Preparation of an emittance transfer experiment in the UNILAC*

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Introduction

Flat hadron beams could facilitate the process of multi-turn injection into circular machines, which imposes different requirements on the horizontal and vertical emittance of the incoming beam. From first principles beams are created round without any coupling among planes. Their rms emittances as well as their eigen-emittances are equal in the two transverse planes. Thus, any transverse round-to-flat transformation requires a change of the beam eigen-emittances by a non-symplectic transformation. Such a transformation can be performed by placing a charge state stripper inside an axial magnetic field region as proposed in [1, 2]. Inside such a solenoid stripper, transverse inter-plane correlations are created non-symplectically. Afterwards they are removed symplectically by a decoupling section including skew quadrupoles.

Experimental Set-up

The new EMTEX (emittance transfer experiment) beam line for the demonstration of transverse emittance transfer is shown in Fig. 1.

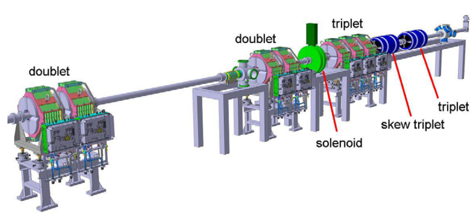

Figure 1: The layout of the EMTEX section at GSI.

The transverse emittance transfer beam line comprises two quadrupole doublets, a solenoid with stripper foil inside, a quadrupole triplet, a skew quadrupole triplet, another quadrupole triplet, a current transformer, and a transverse emittance measurement unit. Its total length is about 12.8 m.

Beam Dynamics Simulation

Fig. 2 illustrates the transverse emittance transfer. In the first step we assume that we turn off the power supplies of the solenoid and the skew quadrupole triplet. This process is an ordinary stripping process and the eigen-emittances are equal to the rms emittances at the exit of this section. Due to the stripping, growth of eigen-emittances and rms emittances is unavoidable. It is the reference scenario to which the emittance transfer scenario is to be compared. In the latter the solenoid field and the decoupling skew quads are turned on. The eigen-emittances diverge inside the solenoid but they are preserved afterwards. Along the decoupling skew quadrupole triplet the rms emittances are made equal to the diverged eigen-emittances. Compared to the reference scenario, the final horizontal rms emittance is reduced significantly by a factor two. The beam rms sizes along the total beam line are shown in Fig. 3 (solenoid and skew quads on).

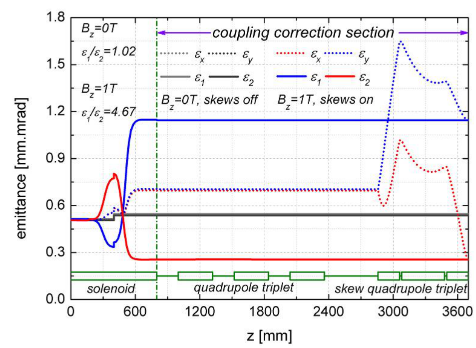

Figure 2: Evolution of rms emittances and eigen-emittances along the longitudinal magnetic field and the decoupling section for two scenarios: solenoid and skew quads off (reference, green and dark green lines); solenoid and skew quads on (emittance transfer), B_z=1.00 T.

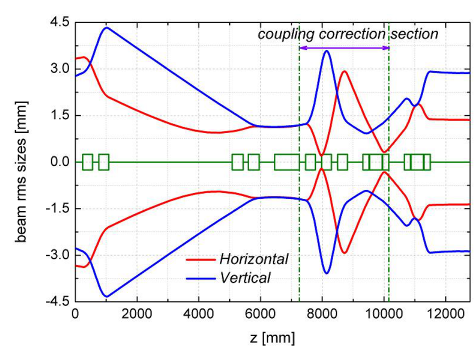

Figure 3: Horizontal and vertical beam rms sizes along the proposed transverse emittance transfer section.

References

[1] L. Groening, Phys. Rev. ST Accel. Beams **14**, 064201 (2011).
[2] C. Xiao et al, "JACoW, Preparation of an emittance transfer experiment", http://arxiv.org/abs/1212.2034.

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