national accelerator laboratory

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A PRELIMINARY REPORT ON A PROMISING TARGET MONITOR

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Introduction

A pair of loss monitors[1] mounted on the Meshall target train show promise of providing a simple and effective target monitoring system. Preliminary results conform to expectations and largely agree with observations by an experimenter in a secondary beam line.

Description

The basic system is indicated in Figure 1. Depicted is the Meshall movable production target preceded by collimators, a secondary emission monitor (SEM, for measuring incident beam intensity) and the pretarget proton beam transport system. The loss monitors are physically positioned so that the longest monitor spans the collimators and ends precisely at the downstream end of the last pretarget collimator; a shorter, 2-foot long monitor resides immediately downstream and is positioned parallel to and about 18 inches from the movable production target. The former is called the collimator loss monitor and the latter the target monitor. The output currents from these monitors are individually integrated during a machine spill and the resulting voltages are digitized for recording.

Discussion of Experimental Results

The first experiment was done when a fixed beam position was maintained while the production target was moved horizontally across the beam. The ratios of the target monitor and the collimator loss monitor to the incident beam intensity were recorded as a function of target position. The results are indicated in Figure 2. The points on the base line (target-out condition) of the target monitor curve were quite reproducible. The ratio of the peak target signal to the background signal (target-in, target-out ratio) is approximately ten to one. The scatter of points on the profile are thought to be real, i.e., relative target interactions changed from pulse to pulse presumably from slight beam position variations. Such variations give more scatter to the points on the shoulder of the profile than elsewhere.

Significantly, the collimator loss monitor output remained almost invariant of target position. Such behavior is important for two reasons. First, it indicates that backscattering at high energies is indeed small, which accounts for the relatively good performance of the target monitor; secondly, it suggests that the collimator loss monitor can serve as a general background monitor during the target scan. If desirable, this background signal, properly weighted, could be subtracted from the target signal so that the base line of the target scan would be zero.

As explained in a previous note[1] the collimator loss monitor may be calibrated approximately to provide a measure of the beam striking the collimator. Basically, the calibration is a simple operation whereby all the beam (at reduced intensity) is purposely steered on to the collimator and the ratio of the monitor reading to the proton beam intensity is recorded. A curve is illustrated in Figure 3 where the ratio of the collimator loss monitor reading to the SEM reading is plotted as the beam was moved vertically across the collimator aperture. The maximum on this curve gives the approximate relative loss monitor output per proton intercepting the collimator.

When the beam is tuned for normal operation, the loss monitor reading may be used to assess the operating loss on the collimator. The ratio of the operating point to the peak point, both indicated in Figure 3, gives an approximate fraction of the beam lost on the collimator. In the case here, the ratio was $\sim \frac{5}{55}$ or ~ 9 per cent of the incident proton beam was intercepting the collimator. It is also easy to see on this curve that the operating point was not the minimum loss point which was $\sim \frac{3}{55}$ or a little over 5 per cent.

Conclusion

The preliminary results indicate that a pair of loss monitors with the proper geometry may offer a viable, reliable target monitoring system. Additional experiments, however, need to be done. It should be demonstrated in every application that each monitor is working on the plateau of its bias curve. It would also be desirable to install this system in conjunction with a working 90 degree counter telescope target monitor and compare performance.

My appreciation goes to Herman Haggerty who collaborated in these experiments and to Tom Nash for correlating the information in a secondary beam line.

References

1. F. Hornstra and E. Bleser, "A Method and a Simple Device to Precisely Measure Accelerator Extraction Efficiency and Beam Line Transport Efficiency", NAL FN252, 26 April 73

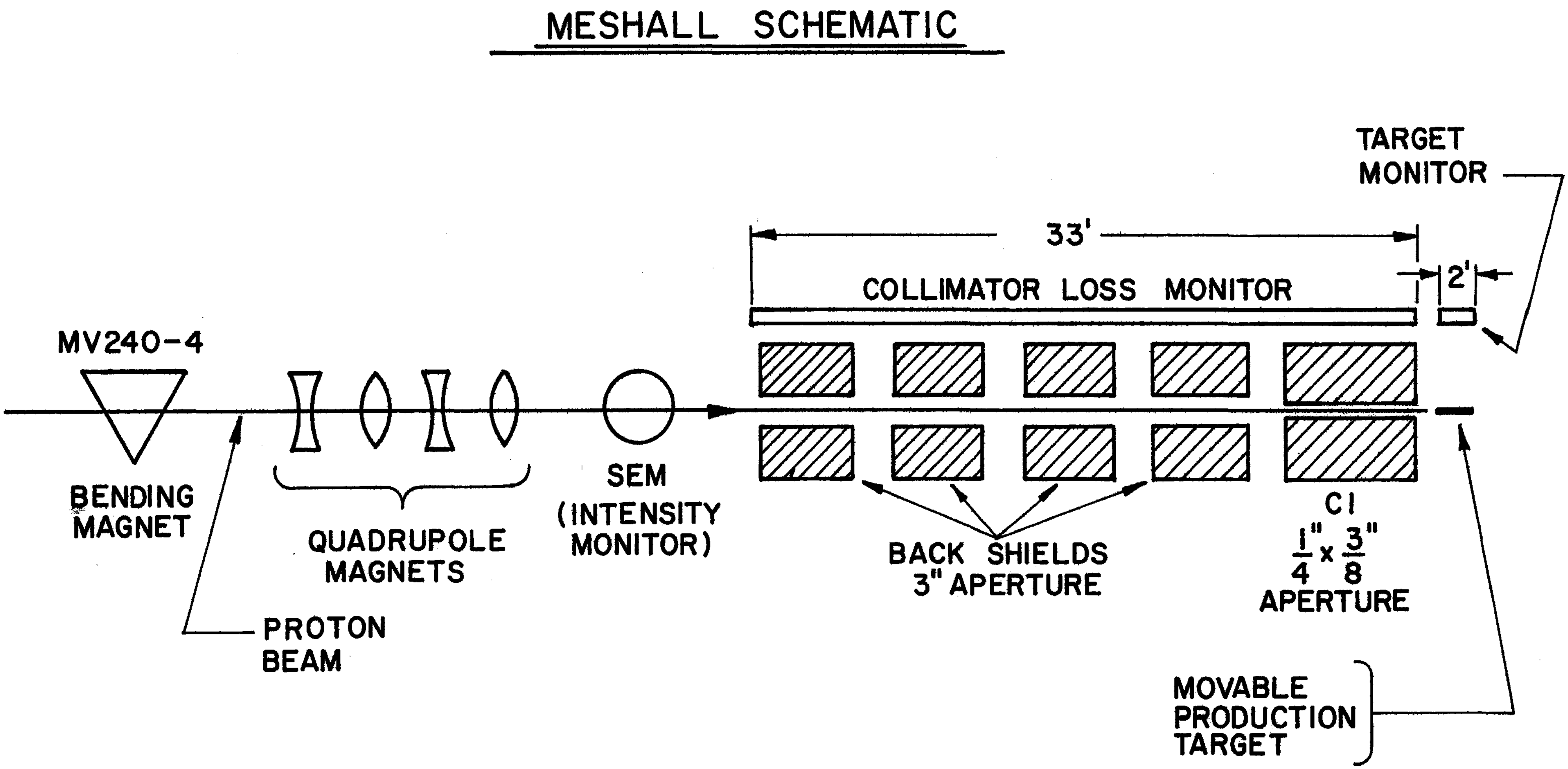

Figure 1

(NOT TO SCALE)

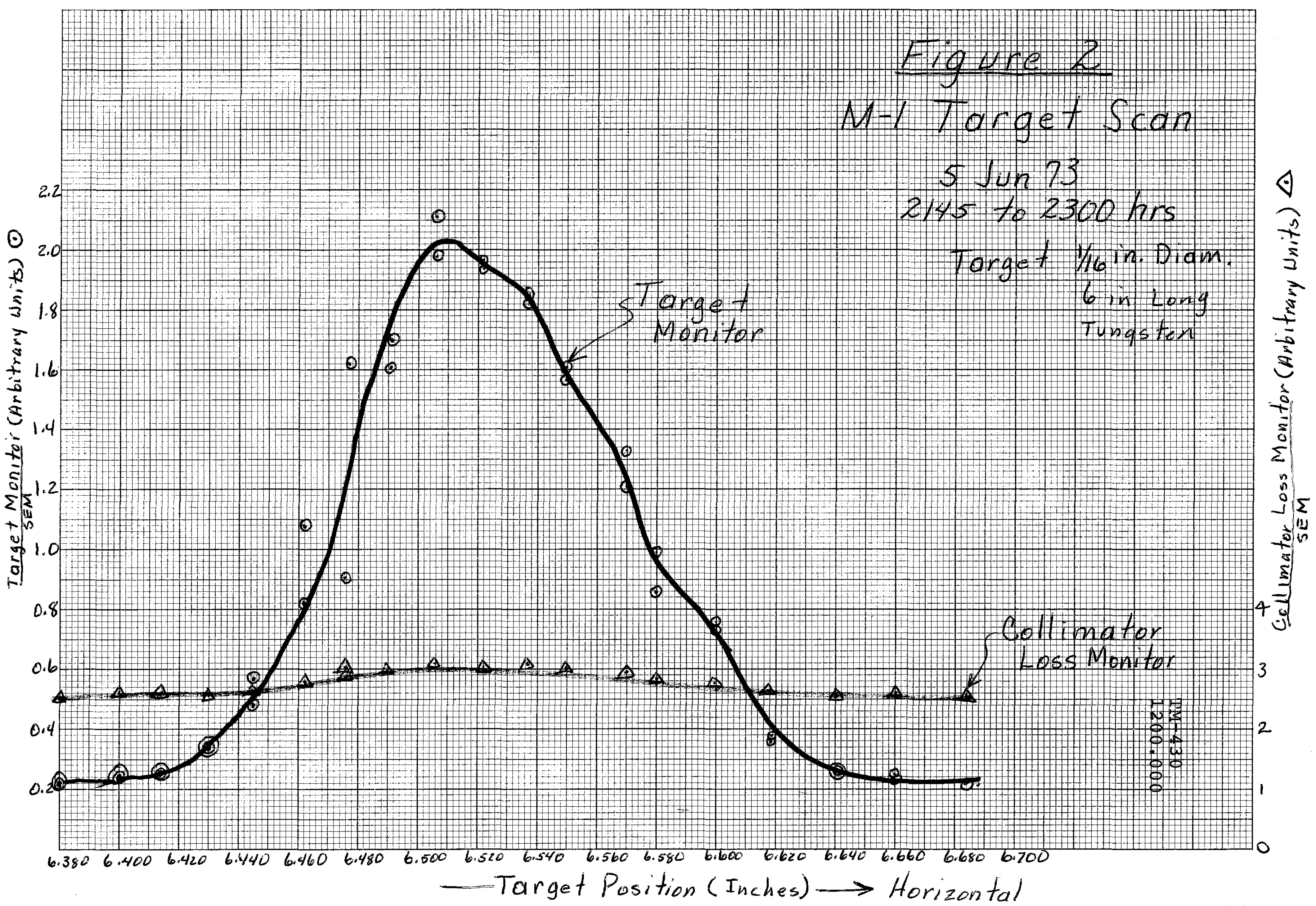

Figure 2
M-1 Target Scan
5 Jun 73
2145 to 2300 hrs
Target 1/16 in. Diam.
6 in. Long
Tungsten
Target Monitor
Collimator Loss Monitor
Target Monitor / SEM (Arbitrary Units) ⊙
Collimator Loss Monitor / SEM (Arbitrary Units) △
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
4
3
2
1
0
6.380 6.400 6.420 6.440 6.460 6.480 6.500 6.520 6.540 6.560 6.580 6.600 6.620 6.640 6.660 6.680 6.700
Target Position (Inches) → Horizontal
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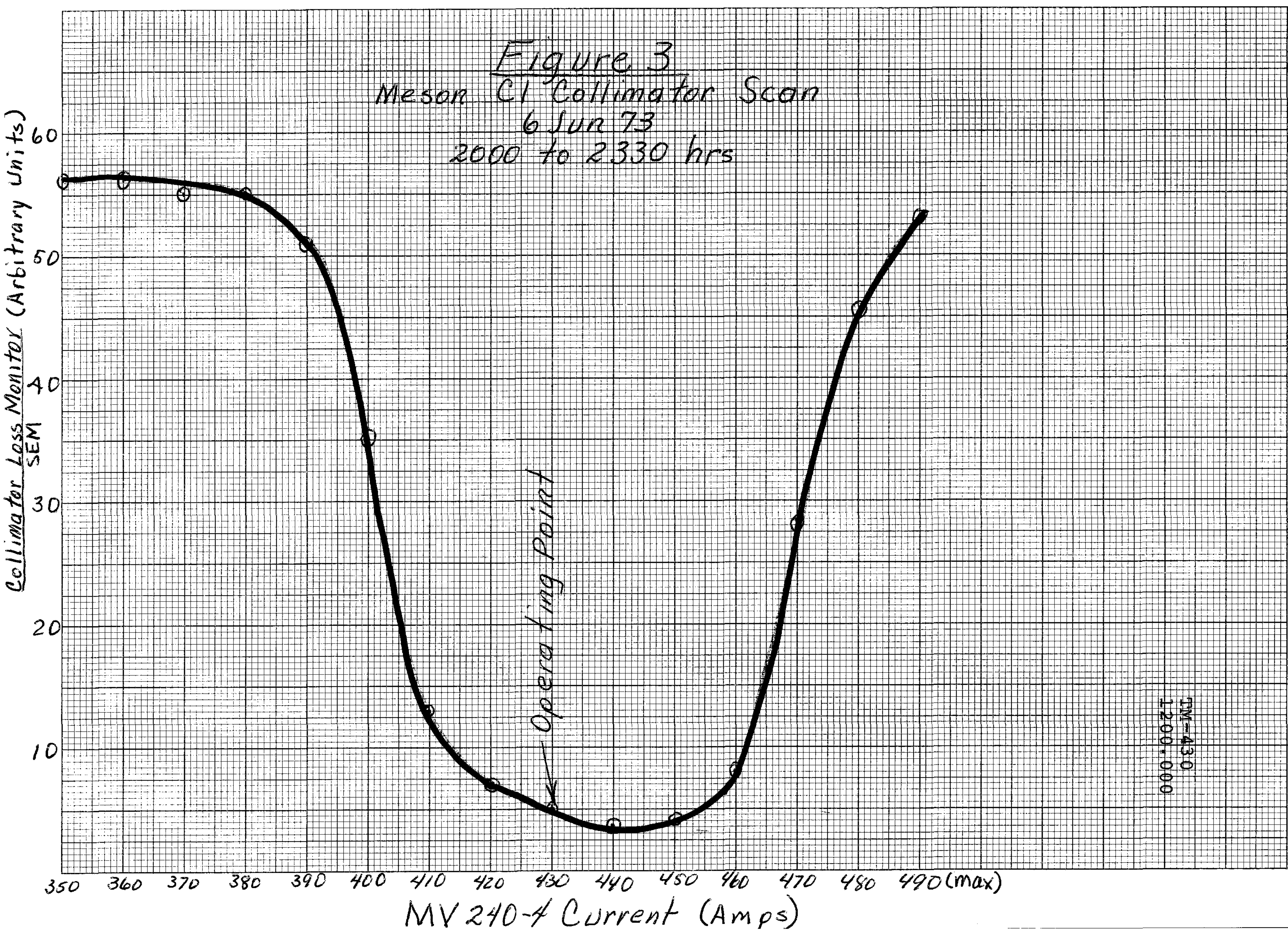

Figure 3
Meson C1 Collimator Scan
6 Jun 73
2000 to 2330 hrs