fermi
national accelerator laboratory

TM-750
2212.200

MESON VERTICAL TARGETTING STUDY

H. F. Haggerty
October 21, 1977

During September, 1977 two vertical vernier magnets were installed upstream of the Meson target in order to expand the vertical targetting angle capability. Primary motivation was to more evenly match the flux entering the M2 line to the experimenters' requirements. At the same time a two-foot long aluminum bar (spoiler) was installed which can be inserted between the target and the first M2 beam defining hole in the target train box. This note summarizes measurements made at the end of September, 1977 on the effectiveness of targetting angle changes and spoiler position.

The normal targetting angle of the primary beam with respect to the M2 beam is presently .7 mrad vertical and 0.0 mrad horizontal. The vernier magnets are capable of changing this vertical angle by ± .5 mrad at 300 GeV/c. All the tests described here were done with 300 GeV/c beam hitting Meson's target. (Targetting geometry is shown in Figure 1.) The primary technique was to fix the upstream vernier (TV1) at some current and to vary the downstream vernier (TV2) from zero to full current while monitoring beam in M2, M7, and SEM.

Figure 2 shows such a sweep done at TV1 = 60 amps. (Positive current increases the targetting angle.) The spoiler was out during this sweep. The first thing to notice is that the apparent target size is smaller when monitoring with M2 than with M7 and its position is shifted. The cause of both of these effects is the same. During the tests a .062" target was used. The location of the downstream vernier is close enough to the target (474") that in sweeping from the top of the target to the bottom the targetting angle changes by .13 mrad. The flux entering M2 is very sensitive to targetting angle; most of the flux comes from the position of the smallest angle, in this case the top of the target. The true size of the target agrees with the M7 yield and the true position is correctly given by the M7 yield. (This was verified by monitoring M1 during part of the tests.) At the left of Figure 2 the M2 yield has another bump which is caused by beam entering the M2 hole in the target box instead of dumping below the hole. The yield as TV2 $\rightarrow$ 0 amps is small probably because the primary beam hits the collimator in the upstream horizontal bender.

Figure 3 is the same as Figure 2 except that the spoiler is now "in". The major difference is the size of the yield when the primary beam misses the Meson target and hits the spoiler (TV2/TV1 $<.7$). The relative height of this bump to the target is a factor of three which is about the same as the ratio of collision lengths of the spoiler to the target. Notice that the lower edge of the spoiler (TV2/TVl = .6) is about 30 amps away from the upper edge of the target (TV2/TVl = 1.1).

In Figure 4 a sweep was made at TVl = 30 amps. Here the lower edge of the spoiler (TV2/TVl = .8) is the same as the upper edge of the target as evidenced by M7. Also, since some primary beam is now going through both the target and the spoiler, the relative heights of the two peaks is lower in this sweep than in Figure 3. The details given so far are leading somewhere. Recall that in Figure 3 the lower edge of the spoiler was 30 amps from the upper edge of the target and in Figure 4 the two edges coincide. The difference in Figure 3 and Figure 4 was a 30 amp difference in TVl's fixed value. Also, notice that the width of the target is 30 amps of TV2 as shown by the M7 yield. The nominal targetting angle is at TV2 = TVl = 0, which is again 30 amps from the Figure 4 value. This means that for nominal targetting the primary beam goes through the target and into the spoiler almost entirely. Measurements were made at 200 GeV and 300 GeV in M2 in which the spoiler was inserted and removed repeatedly and no significant yield difference was obtained. Since the target by itself is about .5 collision length and the spoiler is about 1.5 collision lengths, the probability of one and only one interaction per particle is in the first instance

$$p = \frac{x}{x_c} e^{-x/x_c} = .5e^{-.5} \equiv .2$$

and in the second instance

$$p = \frac{x}{x_c} e^{-x/x_c} = 2e^{-2} \equiv .3$$

Therefore, if it were precisely true that all the primary beam hit both the target and the spoiler, then with the spoiler "in", there should have been a 50% increase in flux at 300 GeV. Clearly, none of these estimates are good enough for that kind of precision.

Continuing on with the measurements, it is clear that in all the measurements made at angles shallower than nominal, the primary beam will hit both the target and the spoiler (if the spoiler is in) but the yield will be about the same whether or not the spoiler is in. Figure 5 shows a sweep at TV1 = -30 amps. As in previous graphs, the apparent target size is smaller when measured by M2 and is shifted toward the smaller targetting angles which in this case is for larger TV2/TV1 ratios (top of the target).

Figure 6 is a plot at 300 GeV of the ratio of yields to the yield at nominal angles. This curve was made with the spoiler "in". With the spoiler out the ratios at smaller than nominal angles will be the same and the ratios at higher than nominal angles will begin to be somewhat larger as T1 is increased. At TV1 = 60 amps and the spoiler out the relative yield should be a factor of 4 larger to compensate for the attenuation of the M2 beam by the spoiler when none of the primary beam hits the spoiler.

To summarize, by changing vertical steering angle and using the spoiler a factor of 600 range in M2 yield can be obtained. Without the spoiler, a factor of 150 can be obtained. By combining these measurements with absolute yields measured previously, the estimate of maximum M2 flux is ~12% of the primary beam.

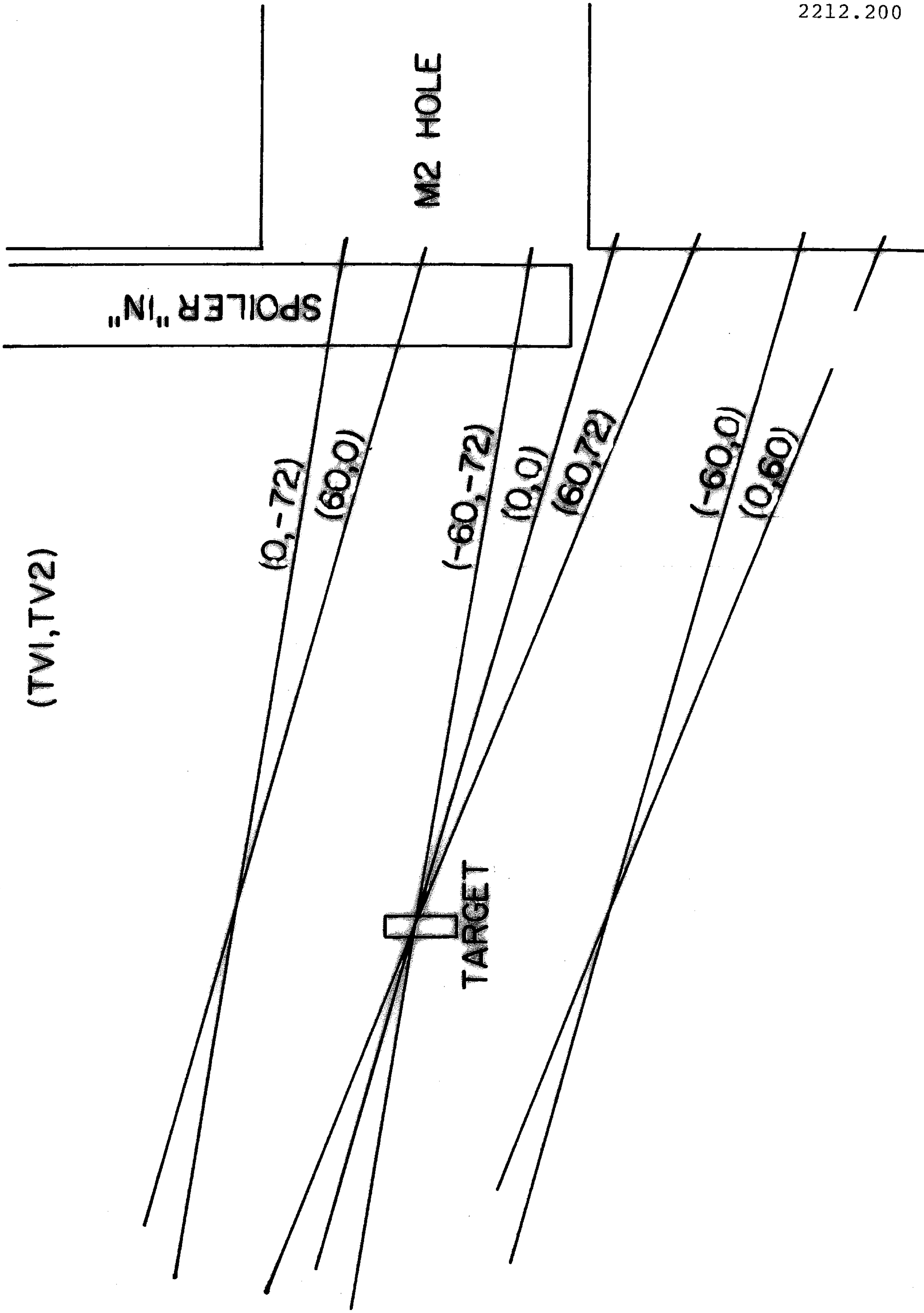

FIG. 1

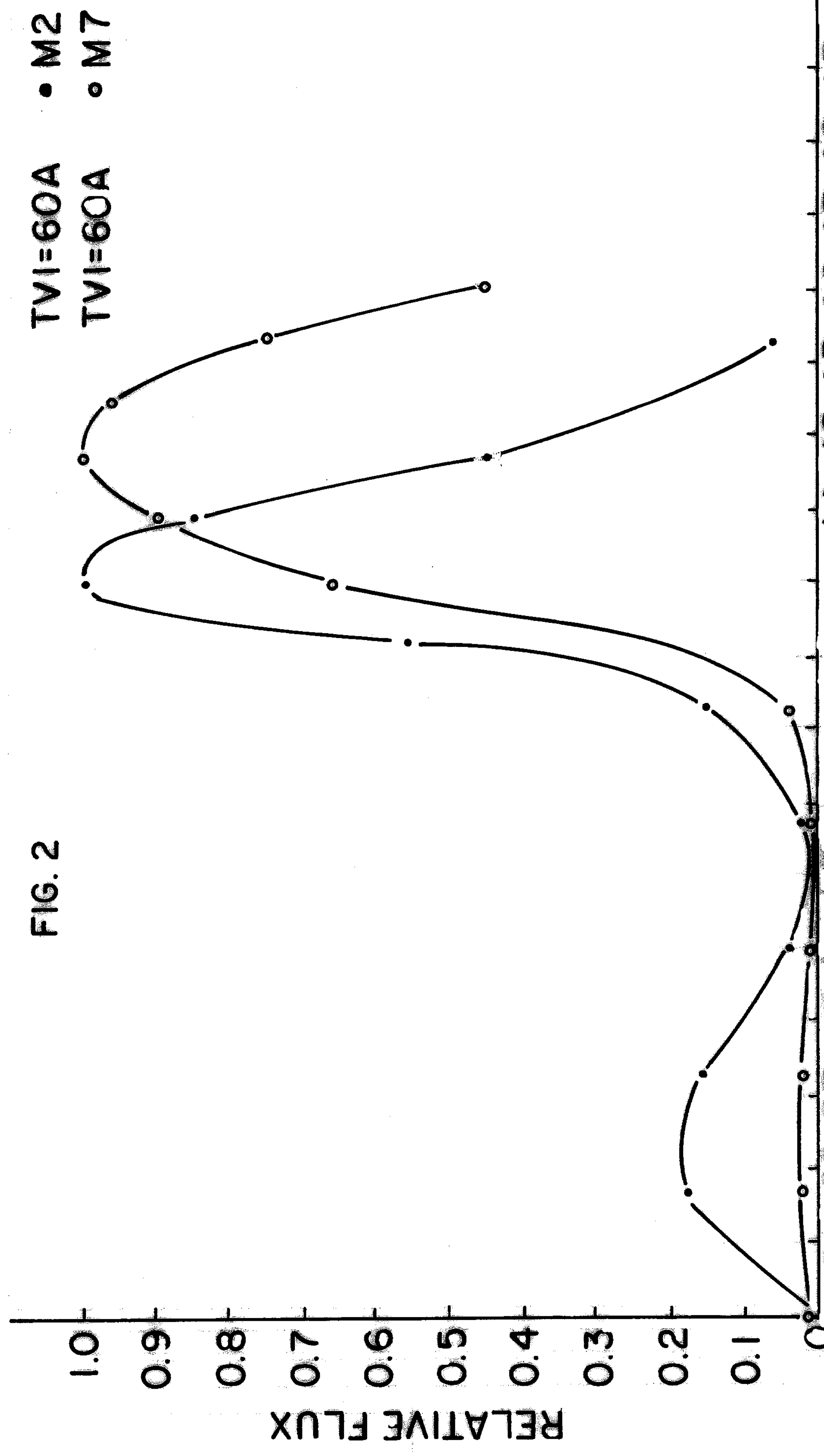
TV1=60A • M2
TV1=60A ∘ M7
RELATIVE FLUX
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
TV2/TV1

FIG. 2

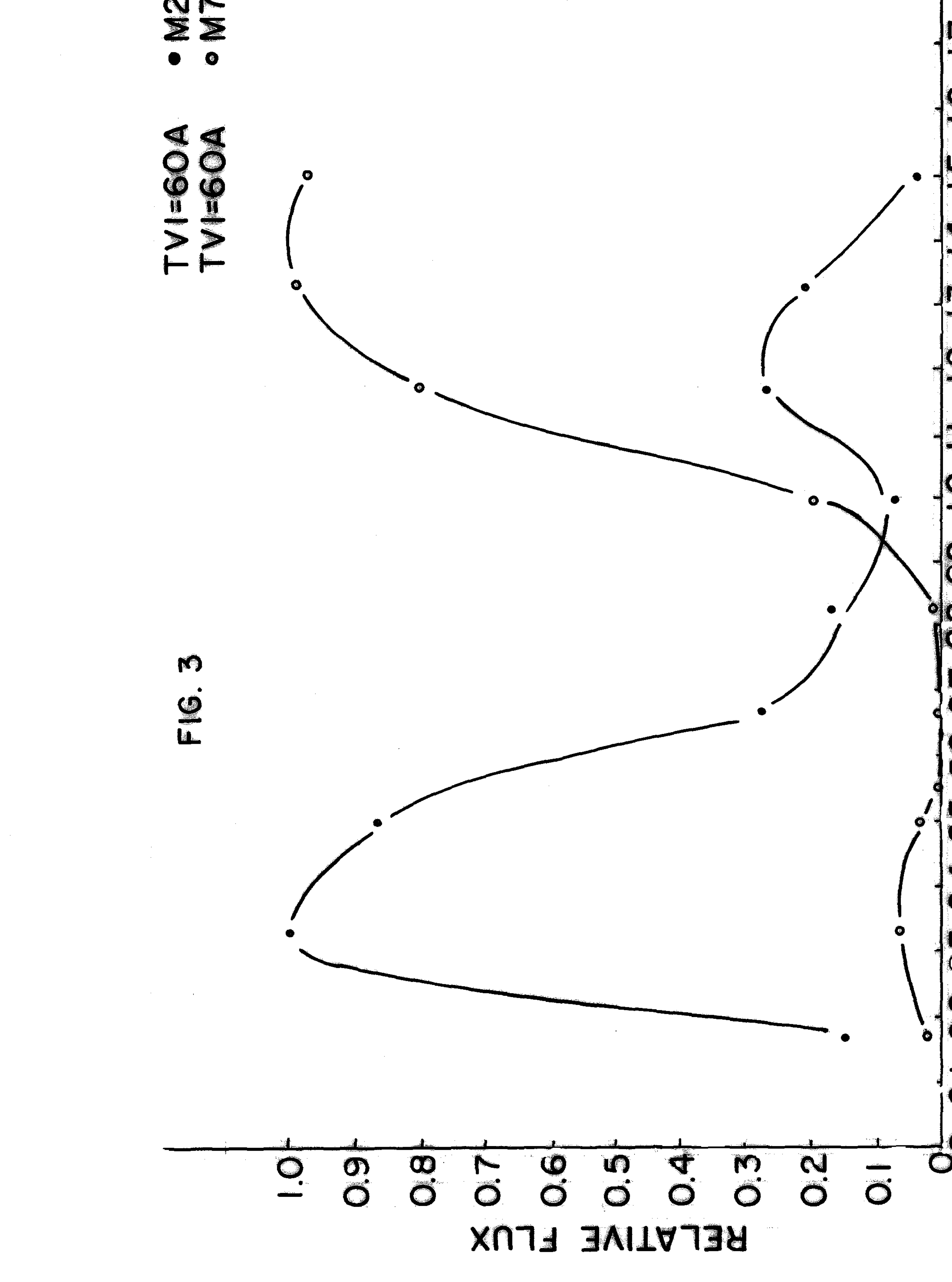
TV1=60A • M2
TV1=60A ∘ M7
RELATIVE FLUX
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7
TV2/TV1

FIG. 3

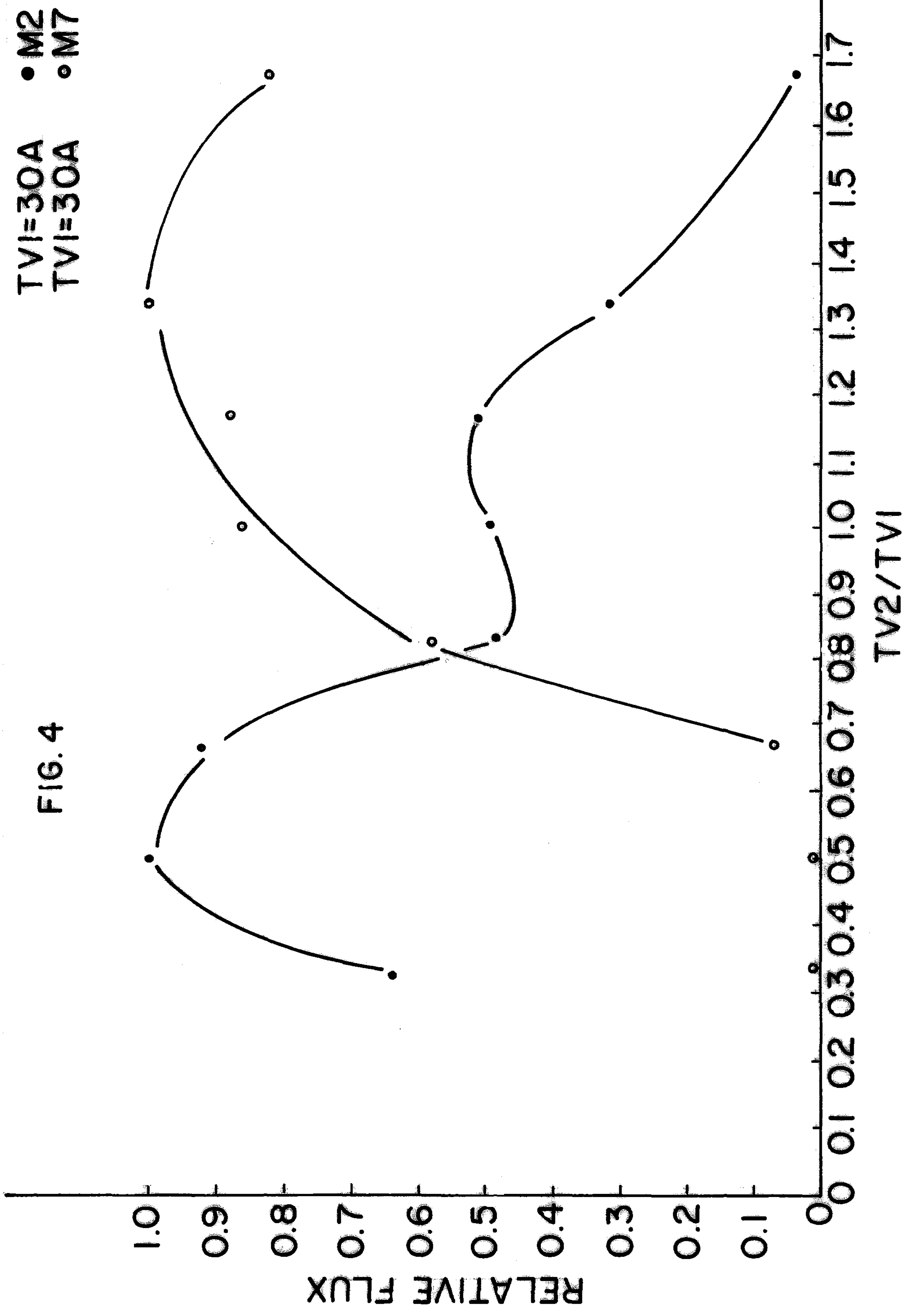
TV1=30A • M2
TV1=30A ∘ M7
RELATIVE FLUX
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
TV2/TV1
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7

FIG. 4

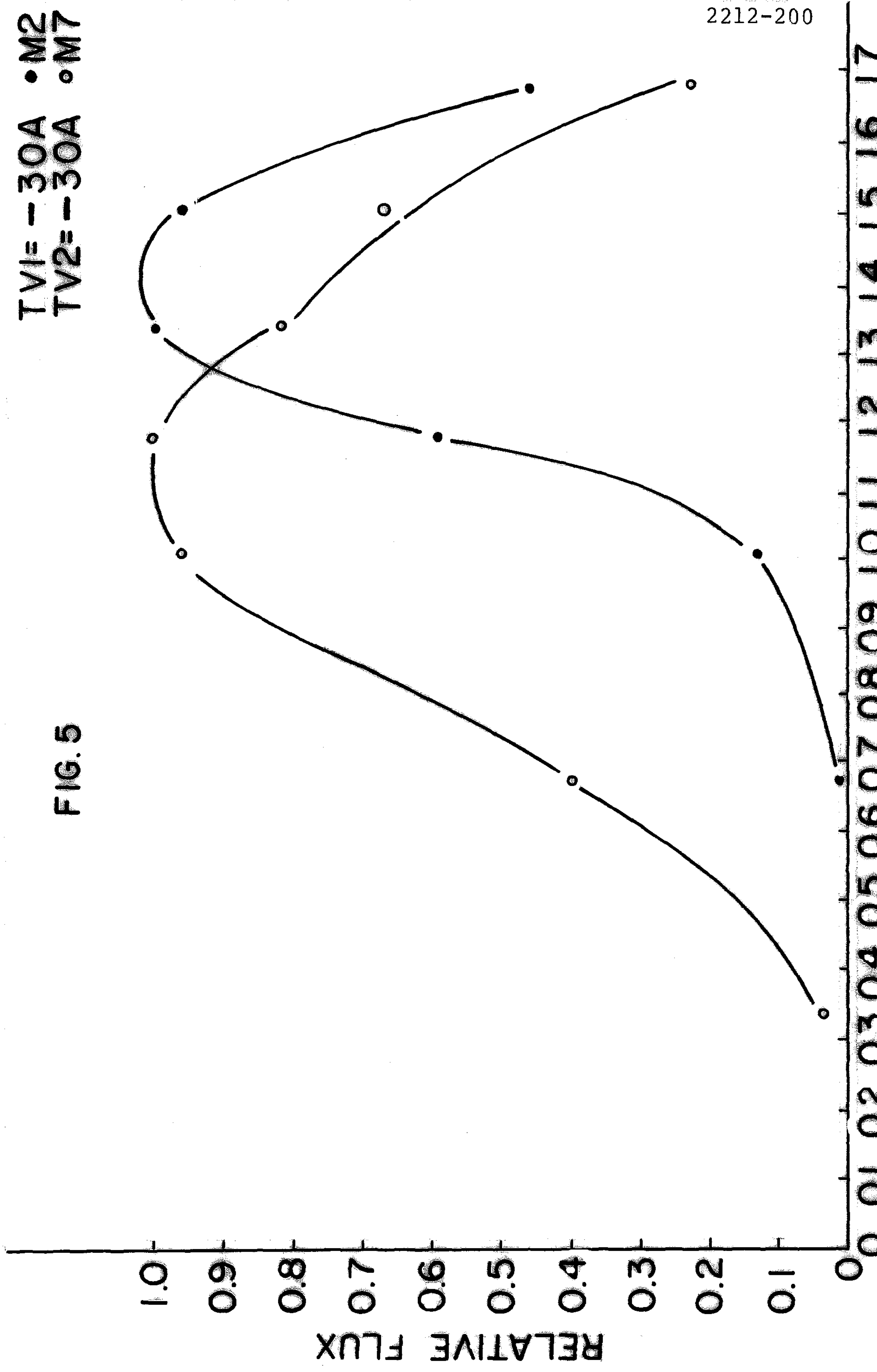
TV1= −30A •M2
TV2= −30A ∘M7
RELATIVE FLUX
TV2/TV1
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7

FIG. 5

FIG. 6