First preliminary results from EuTEF DOSTEL

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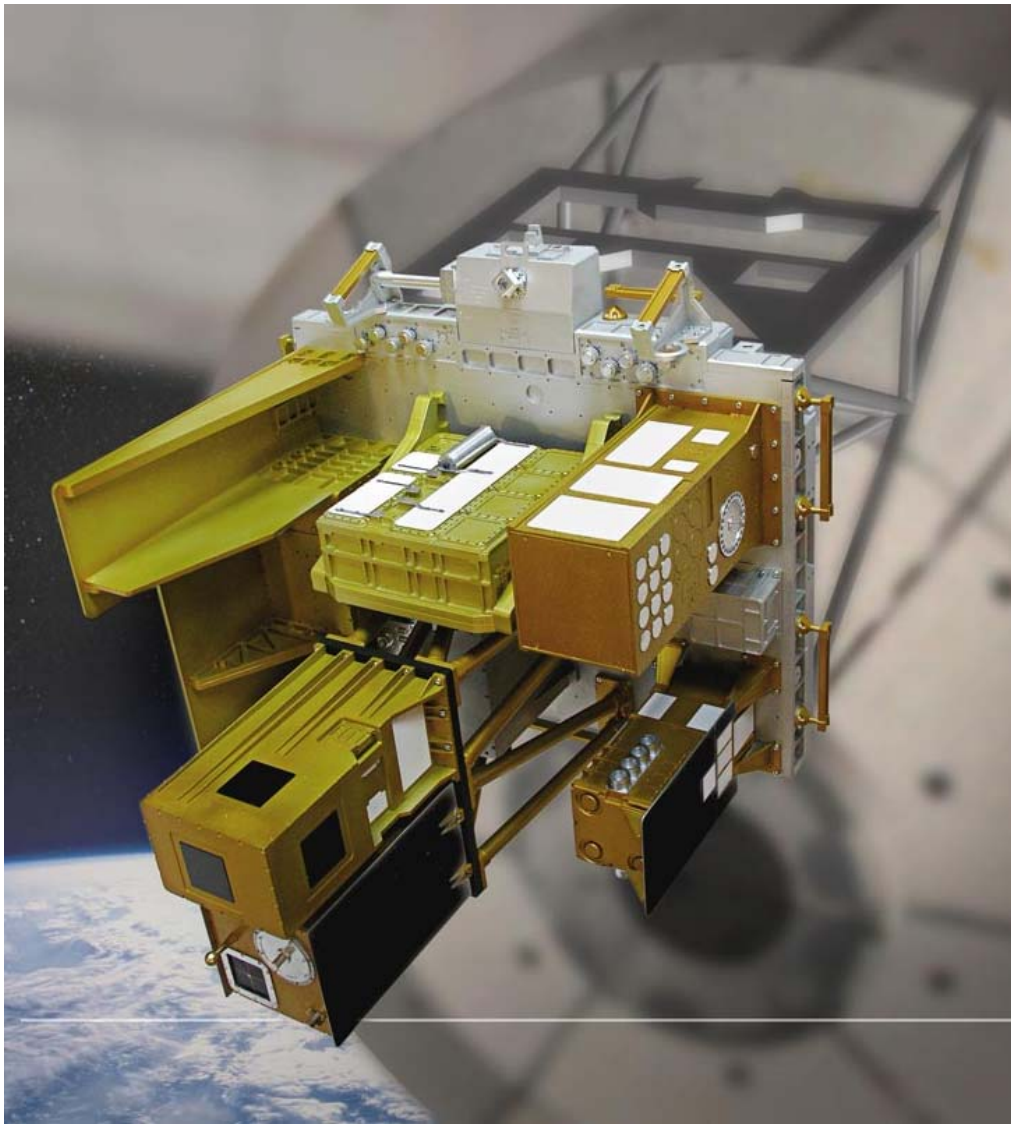
Outline

- EuTEF
- EuTEF DOSTEL
- Energy Calibration
- Calculation of Dose D and Dose Equivalent H

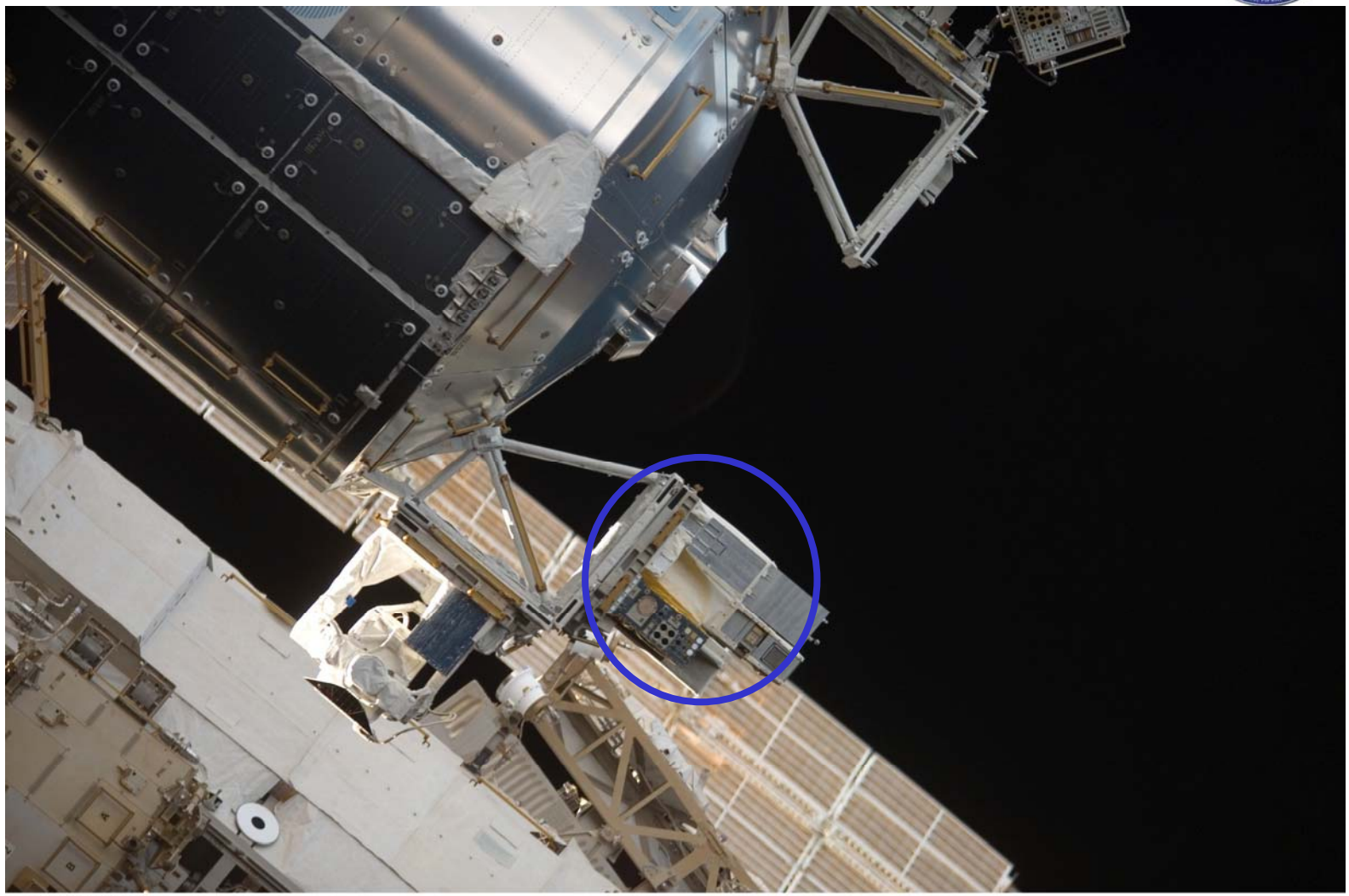
EuTEF

- European Technology Exposure Facility
- multi-user external facility on the outside of Columbus
- installed February 15th 2008
- will stay in orbit for 18 months
- 9 experiments are attached
  - biological experiments
  - instrument to measure atomic oxygen
  - experiment to measure orbital debris
  - new materials are tested
  - one device to measure radiation levels

  → EuTEF DOSTEL



DOSTEL on EuTEF



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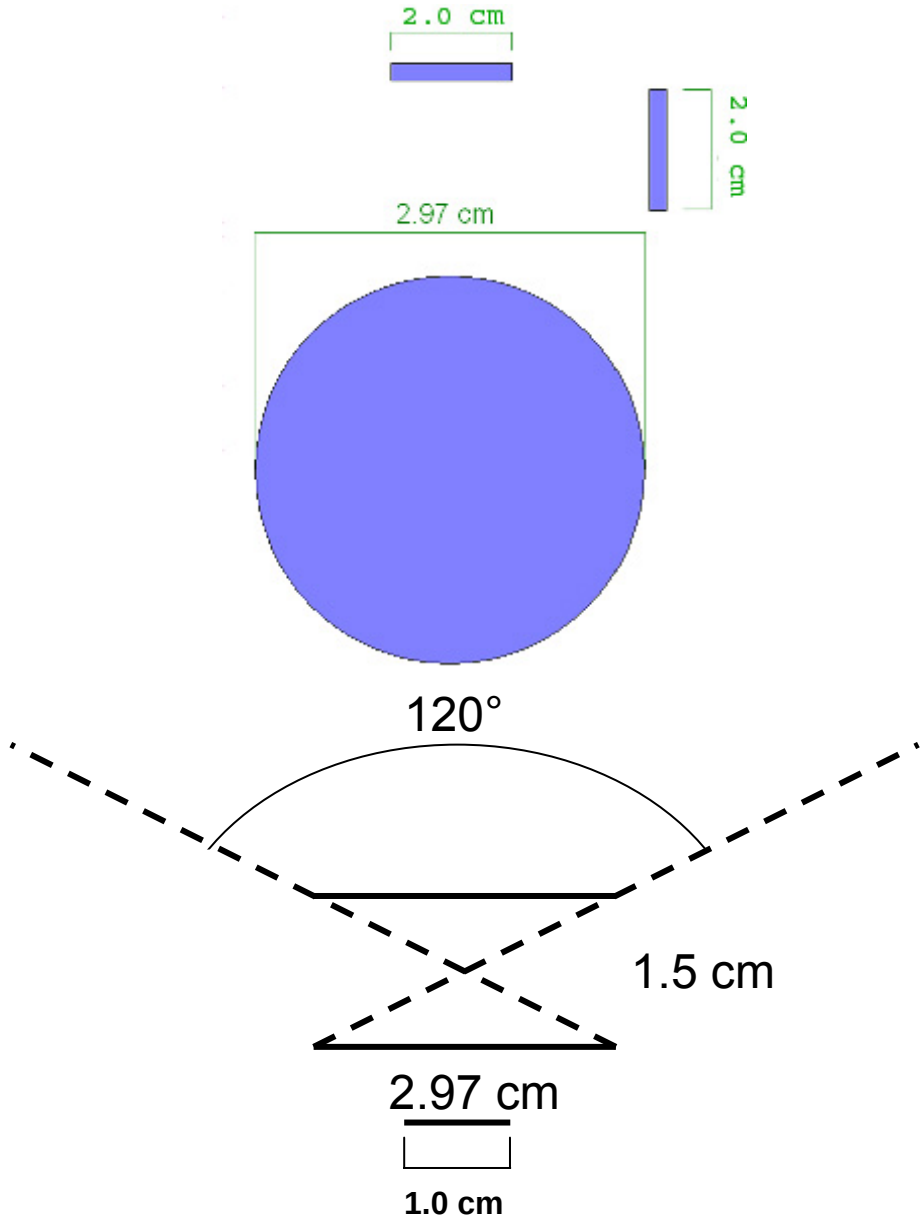
- the EuTEF DOSTEL is in operation since February 25th 2008

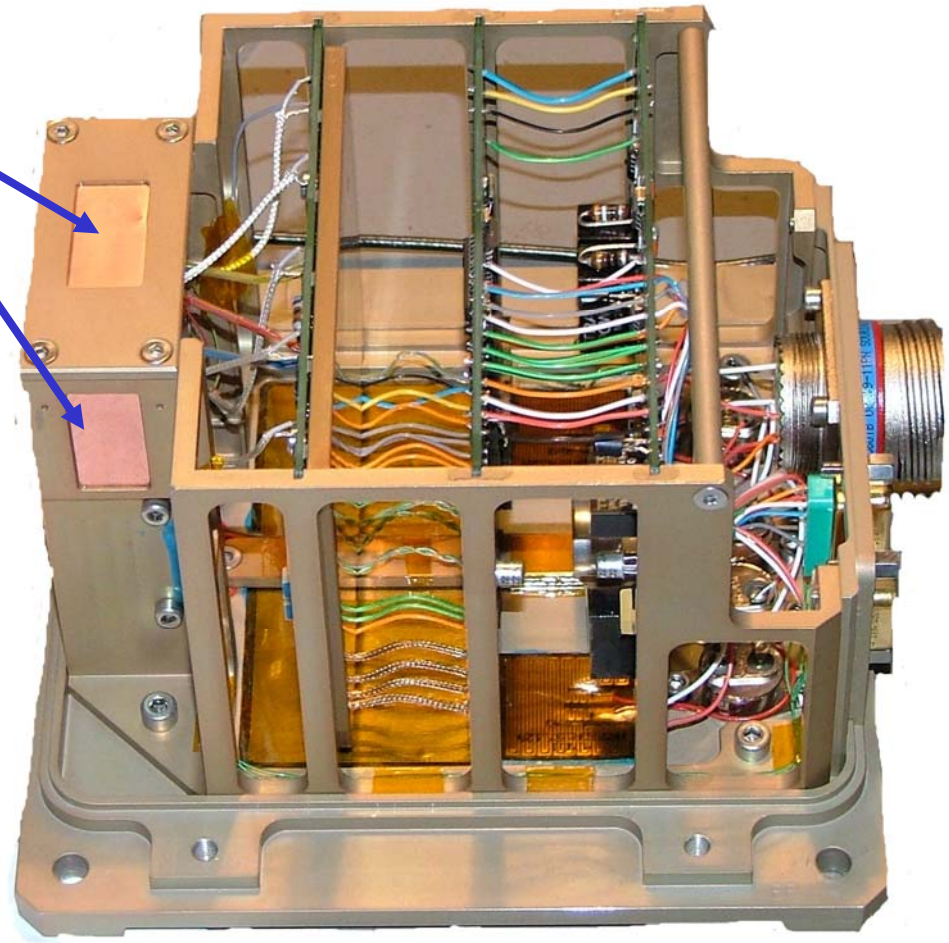
EuTEF DOSTEL

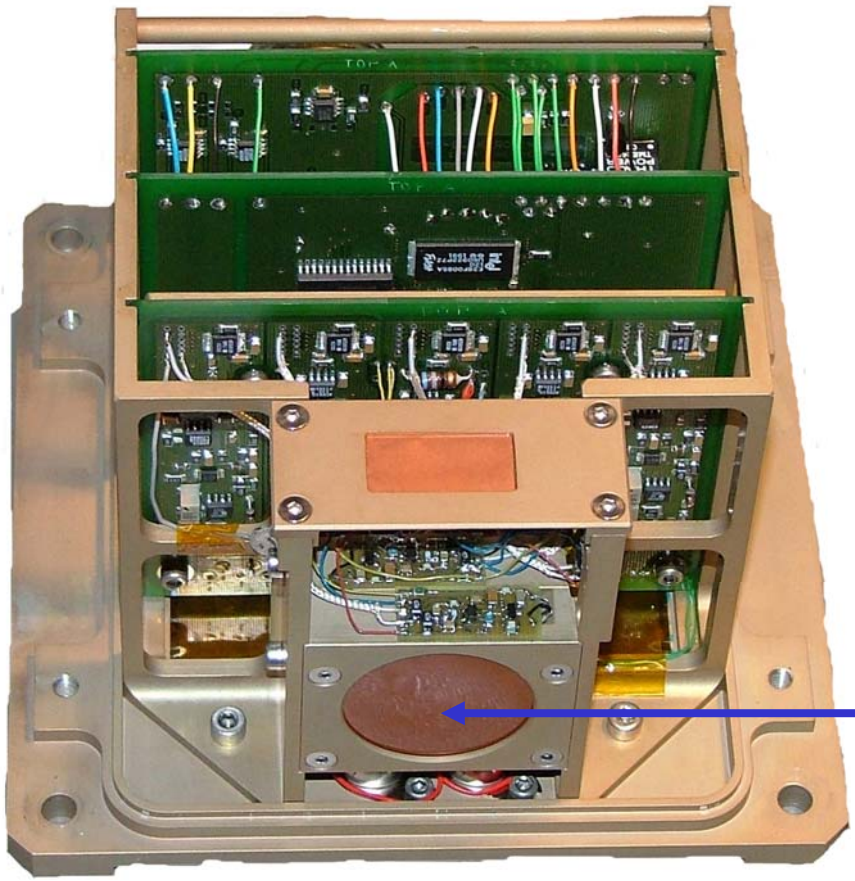
- dosimetry telescope
  - 2 passivated implanted planar silicon (PIPS) detectors active area 6.93 cm²
    - front detector thickness : 158 µm
    - rear detector thickness : 310 µm
- 3 silicon PIN diodes
  - top and side PIN diode : active area of 2.31cm²
  - rear PIN diode : active area of 1.21 cm²



EuTEF DOSTEL

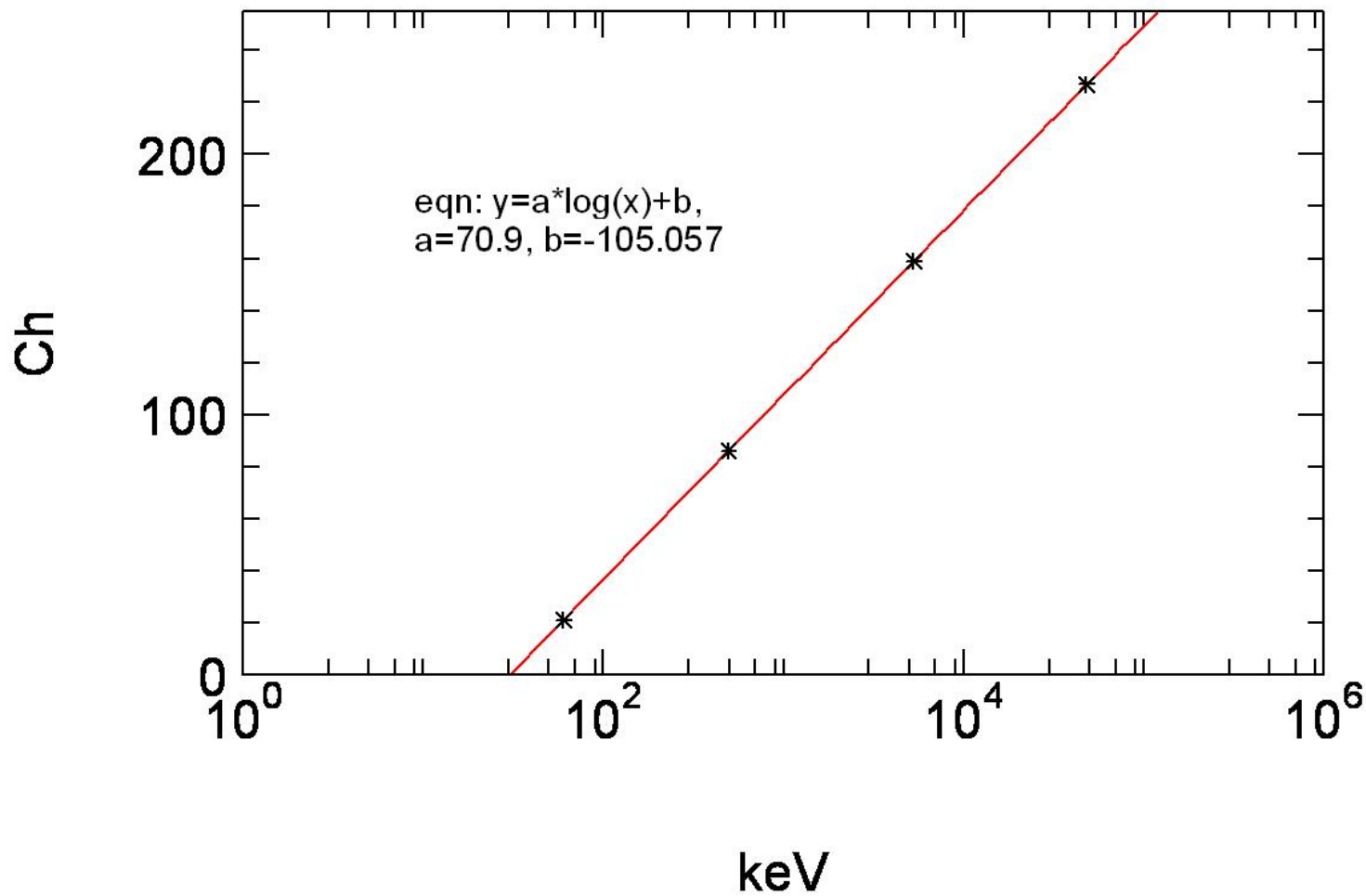
Hamamatsu
PIN diodes
(behind capton
foil)





Canberra PIPS
(behind capton foil)

Energy Calibration



- analogue signal section : logarithmic amplifier
- calibration
  - slope : test pulses of different amplitude
  - offset : source with well defined energy : ^{241}Am (59.54 keV)

Energy Range and LET Range

- **energy range of the detectors:**
  - D1 (telescope rear detector) : Δ E : 30 keV to 120 MeV
  - D2 (telescope front detector) : Δ E : 17 keV to 74 MeV
  - D3 (photodiode on the side) : Δ E : 30 keV to 123 MeV
  - D4 (photodiode on top) : Δ E : 31 keV to 132 MeV
- **LET range in water for the detectors:**
  - D1 : 0.144 keV/µm – 173 keV/µm
  - D2 : 0.048 keV/µm – 209 keV/µm

Dose D and the Dose Equivalent H

- dose $D = \Delta E_{Si} / m$ [Gy] ;
  ΔE_{Si} = energy deposit in J , m = mass of detector in kg

- dose equivalent $H = Q * D_{water}$ [Sv] ;
  Q = weighting factor

Calculation of the dose D from the spectrum:

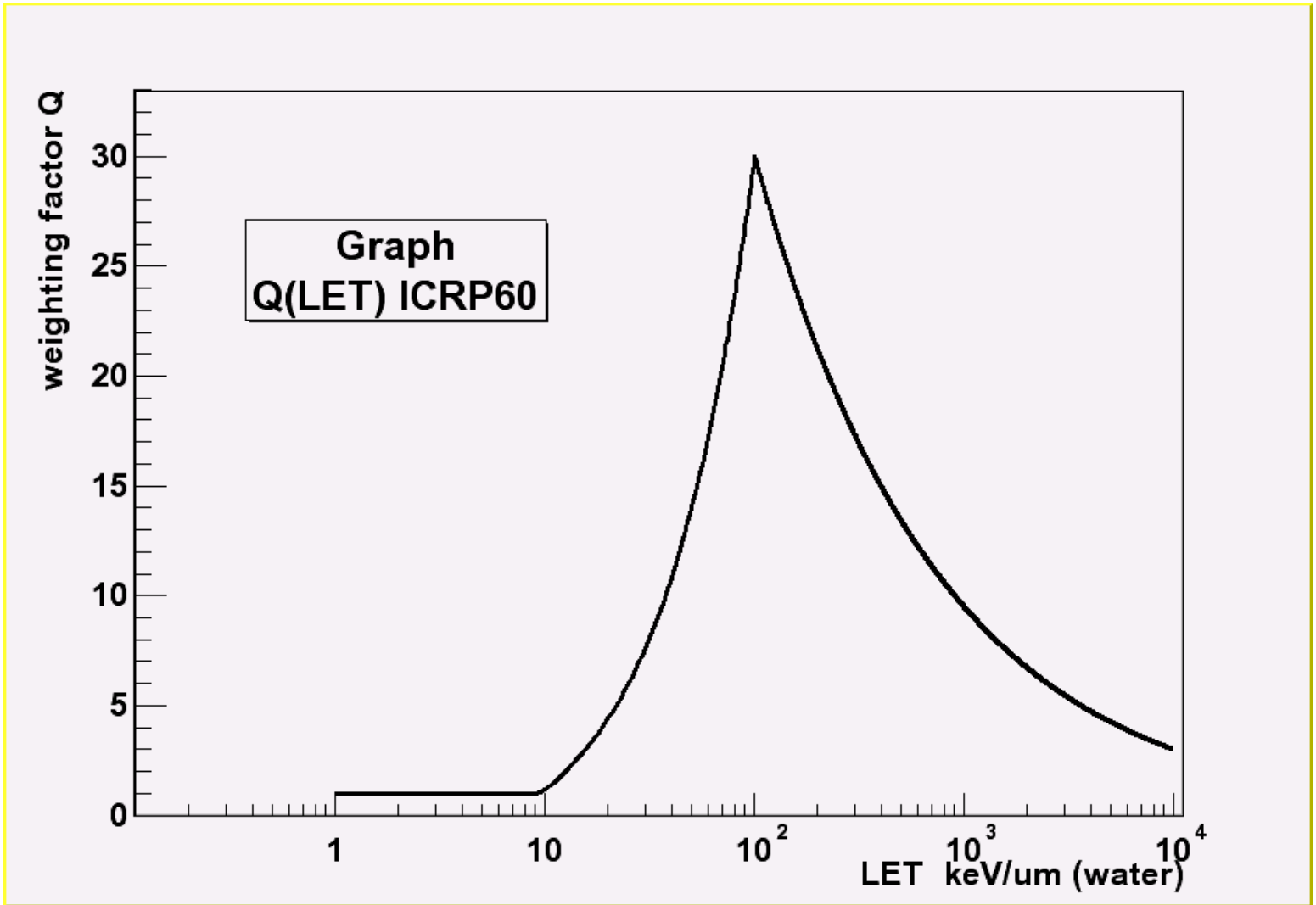
- $D_i = 1/m * \Delta E_i$ [keV] $* N_i * 10^3 * 1.602 * 10^{-19}$ [eV] $* 5.28$

$5.28 = 6.93\ cm^2 * 2 * \pi / 8.24\ cm^2 * sr$

$\rightarrow D = \Sigma_i D_i$

Calculation of the Weighting Factor Q

- determine Q with the function Q(LET) from the ICRP 60,1991 and LET_{water}



Calculation of LET in Water and the Dose Equivalent H

- $LET_{Water,i} = \Delta E_{Si,i} / \Delta L / 2.33 * 1.21;$

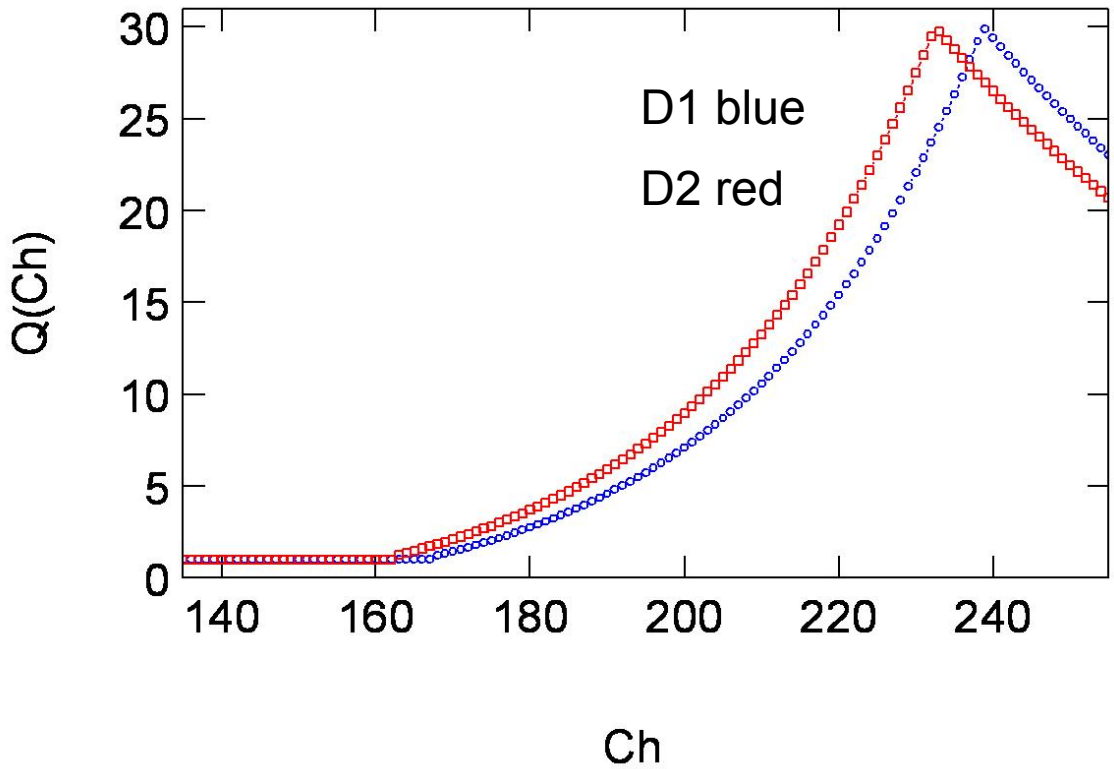
ΔE_{Si} : energy loss in silicon [kev]
ΔL : path length in detector [µm]

- $Q_i = LET_{Water,i} * Q(LET)$

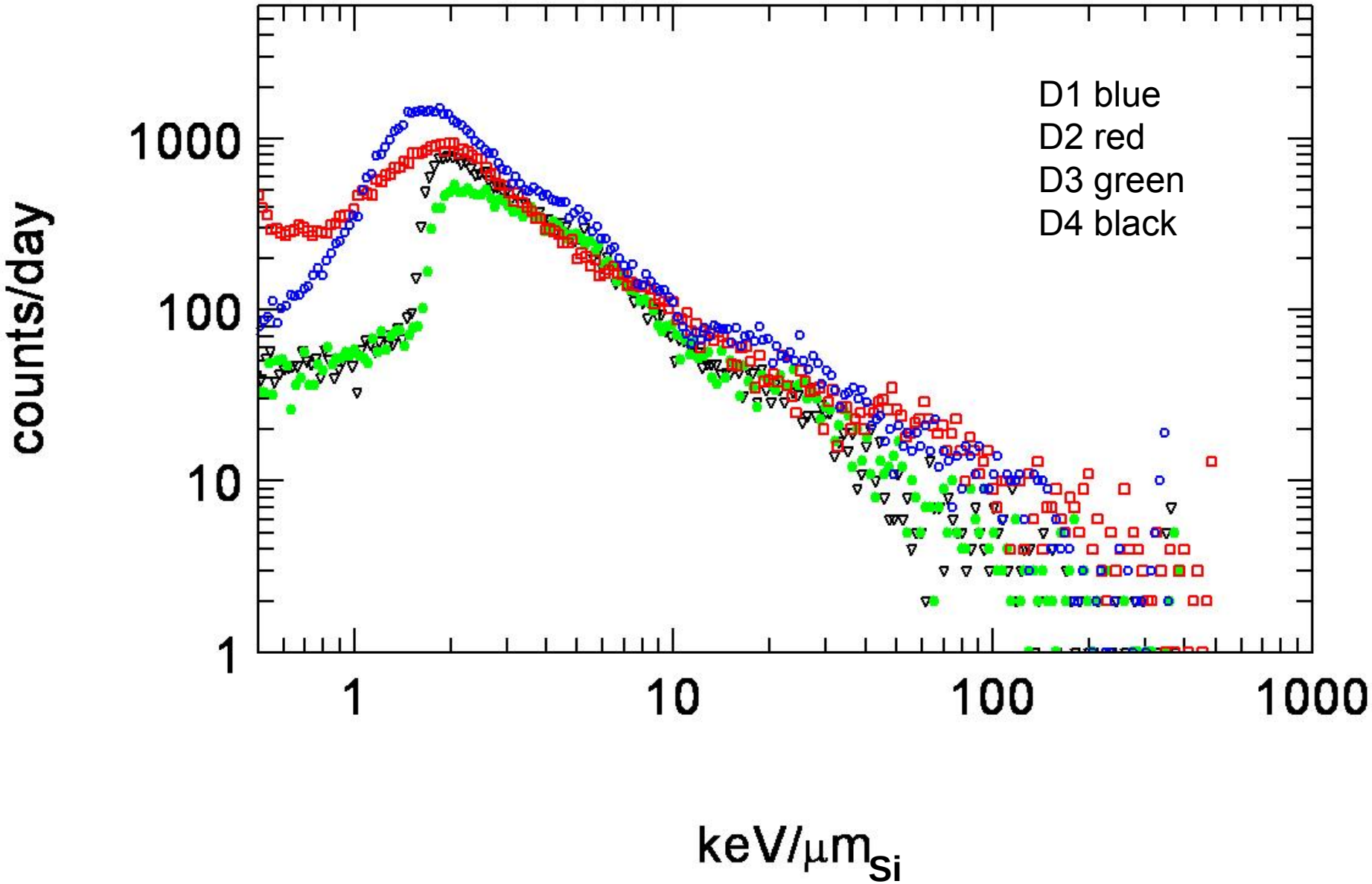
$$\bar{Q}\ (D1) = 2.2 \pm 0.1$$
$$\bar{Q}\ (D2) = 3.1 \pm 0.6$$

- $H_i = D_{Si,i} * Q_i * 1.21$

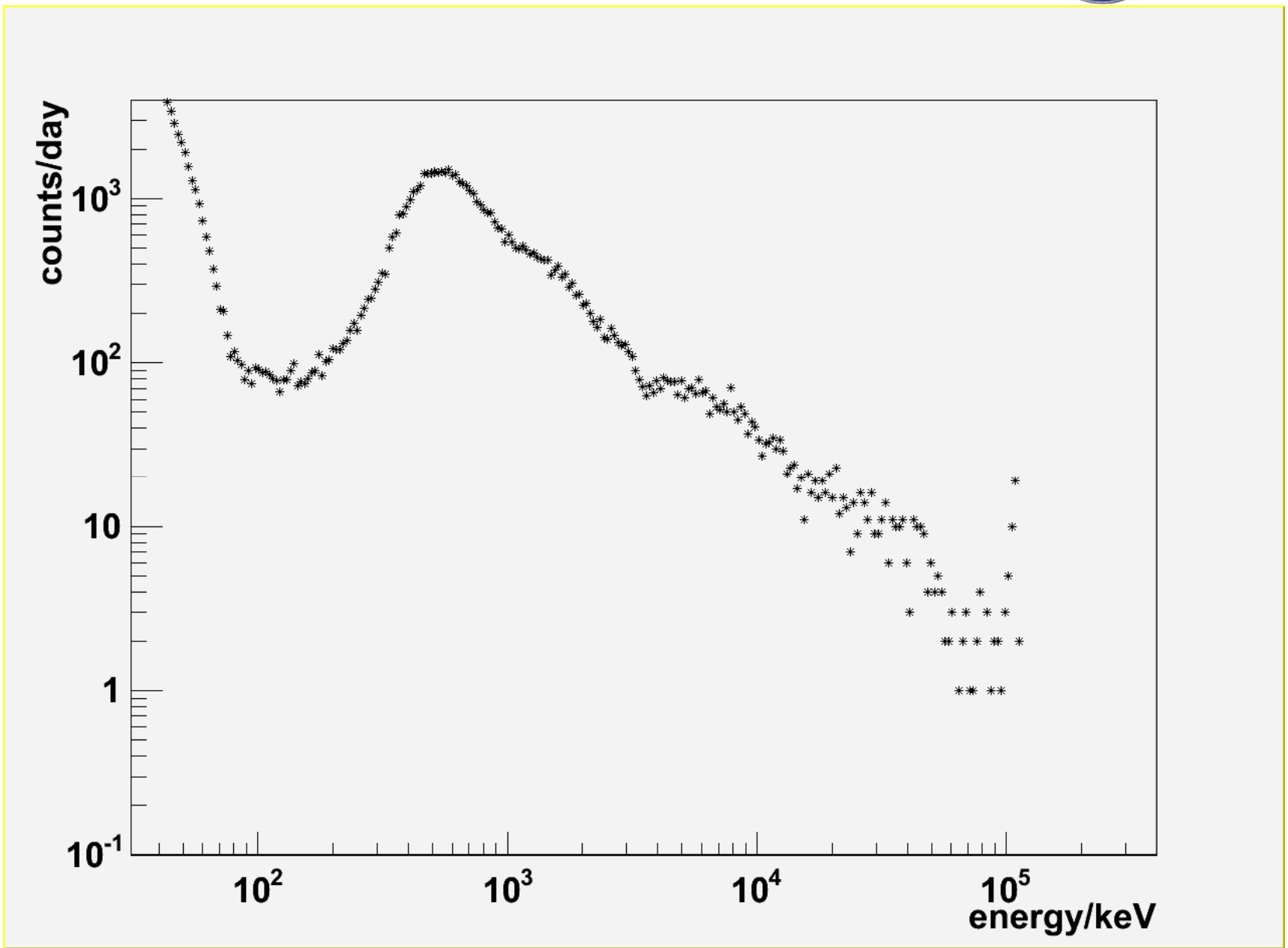
$\rightarrow H = \Sigma_i H_i$



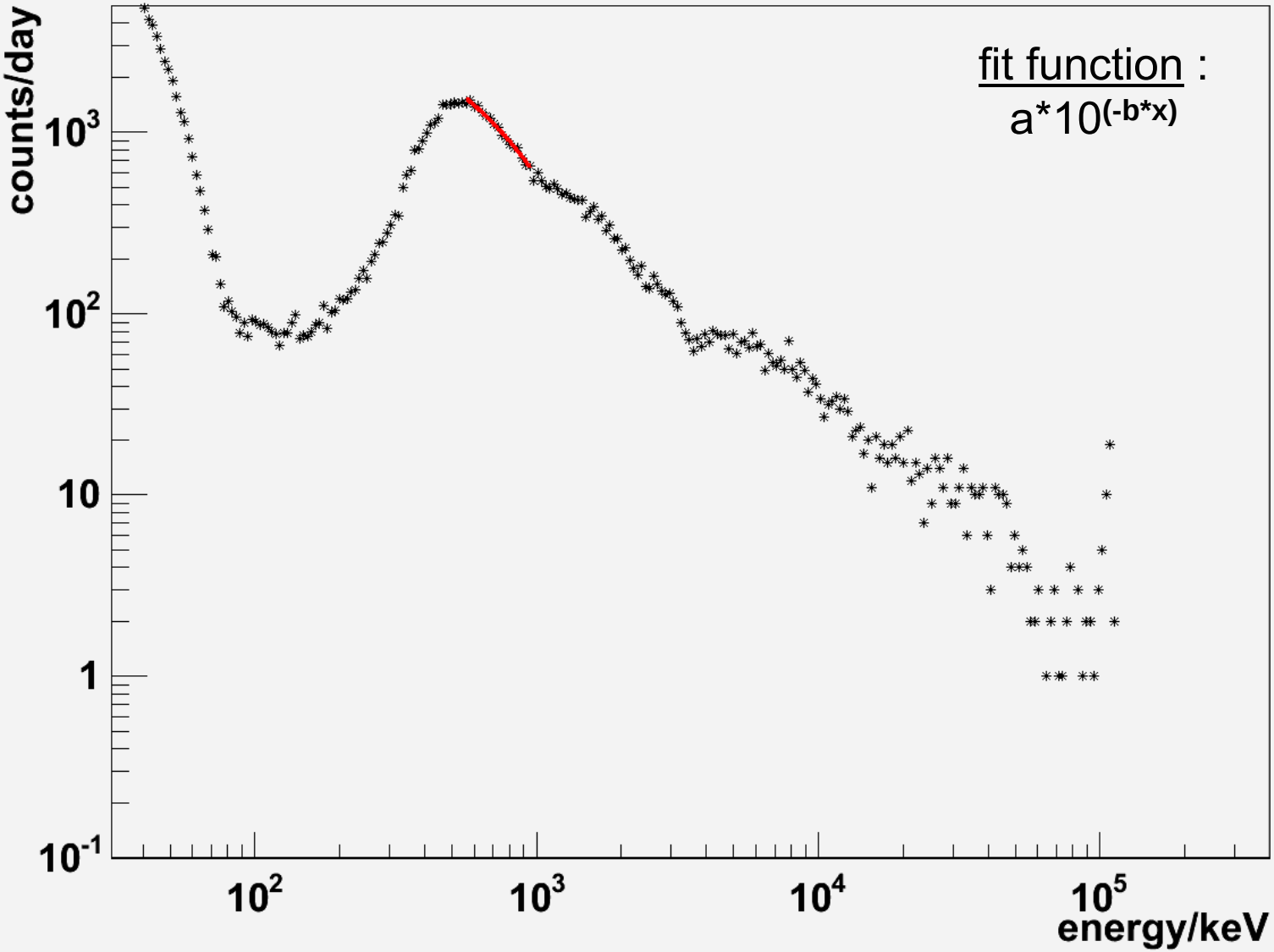
LET- Spectra March 5th 2008



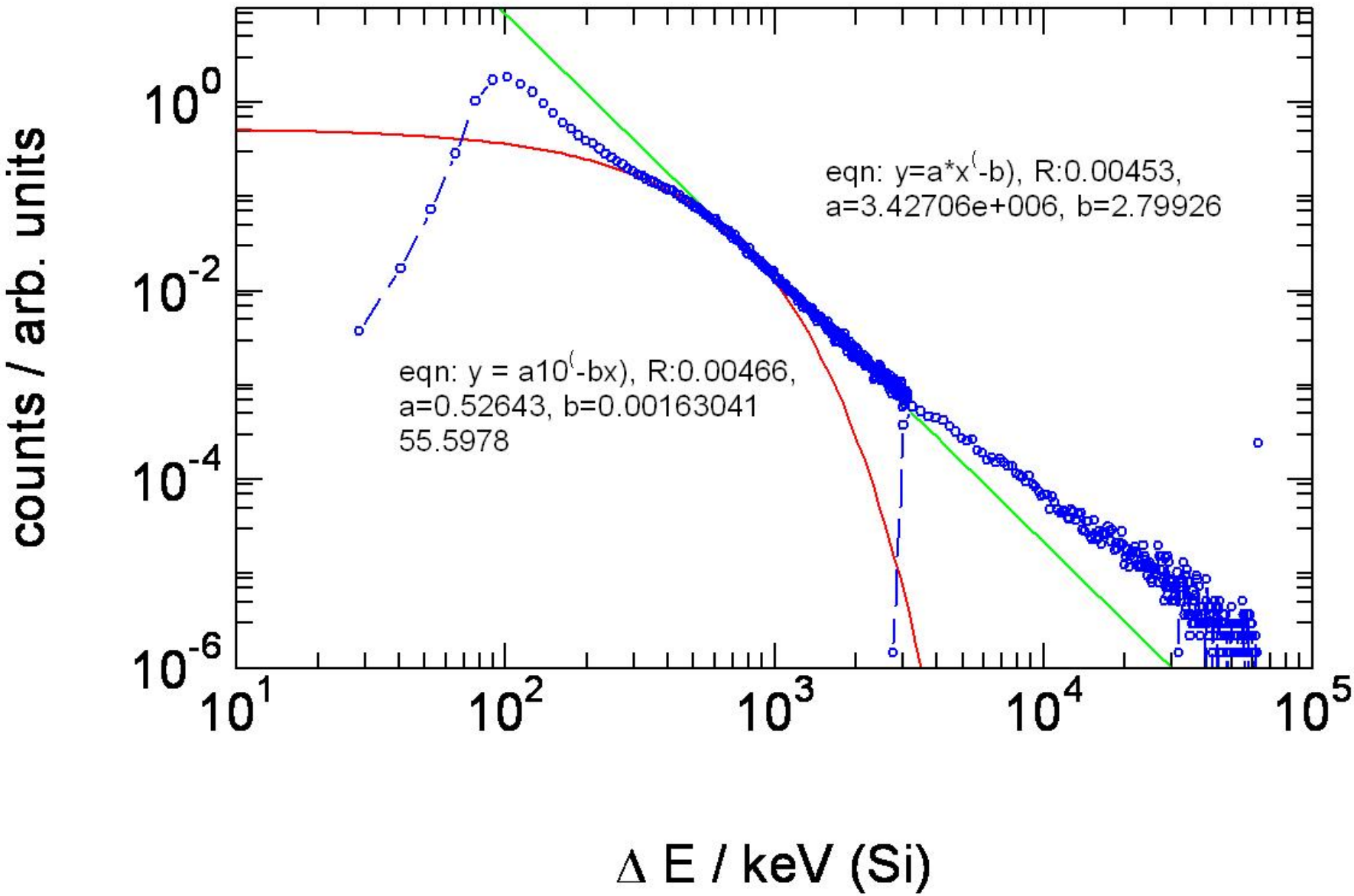
Spectrum Detector D1



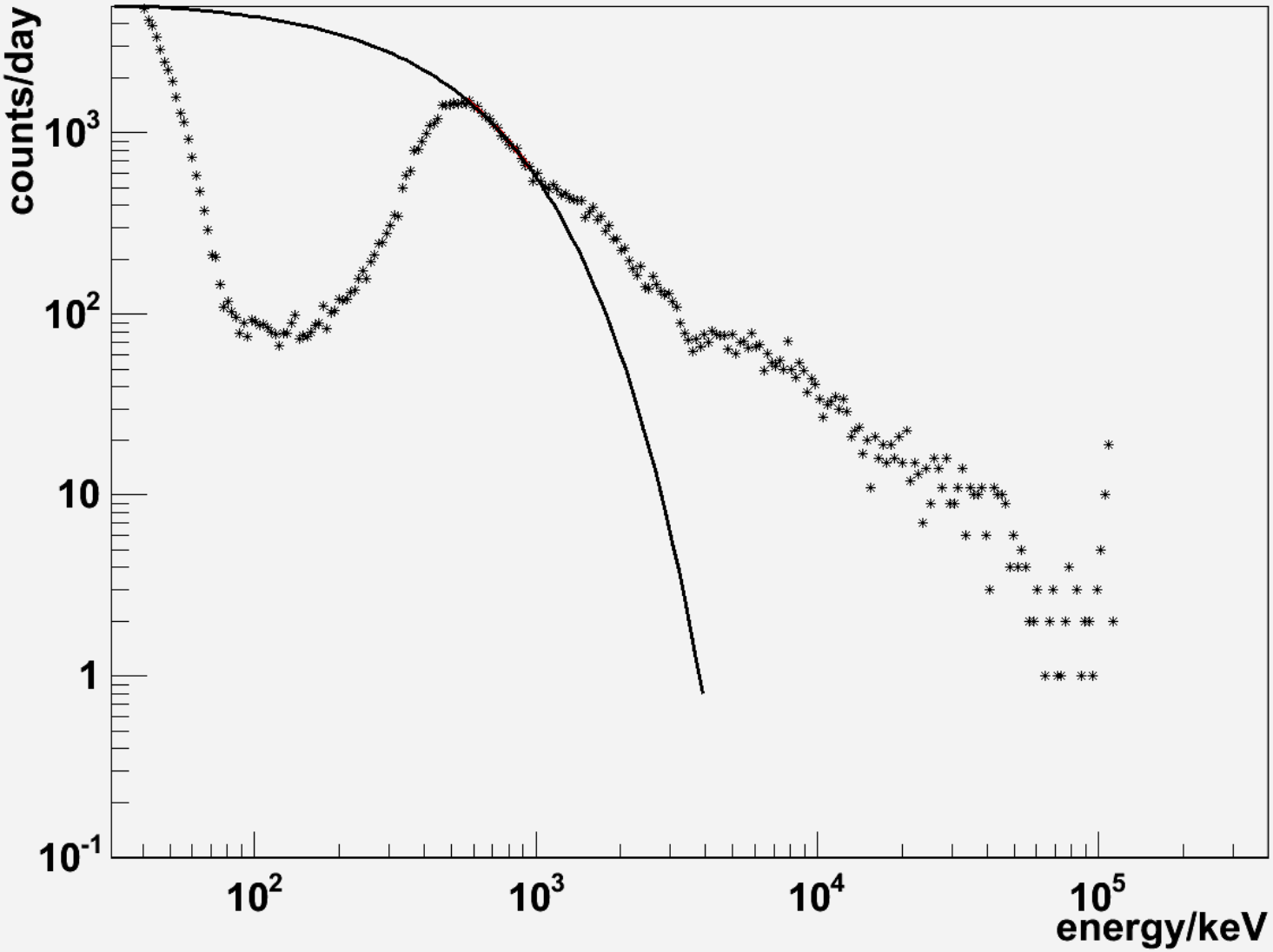
Spectrum Detector D1 with Fit



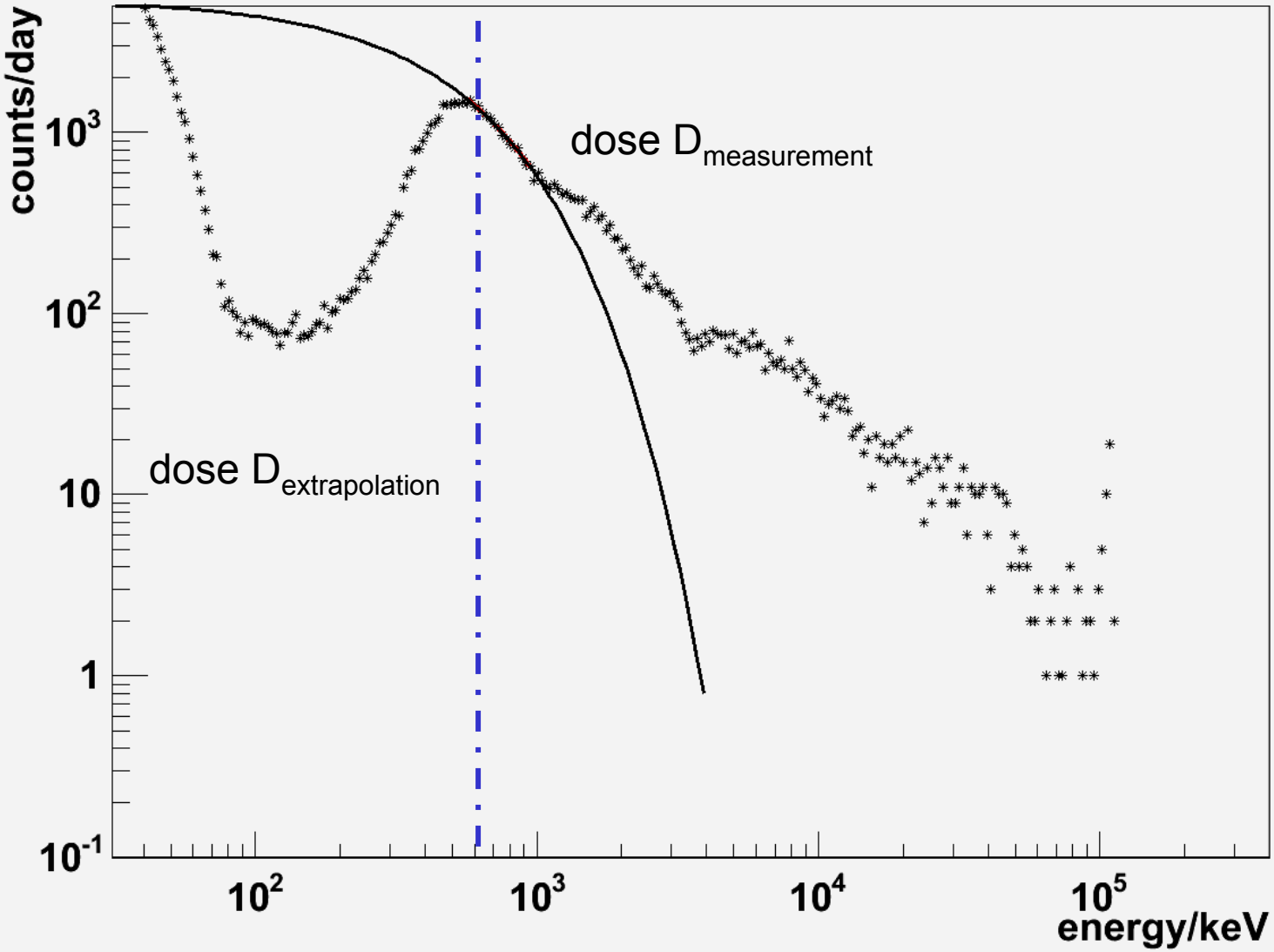
Verifying the Fit Function with Dosmap Data



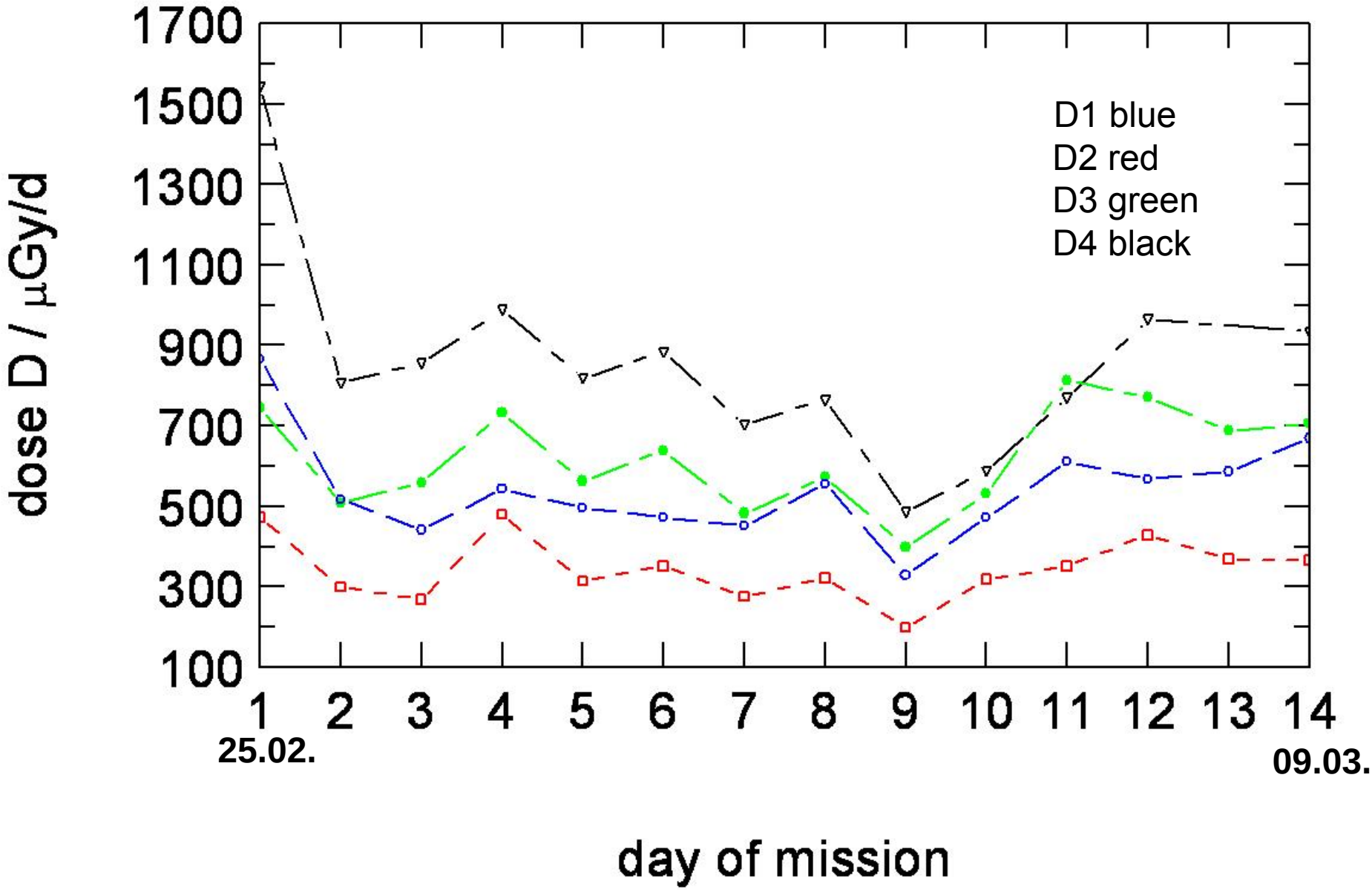
Spectrum Detector D1 with Extrapolation



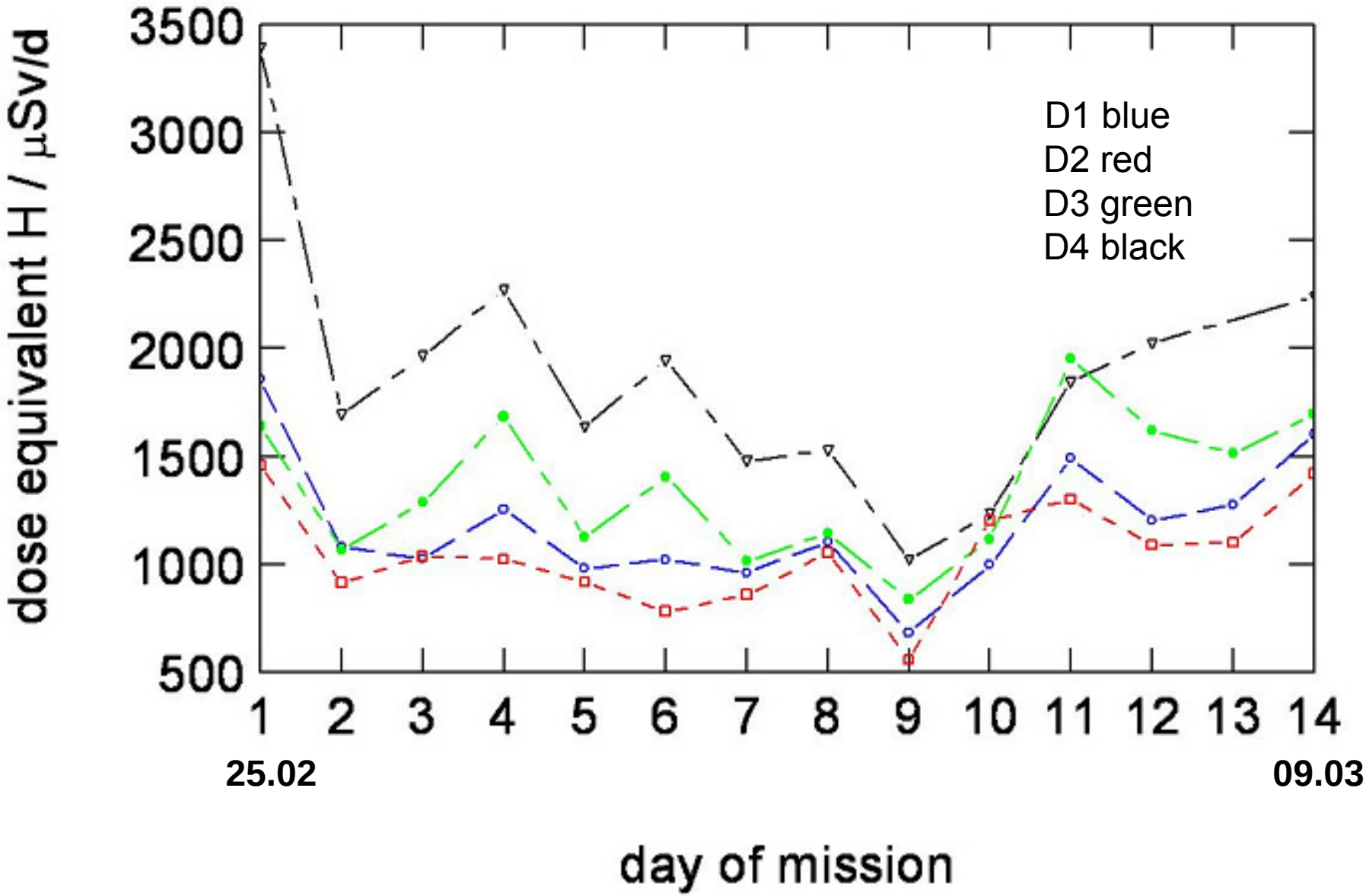
Calculation of the Dose D from the Spectrum



Dose D


dose D / µGy/d
1700
1500
1300
1100
900
700
500
300
100
D1 blue
D2 red
D3 green
D4 black
1
2
3
4
5
6
7
8
9
10
11
12
13
14
25.02.
09.03.
day of mission

Dose Equivalent H



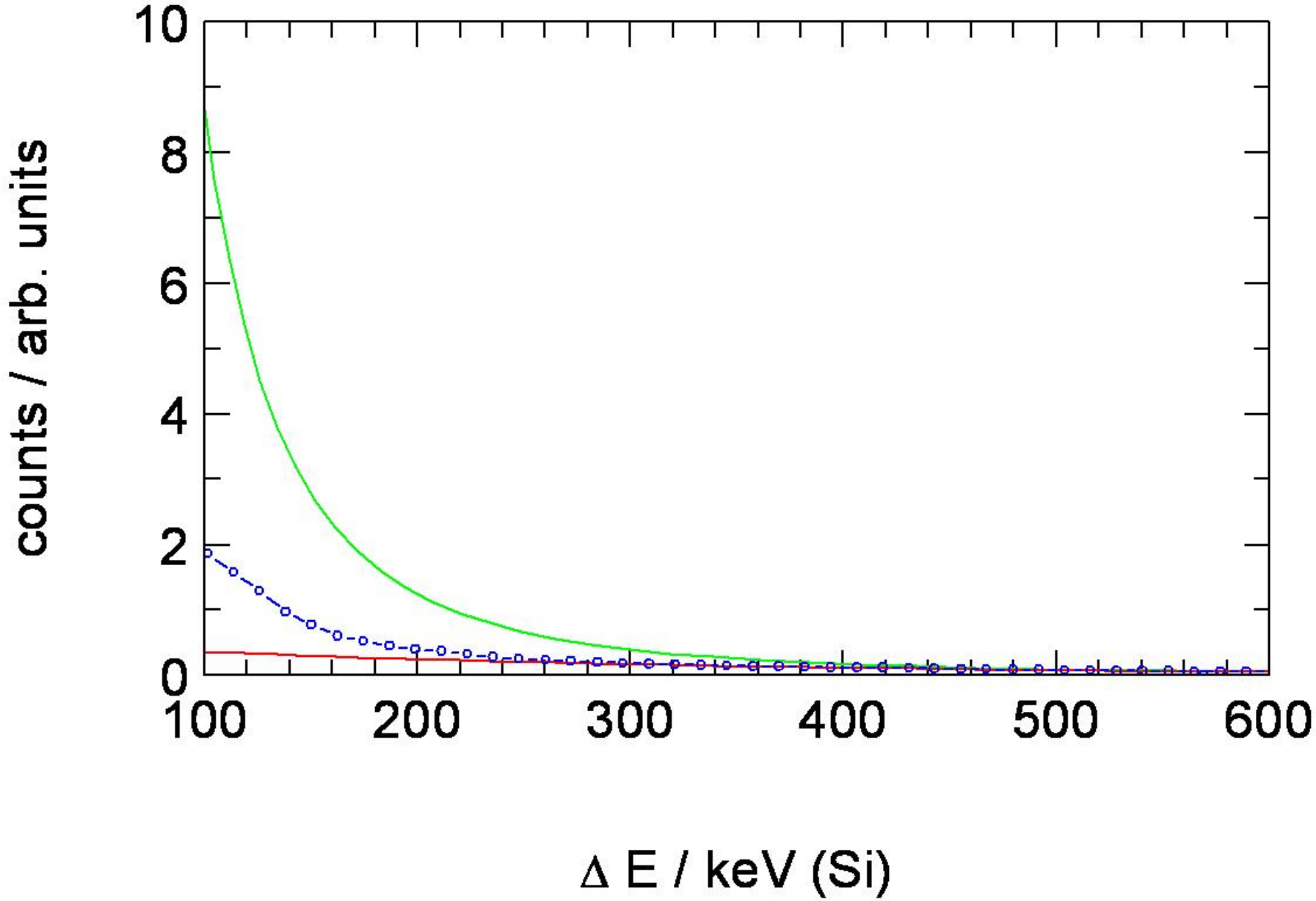
Comparison with other DOSTEL Measurements

mission	D average all [µGy/d]	H average all [µSv/d]
STS76	246	566
STS81	247	610
STS76(M6)	279	662
STS84(M7)	262	606
Dosmap	152	472
MATROSHKA	422	1265
EuTEF D1	541 ± 120	1139 ± 300
EuTEF D2	344 ± 70	1052 ± 250
EuTEF D3	622 ± 120	1364 ± 330
EuTEF D4	855 ± 250	1869 ± 590

Acknowledgements

- This work is financially supported by DLR Bonn under grant 50WB9906 and 50WB0526
- Parts of the calibration were performed at NIRS/ HIMAC therefore we would like to thank Yukio Uchihori and the ICCHIBAN working group
- We would like to thank DLR Köln for the good collaboration

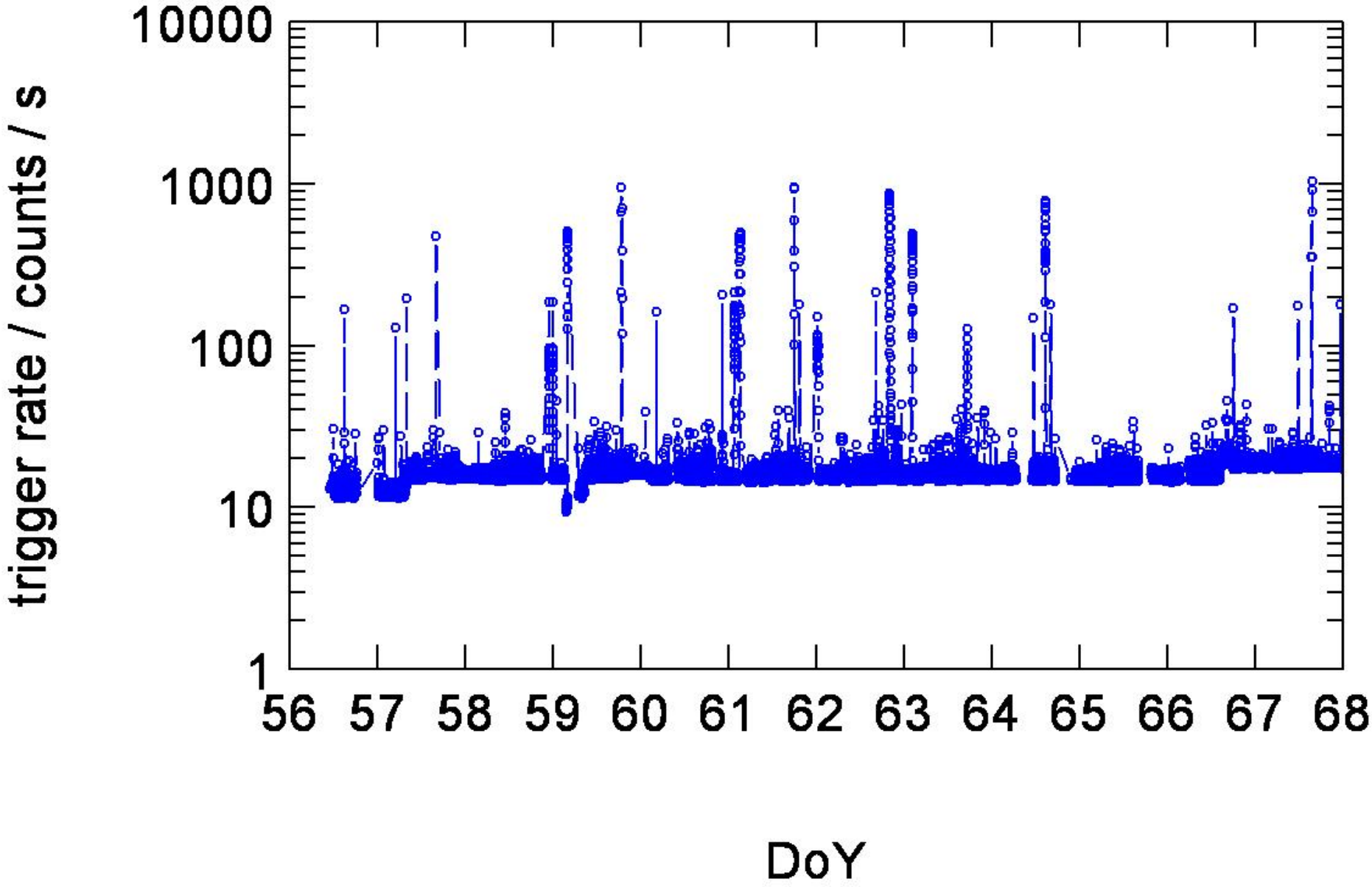
Verifying Fit



EuTEF DOSTEL : Modes of Operation

detector / mode	telescope rear	telescope front	PIN-diode (side)	PIN-diode (top)	AK
A	D2	D1	PIN-diode (side)	PIN-diode (top)	1 cm²
B	D2	D1	-	-	1 cm²
C	1 cm²	-	PIN-diode (side)	PIN-diode (top)	-
E	1 cm²	-	-	-	-

Trigger Rates



Trigger Rates