

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

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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**

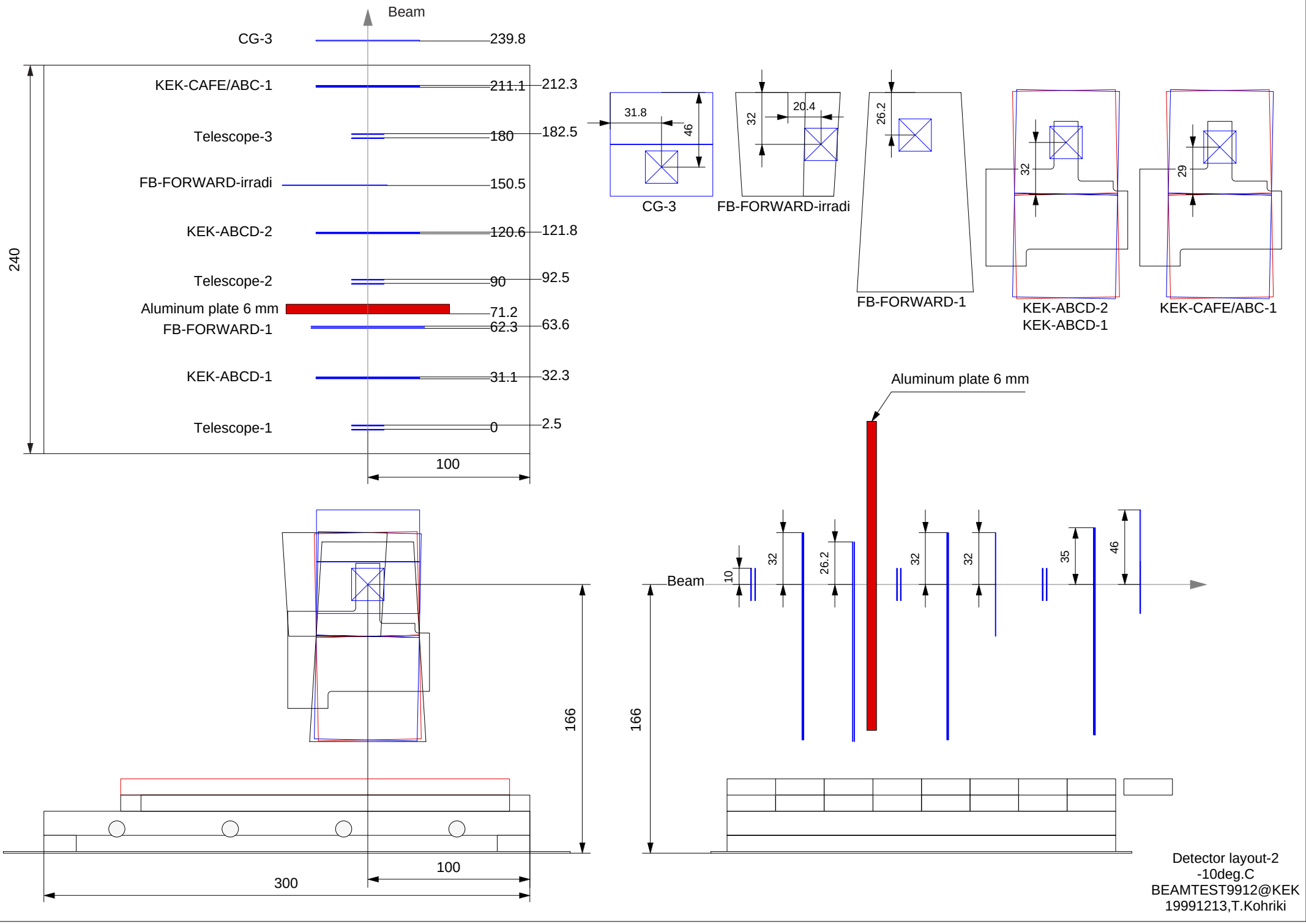
- π^2 beamline in the 12 GeV PS at KEK, 4 GeV/c π^-
- **Participants:**
 - Domestic = Y. Unno, Y. Ikegami, T. Kohriki, +6~9 students
 - Abroad = G. Moorhead, K. Runge, J. Ludwig, Z. Dorazel
- Photo's out of the beamtest

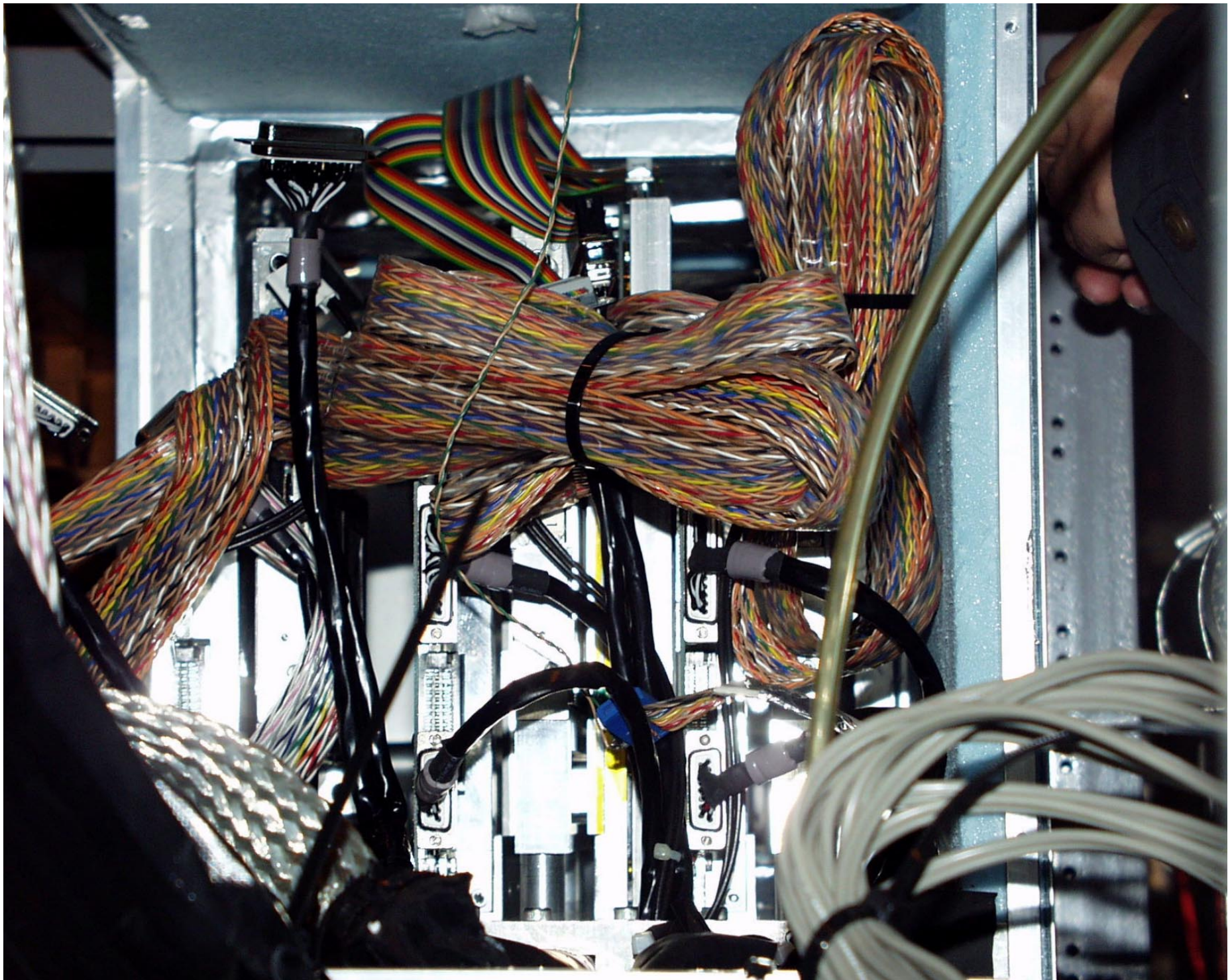
- **DUT's: 4 full modules + 1 irradiated det-module**

- Module 0: KEK-ABCD#1 , 12 chips, 285 um, trim 2 fC to 200 mV
- Module 1: FR-ABCD, 12 chips, 285 um, trim 2 fC to 200 mV
- Module 2: KEK-ABCD#2, 12 chips, 325 um, no trim
- Module 3: FR-irrad det-ABCD, 2 chips, 285 um, trim 2fC to 200 mV
- Module 4: KEK-CAFE/ABC, 12 chips, 285 um
- 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**

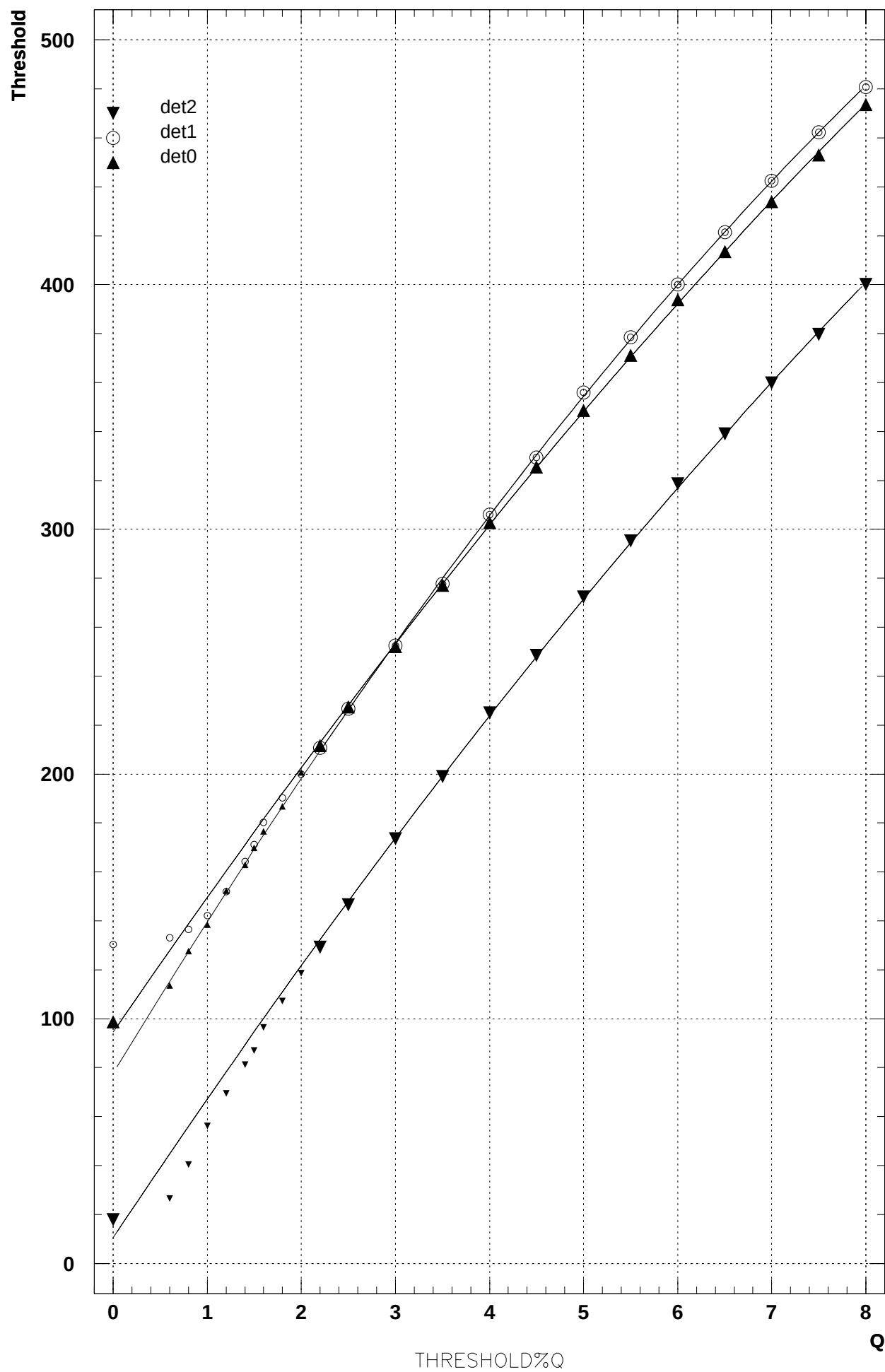
- Setup of -10 °C
- Setup of +10 °C

Calibrations

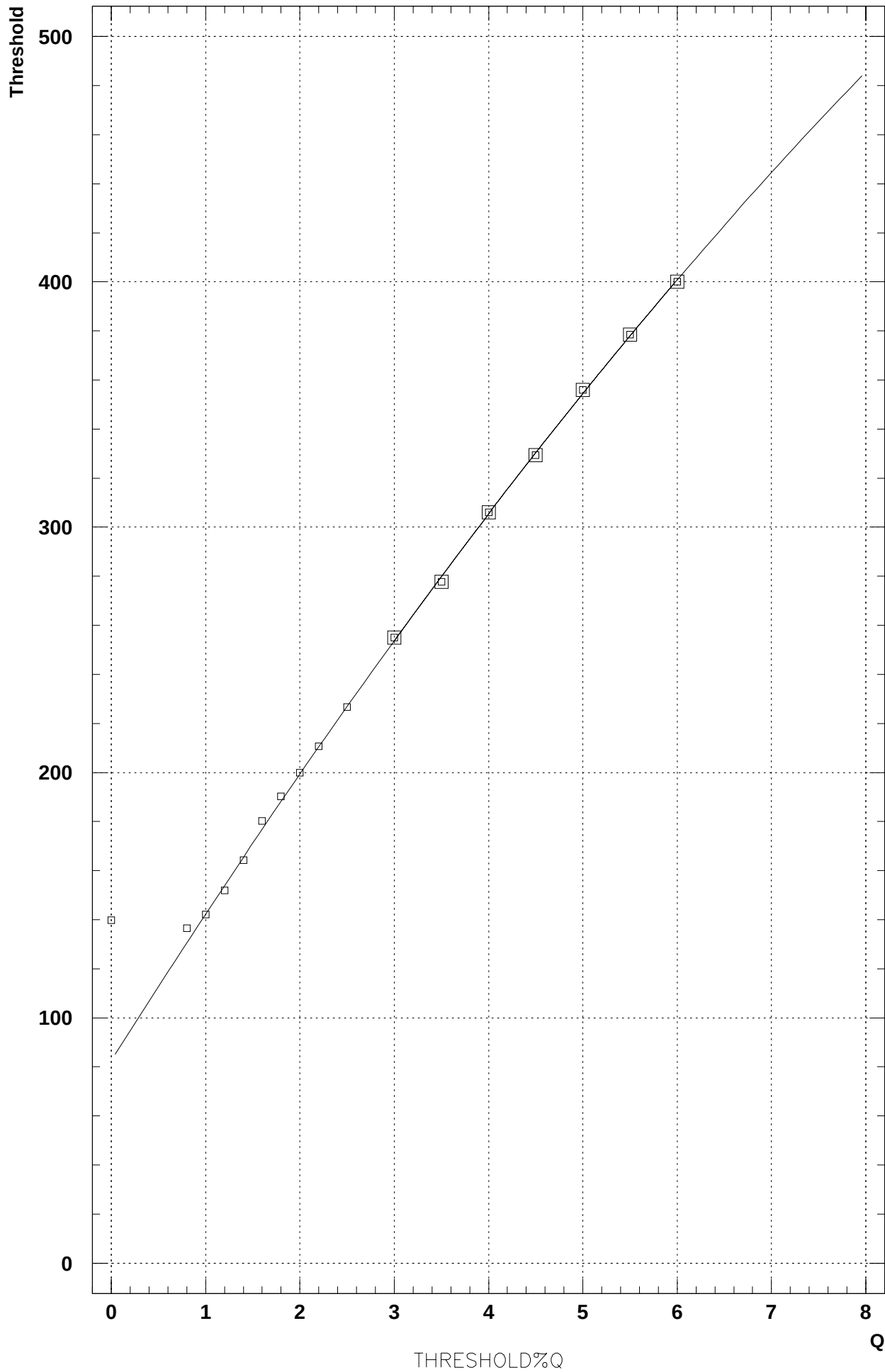
- **Summary**

- 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 μA = 10 fC
 - KEK internal scale: IDAR~300 μA ~ 7 fC

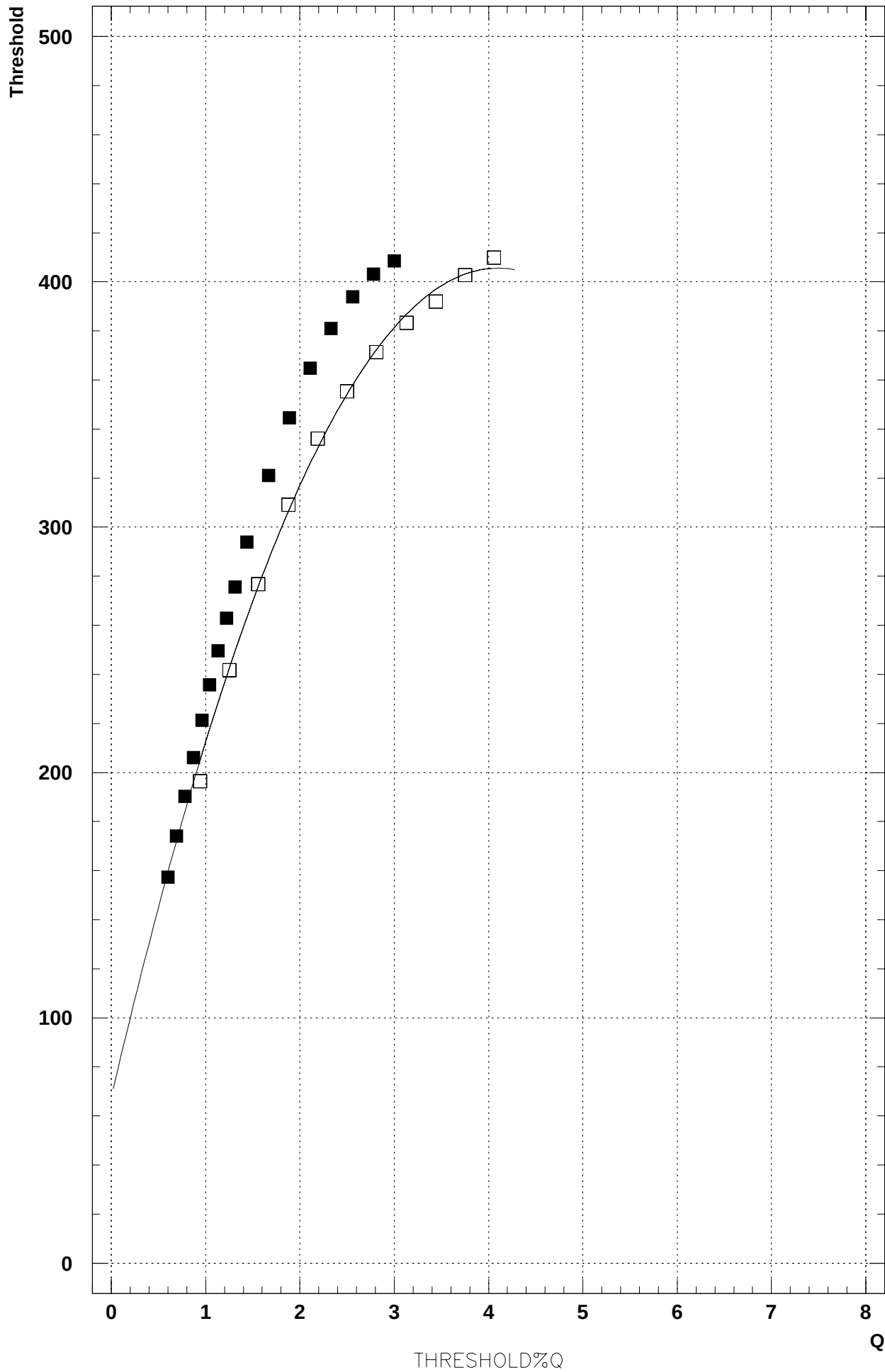
det0,det1,det2



det3



det4



Threshold scans

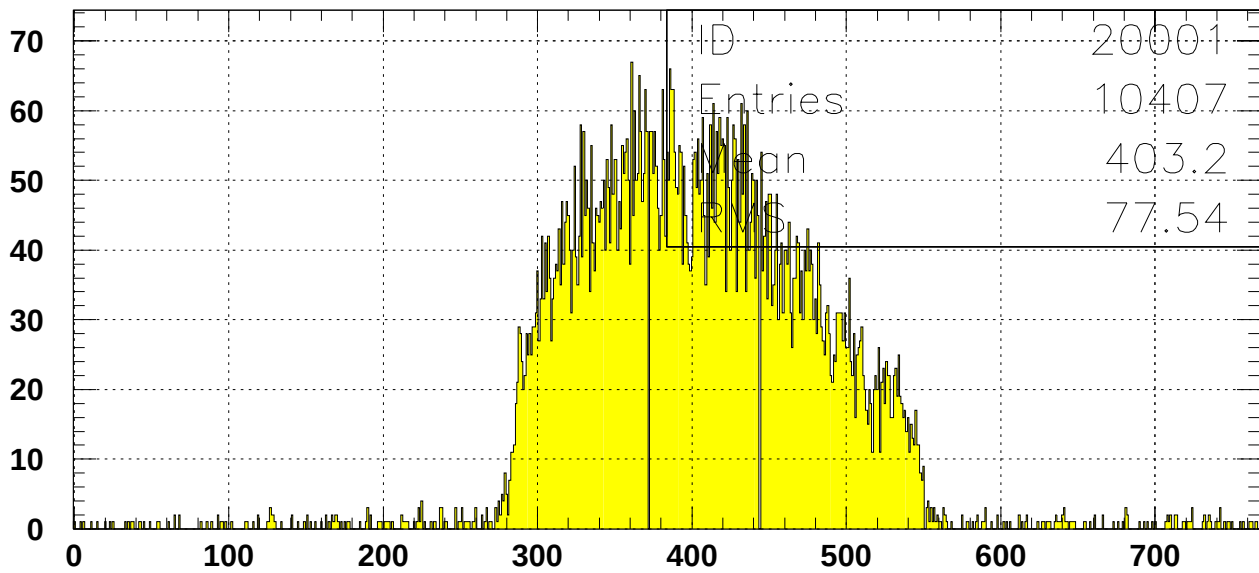
- **In beam**

- 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

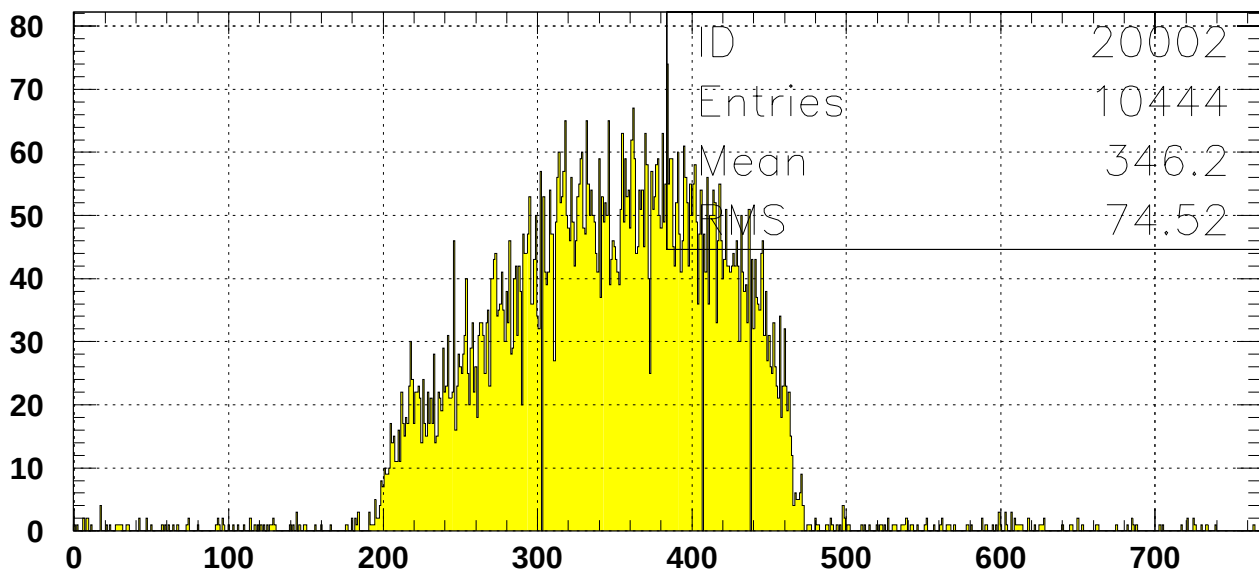
- **Efficiency**

- 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

Hit map (KEK3103 : 120V, 1.2fC)

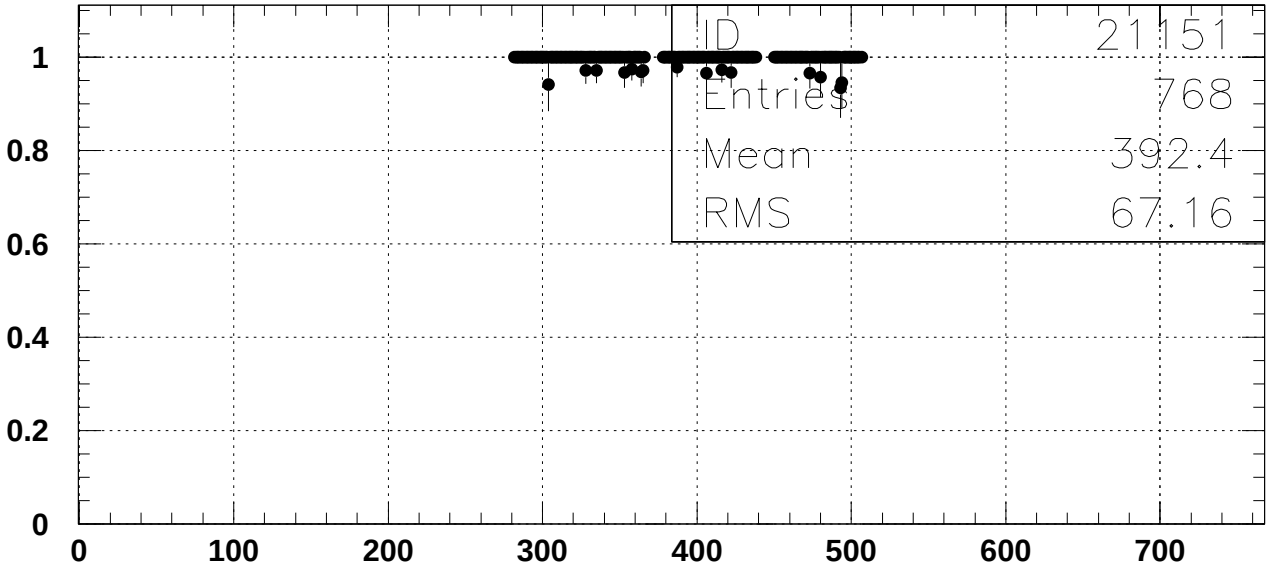


Mod0s0 hitmap (channel)

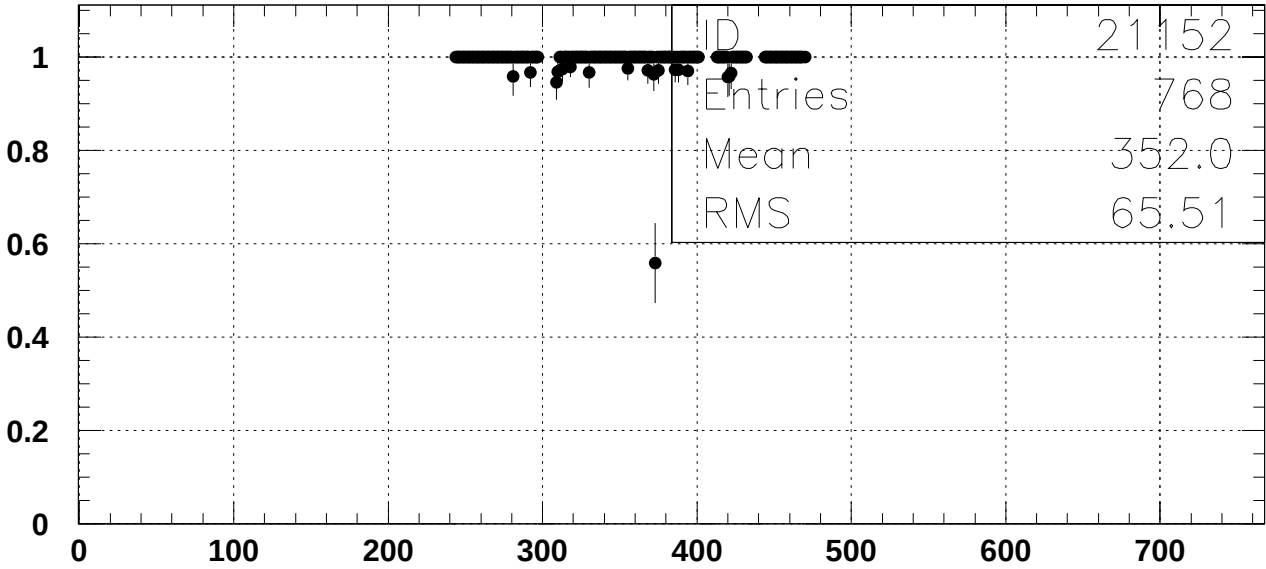


Mod0s1 hitmap (channel)

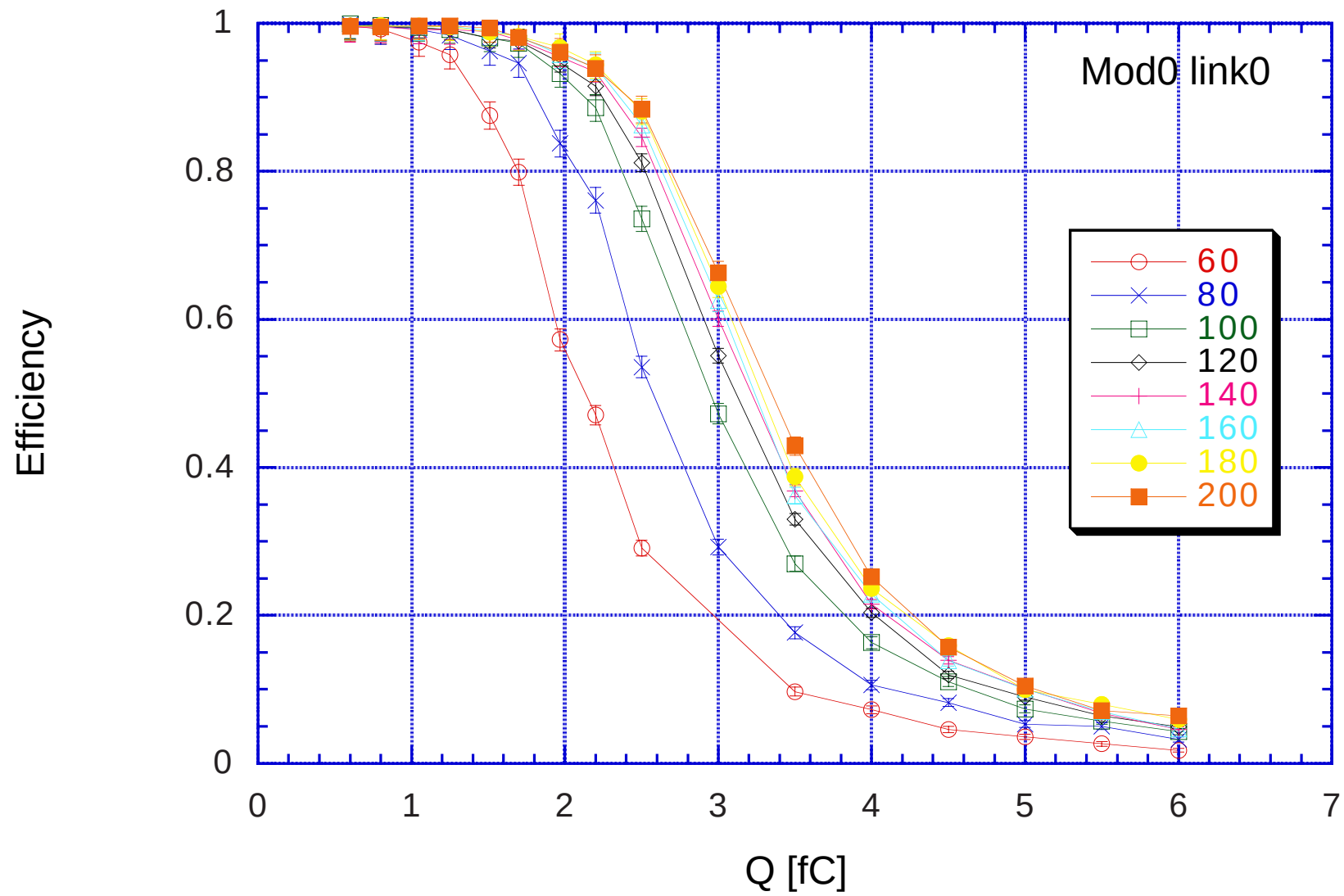
Efficiency (KEK3103 : 120V, 1.2fC)

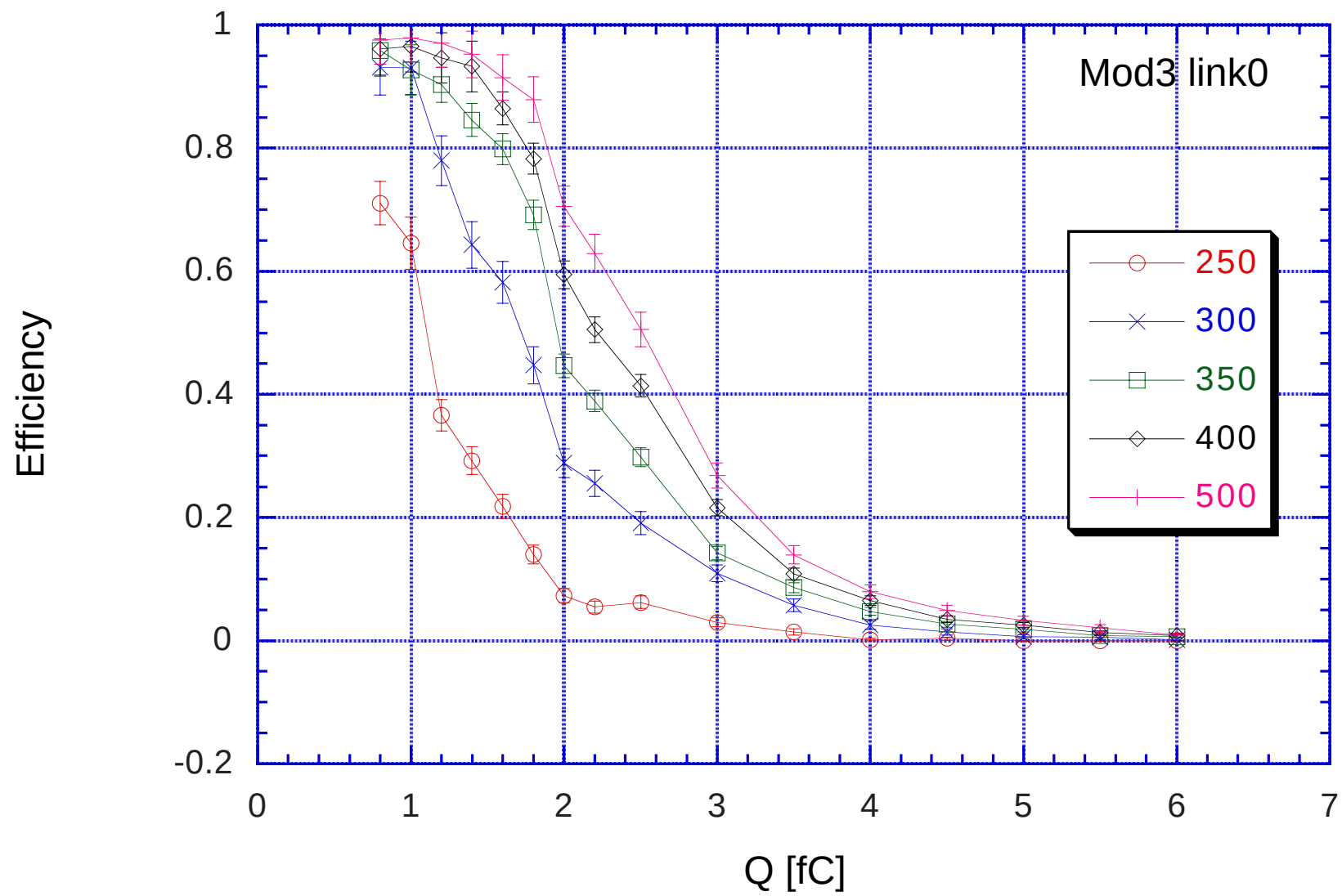


Efficiency in strip (Mod0s0)



Efficiency in strip (Mod0s1)

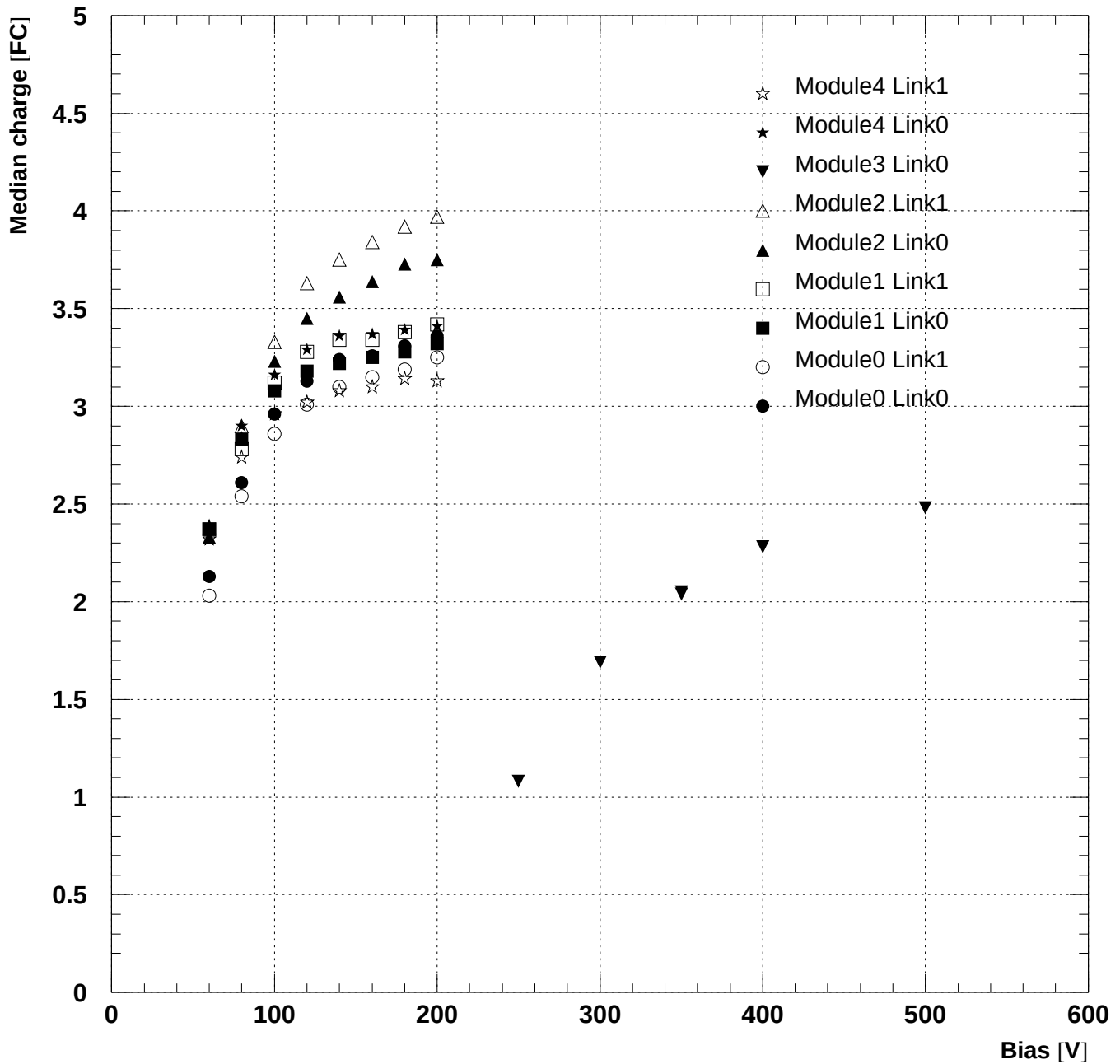




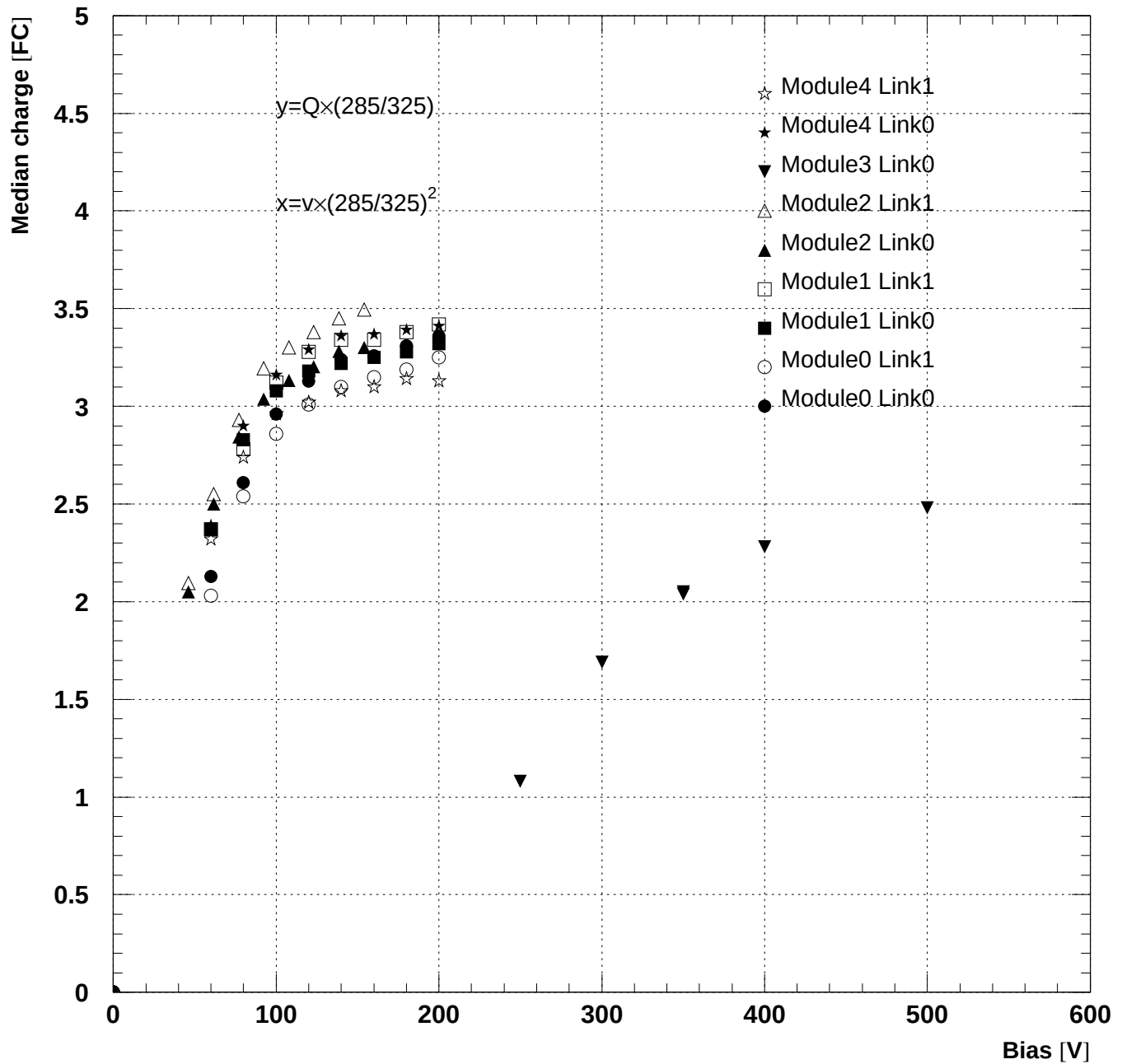
Bias voltage dependence of median charges

- Charges of 50% efficiency derived from the fits
 - All 285 μm detector modules saturate at about 3.3 fC
 - 325 μm 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 μm) renormalization to thickness 285 μm
 - Bias voltage $\propto (\text{Depletion thickness})^2$
 - Collected charge $\propto \text{Depletion thickness}$
 -
 - Bias voltage (285 μ) = $(285\mu/325\mu)^2 * \text{Bias voltage}(325\mu)$
factor = 0.77
 - Median charge (285 μ) = $(285\mu/325\mu) * \text{Median charge}(325\mu)$
factor = 0.88
 - Saturation at about 3.4 fC at $\sim 130\text{ V}$

Bias Dependence (Mod2 Before correction)



Bias Dependence (Mod2 After correction)



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

- One time bin, either “100” or “001”

ABCD beam timing = 010, CAFE/ABC=100

- **Noise occupancy**

- 1.35×10^{-3} @ 3sigma

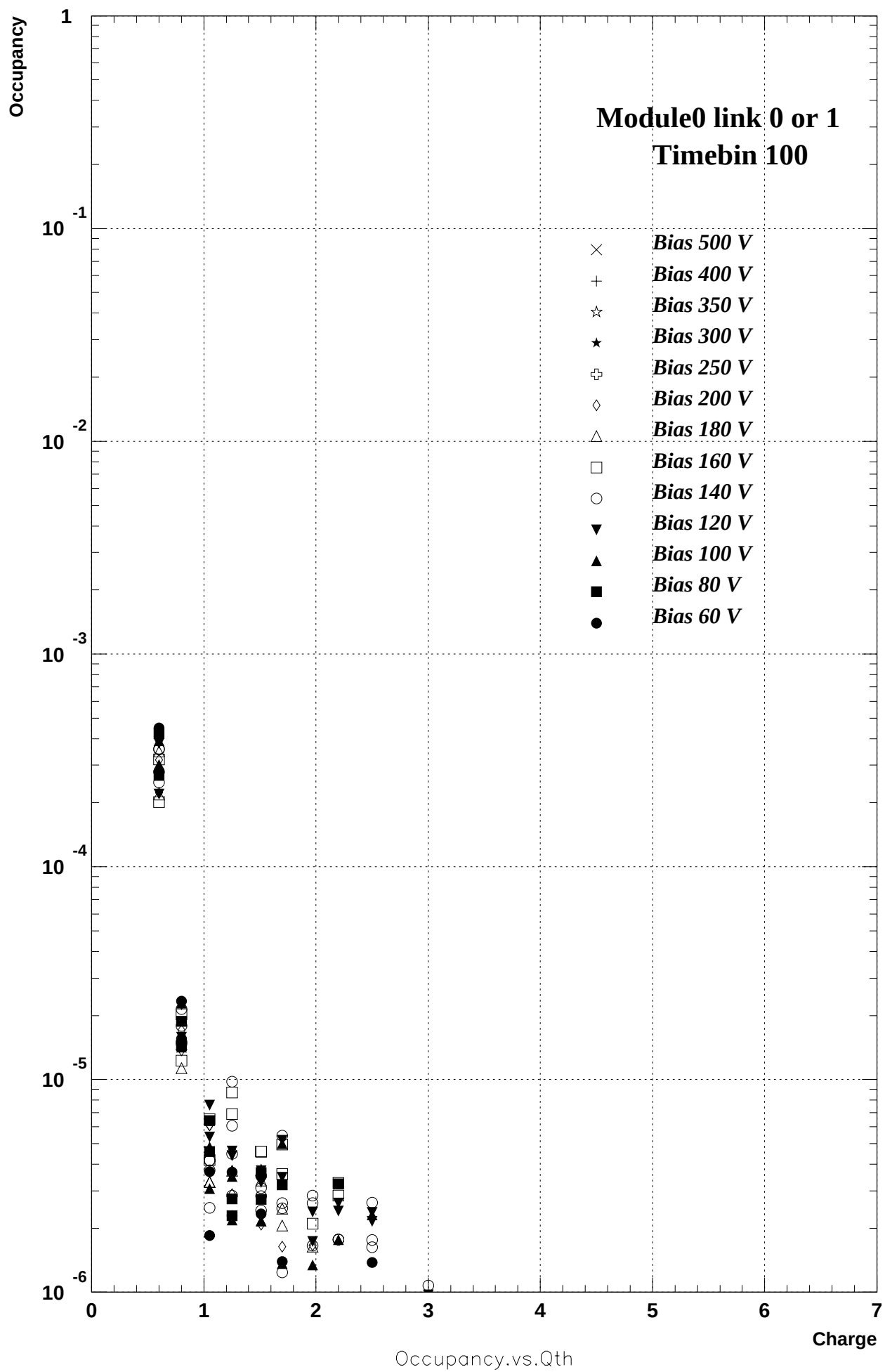
- 3.17×10^{-5} @ 4sigma

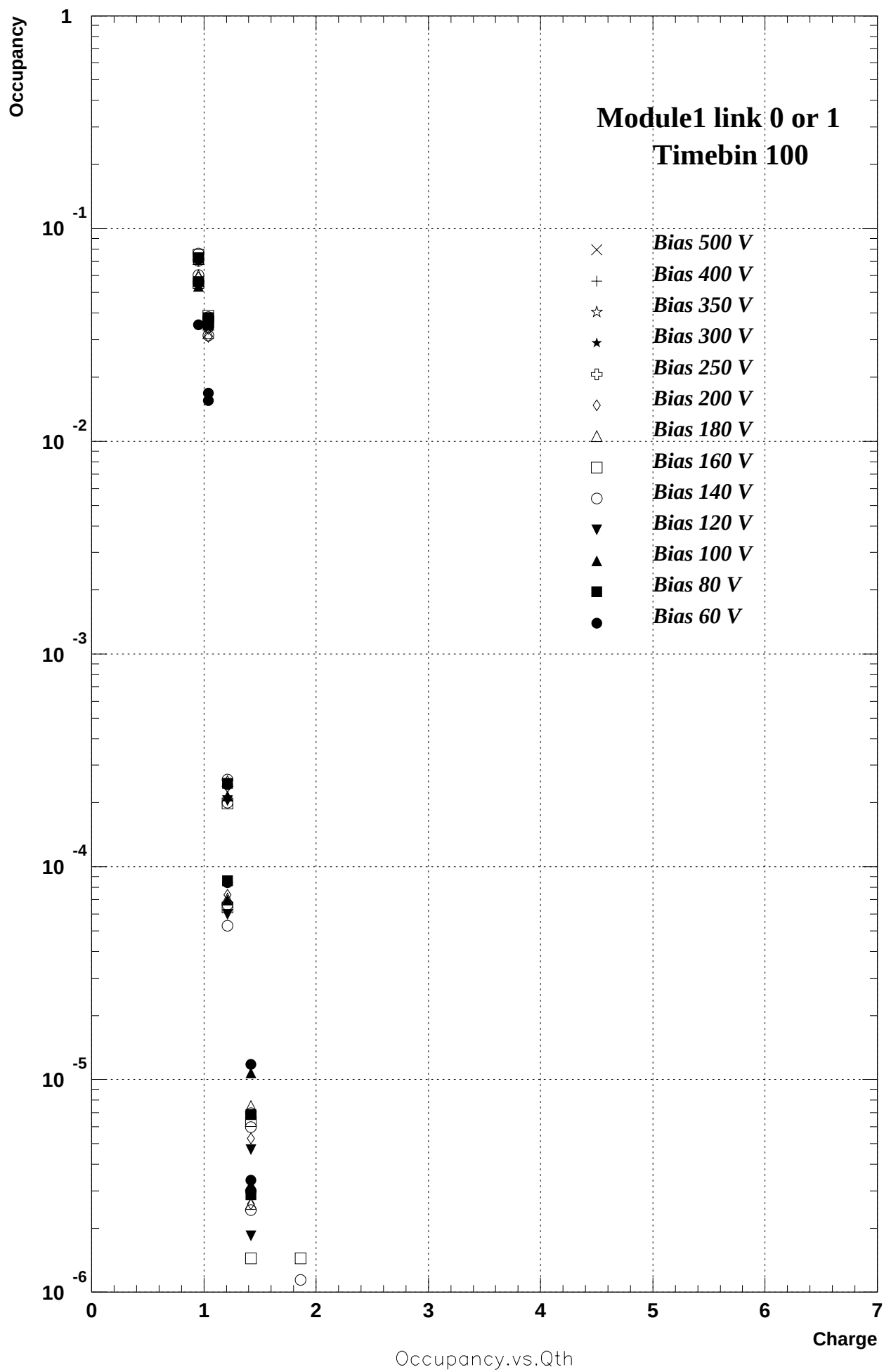
1 fC = 6250 e

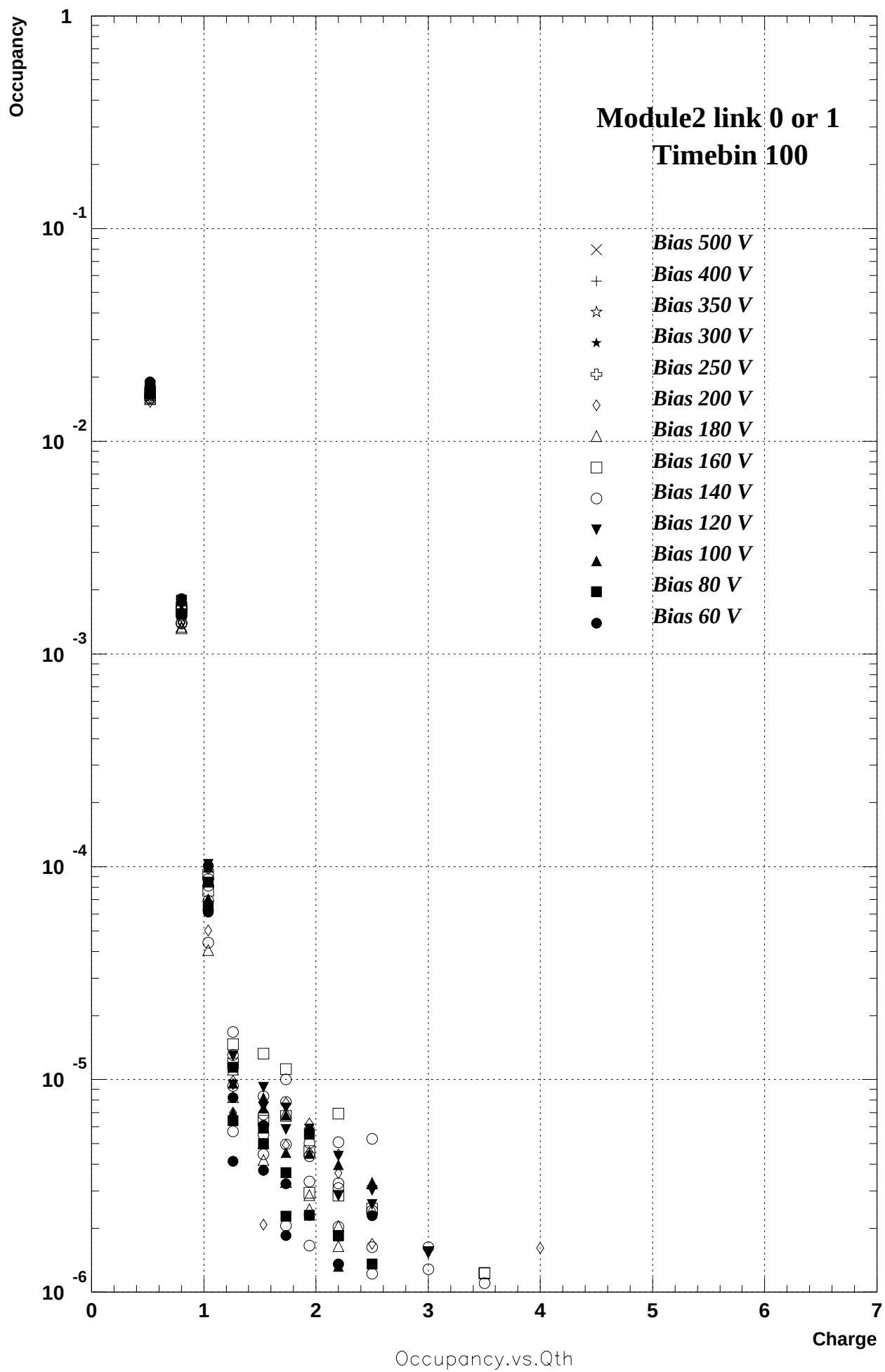
- If 4 sigma = 0.8 ~ 1.0 fC, then sigma = 0.2 ~ 0.25 fC, i.e.,
sigma = 1250 ~ 1560 e

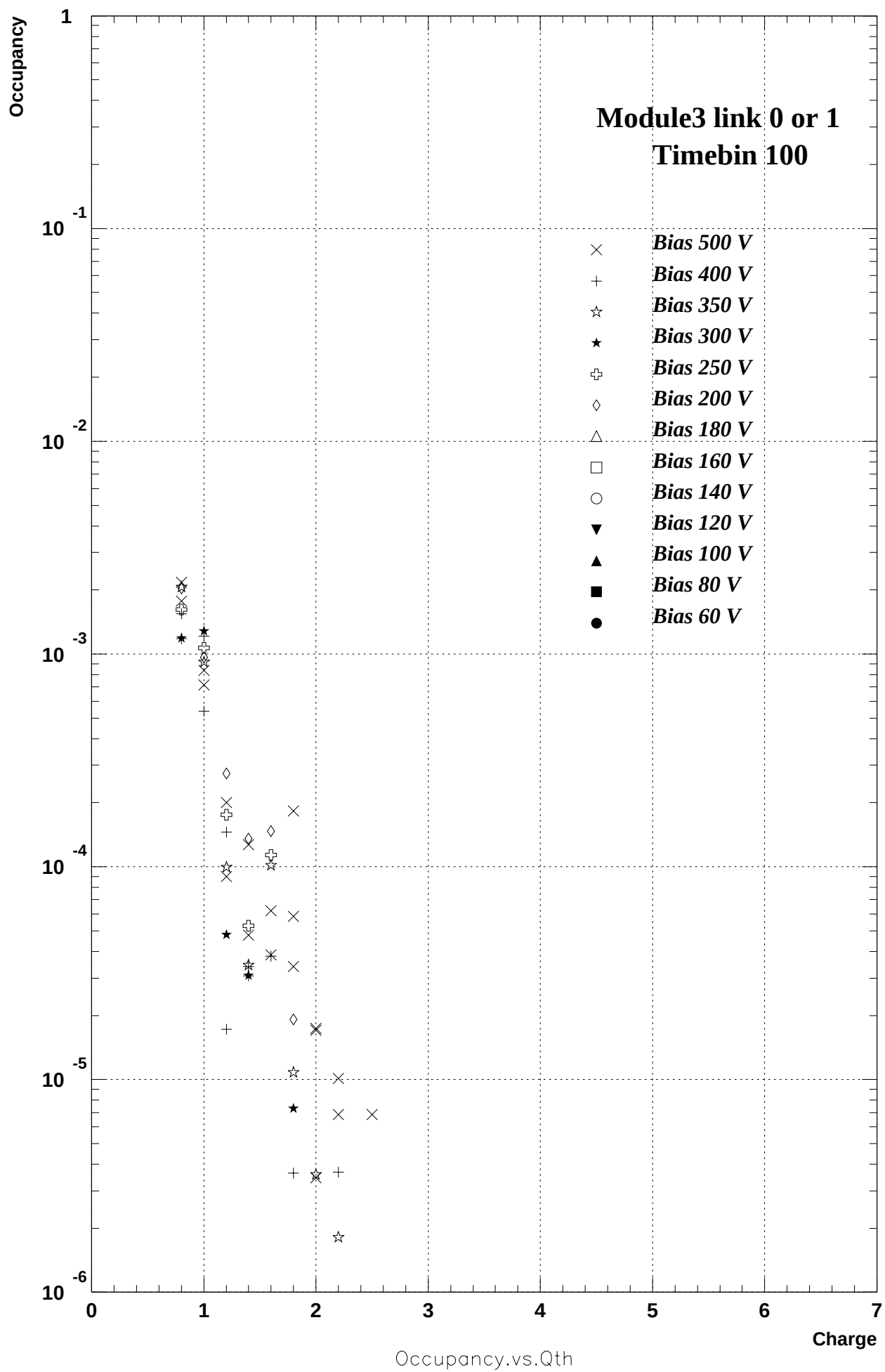
- **Notes:**

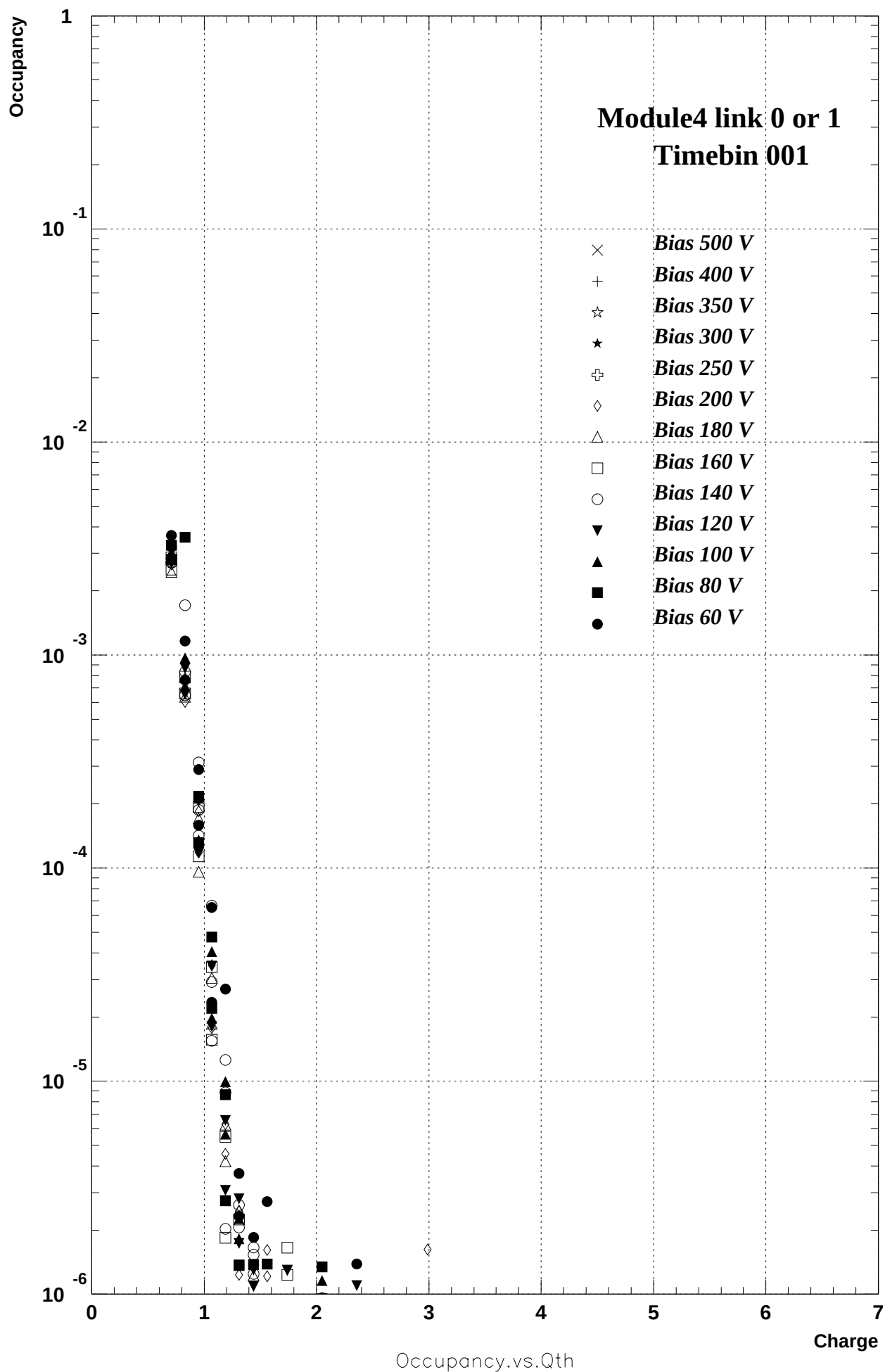
- There is systematic ambiguity of at most 0.2 fC in the charge near the 1fC threshold











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 μm 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 charge inj. calibration)
 - CAFE/ABC
 - Noise ~ 1550 e (module charge inj. cal., -10 °C)