Time-integrated raw asymmetry in $D^0 \longrightarrow K^+K^-$

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Physics Motivation

- $D^0 \longrightarrow K^0_S K^0_S$ is a Singly Cabibbo Suppressed (SCS) decay, which involves the interference of $c\bar{u} \longrightarrow s\bar{s}$ and $c\bar{u} \longrightarrow d\bar{d}$ transitions, due to which the CP Asymmetry ($\mathcal{A}_{CP}$) may be enhanced to an observable level within the Standard Model.
- Previous Belle measurement (Phys. Rev. Lett. 119 171801): $\mathcal{A}_{CP}(D^0 \longrightarrow K^0_S K^0_S) = (-0.02 \pm 1.53 \pm 0.02 \pm 0.17)\%$.
- We intend to use $D^0 \longrightarrow K^+K^-$ as the control sample in the measurement of $\mathcal{A}_{CP}(D^0 \longrightarrow K^0_S K^0_S)$. The ($\mathcal{A}_{CP}$) in $D^0 \longrightarrow K^+K^-$ is measured with 0.11% precision (as per the Heavy Flavour Averaging Group) and is expected to improve.
- **Here, we measure the signal yield time integrated raw asymmetry (A_{raw}) in $D^0 \longrightarrow K^+K^-$ using Belle II simulation.**

Sample and Selection Criteria

- 88fb^{-1} of Monte Carlo sample.
- $D^0 \longrightarrow K^+K^-$ are reconstructed using tracks of two oppositely charged kaons for which, $\mathcal{L}_K/(\mathcal{L}_K + \mathcal{L}_{\pi/e})$ is greater than 0.6(0.1).
- The D^0 thus reconstructed is combined with low momentum pions (π_s) to form the $D^{*+} \longrightarrow D^0\pi_s^+$ decay.

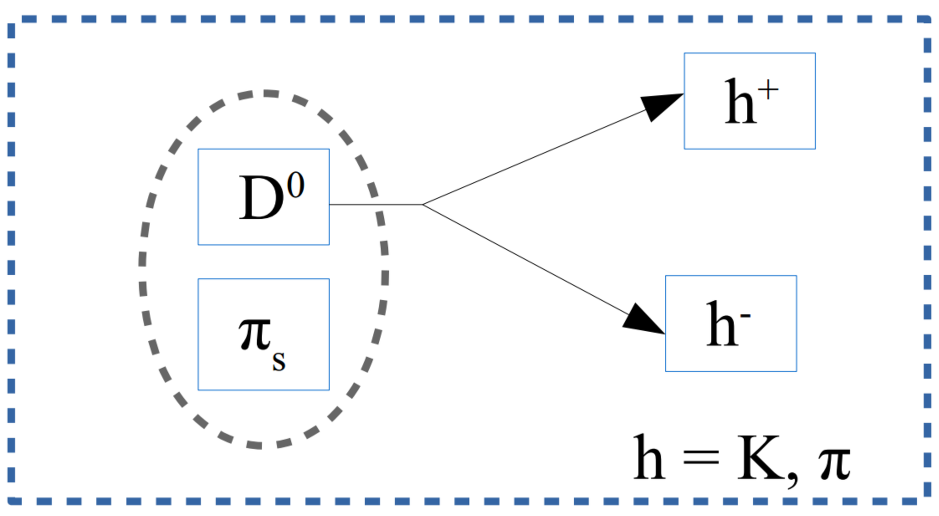
Fit strategy

- An unbinned maximum likelihood fit to $(m(K^+K^-), m(D^0\pi_s))$ is performed to measure A_{raw} defined as:

$$A_{raw} = \frac{N(D^0) - N(\overline{D}^0)}{N(D^0) + N(\overline{D}^0)}$$

where, $N(D^0)$ is the measured yield of the D^0 decay while $N(\overline{D}^0)$ is that of the corresponding $\overline{D}^0$ decay.

- $m(D^0\pi_s)$ is essentially the mass of the D^* but with no mass hypothesis on the D^0 daughters A. Di Canto, FERMILAB-THESIS-2011-29.



- All $D^{*+} \longrightarrow D^0(\longrightarrow h^+h^-)\pi^+$ decays have identical $m(D^0\pi_s)$ distributions unlike the conventional Δm, thereby largely simplifying the fit. Here, $\Delta m = m(D^*) - m(D^0)$.

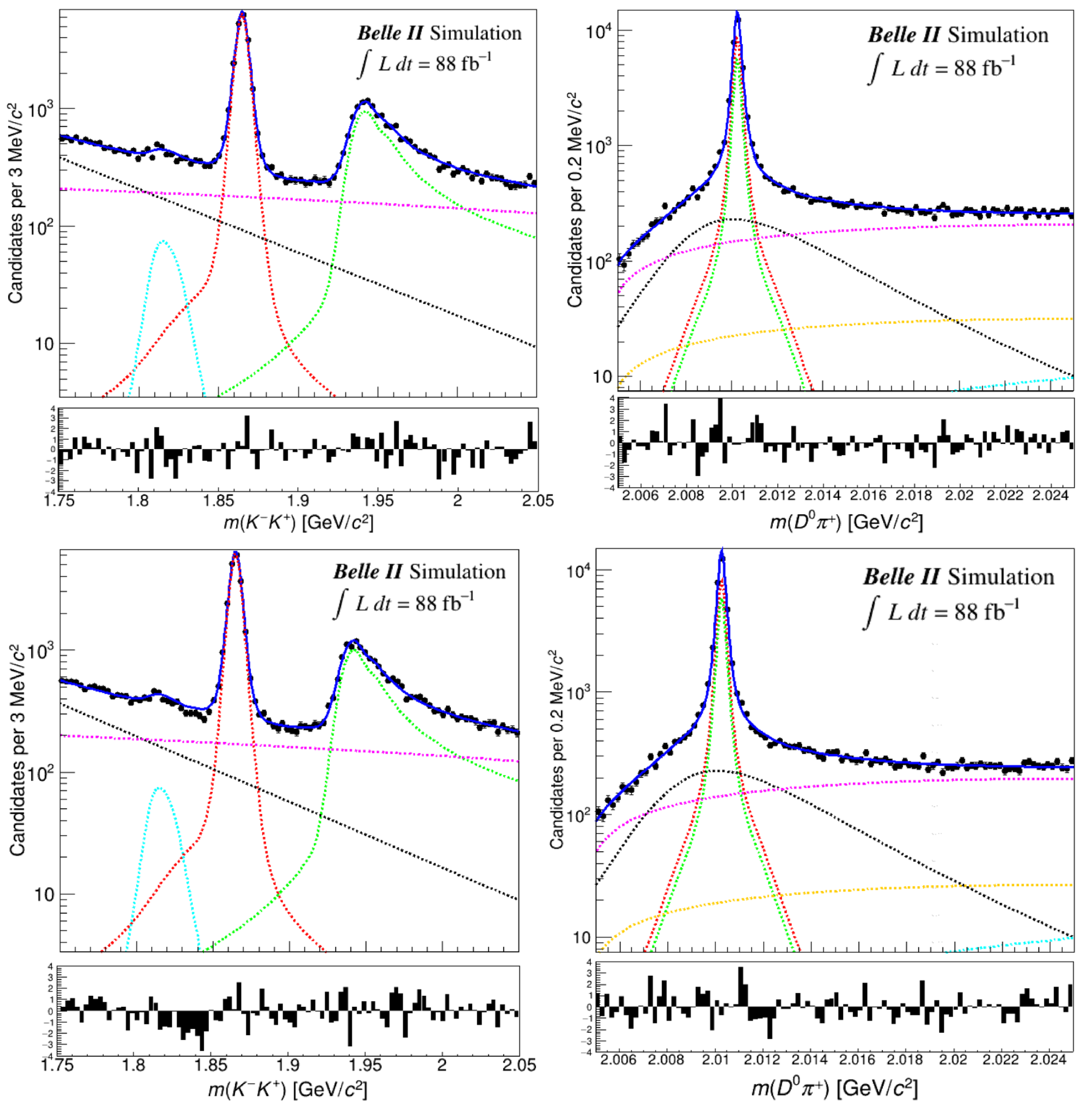
- Except the the yields and corresponding raw asymmetries, all fit parameters, are fixed to the values obtained from separate fits to the components.

Summary

- A detailed background study of the decay $D^0 \longrightarrow K^+K^-$ is performed.
- Total signal yield and A_{raw} and are measured in simulation, using a simultaneous fit to $(m(K^+K^-), m(D^0\pi_s))$.

Results

- Shown below are the distributions of $m(K^+K^-)$ (left) and $m(D^0\pi_s)$ (right) for D^0 sample (top) and $\overline{D}^0$ (bottom), with fit projections overlaid.



Probability density functions (PDF) of each components are tabulated below. The colours in table represent the corresponding components in the plots.

Components	$m(D^0\pi_s)$	$m(K^+K^-)$
$D^* \longrightarrow D^0(\longrightarrow KK)\pi_s$	Double gaussian + Johnson	Double gaussian +Johnson
$D^* \longrightarrow D^0(\longrightarrow K\pi)\pi_s$	Double gaussian + Johnson	Gaussian+Johnson
$D^* \longrightarrow D^0(\longrightarrow multibody)\pi_s$	Johnson	Exponential
$D^0 \longrightarrow KK$ + random pion	$(x-x_0)^{1/2} + \alpha(x-x_0)^{3/2}$	Corresponding $m(K^+K^-)$
$D^0 \longrightarrow K\pi$ + random pion	$(x-x_0)^{1/2} + \alpha(x-x_0)^{3/2}$	Corresponding $m(K^+K^-)$
$D^0 \longrightarrow multibody$ + random pion	$(x-x_0)^{1/2} + \alpha(x-x_0)^{3/2}$	Corresponding $m(K^+K^-)$
$D_s \longrightarrow KK\pi$	1^{st} order Chebyshev	Johnson
Combinatorial	$(x-x_0)^{1/2} + \alpha(x-x_0)^{3/2}$	1^{st} order Chebyshev

- $D^0 \longrightarrow multibody$ includes, semileptonic, $K\pi\pi^0$ decays. Also, $x_0 = 2.00441$, the threshold.
- Same PDF model is assumed for both, D^0 and $\overline{D}^0$ samples.
- **Results:**
  - **Total Signal Yield = 36795 ± 199.**
  - $A_{raw} = 0.0231 \pm 0.0054$.