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

T. Berger

DLR – German Aerospace Center

Institute of Aerospace Medicine, Cologne

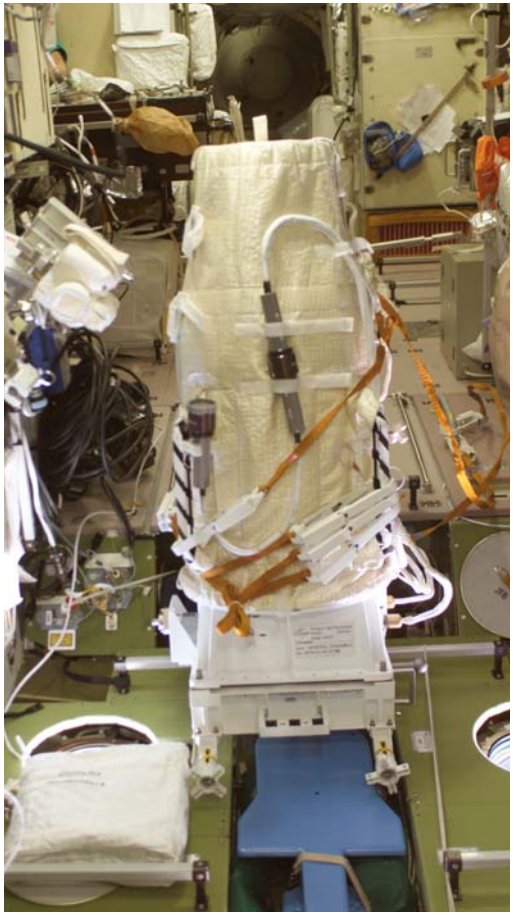
- MATROSHKA

- 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

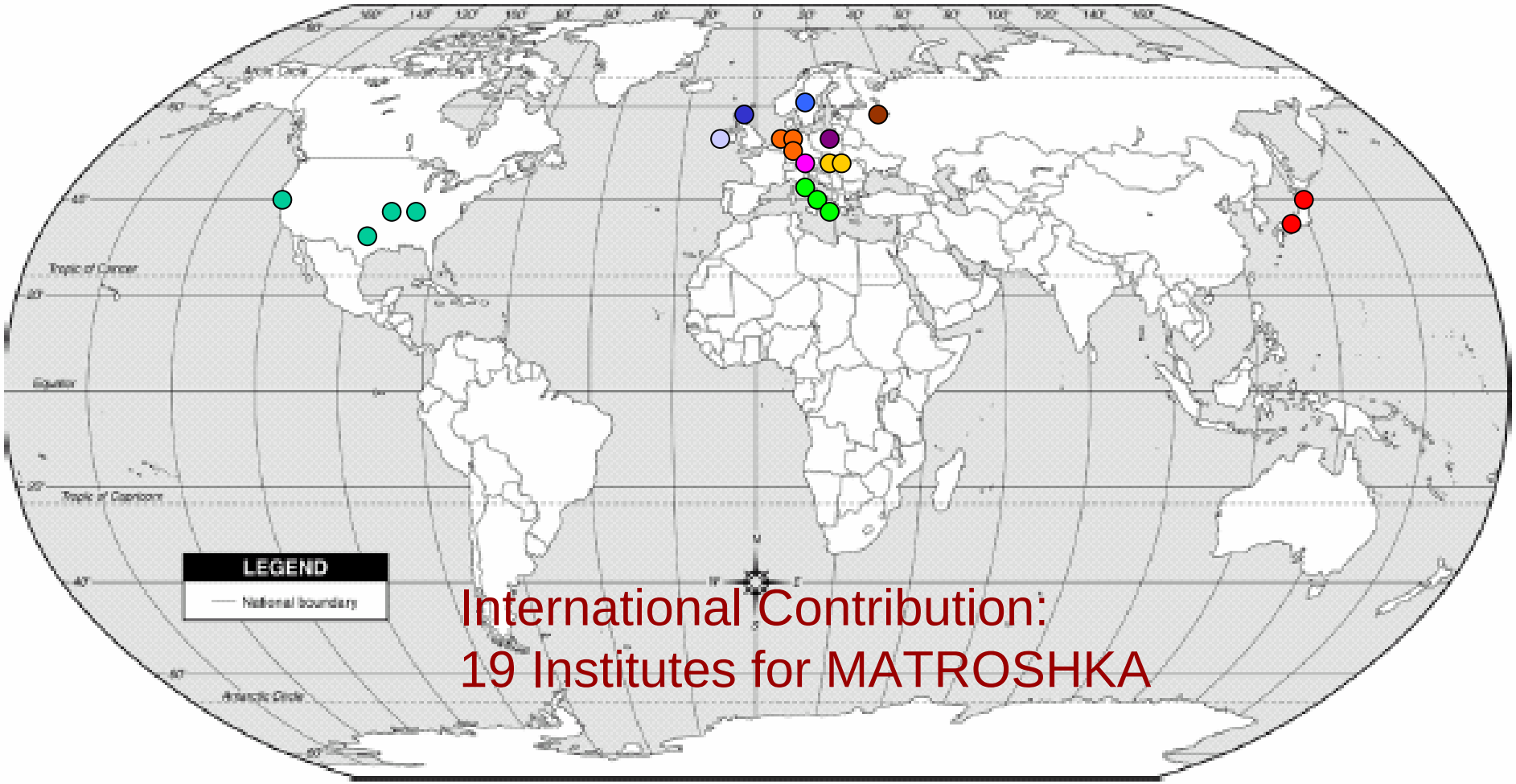
MATROSHKA

- 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

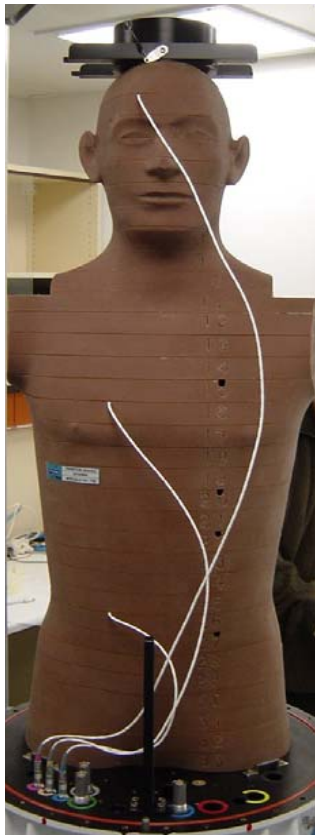
Science and Project Lead: G. Reitz, DLR



International Contribution:
19 Institutes for MATROSHKA

The MATROSHKA Facility

Phantom Torso



+ Poncho

+ Container

+ MLI (MTR-1)

The MATROSHKA Facility – Active radiation detectors

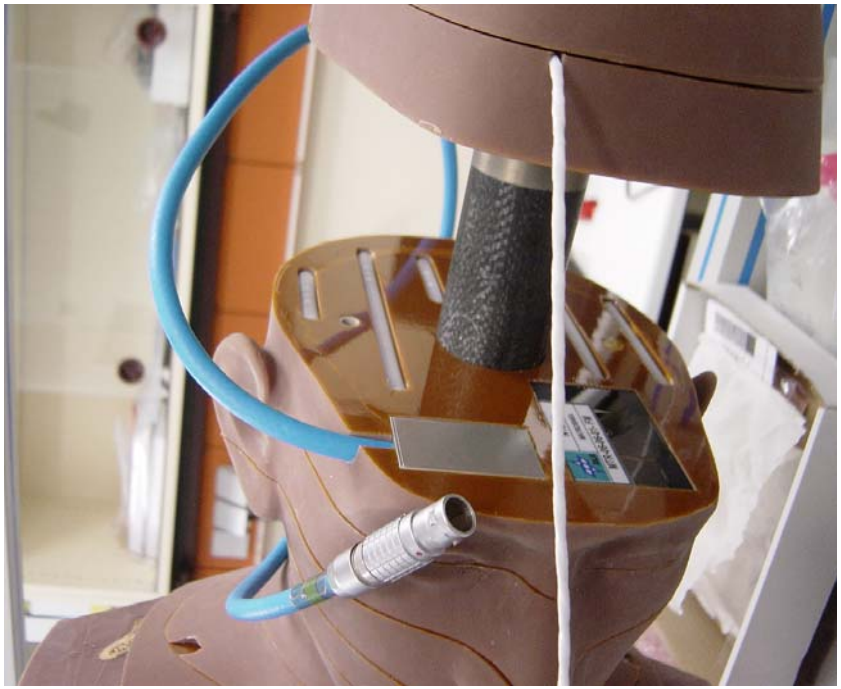
DOSTEL
(Dosimetric Telescope)

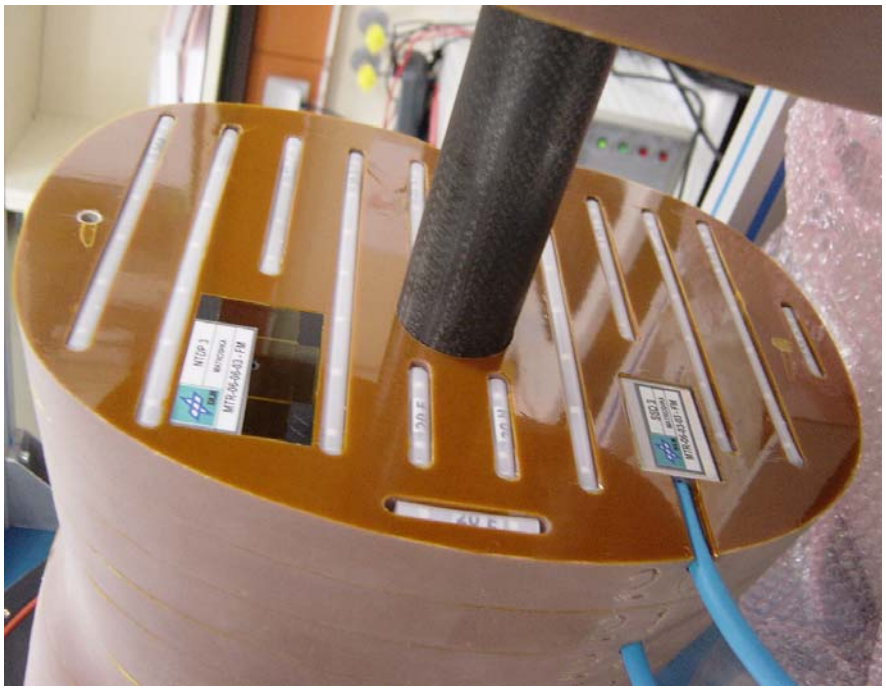
SSD
(Silicon Scintillator Device)

- Eye
- Lung
- Stomach
- Kidney
- Intestine

TEPC
(Tissue equivalent proportional counter)

The MATROSHKA Facility – Passive radiation detectors



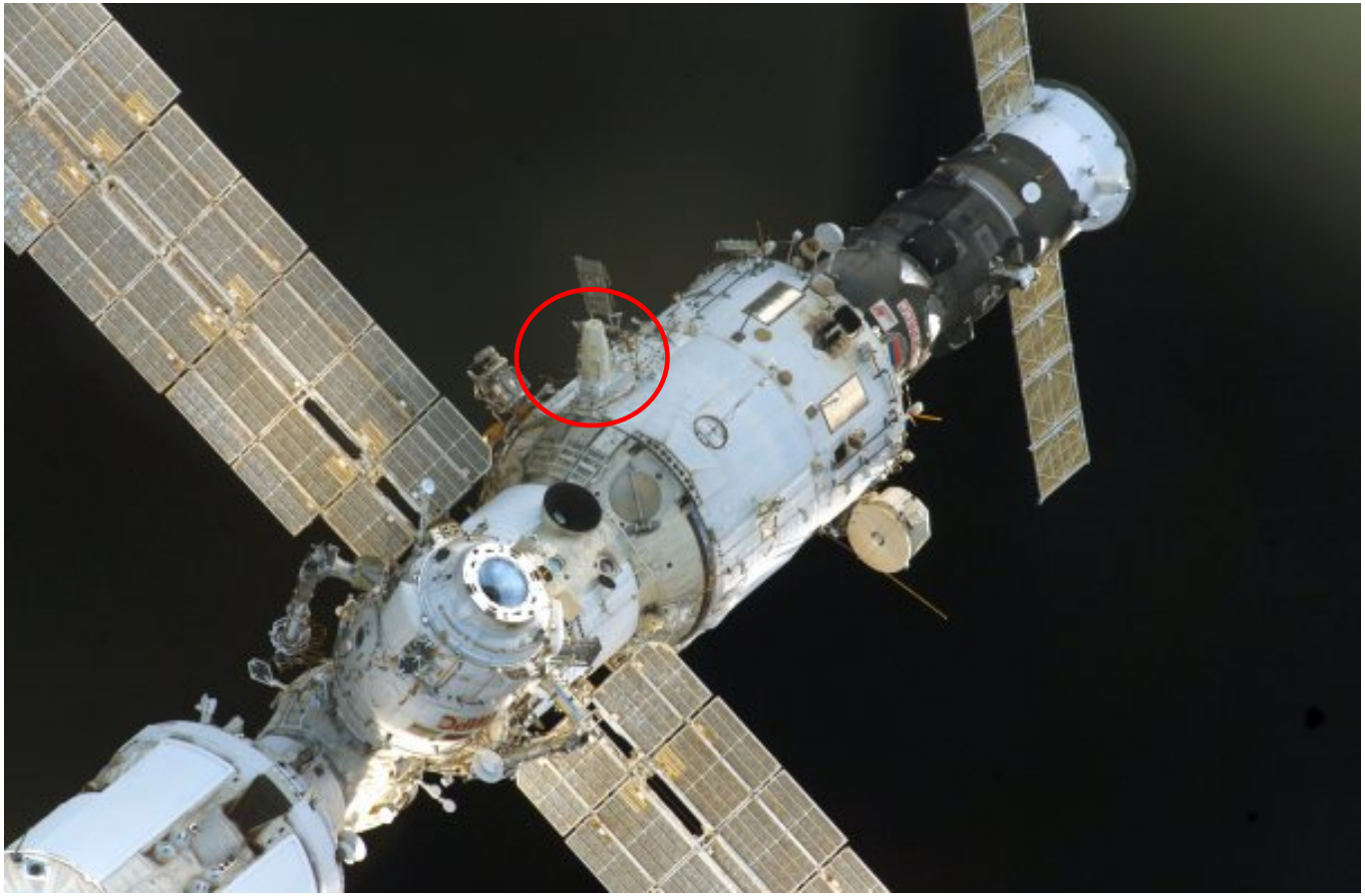


Thermoluminescence detectors (TLDs) and Nuclear Track Etch detectors
Total Number : ~ 6000

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

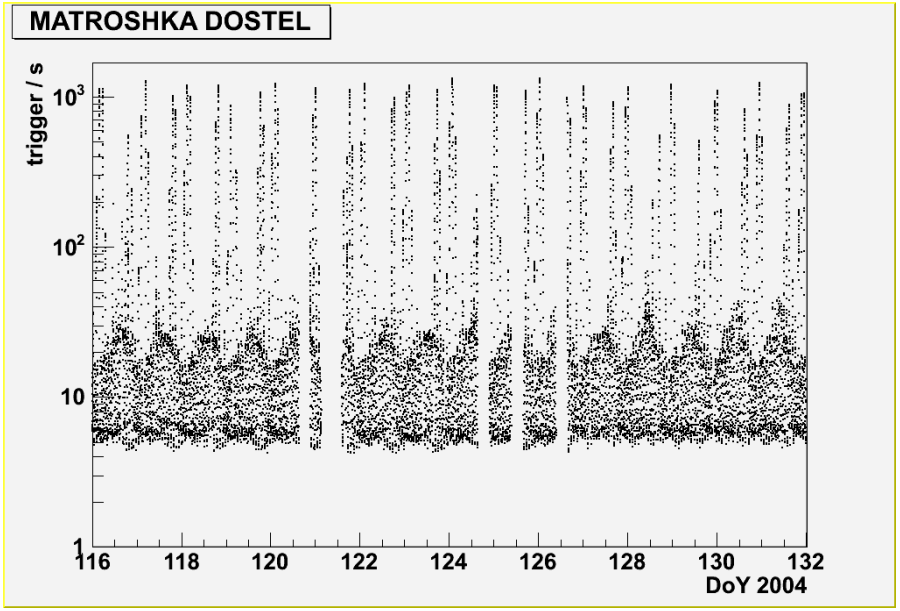
MATROSHKA-1



MATROSHKA mounted outside the ISS February 2004 – August 2005

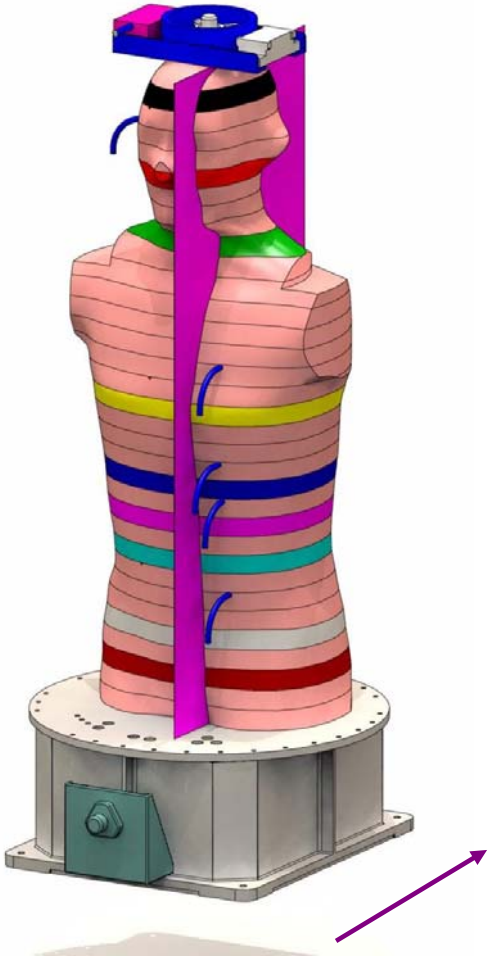
MATROSHKA-1 Science (active DOSTEL)

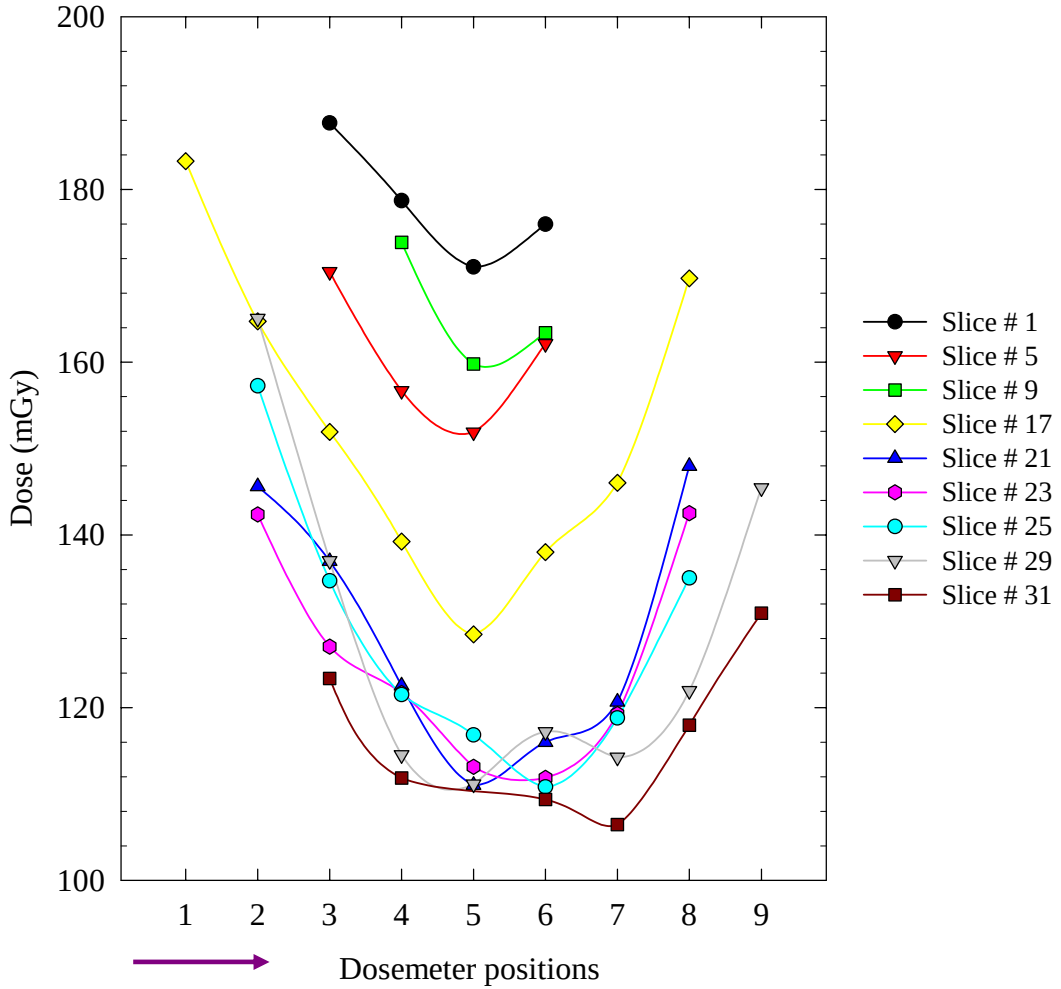
- Radiation exposure during an EVA: 1.3 mSv/day
- Radiation exposure inside the ISS: 0.4 mSv/day



Countrate of DOSTEL over a period of 16 days

MATROSHKA-1 Science (passive TLDs)

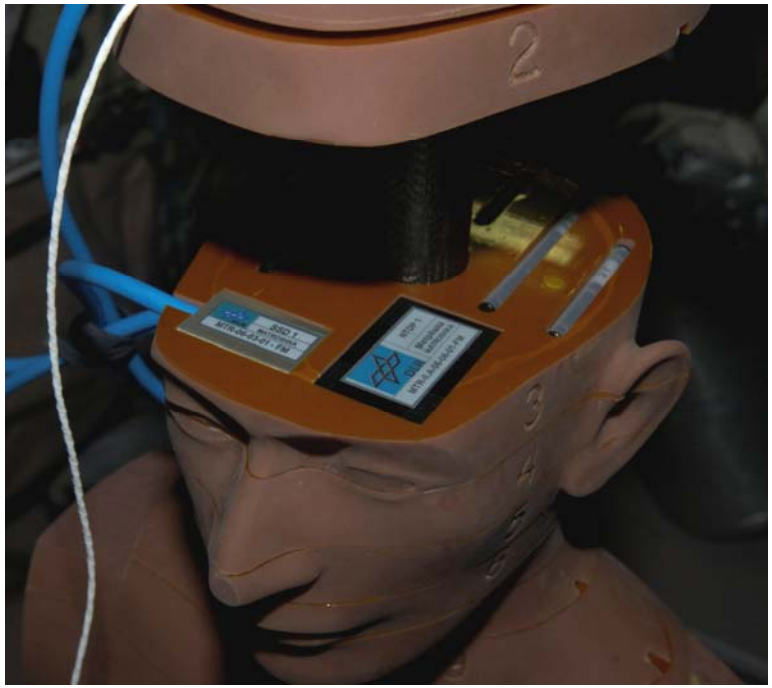




MATROSHKA-2 Timetable

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
	~ September 2006
	Autumn 2006 (6 months)
	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 / Qualitfactor … Neutron component

EuCPD

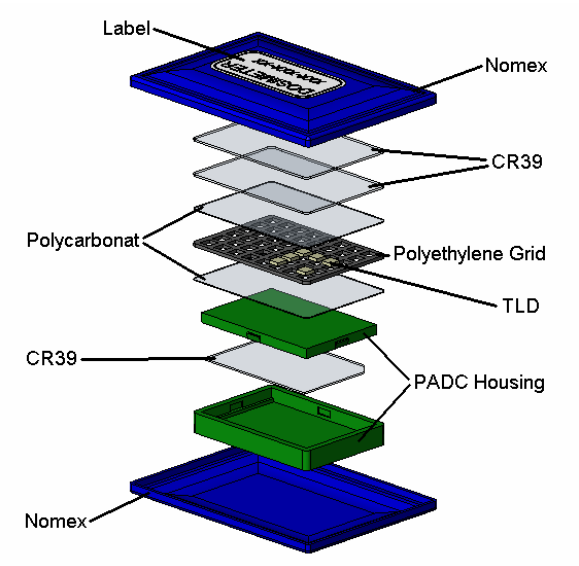
European Crew Personal Dosemeter

Starting with STS-121 … STS-116…

EuCPD

European Crew Personal Dosemeter

Light weight (~ 30g) passive dosemeter system



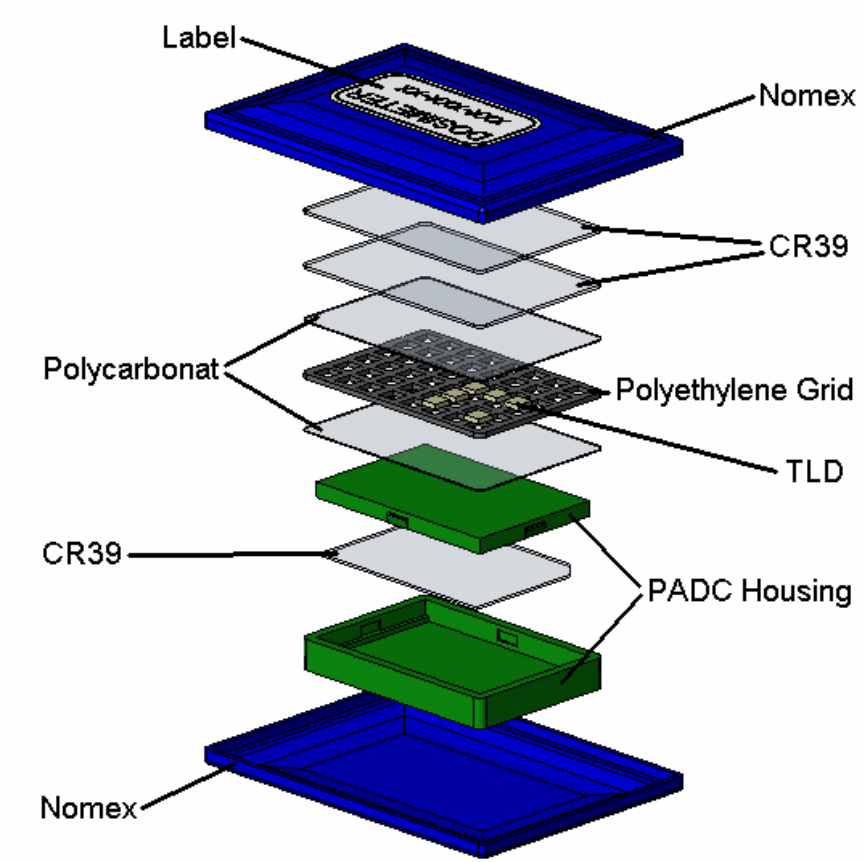
- Thermoluminescence Detectors (TLD´s)
- CR-39 Nuclear Track Etch Detectors
- PADC Neutron Detector

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)

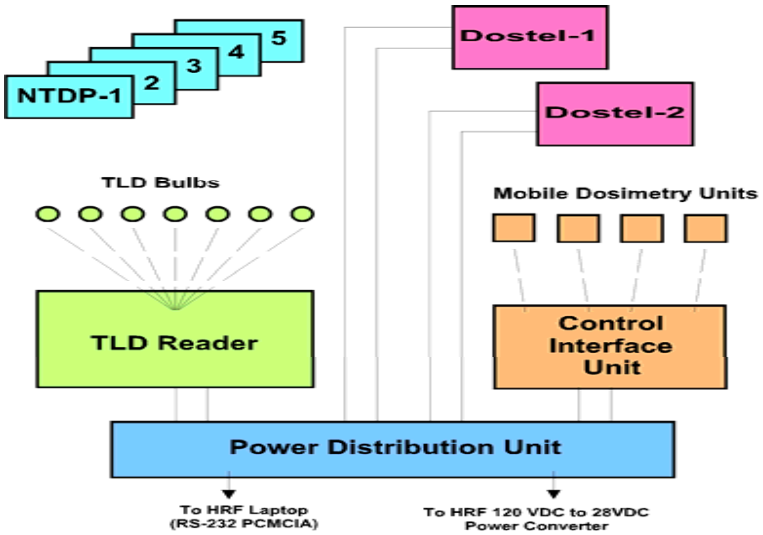
  → Development of a small active device (based on Silicon detectors)

ALTCRISS

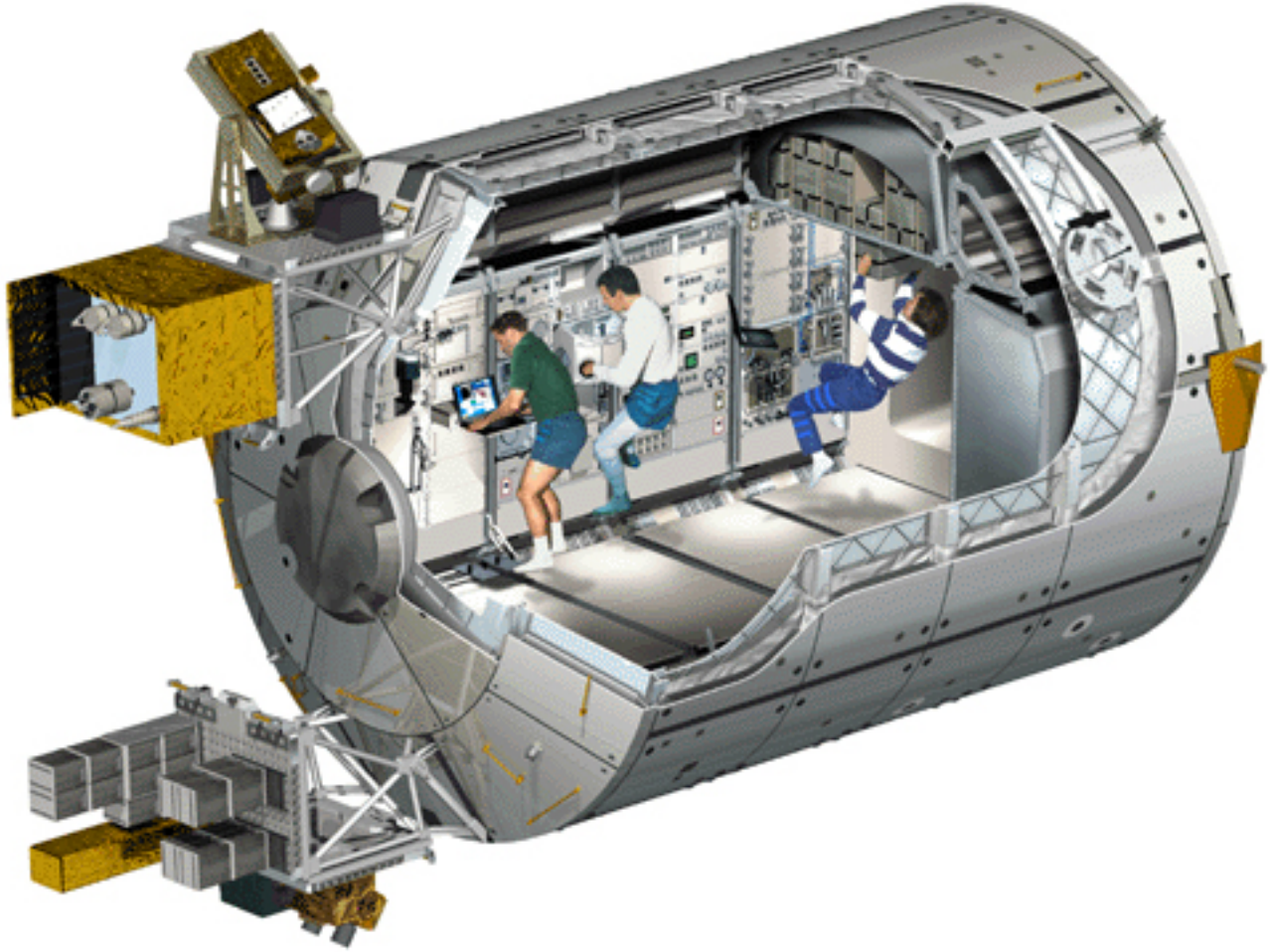
DOSIS

Dose Distribution Inside ISS

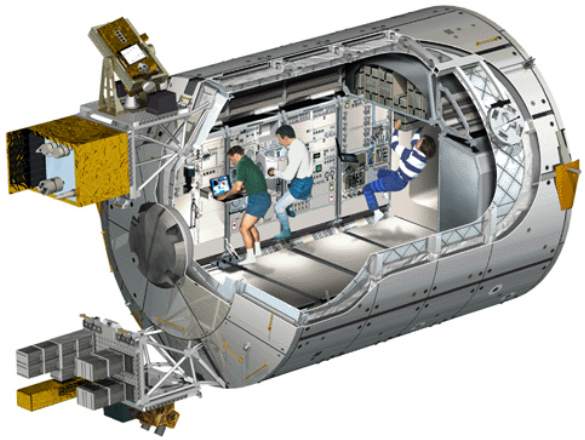
- Dosimetric Mapping Experiment
- Dosimetry inside the ISS using active and passive devices



Columbus

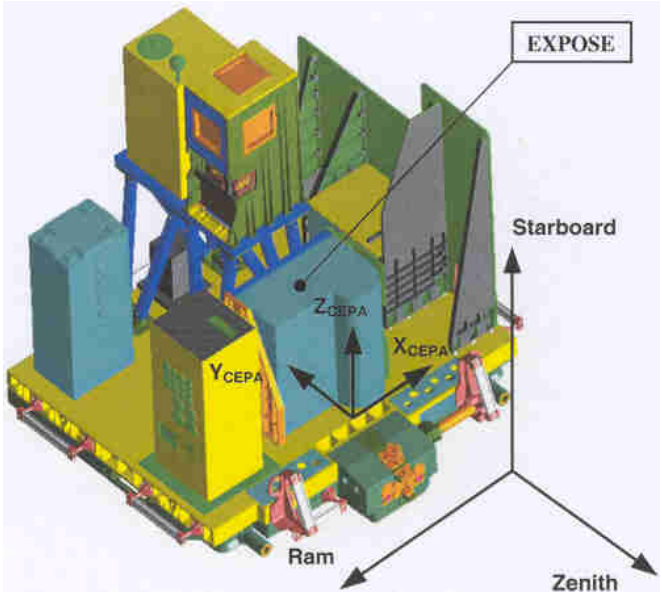


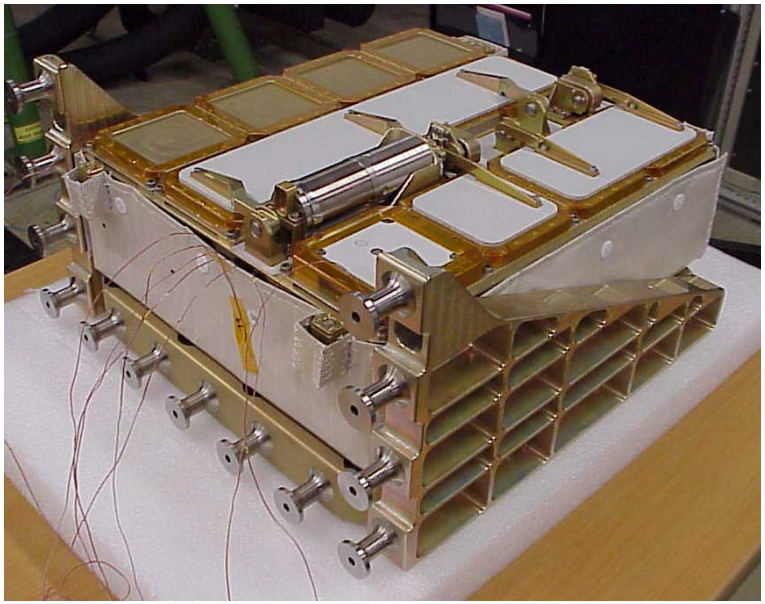
Columbus



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

Columbus / EuTEF



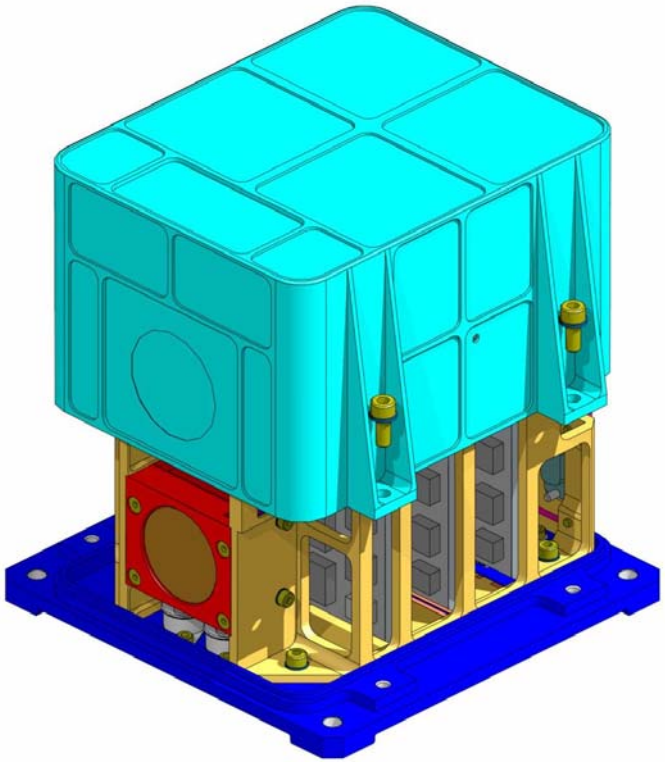


EuTEF – Active dosimetry

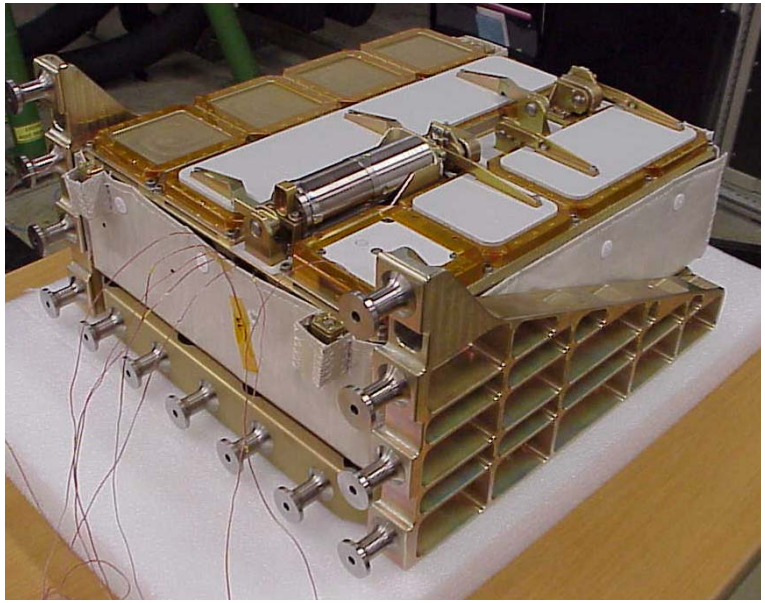
Expose – Passive dosimetry

Columbus / EuTEF

- **EuTEF → DOSTEL (active)**

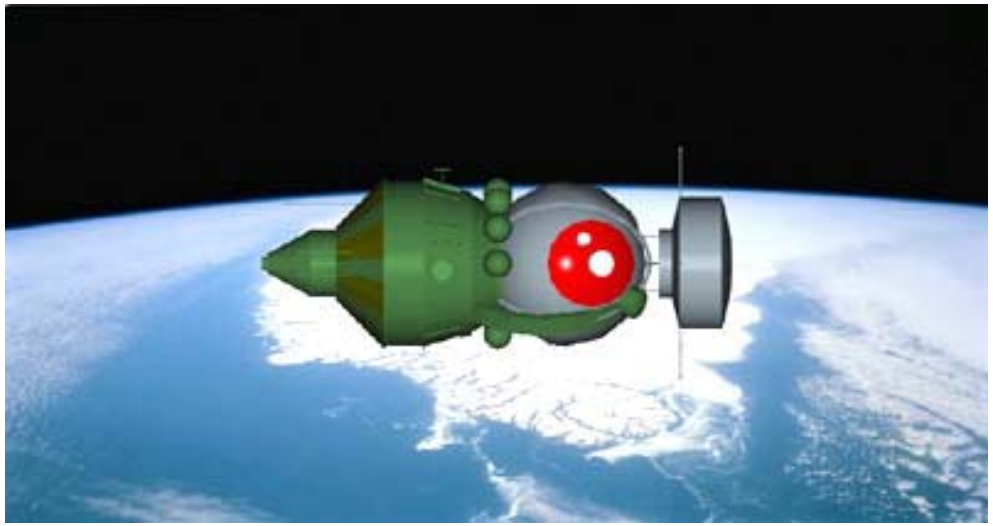


Expose / Expose-R



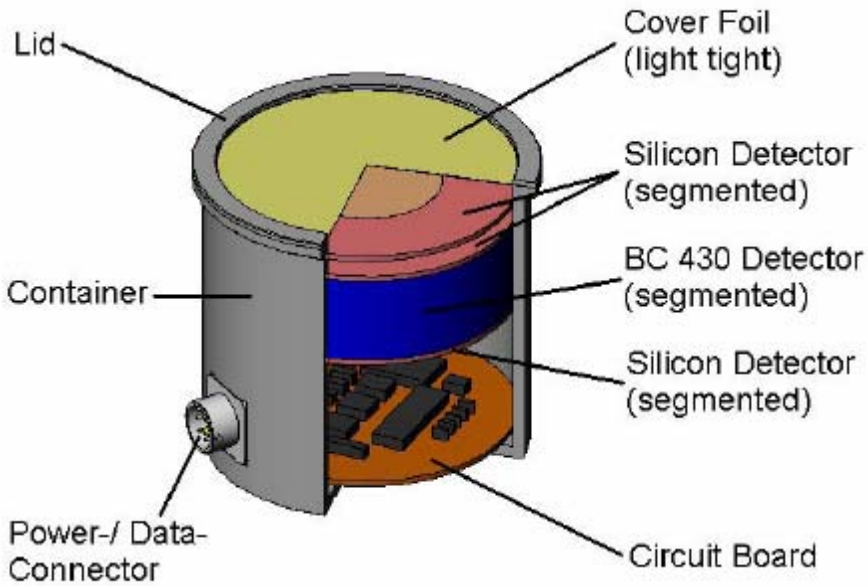
- **Passive Dosimetry**

FOTON – Biopan Missions



- **Dosimetry for very low shielding thicknesses**

ExoMars



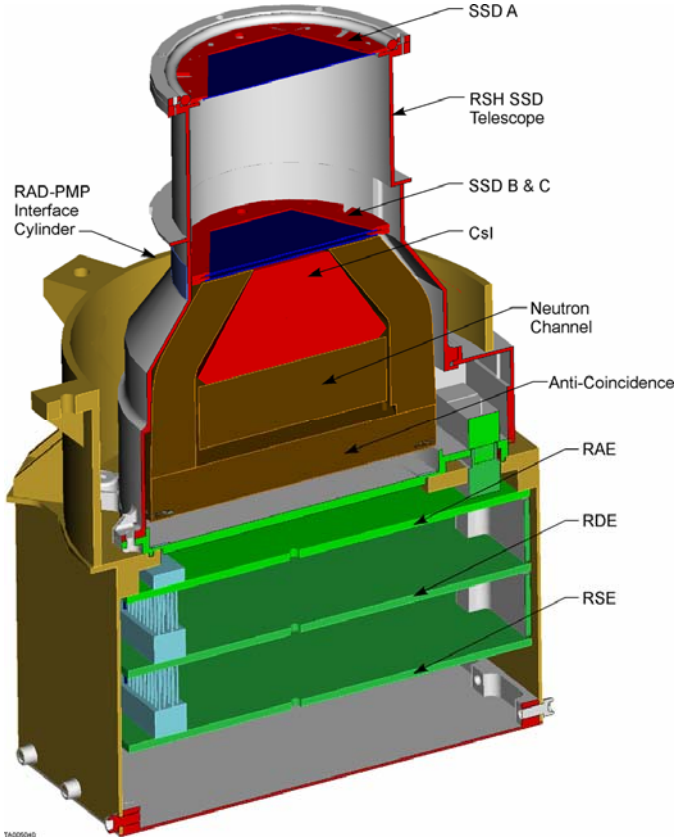
Dimensions: Ø 58 mm, Height 55 mm

Mass: ~ 500g

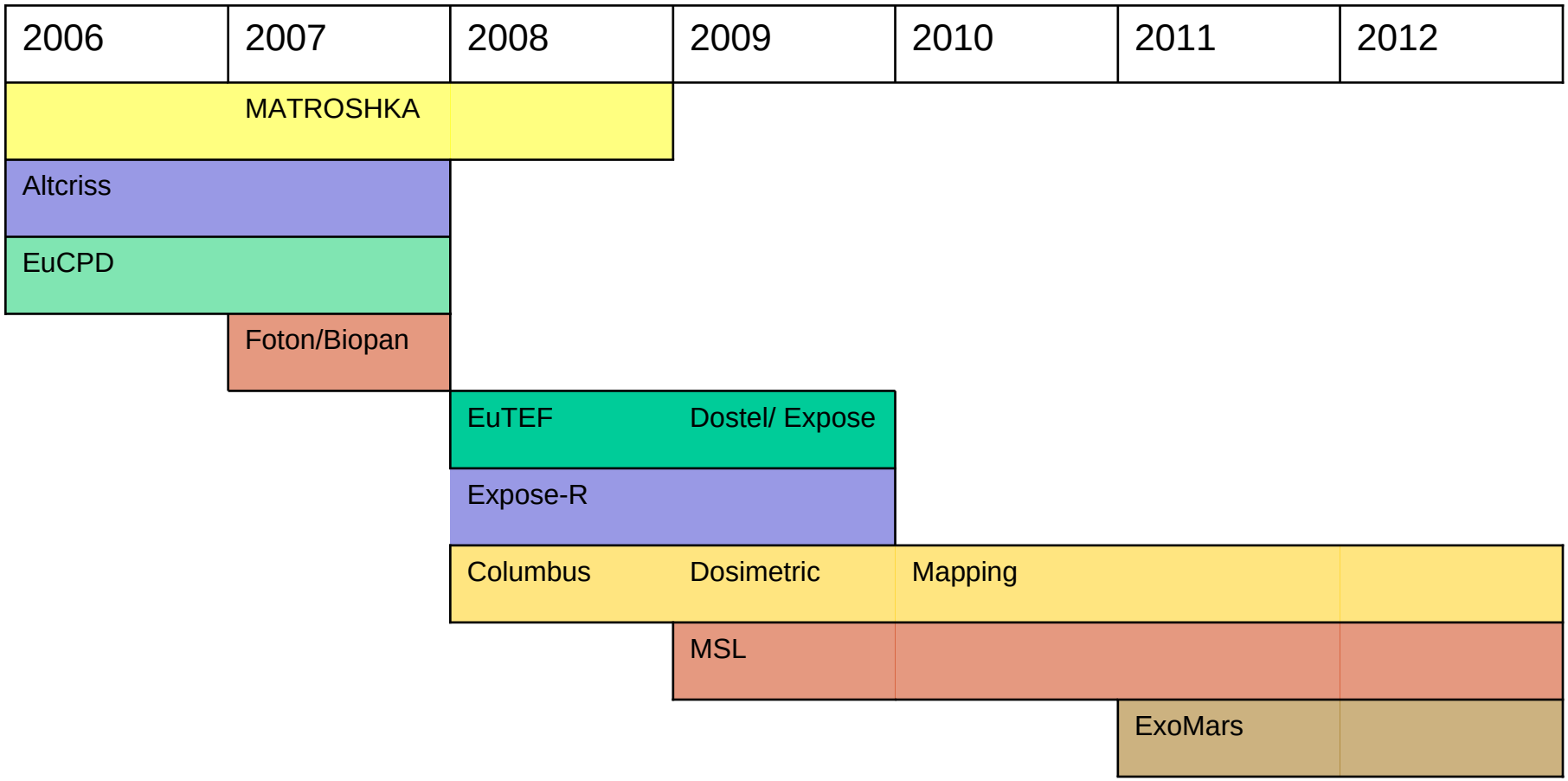
Power consumption: 600mW

MSL

NASA's Mars Exploration Program


SSD A
RSH SSD Telescope
SSD B & C
CsI
RAD-PMP Interface Cylinder
Neutron Channel
Anti-Coincidence
RAE
RDE
RSE

Timeline:


2006
2007
2008
2009
2010
2011
2012
MATROSHKA
Altcriss
EuCPD
Foton/Biopan
EuTEF
Dostel/ Expose
Expose-R
Columbus
Dosimetric
Mapping
MSL
ExoMars