AGS Complex Machine Studies (AGS Studies Report No. 324) The BTA Horizontal Orbit as a Function of the Booster Extraction Point
Study Period: March through July, 1994
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Machine: AGS Proton Complex
Aim: To Find the Reason for Motion of the Horizontal Beam in the BTA.

SUMMARY

Most of the horizontal motion of the beam in the BTA line can be explained by changes in the Booster extraction parameters.

MODEL

For this note we assume the BTA line is fixed and constant from May 31 to July 31, 1994, the last months of the proton run. The details of the model will be documented later. The parameters are given in Table 1.

TABLE 1. BTA LINE HORIZONTAL OPTICS

	BETAX	ALPHAX	MUX
	m		2 Pi
F6 SEPT ENT	12.246	1.771	0.003
F6 SEPT MP	8.244	1.341	0.023
MW006	3.368	0.378	0.114
MW060	86.528	8.937	1.168
MW125	23.581	2.345	1.223
MW166	3.082	−0.752	1.48

DATA

The data come from the Daily Log Reports and are the horizontal beam positions measured at the four multiwires in the BTA as well as the extraction bump and extraction radius.

RESULTS

From the positions of the beam at MW060 and at MW125, we can calculate the angle of the beam at MW060 and plot in Figure 1 the phase space at MW060. These results are very similar to the results in AGS Studies Report No. 323, except we have selected a time period for which we surmise the BTA magnet settings were not changed. We are using MW060 since beta is large and we get good resolution. Our question is why does the beam move over a range of 30 millimeters as it does in Figure 1.

The motion we see in phase space at MW060 cannot be easily explained by changing any magnets in the BTA line. However, it can be readily explained by assuming that the position and angle of the beam extracted from the Booster is changing.

BOOSTER EXTRACTION

We can define the extraction point from the Booster as the entrance to the F6 septum magnet. The Booster extraction devices that primarily control the position at this point are:

1. The Booster orbit radius
2. The extraction bump amplitude
3. The F3 kicker

The Booster device that primarily controls the angle at this point is:

1. The extraction bump angle

In addition the F6 septum, located just downstream of what we have defined as the extraction point, has a large effect on the angle of the beam entering the BTA line.

We have no data on the F3 kicker, we can assume it is fixed and constant, and we can ignore it for this paper. Thus, we can assume the position and angle at the extraction point are effectively controlled by four knobs:

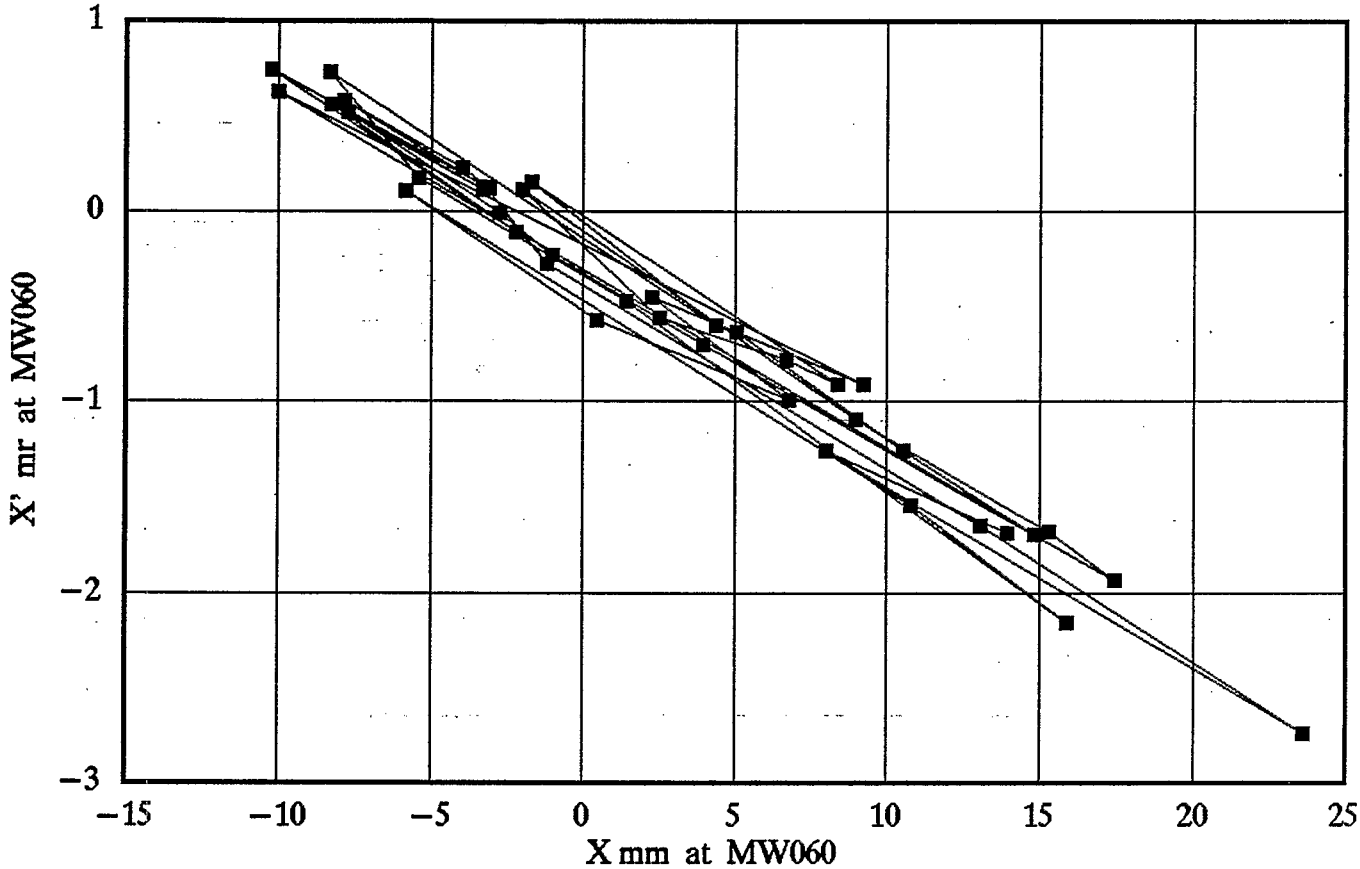
1. The Booster orbit radius
2. The extraction bump amplitude
3. The extraction bump angle
4. The F6 septum bend angle

In normal operations, all four of these knobs are used frequently. Note that in principal only two are needed. Note also that the actual radius of the extraction orbit is determined by the interaction of both the Booster and the AGS. The extraction orbit is actually controlled by a multiplicity of settings and not by one knob. A realistic discussion is beyond the scope of this note. We report here the number recorded in the Daily Log. It is worth noting that this number shows significant variability, for reasons not clear at the moment, and this number does not correlate with the other data we are examining.

The extraction orbit, the bump amplitude, and the bump angle are recorded as daily numbers, and are shown in Figures 2 and 3. Figure 4 shows the orbit radius, the orbit plus the bump amplitude, which should give the position of the beam center at the septum, and the edge of the beam defined as 2.2 sigma beam widths (one full width at half maximum, scaled from MW060). This picture is nicely plausible, the edge of the beam just skirting the edge of the septum. It is apparent from these figures that there is a day-to-day variation of the order of 10 millimeters. This is probably due to operational adjustments made to minimize losses. Since the beam has to be set up to just scrape the septum, any injection adjustments which change the beam size can plausibly lead to adjustments at extraction.

In Figure 5, we show the phase space at the septum entrance. One set of data is the data from Figure 1 projected back to this position. The other set of data is just a plot of the angle and position of the extraction bump (arbitrarily centered) as recorded in the Daily Log. Note that the variation in the extraction bump seems to account for two thirds of the variation in the BTA beam. The additional variation could well result from variations in the F6 septum as discussed in AGS Studies Report No. 323. It is not possible to generate convincing correlation plots from the data, which is not surprising since there are five possible variables here. However, the important point of this note is that the variation in the position and angle of the extracted beam from the Booster can easily account for the beam variations down the BTA line.

Figure 1: HORIZONTAL PHASE SPACE AT MW060
MAY 31 – JULY 31, 1994



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08–Mar–95

Figure 2: BOOSTER EXTRACTION ORBIT

MAY 31 – JULY 31, 1994

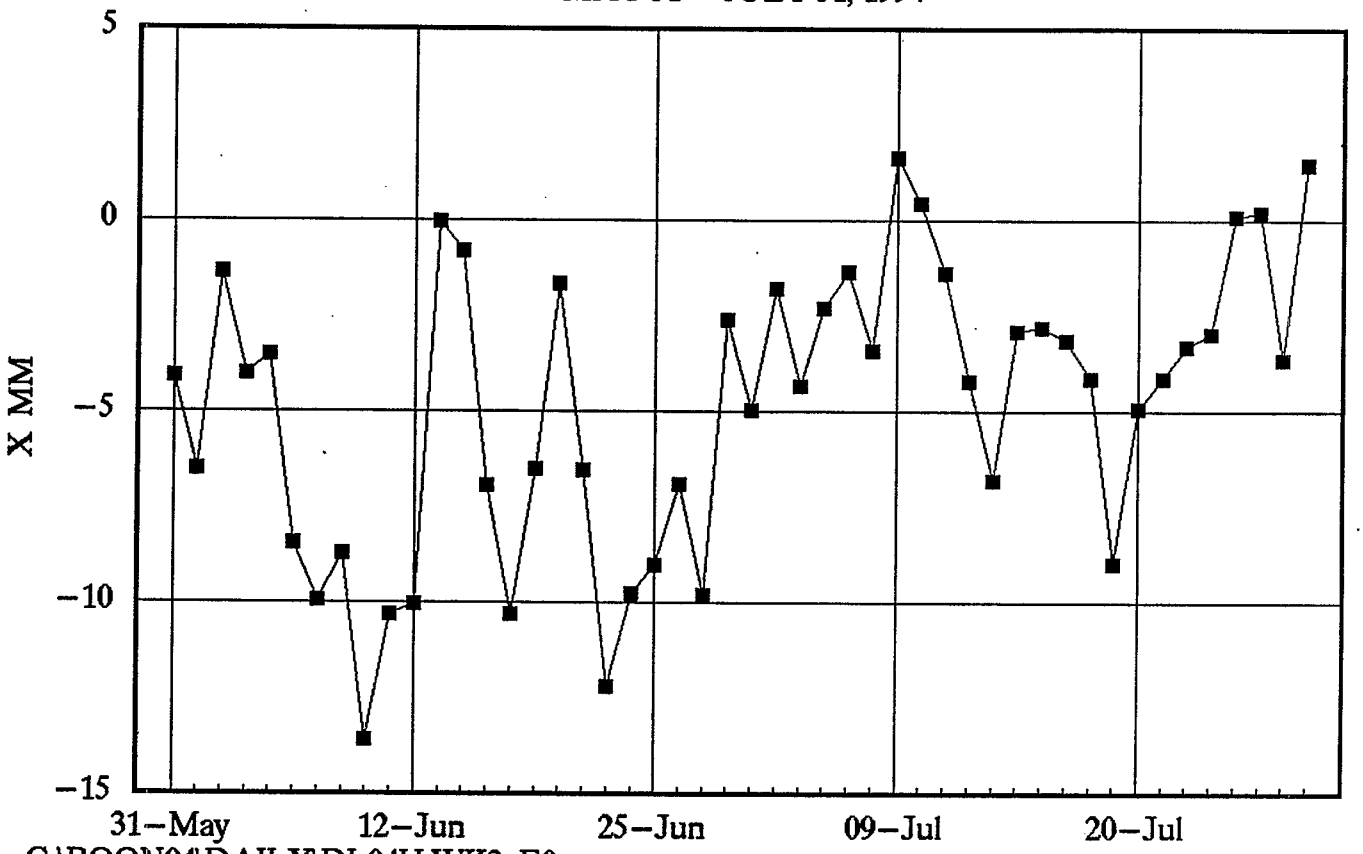

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Figure 3: EXTRACTION BUMP

MAY 31 – JULY 31, 1994

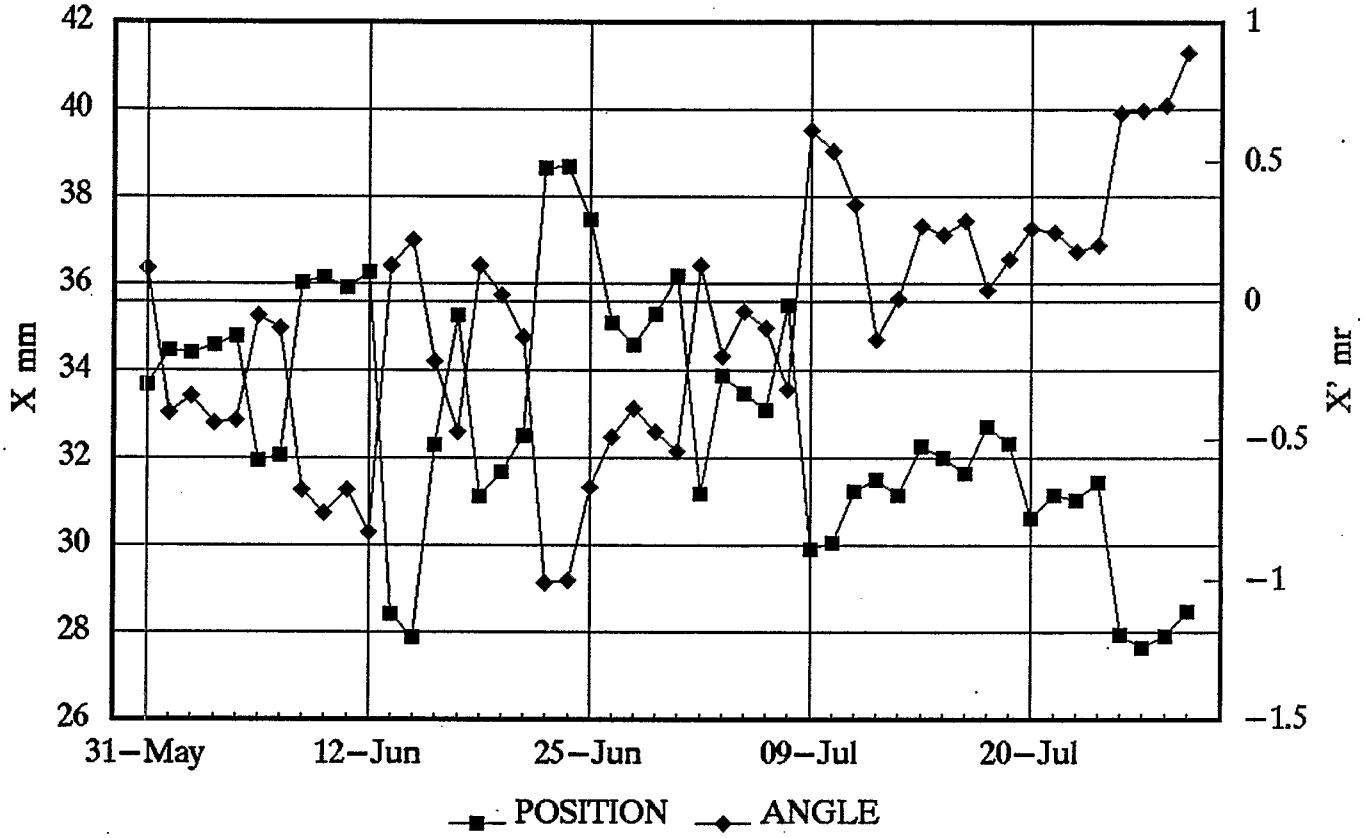

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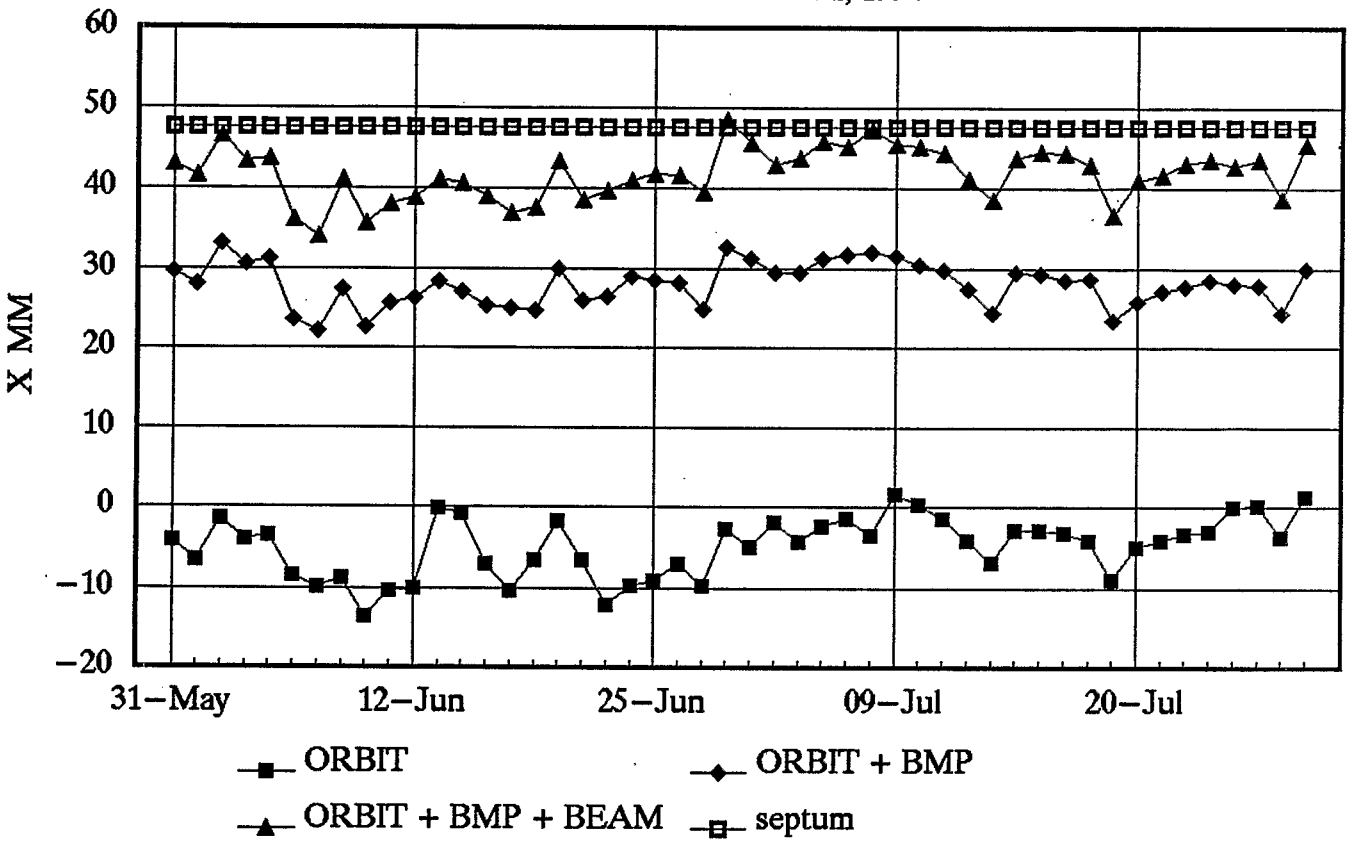
Figure 4: BOOSTER BEAM at the F6 SEPTUM

MAY 31 – JULY 31, 1994



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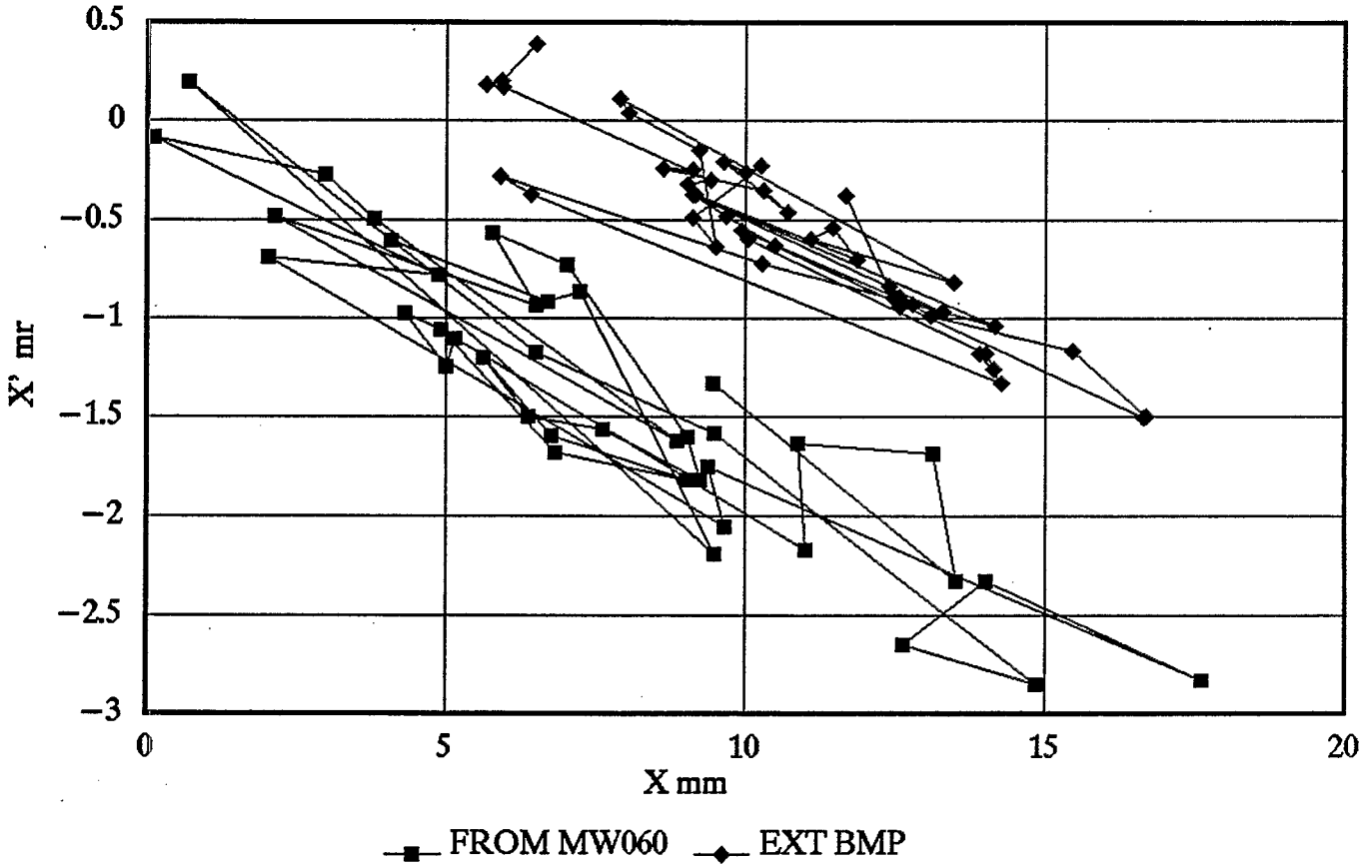
08−Mar−95

Figure 5: PHASE SPACE at SEPTUM ENTRANCE
MAY 31 – JULY 31, 1994



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08–Mar–95