A SCANNING TARGET PROFILE MONITOR FOR THE SLOW EXTRACTED BEAM AT THE AGS*

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1 INTRODUCTION

The purpose of this new instrument is for probing beam halo and obtaining beam profiles of the resonant extracted beam at the AGS. The device described here is a prototype version, to obtain data and prepare for a more permanent device. The goals of the permanent device are to allow emittances of low current, but high intensity slowly extracted beams to be accurately measured and to have a diagnostic for probing the wings of the beam distribution. The device works on secondary emission from thin targets as well as scattering into two scintillator telescopes. The targets are movable over the entire aperture at the device.

We were motivated to build a new device by the very high intensity beams now routinely being extracted from the AGS. We typically run at intensities that are as high as 6×10^{13} protons per AGS pulse. The AGS Switchyard was originally designed to operate at 1×10^{13}. The central core emittance of the beam does not change too greatly with beam intensity.[1] With the increased AGS injection energy, that came with the AGS Booster, it has been found that to reach these high intensities, the full acceptance of the AGS was being used at injection. This implies that the normalized emittance is increased. Measurements of the emittance, last year and again this year, show that the emittance of the resonant extracted beam is more than twice as big as it was in the pre-Booster era. What is more significant, though, is the twiss parameters were significantly changed. In effect the orientation of the phase space had not changed, but we now were extracting a beam which was fatter.[2] Modeling simulations agreed with the measured results.[3] The measurement results are shown in table 1.

Table 1: Summary of emittance measurement results.

(note: β and α are referred to start of SEB line)

	$\epsilon_x^{95\%,N}$	β_x *(m)*	α_x	$\epsilon_y^{95\%,N}$	β_y *(m)*	α_y
FY82	31.9	57.6	-6.6	38.8	3.25	0.87
FY96	$64.4\pm$ 9.60	$8.8\pm$ 1.4	$-0.9\pm$ 0.2	$54.7\pm$ 5.0	$4.2\pm$ 0.4	$1.0\pm$ 0.09

The performance of this new device has exceeded our expectations. We were very concerned about singles rates in the area, since the telescopes were located inside the beam enclosure and had effectively no sheilding. The singles rates were not insignificant, as high as 1 MHz, but the triple coincidence circuitry had no problems contending with these rates.

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2 DISCUSSION

The device consists of two 2.5 mm tungsten targets, one which scans accross the beam horizontally and the other scans vertically. It is located at the beginning of the AGS Switchyard, before the electrostatic splitters. The vacuum at this location is in the range of 10^{-7} torr, making it very good for looking at secondary emission. For the secondary emission to be seen we apply a voltage to the wires, to repel any stray electrons that may wish to collect back onto the targets. Good signals were obtained at voltages down to about 20 volts. Above that we saw little change in the signal. Since the majority of the electrons knocked out of the target have energies in the range of less than 10 eV, it isn't suprising that we didn't need very much voltage.

The scintillator telescopes consisted of three EMI 9813 photomultiplier tubes, covered with mu-metal shielding and steel pipe shielding. The stray magnetic fields at the photomultiplier tubes were estimated to be in the range of a few gauss to at most 10 gauss. There are two telescopes, one in the vertical plane and the other in the horizontal plane, each at 90 degrees in the lab frame. The first detector is located 1 meter from the target and the detectors are seperated by 10 cm. The solid angle acceptance of each telescope is about 10^{-4} steradian.

We were initially concerned about temperature problems with the targets, since they were to be electrically isolated and they were relatively massive. Initial calculations, a small amount of simulation, and tests made with an electron-beam welder (in a 10^{-3} torr vacuum), all showed that the targets and holder assembly would be very stable and temperatures would not reach any significant levels.

One unique concern we had was with the significant change in solid angle seen by the telescopes due to the movement of the targets. In order to cope with this we designed the sizes of the scintillators such that they accepted the same solid angle and could accept a source changing in angle relative to the alignment of the scintillators. The area of the scintillators increase much more than just the linear change in distance from the target. This allowed the horizontally moving target to be viewed with the vertically mounted telescope, and give very little change in observed solid angle over the range of movement of the target.

3 RESULTS

These results are very preliminary, the data only taken recently. We have had no time to carefully go over the data, so it is certainly possible that systematic errors may exist. Figures 1 - 4 demonstrate some of the data taken with the scanning target. The beam at this time had a definite momentum tail on it, which is most easily seen in figure 2. Figure 1 shows that for a normal plot the two telescopes basically give the same curve. But in figure 2 it is seen that the Horizontal telescope shows a wider beam, more clearly, than the vertical telescope.

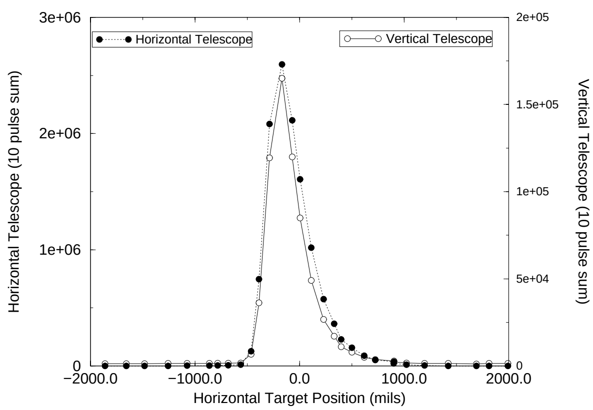

Figure 1: Horiz. and Vert. Telescope triples for Horz. scan

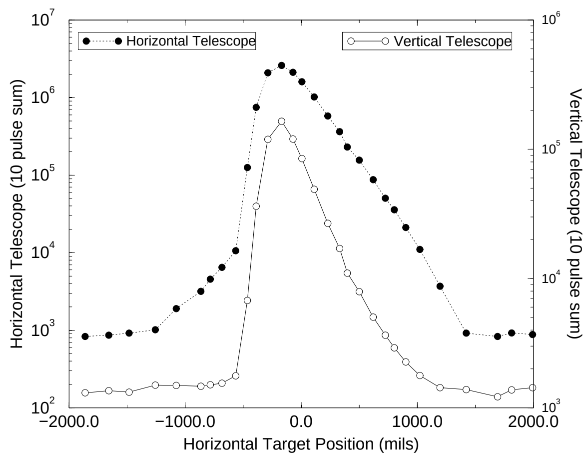

Figure 2: Horz. and Verti. Telescope triples for Horz. Scan

This is the effect of the solid angle changing more for the horizontal telescope than for the vertical, which has much less change in solid angle over the same range. Figure 3 shows the curves for the secondary emission from the target, on linear and on logrithmic scales. The secondary emission curve closely follows the vertical telescope. Figure 4 demonstates the ratio of telescope counts to secondary emission counts for each. Again the vertical telescope has much less variation than the horizontal.

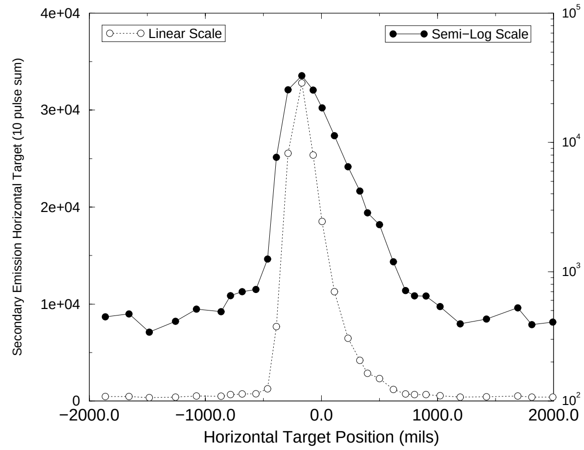

Figure 3: Secondary Emission from target for Horz. Scan

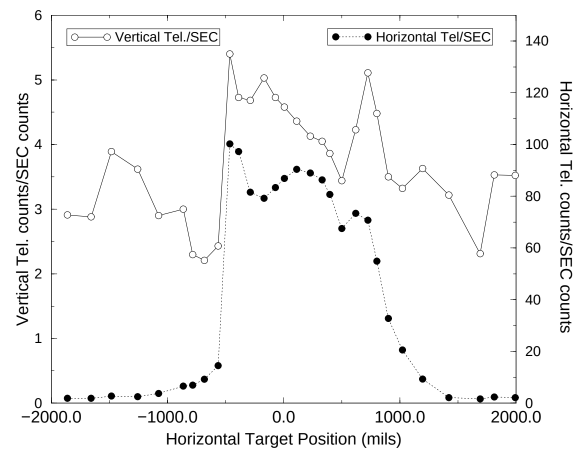

Figure 4: Ratio of Telescope Counts to SEC Emission

4 CONCLUSIONS

The performance of the device has exceeded our expectations. We see a clean dynamic range of over 5 orders of magnitude giving significant resolution of the wings of the beam distribution. Unfortunately the device does not perform well at the higher beam intensities. Background singles rates are larger than we anticipated and at high intensities become a serious problem. But we are actually encouraged, since this is at least a parameter we have control over. We could reduce the mass of our targets without effecting the performance, and reduce the solid angle acceptance of the telescope without greatly effecting the dynamic range. The effort that went into considering the solid angle effects for the telescope produced a fairly flat response for the vertical telescope when moving the horizontal target. The same compensations done for the horizontal telescope yields a similarly flat response when targeting on the vertical target.

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The AGS instrumentation group, supervised by T. Curcio, along with the excellent mechanical skills of the AGS Beam Components group, supervised by D.Lehn, did a tremendous job putting together this entire system in less than 6 months.

6 REFERENCES

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