MICE CKOVs - Brief Update

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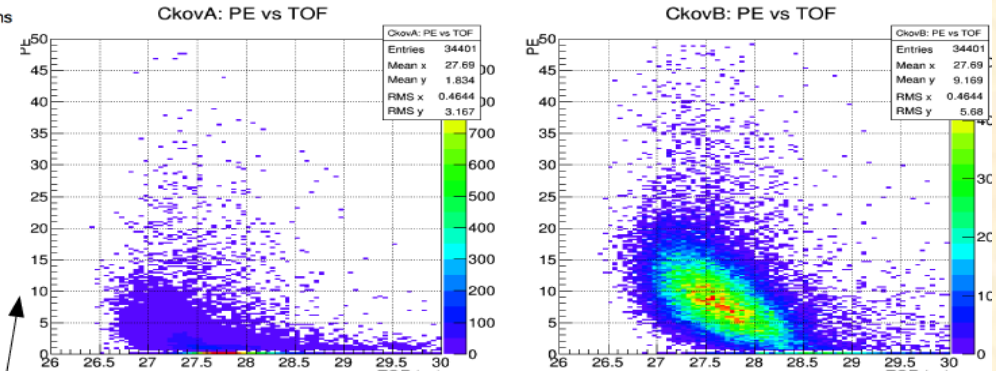
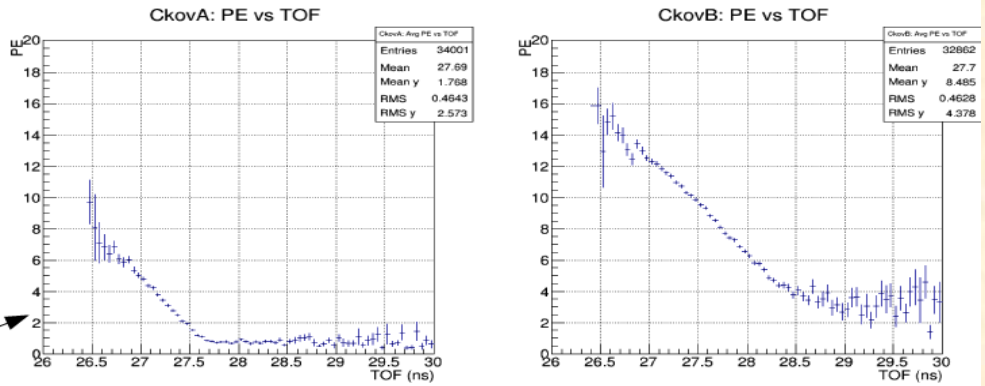
- Hardware update.
- Thresholds and calibration.
- Detection of high momemtum muons and pions.
- Below are files processed by Michael and Miles for our studies.

Muons: High MeV/c Response

Run #	D1(MeV/c)	D2(MeV/c)	Calibration	Muons	Pions
3253	297	294	x	x	x
3254	297	294	x	x	x
3423	343	341	x	x	x
3424	343	341	x	x	x
3426	364	362	x	x	x
3482	390	388	x	x	x
3487	425	423	x	x	x
3488	425	423	x	x	x
3489	452	450	x	x	x
3492	152	148	x		
3497	324	189	x	x	
3499	324	189	x	x	
3501	390	388	x	x	x
3506	405	237	x	x	
3507	405	237	x	x	
3508	405	237	x	x	
3509	405	237	x	x	
3511	152	148	x		
3512	405	237	x	x	
3513	405	237	x	x	
3514	405	237	x	x	
3515	405	237	x	x	
3516	405	237	x	x	
4033	152	148	x		
4034	152	148	x		
4036	397	394	x	x	x
4060	313	310	x	x	x
4061	313	310	x	x	x
4062	313	310	x	x	x
4075	343	341	x	x	x
4078	450	265	x	x	
4079	450	265	x	x	
4080	447	444	x	x	x
4081	447	444	x	x	x
4082	507	294	x	x	
4083	507	294	x	x	
4084	507	294	x	x	
4096	468	276	x	x	
4097	468	276	x	x	
4098	468	276	x	x	





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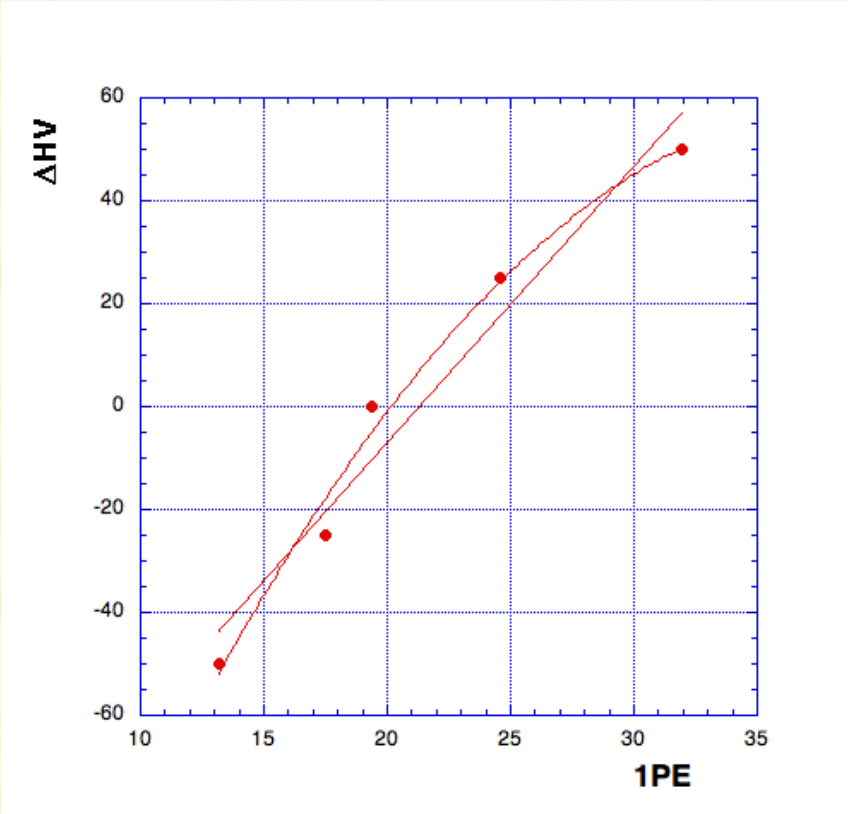
HARDWARE UPDATE

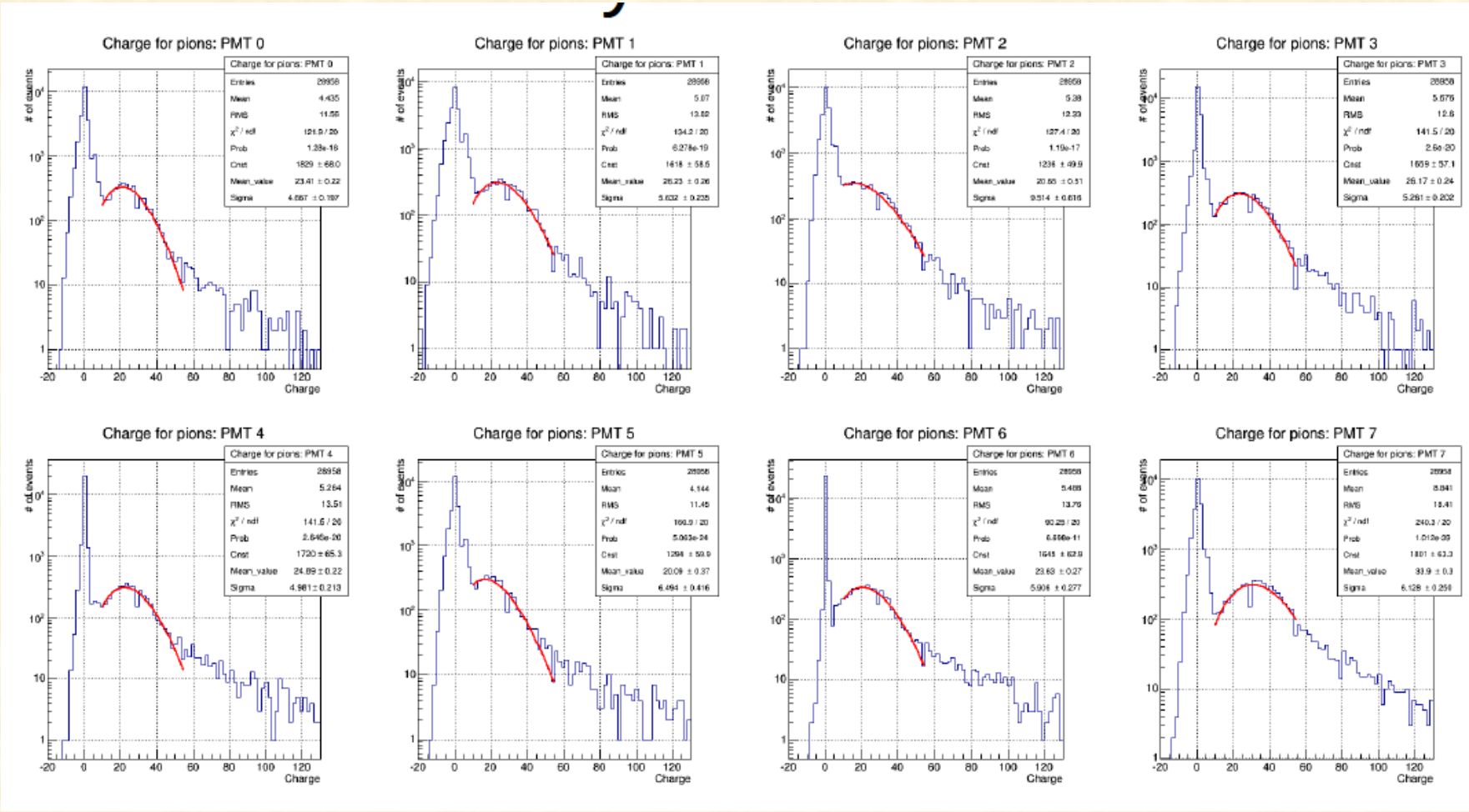
- HV scan was performed summer 2014 with CAEN ST1527 HV.
- Nominal default HV settings were determined to the pmt balance gains.
- A new CAEN SY4527 +HV module is being installed and we should verify that gains have not changed.
- With a quadratic fit and adjusting 1PE=25, the results are given below. The other channels are similar.



PMT0	**HV0**	**delta_HV**	**HV_NEW**
PMT1	1610	25.8	1635.8
PMT2	1520	6.8	1526.8
PMT3	1570	28.7	1598.7
PMT4	1620	3.0	1623.0
PMT5	1540	-10.5	1529.5
PMT6	**1715**	16.9	1731.9
PMT7	1550	-15.3	1534.7
PMT8	1500	-27.2	1472.8

HARDWARE UPDATE (cont)

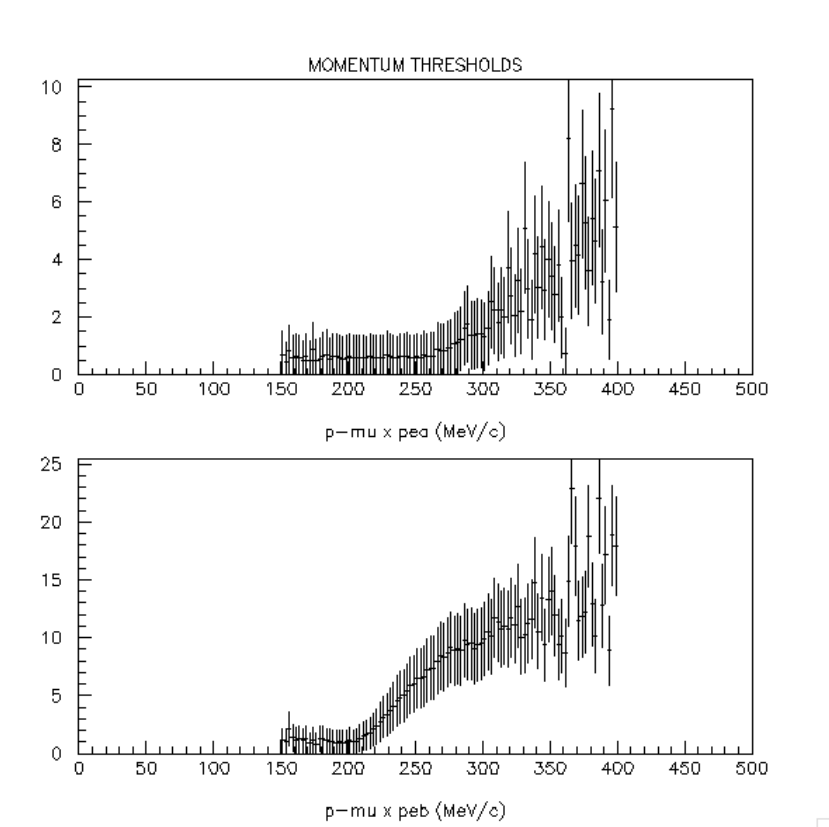
- These are examples of muon/pion data from which 1PE signals are easily extracted.
- A simple gaussian fit is used to find the estimate 1pe peak.
- This calibration/fit could be performed run-by-run and automated.



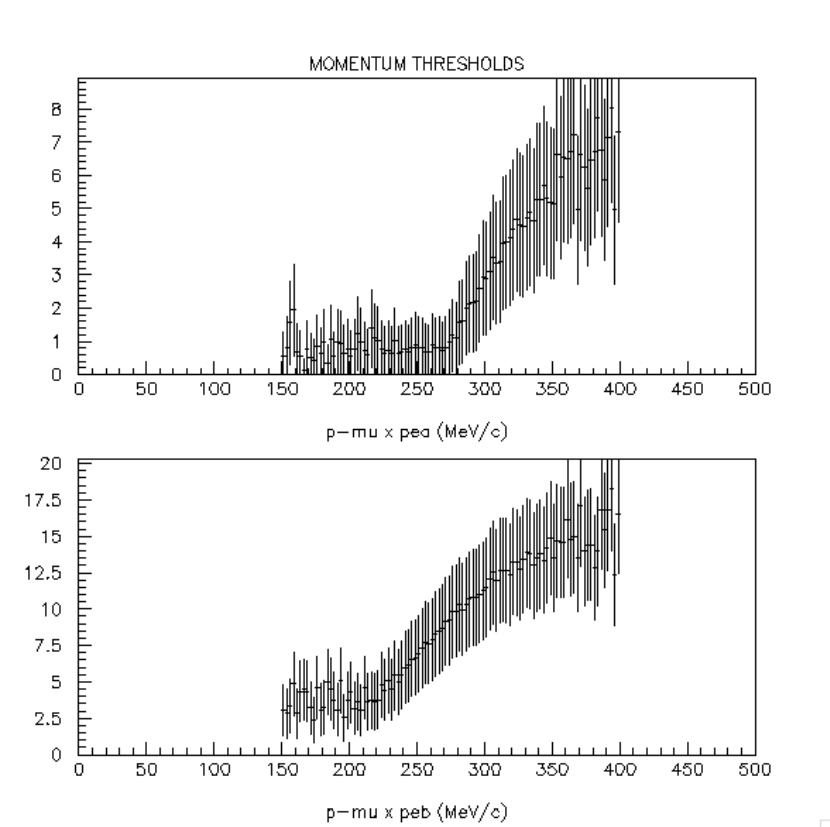
MOMENTUM THRESHOLDS (pre-2014 data)

- In pre -2014 data thresholds we plot the pe vs p, where (p taken from tof.
- We do a histogram of p weighted by pea(b) and divide by histogram of p.
- The aerogel n112 and n107 thresholds are at 210 MeV/c and 270 MeV/c.
- These thresholds correspond to n107 = 1.07 and n112=1.11, close to the expected values.

237 Mev/c data



290 Mev/c data



MOMENTUM THRESHOLDS (2015 data)

http://micewww.pp.rl.ac.uk/issues/1667

- From 2015 P–scan data Ryan B performed an analysis of thresholds. The results show a shift in threshold to lower momenta.

  muon pion

  Pth_a = 260 MeV/c, 325 MeV/c

  Pth_b = 190 MeV/c, 260 MeV/c

- This corresponds to a change in index

  n107 = 1.09 n112 = 1.14

- The original densities are measured

  ρ =0.261 g/cc ρ= 0.371g/cc

- Aerogel panels sizes are 1.15x1.15x1. cm^3

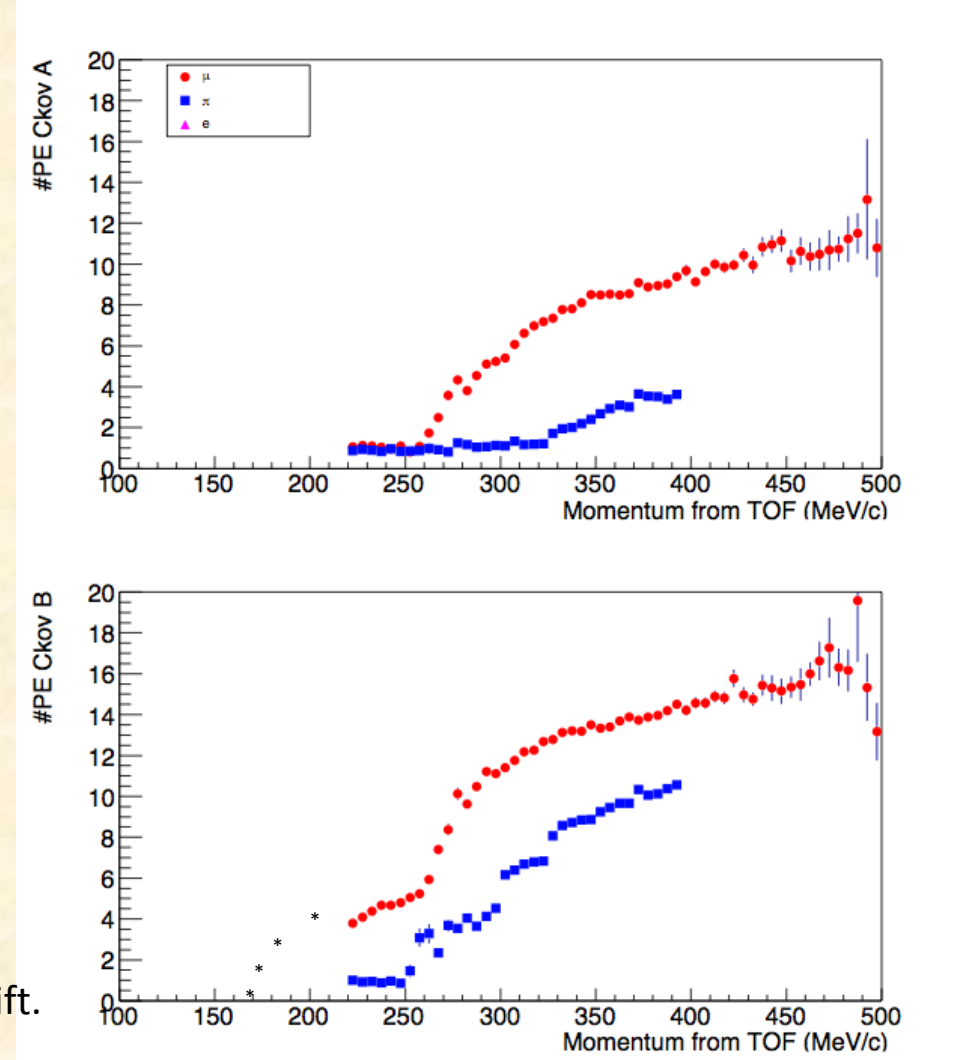
- The aerogel density could have changed?

  n = 1. + 0.27 ρ(g/cc)

  ⊗n = 0.27 ⊗⟩

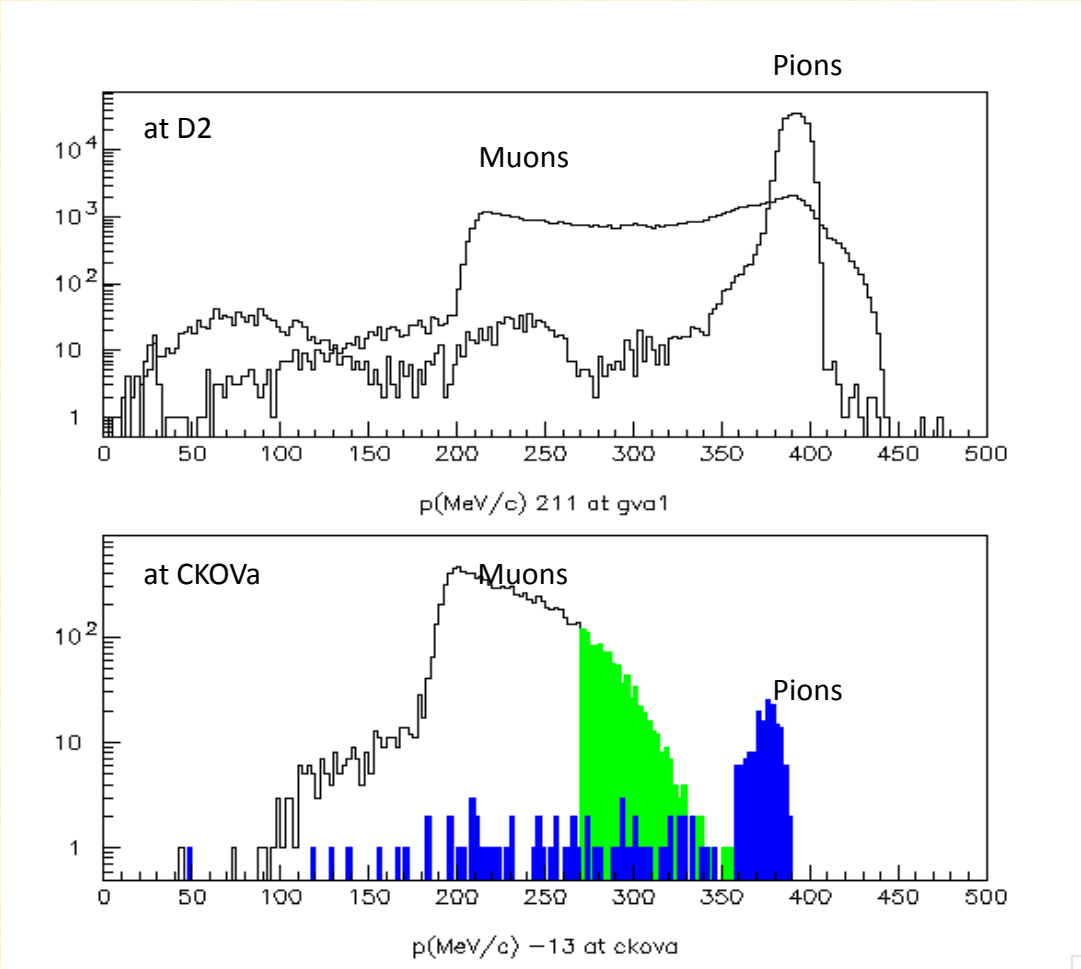
  ⊗⟩ = 0.02/0.27 = +0.07g/cc

- This Increase in aerogel density is puzzling.
- A p scaling problem might also explain the shift.



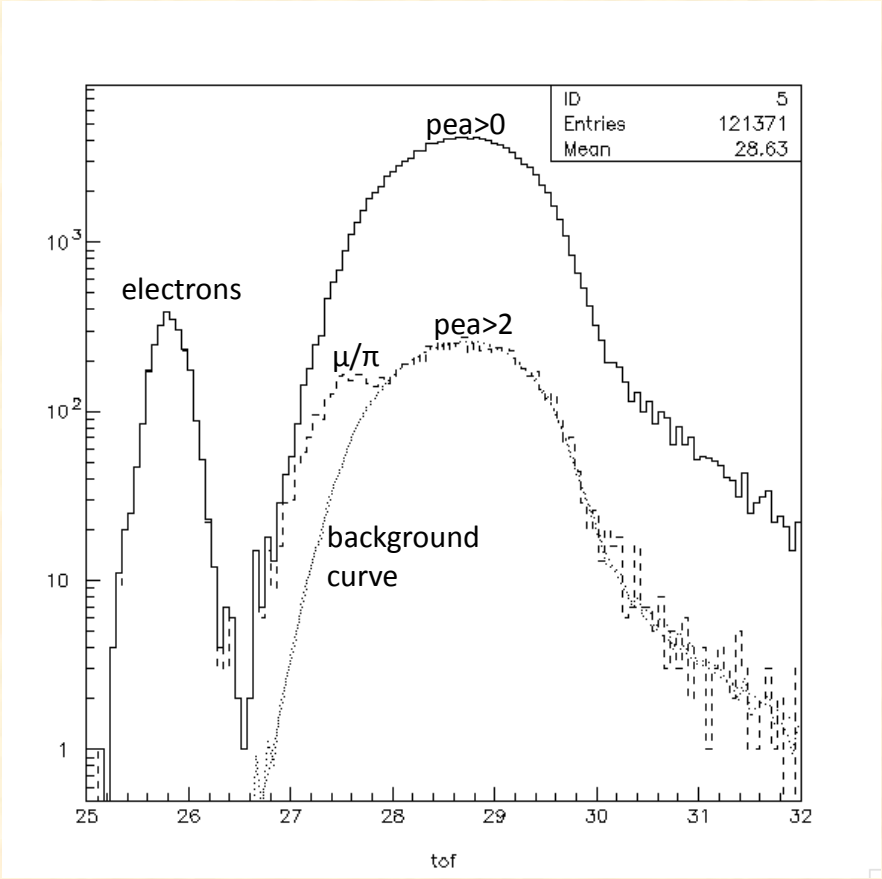
HIGH MOMENTUM PIONS AND MUONS

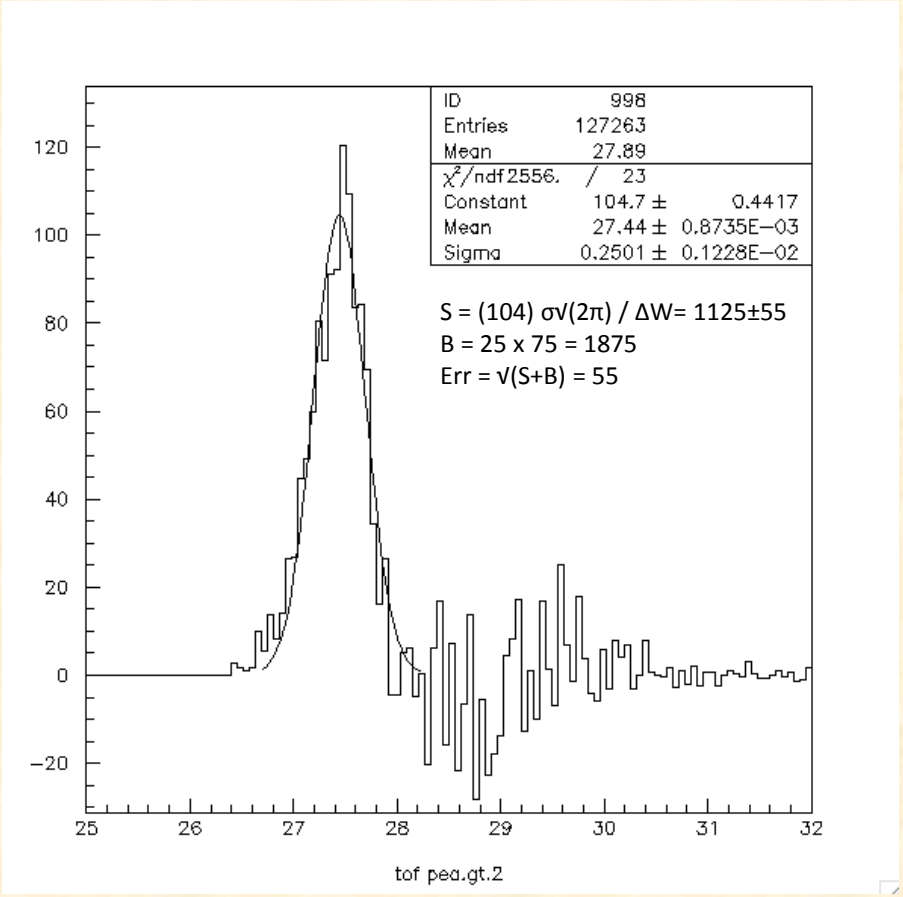
- G4BL suggests our pion contamination from high momentum π's leaking through D2.
- The high momentum muons and pions will trigger in CKOVa.
- We expect 1-2pe signals at thresholds p_μ>270 MeV/c and pions p_π>355 MeV/c.
- This signal should be prominent in 237 MeV/c data.



HIGH MOMENTUM PIONS AND MUONS - DATA

- We look in a sample of 237 MeV/c Muon Data, and required a pea> 2 cut.
- A shoulder at 25.5 ns in the tof spectra indicates about 1125 ± 55 fast μ/π's.
- pea>2 is highly efficient for electrons are highly efficient.
- On the right is a gaussian fit to the residual S(pea>2)-B. (B scaled from pea>0 shape).
- The separation of fast μ/π'scan only be made at the MC level.





HIGH MOMENTUM PIONS AND MUONS – G4BL

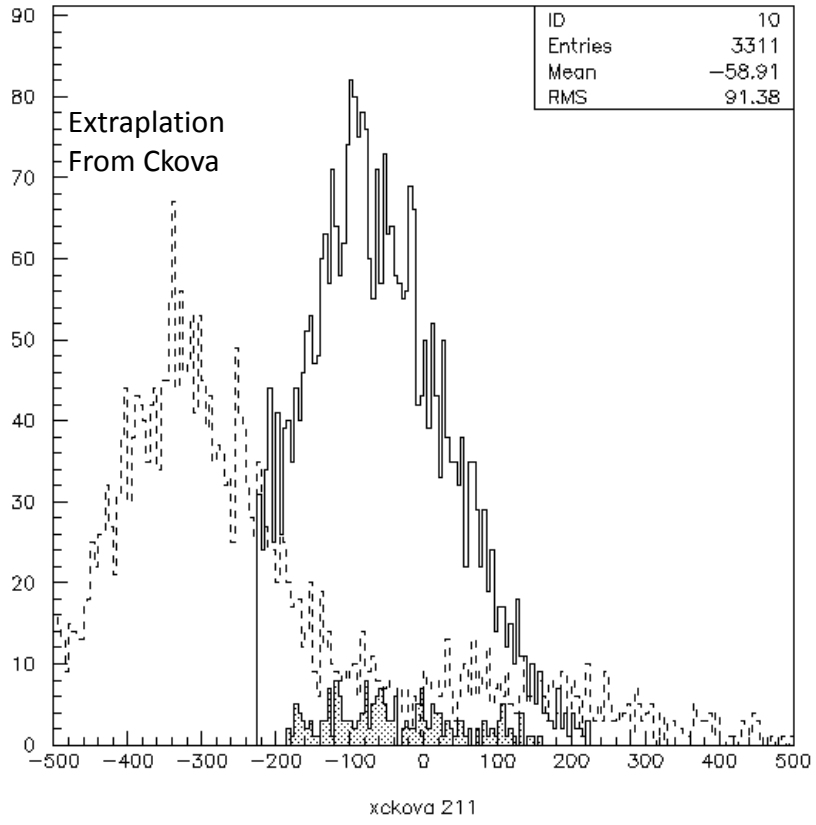
- We (Dan) performed a series of G4BL runs at 237 MeV/c with John N deck.
- The position and # of pions are displayed at CKOVa and TOF1 (hatched).

Pions

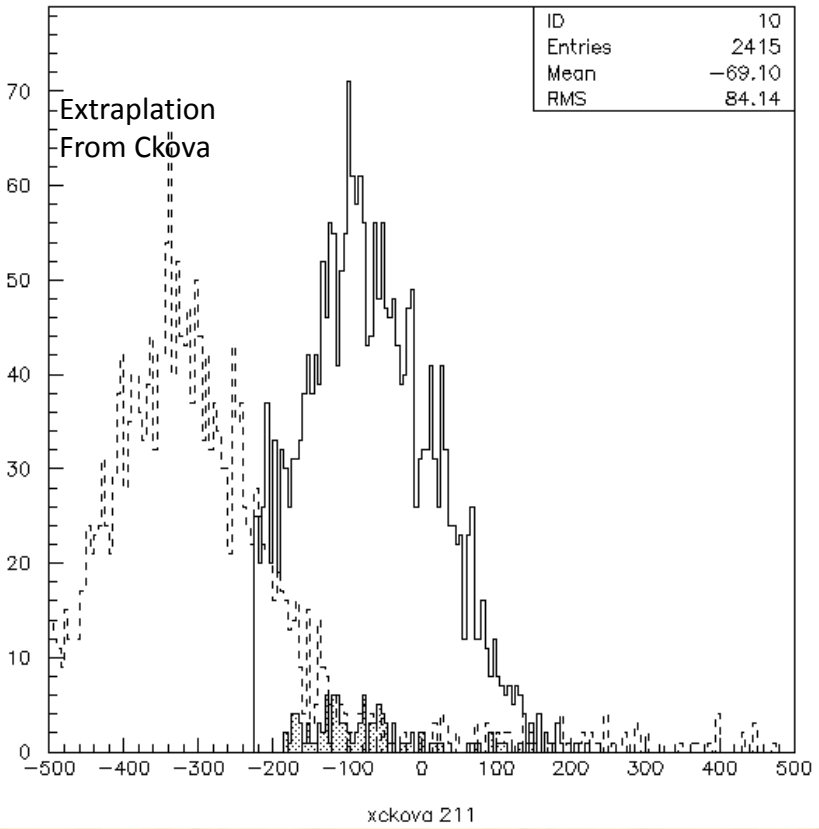
- Pions (3311) at CKOVa
- Pions (196) at TOF1

Pions w p > 355 MeV/c

- Pions (2415) at CKOVa
- Pions (107) at TOF1



P>355 MeV/c



HIGH MOMENTUM PIONS AND MUONS – G4BL

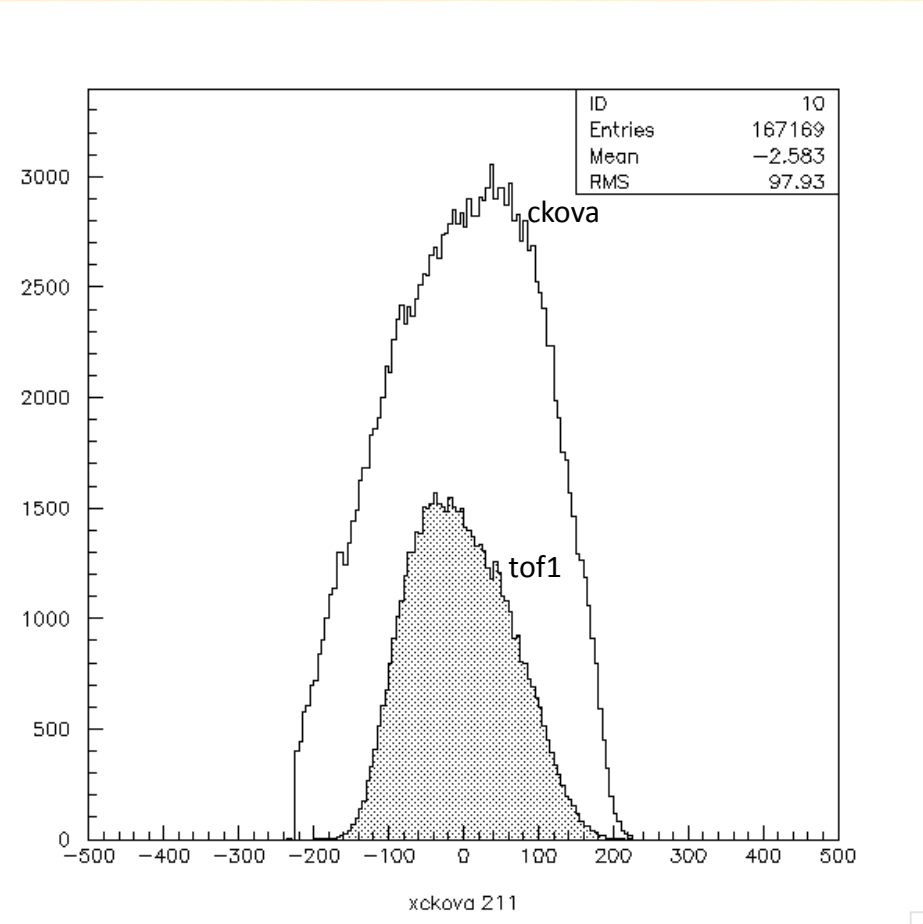
- .The position and # of muons are displayed at CKOVa and TOF1 (hatched).

Muons

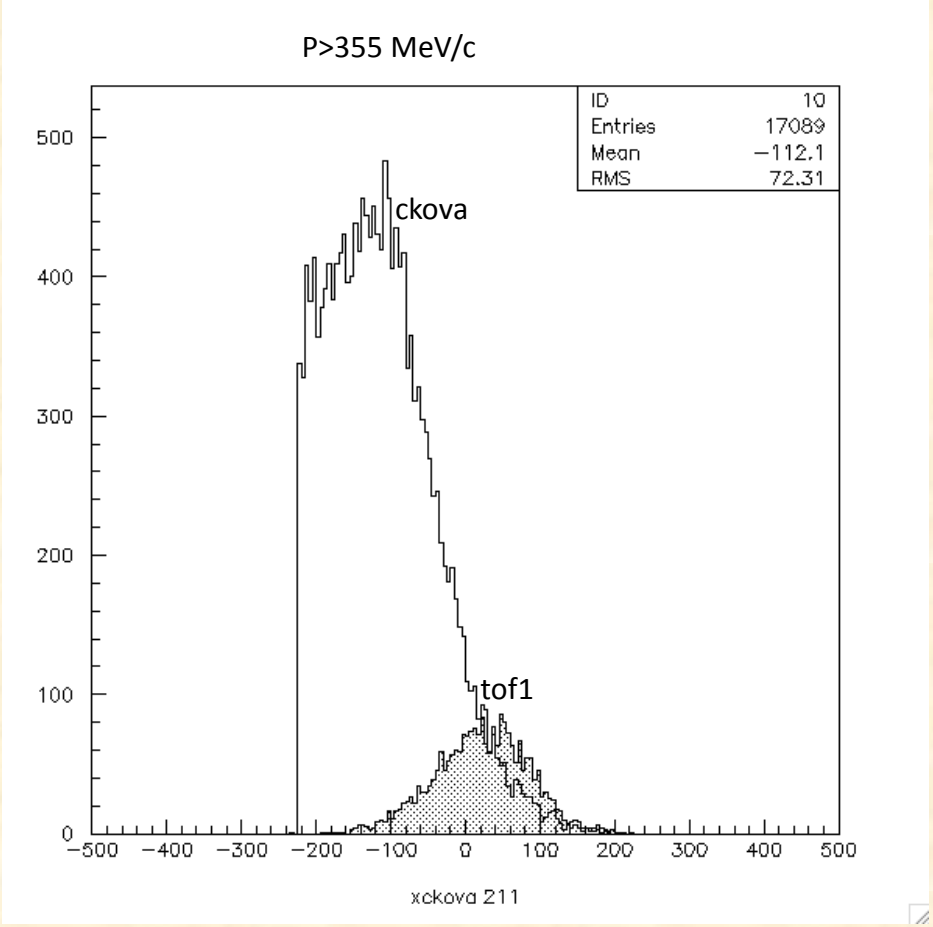
- Muons (167169) at CKOVa
- Muons (55924) at TOF1

Muons w p > 270 MeV/c

- Muons (17089) at CKOVa
- Muons (2341) at TOF1



P>355 MeV/c



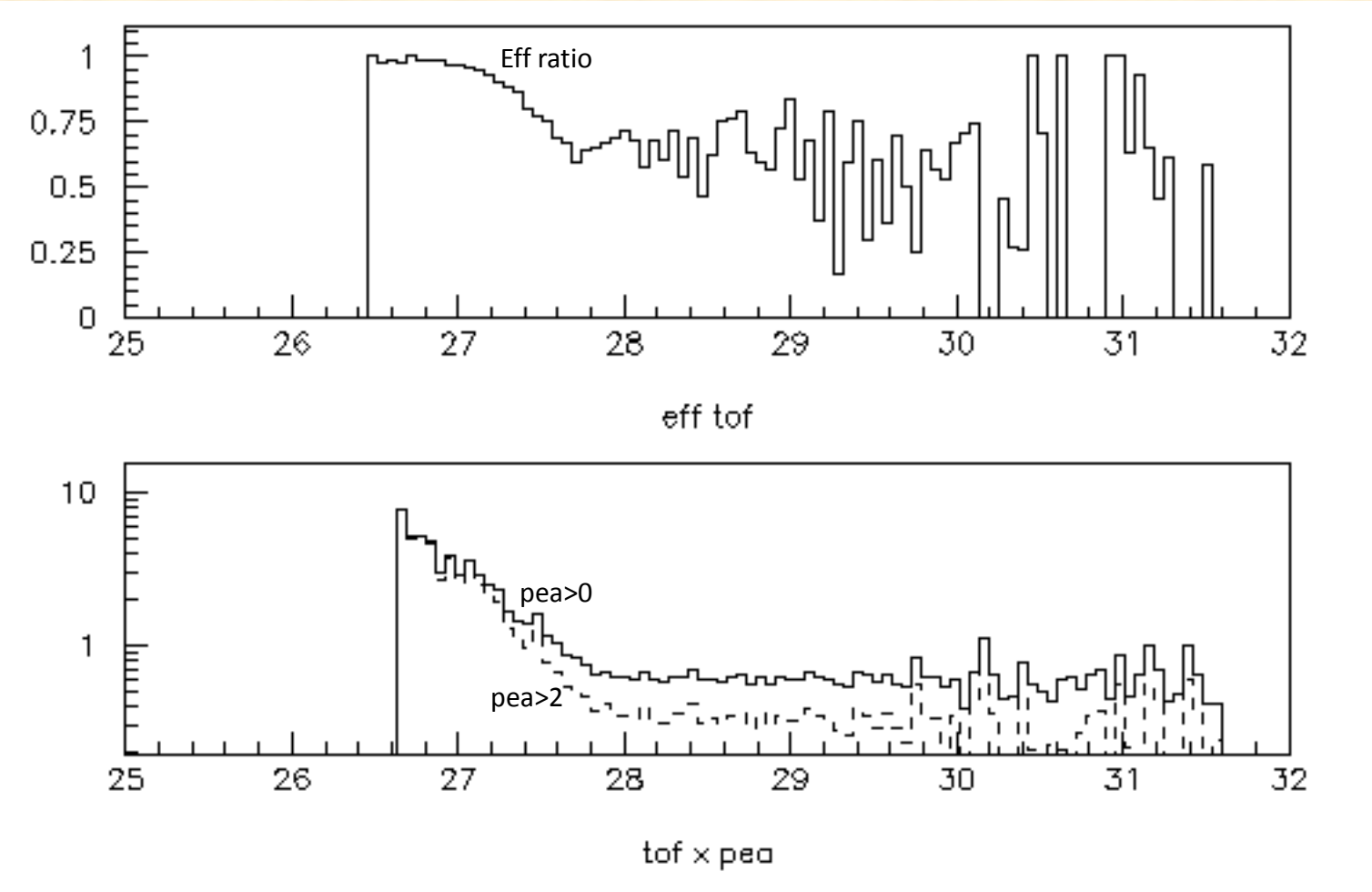
HIGH MOMENTUM PIONS AND MUONS – G4BL SUMMARY

CKOVa	D2	CKOVa	TOF1
All			
MUONS		167169	55924
MUONS P>270		17089	**2341**
PIONS		3511	196
PIONS P>355		2415	**107**
HIghP μ/π Data All beam w/o e+-	 **118793**	1125±48 **1411±56 eff corr**	

π/μ ratio	=107/2341=0.046±0.004
$f_{\pi+\mu}$ ratio	=1411/118793 =0.012

HIGH MOMENTUM PIONS AND MUONS – EFFICIENCY

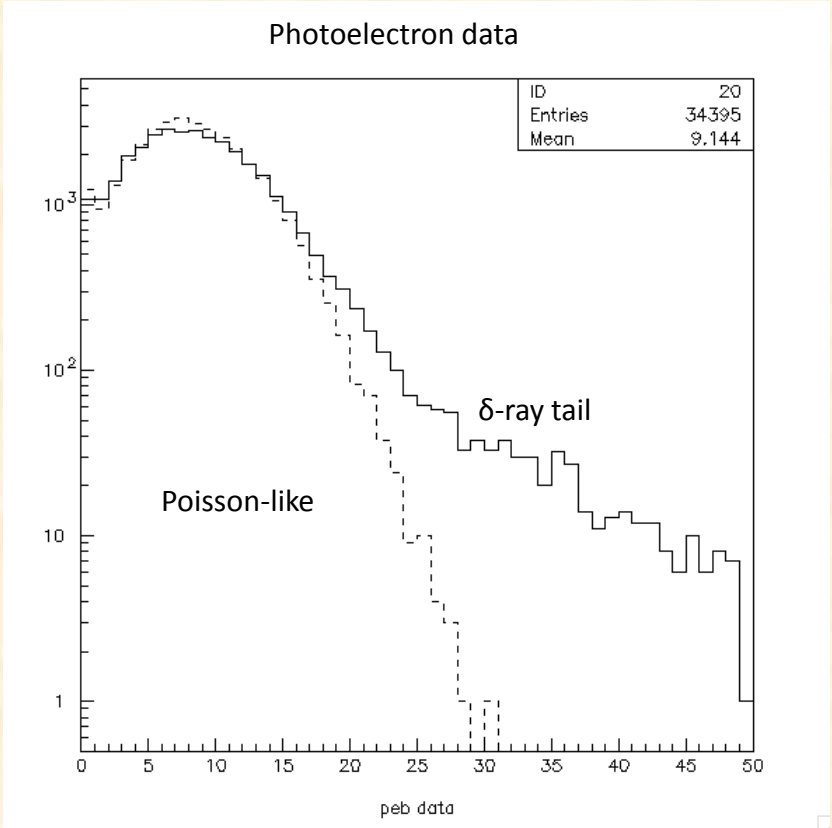
- Take an independent sample of muons and evaluate the tof with and w/o the pea>2 cut.
- The ratio is a fair approximation of the cut efficiency vs tof.



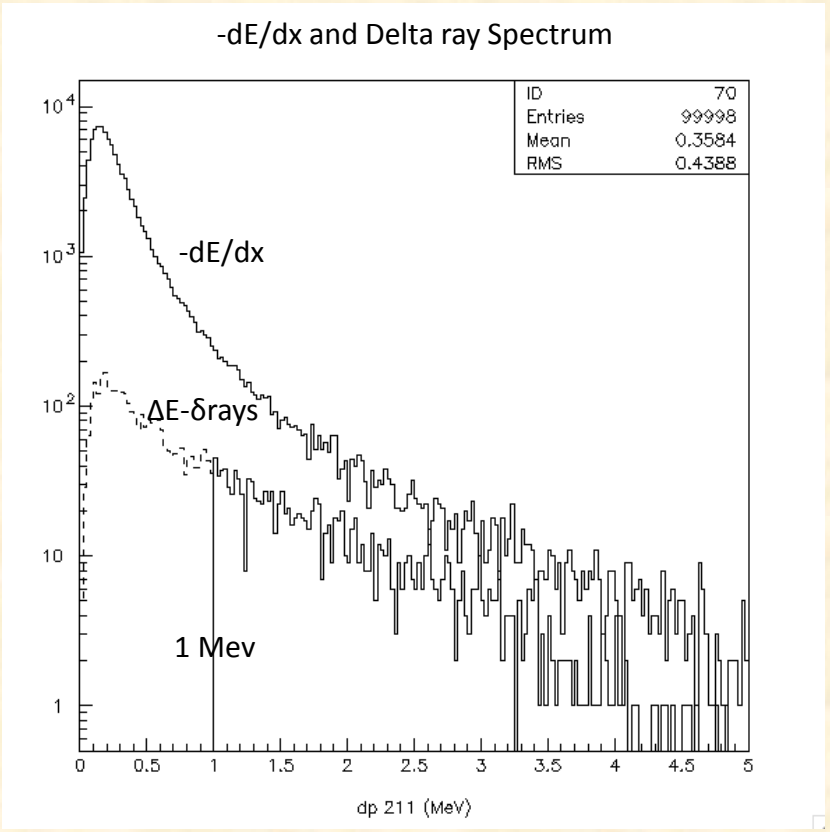
Photoelectron Modeling for MAUS

- A full ckov photoelectrons model should include cherenkov, δ-rays, and pedestal noise.
- Delta rays production is significant at the 3-5% level. Pe≥1MeV/c radiate-čerenkov light.
- Photoelectron data can be reproduced by a poisson light distribution using mean pe-yield and directly adding additional light from δ-rays as a tail; avoiding optical photons in G4!
- Pedestal (pe=0,1) not Poisson-like and must be studied (most challenging).

Photoelectron data



-dE/dx and Delta ray Spectrum



COMMISSIONING

- We should perform a mini-HV Scan with new CAEN SY4527 +HV module in place.

- We should check aerogel thesholds and/or density with 2015 data.
  - Standard 237, 290 MeV/c muon runs are adequate.
  - Or a dedicated p scans ccan be performed.

SUMMARY

- We performed some CKOV analysis of high momentum μ/π.
- We are working on some methods of characterizing the CKOV efficiency.
- We are working on MAUS simulation of photoelectron yields. These are working at some level and need to be implemented in to MAUS.