Ckov Analysis: CM41

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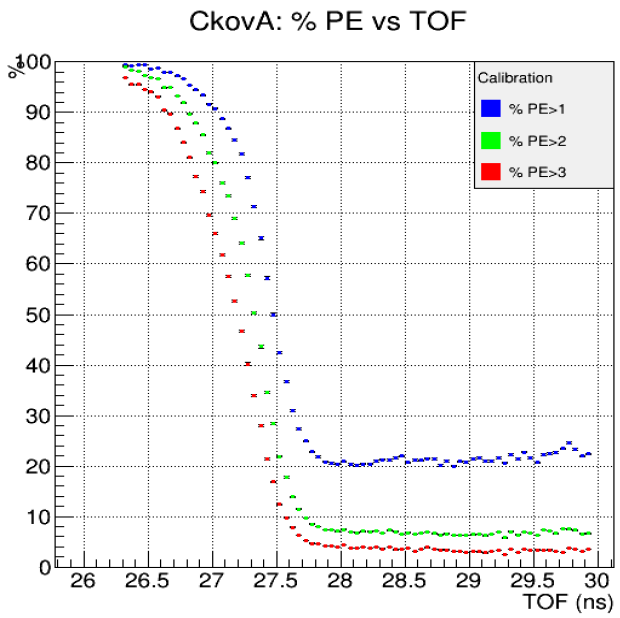
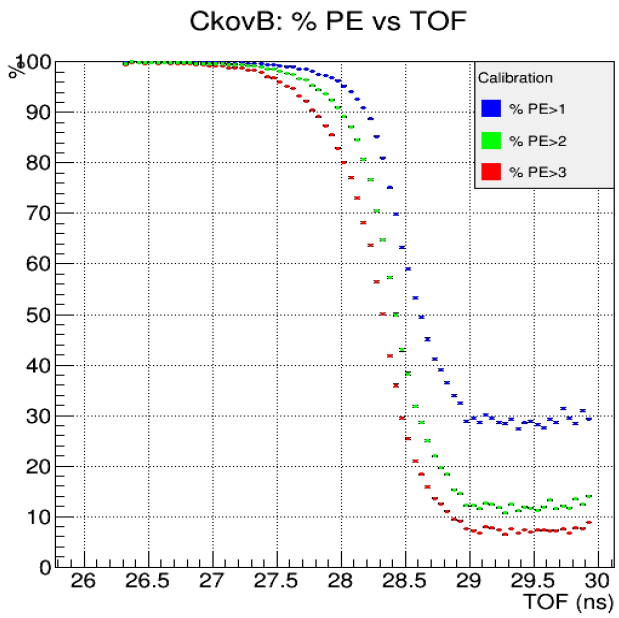
Ckov Reconstruction Items

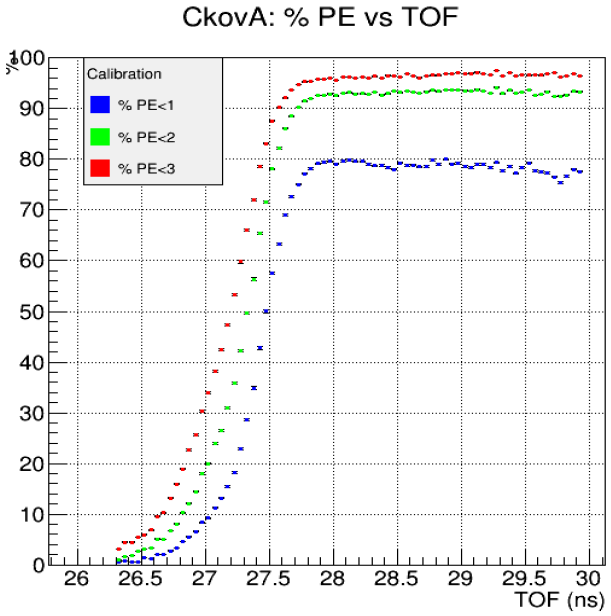
- Pedestal and fadc Integrators reworked by Miles Winter and Michael Drews at IIT, Fall 2014.
- New code very close to being submitted.
- 2014 HV scans have been analyzed with new pedestal and fadc charge integrators.
- Private versions of MC hit generators exist and need to be implemented into MAUS.
- Private versions of reco likelihood algorithms need to be finalized and uploaded.
- Ckov thresholds and responses reasonable and stable.
- Light splashes below Ckov threshold being investigated.

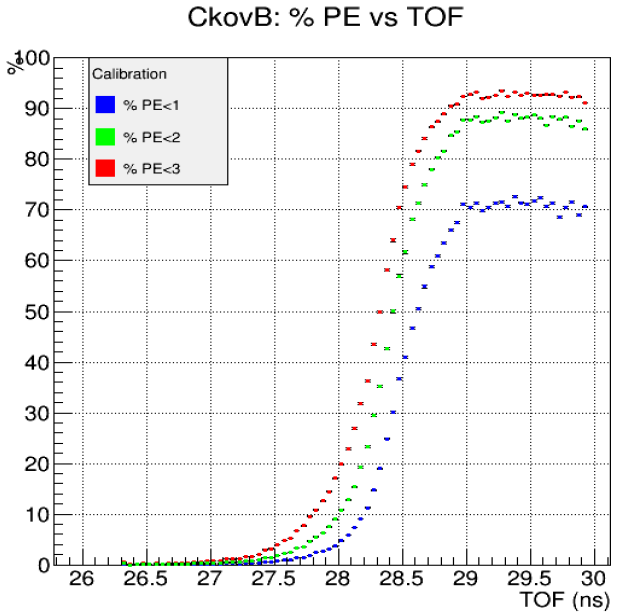
Ckov Light Threshold Curve

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	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	





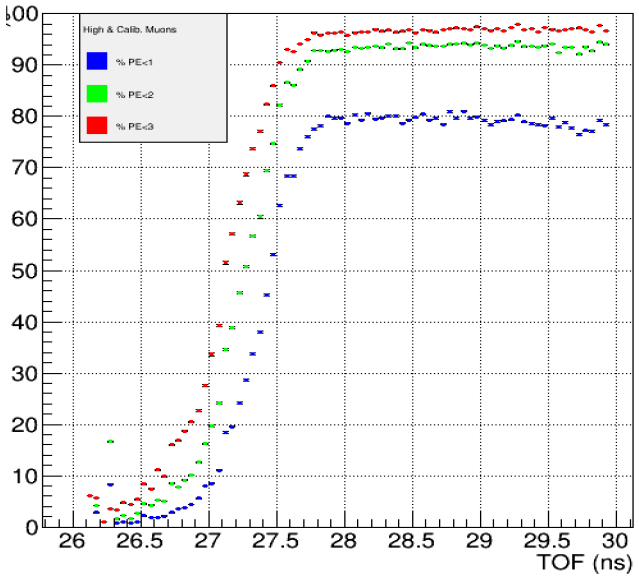




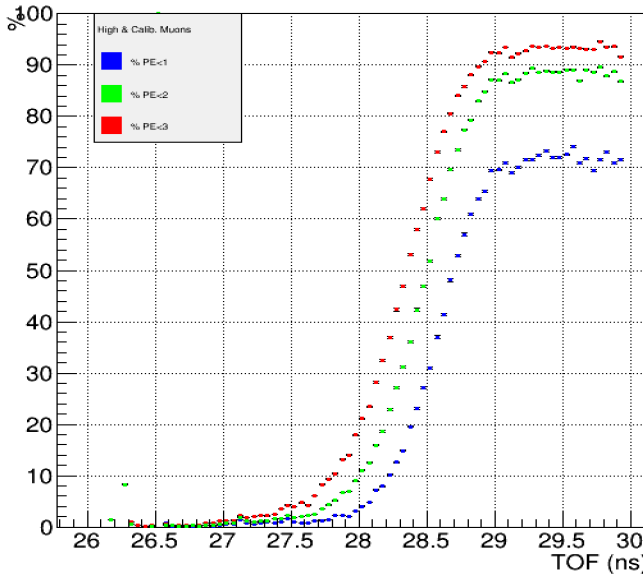
Muon vs Pion Response

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	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	

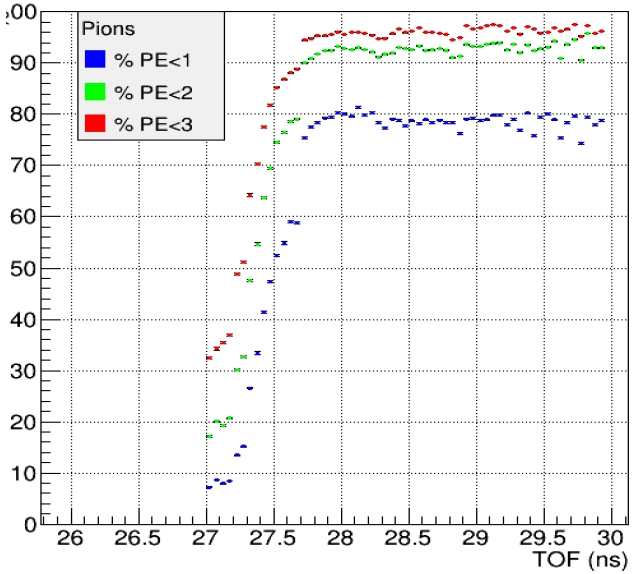
Muons CkovA: % PE vs TOF



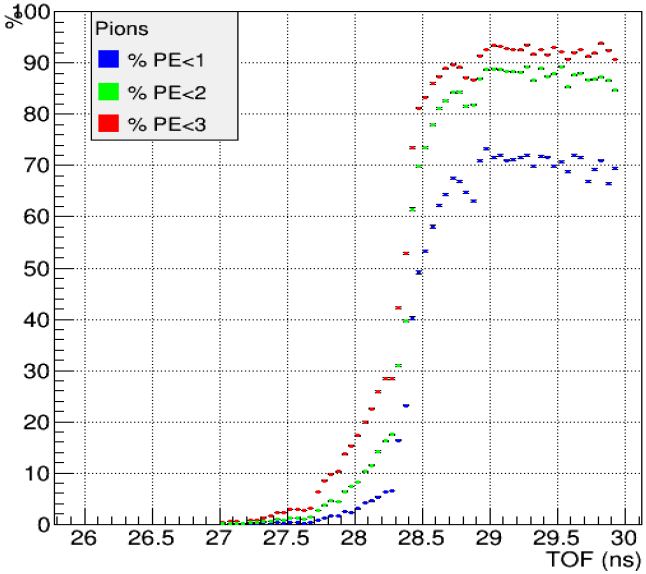
Muons CkovB: % PE vs TOF



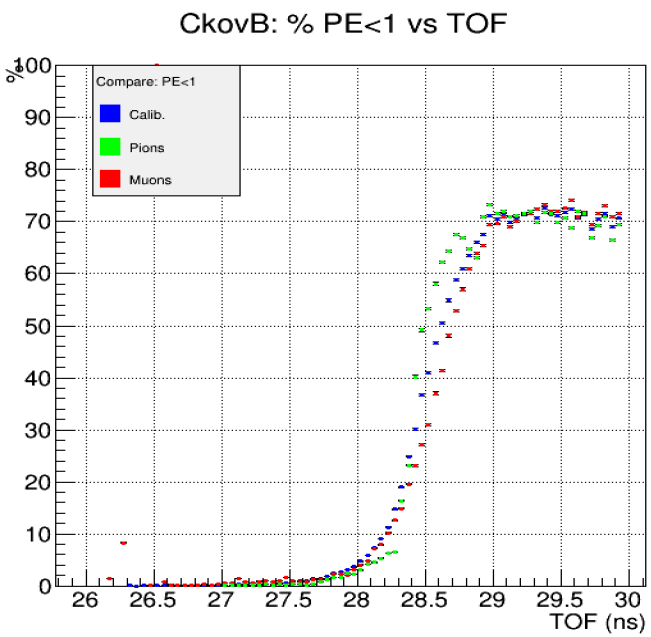
Pions CkovA: % PE vs TOF

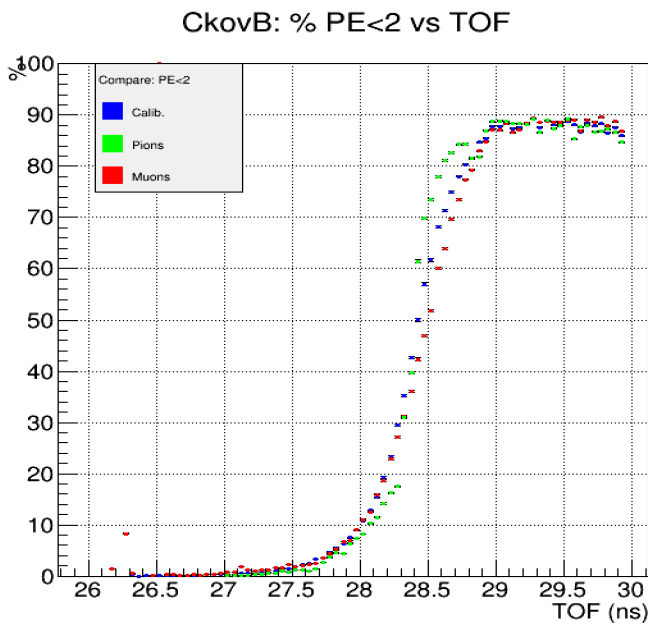


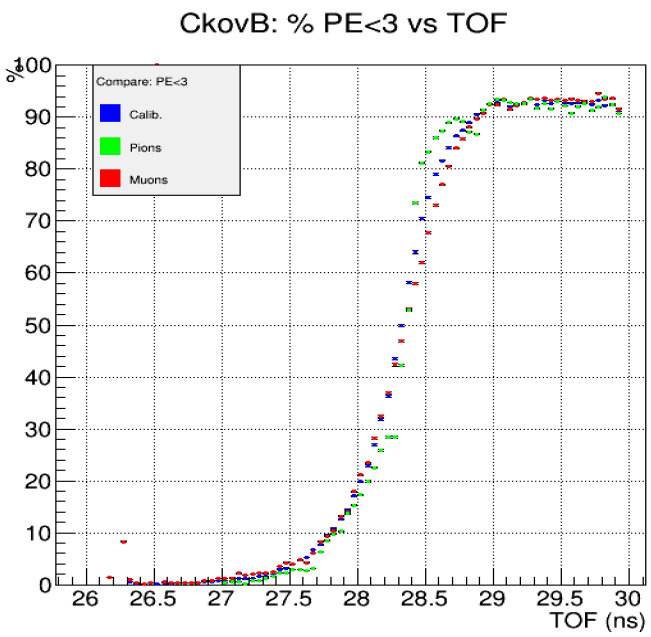
Pions CkovB: % PE vs TOF

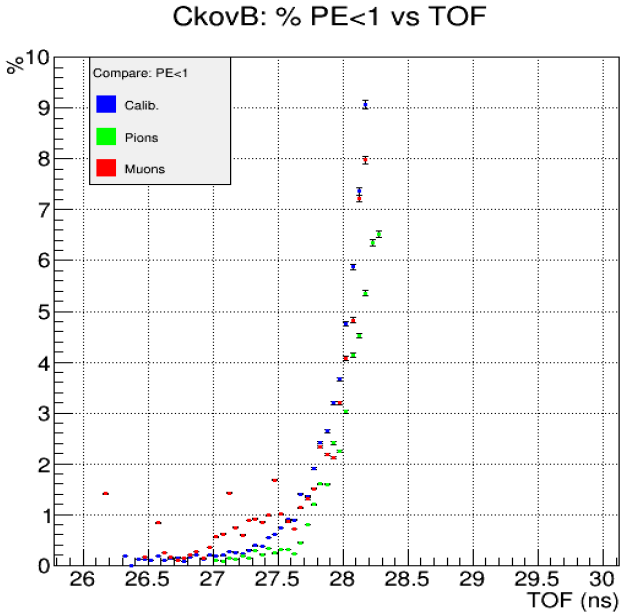


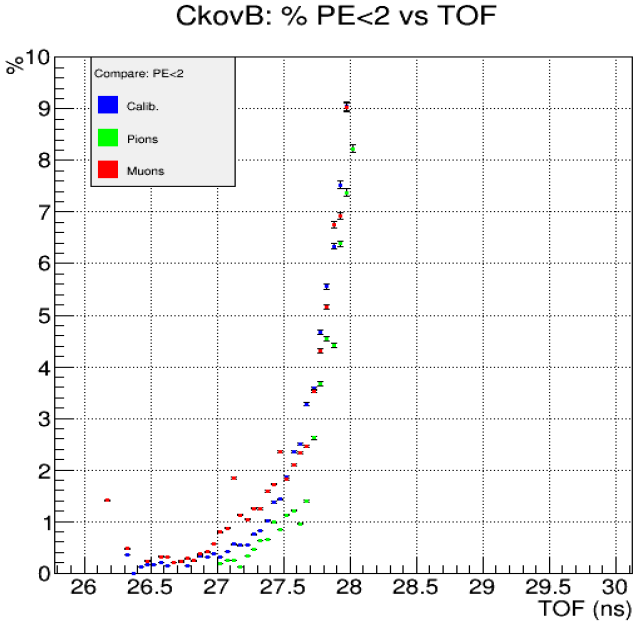
Muon vs Pion Response

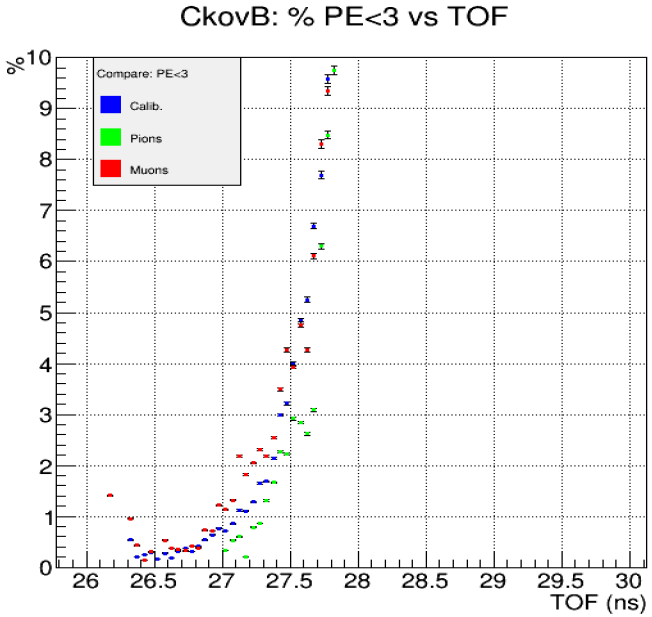




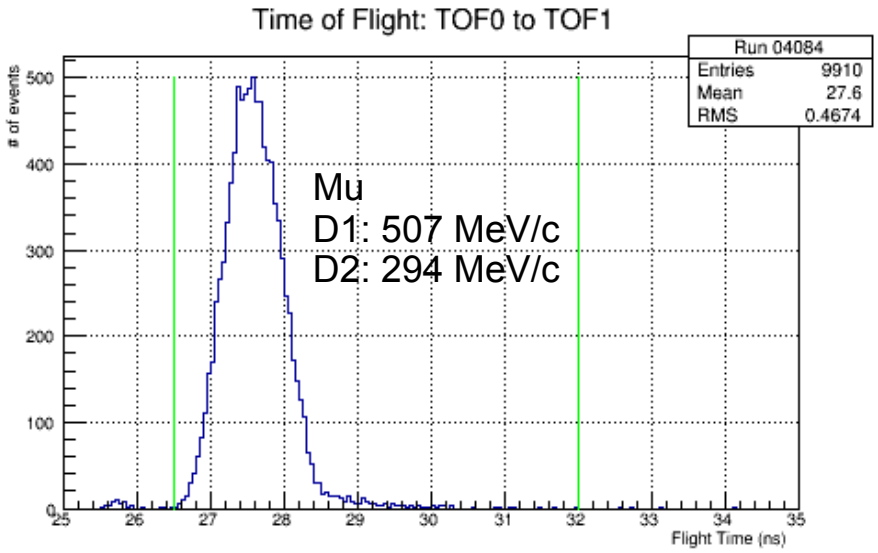


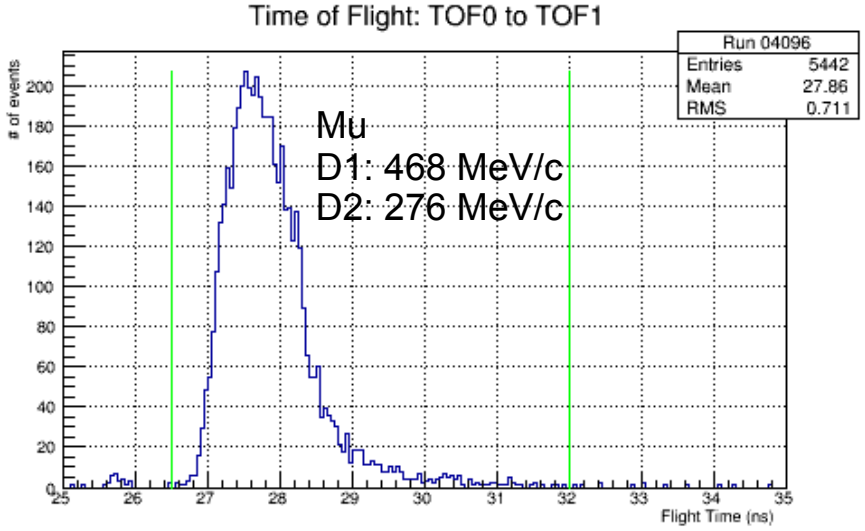






High Momentum Muons

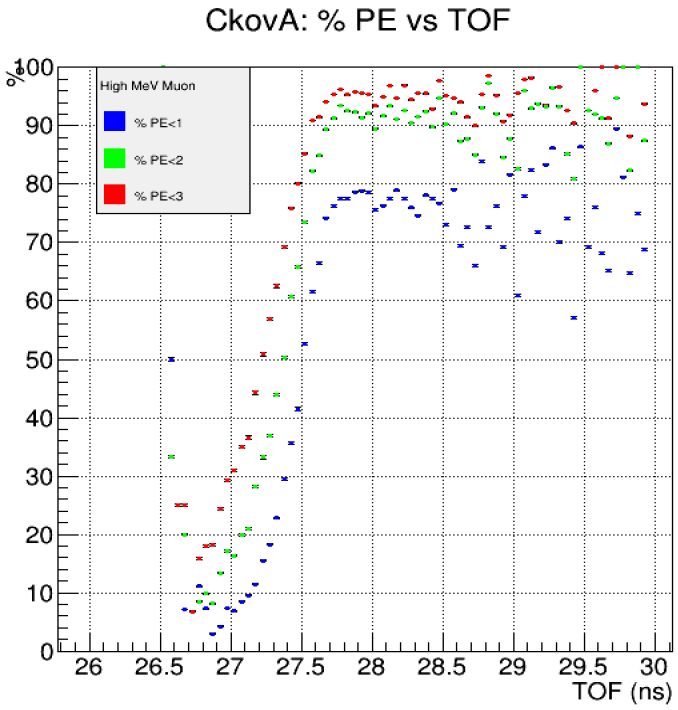


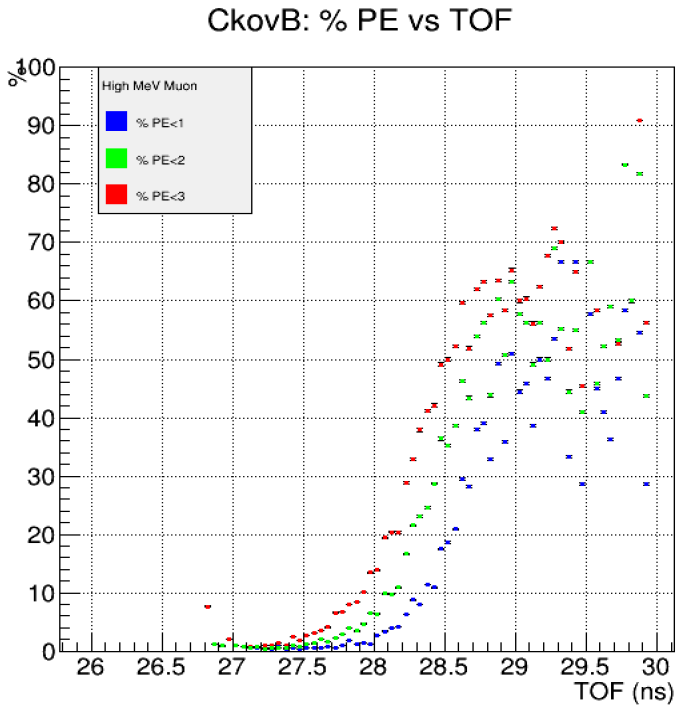


Runs Used

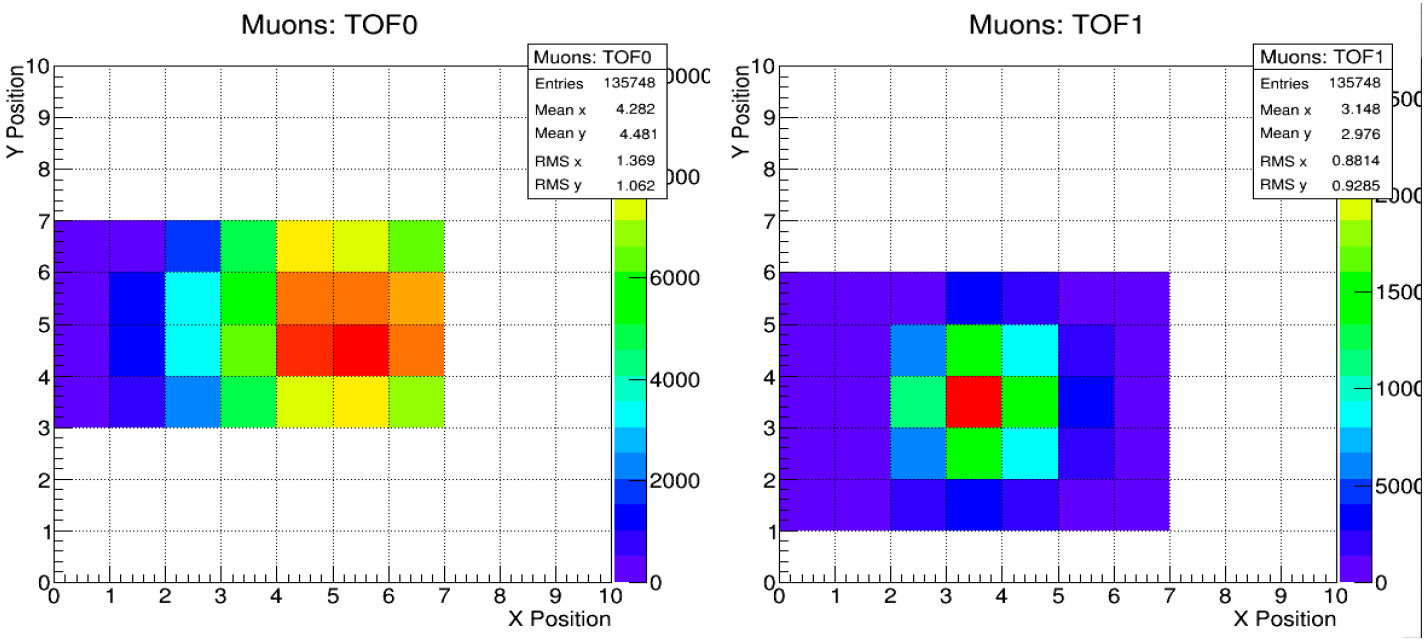
D1: 507 MeV/c
D2: 294 MeV/c
04082-04084

D1: 468 MeV/c
D2: 276 MeV/c
04096-04098



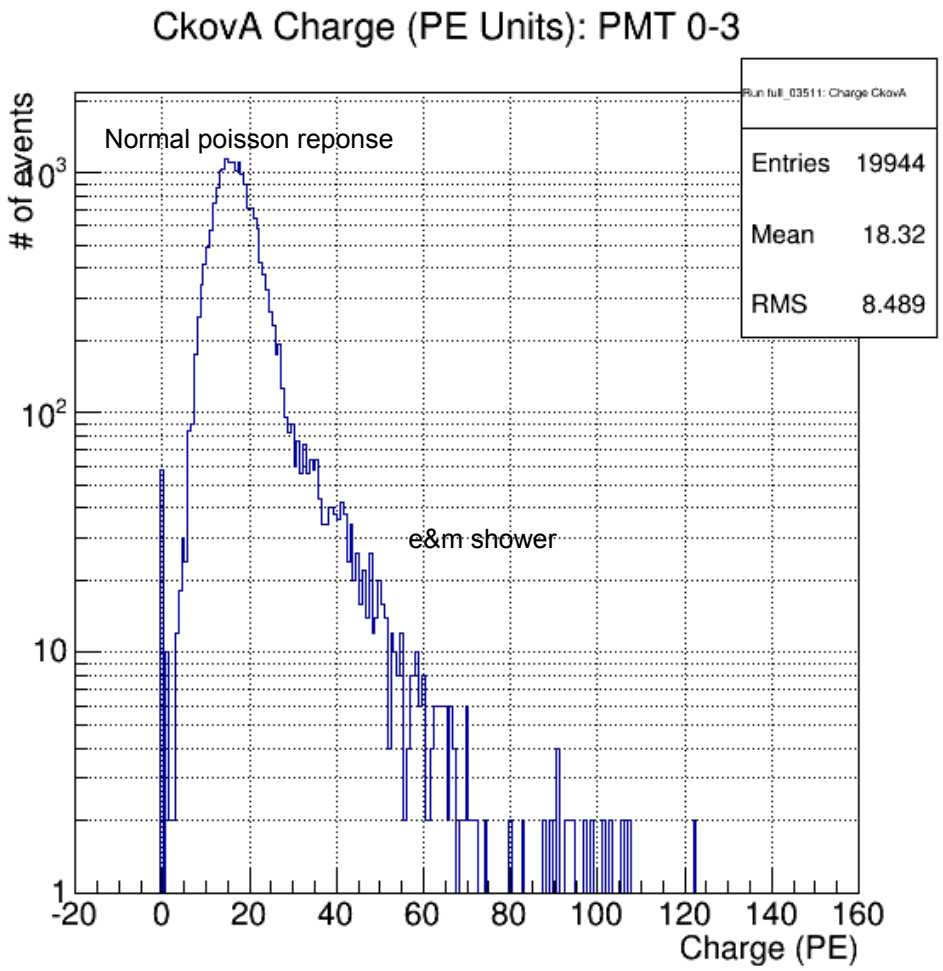


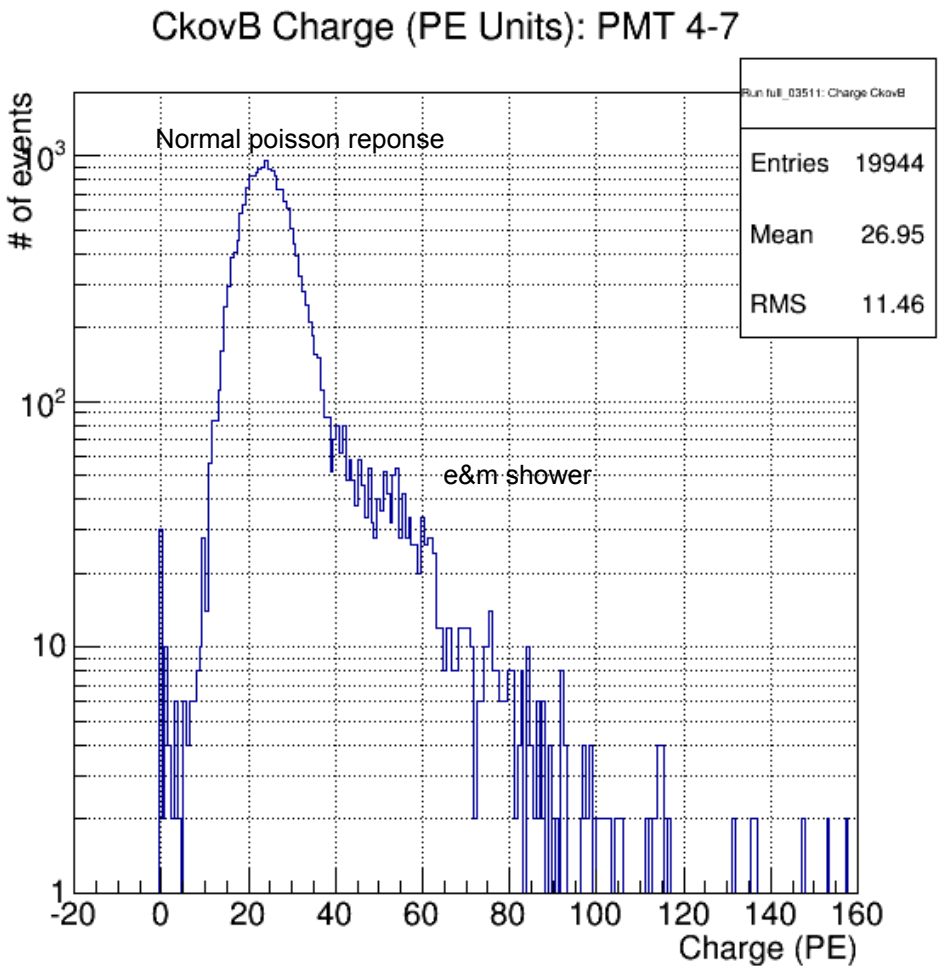
Comparison: Tof Slab Hits



Run 03511: e+\e- PE

TOF Cut: 25-27ns





Investigation of super-pulses w
μ → e ν ν decays and knock-on electrons

Aerogel Reminders

Silicon radiation length 27.25 g/cm^2
Silicon collision length 96.9 g/cm^2
Aerogel thickness = 2.3 cm

rho1= 0.261+/-0.005 g/cc radL = 104.32cm 2.2% XL
rho2 =0.371+/-0.005 g/cc radL = 73.65 cm 3.1% XL

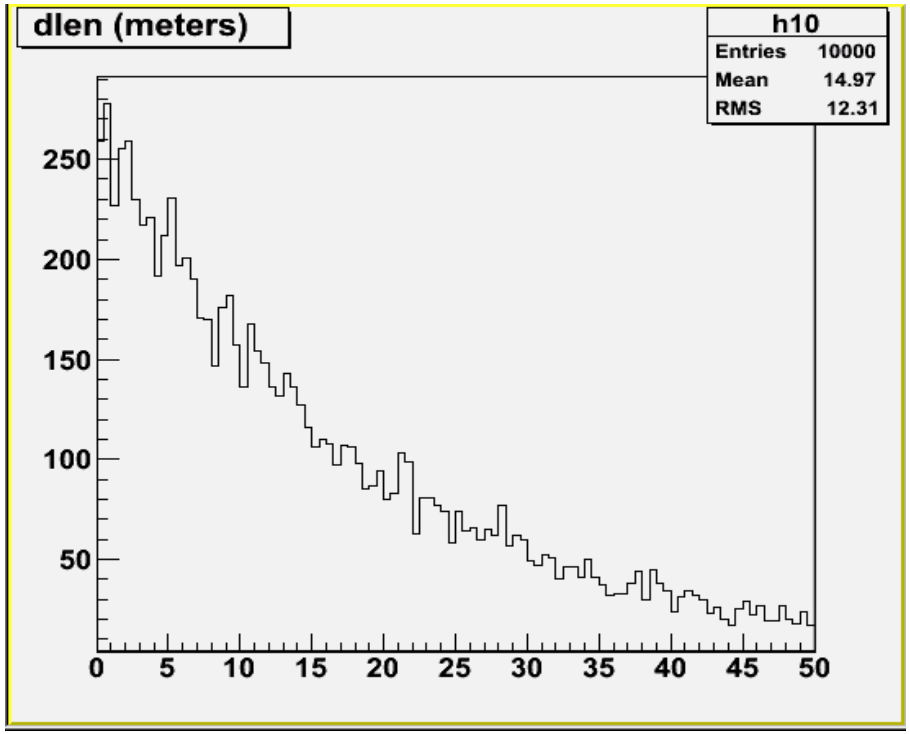
rho1= 0.261+/-0.005 g/cc intL = 371.36 cm 0.62% Xa
rho2 =0.371+/-0.005 g/cc intL = 261.19 cm 0.88% Xa

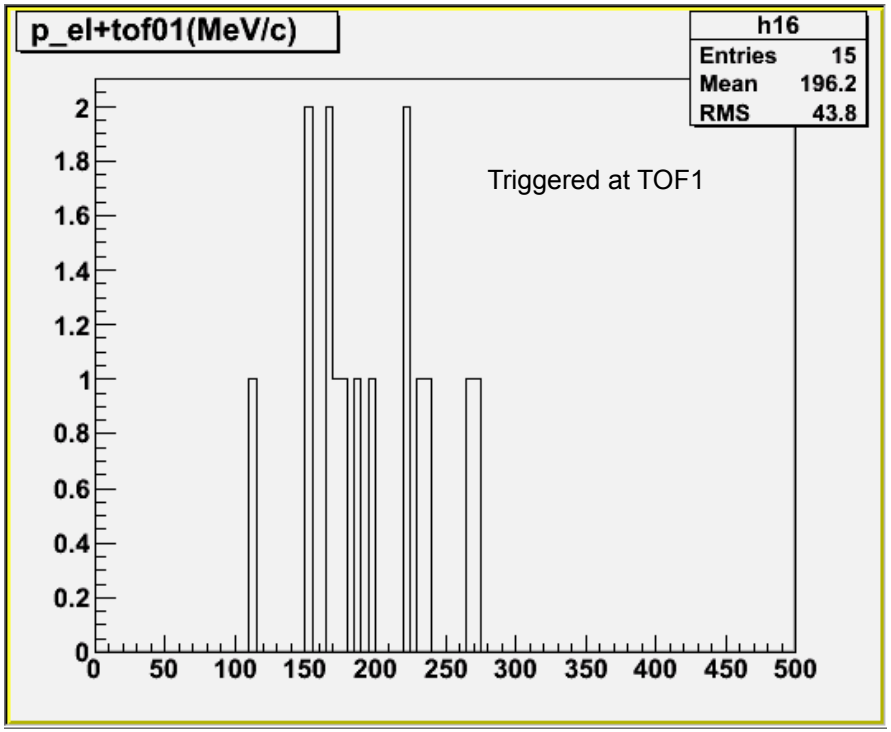
Low energy pions and muons have similar behavior in matter.
Delta rays and ionization contribute to -dE/dx.

During our studies there seemed occasionally to be large light pulses associated with particles, some in time some out of time.
All pmts were involved, so probably not a tube issue!

Muon to electron decays D2-TOF0 $\mu \rightarrow e\ \nu\ \nu$

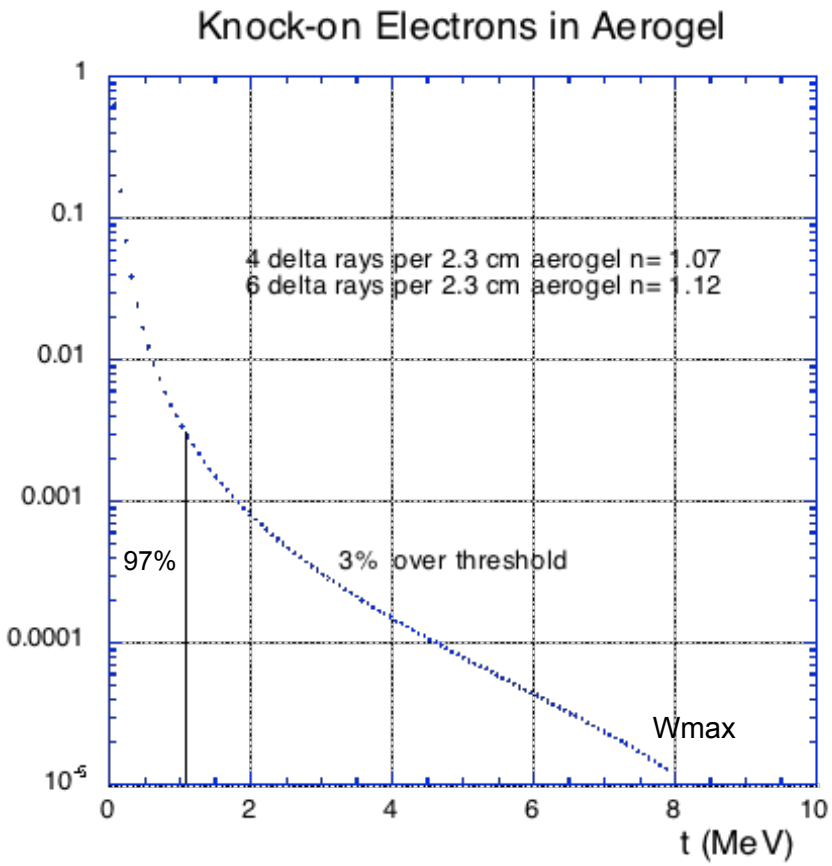
- 290 MeV/c muons generated.
- A small fraction decay before TOF0 (order 5%).
- Only 15/10000 reach TOF1 (0.15%) trigger.
- Expect some contamination, seen as large pulses in CkovA,B.
- These should be ID'ed as electrons by TOF and Ckov.





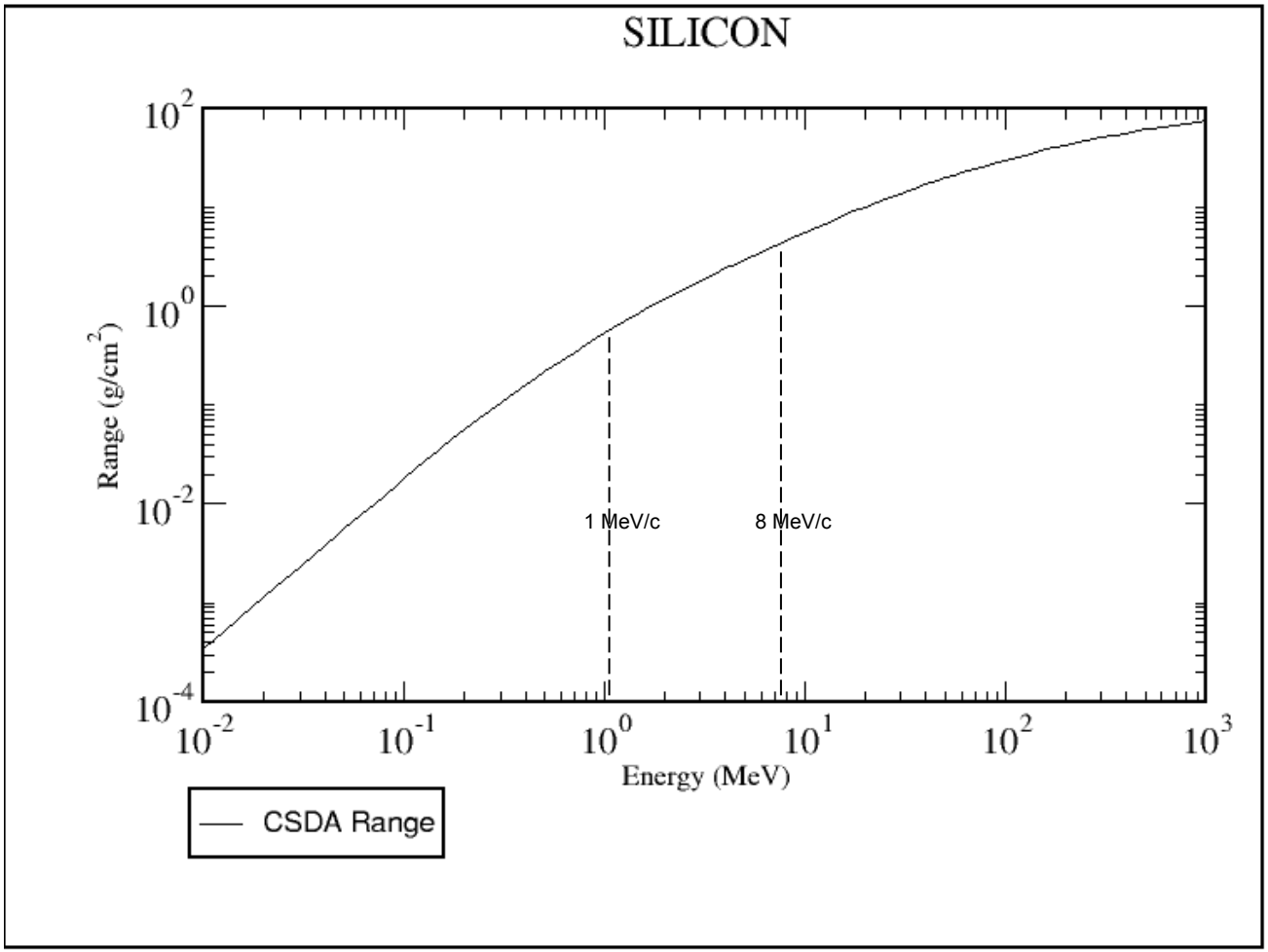
Knock on Electron Spectra from Muons

- Electron threshold in CkovA,B ~ 1 MeV/c (pe_{th} = (m_e/m_μ) 210 MeV/c)
- About 5 delta rays per passage expected, 97% below light threshold.
- The delta ray range is significant and may occur pre-Ckov.
- P_delta-ray giving light = 5 x 3%



Beta Range in silicon

Range = 1g/cm^2 / 0.261g/cc = 3-15 cm aerogel 1.07
Range = 1g/cm^2 / 0.371g/cc = 2-10 cm aerogel 1.12
These delta-rays are likely to leave full beta=1 on the aerogels.
Setting up a G4 run to confirm.



Basic Ckov PID

- With momentum information from the traker estimate the momentum at CkovA/B.
- Predict the number of photoelectrons expected pe_A/B from the known threshold curve for CkovA/B.
- Use Poisson statistics to compare the expected number to the measured number and form the likelihood. Use both counters to form a likelihood!
- Some other approaches might use Bayesian or Likelihood ratios. Lots of fun.
- Ckov likelihood merged into global PID.

Summary

- New pedestal and fadc Integrators code very close to being submitted.
- 2014 HV scans have been analysed with new pedestal and fadc charge integrators.
- MC hit generators and reco code forthcoming.
- Ckov thresholds and responses seem stable. Efficiency is high for particles above threshold. The inefficiency is more important for pion ID.
- Light splashes below Ckov threshold being investigated.