



RADIATION MONITORING onboard the RUSSIAN SEGMENT OF THE ISS: COMPARISON between DOSE MEASUREMENTS OBTAINED with "PILLE-ISS" and "R-16" OPERATIONAL INSTRUMENTS

**Yu.A. Akatov¹, V.V. Arkhangelsky¹, V.A. Bondarenko¹, V.V. Tsetlin¹,
I. Apathy², S. Deme²**

¹State Research Center of Russia Institute for Biomedical Problems
Russian Academy of Sciences, Moscow, Russia

²Atomic Energy Research Institute – KFKI, Budapest, Hungary

Operational Dosimeter PILLE-ISS (TLD type with on board reader)



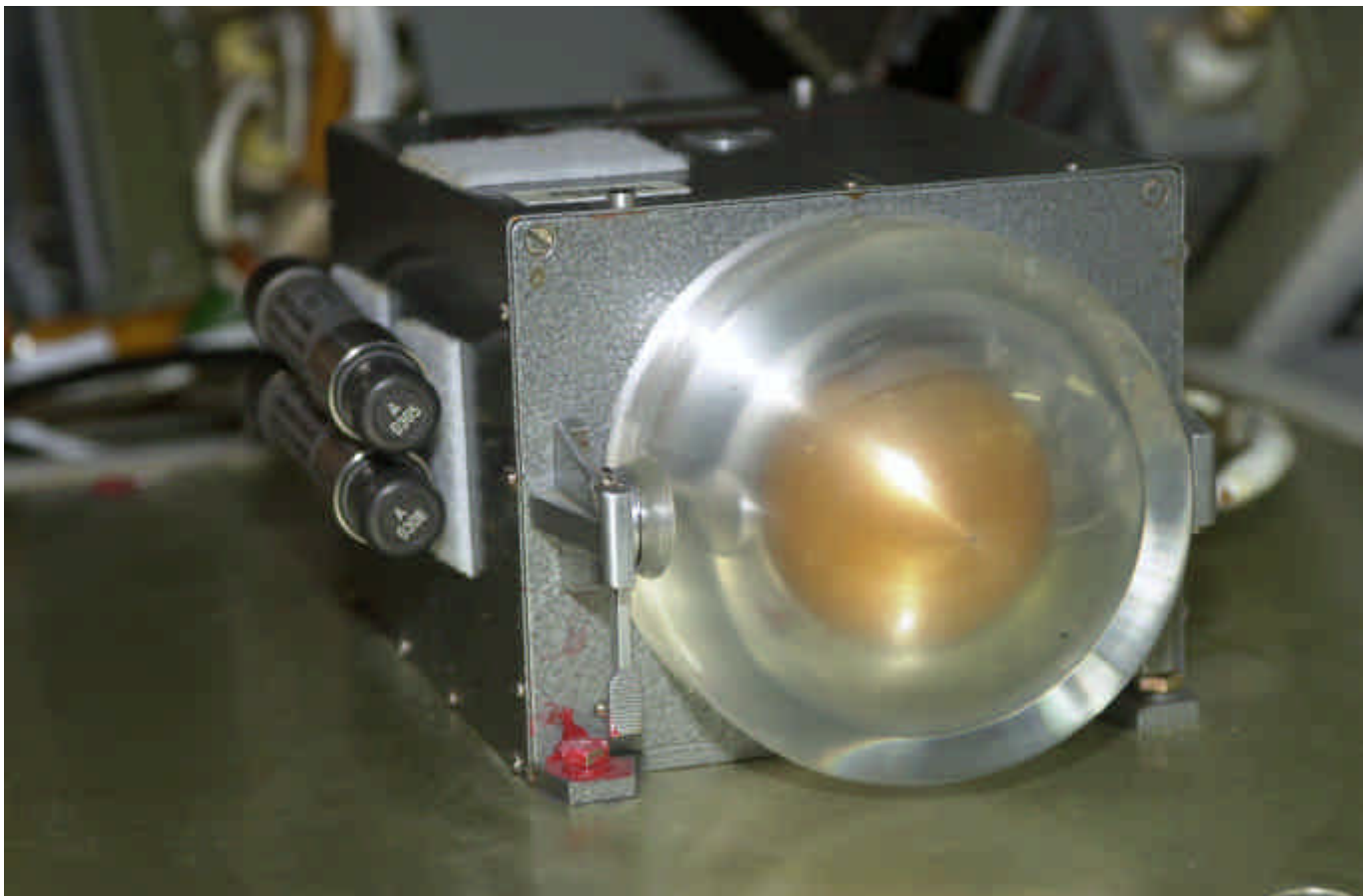
IN-FLIGHT INTERCOMPARISON

- **Pille-ISS and R-16 instruments are parts of the radiation control operational system of the Russian Segment of ISS**
- **Thermoluminescent dosimeter "Pille-ISS" consists of ten autonomic detectors and the onboard compact reader**
- **Radiometer "R-16" consists of two ionizing chambers.**
- **The intercomparison between two above mentioned instruments has been carried out during ISS-8 and ISS-9 flights.**

METHOD OF THE IN-FLIGHT INTERCOMPARISON

- **Two "Pille" detectors, that had been previously annealed, were placed on the body of radiometer "R-16" and were exposed there constantly**
- **Periodic measurement on the reader were done each 30 days, approximately.**
- **The data obtained with both instruments were transferred to the Earth to the IBMP Space Flights Radiation Safety Service, and have been analyzed.**

«PILLE-ISS» SENSORS ON THE «R-16» RADIOMETER



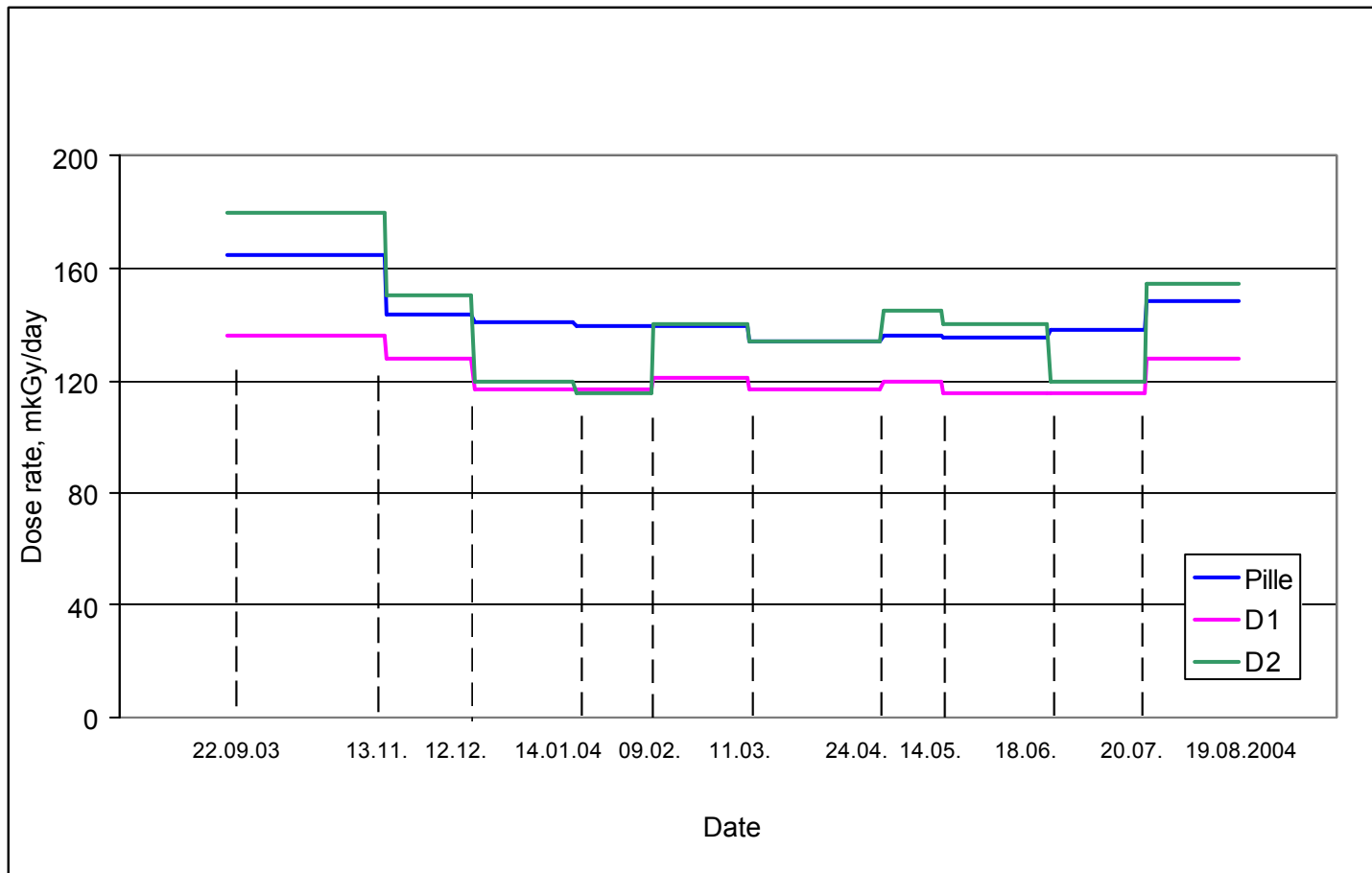
RUSSIAN SEGMENT OF THE ISS. «PILLE-ISS» READER



**INTERCOMPARISON of the RESULTS OBTAINED with «PILLE-ISS» and
«R-16» ON THE RUSSIAN SEGMENT ISS DURING ISS-8 and ISS-9
EXPEDITIONS (2003 – 2004)**

EXPOSURE PERIOD	EXPOSURE DURATION, DAYS	MEASURED DOSES, mGy			
		PILLE-ISS SENSORS		R-16 SENSORS	
		? 0305	? 0306	D1	D2
22.09.2003-13.11.2003	52	9.10	8.06	7.10	9.35
13.11.2003-12.12.2003	29	4.33	4.00	3.70	4.35
12.12.2003-14.01.2004	33	4.81	4.49	3.85	3.95
14.01.2004-09.02.2004	26	3.69	3.55	3.05	3.00
09.02.2004-11.03.2004	31	4.13	4.51	3.75	4.35
11.03.2004-24.04.2004	44	5.67	6.11	5.15	5.90
24.04.2004-14.05.2004	20	2.76	2.67	2.40	2.90
14.05.2004-18.06.2004	35	4.58	4.89	4.05	4.90
18.06.2004-20.07.2004	32	4.24	4.59	3.70	3.85
20.07.2004-19.08.2004	30	4.55	4.34	3.85	4.65

INTERCOMPARISON BETWEEN the RESULTS OBTAINED with «PILLE-ISS» and «R-16» ONBOARD the RS ISS



EVA Dose Measurements

- Measurements of doses at the operations of Extravehicular Activity (EVA) were carried out with "Pille-ISS" sensor placed in an external pocket of the space suit of each cosmonaut on the right shin.
- Directly before an EVA three "Pille-ISS" sensors were simultaneously annealed.
- Then two sensors were placed in the pockets of space suits. The third sensor remained inside RS ISS. After finishing EVA the all three sensors were simultaneously measured again.
- The data were operatively transferred to the Earth to the IBMP Space Flights Radiation Safety Service, and have been analyzed.
- Such procedures have been carried out for five EVA of the ISS-8 (27.02.2004) and ISS-9 (25.06.2004, 01.07.2004, 03.08.2004, 03.09.2004) crews.



RESULTS OF THE RADIATION CONTROL OF ISS-8 and ISS-9 CREW MEMBERS DURING EVA WITH PILLE-ISS

Mission, Date, Time interval EVA	EVA Duration	Dose value for the period of experiment, mGy			Estimation of excessive dose due to EVA, mGy	
		Sensor inside the ISS	Sensor on the space-suit of the Russian cosmonaut	Sensor on the space-suit of the USA astronaut	Russian cosmonaut	USA astronaut
ISS-8 27.02.2004 0h 17' –4h 12'	3h 55'	340	494	550	154	210
ISS-9 25.06.2004 0h 57' –1h 10'	0h 13'	429	521	578	92	149
ISS-9 01.07.2004 0h 19' –5h 59'	5h 40'	390	664	645	264	255
ISS-9 03.08.2004 9h 55' –14h 28'	4h 30'	409	661	723	252	314
ISS-9 03.09.2004 19h 43' - 04.09.2004 01h 04'	5h 21'	319	617	623	298	304

DISCUSSION

- 1. Results of the intercomparison experiment with two operational instruments "Pille ISS" and "R-16" can be accepted as satisfactory. These results allow us to carry out correct estimations of radiation conditions in-flights the RS ISS crews.**
- 2. Sources of errors in such experiments can be:**
 - not identical shielding distribution around the sensors of the two instruments due to some difference of their localization at the station, and due to an essential difference of the sizes of their sensitive volumes of the sensors.**

It is planned at the following stage of this experiment to take off the additional protection (3.0 g/cm²) from the D-1 sensor of the R-16 and to carry out intercomparison measurements similar way.
- 2. Using the "Pille-ISS " sensor placed in the pocket of the space suit on a shin it is possible to consider the results of dose measurements as an estimation of radiation load during an EVA near to the Station. In this case, the shielding conditions of the sensor are more important than inside the ISS, and the obtained dose values can be considered as close to maximum estimation.**
- 3. The next step of the EVA dose study is an accommodation of two "Pille-ISS" sensors during EVA: one - inside the space suit on a breast and the second one - on a shin.**

Conclusions

- **The first experiment for intercomparison of two operational dosimeters – "Pille-ISS" and "R-16" are carried out onboard RS ISS.**
- **The experiment included 10 sessions of joint exposure of these dosimeters, from 20 till 52 days. Full duration of the experiment was 332 days.**
- **The data obtained in each session of measurements are submitted. It is shown, that the results obtained with the dosimeters – "Pille-ISS" and "R-16" are satisfactorily coordinated between themselves.**
- **Results of dose measurements obtained with the autonomous sensors "Pille-ISS" during five EVA sessions of crews ISS-8 (1 session) and ISS-9 (4 sessions) are submitted also.**
- **The average values of dose rate during EVA from 4 to 10 times exceed similar values inside the station according to these measurements.**

ACKNOWLEDGEMENT

- **Authors thank the Russian cosmonauts Alexander Kaleri and Gennady Padalka for the fine operational activity on maintenance of onboard experiments during ISS-8 and ISS-9.**