Closed orbit correction in CRYRING

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To avoid acceptance limitations in the CRYRING [1], the close orbit (CO) distortions should not be larger than a few mm. During the multi-turn injection from the local ion source the intensity of the stored beam strongly depends on the ring acceptance and therefore it is important to control the CO. For slow extraction, large CO distortions can change the position and the orientation of the phase space separatrix limiting the extraction efficiency. In this report we describe the CO correction system and discuss the magnet alignment requirements based on ion-optical calculations.

In the present CRYRING layout seven horizontal and seven vertical beam position monitors installed in the sections YR02, YR06, YR07, YR08, YR10, YR11 and YR12 (see Fig. 1) will be used for CO measurements.

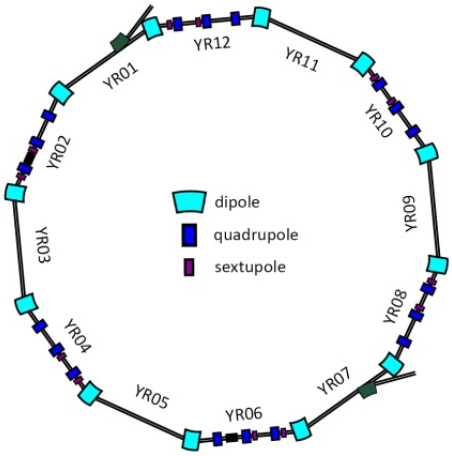

Figure 1: The CRYRING layout.

The CO correction will be provided by six pairs of horizontal and vertical correction magnets. Five pairs are installed in the magnetic sections YR02, YR04, YR08, YR10 and YR12 as described in [2]. In order to leave space for the extraction kicker magnet one horizontal corrector will be installed in section YR06, and a vertical corrector will be moved to section YR07. Additionally, all main dipole magnets have back-leg windings which can be used for corrections of the horizontal CO. According to calculations, a magnet alignment accuracy of 0.1 mm for displacement and 0.3 mrad for roll angle would result in a maximum peak-to-peak CO deviation of a few mm along the ring [3]. In this case, taking into account that the beam position monitors have an absolute measurement uncertainty of 1 mm it is not possible to further reduce the CO deviation. On the other hand, the required alignment accuracy can be slightly relaxed if the available correction magnets are used. Fig. 2 illustrates the calculated distribution of the peak-to-peak CO deviation for magnet displacement and roll accuracy of 0.3 mm and 0.3 mrad, respectively.

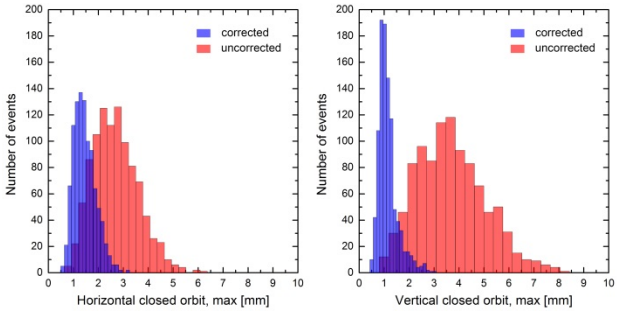

Figure 2: Calculated peak-to-peak deviation of the horizontal (left) and vertical (right) closed orbit.

For these MAD-X calculations 1000 random seeds of alignment errors have been used. The horizontal and vertical CO can be corrected to a RMS value of about 1.5 mm. Kick angles of at most 1.5 mrad, corresponding to a field strength of 0.01 T for a rigidity of 1.44 Tm, are required for correction. This is well within the maximum possible field strength of 0.03 T specified for the correction magnets. As an example, in Fig. 3 calculated CO before and after the correction is shown for several random sets of alignment errors.

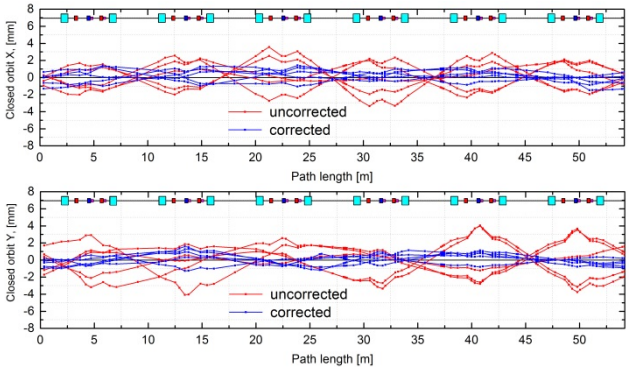

Figure 3: Calculated horizontal (upper) and vertical (lower) closed orbit.

References

[1] Lestinsky M et.al. CRYRING@ESR: A study group report, GSI, 2012.
[2] Danared H et.al. LSR Low-energy Storage Ring, Technical Design Report, MSL, 2011.
[3] Carle P et. al. Magnet alignment and survey in CRYRING, NIM A, v. 366, p.31, 1995

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