Resolution Study with Υ Production at EIC

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Exclusive, Diffractive, & Tagging Meeting

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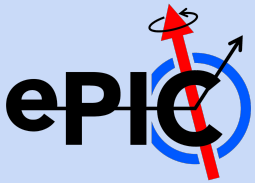
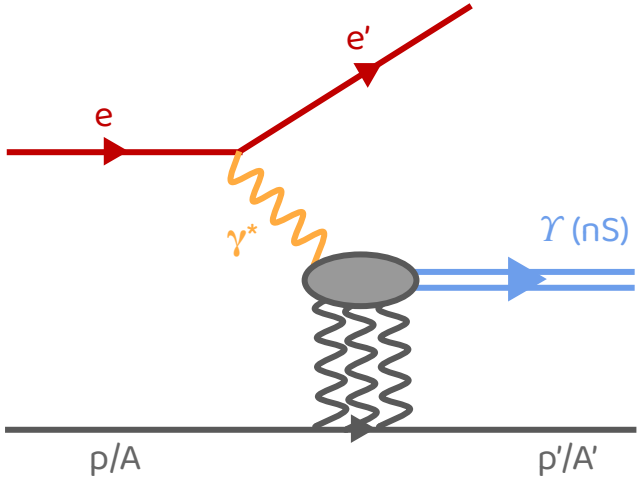


Introduction

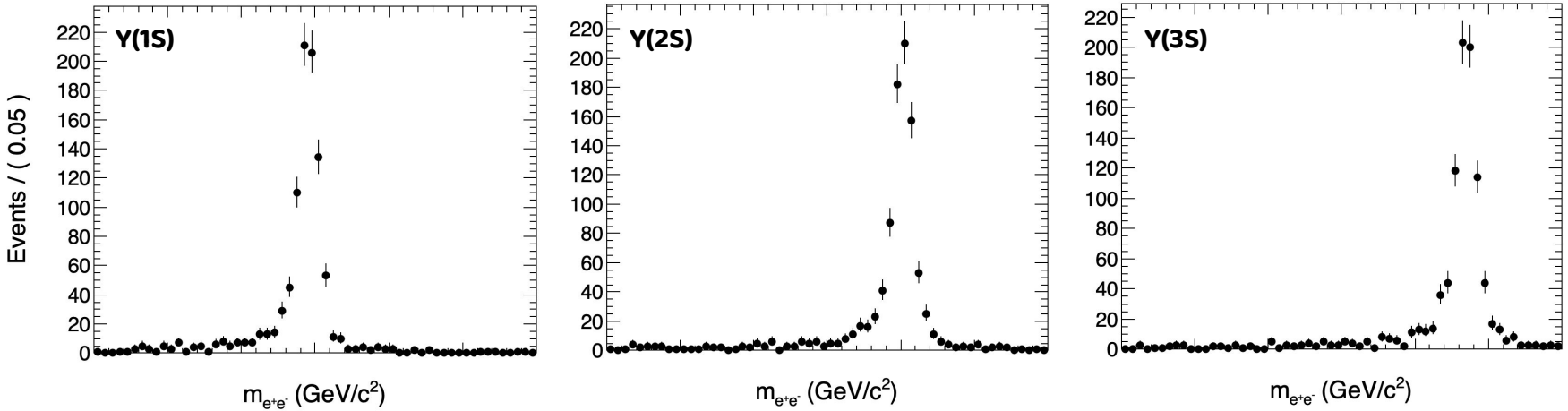
- Our first goal: Invariant mass spectrum of $\Upsilon(1S)$, $\Upsilon(2S)$, and $\Upsilon(3S)$ in the electron channel by EPIC for the resolution study

- This presentation is a brief update on the previous report
  - Vector Mesons:
    - $\Upsilon(1S)$, $\Upsilon(2S)$ and $\Upsilon(3S) \rightarrow e^+e^-$
  - Update on:
    - New sample with the current detector configuration
    - Fixed energy of Electron and Au beams:
      Electron (18 GeV) on Au (275 GeV/nucleon) to
      Electron (10 GeV) on Au (110 GeV/nucleon)

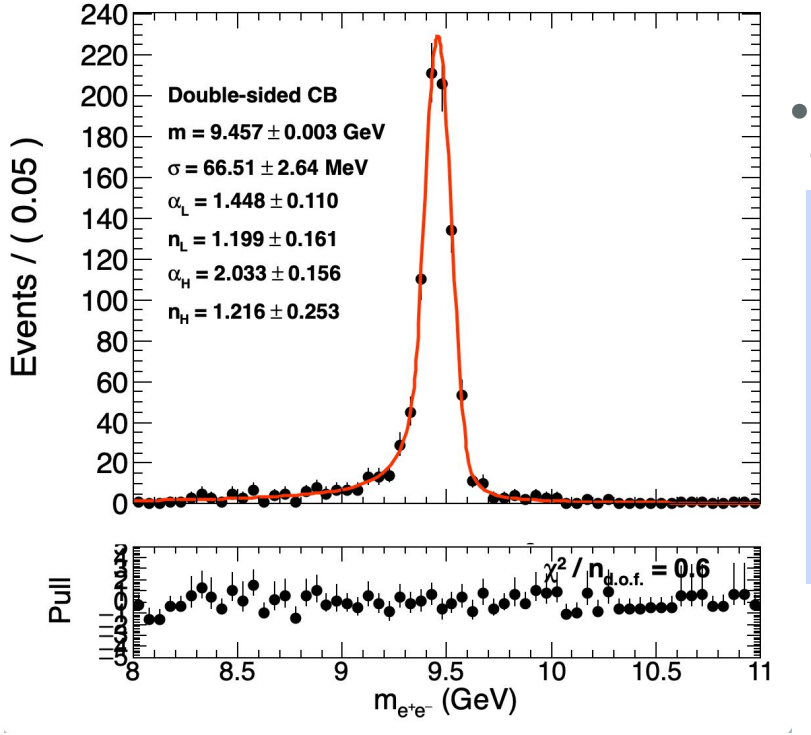


Invariant Mass of Reconstructed Υ(1S), Υ(2S), Υ(3S)

- Created Υ(1S), Υ(2S) and Υ(3S) samples separately in the region of $0 < Q^2 < 0.01$ GeV^2 (Truth seeding)
  - eSTARlight (generate seeds) → ~~AfterBurner (beam spreads)~~ → npsim (digitalization) → EICrecon (reconstruction)
  - 1000 events each



Fit Model: DSCB



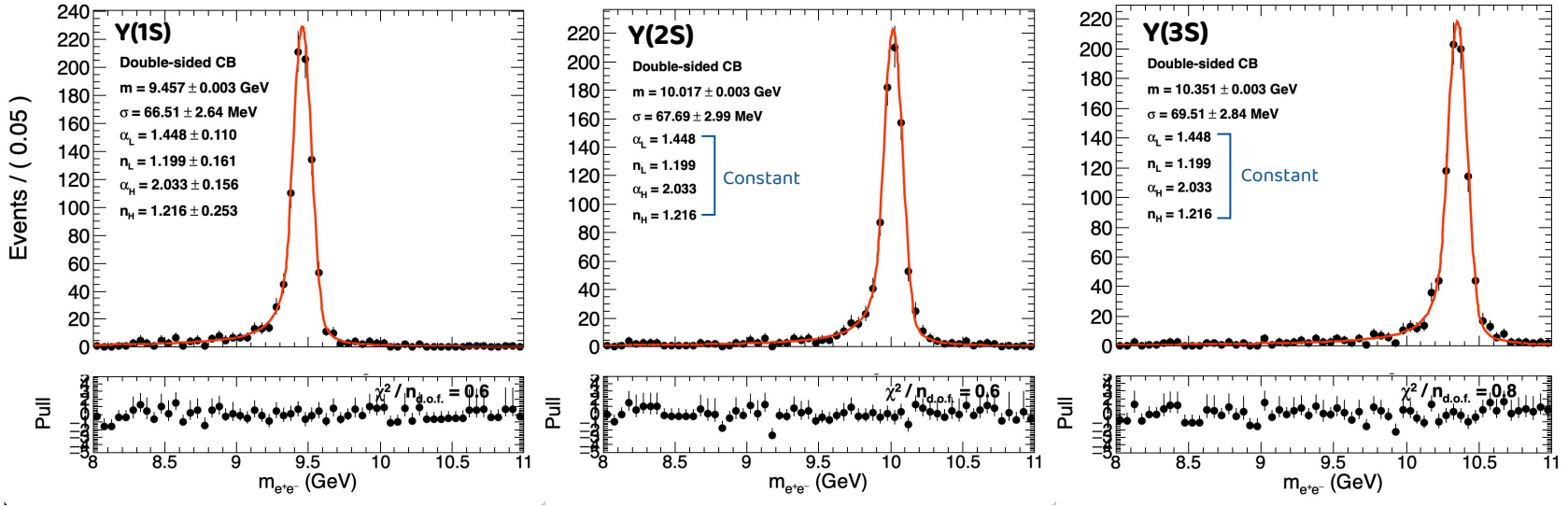
- Fit to a Double Sided Crystal Ball (DSCB) function
  - Double Sided Crystal Ball (DSCB) function

$$\mathrm{DSCB}(m;\mu,\sigma,\alpha_L,n_L,\alpha_H,n_H) = \begin{cases} e^{-0.5t^2} & \text{if } -\alpha_L < t < \alpha_H \\ e^{-0.5\alpha_L^2}\left[\frac{\alpha_L}{n_L}\left(\frac{n_L}{\alpha_L} - \alpha_L - t\right)\right]^{-n_L} & \text{if } t < -\alpha_L \\ e^{-0.5\alpha_H^2}\left[\frac{\alpha_H}{n_H}\left(\frac{n_H}{\alpha_H} - \alpha_H + t\right)\right]^{-n_H} & \text{if } t > \alpha_H \end{cases}$$

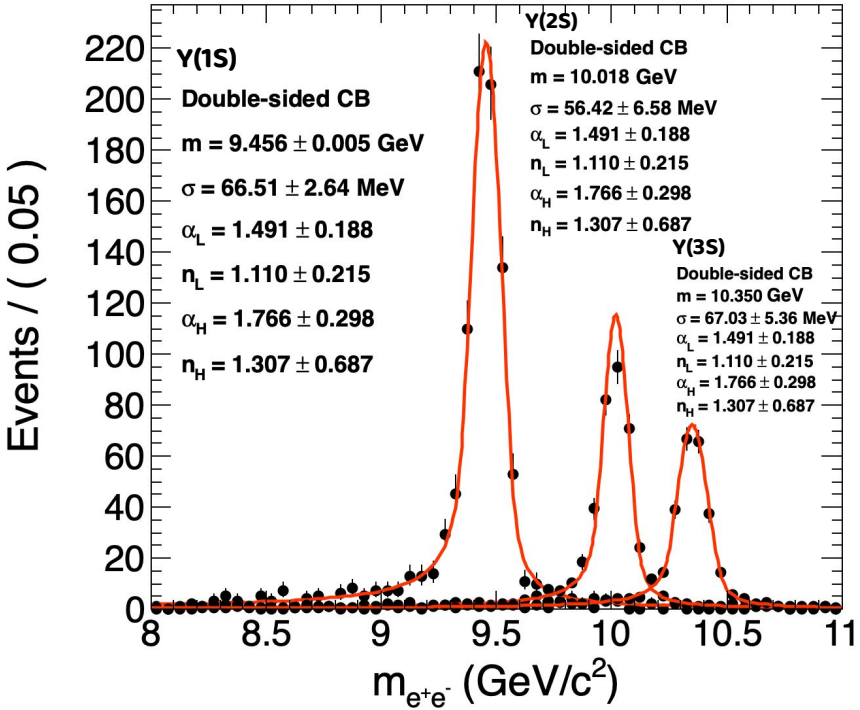
where $t = (m - \mu)/\sigma$

Invariant Mass Fit of Reconstructed Υ(1S), Υ(2S), Υ(3S)

- Fit each peak with DSCB
  - Tail parameters (α_L, n_L, α_H, n_H) of Υ(2S) and Υ(3S) mass peaks are fixed with the values taken from Υ(1S) mass fit



Invariant Mass Fit of Reconstructed Υ(1S), Υ(2S), Υ(3S)



- Used the ratio for the yields
  1 : 0.45 : 0.33
  from the STARlight paper

- Fitted with the DSCB(Double-Sided Crystal Ball) function with the constraints on the mean and tail parameter values of Υ(2S) and Υ(3S).

- $m_{YnS} = m_{Y1S} * \frac{PDGmass_{nS}}{PDGmass_{1S}}$

- Resolution of each peak:
  σ_{1S} = 66.52 ± 2.64 MeV
  σ_{2S} = 56.42 ± 6.58 MeV
  σ_{3S} = 67.03 ± 5.36 MeV
  → need to obtain values using a larger sample size

Summary & Outlook

- Detector resolution study to separate $\Upsilon(1S)$, $\Upsilon(2S)$, $\Upsilon(3S)$ peaks is in progress using simulation
  - eSTARlight (generate seeds) → npsim (digitalization) → EICrecon (reconstruction)

- The resolution of the three peaks was obtained using DSCB fits in the region of $0 < Q^2 < 0.01\ GeV^2$ with the truth seeding
  → Seem to have consistent resolution in each peak within the uncertainties
  → Need fine-tuning of the fits
  → Need to obtain the resolution value using a larger sample size

- Next steps:
  - Add beam spreads using AfterBurner and generate a larger sample
  - Detector resolution study using realistic seeding and in different region of the detector (barrel vs end cap)