Recent and Future European Measurements on Manned Missions

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Dosimetry on ISS

Operational Dosimetry

- Area Monitoring detectors from USA and RUSSIA
- Personal dosemeters from IMBP, NASA , ESA

Research projects :

- BRADOS, MATROSHKA, MATROSHKA – R, EuTEF
- ALTEA/Alteino

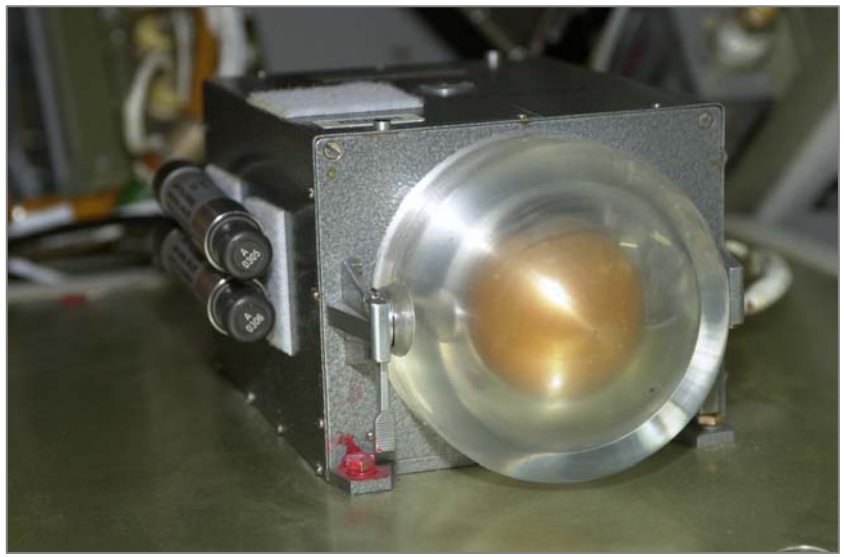
Operational Dosimetry

Active radiation measurement devices onboard the ISS - US contribution

Tissue Equivalent Proportional Counter (TEPC)

Charged Particle Directional Spectrometers IV-CPDS (left:Internal; right: outside)

Active radiation measurement devices onboard the ISS - Russian contribution

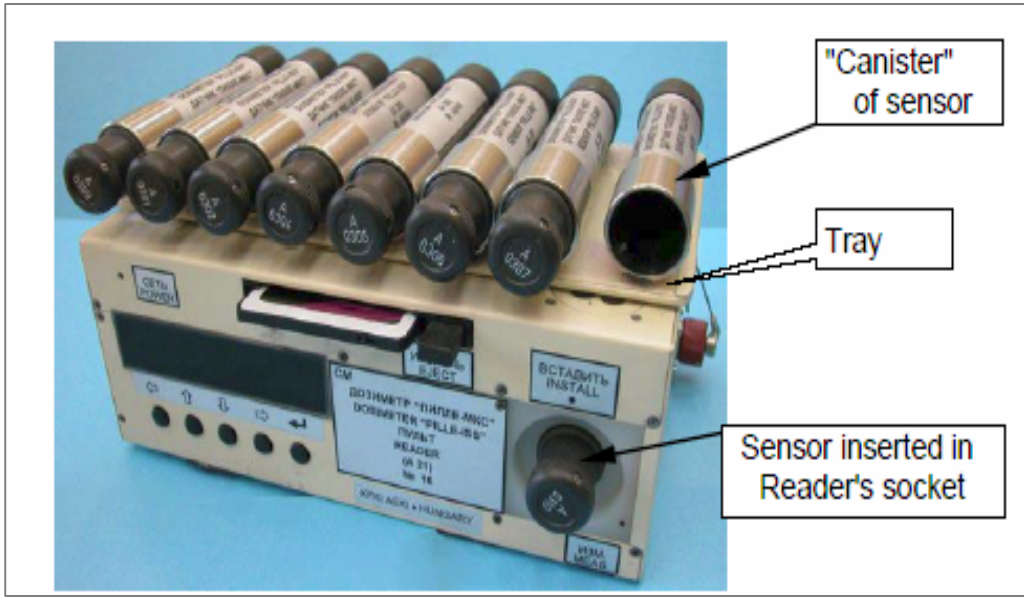


Radiometer R16

Liulin Silicon dosemeter

Semi - Active radiation measurement devices onboard the ISS - Russian Hungarian contribution

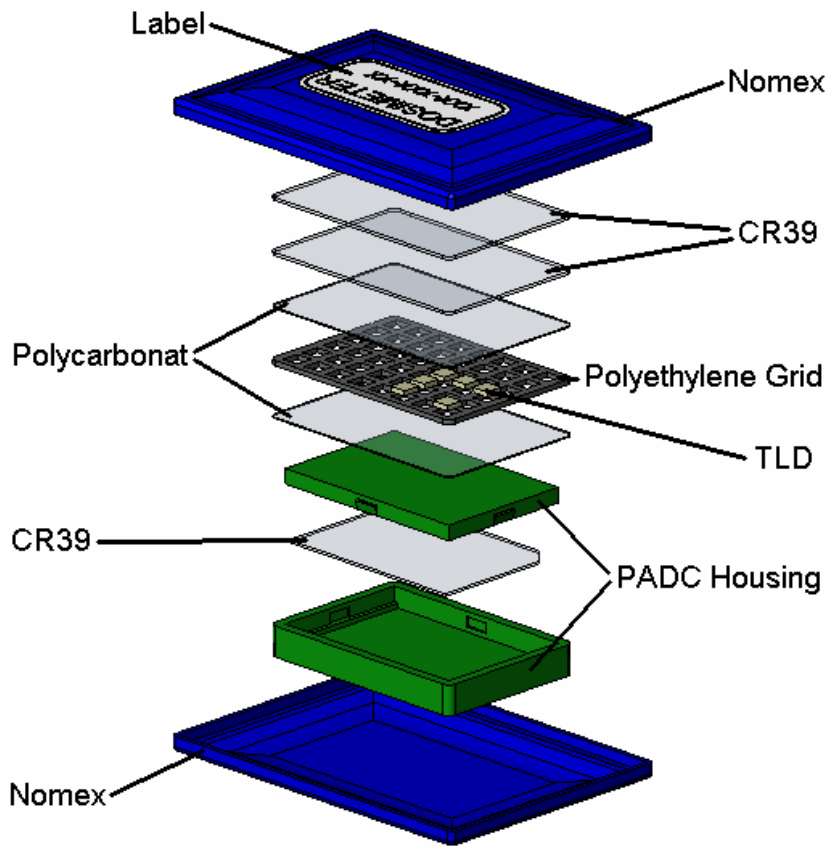
Operational Dosimeter PILLE-ISS (TLD type with on board reader) (also used as EVA-Dosimeter)



US Passive Area Dosemeters
(TLDs, Track etch and Bubble Detectors)

European **C**rew **P**ersonal **D**osemeter (**EuCPD**)

- 48 x TLD´s
- 2 x CR-39
- 1 x PADC



ESA Crew Personal Dosemeters

Intercalibration of US, Russia and ESA personal dosemeters

ISS013E67495

EuCPD
European Crew Personal Dosemeter

Starting with STS-121 … STS-116…

Design of a Passive Personal Dosemeter

Choose

A TLD Dosemeter for ionising particles for LET $\leq$ 10keV/µm

(ideal η = 1 for LET $\leq$ 10 keV and 0 for LET $\geq$ 10 keV/µm)

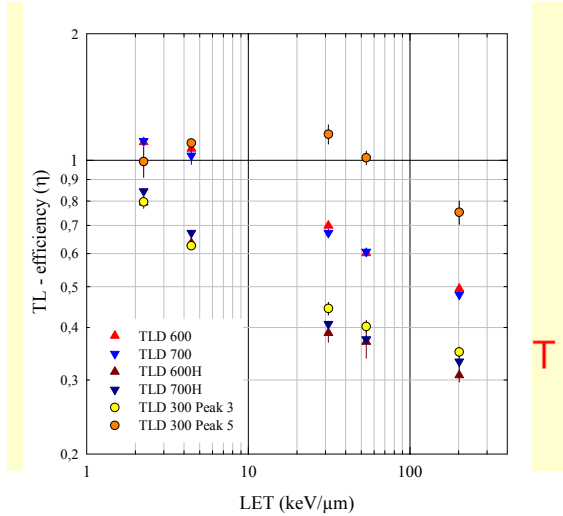
and

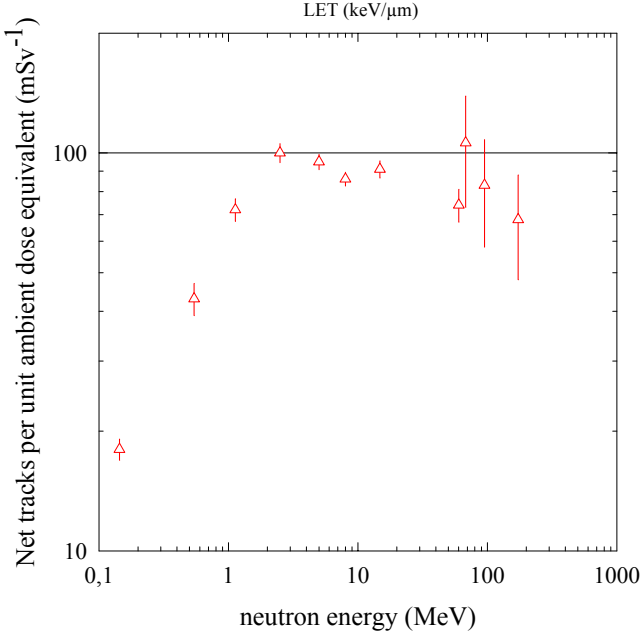
A PNTD for ionising particles with LET$\geq$ 10 keV/µm (chemical etch)

and for neutrons (electrochemical etch)

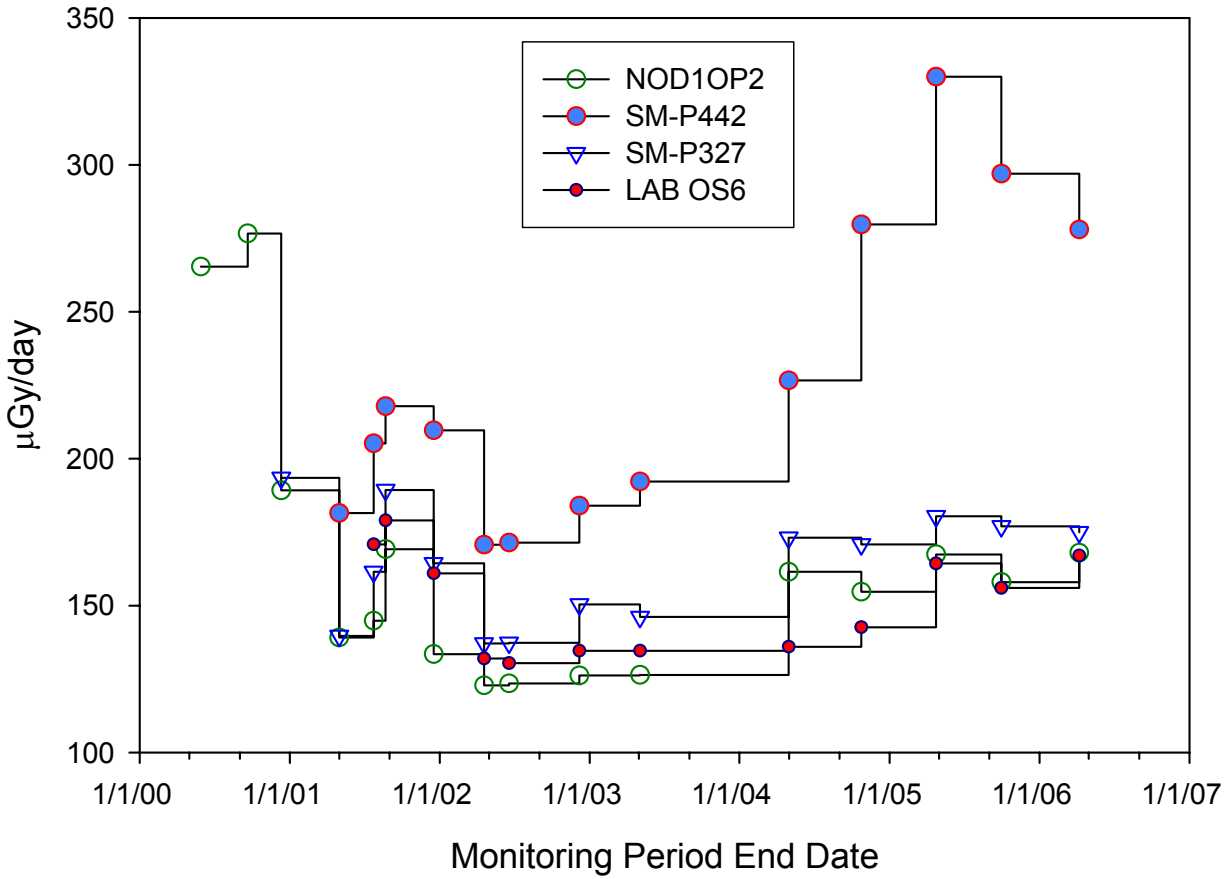
Therefore the dose equivalent is

$$H = D_{TLD\ (\leq 10\ keV)} + H_{n,CR39} + \int D_{PNTD}(L)\, Q(L)\, dL$$

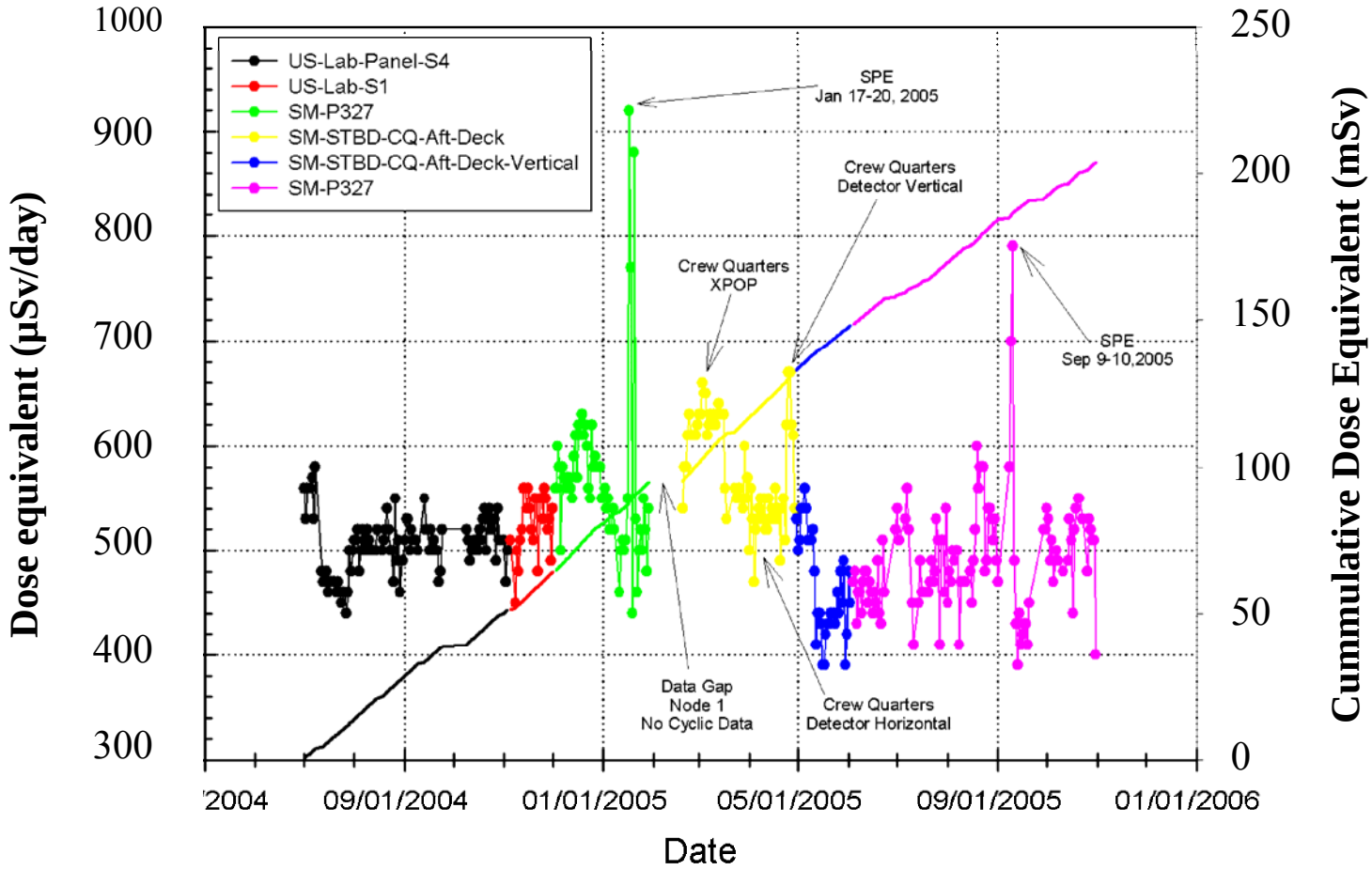




ISS TLD 100 Dose Rate Summary

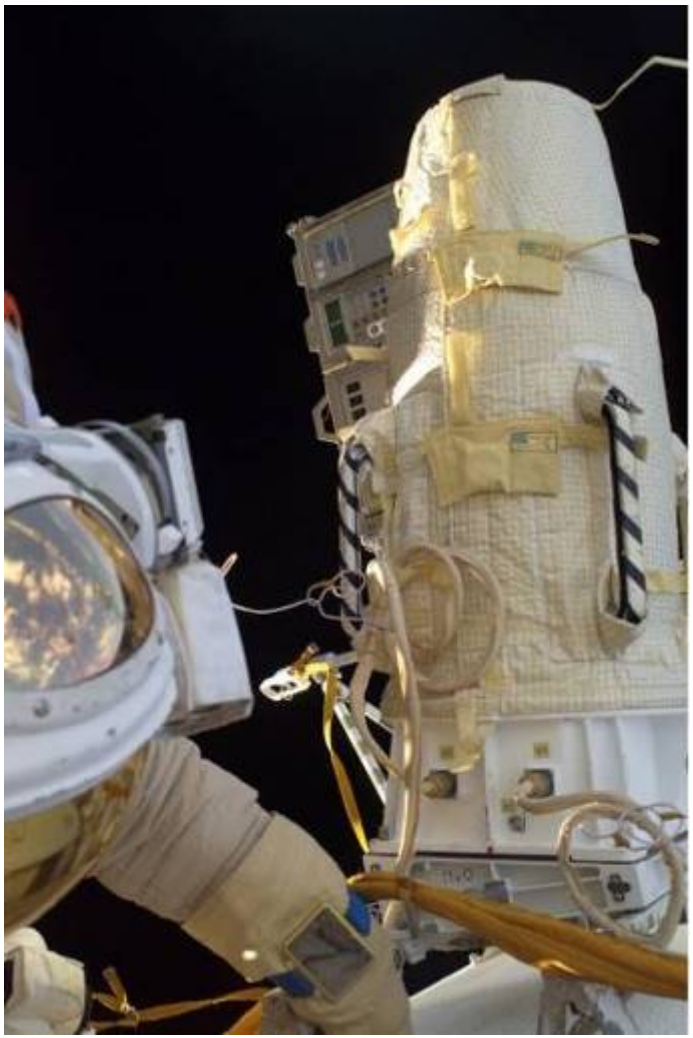


ISS TEPC During 2005 (Dose Equivalent Rate)

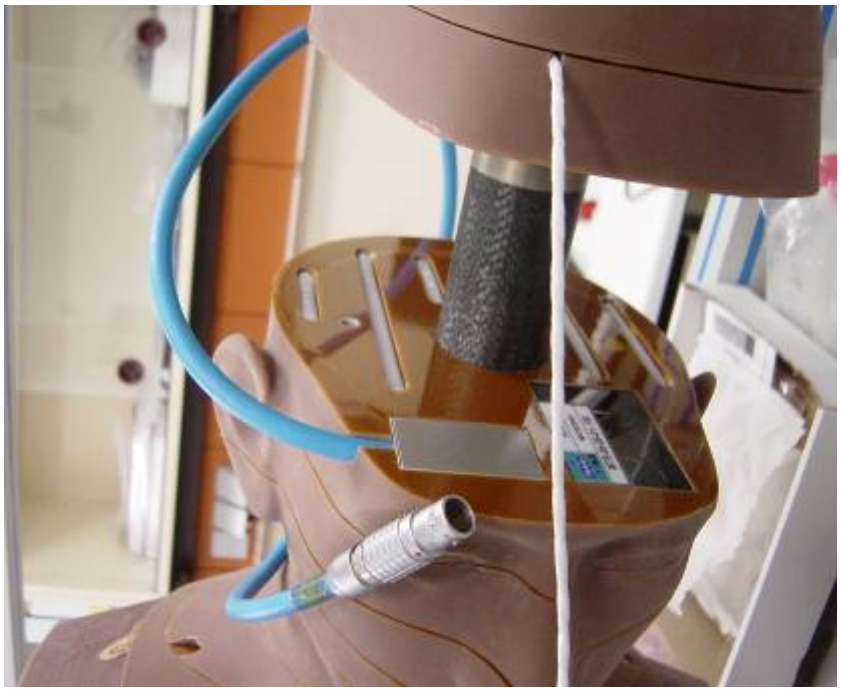


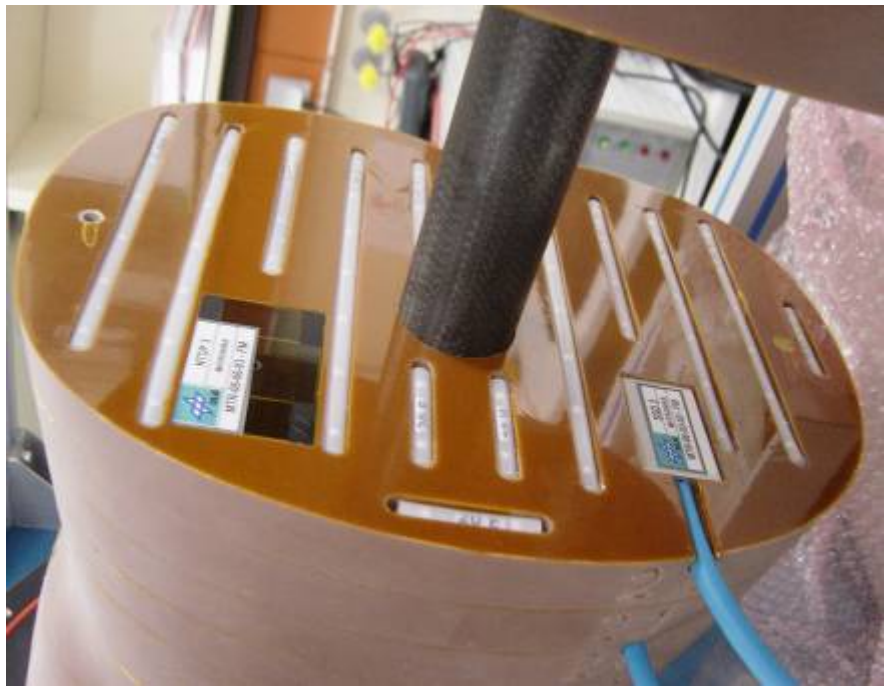
RESEARCH
Projects

MATROSHKA



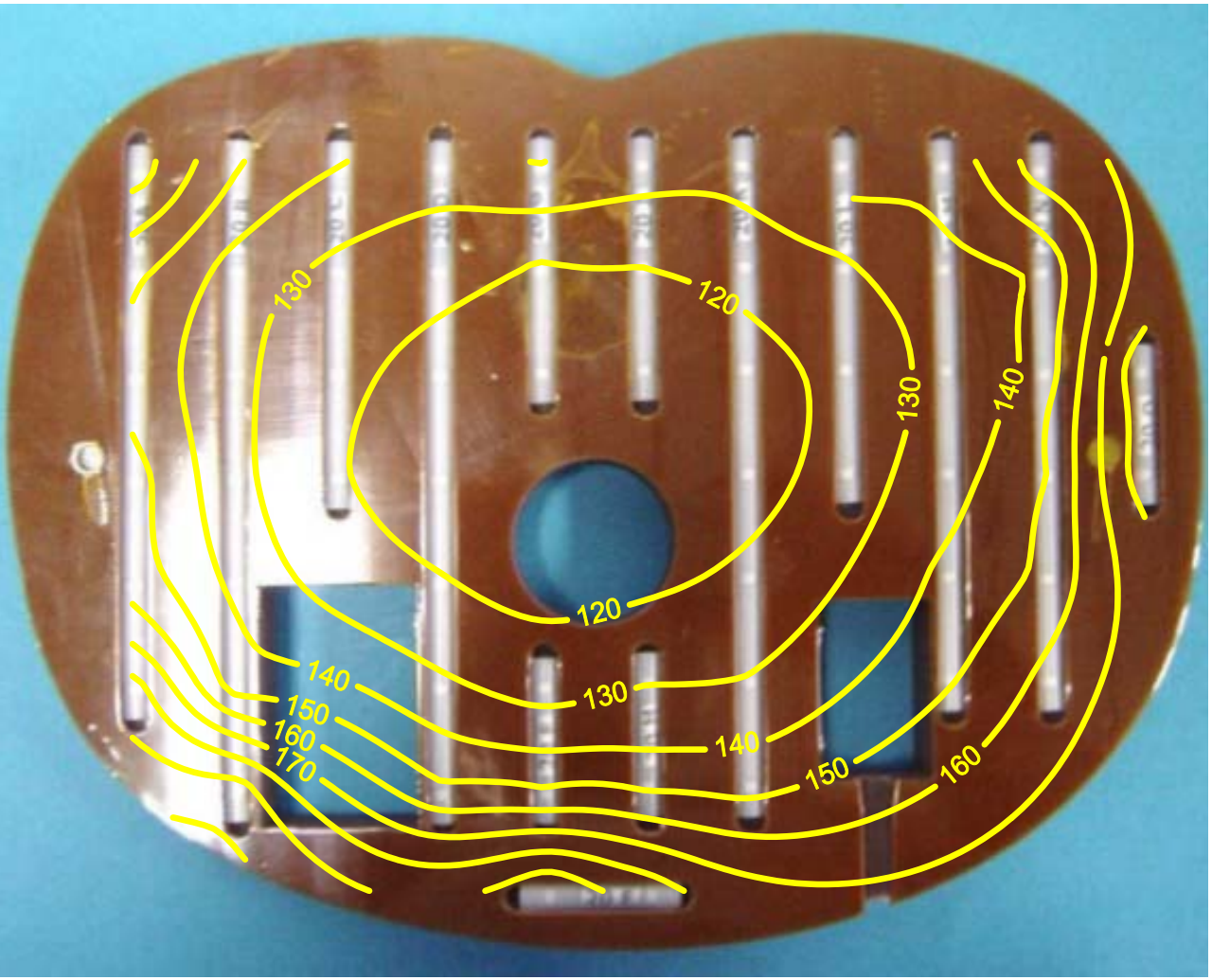
The MATROSHKA Facility – Radiation detectors

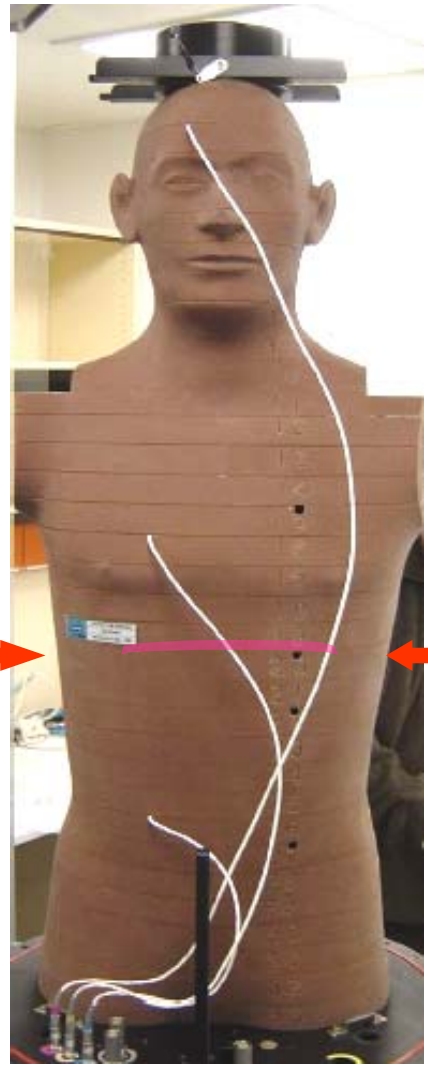




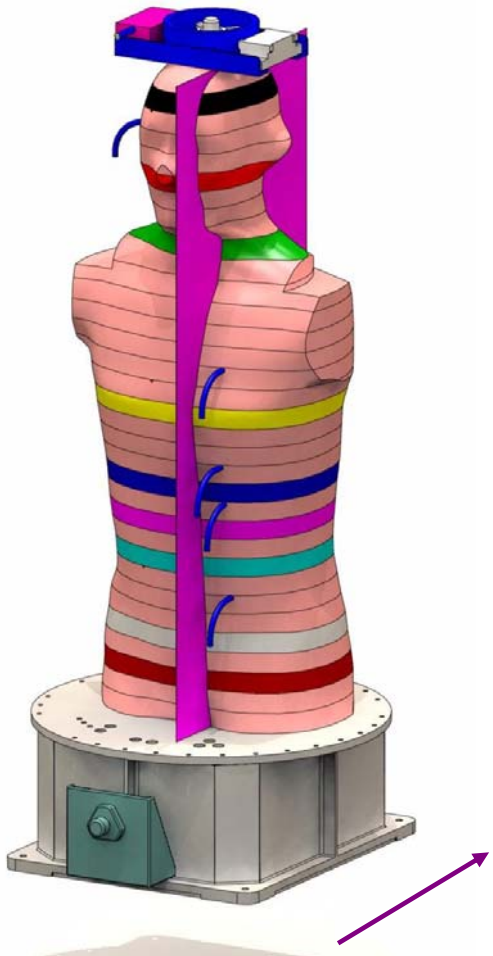
Thermoluminescence detectors (TLDs) and Nuclear Track Etch detectors, Scintillator/Silicon detectors, silicon telescope, tissue equivalent proportional counter (TEPC)

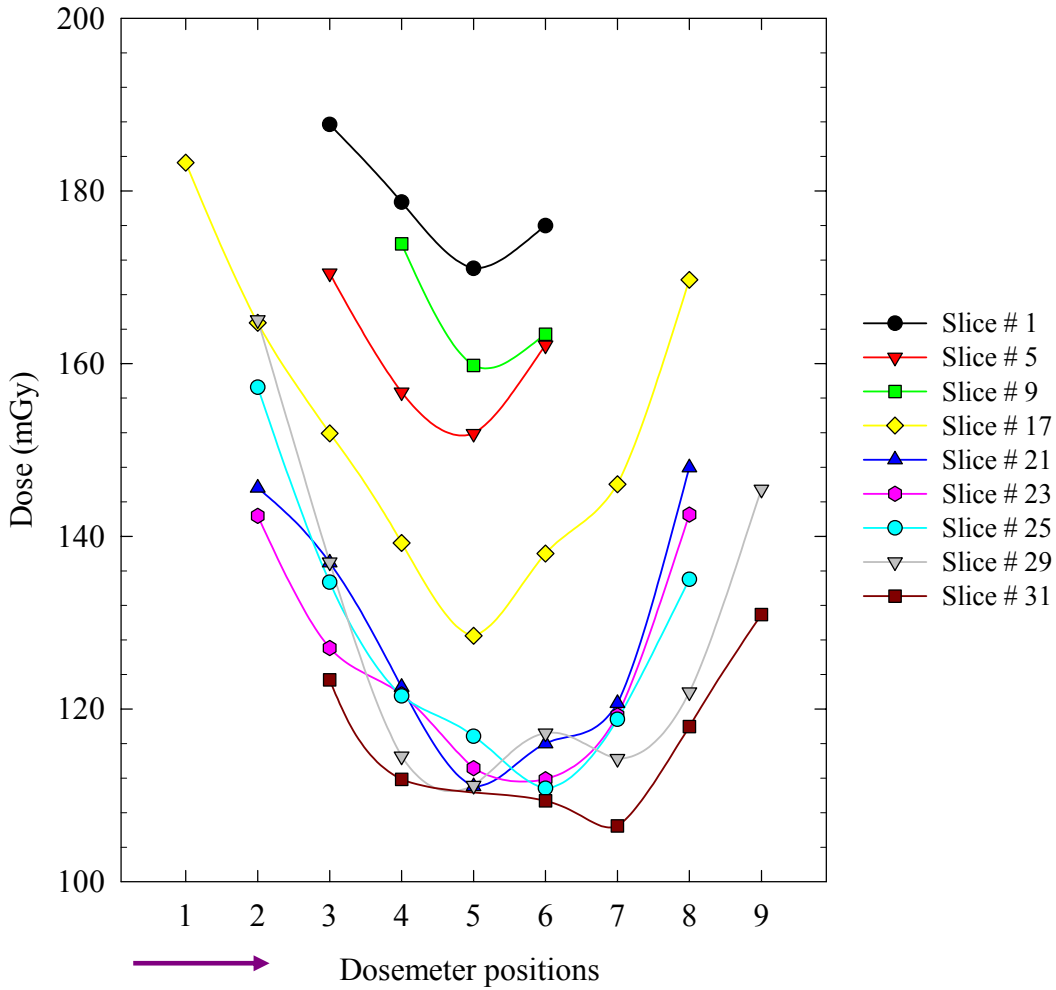
MATROSHKA iso doses [mGy]





MATROSHKA-1 Science (TLDs)





SEVENTH FRAMEWORK PROGRAMME
THEME 9
FP7 Space Research Call 1, FP7-SPACE-2007-001

HAMLET – Human Model MATROSHKA for Radiation Exposure Determination of Astronauts

EC – Project Nr: 218817

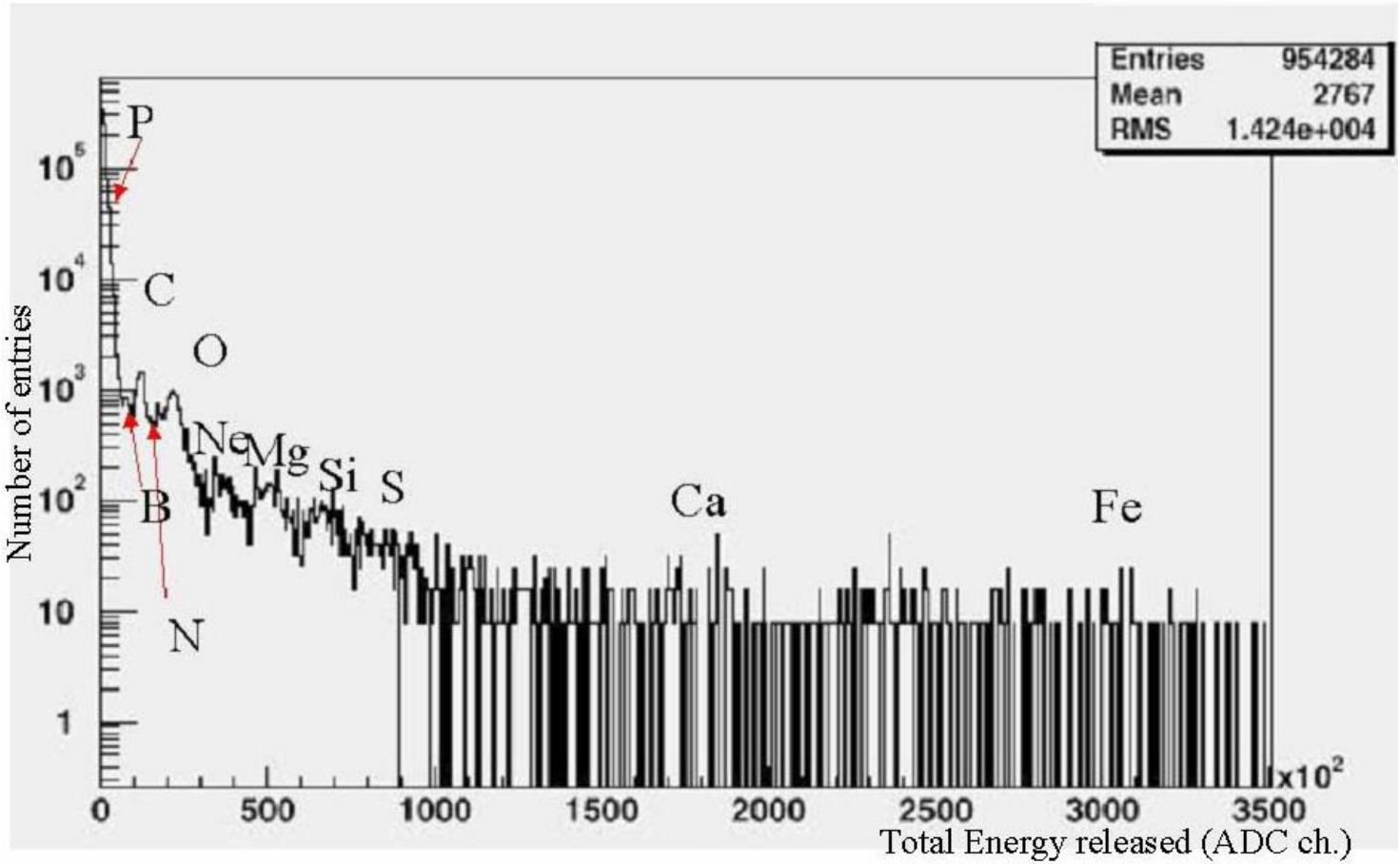
Statement of Work of the HAMLET Project

"The aim of HAMLET is the effective scientific exploitation of data obtained from the ESA MATROSHKA project. This will be achieved by bringing together leading European scientists in the field of space dosimetry to increase and enhance the output of the project and present it to the scientific community as well as the public audience."

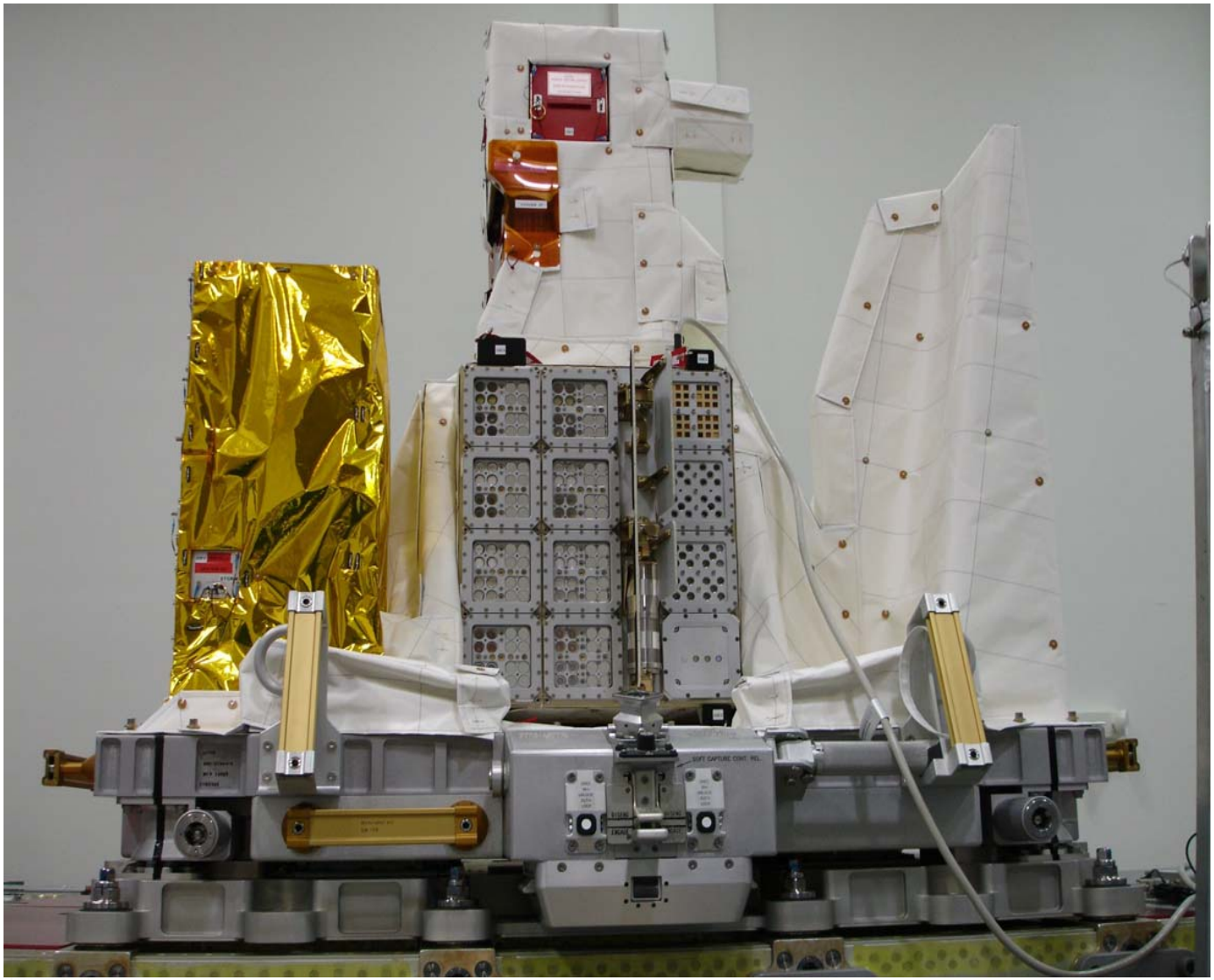
ALTCRISS

- Long term monitoring inside ISS using Alteino
- Selected by ESA in the Life Science AO
- "Anticipated" to ESA Long Duration Mission of Thomas Reiter
- Intercomparison with other detectors in the framework of MATROSHKA II
- Currently 6 month mission: 3 locations with and without shielding (Polyethylene shielding only on top of Alteino detector – 5g/cm^2)
- Various dosemeters: Napoli + DLR
- Comparison with ground data & simulations

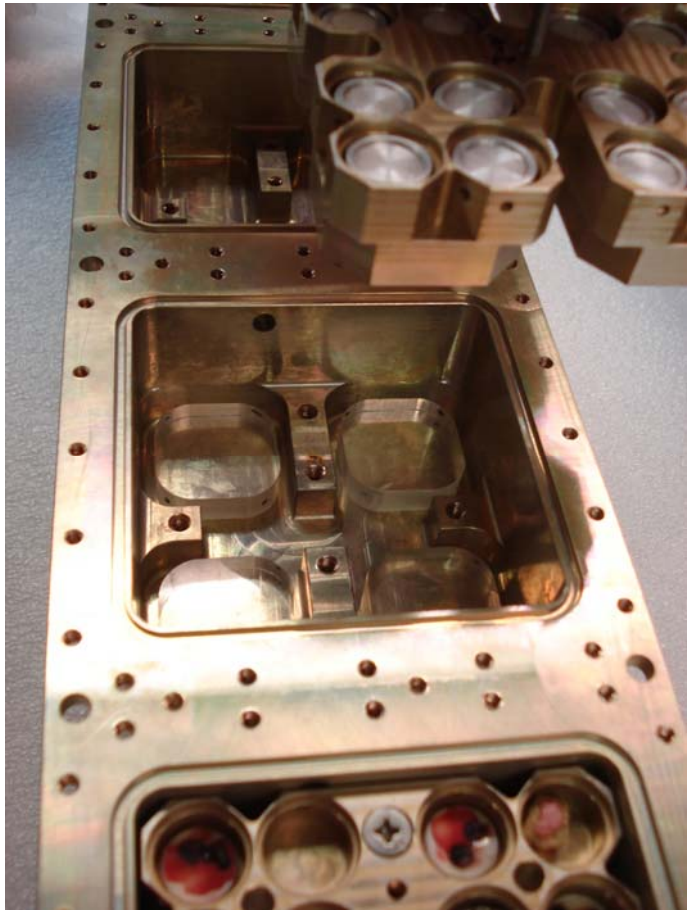
Charged Particle Spectra on ISS



EuTEF Facility



DOSIS (ISLRA-2004-167) / Expose-EuTEF

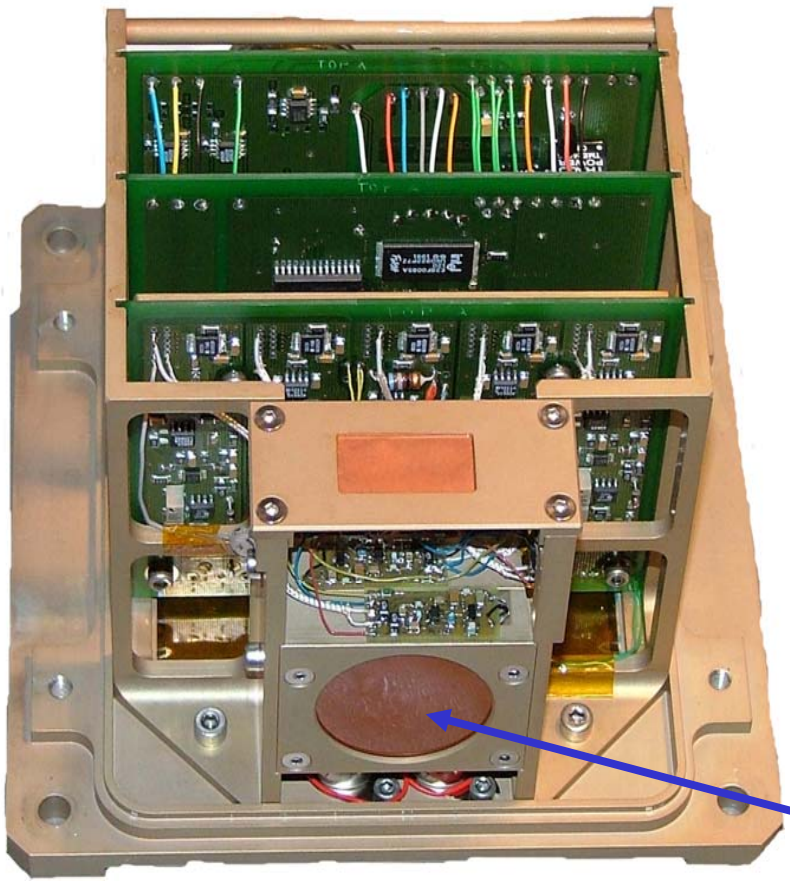


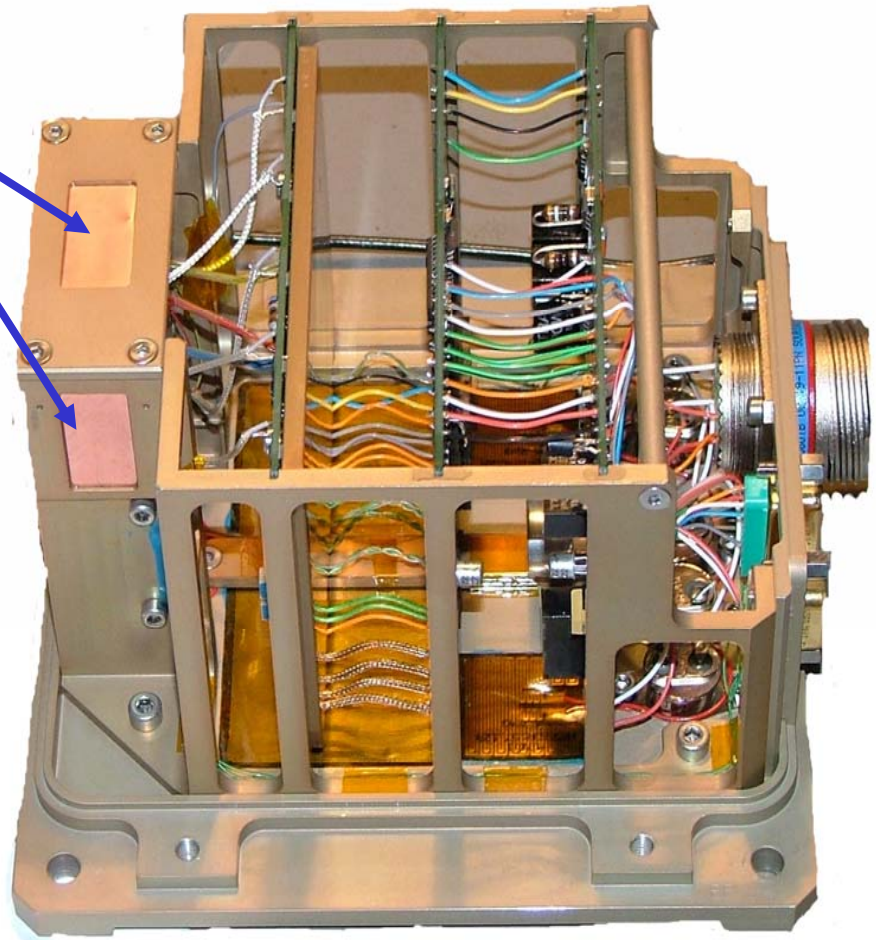
DOSIS (ISLRA-2004-167) / Expose-EuTEF

Depth dose TLD stack

EuTEF DOSTEL

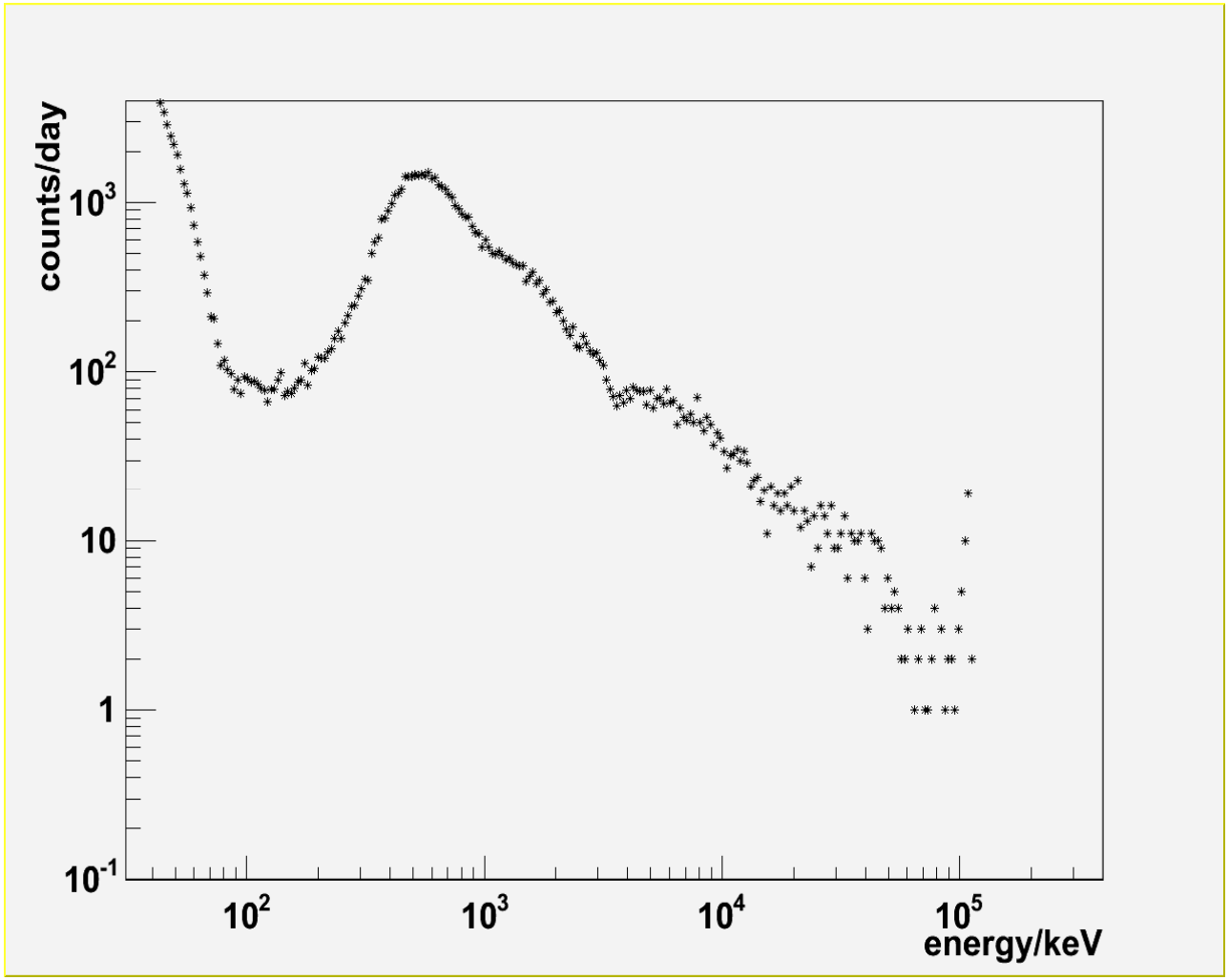
Hamamatsu
PIN diodes
(behind capton foil)





Canberra PIPS
(behind capton foil)

Spectrum Detector D1



Future Dosimetry Projects on ISS

ESA Dosimetry Planning

	Inc15	Inc16	Inc17	Inc18	Inc19	Inc20
	Apr07-Oct07	Oct07-Apr08	Apr08-Oct08	Oct08-Apr09	Apr09-Oct09	Oct09-Apr10
ALTCRISS	SM & FGB 6	FGB & COL 3	COL 3			
ALTEA-SHIELD					US-Lab 2	US-Lab 2
MATROSHKA-2B	SM [4]	SM [4]	SM [4]	SM	JEM	
MATROSHKA-2C TBC						SM External [8]
DOSIS DOS/NTDP					COL: EPM	COL: EPM
DOSIS TLD					COL: Pille Reserve	COL: Pille Reserve
DOBIES				RS 0	COL 0,5	
TRITEL					COL 0,5	COL 0,5
LIULIN-5E				SM 1	SM 1	
DOSIS / DOBIES External			COL: EXPOSE 0	COL: EXPOSE 0	COL: EXPOSE 0	
Total crew time		**3**	**3**	**3,5**	**4**	**2,5**
Crew time vailable		**3**	**2**	**2**	**2**	**4**

Dosemeter Equipment of DOSIS

Passive Detector Boxes

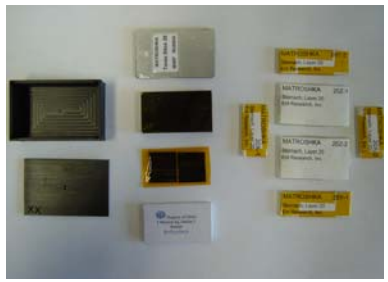
TLD Reader PILLE

Detector Telescope DOSTEL

Alteino

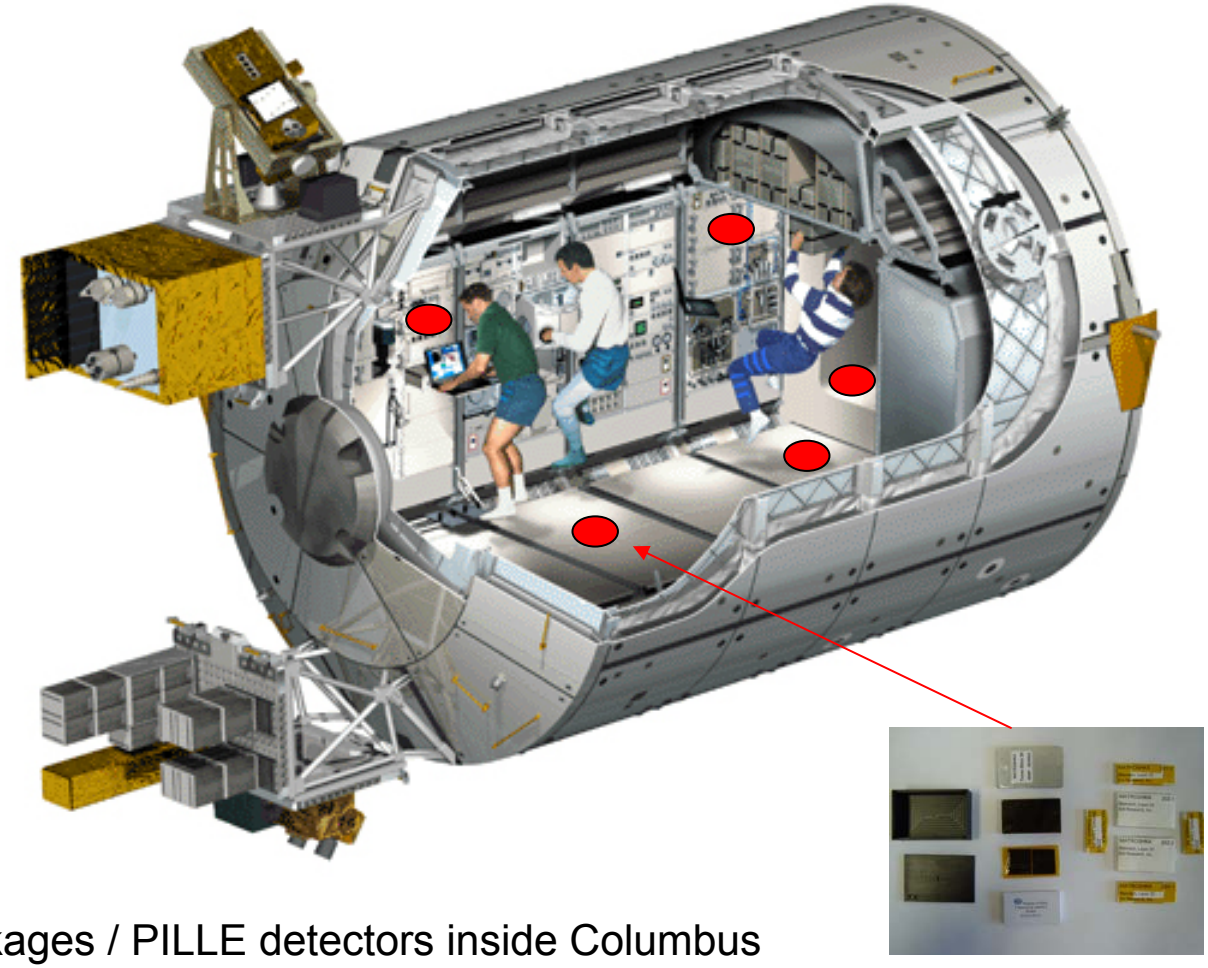
Neutrondosemeter

DOSIS (EPM)



2 DOSTEL and up to three NTDP packages attached to EPM
→ DOSTEL data transfer and download (via EPM LAN)
→ Exchange of NTDP packages every 6 month

DOSIS (passive detector locations)



10 NTDP packages / PILLE detectors inside Columbus
→ Exchange of NTDP packages every 6 months

European Crew Personal Active Dosemeter (EuCPAD)

The EuCPAD system is proposed to consist of the following main parts:

- Rack unit
  - Read-out Module
  - Charging unit
  - Main Processing unit
  - Interface to Columbus/Rack
  - TEPC Module

- Portable EuCPAD instrument with:
  - Silicon detector module (thick and thin diode)
  - Absorbed dose detector module (DIS plus RADFET = RADDIS)

NASA's New Development Overview

- The developments essentially captured in three designs
  - Tissue Equivalent Proportional Counter (TEPC)
    - Tissue Equivalent Measurement
    - Electron and Proton Measurement
  - Radiation Assessment Detector (RAD)
    - Charged Particle Spectroscopic Measurement
    - Neutron Spectroscopic Measurement
  - TEPSC (Tissue Equivalent Plastic Scintillator Counter)
    - is the new generation active personal dosimeter being developed by RMD (Radiation Monitoring Devices, Inc., Boston, MA)
    - TEPSC integrated in a chip with PS and SSPM (Solid-State Photon Multiplier)

DLR Science Projects

- Dose Distribution inside ISS Columbus and EXPOSE
- Continuation of MATROSHKA and MATROSHKA-R Experiments
- Advanced DOSTEL on EuTEF
- Continuation of ALTCRISS
- Continuation of EUCPD and EuCPAD
- Radiation Sensor (IRAS) on ExoMars and Radiation Assessment Detector (RAD) on NASA Mars Science Lab

Achievement-Actions

- Workshop on Radiation Monitoring on the ISS (WRMISS)
- Instrument Calibration Programm ICCHIBAN
- ESA Programm IBER
- Cooperation in Space Experiments eg STS-114, ISS Expedition 2, MATROSHKA, BRADOS, etc.
- Design and implementation of the next generation space dosimetry system needs to be a colloborative effort making use of the skills of the different groups

Conclusion

Europe has an excellent instrument suite available to cover the work still to be done :

- Realisation and provision of advanced and new instrumentation and their implementation in future missions
- Characterisation and cross- calibration of instruments

- More accurate and reliable data by improved characterisation of the different environments
- Improved Calculation of Radiation Exposure of Astronauts
- Model benchmarking
- Reduction of uncertainties in risk assessment