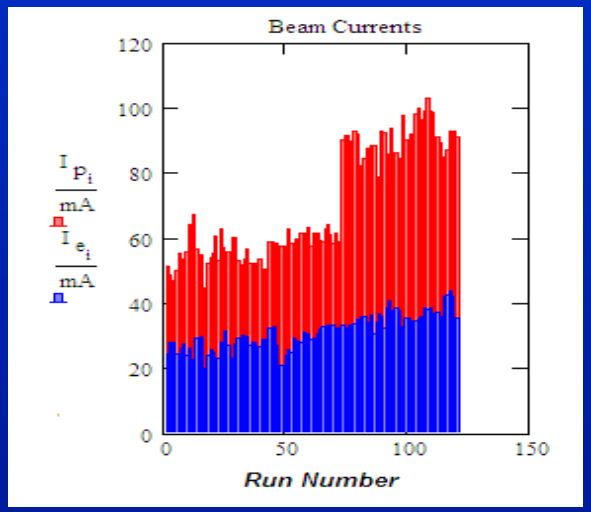
HERA Performance and Prospects for Electron Operation

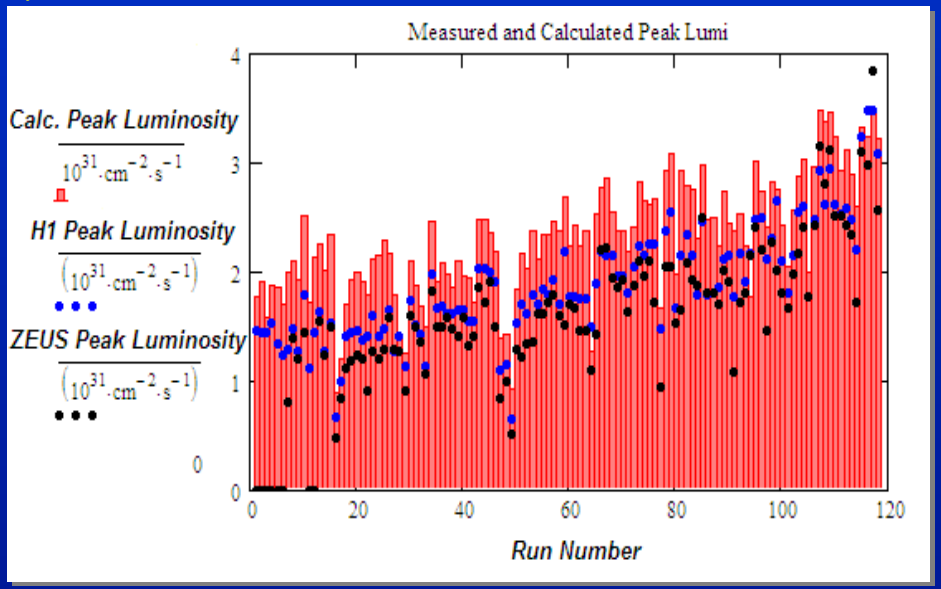
HERA-Experiments Coordination Meeting
April 23 2004 , DESY

F. Willeke, DESY

- HERA present performance
- HERA challenges and issues
- Luminosity prospects
- HERA Operation with

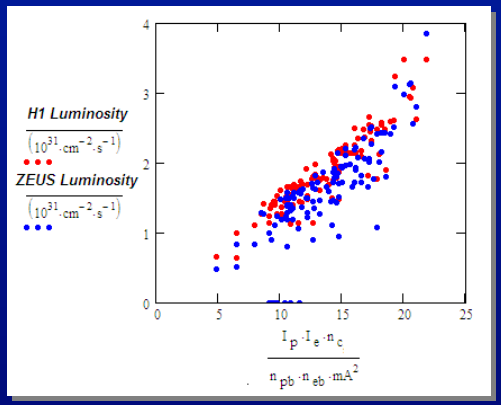
HERA Luminosity 2004: Steady increase of of Luminosity with increasing lepton beam currents





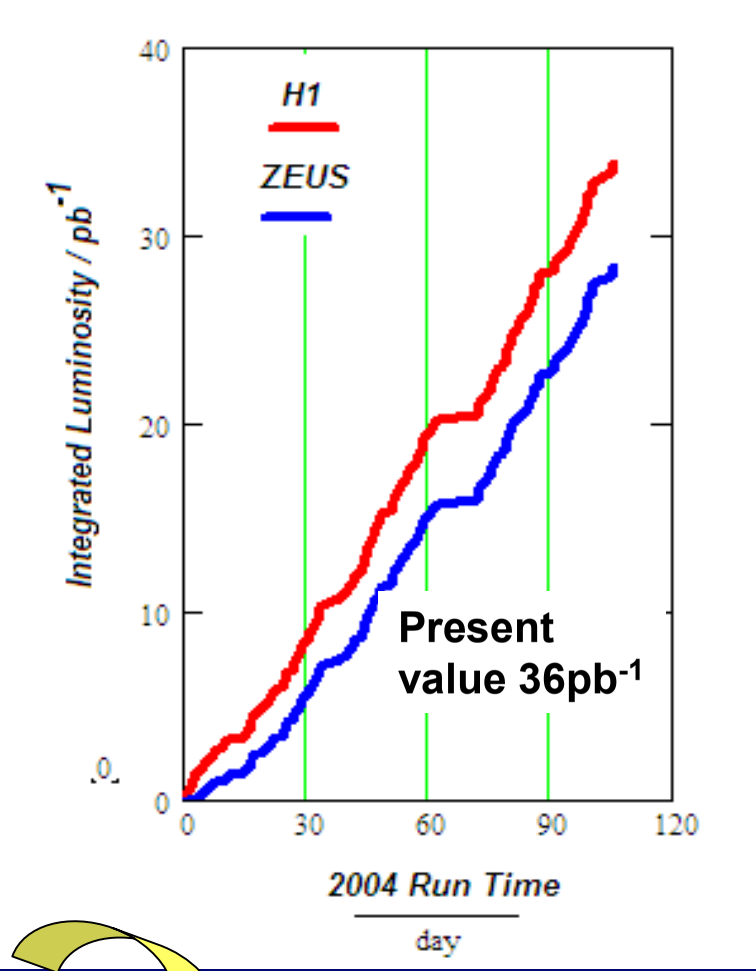
Accelerator Physics Issues Solved

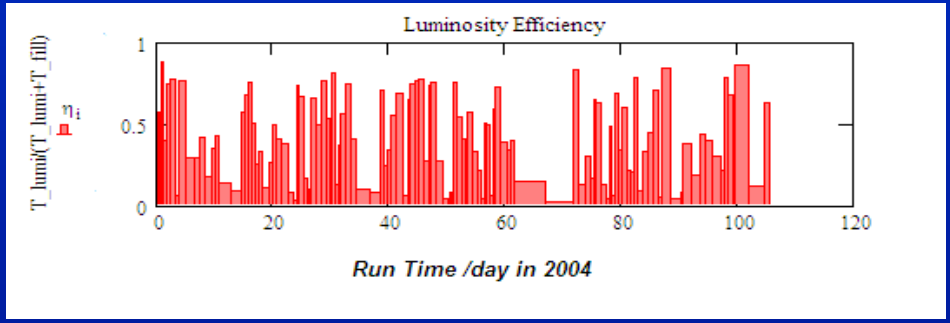
- ➔ Peak Luminosity ~ I_p x I_e
- ➔ Peak Luminosity doubled since January
- ➔ Record so far 3.5 $10^{31}cm^{-2}s^{-1}$



Expect to approach HERA II peak Luminosity goal of $4.5 \cdot 10^{31}$ $cm^{-2}s^{-1}$ within the next few months as soon as 50mA of positrons can be stored

Integrated Luminosity Jan-April suffered from technical failures

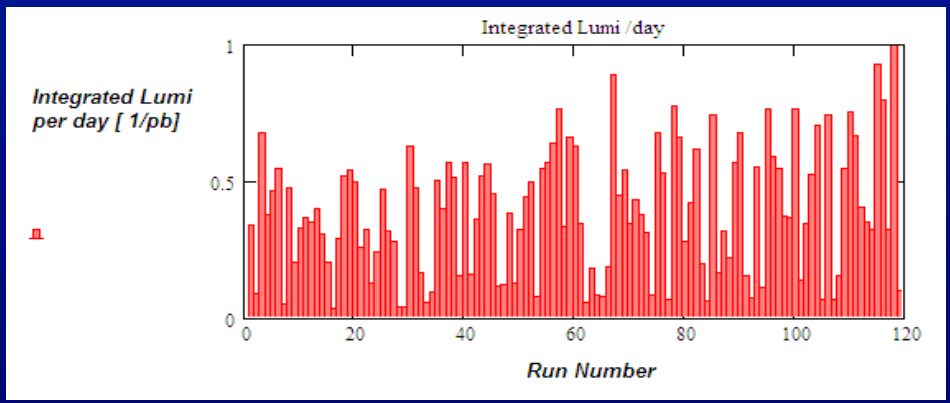




Peak Daily production Rate 1000nb-1

But average efficiency only 40% ➔

Average Daily production Rate 355nb^{-1}



Improvement of overall Accelerator availability is the largest challenge

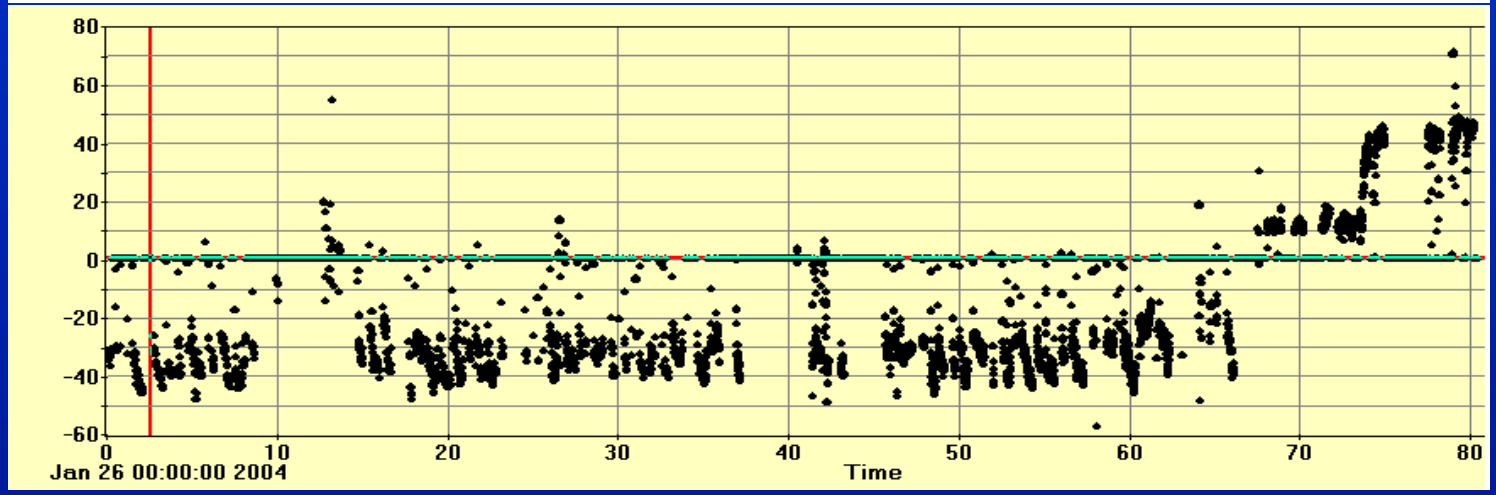
Present Technical and Operational Issues

- Large Beam Pipe Temperatures SR/NR
  risk of vacuum leaks ➔ new NR/SR 11m-absorbers
- Ground faults of HERAP main power circuit (BU-type n.c. dipoles)
  ➔ cured for the time being?
- Noise in RF Frequency generation ➔ strong coasting beam production ➔backgrounds : under study
- Frequent Technical Failures: maintain alertness of technical groups,
- Operational Efficiency: improved operator training, improved communications

Optimistically Projected Performance

Month	?dt L [1 / pb]
January	8
February	11
March	8
April	12
May	15
June	20
July	22
August *)	12
SUM	108

HERA Longitudinal Polarization



Polarization in collisions: 30-40%
Polarization without collisions up to 50%

Further improvement plans:

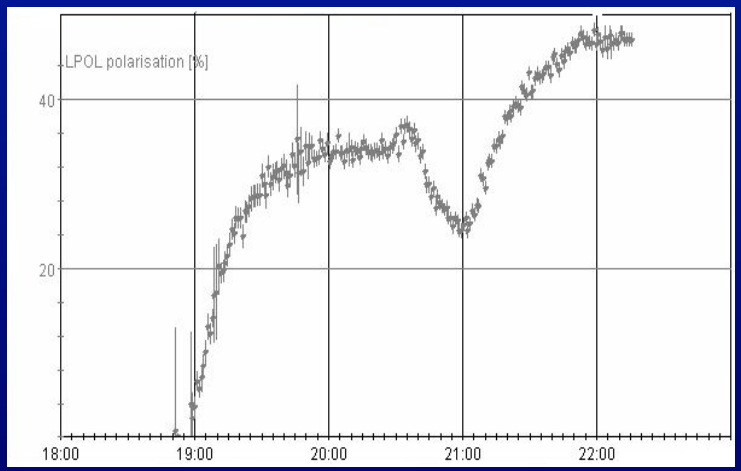
Dedicated 2 Polarization Studies

Beam Based alignment
(suffers from lack of resources)

Need better polarization measurement for fast tuning!!

Regular Rotator Flip

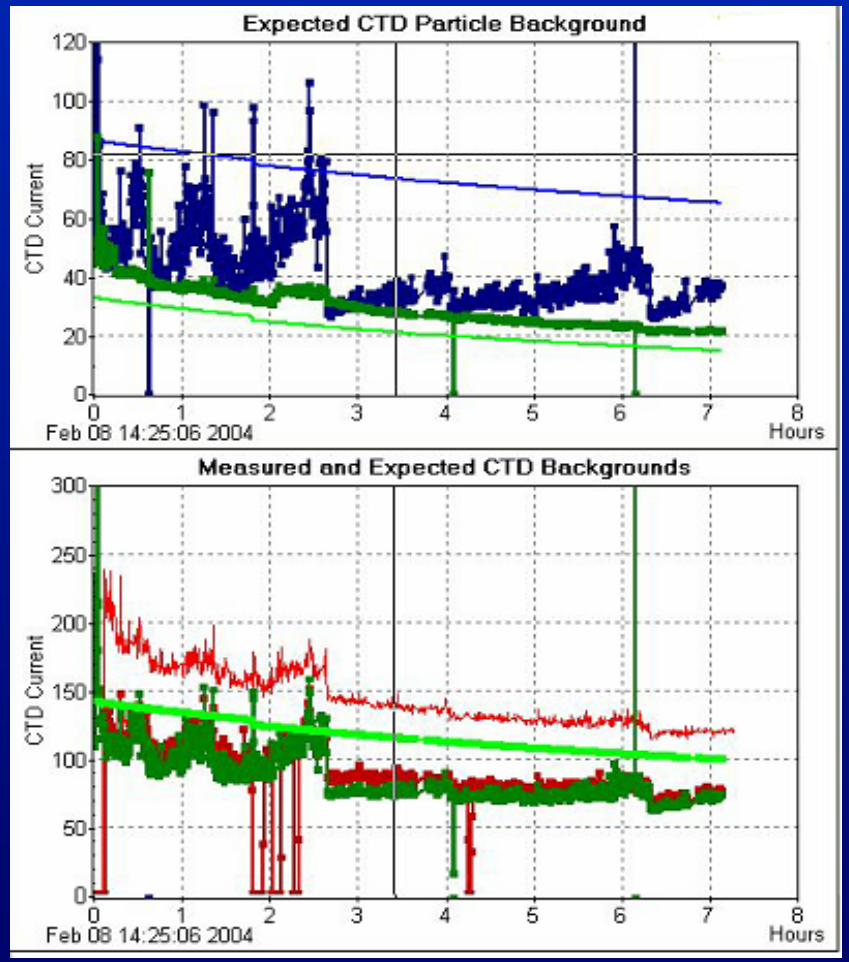
Polarization after p-Beam Loss on Feb. 12, 2004



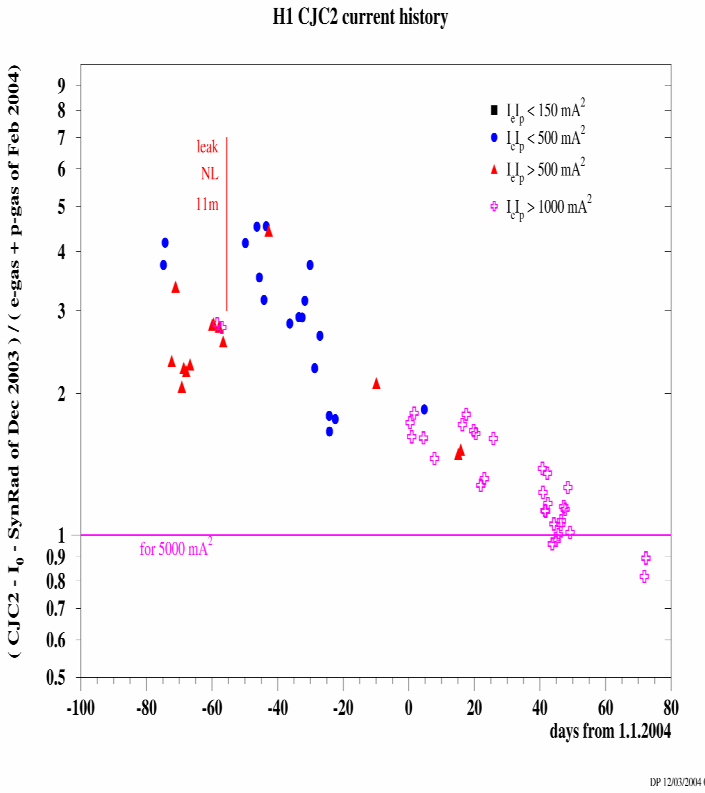
Backgrounds

ZEUS Background Monitor

Helps to keep backgrounds under control



H1 Backgrounds do not limit HERA Performance any more!



Accelerator Physics Issues

Coherent Beam-Beam Effects

➔ Work around

Beam-Beam Footprint accommodation

➔ Under control for I_p~ 100mA

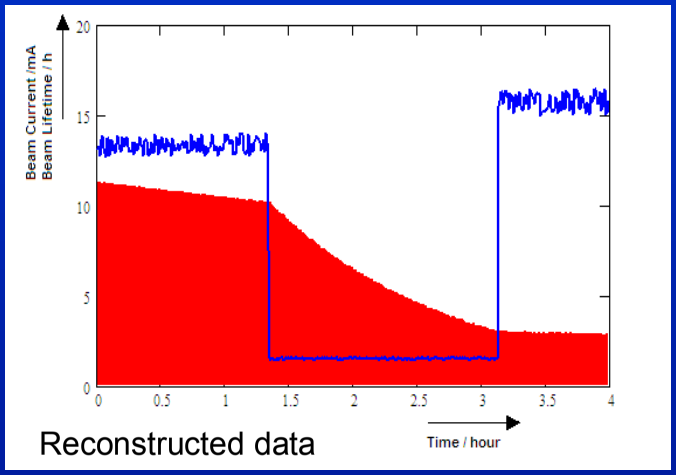
Proton Beam Longitudinal Stability

➔recently more severe, need to proceed with improvement program

First order linear Beam Parameters and low intensity specific luminosity

➔ Good control of beam optics, beam orbits and cross coupling

Problems with Electrons due to "Dust"



Reconstructed data

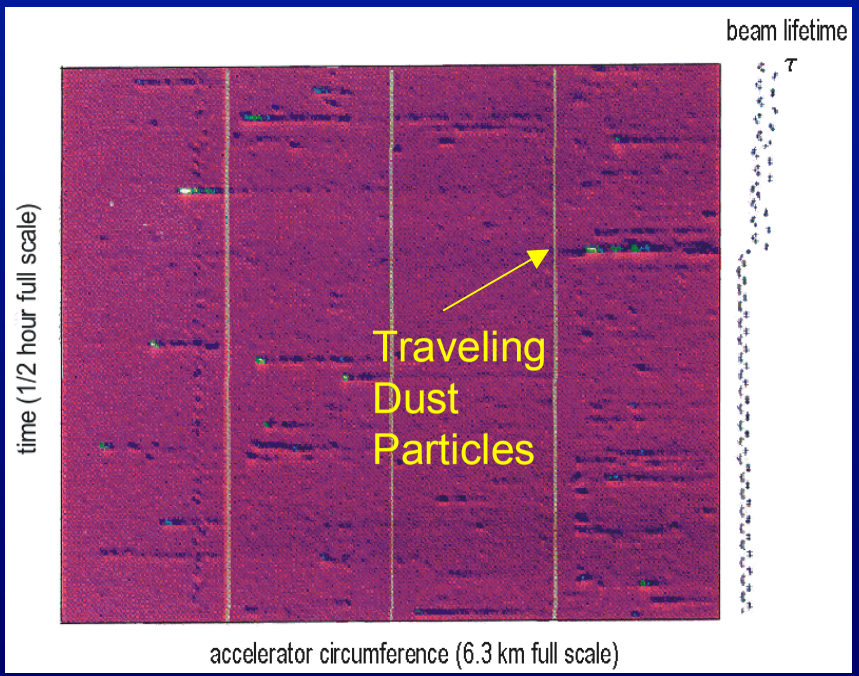
Sudden breakdown of the beam lifetime due to dust a ~1μm size dust particle above ~10mA beam current

Emitted by the integrated ion pumps

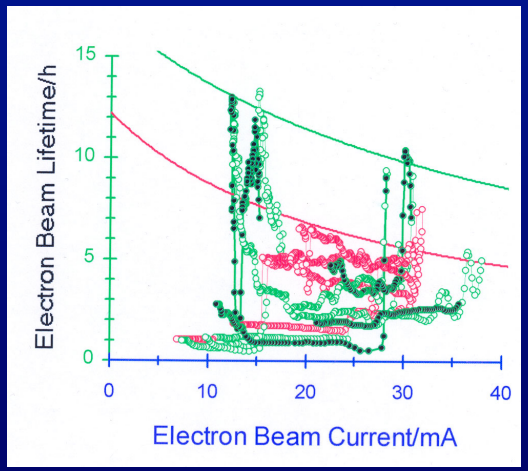
Replace all integrated ion pumps by NEG pumps in 1997/8

➔ **Operate with e^+ 1994-1997**

HERA electron losses in space and time

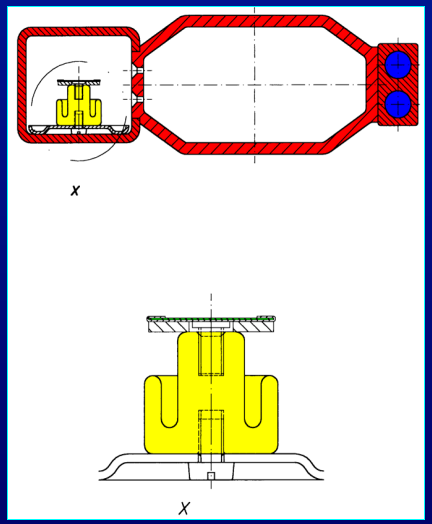


Experiments confirms the ion pumps as major source



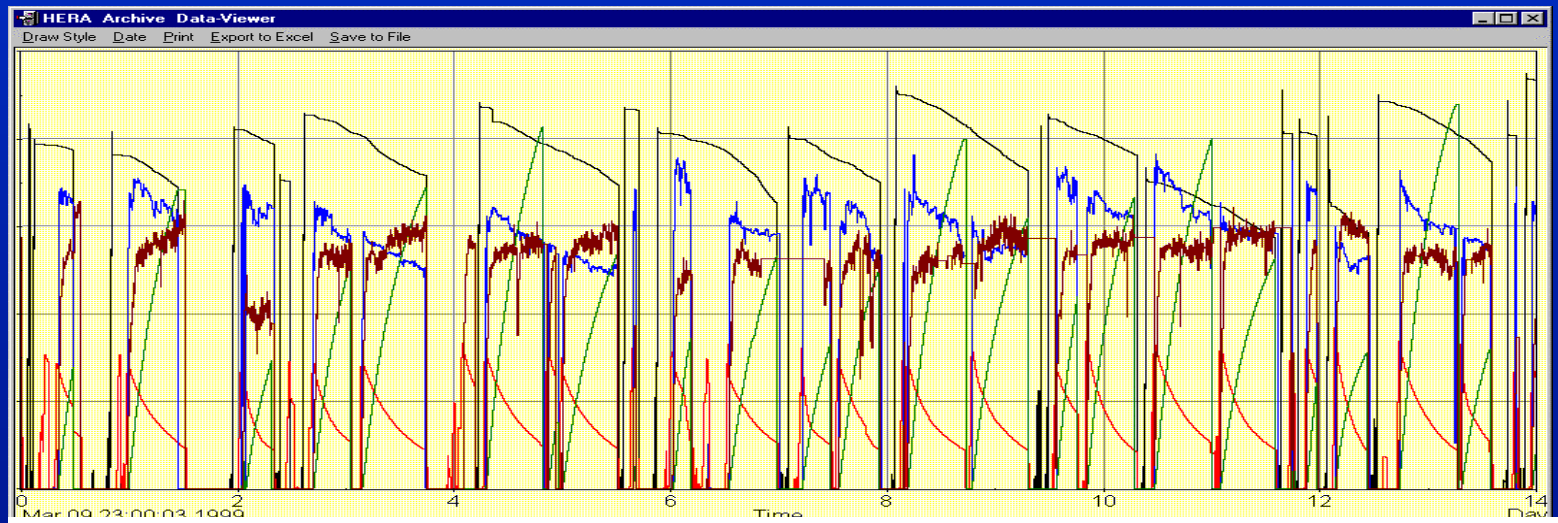
Replace Ion Pumps by NEG Pumps

WS 1997/1998



Successful operation with electrons in 1999

2 Weeks of HERA Luminosity Operation with e^- in March 1999



- Proton currents 80-90mA; e- currents 30-35mA; e-beam lifetime (8-14) h
- two e-fills per p-Fill
- Polarization ok, backgrounds tolerable
- Up to 400/nb /day, up zu 2/pb pro week
- short Fill time close to Minimum
- Good reliability

➔ HERA II Running with Electrons

- Expect average beam currents of 35mA instead of 45mA
- Beam lifetime expected to be somewhat shorter (11h ➔ 8h) ➔ shorter runs
- Particle backgrounds due to tails in transverse e- distribution expected to increase
- One has to expect more frequent background "spikes"
- SR heating SR7NR more severe
- Increase p-Backgrounds due to larger SR load SR/NR

➔ e- Luminosity production somewhat less effective compared to e+

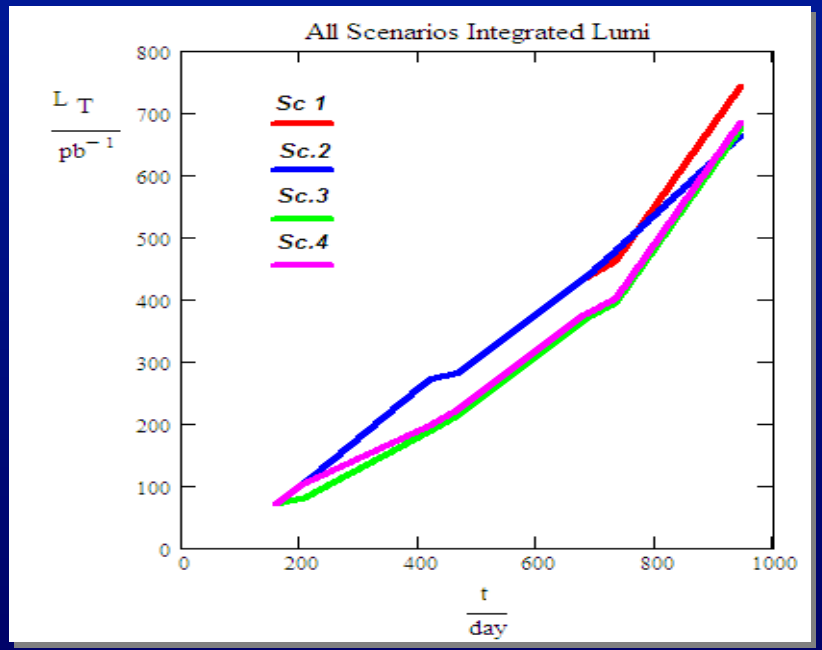
HERA Improvement Program:

rich program with 70 items, the most important ones being:

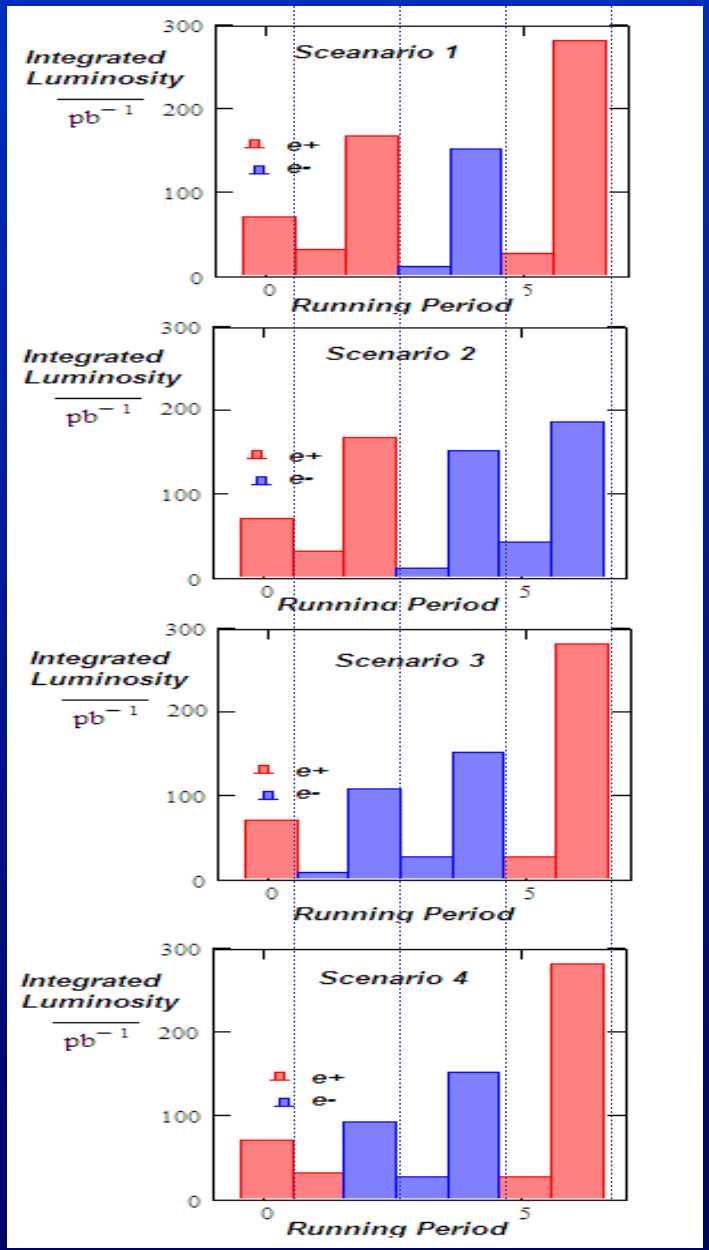
Proton RF Systems	Improved low-level controls Suppression of long. Instability	2/2/.5 PJ	0.55 M€
Injection Systems	Improved monitoring vertical excitation kicker	0/0.2/0.2 PJ	0.09 M€
Collimation Systems	increased reliability	0/0.25/0.2 PJ	0.10M€
Diagnostics Systems	improved monitors (BPM, SR)	1./0.3/0.1 PJ	0.15 M€
RF-Controls	p-RF freq. control, etc	1/0.25/0.25 PJ	0.04 M€
Vacuum System	better pumping in RF sections	0/0.5/1.0PJ	0.5 M€
Power Supply Systems	add'l Ps for spin matching	0 /0.3/0.2 PJ	0.2 M€
e-RF Systems	RF Modulator	0/0.5/.95 PJ	0.13 M€
Cryogenic Systems	compressor and controls upgr.	0 /0.5/1.5 PJ	0.45 M€
Summe:	**14.6 PJ @ 0.605 M€** (add'l only)		**2.26 M€**

Projected Performance

Scenario	1	2	3	4
1-8 2004	p	p	p	p
10-12 2004	p	p	e	p
1-8 2005	p	p	e	e
10-12 2005	e	e	e	e
1-8 2006	e	e	e	e
10-12 2006	p	e	p	p
1-8 2007	p	e	p	p



Summer 2004/2005/2006/2007



Summary

- The background problems which occurred with the luminosity upgrade are now solved
- HERA made rapid progress towards operating with twice the Y2000k peak luminosity and with longitudinally polarized positrons at the 3 IPs
- The challenge is now to achieve the Y99/2000 operating efficiencies
- And to improve on the "usual" backgrounds
- There is a good chance to deliver a decent amount of luminosity until the end of the HERA II running period
- HERA is preparing to switch to e- but from the accelerator point of view it appears to much more preferable to postpone
  this until HERA has demonstrated full performance for some time