Status of the D*N |q/p| Analysis

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First studies on Real Data:

- Definition of Dtag Δt shape
- Very Preliminary BLIND Results
- First Systematic errors & cross checks:
  - Dtag description
  - Disentangle between |q/p| and detector Asymmetries

- Discussion on strategy to manage the double counting of events in different binomial constraints

- Conclusion/Next Steps

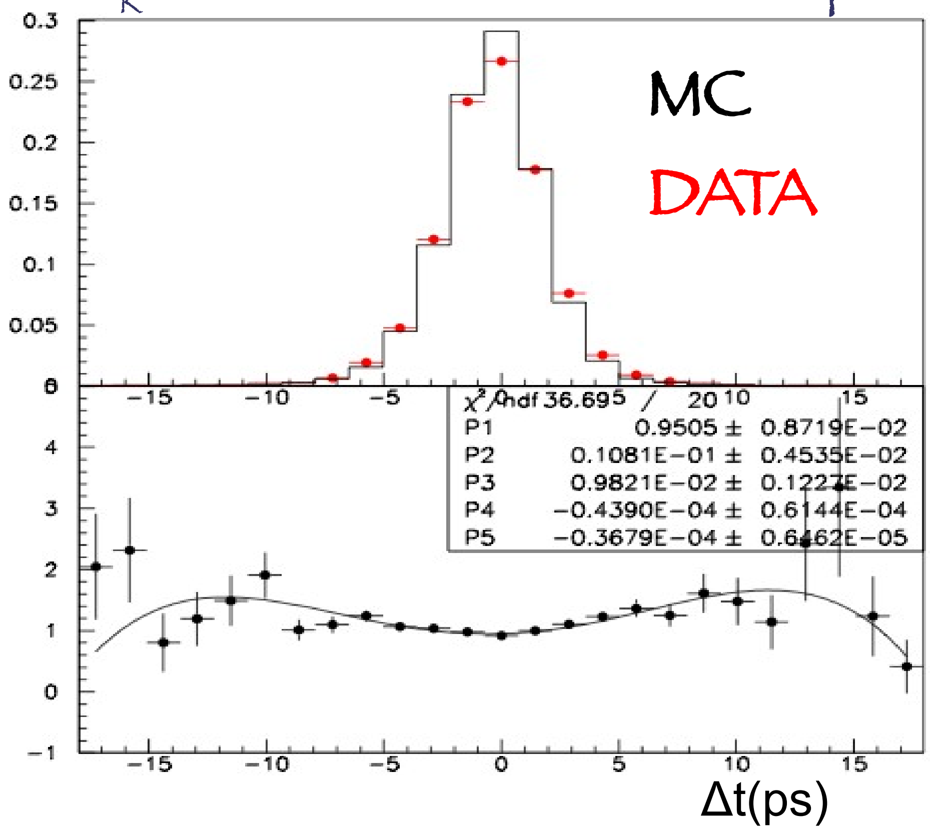
Dtag description on Real Data

Dtag Δt shape from the High Purity selection:

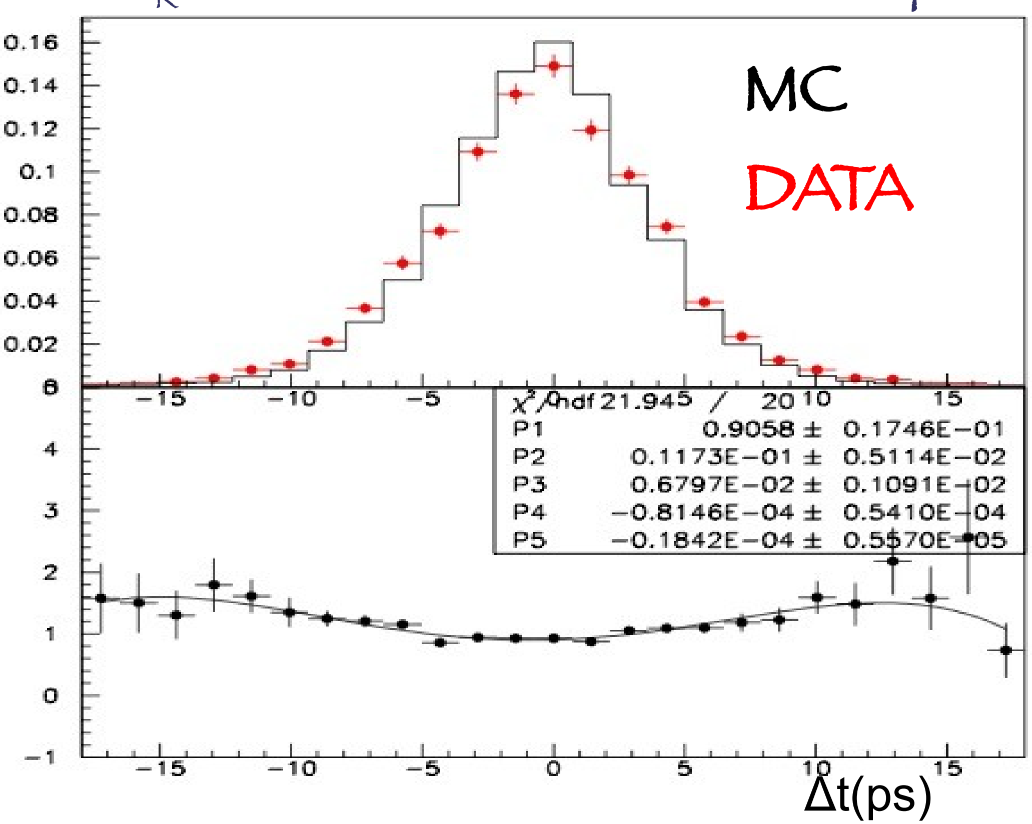
$PDF^{DATA}_{Class\ i} = PDF^{MC}_{Class\ i} * (PDF^{DATA}/PDF^{MC})_{High\ Purity\ Selection}$

- 4 Dtag Classes: (B^0/B^+)X(Peaking/BKG)
- Data/MC Corrections computed in bin of (PK, σΔt)

P_K=0.2/0.52 GeV, σΔt=1.2/1.8 ps



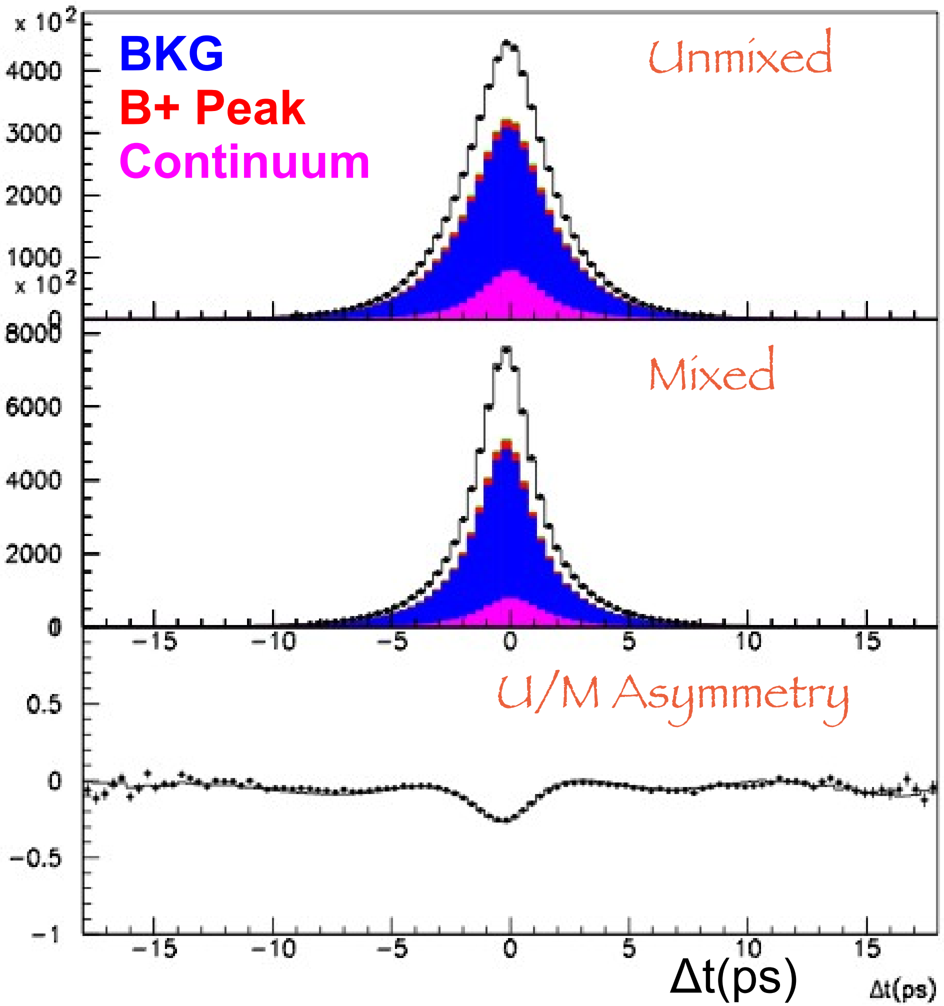
P_K=0.2/0.52 GeV, σΔt=2.4/3.0 ps

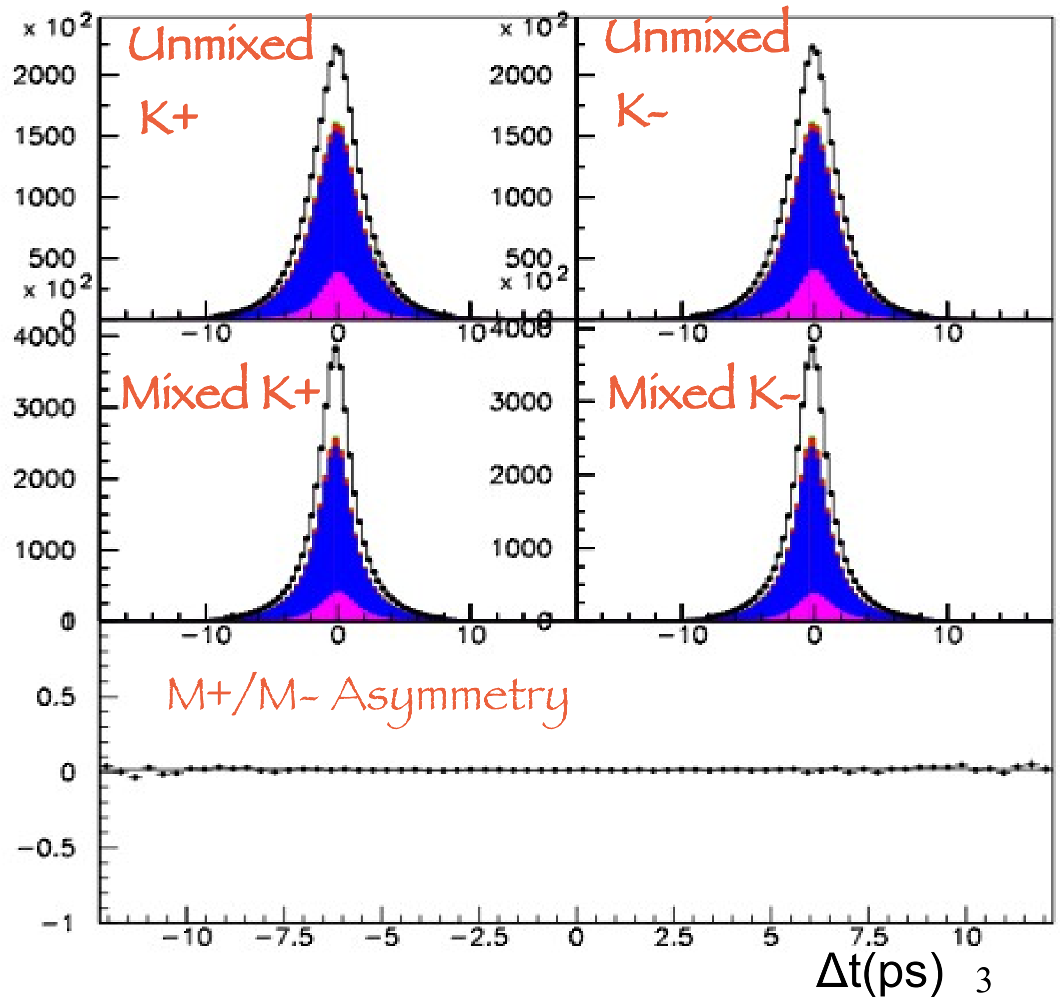


Preliminary BLIND Results

Fitted Δt Shapes

- Only parameters correlated with |q/p| floated, resolution fixed

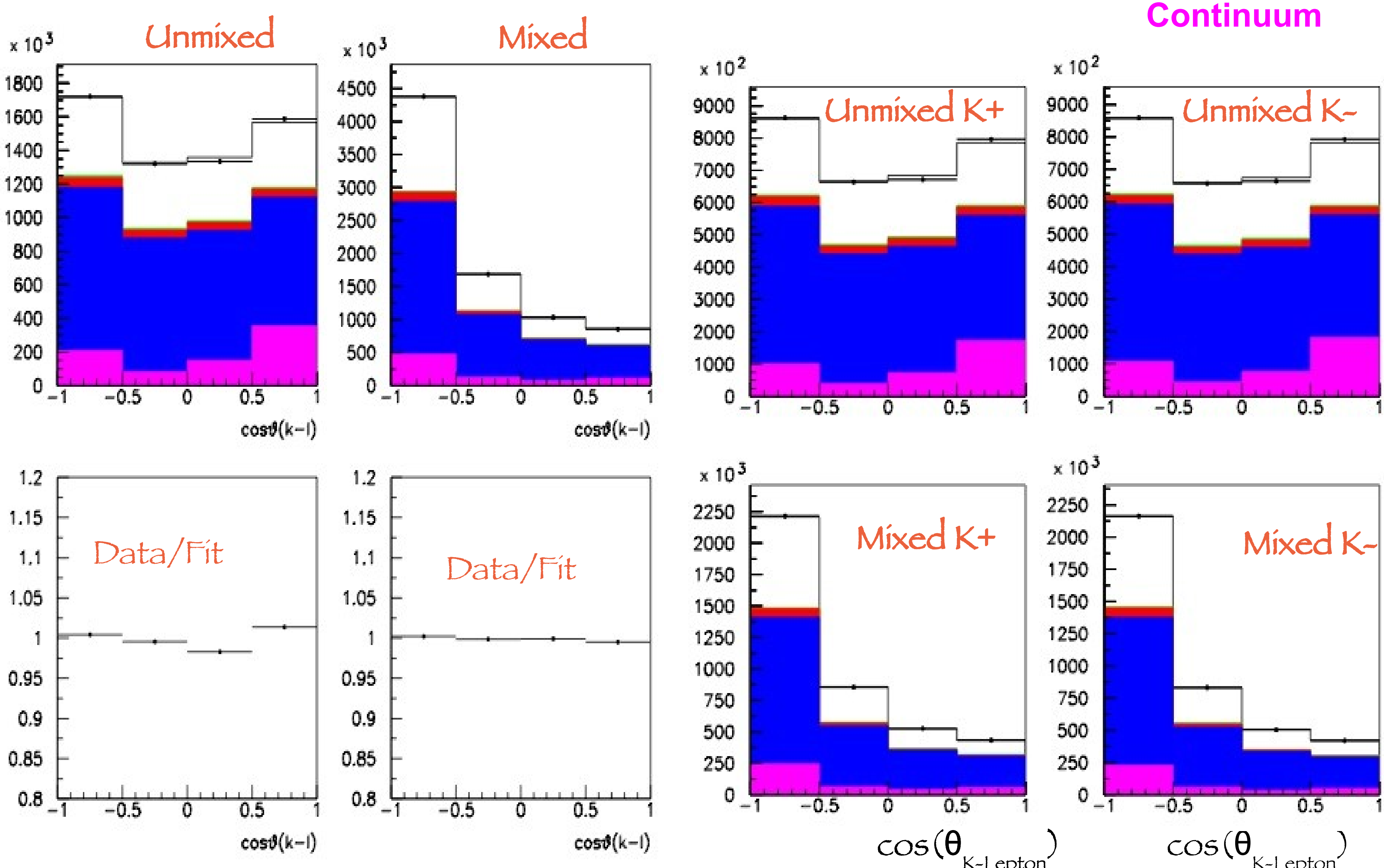




Preliminary BLIND Results

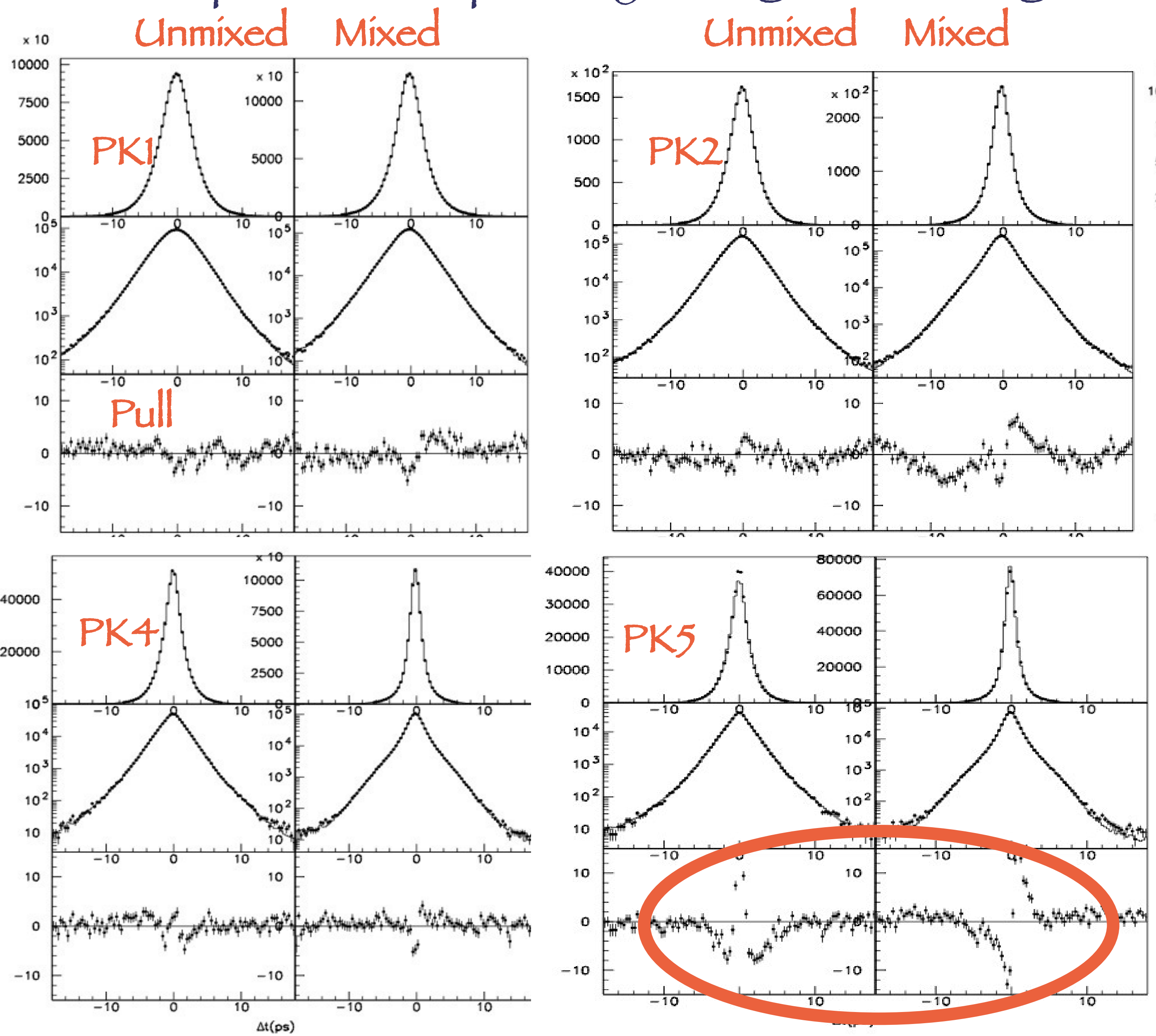
Fitted $\cos(\theta_{K\text{-}Lepton})$ Shapes

BKG
B+ Peak
Continuum



Fitted Δt Shapes in P_K bins

- Agreement to be optimized by floating also the resolution parameters
- Some problem expecially at high PK: Dtag Shape, Fraction, Resolution?



PKtag Bins:

PK1=(0.2-0.52) GeV

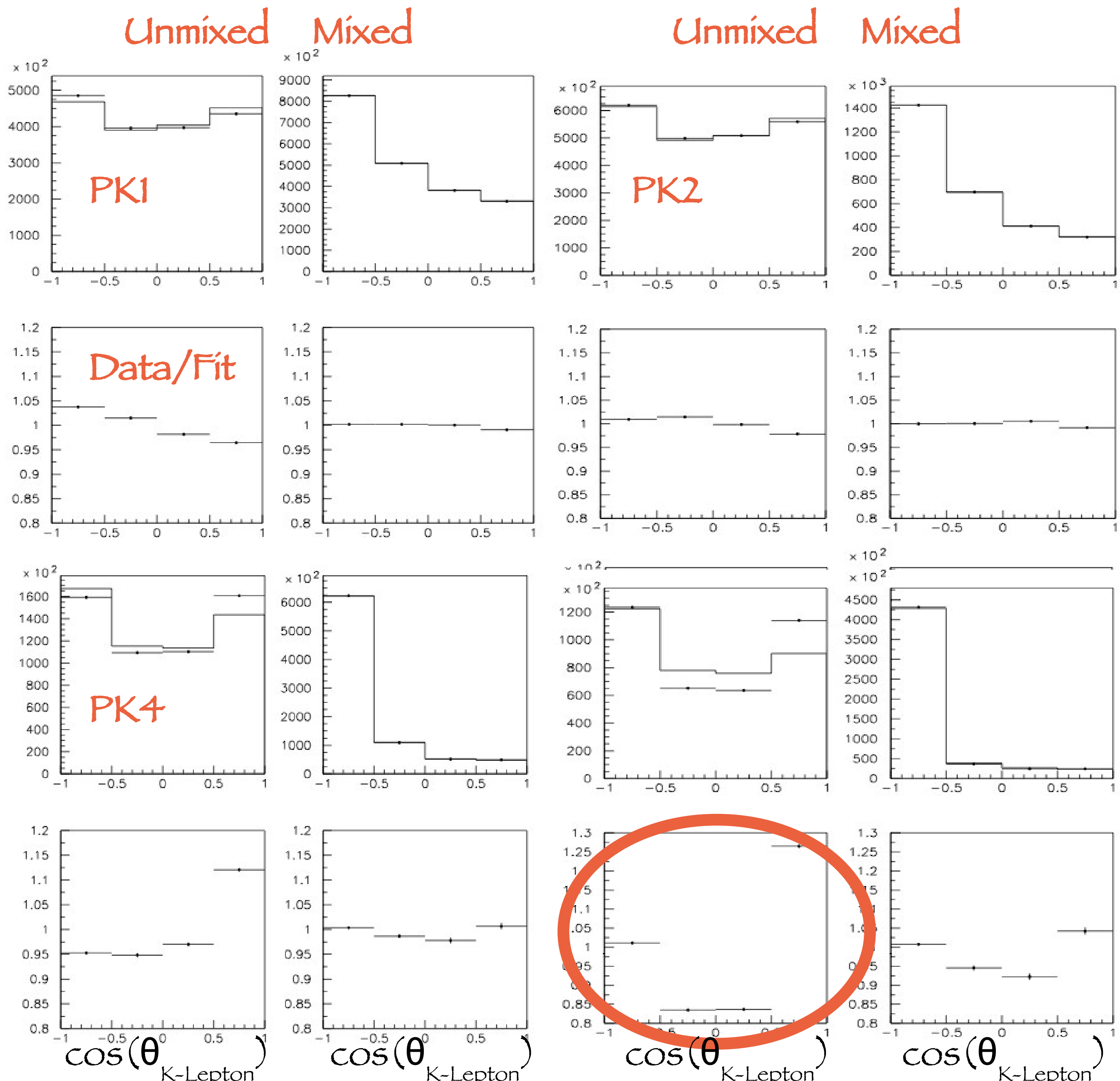
PK2=(0.52-0.84) GeV

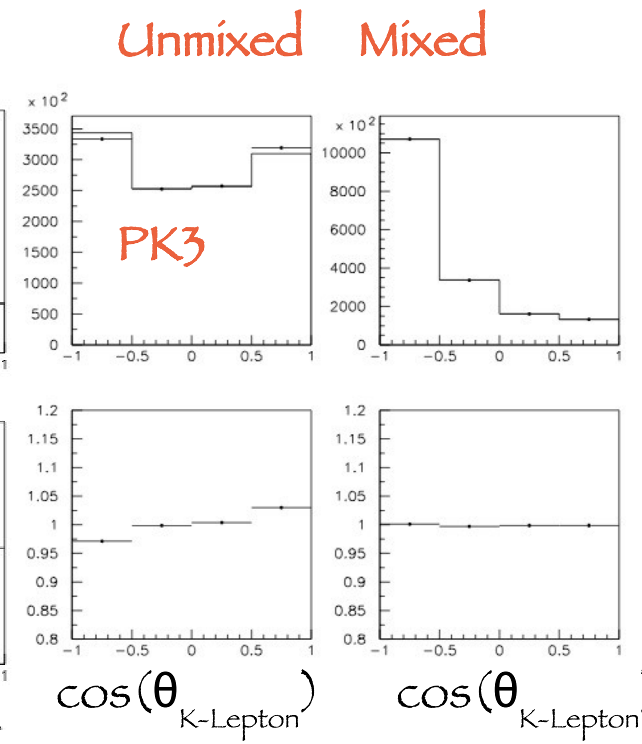
PK3=(0.84-1.16) GeV

PK4=(1.16-1.48) GeV

PK5>1.48 GeV

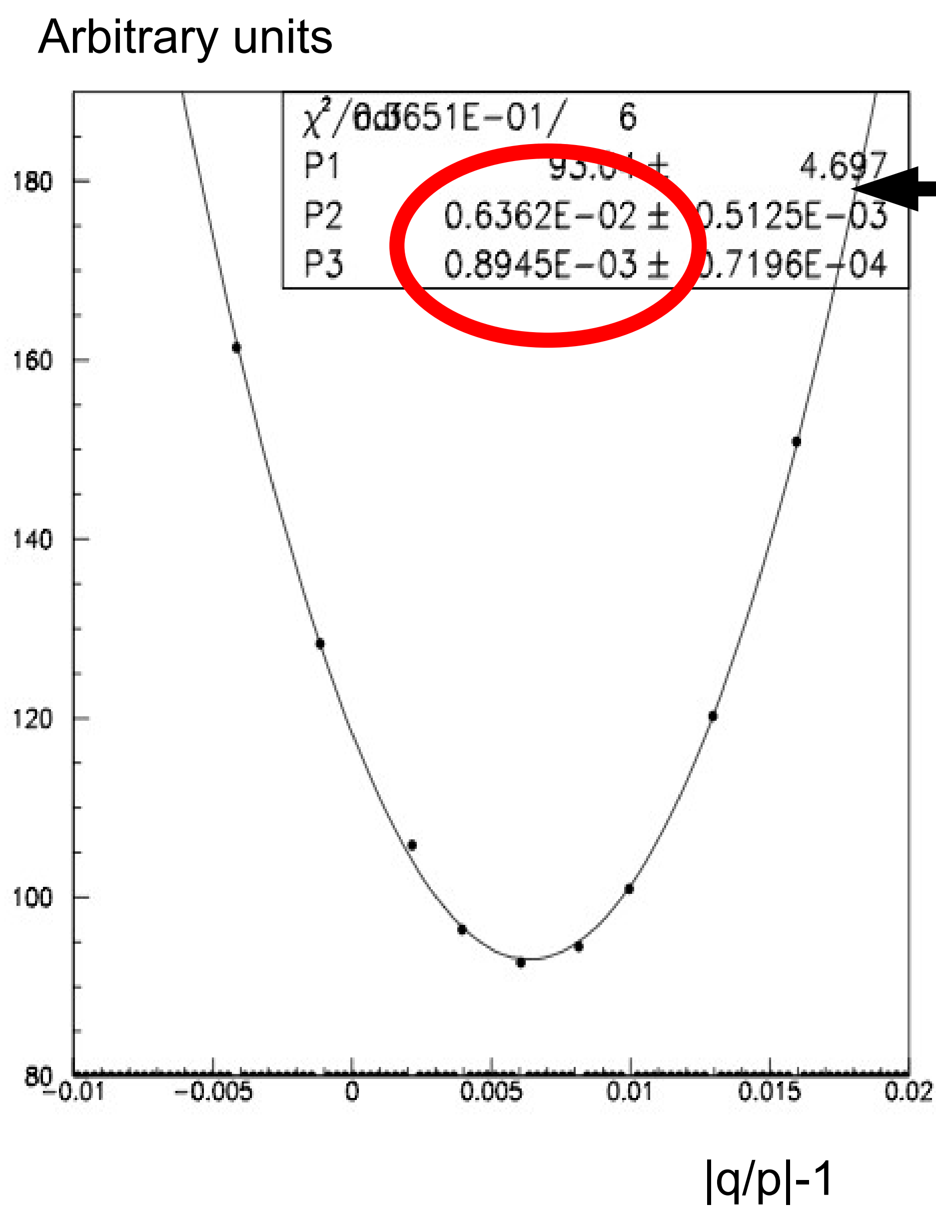
Fitted $\cos(\theta_{K\text{-}Lepton})$ in P_K bins





- Again problem at high PK: Dtag Shape, Fraction ?

Preliminary BLIND Results



Blind Result:

$|q/p|-1=(6.36\pm0.89)*10^{-3}$

- Only parameters correlated with |q/p| floated, resolution fixed
- Nice convergence reached
- Statistical error scales correctly wrt Real Data/MC statistics

Preliminary Systematics: Dtag description

Dtag description is one of the few elements of the analysis not completely data-driven: source of systematic errors:

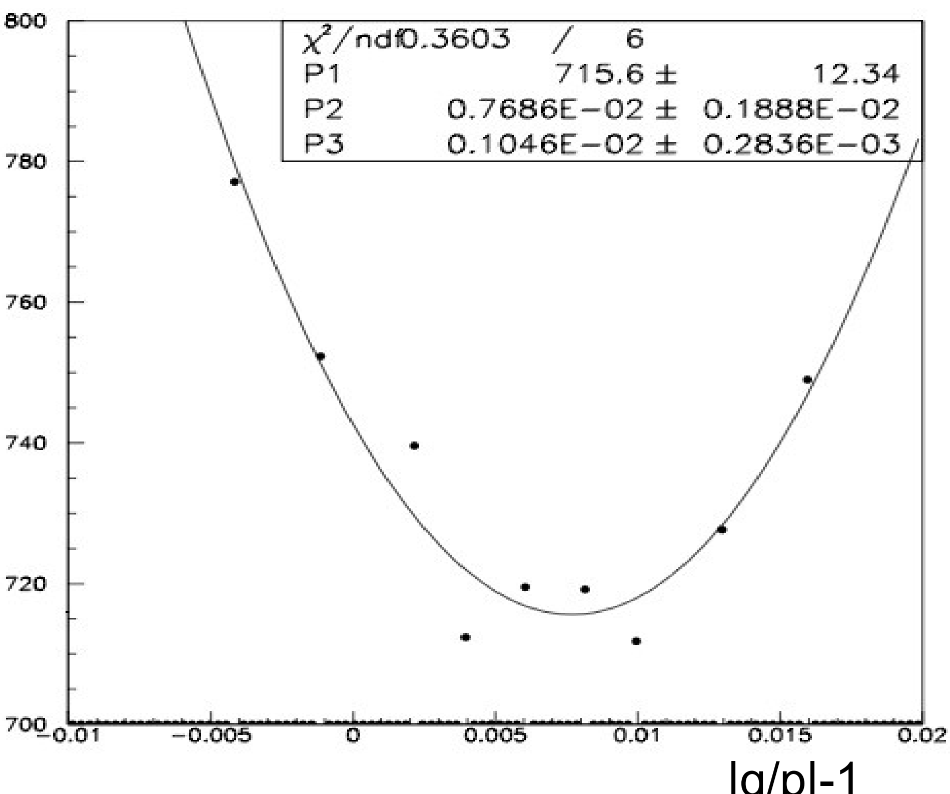
- Dtag Δt shape from Data/MC correction
  - ➔ Use alternatively Δt shape from High Purity selection on Real Data or from "inclusive" Dtag from MC

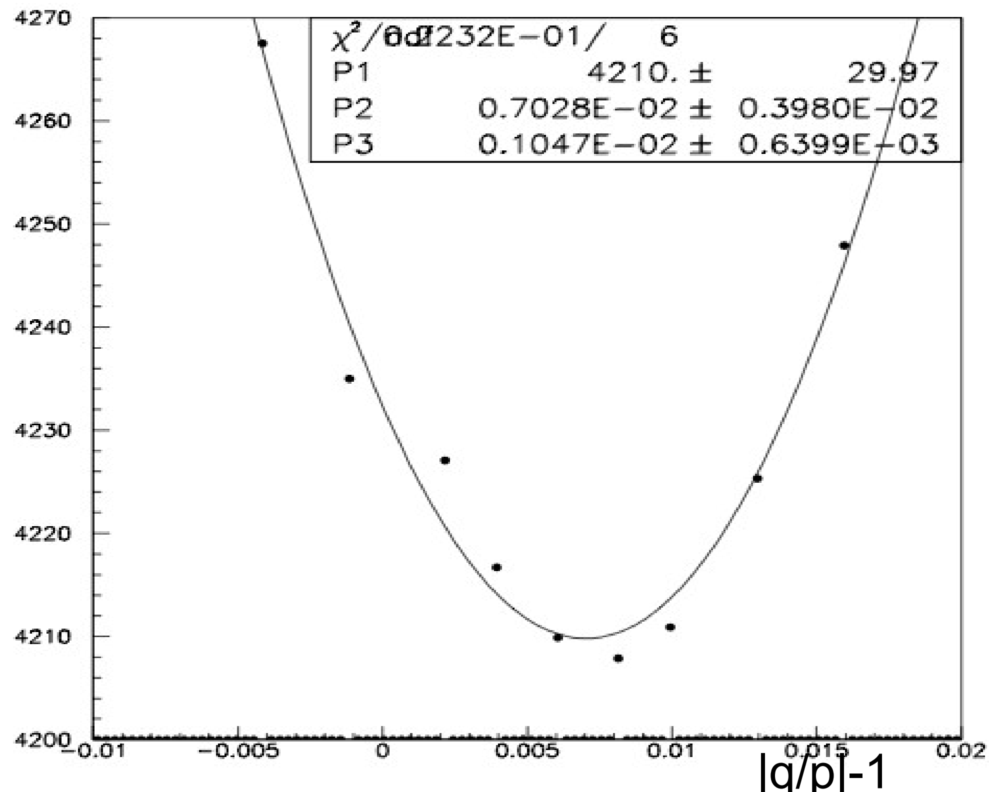
- Dtag Fraction in the B^+ sample (Peaking & BKG) constrained to B^0 one using ratios $R_{MC}(P_K)=F^{B+}_{Dtag}/F^{B0}_{Dtag}$ from MC
- R_{MC} depend on $BR(B^{0/+} \rightarrow DX \rightarrow KY)$
  - ➔ Conservatively vary R_{MC} by 20%, to be optimized

Dtag Systematics: Δt shape

Dtag Δt shape from:

- High Purity selection on Real Data
- Inclusive Dtag from MC





- Difference wrt Standard Procedure (scans to be optimized):

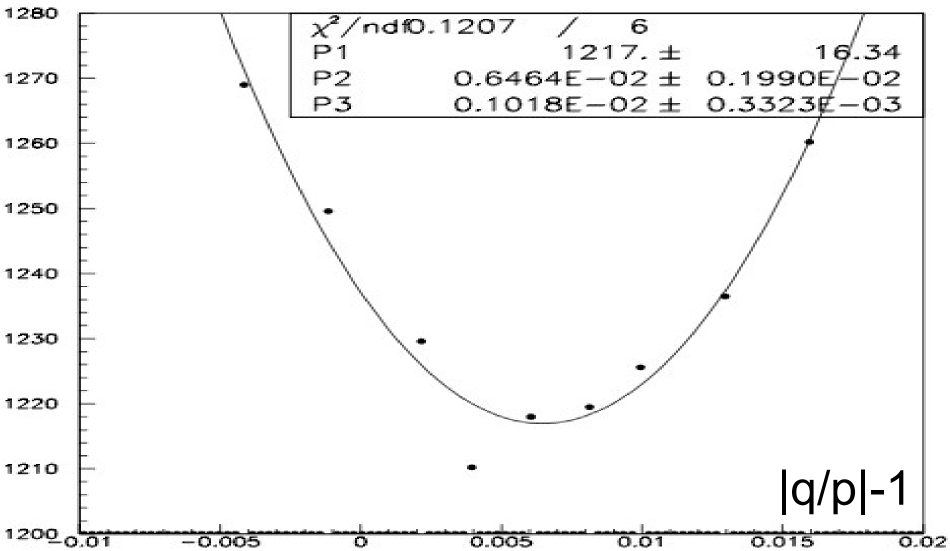
→ $\Delta|q/p|=+1.3\ 10^{-3}$ $\Delta|q/p|=+7\ 10^{-4}$

Dtag Systematics: B^+ sample fraction

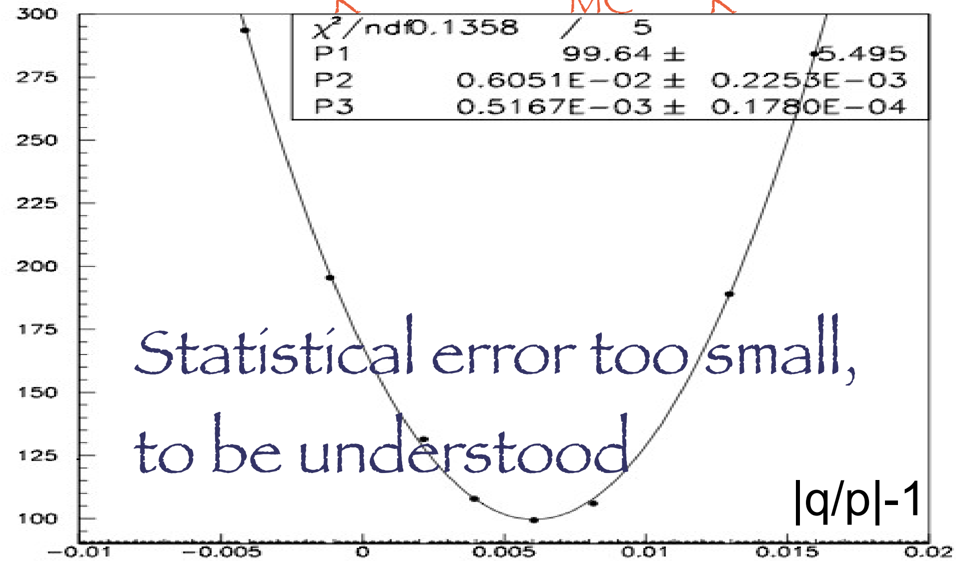
Dtag Fraction in the B^+ sample:

- $R_{MC}(P_K)=F^{B+}_{Dtag}/F^{B0}_{Dtag}$ varied by ±20%

$R(P_K)=0.8*R_{MC}(P_K)$



$R(P_K)=1.2*R_{MC}(P_K)$



Statistical error too small, to be understood

- Difference wrt Standard Procedure (to be optimized):
  - → $\Delta|q/p|=+1.0\ 10^{-4}$ $\Delta|q/p|=-3.1\ 10^{-4}$
  - → Total preliminary systematic error from Dtag $\Delta|q/p|= {}^{+1.3\ 10^{-3}}_{-0.3\ 10^{-3}}$

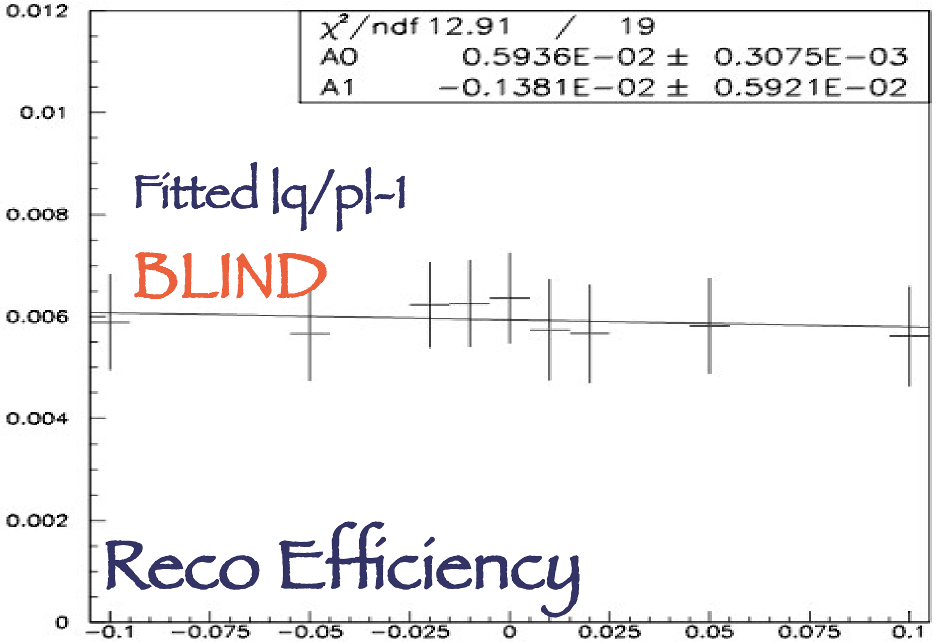
|q/p| vs detector Asymmetries

- Strategy of the measurement: disentangle the Physical vs Detector Asymmetries by exploiting all the available informations from different subsamples

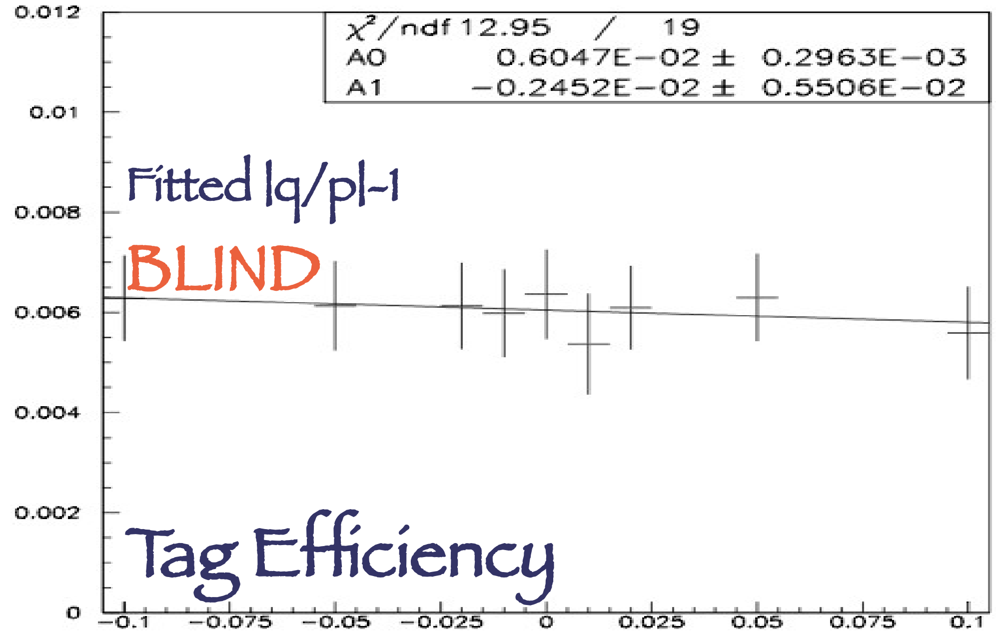
  → |q/p| and detector Asymmetries are strongly related in the PDF

- Test performed to look for possible bias on the |q/p| determination produced by a not correct description of the Physical vs Detector Asymmetries interconnection in the Fit constraints:
  - → Artificial efficiency asymmetry produced by random rejecting positive or negative leptons/kaons from the selected sample
  - → Artificial $\Delta\varepsilon=\varepsilon^{+}-\varepsilon^{-}$ = -10%,-5%, -2%, -1%, 1%, 2%, 5%,10% produced
- To be compared with: Areco(l^{+}, l^{-}) ~0.65%, Atag(K^{+},K^{-}) ~1.5% fitted on Data & MC

$|q/p|-1$ vs $\Delta\varepsilon$



$\varepsilon(l^+\pi^-)-\varepsilon(l^-\pi^+)$



$\varepsilon(K^+)-\varepsilon(K^-)$

- Observed $|q/p|$ variation < 0.001 in all the $\Delta\varepsilon$ range
- $\Delta\varepsilon$ varied in a huge range wrt reasonable values
- The Fit correctly disentangles physical vs detector asymmetries
- Fitted Areco(e+μ) ~6.5 10^{-3}, Atag~1.5%
  - → $\Delta\varepsilon$(Reco)<1.3%, $\Delta\varepsilon$(Tag)<3% (PID tables <1%, ~1.5%)
  - → $\Delta|q/p|$(Reco)<2 10^{-5}, $\Delta|q/p|$(Tag)<6 10^{-5} (to be optimized)

Double Counting Problem

|q/p| and Detector Asymmetries are simultaneously obtained by applying Binomial-Constraints on:

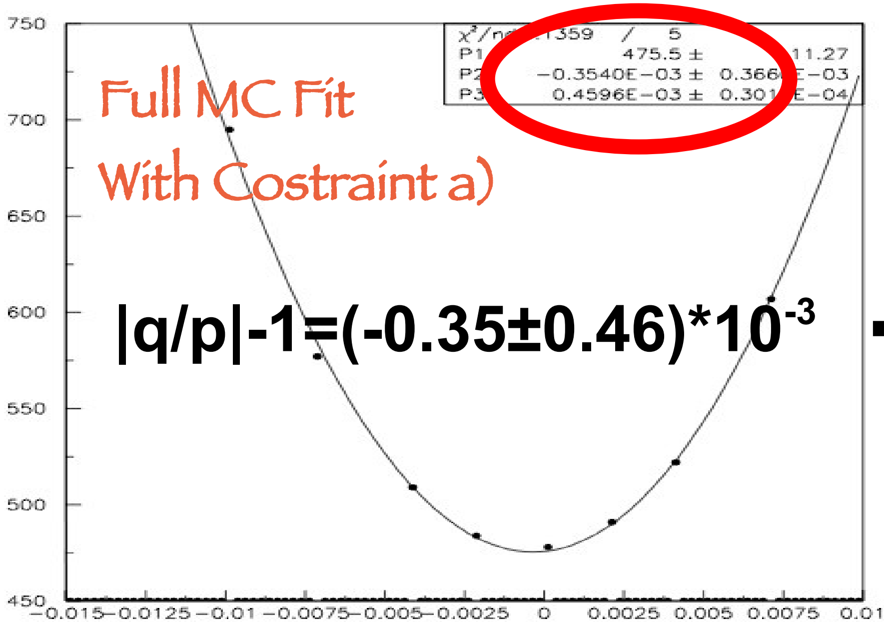
a) Reconstructed Tagged+Untagged Events:
Constrains Reconstruction Asymmetry

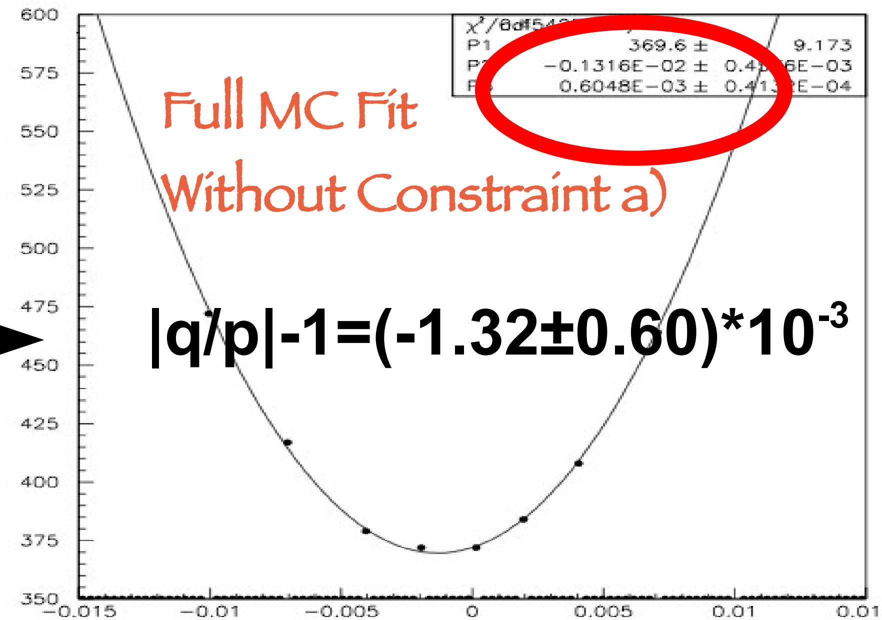
b) Tagged Events divided in different categories
(B^0, B^+)X(Btag, Dtag)X(Peaking, BKG)X(Mixed, Unmixed):
Constrain Physical and/or Detector Asymmetries

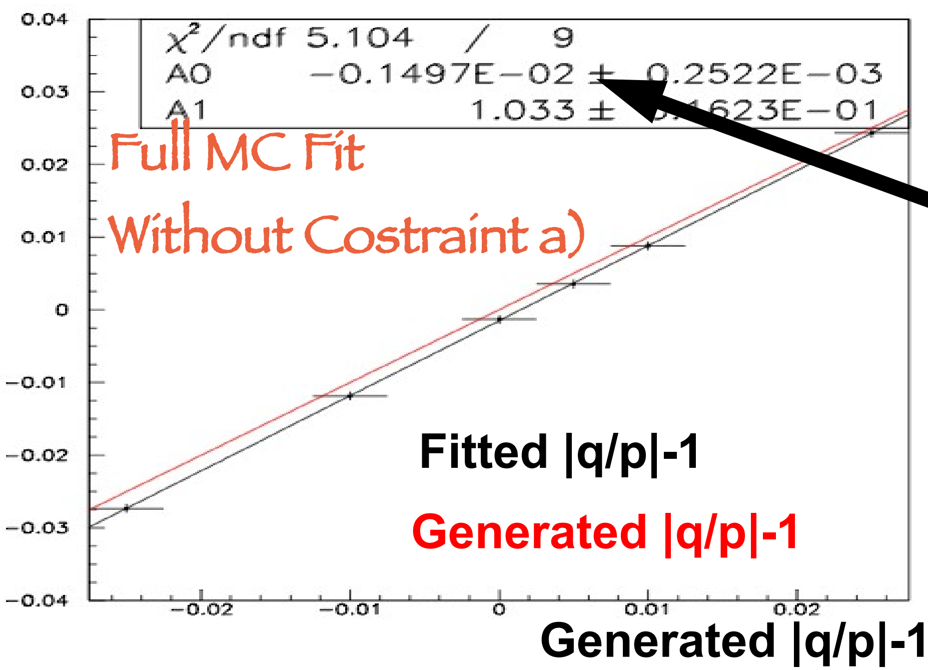
- **Underestimation of statistical error due to double counting of events in the two different Binomial-Constraints has to be avoided**
- Possible Solutions:
    1) Remove Constraint a)
    2) Modify the Likelihood
    3) Estimate a statistical error correction using a Toy MC

Double Counting Problem

Solution 1): MC Test removing Constraint a)



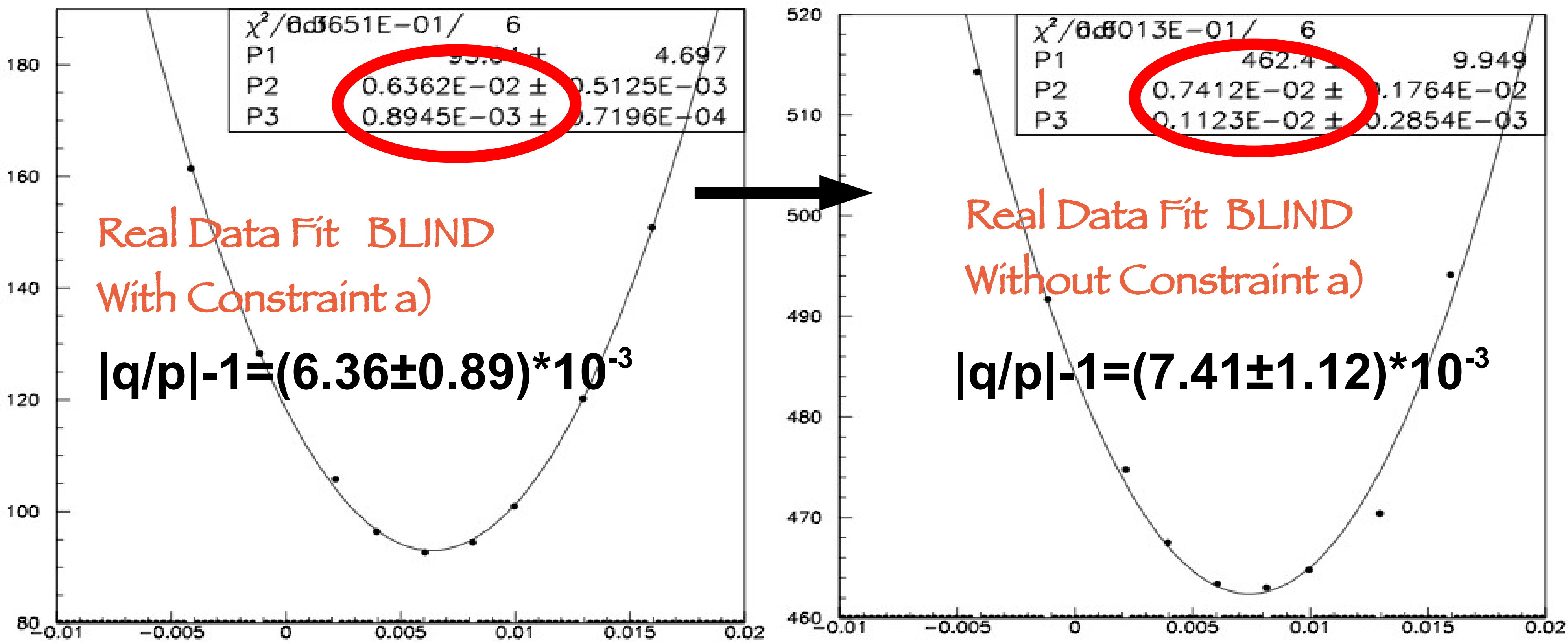




- Statistical error increases by 30%
- Bias ~0.0015 on |q/p| for |q/p|~1
  - ➔ Constraint a) is very useful to disentangle Physical vs Detector Asymmetries

Double Counting Problem

Solution 1): Real Data Test removing Constraint a)



- Statistical error increases by 25%
- Central Value moves by $-1.0\ 10^{-3}$ in the opposite direction wrt MC
  - → Do not remove Constraint a)

Double Counting Problem

Solution 2): Multinomial Constraint

- For every $(l^+, l^-) \times (B^0, B^+) \times$ (Peaking, BKG) category:

$$L = \frac{\nu^N e^{-\nu}}{N!} \frac{N!}{NBt^{Mix}!\, NBt^{Unm}!\, NDt^{Mix}!\, NDt^{Unm}!\, NNt!} \times$$

$$P(Bt^{Mix})^{NBt^{Mix}} P(Bt^{Unm})^{NBt^{Unm}} P(Dt^{Mix})^{NDt^{Mix}} P(Dt^{Unm})^{NDt^{Unm}} P(Nt)^{NNt}$$

$$N = NBt^{Mix} + NBt^{Unm} + NDt^{Mix} + NDt^{Unm} + NNt$$

- Poissonian term constrains the Reconstruction Asymmetry
- Different probabilities are proportional to the corresponding tagging efficiencies:

$$P(Bt) \propto \epsilon(Bt);\, P(Dt) \propto \epsilon(Dt) \qquad P(Nt) = 1 - \epsilon(Bt) - \epsilon(Dt)$$

  - ➔ Fit in addition also the Tagging Efficiencies ε(Bt) and ε(Dt) for Btag and Dtag events

- Fit code not ready in time for summer conferences
- Proposal: use a Toy MC for the determination of the statistical error

Expected Final Errors

Statistical Error:

- From fit with fixed resolution parameters $\pm 0.9\ 10^{-3}$
- Preliminary results obtained by floating all the parameters show a relative increase of ~10%
- Double counting studies show an increase of ~25% by removing the constraint on total number of reconstructed events
  - → Estimated $\delta(|q/p|) \pm 1.25\ 10^{-3}$ ($\delta A_{SL} \sim 2.5\ 10^{-3}$)

Systematic Uncertainties:

- Dtag description $\pm 1.3\ 10^{-3}$
- Detector Asymmetries $\sim 0.1\ 10^{-3}$
- Sample Composition from external fit to M_{ν}^{2}
- Resolution (SVT alignment); Fixed Parameters (?)
  - → Rough Estimation $\delta(|q/p|) \pm 1.8\ 10^{-3}$ ($\delta A_{SL} \sim 3.6\ 10^{-3}$)

Conclusion & Next Steps

- Real Data Run1-Run6 Release 24, Analysis 51:
  - Dtag Δt shape optimized for Real Data, preliminary systematic errors evaluated
  - Preliminary Blind Results obtained with statistical error in agreement with MC predictions
  - Fit is able to disentangle Physical vs Detector asymmetries with almost negligible systematic error
- Next Steps:
  - Update the Documentation & Restart the Review process
  - Reproduce results by floating also resolution parameters
  - Develop a Toy MC for the evaluation of the statistical error
  - Finalize systematic errors evaluation (sample composition from external fit, resolution parameterization)
  - Cross checks: e/μ, Mass Band/Side Band...

Backup

MC statistics: ~47 Mevents

B0 Btag Mixed Events

$\delta\|q/p\|_{stat}$		Limit	Meas.	Corrected (expected)
Signal	1519576			
Combinatorial	2002682			
Total	3522258	$2.7\ 10^{-4}$	$4.6\ 10^{-4}$	$6.6\ 10^{-4}$

Data statistics: ~14 Mevents

B0 Btag Mixed	~1174000	$4.6\ 10^{-4}$	$8.9\ 10^{-4}$	$1.25\ 10^{-3}$