

Spatial distribution and high LET component of absorbed dose measured by passive radiation monitors in ISS Russian segment

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BRADOS experiment

We conducted an intercomparison experiment for passive radiation dosimeters, Space Intercomparison/BRADOS, aboard the International Space Station (Russian Service Module).

Phase-1

- Intercomparison for passive dosimeters from five labs
- Exposure duration: 91.5 days

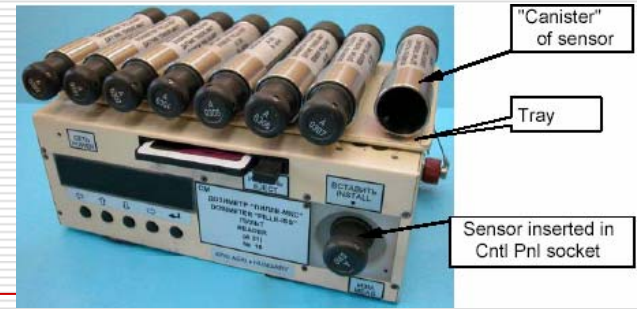
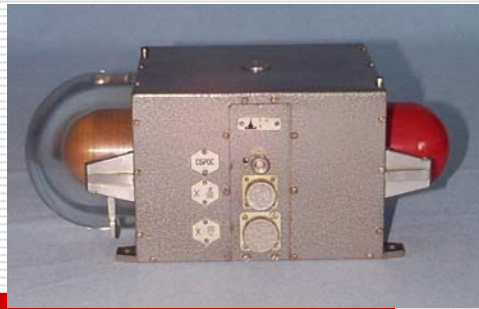
Phase-2

- Spatial distributions of dose (rate) at 5 locations
- Intercomparison for dosimeters of NIRS and IBMP
- Exposure duration: 268.5 days

Overview of presentation

- Spatial dose distribution
(5 (6) locations in Russian Service Module)
 - Comparison of luminescence detector and on board monitors (R-16, DB-8 and Pille-ISS)
 - Estimation of dose contribution of short range particle
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Detectors



- ❑ R-16 (1 location) with Pille-ISS
- ❑ DB-8 (4 locations)

- ❑ BRADOS BOX (5 locations)

from IBMP

- TLD LiF:Mg,Ti

from NIRS

- TLD LiF:Mg,Ti

- Luxel OSL

- Glass detector

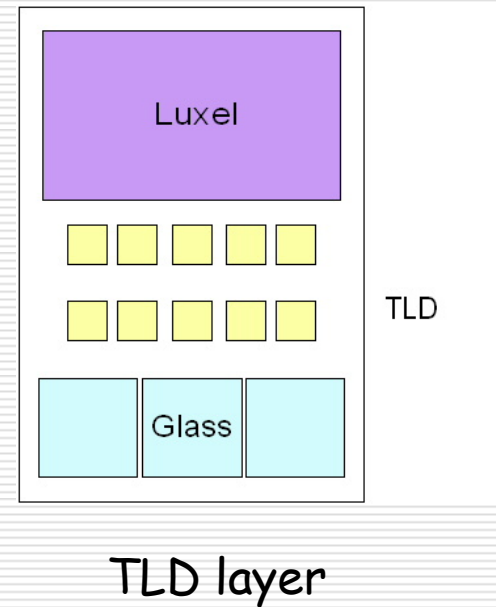
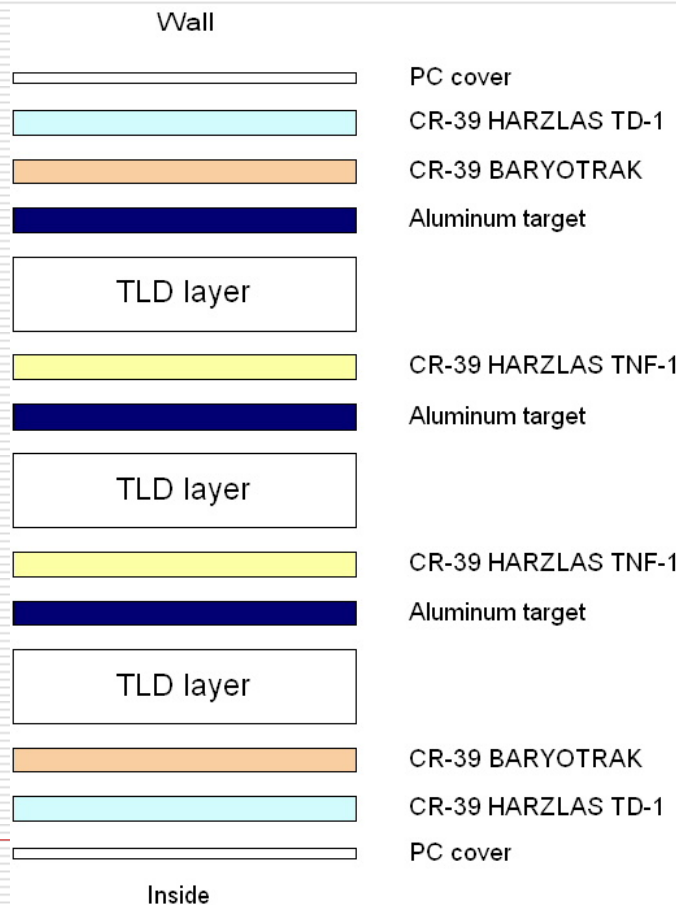
- CR-39 (HARZLAS TD-1, TNP-1, BARYOTRAK)



*One box was located near the R-16 detector.

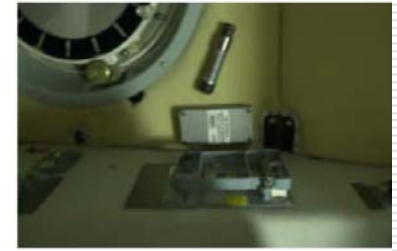
*Two Pillies were located on the R-16 detector.

Passive dosimeter (NIRS)

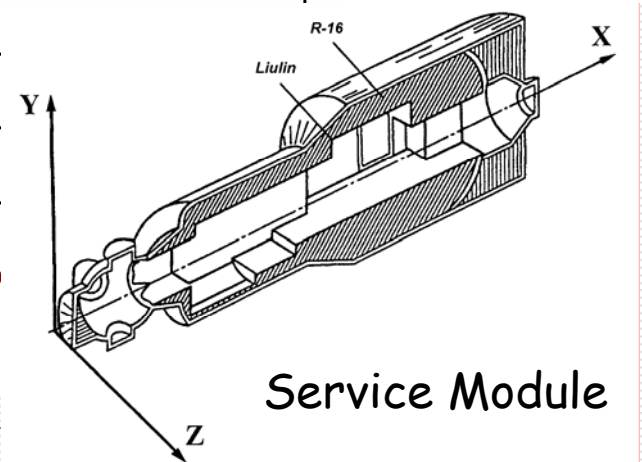
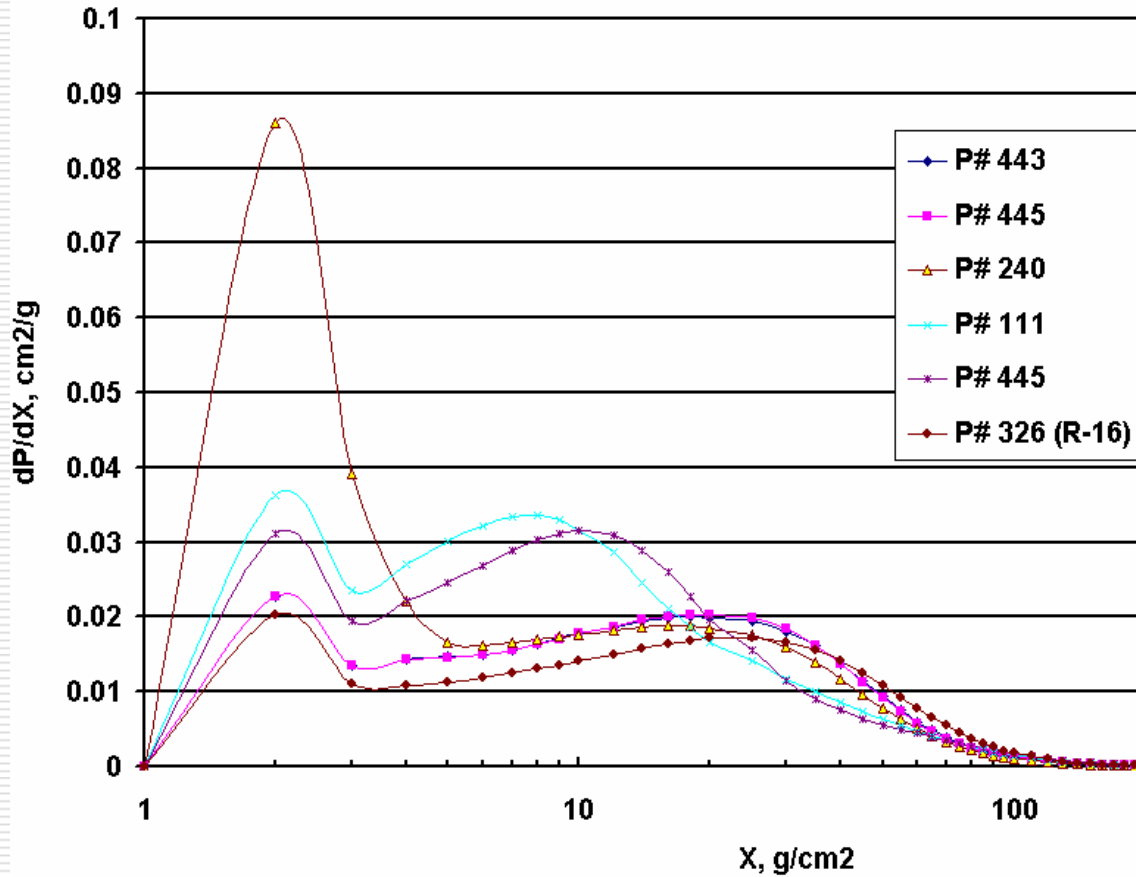


Locations of BRADOS boxes and exposed durations

Box # (Panel #)	Location	Exposure duration (days)
A46 (P#443)	Starboard side	91.5
A41 (P#445)	Starboard side	268.5
A42 (P#240)	Port side	268.5
A43 (P#111)	Floor, Starboard side	268.5
A44 (P#445)	Starboard side	268.5
A45 (P#326)	Ceiling near the R-16, port side	268.5

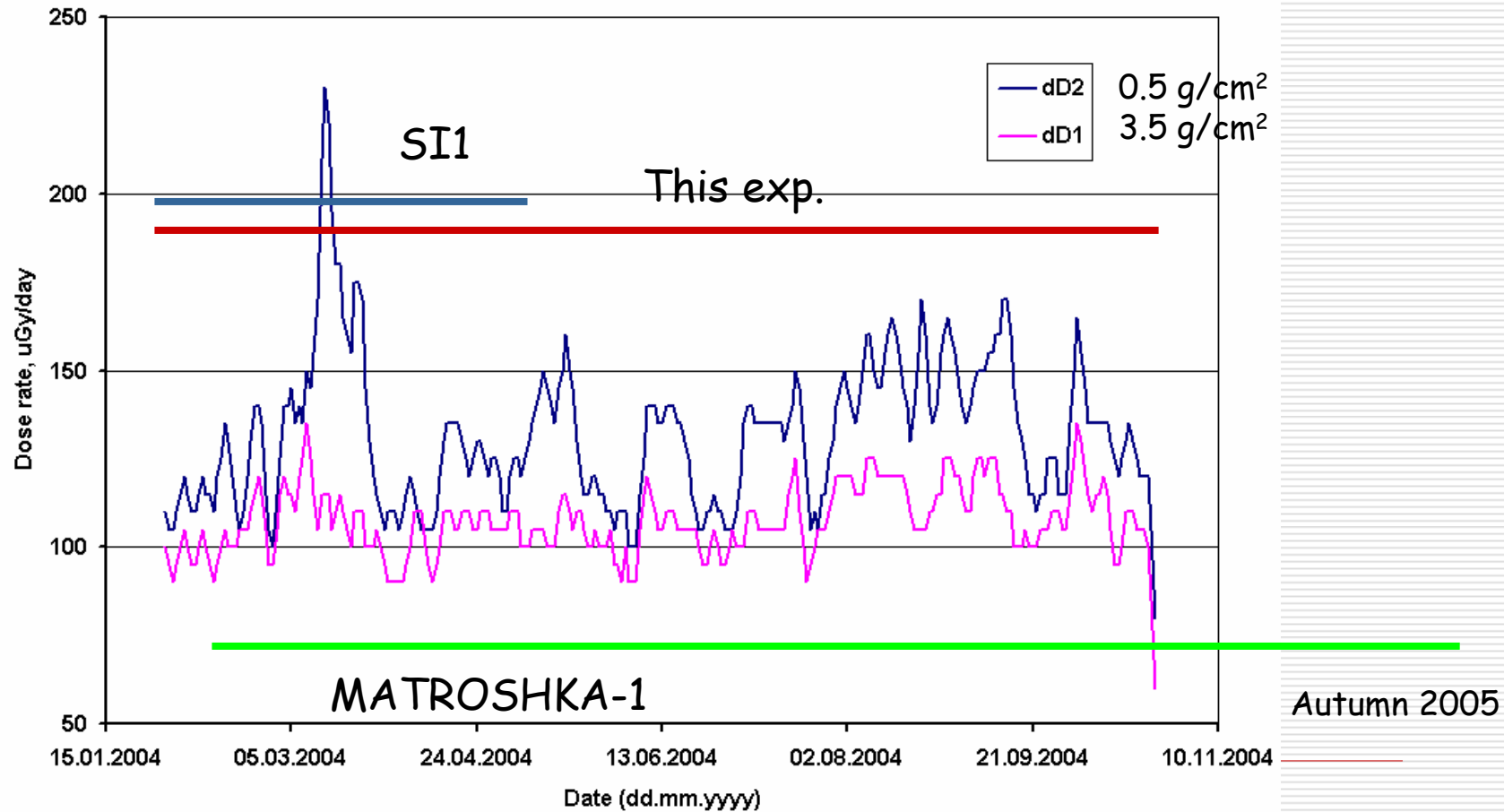


Shielding functions in the Service Module model

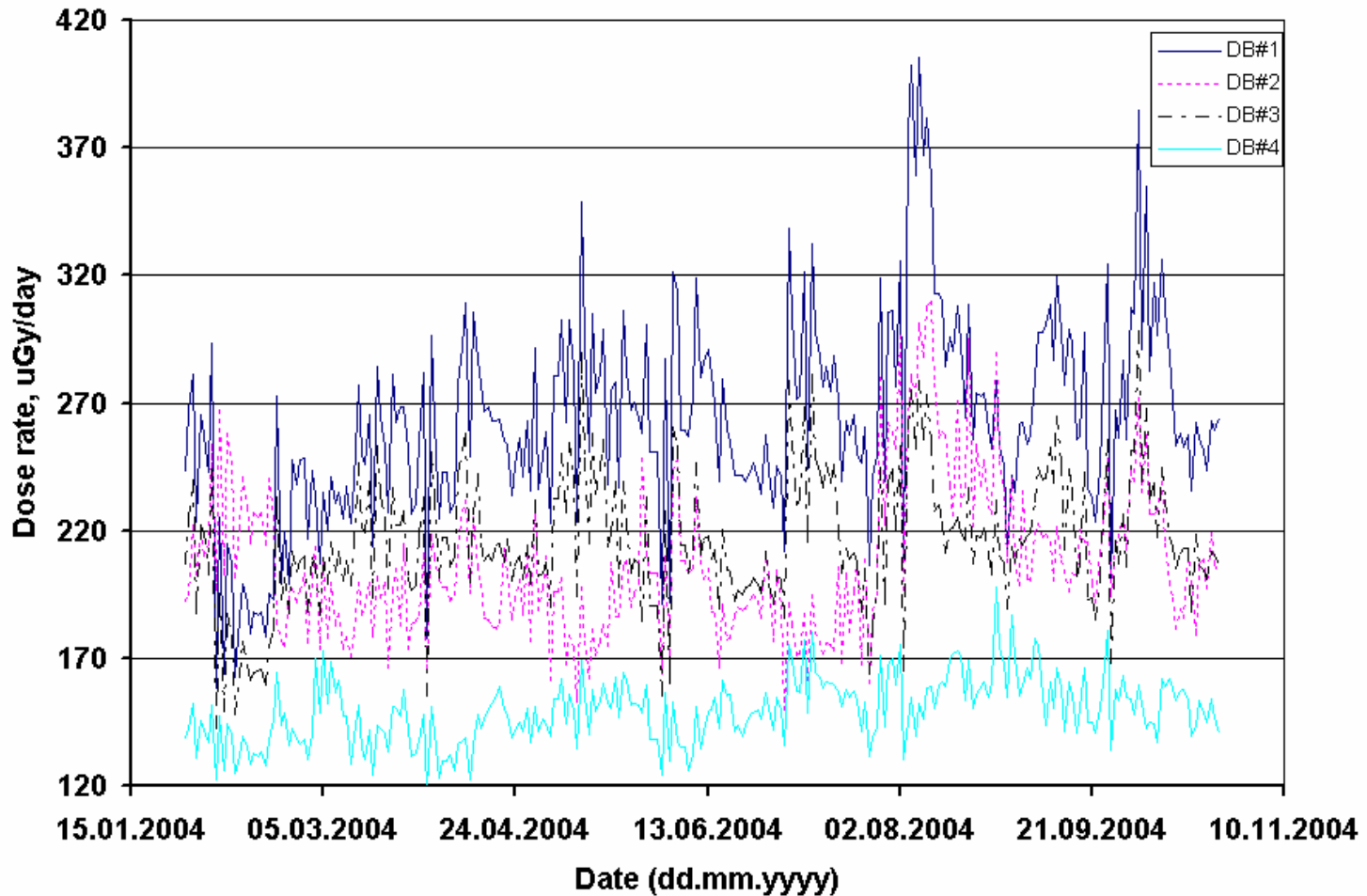


Service Module

R-16 detector



DB-8 detectors



* DB-8 monitors: 264, 208, 219, 146 $\mu\text{Gy}/\text{day}$

$\sim\pm 30\%$

Results

Box # (Panel #)	Location	Exposure duration (days)	TLD-100 (LiF) $\mu\text{Gy}/\text{day}$	Glass $\mu\text{Gy}/\text{day}$	R-16 $\mu\text{Gy}/\text{day}$
A46 (P#443)	Starboard side	91.5	222 \pm 4	205 \pm 2	117 (3.5g/cm ²) 145 (0.5g/cm ²)
A41 (P#445)	Starboard side	268.5	206 \pm 18	228 \pm 17	
A42 (P#240)	Port side	268.5	208 \pm 12	221 \pm 3	
A43 (P#111)	Floor, Starboard side	268.5	204 \pm 11	219 \pm 8	
A44 (P#445)	Starboard side	268.5	157 \pm 7	172 \pm 2	
A45 (P#326)	Ceiling near the R-16, port side	268.5	169 \pm 14	180 \pm 10	119 (3.5g/cm ²) 146 (0.5g/cm ²)

$\sim\pm 20\%$

Difference $\sim 20\%$

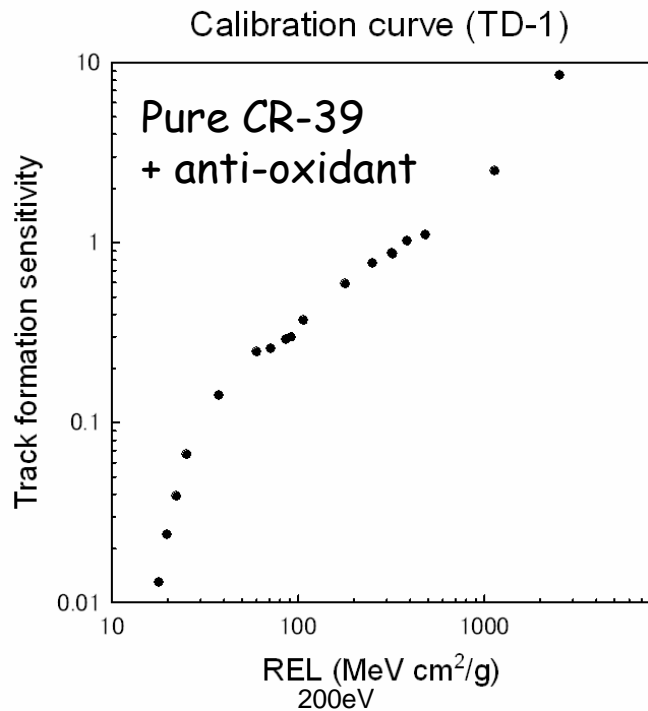
Interval of measurements (dd.mm.yyyy)	Exposure duration, day	Absorbed dose, mGy			
		Pille-ISS*)		R-16	
		A0305	A0306	D1	D2
14.01.2004- 09.02.2004	26	3.69	3.55	3.05	3.00
09.02.2004- 11.03.2004	31	4.13	4.51	3.75	4.35
11.03.2004- 24.04.2004	44	5.67	6.11	5.15	5.90
24.04.2004- 14.05.2004	20	2.76	2.67	2.40	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
19.08.2004- 24.09.2004	36	5.59	5.34	4.06	5.24
24.09.2004- 14.10.2004	20	3.00	2.84	2.27	2.65
14.10.2004- 08.11.2004	25	3.58	3.87	-	-

Factor ~ 1.2

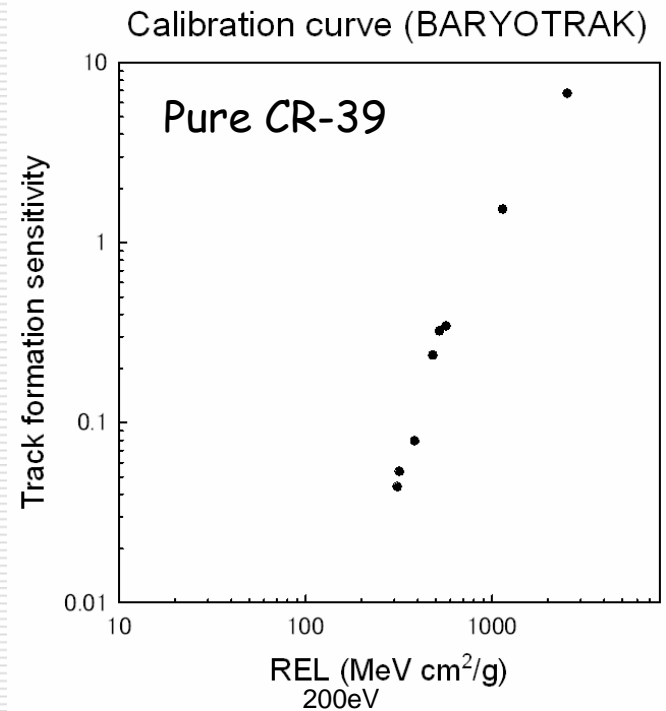
Estimation of dose contribution of short range particles

- AFM
 - Different types of CR-39 detectors
(HARZLAS TD-1 for >5 keV/mm)
(BARYOTRAK for higher LET particles)
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Calibration curves for different types of CR-39



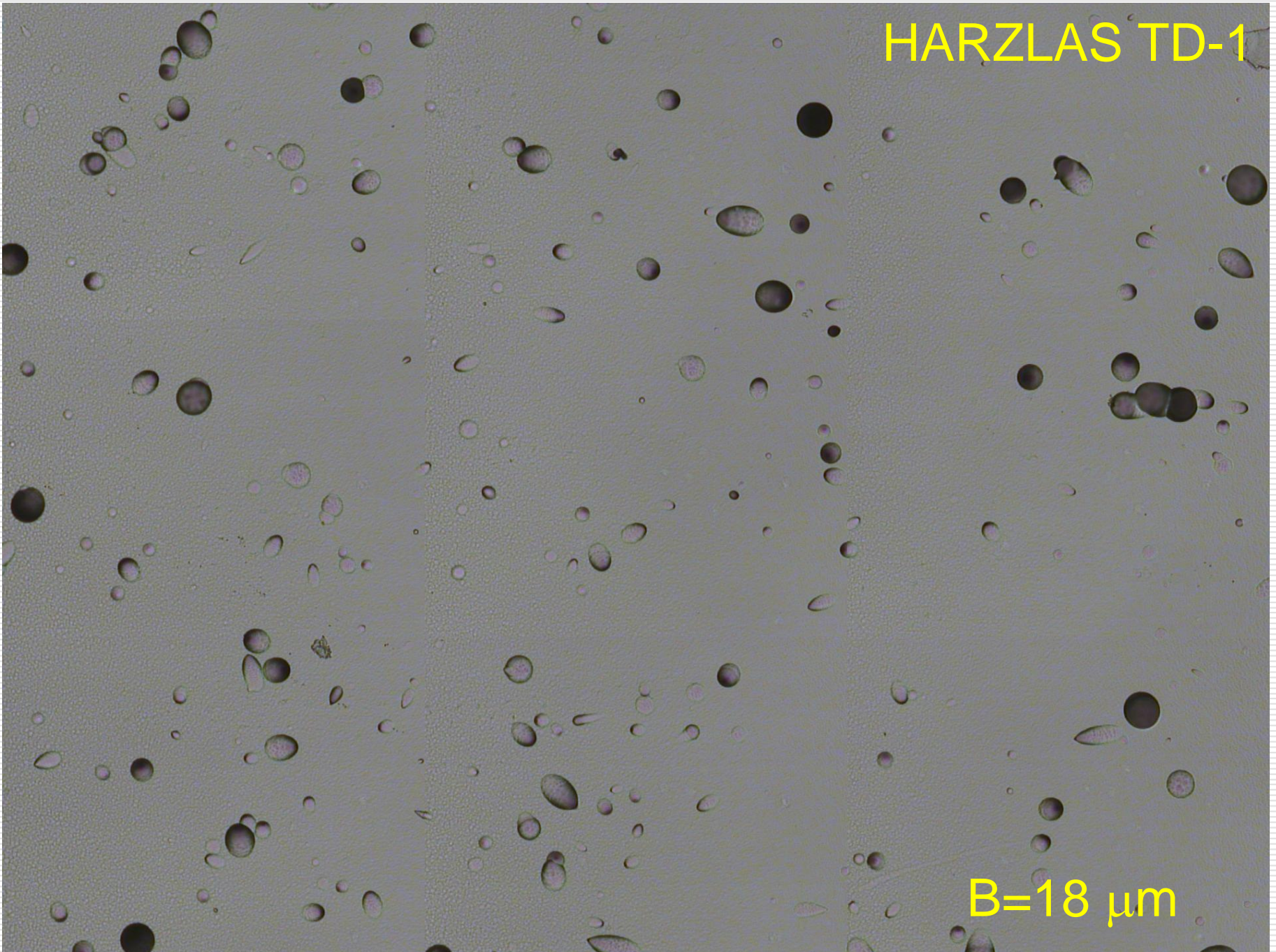
LET Threshold ~ 5 keV/ μ m



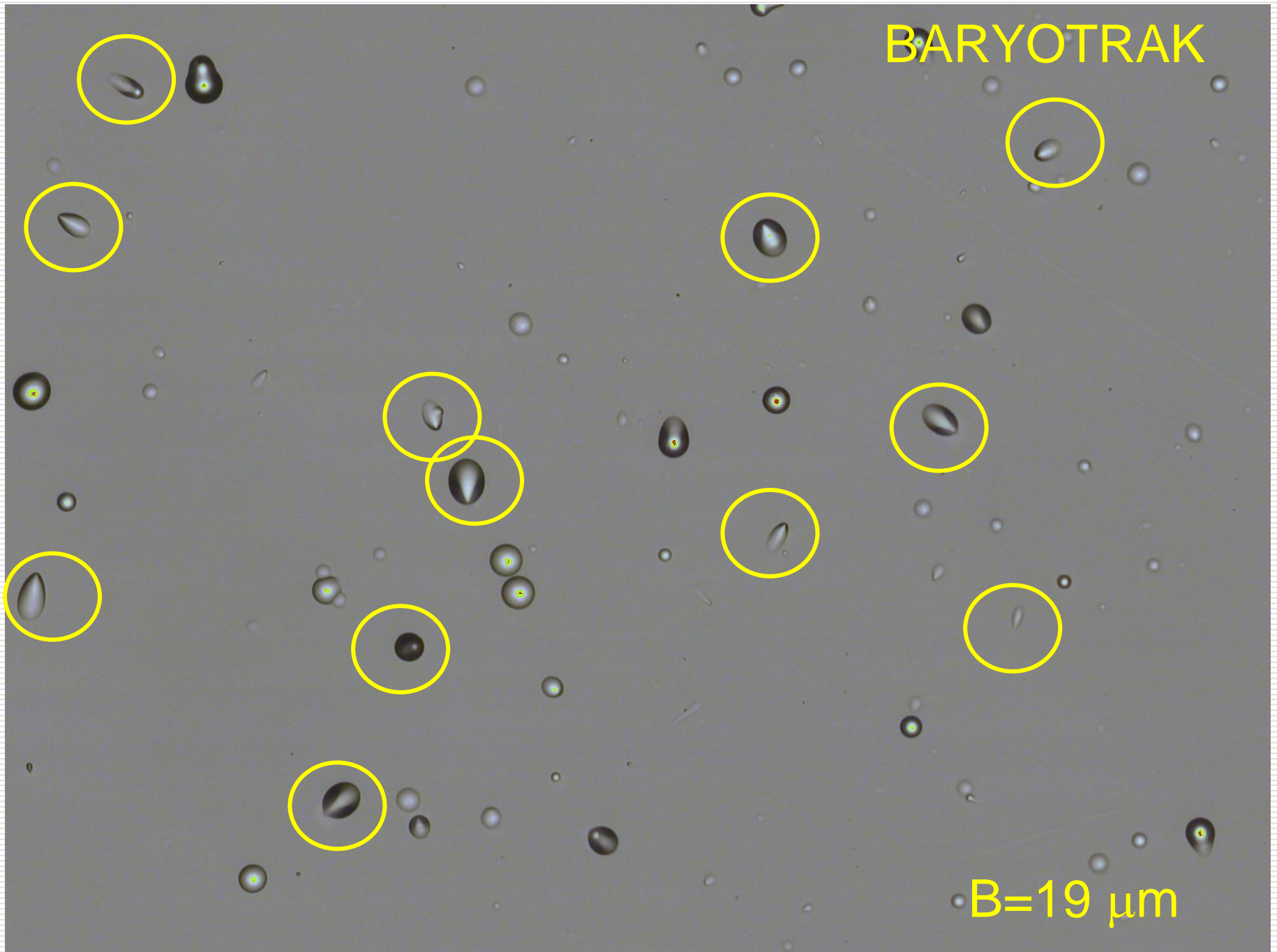
LET Threshold ~ 50 keV/ μ m

HARZLAS TD-1

B=18 μm



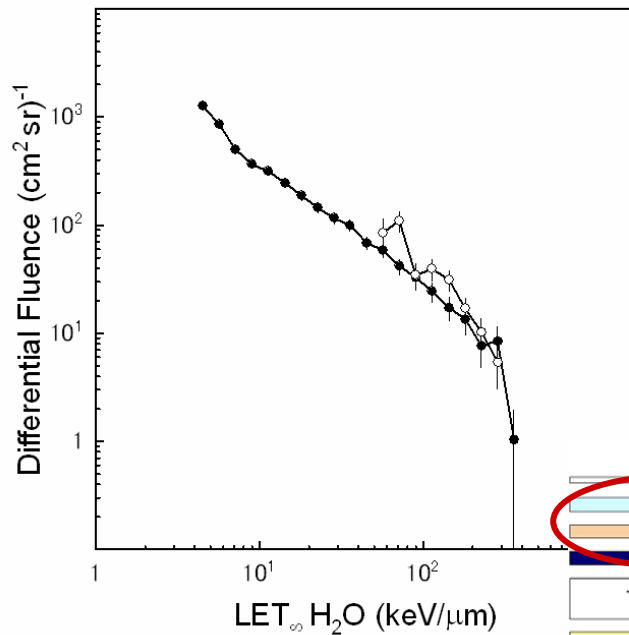
BARYOTRAK



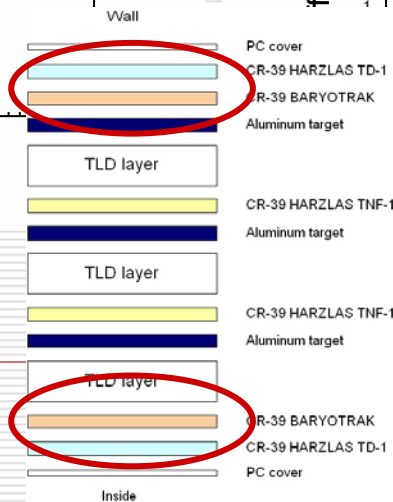
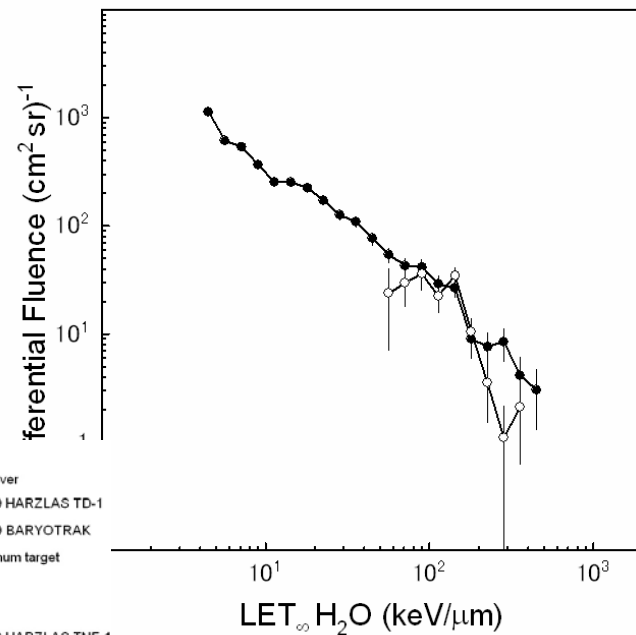
$B=19\ \mu\text{m}$

LET spectra (cone shape track only)

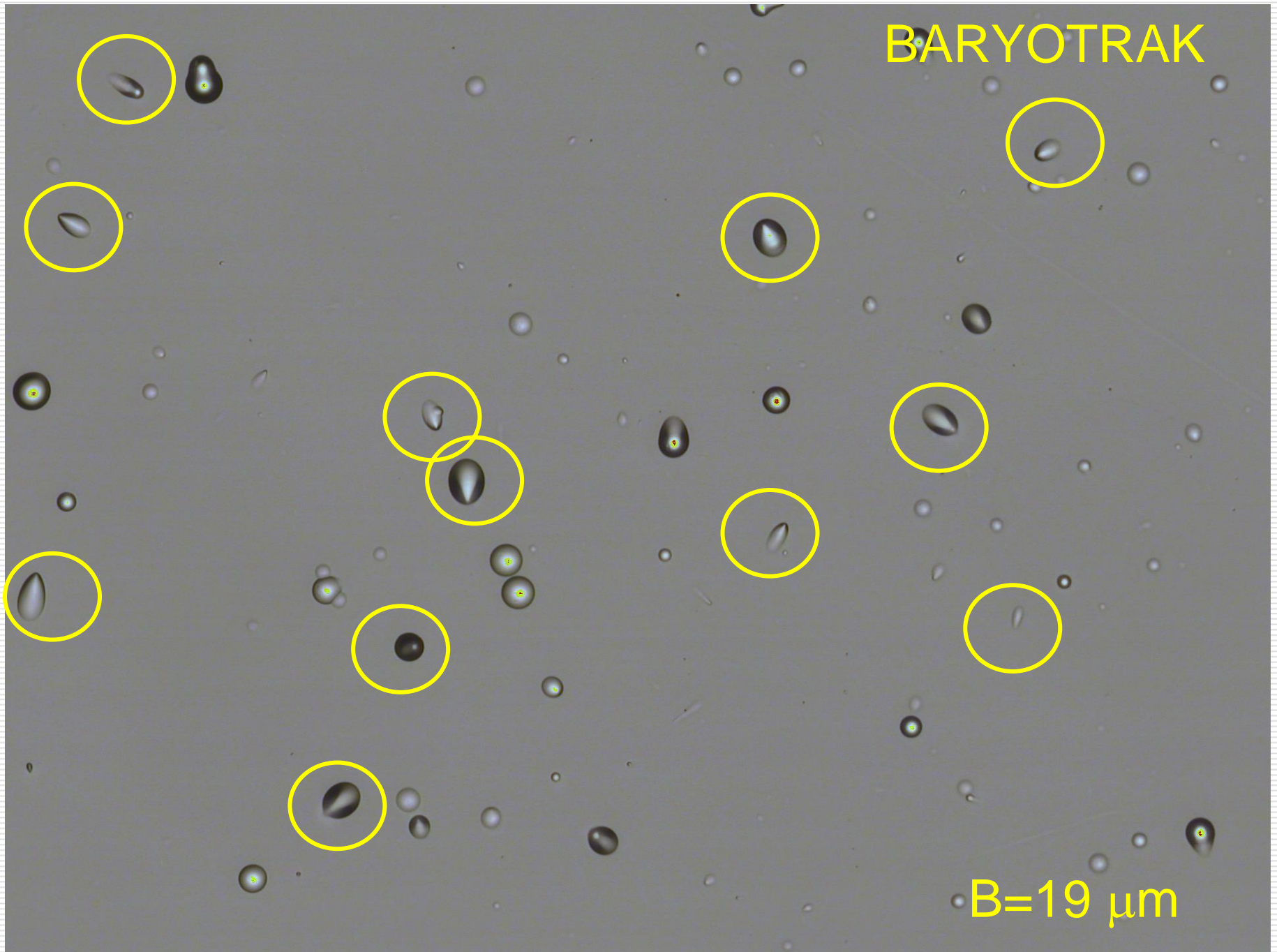
TD-1 + BARYOTRAK A41(Panel#445) TOP



TD-1 + BARYOTRAK A41(Panel#445) Bottom



BARYOTRAK



B=19 μm

How to estimate

In BARYOTRAK,

The component of cone shape track is good agreement with TD-1 detector.

Assumption:

-all the shallow track has $LET = 50 \text{ keV}/\mu\text{m}$
(Threshold LET: minimum case)

Results

Top layer of A41 stack	TD-1 only	TD-1 only	TD-1 + shallow track in BARYOTRAK	TD-1 + shallow track in BARYOTRAK
Method (combination)	CR-39/Glass	CR-39 /TLD-100	CR-39/Glass	CR-39 /TLD-100
TLD Dose Rate ($\mu\text{Gy}/\text{day}$)	206 ± 18	228 ± 17	206 ± 18	228 ± 17
Dose Rate $\geq 5 \text{ keV}/\mu\text{m}$ ($\mu\text{Gy}/\text{day}$)	28 ± 1		48 ± 2	
Total Dose Rate ($\mu\text{Gy}/\text{day}$)	234 ± 14	207 ± 8	243 ± 14	216 ± 8
Dose Equivalent Rate $\geq 5 \text{ keV}/\mu\text{m}$ ($\mu\text{Sv}/\text{day}$)	324 ± 27		812 ± 45	
Total Dose Equivalent Rate ($\mu\text{Sv}/\text{day}$)	530 ± 30	503 ± 28	1007 ± 47	979 ± 45
Averaged Quality Factor	2.3 ± 0.2	2.4 ± 0.2	4.1 ± 0.3	4.5 ± 0.3

x 1.8 (at least)

Conclusions

- Spatial distribution (dose rate)
for 5 locations were varied $\pm 20\%$ (Luminescence Detectors)
for 4 locations were varied $\pm 30\%$ (DB-8 detectors)
 - Difference of dose rate
luminescence detector and R-16 was $\sim 20\%$ (@same location)
Pille-ISS / R-16 = ~ 1.2
 - Contribution of short range tracks was estimated with
assumption (all shallow tracks = $50 \text{ keV}/\mu\text{m}$).
to averaged QF ($\times 1.8$) (at least)
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