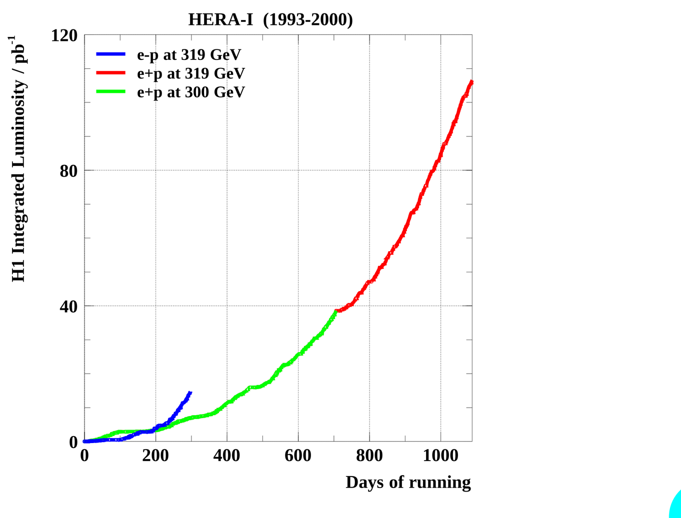
The H1 Experiment at HERA II

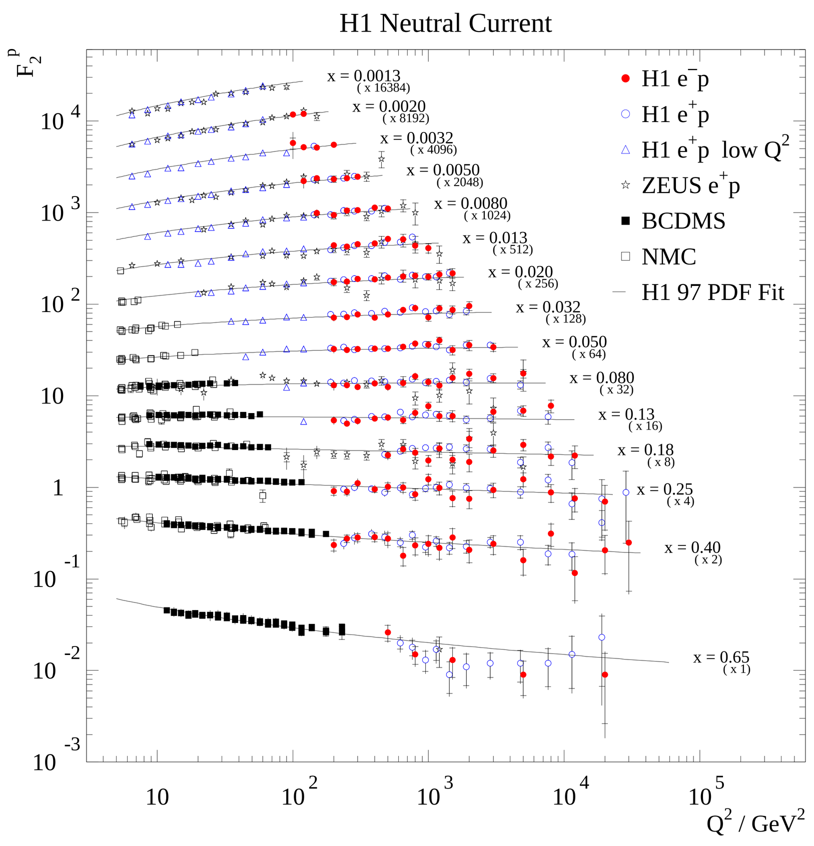
H1 at HERA I (1992-2000)



At HERA I a total luminosity of ~100 pb^{-1} has been accumulated at a centre of mass energy of ~300 GeV. The neutral current (NC) cross section, given by

$$\frac{d^2\sigma^{NC}}{dxdQ^2} = \frac{2\pi\alpha^2}{xQ^4}\left[(1+(1-y)^2)\tilde{F}_2(x,Q^2) + (1-(1-y)^2)x\tilde{F}_3(x,Q^2)\right]$$

has been measured over a range of 5 orders of magnitude in x and Q^2 with high precision. This enabled a wide physics program where the proton structure function $F_2(x,Q^2)$ has been compared to predictions of QCD. The strong coupling constant α_s has been obtained by a global fit.



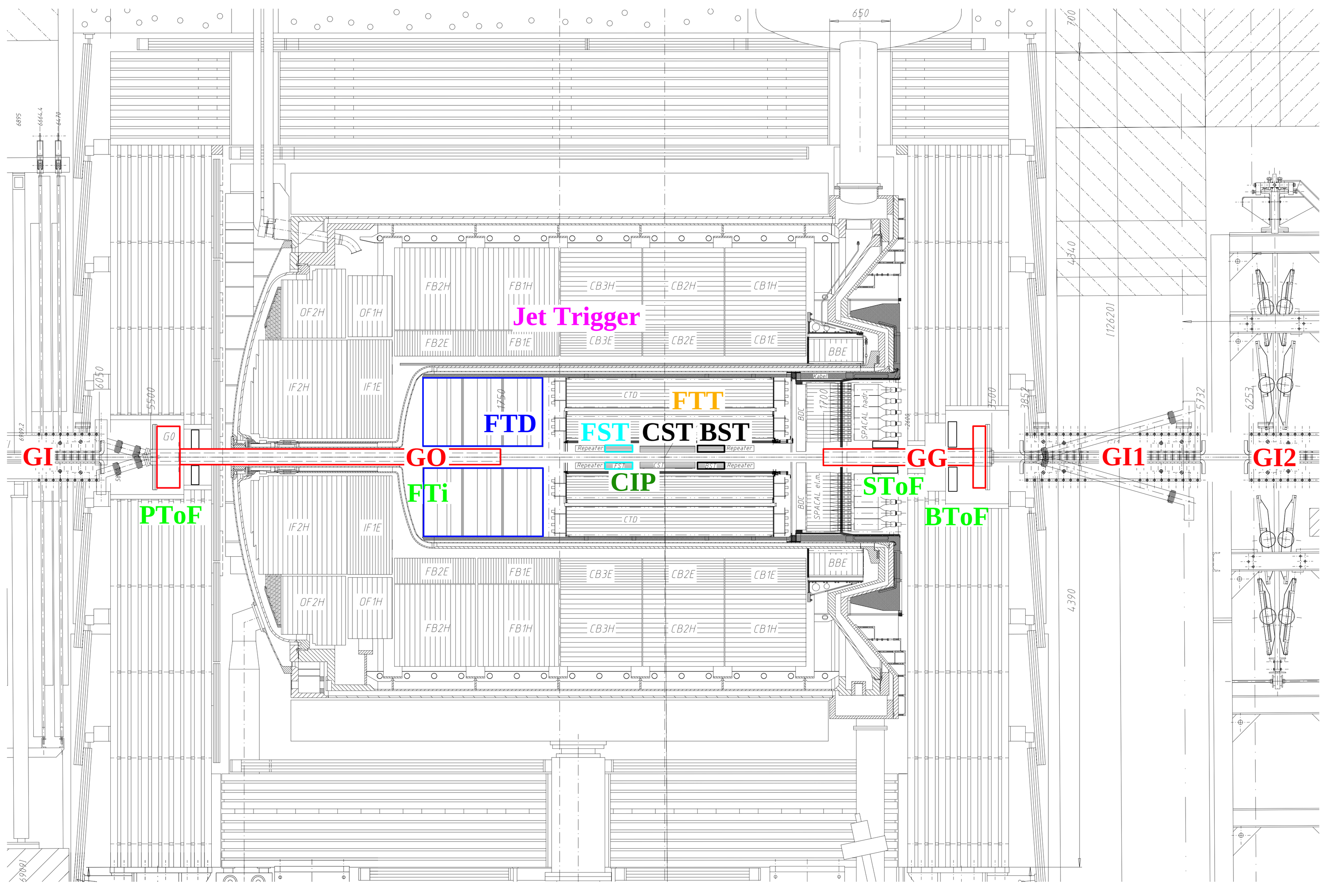
HERA II

High Luminosity and Electron Polarization

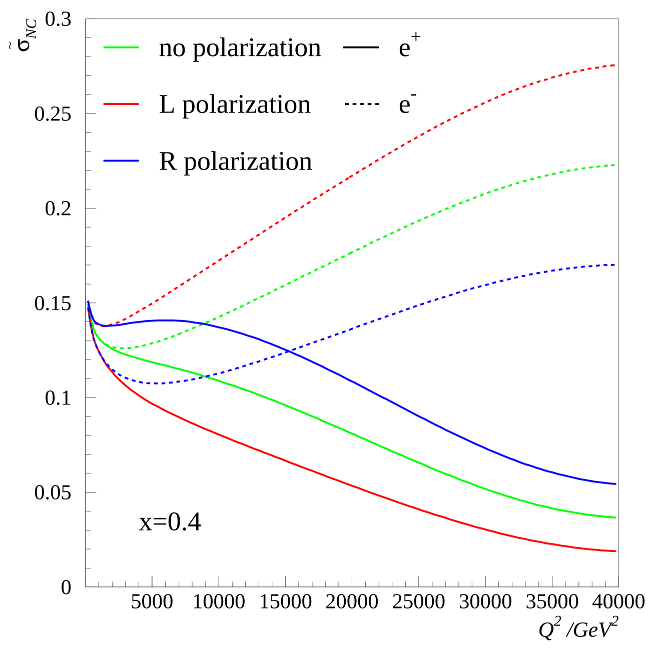
The H1 experiment will benefit from the upgrade of the HERA machine in two ways. **Longitudinally polarized electrons** will extend the investigations of electroweak physics into new domains. It is expected to accumulate in the HERA II phase a **luminosity** of 1 fb^{-1}, a factor ten more than that obtained at HERA I, thus extending the reach for searches for physics beyond the Standard Model (SM). In addition this will enable precision experiments to be performed in those areas which are presently statistics limited e.g. processes at high Q^2, high E_T, production of heavy quarks.

Upgrade of the H1 Detector for HERA II

The detector has been upgraded substantially to cope with the new challenges at HERA II. The innermost detector regions saw major modifications to accommodate the superconducting quadrupoles of HERA II. The new silicon detector system completely surrounds the interaction region to significantly improve vertexing and tracking in conjunction with the upgraded inner tracking system. Combined with upgrades in the trigger and DAQ systems H1 is thus prepared to make best use of the luminosity increase in all physics areas.



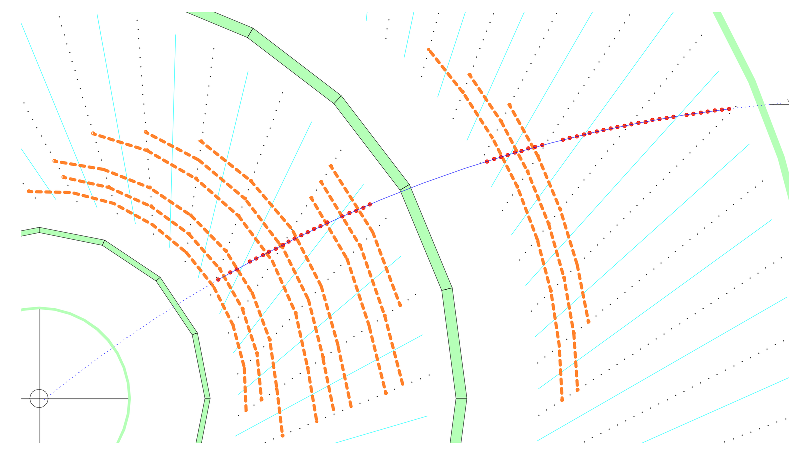
Polarization



The polarized electron beam at HERA II will have dramatic influence on the interaction rate for parity violating processes. The charged current varies as $\sigma_{pol} = (1+P)\cdot\sigma_{unpol}$ for a beam polarization P - right-handed electrons do not interact with the proton at all. The neutral current interaction (see above) is more subtle: the parity violating components alter the cross-sections beyond what is observed as the γZ interference at large Q^2. Beam polarization and polarity are the tools to separate different flavours in the proton and to pin down the chirality of new couplings.

The New H1 Trigger System

The higher rates at HERA II necessitate an upgrade of the H1 Trigger capabilities, i.e. a new Time Of Flight system (TOF), a new multi-wire proportional chamber (CIP), a new calorimetric jet trigger, an upgraded neural net event trigger for the second level and a new processing farm for the third level.



The new Fast Tack Trigger (FTT) reconstructs charged particle momenta measured in the Central Jet Chamber (CJC) at the very first trigger levels.

The first level trigger identifies track segments in two dimensions within 2.1 µs using a farm of 180 ALTERA FPGAs (Field Programmable Gate Arrays) with 400.000 gates each. At second trigger level up to 48 tracks with transverse momenta down to 100 MeV are reconstructed and fitted using fast floating point DSPs (Data Signal Processors) within about 20 µs. The FTT track parameter resolution is almost comparable with that obtained offline and allows the identification of e.g. particle resonances ρ, Φ, J/Ψ, Υ, D*, D_s already at trigger stage.

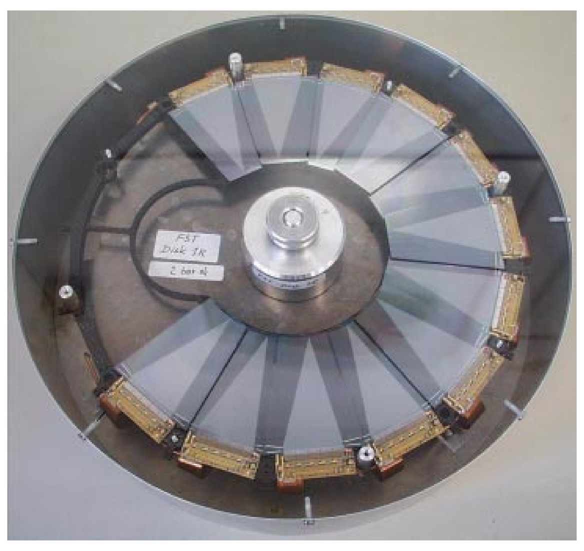
The New Tiny Superconducting Coil

The superconducting magnet GO and the central beam pipe are prepared for installation in the liquid argon cryostat. The GO magnet provides vertical focusing and an 8 mrad bend for the electron beam in a compact coil design.
The central 1 m section of the beam pipe is made from a beryllium-aluminium alloy with an elliptical cross section of 60 x 123 mm and a wall thickness of 2 mm (1% X_0).

The New Forward Tracker

The upgraded Forward Track Detector (FTD) is being craned into position for installation. Five new and nine re-used planar drift chamber provide up to 76 measured points in 5 projections for tracks in the forward direction.

The Forward Silicon Tracker

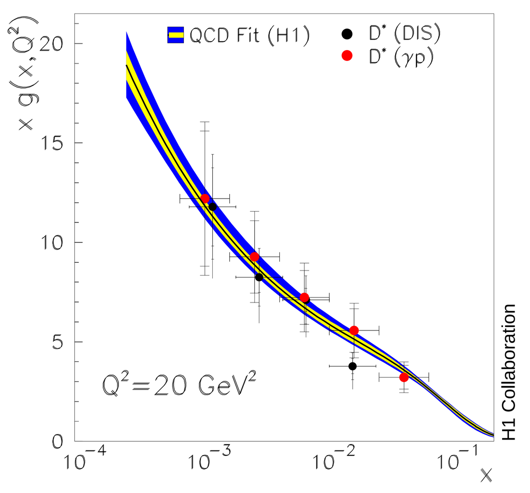


The new Forward Silicon Tracker (FST) consists of 12 single-sided silicon planes measuring tracks in 3 projections in the range from 7° to 17°. A radial plane shown here has 640 strips between 6 and 12 cm radius. The elliptical and excentric beam pipe accommodates only 12 of 16 azimuthal sectors.

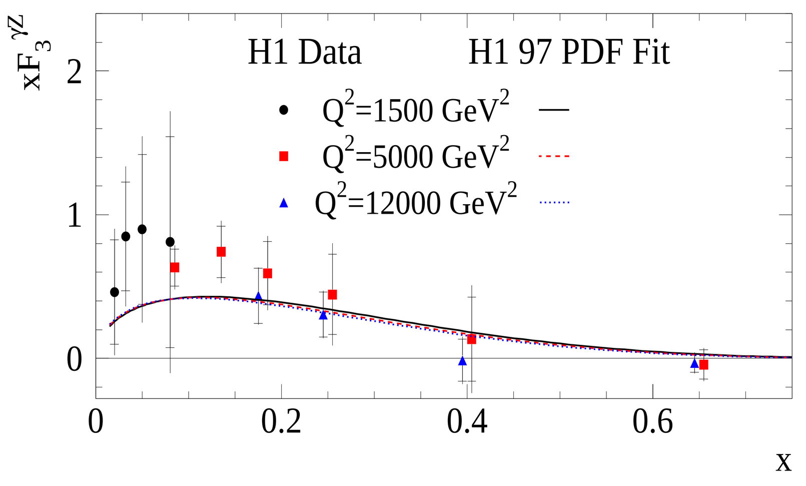
Selected Physics Topics at HERA II

Gluon Density From Heavy Quarks

The distribution of gluons inside the proton is a key topic in the investigation of the proton structure. Scaling violations of the structure function $F_2(x,Q^2)$ are mostly attributed to gluons. The distribution $xg(x)$ of the gluons can thus be indirectly extracted. Data on charmed particle production, via the gamma-gluon fusion process directly sensitive to the gluon distribution, yield an independent measurement of $xg(x)$. The high luminosity at HERA II combined with new trigger capabilities and an upgraded silicon vertex detector system will elucidate this area of proton structure research.



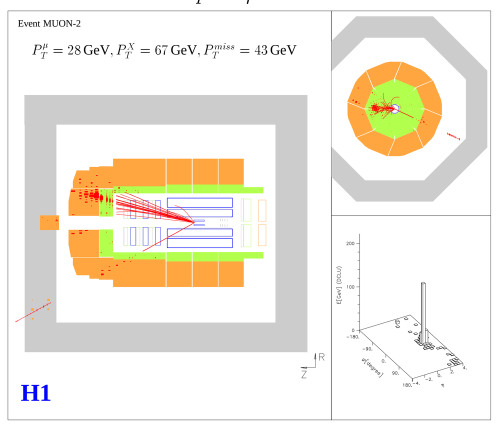
xF_3 Measurement



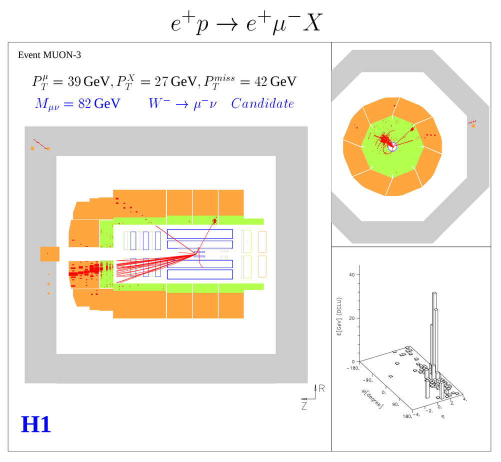
Z_0 exchange in deep inelastic ep scattering has been observed at the highest momentum transfers Q^2 at HERA I. The data provide a first indication of the contribution of the structure function xF_3. With much higher luminosity at HERA II the valence d-quark density at high x, a quantity not well measured presently, can be determined.

Searches

$e^+p \rightarrow \mu^+ X$



$e^+p \rightarrow e^+\mu^- X$



The high luminosity expected at HERA II is essential to extend the searches for physics beyond the Standard Model. It is of particular importance to clarify the physics behind the spectacular events observed at HERA I showing a lepton, a hadronic jet and significant missing transverse momentum. Other search topics at HERA continue to be leptoquarks, R-parity violation SUSY, excited fermions and compositeness. Polarization will be a valuable tool to disentangle the chiral structure of couplings.