

Recent results of TLD and OSL measurements from SCK•CEN

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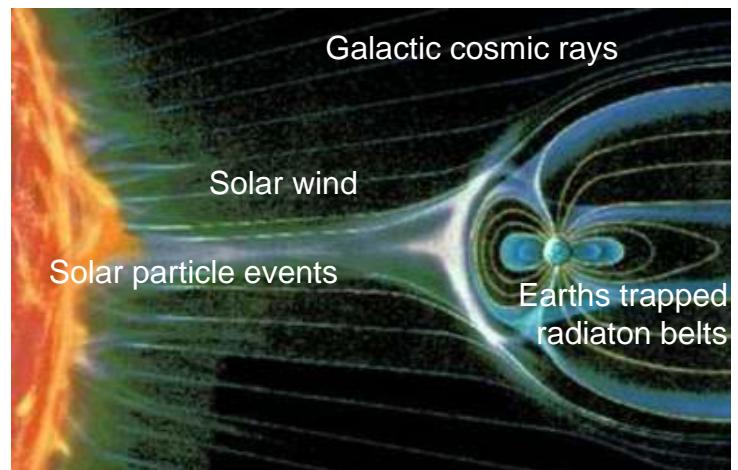
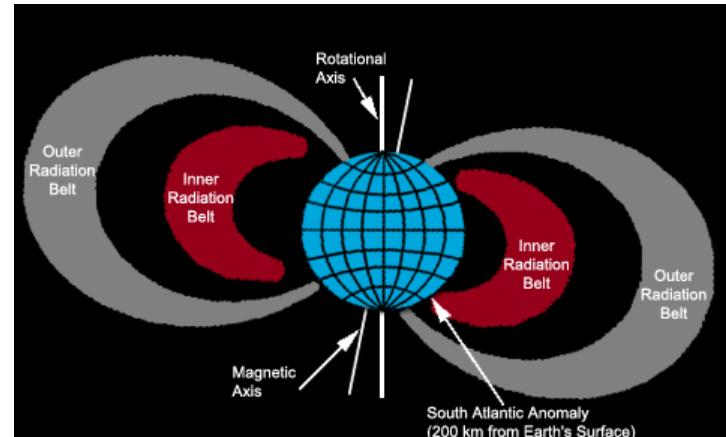


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 - Experimental setup
 - results
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- Complex radiation field:
Protons, neutrons, electrons, heavy charged particles
LET-value 1 → 1200 keV/ μ m
- Effect of this radiation field is important for biological experiments and humans
- Dosimetry using a combination of different technologies to cover the complete LET-spectrum:
 - OSL, TL: low LET-part
 - track etch: high LET-part



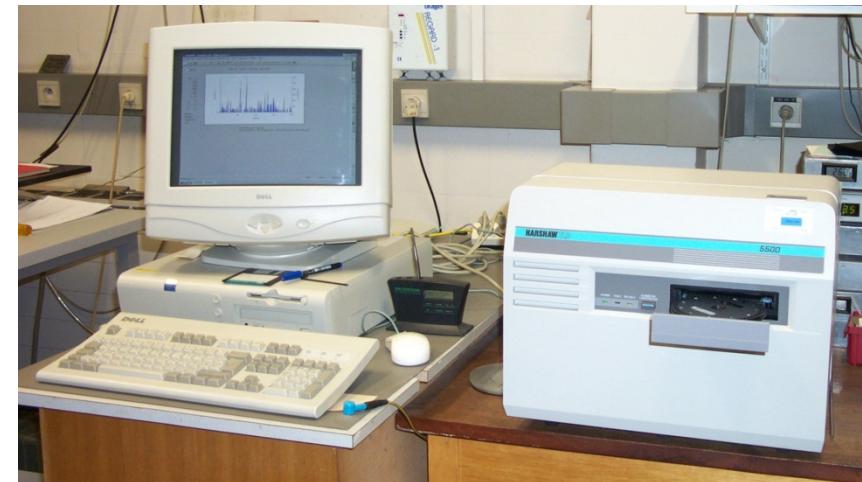
Types of dosimeters used at SCK•CEN

Thermoluminescence detectors

- LiF: Mg, Ti
- LiF: Mg, Cu, P

- All detectors are read out using Harshaw 5500
 - Heating rate: 1 °C/s
 - Integration of area under glow curve

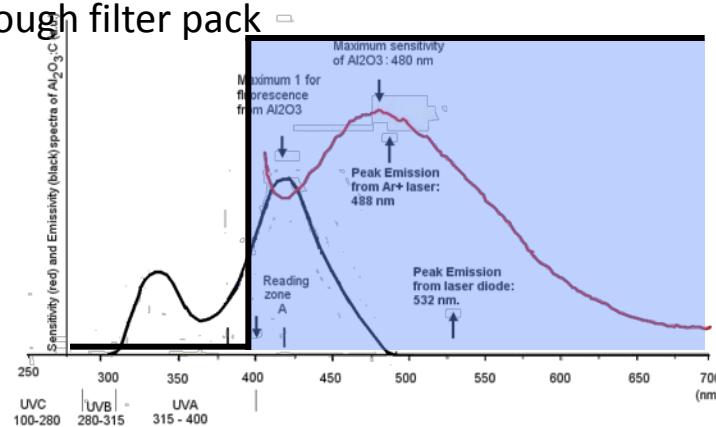
- Calibration:
 - ^{60}Co
 - In the middle of exposure period (fading included)
 - Single element correction factor
 - Results in absorbed dose to water
 - Background detectors
 - Uncertainties: calibration, spread different detectors, individual sensitivity



Types of dosimeters used at SCK•CEN

Optically stimulated luminescence detectors

- Al_2O_3 : C (Luxel[®], TLD 500)
- All detectors are read out using Ar-ion laser (green stimulation light)
 - 488 nm, 120 mW/cm²
 - 100 s of optical stimulation
 - CW-OSL
 - Discrimination through filter pack
- Calibration:
 - Cfr. TLD



Detector characterization - Results of ICCHIBAN 3

- ICCHIBAN irradiation series are intended to characterize the high LET-behaviour of detectors



Detection efficiency is different for different LET values
Different for each detector type



Measured low LET dose is different for each detector type



Corrections should be made taking into account high LET response

Detector characterization - Results of ICCHIBAN 3

- ICCHIBAN-3 protocol:
 - Protonbeam 30 MeV (1, 10, 50, 100 mGy + 3 blinds) (LET = 1.9 keV/ μ m)
 - Protonbeam 235 MeV (300, 10, 50, 100 mGy + 3 blinds) (LET = 0.41 keV/ μ m)

Calculated dose in water (mGy)

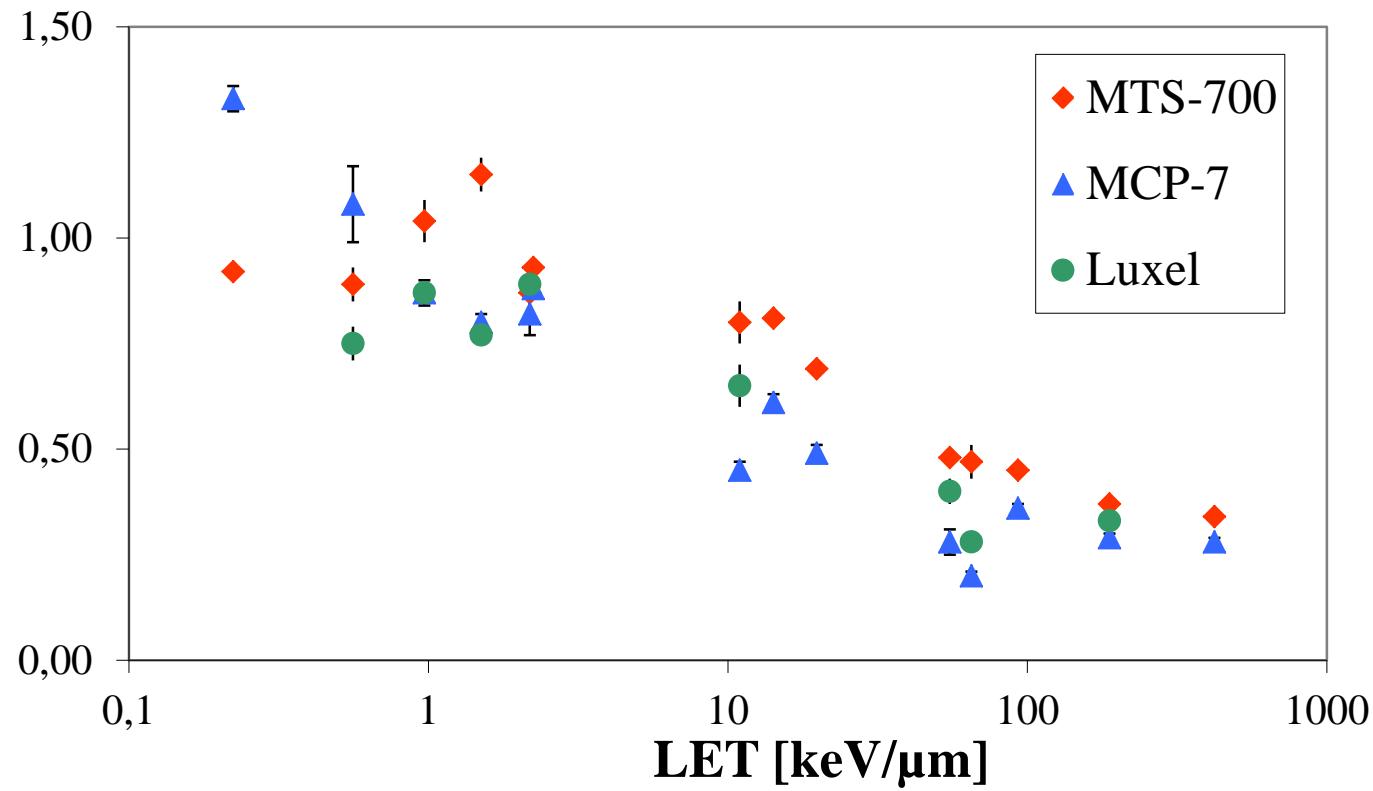
	Given dose (mGy)	MTS600		MTS700		MCP600		MCP700	
		Dw	u	Dw	u	Dw	u	Dw	u
30 MeV	1			0.90	1.04	0.54	0.11	0.61	0.05
	10	10.4	0.8	6.7	0.5	5.2	0.2	6.4	0.4
	50	48	4	36.5	1.6	28.1	1.9	31.1	1.7
	100	98	7	75	3	55.4	2.2	63	4
	2 mm Al absorber	56	4	43.5	2.4	29.4	1.5	34.6	2.1
	Blind n°1	55	4	43.0	1.8	31.4	2.6	36.7	2.0
	Blind n°2	223	18	182	7	133	6	153	10
	Blind n°3	138	11	114	5	87	11	101	7
235 MeV	300 mGy	409	32	337	14	351	18	396	28
	10 mGy	16.3	1.3	11.5	0.6	12.5	0.7	15.2	1.0
	50 mGy	72	5	57.0	2.1	57	5	68	5
	100 mGy	141	10	117	6	121	6	137	8
	Blind n°2	41	4	35.6	1.7	22.7	0.8	26.4	2.1

Detector characterization - Results of ICCHIBAN 3

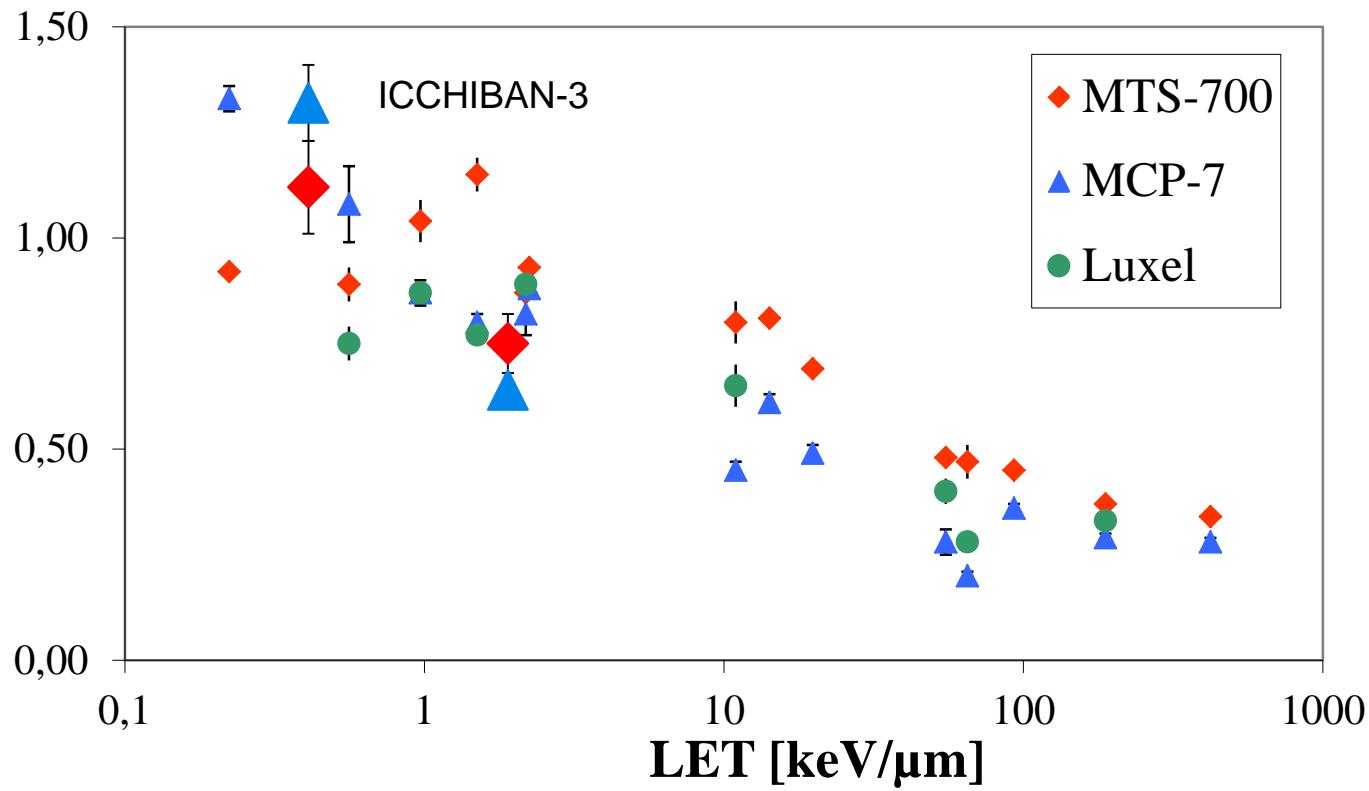
Calculated Response

		MTS600		MTS700		MCP600		MCP700	
	Given dose (mGy)	R	u	R	u	R	u	R	u
30 MeV	1			0.90	1.04	0.54	0.11	0.61	0.05
	10	1.05	0.08	0.66	0.05	0.52	0.02	0.64	0.04
	50	0.98	0.08	0.73	0.03	0.56	0.04	0.62	0.03
	100	0.98	0.07	0.75	0.03	0.55	0.02	0.64	0.04
	Average	1.00	0.03	0.76	0.26	0.54	0.03	0.63	0.02
	stdev	0.04		0.10		0.02		0.02	
235 MeV	300	1.37	0.11	1.12	0.05	1.17	0.06	1.32	0.09
	10	1.63	0.13	1.15	0.06	1.25	0.06	1.52	0.10
	50	1.43	0.11	1.14	0.04	1.14	0.10	1.36	0.09
	100	1.41	0.10	1.17	0.06	1.21	0.06	1.37	0.08
	Average	1.46	0.06	1.15	0.03	1.19	0.04	1.39	0.05
	stdev	0.12		0.02		0.05		0.09	

Detector characterization - Results of ICCHIBAN 3

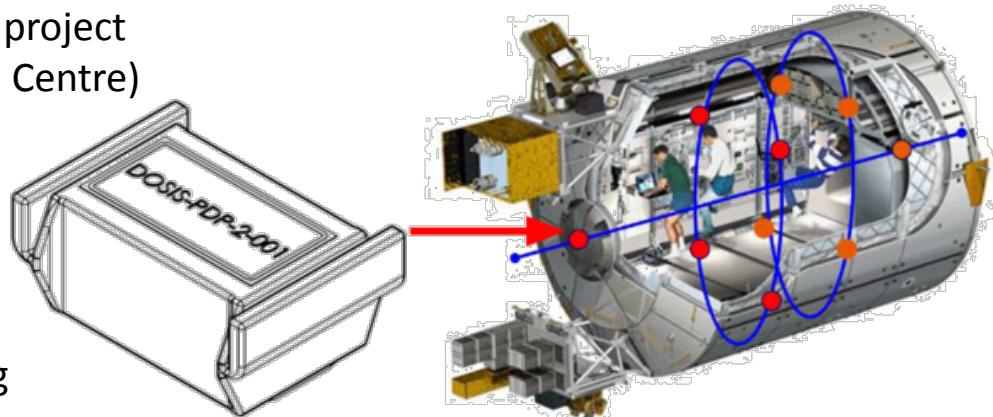


Detector characterization - Results of ICCHIBAN 3



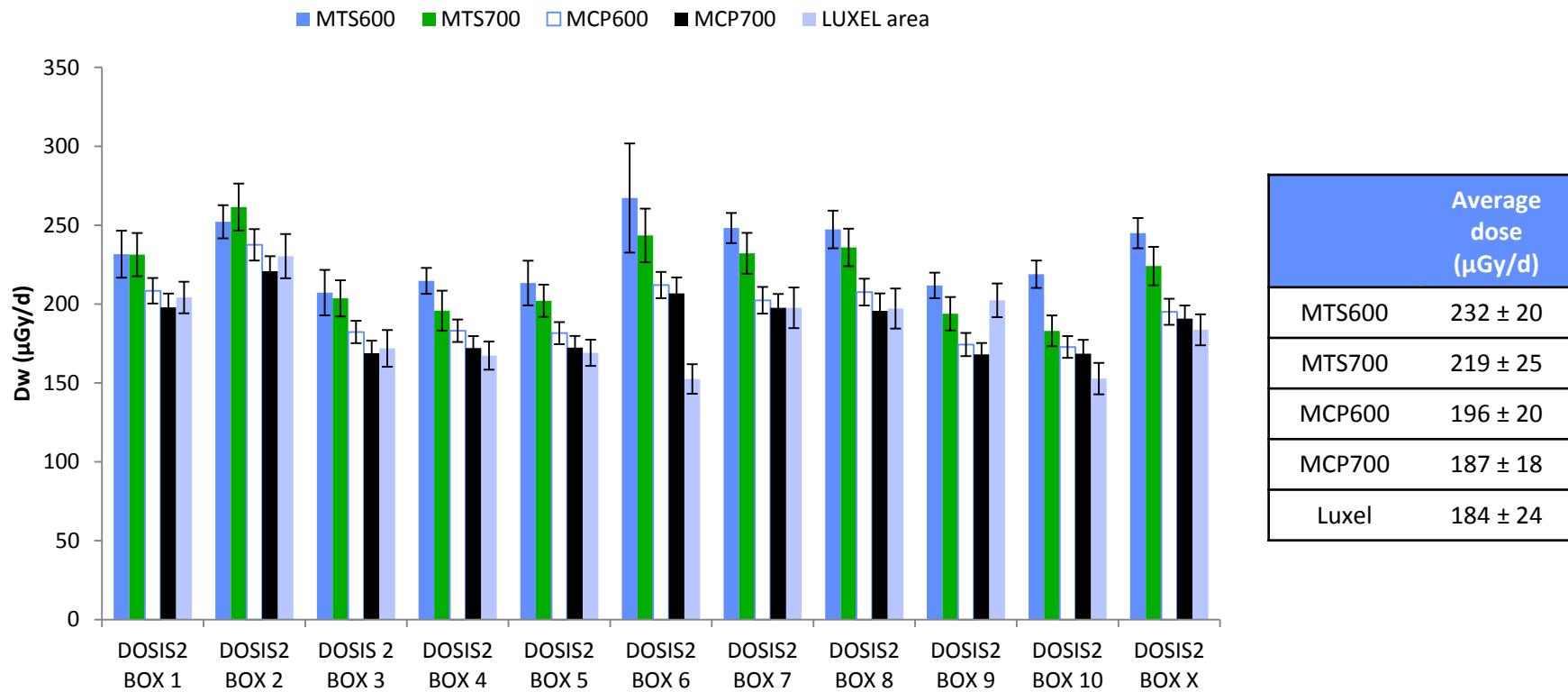
Experiment description

- Dose distribution inside ISS (a multi-lateral project under direction of DLR, German Aerospace Centre)
- Characterization of radiation field and dose mapping inside Columbus module
- Passive Detector Packages (PDP) containing luminescence and nuclear track detectors

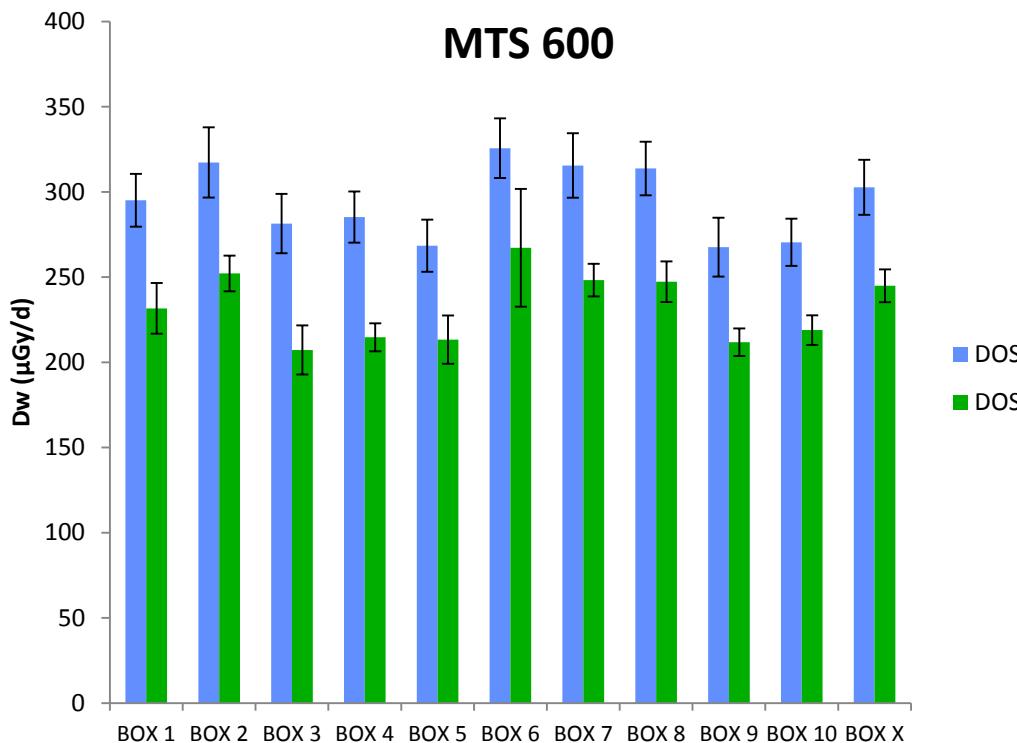


	Jul/09	Aug/09	Sep/09	Oct/09	Nov/09	Dec/09	Jan/10	Feb/10	Mrch/10	Apr/10	May/10	
DOSIS I												135 days
DOSIS II												191 days

Results DOSIS II



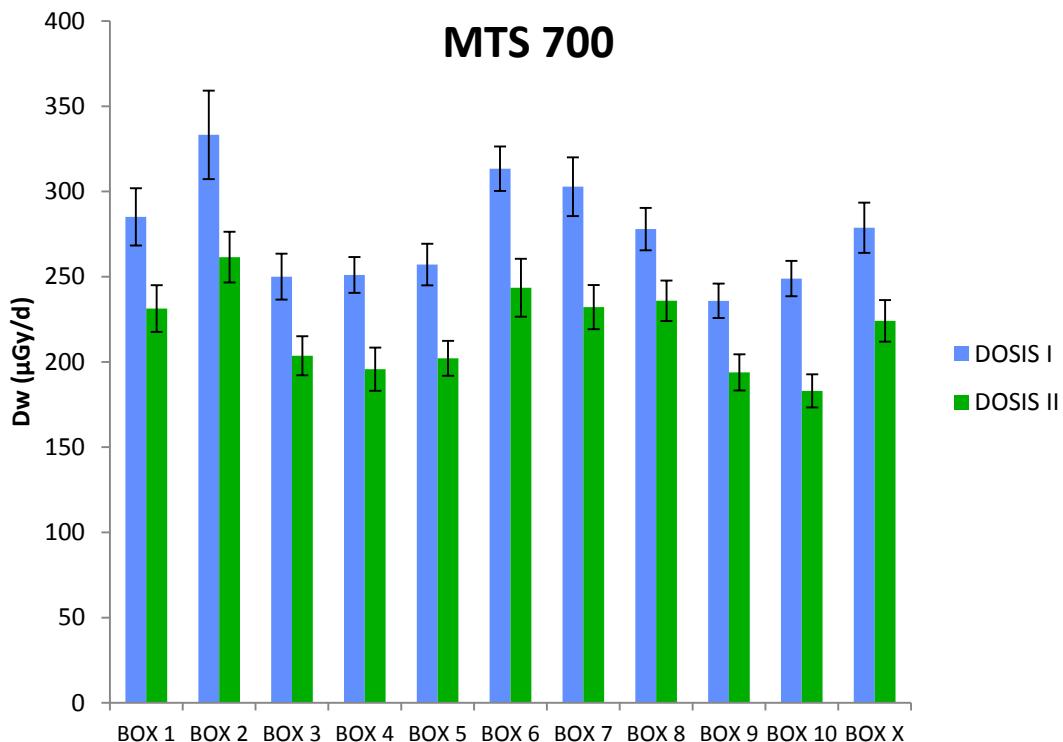
Comparison DOSIS I - DOSIS II



█ DOSIS I
█ DOSIS II

MTS600				
	DOSIS I		DOSIS II	
	Dw ($\mu\text{Gy}/\text{d}$)	u ($\mu\text{Gy}/\text{D}$)	Dw ($\mu\text{Gy}/\text{d}$)	u ($\mu\text{Gy}/\text{D}$)
BOX 1	295	16	232	15
BOX 2	317	21	252	11
BOX 3	281	17	207	14
BOX 4	285	15	215	8
BOX 5	268	15	213	14
BOX 6	326	18	267	35
BOX 7	316	19	248	10
BOX 8	314	16	247	12
BOX 9	268	17	212	8
BOX 10	270	14	219	9
BOX X	303	16	245	10

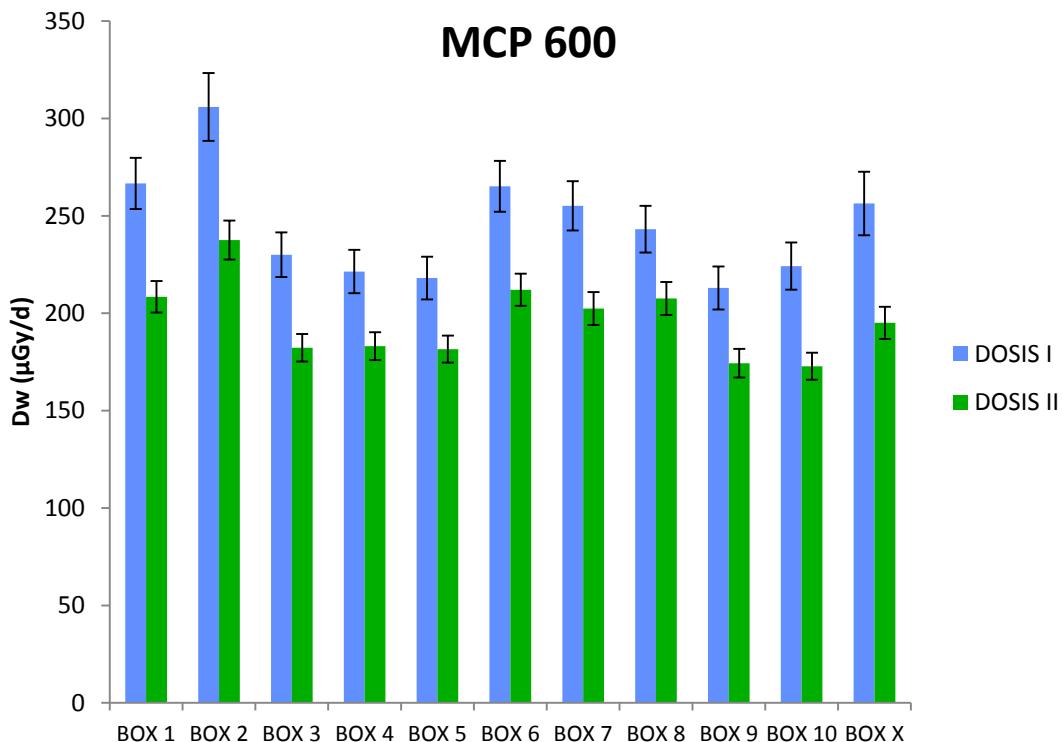
Comparison DOSIS I - DOSIS II



█ DOSIS I
█ DOSIS II

MTS700				
	DOSIS I		DOSIS II	
	Dw ($\mu\text{Gy}/\text{d}$)	u ($\mu\text{Gy}/\text{D}$)	Dw ($\mu\text{Gy}/\text{d}$)	u ($\mu\text{Gy}/\text{D}$)
BOX 1	285	17	231	14
BOX 2	333	26	261	15
BOX 3	250	13	204	11
BOX 4	251	11	196	13
BOX 5	257	12	202	10
BOX 6	313	13	244	17
BOX 7	203	17	232	13
BOX 8	278	12	236	12
BOX 9	236	10	194	11
BOX 10	249	10	183	10
BOX X	279	15	224	12

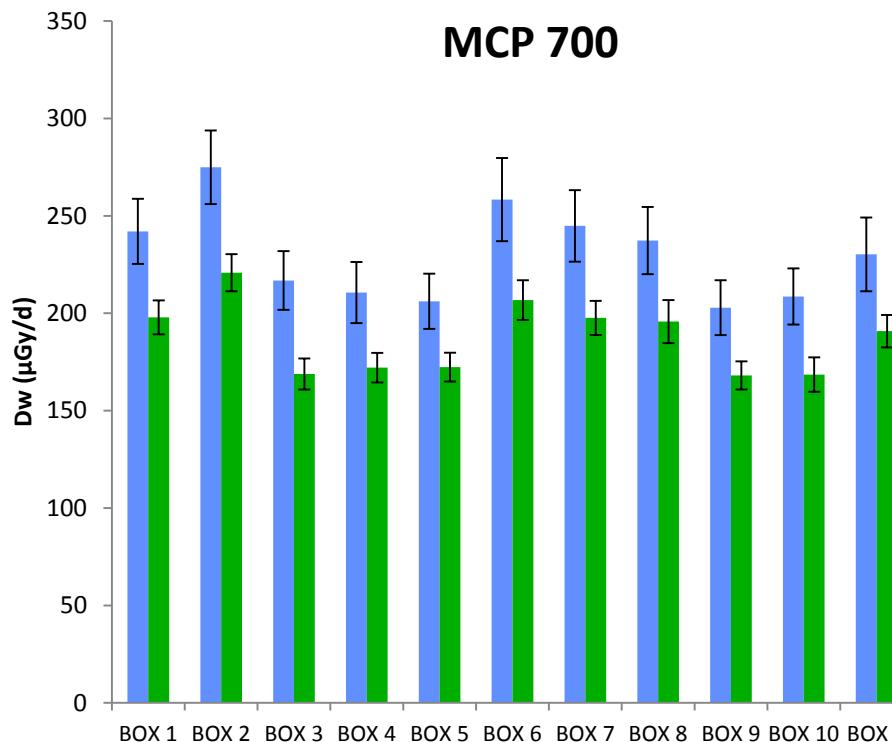
Comparison DOSIS I - DOSIS II



■ DOSIS I
 ■ DOSIS II

MCP600				
	DOSIS I		DOSIS II	
	Dw ($\mu\text{Gy}/\text{d}$)	u ($\mu\text{Gy}/\text{D}$)	Dw ($\mu\text{Gy}/\text{d}$)	u ($\mu\text{Gy}/\text{D}$)
BOX 1	267	13	208	8
BOX 2	306	17	238	10
BOX 3	230	11	182	7
BOX 4	221	11	183	7
BOX 5	218	11	182	7
BOX 6	265	13	212	8
BOX 7	255	13	202	8
BOX 8	243	12	208	8
BOX 9	213	11	174	7
BOX 10	224	12	173	7
BOX X	256	16	195	8

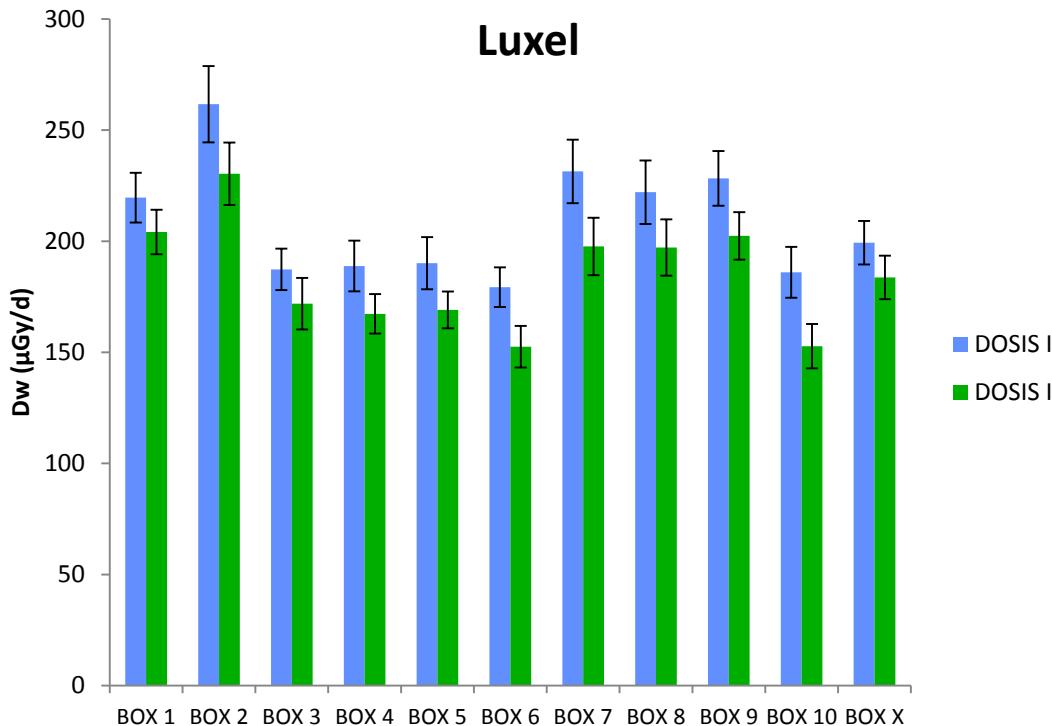
Comparison DOSIS I - DOSIS II



█ DOSIS I
█ DOSIS II

MCP700			
	DOSIS I	DOSIS II	
	Dw ($\mu\text{Gy}/\text{d}$)	u ($\mu\text{Gy}/\text{D}$)	Dw ($\mu\text{Gy}/\text{d}$)
BOX 1	242	17	198
BOX 2	275	19	221
BOX 3	217	15	169
BOX 4	211	16	172
BOX 5	206	14	172
BOX 6	258	21	207
BOX 7	245	18	198
BOX 8	237	17	196
BOX 9	203	14	168
BOX 10	209	14	169
BOX X	230	19	191

Comparison DOSIS I - DOSIS II



■ DOSIS I
 ■ DOSIS II

		Luxel	
		DOSIS I	
		Dw ($\mu\text{Gy}/\text{d}$)	u ($\mu\text{Gy}/\text{D}$)
BOX 1		220	11
BOX 2		262	17
BOX 3		187	9
BOX 4		189	11
BOX 5		190	12
BOX 6		179	9
BOX 7		231	14
BOX 8		222	14
BOX 9		228	12
BOX 10		186	11
BOX X		199	10

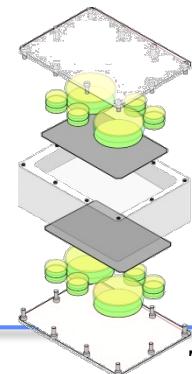
Experiment description

- Growth and survival of colored fungi in space
- Determine the effect of microgravity and cosmic radiation on the growth and survival of coloured fungi species
- 4 biocontainers:

3 Biocontainers:

2x2=4 Microcells 60 mm - Fungi

4x2=8 Microcells 30 mm - Spores

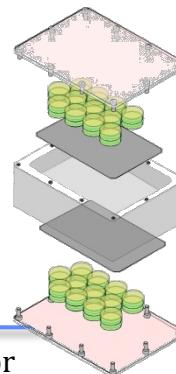


Introduction

Types of
dosemeters

1 Biocontainer:

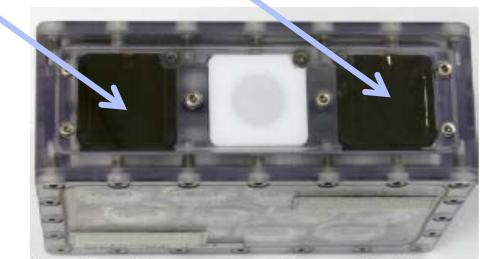
12x2=24 Microcells 30 mm- Spores



Detector
characterization

DOSIS II

Radiation detectors from **SCK (TL/OSL)**, **NPI (TL/OSL/track etch)** and **OSU (OSL)** were placed outside the biocontainer

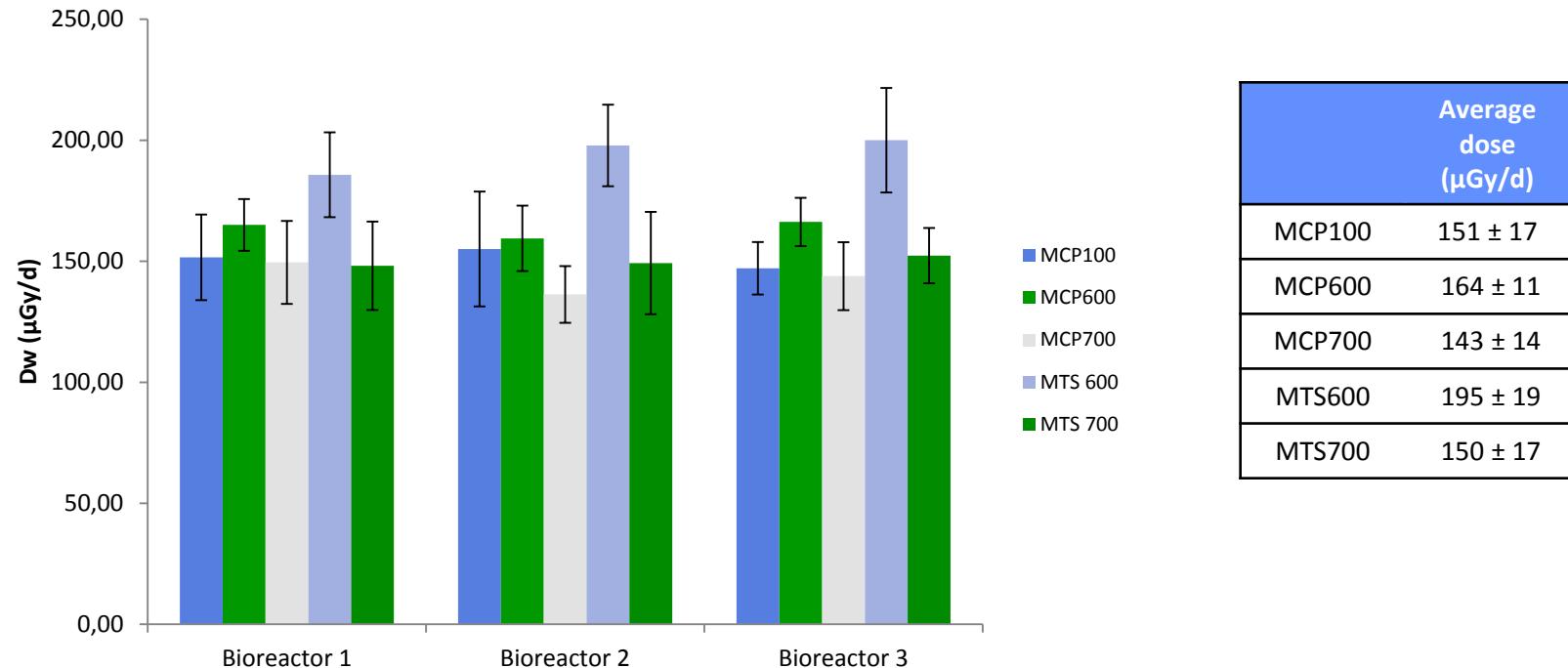


CFS-A short term

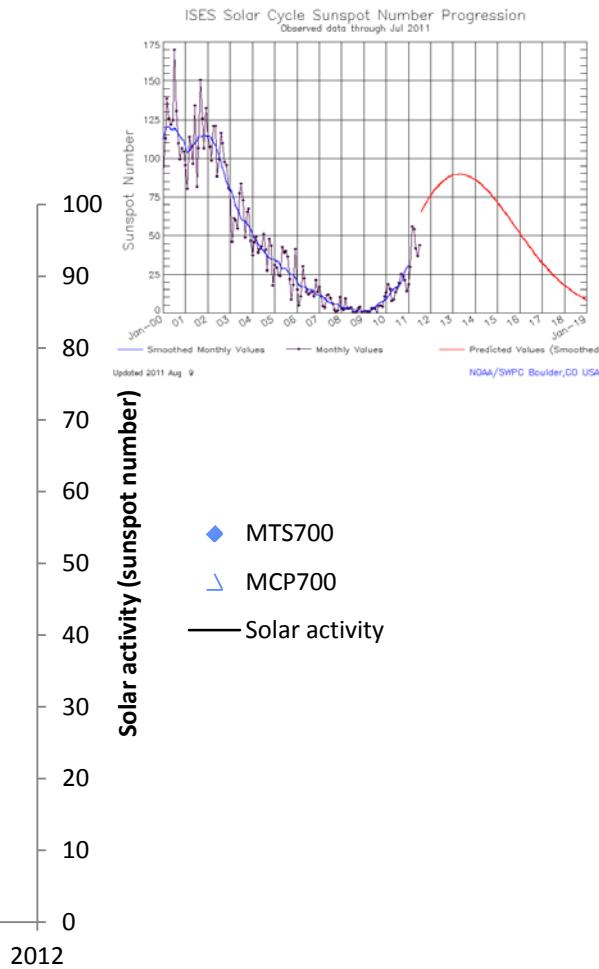
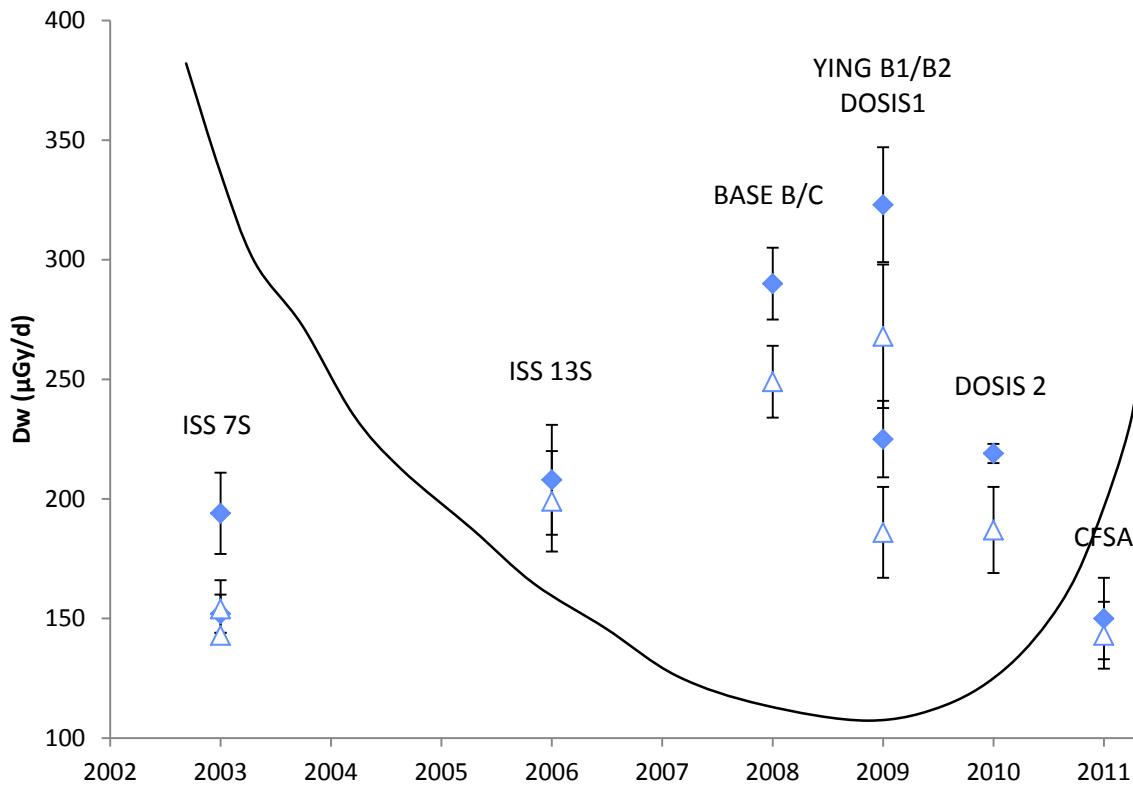
Conclusion

Results CFSA

- Short term results (biocontainer 1, 2, 3): 24/02/2011 → 09/03/2011 (14 days)



Overview all space flights



General conclusion

- Space dosimetry is not straightforward due to the complex radiation field
- A combination of several detectors is used to cover the complete LET-spectrum (nuclear track detectors and luminescence techniques)
- SCK•CEN has participated in a lot of experiments (luminescence techniques)
- The data are consistent for all experiments



Next step:
Correction for the differences in detection efficiencies for the high LET-part of the spectrum



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