

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

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# BRADOS experiment

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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

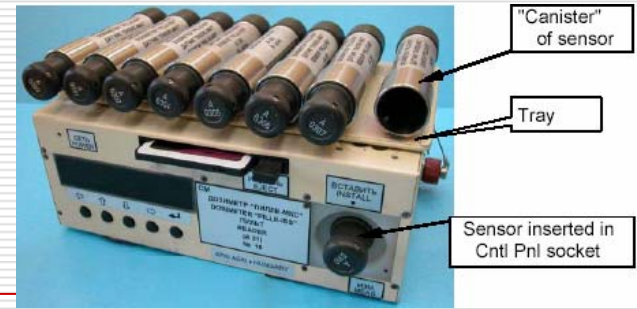
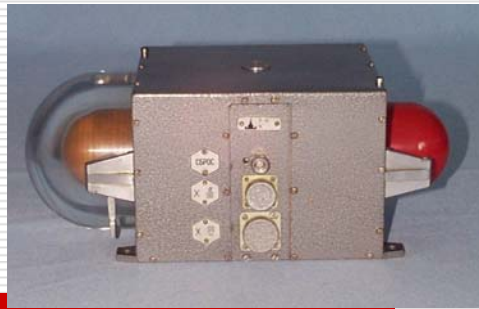
- Spatial distributions of dose (rate) at 5 locations
- Intercomparison for dosimeters of NIRS and IBMP
- Exposure duration: 268.5 days

# Overview of presentation

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- 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

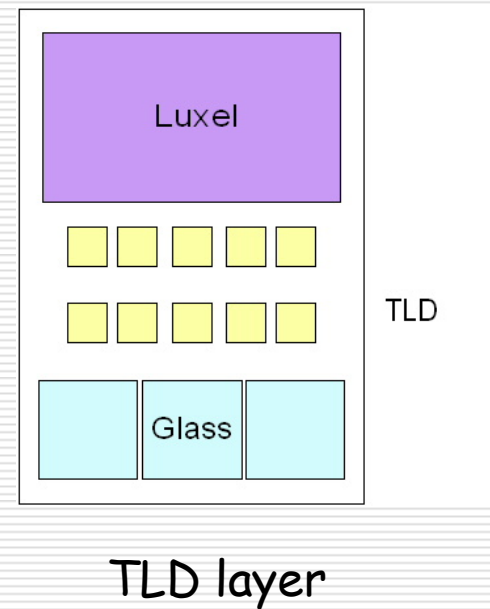
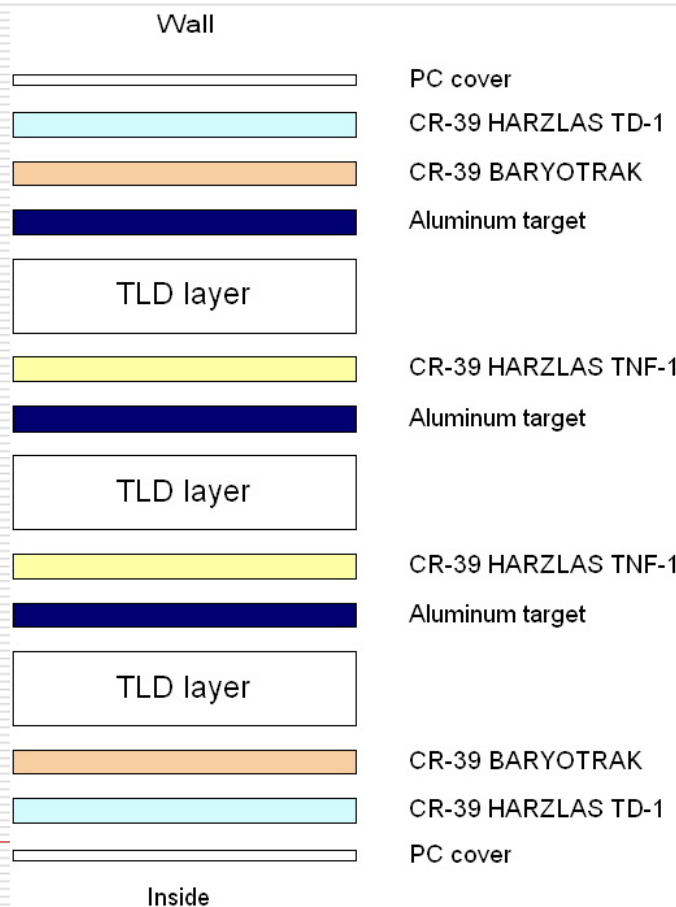
- CR-39 (HARZLAS TD-1, TNP-1, BARYOTRAK)



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

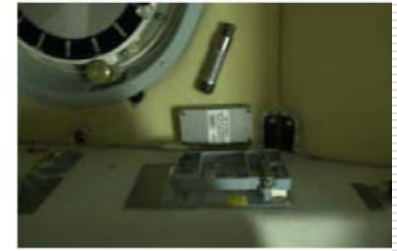
\*Two Pillies were located on the R-16 detector.

# Passive dosimeter (NIRS)

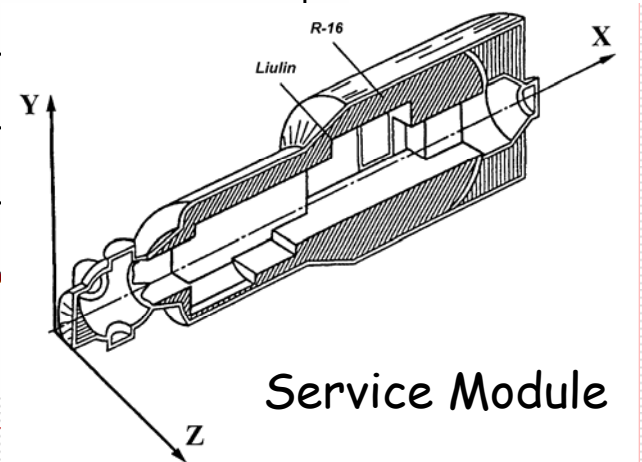
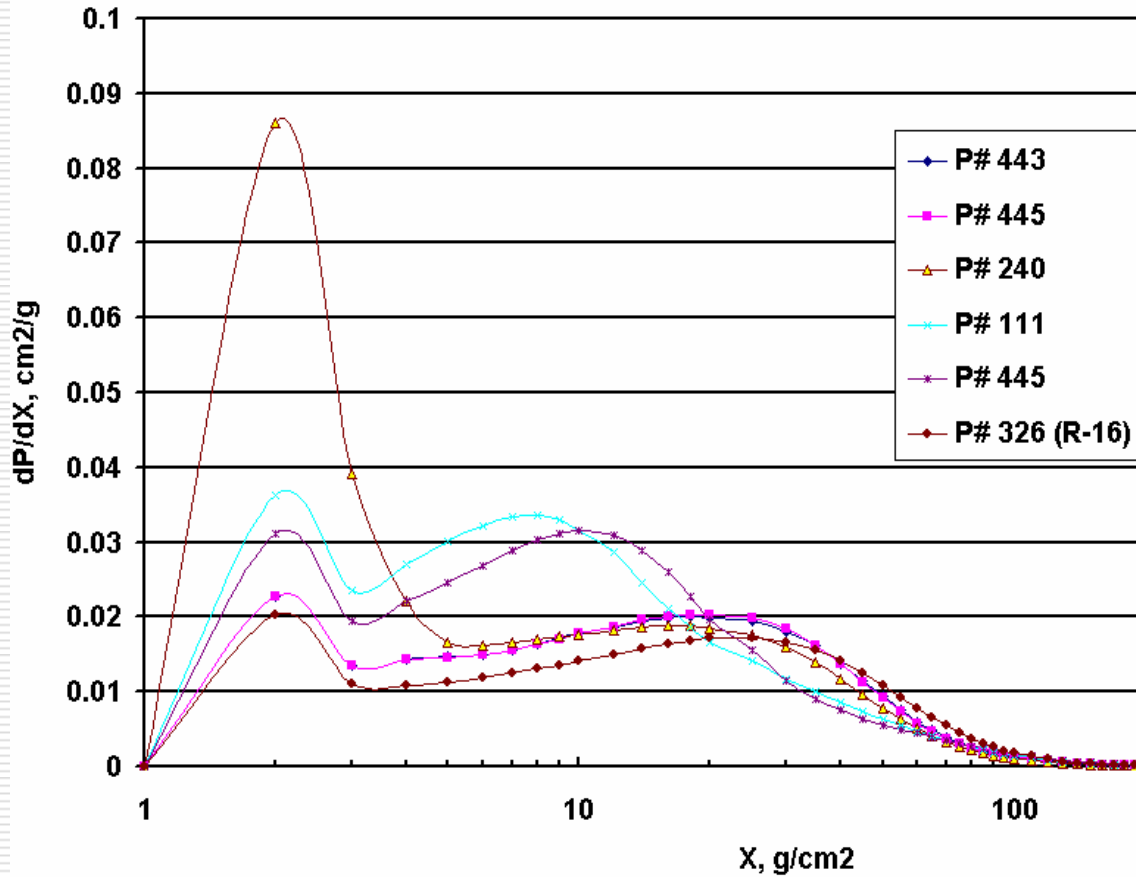


# Locations of BRADOS boxes and exposed durations

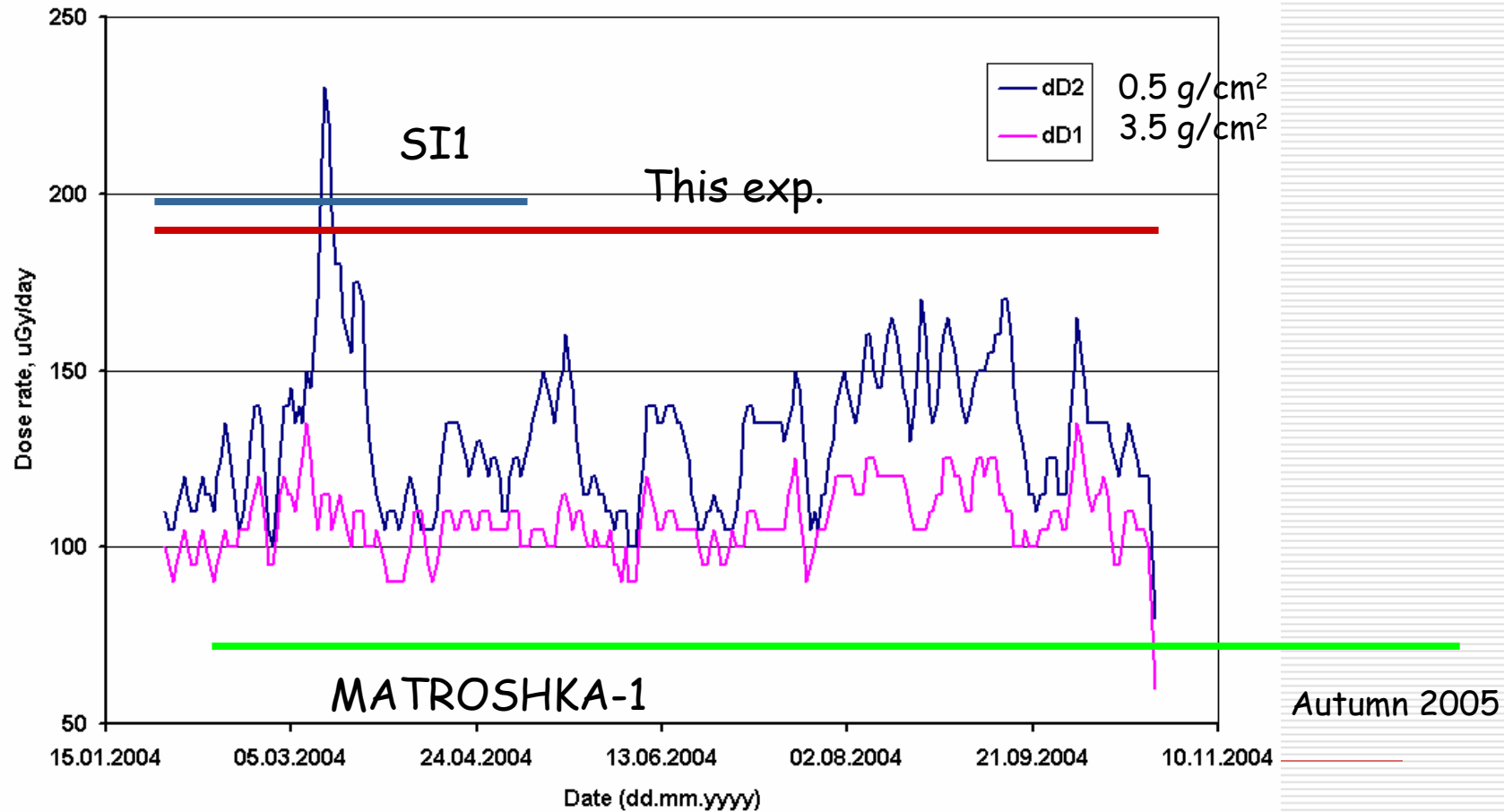
Box # (Panel #)	Location	Exposure duration (days)
A46 (P#443)	Starboard side	91.5
A41 (P#445)	Starboard side	268.5
A42 (P#240)	Port side	268.5
A43 (P#111)	Floor, Starboard side	268.5
A44 (P#445)	Starboard side	268.5
A45 (P#326)	Ceiling near the R-16, port side	268.5



# Shielding functions in the Service Module model

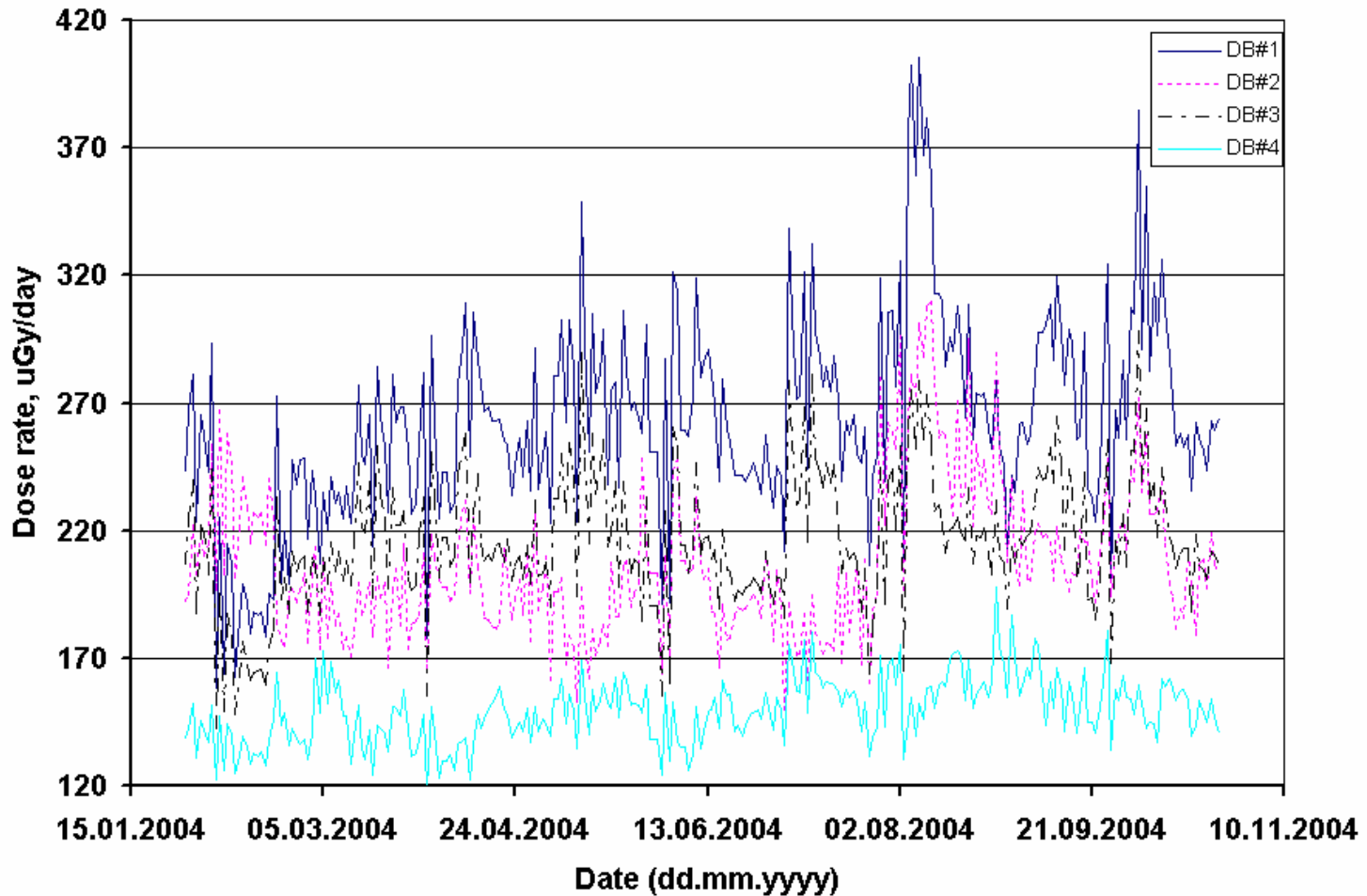


# R-16 detector





# 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 <sup>2</sup> ) 145 (0.5g/cm <sup>2</sup> )
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 <sup>2</sup> ) 146 (0.5g/cm <sup>2</sup> )

$\sim\pm 20\%$

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

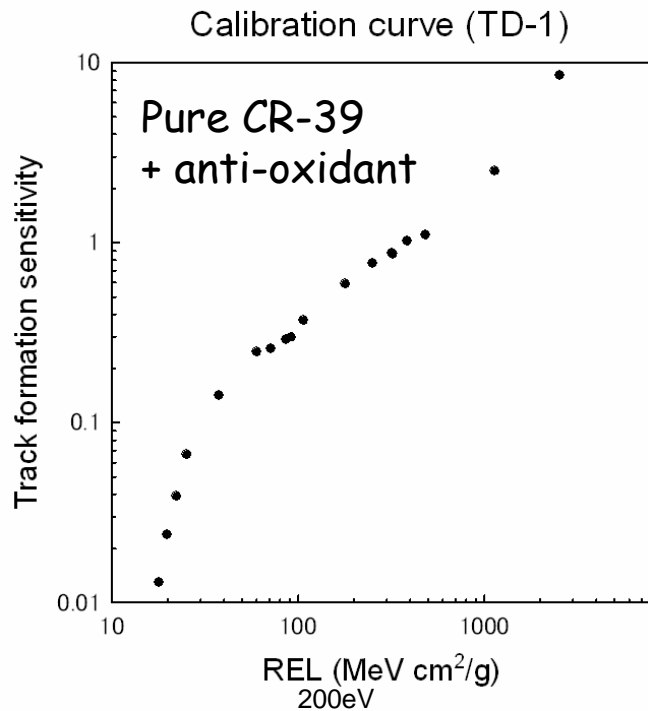
# Estimation of dose contribution of short range particles

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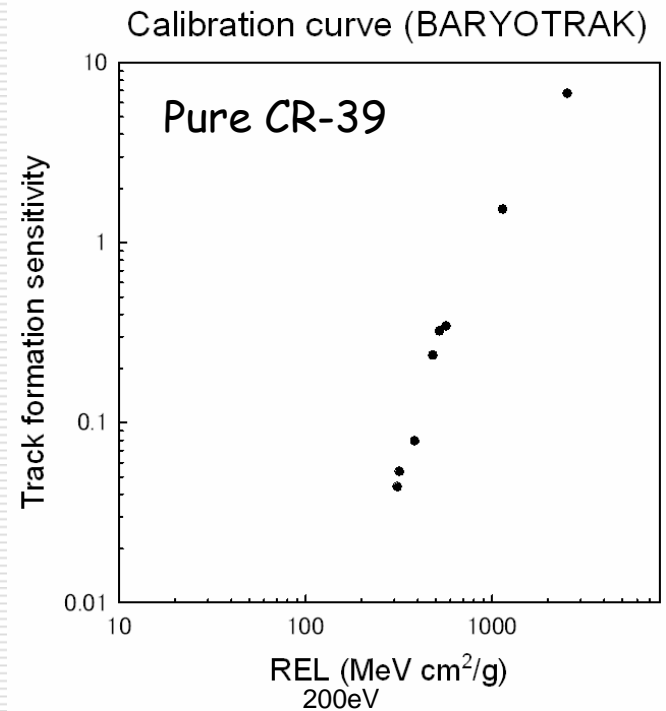
- AFM
  - Different types of CR-39 detectors  
(HARZLAS TD-1 for  $>5$  keV/mm)  
(BARYOTRAK for higher LET particles)
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# Calibration curves for different types of CR-39

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LET Threshold ~ 5 keV/ $\mu$ m

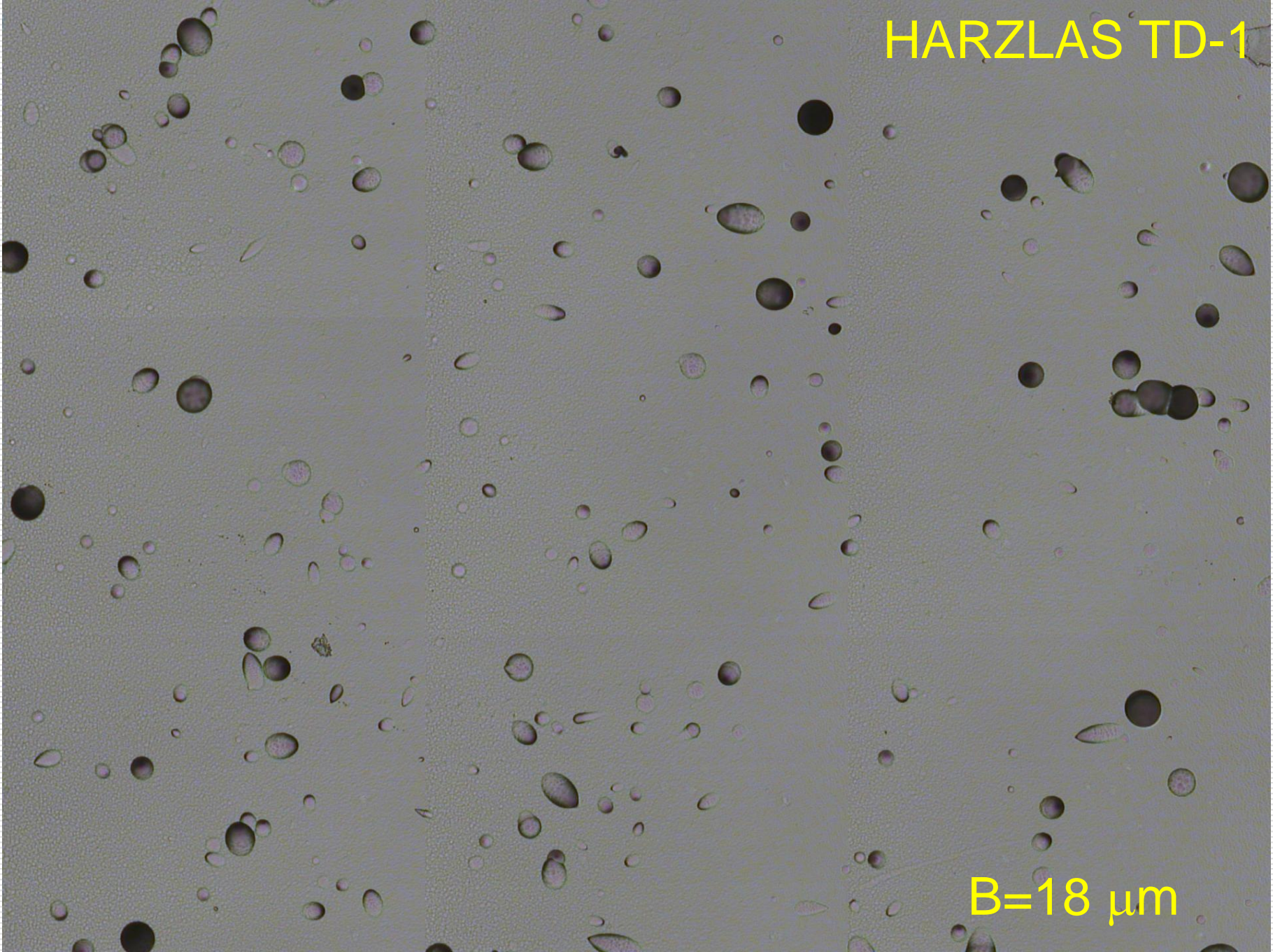


LET Threshold ~ 50 keV/ $\mu$ m

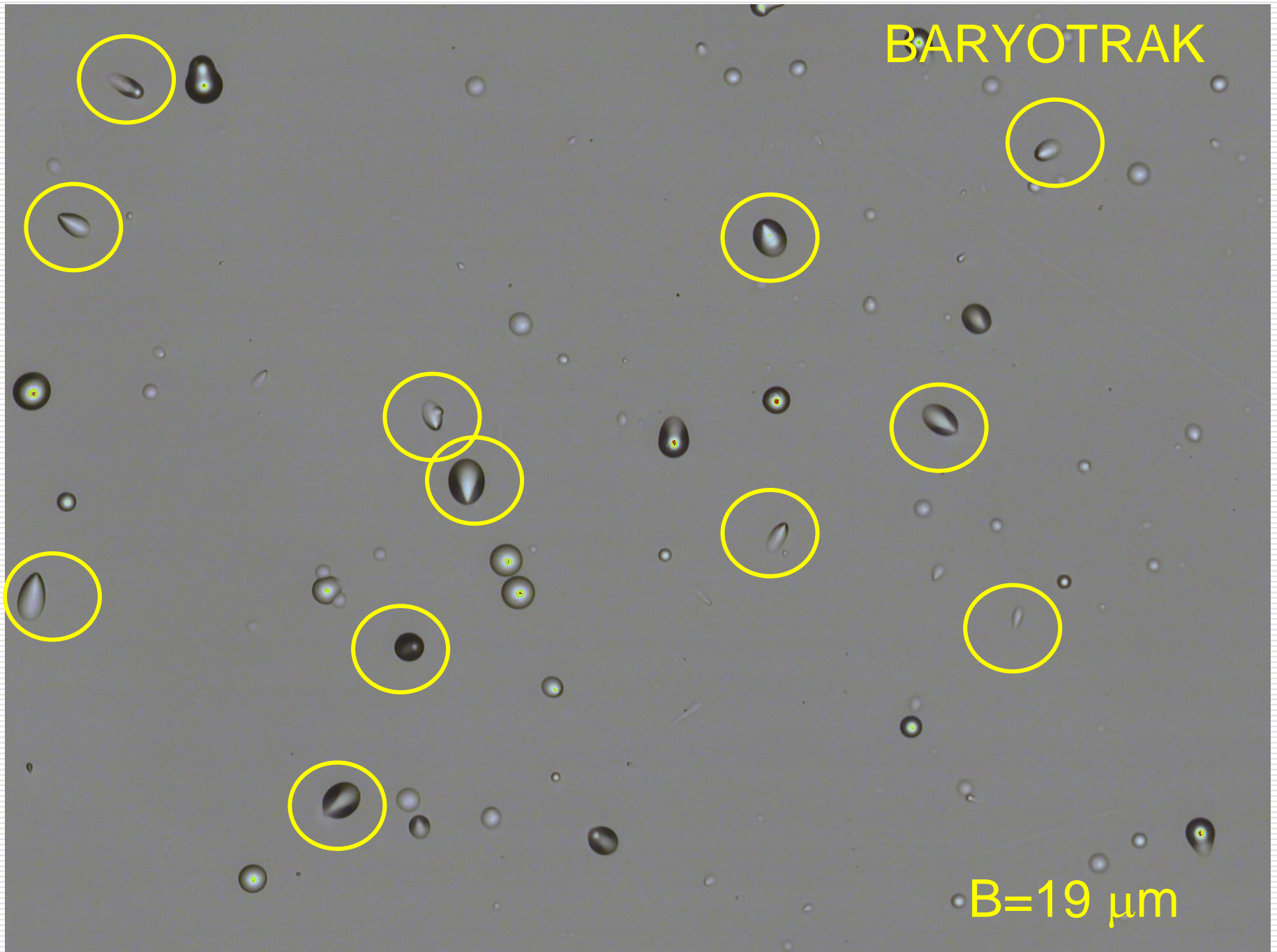
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HARZLAS TD-1

B=18  $\mu\text{m}$



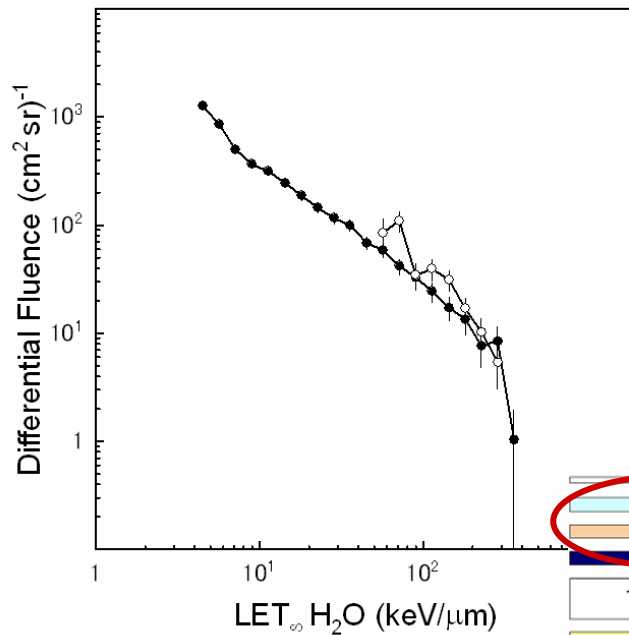
BARYOTRAK



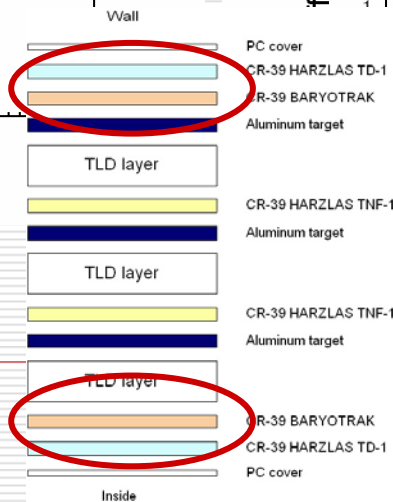
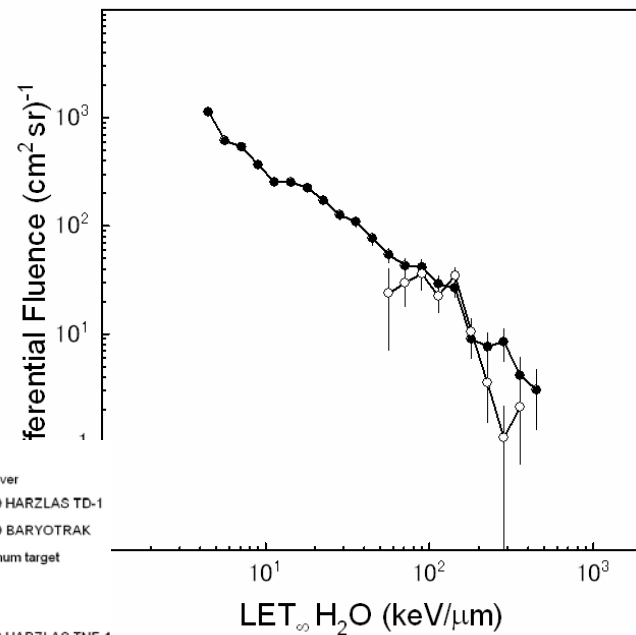
B=19  $\mu\text{m}$

# LET spectra (cone shape track only)

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

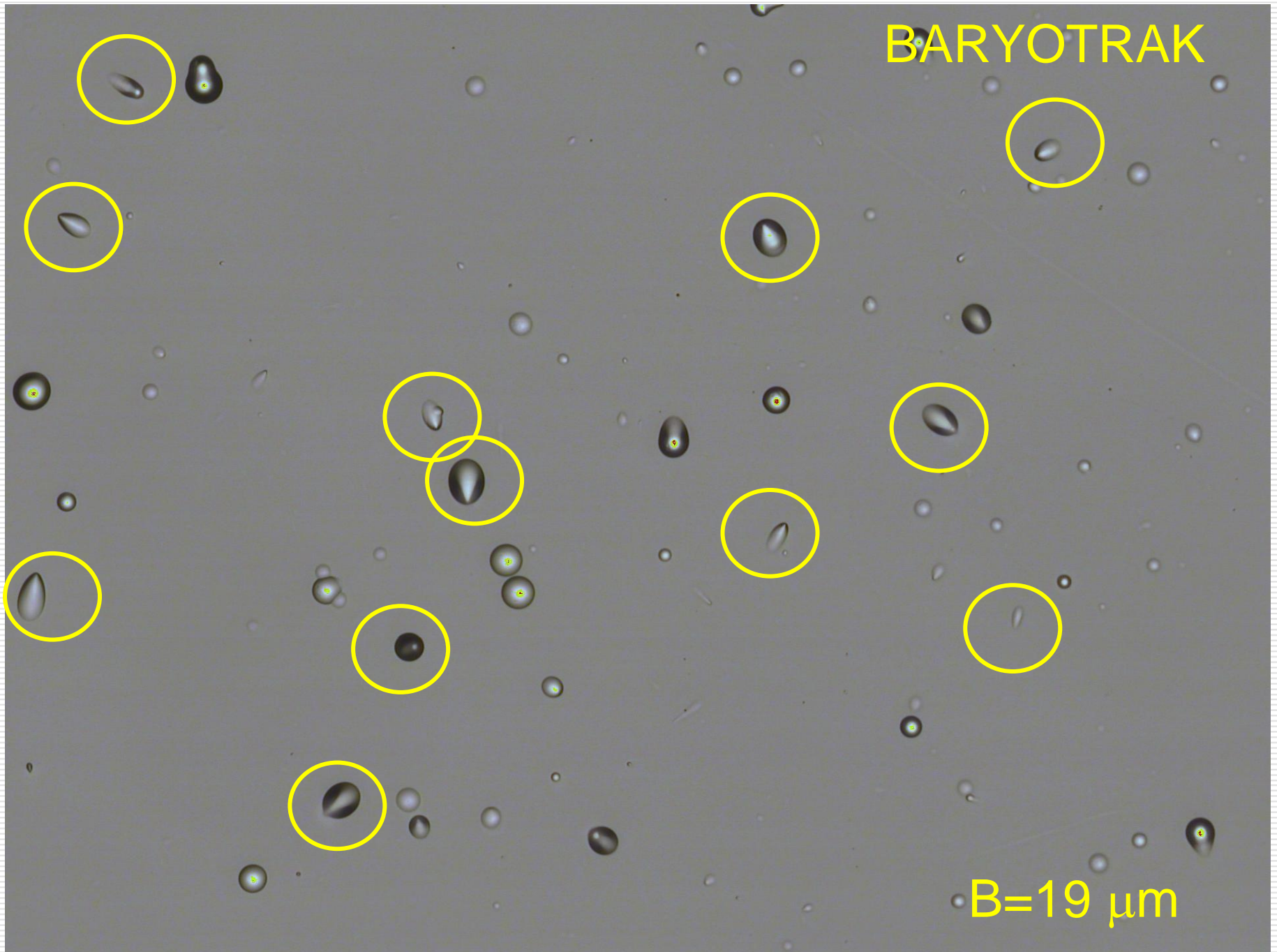


TD-1 + BARYOTRAK A41(Panel#445) Bottom





BARYOTRAK



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

# How to estimate

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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)

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# 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 ( $\mu\text{Gy}/\text{day}$ )	$206 \pm 18$	$228 \pm 17$	$206 \pm 18$	$228 \pm 17$
Dose Rate $\geq 5 \text{ keV}/\mu\text{m}$ ( $\mu\text{Gy}/\text{day}$ )	$28 \pm 1$		$48 \pm 2$	
Total Dose Rate ( $\mu\text{Gy}/\text{day}$ )	$234 \pm 14$	$207 \pm 8$	$243 \pm 14$	$216 \pm 8$
Dose Equivalent Rate $\geq 5 \text{ keV}/\mu\text{m}$ ( $\mu\text{Sv}/\text{day}$ )	$324 \pm 27$		$812 \pm 45$	
Total Dose Equivalent Rate ( $\mu\text{Sv}/\text{day}$ )	$530 \pm 30$	$503 \pm 28$	$1007 \pm 47$	$979 \pm 45$
Averaged Quality Factor	$2.3 \pm 0.2$	$2.4 \pm 0.2$	$4.1 \pm 0.3$	$4.5 \pm 0.3$

x 1.8 (at least)

# Conclusions

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- 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 =  $\sim 1.2$
  - 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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