

# **Beamtest in Dec 2000 at KEK**

**Y. Unno, KEK**

**for the participants:**

**G. Moorhead, L. Eklund, M. Vos, P. Bernabeu, C. Ketterer, and domestic collaborators**

**and**

**many other contributors**

- **DUT's: non-irradiated**

**k3103 - anchor**

**k11 - ABCD3T double-decker barrel module**

**k22 - ABCD3Tm ThinMetalized barrel module**

**Val165 - ABCD3T forward (Valencia)**

**CG - ABCD3T forward (CERN/Geneva)**

- **DUT's: irradiated**

**k03 - ABCD3T barrel module irradiated**

**Val166 - ABCD3T forward module (Valencia) irradiated**

- **Date: Nov. 28 - Dec. 9, 2000**

# Setup

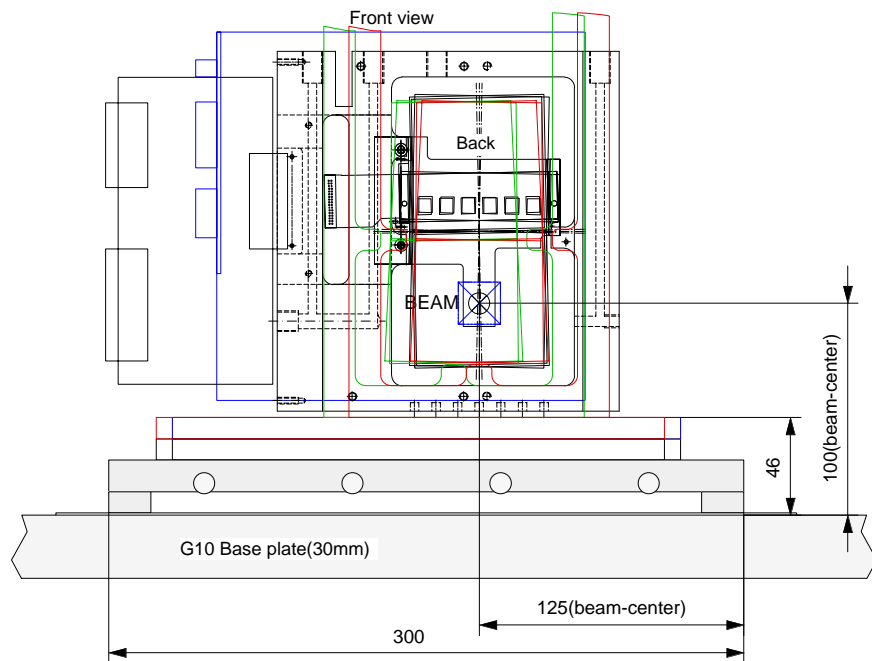
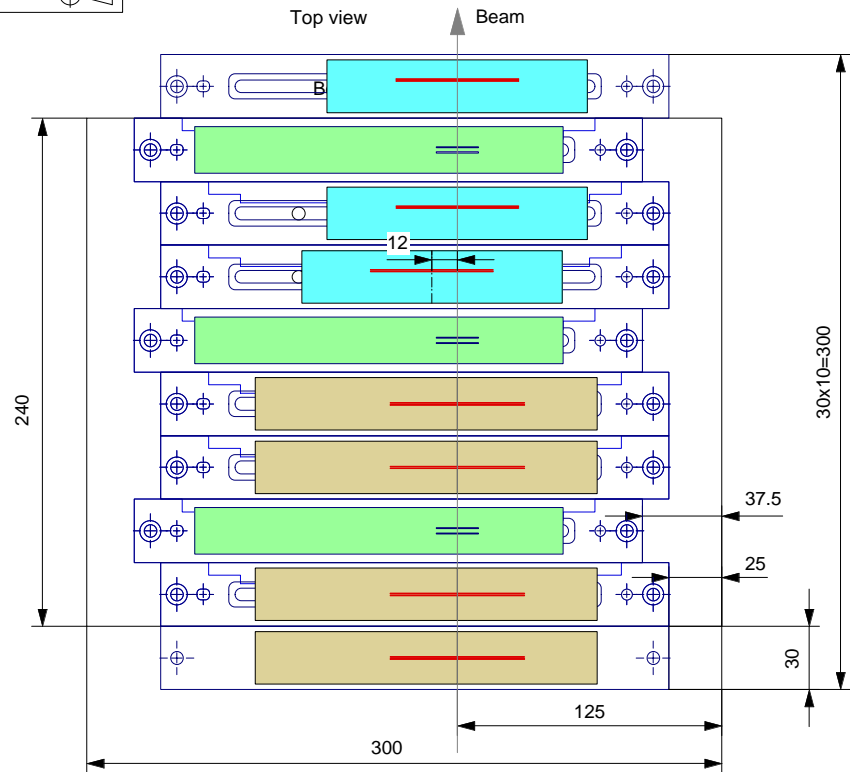
- **Module sequence**

<b>Mod0</b>	<b>k3103</b>	<b>ABCD2T chips</b>
<b>Mod1</b>	<b>20220170200011</b>	<b>ABCD3T DD</b>
<b>Telescope-A</b>		
<b>Mod2</b>	<b>20220170200022</b>	<b>ABCD3T Thin&amp;Meta</b>
<b>Mod3</b>	<b>20220170200003</b>	<b>ABCD3T irradi.</b>
<b>Telescope-B</b>		
<b>Mod4</b>	<b>Val-k3-166</b>	<b>ABCD3T irradi.</b>
<b>Mod5</b>	<b>Val-k3-165</b>	<b>ABCD3T</b>
<b>Telescope-C</b>		
<b>Mod6</b>	<b>CG-k3-170</b>	<b>ABCD3T</b>

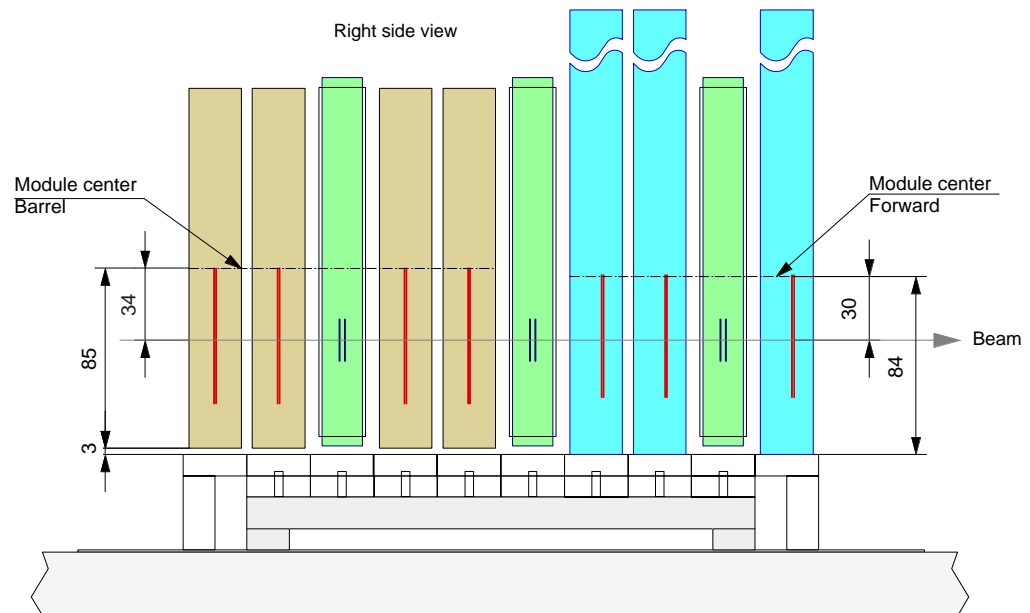
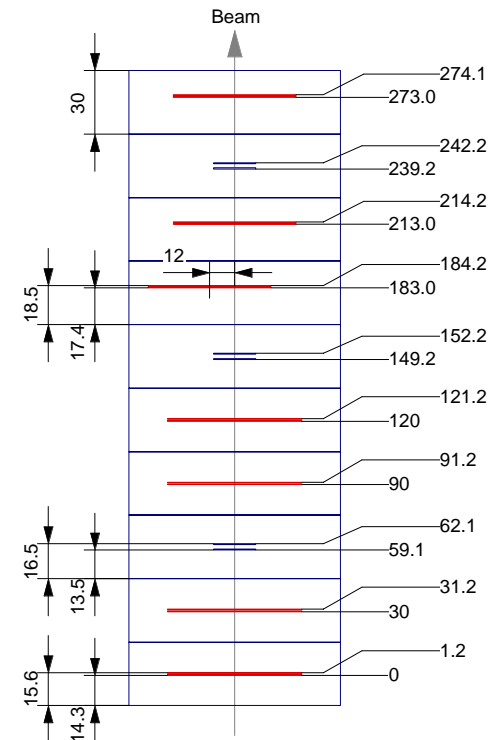
- **Drawings and photos**

**Drawing - A3- AT2k1204**

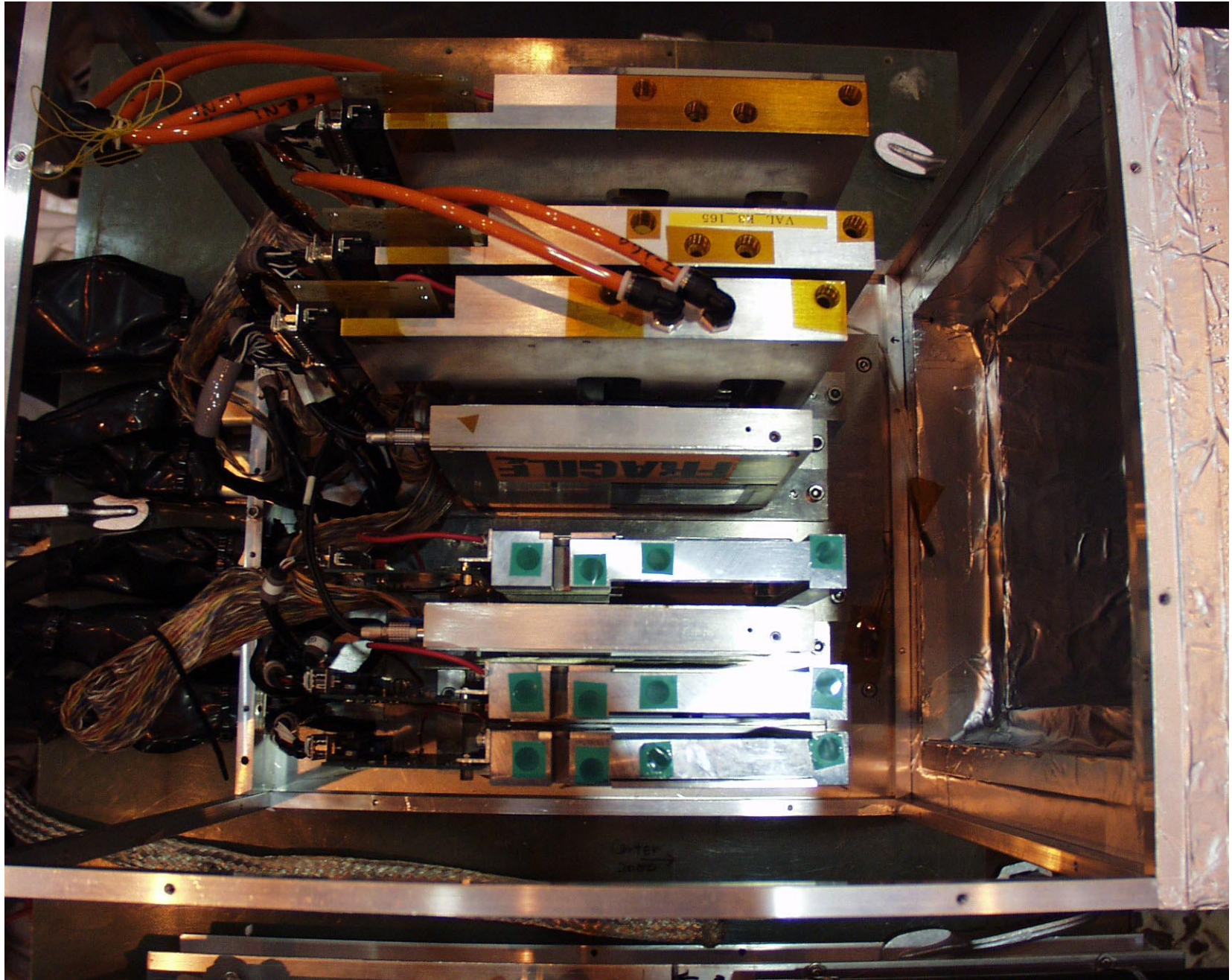
PROJECTION



- CERN/GNV (ABCD3T)/Freiburg irradi.
- Telescope C
- Valencia non-irrad (ABCD3T)
- Valencia irrad (ABCD3T)
- Telescope B
- KEK irrad (ABCD3T)
- KEK non-irrad (ABCD3Tm Thin&Metalized)
- Telescope A
- KEK non-irrad (ABCD3T double-decker)
- Anchor (k3103)



TITLE FestBeam_KEK200012 Detector layout	DRAWING No. A3-AT2k1204-2/2	ORIGINAL SCALE x0.4	2k1208/R0 T.Kohriki@KEK
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# Data taking

- **Run-I (no k03 irradiated module)**
- **Run-II (all modules in)**

**k03 - nearly all chips were stuck at trim range=0. put in the “soft” annealing and to be set in the beamline in the Dec 5 intermission  
later found -**

**1) trim range was not “stuck”, but was not transmitted to the trimDAC from the receiver**

**2) higher temperature cured (partially) to transmit the setting**

**3) Irrad modules were cooled via module-box liquid cooling, in addition to the liquid cooling of the base of the thermo-box and the cold air circulation**

**- water at -13°C**

**- air at -20°C**

**4) temperature was adjusted so that the leakage current of the irradiated module was about 2mA**

**- k03 water cooling stopped**

**5) Hybrid temperature, typically**

**- k03: 1.5°C**

**- Val-k3-165: 50°C**

# **(Preliminary) Results**

**Charge collection**

**Noise occupancy**

**Resolution**

# Charge collection

- **Pulse shape reconstruction**

Edge detection OFF = 40 MHz random sampling

Three time bins + TDC (0.2ns resolution) = 75 ns with 0.2ns resolution

Shaper peaking time ~ 20ns

Peak walk

TDC window - tdc full width (ns) around the peak: 10 ns

- **Efficiency in strip**

e.g., 1fC threshold

Beam in 2 chips

Dead/Excluded region

- **Efficiency vs threshold**

50% efficiency threshold - Median charge

- **Median charges vs Bias voltage**

Irradiated modules - voltage drop in the series resistance in the bias feed circuit subtracted

Barrel module - 11 k $\Omega$

Forward module - 5.5 k $\Omega$



## Charge collection cont'd

- **Saturated charges**

Non-irrad - Barrel:  $\sim 3.6\text{fC}$ , Forward:  $\sim 3.8\text{fC}$

Irrad (at 500V) - Barrel:  $\sim 3.6\text{fC}$ , Forward:  $\sim 3.8\text{fC}$

(Once the saturated charge is scaled,) bias voltage dependence of the charge collection of the barrel and the forward is similar

- **Efficiency at 1fC**

Mostly  $>99.6$  or  $99.8\%$ , Some links  $>99\%$ , saturate

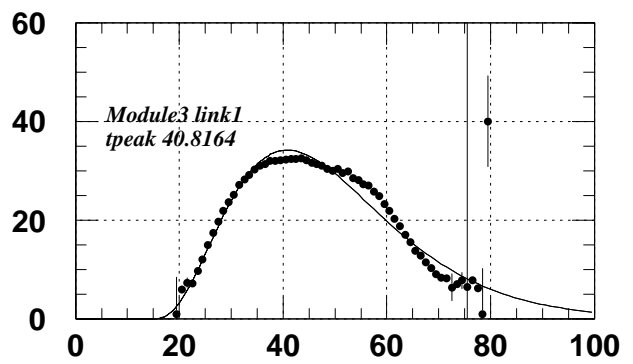
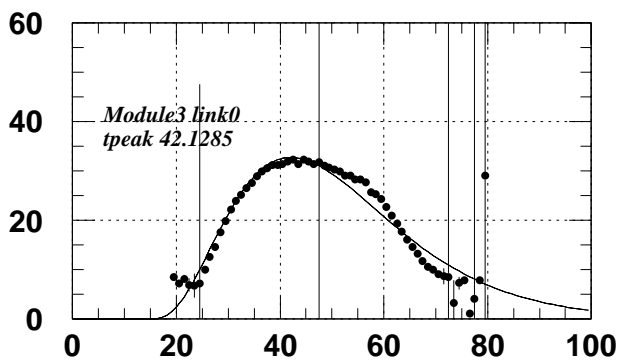
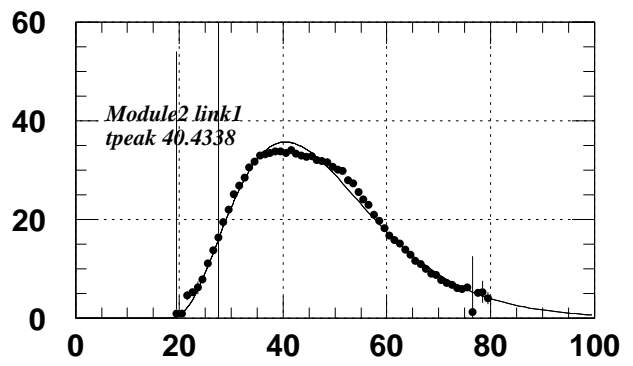
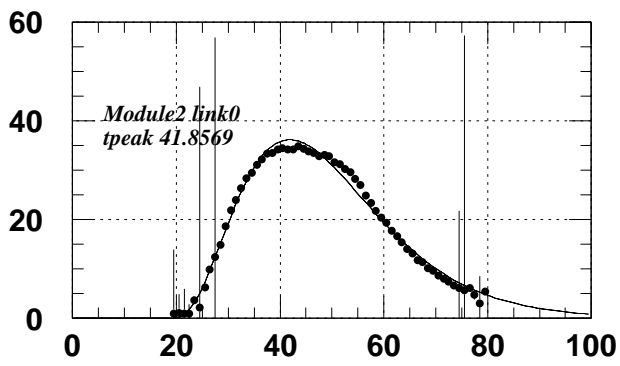
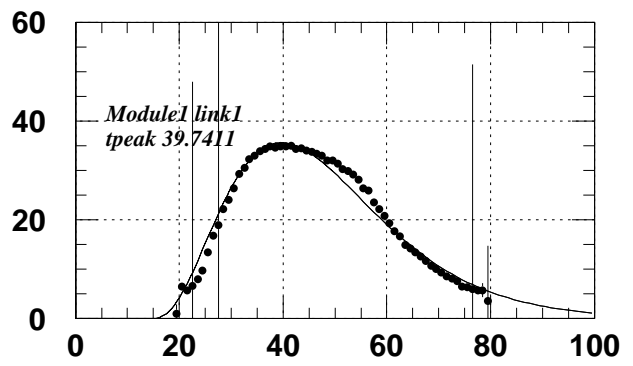
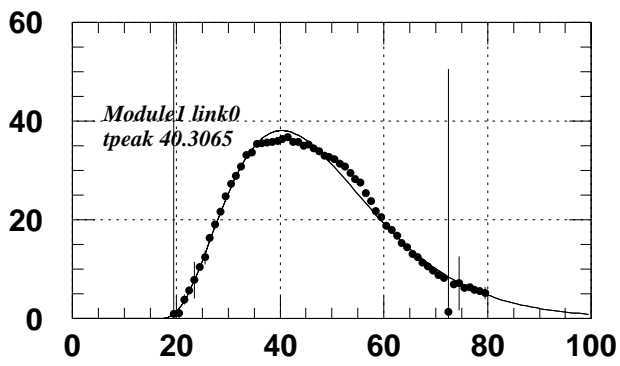
Non-irrad: bias voltage  $>100\text{V}$

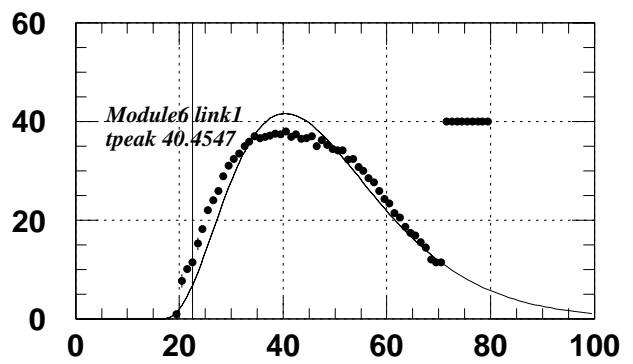
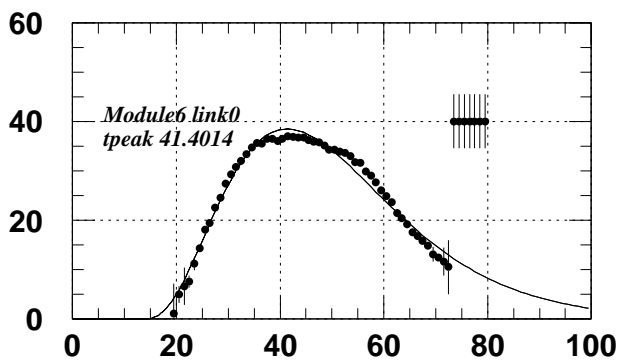
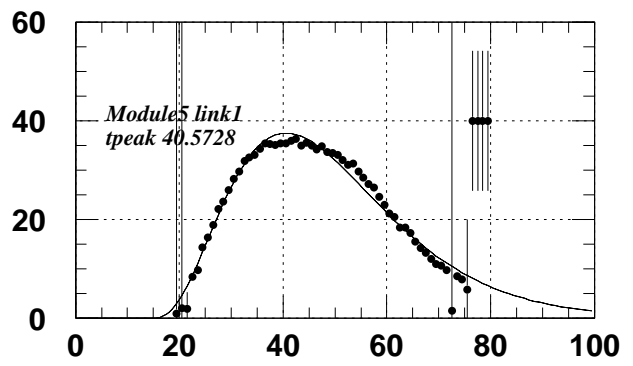
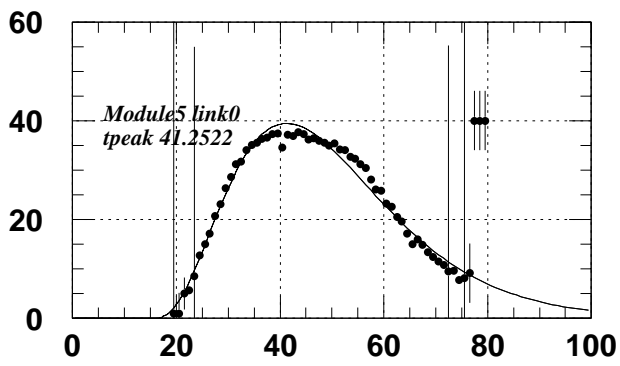
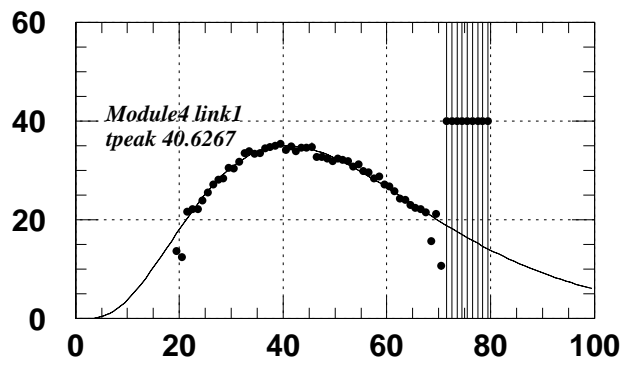
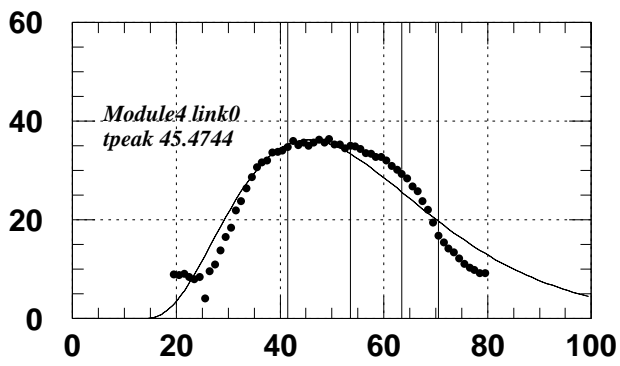
Irrad (Barrel):  $>300\text{V}$  (resistance uncorrected)

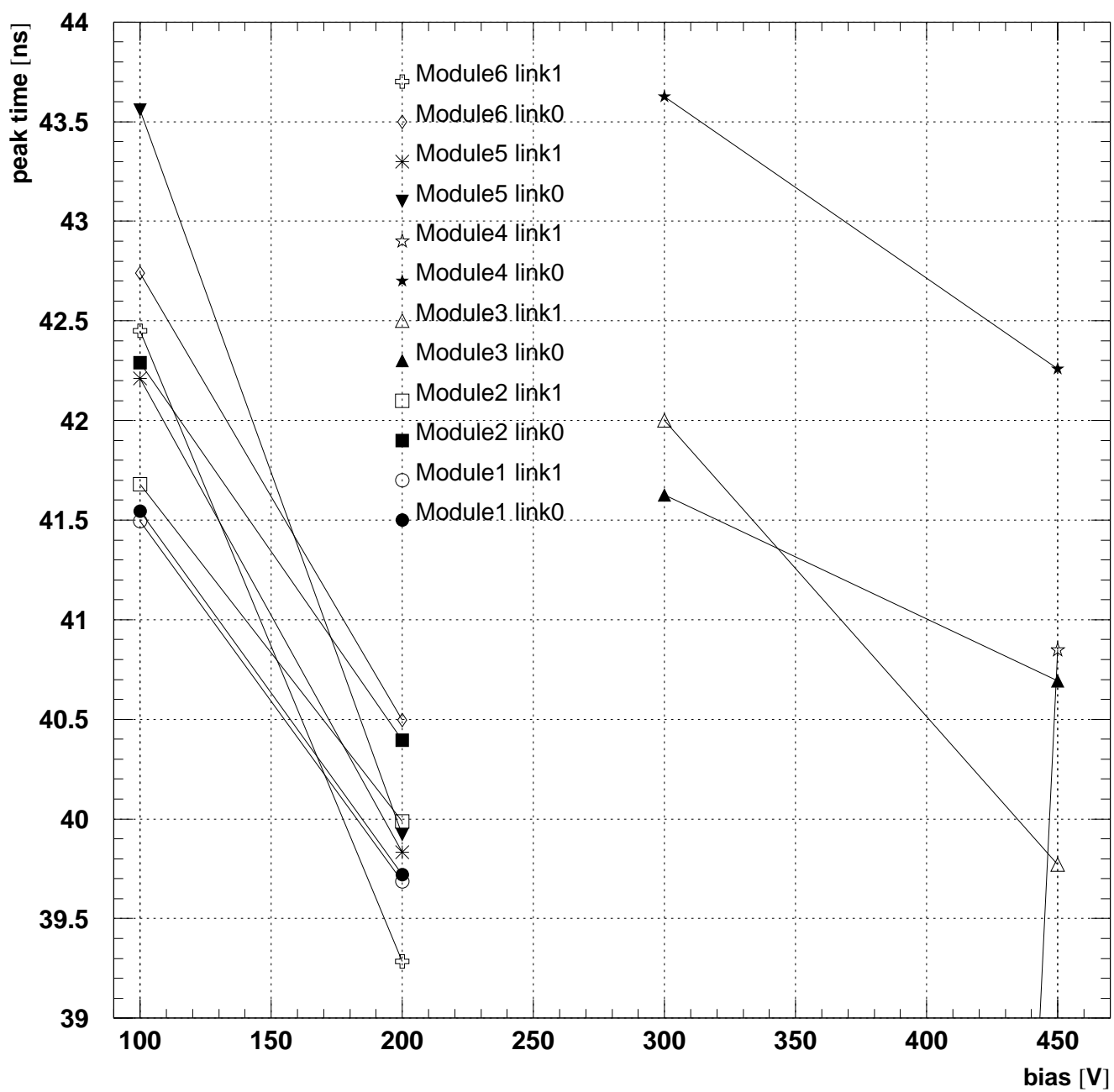
Efficiency  $>95\%$

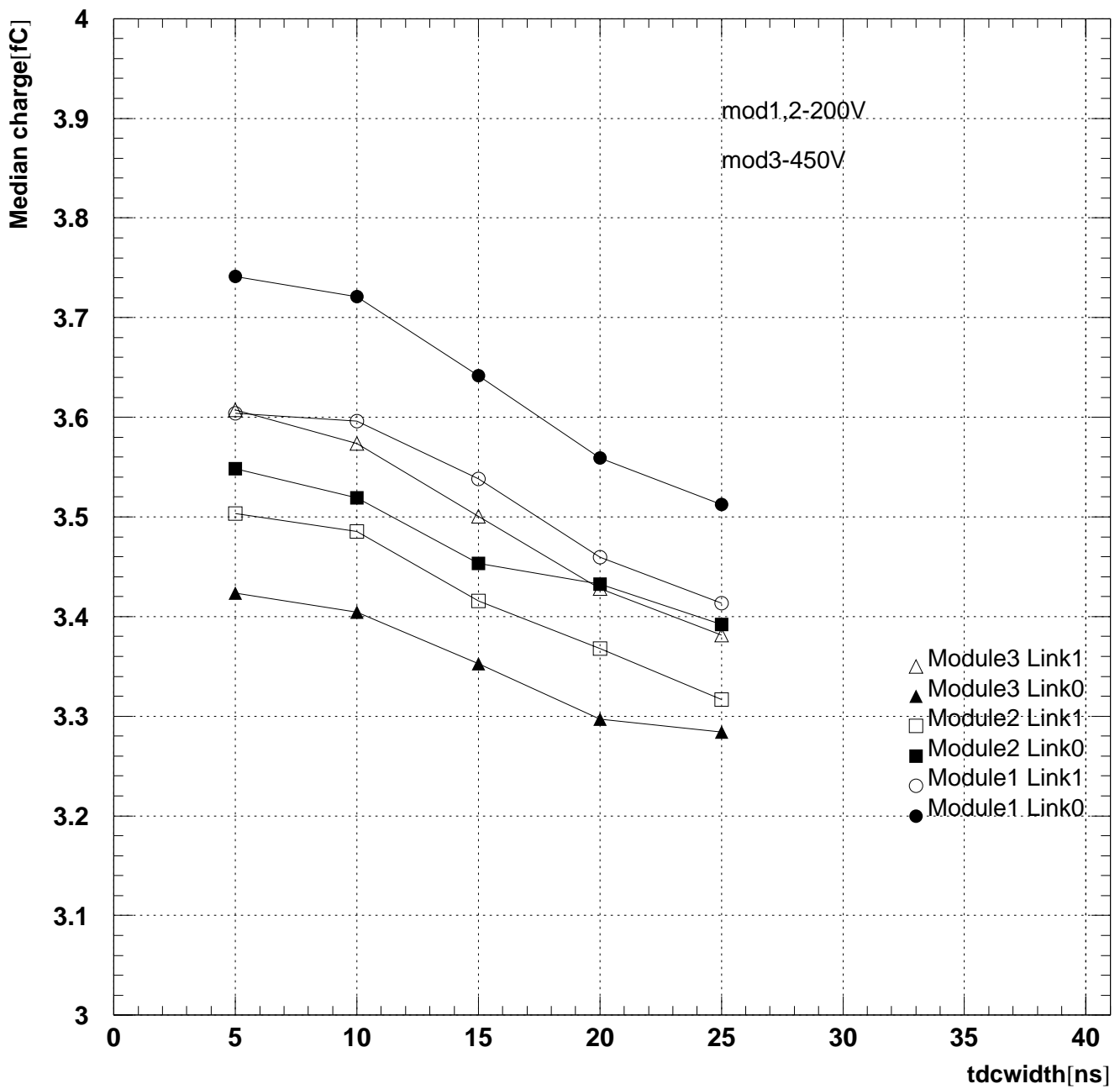
Non-irrad:  $>50\text{V}$

Irrad (Barrel):  $>250\text{V}$

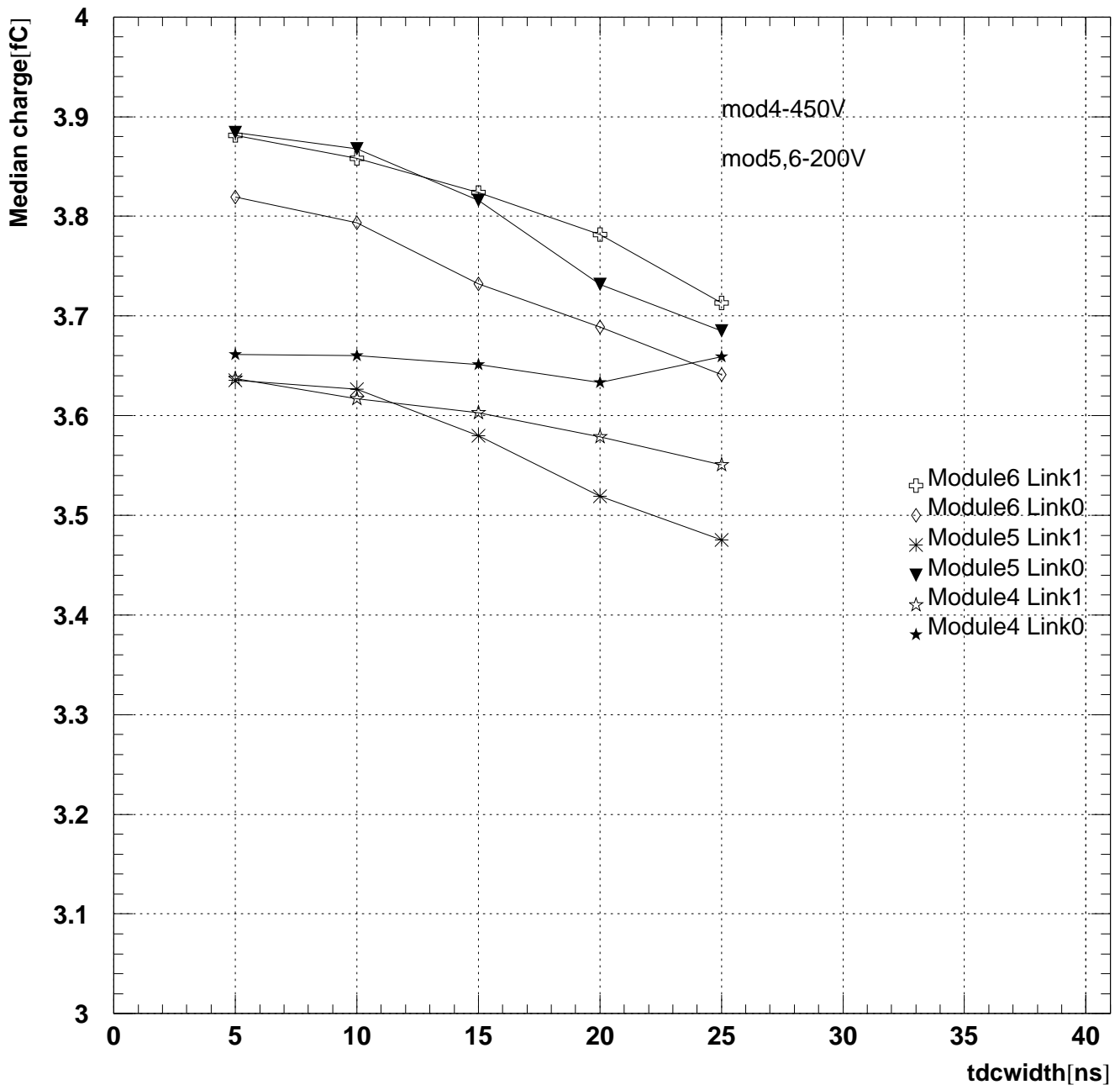


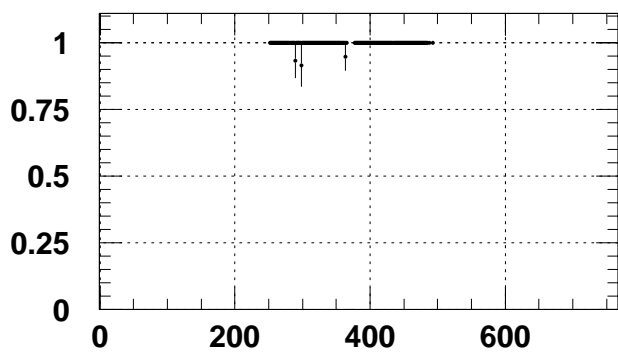




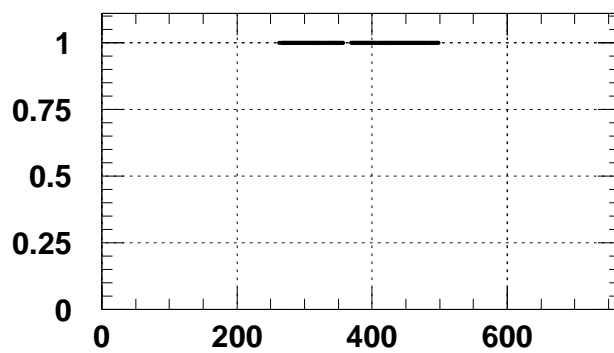




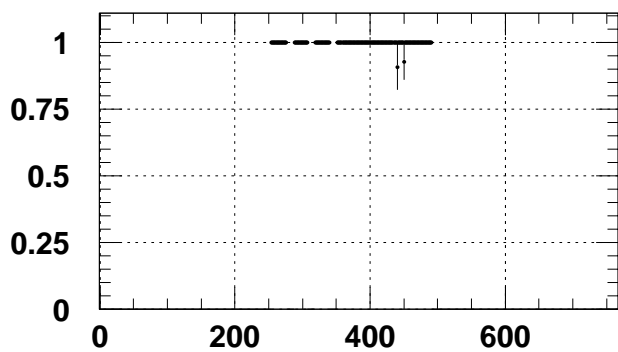




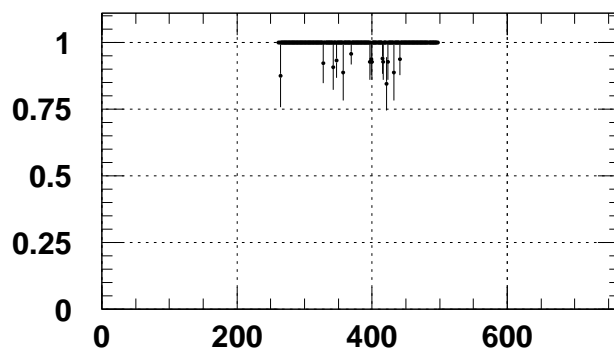
Efficiency in strip (Mod1s0)



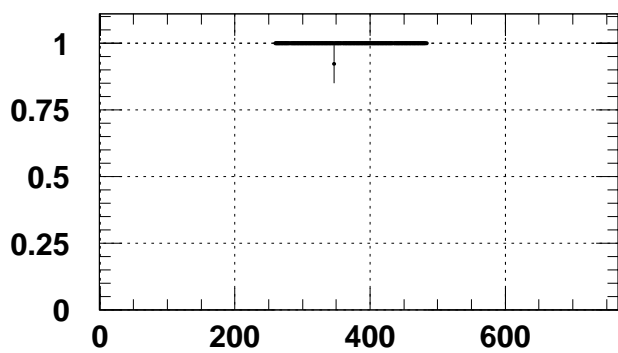
Efficiency in strip (Mod1s1)



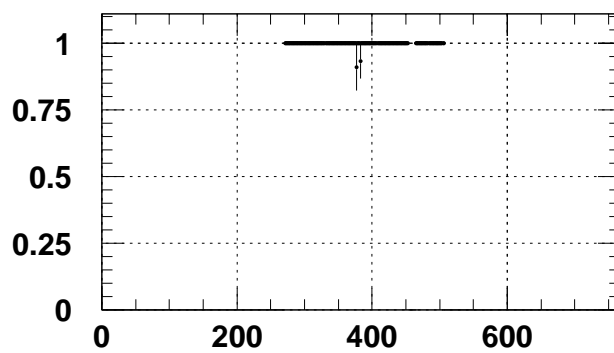
Efficiency in strip (Mod2s0)



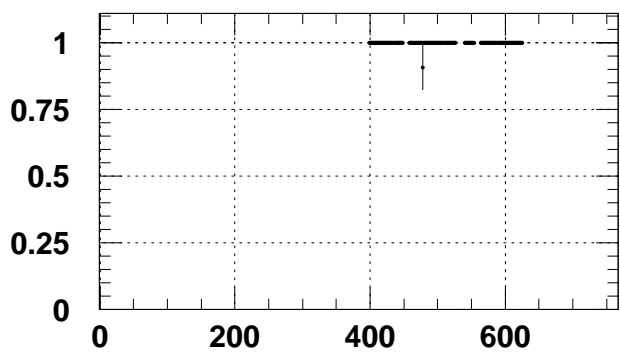
Efficiency in strip (Mod2s1)



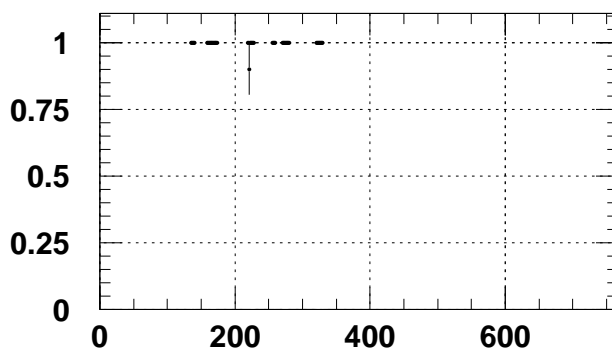
Efficiency in strip (Mod3s0)



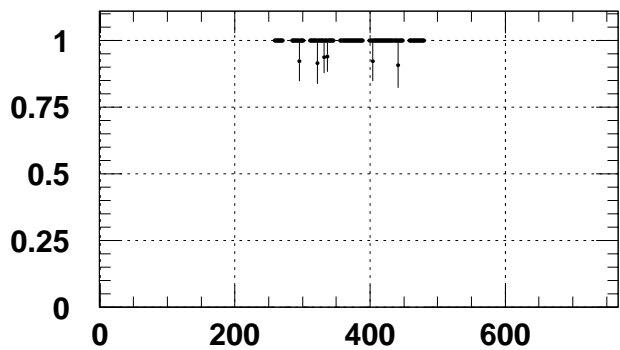
Efficiency in strip (Mod3s1)



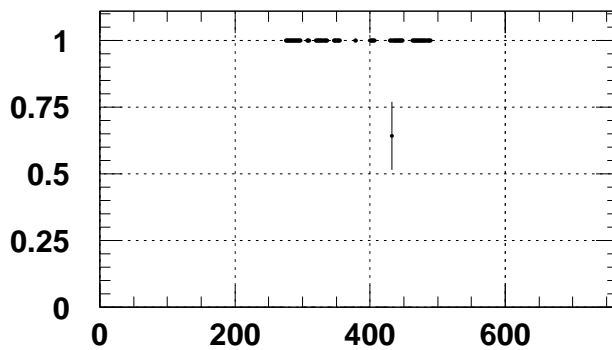
Efficiency in strip (Mod4s0)



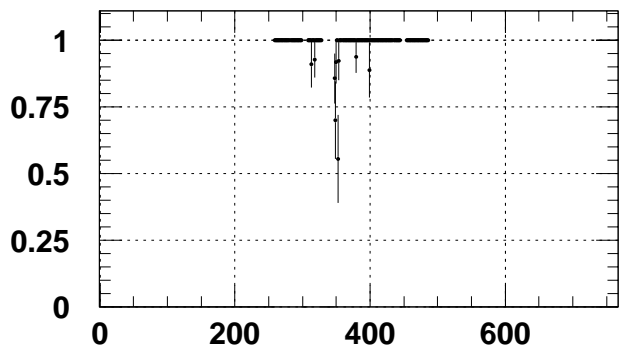
Efficiency in strip (Mod4s1)



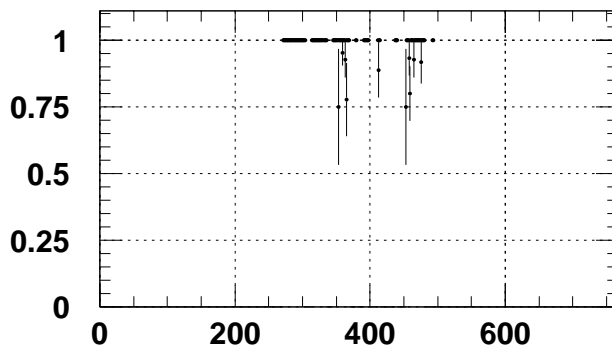
Efficiency in strip (Mod5s0)



Efficiency in strip (Mod5s1)

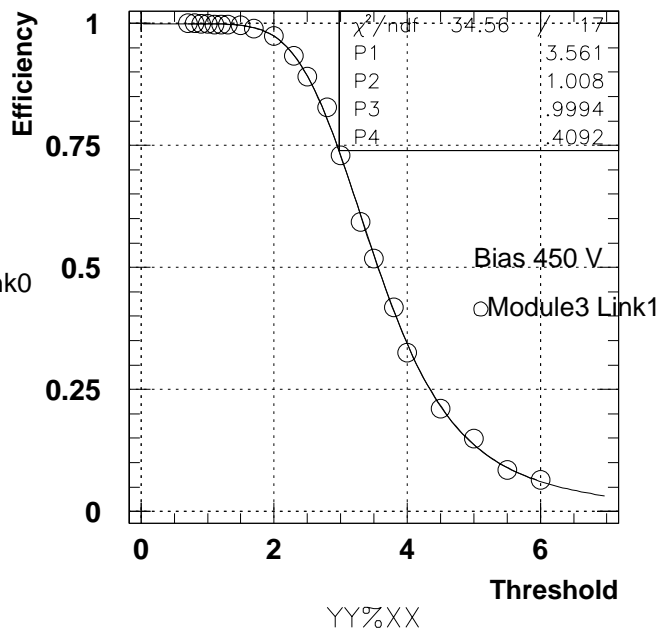
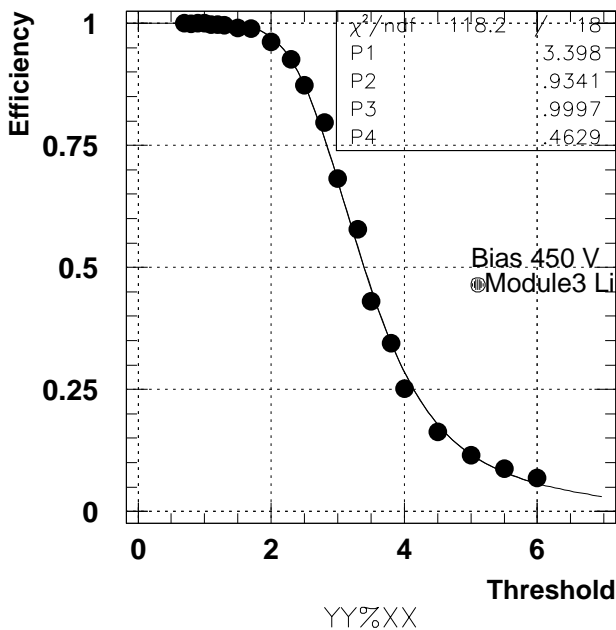
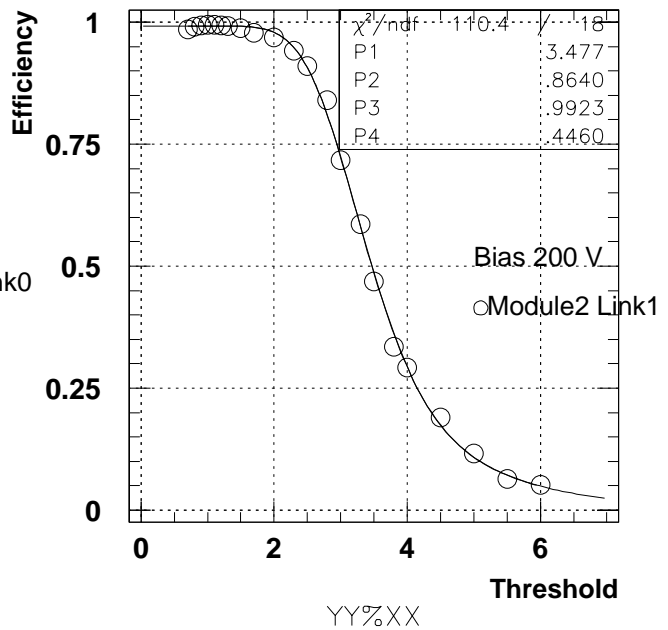
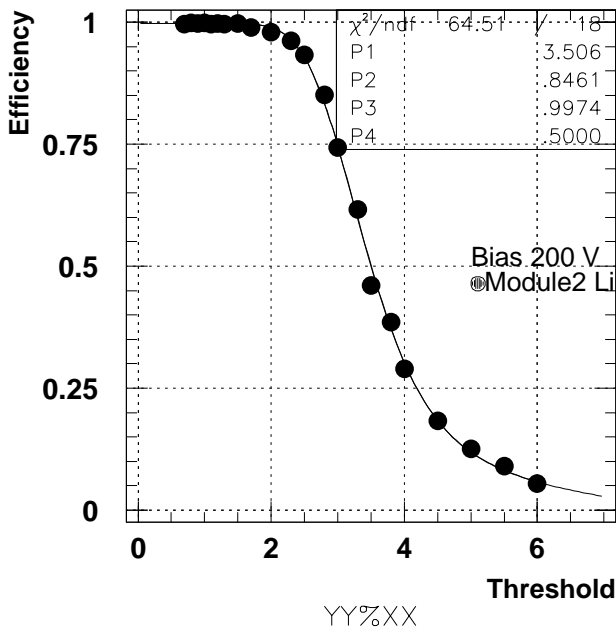
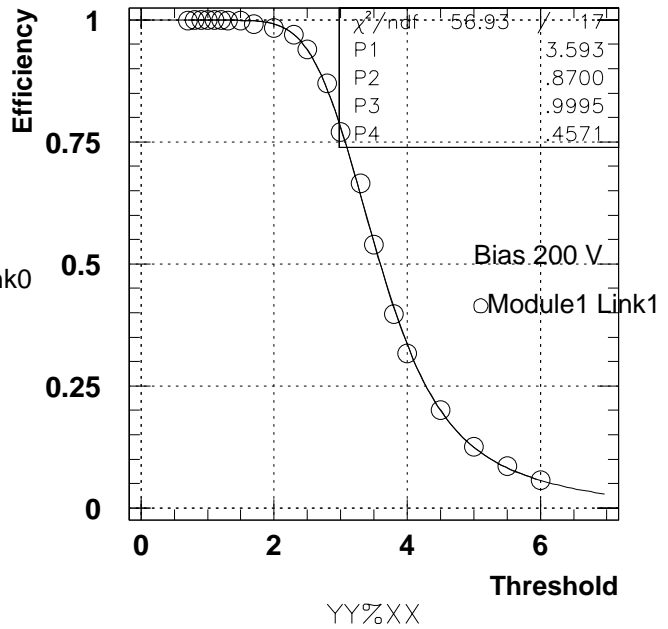
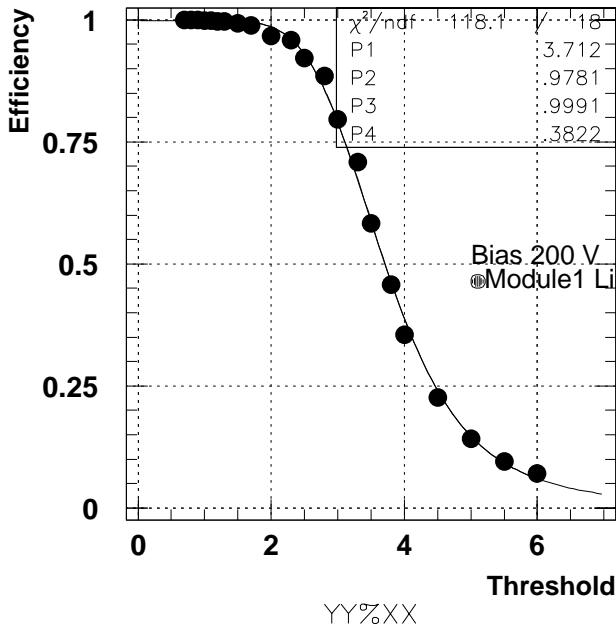


Efficiency in strip (Mod6s0)

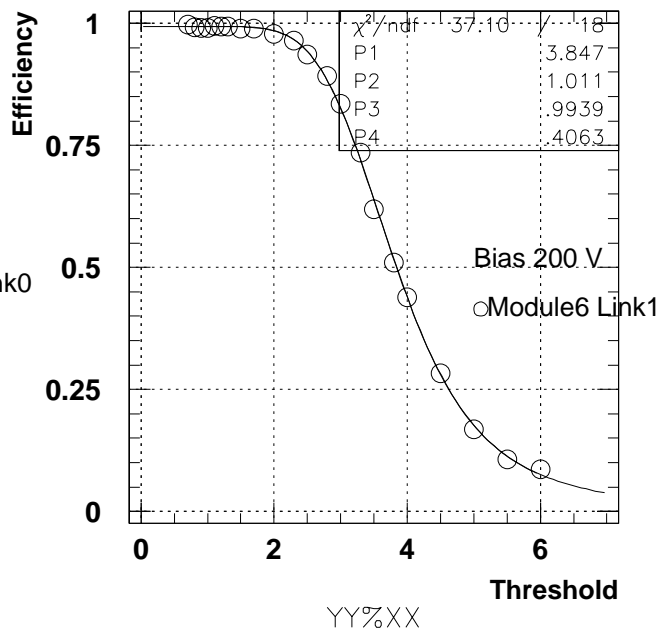
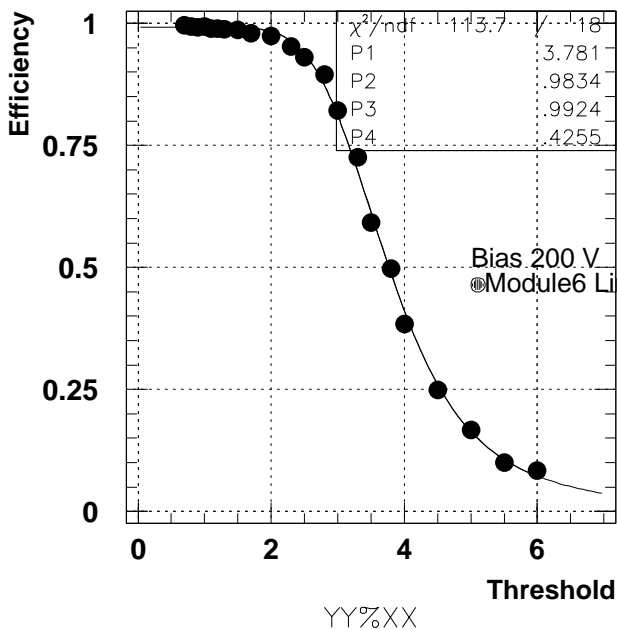
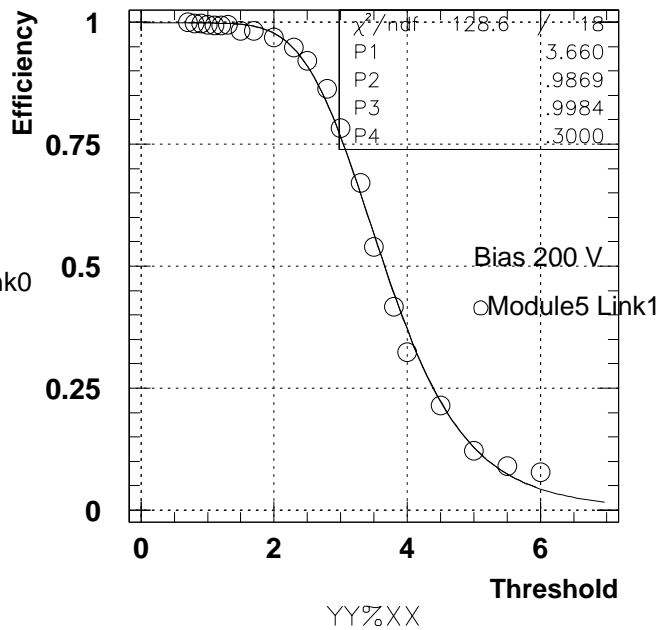
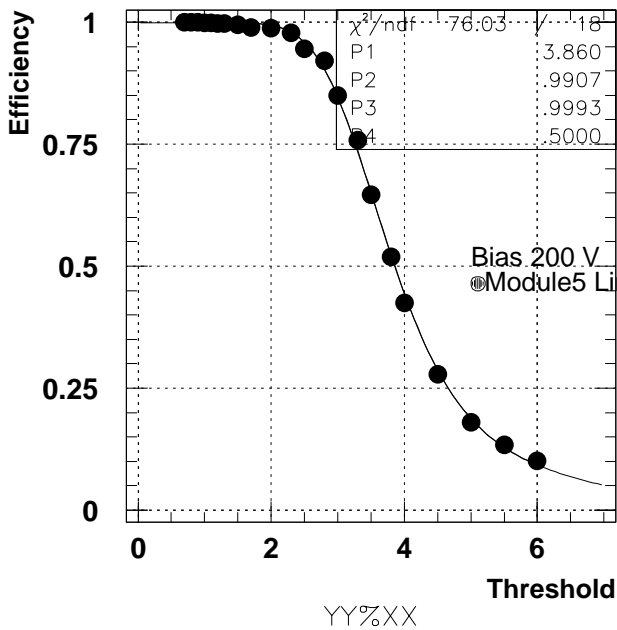
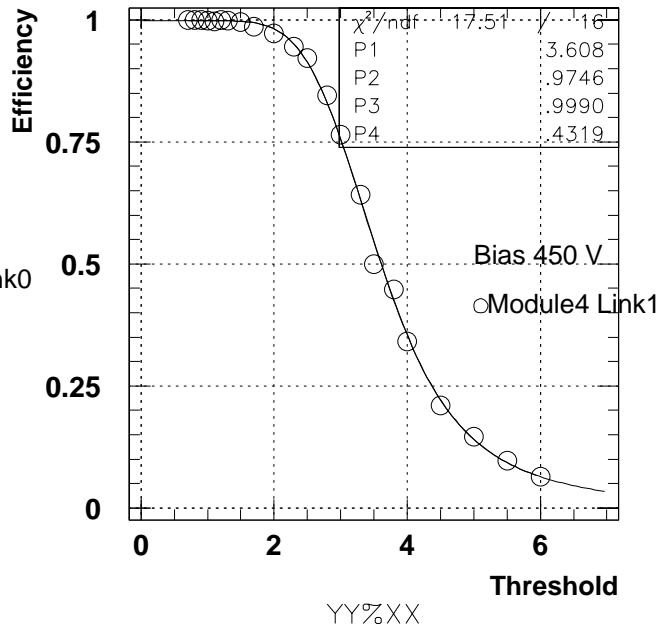
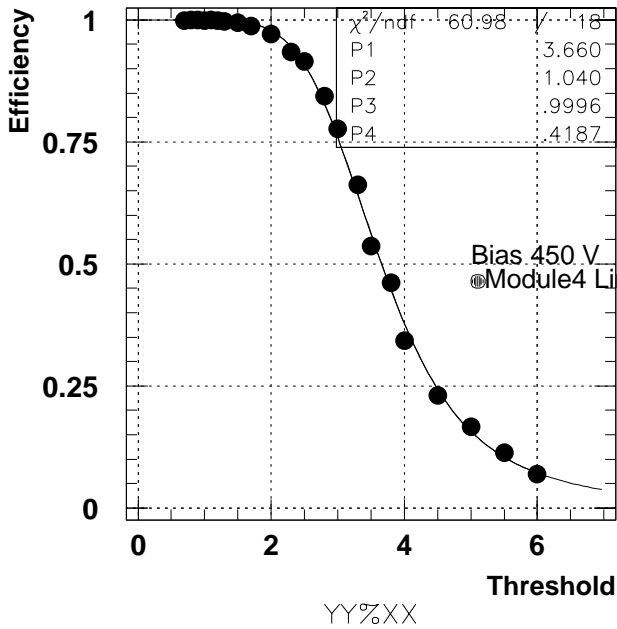


Efficiency in strip (Mod6s1)

# medianfit

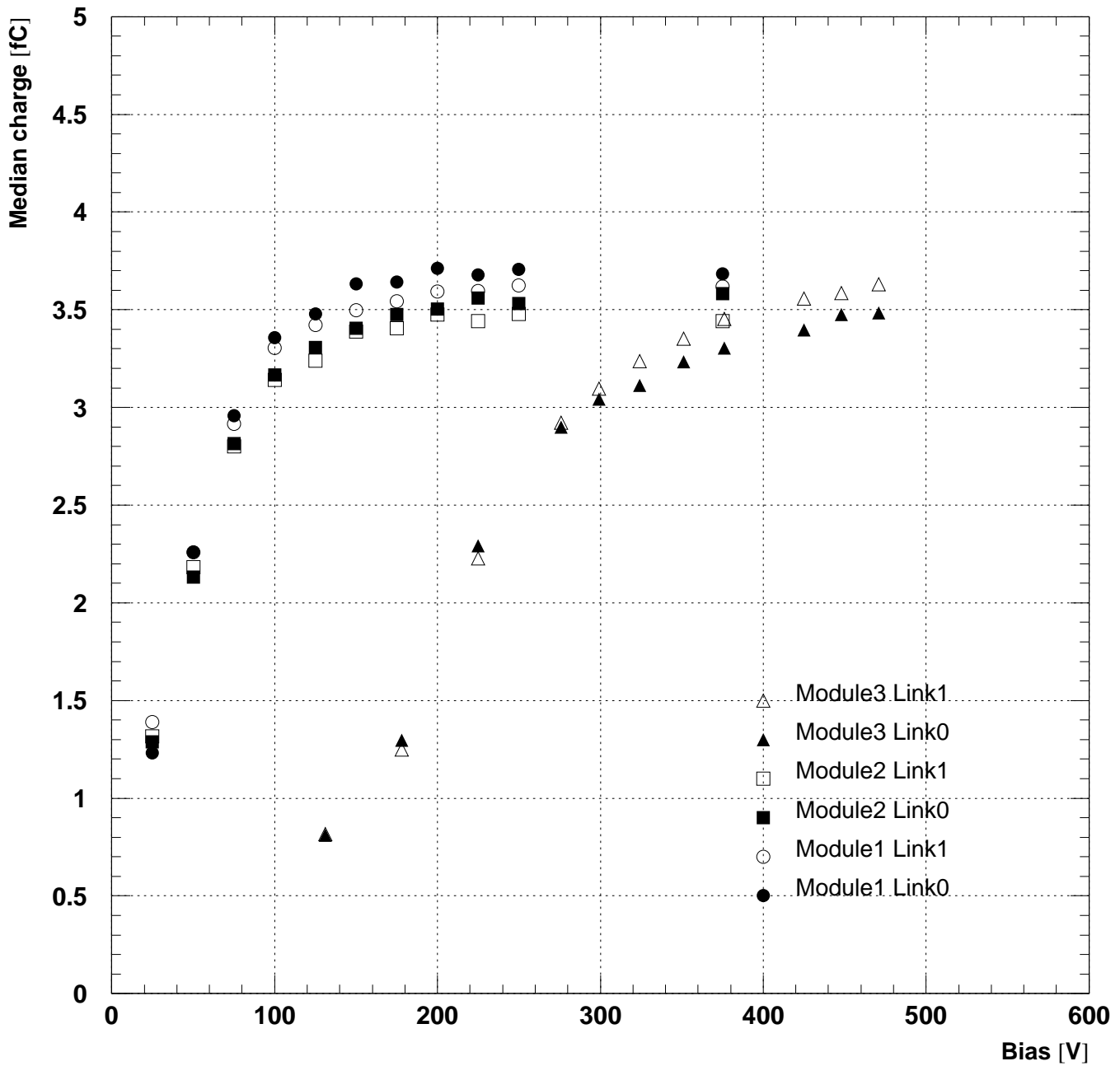


# medianfit

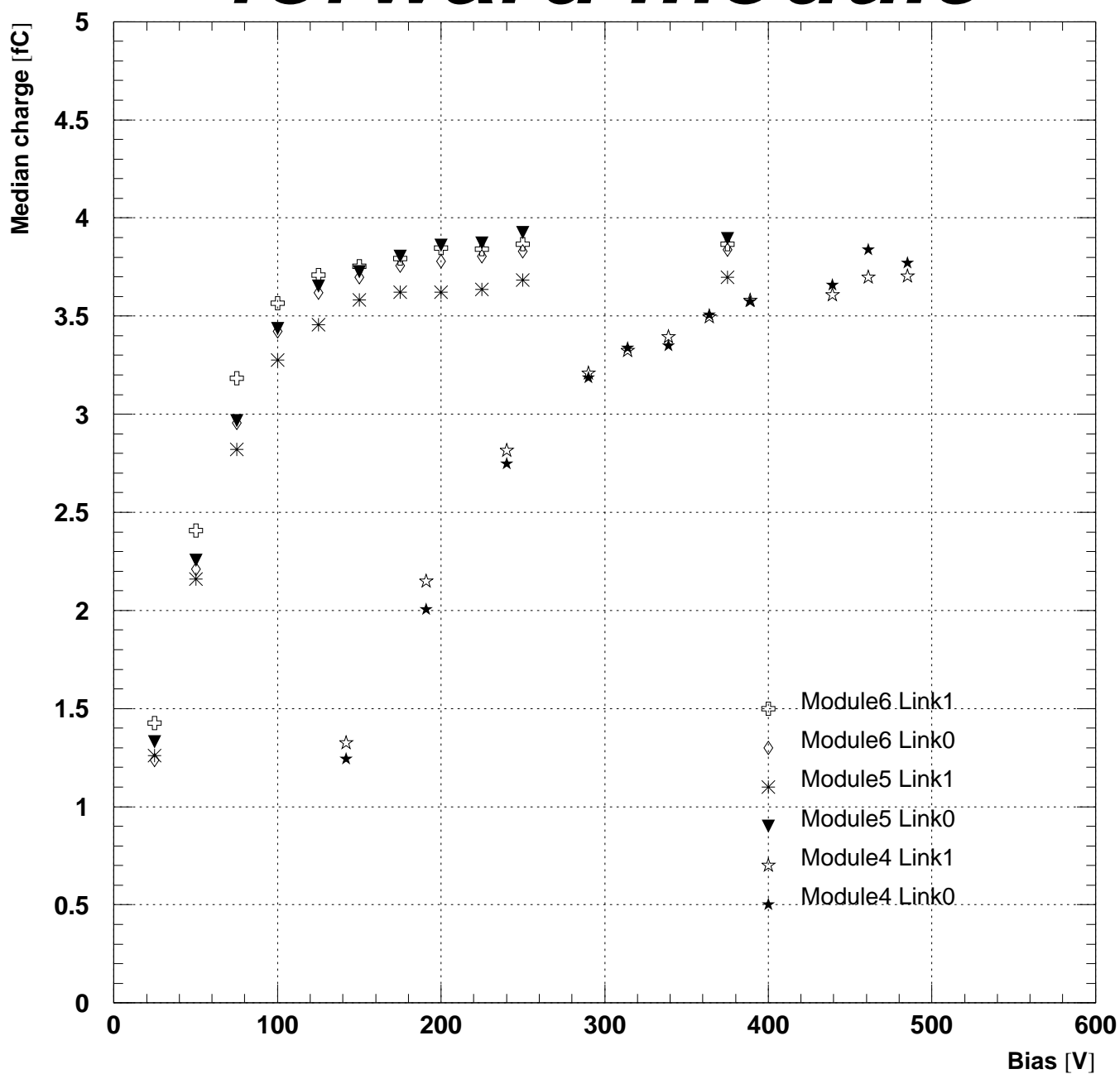




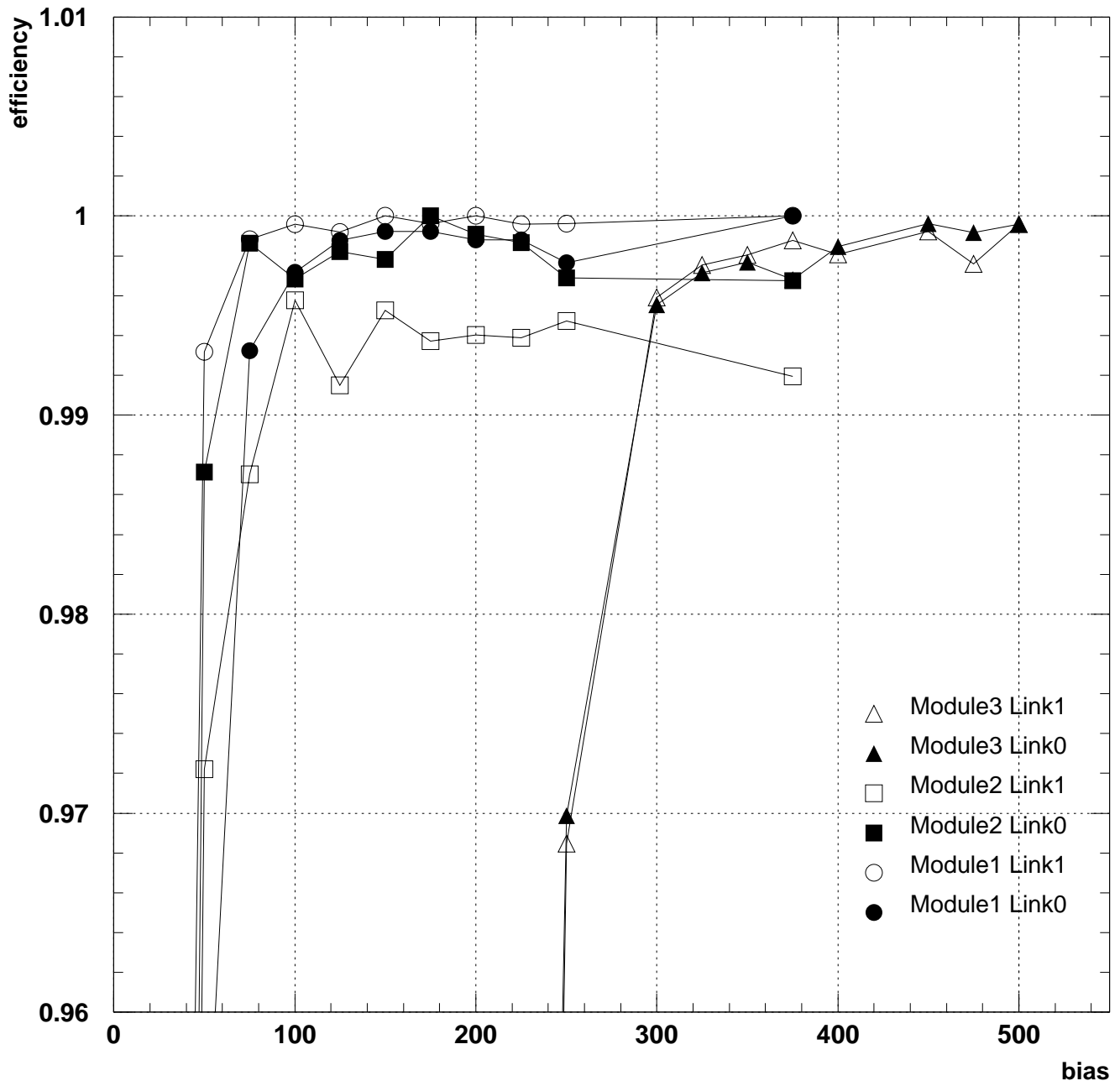
# *barrel module*



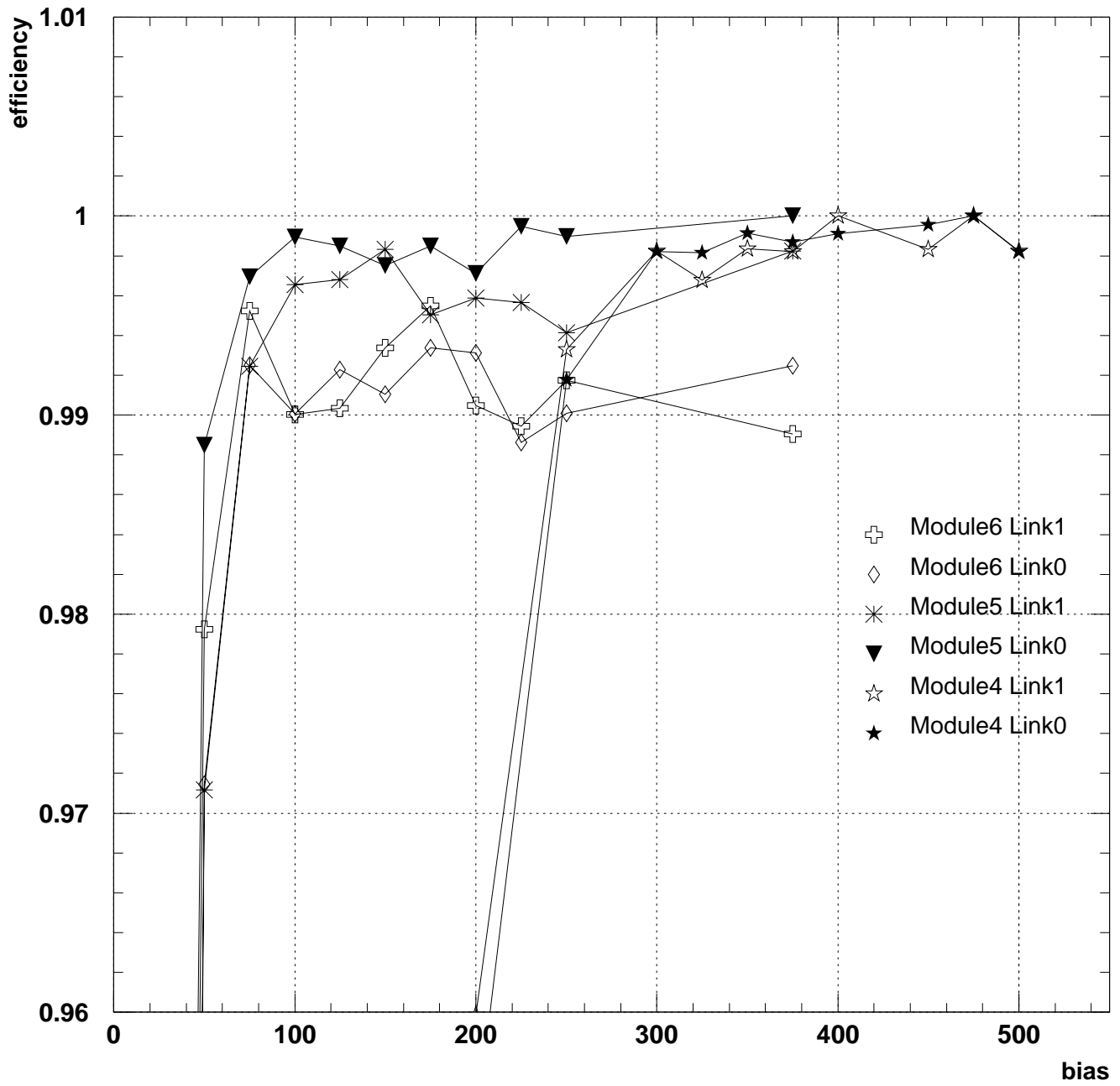
# *forward module*

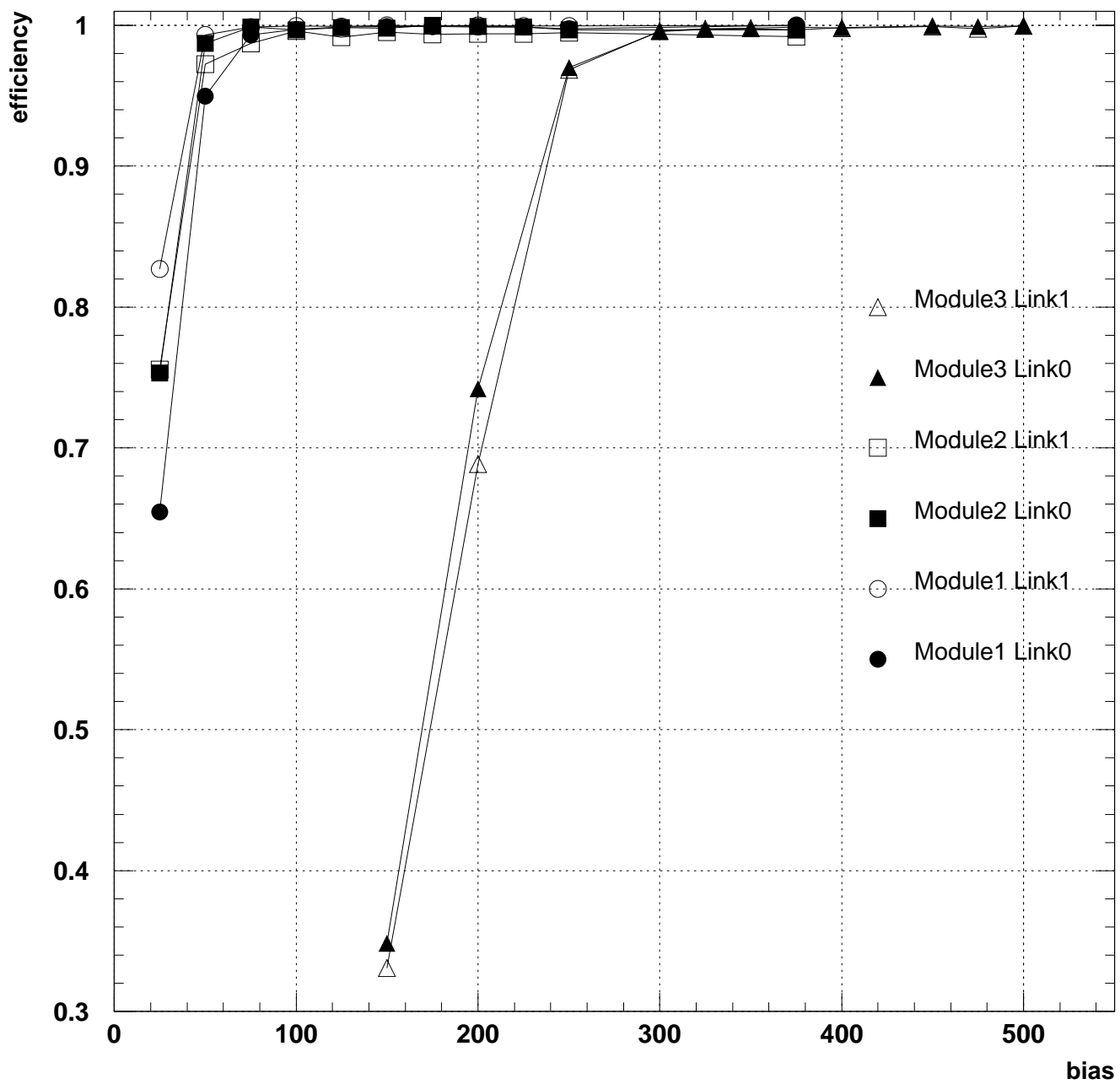


# efficiency at 1fC



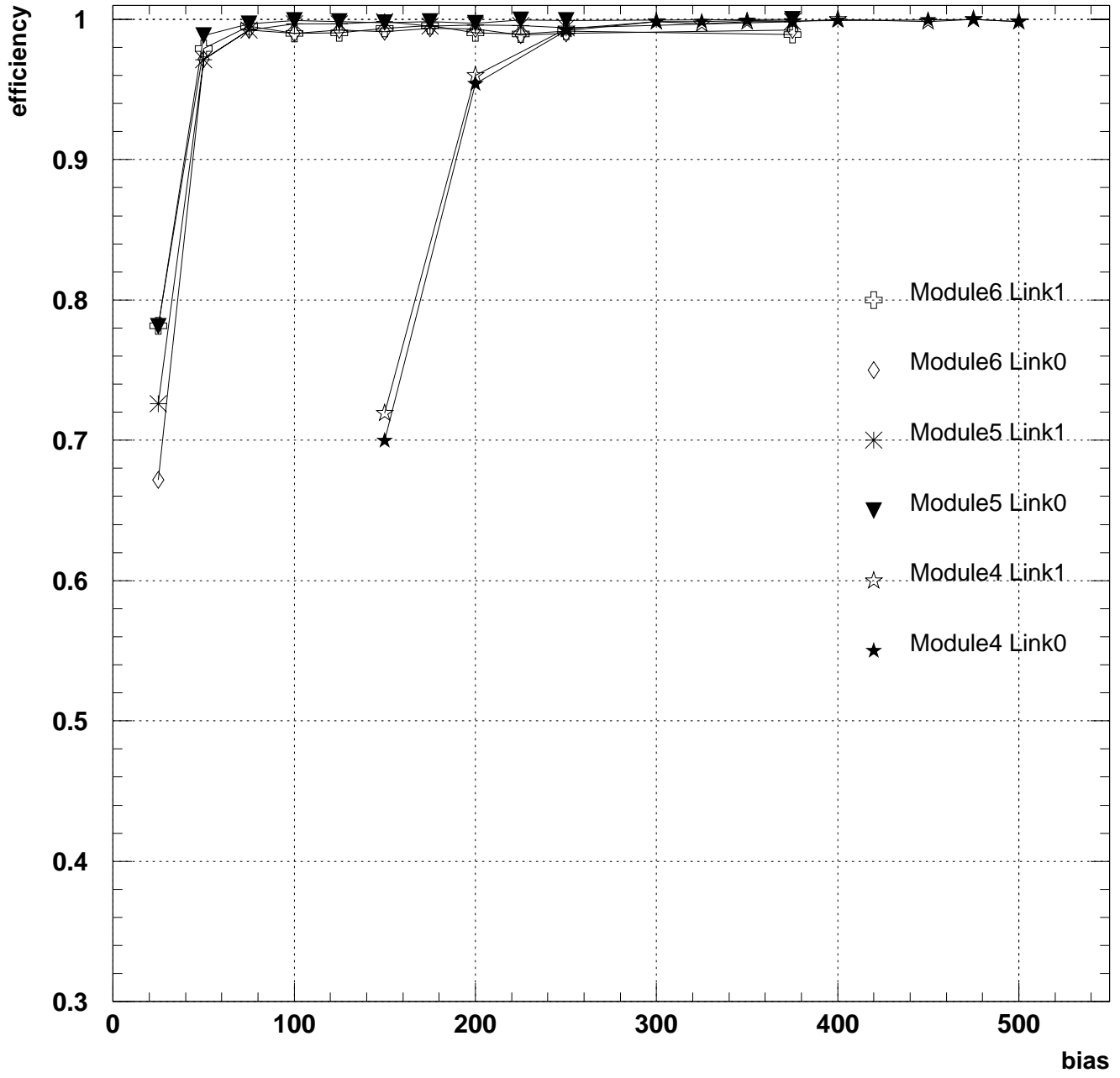
# efficiency at 1fC







# efficiency at 1fC



## Hybrid temperatures

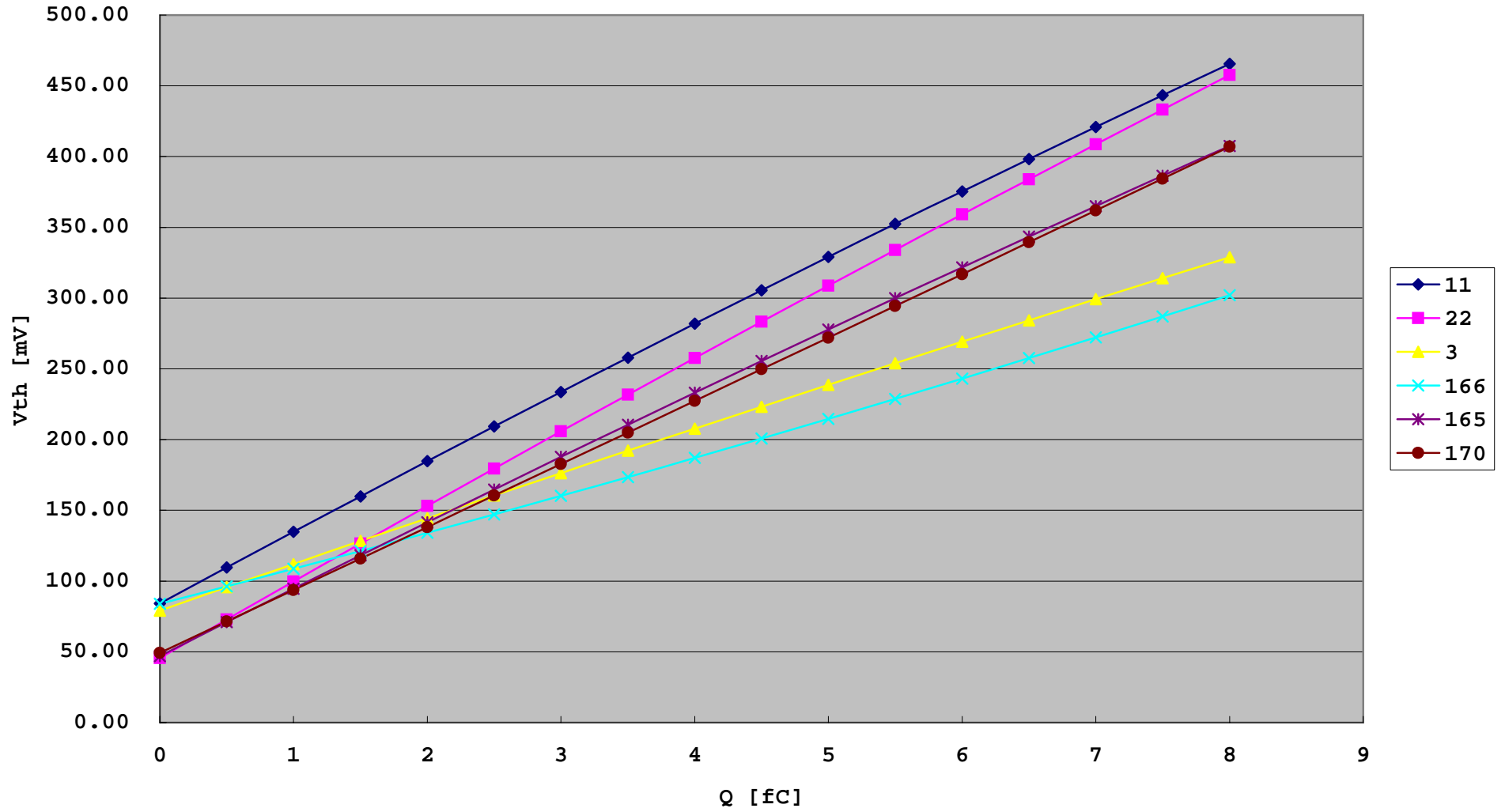
Mod#	<temp> [°C]	Vcc [V]	Icc [A]	Vdd [V]	Idd [A]	P [W]
0	0.6	3.5		4.0		
1	-1.7	3.5	~0.9	4.0	~0.5	~5.2
2	0.8	3.5	~0.9	4.0	~0.5	~5.2
3	1.4	3.5	~0.6(*)	4.8	~0.8	~5.9
4	50	3.64	~0.6(*)	5.1	~0.8	~6.3
5	34	3.5	~0.9	4.0	~0.5	~5.2
6	--	3.5	~0.9	4.0	~0.5	~5.2

(\*) FEbias current=129 $\mu$ A, FEshaper=24 $\mu$ A

## Calibration curves - in situ (cold)

Mod#	Name	<Gain> (at 0fC) [mV/fC]
1	11	51.2
2	22	54.5
3	03	33.1
4	166	24.3
5	165	48.0
6	170	44.3

Calibration (cold)



# Noise occupancy

- **Timebin distribution**

Timebin=100

- **Threshold dependence**

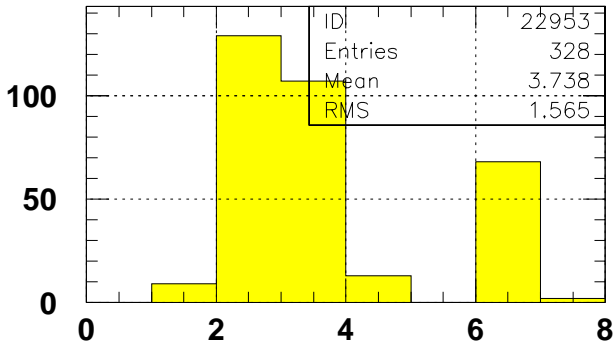
- **Bias voltage dependence at 1fC**

Barrel: non-irrad  $\sim 2 \times 10^{-6}$ , irrad  $\sim 3 \times 10^{-4}$

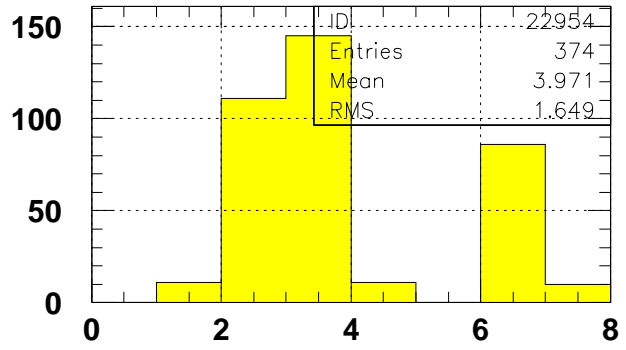
Forward: non-irrad  $\sim 2 \times 10^{-5}$ , irrad  $\sim 3 \times 10^{-3}$

Forward: one order larger than the barrel

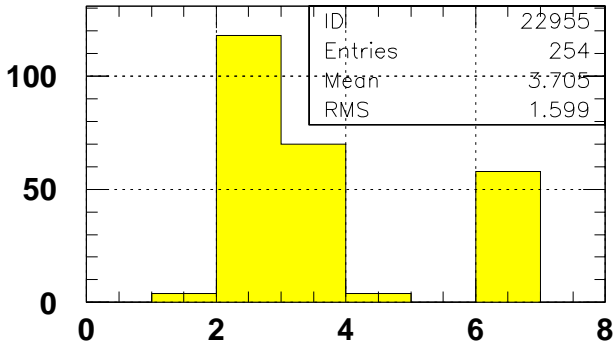
# bias(mod1,2,5,6:200V 3,4:450V) threshold(1fC) run3479



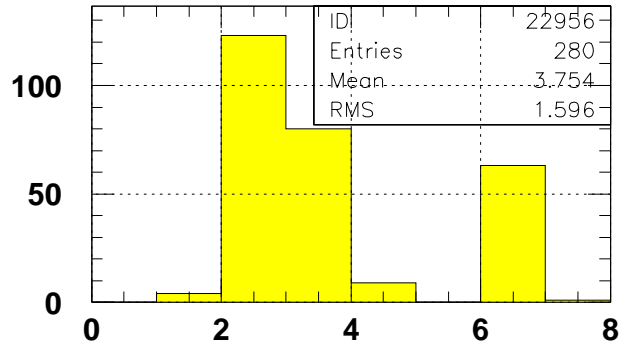
Noise hit channel per timebin (Mod1s0)



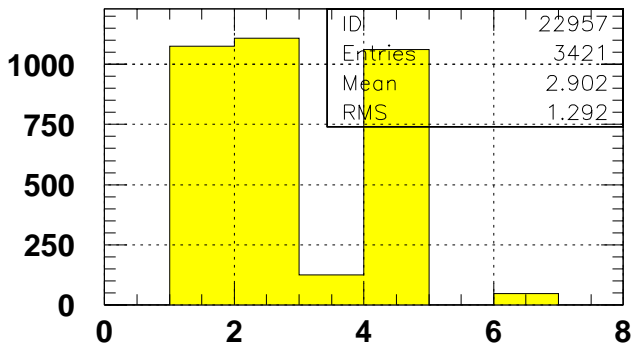
Noise hit channel per timebin (Mod1s1)



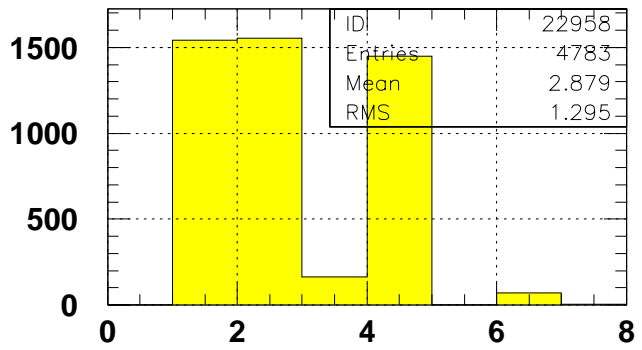
Noise hit channel per timebin (Mod2s0)



Noise hit channel per timebin (Mod2s1)

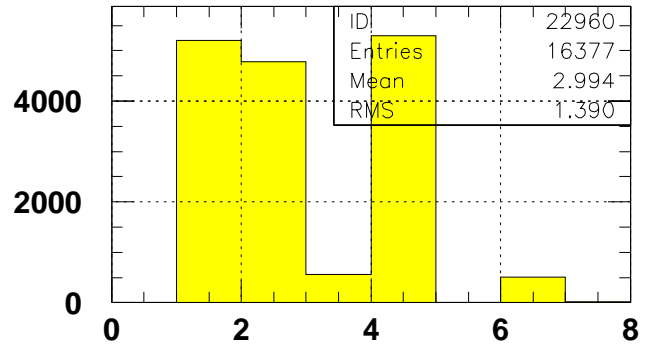
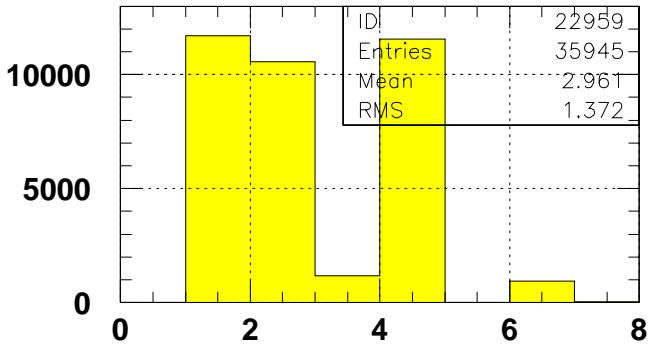


Noise hit channel per timebin (Mod3s0)



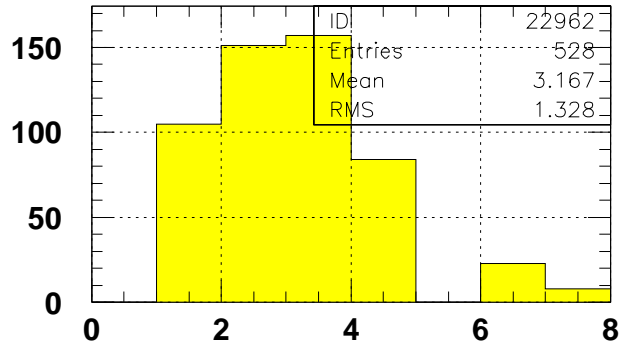
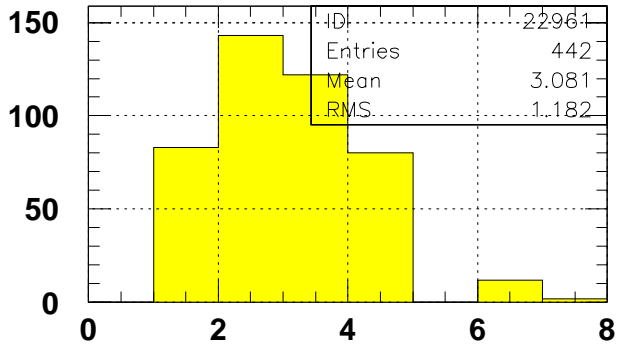
Noise hit channel per timebin (Mod3s1)

# bias(mod1,2,5,6:200V 3,4:450V) threshold(1fC) run3479



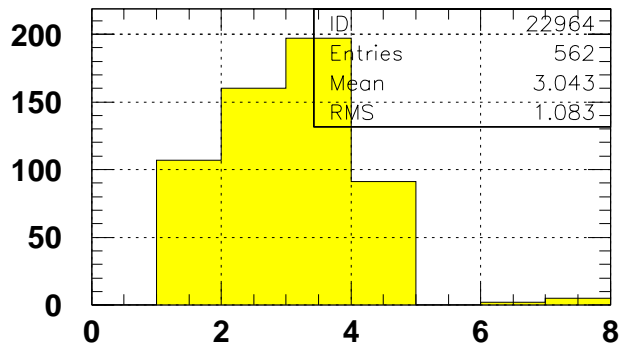
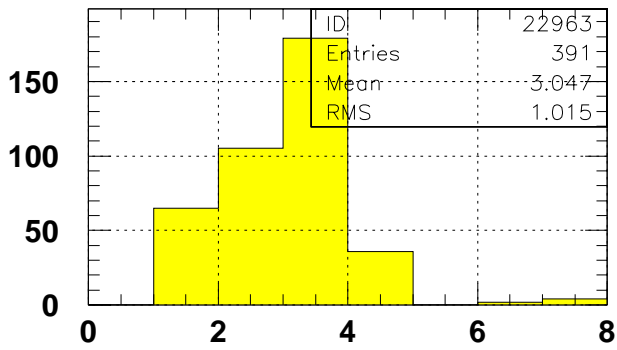
Noise hit channel per timebin (Mod4s0)

Noise hit channel per timebin (Mod4s1)



Noise hit channel per timebin (Mod5s0)

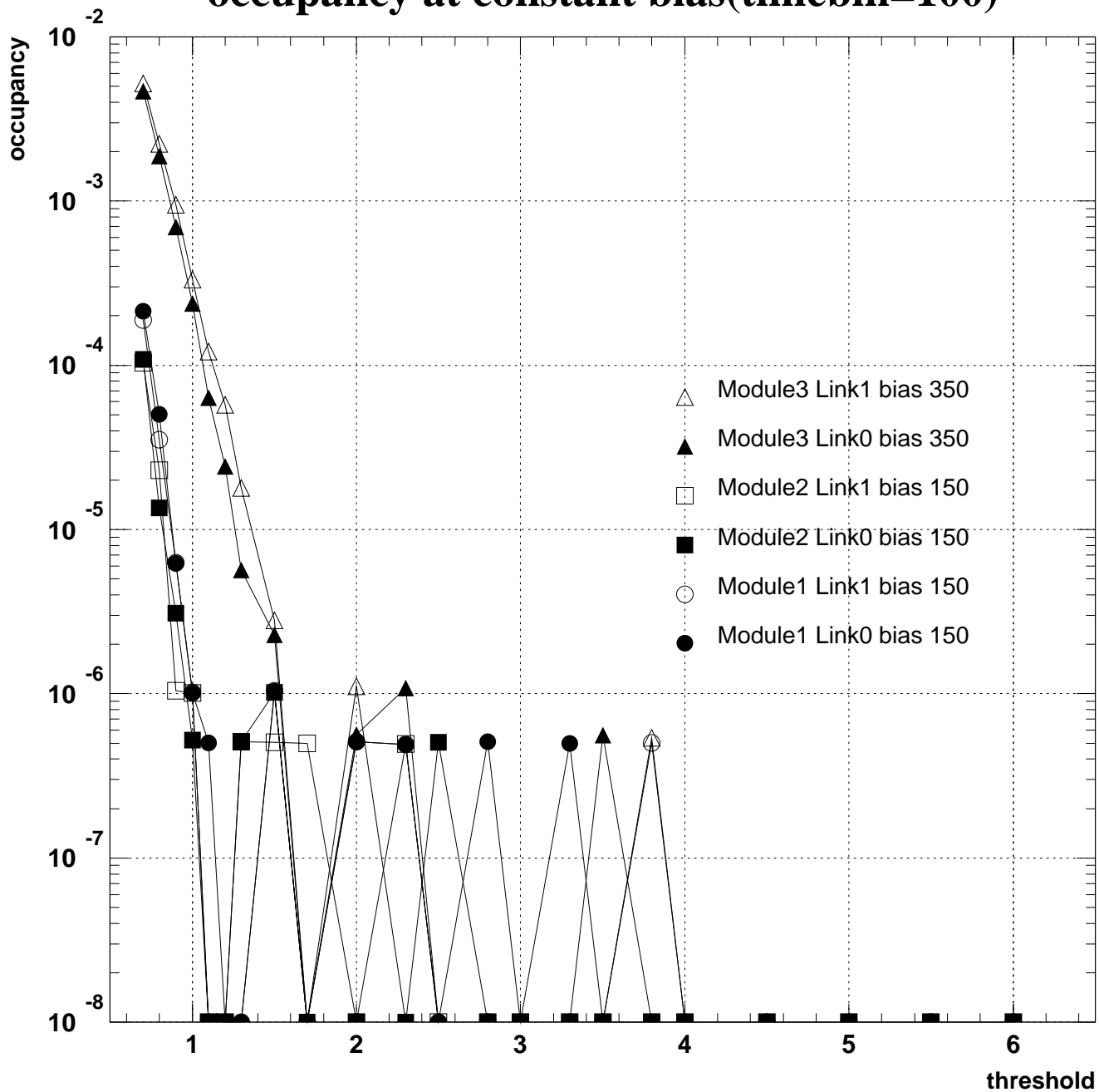
Noise hit channel per timebin (Mod5s1)



Noise hit channel per timebin (Mod6s0)

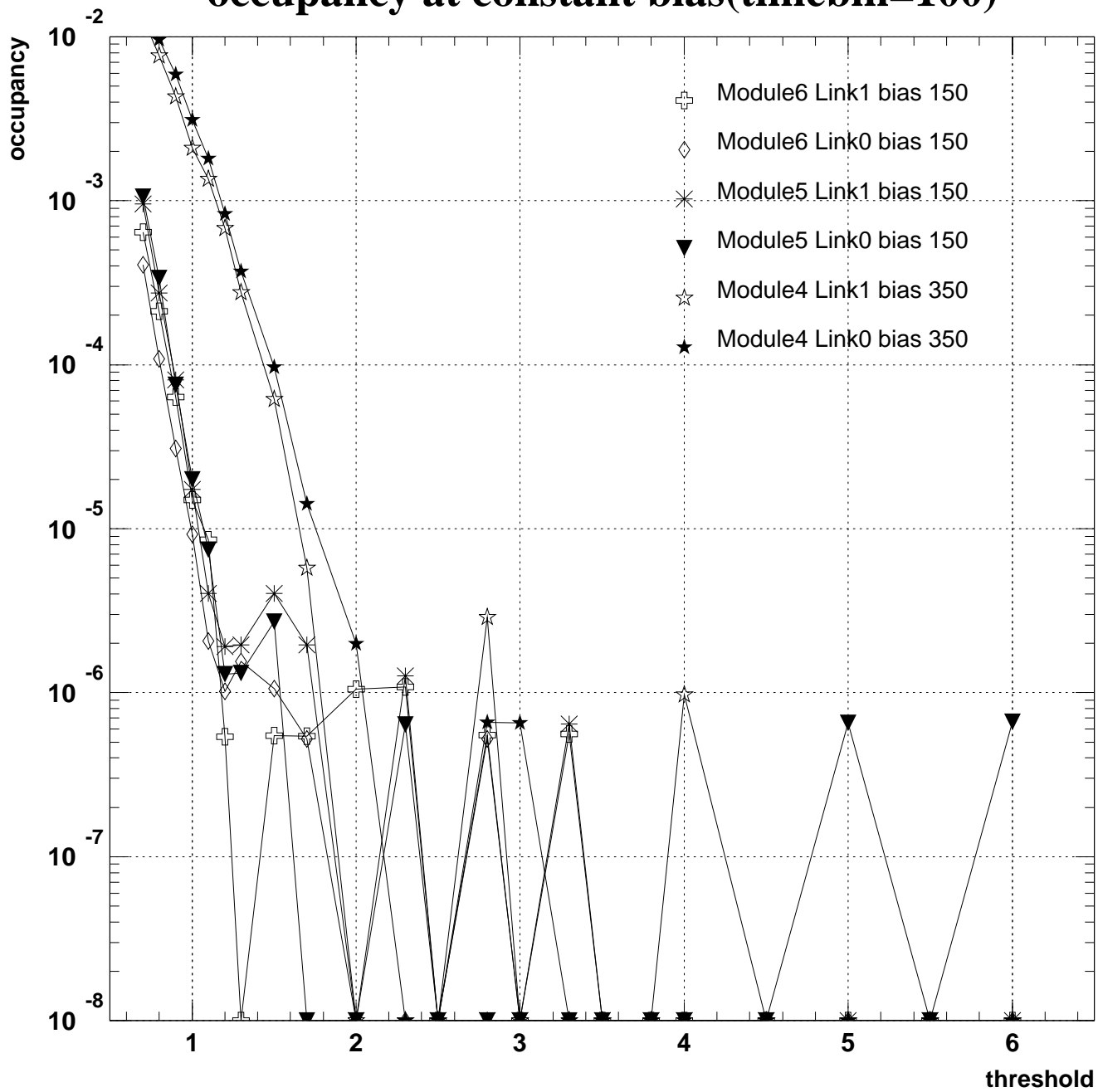
Noise hit channel per timebin (Mod6s1)

# occupancy at constant bias(timebin=100)

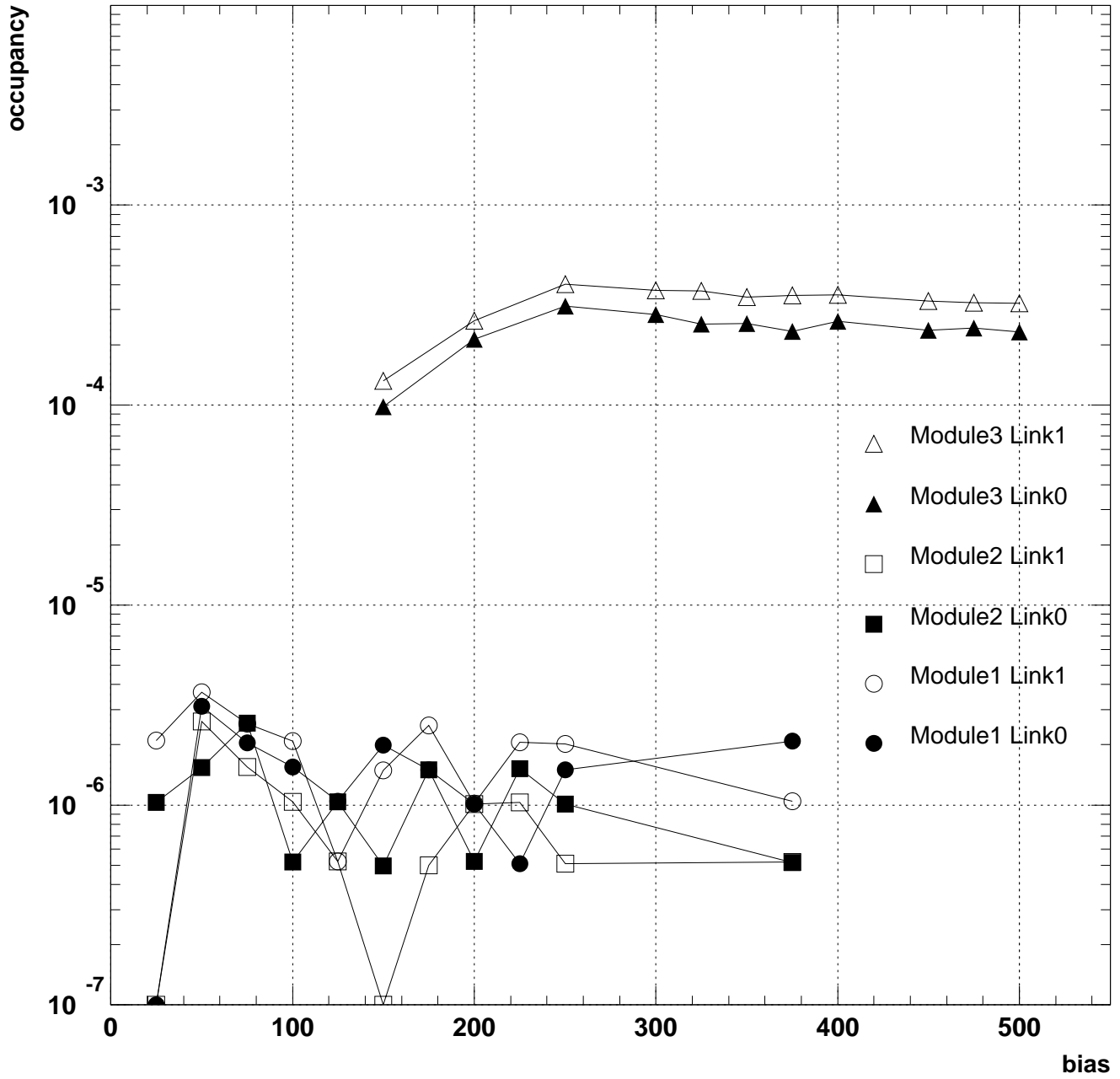




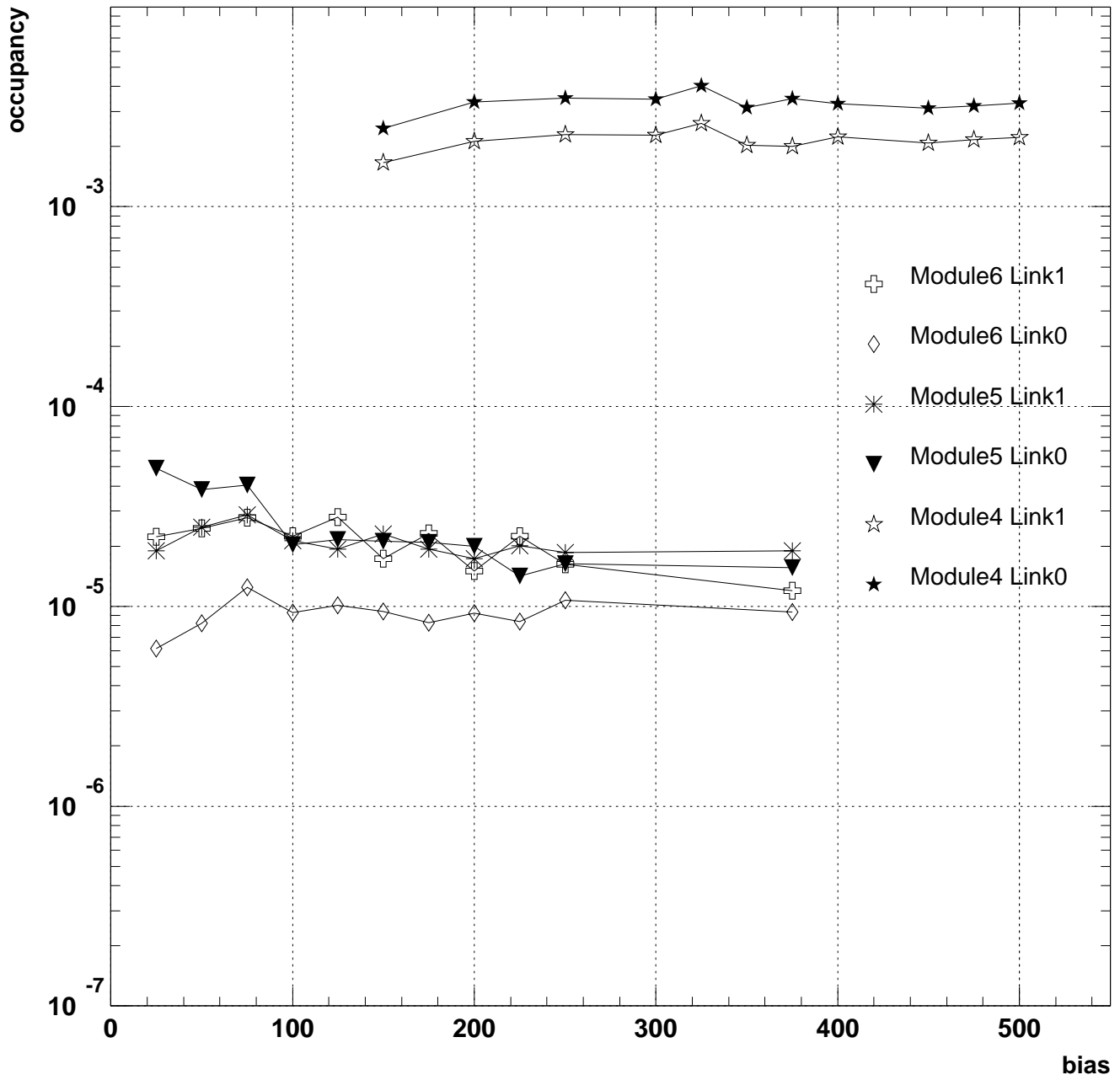
# occupancy at constant bias(timebin=100)



# occupancy at 1fC: timebin=100



# occupancy at 1fC: timebin=100



# Resolution

- **Threshold dependence**

**Barrel:**

**Mod 2, 3: Gaussian sigma (weighted fit)  $\sim 25 \mu\text{m}$  at 1fC**

**Mod1:  $\sim 29 \mu\text{m}$  (track extrapolation)**

**Forward:**

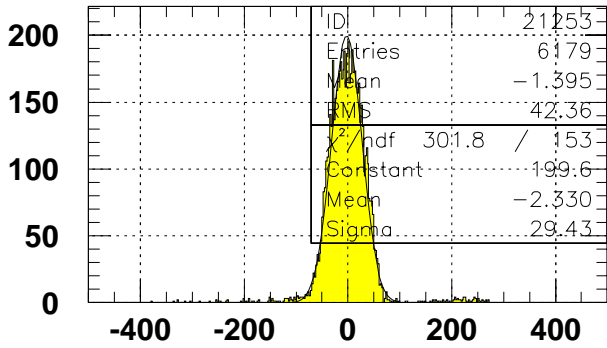
**Strip pitch  $\sim 85 \mu\text{m}$**

**Not optimized yet**

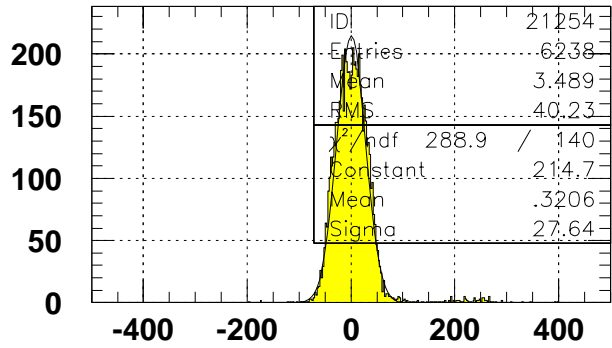
- **Bias voltage dependence at 1fC**

**no dependence**

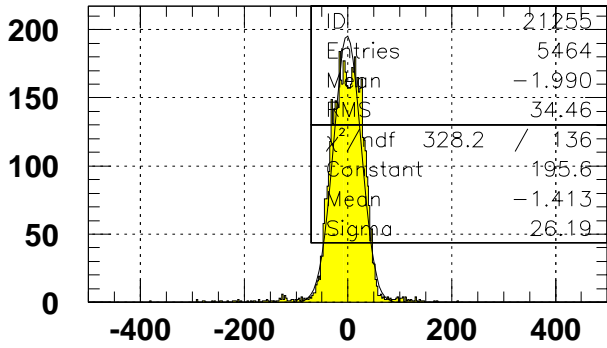
# bias(mod1,2,5,6:200V 3,4:450V) threshold(1fC) run3479



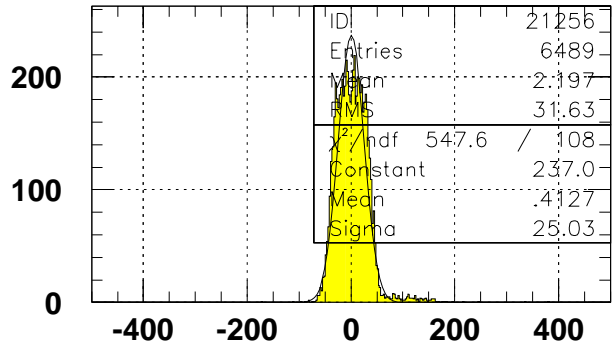
Diff (Nearest clus - track) (Mod1s0)



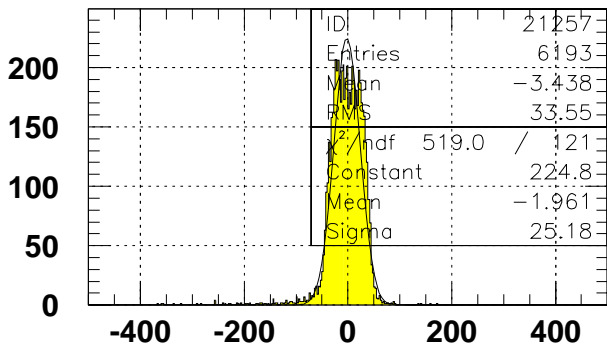
Diff (Nearest clus - track) (Mod1s1)



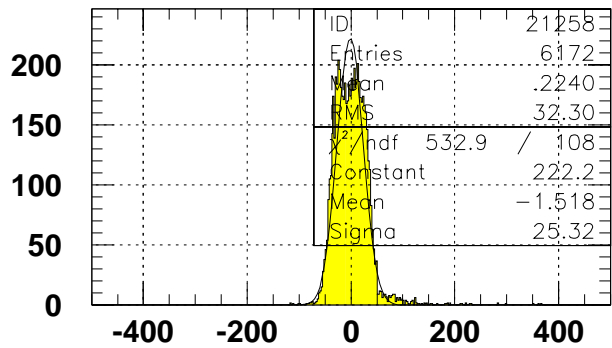
Diff (Nearest clus - track) (Mod2s0)



Diff (Nearest clus - track) (Mod2s1)

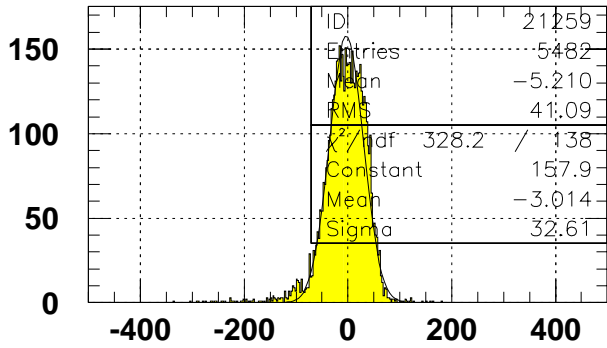


Diff (Nearest clus - track) (Mod3s0)

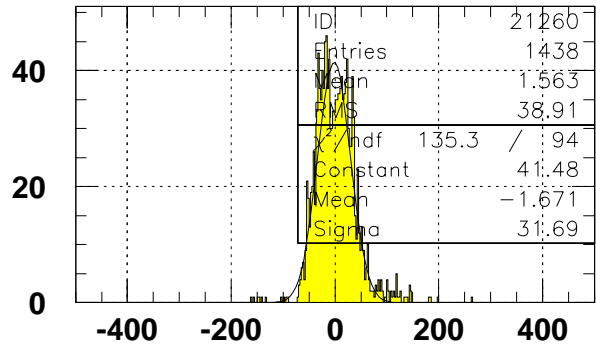


Diff (Nearest clus - track) (Mod3s1)

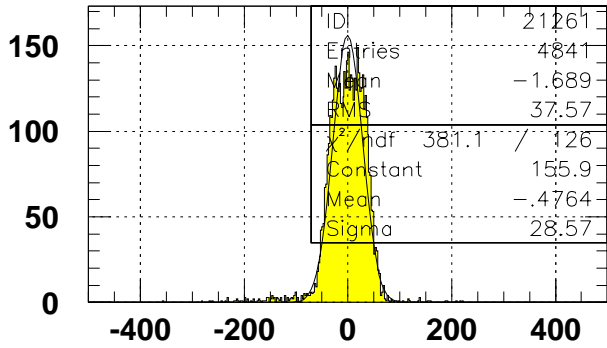
# bias(mod1,2,5,6:200V 3,4:450V) threshold(1fC) run3479



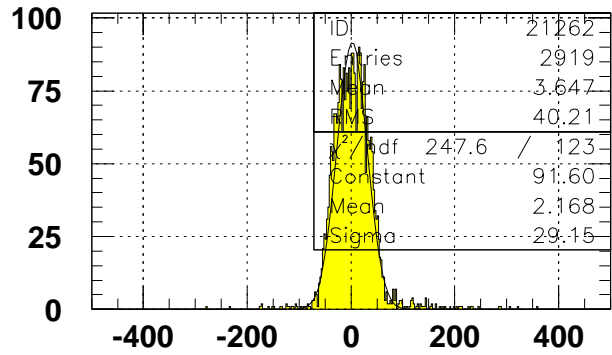
Diff (Nearest clus - track) (Mod4s0)



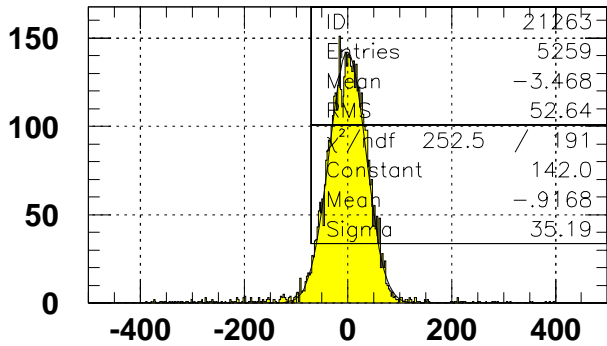
Diff (Nearest clus - track) (Mod4s1)



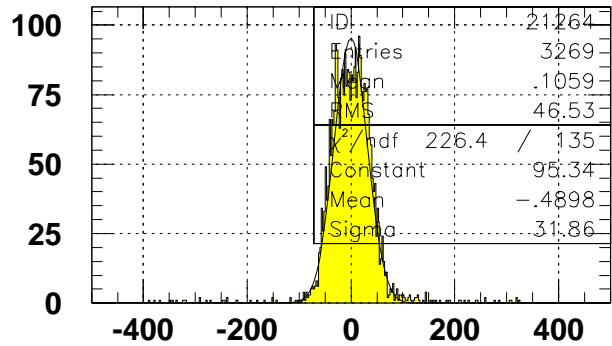
Diff (Nearest clus - track) (Mod5s0)



Diff (Nearest clus - track) (Mod5s1)

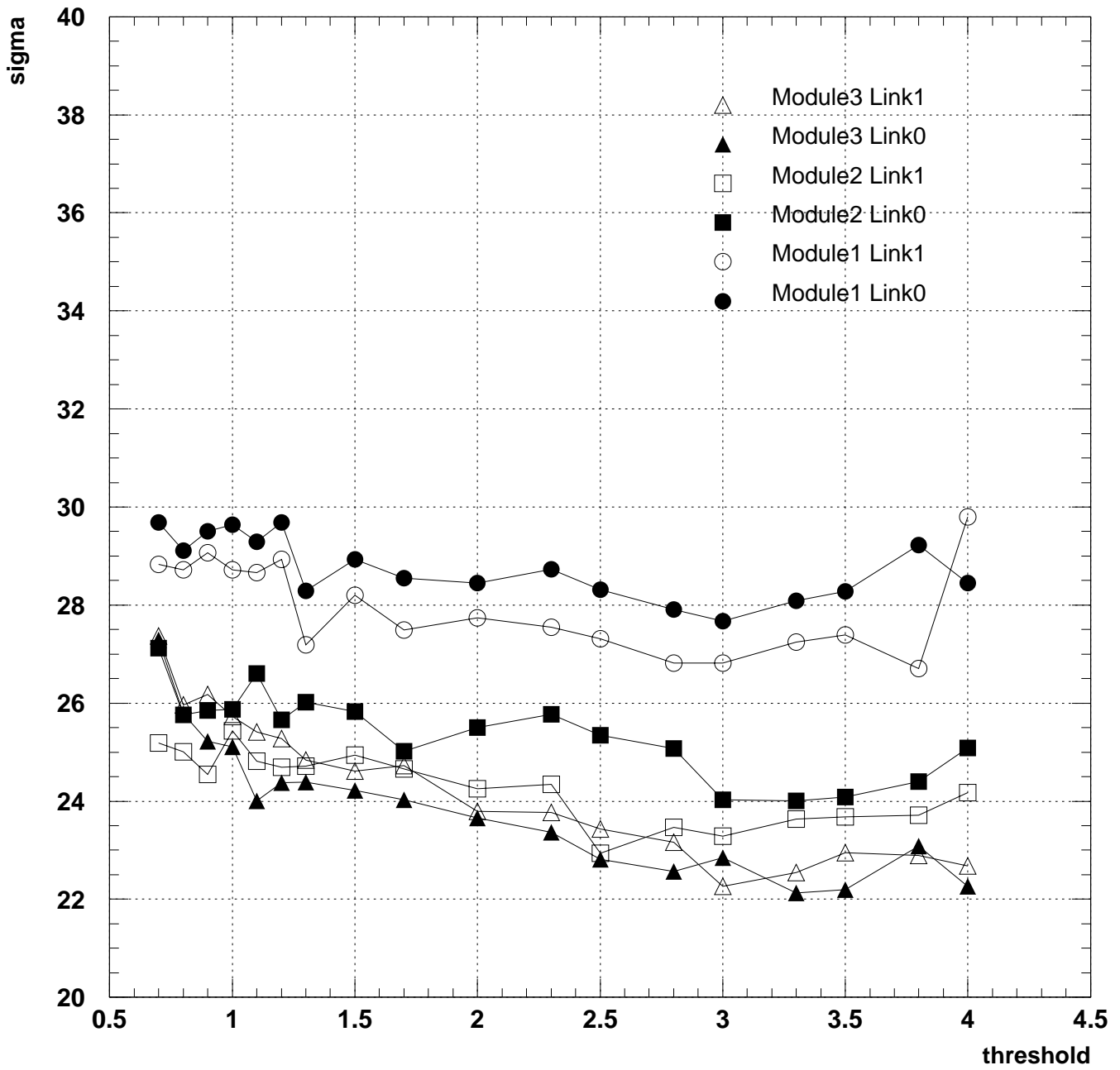


Diff (Nearest clus - track) (Mod6s0)

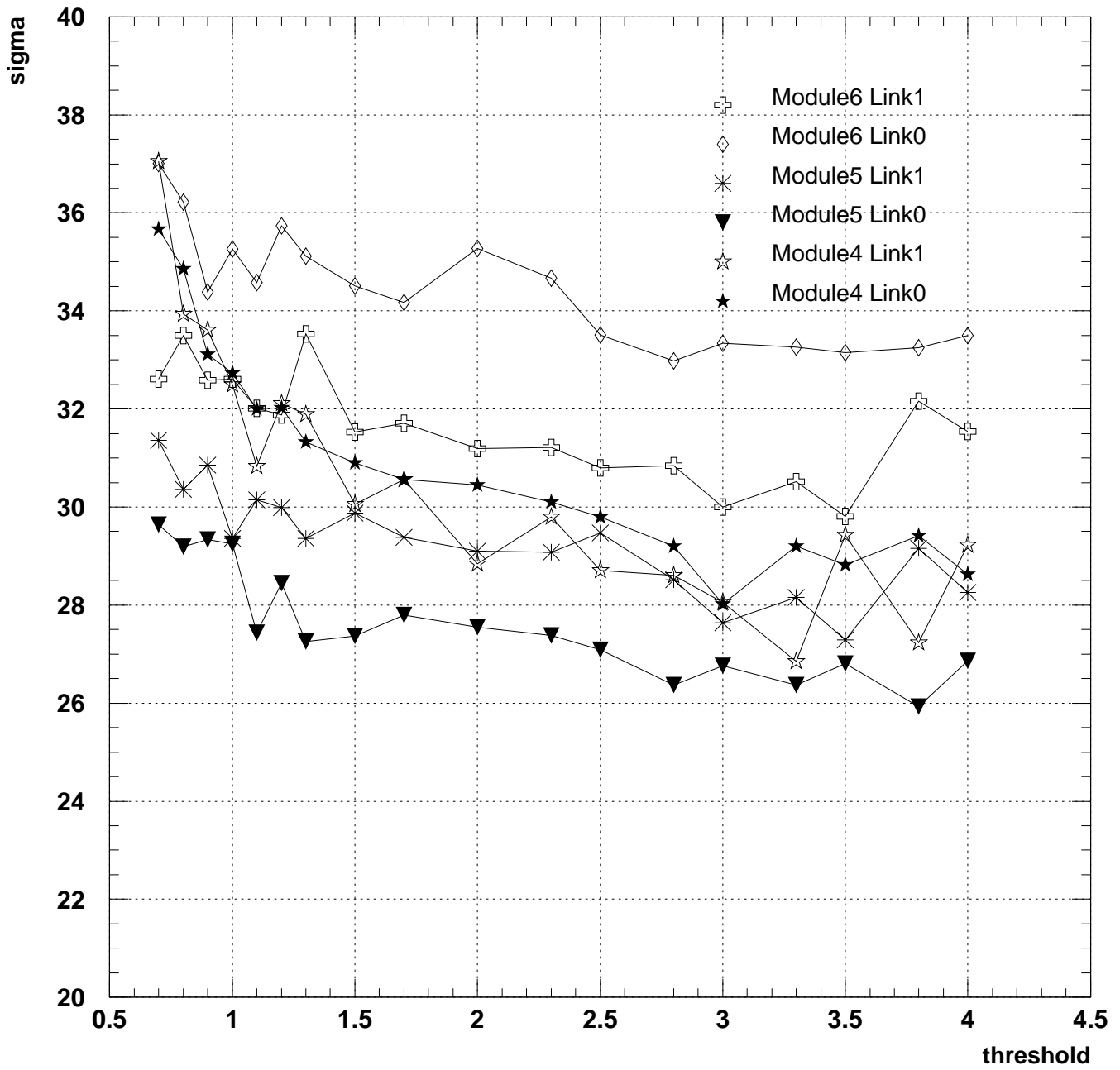


Diff (Nearest clus - track) (Mod6s1)

# sigma vs threshold

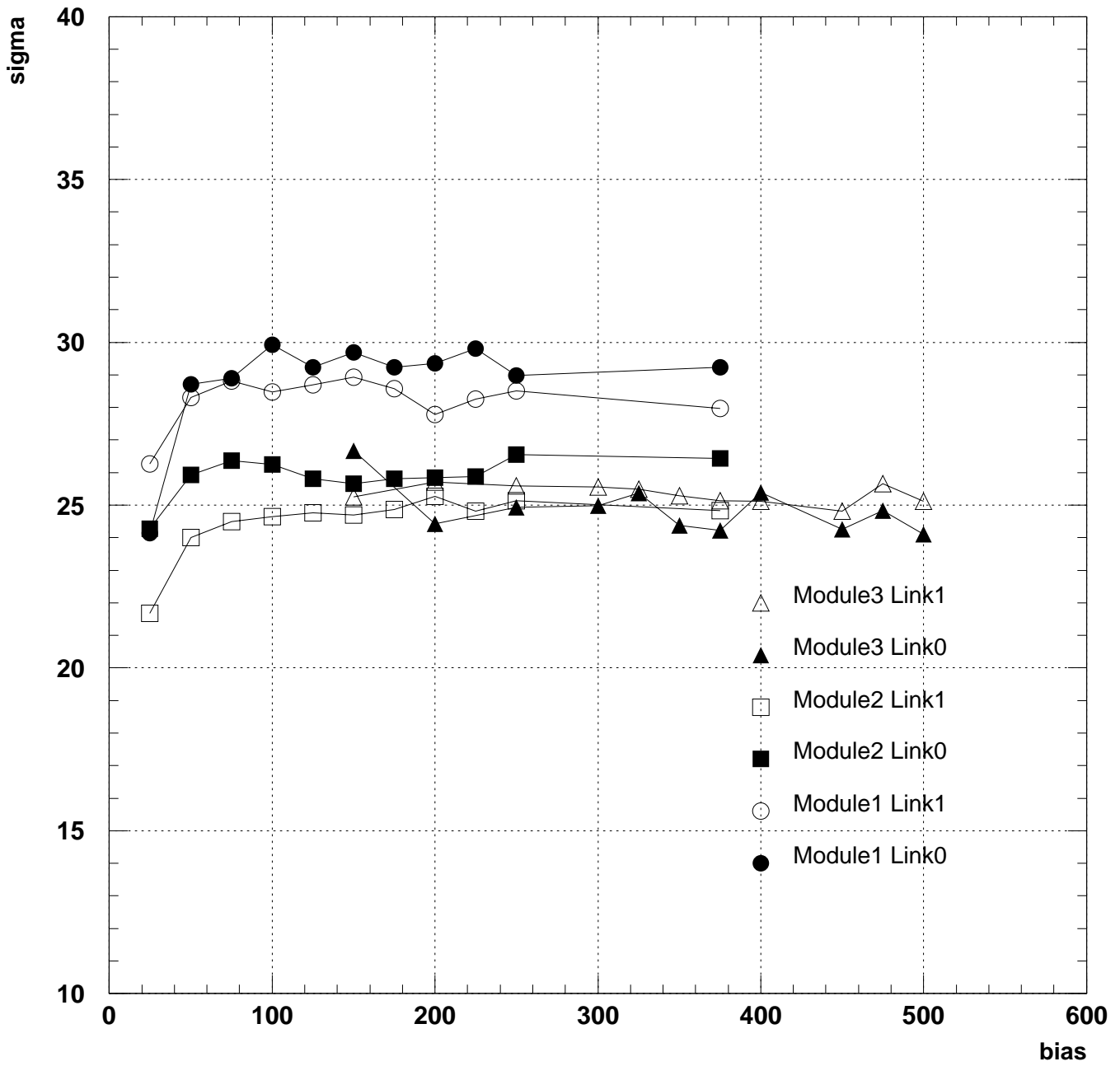


# sigma vs threshold

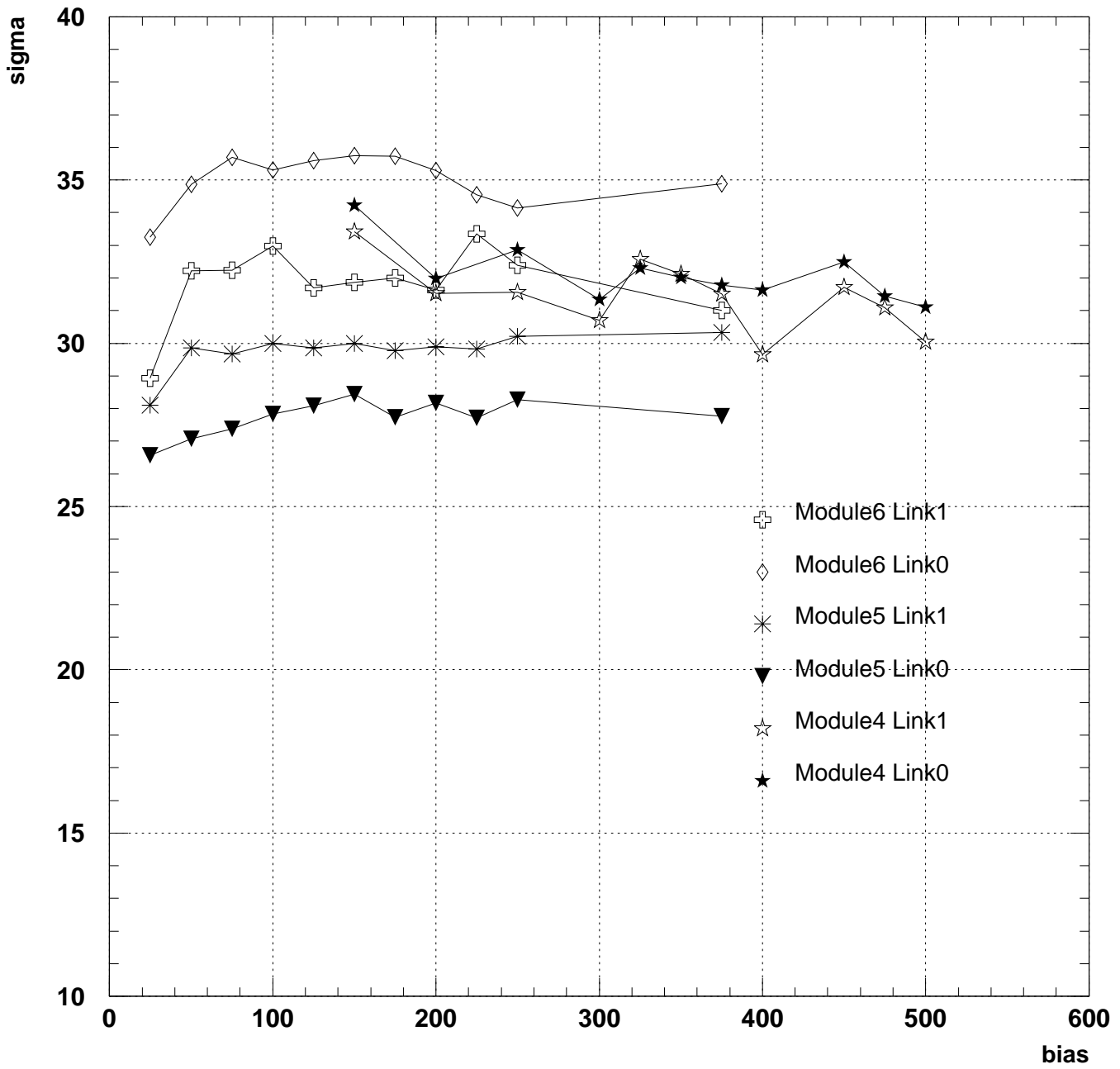




# sigmavsbias



# sigmavsbias



# Summary