

Determination of Beam Loss Sensitivity for 10kW FEL Upgrade

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Abstract

We have calculated the sensitivity of the accelerator beam transport system to beam loss. With these results we have determined prospective positions for Beam Loss Monitors (BLMs).

Introduction

The sensitivity of the transport system to beam loss from a deflection is proportional to the steering response of the beam (λ) and the beam size (α), and inversely proportional to the vacuum system aperture (ω). We may therefore define the "beam loss sensitivity" of the lattice as follows.

$$\text{Beam Loss Sensitivity} = \frac{\lambda\alpha}{\omega}$$

By (simulated) steering with any corrector magnet in the system, we can determine the beam loss sensitivity from a nearby deflection.

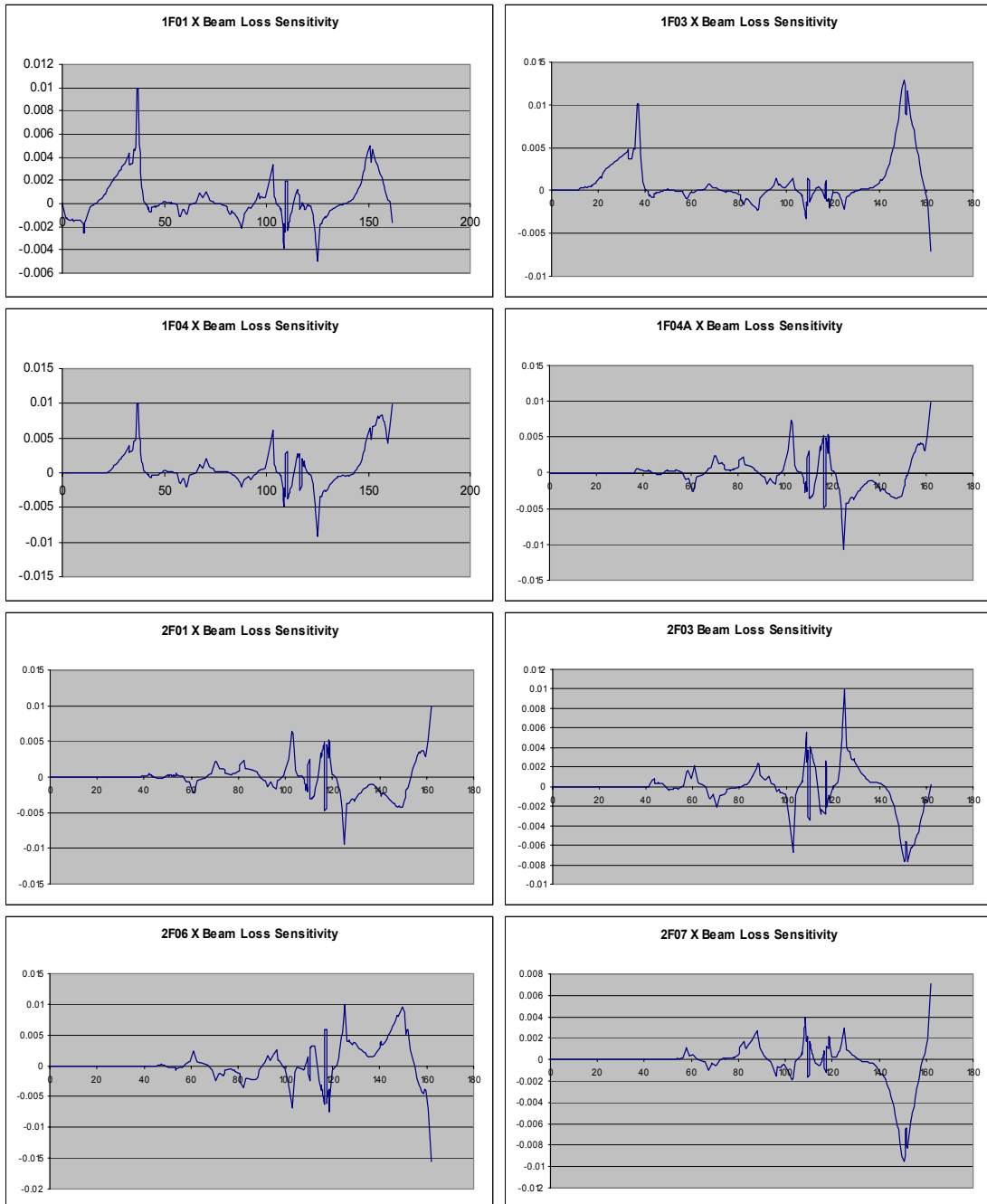
Compilation of all such results allows us to detect regions of the beam transport system that are locally sensitive to upstream steering errors. Regions with large sensitivity will be the most likely to experience beam loss, and thus are candidate locations for beam loss monitors (BLMs). By such appropriate positioning of beam loss monitors, even low levels of loss should be detectable.

Results for loss sensitivity and placement of BLMs

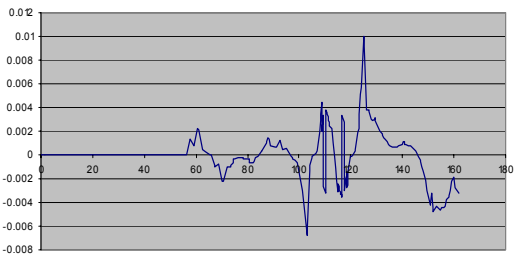
We have performed a simulation of beam loss using a spreadsheet-based model of the upgrade driver accelerator. This model computes beam envelopes and sizes, and will evaluate steering response to the excitation of any corrector magnet. By introducing a table of vacuum system apertures, we can also evaluate sensitivity to beam loss both horizontally and vertically for steering using any corrector (Figures 1 and 2 respectively). Steering by each corrector and collecting the results provide a summary of beam loss sensitivities. This is displayed in Figure 3, where we see that various areas are locally sensitive to loss. Superposed on figure 3 is the presently planned placement of BLMs.

Figures

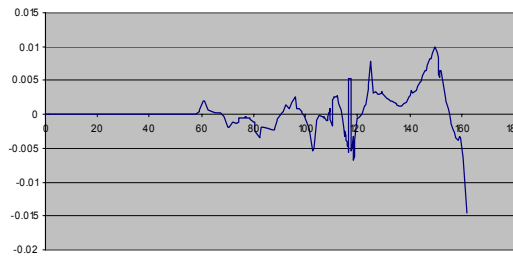
Figure 1. Below are graphs of various regions' sensitivity to beam loss in the horizontal direction.



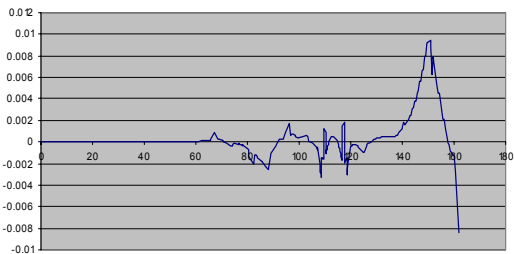
2F09 X Beam Loss Sensitivity



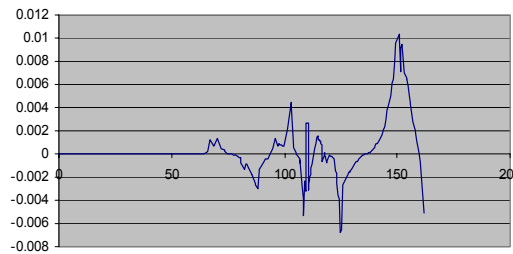
3F01 X Beam Loss Sensitivity



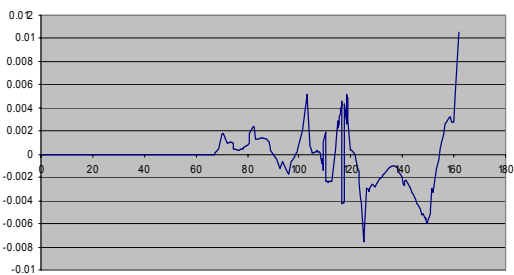
3F02 Beam Loss Sensitivity



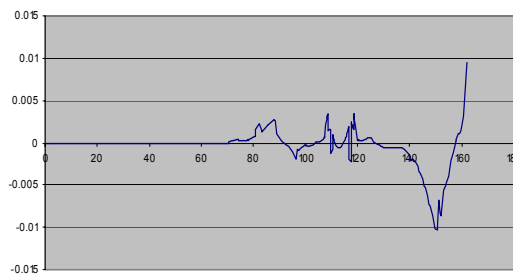
3F04 Beam Loss Sensitivity



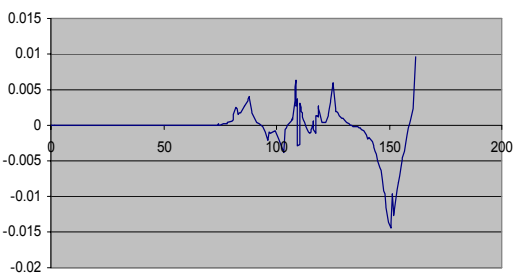
3F06 X Beam Loss Sensitivity



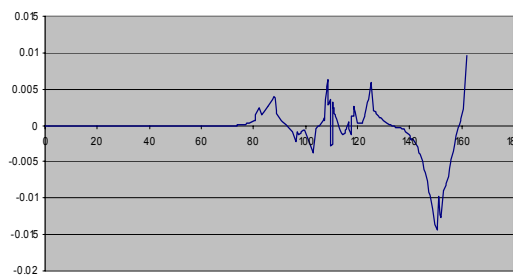
3F08 X Beam Loss Sensitivity



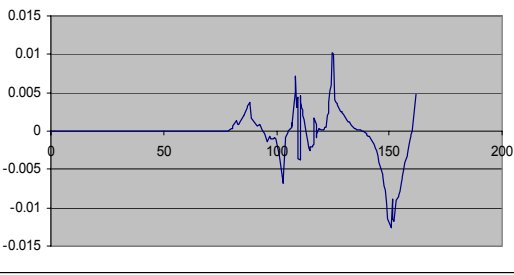
3F10 X Beam Loss Sensitivity



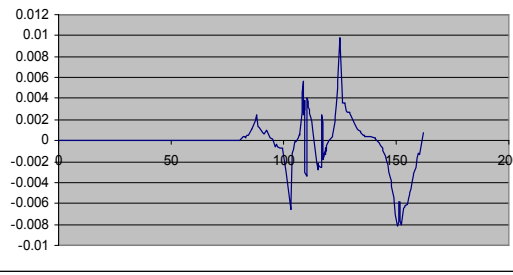
3F12 X Beam Loss Sensitivity



4F00 X Beam Loss Sensitivity



4F01 X Beam Loss Sensitivity



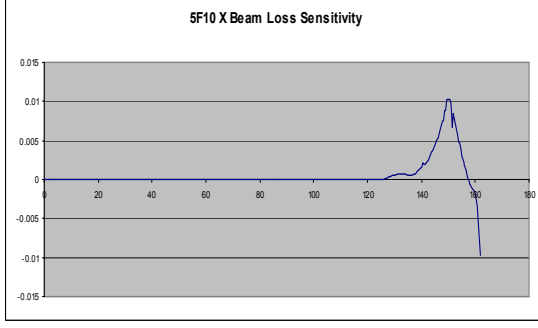
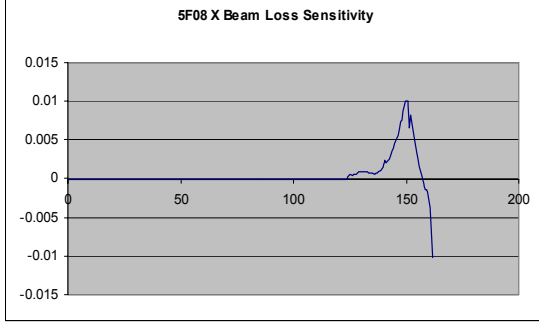
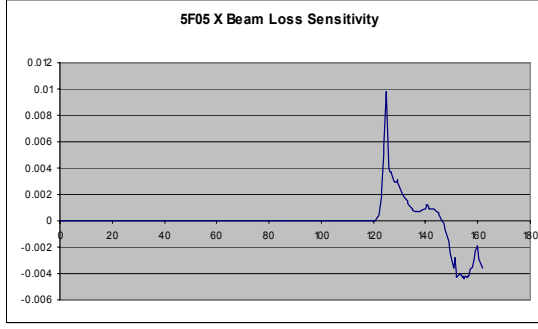
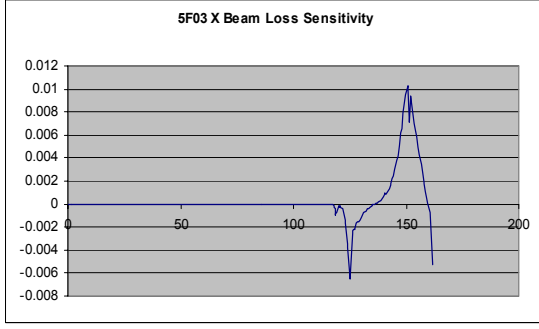
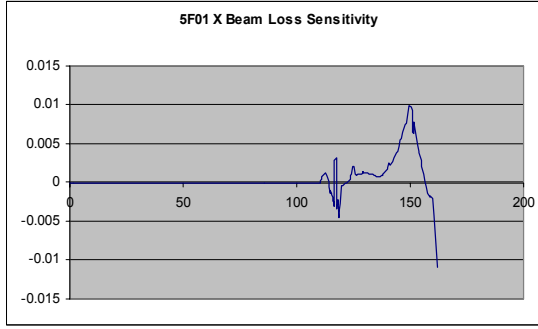
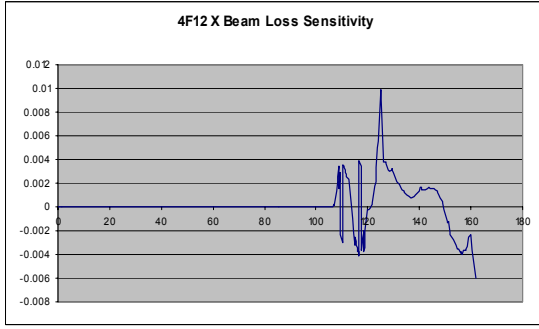
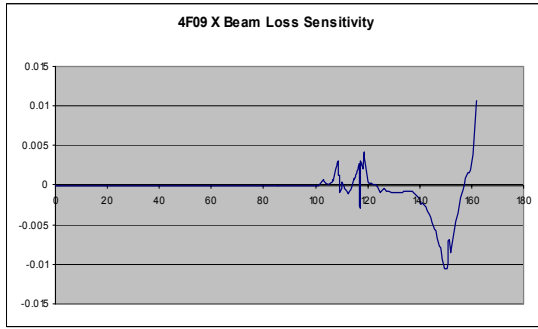
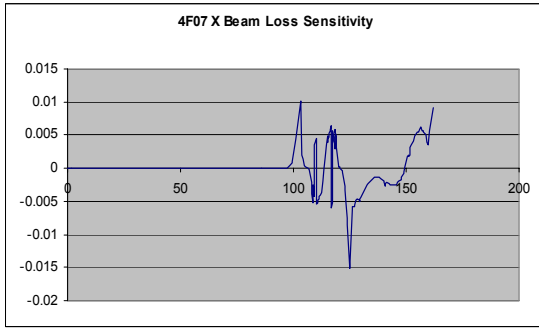
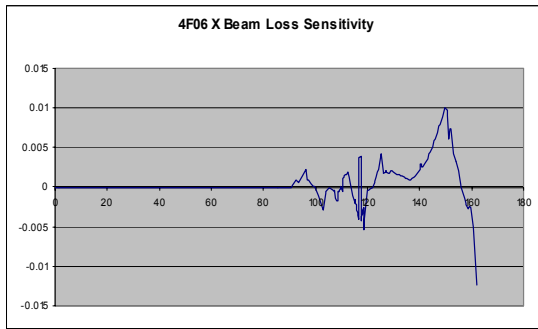
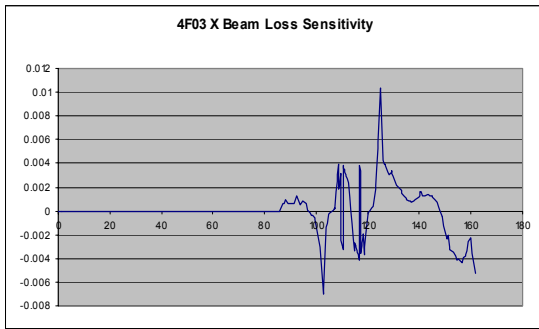
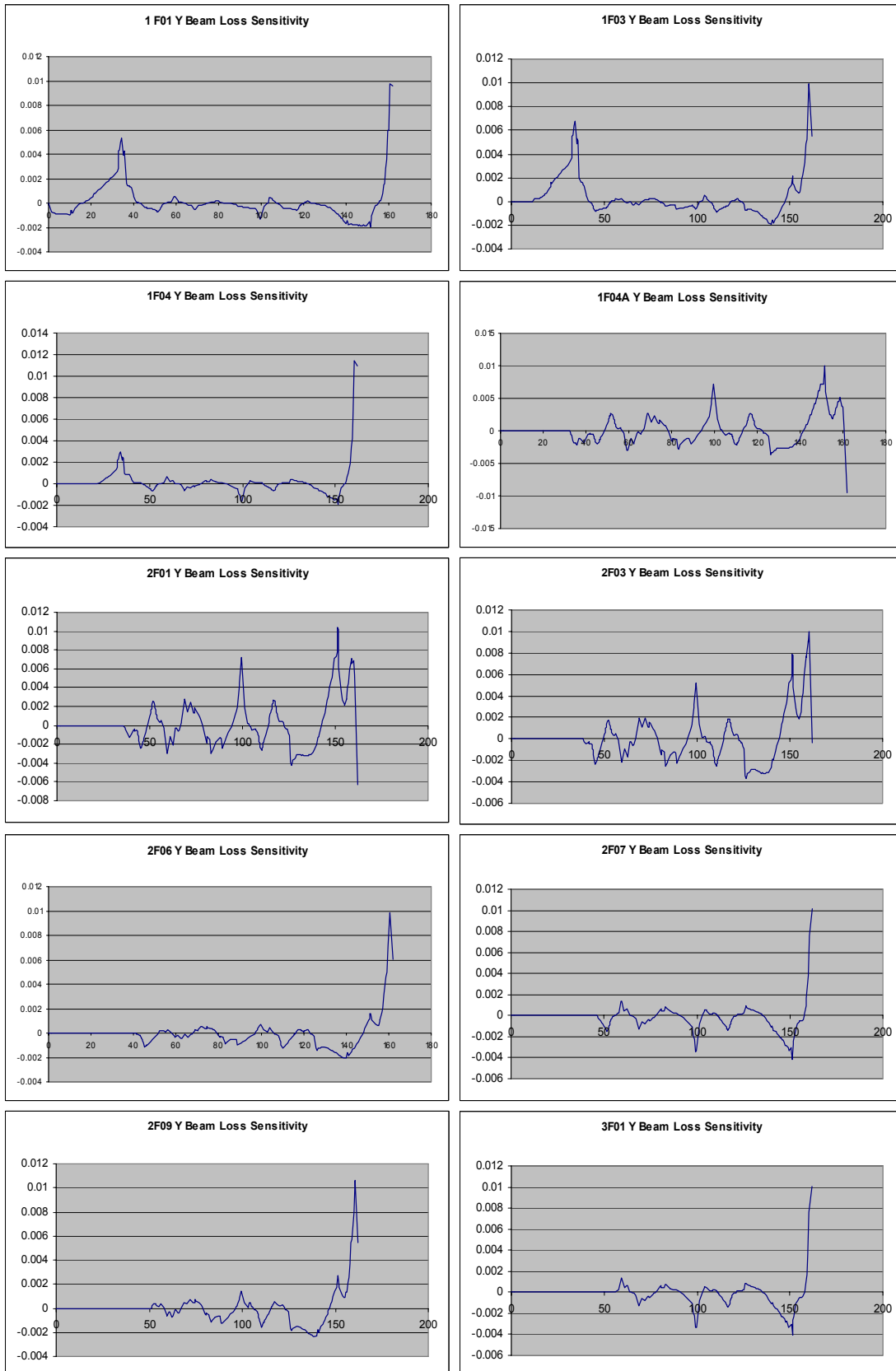
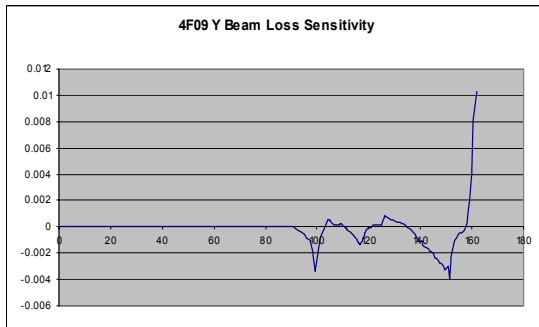
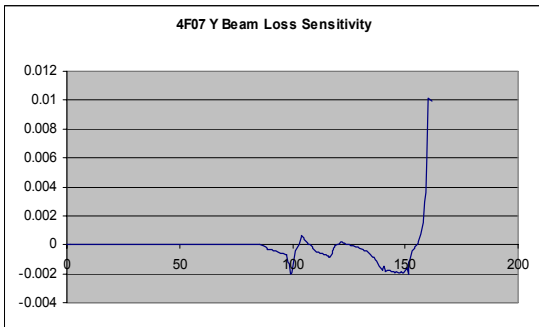
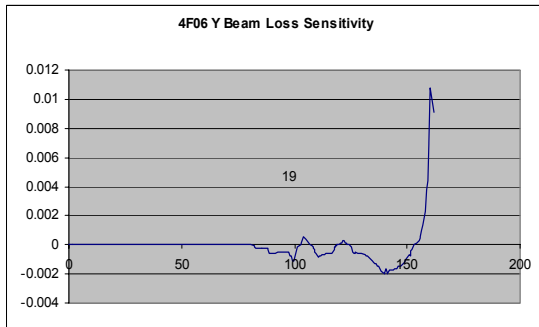
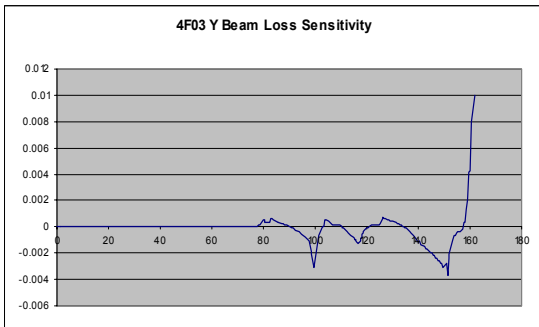
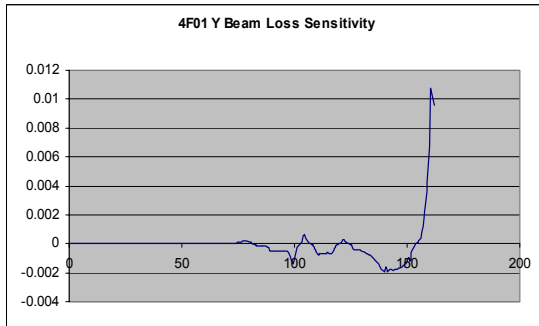
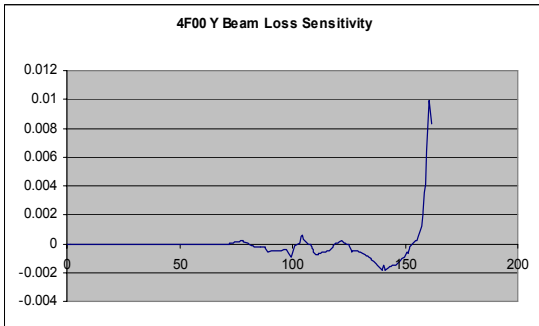
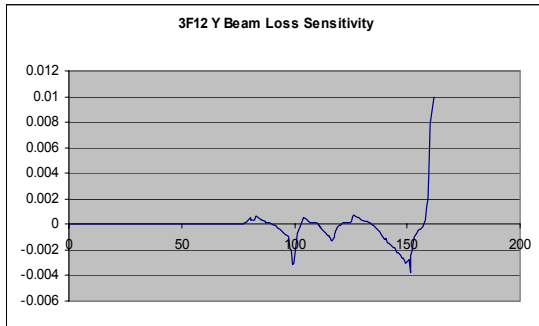
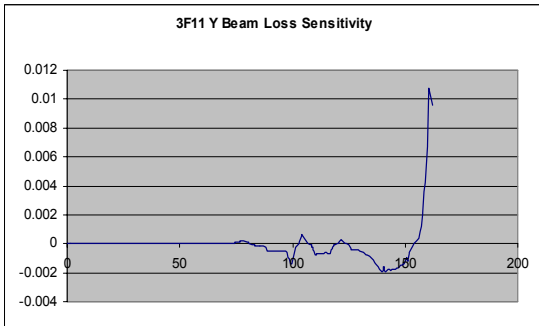
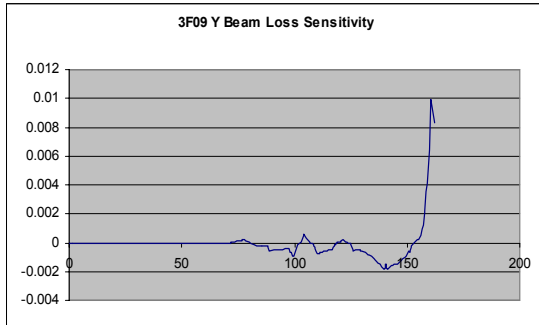
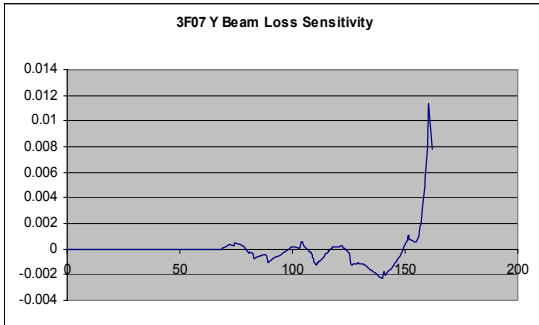
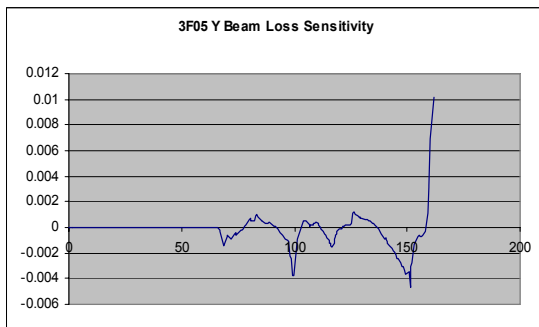
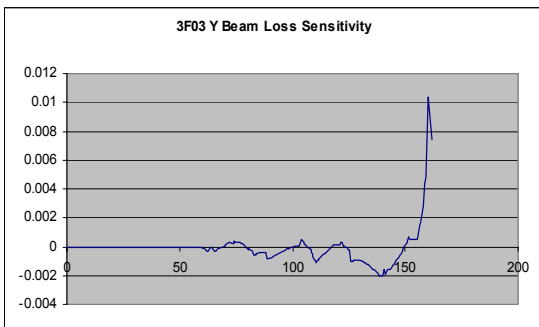
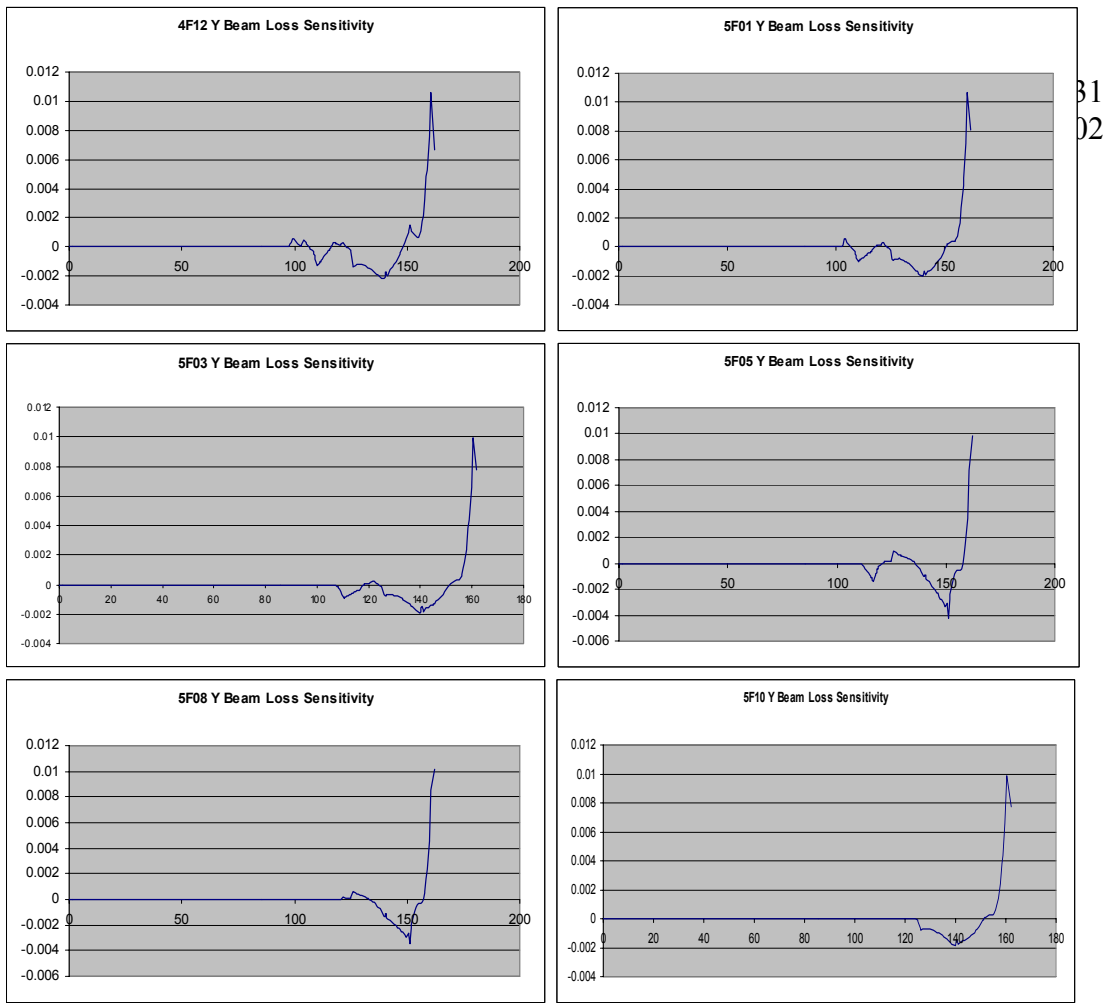


Figure 2. Below are graphs of various regions' sensitivity to beam loss in the horizontal direction.







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Figure 3. Summary of beam loss sensitivity with superimposed positions of BLMs.

