Report of the Technical Coordinator

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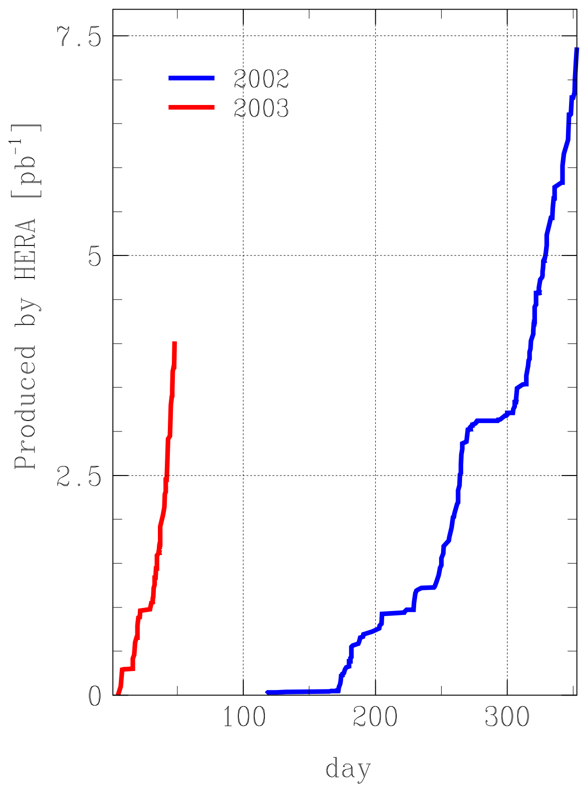
H1 collaboration meeting, 19.2.2003

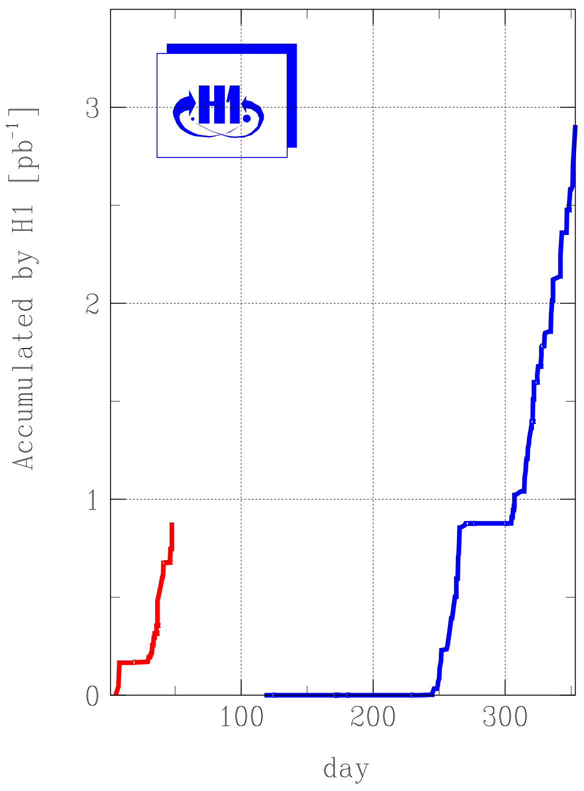
- Luminosity running
- Background evolution
- Shutdown plans

2002–2003 Luminosity run

INTEGRATED LUMINOSITY (17.02.03)



HERA delivered

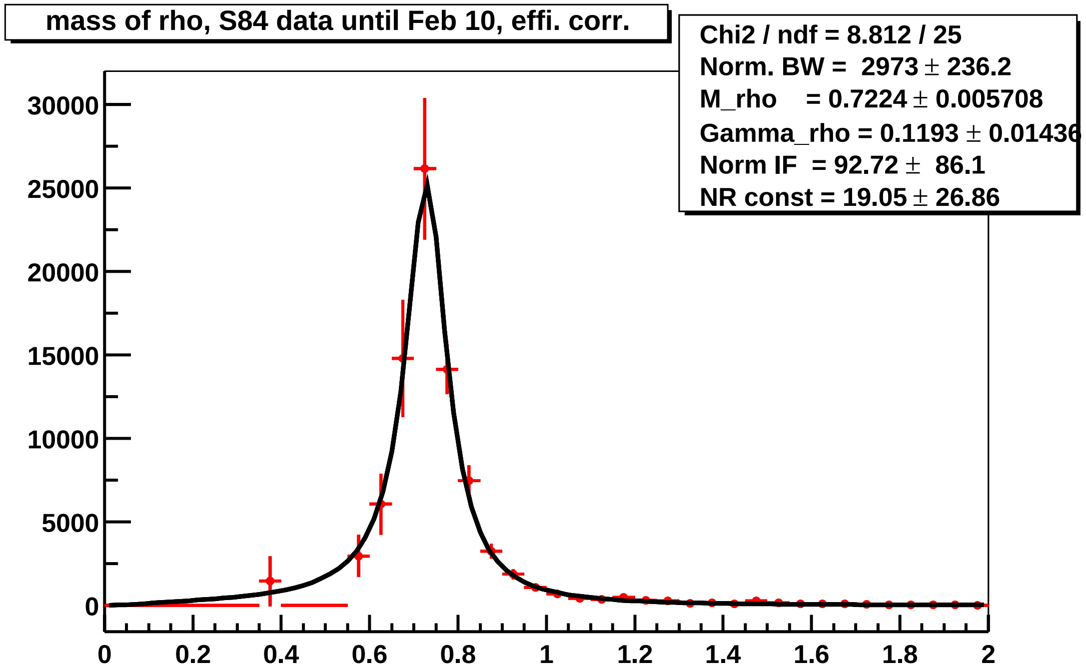


good and medium runs

- Total HERA delivered: $11.5\,\mathrm{pb}^{-1}$.
- H1 good and medium runs: $3.8^{+}\,\mathrm{pb}^{-1}$.
- CJC1 and 2 at full HV: $2.8^{+}\,\mathrm{pb}^{-1}$.
- Peak lumi: $1.7 \cdot 10^{31}\,\mathrm{cm}^2/\mathrm{s}$ on 11.2.2003, as in 2000.
- Best fill delivered $320\,\mathrm{nb}^{-1}$ on 11./12.2.2003. $350\,\mathrm{nb}^{-1}$ on 16.7.2000.

ρ^0 photoproduction

Efficiency-corrected $\pi^+\pi^-$ mass plot:



- Based on DCRφ trigger, with lots of clever vetoes.
- 6300$^+$ reconstructed signal events.
- Goal: measure $\frac{d\sigma}{dt}$ out to $t \approx -3\,\mathrm{GeV}^2$.

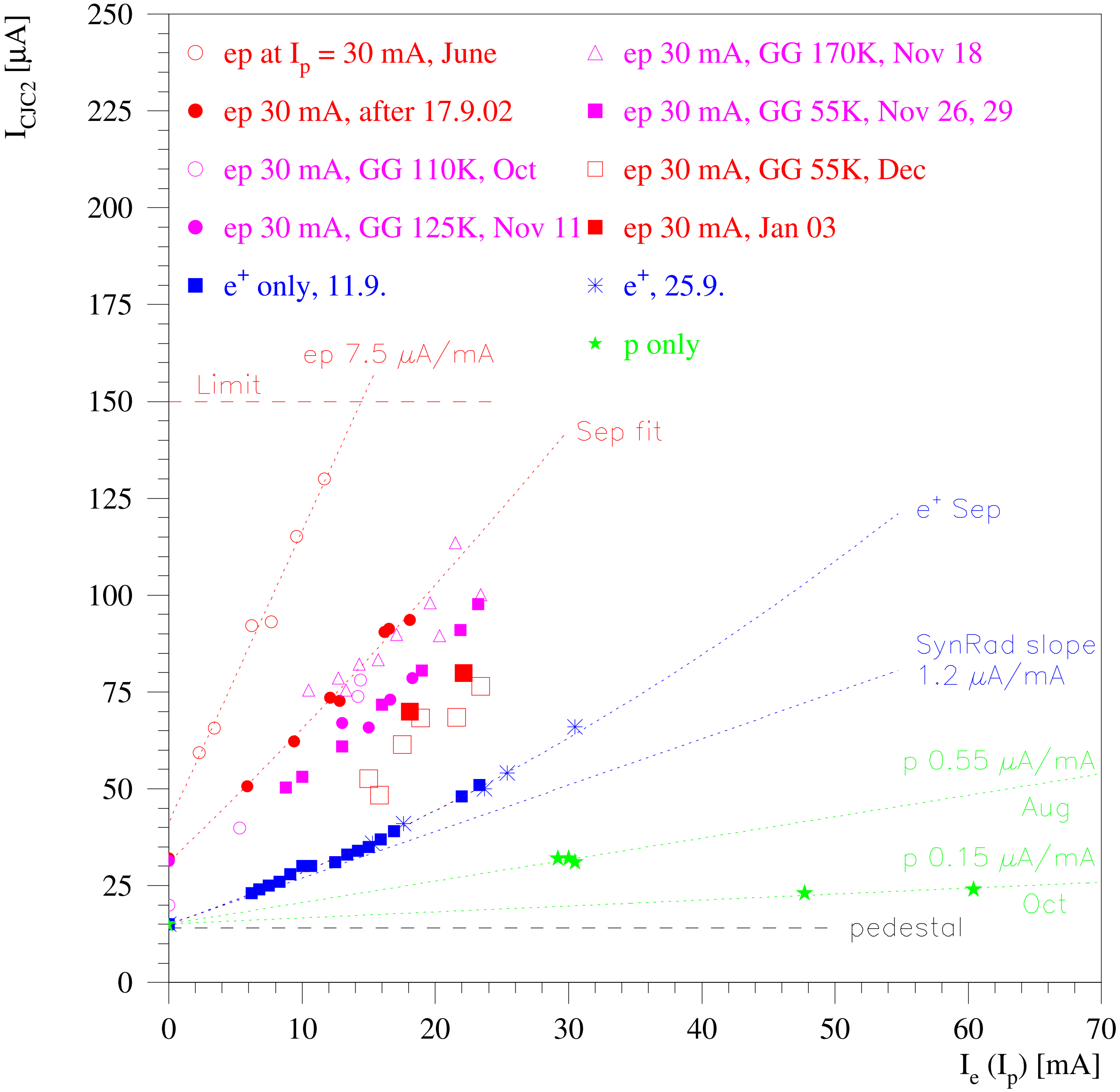
Error bars due to MC statistics.

First (painful) H1SIM production for HERA II physics!

Running experience

- Frequent CJC trips by background 'spikes'. One source identified: 110 kV transformer regulator.
- BST Pads: 4 of 6 double sectors inoperable after beam accidents.
- BST Radiation monitor: vital device — makes development of Pad trigger difficult.
- FTD: signal and HV cabling errors corrected. Suffered from BG like CJC. Only little ep data with full HV.
- FST: works beautifully! Excellent S/N, good efficiency, internal alignment done.
- PVSS HV control: stability now very good. Extension to Digital Muons in progress.
- Calorimeters: stable!
- Spacal kinematic peak calibration implemented end Oct 2002.
- FTT installed, first tests performed
- 40% e^+ beam polarization for Hermes observed in Oct. Spin rotators N,S to be tested next week.
- Good collaboration with machine group in background experiments.
- 3 BG working groups with ZEUS and machine: p-gas, e-gas, SynRad and weekly plenary.
- Always found compromise on running modes with HERA-B, Hermes, ZEUS.

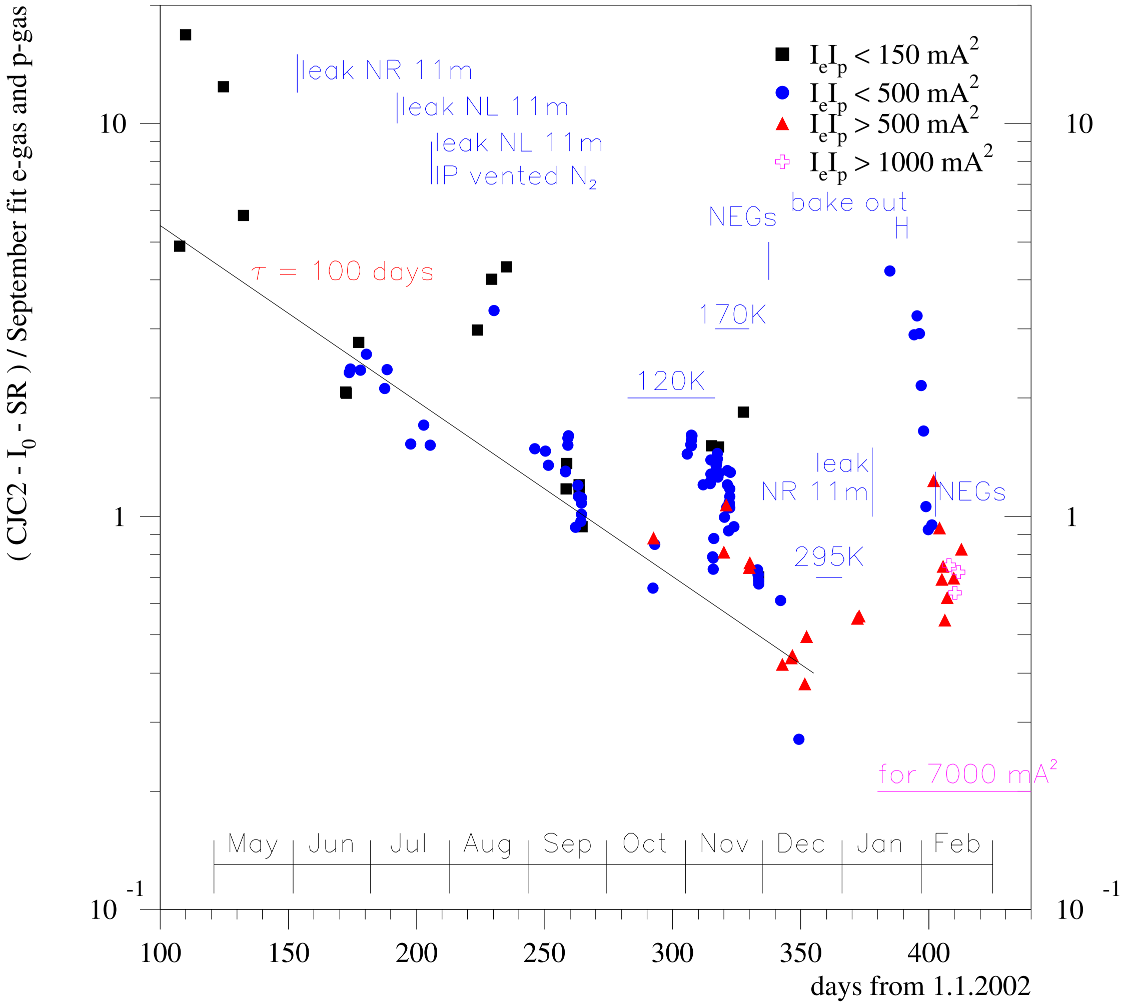
$$I_{\mathrm{CJC}} = I_0 + \alpha_{\mathrm{SR}}\, I_e + \alpha_e\, I_e^2 + I_p\,(p_0 + \alpha_p\, I_e)$$



- Parameterization tested up to $I_e = 25 - 30$ mA.
- p-gas reduced by factor 2.5 from Sep to Dec due to better vacuum.
- Safe chamber operation up to $I_e \cdot I_p = 1100\,\mathrm{mA}^2$, limited by p-gas BG.
- e^+-only unchanged from Sep until Feb.
- p-only operation without problem: good base pressure.

Chamber current history

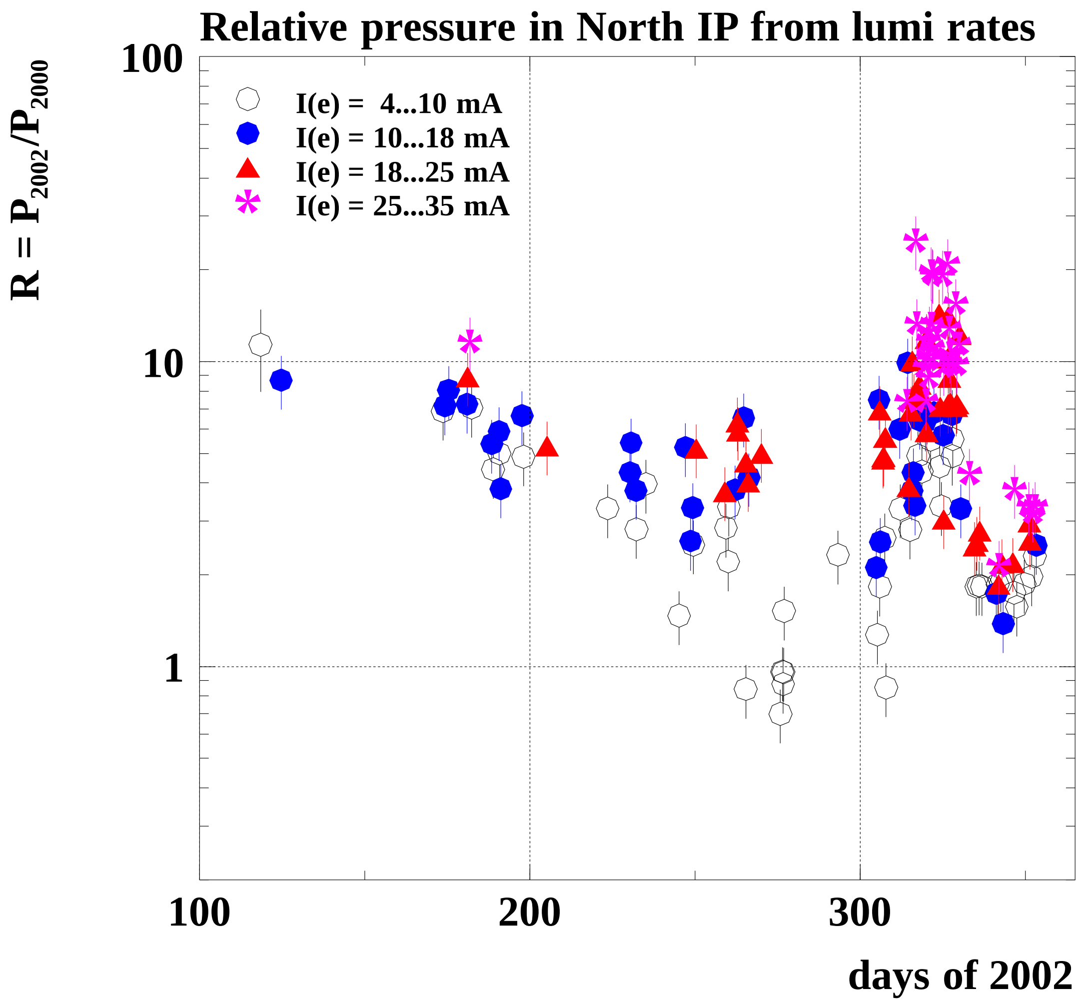
CJC2: pedestal and SynRad subtracted, normalized to Sep 2002 fit:



Lumi runs, full HV, after BG tuning.

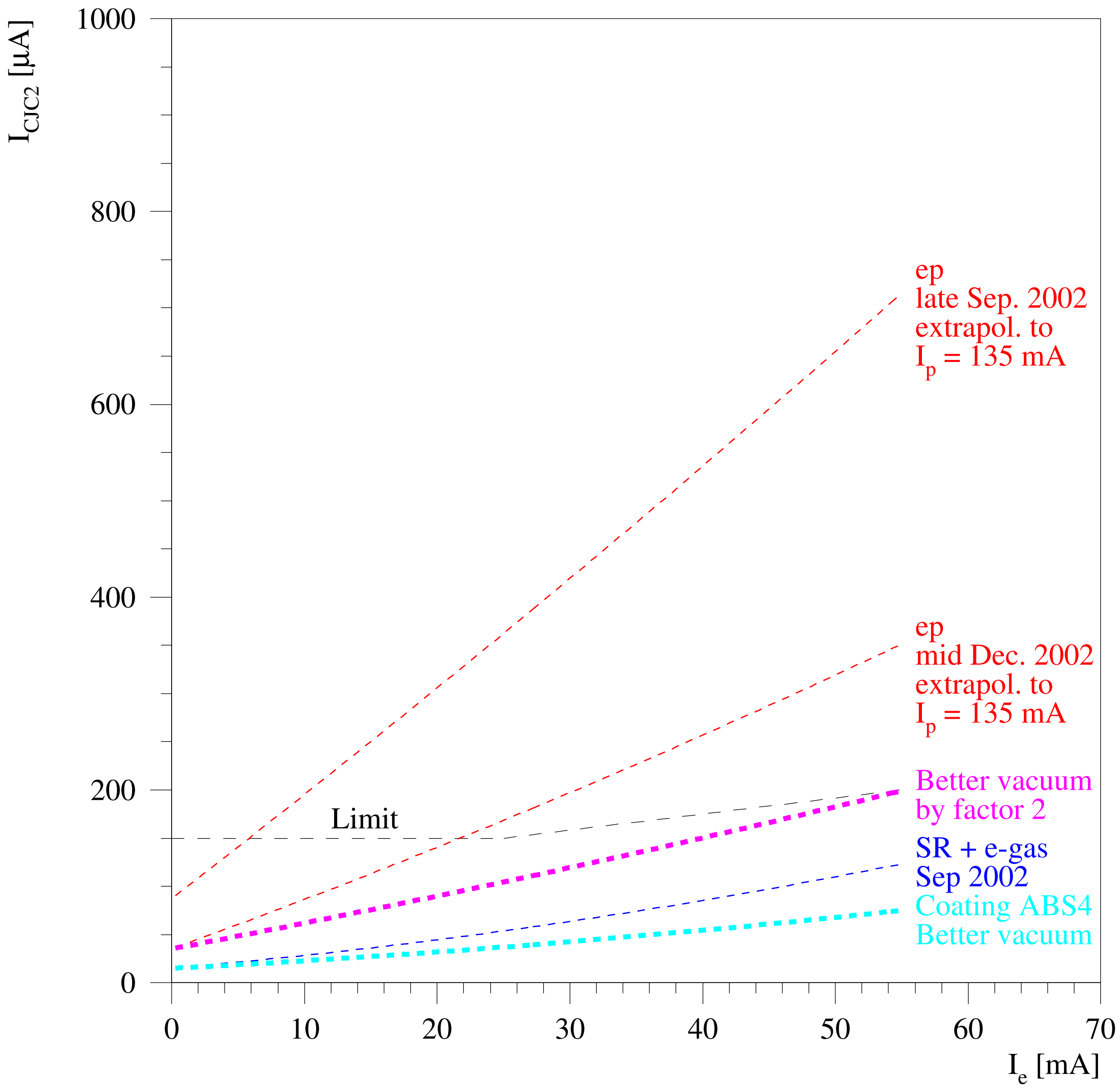
- Long-term improvement by factor ≈ 20 with $\tau \approx 100$ days Apr–Dec.
- Trend interrupted by venting in July and operating at higher GO,GG beam pipe temperatures in Oct/Nov.
- Flange leak NR 11 m on 12.1.2003.
- Almost full recovery within 3 weeks. Benefit of 12 GeV bake-out unclear.
- Deterioration over the last 5 days of running. NEG pump regeneration needed.

Pressure history



- Derived from e-gas Bremsstrahlung rate with pilot bunches.
- Measures the average pressure within ± 2 m around the IP.
- Long-term improvement by factor ≈ 8 with $\tau = 130$ days.
- Higher pressure with increased GO,GG beam pipe temperatures in Oct/Nov: cryo pump effect at 55 K.
- Dec 2002: factor 2 above 2000 level for 25 mA at 27.5 GeV.

Extraction to $I_p = 135\,$mA



- Conditions from end Sep 2002 extrapolated to $I_p = 135\,$mA.
- Conditions from mid Dec 2002 extrapolated to $I_p = 135\,$mA.
- Future: reduce pressure by factor 2 everywhere,
  reduce SynRad by 1.7 (coating ABS4).
- e^+-only contribution Sep 2002.
- e^+-only contribution after improvements.
- Safety factor desired for more stable operation, and for e^- operation.

Optimizing luminosity

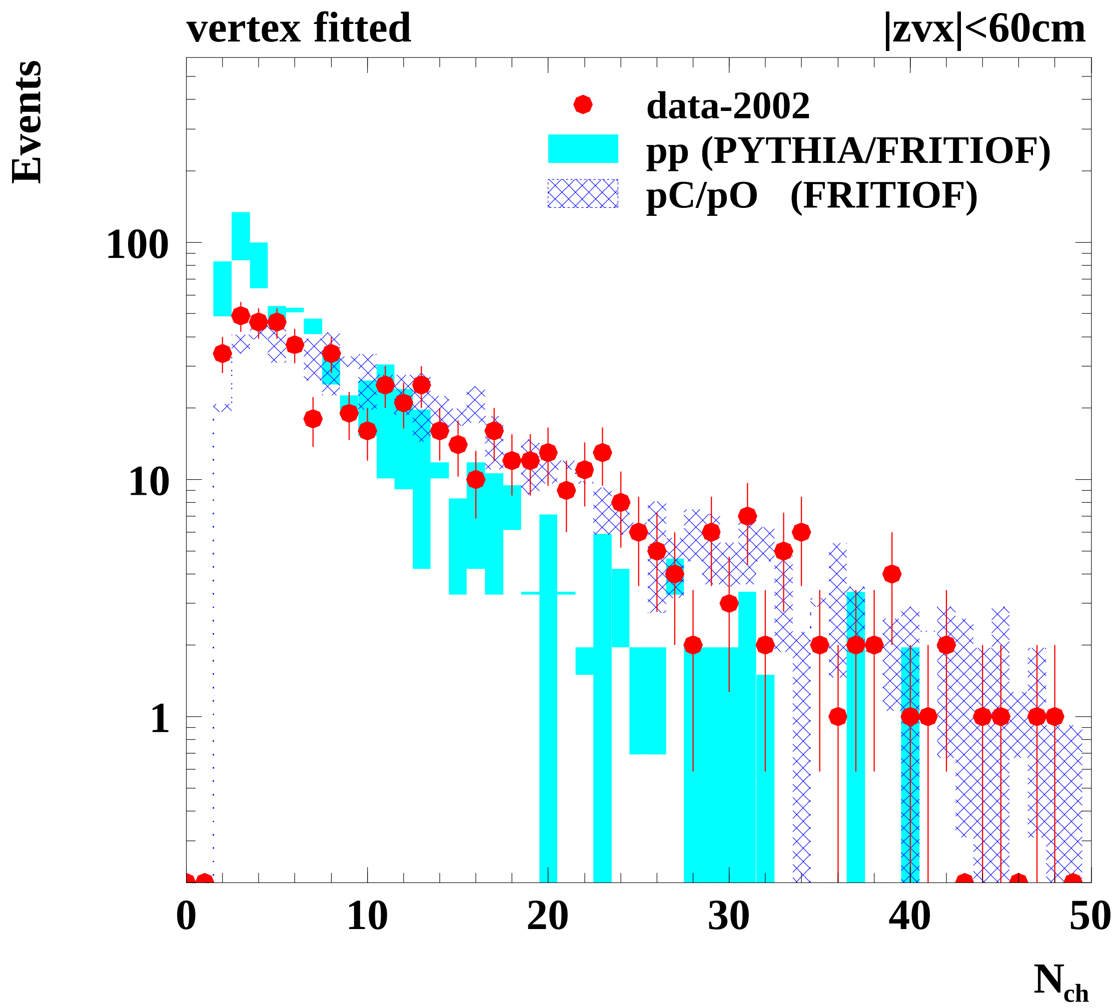
$$\mathcal{L} = \frac{I_e \cdot I_p}{4\pi q^2 N_B f_{\text{rev}} \sigma_x \sigma_y} = \mathcal{L}_{\text{spec}} \frac{I_e \cdot I_p}{N_B}$$

- Upgrade: $\mathcal{L}_{\text{spec}} = 1.8 \cdot 10^{30}$ /cm²/s/mA².
- $I_e \cdot I_p$ limited by chamber currents. $\Rightarrow$ Reduce N_B
- Bunch current limits:
  - p: $\lesssim 0.6$ mA/bunch, space charge limit at injection. Ultimate goal: 0.75 mA/bunch.
  - e: $\lesssim 0.25$ mA/bunch, limited by beam-beam effects. Ultimate goal: 0.3 mA/bunch.

N_B	$I_p^{\max}$ [mA]	$I_e^{\max}$ [mA]	$I_e \cdot I_p$ [mA²]	$\mathcal{L}^{\text{peak}}$ [10^{31}/cm²/s]
60	36	15	540	1.6 (like 2000)
90	54	22.5	1200	2.4
120	72	30	2200	3.2
180	108	45	4900	4.8
180	55	30	1650	1.7 (best in 2003)

p-gas simulation vs data

Charged multiplicity distribution:

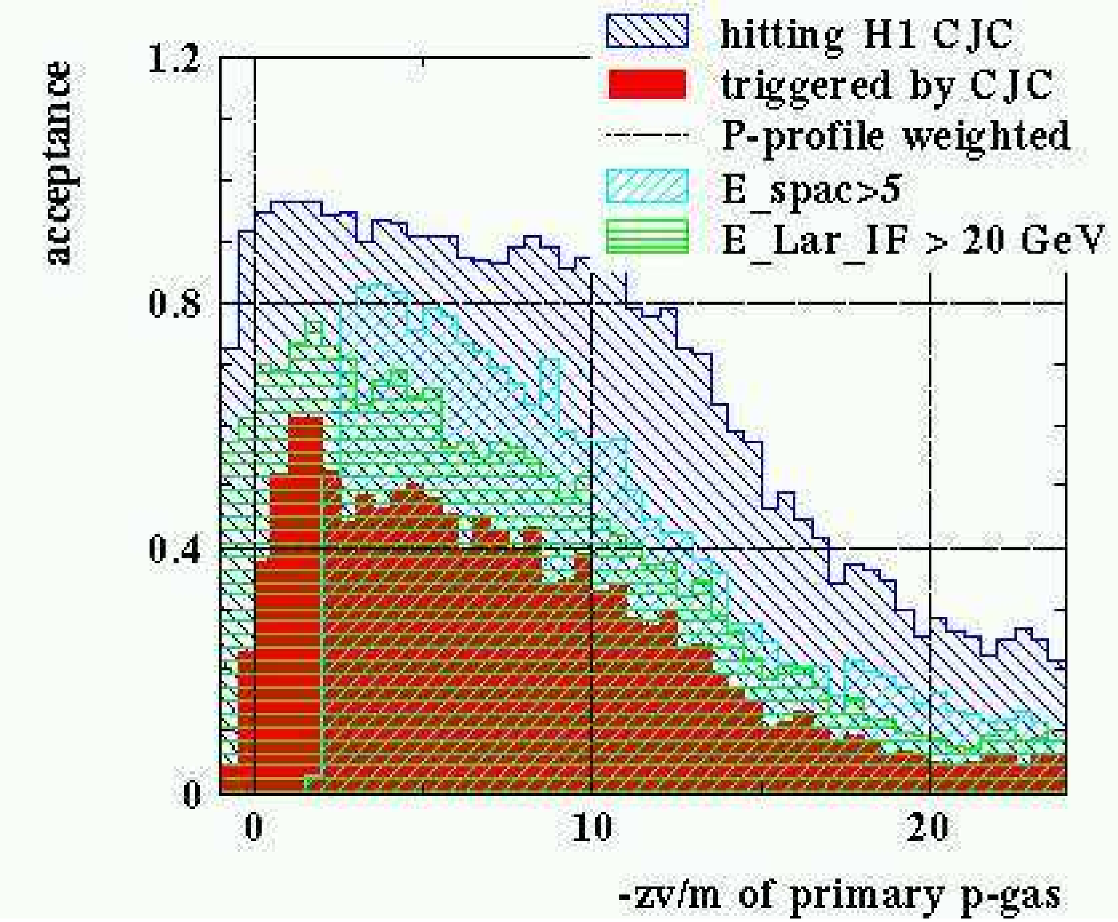


- Pure hydrogen is excluded.
- Data consistent with CO.
- Similar result for 1997–2000 data

$\Rightarrow$ Gas composition is 'constant feature' of HERA.

p-gas simulation: sources

2002 acceptance for pC:

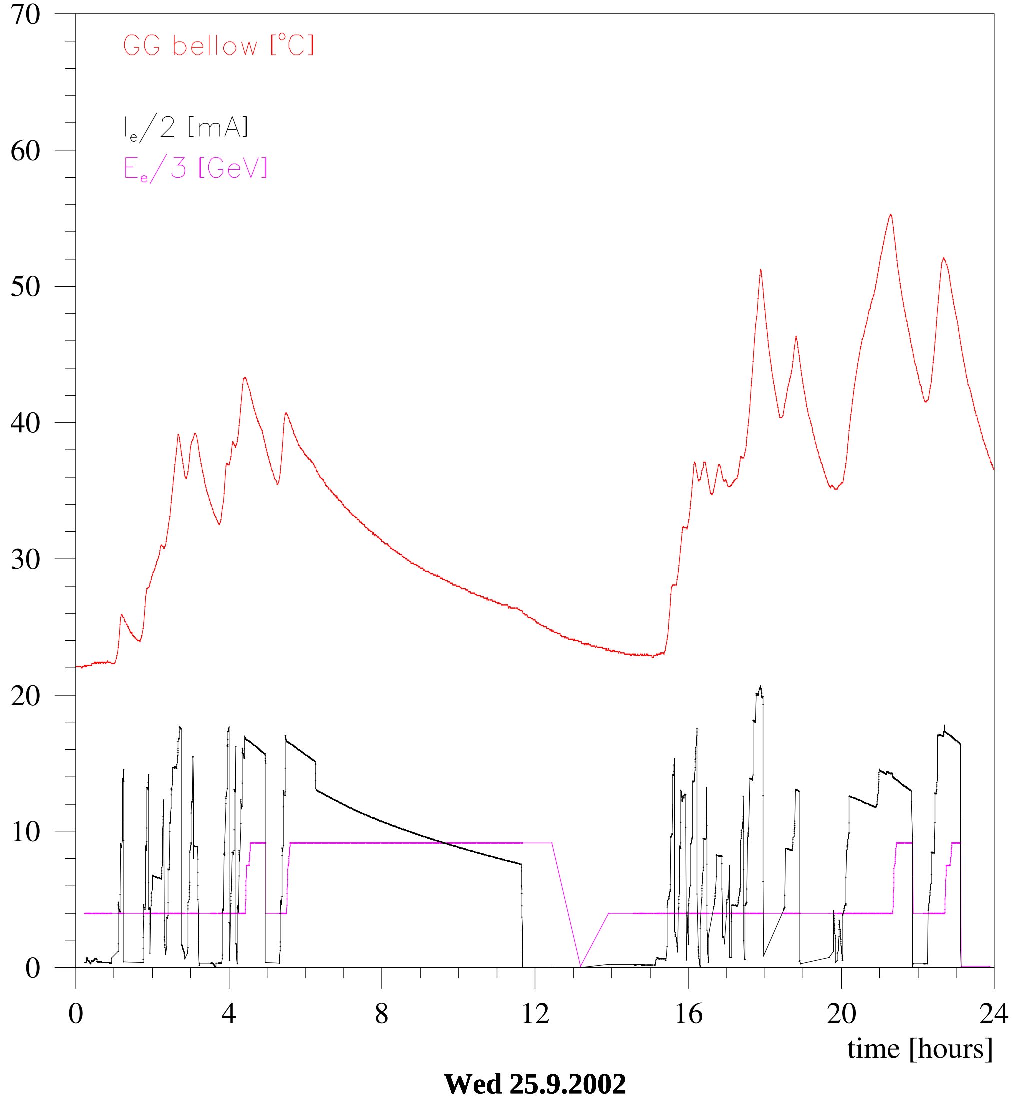


- Full beam line simulation up to $z = -64\,\mathrm{m}$.
- Acceptance drops beyond -15 m.
- To be folded with rest gas density profile: large uncertainty.
- New scintillators installed at -6, -8.3, -10.9, -28 m (BTS).

$\Rightarrow$ Contribution of region beyond -6 m is 40–50%.

Beam pipe temperature example

T sensor on BP at -1.5 m:



- Temperature rise time ≈ 0.5 h.
- Cool down as soon as E_e is ramped from 12 GeV.
- Faster cool down after beam dump.

$\Rightarrow$ Some beam heating also at 27.5 GeV.

- Suspected source: higher order mode EM heating by the e^+ beam due to abrupt changes in beam pipe diameters.

New C5b collimator with integrated ion getter pump

- Use space under BPC at $z = -1.45\,\mathrm{m}$.
- Tungsten thickness reduced to 5 mm:
  - Reduction factor for X-rays is still 10^{-4}.
  - Increase outer radius to protect silicon detector. $m_W = 1.3\,\mathrm{kg}$ unchanged.

- Place tungsten outside of stainless steel beam pipe to reduce outgassing.
- Add taper to reduce higher order mode heating by 15–30%
- Add water cooling to reduce temperature peaks at injection.
- Add an integrated ion getter pump with 400 ℓ/s. Reduces CJC rate to 0.67.
- Keep bellow for GG movement, beam position monitors.

Further remedies

- Coating of the primary synchrotron radiation absorbers at -10.8, -19, and -26 m: factor 1.7 less backscattered SynRad. Under preparation by MVA.

- Increase pumping speed at -3.6, -6.0, and -8.3 m by opening the RF grid, as allowed by HOM calculations.

- Reduce cooling water temperature for iron magnets GI1,2, GJ from 30^{o}C to about 10^{o}C to reduce beam pipe outgassing.

- Install rest gas analyzers at -3.6 and -6.0 m for better diagnostics. Available.

Shutdown planning: boundary conditions

- Shutdown starts Mon 3.3.2003.
- H1 stays in beam position.
  $\Rightarrow$ access to Spacals, BPC, silicons, CIP.
  No access to FTI, FTD, C4, CJC $+$z.
- Central beam pipe stays in place.
- Kryogenic and superconducting lines for GO and GG are not cut.
  GG is raised in situ by ≈ 50 cm.
- HERA-B stays in beam position
  $\Rightarrow$ transport VFPS bypass through Hall North.
  $\Rightarrow$ extensive crane work with shielding concrete blocks!
- Duration 17 weeks (ZEUS STT) until 6.7.2003.

Time for detector work

Spacals	14 weeks in Hall North	Repair of a few channels.
BPC	12.5 weeks in hall 5	Exchange some frontend chips, improve gas flow.
BST	10 weeks in Zeuthen	Replace old BST r-sensors with ϕ sensors as in FST.
		Exchange radiation damaged electronics.
CST	8.5 weeks at PSI	Equip fully with RadHard chips.
FST	7 weeks in Zeuthen	Improve electronics cooling.
CIP	6 weeks in situ	Exchange frontend electronics.
BToF	14 weeks in situ	Install new, larger scintillators.
VFPS	12 weeks NL 220 m	install He bypass and 2 Roman pots.
FPS	1 week	install 60 and 80 m horizontal stations.
LPOL	4 week OR 60 m	Install laser cavity.

Summary

- A difficult 11 month running period lies behind us.
- The luminosity goals have not been met by far.
- The dominant background source are p-gas interactions up to 11 m from the IP.
- A procedure to accelerate the long-term vacuum improvement has not been found.
- The vacuum system in and around H1 will be improved during the shutdown.
- After a dedicated bakeout and conditioning period we expect to go to luminosity running in late summer 2003.
- The HERA II physics programme will only start after the shutdown.