

# **Results from the beamtest and lab measurements of ABCD2T and CAFE/ABC modules at KEK**

Y. Unno

Physics, KEK

for many other contributors to the beamtest

- **Dec99 beamtest at KEK (T450)**
- **Calibrations**
- **Threshold scans**
- **Bias voltage dependence of median charge**
- **Summary**

# Dec99 beamtest at KEK (T450)

- **Execution: Dec 10-21, 1999**

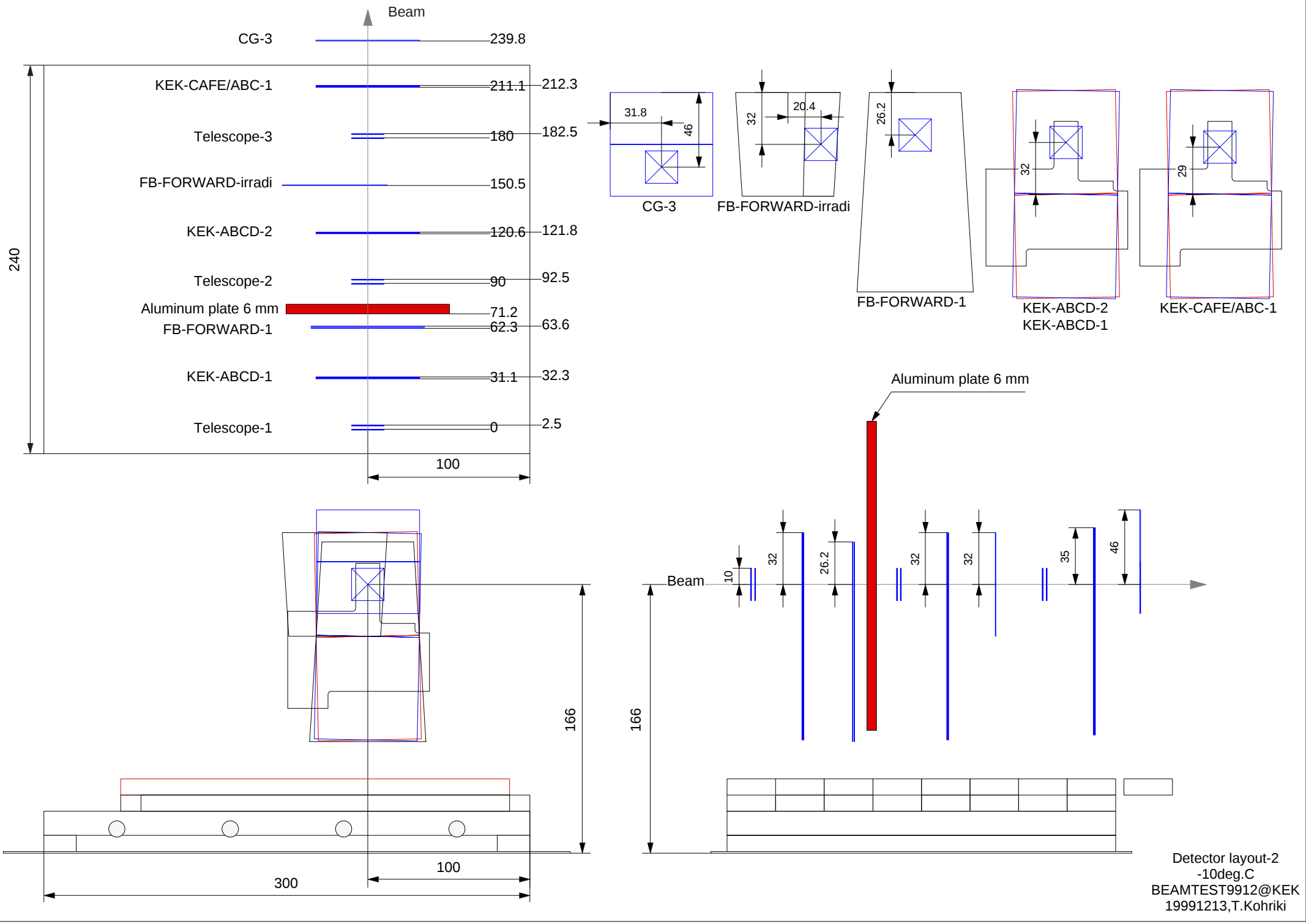
- $\pi^2$  beamline in the 12 GeV PS at KEK, 4 GeV/c  $\pi^-$
- Participants:
  - Domestic = Y. Unno, Y. Ikegami, T. Kohriki, +6~9 students
  - Abroad = G. Moorhead, K. Runge, J. Ludwig, Z. Dorazel
- Photo's out of the beamtest

- **DUT's: 5 modules**

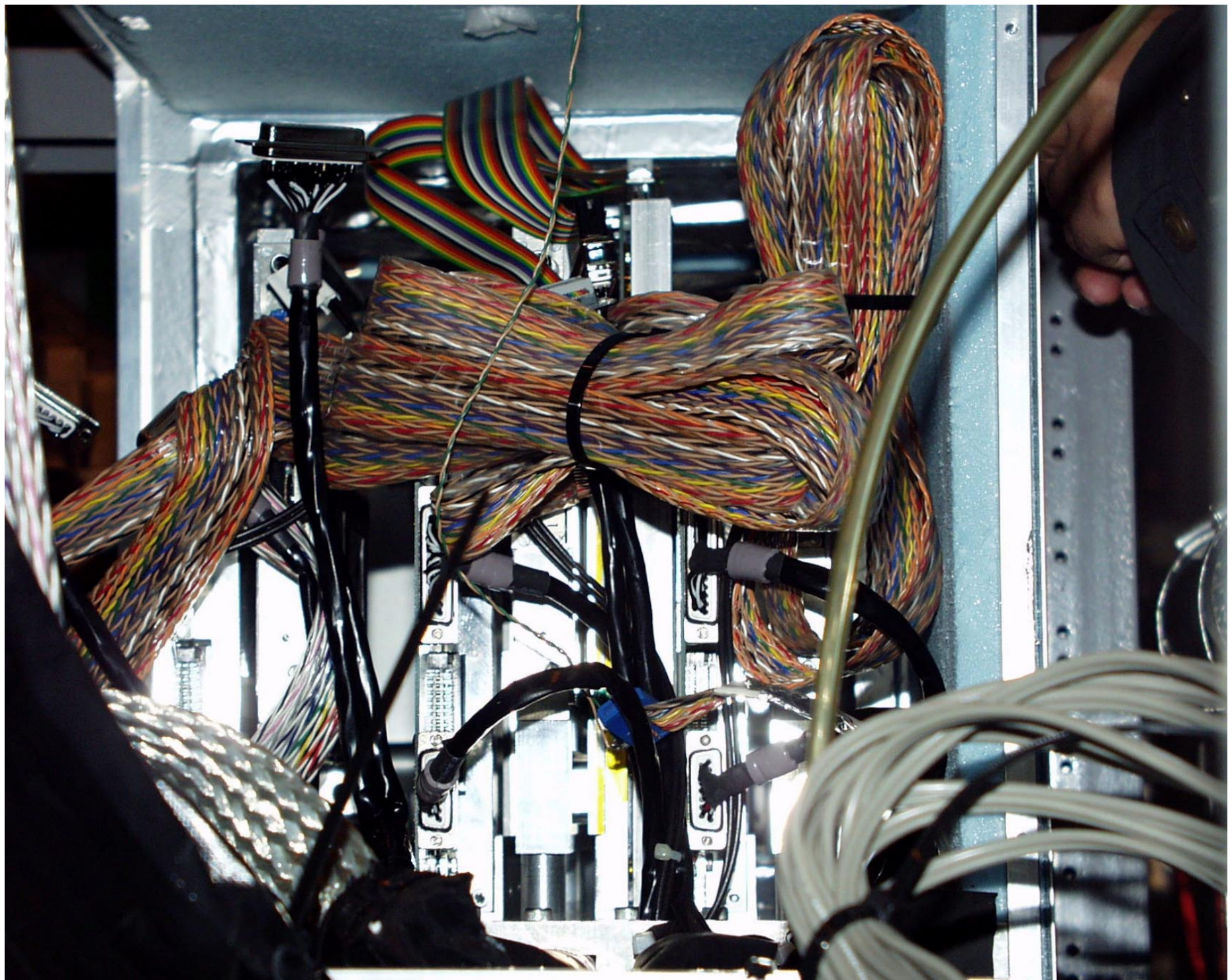
- Module 0: KEK-ABCD#1, 285  $\mu\text{m}$ , trimmed at 2 fC to 200 mV
- Module 1: FR-ABCD, 285  $\mu\text{m}$ , trimmed at 2 fC to 200 mV
- Module 2: KEK-ABCD#2, 325  $\mu\text{m}$ , not trimmed
- Module 3: FR-irrad det-ABCD, 285  $\mu\text{m}$ , trimmed?
- Module 4: KEK-CAFE, 285  $\mu\text{m}$
- Module 5: CG3, anchor

- **Run conditions:**

- Edge detection=ON, Mode=Any hits
- 2cm x 2cm triggered region with 3 planes of scintillator
- Two temperatures: +10, and -10 °C
  - +10 °C = Mod0, Mod1, Anchor
  - 10 °C = All







# Modules setup

- **Three telescope planes + Anchor**

- Two DUT's between telescopes or anchor
- Separation: 30 mm each
- Sequence:

- Telescope1

- Mod0.....KEK-ABCD#1

- Mod1.....Freiburg-ABCD

- (6 mm Al plate)

- Telescope2

- Mod2.....KEK-ABCD#2

- Mod3.....Freiburg-irradiated detector

- Telescope3

- Mod4.....KEK-CAFE/ABC

- Anchor (CG3)

- No shielding between the DUTs
- 6 mm Aluminum plate was forgotten to be removed

- **Setup drawings**

- Setup of -10 °C
- Setup of +10 °C

# Module stability - continued

- **Mod0 - KEK-ABCD#1**

- Trimmed: 200 mV = 2 fC
  - Gain ~ 50 mV/fC, then pedestal ~ 100 mV
- Top: 2 deads + 1 noisy channels in the beam region
- Bottom: 2 deads + 1 sick + 1 noisy in the beam region

- **Mod1 - Freiburg ABCD**

- See the report by Freiburg

- **Mod2 - KEK-ABCD#2**

- Not trimmed
  - chip3 (0-5) of top side, ~50 mV/trim step (normally ~5mV/step)
  - did not find a way to incorporate both good and sick trim chips
- Top: 1 noisy channels in the beam region
- Bottom: none?

- **Mod4 - KEK-CAFE/ABC**

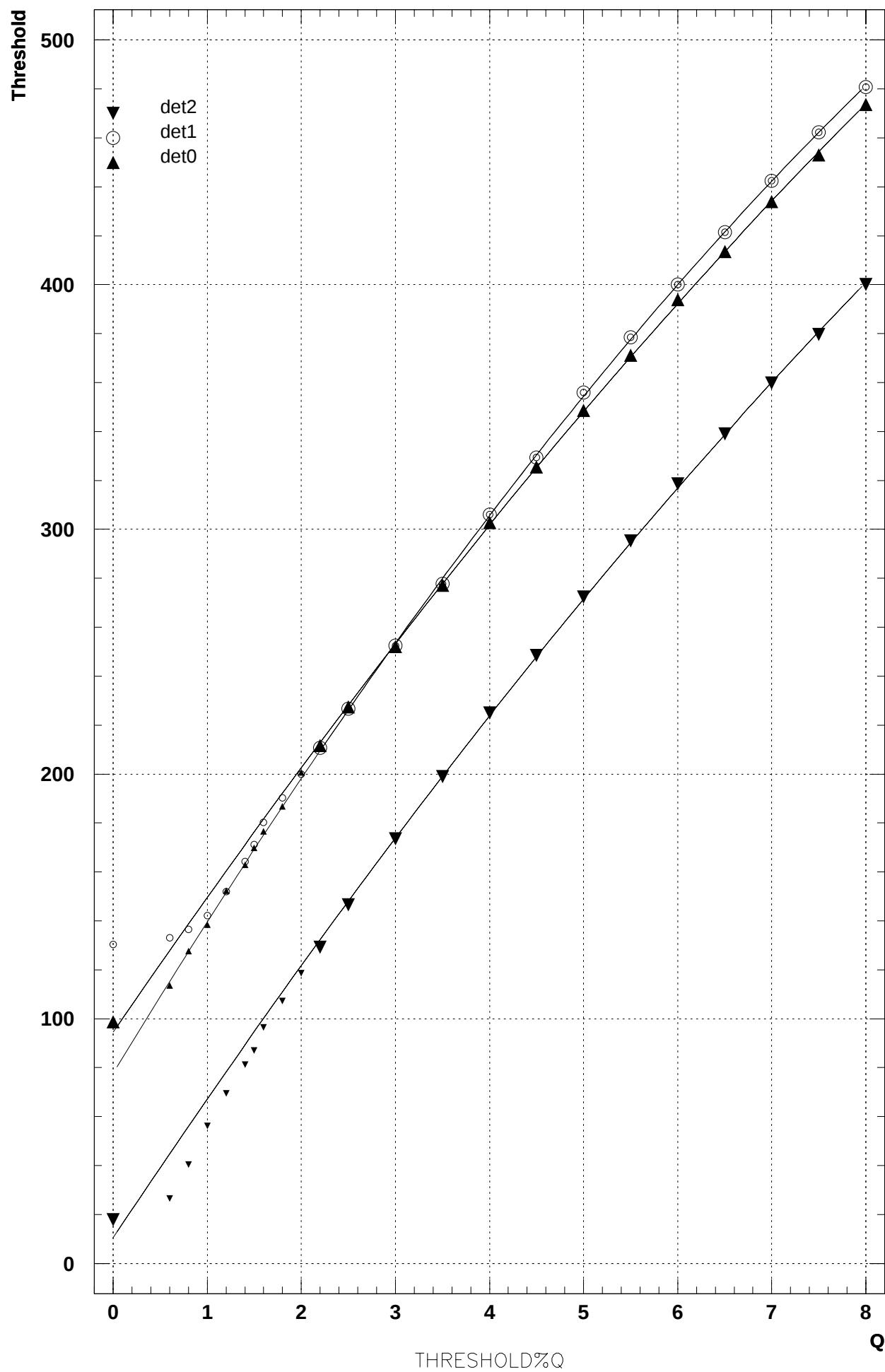
- Unstable upto 160 or 170 mV (0.6~0.7 fC)
  - Hybrid: unstable upto 100 mV (~0.3 fC)

# Calibrations

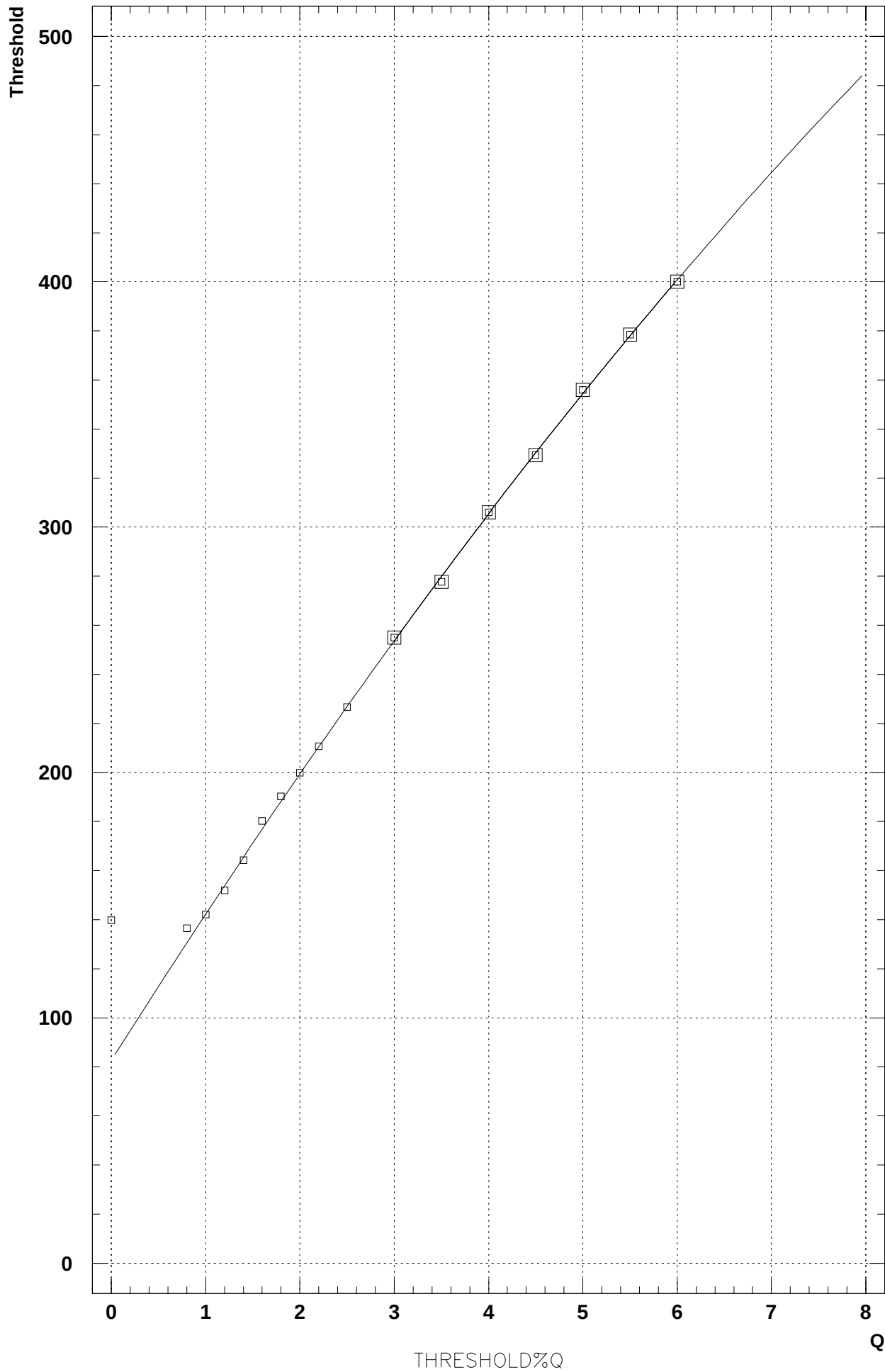
- **Summary**

- Lab calibration runs: Bias 150V (irrad 350V)
  - Scan points were fed into the thresholds of beamtest
- Later, fitted to a response curve and charge values are corrected
  - Scan points with larger markers were those used for the fit
- Det4(Mod4):
  - Threshold in (ABCD) mV
    - 640 (ABCD)mV~680 (CAFE)mV
  - open square (nominal scale)
  - filled square (KEK internal)
- Nominal charge scale: IDAR~300  $\mu\text{A}$  = 10 fC
  - KEK internal scale: IDAR~300  $\mu\text{A}$  ~ 7 fC

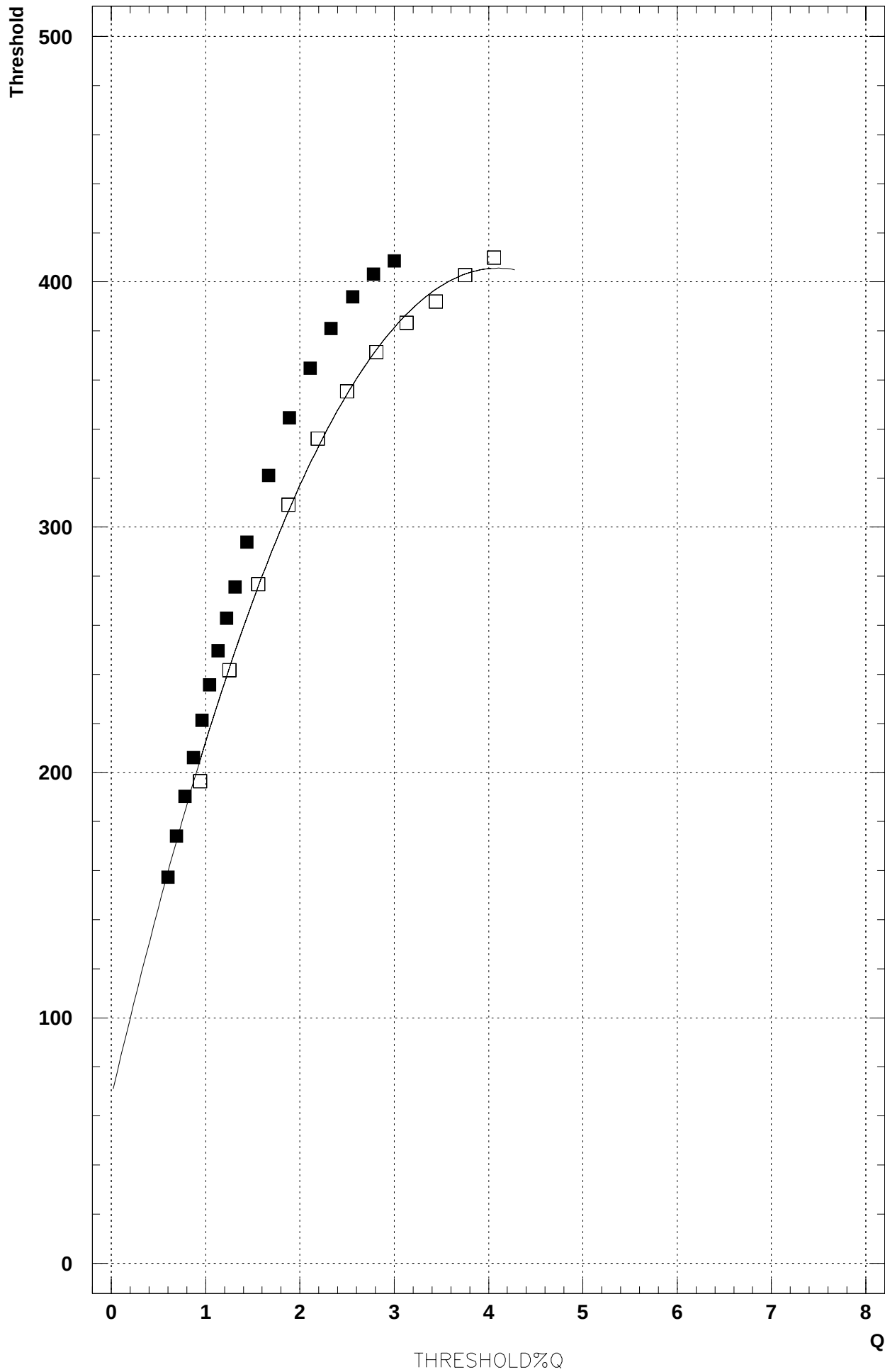
det0,det1,det2



# det3



# det4



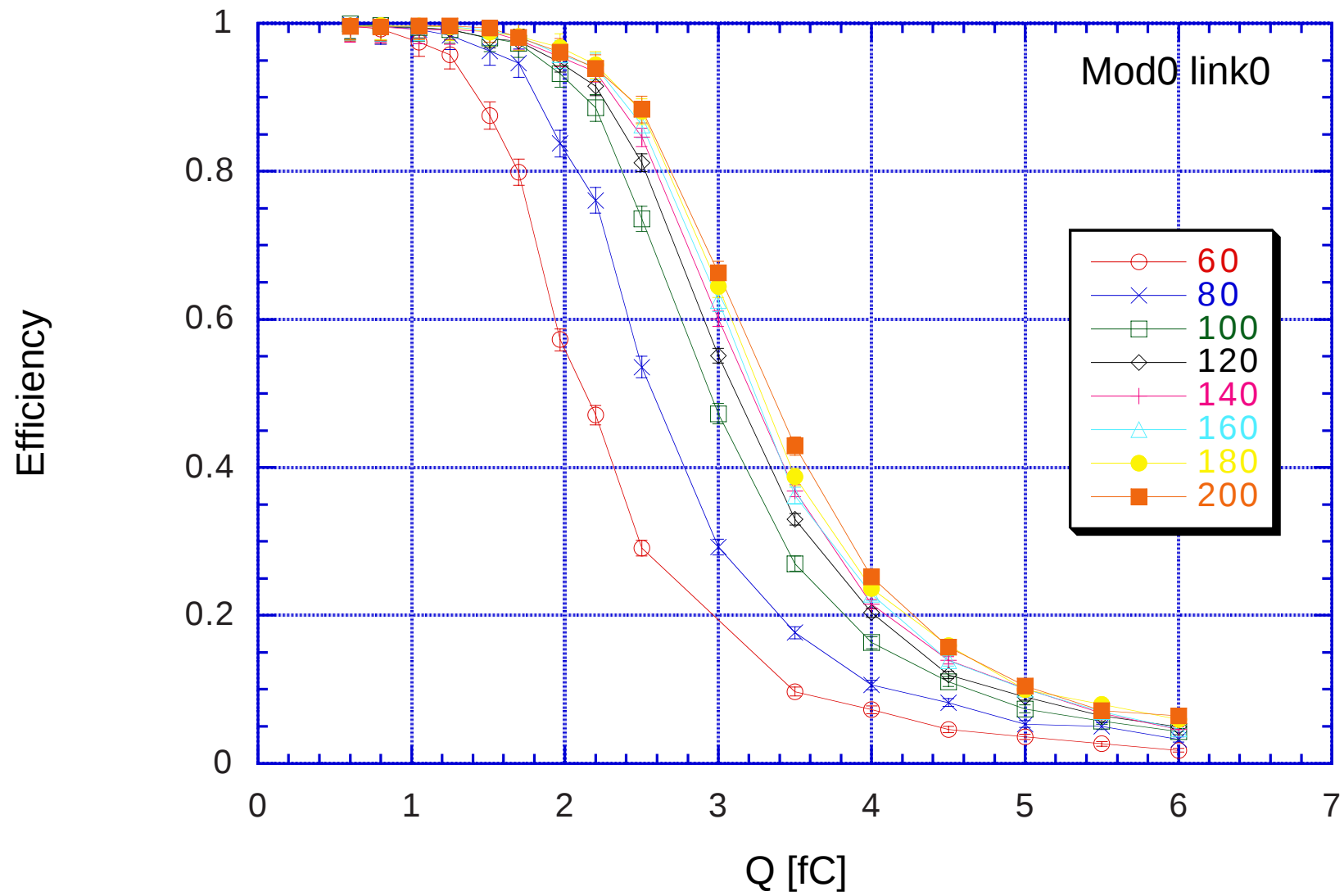
# Threshold scans

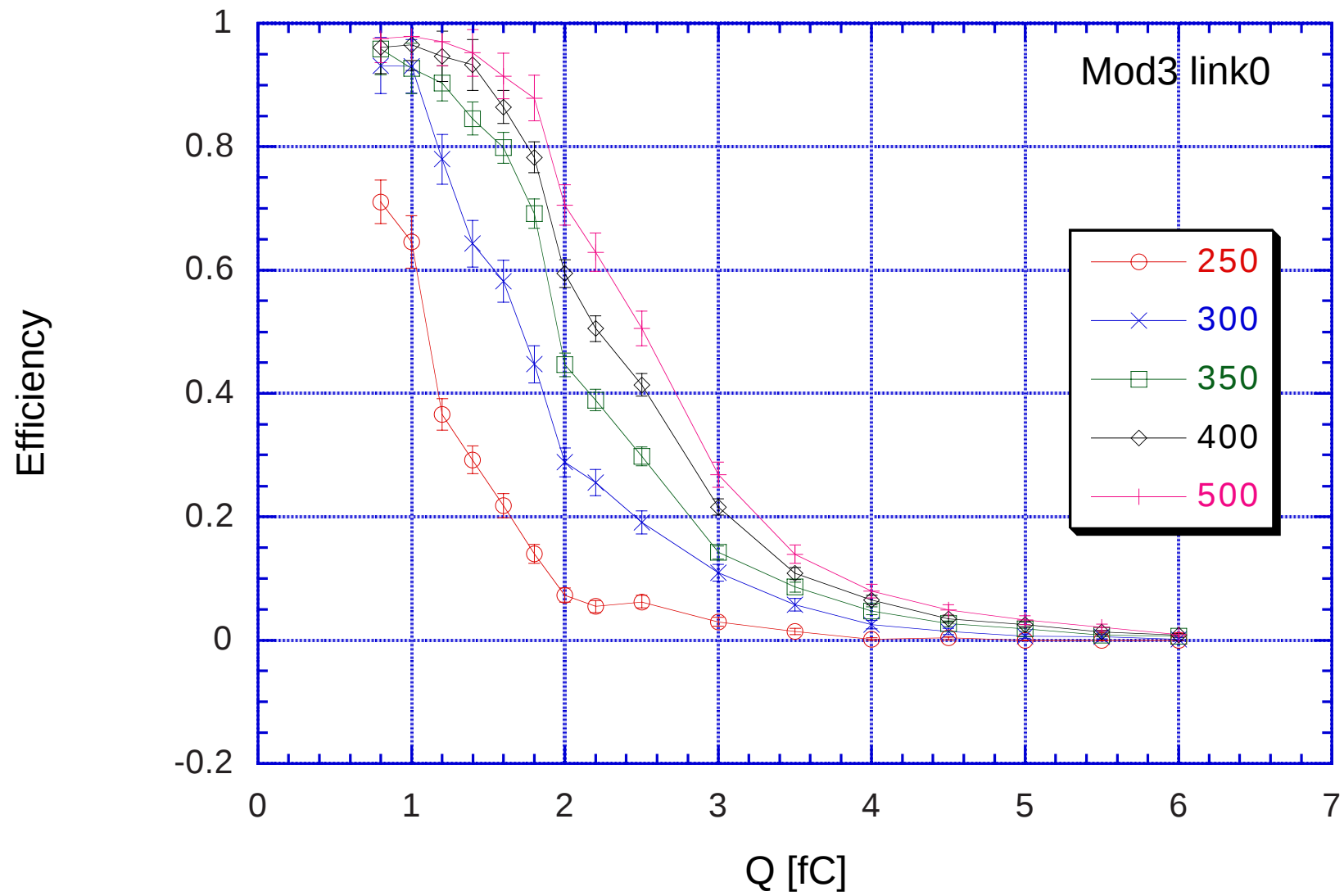
- **In beam**

- Scan points: typically, 0.8, 1.0,..., 2.2, 2.5, 3.0,..., 8.0 fC
- Bias voltages of 60, 80, 100, 120, 140, 160, 180, 200 V
- 5k events per point, several points in 10k or more
- low threshold points being re-calibrated after the calibration curve fit

- **Efficiency**

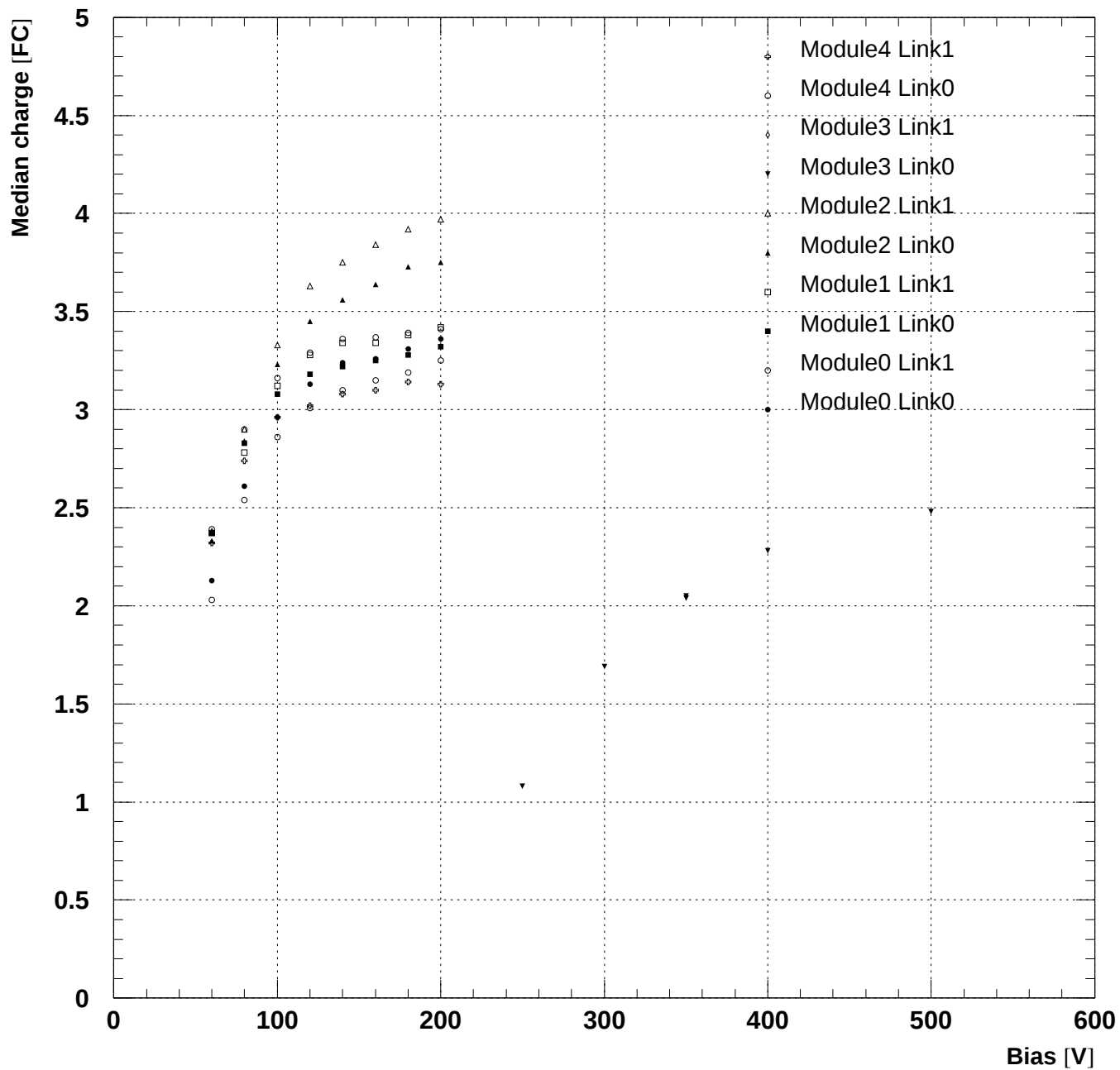
- Only correlation with anchor
- Rather wide window (but multiplicity was mostly single)
- In future, of course, with a track defined by telescope planes
- Fit to a modified Error function
  - Median charge = p1
  - Saturation = p3

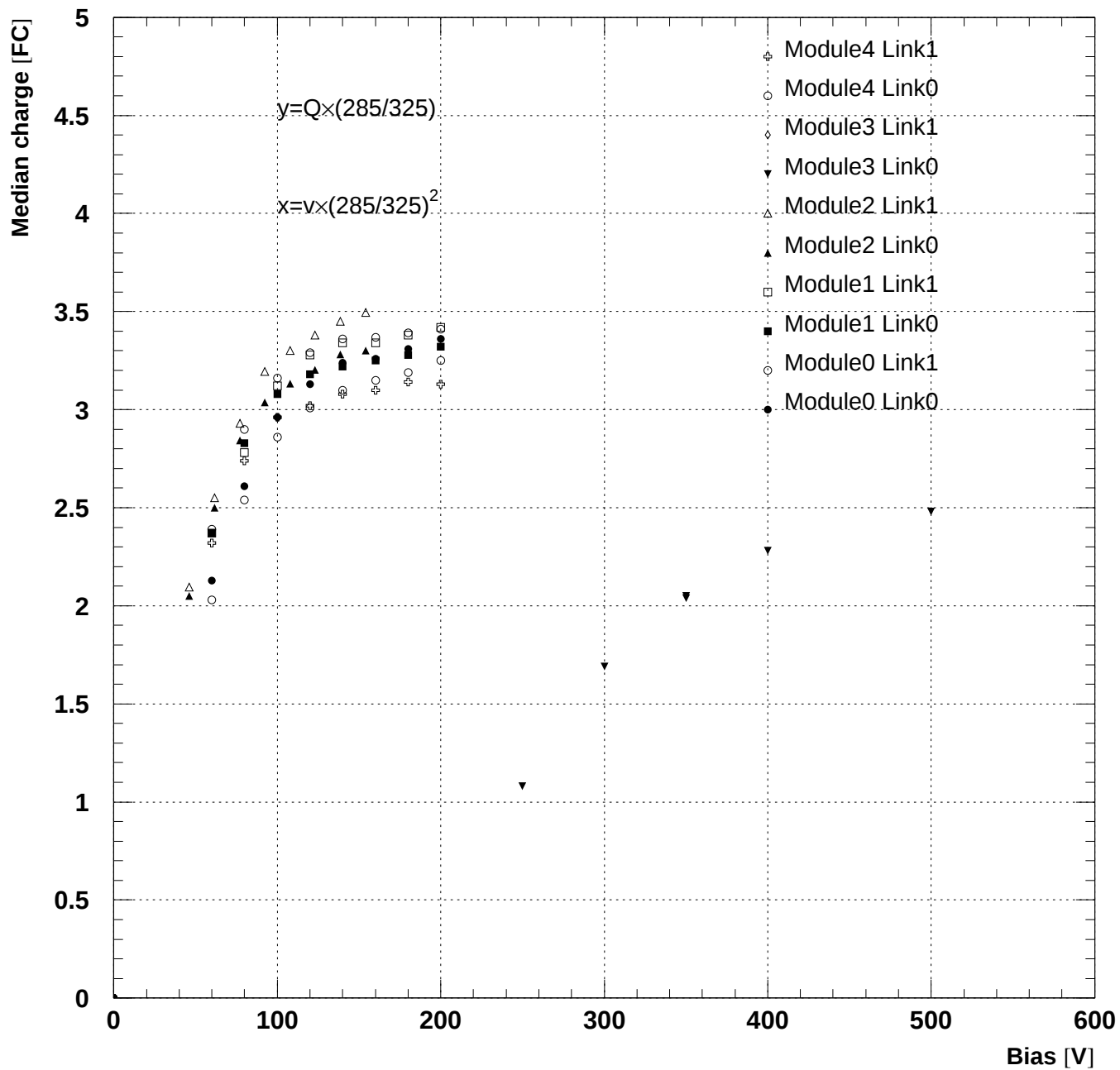




# Bias voltage dependence of median charges

- Charges of 50% efficiency derived from the fits
  - All 285  $\mu\text{m}$  detector modules saturate at about 3.3 fC
    - 325  $\mu\text{m}$  detector at about 3.8 fC, see renormalization
  - Saturation above 120 V
    - Required  $\sim 50\text{V}$  overdepletion to get full charge
  - CAFE/ABC nominal charge scale seems correct
- Mod2(325  $\mu\text{m}$ ) renormalization to thickness 285  $\mu\text{m}$ 
  - Bias voltage  $\propto (\text{Depletion thickness})^2$
  - Collected charge  $\propto \text{Depletion thickness}$
  - 
  - Bias voltage (285 $\mu$ ) =  $(285\mu/325\mu)^2 * \text{Bias voltage}(325\mu)$   
factor = 0.77
  - Median charge (285 $\mu$ ) =  $(285\mu/325\mu) * \text{Median charge}(325\mu)$   
factor = 0.88
  - Saturation at about 3.4 fC at  $\sim 130\text{ V}$





# Noise occupancy

- **Hit strip counts**

- Outside of the efficiency window

efficiency window:  $\pm 250 \mu\text{m}$  from the expected track

Outside = 2 x efficiency window

- **Noise occupancy**

- $1.35 \times 10^{-3}$  @ 3sigma

- $3.17 \times 10^{-5}$  @ 4sigma

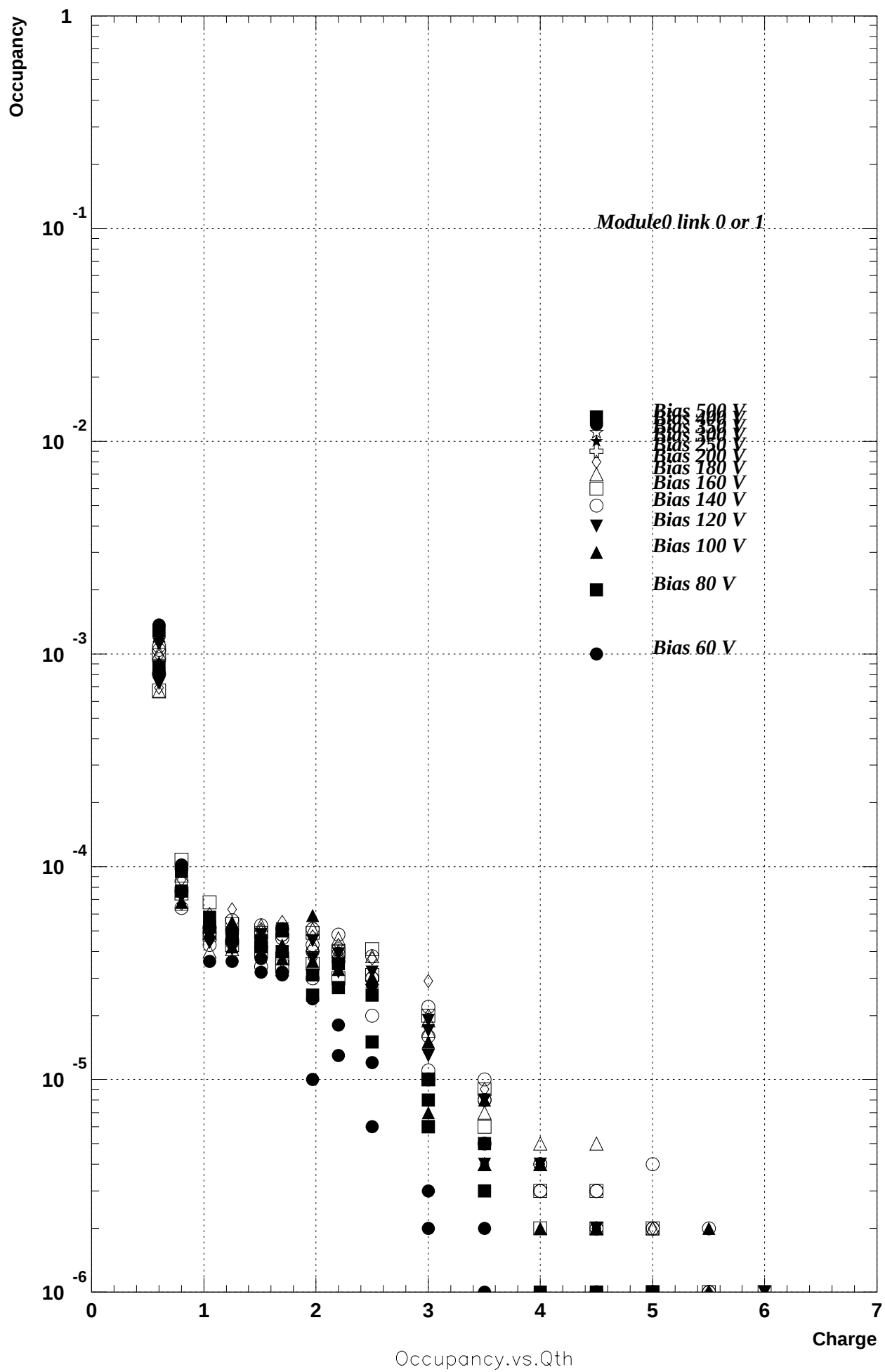
$$1 \text{ fC} = 6250 \text{ e}$$

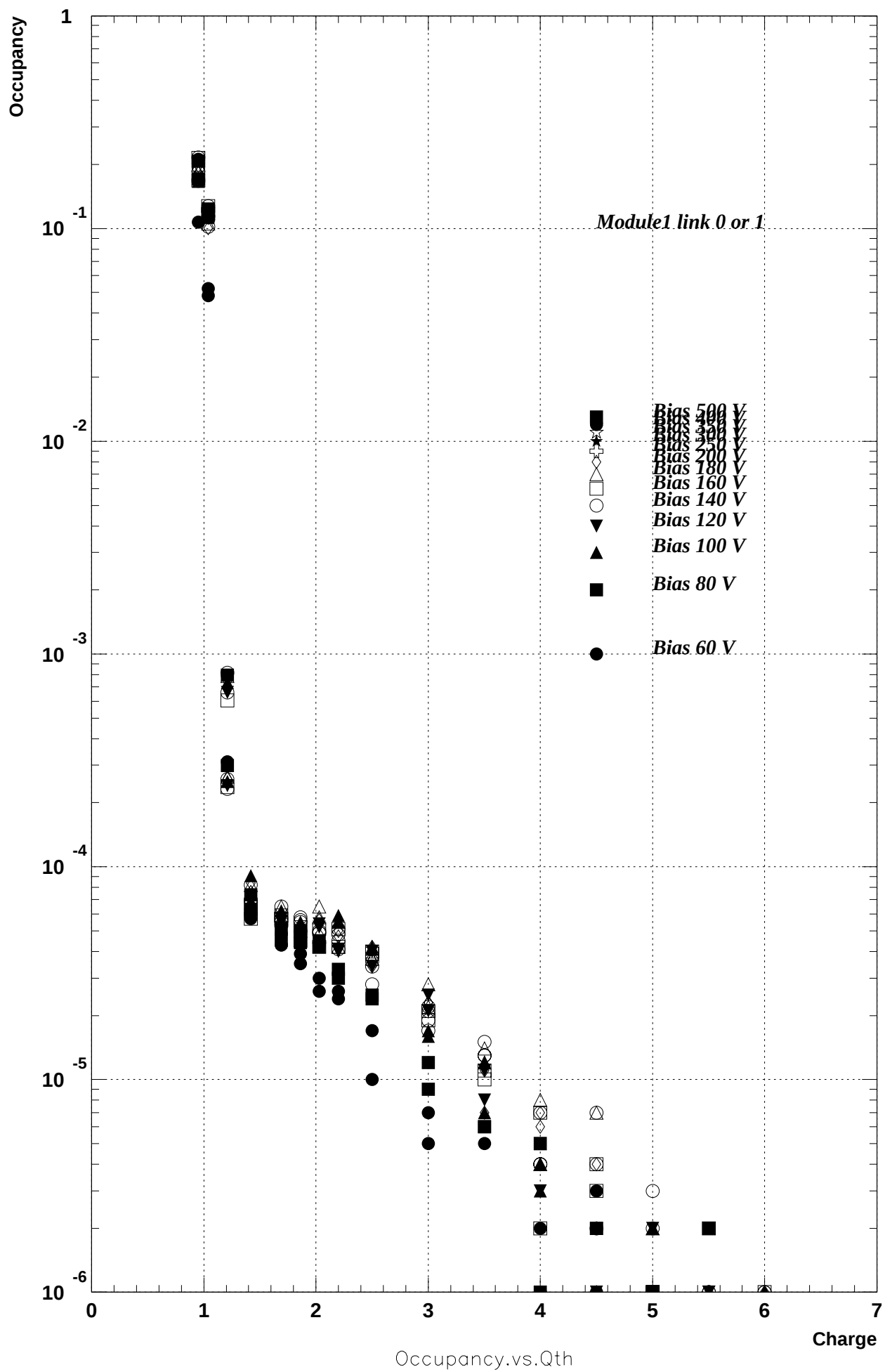
- If 4 sigma = 0.8 ~ 1.0 fC, then

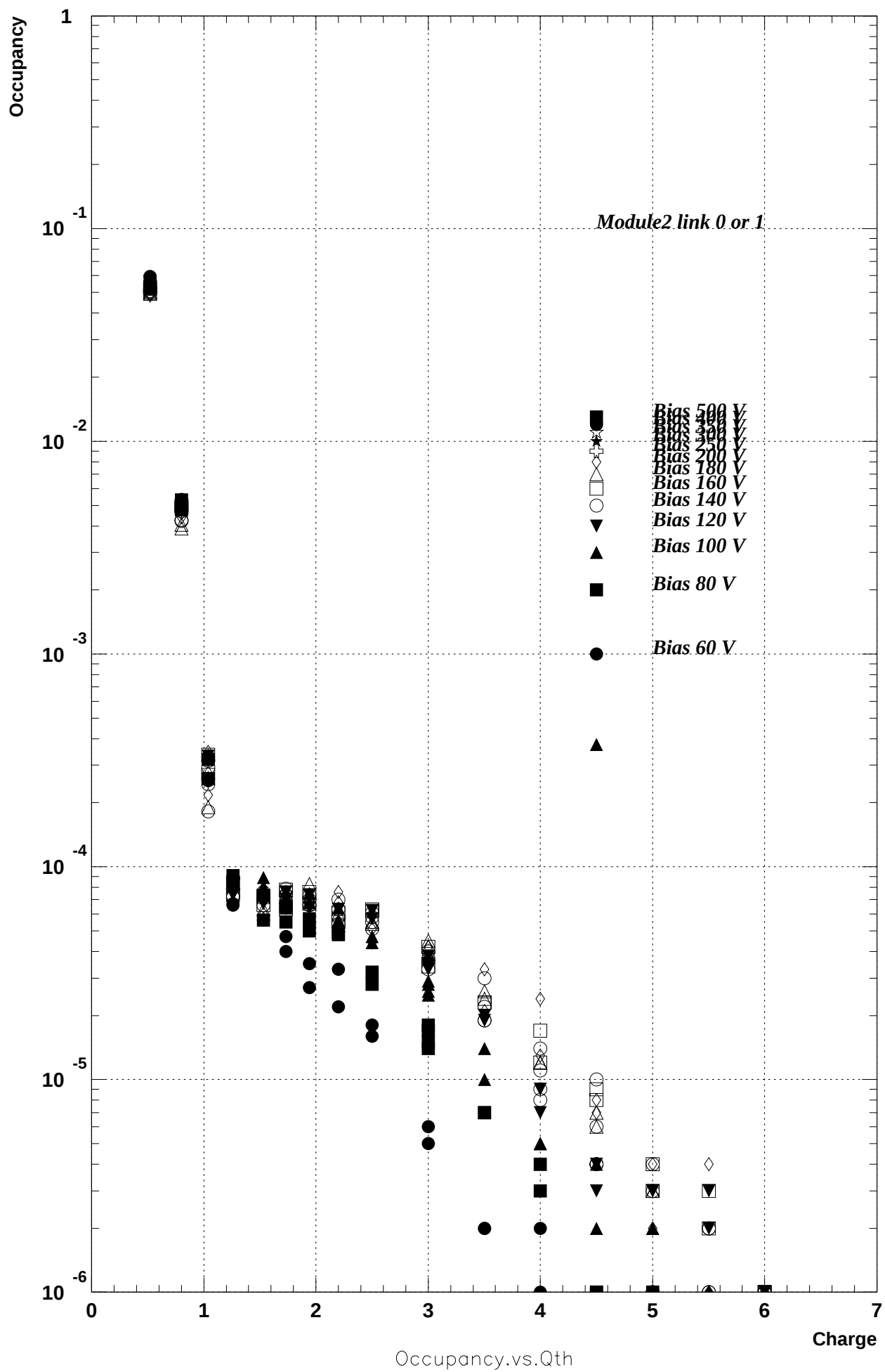
$$\text{sigma} = 1250 \sim 1560 \text{ e}$$

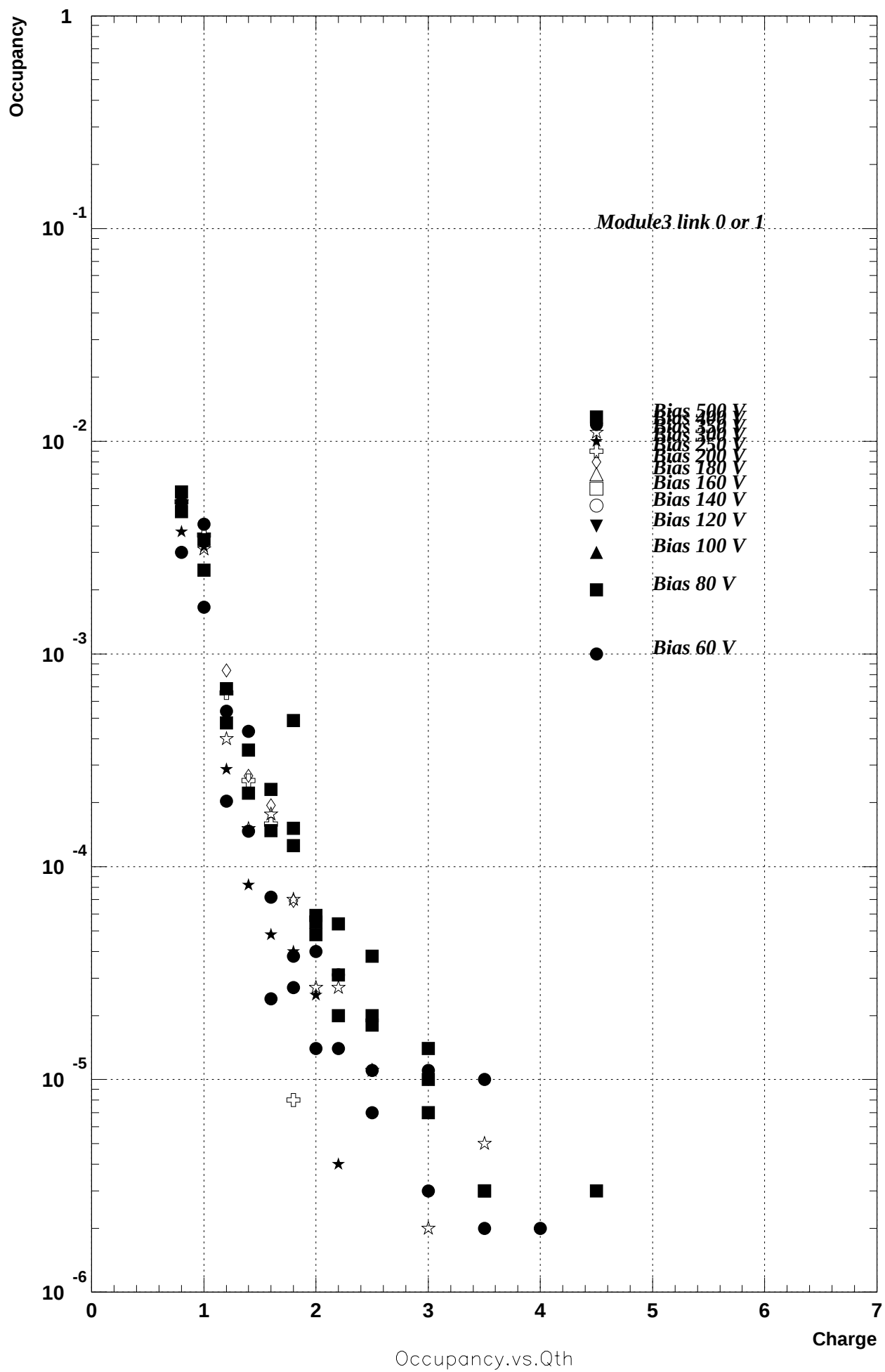
- **Notes:**

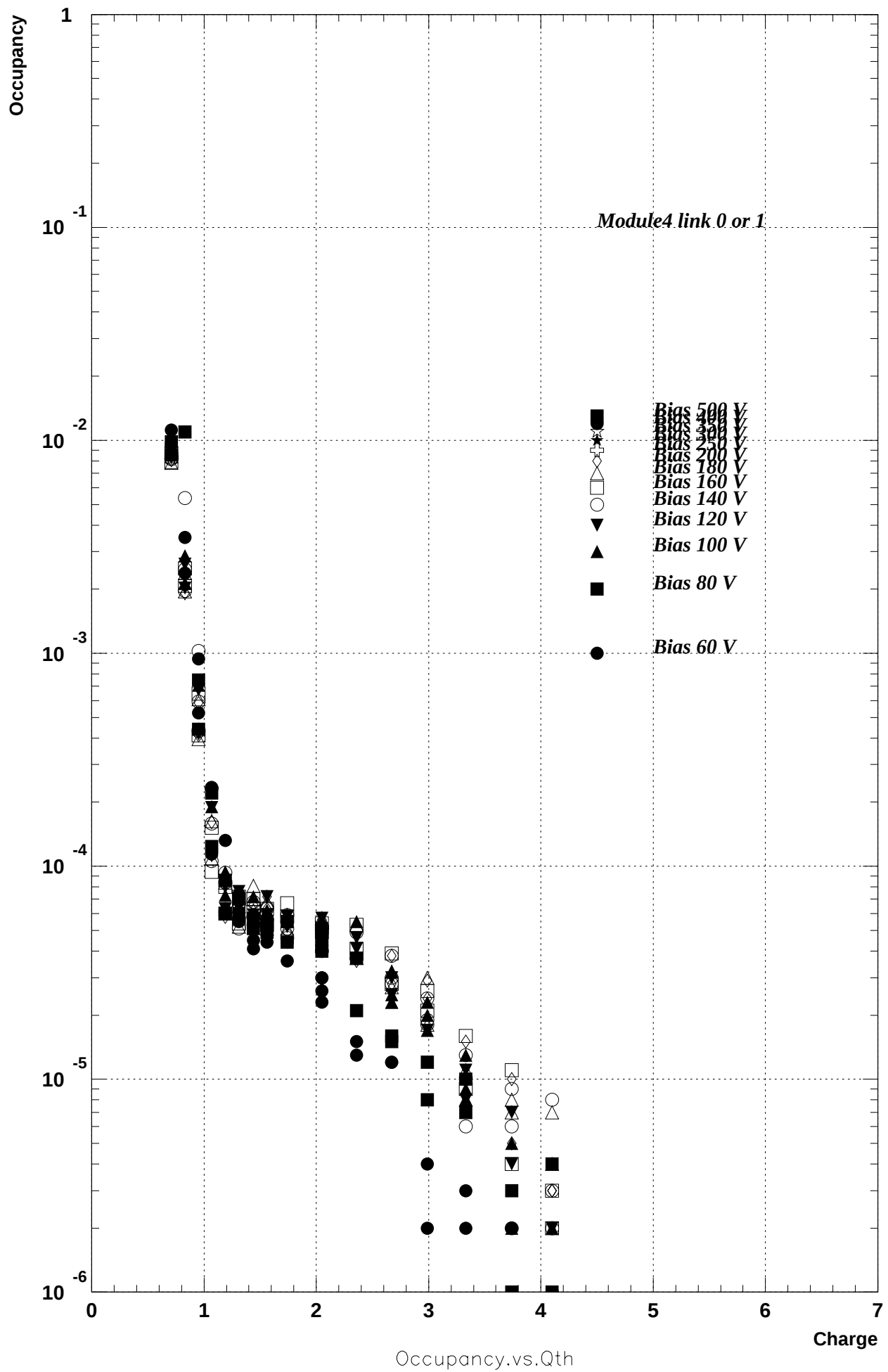
- There is systematic ambiguity of at most 0.2 fC in the charge near the 1fC threshold











# Summary

- **Dec 99 beamtest at KEK was carried out successfully**
  - with a new PC-based SCTDAQ
  - 4 ABCD2T and 1 CAFE/ABC modules
- **Reasonable behaviours of median charges**
  - Saturation above 120 V
  - Saturation at 3.3 fC for 285  $\mu\text{m}$  thickness
  - Irradiated sensor saturated at 2.5 fC -- Strange!?
- **ASIC/hybrid/Module performance (Preliminary)**
  - ABCD2T
    - Same performance in lab and beam
    - noise~ 1450 e (module)
  - CAFE/ABC
    - Noise ~ 1550 e (module, -10 °C)