Introduction of Helix Corrections

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Motivation

- Obvious difference between MC and data on the distribution of χ^2_{4c} and pulls are observed in most analysis.

- **The traditional method:** using control samples to estimate the systematic error of this difference.

- **Disadvantages: Firstly** for most channels, it is hard to find appropriate reference channel with the final states and momentum distribution similar to the analysis process. **Furthermore,** it is difficult to select pure control sample without using kinematic constraints or selection criteria correlated with kinematic constraints such as total energy, total momentum and so on.

- **Method:** Correct the track helix parameters to reduce the difference between MC and data.

- The control samples used for μ and K corrections are: $e^+e^- \to j/\psi\pi^+\pi^- \to \mu^+\mu^-\pi^+\pi^-$ and $e^+e^- \to K^*K^\pm\pi^\mp \to K^+K^-\pi^+\pi^-$

Selection of $e^+e^- \to j/\psi\pi^+\pi^- \to \mu^+\mu^-\pi^+\pi^-$

Event selection

- Charged Track

$d_{xy} < 1.0$ cm, $d_z < 10.0$ cm, $\cos\theta < 0.93$;
nGood == 4, nCharged == 0;

- Lepton and pion idetify

P > 1.0 GeV : lepton
P < 1.0 GeV : π
npion+ = npion-, nlepton+ = nlepton-
E/P > 0.7 : e
E < 0.45 GeV : μ

- Kinematic fit : $\chi^2_{4C} < 60$

- J/ψ mass window cut

$|M(J/\psi) - 3.097| < 0.02$

- open angle cut

$\cos\theta\ (\pi^+\pi^-) < 0.98$
$\cos\theta\ (l^+\pi^-) < 0.98$
$\cos\theta\ (l^-\pi^+) < 0.98$

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Selection of $e^+e^- \to K^*K^\pm\pi^\mp \to K^+K^-\pi^+\pi^-$

Good charged tracks:

- $|V_z| < 10$ cm, $V_r < 1$ cm and $|cos\theta| < 0.93$
- N_{Good} =4, $\sum Q_{track} = 0$

PID:

- For K :
$Prob_K > Prob_\pi \&\& Prob_K > Prob_p \&\& Prob_K > 0.001, N_{K^+} = N_{K^-} = 1$
- For π :
$Prob_\pi > Prob_K \&\& Prob_\pi > Prob_p \&\& Prob_\pi > 0.001, N_{\pi^+} = N_{\pi^-} = 1$

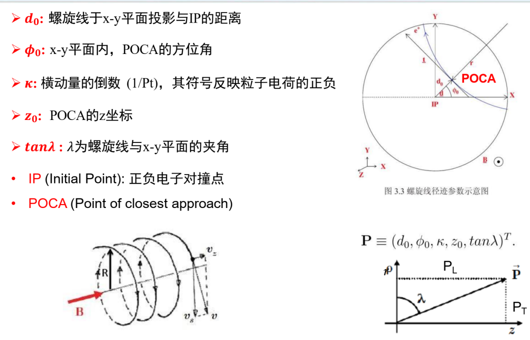
Vertex Fit:

- Successful vertex fit for the two charge tracks

Kinematic Fit:

- Successful 4c kinematic fit, χ^2_{4c} <60
- One of $M_{K^\pm\pi^\mp}$ should in the K^* window:[0.8, 1] GeV/c^2.

The pull distribution

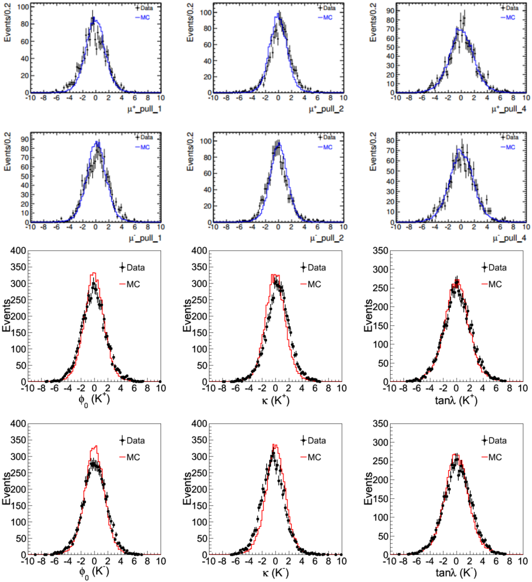


- One charge track of BESIII can be described by 5 parameters.
- The pull distribution is defined as: $pull_i = \frac{\alpha_i - \alpha_{0i}}{\sqrt{|(V_{a0})_{ii} - (V_a)_{ii}|}}$

α_i:the i^{th} track parameter. V:the covariance matrix.

- Theoretically, the distribution of pull is a standard Normal distribution.

The pull distribution



Correction of the track parameters of MC simulation

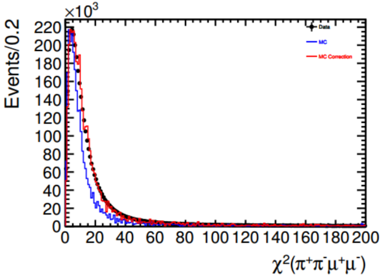
- Actually the pull distribution obeys a Normal distribution with mean μ_i and standard deviation σ_i.
- To reduce the difference between data and MC: enlarge the resolution of α_{0i} by smearing it with a Gaussian, and the mean and sigma of the smeared Gaussian is:

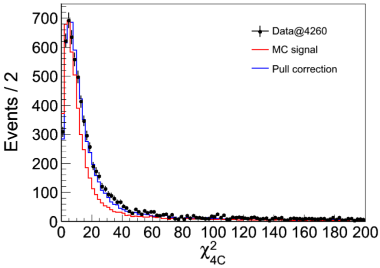
$\alpha_{0i} + (\mu_i^{data} - \mu_i^{MC}) * (V_{a0})_{ii}$ and $\sqrt{((\sigma_i^{data}/\sigma_i^{MC})^2 - 1) * (V_{a0})_{ii}}$

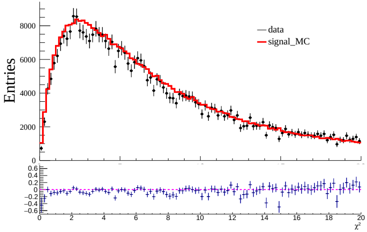
	ϕ_0		κ		tgλ	
	$m^{data} - m^{MC}$	$\sigma^{data}/\sigma^{MC}$	$m^{data} - m^{MC}$	$\sigma^{data}/\sigma^{MC}$	$m^{data} - m^{MC}$	$\sigma^{data}/\sigma^{MC}$
π^+	-0.007	1.087	0.362	1.178	0.168	1.178
π^-	-0.060	1.162	-0.361	1.131	0.211	1.253
μ^+	-0.045	1.277	0.499	1.103	0.184	1.129
μ^-	0.031	1.269	-0.464	1.057	0.233	1.138

	ϕ_0		κ		tgλ	
	$m^{data} - m^{MC}$	$\sigma^{data}/\sigma^{MC}$	$m^{data} - m^{MC}$	$\sigma^{data}/\sigma^{MC}$	$m^{data} - m^{MC}$	$\sigma^{data}/\sigma^{MC}$
π^+	-0.02±0.03	1.15±0.02	0.42±0.03	1.14±0.02	0.07±0.03	1.09±0.02
π^-	-0.01±0.03	1.16±0.02	-0.36±0.03	1.13±0.02	0.08±0.03	1.09±0.02
K^+	-0.08±0.03	1.17±0.02	0.37±0.03	1.12±0.02	0.06±0.03	1.07±0.02
K^-	0.06±0.03	1.16±0.02	-0.43±0.03	1.11±0.02	0.07±0.03	1.09±0.02

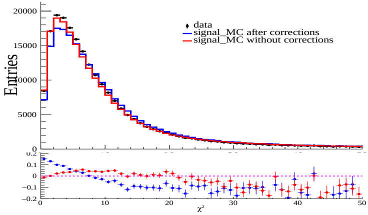
χ^2_{4c} distributions after distribution





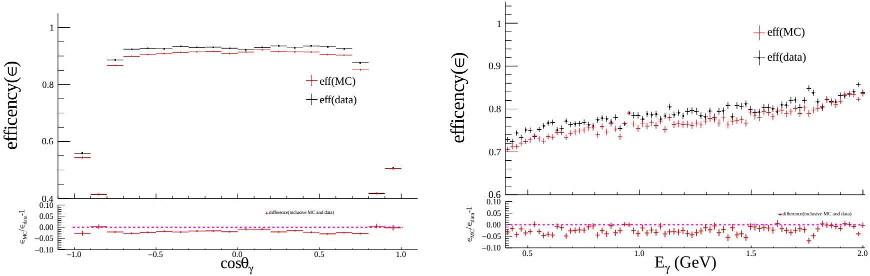


χ^2_{4c} of $K^+K^-\gamma_{ISR}$



χ^2_{4c} of $\mu^+\mu^-\gamma_{ISR}$

efficiency after corrections of $\mu^+\mu^-$



(a) (b)

- The situation of kinematic fit efficiency still exists.