

Amplitude Analysis on $\Lambda_c^+ \rightarrow \Sigma^0 \pi^+ \pi^0$

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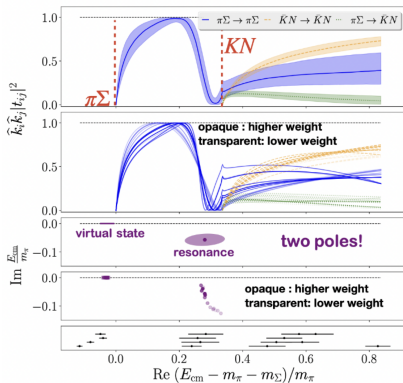
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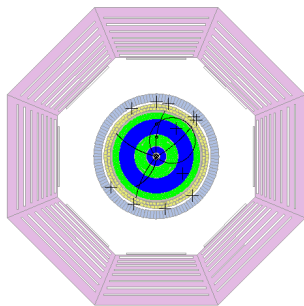
$\Lambda(1405)$ a mysterious particle

- $\Lambda(1405)$ is predicted to be a molecular state of \bar{K} and N [1] [2] with quark content ($\bar{s}duud$)
- In order to explain the unexpected experiments' observation of the lower mass of a $J = -\frac{1}{2}$ excited hyperon [3] [4]. The two pole states [5] [6] was firstly proposed
- The $\Sigma^0\pi^0$ can couple to $\Sigma\pi$ and scatter to $\bar{K}N$, arising the so called two poles.
- $\Lambda_c^+ \rightarrow \Sigma^0\pi^+\pi^0$ will be a idea place to reconstruct $I = 0$ combination.

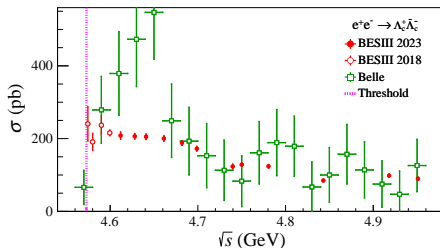




- Symmetric e^+e^- beam, running at $\sqrt{s} = 2.0 - 4.95$ GeV (light hadron spectrum, τ charm energy region).
- Peak luminosity 1.1×10^{33} at $\sqrt{s} = 1.89$ GeV ($\Psi(3770)$ peak)



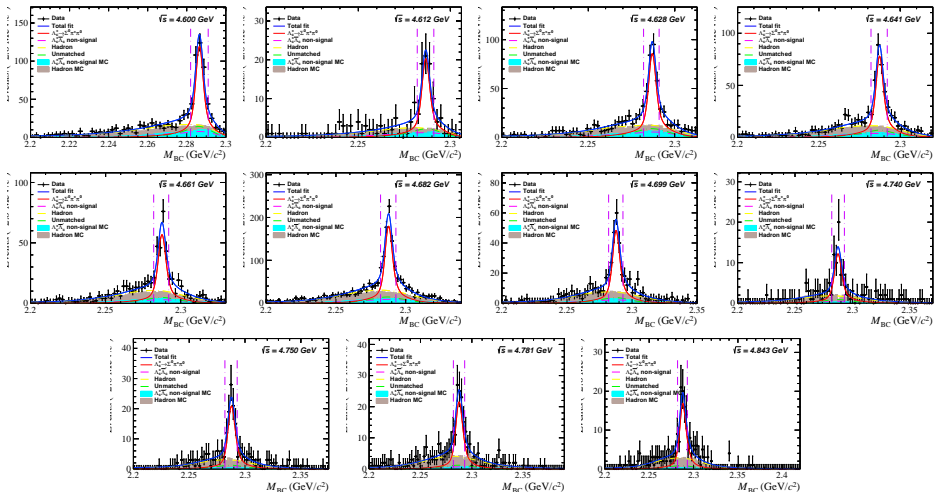
XY View



- 4π acceptance, generic detector
- We take data from 11 energy point near threshold
- No other hadron produced with $\Lambda_c^+ \bar{\Lambda}_c^-$ pair.

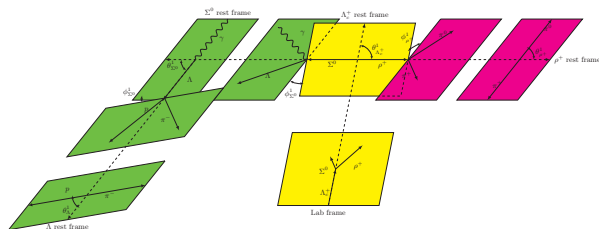
- $$M_{BC}^1 = \sqrt{E_{beam}^2 - \hat{P}_{rec-\Lambda_c^+}^2}$$

¹Beam constrained mass



- Discriminate variable M_{BC} to extract the weight data to be likely a signal

Helicity definition



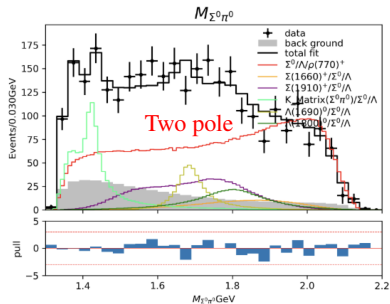
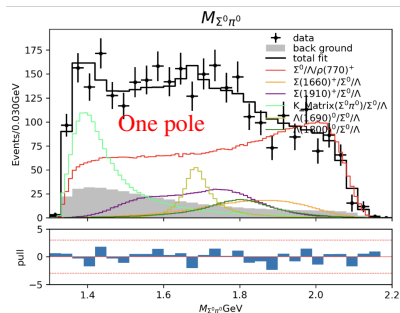
- Helicity angle is defined:

- Polar angle: θ the angle between the final states in the rest frame of resonance
- Azimuths angle: ϕ the angle between two decay plane.

- The full decay chain was formalized with a quasi-3 body decay

$$\Lambda_c^+ \rightarrow \Sigma^0(\Lambda\gamma, \Lambda \rightarrow p\pi^-)\pi^+\pi^0 \text{ with cascade decay of}$$

- Electron-magnetic $\Sigma^0 \rightarrow \Lambda\gamma$, mass-less particle have only $\lambda = \pm 1$, and constrained with conservation law.
- Weak decay of $\Lambda \rightarrow p\pi^-$ are well measured by $J\psi \rightarrow \Lambda\bar{\Lambda}$, amplitude are fixed according to.



- Focus on the low lying region, where we would like to investigate the $\Lambda(1405)$:
 - With hypothesis test, evidence ($> 3\sigma$) of two pole structure been get.

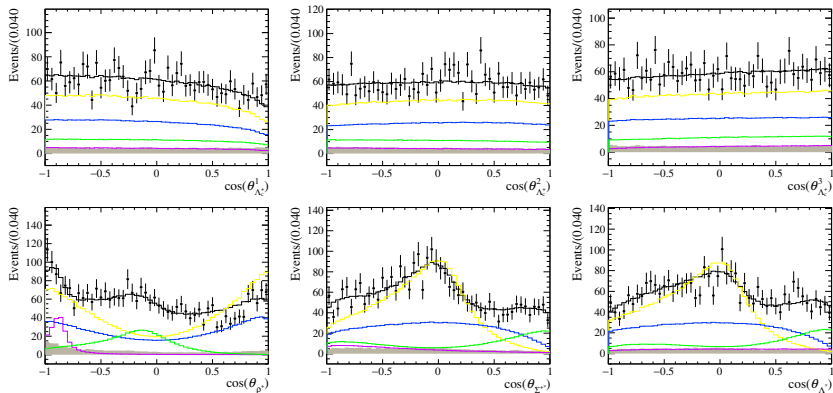
- With the scanned data taken by BESIII at $\sqrt{s} = 4.59 - 4.84$ GeV, we conducted an amplitude analysis on $\Lambda_c^+ \rightarrow \Sigma^0 \pi^+ \pi^0$ decay.
- We find an evidence of the two pole structure of $\Lambda(1405)$.
- Branching fraction of $\Lambda_c^+ \rightarrow \Sigma^0 \rho(770)^+ (\rho \rightarrow \pi^+ \pi^0)$ has been measured.
- The study of systematic uncertainties will be next step.

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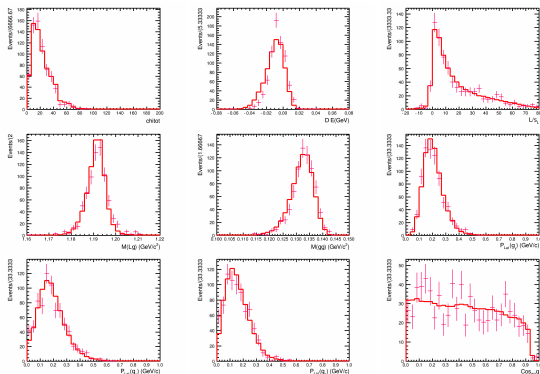
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Back up

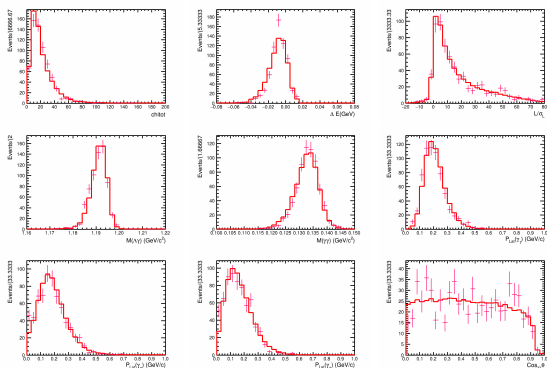
PWA result (Helicity angle)



- The **magenta error bar** is the data with BDTG cut and signal weight
- The **magenta solid line** is the signal shape MC with BDTG cut



- The **magenta error bar** is the data with BDTG cut and signal weight
- The **magenta solid line** is the signal MC with BDTG cut



- The **magenta error bar** is the data with BDTG cut and bkg weight
- The **azure solid line** is the Cocktail MC with BDTG cut

