ψ': towards solving the 2/4-prong puzzle lessons from DIS channel

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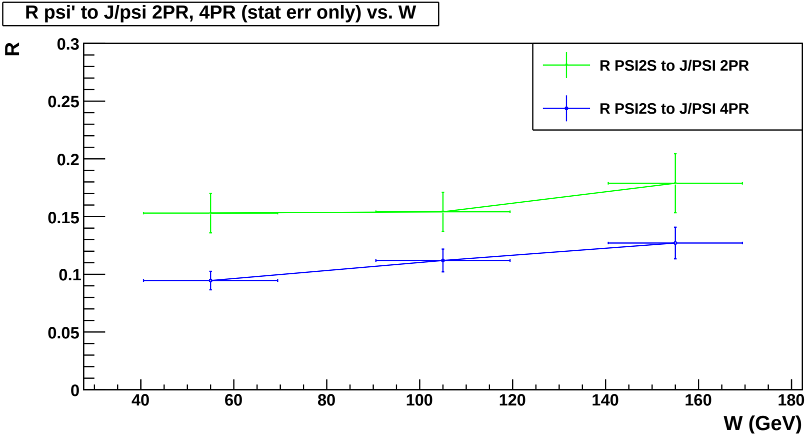
R: PHP channel (stat. only errors)



- cross section ratio R of $\psi(2S)$ to J/ψ from 2-prong and 4-prong
- stat only errors

Current approach: R

- Three main ingredients to calculate R value:
  - Number of J/ψ and ψ' events in 3 W bins extracted from data
  - Branching ratio (BR) of investigated muon decay channels
    $BR(\psi(2S) \to \mu^+\mu^-) = 0.0079 \pm 0.0009$
    $\sim$ 10% uncertainty
  - Acceptance, efficiency for muons (trigger and offline)

Current approach: MC

- acceptance calculation is based on MC simulation
- detector response to muons is poorly described in MC and needs to be corrected for various effect:
  - trigger (MUON chambers, BAC, three levels...)
  - offline (F/B/RMUON chamber, CAL, BAC, ...)
- MC needs to be reweighted w.r.t. to δ (W^{δ}), *b*-slope, ...
- unknown fraction of proton dissociative events
- $\rightarrow$ source of additional systematic

Current approach: MC muon corrections

- single muon efficiency in (p_t *vs.* η) bins extracted from DATA (using TAG and PROBE method) to correct MC
- extracted for each HERA-II data taking period
- requires big statistic, available only for muons from J/ψ
- works very well, correct control plots (W, θ_μ, etc... dominated by muons from J/ψ)
- corrections for muons from ψ' affected by low statistic used to extract the efficiency
- $\rightarrow$ yet another systematics

Muon corrections: New idea

- what we need is not absolute acceptance but the ratio of acceptances for corresponding decay channels
- this can be estimated directly from data using DIS channels and independent DIS triggers
- no MC is needed !
- DATA is the ultimate answer for detector performance
- yes, DIS has much lower stat, than PHP but we can calculate acceptance corrections “per process” not for “single muon”
- initial study has shown that the expected statistical uncertainty is comparable to the systematics in the previous method and ψ' BR uncertainty

New idea: proposed implementation

- use DIS events without track matched to scattered electron (relatively low-Q^2 events) $\rightarrow$ preserve the 2-prong and 4-prong event topology,
- otherwise use exactly the same selection for DIS and PHP sample
- 2-PRONG: (μ^+, μ^- form J/ψ and ψ')
  as TAG use DIS VM triggers (without MUON chambers triggers)
  corrections in 3 W bins (W from PHP formulae)
  $\rightarrow$ extract MUON efficiency (combined trigger plus off-line)
- 4-PRONG: (μ^+, μ^- only from J/ψ, muons effic. cancels in R)
  as TAG use FLT30 $\rightarrow$ the only slot without CTD FLT track vetos
  $\rightarrow$ extract CTD FLT correction to MUON triggers
  (one global correction for all W bins due to slow pions π^+, π^-)
  (impossible to extract in old method)

New idea: assumptions (to check)

- efficiency for process, not for single muon $\rightarrow$ requires the same final state topology of the process used to extract the effic
- the same distributions of muons from direct J/ψ decay and cascade decay of ψ'
- similar distribution of muons form ψ' and Bethe-Heitler around ψ' mass peak (irreducible background)
- (W^{δ} dependence of DIS and PHP)
  (remember: we compare PHP and low-Q^2 DIS, no electron track)
- ($f_{p.diss}$ fraction for DIS and PHP, is the same, cancels it out ?)

New idea: systematics

- many systematics related to MC is not present
- systematics will be dominated to the limited stat. of DIS events
- to control it one can relax the main selection cuts (p_t, N_{SL}, track-vertex matching, etc,...) $\rightarrow$ will increase the statistic of DIS events

Summary/Plans

- work already started
- one example: CTD FLT correction (w.r.t the FLT30 slot):

$$\frac{Acc_{4PR}}{Acc_{2PR}} = 1.33 \pm 0.19 \ (14\%)$$

  average number for HERA-II
  (for one particular set of selection cuts)
- more results on next ZAF meeting