

Search for excited doubly charmed baryons

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Overview

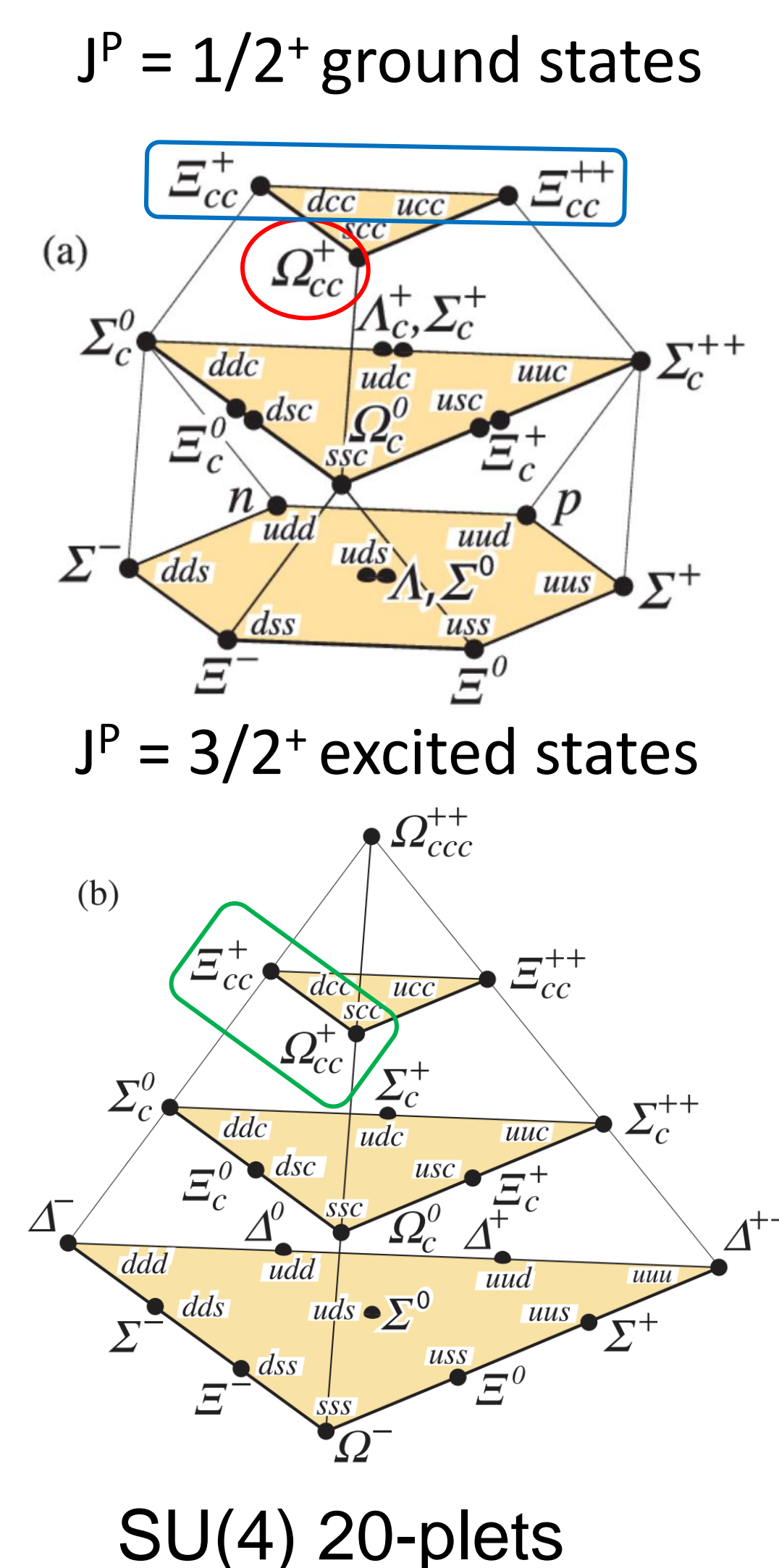
Three weakly decaying doubly charmed baryons are expected:

- Ξ_{cc} **isodoublet** (ccu, ccd)
→ Similar masses (isospin symmetry)
- Ω_{cc} **isosinglet** (ccs)

LHCb observed the first doubly charmed baryon, the Ξ_{cc}^{++} baryon, in
 $\Xi_{cc}^{++} \rightarrow \Lambda_c^+ K^- \pi^+ \pi^+$ decays

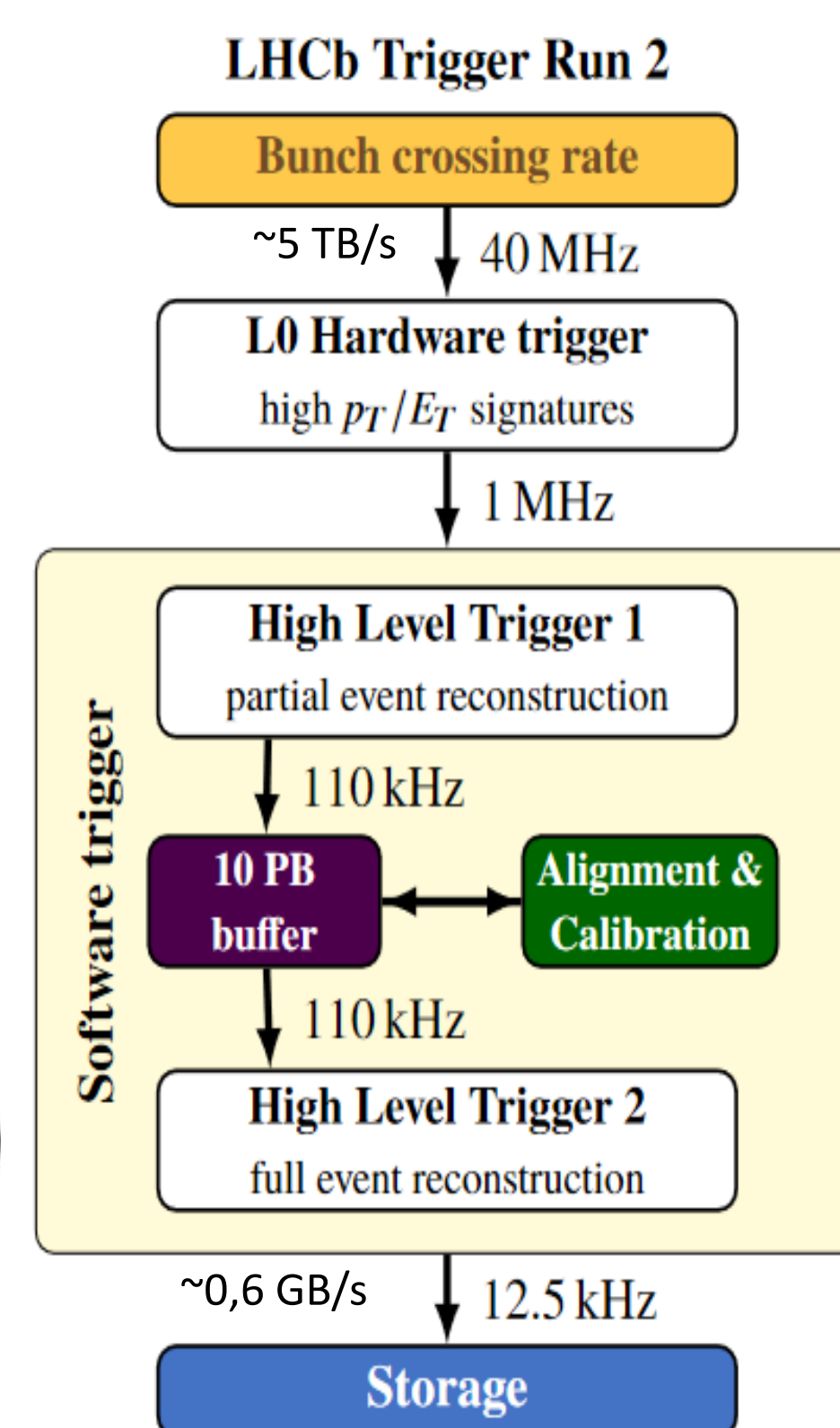
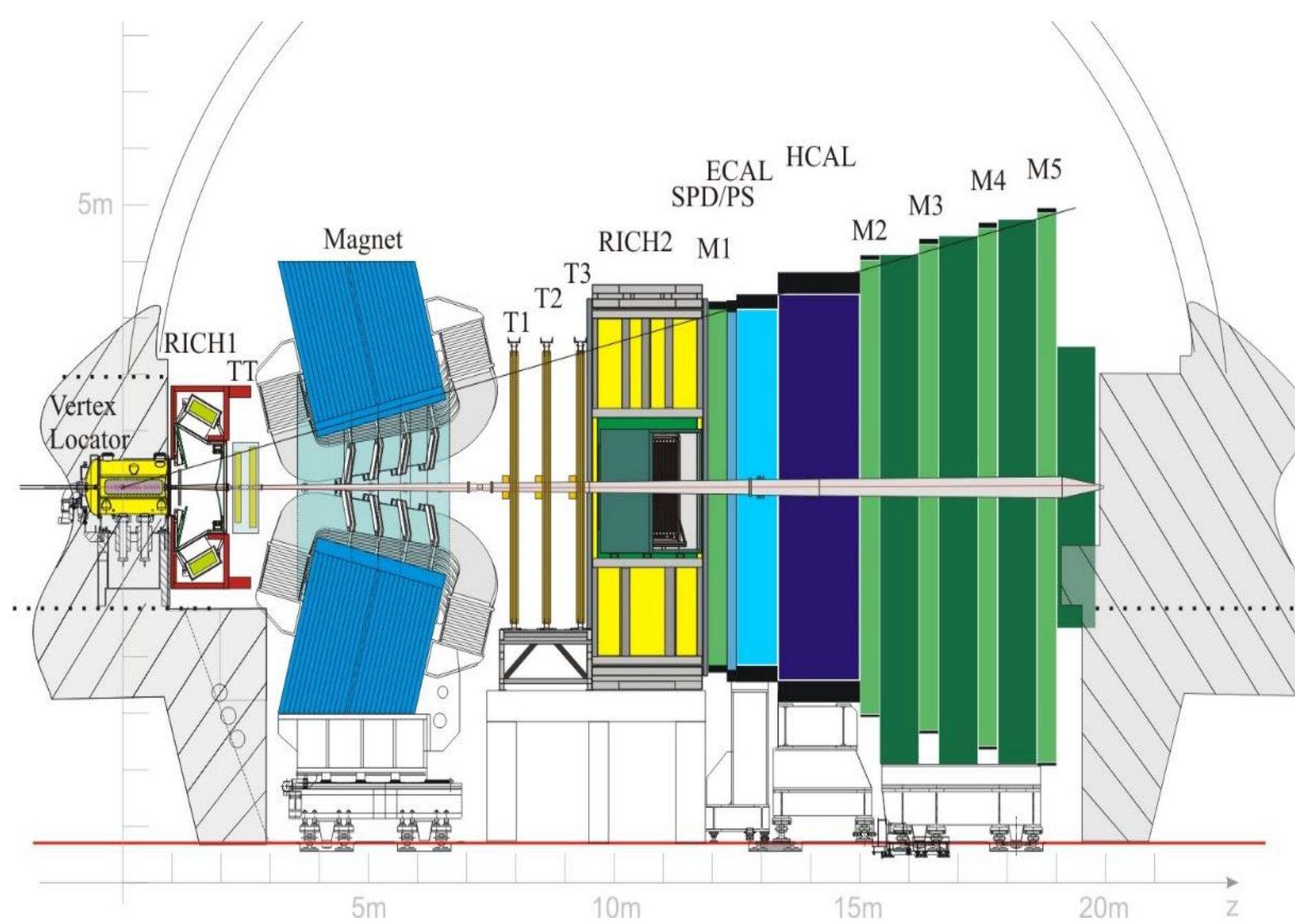
We study **two excited states**, looking for two spectra:

- $\Xi_{cc}^{*++} \rightarrow \Xi_{cc}^{++} \pi^-$
- $\Omega_{cc}^{*++} \rightarrow \Xi_{cc}^{++} K^-$



LHCb detector

- Single arm forward spectrometer
- Excellent tracking, particle ID and efficient trigger system



- LHCb is a superb laboratory for studies of Ξ_{cc} decays

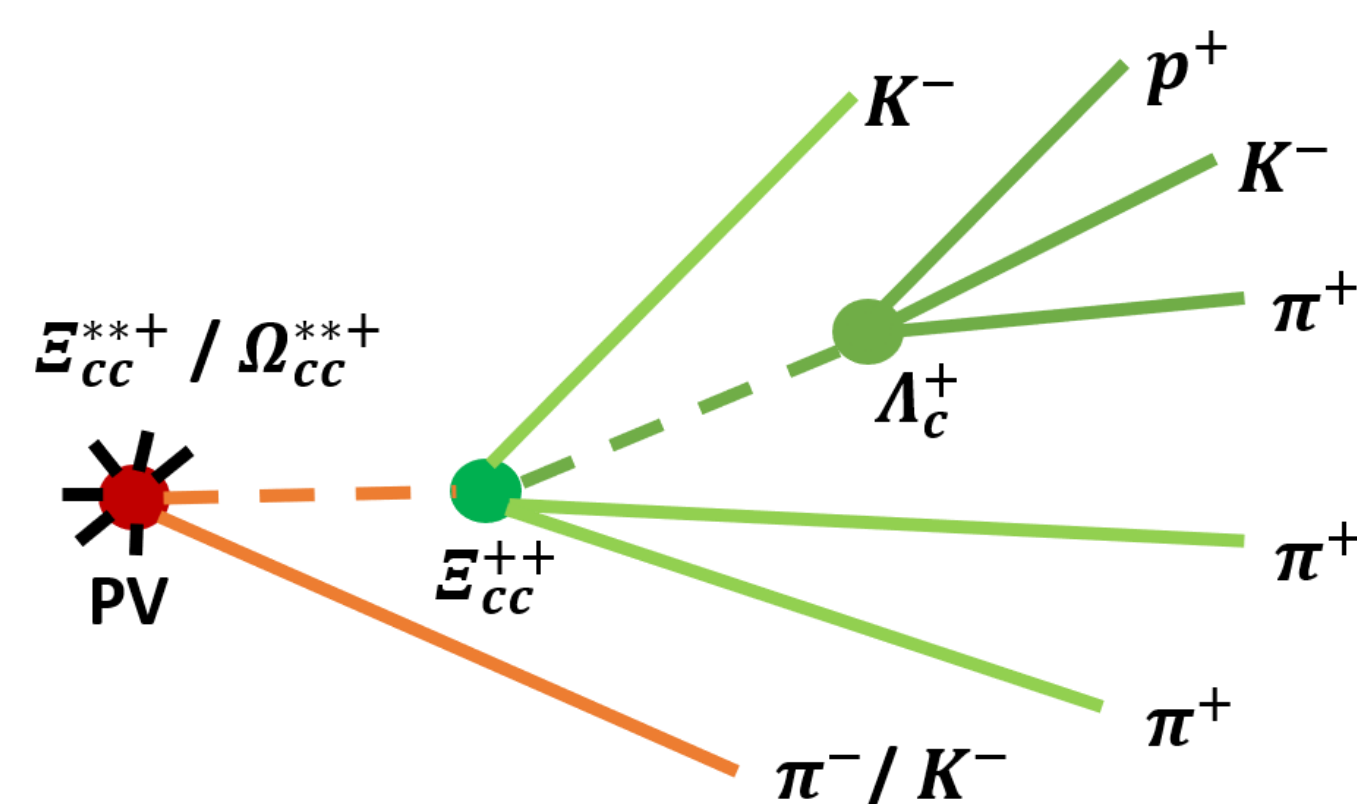
Analysis approach

1. Reconstruct Ξ_{cc}^{*++} candidates

2. Combine those candidates to a $\Xi_{cc}^{*++} / \Omega_{cc}^{*++}$ candidates

How to reconstruct candidates

1. Events are filtered and candidates are reconstructed and selected centrally through the trigger
2. A cut-based pre-selection is applied
3. A multivariate selection is applied after training using simulation and background data
4. Clone and duplicated candidates are removed



Ξ_{cc}^{*++} reconstruction

• Decay mode :

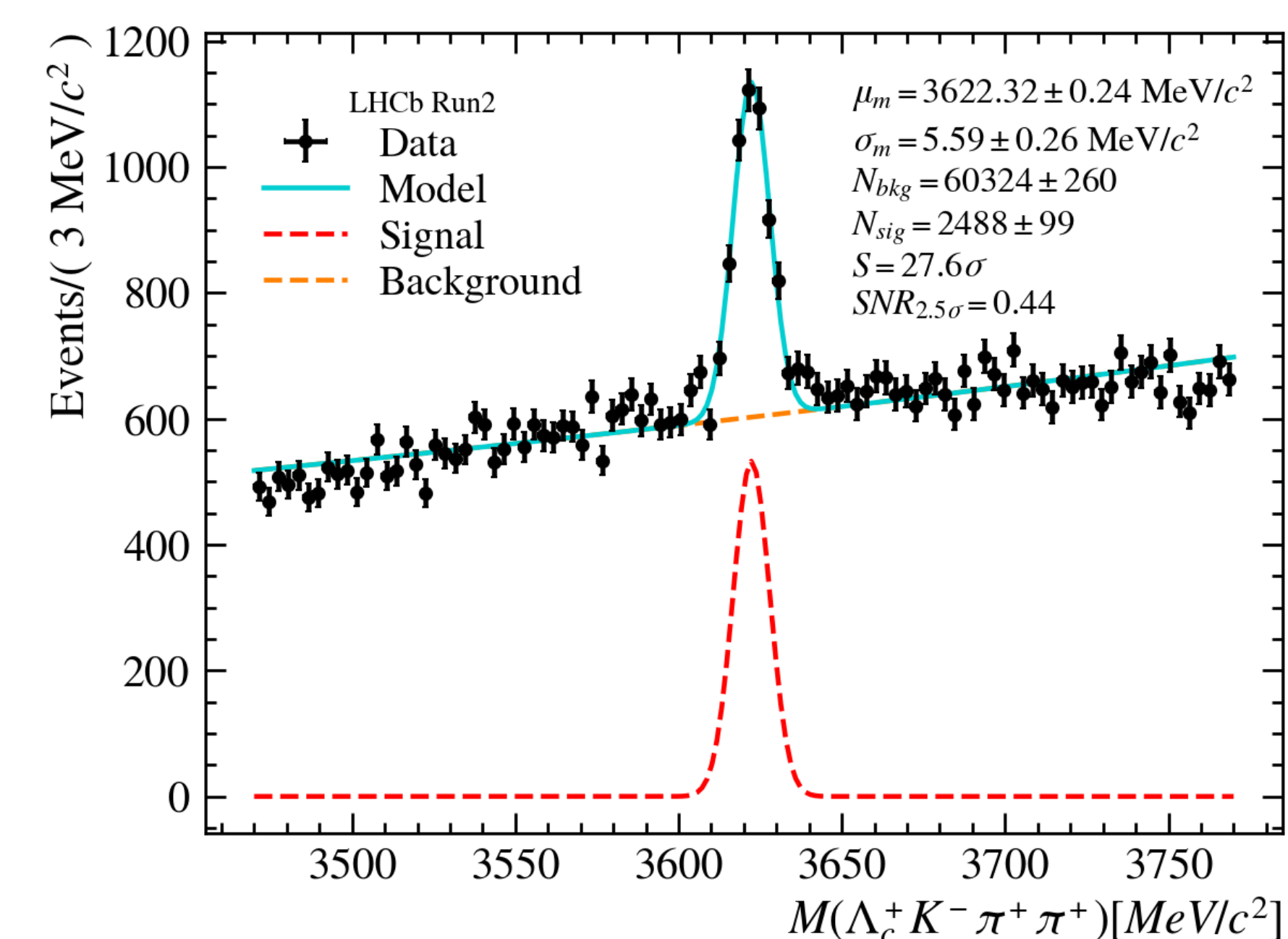
$$\Xi_{cc}^{*++} \rightarrow \Lambda_c^+ K^- \pi^+ \pi^+$$

- ~2500 candidates

- Local significance > 27 σ

- Resolution = 5.59 ± 0.30 MeV (consistent with expected detector resolution)

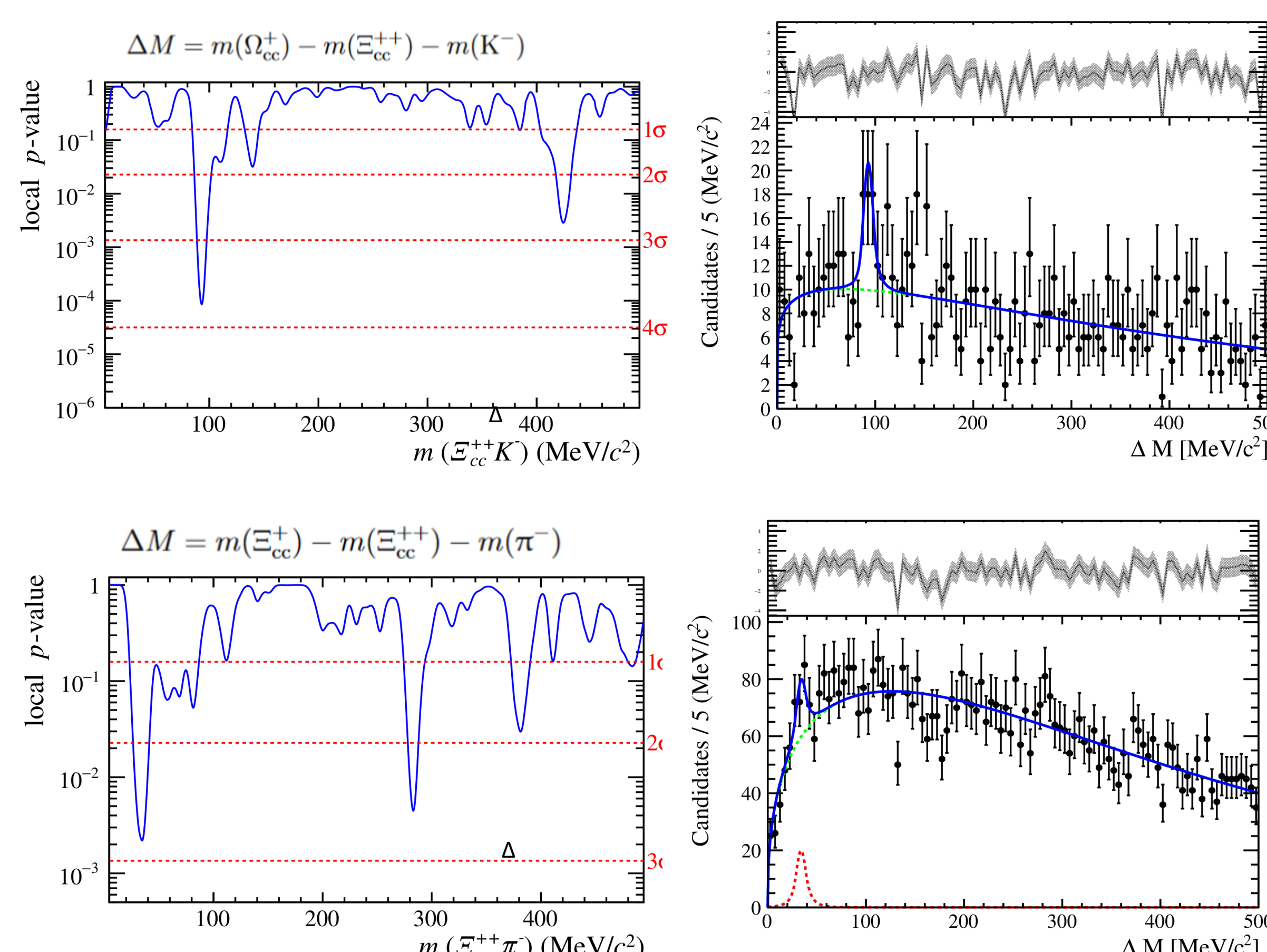
- SNR = 0.44 (signal purity)



$$m(\Xi_{cc}^{*++}) = 3622.32 \pm 0.24 \text{ MeV}$$

Excited states reconstruction

A search for both the Ξ_{cc}^{*++} baryon through the $\Xi_{cc}^{*++} \pi^-$ decay and the Ω_{cc}^{*++} baryon through the $\Xi_{cc}^{*++} K^-$ decay are performed, using pp collision data collected by the LHCb experiment from 2016 to 2018 at a centre-of-mass energy of 13 TeV, corresponding to an integrated luminosity of 5.4 fb^{-1} . No significant signal is observed in the mass range of 0 to 500 MeV from the mass threshold.



Future work

- Future searches by the LHCb experiment with upgraded detectors, improved trigger conditions, additional Ξ_{cc}^{*++} and Ω_{cc}^{*++} decay modes, and larger data samples will further increase Ξ_{cc}^{*++} and Ω_{cc}^{*++} signal sensitivity
- Measure lifetimes, masses, quantum numbers and production cross sections of all states
- LHCb aims to build an accurate and concise picture of doubly charmed baryons as a whole

References :

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- A. V. Berezhnoy, I. N. Belov, and A. K. Likhoded, Production of excited states of doubly heavy baryons at the large hadron collider, Physics of Atomic Nuclei 83 (2020) 892
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