News on CPV Analysis with D*l ν

Martino on behalf of Frascati, Padova & Perugia, 12/14/05

- Summary of New Event Selection:

➔ Motivation & Strategy;

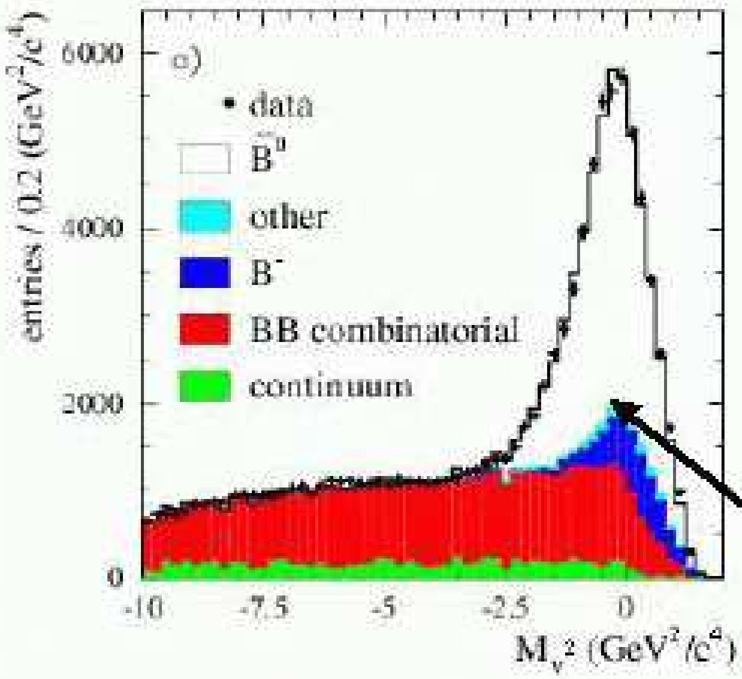
- Signal MC tests:

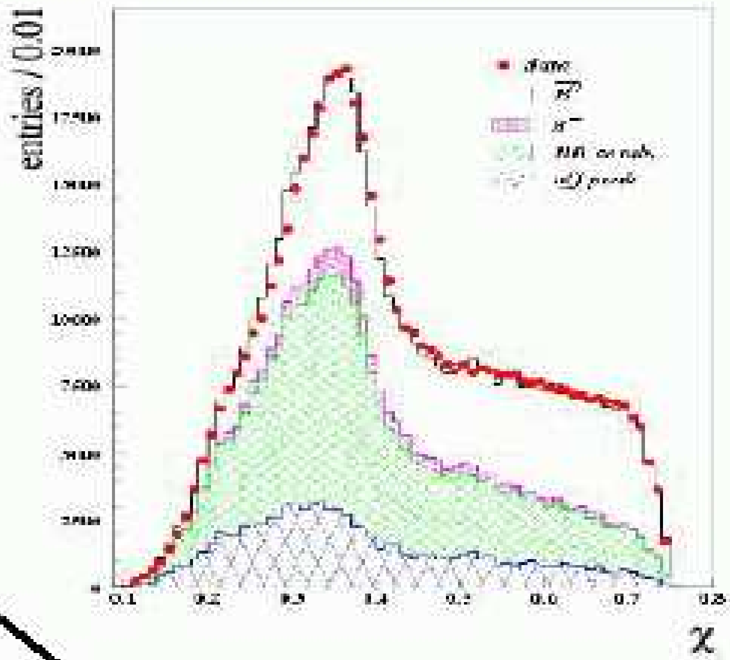
➔ Analys Bias Determination;

➔ Stability versus Run number;

➔ Very Preliminary Signal MC Δt Fit Results.

New Event Selection: Motivation−1





- Only one $l^+\pi^-$ candidate per event in the Mass Band with the right charge correlation is selected;

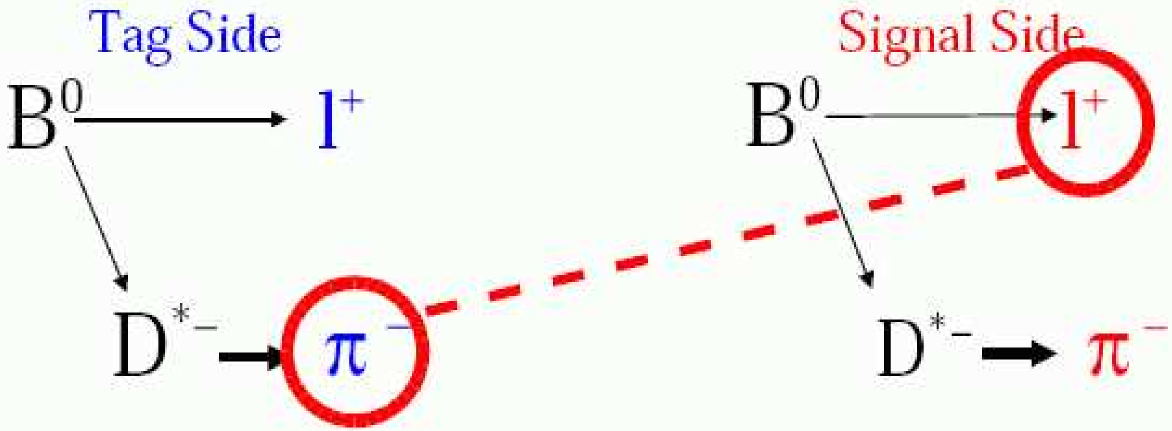
- If more than one is present, a Best Pair is chosen exploiting the Likelihood Ratio selection variable:

- χ(pl, pπ*, Prob_Vertex(lπ))

New Event Selection: Motivation−2

- Event with two $B^0 \rightarrow D^* l\nu$ decays:

the candidate formed by a lepton and a pion from different B^0 decays can be accidentally chosen as the Best Pair in the Mass Band with the right charge correlation:



- As a consequence, the event is removed from the Signal and added to the BKG
- Due to $l^+\pi^-$ charge correlation this effect affects mainly the Mixed Event Sample

→

Negative Large Bias:

χ_d = Nmixed/(Nmixed+Nunmixed) < χ_d^{True} ($\delta\chi_d \sim -1.2\%$)

which reflects in $\delta\tau_{B0} \sim -0.02$; $\delta\Delta m_d \sim -0.01$

($\chi_d = x^2/(2(1+x^2))$, $x=\tau_{B0} * \Delta m_d$)

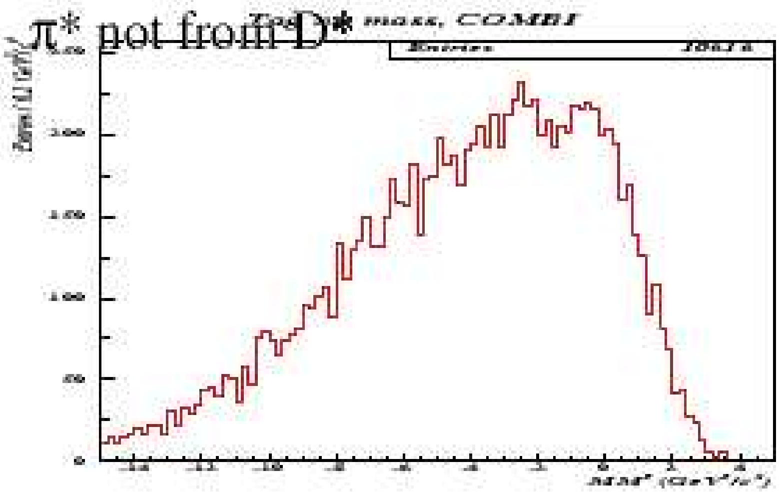
Old Approach

- Used in the τ_{B0} & Δm_d Analysis, BADs 287, 1176:

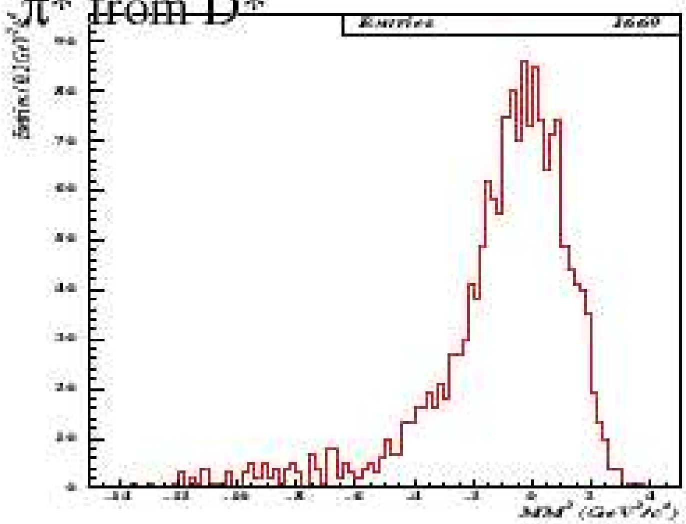
Remove the events with more than one π^* coupled to the same signal lepton, if one of them is likely to come from a D* from the Tag−B^0 decay.

- Look at $m^2\nu$ on tag−side (i.e. Using the tag−lepton instead of the signal one)

π^* not from D*



π^* from D*

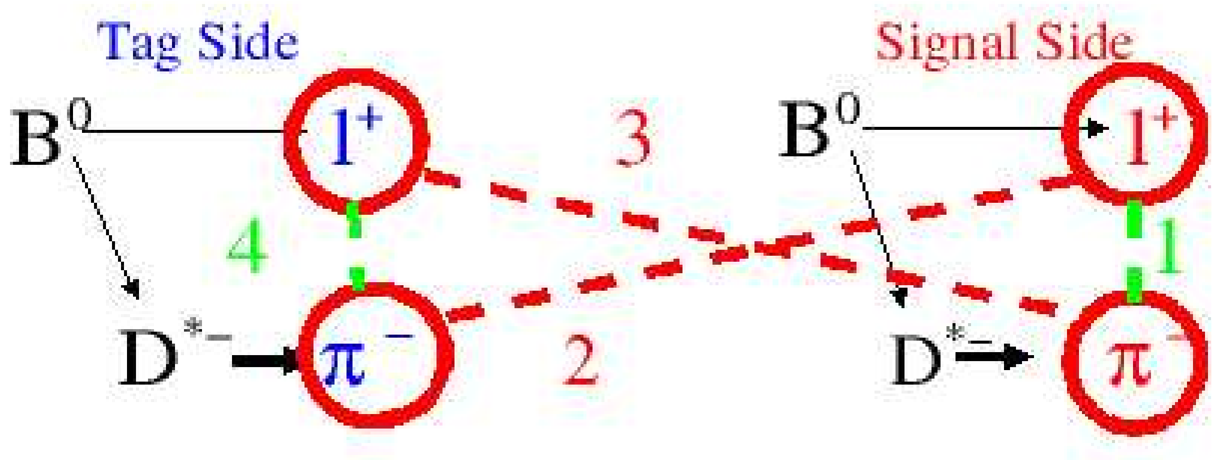


- Event Removed if $m^2\nu$ tag−side>−3GeV^2 both for right and wrong charge correlation pairs (Mixed & Unmixed events)

- Bias removed, ...but ~20% loss in statistics

New Event Selection: Strategy

How can we avoid to remove the double $D^*l\nu$ events from the analysis?



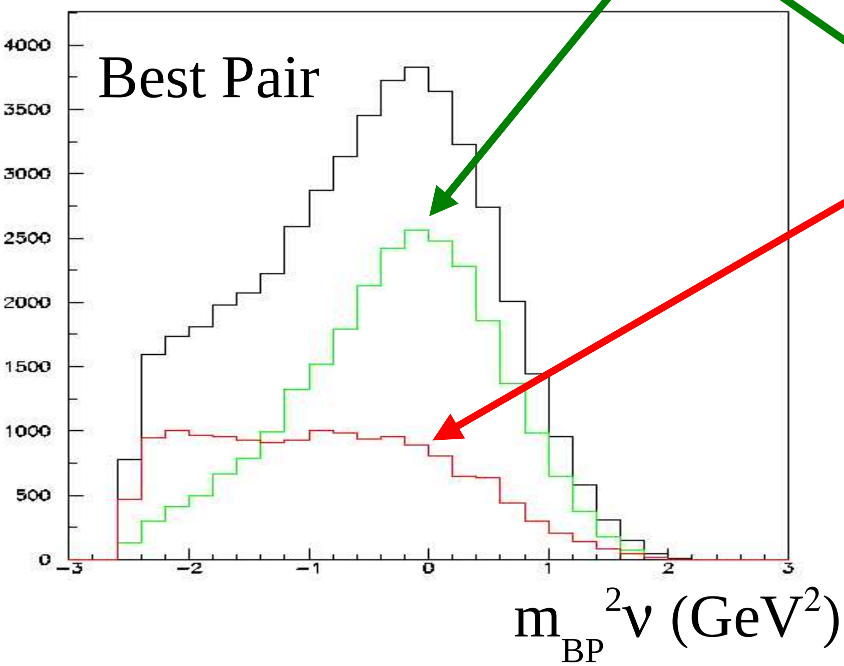
- First Attempt:

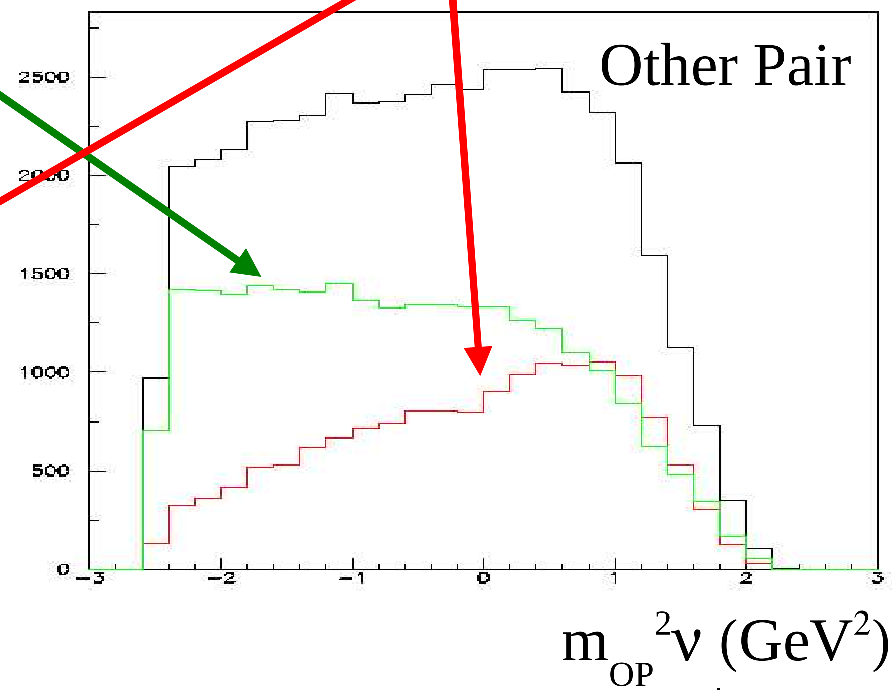
Try to discriminate the signal pair from all the $l^+\pi^-$ combinations based on the $m^2\nu$ value: Unsuccessful (due to large tails);

- Second Attempt:

Use the candidate Best Pair in the fit and estimate the fraction of Signal Event as a function of $m^2\nu$: Successful!

- $m^2\nu$ distribution: Signal=Best Pair Signal=Other Pair

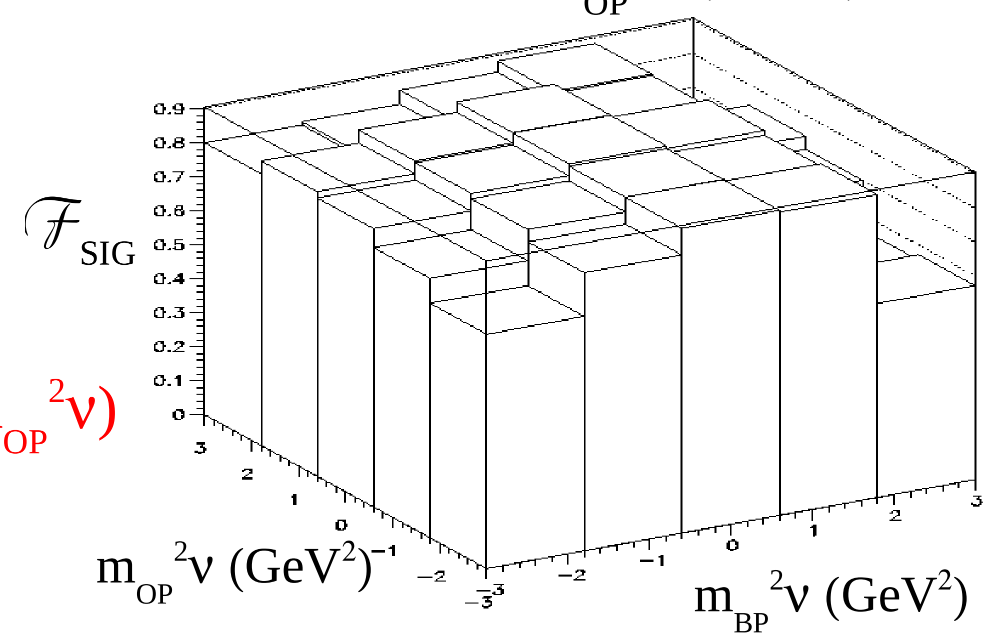




- Signal Fraction:

$\mathcal{F}_{SIG}(m_{BP}{}^2\nu, m_{OP}{}^2\nu)=$

$\mathcal{F}_{SIG\_BP}(m_{BP}{}^2\nu, m_{OP}{}^2\nu)+\mathcal{F}_{SIG\_OP}(m_{BP}{}^2\nu, m_{OP}{}^2\nu)$



Strategy checked on Run1−Run4 MC Event Sample:

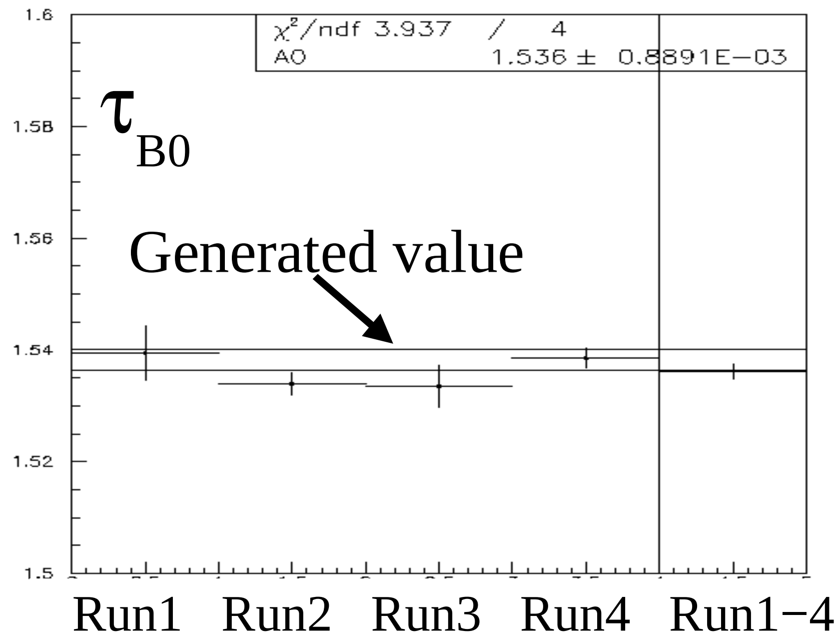
- The PDF for the double D*lν events in the CPV Δt fit is obtained in terms of their probability to be signal or combinatorial BKG:

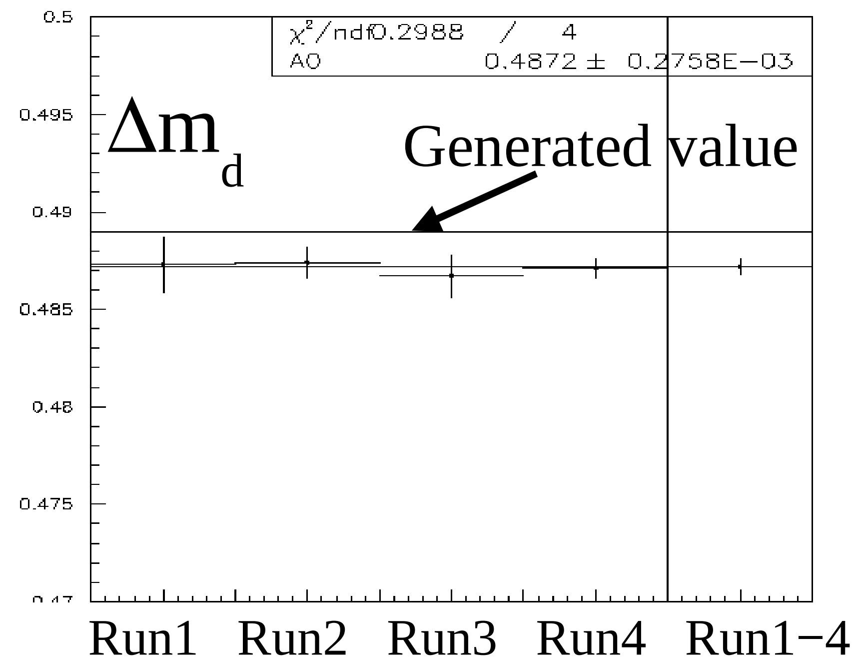
$$\mathcal{F}_{DOUBLE}(\Delta t, \sigma\Delta t, m^2_{BP}, m^2_{OP} \mid \tau_{B0}, \Delta m_d, \ldots) = \ell_{SIG}(m_{BP}{}^2\nu, m_{OB}{}^2\nu) \times \mathcal{F}_{SIG}(\Delta t, \sigma\Delta t \mid \tau_{B0}, \Delta m_d, \ldots) + (1-\ell_{SIG}(m_{BP}{}^2\nu, m_{OB}{}^2\nu)) \times \mathcal{F}_{BB\_BKG}(\Delta t, \sigma\Delta t)$$

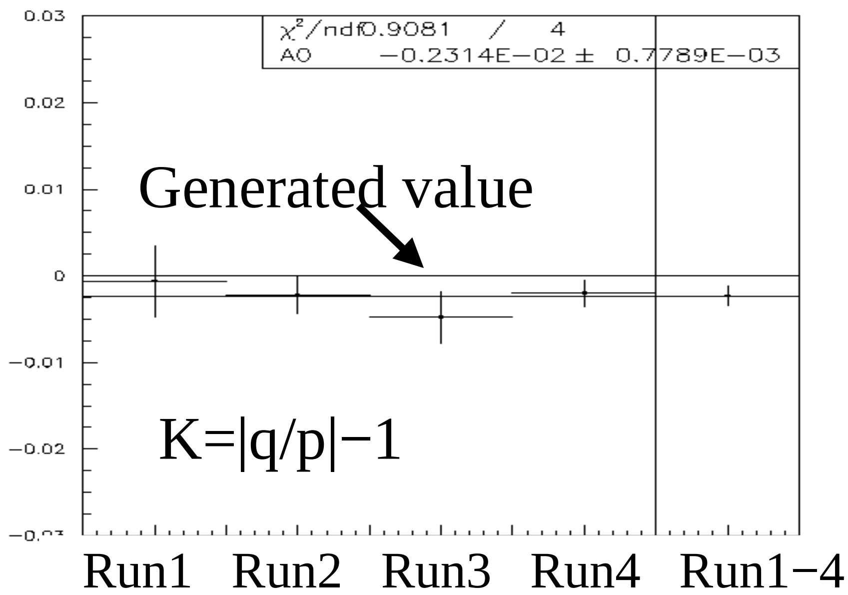
- MC results: Analysis Bias strongly reduced!

	χ_d	τ_{B0} (ps)	Δm_d (ps^{-1})
Generated Value	0.181	1.540	0.489
Best Pair	0.1701±0.0003	1.5140±0.0013	0.4809±0.0004
New Approach	0.1797±0.0004	1.5362±0.0013	0.4872±0.0004

MC Test: Stability versus Run Number







- Residual Analysis Bias:

$\delta\tau = -0.0038 \mp 0.0013$ ps

$\delta\Delta m = -0.0018 \mp 0.0004$ ps^{-1}

$\delta K = -0.0023 \mp 0.0011$

Very Preliminary Signal MC Results (Run2 Sample)

- Validate in the simulation the measured tagging dilution & the resolution model comparing the generated τ, Δm_d, K values with the results of the fits using:

➔ True Δt & tagging (Selection Bias);

➔ True Δz & tagging (Boost Approximation check);

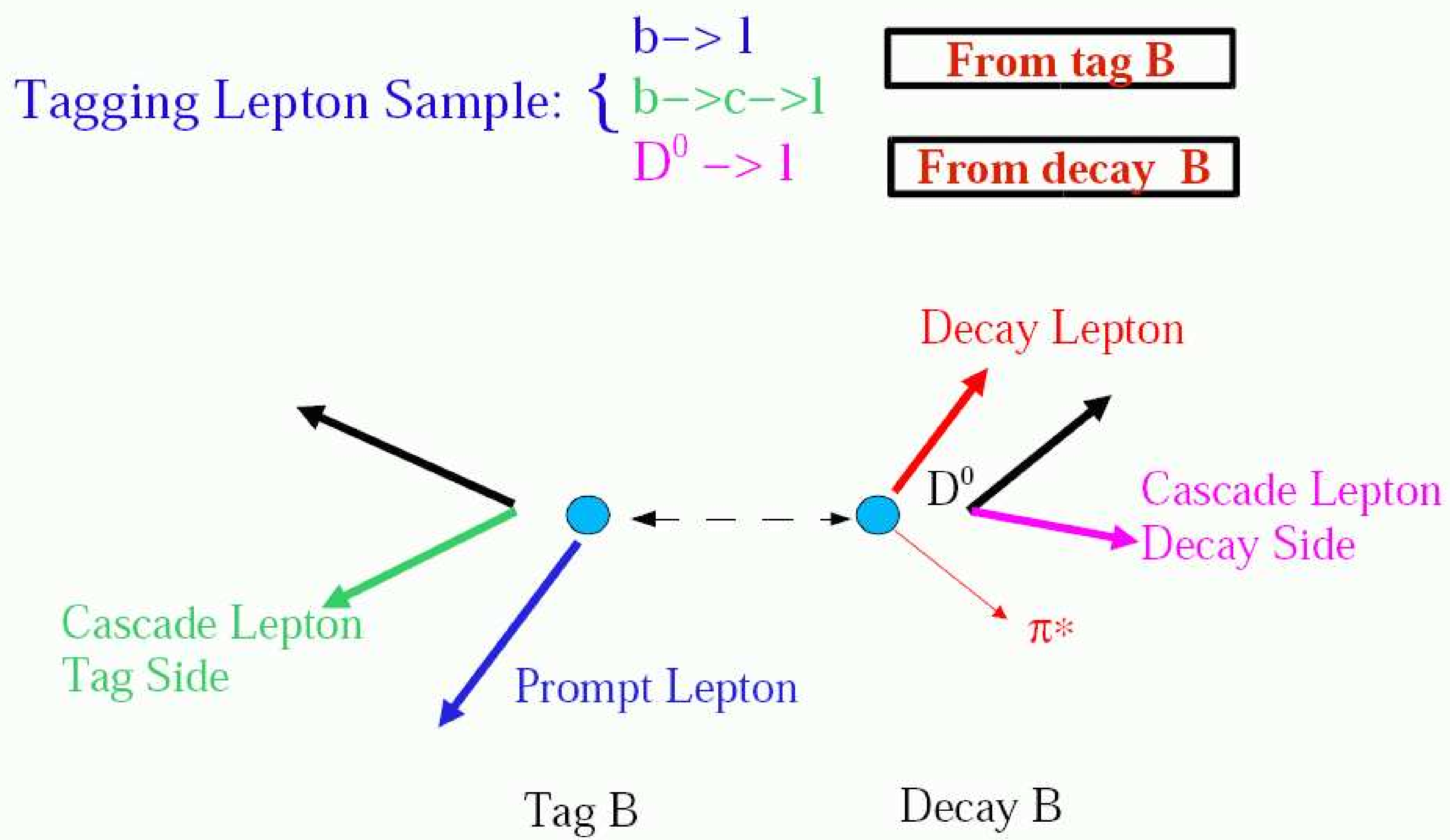
➔ True Δz & experimental tagging (realistic dilution);

➔ Experimental Δz & True tagging (resolution function);

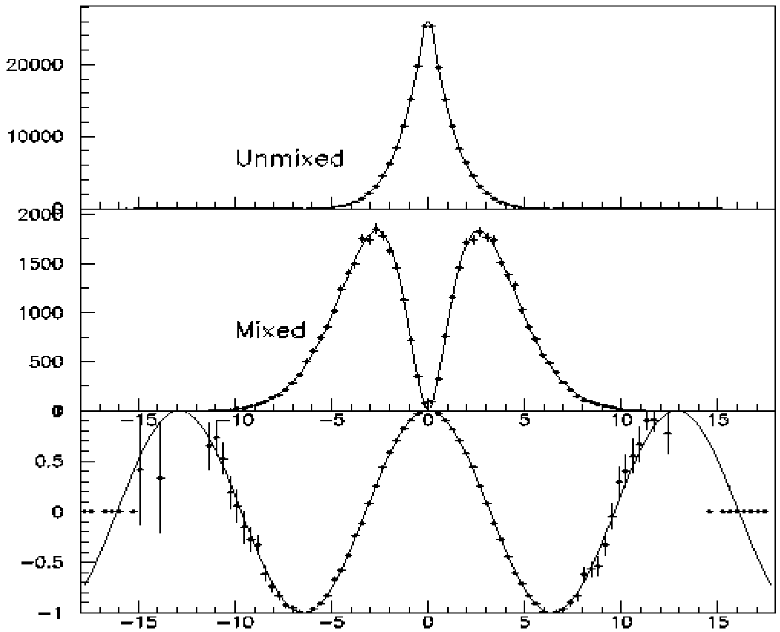
➔ Experimental Δz & tagging (realistic fit).

- Validate in the simulation every term in the Signal PDF according to the tagging lepton kind (prompt, cascade decay side, cascade tag side):

➔ Add terms one a time and repeat the fit.

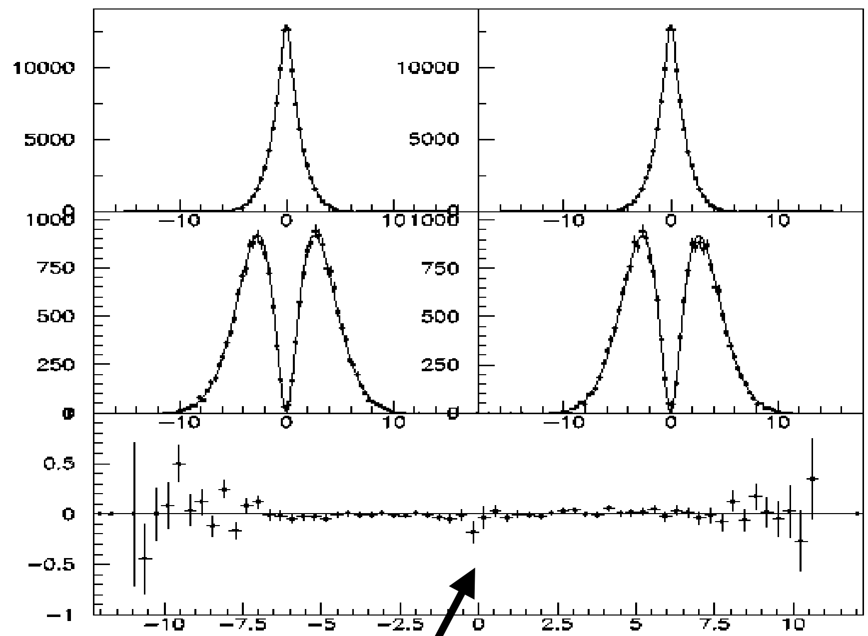


Prompt Leptons: Perfect resolution & tagging



Δt (ps)

Tag Lepton: l^+ l^-



Δt (ps)

$$\frac{N(l^+l^+)-N(l^-l^-)}{N(l^+l^+)+N(l^-l^-)} = \frac{-2K}{1+2K}$$

- Using true Δt:

τ_{B0} = 1.533 $\mp$ 0.003 ps

Δm_d = 0.488 $\mp$ 0.001 ps^{-1}

K = −0.001 $\mp$ 0.002

- Using true Δz:

τ_{B0} = 1.539 $\mp$ 0.003 ps

Δm_d = 0.483 $\mp$ 0.001 ps^{-1}

K = −0.001 $\mp$ 0.002

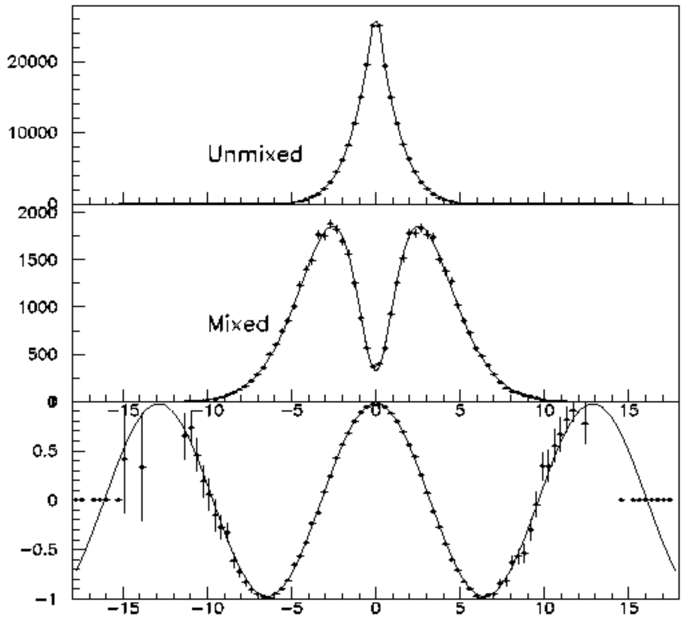
- Boost Approximation Effect

$\delta\tau_{B0}$ = +0.006 ps

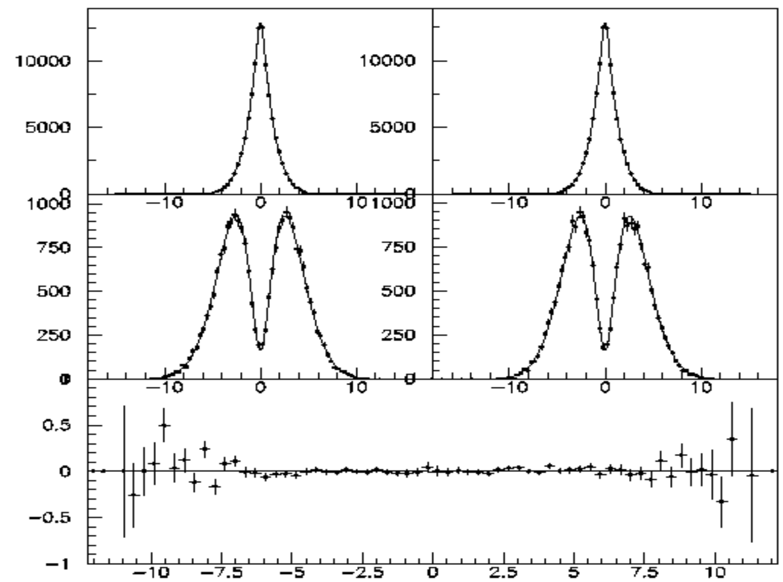
$\delta\Delta m_d$ = −0.005 ps^{-1}

Prompt Leptons: True Δt & Experimental tagging

Tag Lepton: l^+ l^-



Δt (ps)



Δt (ps)

- Dilution & Δw floated in the fit:

$\mathcal{M}_P = 0.976 \mp 0.001$

$\Delta w = -0.0001 \mp 0.0008$

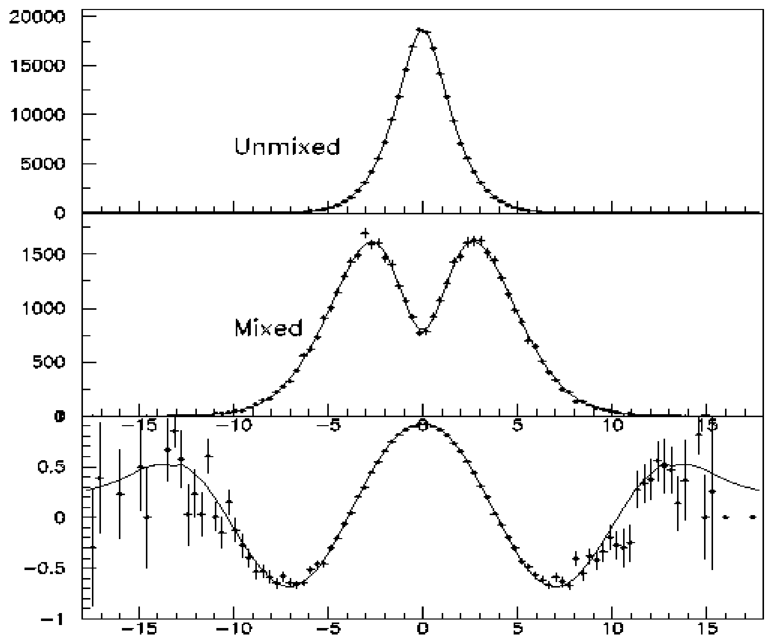
$\tau_{B0} = 1.532 \mp 0.003$ ps

$\Delta m_d = 0.487 \mp 0.001$ ps^{-1}

$K = -0.002 \mp 0.003$

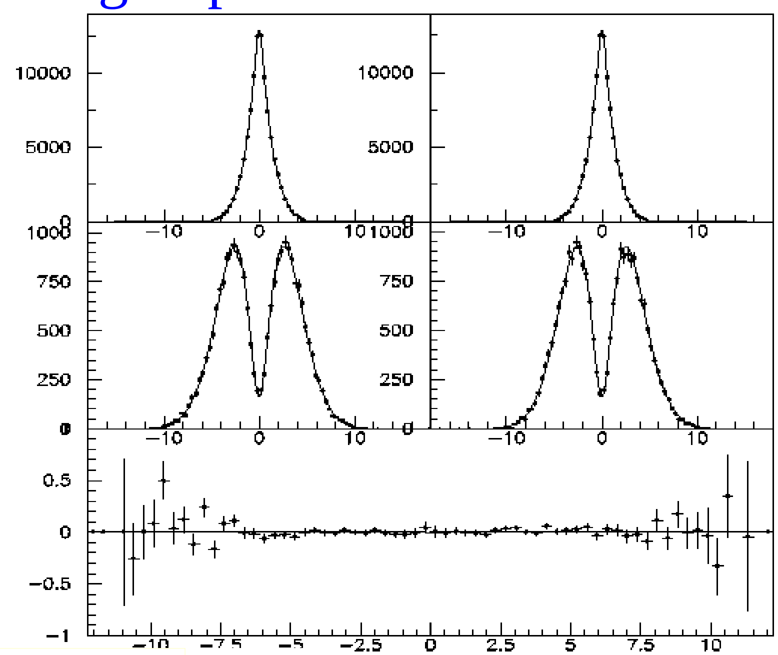
➔All parameters show good agreement w.r.t. Perfect tagging

Prompt Leptons: Experimental Δz & tagging



Δt (ps)

Tag Lepton: l^+ l^-



Δt (ps)

- Resolution Function:

$$\mathcal{R}(\delta\Delta t, \sigma\Delta t) \sim (1-f_w-f_o)\ \exp(-(\delta\Delta t - o_n)^2/2(S_n\sigma\Delta t)^2) \quad \text{Narrow}$$
$$+\ f_w\ \exp(-(\delta\Delta t - o_w)^2/2(S_w\sigma\Delta t)^2) \quad \text{Wide}$$
$$+\ f_o\ \exp(-\delta\Delta t/2S_o^2) \quad \text{Outlier}$$

- $\delta\Delta t = \Delta t(\text{measured}) - \Delta t(\text{true})$

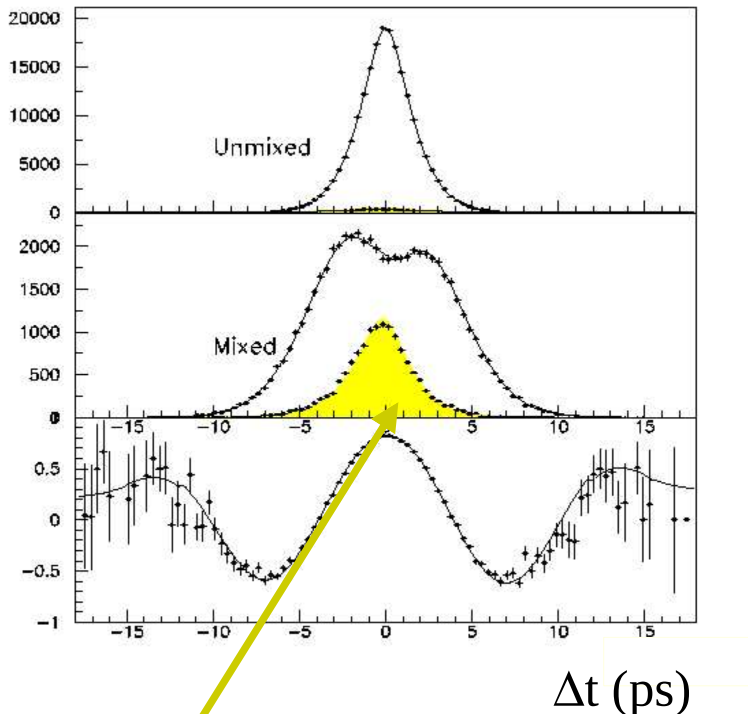
$\tau_{B0} = 1.527 \mp 0.004$ ps

$\Delta m_d = 0.483 \mp 0.001\ \text{ps}^{-1}$

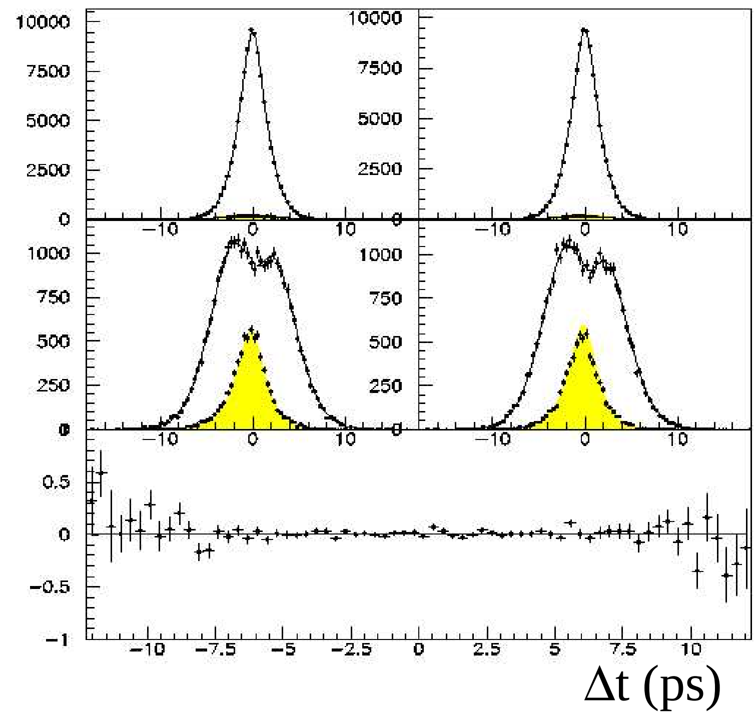
$K = -0.001 \mp 0.003$

- B.A. Effect not perfectly absorbed by floating the resolution function...
- To be further investigated using the full available MC statistics.

Prompt + Tag−Side Cascade Leptons



Tag Lepton: l^+ l^-



Tag−Side Cascade: fraction & dilution floated :

$F_{bcl} = 0.075 \mp 0.001$

$\mathscr{M}_{bcl} = -0.43 \mp 0.02$

$\Delta w_{bcl} = -0.050 \mp 0.009$

$\tau_{B0} = 1.535 \mp 0.003$ ps

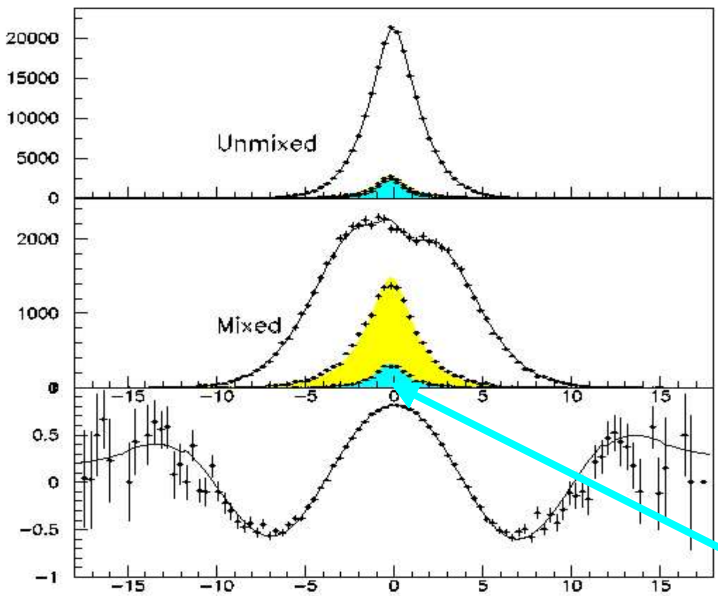
$\Delta m_d = 0.487 \mp 0.001$ ps^{-1}

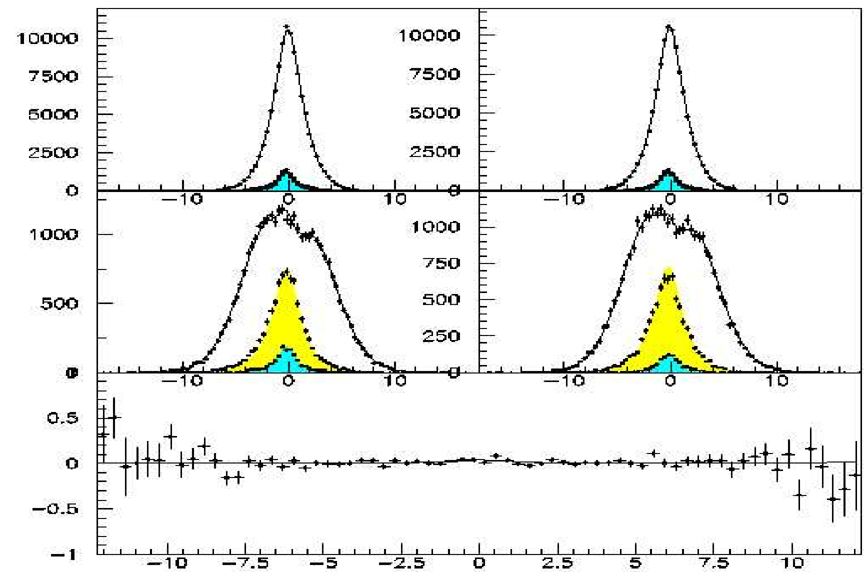
$K = -0.001 \mp 0.002$

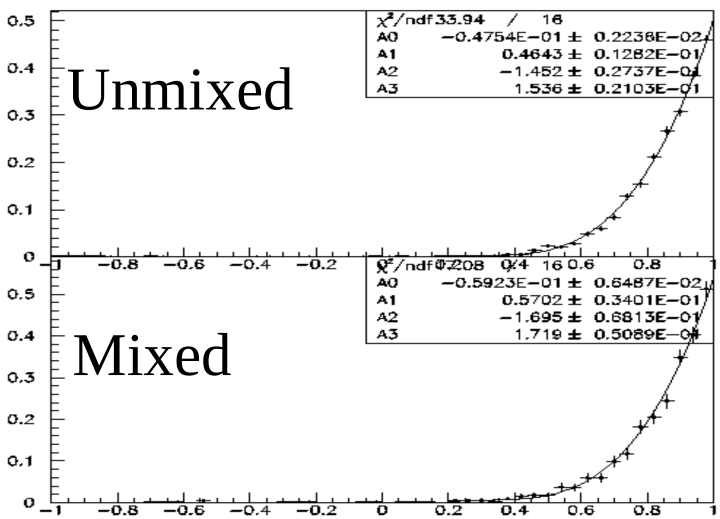
➔Inclusion of tag−side cascade removes the bias on τ & Δm_d...

Full B^0 Signal

Tag Lepton: l^+ l^-







Decay−Side cascade: fraction from angle l(tag)−π_s

$\tau_{B0} = 1.536 \mp 0.003$ ps

$\Delta m_d = 0.487 \mp 0.001$ ps^{-1}

$K = -0.001 \mp 0.003$

- Results in good agreement w.r.t. Perfect resolution & tagging

Conclusion

- New event selection allows to strongly reduce the selection bias without loss in statistics;

- Nice stability in χ_d, τ_{B0}, |q/p| found over the different MC runs;

- Reasonable stability in the fitted parameters found in the preliminary Signal MC Run2 fit, to be further investigated using all the available statistics.

- Next Steps: inclusion of combinatorial and B^+ BKG in the MC fit.