TPC PID Update

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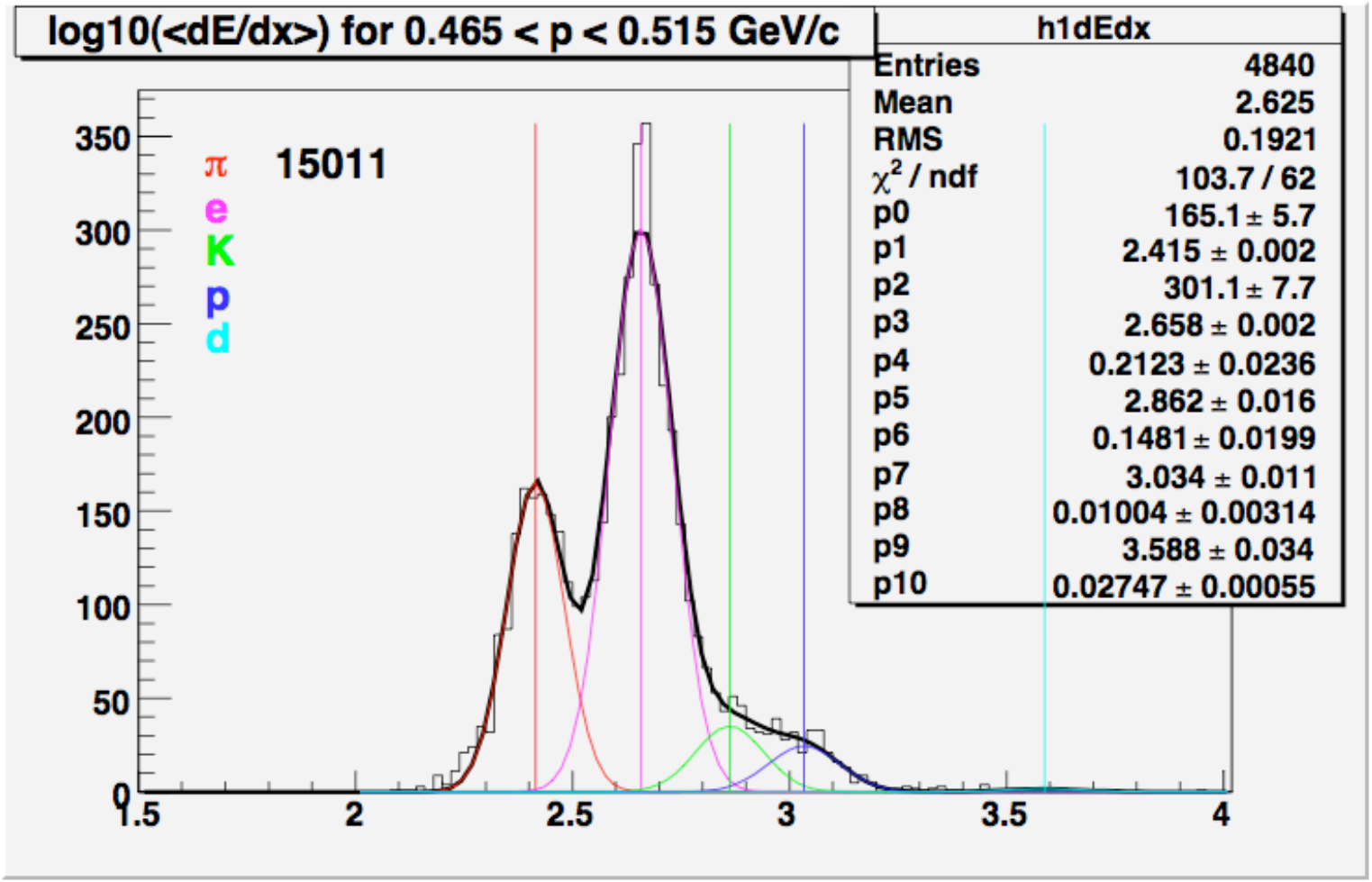
07-Jun-2007

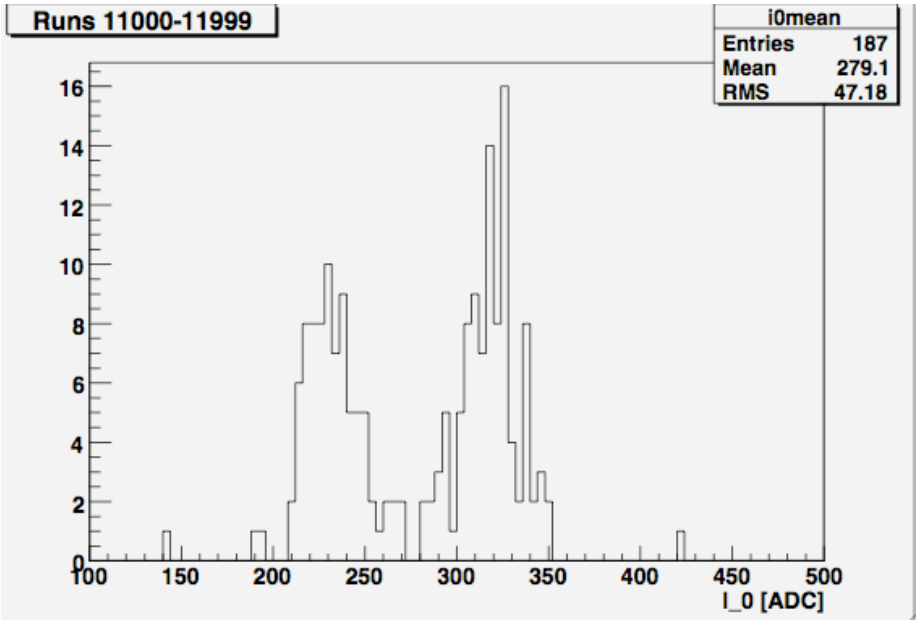
To-do list from 07-Dec-2006

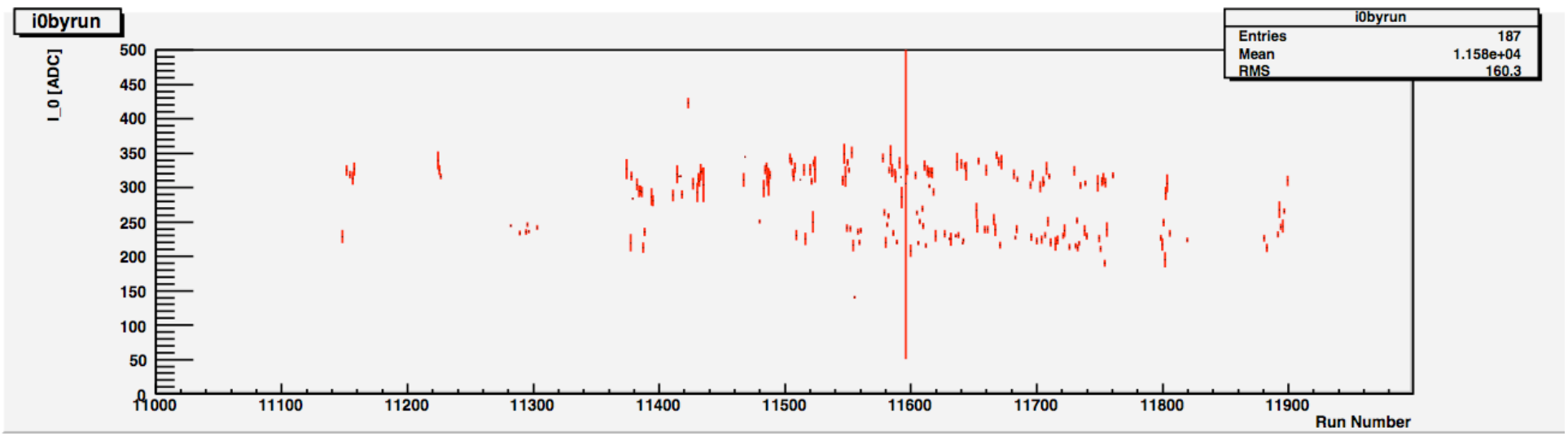
- ✓ 1. dE/dx truncation parameter optimization
- ✓ 2. Normalize all dE/dx to I_0 - minimum ionizing
- ✓ 4. Bethe-Bloch parameter determination
- ✓ 3. Nhits ↔ resolution study
- ✓ 5. PID probabilities

I_0 fit example

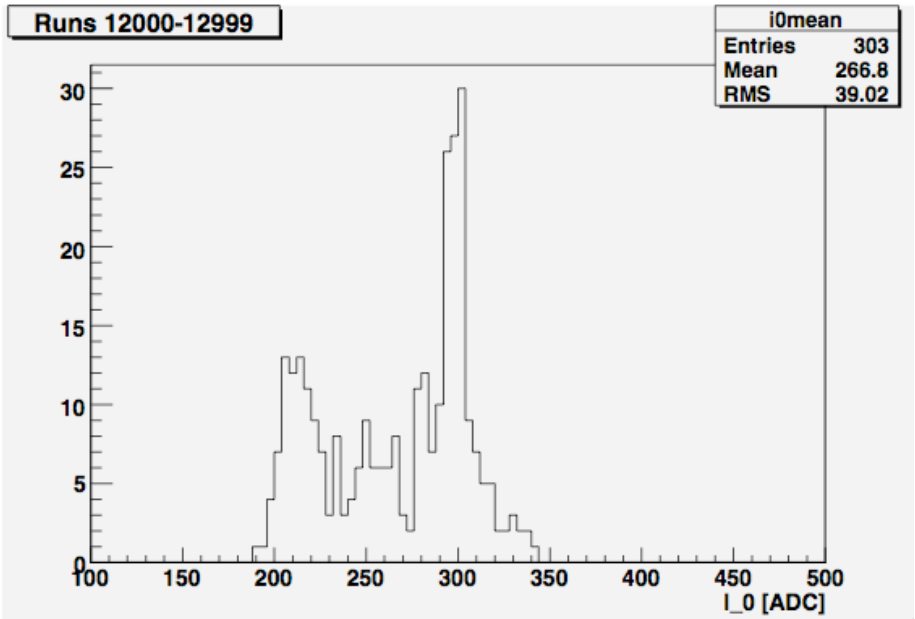


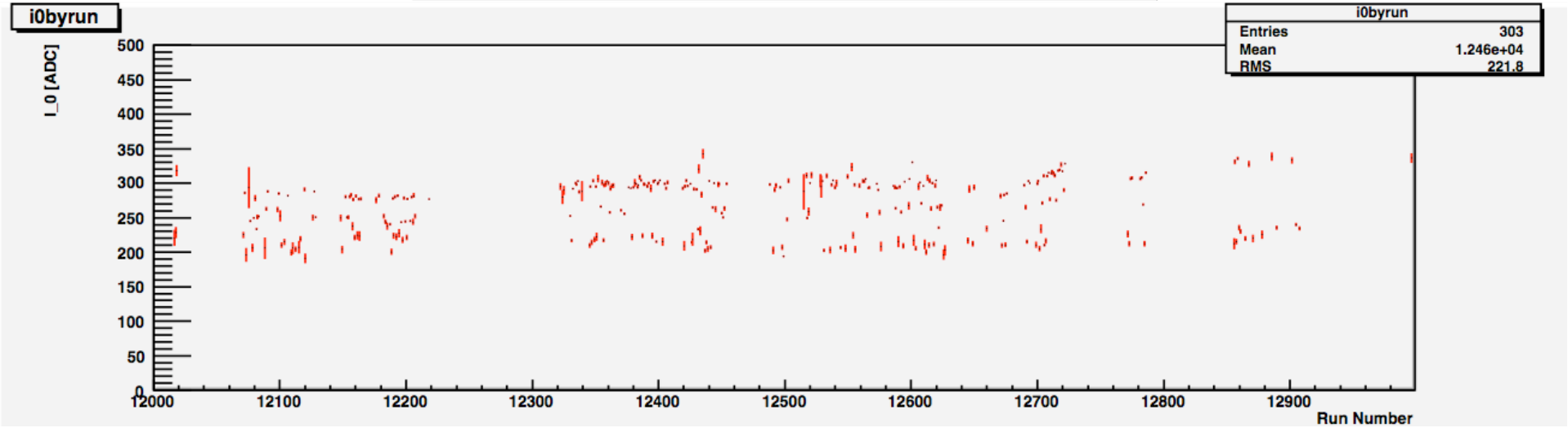
I_0 vs. run (11000-11999)



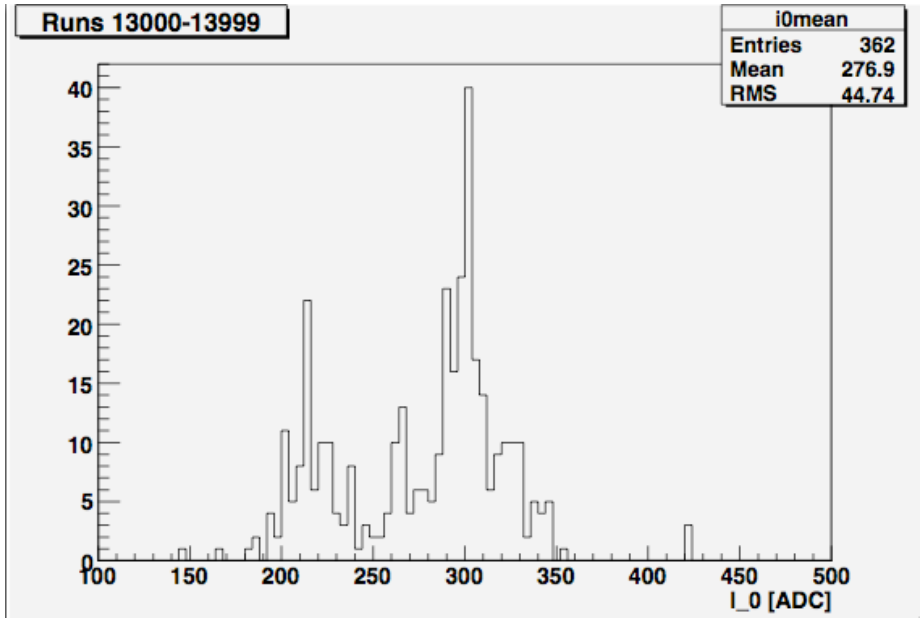


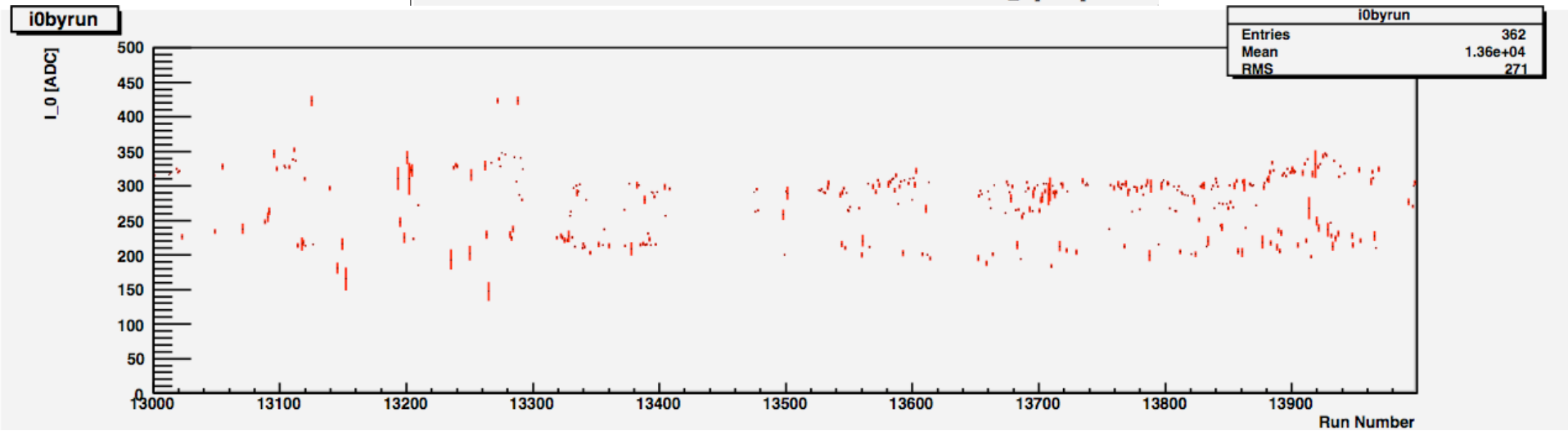
I_0 vs. run (12000-12999)



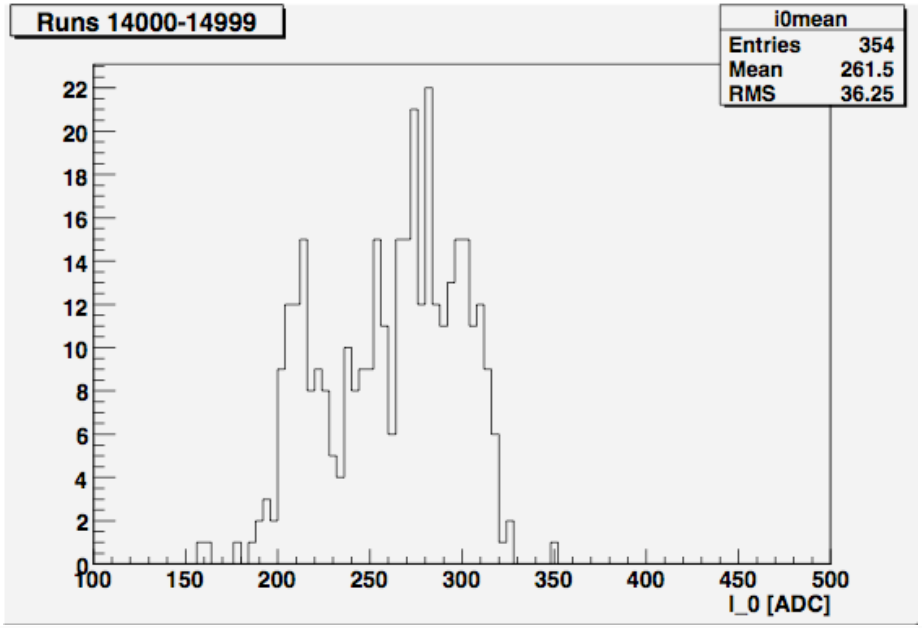


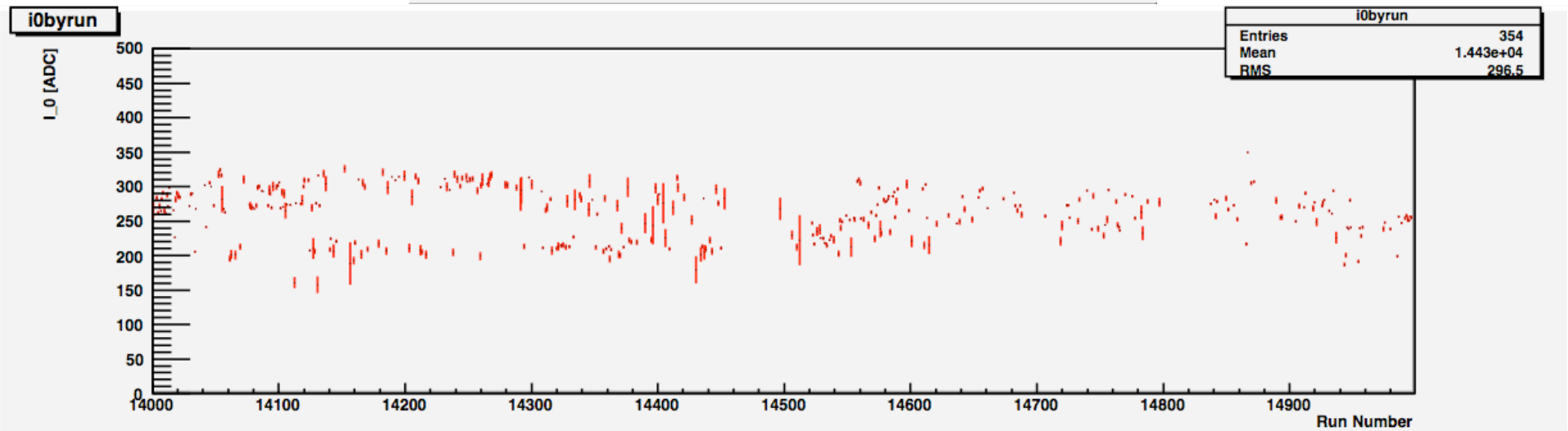
I_0 vs. run (13000-13999)



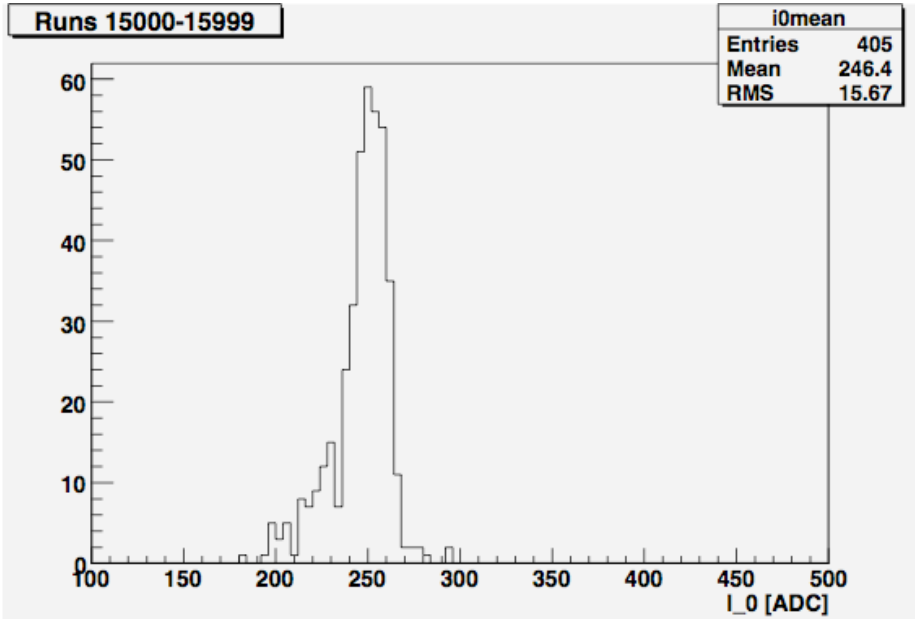


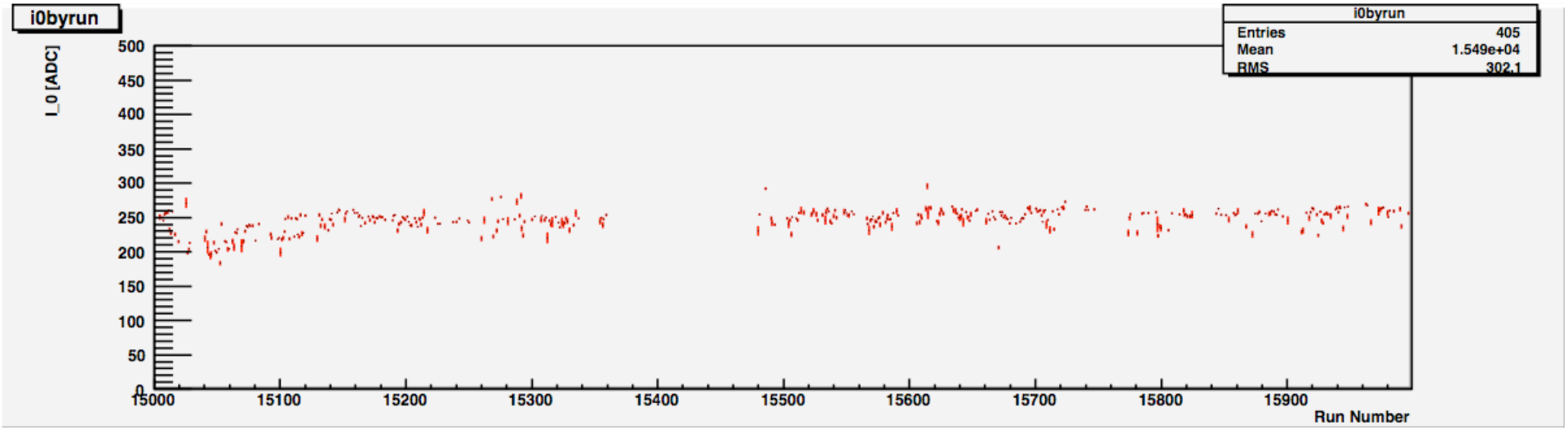
I_0 vs. run (14000-14999)



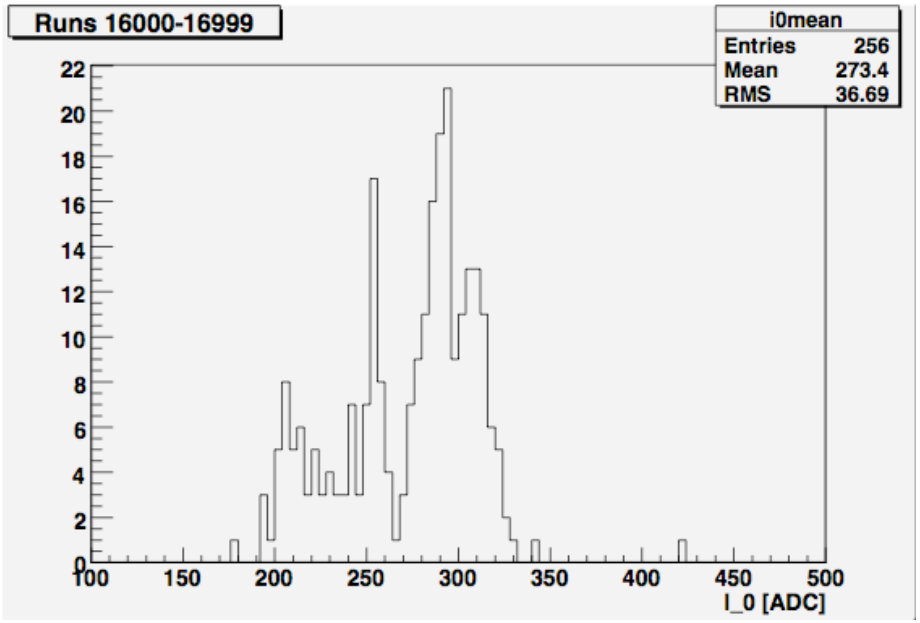


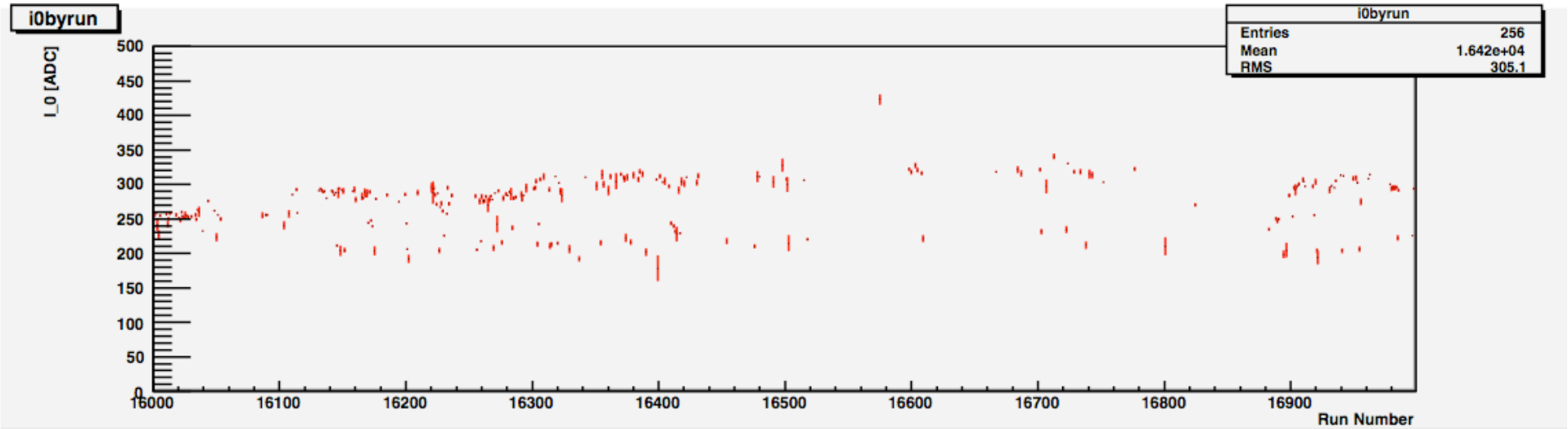
I_0 vs. run (15000-15999)



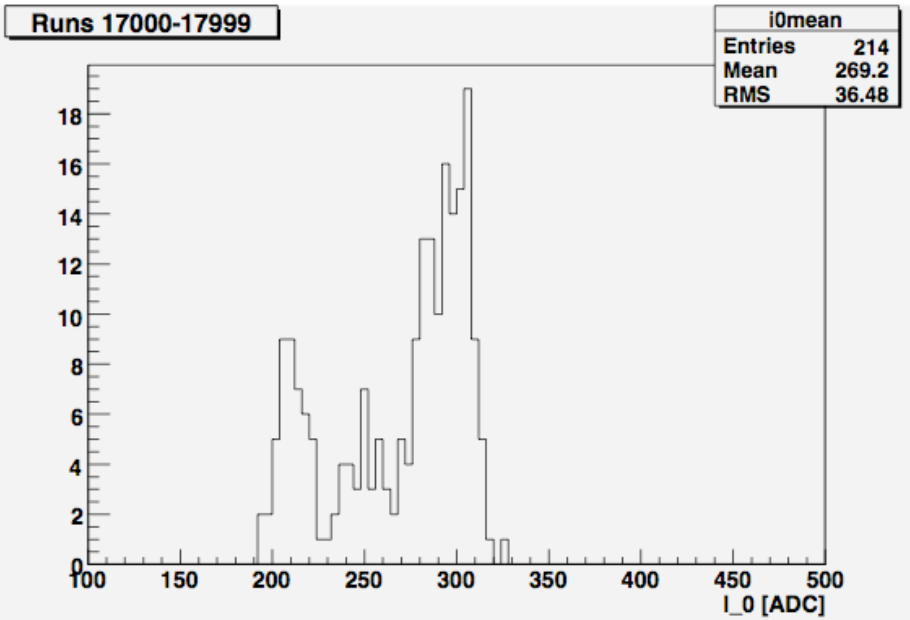


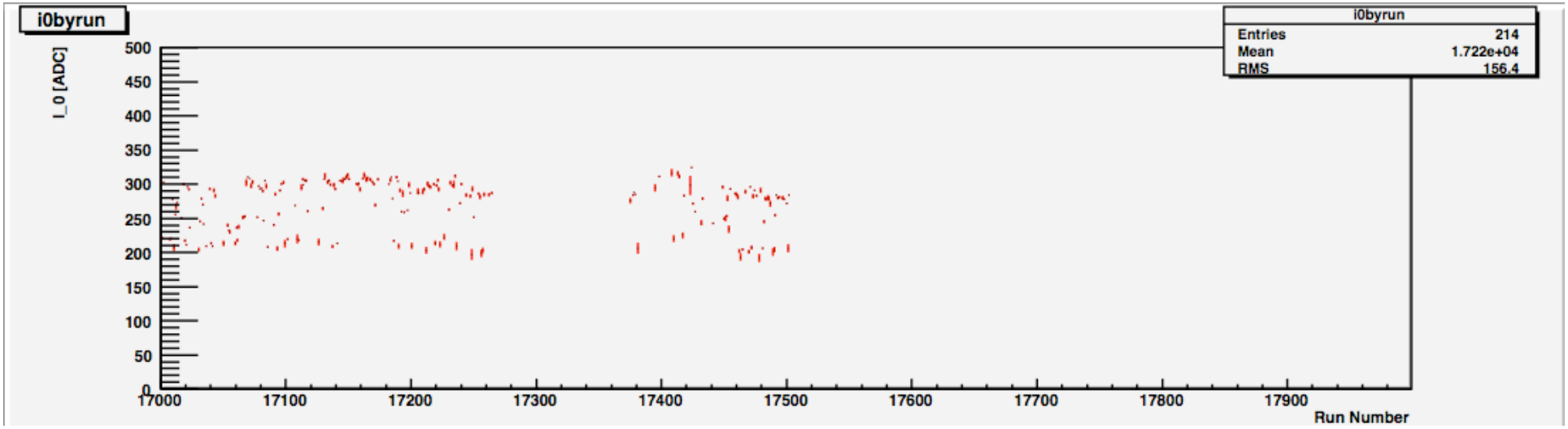
I_0 vs. run (16000-16999)





I_0 vs. run (17000-17999)



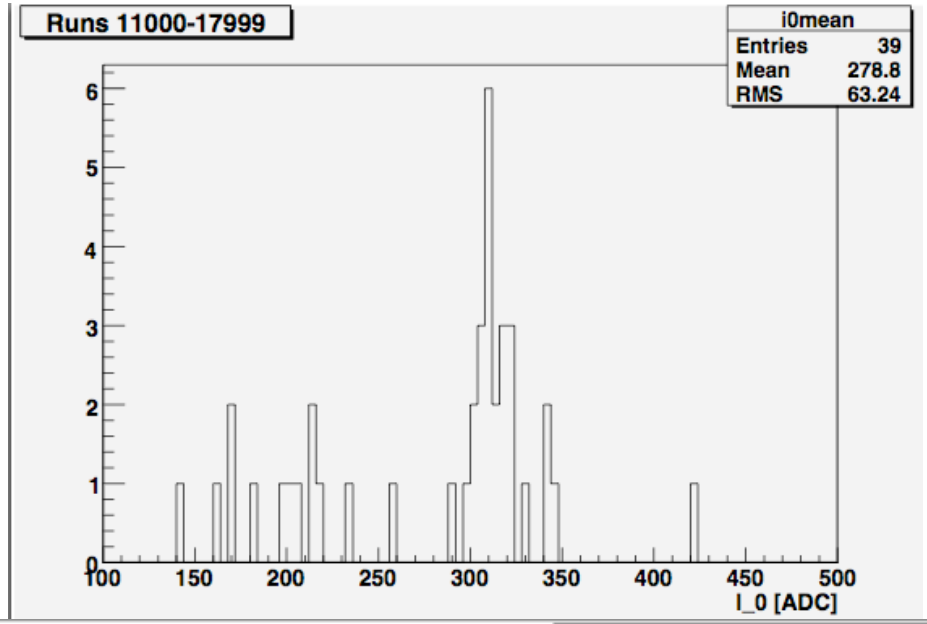


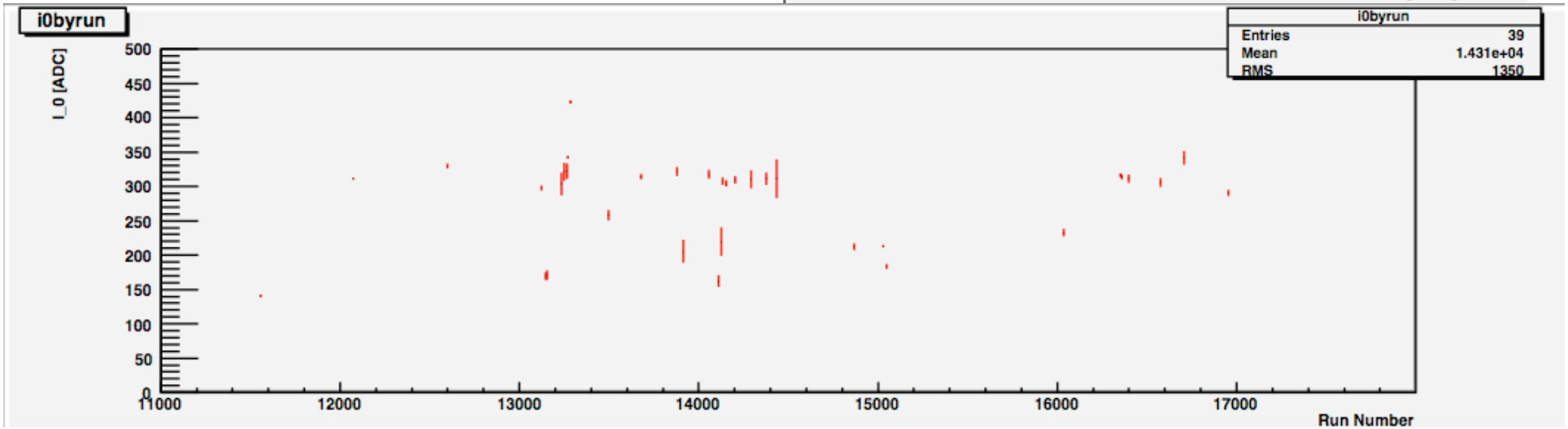
I_0 hand scan

Any runs where histo->Entries() < 100 was thrown out

Of ~2082 runs left, I went by hand through each fit and found 39 that needed to be refit.

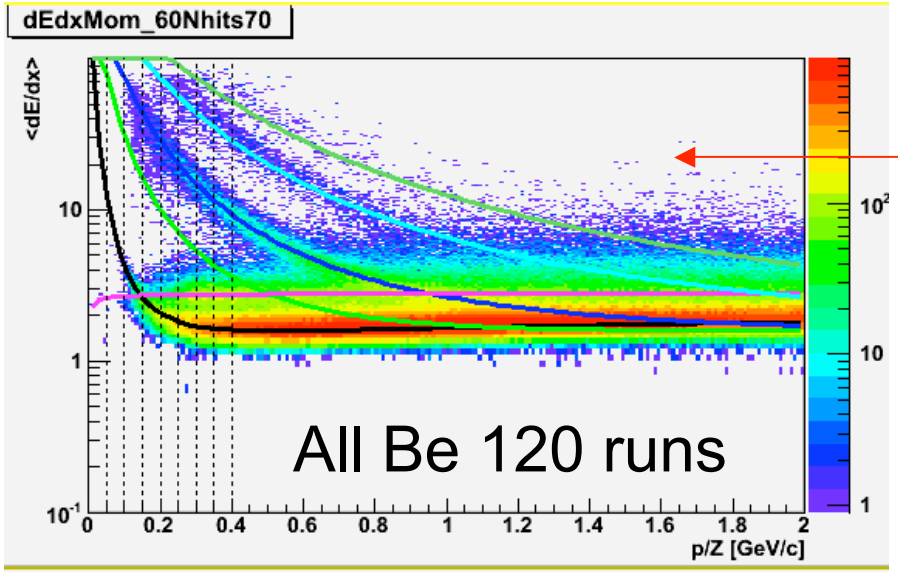
Ended up with 2039 good I_0 results that went into the db (mdbCompleteRSR was run to fill out the rest)

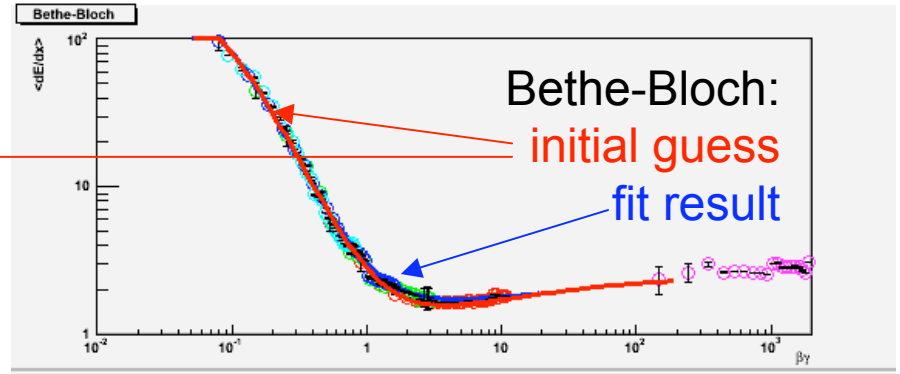


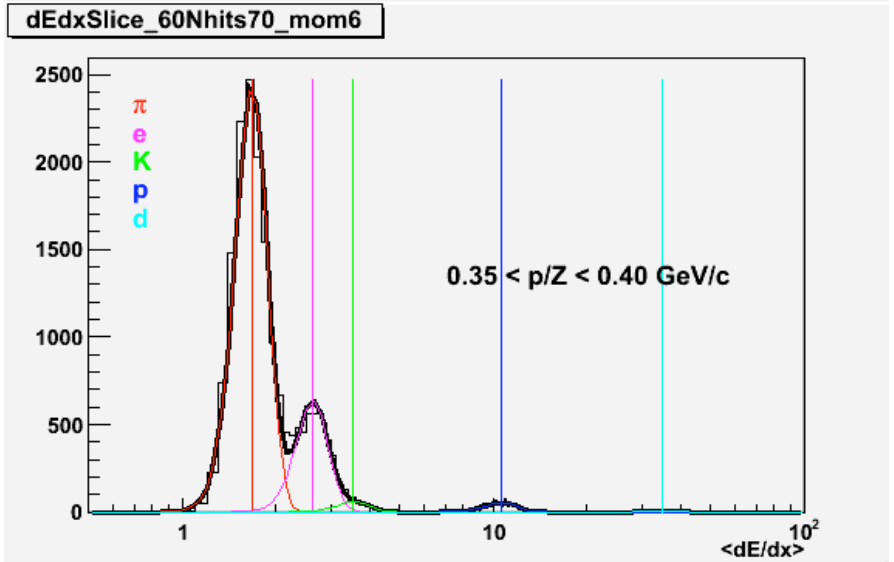


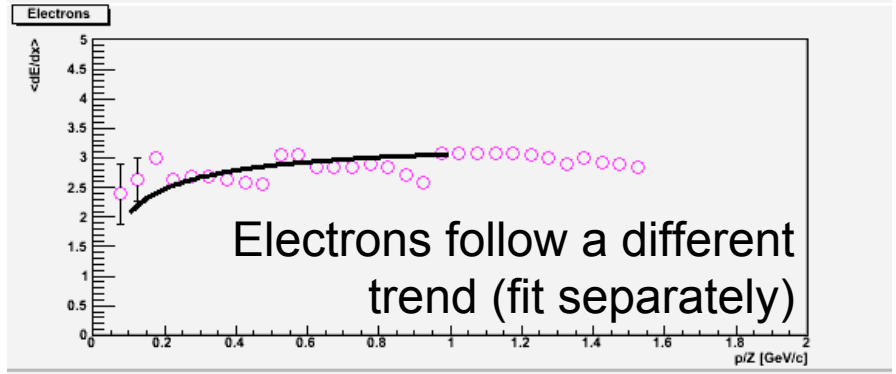
Bethe-Bloch: Beryllium 120

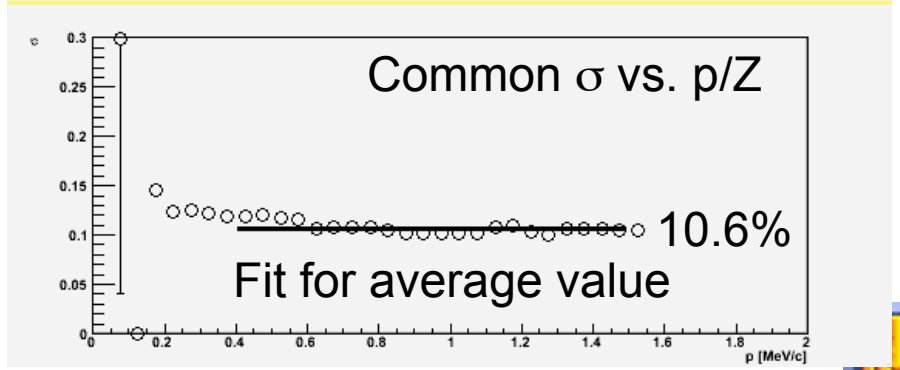
Auto-updating canvases as fitBBloch.C fits each 50 MeV/c bin from 0-1.55 GeV/c



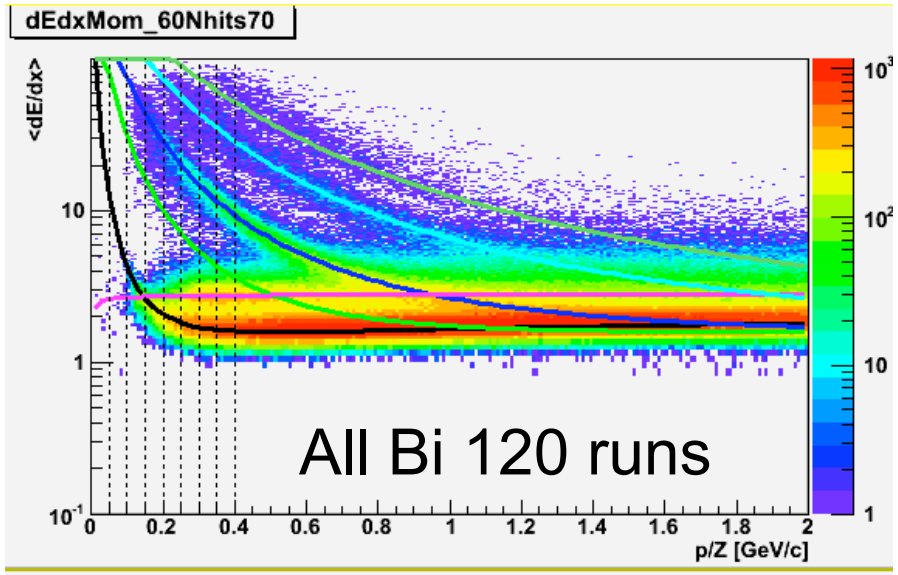


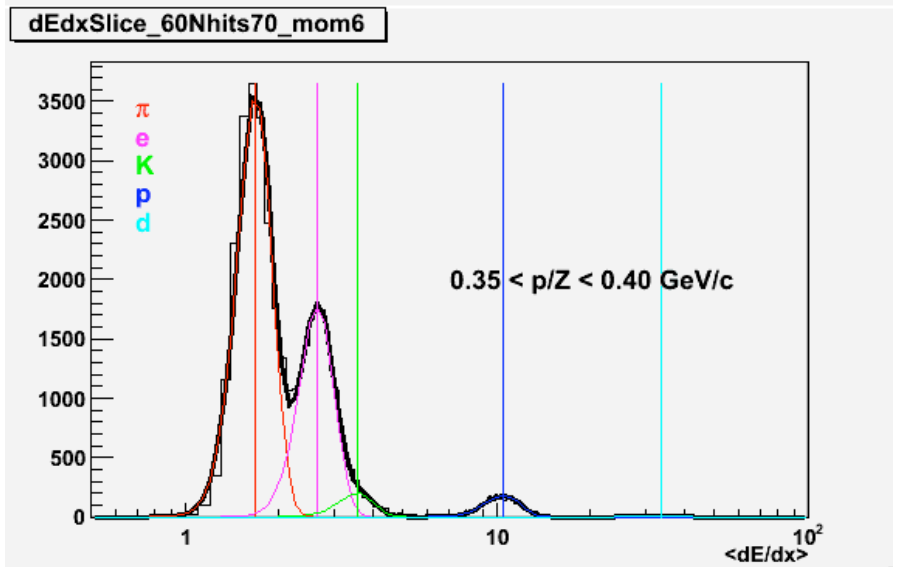


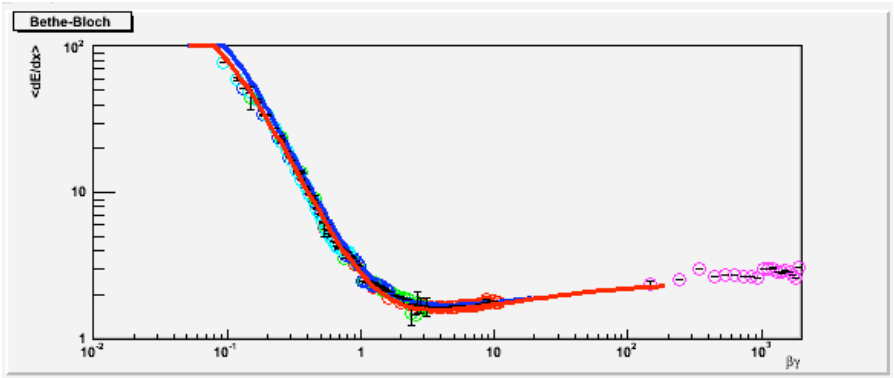


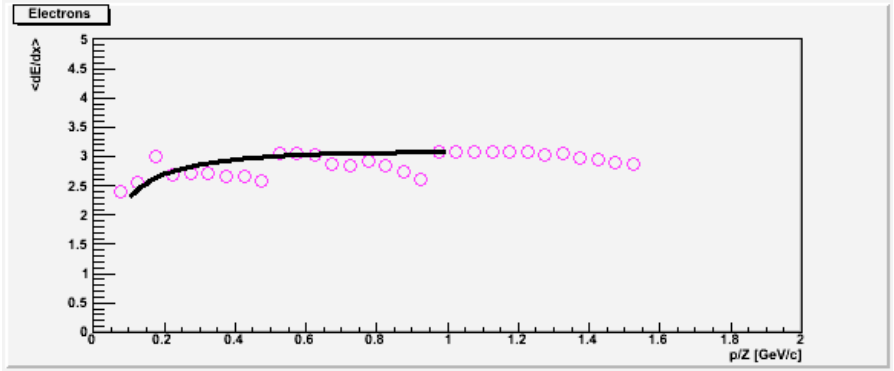


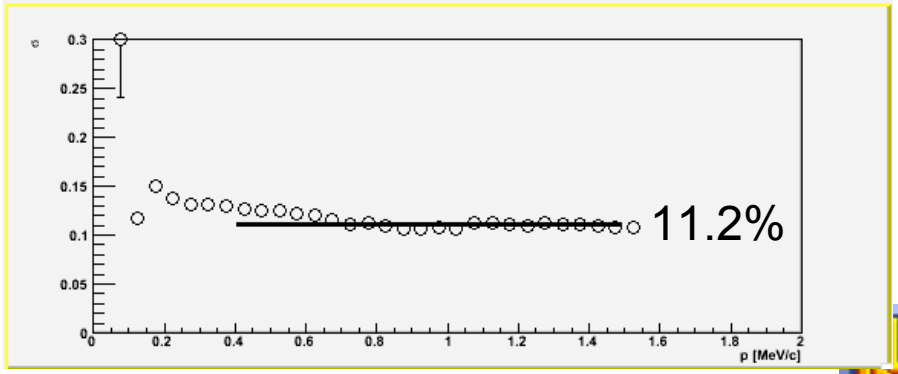
Bethe-Bloch: Bismuth 120



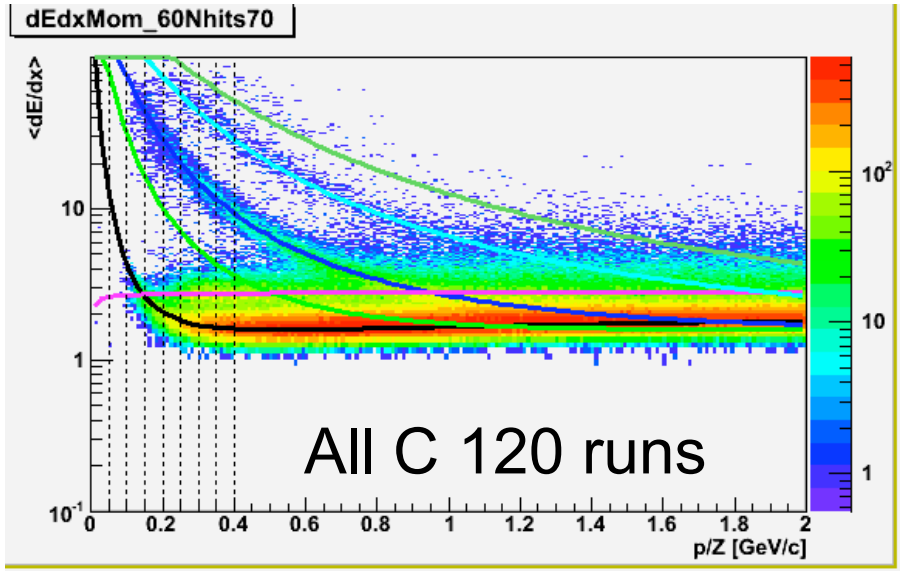


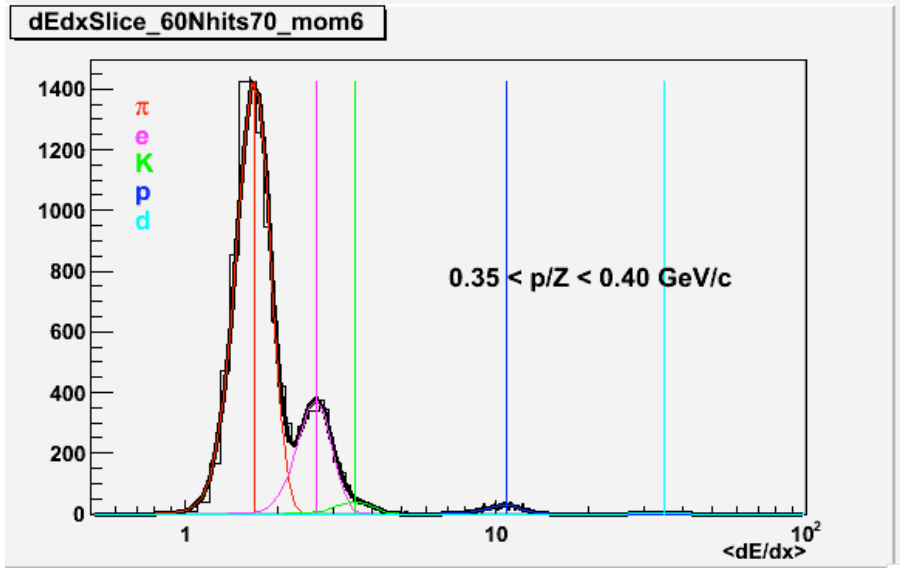


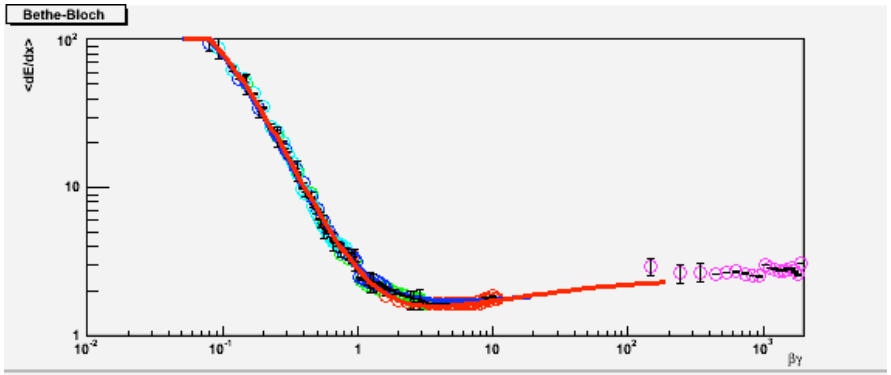


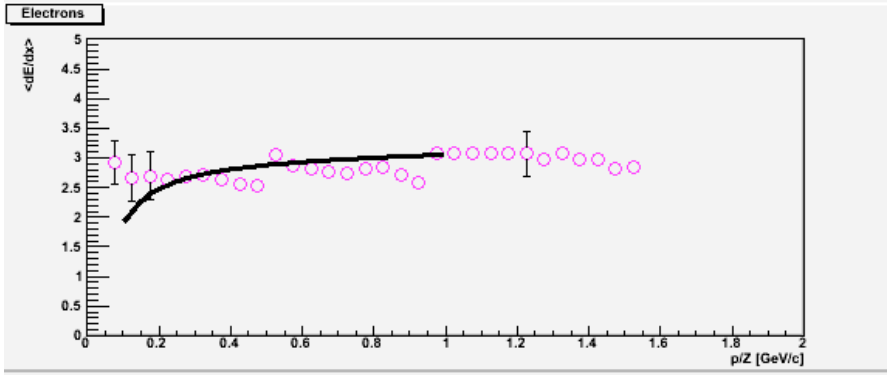


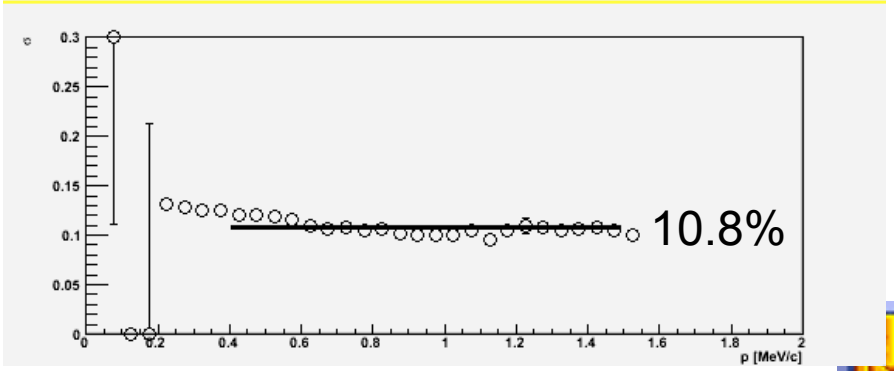
Bethe-Bloch: Carbon 120



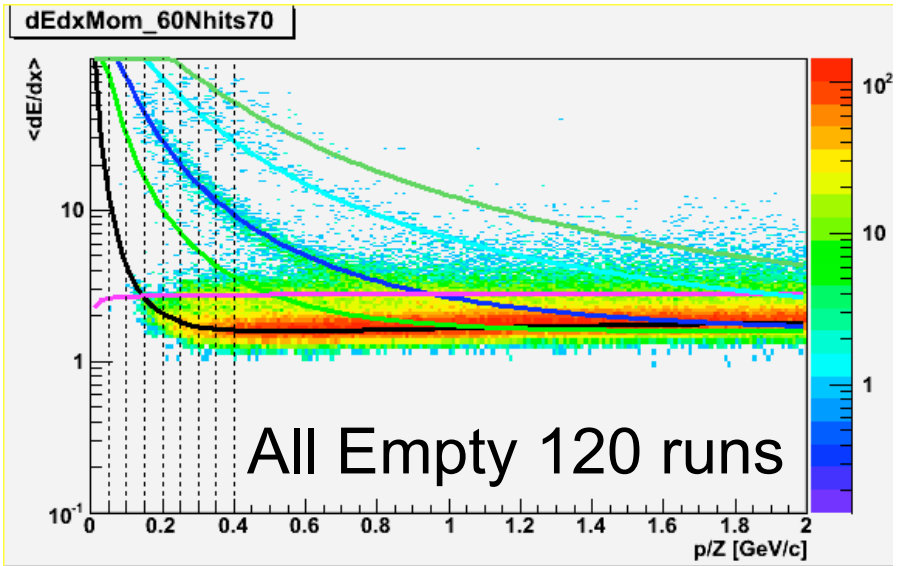


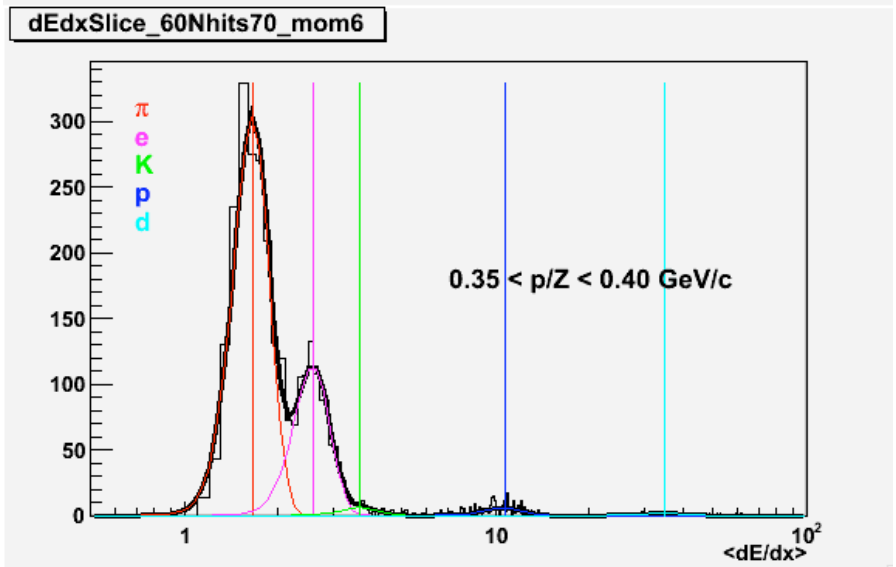


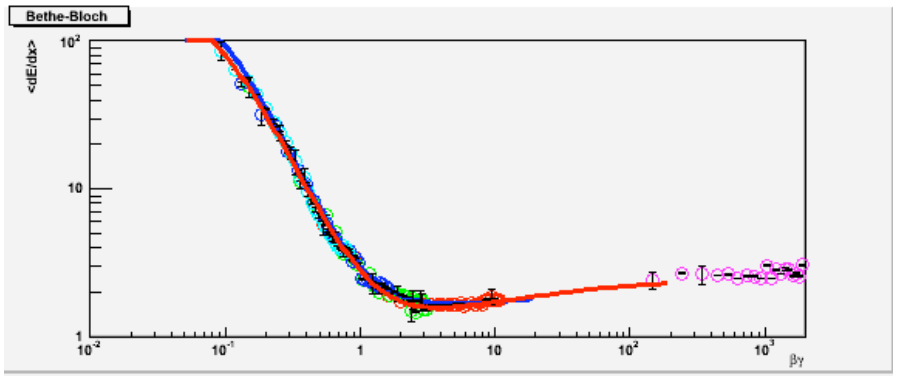


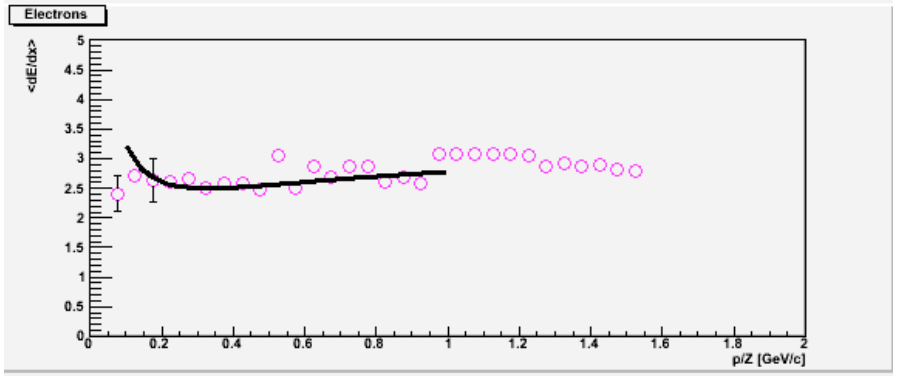


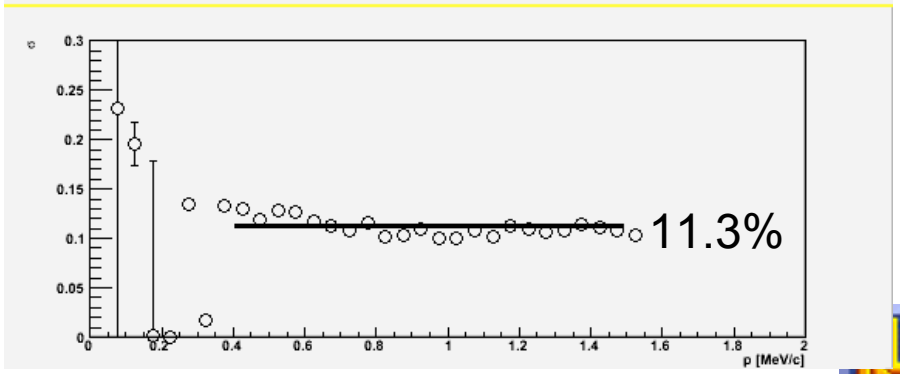
Bethe-Bloch: Empty 120



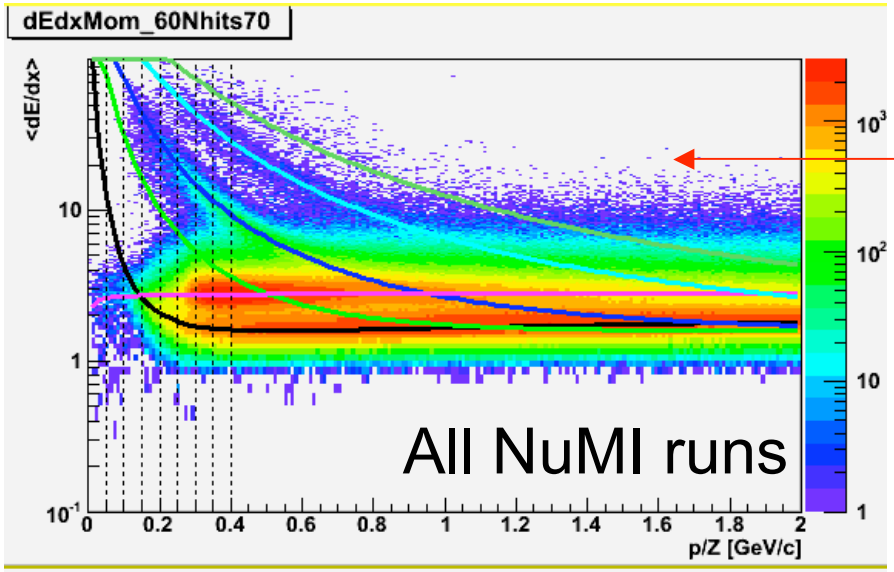


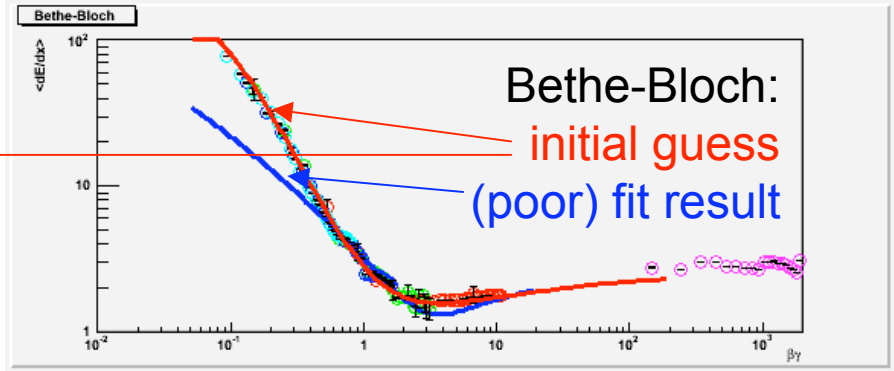


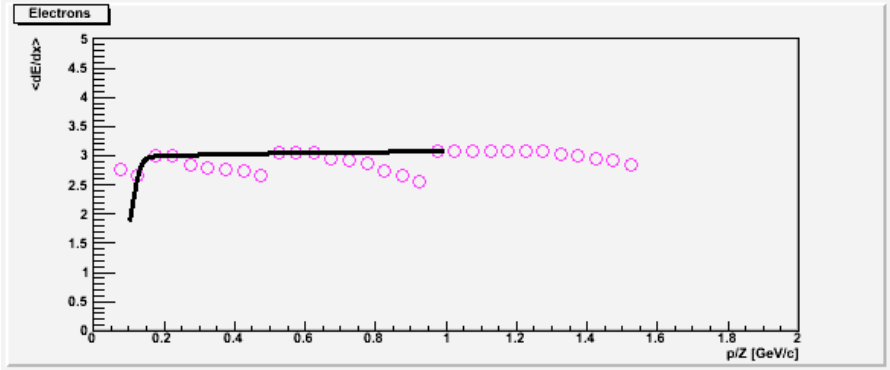


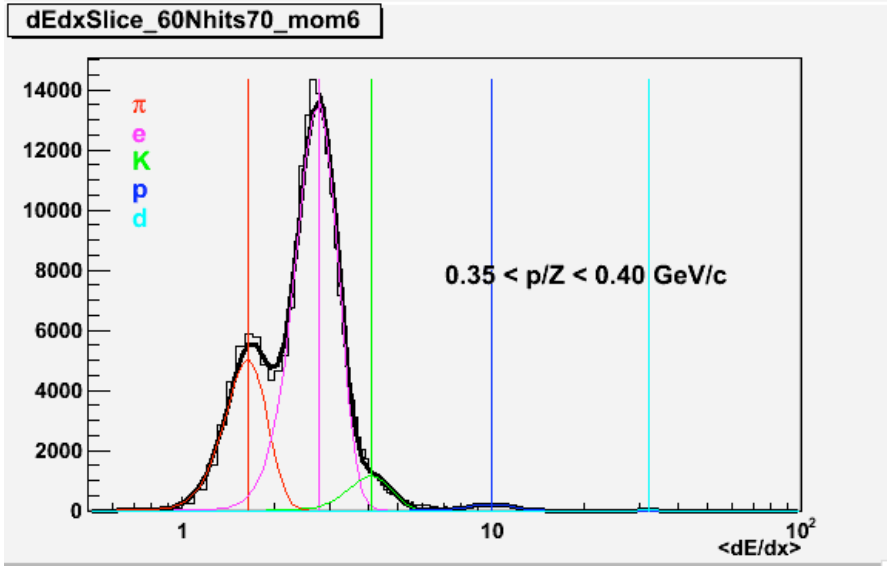


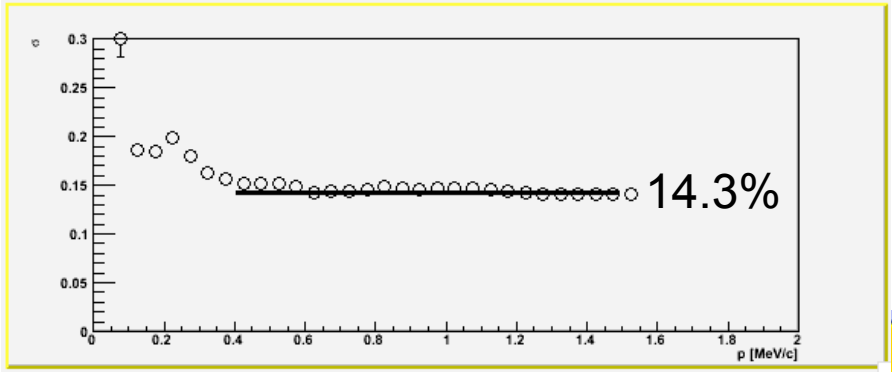
Bethe-Bloch: NuMI 120











Bethe-Bloch Study II

The “initial guess” parameters came from E910, with minor modifications for the overall normalization and saturation parameter.

The fits allow the <dE/dx> to vary within 5-10% tolerance (p/Z-dependent) of the initial guess values.

Since they worked pretty well, I decided to use the “initial guess” values

	A	B	C	D	f_{max}
MIPP (h)	0.609946	6.1858	-0.5516	1.0524	200.0
MIPP (e)	0.03758	2.7944	0.00589	-0.70	N/a
E910 (h)	0.11455	11.0	0.24297	1.145	100.0
E910 (e)	0.03758	1.5944	0.00589	-0.70	N/a

$$\langle dE/dx \rangle_0 = A\frac{z^2}{\beta^2}\left\{\frac{1}{2}\ln T_{\max} + C\ln(\beta\gamma) - \beta^2 + B\right\}$$

$$\langle dE/dx \rangle' = \langle dE/dx \rangle_0^{\,D}$$

$$\langle dE/dx \rangle_{trunc} = \frac{f_{\max}\langle dE/dx \rangle'}{f_{\max} + \langle dE/dx \rangle'}$$

Hadrons

Electrons:

$$\langle dE/dx \rangle_{trunc} = \overbrace{A\ln p + B - C(D - \ln p)^3}^{if\ \ln p \le D}, \underbrace{A\ln p + B}_{otherwise}$$

Bethe-Bloch in db

New table in calib db: TPCdEdxBBloch

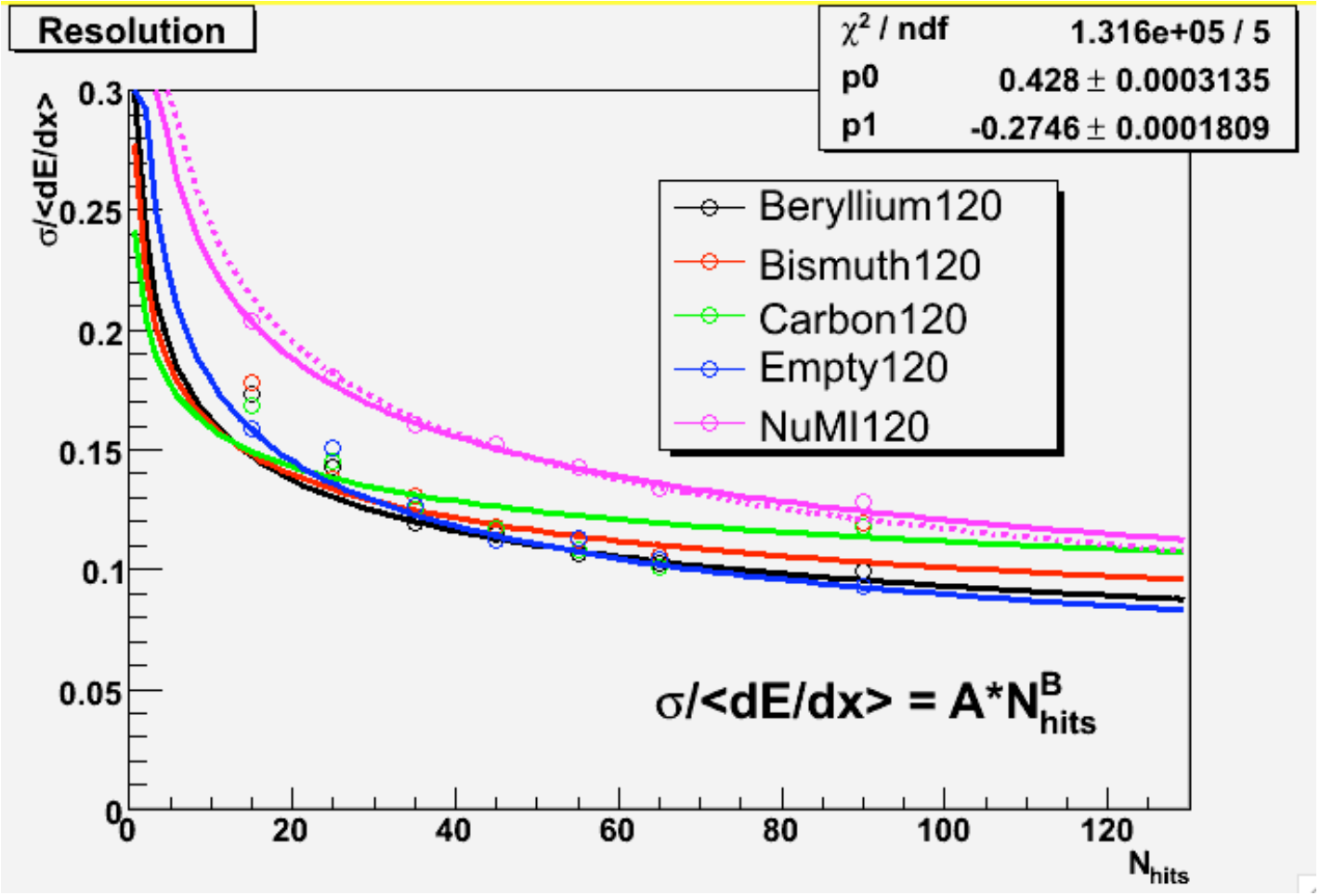
Contains 9 Bethe-Bloch parameters
(hA,hB,hC,hD,hfmax,eA,eB,eC,eD,resA,resB)

TPCRUtils.h contains methods to get predicted <dE/dx> and resolution:

```
float BetheBlochdEdx(float mom, float mass);
float dEdxResFraction(float nhits);
```

Currently one set of parameters in db with run validity range 11000-18000

Resolution vs. Nhits



Note: Purple-dashed curve reflects parameters in db.

(Purple solid curve is a refit with 80-100 bin in the correct place)

PID Probabilities

Inside TPCRPid:

Given a measured track's momentum, the predicted $<dE/dx>_{ii}$ (where ii = {e, μ, π, k, p, d}) are calculated

Given the same track's N_{hits}, the resolution and then σ_{ii} are calculated

Given the track's measured <dE/dx>, the log likelihood of it being one of the particles ii is

$$(LLPID)_{ii} = \text{const.} - \ln\left[0.5*(<dE/dx>_{meas} - <dE/dx>_{ii})^2/\sigma_{ii}^2\right]$$

Constant is currently set to 0. and default $(LLPID)_{ii}$ are set to -999.

Current PID assignment possibilities: e, μ, π, k, p, (d is stored in RBPID::PIDDef[kUnDef] at the moment)

We could add d,t into RBPID::PIDDef but I didn't want to make that change without discussion first

LLPID code will be slightly cleaned up to use RBPID::PIDDef info once list of PIDs is settled.

Summary

Full chain of TPC <dE/dx> PID is implemented and running,
(NuMI data should be considered reasonably final)

To-do: Add resolution vs. Nhits parameterizations for other beam species to db, check energy dependence…

Possible improvements:

-Increase array of possible PID particles, clean up code

-Target/energy dependence of parameters could be checked

-Spectrum analysis based on <dE/dx> fitting could be adapted from Bethe-Bloch fitting routine