

Overview of Active and Passive Dosimetry for the MATROSHKA experiment

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Phantom Torso

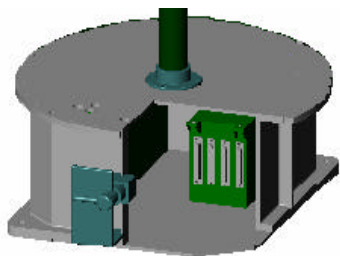
Phantom Poncho

MLI

- Reference Dosemeters (GBS)



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 ($0.5 - 1 \text{ g/cm}^2$).



Base structure



Phantom



Container



MATROSHKA

PHANTOM (RANDO)

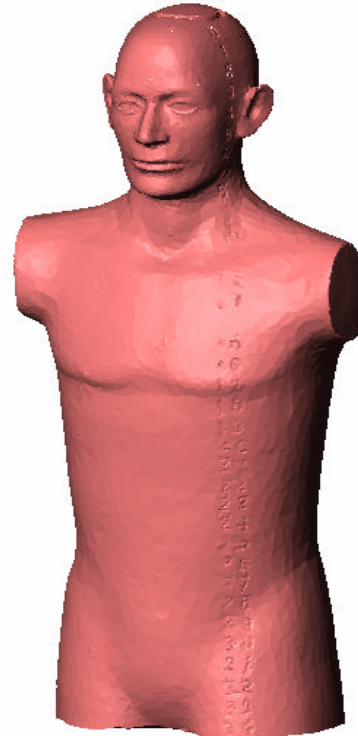
The Phantom simulates the human body with respect to

- Size
- Shape
- Mass density
- Nuclear interaction

The Phantom consists of

- Tissue equivalent material (Poly-Urethane (PU))
- Natural bone and
- PU of lower density to simulate lungs

The phantom is build up of 33 slices of 25 mmm thickness stabled over a middle rod. Each slice provides an alignment pin to define the orientation of the slice to each other.



Phantom torso



Computer Tomography

Dosemeter Locations

The dosimeter types SSD (active) and PNTD (passive) are located at the sites of important organs inside the phantom.

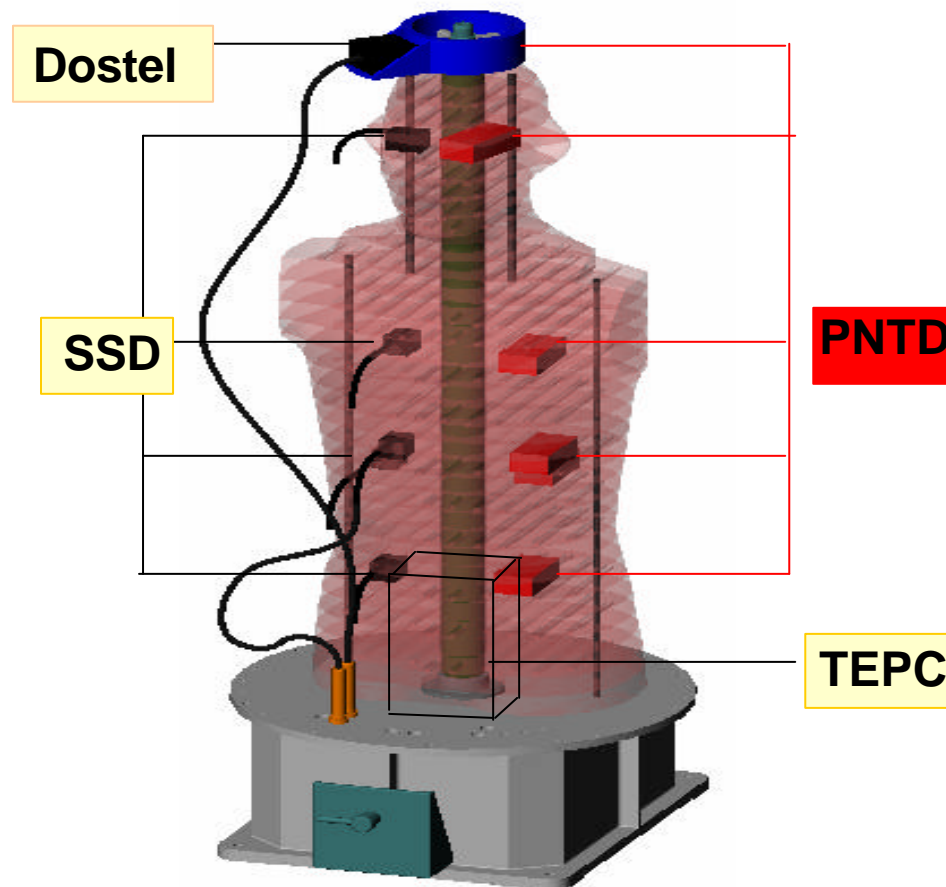
- Eye
- Lung
- Stomach
- Kidney
- Intestine

The TEPC is mounted in front of the phantom.

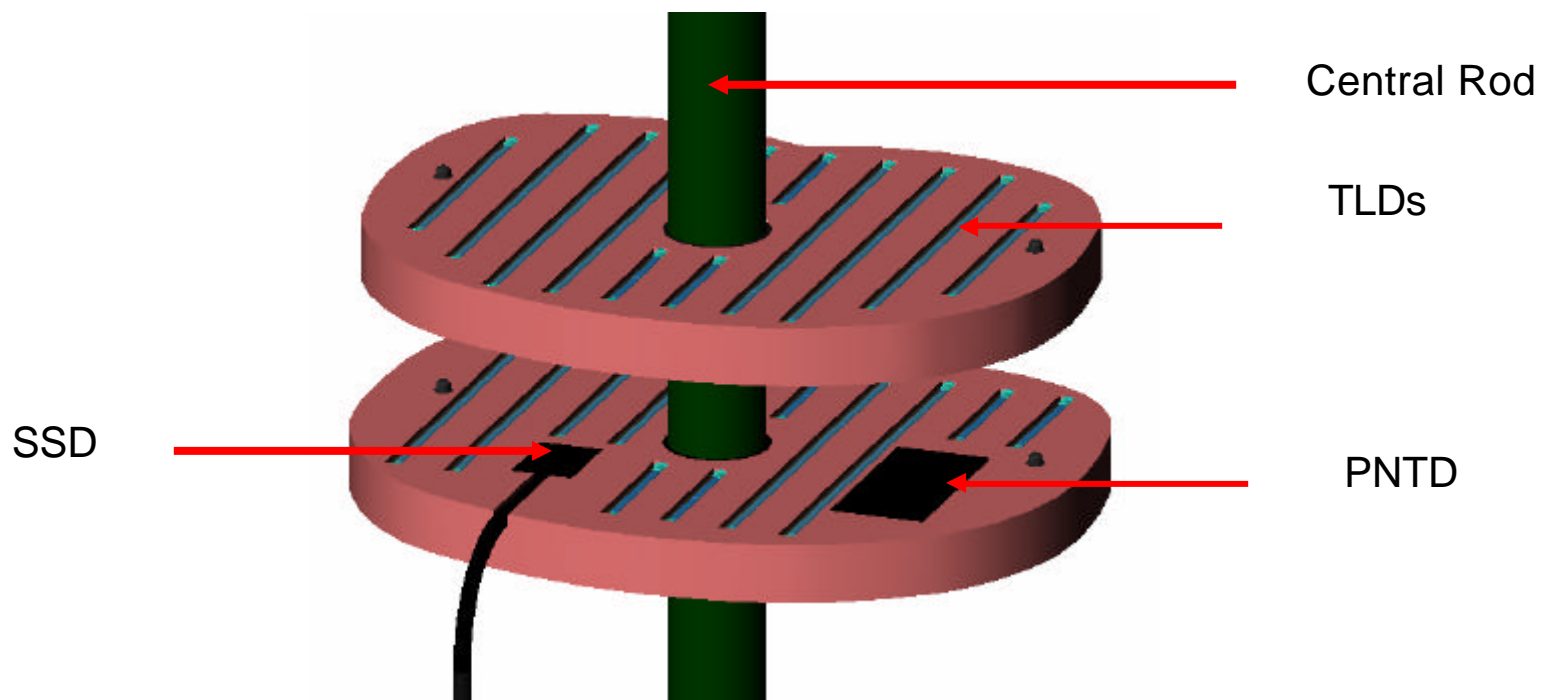
DOSTEL and one PNTD are accommodated at top of the head.

TLD crystals are distributed inside the 33 slices of the phantom within a raster of 2.5 cm.

Besides this passive dosimeters are located in the poncho and outside on the MLI.

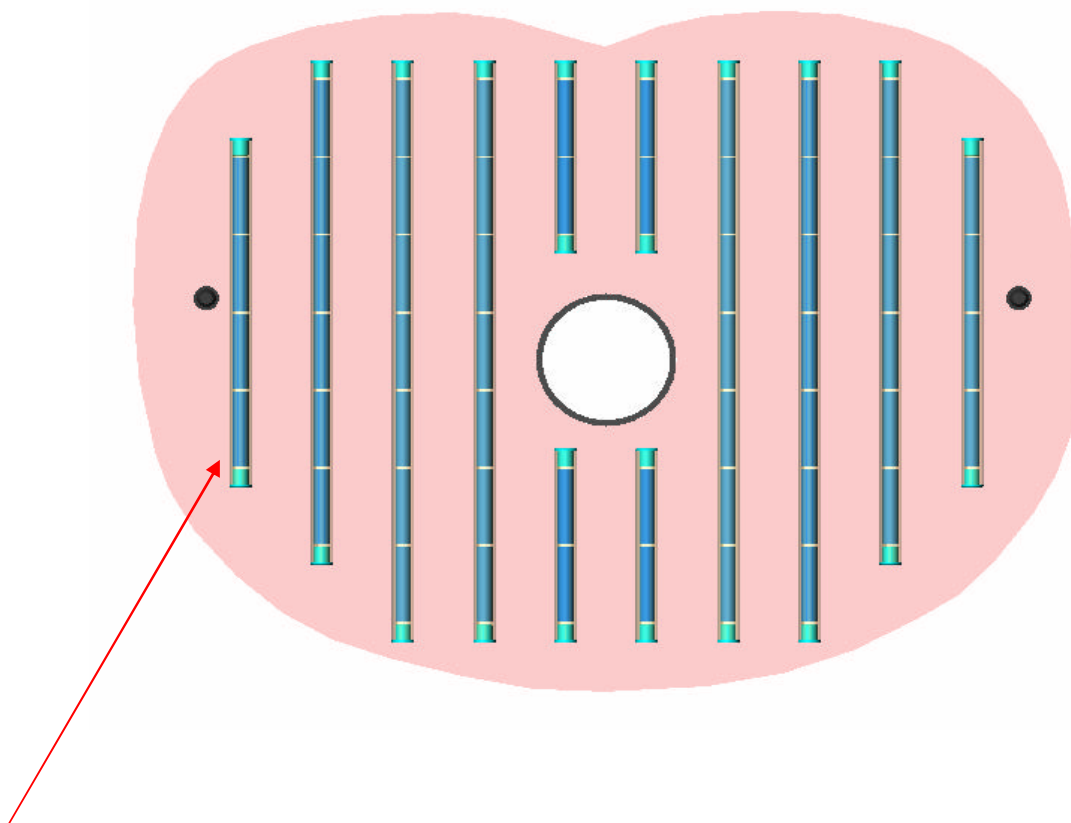


Phantom Torso (SLICES 1 – 33)



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

Phantom Torso (SLICES 1 – 33)



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

Phantom Torso (SLICES 1 – 33)

Investigator	Dosemeter types
DLR, Germany	TLD 600, TLD 700, TLD 700H
Atominstute of the Austrian Universities, Austria	TLD 600, TLD 700
Institute for Nuclear Physics, Poland	MTS-7, MTS-6, MCP- 7, MTT-7
Oklahoma State University, USA	TLD 100, TLD 300, Luxel OSL

Investigators and TLD systems for the phantom torso experiment

Phantom Torso (SLICES 1 – 33)

Slice Number	Positions CI ko	Positions DLR	Positions ATI	Positions McKeever
1		16		
2	22			
3			18	
4	20			6
5		17		
6	18			
7			12	
8	12			
9		10		
10	20			
11		16	16	
12	24			
13		32	32	
14	22			
15		33	33	
16	21			7
17		38	39	
18	23			
19		36	32	
20	21			
21		24	31	7
22	20			
23		22	29	7
24	20			
25		29	29	
26	25			
27		28	29	
28	25			7
29		32	33	
30	20			
31		35	36	
32	23			
33		37	38	
Total	785	405	407	34

Dosemeter distribution for Slices 1 - 33

- SLICE 2 – 32 (even numbers)
Institute for Nuclear Physics, Krakow, Poland
- SLICE 1 – 33 (odd numbers)
DLR, Cologne, Germany and
Atominstute, Vienna, Austria
- SLICES 4, 16, 21, 23, 28
Oklahoma State University, USA

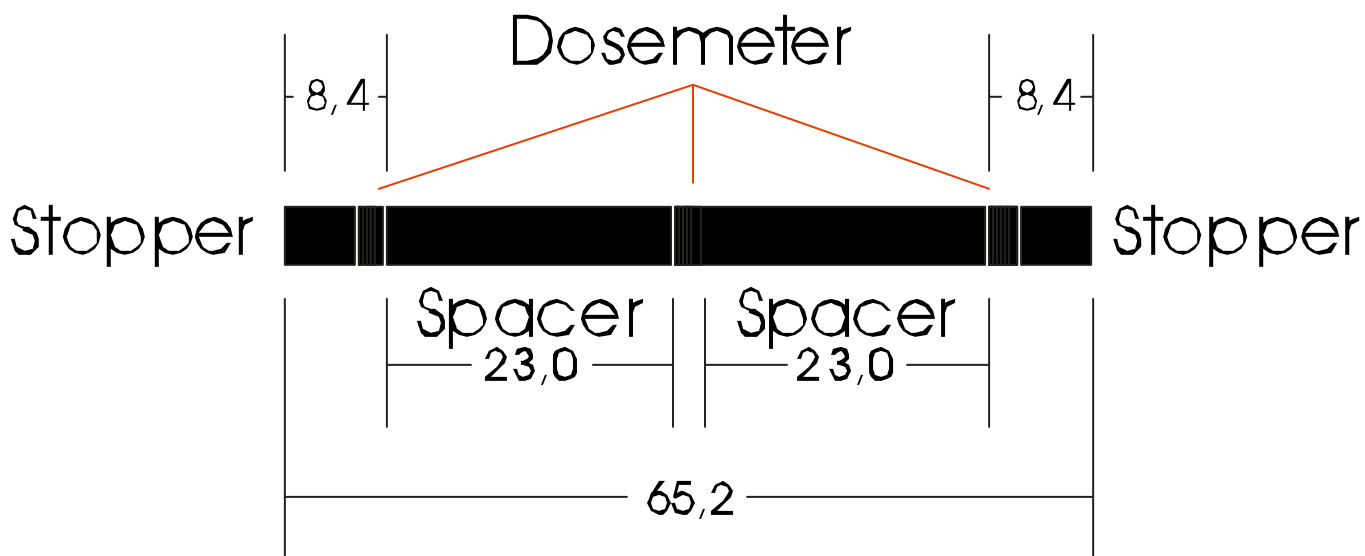
→ 1631 dosimeter positions in total

Phantom Torso (SLICES 1 – 33)

Investigator	Dosemeter at position	Thickness	Total Thickness
DLR	1 x TLD 600, 1 x TLD 700, 1 x TLD 700H	0.9 mm 0.9 mm 0.6 mm	2.4 mm
Atominstiute	1 x TLD 600, 1 x TLD 700	0.9 mm 0.9 mm	1.8 mm
Institute for Nuclear Physics	1 x MTS-7, 1 x MTS-6, 1 x MCP-7, 1 x MTT-7	0.6 mm 0.6 mm 0.6 mm 0.6 mm	2.4 mm
Oklahoma State University	3 x TLD 100, 3 x TLD 300	2.7 mm 2.7 mm	5.4 mm

Thickness of the dosimeter packages for each group

Phantom Torso (SLICES 1 – 33)



Configuration of the dosimeters inside the tubes

Phantom Torso (SLICES 1 – 33)

Tube length (mm)	Number of dosemeter positions
39.8	2
65.2	3
90.6	4
116	5
141.4	6
166.8	7
192.2	8

Tube length and number of dosimeter positions

Phantom Torso (SLICES 1 – 33)



2 dos. pos.



3 dos. pos.



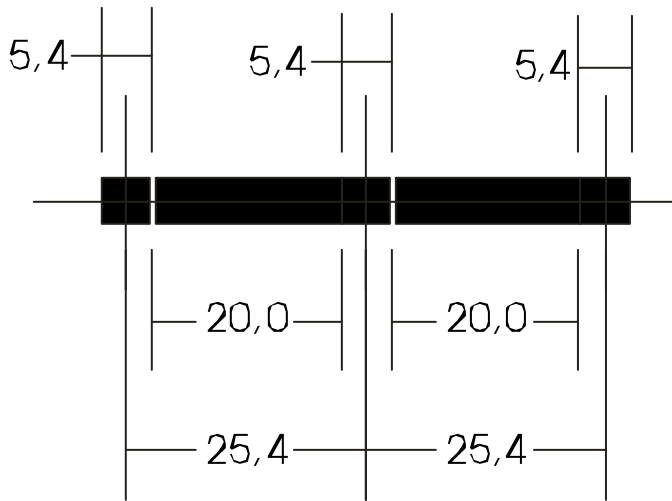
4 dos. pos.



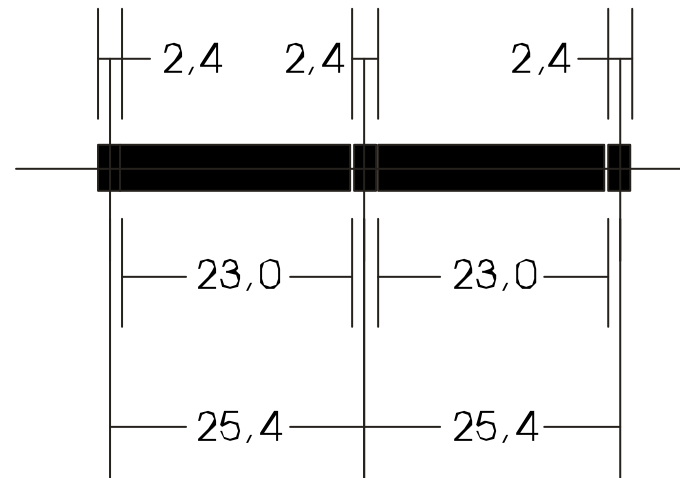
5 dos. pos.

Examples of dosemeter distribution in tubes with 2, 3, 4 and 5 dosemeter positions

Phantom Torso (SLICES 1 – 33)

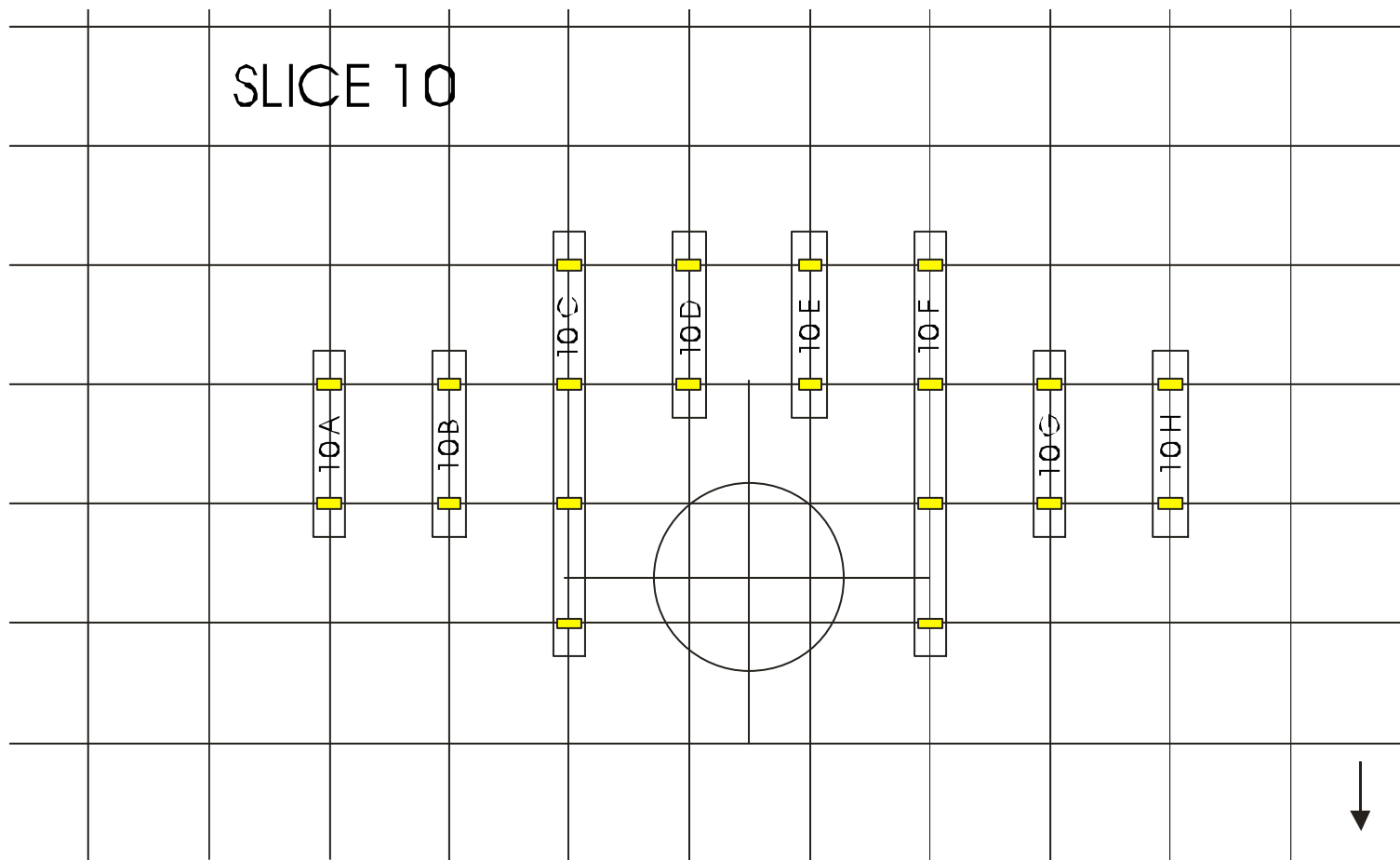


Dosemeter configuration
McKeever

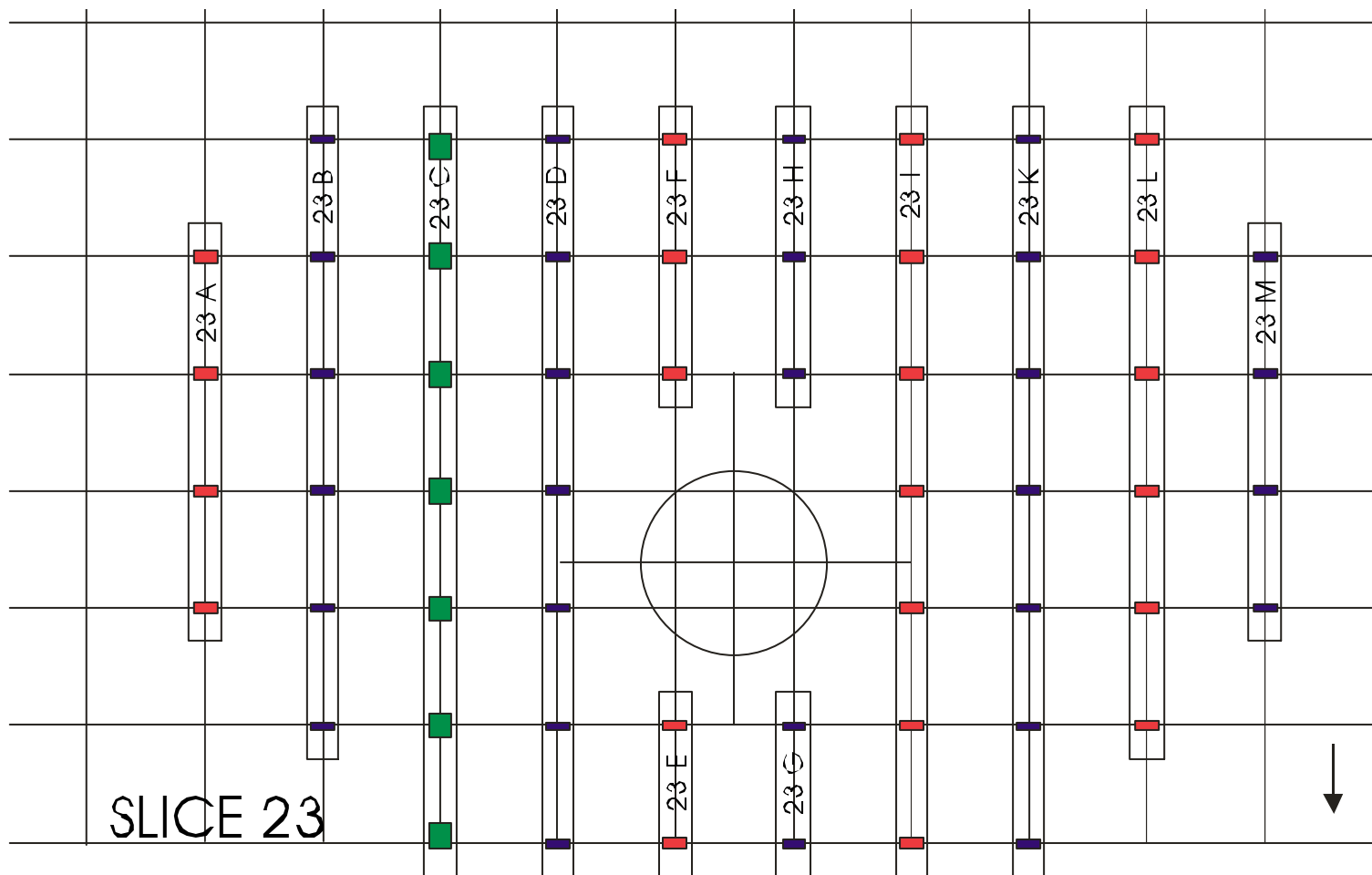


Dosemeter configuration
Olko

Phantom Torso (SLICES 1 – 33)



Phantom Torso (SLICES 1 – 33)



Phantom Torso (SLICES 1 – 33)

Investigator	Dosemeter at position	Positions	Number of dosimeters	Total number of dosimeters
DLR	1 x TLD 600 1 x TLD 700 1 x TLD 700H	405	405 x TLD 600 405 x TLD 700 405 x TLD 700H	1215
Atominstutite	1 x TLD 600 1 x TLD 700	407	407 x TLD 600 407 x TLD 700	814
Institute for Nuclear Physics	1 x MTS-7 1 x MTS-6 1 x MCP-7 1 x MTT-7	785	785 x MTS-7 785 x MTS-6 785 x MCP-7 785 x MTT-7	3140
Oklahoma State University	3 x TLD 100 3 x TLD 300	34	102 x TLD 100 102 x TLD 300	204
Total Number				5373

Total number of dosimeters in the Phantom (Slices 1 – 33)

Phantom Torso (Organ Dose)

Phantom Slice Nr.	Organ
3	Eye
15	Lungs
20	Stomach
22	Kidney
27	Intestine

Organ dose passive boxes:

Dimension outside: 59 x 39 x 24 mm

Dimension inside: 54 x 34 x 20 mm

Phantom Torso (Organ Dose)

Investigator	TLD	OSL	CR - 39
DLR, Cologne, Germany	X		
Atominstiute, Vienna, Austria	X		
Institute for Nuclear Physics, Krakow, Poland	X		
Oklahoma State University, USA	X	X	
Institute for Biomedical Problems, Moscow, Russia	X		X
Eril Research, San Francicso, USA			X
AERI, Budapest, Hungary			X

Phantom Torso (Organ Dose)

- **DLR, Cologne, Germany**
TLD 600, TLD 700, TLD 600H, TLD 700H in each box
- **Atominstitute, Vienna, Austria**
TLD 600, TLD 700, TLD 700H, TLD 300 in each box
- **Institute for Nuclear Physics, Krakow, Poland**
MTS – 7, MTS – 6, MCP – 7, MTT – 7 in each box
- **Oklahoma State University, USA**
TLD 100 and TLD 300 in each box + LUXEL OSL sheets
(two times $19 \times 16 \times 0.29 \text{ mm}$) in all the five passive boxes.
- **Institute for Biomedical Problems, Moscow, Russia**
Combination of TLDs (LiF:Mg, Ti and Al₂O₃) with CR – 39
in all the five passive boxes. *Dimension: 55 x 35 x 2,5 mm*

Phantom Torso (Organ Dose)

- **AERI, Budapest, Hungary**

Passive dosimeter stack in the passive box in slice Nr. 15 (lung) and slice Nr. 22 (kidney)

Dimension for the passive boxes inside: 52 x 32 x 10 mm

Phantom Torso (Organ Dose)



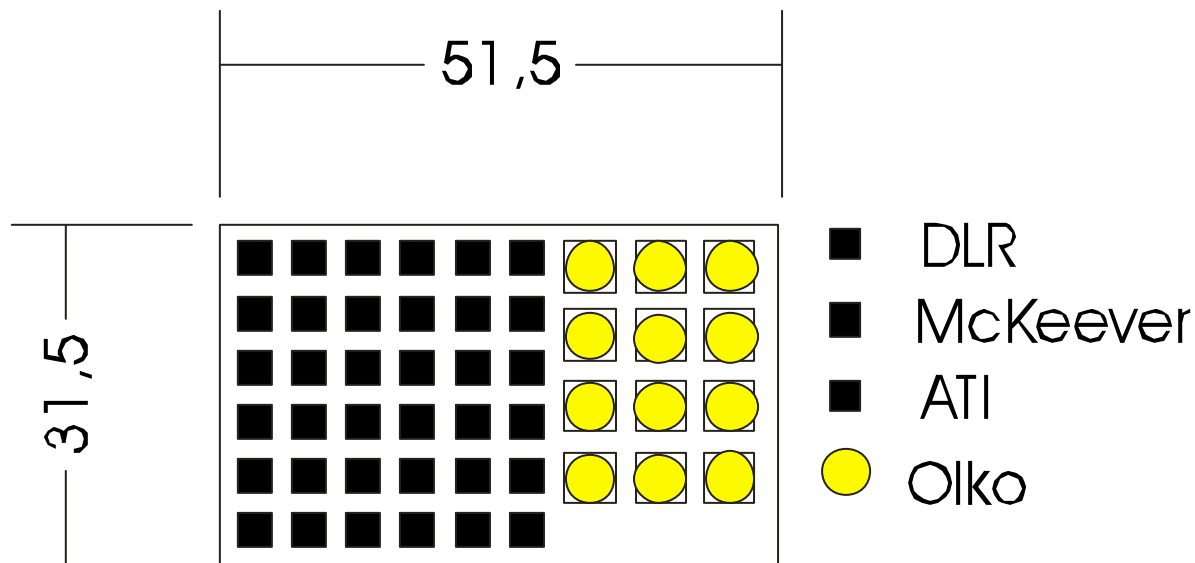
Phantom Torso (Organ Dose)

- **Eril Research, USA**

CR – 39 track etch detectors in each of the five passive boxes.

Phantom Slice Nr.	Organ	Dimension (mm)	Dimension (mm)
3	Eye	2 x (49 x 17.5 x 3) 2 x (49 x 29 x 3) 2 x (35 x 17.5 x 3)	
15	Lungs		1 x (52 x 17.5 x 3) 1 x (52 x 32 x 3) 1 x (35 x 17.5 x 3)
20	Stomach	2 x (49 x 17.5 x 3) 2 x (49 x 29 x 3) 2 x (35 x 17.5 x 3)	
22	Kidney		1 x (52 x 17.5 x 3) 1 x (52 x 32 x 3) 1 x (35 x 17.5 x 3)
27	Intestine	2 x (49 x 17.5 x 3) 2 x (49 x 29 x 3) 2 x (35 x 17.5 x 3)	

Phantom Torso (Organ Dose)



TLD configuration for Slices 15 and 22

Phantom Torso (Organ Dose)



TLD configuration for Slices 3, 20 and 27

Phantom Torso (Passive Box Head)

Investigator	TLD	OSL	CR - 39
DLR, Cologne, Germany	X		
Atominstiute, Vienna, Austria	X		
Institute for Nuclear Physics, Krakow, Poland	X		
Oklahoma State University, USA	X	X	
Institute for Biomedical Problems, Moscow, Russia	X		X
Eril Research, San Francicso, USA			X

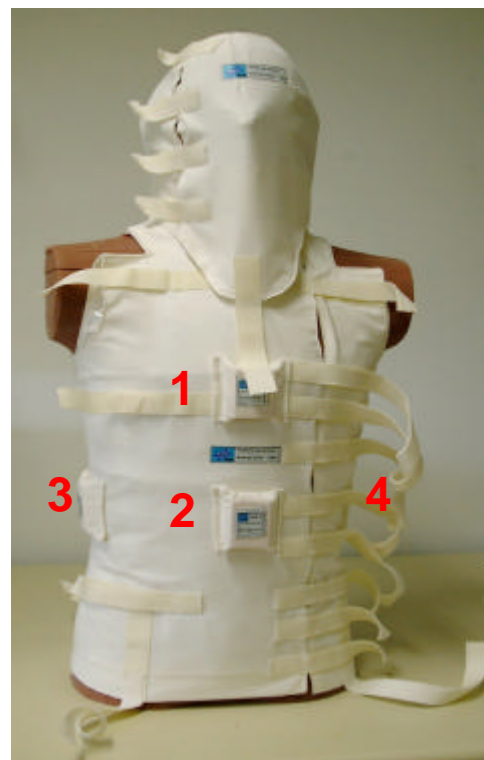
Dimension outside:

70 x 40 x 30 mm

Dimension inside:

64 x 34 x 24 mm

Phantom Poncho (Passive Boxes)



6 passive dosimeter boxes mounted onto the Poncho

Phantom Poncho (Passive Boxes)

Package	Location
1	Front up
2	Front down
3	Side right
4	Side left
5	Back up
6	Back down

Poncho passive boxes:

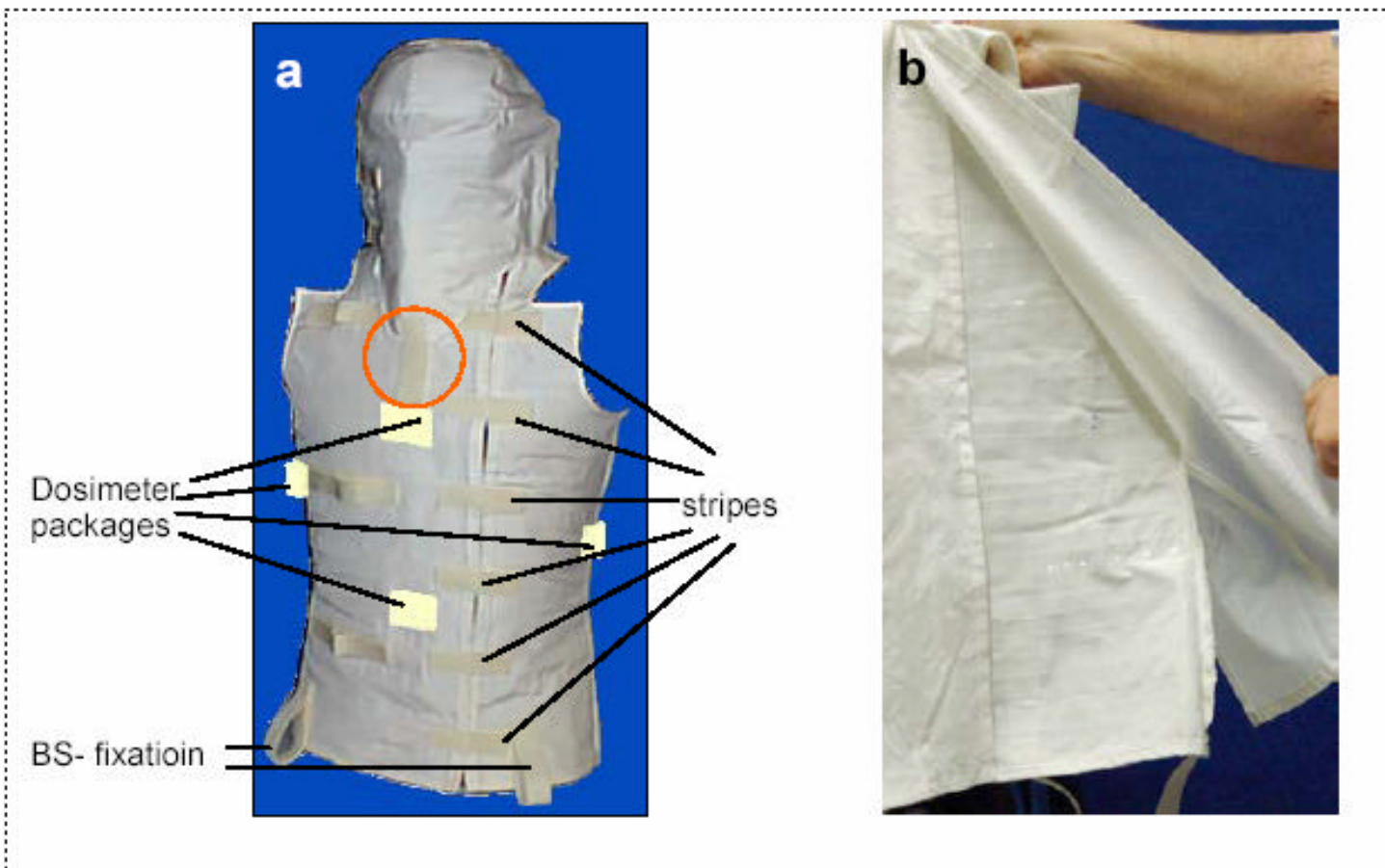
Dimension outside: 59 x 39 x 14 mm

Dimension inside: 54 x 34 x 10 mm

Phantom Poncho (Passive Boxes)

Package	IMBP CR – 39 + TLDs Dimension 55 x 35 x 2,5 mm	KFKI CR – 39 Dimension 55 x 35 x 5 mm	Eril Research CR – 39 Dimension 55 x 35 x 3 mm	TLDs provided by DLR, ATI, McKeever and Olko
1	X		X	X
2	X		X	X
3		X	X	X
4		X	X	X
5	X		X	X
6	X		X	X

Phantom Poncho



Phantom Poncho

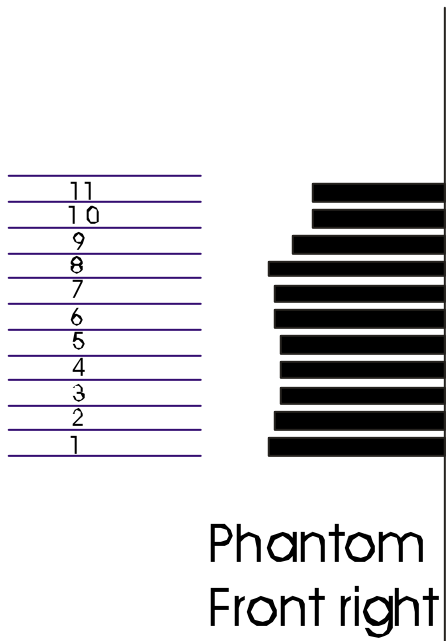


TLDs are embedded in PE stripes and sewed to the inner side of the poncho

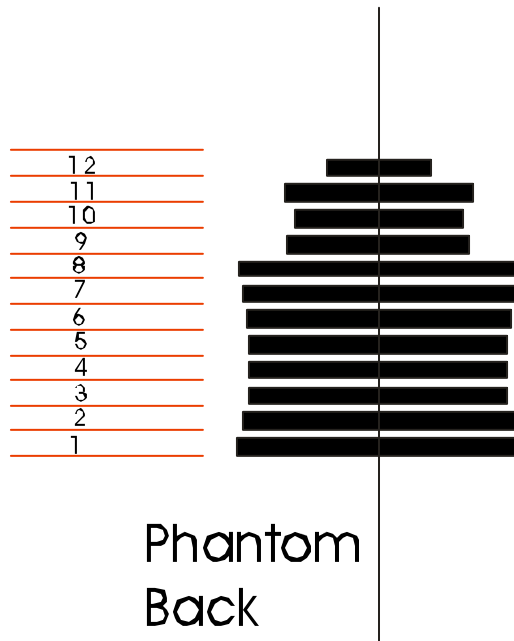
TLDs will be provided by the following groups:

- DLR, Germany
- ATI, Austria
- Institute for Nuclear Physics, Poland
- IMBP, Russia
- Oklahoma State University, USA

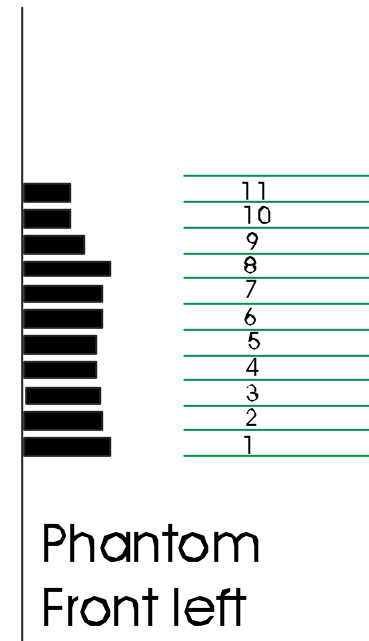
Phantom Poncho



220 dosemeter positions



350 dosemeter positions

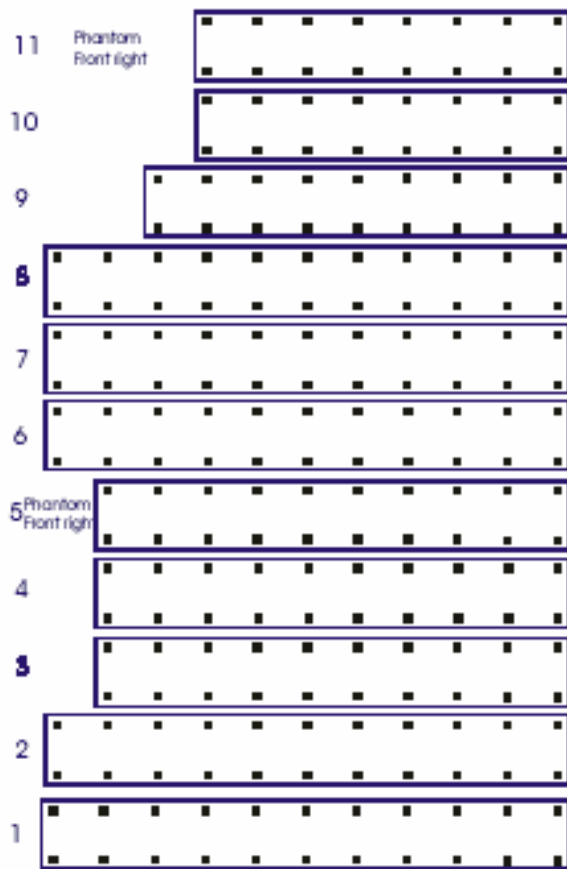


104 dosemeter positions

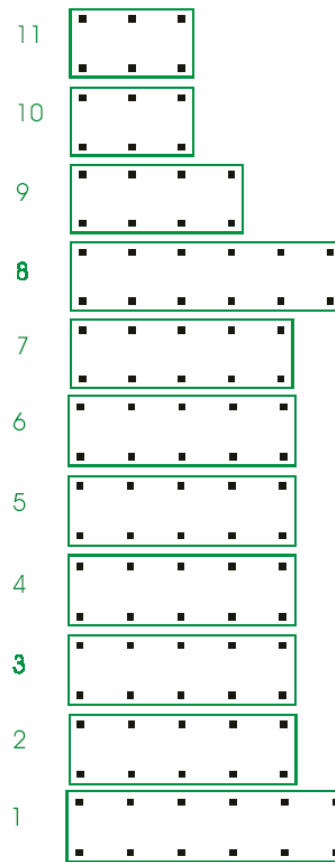
Phantom Poncho

**Phantom
Front
Right**

**220
Dosemeter
positions**



Phantom
Front
Left



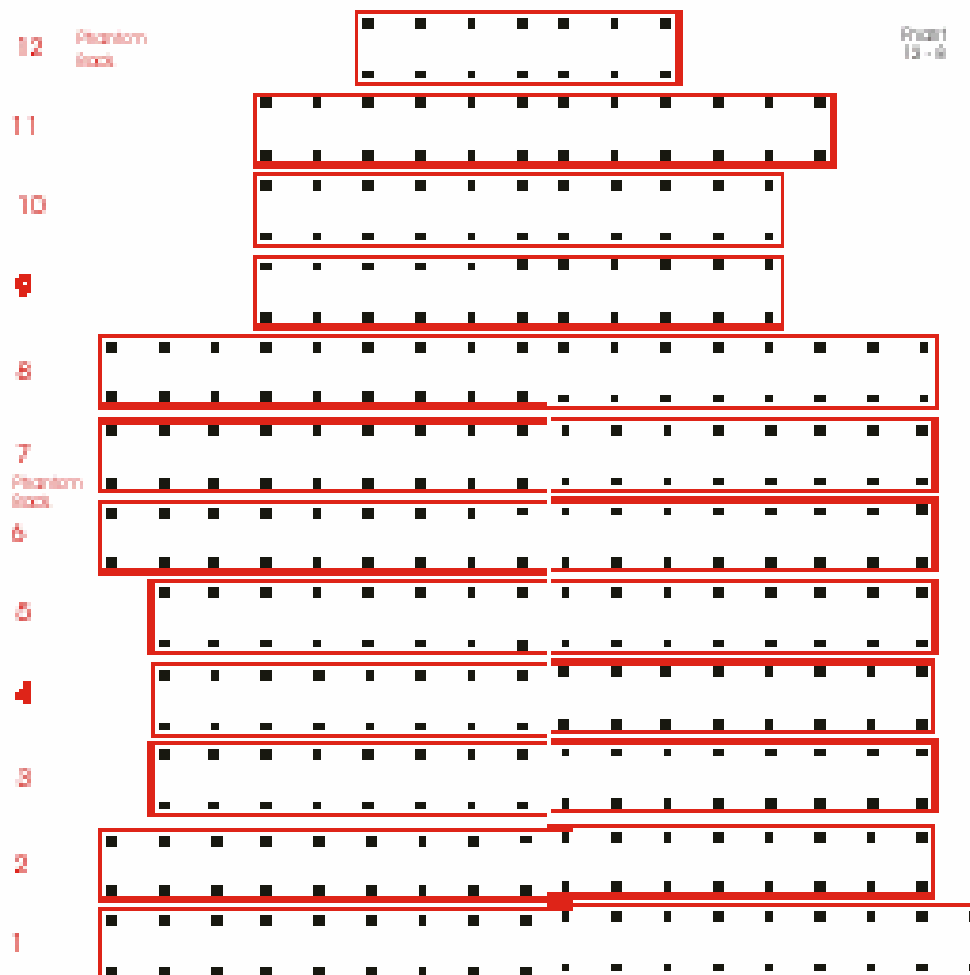
**Phantom
Front
Left**

**104
Dosemeter
positions**

Phantom Poncho

Phantom
Back

350
Dosemeter
positions

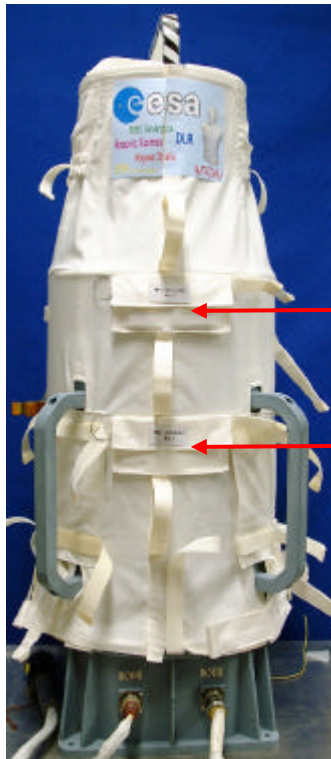


Phantom Poncho

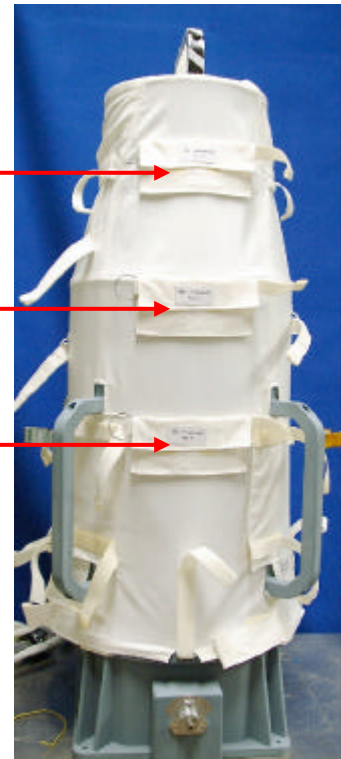
In addition to the TLDs neutron detection packages will be provided by:

- D. Bartlett, NRPB, Chilton, Great Britain
→ NRPB PADC
- M. Luszik – Bhadra, PTB, Germany
→ PTB PADC

Phantom MLI



Detector
bags



Phantom MLI

	Outer dimension	Inner dimension
Package 1	59 x 59 x 14 mm	55 x 55 x 10 mm
Package 2	59 x 39 x 14 mm	55 x 35 x 10 mm

Total number of five exposure positions equipped with two packages (Package 1 and Package 2) each.

The end configuration of passive detectors inside the MLI packages still needs TBD !!

Reference Dosimetry

The following „Reference Dosimetry“ experiments are planned for the duration of the MATROSHKA experiment:

- **Reference passive dosemeter package onboard the ISS**
- **Ground Reference Experiments**

Fading tests for the TLDs based on thermal sensor data from the MATROSHKA experiment

Intercalibration of the various TLD materials in reference fields

Start of reference dosimetry

→ Launch of the MATROSHKA experiment