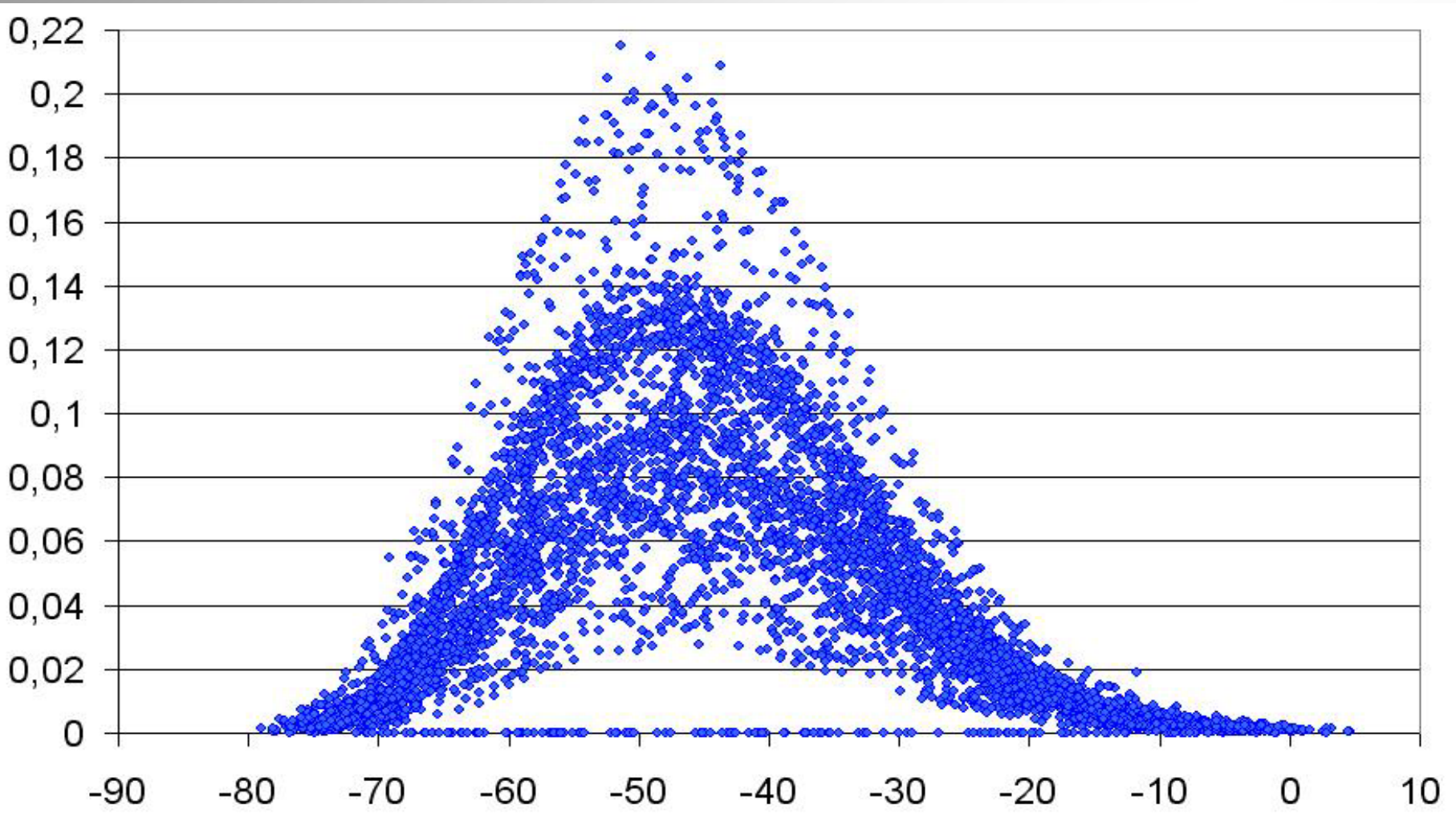
Dose rate during SAA crossing measured November 1 2003 with DB-8 #1.



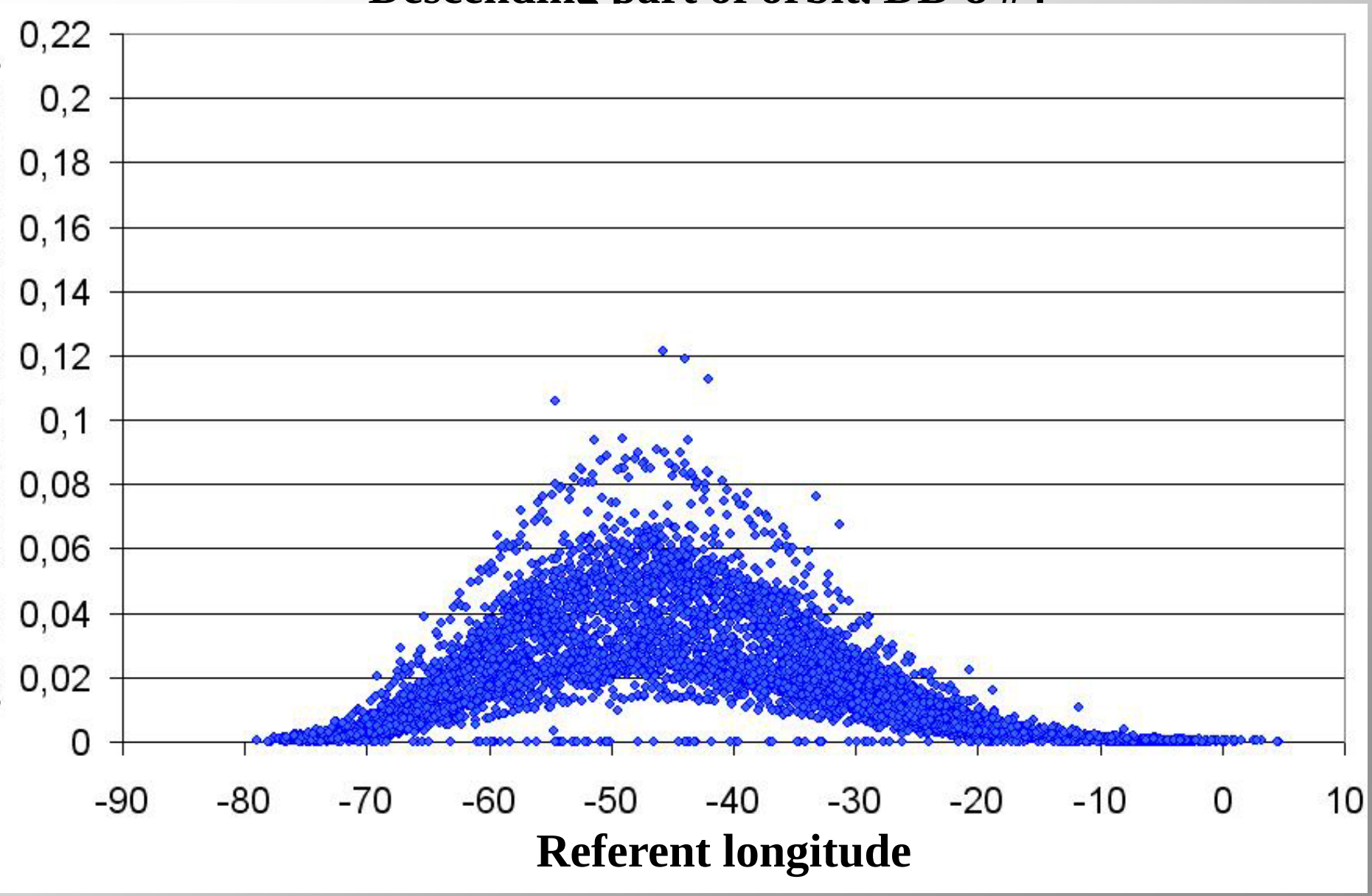
Dose rate during SAA crossing measured November 1 2003 with DB-8 #1.



Doses for one SAA crossing (mGy) versus referent longitude (longitude of orbit intersection with parallel 30° south latitude). Descending part of orbit, DB-8 #1



Doses for one SAA crossing (mGy) versus referent longitude (longitude of orbit intersection with parallel 30° south latitude). Descending part of orbit. DB-8 #4

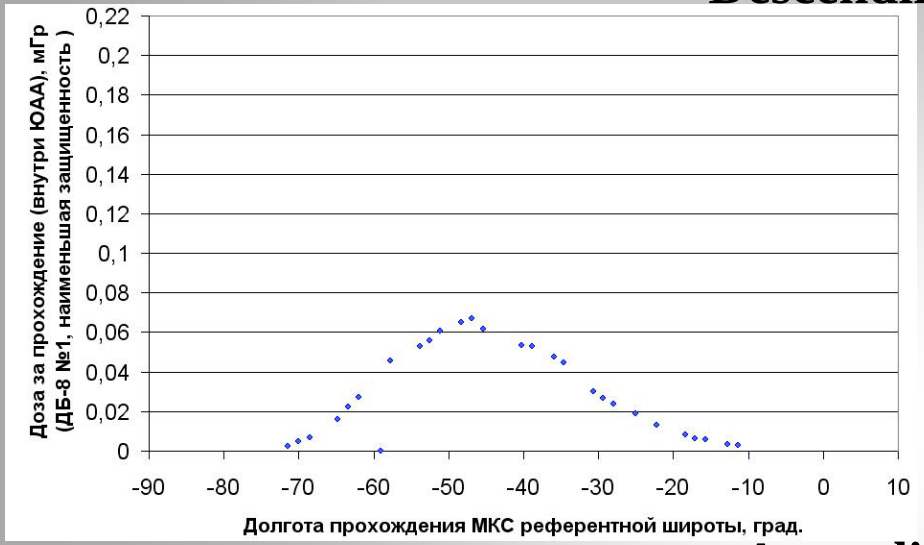


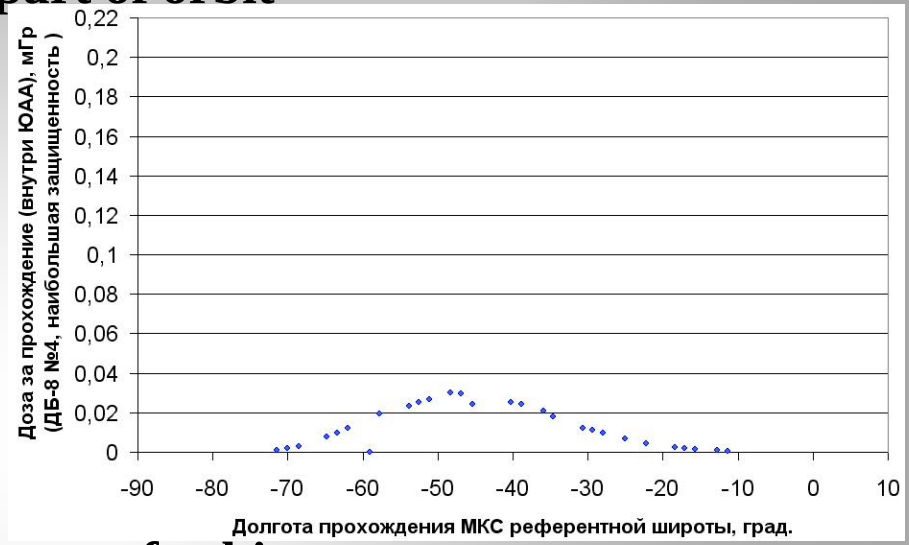
Doses for one SAA crossing versus referent longitude
Altitude 320 - 330 Km

DB-8 #1. The least shielding

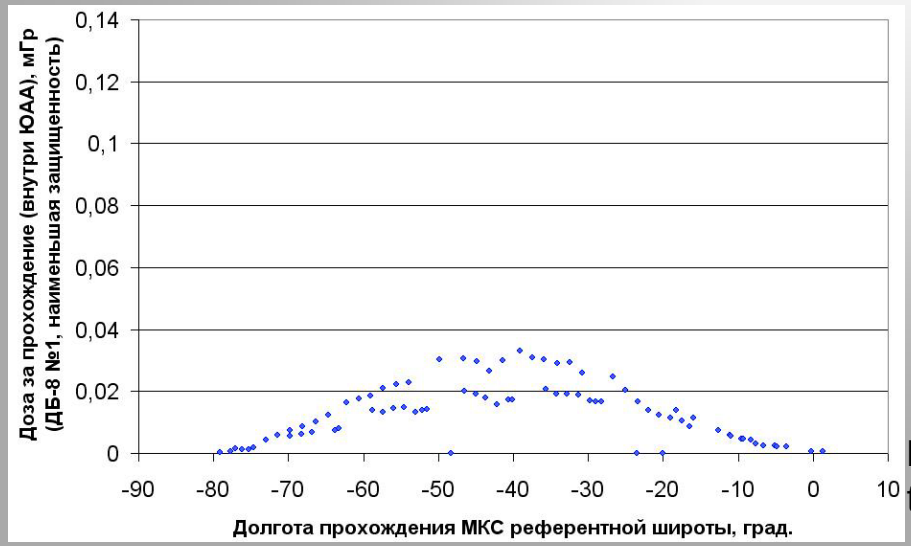
DB-8 #4. The most shielding

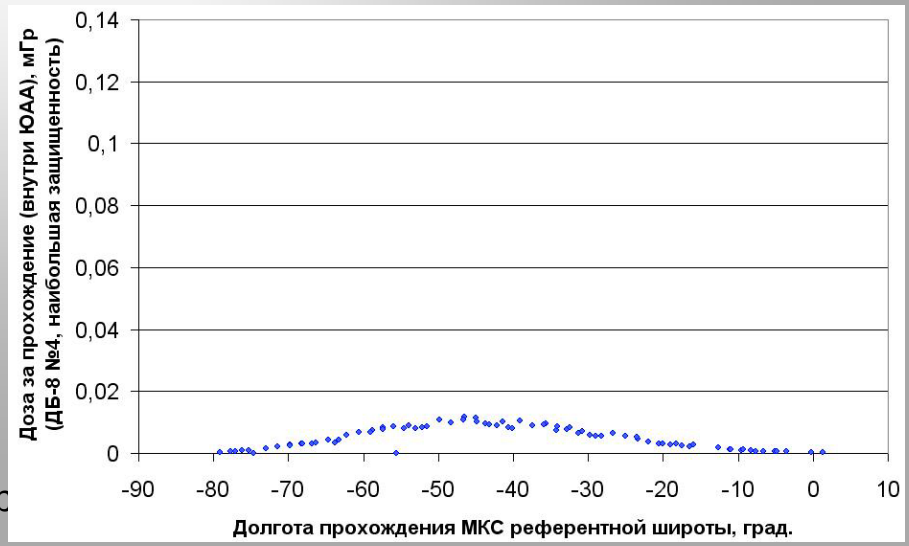
Descending part of orbit





Ascending part of orbit





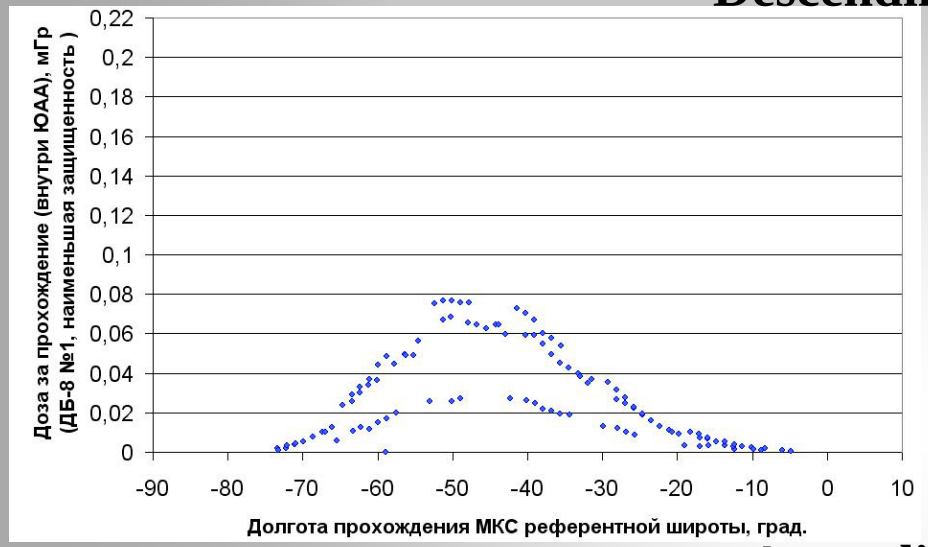
ISS,
temb

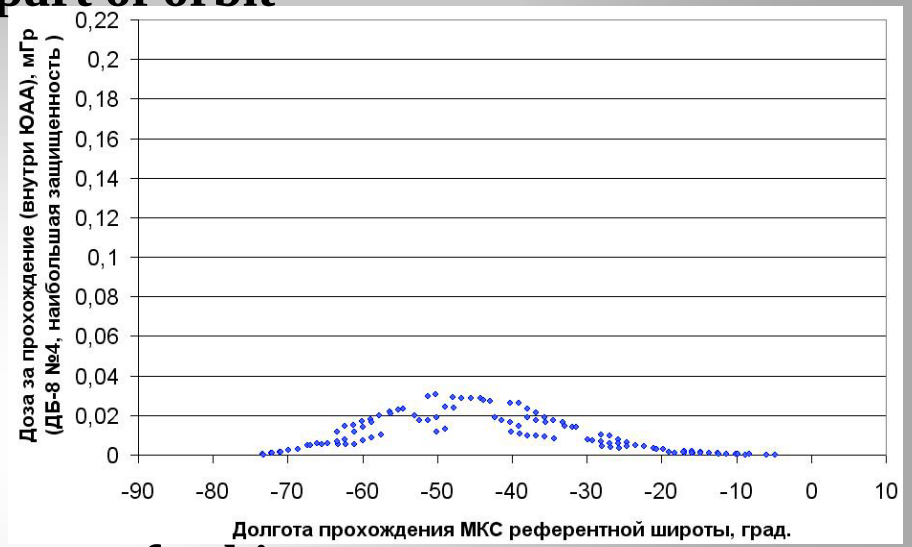
Doses for one SAA crossing versus referent longitude
Altitude 330 - 340 Km

DB-8 #1. The least shielding

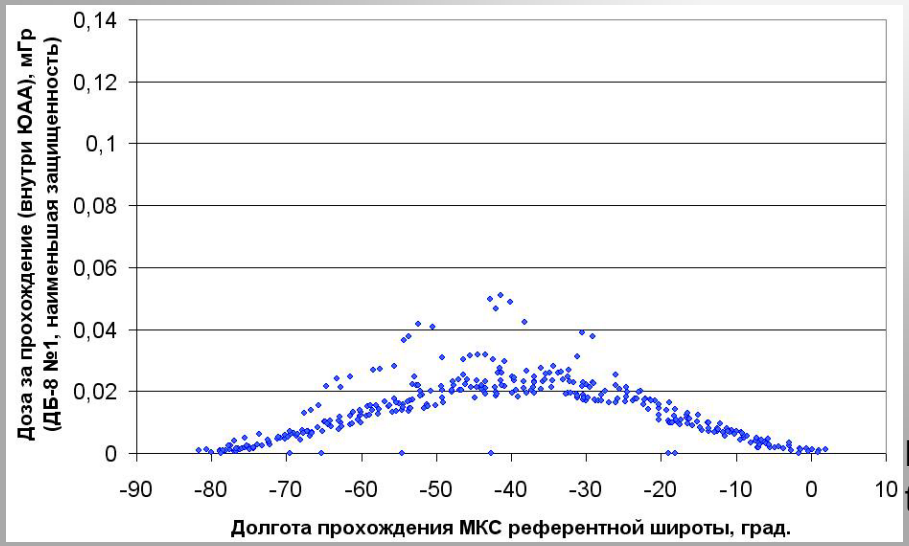
DB-8 #4. The most shielding

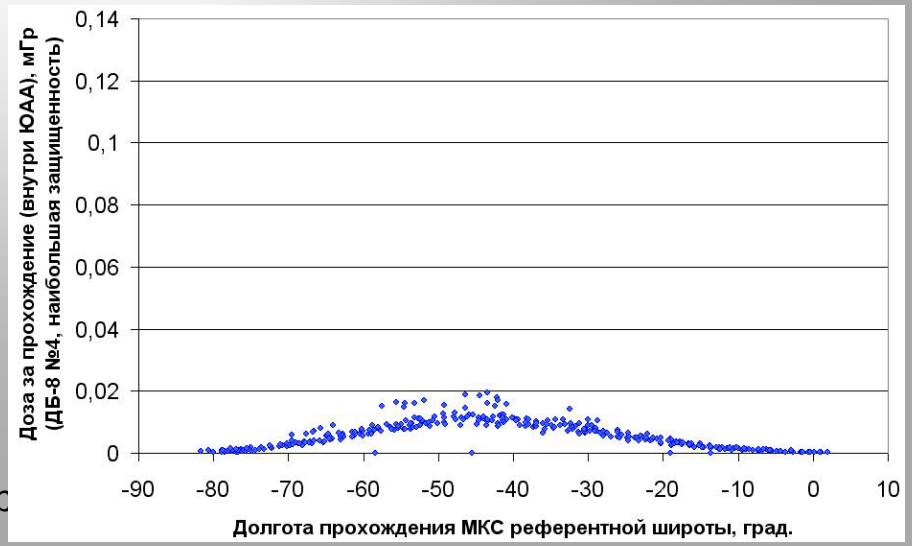
Descending part of orbit





Ascending part of orbit





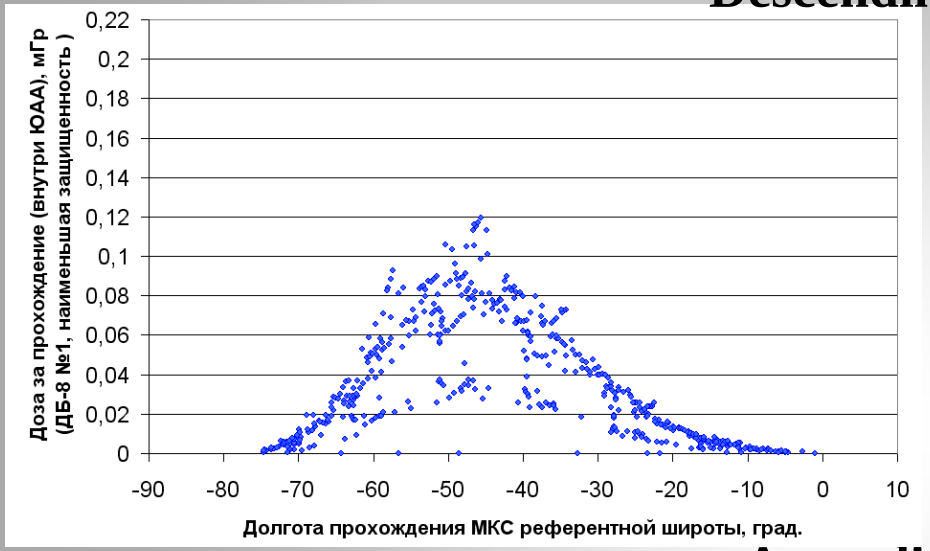
ISS,
temb

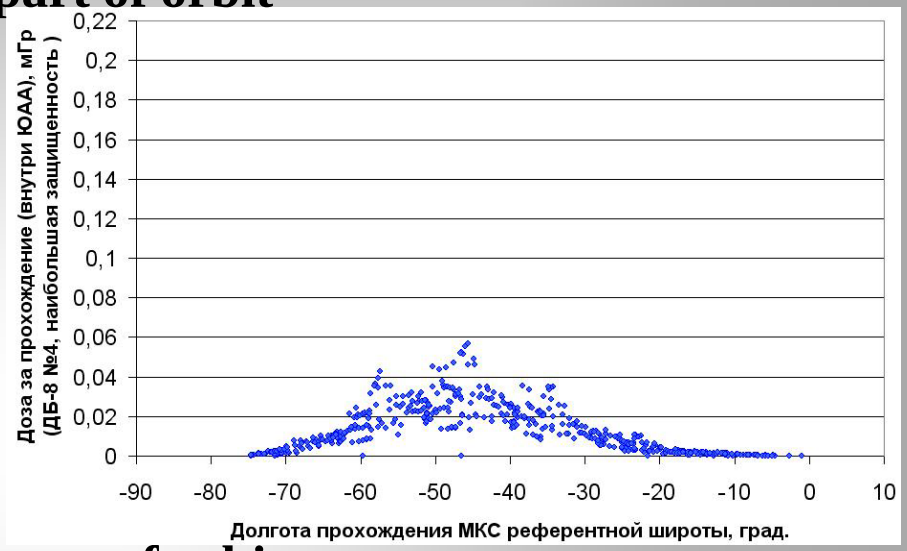
Doses for one SAA crossing versus referent longitude
Altitude 340 - 350 Km

DB-8 #1. The least shielding

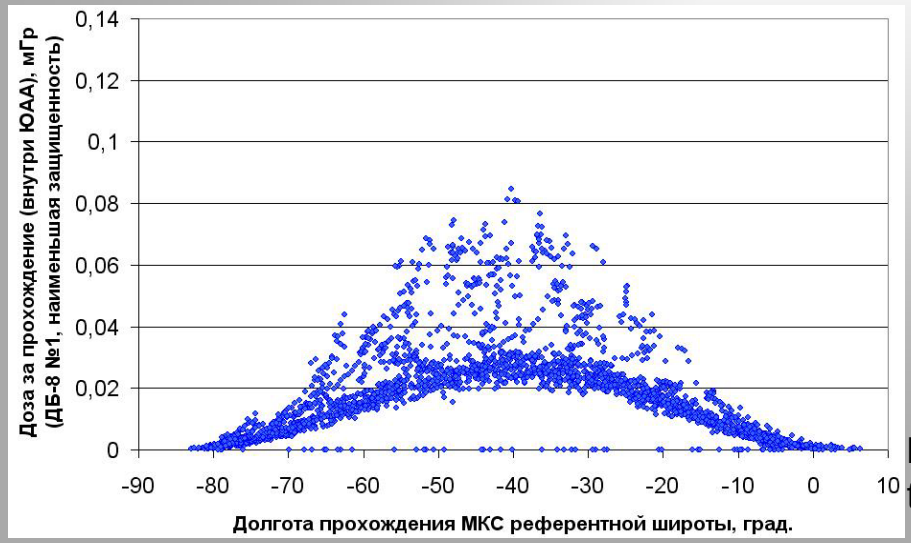
DB-8 #4. The most shielding

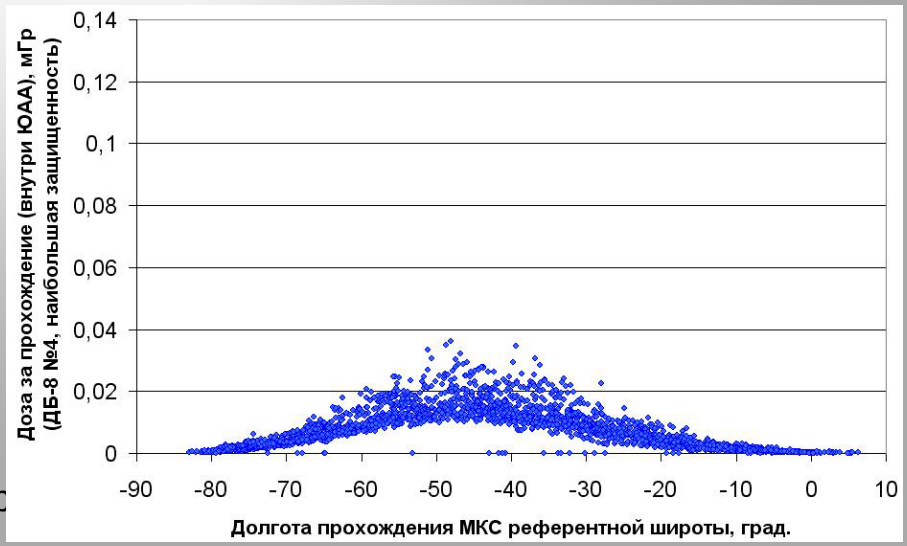
Descending part of orbit





Ascending part of orbit





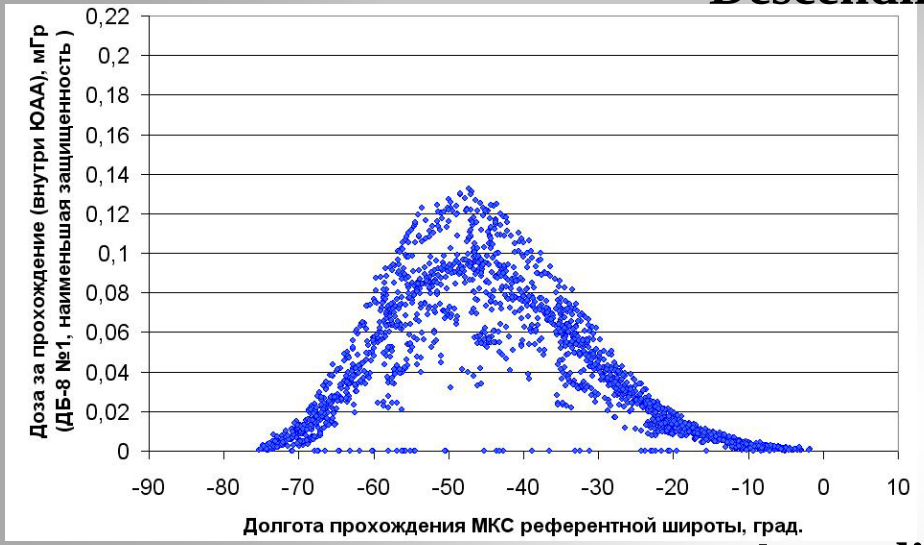
ISS,
temb

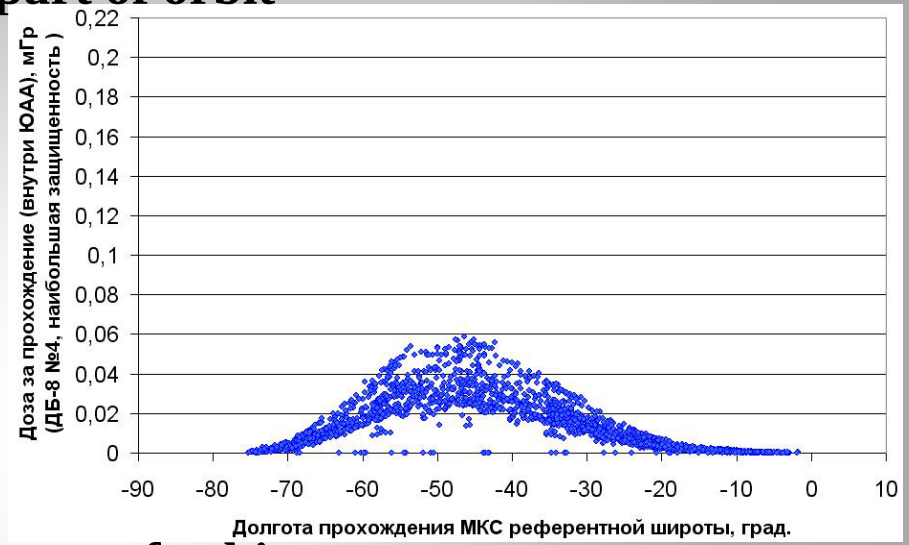
Doses for one SAA crossing versus referent longitude
Altitude 350 - 360 Km

DB-8 #1. The least shielding

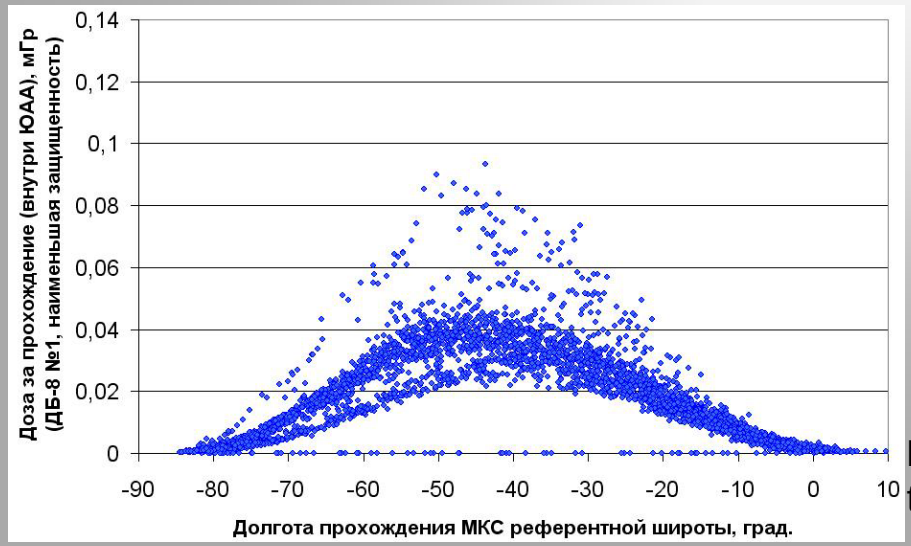
DB-8 #4. The most shielding

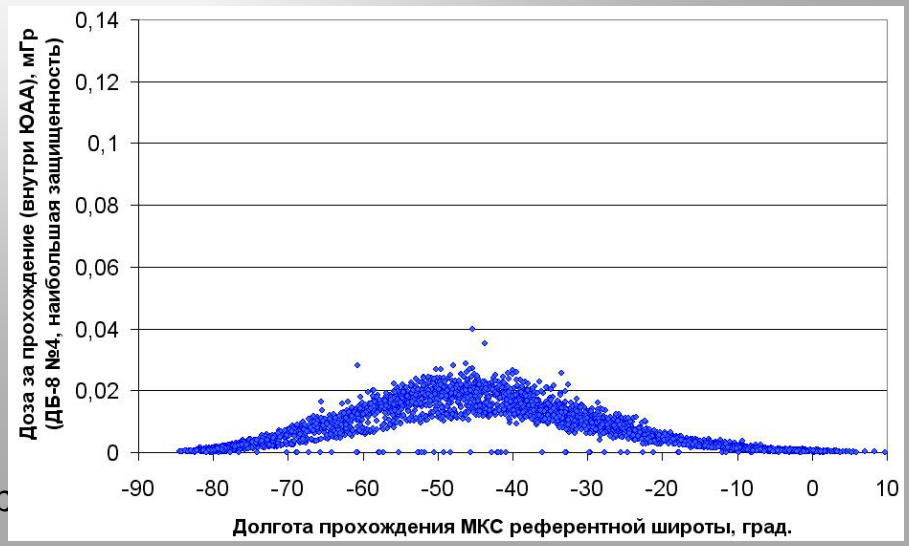
Descending part of orbit





Ascending part of orbit





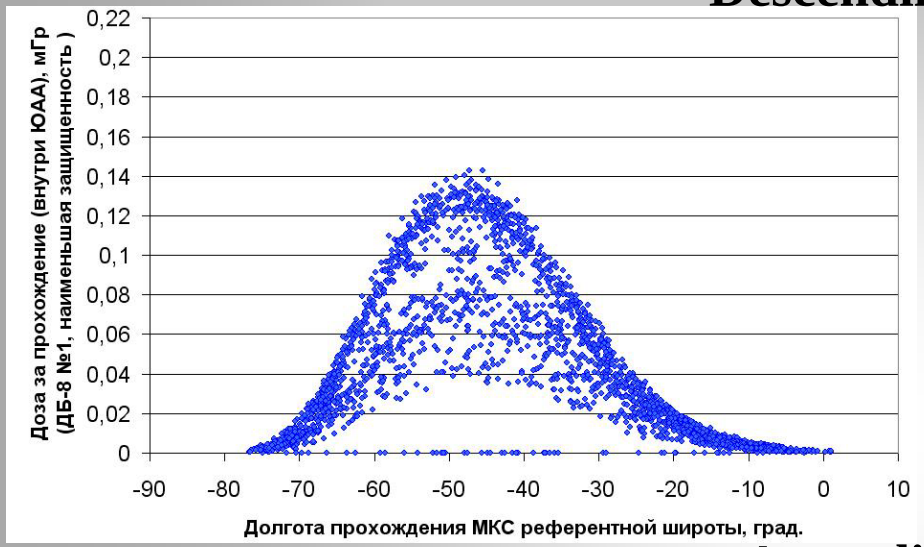
ISS,
temb

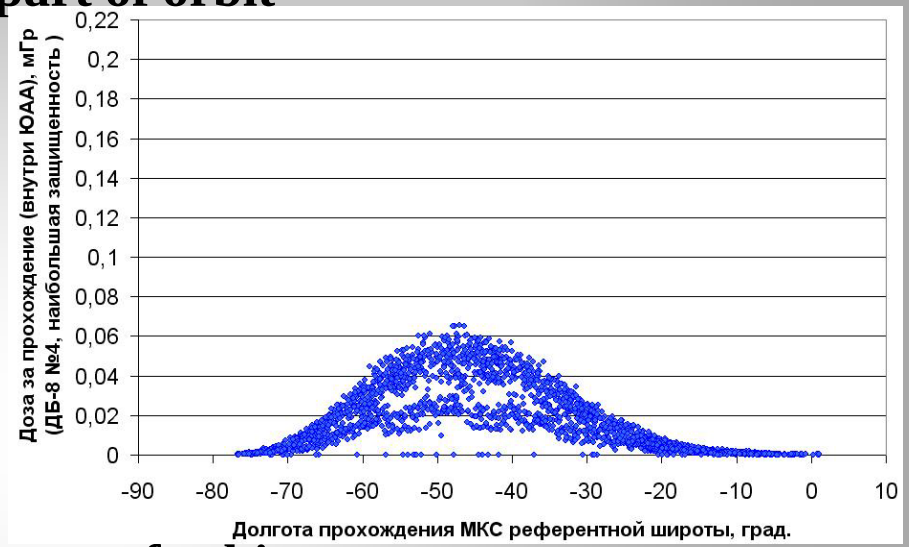
Doses for one SAA crossing versus referent longitude
Altitude 360 - 370 Km

DB-8 #1. The least shielding

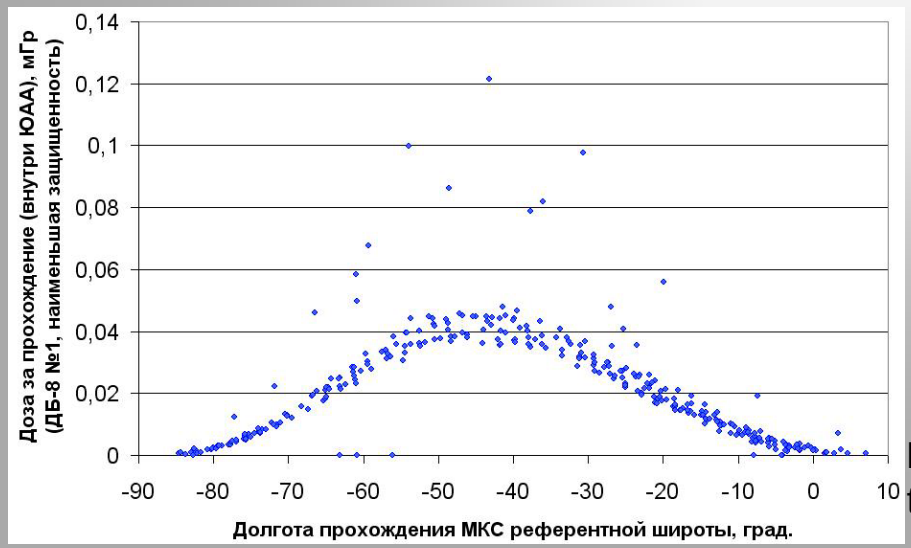
DB-8 #4. The most shielding

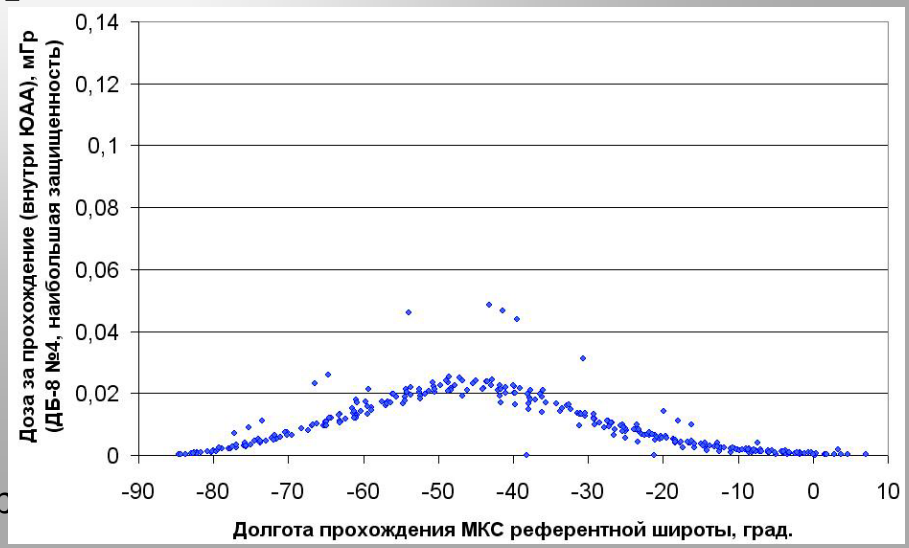
Descending part of orbit





Ascending part of orbit

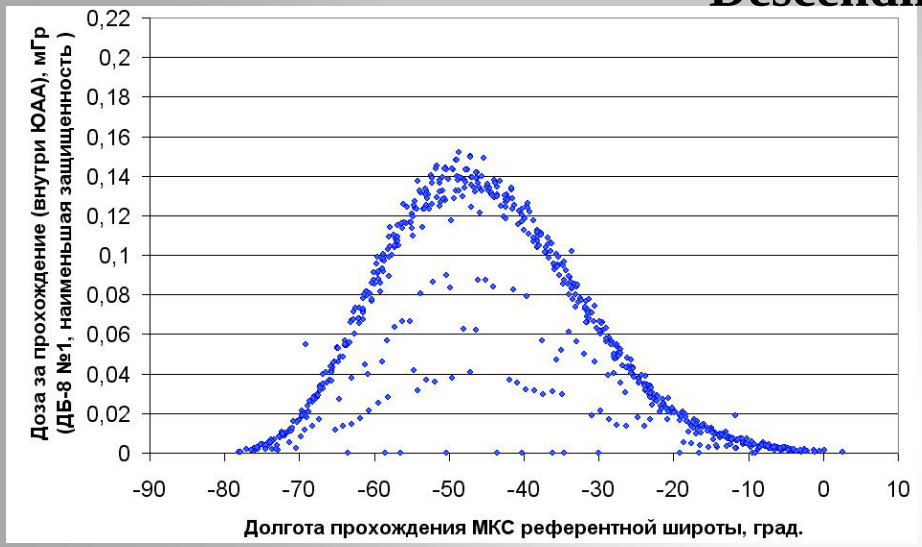




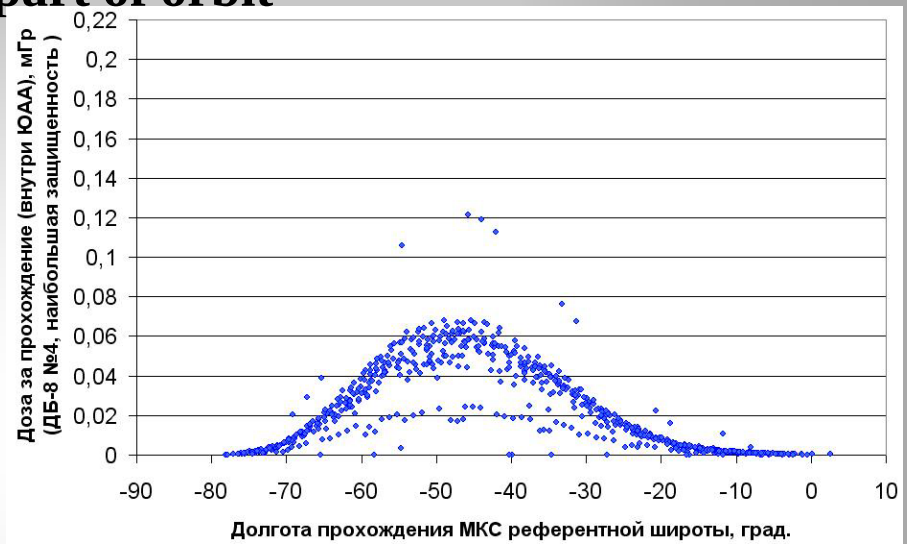
ISS,
temb

Doses for one SAA crossing versus referent longitude
Altitude 370 - 380 Km

DB-8 #1. The least shielding



DB-8 #4. The most shielding



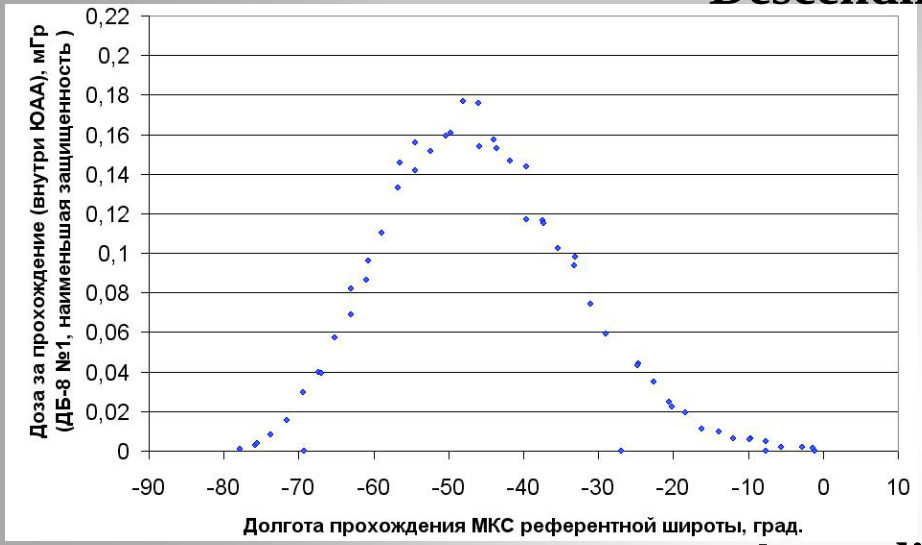
Descending part of orbit

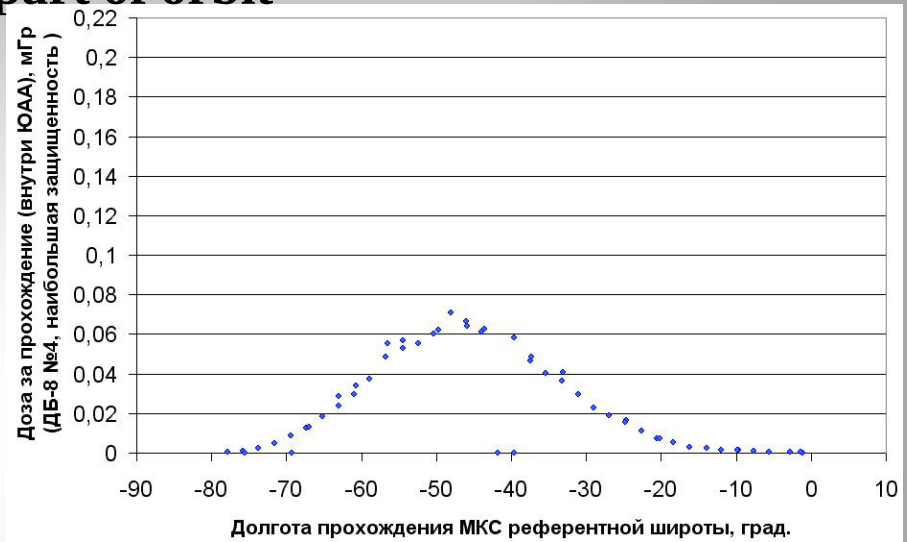
Doses for one SAA crossing versus referent longitude
Altitude 380 - 390 Km

DB-8 #1. The least shielding

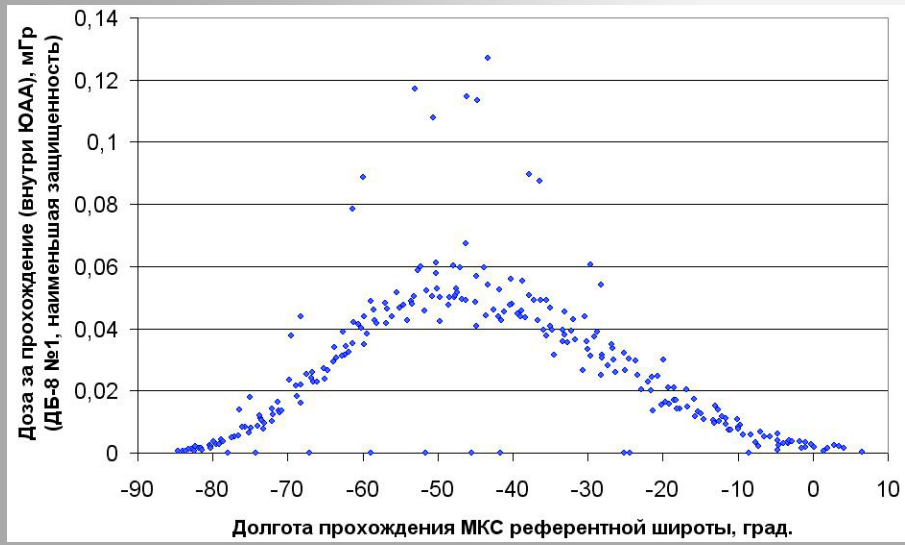
DB-8 #4. The most shielding

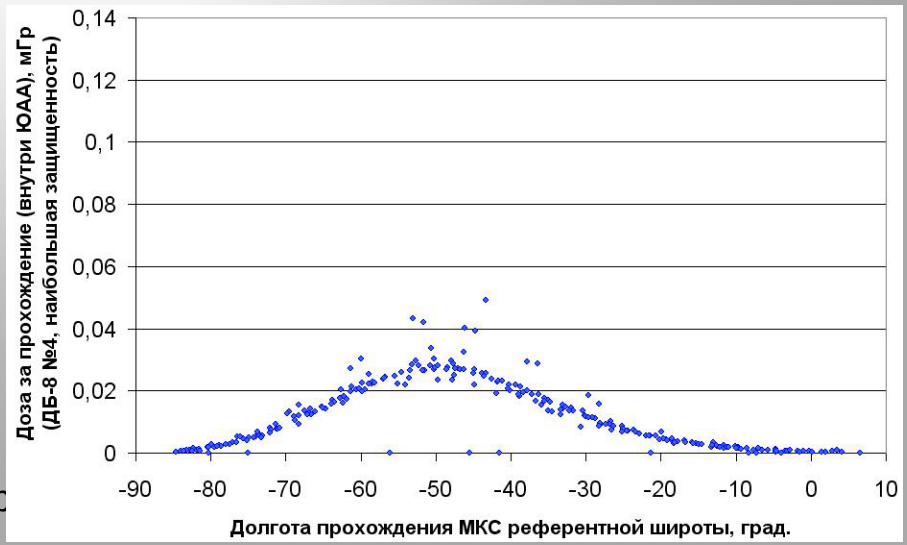
Descending part of orbit





Ascending part of orbit





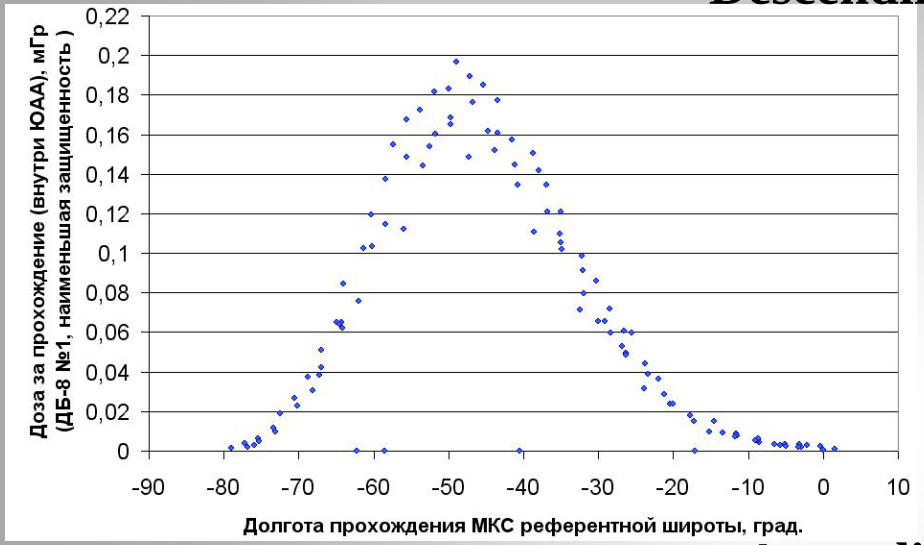
ISS,
temb

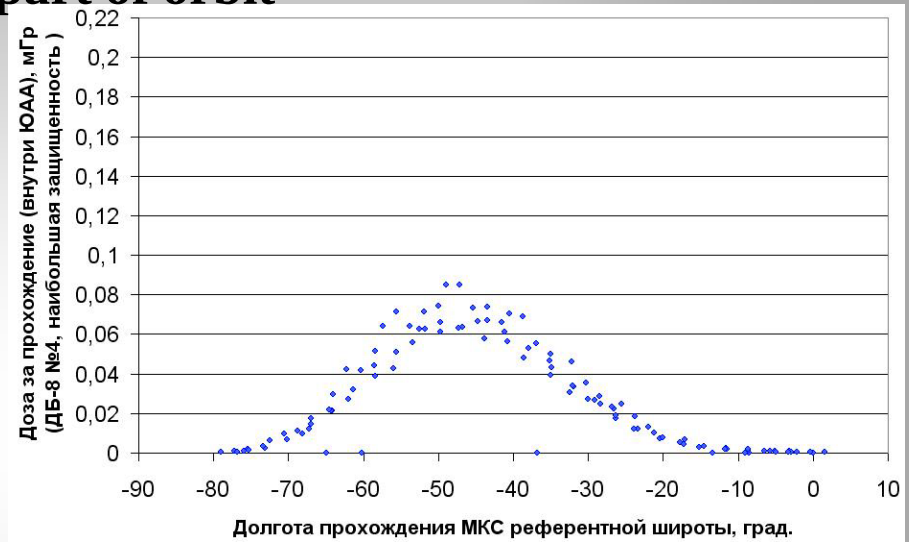
Doses for one SAA crossing versus referent longitude
Altitude 390 - 400 Km

DB-8 #1. The least shielding

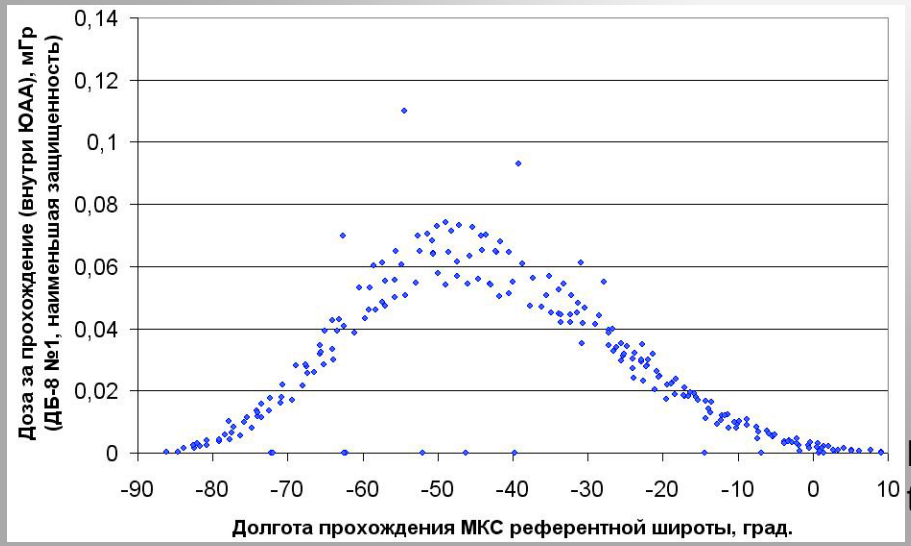
DB-8 #4. The most shielding

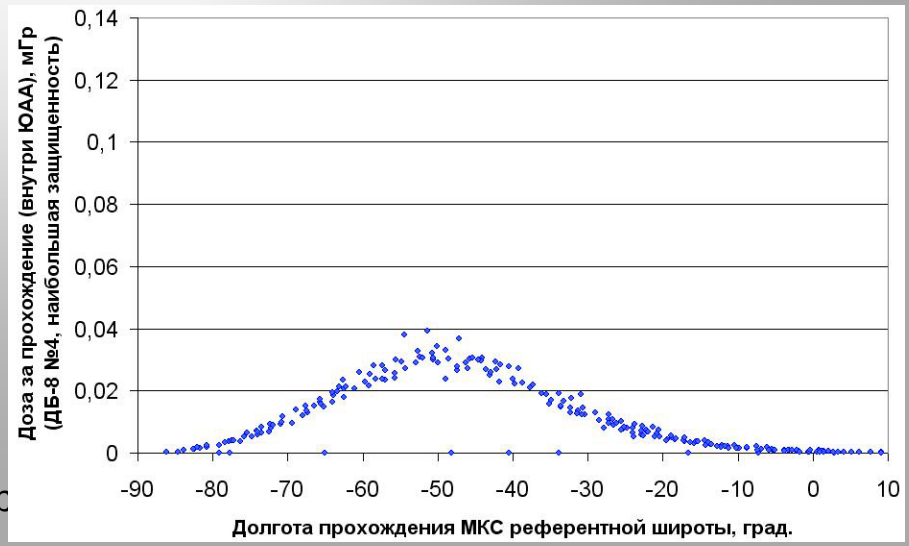
Descending part of orbit





Ascending part of orbit





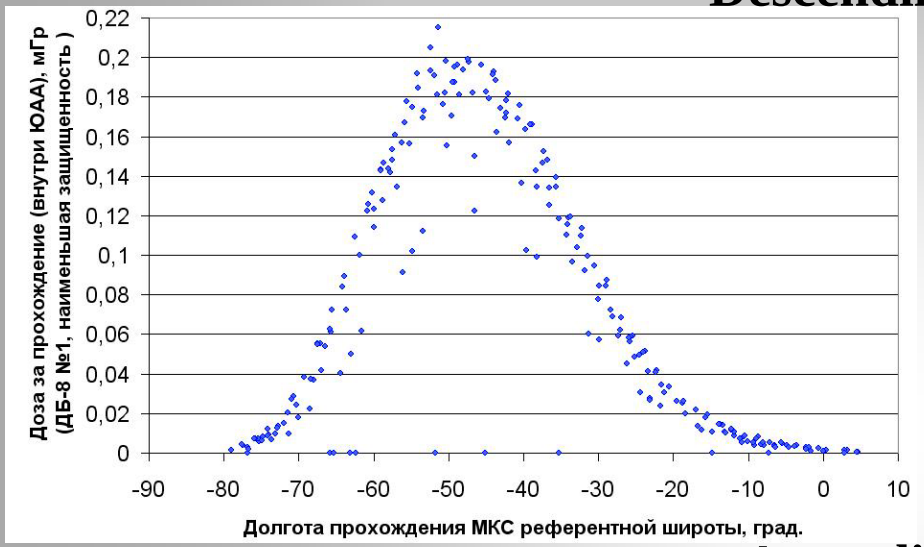
ISS,
temb

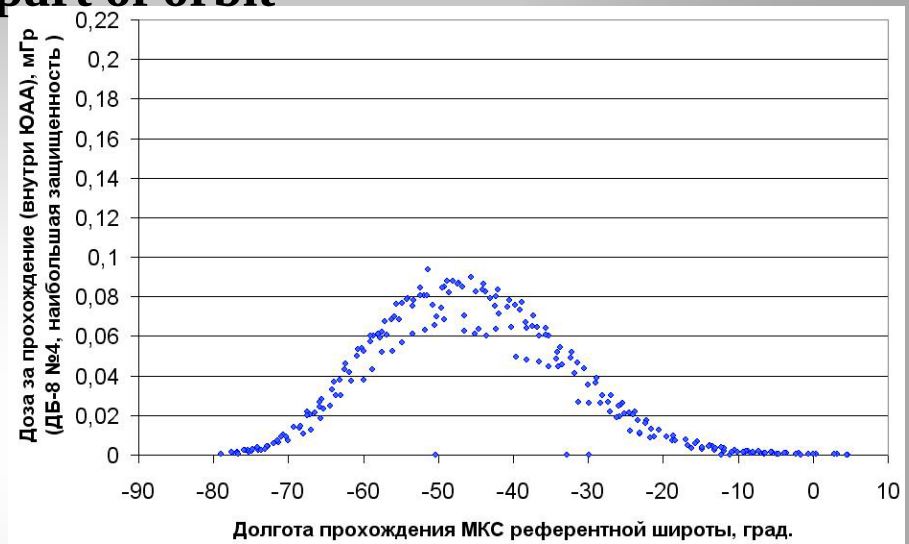
Doses for one SAA crossing versus referent longitude
Altitude 400 - 410 Km

DB-8 #1. The least shielding

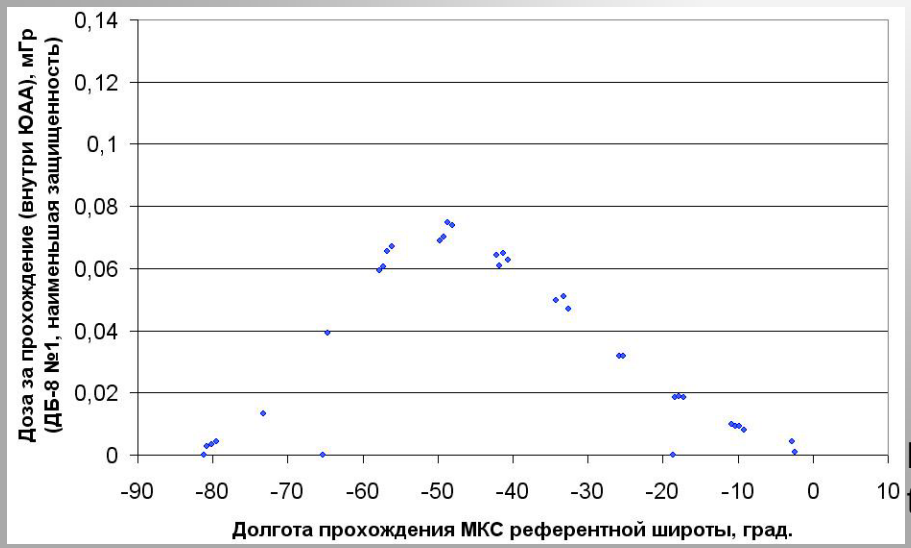
DB-8 #4. The most shielding

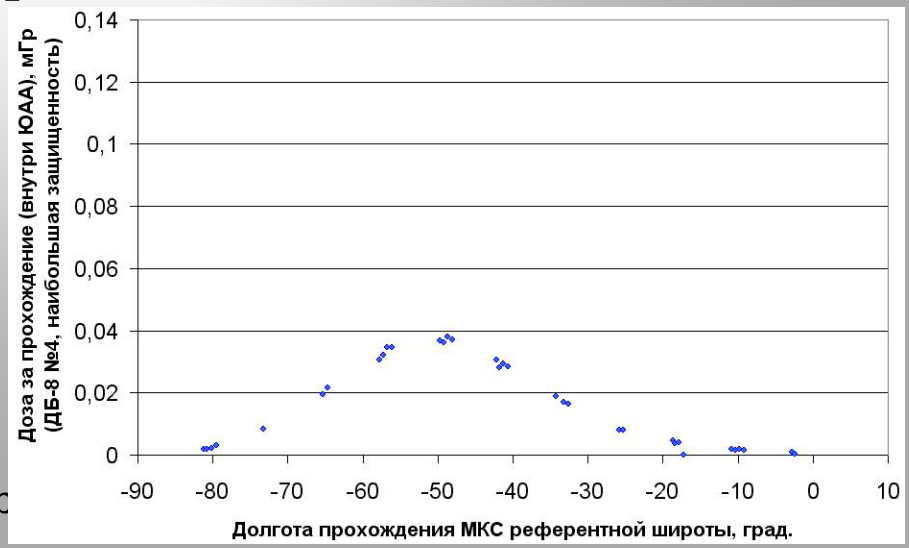
Descending part of orbit





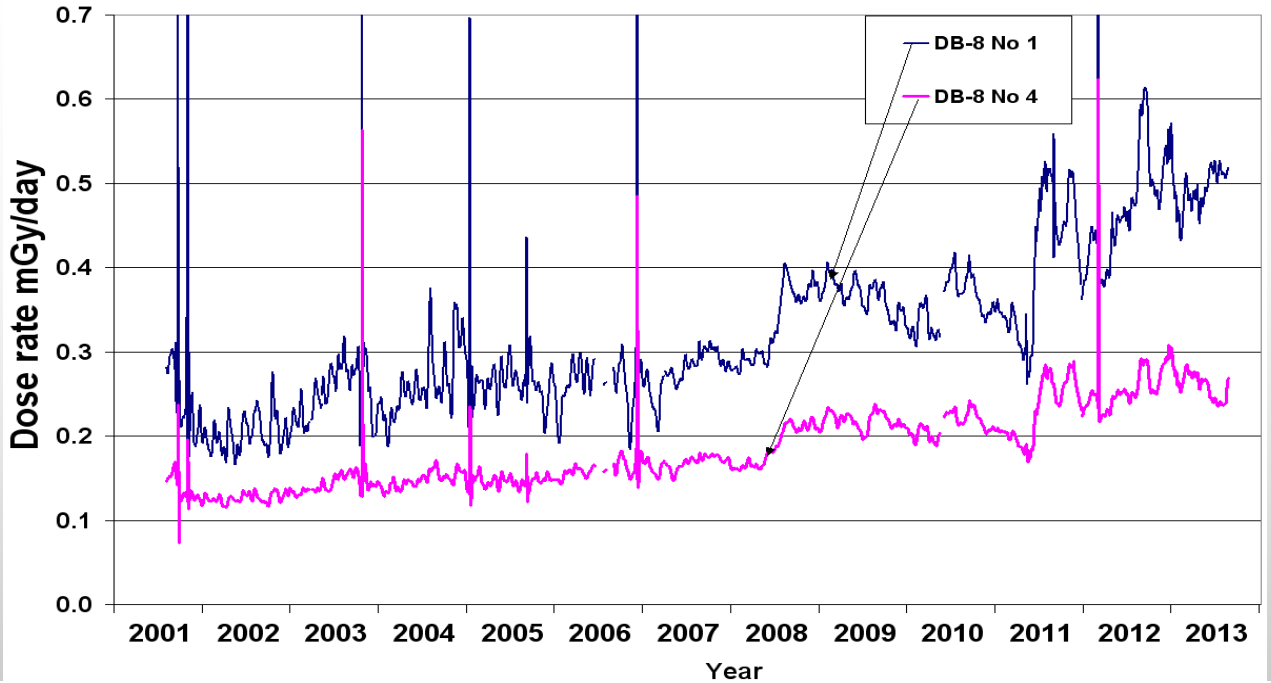
Ascending part of orbit

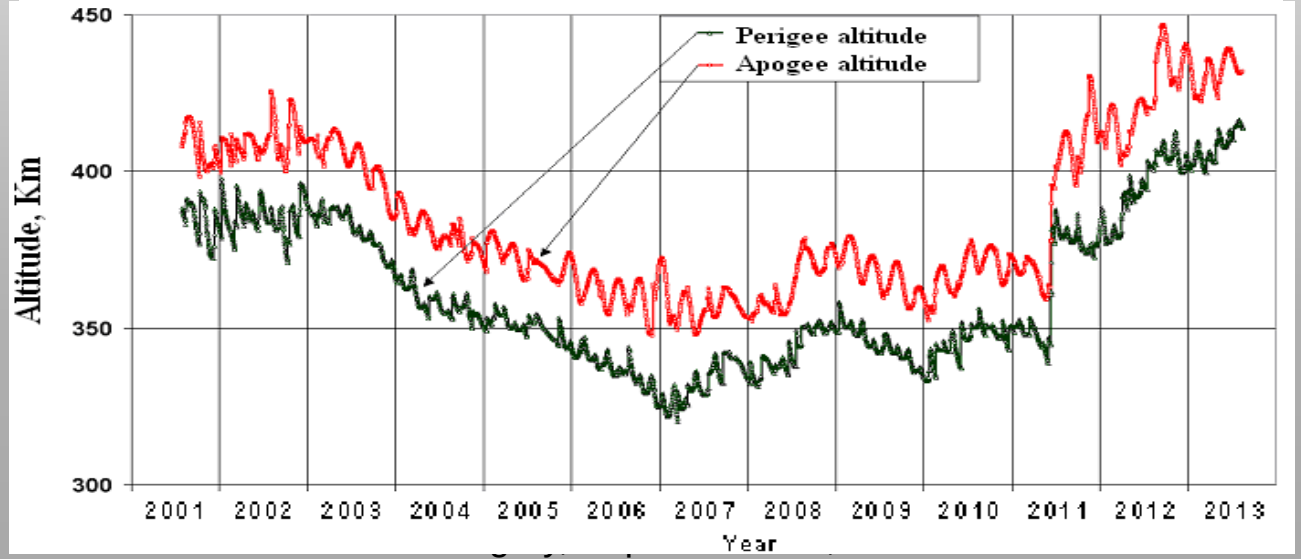




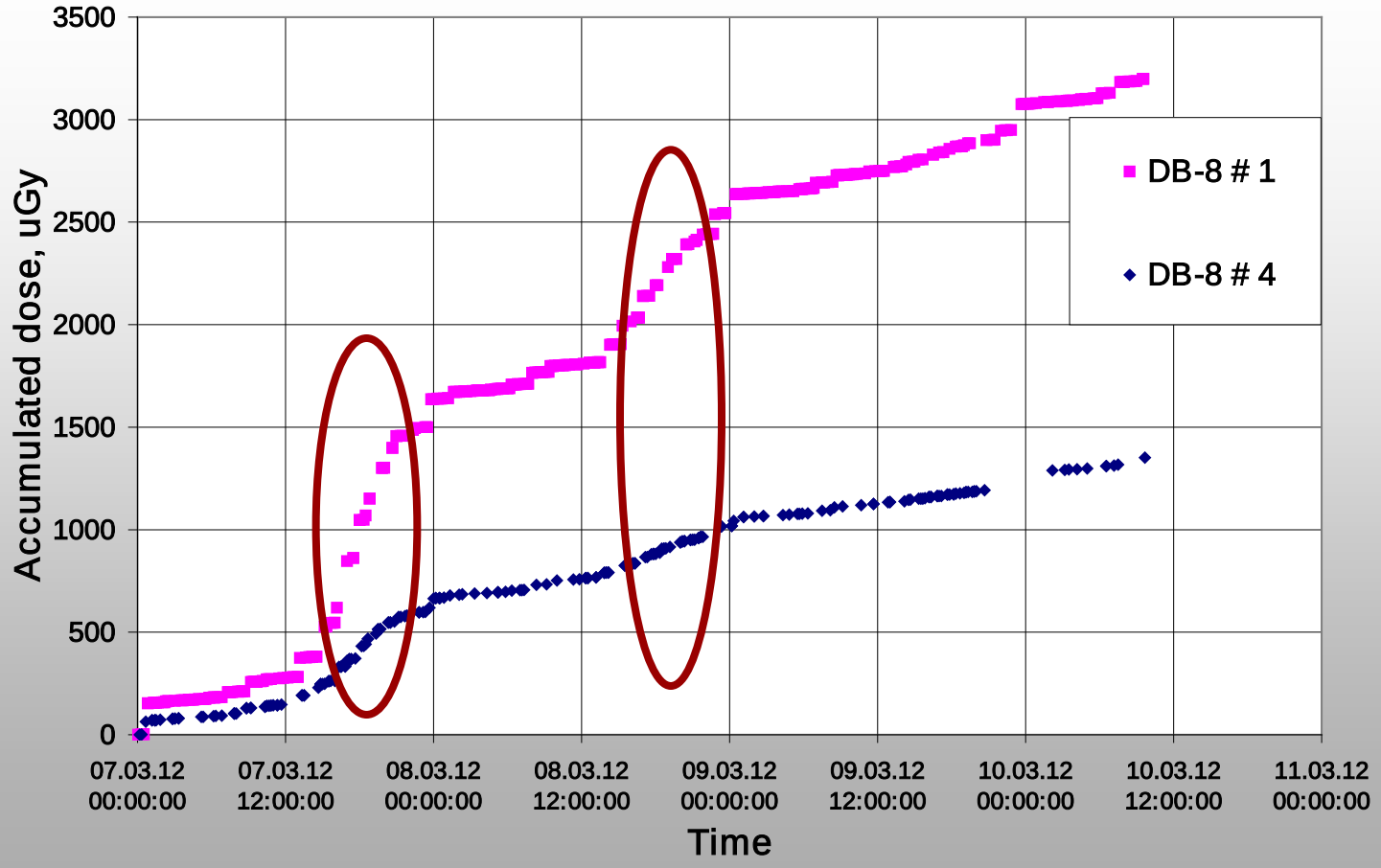
ISS,
temb

Comparison of dose rate measured from August 2001 to August 2013 with DB-8 units # 1 and # 4 unshielded detectors and flight altitude

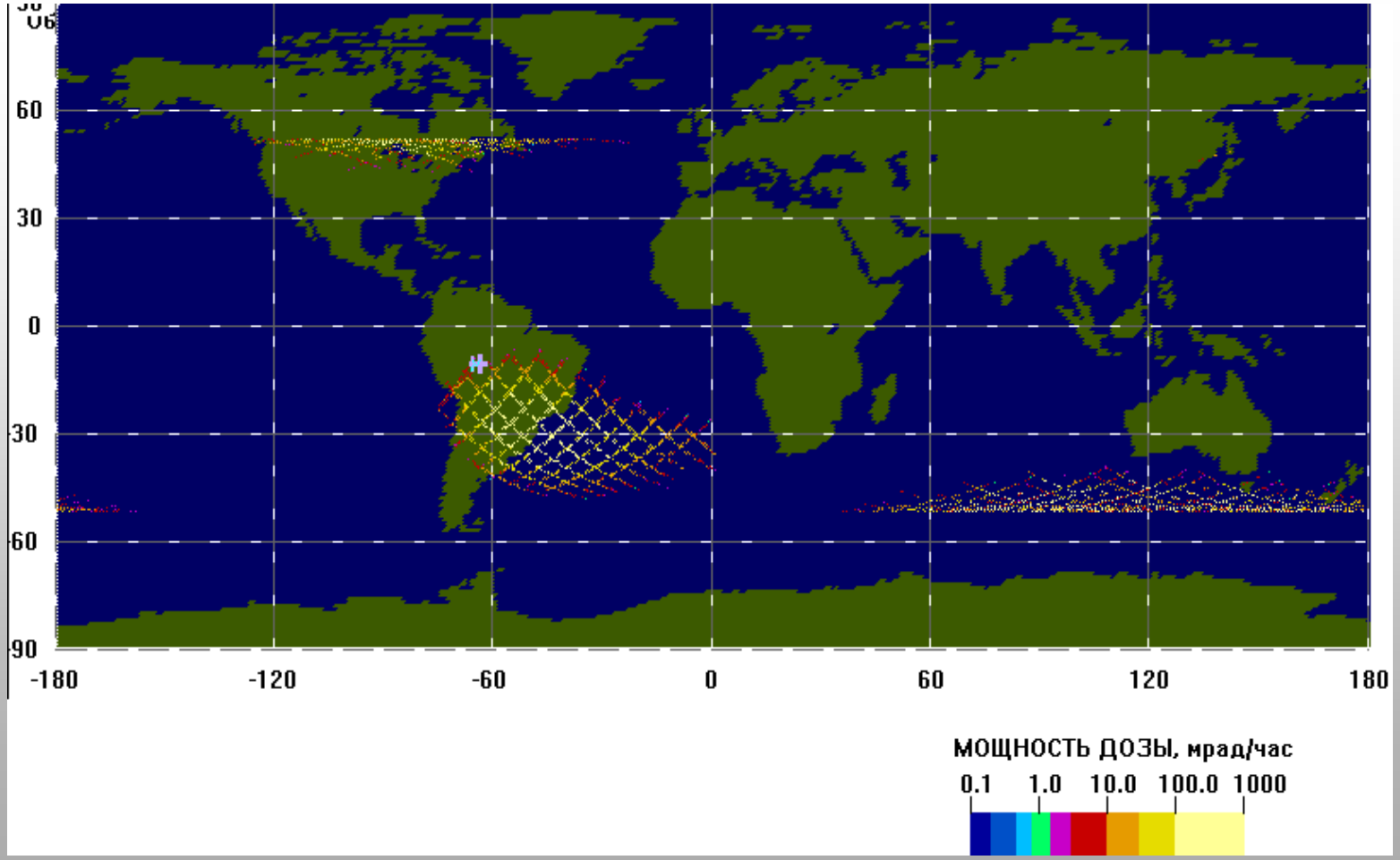




The dose accumulation during SPE March 7 2012 measured with DB-8 #1 and #4.



Improved dose rate area in the first decade of March 2012



SPE doses measured 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
2003/10/28	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
2012/03/07	1.84	1.58	1.26	1.59	1.56	1.07	0.57	0.55

Conclusion

- The radiation monitoring system has been working onboard the ISS since August 2001. RMS regularly provides the Radiation safety service group with operative dosimetry data
- The RMS measurement data set obtained up to now covers about 12 years
- The difference in daily doses measured in the ISS Service Module in undisturbed conditions keeps about factor of 2.
- The dose rate value increasing in 2008 - 2012 years is coursed by the flight altitude increasing.
- The March, 7 2012 SPE caused to the additional doses corresponds approximately to the dose for two days of flight for the strongly shielded detector and dose for five days - for poorly shielded.

Thank you for your attention!