



MATROSHKA-R EXPERIMENT ONBOARD THE ISS: CURRENT STATUS AND PRELIMINARY RESULTS





V.A.Shurshakov¹, Yu.A. Akatov¹, V.M.Petrov¹, V.V.Arkhangel'sky¹,
S.V. Kireeva¹, E.N.Yarmanova¹,
A.Yu.Kalery², V.I.Lyagushin²,
I.S.Kartsev³, V.I.Petrov³, B.V.Polenov³

- ¹) State Research Center of the Russian Federation Institute of Biomedical Problems RAS, Moscow, Russia, shurshakov@imbp.ru
- ²) Rocket Corporation Energia, Korolev, Moscow Region, Russia
- ³) Science and Engineering Center NIC SNIIP, Moscow, Russia

Matroshka-R is a multi-user experiment facility for space mission

- P.I. – V.M.Petrov (IBMP)
- Co P.I. – G.Reitz, DLR, Germany
- Executive manager – V.A.Shurshakov
- Start of the experiment Jan. 2004
(Phase I, II, III, IV ...)

Participating organizations

- IBMP, Energia, SNIIP, (Russia)
- DLR (ESA) – Torso Phantom
- NIRS-ISRL, Japan
- Atomic Institute of AU (Austria)
- Institute of Nuclear Physics (Czech Republic)
- STIL BAS, Bulgaria (Liulin-5)
- CSA (Bubble detectors, MOSFET dosimeter)

Main goals of the project

- Long-term dose measurements including neutron contribution inside the phantoms, in the habitat module, and outside ISS;
- Verification of the transport codes for calculating the dose distribution inside ISS and inside the phantoms

The Instruments to be used in the Matroshka-R Experiment

Phase 1 - 2004

- SPD package (IBMP)
- Spherical phantom (IBMP)
- Torso phantom (ESA)



Phase 2 – 2005-2006

- + Bubble + MOSFET (CSA) + Liulin-5 (STIL BAS, Sofia Bulgaria) in the Spherical phantom



Phase 3 - 2006- ...

- + TRITEL Charged Particle Directional Spectrometer (KFKI, Budapest, Hungary) on the outer surface of the ISS



Phase I Instruments: SPD Outfit

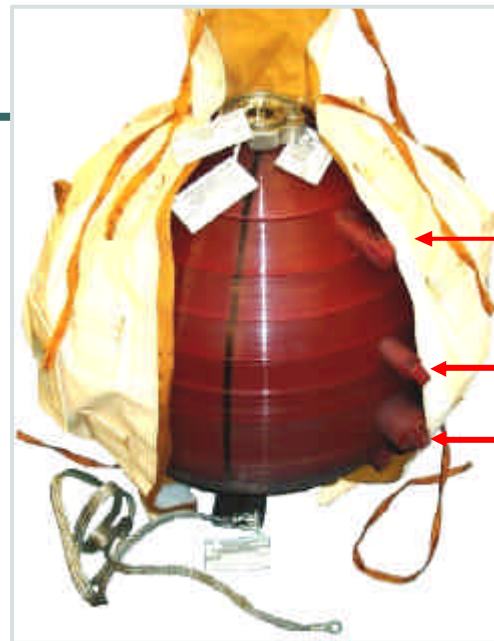
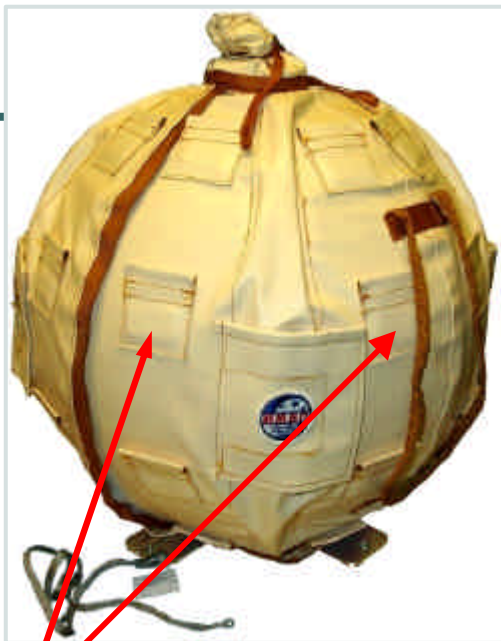


SPD locations



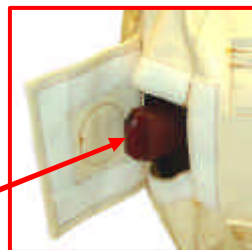
Spherical phantom

Size: 370x370x390 mm; mass: 32 kg



Working jacket with
TLDs and CR-39 in
pockets

Container



Containers



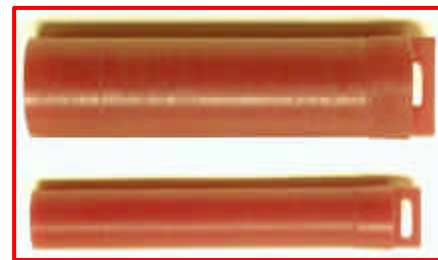
МАТРЕШКА

● Phantom package:

1. Working jacket
2. Container set
3. Grounding band



Containers with detectors



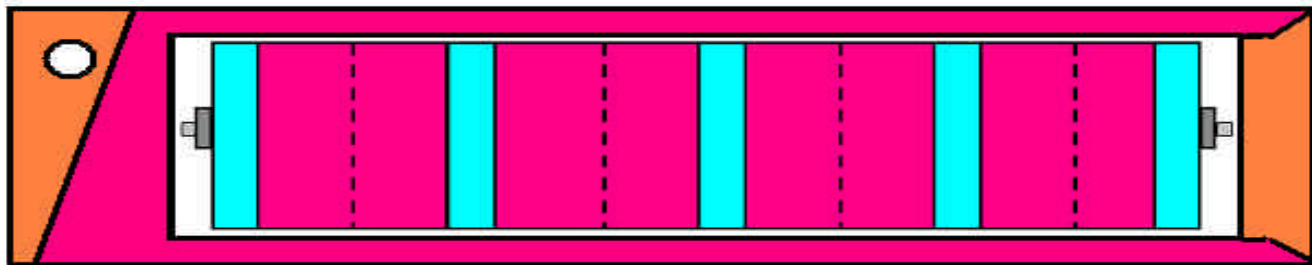
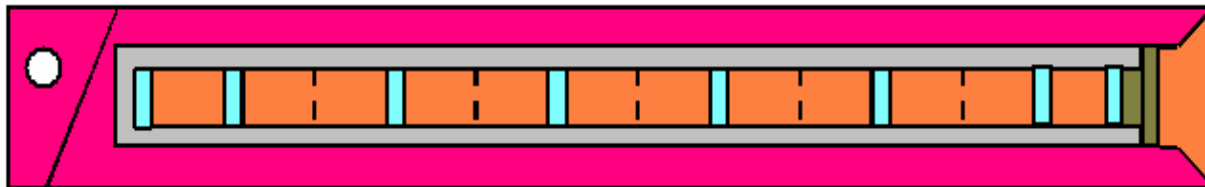
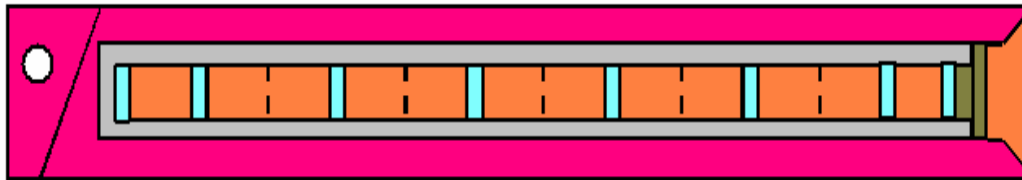
Passive detectors of the Spherical Phantom

Detector containers for placing inside the phantom: 20 = 4 thick + 16 thin

Jacket of the phantom: 32 outside pockets

- TLD (TLD-100, TLD-600 and 700);
- SSTD (CR-39)

Detector containers:



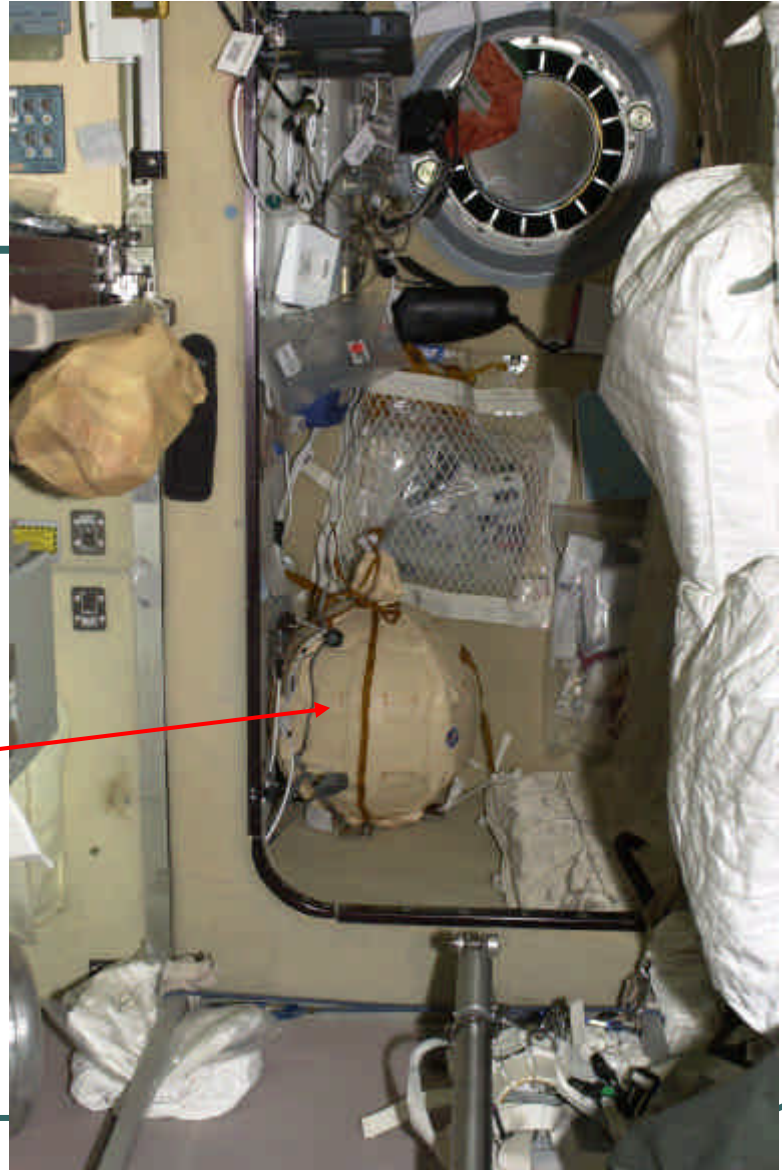
Comparison of the spherical and anthropomorphic phantom properties

Property	Spherical phantom	Anthropomorphic phantom
Mass	32 kg	Full body is 70 kg; The torso with head is about 60 kg
Size	35 cm diameter	Full height is 170 cm; The torso with head height is about 90 cm
Detector placement and retrieval	Easy retrieval of the detector containers from the radial holes without full disassembling	Special locations for the detectors distributed throughout the phantom body. Full disassembling required for detector retrieval

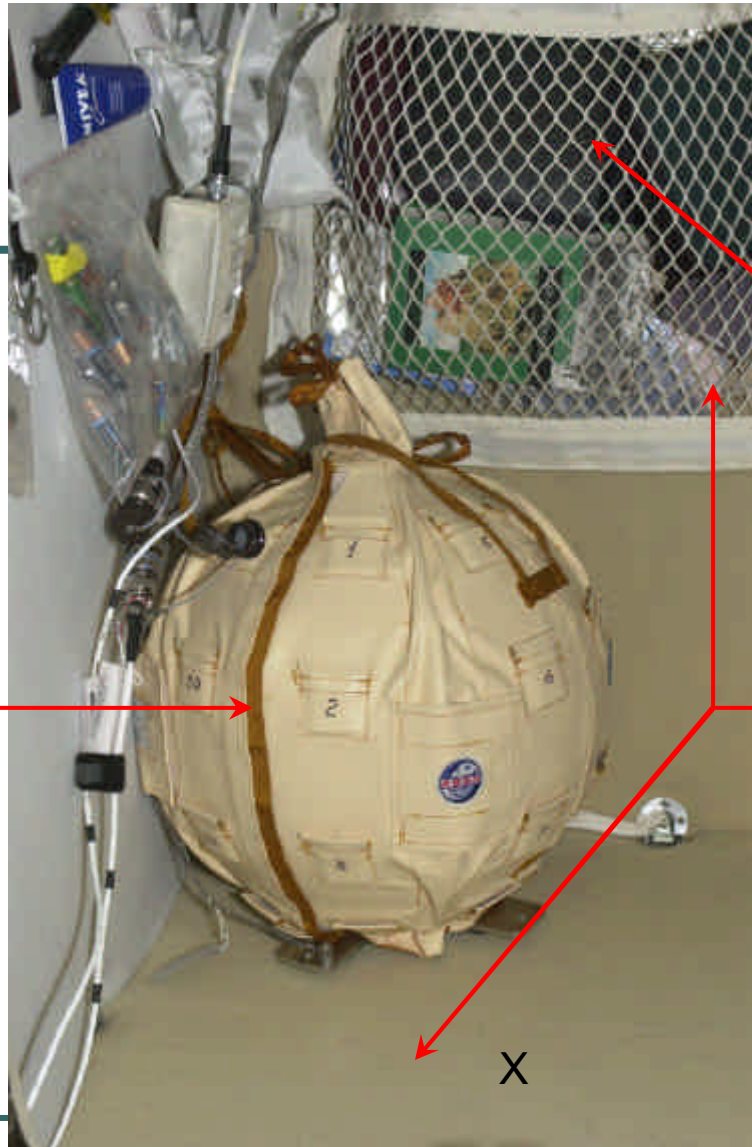
Chemical composition

Chemical element	Standardized phantom	RANDO phantom	Spherical phantom
	%		
H	10	9.2	8.6
N	2.6	2.5	2.6
O	61.3	20.3	32.3
C	23.1	67.8	56.5

**Spherical
phantom in
the crew
cabin (right
board)**



Zero
meridian
line of the
phantom
surface



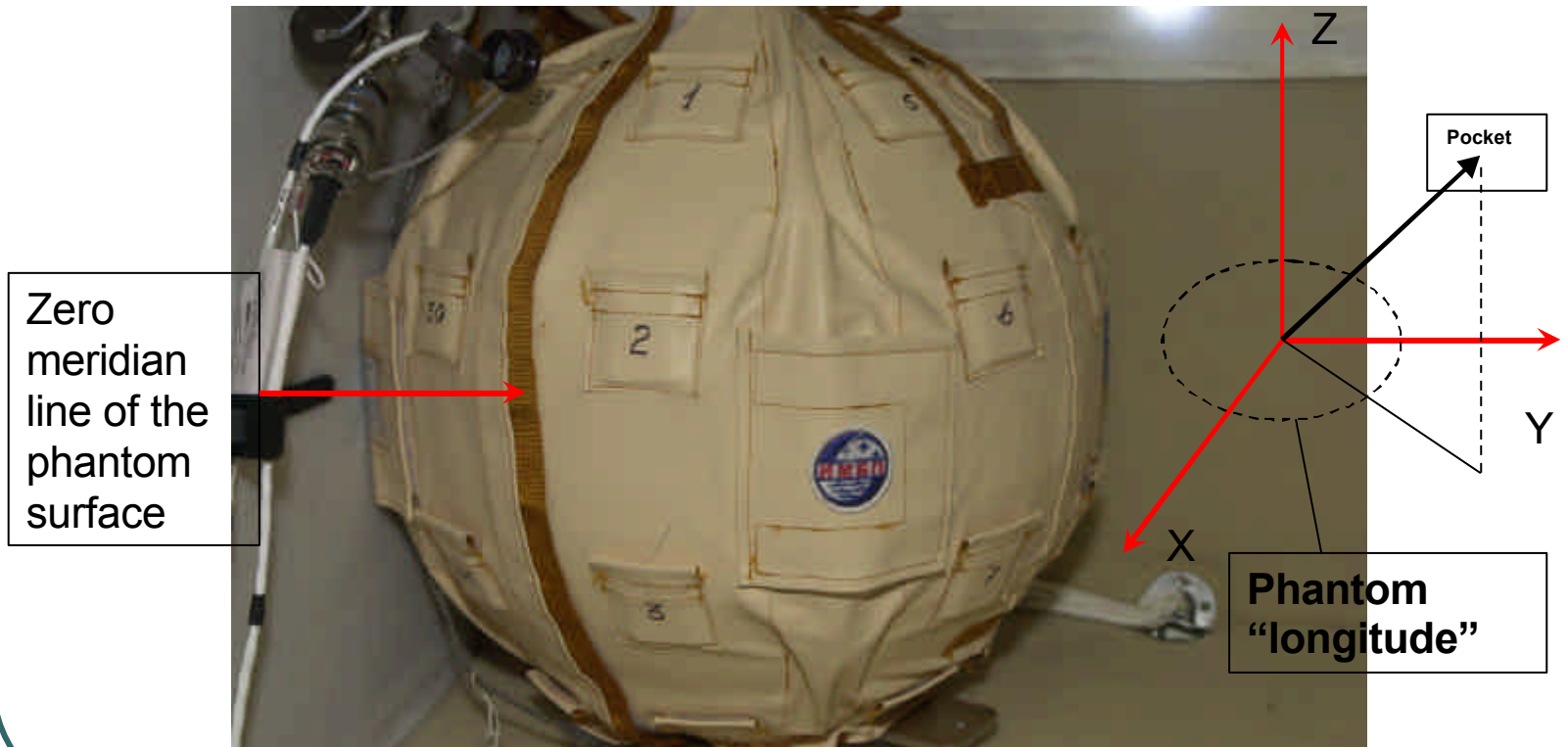
Outer
wall of
the cabin

X

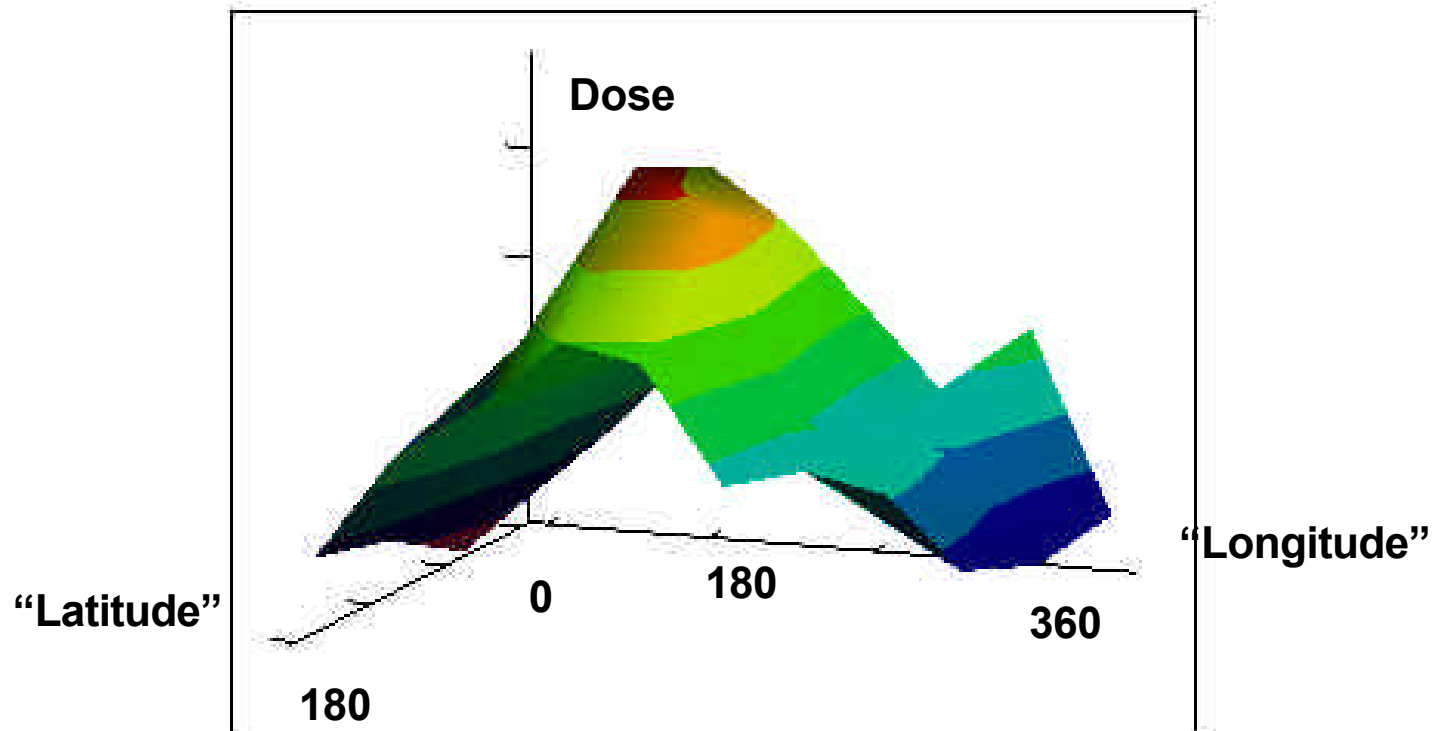
Y

Z

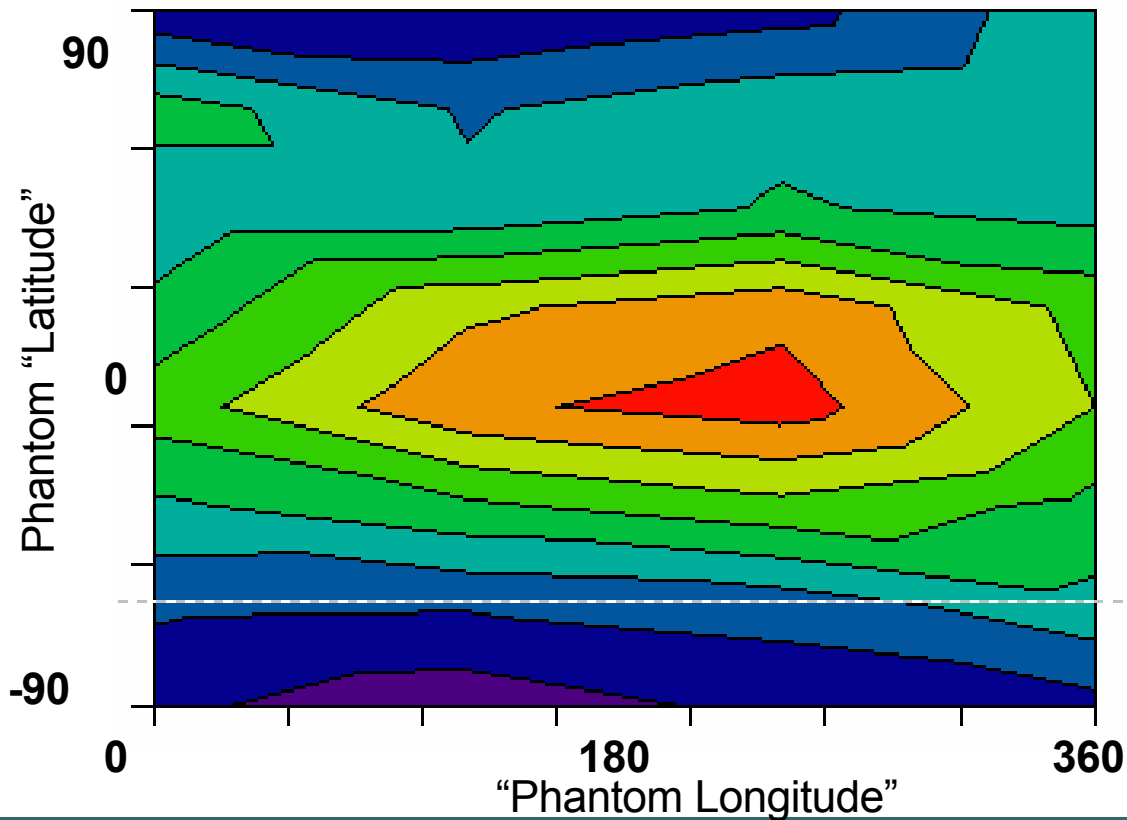
Phantom location and attitude



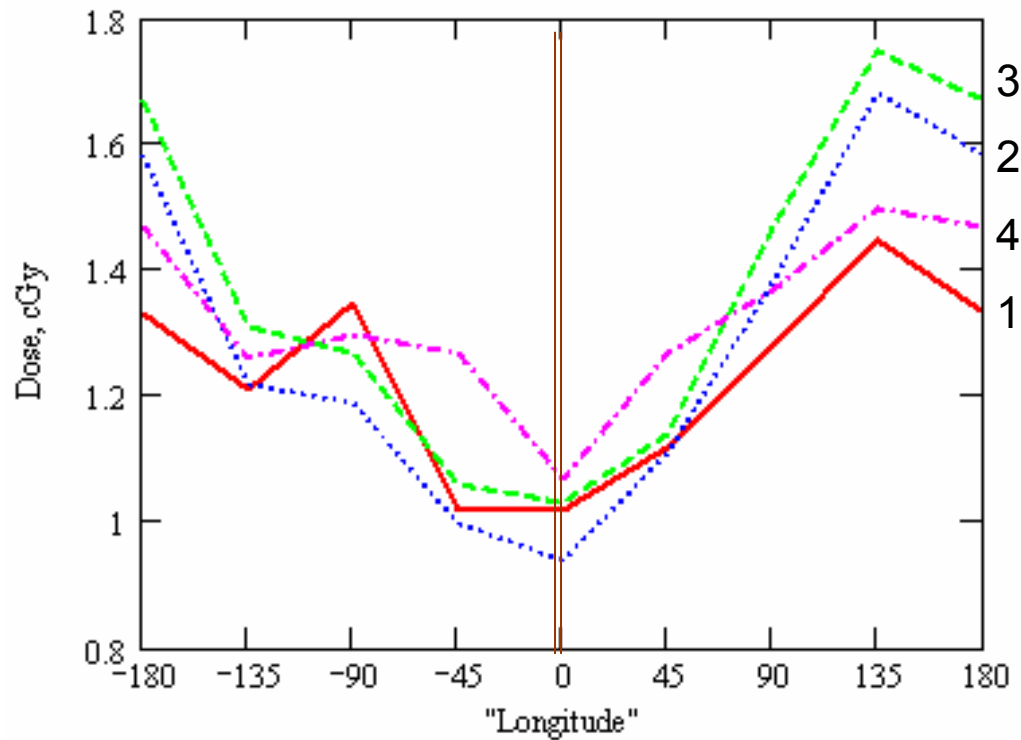
Doses in the phantom pockets



“Pocket Anomaly” Region



91.5 Day Doses in the pockets on the phantom surface



Doses in the pockets on the spherical phantom surface

- Measurement duration – from late January to late April, 2004, 91.5 days total exposure
- Mean dose rate on the phantom surface – 140 mGy/day
- Dose rate variation -
from 103 to 191 mGy/day

Conclusion

- SPD and Spherical phantom were successfully delivered and installed in the Service Module of the ISS in late Jan., 2004
- The spherical phantom made from tissue-simulating materials will be used for critical organ dose estimation of a crew member when in the crew cabin
- Effect of an additional water or polyethylene shielding if added in the crew cabin can also be studied with the spherical phantom
- New active and passive radiation detectors will be used in the Matroshka-R space experiment in 2005-2006