INSTALLATION STATUS OF THE ELECTRON BEAM PROFILER
FOR THE FERMILAB MAIN INJECTOR*

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Abstract
The planned neutrino program at Fermilab requires large proton beam intensities in excess of 2 MW. Measuring the transverse profiles of these high intensity beams is challenging and often depends on non-invasive techniques. One such technique involves measuring the deflection of a probe beam of electrons with a trajectory perpendicular to the proton beam. A device such as this is already in use at the Spallation Neutron Source at ORNL and the installation of a similar device is underway in the Main Injector at Fermilab. The present installation status of the electron beam profiler for the Main Injector will be discussed together with some simulations and test stand results.

Theory

Experimental Techniques

Fast Scan
Electron beam scanned diagonally through single proton bunch. Requires fast deflector. For Main Injector, scan time must be < 1 ns.

Slow Scan
Deflection of a stationary electron beam as the proton bunch passes by. There is some deflection along the proton beam direction due to the magnetic field of the proton beam, but it is much smaller than the deflection transverse to the proton beam.

Simulations
Deflection plot of electron beam using slow scan method, and the derivative of it, showing agreement to better than 2%.

External Magnetic Fields
CST simulation of magnetic field from magnet busses along the line of the electron beam. The horizontal component is most important as the electron beam is vertical. The maximum horizontal field without shielding is 2 G (left). The majority of the field is removed with shielding.

Test Stand
Horizontal and vertical rms beam sizes at the first (blue) and second (red) crosses in the test stand. The measurements are from OTR taken at ~50 keV and 1 mA beam current onto the stainless steel mirrors.

Trace of the electron beam on the phosphor screen for a deflecting voltage of ~150 V. This image was taken with just a camera and objective lens.