

Inelastic J/ψ production at H1

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**5th international workshop on heavy quarkonia,
17.10.2007, DESY Hamburg**

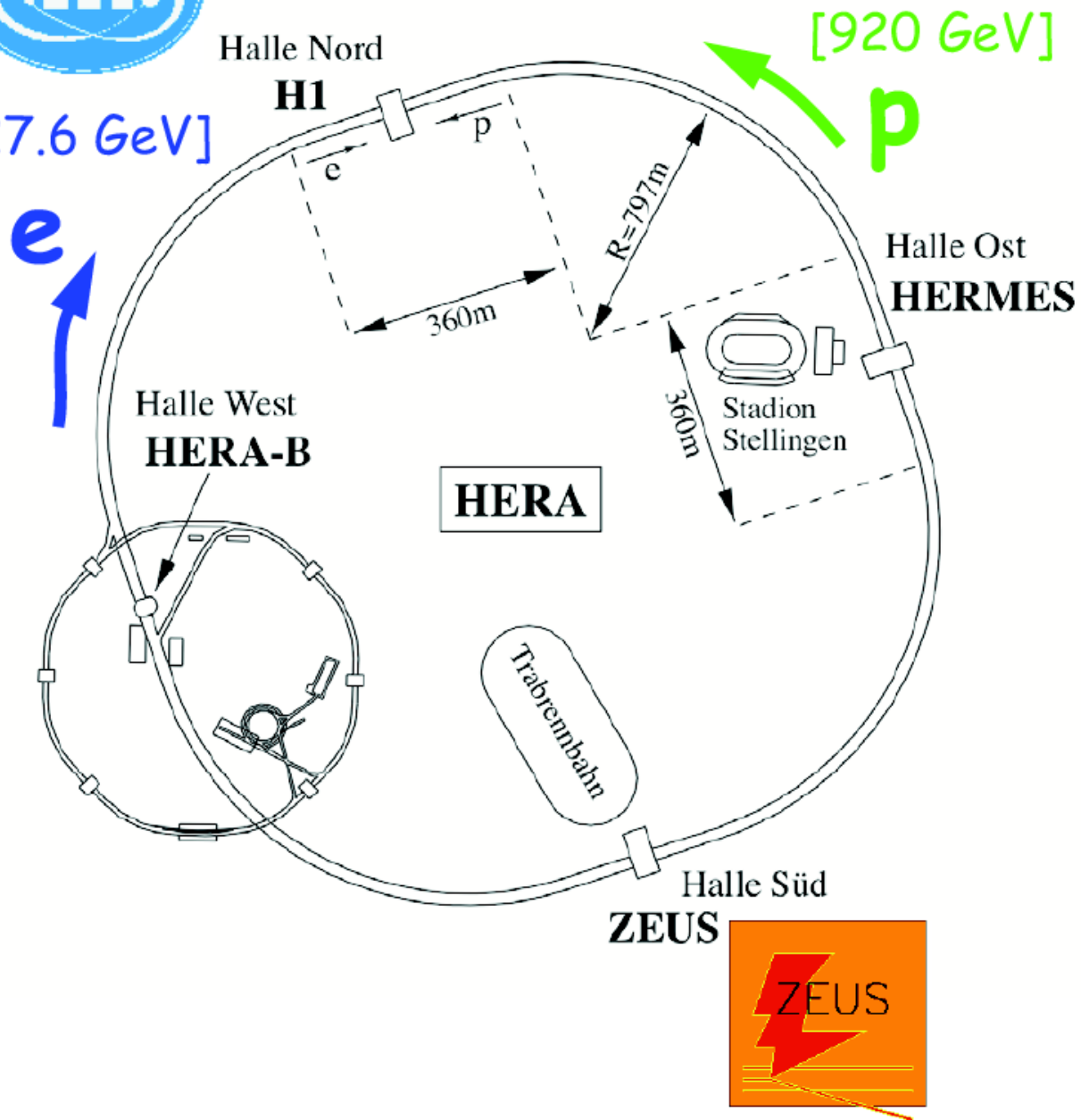
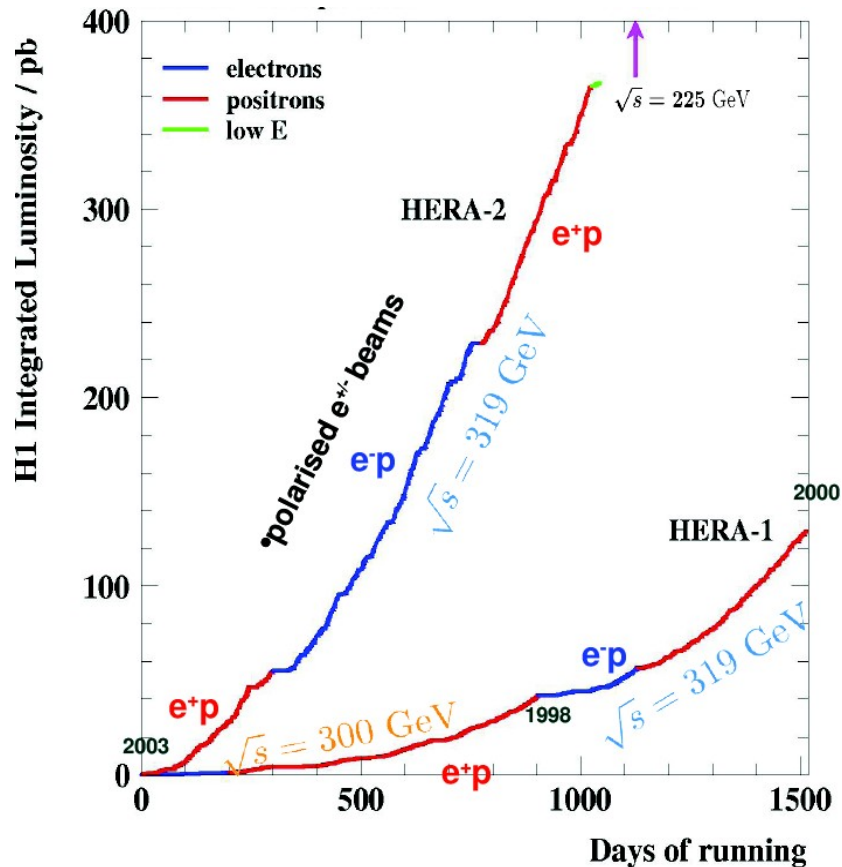
- 1 introduction**
- 2 data samples and selections**
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HERA



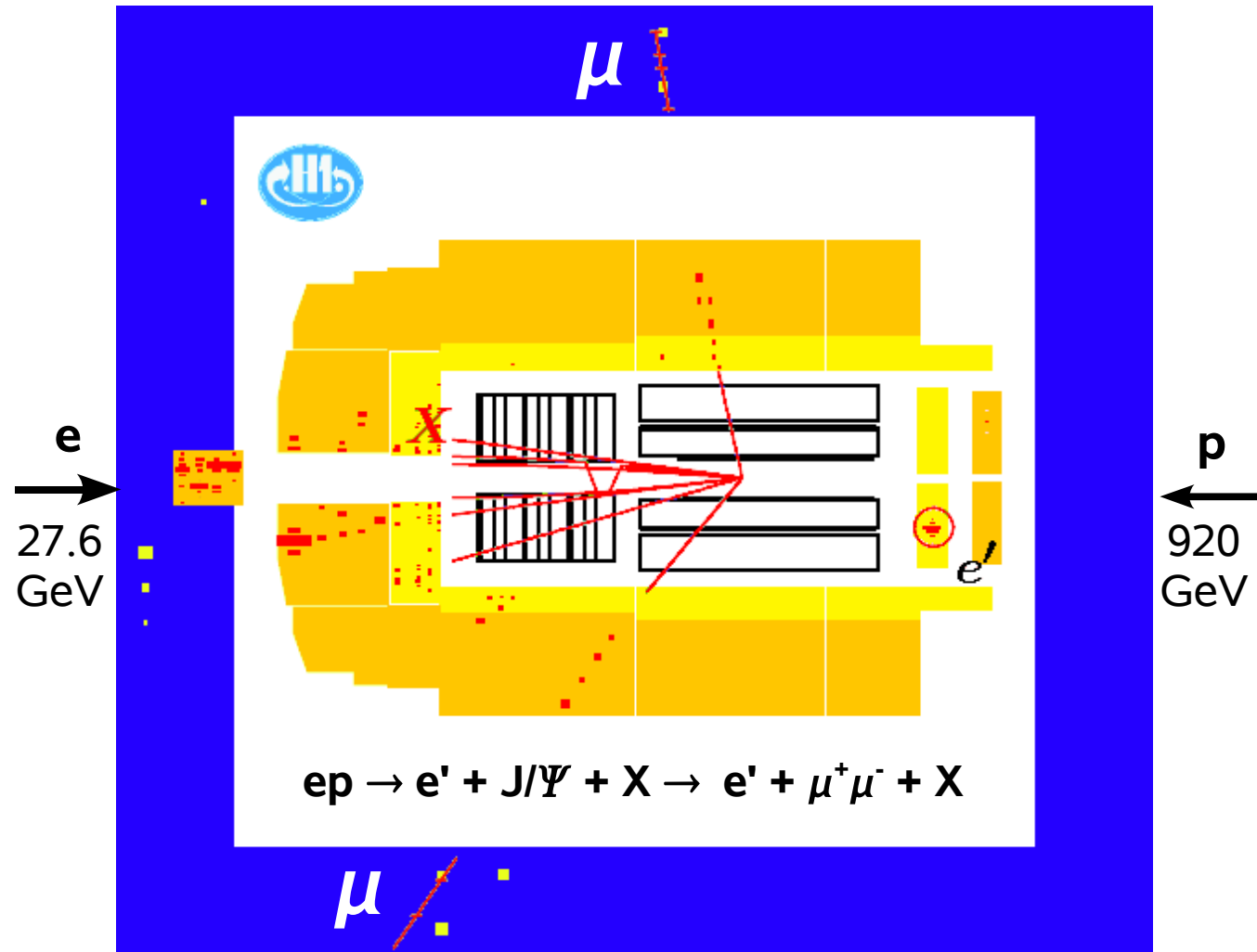
$$\sqrt{s} = 320 \text{ GeV}$$

integrated luminosity
 HERA I 120 pb⁻¹
 HERA II 360 pb⁻¹



H1

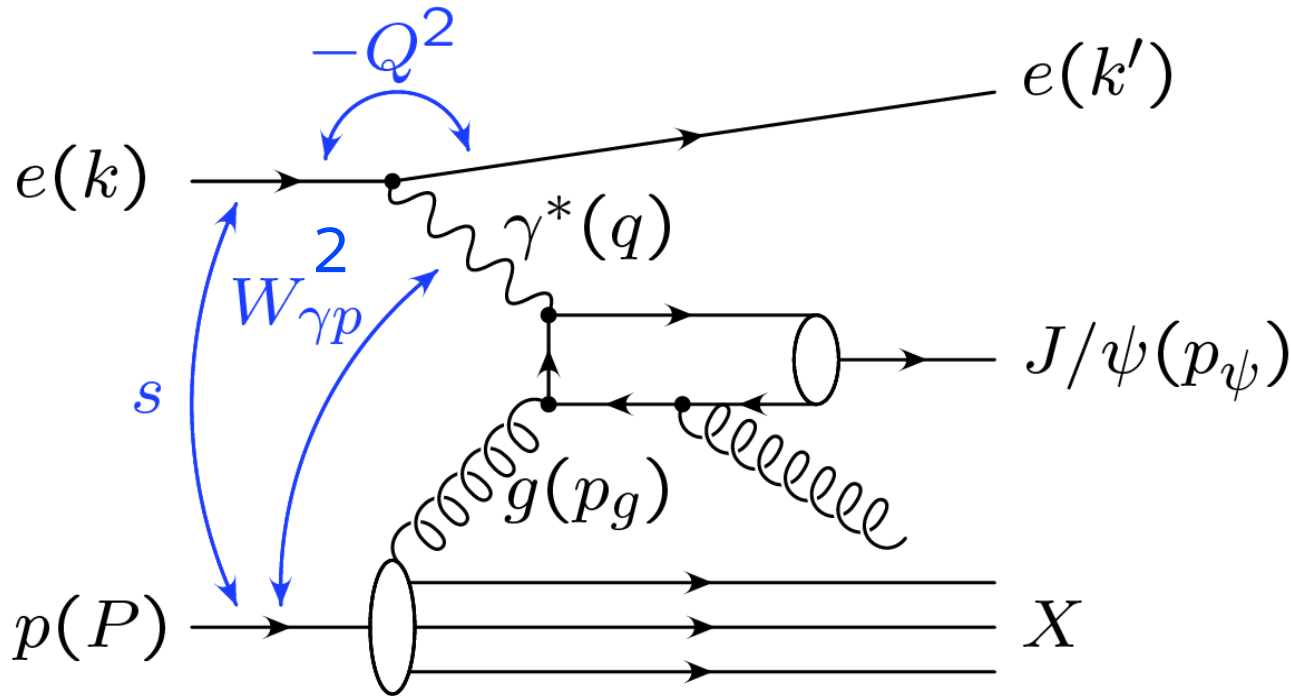
- 4π multi purpose detector
- lepton identification in
 - LAr calorimeter (e/μ)
 - muon detector (μ)
- inelastic J/Ψ event
 - two decay leptons
 - additional particles
- H1 sensitive down to $P_T(J/\Psi) = 0$ GeV



boson gluon fusion (BGF)

main charm production process

$$\gamma^* + g \rightarrow c + \bar{c}$$



kinematic variables

$$Q^2 = -q^2$$

$$s = (P + k)^2$$

$$W_{\gamma p}^2 = (P + q)^2$$

$$z = \frac{p_\psi \cdot P}{q \cdot P}$$

in p rest frame

$$= \frac{E_\psi^*}{E_\gamma^*}$$

$$Q^2 > 3.6 \text{ GeV}^2$$

electroproduction (DIS)

scattered lepton in main detector

$$Q^2 \sim 0 \text{ GeV}^2$$

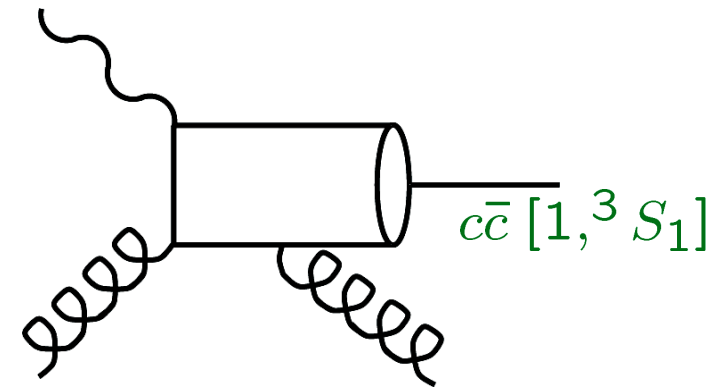
photoproduction (γp)

inelastic J/Ψ production

color singlet model (CS)

Berger et al, Baier et al, 1981

- radiation of hard gluon
- J/Ψ coupling to quark pair determined by $|R_{\Psi}(0)|$



data compared to

	photoproduction (γp)	electroproduction (DIS)
CSM LO (DGLAP)	EPJPSI	EPJPSI
CSM LO (kt-factorization)	CASCADE v2.0	CASCADE v1.2
CSM NLO	Krämer et al	n/a

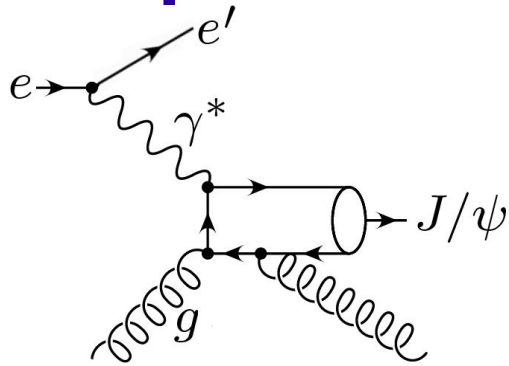
EPJPSI

- DGLAP evolution, collinear factorization

CASCADE

- CCFM, kt-factorization, incoming parton can be off-shell

data samples and selections



electroproduction (DIS)

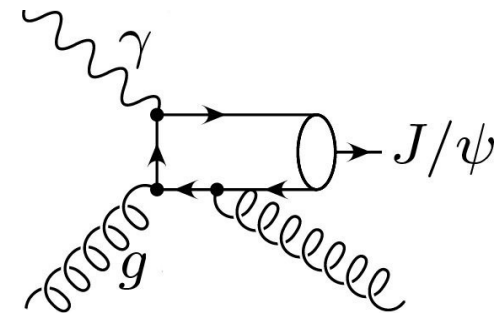
$\mathcal{L} \approx 258 \text{ pb}^{-1}$ (2004-2006)

$3.6 < Q^2 < 100 \text{ GeV}^2$

$50 < W_{\gamma p} < 225 \text{ GeV}$

$P_{T,\Psi}^* > 1.0 \text{ GeV}$ (P_T in γp rest frame)

$0.3 < z_{J/\psi} < 0.9$



photoproduction (γp)

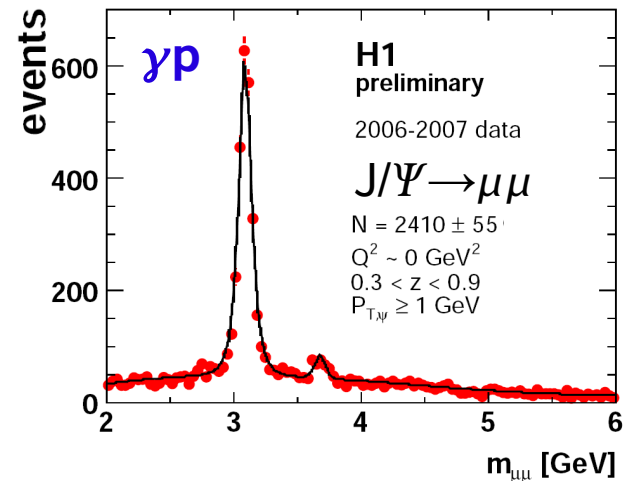
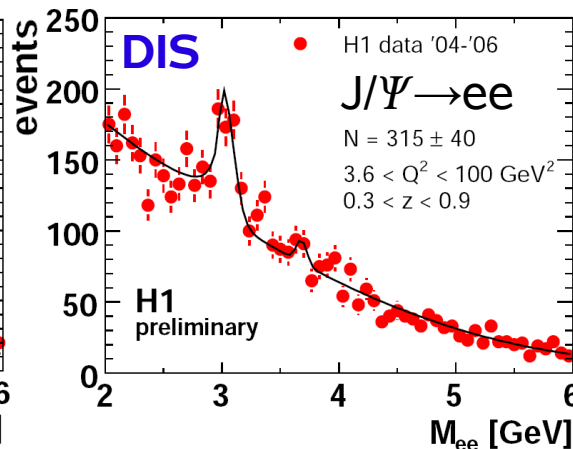
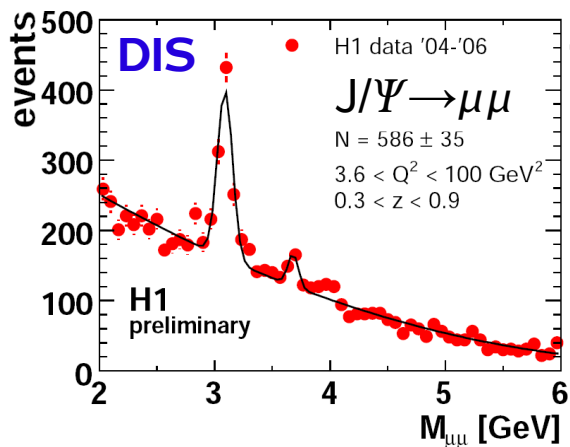
$\mathcal{L} \approx 166 \text{ pb}^{-1}$ (2006-2007)

$Q^2 \sim 0 \text{ GeV}^2$

$60 < W_{\gamma p} < 240 \text{ GeV}$

$P_{T,\Psi} > 1.0 \text{ GeV}$

$0.3 < z_{J/\psi} < 0.9$



backgrounds from indirect J/Ψ production

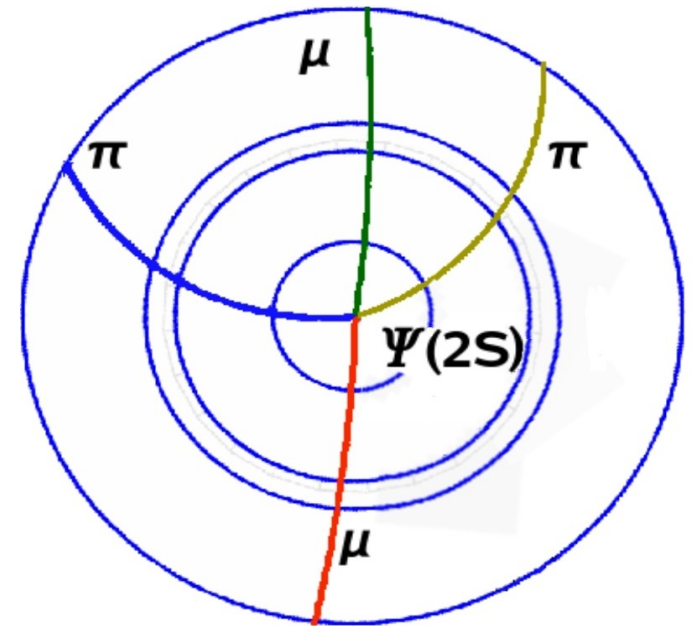
diffractive $\Psi(2S)$ feed down

- $\Psi(2S) \rightarrow J/\Psi \pi^+ \pi^-$ (BR $\sim 30\%$)
- high z region ($z \sim 0.85$)

→ suppression cut: $N_{\text{Tracks}} \geq 5$
- corrected in measured cross sections

- remaining contribution:

- overall: $\sim 1.5\%$
- highest z bin: $< 5\%$



B meson decays

- low z region
- high track multiplicity, larger $P_T(J/\Psi)$

- contribution:

- overall: $\sim 2.5\%$
- lowest z bin: $< 10\%$

→ contributions **not** subtracted from cross section measurements

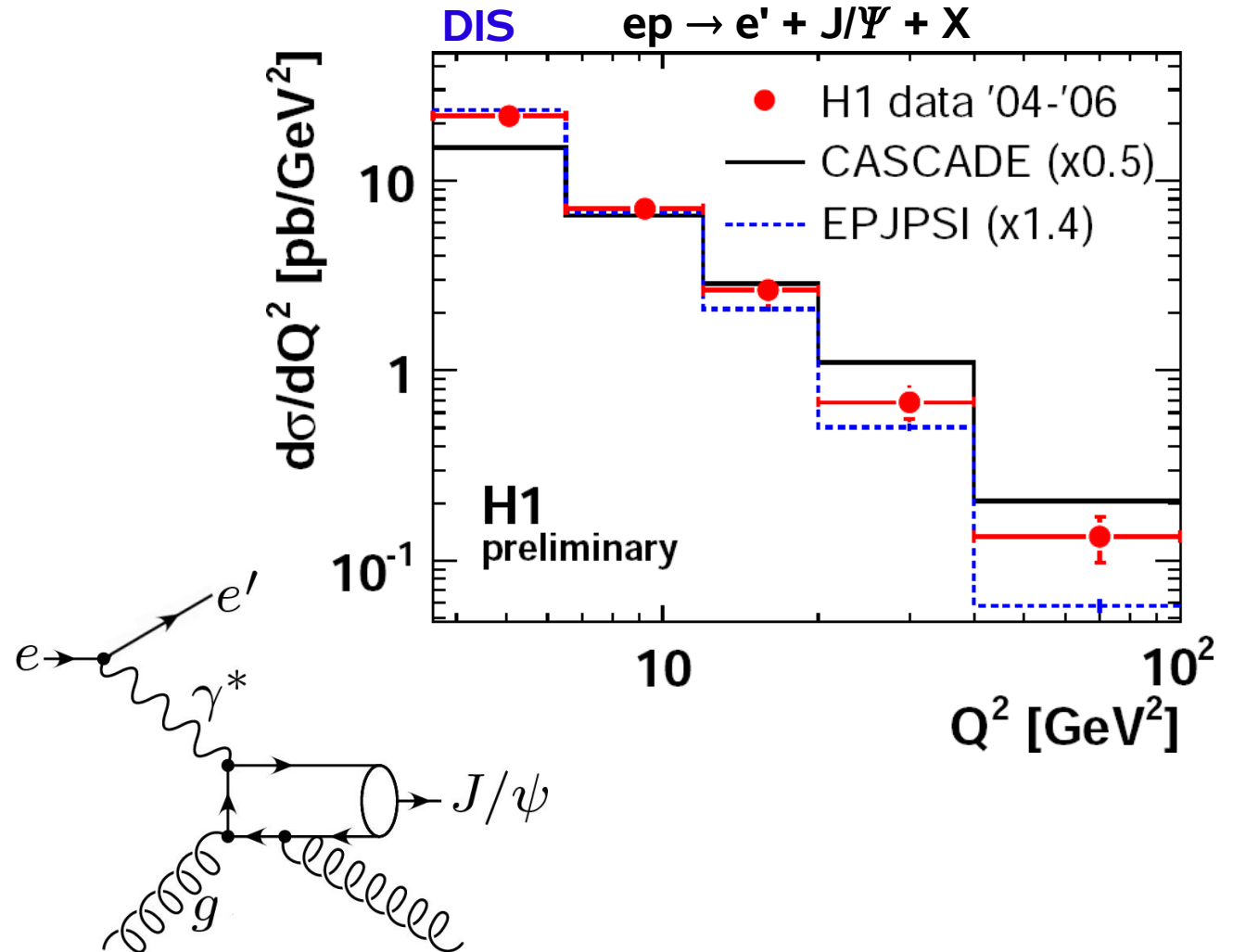
cross sections – Q^2

EPJPSI:

- Q^2 too steep
- normalization too low

CASCADE v1.2:

- Q^2 too hard
- normalization too high



cross sections – z

DIS and γp have similar shapes

EPJPSI:

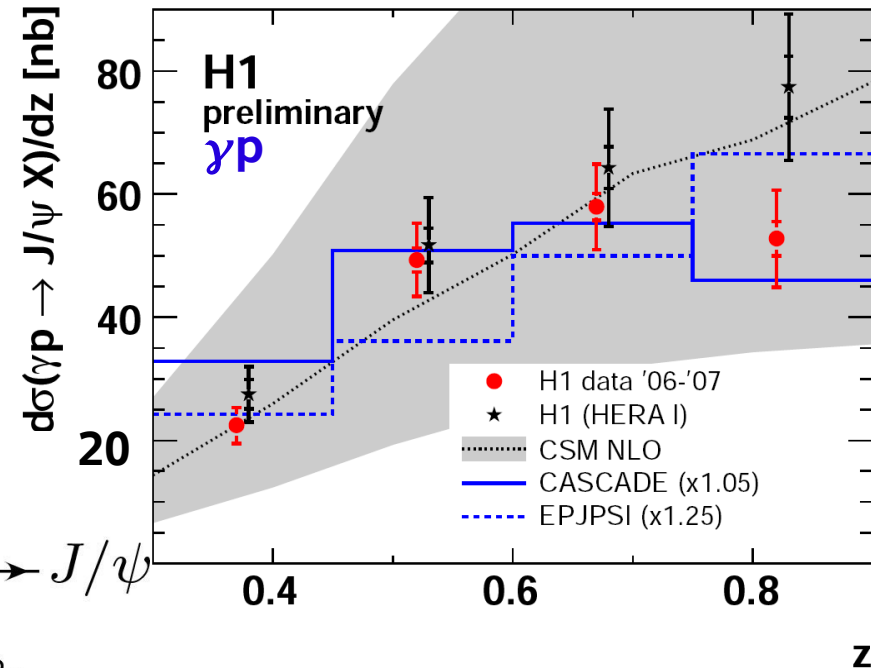
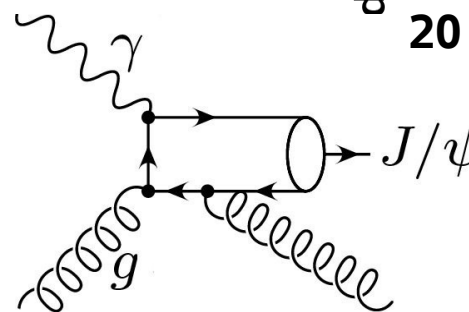
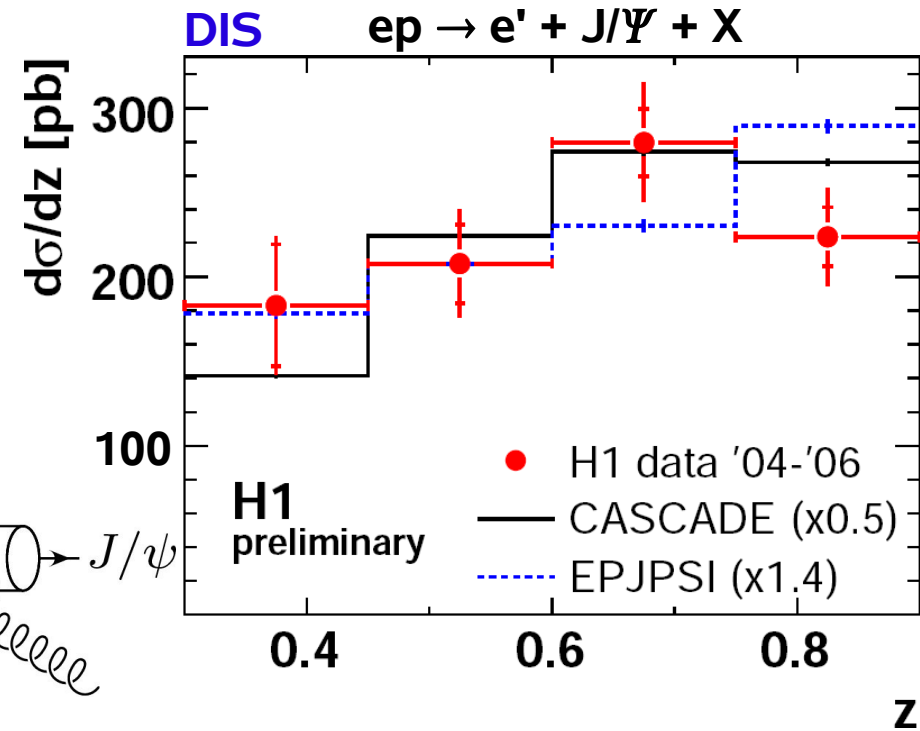
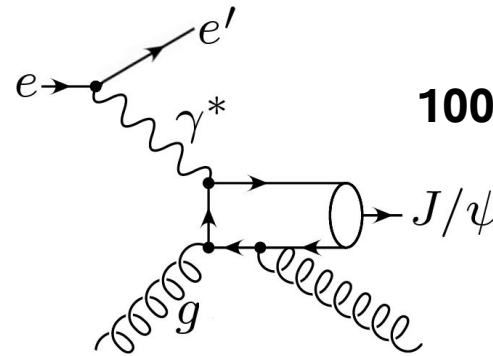
- rise towards large values of z (relativistic corrections)

CASCADE:

- data well reproduced
- good absolute normalization (CASCADE v2)

CS NLO (γp):

- rise towards larger values of z (large normalization uncertainties)



inelastic J/ψ production

cross sections – $W_{\gamma p}$

EPJPSI:

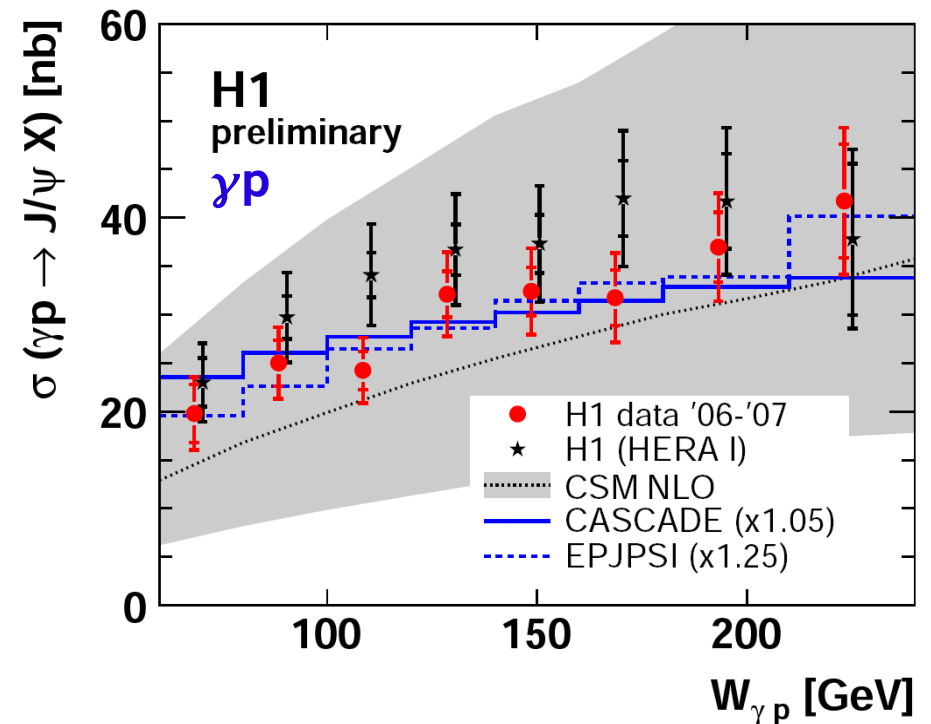
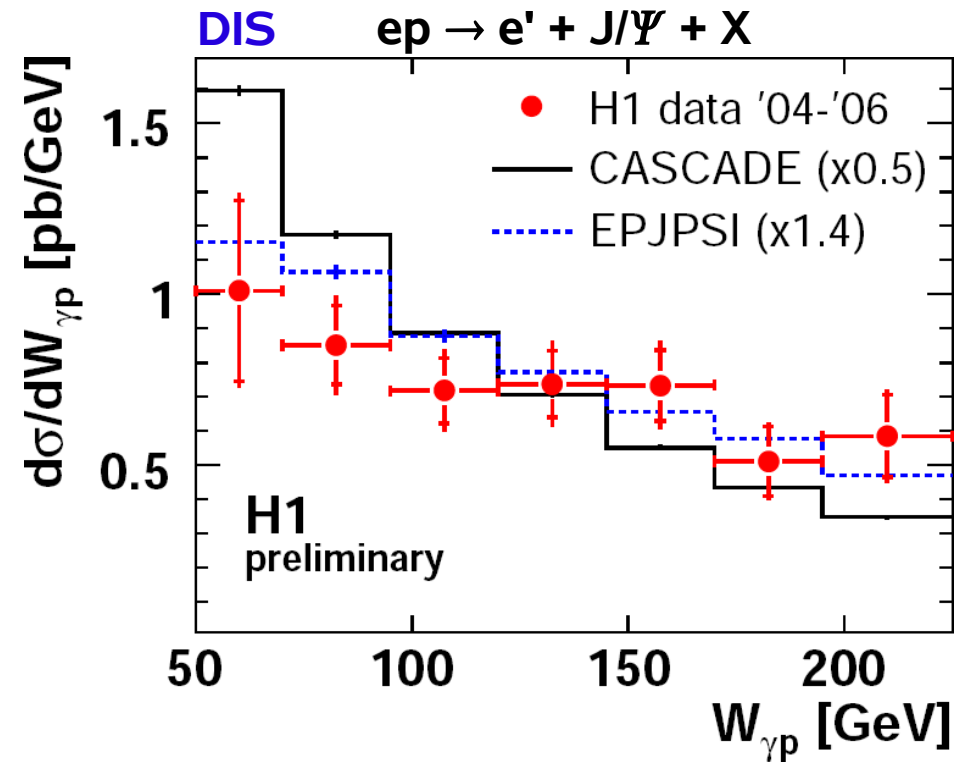
- shape of $W_{\gamma p}$ well reproduced

CASCADE:

- $W_{\gamma p}$ distribution somewhat too high at low $W_{\gamma p}$

CS NLO (γp):

- describes data well (large normalization uncertainties)



cross sections – P_T^2

EPJPSI MC:

- too steep in P_T

CASCADE:

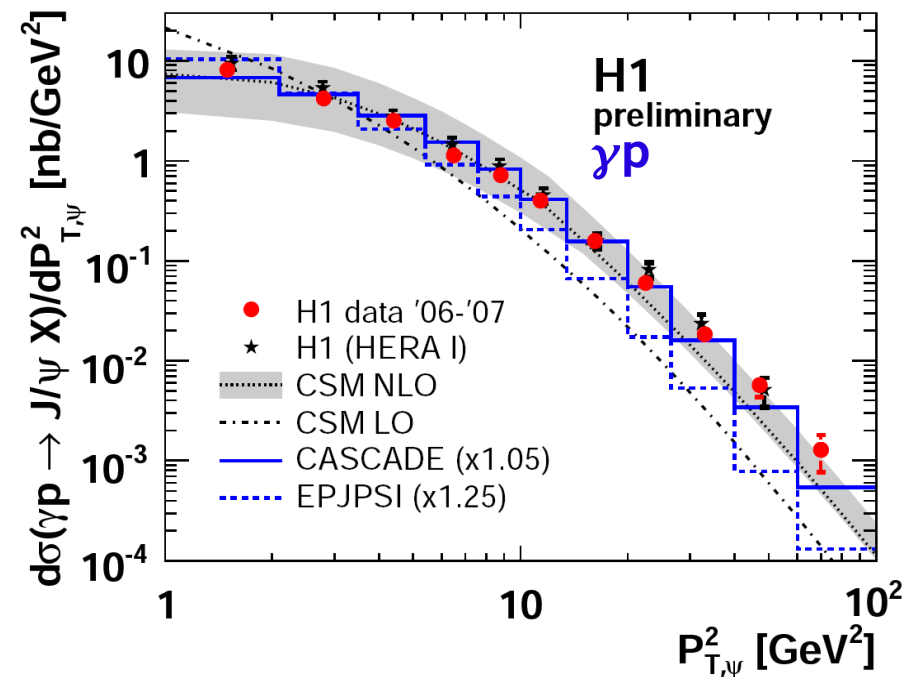
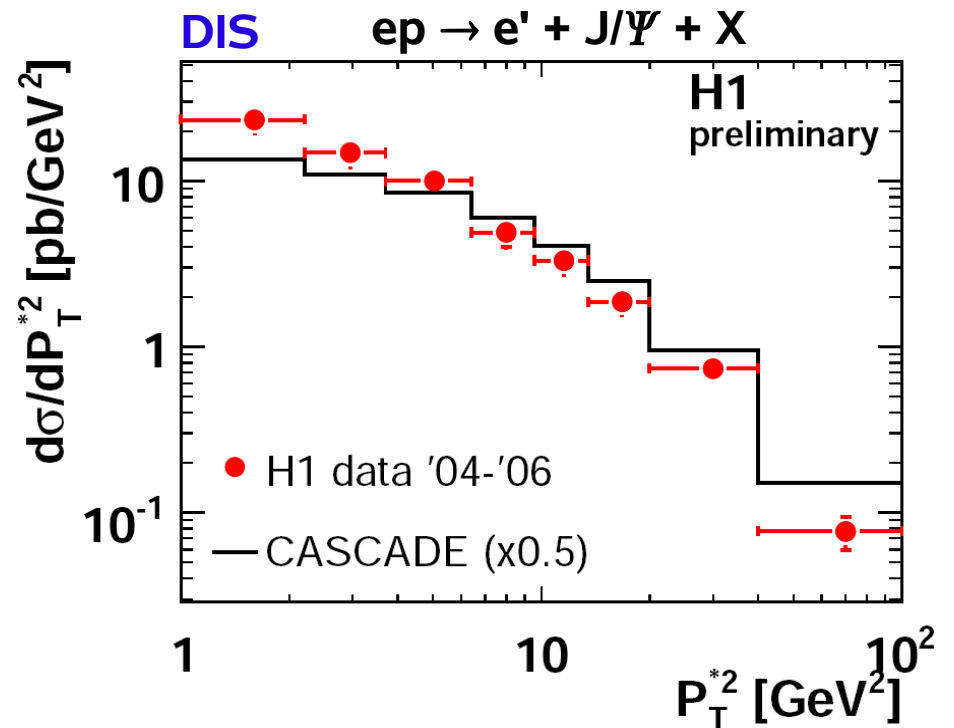
- DIS: P_T spectrum too hard
- γp : data well reproduced

CS NLO (γp):

- data well described
(large normalization uncertainties)

CS LO (γp):

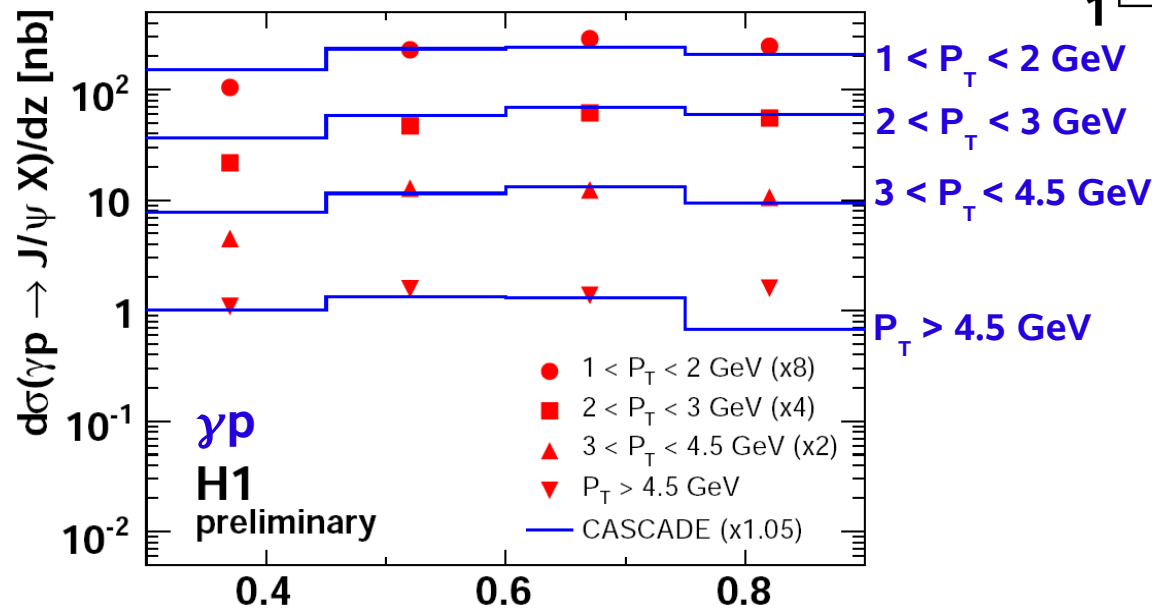
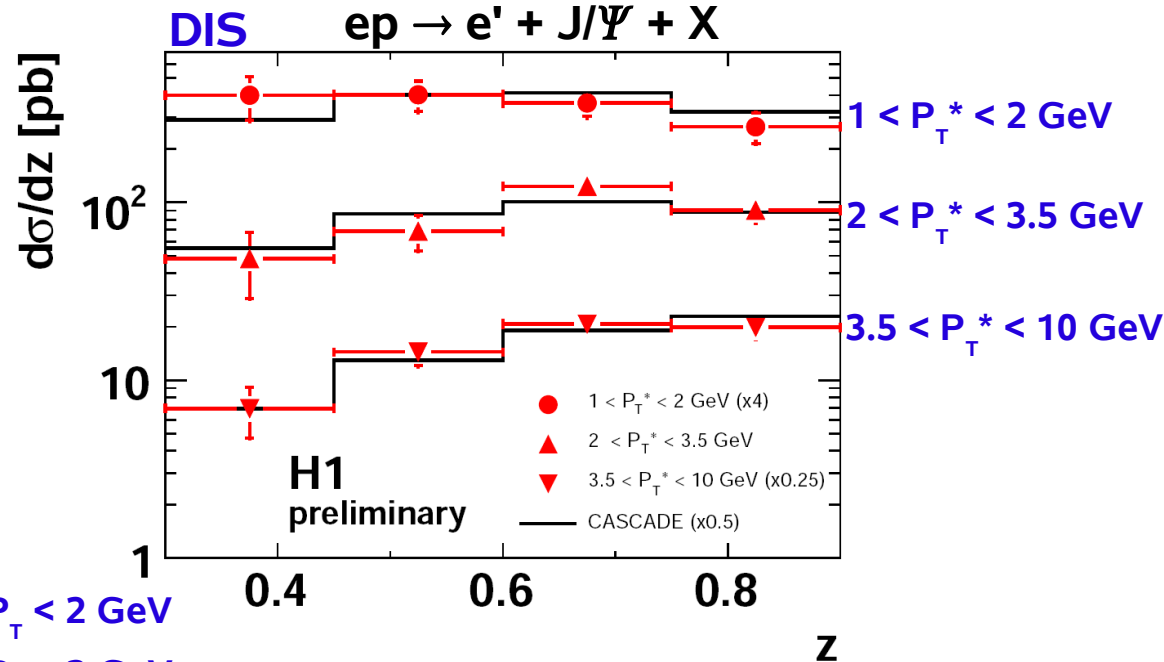
- too steep in P_T



cross sections

as function of inelasticity z in bins of P_T

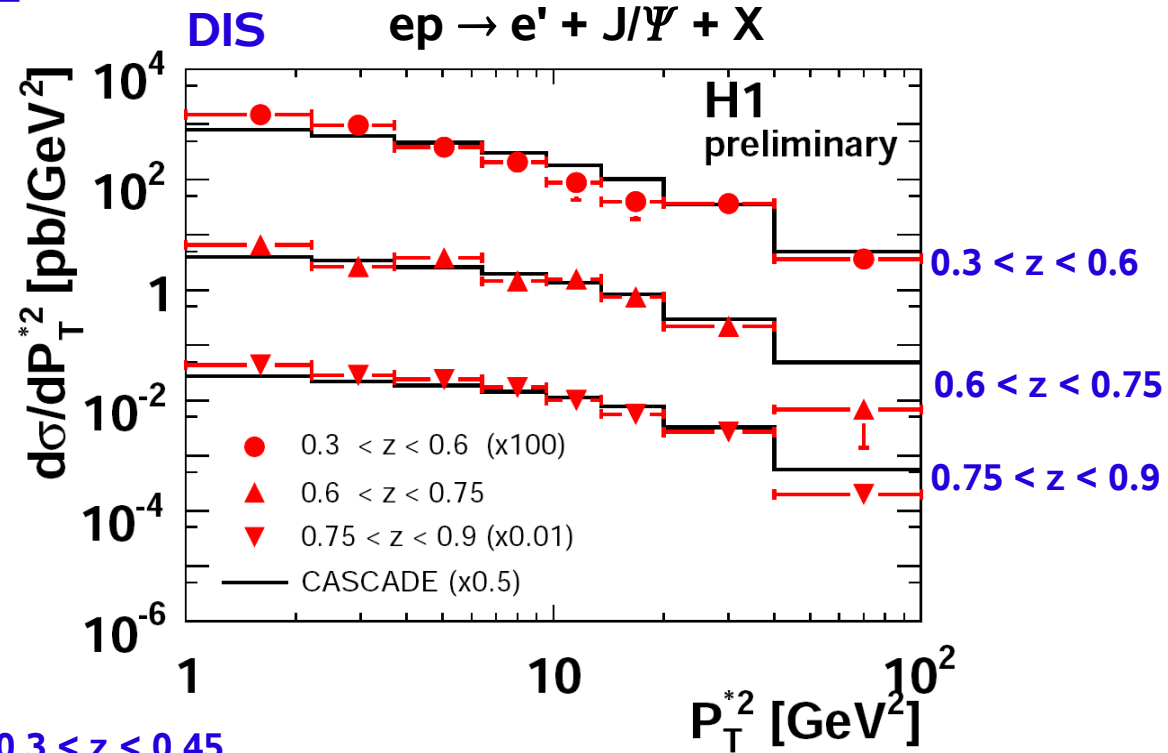
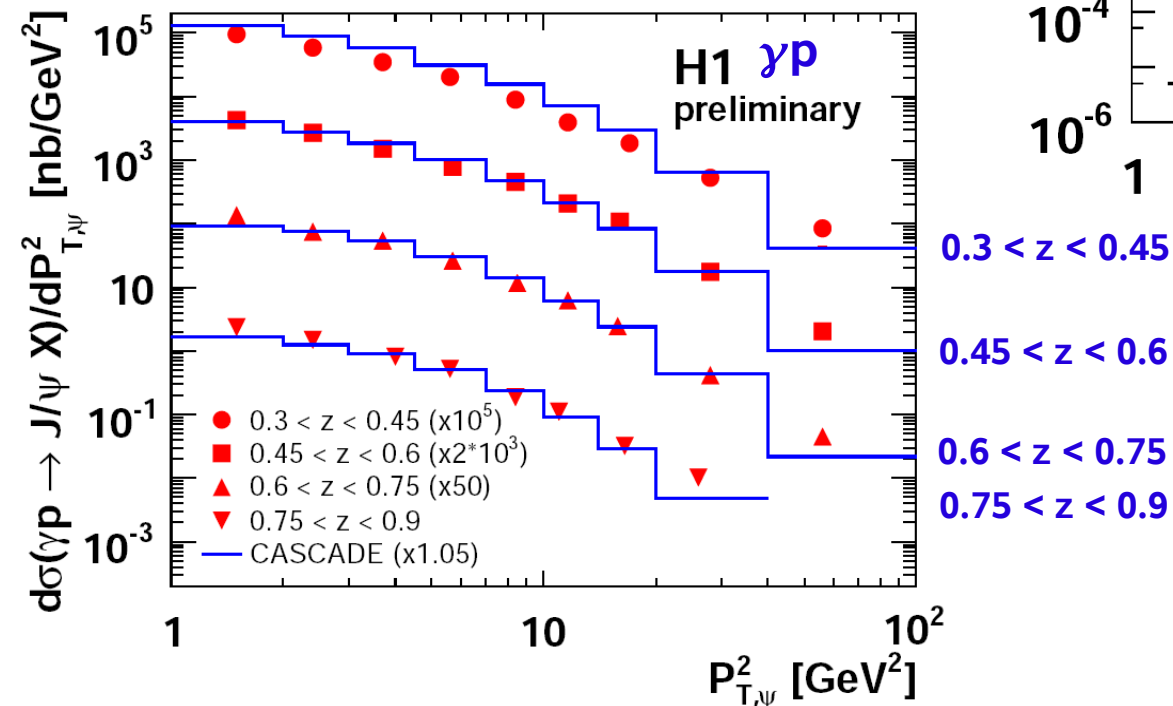
- data well modeled by CASCADE
- overall and in bins of P_T
- somewhat higher at low z
- somewhat lower at large z and P_T



cross sections

as function of P_T^2 in bins of z

- DIS: P_T spectrum somewhat too hard
- γp : data well reproduced
 - overall
 - in bins of P_T



summary

new H1 measurements of inelastic J/Ψ production cross sections

- higher luminosity (HERA II)
 - so far 75% of HERA II luminosity analyzed
 - smaller statistical and systematic errors
- reduced background from diffractive $\Psi(2S)$

CS provides generally good description of data

- when using kt-factorization or NLO
- no significant color octet contributions required

outlook

J/Ψ polarization measurement

extension to low and high z

$\Psi(2S)$ production

J/Ψ from B decays (low z)

aiming for comparisons with up-to-date theory calculations

BACKUP

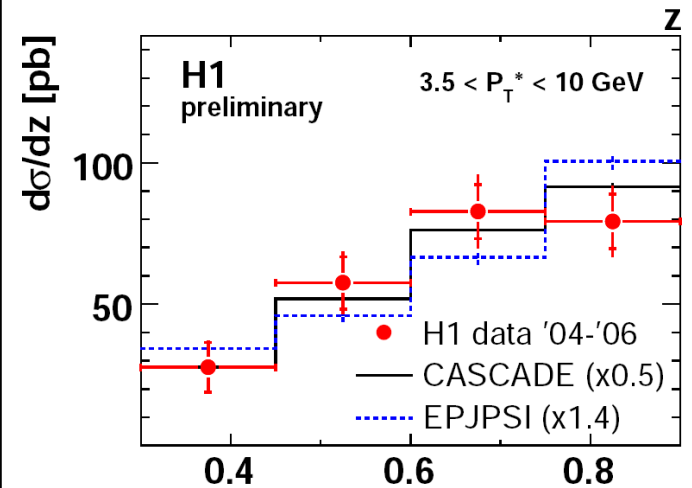
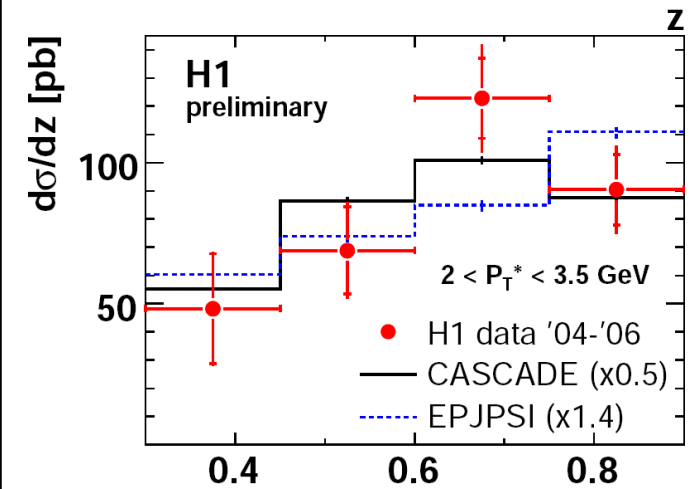
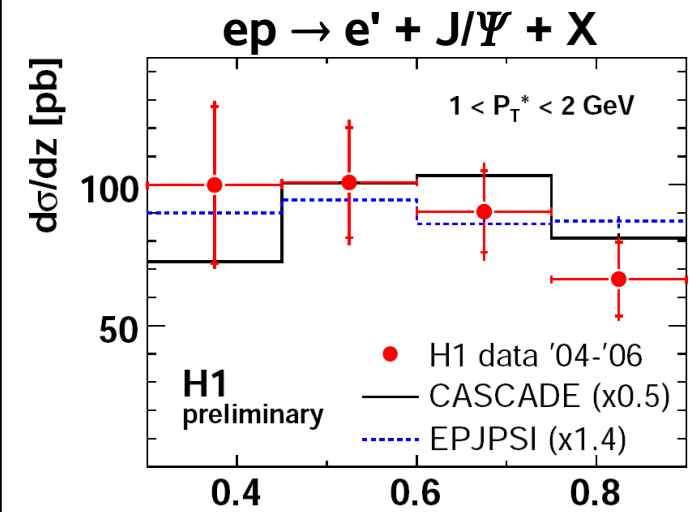
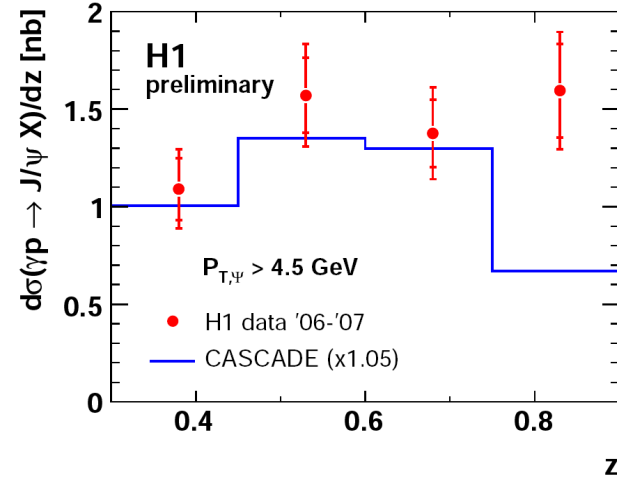
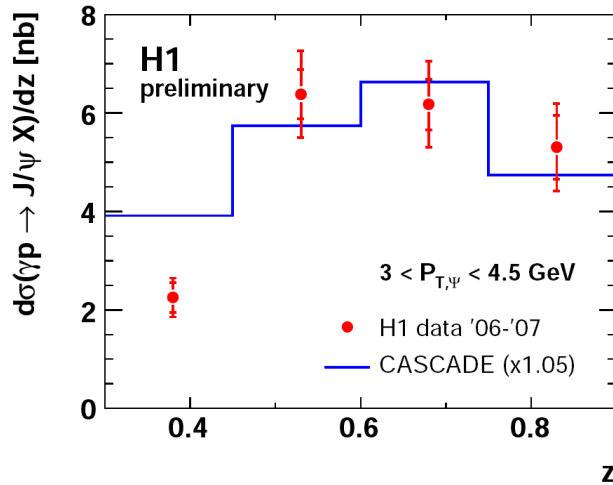
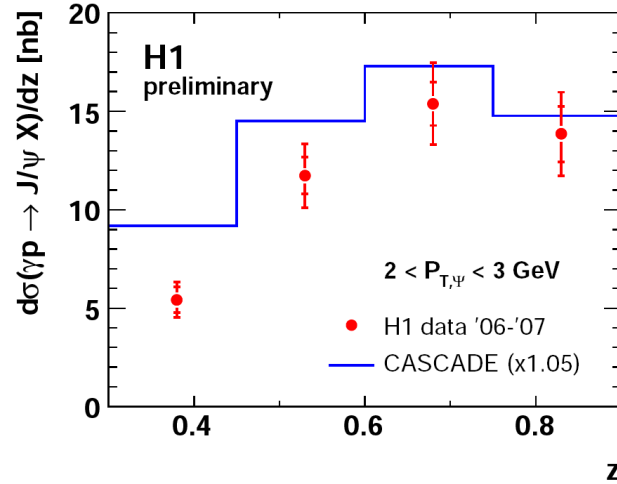
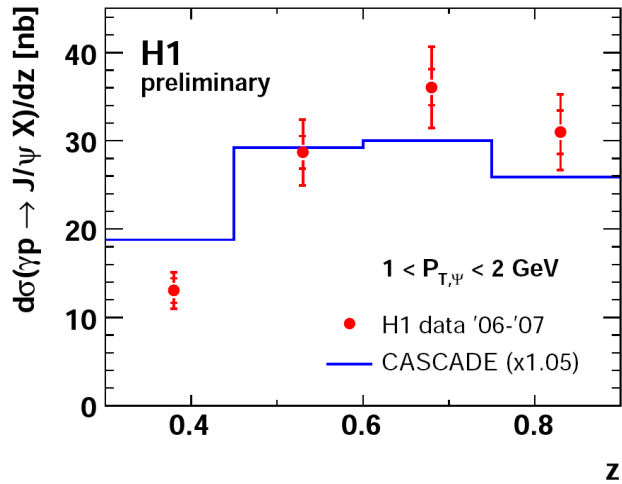
norm. uncertainties (CSM NLO)

$$m_c = (1.4 \pm 0.1) \text{ GeV}$$

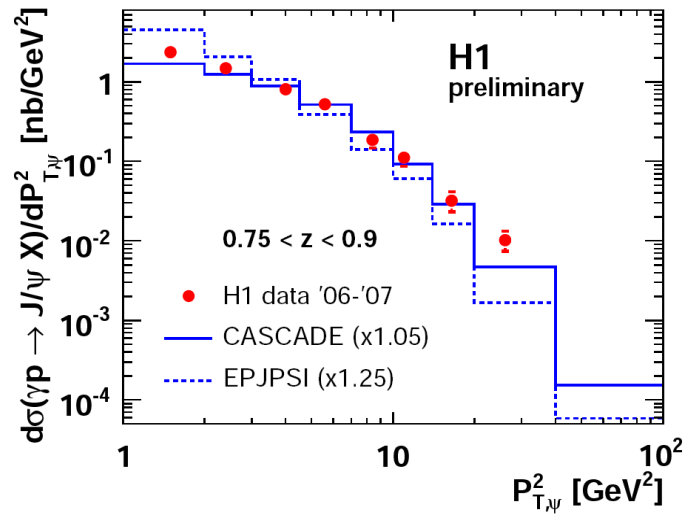
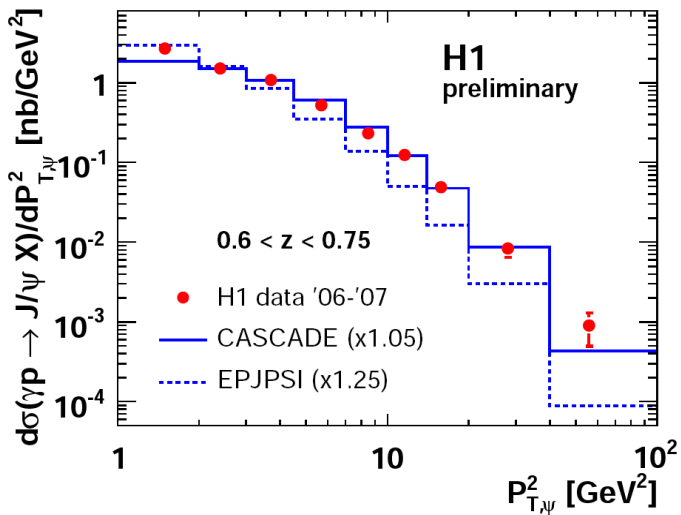
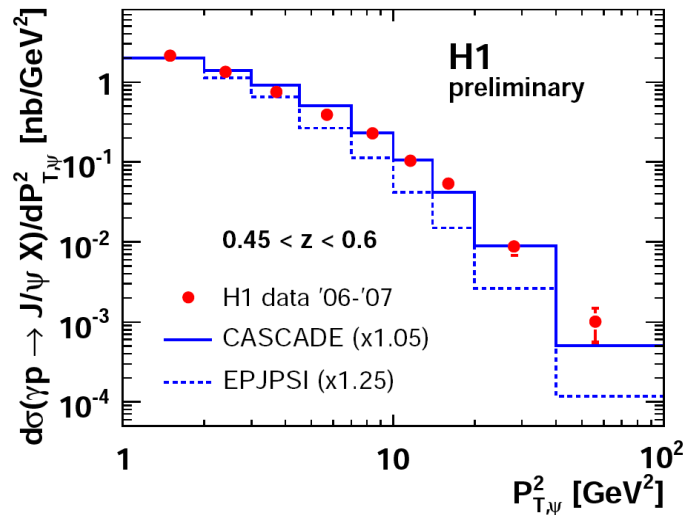
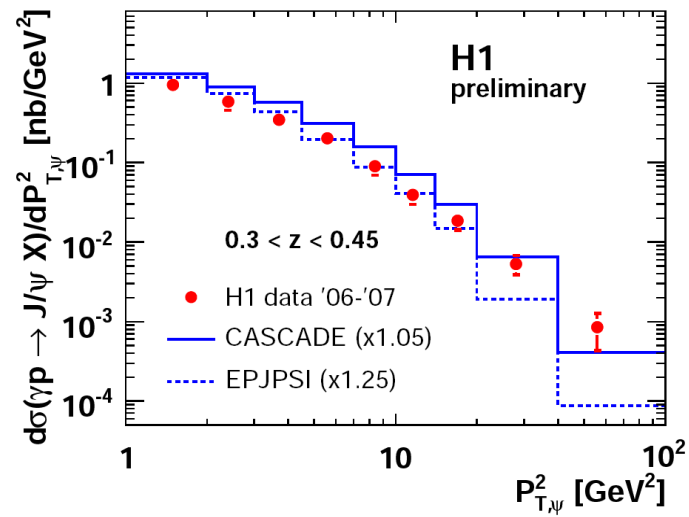
$$\alpha_s = 0.1200 \pm 0.0025$$

cross sections

γp



cross sections



ep → e' + J/Ψ + X

