

# X(3872) production in pp vs. multiplicity



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# Poster

## Probes

We use the  $\chi_{c1}(3872)$  and the  $\psi(2S)$   
to see how the initial particle multiplicity influences the production yield

## Why these particles

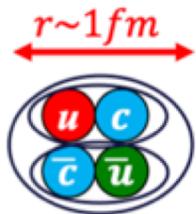
These two particles - same decay similar mass – are thought to be very different in their structure

The  $\psi(2S)$  is a conventional  $c\bar{c}$  state.

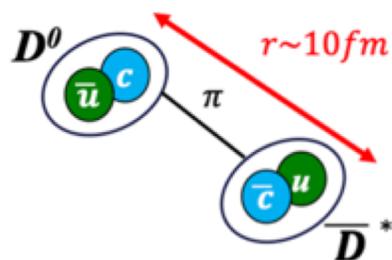
The  $\chi_{c1}(3872)$  does not fit in the general charmonium picture.

Its structure is not entirely clear and still debated

**Compact tetraquark**



**Hadronic molecule**

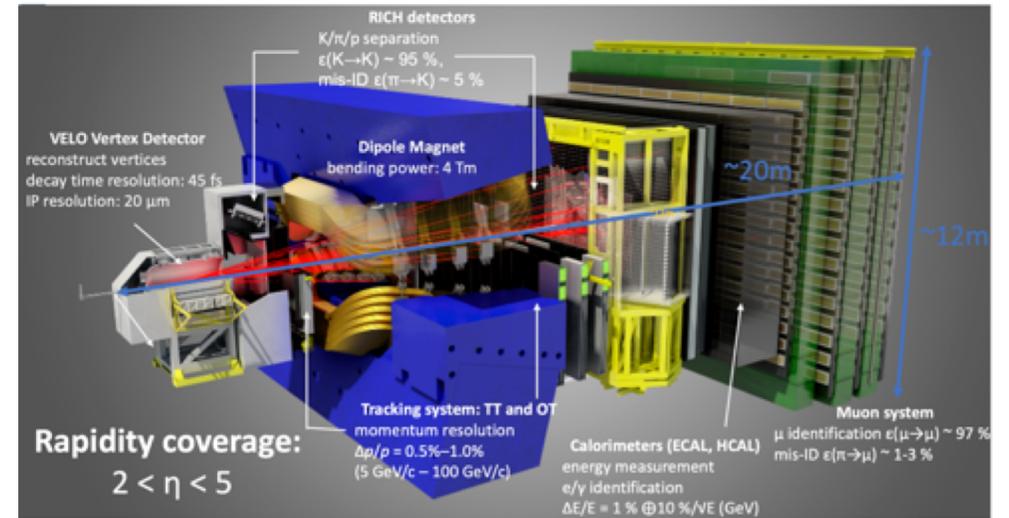


Could also be a superposition of different states

$$\chi_{c1} = a|c\bar{c}\rangle + b|c\bar{c}q\bar{q}\rangle$$

## Data

- For this analysis we study pp collision at 8 TeV recorded with the LHCb detector at CERN.
- We reconstruct the two particles  $\chi_{c1}(3872)$  and  $\psi(2S)$  in the decay  $J/\psi\pi\pi$ .
- We bin the data in number of charged VELO tracks.



LHCb collaboration,  
arXiv:2009.06619v1

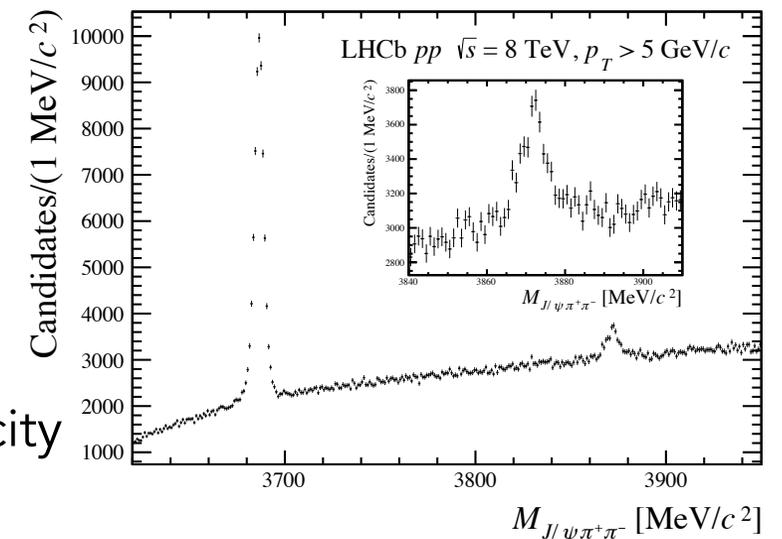
## Observable

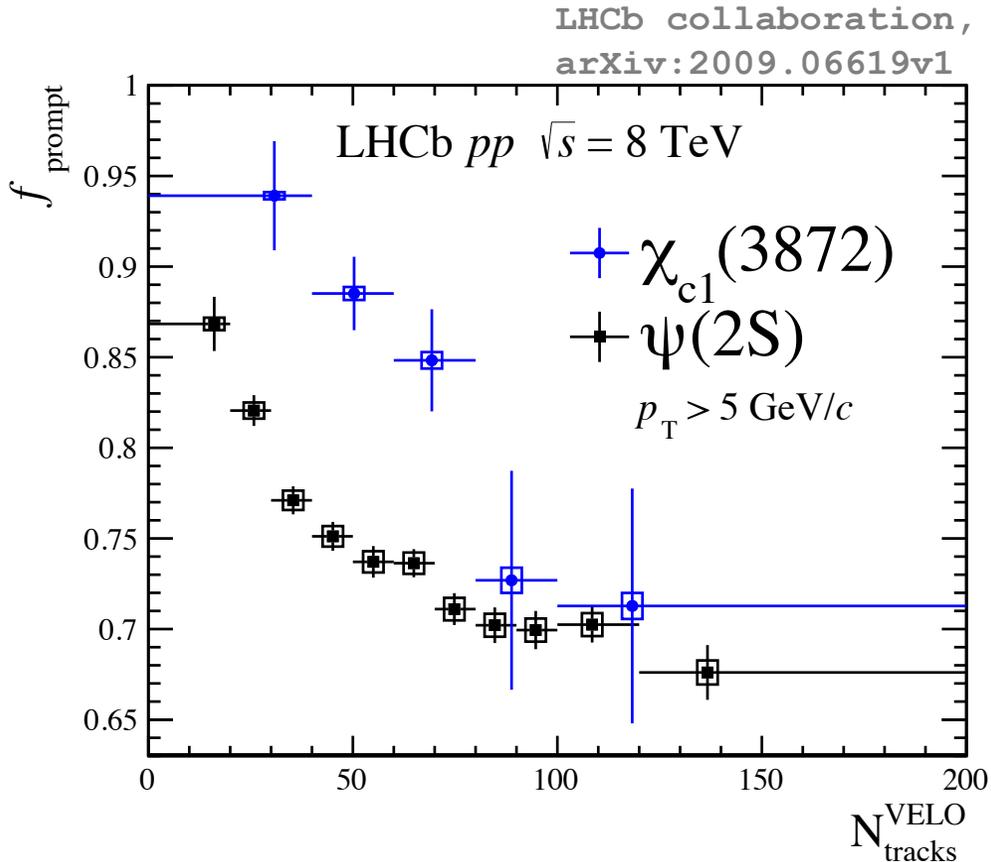
Distinguish prompt from non-prompt production of the two particles as a function of charged particle multiplicity.

$$f_{\text{prompt}} = \frac{N_{\text{prompt}}}{N_{\text{prompt}} + N_{b\text{-decay}}}$$

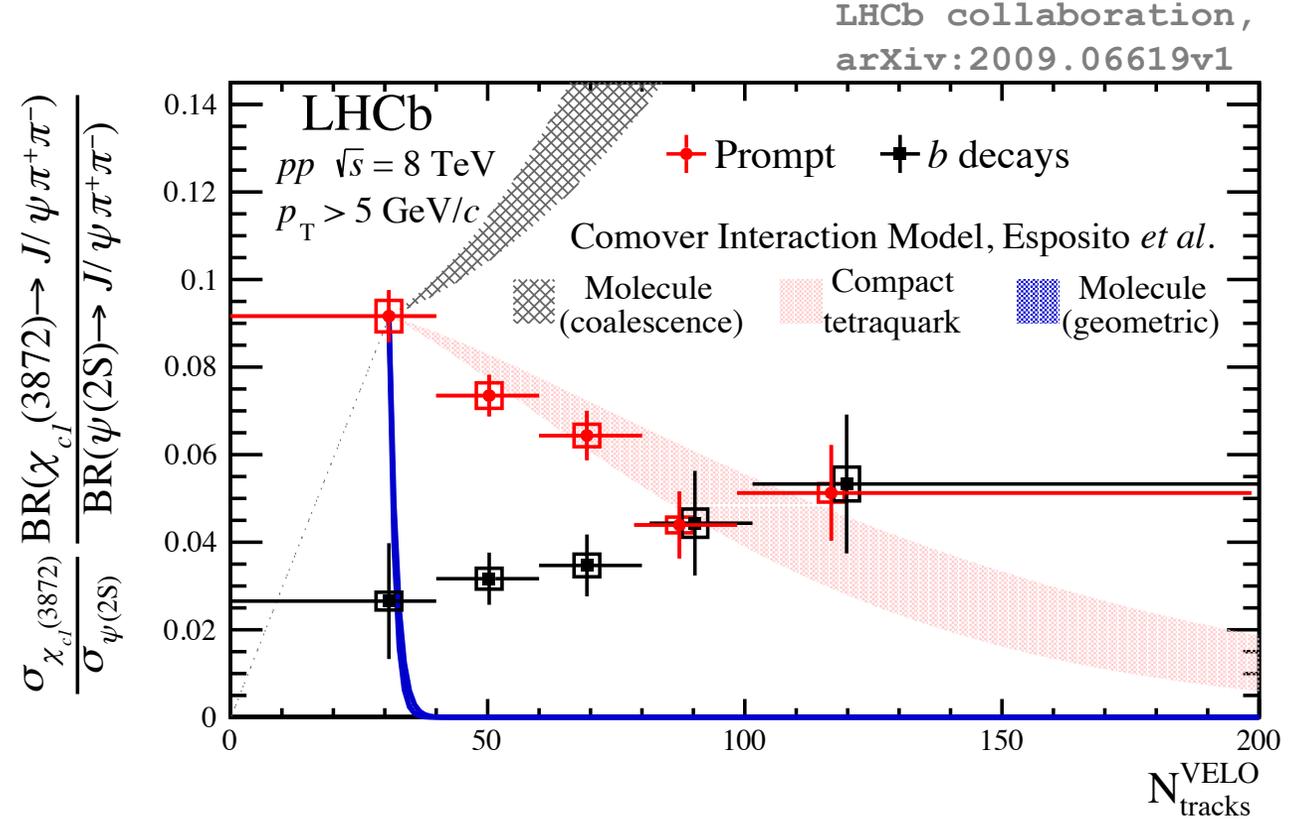
## Why

Prompt production yield should be sensitive to particle multiplicity while non-prompt production should be independent.





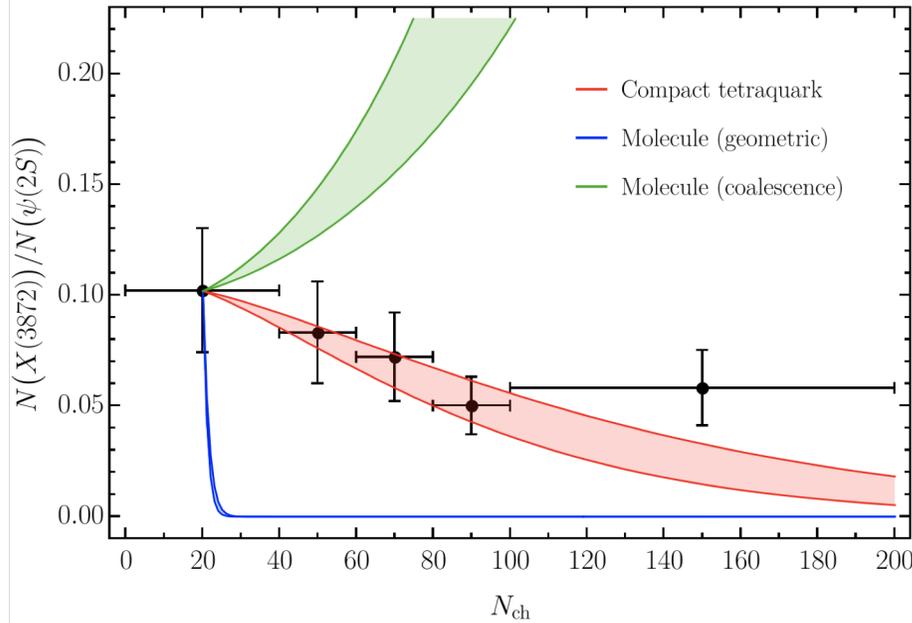
The fraction of prompt production decreases with particle multiplicity for both states.  
More b-decay daughters remain at higher  $N_{\text{tracks}}$



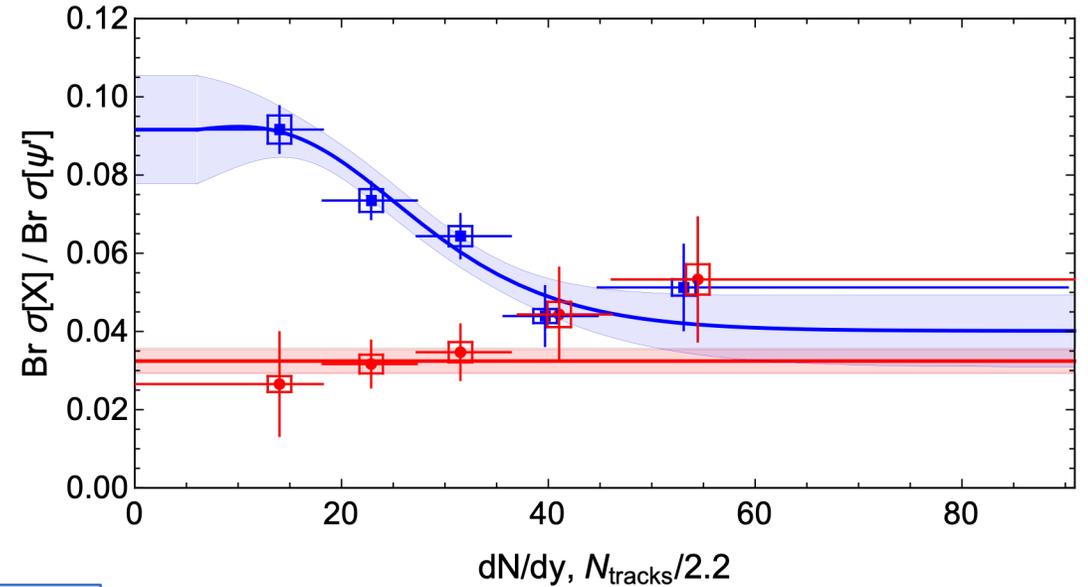
**b-decay products:** No significant change in relative production, as expected for decays in vacuum.  
**Prompt production:**  $\chi_{c1}(3872)$  yield decreases relative to the  $\psi(2S)$  yield.

# Theory comparison

A. Esposito, E. Ferreiro, A. Pilloni, A. Polosa, C. Salgado  
arXiv:2006.15044



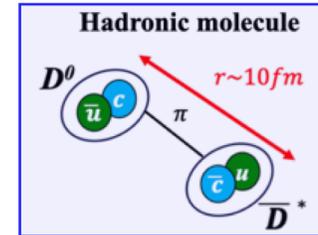
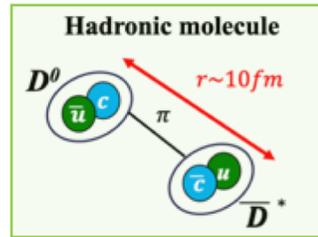
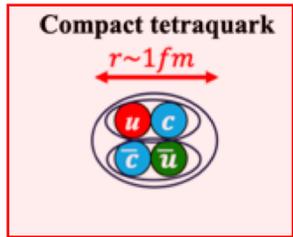
E. Braaten, L. He, K. Ingles, J. Jiang  
arXiv:2012.13499v1



$$\sigma_{Breakup} \propto r_Q^2 \cdot N_{comovers}$$

Modeling of comover interaction

$$\sigma_{Breakup} \propto \sigma_{\pi D}$$



Fits only with a compact tetraquark assumption

Molecule assumption fits well with this new model