AGS Complex Machine Studies (AGS Studies Report No. 327) DEPENDENCE OF THE F6 BTA EXTRACTION MAGNET ON BOTH USER 1 AND USER 3
Study Period: 1700, April 3, 1995
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Reported by: E. Bleser
Machine: AGS PROTON COMPLEX
Aim: To understand the dependence of beam position in the BTA on the settings of the F6 extraction magnet for both User 1 and User 3.

I. SUMMARY

The F6 extraction magnet settings for User 1 and User 3 should be identical. If they are not, hysteresis effects will produce cycle to cycle motion of the beam in the BTA. In addition some motion is produced by droop in the current in the A1 extraction magnet, which should be fixed soon. These two problems MAY be sufficient to explain all cycle to cycle motion in the BTA.

II. PHYSICS

Consider Figure 1. Assume the current is looping between Ia and Ib. Then the field will be following the hysteresis loop shown figuratively between points A and B. For a given current loop there is only one stable hysteresis loop. Consider Figure 2. The current continues past Ib to Ic. We now return to Ia but the field is at point D, higher than at point A. If we now run the current up to Ib, the field goes to point E, higher than point B. If we continue to loop the current between Ia and Ib, the field will track through points F, G and so on, eventually reproducing the curve in Figure 1. Thus at the end point, Ib, the field will initially be high but will asymptotically return to point B from above. In Figure 3, we raise the current from Ia to Ic, less than Ib. If we now return to the Ia-Ib loop, the end field will asymptotically return to point B, but in this case from below.

III. OPERATIONS

In the Booster we typically operate with five magnet cycles on User 1, followed by one cycle on User 3. If User 3 is different from User 1 the magnet cycles in User 1 will differ from one another. Partially for this reason Cycle 1 in User 1 is not used to accelerate beam. Our assumption in operating the Booster is that by Cycle 2 the magnets have returned to their stable condition as exemplified in Figure 1. This experiment examines the validity of this assumption and finds it invalid for the F6 septum magnet.

IV. EXPERIMENT

The experiment consisted of holding F6 on User 1 constant at a setting of 10703, while varying F6 on User 3, taking one group of cycles at each value of F6 and recording the position at MW060 for each of the four cycles in the group. The results are plotted in Figure 4. If F6 on User 3 is increased or decreased from its value on User 1, the beam is displaced on Cycle 2 but asymptotically returns to its central value by Cycle 5. In Figure 5 we have converted the position shifts at MW060 into current shifts at F6 (1 mm = 3.901 Amps) and plotted them along with the current shifts on User 3.

V. EXTRACTION BUMP STABILITY

Figure 6 shows the case for F6(U3) = F6(U1) = 10703. It should be flat but droops in Cycles 4 and 5. This may be random or it may correlate with the reported droop in the current of the A1 extraction bump. A. Luccio has calculated the position and angle change at the F6 septum resulting from a current change in the A1 extraction bump magnet. His results are shown in Figures 7 and 8. These results can be projected to give the position shift at MW060 shown in Figure 9. From this curve and the observed positions in Figure 6 we can calculate a projected current change in the A1 magnet. These results are shown in Figure 6. These projected changes are in qualitative accord with observation.

VI. CONCLUSION

These results suggest that for F6, which is a very critical magnet, it takes several cycles for the end field to return to its desired value. It is very desirable to hold the beam steady to a few millimeters, therefore it is imperative to set F6 on User 3 equal to F6 on User 1 at all times. Several better fixes are possible and one will be implemented as soon as we accumulate a little more data.

Some current droop has been reported for extraction bump magnet A1 which is in full accord with the beam shift observed after we match F6 on both users.

This note is based on very limited data., but since data is hard to get his week, it is being issued. Next week (4/12/95) the A1 power supply should be replaced. We might then expect cycle to cycle motion to be very small.

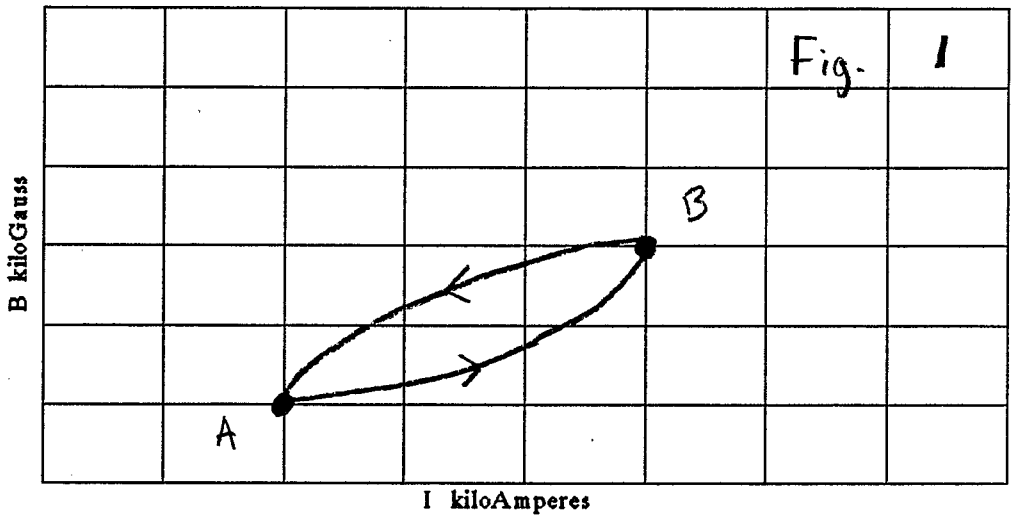


Fig. 1
B kiloGauss
B
A
I kiloAmperes

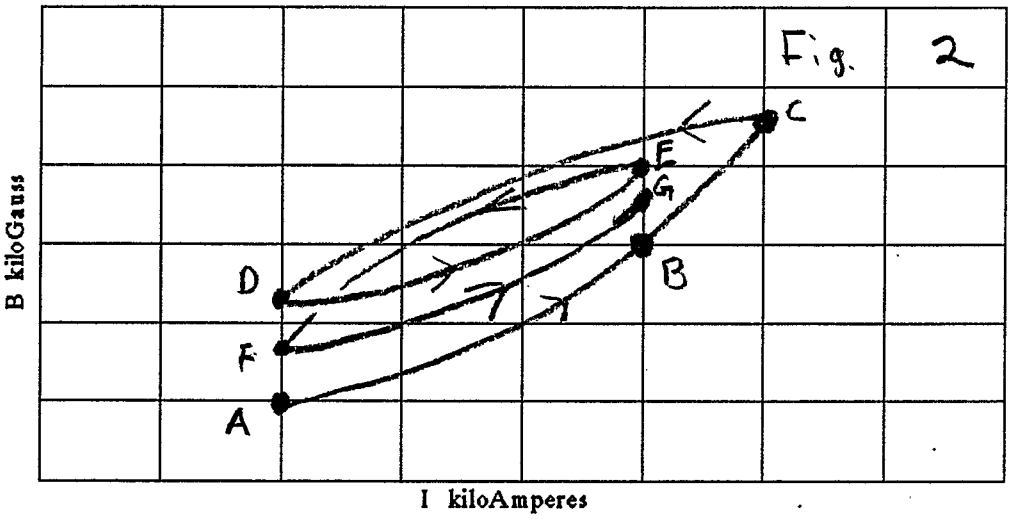


Fig. 2
B kiloGauss
C
E
G
D
B
F
A
I kiloAmperes

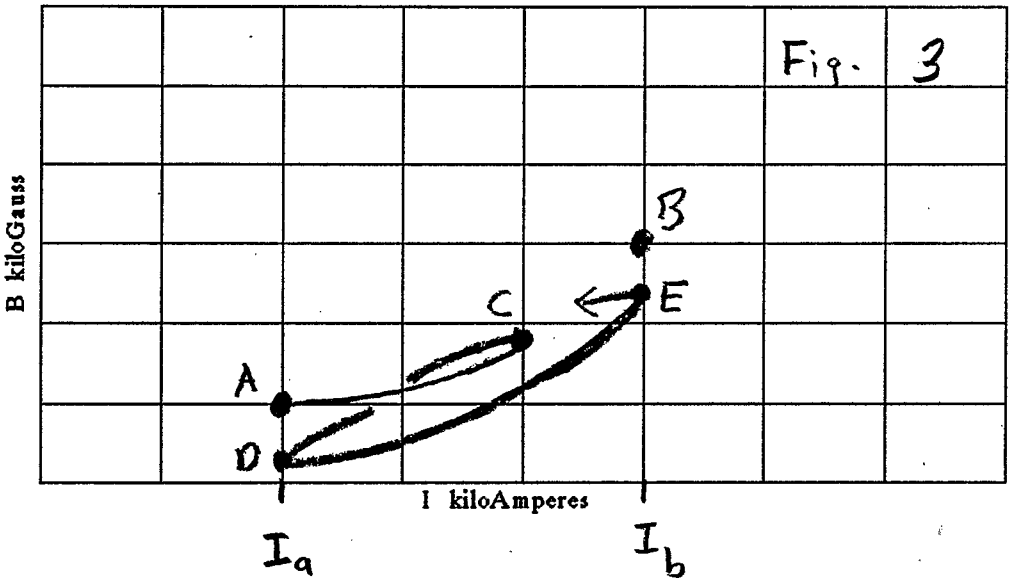
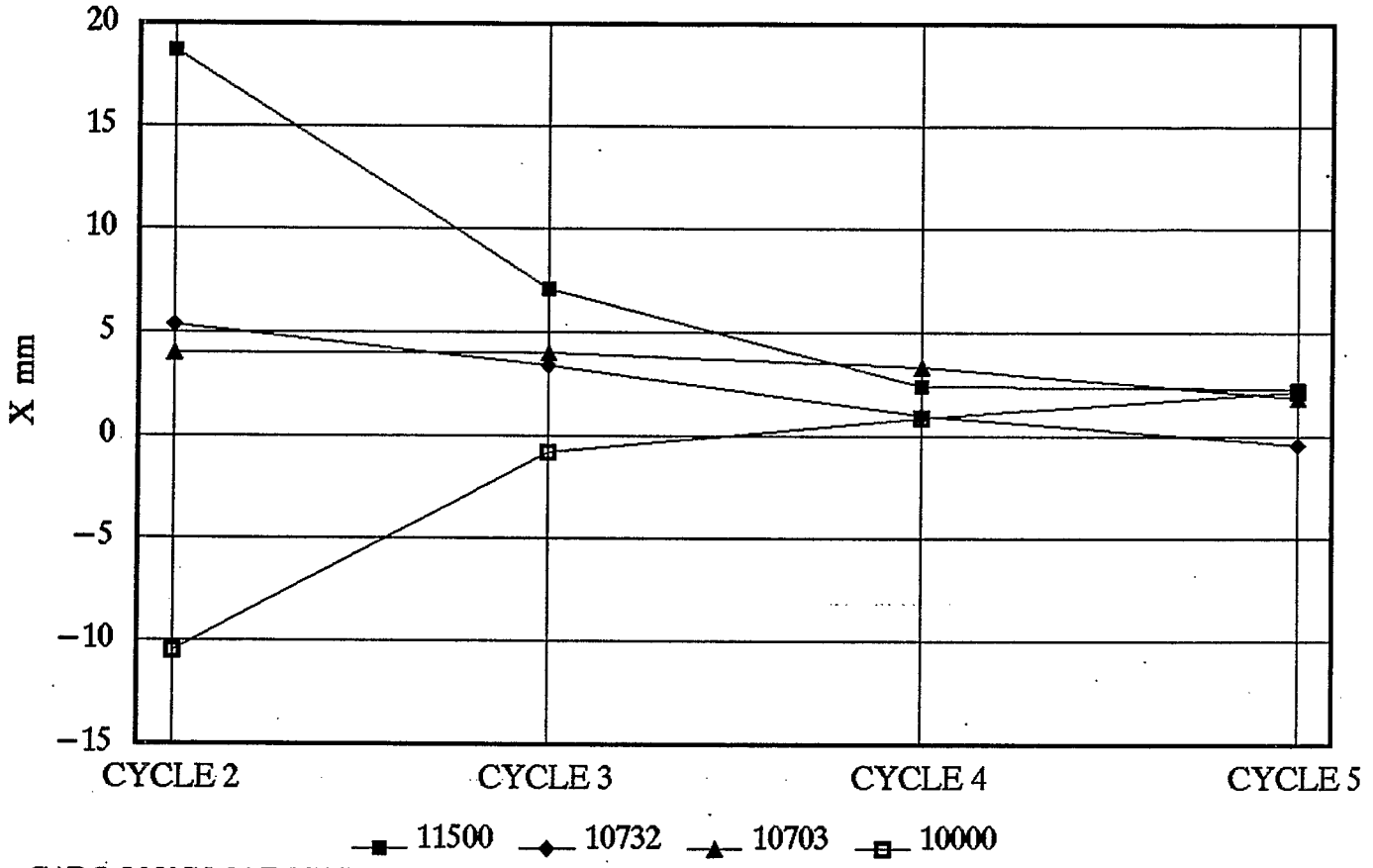


Fig. 3
B kiloGauss
B
C
E
A
D
I kiloAmperes
I_a
I_b

X at MW060 per CYCLE for F6 SETTINGS on USER 3 Figure 4
F6 on USER 1 = 10703



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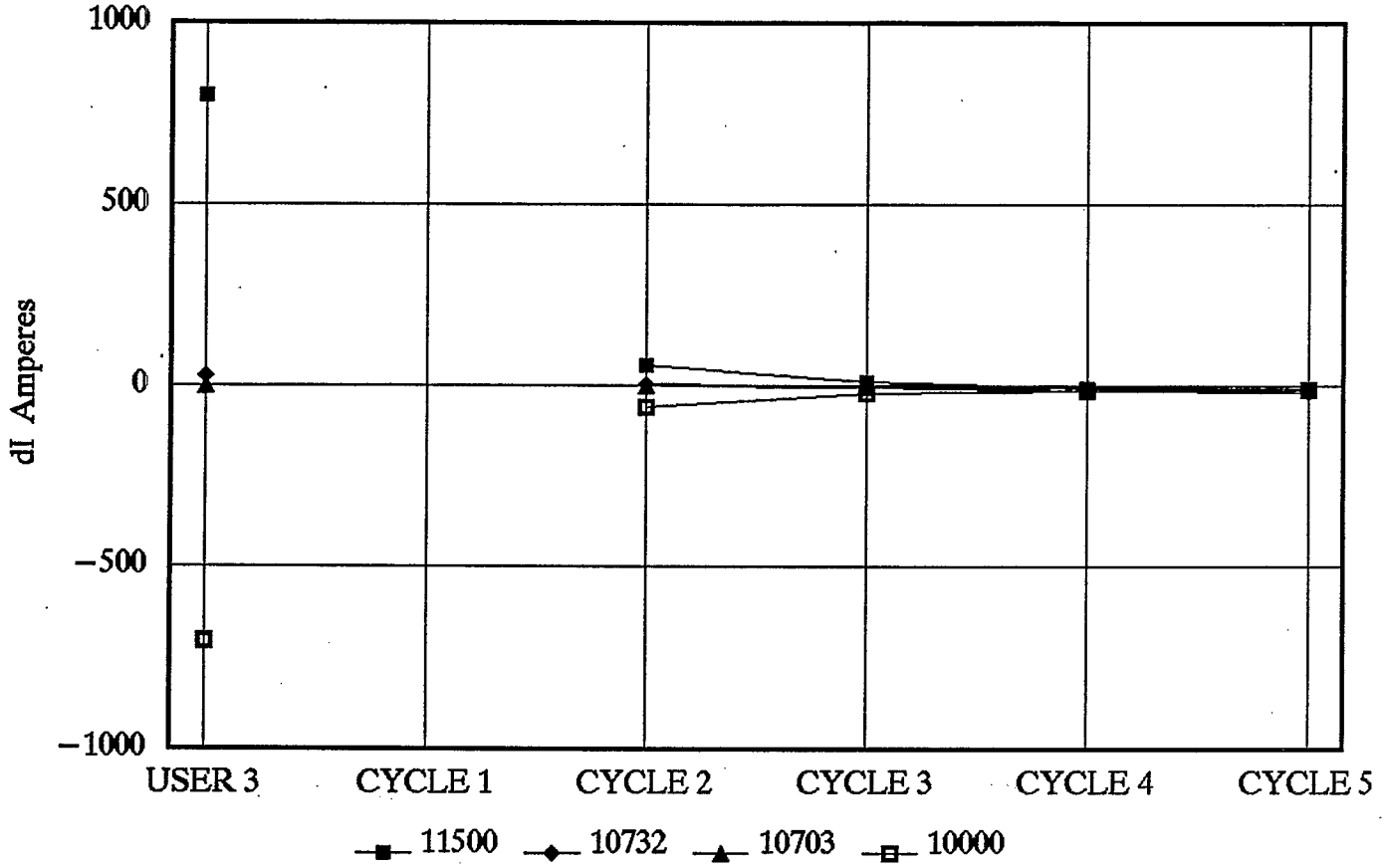
DERIVED dI at F6 per CYCLE for F6 SETTINGS on USER 3 Figure 5
F6 on USER 1 = 10703



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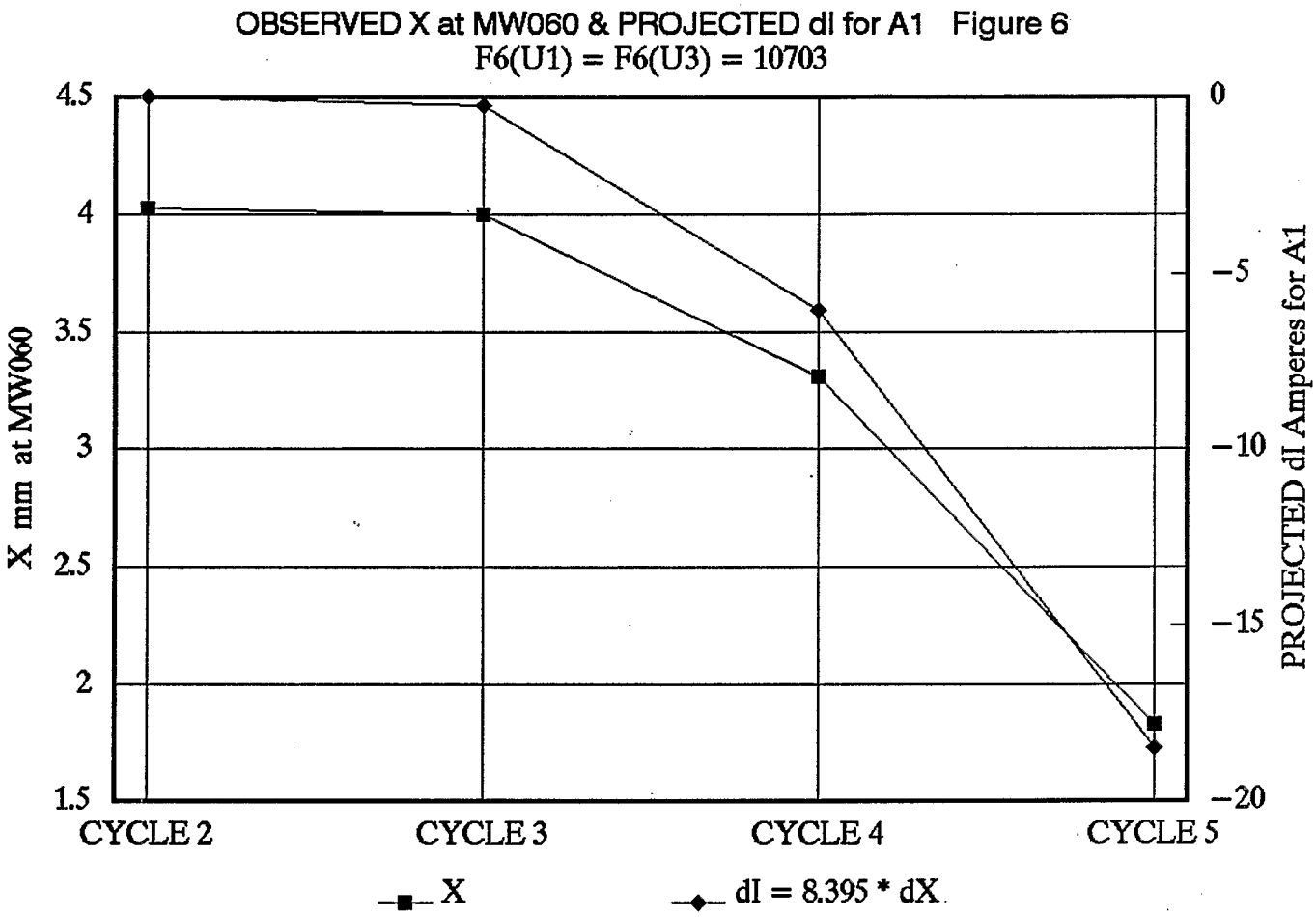

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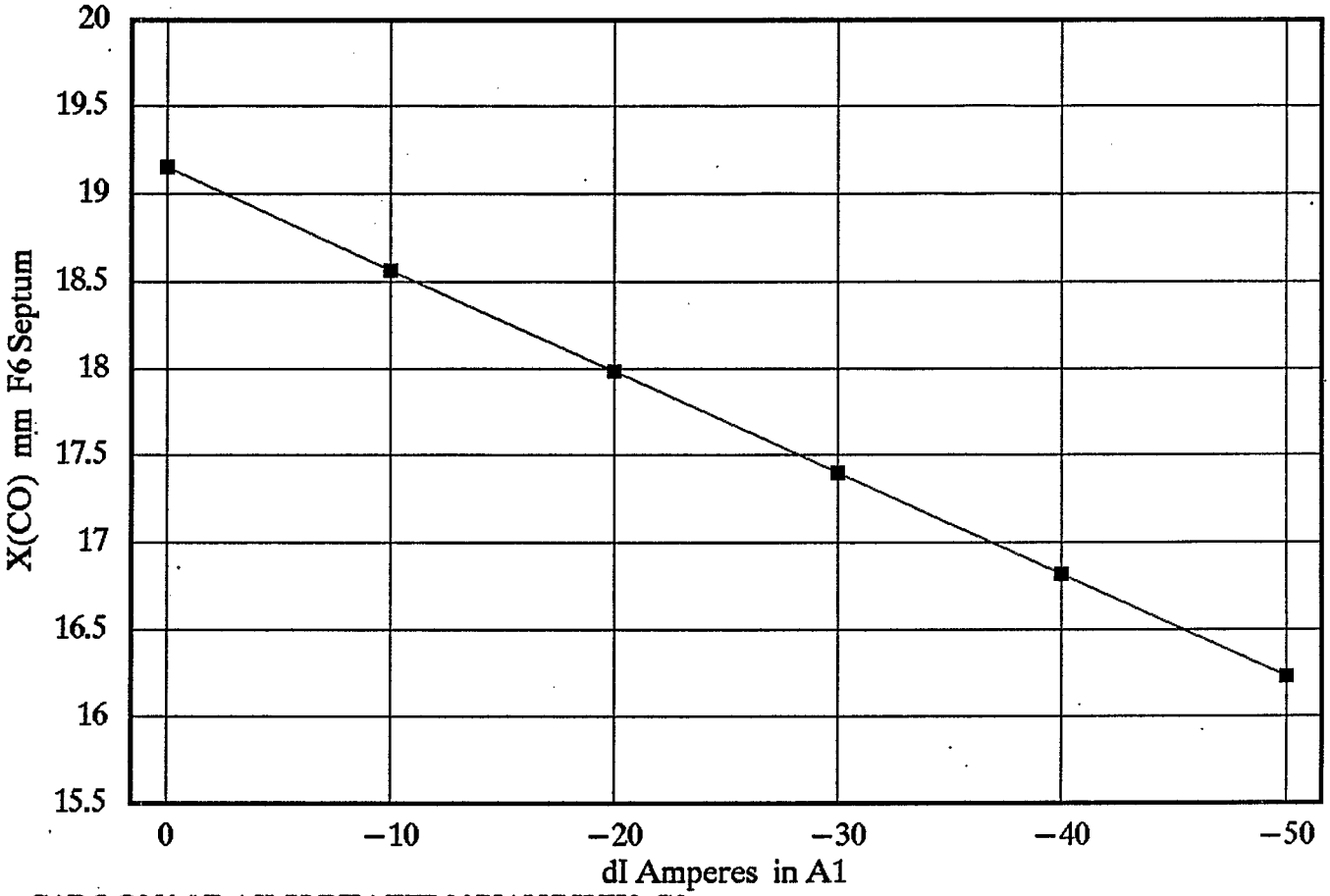
ORBIT SHIFT from CURRENT ERROR IN A1 Figure 7



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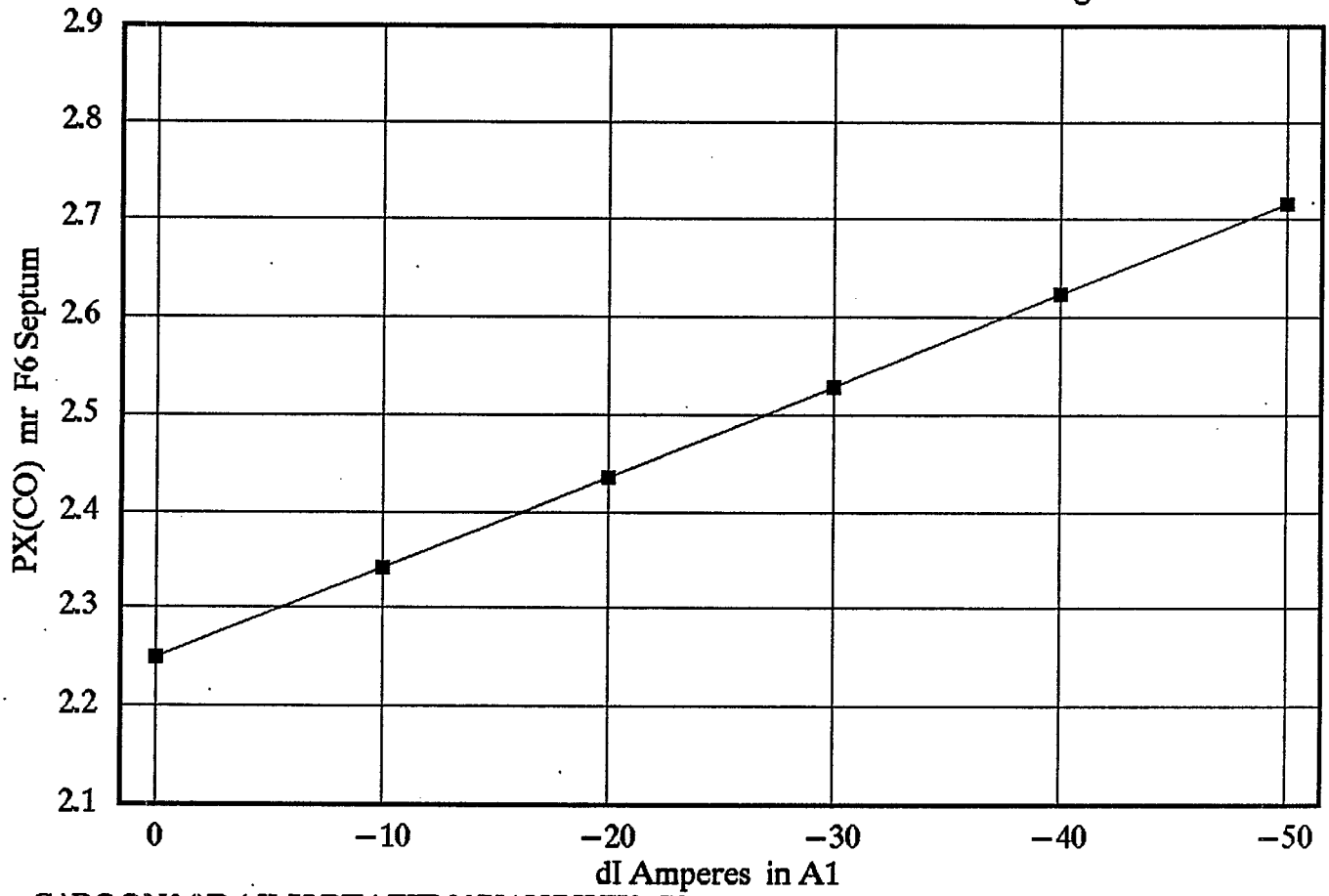
ORBIT ANGLE SHIFT from CURRENT ERROR IN A1 Figure 8



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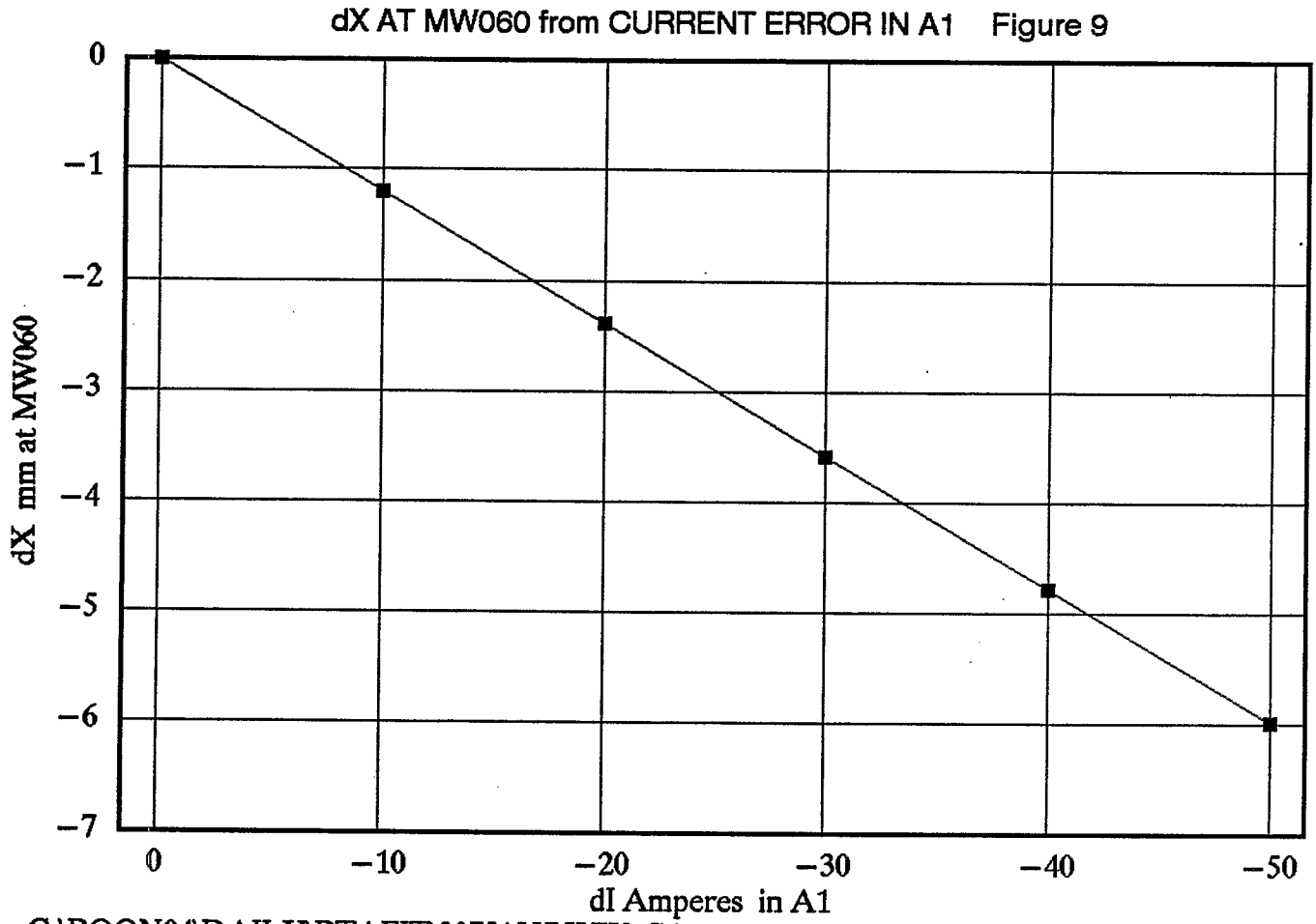

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