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SEB Extraction Efficiency for Au+77 and Au+79

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Reported by K.Brown

Subject SEB Extraction Efficiency for Au^{+77} and Au^{+79}

Introduction

The extraction efficiency was measured using the standard method [1]. This method assumes beam losses during extraction have a fixed geometry and can be measured. If the geometry changes or there is beam lost which cannot be measured then the results will not be accurate. The results of this measurement suggest an extraction efficiency of approximately 50 %. Various extraction setups have been attempted, yielding at best an efficiency of 55 %, given the calibration from this study.

On 30 September, a study was done in which Au^{+79} was accelerated and extracted. The extraction efficiency of 55 % was achieved in this study.

Data

Data was collected using the PDP10 program IAGP. Two beam loss conditions were studied. In one set of data the thickness of the F5 septum was kept constant (both ends of the septum were moved together). In the second set the thickness of the septum was varied (only the upstream end was moved). Data was saved in the files F5EFF.G93, F5EF2.G93, and F5EF3.G93 for Au^{+77} data taken 9/15, in files F5HIP.993, FDHIP.993, FUHIP.993, F1HIP.993, and F2HIP.993 for Au^{+79} data taken 9/30, and in F5109.HIP, F4109.HIP, and FU109.HIP for Au^{+77} data taken 10/3. For Au^{+79} data was also taken for different momentum spreads.

Analysis

For all figures the data presented is averaged for each F5 position. Error bars are given only for standard deviations for these averages.

Results

Results are shown in figures 1 - 12.

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Figure 1: Both F5US and F5DS were moved together in equal increments to provide a `constant' thickness septum. The Gold 79 beam required a different skew of the F5 than the Gold 77 beam, all other parameters the same. For this data the skew of F5 had not been optimized for the Gold 79, but was in the Gold 77 skew setting.

Figure 2: Only the F5US position was changed, making a variable thickness septum. The positions of the F5 for the Gold 79 beam were set roughly to minimize losses.

Figure 3: The scan done on 10/3 was done under unusually stable conditions. The positions of F5 and F10 had been adjusted to minimize losses on F5 and F10. This data shows both the constant thickness septum and the variable thickness septum data.

Figure 4: F5 Loss is plotted versus the difference between the F5DS and US positions (e.g., F5 loss vs skew of F5).

Figure 5: F5 Loss for data taken on 10/3 plotted versus the difference between the F5DS and US positions.

Figure 6: With the F5 loss normalized on the minimum measured loss, the data for gold 79 for normal running is compared to data from the 1992 silicon run and gold 79 data with no debunching on. The lines shown are 3rd order polynomial fittings of the data.

Figure 7: F5 loss normalized on the minimum measured loss vs F5 skew. The gold 77 data is shown with the gold 79 data. The gold 79 data is fitted with a 3rd order polynomial. The gold 77 data is fitted with a 10 node spline.

Figure 8: F5 loss normalized on the minimum measured loss vs F5 skew. The proton data is shown with the silicon 1992 data. The silicon data is fitted with a 3rd order polynomial. The proton data is fitted with a 10 node spline.

Figure 9: Inefficiency is plotted vs Efficiency. For Gold 77 the best efficiency achieved is 51 %. For Gold 79 the best efficiency achieved is 55 %. The inefficiency for Gold 79 is much greater than for Gold 77 since the signal is smaller (lower intensity); the integrator offset has become significant for the Gold 79.

Figure 10: Inefficiency for data taken on 10/3 plotted versus the Efficiency. The best efficiency appears to now be approx. 48 %.

Figure 11: F5 Loss is plotted vs Efficiency. For Gold 77 the best F5 loss is 10 %. For Gold 79 the best F5 loss is 34 %. Again, the integrator offset is significant for the Gold 79. The real F5 loss can only be said to be between 10 and 30 %.

Figure 12: F5 and F10 Losses for data taken on 10/3 plotted versus the Efficiency. It isn't obvious that for the linear region of the F5 loss curve, that both skew and translation data should have the same slopes.

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Conclusions

There is obviously something unusual occurring for SEB with gold beams. It is not obvious whether or not the problem is a stripping process occurring during extraction since both Gold 77 and Gold 79 exhibit similar behavior. The correlation between F5 loss and F5 position suggests the effective thickness of the F5 septum relative to the beam is very large. It is not thought that this increase in effective thickness is due to a larger divergence in the beam since the beam sizes at F5 and F10 appear normal. This increase in thickness is particularly evident in figure 12, in which the losses on F5 are seen not to be sensitive to the DS position. The silicon and proton data show how the thickness of these curves (figures 6-8) has appeared in the past. Inefficiency versus Efficiency figures show this correlation remains very linear over a very large range of losses. This suggests the geometry of losses is not changing under this particular loss condition (of moving F5 position in various ways). It also suggests that this is still a good method of determining relative calibrations between the circulating current transformer and the external ionization chamber.

References

1. AGS/AD/Tech. Note No. 334; An Overview of the Slow Extraction at the AGS, M. Tanaka, 21 December 1989.

2. Exploitation of Nonlinear Growth of Betatron Oscillations to Obtain Efficient Slow Extraction from the AGS, H. Weisberg and J.W. Glenn; Nuclear Instruments and Methods 169 (1980) 319 -326.

FIGURE 1: F5 LOSS VS F5US POSITION

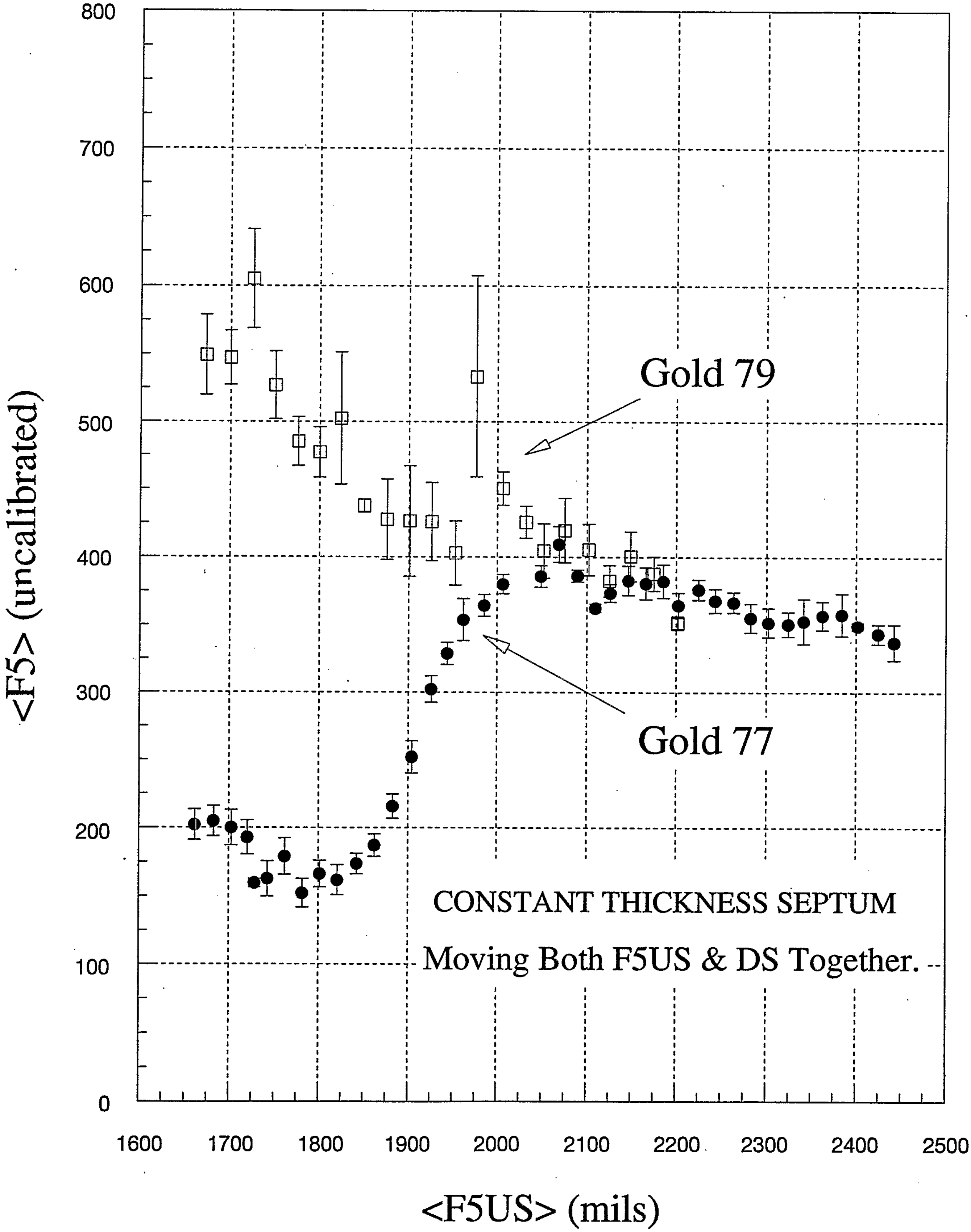

Figure 2: F5 Loss vs F5US Position

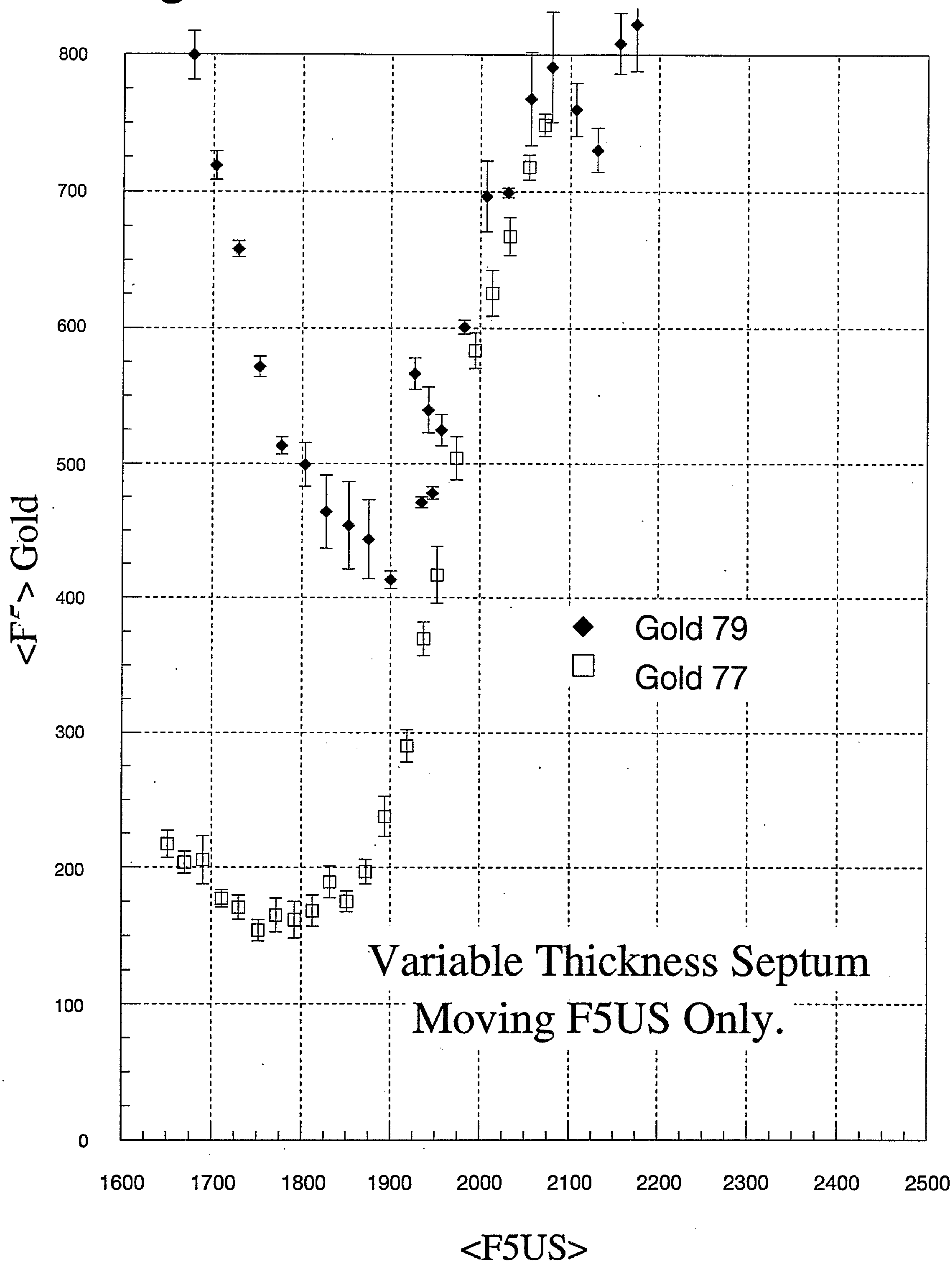

Figure 3: F5 Loss vs F5US Position

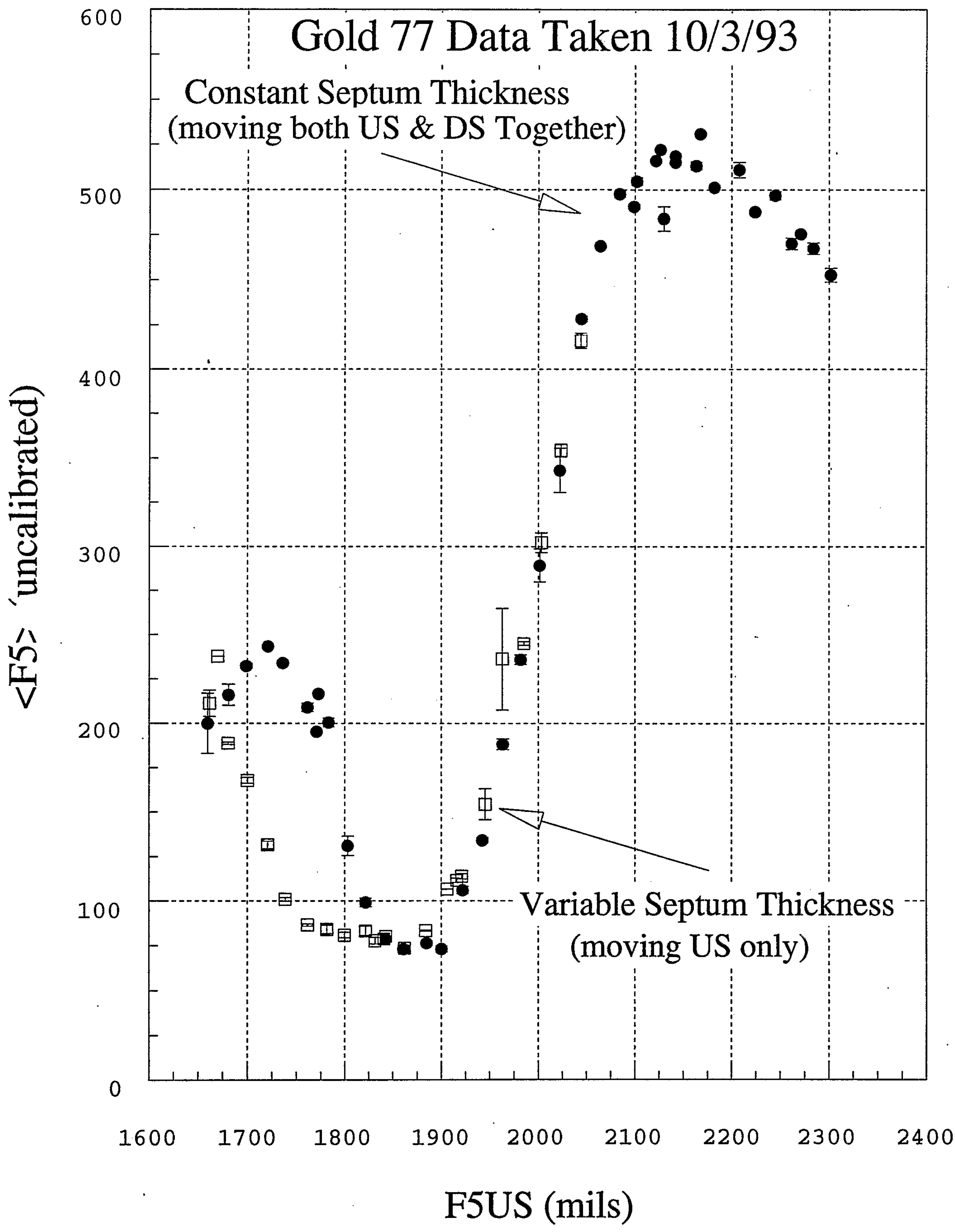

FIGURE 4: F5 LOSS VS F5 SKEW

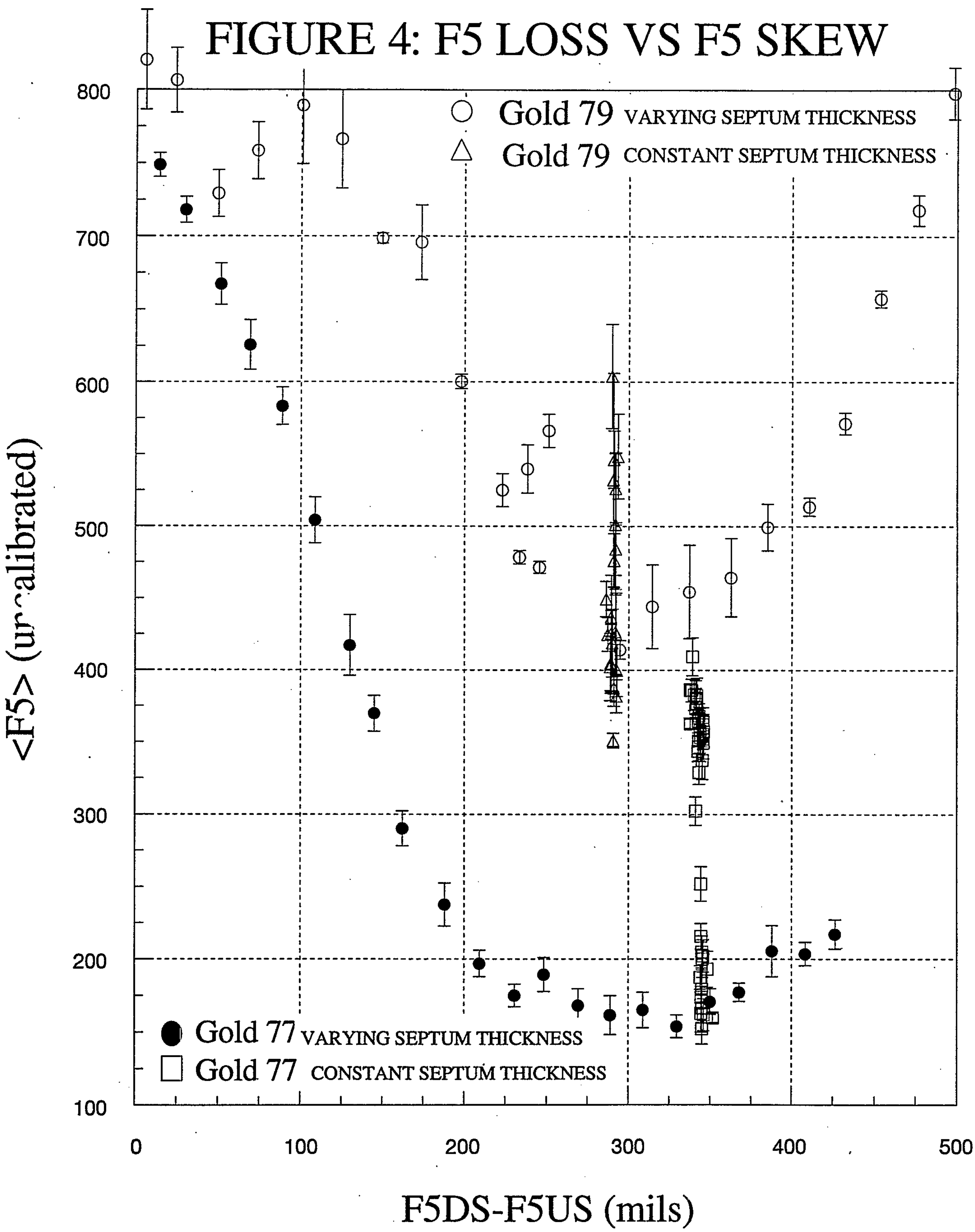

Figure 5: F5 Loss vs F5 SKEW

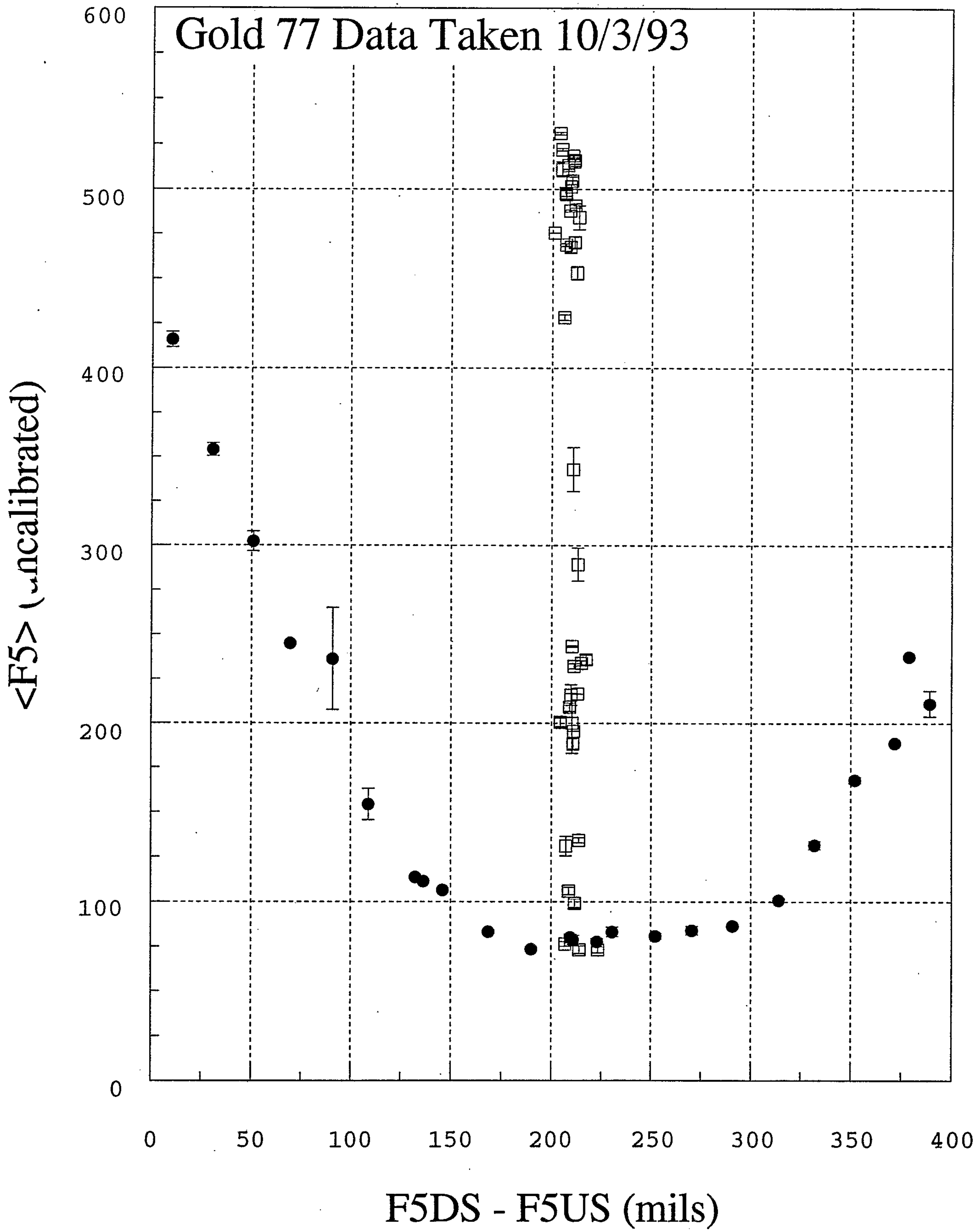

Figure 6: F5 Loss Normalized on Minimum Loss vs F5 Skew

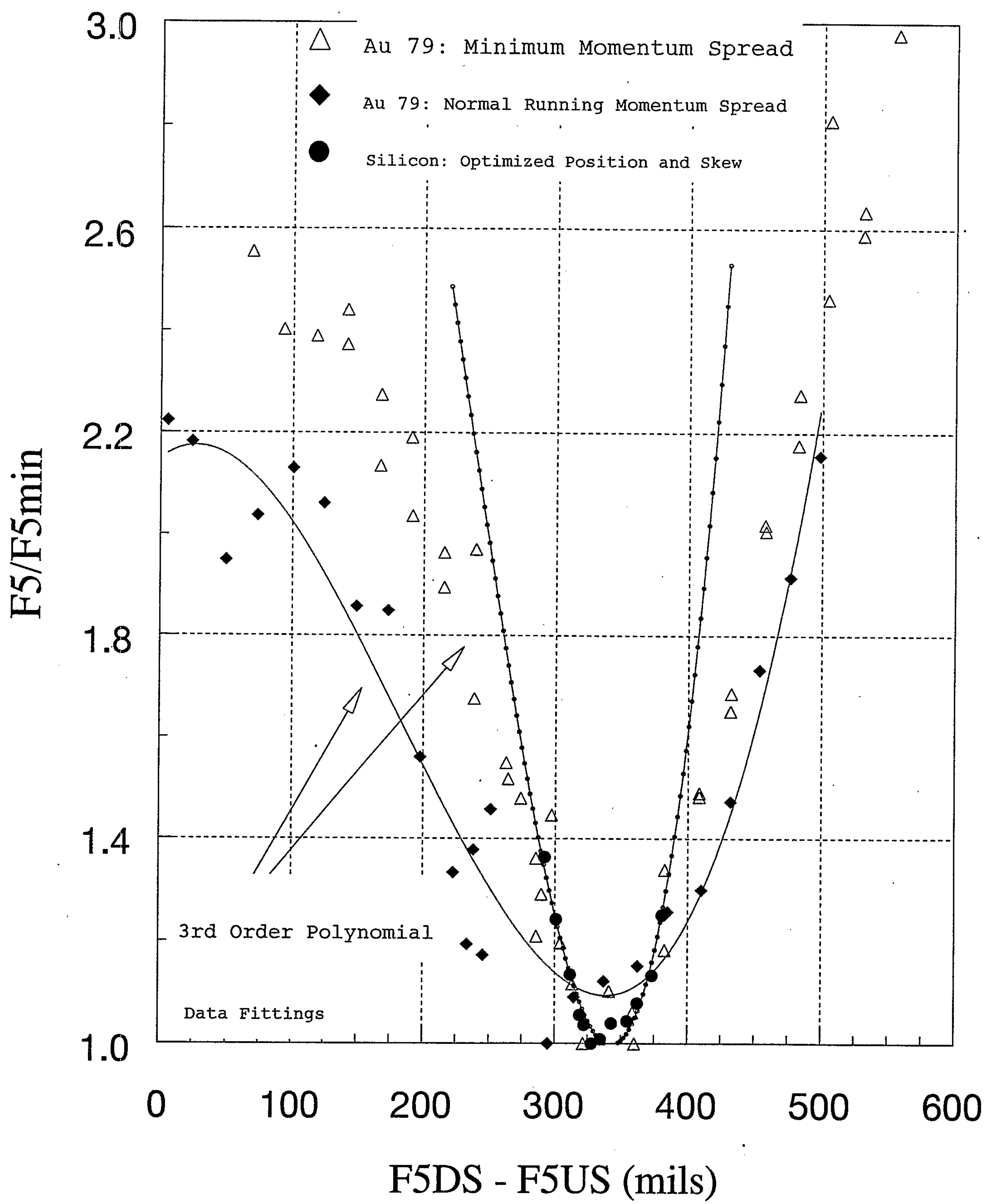

Figure 7: F5 Loss Normalized on Minimum Loss vs F5 Skev

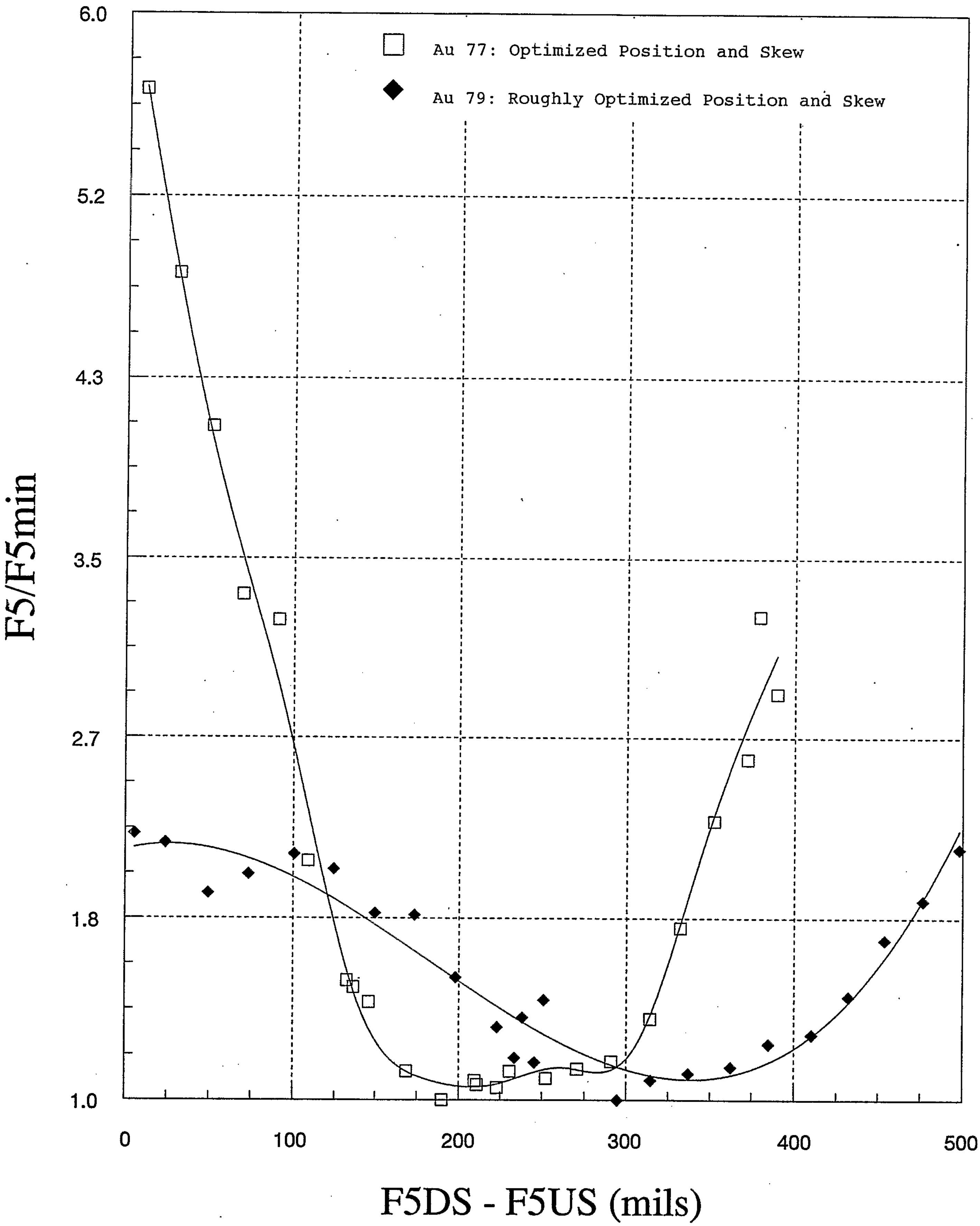

Figure 8: F5 Loss Normalized on Minimum Loss vs F5 Skev

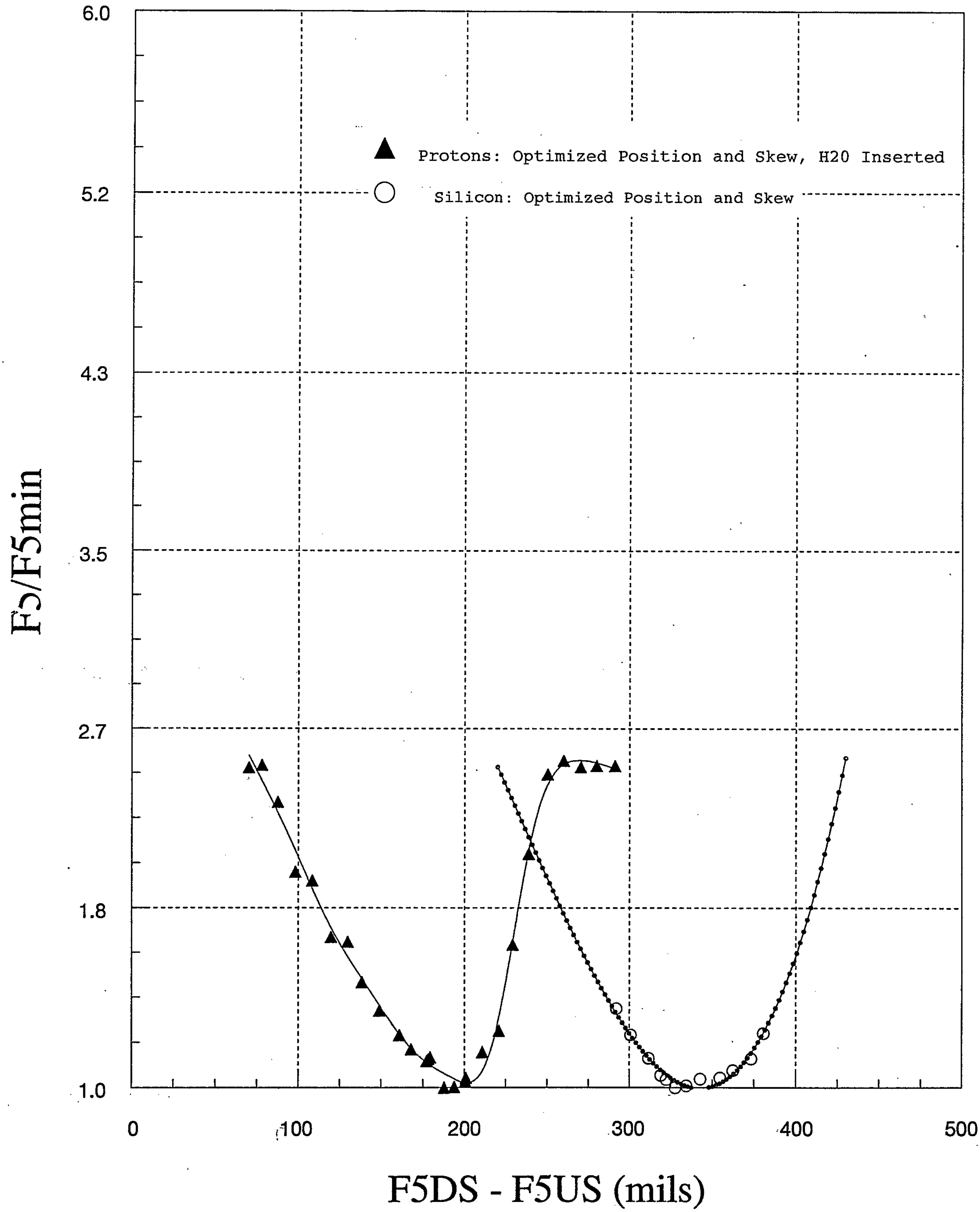

FIGURE 9: INEFFICIENCY VS EFFICIENCY

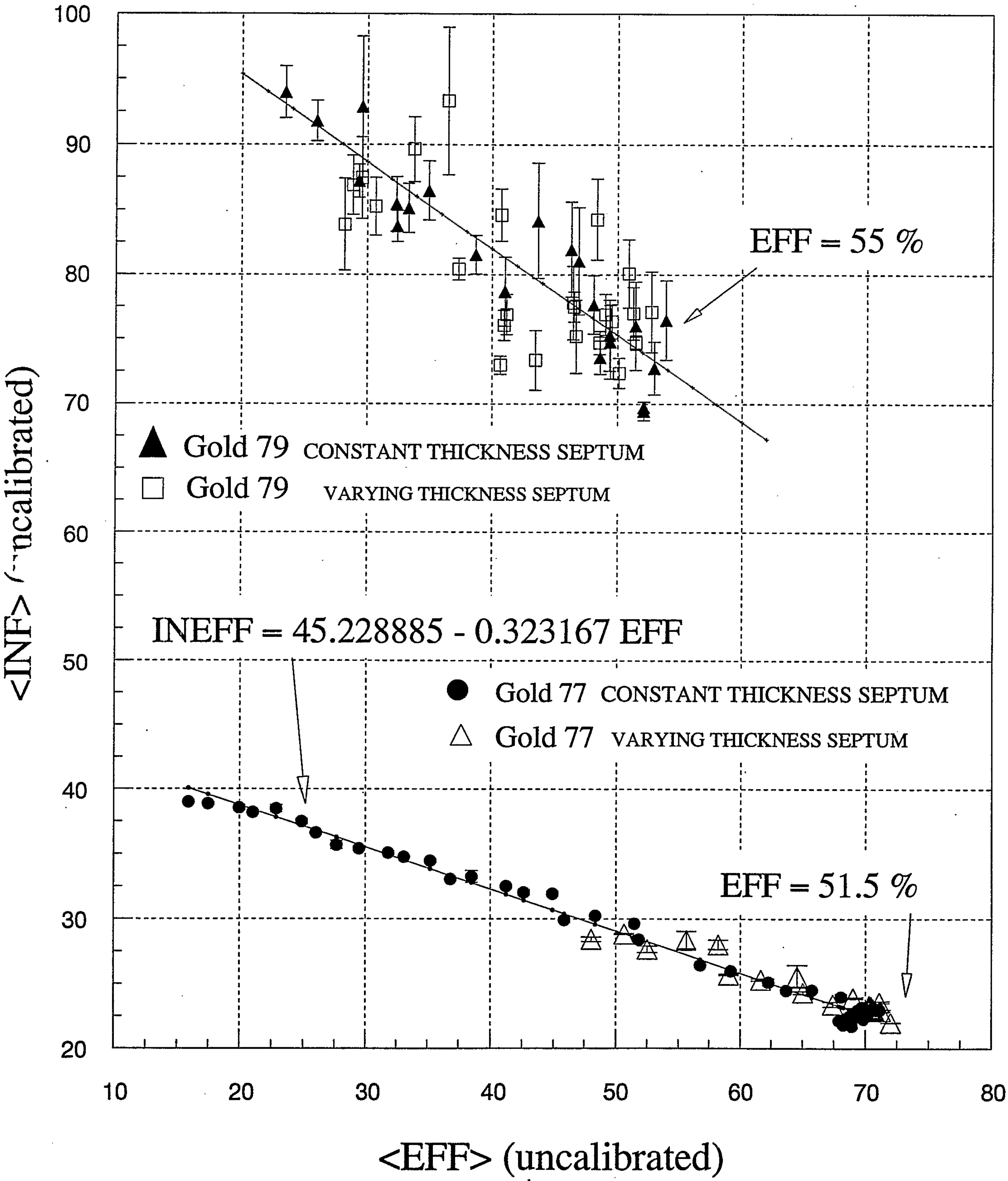

Figure 10: Inefficiency vs Efficiency

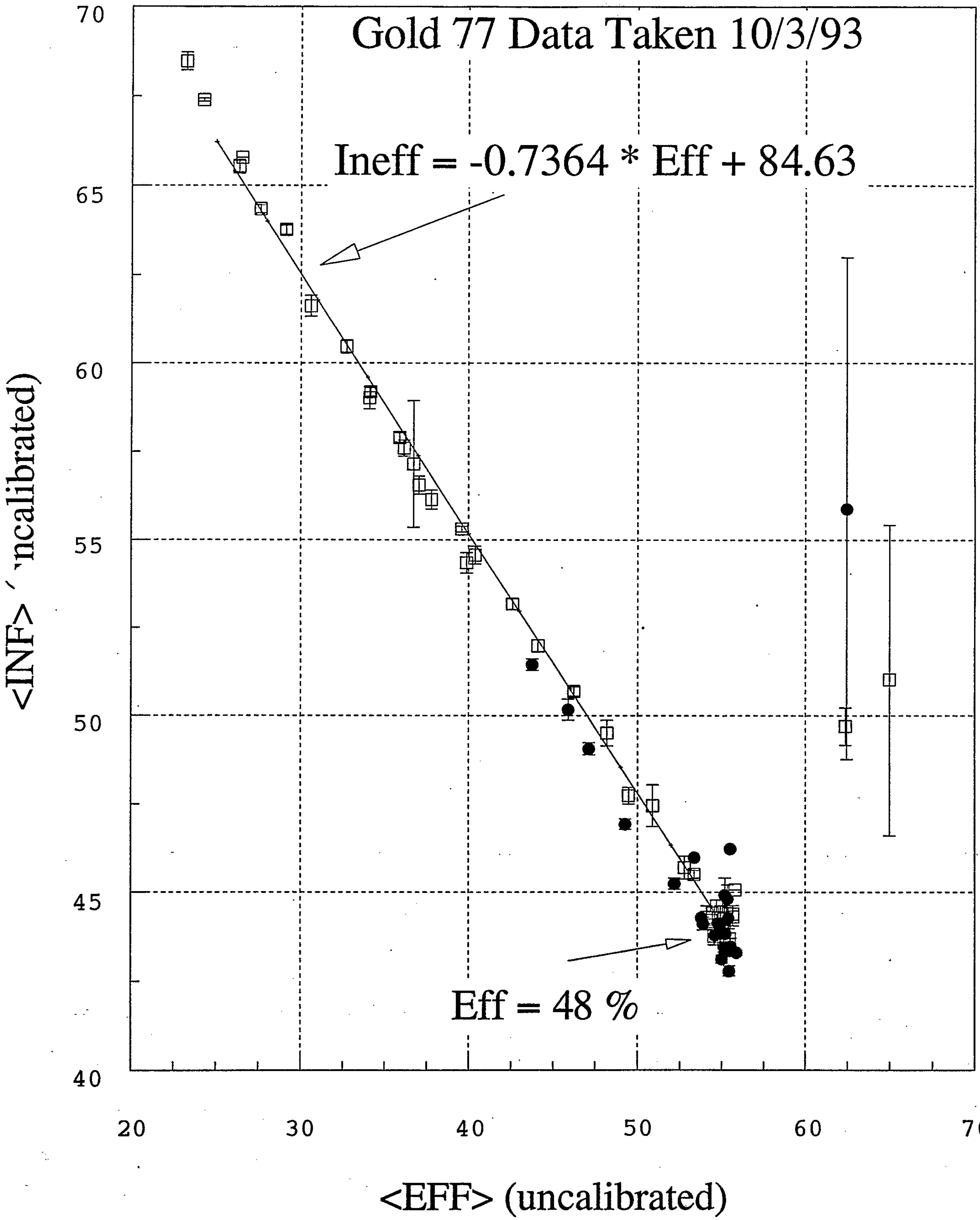

Figure 11: F5 Loss vs Efficiency

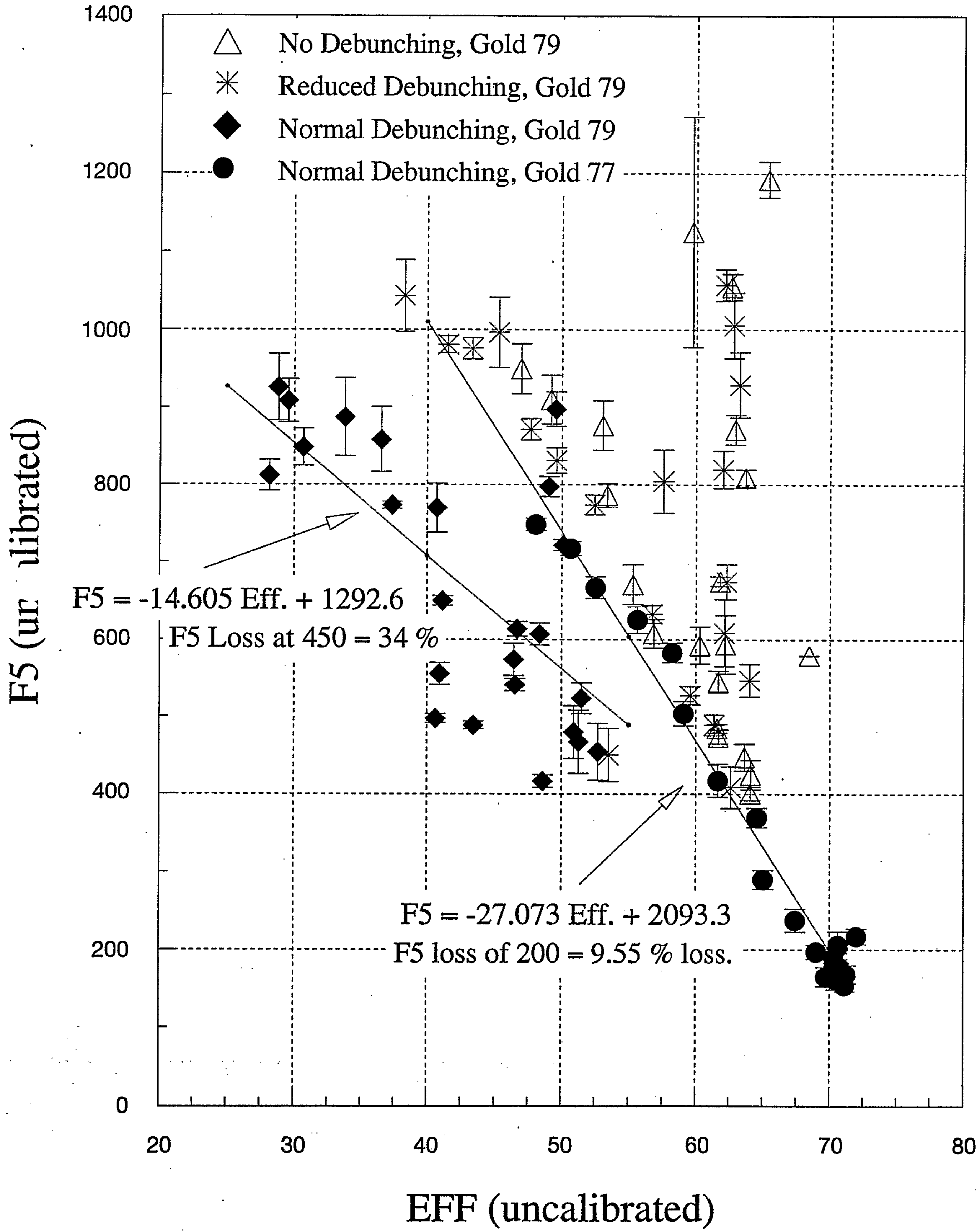

Figure 12: F5 and F10 Losses vs Efficiency