From: STSCIC::HARTIG "George Hartig" 2-APR-1992 16:19:49.55
To: FITCH
CC:
Subj: Ed Beaver's report on lab GIMP test

From: CASS05::BEAVER 2-APR-1992 16:11:25.82
To: STSCIC::HARTIG,BEAVER
CC:
Subj: RE: GIMP sensitivity vs obs mode

George- Our Lab GIMP setup involves placing the Spare FOS Blue Digicon in the center of a 4 foot diameter Helmholtz coil. The Helmholtz coil magnetic field is oriented parallel to the diode array axis. An IBM computer automatically increments the Helmholtz coil current, supplies current commands to the detector X,Y deflecton coils to deperm the detector, and scans a slit image for positional information. The positional information is then stored onto disk along with the commanded deperm schedule. A 25 micron wide slit image is projected onto the digicon photocathode. Paul Foster, one of our student workers, set up this equiptment and is now taking more data.

A Helmholtz coil current of 0.01 amp is equal to .031 Gauss at the detector. The step size on the y-axis of the FAXed graphs is 15 microns. If we assume a sinusoidal type of variation in the earth's orbital field at 2 cycles per 90 minute orbit with peak amplitude of 0.25 gauss, then very roughly we would expect to see a B-field rate of change of on average 0.067 Gauss per 3 minutes of orbit. Thus the 0.02 amp increment plots that I FAXed most closely simulates your Y-sweep section in the GIMP proposal. In that HST/FOS Y-sweep section, the degauss occured every 3 minutes with a resulting GIMP coefficient of 86.5 microns/Gauss. The GIMP coefficient for HST/FOS observations with single degauss only at the beginning of the observation is around 150 microns/gauss.

Note that the plots that I am sending are based on data taken many months ago to discover the dominant source for GIMP variation. If you recall, we were arguing at the time that the variation in GIMP was due to either the Y-STEP action or the Deperm timing schedule. We have more recently "advanced" to the point of running many cycles of sinusoidal simulations of orbital field variation.

Thus this set of data is not an exact simulation of our orbital GIMP. An exact simulation would require programing the calculated magnetic field orbital variation into the lab computer and performing these test for each comparison data set from the HST FOS Instrument. The data files shown in the plots have the label "RHP" since they only represent the approximate FOS performance in the lower right hand quadrant of the full hysteresis plot.

The test files shown in the plots are described as follows:

SWEEP_RHP_01.* is the measured peak position at every 0.031 gauss step into the Helmholtz coil as determined by an xsweep of the digicon deflection coils. No deperms performed in this test. The GIMP coefficient from this test is 167 microns/gauss. This is to be yielding 150 microns/gauss.

XSWEEP_ALTDEPERM_RHP_02* is the measured peak position every 0.031 gauss with an FOS deperm followed by an immediate xsweep positional measurement every 0.062 Guass. The GIMP coefficient from this test is 113.7 micron/gauss. This is to be roughly compared to the HST/FOS GIMP proposal ysweep GIMP coefficient of 86.5 microns/ gauss.

XSWEEP_ALTYSWEEP_RHP_02.* is the measured peak position with an xsweep positional measurement every 0.031 gauss with an additional xsweep positional measurement every 0.062 gauss taken after a ysweep was performed. The size of the Ysweep is set up to simulate that performed in the FOS GIMP proposal. The GIMP coefficient from this test is 167 microns/gauss.

DP_XSWEEP_RHP_01.* is the measured peak position with an FOS deperm followed by an immediate positional xsweep every 0.031 gauss. The GIMP coefficient from this test is 81 microns/gauss. This is the lowest coefficient value that we measured in the lab and remarkably similar to the HST/FOS ysweep result.

XSWEEP_ALTDEPERM_RHP_01 is positional data from an xsweep followed be a deperm and an immediate xsweep at the same point every 0.031 gauss. The GIMP coefficient from this test is 106 microns/gauss, determined by the tops of the "sawtooth". Note that for some unknown reason the slope is significantly greater than that for DP_XSWEEP_RHP_01.*. Evidently the additional xsweep before the deperm is negating some of the deperm effect.

BIG.* is positional data taken at only two points of 0.155 gauss and 0.31 gauss followed by a deperm and positional xsweep at the 0.31 gauss point. The GIMP coefficient from this data is 169 microns/gauss with the last depermed position jumping up slightly above the DP_XSWEEP_RHP_01.* slope!

DPXSW_XSW_RHP_01.* is a series of deperms with xsweep positional data to 0.155 gauss followed by a series of non-depermed xsweeps to 0.31 gauss, all at 0.031 gauss increments. The slope for the first half of the plot is that of DP_XSWEEP_RHP_01.* data. The slope of the second half is that of the XSWEEP_RHP_01.* data.

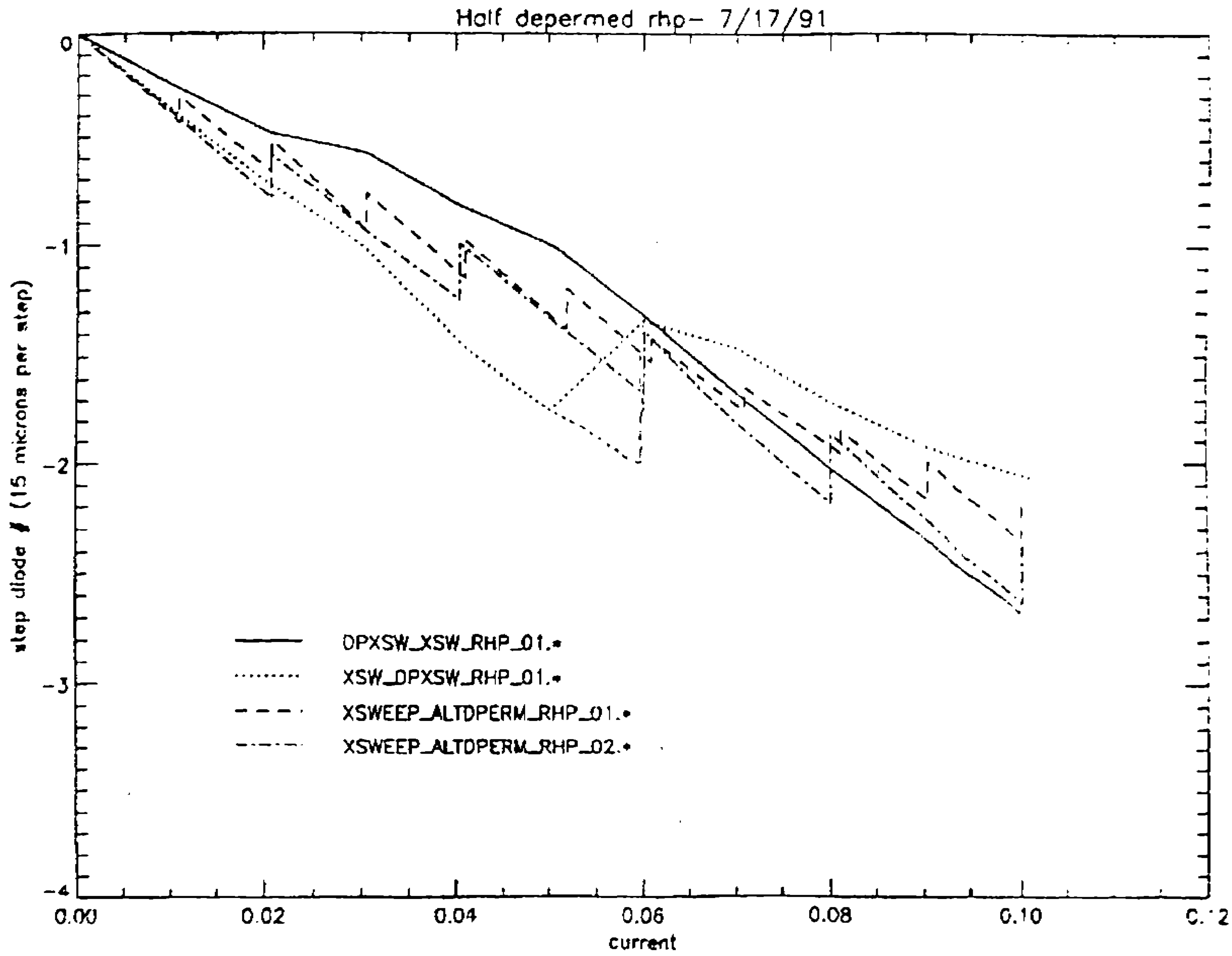
XSW_DPXSW_RHP_01.* is a series of non-depermed xsweeps to 0.155 gauss followed by a series of deperms with xsweep to 0.31 gauss, all at 0.031 gauss increments. The slopes are the reverse of the DPXSW_XSW_RHP_01.* result, as expected.

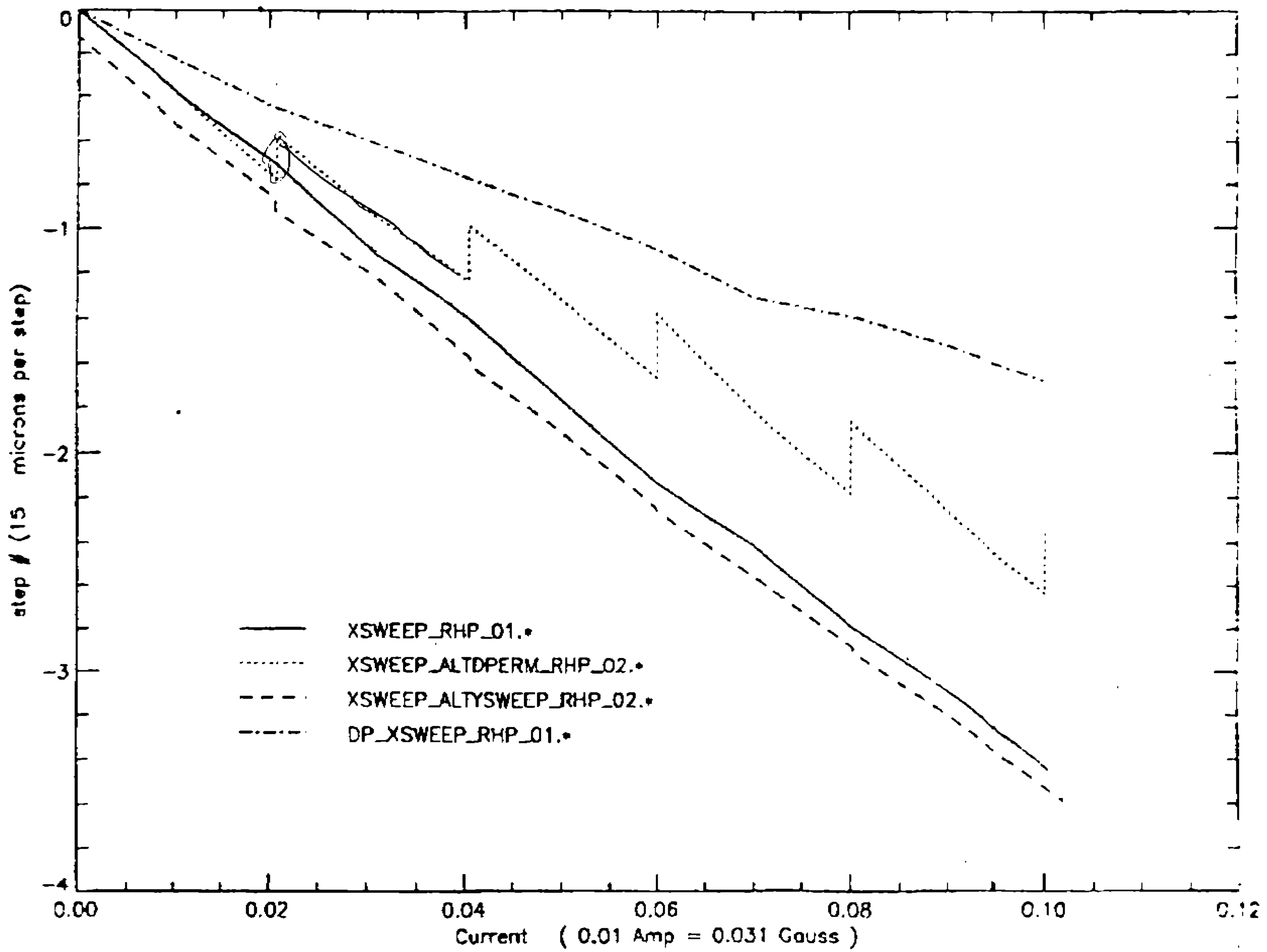
Thus a ysweep of the size performed in the GIMP proposal (400 microns) has virtually no effect on the GIMP coefficient. Also the lab tests nfirm that performing many deperms during an observation reduces the GIMP coefficient and in effect improves the magnetic shield. While the magnitude of the FOS and lab GIMP coefficients are not exact, they are

.oas in BIG.*, a final single deperm returns a position expected
m the DP_XSWEEP_RHP_01.* slope.

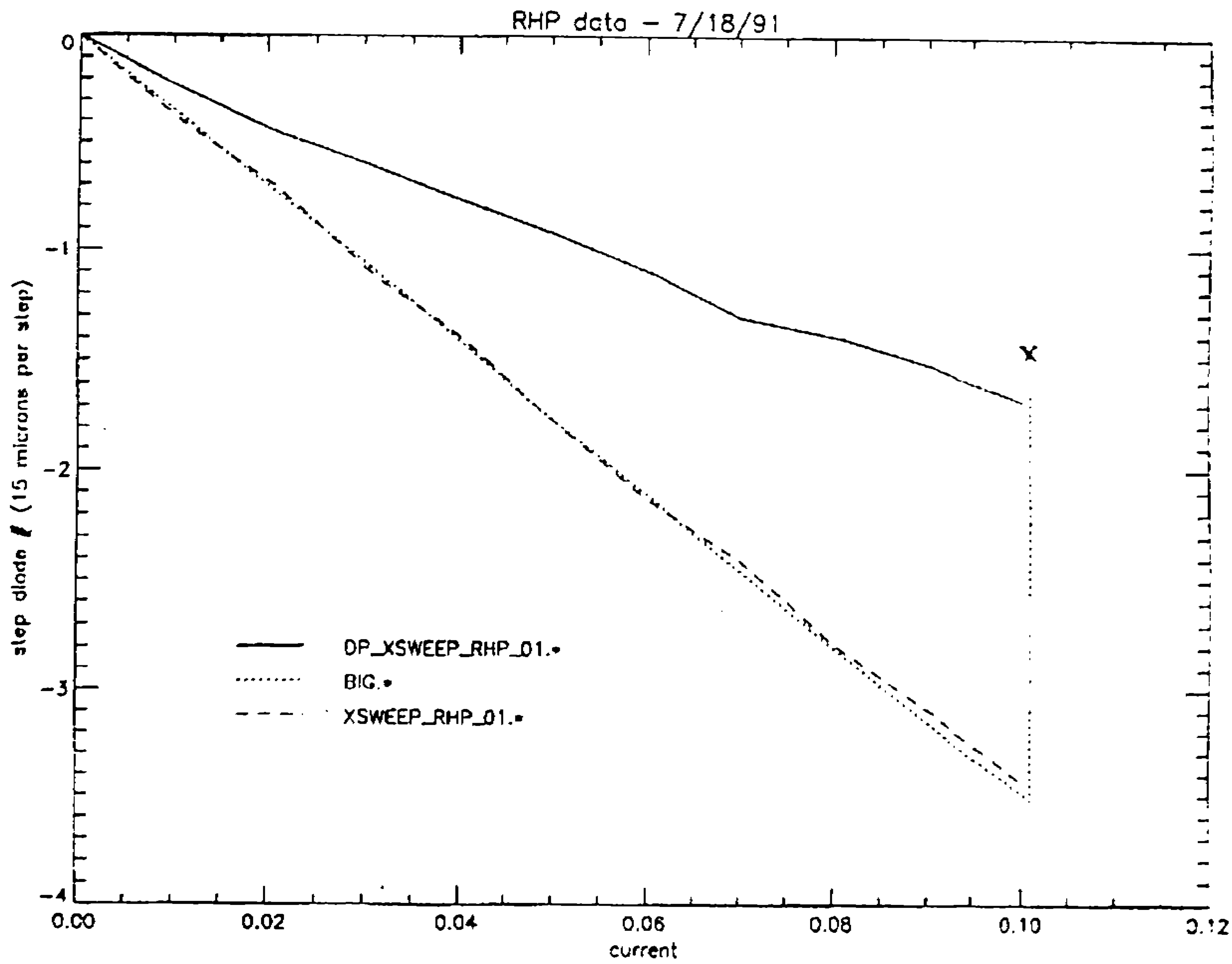
e are in the process of taking more data. Feel free to suggest your own deperm schedule. For now we could ignore the xsweep anomally d just determine the functional relationship between frequency of deperms and the GIMP coefficient, as you suggested. We may find that apart from a constant factor that we will get the same result for a series of deperm-xsweep's versus the xsweep-deperm-xsweep's. We undoubtedly would need a constant as a fudge factor anyway since the magnetic shield factor for the spare detector could slightly different from that for the HST/FOS Red detector.

Regards, Ed Beaver


Half depermed rho- 7/17/91
step diode # (15 microns per step)
current
0
-1
-2
-3
-4
0.00
0.02
0.04
0.06
0.08
0.10
DPXSW_XSW_RHP_01.*
XSW_DPXSW_RHP_01.*
XSWEEP_ALTDPERM_RHP_01.*
XSWEEP_ALTDPERM_RHP_02.*



step # (15 microns per step)
0
-1
-2
-3
-4
0.00
0.02
0.04
0.06
0.08
0.10
0.12
Current (0.01 Amp = 0.031 Gauss)
XSWEEP_RHP_01.*
XSWEEP_ALTDPERM_RHP_02.*
XSWEEP_ALTYSWEEP_RHP_02.*
DP_XSWEEP_RHP_01.*



RHP data - 7/18/91
step diode # (15 microns per step)
0
-1
-2
-3
-4
0.00
0.02
0.04
0.06
0.08
0.10
0.12
current
DP_XSWEEP_RHP_01.*
BIG.*
XSWEEP_RHP_01.*
X

[redacted]

STSCIC::HARTIG "George Hartig" 6-APR-1992 14:33:04.49
FITCH

Subj: Ed's latest treatise on GIMP

From: CASS05::BEAVER 6-APR-1992 14:26:52.58
To: STSCIC::HARTIG,BEAVER
CC:
Subj: RE: GIMP lab data

George- Just a note to keep you informed on this GIMP coefficient theory, based on lab testing. Note that we are to for a while this magnetics testing at the end of this week; the GHRS sensor head is coming to UCSD for High Voltage discharge testing.

I have put together most of our lab data and come up with a reasonable theory based also on the properties of magnetic materials. As you know, the basis for the theory of variable GIMP coefficient is that the degauss schedule (alias "deperm") tends to reorient the domains of the magnetic material in the FOS detector structure and reduces the PMFA magnetization vector "M". Thus the total magnetic field "B" seen by the detector electron image is

$$F = E*A + M$$

where "A" is the attenuation of the detector shield
"H" is the external Earth field incident on the detector.

Now we see from the lab data several things.

1. That the reduction in "M" after a degauss is proportional to the size of the change in "F" since the last degauss.

   The literature on magnetic materials describes the domains as small, sticky regions that rotate with changing magnetic fields. They of course are not all rotated in the same direction but collectively tend to rotate in the dirction of the external field. In this situation we would say that the torque force to cause these domains to rotate so as to give a minimal "M" is prportional to the change in the B field since the last degauss. This is why the single "BIG" degauss leads to a major jump at the 0.31 gauss point, whereas the jump at every 0.062 gauss is less than that for every 0.031 gauss.

2. After a degauss, the shift in image position always follows the "no degauss" GIMP coefficient of 167 microns/gauss.

   A degauss rotates the "sticky" domains to a certain orientation that collectively results in a reduction of "M". However the slowly changing "F" field is not capable of torquing these domains any further into the direction of "F". So that the same slope occurs after a degauss as before only the starting point changes. Note the temporal caveat in item 4.

3. Data that you have not seen yet is that the GIMP coefficient obtained by substituting the GHRS degauss schedule for the FOS yields 34 microns/guass, 61 % less than the FOS GIMP coefficient at the same rate of 0.031 gauss

rotates the domains and reduces the "M" vector. It is believed that this resulting high GHRS magnetic field really moves the domains around.

4. If the detector is put in an external field and a degauss is performed then over a period of hours to days the image moves back toward the original position before the degauss.

   The magnetic domains in the PMFA are slowly realaigning with the external magnetic field. This is probably caused by thermal effects and may not even be seen in the FOS instrument since it sits at -10 degrees C. Even in the lab test this temporal factor appears to be a small factor we try to do the tests in 1/2 hour or so.

Thus the net GIMP factor for a particular observation is a function of the degauss schedule, the Earth's field profile for the orbit and the specific functional relationship of the PMFA magnetization vector with degauss and the size of the magnetic field change between degausses. No wonder we never get the same GIMP coefficient with the FOS!

However a computer study of the GIMP coefficient for various orbits likely would give an average sort of GIMP factor that is functionally related to the frequency of degaussing; after all this appears to be the dominant factor. Seems to me that we could for now just take the saw tooth model shown in XSEEP_ALTDEPERM_02. That is, the image shifts at a rate of about 150 microns/gauss; however when a degauss occurs the image position jumps a fixed amount inversly related to the frequency of the degaussing then decays at 150m/g....

In any event I will fine tune this model in the next few days. I may ask one of our undergaduate students to look into the degree of variation we would expect to see for extreme orbits.

Regards, Ed Beaver

STSCIC::HARTIG "George Hartig" 7-APR-1992 14:27:25.79
FITCH

bj: More on GIMP from Ed

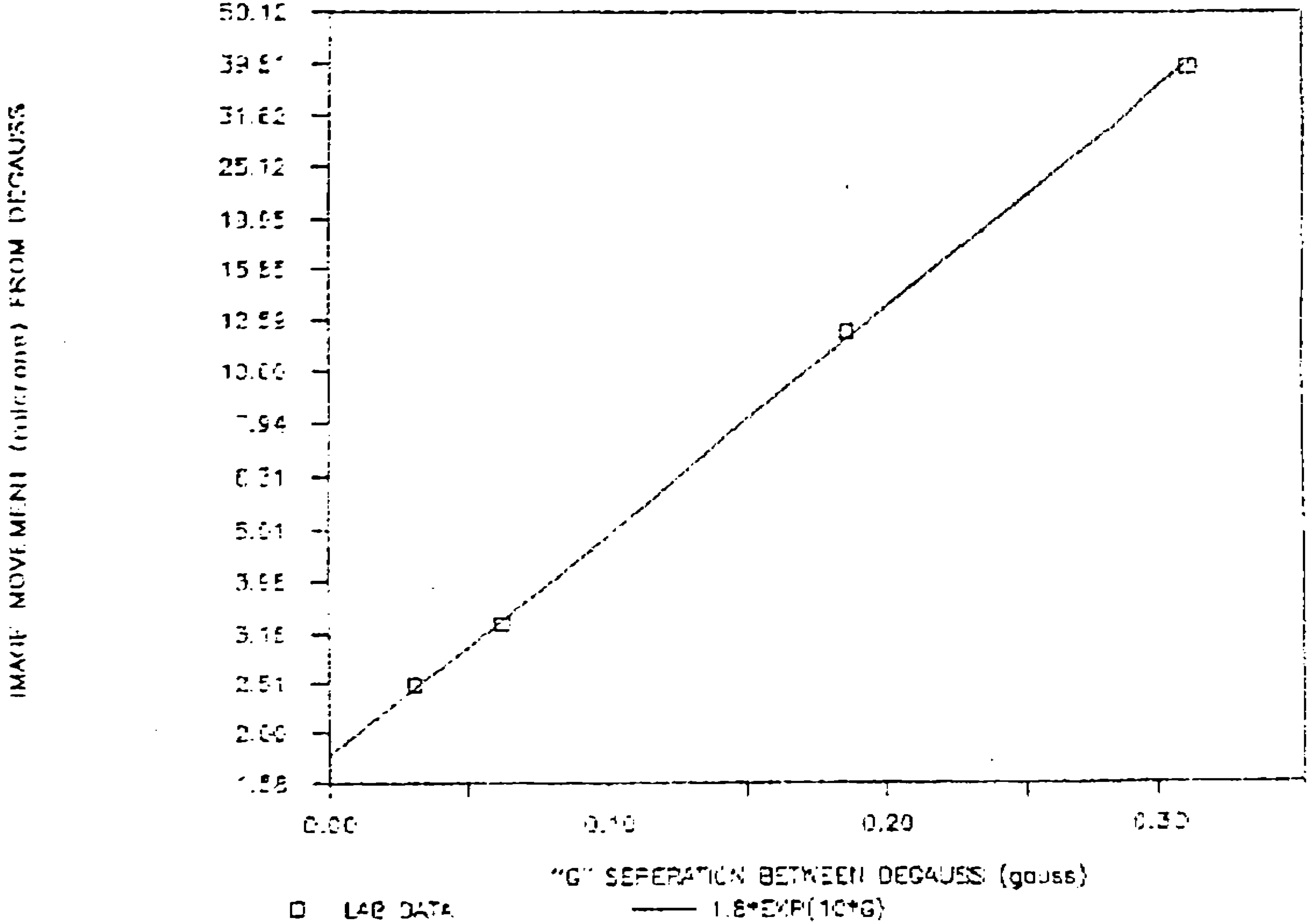
om: CASS05::BEAVER 7-APR-1992 14:10:40.40
To: STSCIC::HARTIG,BEAVER
CC:
Subj: RE: GIMP model

George- I am sending FAX to you of a plot of the image shift caused by an FOS degauss as a function of the separation "G" in gauss from a previous degauss. As you see, this lab data is fit almost perfectly by the equation 1.8 microns times EXP[10*G]. If the "sawtooth" theory holds up to further testing, then we can at least explain the image shifts that take place during an observation, such as the 40 micron degauss jump in big. It seems to me that we could now come up with the functional relationship between the average GIMP coefficient and the rate of degaussing if we approximate the orbital magnetic field with a sinusoid. I will look into this.

Your idea of no degauss at all is very attractive. My only worry is the degree of image wandering that will take place due to hystersis during a long observation. Undoubtedly any degauss activity would tend to suppress hysteresis effects. I will think about this also. In any event these are all details and implimenting an average real time GIMP should greatly improve our present situation.

FOS/LAB DEGAUSS FUNCTIONAL RELATIONSHIP

EAB 4/7/92



STSCIC::HARTIG "George Hartig" 9-APR-1992 14:07:29.77
FITCH

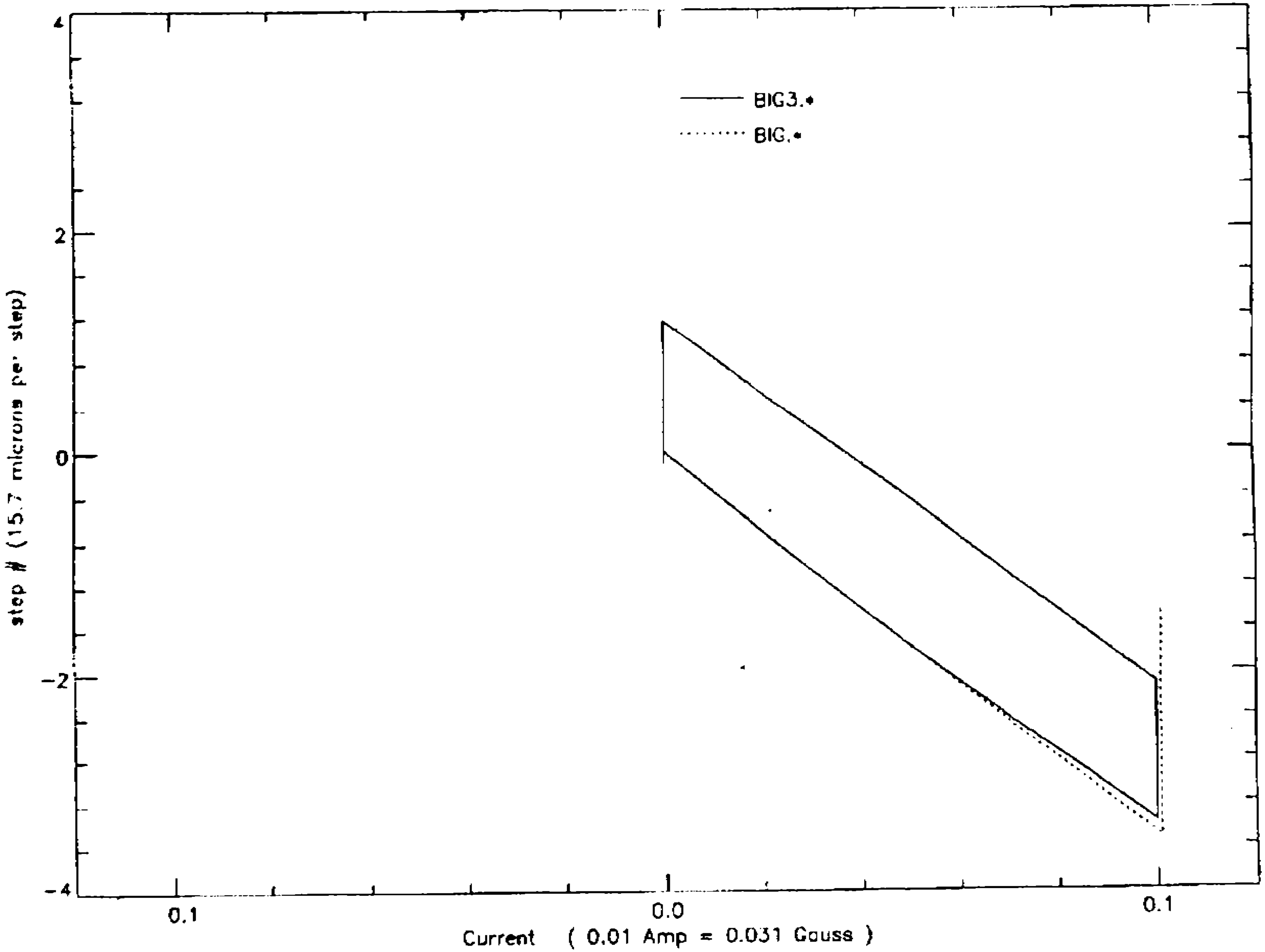
bj: More GIMP data from Ed

om: CASS05::BEAVER 9-APR-1992 13:58:55.06
To: STSCIC::HARTIG,BEAVER
CC:
Subj: GIMP theory prediction actually verified by data

George- In setting up the GIMP theory based on "Sawtooth" plots, I immediately had the question as to what happens when going from say 0.3 gauss to 0. gauss. Paul just ran "Big" again and added the next step of .3 to 0 gauss with one additional degauss at 0. gauss, the last step. My prediction (based on Sawtooth) was that we would see a traposoid with the final point after degauss around 0. gauss. Every one was amazed (even myself) that this prediction actually was verified by the data. Now on to computer simulation.

Pam is FAXing "Big3" to you now. Certainly is an eye opener to what is taking place in orbit.

Regards, Ed Beaver



** TOTAL PAGE.02 **

CASS05::BEAVER 9-APR-1992 18:04:16.57
STSCIC::HARTIG,BEAVER

bj: Please discard previous mailing and use this

Jorgo- We did take the data you want to see back on Aug. 15 ! Stop the world, it's all going to fast. Anyway it was a five cycle run; for reference, file is entitled " XSWND.* ". Pam is FAXing plot of first cycle (simulating 45 minutes of orbit) and then a plot of all 5 cycles. You can see the small (2.3 micron) hysteresis effect at 0.0 gauss. This hardly seems very important. Note also in the full 5 cycle plot that we are seeing a small drift movement with each cycle to lower position values. We are not sure if this is something also hapening in space or an artifact of our Lab setup. To do the Lab setup 100%, we should really have the Helmholtz coil with detector in a magnetically shielded room.

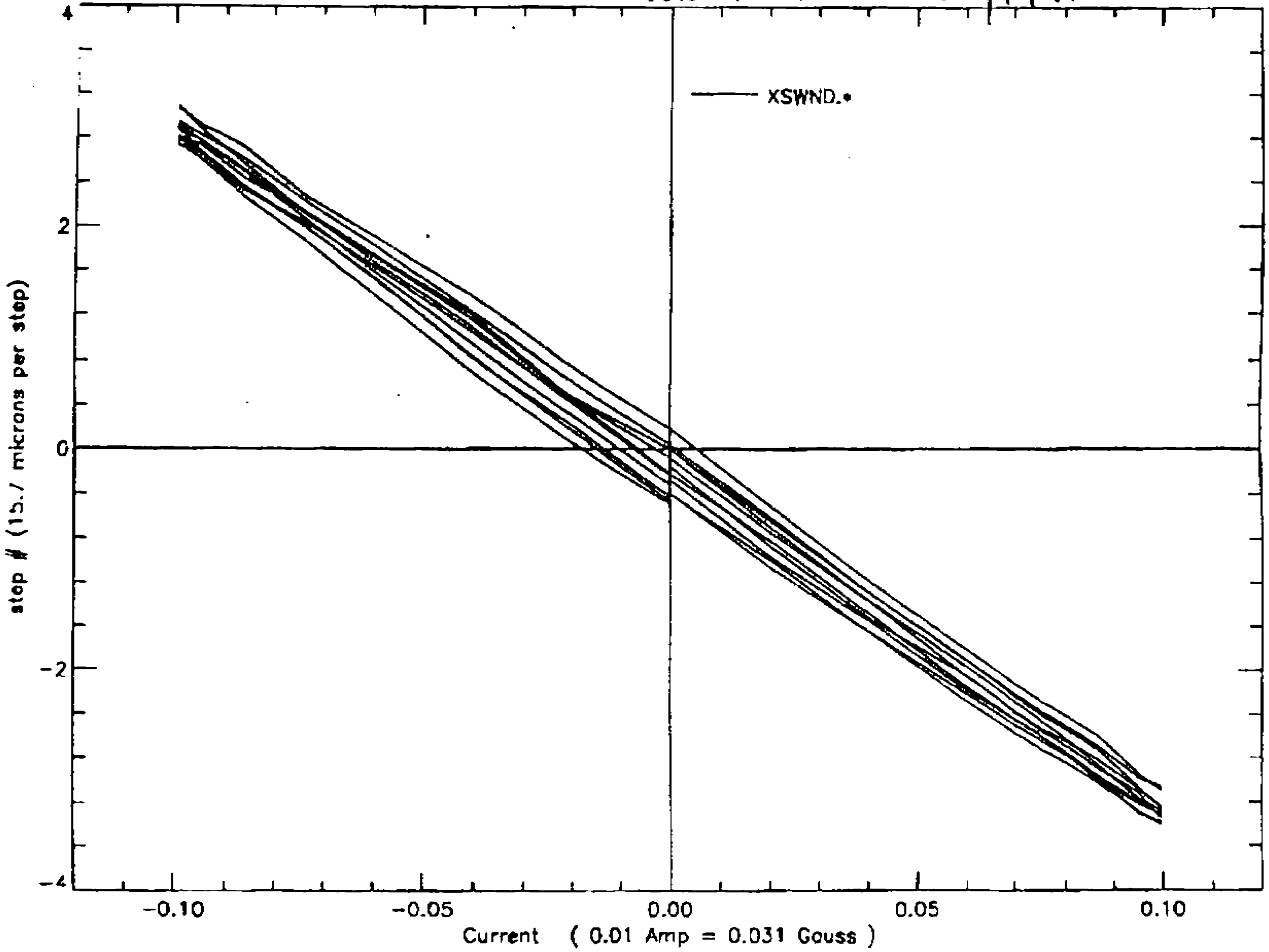
What makes me think that this drift effect may have some significance to the HST space digicons is that it becomes less with degaussing and also appears to showup in this computer simulation I have just completed. However as I said, we also see the drift, albeit somewhat smaller in the degauss data, and the drift is small for a typical hour long orbit; so " no degauss" real time GIMP looks good to me.

The next issue is whether we do a degauss at the start of an observation to make sure our "origin" remains fixed. My feeling is that this might be important in stablizing any long term drifting. However the data from "Big" worries me since it suggests that infrequent degaussing can lead to large jumps. Too bad we can't perform an SV tests on these issues. I can look at them in the lab but someone is going to have to pay a few bucks for better equiptment.

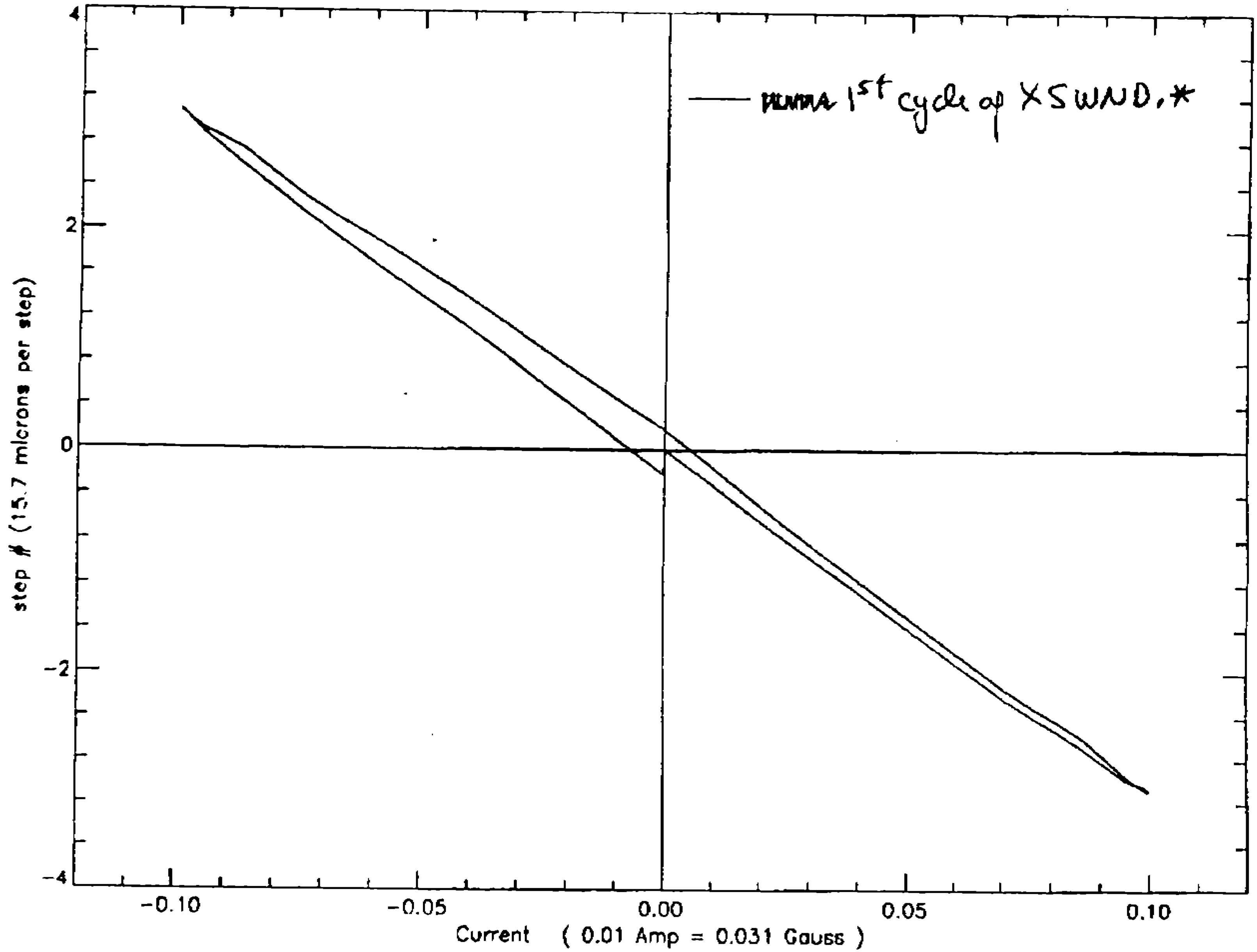
I will think about this last issue. Do we have any data on Space FOS image drift?

Regards, Ed Beaver

date 8/20/91 AUG 15, 1991



** TOTAL PAGE.03 **



1st cycle of XSWND.*
step # (15.7 microns per step)
4
2
0
-2
-4
-0.10
-0.05
0.00
0.05
0.10
Current (0.01 Amp = 0.031 Gauss)

```
From:    STSCIC::HARTIG        "George Hartig" 15-APR-1992 09:46:32.17
To:      FITCH
CC:
Subj:    More on GIMP from Ed

  om:    CASS05::CAPODICCI    13-APR-1992 17:14:15.56
To:      SCIVAX::HARTIG,CAPODICCI
CC:
Subj:    e-mail, beaver
```

Dr. Hartig:

Ed left for a business trip and was having difficulty mailing you this email message prior to leaving. You should also have received a fax of several pages dated 4/13/92. Thanks - Pam

```
From:    CASS05::BEAVER       13-APR-1992 13:25
 o:      CAPODICCI
 ubj:    Please EMAIL to Hartig

From:    CASS05::BEAVER       13-APR-1992 13:11
To:      STSCIC::HARTIG,BEAVER
Subj:    Gim model output
```

George- Pam is FAXing to you the computer GIMP model plots. This model is setup as we have discussed previously with non-degaussed GIM factor of 150 microns/gauss and the exponential function for the degauss factor. The model imput earths magnetic field is a sine function with amplitude of 0.25 gauss. The sin fit you see on the ots is the GIM factor shown on the plots times the sine function. e period of the sine function is 45 minutes.

Note that our test data on which this model is based only covers a region degaussing repitition region of from several minutes to some 10 minutes. The several plots outside this region shoud only be considered "food for thought" until verified by experiment.

Several points of interest are:

1. Degaussing every 3 minutes gives almost the exact GIM factor we see in the Target Acquisition observation: Model 90 microns/gauss vs. measured 86 microns/gauss.

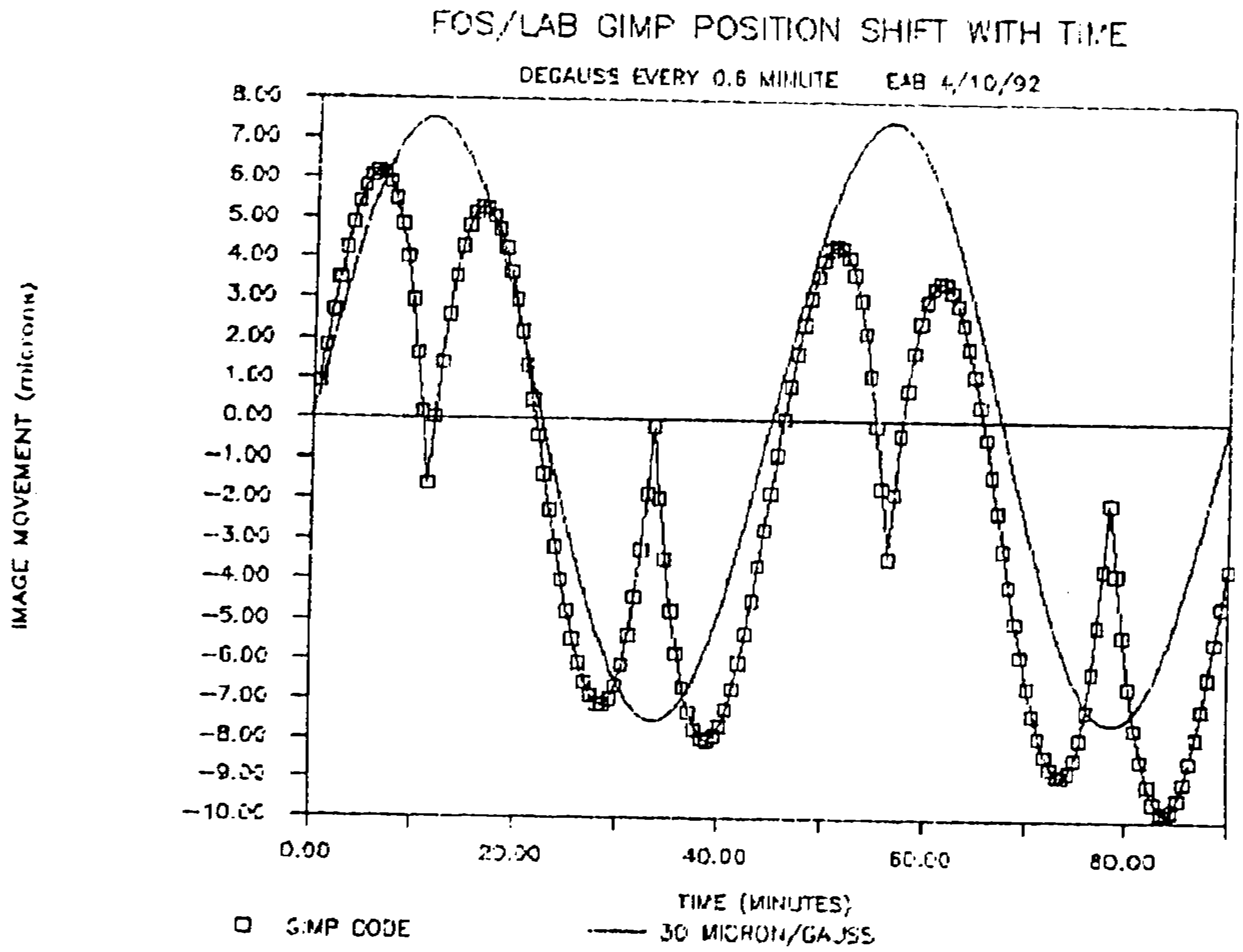
2. from 2 minutes to 6 minutes, the GIM factor remains fairly constant at about 90 microns/gauss.

3. Below 2 minutes the accumulative degauss action starts to overcome the GIM shift and significantly reduce the GIM factor. Note again this may be an artifact of the model since the exponential fit says that at 0.0 gauss seperation between degaussing, there is still a 1.8 micron shift. We will check this experimentally.

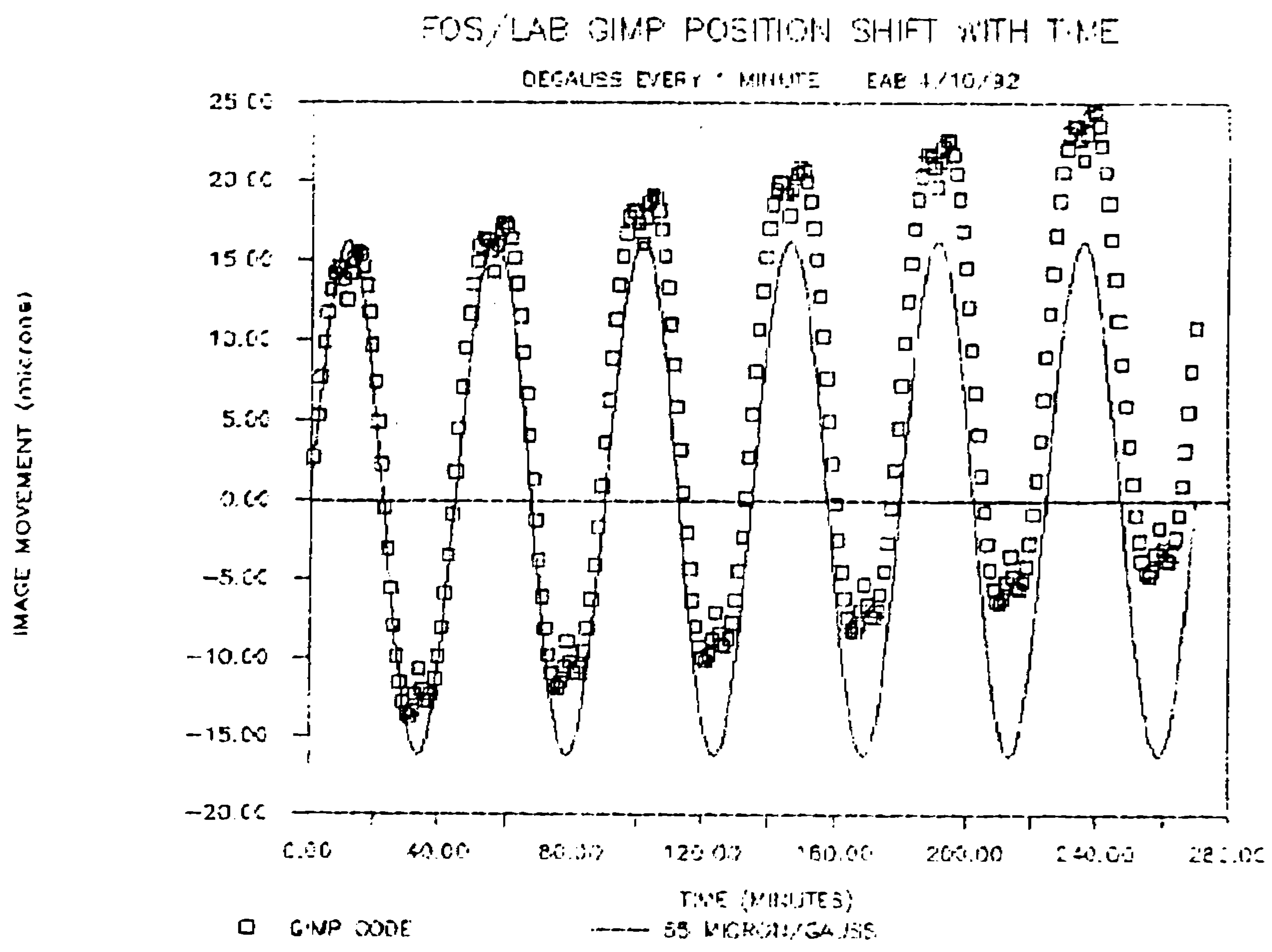
4. Above 6 minutes, obvious undersampling phenomena start to appear. This becomes particularly noticeable at 20 minutes.

5. Except at 4.5 minutes, all the models tend to drift with me, one way or the other.

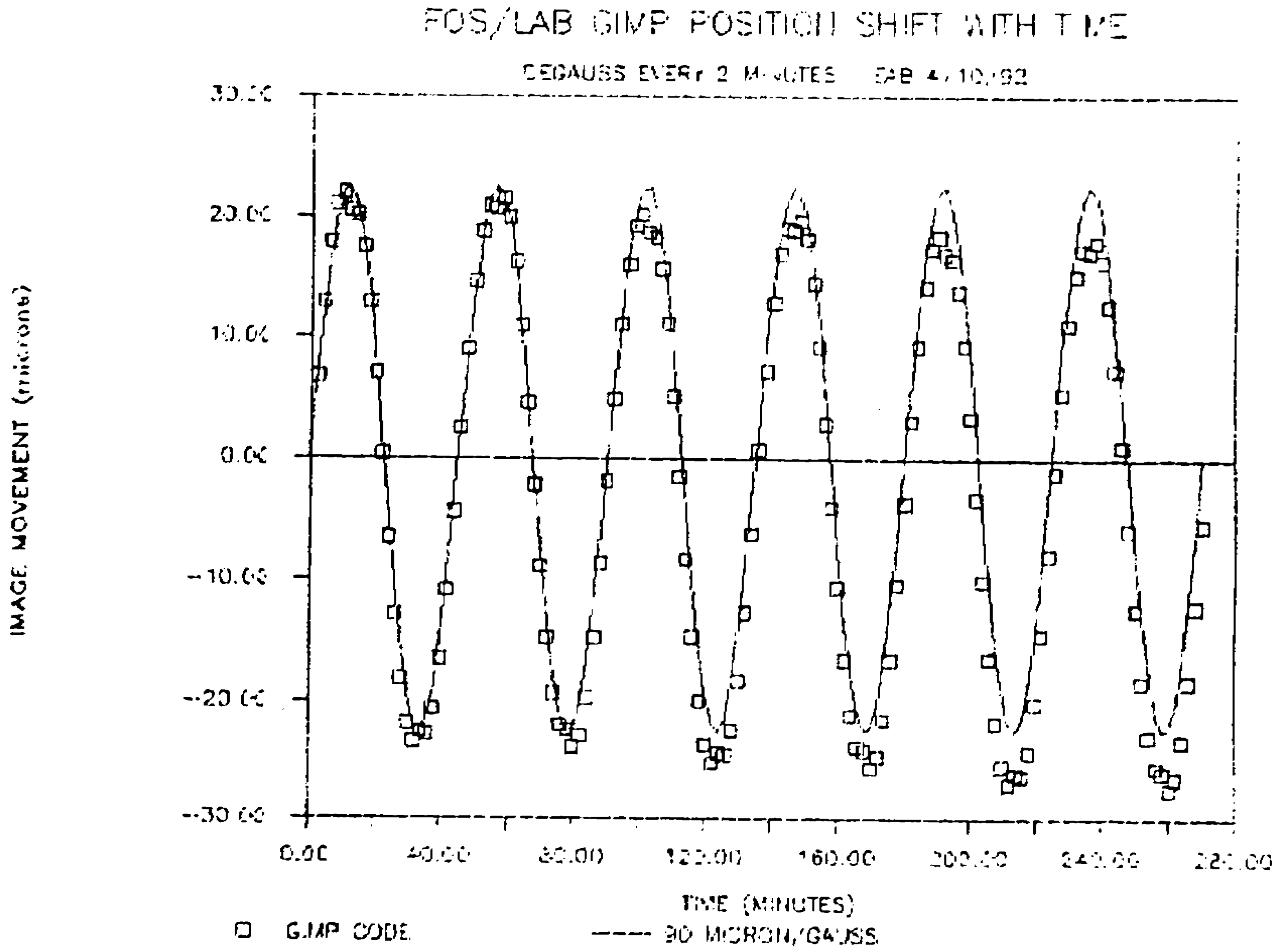
Bill Baity and I are now going to pick up the GHRS spare sensor head. This will take several days. Hopefully we can complete these Lab

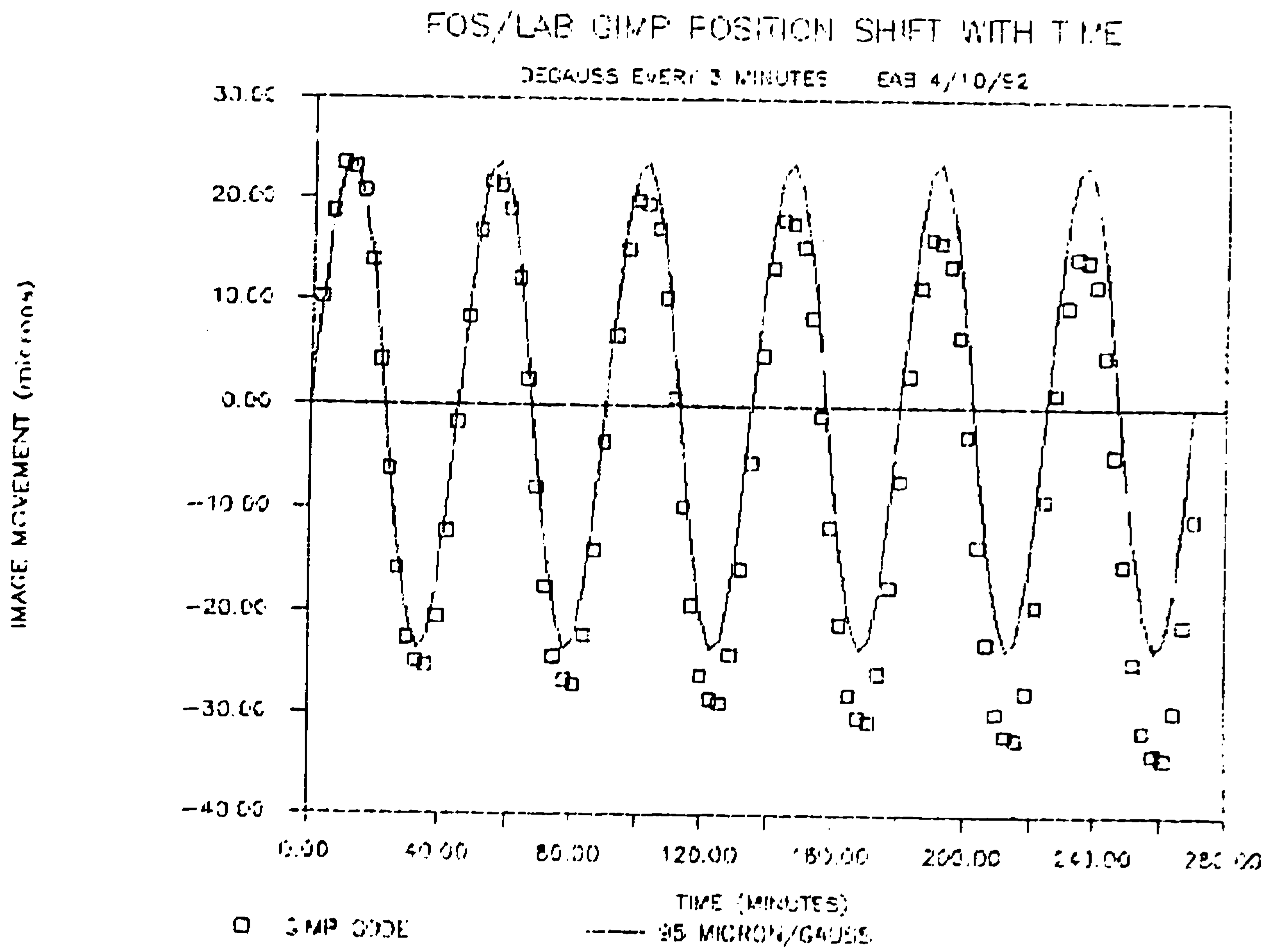


FOS/LAB GIMP POSITION SHIFT WITH TIME
DEGAUSS EVERY 0.6 MINUTE
EAB 4/10/92
IMAGE MOVEMENT (microns)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
−1.00
−2.00
−3.00
−4.00
−5.00
−6.00
−7.00
−8.00
−9.00
−10.00
0.00
20.00
40.00
60.00
80.00
TIME (MINUTES)
GIMP CODE
30 MICRON/GAUSS



FOS/LAB GIMP POSITION SHIFT WITH TIME
DEGAUSS EVERY 1 MINUTE EAB 4/10/92
IMAGE MOVEMENT (microns)
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
0.00
40.00
80.00
120.00
160.00
200.00
240.00
280.00
TIME (MINUTES)
GIMP CODE
55 MICRON/GAUSS

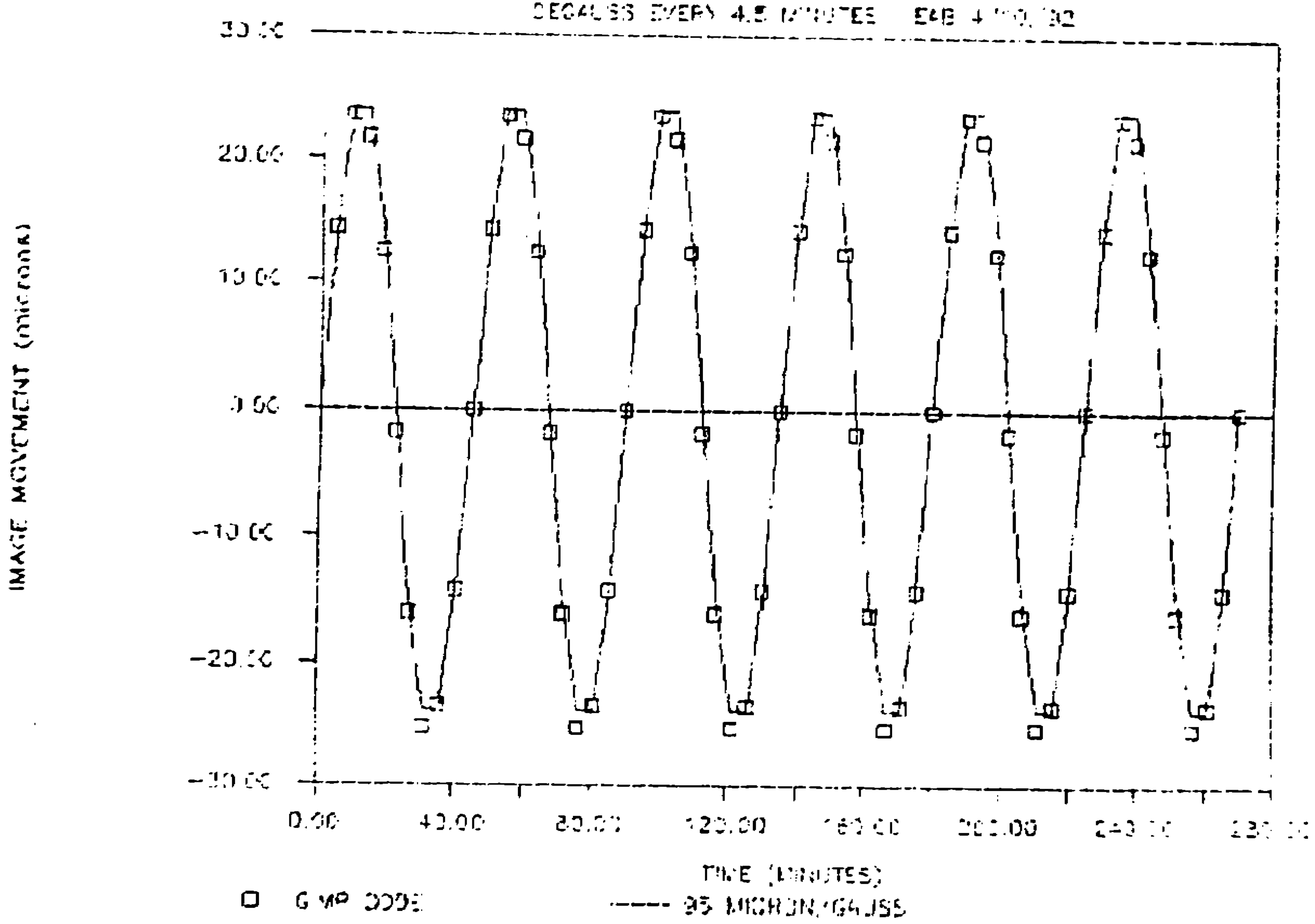

FOS/LAB GIMP POSITION SHIFT WITH TIME
DEGAUSS EVERY 2 MINUTES FAB 4/10/92
IMAGE MOVEMENT (microns)
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
0.00
40.00
80.00
120.00
160.00
200.00
240.00
TIME (MINUTES)
GIMP CODE
90 MICRON/GAUSS

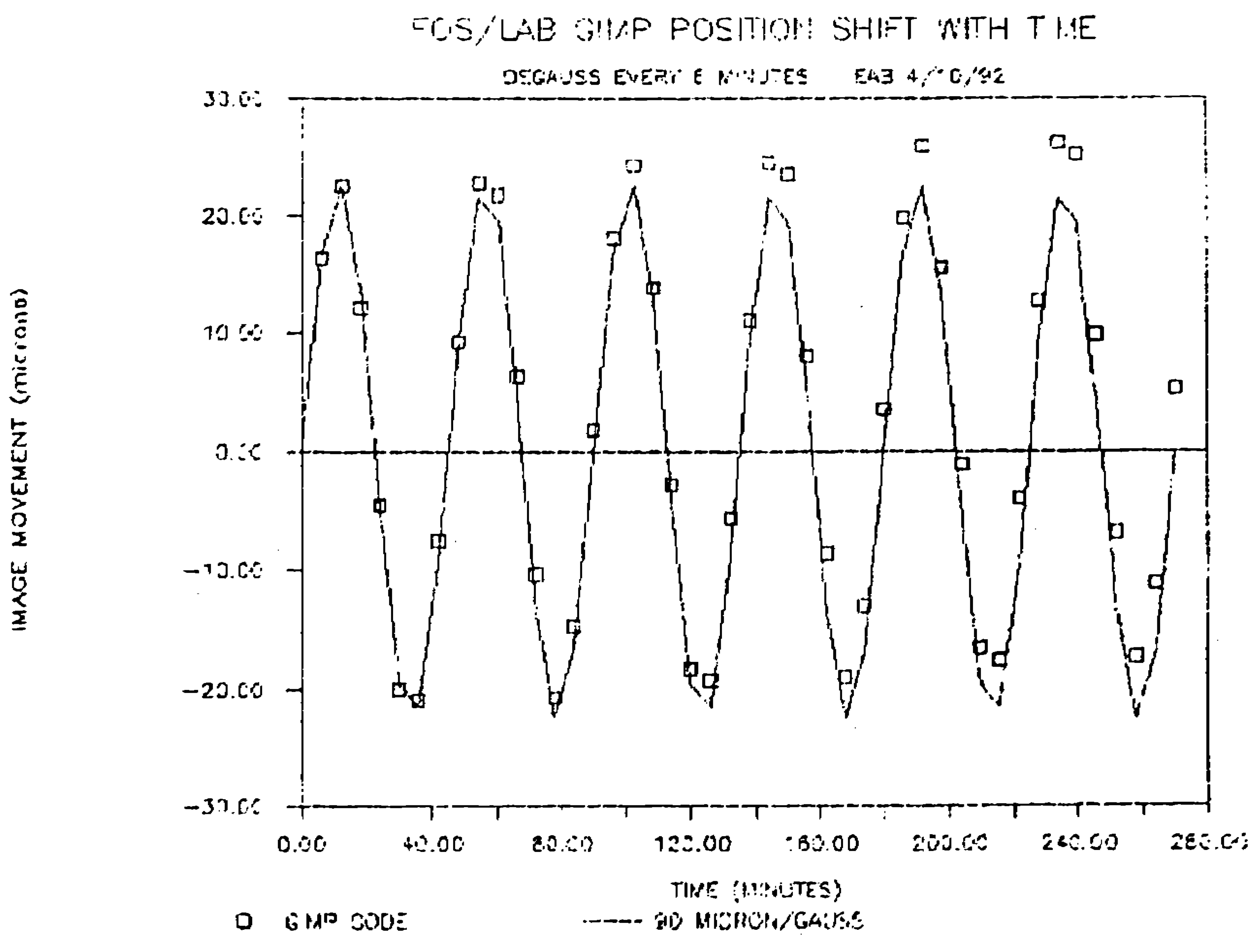


FOS/LAB GIMP POSITION SHIFT WITH TIME
DEGAUSS EVERY 3 MINUTES EAB 4/10/92
IMAGE MOVEMENT (microns)
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
0.00
40.00
80.00
120.00
160.00
200.00
240.00
280.00
TIME (MINUTES)
GIMP CODE
95 MICRON/GAUSS

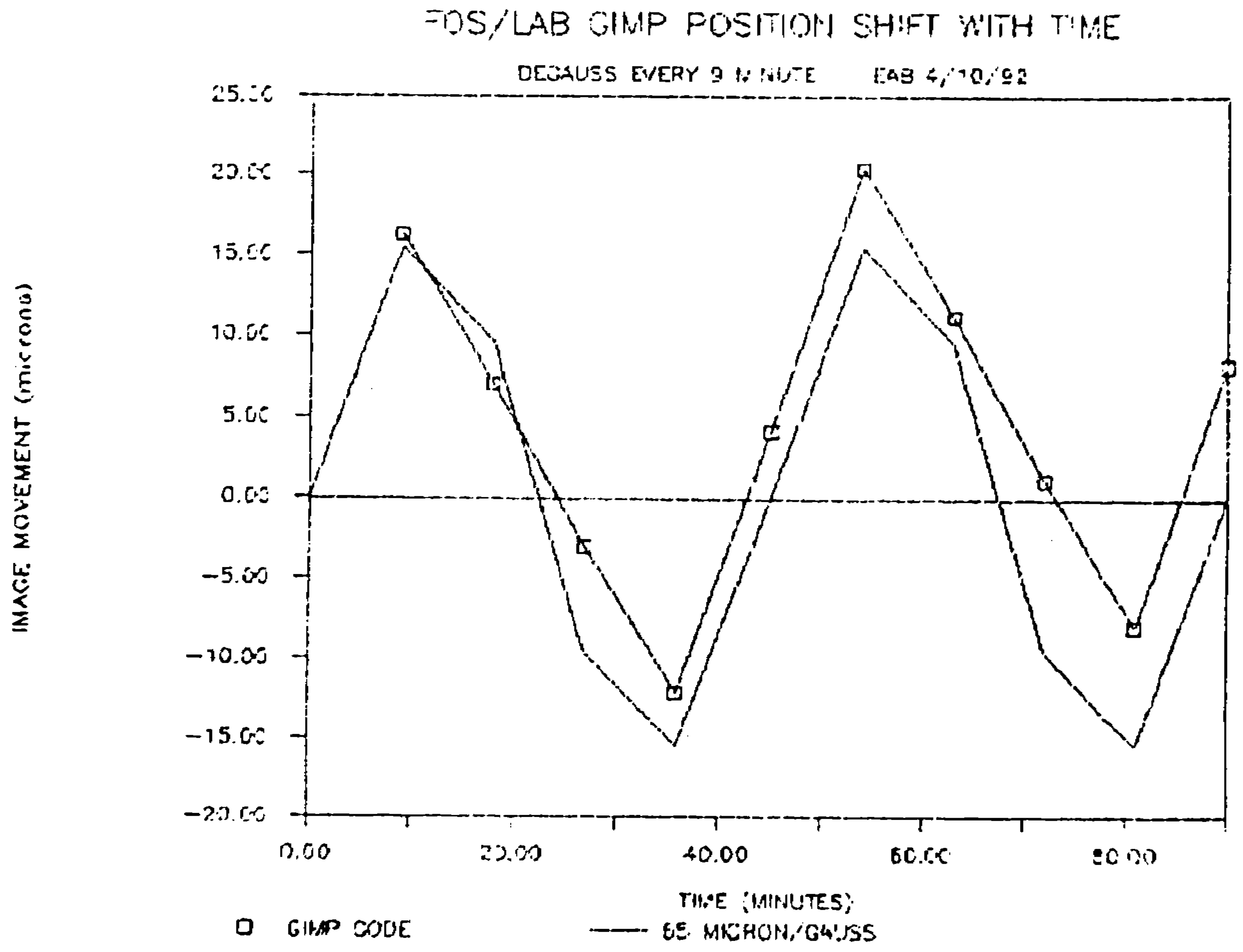
FOS/LAB GIMP POSITION SHIFT WITH TIME

DEGAUSS EVERY 4.5 MINUTES



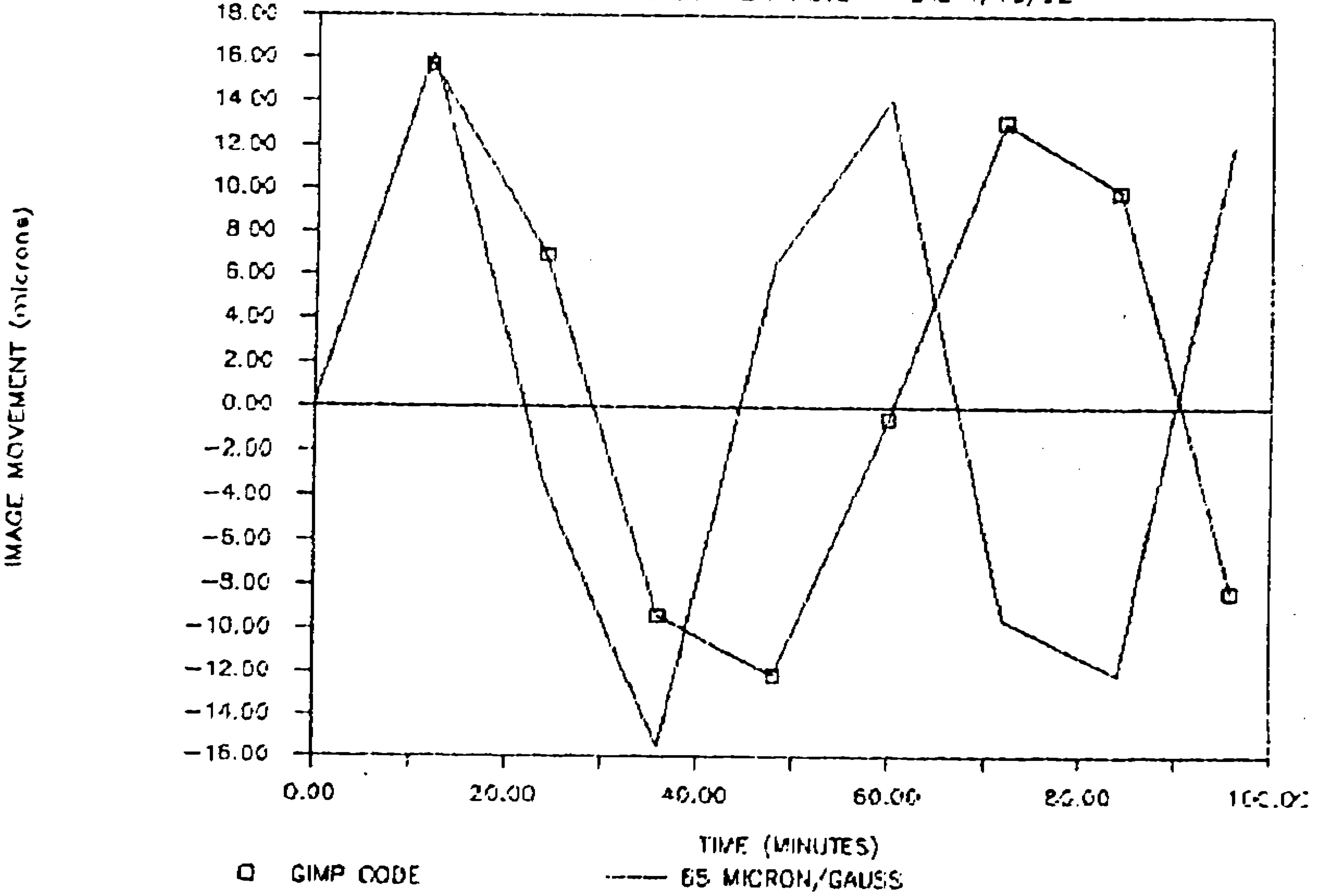


FOS/LAB GIMP POSITION SHIFT WITH TIME
DEGAUSS EVERY 6 MINUTES
IMAGE MOVEMENT (microns)
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
0.00
40.00
80.00
120.00
160.00
200.00
240.00
280.00
TIME (MINUTES)
GIMP CODE
90 MICRON/GAUSS


FOS/LAB GIMP POSITION SHIFT WITH TIME
DEGAUSS EVERY 9 MINUTE
EAB 4/10/92
IMAGE MOVEMENT (microns)
25.00
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
0.00
20.00
40.00
60.00
80.00
TIME (MINUTES)
GIMP CODE
65 MICRON/GAUSS

FOS/LAB GIMP POSITION SHIFT WITH TIME

DEGAUSS EVERY 12 MINUTE EAB 4/10/92



FOS/LAB GIMP POSITION SHIFT WITH TIME

DEGAUSS EVERY 20 MINUTES EAB 4/10/92