MEASUREMENTS OF TRANSVERSE TAILS IN PEP-II*

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Abstract

Transverse tails have been observed in both PEP-II rings. They are measured by scraping the beam with a (fixed) collimator and observing the lifetime of the beam for different distances between collimator and beam. Results from measurements in and out of collision are shown.

1 INTRODUCTION

Scraping measurements have already been used for many years as a tool to measure transverse tails [1]. The results can also be used to determine the transverse beam size, provided the beam is Gaussian to about six standard deviations [2].

Usually movable collimators are used to scrape the beam. Unfortunately in PEP-II there are no movable collimators available for these measurements. Therefore the fixed collimators are used. They consist of one jaw mounted permanently to a certain position in the beam pipe. The setting of the collimator is changed using a closed orbit bump.

This method has two disadvantages:

1. One can scan only from one side. It is therefore not possible to check the symmetry of the tails. Also the position of the center of the beam with respect to the collimator jaw is more difficult to obtain than in the case of a two-sided collimator which makes estimates of the emittance more complicated.

2. One can determine the change of the beam position with respect to the collimator only with some errors as the lattice and the beam position monitors are not perfect.

The lifetime is calculated from the measured beam currents. A fixed integration time (usually three or five seconds) is used. This gives good results for lifetimes which are shorter than the lifetimes with the collimator open and at least a few usable points with very short lifetimes before the beam is gone. For the lifetimes where the collimator is open, the results are somewhat noisy. Therefore the measurement is sometimes repeated with a longer integration time and fewer steps to get a clearer picture for the low level tails.

The beam is moved in steps and at each step the waiting time is longer than the integration time to be sure to get a clean measurement.

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2 HIGH ENERGY RING (HER)

The High Energy Ring of PEP-II is an electron storage ring operating at a beam energy of 9 GeV. In the arcs it uses a regular FODO-lattice [3].

Most single beam measurements show some kind of exponential tails in addition to the Gaussian core. Usually only a few points are available on the Gaussian part of the beam which makes it hard to get an accurate estimate of the emittance as one cannot do a double-sided scan. Figure 1 shows typical results for both planes. In some measurements a change of slope in the tails (”knee”) was observed.

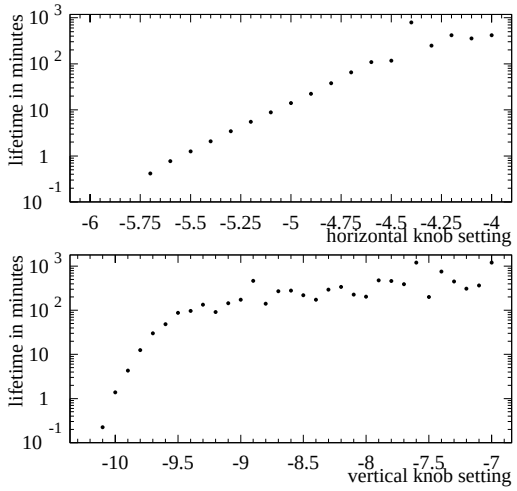

Figure 1: Results of vertical scraping measurements in the HER with single beams. The top plot shows the horizontal, the bottom plot the vertical plane. The knob setting is given in mm at the collimator. Moving in the negative direction on the knob brings the beam closer to the collimator.

The horizontal emittance in these scans usually gives results slightly larger than the design emittance, the vertical is about 50 % larger.

On one occasion measurements were done in collision. Only a small number of bunches was used and measurements were done once with high single bunch currents and once with low single bunch currents (same number of bunches) keeping the current ratio between the two beams approximately constant.

- In the horizontal plane no significant difference between single or colliding beams was observed. Also there was no difference between high and low bunch currents with colliding beams.

- In the vertical plane results are hard to interpret. One can either explain them by having significantly less tails at high current or by having slightly larger tails but a very different orbit. The results are shown in Fig. 2.

3 LOW ENERGY RING (LER)

The Low Energy Ring of PEP-II is a positron storage ring with a beam energy of 3.1 GeV. Like the HER, the arcs consist of regular FODO-cells [3].

When the first measurements reported here were done, the lifetime of the LER beam was still low due to high gas pressure. In those measurements no tails could be observed as the lifetime was about 20 minutes.

- In the horizontal plane emittances were obtained which were slightly larger than the expected emittance but within errors (and regarding the not yet well optimized lattice), the results made sense (at that time the synchrotron light monitor could only be used for qualitative measurements).

- In the vertical plane, what in the measurements looked like the Gaussian core of the beam turned out to correspond to emittances of the order of 80 nm, i.e. larger than the horizontal emittance which according to the synchrotron light monitors definitely could not be true.

  Measurements in September 1999 at 20 mA with a lifetime of 200 minutes only show something which looks like a Gaussian but in that case would correspond to an emittance of 280 nm in the vertical plane, i.e. even worse than before. The cause of that is not understood but it reproduced in several measurements at different dates, and it was independent of things like the setting of the skew quadrupole magnets which control the coupling. This might be caused by Touschek scattering. We have not yet simulated if this could indeed be the cause of the tails (the lifetime in LER is dominated by gas scattering but there might be a contribution from Touschek-scattering).

Some measurements were done with the beams in collision. As the collimators cannot stand large amounts of currents dumped into them in a short time, the measurements were done with 21 bunches per beam, once at low and once at high current. Due to lack of time unfortunately there were no measurements taken with a single beam on the same occasion.

Figure 3 shows the results in the horizontal plane. One can clearly see an enhancement of the tails with high bunch current. In the vertical plane the results are inconclusive.

4 CONCLUSION

4.1 HER

Transverse tails have been observed for single and colliding beams. At least in the vertical plane there is a contribution from the beam-beam interaction. The observed tails for single beam might be caused by scattering on residual gas.

4.2 LER

In the LER very significant tails have been observed. They are not understood but they might be caused by Touschek scattering. At least in the horizontal plane the tails are enhanced by the beam-beam interaction.

5 ACKNOWLEDGMENTS

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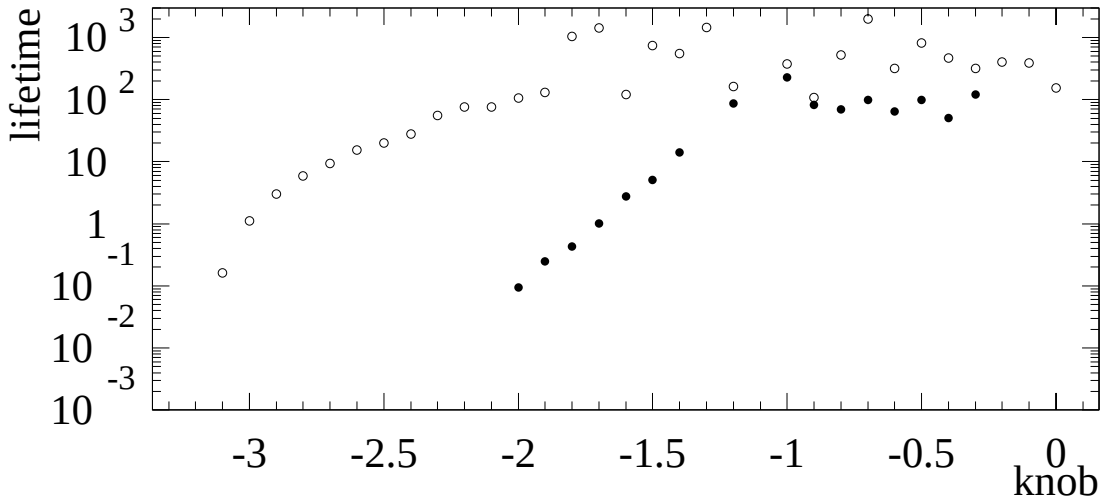

Figure 2: Results of vertical scraping measurements in the HER with colliding beams. Open circles are with high, bullets with low currents. The knob setting is given in mm at the collimator and the lifetime in minutes. Moving in the negative direction on the knob brings the beam closer to the collimator.

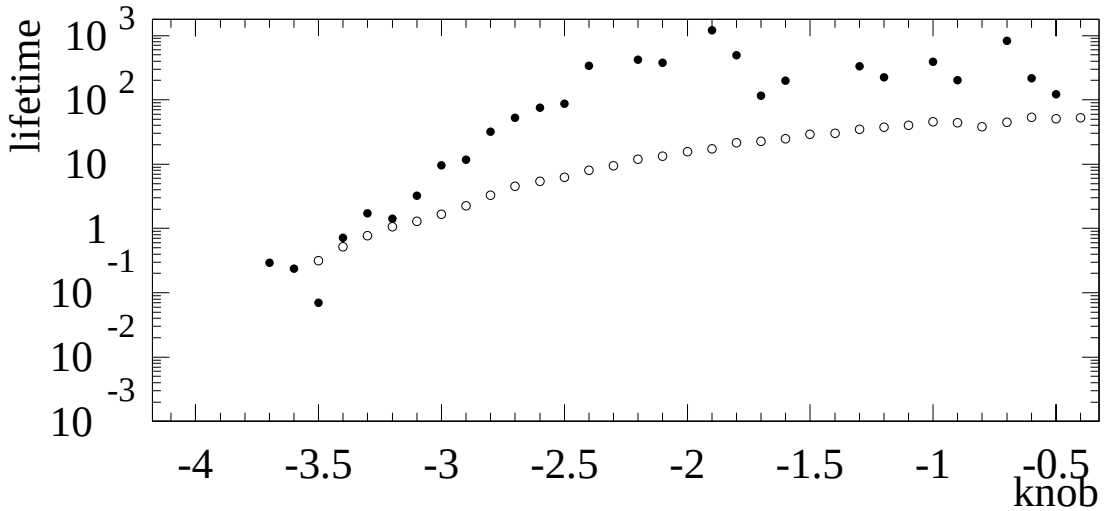

Figure 3: Results of horizontal scraping measurements in the LER with colliding beams. Open circles are with high, bullets with low currents. The knob setting is given in mm at the collimator and the lifetime in minutes. Moving in the negative direction on the knob brings the beam closer to the collimator.