HERA Background Review Meeting, January 16, 2003

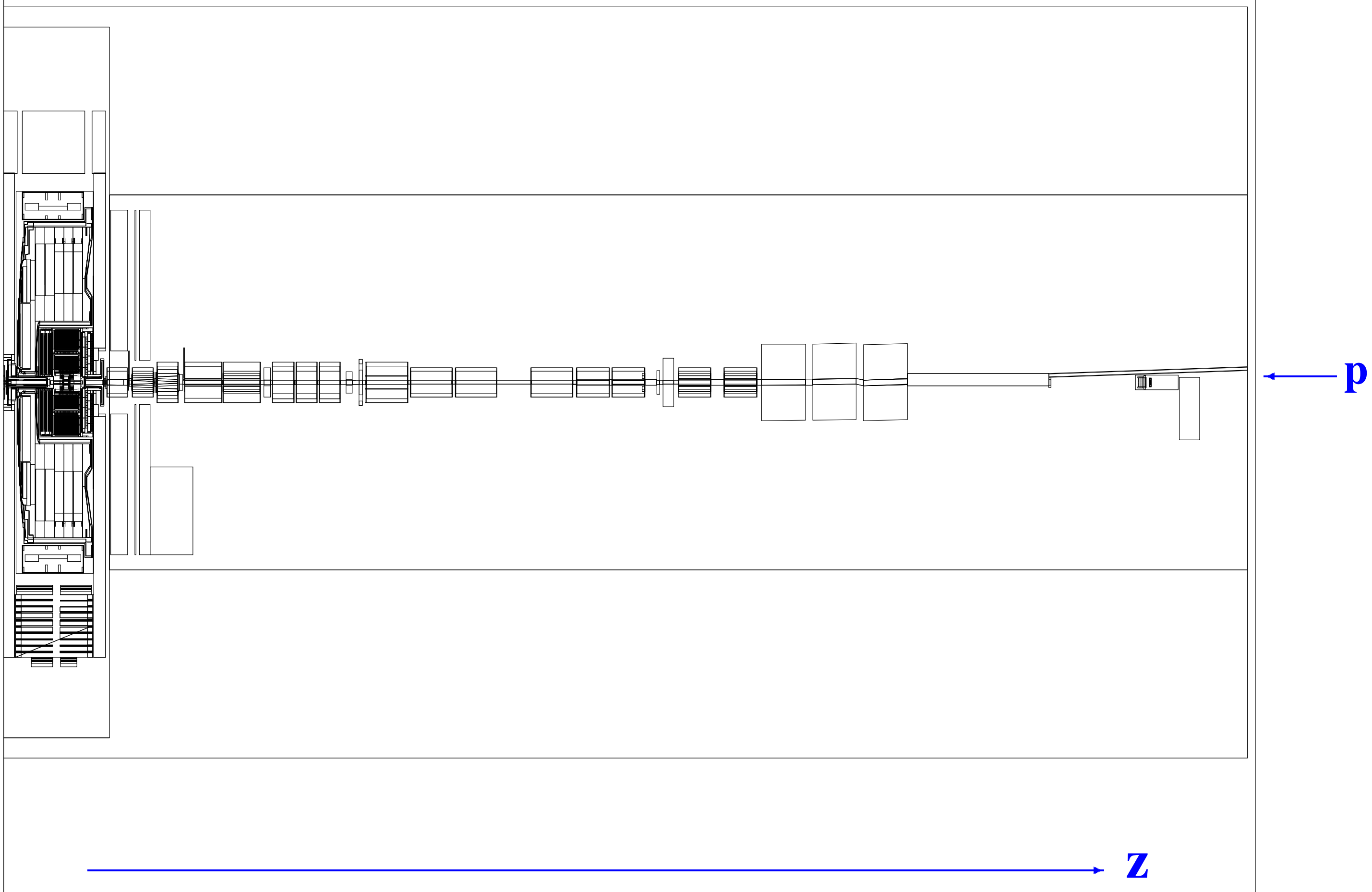
Progress in understanding p-induced background

S. Levonian, for H1 and ZEUS

$$R(\mathrm{p-bgr}) \;\propto\; I_p \cdot \int_{z_{min}}^{z_{max}} \sigma_{p\text{–}gas}(Z) \cdot P(z) \cdot A(z) \cdot dz$$

- Introductory remarks
- Rest gas composition
- Pressure profile around IP
- Sensitivity to the different $z-$origin
- Summary

Geometry and coordinate system



Summary from October Meeting

- Sensitivity to the p-gas sources up to $z = 60 - 70$ m
- Evidence for medium nuclei in the rest gas; pure H_2 excluded
- Collimator's modifications can bring at most 30% reduction of p-background
- Better vacuum (by factor of at least 5) is needed

Questions raised:

- Do we see the same gas composition as it was in 2000 ?
- What is the difference between HERA-1 and HERA-2 wrt p-induced background: just vacuum? Or aperture/material budget around IP?
- Do both H1 and ZEUS see same things?
- Where the most dangerous background sources are located along the beamline? (Where to put emphasis of the shutdown work?)

Methods and Tools

- Complete GEANT simulation of HERA-2 setup for the range $-1m < z < 63m$ (both H1 and ZEUS)
- Complete GEANT simulation of HERA-1 setup for the range $-1m < z < 32m$ (H1)

$\sigma_{p-gas}(\sigma_{e-gas})$

- rest gas composition from charged particle multiplicity inside Central Tracker
- assume same ($z-$independent) composition at equilibrium; define from the data which gas is released during heating pump experiments

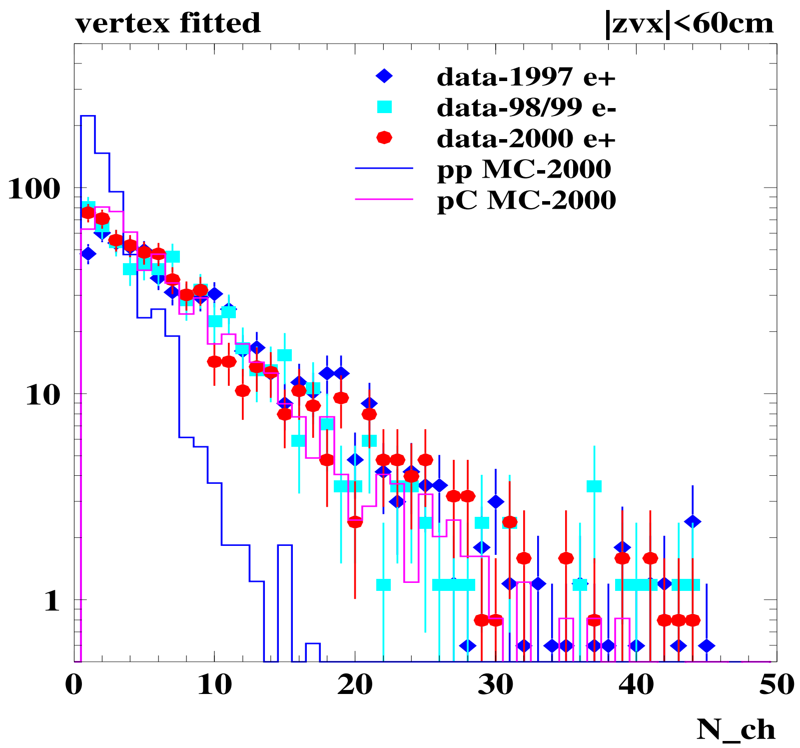
$A(z)$

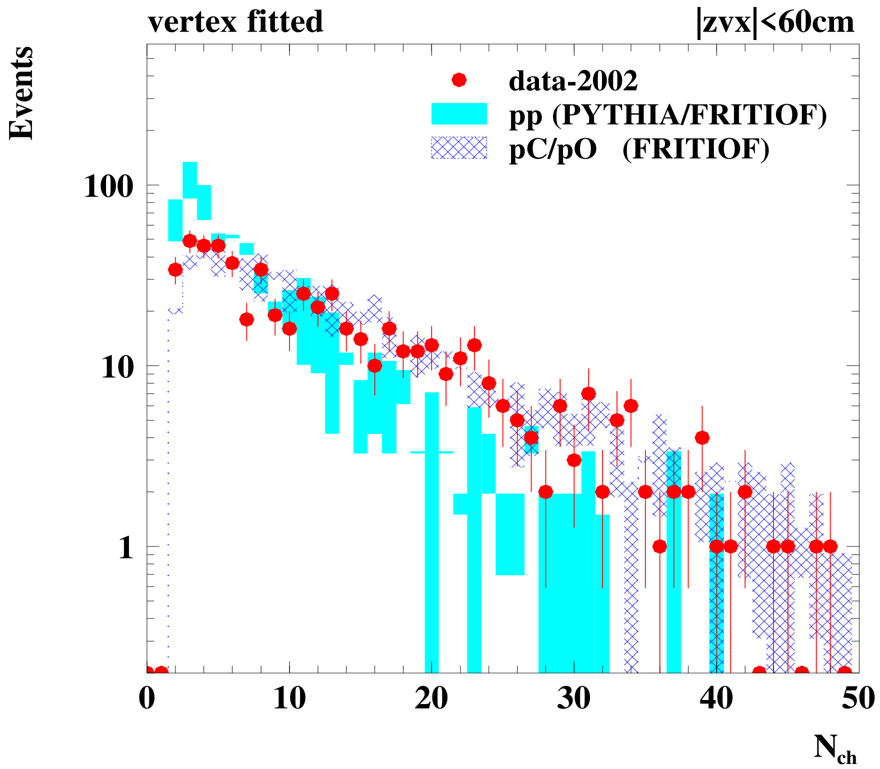
- from MC (GEANT simulation)
- from data
  - ▷ pump heating/firing at different positions
  - ▷ using $z-$dependent ”taggers” (FST, BTS, RCAL, Veto wall)

$P(z)$

- from lumi rates (bremsstrahlung on the rest gas)
- from pump readings (after calibration) $+$ some model for interpolation (conductance, outgasing, ...)

Pure p-gas events in North IP (HERA-1 vs HERA-2)

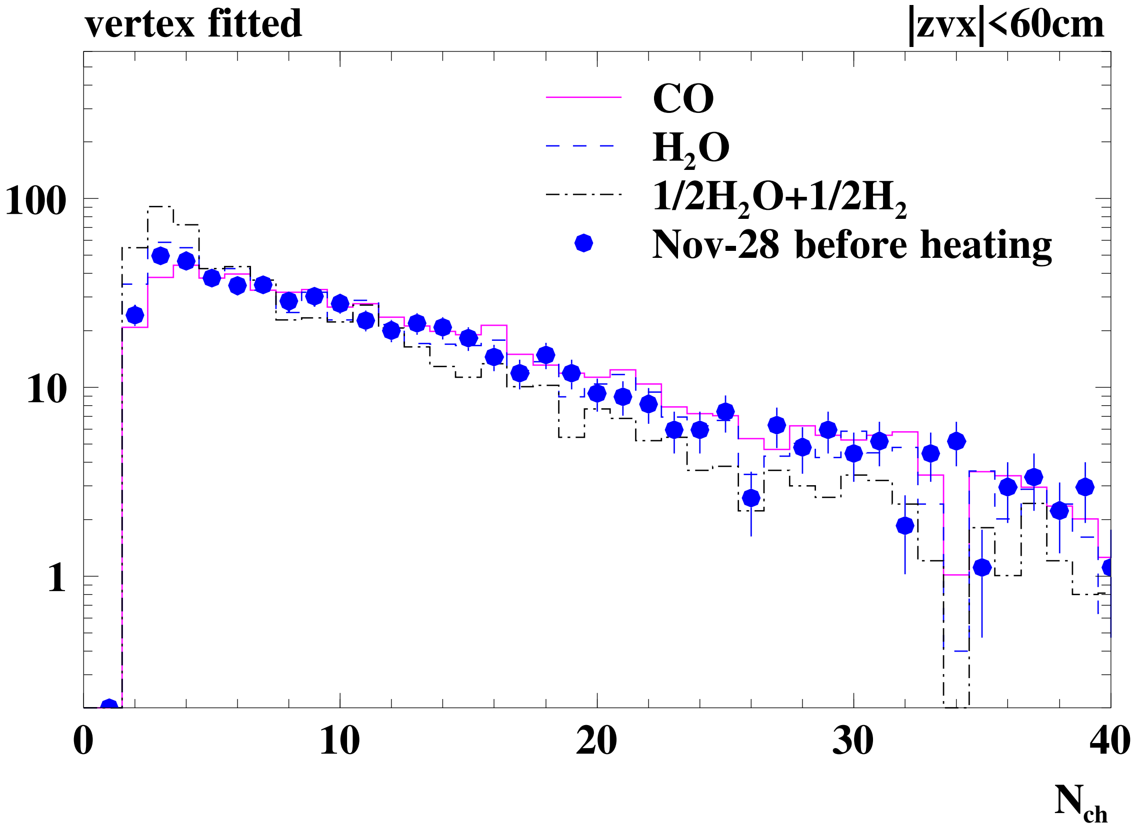


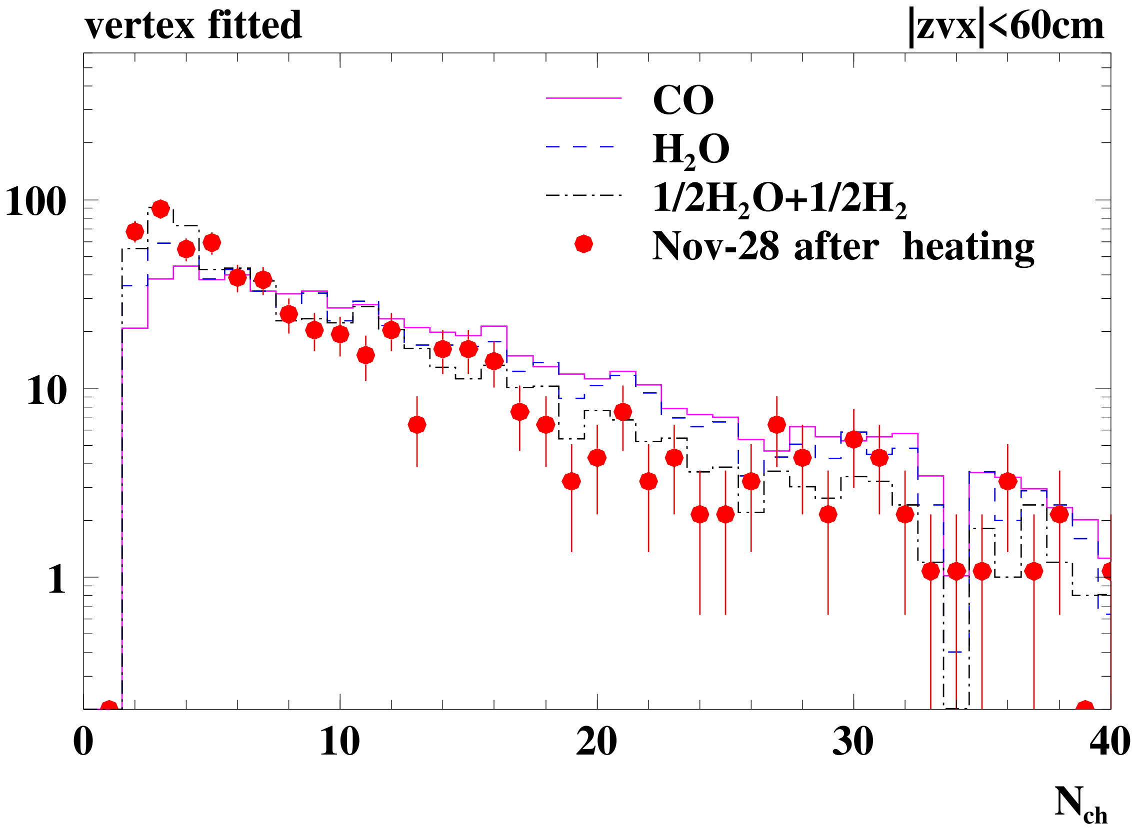


Similar rest gas composition in 1997-2000, e^+ and e^-

(Universal property of the ring?)

p-gas multiplicity during heating exercise





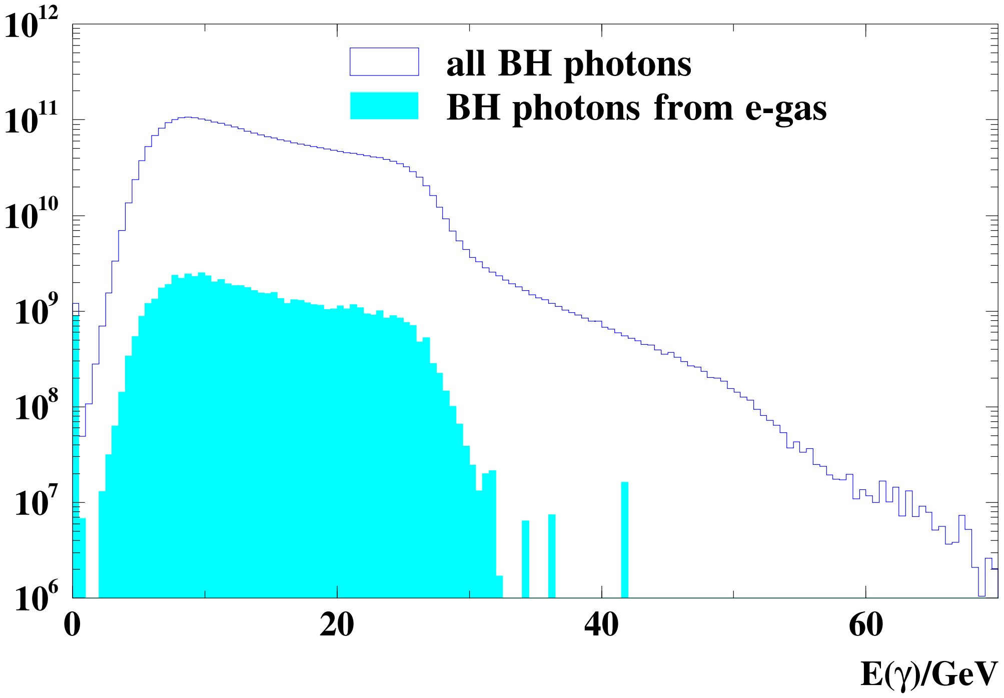
Summary for the rest gas composition

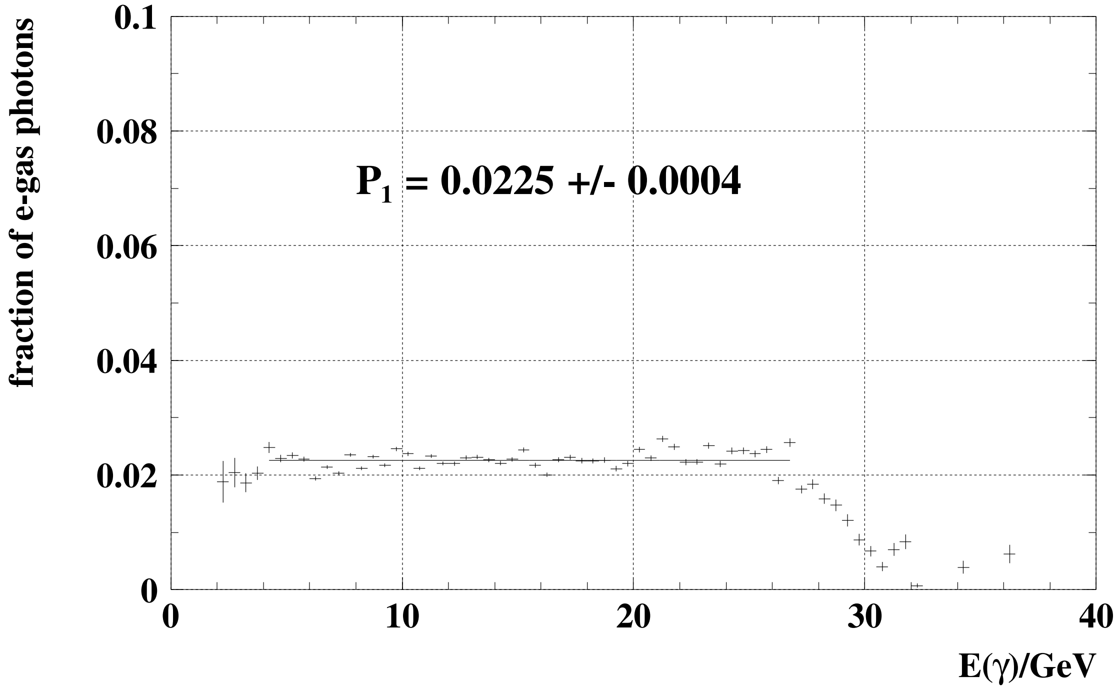
- At the nominal running conditions rest gas is consistent with components like CO, CH_4, H_2O; ($< Z > \simeq 4 \div 5$)

- This is the same in both HERA-1 and HERA-2 periods and cannot explain increased background at HERA-2 setup

- During heating pump experiments released gas is predominantly H_2

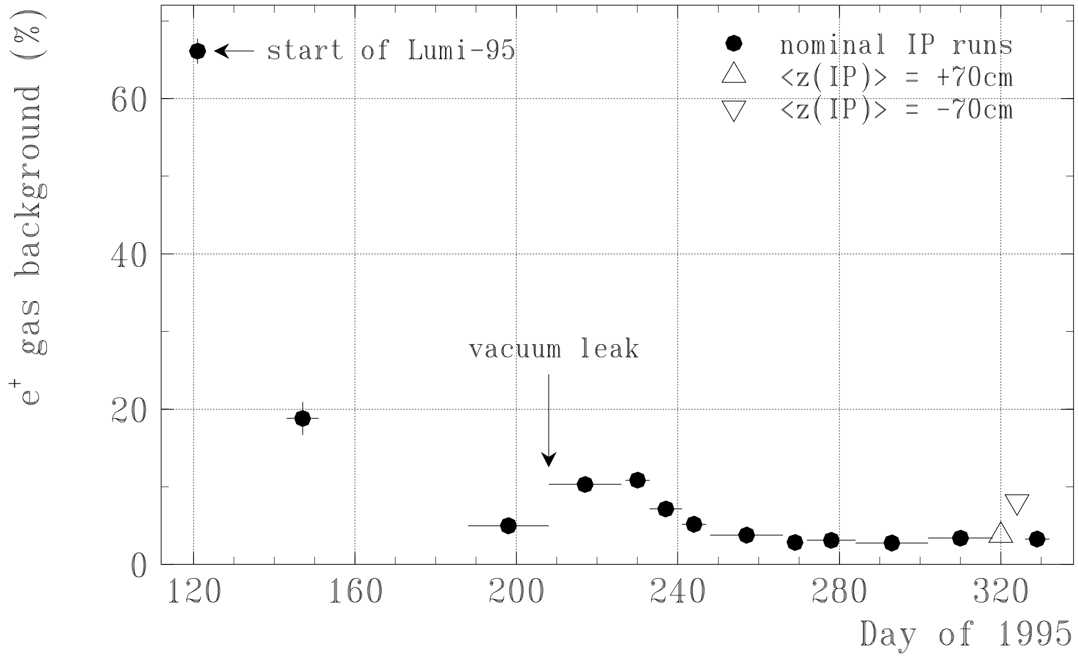
H1 Lumi Monitor data 2000

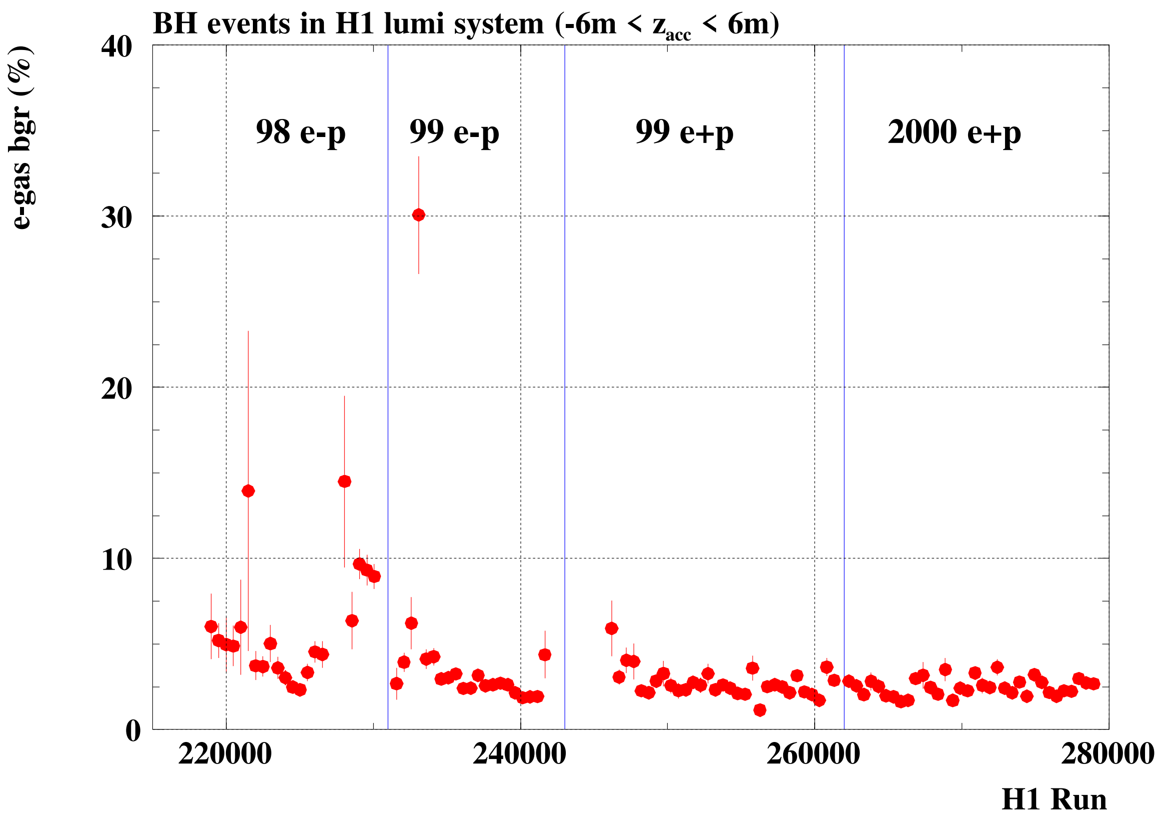




e-gas contribution estimated from e-pilot bunches

Vacuum at HERA-1

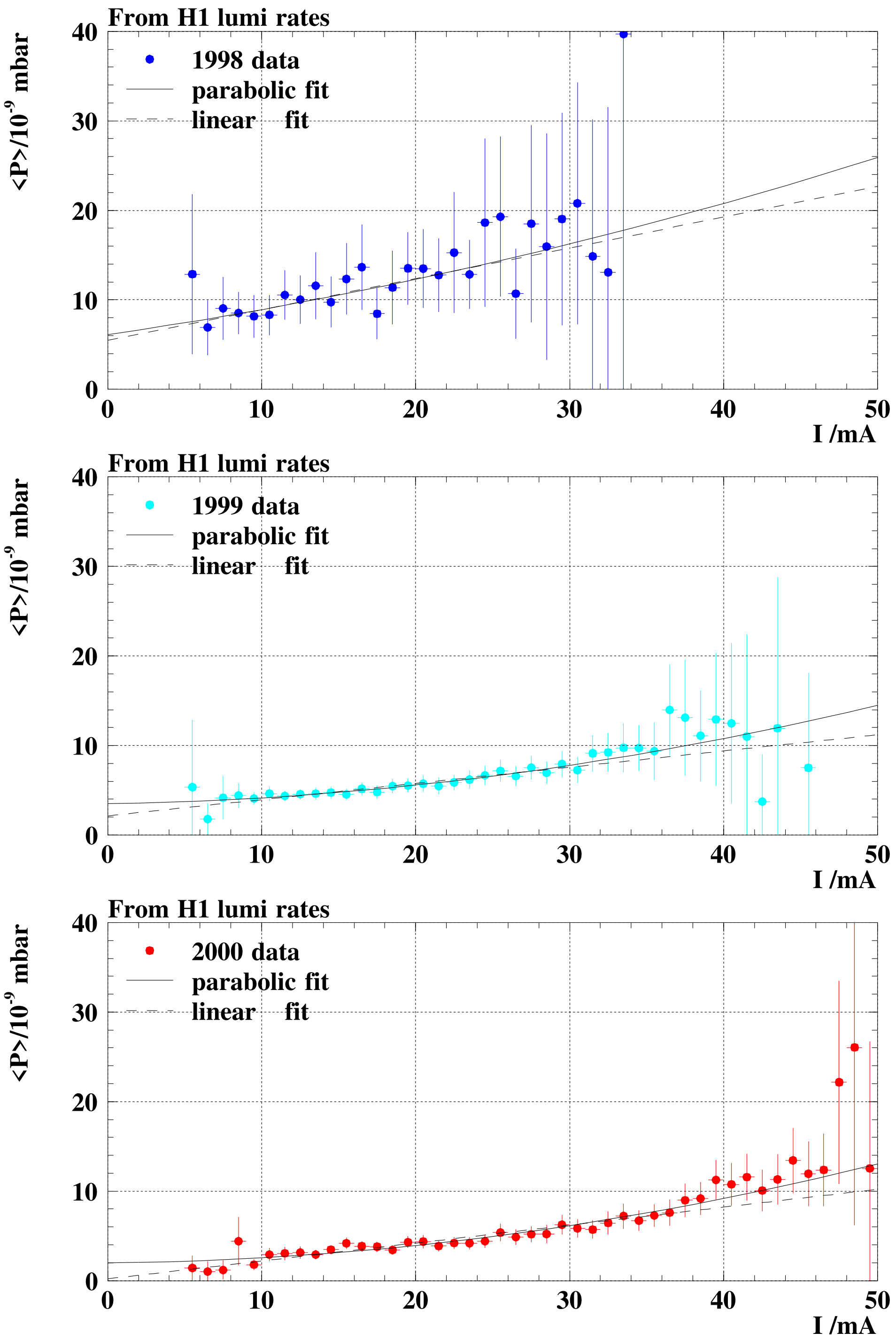




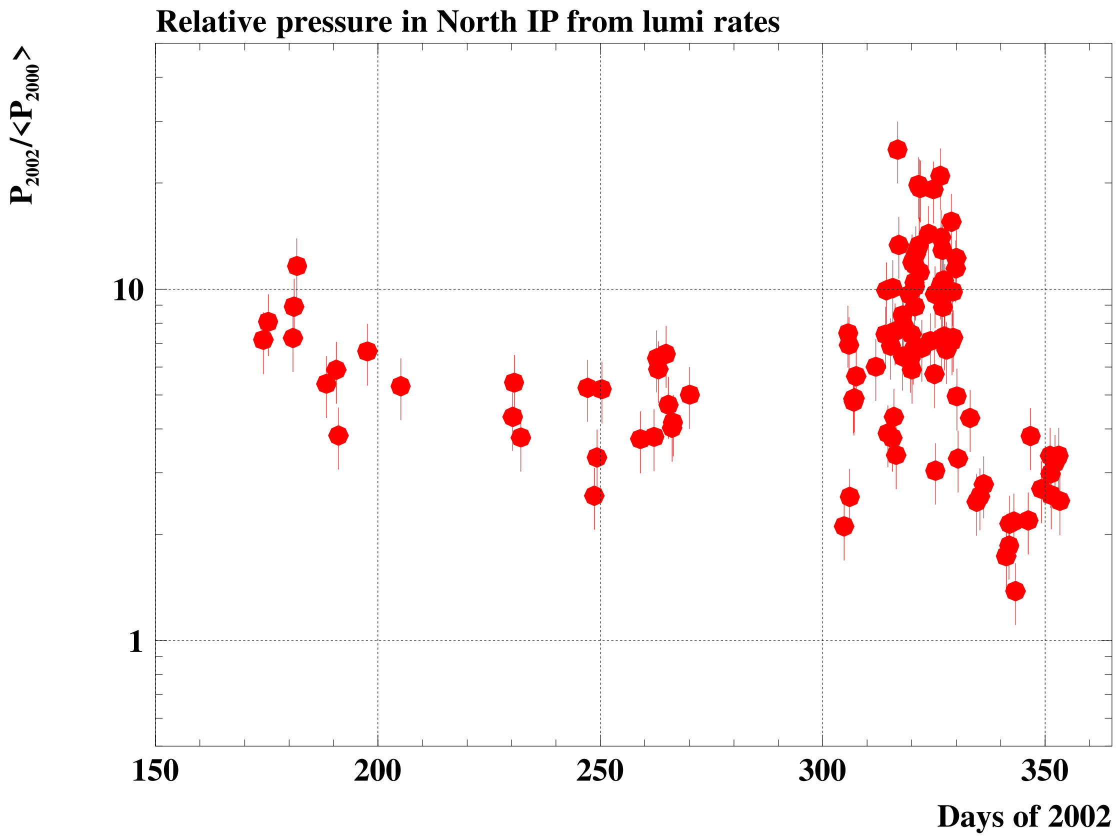
Absolute vacuum at HERA-1 vs e-Current

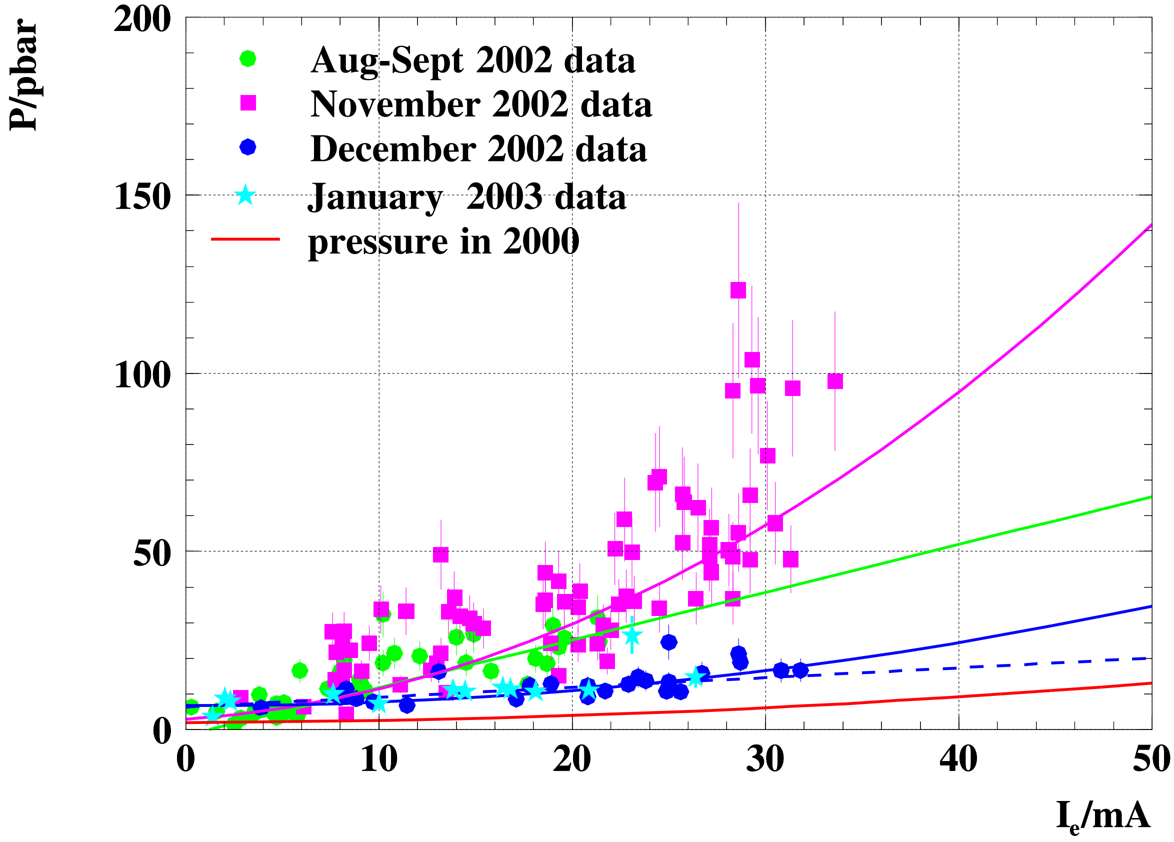
Definitions: $\overline{Z} = 5 \; (\frac{\sigma_{eZ}}{\sigma_{ep}} = 8.0 \pm 0.3) \qquad \langle P \rangle = \frac{1}{12\mathrm{m}} \int_{-6\mathrm{m}}^{+6\mathrm{m}} P(z) dz$

(systematics due to $\overline{Z}$ assumption $(4.2 \div 5.0)$ is $\sim 23\%$)

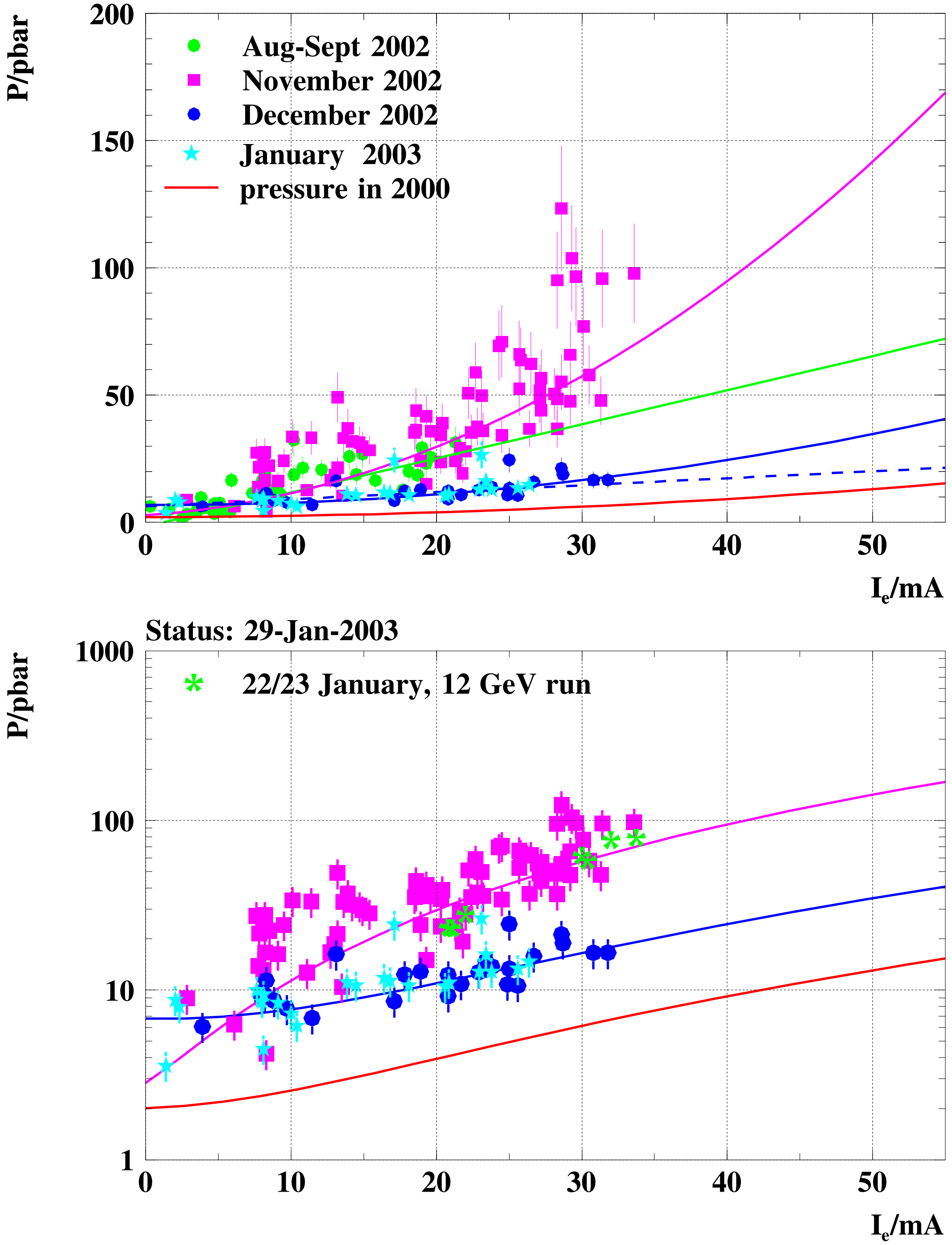


Vacuum at North IP in HERA-2 as compared to HERA-1



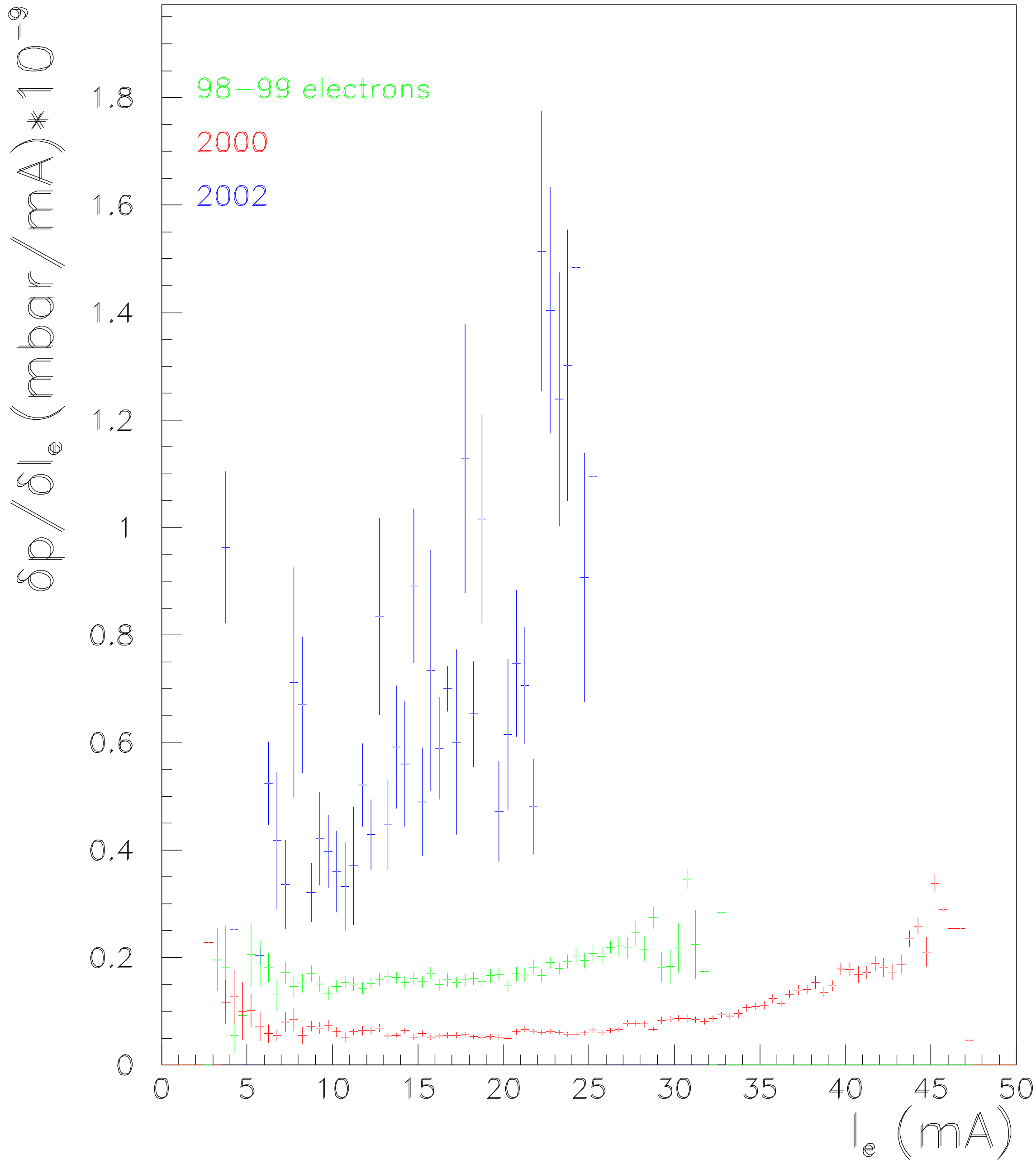


Vacuum history at North IP, from lumi rates

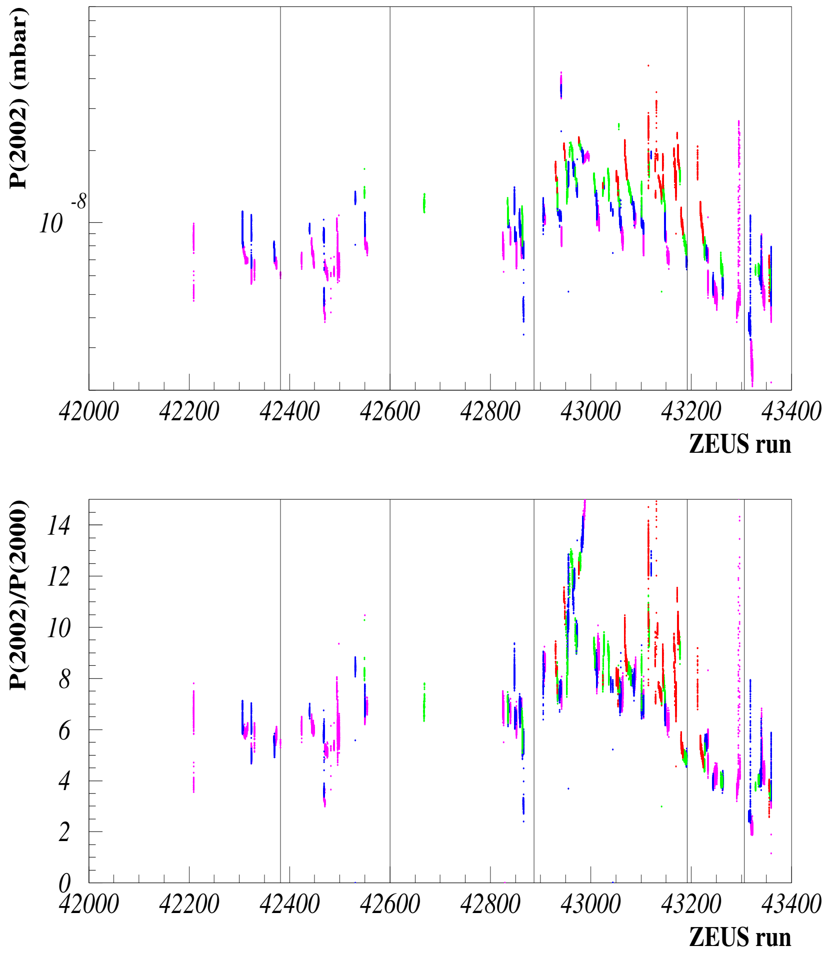


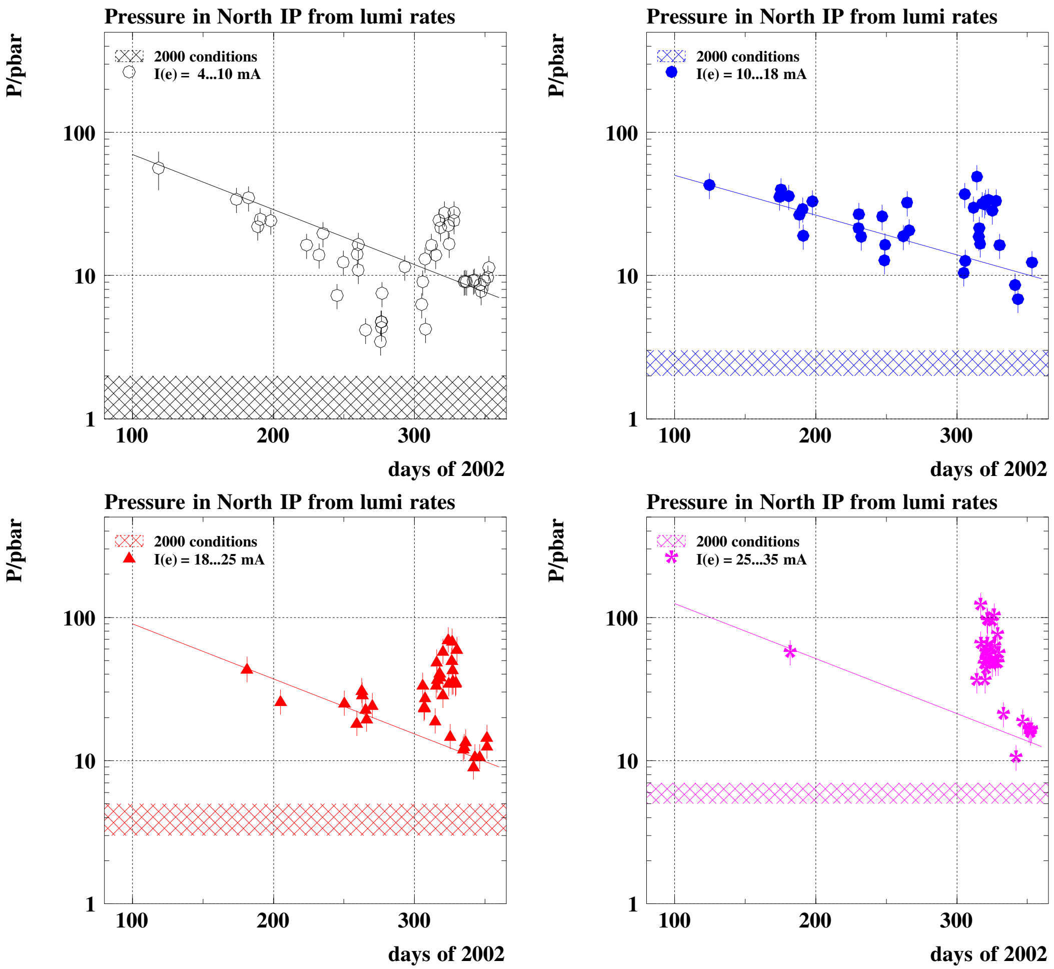
Overall systematic error of $\sim 20\%$ for 12 GeV data due to E_{thr} is not shown

Rise of the dynamic pressure with e-current in ZEUS IP



Vacuum in HERA-2 as compared to HERA-1

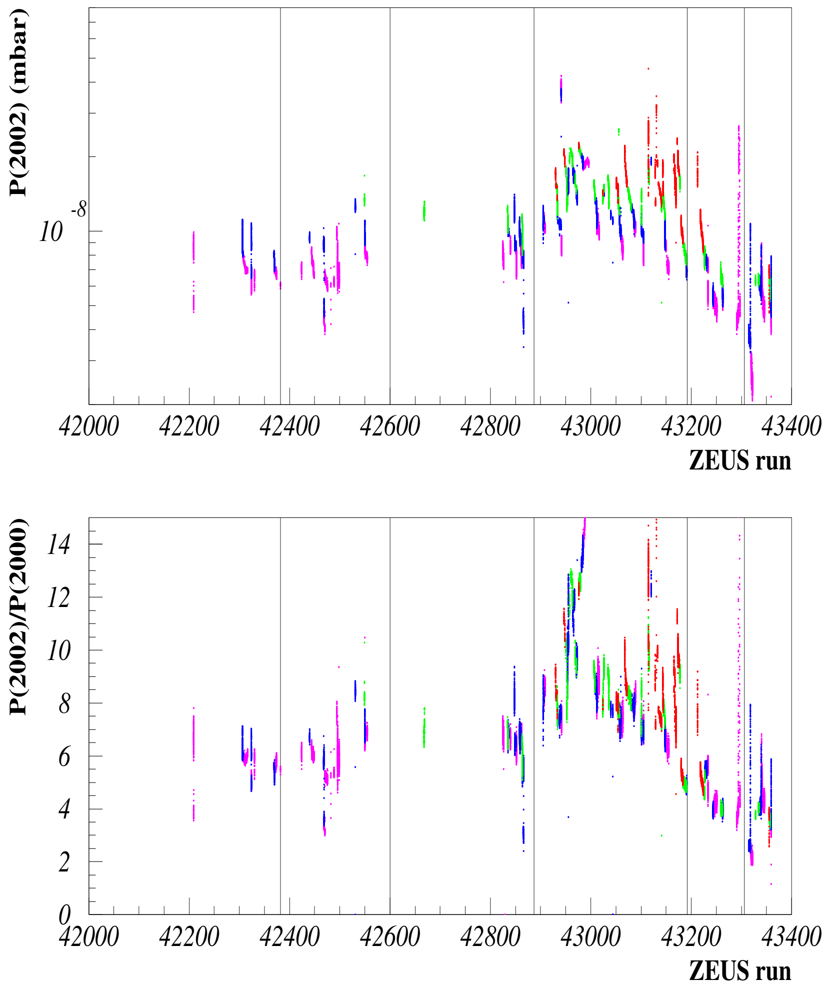


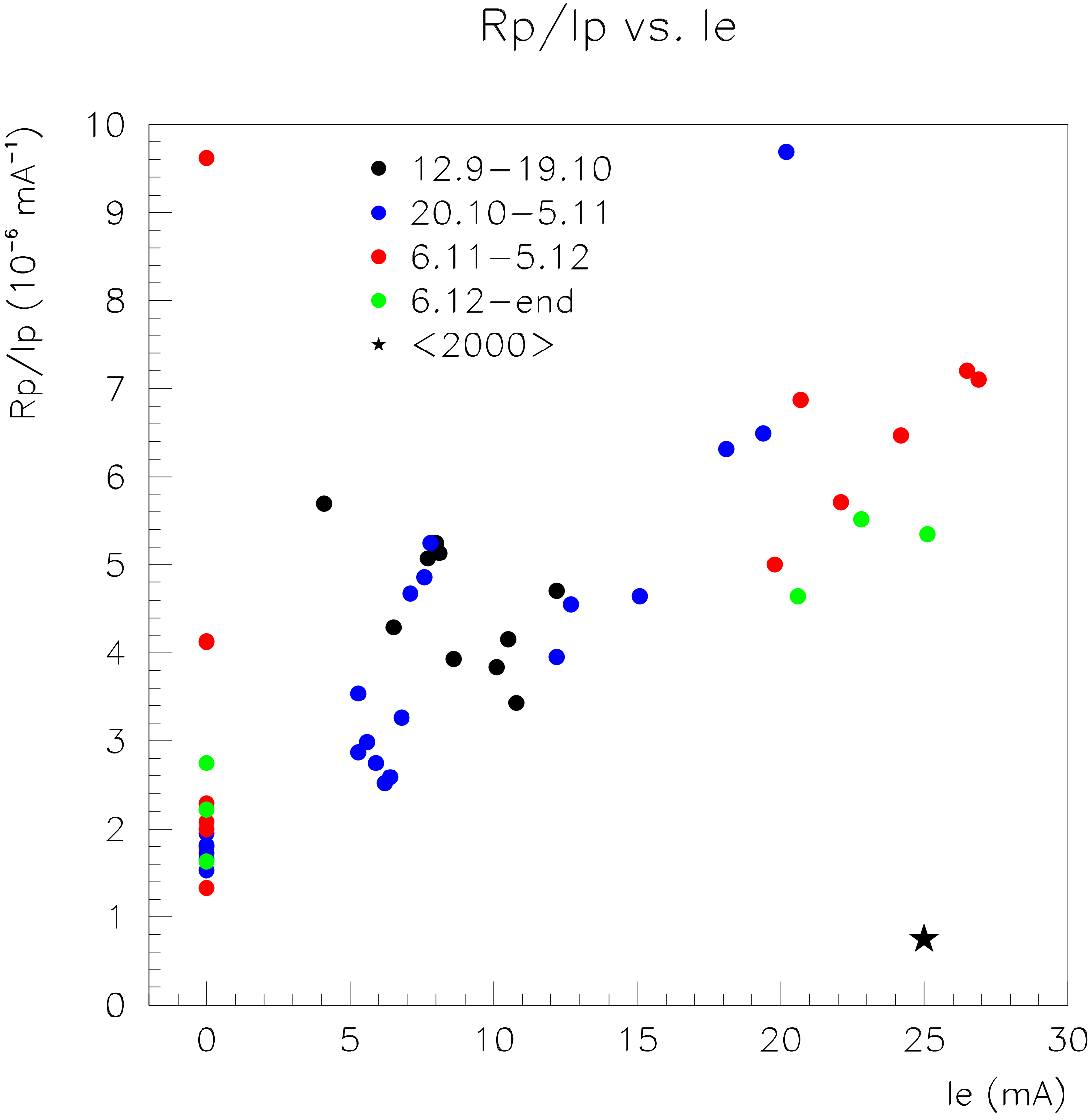


South IP

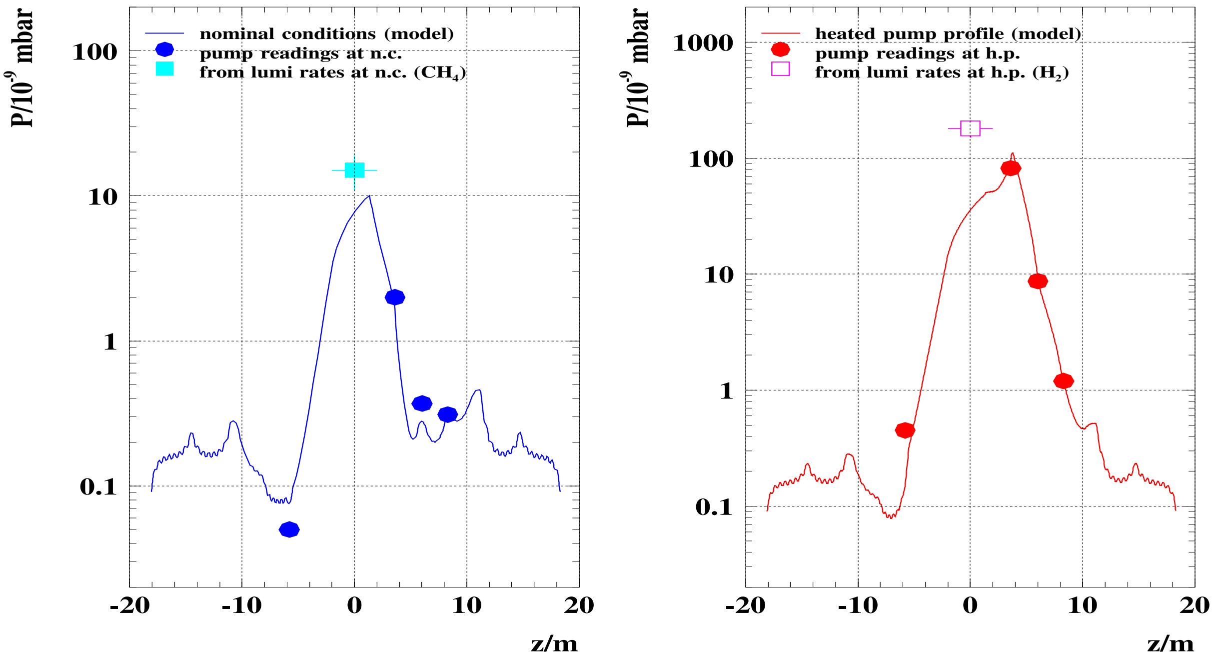
North IP

Cross check at ZEUS IP: ”lumi vacuum” vs ”p-gas rate”

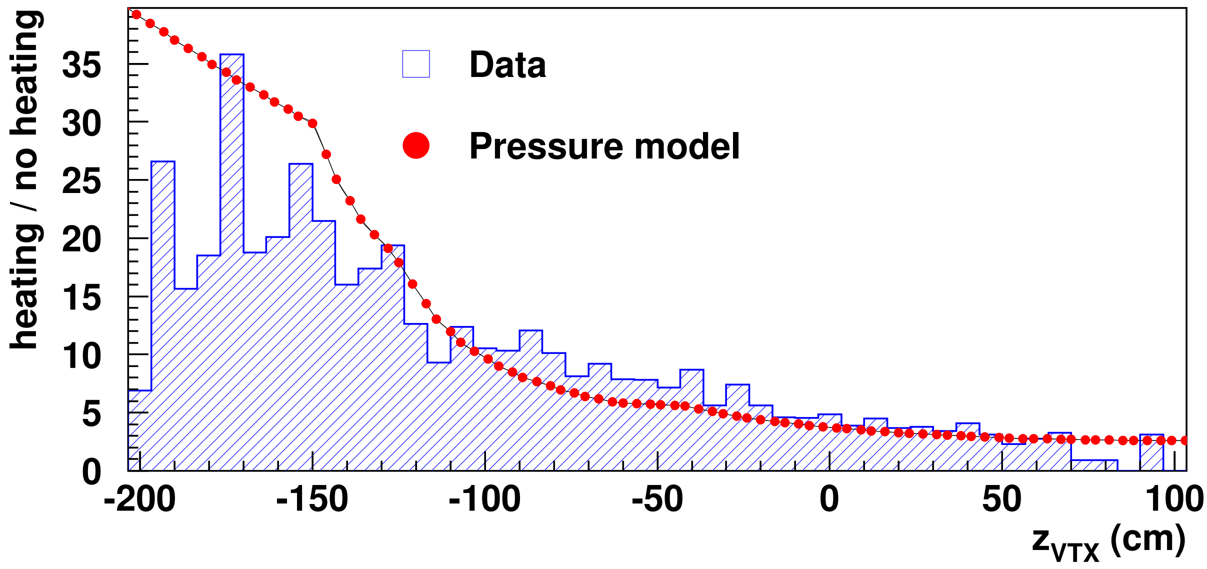




Calibrating pressure profile...

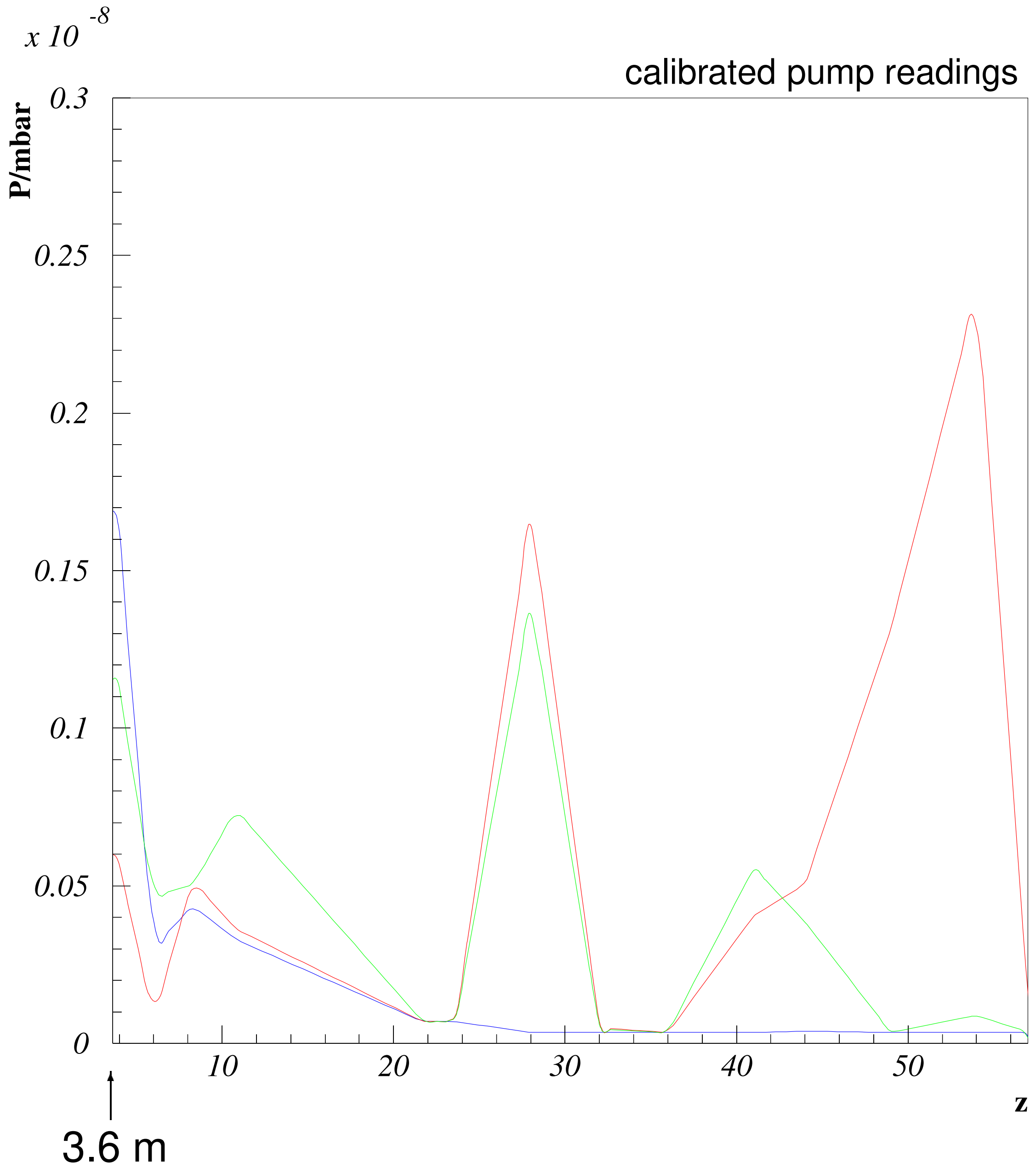


... by lumi monitor rates (Nov-20 heating 3.6m pump)



... by $z-$distribution of p-gas events

Development of the pressure profile upstream ZEUS IP
$(3.6m < z < 60m)$



red – Oct-Nov 2002 ($I_e \simeq 12$ mA)

green – Dec 2002 ($I_e \simeq 12$ mA)

blue – first days of 2003 ($I_e \simeq 10$ mA)

Summary on the pressure measurements

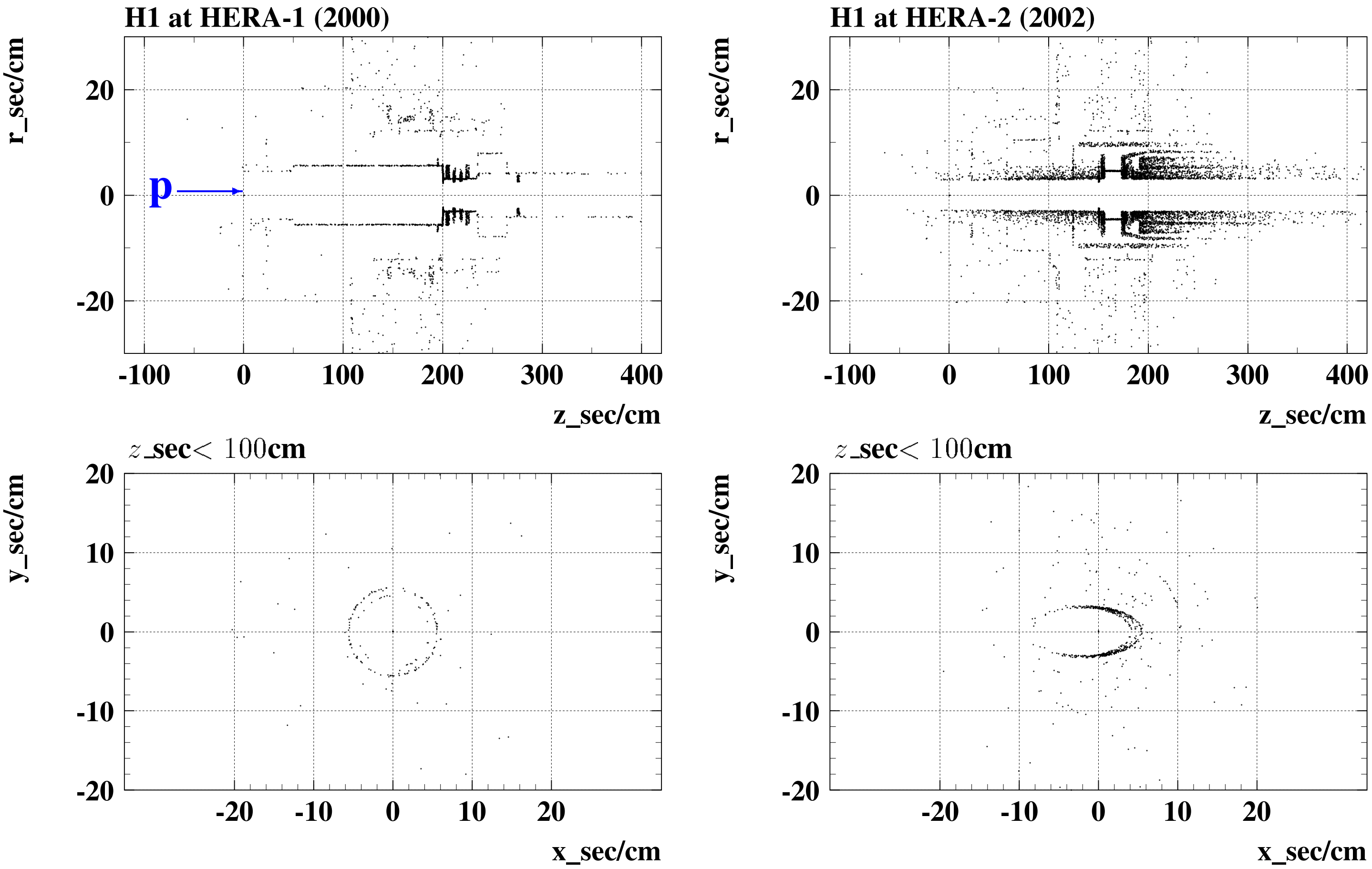
- Luminosity system provides reliable monitoring of the absolute pressure around IP ($|z| < 6$m at HERA-1 and $|z| < 2$m at HERA-2)

- Pressure profile, $P(z)$, beyond the lumi acceptance requires proper calibration of the pump readings and is model dependent

- Long term history of the vacuum at IP shows an improvement by a factor of ~ 5 over the period of 8 months. At the end of 2002 both H1 and ZEUS were still by factor of 3 to 4 worse as compared to 2000 vacuum

- Running with warm GG/GO surfaces (November data) is disfavoured

pC MC, 2000 vs 2002: secondary interactions inside H1



(for primary p-gas events at $|z_{prim}| < 60$cm)

$\Rightarrow$ more material and tighter aperture at HERA-2 lead to $\sim 25\%$ larger activity inside Central Tracker

pC MC, 2000 vs 2002: p-gas activity vs z_{vx}

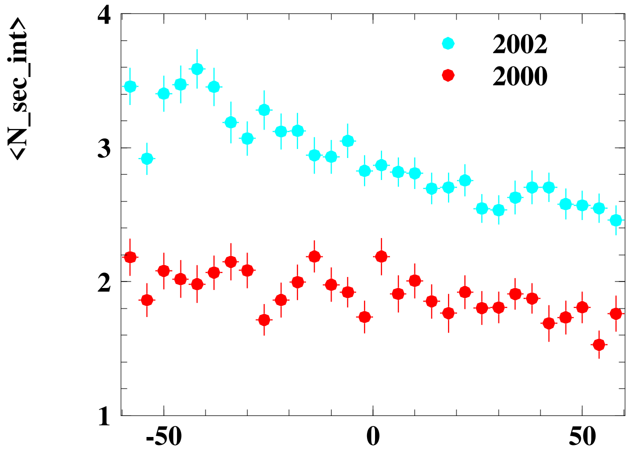


Figure 200

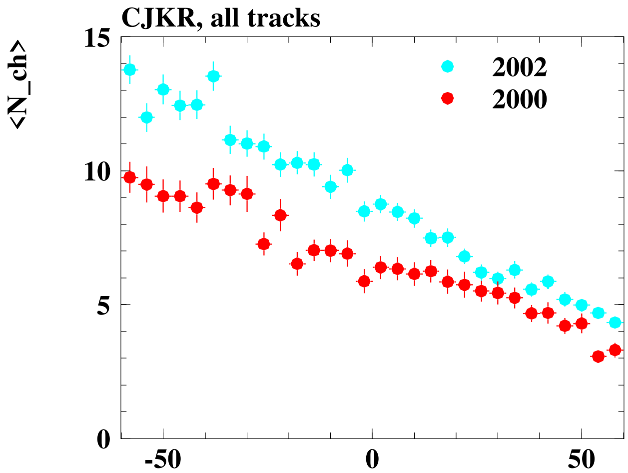


Figure 202

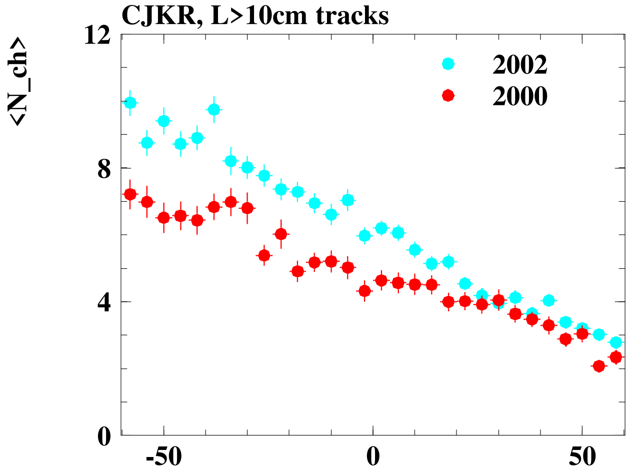


Figure 203

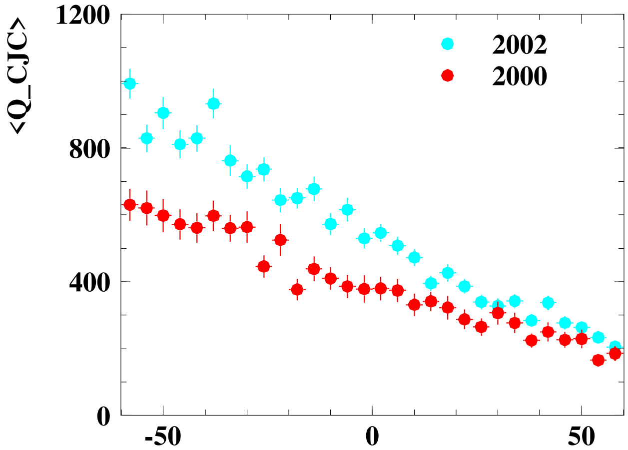


Figure 206

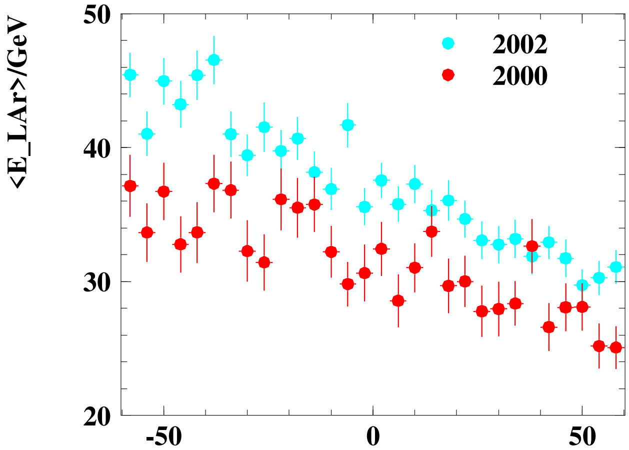


Figure 204

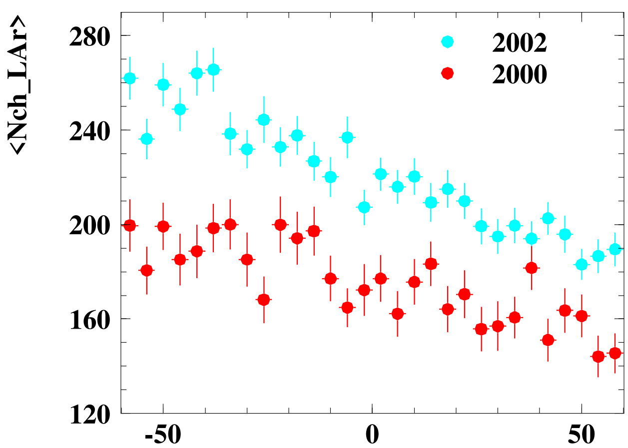
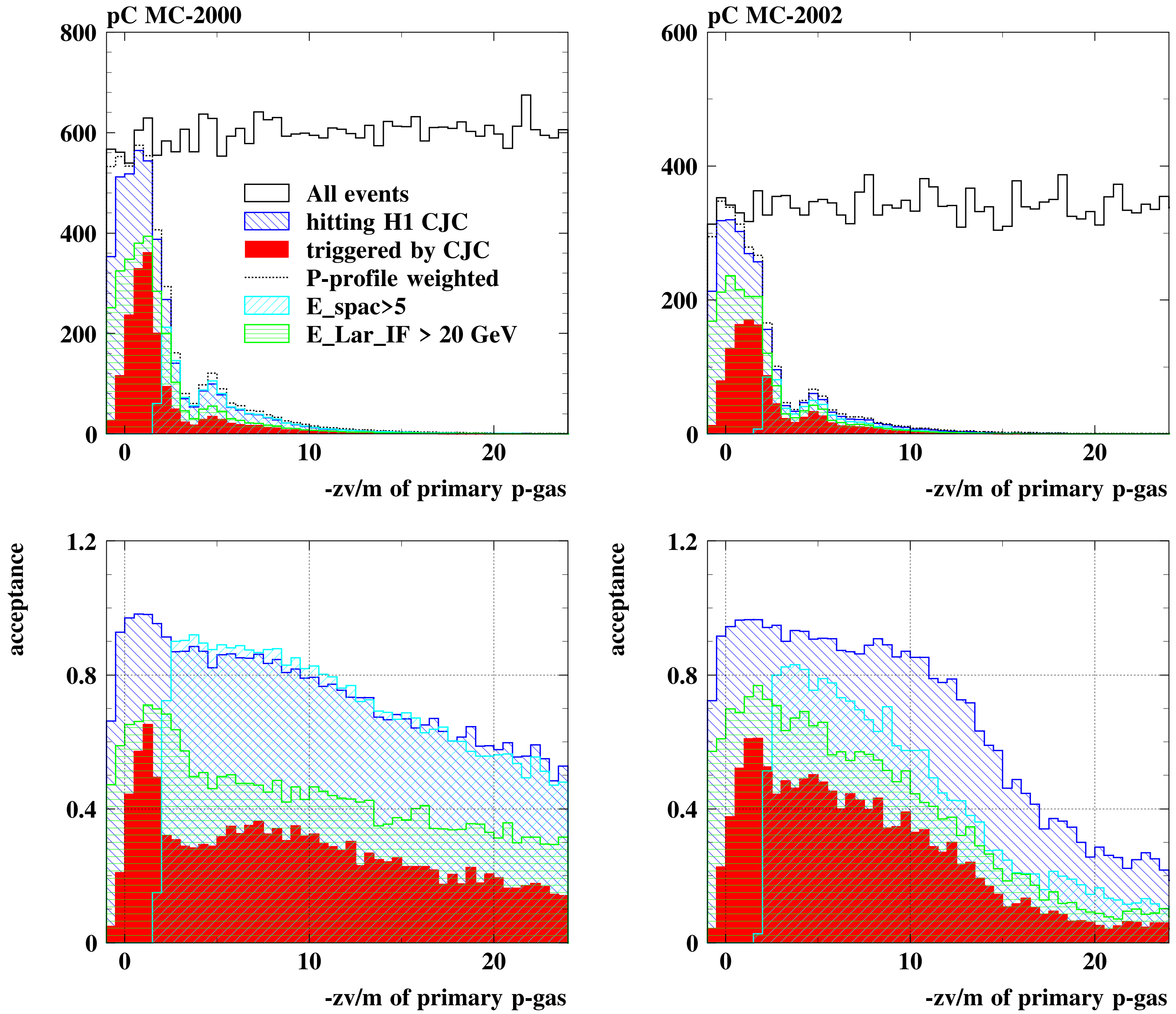
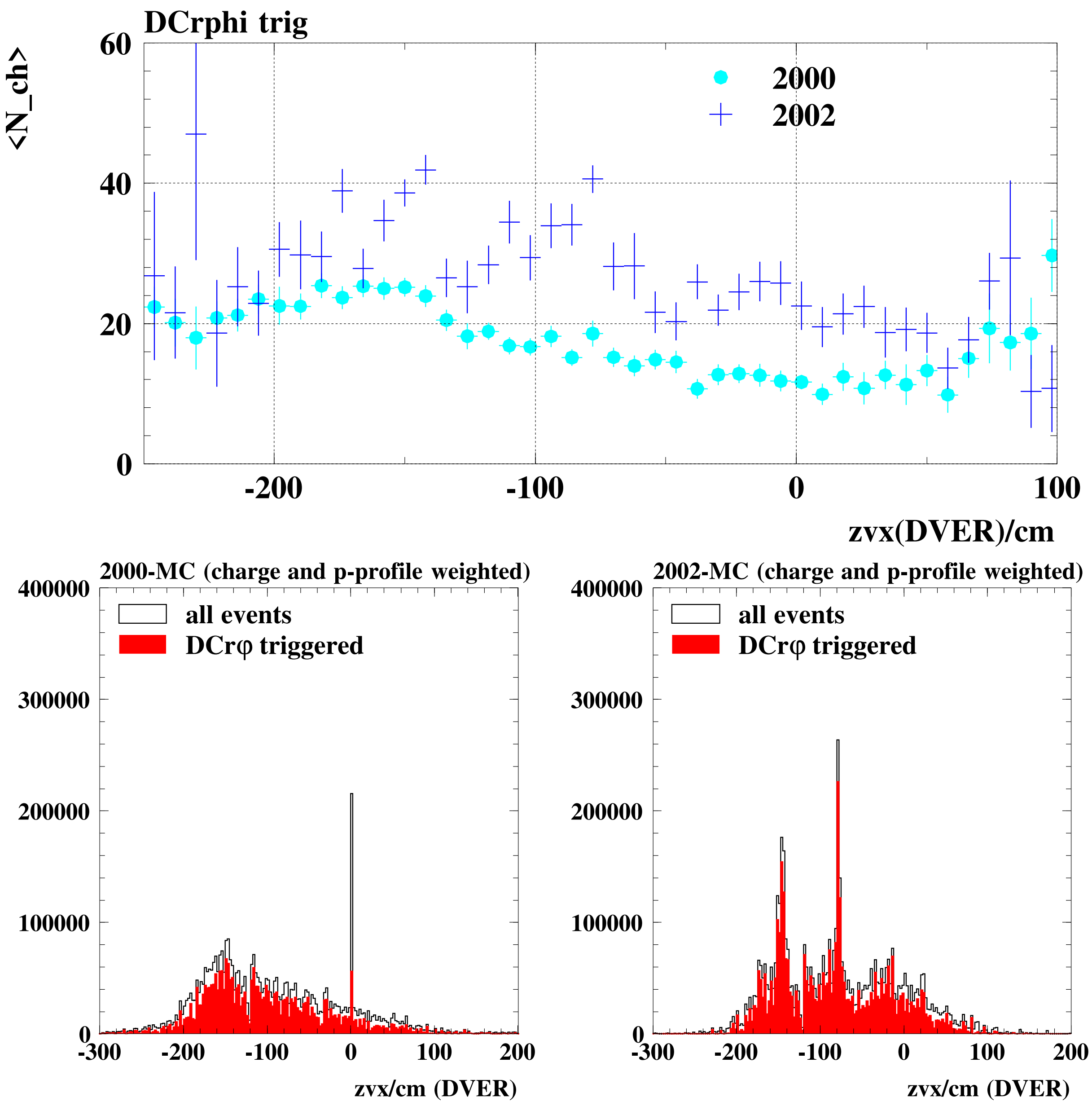


Figure 207

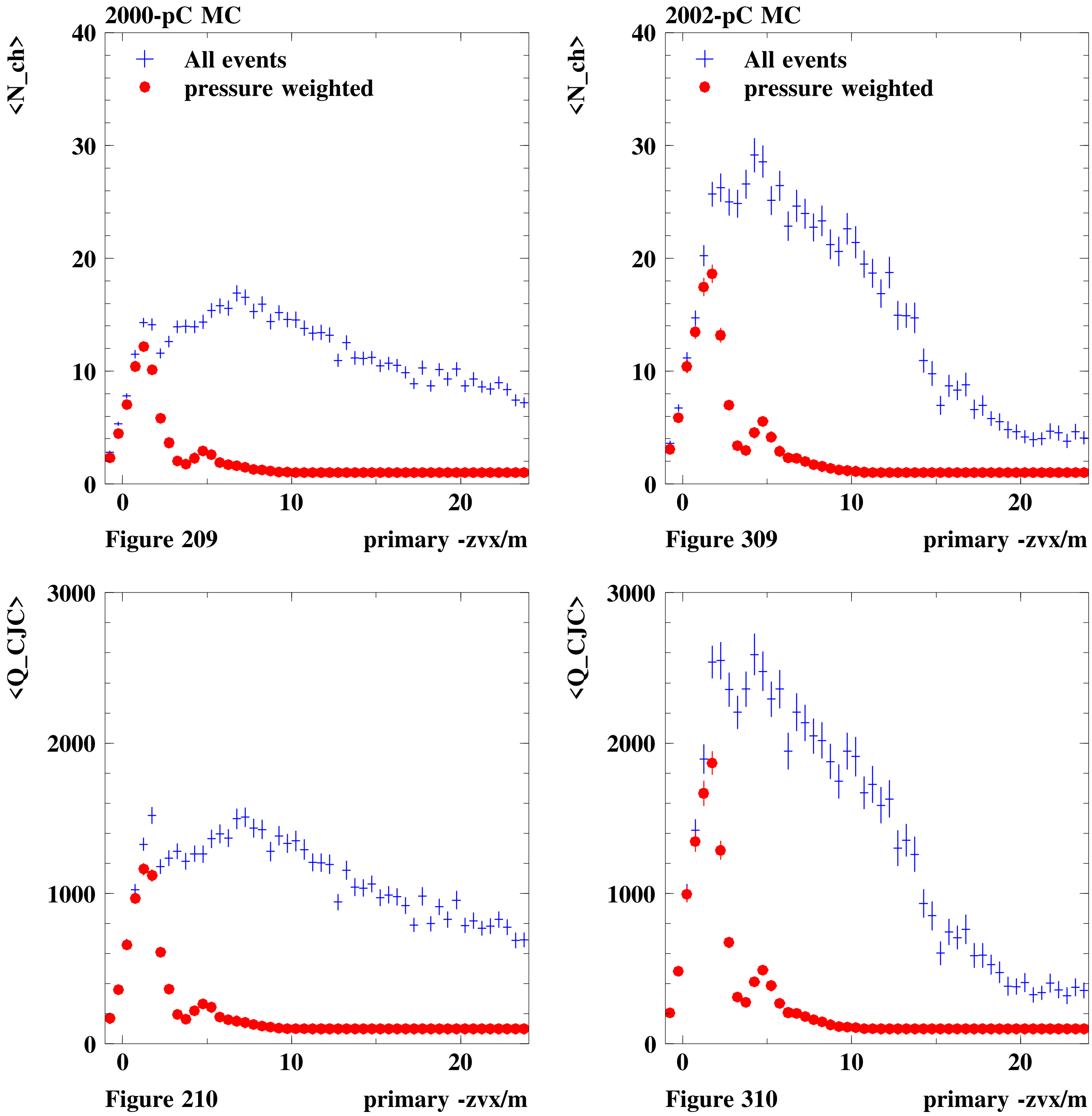
HERA-1 vs HERA-2: z-acceptance



HERA-1 vs HERA-2: charged multiplicity

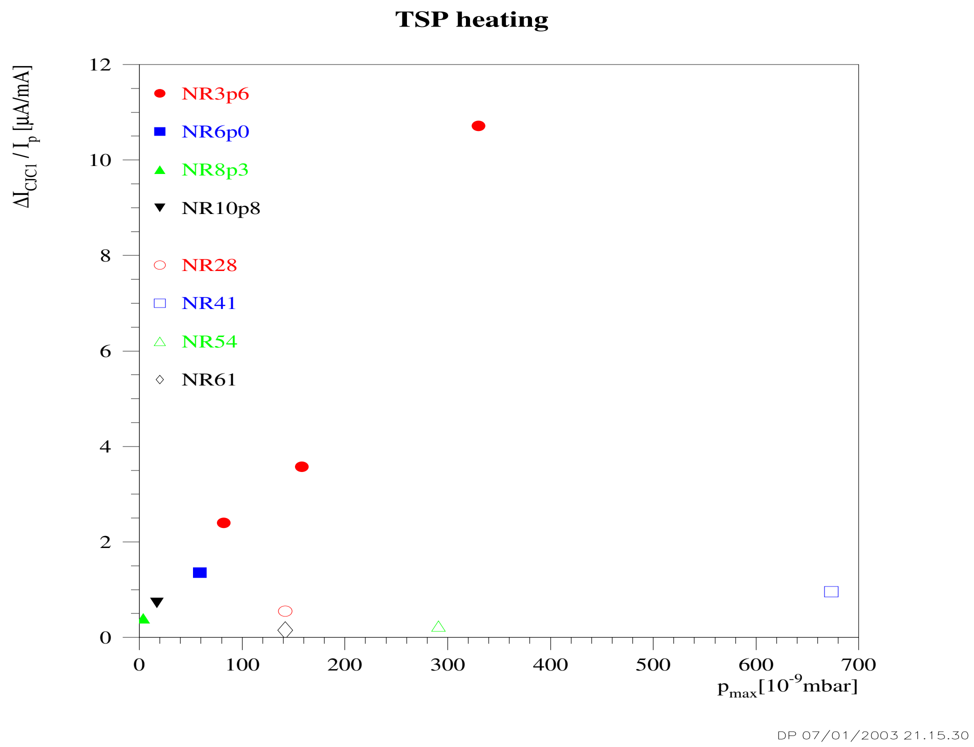


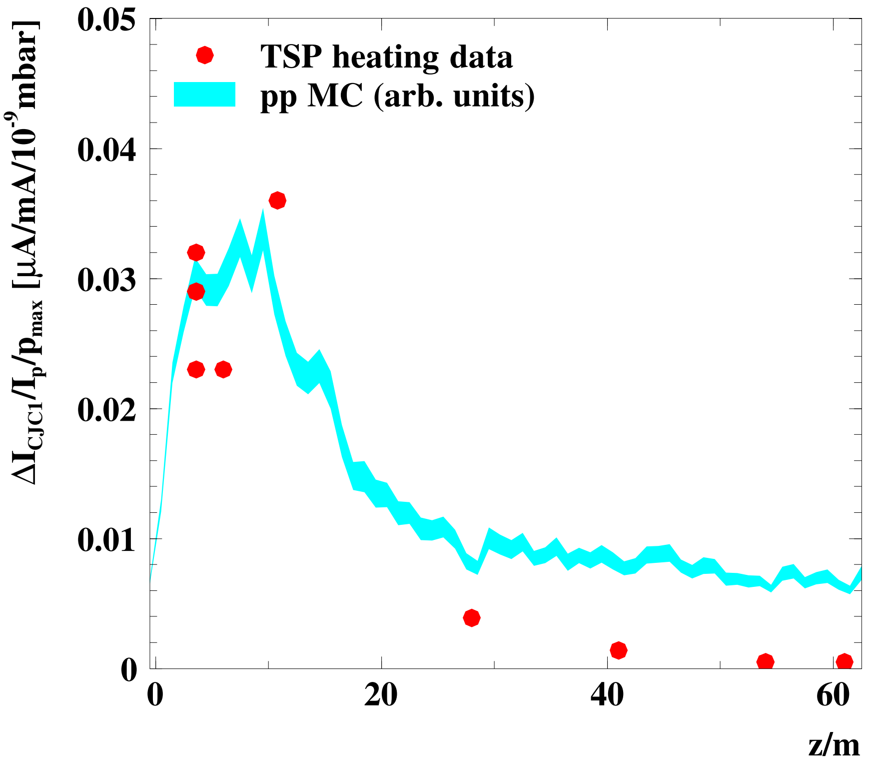
HERA-1 vs HERA-2: CJC load



$\Rightarrow$ CJC current increased by a factor of ~ 1.6 from HERA-1 to HERA-2, at the same pressure

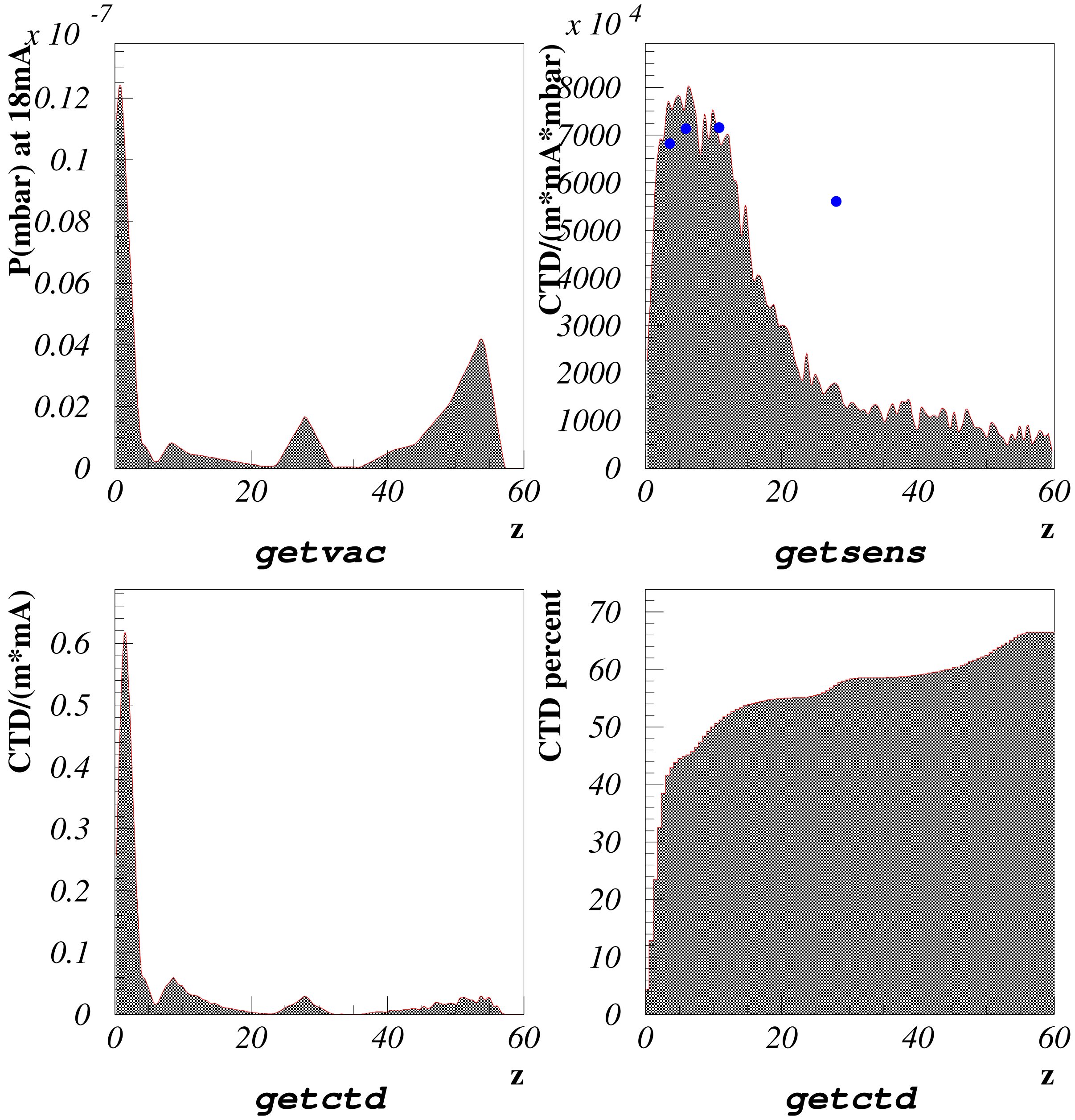
H1: $z-$dependence of the sensitivity of CJC current



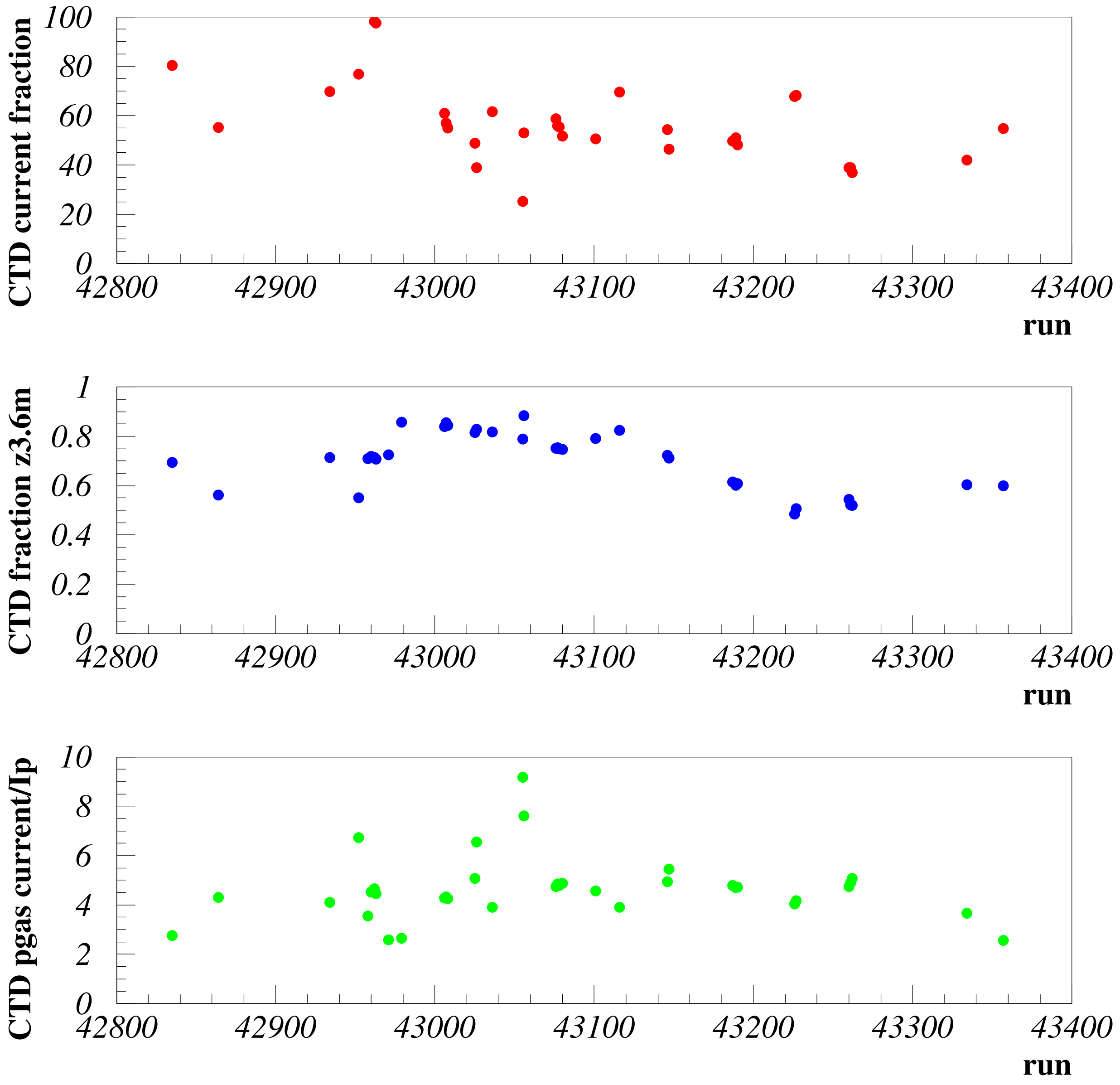


$\Rightarrow$ fraction of CJC current due to $z > 3.6$m region $= (16 \pm 3)\%$
(using Nov-20 pressure profile from M.Seidel)

ZEUS: $z-$dependence of the sensitivity of CTD current



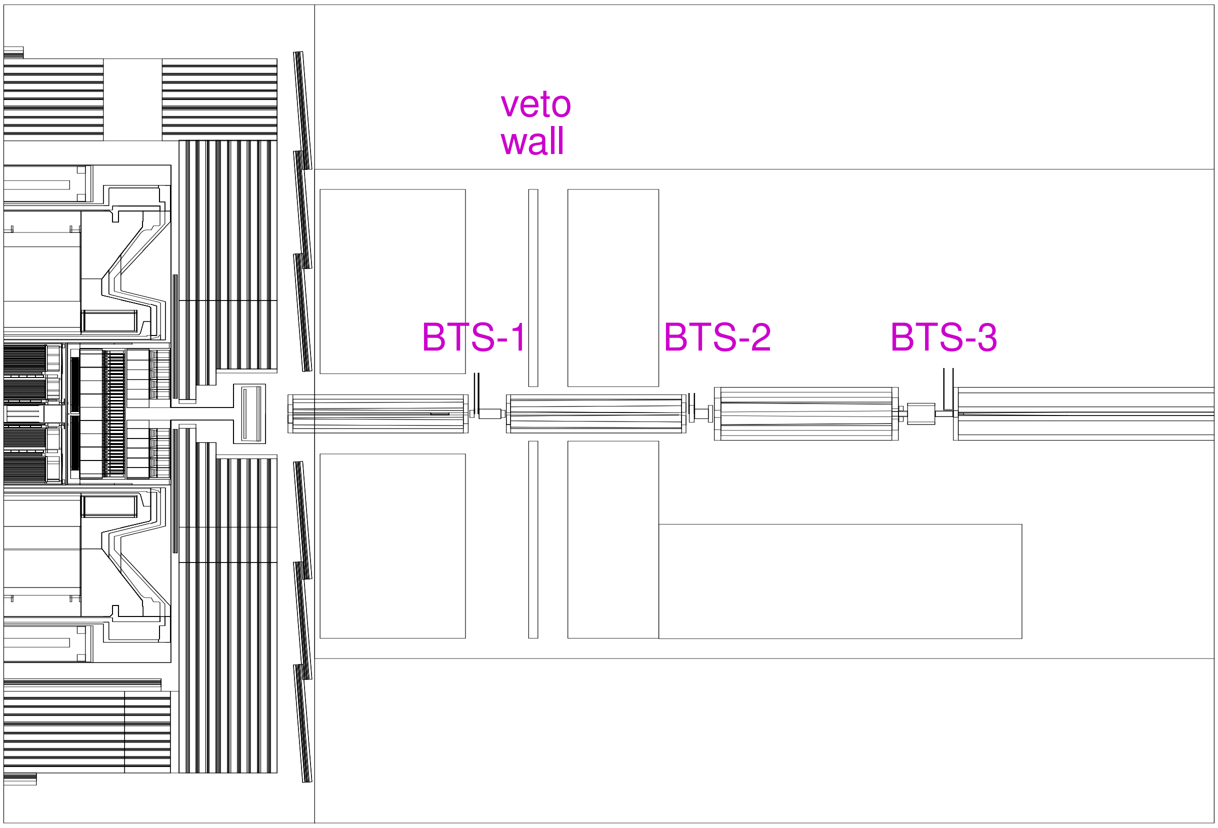
History of the proton related CTD current in ZEUS

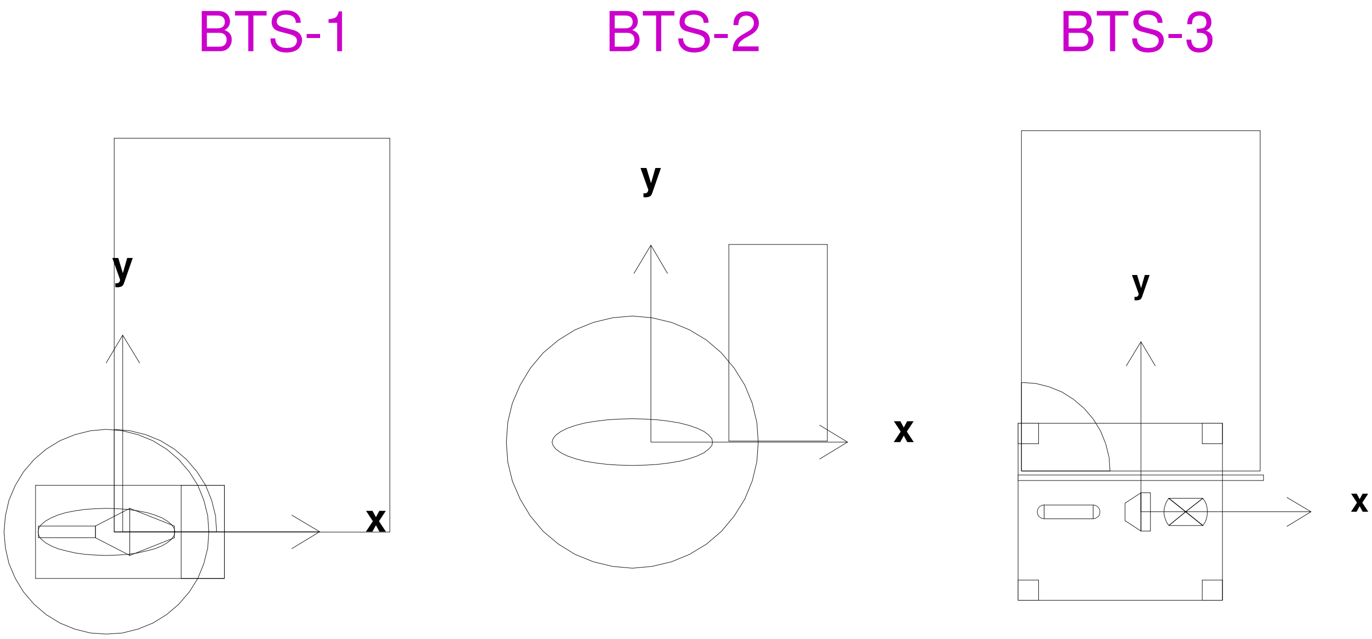


Summary on $z-$dependent acceptance

- Both H1 and ZEUS Monte Carlo predict very similar acceptance for p-induced background as a function of its z origin
- The difference between HERA-1 and HERA-2 setups can only account for $\sim 50\%$ increase in CT current
- $z-$region close to the IP is most important, but non-negligible fraction (around 30%) of the background originate from $z > 3.6$m
- more precise monitoring of the $z-$origin would be useful

BTS geometry in H1 Geant Simulation





Acceptance of the BTS counters

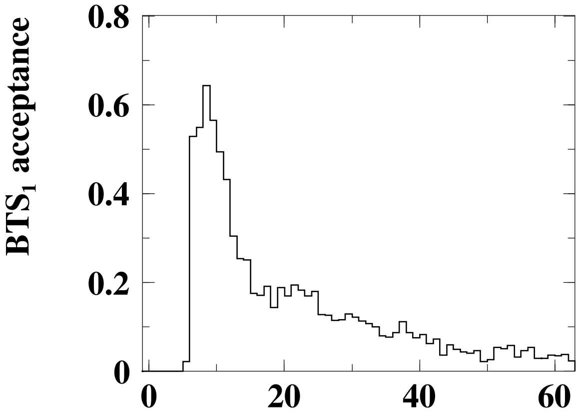


Figure 61 -z/m

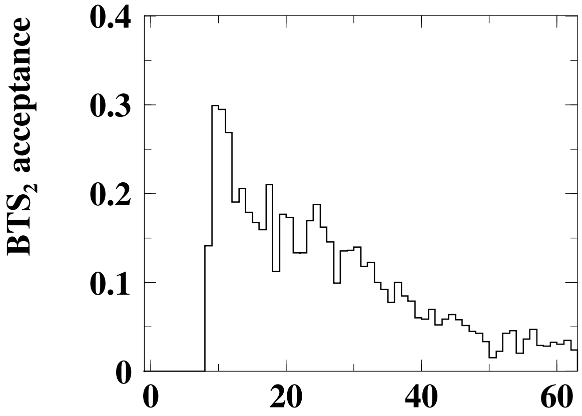


Figure 62 -z/m

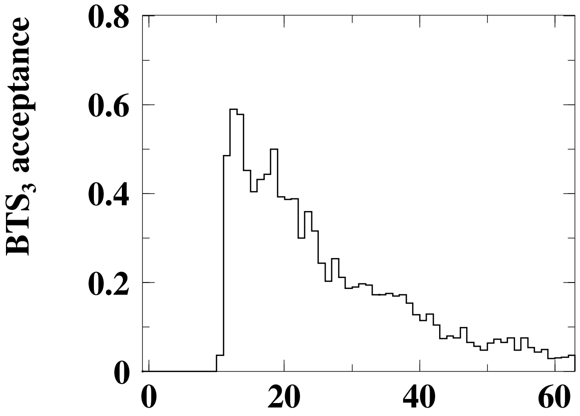


Figure 63 -z/m

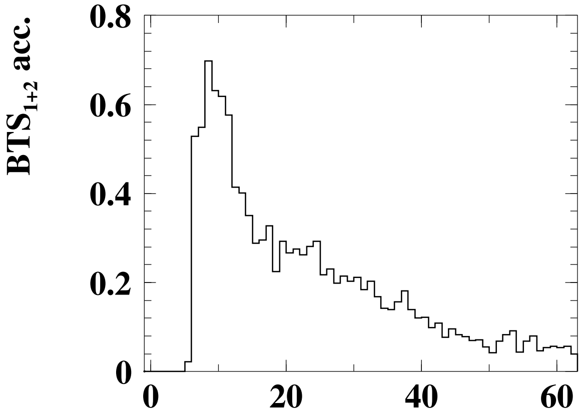


Figure 64 -z/m

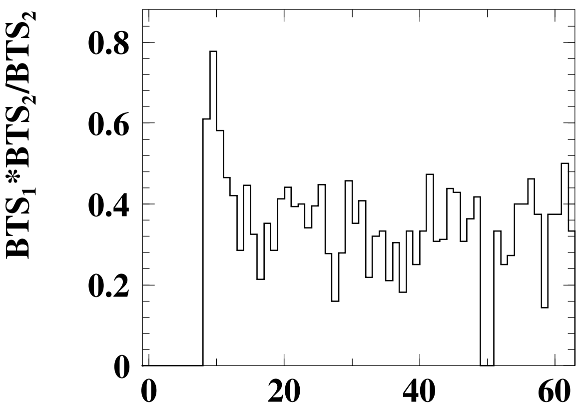


Figure 65 -z/m

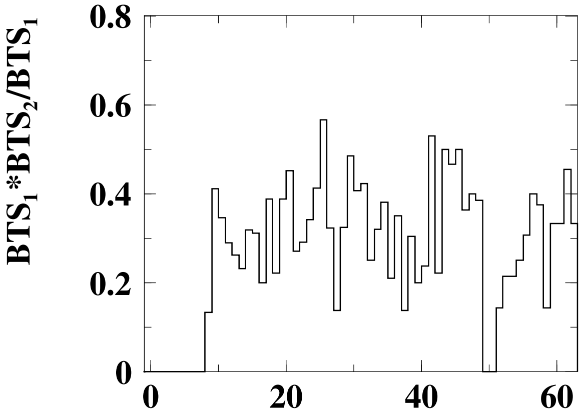
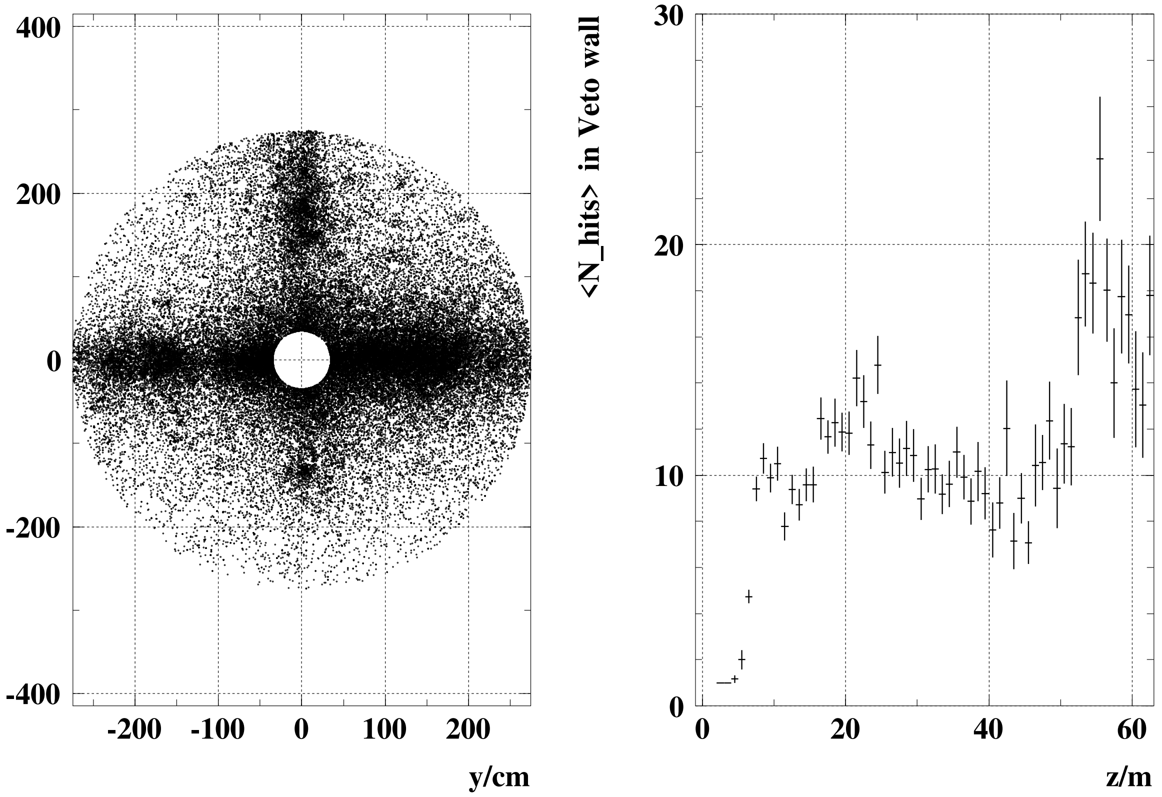
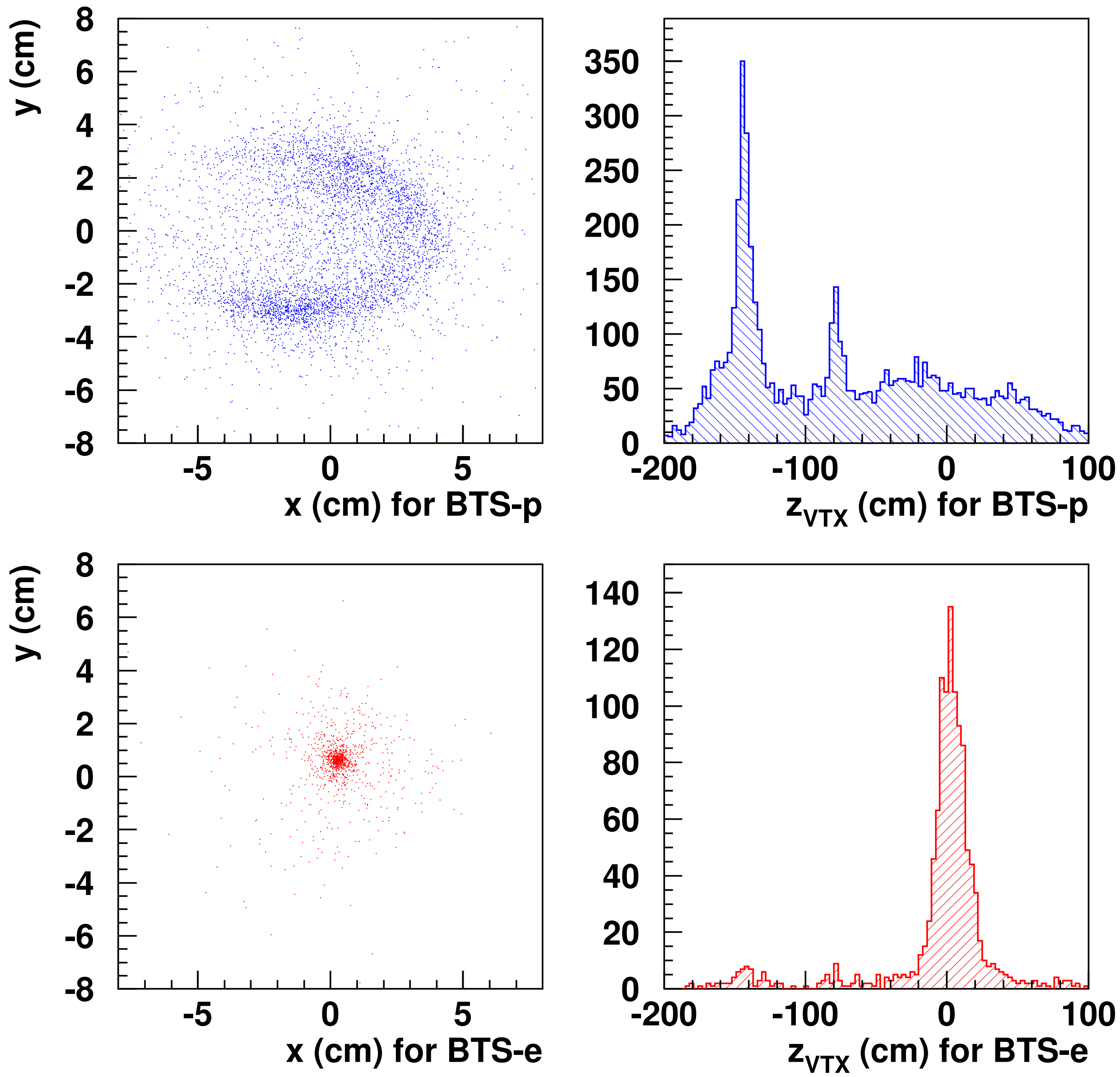


Figure 66 -z/m

Hit map in the H1 veto wall (pC MC)



BTS tagged events from p and e time windows



$\Rightarrow$ Very clean separation between $p-$background and ep events

$\Rightarrow$ Indication for a large $(20 \div 40\%)$ fraction originating from $z > 6$m

Conclusions

- Rest gas composition did not change in time between 1997 and 2002, and hence cannot be the reason of the increased background

- The difference between HERA-1 and HERA-2 setups (geometry, material budget, magnetic fields) can only account for $\sim 50\%$ increase in the proton induced background

- Major trouble – large difference in pressure around IP between HERA-2 and HERA-1 periods

- In the course of 2002 running the vacuum has improved, but is still by factor of 3 to 4 worse as compared to 2000 conditions

- Although main contribution to the background originates from the vicinity of IP, more distant region $z > 3.6$ m cannot be neglected