Momentum Calibration

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31 Aug 2015

- Update of work done in 2012–3 (see e.g. http://hallaweb.jlab.org/12GeV/SoLID/meeting_coll/2013_03/rsholmes_kin.pdf)

- Up to date CLEO field — more complex fit than earlier

- Lessons learned about field granularity and propagation in GEMC

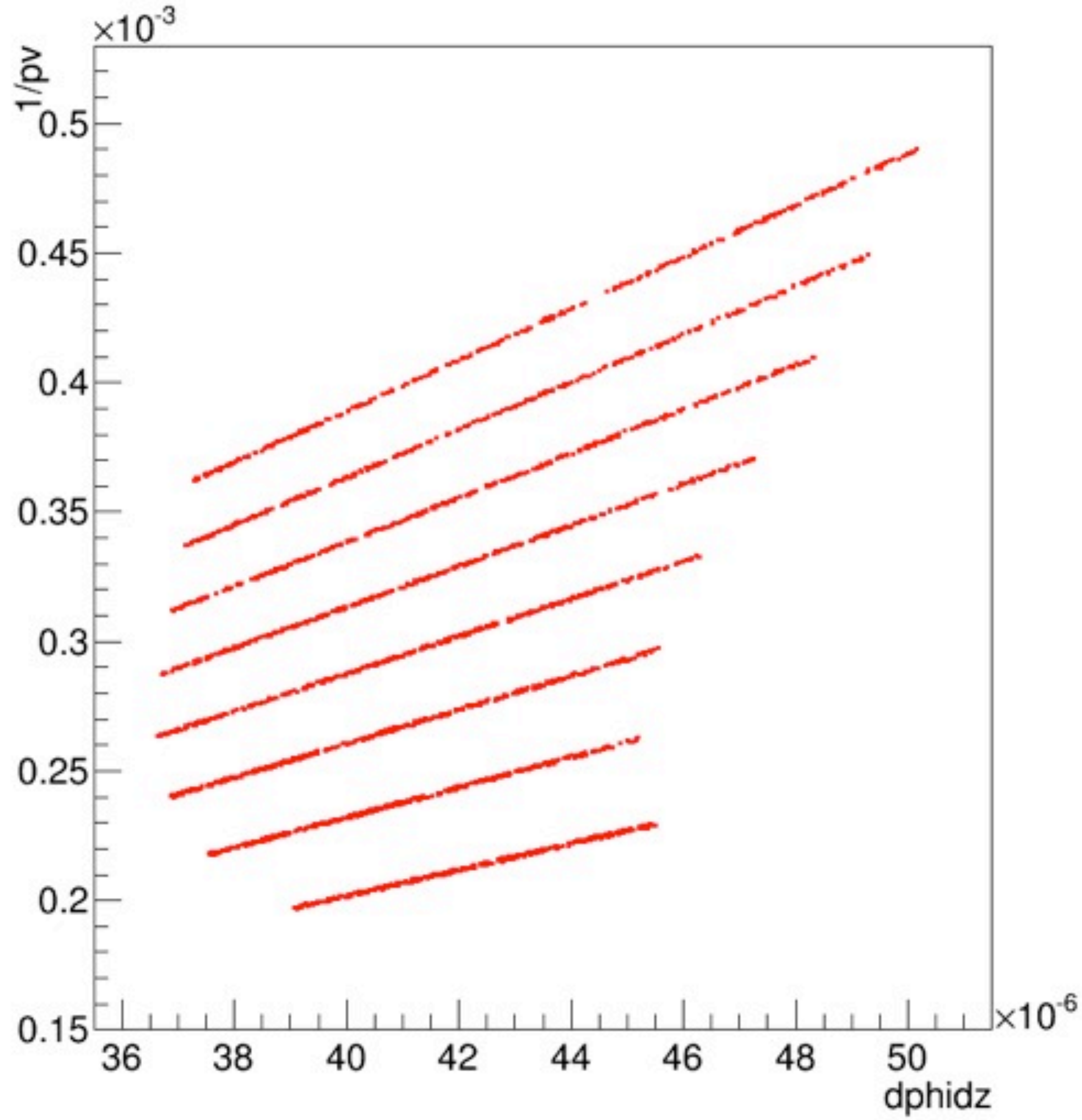
- Trajectory determined by vertex (x_v, y_v, z_v) and momentum (p, θ_p, ϕ_p). x_v, $y_v \approx 0$.
- Hits in 2 GEM chambers give 4 quantities x_1, y_1, x_2, y_2 or r_1, ϕ_1, r_2, ϕ_2
- Invert the mapping.

- Cylindrical symmetry => Use variables independent of ϕ_p:
  - $R \equiv (r_1 + r_2) / 2$
  - $\Delta\phi \equiv \phi_2 - \phi_1$, $\Delta r \equiv r_2 - r_1$
- $\Delta\phi$ is strongly correlated with 1/p.
- Δr is correlated with $\tan \theta_p$
- $\Delta r/R$ is correlated with z_v
- For easier comparison between plane pairs, R is normalized by $(z_1+z_2)/2$ and $\Delta\phi$, Δr are normalized by $z_2 - z_1$

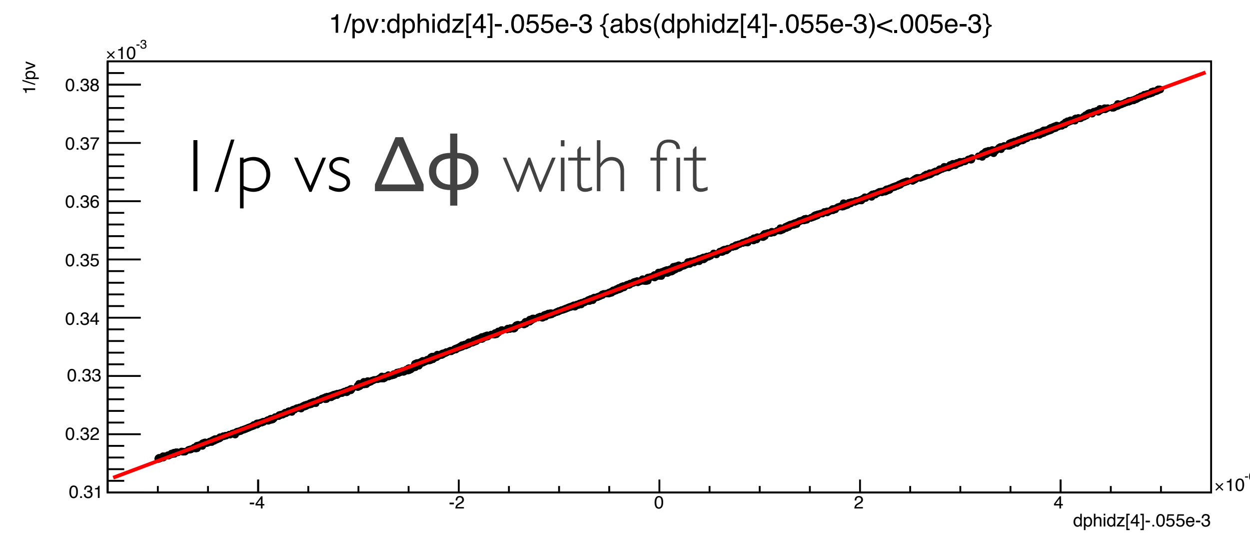
1/p vs $\Delta\phi$ for thin target (z_v=0) and fixed values of Δr. 1/p ~ linear in $\Delta\phi$ but not proportional.

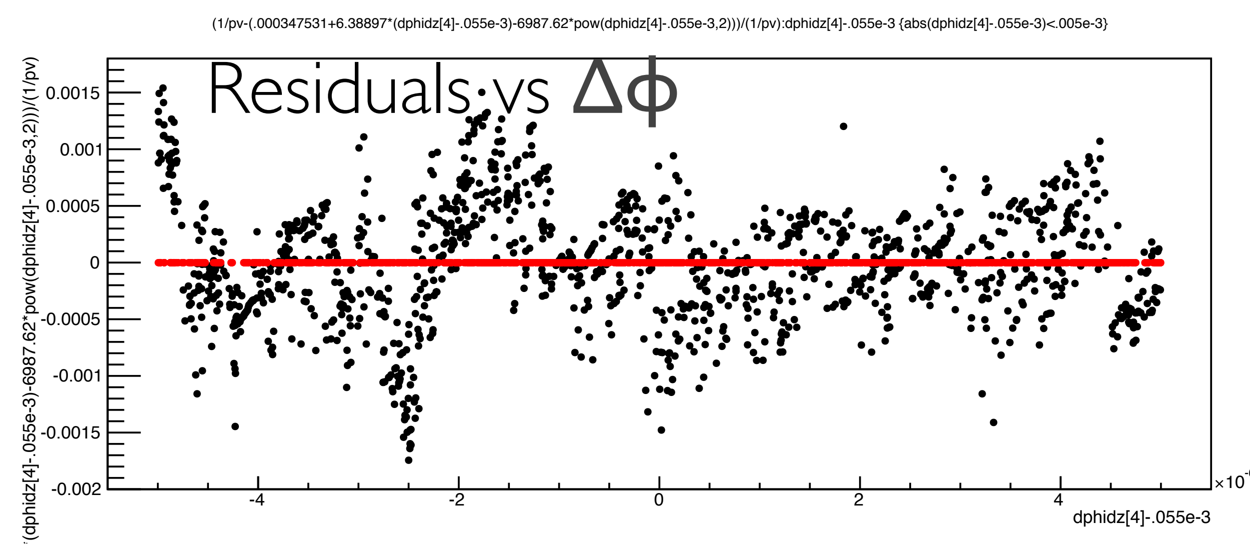
- For uniform field, 1/p is proportional to $\Delta\phi$. In previous work with older field this proportionality held, so 1/(p $\Delta\phi$) could be fit to 2-d polynomial in Δr, Δr/R

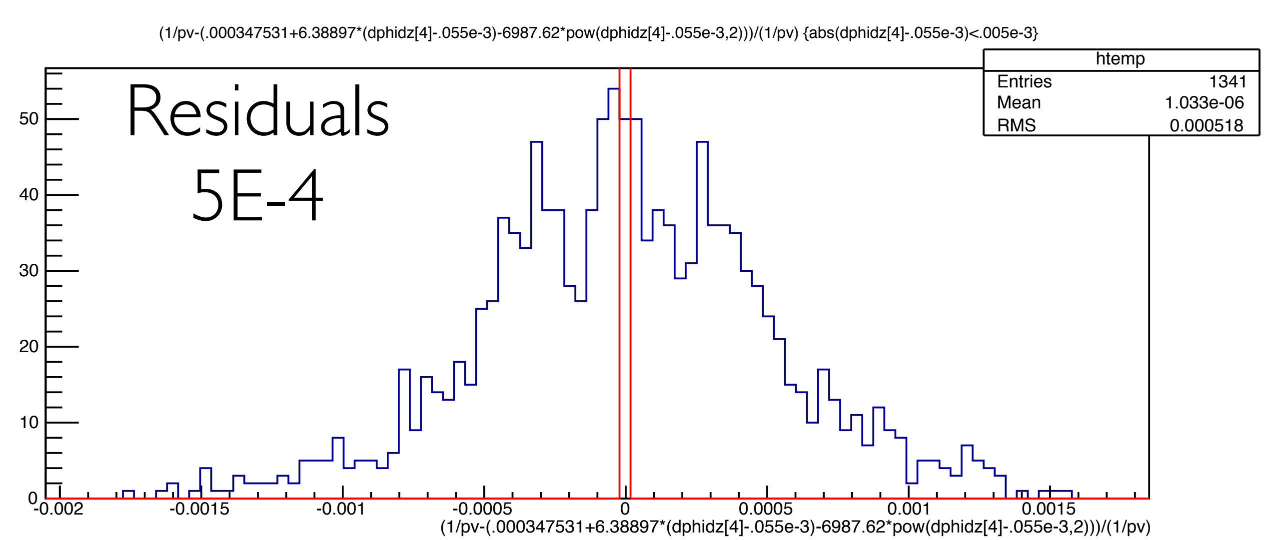
- For current version of field this does not work.



- Start with 1-dimensional problem. Use data where θ_p and z_v are fixed and fit 1/p to $\Delta\phi$. Use truth values of hit positions. NO material in simulation. No raster.
- Residual widths of order 0.1%. Why?
- For uniform field, residual width is zero.

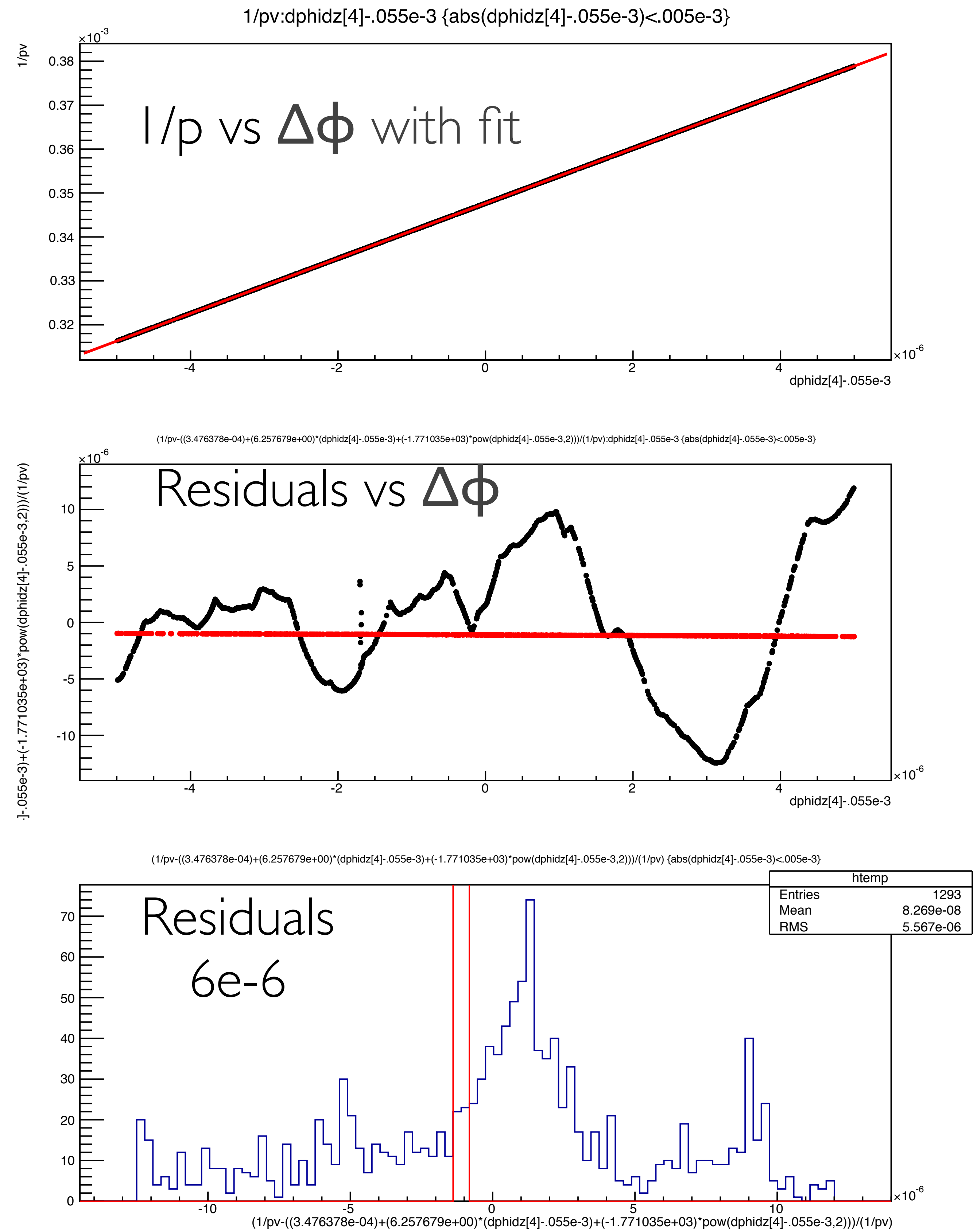






- Zhiwen recommended changes to field parameters in GEMC. Character of residuals vs Δϕ changed (less “noisy”) but only small reduction in width.

- Standard GEMC uses only sampled field map without interpolation. Adding linear interpolation reduced widths by factor ~100.

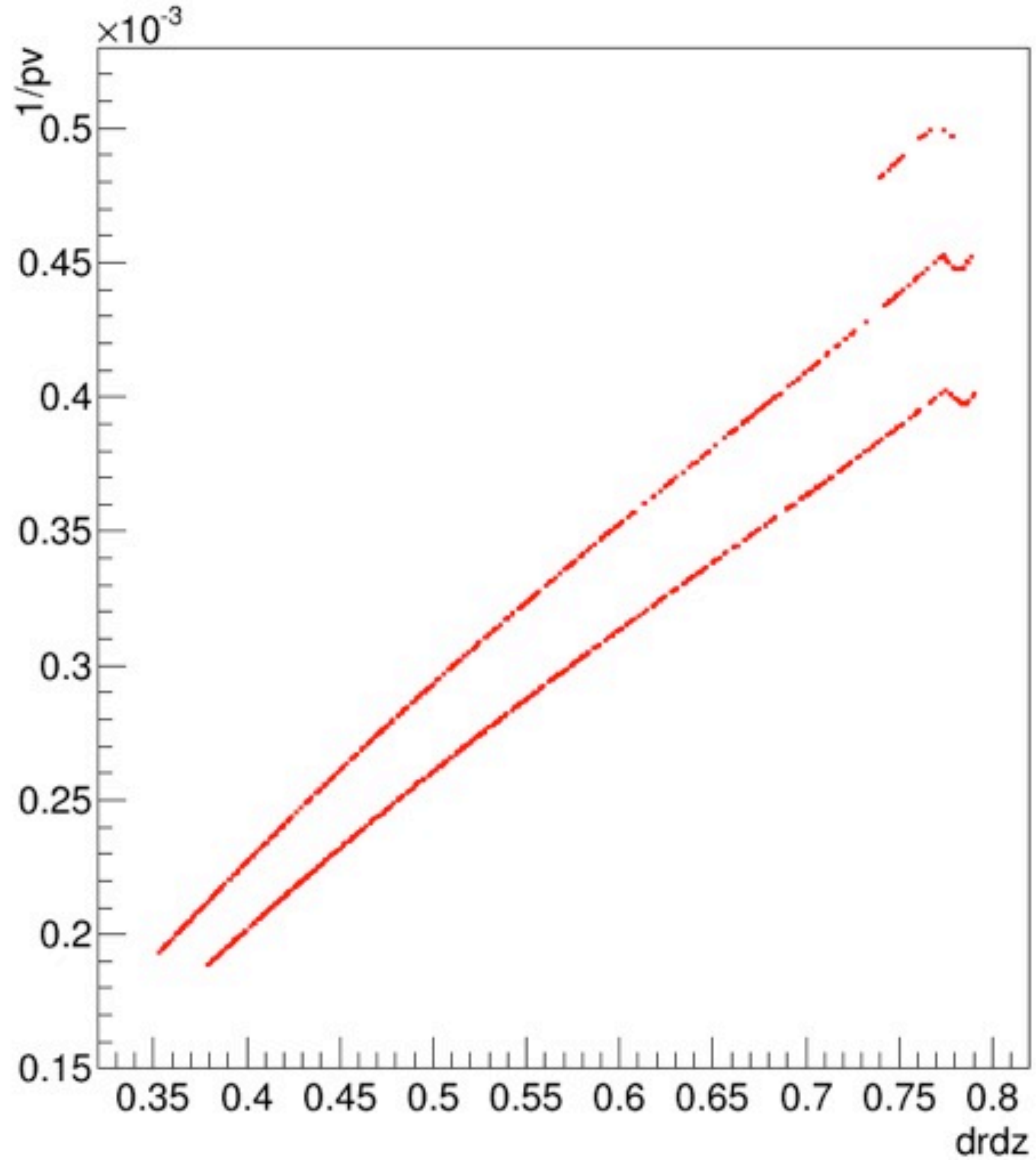


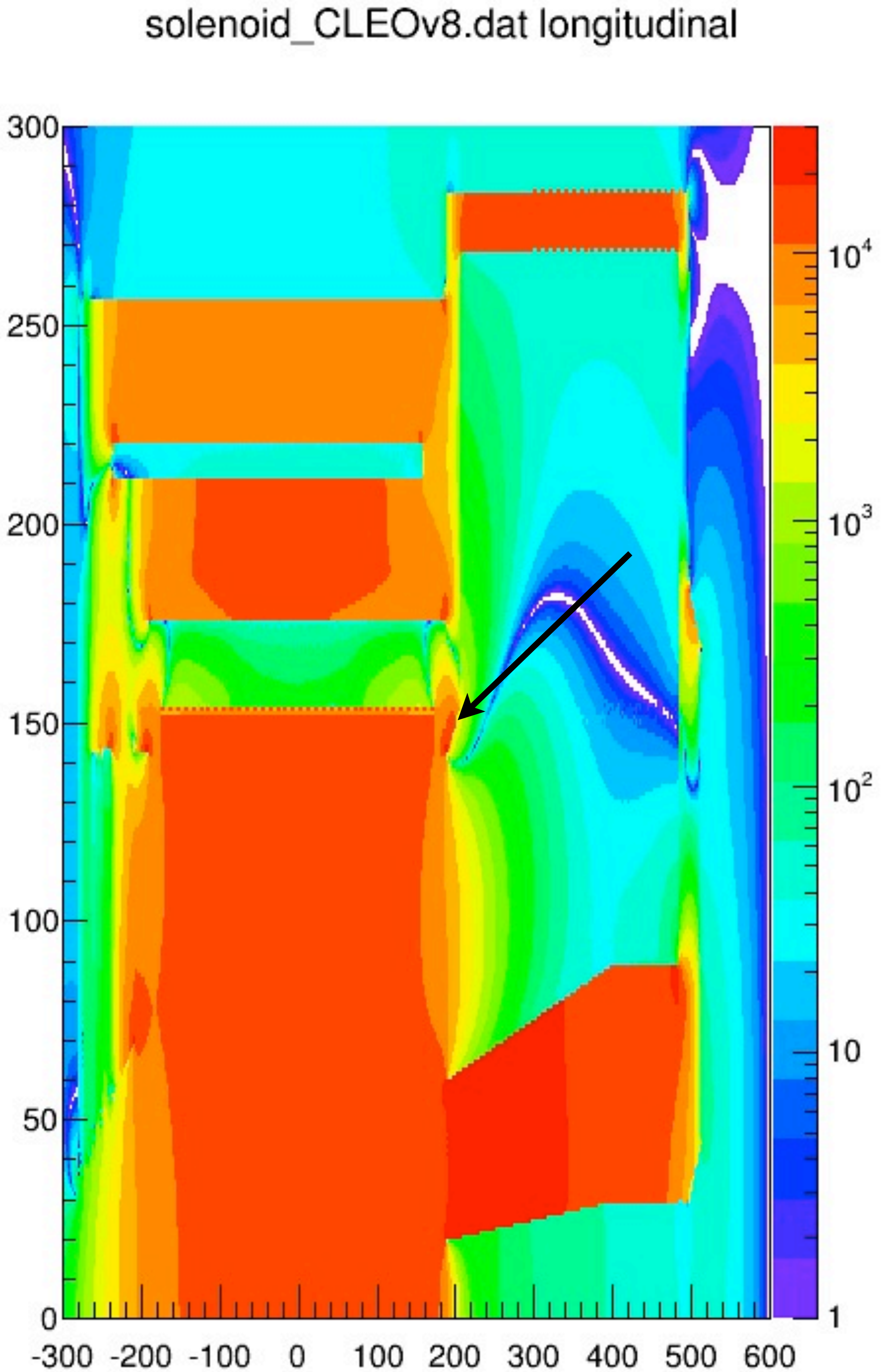
- 3D data (uniform p 2–6 GeV, θ_p 19°–40°, z_v -10–30 cm, with cuts for x_{bj} > .55, W^2 > 4 GeV^2, Q^2 > 6 GeV^2) fit of 1/p to polynomial in $\Delta\phi$, Δr, $\Delta r/R$. Poor results.

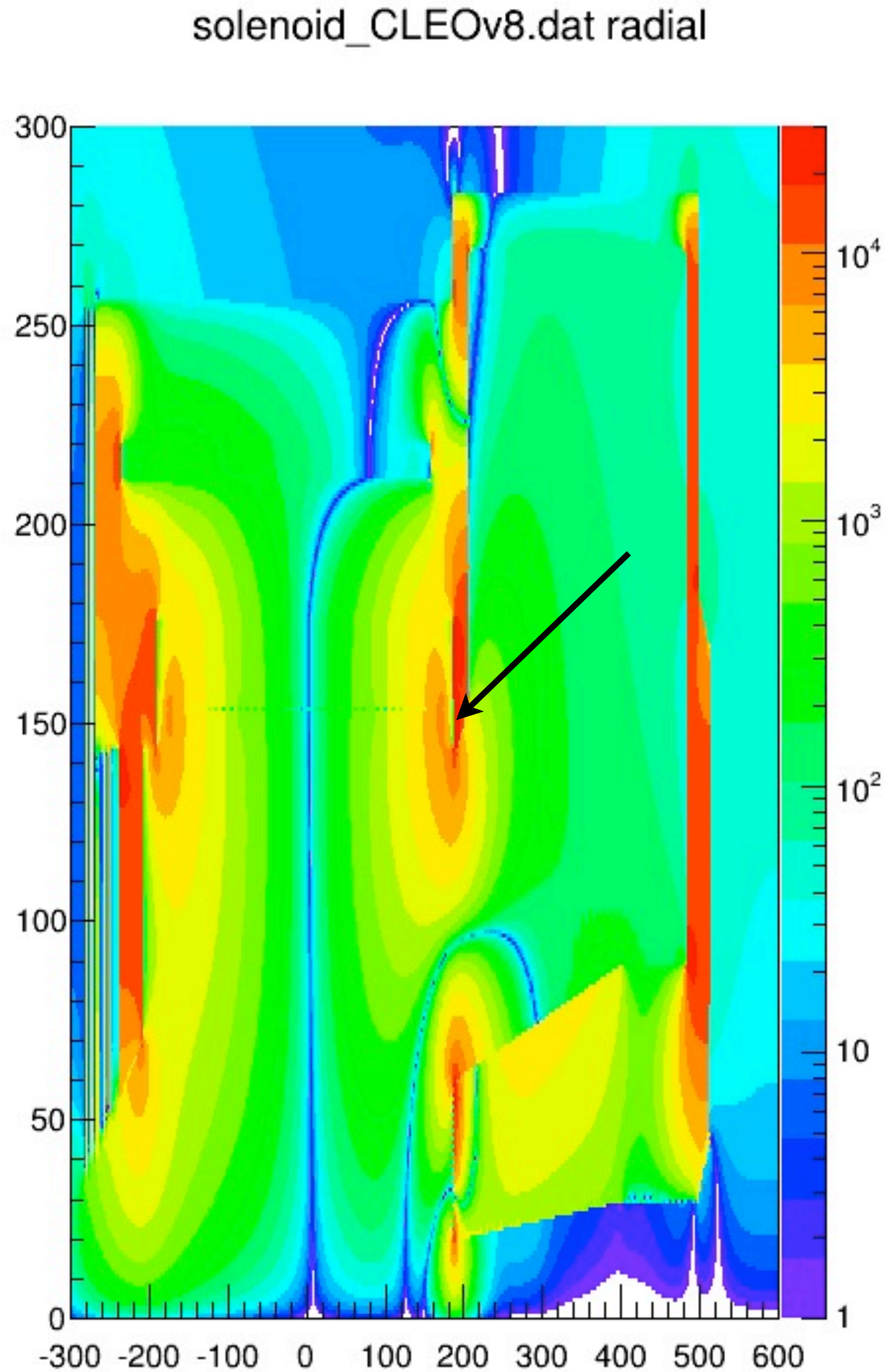
- Cause: "kink" in 1/p vs. Δr observed when using downstream GEMs

- Cause of kink not known in detail but associated with passing through z ~ 200 cm, r ~ 150 cm

1/p vs Δr for thin target (z_v=0) and fixed values of $\Delta\phi$.




solenoid_CLEOv8.dat longitudinal
300
250
200
150
100
50
0
-300 -200 -100 0 100 200 300 400 500 600
10^4
10^3
10^2
10
1


solenoid_CLEOv8.dat radial
300
250
200
150
100
50
0
-300 -200 -100 0 100 200 300 400 500 600
10^4
10^3
10^2
10
1

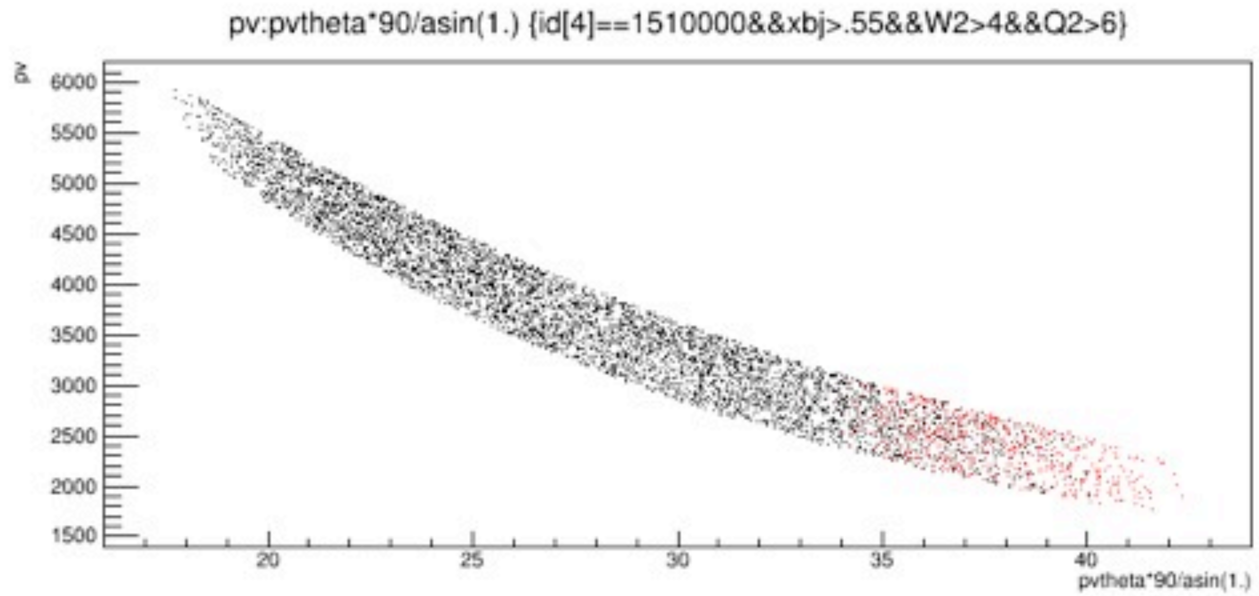
- With cuts on Δr to remove kinks, fits for all GEM pairs using downstream GEMs give 1/p with residual width ~ 0.007%. Upstream GEMs are worse: 0.014% (1 and 2), 0.021% (1 and 3), 0.07% (2 and 3).

- Kink cut rejects about 4% of total rate. (Not optimized.) High Q^2, ~uniform x_{bj}.

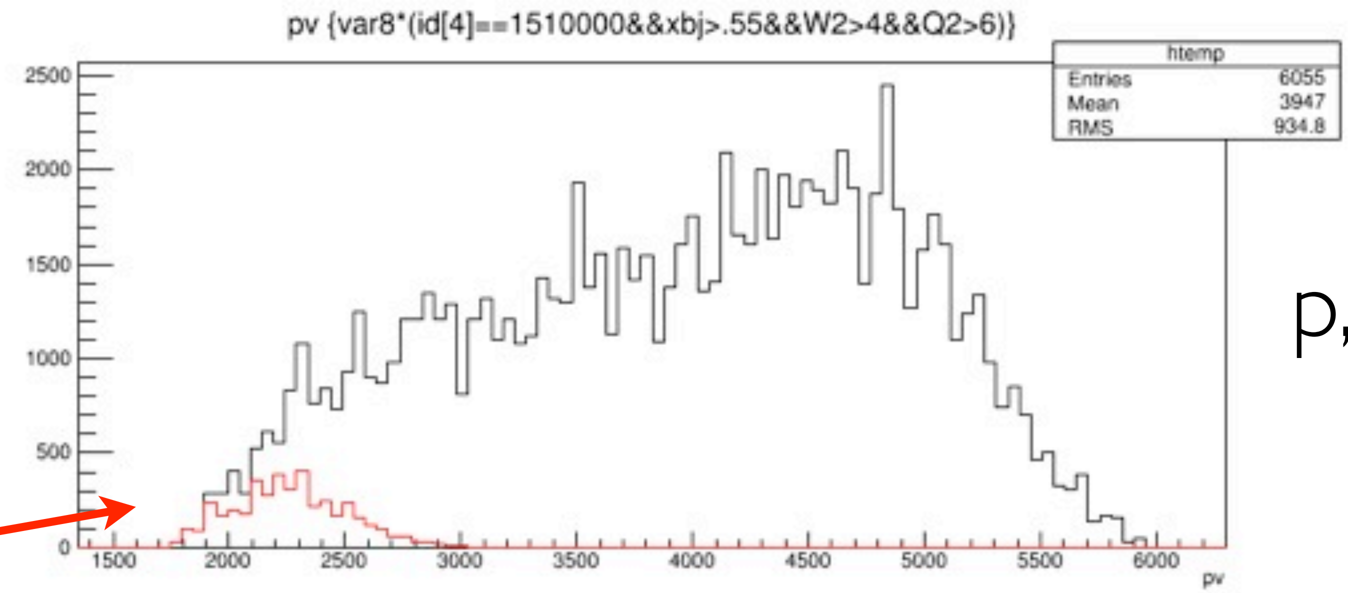
- Using 3D polynomial of order 1 in Δϕ, 4 in Δr, 3 in Δr/R. (40 parameters.)

- Not dealt with yet: Digitized signals, material, effects of rastering, cross calibration with elastics.

Extra



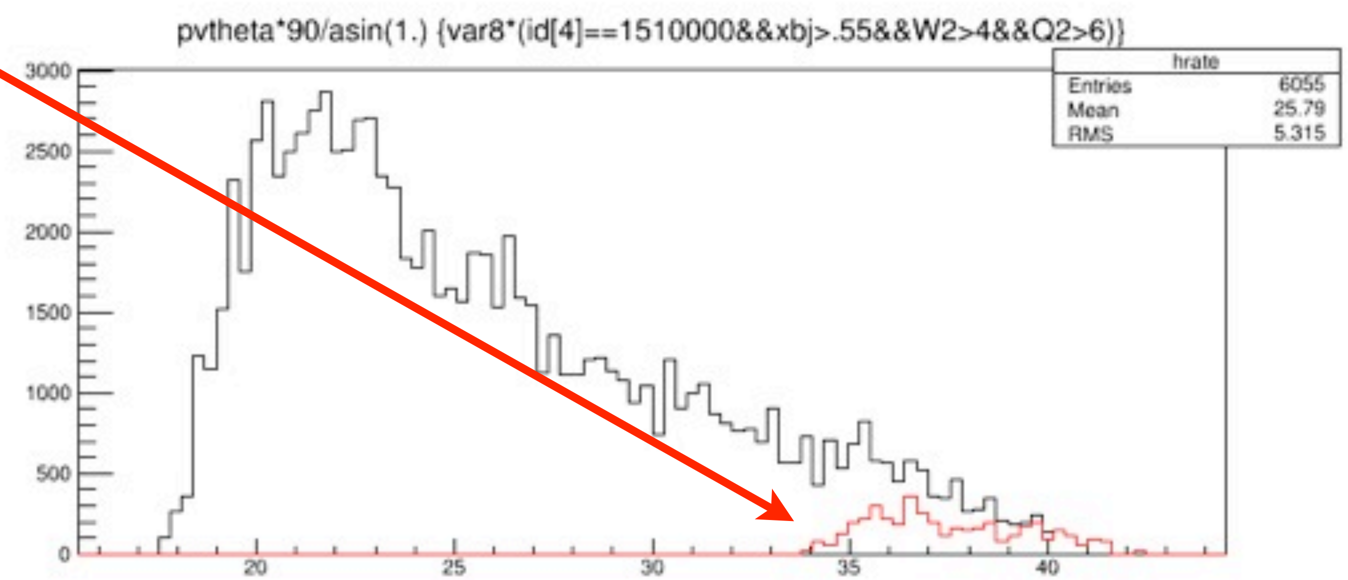
p vs θ_p



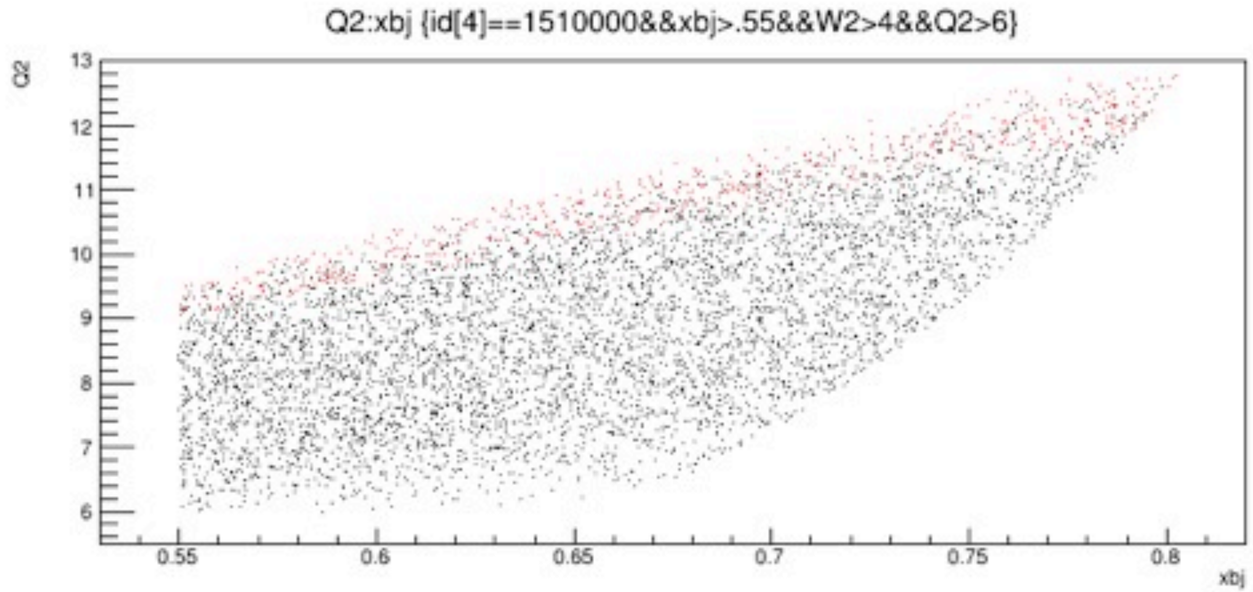
p, DIS rates

Kink cut

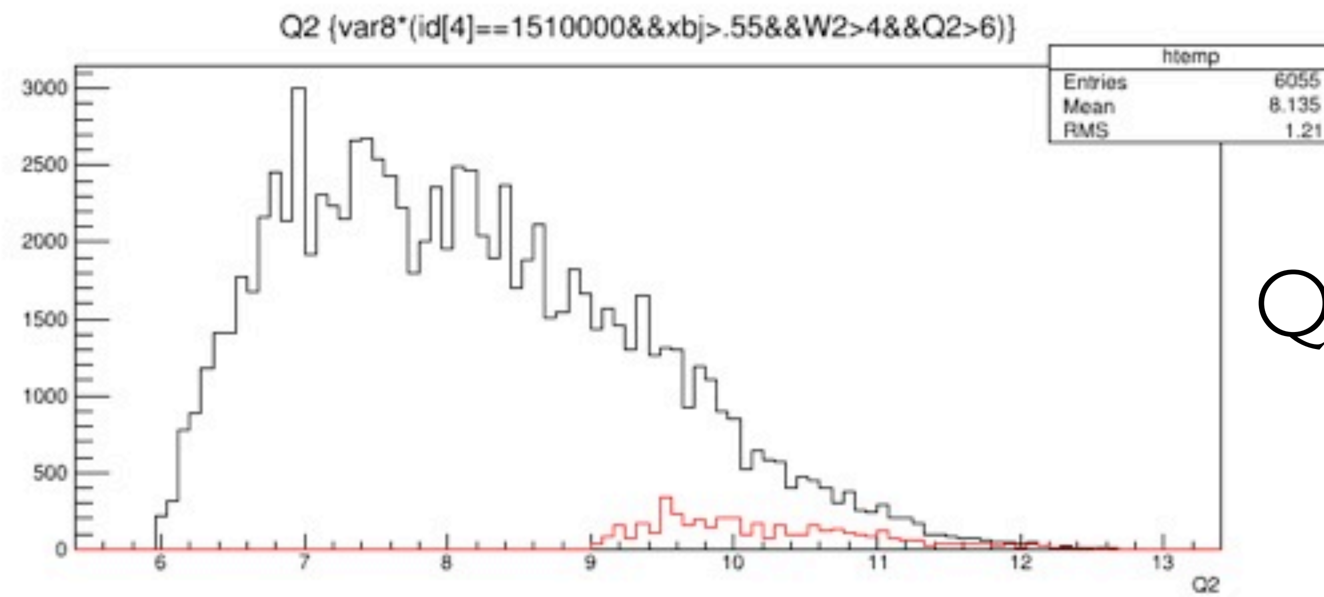
~4% of total rate



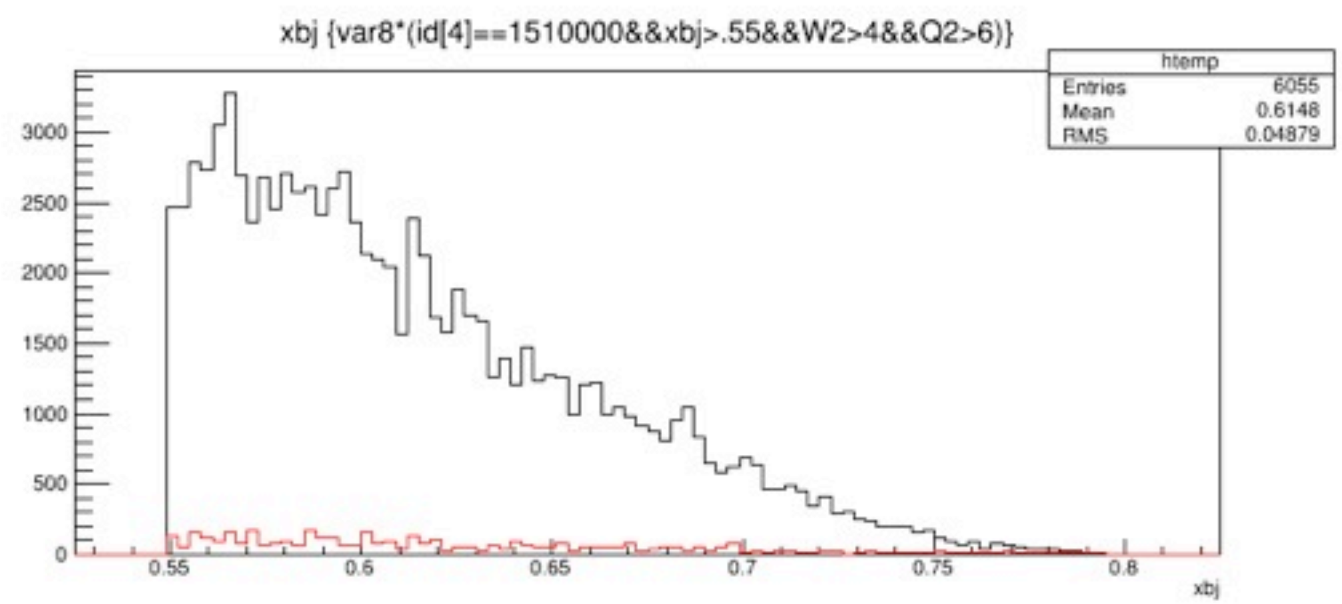
θ_p



Q^2 vs x_{bj}



Q^2, DIS rates



x_{bj}