



# **DLR and ESA Human Space Dosimetry – Current experiments and the future**

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***Institute of Aerospace Medicine, Cologne***

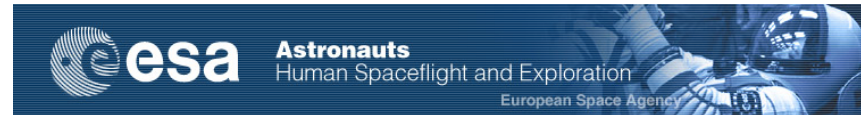


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➤ MATROSHKA



➤ EuCPD



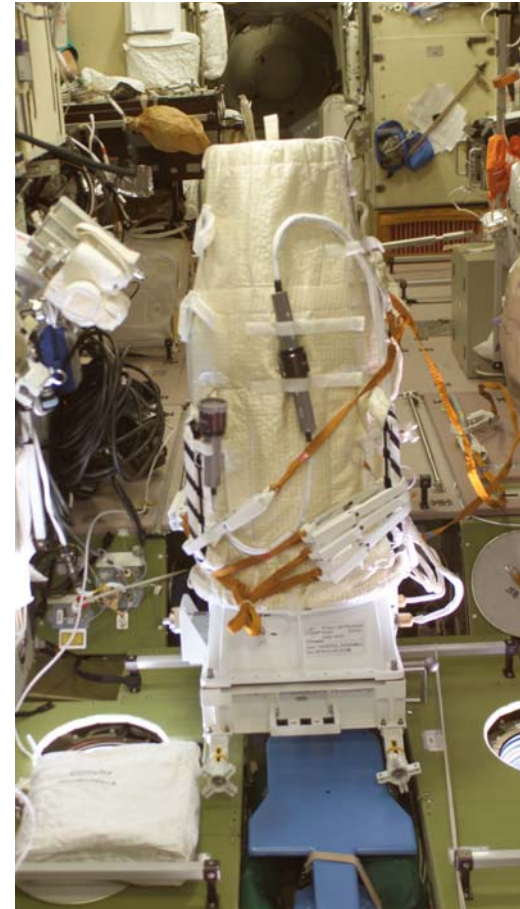
➤ Future....



# MATROSHKA



- MATROSHKA (MTR) Facility is designed to determine the radiation exposure of an astronaut / cosmonaut during an extravehicular activity (EVA) (MTR-1) and during his stay inside the International Space Station (MTR-2 A/B)
- Radiation exposure is measured in a Phantom simulating an Human Upper Torso shielded with a Carbon Fibre structure simulating the EVA suit
- Active and Passive Radiation Detectors are distributed over the whole body to determine skin and organ doses



MATROSHKA inside ISS January 2004

# MATROSHKA



- **MATROSHKA-1** was the first long duration phantom experiment positioned outside a Space Station (Duration of ~ 600 days)
- **MATROSHKA-2 A/B** will measure the dose distribution of an astro – and cosmonaut inside the ISS
- The combination of **MTR-1** and **MTR-2** will for the first time allow the comparison of skin- and depth dose measurements performed with the same facility in and outside the ISS
- Results will give the dose distribution inside a Human Phantom for a better correlation between skin and organ dose and for better risk assessment in future long duration space flight

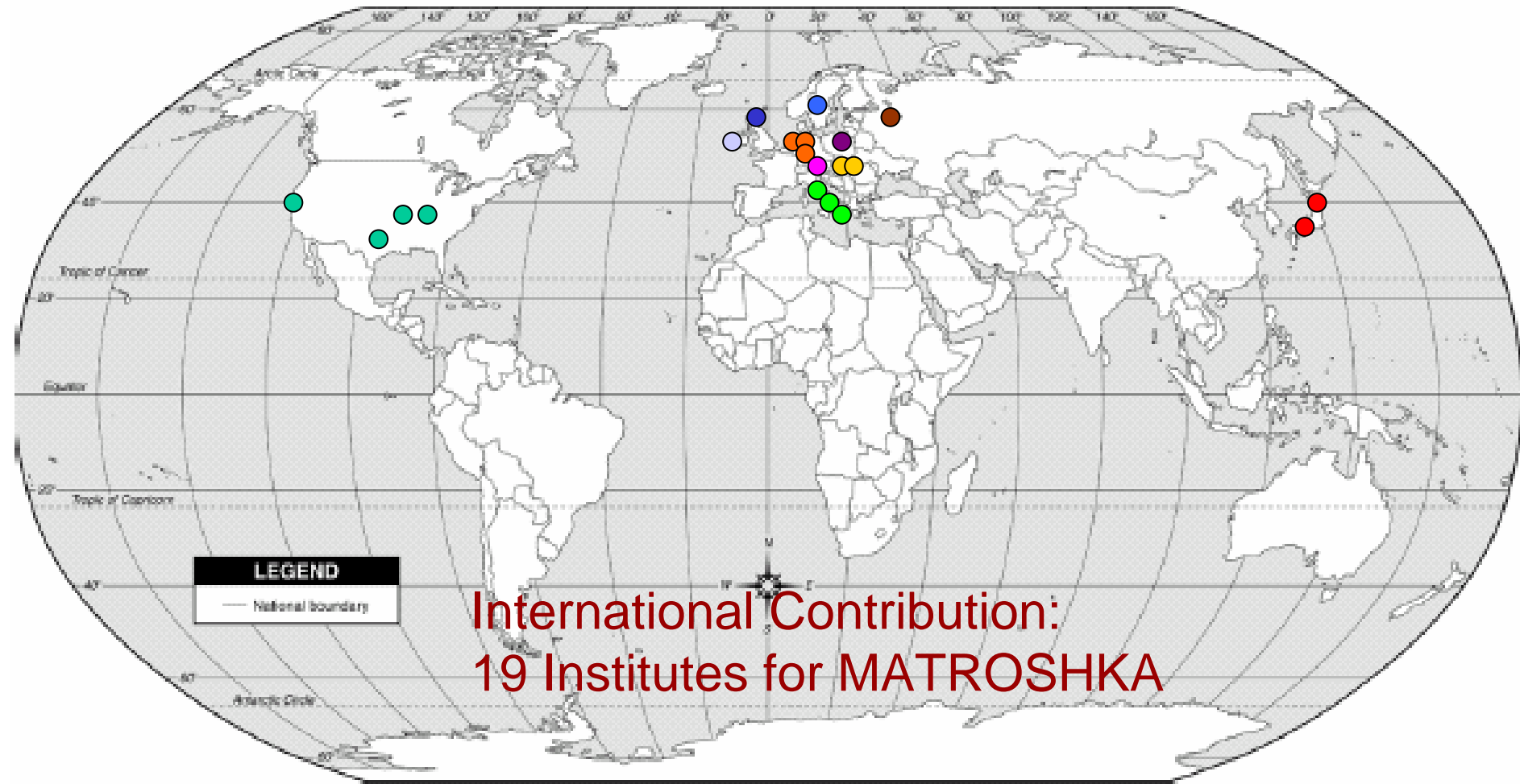


MATROSHKA-1 EVA February 2004

**ESA Project**



**Science and Project Lead: G. Reitz, DLR**



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# The MATROSHKA Facility

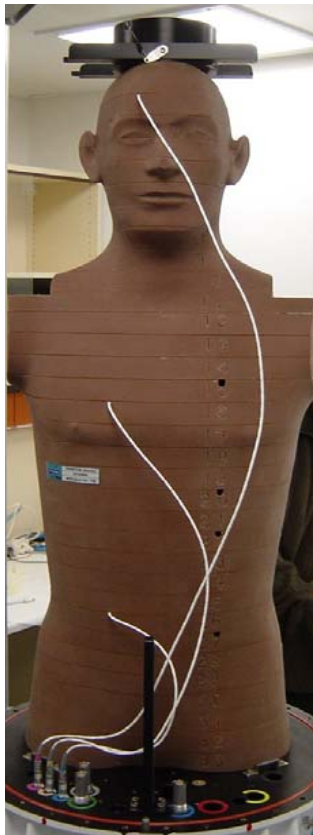


Phantom Torso

+ Poncho

+ Container

+ MLI (MTR-1)



# The MATROSHKA Facility – Active radiation detectors



**DOSTEL**  
(Dosimetric Telescope)



**SSD**  
(Silicon Scintillator Device)

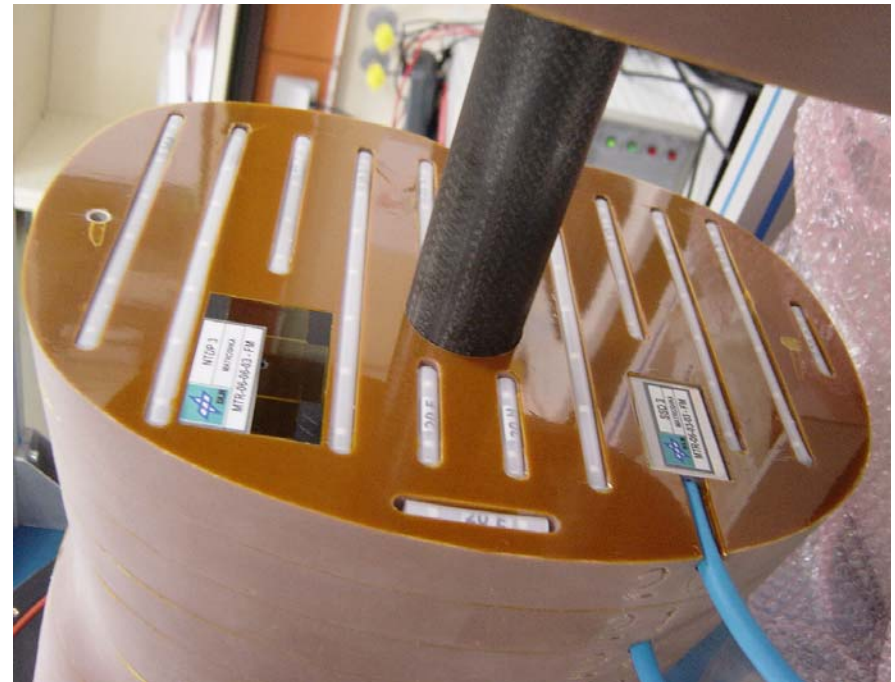
- Eye
- Lung
- Stomach
- Kidney
- Intestine



**TEPC**  
(Tissue equivalent proportional counter)



# The MATROSHKA Facility – Passive radiation detectors



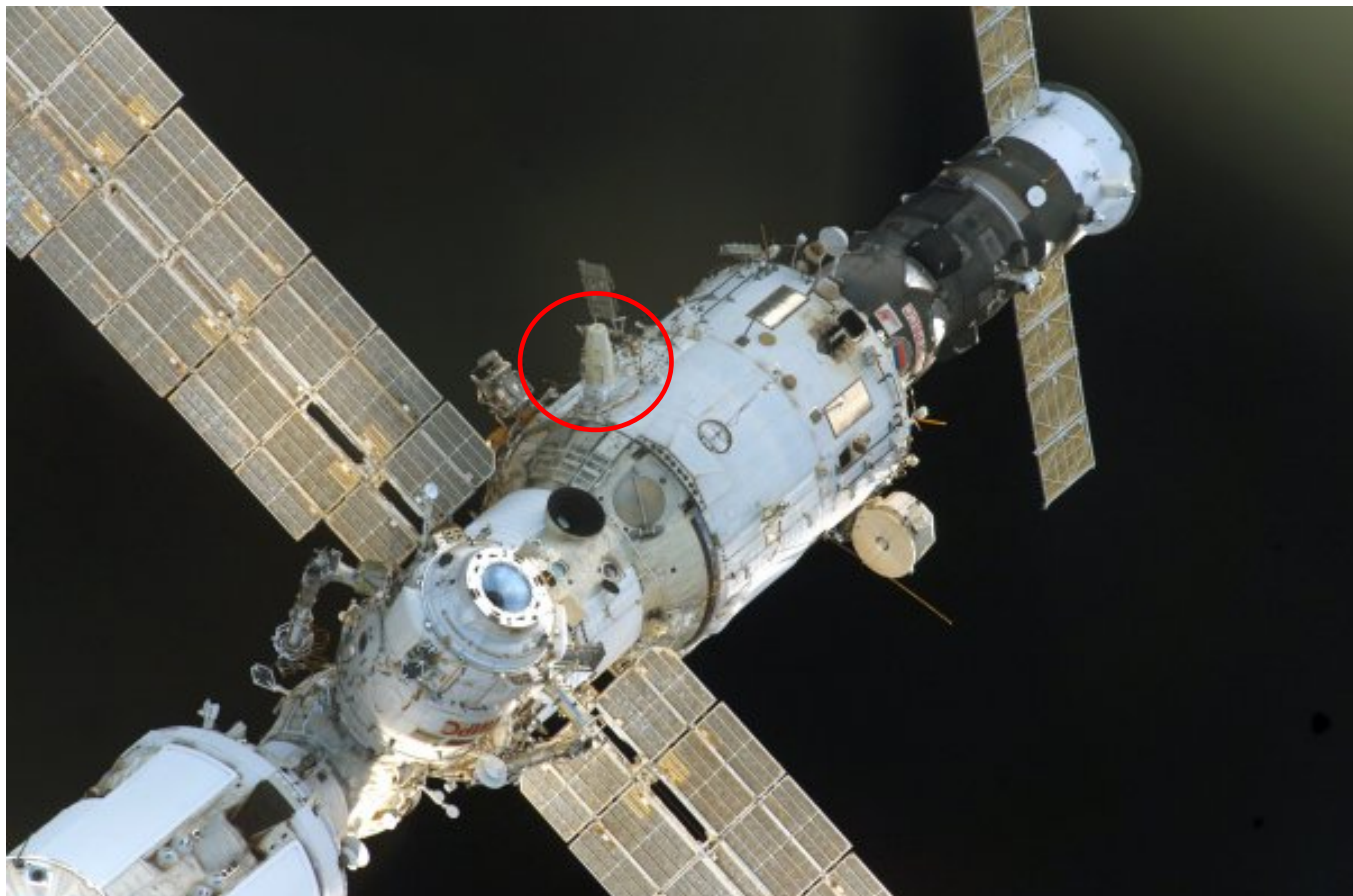
Thermoluminescence detectors (TLDs) and Nuclear Track Etch detectors  
Total Number : ~ 6000

# MATROSHKA-1 Timetable



|                                      |  |
|--------------------------------------|--|
| Launch of MATROSHKA                  | 29. January 2004 with PROGRESS   |
| Docking with ISS                     | 31. January 2004   |
| EVA                                  | 26. February 2004 performed by expedition 8 crew Alexander Kaleri Michael Foale      |
| Activation of the active instruments | 16. April 2004   |
| Outside Exposure                     | 26. February 2004 – 18. August 2005  |
| EVA                                  | 18. August 2005 performed by expedition 11 crew Sergei Krikalev and John Phillips    |
| Dismounting of the passive detectors | 14. September 2005 performed by expedition 11 crew Sergei Krikalev and John Phillips |
| Detector download                    | 11. October 2005 with Soyuz  |

# MATROSHKA-1

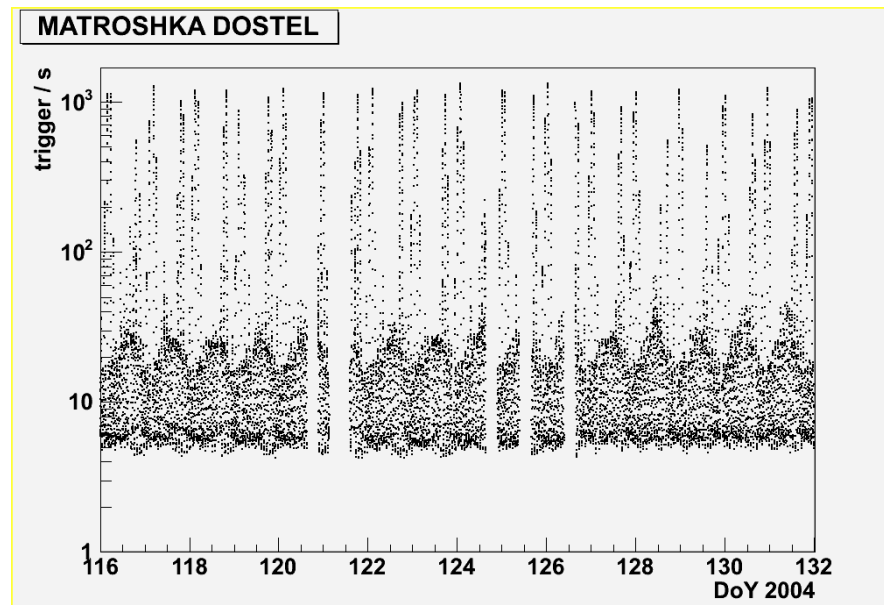


MATROSHKA mounted outside the ISS February 2004 – August 2005

# MATROSHKA-1 Science (active DOSTEL)

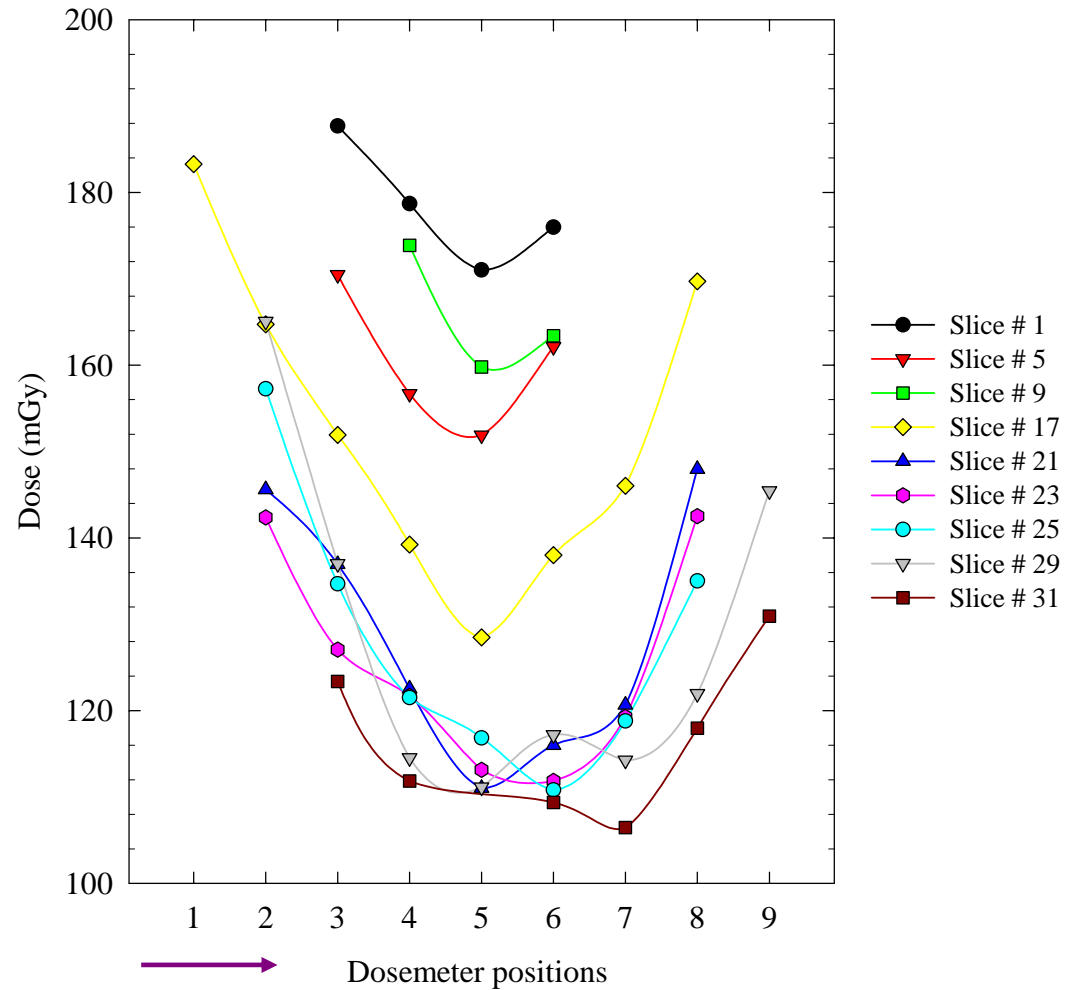
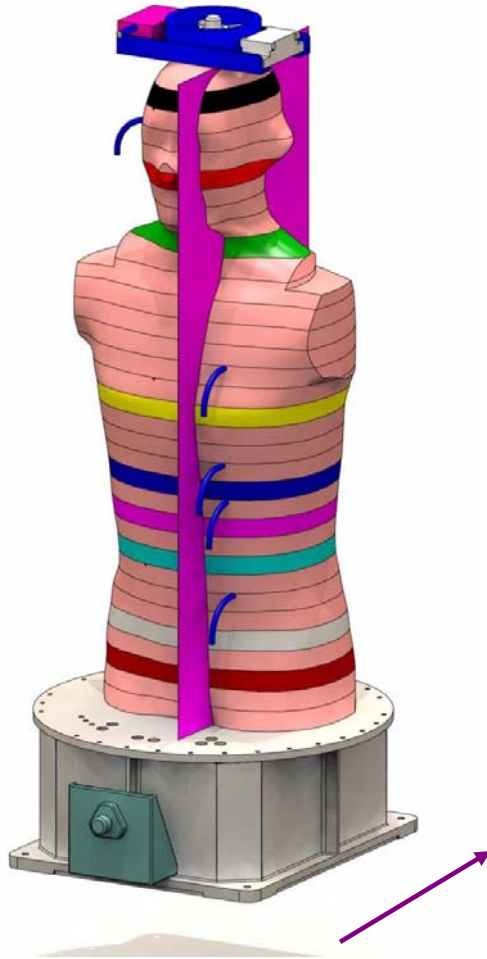


- Radiation exposure during an EVA: 1.3 mSv/day
- Radiation exposure inside the ISS: 0.4 mSv/day



Count rate of DOSTEL over a period of 16 days

# MATROSHKA-1 Science (passive TLDs)

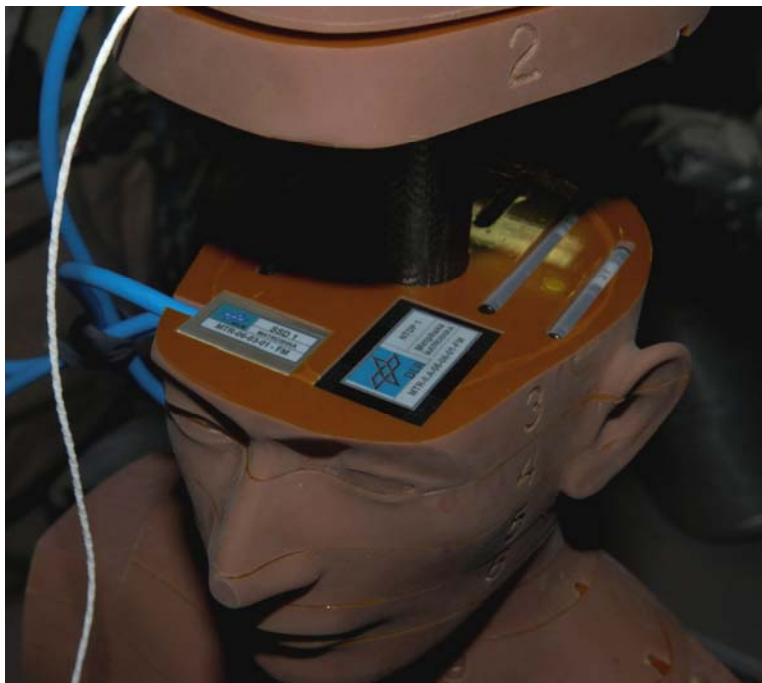


# MATROSHKA-2 Timetable



|   |  |
|---|--|
| New Detector upload – Start of MATROSHKA-2 Phase A (passive)        | 21. December 2005 with PROGRESS 20P  |
| Integration of the passive detector set into the MATROSHKA Facility | 05. January 2006 performed by expedition 12 crew William McArthur and Valery Tokarev |
| Exposure time for MATROSHKA-2 Phase A                               | ~ September 2006   |
| Start of MATROSHKA-2 Phase B (passive and active)                   | Autumn 2006 (6 months)   |
| Start of MATROSHKA-2 Phase C (2 <sup>nd</sup> outside exposure)     | Spring 2007  |

# MATROSHKA-2 Detector mounting



MATROSHKA-2 Phase A passive detector mounting January 2006

# MATROSHKA-2 Exposure Inside ISS



MATROSHKA-2 Phase A ISS exposure in the docking compartment (DC-1)

# MATROSHKA



## ➤ **Passive dosimetry**

Combination of TLD/ OSL with CR-39 detectors for the determination of

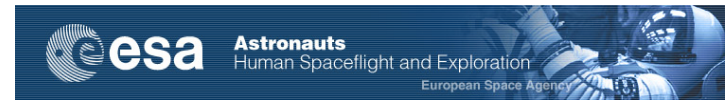
- absorbed dose
- LET spectra / Qualityfactor
- dose equivalent
- neutron dose

## ➤ **Active dosimetry**

- Tissue equivalent proportional counter
- Silicon telescope
- Plastic scintillator
- LET spectra / Qualityfactor ... Neutron component

# EuCPD

## European Crew Personal Dosemeter

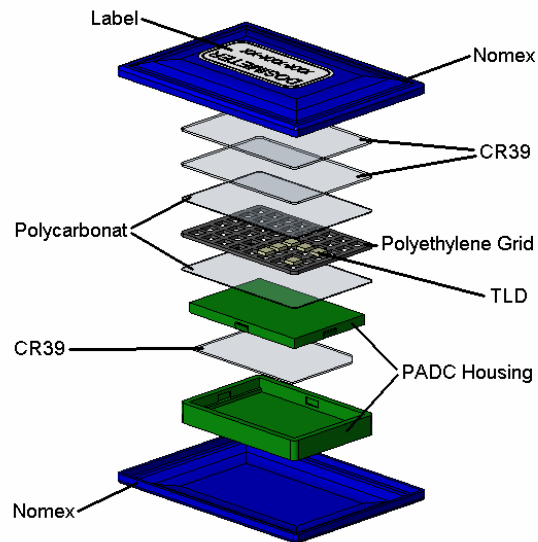


Starting with STS-121 ... STS-116...

# EuCPD

## European Crew Personal Dosemeter

Light weight (~ 30g) passive dosemeter system



- Thermoluminescence Detectors (TLD's)
- CR-39 Nuclear Track Etch Detectors
- PADC Neutron Detector

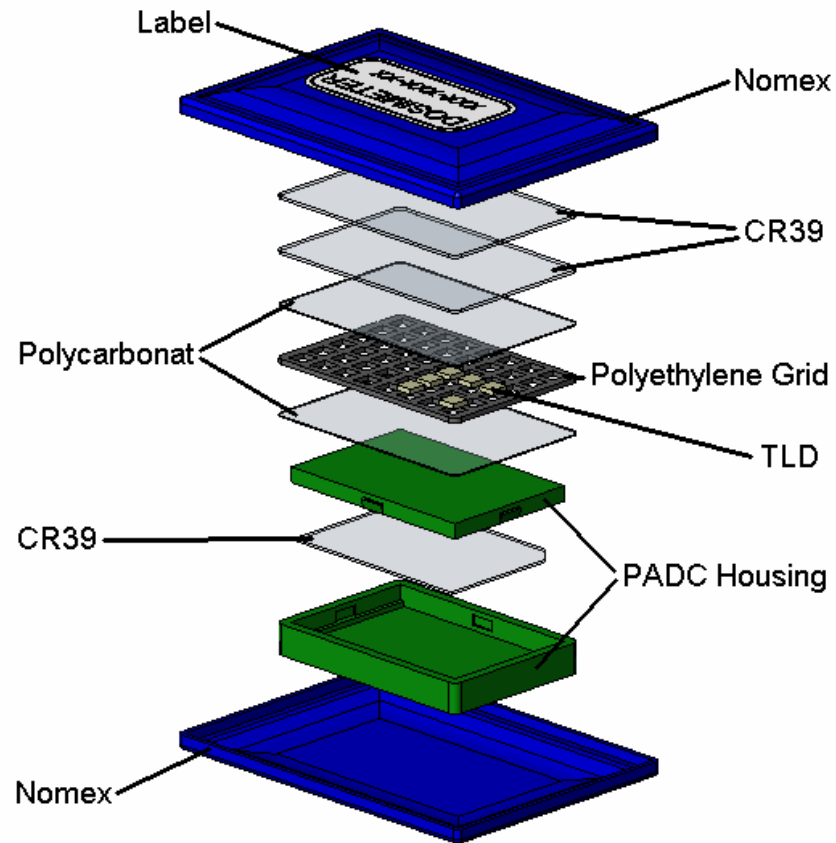
Personal Dosemeter for European Astronauts (inside (IVA) and outside (EVA) the ISS)

# EuCPD

## European Crew Personal Dosemeter

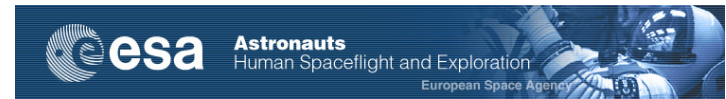


- 48 x TLD's
- 2 x CR-39
- 1 x PADC



# EuCPD

## European Crew Personal Dosemeter



### ➤ Personal Crew Dosemeter

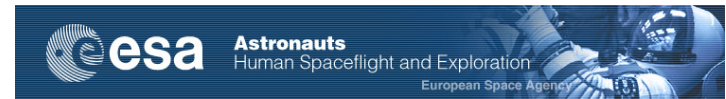
→ Passive Systems (easy to handle)

→ Development of a small active device  
(based on Silicon detectors)

# ALTCRISS

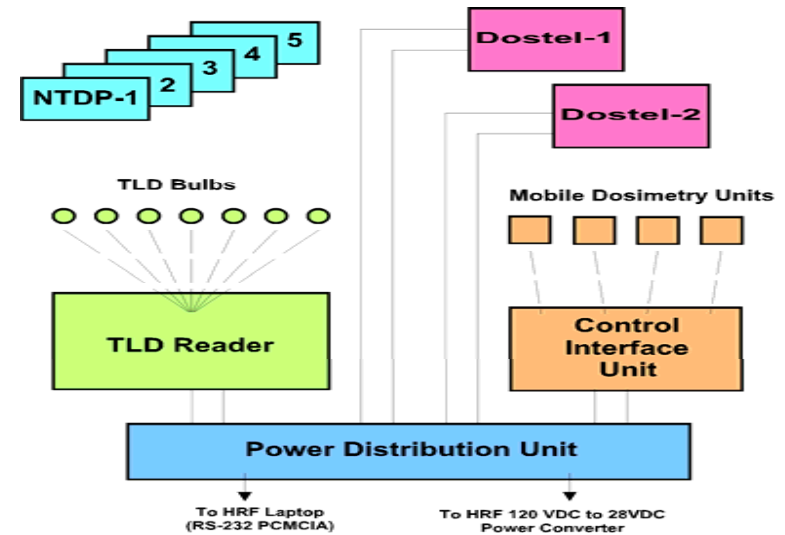


# DOSIS

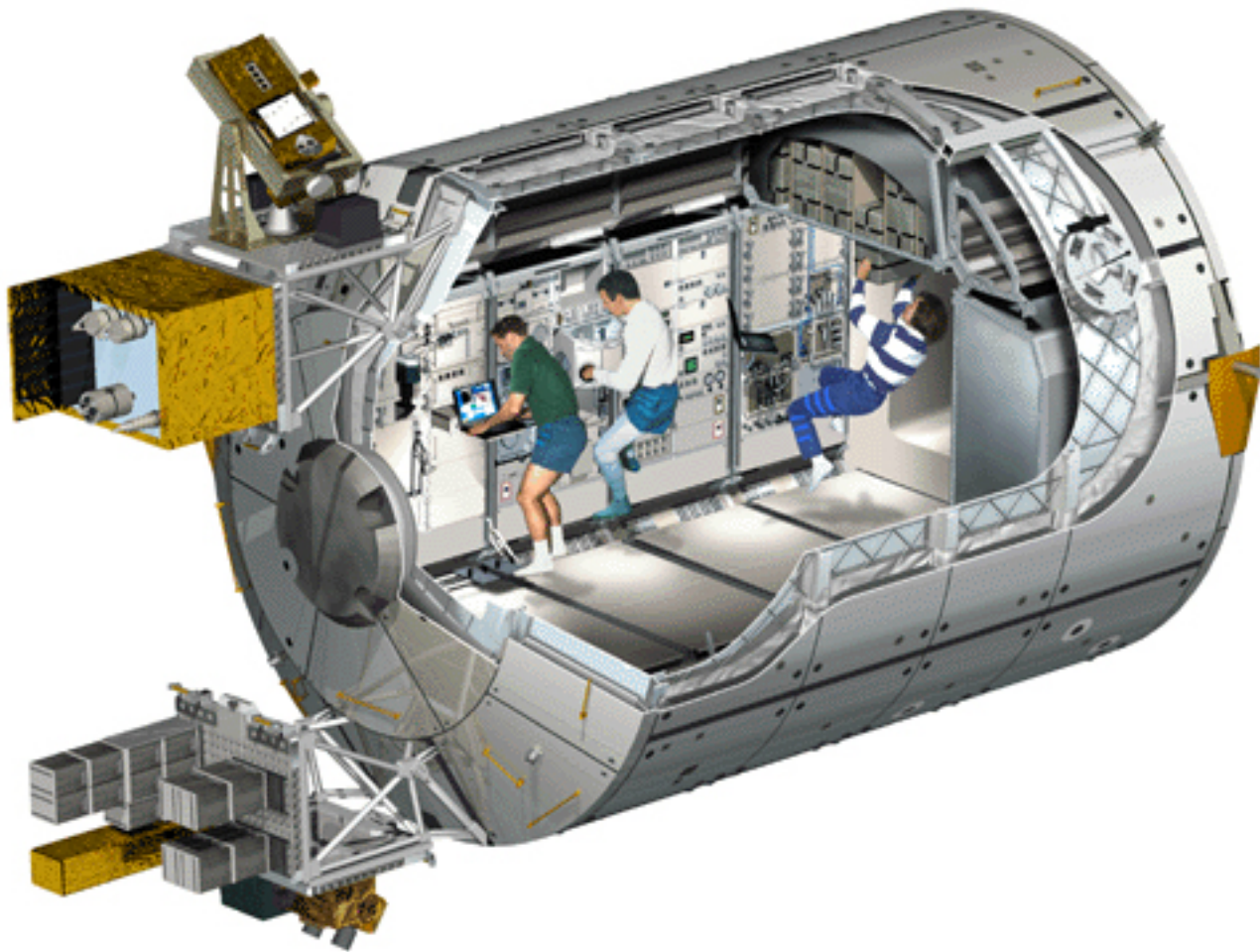
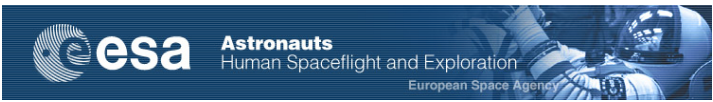


## Dose Distribution Inside ISS

- Dosimetric Mapping Experiment
- Dosimetry inside the ISS using active and passive devices

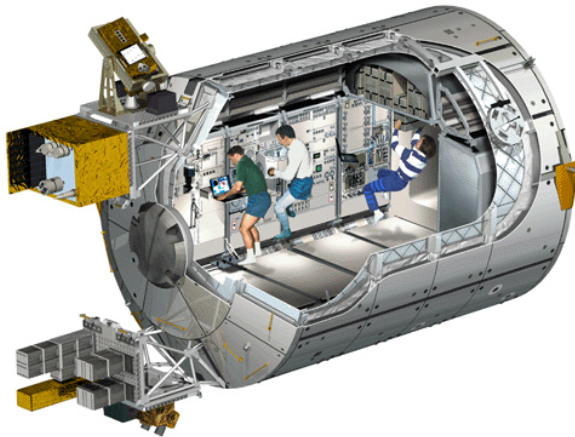


# Columbus



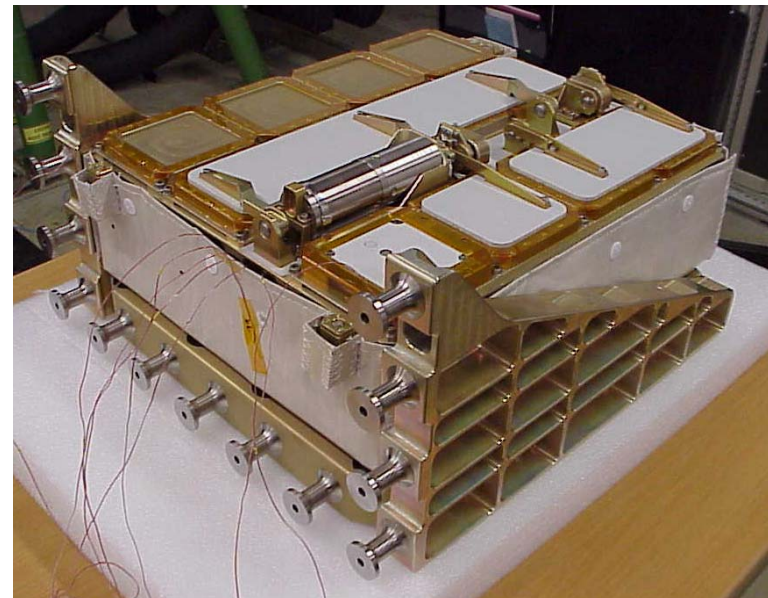
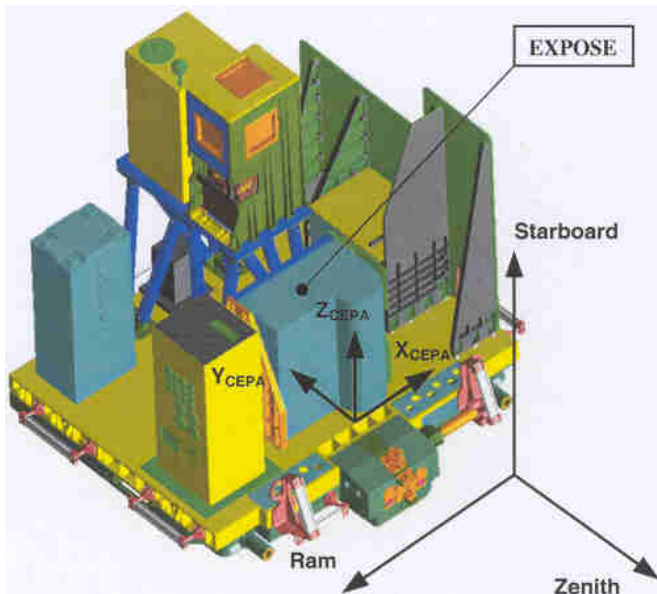
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# Columbus



- Permanent Dosimetric Mapping Inside the Columbus module
- Outside : Dosimetry on **EuTEF** and on **Expose**

# Columbus / EuTEF



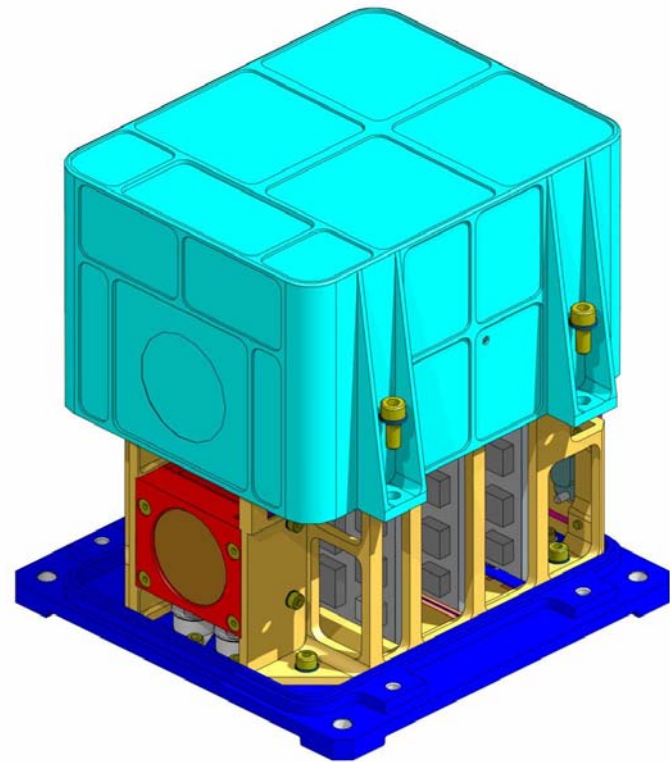
EuTEF – Active dosimetry

Expose – Passive dosimetry

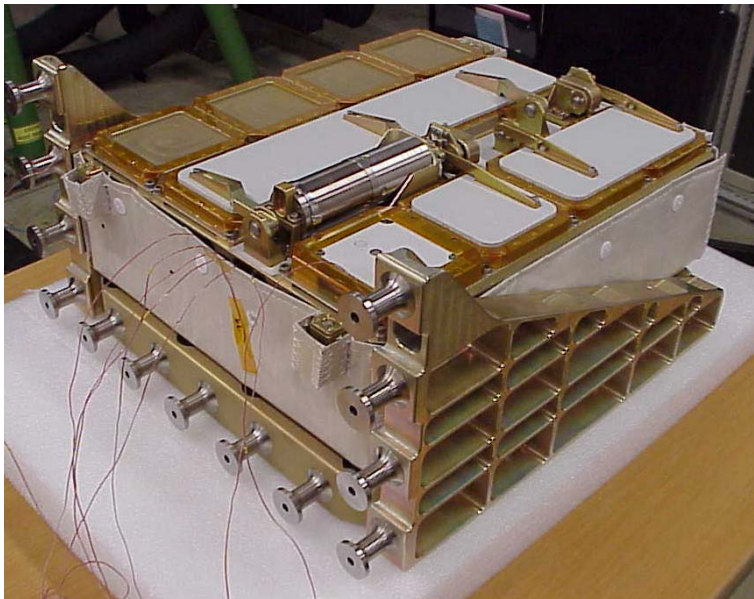
# Columbus / EuTEF



➤ **EuTEF** → **DOSTEL (active)**



# Expose / Expose-R

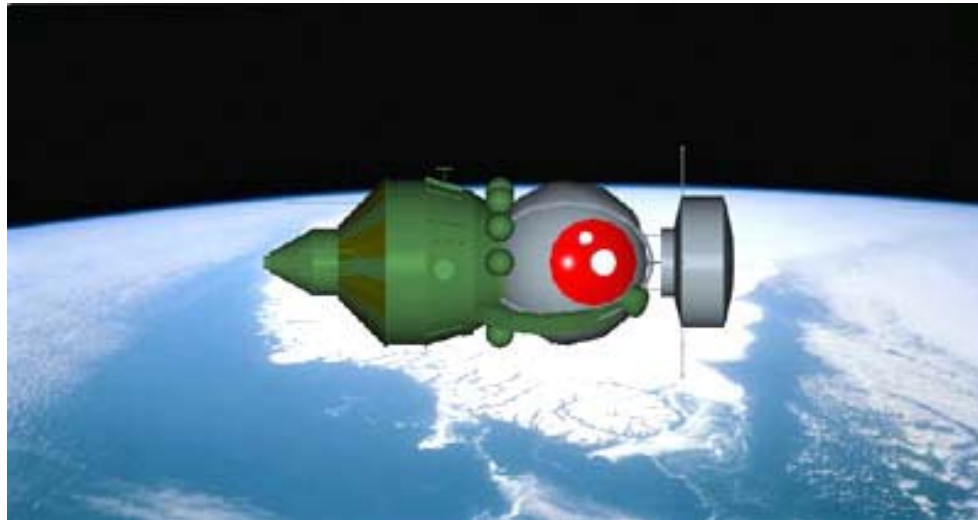


➤ **Passive Dosimetry**

# FOTON – Biopan Missions



**Astronauts**  
Human Spaceflight and Exploration  
European Space Agency

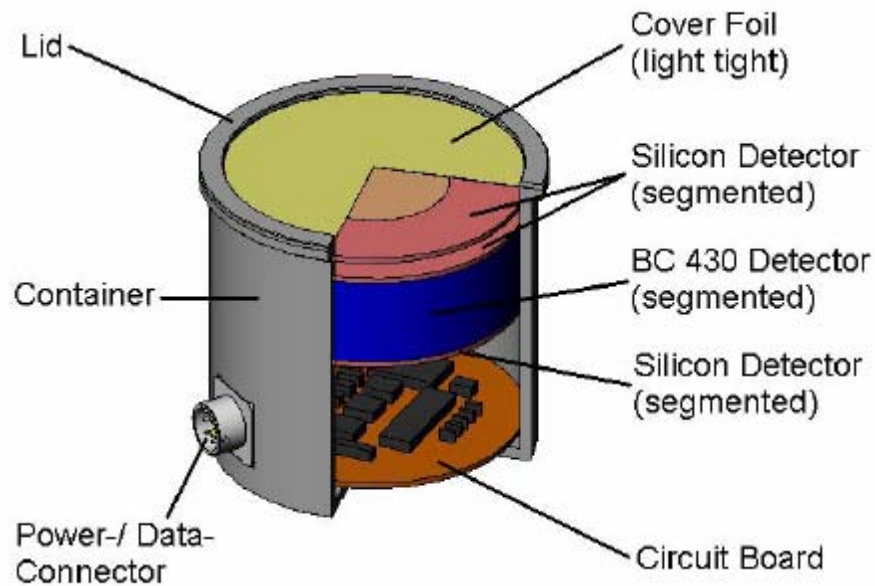


➤ **Dosimetry for very low shielding thicknesses**



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# ExoMars

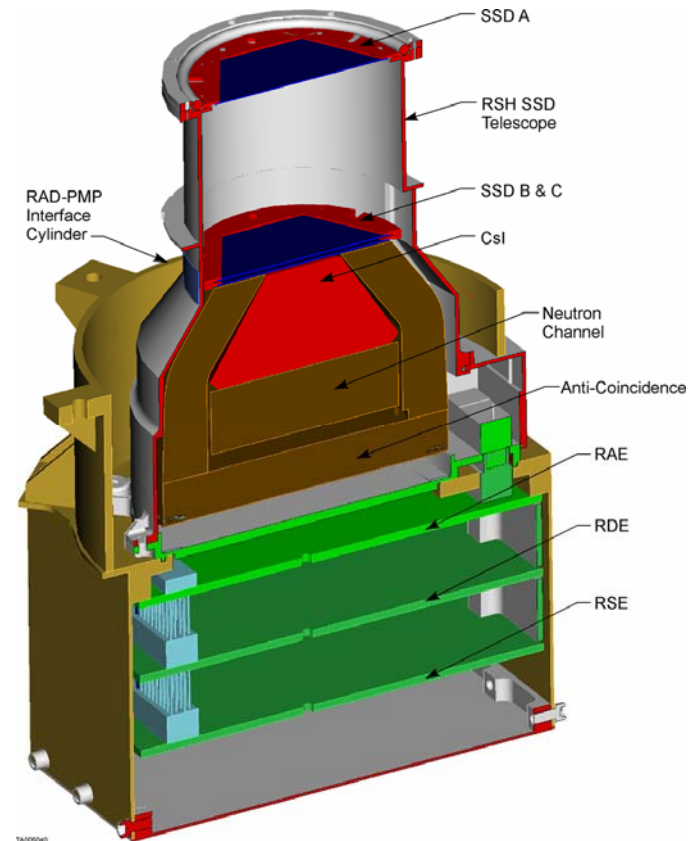


Dimensions: Ø 58 mm, Height 55 mm

Mass: ~ 500g

Power consumption: 600mW

# MSL



# Timeline:

