

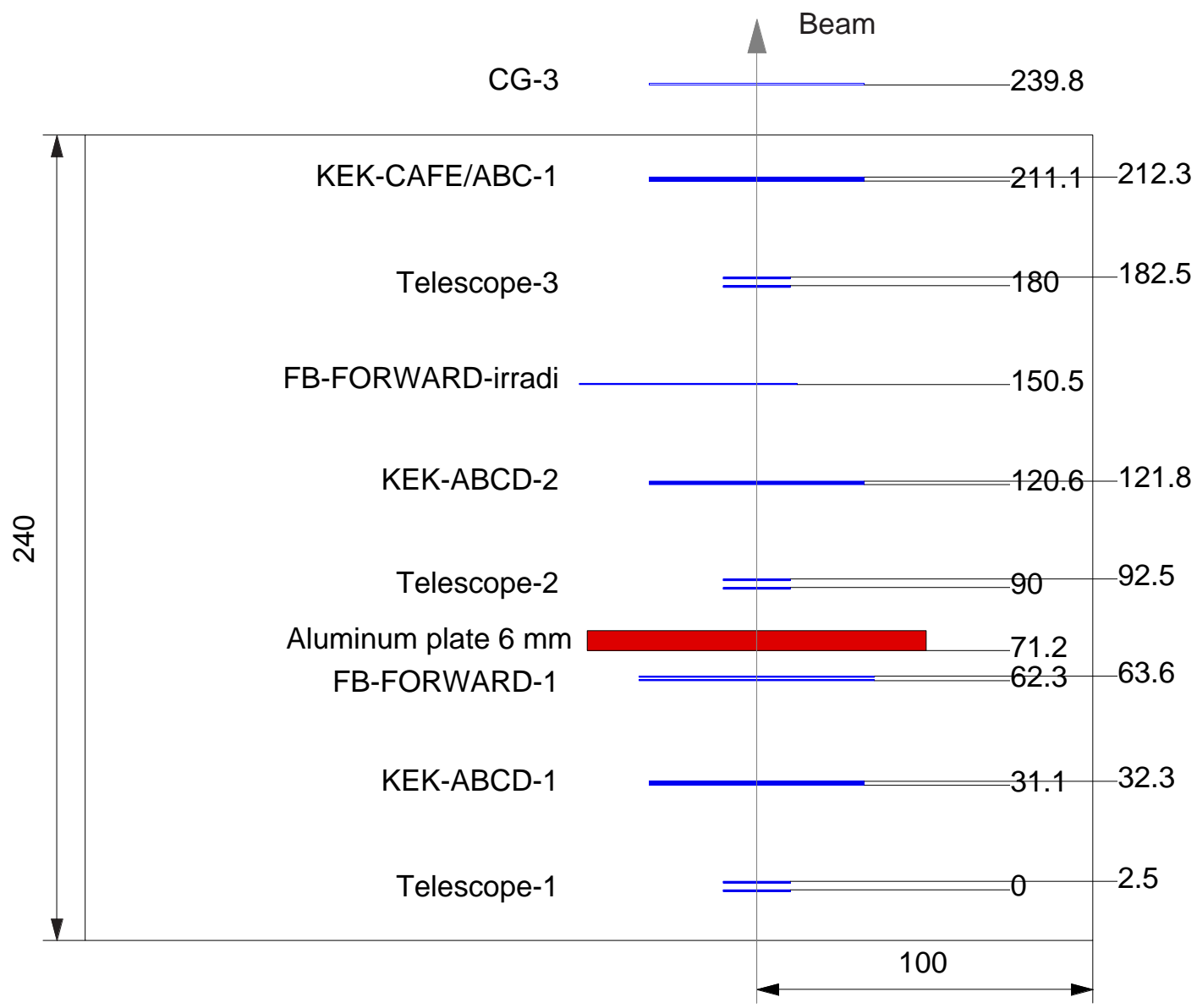
# **Beamtest of ABCD2T and CAFE/ABC modules at KEK**

(May/June 2000 SCT week updates)

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KEK, Okayama Univ., Univ. Tsukuba, Univ. Melbourne, Univ. Freiburg, Acad.  
Scie. Czech Republic-Prague

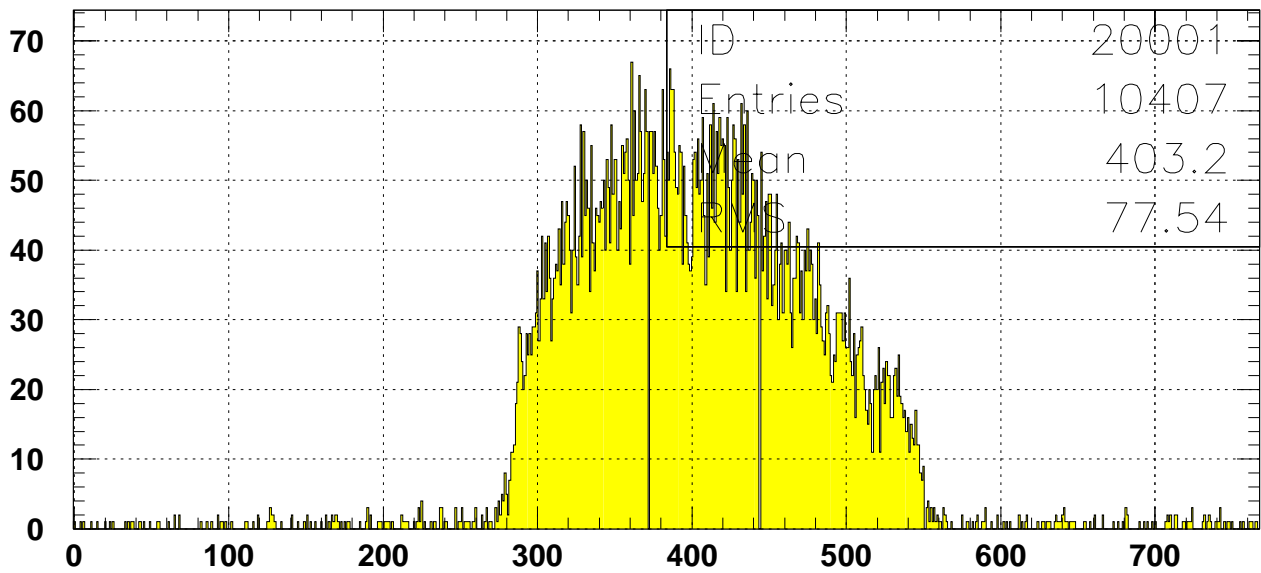
- **Proper fiducial volume definition**
- **Position resolutions**
- **Efficiencies (overall) and Median charges**
- **Responses between the strips**
  - Strip and Midway regions
- **Discussion of responses**
- **Summary**



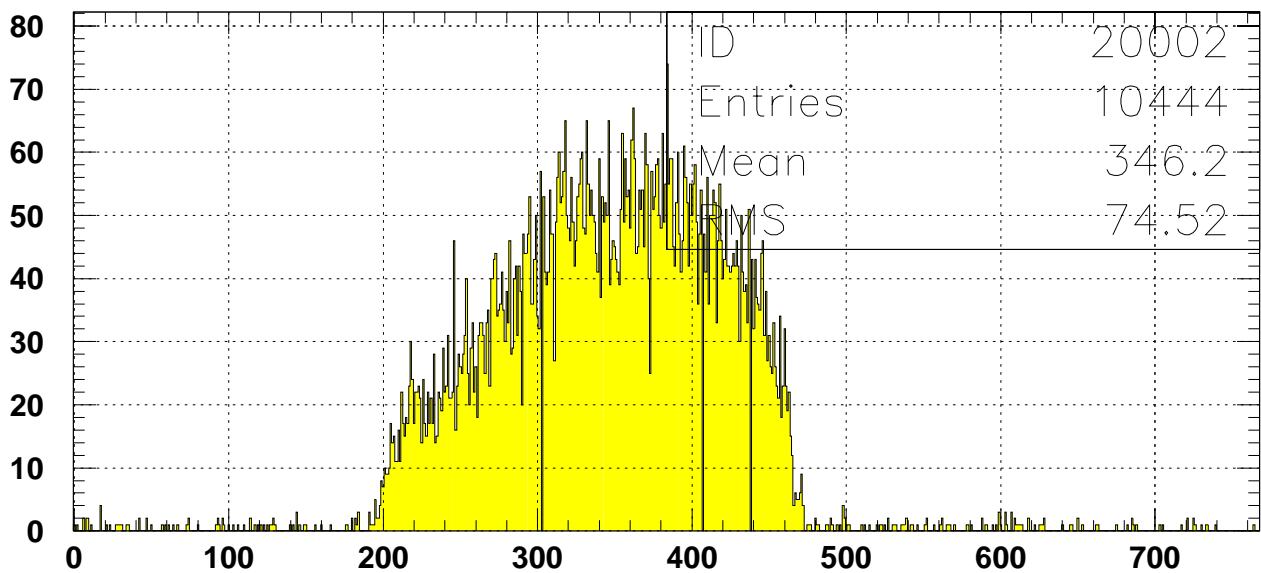
# Proper fiducial volume definition

- **Excluding strips  $\pm 250 \mu\text{m}$  from**
  - dead,
  - hot,
  - sick channels
  
- **Tracks in 3 telescope planes,  $\pm 250 \mu\text{m}$  each other**
  
- **Track hit in the anchor plane**
  - Same ABCD frontend chips
  - Preventing mis-timing of telescope readout

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

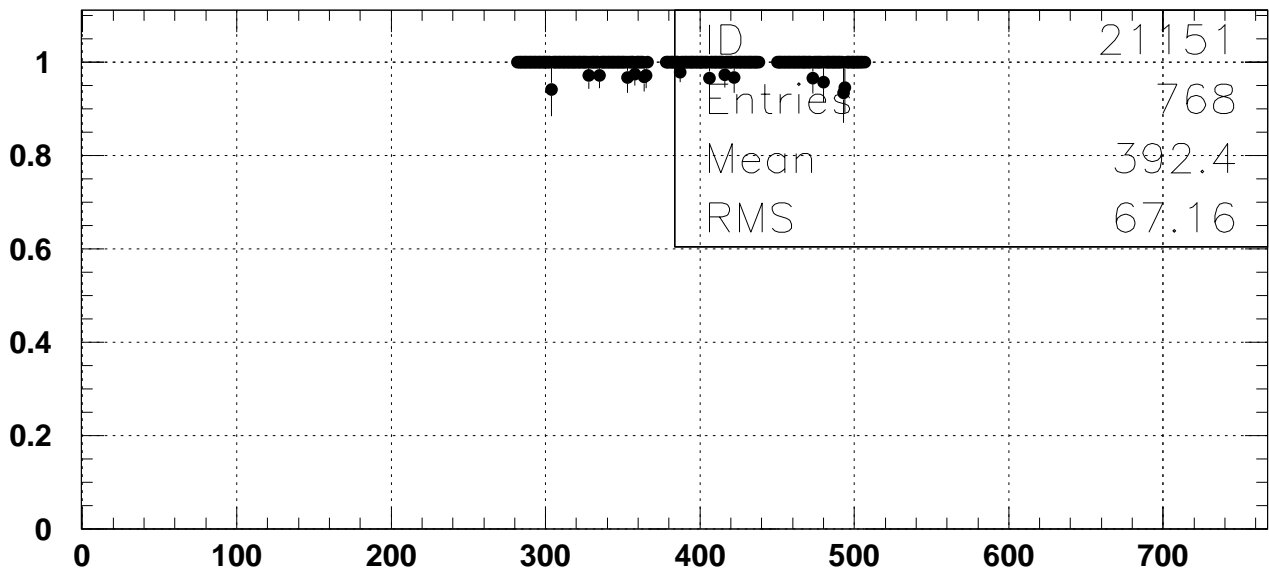


Mod0s0 hitmap (channel)

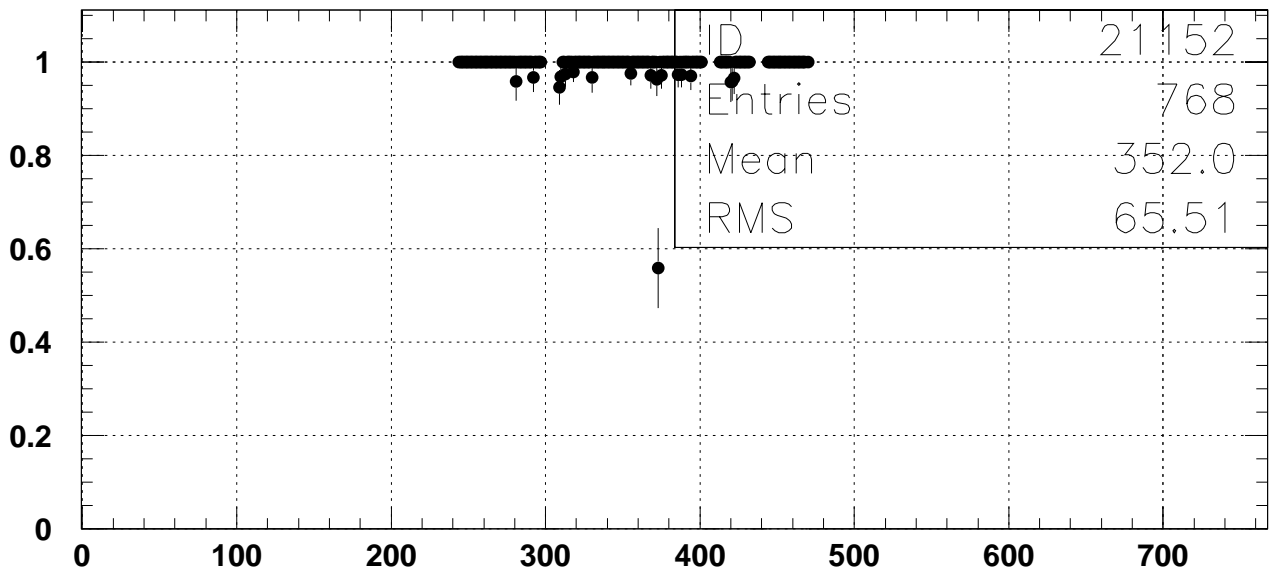


Mod0s1 hitmap (channel)

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



Efficiency in strip (Mod0s0)

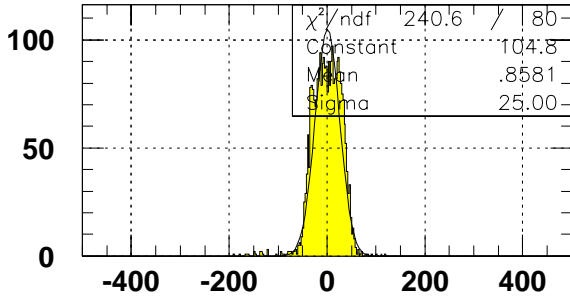


Efficiency in strip (Mod0s1)

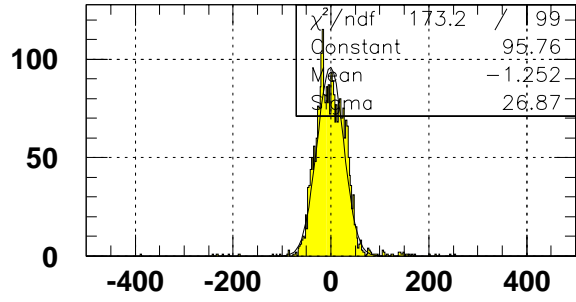
# Position resolutions

- **Tracks defined by two telescopes sandwiching the DUT's**
  - Exception: CAFE/ABC module has only one telescope in upstream
  - Beam particles were scattered at the telescopes noticeably with respect to the DUT position resolution
  
- **Fan geometry correction**
  - hits were scaled on a virtual x-axis
  
- **Dependence on thresholds and bias voltages**
  - Resolution of 25~27  $\mu\text{m}$
  - Must consider contributions of
    - telescope resolution of about 5  $\mu\text{m}$
    - statistical fluctuation near the end of "box"
    - Gaussian fit to the "box" distribution
  - Dependence was weak

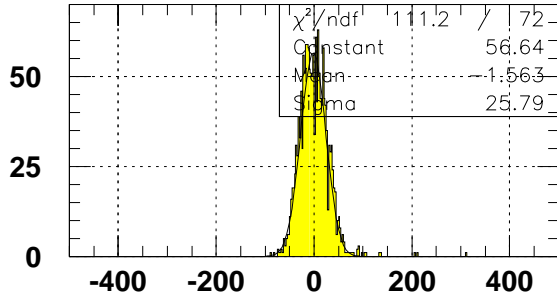
# Resolution (200V, 1.4fC)



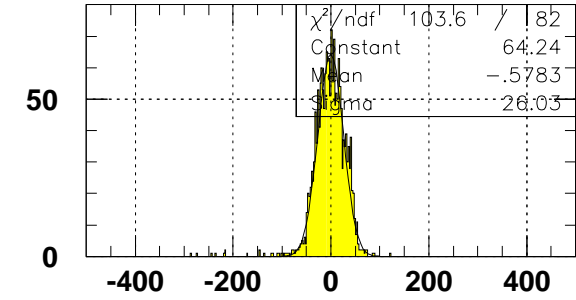
Diff (Nearest clus - track) (Mod0s0)



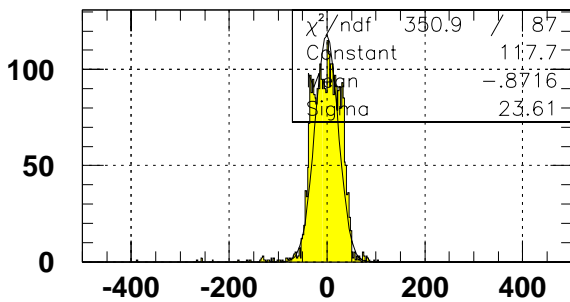
Diff (Nearest clus - track) (Mod0s1)



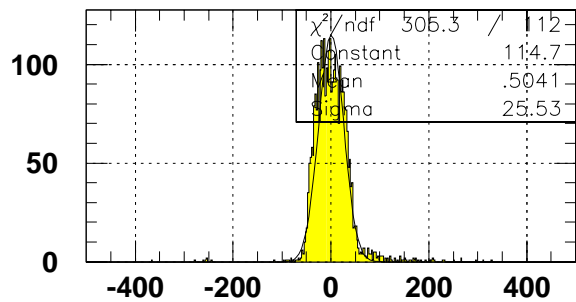
Diff (Nearest clus - track) (Mod1s0)



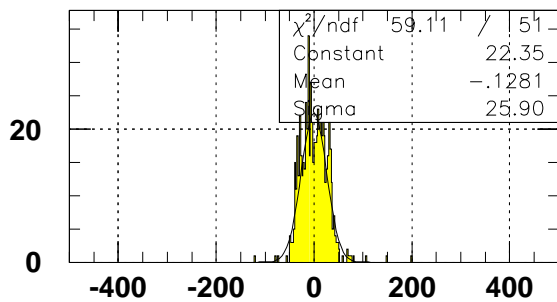
Diff (Nearest clus - track) (Mod1s1)



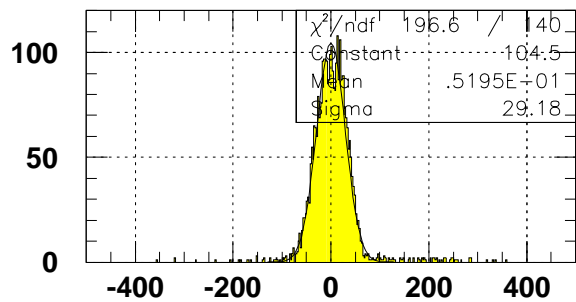
Diff (Nearest clus - track) (Mod2s0)



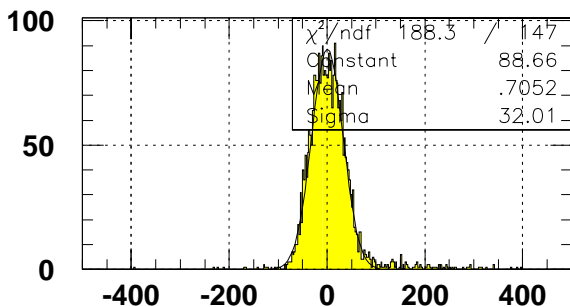
Diff (Nearest clus - track) (Mod2s1)



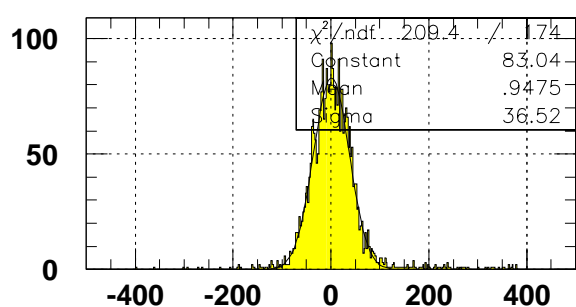
Diff (Nearest clus - track) (Mod3s0)



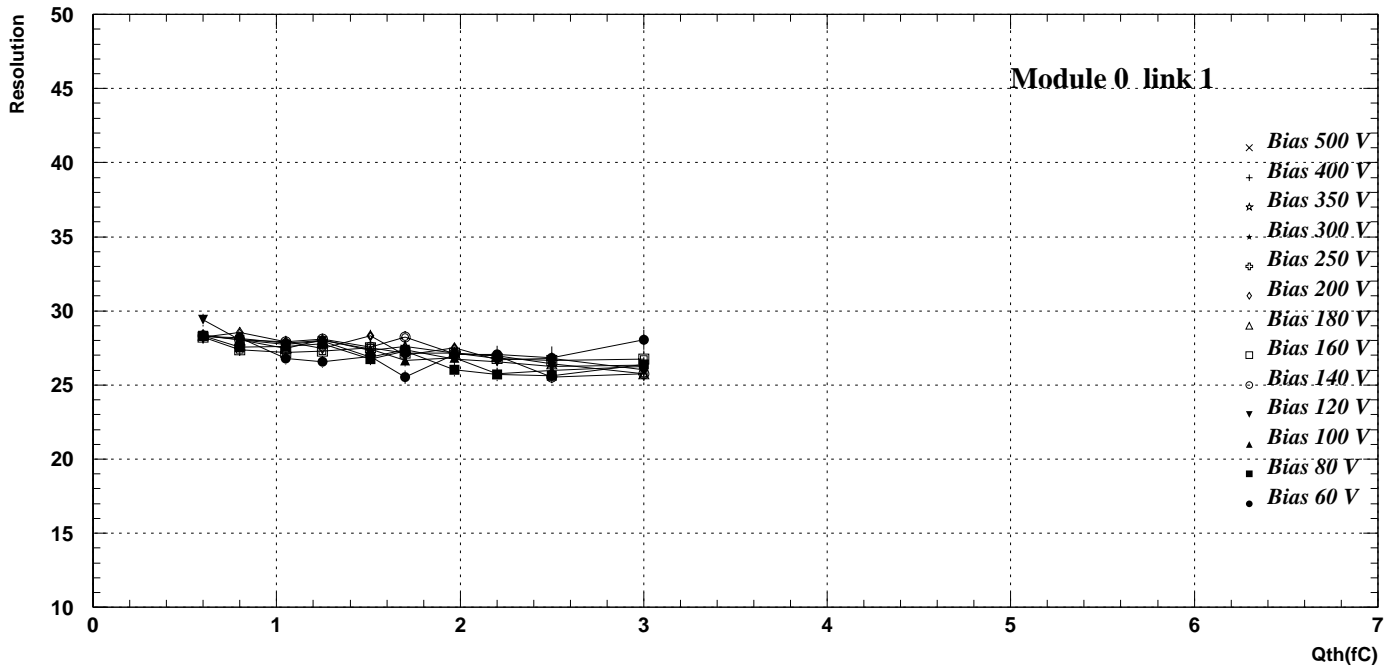
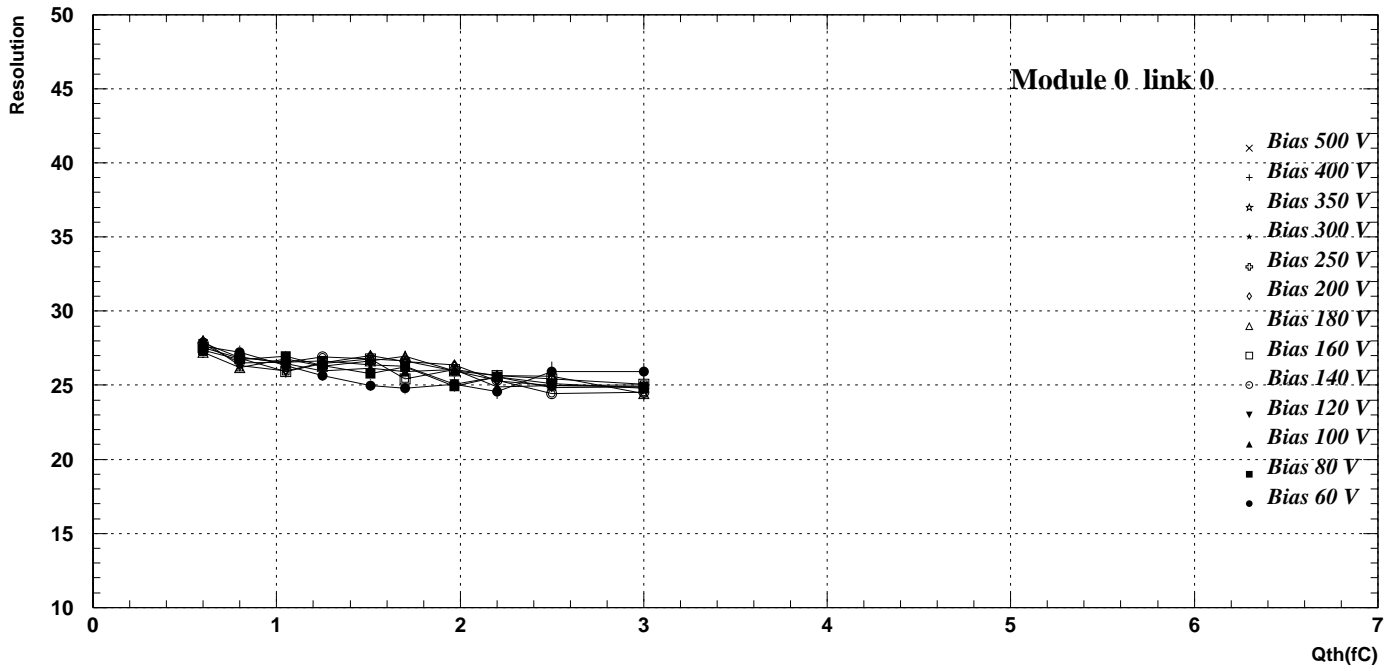
Diff (Nearest clus - track) (Mod4s0)



Diff (Nearest clus - track) (Mod4s1)



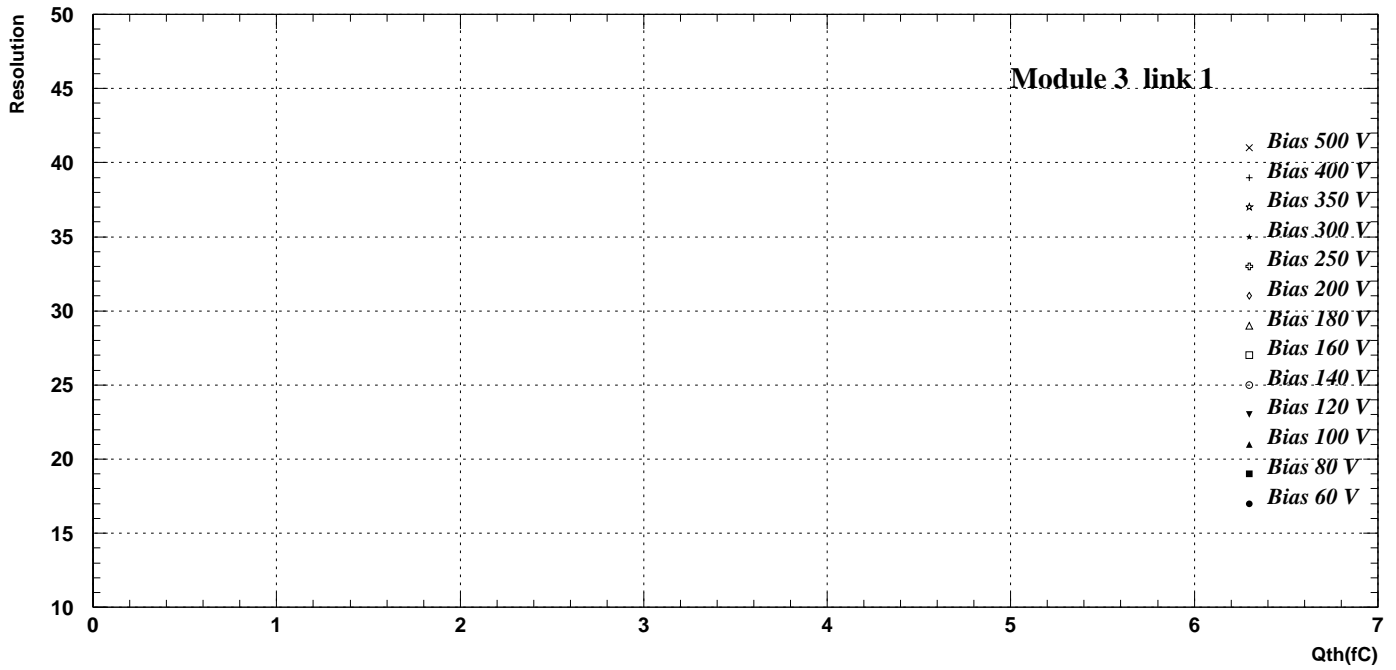
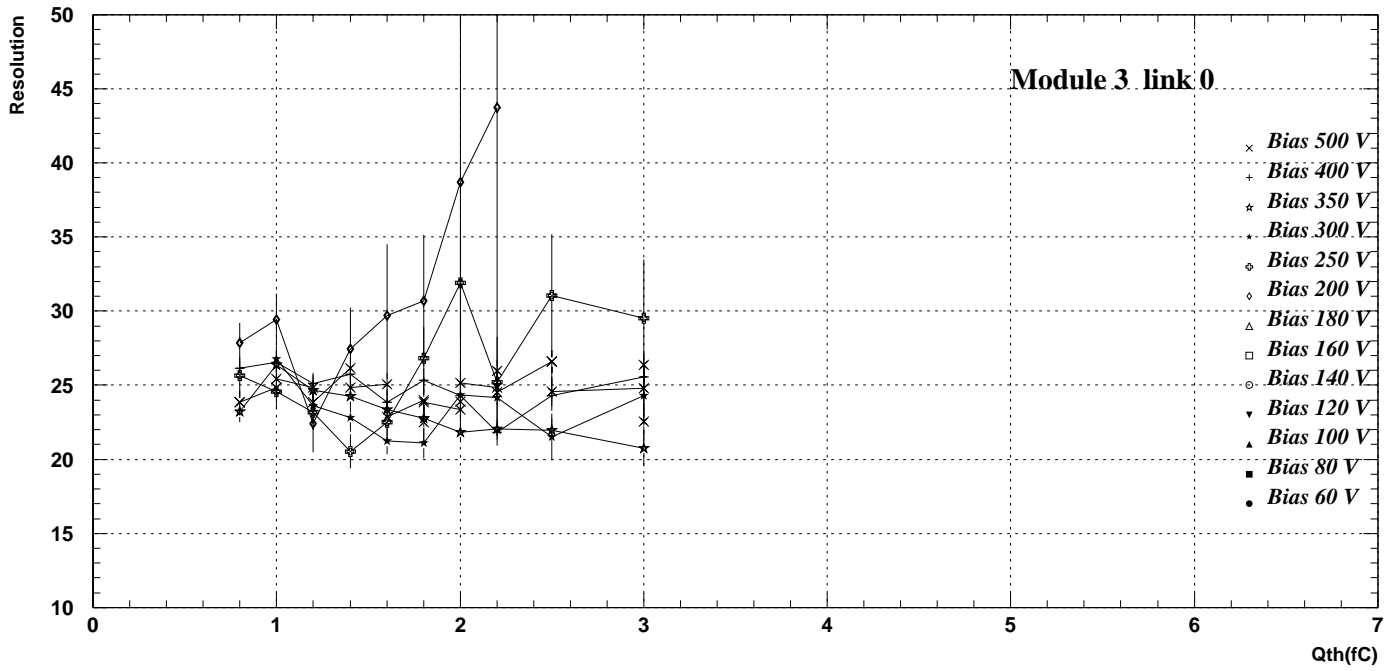
Diff (Nearest clus - track) (Mod5s0)











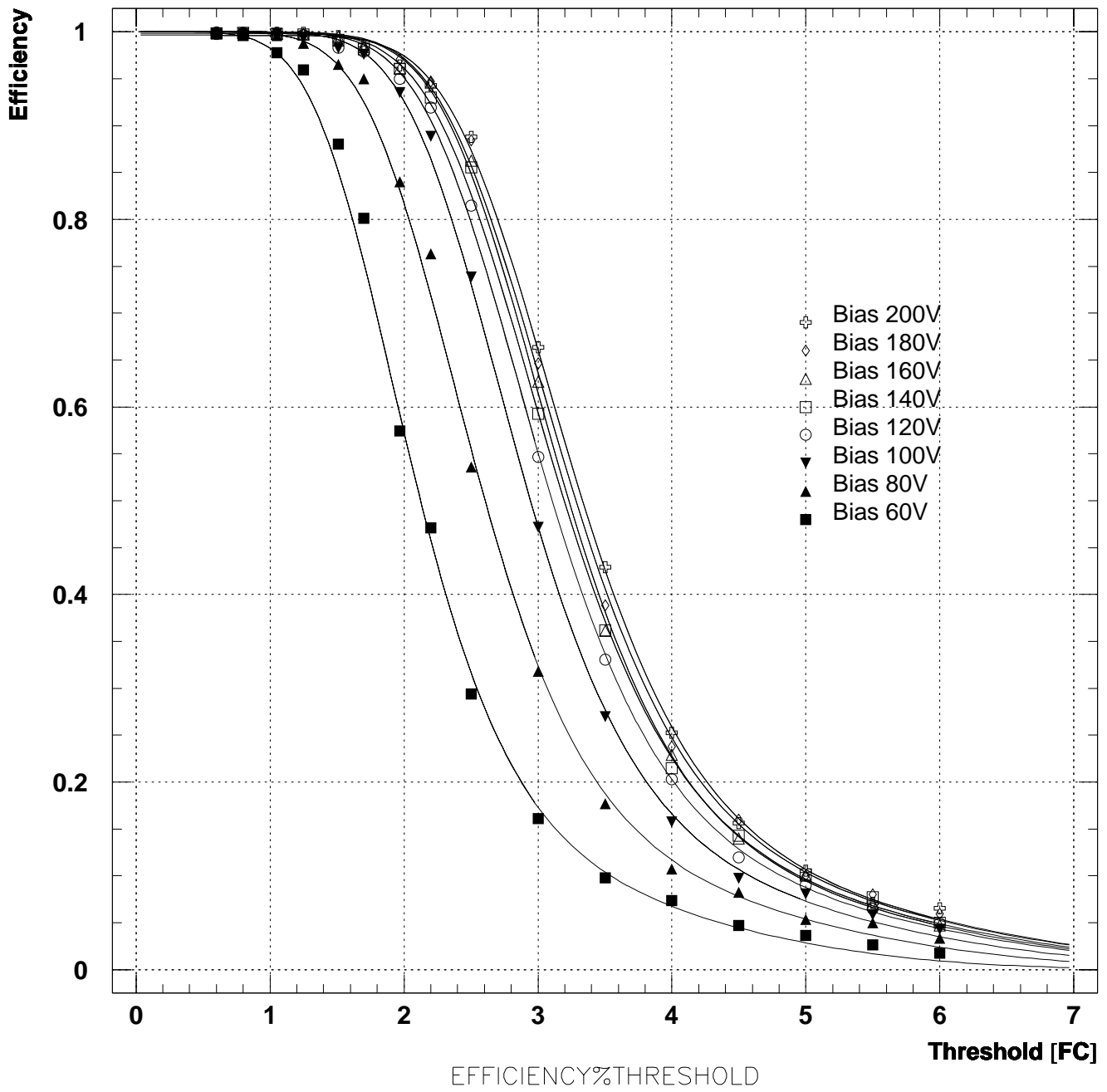


# Efficiencies (overall) and Median charges

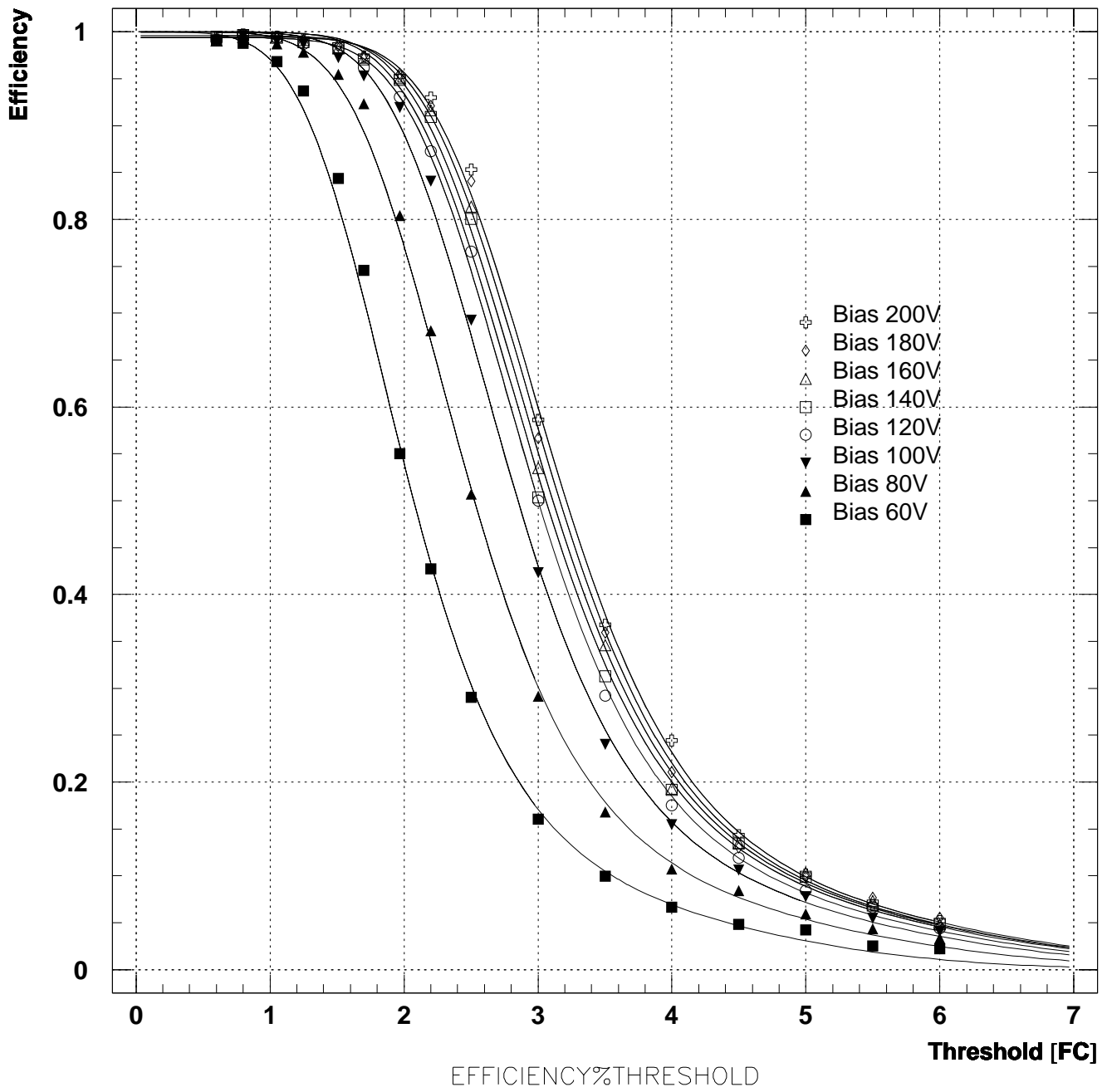
- **New efficiency derived with the fiducial volume cuts**
- **“Modified” Error function fit**
  - Simulating energy deposition in a thin material
  - Integrated landau distribution by varying sigma
- **Irradiated sensor**
  - Reasonable efficiency saturation toward 100%
  - Median charge at about 2.5 fC toward 500V
- **Comparison with previous results of irradiated n-strip and p-strip sensors**

# **Efficinecy vs thresholds**

# Efficiency Curve (Mod0 Link0)



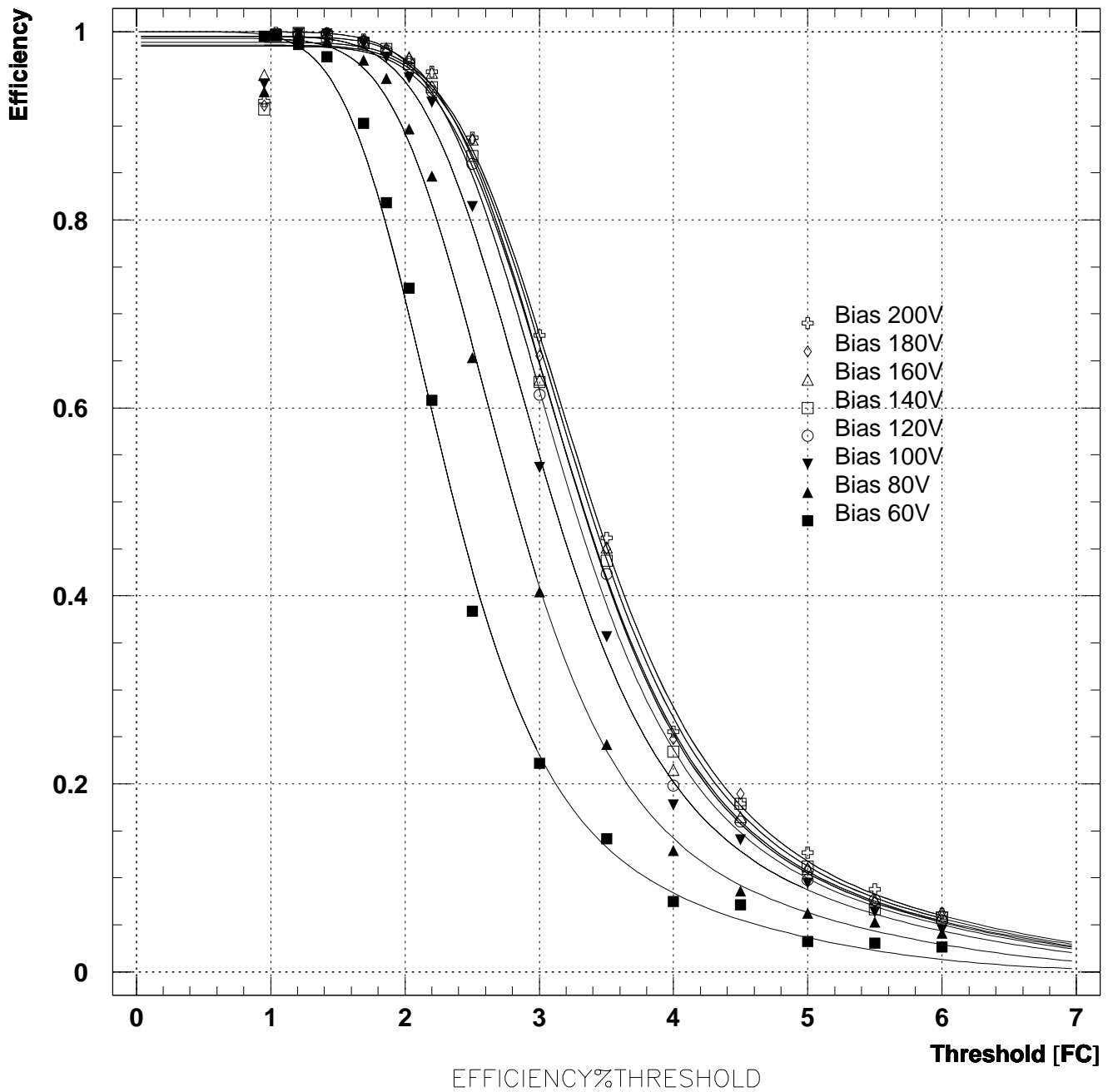
# Efficiency Curve (Mod0 Link1)



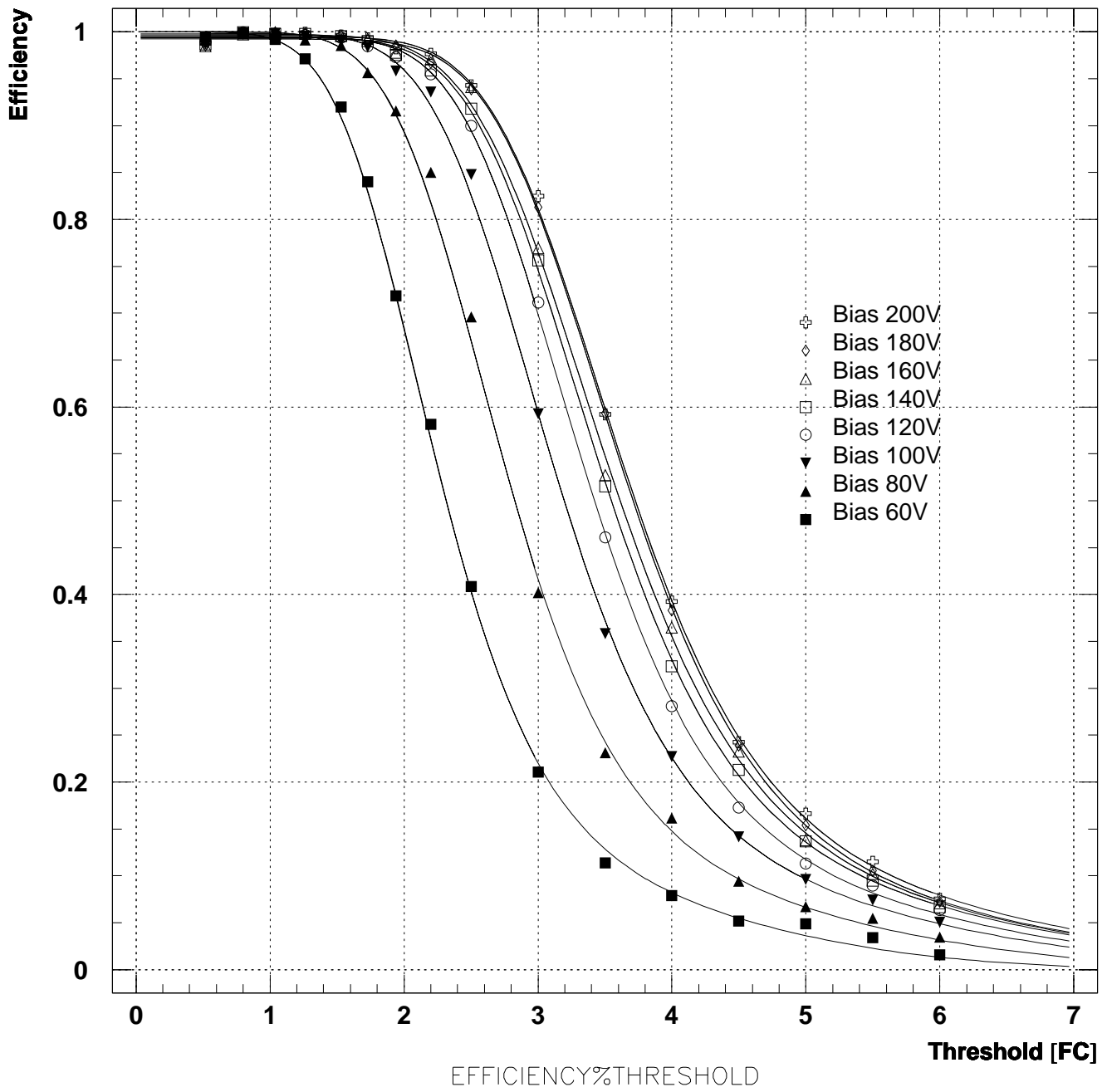




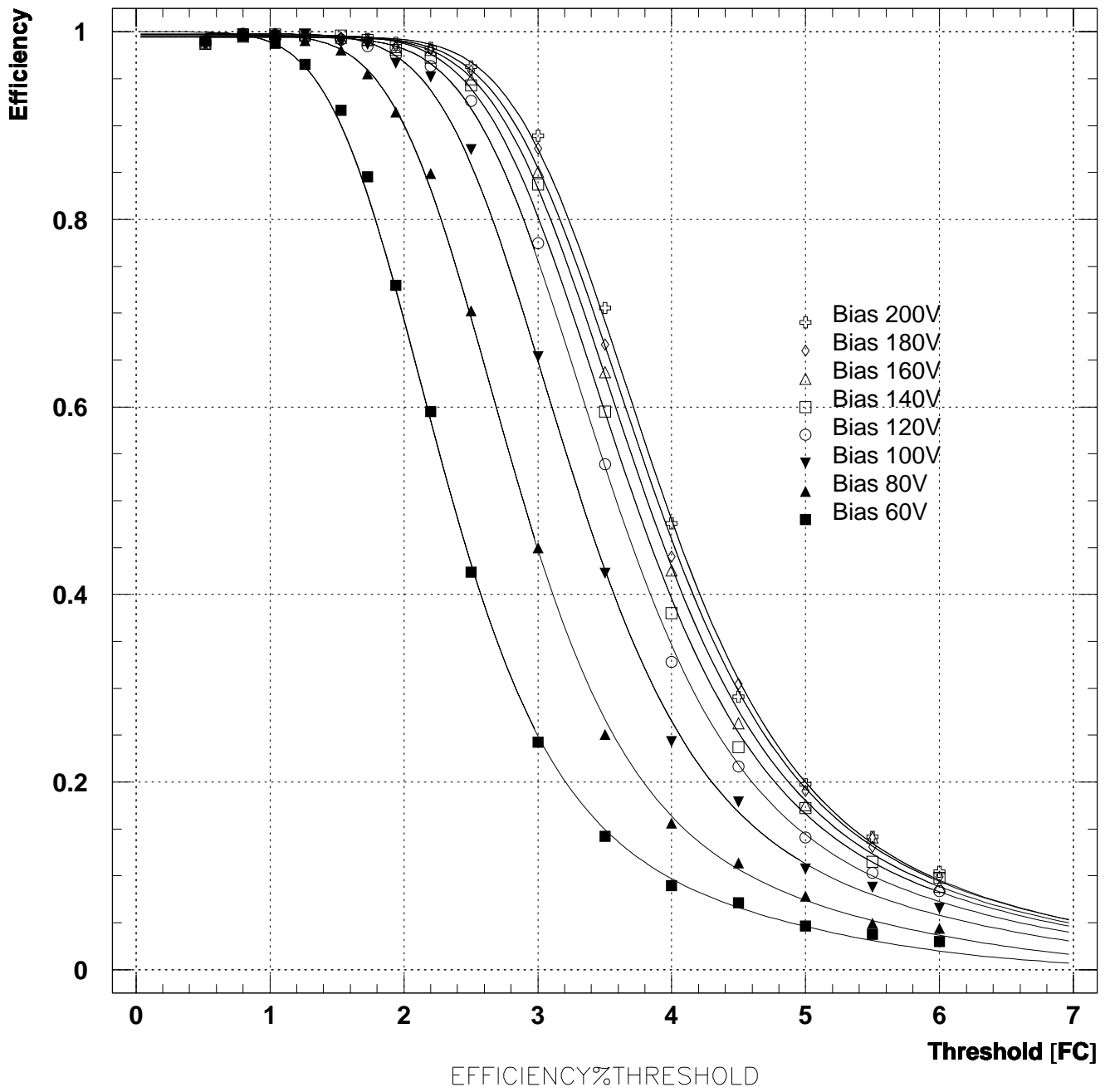
# Efficiency Curve (Mod1 Link1)



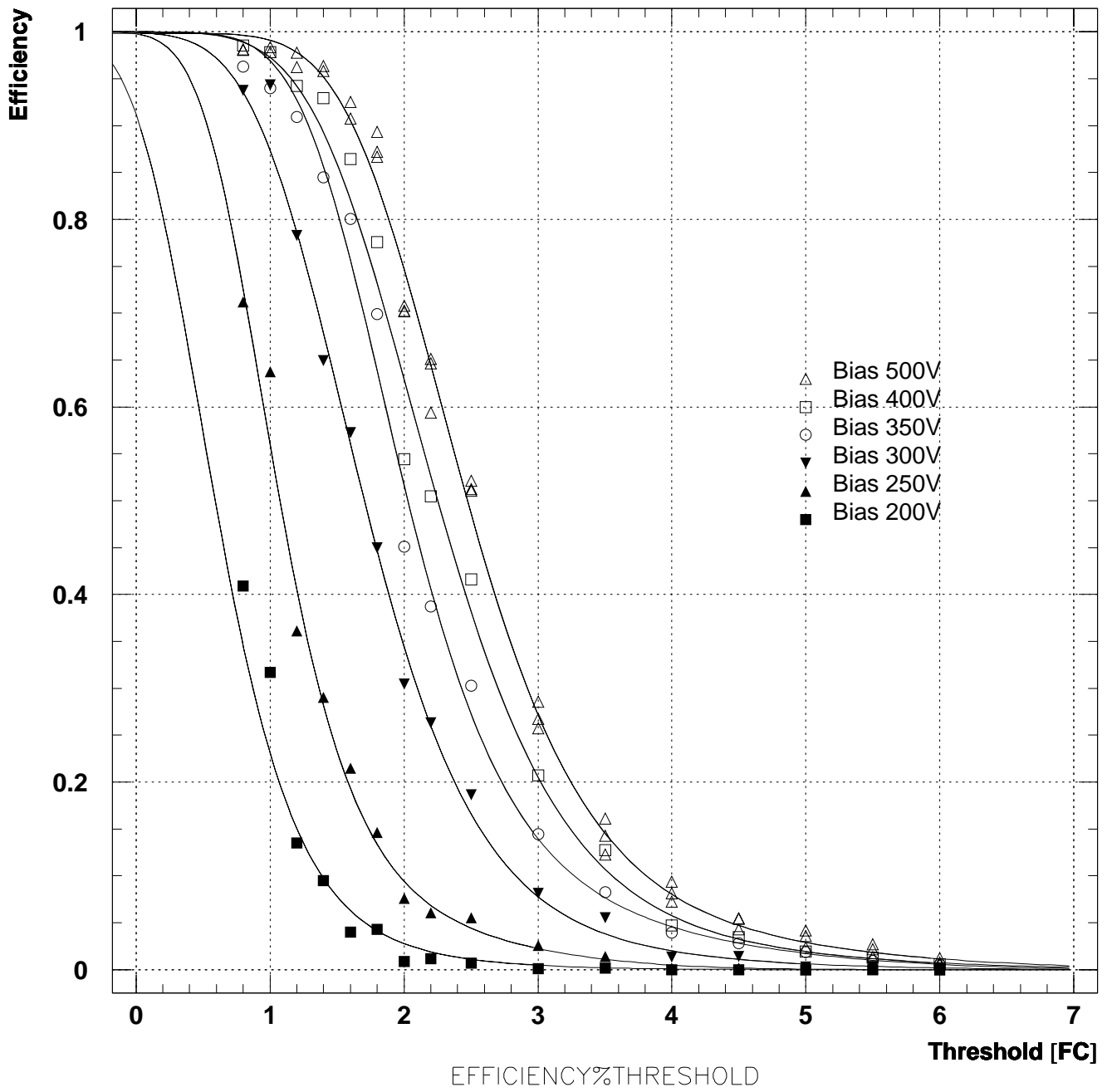
# Efficiency Curve (Mod2 Link0)



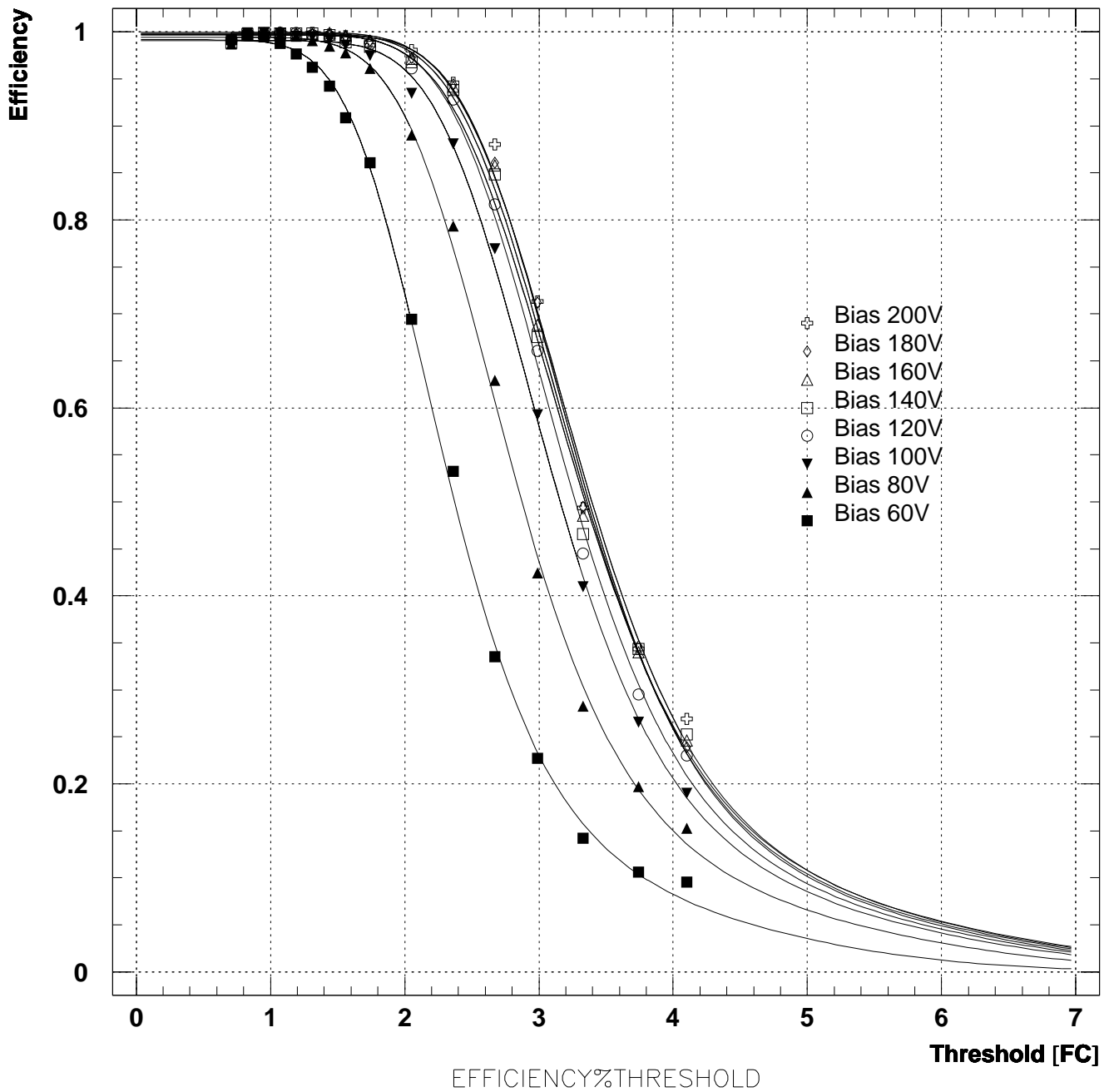
# Efficiency Curve (Mod2 Link1)



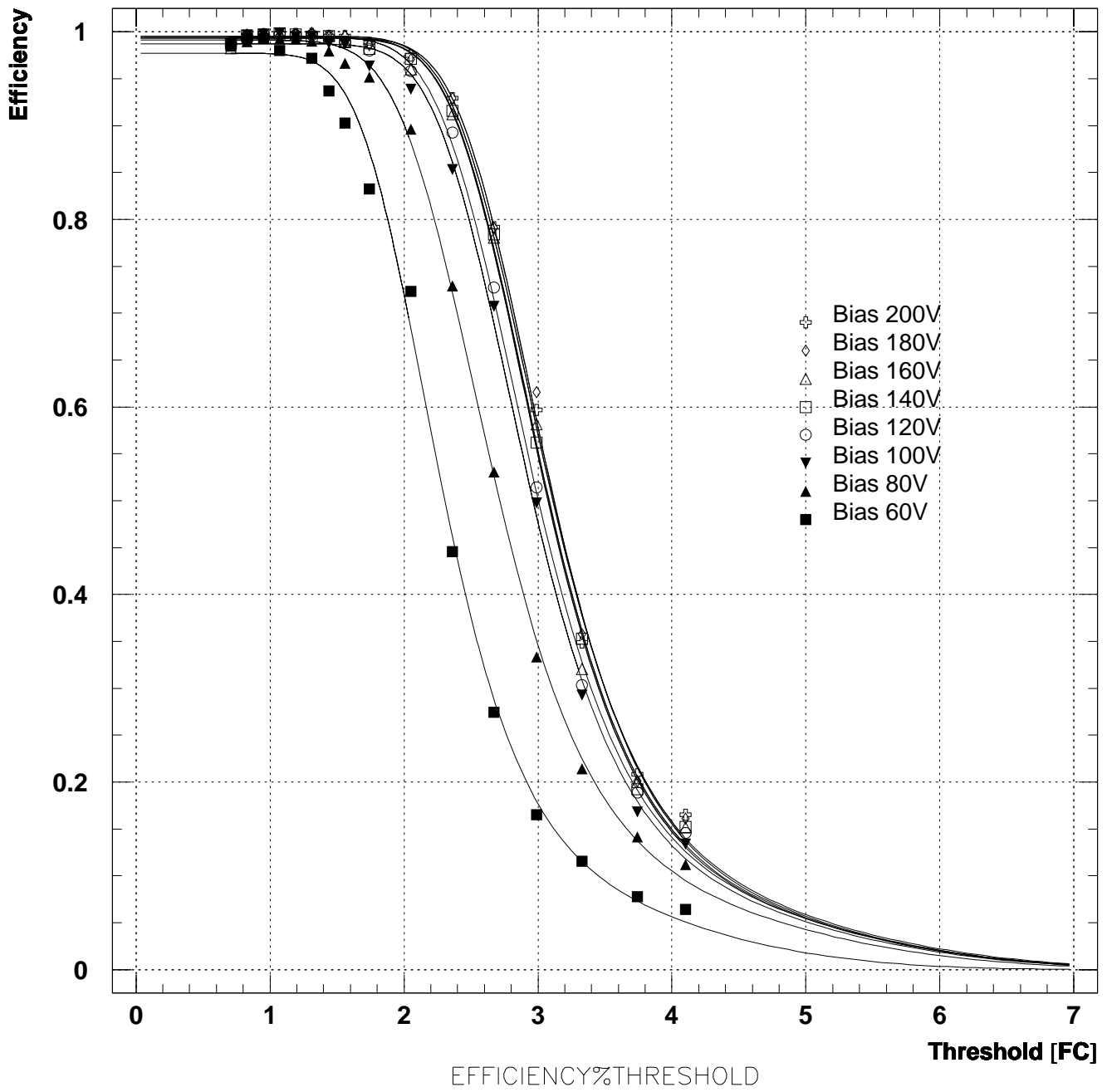
# Efficiency Curve (Mod3 Link0)



# Efficiency Curve (Mod4 Link0)

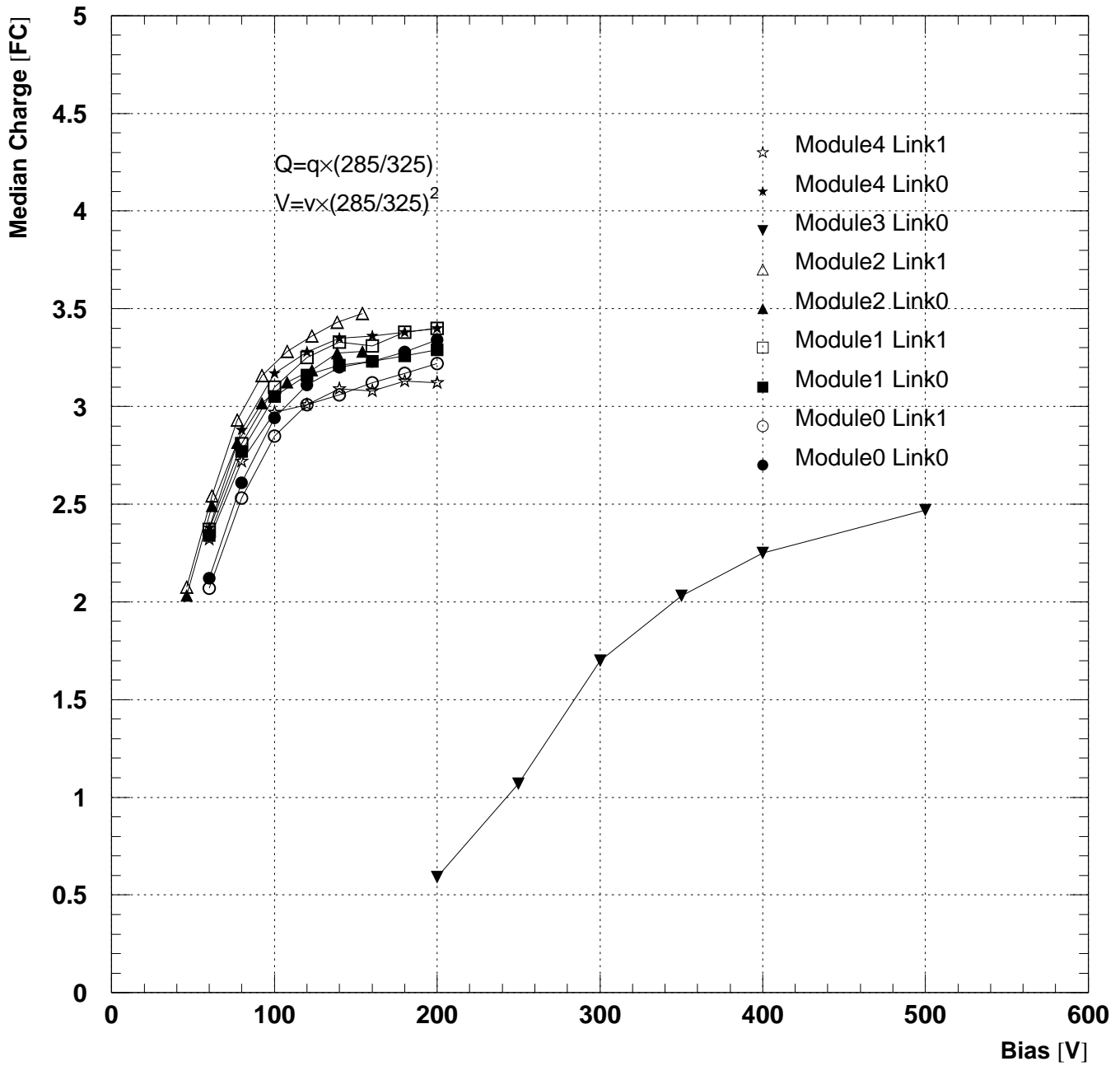


# Efficiency Curve (Mod4 Link1)



# **Bias voltage dependence of median charges**





# Response between the strips

- **Efficiency plots**

- Thresholds around median charge in each bias voltage

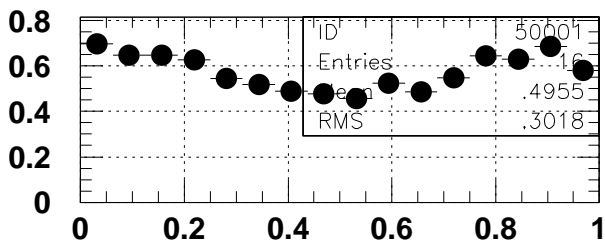
- Strip region:  $\pm 20 \mu\text{m}$  around the strip

- Midway region:  $\pm 10 \mu\text{m}$  around the centre between the strips, i.e., 25% of region

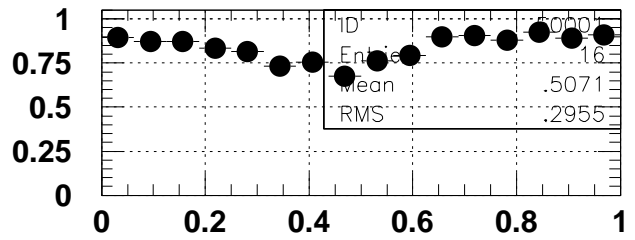
- **Bias voltage dependence of median charges**

- Strip region

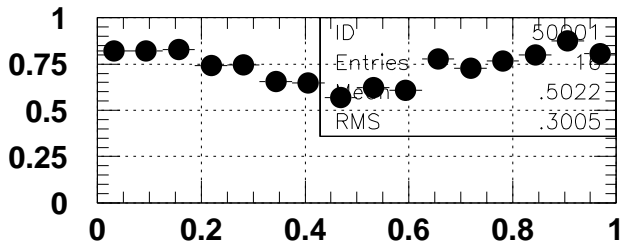
- Midway region



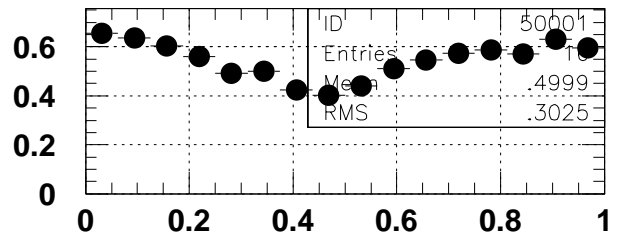
Efficiency in Eta (Mod0s0) run772



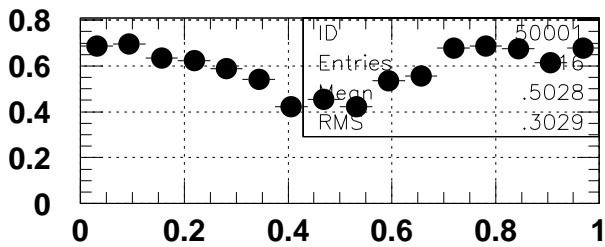
Efficiency in Eta (Mod0s0) run791



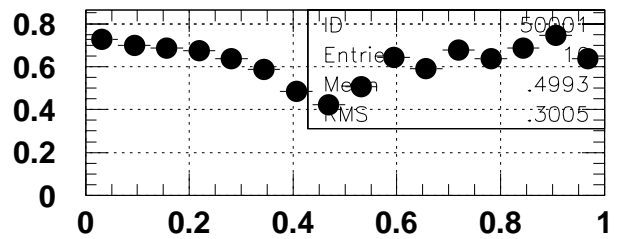
Efficiency in Eta (Mod0s0) run756



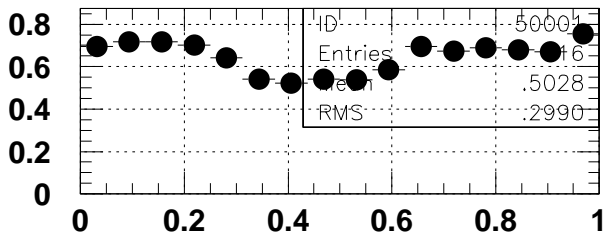
Efficiency in Eta (Mod0s0) run957



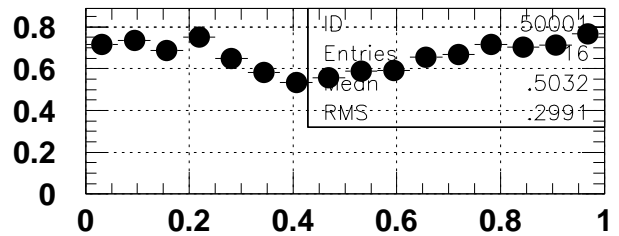
Efficiency in Eta (Mod0s0) run917



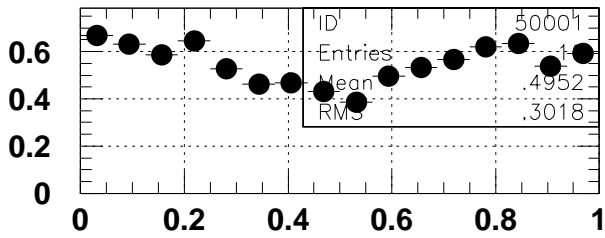
Efficiency in Eta (Mod0s0) run863



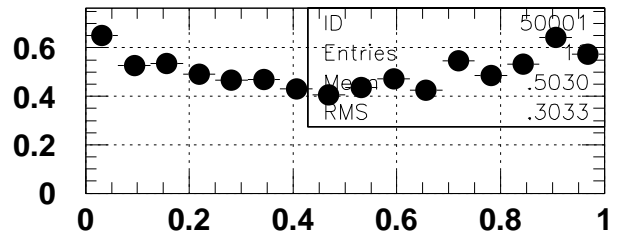
Efficiency in Eta (Mod0s0) run879



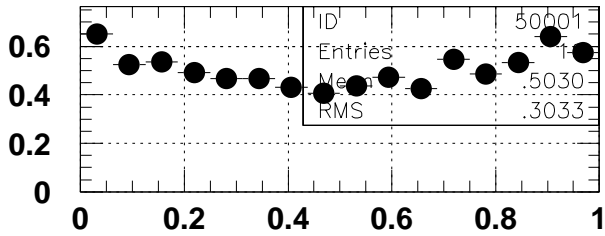
Efficiency in Eta (Mod0s0) run896



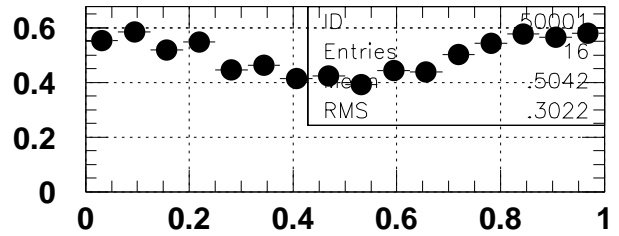
Efficiency in Eta (Mod0s1) run772



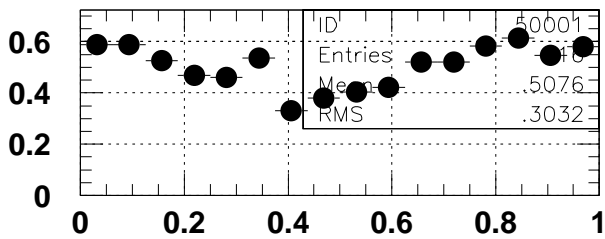
Efficiency in Eta (Mod0s1) run793



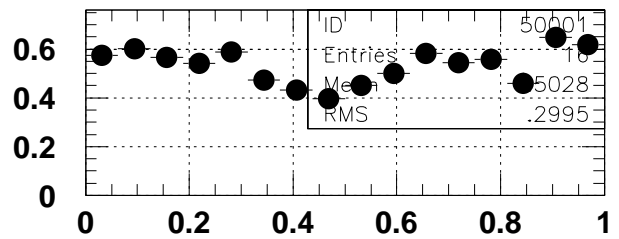
Efficiency in Eta (Mod0s1) run793



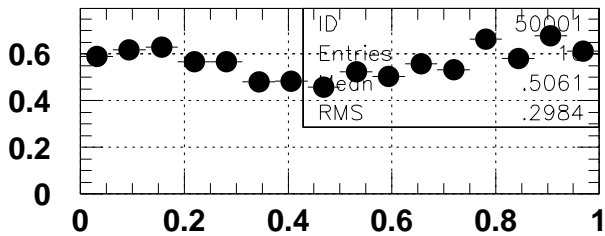
Efficiency in Eta (Mod0s1) run957



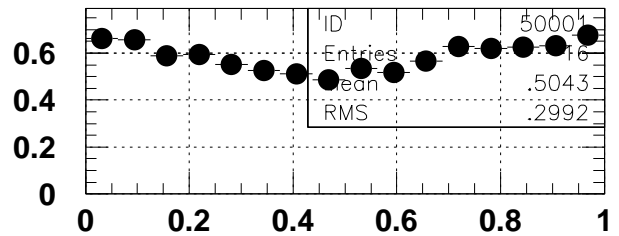
Efficiency in Eta (Mod0s1) run917



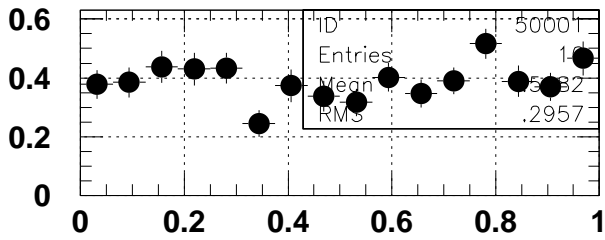
Efficiency in Eta (Mod0s1) run863



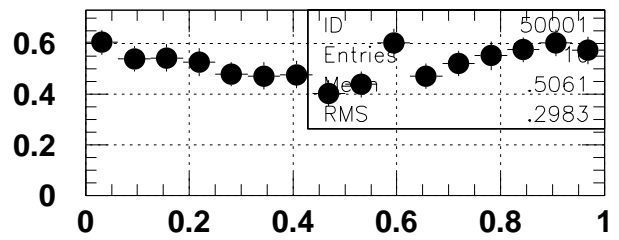
Efficiency in Eta (Mod0s1) run879



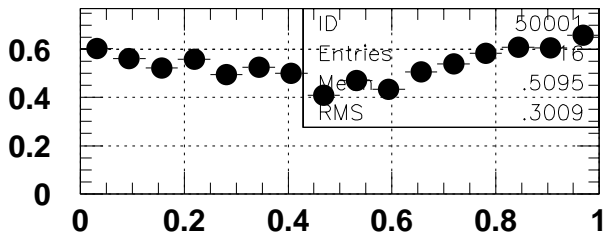
Efficiency in Eta (Mod0s1) run896



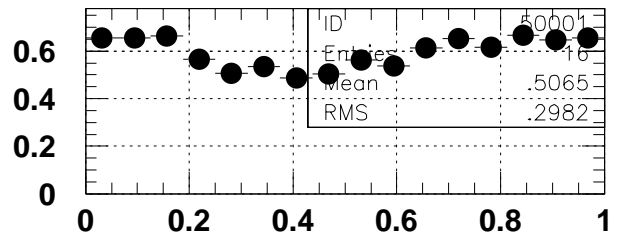
Efficiency in Eta (Mod1s0) run774



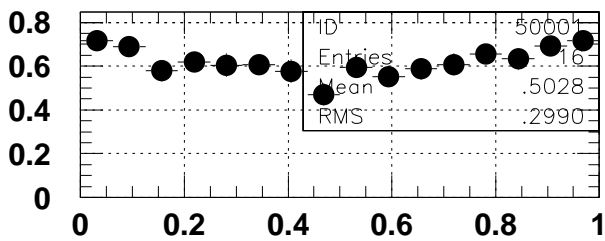
Efficiency in Eta (Mod1s0) run794



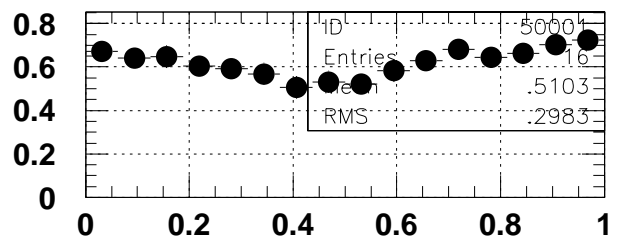
Efficiency in Eta (Mod1s0) run956



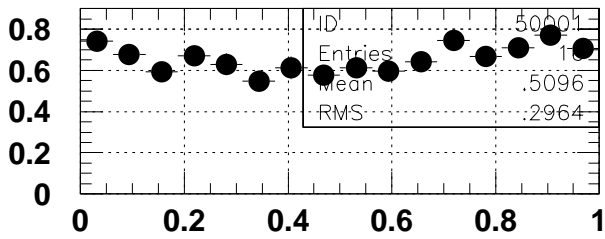
Efficiency in Eta (Mod1s0) run957



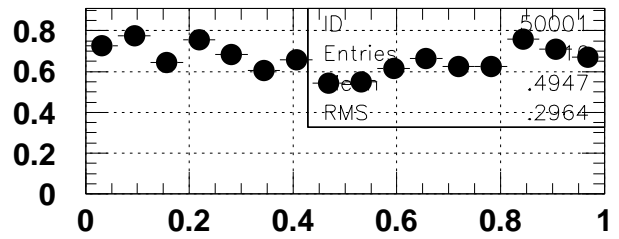
Efficiency in Eta (Mod1s0) run917



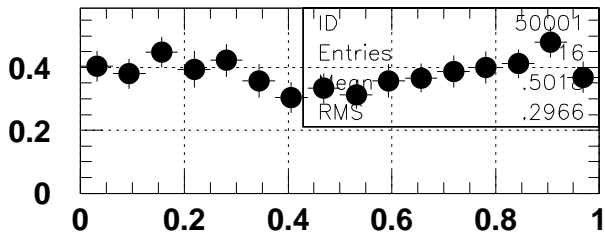
Efficiency in Eta (Mod1s0) run863



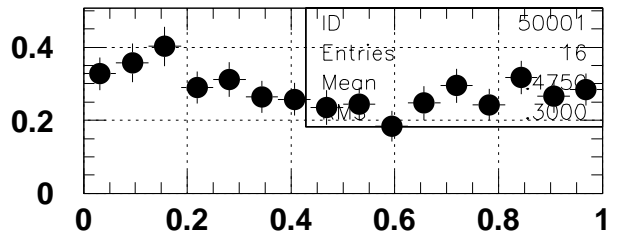
Efficiency in Eta (Mod1s0) run879



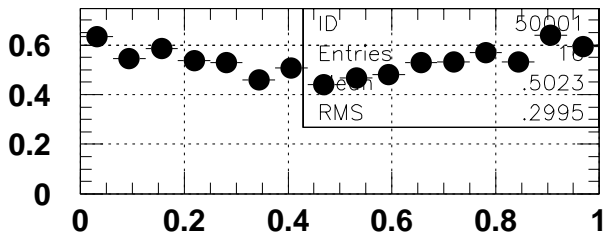
Efficiency in Eta (Mod1s0) run896



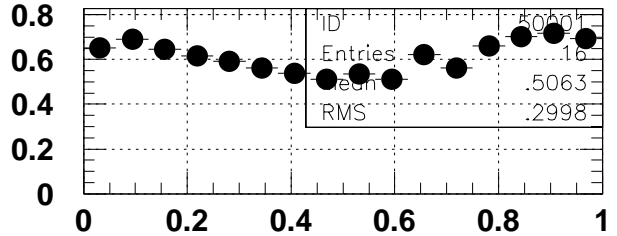
Efficiency in Eta (Mod1s1) run774



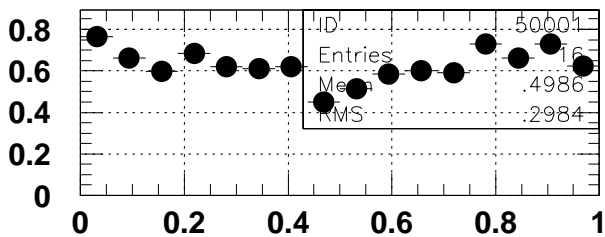
Efficiency in Eta (Mod1s1) run794



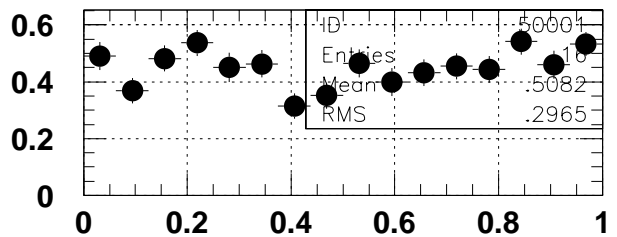
Efficiency in Eta (Mod1s1) run956



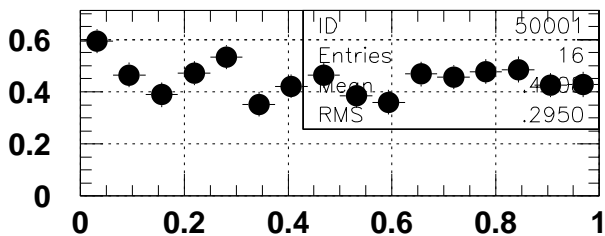
Efficiency in Eta (Mod1s1) run957



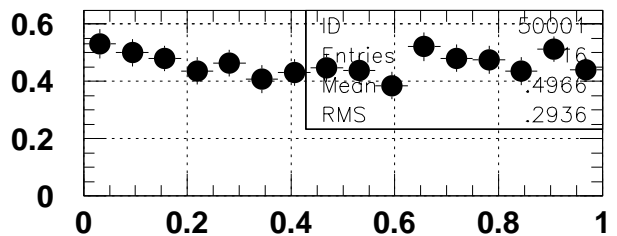
Efficiency in Eta (Mod1s1) run917



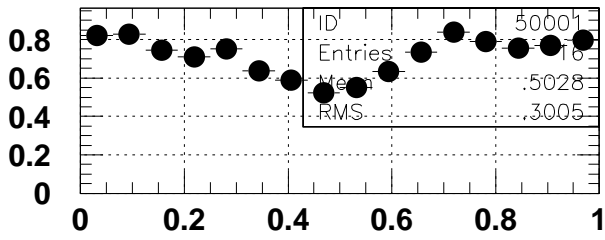
Efficiency in Eta (Mod1s1) run864



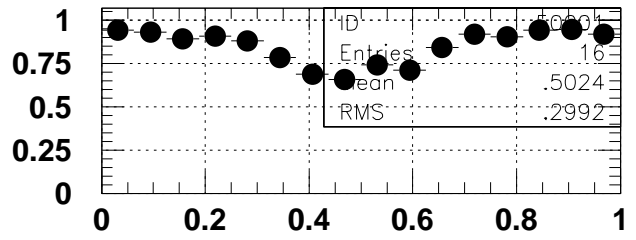
Efficiency in Eta (Mod1s1) run881



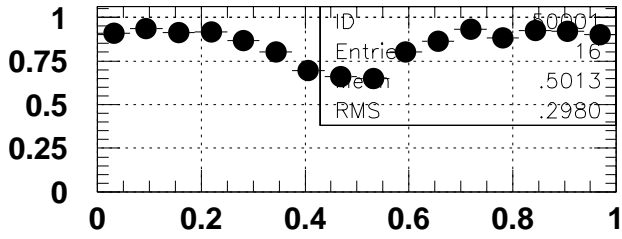
Efficiency in Eta (Mod1s1) run897



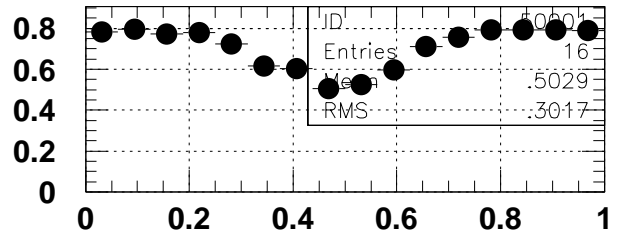
Efficiency in Eta (Mod2s0) run772



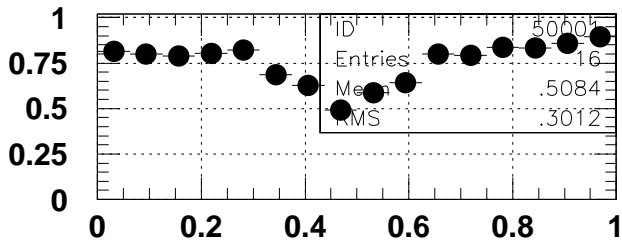
Efficiency in Eta (Mod2s0) run792



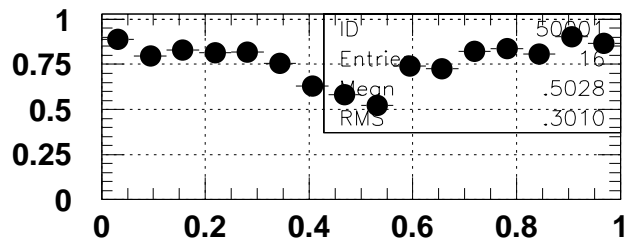
Efficiency in Eta (Mod2s0) run756



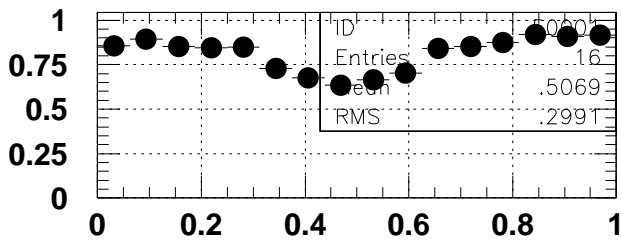
Efficiency in Eta (Mod2s0) run957



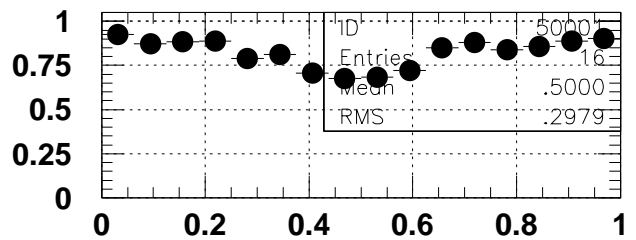
Efficiency in Eta (Mod2s0) run917



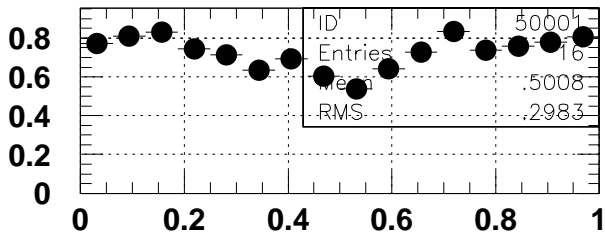
Efficiency in Eta (Mod2s0) run863



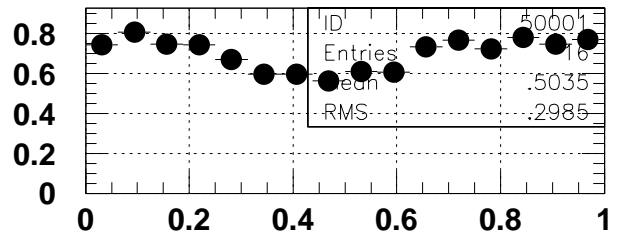
Efficiency in Eta (Mod2s0) run879



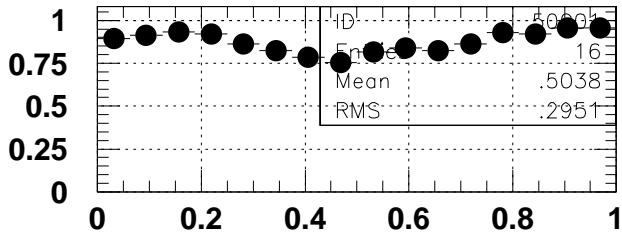
Efficiency in Eta (Mod2s0) run896



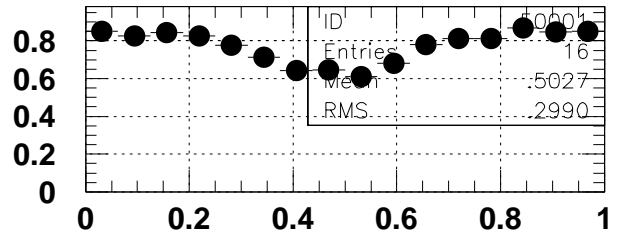
Efficiency in Eta (Mod2s1) run772



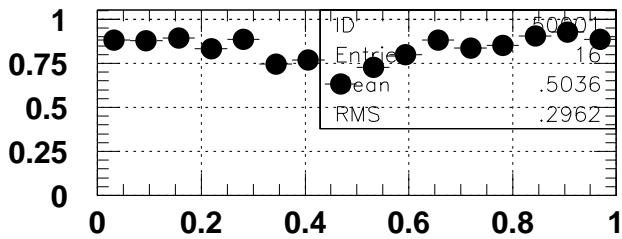
Efficiency in Eta (Mod2s1) run793



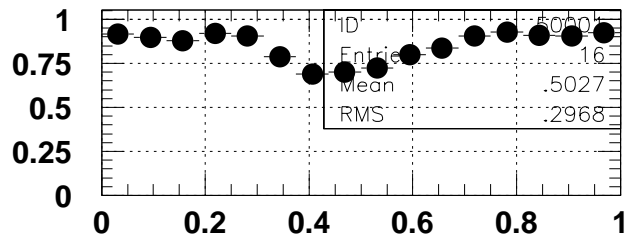
Efficiency in Eta (Mod2s1) run756



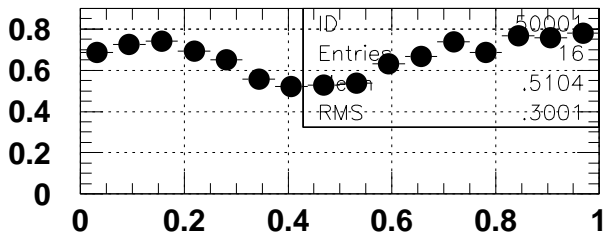
Efficiency in Eta (Mod2s1) run957



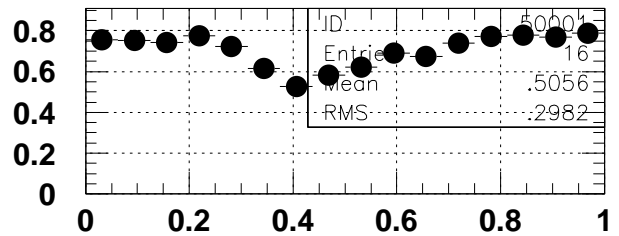
Efficiency in Eta (Mod2s1) run917



Efficiency in Eta (Mod2s1) run863

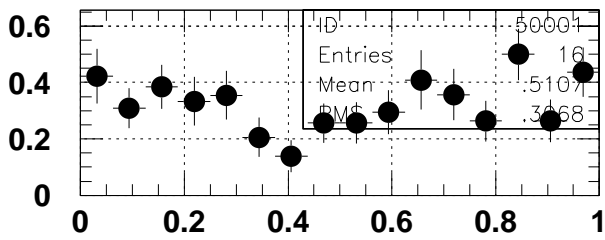


Efficiency in Eta (Mod2s1) run881

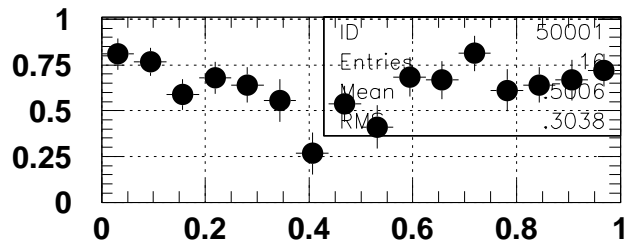


Efficiency in Eta (Mod2s1) run897

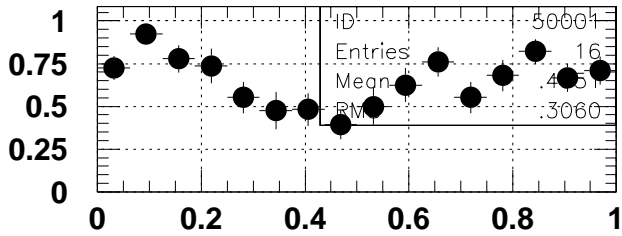




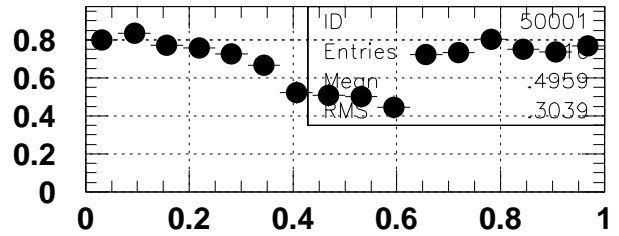
Efficiency in Eta (Mod3s0) run767



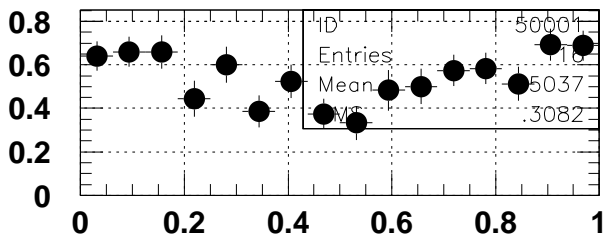
Efficiency in Eta (Mod3s0) run785



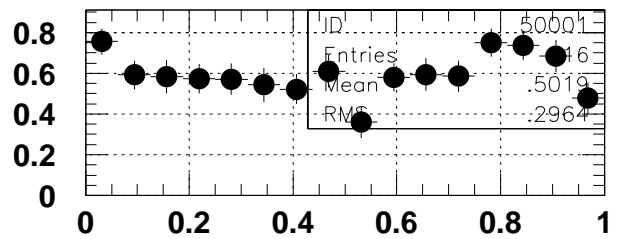
Efficiency in Eta (Mod3s0) run751



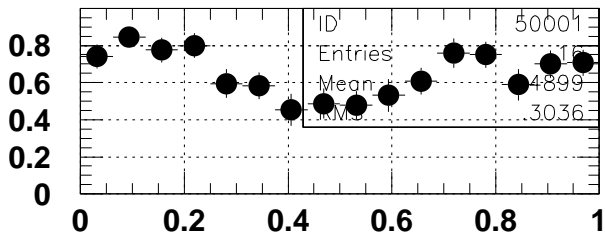
Efficiency in Eta (Mod3s0) run807



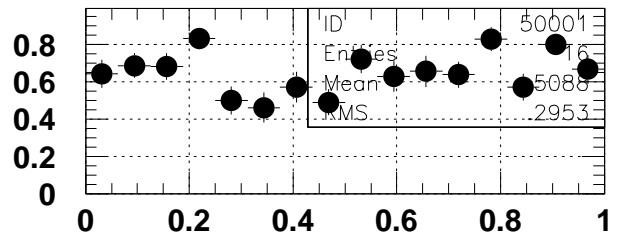
Efficiency in Eta (Mod3s0) run914



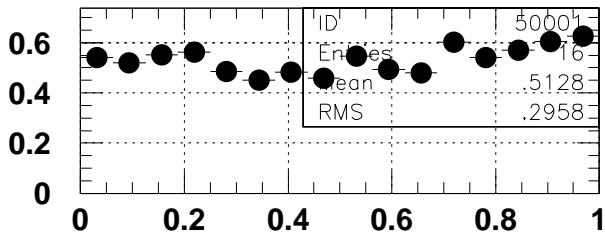
Efficiency in Eta (Mod3s0) run860



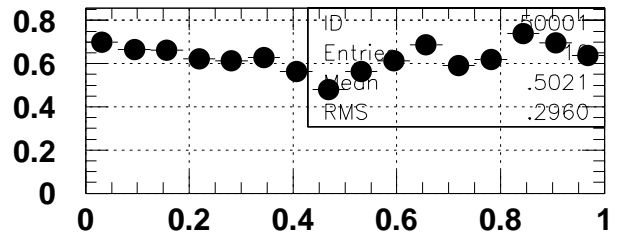
Efficiency in Eta (Mod3s0) run877



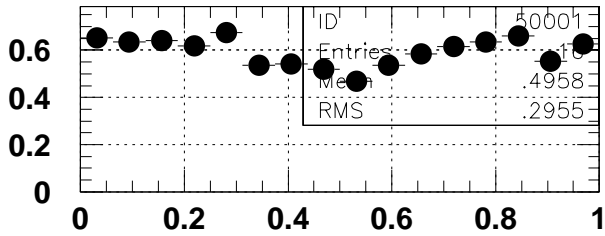
Efficiency in Eta (Mod3s0) run894



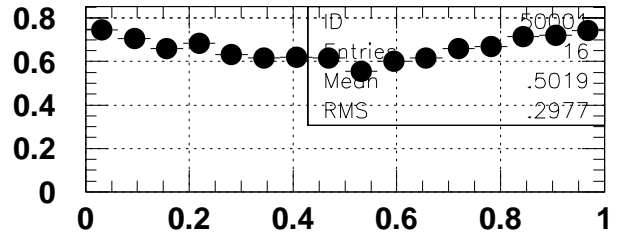
Efficiency in Eta (Mod4s0) run776



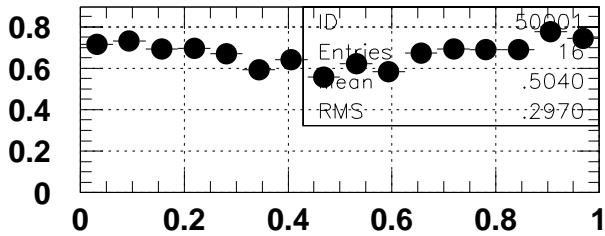
Efficiency in Eta (Mod4s0) run796



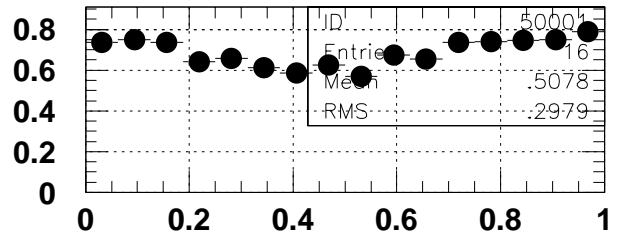
Efficiency in Eta (Mod4s0) run926



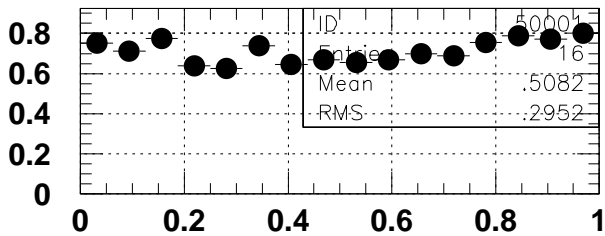
Efficiency in Eta (Mod4s0) run814



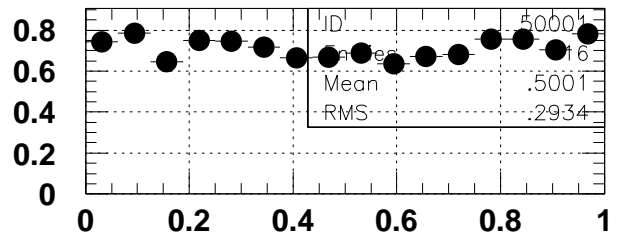
Efficiency in Eta (Mod4s0) run920



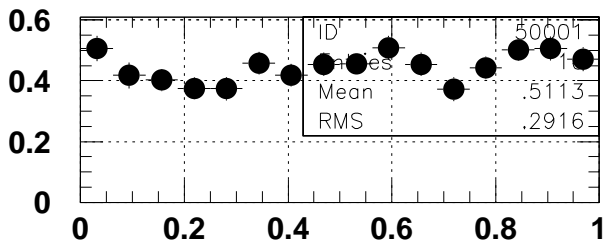
Efficiency in Eta (Mod4s0) run866



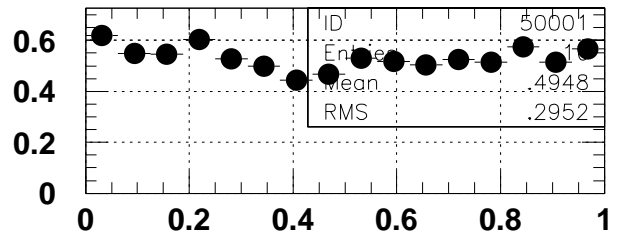
Efficiency in Eta (Mod4s0) run883



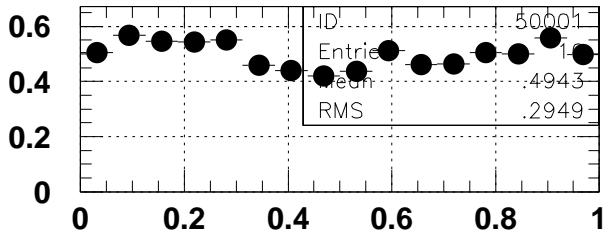
Efficiency in Eta (Mod4s0) run902



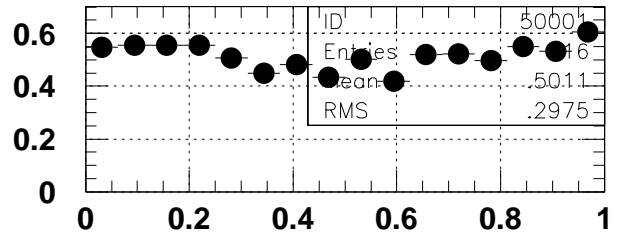
Efficiency in Eta (Mod4s1) run776



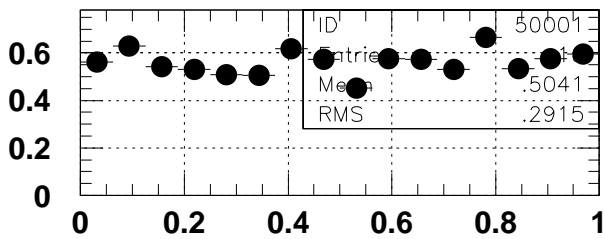
Efficiency in Eta (Mod4s1) run796



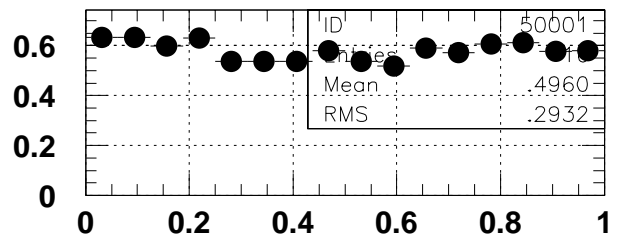
Efficiency in Eta (Mod4s1) run926



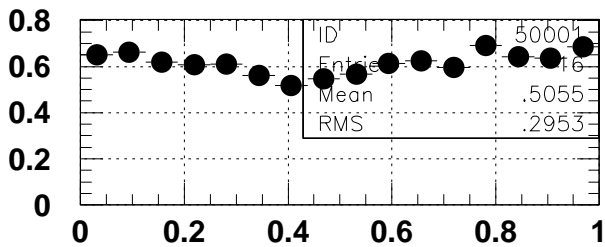
Efficiency in Eta (Mod4s1) run814



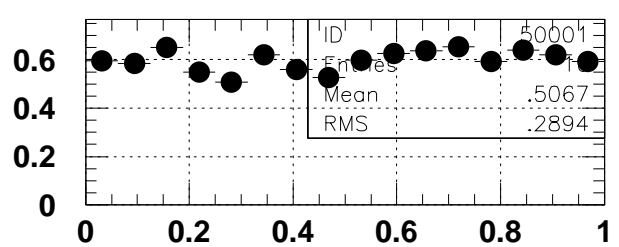
Efficiency in Eta (Mod4s1) run920



Efficiency in Eta (Mod4s1) run866



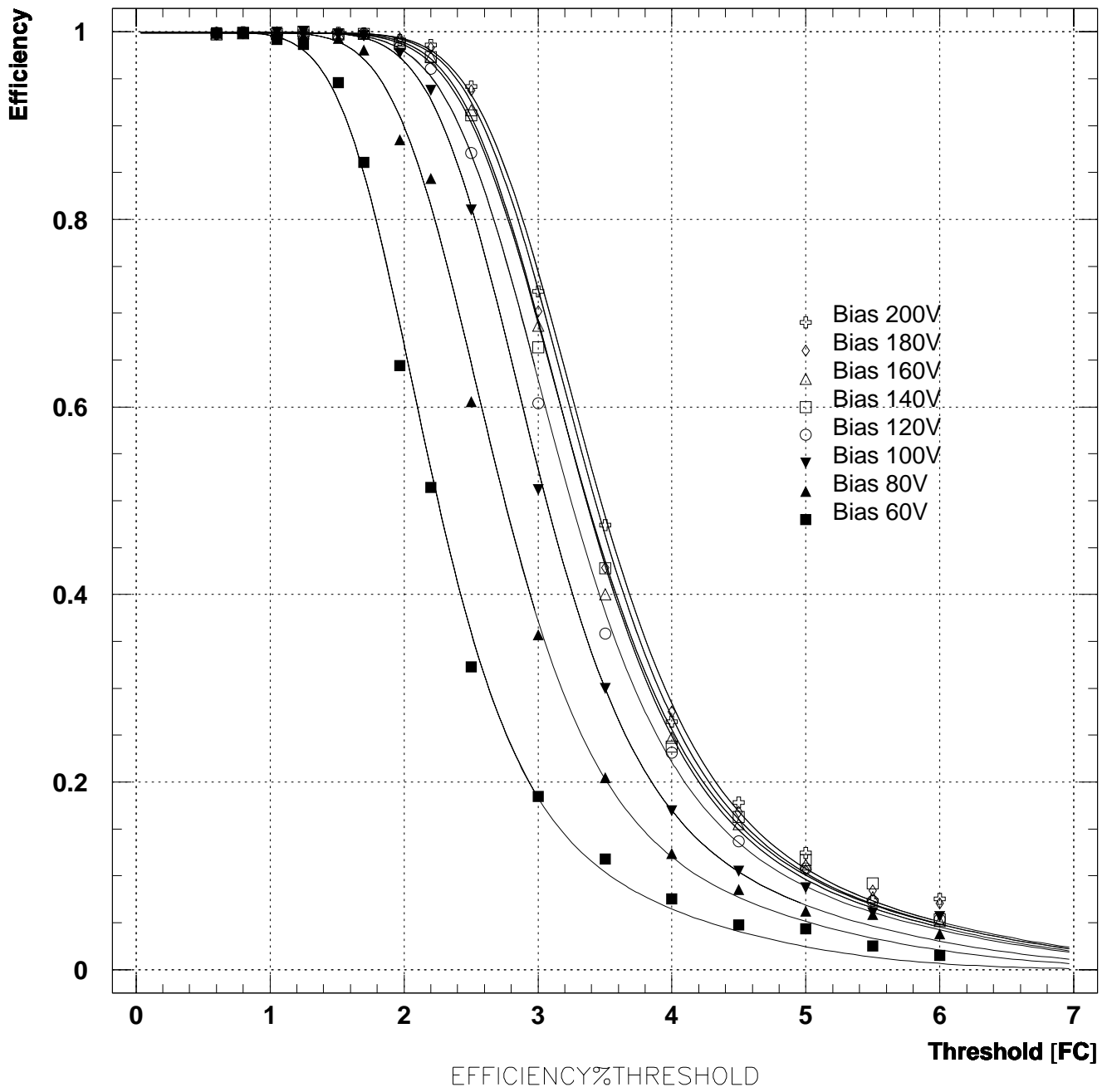
Efficiency in Eta (Mod4s1) run883



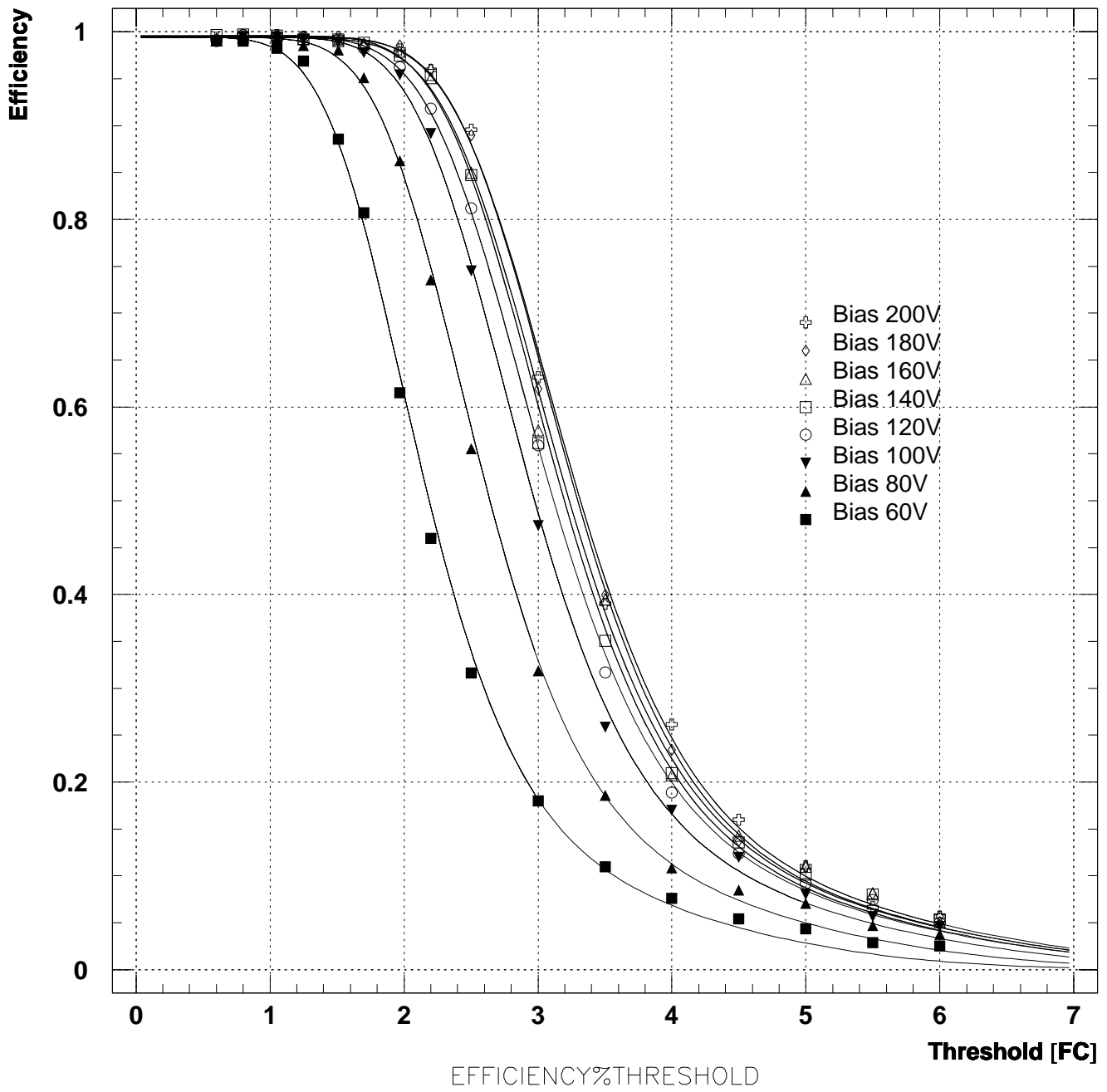
Efficiency in Eta (Mod4s1) run902

# Efficiency vs threshold, Strip region

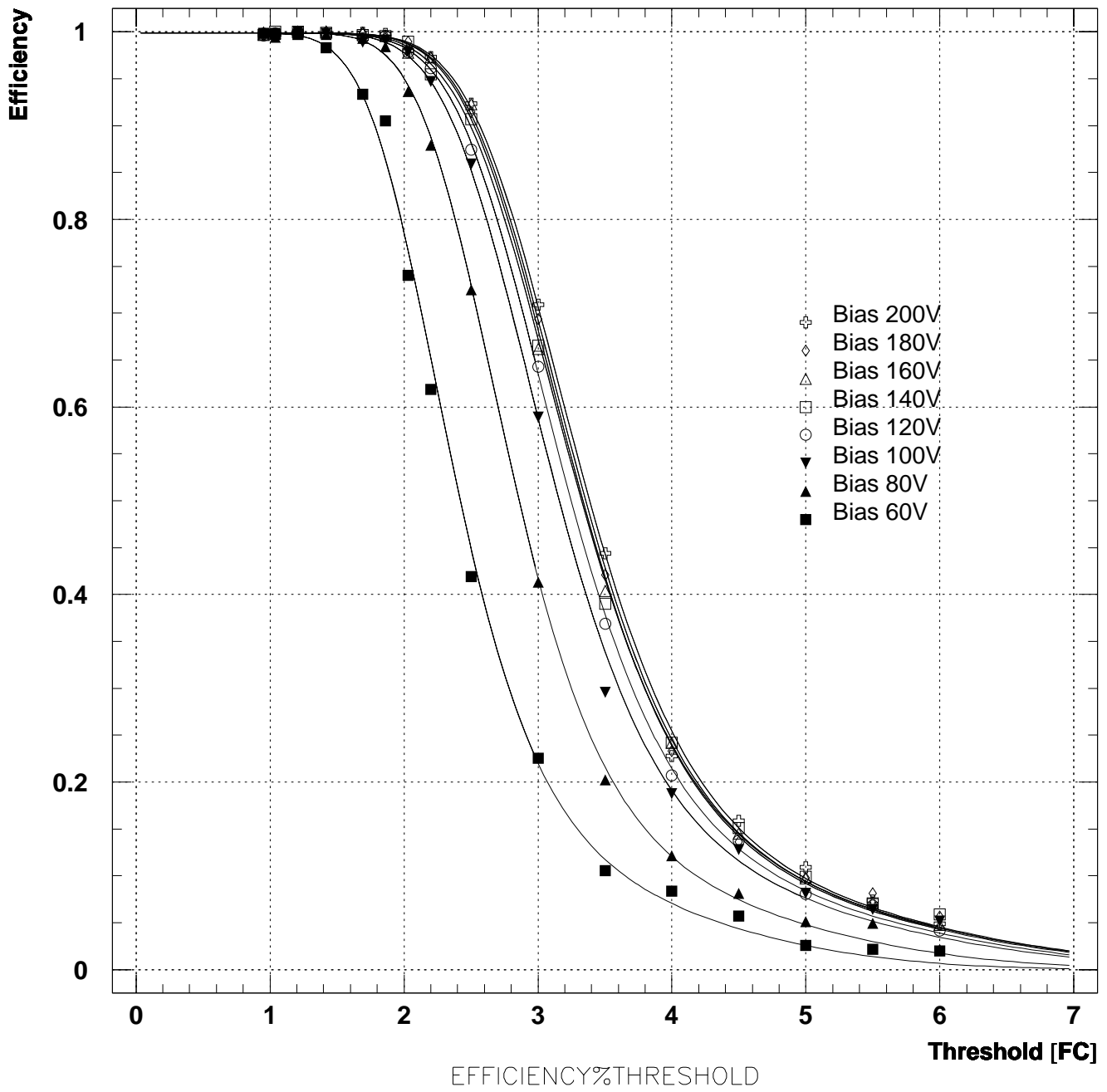
# Efficiency Curve (Mod0 Link0)



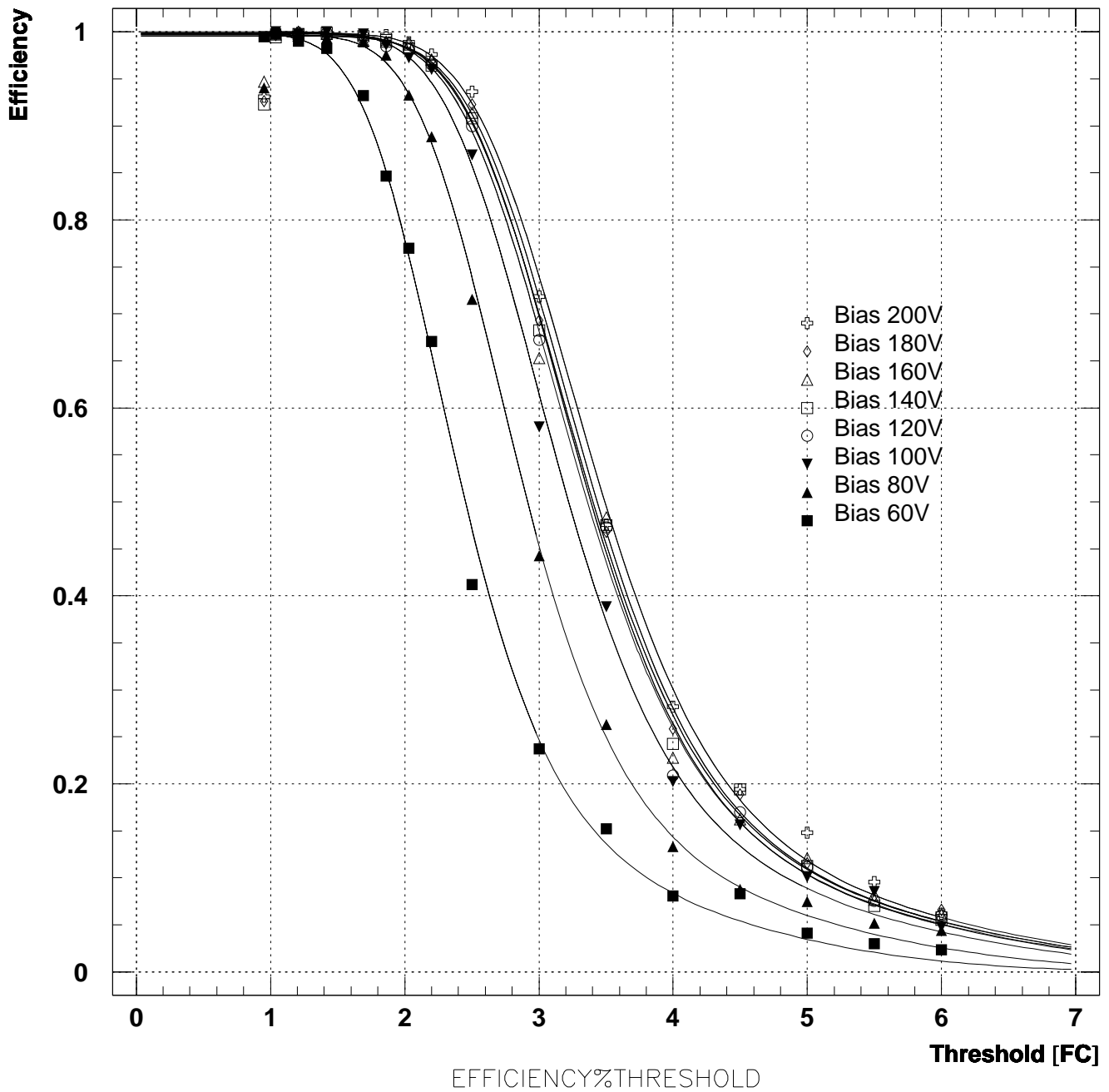
# Efficiency Curve (Mod0 Link1)



# Efficiency Curve (Mod1 Link0)

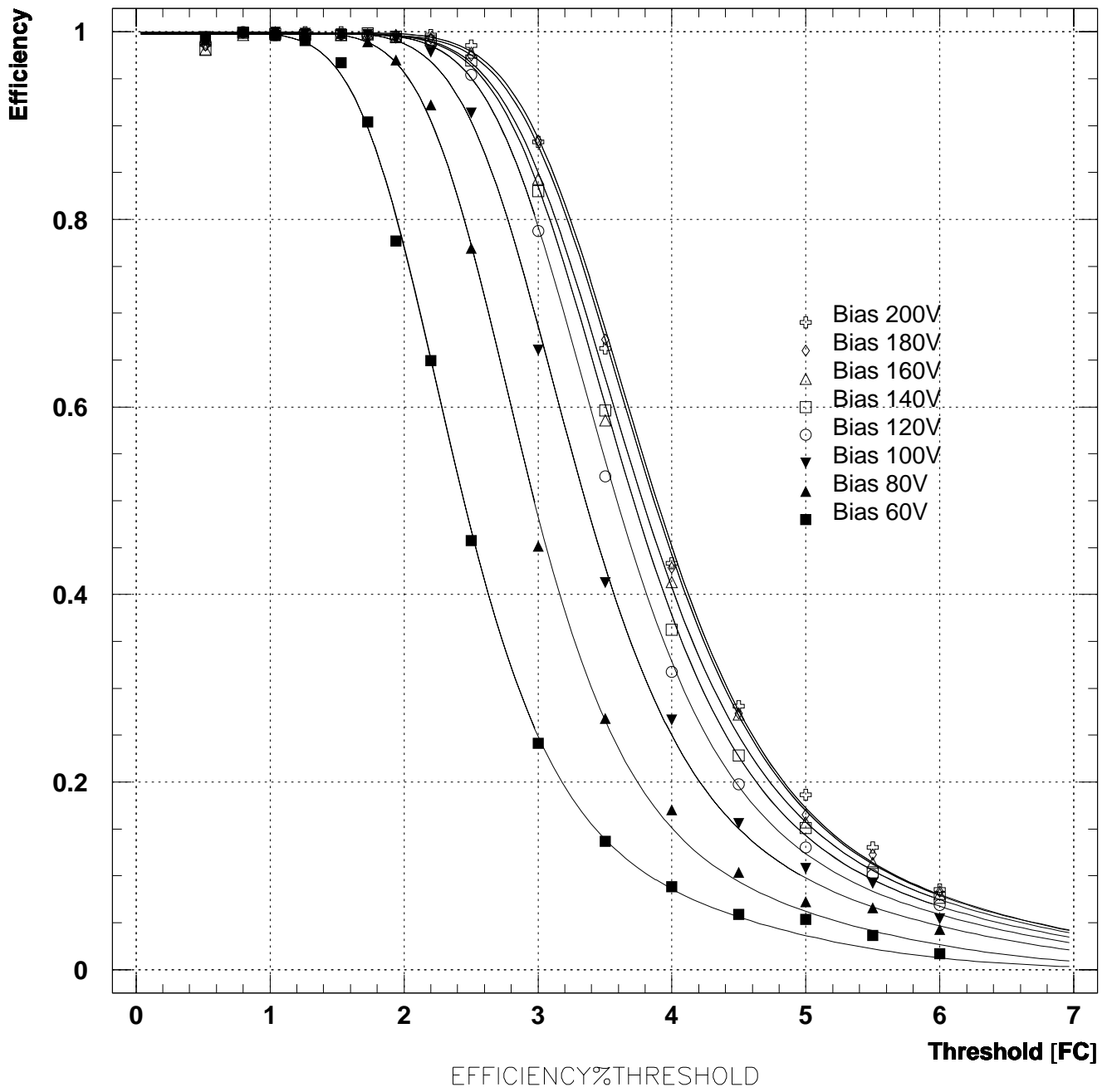


# Efficiency Curve (Mod1 Link1)

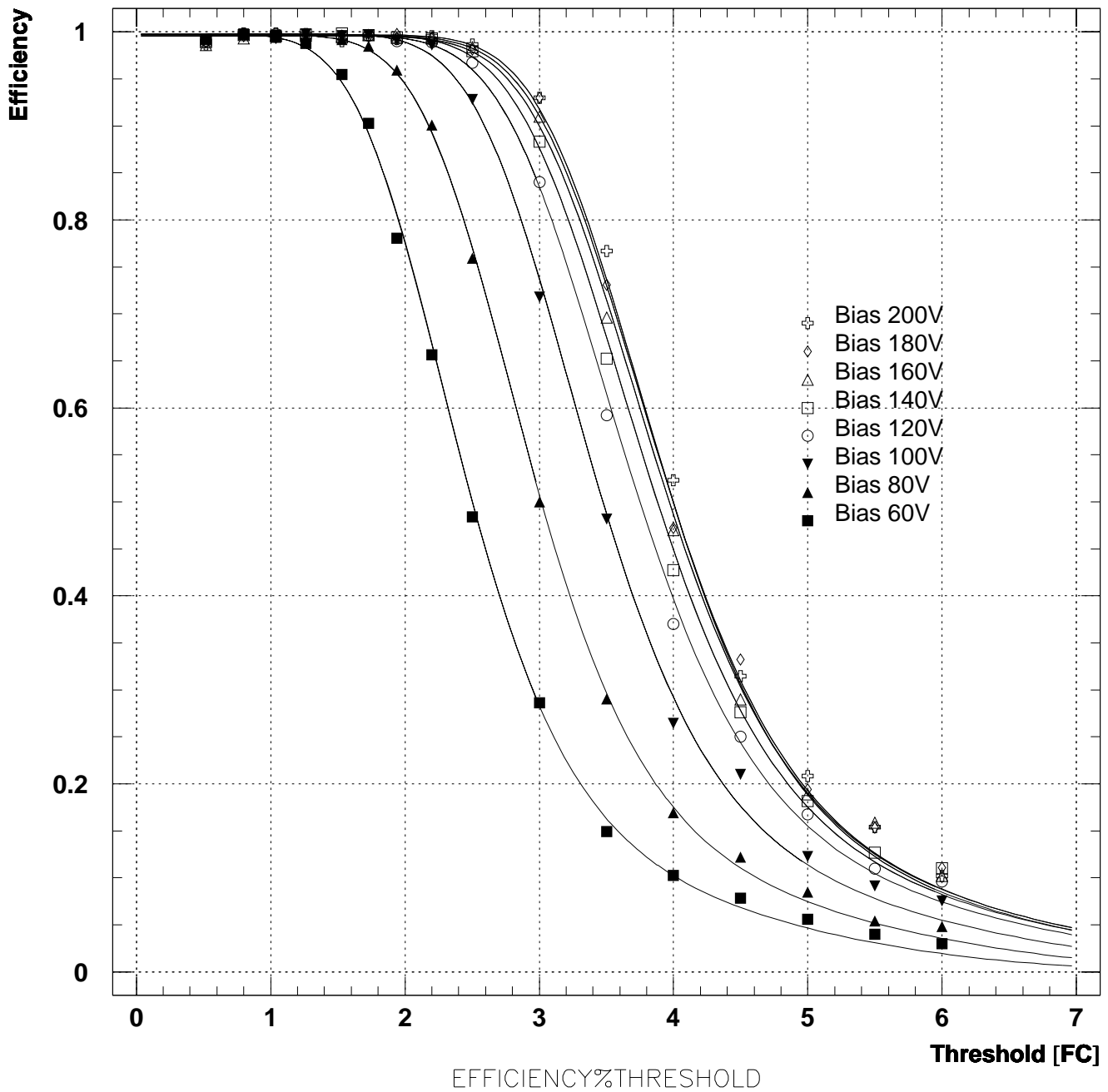




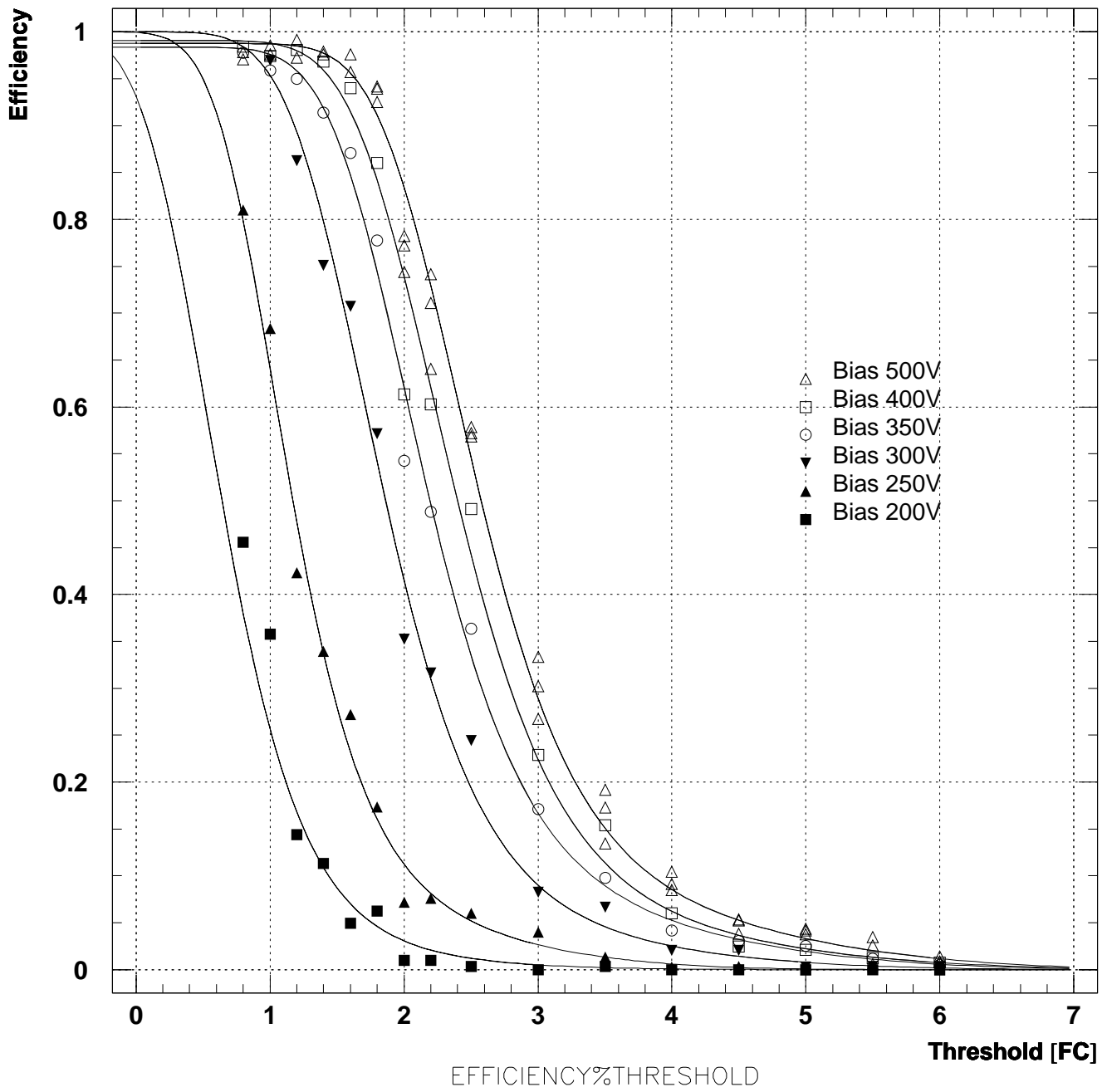
# Efficiency Curve (Mod2 Link0)



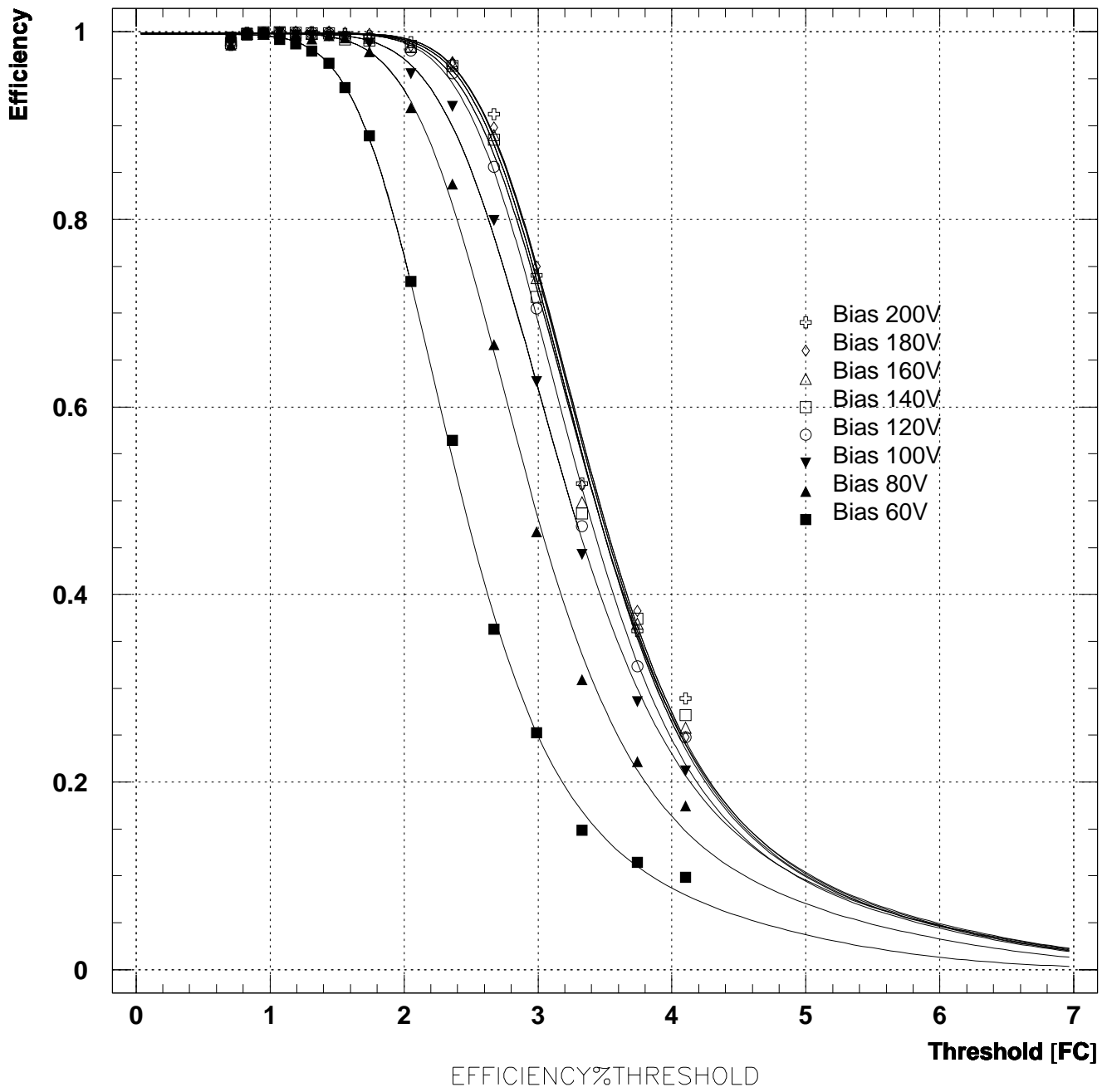
# Efficiency Curve (Mod2 Link1)



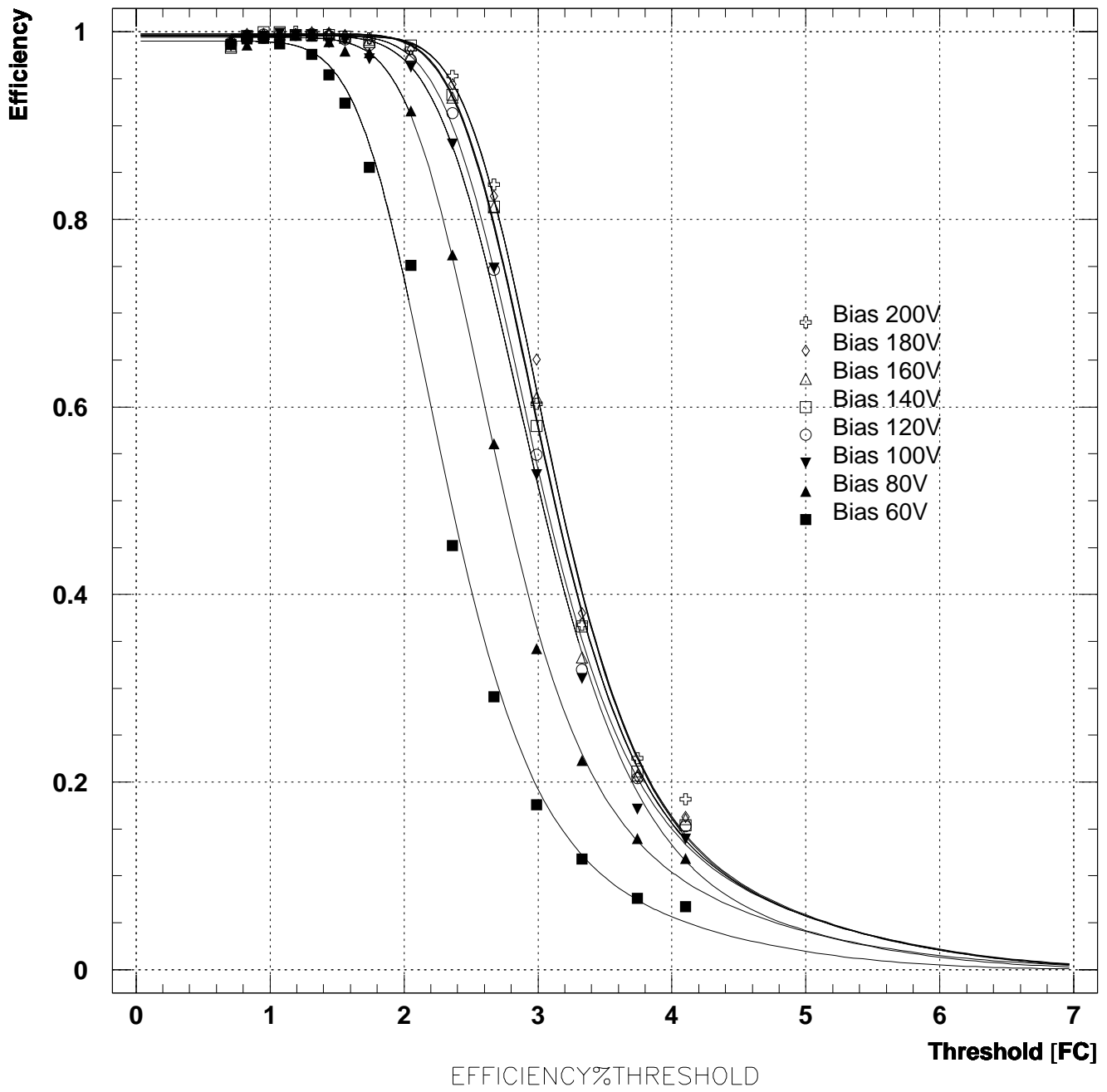
# Efficiency Curve (Mod3 Link0)



# Efficiency Curve (Mod4 Link0)

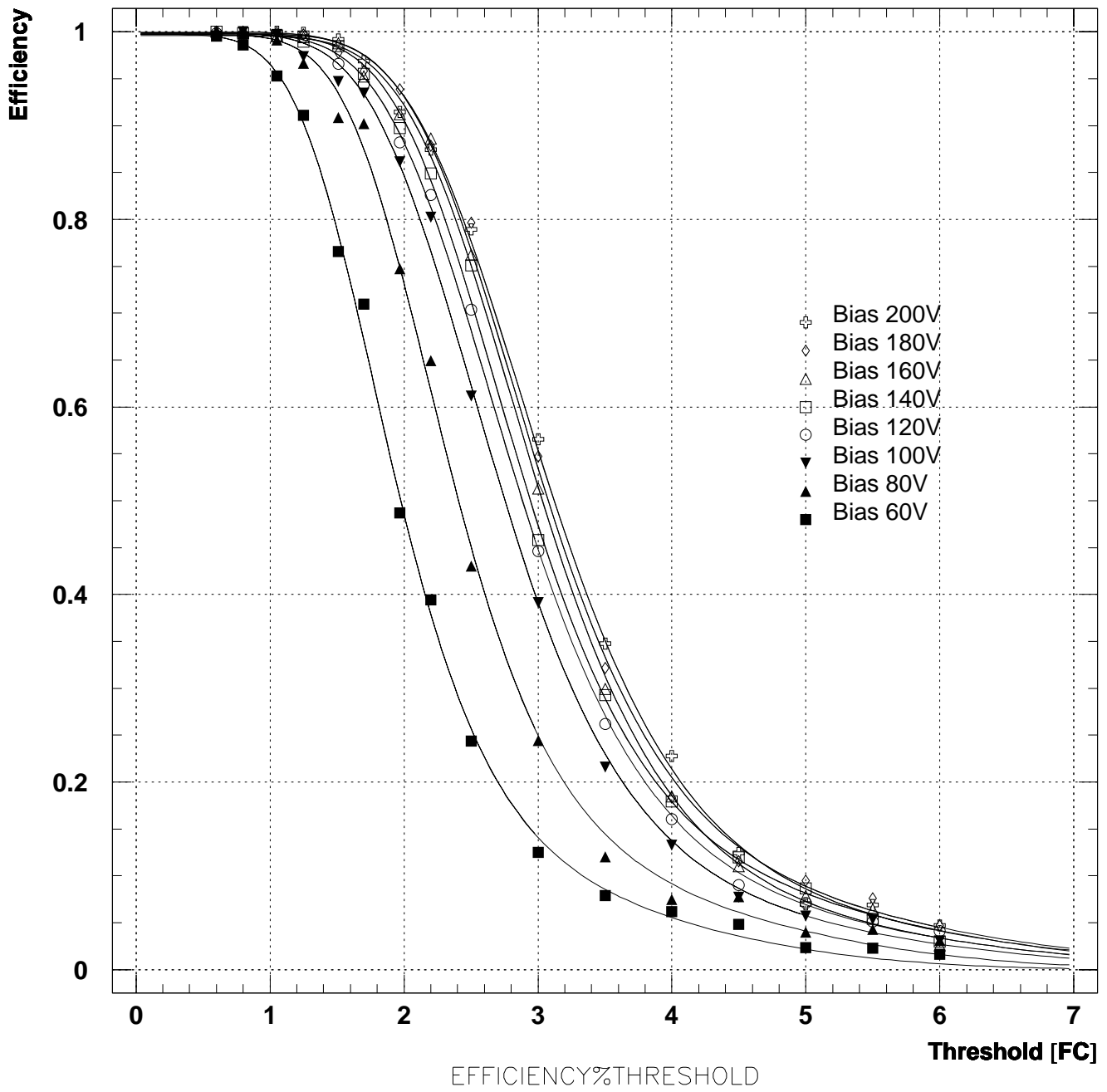


# Efficiency Curve (Mod4 Link1)

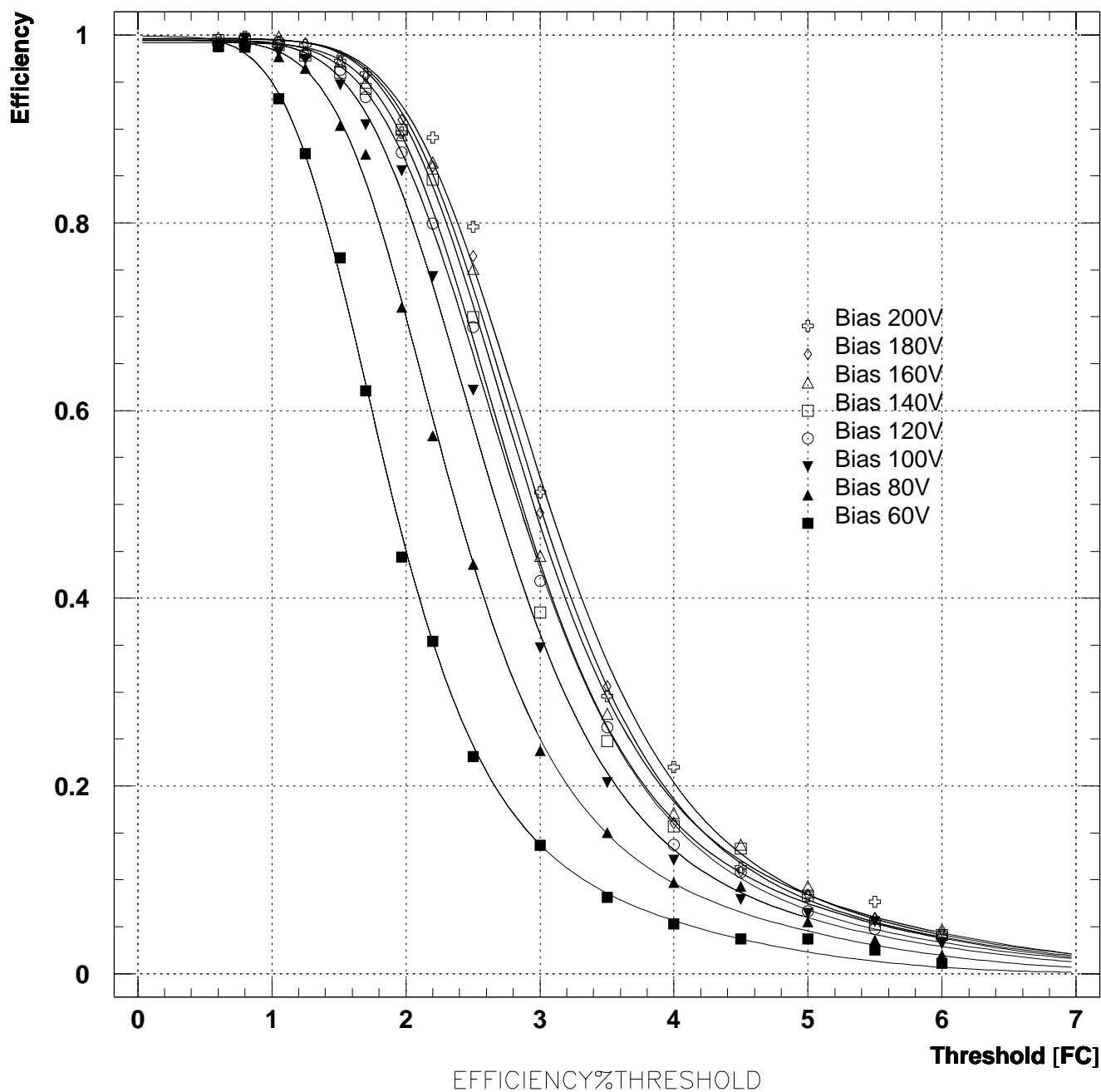


# Efficiency vs threshold, Midway region

# Efficiency Curve (Mod0 Link0)

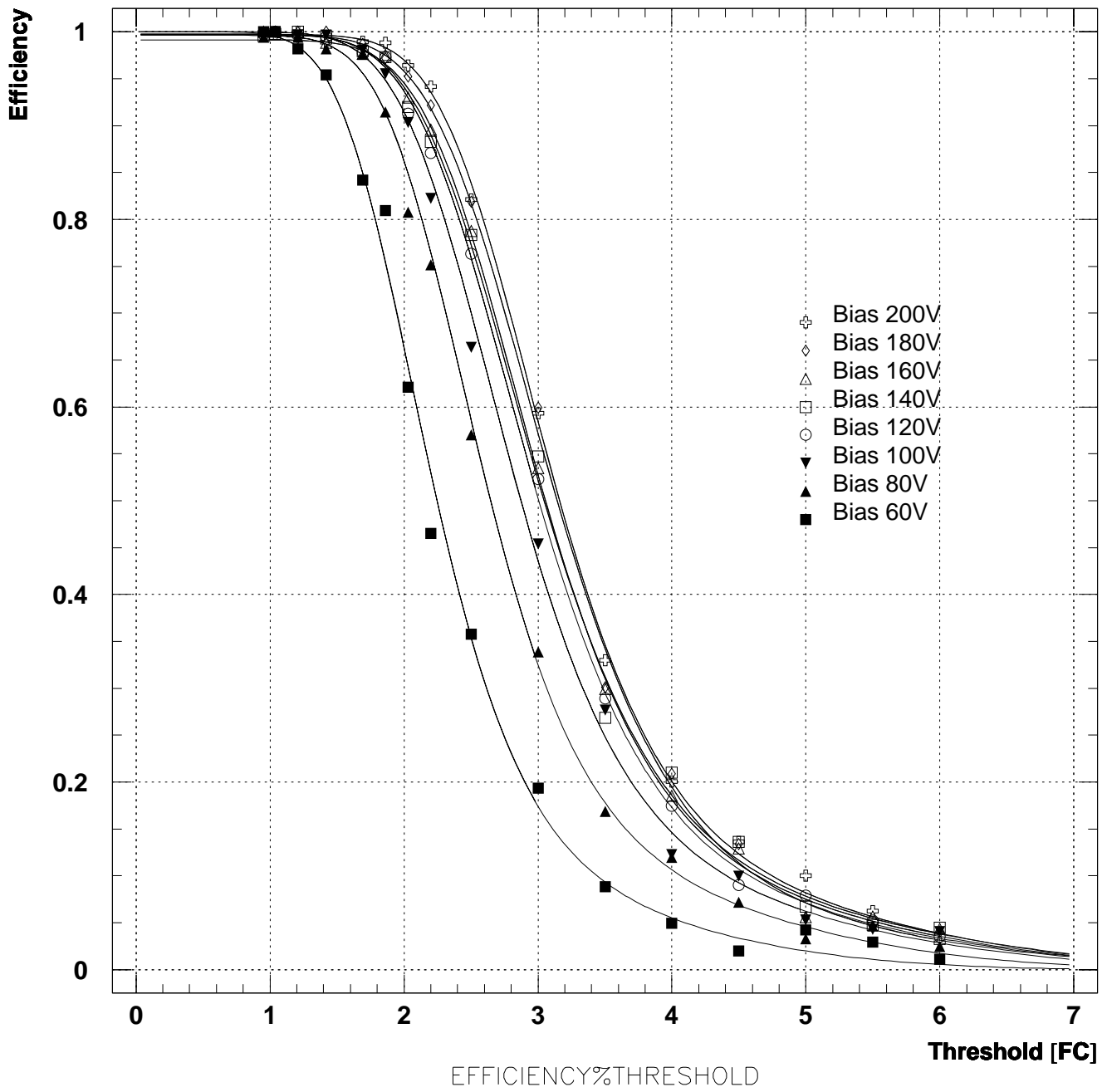


# Efficiency Curve (Mod0 Link1)



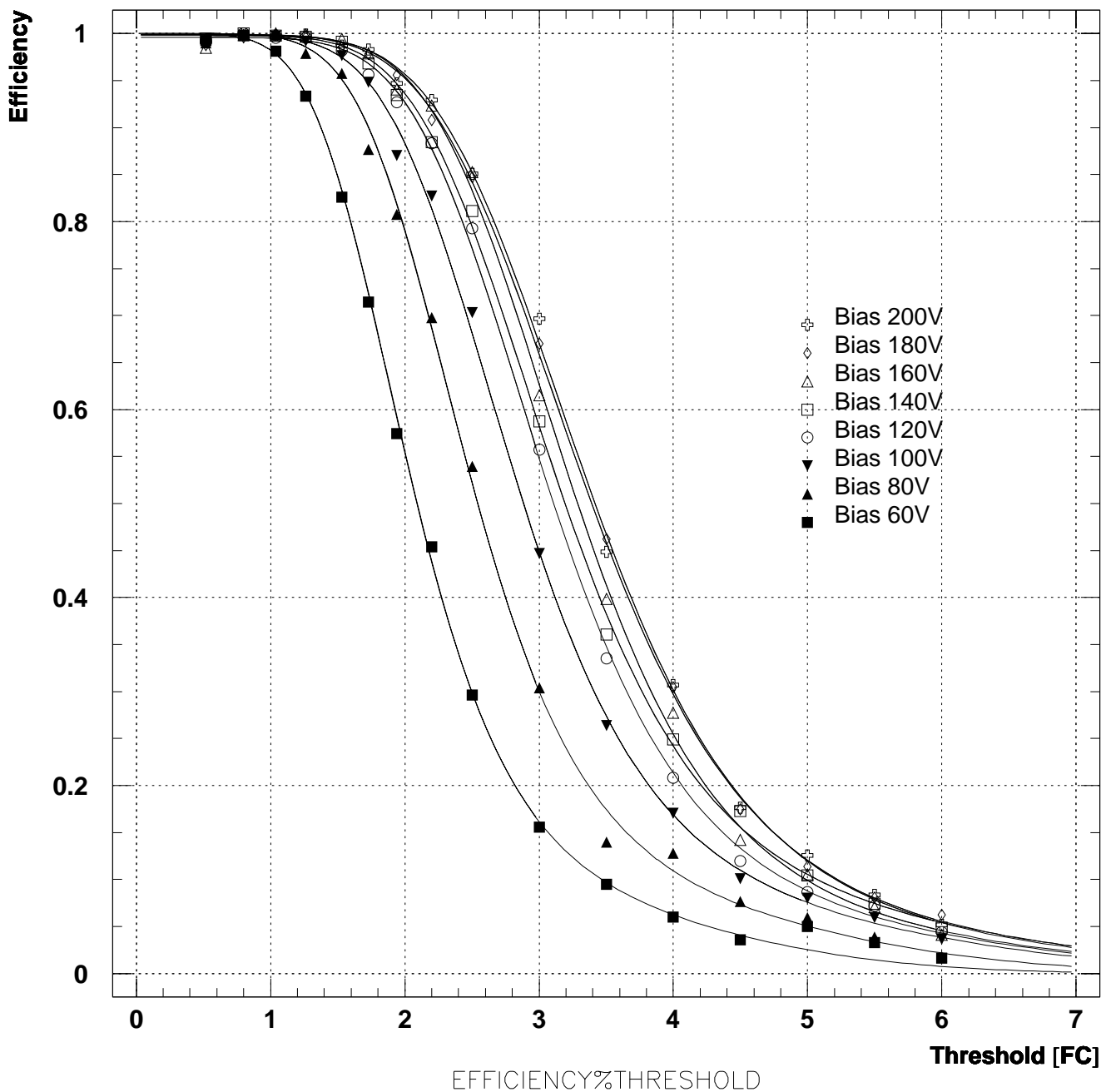


# Efficiency Curve (Mod1 Link0)

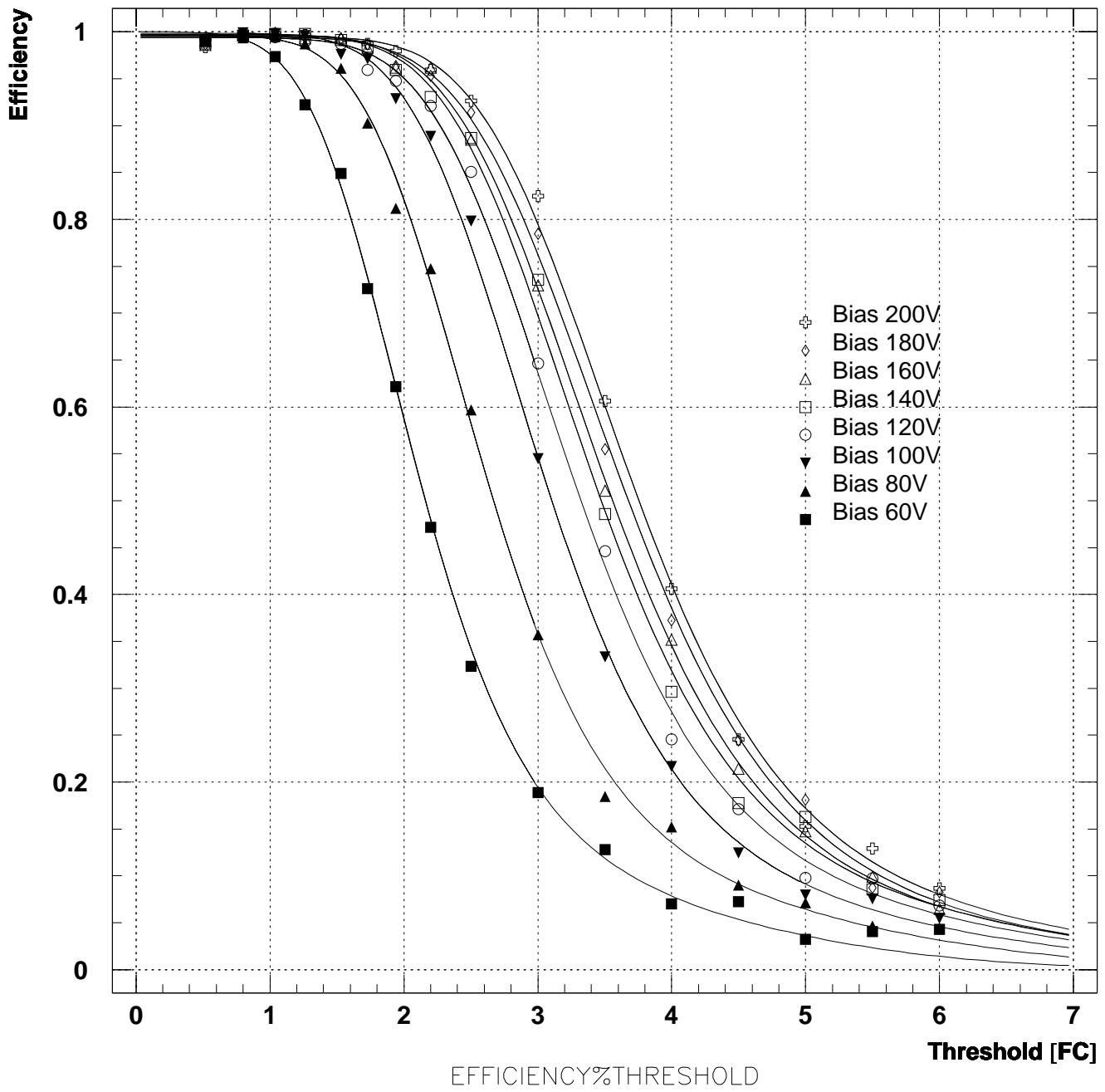




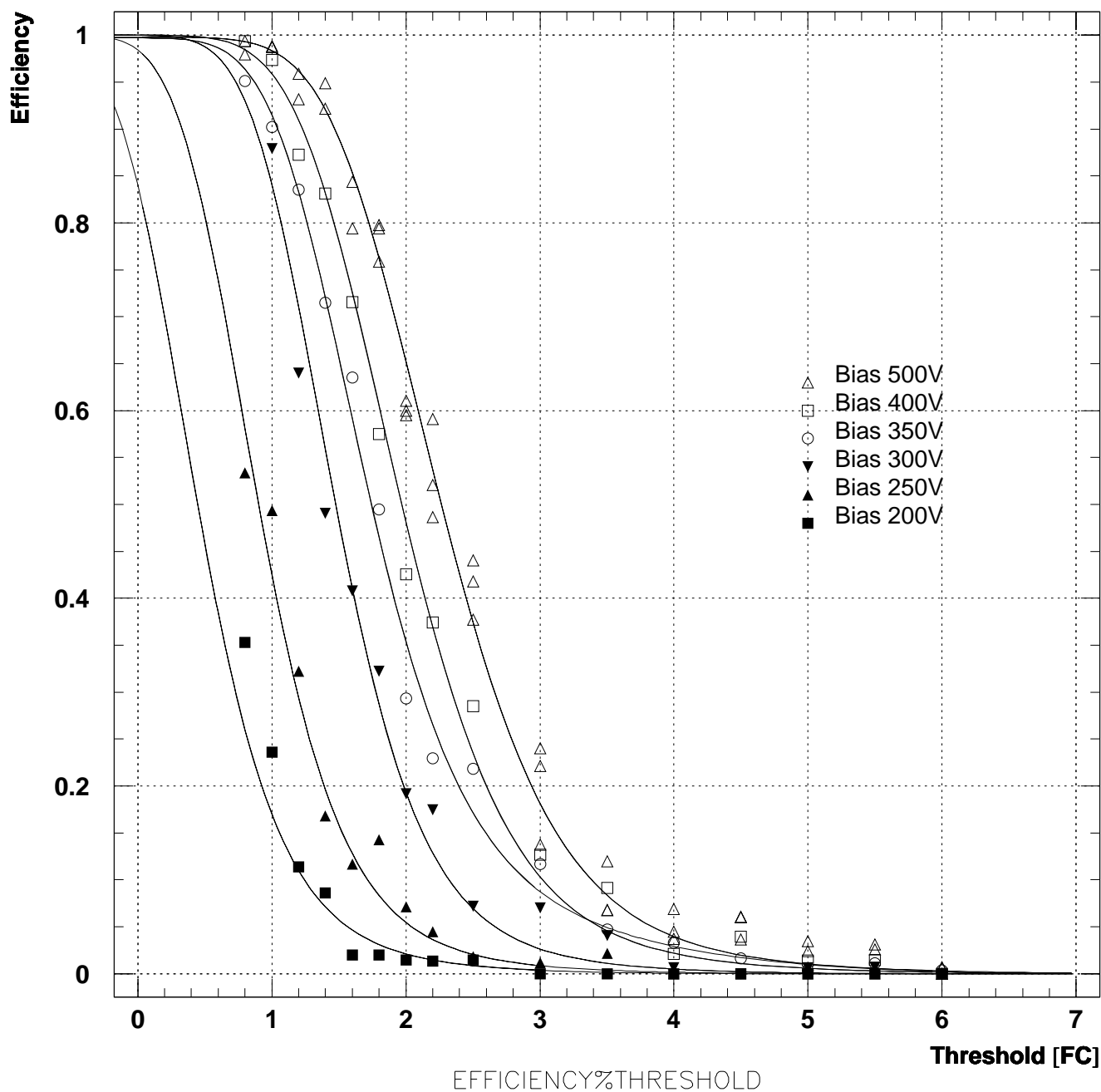
# Efficiency Curve (Mod2 Link0)



# Efficiency Curve (Mod2 Link1)

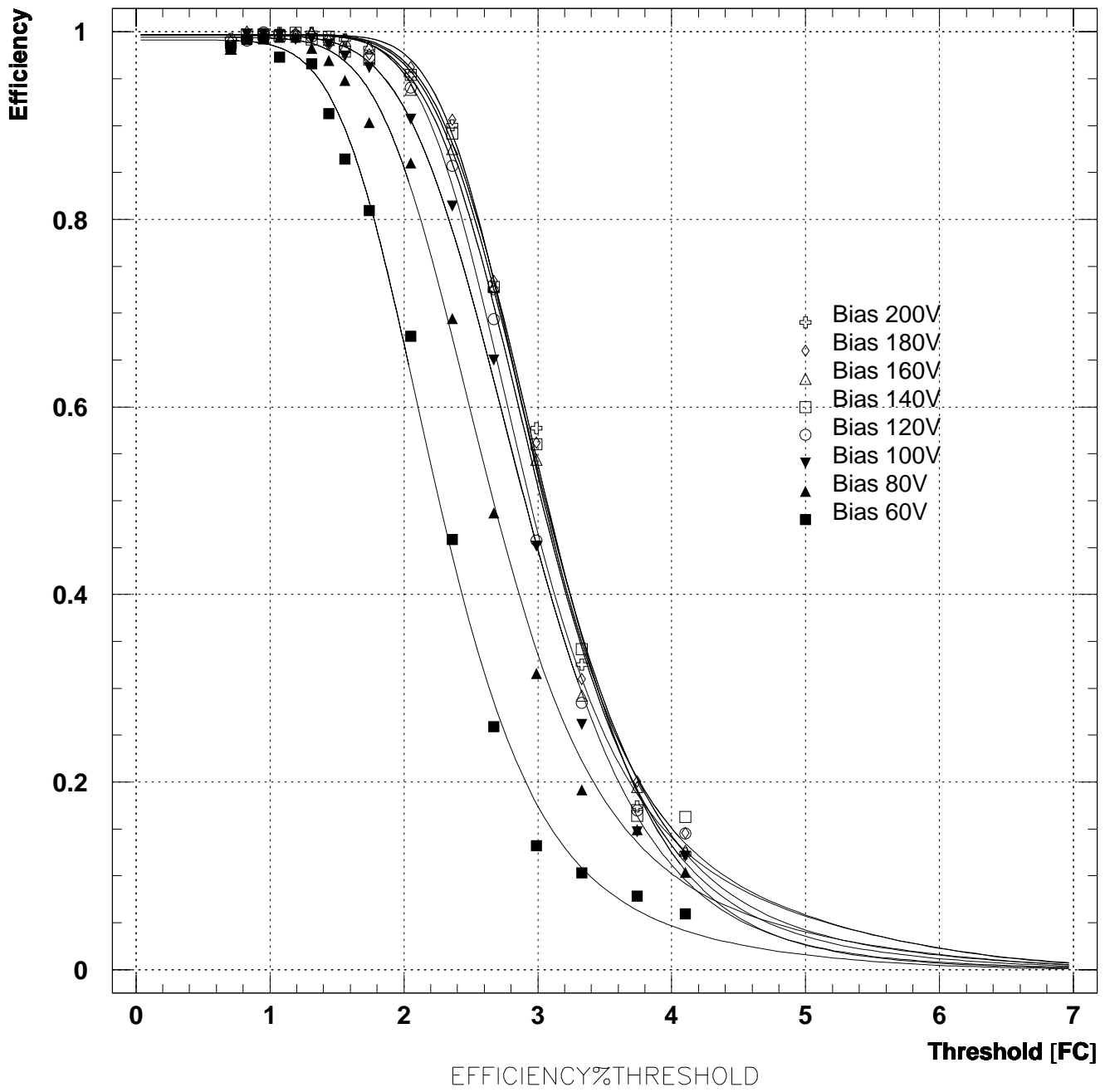


# Efficiency Curve (Mod3 Link0)





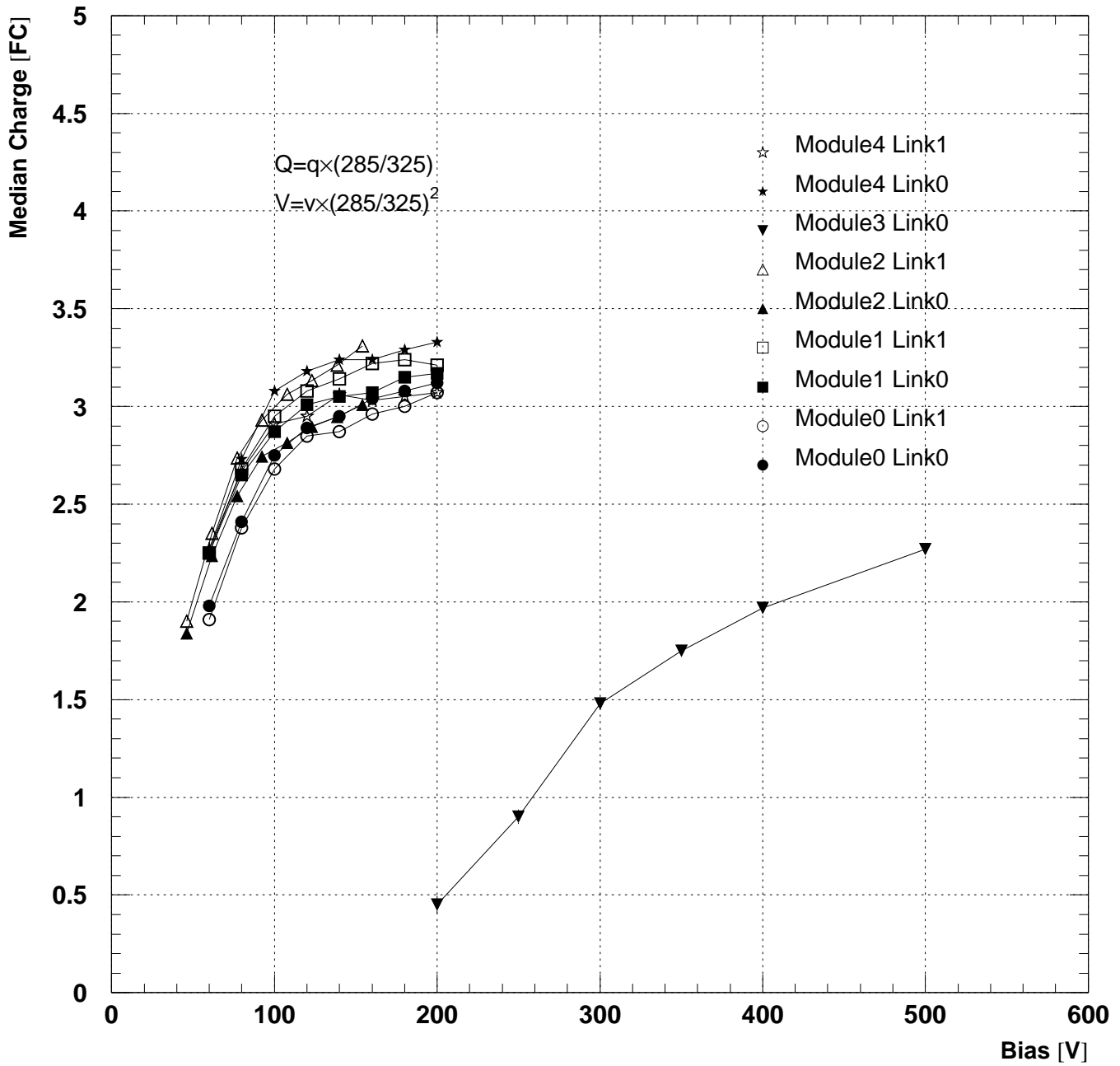
# Efficiency Curve (Mod4 Link1)

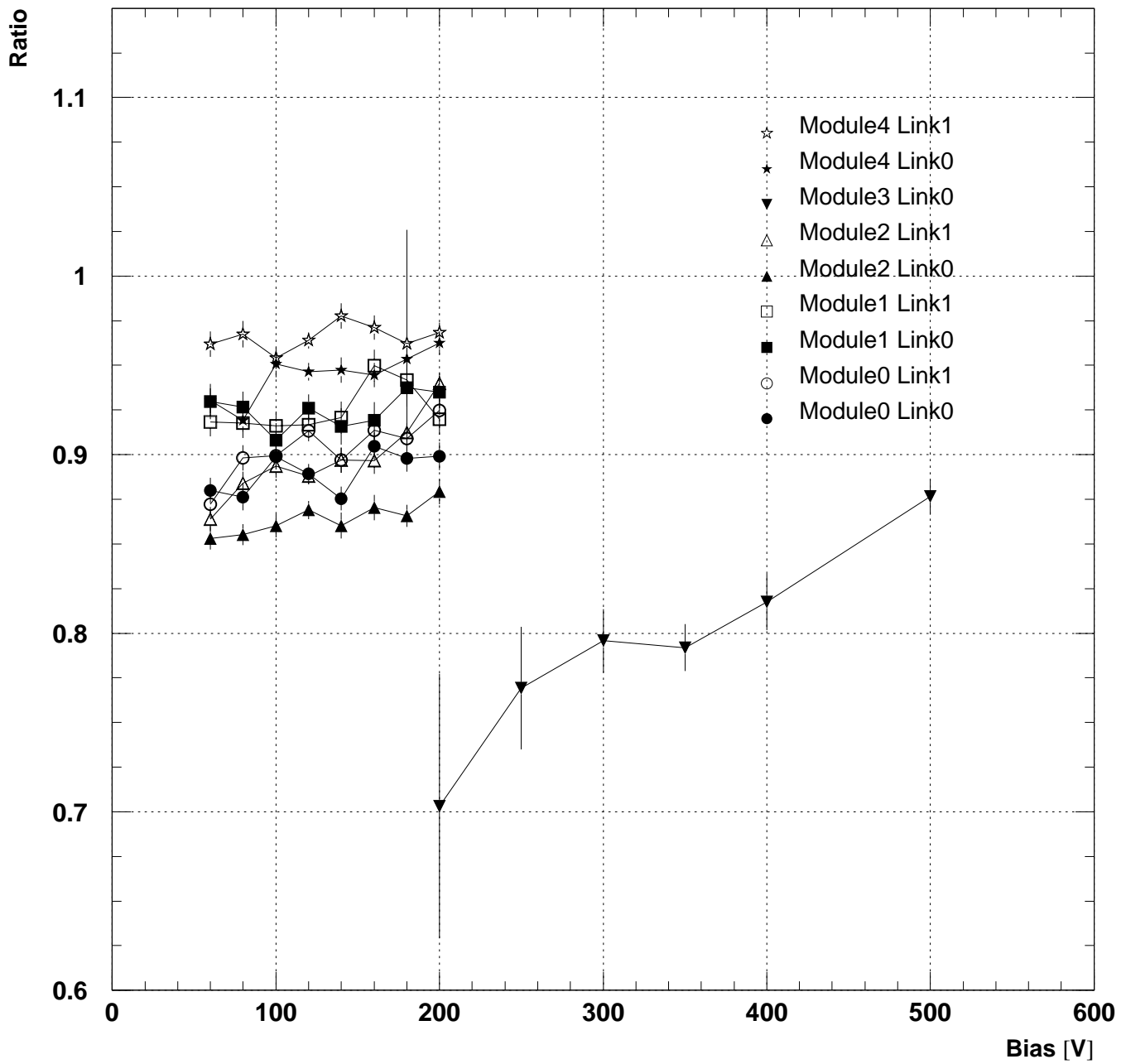


# **Bias voltage dependence of median charges of strip and midway regions**









## **Discussion of responses**

- **Ratios of median charges of “Strip” and “Midway” regions**
  - About 0.9 in non-irradiated
  - From 0.7 to 0.9 in irradiated
  
- **Comparison with the previous result**
  - Good coincidence

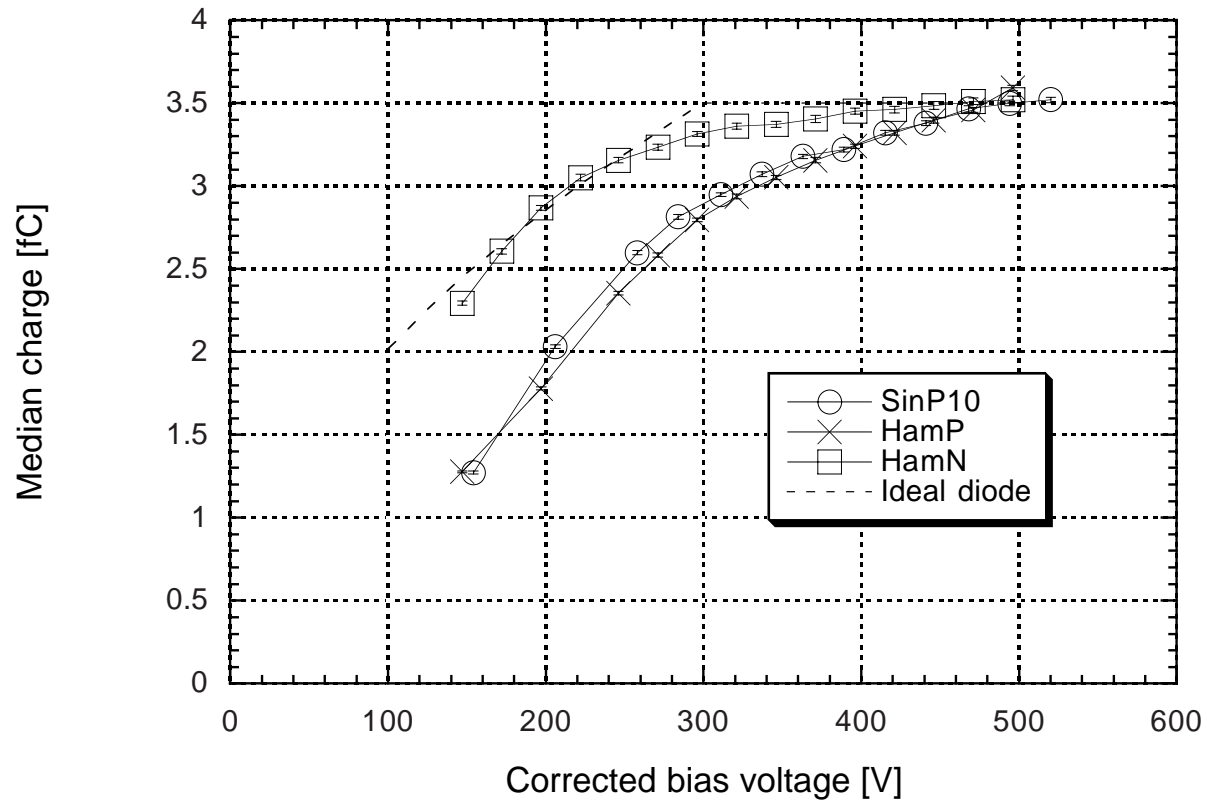


Figure 7: Median charges of the irradiated detectors as a function of bias voltages. The “ideal diode” is the theoretical expectation of the collected charges which scales as  $\sqrt{V}$  and saturates at 300 V.

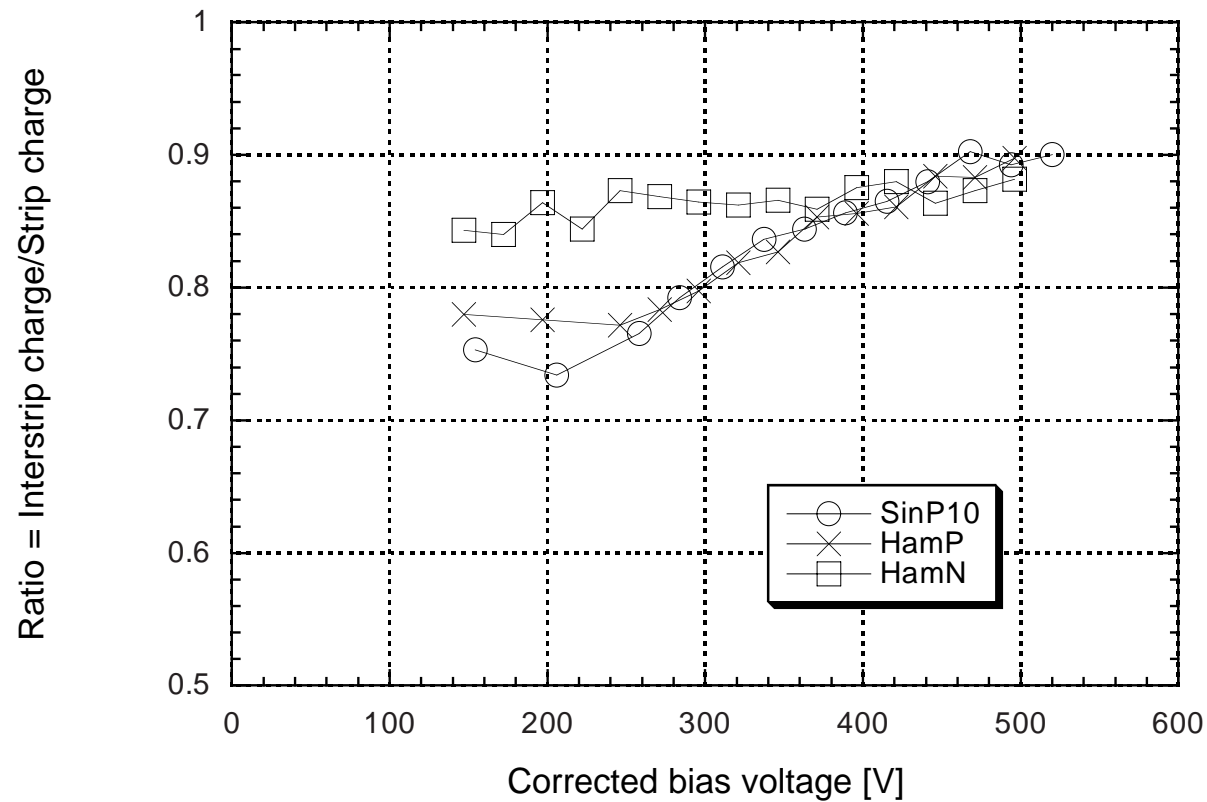


Figure 8: Ratios of the median charges in the inter-strip and the strip regions as a function of the bias voltage, of the irradiated p-in-n (circle and cross) and the irradiated n-in-n detectors (square). The inter-strip region was defined as an area midway between the strips with a width of  $20\ \mu\text{m}$ , and the strip region as being around the strips with a width of  $40\ \mu\text{m}$ .

# Summary

- **Results became clean after the fiducial volume cuts**
- **Position resolutions were reasonable, weak dependence on threshold and bias voltage**
- **Non-irradiated sensor saturate at about 3.3 fC and “irradiated” at about 2.5 fC**
- **Loss of efficiency in the midway region was confirmed**
  - **About 80% response in average in 25% region**
- **Confirmation of the response of the irradiated sensors in proper modules is urgently needed**