The MATROSHKA Facility – Dose determination during an EVA

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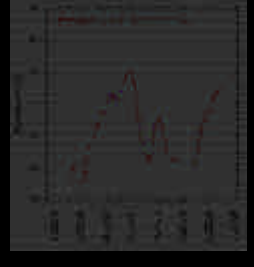
Cologne, Germany

Content

- Phantom Experiments in Space

- The MATROSHKA Facility

- MATROSHKA – Scientific and Housekeeping Data

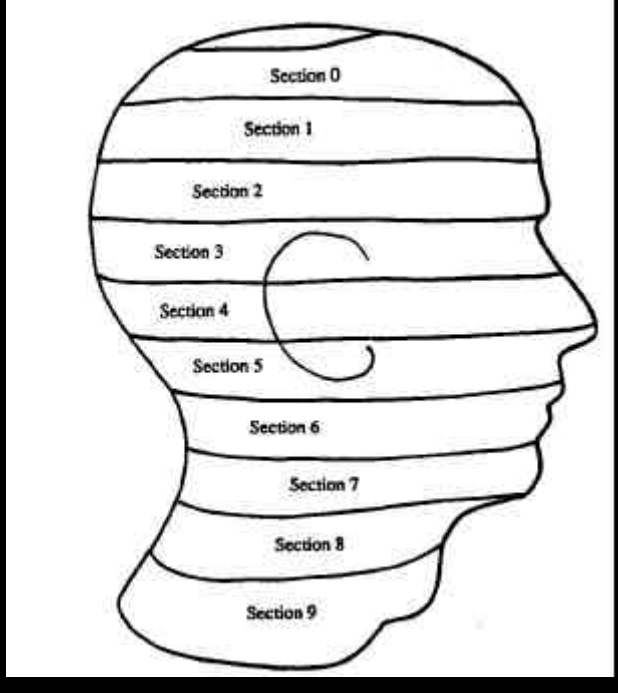


Phantom Experiments in Space

- Phantom Head (1989 – 1990)
- Spherical Phantom (1997 – 1999)
- Anthropomorphic Phantom (1998)
- Anthropomorphic Phantom (2001)
- Spherical Phantom – MATROSHKA - R (2004)
- MATROSHKA (2004)

MATROSHKA

- **STS – 28 (August 1989)**
- **STS – 36 (February 1990)**
- **STS – 31 (April 1990)**



Konradi A., Atwell W., Badhwar G.D., Cast B.L., Hardy K. A., (1992), Low *Earth orbit radiation dose distribution in a phantom head.* Nucl. Tracks. Radiat. Meas. 20 (1), 49-54

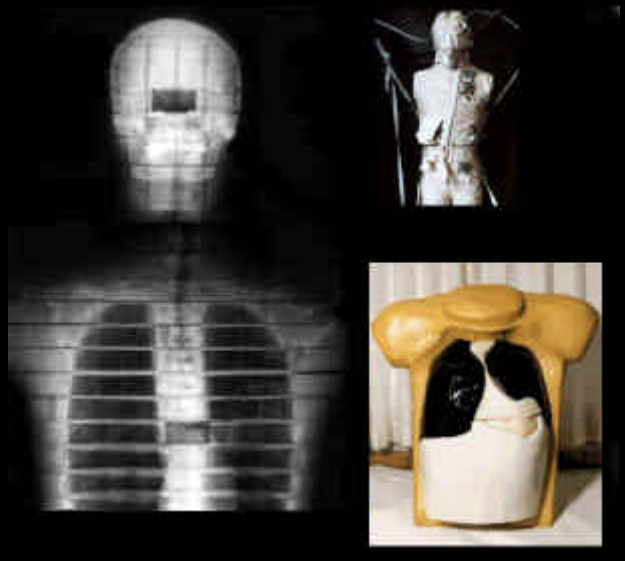
MATROSHKA

- **Phantom 1 MIR (May 1997 – February 1998)**
- **Phantom 2 MIR (May 1998 – August 1998)**
- **Phantom 3 MIR (August 1998 – February 1999)**

Berger, T. Hajek, M. et al (2002), *Application of the HTR-Method for Evaluation of the Depth Distribution of Dose Equivalent in a Water Filled Phantom on Board Space Station MIR,* Radiat. Prot. Dosim. 101 (1-4) 503 - 506.

MATROSHKA

- **STS – 91 (June 1998)**



Badhwar G.D., Atwell W., Badavi F.F., Yang T.C., Cleghorn T.F., (2002), *Space radiation absorbed dose distribution in a human phantom*. Radiat. Res. 157 (1), 76-91,

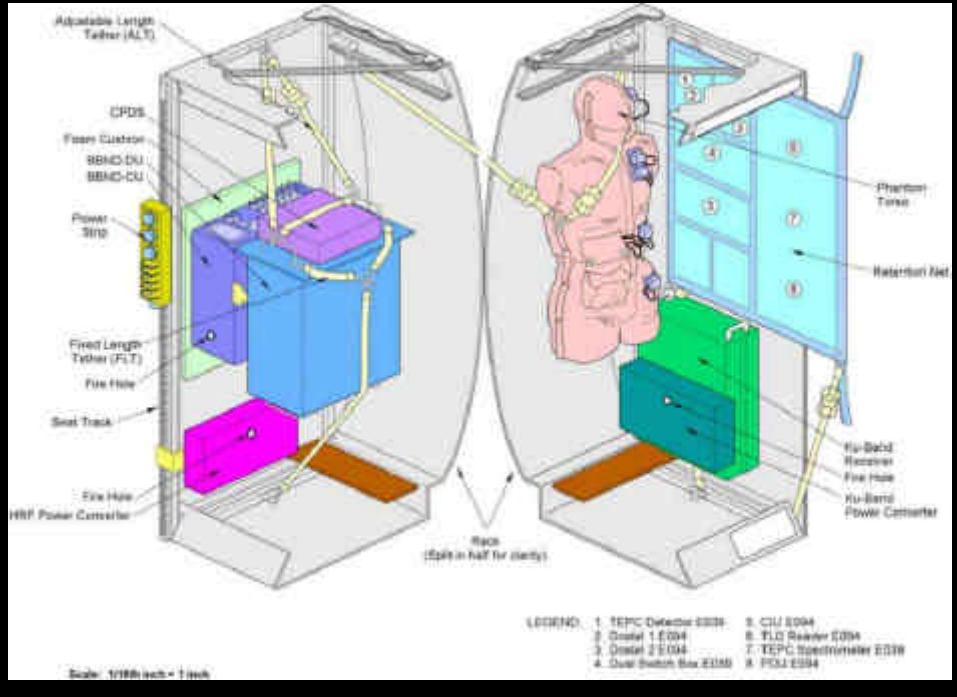
Yashuda H., Badhwar G.D., Komiyama T., Fujikata K., (2000), *Effective dose Equivalent on the Ninth Shuttle – Mir Mission (STS – 91).* Radiat. Res. 154 (6), 705 – 713

MATROSHKA

- **STS – 100 (May 2001)**

  → **ISS Exposure**

- **STS – 105 (August 2001)**



Semones E., Gibbons F., Golightly M.J., Weyland M.D., Johnson A.S., Smith G.E., Shelfer T., Zapp N., (2002) *Measurement of absorbed dose during the phantom torso experimenton the International Space Station*, Proc. 2nd World Space Congress, Houston

MATROSHKA

•) **Start February 2004**

V. Petrov V. Shurshakov, Project : Study of Radiation Environment Dynamics along the Flight Trajectory and in International Space Station Compartments, and Dose Distribution in Anthropomorphic Phantom Located Inside and Outside the Station

The MATROSHKA Facility

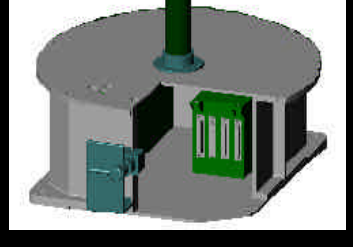
→ESA Project

→Project Manager Dr. Reitz, DLR

→ International Contribution 15 Institutes

MATROSHKA

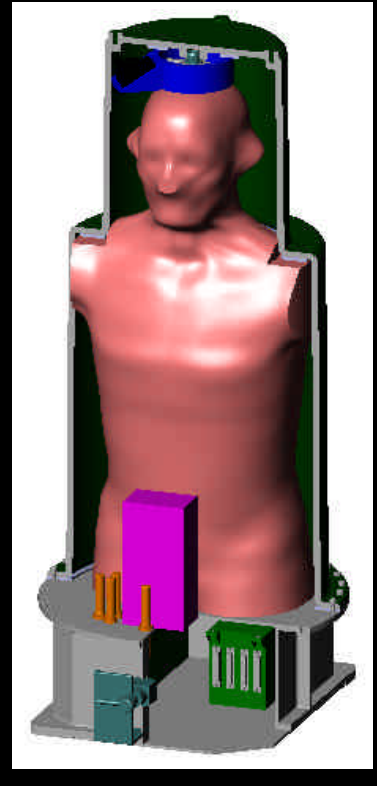
MATROSHKA simulates an astronaut during an Extra Vehicular Activity. A human phantom is exposed in a pressurized container which meets the mean shielding thickness of a space suit (0.5 – 1 g/cm2).



Base structure

Phantom

Container



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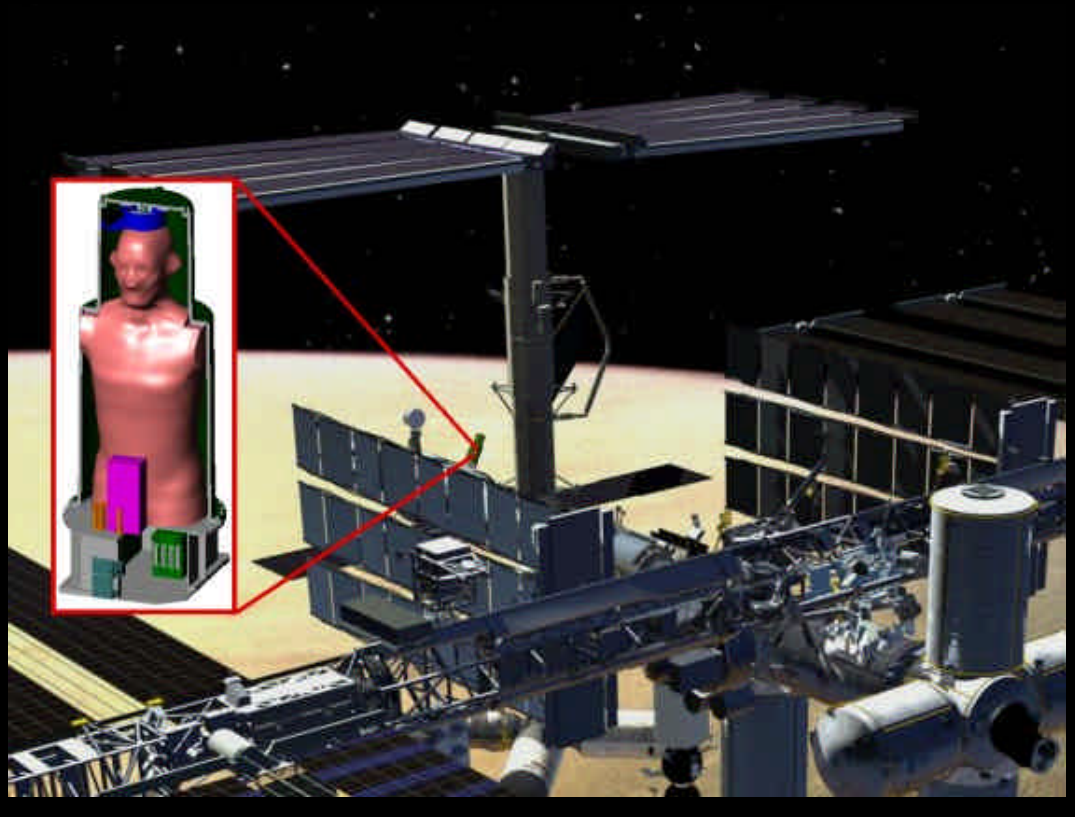
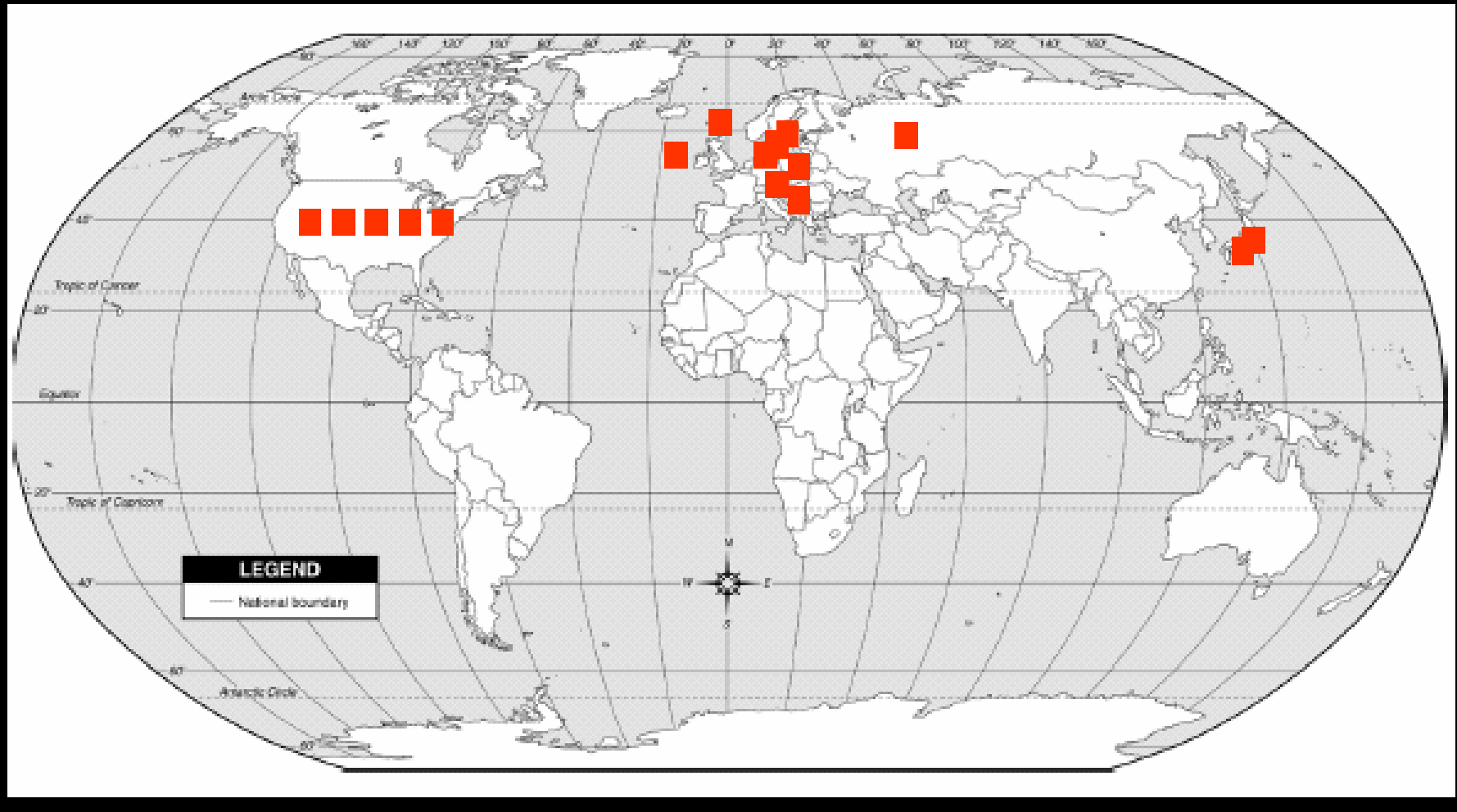
The MATROSHKA Facility

→ Launch: 29. January 2004
→ Docking: 31. January 2004
→ EVA: 26. February 2004
→ Exposure Time: ~ 1 year

→ EVA: 26. February 2004



MATROSHKA



International cooperation

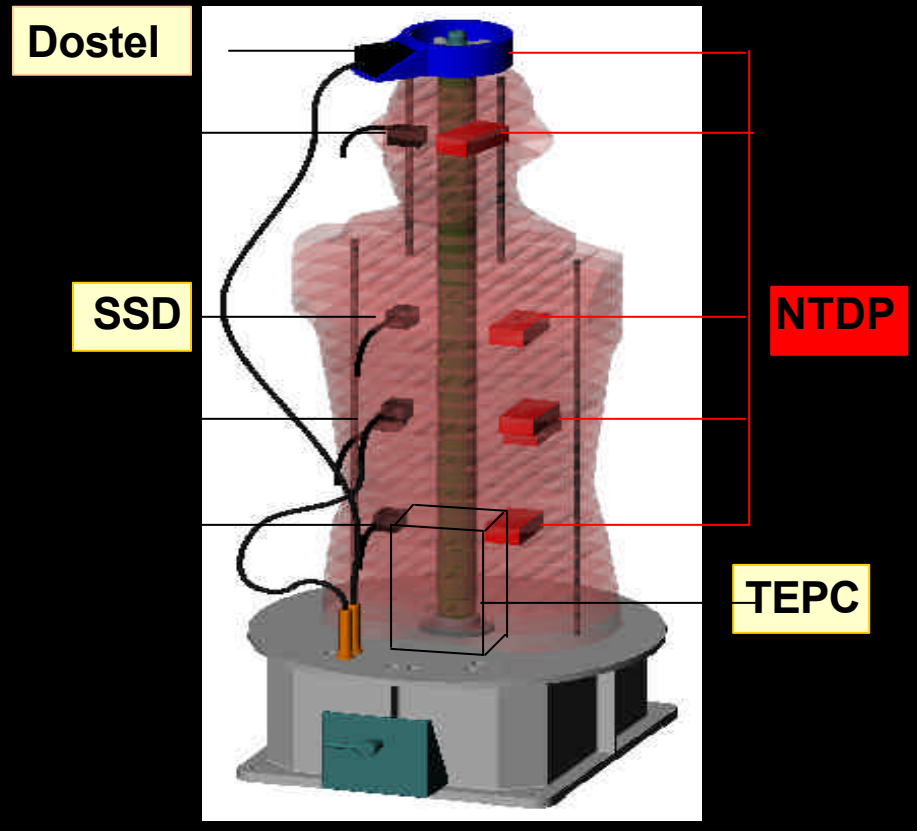
MATROSHKA

Günther Reitz	German Aerospace Center, DLR, Cologne, Germany
Rudolf Beaujean	Christian-Albrechts-Universität Kiel, Kiel, Germany
M. Luszik-Bhadra	Physikalisch-Technische Bundesanstalt, PTB, Braunschweig, Germany
V. Shurshakov, Y. Akatov	Institute for Biomedical Problems, IMBP, Moscow, Russia
P. Olko, P. Bilski	Institute for Nuclear Physics, INP, Krakow, Poland
J. Palfalvi	Atomic Energy Research Institute, AERI, Budapest, Hungary
D. O´Sullivan	DIAS, Dublin, Ireland
D. Bartlett	National Radiological Protection Board, NRPB, Chilton, UK
N. Vana	Atominstitute of the Austrian Universities, ATI, Vienna, Austria
Y. Uchihori	NIRS, Chiba, Japan
S. Yoshitomi, A. Nagamatsu	JAXA, Japan
F. Cucinotta	NASA JSC, Houston, TX, USA
B. Atwell	Space Systems Division, Boeing, Houston, USA
E. Benton	Eril Research Inc.,Richmond, CA , USA
S. McKeever	Oklahoma State University, Stillwater, USA
J. Miller and C. Zeitlin	Lawrence Berkeley Laboratory,Berkeley, CA, USA

MATROSHKA

→ Active Detectors

→ Passive Detectors



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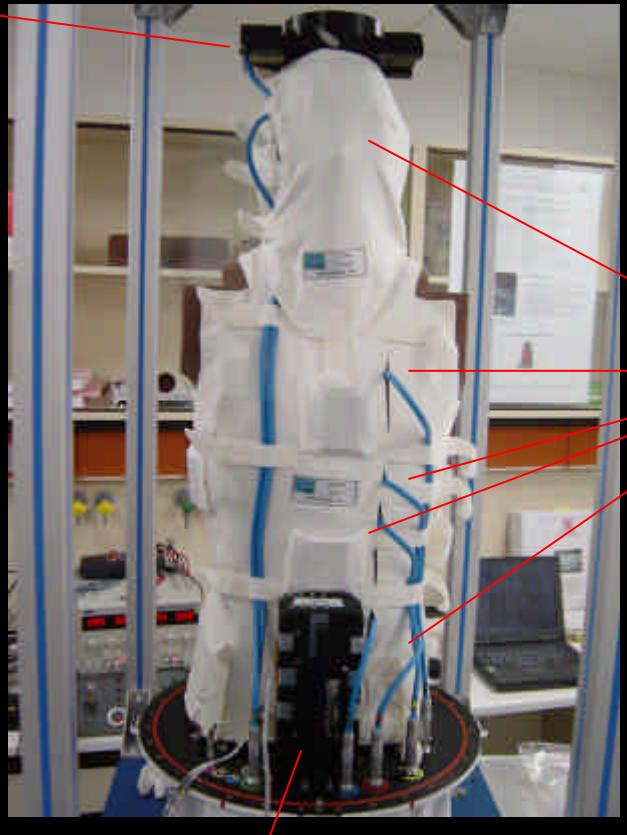
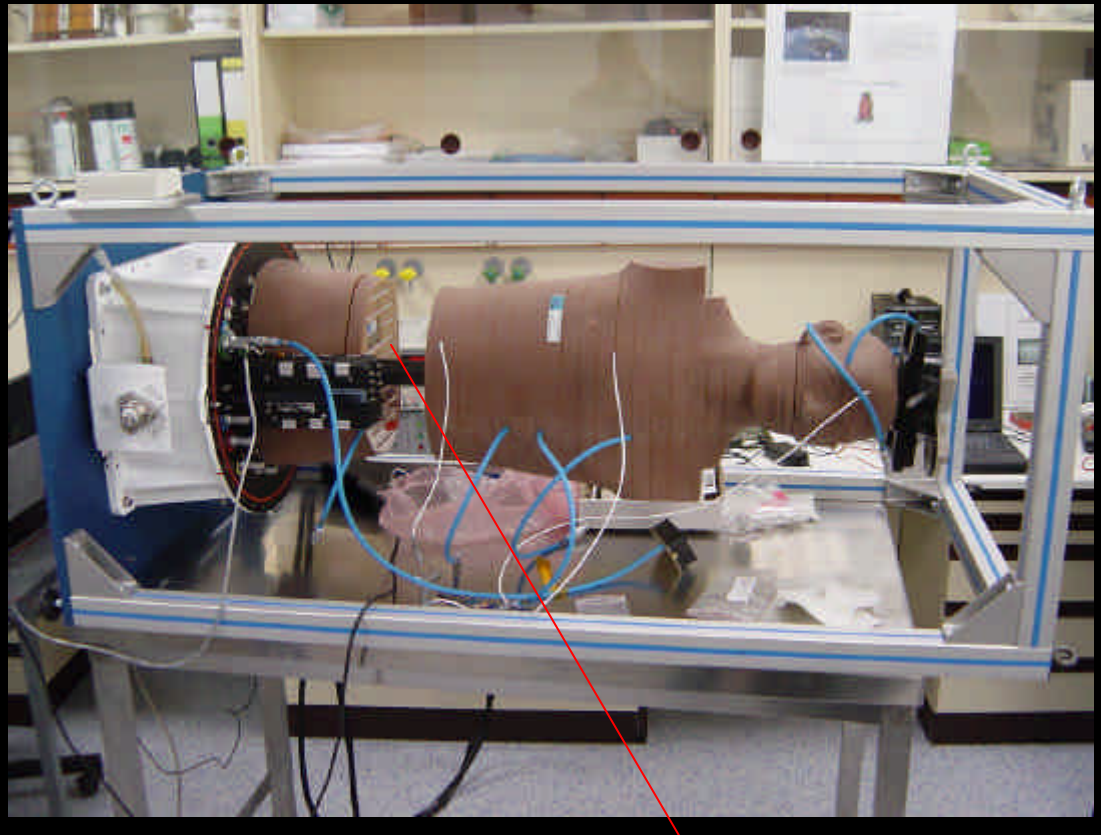
DOSTEL



SSD
- Eye
- Lung
- Stomach
- Kidney
- Intestine

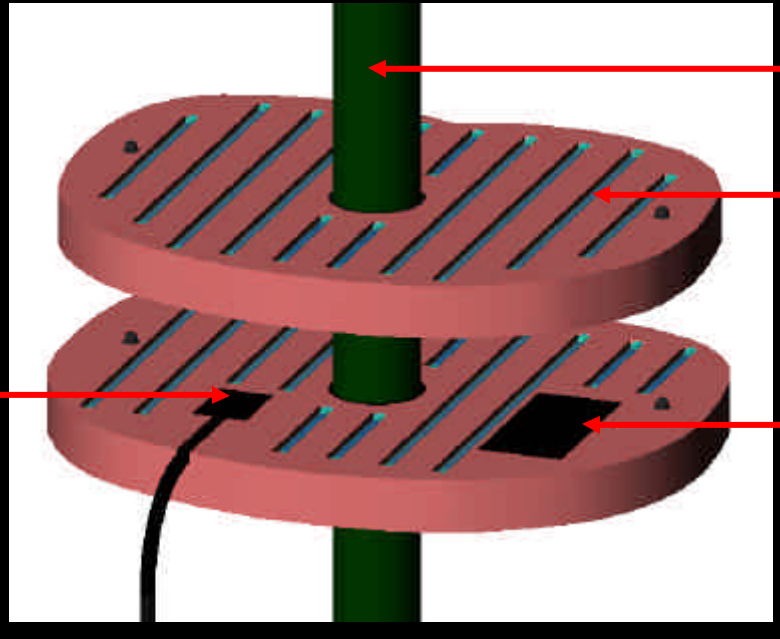
TEPC

MATROSHKA



TLD tubes

MATROSHKA



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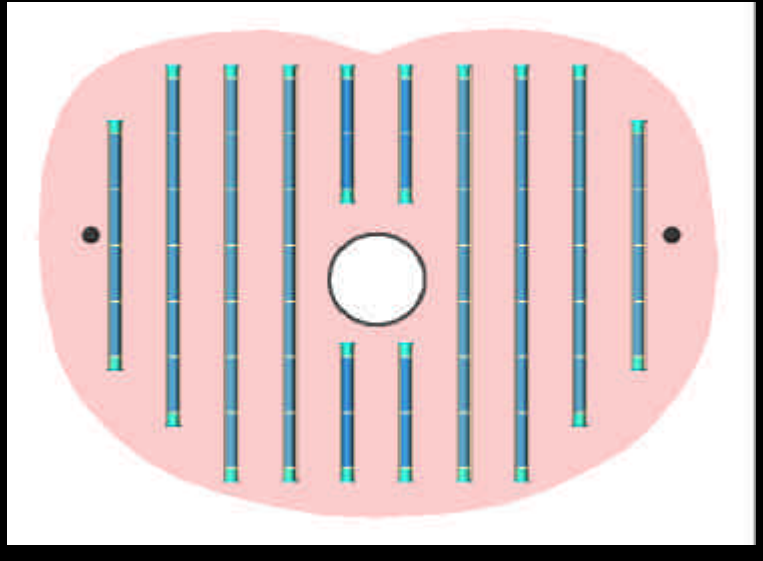
1631 TLD Positions



- Slice 2 – 32 INP
  784 Positions
- Slice 1 – 33 DLR & ATI
  405 Positions DLR
  408 Positions ATI
- Slice 4 – 28 OSU
  34 Positions OSU

TLDs are positioned in tubes in an 1 inch grid within the 33 slices of the phantom

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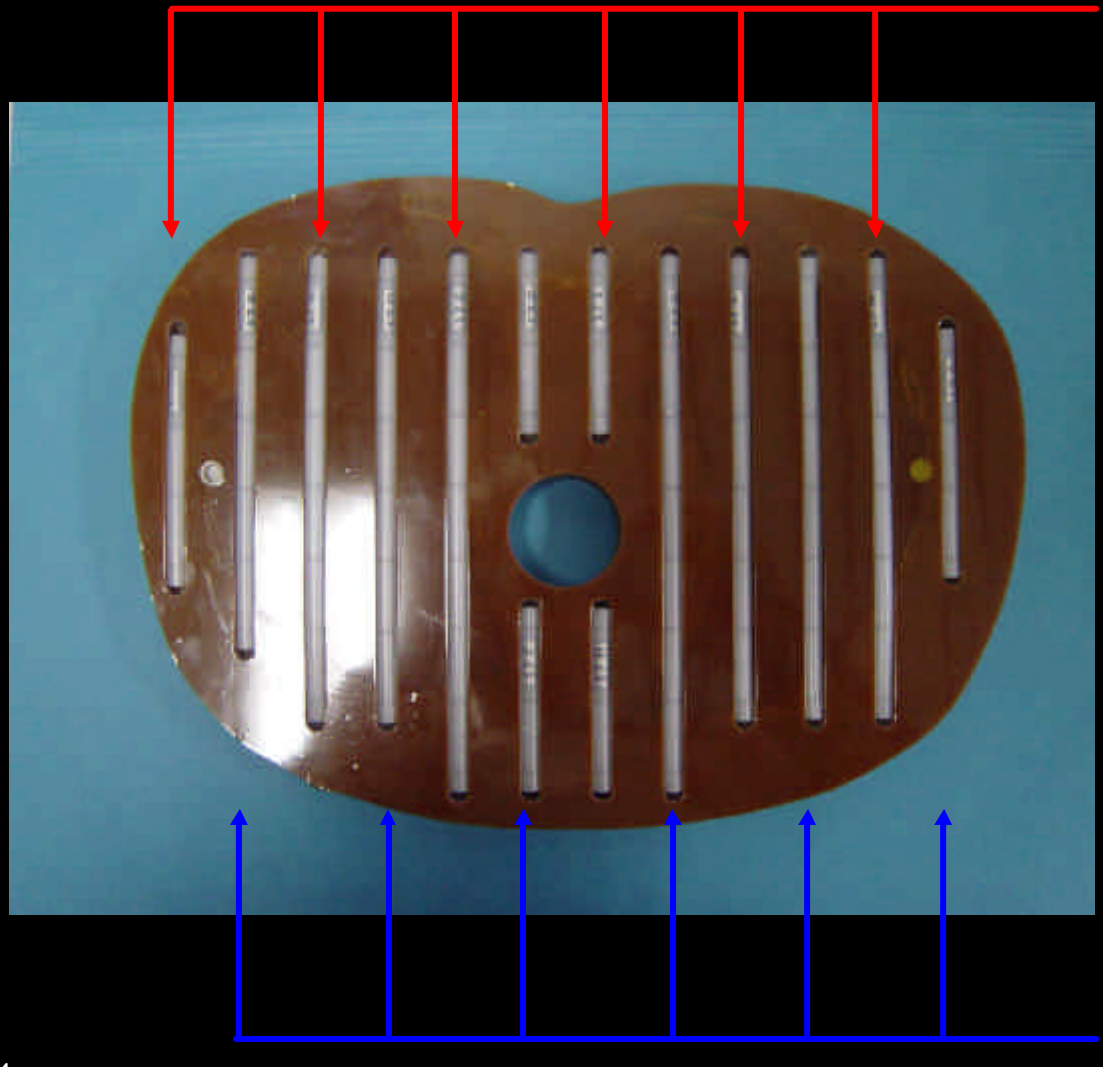
SLICE 5

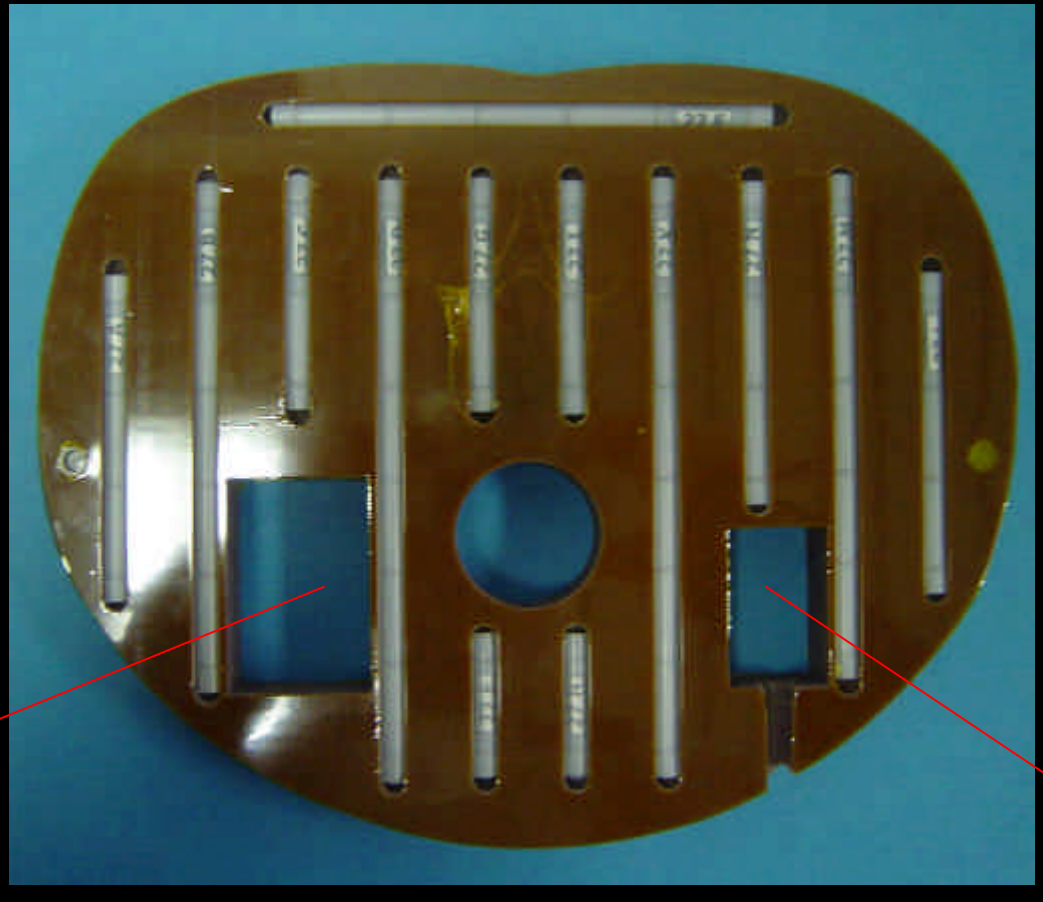
SLICE 12

MATROSHKA

SLICE 17



MATROSHKA



Organ dose box (passiv)

SSD

SLICE 27 (Intestine)

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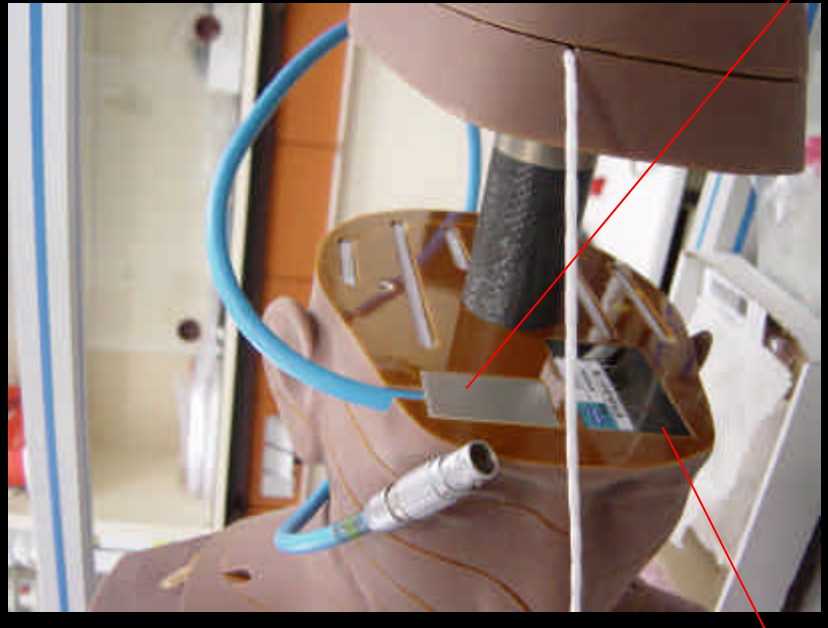
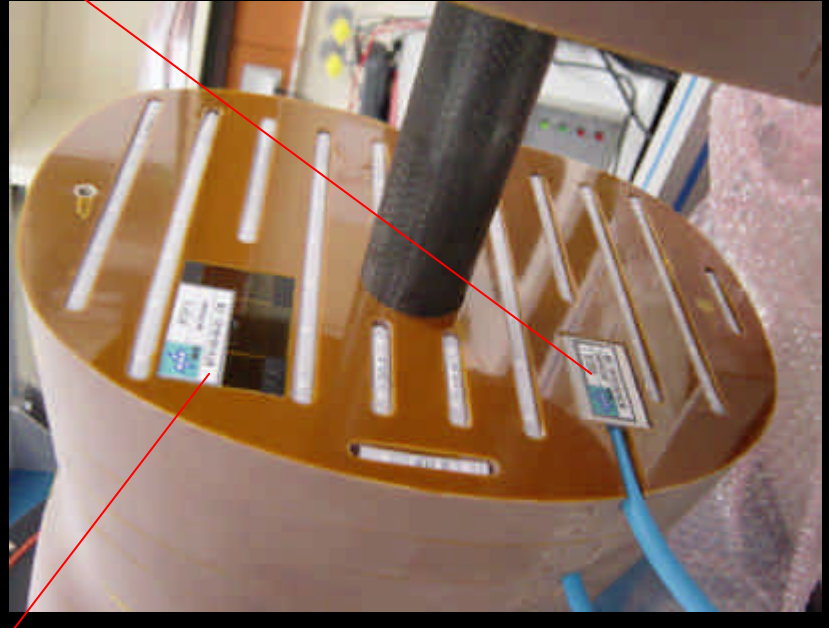
SSD





SLICE 3 (Eye)

SLICE 20 (Lungs)

Organ dose boxes

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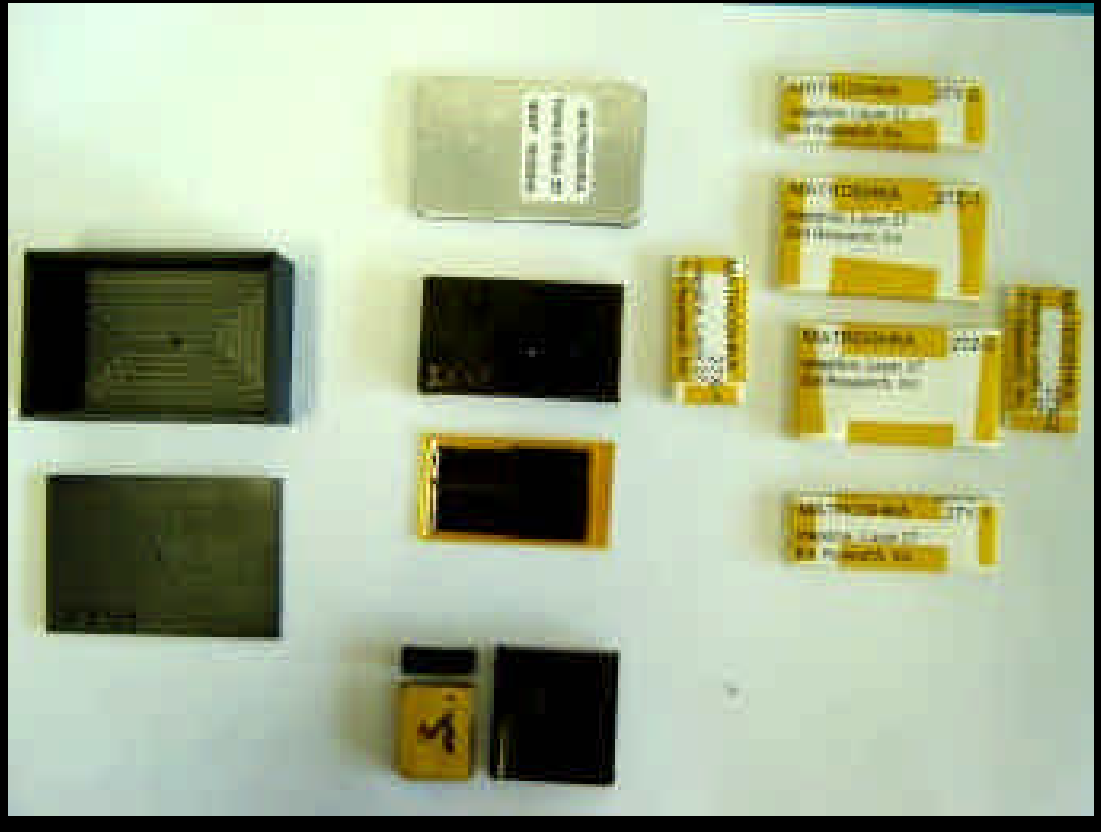
Organ Dose Boxes (Slice 27 Intestine)



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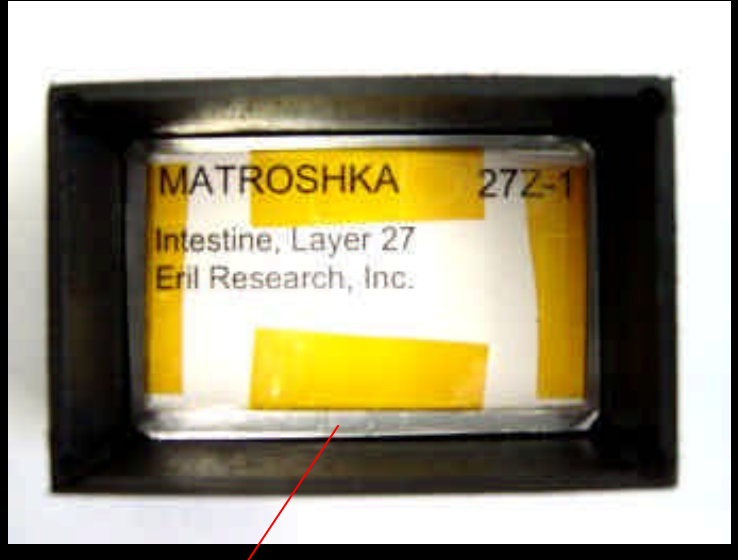
Organ Dose Boxes (Slice 27 Intestine)

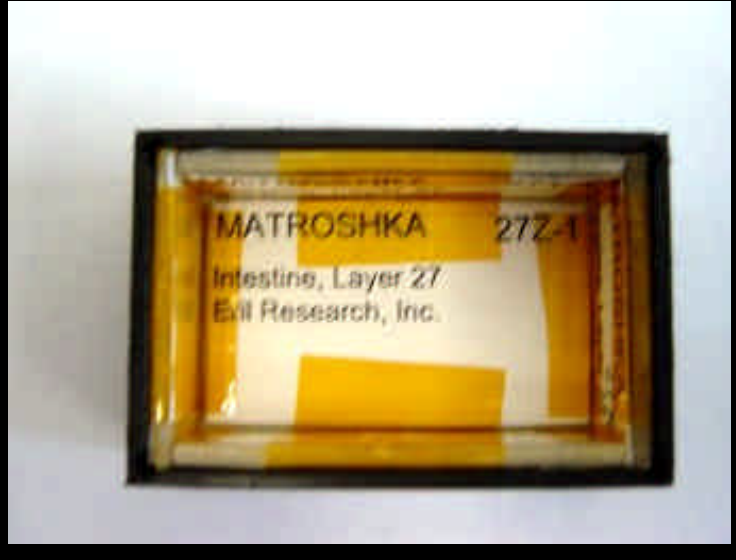
IBMP



ERIL

MATROSHKA

Organ Dose Boxes (Slice 27 Intestine)



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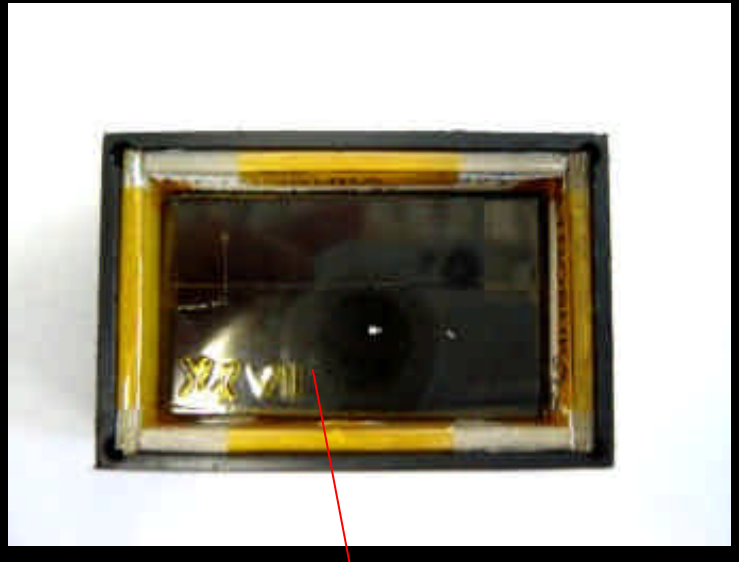
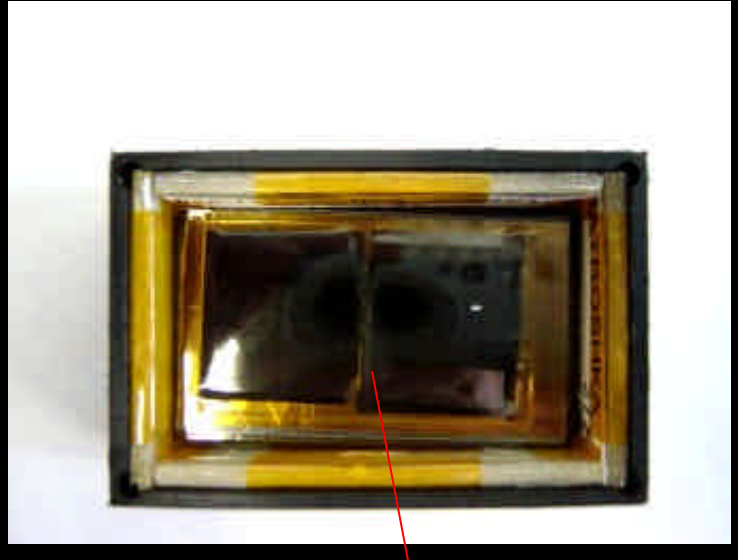
Organ Dose Boxes (Slice 27 Intestine)



ATI, DLR, INP, OSU, NASA



OSU

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Organ Dose Boxes (Slice 27 Intestine)

NIRS

JAXA

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Organ Dose Boxes (Slice 27 Intestine)

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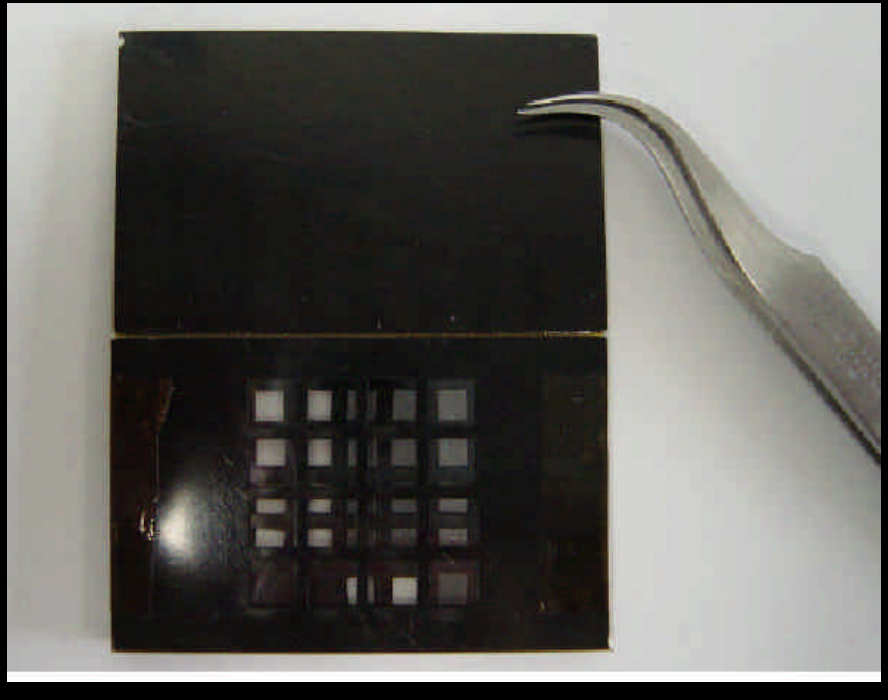
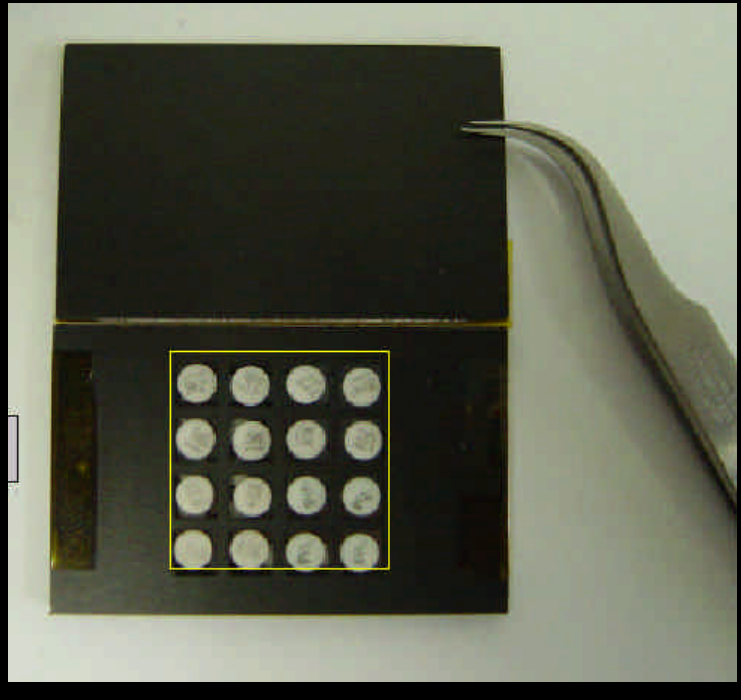
TLD Boxes





→ Up to 60 TLDs in one box

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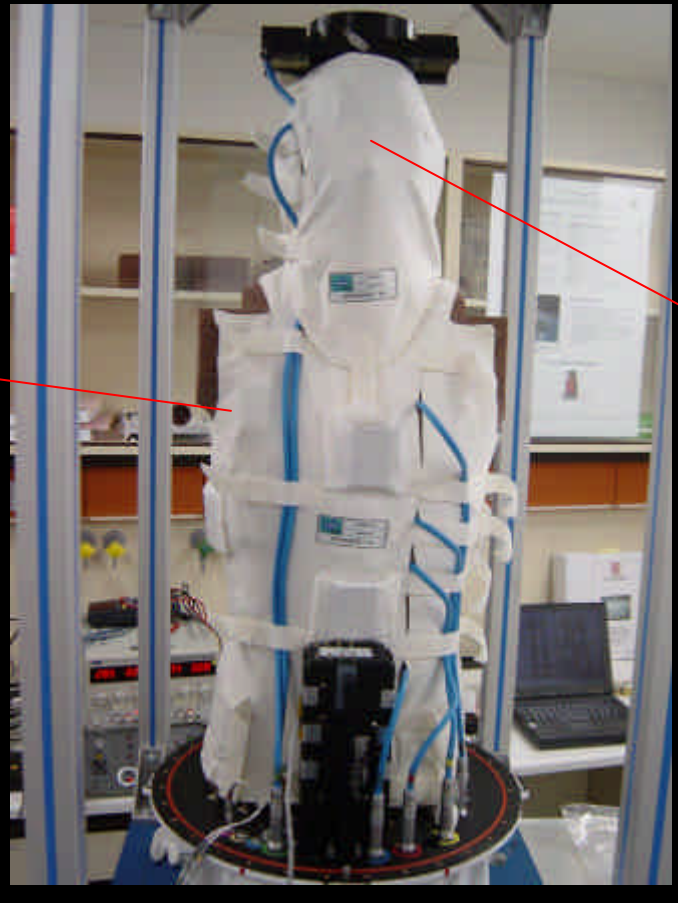

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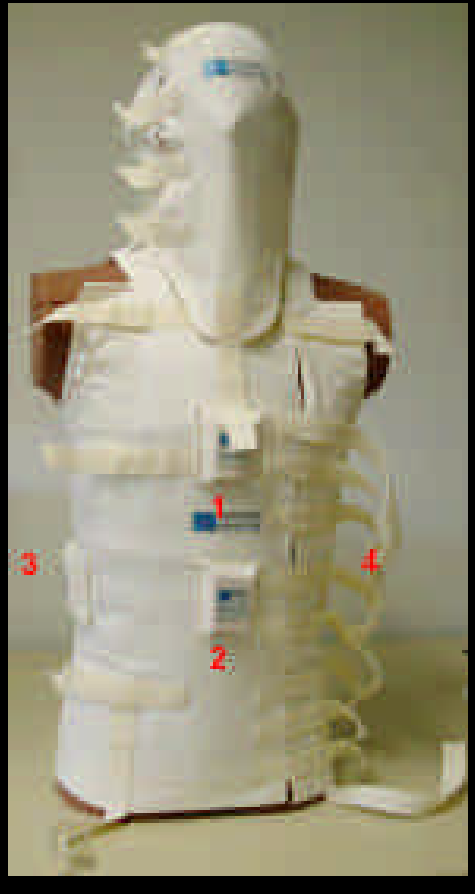
Poncho

MATROSHKA

6 passive
Dosemeter boxes

Poncho



MATROSHKA

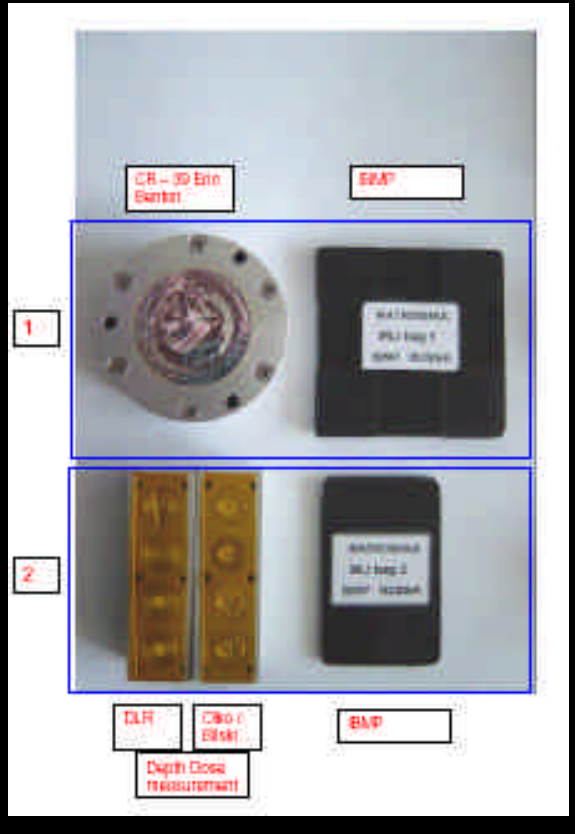
Hood

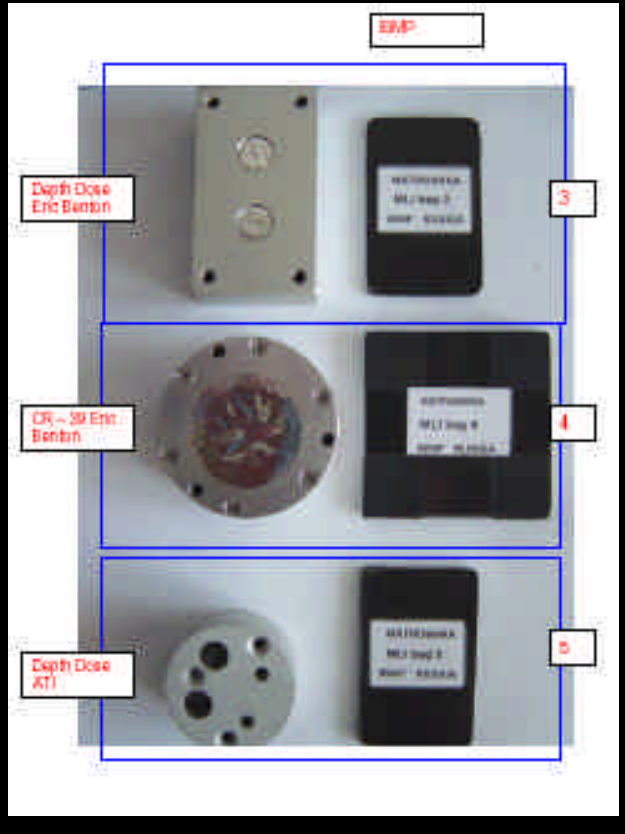
MATROSHKA

MLI Experiments

MATROSHKA

MLI Experiments





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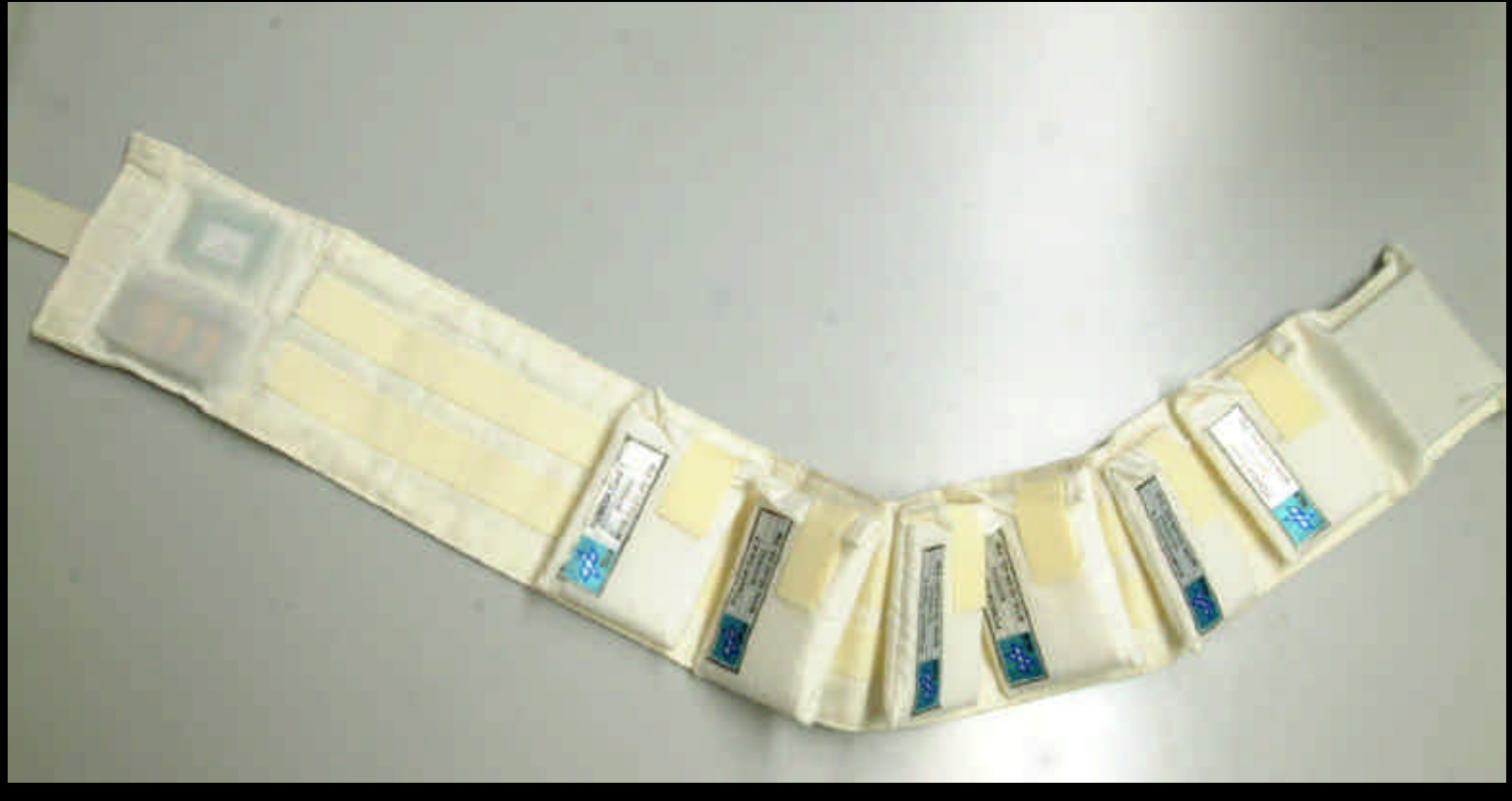
Reference Packages



MATROSHKA Scientific and Housekeeping Data

➢ MATROSHKA Housekeeping Data

- ➢ Russian Data Files (bpar, mtk)
  2 temperature und 1 pressure sensor + Status data

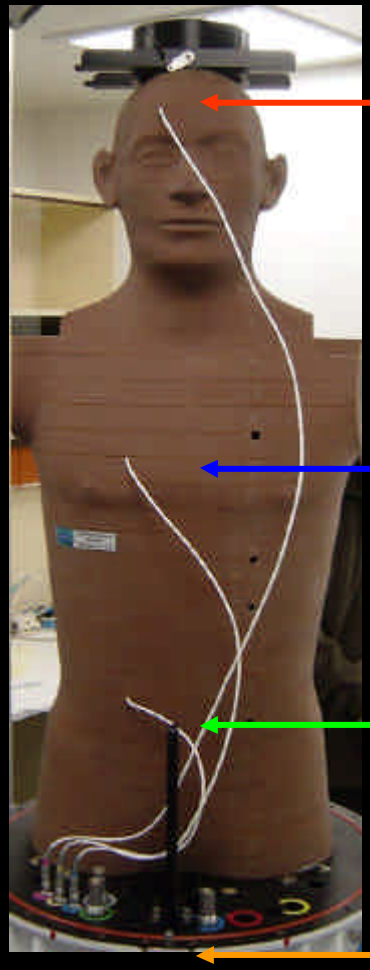
- ➢ MATE Housekeeping dat (mhk)
  6 temperature and 2 pressure sensors

➢ MATROSHKA Scientific Data

- ➢ S1: DOSTEL
  S3: SSD
  S4: TEPC

- ➢ Data downlinked or stored on PCMCIA card

MATROSHKA



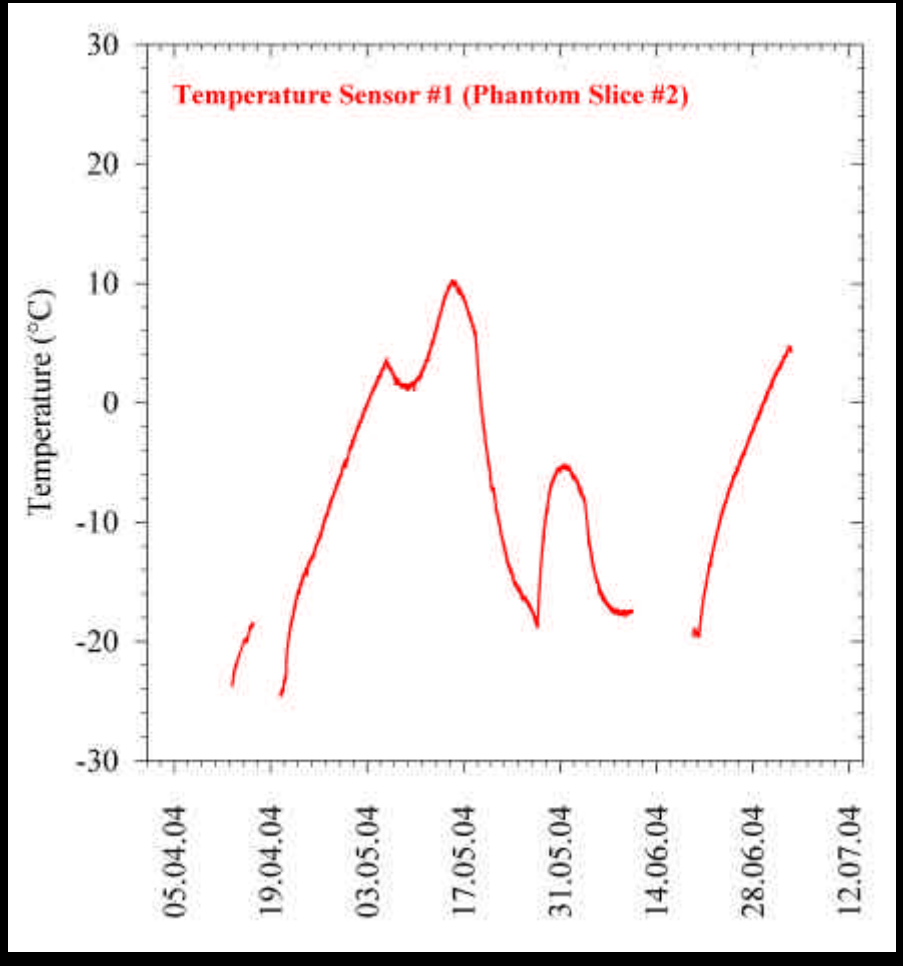
Temperature Sensor # 1
Slice #2

Temperature Sensor # 2
Slice #16

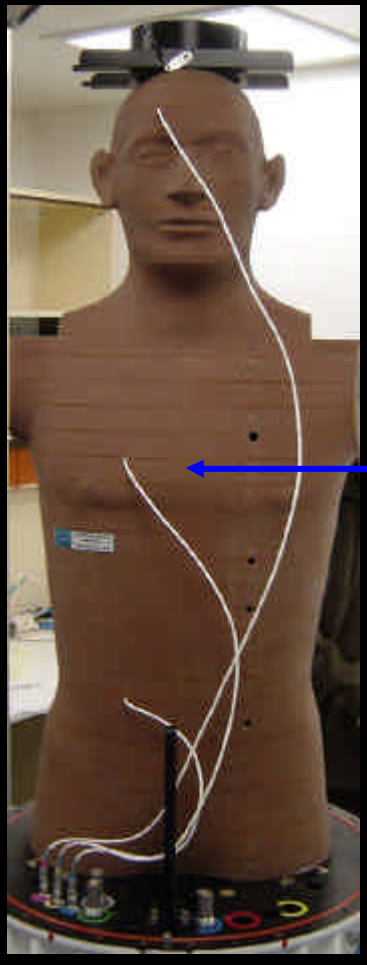
Temperature Sensor # 3
Slice #26

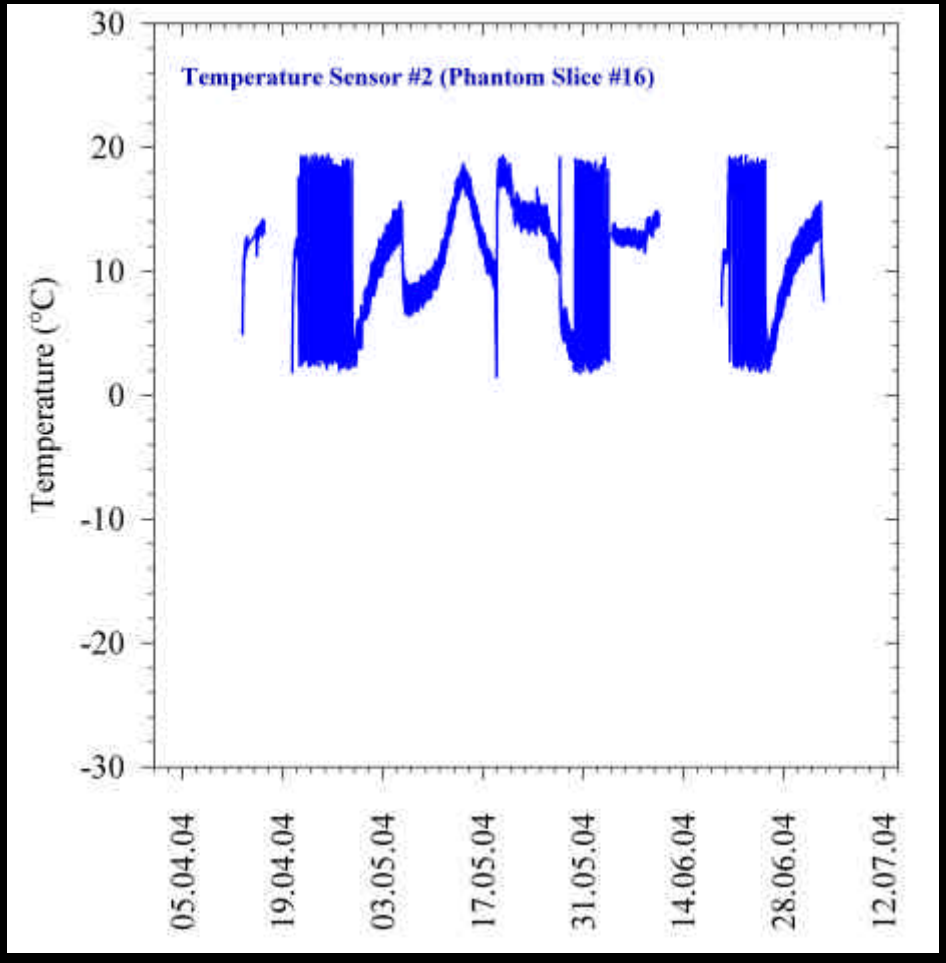
Pressure Sensor # 1
Base Structure

MATROSHKA

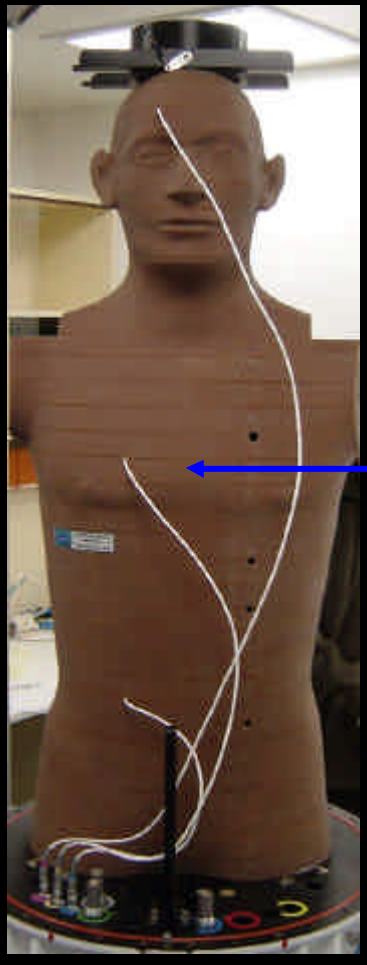

Temperature Sensor #1 (Phantom Slice #2)
Temperature (°C)
30
20
10
0
-10
-20
-30
05.04.04
19.04.04
03.05.04
17.05.04
31.05.04
14.06.04
28.06.04
12.07.04

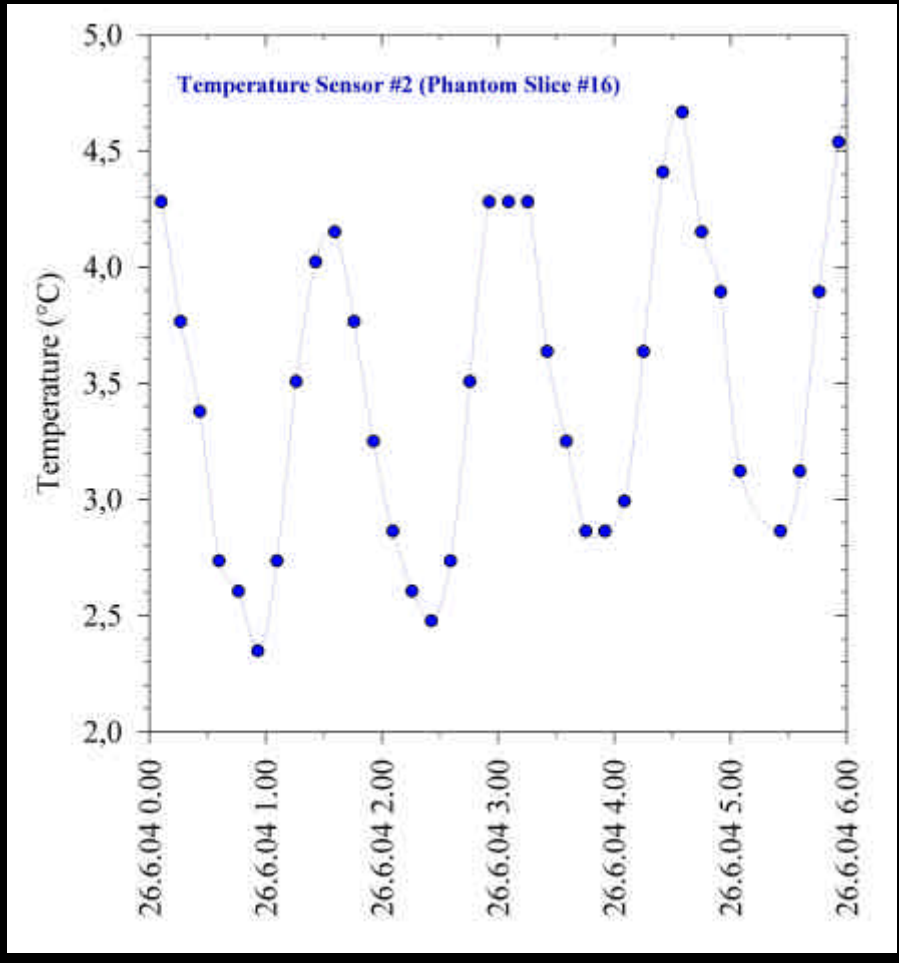
MATROSHKA



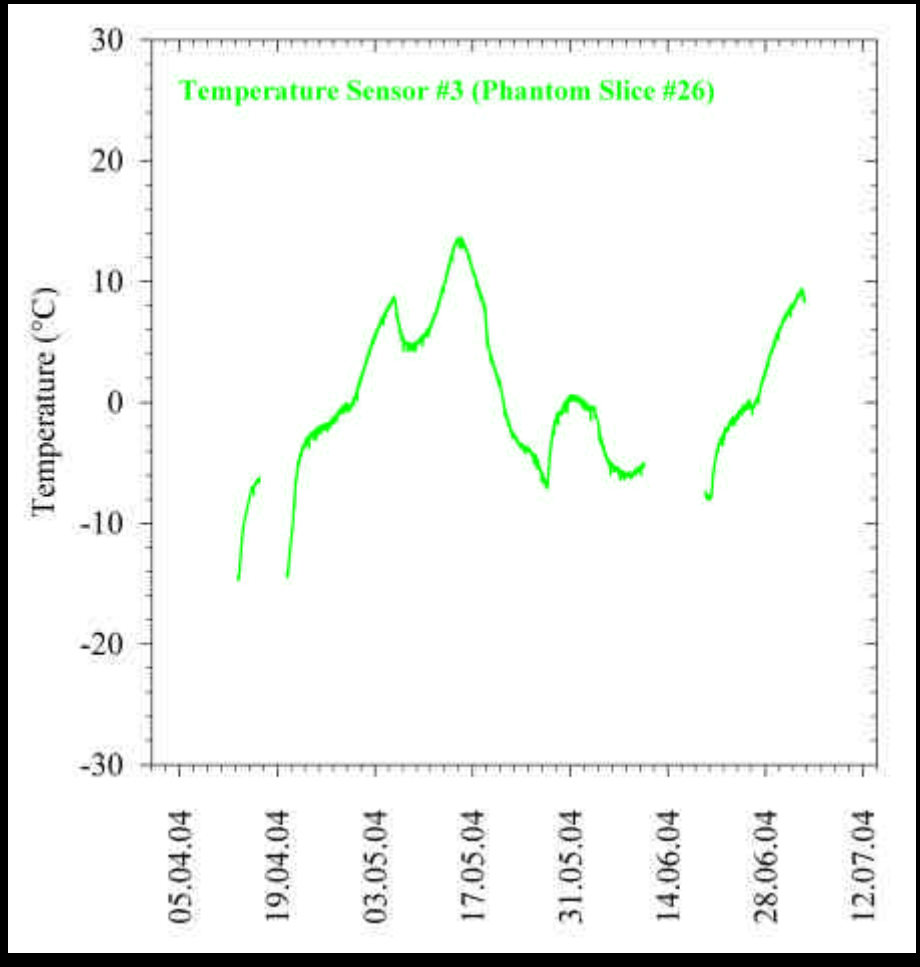

Temperature Sensor #2 (Phantom Slice #16)
Temperature (°C)
30
20
10
0
-10
-20
-30
05.04.04
19.04.04
03.05.04
17.05.04
31.05.04
14.06.04
28.06.04
12.07.04

MATROSHKA

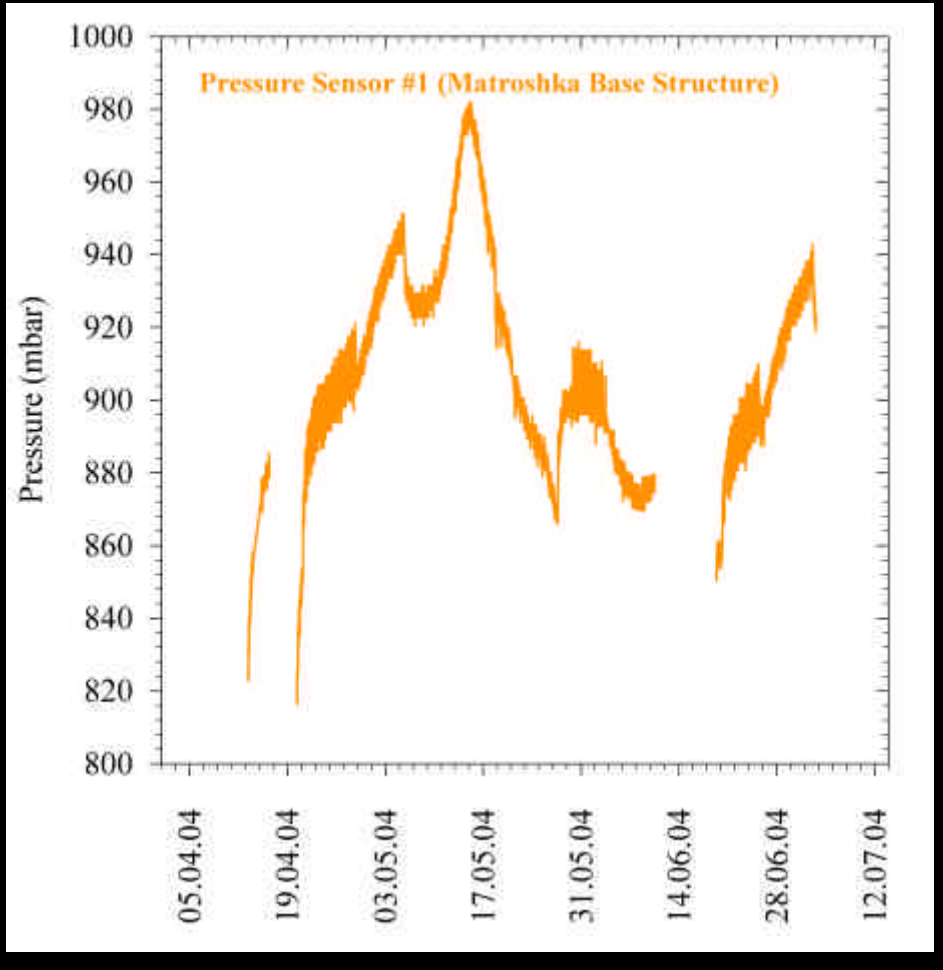



Temperature Sensor #2 (Phantom Slice #16)
Temperature (°C)
5,0
4,5
4,0
3,5
3,0
2,5
2,0
26.6.04 0.00
26.6.04 1.00
26.6.04 2.00
26.6.04 3.00
26.6.04 4.00
26.6.04 5.00
26.6.04 6.00

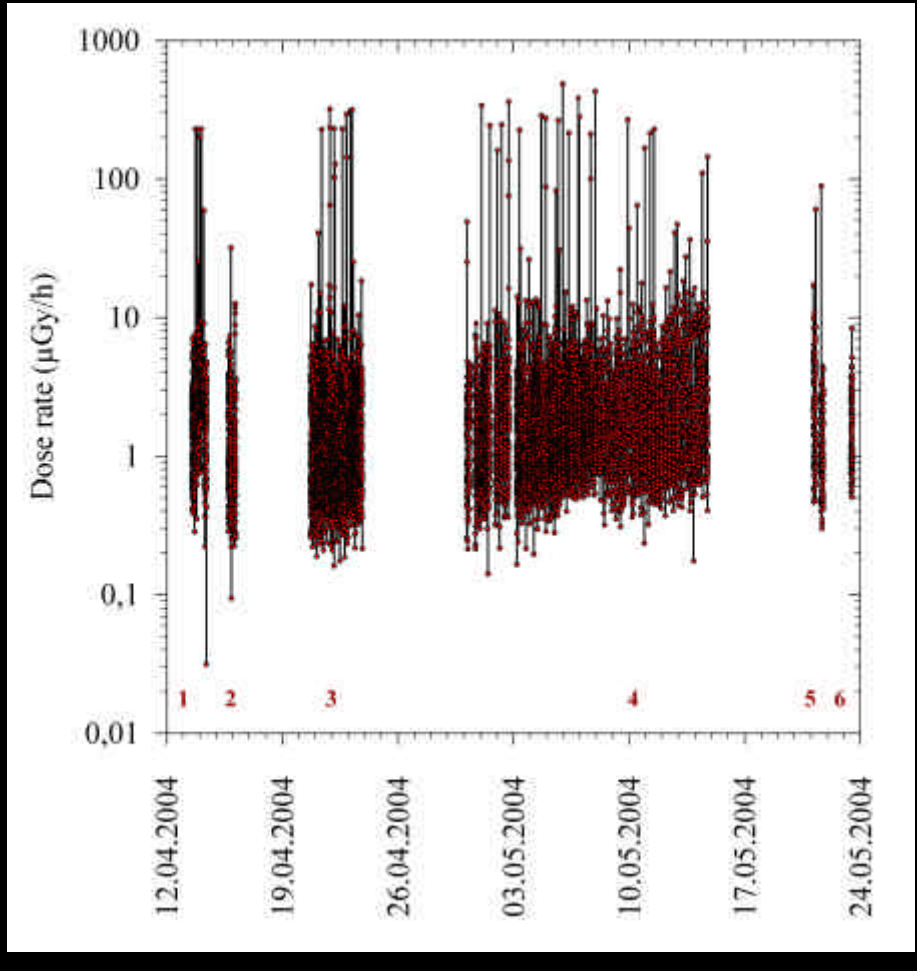
MATROSHKA


Temperature Sensor #3 (Phantom Slice #26)
Temperature (°C)
30
20
10
0
-10
-20
-30
05.04.04
19.04.04
03.05.04
17.05.04
31.05.04
14.06.04
28.06.04
12.07.04

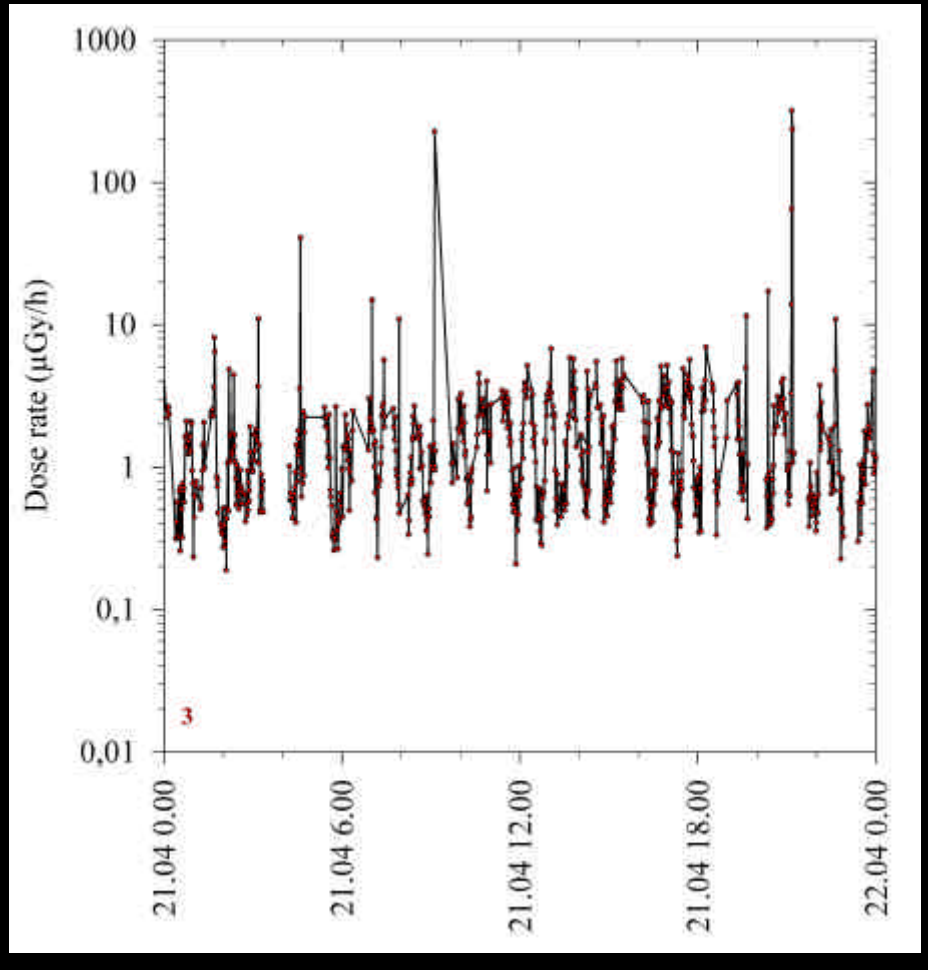
MATROSHKA


Pressure Sensor #1 (Matroshka Base Structure)
Pressure (mbar)
1000
980
960
940
920
900
880
860
840
820
800
05.04.04
19.04.04
03.05.04
17.05.04
31.05.04
14.06.04
28.06.04
12.07.04

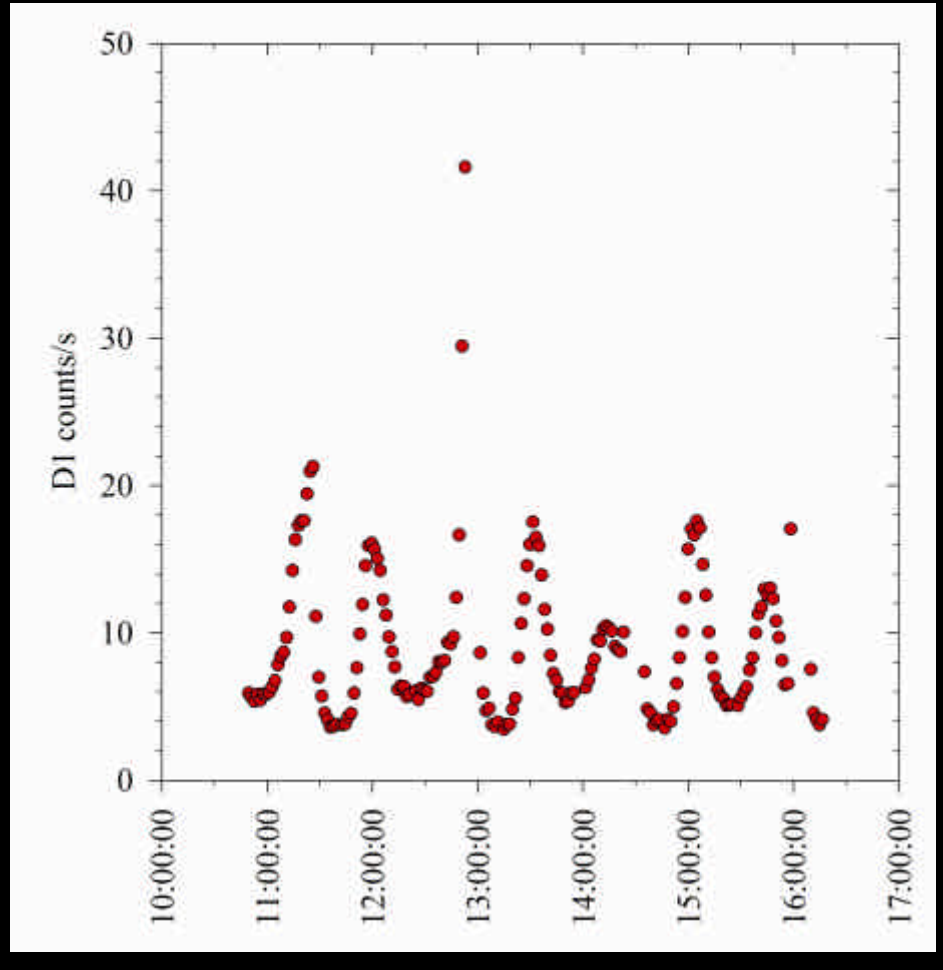
MATROSHKA


1000
100
10
1
0,1
0,01
Dose rate (µGy/h)
1
2
3
4
5
6
12.04.2004
19.04.2004
26.04.2004
03.05.2004
10.05.2004
17.05.2004
24.05.2004

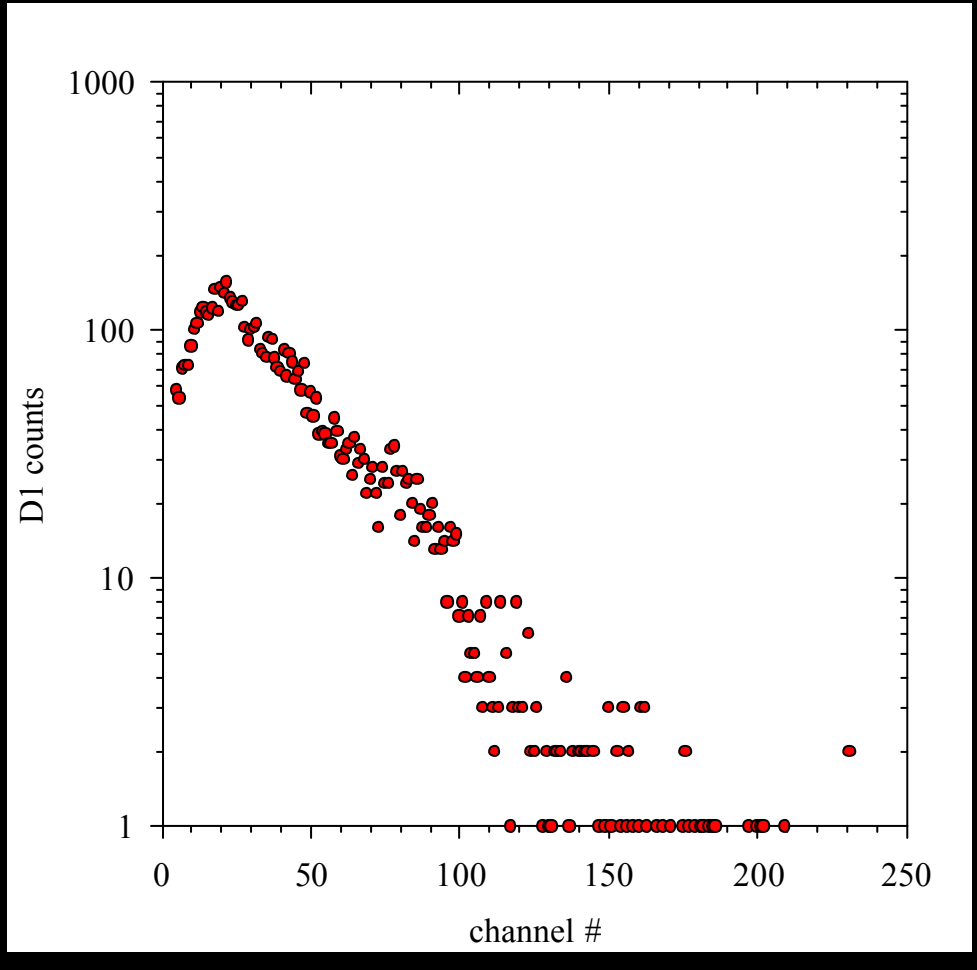
MATROSHKA


1000
100
10
1
0,1
0,01
Dose rate (µGy/h)
3
21.04 0.00
21.04 6.00
21.04 12.00
21.04 18.00
22.04 0.00

MATROSHKA


D1 counts/s
0
10
20
30
40
50
10:00:00
11:00:00
12:00:00
13:00:00
14:00:00
15:00:00
16:00:00
17:00:00

MATROSHKA



MATROSHKA

Thank‘s for your attention !