Quarkonium Results and Prospects from H1 and ZEUS

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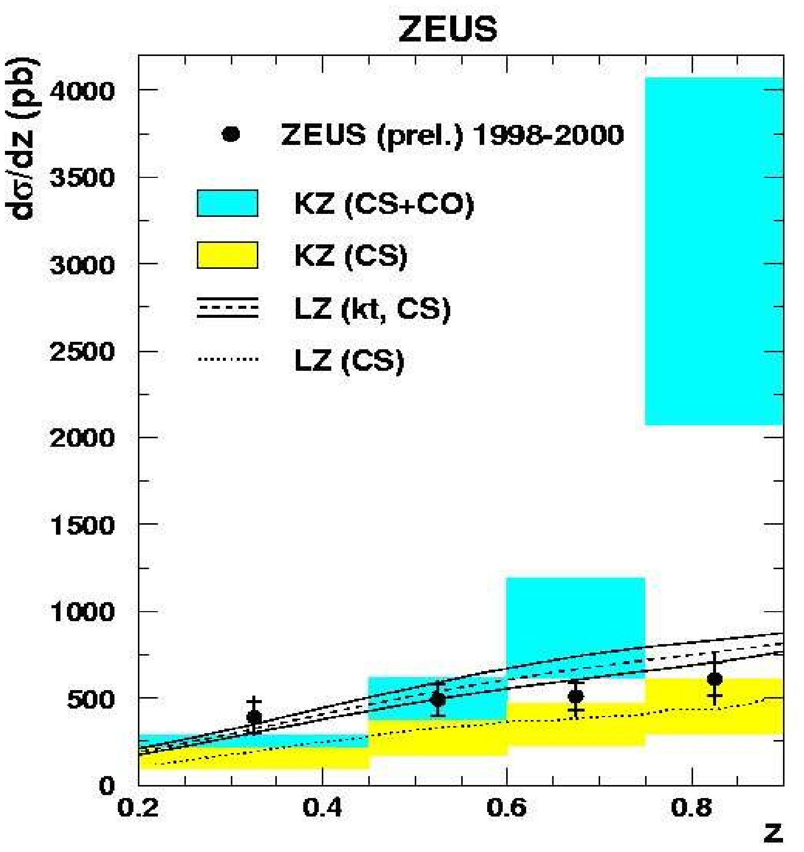
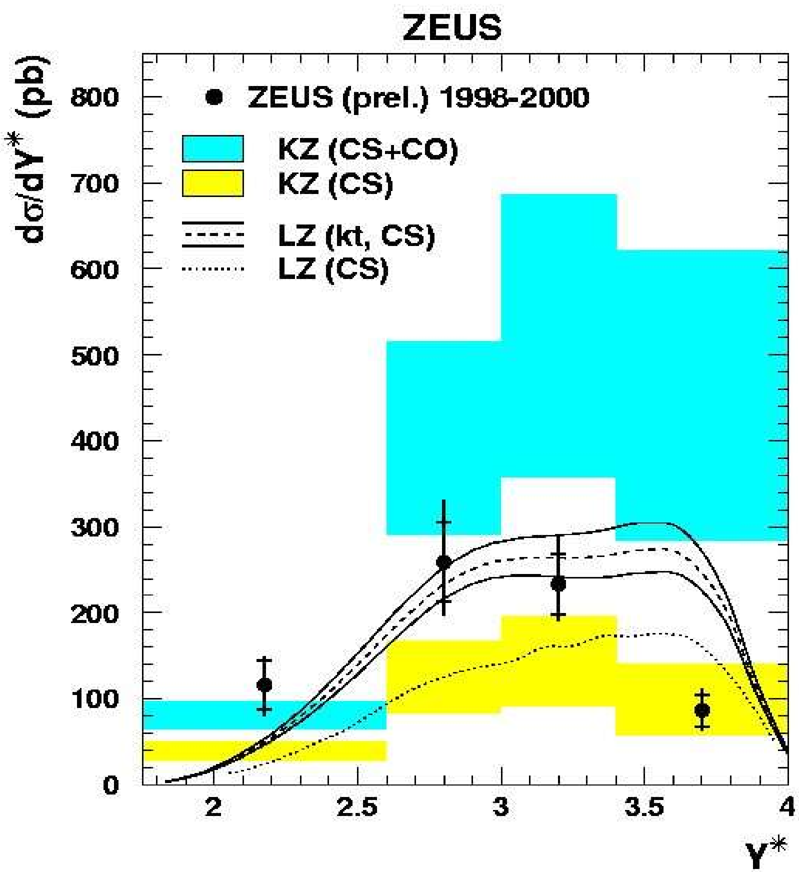
on behalf of the
H1 and ZEUS Collaborations

- **Last ZEUS results**
- **The upgraded H1 and ZEUS detectors**
- **HERA-II status**
- **Physics perspectives**
- **Summary**

Inelastic J/ψ in DIS: ZEUS results

Contributed paper EPS03-565

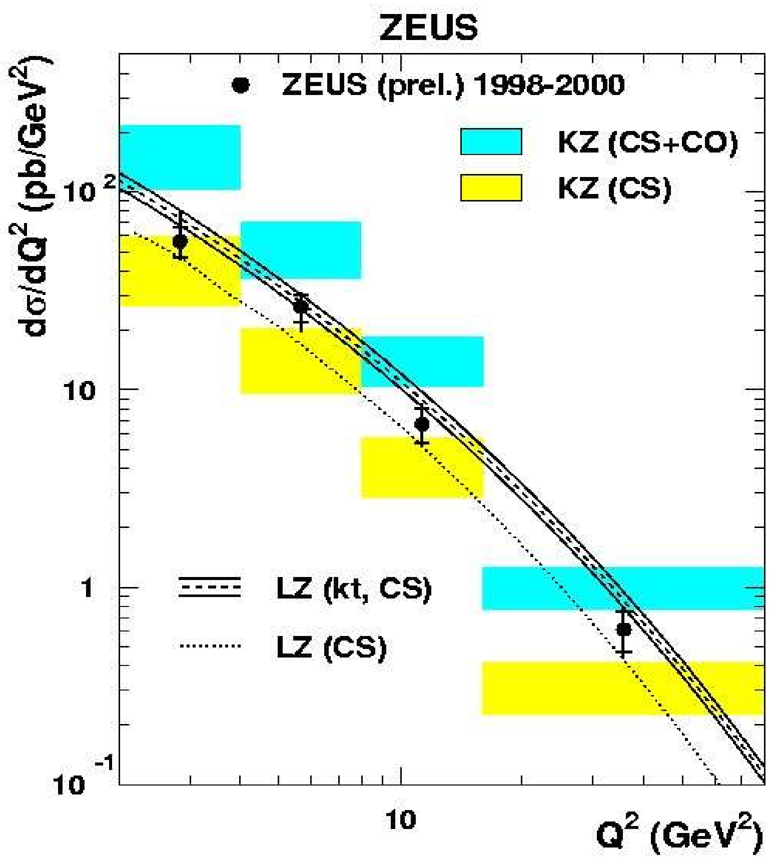


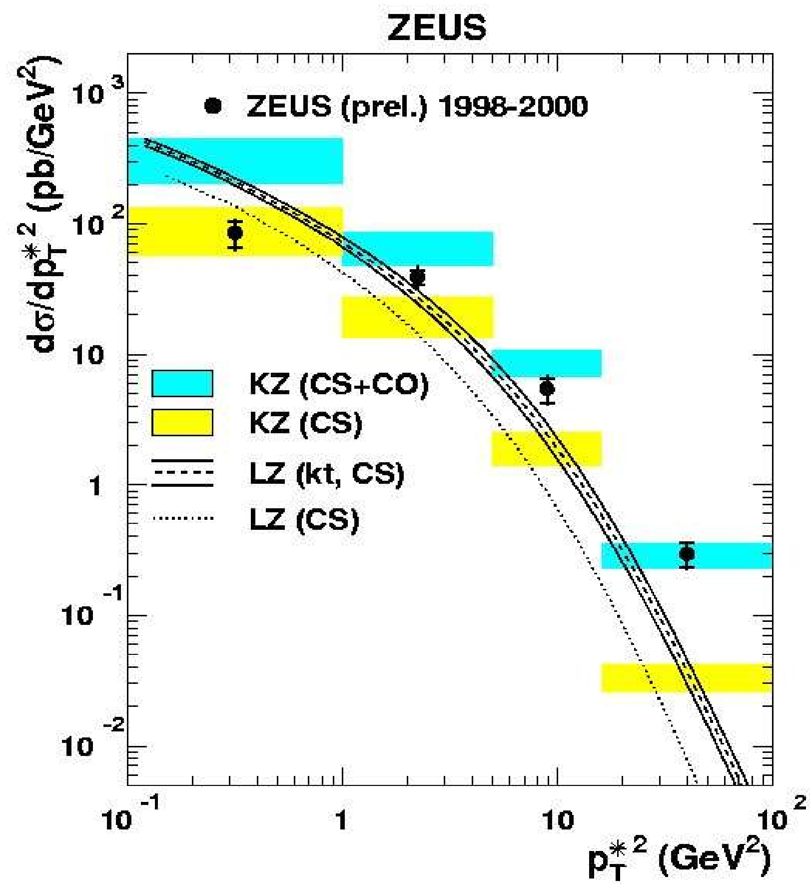


- ♣ z: missing resummation of soft terms for CS+CO; CS in good shape with data
- ♣ CS below data but shape consistent; CS+CO above data

Inelastic J/ψ in DIS: ZEUS results

Contributed paper EPS03-565





- CS too low both in Q^2 and in p_T^{*2} CS too steep in p_T^{*2} missing of higher orders?
- CS+CO too high at low Q^2 and p_T^{*2} ; CS+CO better at high Q^2 and p_T^{*2}

Polarization measurements

- Polarization of J/ψ provides information on production mechanism independent of normalization uncertainties.
- Polarization is measured in decay angular distributions in J/ψ rest frame:
  θ^* : angle μ^+ to z' axis, direction opposite to that of the proton;
  φ^*: angle μ^+ to plane determined by incoming photon and proton.

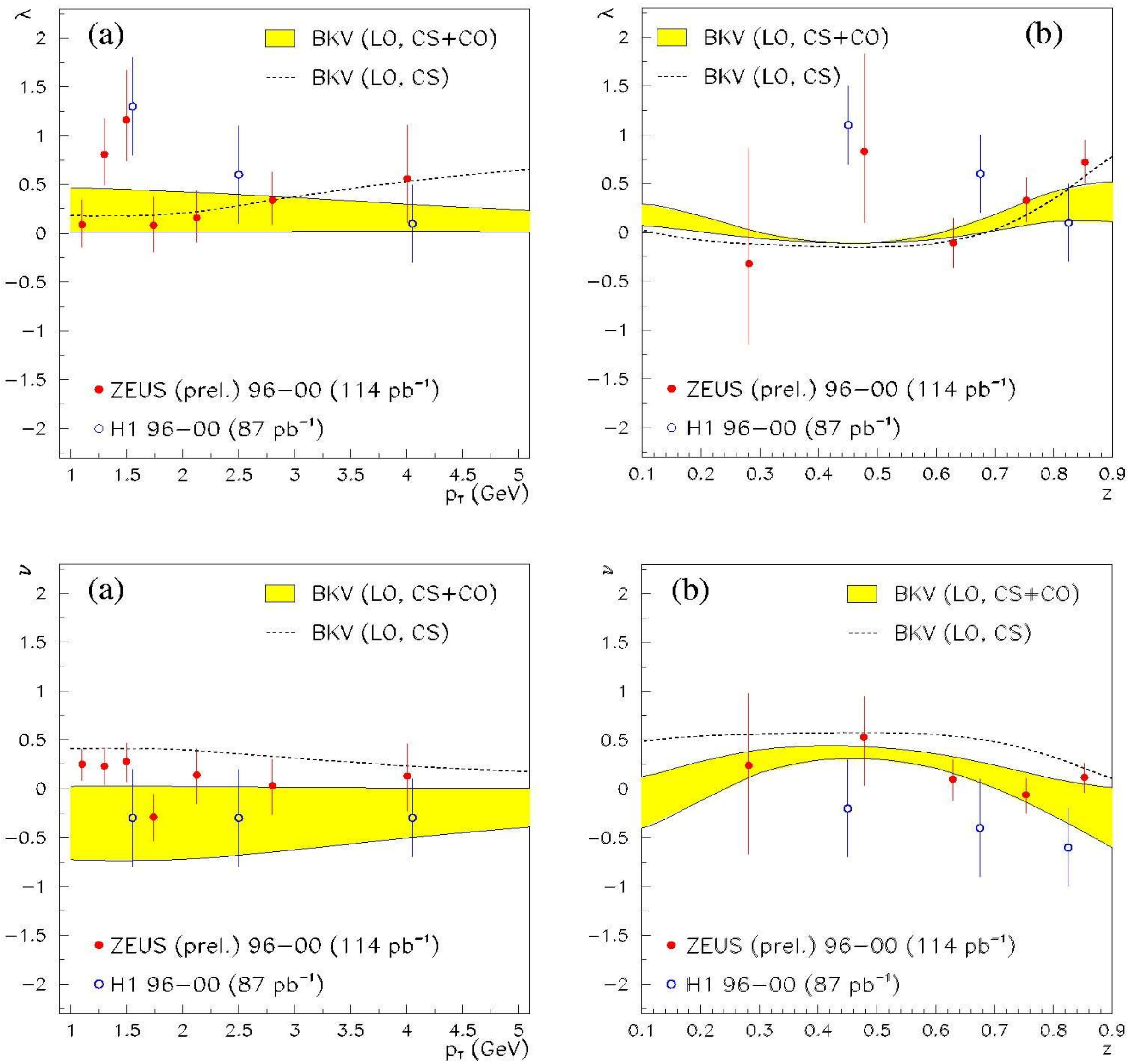
$$\frac{1}{\sigma}\frac{d\sigma}{d\cos\theta^*} \propto 1 + \lambda\cos\theta^*$$

$\lambda = +1$: transverse polarization
$\lambda = -1$: longitudinal polarization

$$\frac{1}{\sigma}\frac{d\sigma}{d\phi^*} \propto 1 + \frac{\lambda}{3} + \frac{\nu}{3}\cos 2\phi^*$$

Polarization measurements

Contributed paper EPS03-569

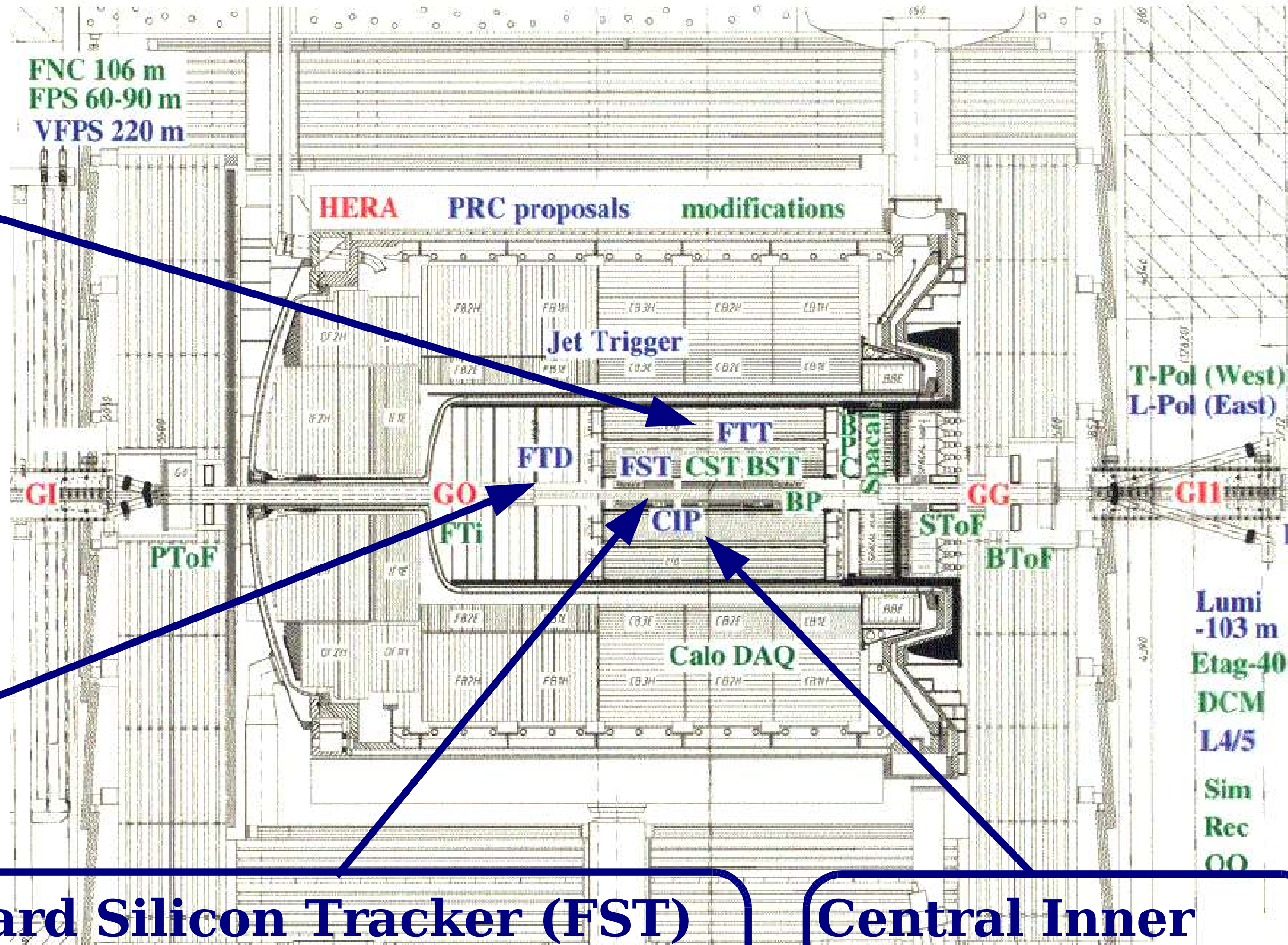


- ♠ ν **more promising variable in order to disantagle the problem**
- ♠ **more data needed for decision on production mechanism**

Detectors Upgrades

- **HERA-II is 3 times more luminous**
- **With present, revised schedule we expect about 500 pb^{-1} till 2007** (i.e. a factor 5 w.r.t. HERA I)
- **To fully exploit the potential, H1 and ZEUS have made important upgrades.**

H1 upgrades



Fast Track Trigger (FTT)

Forward Tracking Detector (FTD)

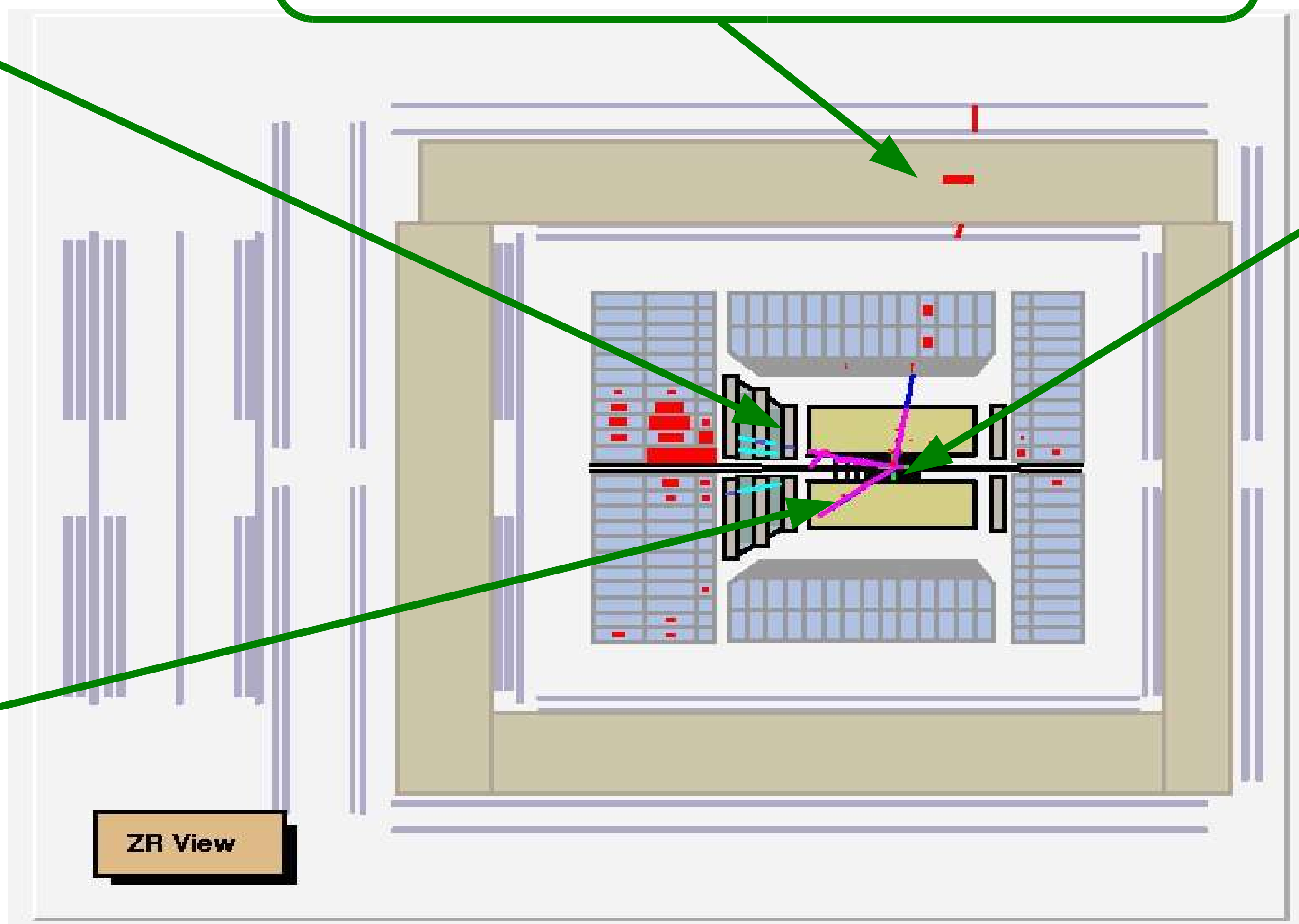
Forward Silicon Tracker (FST)
Central Silicon Tracker (CST)
Backward Silicon Tracker (BST)

Central Inner Propor. Chamber (CIP)

ZEUS upgrades

additional muon trigger based on BACking calorimeter

Straw Tube Tracker (STT)

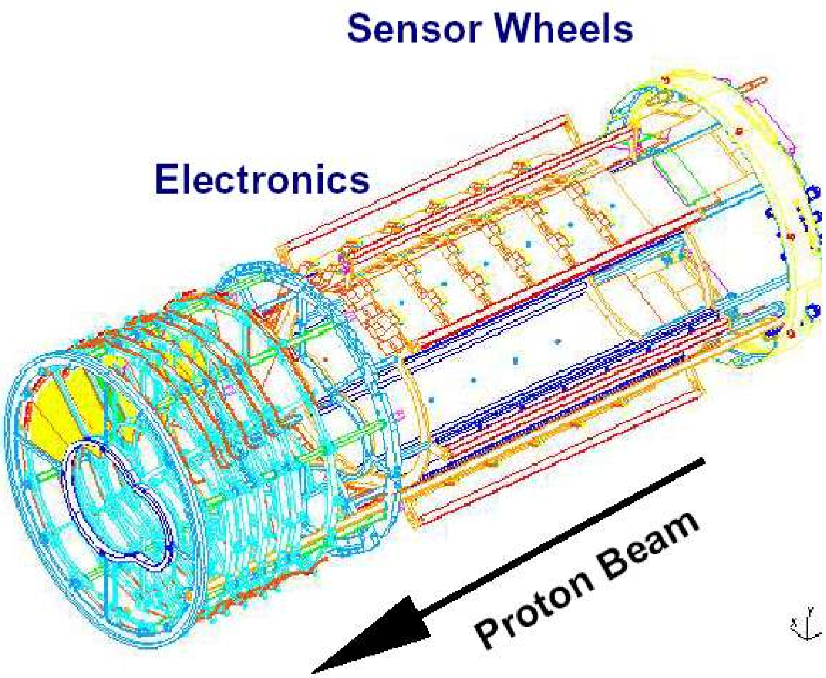


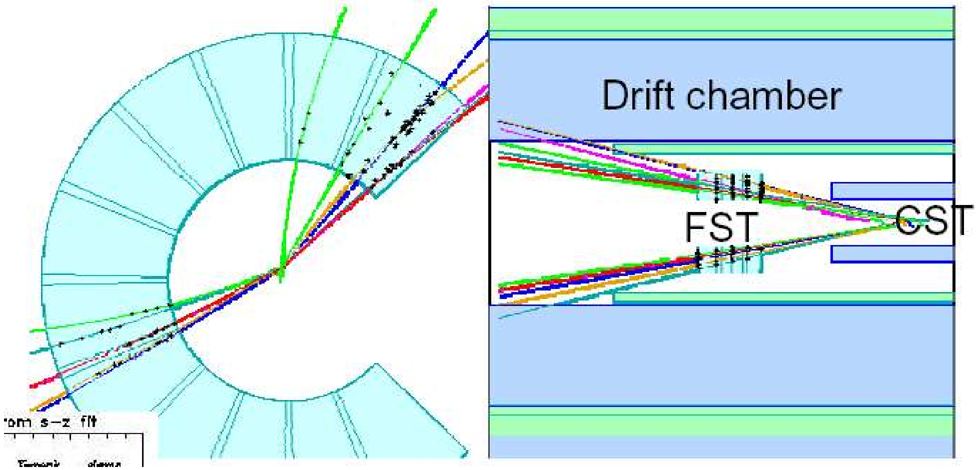
silicon Micro-Vertex-Detector (MVD)

Global Tracking Trigger (GTT)

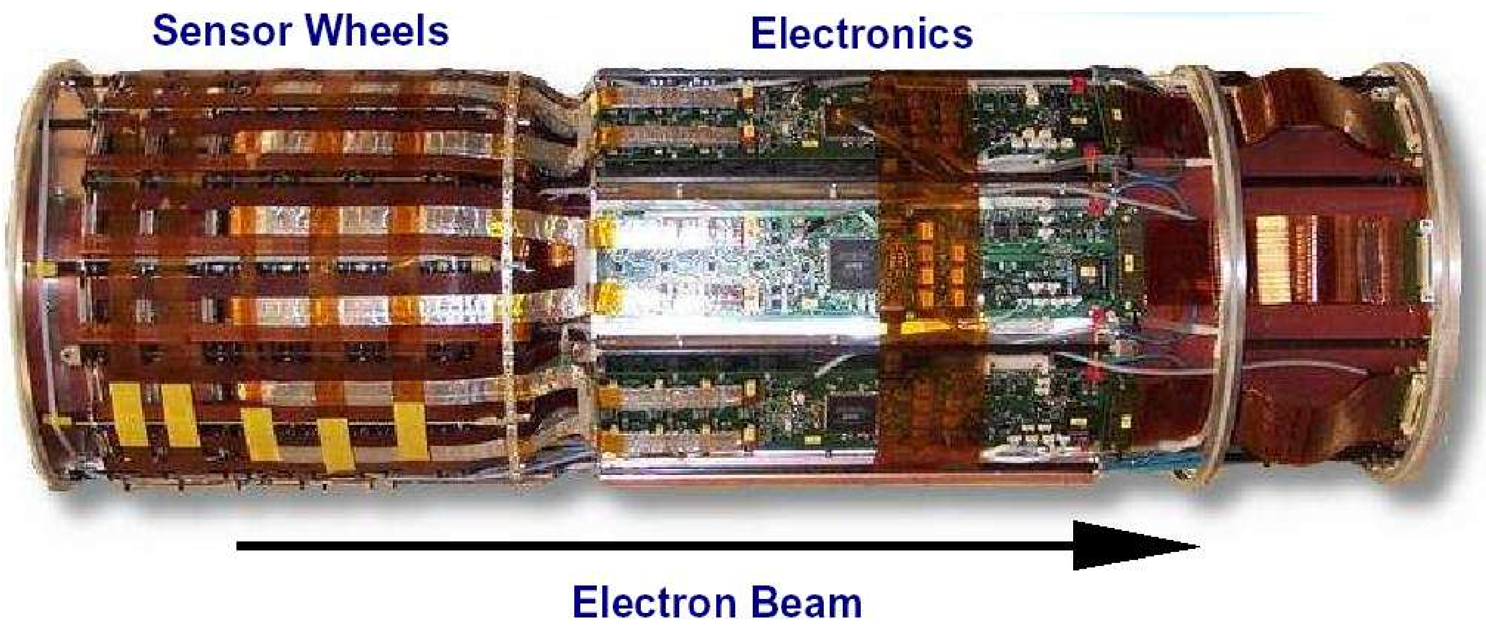
H1: Forward Silicon Tracker

- **7 disks, 5 u/v + 2 r, 92k channels**
- **After alignment: Resolution 12 μm**





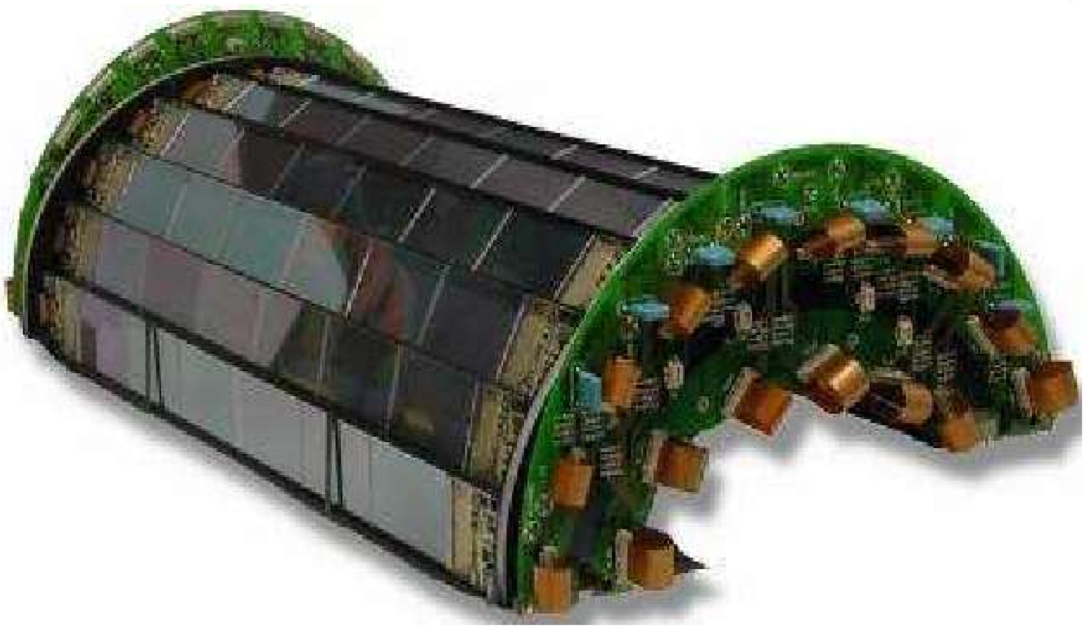
H1: Backward Silicon Tracker



- **6 wheels (u/v) for tracking**
- **84k channels**
- **Plus 4 trigger wheels with pads**

H1: new CST

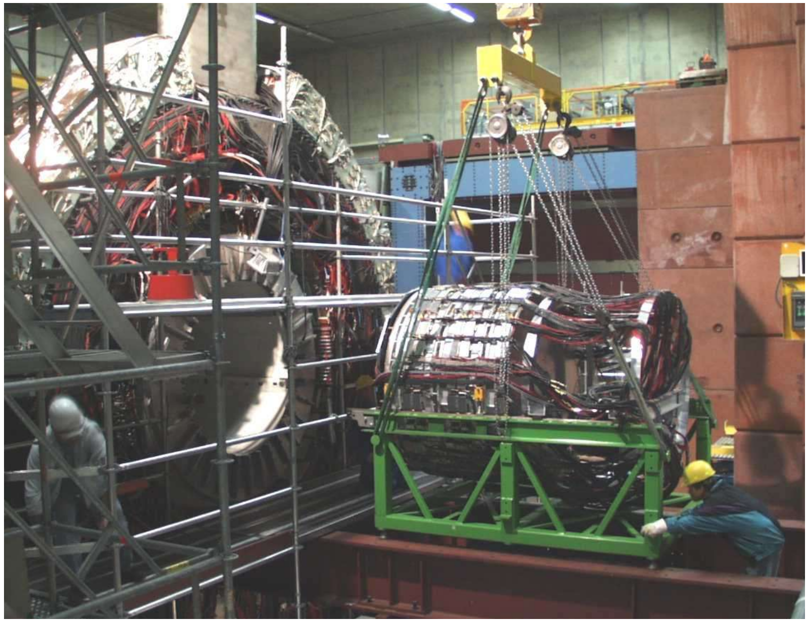
- 2 layers, 82k channels;
- Radiation hard electronics



H1: Forward and Central Tracking Upgrades

Forward tracking: →

Additional planar chamber layers to add redundancy for pattern recognition



Central Inner Prop. Chamber

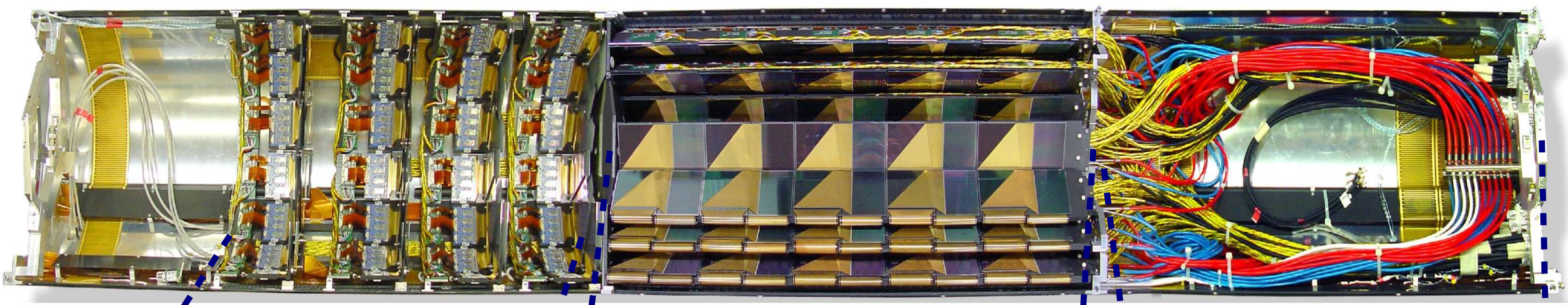
projective geometry, 10k ch'ls

z-vertex at trigger level

ZEUS: Micro Vertex Detector

forward

rear



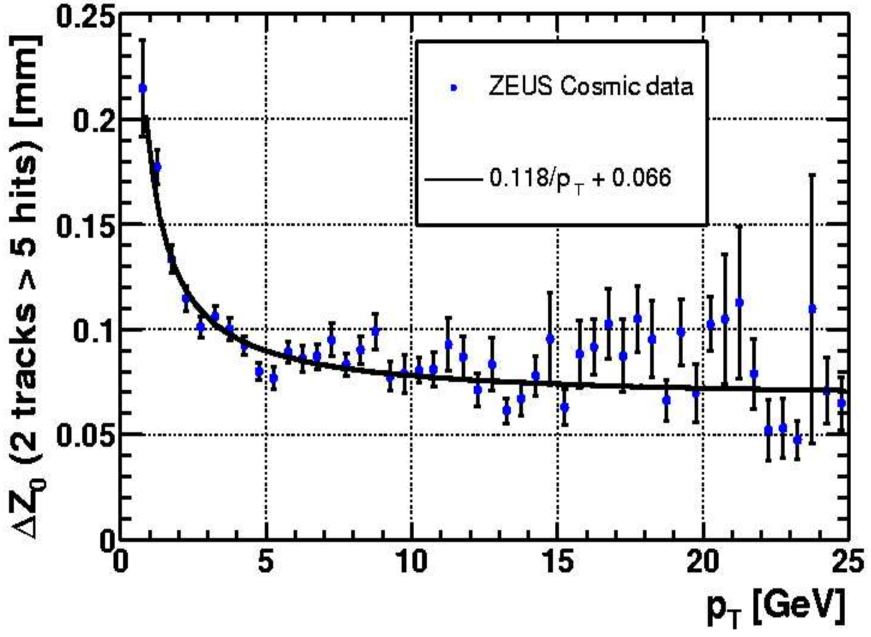
The **forward** section:
- 4 wheels;
- each one composed by 2 layers of 14 Si detectors
- Total of 112 hybrids, >50k channels

The **barrel** section:
- 30 ladders;
- each one composed of 5 modules of 4 Si detectors
- Total of 300 hybrids, >150k channels

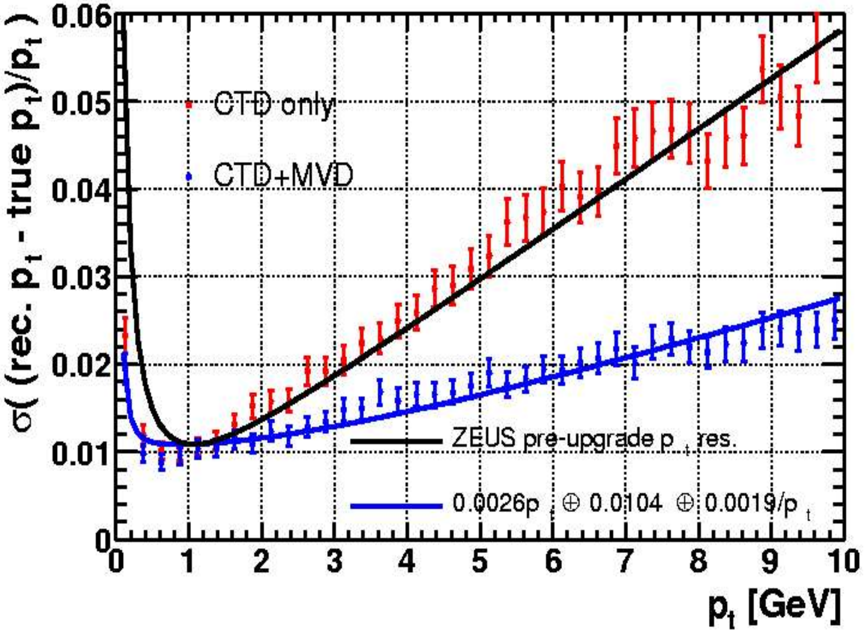
The rear section:
- Cooling pipes and manifolds;
- Distribution of FE, slow control and alignement cables

ZEUS: Micro Vertex Detector

Impact parameter resolution

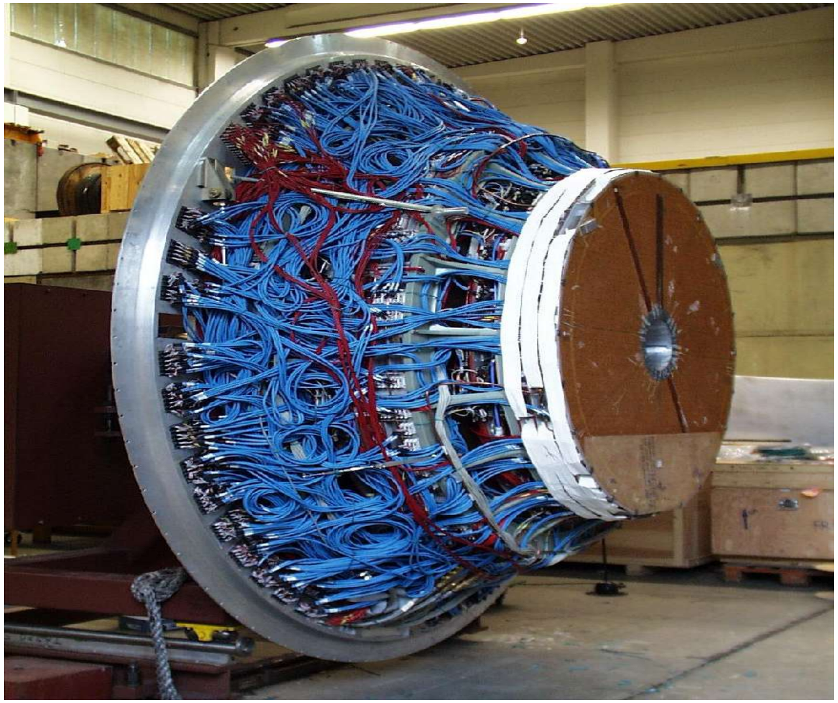


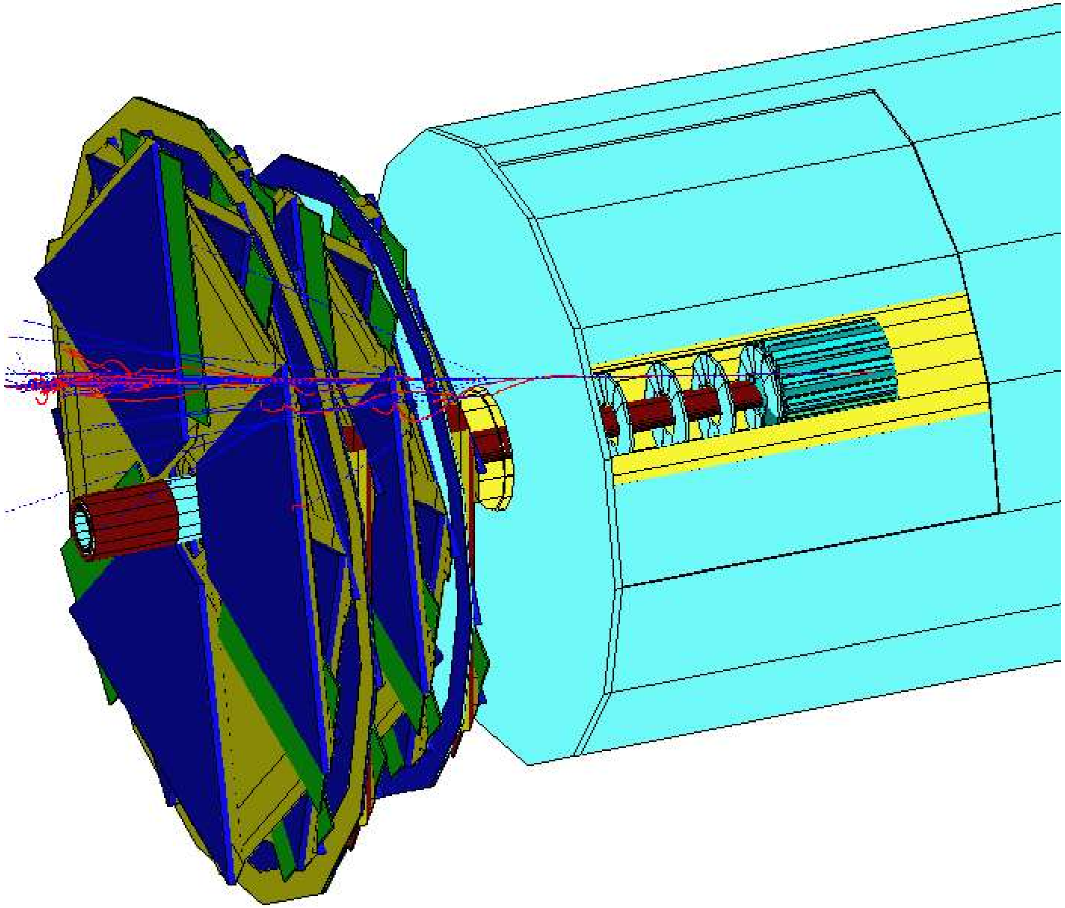
Track resolution



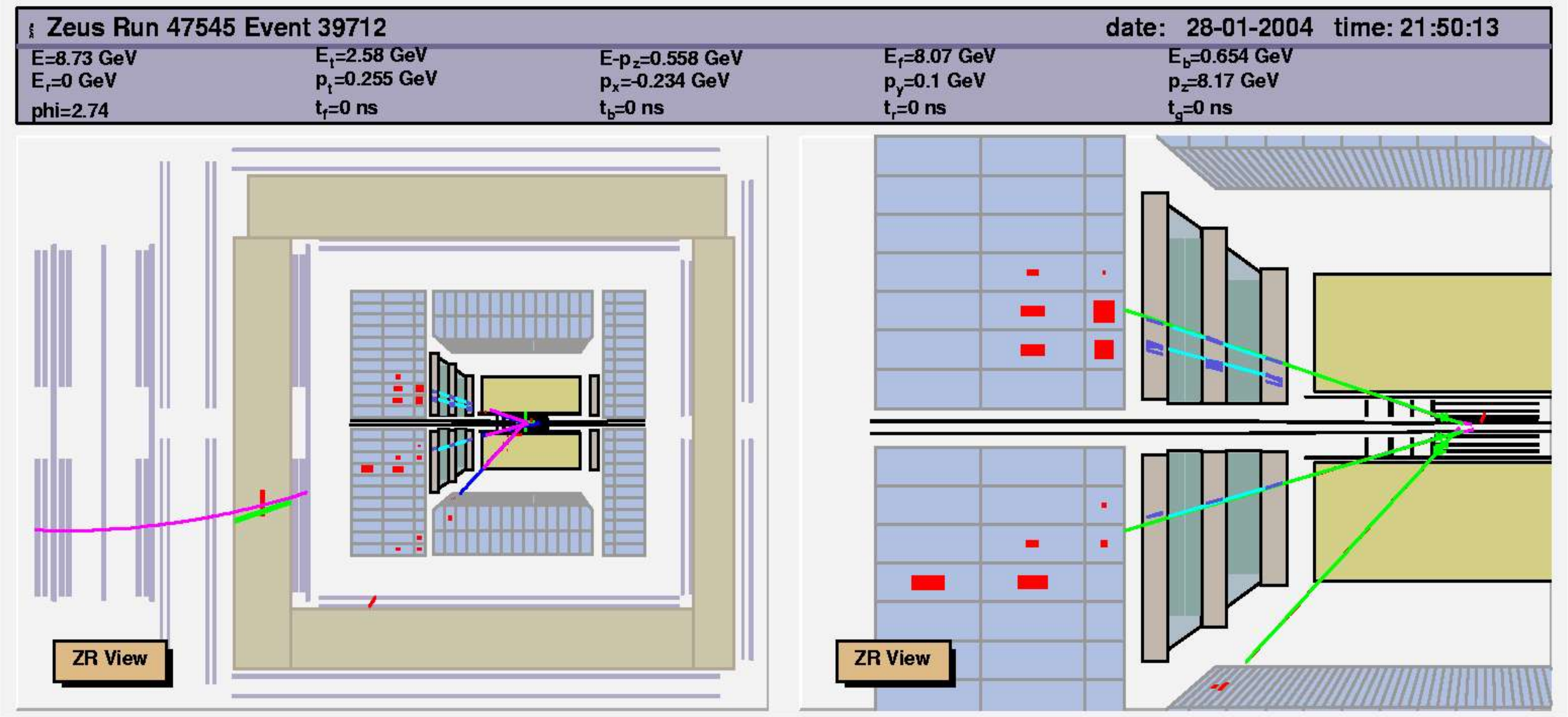
ZEUS:Forward Tracking Detector

Straw Tube Tracker (STT)
angular acceptance:
$5^{o} < \theta < 25^{o}$



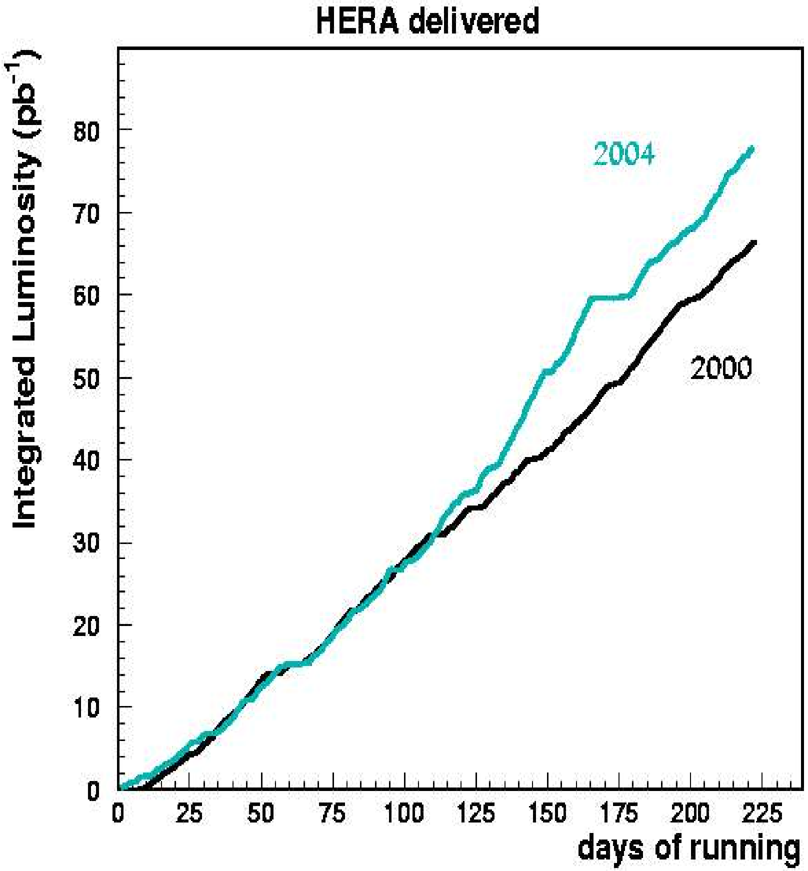


ZEUS: Forward Tracking Detector



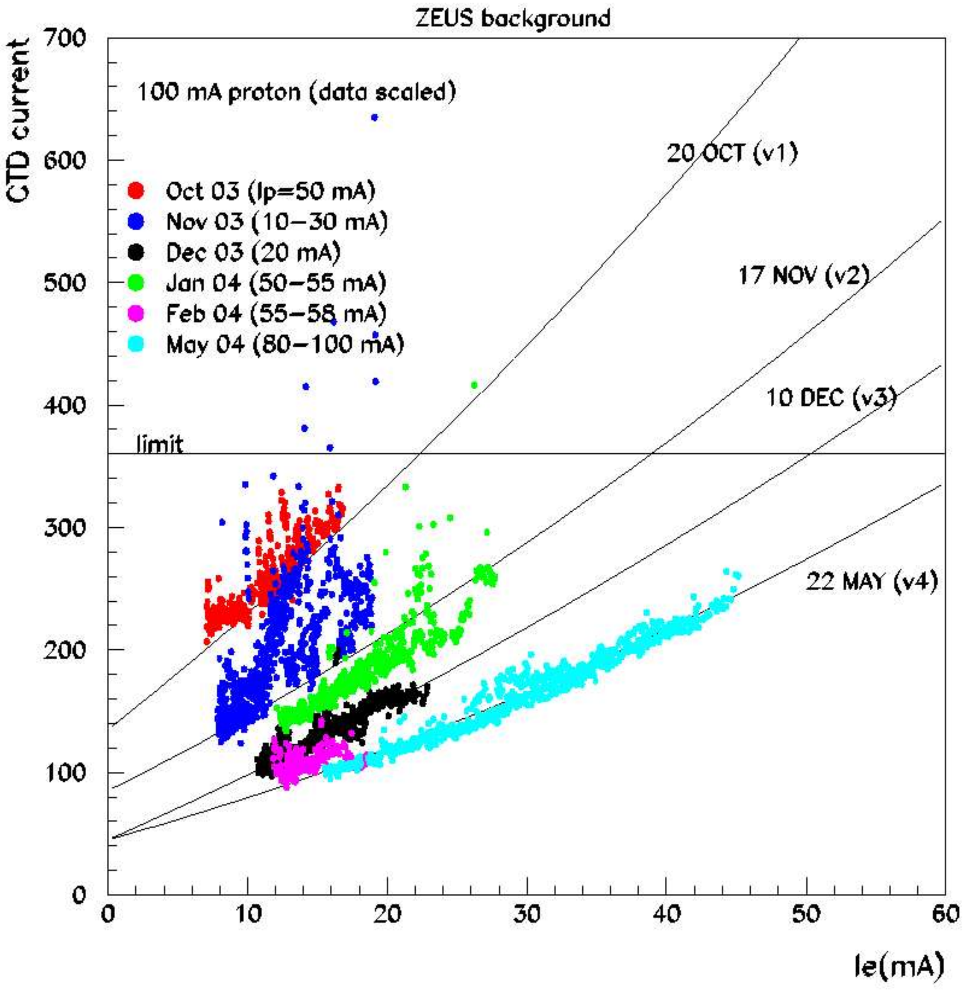
Tracks followed in MVD, STT and FMUON
Reconstruction of the forward tracks, essential for the quarkonia physics at low z ($7^o < \theta < 22^o$)

News from HERA



- Luminosity record: 3.8×10^{31} $cm^{-2}s^{-1}$ (2×pre-upgrade)
- Target : 5×10^{31} $cm^{-2}s^{-1}$
- Luminosity delivered from HERA per week: 5 pb^{-1}
- Target: 7 pb^{-1} per week

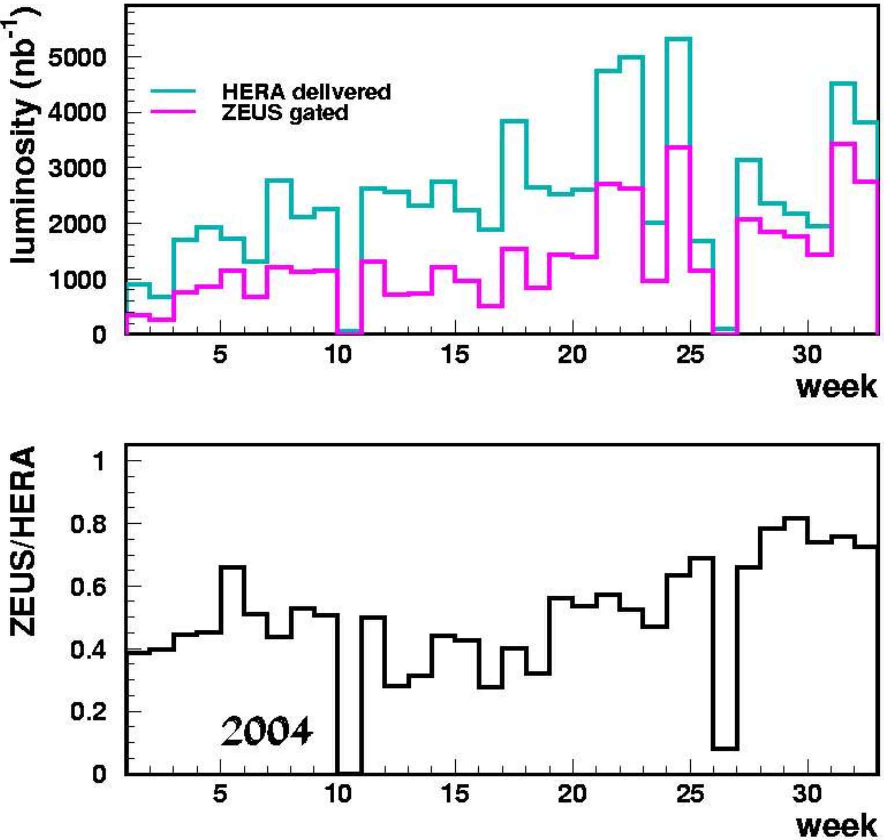
Data taking 2003-2004

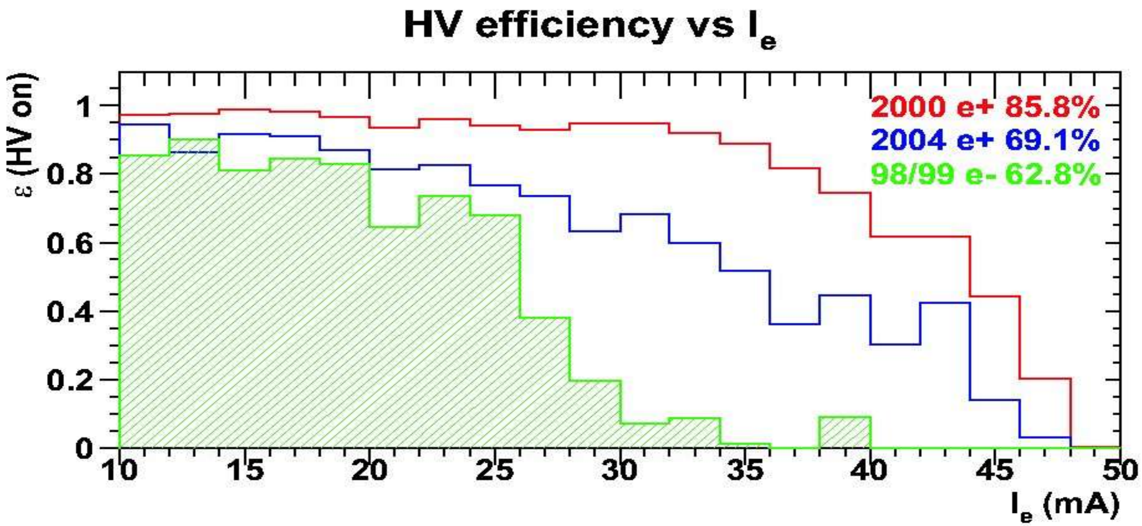


example from ZEUS

❄ **Problem of the high background finally solved !**

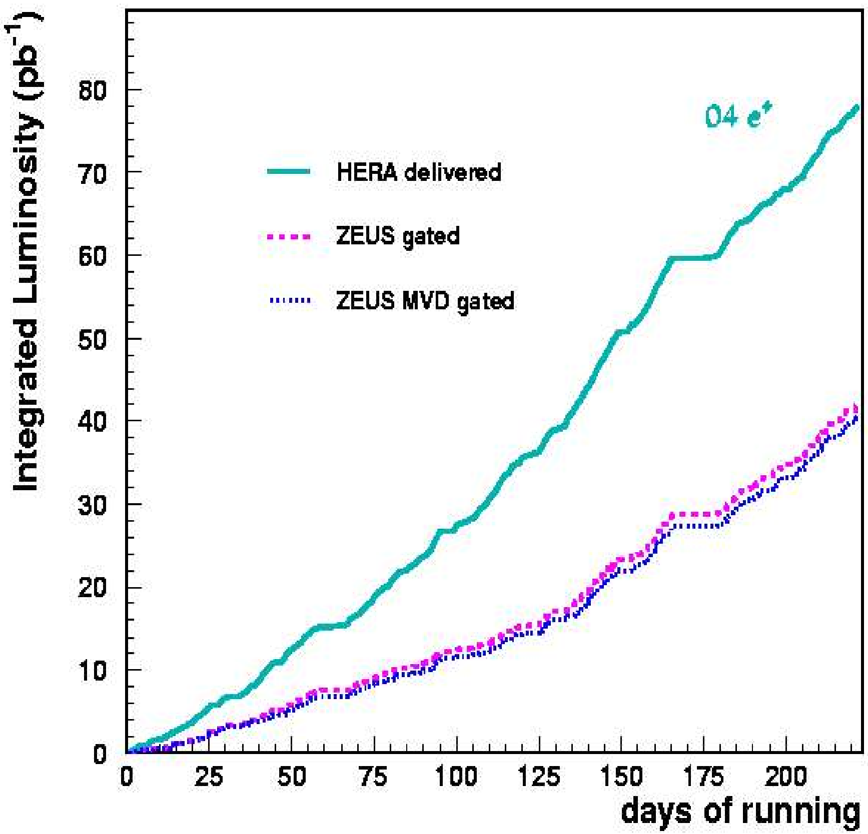
Data taking 2003-2004

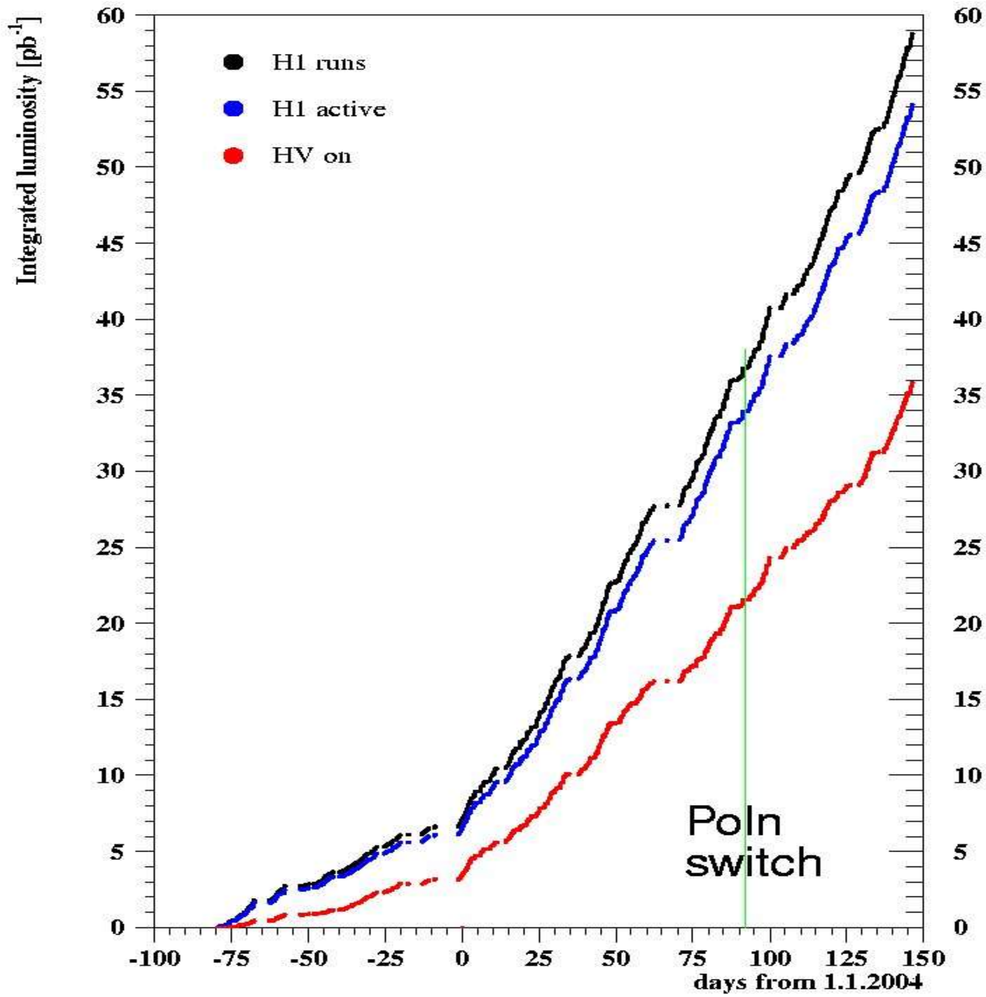




- **ZEUS data-taking efficiency ≅80 % in the last period (as in HERA-I)**
- **also H1 data-taking efficiency is now reaching the level of 2000 HV-on efficiency**

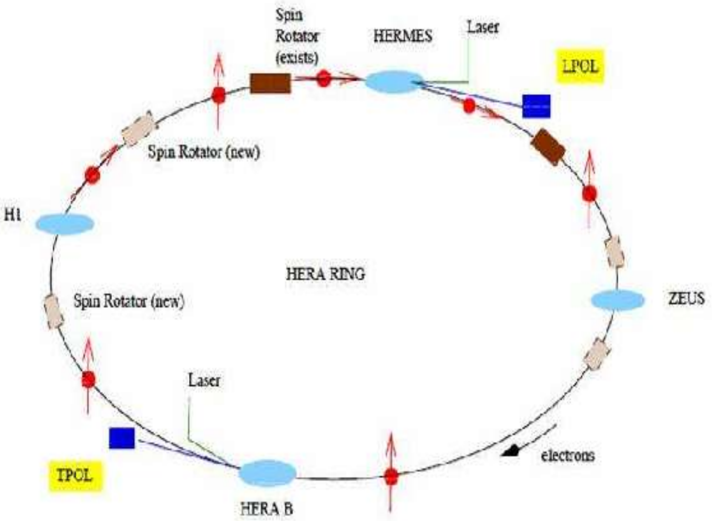
News from HERA

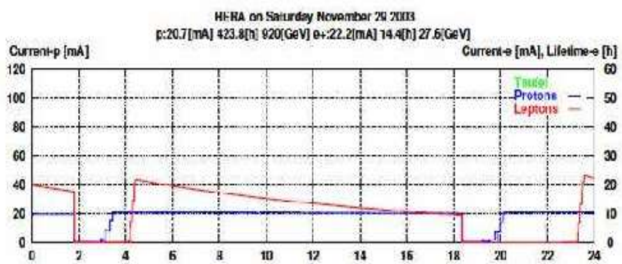


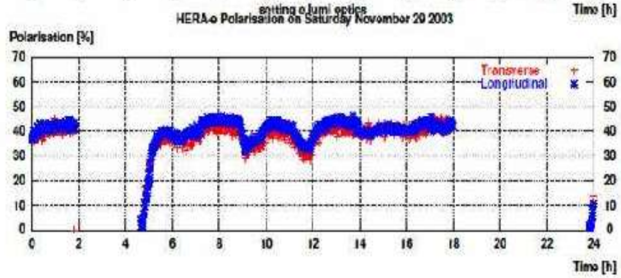


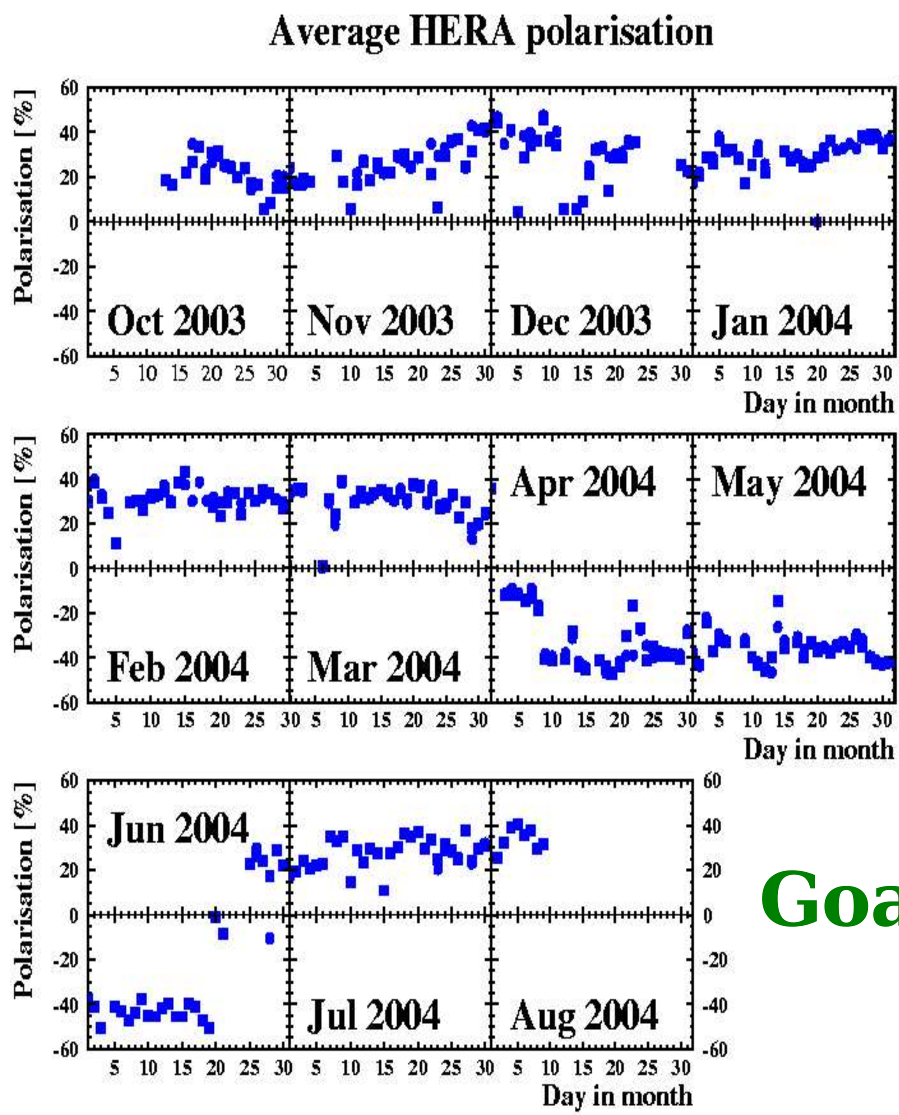
- ZEUS: 45 pb^{-1} of integrated Luminosity from October 2003 to August 2004 (97% with MVD)
- H1: similar performaces with HV on

Polarization 2003-2004









30-40%

Goal: 50%

Scenario ⟶ 2007

Possible scenario of HERA delivered luminosity up to the middle of 2007:

Scen	04	04	05	05	06	06	07	e^+	e^-	Sum
1	e^+ 70	e^+ 30	e^+ 170	e^- 15	e^- 150	e^+ 30	e^+ 230	e^+ 530	e^- 165	695
2	e^+ 70	e^+ 30	e^+ 170	e^- 15	e^- 150	e^- 45	e^- 160	e^+ 270	e^- 370	640
3	e^+ 70	e^- 10	e^- 110	e^- 30	e^- 150	e^+ 30	e^+ 230	e^+ 330	e^- 300	630
4	e^+ 70	e^+ 30	e^- 90	e^- 30	e^- 150	e^+ 30	e^+ 230	e^+ 360	e^- 270	630

- DESY directorate has chosen the scenario n.3
- With equal luminosity for e^+ ed e^- (and divided equally in P = RH and P = LH)

Physics prospects for Hera II

From the Chapter 5 of the Yellow Report:

- J/ψ and $\psi(2S)$ measurements can be improved and extended into new kinematical regions.
- Search for inelastic χ_c photoproduction: powerful tool in order to discriminate between evaporation model and NRQCD.
  In fact evaporation model predicts a large universal cross section, similar to that at hadron colliders, for which of $\sigma(\chi_c)/\sigma(J/\psi) \approx 0.5$; in NRQCD the ratio is a process dependent strongly suppressed:
  $$\sigma(\gamma p \to \chi_{cJ} X)/\sigma(\gamma p \to J/\psi X) \approx (2J+1)\times 0.005.$$
- Search of the states $\eta_c(1S)$, $\eta_c(2S)$, $h_c(1P)$: important from the theoretical point of view, but difficult to find from the experimental side.

Physics prospects for Hera II

From the Chapter 5 of the Yellow Report:

- Search for the process: γp → J/ψ+γ+X : for z ≥ 0.5 the process proceeds only as colour octet process, at low z both color octet and color singlet contribute. Very low cross-section and large background from π^0, η decays.
- Study of the inelastic photoproduction of bottonium states for the first time. Theoretical predictions on a safer ground respect to the J/ψ…but bottonium cross section 2 order of magnitude lower than charmonium.

Summary

- ZEUS is completing two papers about inelastic J/ψ using HERA-I data (see prel. results at EPS03).
- H1 and ZEUS detectors have improved performances respect to HERA-I period due to new detectors, new trigger tools and offline algorithms.
- The major part of these upgrades are devoted to heavy quark physics.
- HERA-II, after a bad period, seems to have reached a stable beams operation and has started to give luminosity near to the upgrade design …
- … so we hope !!!

Backup slides

News from the Zeus Detector

- New microvertex detector (MVD): →
  better tracking
- New forward tracking detector (STT): →
  higher angular acceptance (quarkonia at low z)
- The BAC detector has now the possibility of triggering: →
  higher angular acceptance (quarkonia at low z),
  higher muon efficiency
- Improved offline muon finder: →
  higher muon efficiency
- In general, good performances of the old detectors: CAL, CTD, Barrel and Rear muon Chambers.