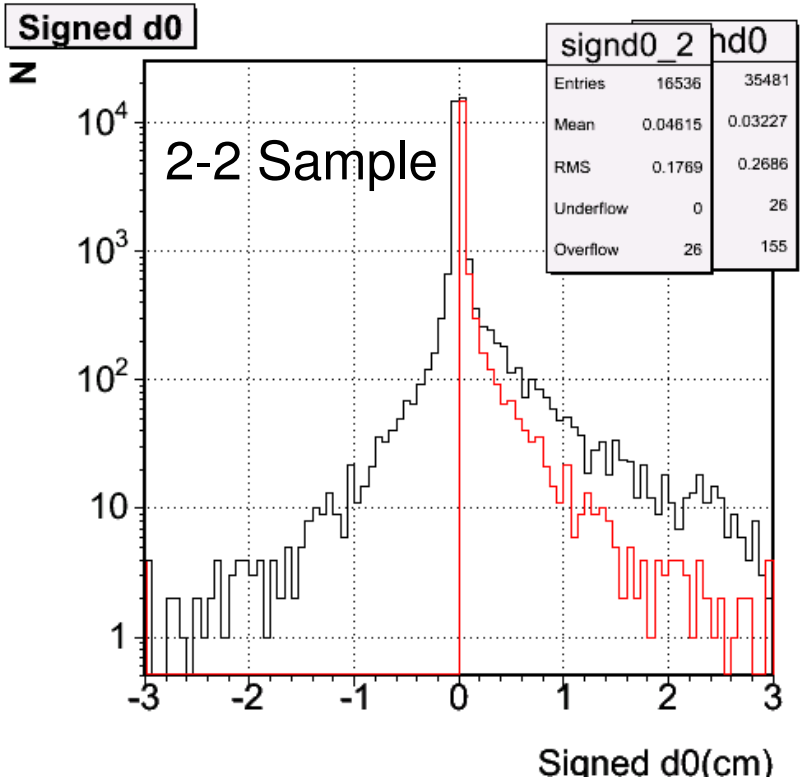
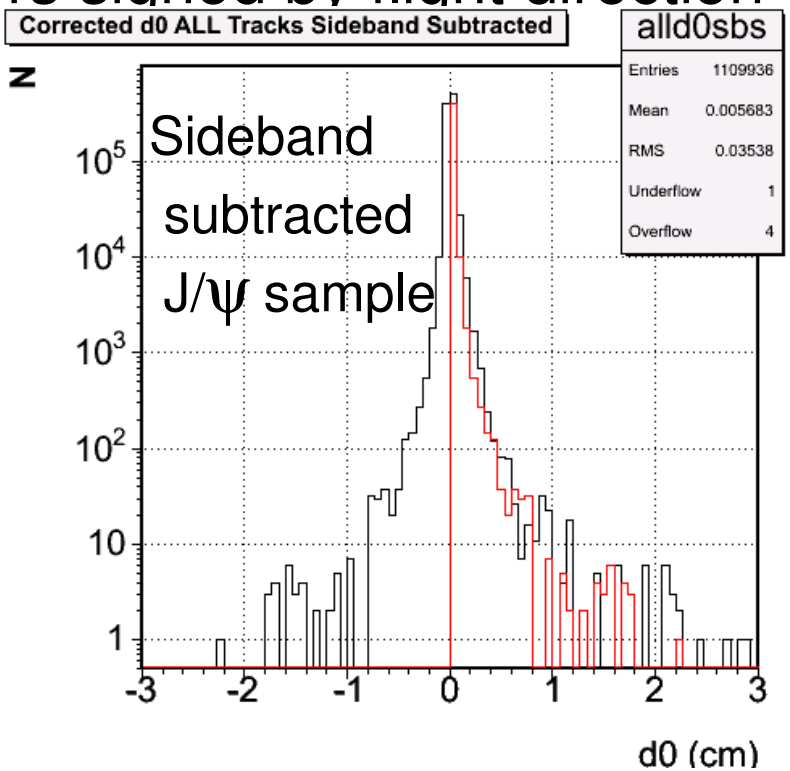
Multi-Muon Ana Review

Signed d0

- 2-2 muons compared to J/ψ events with one CMUP muon
- Plots of sd0: impact parameters signed by flight direction

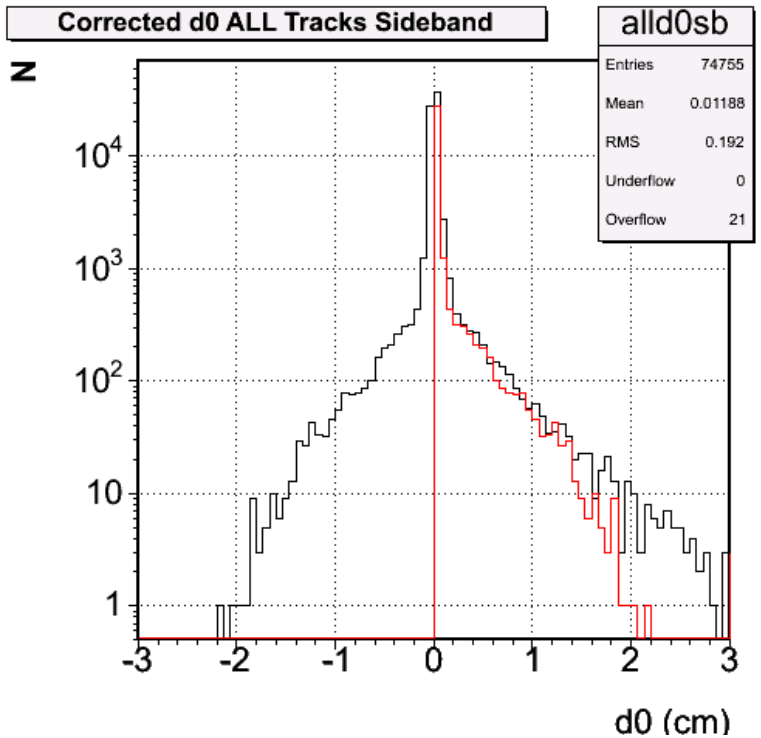




- Negative sd0 plotted in red. Significant -sd0 seen inconsistent with long lived particles given jetty nature of the events
- No evidence of significant mis-measurement. Occupancy is not high in J/ψ events.

Signed d0

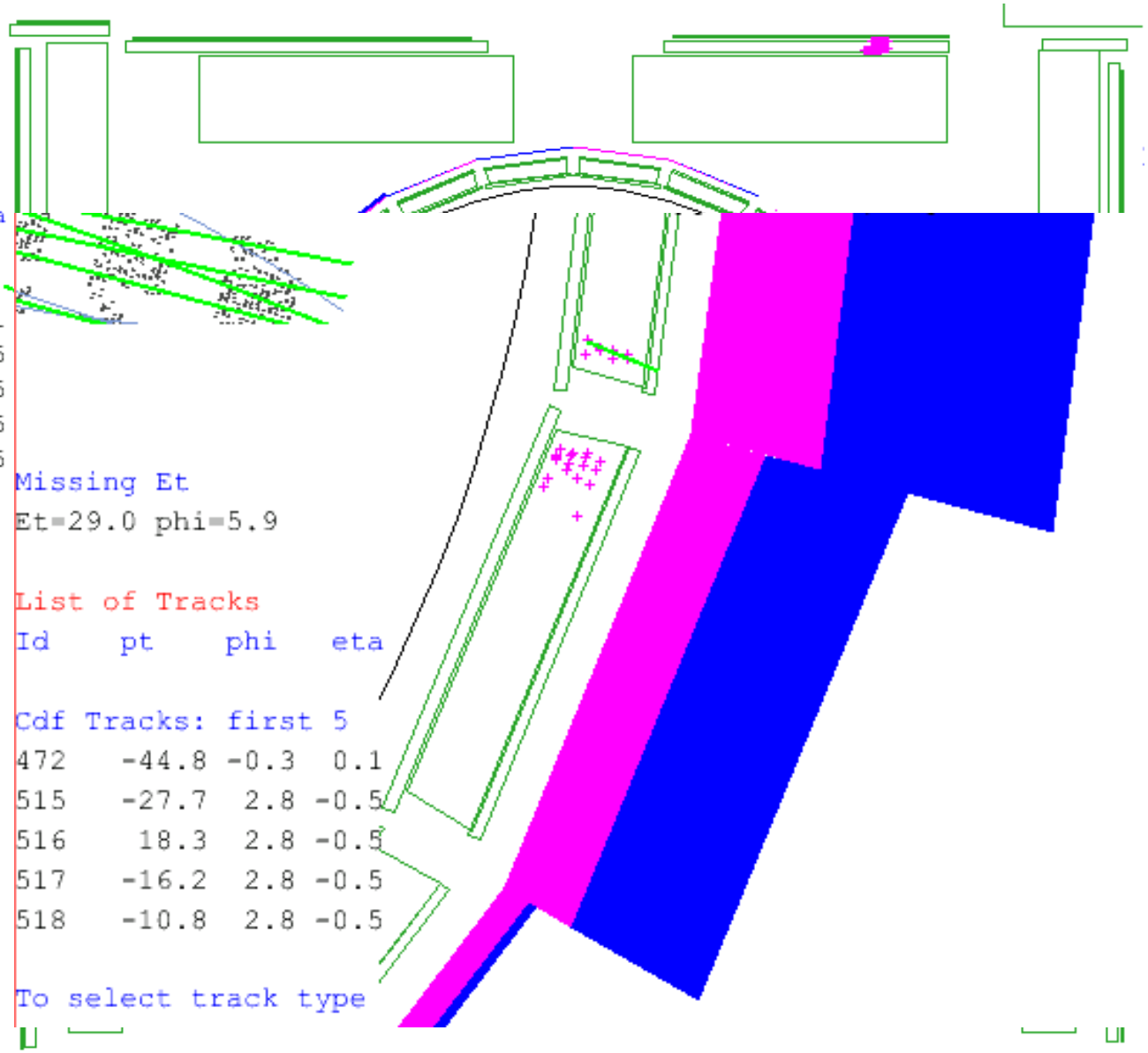
- J/ψ Sidebands



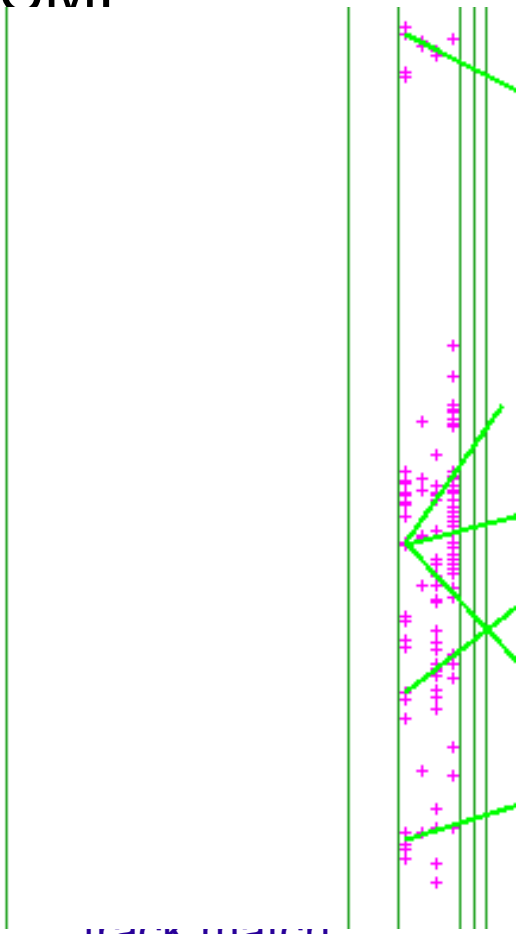
- Silicon hits on large d0 tracks seem incorrect. d0 not changed by tracking with COT only. That result is consistent with signal or COT tracking problems.
- No obvious problems with tracking. This should not be taken as a definitive statement that the pattern tracking is proven to be good.

- J/ψ Sideband events have long tails (200pb-1 data)
- Possibly K^+ decay in flight, K_s or Λ?
- Authors hypothesize that this must be their physics signal and that the x-section is correct. Note this is 1/10 the data. No reply from authors.

Muon Quality

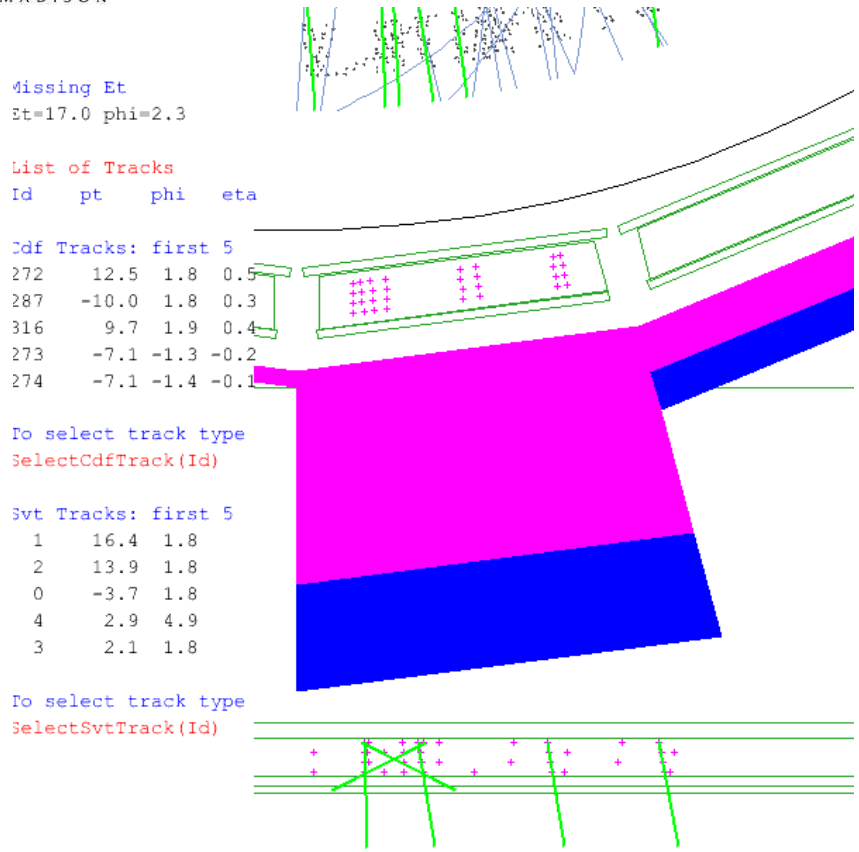


- Noted high occupancy in CMP



track match

Signal Muon Quality

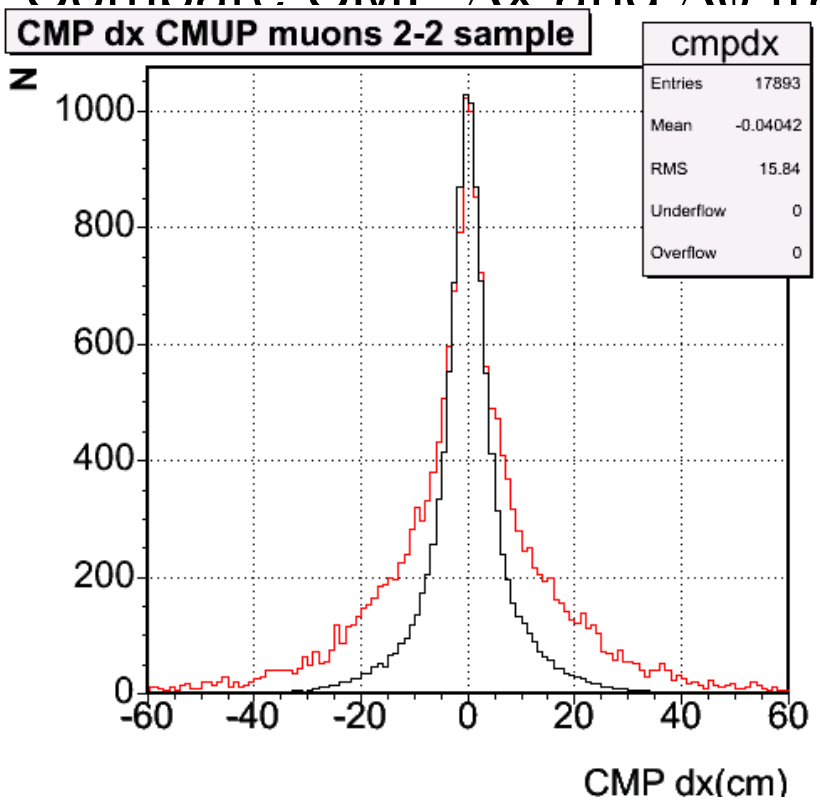


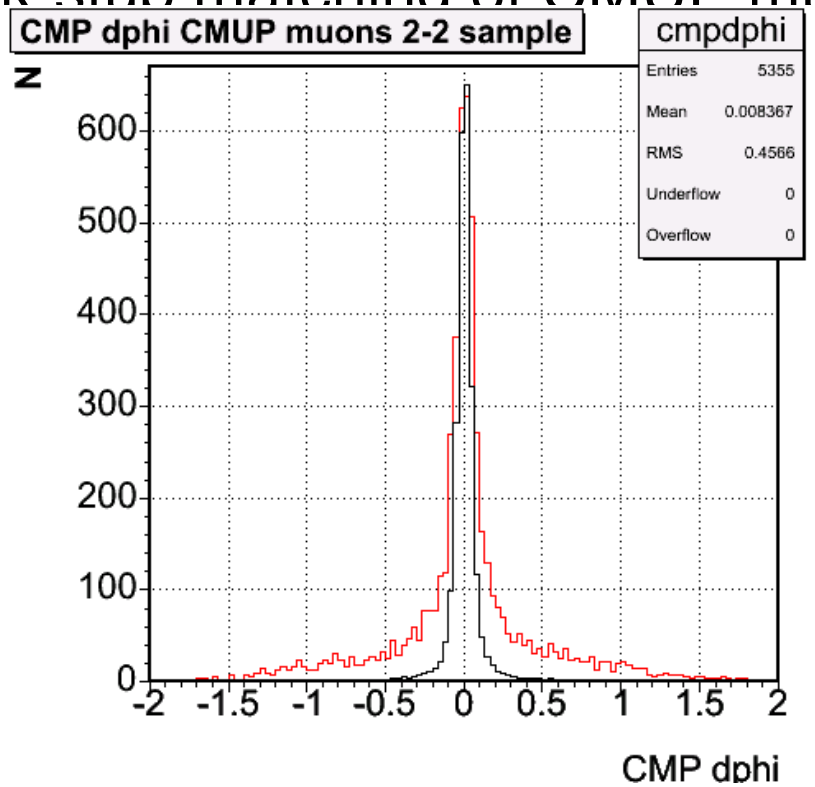
- Events displays led me to look at $\Delta\phi$ and SLT notes
- Delta phi matching for SLT tested to fairly high multiplicity in run 2. Used in top physics.
- Not a perfect quantitative study. Events displays show there is a source of fakes not quantified by the authors.

- Problems exist in signal events as well
- Events look qualitatively different.
  - Events shown here are representative. Look for yourself, data is available.
  - Don't let the authors swiftboat you into believing there is no problem

CMUP Muon Quality

- Compare CMP Δx and $\Delta\phi$ track-stub matching of CMUP muons

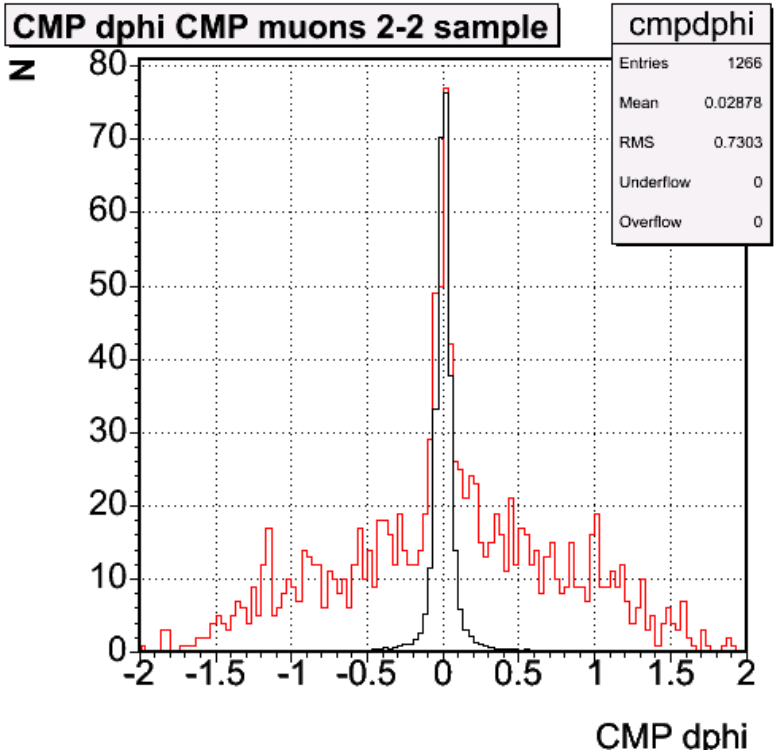




- 2-2 sample red and J/ψ black.
  - p_T 6-12GeV: above scattering dominated region, p_T reweighed to match 2-2 sample.
  - 2-2 muons have long dx tail and a narrow peak(multiple stubs in matching window)
- 2-2 muons have significantly broader $\Delta\phi$. ~55% distribution probably fake

CMU Muon Quality

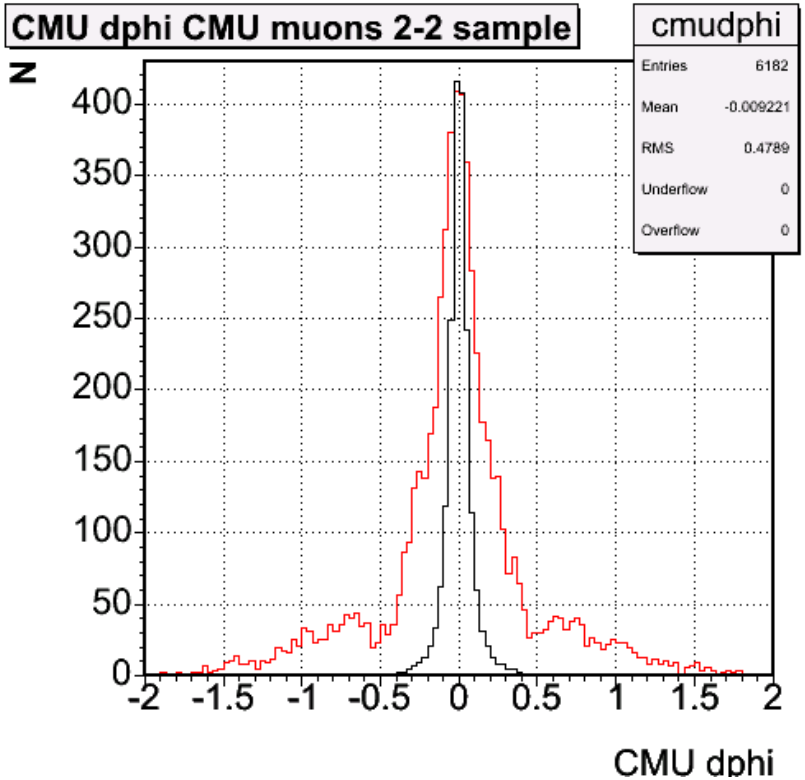
- Compare $\Delta\phi$ track-stub matching of CMP muons

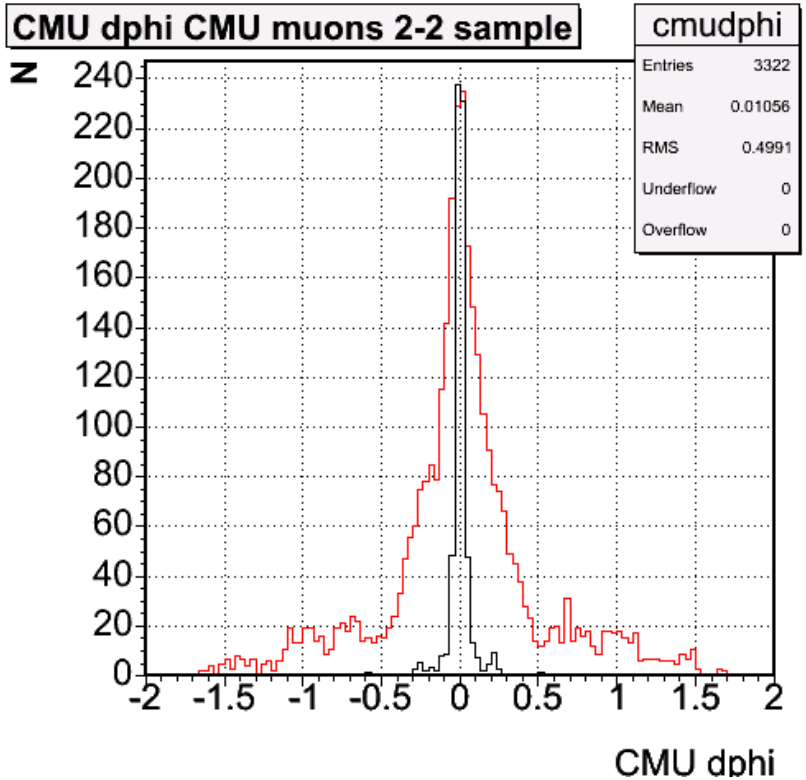


- 2-2 sample red and J/ψ black.
- 2-2 muons have significantly broader $\Delta\phi$. ~75% distribution probably fake

CMU Muon Quality

- Compare $\Delta\phi$ track-stub matching of CMU muons





- 2-2 sample red and J/ψ black.
- Divide into <3GeV and >3GeV(enough to reach the CMP)
- ~75% distribution probably fake for <3GeV
- ~90% distribution probably fake for >3GeV. 70% fake for all muons

Conclutions

- Tracking quality looks good
- Substantial background from long lived particles in J/ψ sideband: K^+ decay in flight, K_s or Λ, Signal?
- Muon quality low in 2-2 sample(even for CMUP muons)
  - Events look consistent with punch through followed by showering into CMP
  - Comparison of J/ψ and 2-2 Δx and $\Delta\phi$ distributions indicates that half of CMUP muons are fake
  - Authors state that background in the CMUP muon category is negligible
  - CMU, CMP categories have higher fake rates. 70% average for all muons.
- Detector effects on muon quality are proven, not suspected.
- Studies muon quality indicate that the high muon multiplicity events have substantial background that are not correctly estimated using low multiplicity D* events. Multi-muon aspect of paper is highly suspect.