H1-15/00-xxx

Addendum VFPS : Background rates

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1 Introduction

Of the possible backgrounds to the VFPS, two may be potentially sizeable and hence harmful to the VFPS physics program:

- “Beam gas” interaction background
- “Coasting beam” background

“Beam gas” background results from proton interactions either with the residual gas in the proton beam pipe or with the beam wall. They can produce good single tracks in both VFPS pots and produce a sizeable fraction of fake diffractive proton triggers. To obtain a reliable estimate for this background rate, a complete description of the proton beam line/pipe from H1 up to 220 m is required. Such a complete simulation is presently not available. We will therefore attempt to estimate the beam gas background using the knowlegde of the measured FPS background rates.

The origin of the "coasting beam" phenomenon is complex, but the fact is that a fraction of the bunched particles leave the RF buckets, are therefore no longer accelerated and travel around the proton ring until they hit one of the beam collimators. These particles constitute a "coasting beam", the current of which can be sizeable and attain the 1 mA level. To estimate which fraction of this coasting beam will be visible in the VFPS as a function of the distance of approach of the VFPS is very difficult. To make such a background estimate more reliable, detailed information of this phenomenon is required which at present is not available to the DESY beam group. The estimate is presently based on a theoretical calculation.

2 Beam gas background

We recall that the present measured rates in the FPS are

1. FPS(horizontal) single rates (coincidences in 1 pot) : $\approx 50 - 80$ kHz
2. FPS(horizontal) coincidence rates (coincidences between 2 pots) : $5 - 10$ kHz depending on the activities of the HERA-B and ZEUS LPS experiments. The reduction in rate (local to coincidence) is understood as a result of the presence of the 3 BU00 bending magnets which strongly reduce the acceptance for low momentum secondary particles.

To evaluate the ratio of the background rates VFPS/FPS we have adopted the following method: PYTHIA was used to generate beam gas events (minimum bias events [1]) and all charged secondaries were tracked through the beam optics. Beam wall interactions were not generated, but to maximize the secondary particle acceptance, the beam pipe diameter was increased. Various locations for the beamgas interaction point were assumed. The results are shown in table 1.

The number of tracks in colum 1 correspond to tracks detected in the appropriate detector from ≈ 100 minimum bias events/meter generated uniformly over the warm beam pipe section. For column 2, in addition to the events quoted in column 1 and equivalent and additional amount of events was generated at the origin of H1 in order to evaluate the effect of upstream interactions, NR of H1. Finally in colummn 3 minimum bias events were generated only in the cold section of the proton beam line downstream of the FPS. If we now assume that the measured number of tracks detected is proportional the rates measured [2] in the FPS we come to the following conclusions

1. **column 1 results** The asymmetry in the number of tracks in FPS 1 and FPS 2 is not reflected by the measured rates. The reduction of the single rates/coincidence rate is not incompatible with the FPS measured data. It is shown by the simulation that most of the coincidences in the FPS are due to inelastic events ($> 60\%$). As in this simulation no beam wall interaction have been included this FPS coincidence rate should be viewed as a lower limit (see also 2). The rate in the VFPS coincidence rate is 2 to 3 times that of the FPS and also equal to the single VFPS rate. The simulation shows that most of these events are elastic events. There is thus hardly any overlap between the set of events seen in the VFPS and FPS.

[1] Cross sections used: $\sigma_{\mathrm{Tot}} \approx 41\,\mathrm{mb}, \sigma_{\mathrm{Inel}} \approx 20\,\mathrm{mb}, \sigma_{\mathrm{El}} \approx 7\,\mathrm{mb}, \sigma_{\mathrm{SD}} \approx 8\,\mathrm{mb}, \sigma_{\mathrm{DD}} \approx 2\,\mathrm{mb}$ and $\sigma_{\mathrm{Lowp_t}} \approx 2\,\mathrm{mb}$

[2] This most probably overestimates the beam gas background as the measured FPS rates can be partly due to coasting beam particles

Condition	Tracks [0,100]m	Tracks [0,100]m+upstream	Tracks cold section
FPS1(local)	1025	1120	-
FPS2(local)	1780	1790	-
FPS1 .and. FPS2	266	320	-
VFPS1	730	750	1840
VFPS2	820	840	2072
VFPS1 .and. VFPS2	730	750	940

Table 1: Tracks from PYTHIA minimum bias events detected in 1 or 2 FPS or VFPS stations for different locations of the beam gas interaction point

2. **column 2 results** The addition of upstream interactions have a sizeable effect on the coincidence rate of the FPS and to a lesser extend on the VFPS as one would expect; only the elastic/diffractive part is important to the VFPS, not so for the FPS.

3. **column 3 results** The beam gas background in the cold section could produce a sizeable contribution to the measured rates. However in this part of the proton beam line one may assume that the pressure is a factor 10 smaller than in the warm section, the N_2 component of the beam gas being completely condensed leaving only the H_2 component. If we assume that the pressure reduction factor implies a similar density reduction factor, the additional contribution of the beam gas interaction in the cold section would add a 10% effect to the measured rates.

3 Coasting beam background

Aperture calculations of off momentum particles have been made by B.Holzer[3]. These calculations show that the collimators limiting the aperture for the coasting beam are determined by by the collimators WL-150 m an WL-105 m. The eventual installation of an additional collimator at WR-33 m does not seem to further improve the situation. The effect of these collimators is that at the level of the VFPS station an extra 3 mm space has to be added to the assumed 12 σ beam envelope in order not to be subjected to backgrounds from this origin.

In order to estimate the effect of this additional distance on the VFPS physics the acceptance as a function of $x_{I\!P}$ is shown for fig. 1 for three different cases: - VFPS approches the beam at a distance $d = 12\ \sigma$ (originally assumed), $d = 12\ \sigma + 3$ mm and $d = 12\ \sigma + 5$ mm. As expected the event loss occurs at the low $x_{I\!P}$ end, the most interesting part for physics, and amounts to 45% and 35% with respect to the original assumption.

The estimates are difficult and more detailed measurements from the beam group could narrow them down. However these measurements also take time and therefore new results are not expected in an immediate future.
On the experimental side optimisations could be envisaged. As the coasting beam will built up slowly after injection, one could have a scenario in which the distance to the beam is varied

[3]Private communication

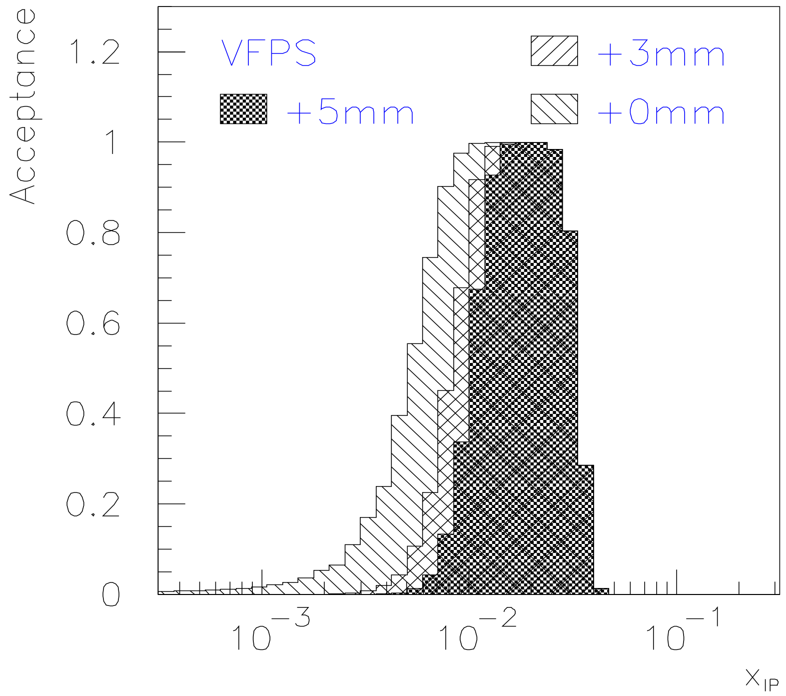

Figure 1: Roman pot acceptance for a 12 σ position,12 σ+3 mm 12 σ+5 mm position

during one lumi fill. This, though, would require an accurate knowledge of the VFPS positions in order not to spoil the proposed calibration method.

4 Conclusion

The present beam gas background estimates are very approximate by the absence of a proper normalisation of rates. However they tend to indicate that the VFPS will operate in similar conditions as the FPS.

The difficulties in estimating the coasting beam background are even bigger. It is clear that we want to run at a 12σ distance, and that a 3 mm extra offset largely cuts into the "VFPS physics". However reducing the coasting beam effect is of major importance not only to the VFPS program but also to other experiments. We therefore are confident that the DESY beam group will succeed in reducing the coasting beam phenomenon in the future running of HERA.