Run-6 CNI pC Polarimeter analysis

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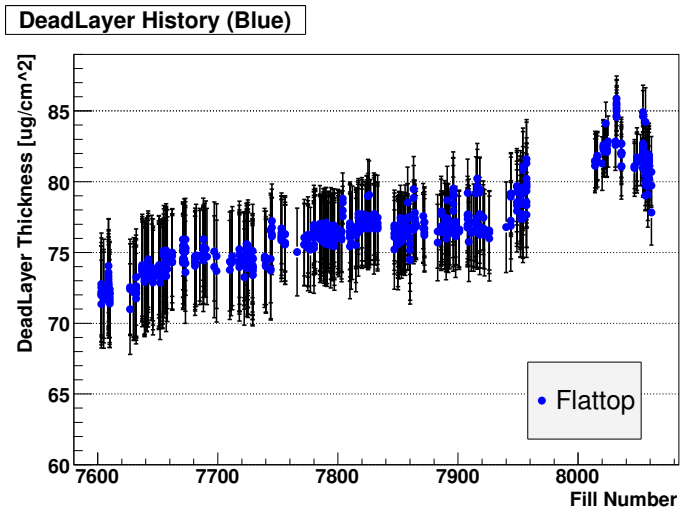
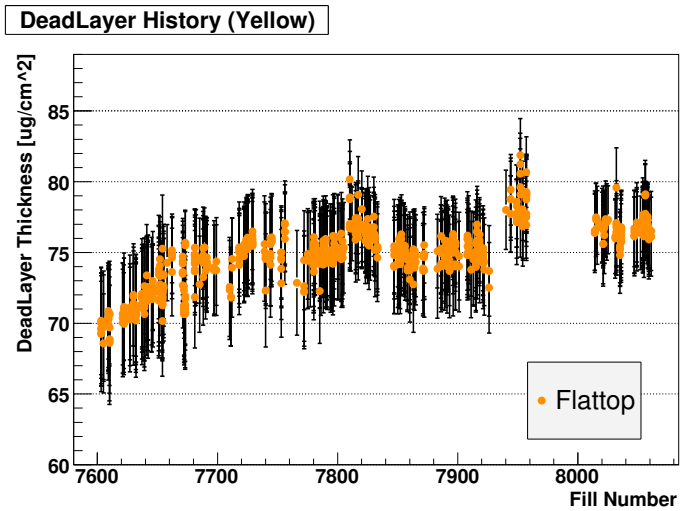
Outline

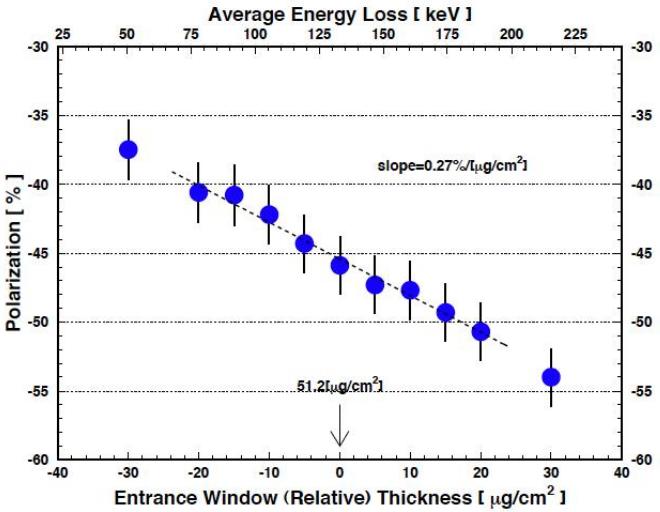
1. QA analysis
2. Scan measurements: luminosity/polarization profile
3. Results from pC
4. Summary

Dead-layer history

Silicon strip dead-layer: obtained by fitting ToF *vs*. Energy







Goal:

10 μg/cm^2 strip-by-strip stability $\Rightarrow$

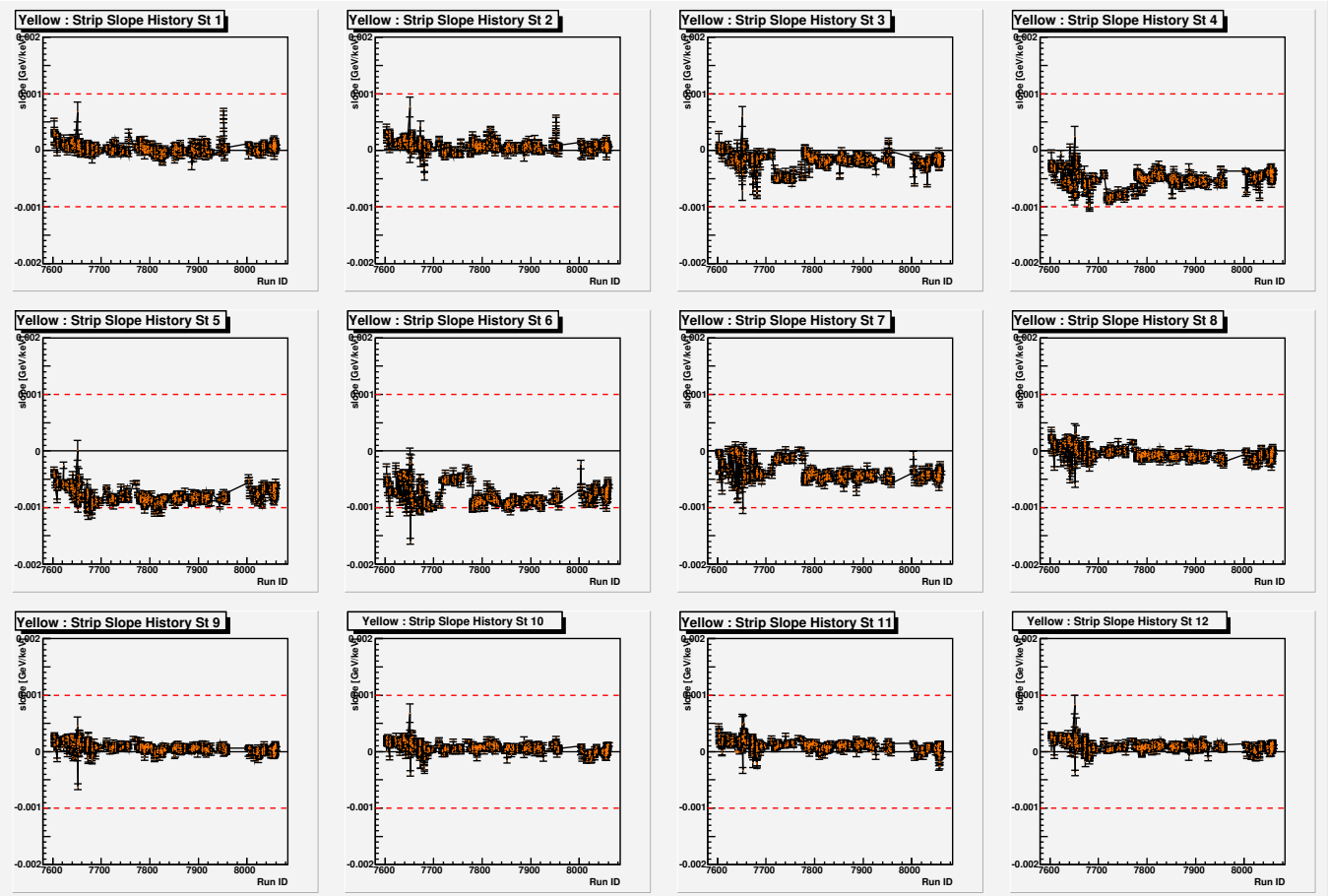
$\approx 3\%$ systematic error in $\mathcal{P}$ (due to DL)

Strip anomaly checks

- C mass–energy correlation
- C mass position
- C mass width
- Number of events in banana

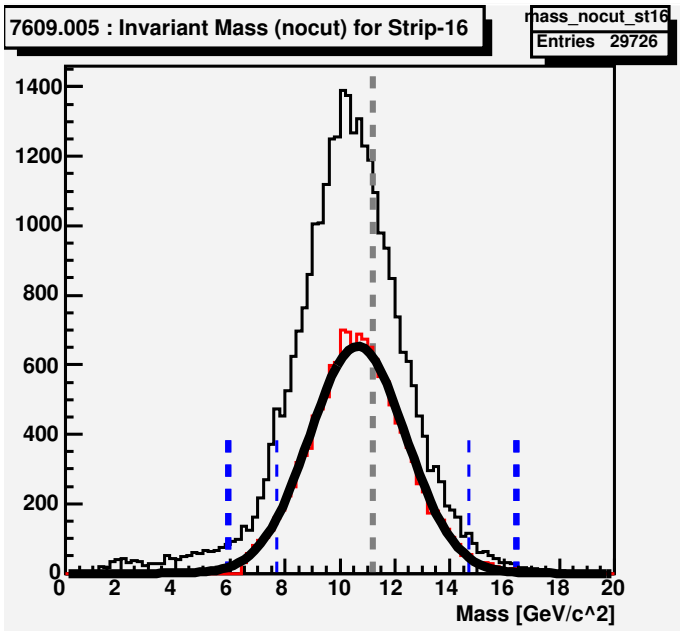
C mass–energy correlation

- 0.001 GeV/keV limit $\Rightarrow\approx$ 3-4% E resolution $\Rightarrow\approx 3\%$ syst. in $\mathcal{P}$
  if all strips showed such a deviation (i.e. very small effect in practice)
- Removed strips $\gg 0.001$ GeV/keV: very few (2–3 strips in 3–4 runs)



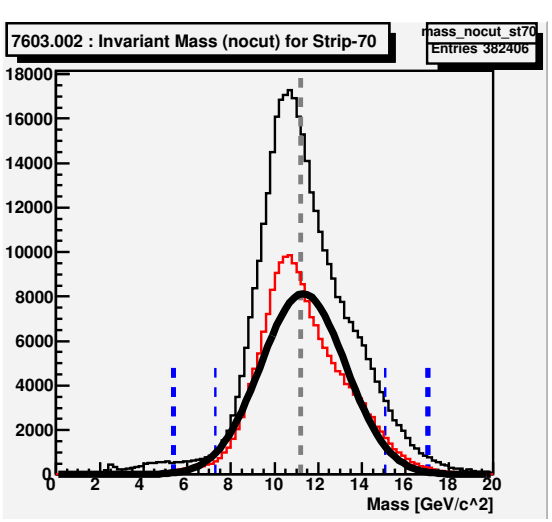
C mass position error

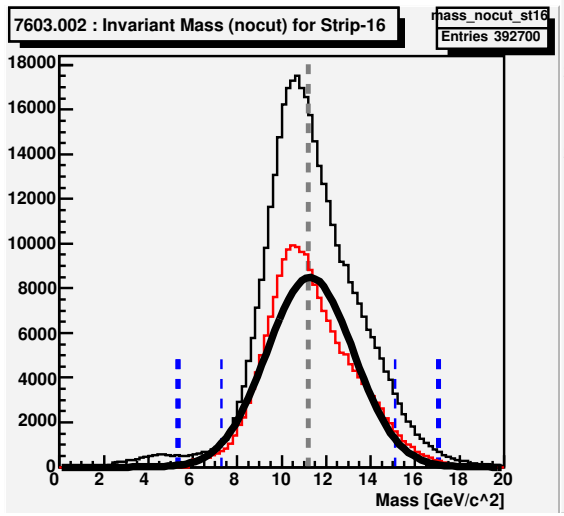
- 0.5 GeV deviation $\Rightarrow \Delta$ToF$=1 \sim 1.25$ ns and $\Rightarrow \approx 3\%$ in $\mathcal{P}$ (again, if all strips showed that deviation)
- Removed strips with deviations 0.5 GeV (only 9 runs affected)

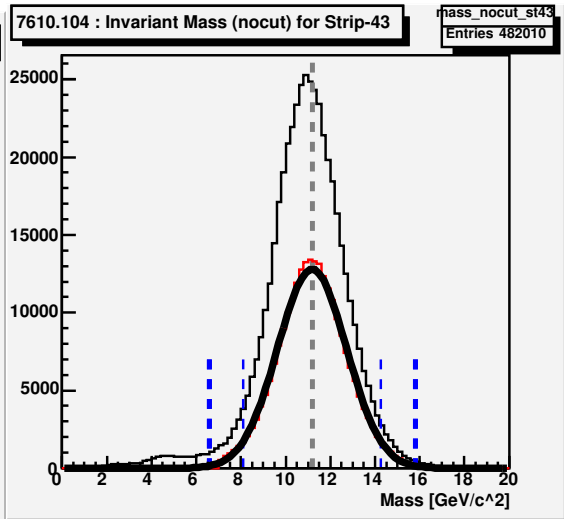


C mass width error

- "Double peak" due to electronics jitter
- Very small effect in $\mathcal{P}$: 1% from 2-σ to 3-σ cut
- No strips disabled due to this error
  (backgrounds are low and only a few strips show this problem)

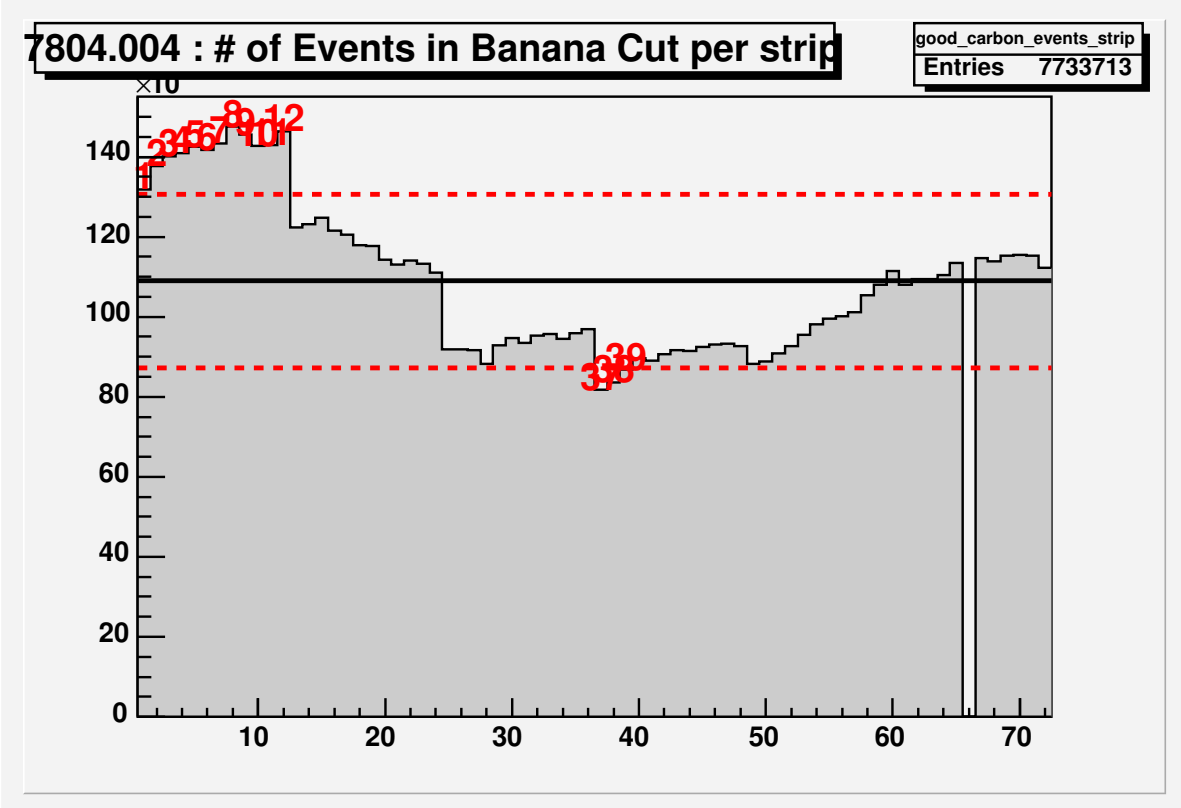






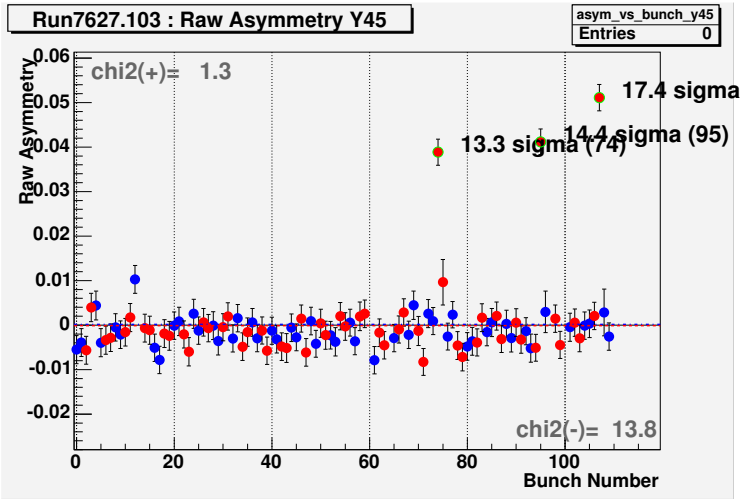
Number of events in banana

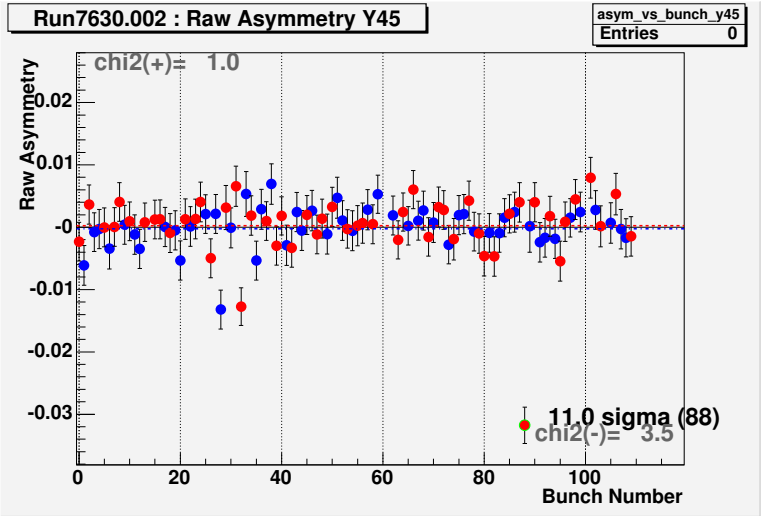
- Limit set at $\pm 20\%$ of the average
- Some strange cases found (4 runs, eg. below), not undestood
  $\Rightarrow$ runs removed

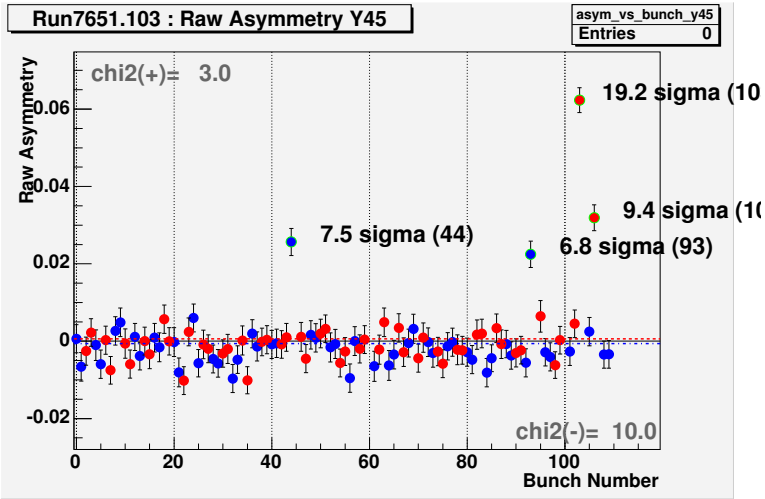


Bad bunch asymetries

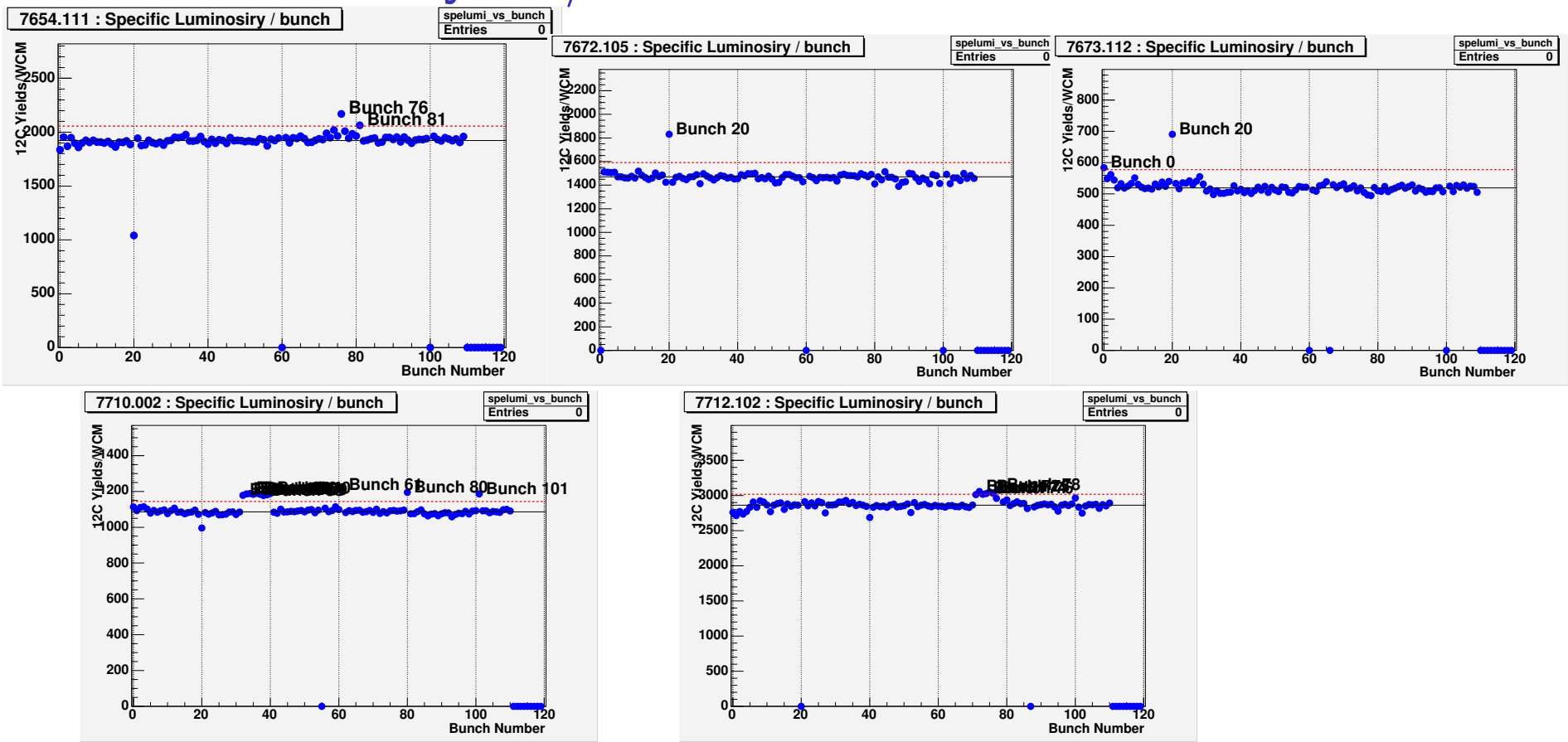
Only seen in 3 runs removed: associated with pC DAQ problem







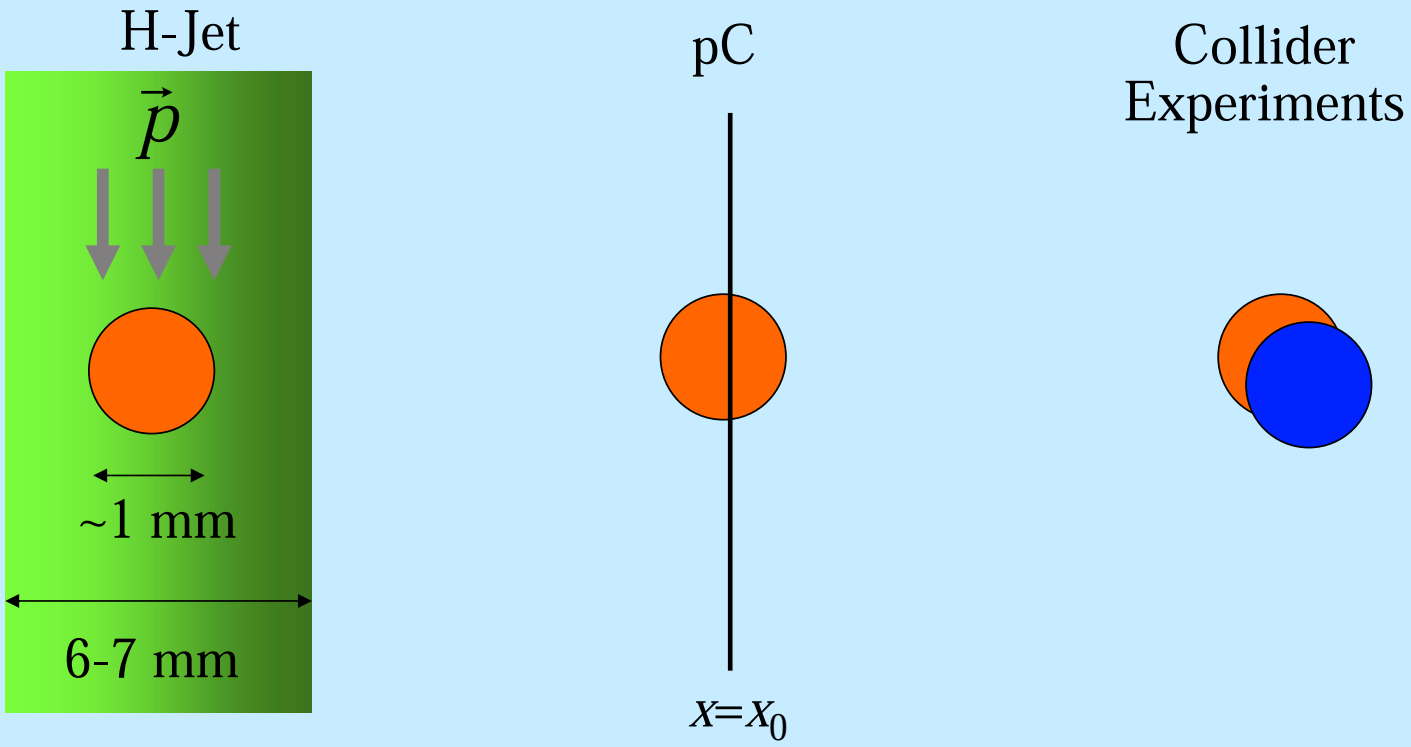
Hot bunches: C yield/WCM *vs.* bunch number



Seen in around 30 fills:

- Disabled only bunch 20 (used for beam tune)
- Bunches slightly above average (maybe due to difference in emmittance) considered OK

Average Polarization

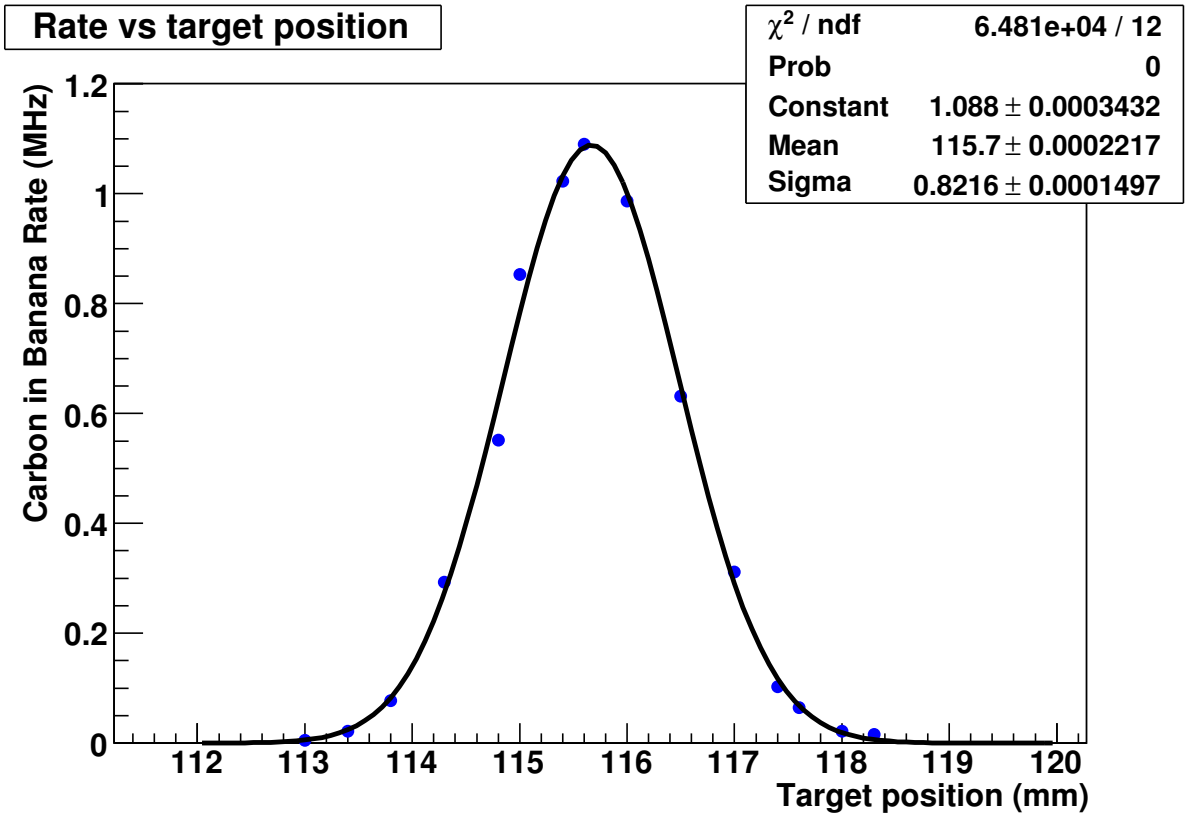


$$\langle P \rangle = \frac{\int P(x,y)\, I(x,y)\, dxdy}{\int I(x,y)\, dxdy} \qquad \langle P \rangle = \frac{\int P(x0,y)\, I(x0,y)\, dy}{\int I(x0,y)\, dy} \qquad \langle P \rangle = \frac{\int P(x,y)\, I_1(x,y)\, I_2(x,y)\, dxdy}{\int I_1(x,y)\, I_2(x,y)\, dxdy}$$

$P(x,y)$ – polarization profile, $I(x,y)$ – intensity profile

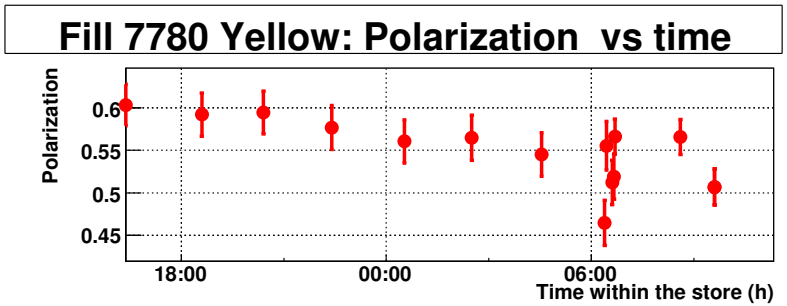
An example: run 7654.005

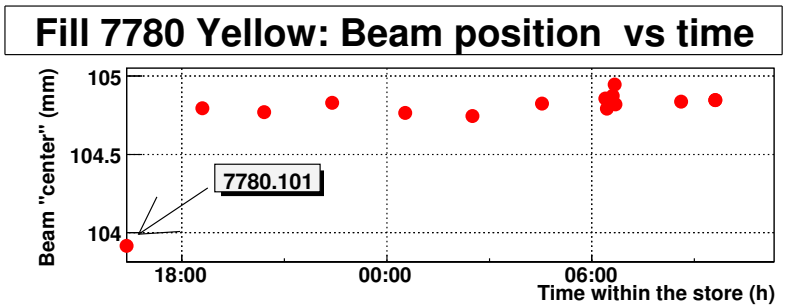
Horizontal scan (vertical target)

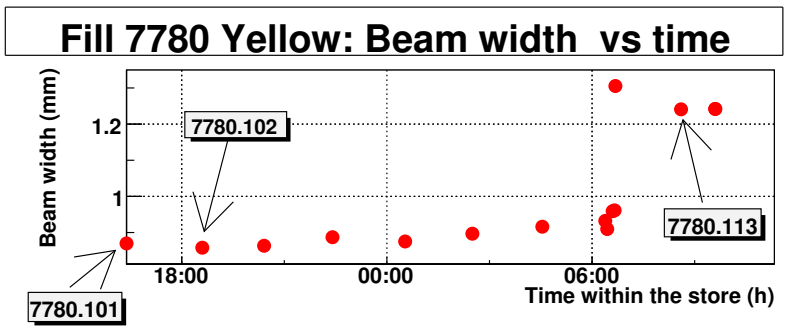


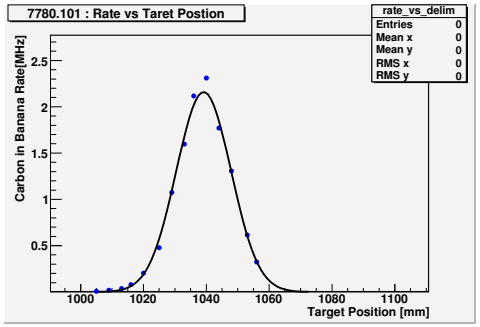
Horizontal width ~ 0.8 mm

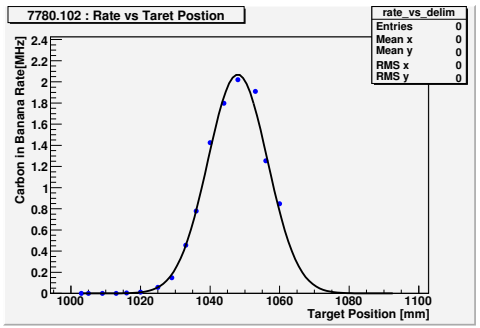
Changes in beam position/width within a fill: 7780-Yellow

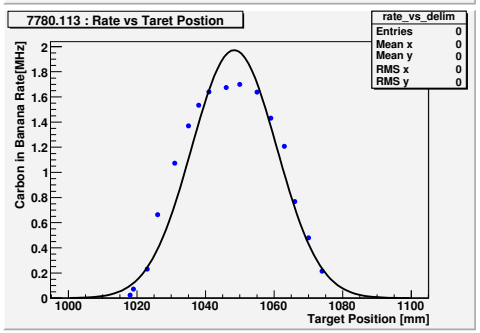










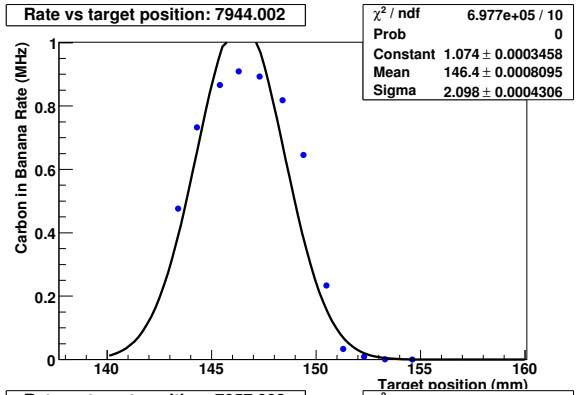


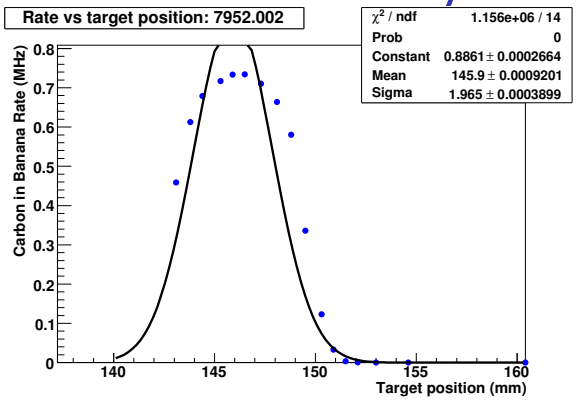
IPM emittance check (by Haixin) showed this is not real $\Rightarrow$ target position problem

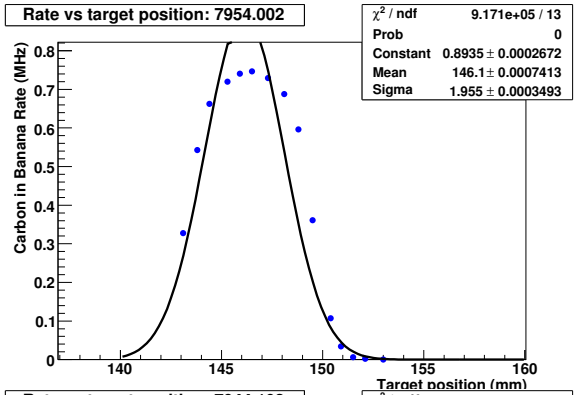
Vertical profile: fill summary

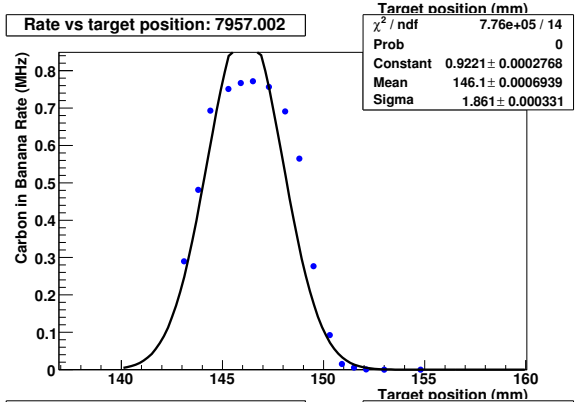
Horizontal scan		Vertical scan		
Blue	Yellow	Blue	Yellow	
133	144	15	6	← TOTAL
		7940	7940	
		7944	7944	
			7949	200 GeV (long)
		7952	7952	
		7954	7954	
		7957	7957	
		8036		
		8047		
		8049		
		8052		
		8054		62 GeV (trans)
		8055		
		8056		
		8058		
		8059		
		8061		

Vertical scans: 200 GeV – blue & yellow



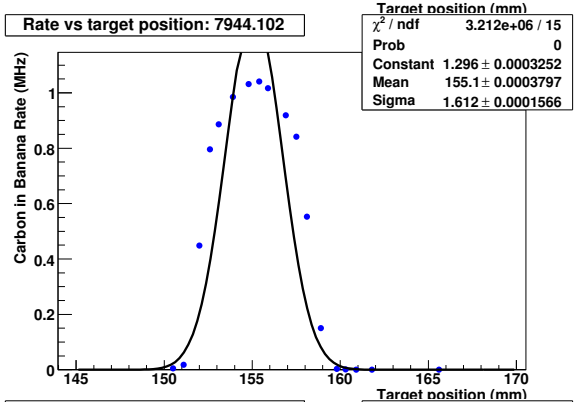


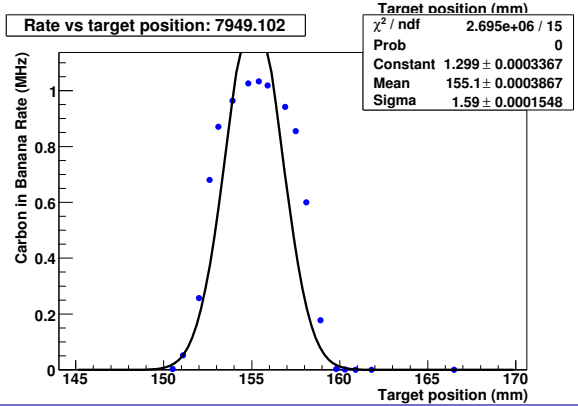


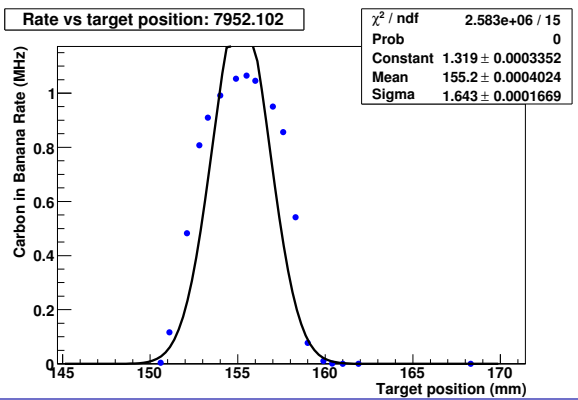


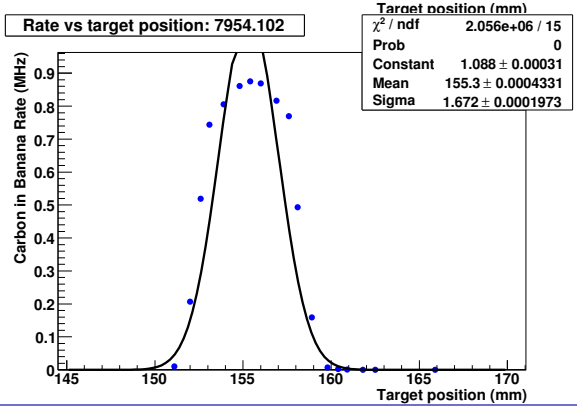
Again,

target position problem



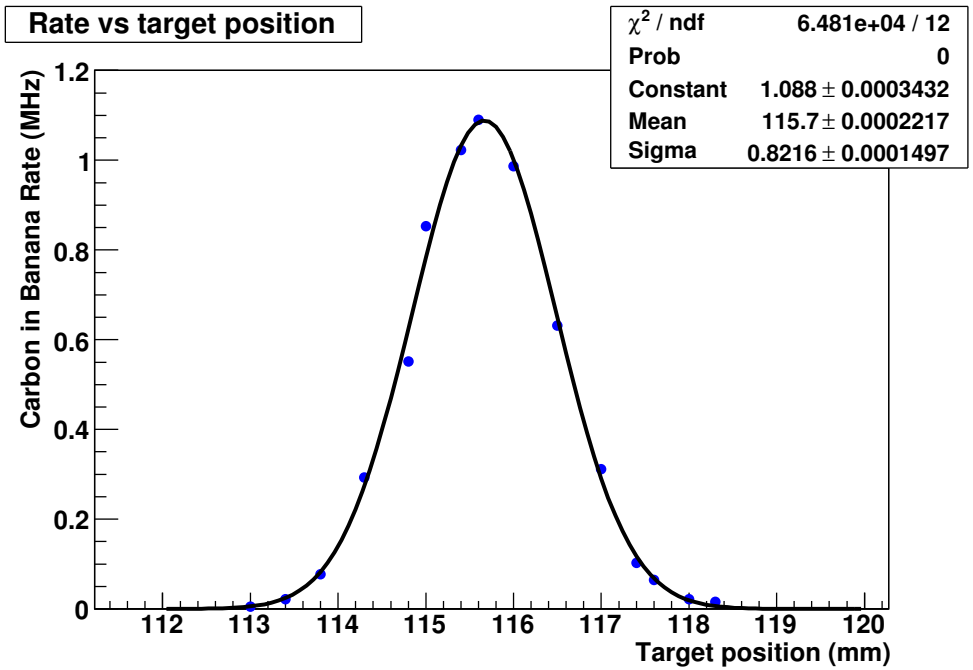


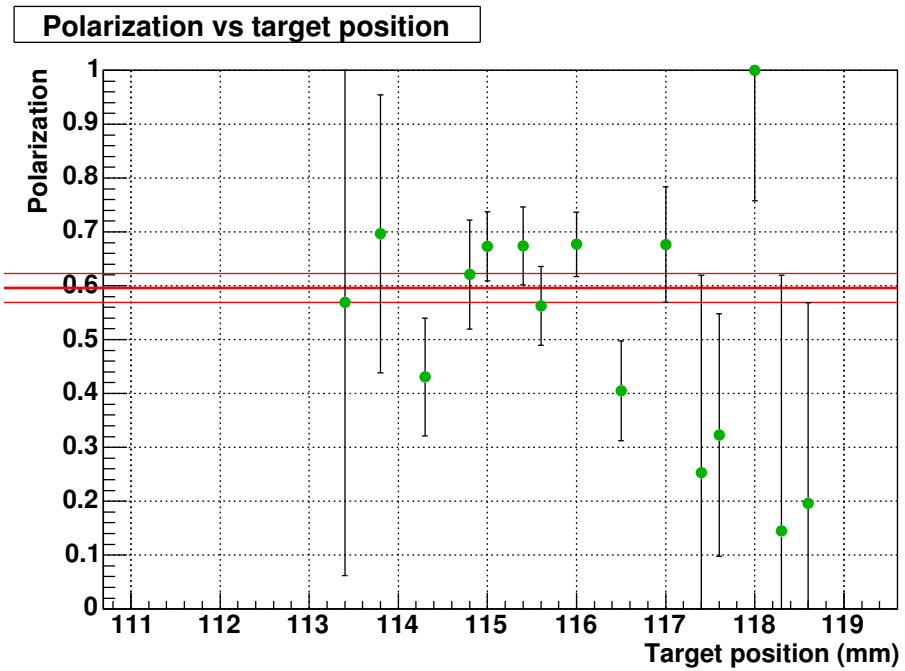




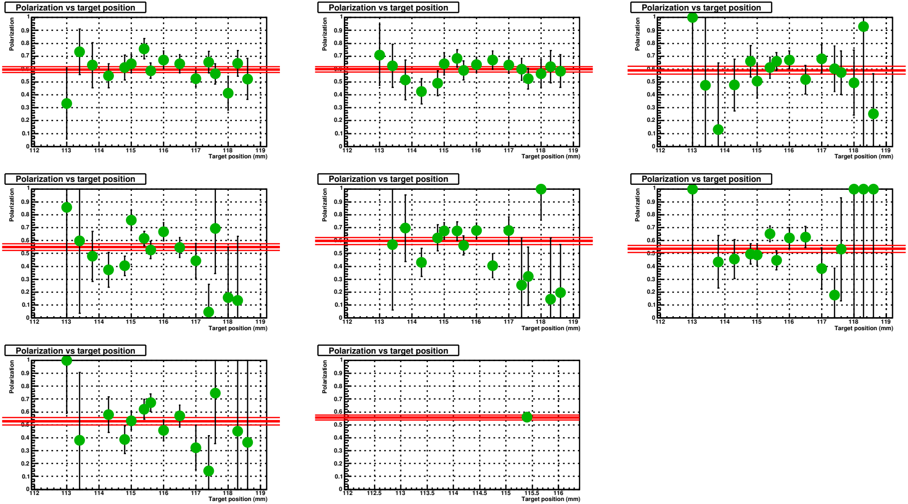
An example: run 7654.005 (200 GeV)

Horizontal scan (vertical target)

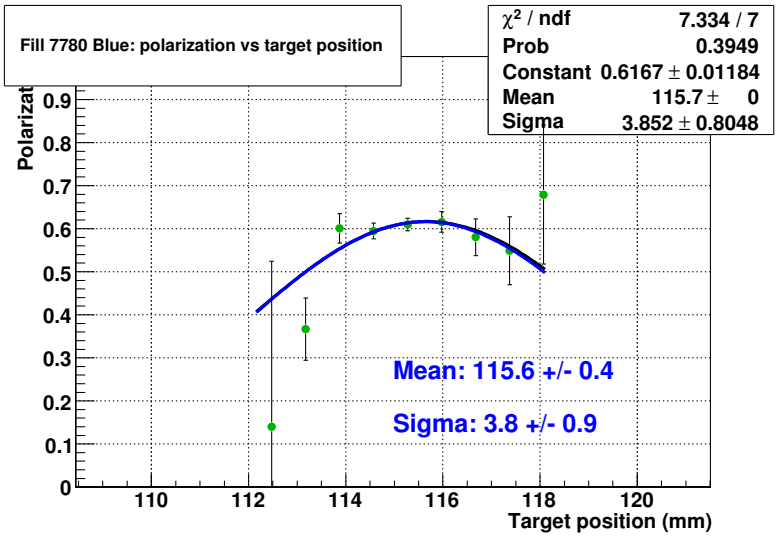


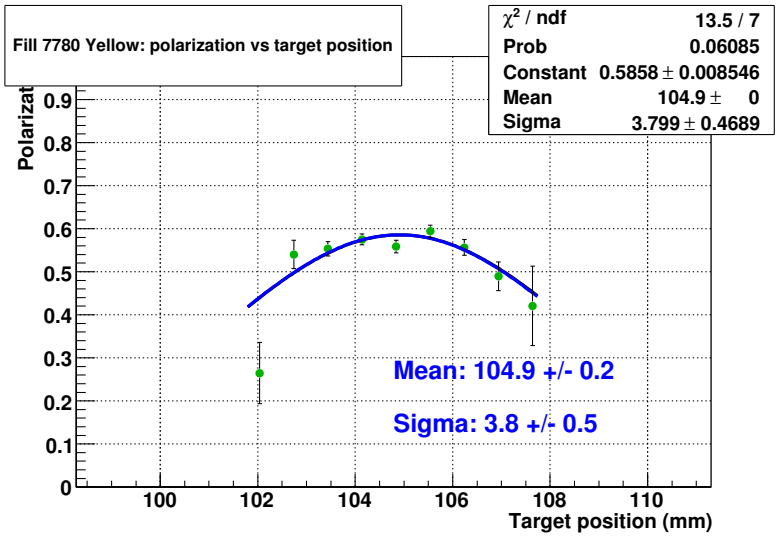


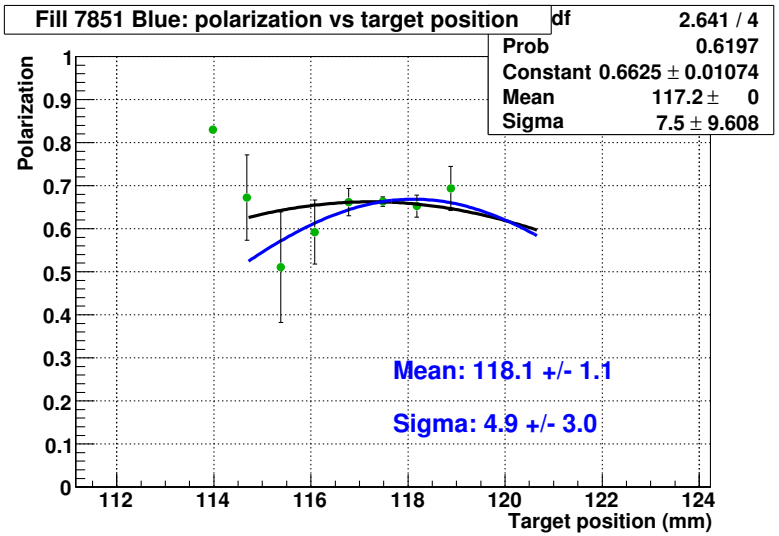
A whole fill: polarization *vs.* target position

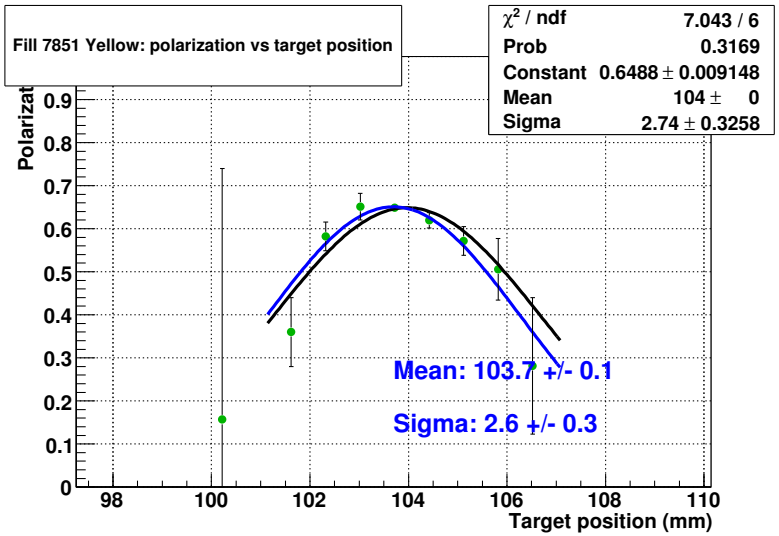


Polarization *vs.* target position: some combined fills









Polarization *vs.* rate fit

Fit polarization vs. rate to extract $r = (\sigma_L/\sigma_P)^2$

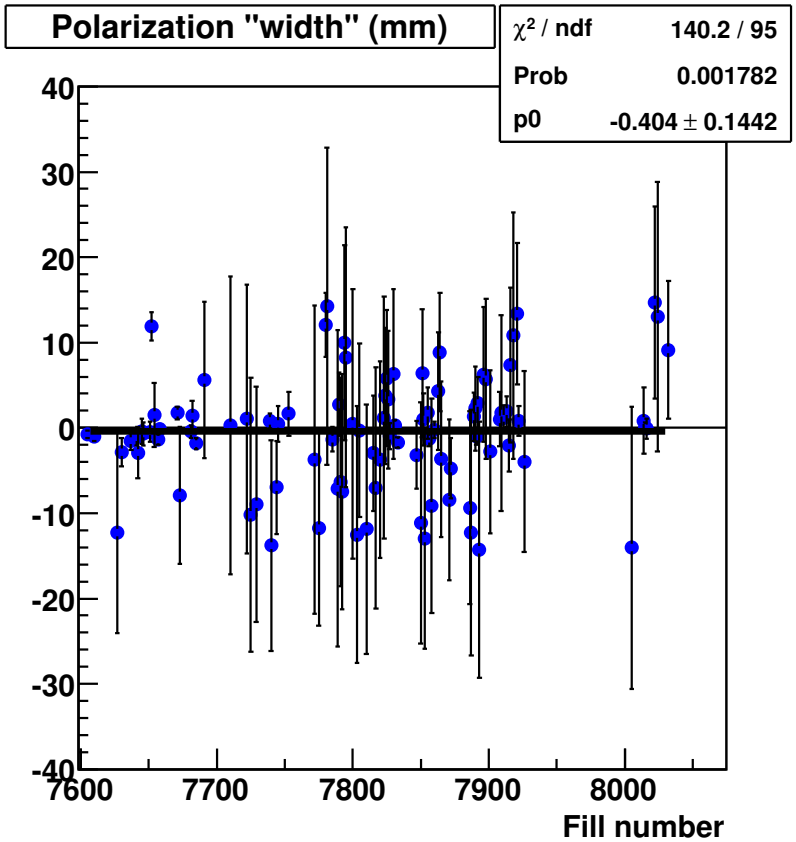
$$\left.\begin{aligned} L &= L_{max} \cdot e^{\frac{-x^2}{2\sigma_L^2}} \\ P &= P_{max} \cdot e^{\frac{-x^2}{2\sigma_P^2}} \end{aligned}\right\} \Rightarrow P = P_{max} \cdot (L/L_{max})^{(\frac{\sigma_L}{\sigma_P})^2}$$

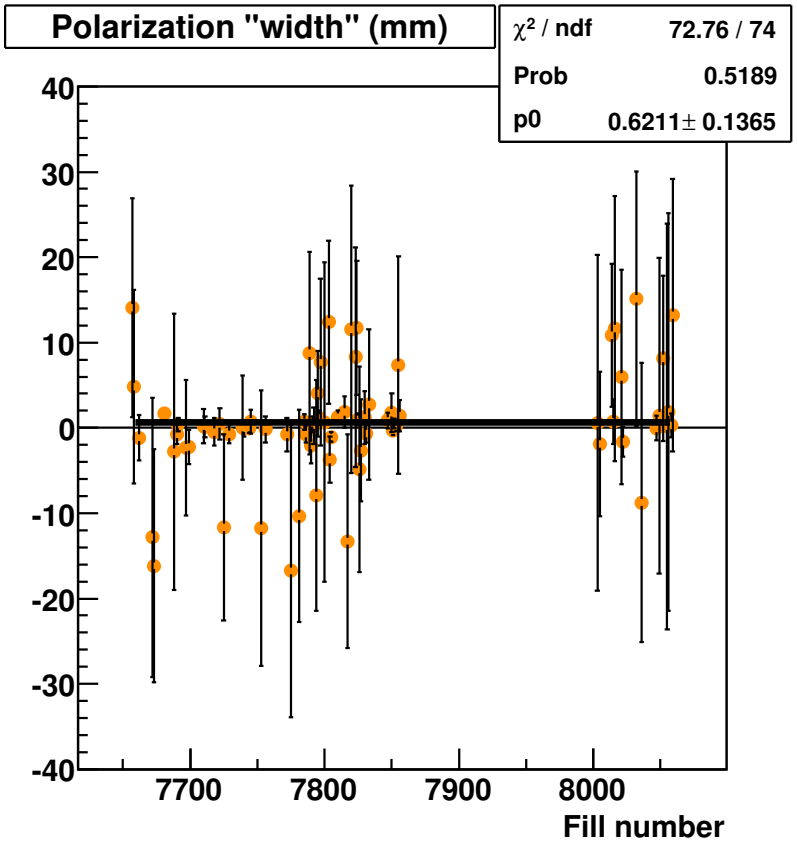
- Fit of P vs L/L_{max}
- P_{max} and $r = (\sigma_L/\sigma_P)^2$ are the 2 free parameters of the fit

- Only r is needed for correcting for polarization profile (no need of σ_L and σ_P separatedly):
  - Correction peak-to-average for Jet: $1/\sqrt{1+r}$
  - Correction peak-to-average (luminosity-weighted) for experiments: $1/\sqrt{1+r/2}$

Variations between two halves of a fill

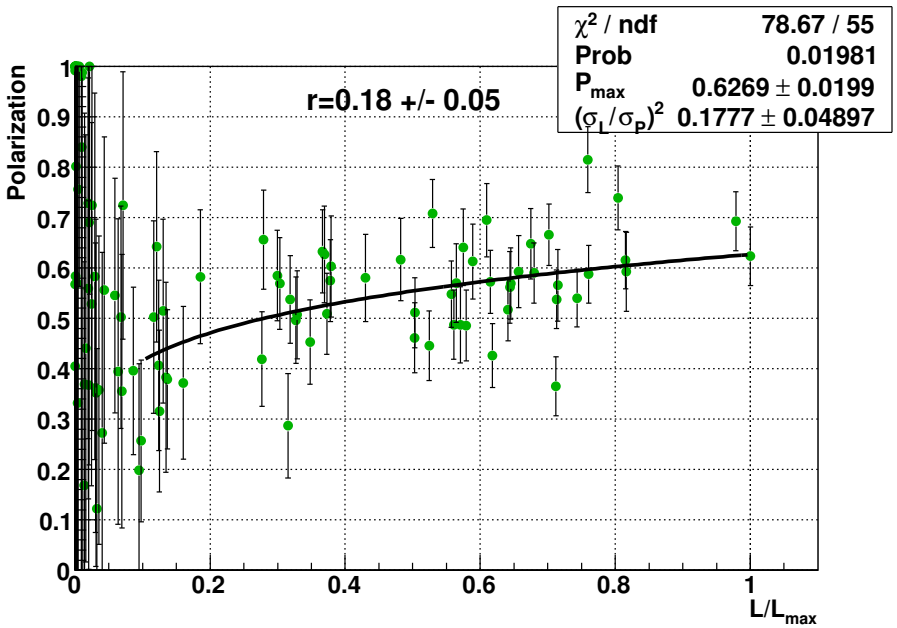
Plots show $\sigma_{aft} - \sigma_{bef}$



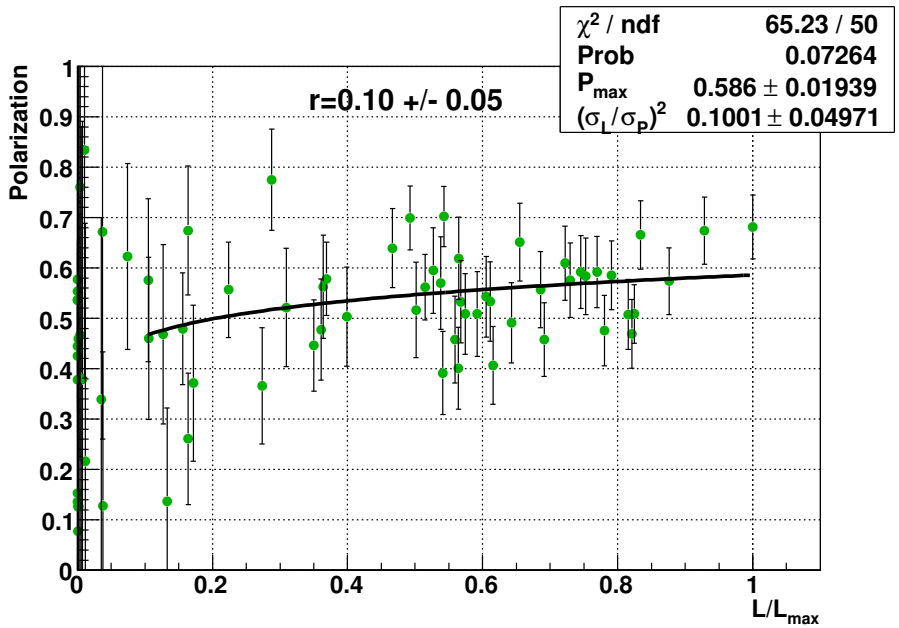


A couple of examples

Fill 7788 – Blue

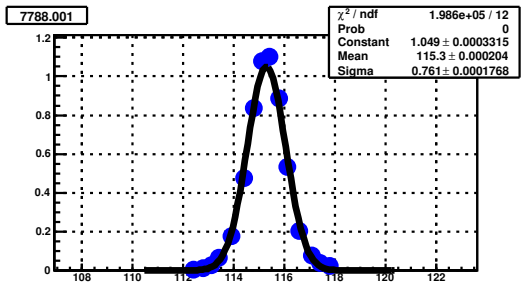


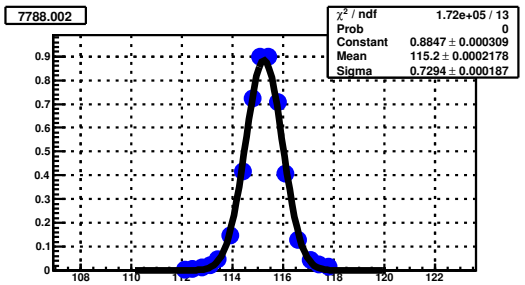
Fill 7642 – Yellow

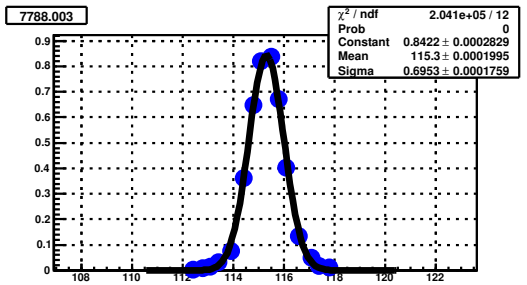


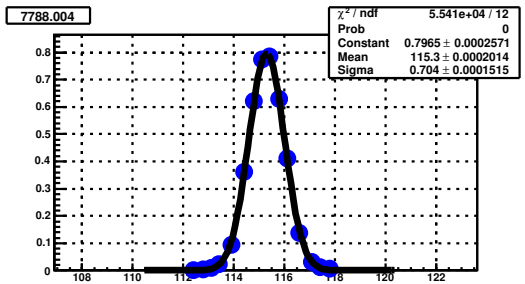
Fill 7788 – blue: luminosity profile

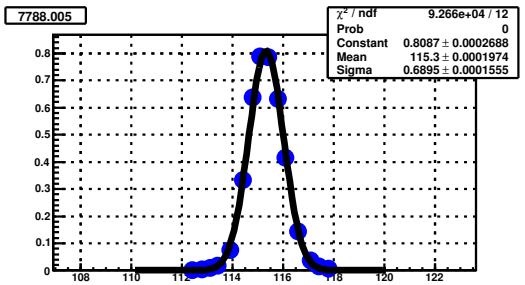
Fill showing *good* (gaussian) luminosity profile

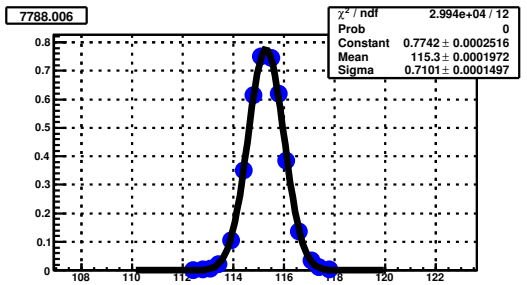


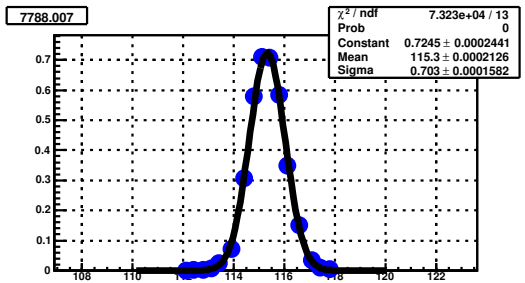


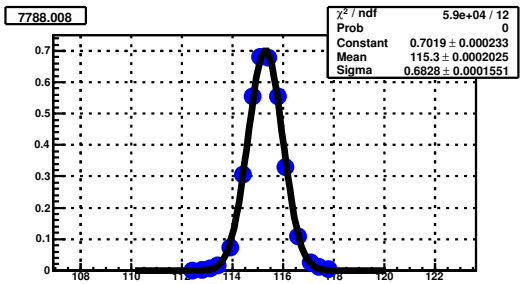




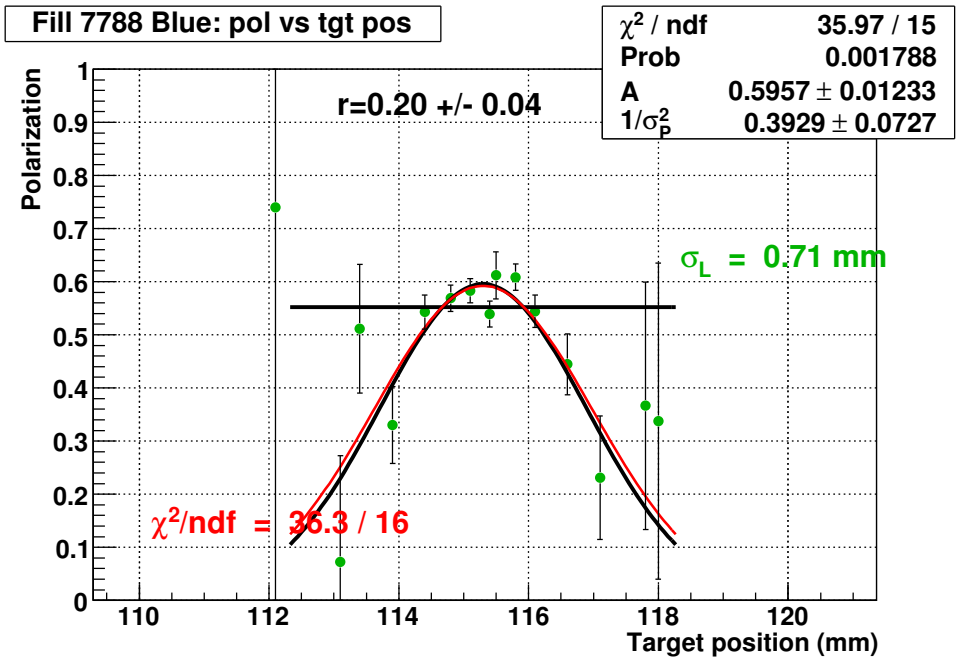


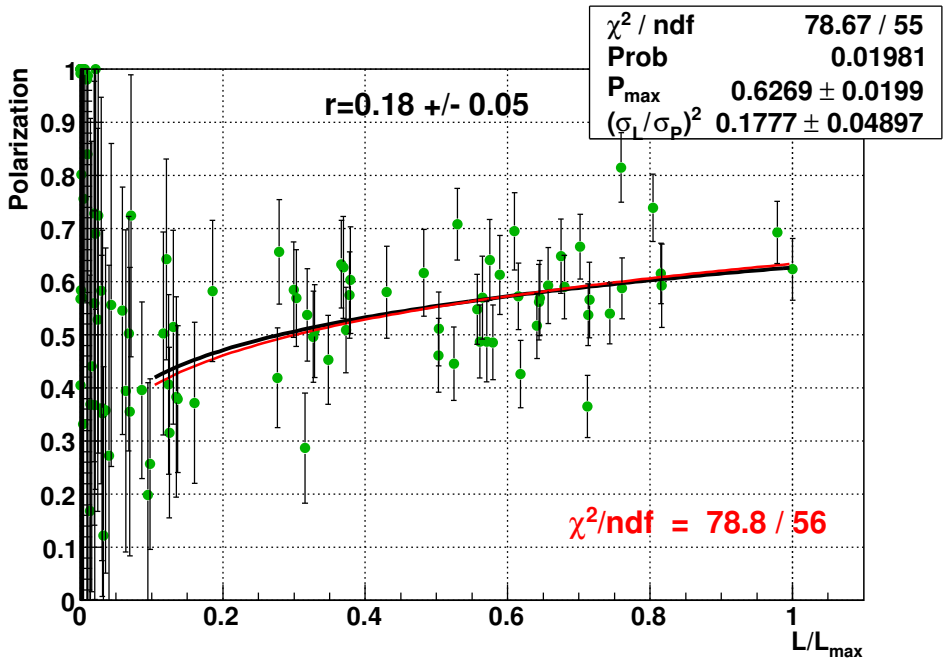






Fill 7788 – blue: comparison of two methods

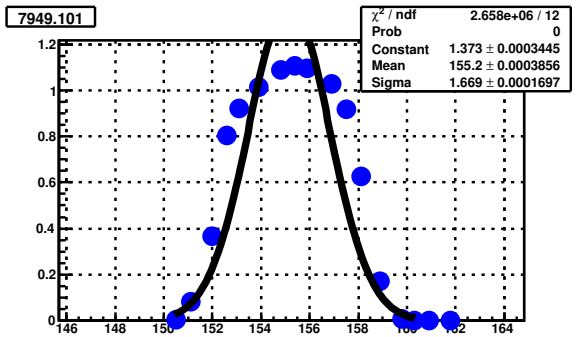


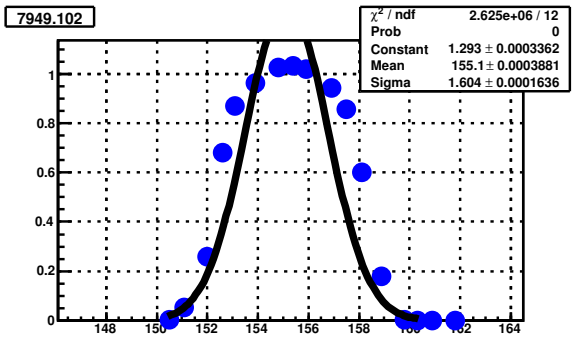


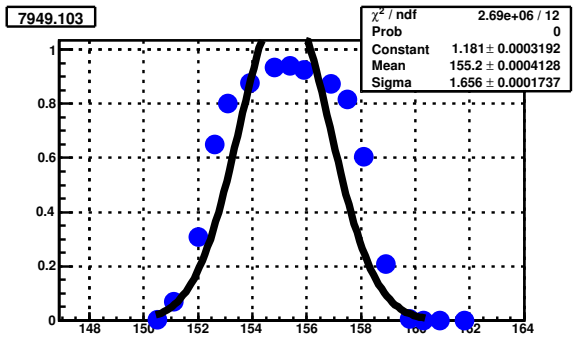
Both methods ($\mathcal{P}$ vs tgt.-pos. & $\mathcal{P}$ vs rate) are consistent

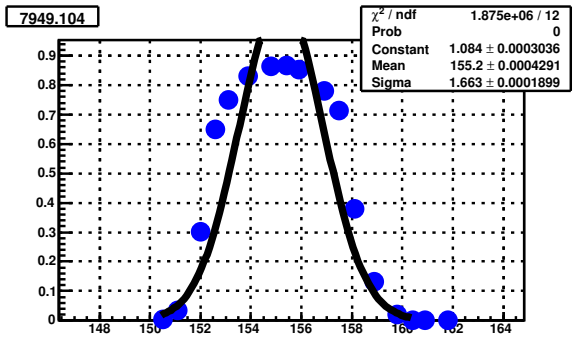
Fill 7949 – yellow: luminosity profile

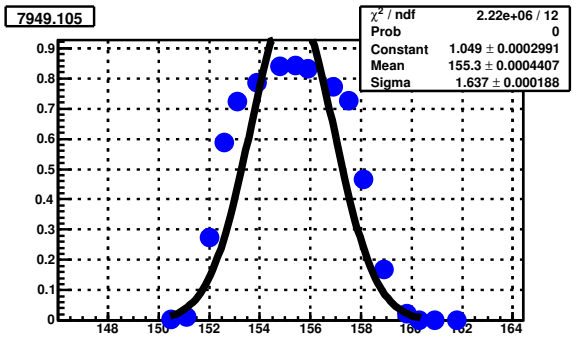
Fill showing "weird" luminosity/intensity profile



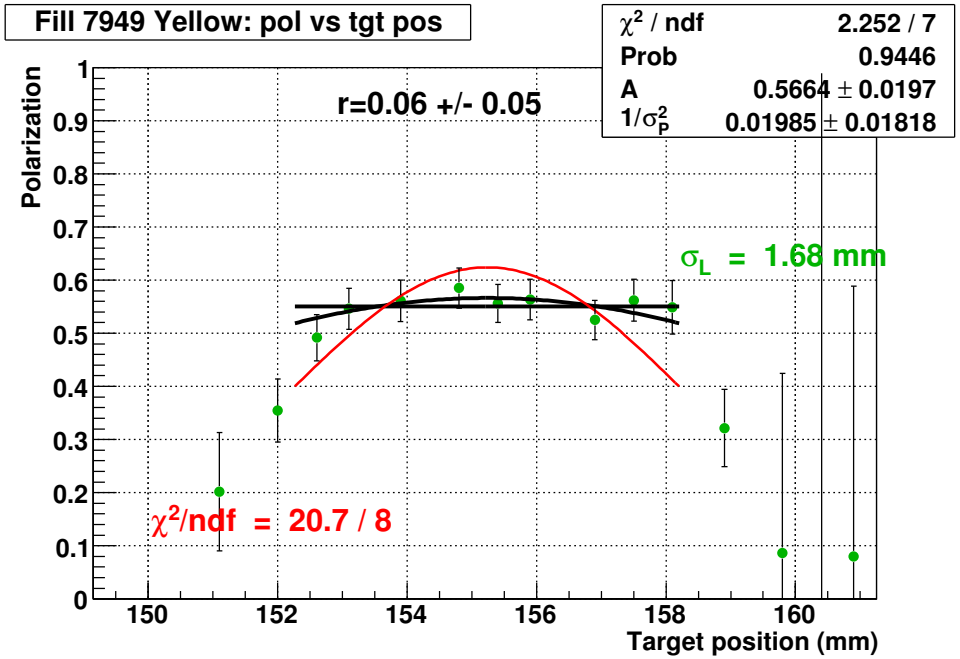


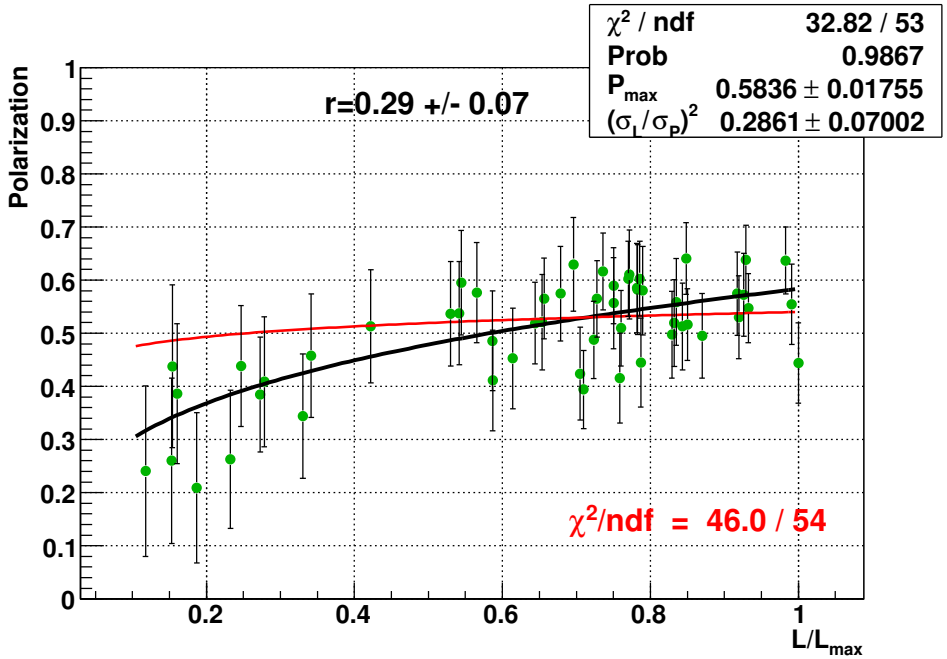






Fill 7949 – yellow: comparison of two methods

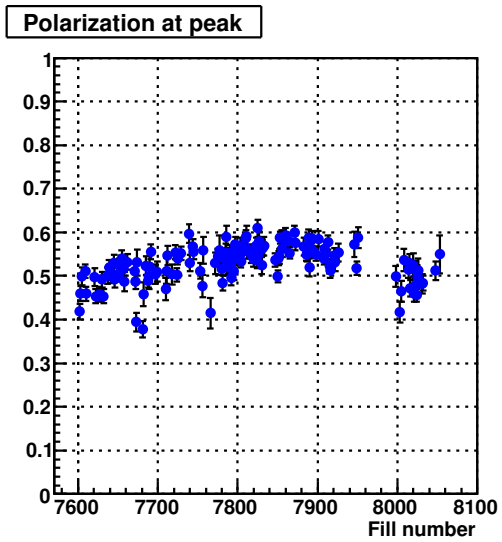


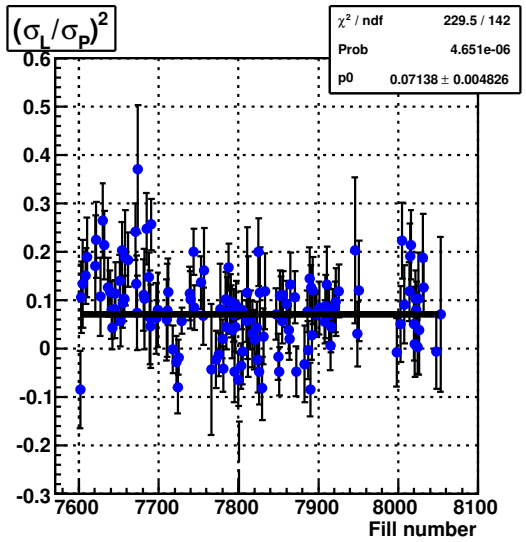


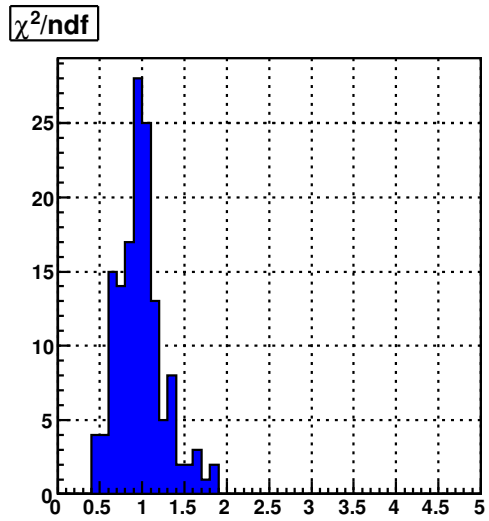
$\mathcal{P}$ vs tgt.-pos. & $\mathcal{P}$ vs rate yield different result

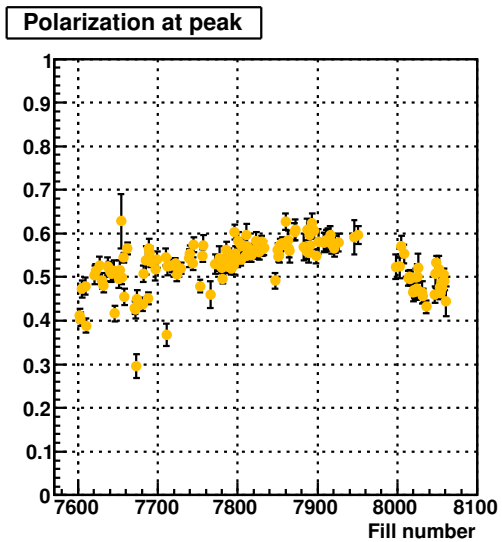
$\Rightarrow$ $\mathcal{P}$ vs rate method used for analysis

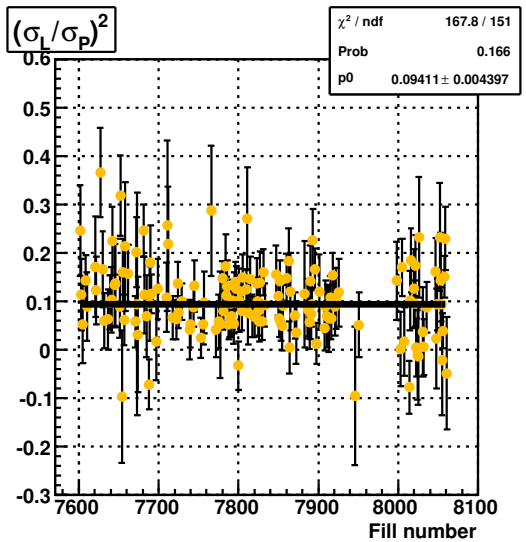
Results (normalized by Jet): horizontal scans

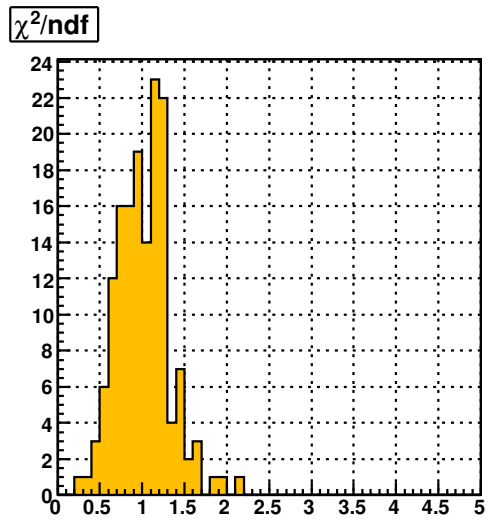




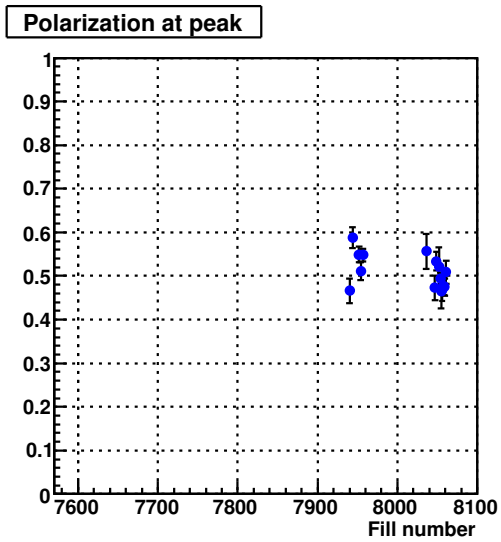


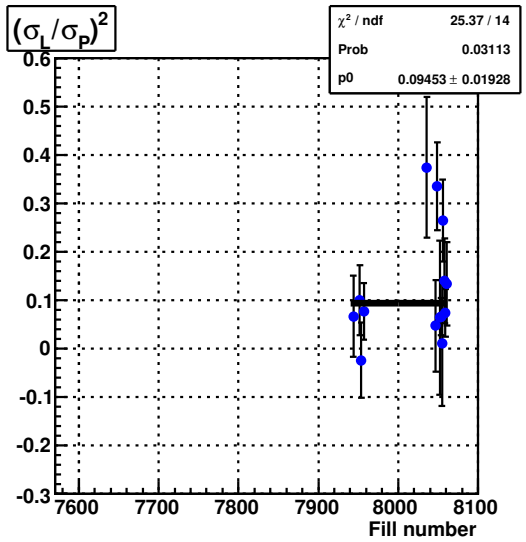


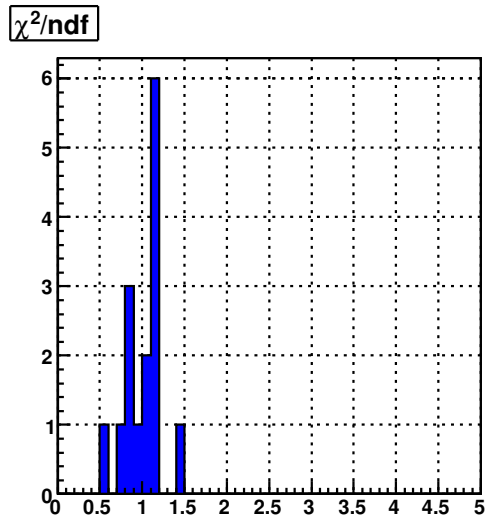


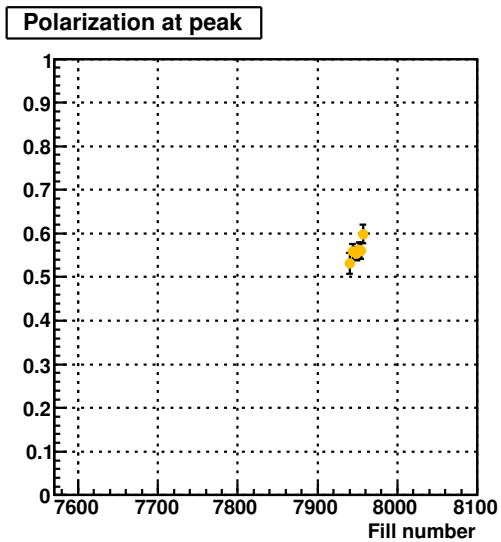


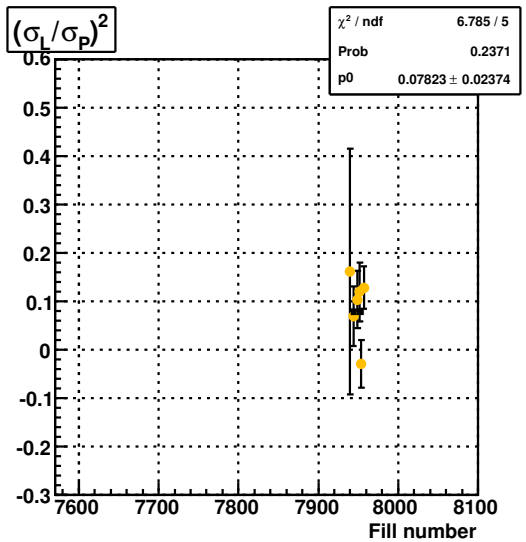
Results (normalized by Jet): vertical scans

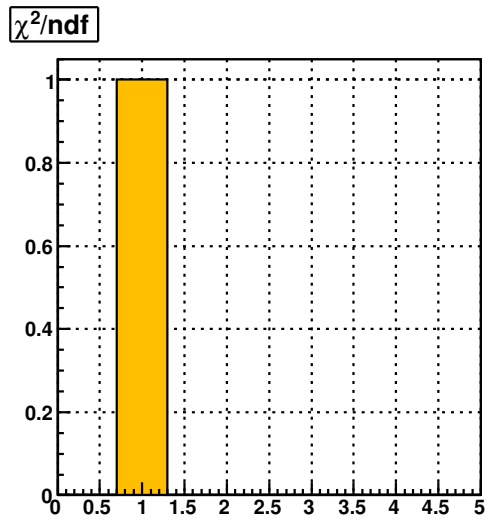




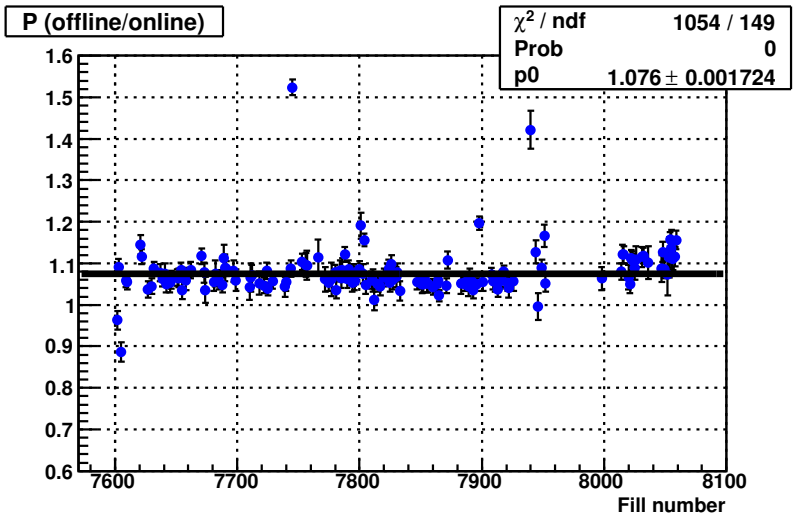


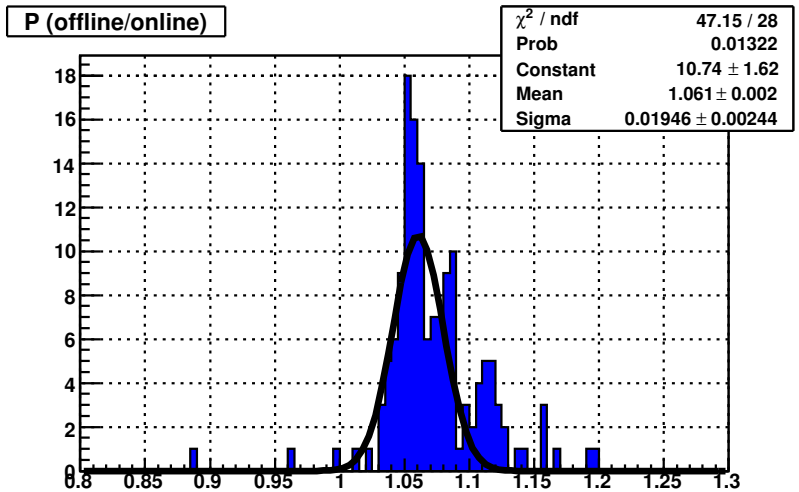


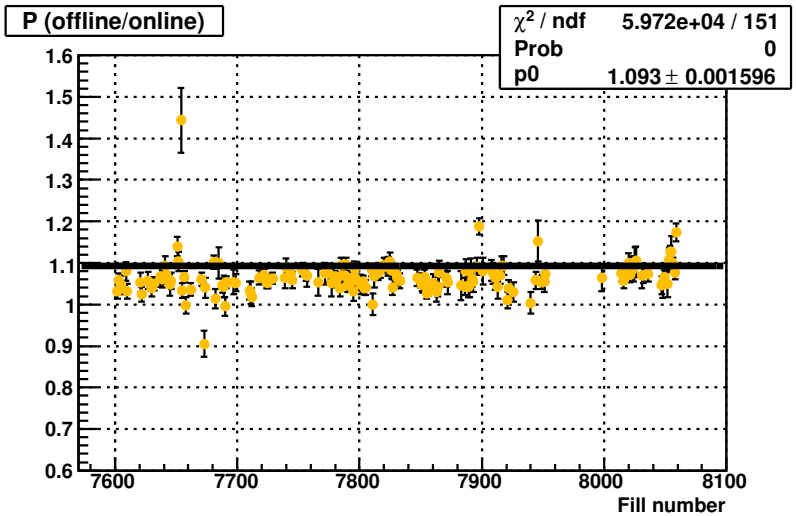


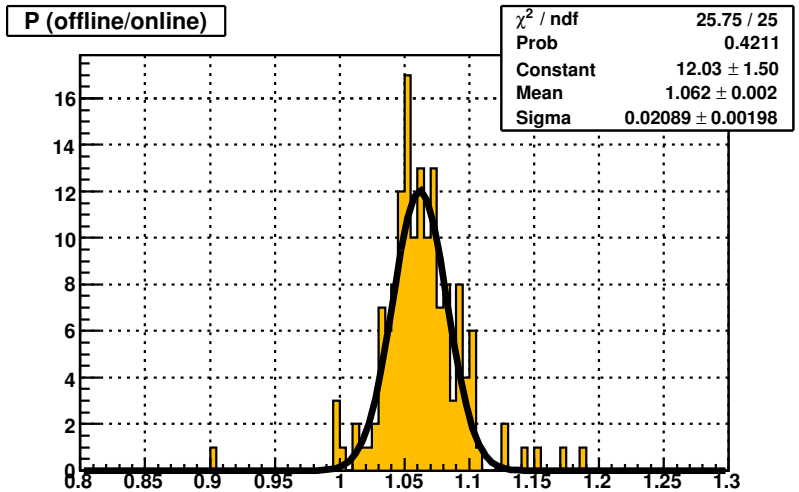


Comparison online/offline (using same A_N)

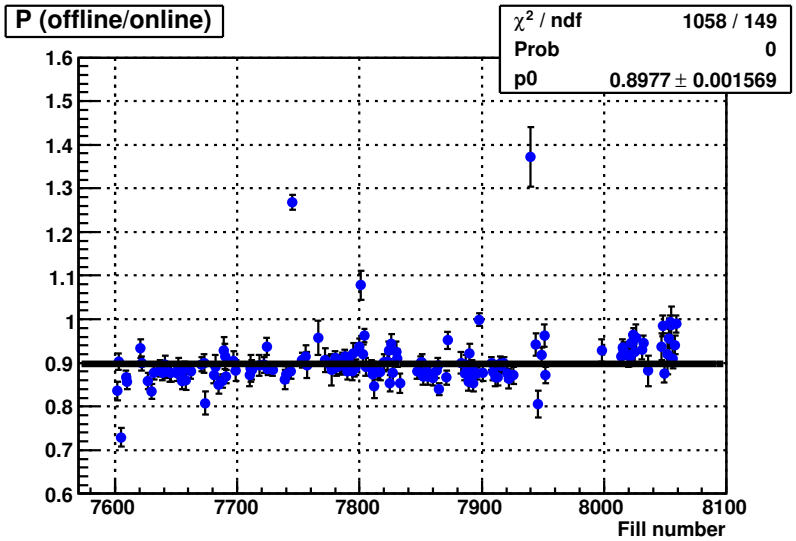


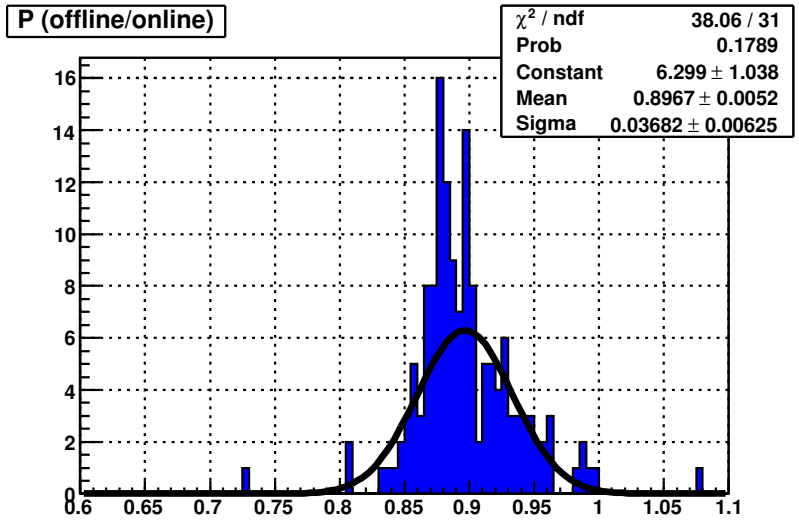


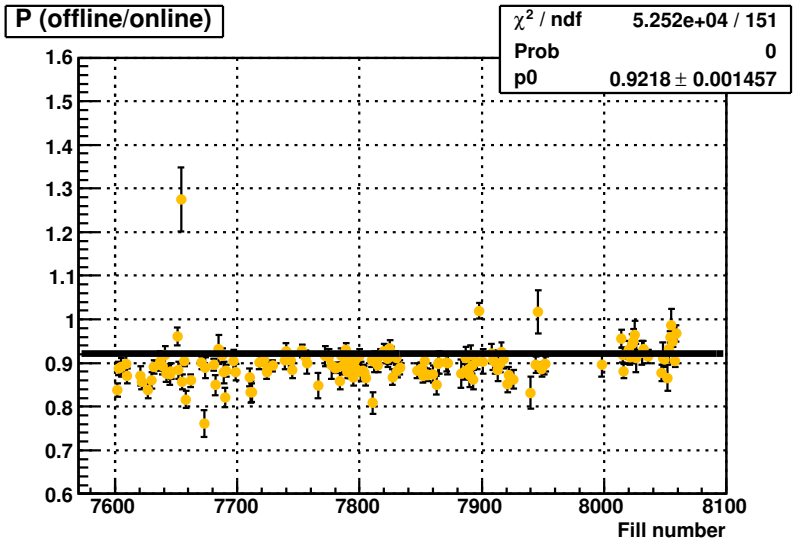


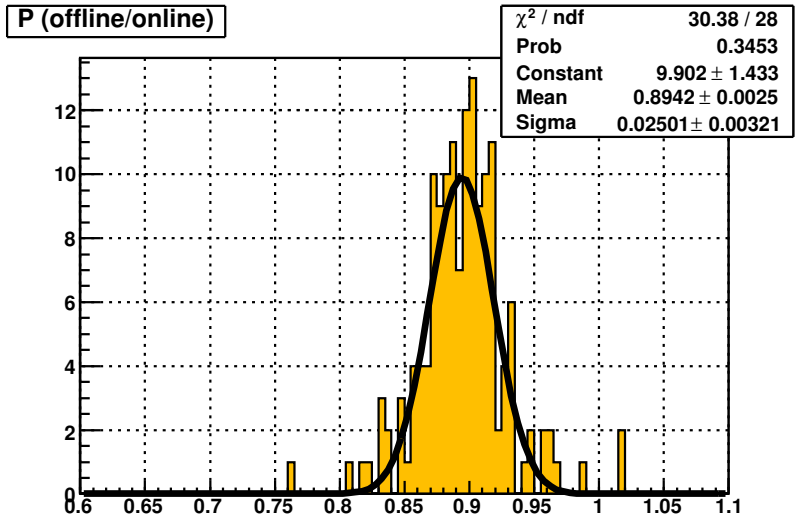


Online/offline (offline normalized by Jet & corrected for pol. prof. for exp.)





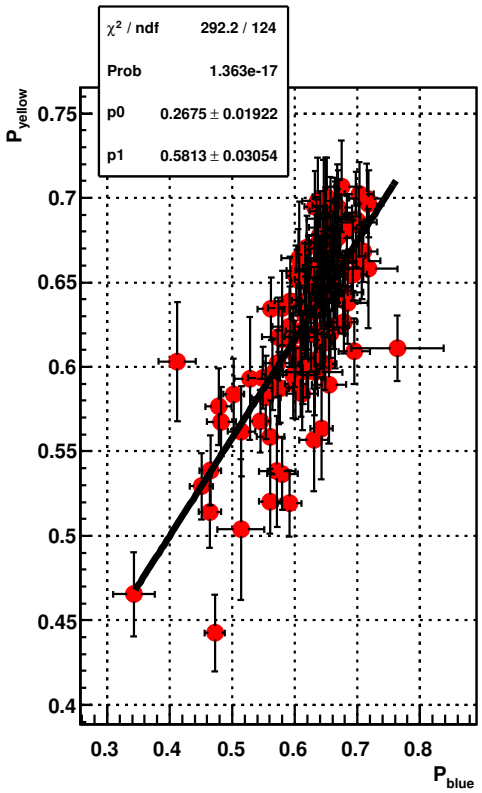


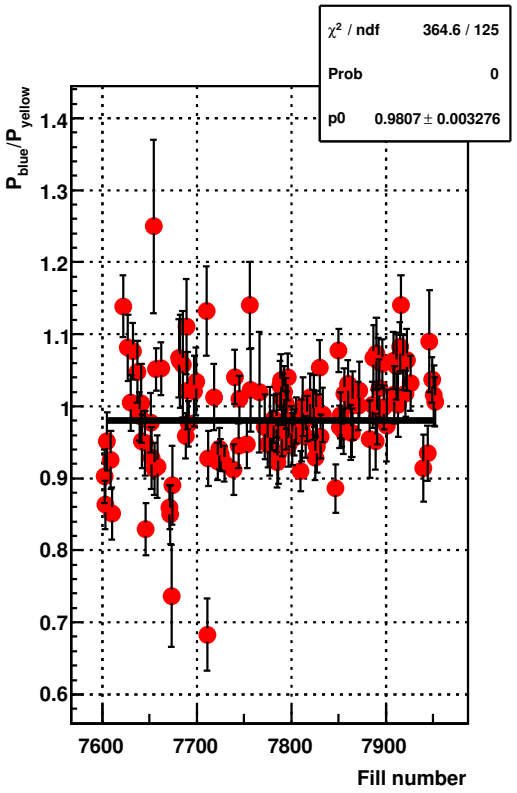


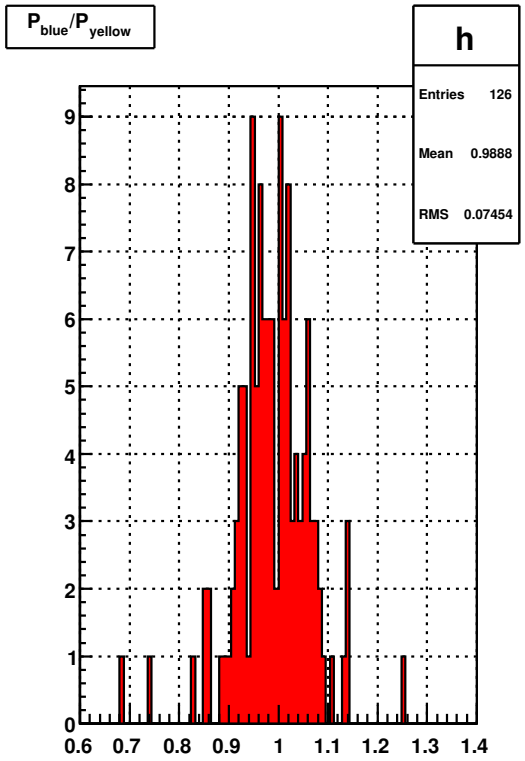
Correlation between blue and yellow polarizations

2 fills have only (good) yellow pC data (7621 & 7804):

We can use blue values for yellow and assign an additional systematic error of 8%



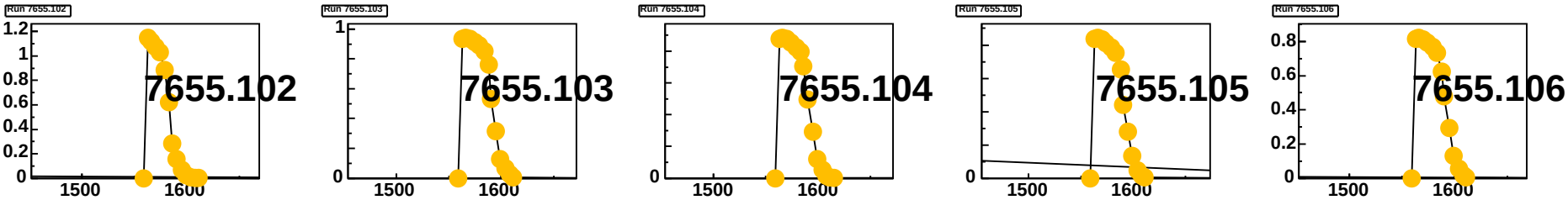




100 GeV

Unfinished scans (6 fills in yellow)

An example:



- Lower limit of polarization measured in these cases
- Used WCM information of these fills and fill with finished scans to estimate the maximum and assign a systematic error

Summary

- Scan measurements in all fills during Run-6
- Both horizontal and vertical polarization profile observed
- Problems with target motion/positioning
  (not important to obtain $\mathcal{P}$ values)
- More on systematic uncertainties in Sasha's talk (next)
- Final values for PHENIX and STAR bunches at:

  http://www4.rcf.bnl.gov/~cnipol/
- Questions:

  cnipol-l@lists.bnl.gov

Supplementary slides

Correlation between blue and yellow polarizations