

18th Workshop on Radiation Monitoring for the International Space Station

3–5 September 2013, Budapest, Hungary

HUNGARY

18TH WORKSHOP ON RADIATION MONITORING FOR THE ISS

BUDAPEST

The Results of 4 Sessions of Experimental Study of Local Water Shielding Efficiency to Space Radiation with the Protective Curtain in ISS Crew Cabin

R.V. Tolochev¹ *, V.A. Shurshakov¹, E.N. Yarmanova¹, I.S. Kartsev¹, I.V. Nikolaev², N. S. Kodaira³, H. Kitamura³, Y. Uchihori³, H. Kawashima³, I. Ambrozova⁴

1 — Instisute of Bio-Medical problems, Russian Academy of Science, Moscow, Russia
Russian Academy of Science, Moscow, Russia

2 -Rocket Space Corporation “Energia”, Moscow region, Russia

3 - National Institute of Radiological Sciences, Chiba, Japan

4 - Nuclear Physics Institute, Academy of Sciences of Czech Republic, Prague, Czech republic



Participants of the current experiment

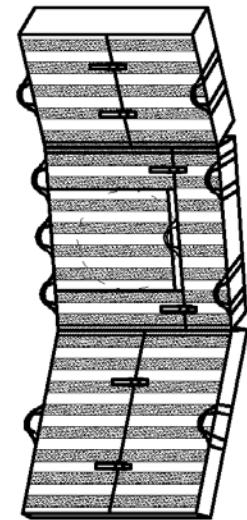
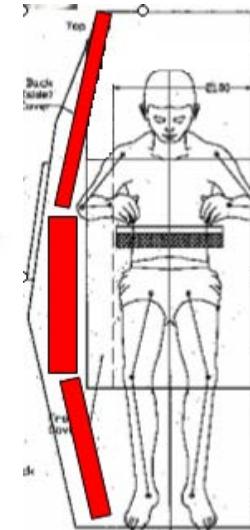
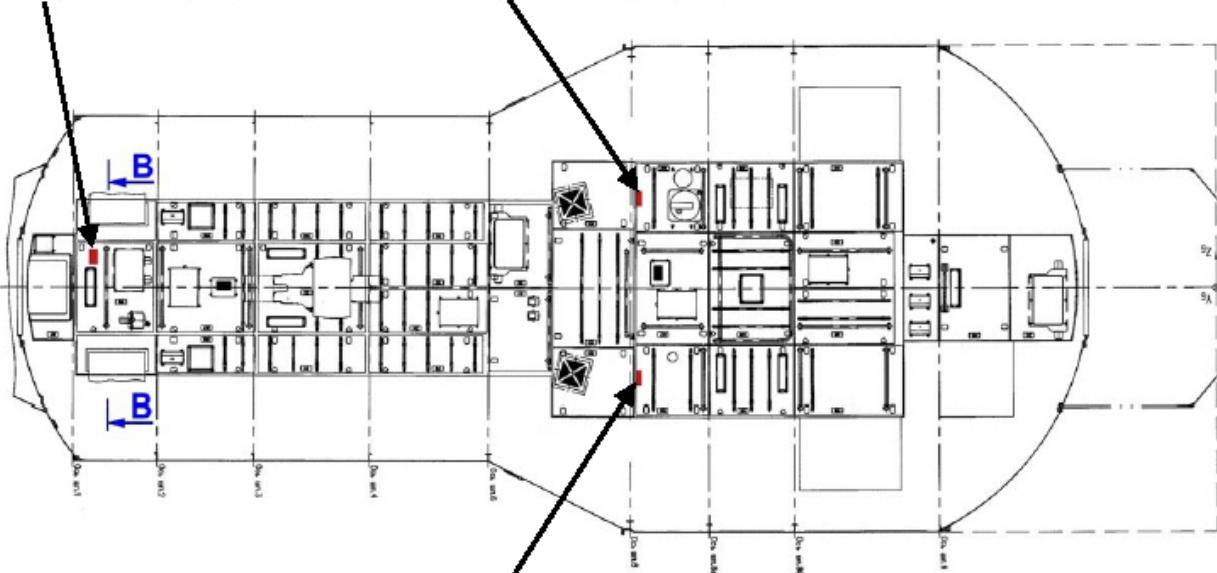
- IBMP, Russia (TLD)
- NPI, Czech republic (TLD, SSNTD)
- NIRS, Japan (TLD, SSNTD)
- MTA CERF, Hungary (Pille-ISS)
- CSA, Canada (BUBBLE detectors)

In this report IBMP, NPI and NIRS data is presented

Crew cabin shielding characteristic

Сборка "СПД" (А06) на пан 305

Сборка "СПД" (А05) на пан 323



Protective curtain

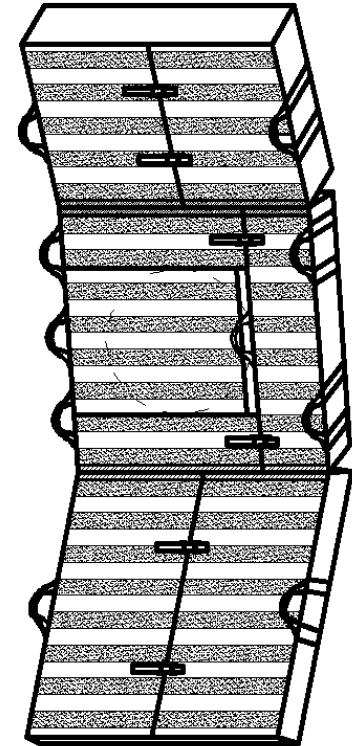
Scheme of Service Module of Russian Segment of ISS

Crew cabin outer wall - 1.5 g/cm² (Al)

Protective curtain ~ 6 g/cm² (dentisty = 1,3 g/cm³)

Protective curtain design

	Sizes, mm	Mass, kg
Upper	682x525x260	25,600
Middle	730x430x235	24,000
Lower	540x470x150	14,600
In total		64,200

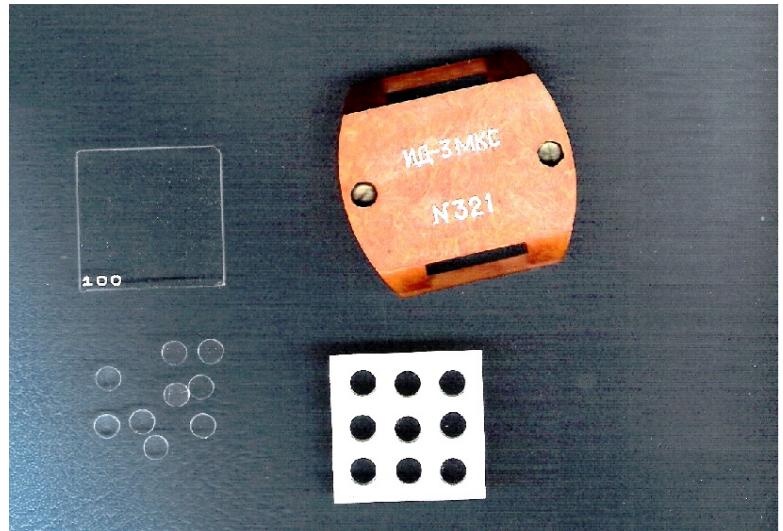


- The internal surface of the protective curtain is made similar style to the station wall surface
- There is a separate part that allows opening of the illuminator area



Measuring instrument

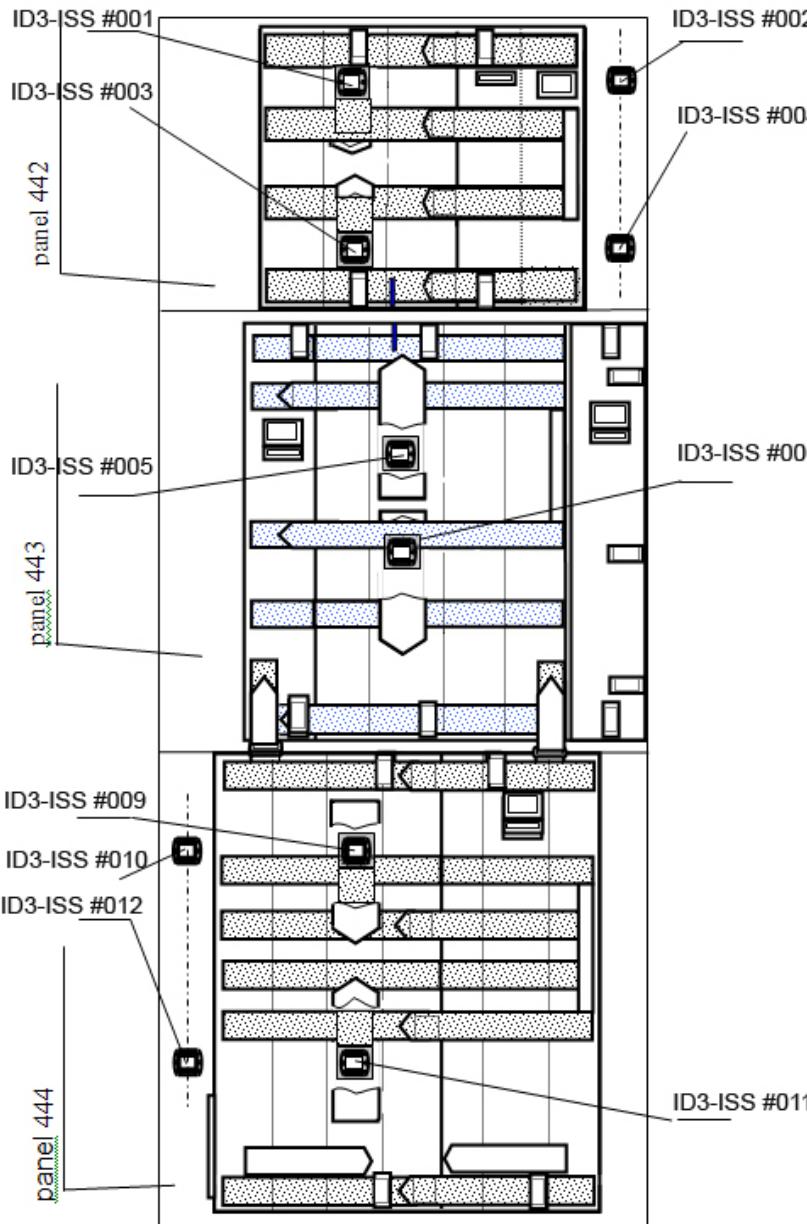
To study radiation effect thermoluminescent detectors (TLD) and solid-state nuclear track detector (SSNTD) have been used.



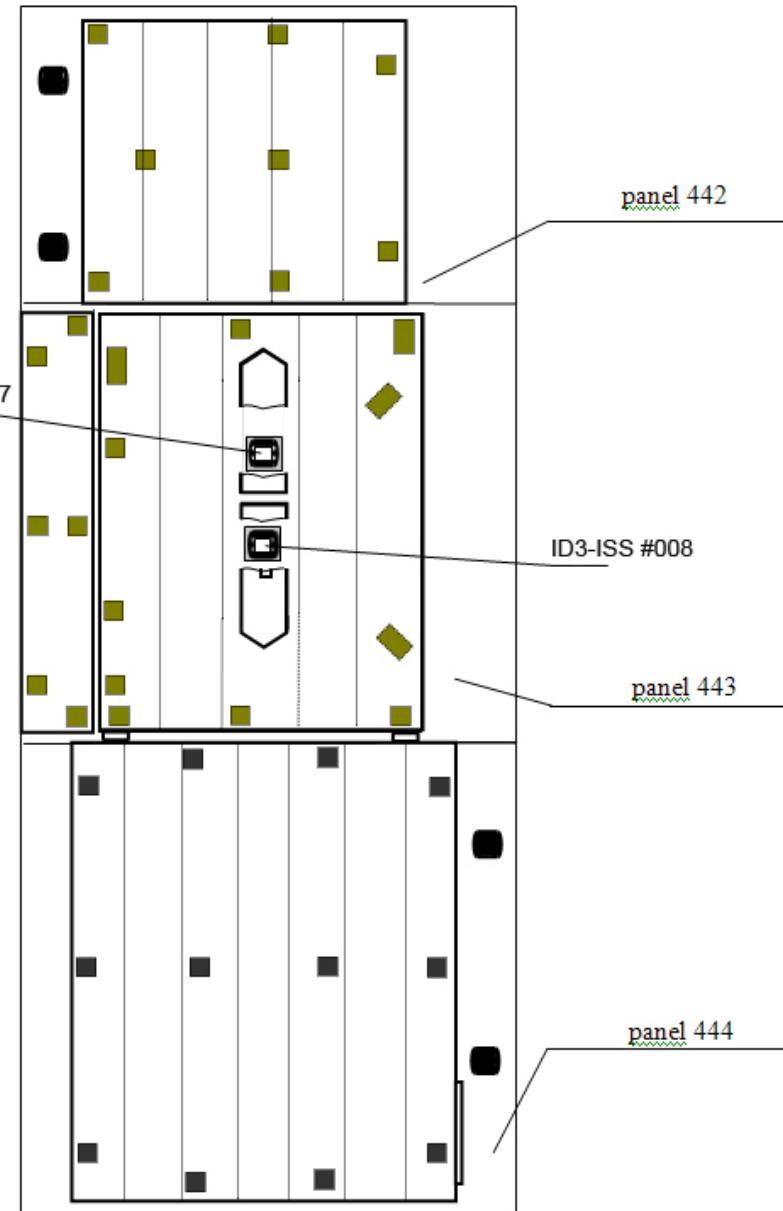
12 passive detectors packages ID3-ISS

ID3-ISS arrangement

Front view (from crew cabin)



Backside view



4 Session Flight Data

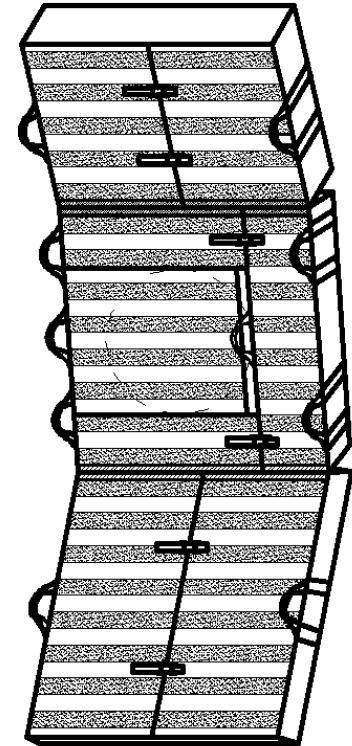
The passive detector packages were exposed in the Service Module starboard crew cabin during 4 sessions:

session#	Start	End	Duration, days
1	30.06.2010	26.11.2010	149
2	15.12.2010	24.05.2011	160
3	21.06.2011	27.04.2012	311
4	15.05.2012	19.11.2012	188
Total duration — 808 days			



Protective curtain design

	Sizes, mm	Mass, kg
Upper	682x525x260	25,600
Middle	730x430x235	24,000
Lower	540x470x150	14,600
In total		64,200



- The internal surface of the protective curtain is made similar style to the station wall surface
- There is a separate part that allows opening of the illuminator area



OBTAINED RESULTS: TLD (IBMP)

Absorbed dose rate, $\mu\text{Gy/day}$

1 session				2 session				3 session				4 session			
# pack	average	error	%	average	error	%	average	error	%	average	error	%	average	error	%
1	248	13	6	224	12	5	272	11	4	293	36	12			
2	380	17	5	383	16	4	500	23	5	567	14	2			
3	235	12	5	219	12	5	265	17	7	310	10	3			
4	414	19	5	364	20	6	474	24	5	558	10	2			
5	224	12	6	208	9	4	254	16	6	278	11	4			
6	213	11	6	193	12	6	231	14	6	274	8	3			
7	255	5	2	236	13	6	345	36	10	337	40	12			
8	259	8	3	224	10	5	280	7	2	346	20	6			
9	233	13	6	227	12	5	278	10	4	289	6	2			
10	316	8	3	310	14	4	383	21	6	422	15	3			
11	234	11	5	233	14	6	271	15	6	308	8	3			
12	382	16	5	351	23	7	423	22	5	499	15	3			

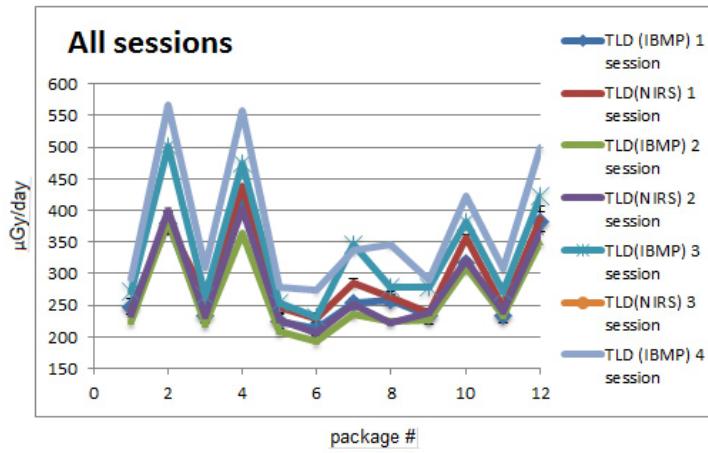
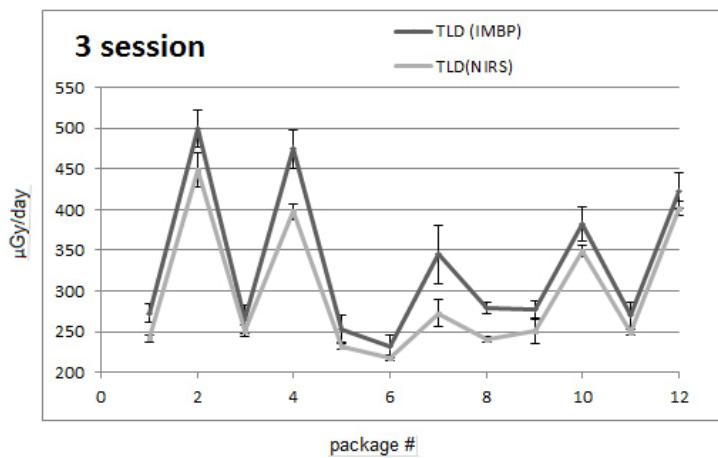
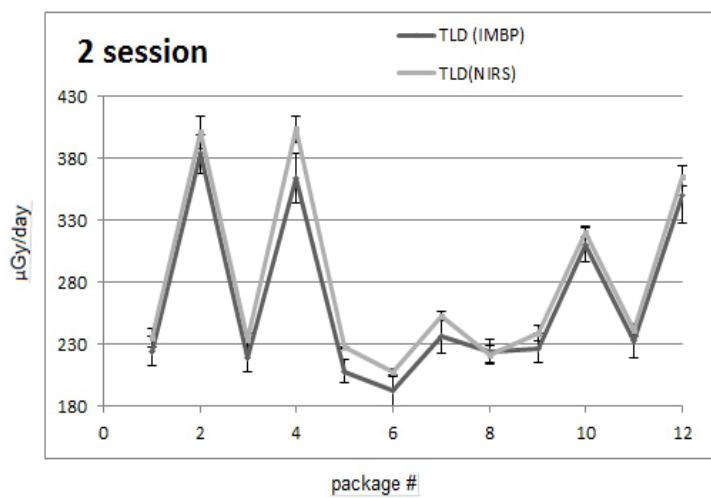
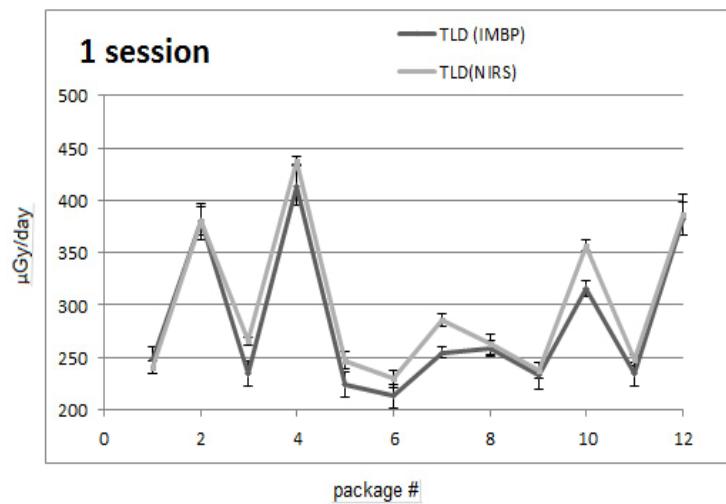
OBTAINED RESULTS: TLD (NIRS)

absorbed dose rate, $\mu\text{Gy/day}$

# pack	1 session			2 session			3 session		
	average	error	%	average	error	%	average	error	%
1	241	6	2	235	7	3	241	5	2
2	381	13	3	401	13	3	449	21	5
3	266	4	2	234	5	2	251	8	3
4	438	4	1	403	11	3	397	10	3
5	247	8	3	227	1	0	231	4	2
6	230	9	4	207	3	2	217	3	2
7	286	6	2	253	4	1	273	17	6
8	263	9	4	222	7	3	240	3	1
9	238	8	3	239	6	3	250	15	6
10	357	6	2	321	4	1	349	7	2
11	248	5	2	241	5	2	249	3	1
12	387	19	5	366	8	2	401	9	2

OBTAINED RESULTS: TLD (IBMP+NIRS)

absorbed dose rate, $\mu\text{Gy/day}$



OBTAINED RESULTS: TLD+SSNTD (NPI+NIRS)

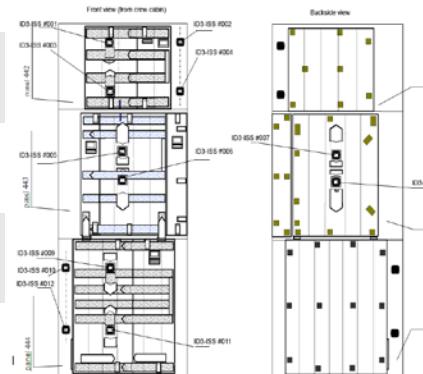
# pack	1 session				2 session			
	dose rate, $\mu\text{Gy/day}$		dose rate, $\mu\text{Sv/day}$		dose rate, $\mu\text{Gy/day}$		dose rate, $\mu\text{Sv/day}$	
	average	RMS	average	RMS	average	RMS	average	RMS
1	241	6	429	28	235	7	338	24
2	381	13	617	33	401	13	588	30
3	266	4	510	30	234	5	336	23
4	438	4	953	40	403	11	458	26
5	247	8	351	26	227	1	239	20
6	230	9	344	26	207	3	243	20
7	286	6	331	25	253	4	339	24
8	263	9	302	23	222	7	266	22
9	238	8	334	24	239	6	275	22
10	357	6	426	27	321	4	282	23
11	248	5	318	24	241	5	282	25

OBTAINED RESULTS: TLD+SSNTD (NPI+NIRS)

# pack	3 session					4 session	
	dose rate, $\mu\text{Gy/day}$		dose rate, $\mu\text{Sv/day}$		dose rate, $\mu\text{Sv/day}$		
	average	RMS	average	RMS	average	RMS	
1	241	5	314	16	480	26	
2	449	21	600	20	902	32	
3	251	8	293	15	435	24	
4	397	10	446	18	876	32	
5	231	4	243	14	379	24	
6	217	3	235	14	353	23	
7	273	17	281	15	378	23	
8	240	3	234	14	475	26	
9	250	15	266	15	394	25	
10	349	7	324	16	461	25	
11	249	3	272	15	379	24	

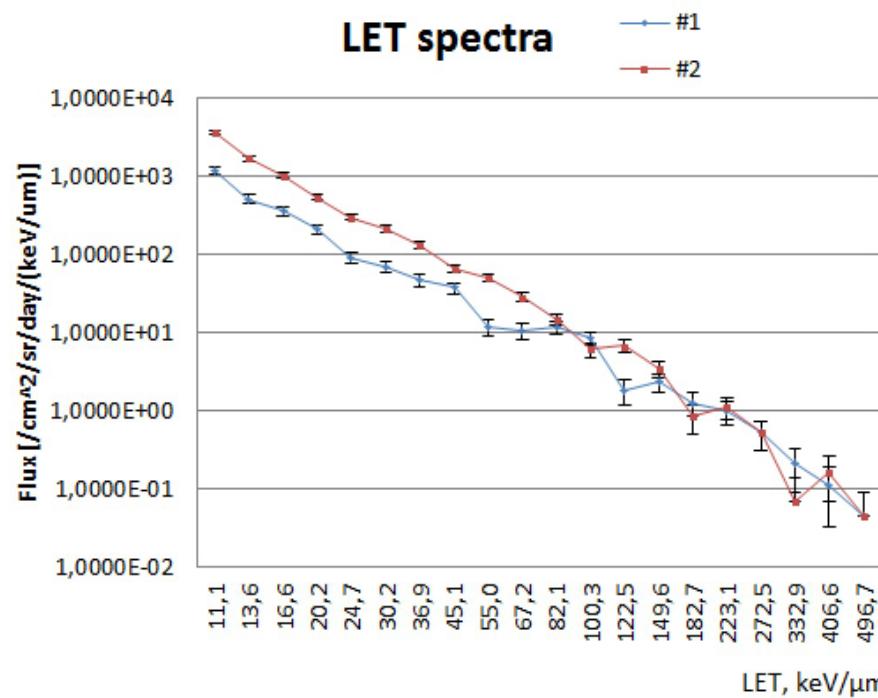
Dose ratio of shielded ID3-ISS to unshielded

	RATIO							RATIO										
	D (IBMP)			D(NPI+ NIRS)				H(NPI+ NIRS)				D (IBMP)			D(NPI+ NIRS)			H(NPI+ NIRS)
1 session	error		error		error			3 session		error		error		error		error		
07/05	1,14	0,07	1,16	0,05	0,94	0,10	07/05	1,36	0,17	1,18	0,07	1,15	0,09					
08 / 06	1,21	0,08	1,14	0,06	0,88	0,09	08 / 06	1,21	0,08	1,10	0,02	1,00	0,08					
04/ 03	1,76	0,13	1,65	0,03	1,87	0,13	04/ 03	1,79	0,15	1,58	0,06	1,52	0,10					
02/ 01	1,53	0,12	1,58	0,07	1,44	0,12	02/ 01	1,84	0,11	1,86	0,10	1,91	0,11					
10/ 09	1,36	0,09	1,50	0,06	1,28	0,12	10/ 09	1,38	0,09	1,39	0,09	1,22	0,09					
12/11	1,63	0,11	1,56	0,09	1,92	0,18	12/11	1,56	0,12	1,61	0,04	1,45	0,10					
2 session							4 session											
07/05	1,14	0,08	1,11	0,02	1,42	0,15	07/05	1,21	0,15									
08 / 06	1,16	0,09	1,07	0,04	1,10	0,13	08 / 06	1,26	0,08									
04/ 03	1,66	0,13	1,73	0,06	1,36	0,12	04/ 03	1,80	0,07									
02/ 01	1,71	0,11	1,71	0,07	1,74	0,15	02/ 01	1,93	0,24									
10/ 09	1,37	0,09	1,34	0,04	1,03	0,12	10/ 09	1,46	0,06									
12/11	1,51	0,13	1,52	0,04	1,28	0,14	12/11	1,62	0,07									

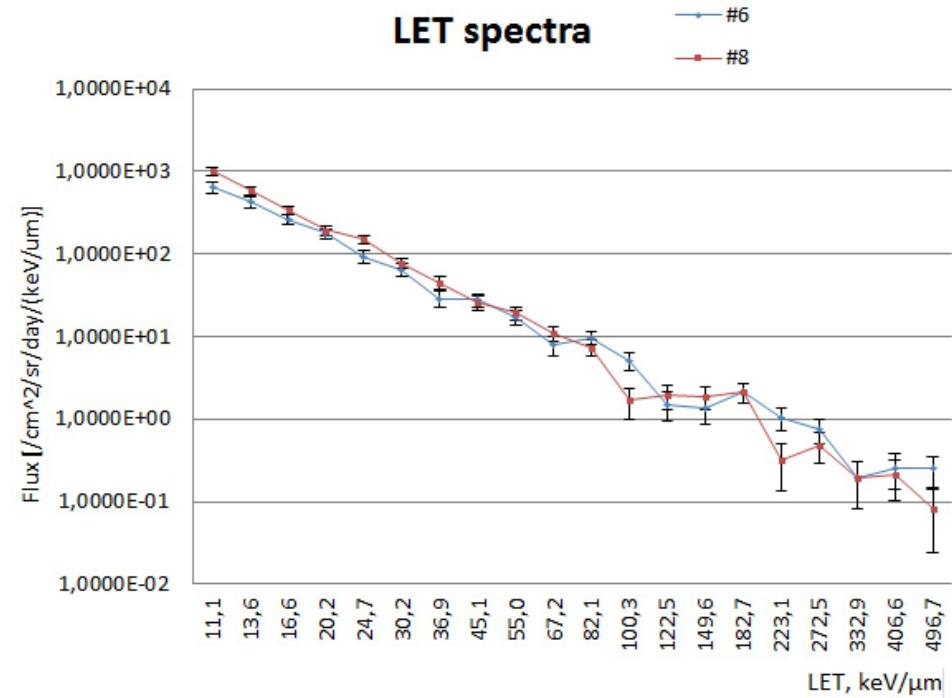


LET spectra

Pack#02 and Pack#1, 2 session



Pack#8 and Pack#6, 1 session



Conclusions

- 4 sessions of the experiment with protective curtain were performed. We planned and made all AT tests for session #5. The launch date is scheduled to be Sep. 25, 2013, though, it will be the last session with water napkins and towels.
- Dose rates measured by ID3-ISS in the crew cabin in the protective curtain study vary from 193 mGy/day to 567 mGy/day.

The unshielded- shielded absorbed dose ratio changes from 1.14 to 1.93. For equivalent dose the ratio is up to 1.93, though, there are 2 cases, when the ratio is lower, then 1.
Average Q = 2,3 and varies from 1,9 to 3,4

We plan to make a calculation and simulation of the protective curtain experiment results. However, it should be mentioned that the higher the unshielded dose the higher the protective curtain shielding effect. In this situation the experimental data obtained are considered to be of big practical validity.

- In this report, both TLD and SSNTD data is presented. for 3 sessions. The data for session is incomplete and can be corrected when the detector processing and analysis by all space intercomparison participants is completed. When available from international participants , SSTD detectors, Pille-ISS, BUBBLE-ISS and Lulin-ISS data will be analyzed and used in future investigations

Thank you for your attention!