

# **Beamtest of ABCD2T and CAFE/ABC modules at KEK**

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- **Dec99 beamtest at KEK (T450)**
- **Calibrations**
- **Threshold scans**
- **Bias voltage dependence of median charge**
- **Noise occupancy**
- **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. Dolezal**

**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=200 mV**

**Module 1: FR-ABCD, 12 chips, 285 um, trim 2 fC=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=200 mV**

**Module 4: KEK-CAFE/ABC, 12 chips, 285 um**

**Module 5: CG3, anchor**

- **Run conditions:**

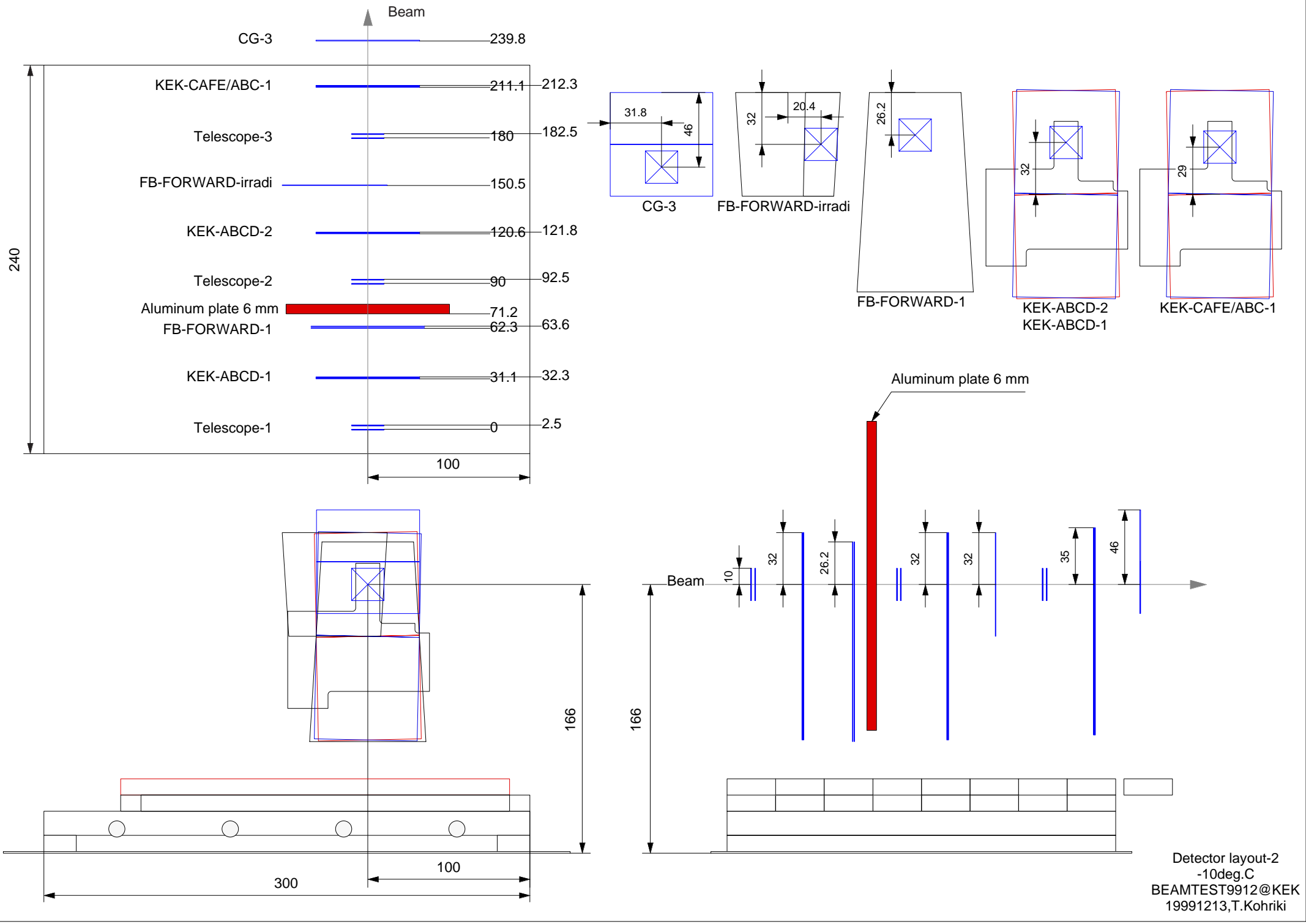
**Edge detection=ON, Mode=Any hits**

**2cm x 2cm triggered region with 3 planes of scintillator**

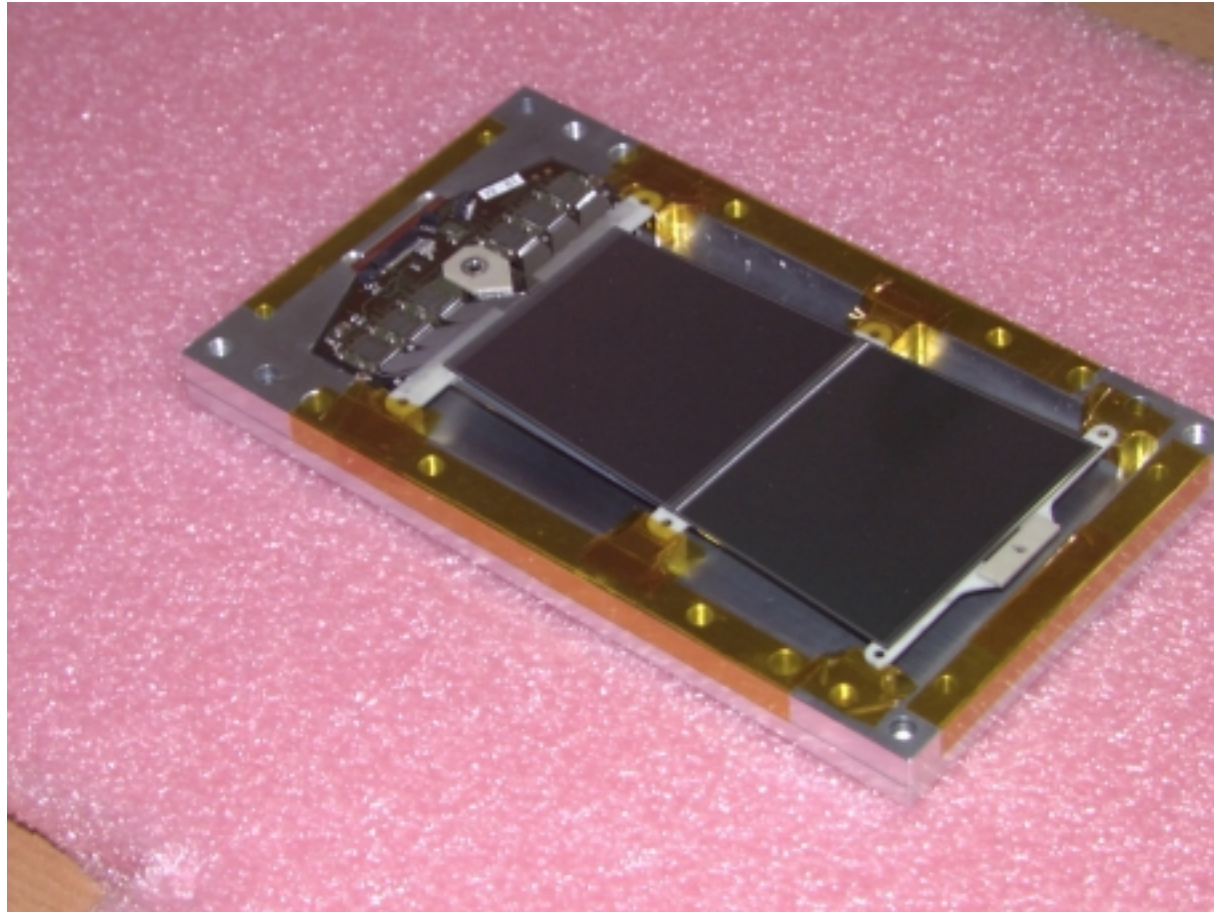
**Two temperatures: +10, and -10 °C**

**+10 °C = Mod0, Mod1, Anchor**

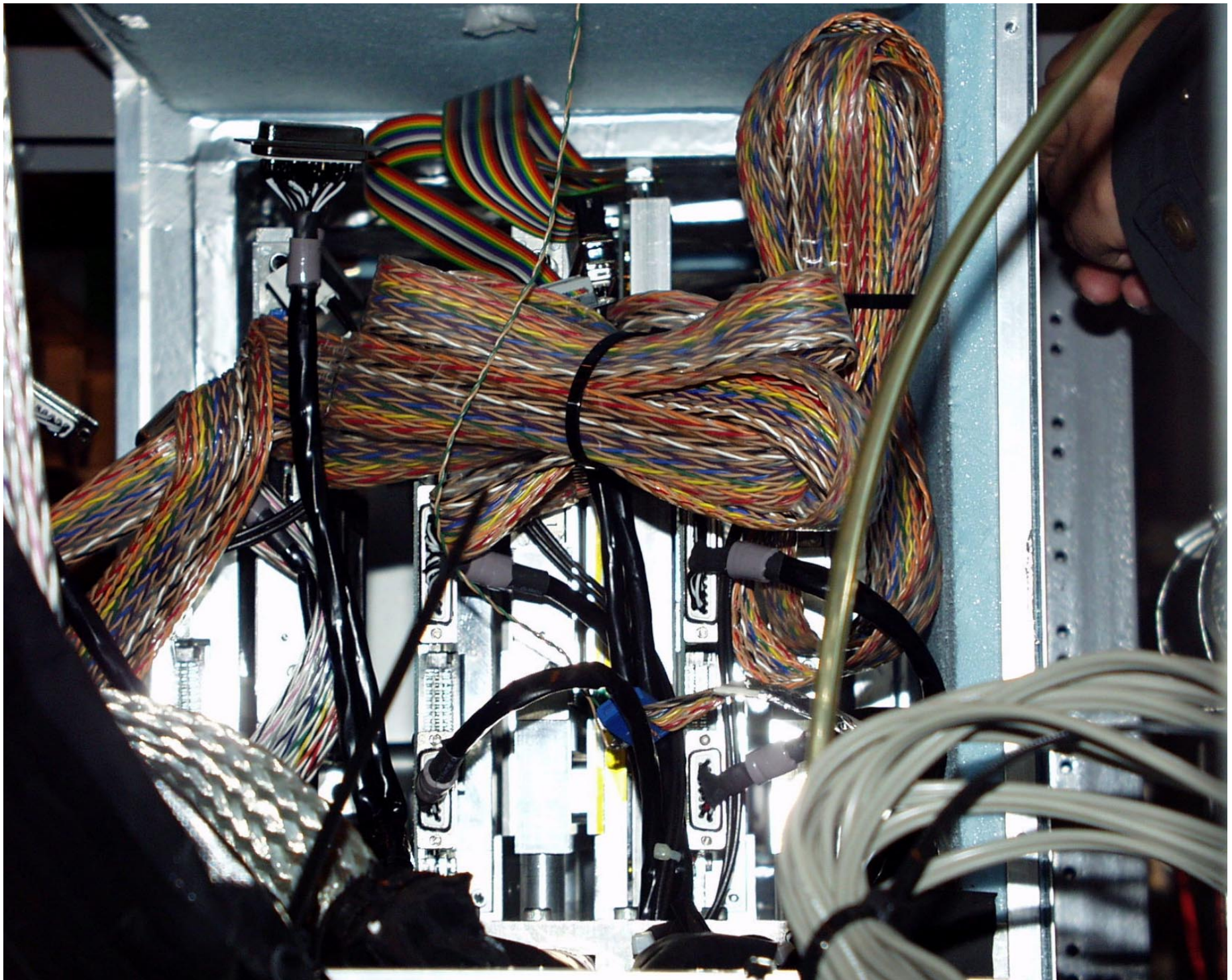
**-10 °C = All**











# Modules setup

- **Beam defining: 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): accidentally left-over

Telescope2

Mod2 KEK-ABCD#2

Mod3 Freiburg-irradiated detector

Telescope3

Mod4 KEK-CAFE/ABC

Anchor (CG3)

No shielding between the DUTs

- **Setup drawing**

Setup of -10 °C

# Calibration

- **In-situ calibration runs:**

**Bias 100V (irrad 350V)**

**Scan points were fed into the thresholds of beamtest**

**Edge detection = OFF**

**Mode = X1X**

**Later, 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  $\mu$ A = 10 fC**

**KEK internal scale: IDAR~300  $\mu$ A ~ 7 fC**



## Calibration (cont'd)

- **Noise sigma:**

Module	Calibration	Noise [e]
Mod0 - KEK-ABCD#1	in-situ	~1460
Mod1 - Freiburg ABCD	in-situ	~1470
Mod2 - KEK-ABCD#2	in-situ	~1515(1680) <sup>a</sup>
Mod4 - KEK CAFE/ABC	in-situ	~1600
	Module@Fuji	~1690
	Hybrid@Fuji	~890

- **Notes:**

- Mod2:

- <sup>a</sup>Chip6,7 were noiser than the rest

- <sup>a</sup>Chip3 was too large trim step

- No particular characteristics in wafer probed data

- Mod4:

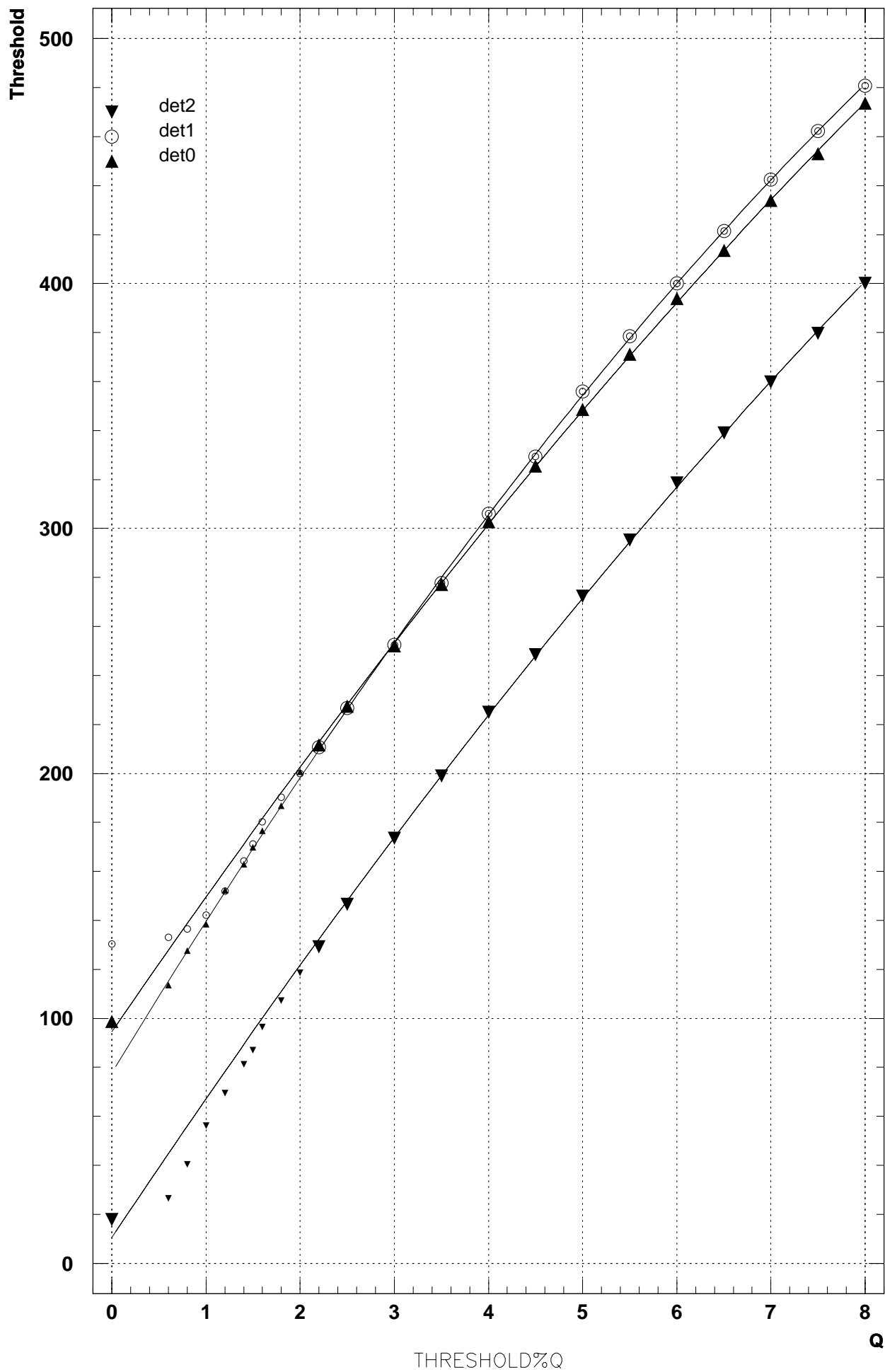
- CAFE/ABC in nominal charge scale, IDAR ~300  $\mu$ A=10fC

- Temperatures:

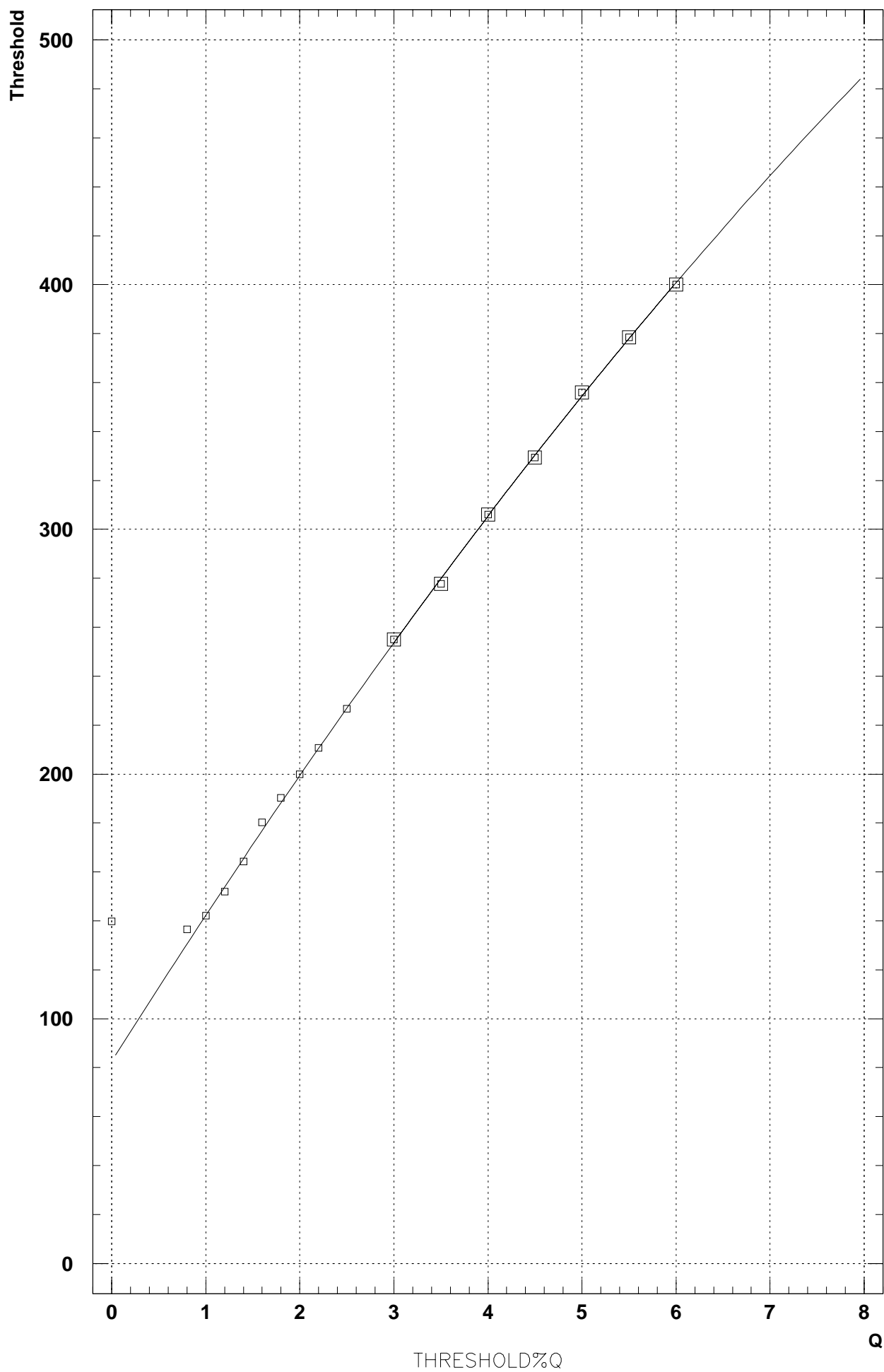
- In-situ: -10 °C environment air cooled

- @Fuji: +20 °C environment air cooled

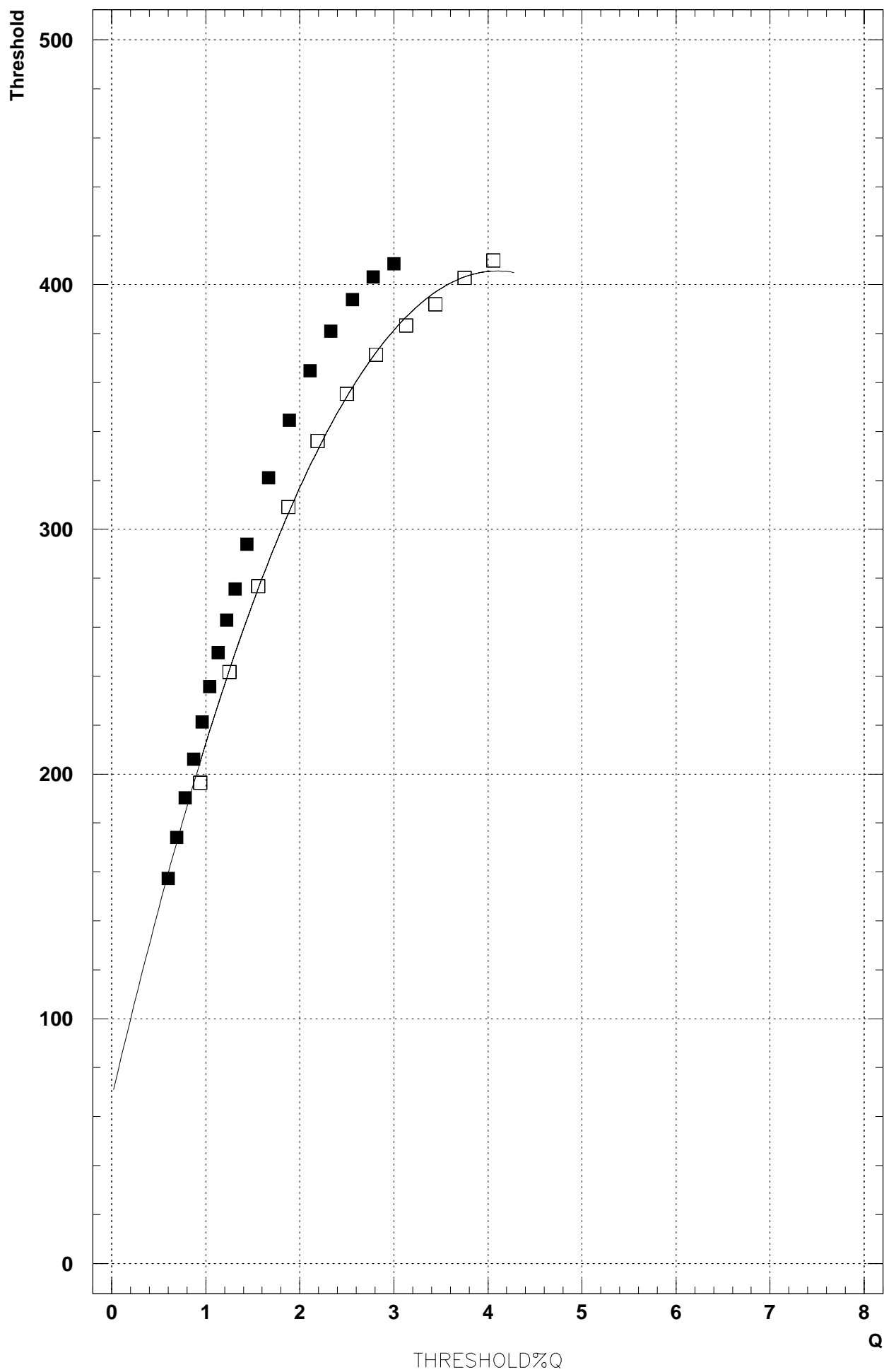
# det0,det1,det2



# 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**

Tracks in 3 telescope and anchor

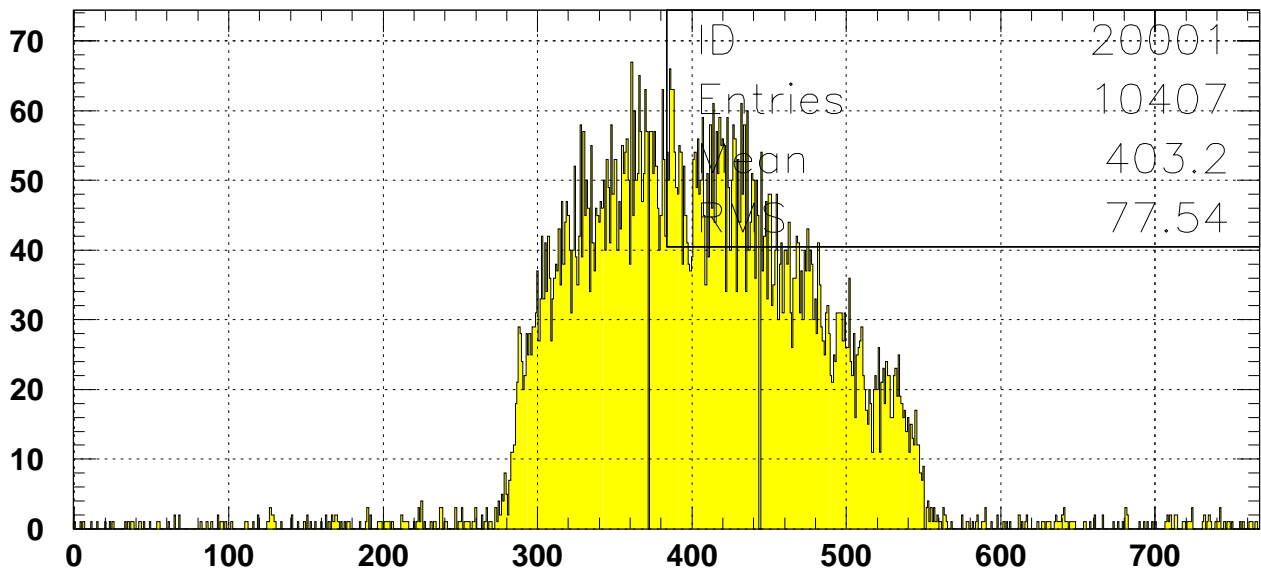
Window ( $\pm 250 \mu\text{m}$ ) from a track defined by two adjacent telescopes

Any time bins

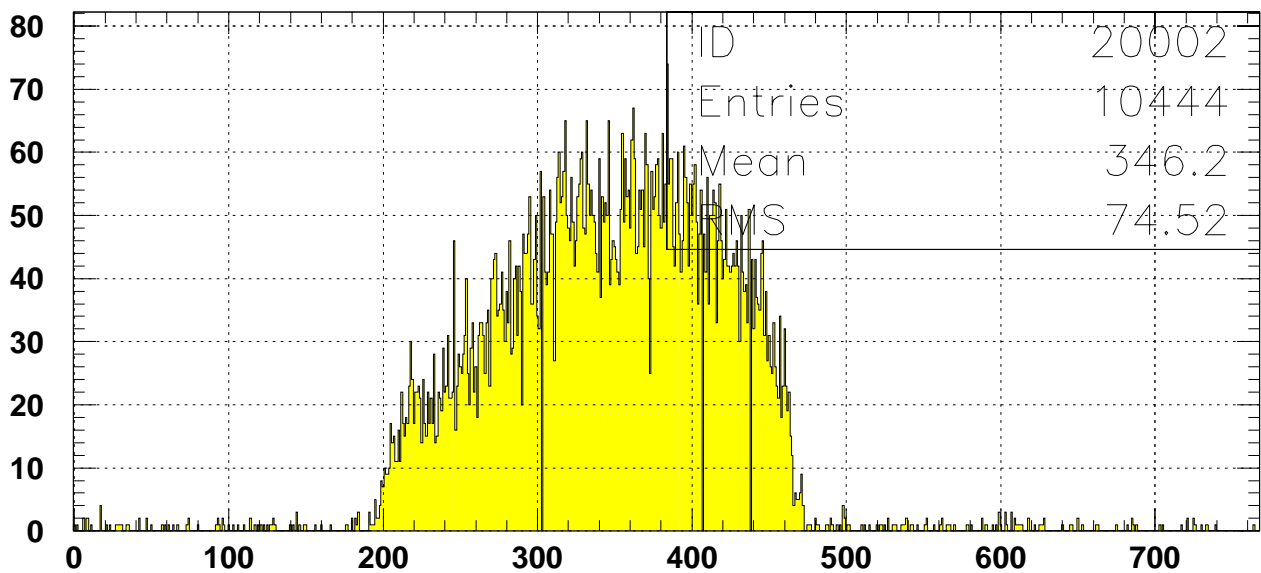
- **Position resolution**

Residual of the nearest hit to the track defined by two adjacent telescopes

### Hit map ( KEK3103 : 120V, 1.2fC )

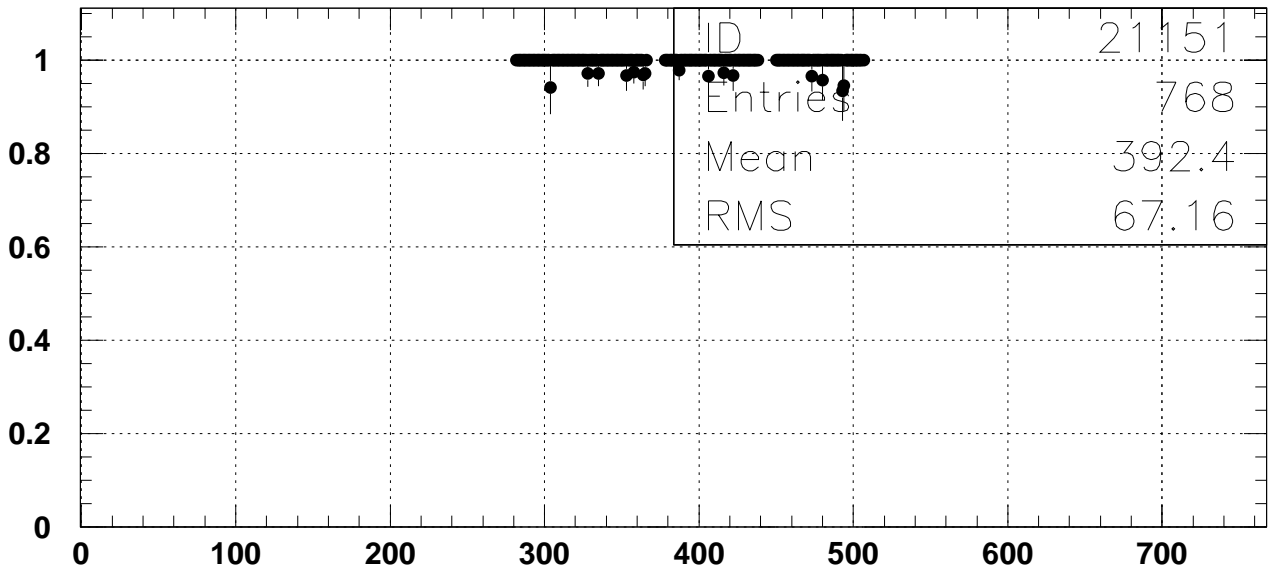


Mod0s0 hitmap (channel)

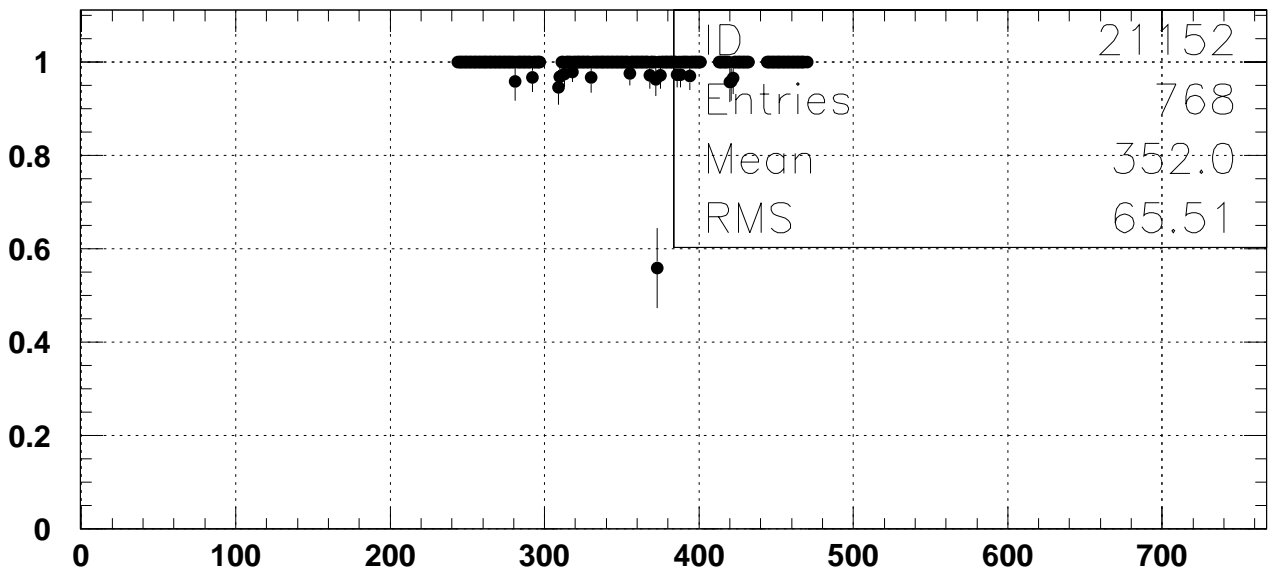


Mod0s1 hitmap (channel)

### Efficiency ( KEK3103 : 120V, 1.2fC )

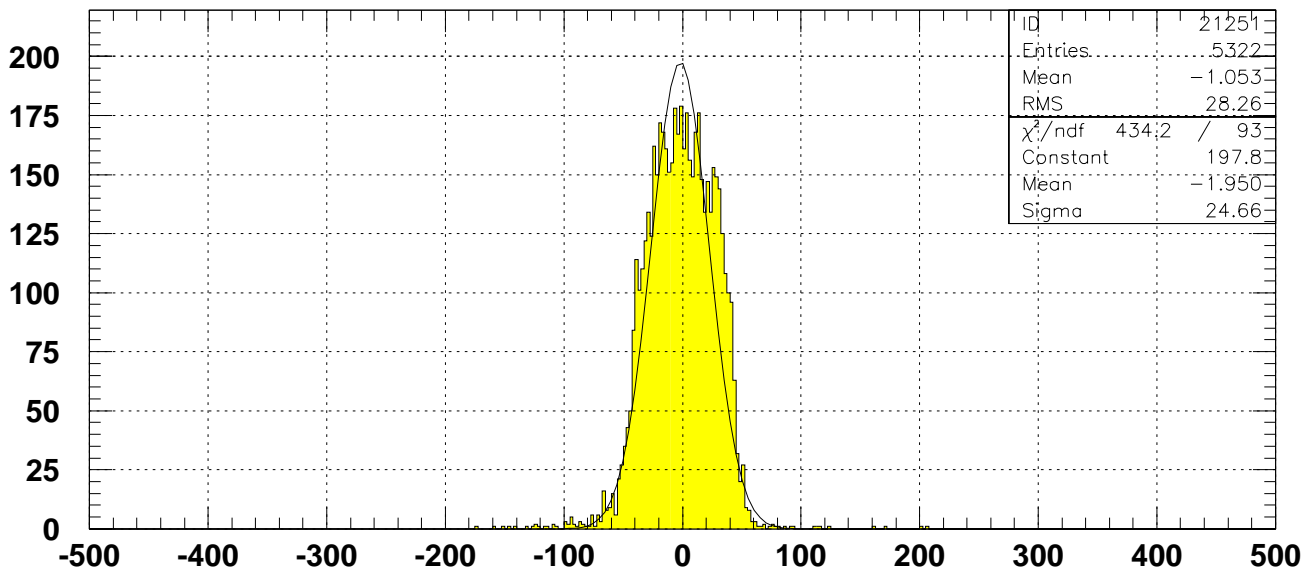


Efficiency in strip (Mod0s0)

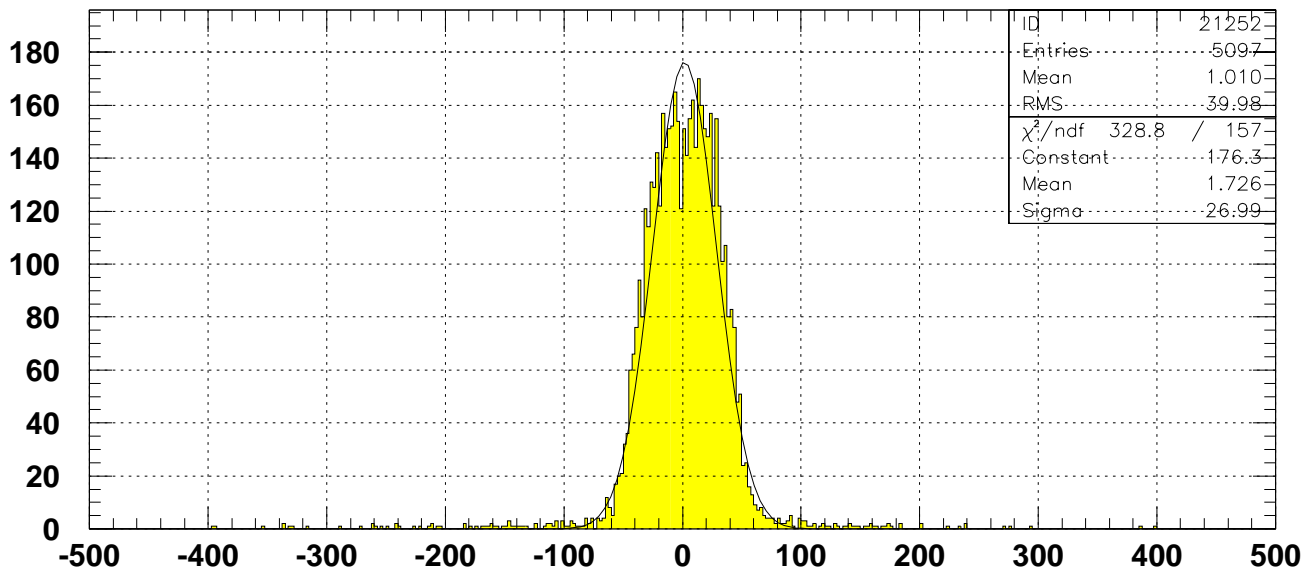


Efficiency in strip (Mod0s1)

## Position Resolution(1.2fC, 120V)



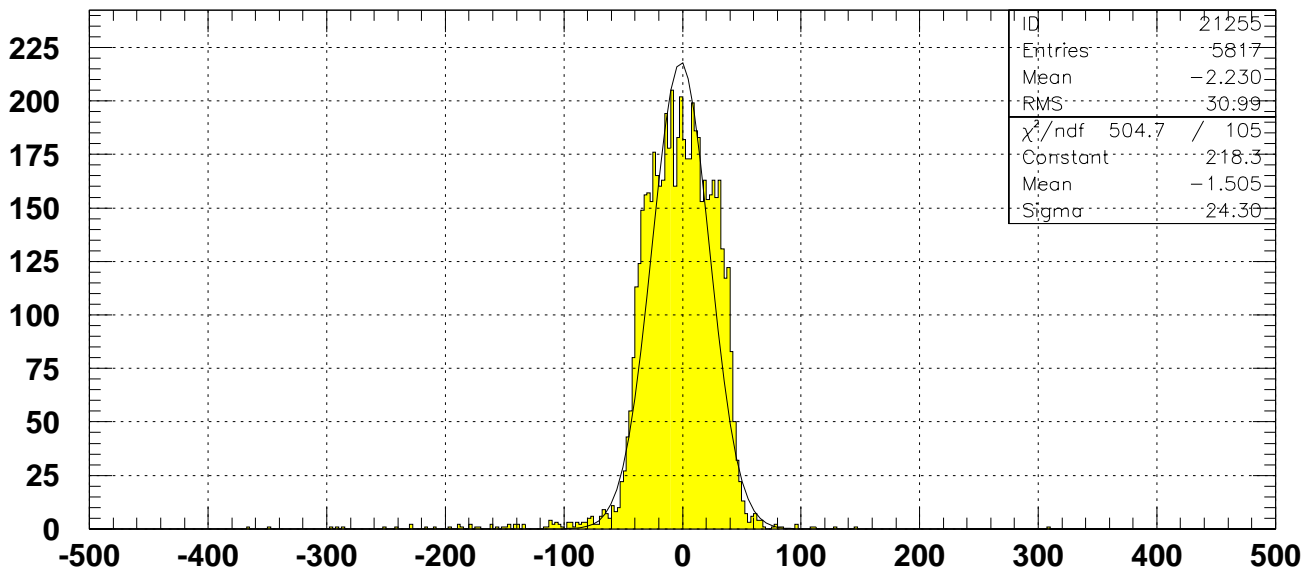
Diff (Nearest clus - track) (Mod0s0)



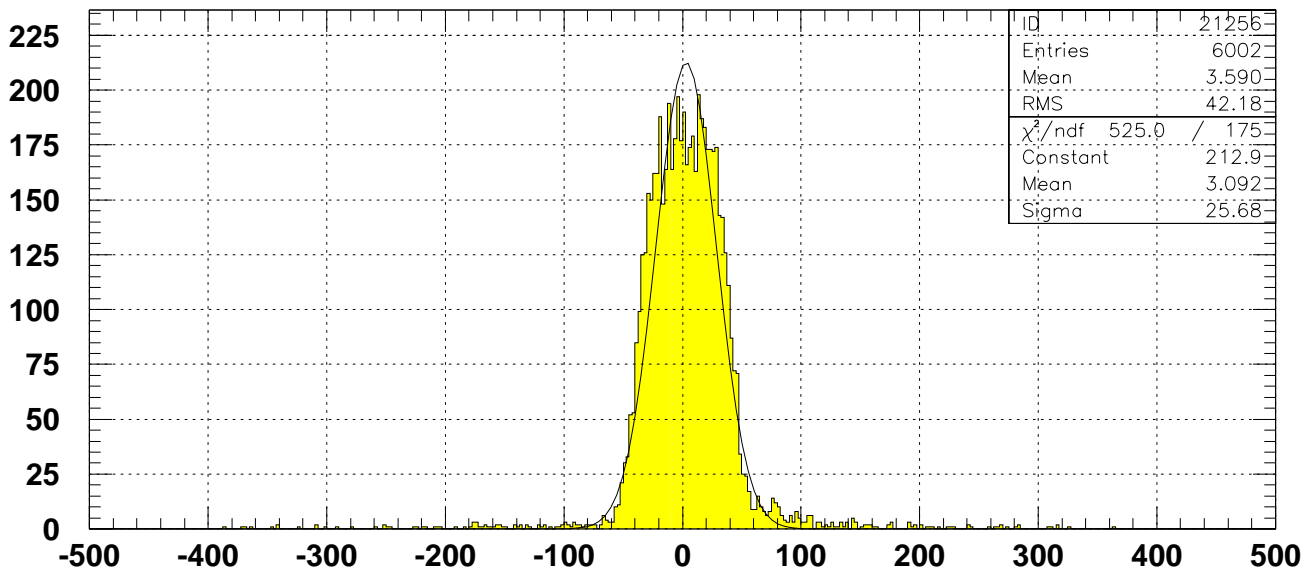
Diff (Nearest clus - track) (Mod0s1)



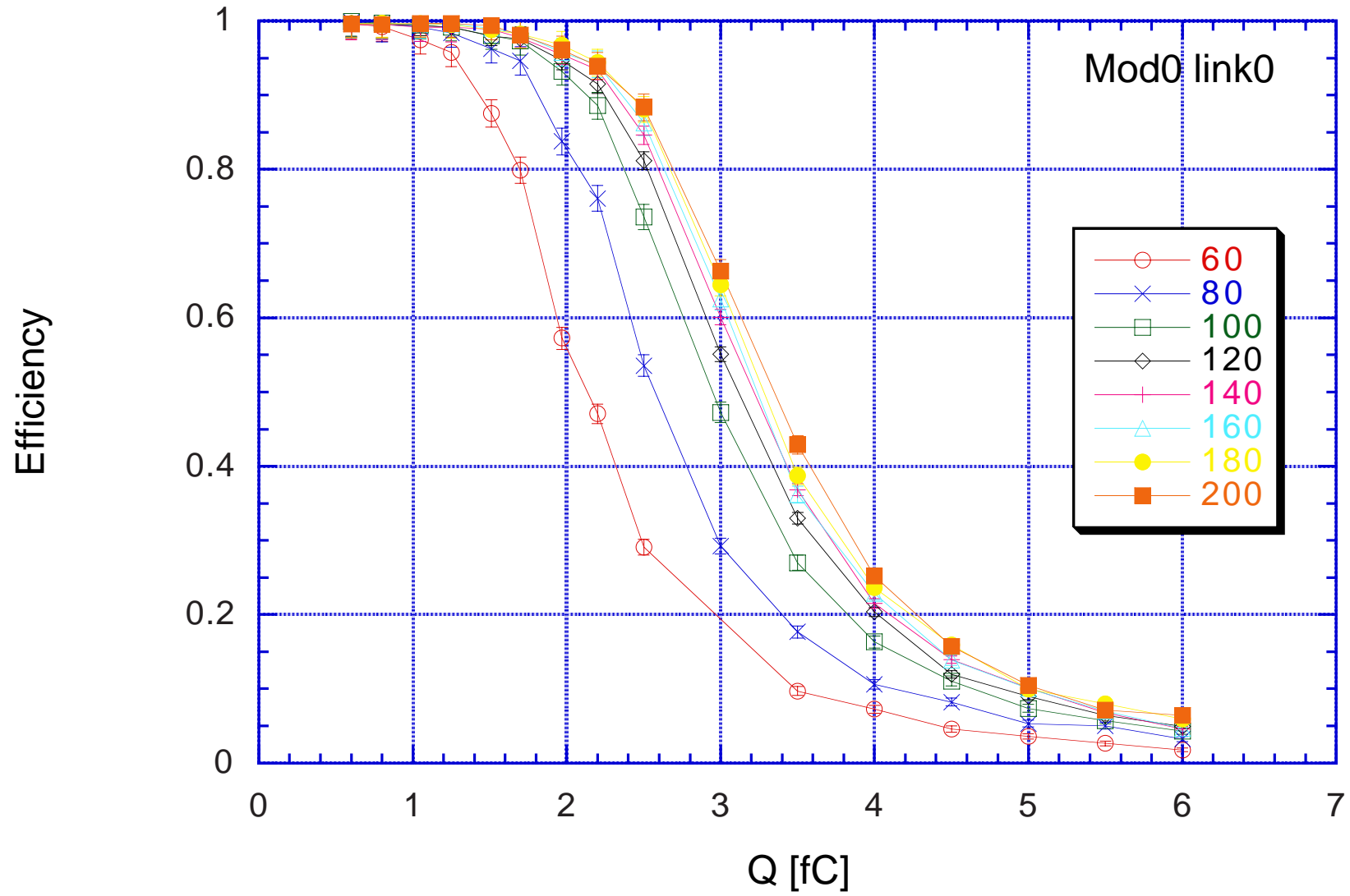
## Position Resolution(1.2fC, 120V)



Diff (Nearest clus - track) (Mod2s0)



Diff (Nearest clus - track) (Mod2s1)



# 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  $\propto$  (Depletion thickness)<sup>2</sup>

Collected charge  $\propto$  Depletion thickness

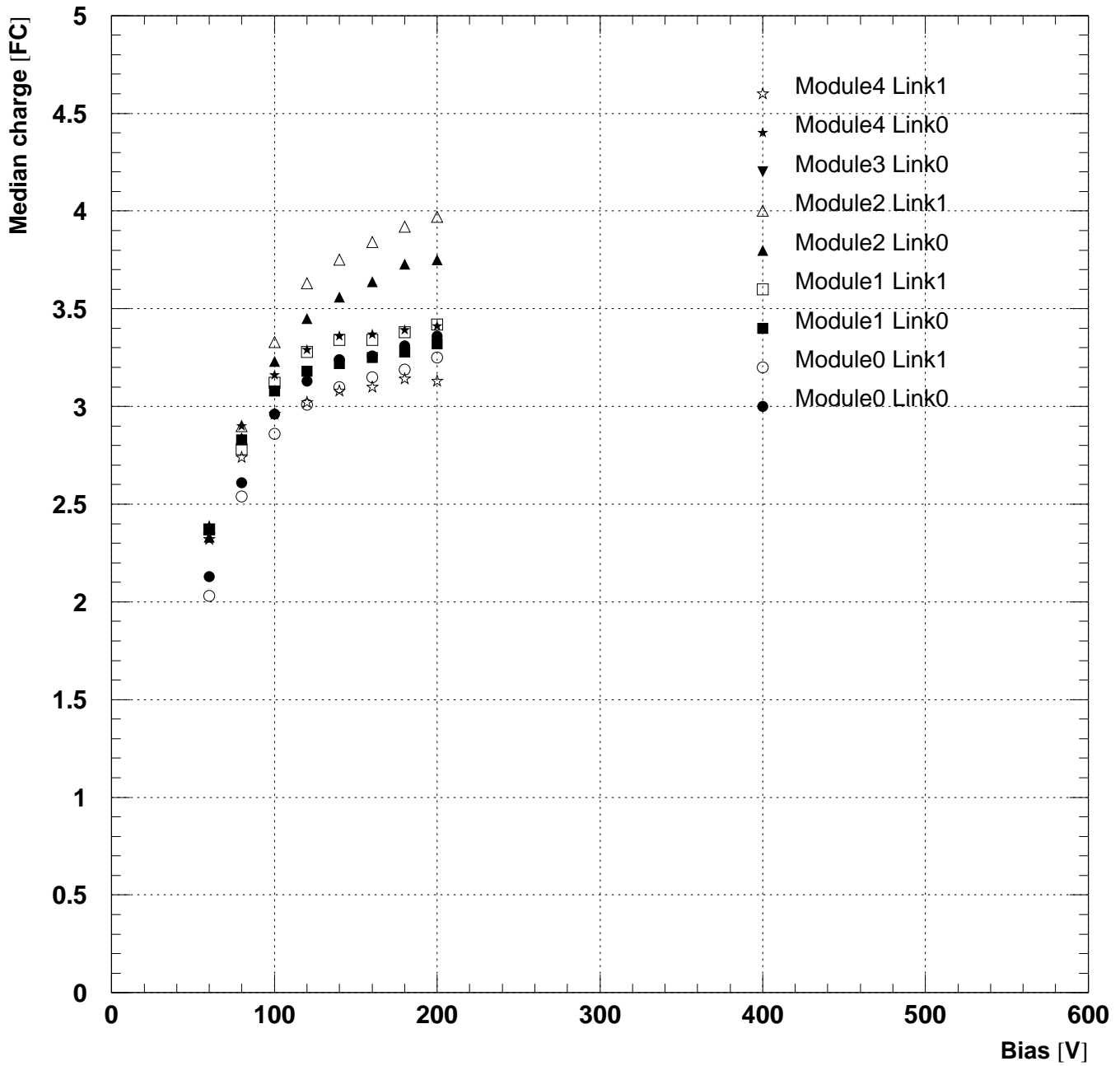
Bias voltage (285 $\mu$ ) = (285 $\mu$ /325 $\mu$ )<sup>2</sup> \* Bias voltage(325 $\mu$ )

factor = 0.77

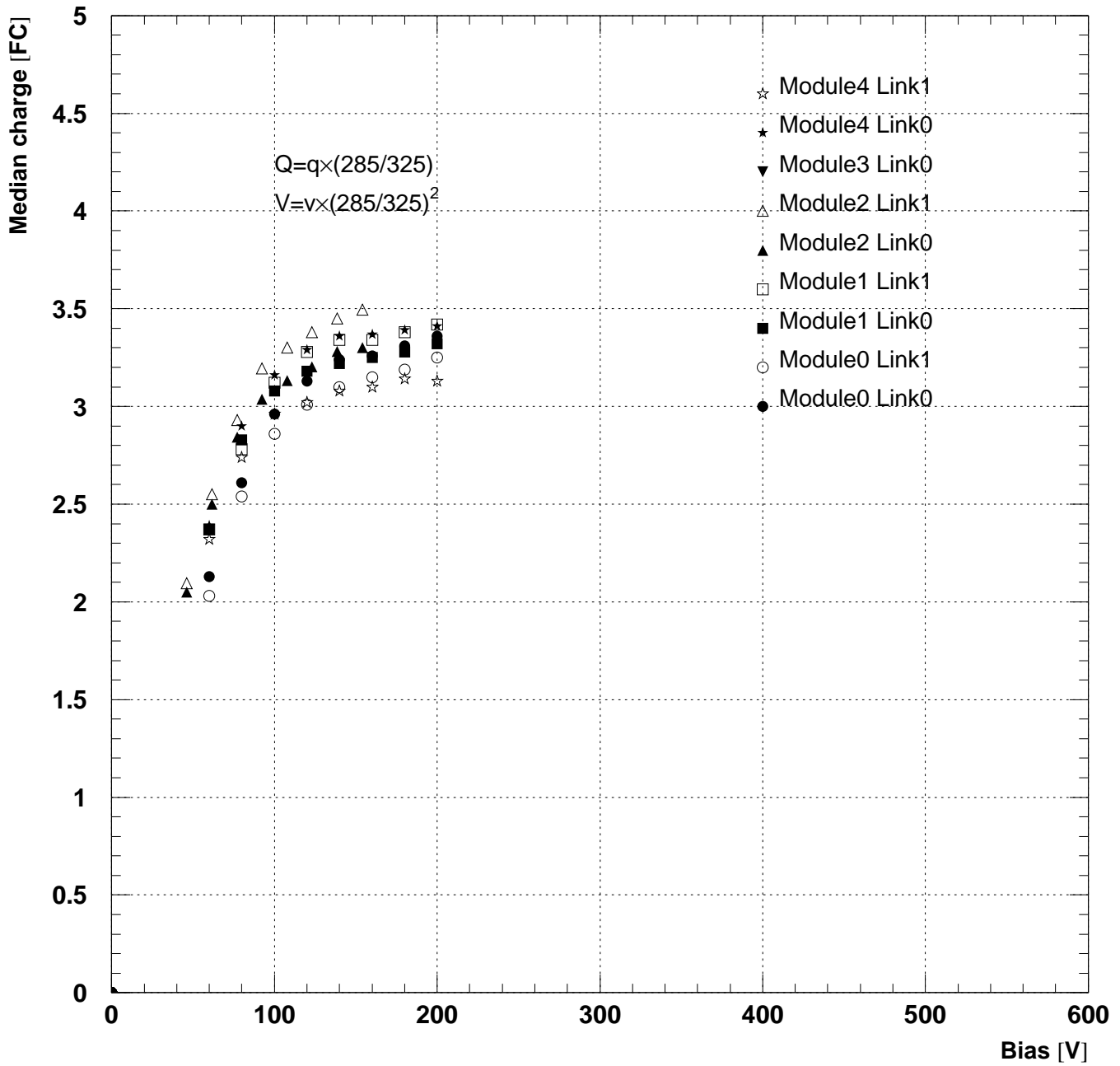
Median charge (285 $\mu$ ) = (285 $\mu$ /325 $\mu$ ) \* Median charge (325 $\mu$ )

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

- **Time bin info, “100”, “010”, or “001”**

ABCD beam timing = mostly 010 and a fraction in 100, i.e.,

CAFE/ABC=100

Higher occupancy in thresholds  $> 1.2 \text{ fC}$ , in time, = accidental coincidence with beam halo?

- **Noise occupancy**

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

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

1 fC = 6250 e

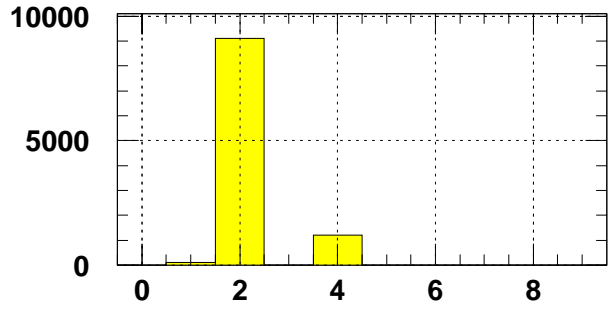
If 4 sigma = 0.8 ~ 1.0 fC, then sigma = 0.2 ~ 0.25 fC, i.e.,

sigma = 1250 ~ 1560 e

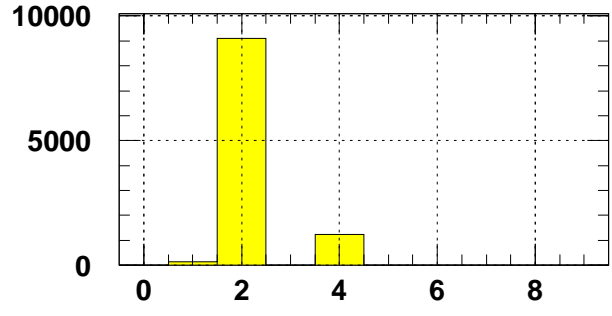
- **Notes:**

Possible systematic uncertainty of at most 0.2 fC in the charge near 1fC threshold

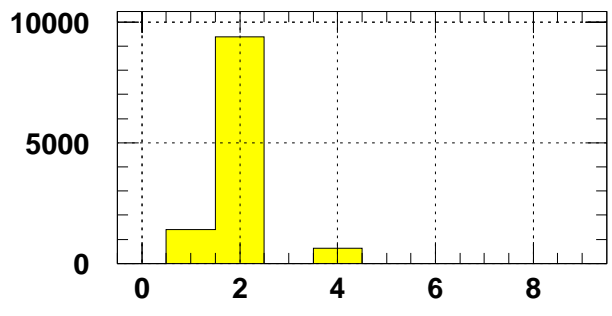
# Timebin(1.2fC, 120V)



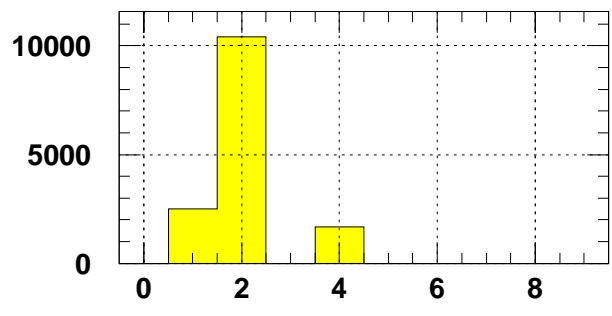
Mod0s0 timebin



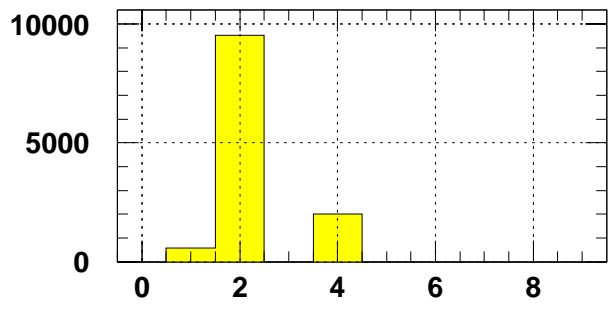
Mod0s1 timebin



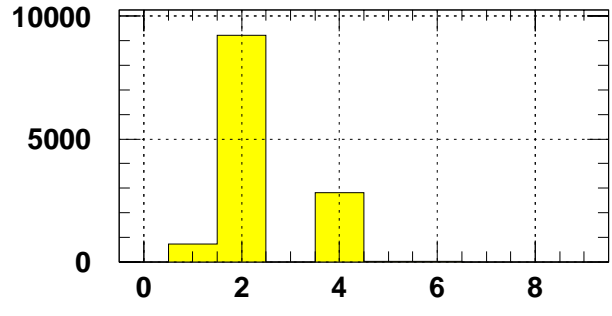
Mod1s0 timebin



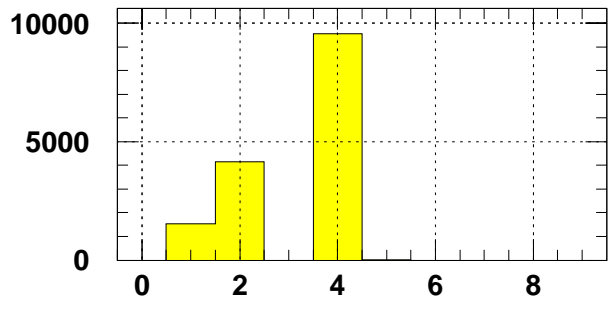
Mod1s1 timebin



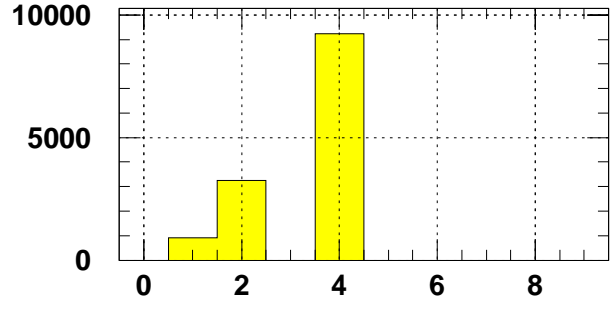
Mod2s0 timebin



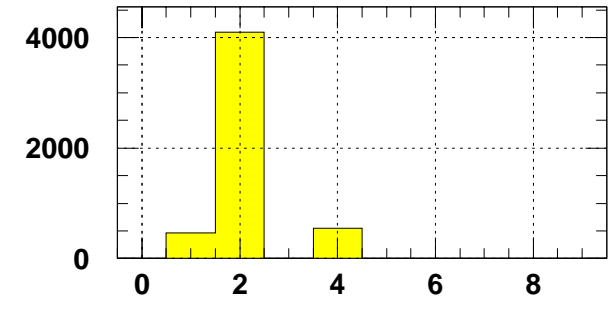
Mod2s1 timebin



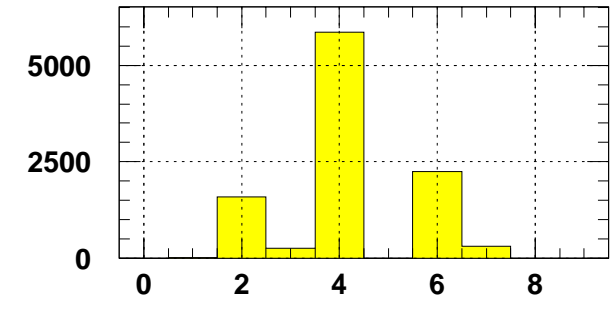
Mod4s0 timebin



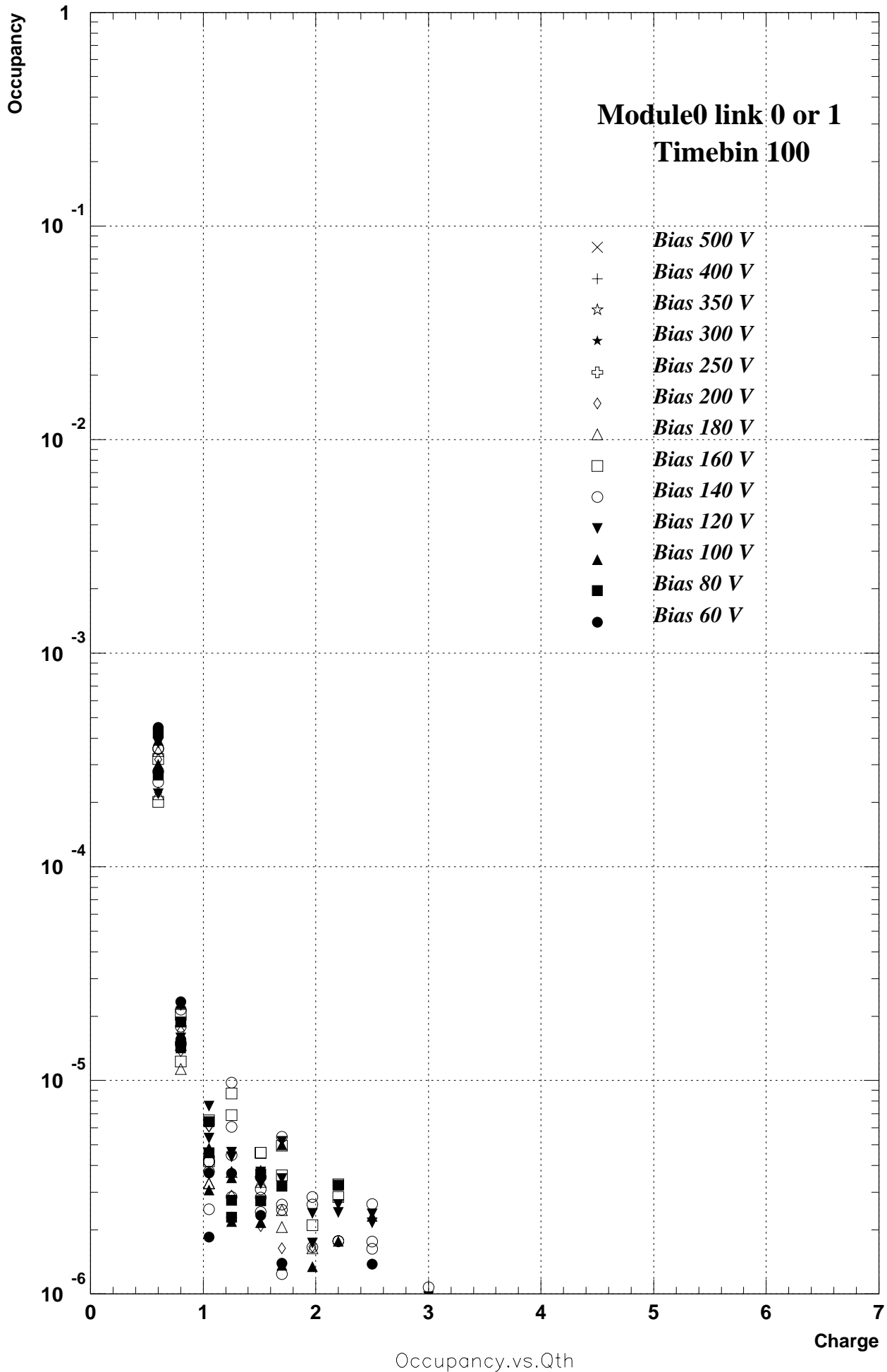
Mod4s1 timebin

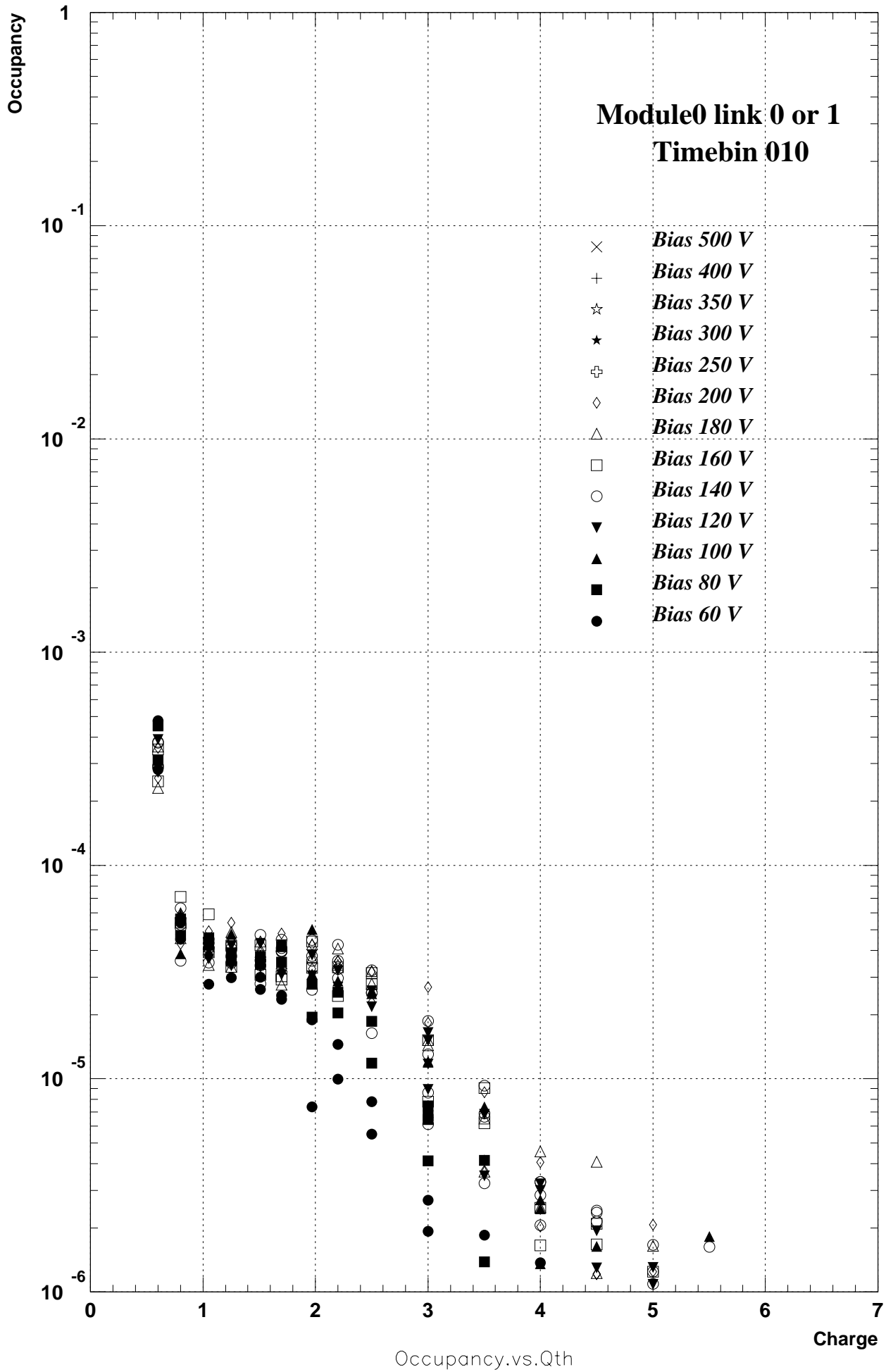


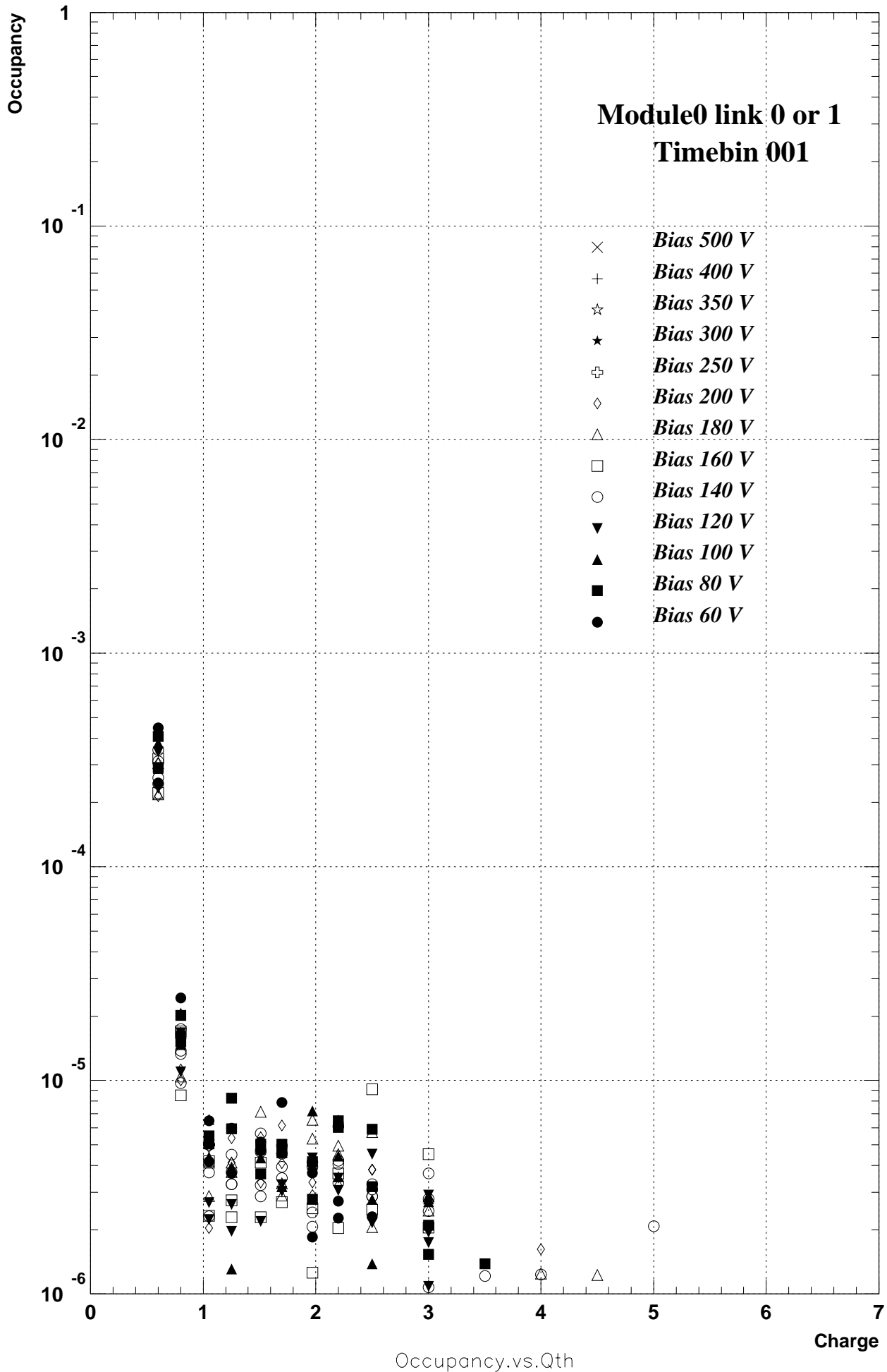
Mod3s0 timebin

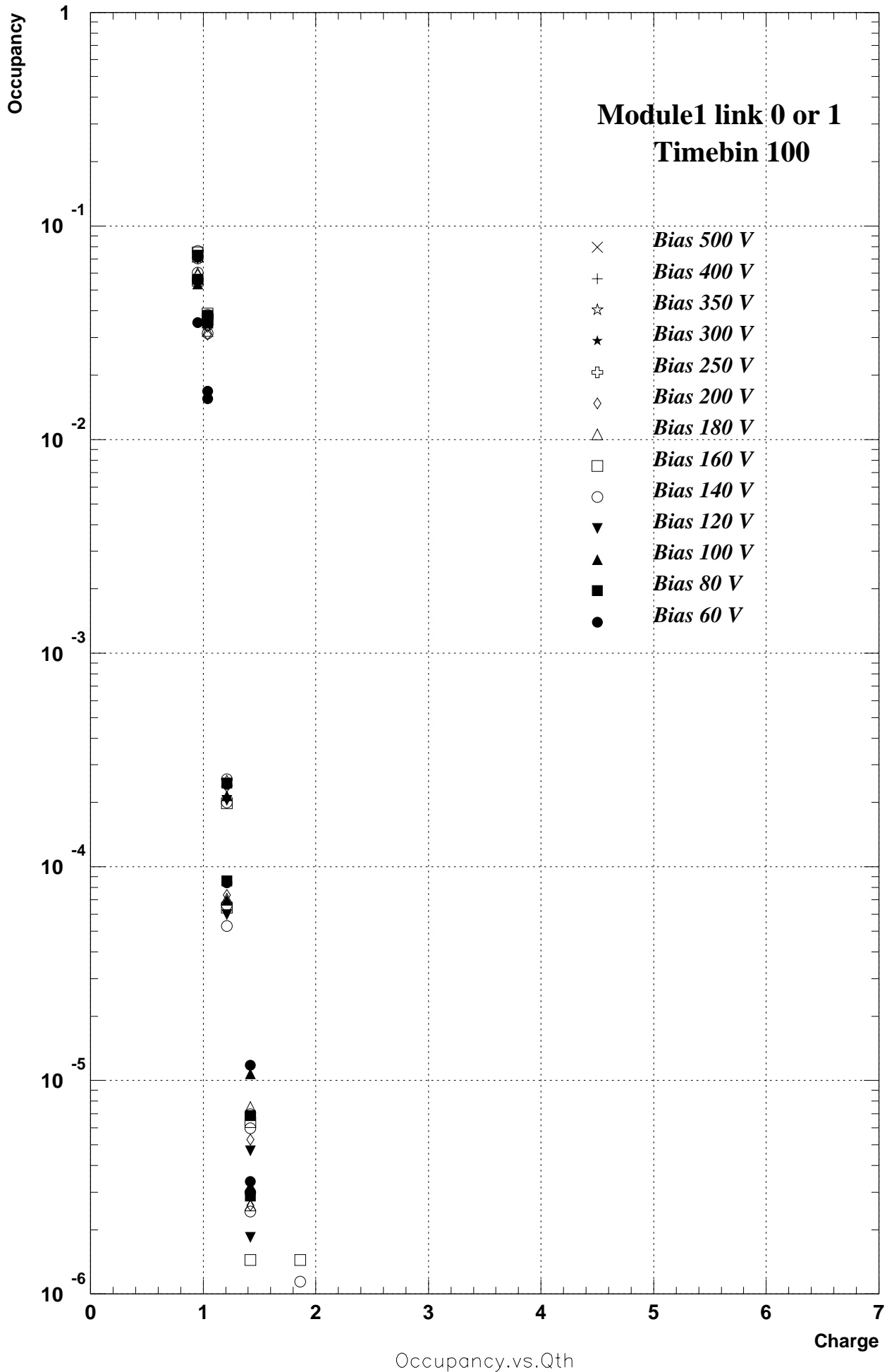


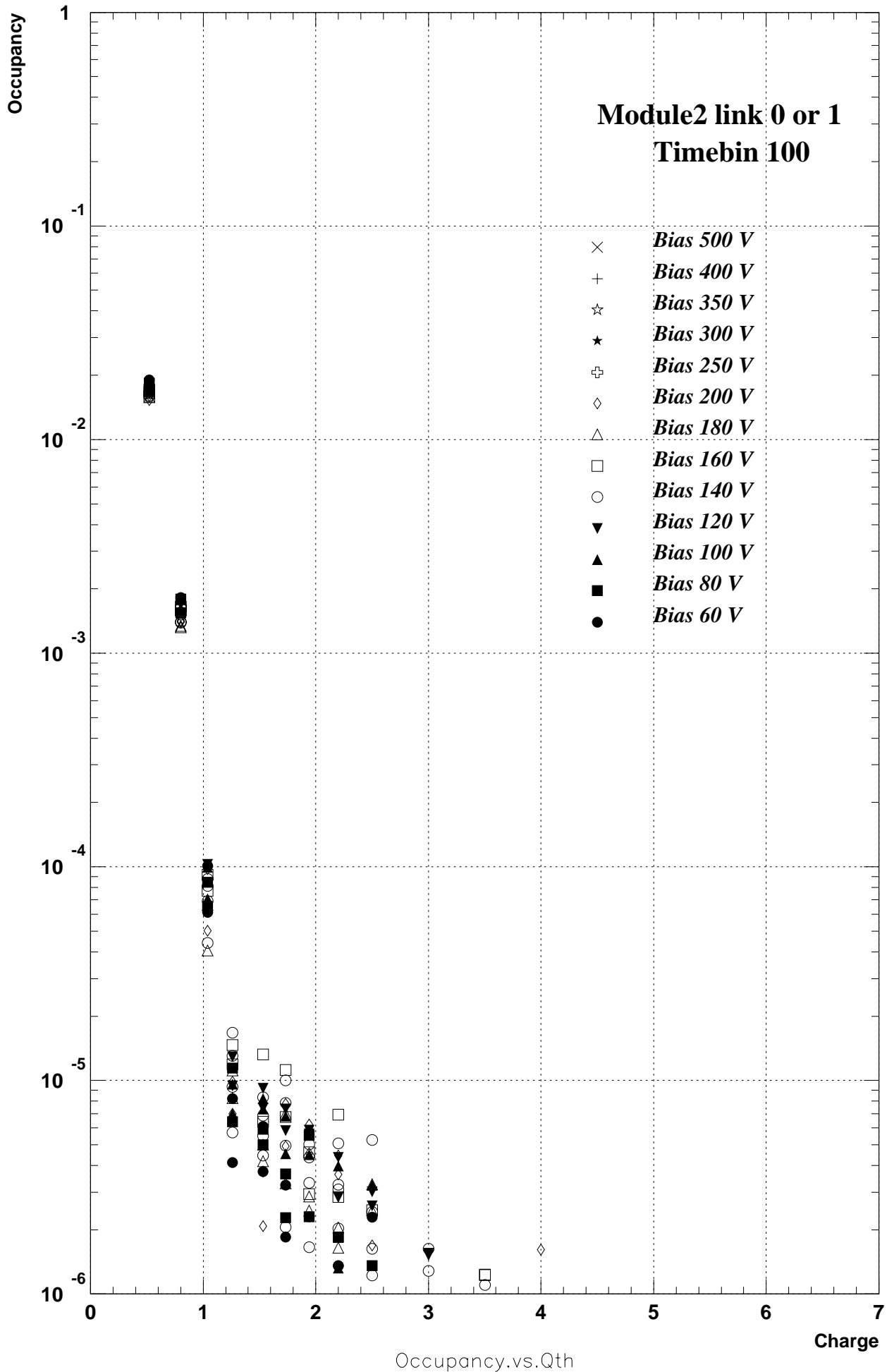
Mod5s0 timebin



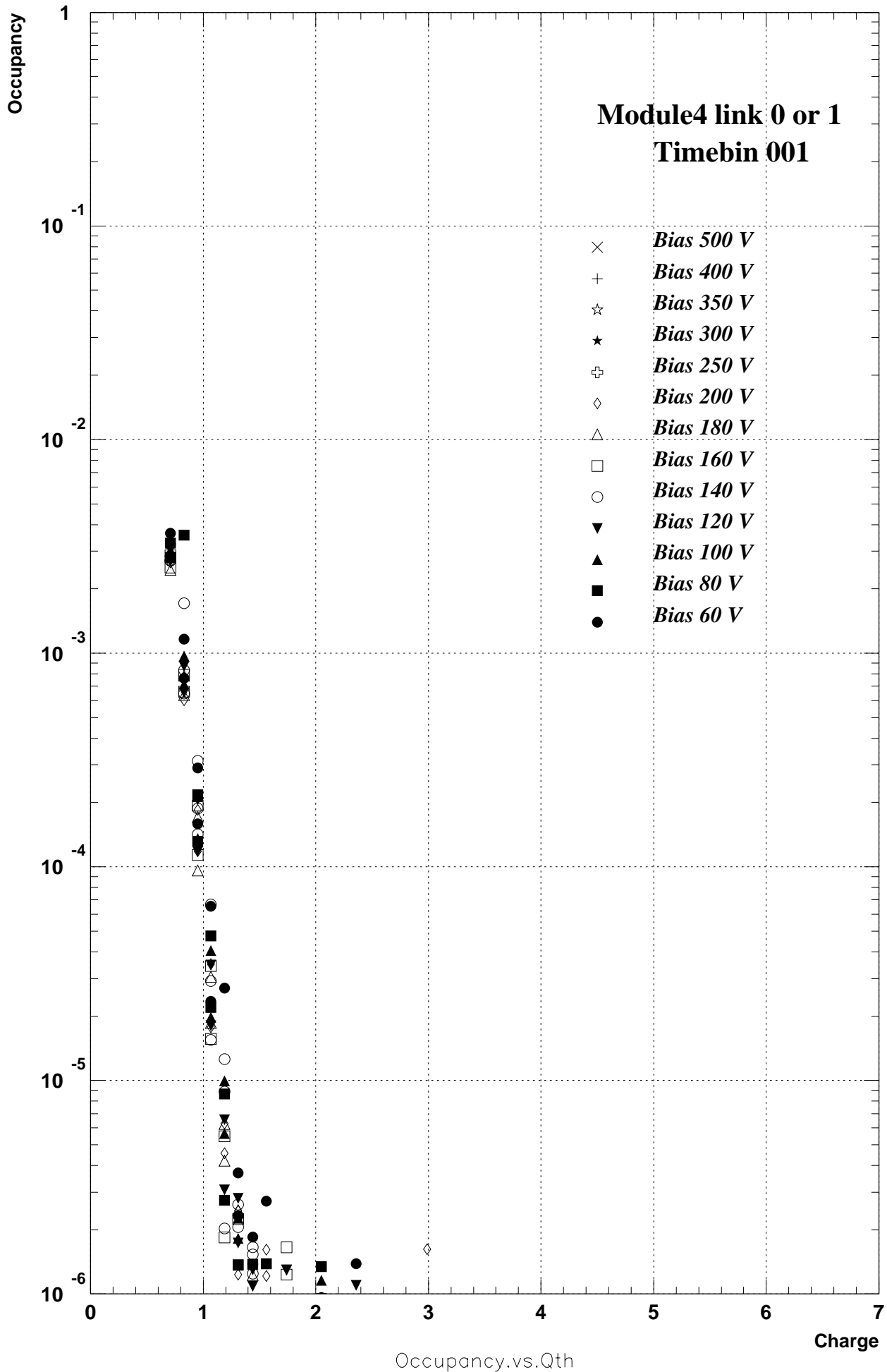












# Summary

- **Dec 99 beamtest at KEK was carried out successfully**

with a new PC-based SCTDAQ

4 ABCD2T and 1 CAFE/ABC modules

- **Position resolution**

Consistent with  $\text{pitch}/\sqrt{12} \sim 23 \mu\text{m}$

- **Reasonable behaviours of median charges**

Saturation above 120 V

Saturation at 3.3 fC for 285  $\mu\text{m}$  thickness

- **ASIC/hybrid/Module performance**

ABCD2T:

noise~ 1450 e (module charge inj. calibration)

CAFE/ABC:

Noise ~ 1550 e (module charge inj. cal., -10 °C)