Status of the Inclusive D*lν Mixing Analysis with Lepton Tag

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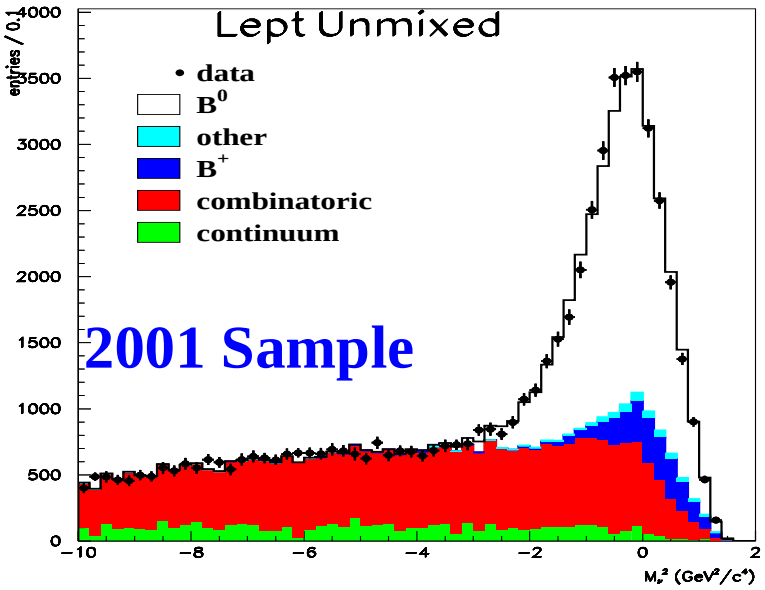
Main News:

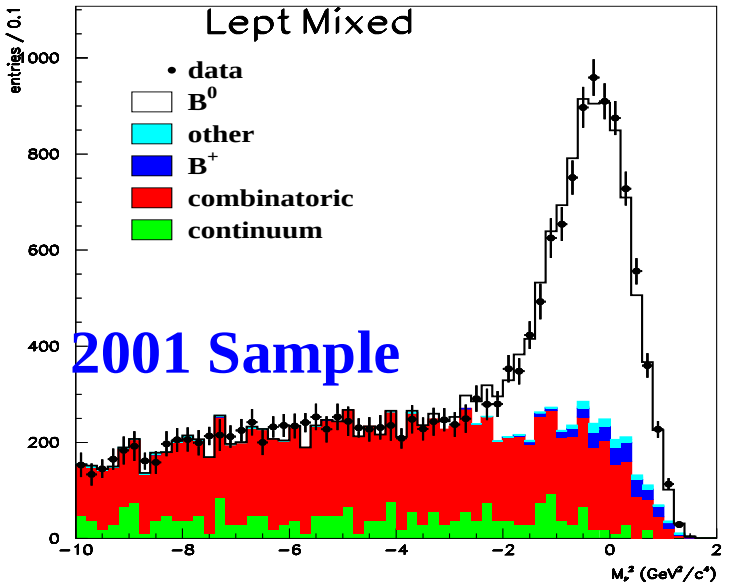
- SP3 → SP4 Sample
- MC Pure Signal fit almost finalized:
  - Selection/Boost Approximation biases
  - Constraint from χ_d
  - **Tag Vertex:** b → l / b → c → l separate treatment
  - **Reco Vertex:** D_0 → l description
- MC Pure Signal Preliminary Results

SP4 Sample

- ε increase ~ 20% w.r.t SP3
- MC/data Statistics ~ 2 (SP3: ~1)

Year	2000	2001	2002
Nevt(data)	143194	241697	147697





Search for Selection/Boost Approximation biases

Fit to pure−signal MC, SP4 2000 B^0B^0 (MC truth for $\Delta t/\Delta z$ and tag)

(generated τ = 1.548 ps, Δm = .473 ps^{-1})

	Nominal selection, no vertex−quality cuts	No selection, D*l in the event	No selection, almost generic
Δt fit	τ= 1.548±.002	1.549±.002	1.539±.001
	Δm= .471±.001	.471±.001	.4711±.0004
	Nevt= 480K	543K	1254K
Δz fit	τ= 1.553±.002	1.554±.002	1.544±.001
	Δm= .466±.001	.466±.001	.4665±.0004

- τ: ~no bias
- Δm: −0.005 ps^{-1} Boost Approximation bias; −0.002 ps^{-1} preselection bias?

χ_d constraint

- The fitted values of τ and Δm can be related to the integrated mixing χ_d:

$$\chi_d = x^2/(2*(1+x^2)); \; x=\Delta m*\tau$$

- Experimentally:

$$\chi_d^{ex} = N_{mix}/N_{tot} = \chi_d \, d + w; \; d=1-2w$$

- Up to now our fit did not take into account explicitly the relative fraction of Mixed events, but only the shapes of the Δz distributions for Mixed and Unmixed events.

→ Fit tends to underestimate χ_d computed in terms of Δm and τ

- Solution:

Add a binomial constraint to the log−likelihood relating the probability to have mixing p(Δm, τ, d), computed at each iteration, to the observed fraction N_{mix}/N_{tot}

→ Improved agreement $\chi_d^{meas}/\chi_d^{gen}$ + Δm statistical error reduction

Example: 2001 MC pure−signal b → l fit (Nevt~77000):

$\chi_d^{ex} = N_{mix}/N_{tot} = .1833 \pm .0014$ from event counting

	No Constraint	Constraint
τ	$1.538 \pm .008$	$1.547 \pm .008$
Δm	$.461 \pm .008$	$.463 \pm .003$
d	$.968 \pm .003$	$.964 \pm .002$
$\rho_{\Delta m \tau}$	.501	−.458

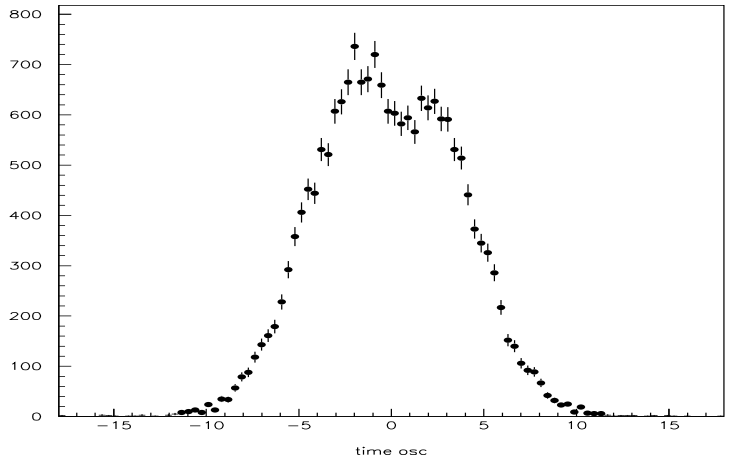
$\chi_d = x^2/(2*(1+x^2))$; $x = \Delta m * \tau$

$= .167 \pm .005$ $\qquad$ $.170 \pm .0014$

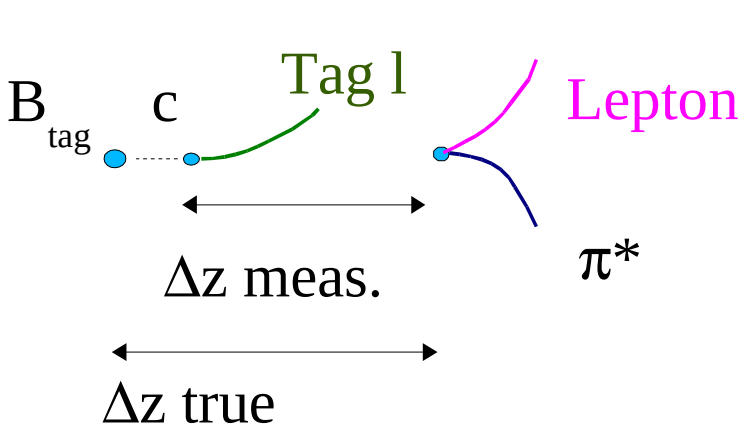
to be compared with $\chi_d^{gen} = .173$, $\tau^{gen} = 1.548$, $\Delta m^{gen} = .473$

Tag Vertex: b→l / b→c→l Description

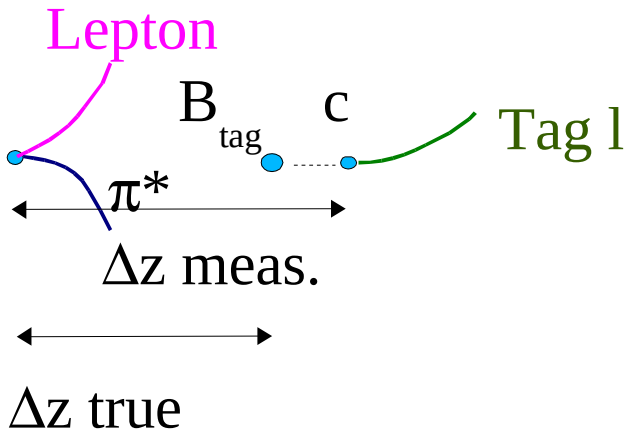
- Δz distribution for mixed events shows an asymmetry which prevents the data to be fitted with a symmetric function
- This effect is due to the cascade lepton sample in the Btag vertex:



$$\Delta z = Z_{reco} - Z_{tag}$$



If $\Delta z > 0$: $\Delta z_{meas} < \Delta z_{true}$



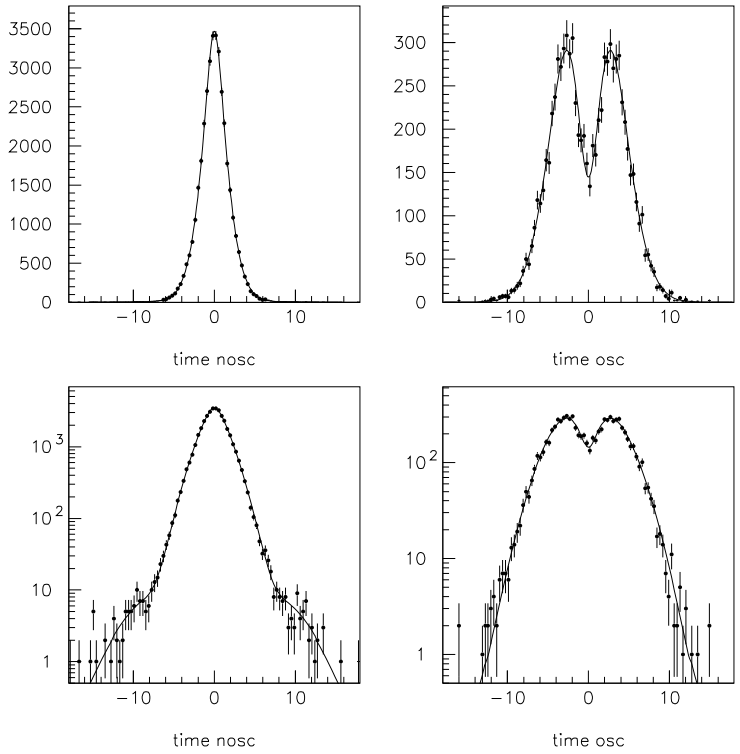
If $\Delta z < 0$: $|\Delta z_{meas}| > |\Delta z_{true}|$

Solution:

- Separate treatment of the prompt and cascade lepton samples in the likelihood: same pulls, different biases (~ 0 for b→l) and dilutions.
- Fix the cascade fraction from external fit (up to now fixed from MC counting)

⟶ better minuit behaviour (successful fits...)

Prompt Lepton fit (2000)



$\tau = 1.539 \pm .008$

$\Delta m = 0.467 \pm .004$

$d = 0.971 \pm .002$ (0.978 from MC counting)

pulln $= 0.97 \pm .02$

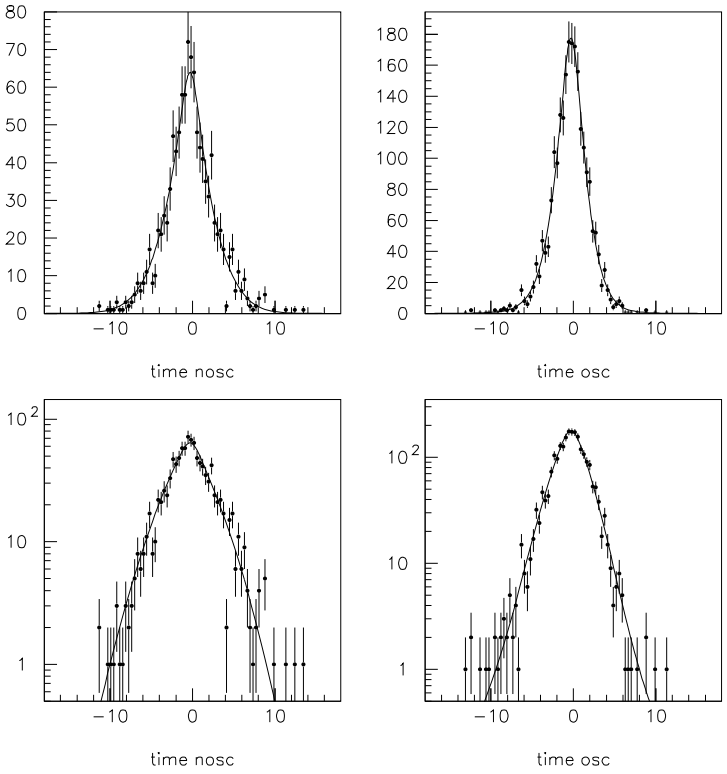
pullw $= 2.35 \pm .11$

biasn $= -0.02 \pm .16$

biasw $= -0.007 \pm .012$

$\chi_d = 0.170 \pm 0.002$

Cascade Lepton fit (2000)



$\tau = 1.584 \pm .048$

$\Delta m = 0.423 \pm .051$

$d = -0.459 \pm .050$ (−0.535 from MC counting)

pulln $= 1.07 \pm .07$

pullw $= 2.15 \pm .54$

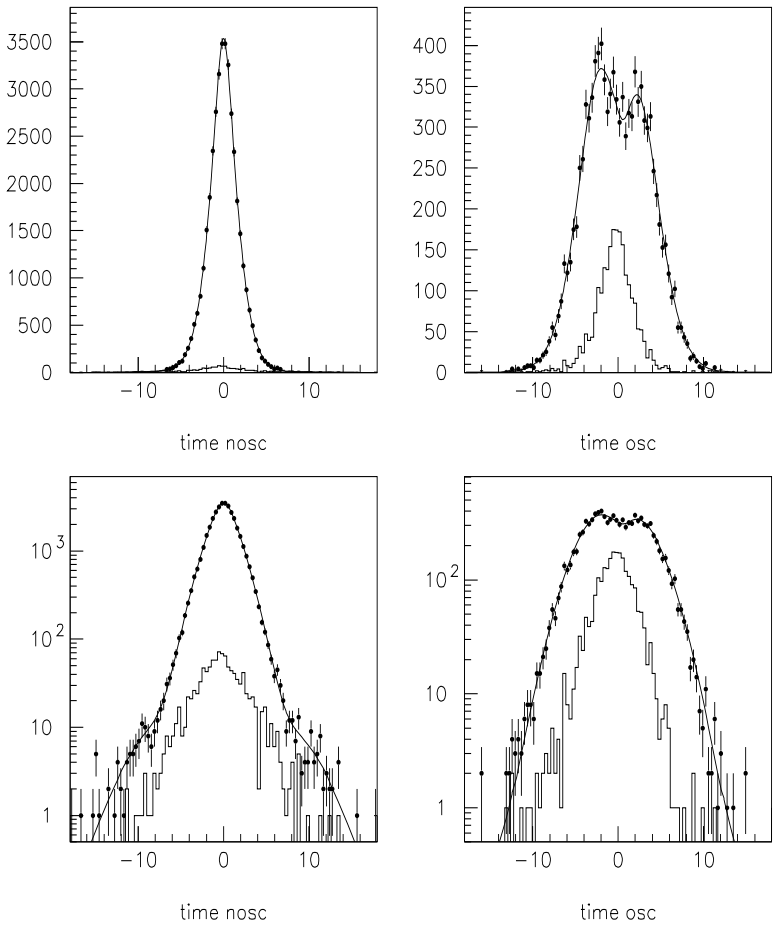
biasn $= -2.35 \pm .49$

biasw $= -0.266 \pm .044$

$\chi_d = 0.155 \pm 0.026$

- $d < 0$ due to charge exchange in the cascade process
- Plots don't show the b → l oscillating behaviour due to the high cascade mistag w~23% (1.1% for prompt leptons)

b → l + b → c → l fit (2000)



F_{bcl}=6.78±.11% fixed from MC counting (in future from external fit)

τ = 1.550±.007

Δm = 0.470±.004

d_{prompt} = 0.973±.003

$d_{cascade}$ = −0.473±0.067

pulln = 0.96±.02

pullw = 2.44±.16

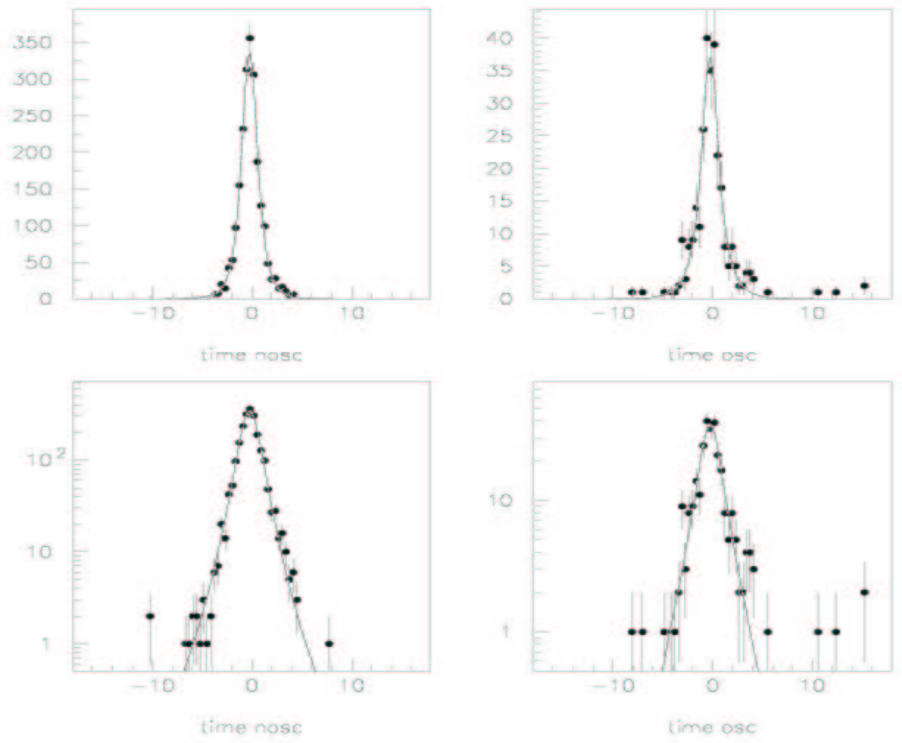
biasn = −2.7±1.4

biasw = −0.27±.09

χ_d = 0.173±0.002

Reco Vertex: $D^0 \rightarrow l$ Description

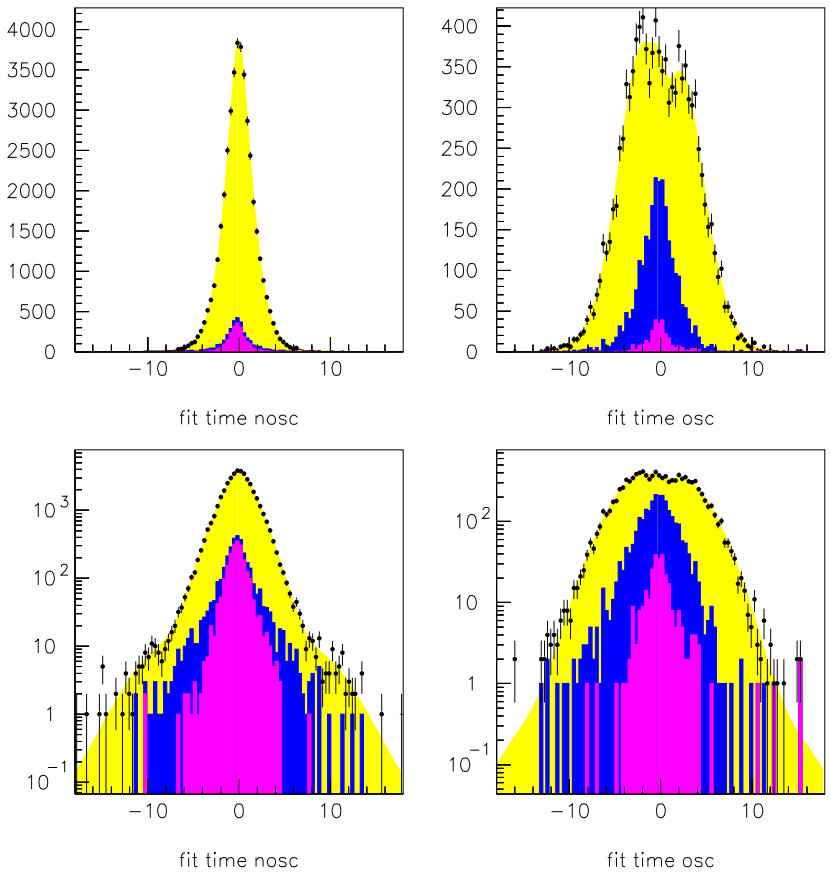
- The lepton tag sample from D^0 decays can be fitted with an exponential convoluted with the same resolution function as the prompt/cascade lepton events.
- Two free parameters: effective τ_{D0}, single bias



$\tau_{D0} = 0.316 \pm 0.022$

bias $= -0.233 \pm 0.019$

Complete pure−signal fit (2000)



F_{bcl}=6.46±.11% fixed from MC counting

F_{D0} from α, ρ functions vs $\cos(\theta_{l-\pi^*})$

$\tau = 1.544 \pm .007$

$\Delta m = 0.472 \pm .004$

$d_{prompt} = 0.980 \pm .003$

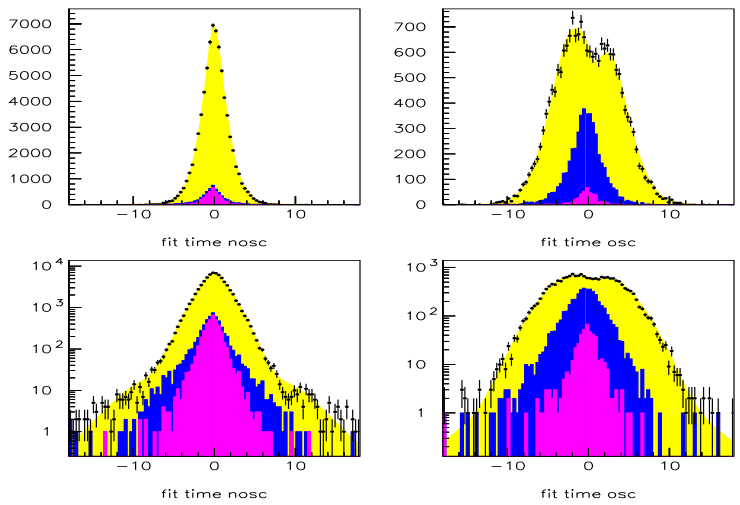
$d_{cascade} = -0.600 \pm 0.057$

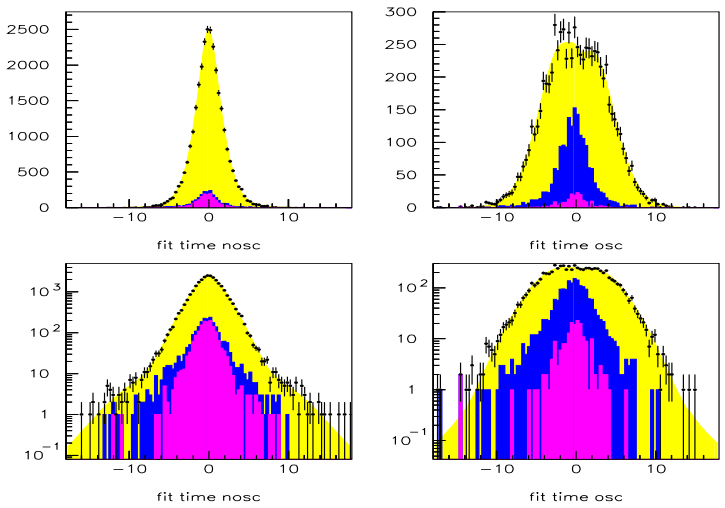
$\tau_{D0} = 0.390 \pm 0.055$

$\chi_d = 0.173 \pm 0.002$

Prompt leptons
Cascade leptons
D^0 leptons

Year by Year Stability





2001: $\tau = 1.569 \pm 0.009$

$\Delta m = 0.462 \pm 0.003$

2002: $\tau = 1.574 \pm 0.009$

$\Delta m = 0.454 \pm 0.005$

Not in agreement with 2000 results... but the binomial constraint depends on $x = \tau * \Delta m$ which reflects in an anticorrelation between τ and Δm.

Two Choices:

- Fix τ to the world average: (ex. $\Delta m(2001) = 0.466 \pm 0.003$)
- Combined use of the overall, untagged sample for simulataneous τ measurement.

Conclusions

- Pure−signal MC fit almost finalized:
  - Constraint from the fraction of mixed events
  - Separate description of prompt and cascade tag leptons
  - $D^0 \rightarrow l$ sample fitted by an exponential in terms of an effective τ_{D0}
- Next Steps:
  - Background description and total fit on MC
  - Fit with fixed τ_{B0} (or combined use of the untagged sample)
  - Fit of data sample
- Lepton Analysis ready in time for Moriond?