Inelastic J/Ψ production at H1

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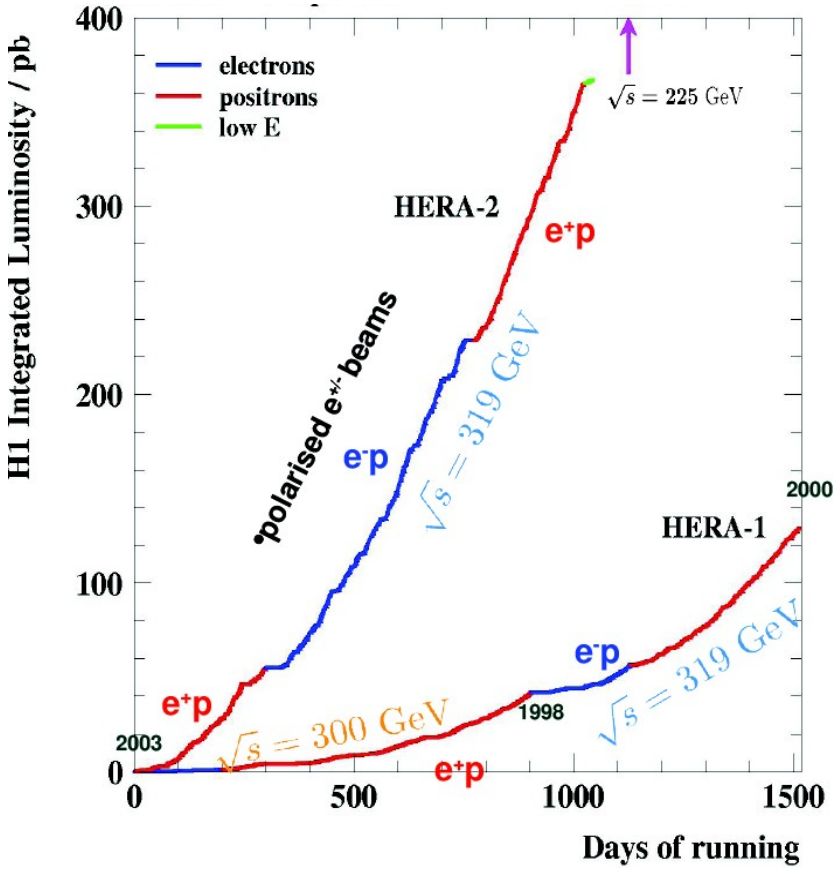
4 summary and outlook

HERA

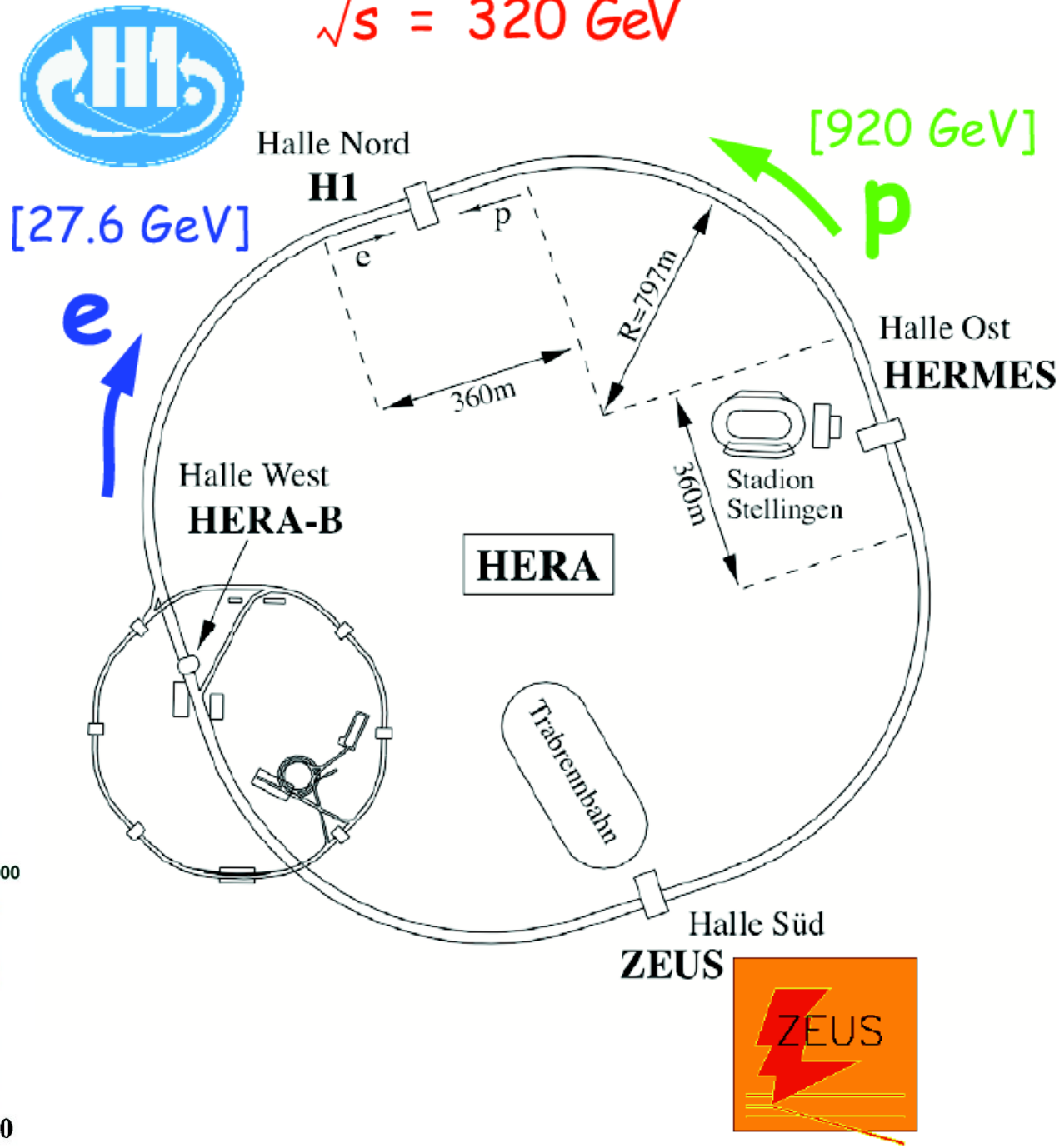
integrated luminosity

HERA I 120 pb^{-1}

HERA II 360 pb^{-1}



$\sqrt{s}$ = 320 GeV



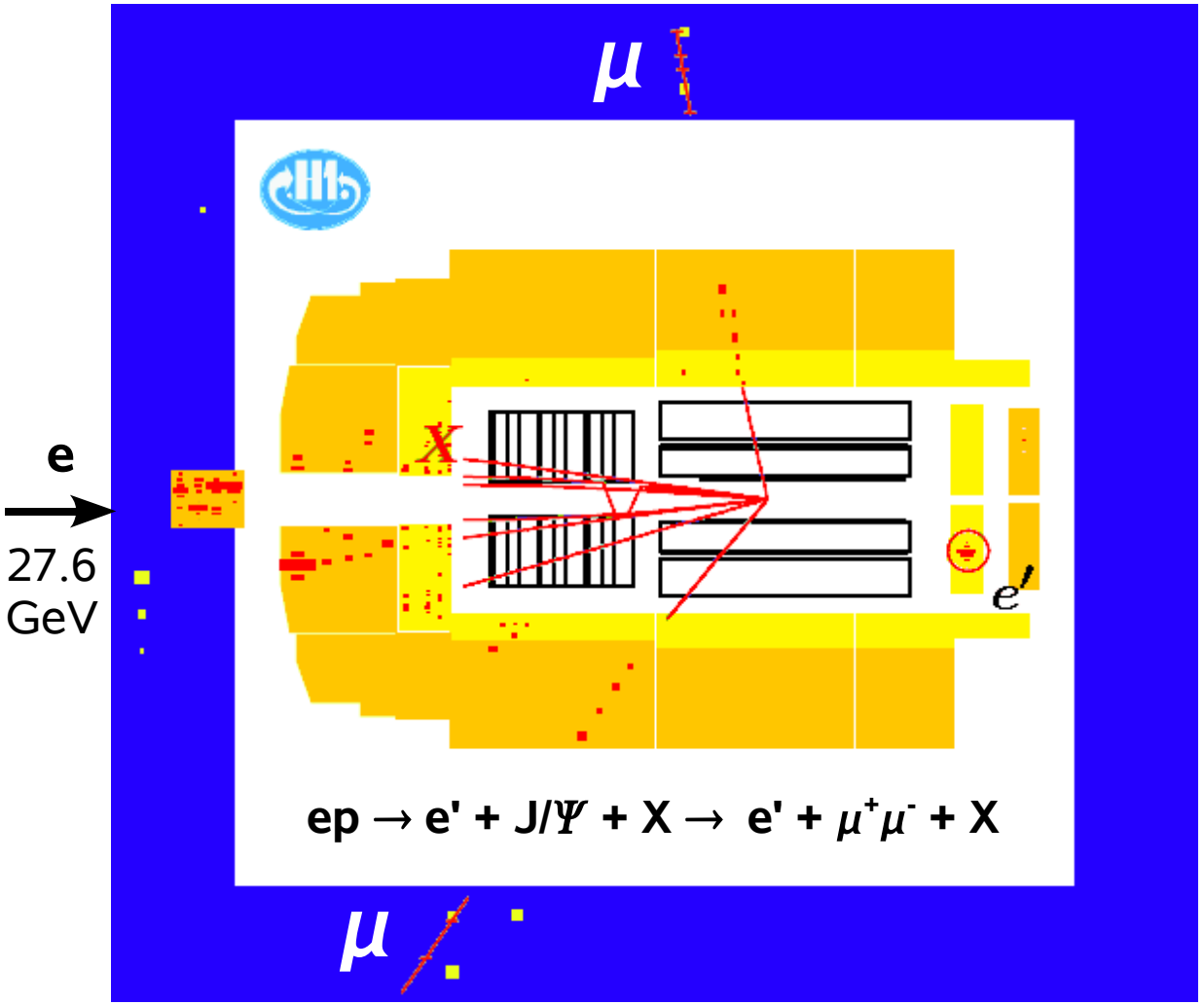
H1

- 4π multi purpose detector

- lepton identification in
  - LAr calorimeter (e/μ)
  - muon detector (μ)

- inelastic J/Ψ event
  - two decay leptons
  - additional particles

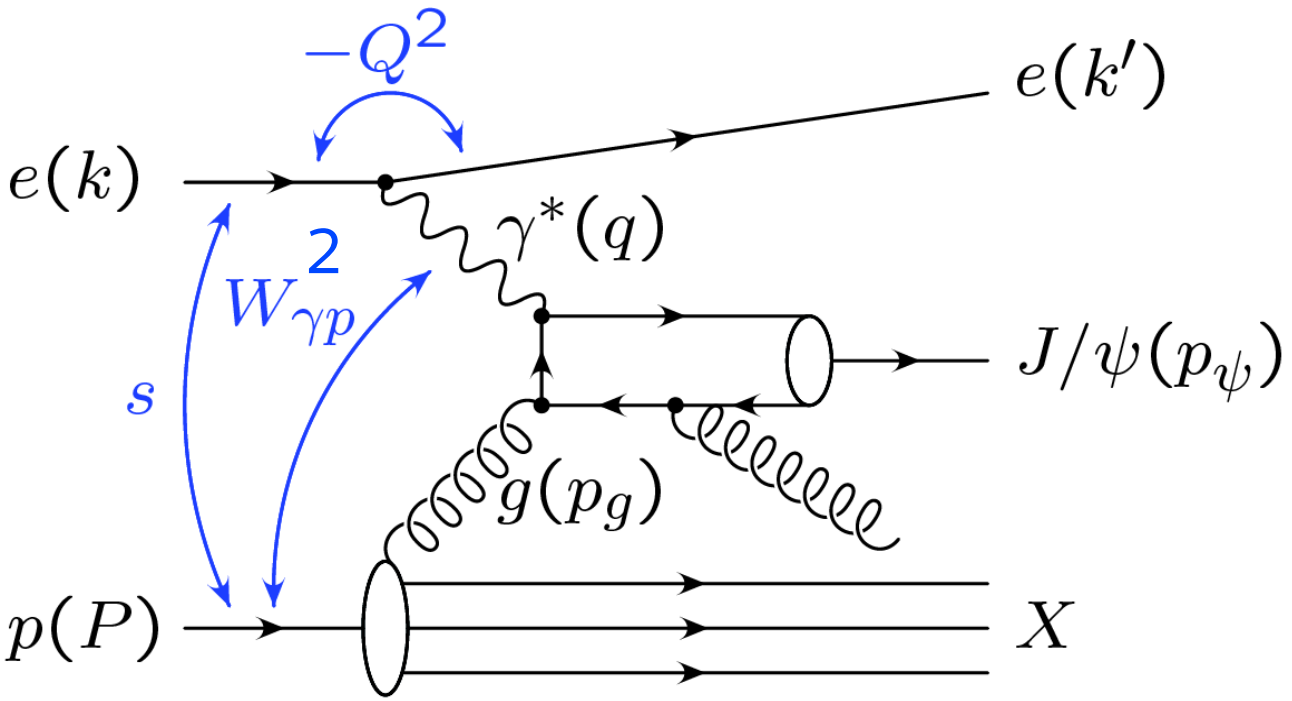
- H1 sensitive down to
  $P_T(J/\Psi) = 0$ GeV



boson gluon fusion (BGF)

main charm production process

γ^* + g → c + $\overline{\text{c}}$



kinematic variables

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

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

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

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

in p rest frame

$$= \frac{E^*_\psi}{E^*_\gamma}$$

$Q^2 > 3.6$ GeV^2 **electroproduction (DIS)**

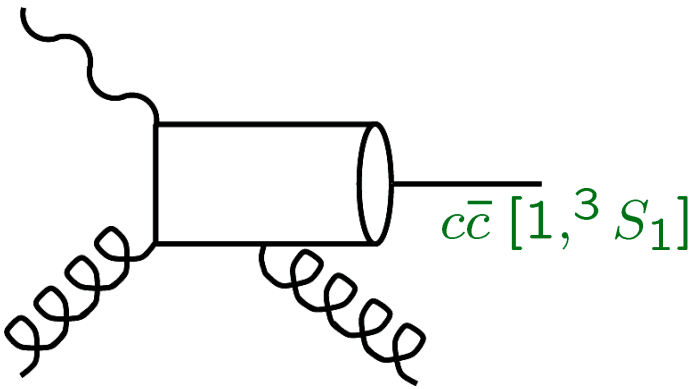
scattered lepton in main detector

$Q^2 \sim 0$ 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

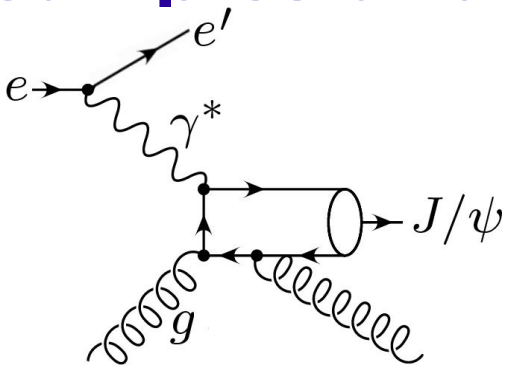
EPJPSI

- DGLAP evolution, collinear factorization

CASCADE

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

data samples and selections



electroproduction (DIS)

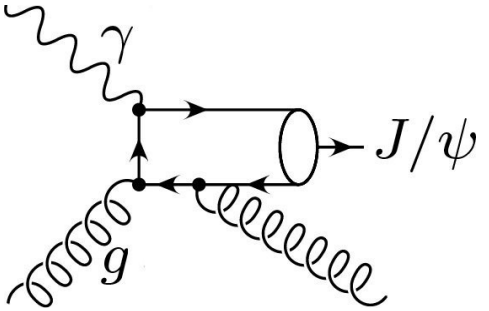
$\mathcal{L} \approx 258\ \text{pb}^{-1}$ (2004-2006)

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

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

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

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



photoproduction (γp)

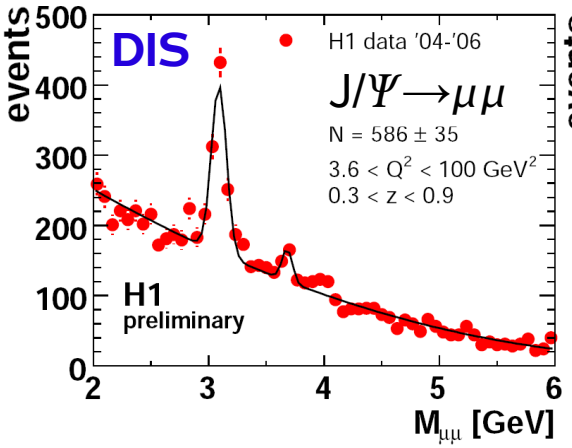
$\mathcal{L} \approx 166\ \text{pb}^{-1}$ (2006-2007)

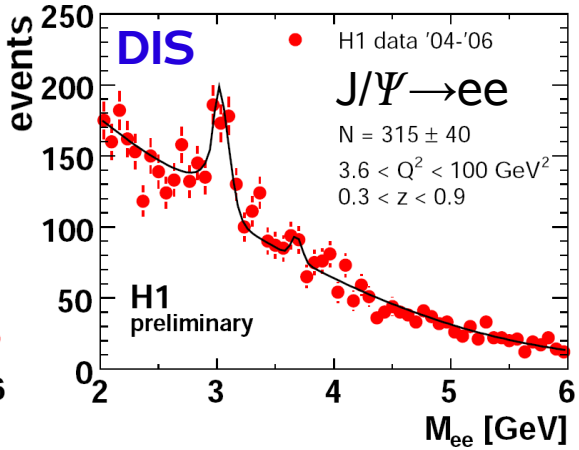
$Q^2 \sim 0\ \text{GeV}^2$

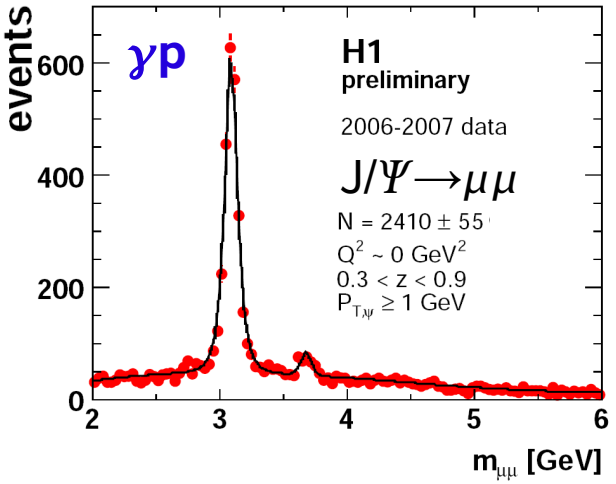
$60 < W_{\gamma p} < 240\ \text{GeV}$

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

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







backgrounds from indirect J/Ψ production

diffractive Ψ(2S) feed down

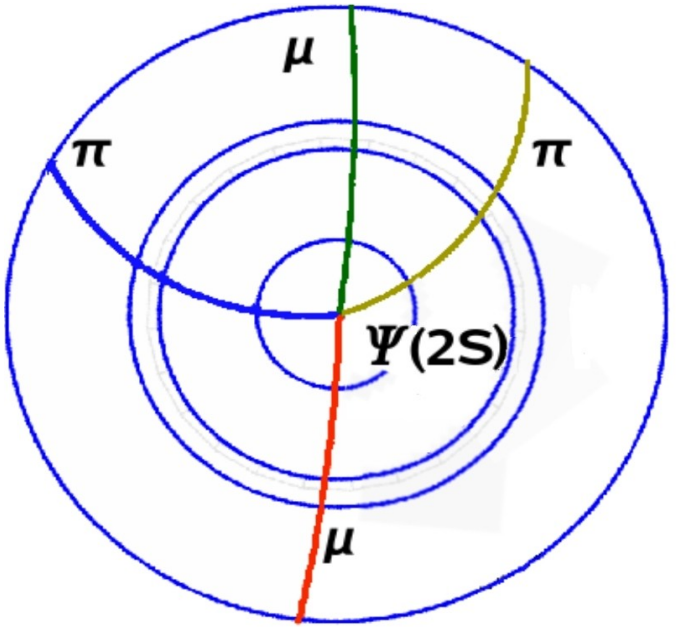
- Ψ(2S) $\rightarrow$ J/Ψ $\pi^+\pi^-$ (BR ~30%)
- high z region (z ~ 0.85)

$\rightarrow$ suppression cut: $N_{Tracks} \geq 5$

- corrected in measured cross sections

- remaining contribution:

- overall: ~ 1.5%
- highest z bin: < 5%



B meson decays

- low z region
- high track multiplicity, larger P_T(J/Ψ)

- contribution:

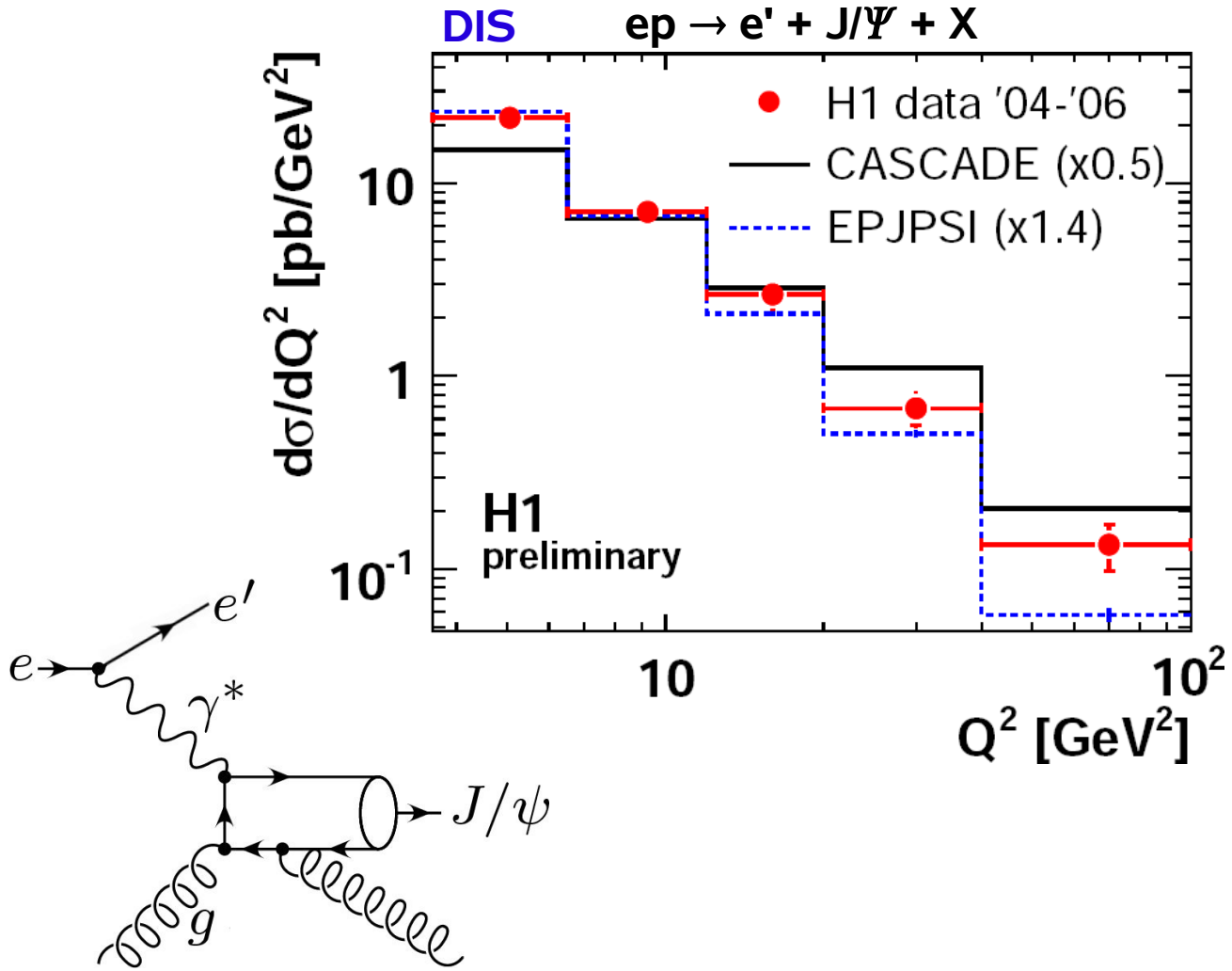
- overall: ~ 2.5%
- lowest z bin: < 10%

$\rightarrow$ contributions not subtracted from cross section measurements

cross sections – Q^2

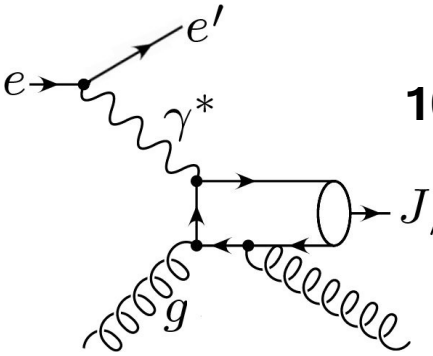
EPJPSI:
- Q^2 too steep
- normalization too low

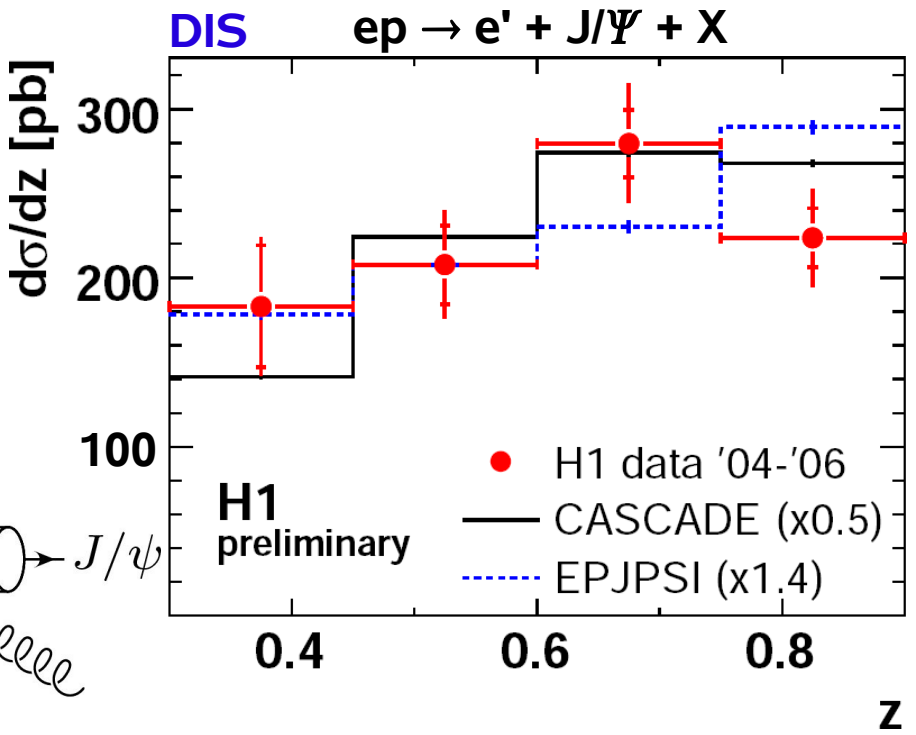
CASCADE v1.2:
- Q^2 too hard
- normalization too high



cross sections – z

DIS and γp have similar shapes

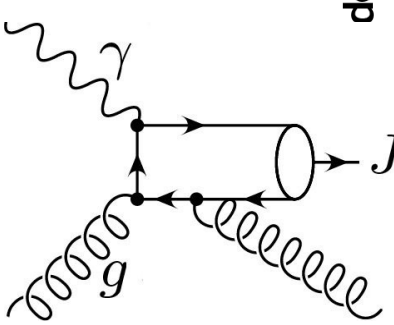


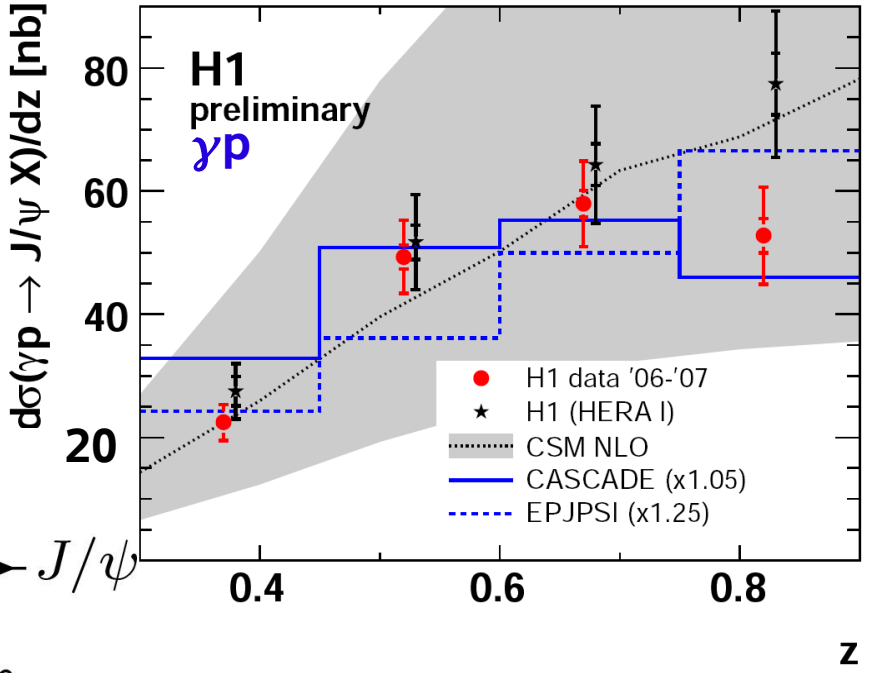


EPJPSI:
- rise towards large values of z (relativistic corrections)

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

CS NLO (γp):
- rise towards larger values of z (large normalization uncertainties)



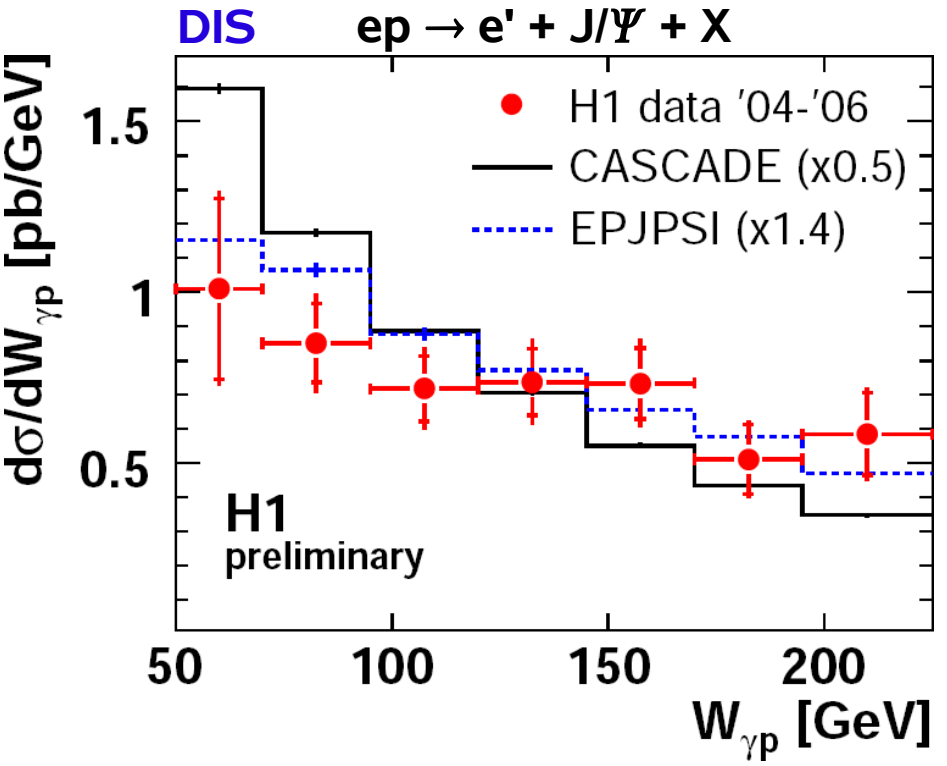


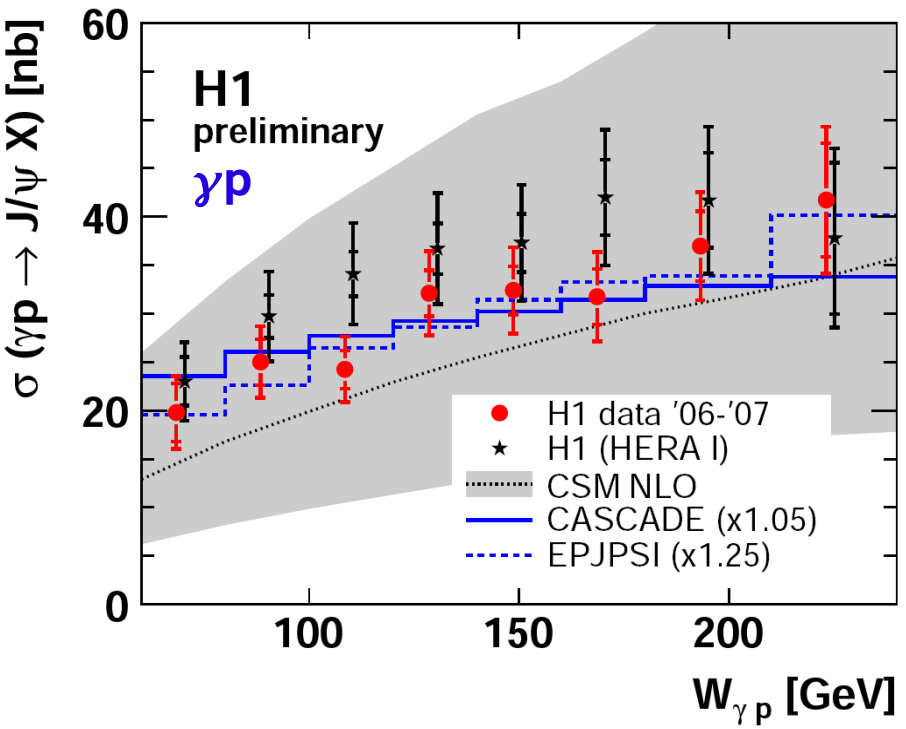
cross sections – $W_{\gamma p}$

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)





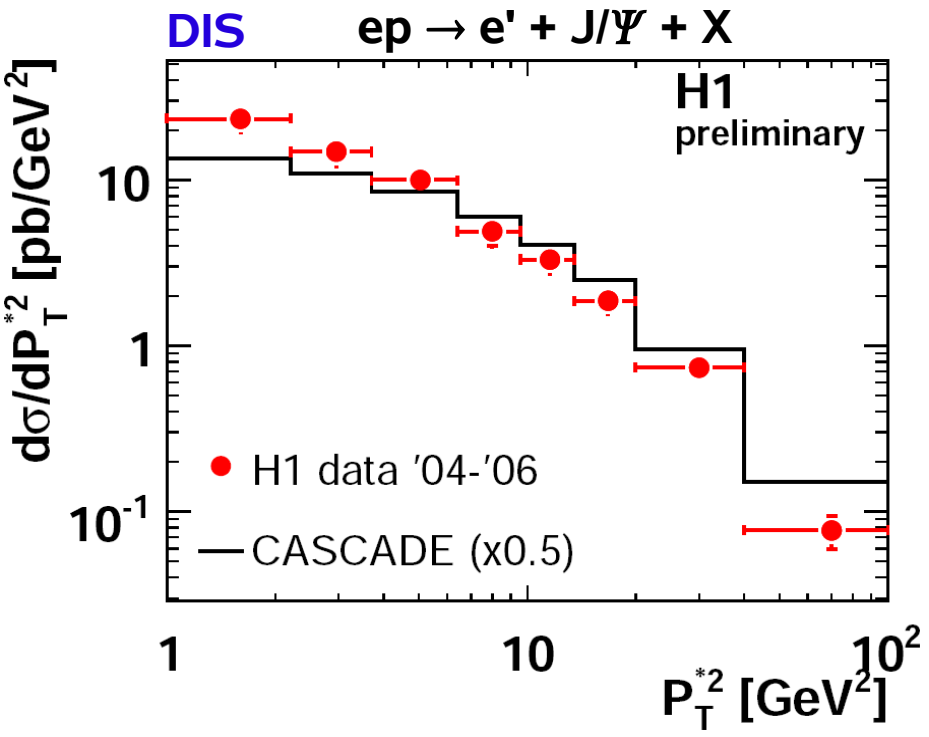
cross sections – P_T^2

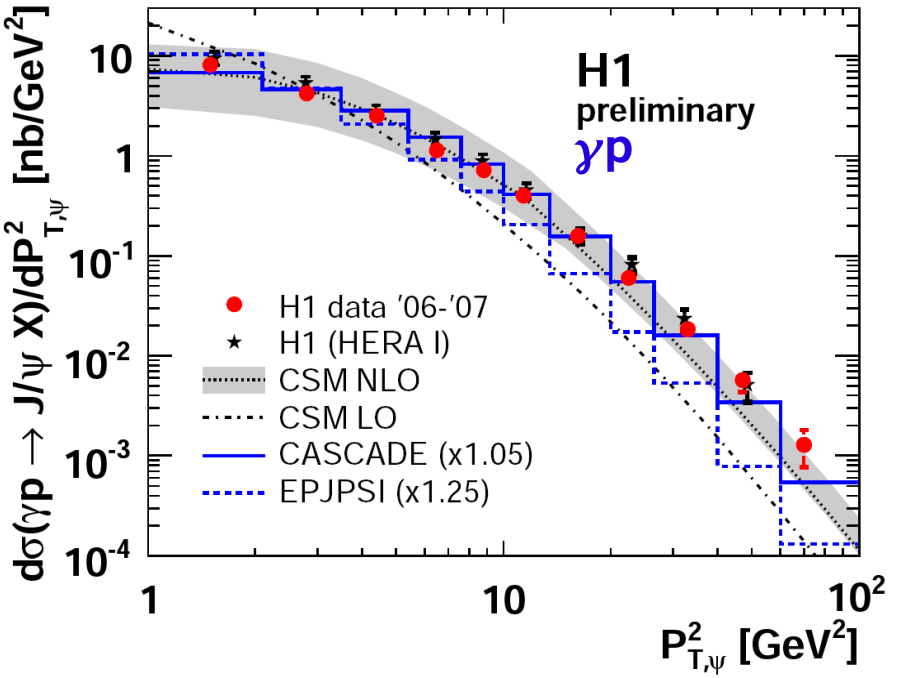
EPJPSI MC:
- too steep in P_T

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

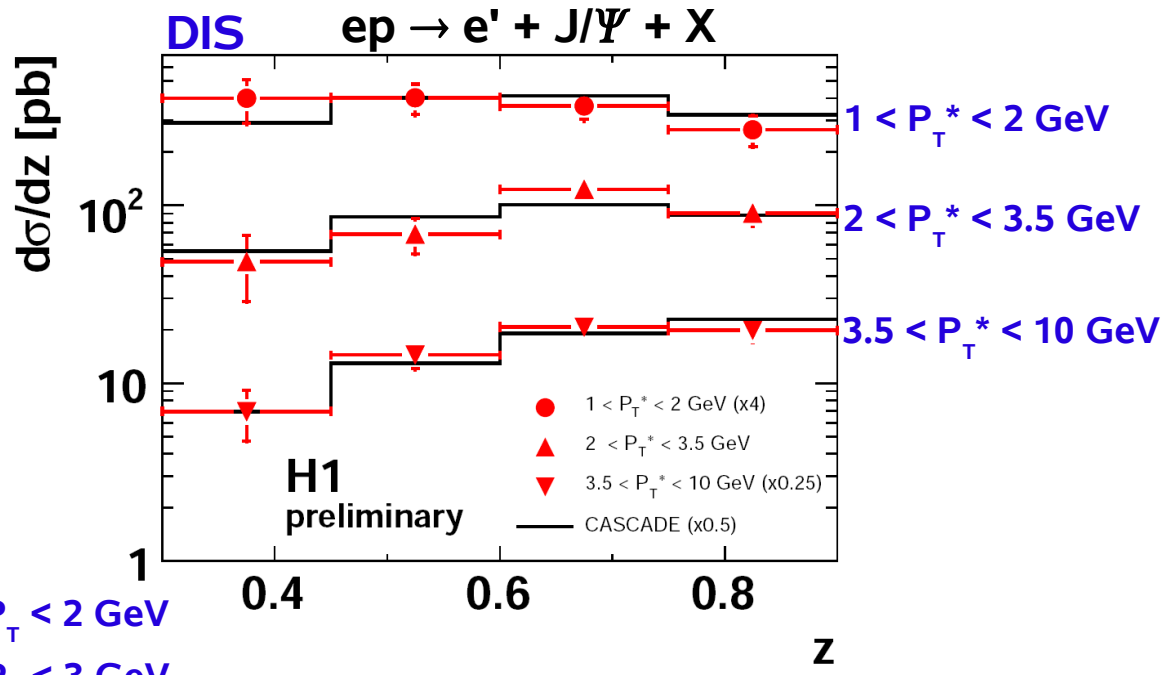


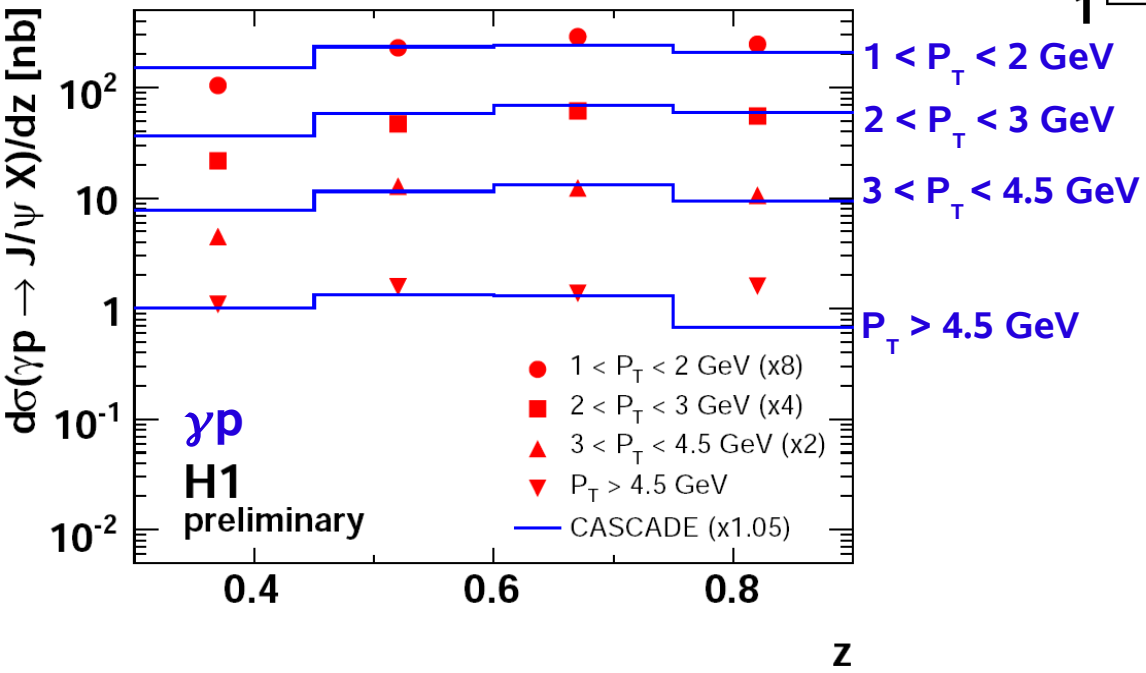


cross sections

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

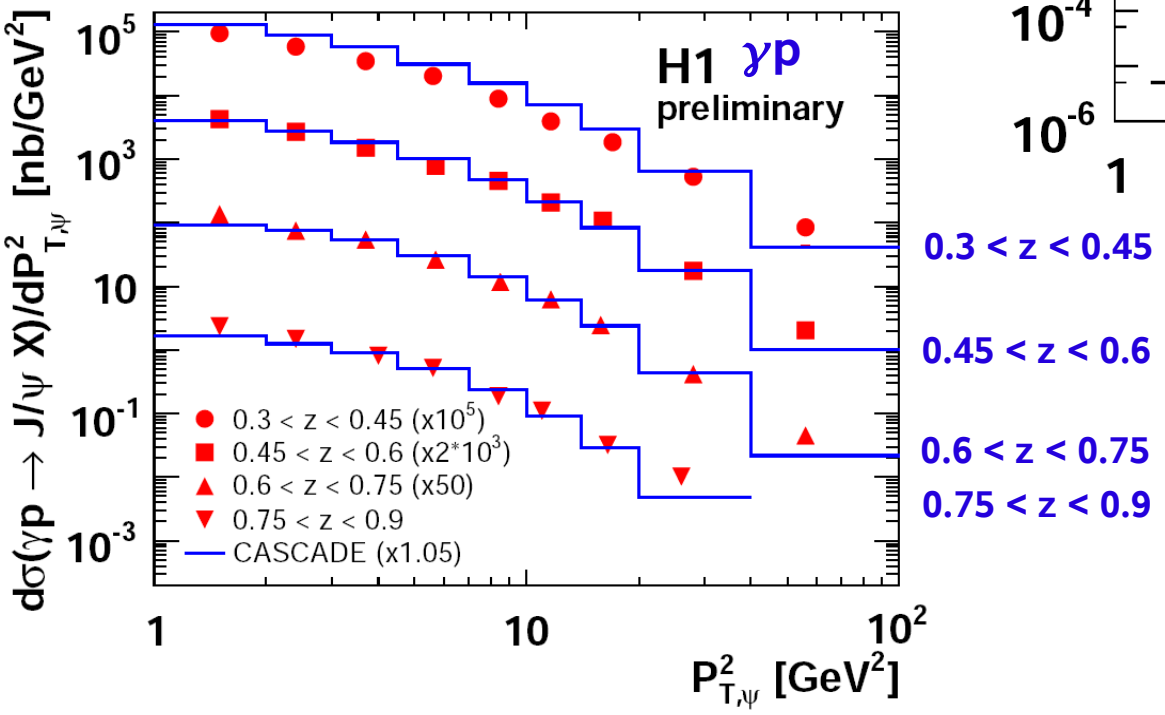


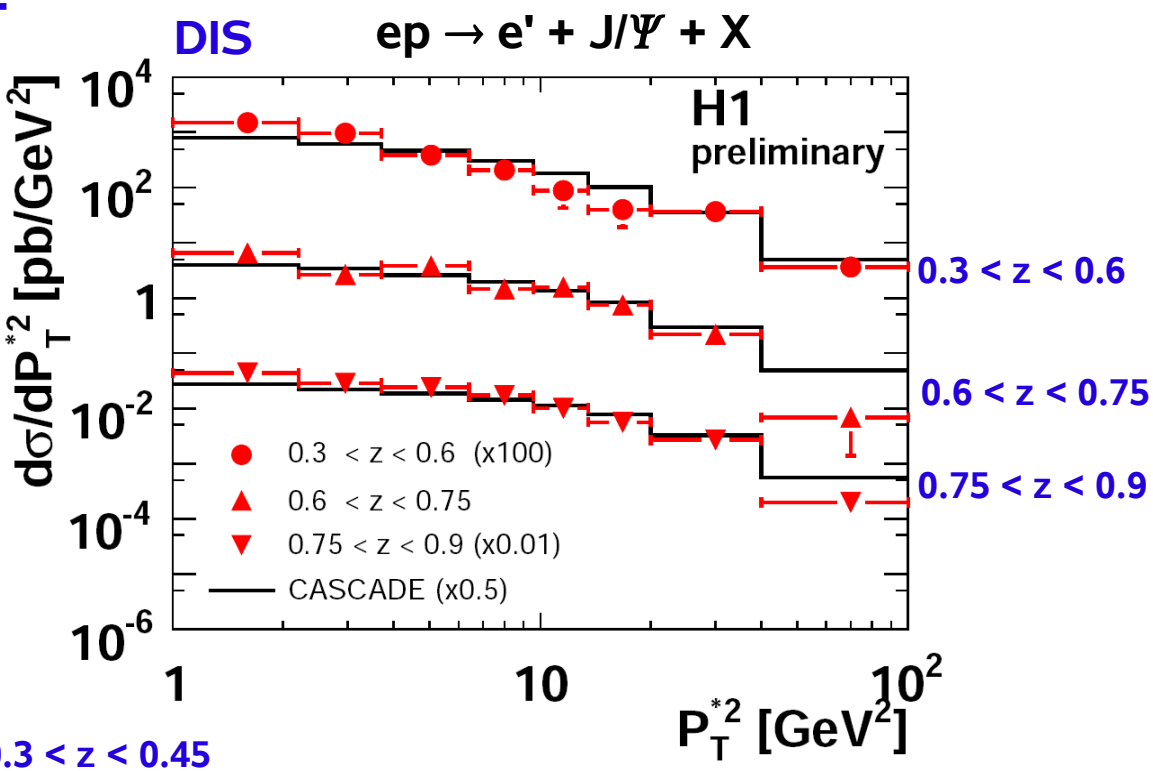


cross sections

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

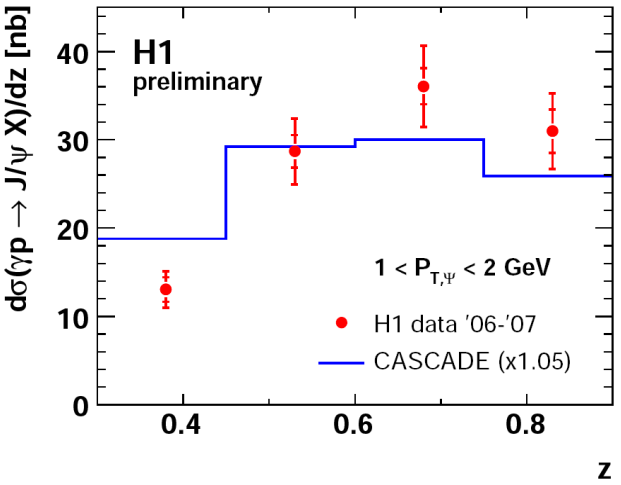
norm. uncertainties (CSM NLO)

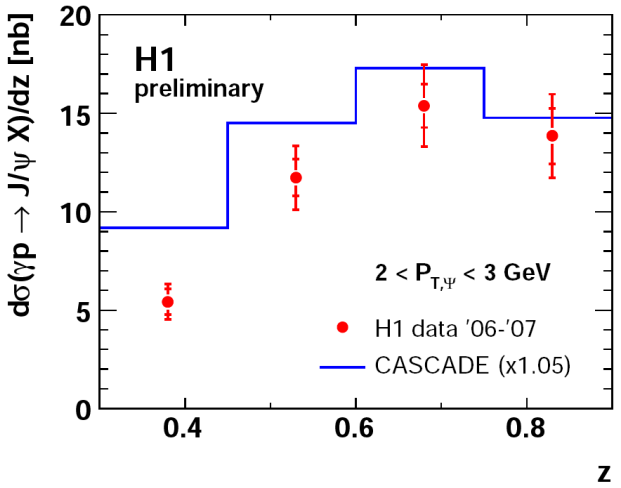
$m_c = (1.4 \pm 0.1)$ GeV

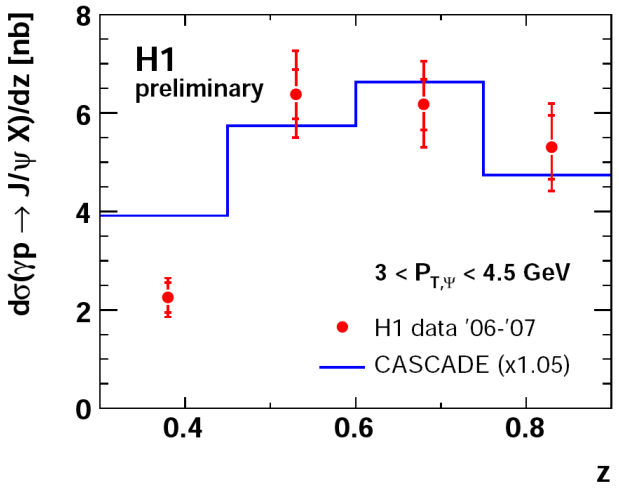
$\alpha_s = 0.1200 \pm 0.0025$

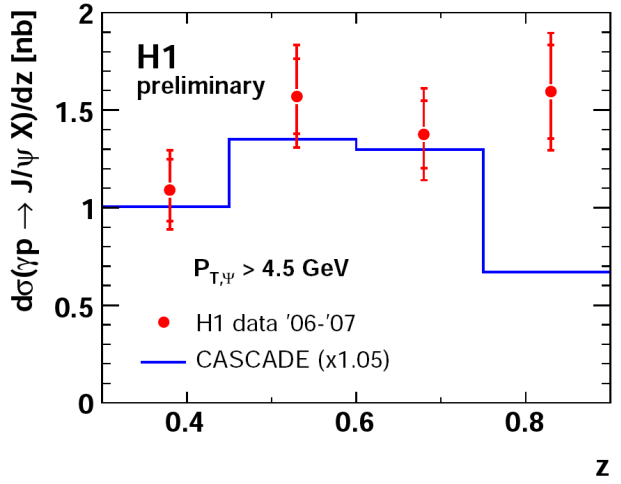
cross sections

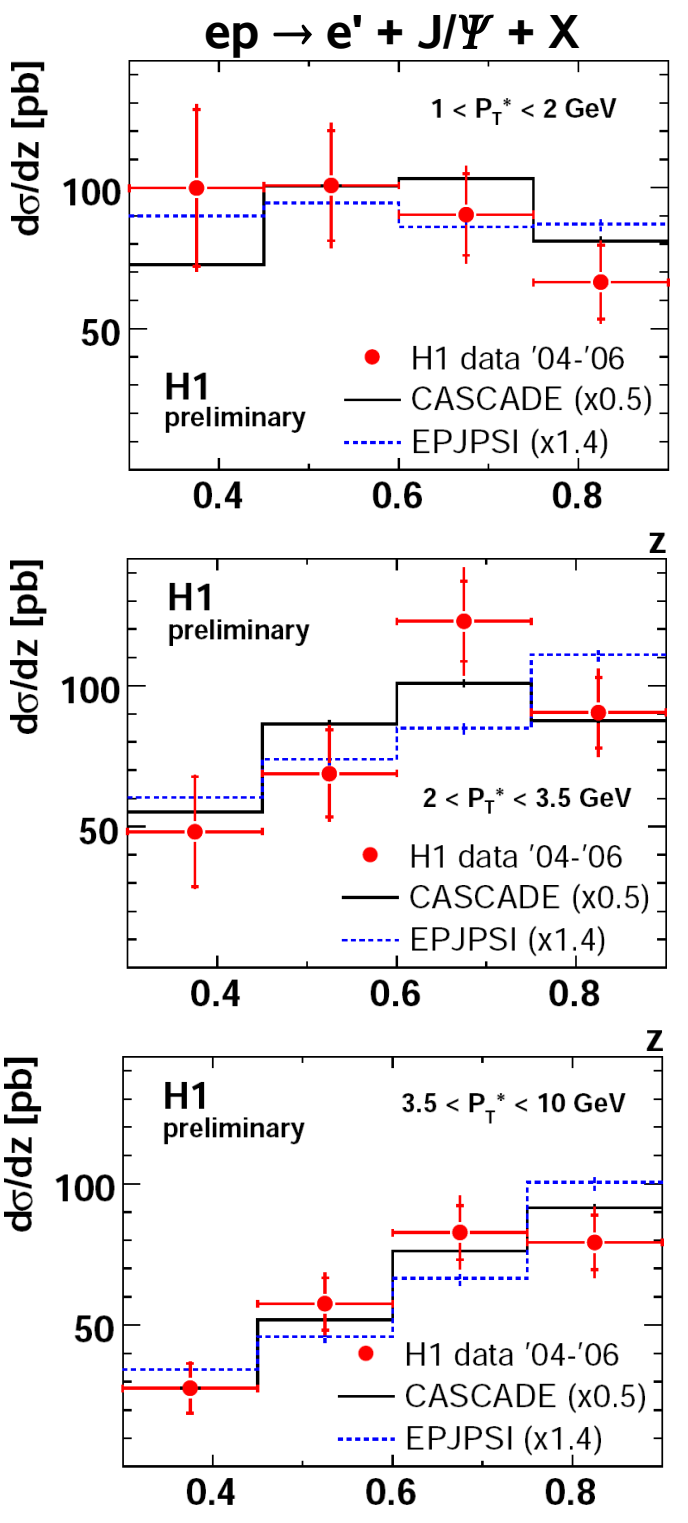
γp



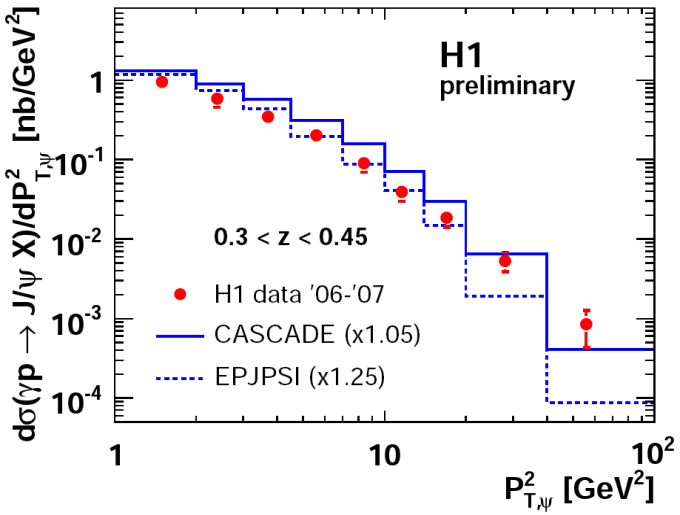


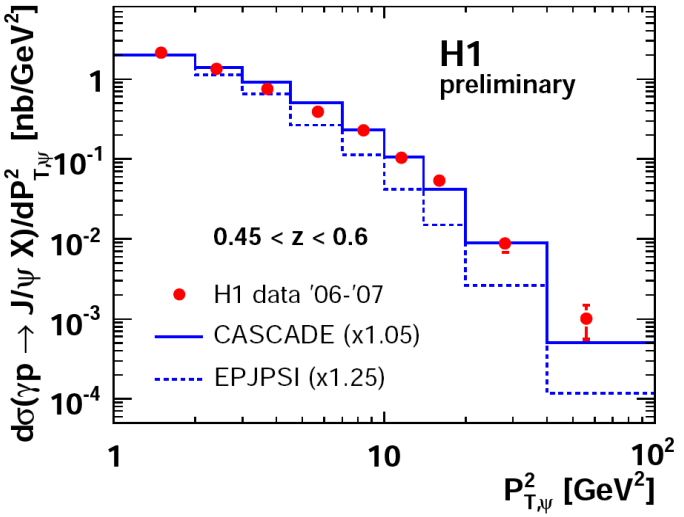


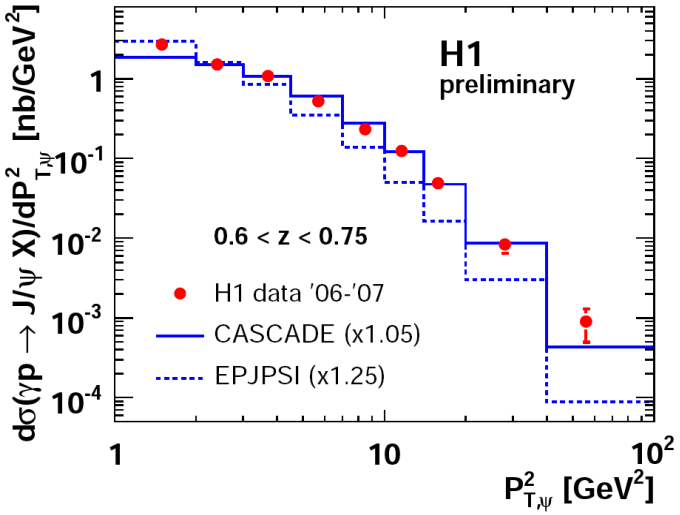


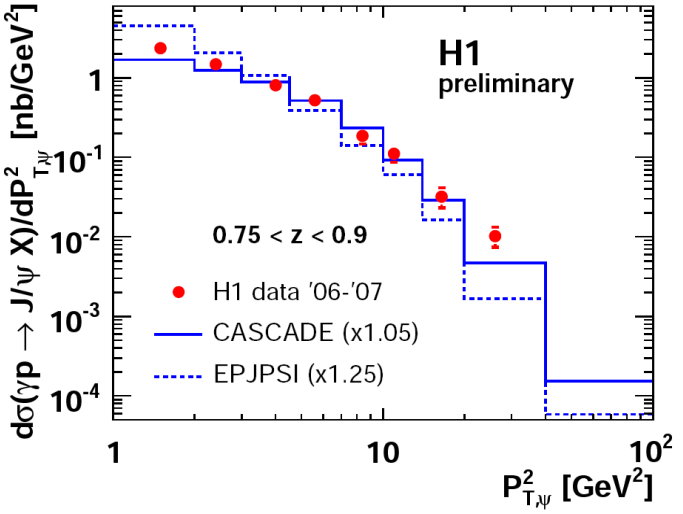


cross sections









ep → e' + J/Ψ + X