The 5^{th} *XYZ* Workshop at Zhengzhou University

Search for $Z_c^{\pm}(3900)$ at ATLAS

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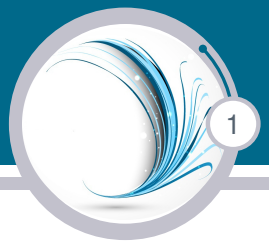
Content



Introduction to ATLAS

- ATLAS is a huge general purpose detector at LHC, where proton or heavy ion beams are accelerated.
- The physics groups in the collaboration: Standard Model measurement, Higgs and Higgs beyond Standard Model, Super-symmetry, Exotic states (such as long-lived particles, dark matter, different from the exotics in hadron spectrum), Top physics, Heavy Ion, *B* physics and light states.
- From next year, there will be a long shut down for 2 years, and about 140 fb^{-1} data are collected now.

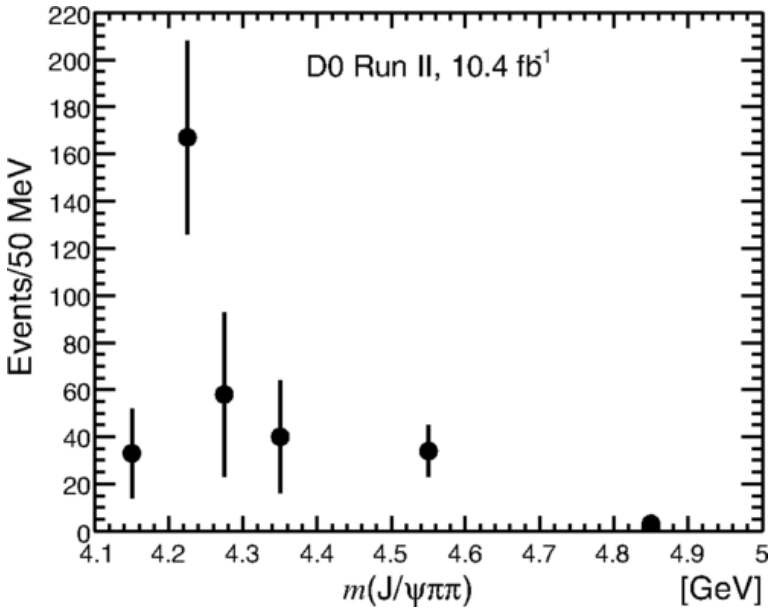
Flavour physics at hadron collider

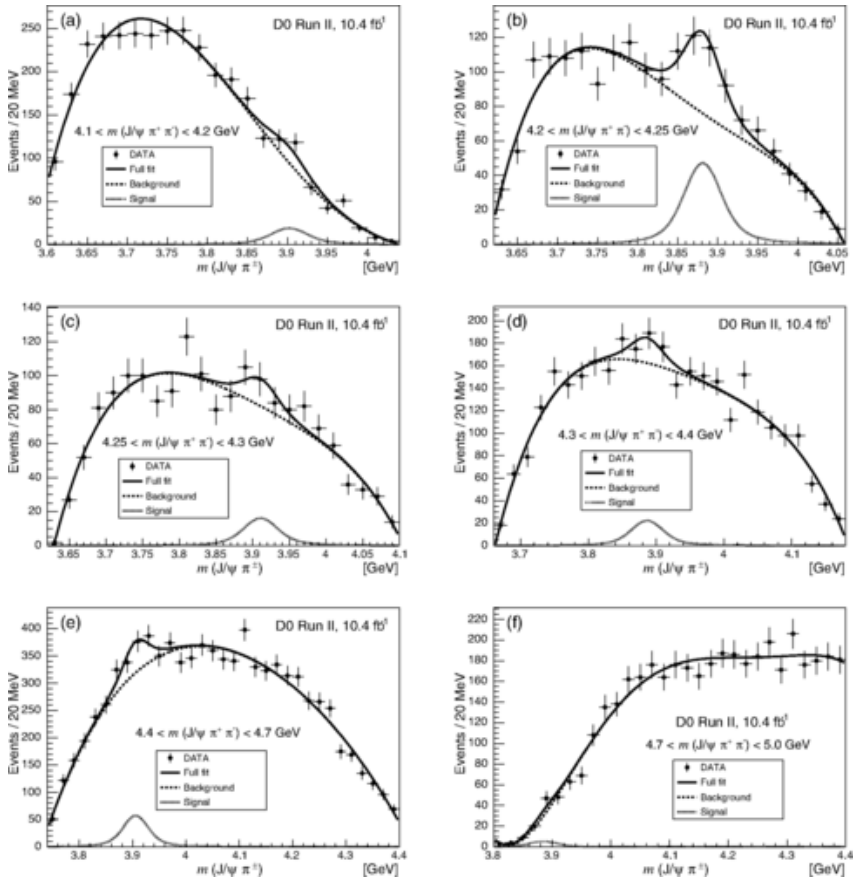
- Plenty of production processes with large production cross section, all resonances can be produced in principle.
- High background level and no PID for hadron states are the main challenges, can be controlled by selecting secondary vertex, selecting muon-pair under the narrow peak plus charged tracks.
- Fruitful results from previous experiments, CDF, D0, CMS: $B_s \to \mu^+\mu^-$ measurement, discovery of $B_c(2S)$ . . . . . .

Evidence of Y(4260) and $Z_c^{\pm}(3900)$ at D0

The evidence for $Z_c^{\pm}(3900)$ decaying to $J/\psi\pi^{\pm}$ in semi-inclusive weak decays of *b*-flavoured hadrons is observed at D0 experiment [Phys. Rev. D **98**, 052010 (2018)].

- 10.4 fb^{-1} $p\bar{p}$ collision data
- $B \to Y(4260)$ + anything, $Y(4260) \to Z_c^{\pm}\pi^{\mp}, Z_c^{\pm} \to \pi^{\pm}J/\psi$

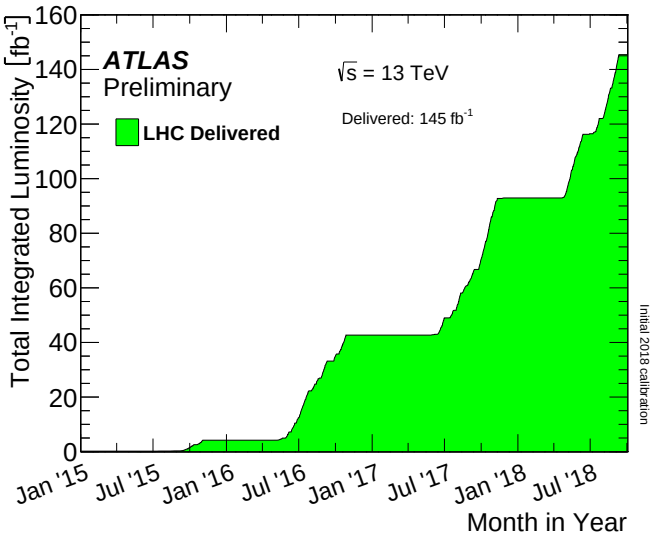


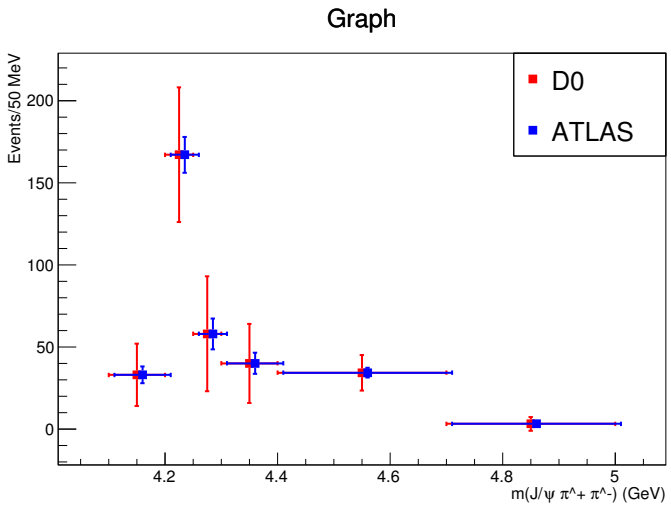


Prospect at ATLAS

At ATLAS:

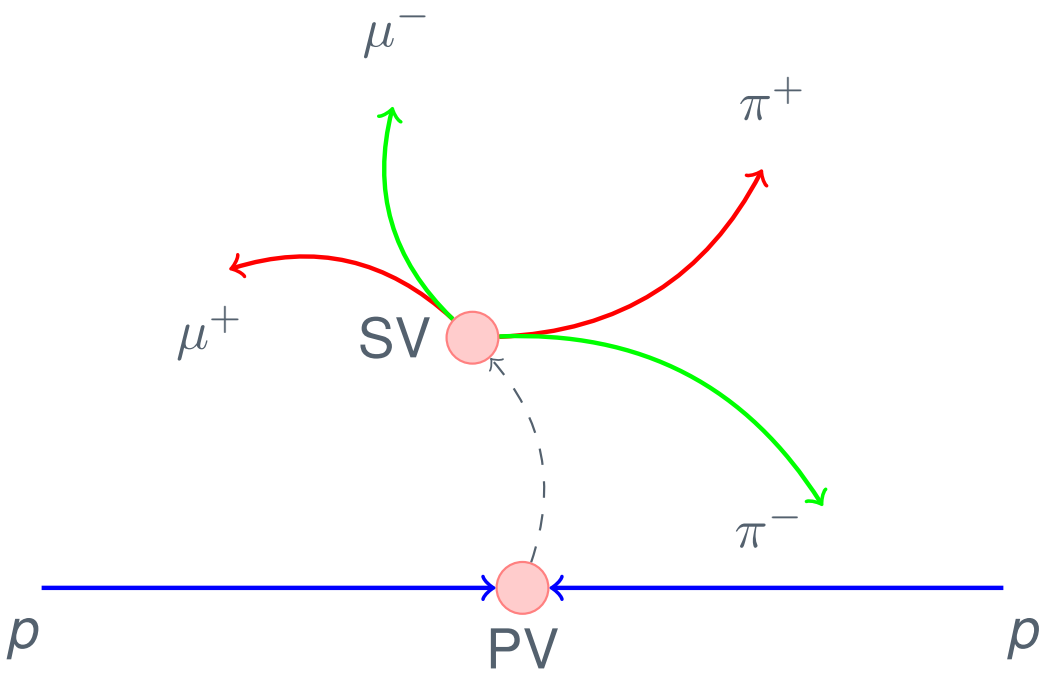
- More data, $\sim$140 fb^{-1} pp collision data.
- Better vertex resolution: 57 $\rightarrow$ 10 μm.
- Assume same background level and detection efficiency, ATLAS could have much more precise results and may be conclude the source of Z_c.





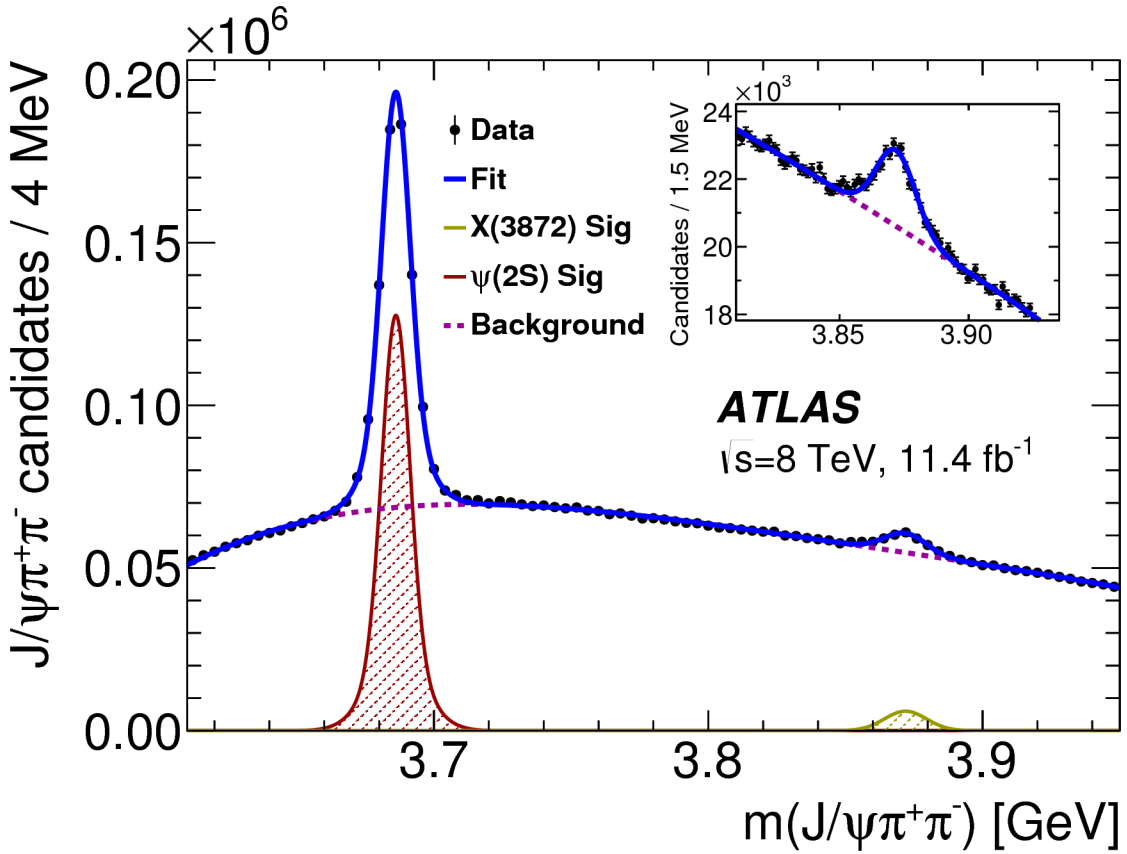
Analysis strategy

- J/ψ candidates reconstructed by fitting a muon pair to a common vertex
- Combining a J/ψ candidate with another two tracks which are assumed as pions
  - Di-muon mass is constrained to the J/ψ world average value in a 4-prong vertex fit



$\psi(2S)$ and $X(3782)$ production

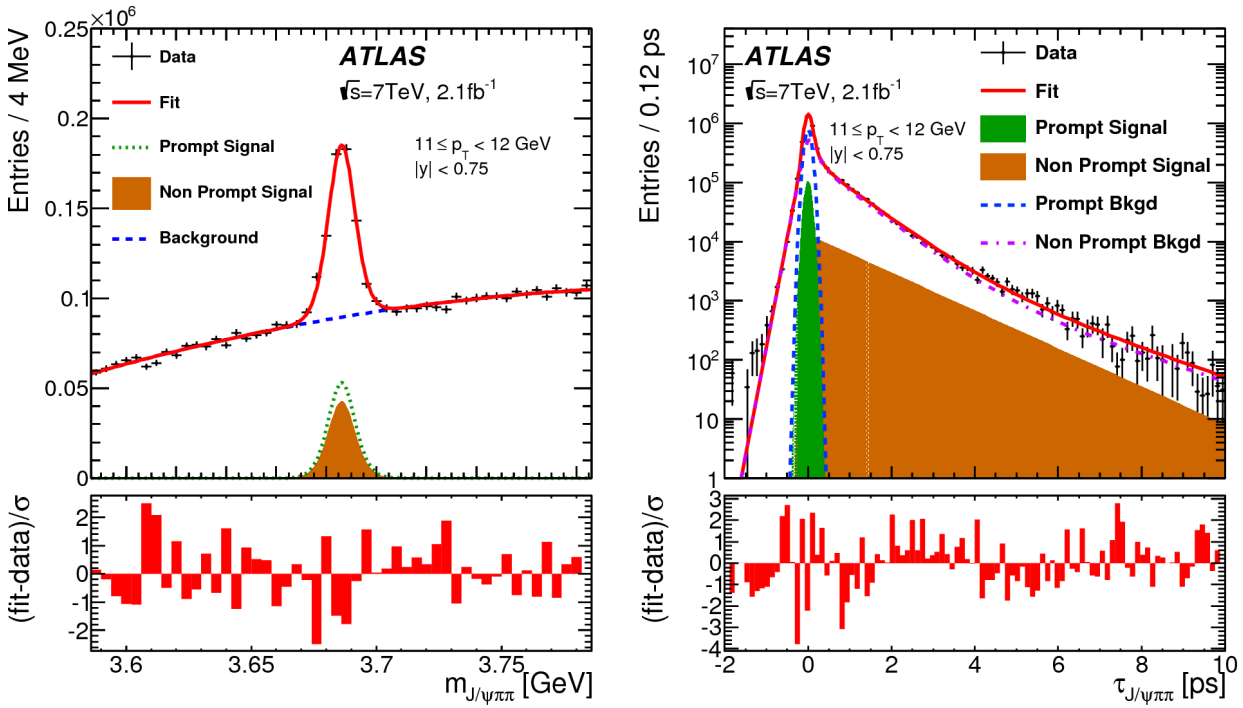
- The $\psi(2S)$ and $X(3782)$ signals are clearly observed from the $J/\psi\pi^+\pi^-$ spectrum [JHEP 01 (2017) 117].



- The plot with more data is not allowed to show without approval.

Pseudo-proper lifetime fit

- Perform a two-dimensional unbinned maximum likelihood fit on the invariant mass and pseudo-proper lifetime ($\tau \equiv mL_{xy}/p_{\mathrm{T}}$) distributions to isolate signal candidates from the backgrounds and separate the prompt process from the non-prompt process [JHEP 09 (2014) 079].



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Current status and plan

Status

- Derivation is ready
- Analysis code is prepared
- Preliminary result is shown inside the ATLAS collaboration

Next to do

- Optimize event selection to suppress the combinatorial backgrounds
- Trying to perform exclusive analysis, rather than the semi-exclusive one performed by D0
- . . .

Other related topics under discussion

1. Search for new resonances in similar processes
   - Change J/ψ to $\psi(2S)$
   - Change $\pi^+\pi^-$ to $K^+K^-, p\bar{p}, pK^-, p\pi^-, \ldots$
2. Search for XYZ states in B sector
   - $X_b, P_b, \ldots$
3. Do you have any other suggested channels?

Thank you!