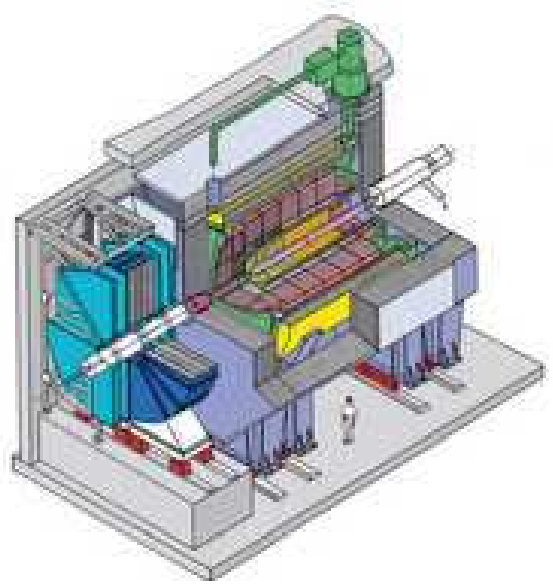
MPI Project Review 2005

Juraj Bracinik for MPI H1 group

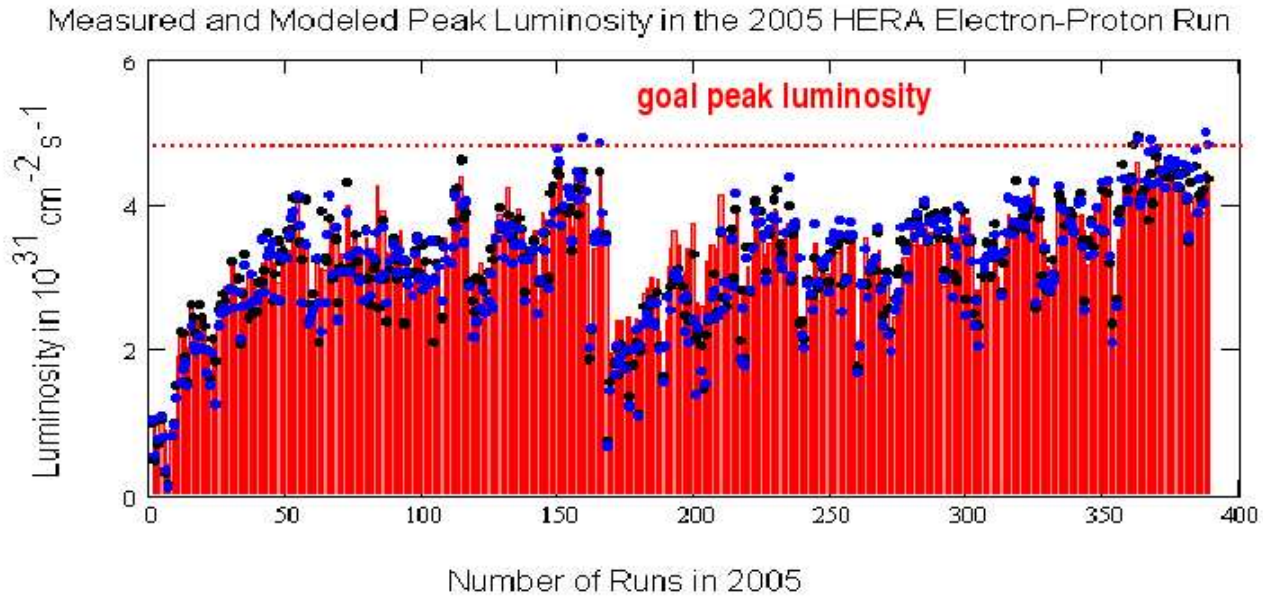
19 dec. 2005

- Introduction
- HERA running
- Status of MPI hardware projects
- Highlights from MPI driven physics analyses
- Near future



Introduction

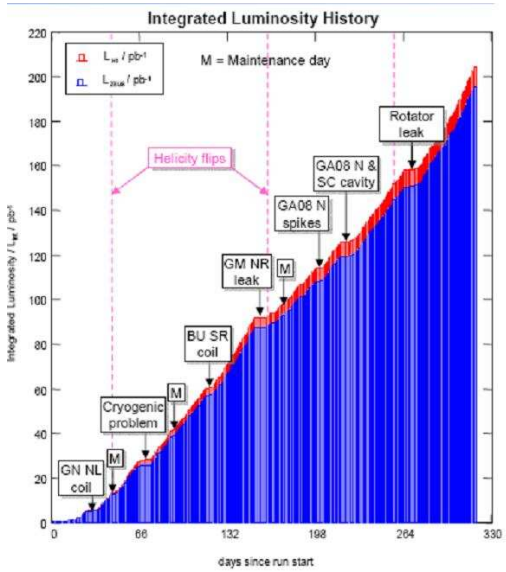
H1 experiment - a lot of data to analyze,
plan to collect at least as much as we have



- since end of 2004 smooth running with e^- (mainly e^+ before)
- limited beam currents (background, later RF)
- specific luminosity better then expected (smaller emmitance of proton beam, dynamic reduction of beta function for electron beam)

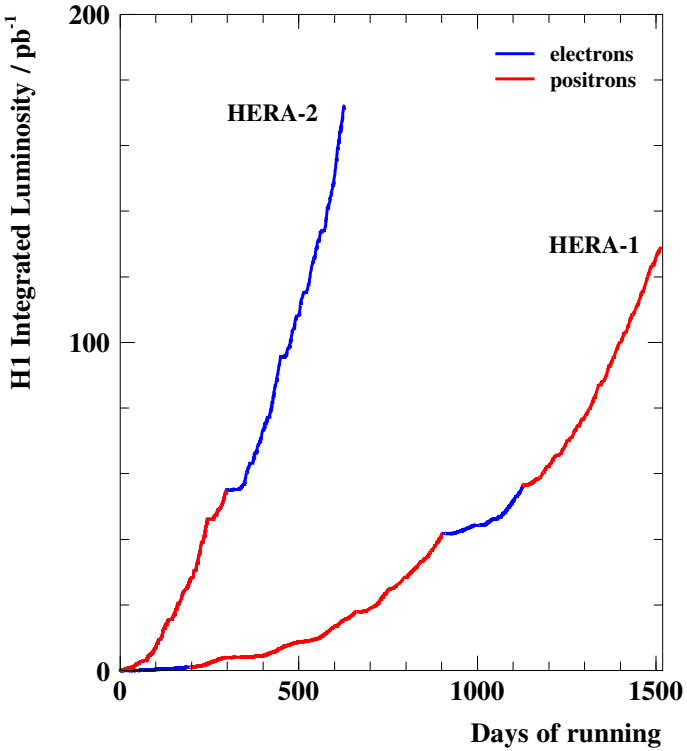
$\Rightarrow$ peak luminosity close to (bit smaller than . . .) design value

HERA performance



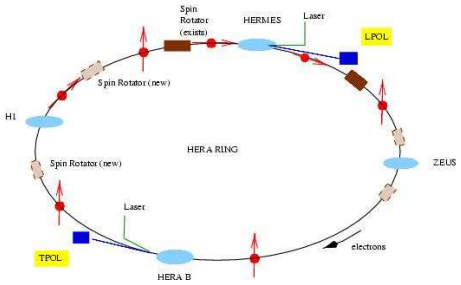
- at the beginning of the year large p-correlated background (venting of IR during shutdown)
- several vacuum leaks
- cryo problems in february
- BU magnet short problems in march/april
- electronic problems in large PS

$\Rightarrow$ spikes in background rates, reduced HV efficiency

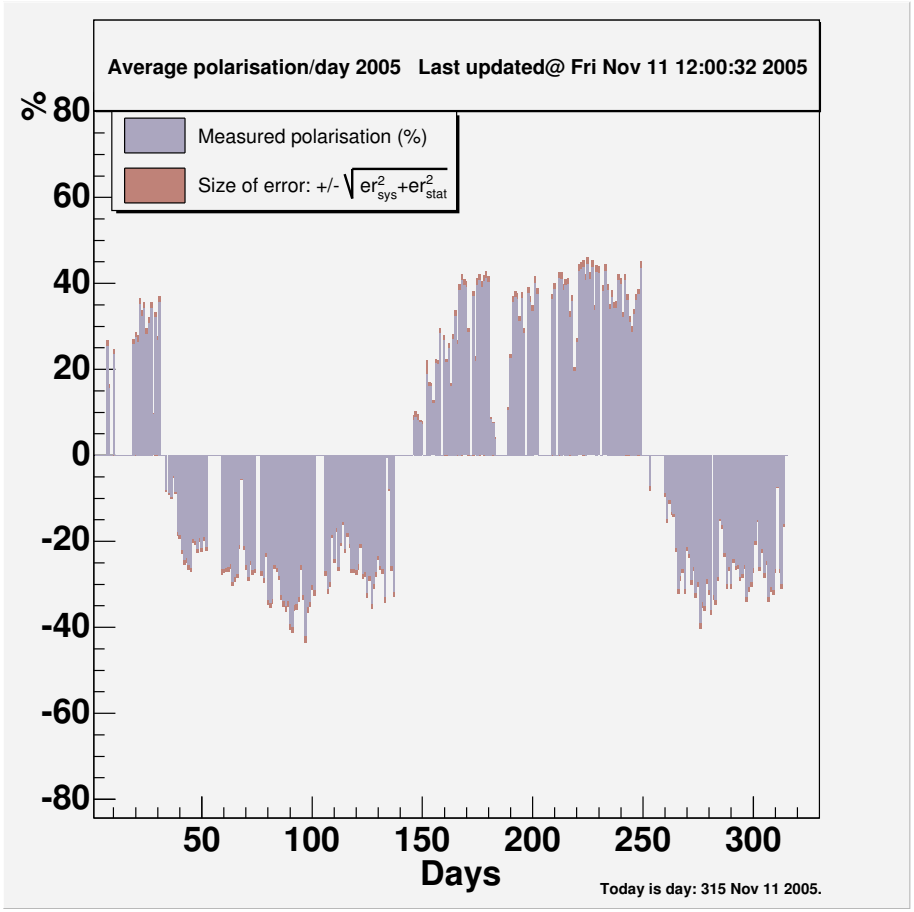


- smooth running from August till November
- in best periods delivered $\sim 1.5\ pb^{-1}/day$
- in total HERA delivered $\sim 200\ pb^{-1}$, H1 took with HV on $\sim 120\ pb^{-1}$
- more than full HERA I. statistics!

HERA performance - Polarization



- longitudinal polarization feature of HERA II
- in 2005 routine running with polarized e^-
- helicity changed several times
- polarization $\sim 40\%$ (colliding bunches), $\sim 50 - 60\%$ (non-colliding bunches)
- strong beam-beam effect



L1 Liquid Argon Trigger

Stable performance. Main trigger for H1 Physics (in particular high Q^2 NC/CC triggers).

Efficiency for NC close to 100% except:

$\longrightarrow$ closed cells with high contribution to trigger rates (≈ 50 out of 4846 total)

$\longrightarrow$ areas with not functioning t0 modules (≈ 30, out of 576 total)

$\Rightarrow$ repair (as much as possible) is planned for this shutdown

Needs a lot of attention, mainly analog part

$\longrightarrow$ ageing components (power supplies, connectors)

$\longrightarrow$ permanent fight with (mainly) external noise sources

Try to optimize physics output (new triggers):

- new subtrigger for dijets in γp (using E_{weight})
- new subtrigger for very high Q^2 (in development)

L2 Neural Network Trigger I.

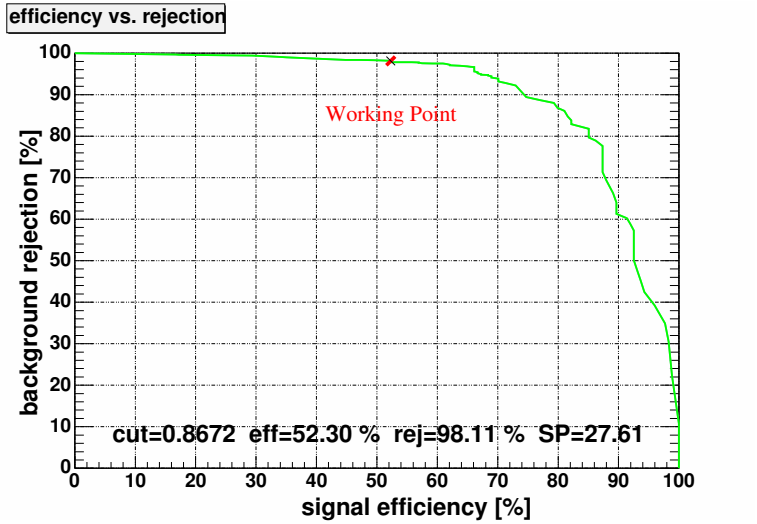
Board	Tr. Element	physics
00	56	untagged D*s
01	41	DVCS (IF)
02	39	Upsilons
03	41	DVCS (FB/CB)
04	15	$J/\Psi \rightarrow \mu$ (inelastic)
05		free (problems)
06	40	SPACAL (back-to-back)
07	78	Charged Current
08	33	J/Ψ (Track-Cluster)
09		free
10	74	DiJets
11	83	tagged D*
12	83	DiJets

- Hardware: very stable system (only concern ageing CNAPS chips)
- New inputs (new L1 trigger systems):
  - Fast Track Trigger (replace DCRϕ trigger)
  - new CIP (replace z-vertex trigger)
  - Jet Trigger (L2NN ready to receive signals)
- Becoming more and more important due to increasing inst. luminosity

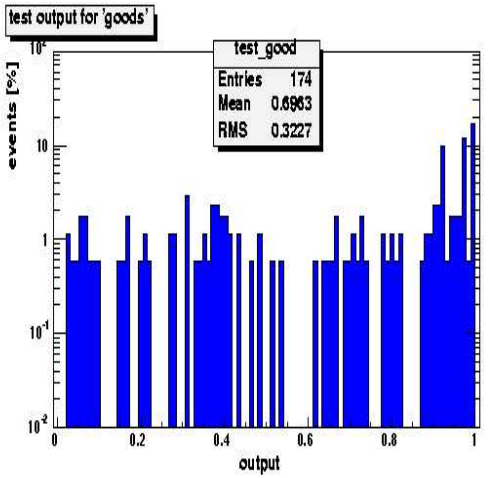
$\Rightarrow$ many requests from working groups (more than trigger boxes)

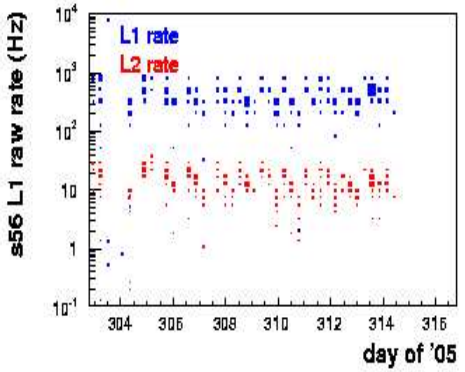
- often the only chance to get given channel

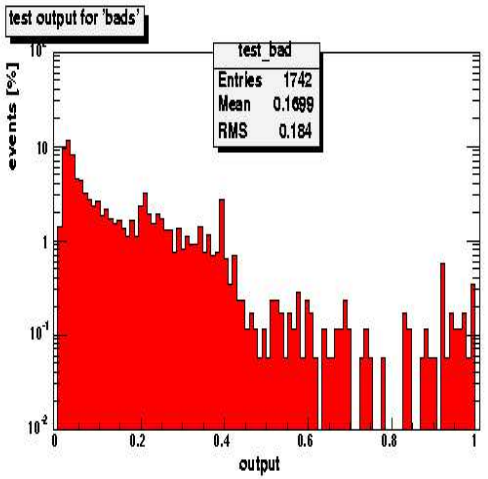
L2 Neural Network Trigger II.

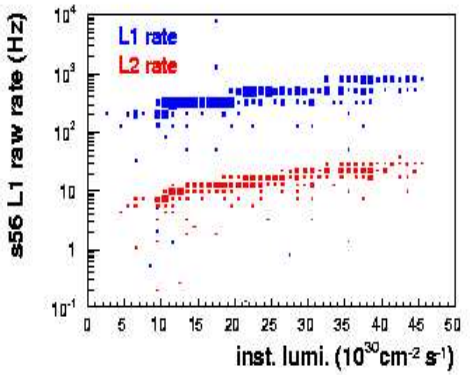


- Example:
  D^* in untagged γp
- Efficiency: 52 %
- Rejection: 98 %
- Rate suppression: factor of ~ 20

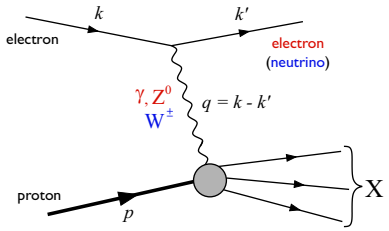


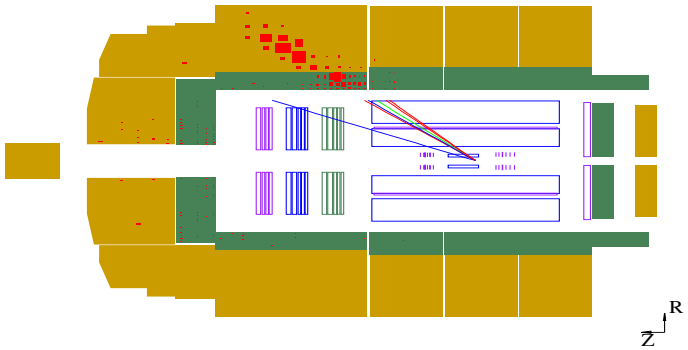


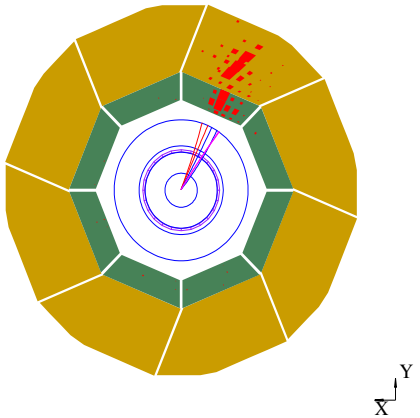




Inclusive measurements - NC/CC I.







- traditional area of activity in our group
- new:
  - polarization
  - high luminosity
- influences both NC and CC measurements

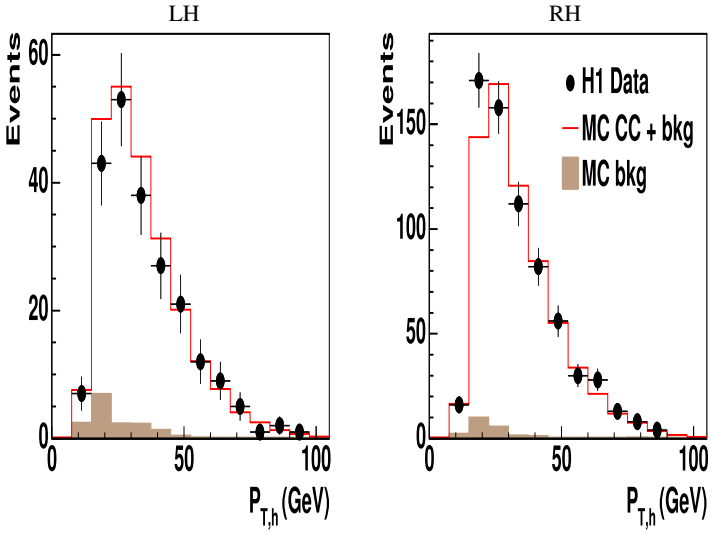
! very clean effect on CC

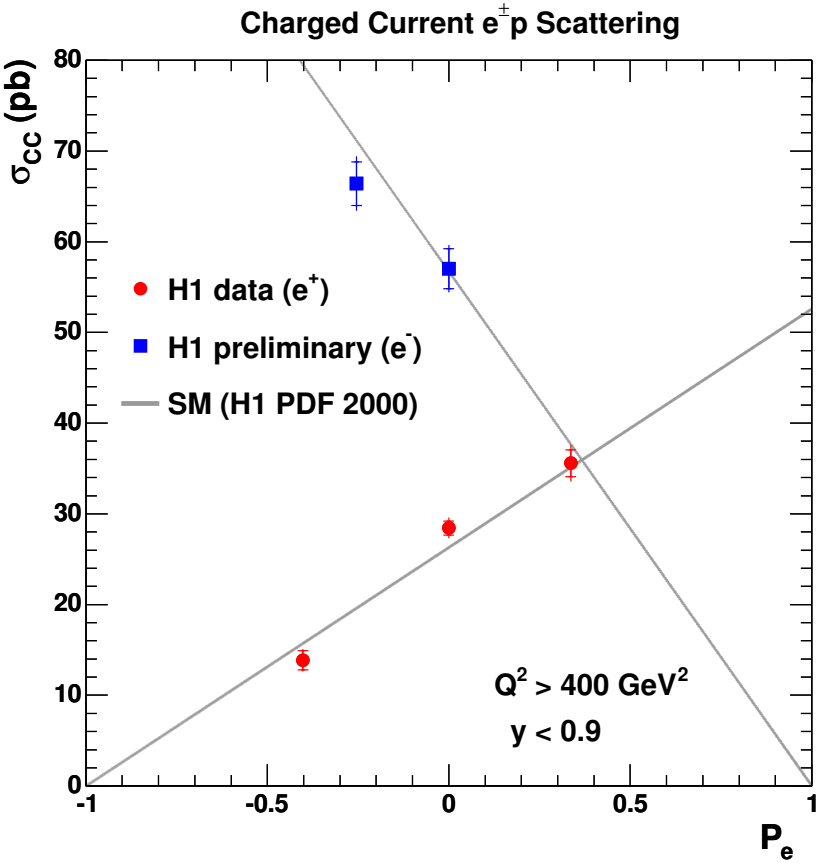
$$\frac{d^2\sigma^{e^\pm p}_{CC}}{dxdQ^2} = (1 \pm P_e)\frac{G_F^2}{2\pi x}[\frac{M_W^2}{q^2+M_W^2}]^2\phi^\pm_{CC}$$

$$\phi^+_{CC} = \overline{u} + \overline{c} + (1-y)^2(d+s+b)$$
$$\phi^-_{CC} = u + c + (1-y)^2(\overline{d} + \overline{s} + \overline{b})$$
$$P_e = (N_R - N_L)/(N_R + N_L)$$

- Linear dependence of the cross section on polarization

Inclusive measurements - NC/CC II.





- kinematics reconstruced from hadrons
- data in very good agreement with model
- extrapolated to the full phase space $Q^2 > 400\mathrm{GeV}^2$, $y < 0.9$
- good agreement with SM
- e^+ data published (DESY 05-249)
- NC and e^- are in progress (e^- preliminary)

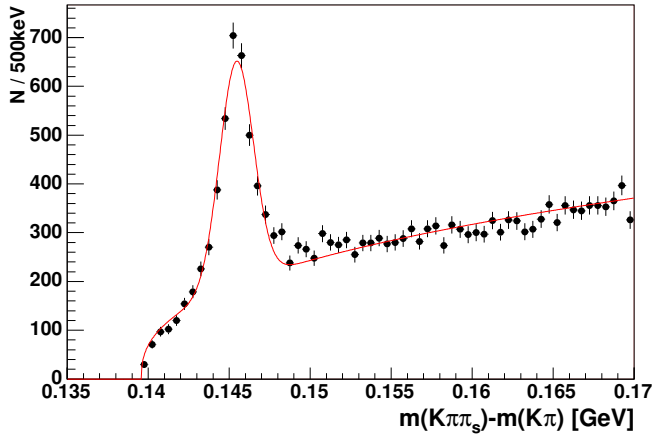
$$\sigma_{CC}(\mathrm{P}e = -1.) = -3.9\ pb \pm 2.3(stat) \pm 0.7(syst) \pm 0.8(pol)$$

Charm production in DIS

$$\sigma(p) = \int dz dp_{part} \sigma(p_{part}) D_H^{part}(z) \delta(p - z p_{part})$$

- $\sigma(p_{part})$ perturbative part, $D_H^{part}(z)$ nonperturbative fragmentation function
- arbitrary division between $\sigma(p_{part})$ and $D_H^{part}(z)$
- usually evolution down to m_c put in $\sigma(p_{part})$, understood?
- $D_H^{part}(z)$ assumed to be universal, valid?

- Charm events tagged by D^* in the golden channel ($K\pi\pi_S$):



! qluon emmision off heavy quark influenced by m_c

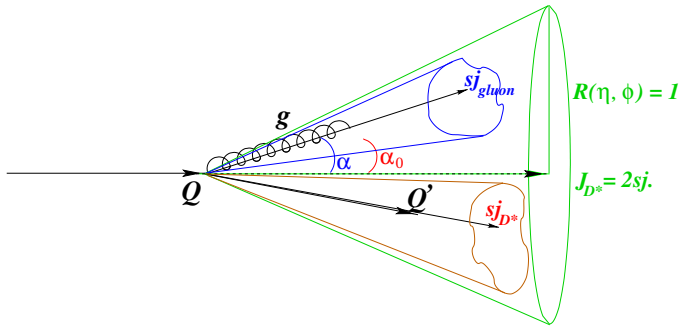
! QCD predicts for small α:

$$\frac{d^2\sigma_{Q\to Q+g}}{d\alpha} \approx K \frac{\alpha^3}{(\alpha^2+\alpha_0^2)^2},$$
$$\alpha_0 = M_Q/E_Q$$

! $\alpha < \alpha_0$ - dead cone

$\Rightarrow$ Study internal structure of charm jets

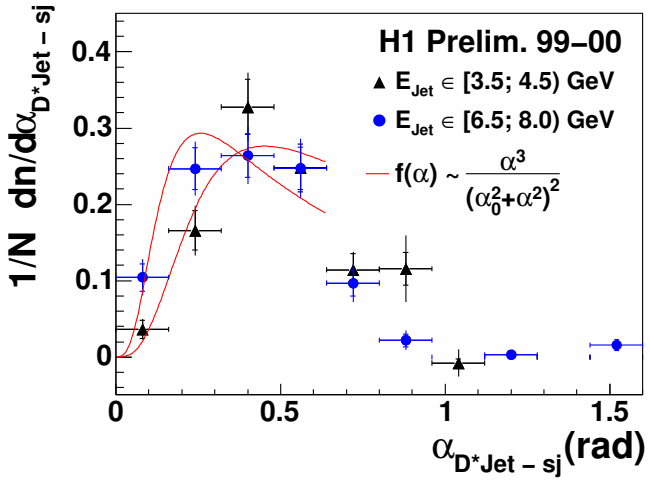
Structure of Charm jets in DIS

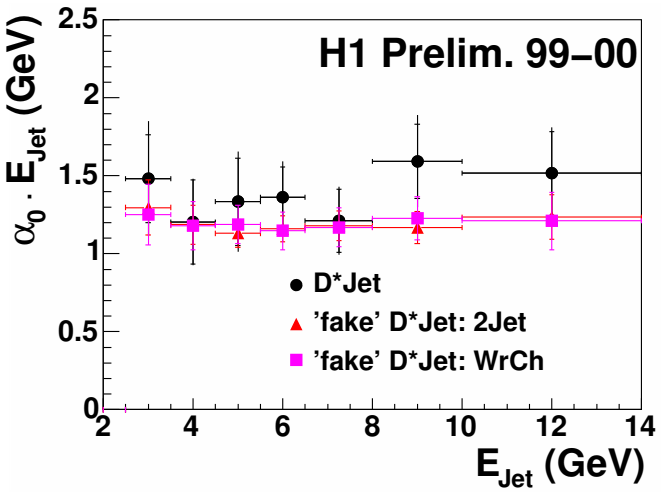


- jet algorithm rerun till exactly two subjets are found
- study angle α between the charm jet axis and non-charm subjet

▷ distribution in agreement with pQCD formula, fit with α_0 as a free parameter

▷ from pQCD formula expect $\alpha_0 E_{jet}$ independent of jet energy





Data consistent with pQCD prediction, difference to light jets statistically not significant

Study of Fragmentation Function - H1

Fragmentation function describes the energy transfer from quark to a given meson.

e^+e^- collisions

- natural choice $$z = \frac{E_{D^*}}{\sqrt{s}/2} = \frac{E_{D^*}}{E_{beam}}$$
- assuming LO processes - direct measurement of non perturbative fragmentation function

ep collisions

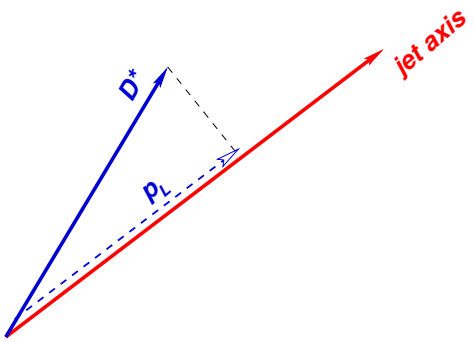
- choice of z observable not so obvious
- differences: IPS contribution,
  different kinematics
  beam energy not known

The Experimental Methods

Jet Method :

- the energy of c-quark is approximated by the energy of the reconstructed D^* jet

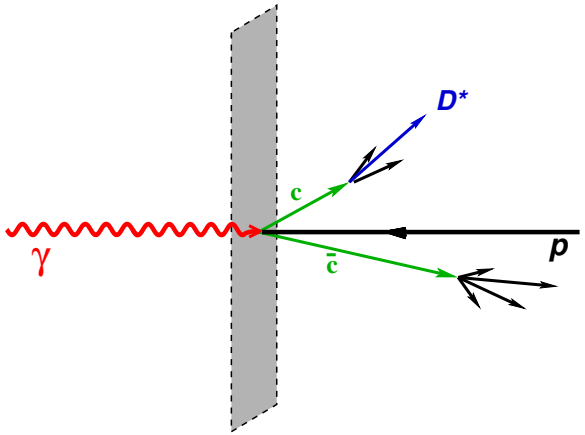
$$z_{\mathrm{jet}} = \frac{(E+p_L)_{D^*}}{(E+p)_{\mathrm{jet}}}$$

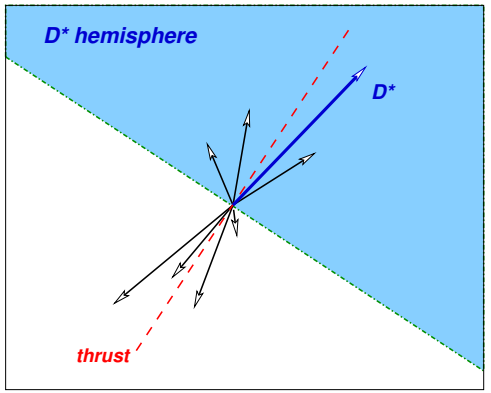


Hemisphere Method :

- in γp-frame the $c\bar{c}$ pair is balanced in p_t
  $\Longrightarrow$ possibility to divide event into two hemispheres

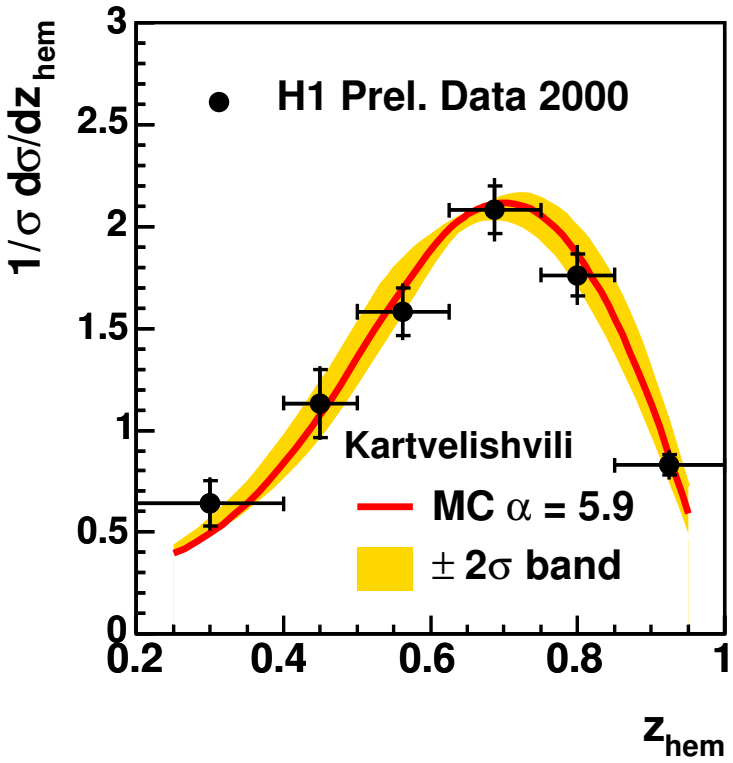
$$z_{\mathrm{hem}} = \frac{(E+p_L)_{D^*}}{\sum_{\mathrm{hem}}(E+p)}$$

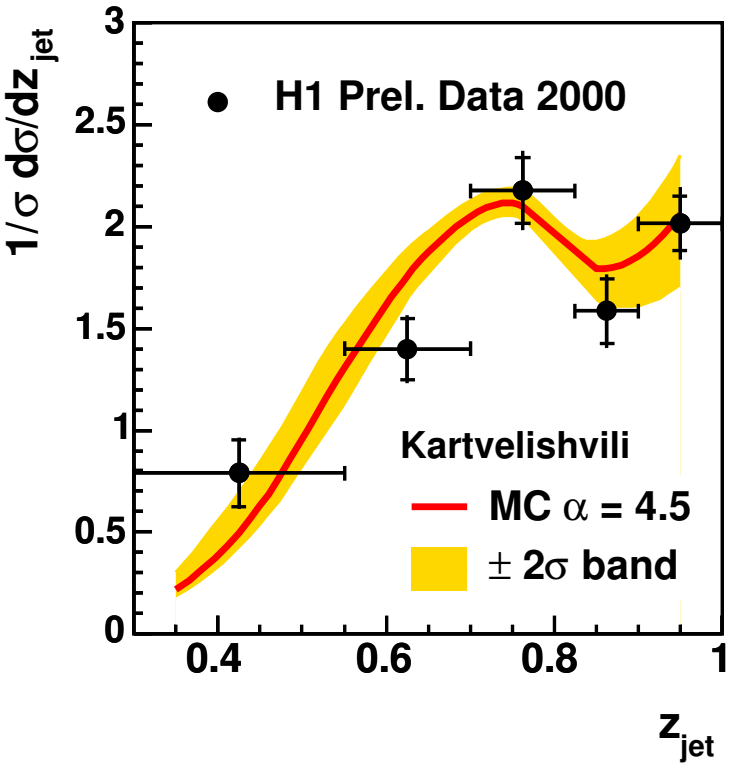




Measured z-distributions with Kartvelishvili parametrization

RAPGAP/PYTHIA+Kartvelishvili : $f(z) \sim z^{\alpha}(1-z)$





Summary of the Fragmentation Function Results

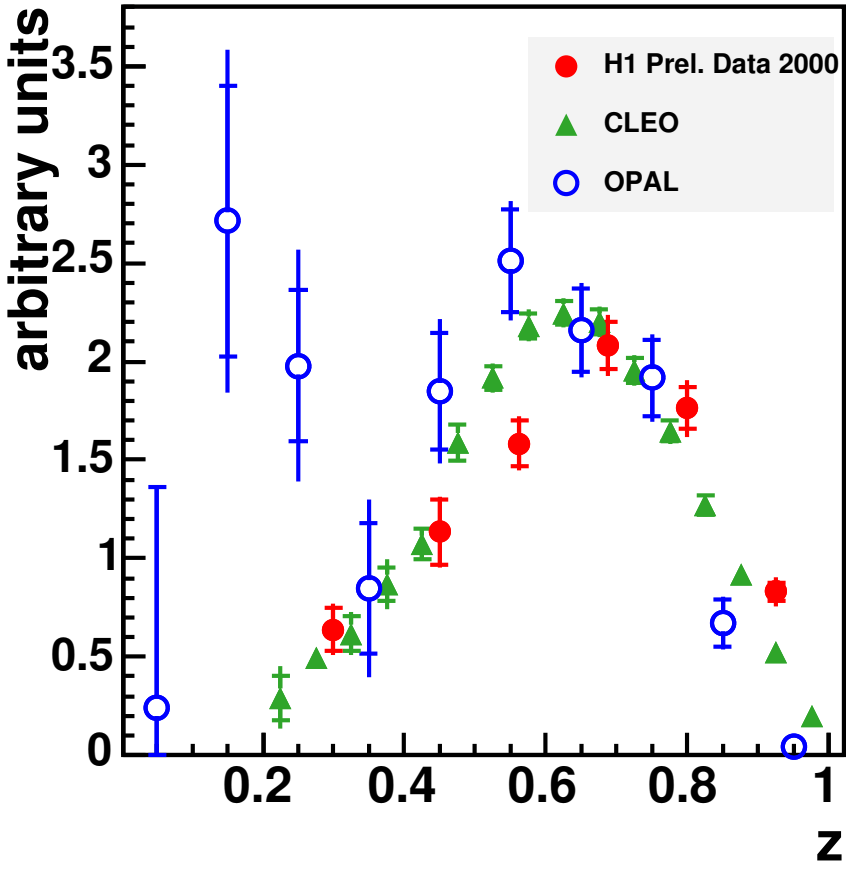
- Kartvelishvili and Peterson parametrizations provide equally good descriptions of the data
- hemisphere method appears to give harder fragmentation function than the jet method

H1 Prel. Data 2000 + RAPGAP/PYTHIA

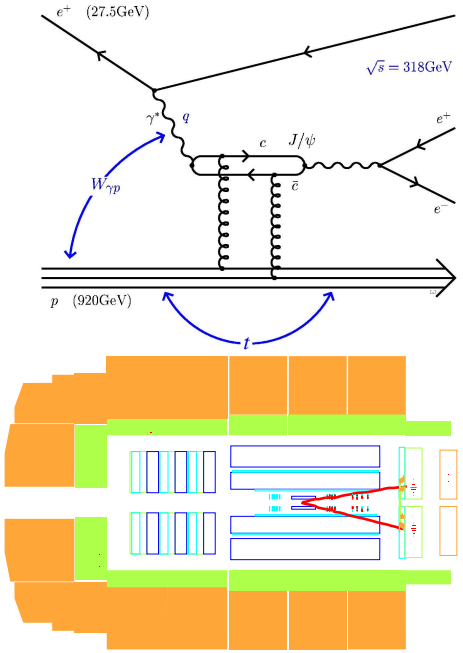
parametrization		Hem. method	Jet method
Peterson	ε	$0.018^{+0.004}_{-0.004}$	$0.030^{+0.006}_{-0.005}$
Kartvelishvili	α	$5.9^{+0.7}_{-0.6}$	$4.5^{+0.5}_{-0.5}$

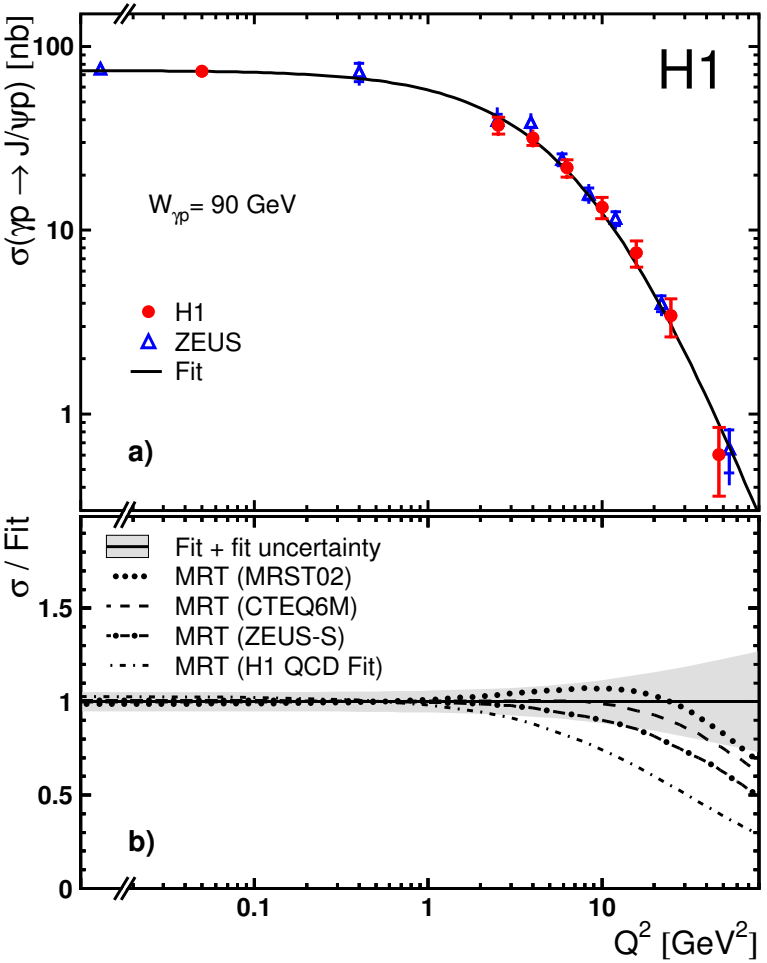
- difference ($< 3\sigma$) between hemisphere and jet method result may indicate imperfect MC description of hadronic final state in charm events
- z hemisphere and e^+e^- have similar shape
- differences between ep and e^+e^- larger then errorbars !

$\Rightarrow$ dedicated analysis needed !



Elastic J/ψ production I.

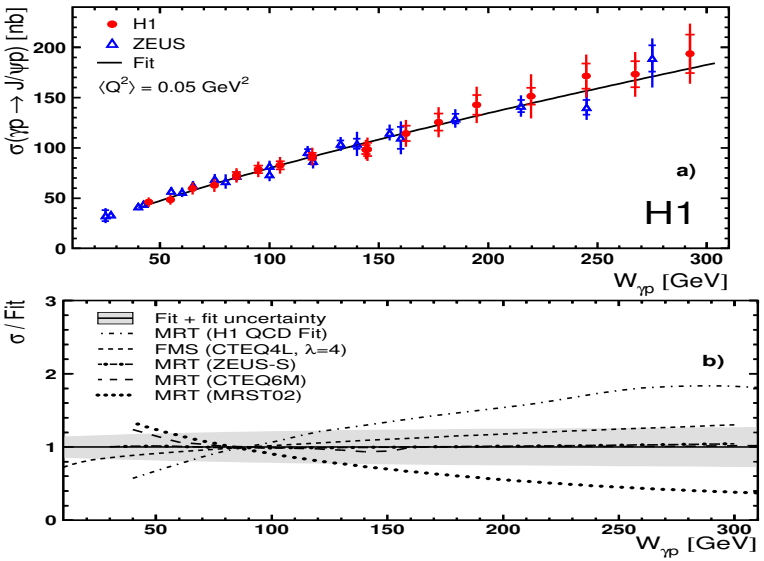




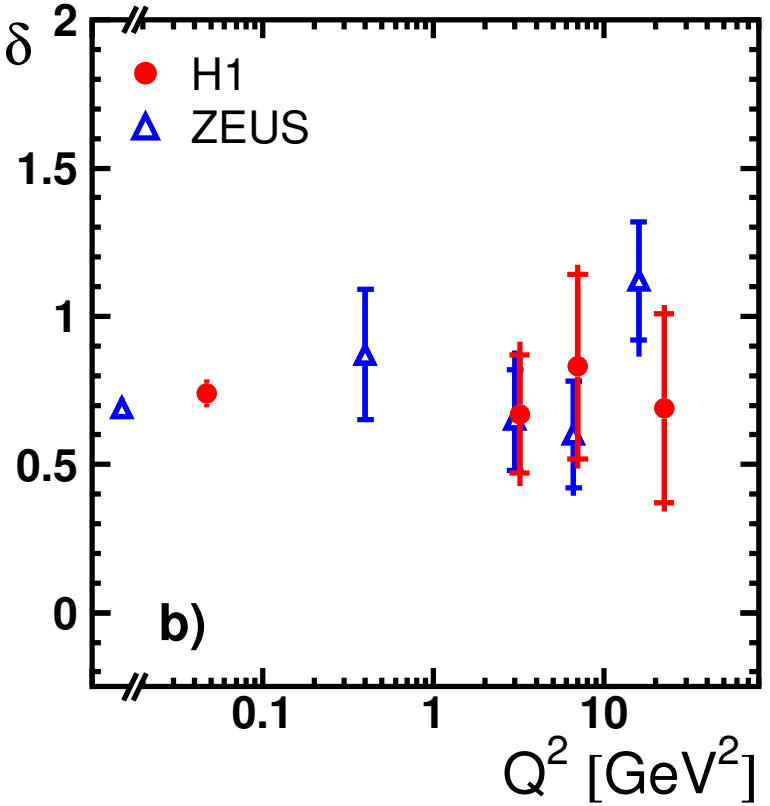
- ⇒ clear experimental signature
- ⇒ sensitive to g^2 (low x, Q^2)
- ⇒ results from high W analysis in e channel (L.Janauschek, C.Kiesling) combined with low W analysis in μ channel
- ⇒ both DIS and photoproduction

Excellent agreement with QCD-based models!

Elastic J/ψ production II.



- nice, consistent data set going up to $300\ GeV$
- smooth transition between different data sets
- QCD based models are able to describe the data
- strong dependence on input gluon density



- slope of W dependence does not depend on Q^2 (in our range of Q^2)

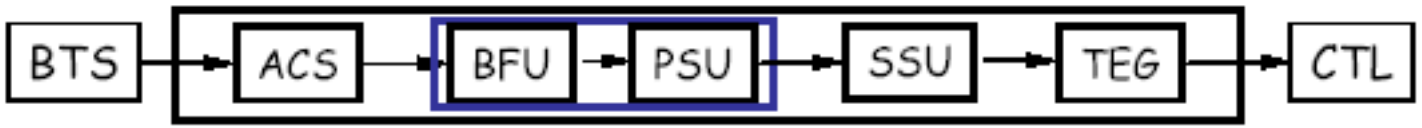
Jet Trigger I.

Jet Trigger - an upgrade of L1 Liquid Argon Trigger

! searches for localized energy depositions - jets (E_T, θ, ϕ)

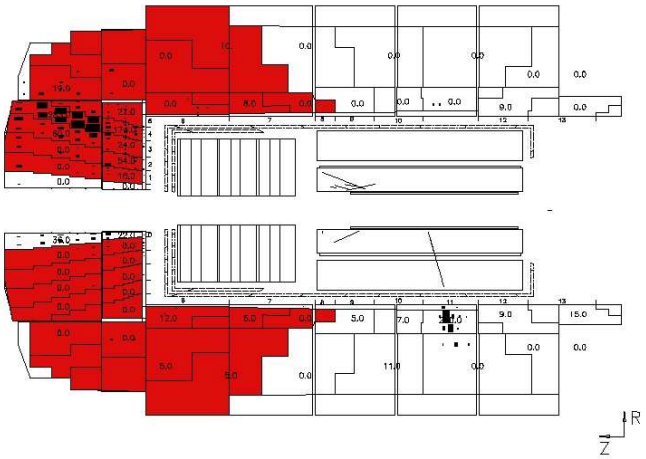
$\Rightarrow$ less sensitive to noise

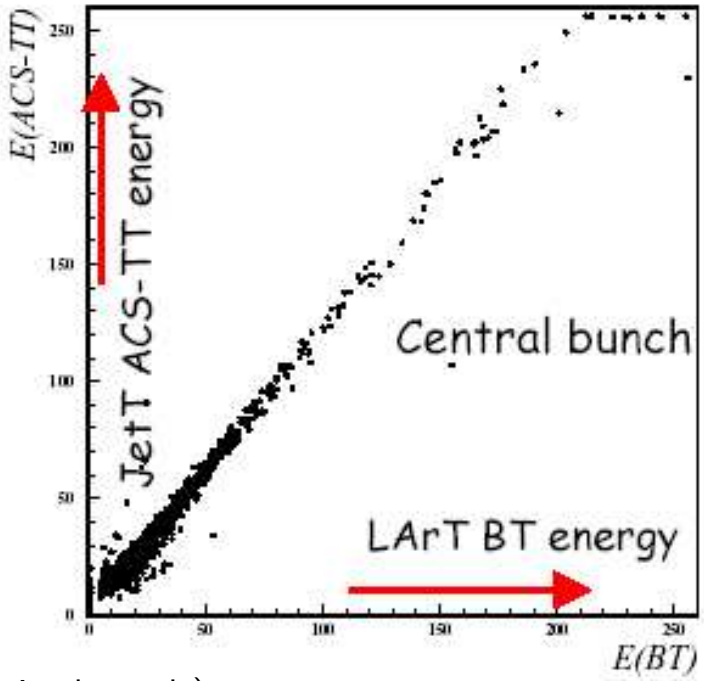
$\Rightarrow$ possible to explore correlations between jets



- Hardware installed in Hamburg
  - system in the readout
    - $\longrightarrow$ standalone test readout
    - $\longrightarrow$ CDAQ readout (most of the system)
  - checked up to sorted list of jets
  - sending test trigger elements to central trigger
  - work ongoing mainly on ACS and TEG

Jet Trigger II. (ACS)





- at the moment forward part instrumented (2/3 of electronic channels)
- ACS in the readout since september 2005
- stable performance
- very good correlation with existing LAr trigger

Jet Trigger III. (TEG, next steps)

TEG:

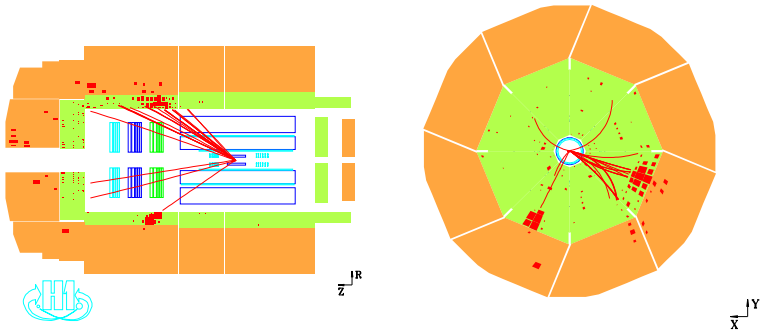
- hardware installed in Hamburg
- sending test trigger elements to CTL
- long-term stability tests ongoing
- work on definition of TE's (PWG's)

Next steps in JT commisioning:

- complete CDAQ readout
- readout stability tests
- fine tuning of hardware
- work on software (loading, simulation)
- instrument full barrel part of calorimeter (ACS, to be competed end of march 2006)
- design of trigger elements (PWG's)
  - ▷ high Q^2 for NC
  - ▷ low y for CC
  - ▷ dijets in γp
  - ▷ ...

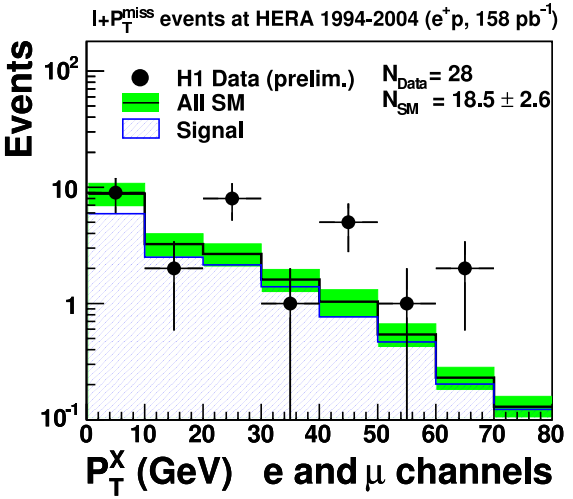
With new lumi coming we expect first events triggered by JT

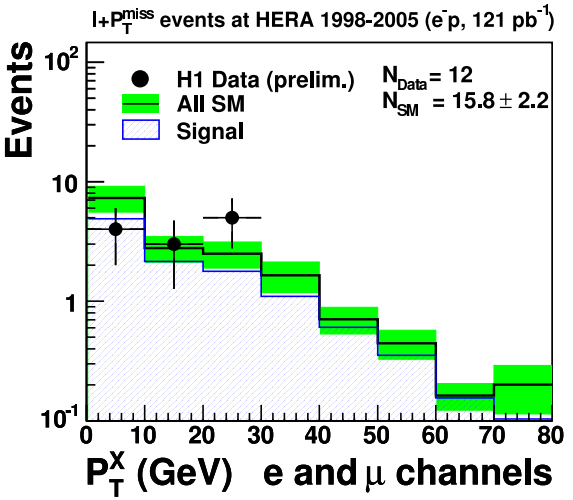
Near future I. (there are still some excitements!)



- events with isolated lepton(e or μ) and high missing Pt($> 12GeV$)
- in SM dominant process: real W production
- excess mainly in e^+p (3.4σ)

$P_T^X > 25$ GeV	e obs./exp.	μ obs./exp.	combined
H1 e^- (121 pb^{-1})	$2/2.4 \pm 0.2$	$0/2 \pm 0.3$	$2/4.4 \pm 0.7$
H1 e^+ (158 pb^{-1})	$9/2.3 \pm 0.4$	$6/2.3 \pm 0.4$	$15/4.6 \pm 0.8$
ZEUS e^+ (106 pb^{-1})	$1/1.5 \pm 0.18$	-	-





Future HERA running II. (current planning)

- november 2005 - february 2006 shutdown, improvements on machine side (in 2005 HERA efficiency $\sim 60\%$, close to HERA I.):
  - exchange all coils of vertical proton bending magnets (BU)
  - improve vacuum systems (mainly close to rotators)
  - improve beam diagnostics
  - magnet current change monitoring
- H1 during shutdown:
  - full silicon back
  - maintenance work on many subsystems
- Future plans:
  - run till june 2007 without big shutdown (~ 450 days of running)
  - change beam charge and several times change of helicity
  - H1 expressed its interest in low energy ep run (direct measurement of F_L and F_L^D, ~ 3 months)

If everything goes well, most of luminosity is still to come!

Group members

The Boss:

- Allen Caldwell

Staff Scientists:

- Christian Kiesling (group leader)
- Vladimir Chekelian
- Günter Grindhammer
- Gerd Buschhorn (emeritus)

Post Doctoral Scientists:

- Juraj Bracinik
- Ana Dubak
- Bob Olivier
- Jens Zimmermann

Support on all sides:

- Franziska Rudert
- Marlene Schaber

PhD Students:

- Andrej Liptaj
- Andrey Nikiforov
- Ringailė Plačakytė
- Zuzana Rúriková (finished)
- Biljana Antunovič

Engineers:

- Markus Fras
- Werner Haberer
- Joseph Huber
- Miriam Klug
- Andreas Wassatch

Group members

Alexei I. Babaev (1935-2005)

Current activities

Hardware:

LAr L1: Juraj Bracinik, Christian Kiesling, Andrej Liptaj, Andrey Nikiforov, Zuzana Rúriková + engineers

L2NN: Christian Kiesling, Ringailė Plačakytė, Jens Zimermann + engineers

JT: Ana Dubak, Christian Kiesling, Bob Olivier, Biljana Antunovič + engineers

Engineers: Markus Fras, Werner Haberer, Joseph Huber,Miriam Klug, Andreas Wassatch

Analyses:

Inclusive (NC, CC) measurement: Vladimir Chekelian, Christian Kiesling, Andrey Nikiforov, Bob Olivier, Ringailė Plačakytė, Biljana Antunovič

Charm physics: Juraj Bracinik, Günter Grindhammer, Andrej Liptaj, Zuzana Rúriková

Special duties:

Vladimir Chekelian: Physics coordinator

Günter Grindhammer: Ringberg workshop organizer

Christian Kiesling: Executive Commitee member, run coordinator

Juraj Bracinik: LAr coordinator, run coordinator

Conclusions

- Group has ambitious activities in the area of hardware and analysis
- Good support from our director
- Plans
  - till mid 2007 collect as much data as possible
  - analysis of the data 3-5 years afterward