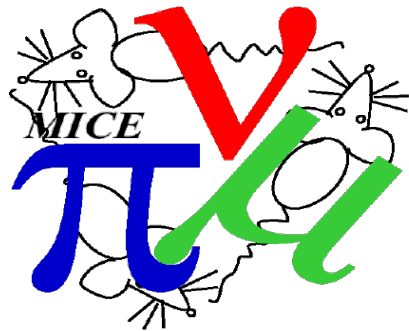


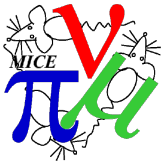
CKOV UPDATE



MICE CM
June 2014



Miles Winter
Michael Drews



Introduction

- MICE uses two threshold Cherenkov detectors each with 4 phototubes for light collection
- Ckov A is upstream of Ckov B; each is filled with a different density silica aerogel (details on the next slide)
- Cherenkov data is recorded in an 8 bit binary format as each particle passes through the respective aerogels
- The MICE Analysis User Software (MAUS) is responsible for data reconstruction
- Following reconstruction, calibration and analysis is required to separate background noise from physics events
- The basic questions: light or no light? Is this expected given the run conditions?

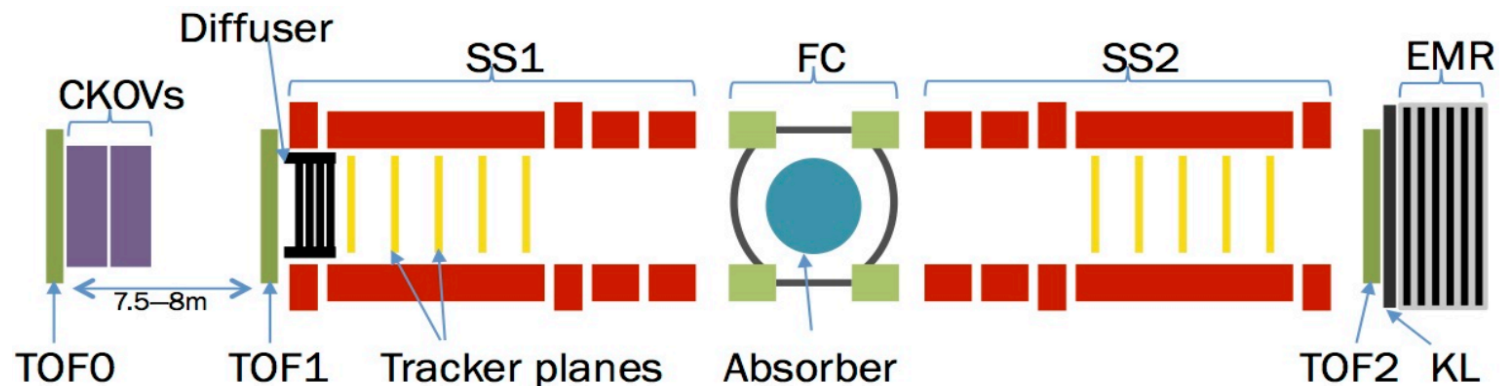
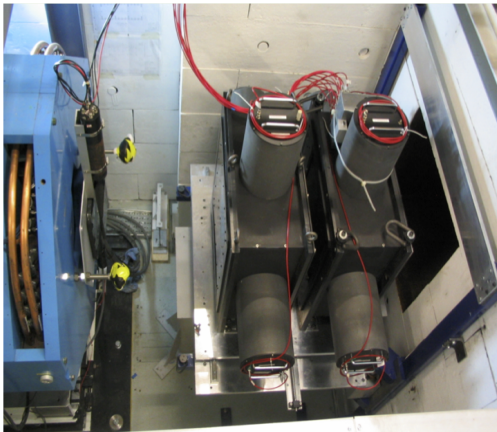
What is reconstructed?

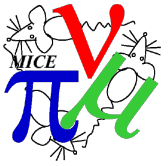
We have access to total charge, arrival times, total nps, etc... All are considered, but the most useful are listed below.

Quantities of Interest:

- 1.ADC (Pedestal)
- 2.Electron (or positron) peaks
- 3.Sub-threshold pions; SPE peaks

More on these in the slides that follow





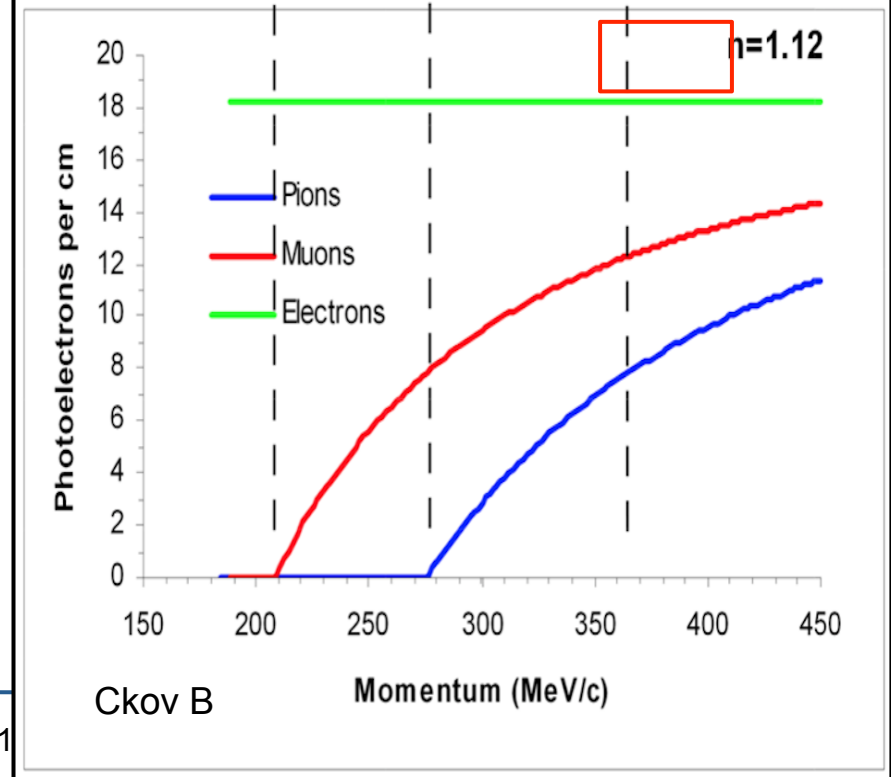
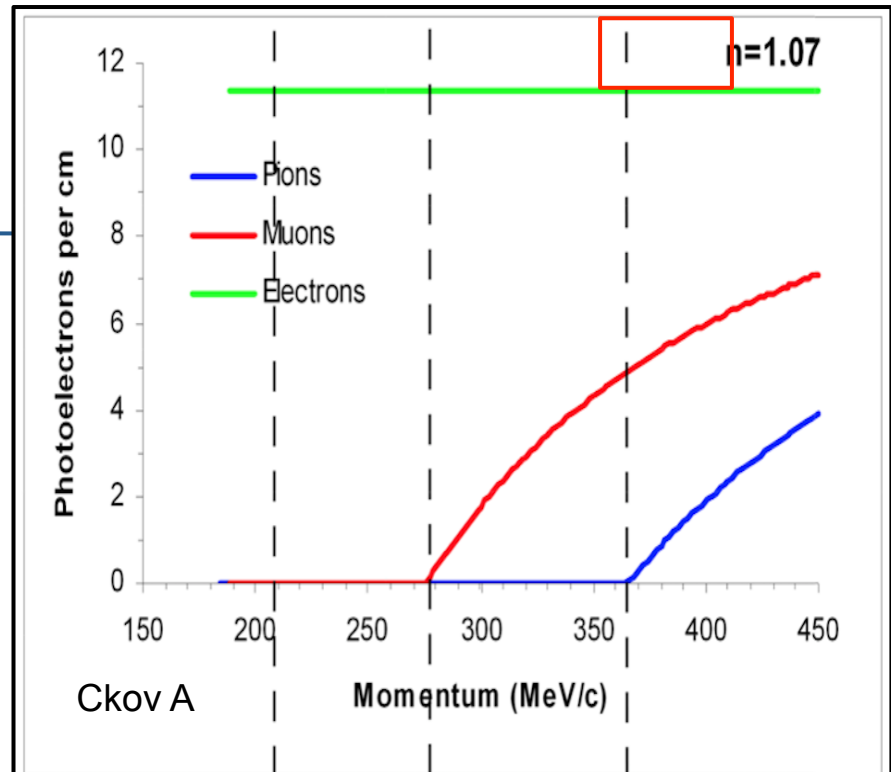
Ckov A & B

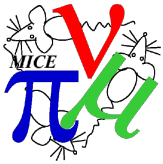
Theoretical Threshold Values*

	Ckov A	Ckov B
n	1.07	1.12
β_t	.935	.893
$p_t(\pi)$	$366.7 \text{ MeV}/c$	$276.8 \text{ MeV}/c$
$p_t(\mu)$	$277.7 \text{ MeV}/c$	$209.6 \text{ MeV}/c$

$$p_t = \frac{mc}{\sqrt{n^2 - 1}} \quad \beta_t = \frac{1}{n}$$

*Electrons always give light

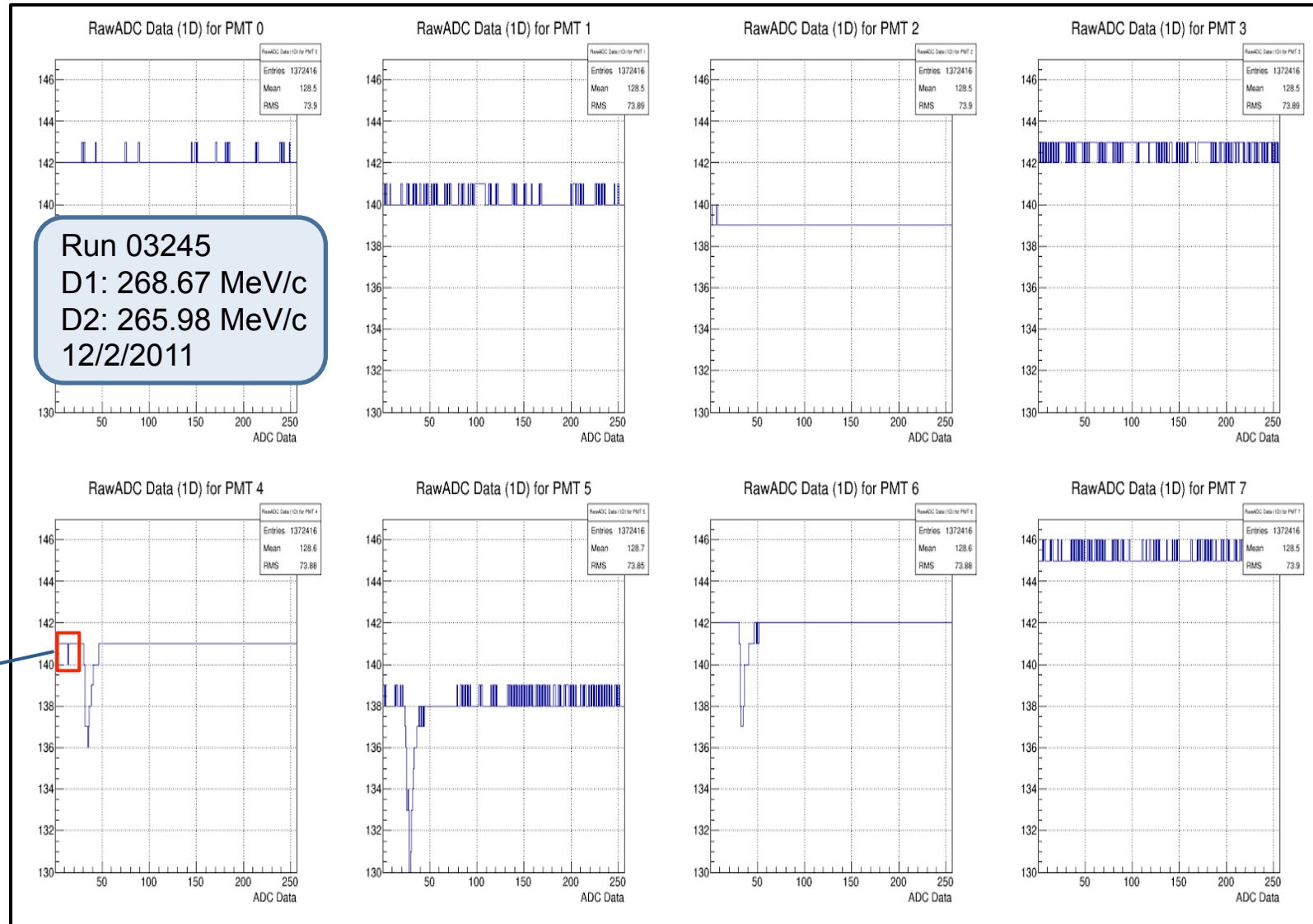




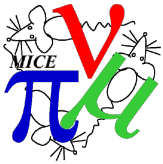
Raw Flash ADC

Pedestal
Calculation:
Average of the
integral of the first
20 bins

First 20 bins are
found to be pulse
free*

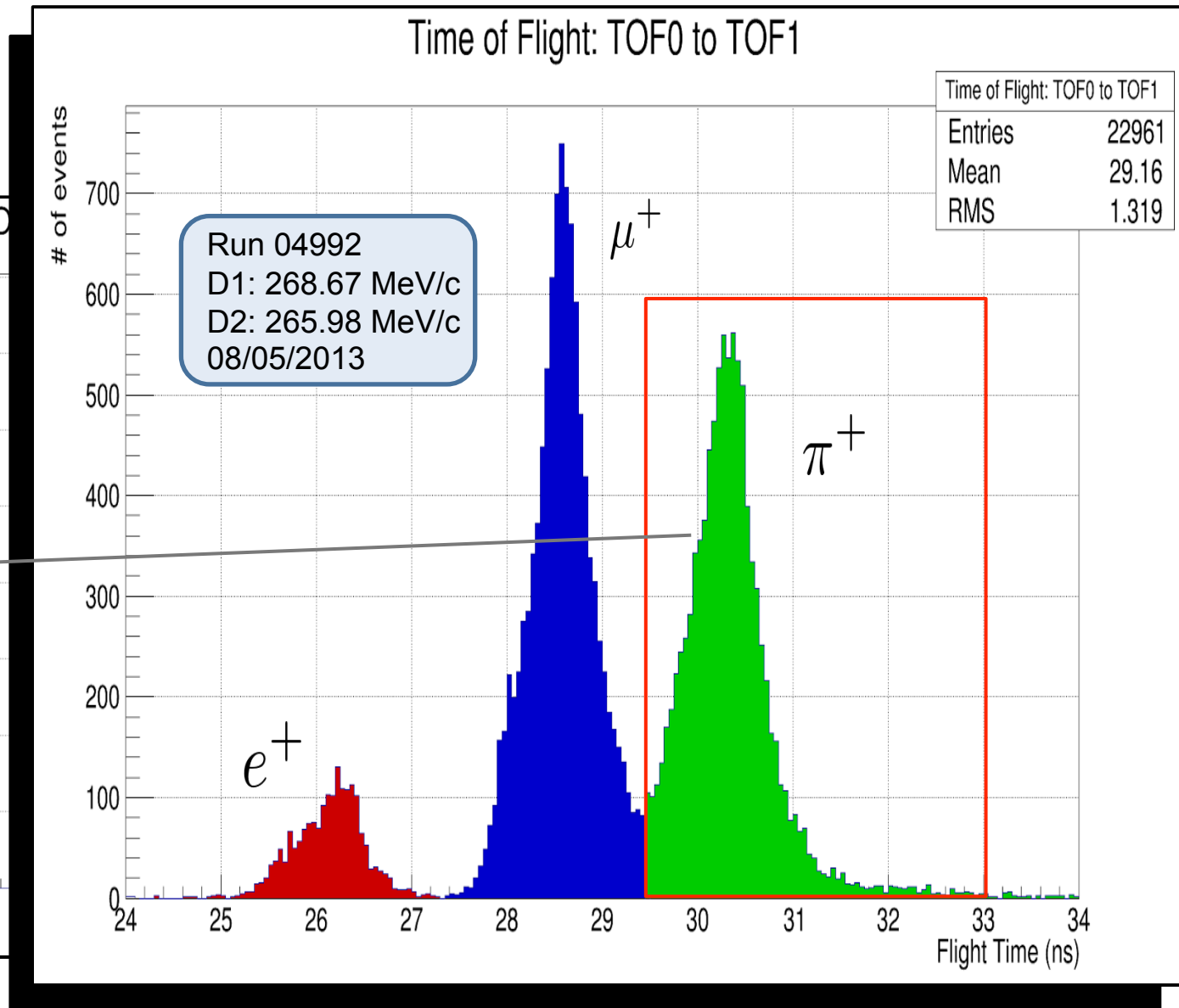
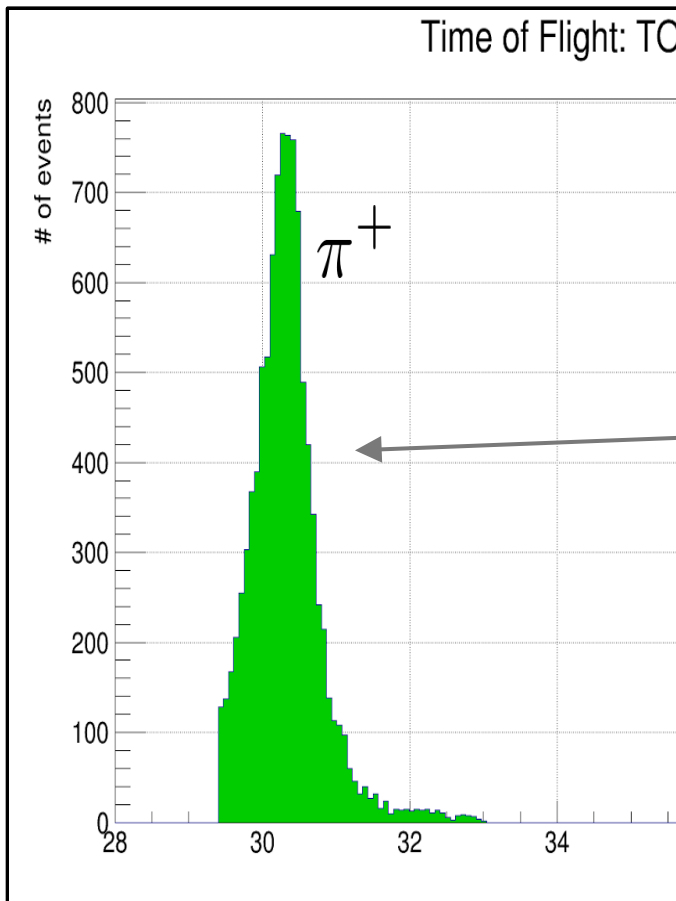


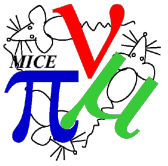
* First 20 bins being pulse free is based on observation.



Particle Selection

- Cuts of TOF histogram are made to get the particle species of interest





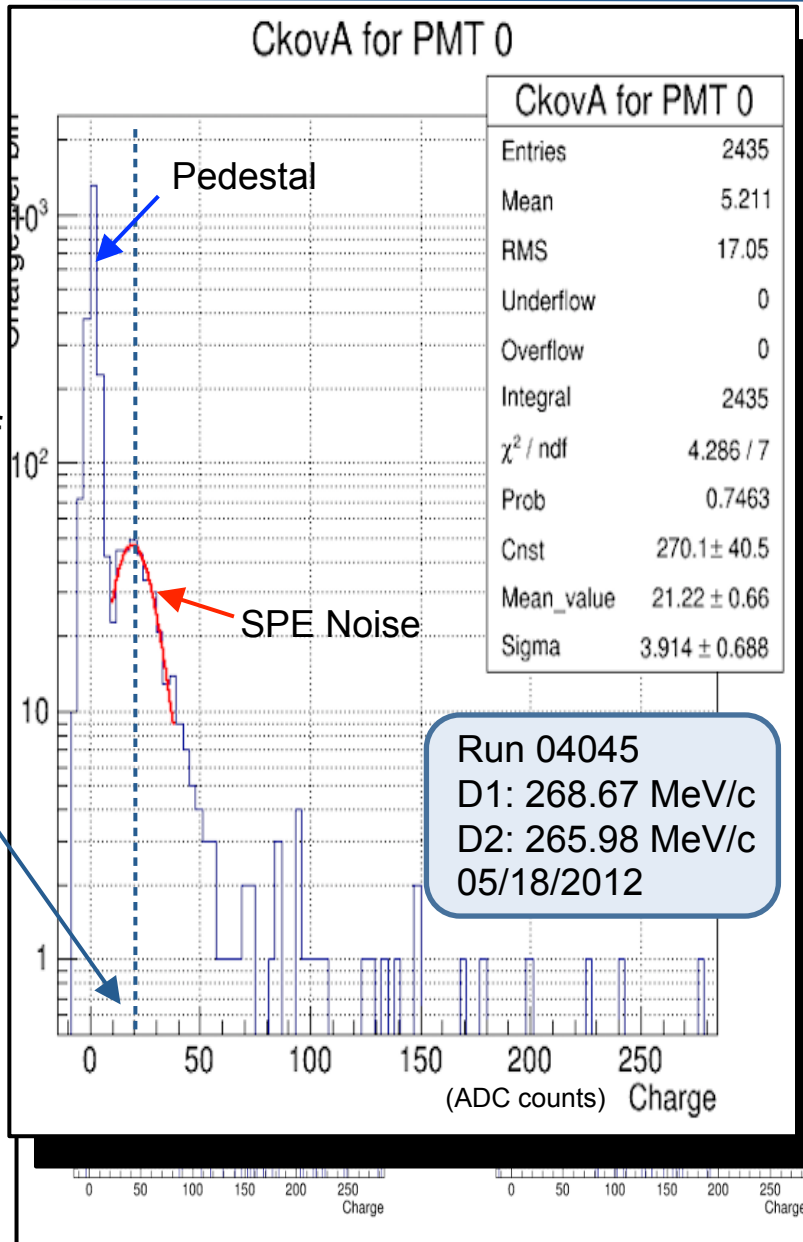
SPE Peak Fitting

-Pedestal subtracted, sub-threshold pion SPE peak. Fit* shown is of SPE noise

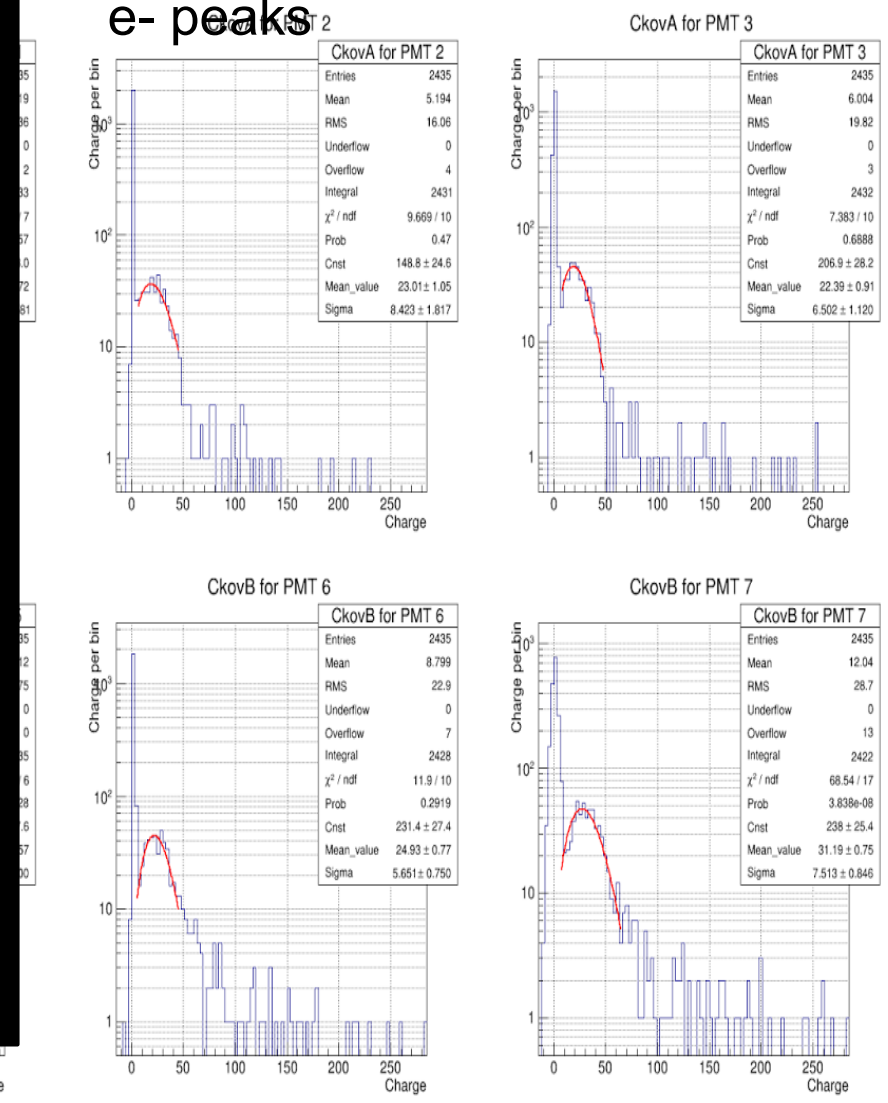
- True number of photoelectrons per pmt is given by:

$$n_{PE} = \frac{ADC}{amp./SPE \text{ constant}}$$

- SPE constant is currently set to 23.0 for all 8 PMTs



*Same procedure used for e+/
e- peaks

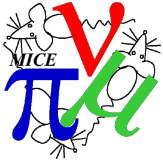




Analysis

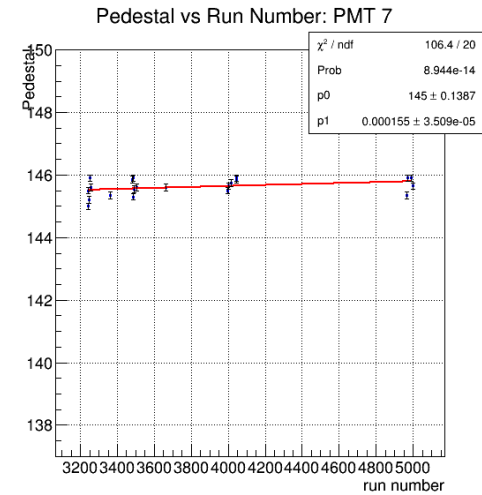
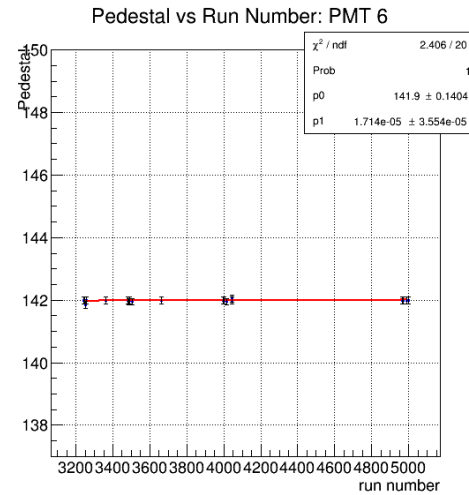
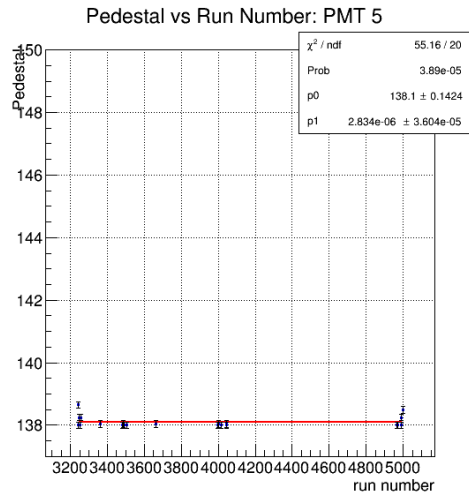
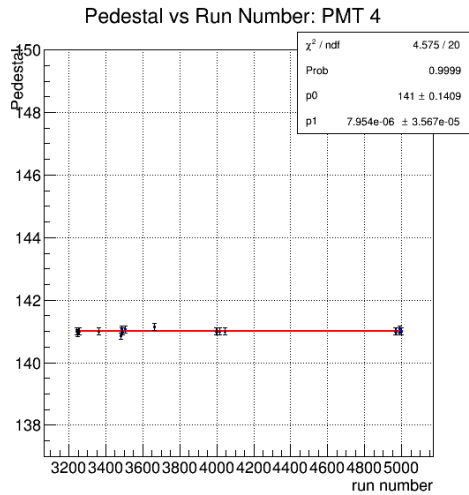
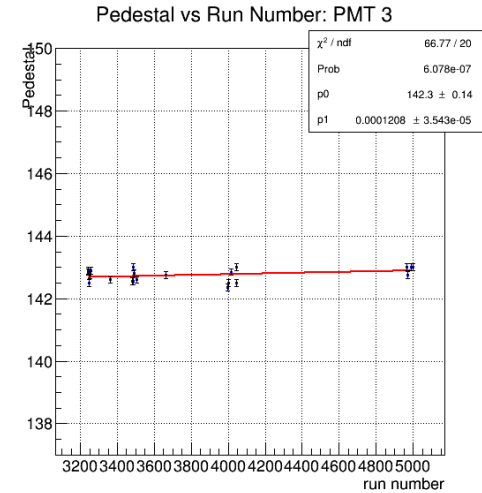
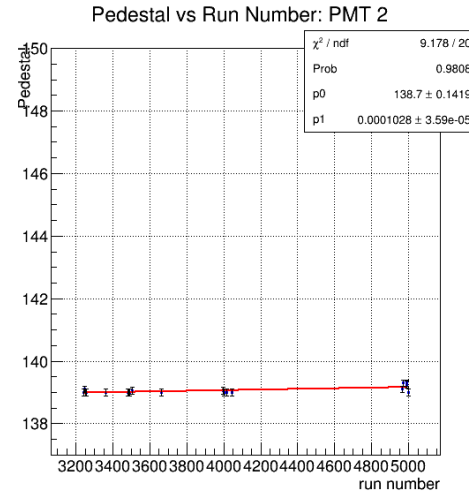
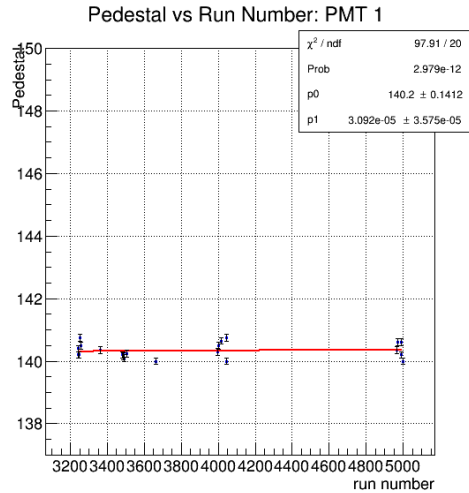
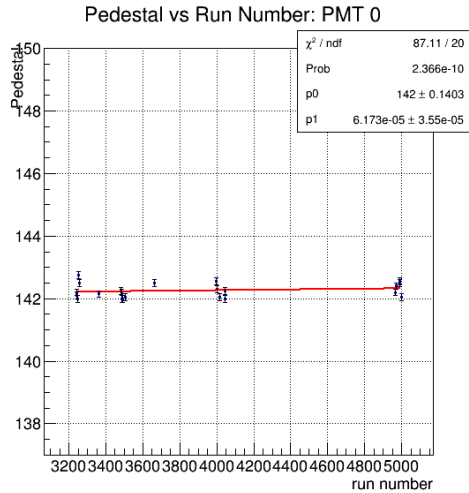
Goals:

- Perform reconstruction and analysis on a large number of electron (or positron) and low momentum pion runs.
- Create historical plots of the data. This includes analysis plotted against long term (monthly/yearly) and short term (daily) time frames.
- These plots will provide us with a $ckov$ baseline that can be used to estimate the accuracy of the calibration constant (mean value) of each PMT
- We not only want to determine the proper constants, but also whether or not the constants have any time dependence. This will allow us to more accurately estimate the correct number of photoelectrons per PMT.
- In addition, the results of this analysis will be used to determine whether or not the high and low voltage values of the PMTs at RAL need to be adjusted.



Pedestal Stability

Linear fit used: all slopes within error of zero



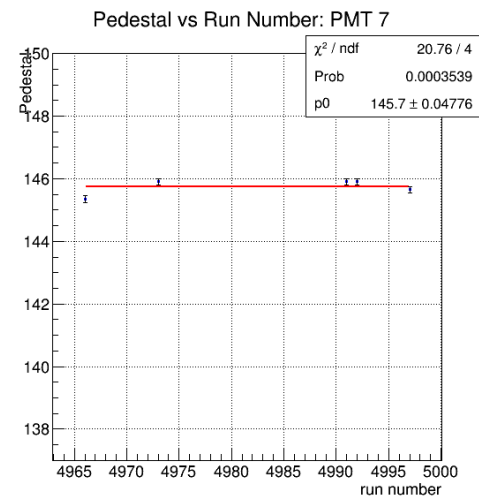
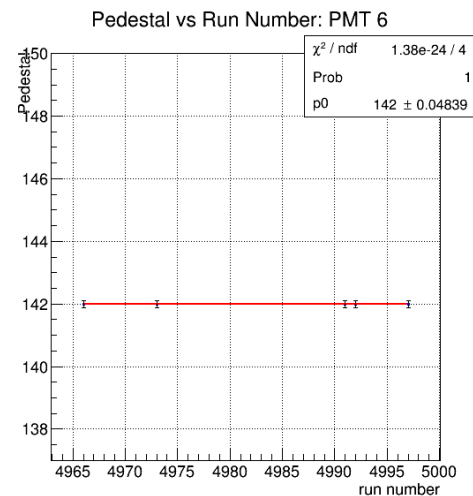
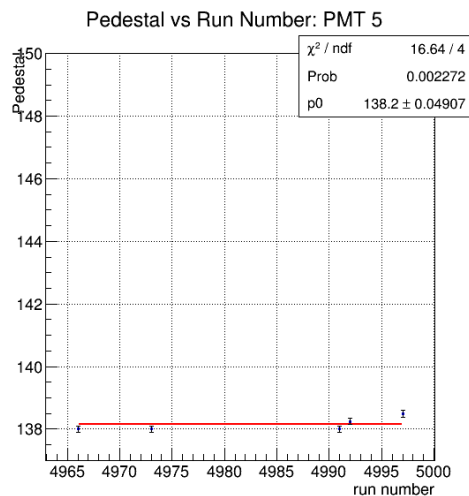
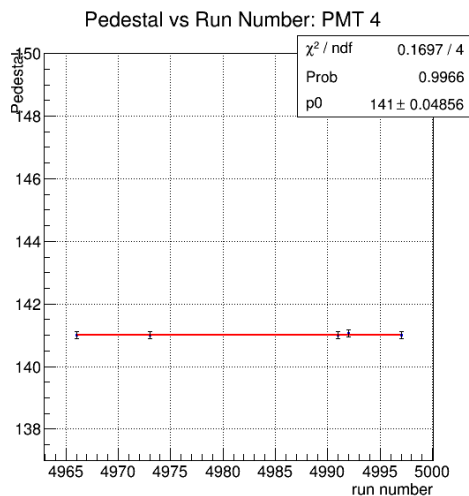
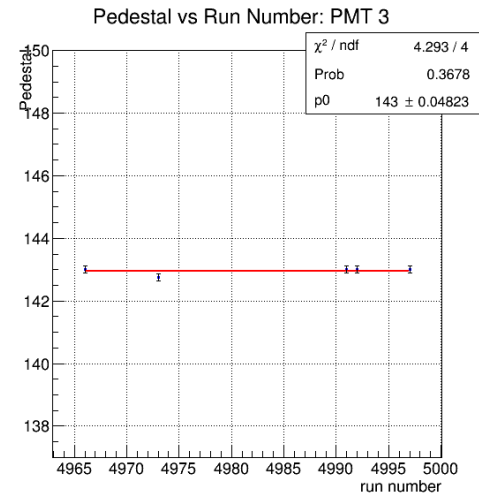
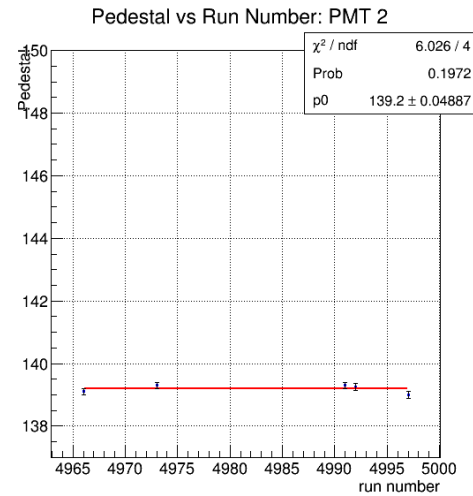
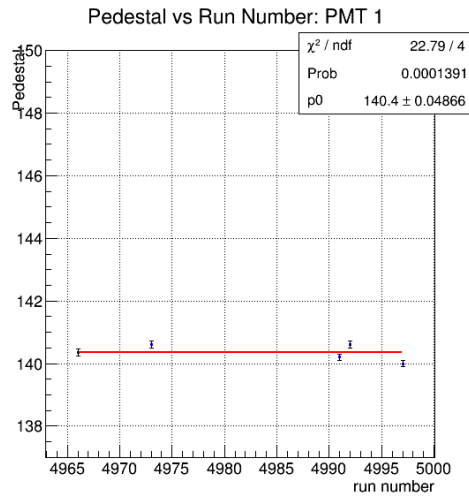
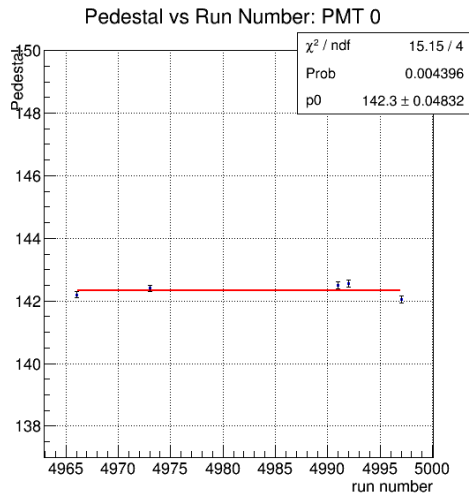
Runs Used: 22 runs ranging from Dec. 2011 – Aug. 2013

03240, 03243, 03245, 03251, 03255, 03364, 03483, 03487, 03488, 03489, 03503, 03661, 03999, 04000, 04018, 04045, 04046, 04966, 04973, 04991, 04992, 04997



Pedestal Stability

Most recent data (Aug. 2013): fit to a constant



Runs Used

Positron run: Aug. 3, 2013
 Runs 04996 & 04973
 D1 = 259.70, D2 = 249.58

Sub-thresh pion run: Aug. 5, 2013
 Runs 04991, 04492, & 04997
 D1 = 268.67, D2 = 265.98



Pedestal & HV Values

Most recent pedestal values for each PMT

<u>PMT</u>	<u>Ped.</u>	<u>Unc.</u>
0	142.3	0.05
1	140.4	0.05
2	139.2	0.05
3	143.0	0.05
4	141.0	0.05
5	138.2	0.05
6	142.0	0.05
7	145.7	0.05

Bad channel in PMT3 (ckova 4); module replaced

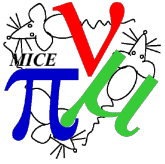
CKOV HV Settings L. Cremaldi/L.Coney 05/12/2011

HV Settings for the MICE CKOV detectors

- as determined from eLog entry #1726.
- Note: ckova4 was a bad channel on the HV module – this was in June 2011 and the module was replaced. New module should be fine.

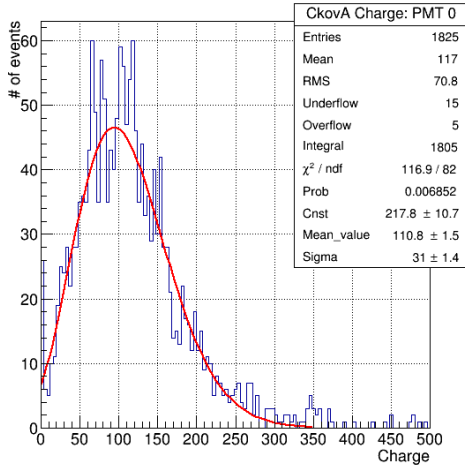
CAEN	channel	HV set	I thr	Iread
CKOVa 1	24	+1610	2mA	817 uA
CKOVa 2	25	+1520	2mA	746
CKOVa 3	26	+1570	2mA	785
CKOVa 4	27	+1625	2mA	4 (bad channel)
CKOVb 1	28	+1540	2mA	770
CKOVb 2	29	+1590	2mA	796
CKOVb 3	30	+1540	2mA	759
CKOVb 4	31	+1495	2mA	739

Values based on 2013 runs only: 04966, 04973, 04991, 04992, & 04997

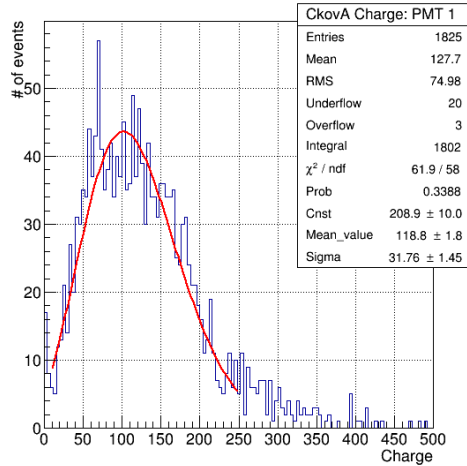


Positron Peaks: Run 04992

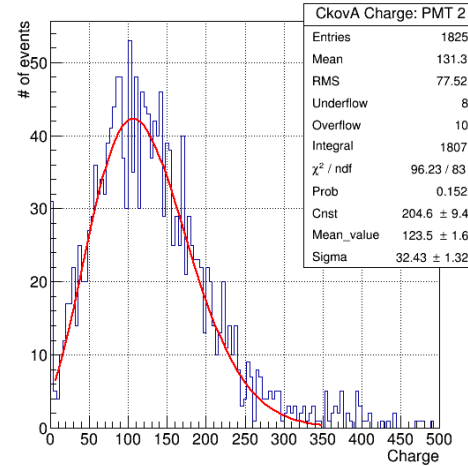
CkovA Charge: PMT 0



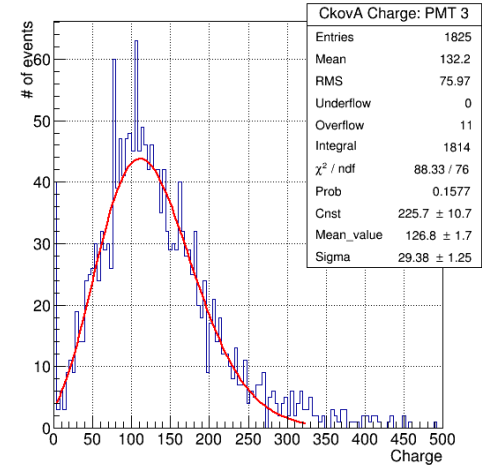
CkovA Charge: PMT 1



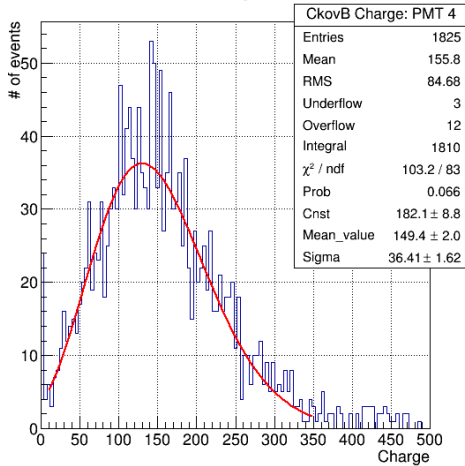
CkovA Charge: PMT 2



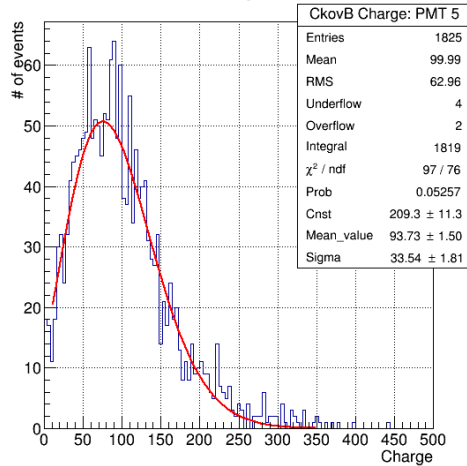
CkovA Charge: PMT 3



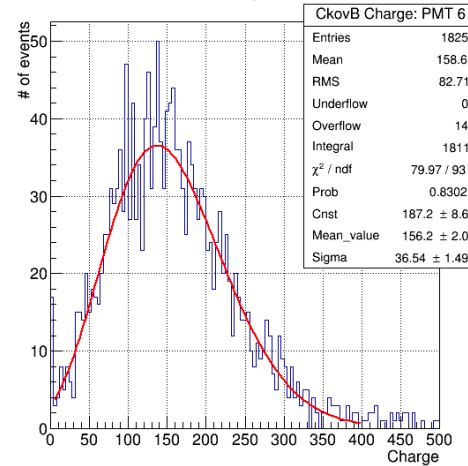
CkovB Charge: PMT 4



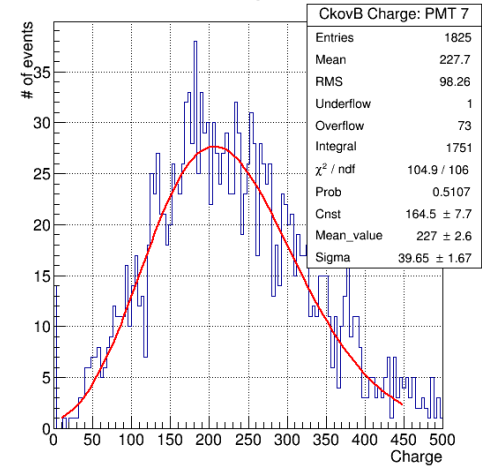
CkovB Charge: PMT 5



CkovB Charge: PMT 6



CkovB Charge: PMT 7

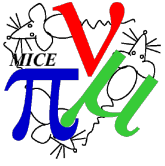


Run Used

Sub-thresh pion run

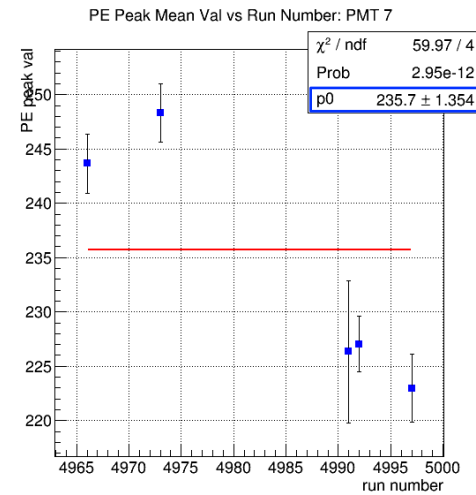
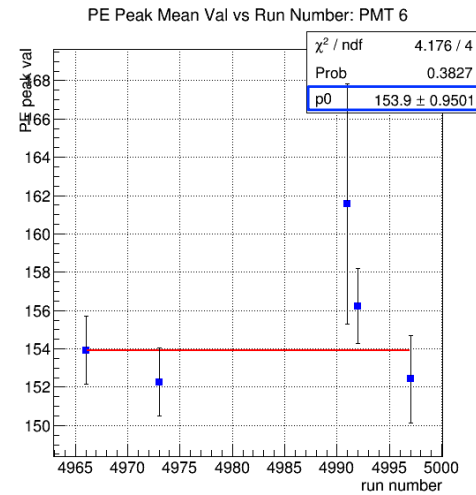
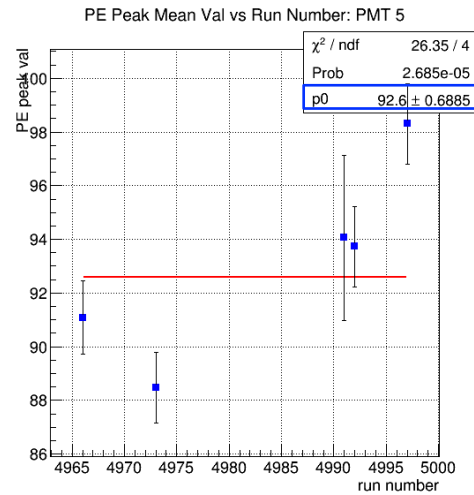
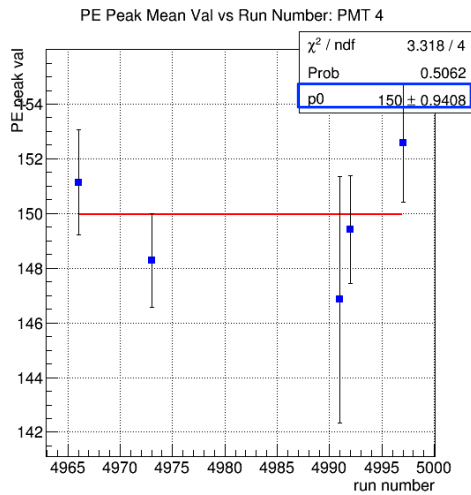
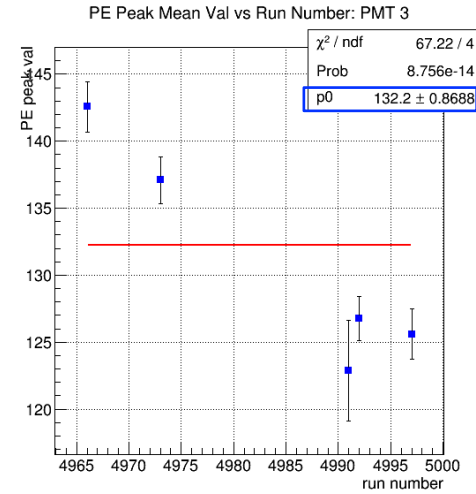
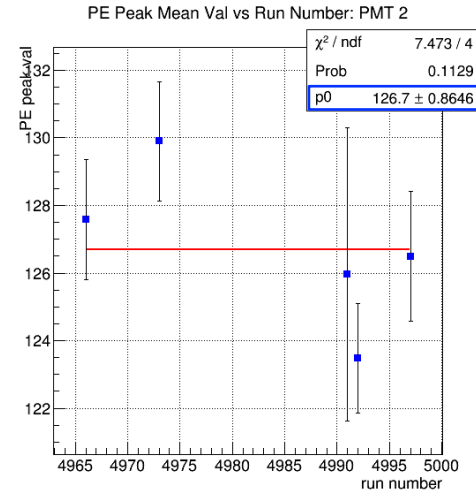
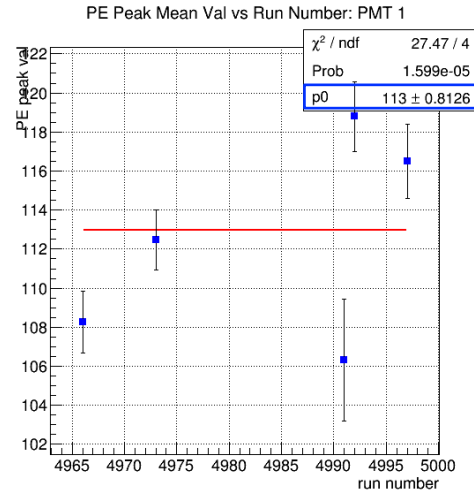
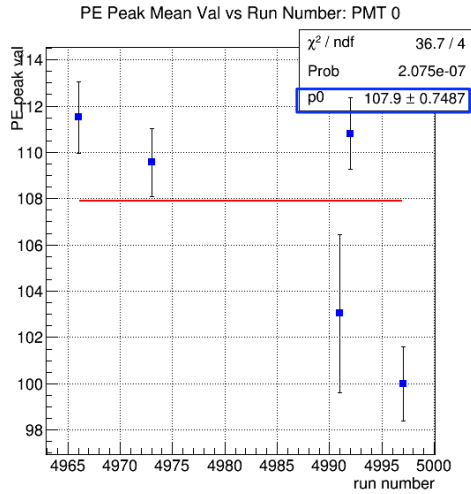
Aug. 5, 2013

D1 = 268.67, D2 = 265.98



Stability: Positron Peaks

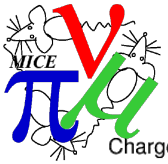
Zeroth order polynomial fit used: estimated value is in blue box



Runs Used

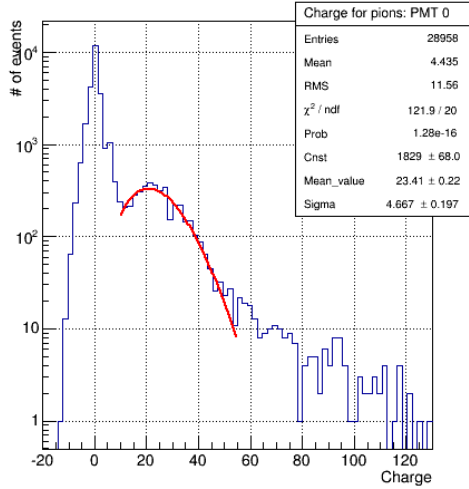
Positron run: Aug. 3, 2013
 Runs 04996 & 04973
 D1 = 259.70, D2 = 249.58

Sub-thresh pion run: Aug. 5, 2013
 Runs 04991, 04492, & 04997
 D1 = 268.67, D2 = 265.98

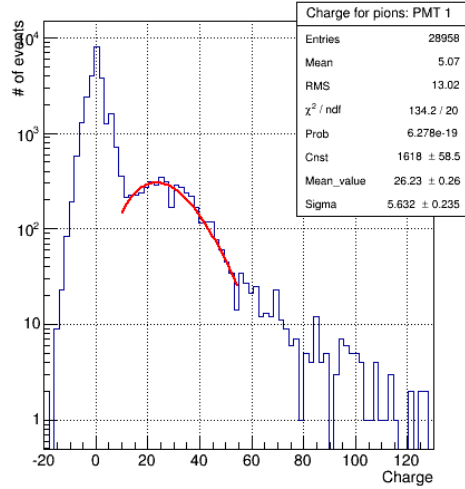


Stability: SPE Peaks

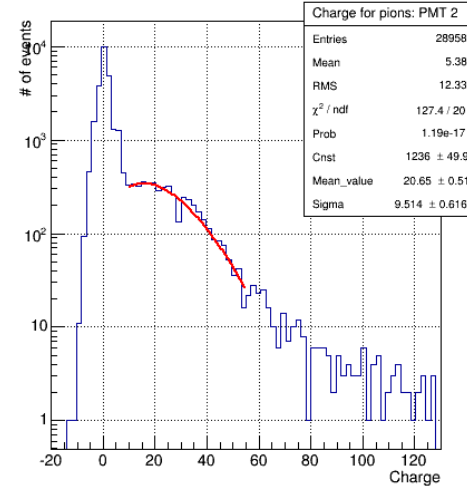
Charge for pions: PMT 0



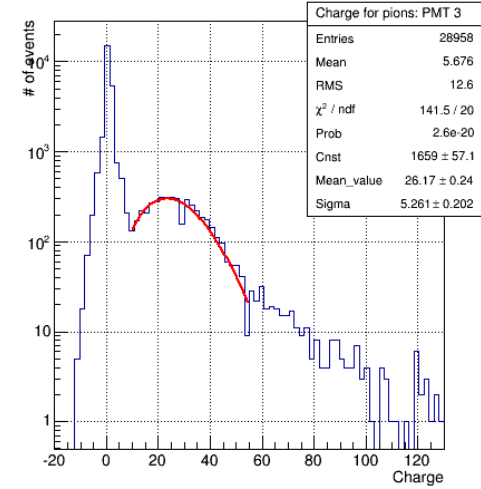
Charge for pions: PMT 1



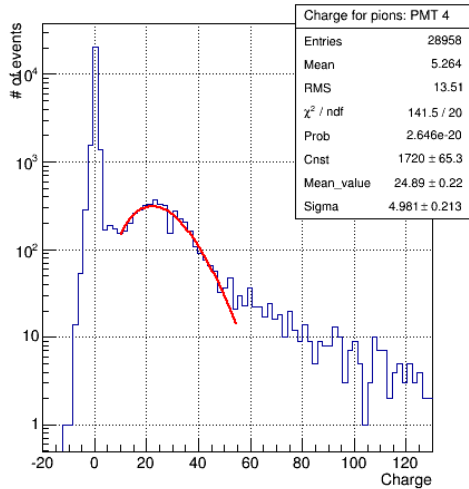
Charge for pions: PMT 2



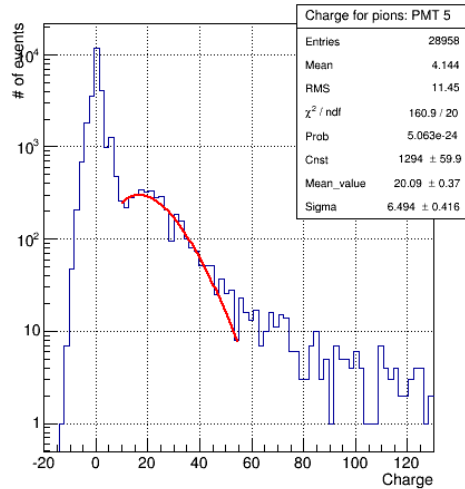
Charge for pions: PMT 3



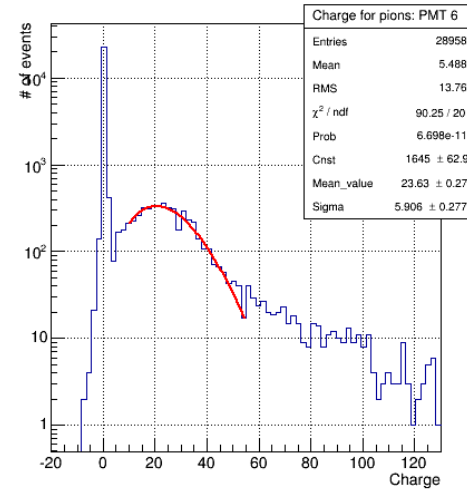
Charge for pions: PMT 4



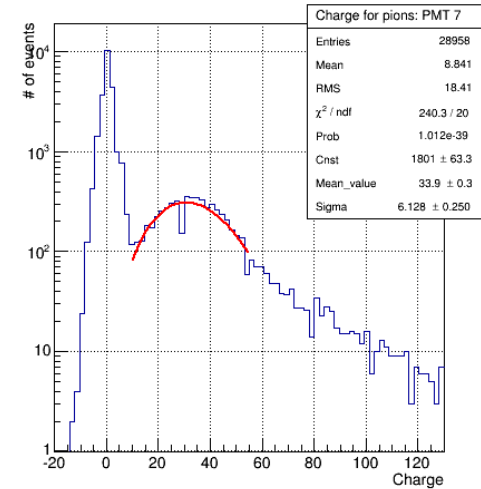
Charge for pions: PMT 5



Charge for pions: PMT 6



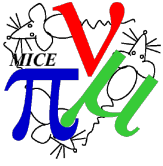
Charge for pions: PMT 7



Runs Used

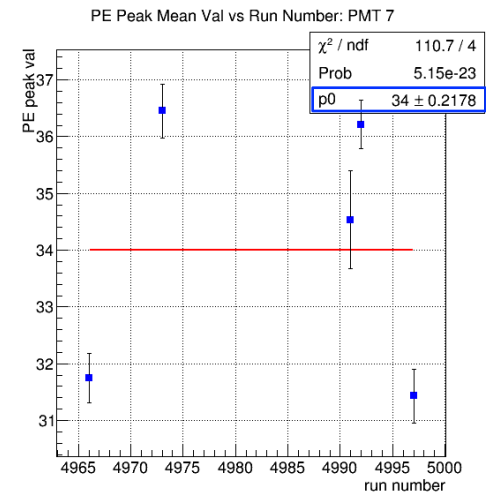
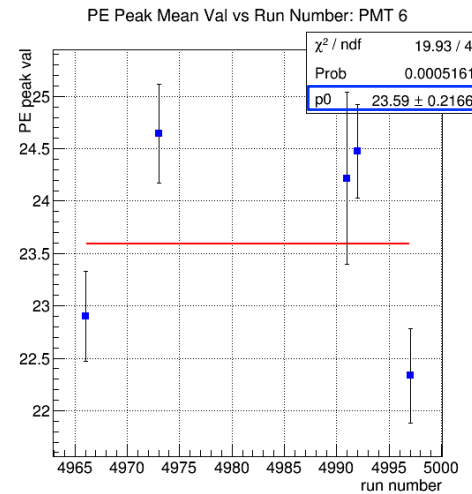
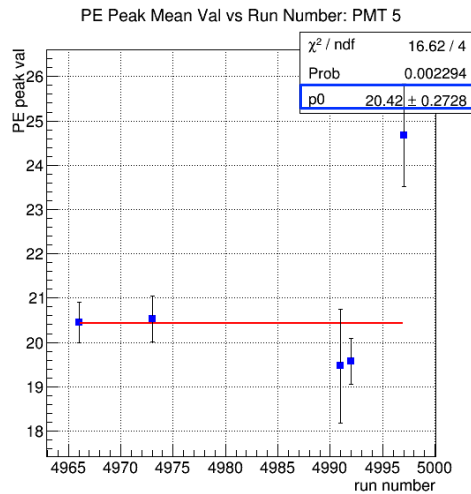
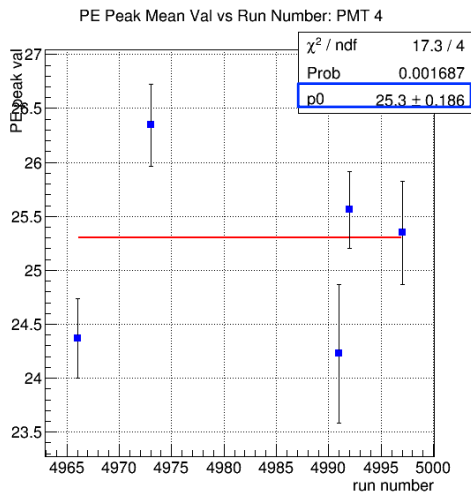
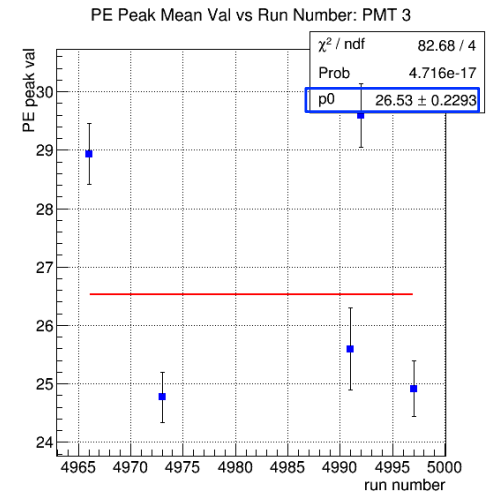
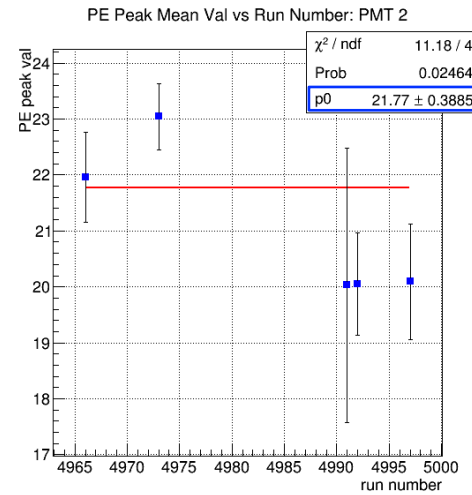
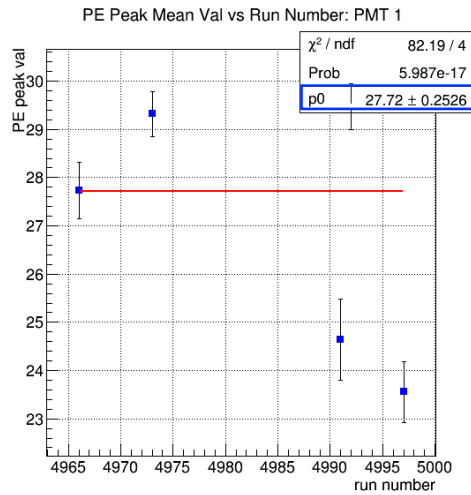
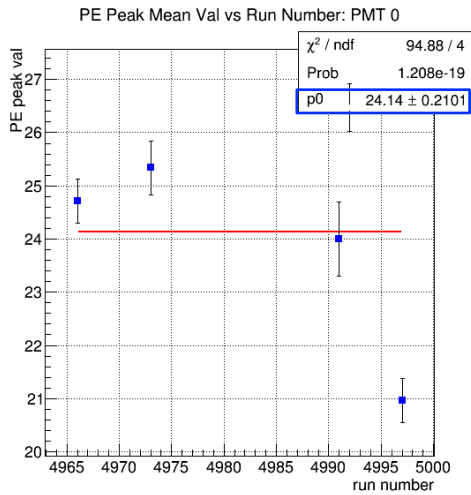
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 D1 = 259.70, D2 = 249.58

Sub-thresh pion run: Aug. 5, 2013
 Runs 04991, 04492, & 04997
 D1 = 268.67, D2 = 265.98



Stability: SPE Peaks

mean charge vs run number: fit to a constant



Runs Used

Positron run: Aug. 3, 2013
 Runs 04996 & 04973
 D1 = 259.70, D2 = 249.58

Sub-thresh pion run: Aug. 5, 2013
 Runs 04991, 04492, & 04997
 D1 = 268.67, D2 = 265.98



Calibration Constants

	<u>May</u> <u>2012</u>		<u>Aug.</u> <u>2013</u>		<u>May</u> <u>2012</u>		<u>Aug.</u> <u>2013</u>		<u>Aug.</u> <u>2013</u>	
<u>PMT</u>	<u>SPE</u>	<u>Unc.</u>	<u>SPE</u>	<u>Unc.</u>	<u>e+/e-</u>	<u>Unc.</u>	<u>e+/e-</u>	<u>Unc.</u>	<u>PED.</u>	<u>Unc.</u>
0	21.4	0.3	24.1	0.2	86.4	1.0	107.9	0.7	142.3	0.05
1	25.5	0.3	27.7	0.3	86.8	1.0	113.0	0.8	140.4	0.05
2	19.3	0.8	21.8	0.3	98.2	1.1	126.7	0.9	139.2	0.05
3	26.8	0.3	26.5	0.2	120.5	1.2	132.2	0.9	143.0	0.05
4	29.7	0.3	25.3	0.2	154.3	1.4	150.0	0.9	141.0	0.05
5	18.4	0.5	20.4	0.3	84.66	0.9	92.6	0.7	138.2	0.05
6	23.8	0.3	23.6	0.2	153.1	1.4	153.9	0.9	142.0	0.05
7	30.7	0.3	34.0	0.2	238.8	1.9	235.7	1.4	145.7	0.05

May 2012: 03999, 04000, 04018, 04045, & 04046

Aug. 2013: 04966, 04973, 04991, 04992, & 04997

Summary & Plans

- Overall the Ckov seems to be behaving reasonably
- In progress
 - Understand fits and fluctuations
 - Update reconstruction to use new calibrations
 - Understand efficiency using electrons/positrons
 - Understand noise
- The primary analysis goal is to study high momentum muon runs & see if we can identify pions that decayed after the Ckov
- Monte Carlo
 - The geometry description has been rewritten
 - Still need to add hit collection code for the sensitive detectors
 - Add digitizer
 - Lucien and his student have started working on the above