H1: Status and Prospects

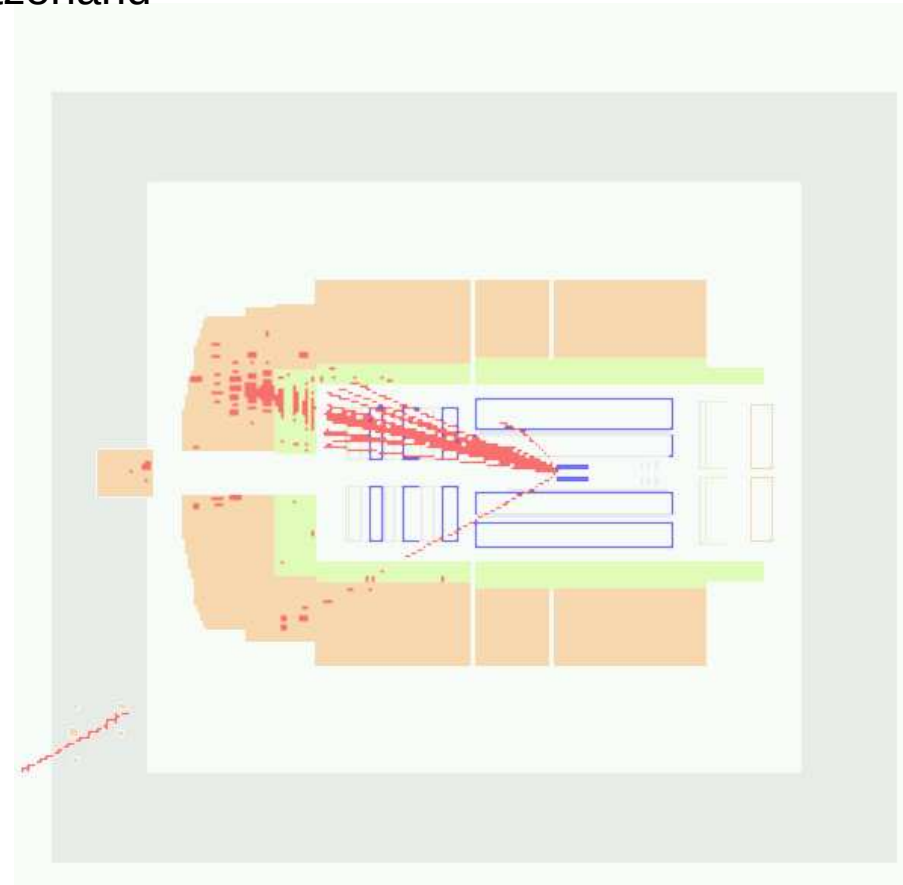
DESY PRC Meeting

May 7th, 2003

André Schöning

ETH Zürich, Switzerland

- Physics Results from HERA I
- HERA II operation
- H1 Shutdown Activities



Physics Results (HERA I)

- DIS Workshop St.Petersburg $\rightarrow$ 29 talks by H1 speakers
- Lot of new results (26):
  - Diffr. DIS Cross Section at low Q^2
  - Diffr. Cross Section $\sigma_r^{D(3)}$ at high Q^2
  - Diffr. Photopr. of Jets at HERA
  - F_2 from QED Compton Scattering
  - Determination of F_L at low Q^2
  - QCD Analysis of NC and CC c.s.
  - Search for Excited Electrons
  - Isolated e and μ events with $p_T^{\rm miss}$
  - Search for doubly charged Higgs production
  - Search for R-parity violating SUSY
  - Search for Magnetic Monopoles
  - Contact Interactions
  - Search for Single Top Production
  - Inclusive Jets in Photoproduction
  - Inclusive Jets in DIS
  - Dijet Production at low x_B in DIS
  - Forward jet production at HERA
  - Forward π^0 production at HERA
  - Inclusive η, ρ, f_0, f_2 Photoproduction
  - Prompt Photon Production with jets
  - Inclusive Prompt Photon Production
  - Diffr. Photopr. of $J/\Psi(2S)$ mesons
  - Diffr. Photopr. of J/Ψ at large t
  - Elastic Photopr. of J/Ψ mesons
  - Photoproduction of D^* mesons
  - D^* mesons associated with jets in DIS

Physics Topics Overview

- Isolated e and μ events with p_T^{miss} (recent paper)
- Search for Single Top Production (preliminary)
- NC and CC cross sections and QCD Analysis (recent paper)
- Contact Interactions (preliminary)
- Determination of F_L at low Q^2 (preliminary)
- Inclusive Jets in Photoproduction (recent paper)

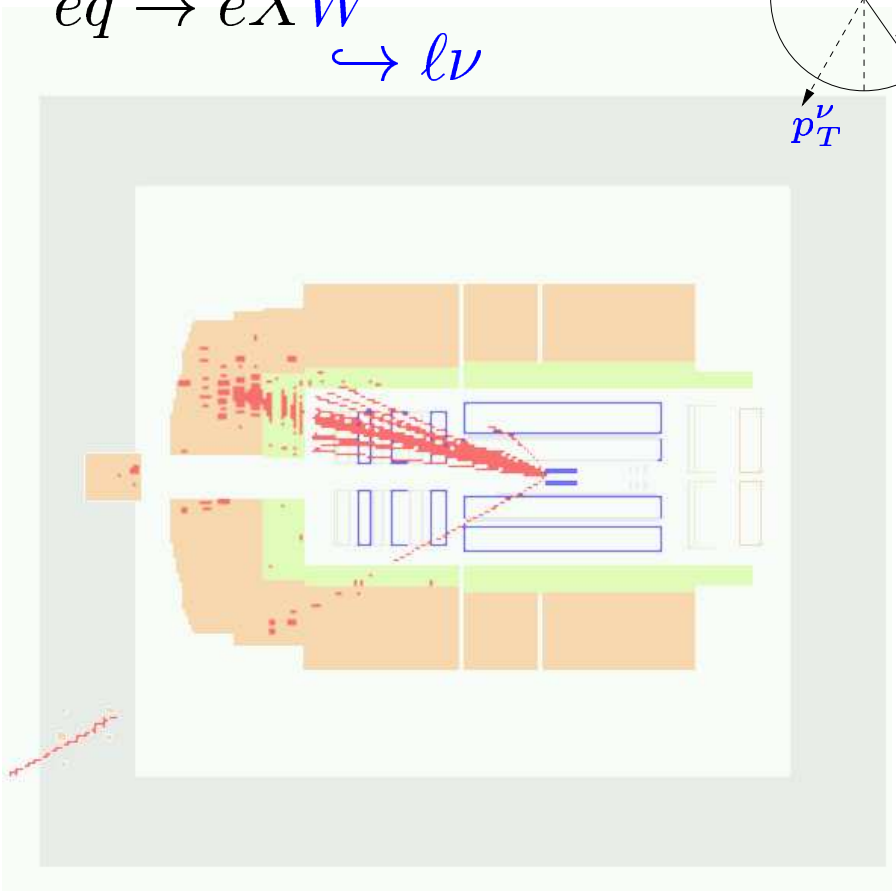
Isolated Lepton Events with $p_T^{\rm miss}$

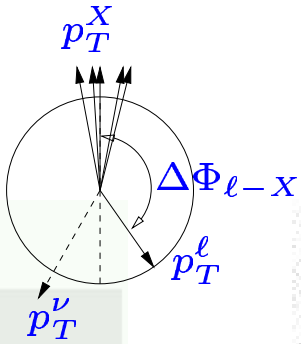
HERA I: DESY 02-224, accepted by *Phys. Lett.* **B**

HERA I analysis finished

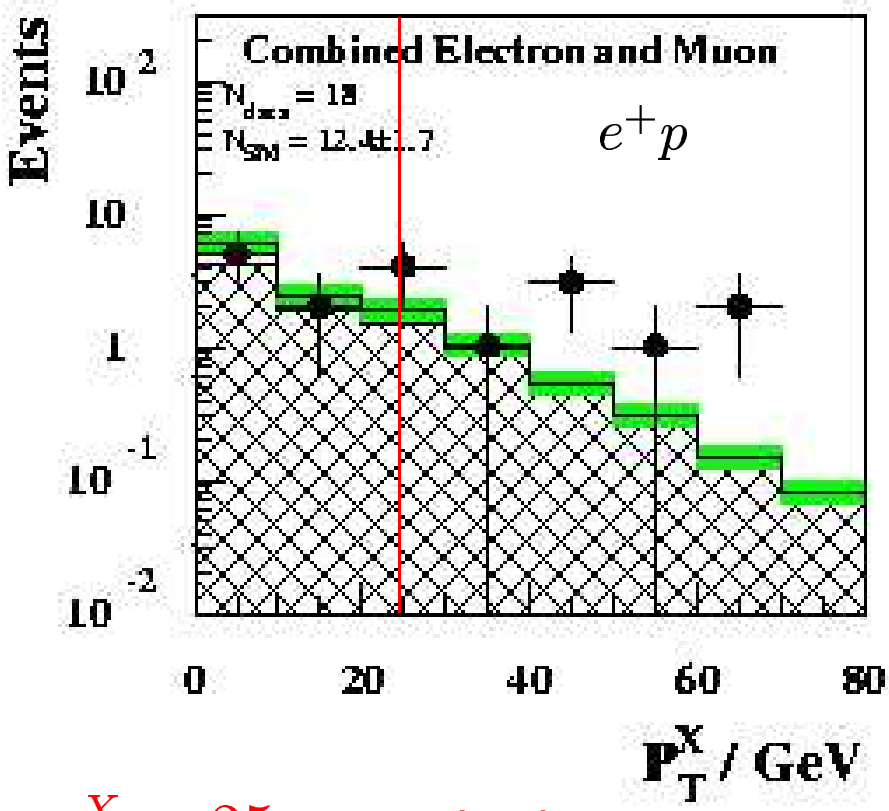
- Main SM production process:

$$eq \to eXW \hookrightarrow \ell\nu$$





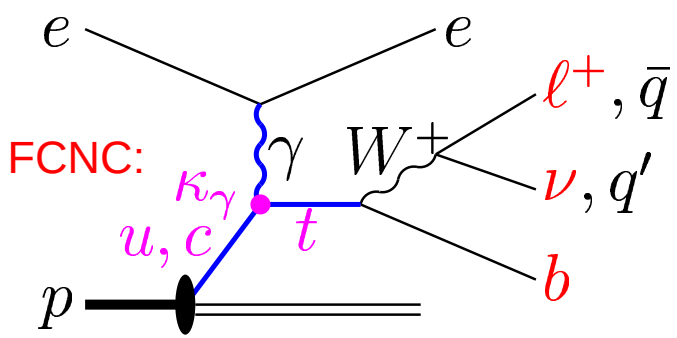
$$p_T^\ell > 10, p_T^{\rm miss} > 12 \text{ (GeV)}$$
$$D_{\ell,\rm jet} > 1$$
$$\Delta\Phi^{\rm aco}_{e(\mu)-X} > 20^\circ (10^\circ)$$



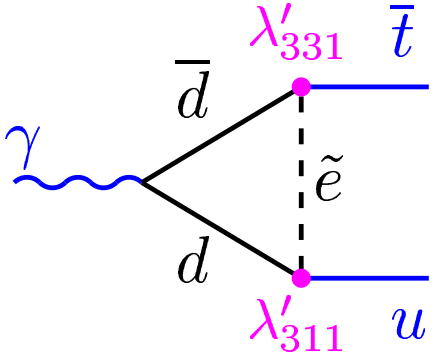
$p_T^X > 25 \Rightarrow$ 10 (2.9) events

Single Top Production

- Production of single top quarks at HERA via anomalous magnetic coupling κ_γ
  - Search for: $eq \to eXt^+$



sensitive to new physics: e.g. SUSY



→ isolated lepton topology (excess)

→ high E_T 3-jet events

e^+p data (105 pb^{-1}):

- top selection cuts:
  - $\mathrm{Charge(top)} = +1$
  - $M_{\ell\nu} > 10$ GeV
  - $p_T^{\mathrm{jet}} > 25, 35$ GeV

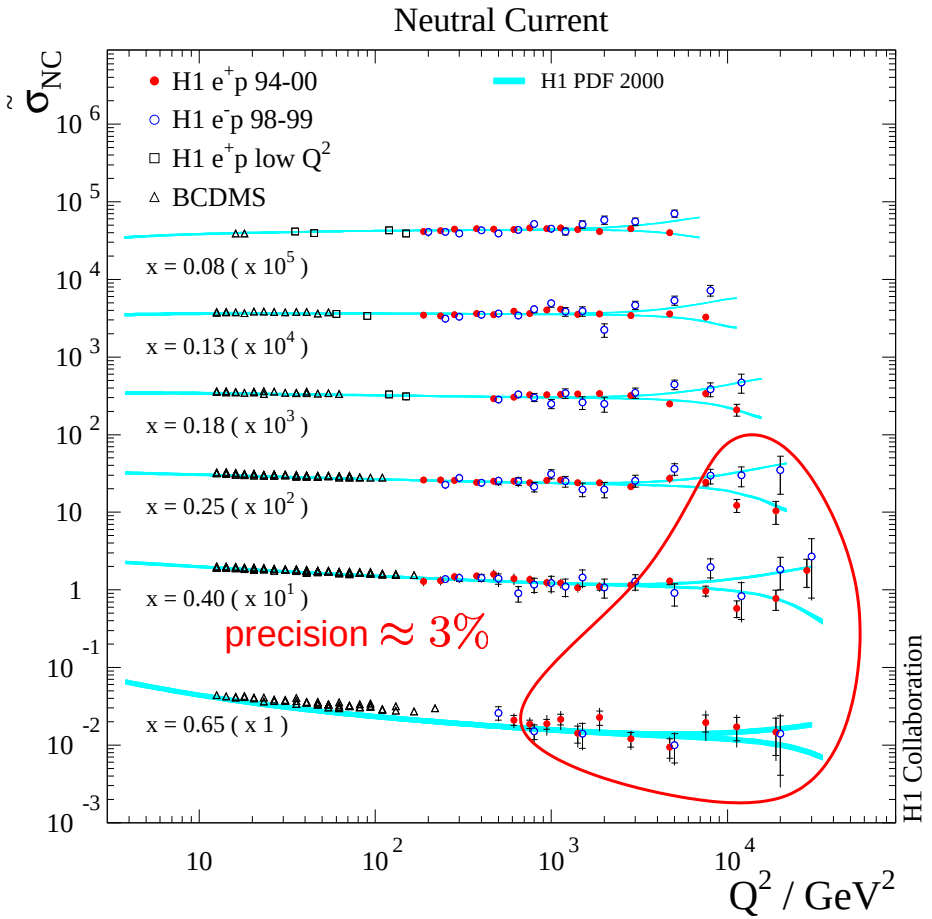
	W selection		Top selection (prel.)	
$p_T^X > 25$	Electron Ch.	Muon Ch.	Electron Ch.	Muon Ch.
Data (SM)	**4 (1.49)**	**6 (1.44)**	**3 (0.75)**	**2 (0.77)**

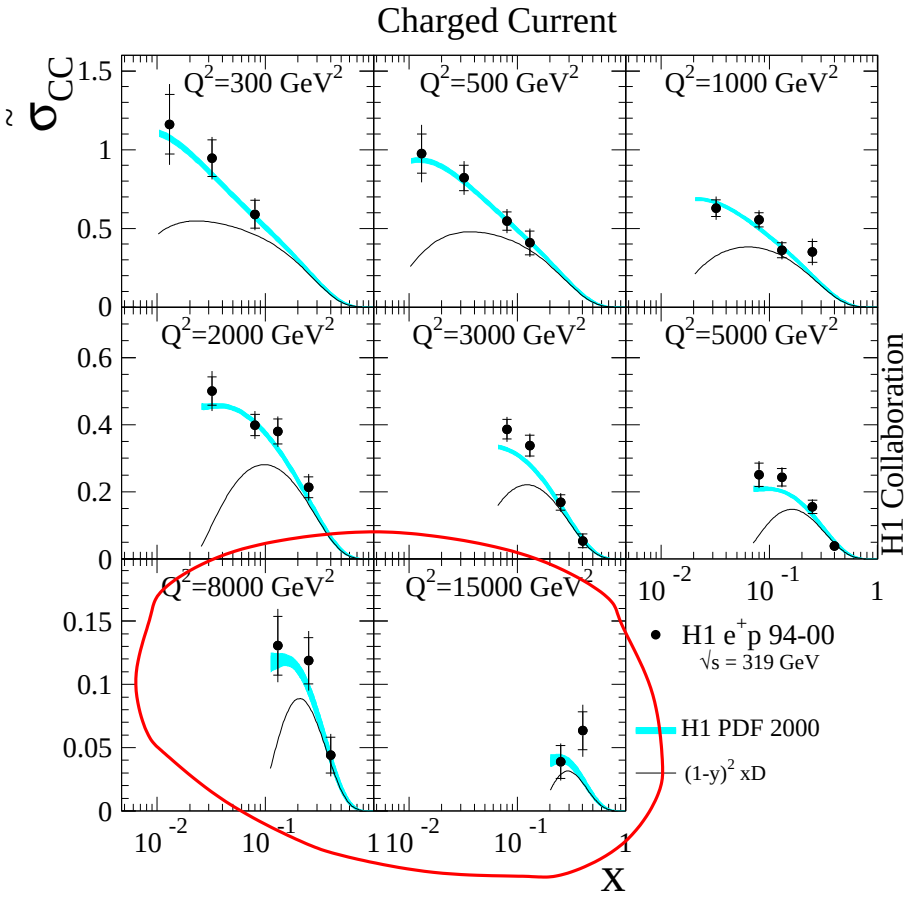
Sign of new physics?

NC and CC Cross Sections and QCD Analysis

DESY 03-038, submitted to *Eur.Phys.J*

final word from HERA I



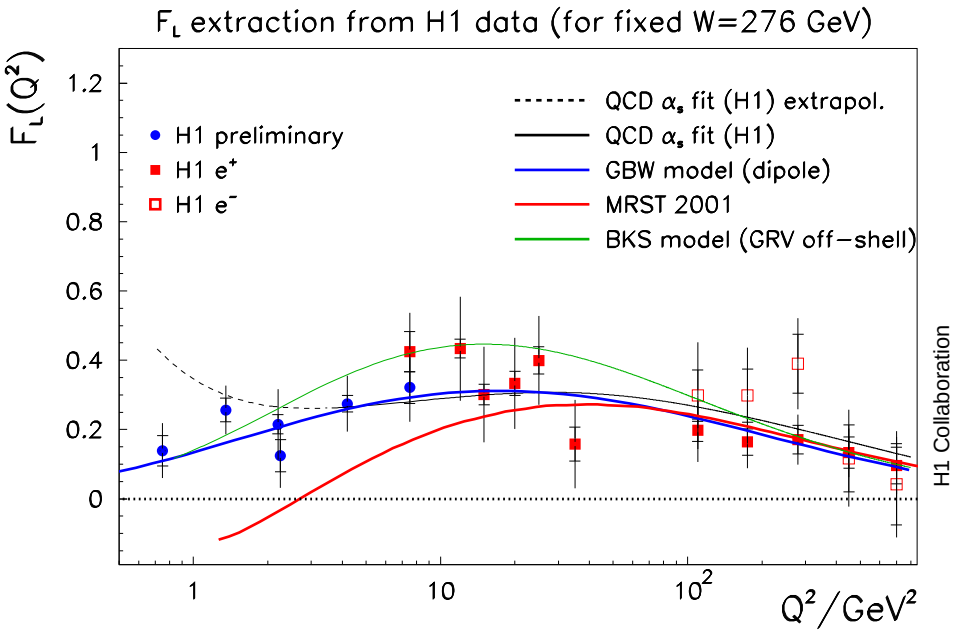


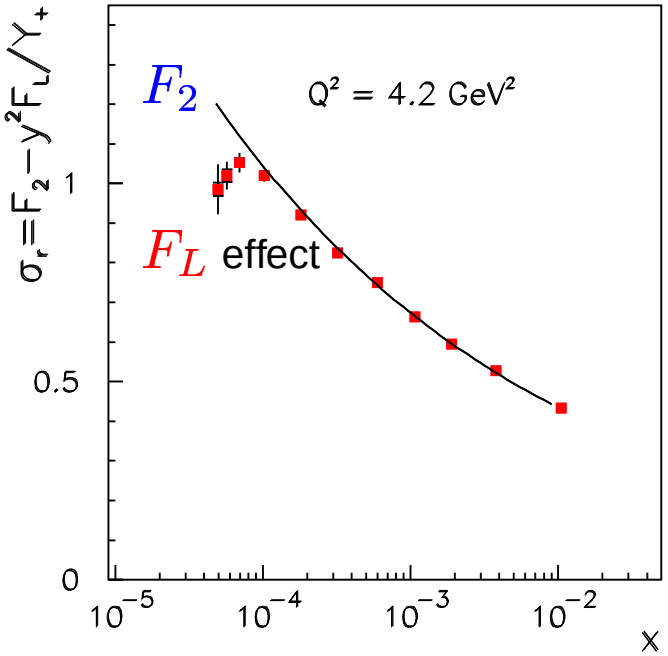
- Extraction of F_2, xF_3, F_L, pdf, α_s statistical uncertainties at high Q^2,x still large
- Search for contact IA: $\Rightarrow \Lambda \gtrsim 1-5$ TeV, extra dim. $M_S > 0.8$ TeV, $R_q \lesssim 10^{-18}$m

Longitudinal Structure Function F_L

- NC cross section: $\frac{d^2\sigma}{dx\,dQ^2} \propto \left(1+(1-y)^2\right) F_2 - y^2 F_L$
- Measurement (indirect):

  extrapolate F_2 measured from a large region of x,Q^2 to high y



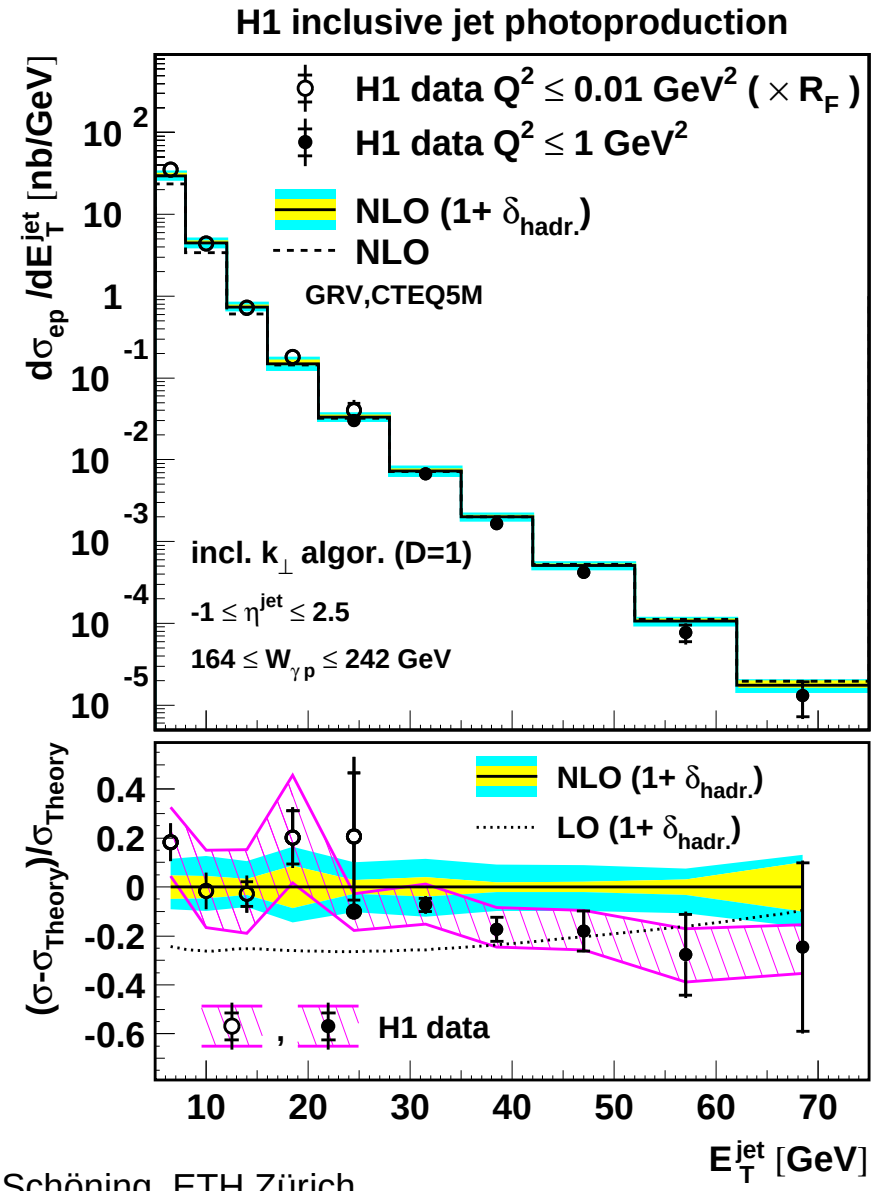


$\Rightarrow$ F_L can discriminate models

- A direct measurement requires running at lower proton beam energies

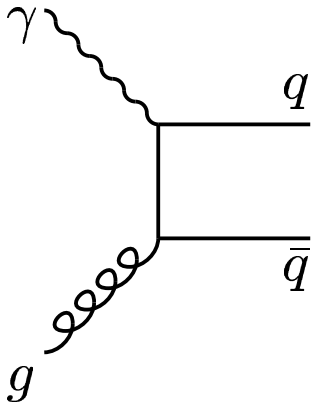
Inclusive Jets and QCD

DESY 02-225, accepted by *Eur.Phys.J*

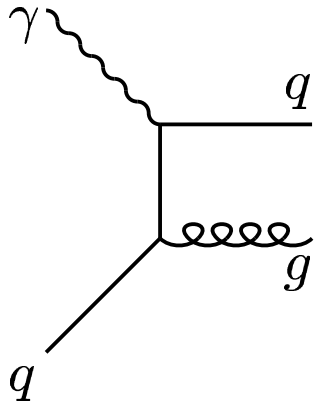


- Example LO diagrams:

gluon-photon fusion



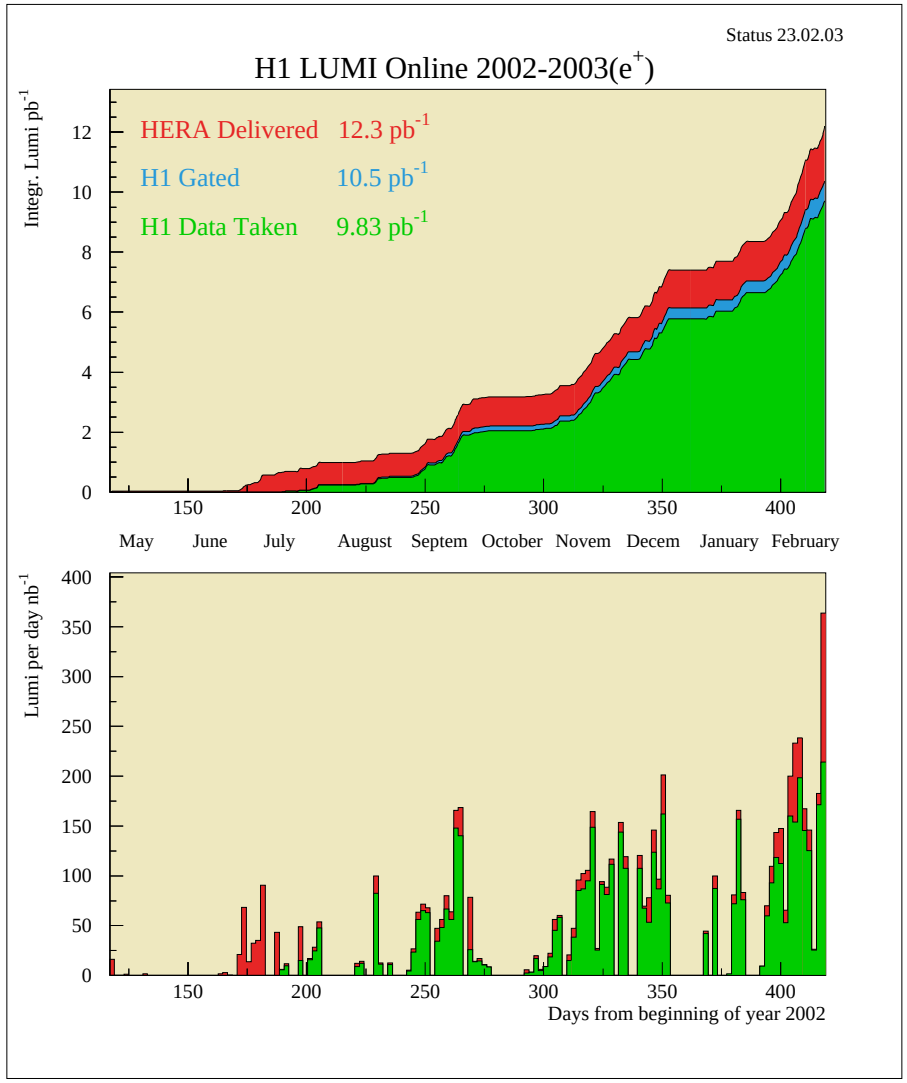
QCD Compton



- good description by NLO calculation over more than 6 orders of magnitude!
- test of pert. QCD at large scales E_T^{jet}

  $\Rightarrow$ sensitive to α_s, pdf

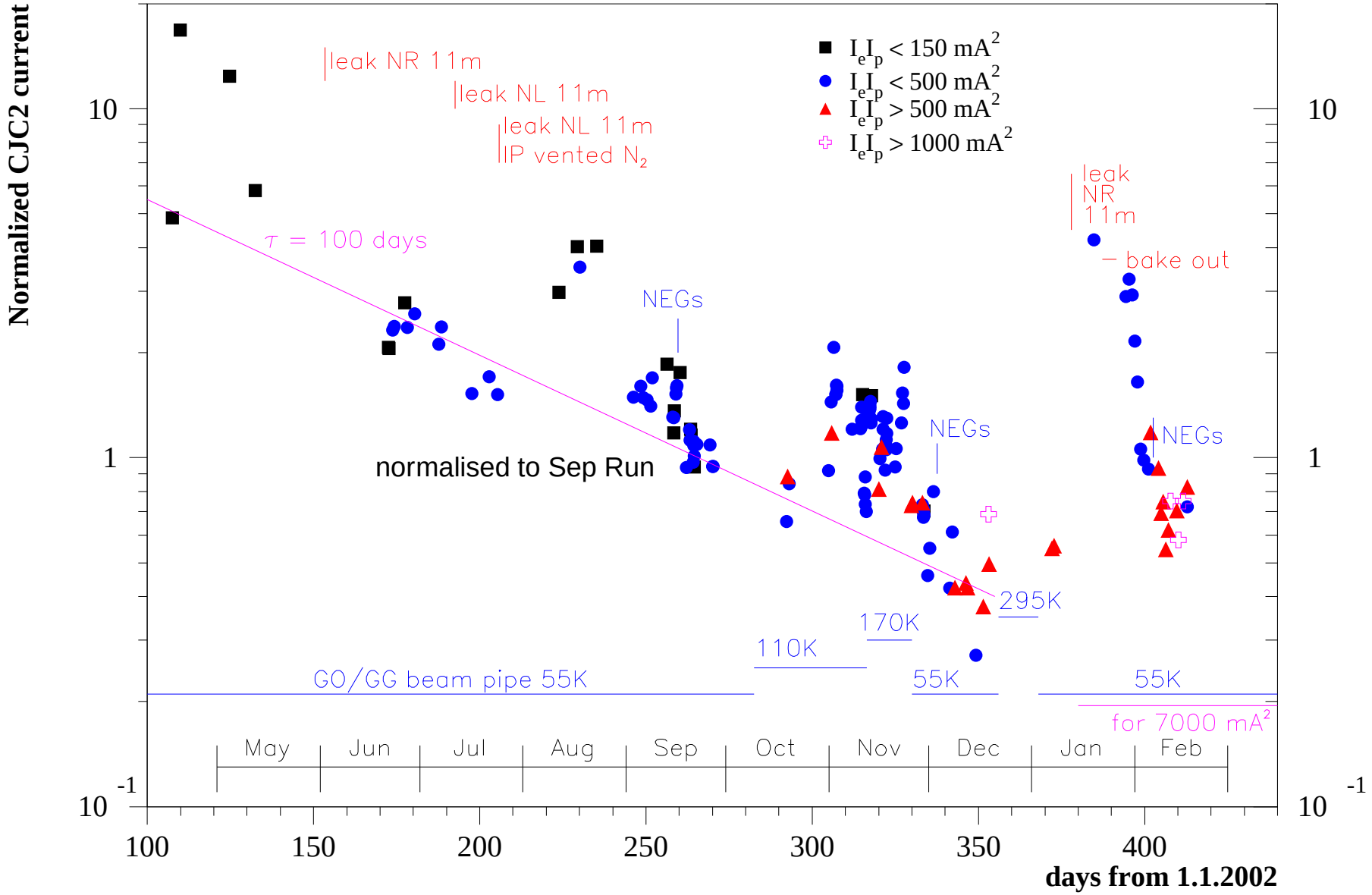
HERA II Operation



- Background conditions limited operation of both central drift chambers CJC1/2 to $\approx 2.5\,\mathrm{pb}^{-1}$ (taken $\approx 10\,\mathrm{pb}^{-1}$)
- lot of time devoted to dedicated backgr. studies
- inner tracking detectors suffered from large radiation and particle background.
- The Backward Silicon Tracker (BST) was radiation damaged (locally 30 kGy)
- more detailed background studies performed (experimental + simulation)

$\Rightarrow$ Further Background Report
http://www-h1.desy.de/publications/bgrep2.ps.gz

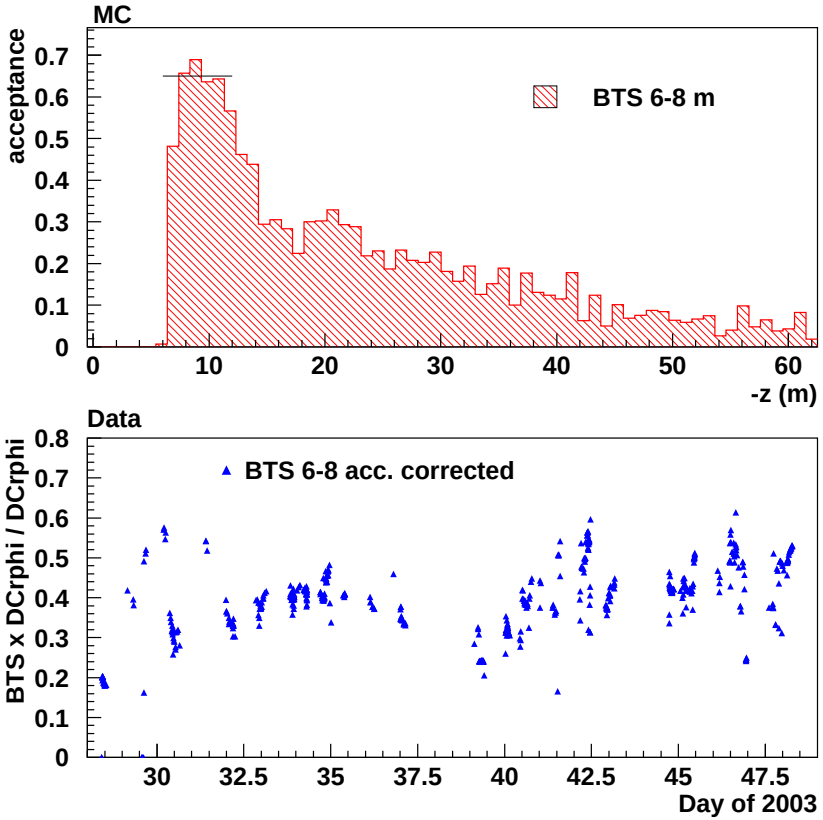
Drift Chamber Currents (CJC2)

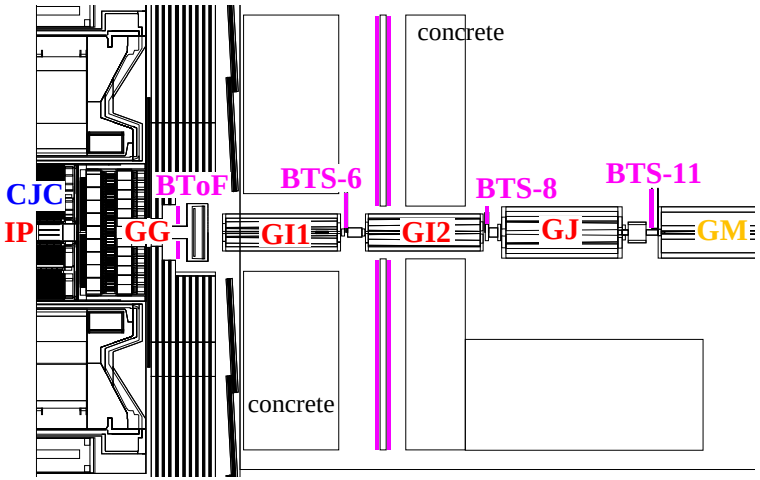


New Backward Tagging System

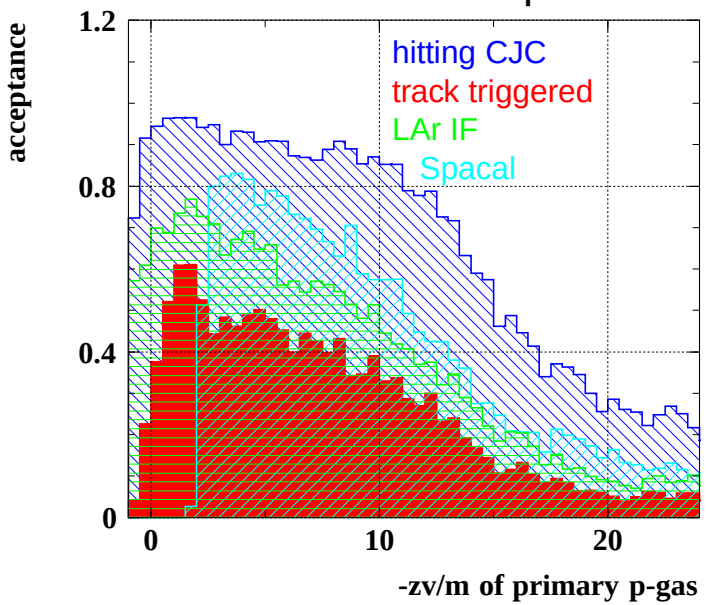
- pairs of scintillators interleaved with 2 mm of lead at 6 m, 8 m (and 11 m)

⇒ measure upstream background



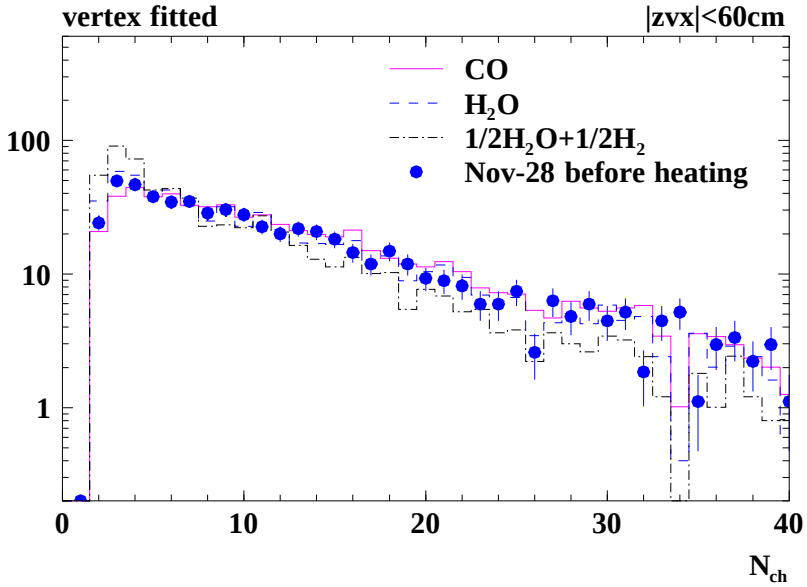


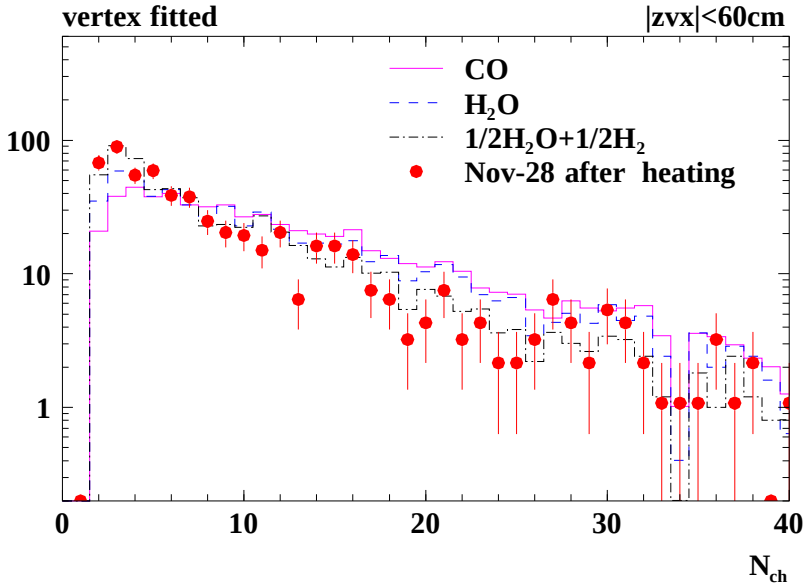
BG simulated acceptance



⇒ ≈ 40-50% of BG originates from 6-8 m or beyond

Chemical Composition of Residual Gas





Analysis of measured charged track multiplicities in drift chambers (CJC)

- Standard Operation
  simulation agrees well for: CO
  (or molecules with similar atomic number)

- Heating test using TSPump @ 3.6 m
  simulation agrees well for:
  $0.5H + 0.5H_2O$

$\Rightarrow$ consistent with results obtained by mass spectrometer

Modifications of the H1 Experiment

Measures to improve BG situation:

mechanical changes:

- reduced thickness of C5b 20 mm $\rightarrow$ 5 mm
- tapered C5b to reduce HOMs, additional water cooling
- coating of synchrotron radiation absorbers
- extra shield of 2 mm lead around C5b

  to protect BST/CIP from synchrotron radiation

diagnostics:

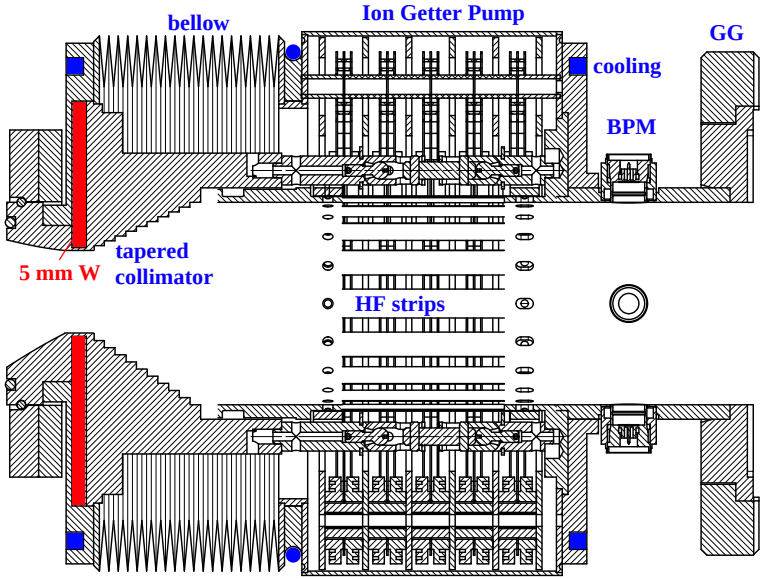
- additional rest-gas analyzer at z = -3.6, -6.0 m
- add radiation monitors

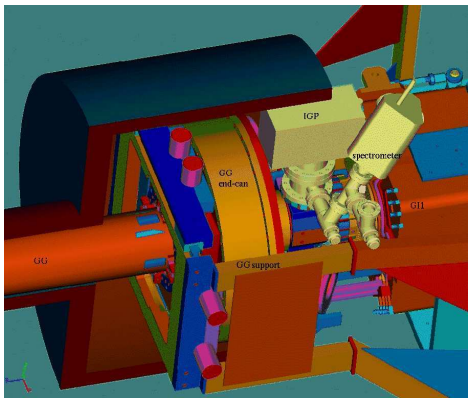
pumping system:

- add Ion Getter Pump $400\ \ell/\mathrm{s}$ at z = -1.5 m

  and wider RF grids for pumps at z = -3.6, -6.0 m

Modified C5b collimator at -1.5 m:





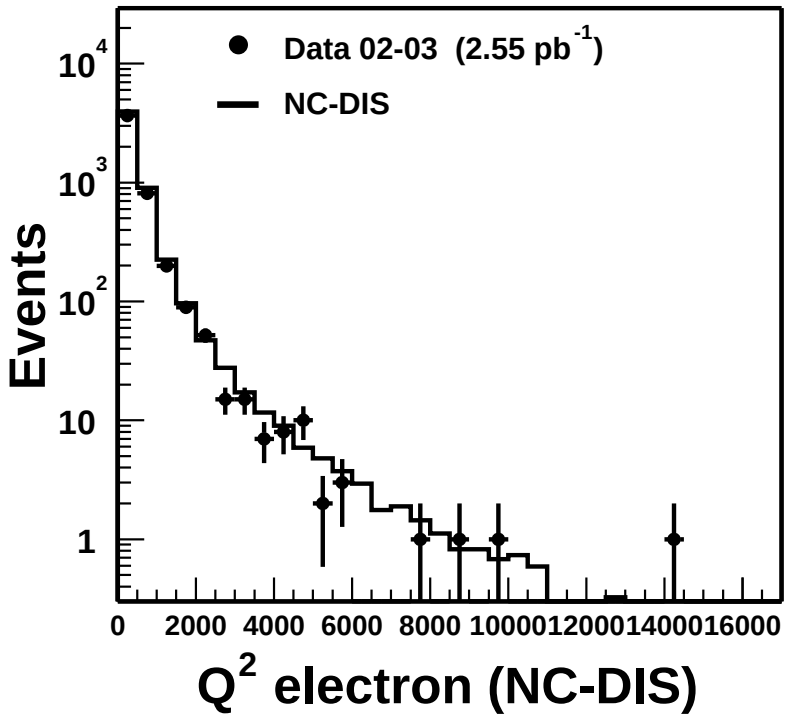
mass spectrometer at z = 3.6 m

HERA II Data Analysis

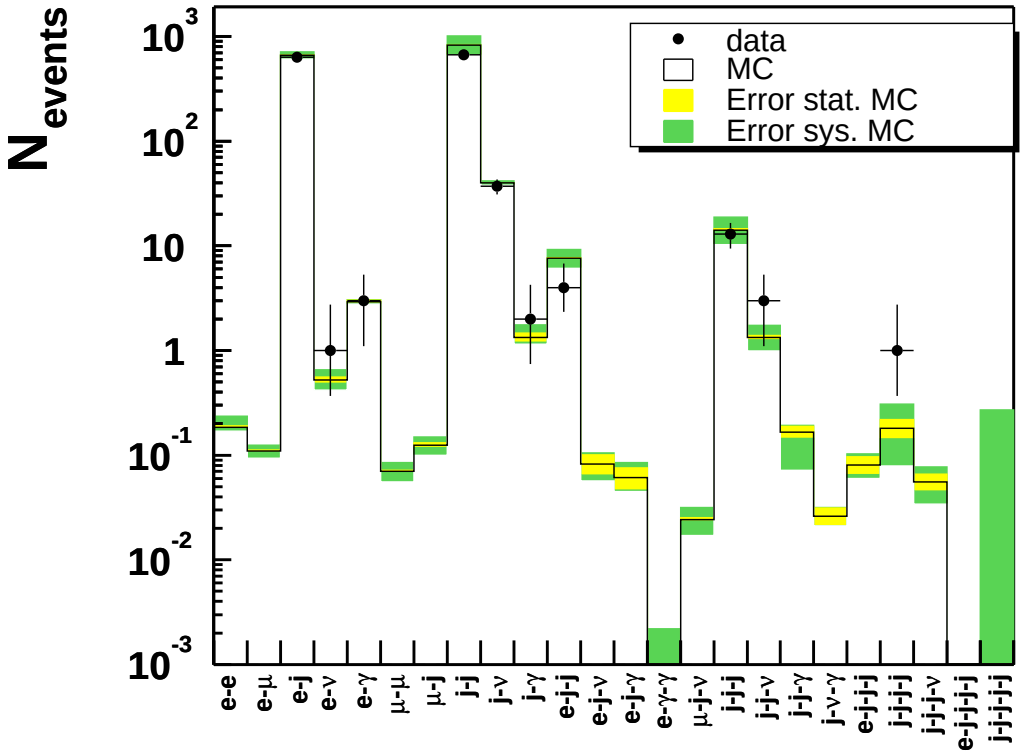
New H1 Detector (26 upgrade projects!)

+ new analysis framework (Object Oriented)

- Neutral Current DIS at high Q^2:



- Generic search for n-body topologies:



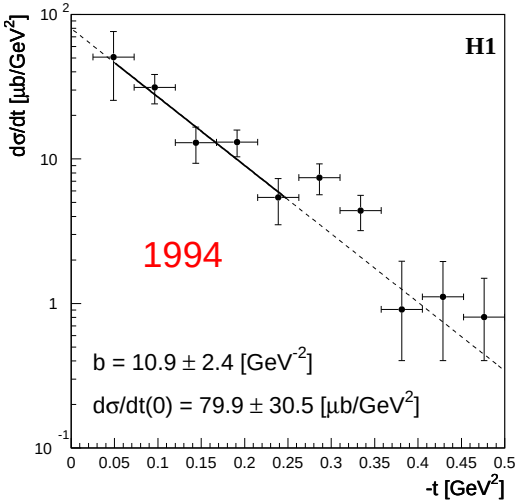
⇒ good agreement between data and expectation

Diffractive Rho Production at HERA II

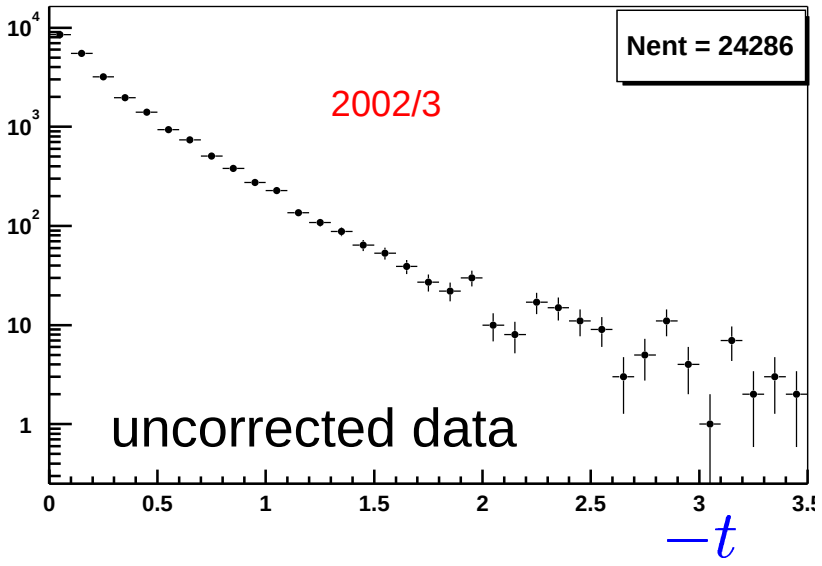
Aim: study diffractive ρ meson production at high momentum transfer t

- last (published) measurement from 1994 ($\approx 20\ \mathrm{nb}^{-1}$)
- dedicated ρ meson track trigger at HERA II:

  $\approx 100\times$ more statistics $\Rightarrow$



Number of Events



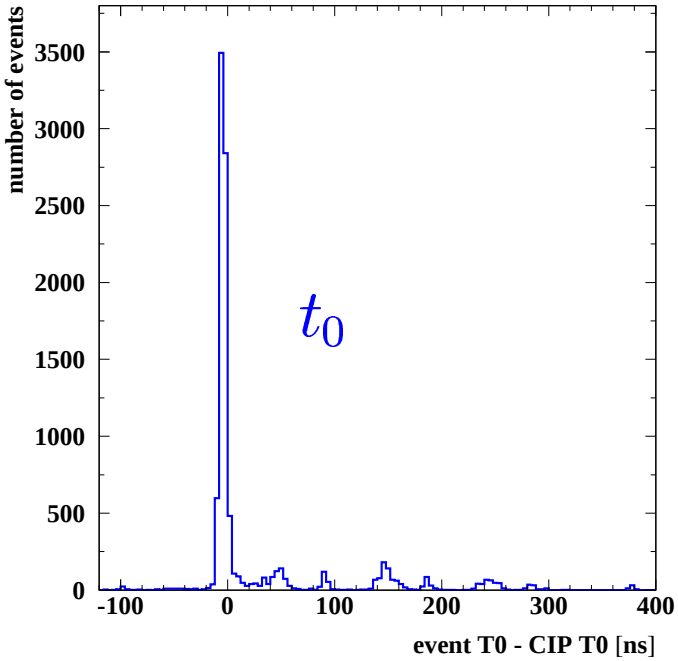
HERA II Upgrade Projects

- Central Inner Proportional Chamber (CIP)
- Fast Track Trigger (FTT)
- Very Forward Proton Spectrometer (VFPS)

Central Inner Proportional Chamber (CIP)

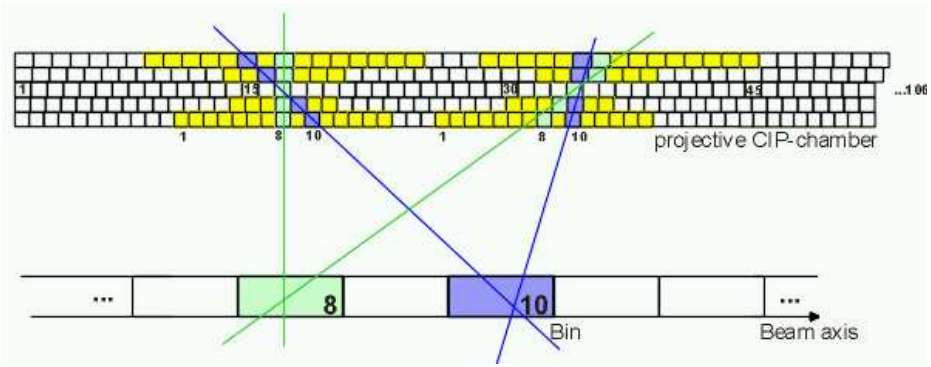
$\Rightarrow$ L1 z-vertex trigger

- operated with 2-3 layers only (02/03):



$\Rightarrow$ CIP trigger commissioned

- 5-layers with 2 cm pad size



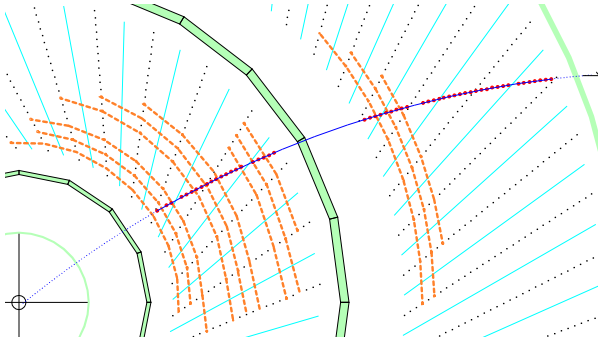
- frontend electronics repaired
- cooling improved

$\Rightarrow$ CIP trigger ready for startup in July

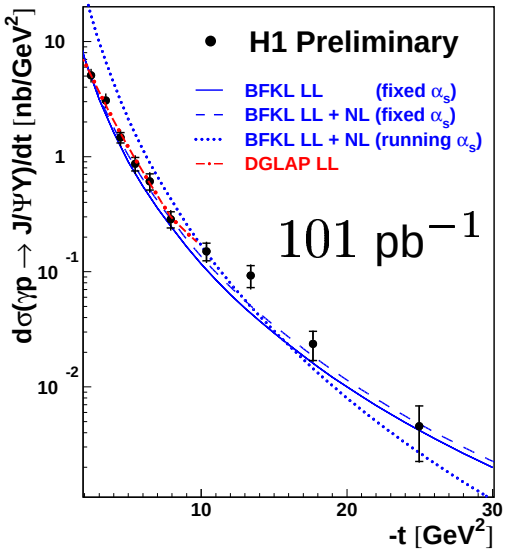
Fast Track Trigger (FTT)

- Motivation: mass reconstruction of particle resonances on trigger level (L3)
- full track reconstruction on trigger L1+L2

  use 450 drift chamber wires:



t spectrum of J/Ψ mesons:



- Frontend System commissioned:

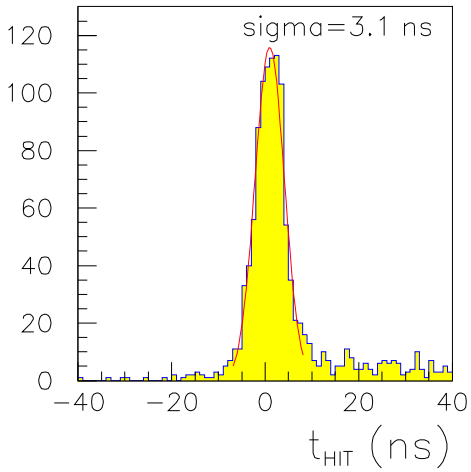
$$\frac{\sigma_z(\mathrm{hit})}{L_{\mathrm{wire}}} \approx 3.5\% , \quad \sigma_t(\mathrm{hit}) = 3.1\ \mathrm{ns} \quad \Rightarrow$$

$$\mathrm{eff}(\mathrm{hit}) = 95\% \quad \text{spec fulfilled!}$$

- commissioning of L1/L2/L3 triggers starting

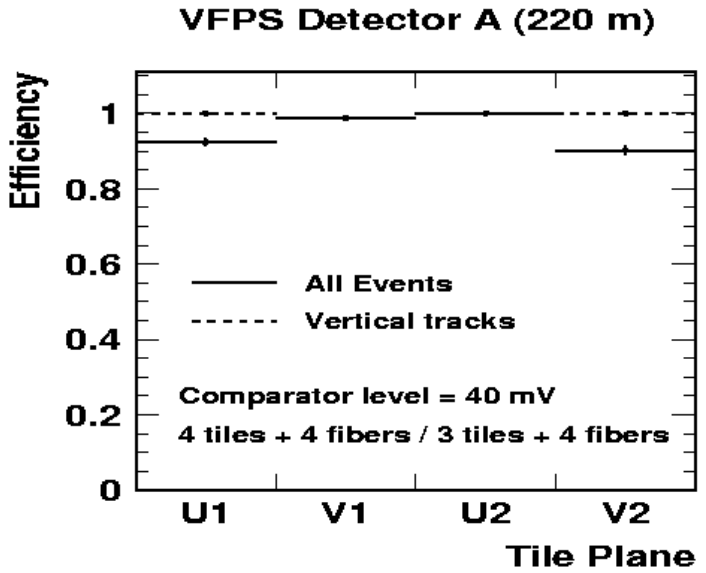
  $\Rightarrow$ first FTT triggered events expected in summer

FTT cosmics



Very Forward Proton Spectrometer (VFPS)

- Study diffractive processes $\rightarrow$ proton intact
  - $F_2^{D(4)}$, Deeply Virtual Compton Scattering
  - Diffractive charm and jet production
- Installation at $z = 220$ m downstream
  - fibre detectors tested: $\text{eff}_{\text{cosmics}} \approx 100\%$ $\rightarrow$
  - Roman Pots being put in beamline this shutdown
  - bypass (cold section) tested and being installed



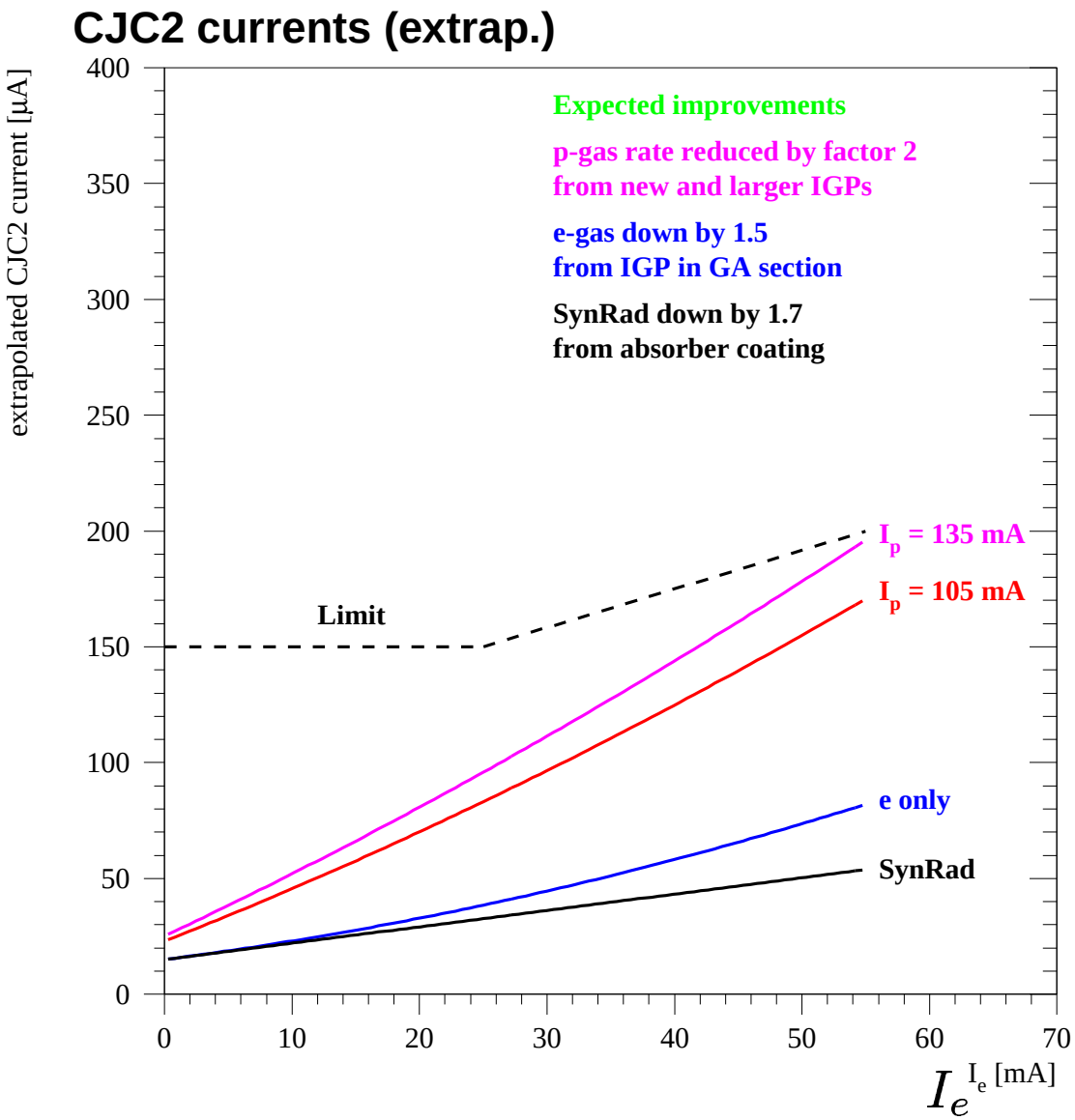
$\Rightarrow$ project on schedule

Bypass:

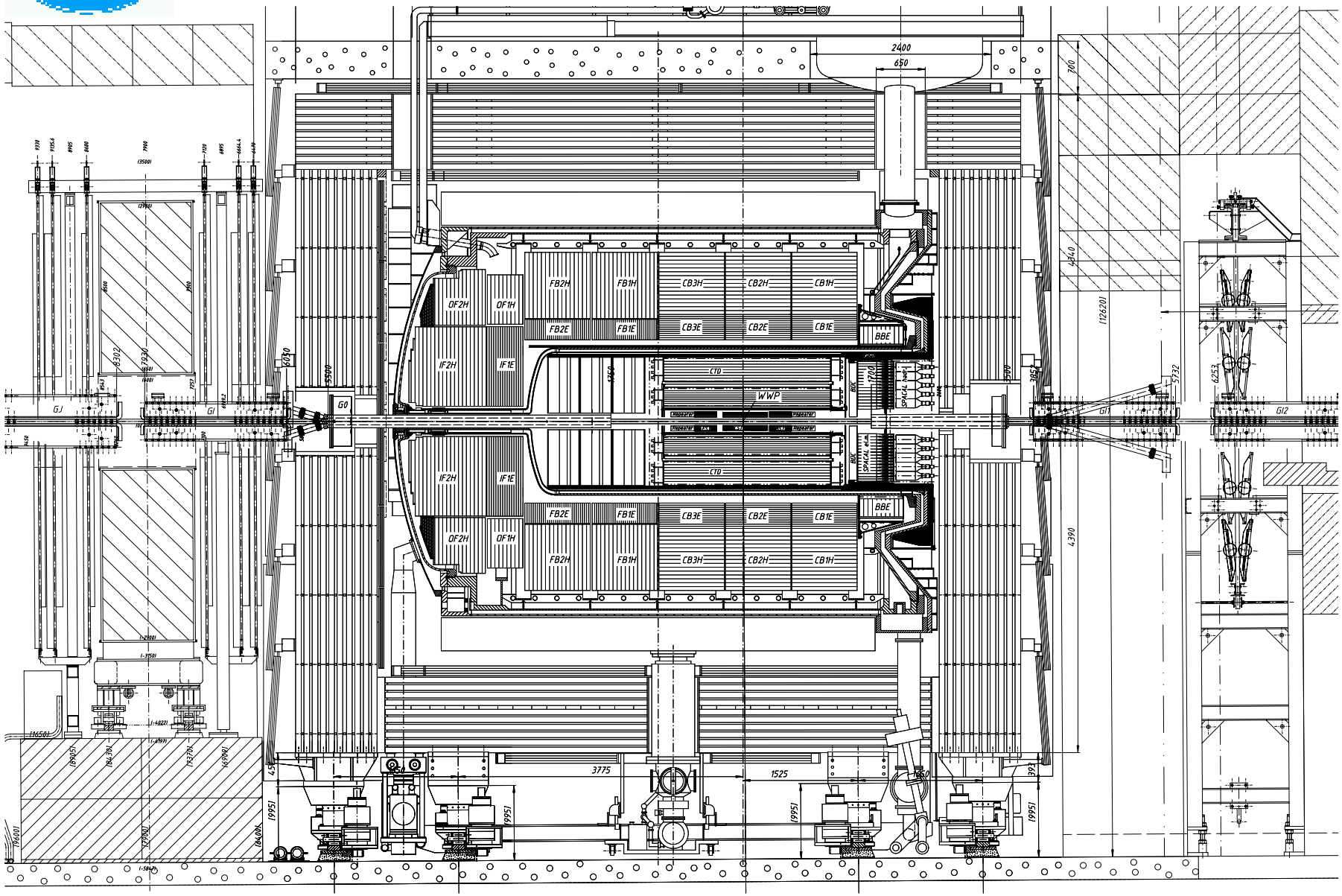
and finally...

- We thank the machine group and the other experiments for the good cooperation.
- Analyses of HERA I data are well progressing - completed in many areas.
- We ask for the full support of the HERA II program and are looking forward for ep physics with an integrated luminosity of 1 fb^{-1} and polarized $e^{\pm}$ beams

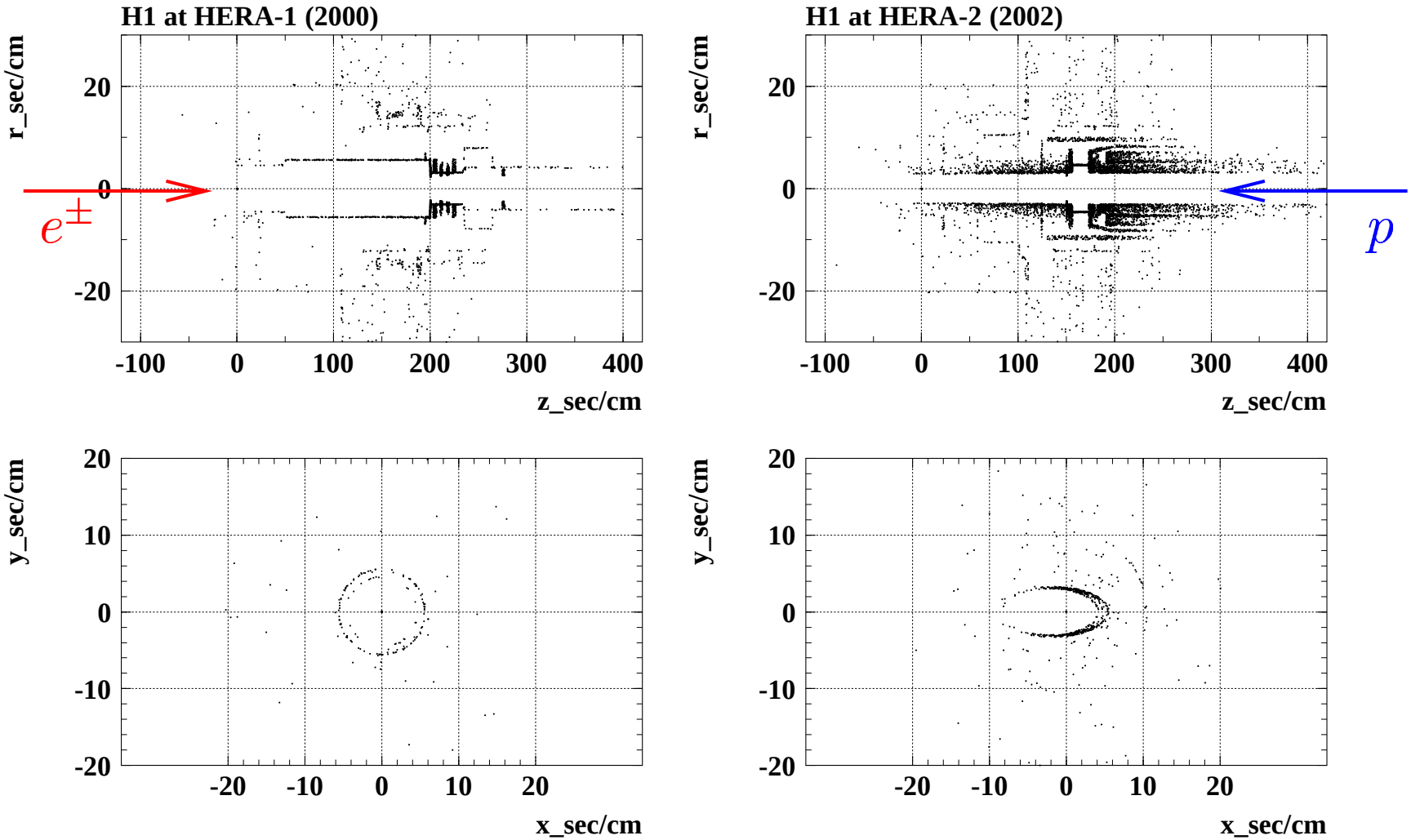
HERA II Running Prospects



H1 Experiment

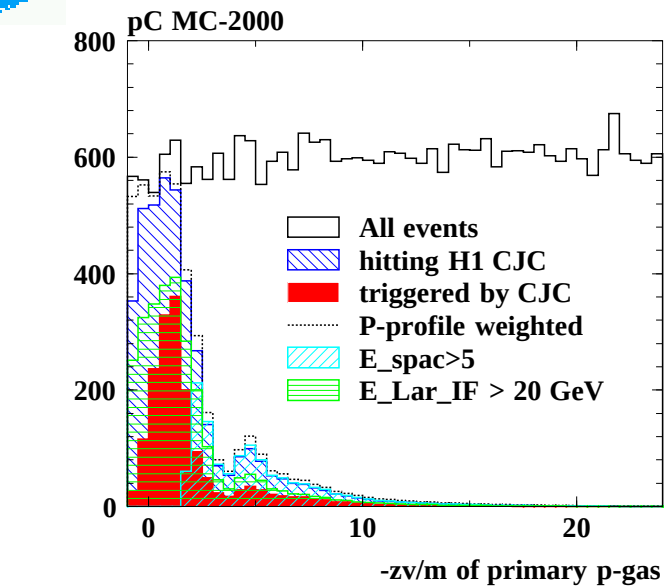


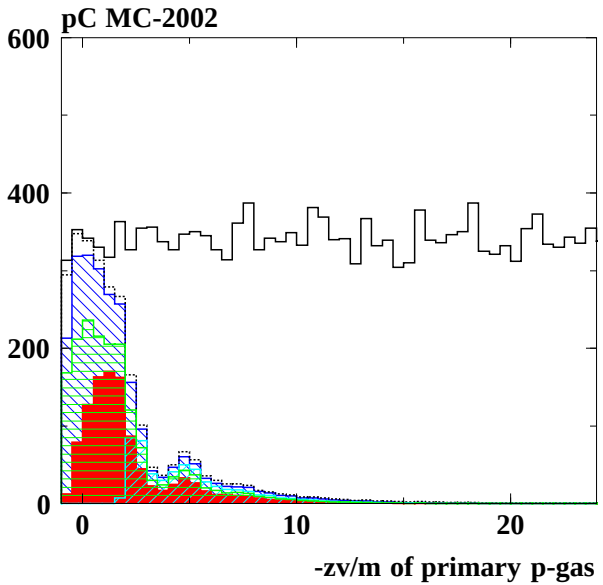
Simulation of Particle Background

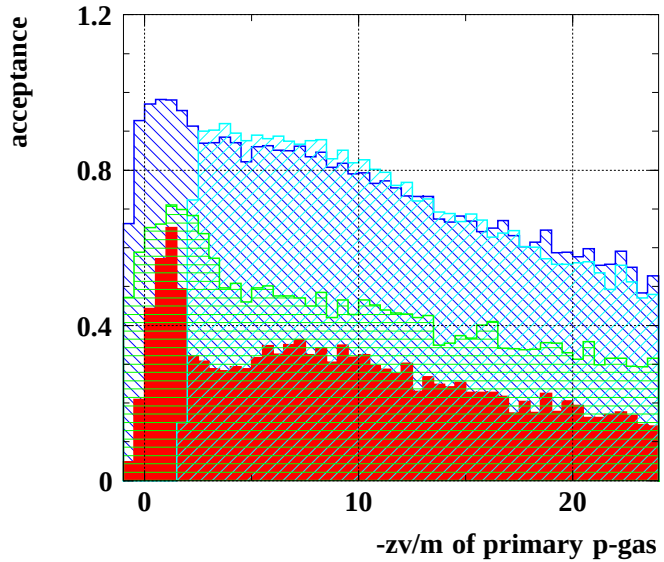


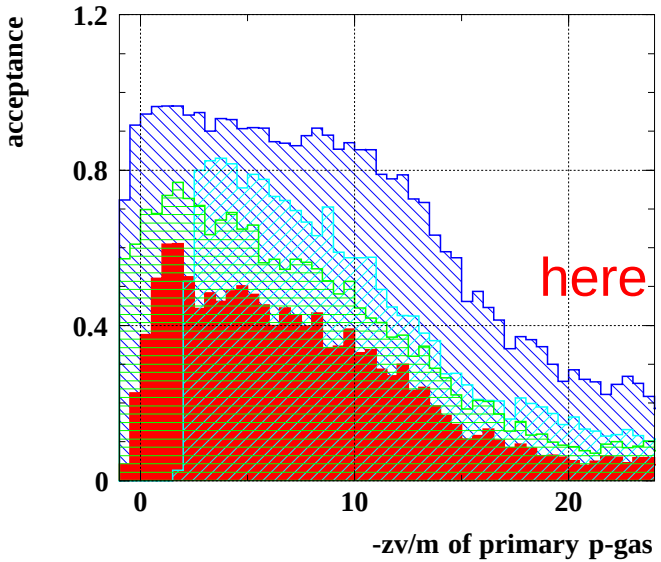
- Mechanism: secondary particle IA in H1 induced by primary proton-gas IA

Background Acceptance (Simulation)



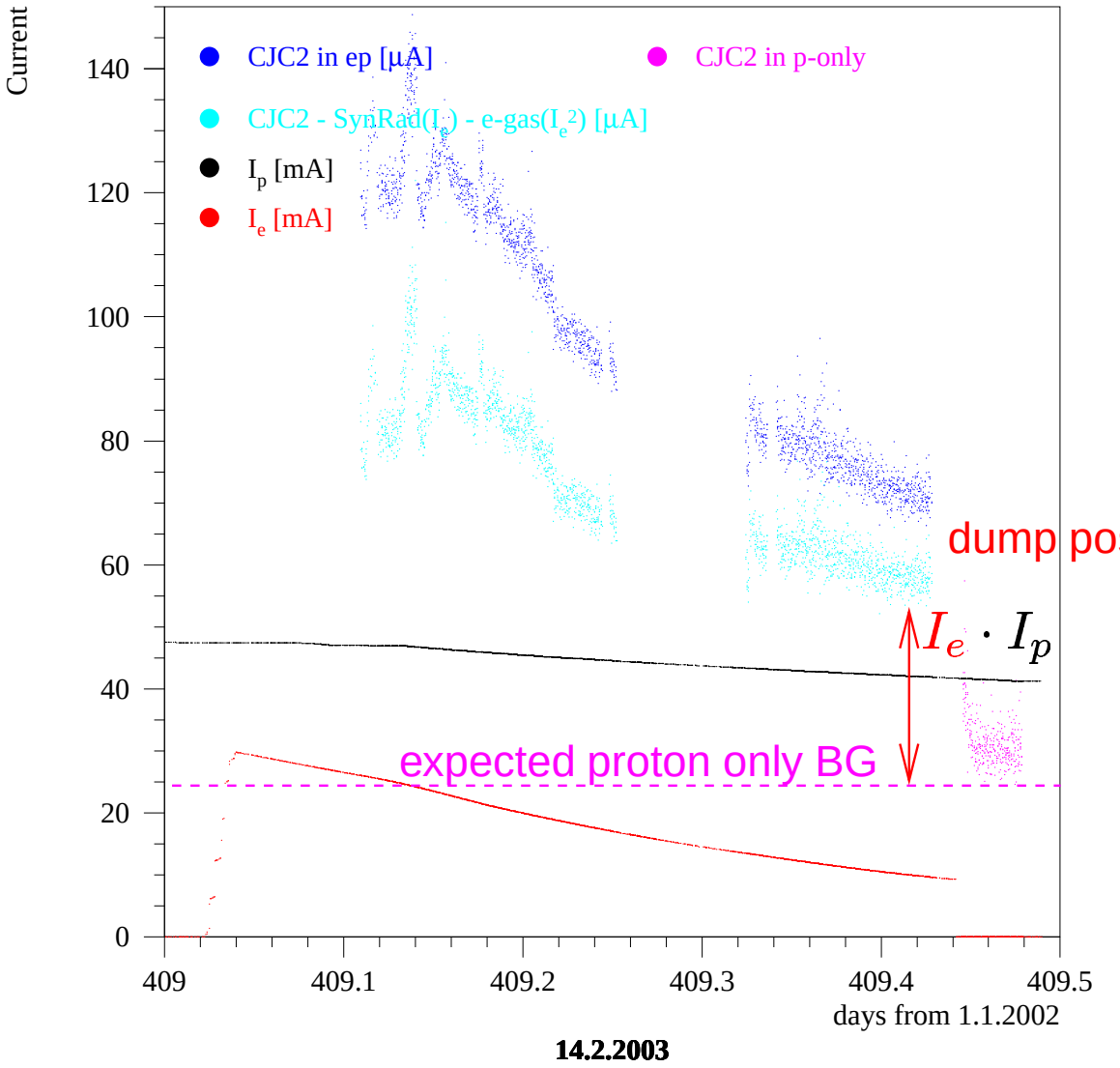






here less sensitive

Dynamic Vacuum Pressure



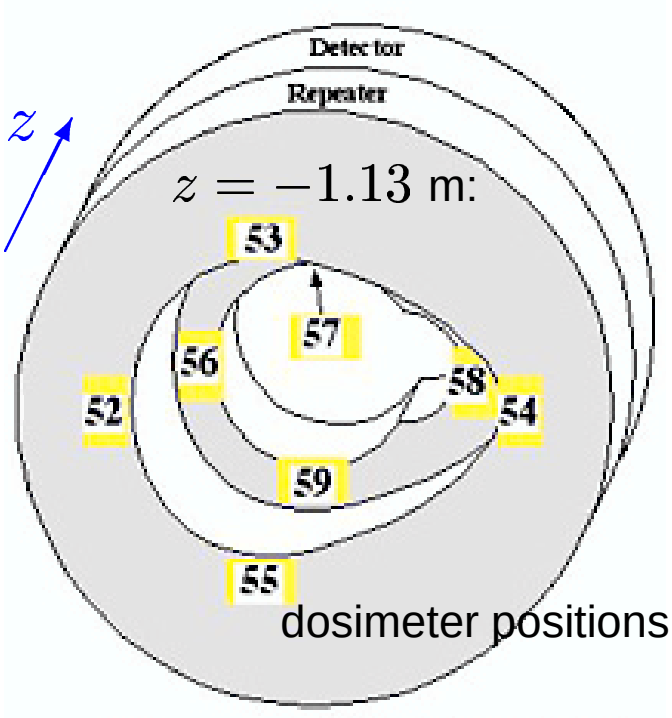
- process of $e^{\pm}$ beam induced dynamic pressure increase not understood

Radiation Damage

- collimeter C5b at $z = -1.5$ m:

$\Rightarrow$ copper got "burned" by incident

- Backward Silicon Tracker (BST):



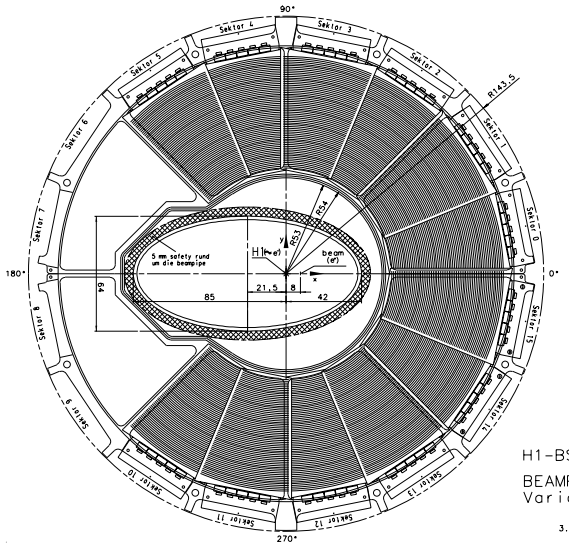
52: 22 kGy
53: 10 kGy
54: 14 kGy
55: 32 kGy

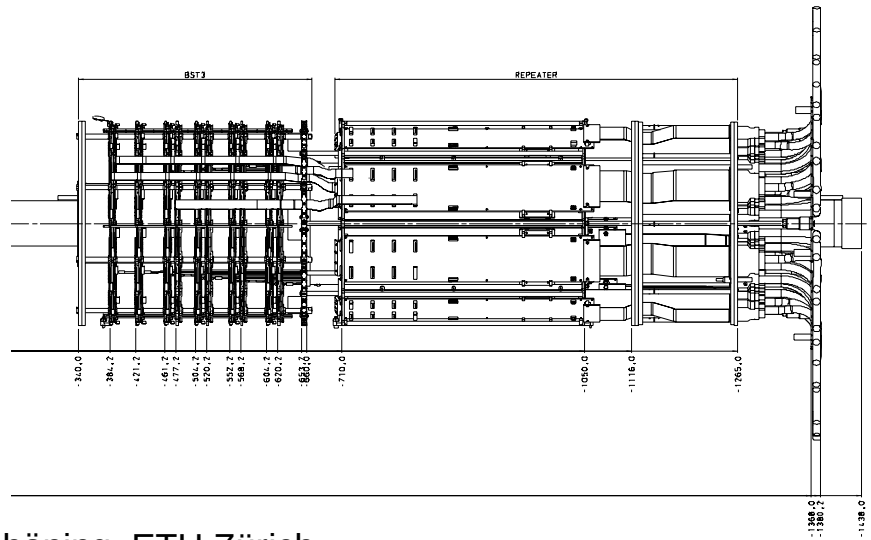
- Radiation dose 2002/03: ≈ 30 kGy

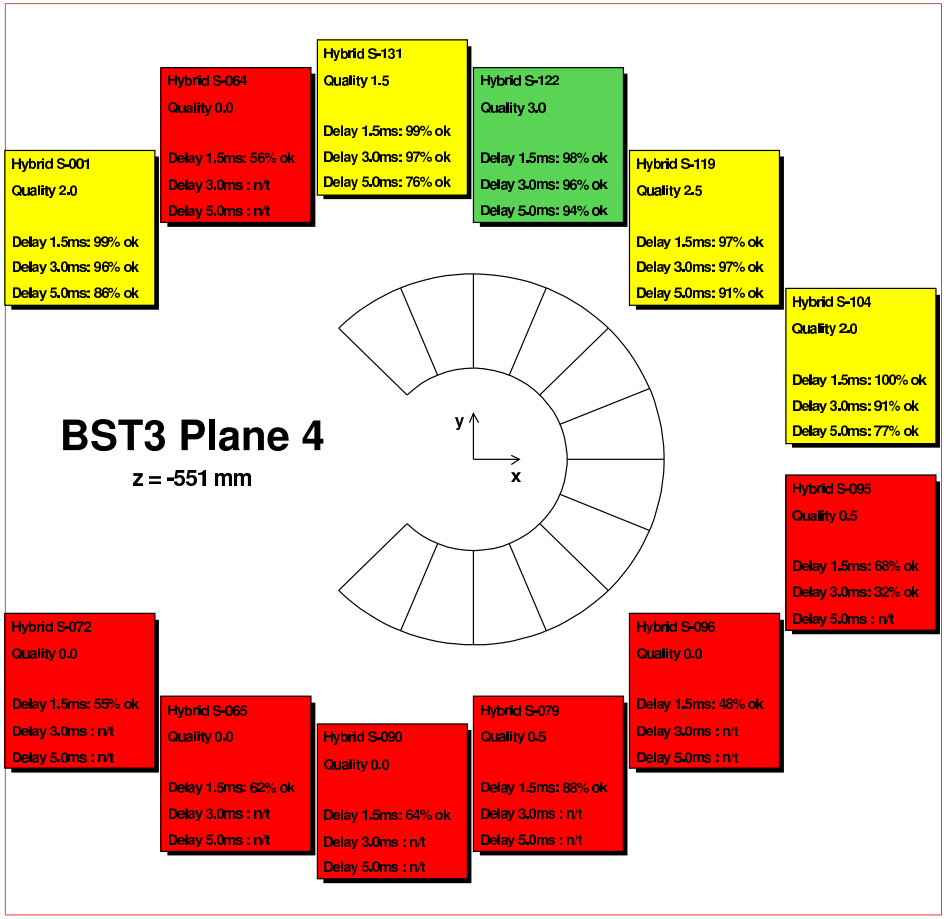
(Radiation dose 98/99 ≈ 0.3 kGy)

$> 50\%$ of readout electronics (APCs) destroyed

Damage BST Plane 4







Backward Silicon Tracker (BST)

- BST3 Upgrade:
  - replace 72 r-sensors by new Φ sensors
- BST Repair:
  - replace damaged Analog Pipeline Chips $\rightarrow$
  - replace radiation damaged clock receivers and transmitters on repeater (PAD trigger + Strips)
  - replace SLIO communication chips (PAD trigger)
  - shortage of hybrids $\rightarrow$ 5.5 out of 6 planes
- Installation of new Radiation Monitor:
  - so far used BST pad detector
  - additional diodes type?

$\Rightarrow$ tight schedule (bonding capacities)