VFPS

A Very Forward Spectrometer in H1 in 2002

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H1 Collaboration

- Physics motivation
- VFPS detector - performance
- Physics topics
- VFPS and the cold bypass
- Conclusions

VFPS - Participating Groups

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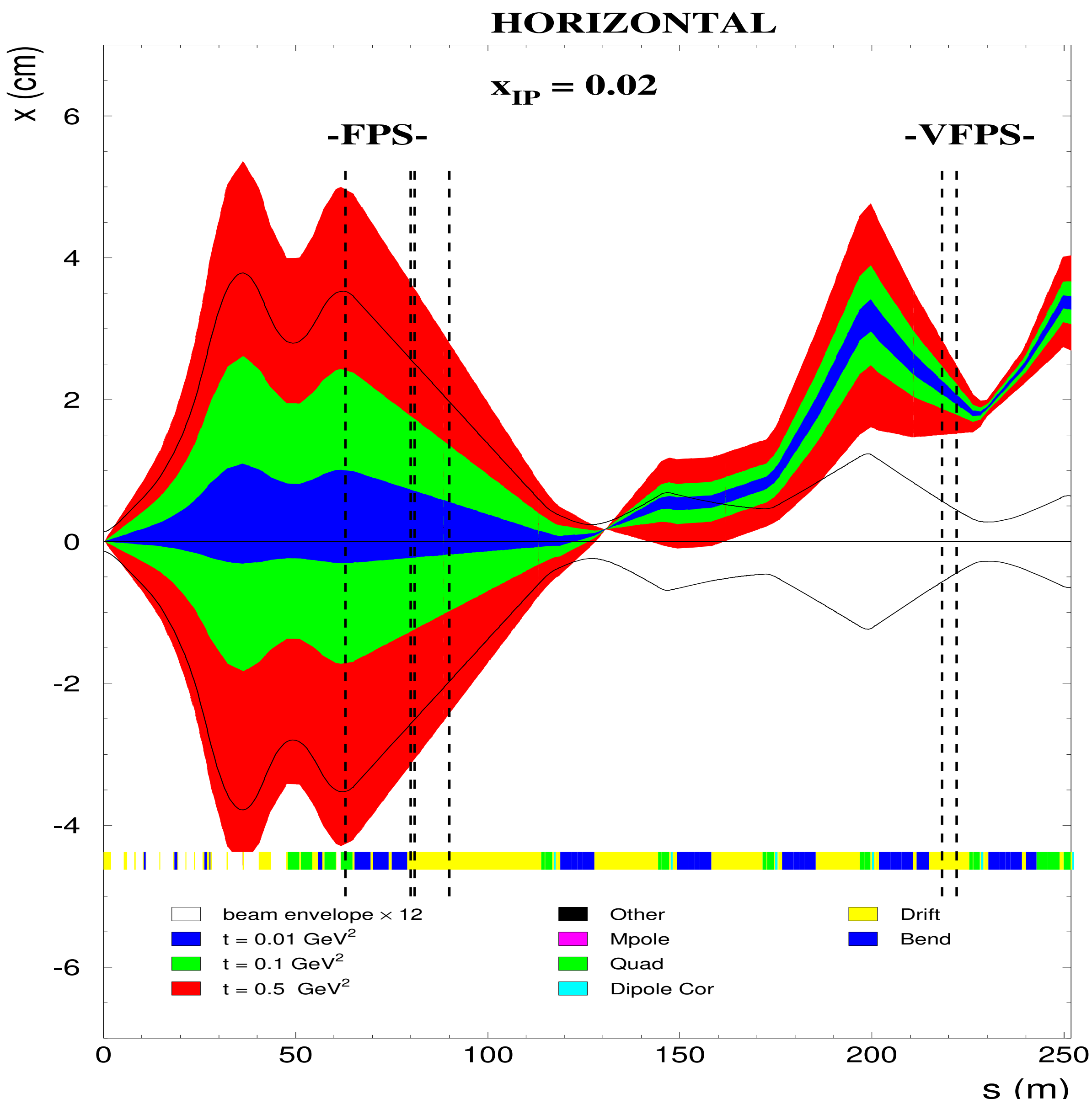
Physics Motivation

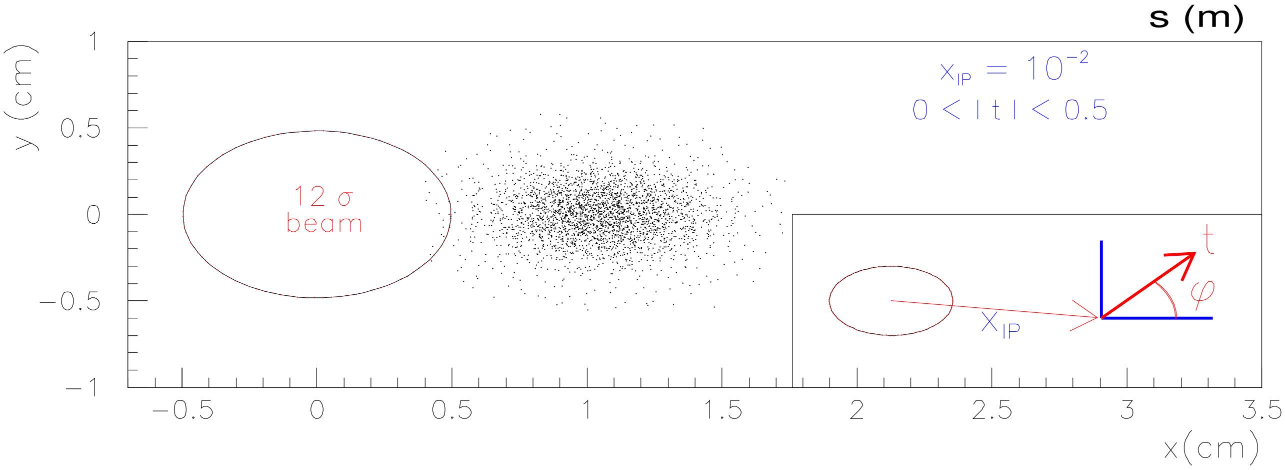
1. **Progress / Interest in Diffractive Topics e.g.**
   - scaling violations observed in $F_2^{D(3)}(x_{I\!P}, \beta, Q^2)$
     $\rightarrow$ gluon dominated parton distributions
   - Dijet and charm production are powerful tools to address the gluonic content of the pomeron.
   - Hadronic final states are well described by inclusive parton distributions
   - J/Ψ photoproduction shows a hard energy scale and a hard t-distribution.
   - The energy dependence in ρ production is also strong as Q^2 increases, with $b_\rho \rightarrow J/\Psi$.
   - The t-dependence of inclusive diffraction ($b = 7$ GeV^{-2}) is in between soft/hard diffraction.
2. **Diffractive event selection**
   - Bulk of diffractive data otained by rapidity gap selection (H1) or missing mass selection (ZEUS)
   - Tagging leading proton - LPS/FPS
3. **Limitations**
   - Considerable amount of proton dissociation backgound
     $\rightarrow$ H1 $11 \pm 5\%$ —— ZEUS $30 \pm 15\%$
   - Present proton spectrometers have small acceptance $\leq 5\%$
     $\rightarrow$ small statistics.

$\longrightarrow$ Proton spectrometer with large acceptance

Beam Profile and Roman Pot location

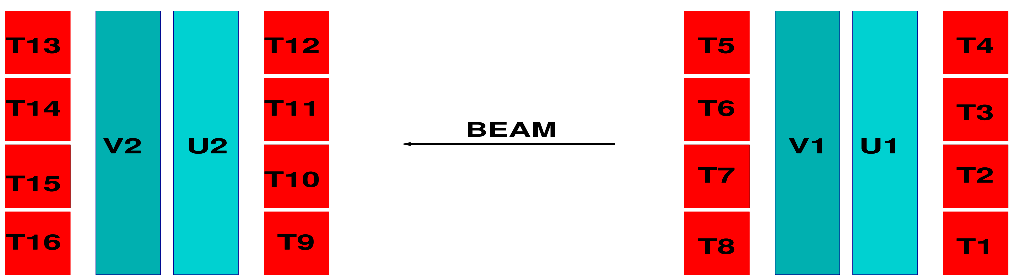
- Beam envelope
- scattered protons for $x_{I\!P} = 0.2$ and $\mid t \mid = 0.001, 0.1, 0.5$ GeV





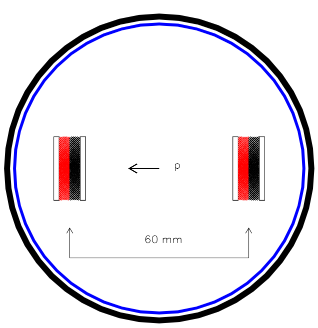
VFPS - Location - Detector Performance

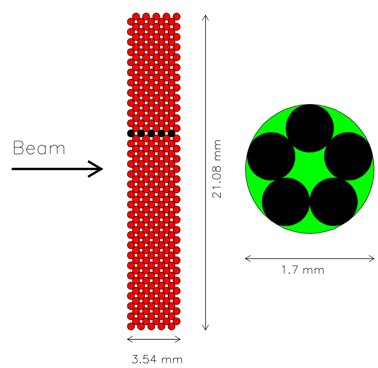
- **VFPS Located at 220 m downstream from H1**
  - acceptance $> .8$
  - $5.10^{-3} < x_{I\!P} <\approx 3.10^{-2}$
  - $t_{min} < t < 0.5$
- **VFPS detector**
  - two roman pots - 2 detectors /roman pot
  - detectors: 2 scintillating fibre planes (u,v coordinates) cfr. FPS.
  - Spacial detector resolution 100μ



Trigger Tiles: T1,T2,...,T16 in +45 direction
U−planes: U1,U2, fibre planes in the −45 direction, measuring v−coordinate
V−planes: V1,V2, fibre planes in the +45 direction, measuring u−coordinate

Connection fibres - lightguide



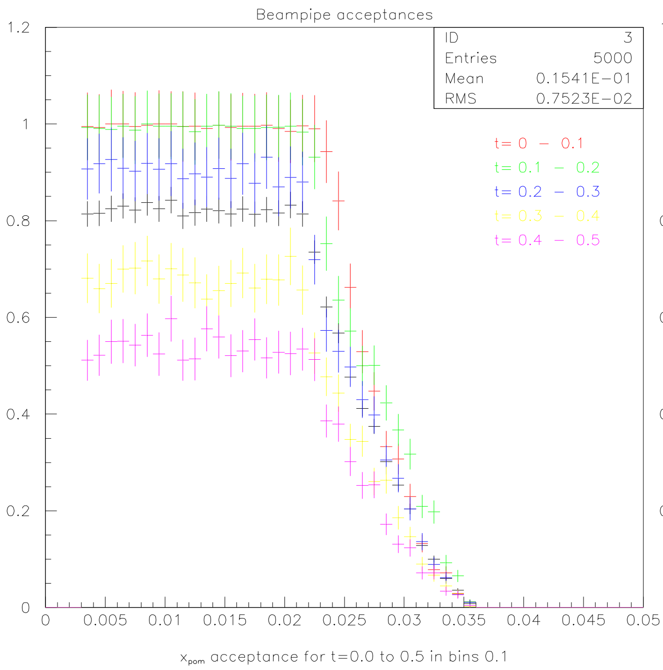


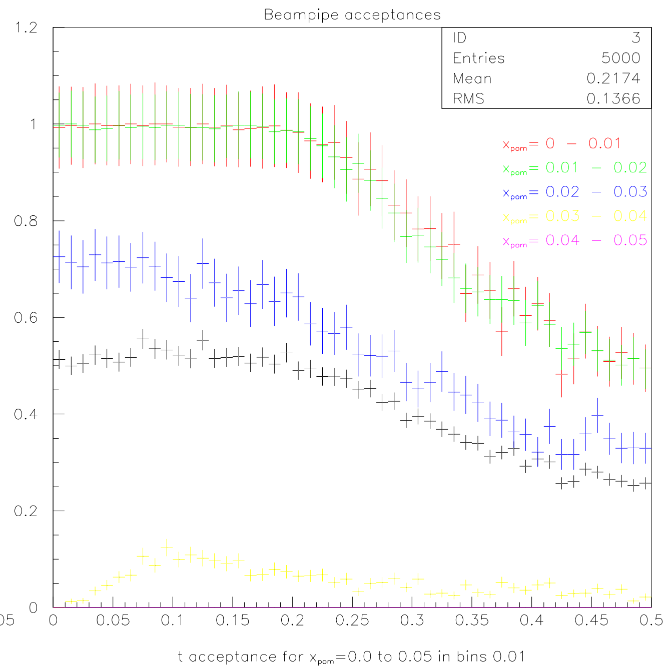
- **VFPS Resolutions**
  - Reconstruct from $(x, y, \theta_x, \theta_x)_{\mathrm{RomanPot}} \rightarrow (t, x_{I\!P}, \phi)$
  - $x_{I\!P}$ resolution $\Delta x_{I\!P} \approx 7.10^{-4}$

VFPS - Acceptances

Beam pipe acceptance

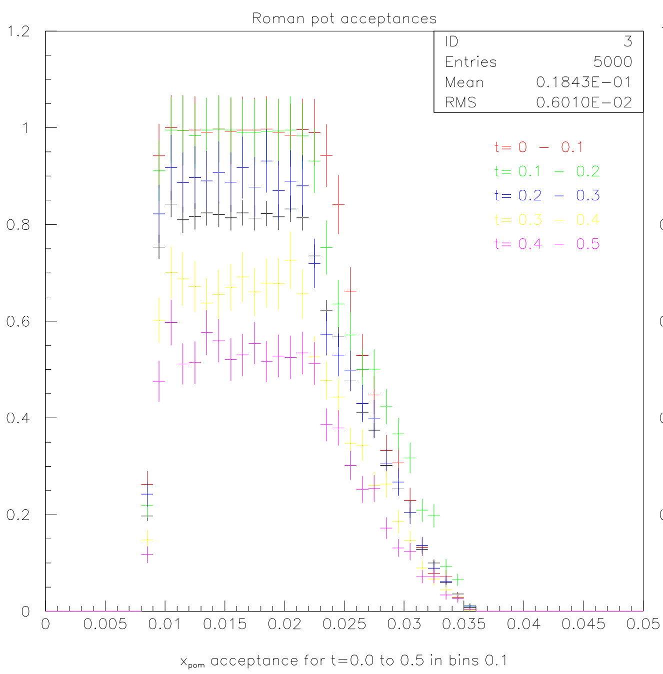
Acceptance x_{IP} / Acceptance t

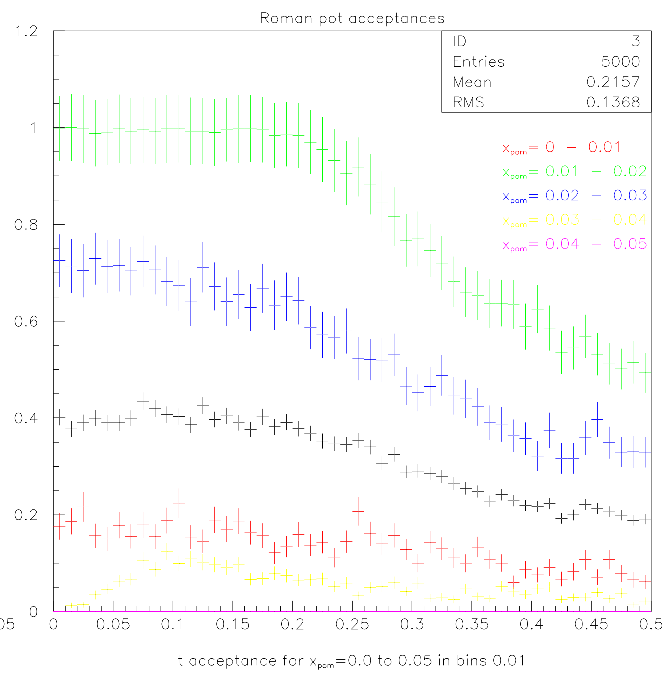




Roman pot acceptance

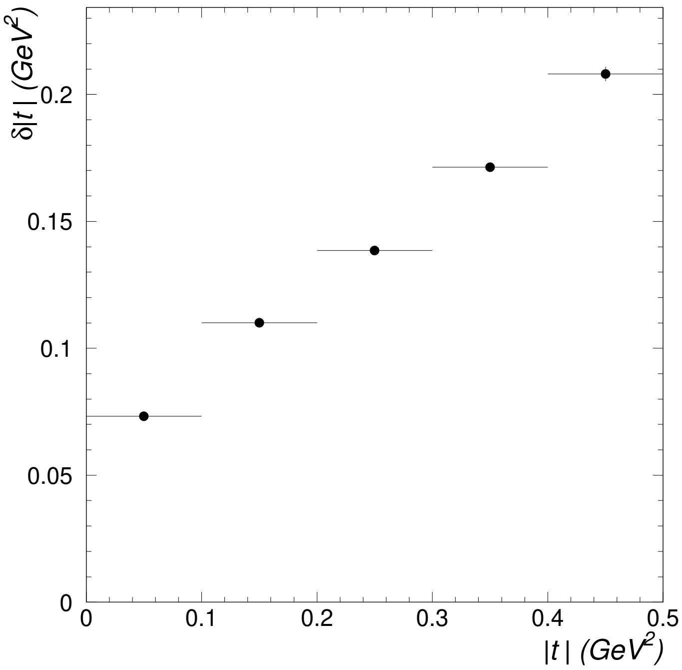
Acceptance x_{IP} / Acceptance t



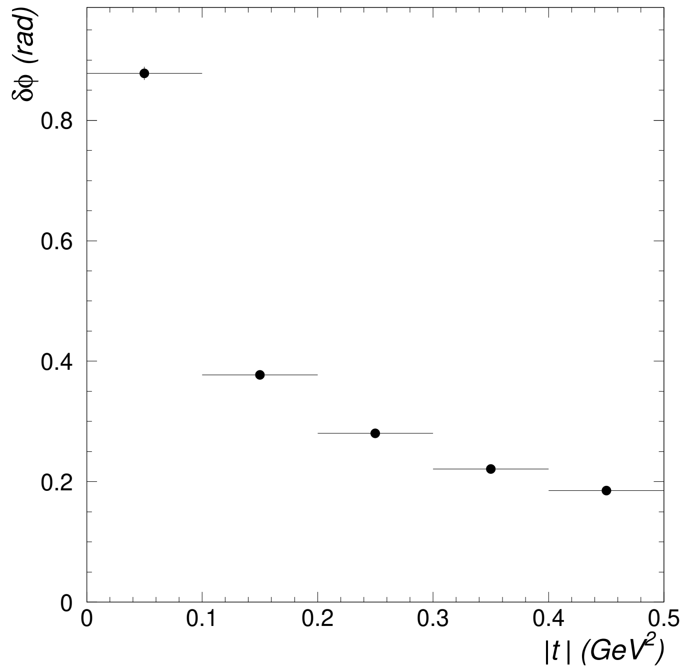


VFPS Detector resolution t,ϕ

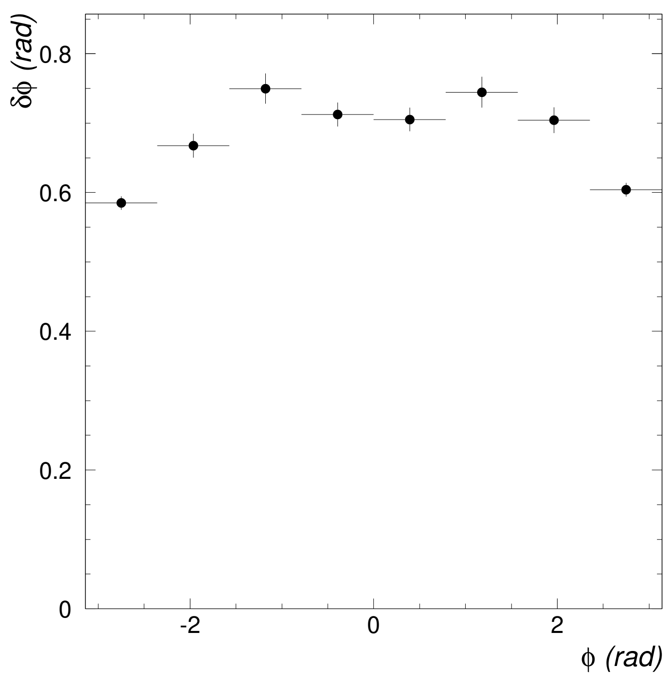
$\delta t(t)$



$\delta\phi(t)$



$\delta\phi(\phi)$



$\delta\phi(\phi)$

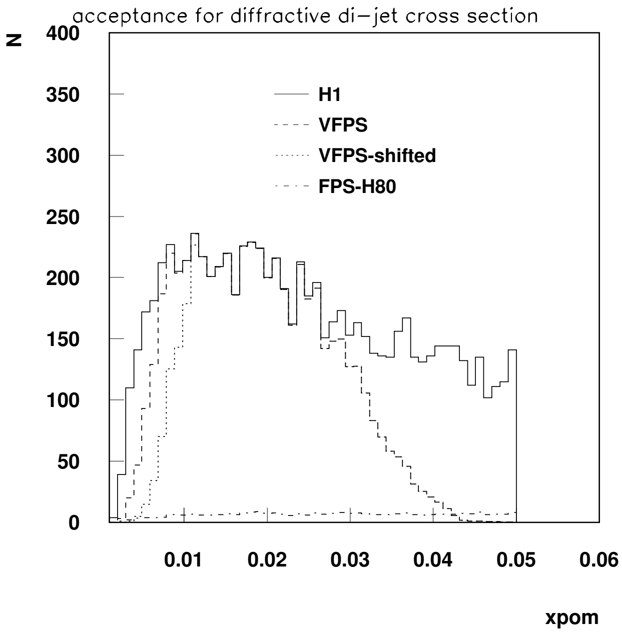
- **VFPS Position calibration**
  - Using peak in inclusive t distribution
  - Using ρ's measured in central detector

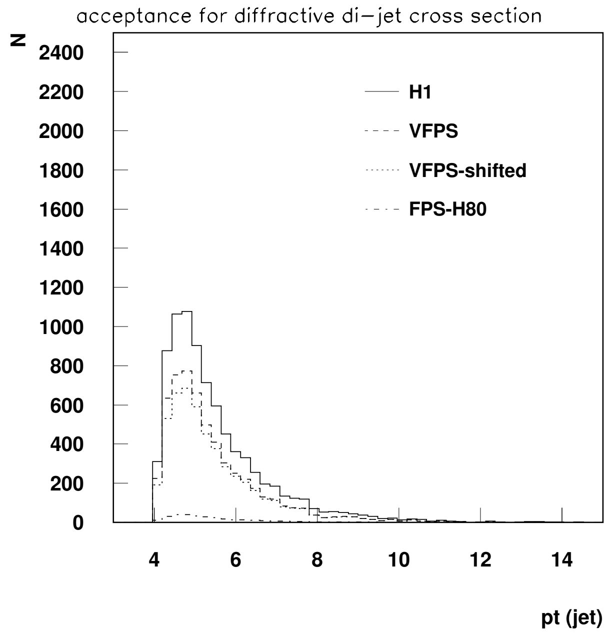
VFPS - Acceptance: Jets

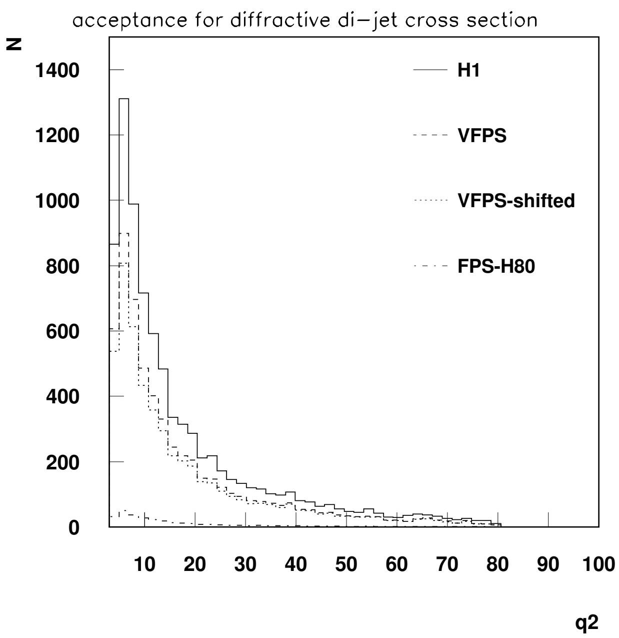
- no VFPS tagging (H1-acceptance)
- VFPS tagging, with VFPS at the 12 σ location
- VFPS tagging, with VFPS at the 12 σ + 3 mm location
- FPS tagging by 80 m pot

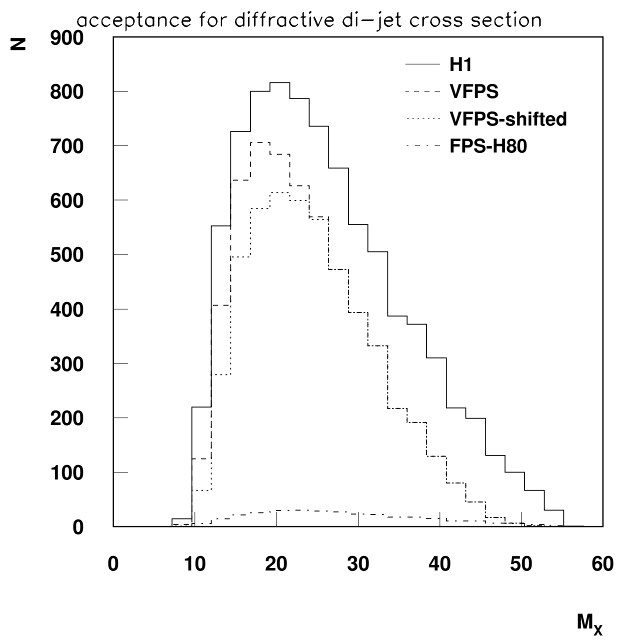
Cuts

$$0.1 < y < 0.7, \quad 4 < Q^2 < 80 \text{ GeV}^2 \quad x_{I\!P} < 0.05$$
$$p_t^{Jets} > 4 \text{ GeV } (\gamma^* \text{p})$$





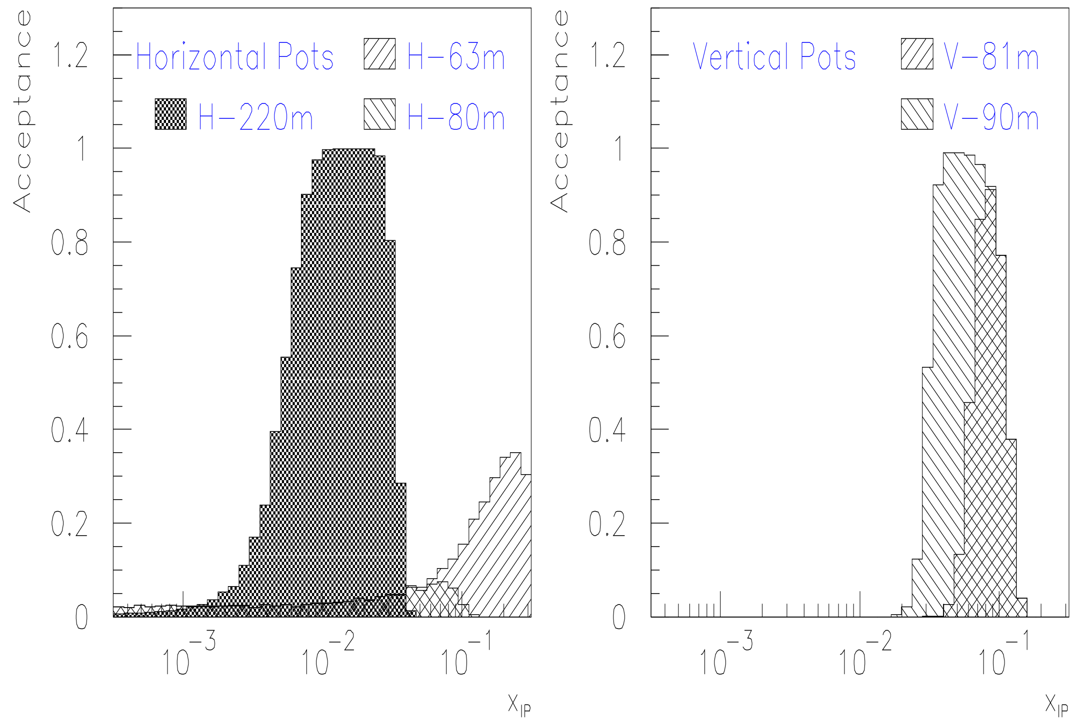




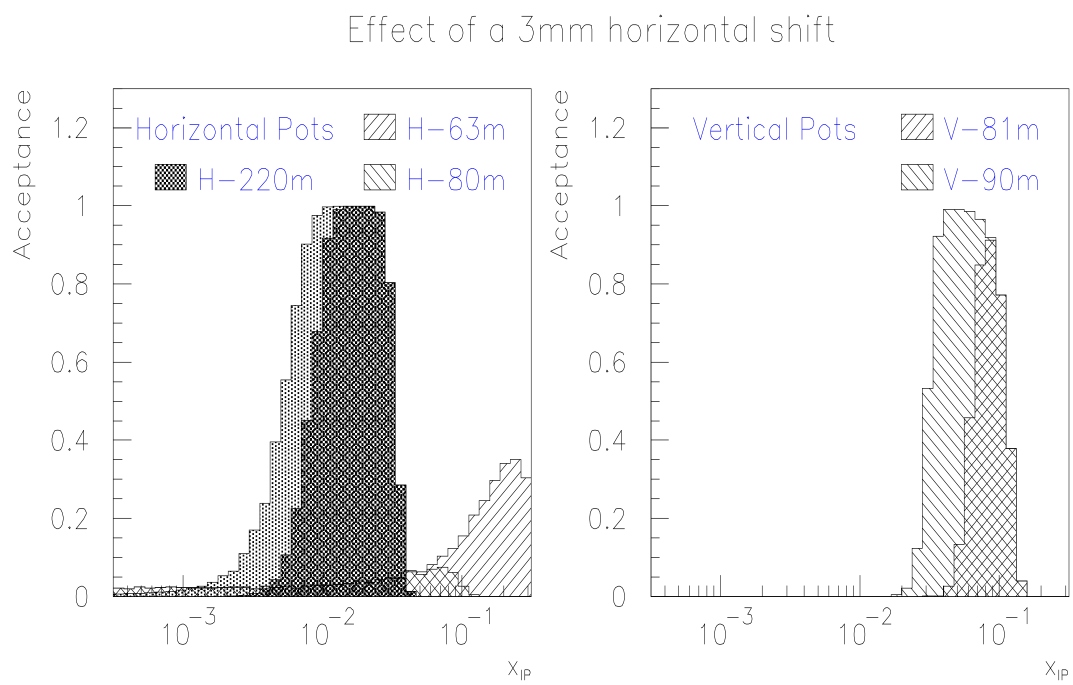
$$x_{I\!P} = \frac{Q^2 + M_x^2}{Q^2 + W^2} \rightarrow \frac{10^2}{150^2} \approx$$

VFPS - FPS

Comparison VFPS - FPS - Coasting beam



Coasting beam effect



VFPS - Physics Topics

With an 80% efficiency and a luminosity of 150 pb^{-1}/year we can collect over 2003-2005 a total of 360 pb^{-1}

Charm production

- Statistics: at least 4-fold increase in statistics in $5.10^{-3} < x_{I\!P} < 3.10^{-2}$
- direct access to the gluon content of the pomeron

Large E_T jets

- Statistics: expect 10000 events $p_t > 5\ GeV^2$,$0.1 < y < 0.7$, $Q^2 > 7.5\ \ \mathrm{GeV}^2$
- direct test of gluon in pomeron (cfr.charm) and discriminate between boson-gluon-fusion and two gluon exchange
- with 60.000 events in photoproduction the resolved photon contribution can be measured $\rightarrow$ gap survival probability

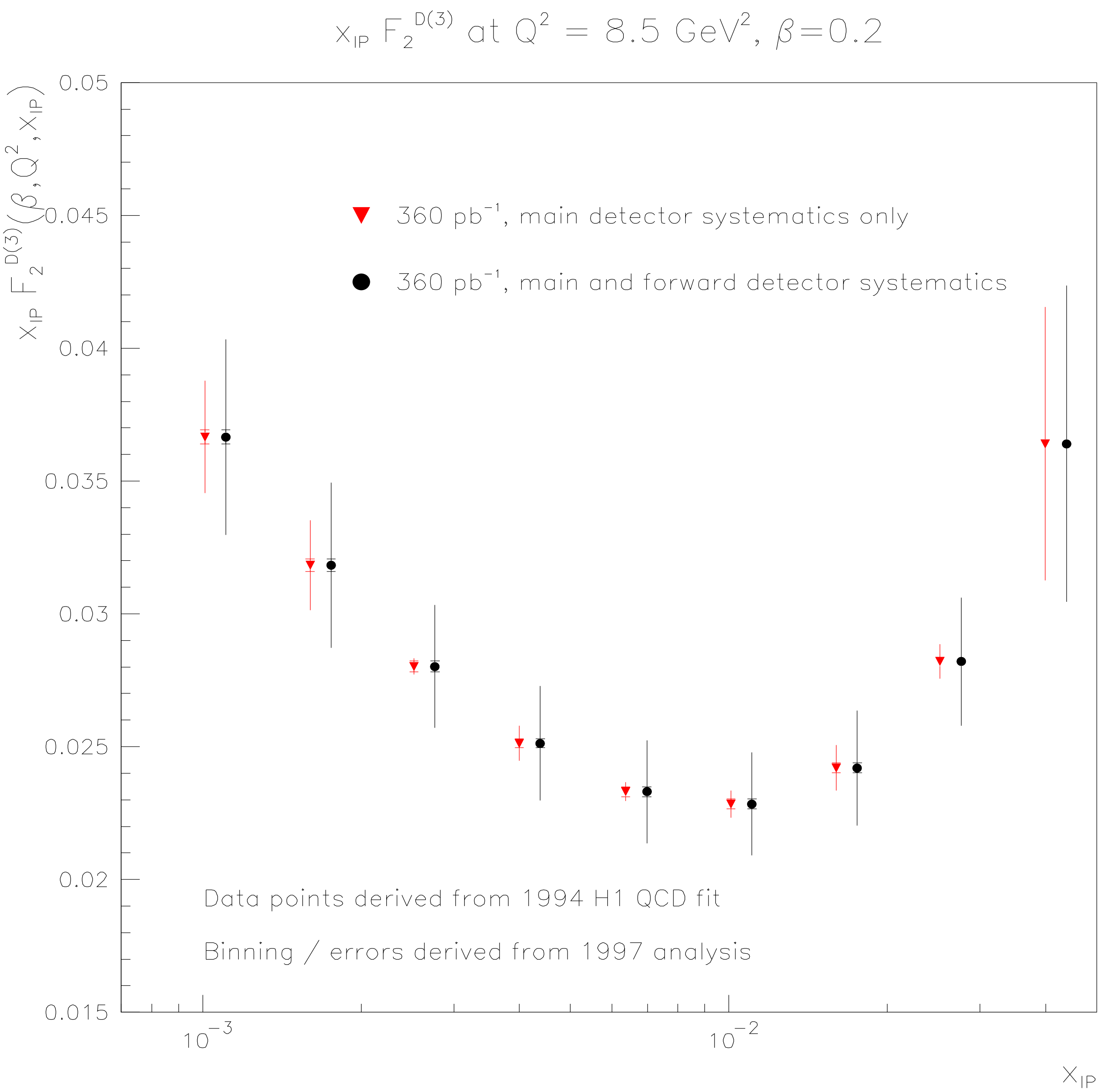
VM

Large data samples of high Q^2 vector mesons will be collected with no proton dissociation
$\mathrm{Accep}^{\mathrm{VM}}(\mathrm{Q}^2 > 20\ \mathrm{GeV}^2) \approx 50\%$; $\mathrm{Accep}^{\mathrm{DVCS}} \approx 25\%$.

Inclusive measurements $F_2^{D(4)(x_{I\!P},\beta,Q^2)}$

- higher precision without proton dissociation background
- t-measurement in 3-4 t bins will permit discrimination between small and large dipoles
- ϕ -measurement in 4-5 bins for $t > 0.1\ \mathrm{GeV}^2\ \ \rightarrow$ measurement of σ_L

VFPS - Dissociation Background $F_2^{D(3)}$



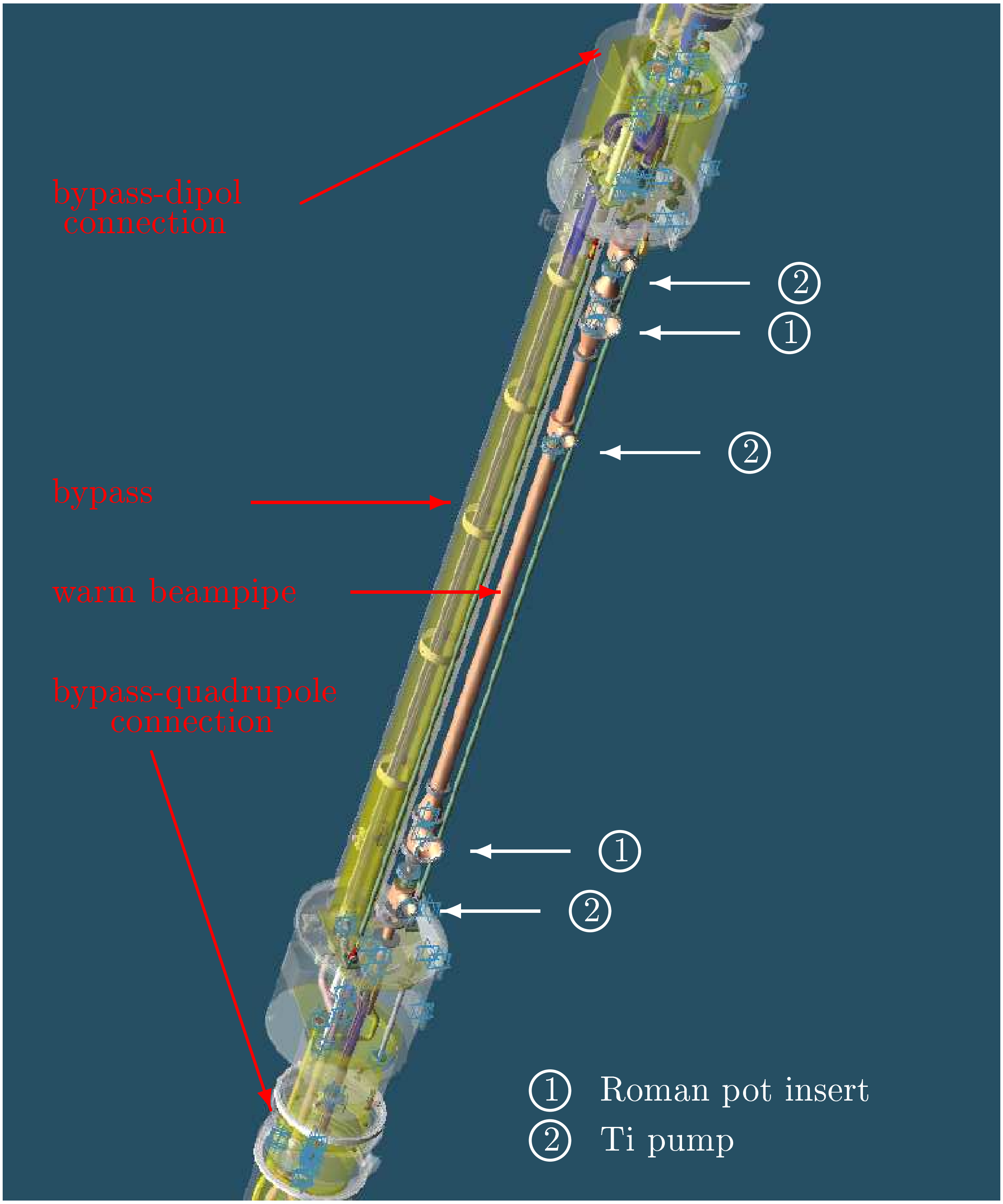
HERA tunnel at 220 m

Proton beamline section to be replaced

Electron beam Proton beam

qq

"Cold" bypass design



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Conclusion

- The VFPS, installed in H1 at 220 m from the central detector can tag diffractive protons with
  - $t_{min} \leq t < 0.5$ GeV^2 and low $x_{I\!P}$
  - with a high efficiency
- Beyond tagging, t and ϕ of the diffractive proton will be measured with a resolution allowing
  - $\approx$ 5 bins in t in the range $t = [t_{min}, 0.5]$ GeV^2
  - $\approx$ 5 bins in ϕ
- Design of cold bypass finished
- Installation of VFPS in shutdown of 2001-2002
- 2003 : Start data taking of a high quality and high statistics diffractive data sample