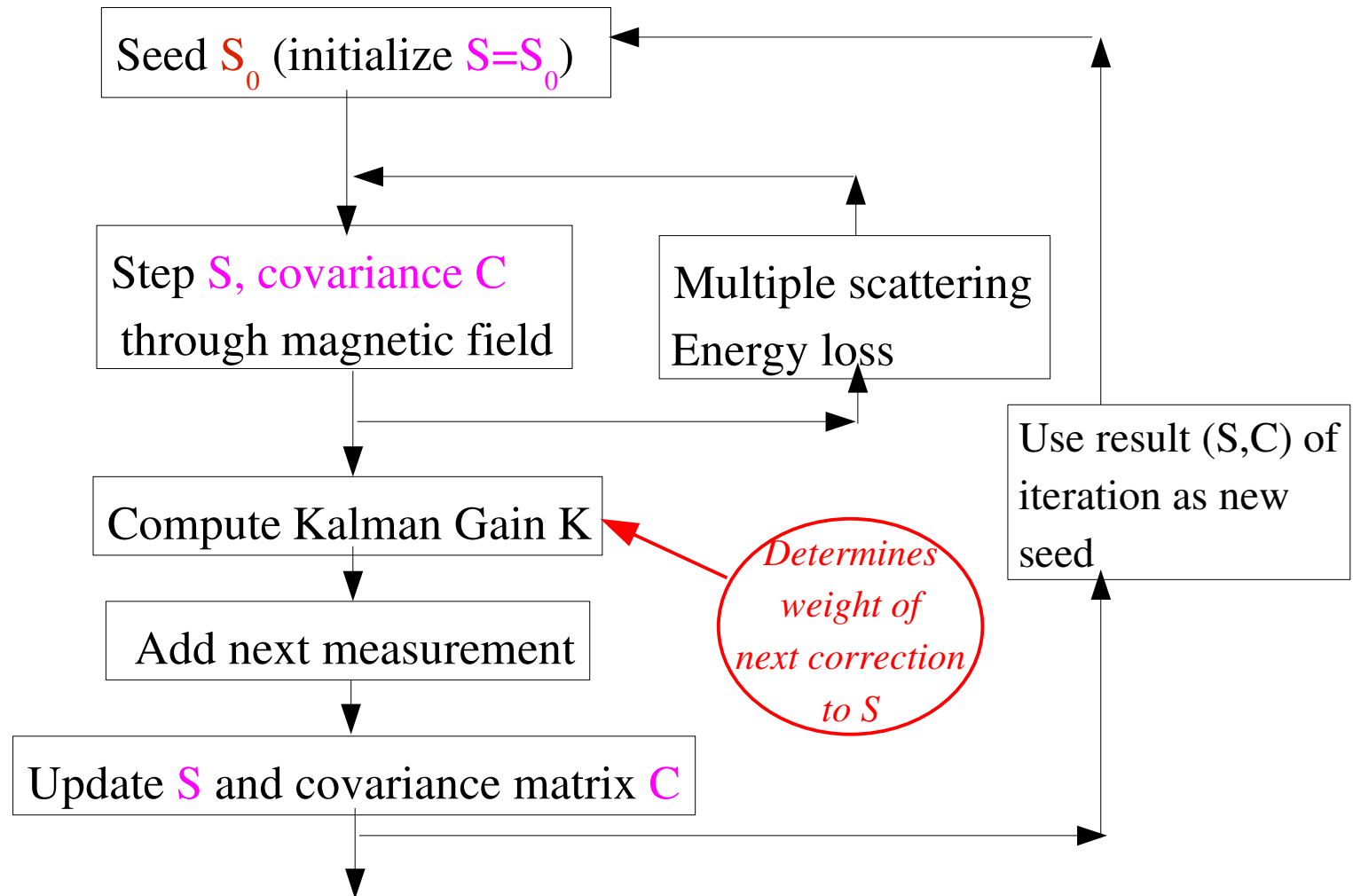


- Track described by **5-parameter state vector** at each point along its path
- **State vector** propagated step-by-step toward target
 - **Multiple scattering** and **energy loss** taken care of at each step
 - Does not require inversions of large matrices (at most 2x2 for FDC hits)
 - Jacobian matrix elements computed analytically
- State vector treated as a perturbation to an initial guess
 - Generate **reference trajectory** by swimming with initial parameters from the target
- Perform filter in three passes
 - Can iterate up to 10 times per pass, checking for χ^2 convergence
 - Regenerate reference trajectory based on results of previous pass

Algorithm

Start with seeds coming from CDC and FDC track finding code (helical fits)

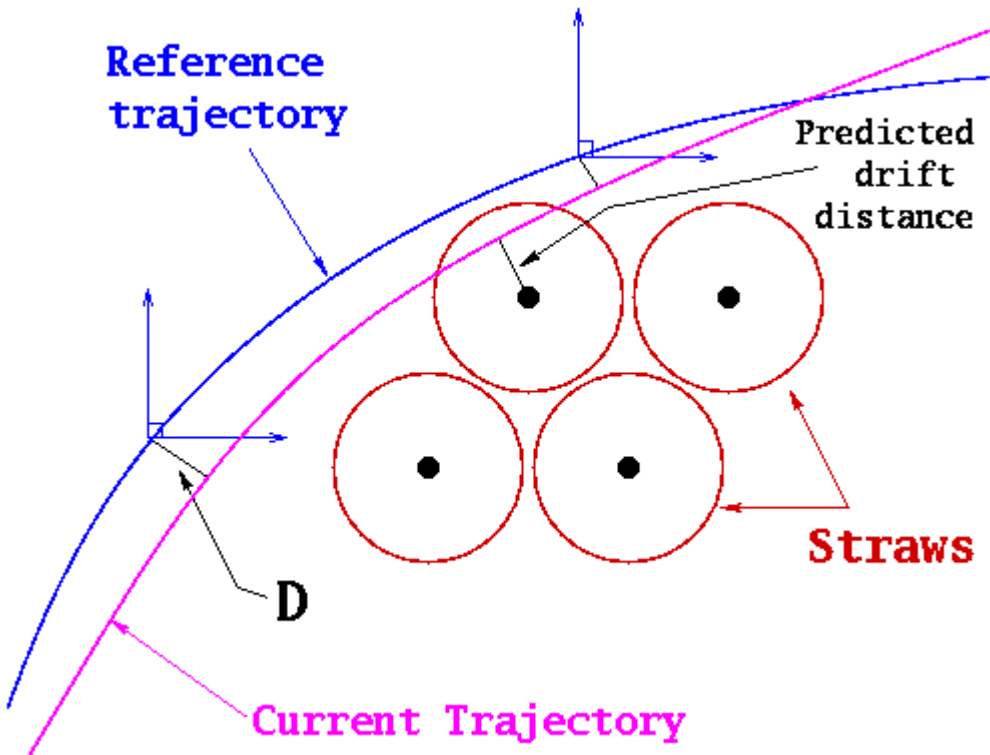


Forward Tracking

- State vector $\{x, y, t_x = dp_x / dp_z, t_y = dp_y / dp_z, q/p\}$
 - “Fitted” state vector considered as small perturbation relative to a **seed**
 - **Seed** determined from list of **track candidates** using helical model
- First step: create reference trajectory from seed, swimming from “vertex” to most downstream FDC hit
 - Take into account multiple scattering and energy loss when stepping through the field – *only do this for the reference trajectory...*
- Measurements added one by one, starting with most downstream hit
 - Apply Lorentz corrections at this stage
 - Iterate up to 10 times – generally only 2 or 3 iterations needed for convergence
 - CDC hits included without changing state vector

Central Tracking

- Start out by swimming a reference trajectory as for forward tracking



- Use central parameters:

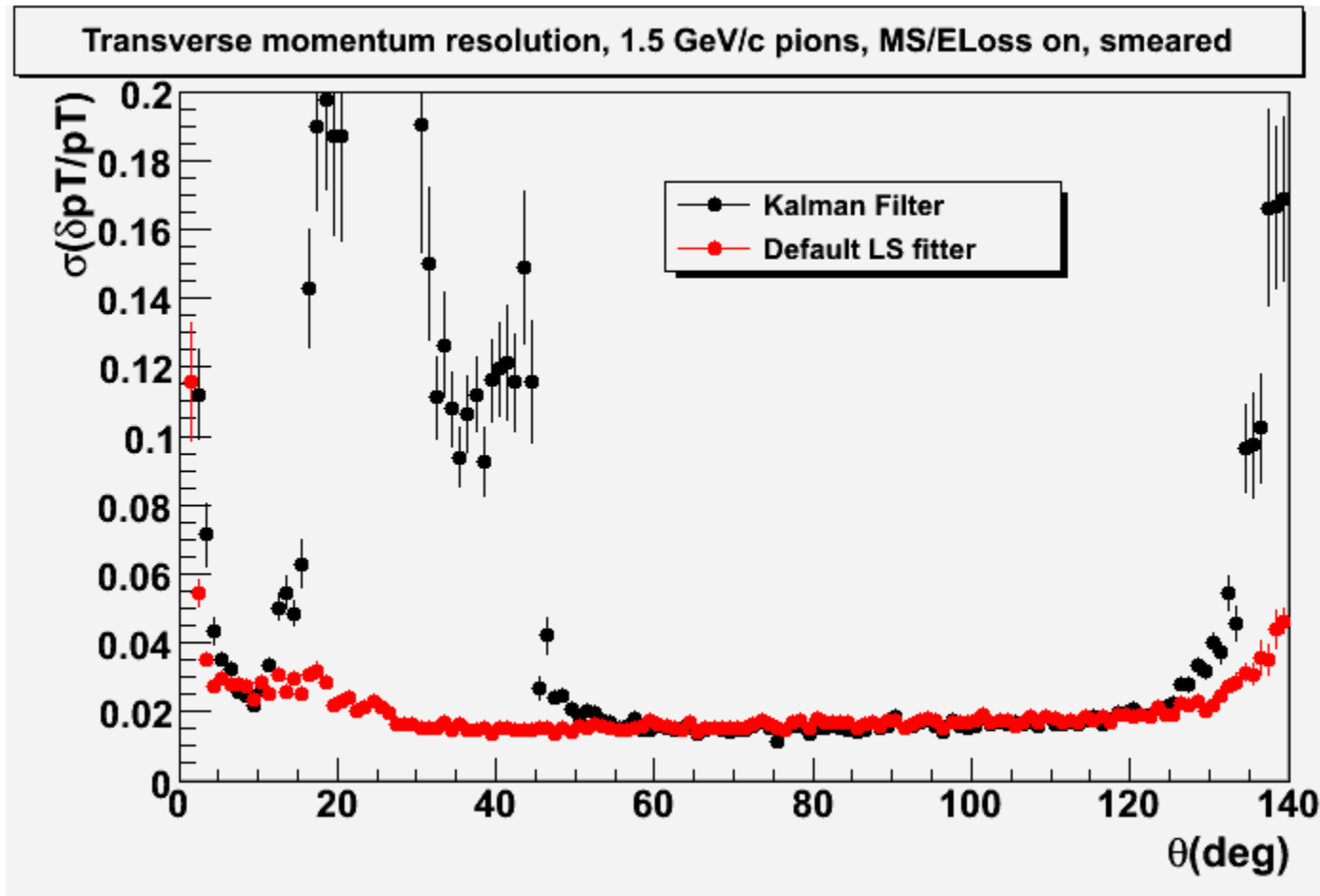
$$\{q/p_T, \phi, \tan \lambda, D, z\}$$

- D =distance of closest approach to the reference trajectory at a given time along the particle's path
 - Origin of coordinate system for D moves from point to point along reference trajectory

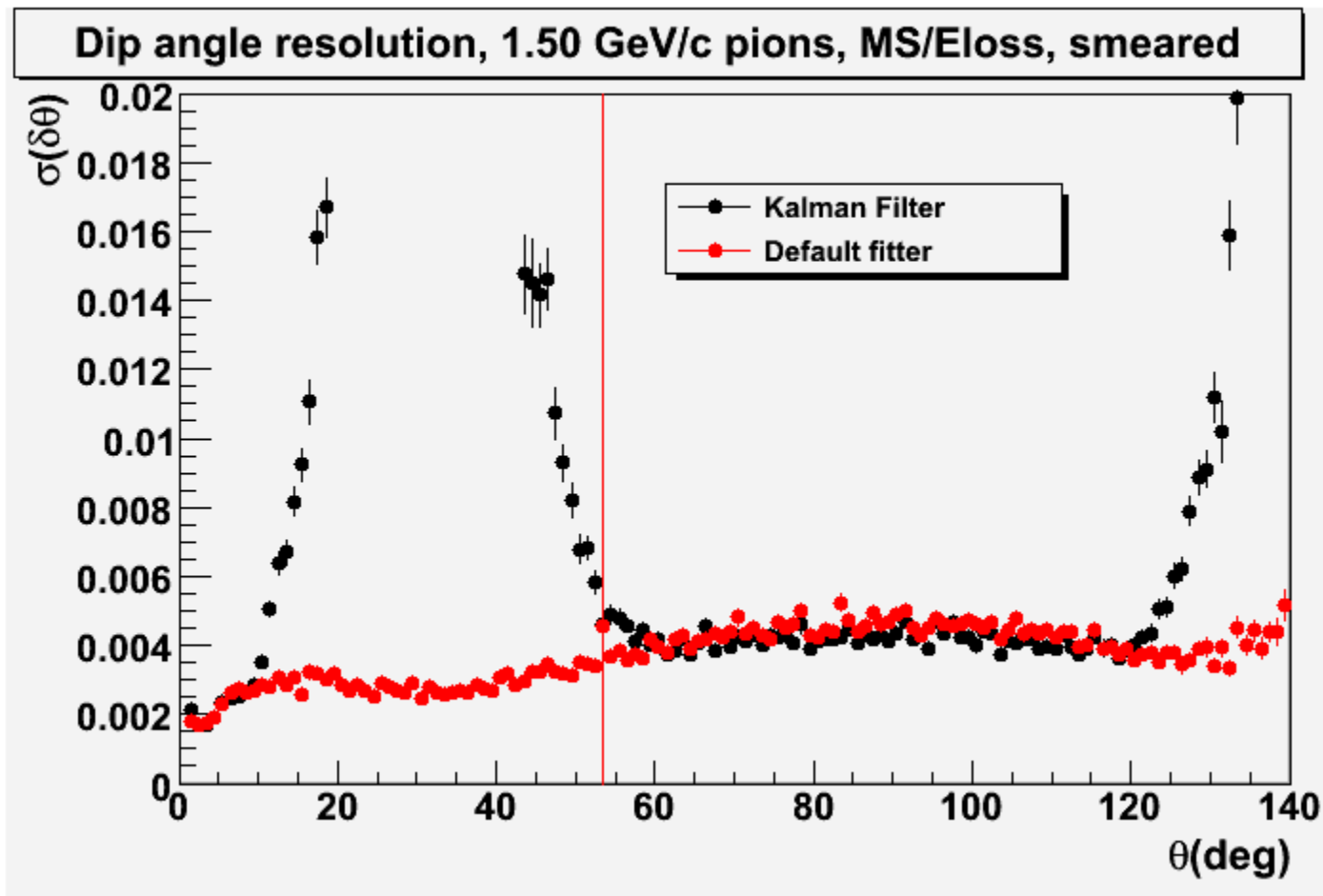
- Initial guess for covariance matrix (off-diagonal elements=0)

$$(\Delta p_T/p_T) = 10\%, \quad \sigma_D = 1 \text{ mm}, \quad \sigma_z = 3 \text{ mm}, \quad \sigma_\phi = 10 \text{ mrad}, \quad \sigma_\lambda = 10 \text{ mrad}$$

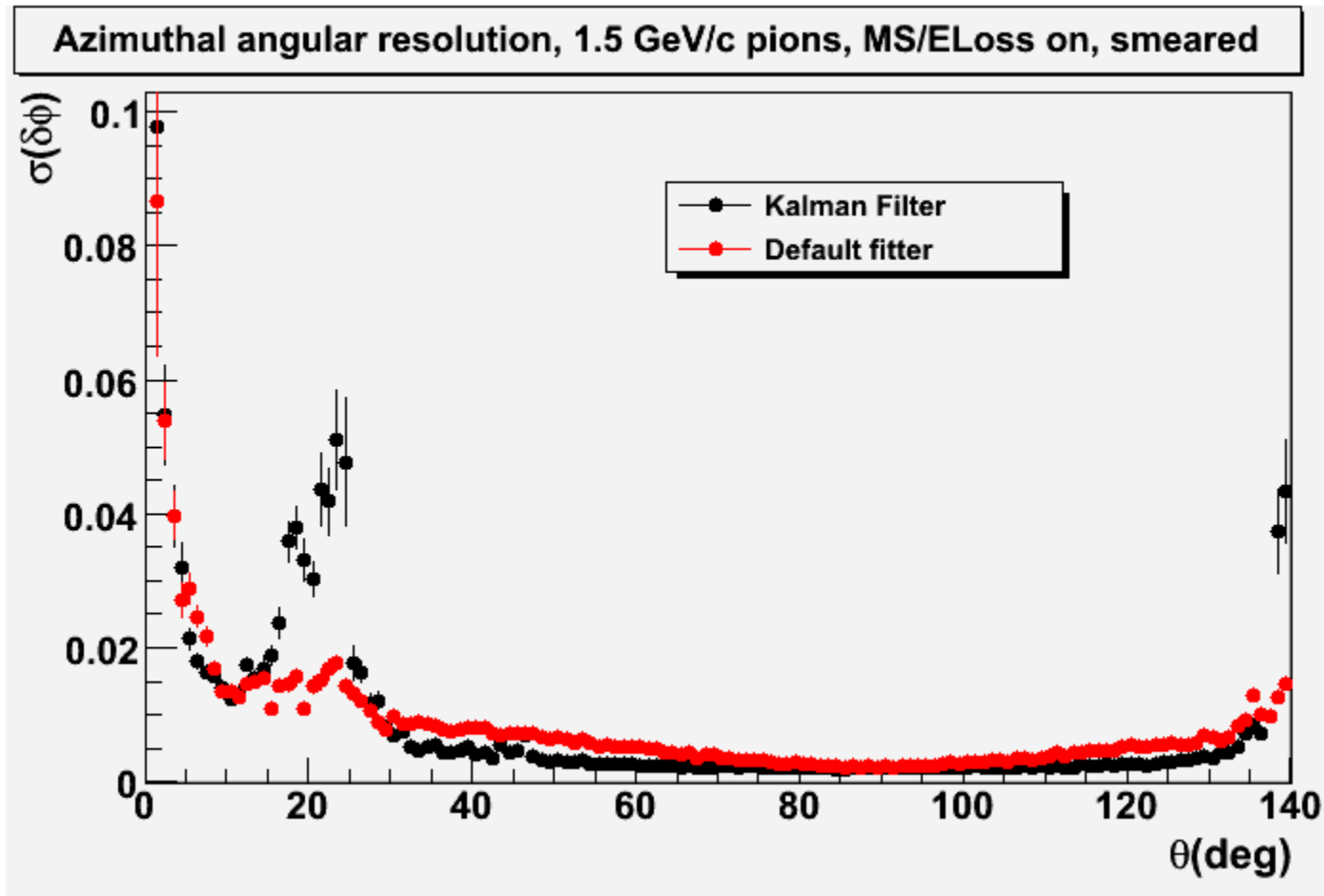
Transverse Momentum Resolution



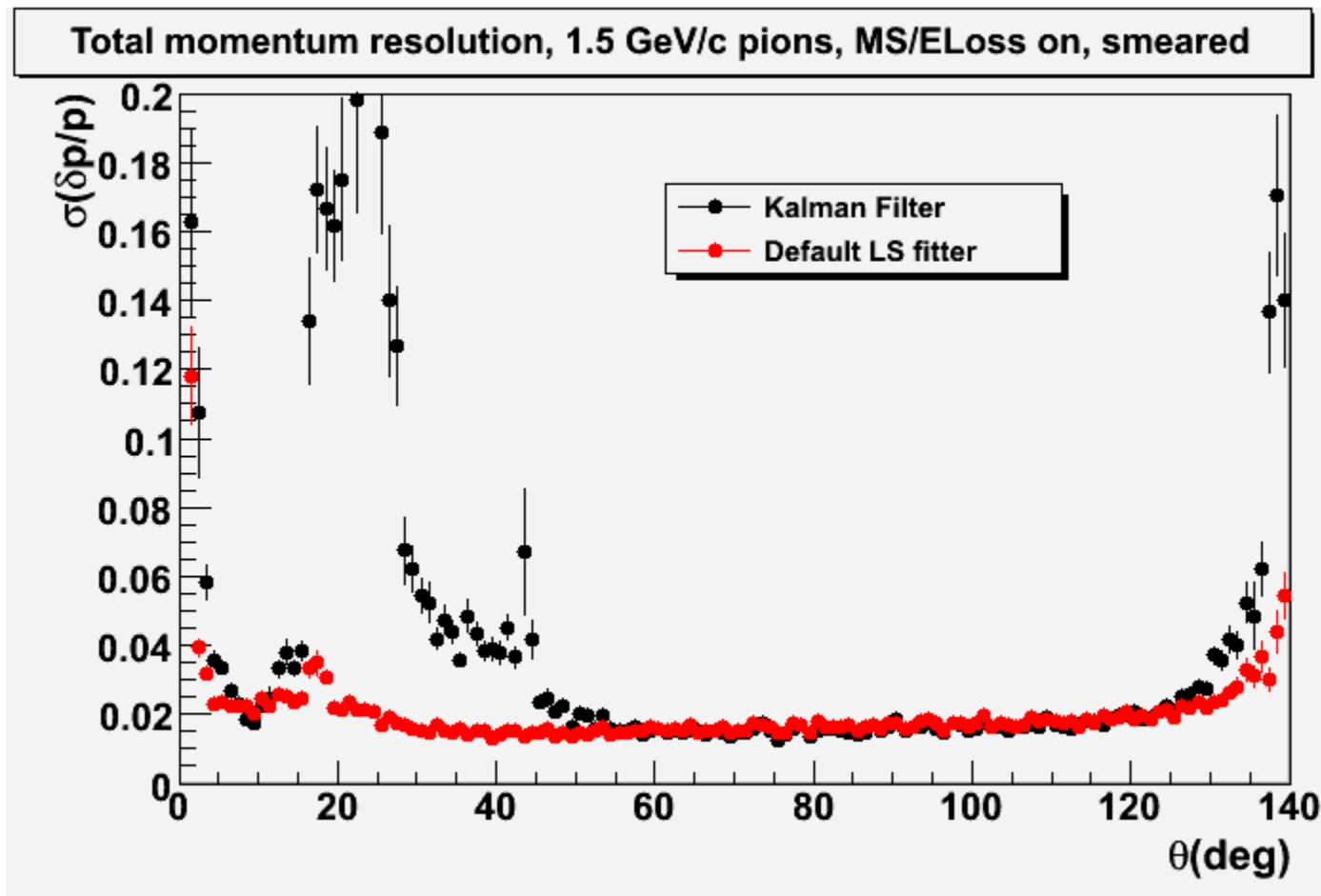
Dip Angle resolution



Azimuthal angle resolution



Momentum magnitude resolution

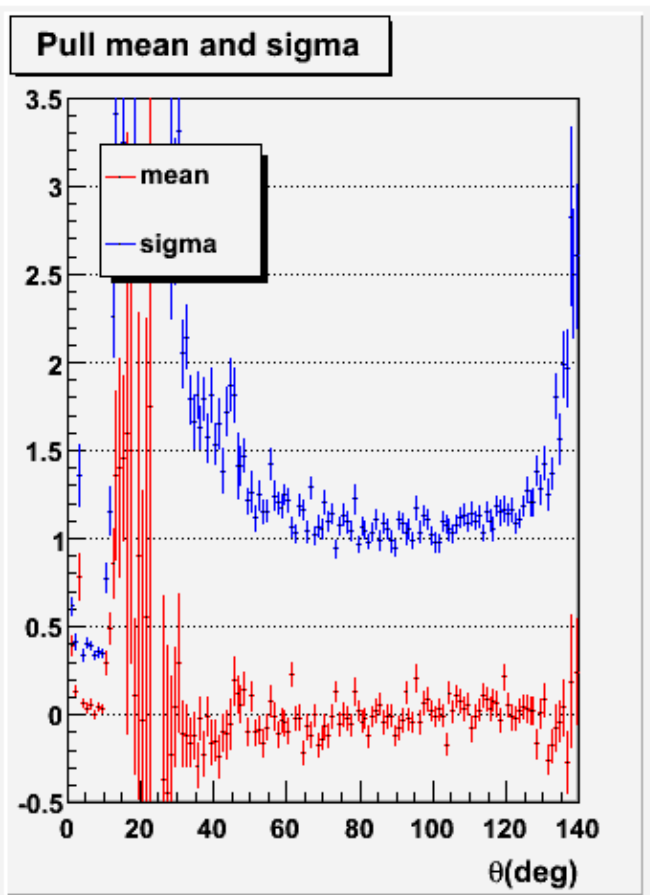
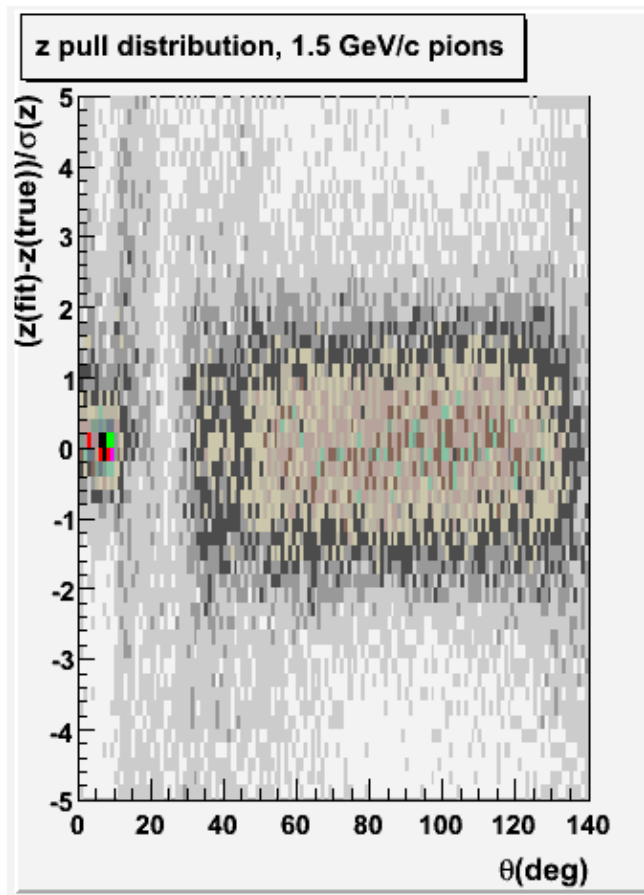


Pull Distributions

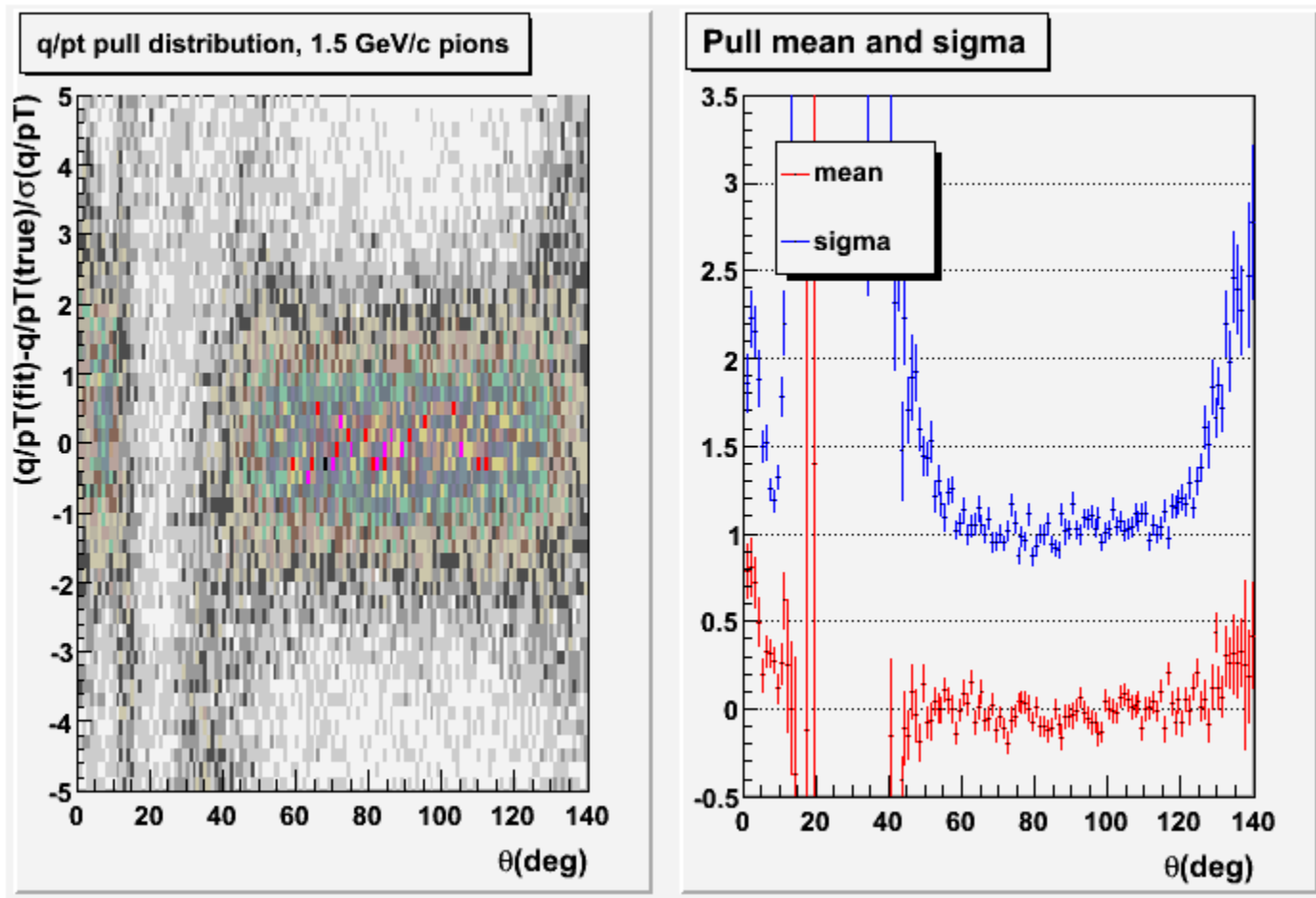
- Check for biases, check that errors are correct

$$Pull(z) = \frac{z - z_{true}}{\sqrt{\sigma^2(z)}}$$

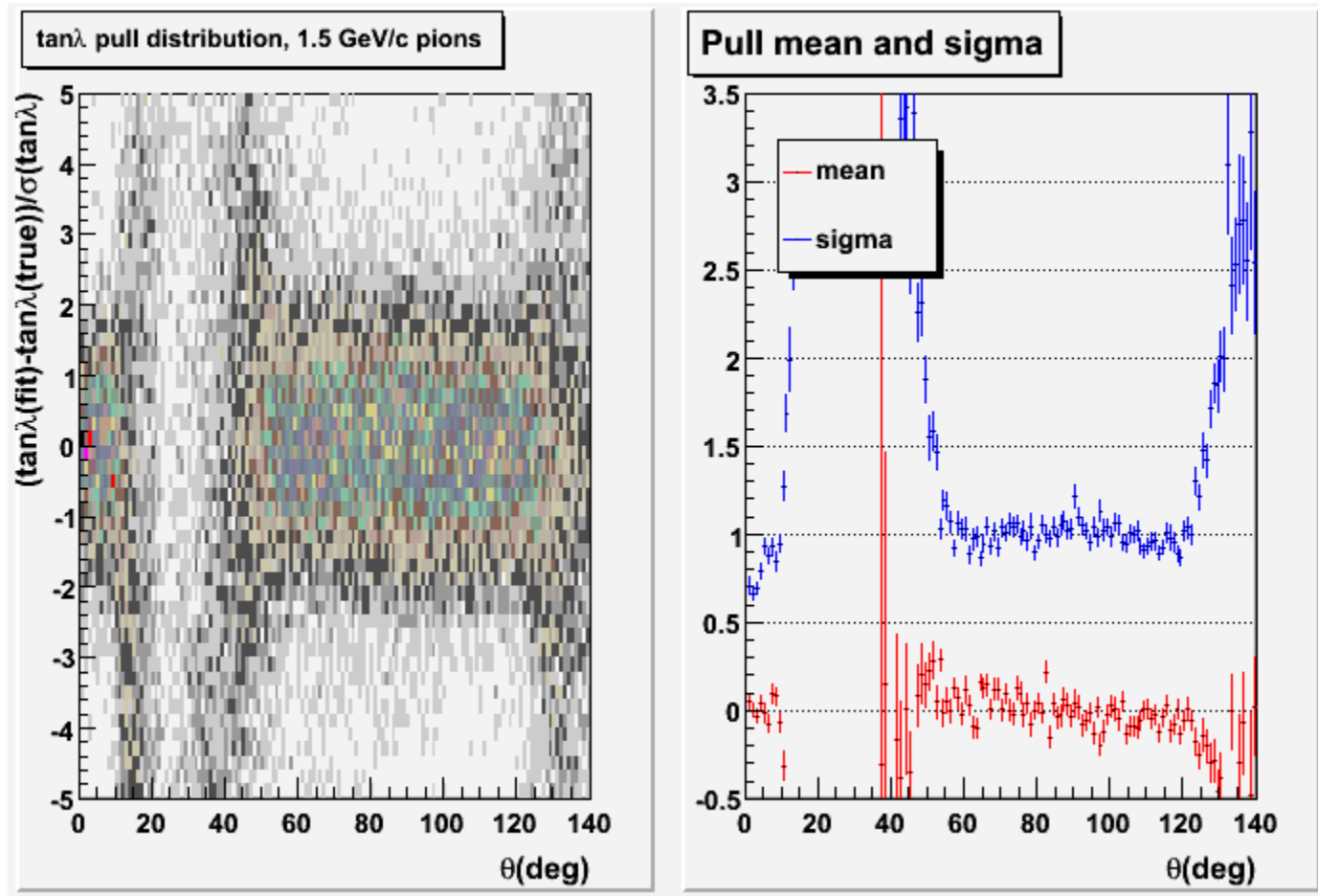
- Mean should be 0
- Standard deviation should be 1



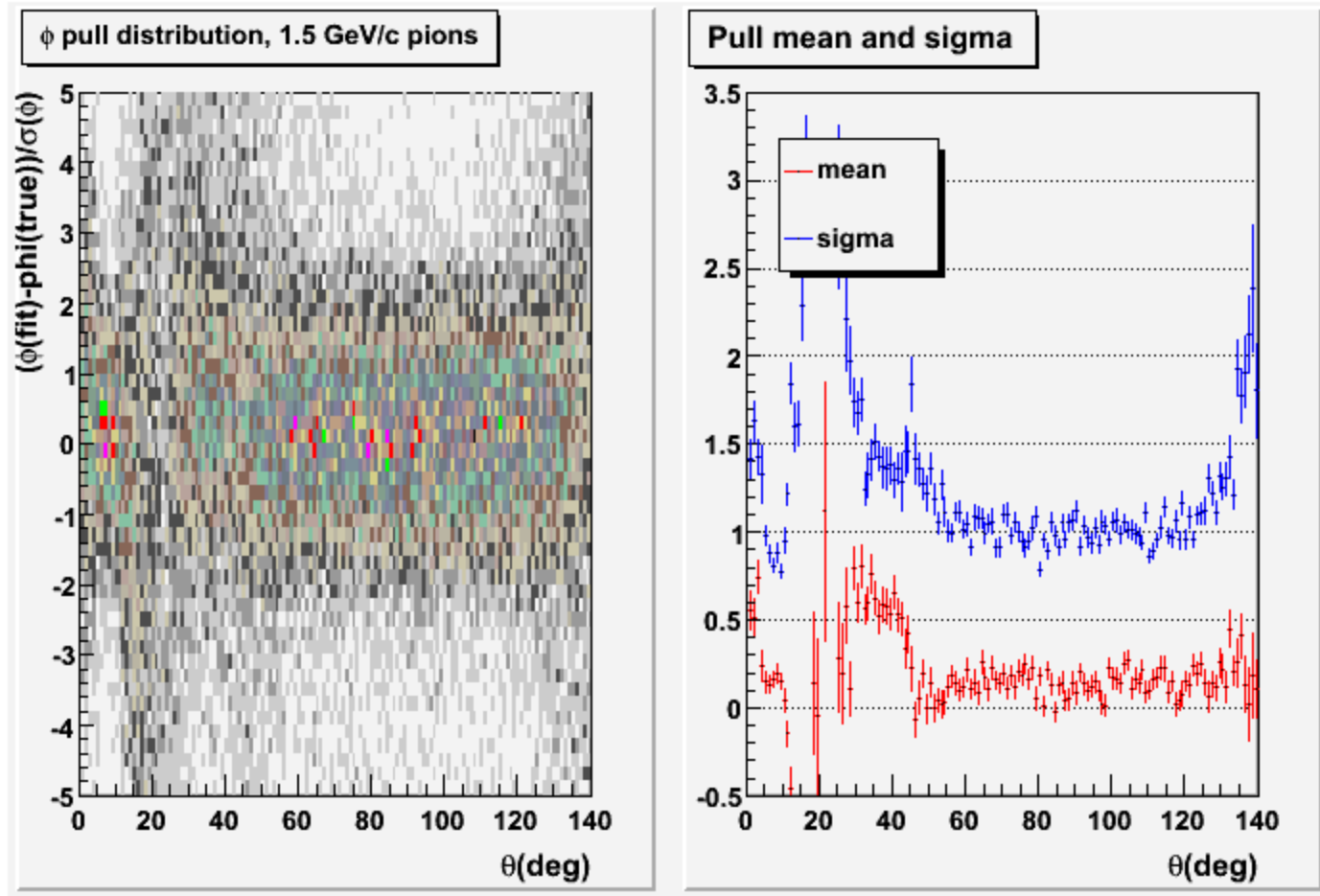
Pull Distribution for q/p_T



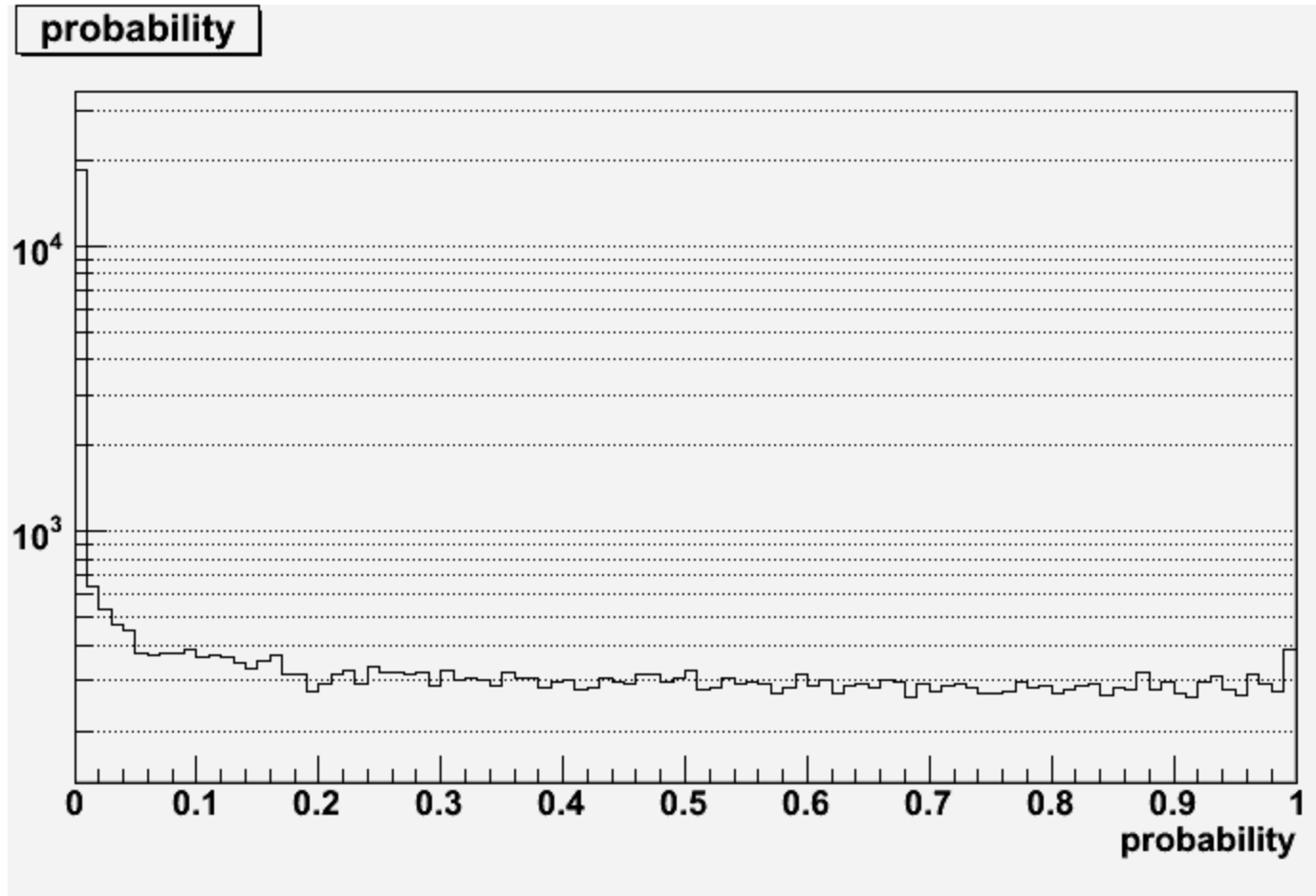
Pull Distribution for $\tan\lambda$



Pull Distribution for ϕ

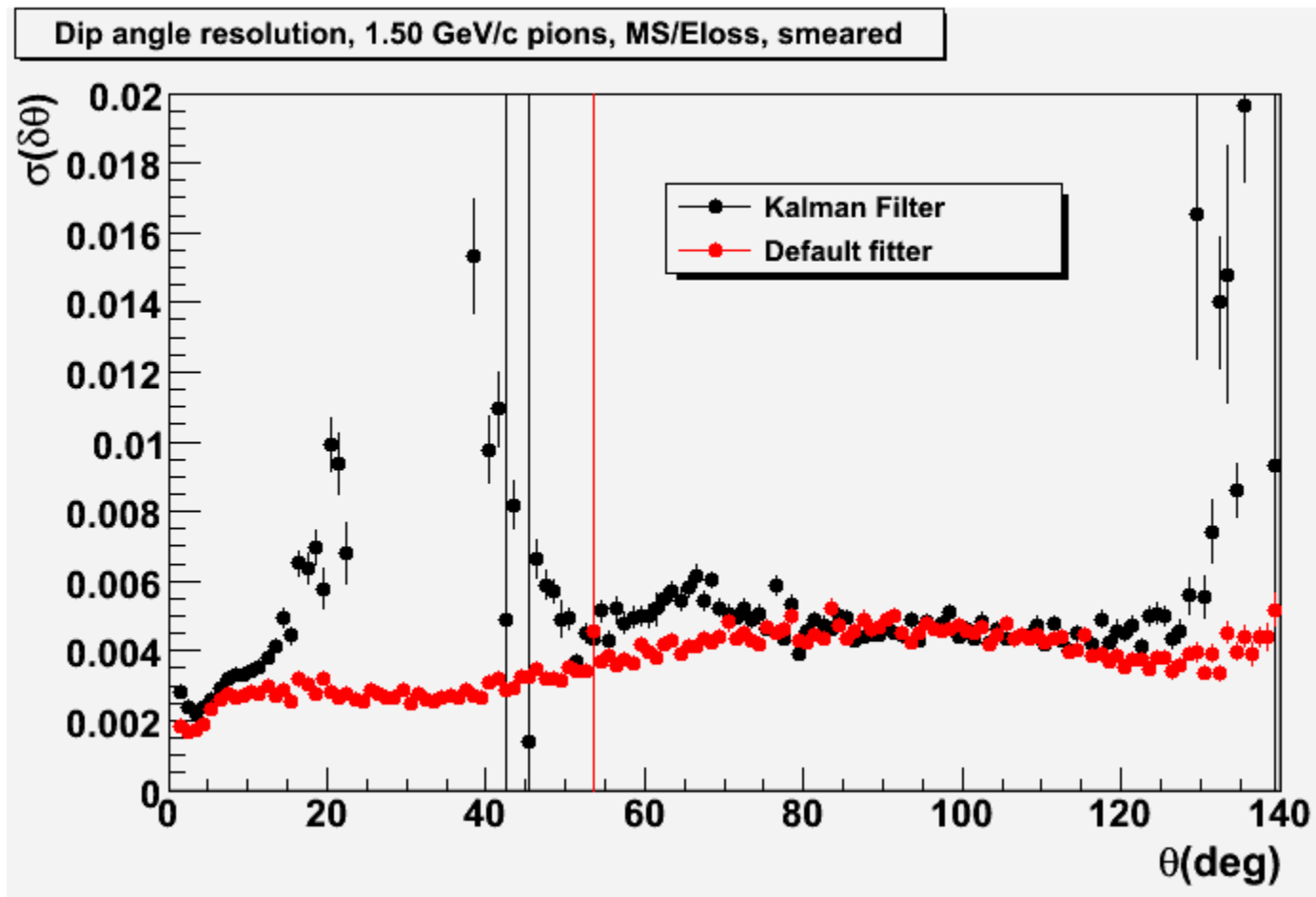


Probability distribution



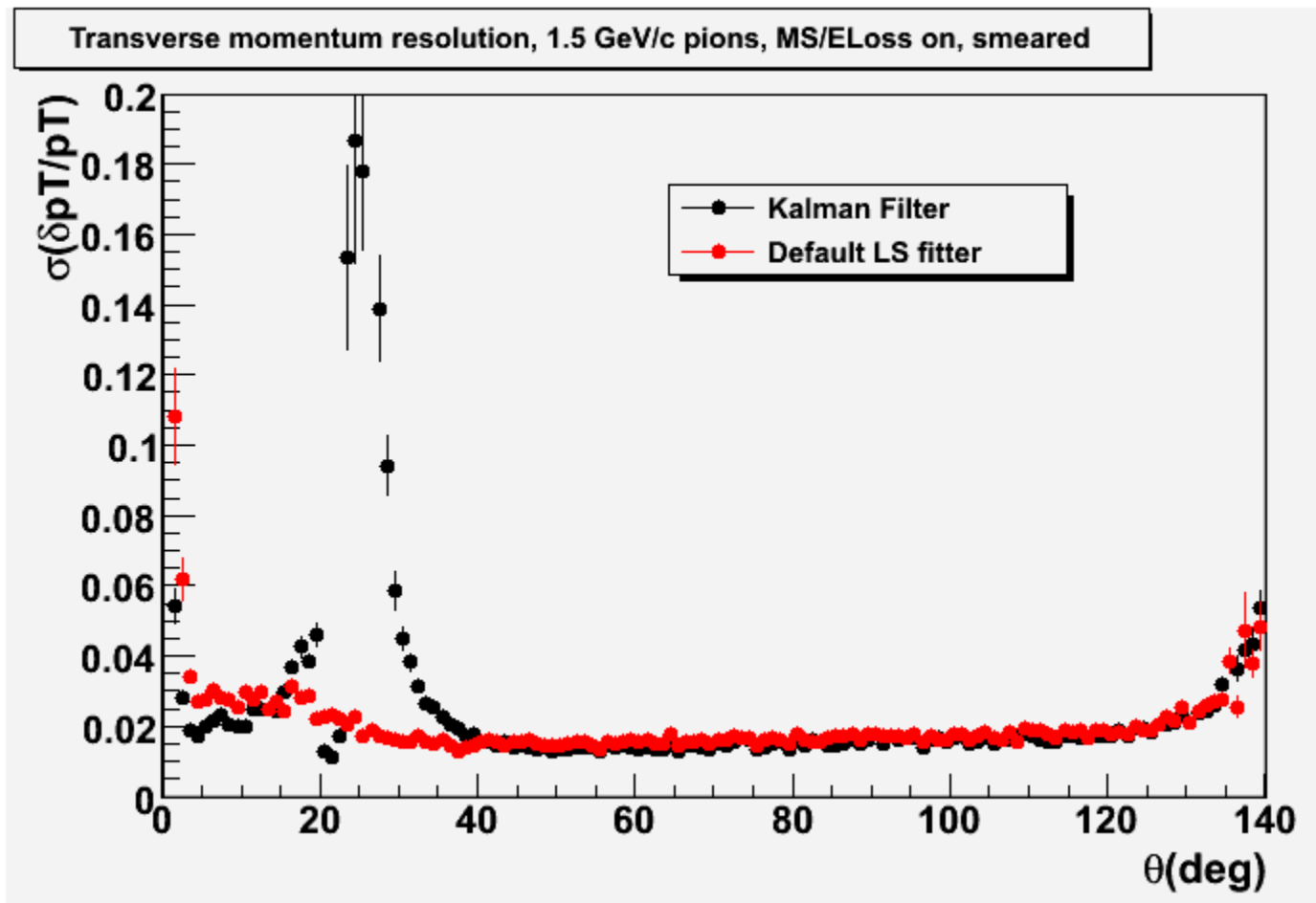
Dip angle resolution, no MS correction

What happens if I turn off the Multiple Scattering contributions to the covariance matrices in the reconstruction?

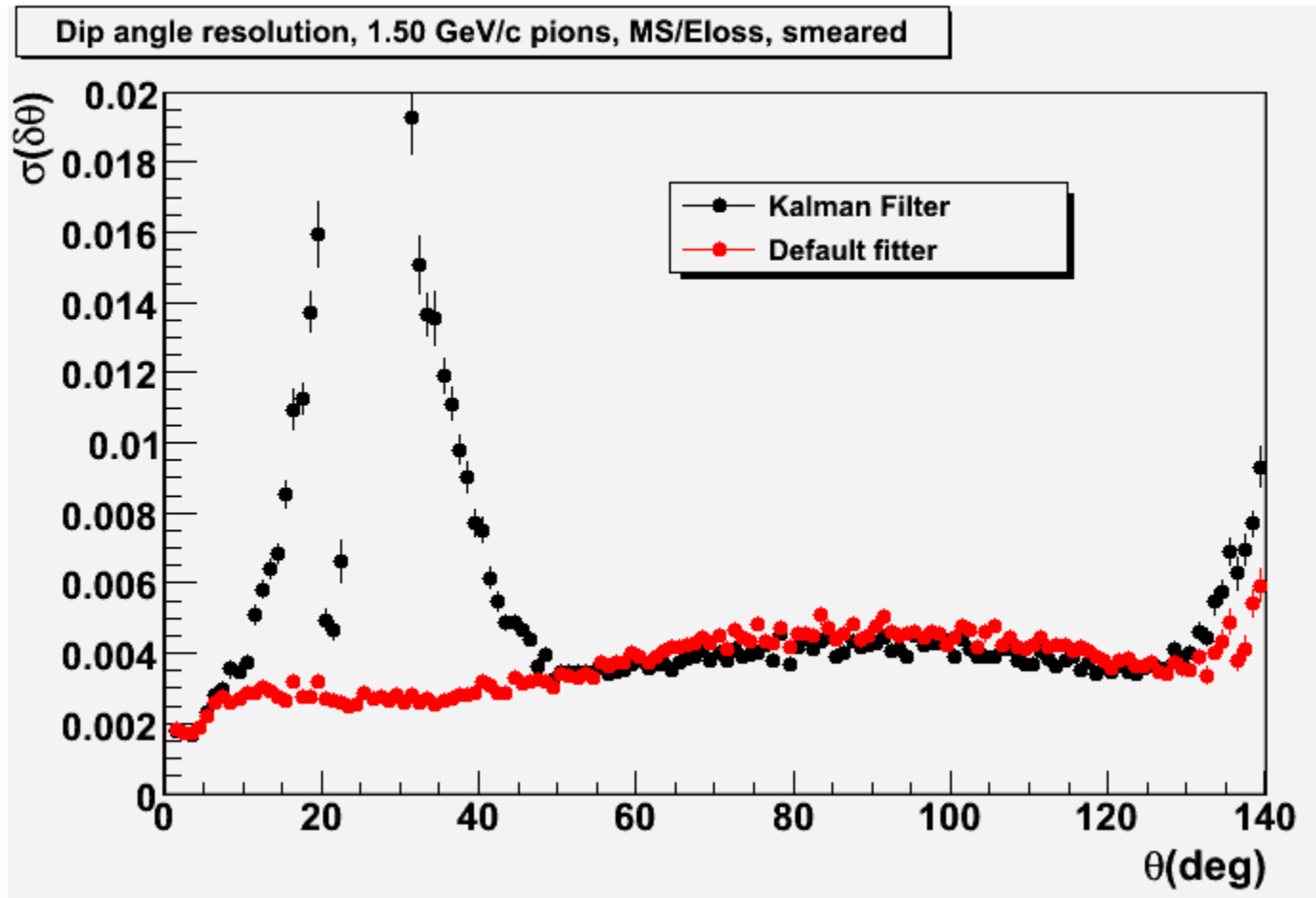


P_T resolution, candidate=thrown

What effect does quality of initial guess (candidate) have?



Dip angle resolution, candidate=thrown



Summary/Outlook

- Kalman filter now working well for $60^\circ < \theta < 120^\circ$
 - Pull distributions have mean ~ 0 , $\sigma \sim 1$
 - Probability distribution is flat
- Code is failing for $\theta > 120^\circ$ and $10^\circ < \theta < 60^\circ$
 - Still investigating source of discrepancy between Kalman filter and least squares fitter
 - Degree of discrepancy depends on quality of candidate
 - Suspect issues with dealing with material (multiple scattering)
 - Do we need to include variations in position as well as angles?