

Status of the D^*lv q/p Analysis

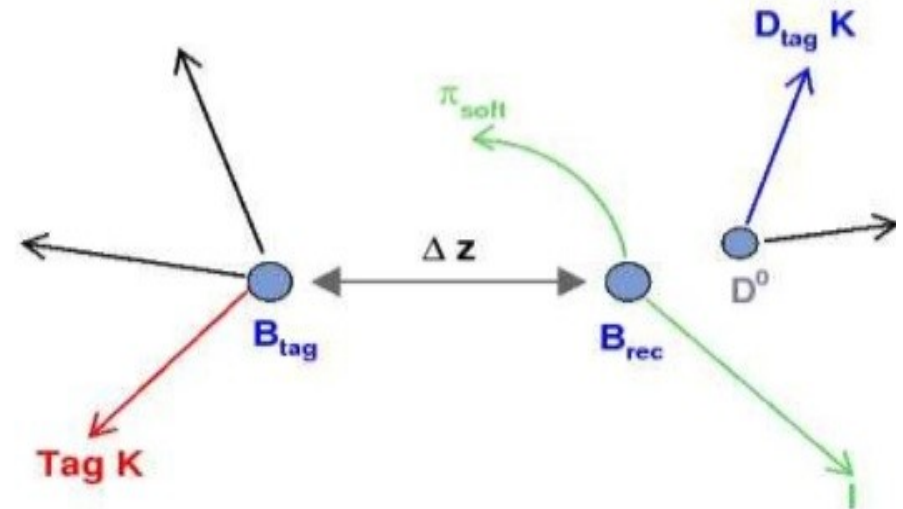
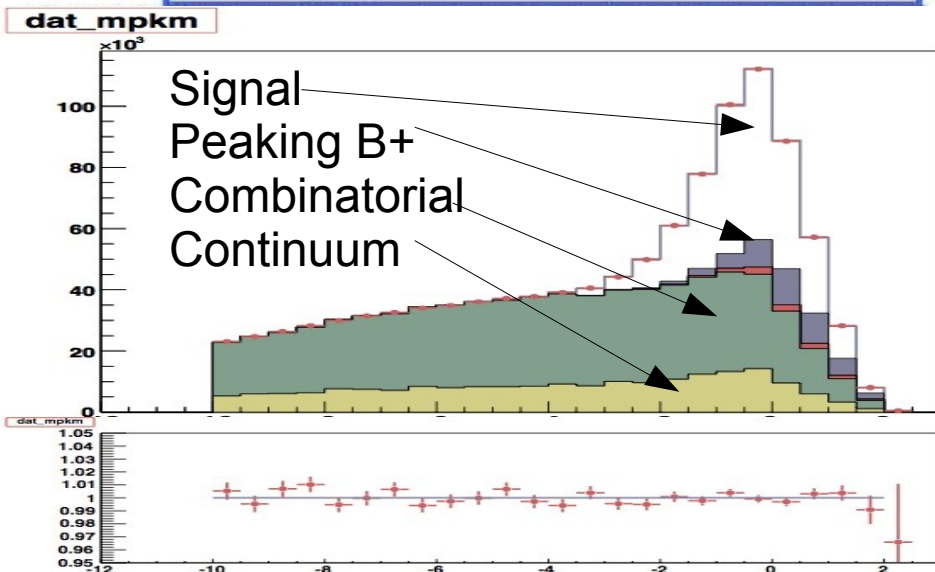
Martino, 1/26/2011

- Brief Review of the Analysis Strategy
- News since last presentation:
Analysis moved from Run1-Run5, Release 18
to Run1-Run6 (full statistics), Release 24-Analysis 51
- Some MC results on R24
- Conclusions & Next Steps

Analysis Strategy

- Partial Reconstruction of $B^0 \rightarrow D^* l \nu$ already exploited in several measurements (Lifetime, Mixing, $|q/p|$ with Lepton tag)
- Reconstruct only Lepton & π_{soft} (high efficiency)
- Signal selection by means of

$$M_\nu^2 = \left(\frac{\sqrt{s}}{2} - \tilde{E}_{D^*} - E_\ell \right)^2 - (\tilde{\mathbf{p}}_{D^*} + \mathbf{p}_\ell)^2$$



- “Other B” flavour from tagging K
- $|q/p|$ from Semileptonic Asymmetry:

$$A_{SL} = \frac{N(B^0 B^0) - N(\bar{B}^0 \bar{B}^0)}{N(B^0 B^0) + N(\bar{B}^0 \bar{B}^0)}$$

$$A_{SL} = \frac{1 - |q/p|^4}{1 + |q/p|^4} \simeq 2 \left(1 - \left| \frac{q}{p} \right| \right)$$

- **Simultaneous Δt Fit to 4 subsamples:**
- **Unmixed ($l^+ K^-$, $l^- K^+$)**
- **Mixed ($l^+ K^+$, $l^- K^-$)**

K-Tagging categories

Tagging Kaon Sample: $\left\{ \begin{array}{l} b \rightarrow K + b \rightarrow c \rightarrow K \\ D^0 \rightarrow K \end{array} \right.$

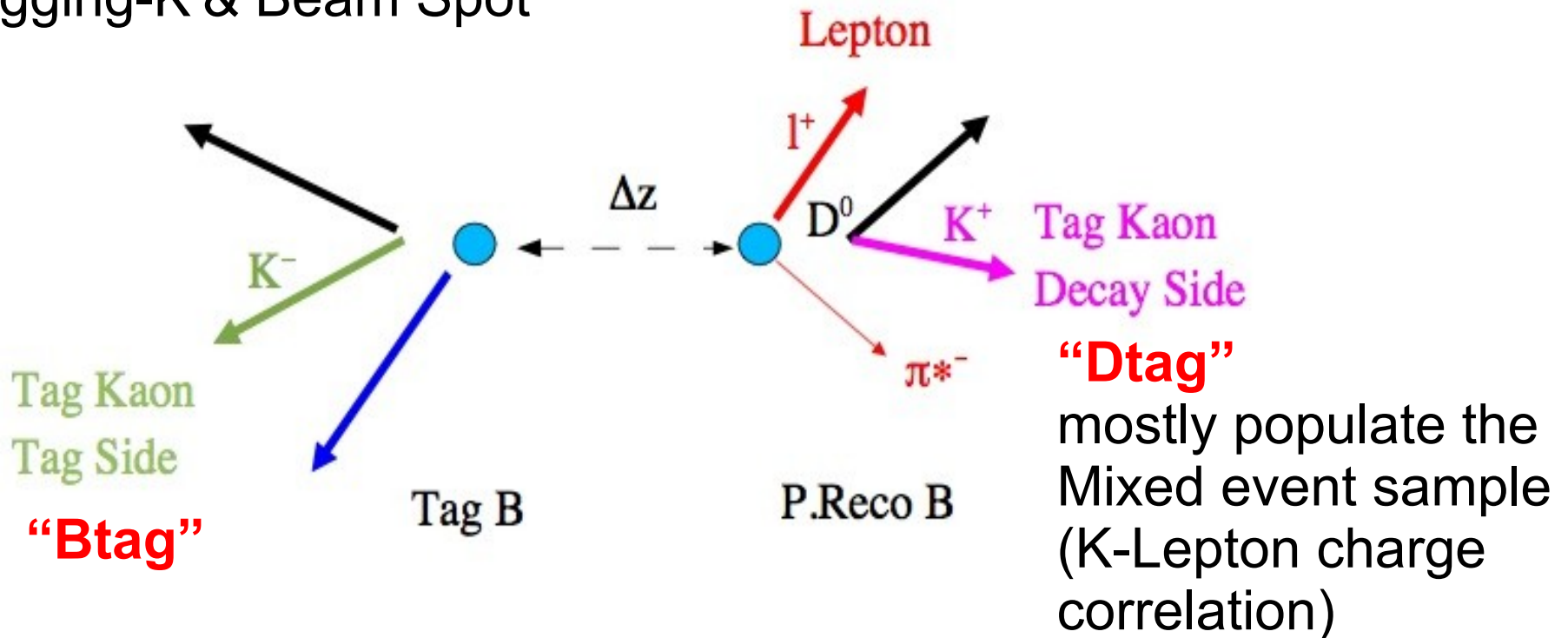
From tag B

“Btag”

From decay B

“Dtag”

Tag Vertex from
Tagging-K & Beam Spot



Detector Asymmetry

- **Crucial Issue: discriminate between Physical & Detector charge asymmetry without relying on control samples**

- Different sub-samples (B^0 , B^+)X(Peaking, BKG)X(Btag, Dtag) share Physical and/or BKG asymmetries in different combinations.

- **Strategy: disentangle the physical vs detector asymmetries in the Fit by exploiting all the available informations from different sub-samples.**

- **Involved observables:**

- **Reconstruction Asymmetry:** $A_r = (\epsilon(l^+\pi^-) - \epsilon(l^-\pi^+)) / (\epsilon(l^+\pi^-) + \epsilon(l^-\pi^+))$

Determined using tagged & untagged Partially Reco events

- **Tag Asymmetry:** $A_t = (\epsilon(K_{tag}^+) - \epsilon(K_{tag}^-)) / (\epsilon(K_{tag}^+) + \epsilon(K_{tag}^-))$

Depends on $P_{K_{tag}}$

PDF(Δt)

- Semileptonic asymmetry does not depend on time
- q/p determination shows slight sensitivity to PDFs Δt Shapes

... but mistag parameters come from Δt fit:

$$\text{PDF}(\Delta t) \sim (1 \pm (1 - 2\omega) \cos(\Delta m \Delta t) + \dots)$$

PDFs Δt Shapes depend on:

- Physics (τ , Δm , DCS, $(\Delta\Gamma)$)
- **Mistag (ω , $\Delta\omega$)**
- **Resolution**



• Good description of Δt shapes improves |q/p| determination

• Mandatory to obtain a precise mistag determination & define a correct Δt resolution model by studying the two items separately.

Mistag Determination

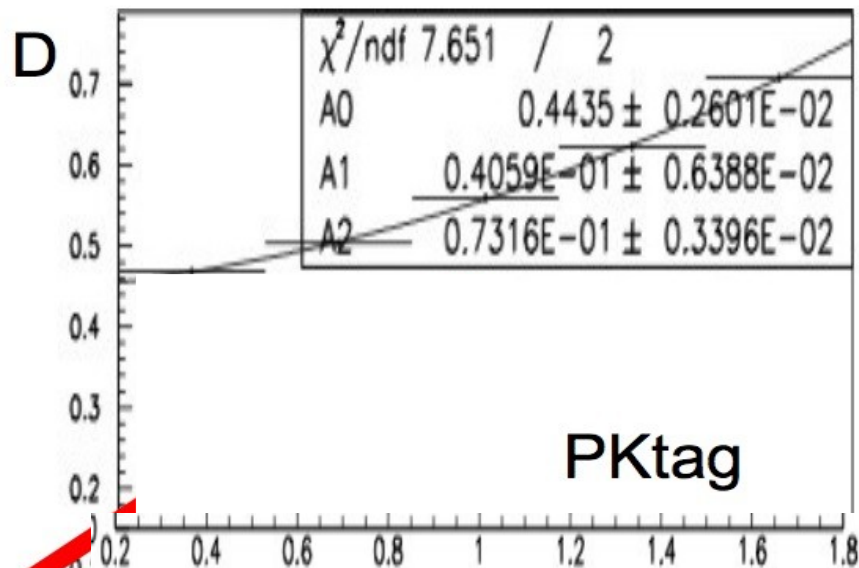
- Dilution $D(P_{Ktag}) = 1 - 2\omega$ floated in the Fit (MC: agreement found between Fit & counting)
- ω lower at higher P_{Ktag}
- $\Delta\omega(P_{Ktag}) = \omega(K^+) - \omega(K^-)$ floated in the Fit

B^0 PEAKING

- $D(\text{Mixed}) = D(\text{Unmixed})$

$$\text{Mixed} = \text{True_Mixed} \cdot (1 - \omega) + \text{True_Unmixed} \cdot \omega$$

$$\text{Unmixed} = \text{True_Unmixed} \cdot (1 - \omega) + \text{True_Mixed} \cdot \omega$$

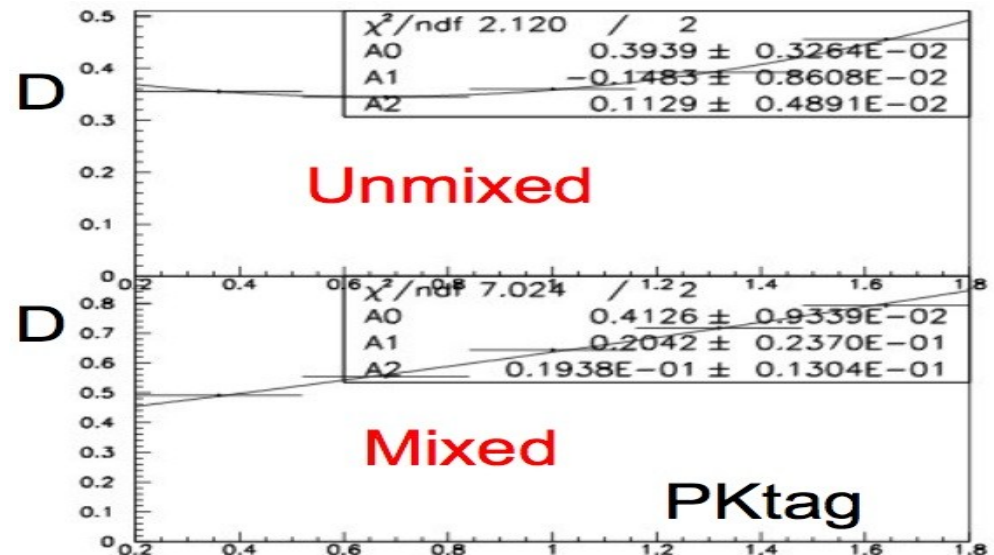


B^0 BKG

- $D(\text{Mixed}) > D(\text{Unmixed})$!

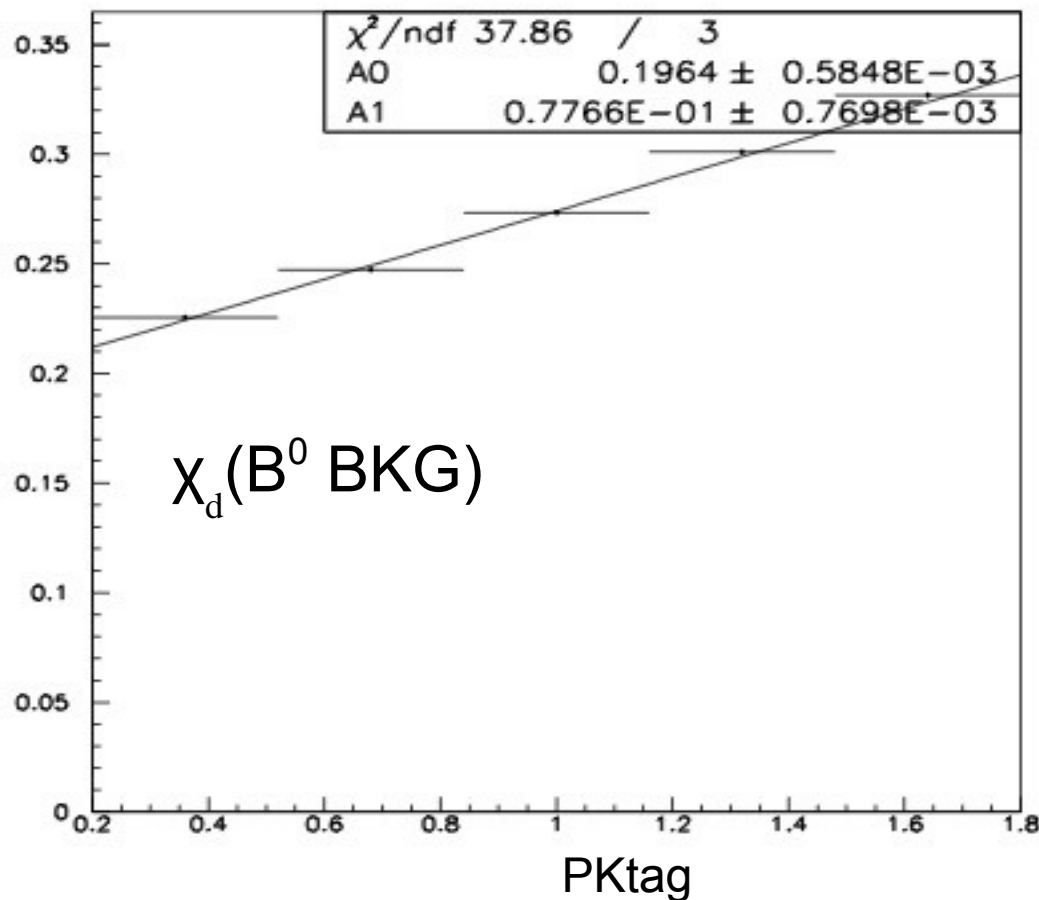
$$\text{Mixed} = \text{True_Mixed} \cdot (1 - \omega_M) + \text{True_Unmixed} \cdot \omega_U$$

$$\text{Unmixed} = \text{True_Unmixed} \cdot (1 - \omega_U) + \text{True_Mixed} \cdot \omega_M$$



B^0 BKG: Effective χ_d

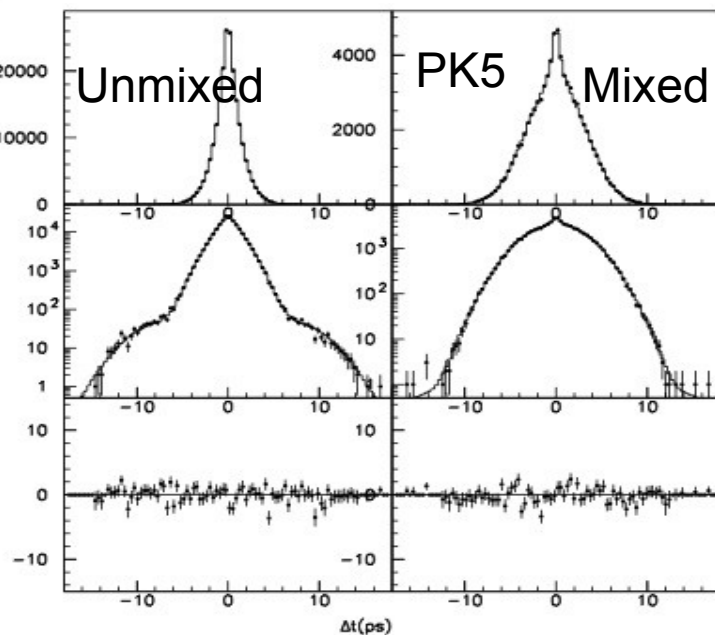
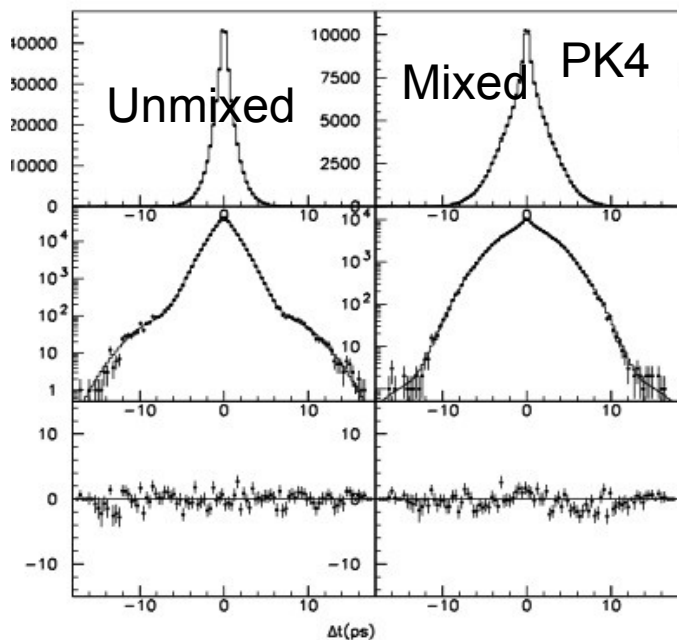
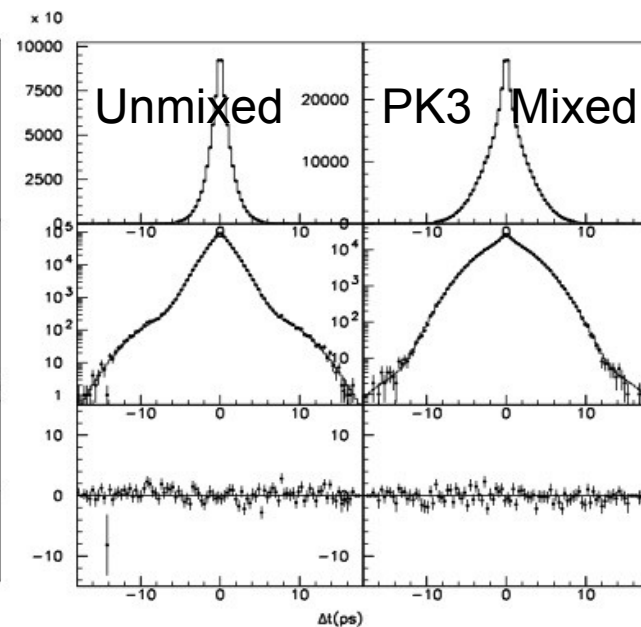
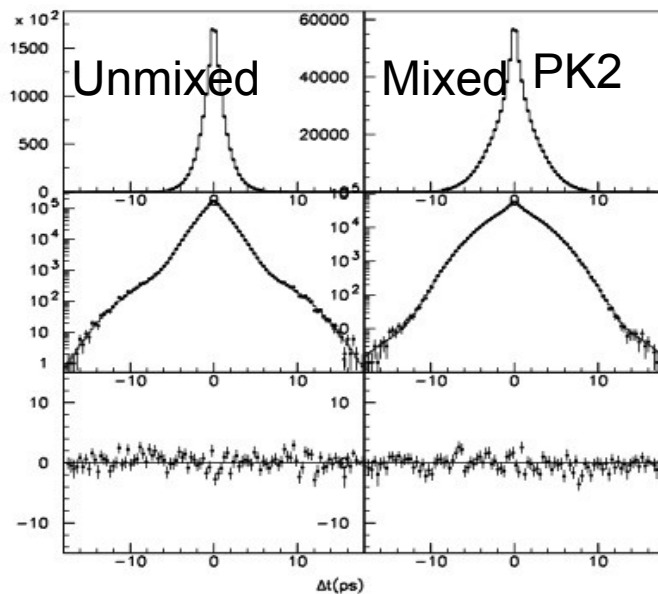
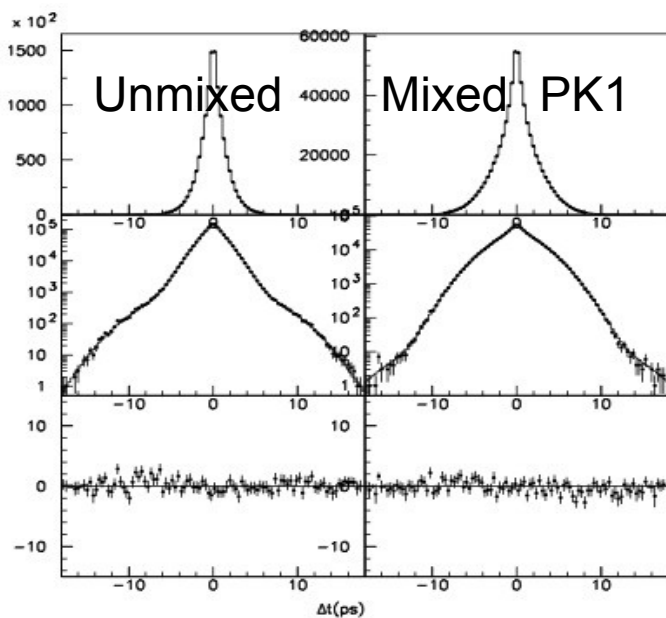
- Due to charge correlation between Lepton & π_{soft} , B^0 BKG Sample shows a higher fraction of mixed events wrt Signal (pick up Lepton & π_{soft} from the two different B^0 decays in the event): $\chi_d^{\text{BKG}} \sim 1.4 \chi_d^{\text{SIG}}$
- χ_d (BKG) depends on P_{Ktag} !



- B^0 BKG PDF changed accordingly in order to disentangle this effect from mistag

B⁰ Peaking with Experimental Mistag

True Δt
Measured Tag

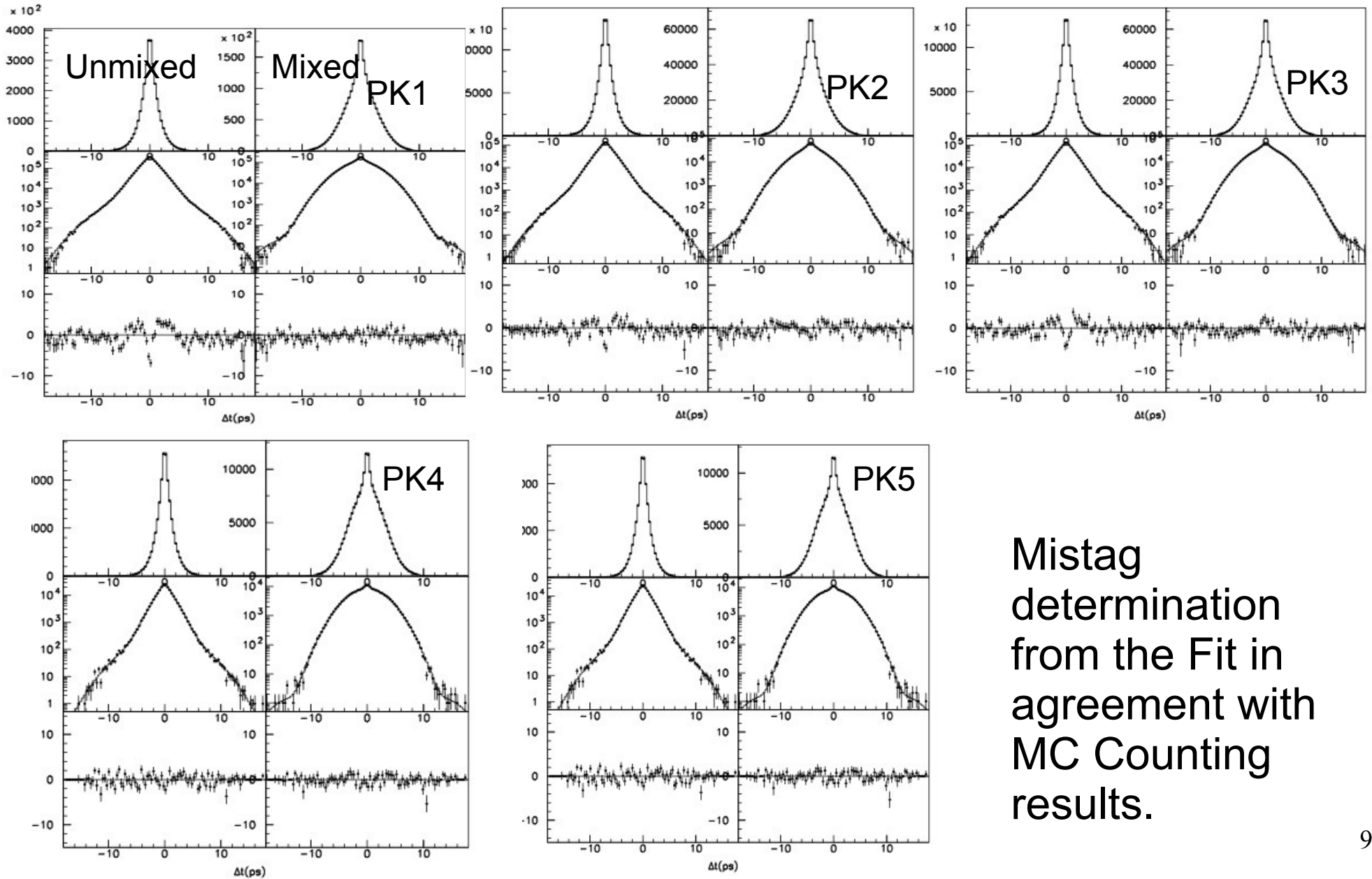


**Fit of mistag in
different PKtag Bins:
PK1=(0.2-0.52) GeV
PK2=(0.52-0.84) GeV
PK3=(0.84-1.16) GeV
PK4=(1.16-1.48) GeV
PK5>1.48 GeV**

B^0 BKG with Experimental Mistag

Effective χ_{BKG} taken into account

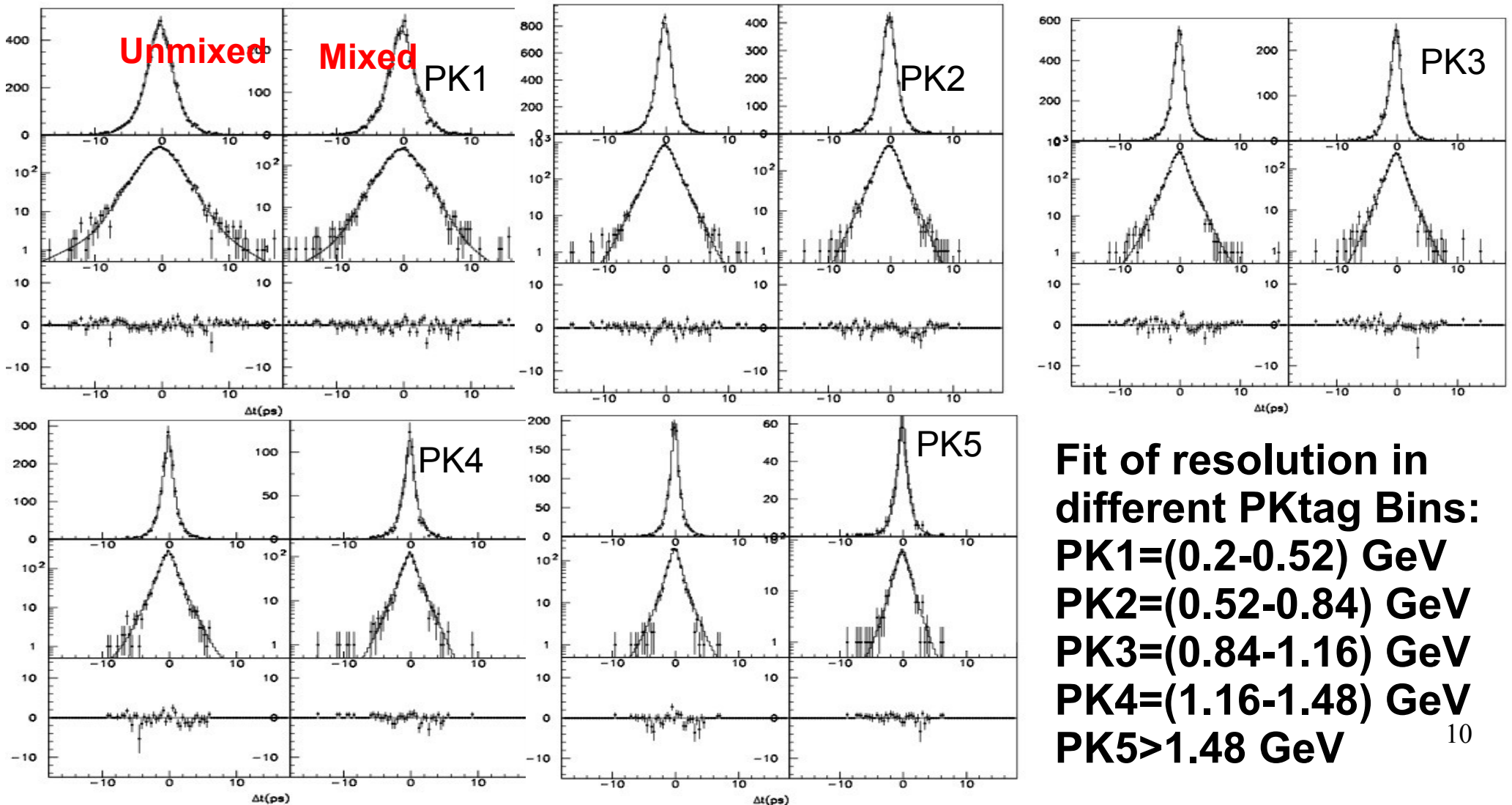
True Δt
Measured Tag



Mistag
determination
from the Fit in
agreement with
MC Counting
results.

Δt Resolution

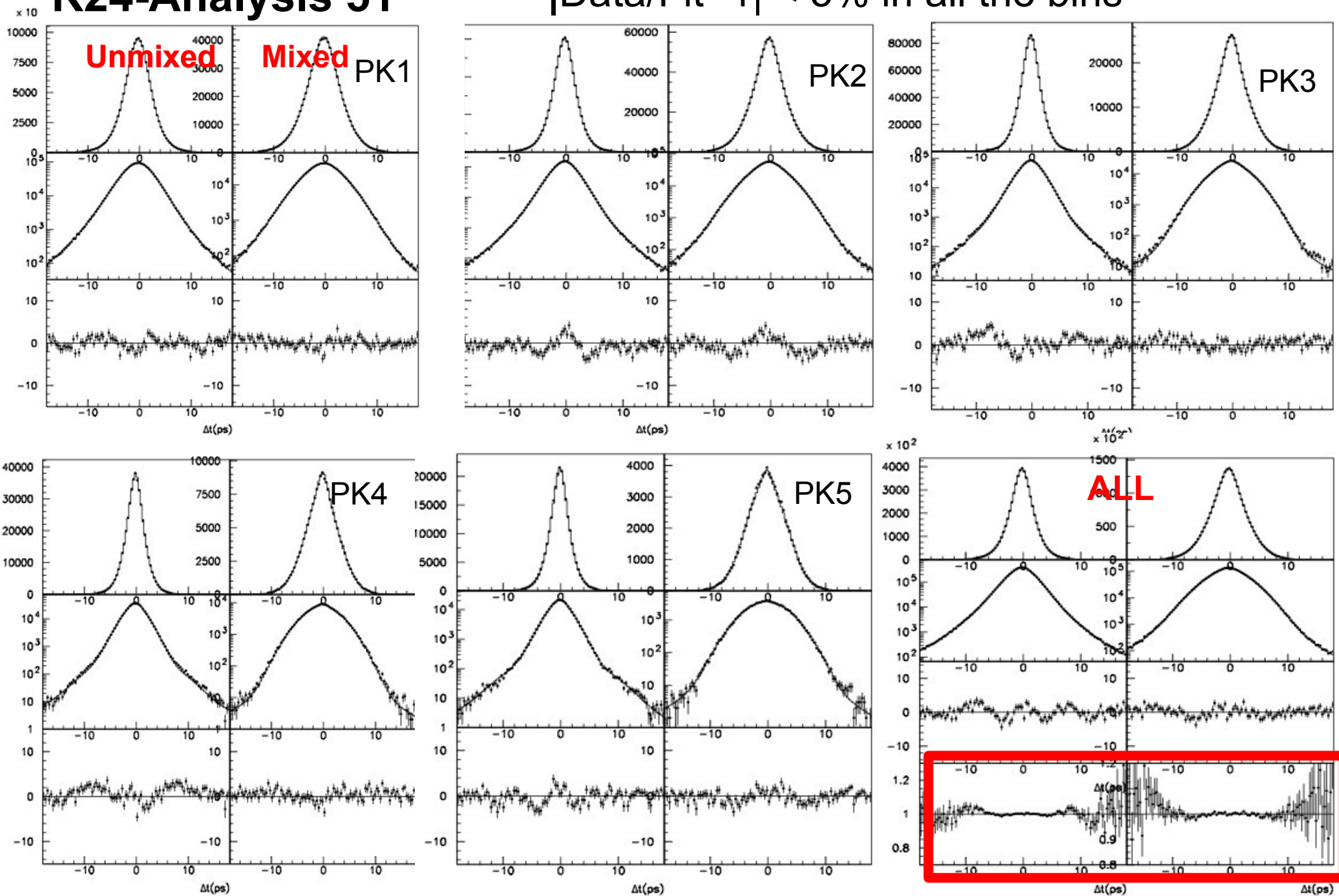
- Resolution Model optimized by fitting $x = \Delta t \text{ measured} - \Delta t \text{ true}$ (Physics & mistag effects removed): Parameters depending on P_{ktag}
- Resolution parameters shared between B^0 & B^+ (different sets for Peaking & BKG)



B^0 Peaking with Experimental Mistag & Resolution

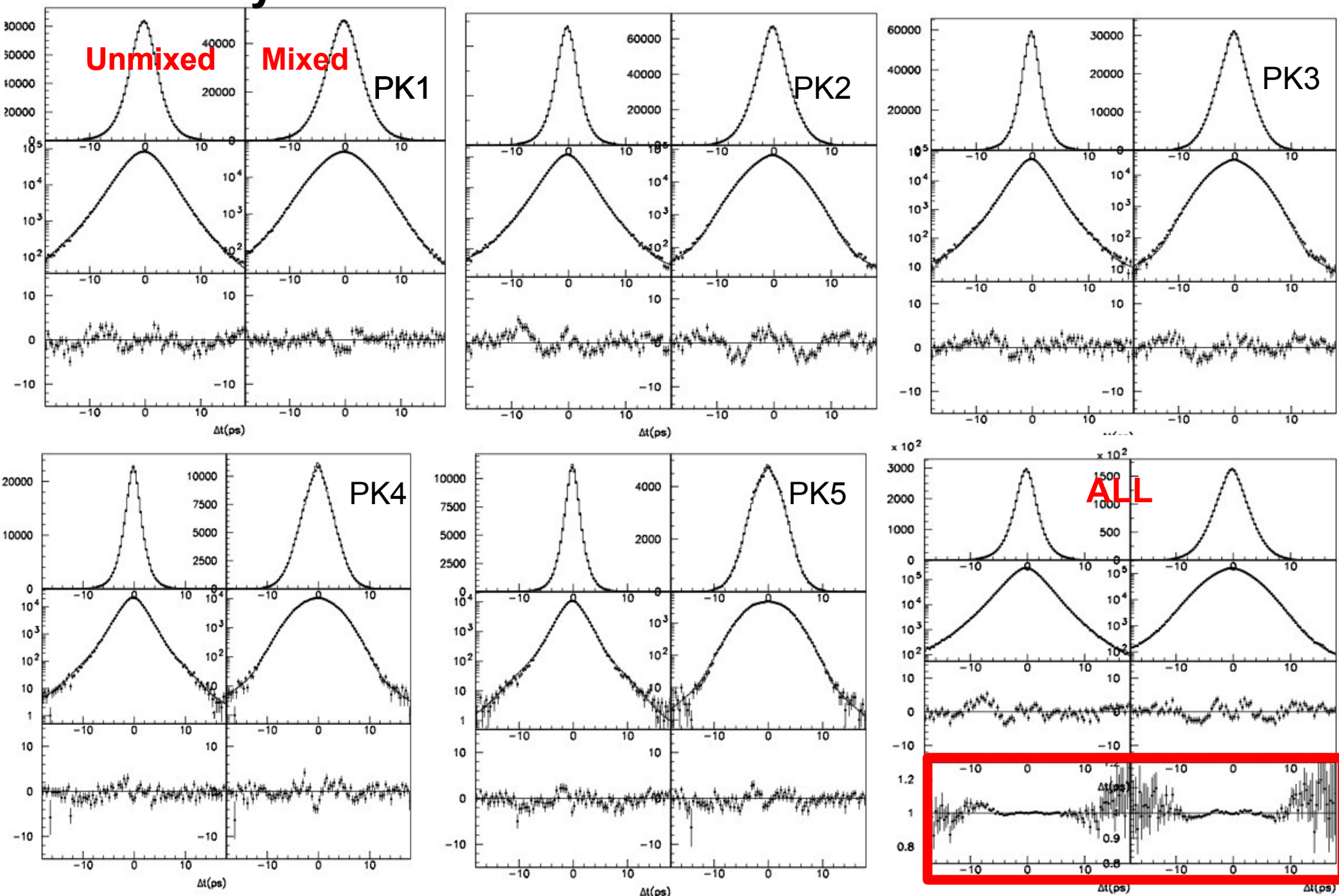
R24-Analysis 51

$|\text{Data}/\text{Fit} - 1| < 5\%$ in all the bins



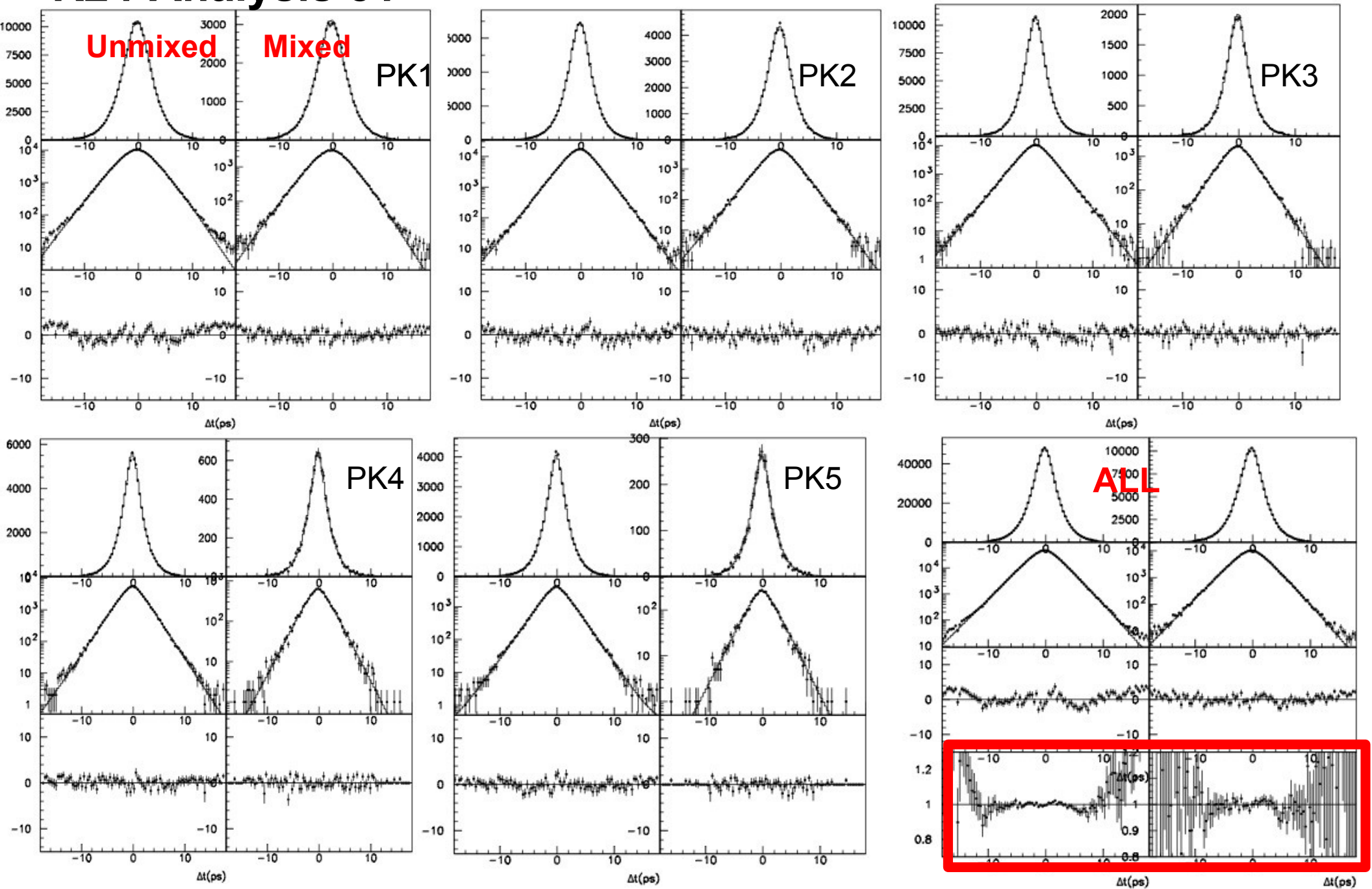
B^0 BKG with Experimental Mistag & Resolution

R24-Analysis 51



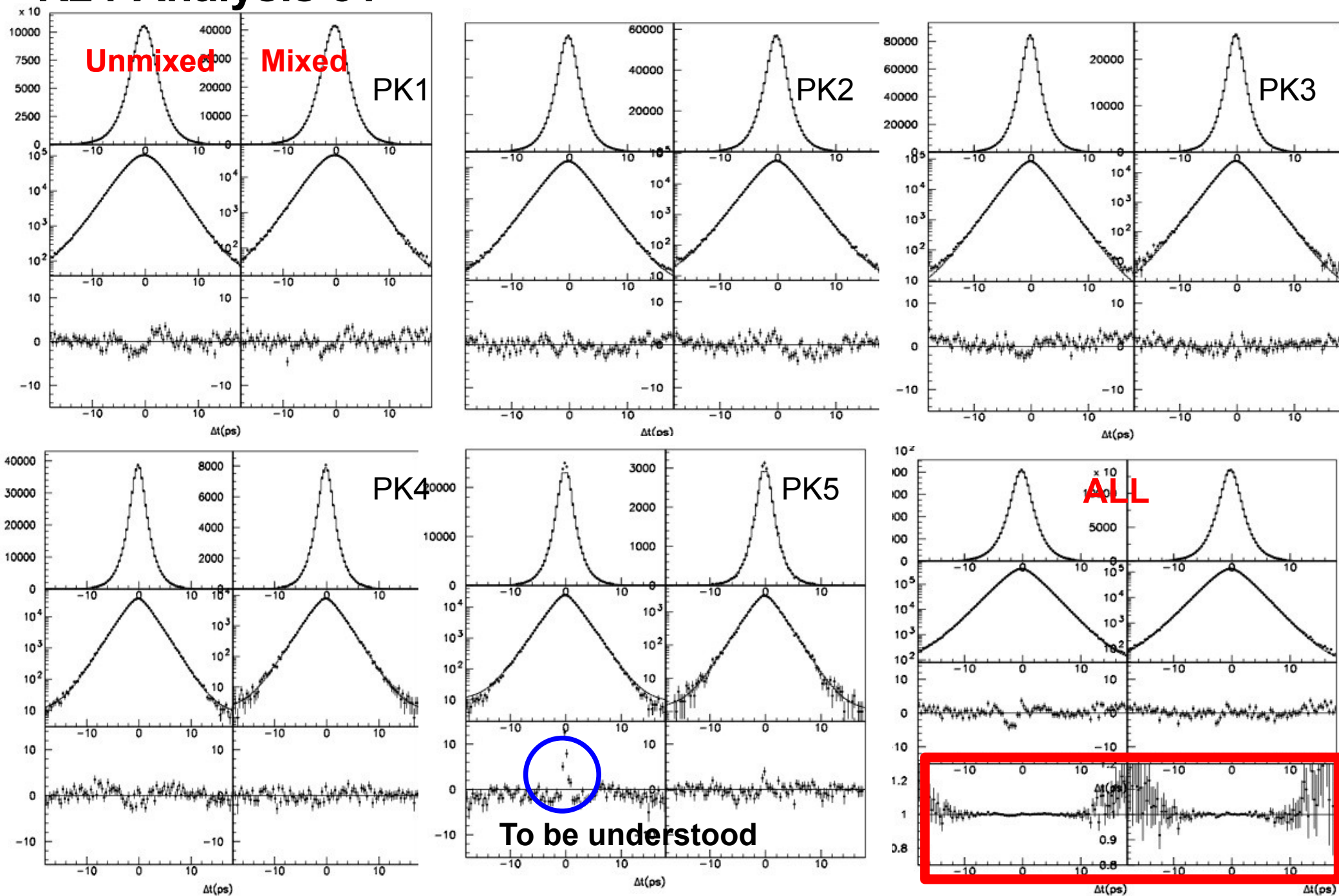
B⁺ Peaking with Experimental Mistag & Resolution

R24-Analysis 51



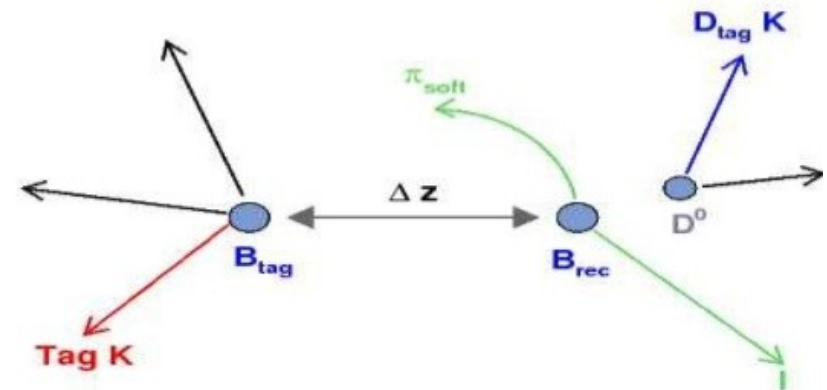
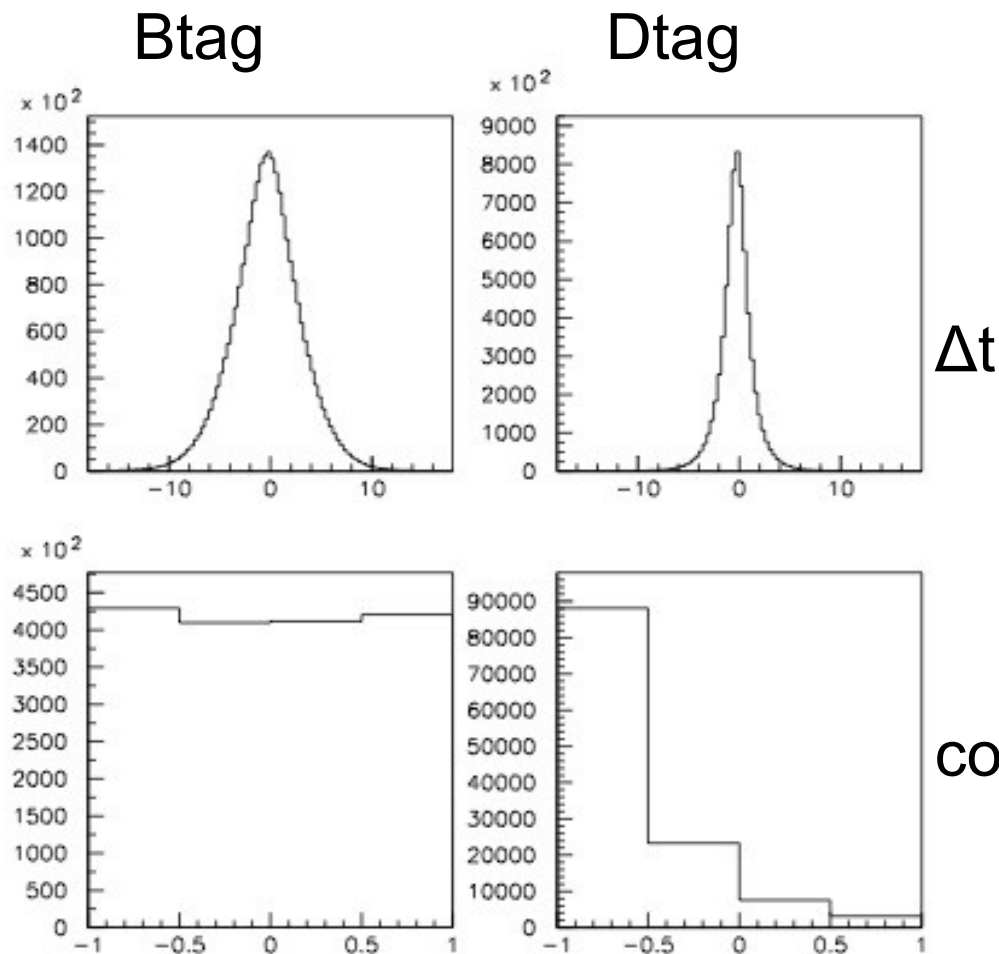
B⁺ BKG wih Experimental Mistag & Resolution

R24-Analysis 51



Dtag Fraction Determination

- Exploit the different Δt & $\theta(\text{Ktag-Lepton})$ distributions wrt Btag events to determine the Dtag Fraction in each subsample (B^0/B^+)X(Peaking/BKG).



- Fix the Btag, Dtag $\cos(\theta_{\text{K-Lepton}})$ & Dtag Δt shapes from the MC in the fit
- Systematics to be evaluated from Data/MC exclusive-reco D control samples

Dtag Fraction Determination

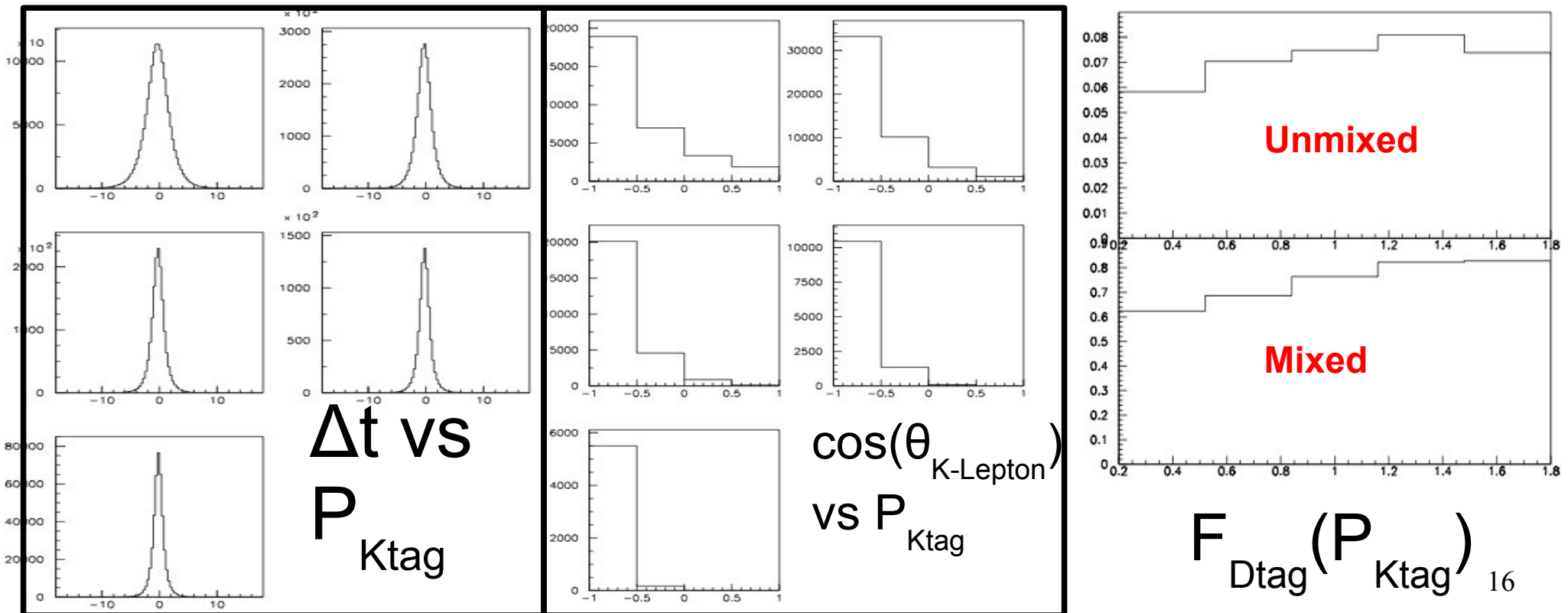
- Take into account the $P_{K_{tag}}$ dependence of Δt & $\theta(K_{tag}\text{-Lepton})$ distributions: **Float Dtag Fraction in every $P_{K_{tag}}$ bin**
- Small Fraction correction vs $\sigma(\Delta t)$ from MC included
- Subtlety: different physical asymmetry in Dtag vs Btag reflects in a q/p dependence of Dtag Fraction

$$Asl\ Btag = -2(|q/p|-1)$$

double tag

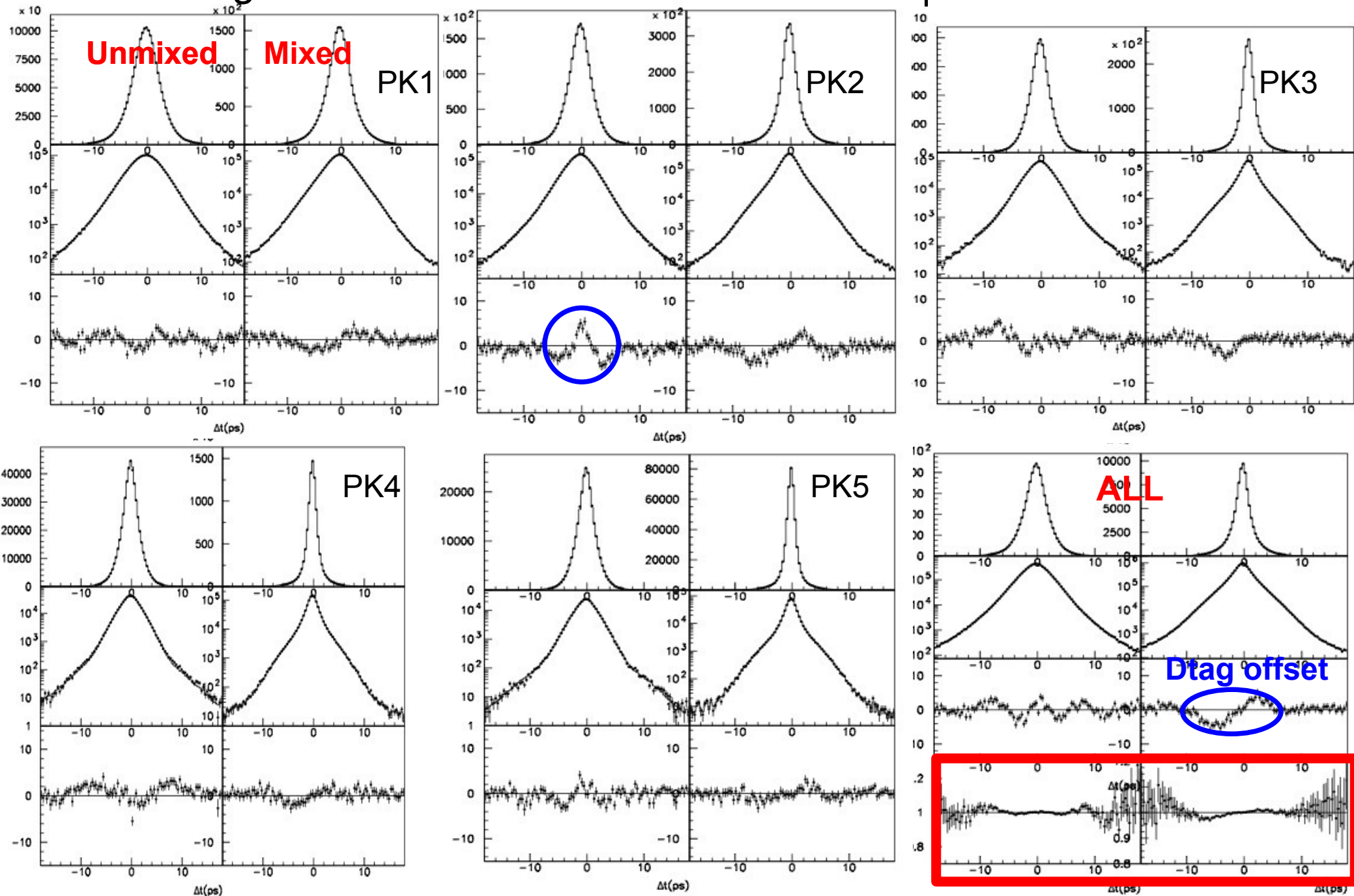
$$Asl\ Dtag = -2(|q/p|-1)\chi_d$$

single tag



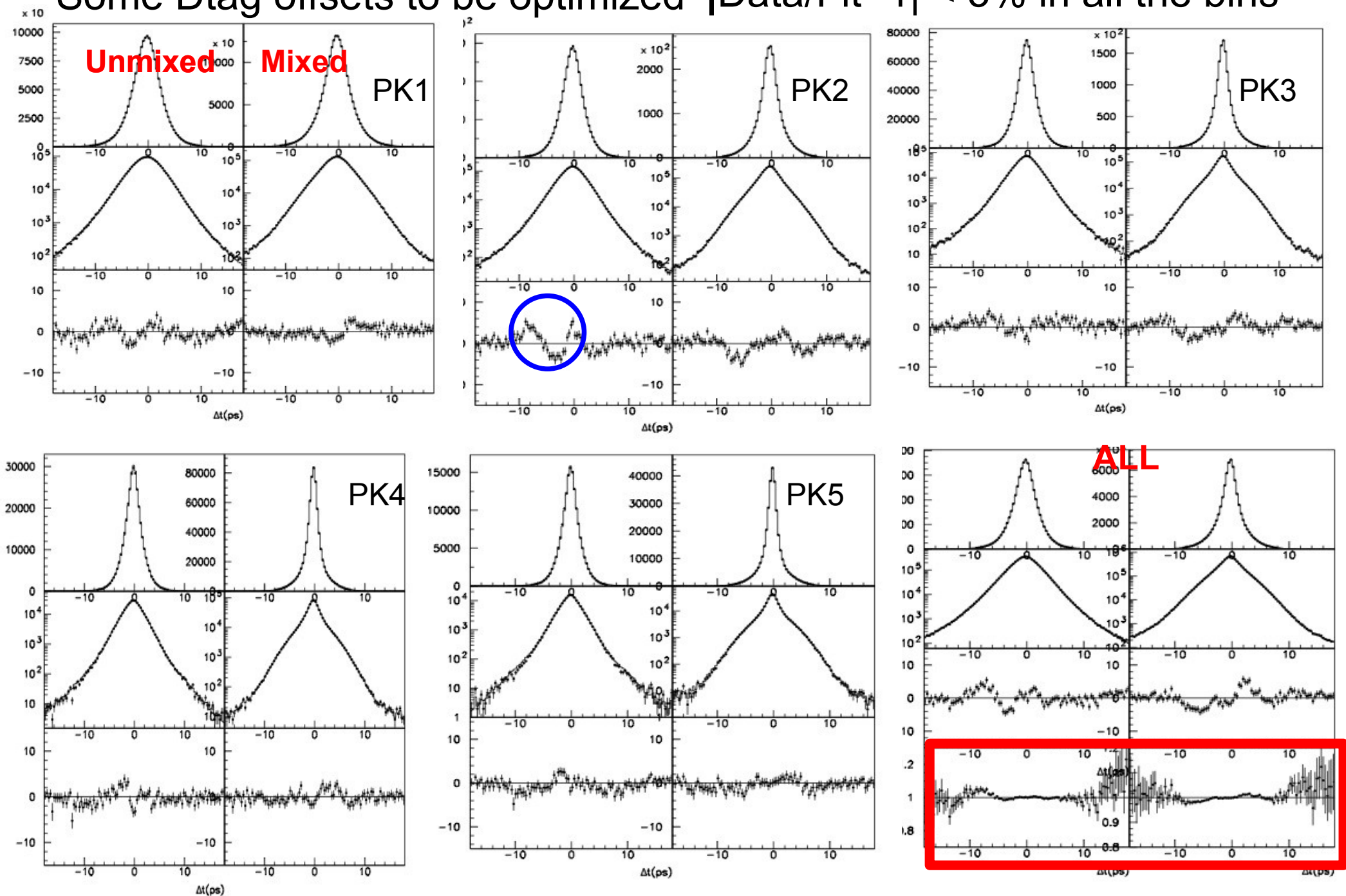
B⁰ Peaking (Btag+Dtag) with Exp. Mistag & Resolution

Some Dtag offsets to be optimized $|Data/Fit - 1| < 5\%$ in all the bins



B^0 BKG (Btag+Dtag) with Exp. Mistag & Resolution

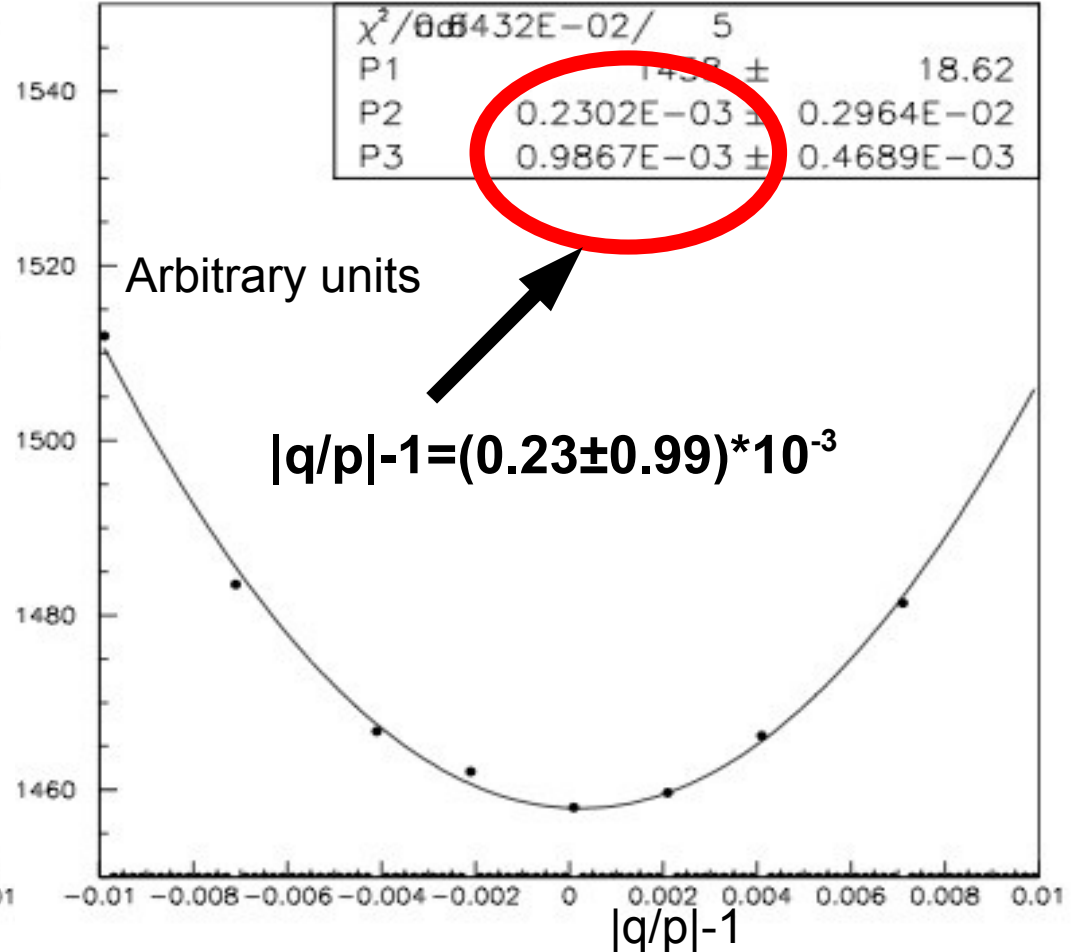
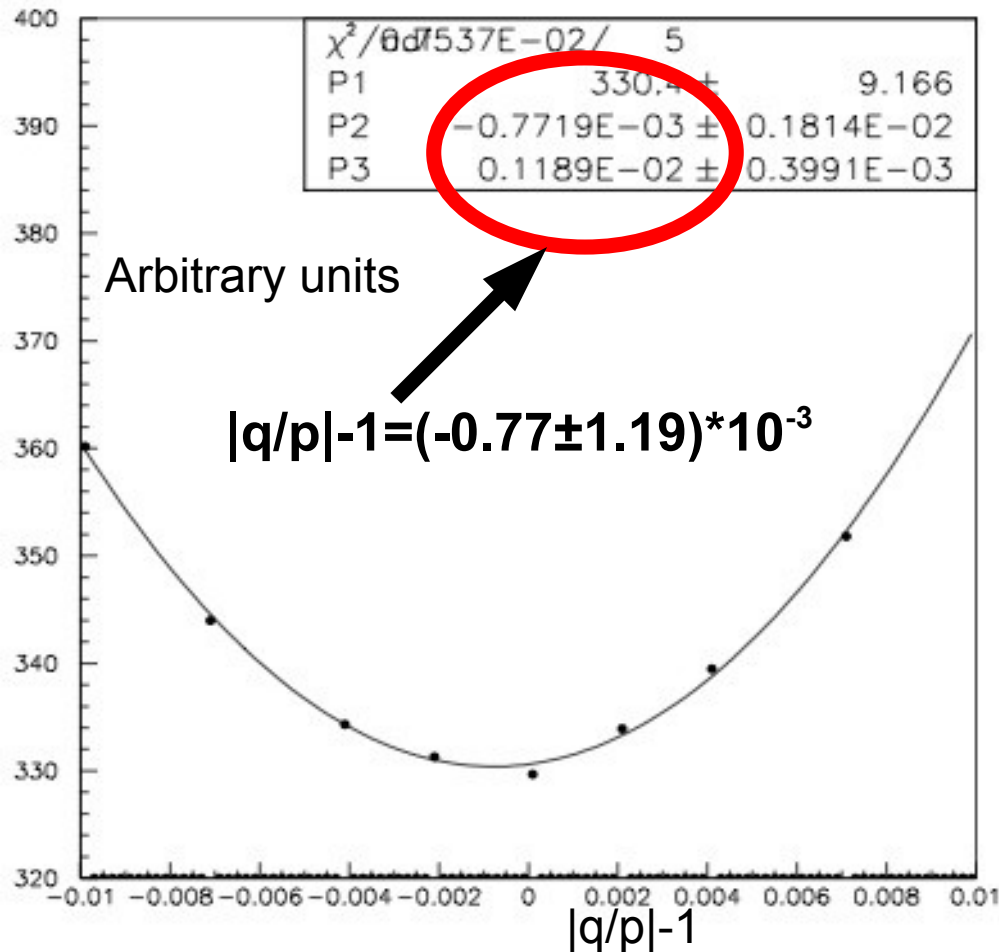
Some Dtag offsets to be optimized $|Data/Fit - 1| < 5\%$ in all the bins



Likelihood-profile of B^0 Signal MC vs $|q/p|-1$

Only Btag

Btag + Dtag

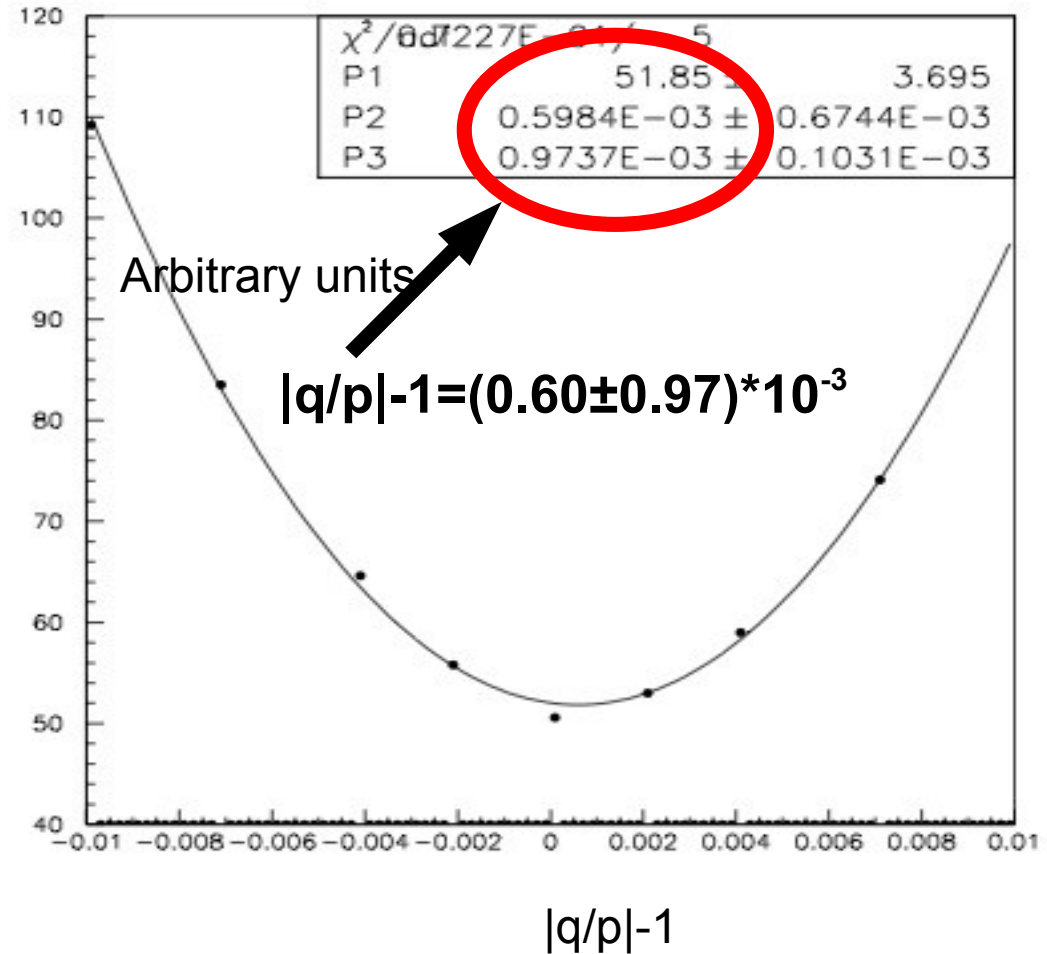
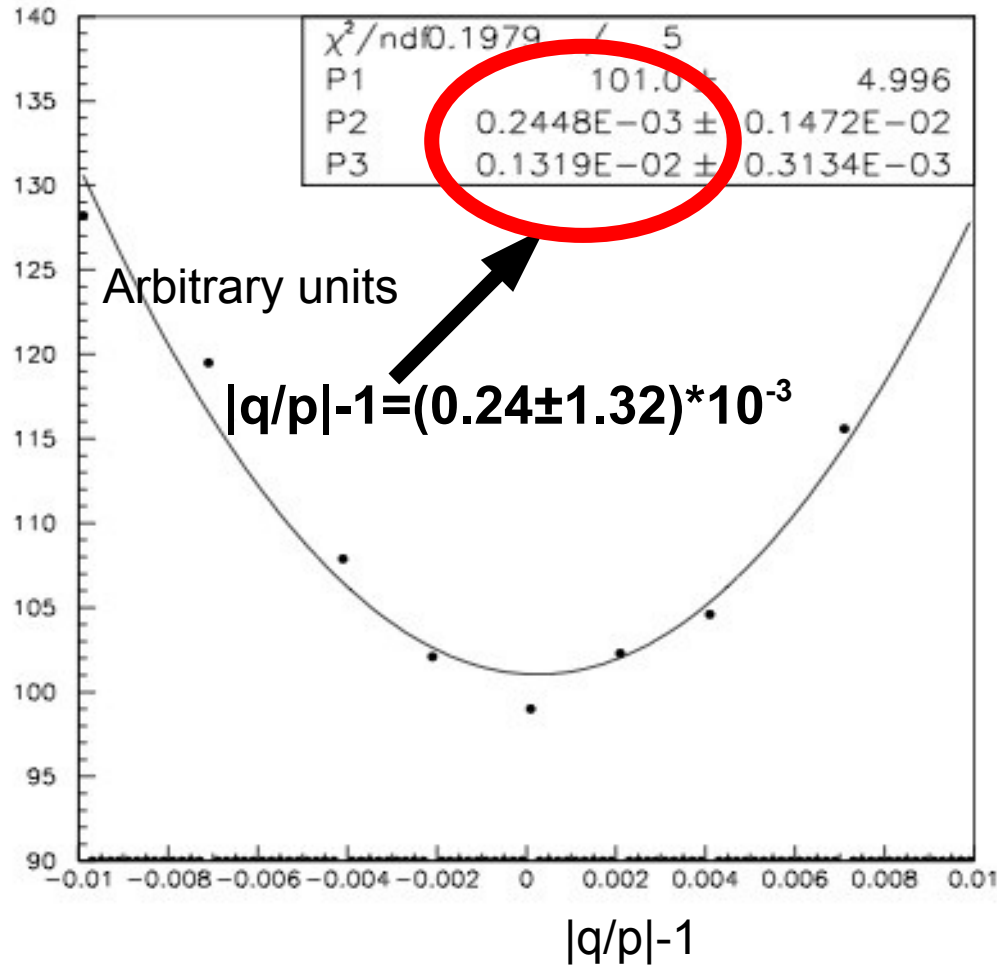


No Bias found in both the samples (expected statistical error on Real Data $\sim 2 \cdot 10^{-3}$)

Likelihood-profile of B^0 BKG MC vs $|q/p|-1$

Only Btag

Btag + Dtag



No Bias found in both the samples

• B^0 & B^0+B^+ **Signal+BKG** scans need determination of subsamples fractions $F_i(m^2v)$: ready in a few days.

Conclusions & Next Steps:

- MC Run1-Run6 Release 24, Analysis 51:
Fit of single components (B^0 , B^+)X(Peaking, BKG)X(Btag, Dtag)
almost finalized
- Likelihood scan performed on B^0 Peaking & B^0 BKG: **No bias found**
- B^+ Btag+Dtag scans are running
- MC Full Fit (B^0+B^+ +Continuum) ready in a few weeks.
- Real Data Analysis will follow soon
- BAD Update