Ion Optics of the High Energy Storage Ring for Operation With Heavy Ions*

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Introduction

In this report we show the latest improvements of the optical properties of the High Energy Storage Ring (HESR) for the operation with heavy ions.

Modified ion optics of the HESR

The ion optical lattice with γ_{tr} = 6.2 [1], which is the standard optics for the PANDA experiment, was taken as a starting point. This lattice has low-beta insertions in the PANDA straight section. Apart from their main function (strongly focus the beam in the interaction region) it drives the amplitude functions to high values around the interaction point. In the case of the SPARC experimental program such amplitudes are not needed. Thus, by varying the strengths of the quadrupoles in the zero-dispersion straight sections a more relaxed behaviour of the beta-functions could be achieved. More precisely, the maximum beta amplitudes (β_x, β_y) = (222 m, 172 m) were decreased to (172 m, 153 m), respectively (see Fig. 1, around $s = 510$ m). This results in a smaller beam size and in an enhanced acceptance for operation with ions. Consequently, the calculations showed an increased dynamic aperture. A working point for the new optics is currently at (7.63, 7.60).

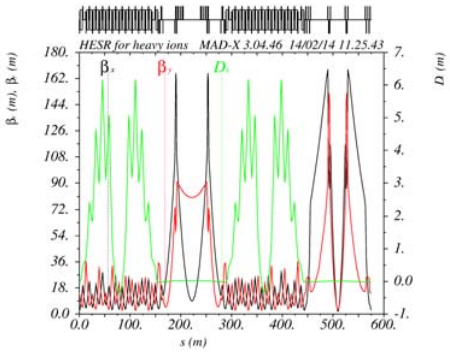

Figure 1: Optics for heavy ions

The beta function amplitudes at the waist of the beam at the PANDA target remained virtually unchanged. This means that the radius of the beam at the PANDA target location stays the same. An expected intensity of the heavy ions during the SPARC experiment is about 3 orders of magnitude less that the antiproton intensity in the PANDA experiment (10^8 vs. 10^{11}). Therefore, even for the bare uranium ions with charge 92+, the beam current for ions is roughly 10 times smaller than for antiprotons. Hence there are no harmful effects expected to the sensitive equipment of the PANDA detector due to intensive heavy ion beam and the SPARC experiments will not necessarily require the disassembling of the PANDA setup. Potential risks valid for both, the antiproton and ion, beams due to injection into the HESR still has to be studied.

Closed orbit bump at internal target location

In order to have the best possible beam-target overlap a feasibility of a closed orbit bump at the SPARC internal target location in the arc was investigated. With a present set of corrector magnets [2], only 3 correctors in the vicinity of the SPARC setup can be used for creating a bump. It allowed for varying the amplitude of the closed orbit at the given point. We proved that a $\pm$5 mm bump is possible (up to 8 mm if needed). In order to additionally vary the angle of the closed orbit, one extra corrector close to the SPARC target needs to be installed.

Closed orbit correction

A closed orbit correction was simulated. On the statistics of 500 seeds it was verified (see Fig. 2) that the maximum values of the closed orbit deviation are as high as 20 mm in a horizontal and 35 mm in a vertical planes. The closed orbit could be corrected down to 2 mm and 4 mm in the horizontal and the vertical planes, respectively.

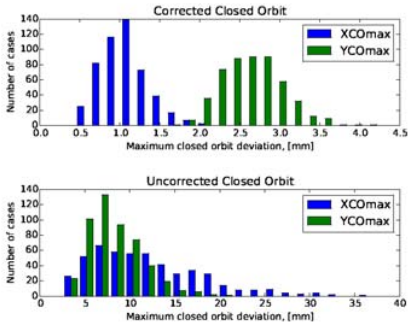

Figure 2: Both corrected (up) and uncorrected (bottom) in horizontal (blue) and vertical (green) planes

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References

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[2] B. Lorentz, Jülich, private communication

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