MOP046

# Measurement of Slice Emittance with Deflecting Cavity and Slit

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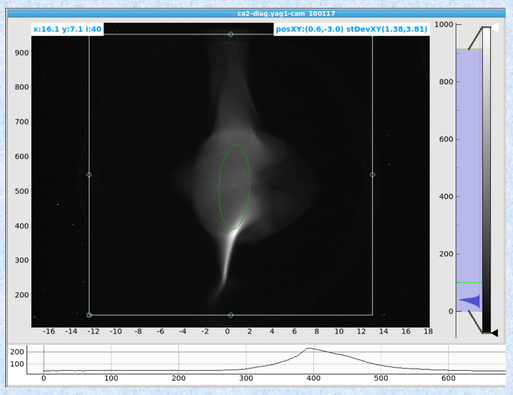
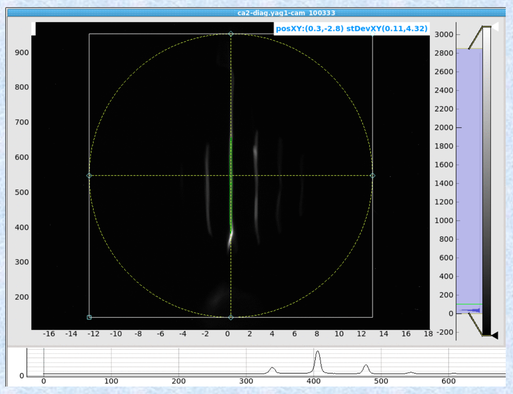
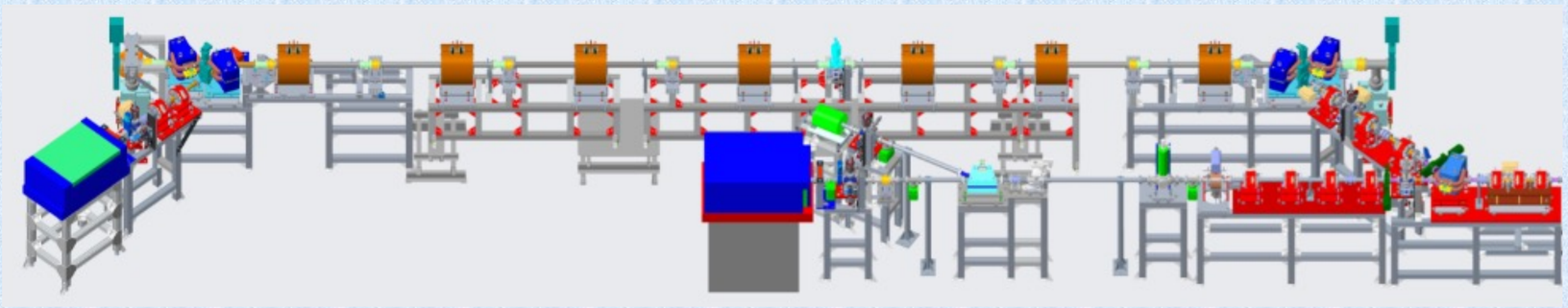
We describe the system for the of measurement slice emittance utilizing transverse deflecting cavity and slit. The image of the beam passing through the slit is used to measure slice intensity and uncorrelated angular divergence. Beam size at slit location is measured by scan of the beam across the slit with calibrated trim. The angular kick by the trim is taken into the account during calculations. Data processing and the experimental results are presented.

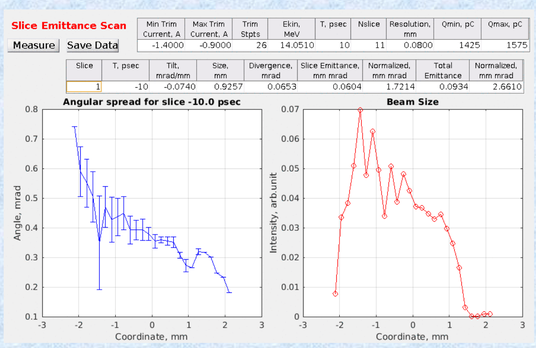


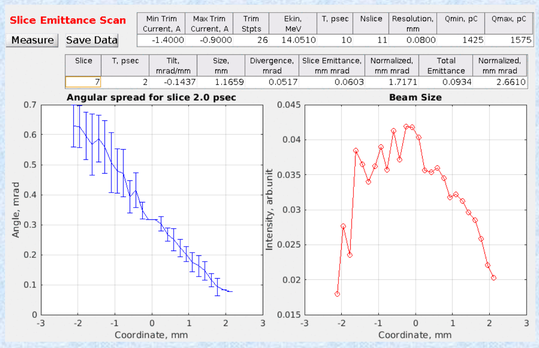



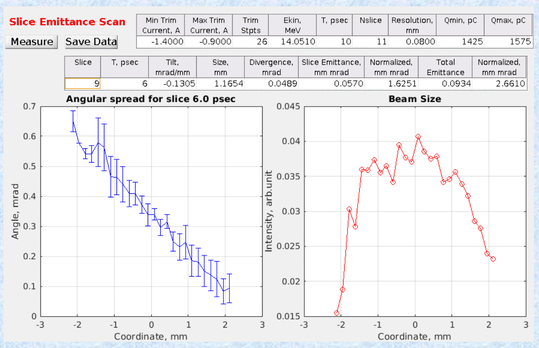



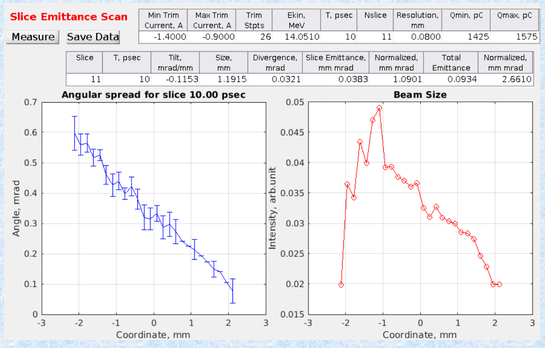
The beam is matched with four quadrupoles. The transverse deflecting cavity tuned to 1.3 MHz provides vertical streak of the beam. Beam can be observed with three profile monitors. The first profile monitor is placed before the 45-degree dipole and used for measurement of the longitudinal profile of the beam. This screen is also used for slice emittance measurement using quadrupole scan. Second profile monitor is placed before the high-power dump and is preceded by a vertical slit. This combination is used for slice emittance measurement described in this paper. The third profile monitor is placed after the 45-degree dipole and is used for measurement of the energy slew and slice energy spread.

The scan of the beam across the slit is performed with two calibrated horizontal trims. The first trim changes position of the beam on the slit and the second trim is restoring initial beam angle (it has the same kick of opposite sign) thus performing parallel scan of the beam over the slit.



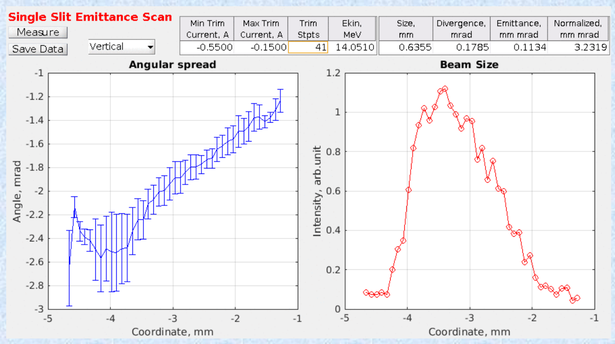




Beamlet intensity $w_i$ is estimated from the image brightness inside of the region of interest (ROI). The beamlet angle $\alpha_i$ is found from its center of gravity on the profile monitor and uncorrelated divergence $\sigma_{x\prime i}$ from the beamlet width. The measured beam size is corrected for the final resolution of the system defined by point spread function of the optical system and slit width.

The emittance of the whole bunch is calculated from the slices data. The weight of each slice is sum of the beamlet intensities. The position and angle of each slice is weighted average. Uncorrelated angular divergence is used from the slice data. The emittance of the whole beam is displayed upon completion of the last slice measurement .




Emittance measurement with slit scan gives close results

The slice emittance is calculated using conventional formula:

$$\varepsilon_{slice}^2 = \langle x^2 \rangle \langle x'^2 \rangle - \langle xx' \rangle^2$$

The displacement of the beam by trim is $\Delta_i$ and beamlet r.m.s. size is:

$$\langle x^2 \rangle = \sum \Delta_i^2 w_i \Big/ \sum w_i$$

Beam divergence is:

$$\langle x'^2 \rangle = \sum \left(\alpha_i^2 + \sigma_{x\prime i}^2\right) w_i \Big/ \sum w_i$$

The correlation term is found:

$$\langle xx' \rangle = \sum \Delta_i \alpha_i w_i \Big/ \sum w_i$$