Exclusive Photoproduction of $J/\psi \to \mu^+\mu^-$ in *e-p* interactions at HERA II

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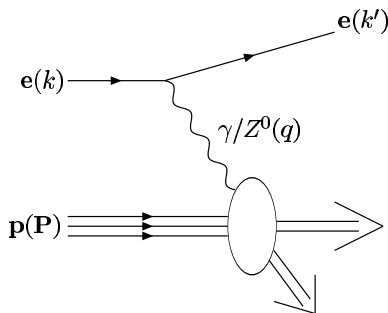11th September 2005

- Photoproduction events.
- Data acquisition and selection.
- Background subtraction.
- Results: mass of the J/ψ and production cross section.
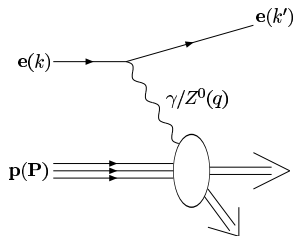
Kinematics of lepton-proton scattering

Lepton - proton interactions are determined by the 4-momenta of the interacting particles:

Vector Meson Photoproduction

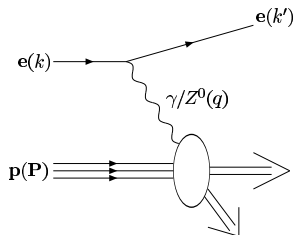Inelastic Scattering or Photoproduction regime is defined by the Q^2 variable:

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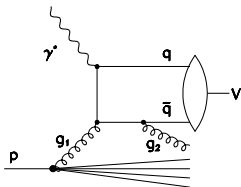Q^2 is also called the *virtuality* of the exchanged photon.

- $Q^2 \approx 0$ Photoproduction.
- $Q^2 > 0$ Inelastic Scattering

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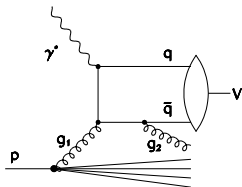
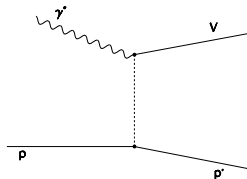- Photoproduction events can be diffractive or non-diffractive.

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In diffractive events a couple of gluon with a null color charge is exchanged between the proton and the virtual photon. Only the vector meson is produced.

The investigated meson is the J/ψ :

- Quark composition: $c\bar{c}$
- Decay modes:
  1. $\to \mu^+\mu^-$ 5.88%
  2. $\to e^+e^-$ 5.93%
  3. $\to$ hadrons 87.7%
- Mass: 3.096 GeV
- Width: 91 keV

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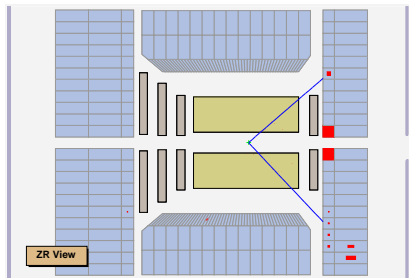
• We are searching for event in which a J/ψ meson is produced elastically and decays in a $\mu^+\mu^-$ pair, so we have to use the available information (the variables in the ntuple) to reject unwanted events.

Applied cuts
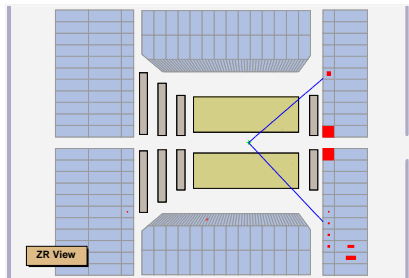
ZR View

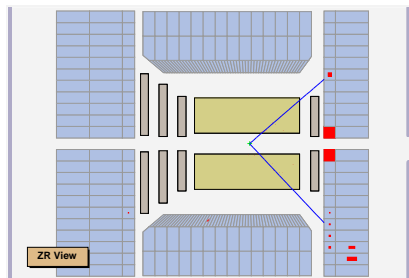# Applied cuts

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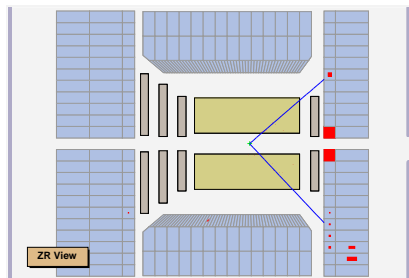3. The tracks have to be generated within 50 cm from the nominal interaction point.
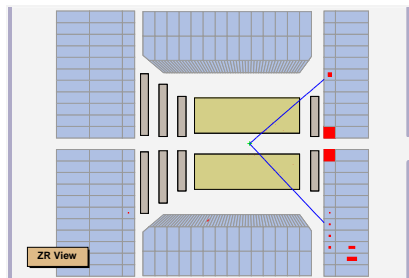
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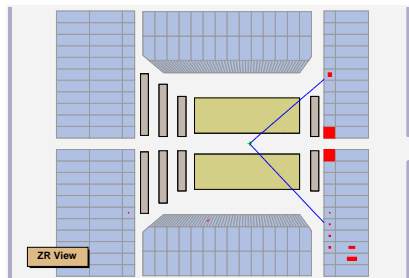4. The angle between the tracks has to be less than 176°.

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5. Each tracks has to be inside the region with the polar angle $17^o < \theta < 163^o$.

• The mass of the J/ψ meson can be reconstructed from the mass and momentum of the outgoing muons:

Invariant mass distribution

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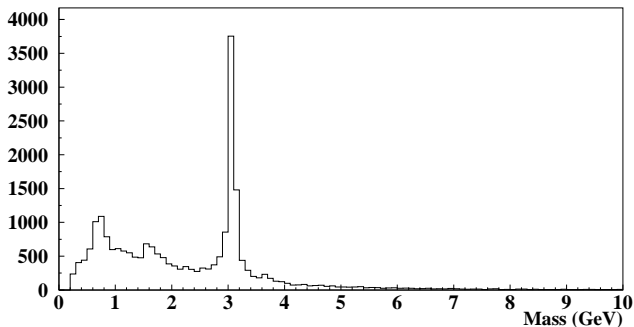
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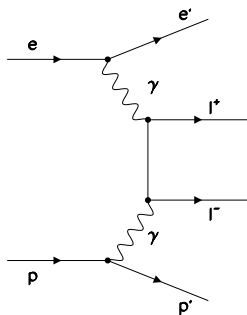
The obtained mass distribution is:

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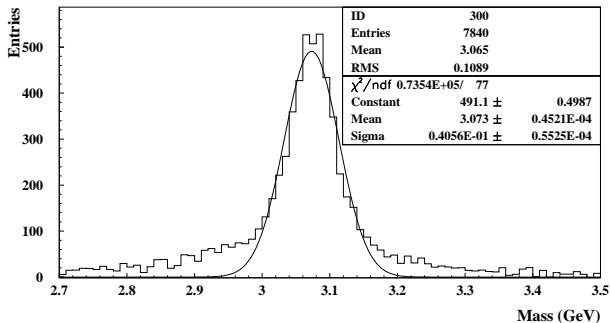• The main source of background is the Bethle-Heitler process, in which two virtual photons emitted from both electron and proton interact and produce a e^+e^- or a $\mu^+\mu^-$ pair.
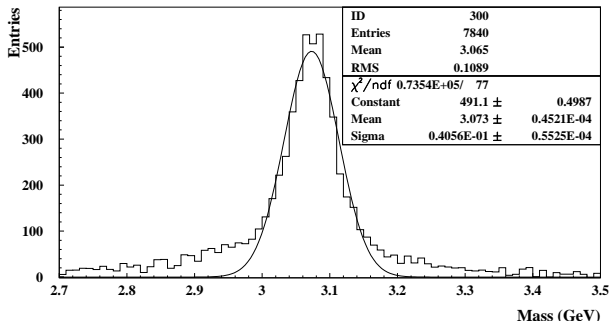
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ID	300	
Entries	7840	
Mean	3.065	
RMS	0.1089	
χ^2/ndf 0.7354E+05/ 77		
Constant	491.1 $\pm$	0.4987
Mean	3.073 $\pm$	0.4521E-04
Sigma	0.4056E-01 $\pm$	0.5525E-04

• The estimated mass is 3.073 GeV, and the width is 40 MeV, with negligible statistical uncertainities. The mass is 0.75% smaller than the given value, while the width is approximatively 10^3 times greater than the given one.

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Obtaining the cross section

The cross section can be calculated with the formula:

$$\sigma_{\gamma p \to e J/\psi p} = \frac{N_{corr}}{L \cdot A \cdot B \cdot \Phi_T}$$

- N_{corr} is the number of events after subtracting the background.
- L is the luminosity, measured by the dedicated LUMI component.
- A is the acceptance, calculated with the Monte Carlo simulation as the ratio between the number of events that pass the selection and the number of generated events.
- B is the muonic decay ratio, 5.88%
- Φ_T is the photon flux factors, computable by QED.

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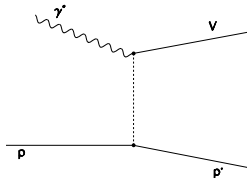
$$W_{\gamma p} \approx \sqrt{2E_p(E_{J/\psi} - P_{zJ/\psi})}$$

where

$$P_{zJ/\psi} = P_{z\mu^+} + P_{z\mu^-}$$

and

$$E_{J/\psi} = \sqrt{M_{\mu^+}^2 + P_{\mu^+}^2} + \sqrt{M_{\mu^-}^2 + P_{\mu^-}^2}$$
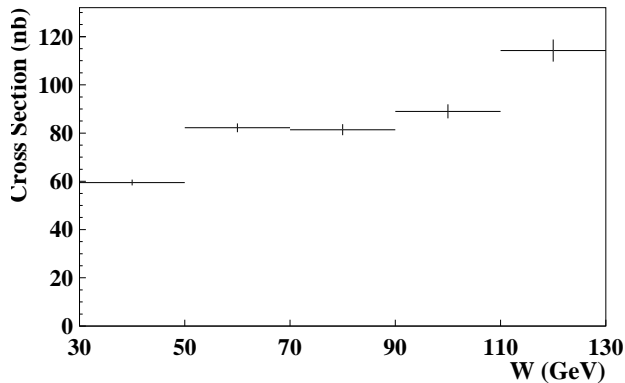
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Cross section *vs W*

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1. Selection of the desired events, applying cuts on the variables.
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3. Measurement of the mass of the J/ψ meson.
4. Mesaurement of the cross section, in function of W^2

Thanks everybody ...
and see you at tonight's party!