Prototype data analysis

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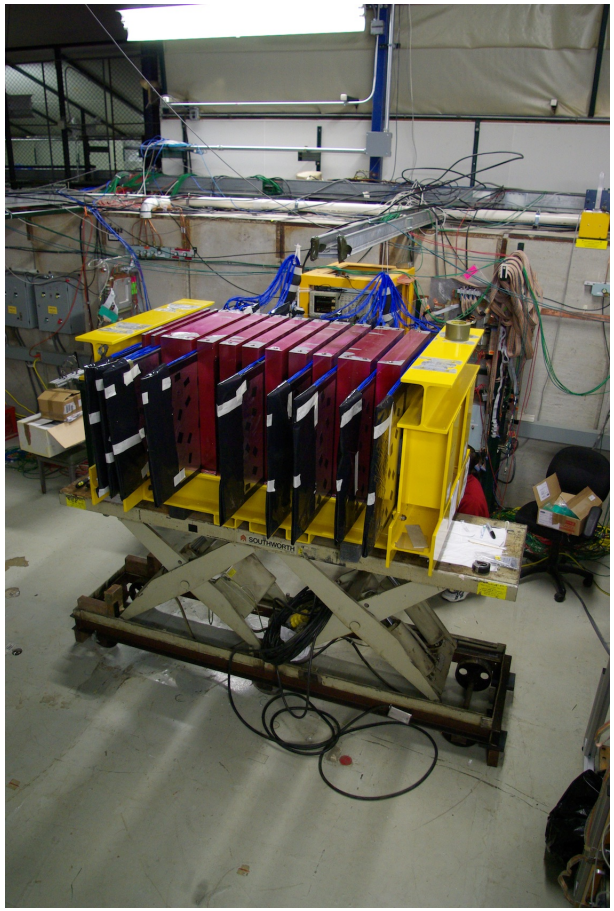
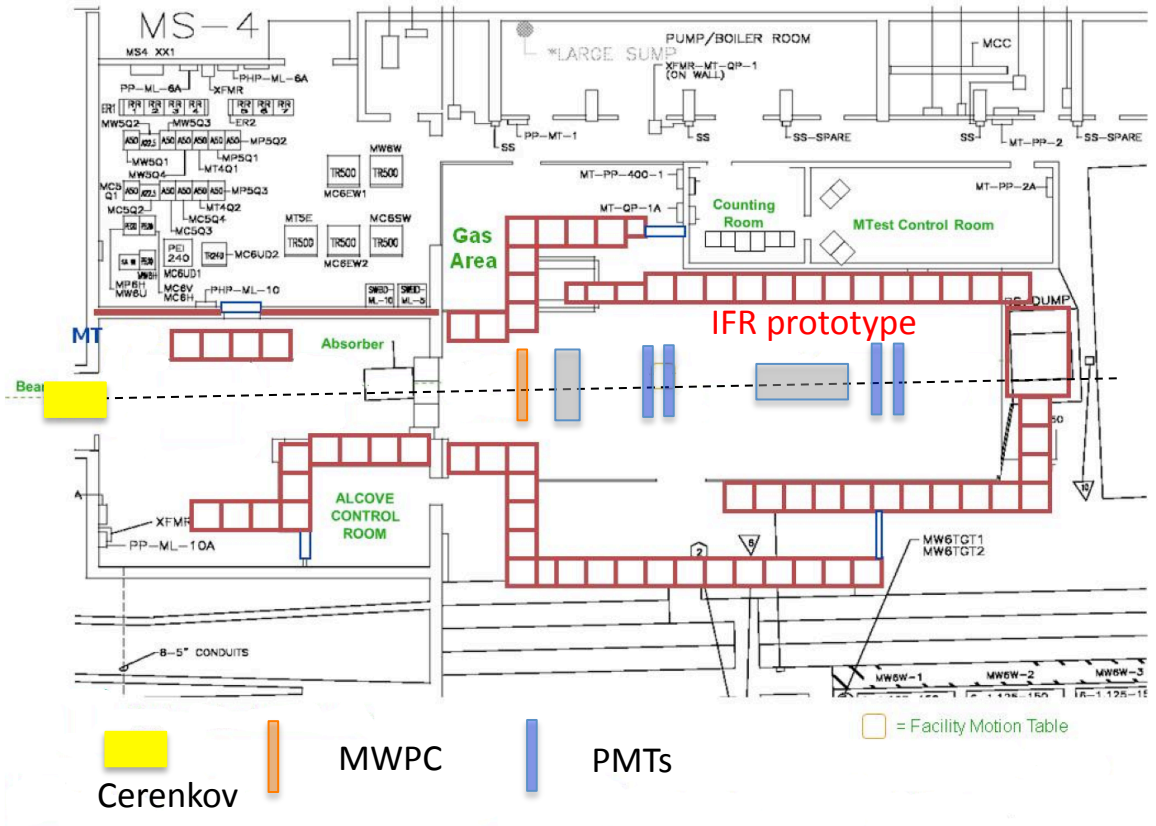
The beam test

A beam test has been done at the FNAL beam test facility last December with muon/ pion beam ranging from 4 to 6 GeV, for details see my talk at the Caltech meeting.



Experimental setup



Analysis strategy

- First understand the detector
- then understand the beam composition, and contamination
  - study muons and pions shape
- tune MC to reproduce muons and pions shape
- study muon ID on one configuration and compare with MC results
- Data – MC comparison and extend to more configurations. More tuning if needed

Analysis on data

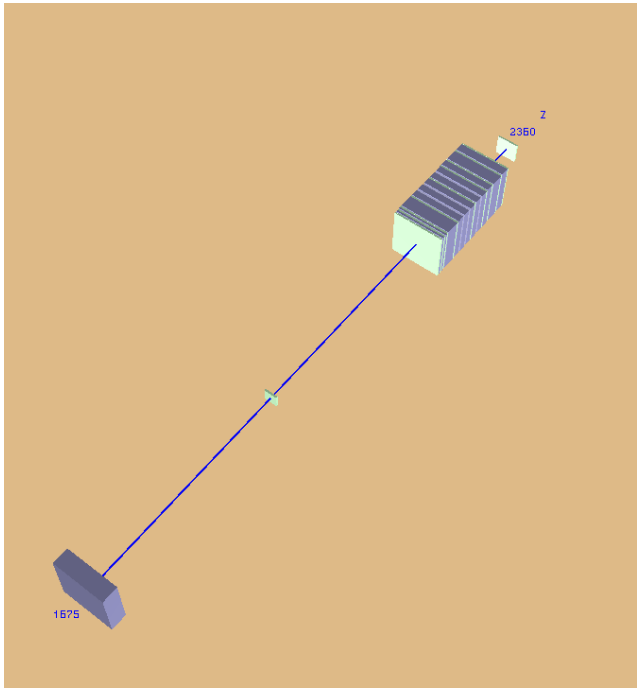
- Preliminary studies **Done**
  - trigger and beam composition
  - Trigger selection variables
  - Ruutples production
- Performance and calibration
  - efficiency **mostly done**
  - time resolution
  - new production
- Less priority code developments
  - double threshold for time readout
  - declusterize BiRO hits

  delayed
- Cosmics run in Ferrara **needed asap**
  - Detector calibration
  - Benchmark for muon signature
  - Random trigger: occupancy, noise
- Muon ID **in progress…**
  - muon/pion shape
  - implement MC reconstruction for prototype.
  - first tuning of MC
  - upgrade fit code for the prototype.
  - muon ID studies with BDT selector
  - …

Monte Carlo status

- Iron positioning
- Add trigger scintillators S1, S2, S3, S4
- Generate mu, pi, $e^{\pm}$
- Beam composition study

Done



- Modify/upgrade/implement recosntruction

To do (highest priority)

Data Sample

All runs

Nevt	Ns1s2	Nelect	Nmupi	Nmu	Npi	Ns3s4
1164136	843353	133177	710106	183214	467204	182651

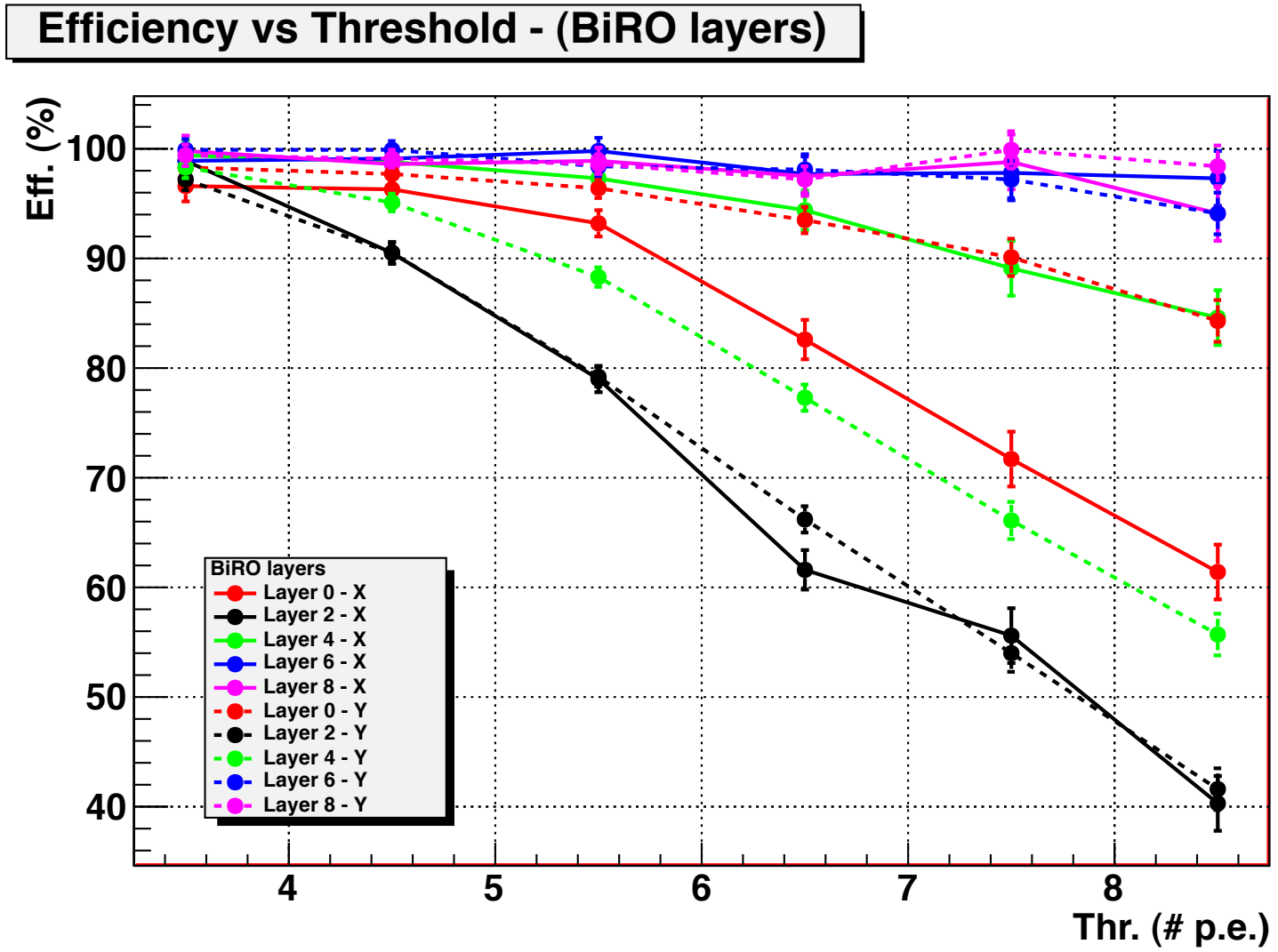
Good runs

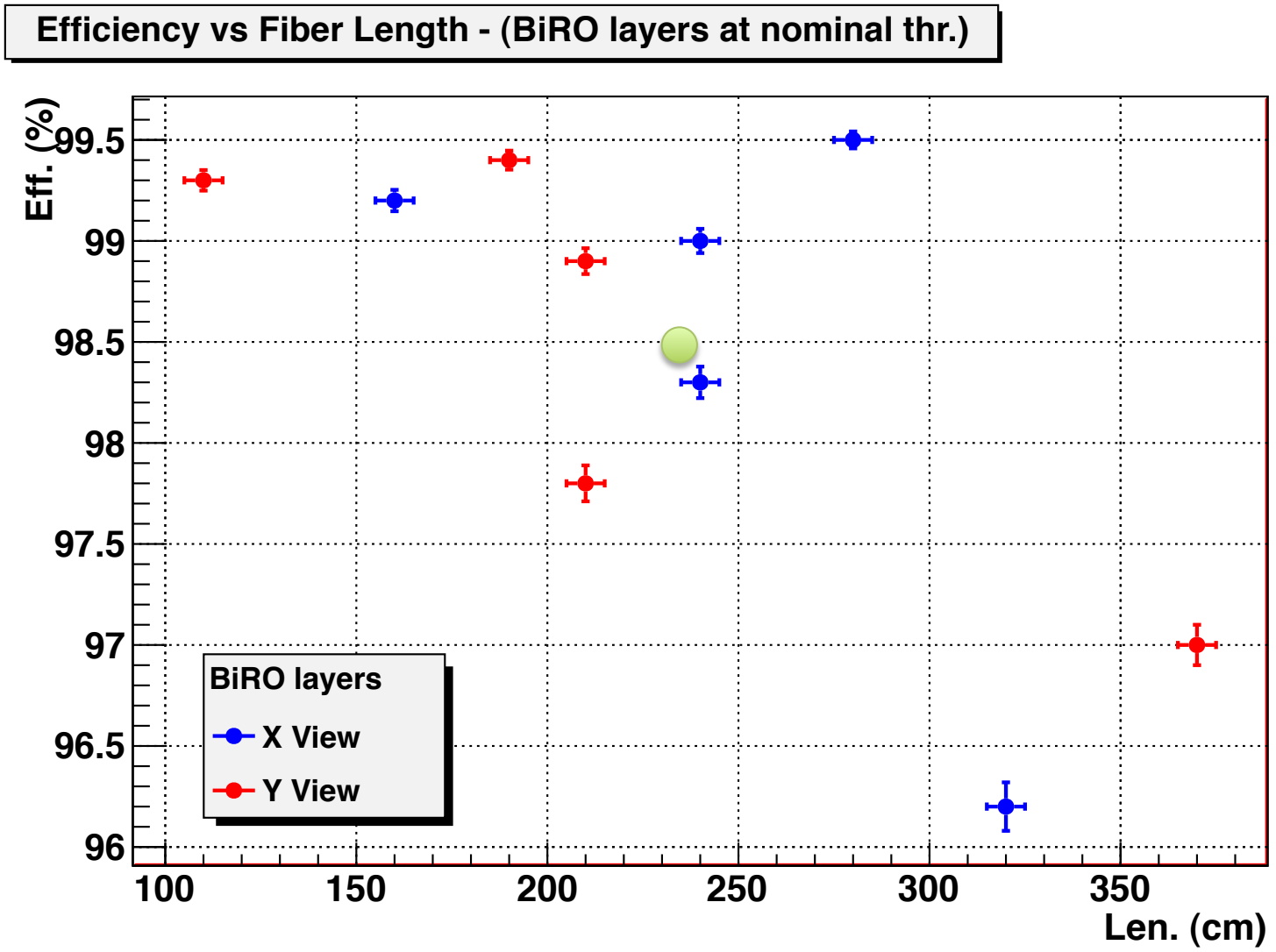
Nevt	Ns1s2	Nelect	Nmupi	Nmu	Npi	Ns3s4
1161654	841892	132729	709093	183010	466646	182462

N Good runs 135 /232

Nevt	Ns1s2	Nelect	Nmupi	Nmu	Npi	Ns3s4
total muon trigger (no scan)						
138288	104576	41133	63418	45327	18091	46508
total mu/pi trigger no scan						
224397	213487	42028	171434	4269	157783	25708
total no scan						
362685	318063	83161	234852	49596	175874	72216

Binary Readout Performances

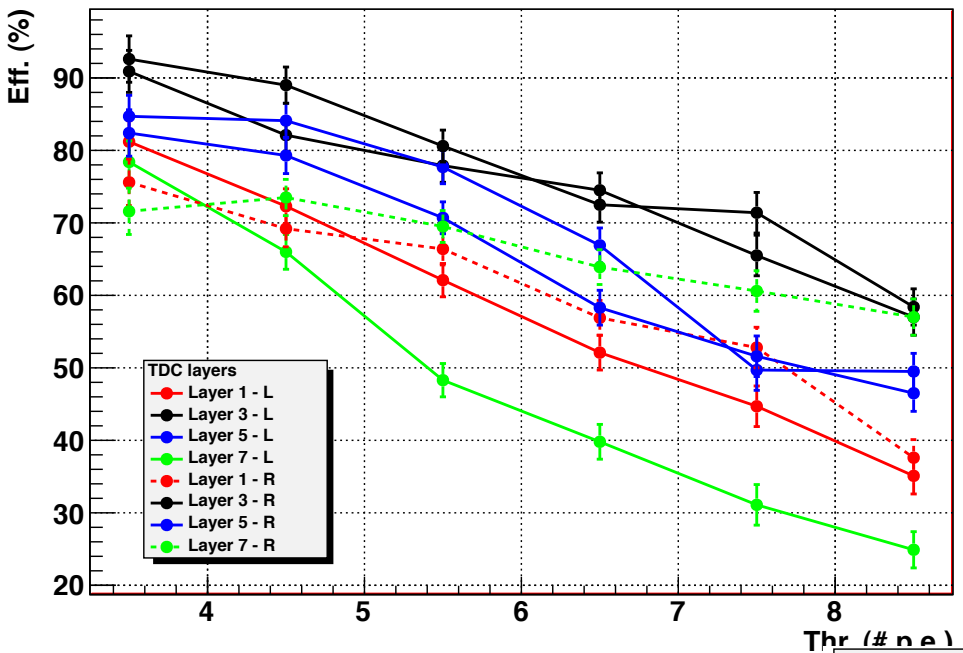

Efficiency vs Threshold - (BiRO layers)
Eff. (%)
100
90
80
70
60
50
40
4
5
6
7
8
Thr. (# p.e.)
BiRO layers
Layer 0 - X
Layer 2 - X
Layer 4 - X
Layer 6 - X
Layer 8 - X
Layer 0 - Y
Layer 2 - Y
Layer 4 - Y
Layer 6 - Y
Layer 8 - Y


Efficiency vs Fiber Length - (BiRO layers at nominal thr.)
Eff. (%)
99.5
99
98.5
98
97.5
97
96.5
96
100
150
200
250
300
350
Len. (cm)
BiRO layers
X View
Y View

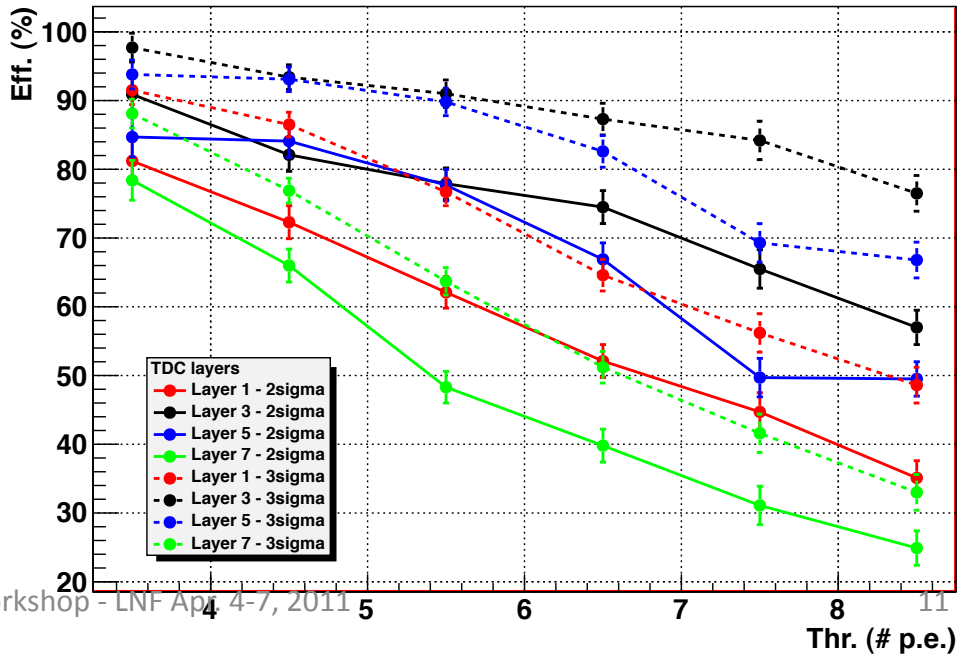
R&D results

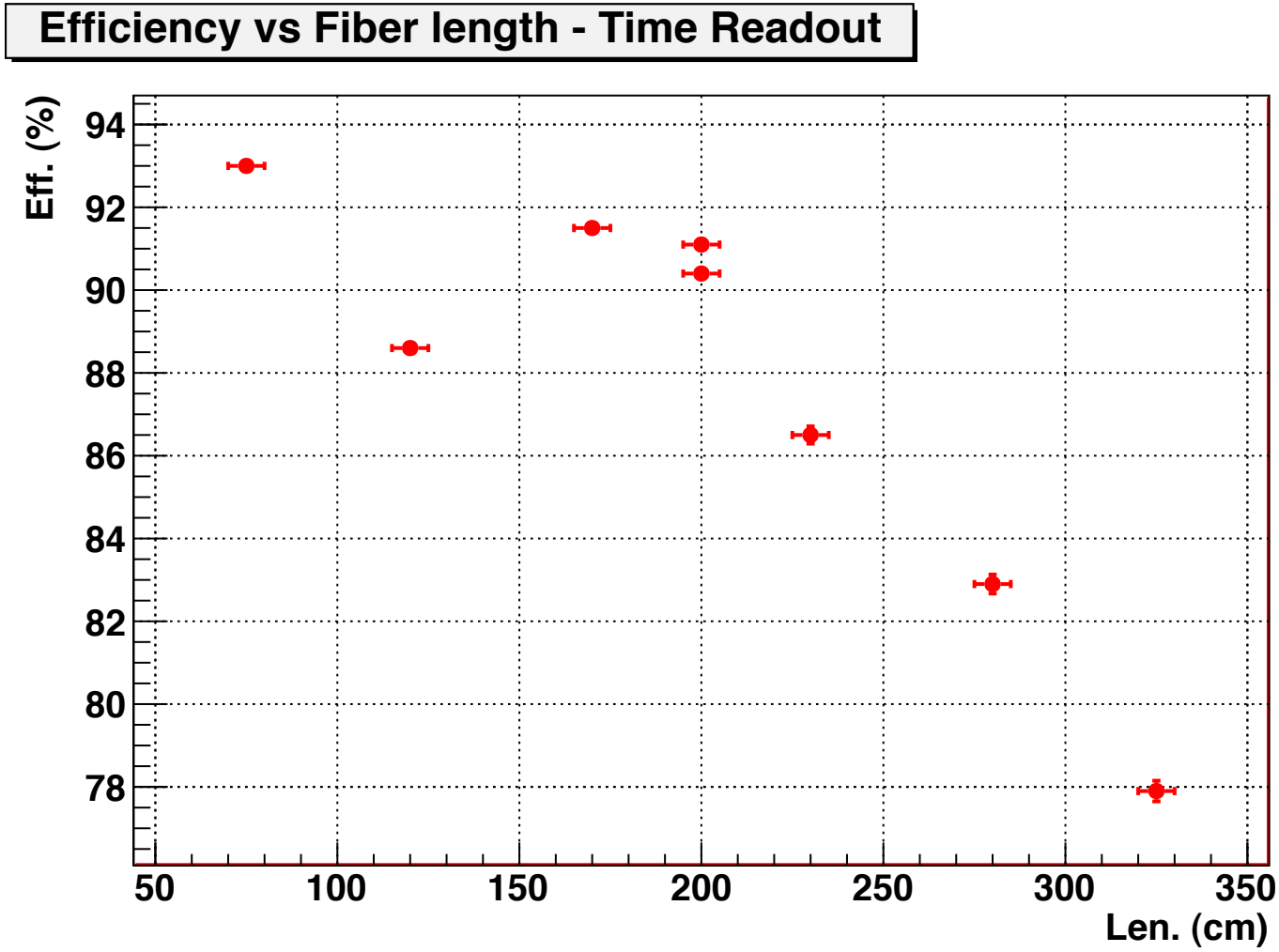
Timing Readout Performances

Eff. vs Thr. - (TDC layers 2σ cut)

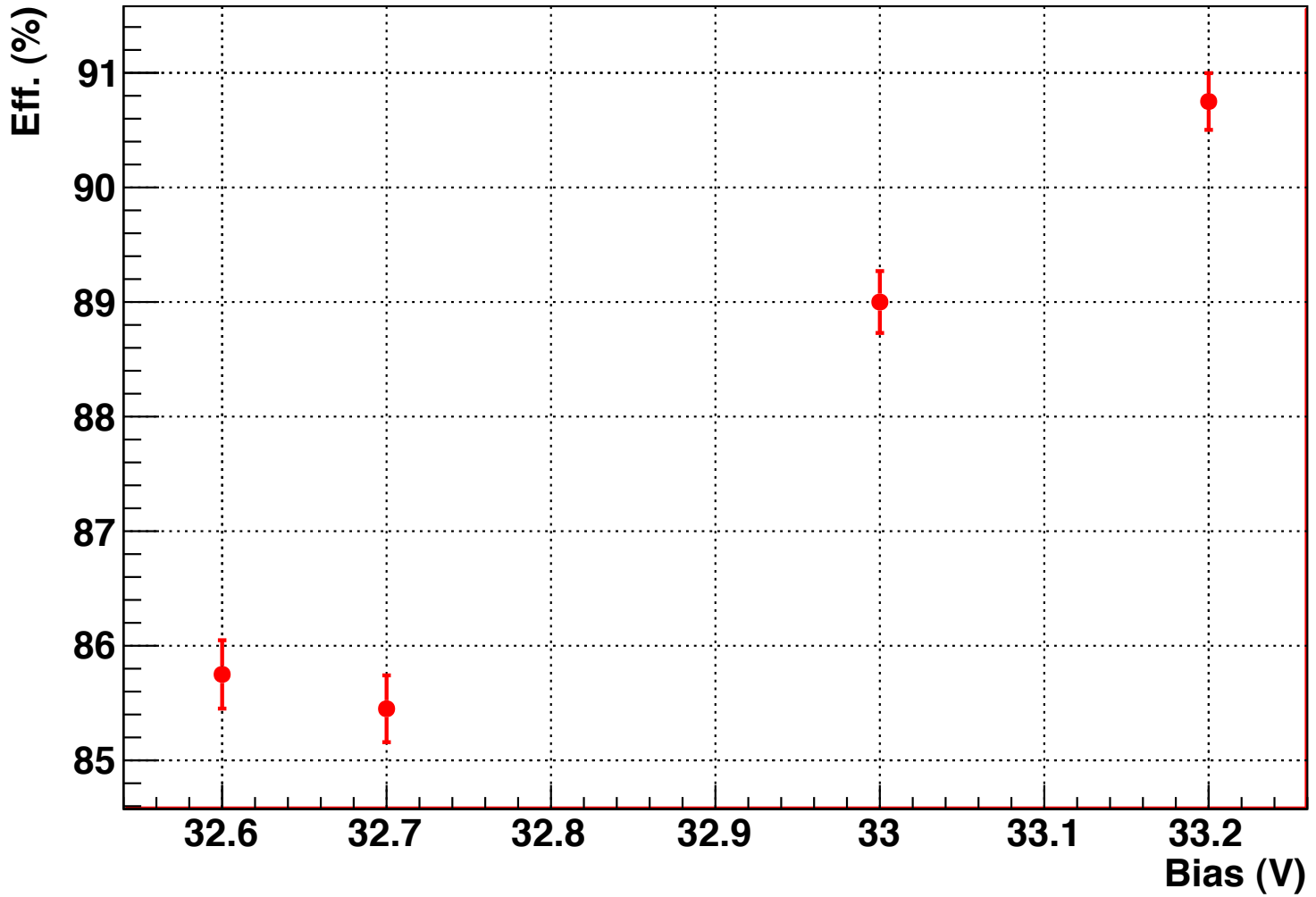


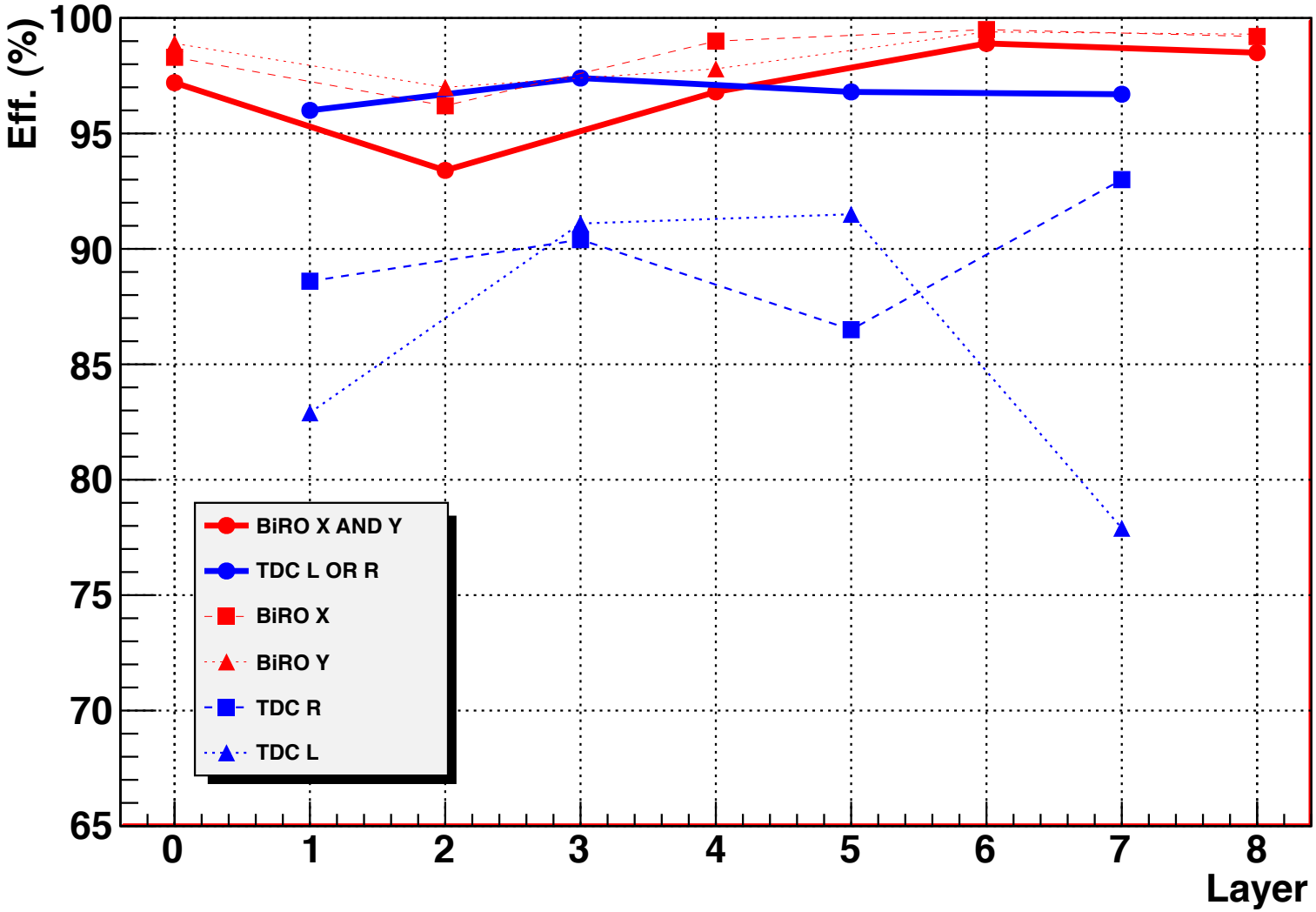
Eff. vs Thr. - (TDC layers 3σ cut)

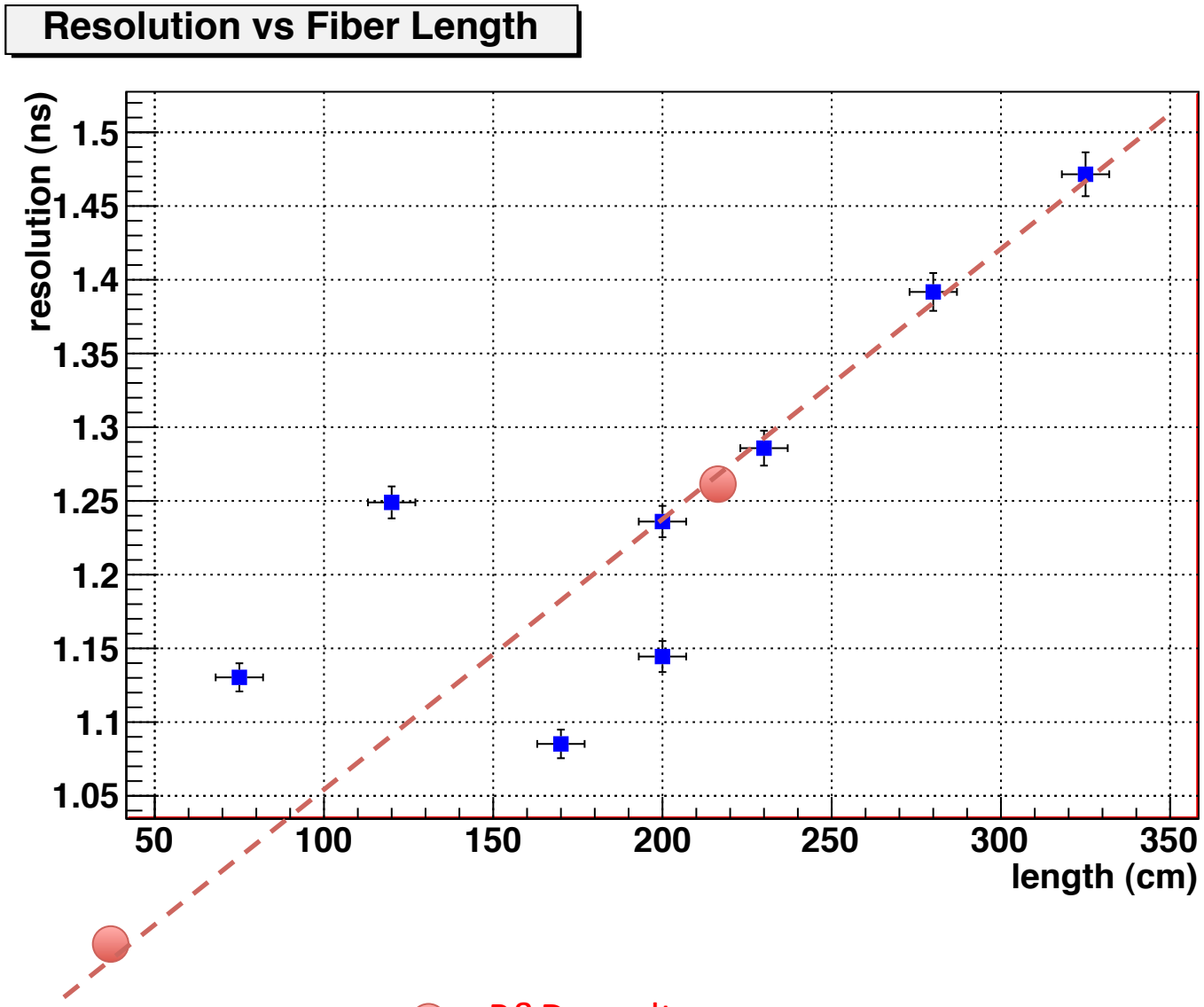


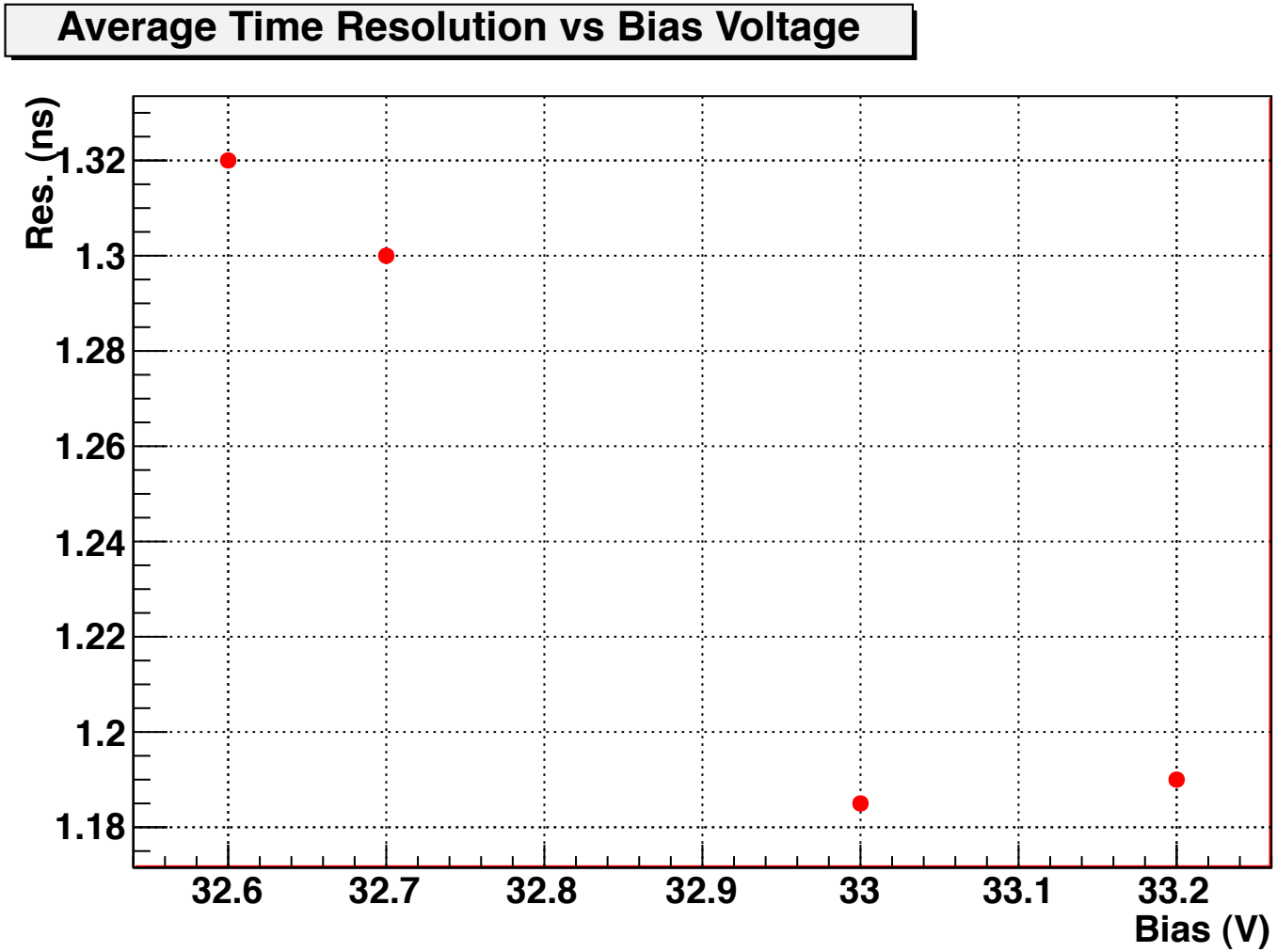

Efficiency vs Fiber length - Time Readout
Eff. (%)
94
92
90
88
86
84
82
80
78
50
100
150
200
250
300
350
Len. (cm)

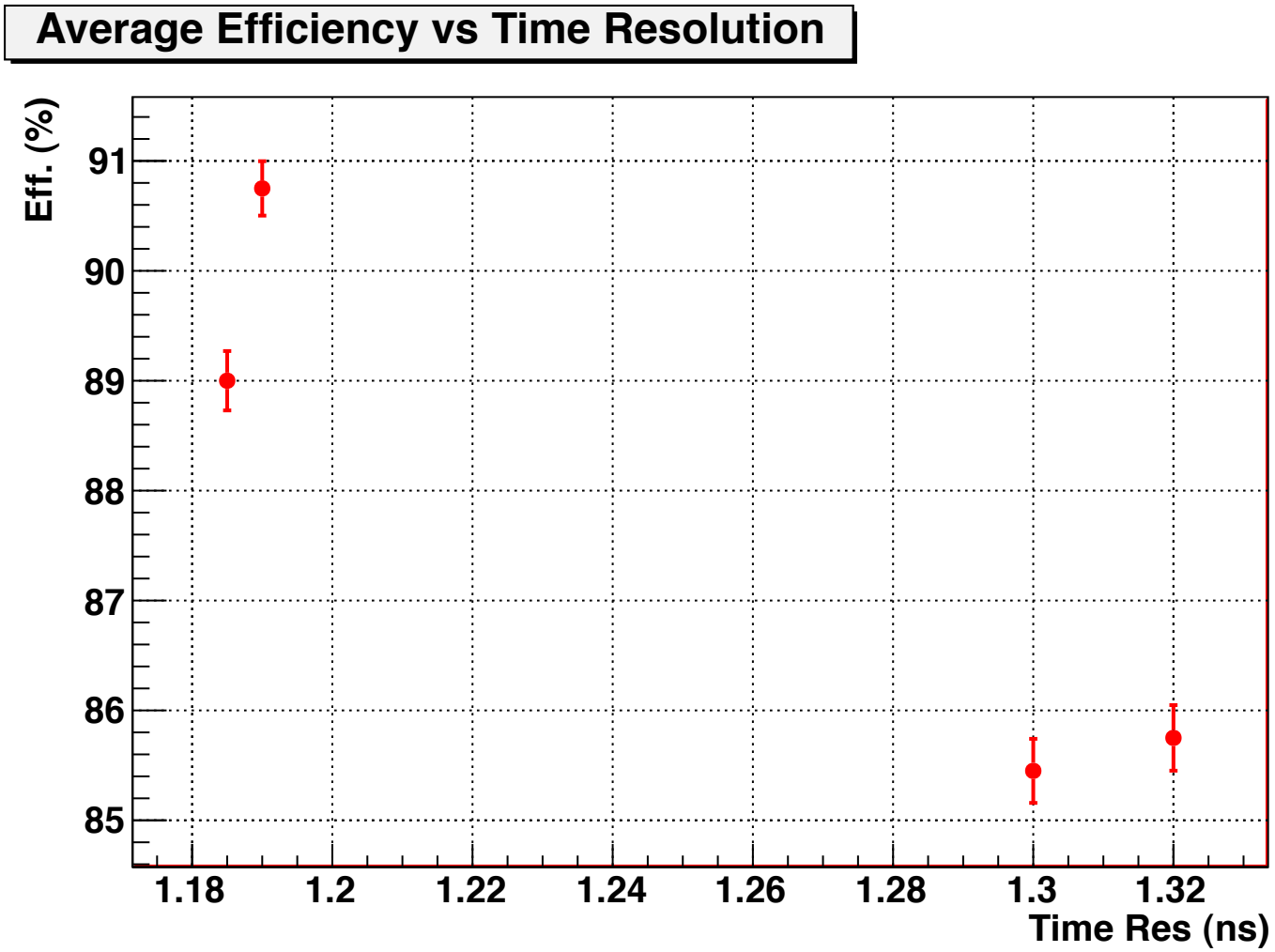
Average Efficiency vs Bias Voltage

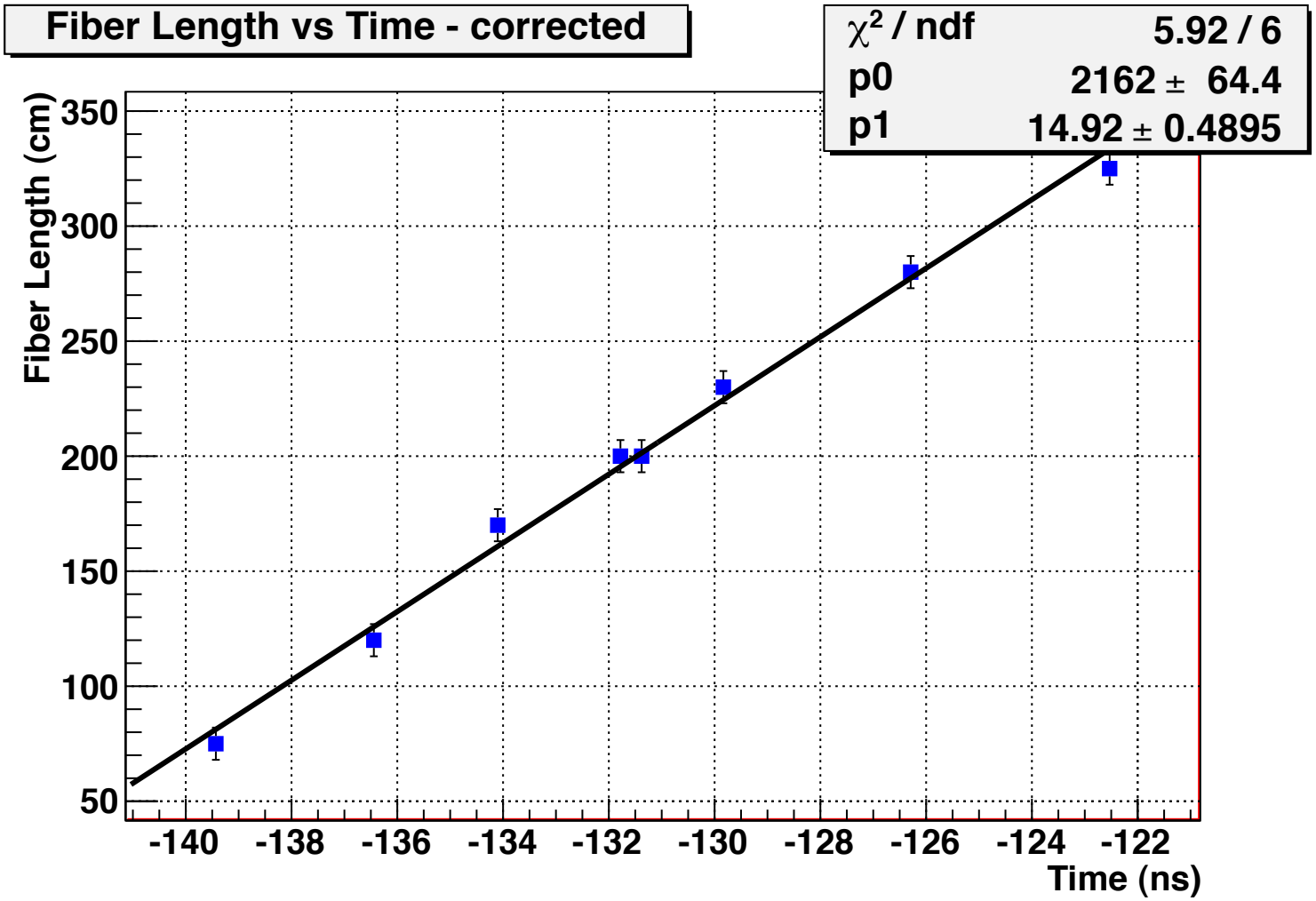



Eff. (%)
100
95
90
85
80
75
70
65
0
1
2
3
4
5
6
7
8
Layer
BiRO X AND Y
TDC L OR R
BiRO X
BiRO Y
TDC R
TDC L


Resolution vs Fiber Length
resolution (ns)
1.5
1.45
1.4
1.35
1.3
1.25
1.2
1.15
1.1
1.05
50
100
150
200
250
300
350
length (cm)
R&D results

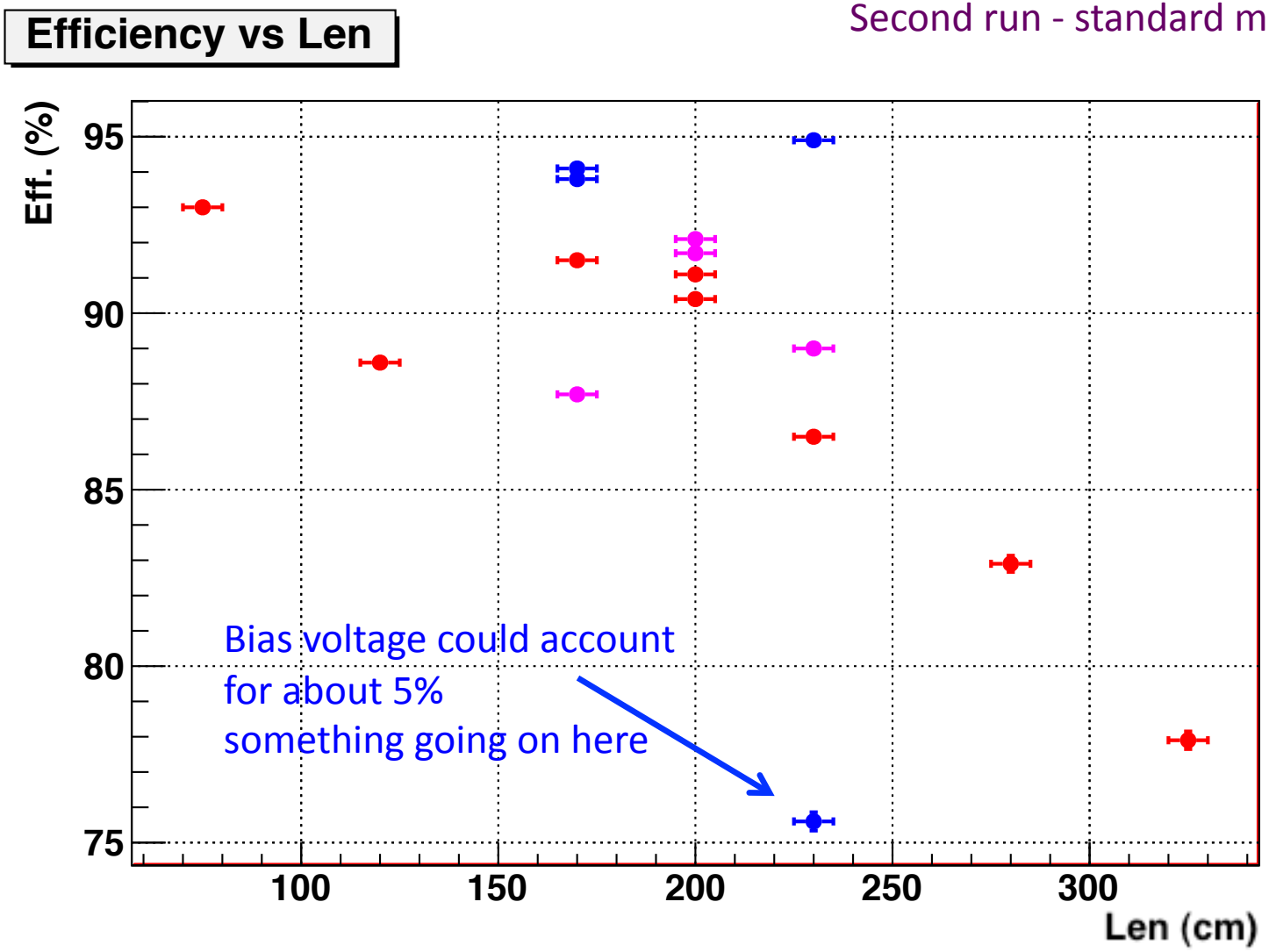

Average Time Resolution vs Bias Voltage
Res. (ns)
1.32
1.3
1.28
1.26
1.24
1.22
1.2
1.18
32.6
32.7
32.8
32.9
33
33.1
33.2
Bias (V)


Average Efficiency vs Time Resolution
Eff. (%)
91
90
89
88
87
86
85
1.18
1.2
1.22
1.24
1.26
1.28
1.3
1.32
Time Res (ns)


Fiber Length vs Time - corrected
χ² / ndf 5.92 / 6
p0 2162 ± 64.4
p1 14.92 ± 0.4895
Fiber Length (cm)
350
300
250
200
150
100
50
-140
-138
-136
-134
-132
-130
-128
-126
-124
-122
Time (ns)

Special Modules Performances

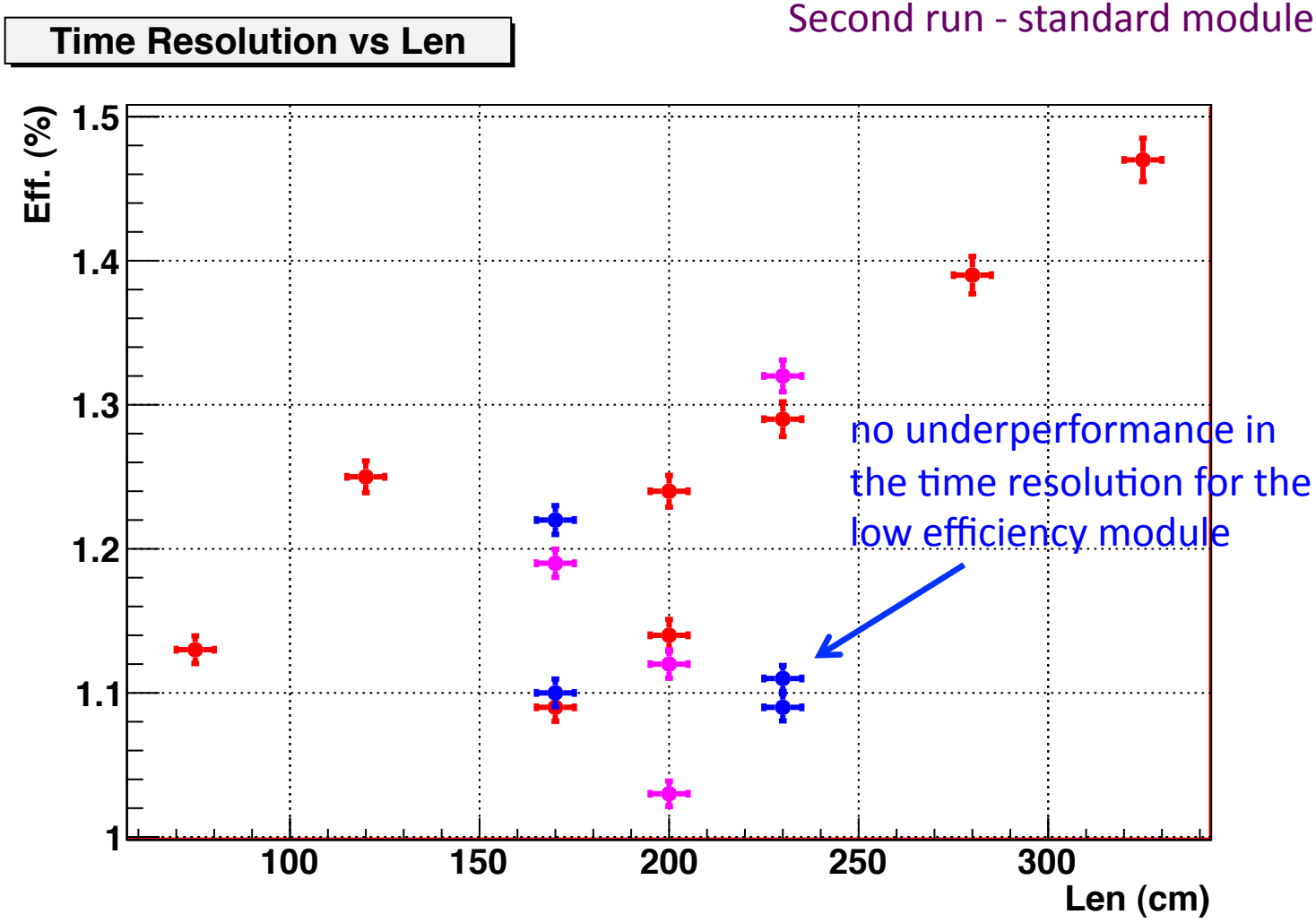
First run – standard configuration
Second run - special modules
Second run - standard modules



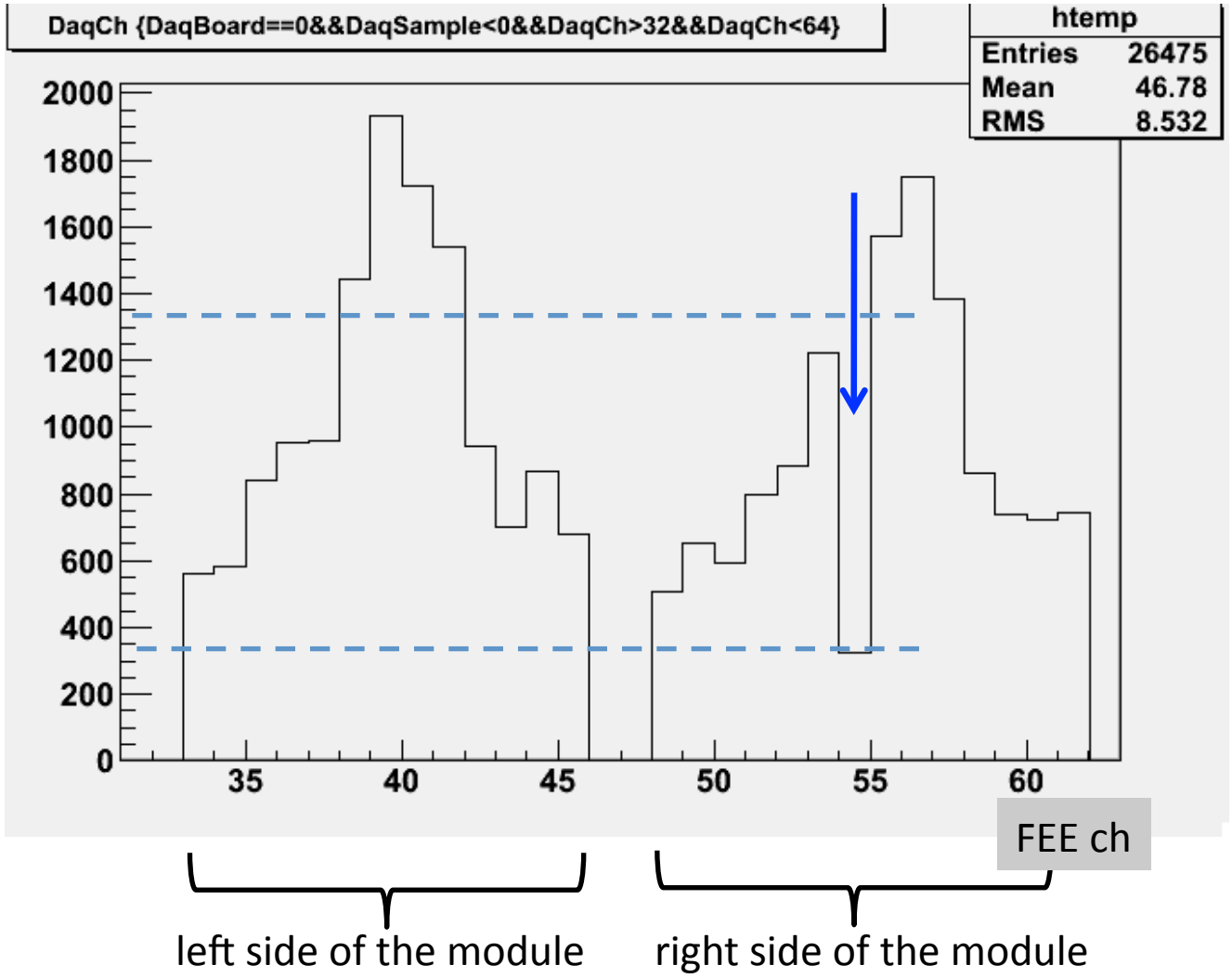
First run – standard configuration

Second run - special modules

Second run - standard modules



To track down the efficiency with one of the special modules I looked at the hit maps of each channel of the module.



Planning next beam test

- Iron too far from the prototype
- S1 e S2 should be closer too.
- S3 e S4 should be larger, they can be missed due to beam size and multiple scattering.
- A pure pion sample is needed and easy to obtain.
- Use the TOF device as reference time even if we don't use the TOF.

Conclusions

- More data we analyzed more feature we discovered.
- Efficiencies and time resolutions in general match the R&D results.
- Bias voltage seems to affect largely the performances, even with gain equalization.
- Special modules perform better, but analysis is not conclusive.
- The measurements presented are dominated by systematic errors.
- Cosmic and noise runs are needed to reproduce and clarify some feature.