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AGS Complex Machine Studies **(AGS Studies Report No. 366)** **Title: Fe(6+) and Fe(10+) Booster Losses**	
Study Period:	15 October 1997, 27 October 1997
Participants:	M. Blaskiewicz, L. Ahrens
Reported by:	M. Blaskiewicz
Machine:	Booster
Beam:	Fe (6+), Fe(10+)
Tools:	Current, Transformers, Labview
Aim:	Check for intensity dependent losses

Fe(10+) and Fe(6+) Booster Losses

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Lifetime studies of Fe(10+) and Fe(6+) beams in the AGS Booster are presented. The Fe(6+) data show some increase in loss rate with initial intensity, but the effect is subtle compared with the the effect seen with Au(15+) beams. The scatter in the Fe(10+) data is large, but there appears to be a tendency for loss rate to increase with intensity.

Fe(6+) Data

Data with Fe(6+) beams were taken on 27 Oct 1997. Booster injection was left alone and the magnetic field after injection was modified to create porches at 2kG, 2.5kG, 3kG, and 4kG. Digitized current transformer data were averaged over $\sim$ 10 cycles and written to disk. Main magnet current was also recorded. The amount of injected beam was varied by inserting harps in the TTB line.

Offline, the log of the current as a function of time on the magnetic porch was fitted to a line using linear least squares. The injected intensity was found from the current transformer reading just after injection time.

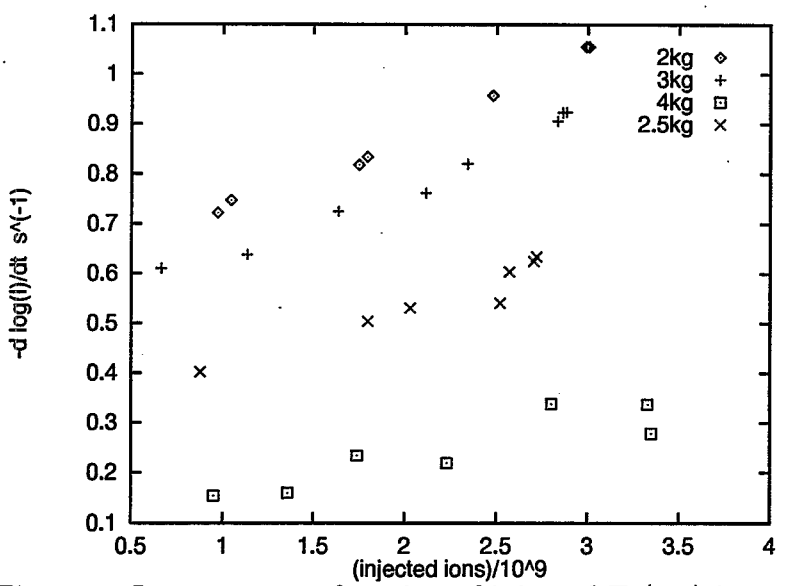

Figure 1. Loss rate as a function of injected Fe(6+) intensity.

As is clear from Figure 1, the loss rate increases with the number of ions injected. Note that the loss rates for a 2.5kG field are less than those for 2kG and 3kG. This may be due to the fact that a there was a large loss during acceleration to the 2.5kG porch. The 2.5kG data are included for completeness, I doubt there are strong variations in cross sections etcetera between 2 and 3 kG. As a rule the loss rates were fairly small, given that the porches were about 1 second long. In comparison, for 2×10^9 Au(15+) ions the loss rate was $\sim 2\text{s}^{-1}$.

Fe(10+) Data

The Fe(10+) data were taken on 15 Oct 1997 in the same way as the Fe(6+) data. In addition to the TTB harps, a window frame aperture in section 28 of the TTB was used to control the injected beam. A summary of the data for the 1.65kG porch is shown in Figure 2. These data were taken in two blocks separated by about an hour. The discrepancy between the two blocks is clear with the first block generally having better survival than the second. The only exception to this rule involves data taken during the second block with the window frame aperture inserted, which are just as clean as the data taken during the first block. The difference between the first and second blocks suggests that TTB was tuned in the interim, which was probably the case since the peak intensity in the first block of data is significantly smaller that the peak intensity in the second block. If the crosses and the union of the diamonds and squares are viewed as independent data sets then a clear increase in loss rate with intensity is apparent. As is clear fomr Figure 3, the window frame reduces the loss rate by $\sim 30\%$ without significantly reducing the number of injected ions.

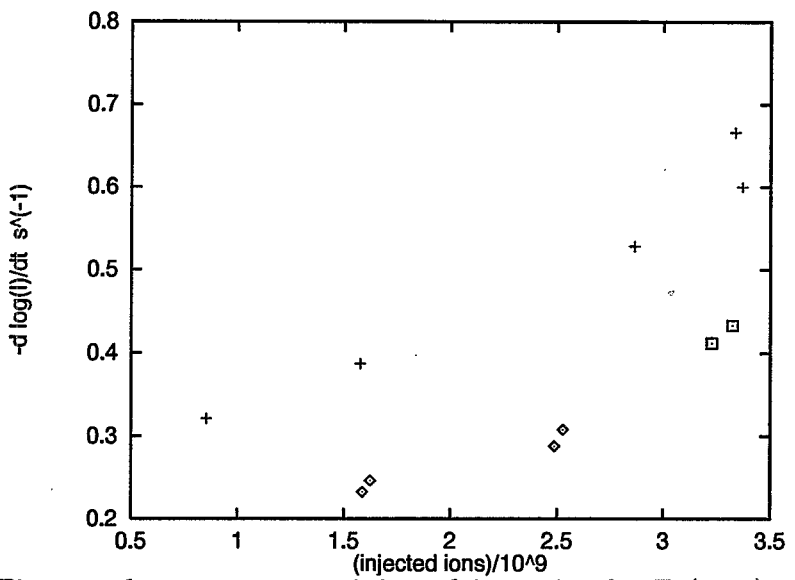

Figure 2 loss rate versus injected intensity for Fe(10+) with a 1.65kG porch. The diamonds correspond to the first block of data taken. The crosses correspond to the second block of data taken with the window frame retracted. The squares correspond to the second block of data taken with the window frame inserted.

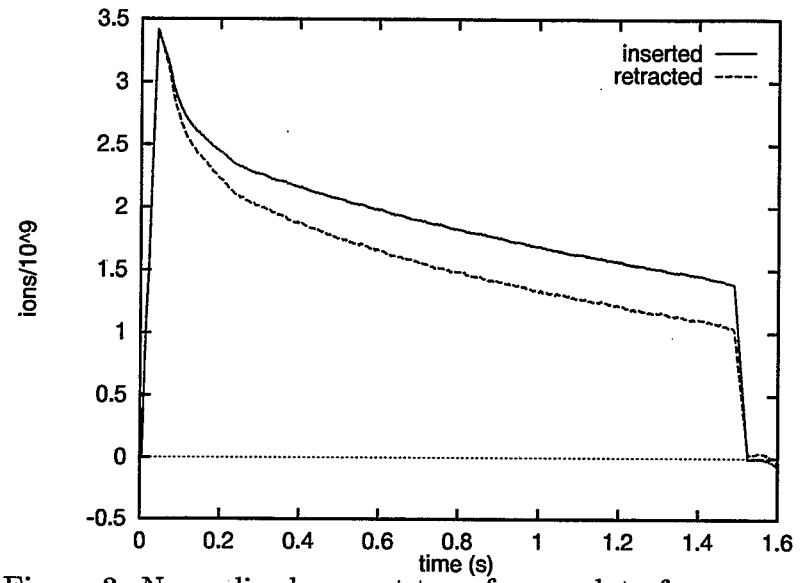

Figure 3. Normalized current transformer data for a magnetic porch at 1.65kG with the TTB window frame aperture inserted and retracted

Loss rates versus injected intensity for Fe(10+) with a 2kG porch are shown in Figure 4. The two data points with initial intensities near 3×10^9 and loss rates below 3.5s^{-1} were obtained when the window frame aperture in the TTB line was inserted. When these points are neglected the data show a clear tendency for loss rate to increase with intensity.

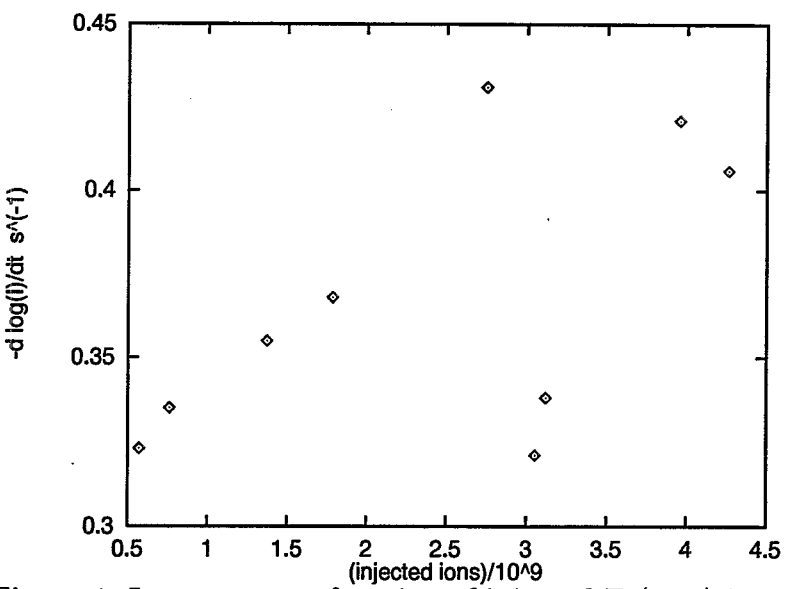

Figure 4. Loss rate as a function of injected Fe(10+) intensity with a 2kG porch.

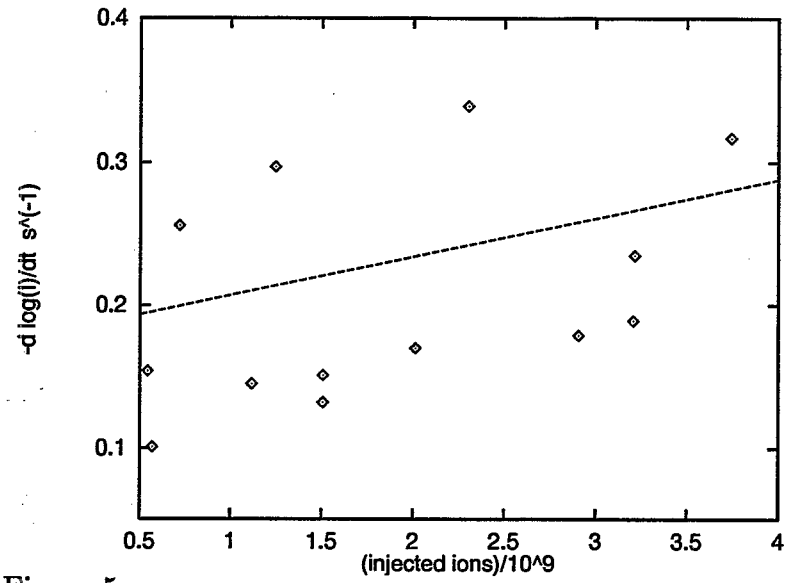

Figure 5.

Loss rate versus Fe(10+) intensity at the start of the 2.5kG porch is shown in Figure 5. Data above the line were obtained using the normalized current transformer, data below the line were obtained using the unnormalized current transformer. The data using the normalized transformer were taken first and the unnormalized traces were taken a few hours later. There is a chance that other machine settings such as tune and TTB steering were different between the two data sets.

Conclusions

The Fe(6+) data show clear increases in loss rate with intensity. Both normalized and unnormalized current transformers were used and there appears to be no difference in the loss rates obtained using the two instruments. Additionally, the data were taken in consecutive blocks, reducing the likelyhood of machine changes for a given porch. The ordering was 3kG, 2kG, 4kG, 2.5kG. Note that the 4kG and 2.5kG loss rates were smaller than those obtained at 3kG and 2kG. Figures 2 and 4 should also be kept in mind. Given the clear dependence of loss rate on the injected beam size (the TTB windowframe) the model used to explain the intensity dependence of losses in Au(15+) (Blaskiewicz et al PAC97)probably does not apply. It is possible that the change in loss rate observed with iron has nothing to do with residual gas.