Beam-Based Measurements in Electron Microscopy

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Twiss (or Courant-Snyder) parameters are widely used for particle accelerators and beamlines. They describe beam sizes, emittance ellipse orientation, and deflection sensitivities at any point in the optical system. Their values are dependent on both optical system design and system tuning. Measurements of beam position as a function of beam deflection allows beam-based determination of Twiss parameters and system tuning.

Twiss parameters are not normally used in electron microscopy, but they apply as well to an electron microscope as to any other beamline. The extremely small spot size in an electron microscope simplifies calculations somewhat, similar to the interaction region of a colliding beam accelerator. Simple expressions can be derived to relate deflection sensitivity of the electron beam to the beam profile. This allows beam-based determination of the tuning of an electron microscope.

We will apply the Twiss formalism to electron microscopy and will present simple relations that result. We will show how this can be a useful, practical technique for system design and system tuning.