test beam data analysis

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Outline

- Data analysis
  - APD gain temperature dependence in LOW GAIN regime
  - crystal intercalibration in LOW GAIN regime
  - APD/PIN comparison and APD gains

- MC studies
  - pion simultion update
  - energy resolution data-mc comparison
  - beam angle tuning

Data Analysis

APD gain vs T in LOW GAIN REGIME: strategy

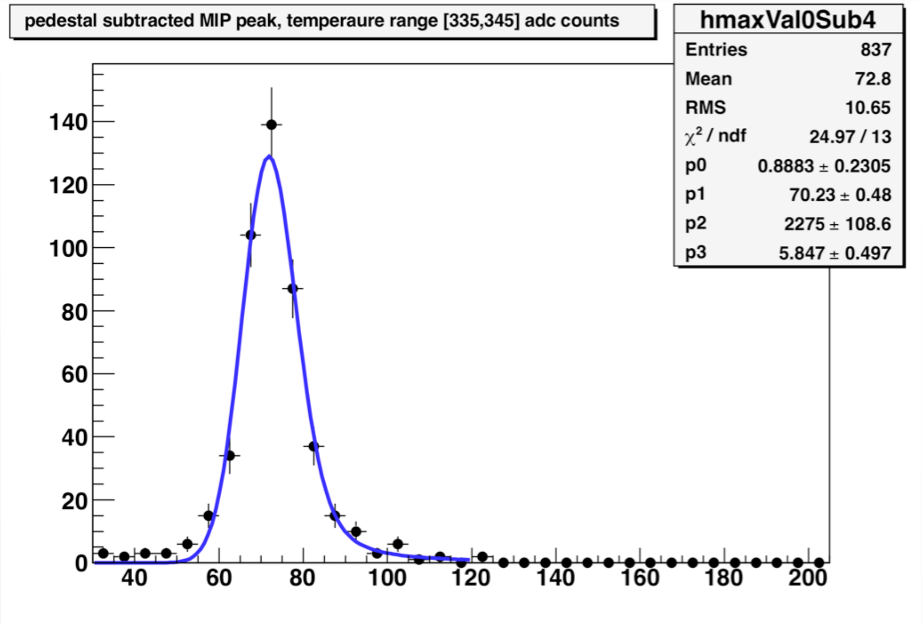
- sample and selection

  runs with beam on xtal12, 1 GeV, Low gain (runs 279,348,448)

  only crystal 12 above threshold (6 countings)

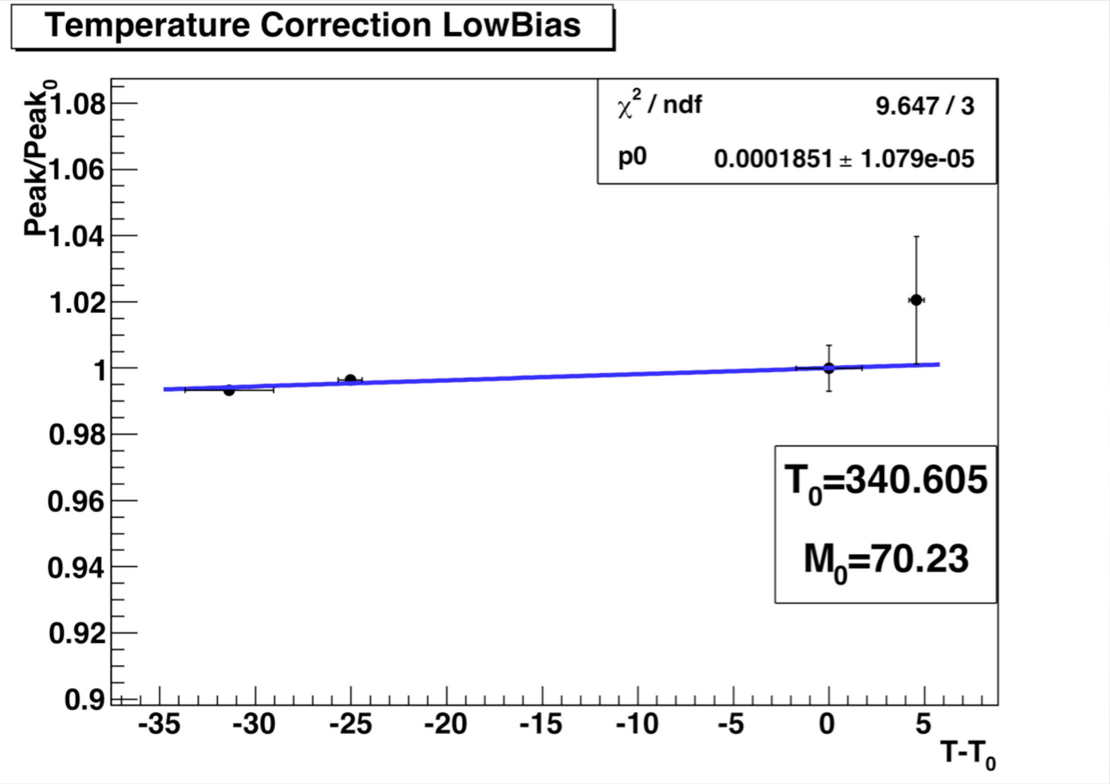
  Cherenkov signal compatible with MIP hypothesis

- fit to single crystal energy deposit in different temperature ranges (T range: [305,355] ADC counts, 10 ADC-count steps) to determine ADC counting corresponding to peak position



- use Langau function (gaussian convoluted with Landau)

APD gain vs T in LOW GAIN REGIME : correction coefficient



maxVal_corr = maxVal_meas / (1+ p_0 (T-T_0))

(maxVal = countings corresponding to peak position)

Intercalibration: strategy

- sample and selection:
  - runs with beam on i^{th} xtal
  - only i^{th} crystal above threshold (10 countings)
  - Cherenkov signal compatible with MIP hypothesis
- Langau Fit to MIP energy deposit to determine maxVal
- i^{th} intercalibration coeff C_i = maxVal_12 / maxVal_i

(nb = some runs @ 3 GeV, other @ 1 GeV; difference in deposited ionization energy taken into account)

- accounting also for temperature correction for APD channels:

maxVal_corr = maxVal_meas * C_i * / (1+ p_0 (T-T_0))

T_0 = 340.486 (HIGH GAIN), 340.605 (LOW GAIN)

p_0 = (-0.0028 +/- 0.0002) HIGH GAIN

p_0 = (-0.000018 +/- 0.000001) LOW GAIN

Intercalibration: fits

HIGH GAIN

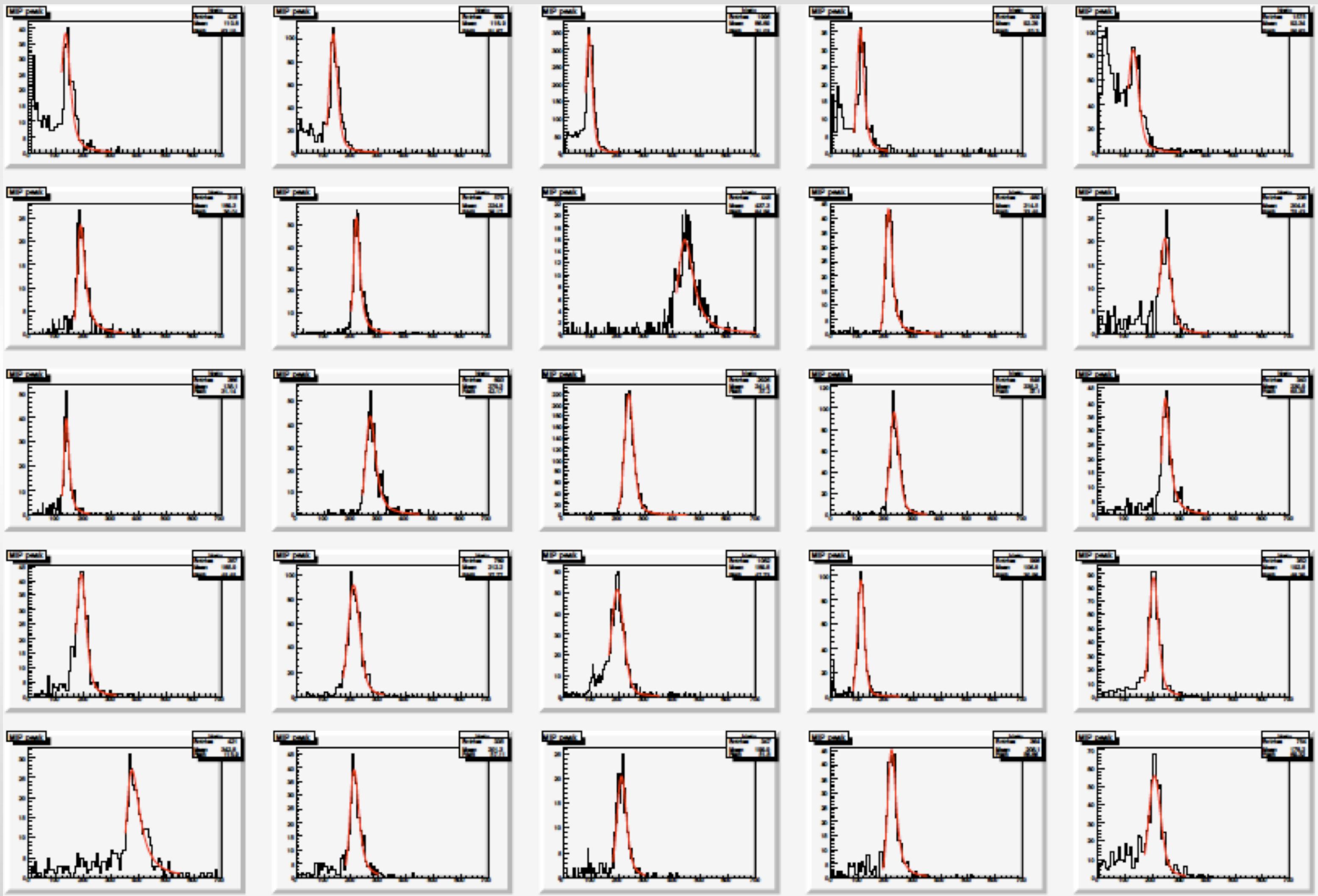
0 1 2 3 4

5

10

15

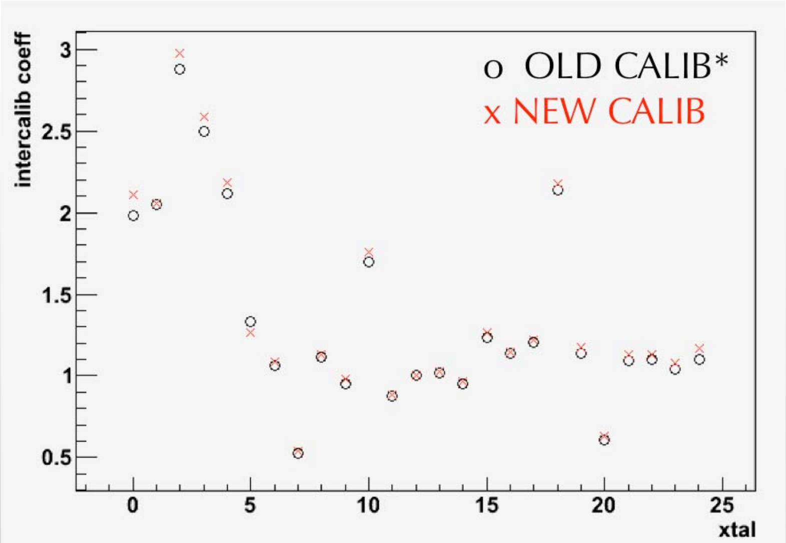
20



Intercalibration: results

HIGH GAIN

	0	1	2	3	4
	2.106 ± 0.024	2.058 ± 0.017	2.972 ± 0.017	2.59 ± 0.04	2.18 ± 0.04
5	1.263 ± 0.008	1.085 ± 0.004	0.537 ± 0.003	1.131 ± 0.005	0.979 ± 0.012
10	1.757 ± 0.012	0.886 ± 0.004	1.000 ± 0.003	1.029 ± 0.006	0.965 ± 0.008
15	1.265 ± 0.014	1.148 ± 0.008	1.220 ± 0.010	2.178 ± 0.015	1.178 ± 0.012
20	0.629 ± 0.005	1.134 ± 0.009	1.133 ± 0.011	1.076 ± 0.007	1.165 ± 0.011

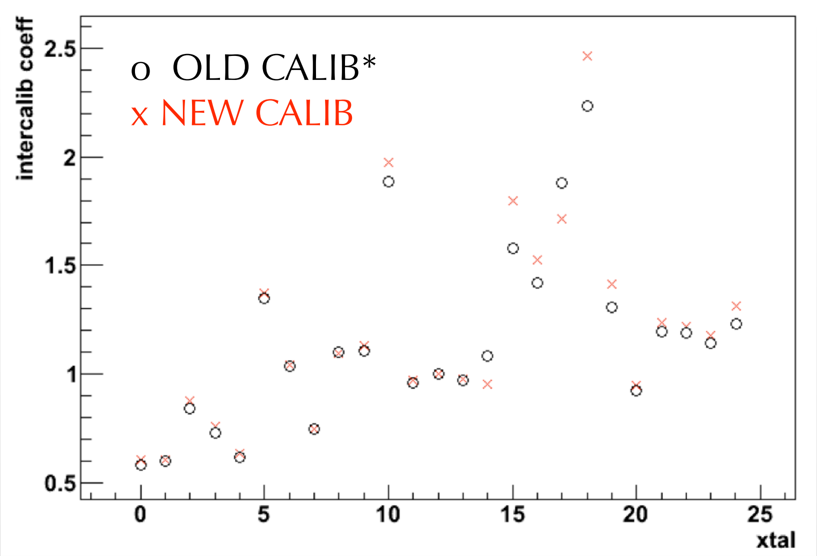


* http://blog.hep.caltech.edu/wiki/index.php/Temperature_corrected_inter_calibration_Oct28_update

Intercalibration: results

LOW GAIN

	0	1	2	3	4
	0.605 ± 0.006	0.606 ± 0.006	0.874 ± 0.005	0.76 ± 0.01	0.635 ± 0.007
5	1.372 ± 0.009	1.044 ± 0.004	0.745 ± 0.004	1.093 ± 0.006	1.128 ± 0.009
10	1.97 ± 0.02	0.968 ± 0.006	1 ± 0.003	0.975 ± 0.004	0.952 ± 0.006
15	1.80 ± 0.03	1.52 ± 0.02	1.71 ± 0.05	2.46 ± 0.01	1.41 ± 0.02
20	0.95 ± 0.01	1.24 ± 0.02	1.219 ± 0.008	1.18 ± 0.03	1.31 ± 0.02



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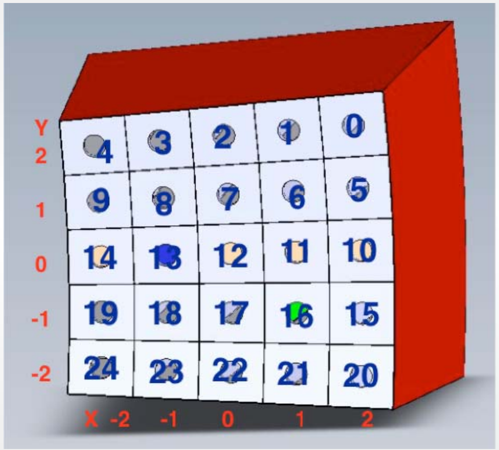
PIN vs APD

LOW GAIN

- Expected $(S)_{APD}/(S)_{PIN}$:
  - APD _coeff ~ 0.25 (geometric attenuation) * 0.3125 (attenuation before ADC) * G (gain)
  - PIN_coeff ~ 1 (geometric attenuation) * 0.5494 (attenuation before ADC) * 1 (gain)



xtal	noise	signal	S/B	S_{APD}/S_{PIN}	APD gain
0 20	1.32 ± 0.05 1.26 ± 0.04	130 ± 1 83 ± 1	98 ± 4 66 ± 2	0.638 ± 0.009	5
1 21	1.27 ± 0.03 1.21 ± 0.04	130 ± 1 63.4 ± 0.8	102 ± 2 52 ± 2	0.488 ± 0.007	3
2 22	1.058 ± 0.017 1.27 ± 0.03	89.9 ± 0.4 64.4 ± 0.4	85 ± 1 51 ± 2	0.716 ± 0.005	5
3 23	1.48 ± 0.06 1.32 ± 0.07	103 ± 1 67 ± 1	69 ± 3 51 ± 3	0.650 ± 0.011	5
4 24	1.35 ± 0.02 1.28 ± 0.03	124 ± 1 59.9 ± 0.9	92 ± 1 47 ± 1	0.483 ± 0.008	3

PIN vs APD

HIGH GAIN

– Expected $(S)_{APD}/(S)_{PIN}$:
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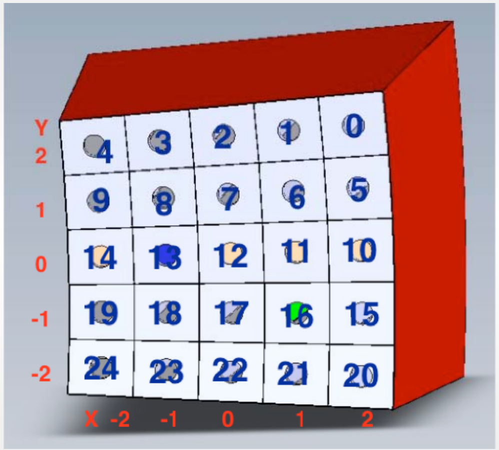
  - PIN_coeff ~ 1 (geometric attenuation) * 0.5494 (attenuation before ADC) * 1 (gain)



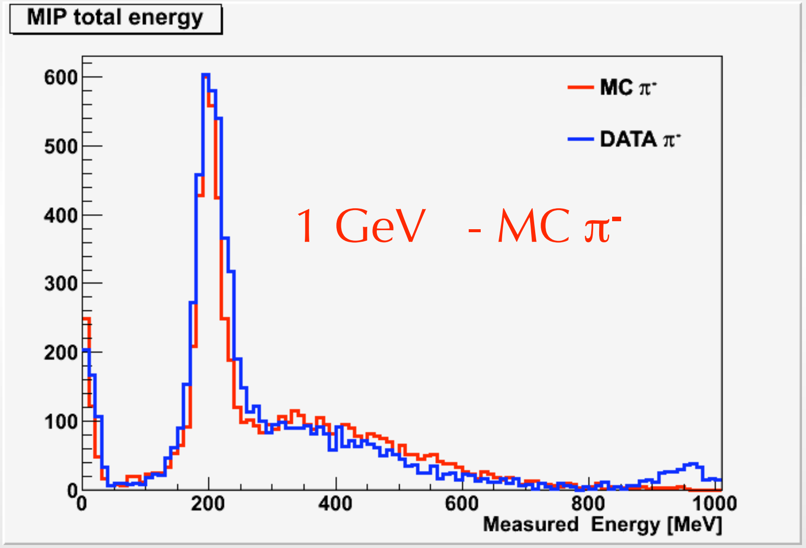
xtal	noise	signal	S/B	S_{APD}/S_{PIN}	APD gain
0 20	1.32 ± 0.04 1.36 ± 0.05	128 ± 1 372 ± 3	97 ± 4 273 ± 10	2.90 ± 0.07	20
1 21	1.28 ± 0.03 1.30 ± 0.05	131 ± 1 207 ± 2	102 ± 2 159 ± 6	1.58 ± 0.02	11
2 22	1.029 ± 0.016 1.29 ± 0.05	90.6 ± 0.4 207 ± 2	88 ± 12 160 ± 6	2.28 ± 0.02	16
3 23	1.48 ± 0.06 1.25 ± 0.05	104 ± 1 217 ± 1	70 ± 3 173 ± 7	2.08 ± 0.02	15
4 24	1.349 ± 0.024 1.25 ± 0.03	124 ± 2 201 ± 2	92 ± 2 161 ± 4	1.62 ± 0.03	11

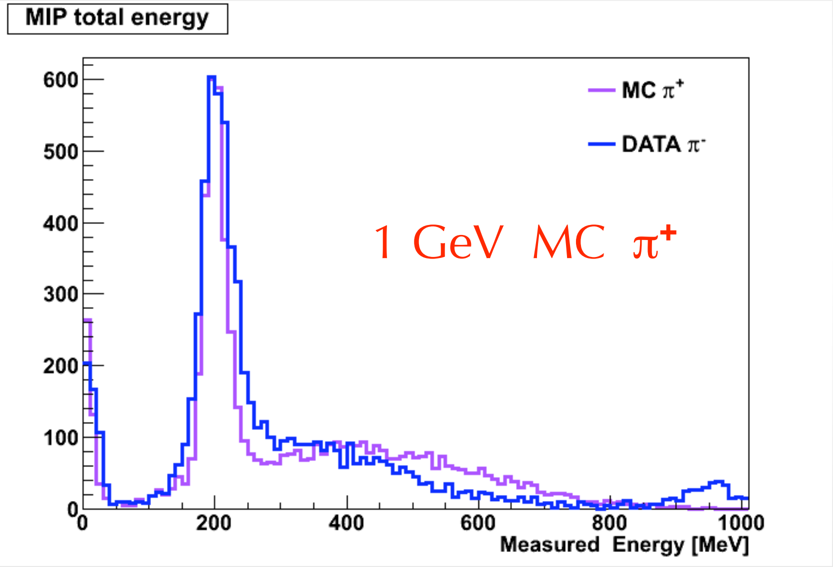
MC studies

Pion total energy

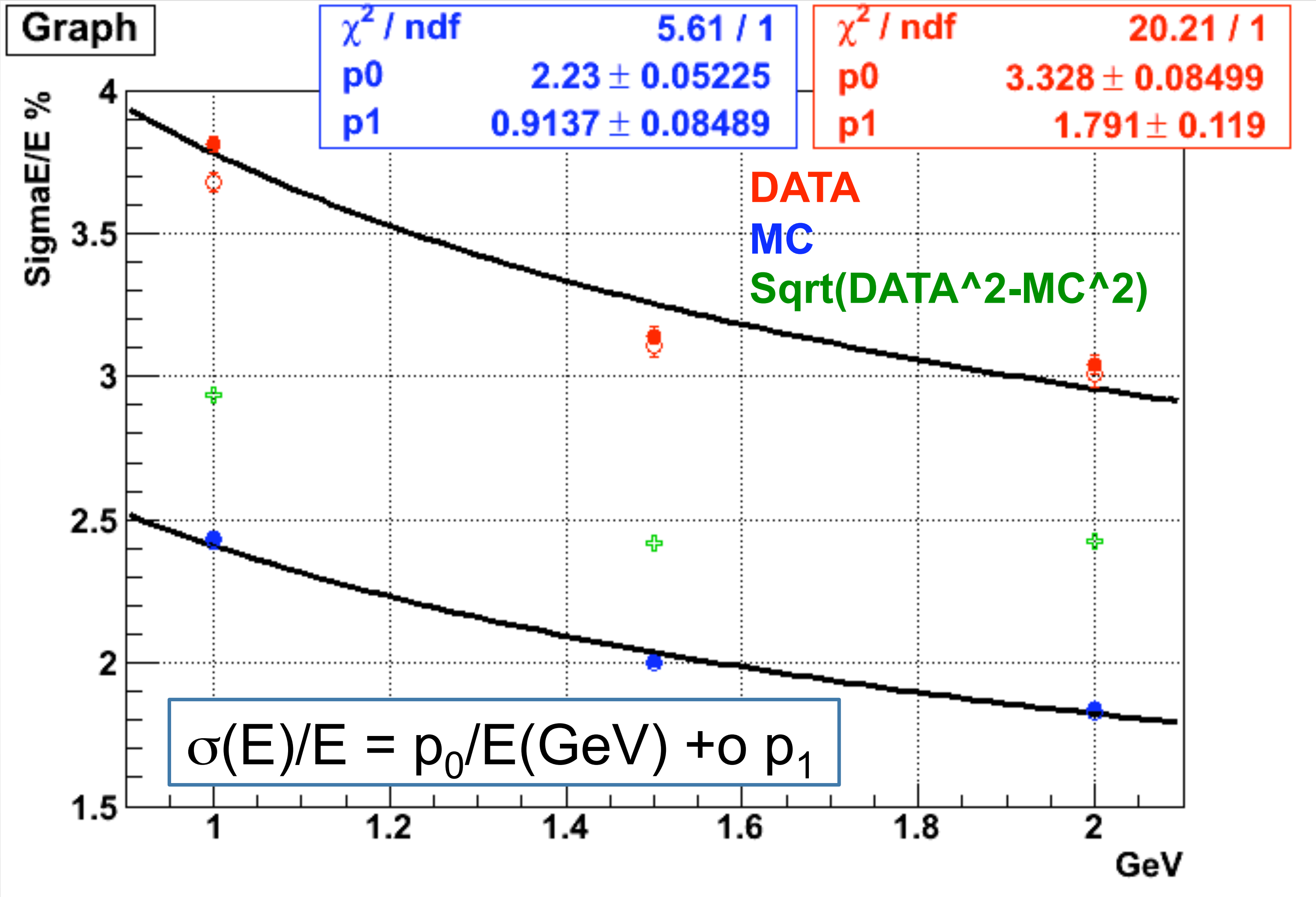
– The original pion simulation had the wrong charge

The pion simulation with π- show a better agreement with data





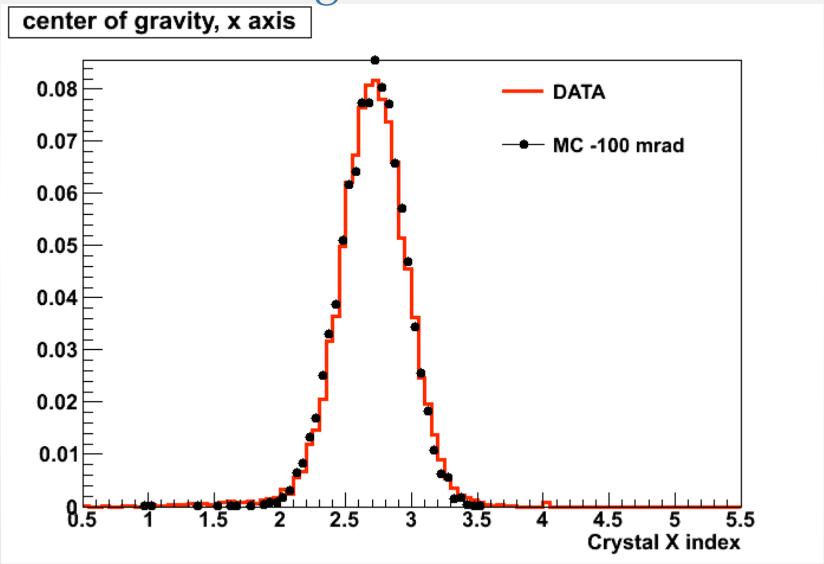
Electron Energy Resolution vs Energy



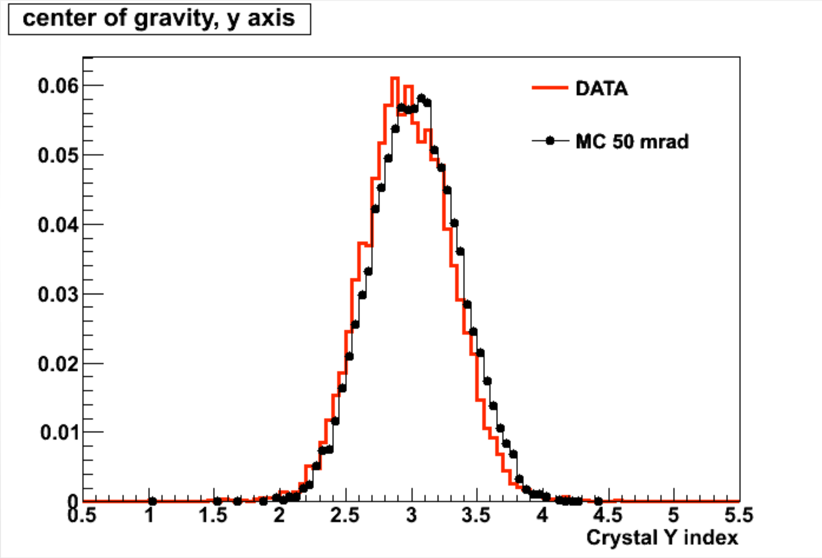
Beam center of gravity

Scanning MC X and Y beam angle we found the “correct” beam direction to match DATA center of gravity position

X Angle : -100 mrad



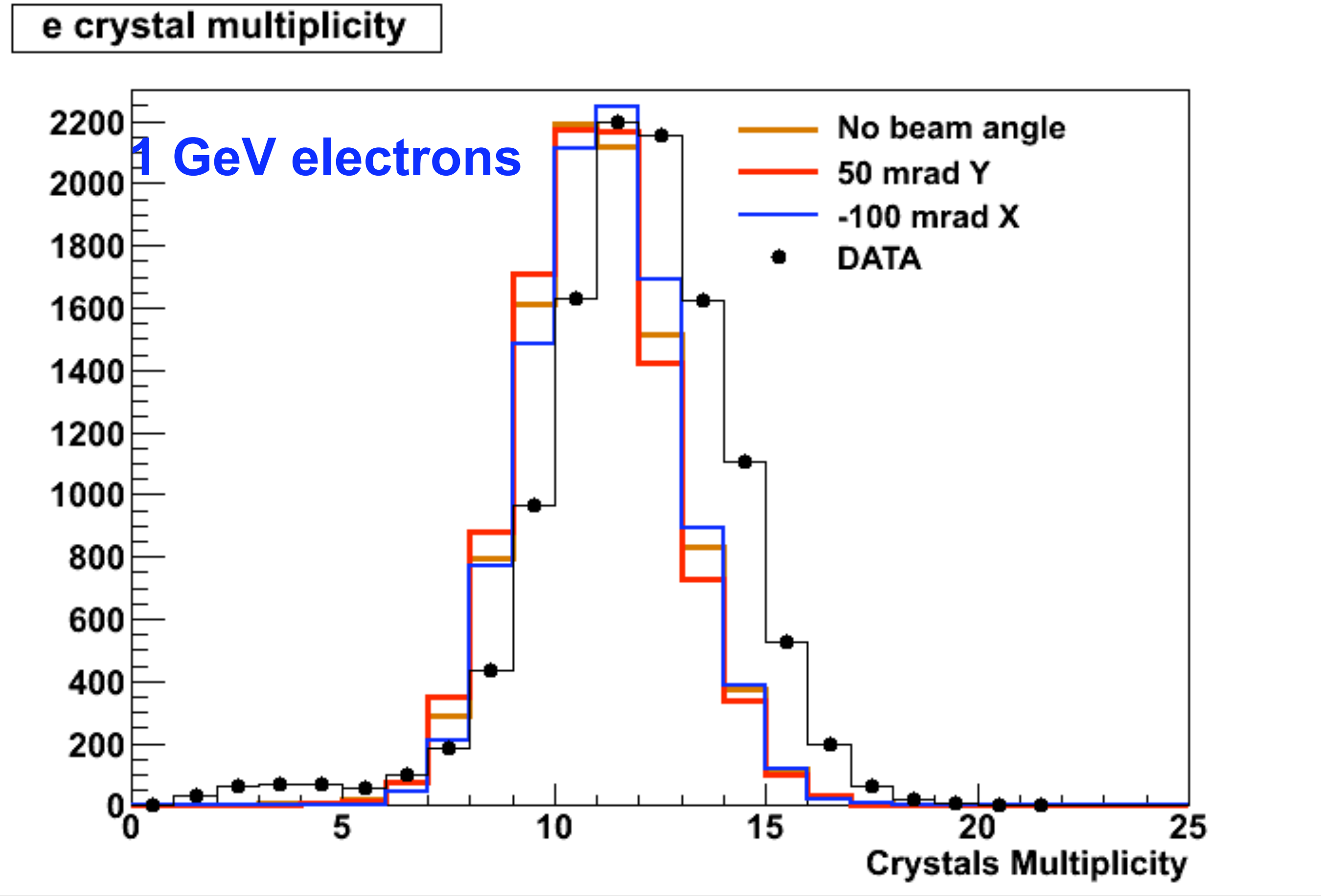
Y Angle : 50 mrad



Need to combine X and Y angle in a single MC run

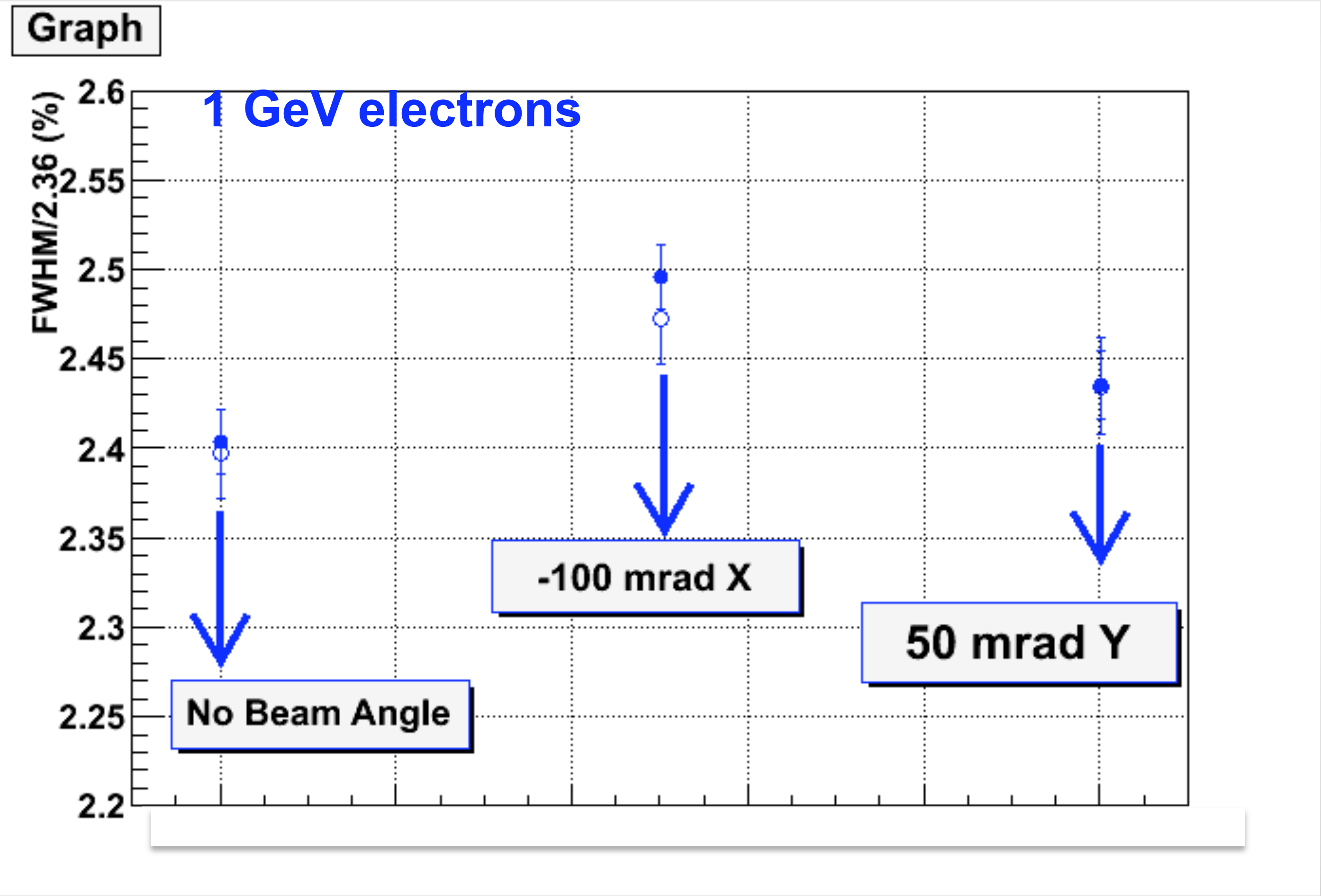
Crystal multiplicity

Beam angle sligthly affects the crystal multiplicity DATA multiplicity is still higher



Energy resolution versus beam angle

Beam angle sligthly affects the Energy Resolution
Not enough to reach DATA agreement



Conclusions

Data analysis

- Temperature correction and calibration of low gain data using MIPs performed
- APD gain in low gain regime ~ 3-5
- Next step is studying resolution on electrons

MC studies

- Some attempts made to improve data-MC comparison (high gain regime)
- Data resolution still ~ 2% far from MC value
- changing X and/or Y beam angle in MC may improve the comparison, even if the angle effect seems to be small compared to data-Mc discrepancy