Time-Dependent CPV in Charm (update)

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→Introduction

→Semileptonic tag at charm threshold

→Hadron tag at charm threshold

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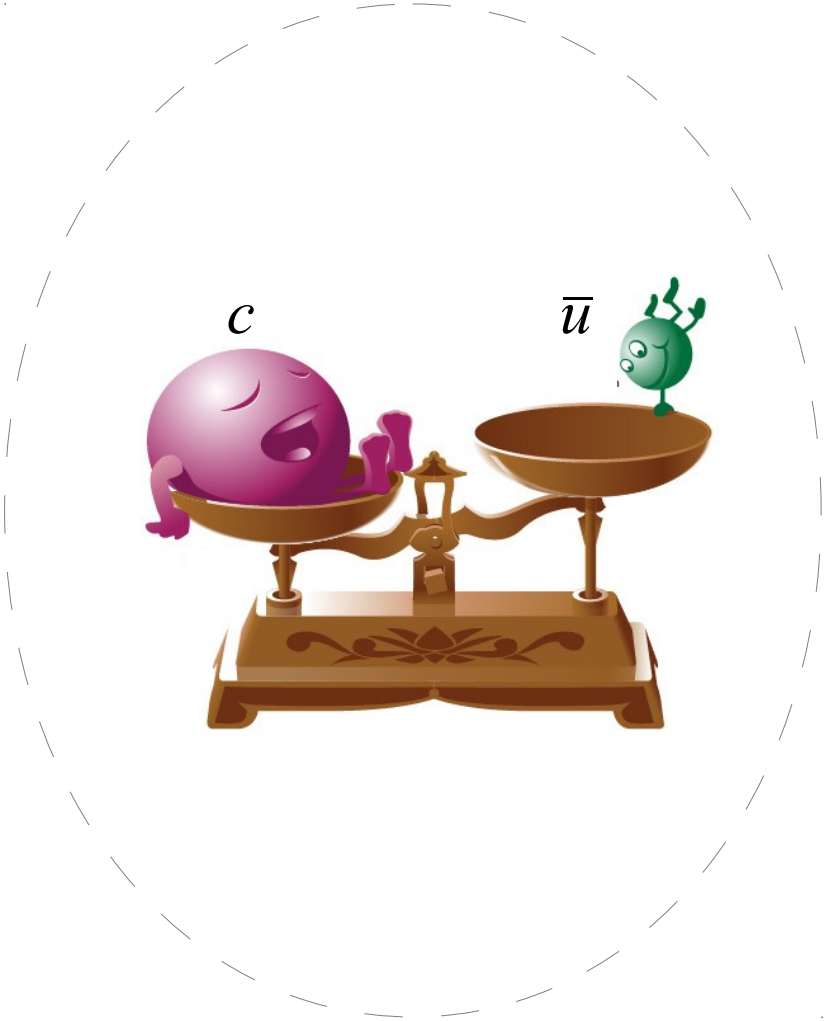
→Introduction

D^0 meson (not complete) Identity Card



c *quark*

$Mass \quad m \simeq 1300\, MeV$

$Electric \quad charge = \frac{2}{3} e$

$\bar{u}$ *antiquark*

$Mass \quad m \simeq 1.7 - 3.3\, MeV$

$Electric \quad charge = -\frac{2}{3} e$

D^0 *meson*

$c - \bar{u}$ *bound state*

$Mass \quad m = 1864.83 \pm 0.14\, MeV$

$Mean \quad lifetime \quad \tau = 410.1 \pm 1.5\, x\, 10^{-15}\, s$

$c\tau = 122.9\, \mu m$

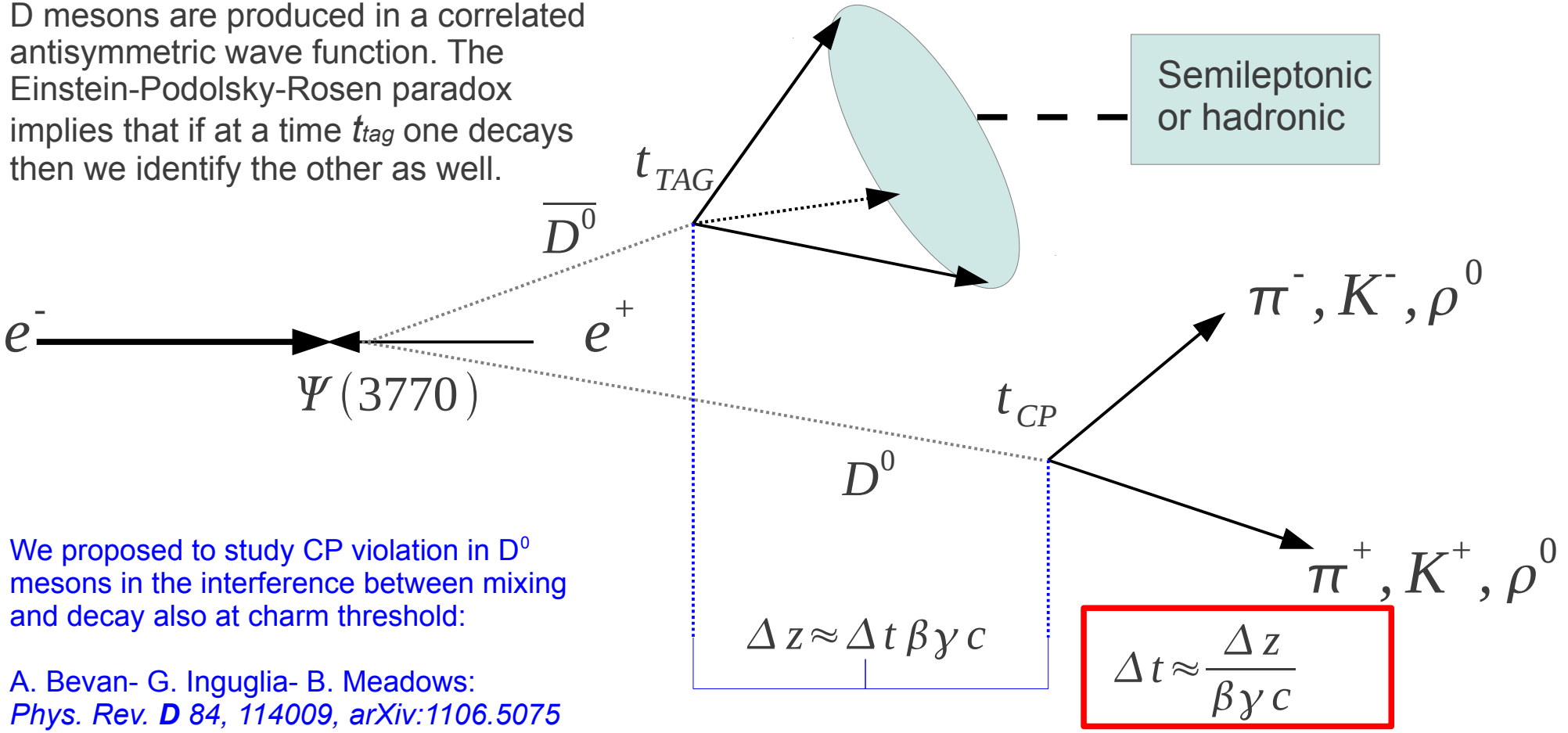
$I(J^P) = \frac{1}{2}(0^-)$

$Production: correlated / uncorrelated$

...

Correlated mesons: D^0 tagging

D mesons are produced in a correlated antisymmetric wave function. The Einstein-Podolsky-Rosen paradox implies that if at a time t_{tag} one decays then we identify the other as well.



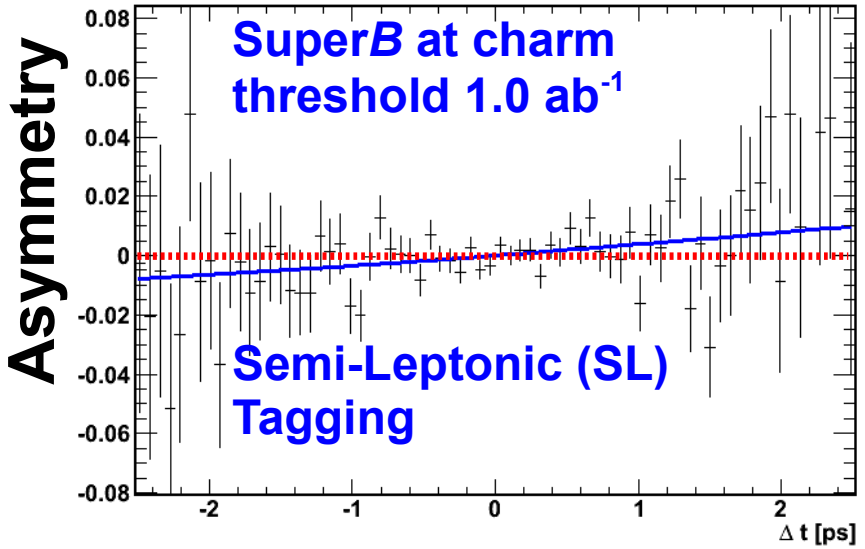
We proposed to study CP violation in D^0 mesons in the interference between mixing and decay also at charm threshold:

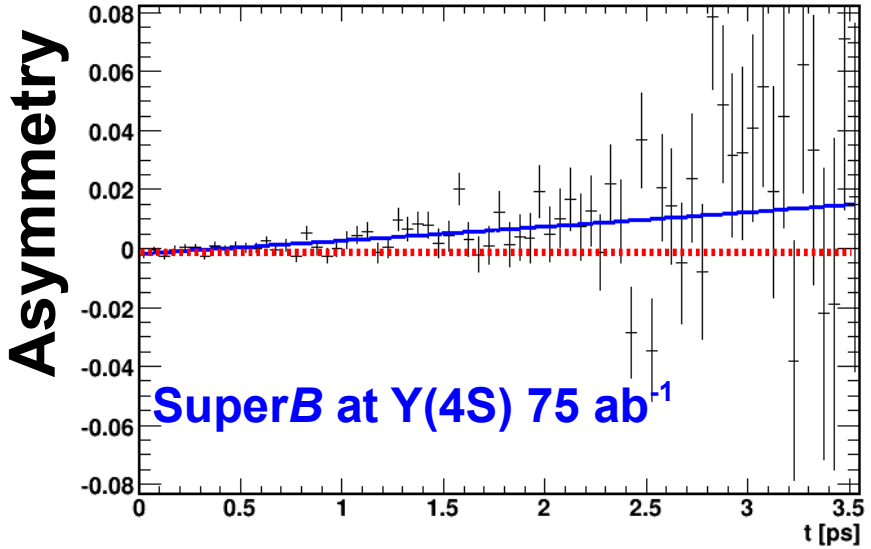
A. Bevan- G. Inguglia- B. Meadows:
Phys. Rev. ***D*** *84, 114009, arXiv:1106.5075*

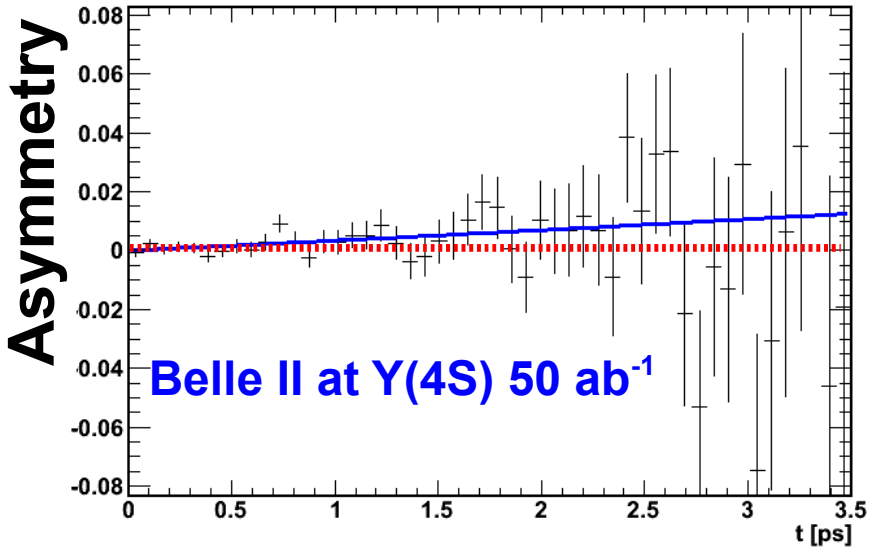
$$A^{Phys}(\Delta t) = \frac{\overline{\Gamma}^{Phys}(\Delta t) - \Gamma^{Phys}(\Delta t)}{\overline{\Gamma}^{Phys}(\Delta t) + \Gamma^{Phys}(\Delta t)} = -\Delta\omega + \frac{(D+\Delta\omega)e^{\Delta\Gamma\Delta t/2}(|\lambda_f|^2-1)\cos\Delta M\,\Delta t + 2\Im(\lambda_f)\sin\Delta M\,\Delta t}{(1+|\lambda_f|^2)h_+/2 + h_-\Re(\lambda_f)}$$

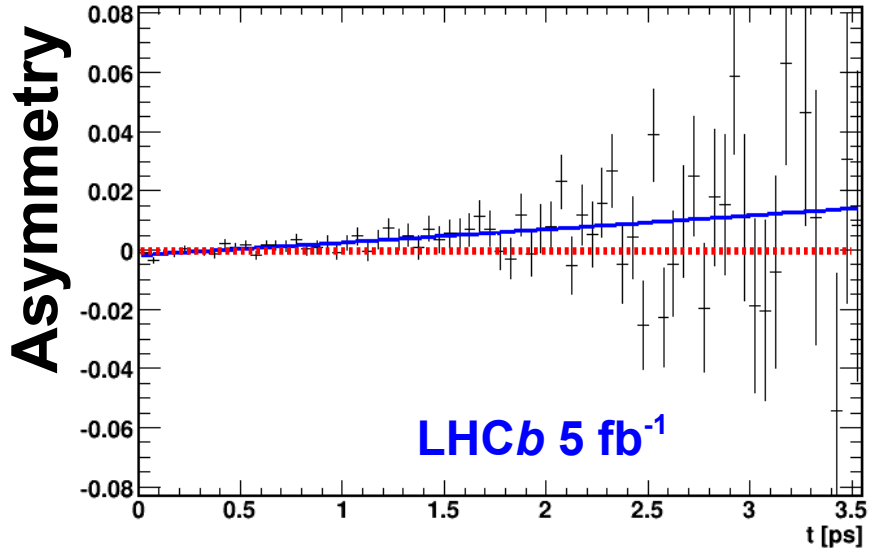
TDCPV in charm: numerical analysis

$$A^{Phys}_{D^0\to\pi^+\pi^-}(\Delta t)=\frac{\overline{\Gamma^{Phys}}(\Delta t)-\Gamma^{Phys}(\Delta t)}{\overline{\Gamma^{Phys}}(\Delta t)+\Gamma^{Phys}(\Delta t)}$$









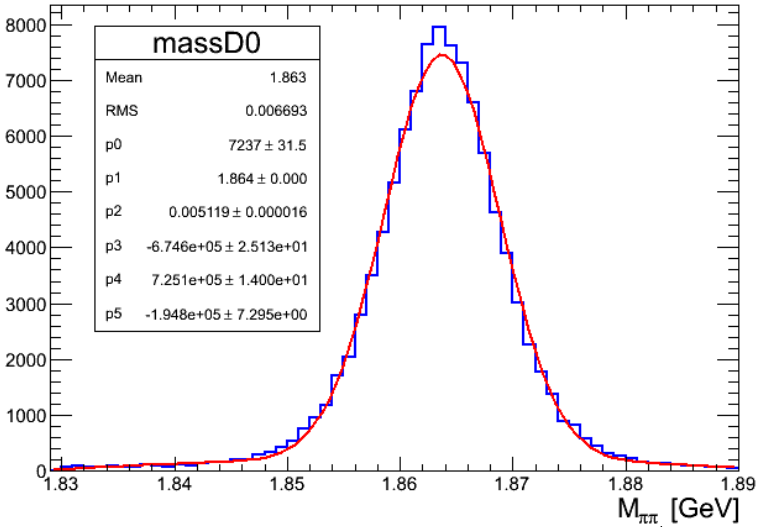
$\rightarrow D^0$ mesons: semileptonic tag at threshold

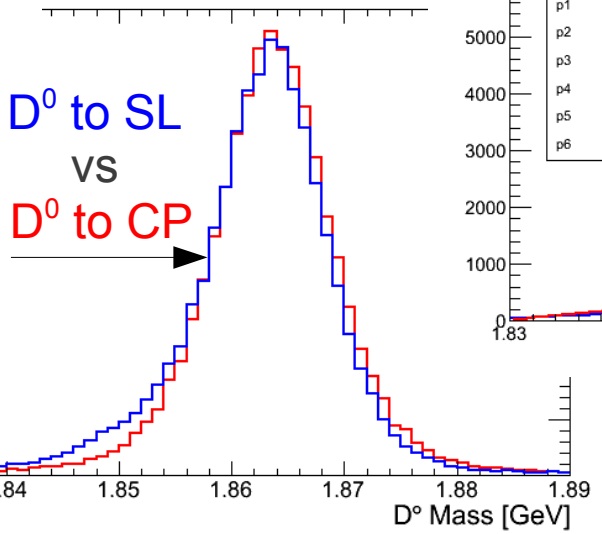
(WORK IN PROGRESS)

Correlated D^0 mesons: (tentative of) Mass reconstruction, βγ=0.56

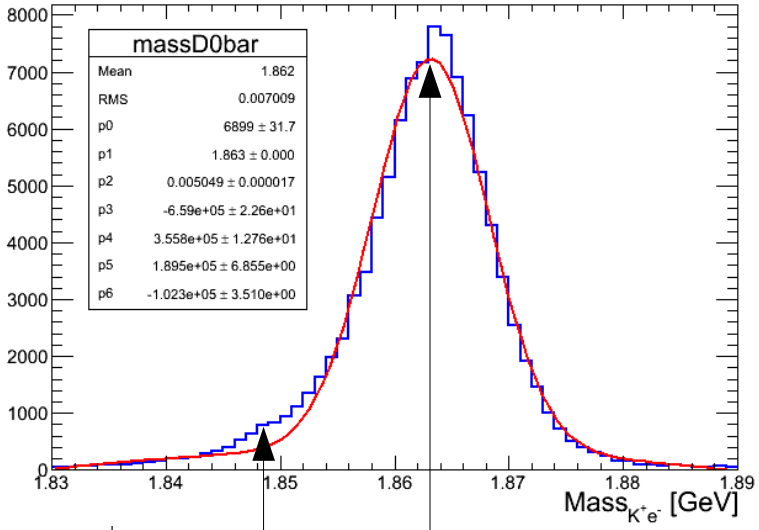
$$e^+ e^- \to \Psi'' \to D^0 \ \overline{D^0} \to \pi^+ \pi^- \ \ K^+ e^- \overline{\nu_e}$$

$D^0 \to \pi^+ \pi^-$





$D^0 \to K^+ e^- \overline{\nu_e}$



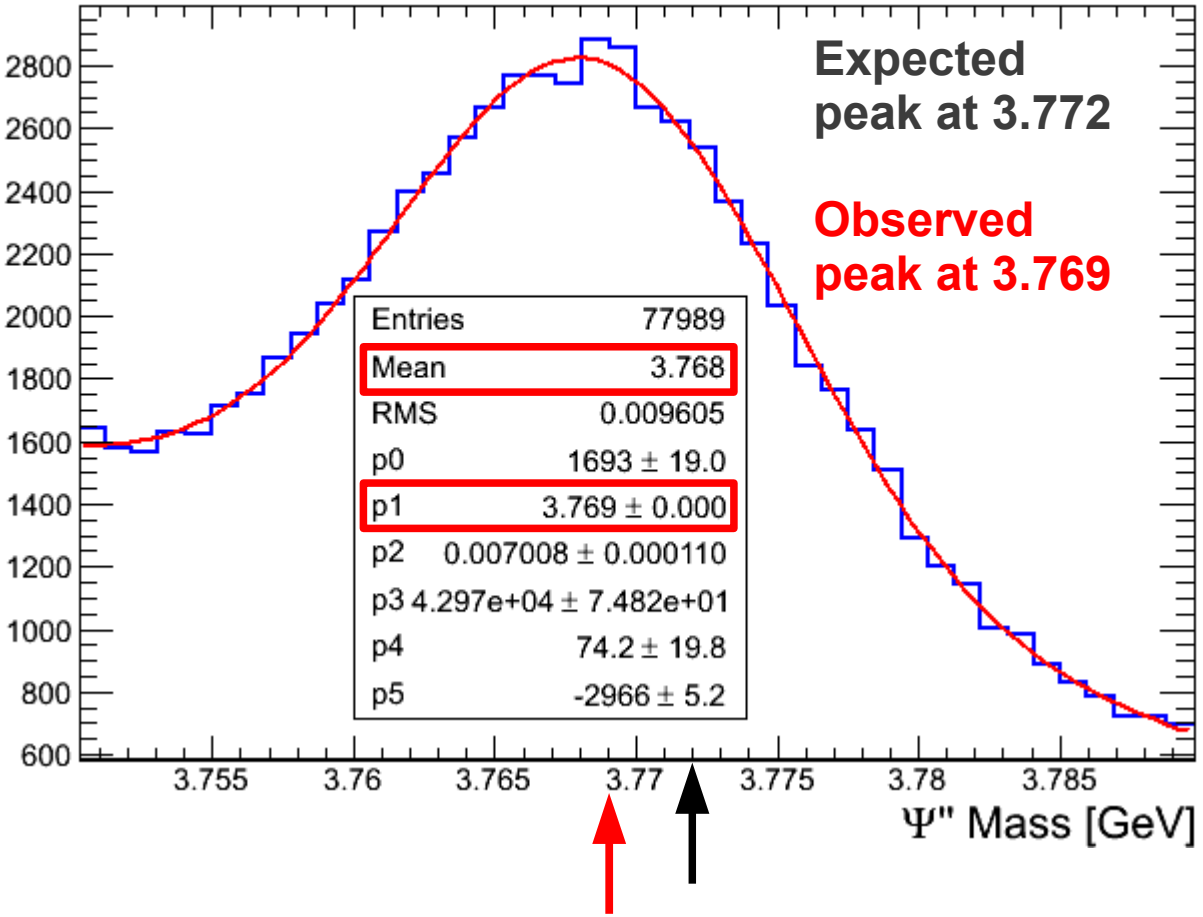
Radiative tail due to the electron

Shift of 1-2 MeV in the peak position due to the neutrino

We generate events at charm threshold and we reconstruct both the D mesons. Few selection criteria are applied (mass, charge, momentum).

Correlated D^0 mesons: (tentative of) ψ" Mass reconstruction, βγ=0.56

$$e^+ e^- \to \Psi'' \to D^0 \ \overline{D^0} \to \pi^+ \pi^- \ K^+ e^- \overline{\nu}_e$$



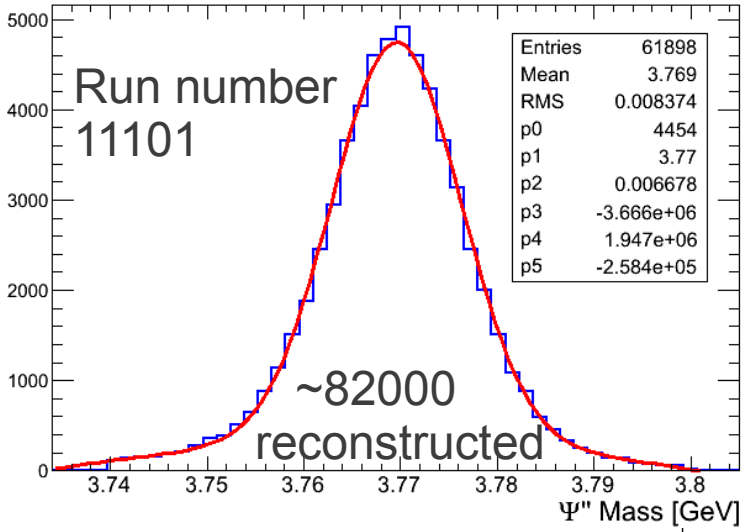
1) THERE SEEMS TO BE A PROBLEM WITH THE VALUE OF THE MASS ..
2) I AM EXPERIENCING EFFICIENCY PROBLEMS WHEN GENERATING SEMILEPTONIC DECAYS..

$\rightarrow D^0$ mesons: hadronic tag at threshold

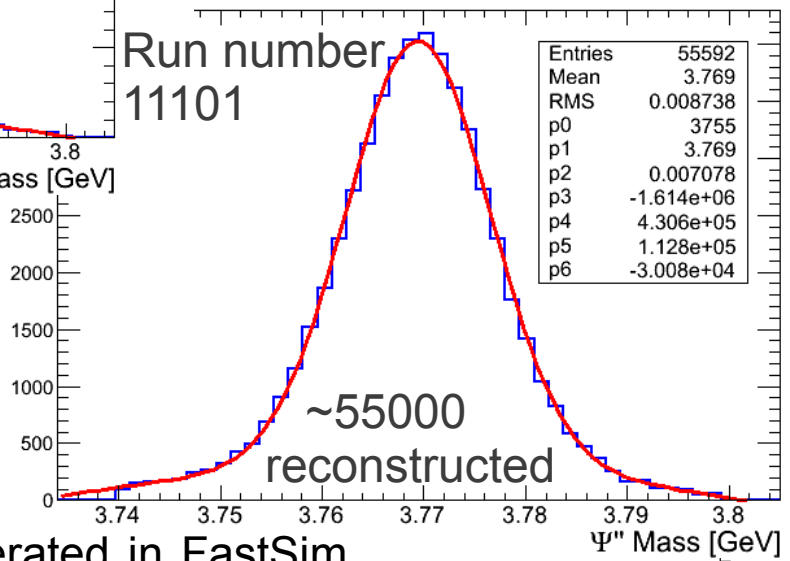
(WORK IN PROGRESS)

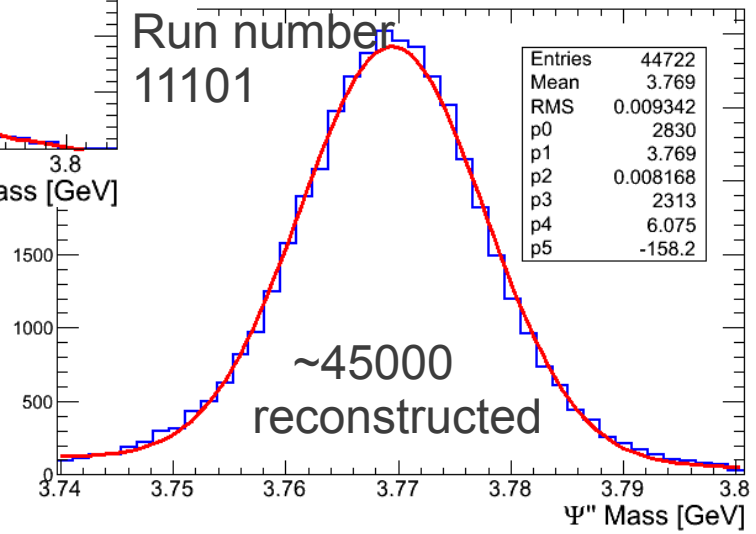
Masses reconstruction (1)

$$e^+ e^- \rightarrow \Psi'' \rightarrow D^0 \ \overline{D^0} \rightarrow \pi^+ \pi^- \ K^+ K^-$$



BOOST→





Note →Plots are as generated in FastSim

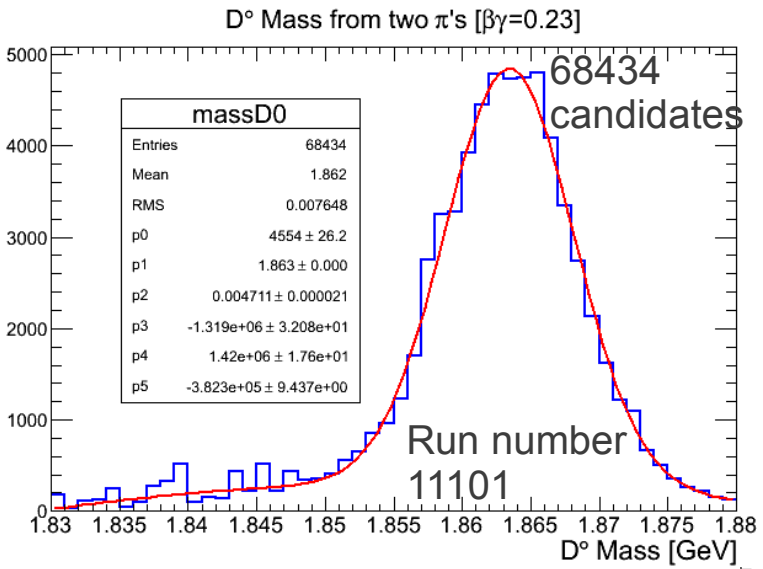
1) Efficiency drops when the boost is increased (31% - 45%)

2) The larger the boost, the wider the distribution

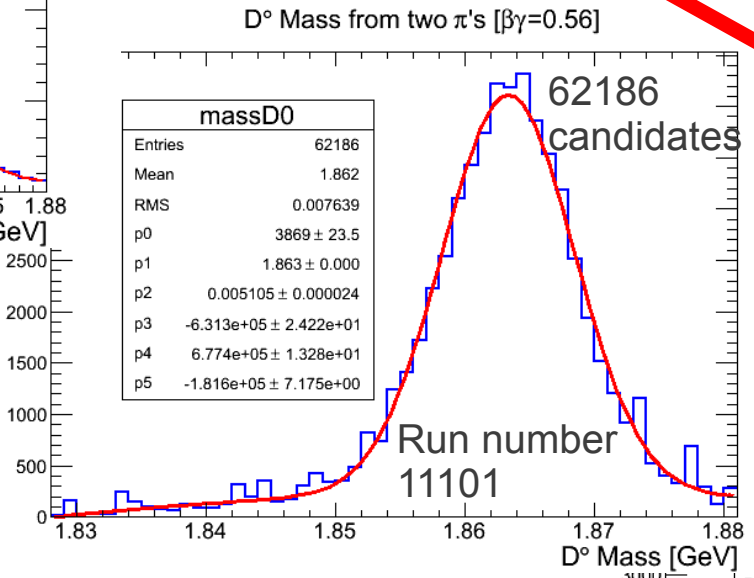
3)PDT/pdt.table

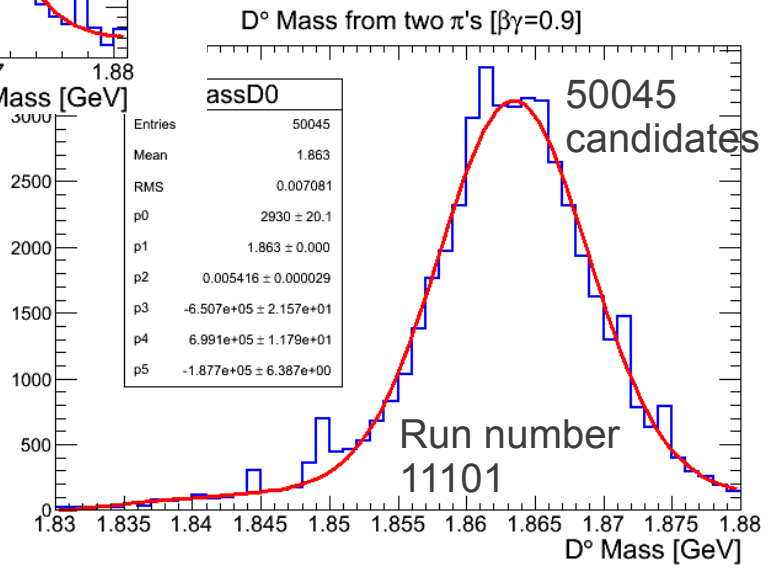
Masses reconstruction (2)

$$e^+ e^- \to \Psi'' \to D^0 \ \overline{D^0} \to \pi^+ \pi^- \ K^+ K^-$$



BOOST →





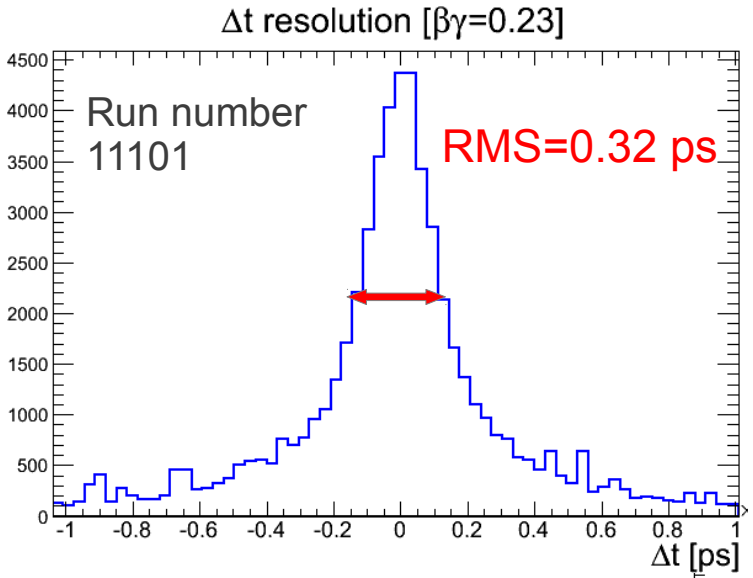
Note → Loose constraints are applied!

1) Efficiency drops when the boost is increased (8.8% - 26.5%)

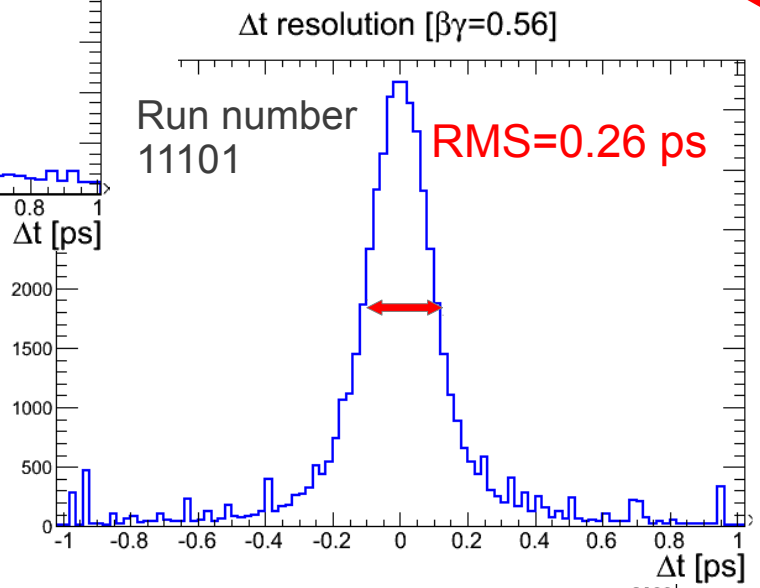
2) The larger the boost, the wider the distribution

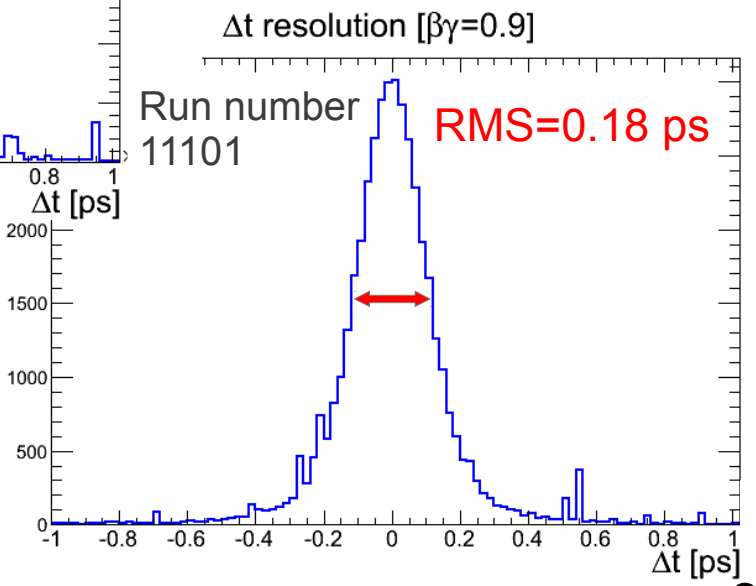
Δt resolution

$$e^+e^- \to \Psi'' \to D^0\ \overline{D^0} \to \pi^+\pi^-\ \ K^+K^-$$



BOOST →





The larger the boost, the better the resolution. However intermediate boost seem to be a good solution

$$\delta(\Delta z) = \Delta z - \Delta z_{TRUE} = (z_{REC} - z^T_{REC}) - (z_{TAG} - z^T_{TAG})$$
$$= \delta(z_{REC}) - \delta(z_{TAG})$$

$$\Delta t \approx \frac{\Delta z}{\beta\gamma c}$$

→Conclusions

- We are moving forward with the study of the D^0 mesons with FastSim.
- We are now evaluating efficiencies and performances for the different processes we want to study.
- We have found the value of the mass of the ψ'' need to be updated.
- In the semileptonic channel we are experiencing problems with the efficiency.
- We have evaluated the Δt resolution in the channels $D^0 \rightarrow \pi^+\pi^-$ $D^0 \rightarrow K^+K^-$ and results look promising.
- More results at the next meeting in Elba.

...Many Thanks...