The Radiation Monitoring System of the Russian Segment of the ISS. Current Status.

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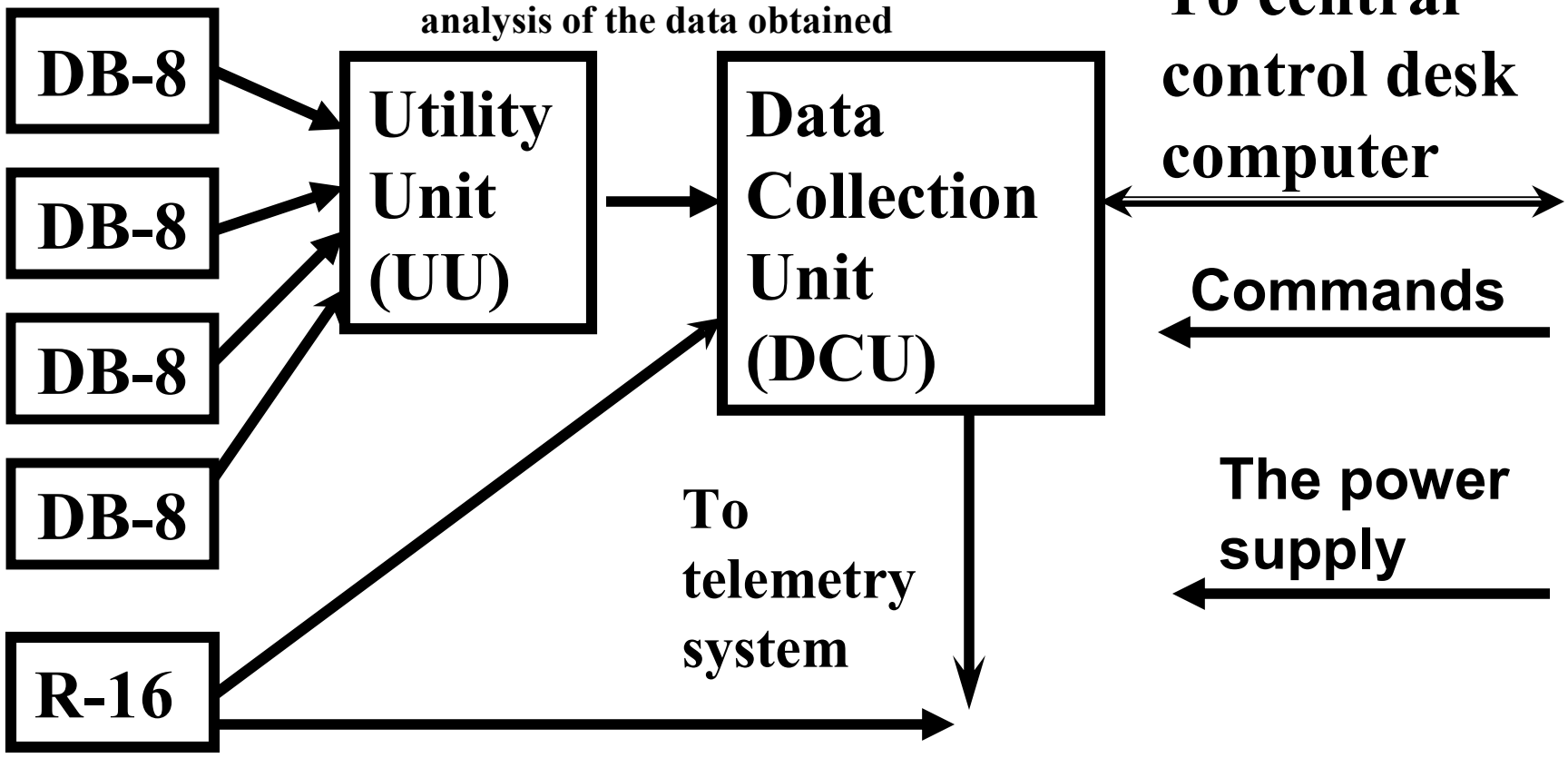
Configuration of the Radiation Monitoring System (RMS)

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

UU and DCU made for processing and analysis of the data obtained

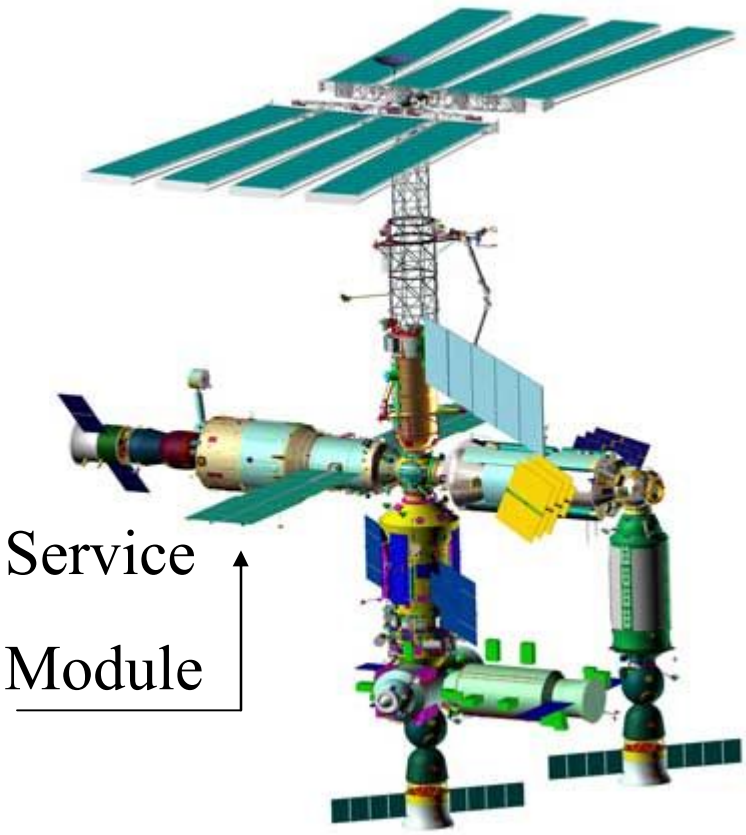


R-16 dosimeter has 2 ionization chambers filled with argon

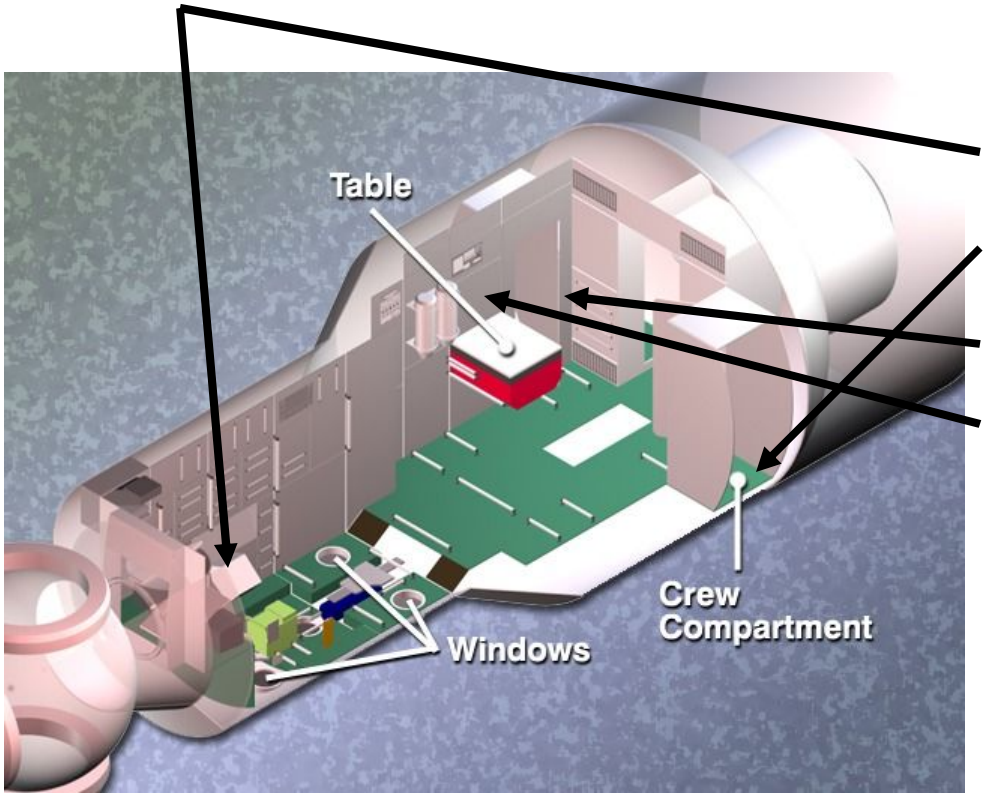
The Russian segment of the ISS

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.

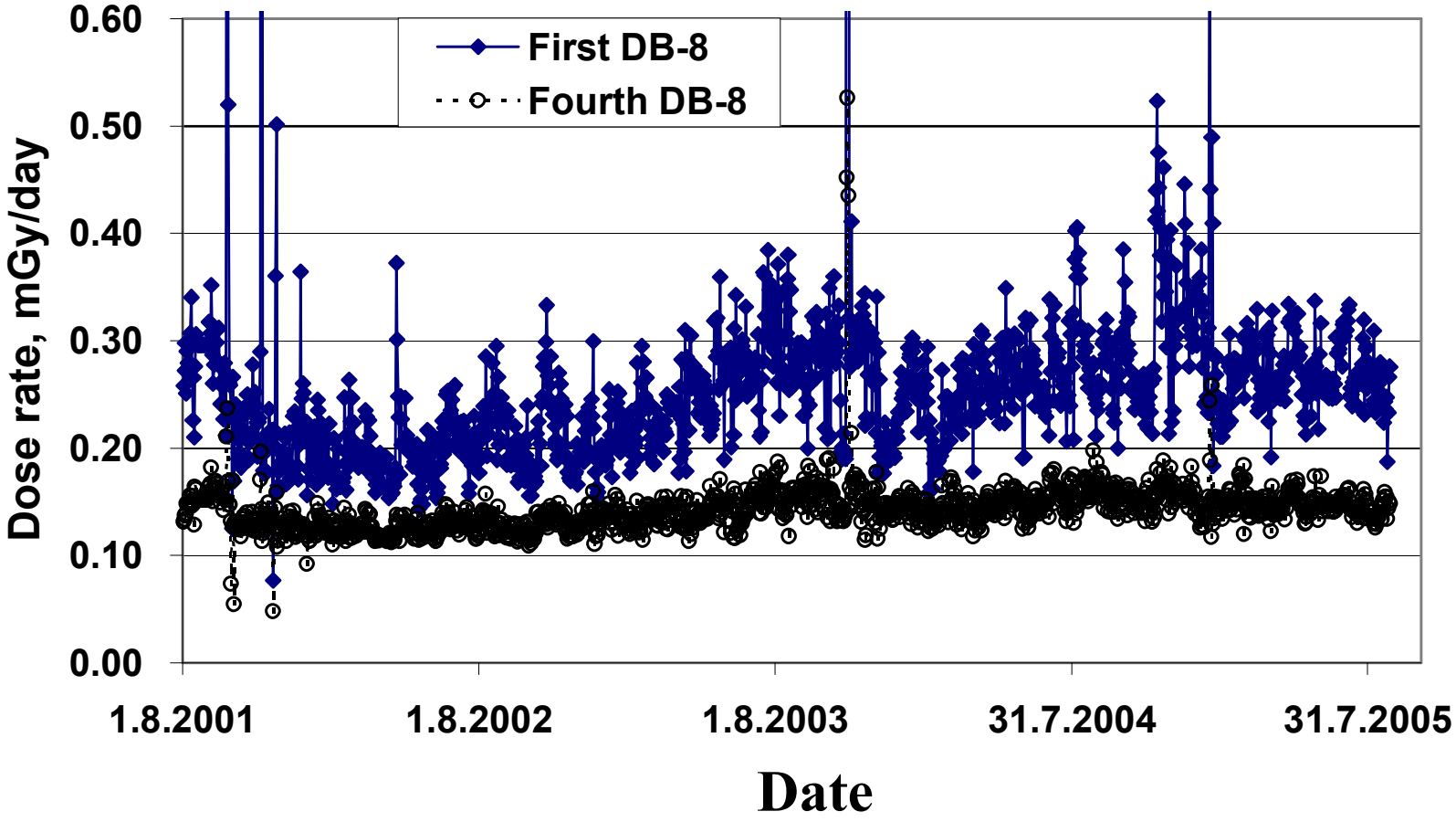


Placements of the RMS Units

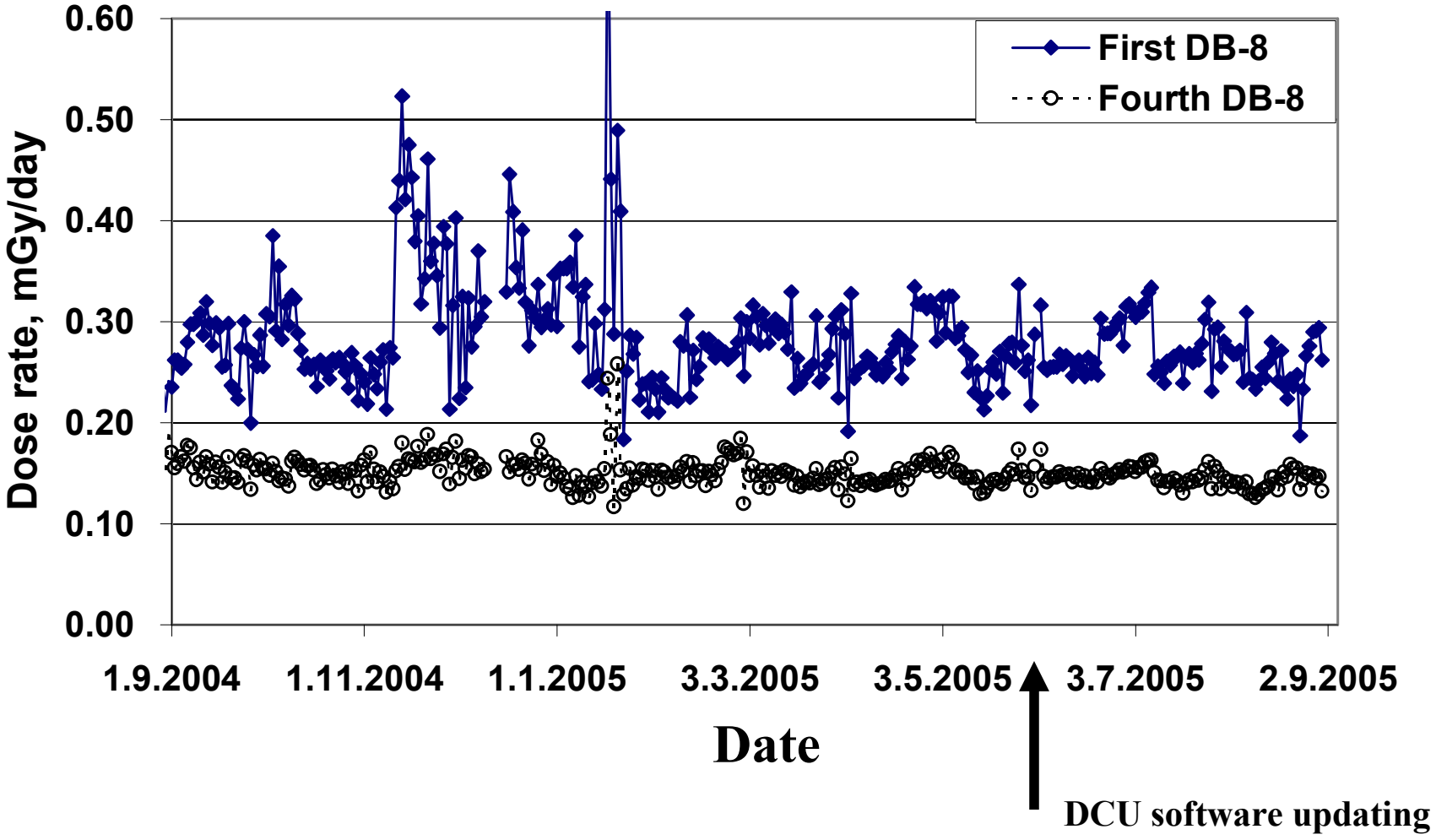


Block	Placement
DB-8 №1	Starboard side, behind panel No 410
DB-8 №2	Port side, behind panel No 244 (cabin)
DB-8 №3	Starboard side, behind panel No 447 (cabin)
DB-8 №4	Starboard side, behind panel No 435
R-16	Ceiling of Big diameter bay, behind panel No 327
UU	Starboard side, behind panel No 447 (cabin)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

Daily doses measured with unshielded detectors of the first and fourth DB-8 units since August 2, 2001 till August 27, 2005



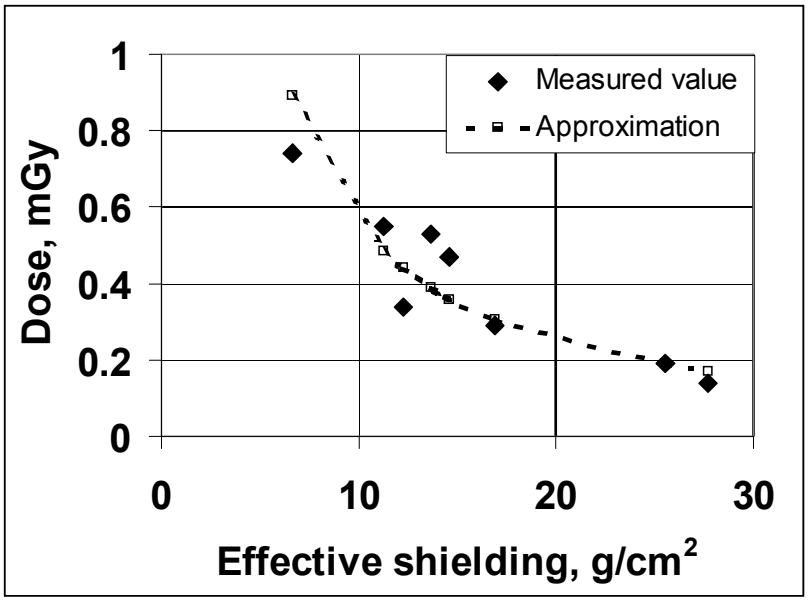
Daily doses measured with unshielded detectors of the first and fourth DB-8 units since September 1, 2004 till August 31, 2005

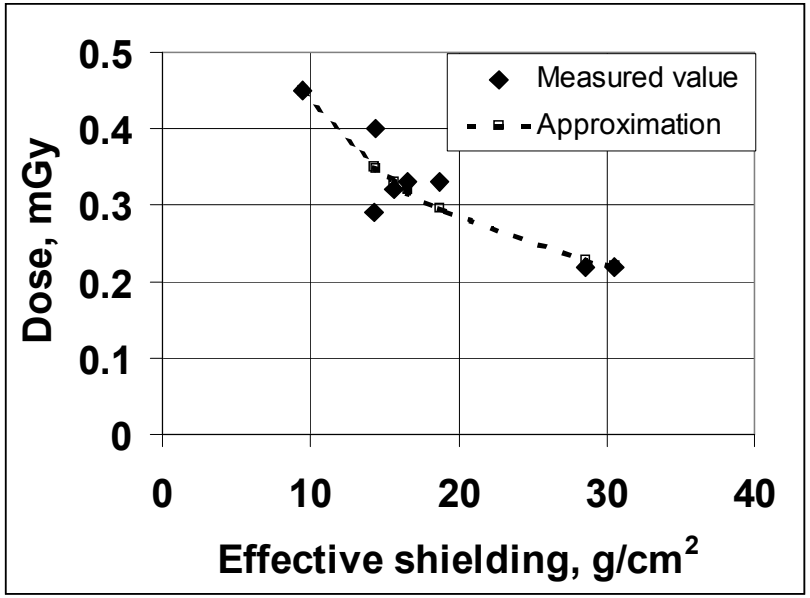


Solar Proton Event Doses registered by RMS in January 2005

Detector		Time interval: January 17 2005 17:00 – January 18 2005 3:00, mGy	January 20 2005 17:00 – January 21 2005 6:00, mGy
DB-8 number 1	Unshielded	0.74	0.45
	Shielded	0.55	0.40
DB-8 number 2	Unshielded	0.34	0.29
	Shielded	0.47	0.33
DB-8 number 3	Unshielded	0.53	0.32
	Shielded	0.29	0.33
DB-8 number 4	Unshielded	0.19	0.22
	Shielded	0.14	0.22
R-16	Unshielded	0.60	0.30
	Shielded	0.15	0.15

$$D(x)=A \cdot x^{-\gamma}$$





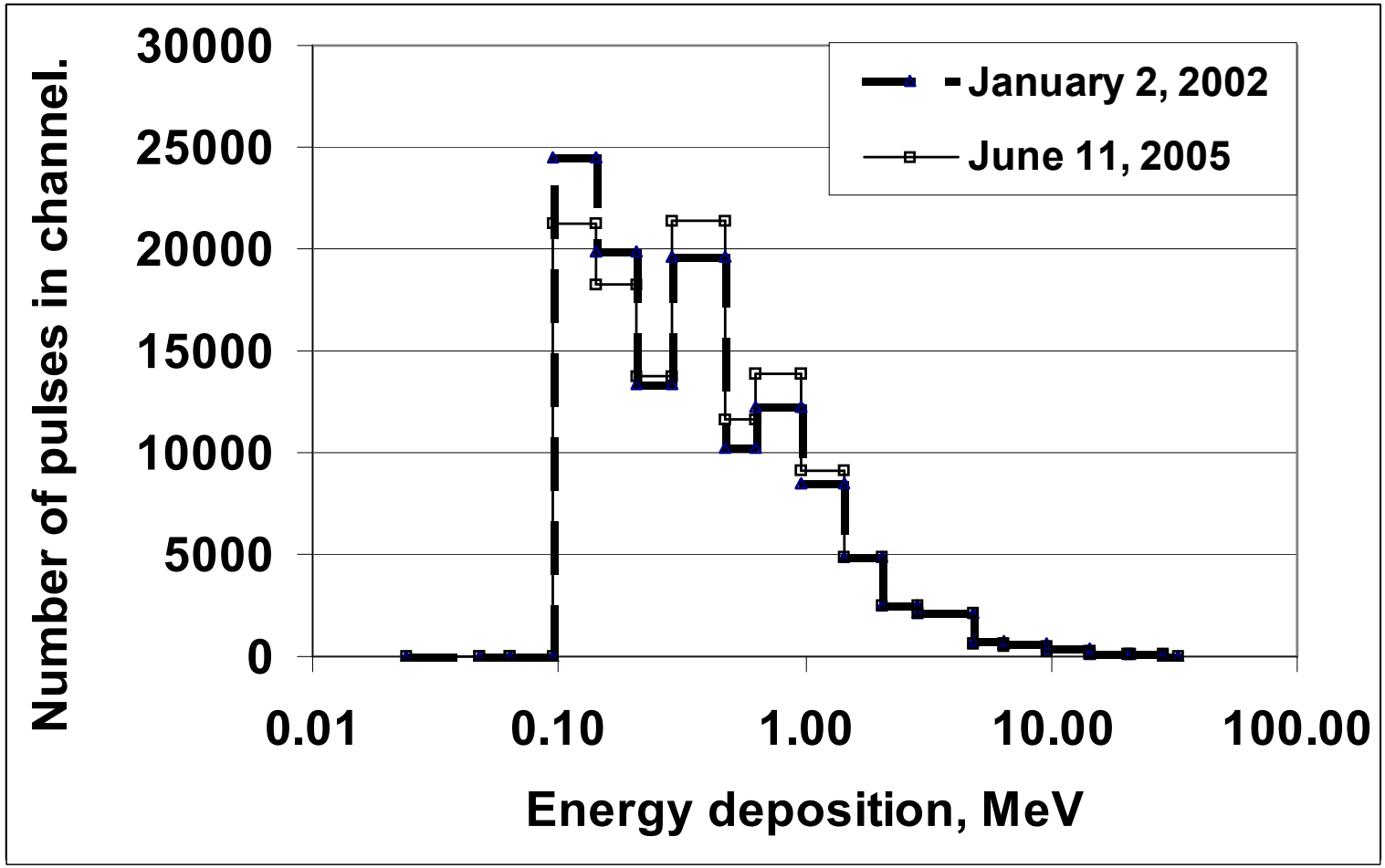
Doses for some Past Solar Proton Events

Detector		Dose per SPE 24 Sep 2001, mGy	Dose per SPE 04 Nov 2001, mGy	Dose per SPE 28 Oct 2003, mGy	Dose per SP 29 Oct 2003 mGy
DB-8 number 1	Unshielded	1.65	2.60	6.63	2.02
	Shielded	0.75	1.10	3.19	1.20
DB-8 number 2	Unshielded	1.26	1.14	2.88	0.91
	Shielded	0.80	0.40	1.16	0.49
DB-8 number 3	Unshielded	0.59	0.75	2.20	0.86
	Shielded	0.41	0.39	1.45	0.64
DB-8 number 4	Unshielded	0.19	0.09	0.73	0.28
	Shielded	0.14	< 0.04	0.60	0.25
R-16	Unshielded	1.25	0.60	> 0.60	0.40
	Shielded	0.20	0.10-0.15	0.25-0.30	0.05 – 0.1(

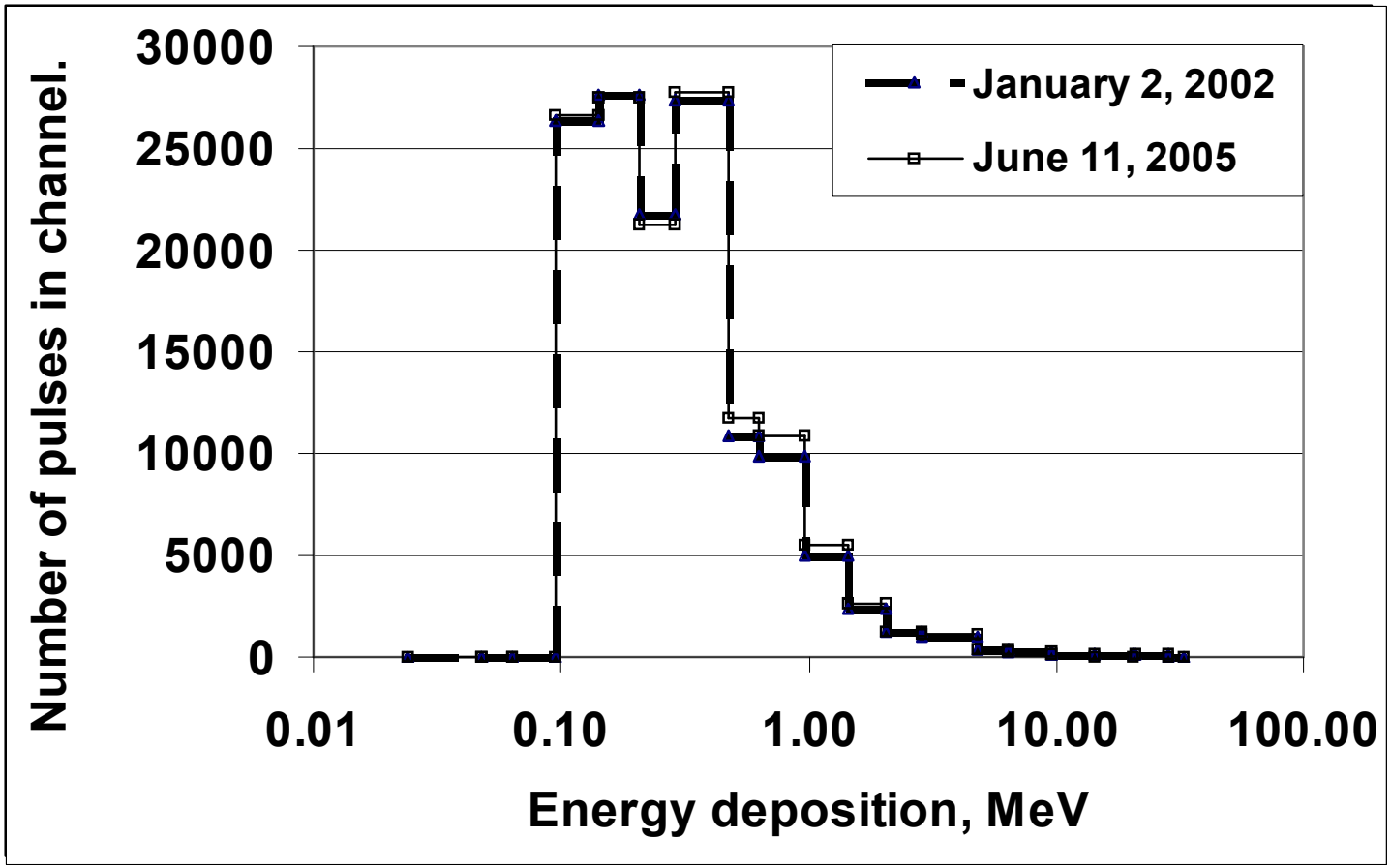
Half-a-year averaged dose rate, mGy/day

Detector \ Time interval		Aug 2001 –Dec 2001	Jan 2002 – Jun 2002	Jul 2002 – Dec 2002	Jan 2003 – Jun 2003	Jul 2003 – Dec 2003	Jan 2004 – Jun 2004	Jul 2004 – Dec 2004	Jan 2005 – Jun 2005
DB-8 number 1	Unshielded	0.27	0.20	0.22	0.24	0.32	0.25	0.30	0.26
	Shielded	0.26	0.20	0.22	0.24	0.28	0.25	0.26	0.24
DB-8 number 2	Unshielded	0.22	0.16	0.18	0.19	0.24	0.20	0.25	0.19
	Shielded	0.21	0.17	0.19	0.19	0.23	0.20	0.22	0.20
DB-8 number 3	Unshielded	0.22	0.18	0.19	0.20	0.24	0.21	0.23	0.21
	Shielded	0.22	0.19	0.20	0.21	0.24	0.22	0.23	0.21
DB-8 number 4	Unshielded	0.14	0.13	0.13	0.14	0.16	0.14	0.16	0.14
	Shielded	0.17	0.15	0.16	0.17	0.18	0.17	0.18	0.16

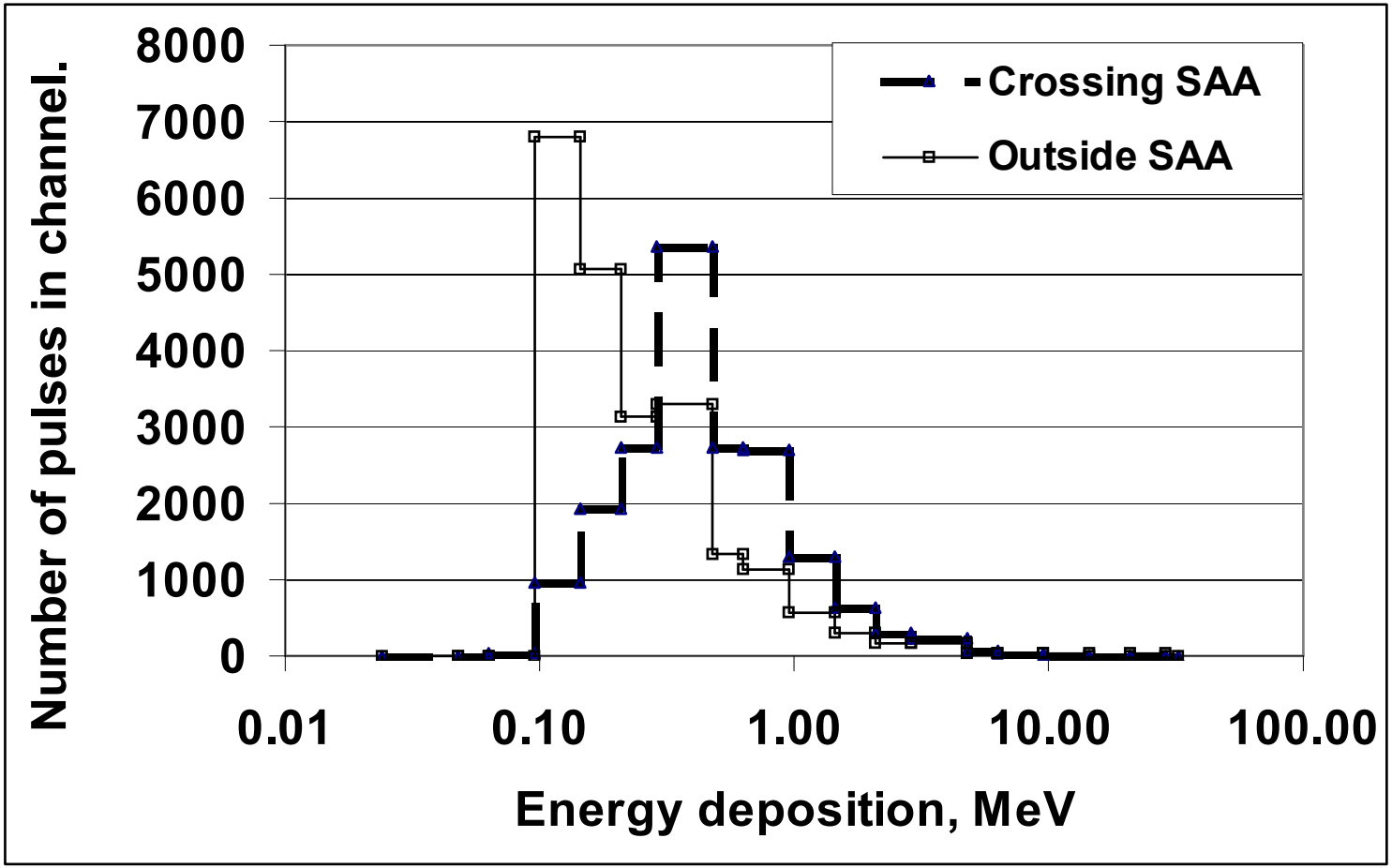
Energy deposition spectra comparison of DB-8 number 1 unshielded detector



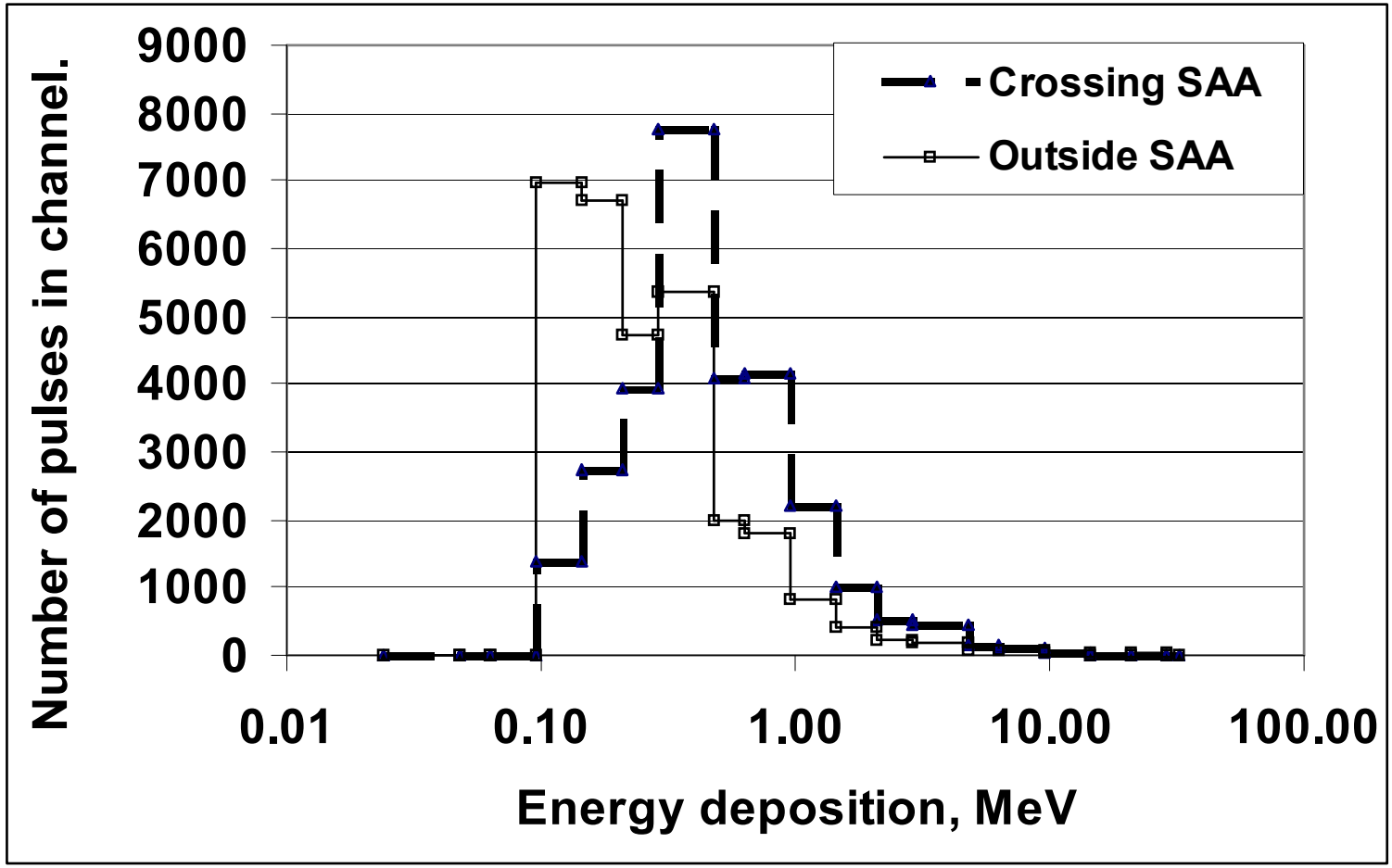
Energy deposition spectra comparison of DB-8 number 4 shielded detector



Energy deposition spectrum of DB-8 number 1 unshielded detector inside and outside SAA



Energy deposition spectrum of DB-8 number 4 shielded detector inside and outside SAA



The RMS software updating

The Data Collection Unit (DCU) software updating was carried out in May, - June 2005.

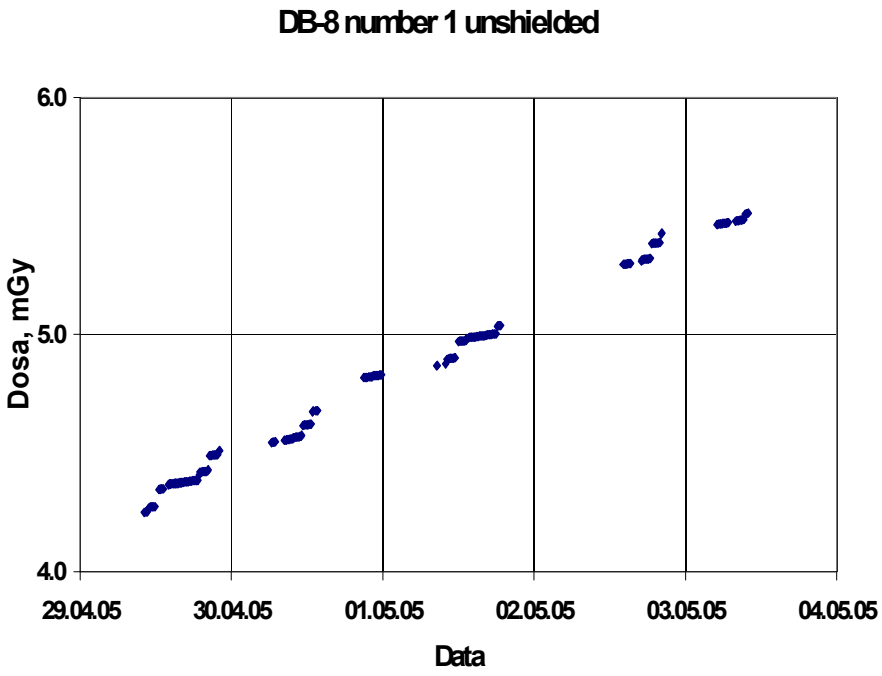
Goals:

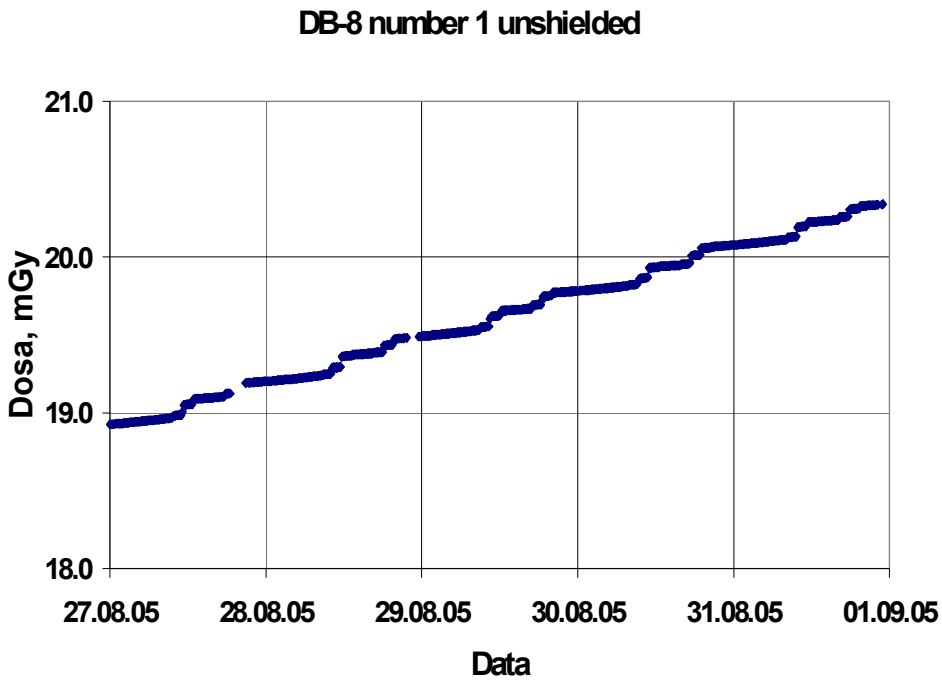
The RMS telemetry information upgrading;

To alert the crew when exposure rates exceed set threshold according to item 5.5.3.3 International Space Station Medical Operation Requirement Document (ISS MORD) ;

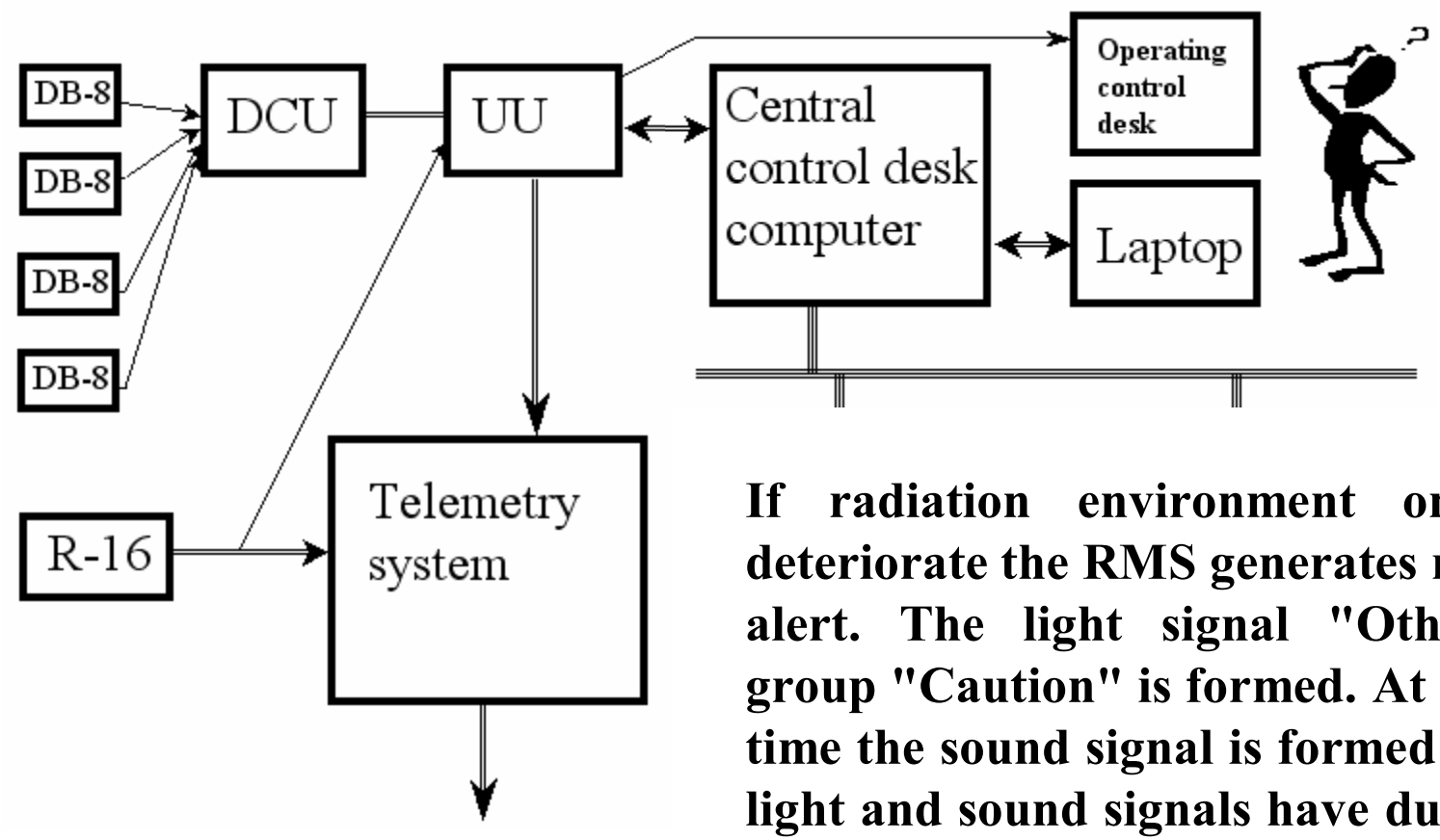
To supply an opportunity of interactive crew communication with the RMS .

The RMS telemetry information upgrading





Configuration of the radiation monitoring system and accompanying on board devices



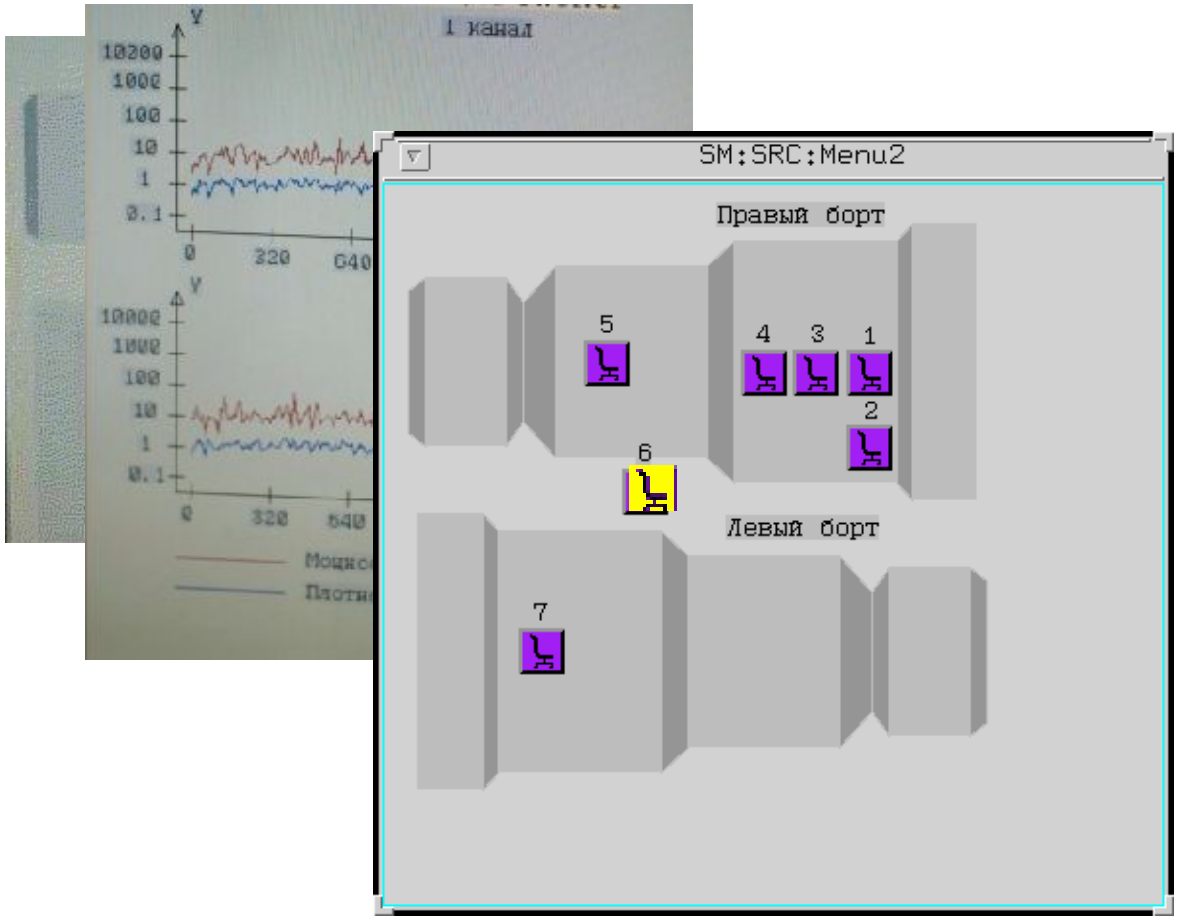
If radiation environment on board deteriorate the RMS generates radiation alert. The light signal "Others" in-group "Caution" is formed. At the same time the sound signal is formed too. The light and sound signals have duration of 60 seconds.

Radiation alert criteria

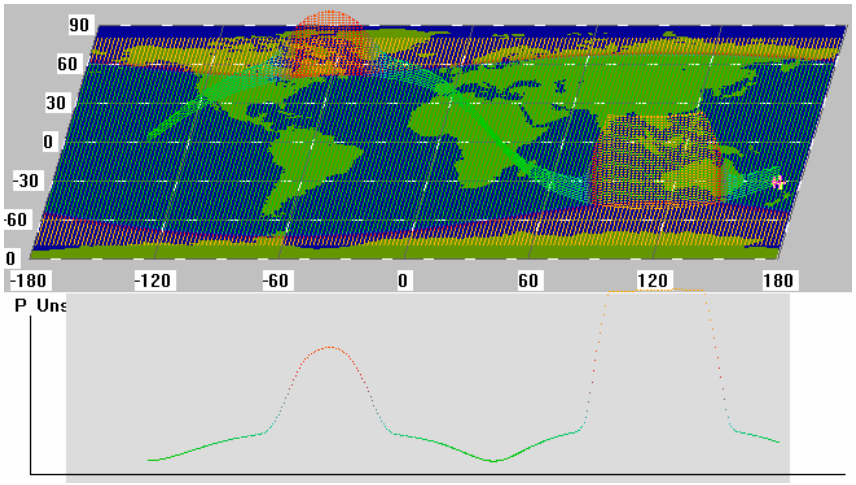
- If during 3 ten-second intervals, not less than 2 detectors simultaneously register the dose rate higher than 4 mGy/hour;
- If the equivalent dose forecast for next 24 hours is more than 5 mSv.

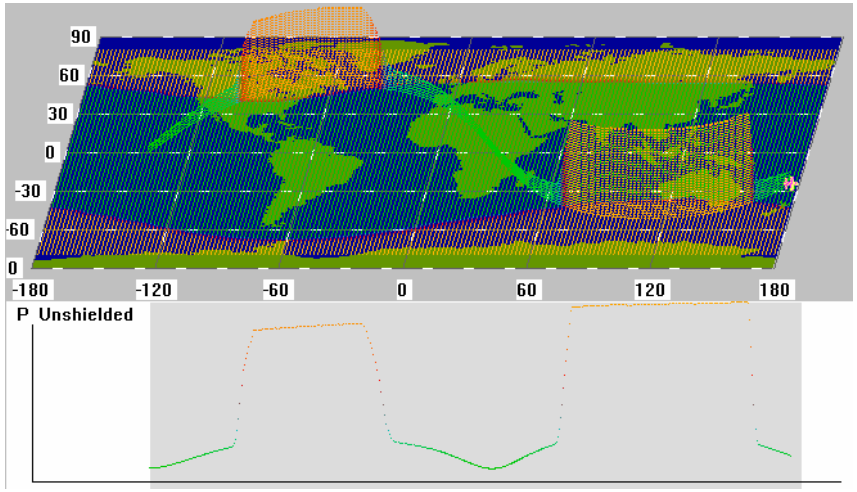
1 - Compartment No 1
2 - Treadmill
3 – Veloergometer (bicycle)
4 - Working table
5 - Control desk
6 - Extravehicular activity
7 - Compartment No 2

The images of the RMS information display on the Laptop screen



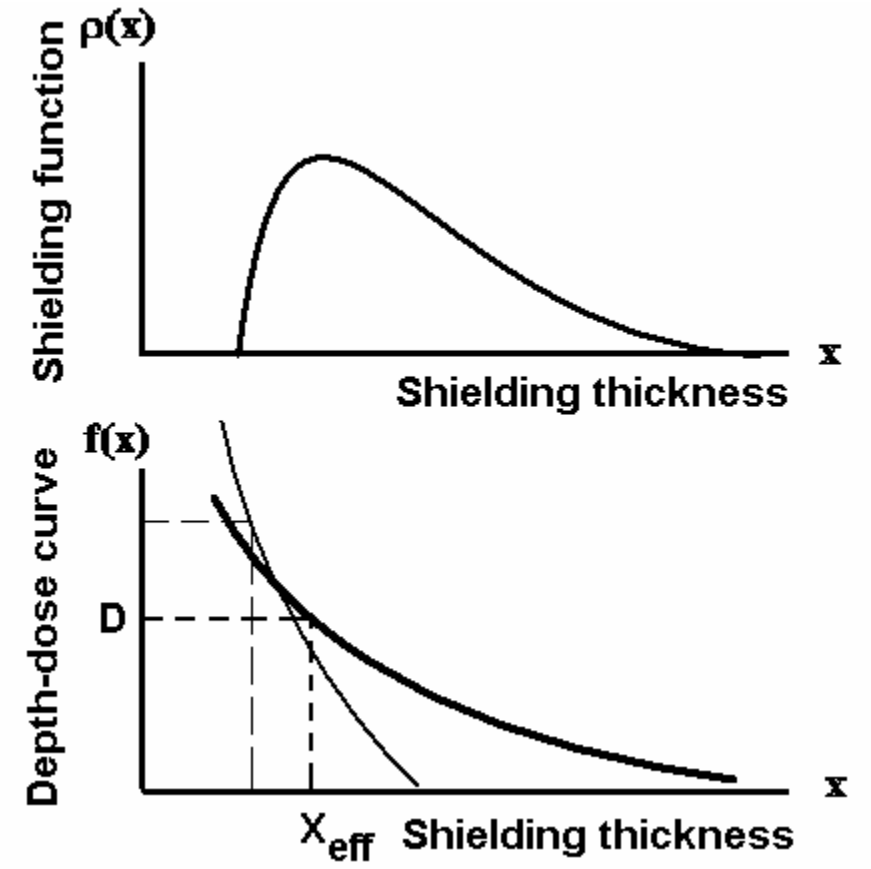
Forecasting supply techniques





- Ballistic calculations.
- Estimations of dose rate and durations of polar cusp crossings.
- Conversion of detector doses into workplaces doses.

Effective depth of detector



$$D = \int f(x)\,\rho(x)\,dx$$

Where: **D** - **absorbed dose;**

x - **shielding value;**

f(x) - **depth-dose curve;**

ρ(x) - **shielding function (probability density to meet shielding thickness x)**

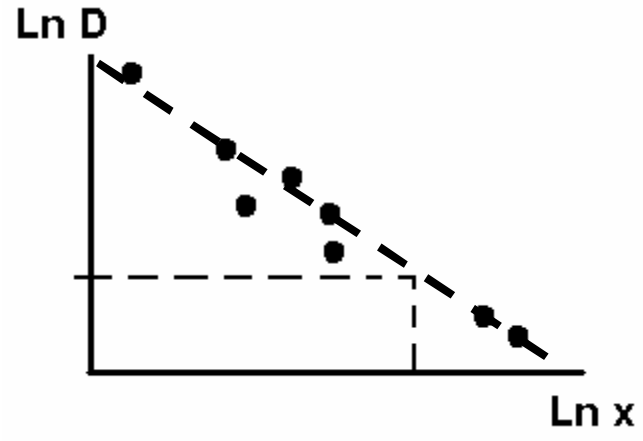
x_{eff} - **effective shielding thickness;**

$$f(x_{eff}) = D$$

Conversion of the detector doses into another place dose

If we attribute the effective shielding depth to each detector we can consider the dose dependence on effective depth.
If we take any dependence of depth-dose curves we can estimate its parameters.

$$D(x)=A \cdot x^{-\gamma} \qquad \text{Ln D = Ln A - } \gamma \text{ Ln x}$$



$$D_{Tissue} = D_{Si} \frac{\left(\frac{dE}{dx}\right)_{Tissue}}{\left(\frac{dE}{dx}\right)_{Si}}$$

Conclusion

The RMS equipment for expired 4 years provided Russian Radiation safety service with the information on doses onboard the ISS Service Module. This information is transferred also to NASA partners.

The Data Collection Unit software updating was carried out in May - June 2005. It permits the RMS telemetry information upgrading, to alert the crew when exposure rates exceed set threshold, to supply an opportunity of crew interactive communication with RMS.

Acknowledgements

The authors should like to gratefully acknowledge the NIRS, and Dr. Uchihory personally for the support of our participation in the Workshop and their grand hospitality