First look with FastDIRC reconstruction

- Reminder: KDE-based reconstruction / FastDIRC
- Estimate of track Cherenkov angle resolution
- Performance under different running conditions

Reminder: KDE-based Reconstruction

Track (momentum, position, angle)

FastDIRC's novel fast ray-tracing technique
(given geometry)

Generate O(100k) hits (i.e. *support points*)
under each particle hypothesis

Loop over observed hits, calculate a
probability against every support points
using a chosen *kernel* (more later)

Obtain a log-likelihood (LL) for this track
under each hypothesis

Kernel and likelihood calculation

$$r^2 = \frac{(x_{O,i} - x_{S,j})^2}{\sigma_x^2} + \frac{(y_{O,i} - y_{S,j})^2}{\sigma_y^2} + \frac{(t_{O,i} - t_{S,j})^2}{\sigma_t^2}$$

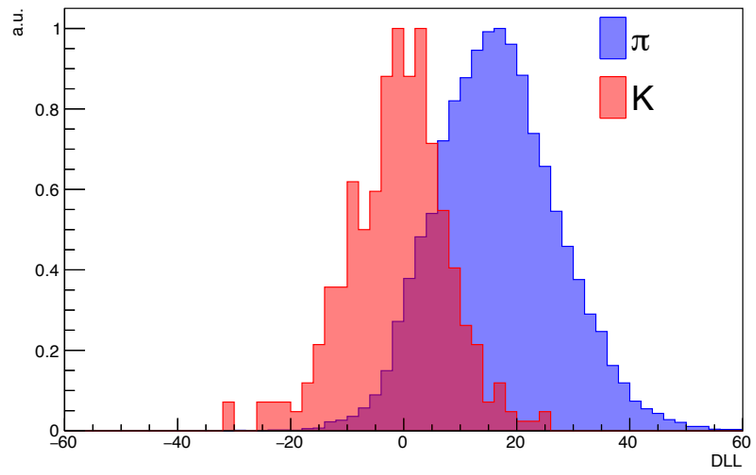
$$\text{likihood} \propto \prod_{i,j} \exp\left(-\frac{r^2}{\sigma_b^2}\right) \quad \text{(Gaussian kernel)}$$

- Cut: if an observed point is n σ_b away from any support points, exclude from LL calculation and discard this hit

- σ_x=σ_y=6(mm), σ_t=1(ns), σ_b=1, and N = 5 (all tunable parameters)

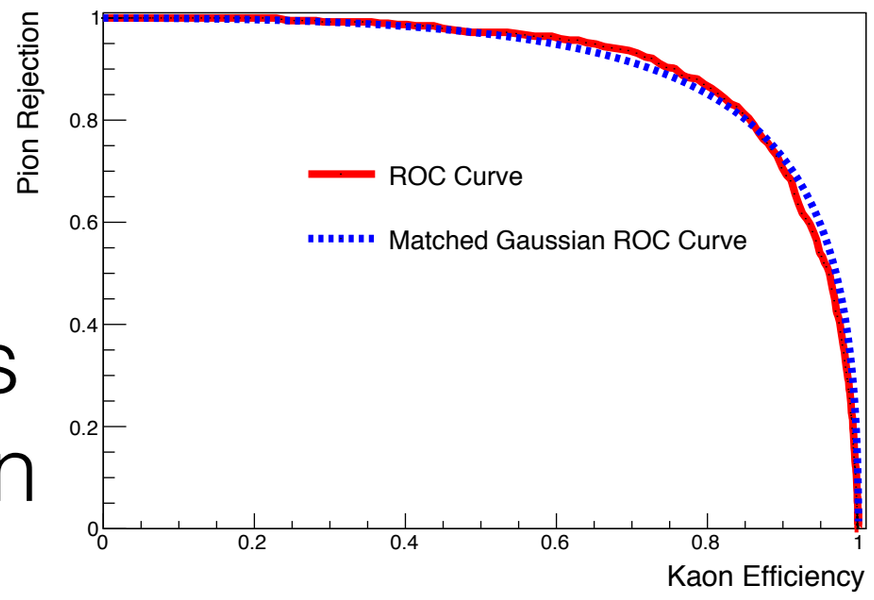
Convert from a DLL to a resolution

Given a DLL distribution:



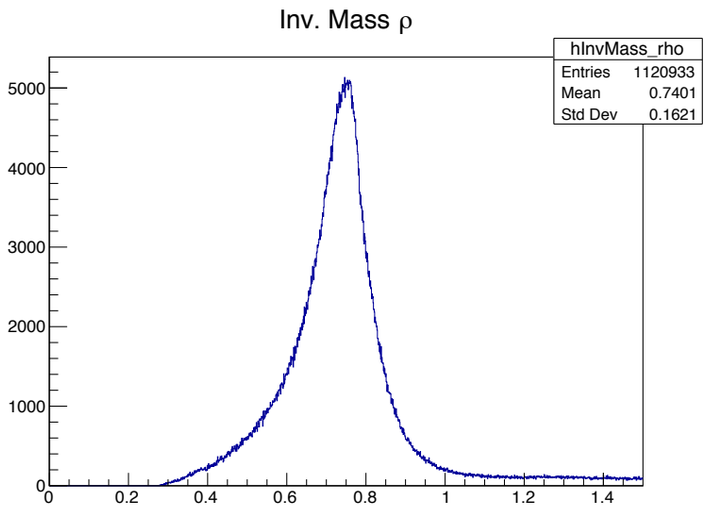
Calculate the ROC curve and its AUC

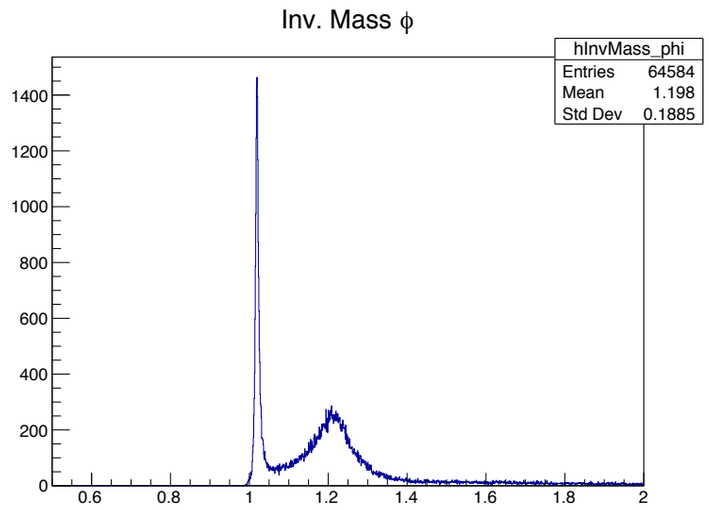
Ask: given this momentum and the expected Cherenkov angles, what is the corresponding angular resolution that gives the same AUC?

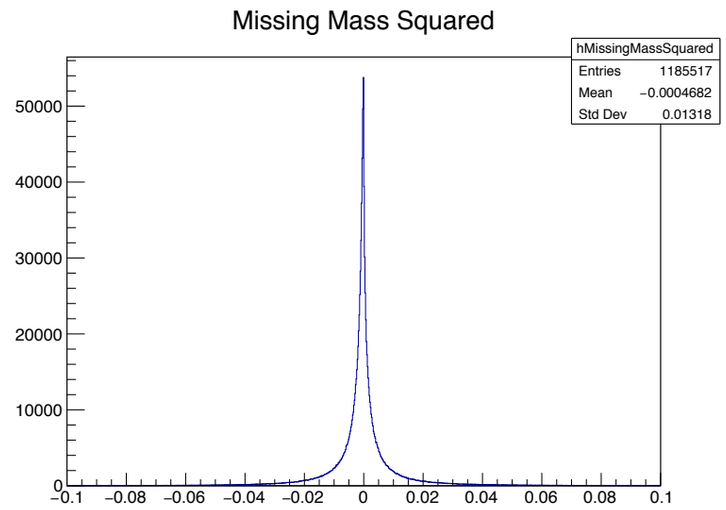


Event and track selection

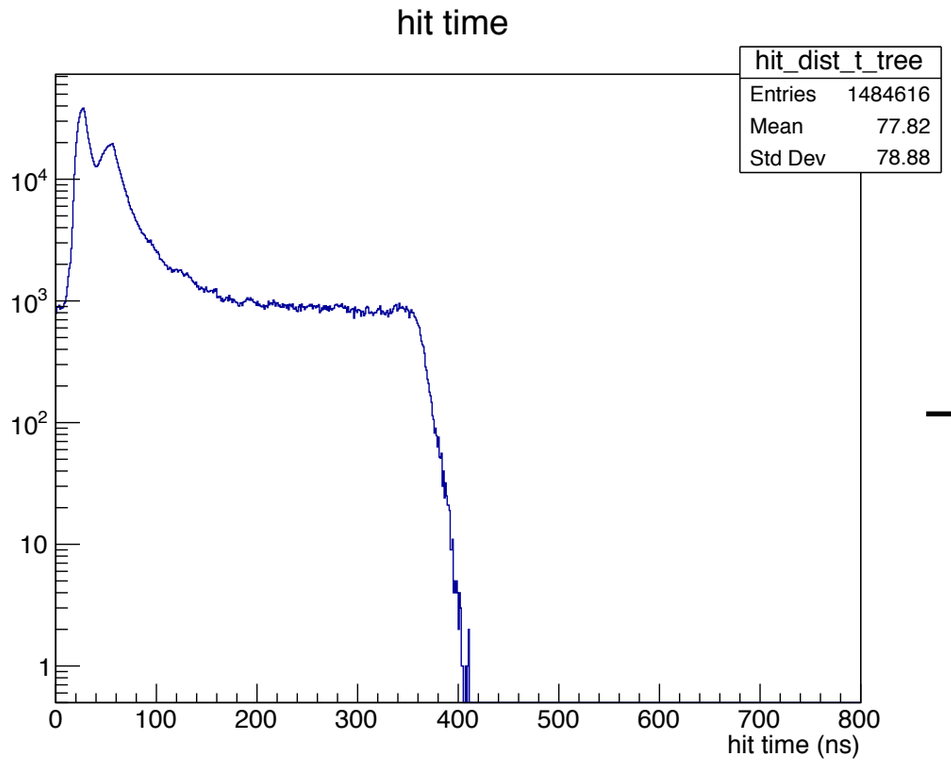
- trees from the updated dirc_tree plugin (ρ to ππ, ϕ to KK, KinFit, track quality)
- 3 additional cuts:
  - m(ρ): [0.6, 0.9] GeV
  - m(ϕ): [1.0, 1.04] GeV
  - missing mass squared: [-0.005,0.005]
- track: only require momentum in [2.9, 3.1] GeV (to see some separation)

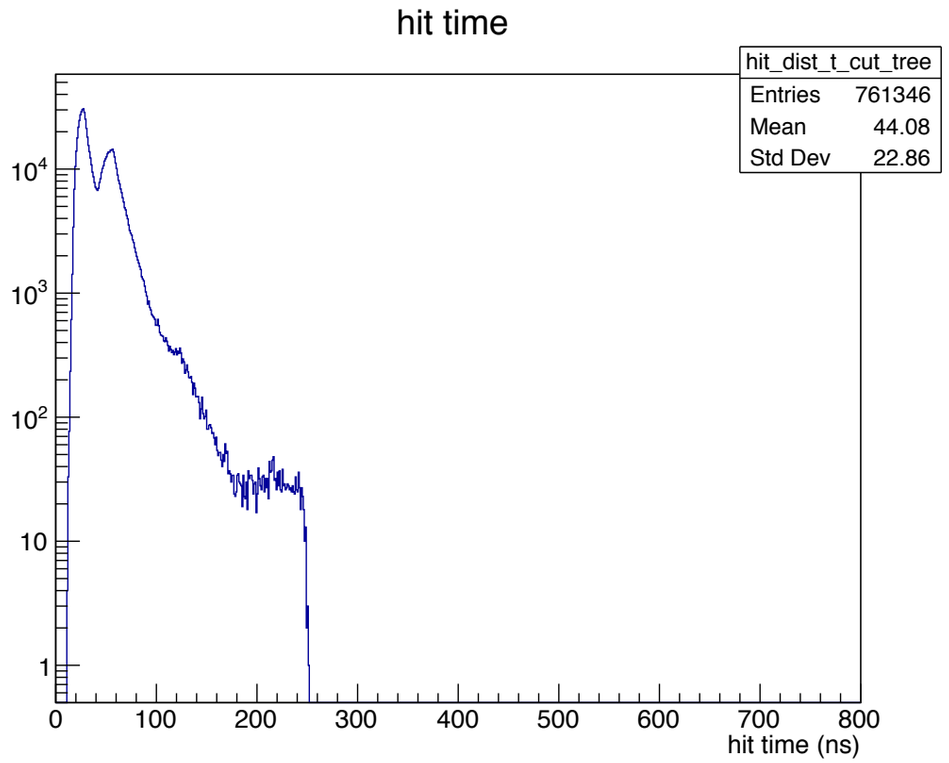




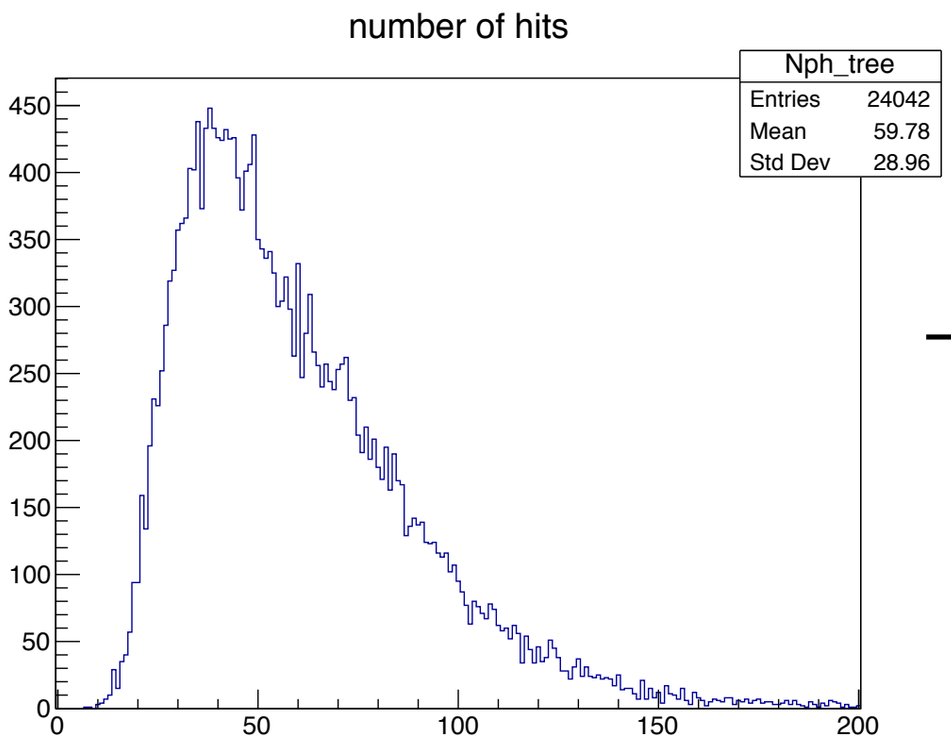


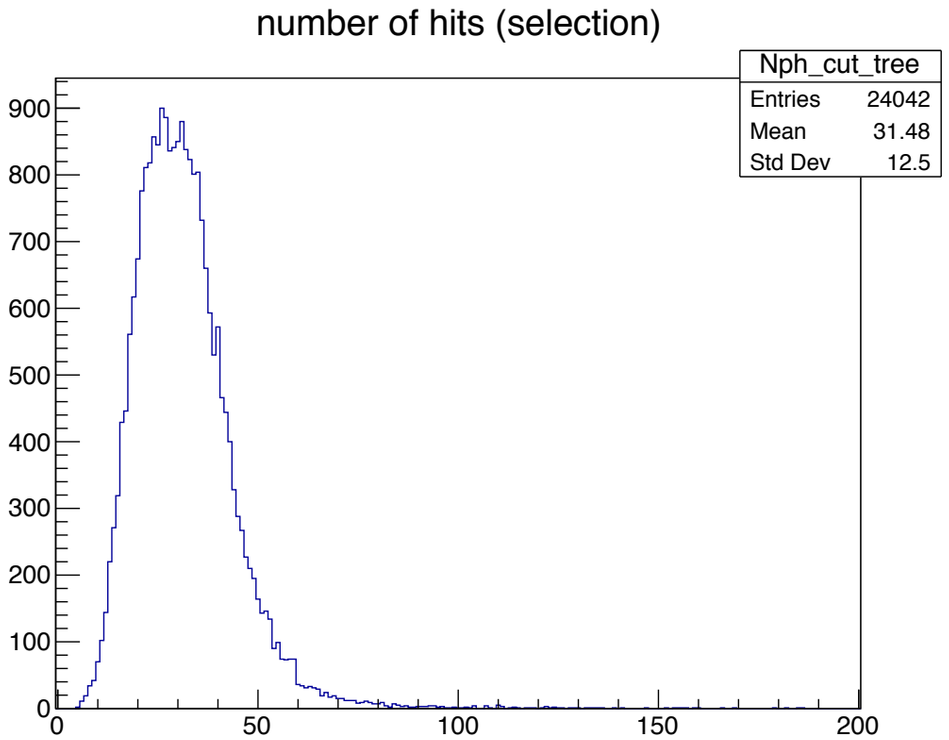
Impact of the N cut

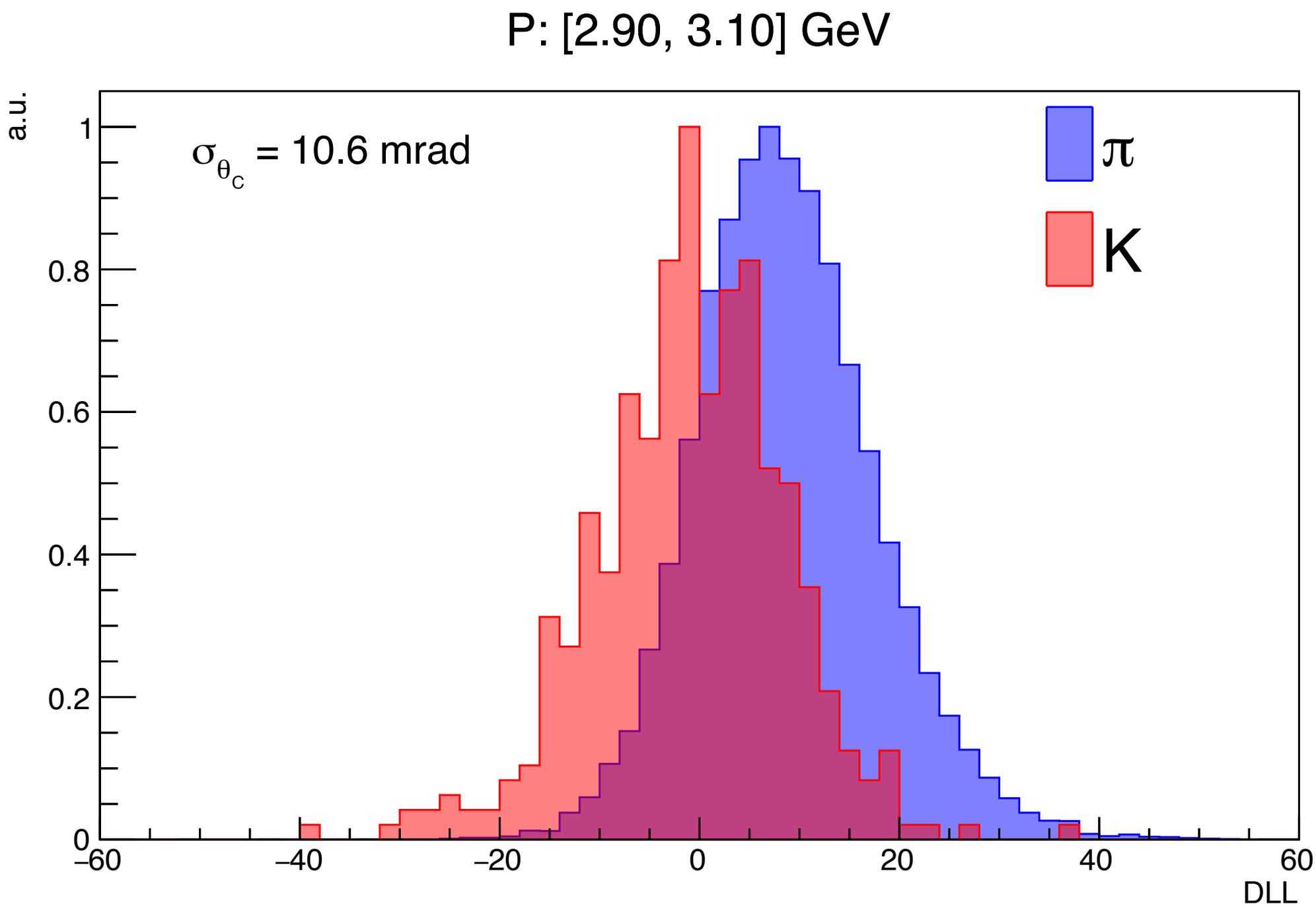




N=5

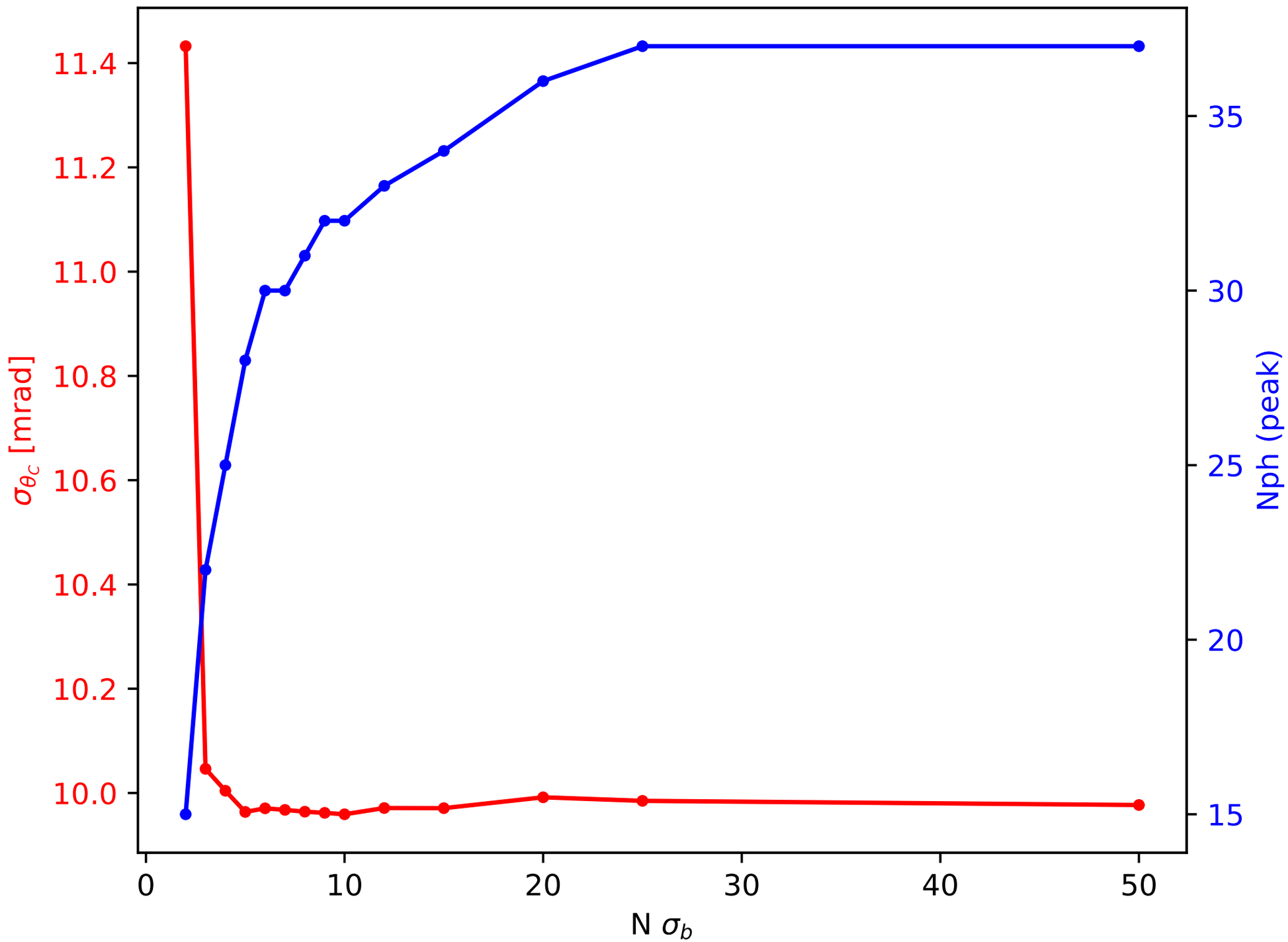






- 5 runs: 60770 — 60780 (Low-intensity Set 3)
- Assuming Nph=30, and SPR = 9 mrad, gives correlated error: 10.47 mrad (subtract in quadrature)

Impact of N on resolution and photon yield

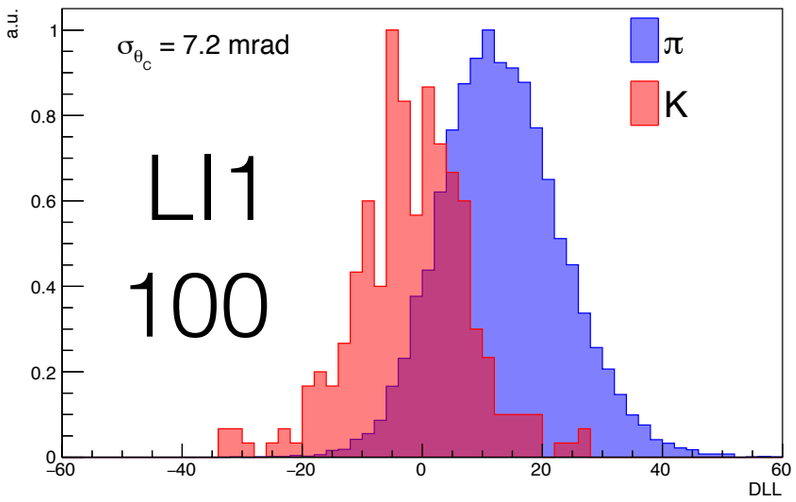


Datasets

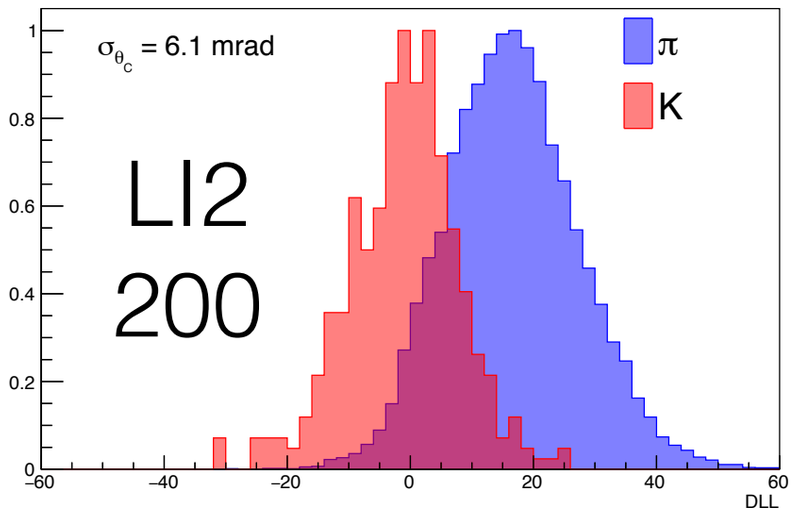
- Low-intensity Set 1: ped.+100
- Low-intensity Set 2: ped.+ 200
- Low-intensity Set 3: ped.+ 50
- Moderate-intensity Set 1: ped.+50
- Moderate-intensity Set 2: ped.+100
- High-intensity Set 1: ped.+100 (before goni. failure)

Details: https://halldweb.jlab.org/wiki/index.php/Spring_2019_DIRC_Commissioning

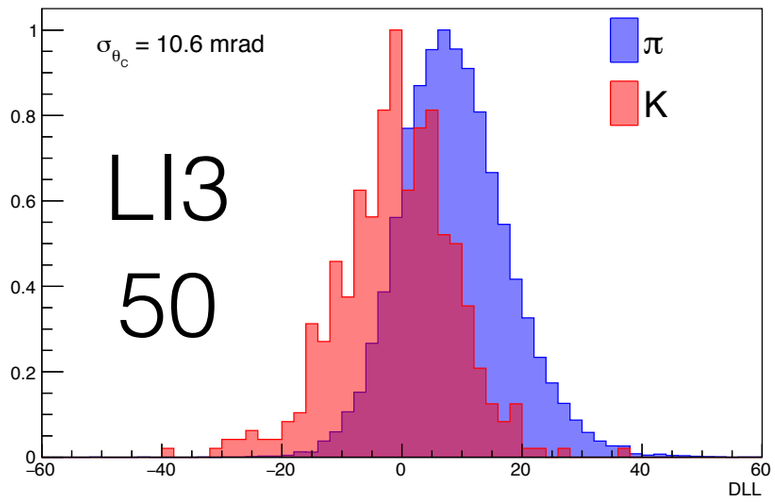
P: [2.90, 3.10] GeV



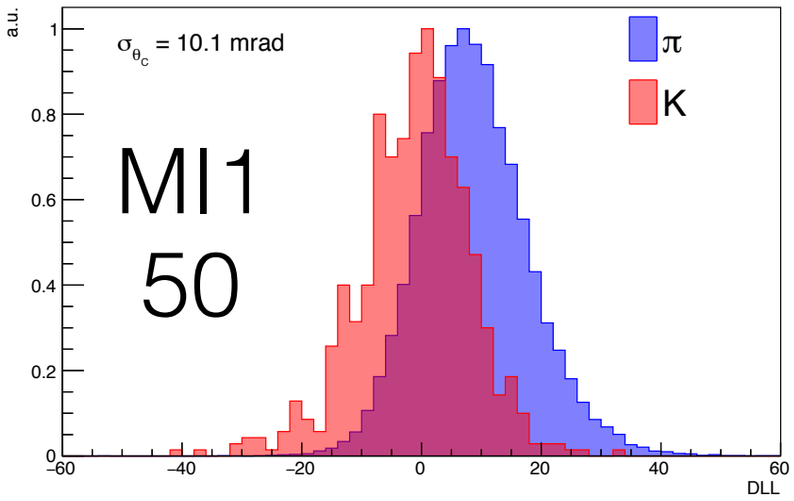
P: [2.90, 3.10] GeV



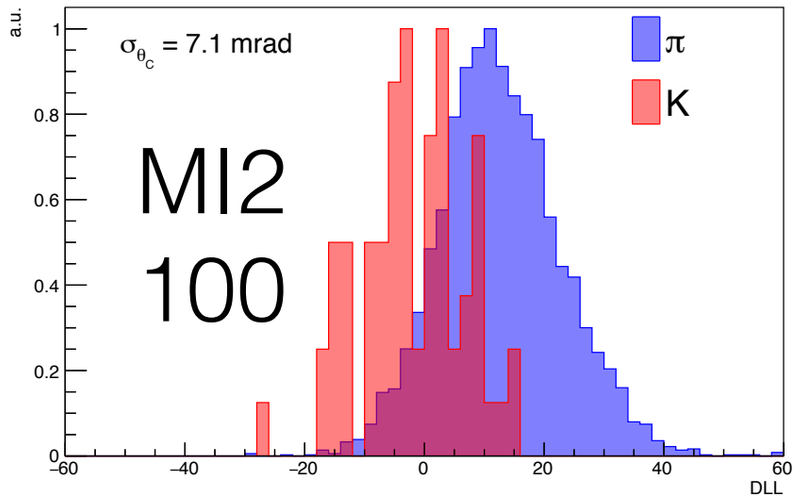
P: [2.90, 3.10] GeV



P: [2.90, 3.10] GeV



P: [2.90, 3.10] GeV



P: [2.90, 3.10] GeV