Preliminary results of SI2 experiment obtained by PADC track etch detectors

J. Szabó, J. K. Pálfalvi, B. Dudás

Hungarian Academy of Sciences
KFKI Atomic Energy Research Institute
P.O.B. 49, H-1525 Budapest, Hungary

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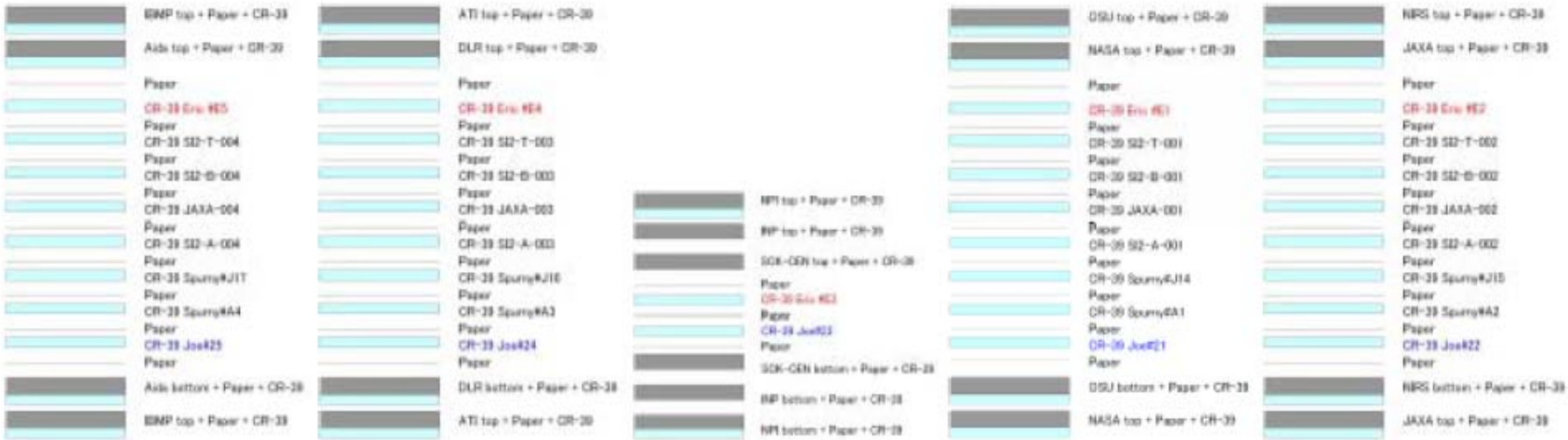
Position of the AERI detectors in the middle of the box



The PADC sheets (marked with blue: 25, 24, 23, 21, 22) were placed close to the bottom of each stack → nearly in the same positions

Etching of the detectors in 6 N NaOH, 70°C

Detector material: polyallyl-diglycol-carbonate (PADC, TASTRAK, Bristol, UK)

Surface: 36 x 18 mm^2

Thickness: 1 mm

1st step: 6h etching to measure the short range, high LET particles, 8 µm removal

2nd step: 15 h etching to measure lower LET & GCR particles, 20.1 µm removal

Investigations by optical microscope

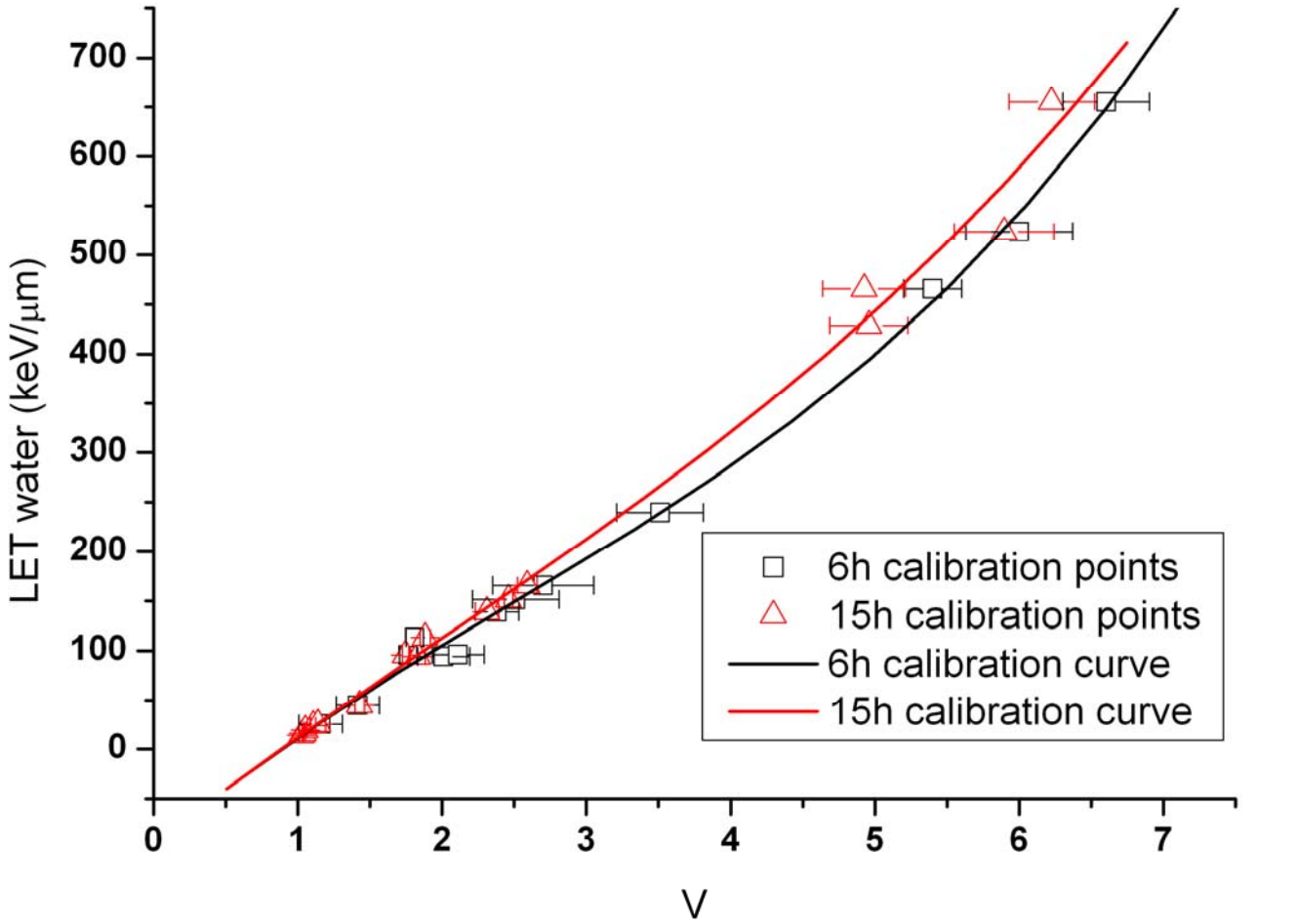
1. Semi-automatic measurements using the VIRGINIA image analyzer → minor and major axes and other geometrical and optical parameters of the tracks

2. Manual measurements of long range HZE particle tracks → minor and major axes, projected range, depth

Calibration – converting the track etch rate ratio (V) obtained from the track parameters into LET

LET = -99.8424+125.00172 V-15.28166 V^2+2.04636 V^3, r^2 =0.9961

LET = -96.35071+114.90343 V-7.77194 V^2+1.27248 V^3, r^2 =0.9926



Expressions used during the calculations

Differential flux

$$\Phi_D(L) = f_c(L)\frac{dN(L)}{dLET}(d\Omega AT)^{-1}$$

$$\Phi_D(L) = \Phi_6(L) if \Phi_6(L) \geq \Phi_{15}(L) otherwise \Phi_D(L) = \Phi_{15}(L)$$

Absorbed dose in water

$$D = \Omega \times 1.6 \times 10^{-6} \times T \times \Sigma(\Phi_D(L) \times \bar{L} \times dLET)$$

Dose equivalent

$$H = \Omega \times 1.6 \times 10^{-6} \times T \times \Sigma(\Phi_D) \times \bar{L} \times Q(L) \times dLET)$$

Averaged quality factor

$$Q = H / D$$

dN(L) - group fluence

dLET - LET interval

dΩ - possible solid angle of the incident particle

A - scanned surface of the detector

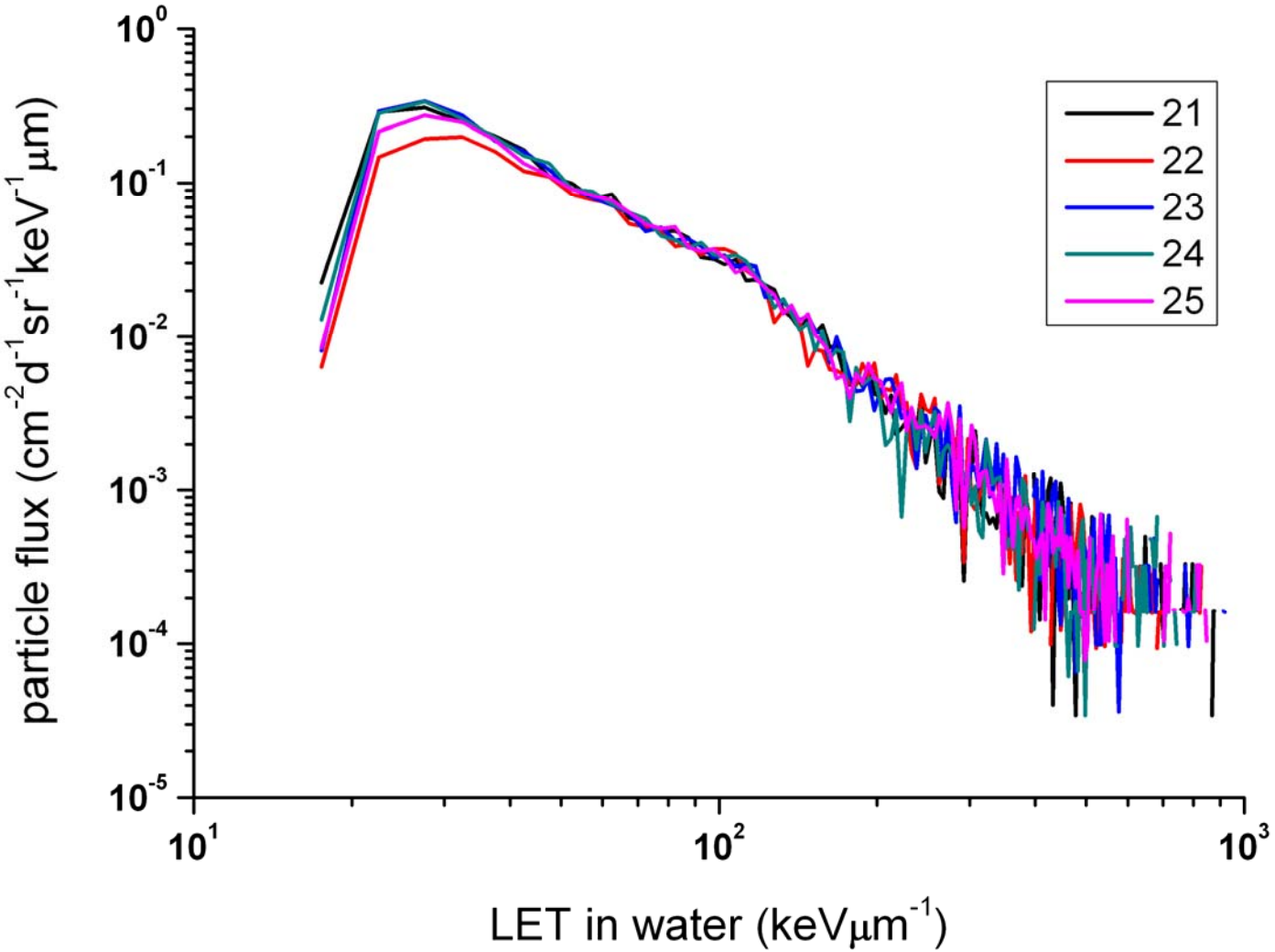
T - exposure time

$f_c(L)$ - LET and dip-angle dependent correction factor

$\bar{L}$ - mean LET

Q(L) - LET dependent quality factor

LET spectra obtained on the PADC detector sheets
6h etching time



Results obtained after 6 h etching
Lower limit of detection threshold: ~17.5 keV/µm

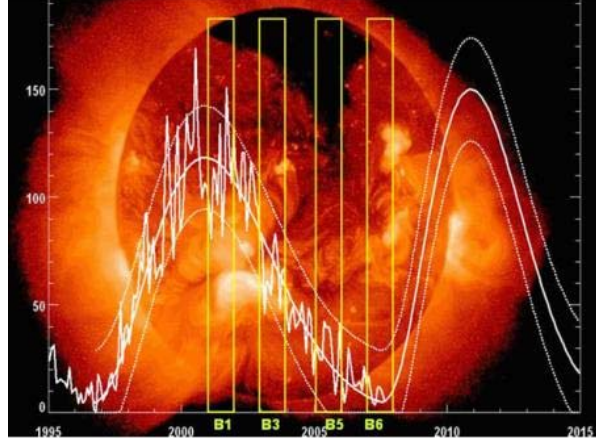
Label	D ±1σ (mGy)	H ±1σ (mSv)	D rate ±1σ (µGy/day)	H rate ± 1σ (µSv/day)	Q ±1σ
21	2.40 ± 0.18	42.53 ± 1.87	14.87 ± 1.14	263.65 ± 11.61	17.75 ± 0.58
22	2.19 ± 0.37	40.76 ± 5.98	13.57 ± 2.24	252.69 ± 37.07	18.65 ± 0.35
23	2.53 ± 0.03	44.56 ± 0.45	15.68 ± 0.19	277.06 ± 3.45	17.67 ± 0.01
24	2.43 ± 0.08	43.99 ± 1.14	15.06 ± 0.47	266.54 ± 7.09	17.71 ± 0.08
25	2.39 ± 0.13	43.27 ± 3.35	14.82 ± 0.79	268.25 ± 20.81	18.09 ± 0.44

Combined results of 6h and 15 h etching
Lower limit of detection threshold: ~10 keV/µm

Only the evaluation of detector no. 21 has been completed

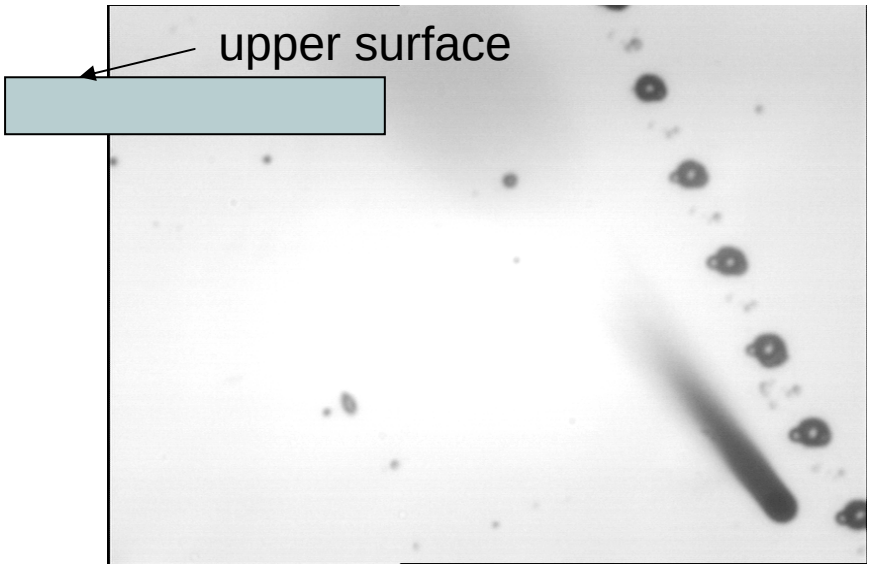
Label	D ±1σ (mGy)	H ±1σ (mSv)	D rate ±1σ (µGy/day)	H rate ± 1σ (µSv/day)	Q ±1σ
21	4.47 ± 0.16	54.22 ± 0.64	27.70 ± 0.97	336.13 ± 3.96	12.14 ± 0.28

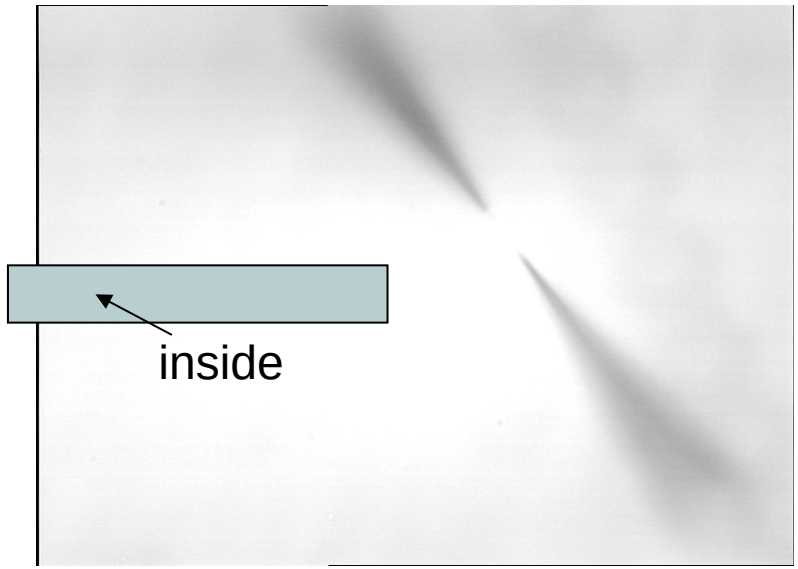
D, H and Q on the ISS
LET ≥ 10 keV/μm



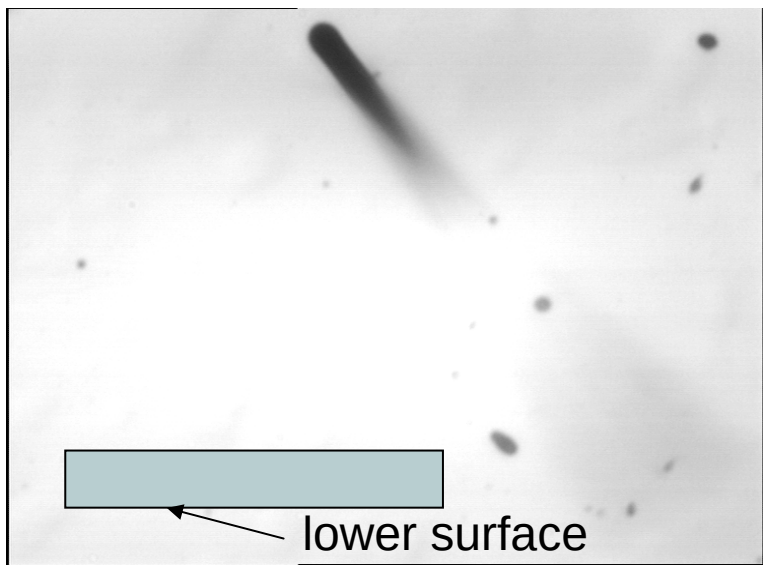
Experiment	Mission date	Location	D rate ±1σ (μGy/day)	H rate ± 1σ (μSv/day)	Q ±1σ
BRADOS-1	02.24. – 31.10.2001	SM, P443	38.8 ± 8.2	324.8 ± 3.6	8.4 ± 1.8
BRADOS-3	02.02. – 28.10.2003	SM, P443	34.8	310.2	8.9
BRADOS-5	28.02. – 11.10.2005	SM, P443	27.0 ± 1.6	211.4 ± 14.4	7.9 ± 0.1
SI2	12.05. – 21.10.2007	SM at Matroshka-R	27.7 ± 0.9	336.1 ± 3.9	12.1 ± 0.3

HZE particles, an example



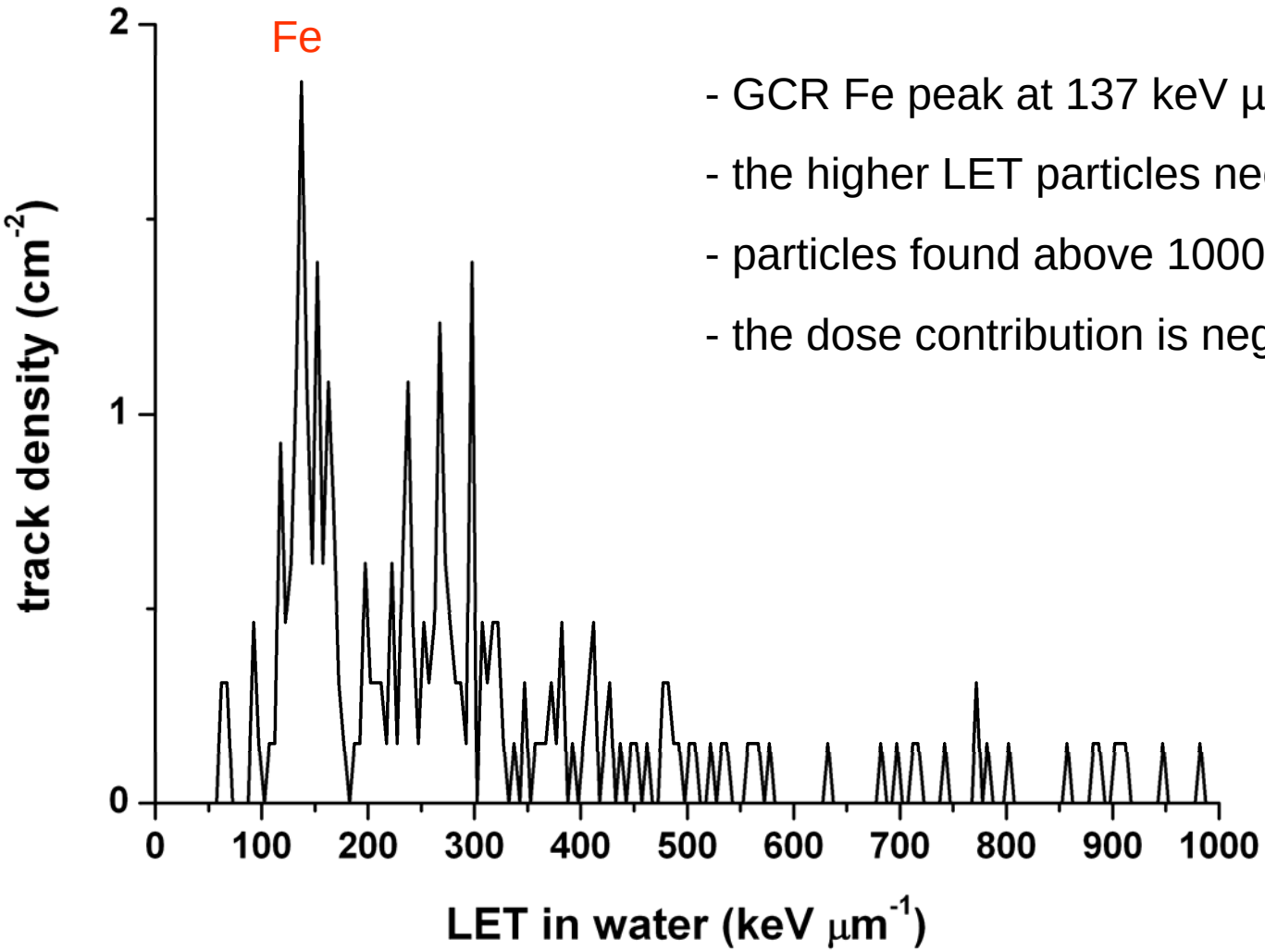


Parameters after 8 µm surface removal:
minor axis: 17.81 µm
major axis: 18.21 µm
projected length: 185.46 µm
depth: 345.00 µm
calculated length: 396.49 µm
incident angle: 27.08°
LET > 1000 keV μm^{-1}



These long range tracks of HZE particles were not included in the dose calculations. Their track density was found small, ~ 43 cm^{-2}, versus the evaluated track density of 5860 cm^{-2}, measured, for instance on detector No. 23.

Distribution of the manually measured HZE tracks detector No. 23



- GCR Fe peak at 137 keV μm^{-1}
- the higher LET particles need to be identified
- particles found above 1000 keV μm^{-1}
- the dose contribution is negligible (~ 1%)

Acknowledgement

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References

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Thanks for your attention!