

Measurement of the Dispersion in the CeC Beamlines

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The coherent electron cooling [1] requires to match the relativistic factors of the hadron and electron beam within 10^{-4} accuracy [2]. Initial matching is based on the energy measurement of the electron beam using solenoid with accuracy about 10^{-3} (the hadron relativistic factor can be found from the revolution frequency). Further matching is done with observation of the recombination rate [3] with fine tuning based on the cooling rate. The last two steps require change of the electron energy which is achieved by change of the linac voltage.

The interaction of the hadron and electron beams is affected by the transverse overlap of two beams. To minimize the effect, we need zero dispersion in the common section. The merge of the beams a dogleg transfer line is used containing two dipoles and three quadrupoles. The zeroing of dispersion is performed by settings of the quadrupoles.

We have developed two ways to measure the dispersion. In the first mostly commonly used we change both dipoles by the same value creating the mismatch between the electron energy and bending magnet. In the compensated dogleg the position in the second dipole should not change, and the trajectory angle will change by the same amount as deflecting angle but in opposite direction. Therefore, the trajectory in the common section will not change. The value of the dispersion can be calculated from the beam displacement divided by the relative change of the dipoles' current.

The second method is based on the change of the electron beam energy using linac. This method requires electron orbit alignment with linac axis to avoid beam steering. The results are shown in Fig.1 and Fig. 2. The first figure shows the dispersion prior the correction, and the second figure after the correction.

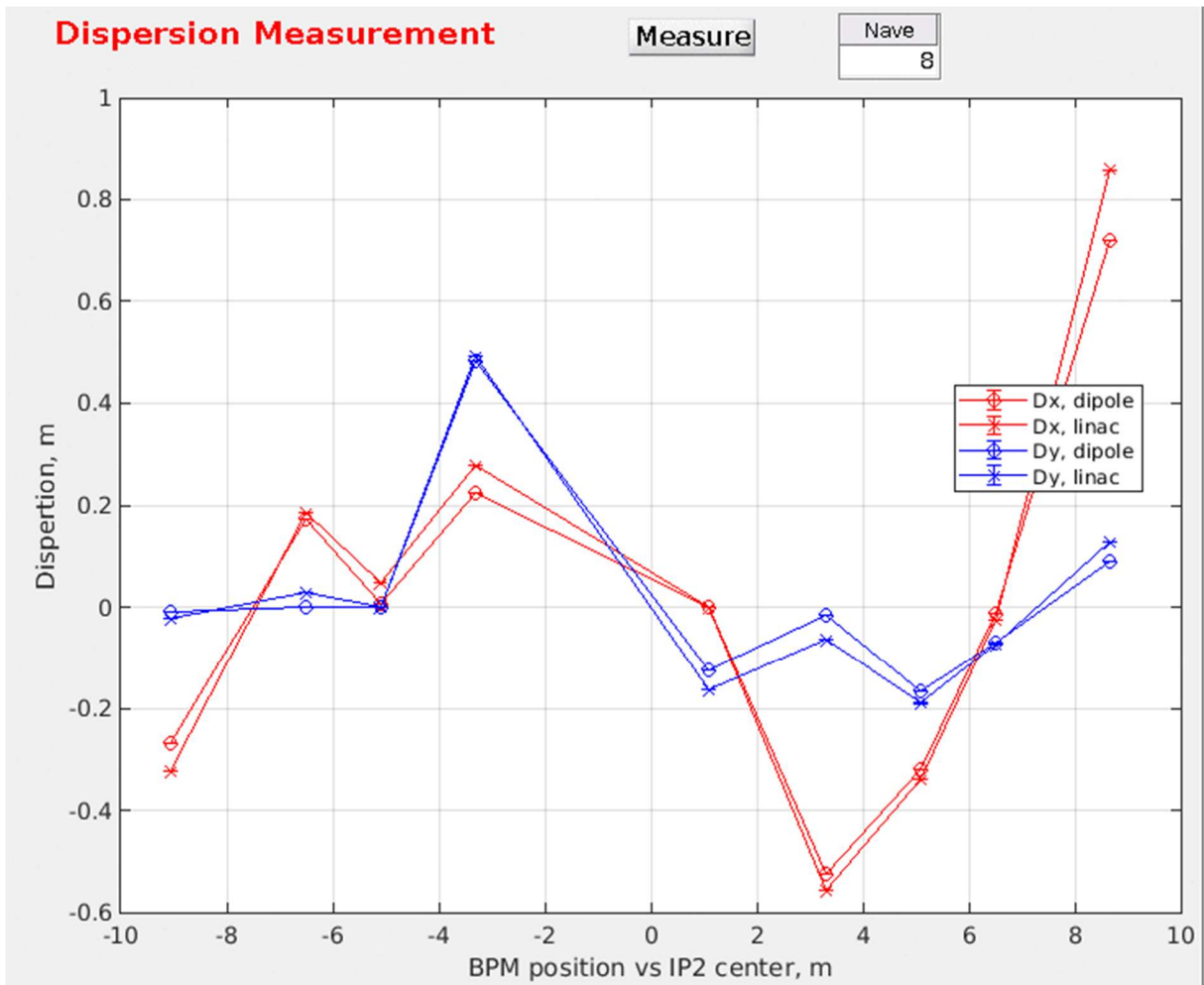


Figure 1: Dispersion measurement prior correction (March 17, 2022, 4:30AM). The left point at -9 meters corresponds to the dogleg BPM, the right point at 9 meters corresponds to the beam dump entrance. Both locations are expected to have non-zero dispersion. Non-zero vertical dispersion is caused by coupling created by the solenoids.

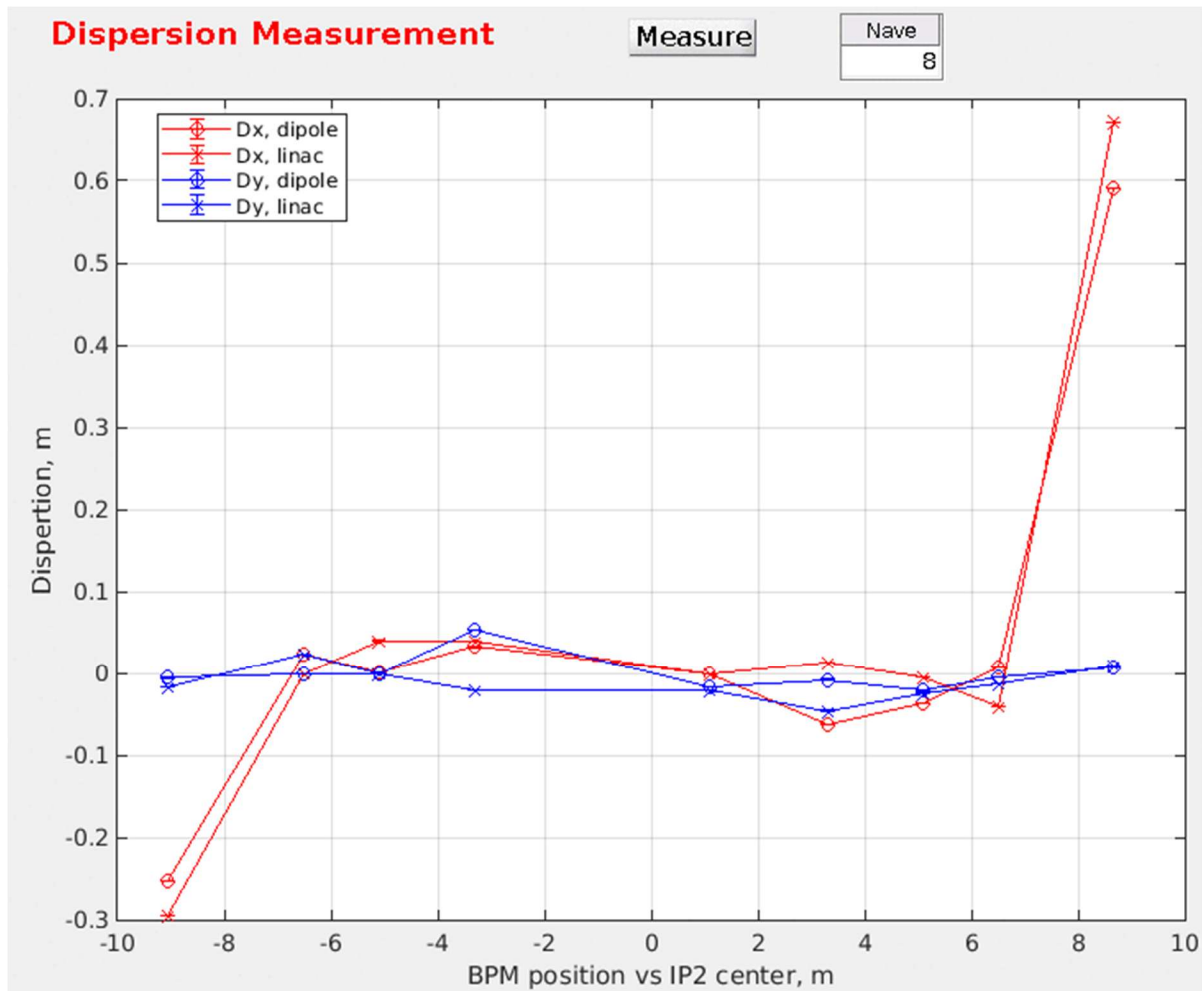


Figure 2: Dispersion measurement after the correction (March 17, 2022, 17:25 4:42AM). Now the dispersion value in the common section does not exceed 5 cm.

References

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