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No. 8

THE GAERTNER AUTOMATIC MEASURING SYSTEM
Operator's Manual

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INTRODUCTION

This technical report describes in detail the various operations of the Gaertner Automatic Measuring System for the benefit of operators and others concerned with its use. It is an operator's manual that describes the processes involved in surveying and measurement of astrometric plates. Also, it provides information that permits users to understand the computer programs and to make modifications to them to satisfy specific applications. The programs as given here refer to the standard version available for 1974 August and located on a master DECtape labeled PROGRAM TAPE (T8). Standard Version (Parallaxes). Other program tapes are generally modified versions of this master tape. Therefore, some of the descriptions in this manual will not apply to the modified tapes which may be described elsewhere.

Other related Lick Technical Reports are as follows:

No. 1 The Lick Observatory PDP 8/I Computers.

3 PDP 8 Machine Language Listings.

6 The Gaertner Automatic Measuring System: FOCAL Programs for Data Taking.

7 The Gaertner Automatic Measuring System: Machine Language Listings for AME Controls.

ACKNOWLEDGEMENTS

Cal Delaney and Terry Ricketts were responsible for the development and installation of the computer interface circuitry and the new electronic controls system that led to the mode of operation described in this report. Support by the NSF (GP 32459) permitted the modifications to the Gaertner Automatic Measuring System to the present mode of operation.

I. PLATE MEASUREMENT WITH THE AME

1. Turn on the PDP8 and mount the DECtapes. (at PDP8)

   1.1 Turn on POWER SW (key)

   1.2 Mount the AME/SM-program (called AMS) DECtape at the lower left tape drive (Unit = 8). By hand wind the tape by 2-3 turns onto the empty, upper right reel. Set tape SW to WRITE LOCK (if not already set). Set tape drive SW from OFF to LOCAL. Press right arrow (→) for 3 seconds to wind the tape part way onto the right reel. Set tape drive SW from LOCAL to REMOTE.

   1.3 Mount the proper survey data tape at the upper left tape drive (Unit = 7), and repeat all the steps above. This tape is not needed for manual measurements.

   1.4 Turn on the teletype (if not already on) and turn the teletype mode switch to LINE (if not already set).

2. Do Bootstrap (at PDP8) **Set address to 200.**

   2.1 Press SINGLE STEP (and return).

   2.2 Press LOAD ADD, DEP, LOAD ADD.

   2.3 Press "lucite" button at lower panel of PDP8.

   Lick FOCAL is now loaded and ready for use when * is typed.

3. Load plate in AME (either DIR or REV)

   3.1 Check that AME carriage is at loading position. If not, then check the following.

      3.11 See that AME ON-OFF SW (at PDP8) is down (red light is off and AME is "enabled").

      3.12 At PDP8 turn SW(1,1) to "view by X,Y" and type G (return). If nothing happens, type CONTRL-C and then X CALL(6,1) and G (return). Respond to request for X,Y values by typing "32(skip)32(skip)." Wait until the carriage comes to rest at loading position.

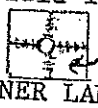
   3.2 Select proper filter and insert at AME. Select proper magnification, usually 16x (3.2x is rarely used except for plates with very large and well-separated images).

   3.3 Load plate in AME (either DIR or REV). If possible, load plate without turning on room lights and HV off.

4. Do photometer adjustment at AME.

4.1 Respond to the request for values of X,Y by typing "250(skip)250(skip)", if this operation immediately follows the plate loading. But if the plate was loaded earlier, then follow rules 3.1: respond to request for X,Y by typing 250,250 instead of 32,32.

4.2 If there is a star in or near the scanner diaphram, type nearby values of X,Y until a clear field is reached. Then press simultaneously CNTRL and C on teletype.



4.3 Adjust the ADJUST SCANNER LAMP (on TV rack) to a value of 5(4 to 6 possible) units. If it is too low, faint stars cannot be measured: they are rejected.

4.4 At the AME check the focus by using the elbow eyepiece. Then turn index left by one division (this is best focus at photometer PMT).

4.5 At the program rack located in the far left corner of the AME room press the PHOT (red) SW called START. Then adjust the lever for the comparison iris so that the reading as seen in the photometer eyepiece is close to 4800 units. Return to the program rack and press the PHOT (green) SW called RESET. Wait until the photometer returns to the rest position (green light is on).

5. Automatic Measurement.

5.1 See that the switch SW(3,3) is straight out (horizontal) for automatic measurements.

5.2 Set plate orientation SW(3,7) straight out for DIR measurements or up for REV measurements.

5.3 Set SW(1,1) to MEASURE and type G(return). Survey data will be transferred automatically from the DECtape on Unit 7 to the disk. Then respond:

5.31 To "REC NO...ST=:" by selected record number for the particular plate measurement, usually starting with "1" for the first plate, "2" for the second one (or the first one reverse), etc. If previous data under the same record number are already stored, PDP8 will ask whether it can be used. If not, type "N" and select a different number; if the old record is not needed, type "Y". The maximum record number is 71. If data need not be recorded on tape, type "-1".

5.32 To "NO. FCC TRIALS=:" by typing "3" for measurement of the first plate on a particular day. Three sets of four numbers each appear, and the last two sets should agree within a couple of units. If disagreement of 3 or more persists, the Electronics Shop must be informed and measurement discontinued until the error is corrected. The response for the second and further plates may be "2", "1", or even "0" if it is found that the four numbers retain their value.

standard values: 5015 5008 1242 1250

5.33 To "SURVEY RECORD NO. SN=:" by typing the number assigned to the survey data record on DECtape 7. This number is assigned in transferring the survey data to tape, and is kept on file for every field.

5.34 For "Do HPM/VAR?": by typing N or Y. This refers to the case where a star may have a large proper motion or large variation of magnitude. The original survey for the star must be replaced by realistic survey data appropriate to the plate being measured. For Pi plates and originally surveyed proper motion plates type N. But for proper motion program plates not actually surveyed, type Y, and follow printe instructions. See last portion of Section II covering the survey machine system for details.

5.35 To "...IMAGES LOADED. SORT THEM?:" by "N" for parallax plates and HPM... On larger plates with many images the sorting will save time and "Y" is advisable. Then seven numbers appear: field number, RA hours and minutes with one decimal, DEC degrees and minutes, number of the surveyed plate, and epoch.

5.36 To "ENTER DATA FOR PLATE IN AME. Pi PLAT?": by Y (if it is a parallax plate) or N (if it is not). The reason for the distinction concerns the amount of plate information that the operator must type in.

For Y - only PL. No., EPOCH, PMA and PMD are typed in. The FIELD RAH, RAM, DD, DM are transferred automatically from the survey record to the AME measures record.

For N - means that operator must type in all items of plate data, namely, these (with formats and units):

FIELD --
RAH, RAM -- XX^{h} $XX.X^{m}$
DD, DM -- ±XX° XX'

Not necessary in latest version. (transferred automatically).

PL. NO. --
EPOCH -- $XX.XX^{y}$ for 1900.00 + XX.XX
TEMP - ±XX.X°
PRESS -- XX.XX inches
OCQ -- XXX for orientation O = 1 (0° = DIR), 2 (90°), 3 (180° = REV), 4 (270°), for color C = 1 (blue), 2 (yellow), and for plate Quality Q (1 = good, 2 = fair, 3 = poor, 4 = useless).

If all is typed correctly, then reply Y when asked "OK?". If there is an error, type N and the process of entering plate data is automatically repeated.

Note: components of proper motion for a parallax star PMA and PMD are either catalogue values or estimates made by the operator. The units to be typed are in arcsec per year. The computer program then applies a proper motion correction to the survey positions for the Pi star so that AME carriage positioning will be more precise for th plate being measured. This correction is needed only for Pi stars with very large motions. Use this format for PMA, PMD: ±X.XX arcse per year.

5.37 To "REF STAR NO.:" by typing the current (not identification number SC) number I of an alignment star for the survey adjustment. The AME moves to the selected star and stops with the star in TV field. A chart is advisable for identification of the star. When it is done, move the image and center carefully in the circle by the joystick, then press SW(3,11) on the teletype, in order to record the position. Do next star similarly on request. When the sufficient number of acceptable images has been measured, respond by "-1" to the request for "REF STAR NUMBER.:".

5.5 As soon as the last step above (typing "-1") is done, PDP8 does least squares solution, types ~~six plate constants,~~ the message "ALIGNMENT DONE", residuals (twice the number of stars), and the question "SOLUTION OK?:". If residuals are below 30 microns, the solution is acceptable and "Y" is typed in response, and automatic measurement starts. If not good, type "N" and select new set of alignment stars.

5.6 If measurement data are to go on the tape, turn on "WRITE ENABLED" the SW for tape 8. Actually, this switch can be left on all the time.

5.7 Normally turn off teletype. Now the process of measurement can (but need not) be watched on the TV screen.

5.8 When PDP8 detects "0" in X field, measurement stops and data are automatically transferred to DECtape on Unit 8, unless "-1" is typed in response to question 5.31, or/and "WRITE ENABLED" is not on.

6. Manual Measurement

Do all steps 1 to 4 except those concerning the survey tape which is not needed here.

6.1 See that SW(3,3) is up for manual measurements.

6.2 Set SW(1,1) to MEASURE and type G(return). Then respond:

6.21 to "REC NO. ON T8 FOR AME OUTPUT ST = ": by typing -1 for no storage of AME data on tape.

6.22 To "NO. FCC TRIALS = ": by 0 to 3 for this many runs. The figures should agree with the standard values to one or two units.

6.23 To "MAN MEAS: BELL RINGS USE JOY
PRESS SW 3,11 TO MEAS": by bringing star to within the TV circle and pressing SW(3,11) to start measurement. Do this process for all stars. The measurements are printed out star by star and are not transferred to the tape at the end.

6.24 Press simultaneously CONTRL and C to terminate the measurements.

7. Printing, Checking, and Correcting AME Measurements.

These operations generally refer to measurements made automatically and which are stored on one of the DECtapes. Each program is described in greater detail in the appropriate Appendix.

7.1 Printing AME data (App. E)

a) PRINT FROM T7 or T8 by setting SW(1,4).
b) PRINT OUTPUT DETAILS FROM DISK by setting SW(1,7).
c) PRINT FINAL RESULTS FROM DISK by setting SW(1,7).
d) Print contents of tapes as a spot check --
LIST PLATE DATA (on T7 or T8) by setting SW(1,7).
READ CONTENTS OF IBM RECORDS by setting SW(1,10).

7.2 Checking AME data (App. D).

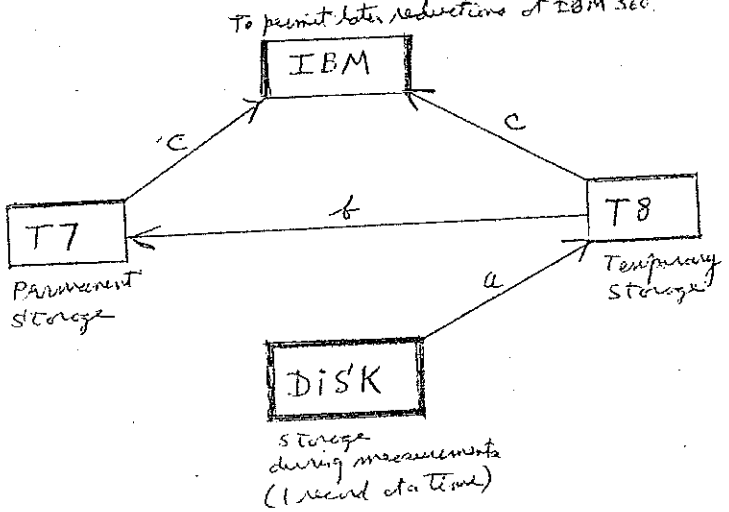
a) SIMPLE CHECK by setting SW(1,1).
To compare measurements of a field made in the same orientation.
b) DIR/REV CHECK by setting SW(1,1).
To compare measurements made in opposite orientations.
c) TV IMAGE CHECK by setting SW(1,1).
To view on the TV screen the images having large differences (limit Z = 100 microns) for the corrected survey position compared with the measured position.
d) PHOTOMETRY COMPARISONS by X CALL (22,4).
To list image by image the photometer readings from several successive records.

7.3 Correcting AME data (App. D).

a) DELETE IMAGE from data record on tape by setting SW(1,4).
This permits the removal of image SC from the tape record on T7 or T8 containing the AME measurements.
b) CORRECT AME OUTPUT ON T7 or T8 by setting SW(1,1).
This permits the correction of a bad measurement on an AME data tape record. It is presumed that the image I has been remeasured manually. It is necessary to specify record number and IC using table of vs. REC, IC, where IC = 1 to 125 only (see part 10 for table). It is also possible to correct plate information in the event that a part of it was mis-typed earlier.

8. AME Data Transfers on Tape.

Once a plate has been measured, the AME data is normally transferred automatically to T8 for temporary storage. The available paths for transferring the data from tape to tape is shown below (see App. F for details).



a) DATA: Disk to T8 - done automatically when measurements are completed for a plate. Permissible range of records on T8 is ST = 1 to 71.

b) DATA: T8 to T7 - by setting SW(1,4).
This transfers AME measurement from temporary storage on T8 to permanent storage on T7. This is usually done after much of T8 has been filled. Permissible range of records on T8 is 1 - 71.

c) DATA: T7/T8 to IBM - by setting SW(1,10).
This transfers AME measurements from either T7 or T8 to the IBM tape. The IBM tape may then be taken to the IBM 360 computer for further reductions.

9. Special Reduction for Parallax Plates.

On the tape labeled PROGRAM I there is a program which applies to the parallax plates measured in direct and reverse orientations. To serve as input to the Vasilevskis Stellar Parallax Program (VSPP), the measurements of the parallax stars must be arranged in front of the input -- all 99's, then 98's, etc., and then the reference stars sorted in increasing star number SC. Moreover, the direct and reverse measurements must be averaged also. So the program first averages the direct and reverse readings for a plate and then sorts the stars as indicated above (if desired). The direct and reverse measurements are taken from T7 at pairs of records and deposits the averaged data on T8. It can later be transferred to the IBM tape for reductions. The program is secured by X CALL (10,2) only.

II. PLATE SURVEYING

(operated in conjunction with the AME and PDP8I)

A. TURN ON AND LOAD SURVEY MACHINE. SELECT SWITCHES.

1. Turn on main power SW at lower left side of base.
2. Turn on the lamp.
3. Load plates in survey machine.
4. Turn on PDP8I. Load dectapes. Do "bootstrap".
5. See that "AME DISABLED" SW is turned OFF (red indicator light is off).
6. See that "pause SW(3,2) is out (and not up).
7. Set "print" SW's to desired positions. For simultaneous operation of AME and SM it is usual to set SW(3,6) to up for no AME printing and possibly to set SW(3,5) to up for SM printing (not really needed).
8. Set "WRITE ENABLED" SW at PDP8I to on in order to permit later transfer of survey (and AME measures) from disk to T8.
9. Select SW(B) for nature of images on plate being surveyed.
   SW(B) = 0 for no grating images.
   SW(B) = 1 for grating images aligned N-S (20-inch astrograph plates).
   SW(B) = 2 for grating images aligned E-W (36-inch refractor plates).

10. Select mode of star numbering SC.
    SW(2,2) = down for manual selection of SC (0 to 999). In any order.
    SW(2,2) = up for automatic incrementing of SC starting from 1.

11. Set SW(C) to start a field as follows:
    SW(C) = 2 if this is a new survey.
    SW(C) = 3 if this is a partially surveyed plate that was filed on T8 after an earlier survey session. This will recall the survey to the disk so that it can be continued.

B. ENTER PLATE DATA BEFORE START OF SURVEY.

AME OFF (or not in measuring cycle)

1. At PDP8 set SW(1,7) at position to SURVEY ALONE and type G (return) and receive message "...TYPE C".

AME ON (and in measuring cycle)

1. At the survey control panel press RECORD once (it will not store survey data this time).

2. If SW(C) was set at 2 (new survey), there will be the typed message "START: INITIALIZE NEW FIELD". Enter plate data as requested. If SW(C) was set at 3 (partially surveyed plate), there will be the typed message "START: INCOMPLETE SURVEY FROM T8". Type data as requested (recall last survey record number S0 for field).

In either case, when step 2 is completed, there will be at the end the typed command set "SW(C)".

At this time the operator should check whether he has made an error in typing. If there is an error, leave SW(C) at 2 or 3 and type C in order to repeat this step. At the end there will be again the message "SW(C)". This time, if all is error-free, set it to either 4 or 5 as follows:

SW(C) = 4 for case where AME is on and actually going through measuring cycles.

SW(C) = 5 for case where AME is not measuring (off).

Then, in either case, type C (or any other symbol) and hit skip bar. If the AME is not measuring, it is possible to start the surveying described in the next section. If the AME is going through measuring cycles, wait until one star has been measured (to be safe) before starting the surveying.

C. TO SURVEY STARS.

1. Find first star. Set it at center of cross (central image only if it has grating images).

2. Set star code SW's as follows:
   SYSTEM, ORDER CLASS, QUALITY and also SW(A) from "normal" if the star has a large proper motion (HPM) or has a large variation at the two epochs (VAR). Set star code number SC if done manually.

3. Press the RECORD SW once briefly to enter survey on disk. When the indicator light goes off it is possible to go to the next star. Note that if the ORDER is one or more there will be two entries for the star - the data for the pair of grating images separately.

Excessively long pressing of the RECORD SW will result in more than one entry for a star and should be avoided.

4. Go to step C.1 to continue survey.

D. TO TERMINATE SURVEY.

Assume survey is complete or still incomplete but to be continued at a future date.

AME OFF (or not in measuring cycle)

1. Turn PAUSE SW(3,2) up in order to stop the survey.
2. Set SW(C) to position 6 denoted FILE SHORT SURVEY ON T8 and then turn the PAUSE SW(3,2) to horizontal. This will automatically transfer the survey from disk to T8 at record number S0 specified earlier by the operator in step B.2.

AME ON (and in measuring cycle)

1. Set SW(C) to position denoted FILE SHORT SURVEY ON T8 and then press RECORD once. This will automatically transfer the survey from disk to T8 at record number S0 specified earlier by the operator in step B.2.
2. (Go to step 3).

3. To CONTINUE

At the end of the above step (either branch) there will be the typed message "SW(C)". Set it at one of the following and type C in order to proceed.

SW(C) = 0 for no more surveying.
SW(C) = 2 or 3 for starting or continuing the survey for another field.
SW(C) = 7 for transferring survey from temporary storage at S0 on T8 to permanent storage at SN on T7. Follow typed instructions.

E. SPECIAL CASES: AME TURNED ON OR OFF DURING MIDDLE OF SURVEY.

It may happen that the operator either (1) starts the survey with the AME not measuring and later starts measuring or (2) starts the survey with the AME measuring but later stops measuring but wishes to continue the survey above.

Case 1. This is very simple. Start the AME measures in normal way. Once the first star is in the process of measurement and if SW(C) is reset to 4 it is possible to continue the survey as before. Go to step C.1 and continue.

Case 2. Assume that CONTRL +C were pressed to stop AME and that the usual DIR/REV or SIMPLE CHEKS have been made. The plate is presumed to be measured and checked and no more are to be done.

To continue survey in progress reset SW(C) to 5 and at PDP8 control panel set SW(1,7) to position denoted TO SURVEY ALONE and type G (return). Then continue surveying as described starting at step C.1.

E-CODE FOR SW(A): FOR SPECIAL TREATMENT OF CERTAIN STARS.

SW(A)=0: NORMAL (no special treatment for survey).

1: HPM (denotes high proper motion star which needs special XI,YI for plate that was not surveyed).

2: VAR (denotes star with large range of light variation so that a different set of images must be measured on the non-surveyed plate compared to that used for the surveyed plate).

3: OTHER

****

HPM (E=1).

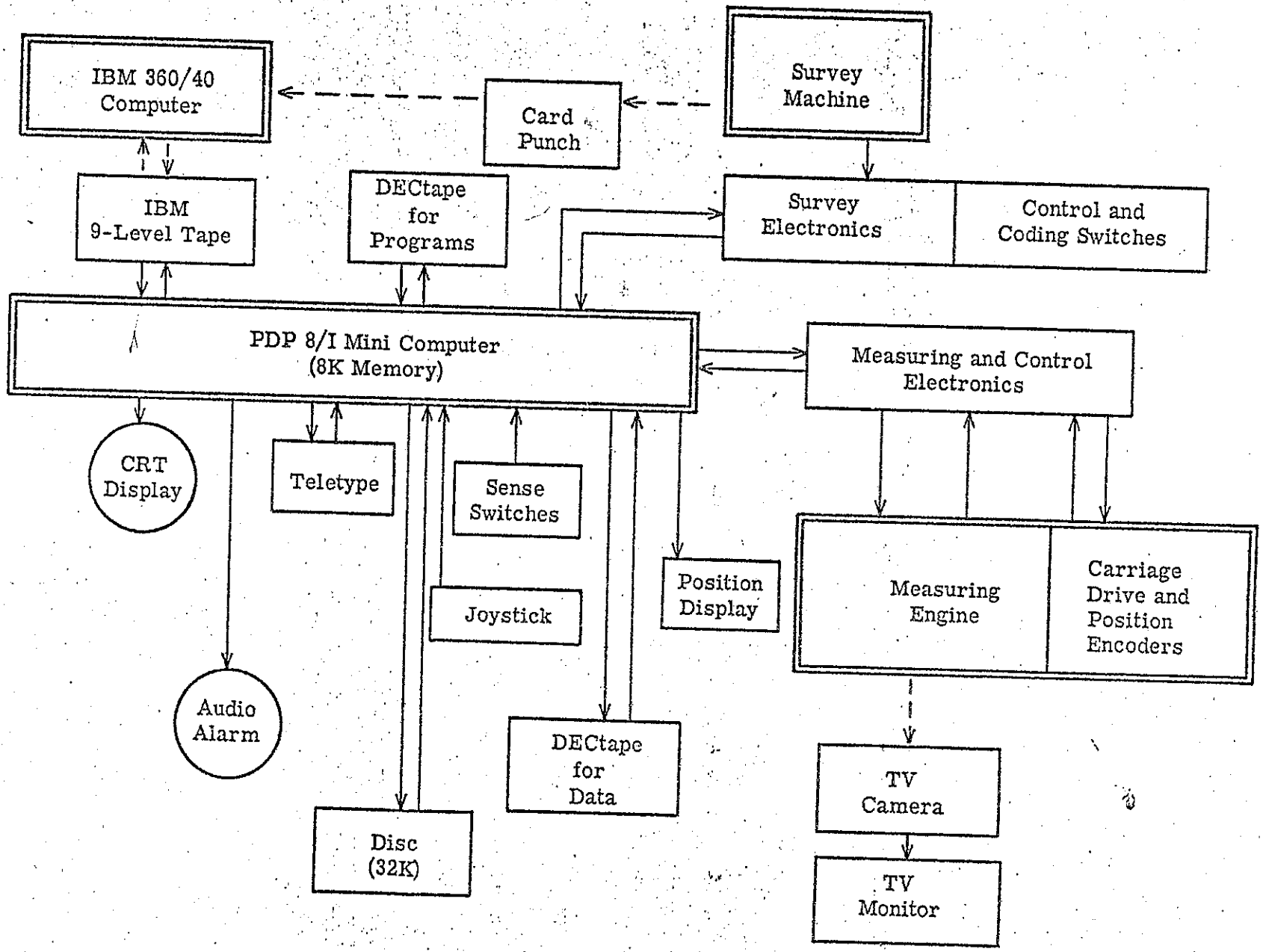
If a star shows an excessively large proper motion displacement over the two epochs, it will be necessary to provide corrected survey positions for the non-surveyed plate when it is measured. The method to follow is the following. Survey the star in the usual way but with one change: set SW(A)=1 instead of 0. Then with the L and R plates closely aligned in the survey machine using surrounding stars, try to estimate the proper motion displacement in RA and DEC in mm units. Write this figure on the record sheet for the field. Include also the I and SC numbers. This E=1 code will let the AME know that the position on the survey tape will need to be corrected before positioning the carriage. This correction will be done after the survey tape T7 has been read in at the time the non-surveyed plate is about to be measured. Upon request the operator types in the total proper motion corrections PMX and PMY in units of millimeters for star SC.

VAR (E=2).

If a star shows excessively large differences in magnitude at the two epochs, it will be necessary to measure a different set of images on the non-surveyed plate compared to that selected for the surveyed plate. This usually means the measurement of the central image on one plate (star faint) and grating images on the other plate (star bright). In order to preserve the same I-count for the star, it is desirable to make a second entry for the plate having only the central image. Assume the same system (I or II but not mixed) is measured on both plates. There are two cases to be distinguished when surveying the R-plate.

Case 1. Star is bright on surveyed (R) plate and faint on non-surveyed (L) plate. Survey the star as usual but with the exception that SW(A)=2 instead of 0. This means that there are two entries for the star, namely, the two grating images. When the non-surveyed plate is measured later, it will be necessary to modify the SOCQ code and XI,YI to permit measurement of the central image alone-and twice to preserve the I-count for the star.

Case 2. Star is faint on surveyed plate (R) and bright on the non-surveyed plate (L). Survey for the central image on the R-plate but ~~give~~ do it twice to preserve the I-count for the star. Later on when the non-surveyed plate is measured, the code E=2 will reveal the need for modifying the XI,YI and SOCQ code so that grating images will be measured instead. This modification is done automatically by the computer program, so that no further work is needed by the operator.


IBM 360/40 Computer
Card Punch
Survey Machine
IBM 9-Level Tape
DECtape for Programs
Survey Electronics
Control and Coding Switches
PDP 8/I Mini Computer (8K Memory)
Measuring and Control Electronics
CRT Display
Teletype
Sense Switches
Joystick
Position Display
Measuring Engine
Carriage Drive and Position Encoders
Audio Alarm
DECtape for Data
TV Camera
Disc (32K)
TV Monitor

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01.01 C-PROG 9-APR. 18/74.
01.02 X CALL(6,1)

06.01 C-REPEATER
06.03 S RC=RC+1
06.04 X AME(0);X CLER(6)
06.10 IF (FPHOS(704)-512)6.2,6.4
06.20 X CLER(1);S ER=FOR(ER,256)
06.30 S TM=-600
06.32 IF (FPHOS(704)-512)6.36,6.4
06.36 S TM=TM+1;IF (TM)6.32
06.40 D 30;IF (D)6.5,6.6
06.50 X CLER(6);S ER=FOR(ER,80)
06.60 IF (RC-4)6.71;CHECK REPEAT COUNT
06.70 S ER=FOR(ER,32);T !"NO RESULT:STAR",%3 I;X CALL(8,3)
06.71 IF (RF)6.72,6.72;S ER=FOR(ER,2);G 6.8
06.72 I (-FSWIT(3,3))6.73,6.8
06.73 I (DA)6.74;S RF=0;D 8
06.74 T "";X JOY(0);S I=I+1;S IC=IC+1
06.76 S XI=FLOC(0)/40;S YI=FLOC(1)/40;G 6.9
06.80 DO 23
06.90 S D=12-FPHOS(12);IF (D)6.92,7.04
06.92 X CALL(7,11)

07.04 IF (FSURV(-1)+FSWTS(2,1))7.10,7.10;X CALL(12,9);C-SURVEY
07.10 DO 30.1;IF (D)7.2,7.5
07.20 X CLER(6);S ER=FOR(ER,80);F J=0,1000;S A=A;C-7 SEC
07.50 X AME(1)
07.60 IF (-FSCNS(2048))7.6
07.64 F J=0,200;S A=A
07.70 IF (FSCNS(16)-16)7.9,9.04
07.90 DO 8;X CALL(10,2);C-SEARCH

08.10 C-SAVE IMAGE DATA
08.11 IF (-RF)8.6;I (I-2)8.6
08.12 S D=FTAK(BR,I-1);S SV=FIN(BI,D,1);S BB=FIN(BI,D,8)
08.14 IF (DN)8.26;C-DON'T STORE
08.15 IF (-DA)8.18;S XM=0;S XV=0;S XS=0;S XT=0
08.16 IF (-FSWIT<3,3>)8.26;G 8.22
08.18 IF (FSWIT(3,3))8.2,8.2;S SV=I-1
08.20 I (-FSWIT(3,6))8.22;T !;T %4 I-1,SV,%9.04 XT;D 8.99
08.22 X SAVX(BO,IC-1,SV,XV*100,XM,XS)
08.23 X SAVY(BO,IC-1,PH,YV*100,YM,YS)
08.24 X SAVX(BM,IC-1,SV,XT*10000,YT*10000,BB);X SAVY(BM,IC-1,0,PH,SQ,ER
08.26 S DA=-1;S RC=0
08.60 S DN=0
08.61 R
08.99 T YT,%4 PH,ER(1),SQ

09.04 S TM=-500;C-20 SEC
09.10 IF (FPHOS(512))11.1,11.1
09.20 S TM=TM+1;IF (TM)9.3
09.22 DO 8;S ER=FOR(ER,512+8);G 9.4
09.30 IF (FSCNS(3840))9.32,9.1
09.32 DO 8
09.40 X CLER(6);S ER=FOR(ER,80)
09.50 S TM=-100
09.60 DO 30;IF (D)9.62,9.7
09.62 S TM=TM+1;IF (TM)9.6
09.70 S X=FSCNR(0);S Y=FSCNR(1)
09.80 S XI=XI-.12+X/5000;S YI=YI-.12+Y/5000
09.90 S RF=1;G 6.03
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11.10 DO 8
11.20 X CALL(11,3)

18.10 DO 8
18.20 X END(0)

23.10 F J=0,1;X MOV(XI*100,YI*100)
23.90 R

30.10 S D=FSCNS(HM)-HM+FMICS(HM)-HM

31.98 W
31.99 X END(0)
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```
01.01 C-PROG.10;FEB.27/74-SEARCH
01.02 X CALL(6,1)

02.01 C-CHOOSE IMAGE SEARCH MODE AT 2.10
02.10 S D=FSWIT(2,7)
02.12 X GO(2,20+D*2)
02.20 G 3.60
02.22 G 3.04
02.24 G 3.04
02.26 G 3.04

03.04 S SR=0;G 5.5
03.10 S TM=-20;C-7 SEC.
03.20 IF (FSCNS(HM)-HM)3.3,3.5
03.30 X CLER(6);S ER=FOR(ER,80)
03.40 S TM=TM+1;IF (TM)3.2
03.44 T !"SCANNER STUCK";S ER=FOR(ER,512)
03.50 IF (SR-17)4.1
03.60 T !"STAR",%3 I-1," NOT FOUND";S ER=FOR(ER,32)
03.90 X CALL(8,3)

04.10 X AME(0);X CLER(6)
04.20 S ER=FOR(ER,4);I (1-FSWIT(2,7))4.22;X GO(20,SR)
04.22 X BUZ(50);X JOY(0);S XI=FLOC(0)/40;S YI=FLOC(1)/40;G 20.90
04.30 S TM=-50;C-14 SEC
04.32 IF (FSURV(-1)+FSWTS(2,1))4.35,4.35;X CALL(12,9);C-SURVEY
04.35 IF (FPHOS(704)-512)4.4,4.5
04.40 X CLER(1);S ER=FOR(ER,256)
04.50 IF (FSCNS(HM)-HM+FMICS(HM)-HM+FPHOS(704)-512)4.6,4.9
04.60 X CLER(6);S ER=FOR(ER,80)
04.70 S TM=TM+1;IF (TM)4.5
04.80 S ER=FOR(ER,1024)
04.90 X AME(1)

05.10 IF (-FSCNS(2048))5.1
05.15 S TM=0
05.20 IF (FSCNS(16)-16)5.4,9.04,5.4
05.40 S TM=TM+1;IF (TM-45)5.2
05.50 S SR=SR+4;G 3.1

09.04 S TM=300;C-5 SEC
09.10 IF (-FPHOS(512))9.2;X CALL(11,3)
09.20 S TM=TM-1;IF (TM)9.4
09.30 IF (FSCNS(3840))9.4,9.1
09.40 X CLER(6);S ER=FOR(ER,80)
09.60 S TM=300;C-7 SEC
09.62 I (FSCNS(HM)-HM)9.64,9.7
09.64 S TM=TM-1;I (TM)9.68;G 9.62
09.68 S ER=FOR(ER,512)
09.70 S X=FSCNR(0);S Y=FSCNR(1)
09.80 S XI=XI-.12+X/5000;S YI=YI-.12+Y/5000
09.90 D 23;S RC=RC+1;I (RC-5)4.3,3.6,3.6
```

```
20.04 S XI=XI+.070;S YI=YI+.050;G 20.9
20.08 S XI=XI-.140;G 20.9
20.12 S YI=YI-.100;G 20.9
20.16 S XI=XI+.14
20.90 X AME(0);X CLER(6);D 23
20.99 GO 4.3

23.10 F J=0,1;X MOV(XI*100,YI*100)
23.90 R

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG.11-APR. 2/74.
01.02 X CALL(6,1)

03.10 S TM=60;C-25 SEC.
03.20 S RF=0;S XM=0;S YM=0;S XS=0;S YS=0;S PH=0;S DA=0
03.30 F J=0,400;S A=A
03.40 S D=FSCNS(HM)+FMICS(HM)-2*HM
03.42 IF (D)3.5,3.8,3.5
03.50 IF (FSCNS(MX))3.54,3.6
03.54 X CLER(2);S ER=FOR(ER,64);G 6.3
03.60 IF (FMICS(MX))3.64,3.7
03.64 X CLER(4);S ER=FOR(ER,16);G 6.3
03.70 S TM=TM-1;IF (-TM)3.72;G 6.04
03.72 IF (FSURV<-1>+FSWTS<2,1>)3.4,3.4
03.74 X CALL(12,9)
03.76 G 3.4
03.80 S XM=FMICR(0);S YM=FMICR(1);S XS=FSCNR(0);S YS=FSCNR(1)
03.82 S XM=XM*0.9943;C-LICK MICR SCALE CORR
03.90 GO 9.1

04.01 C- FINAL RESULT
04.20 S D=XI-FITR(XI);S M=XM;DO 14
04.22 S XT=XI+N
04.30 S D=YI-FITR(YI);S M=YM;D 14
04.32 S YT=YI+N
04.38 C-GAERTNER CORR
04.40 S XT=FITR(XT)+(XM+XS)/5000+FCOR(XI)/10000
04.50 S YT=FITR(YT)+(YM+YS)/5000+FCOR(YI,1)/10000
04.90 R

06.04 IF (FMICS<HM>-HM)6.06,6.2
06.06 X CLER(4);S ER=FOR(ER,16+1024)
06.10 IF (-FAND<ER,8>)6.2;S ER=FOR(ER,8)
06.14 S TM=-500
06.16 S TM=TM+1;IF (TM)6.17;X CLER(4);G 6.6
06.17 IF (FMICS<HM>-HM)6.16,6.18,6.16
06.18 X GMIC(0);G 3.1
06.20 IF (FSCNS(HM)-HM)6.24,6.3
06.24 X CLER(2);S ER=FOR(ER,64+512)
06.30 S TM=100;C-20 SEC
06.40 DO 3.4;IF (D)6.5,3.8
06.50 S TM=TM-1;IF (-TM)6.4
06.60 IF (FMICS(HM)-HM)6.62,6.7
06.62 S ER=FOR(ER,1024)
06.70 IF (FSCNS(HM)-HM)6.72,9.82
06.72 S ER=FOR(ER,512);G 9.82
```

```
09.10 IF (XS-50)9.3;IF (1200-XS)9.3
09.20 IF (YS-50)9.3;IF (1200-YS)9.3;G 9.4
09.30 S XI=XI-.12+XS/5000;S YI=YI-.12+YS/5000;G 9.8
09.40 IF (XM-50)9.5;IF (XM-4950)9.6
09.50 S XI=XI+(1+RC)*.025*FSGN(XS-600);GO 9.8
09.60 IF (YM-50)9.7;IF (YM-4950)10.1
09.70 S YI=YI+(1+RC)*.025*FSGN(YS-600)
09.80 S ER=FOR(ER,128)
09.82 S RF=1
09.84 S DA=-1
09.90 X CALL(9,6);C-REPEAT

10.10 DO 4
10.80 S DA=1
10.90 X CALL(8,3);C-ALL OK

14.10 S N=0
14.20 IF (D-.9)14.3;IF (1000-M)14.9;S N=1;G 14.9
14.30 IF (.3-D)14.9;IF (M-3000)14.9;S N=-1
14.90 R

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG.12   SURVEY
01.02 X CALL(6,1)

09.04 S BB=FTAKL(BS,28);S ST=FTAKL(BS,30);S SI=FTAKL(BS,32)
09.10 I (FSWTS(3,240)/16-1)9.12,9.14,9.16
09.12 X SWTS(0);X DISP(ST);G 9.92
09.14 D 10.1;G 9.1
09.16 I (FSWTS(3,240)/16-3)9.18,9.20,9.22
09.18 X CALL(13,3,1);C-START:NEW
09.19 D 10.1;G 9.1
09.20 X CALL(13,4,1);C-START:INC
09.21 D 10.1;G 9.1
09.22 I (FSWTS(3,240)/16-5)9.23,9.24,9.25
09.23 S AS=1;G 9.27;C-SURV:AME ON
09.24 S AS=0;G 9.27;C-SURV:AME OFF
09.25 X CALL(13,2,1);C-CONT
09.26 D 10.1;G 9.1
09.27 G 10.3
09.28 S SX=FSURV(0)/20;S SY=FSURV(1)/20
09.29 S S=FSWTS(2,4)/4+1;S O=FSWTS(2,56)/8
09.30 S C=FSWTS(2,448)/64;S Q=FSWTS(2,3584)/512
09.31 S B=FSWTS(3,12)/4; S E=FSWTS(3,3);G 10.6
09.32 IF (SX)9.34,9.34;IF (SY)9.34,9.34,9.36
09.34 X DISP(0);DO 10.2;G 9.6;C-ERROR IN DATA
09.36 S SI=SI+1;I (FSWTS(2,2))9.40,9.40
09.37 S ST=ST+1
09.40 F J=0,10;S A=A
09.42 IF (FSWTS<2,2>-2)9.44,9.46
09.44 S ST=FSWTS(1);C-MANUAL
09.46 I (O)9.49,9.49;S SX=SX-GX*O;S SY=SY-GY*O;S B=1;G 9.5
09.47 S SX=SX+GX*O*2;S SY=SY+GY*O*2;S B=2;S SI=SI+1;G 9.5
09.49 S B=0
09.50 X SAVX(BS,SI,ST,SX*100,SY*100,S);X SAVY(BS,SI,O,10*C+Q,E,B)
09.51 X DISP(ST)
09.52 I (FSWIT(3,5))9.58,9.58
09.54 T !%3 SI,ST,%5.02 SX,SY,%1 S,O,C,Q,E,B
09.58 I (B-1)9.6,9.59,9.6
09.59 I (125-SI)10.34,10.34,9.47
09.60 IF (FSWTS(2,1))9.82,9.82
09.62 IF (-SI)9.66
09.64 S SI=0;S ST=0;G 9.82
09.66 X SAVX(BS,SI);X SAVY(BS,SI)
```

```
09.70 D 9.4
09.74 S SI=SI-1
09.80 S ST=FIN(BS,SI,1)
09.82 X SWTS(0)
09.83 X PUTL(BS,28,BB);X PUTL(BS,30,ST);X PUTL(BS,32,SI)
09.84 X DISP(ST)
09.86 I (-FSWIT(3,2))9.86,9.92,9.92
09.92 IF (-AS)9.96;G 9.1;C-AME OFF
09.96 X END(0)

10.10 A "SET C",A!
10.20 F J=0,10;X BUZ(10);F K=0,20;S A=A
10.30 I (FSURV(-1))9.6,9.6
10.32 I (124-SI)10.34,9.28,9.28
10.34 S BB=BB+SI;D 9.83
10.36 S SO=FTAKL(BS,36)
10.38 X MPUT(BS,16*SO,16,8)
10.40 X PUTN(BS,0,0,2024)
10.42 S SI=0;S SO=SO+1
10.44 X PUTL(BS,36,SO);I (B-1)9.86,9.47,9.86
10.60 I (B-1)10.62,10.63,10.64
10.62 S GX=0.0;S GY=0.0;G 9.32
10.63 S GX=0.0;S GY=0.250;G 9.32
10.64 S GX=0.575;S GY=0.0;G 9.32

31.98 W
31.99 X END(0)
```

13

```
01.01 C-PROG.13-SURVEY INITIALIZE
01.02 X CALL(6,1)

02.01 I (FSWTS(3,240)/16-7)5.01,2.1,2.99
02.10 T "TRANSFER SURV FROM T8 TO T7",!;S BS=176
02.11 A "FIRST REC ON T8 SO=",SO,!
02.12 A "NO. REC TO TRANSFER=",SI,!
02.13 A "FIRST REC ON T7 SN=",ST,!;G 2.4
02.14 A " OK?",A;I (A-0Y)2.11,2.2,2.11
02.20 X MTAK(BS,16*SO,16,8)
02.21 X PUTL(BS,28,BB)
02.22 X MPUT(BS,16*ST,16,7)
02.24 S SI=SI-1;I (SI)2.98,2.98;S SO=SO+1;S ST=ST+1;G 2.2
02.40 S I=1;X MTAK(BS,16*(SO+SI-1),16,8)
02.44 I (FIN(BS,I,2))2.46,2.46;S I=I+1;G 2.44
02.46 S BB=125*(SI-1)+I-1;G 2.14
02.98 T " NI=",BB," DONE",!
02.99 X END(0)

03.01 T "START:NEW FIELD FOR SURVEY",!;S BS=176
03.02 X SWTS(0)
03.05 A "REC NO. ON T8 FOR TEMP. STORE OF SURVEY SO=",SO,!
03.06 I (49-SO)3.1;T "SO UNDER 50 IS ILLEGAL",!;G 3.05
03.10 X PUTN(BS,0,0,2064);T "TYPE PLATE DATA",!
03.22 X PUTL(BS,34,-1234);S N=0
03.30 A "FIELD",A;D 3.4;A " RAH",A;D 3.4;A " RAM",A;S A=A*10;D 3.4
03.31 A " DD",A;D 3.4;A " DM",A;D 3.4;T !
03.32 A " PLNO",A;D 3.4;A " EP",A;S A=A*100+0.1;D 3.4;T !
03.34 A "ALL OK?",A;I (A-0Y)3.3,3.42,3.3
03.40 X PUTL(BS,N,A);S N=N+2
03.42 S SI=0;S BB=0
03.44 X PUTL(BS,36,SO)
03.50 T "DONE",!;X END(0)
```

```
04.01 T "START:RECALL T8",!
04.03 X SWTS(0)
04.04 S BS=176
04.05 A "LATEST SURVEY WAS AT SO=",SO,!
04.12 X MTAK(BS,16*SO,16,8)
04.13 D 4.6;D 4.61;D 4.62
04.14 S SI=FTAKL(BS,32);S ST=FTAKL(BS,30);S BB=FTAKL(BS,28)
04.20 I (125-SI)4.24,4.24,4.30
04.24 S SO=SO+1;X PUTN(BS,0,0,2024)
04.26 T %2,"REC",SO-1," IS FILLED SO SURVEY STARTS AT SO=",SO,!
04.27 S SI=0
04.30 T %3" DONE TO IMAGE I=",SI," AND SC=",ST,!
04.34 A "ALL OK?",A;I (A-0Y)4.05,4.36,4.05
04.36 X PUTL(BS,36,SO)
04.40 T "DONE",!;X END(0)
04.60 T %4 FTAKL(BS,0),FTAKL(BS,2),%4.01 FTAKL(BS,4)/10
04.61 T %4 FTAKL(BS,6),FTAKL(BS,8),FTAKL(BS,10),%5.02 FTAKL(BS,12)/100
04.62 T !

05.01 T !"FILE T8",!
05.03 S BS=176
05.04 X SWTS(0);X DISP(0)
05.05 S ST=FTAKL(BS,30);S SI=FTAKL(BS,32);S SO=FTAKL(BS,36)
05.10 X MPUT(BS,16*SO,16,8)
05.11 T "AT REC=",%2 SO," WAS FILED "
05.12 T %3, "LAST I=",SI," AND SC=",ST," ON T8.  DONE",!
05.20 X END(0)

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG.14
01.02 X CALL(6,1)

02.01 C-PLATE ALIGN
02.02 I (FSWIT(3,2))02.03,02.03,02.11
02.03 S UZ=FTAKL(16,12);T !,%4 FTAKL(16,0),FTAKL(16,2)
02.04 T %4.01 FTAKL(16,4)/10,%4 FTAKL(16,6),FTAKL(16,8)
02.05 T FTAKL(16,10),%5.02 UZ/100,!;D 4
02.11 S NS=1;T "ALIGN STARS"
02.12 A J;I (J)2.20
02.13 S XI=FIN(BI,J,2)/100;S YI=FIN(BI,J,3)/100
02.14 I (FSWIT(3,7))02.16,02.16
02.15 S XI=500-XI;S YI=500-YI
02.16 S XR(NS)=XI;S YR(NS)=YI;D 23;D 3
02.18 S XM(NS)=X;S YM(NS)=Y;S NS=NS+1;G 2.12
02.20 T !;S NS=NS-1
02.22 X CALL(15,2,1)
02.24 F N=1,NS;S LX(N)=LX(N)-AX*XR(N)-BX*YR(N)-CX
02.26 F N=1,NS;S LY(N)=LY(N)-AY*XR(N)-BY*YR(N)-CY
02.28 T !;F N=1,NS;T %4.01 LX(N)*1000,LY(N)*1000
02.30 T " SOLUTION OK?";A N;I (N-0Y)02.11,02.32,02.11
02.32 T !;X END(0)

03.20 X JOY(0)
03.30 S X=FLOC(0)/40;S Y=FLOC(1)/40;R

04.05 T "SET D/R SW(3,7). "
04.06 A "ENTER DATA FOR PLATE IN AME. PI PLATE?",J,!;S N=0
04.07 S C=(FSWIT(3,7)+1)*2-1;I (J-0Y)4.10,4.56,4.10
04.10 A "FIELD",A;D 4.2;A " RAH",A;D 4.2;A " RAM",A;S A=A*10
04.12 D 4.2;A " DD",A;D 4.2;A " DM",A;D 4.2;T !
04.13 A " PL NO",A;D 4.20;A " EP",A;S A=A*100+0.1;D 4.20
04.14 A " TEMP",A;S A=A*10+0.1;D 4.20
04.16 A " PRESS",A;S A=A*100+0.1;D 4.20;T !
04.17 A " QUAL",A;A " COLOR",B;S Z=A+B*10+C*100
```

III. MEASURING SEQUENCE

An overall schematic of the measuring system is shown in figure 1. In order to understand the functions of various items of hardware, it is worthwhile to follow the sequence of events involved in measurement of an image.

Survey Phase.

-- An image is located on a plate in the Survey Machine.

-- Coordinates are recorded on the disc, later copied to DECtape. (Coordinates can be card-punched but then must be transferred to magnetic tape using the IBM computer center equipment, since no card reader is available to the PDP 8/I.) Also, survey positions may be typed by hand and stored on the DECtape.

Measurement Phase.

-- The plate is moved to the Measuring Engine at some later date.

-- Survey information for all the images on the plate is copied from DECtape to the magnetic disc. These coordinates may be sorted to minimize Measuring Engine travel distance. (Sorting time is only a few seconds.)

-- Plate alignment corrections are made, using the joystick in combination with the TV monitor and a computer program which calculates a plate alignment correction.

-- Survey coordinates for each image are read sequentially from the disc, corrected for plate alignment, and used to approximately center each image for the measuring engine.

-- The AME control electronics are triggered by the computer and operate automatically until the measurement of the exact position is complete, unless some abnormality exists in the image or the initial centering.

-- The micrometers search for the closest millimeter line, null on it, and count 0.2 micron intervals back to home position. The counts are stored in a scaler.

-- At the same time the scanner tries to center exactly on the image.

-- If the scanner centers and nulls successfully, the iris photometer switches on, nulls, and starts to count the distance between the "null" position and the fully open position.

-- When the photometer has nulled, the scanners recenter and count in 0.2 micron steps back to home position. The counts are stored in a scaler.

-- During the measurement, the computer monitors the action, checking that the scanner detected an image, that neither scanner nor micrometer have hit a limit and that the photometer cycle starts and finishes on schedule.

-- If the measurement is successfully completed, the computer reads the scalers, stores the numbers on the disc and moves to the next image.

-- The computer may abort a measurement, recenter the image, or reset any device that acts in an unexpected manner. Such action is needed quite often due to the wide range of image shapes and sizes, and large differences in plate quality.

-- When 125 images, or all those wanted on a plate have been measured, the computer copies the data from the disc to DECtape for permanent record.

-- The computer FOCAL language program used to measure an image is far too large to fit into the core memory, so that during each image measurement, several subprograms are loaded from DECtape. (The tape transport will be seen to be quite active.)

-- Timing loops in the program prevent the system from hanging up. The program will always move on to the next image after several tries. Abnormal conditions associated with any measurement are flagged by including a diagnostic code with the data for that image, so that the operator can recheck the measurement before the plate is removed from the measuring engine.

Post-Measurement Phase

-- When the measurements for a plate are completed, it may be compared with previously measured plates for the same field in the same orientation or with the same plate measured repeatedly in the same or opposite orientation.

-- Images with poor measurements, as shown from the residuals in the above checks, may be remeasured manually and the new values stored at the correct location on the DECtape.

-- Programs are provided that permit transfers of data records between DECtapes and to IBM tapes for further reductions with the IBM 360 computer.

APPENDIX A. VARIOUS MODES OF AME CARRIAGE POSITIONING

There are three modes by which the operator may cause the carriage (and photographic plate) to move and position on selected objects:

a) by joystick.
b) by typing in XI, YI positions.
c) by typing in index number I for image in survey located on the disk.

Position by Joystick.

Normally this mode of operation is acquired by the setting SW(1,1) at the AME control panel and typing G (return). It is denoted JOYSTICK. The short program is given below (Prog. 6):

```
02.40  X JOY(Ø); C- JOYSTICK
02.41  Q
```

Position by Typing XI,YI.

Normally this mode of operation is acquired by setting SW(1,1) at the AME control panel and typing G (return). It is denoted VIEW-BY X,Y. The positions that are typed in are always expressed in units of mm. Example: For XI and YI type :246.18:371.25.

Values of XI,YI that lie outside the range of the AME carriage, namely, 20 and 480 mm, are not accepted as shown in the program at statement 12.20. To terminate the program type -1, which is tested at statement 12.10.

Position by Typing Image Index Number I.

Normally this mode of operation is acquired by setting SW(1,7) at the AME control panel and typing G (return). This switch position is denoted VIEW-BY INDEX I. It is assumed that there exists already a set of survey positions on the disk starting at record BI=16. A test for the existence of a survey is made at statement 10.12 for the presence of the number -1234 at word number 34 of the 40 words allotted to the plate data at the start of the 16-block record (see App. H for plate data formats). It was stored by the command X PUTL(BI,34,-1234) and may be acquired by FTAKL(BI,34), which is equivalent to FIN(BI,Ø,6) used here for image number I=Ø.

When I is specified by the operator, the position XI,YI is then acquired at statement 10.30. The test at 10.32 corrects the position to a plate rotated 180°. To terminate the program type -1, which is tested at statement 10.35.

In either case, if viewing by XI,YI or by Index I, the AME carriage is moved by the proper amount according to the command X MOV(XI*100,YI*100) which is issued twice at 23.10. The reason for the duplicate command is that the AME carriage can

overshoot by 0.02 mm or so and needs to be corrected back by the second command to yield a carriage position called for by the corrected survey coordinates.

If there is no survey on the disk, it may be acquired from the tape (if it is there) by setting SW(1,4) and typing G (return). This switch position is denoted SURVEY:T7 to DISK.

Below are the programs for the two modes by which the AME carriage may be set by the operator (Prog. 3).

```
10.10 T "VIEW BY INDEX I. END BY -1"
10.12 IF (FIN<BI,0,6>+1234)10.14,10.2
10.14 T !"NO SURVEY ON DISK",!;Q
10.20 T !"TYPE INDEX I OF IMAGES. I="
10.30 A !I;S XI=FIN(BI,I,2)/100;S YI=FIN(BI,I,3)/100
10.32 IF (FSWIT(3,7))10.35,10.35
10.34 S XI=500-XI;S YI=500-YI
10.35 IF (I)10.9;D 23;G 10.3
10.90 T "END",!;Q
[redacted]
12.01 T "VIEW BY X,Y. END BY -1"
12.04 T !"TYPE X,Y"
12.10 T !;A XI;I (XI)12.50
12.12 A YI;I (YI)12.50
12.20 IF (480-XI)12.04;IF (XI-20)12.04;IF (480-YI)12.04;IF (YI-20)12.04
12.30 D 23;G 12.1
12.50 T "END",!;Q
[redacted]
23.10 X MOV(XI*100,YI*100);X MOV(XI*100,YI*100)
23.90 R
*
```

APPENDIX B. VARIOUS MODES OF PROVIDING SURVEYS ON SURVEY TAPE

There are several methods by which survey coordinates may be entered on a DECtape. These coordinates serve as input to the AME by the command X CALL(4,2), which transfers the survey to the disk. The various modes of preparing survey coordinates are as follows:

a) Direct Survey of a plate.

(1) AME measuring: Set SW(C) of survey panel and press RECORD once. follow typed instructions.

(2) AME not measuring: Set SW(1,7) at PDP8 control panel and type G (return). This position is denoted DO SURVEY ALONE. Follow typed instructions.

See special instructions called SURVEY MACHINE SYSTEM for detailed operational steps for surveying a plate.

b) Transfer of survey from punch cards.

It may happen that one has on hand a plate survey in the form of a deck of punch cards. With the AME in the new upgraded mode of operation, these surveys must be transferred to the survey tape before they can serve as input to the AME. The transfer process involves two steps:

First: Transfer survey from cards to IBM tape at IBM 360 computer. Use programs PITRAN (for parallax plates) or MUTRAN (for proper motion plates).

Second: Transfer survey from IBM tape to DECtape at PDP8 computer. Set switch SW(1,7) and type G (return). This position is denoted SURVEY:IBM to T7.

Details of transfer from cards to IBM tape:

Since cards may have differences in certain details of the format, different versions of the IBM 360/40 programs may be written: PITRAN and MUTRAN are just two existing possiblities. But all versions fill in a standard format on the IBM tape (which is ultimately compatible as AME input format). See copies of the programs for input formats for the PLATE DATA and the SURVEY DECK. Formats for the PDP8 are described in App. H.

In general, the card order is as follows:

--Control cards preceeding source deck.
--Source deck (IBM 360).
--Control cards between source deck and data deck.
--Data decks: 1 plate data card and survey deck (+ one end blank).
--Final end blank + final control card.

For formats of the various I/O cards see the programs for details.

PITRAN

026

```
/JASTEI JOB (3023,2,5),KLEMBLA,MSGLEVEL=0
/*MESSAGE      MOUNT AMA-01 TAPE WITH RING LEFT ON.
//STEP1 EXEC FORTGCLG,PARM.FORT='BCD'
//FORT.SYSIN DD *
      INTEGER COLORS,ORIENS,FIELD,PLATE,USE
      DIMENSION IST(125),IS(125),IO(125),IC(125),IQ(125), IB(125),
     1 IX(125),IY(125),MHD( 32),ICQ(125)
C     PROGRAM TO TRANSFER SURVEY DECK TO IBM TAPE FOR PARALLAX PROGRAM.
C     INITIALIZE.
    1 CONTINUE
      DO 5 I=1, 32
    5 MHD(I)=0
C     READ IN GENERAL PLATE INFORMATION.
      READ(5,1008) FIELD,IAH,IAM,IDD,IDM,PLATE,EPOCH
 1008 FORMAT(I4,I3,I4,I4,I3,I5,F6.2)
      IF(FIELD) 99,99,4
    4 MHD(1)=FIELD
      MHD(2)=IAH
      MHD(3)=IAM
      MHD(4)=IDD
      MHD(5)=IDM
      MHD(6)=PLATE
      EPOCH=EPOCH*100.0+0.1
      MHD(7)=IFIX(EPOCH)
      MHD(18)=-1234
      MHD(22)=FIELD
      WRITE(6,1004)
 1004 FORMAT('0')
      WRITE(6,1003) FIELD,IAH,IAM,IDD,IDM,PLATE,MHD(7),(MHD(I),I=8,20)
 1003 FORMAT(10X,20I5)
C     DATA FOR SURVEYED PLATE.
      DO 2 L=1,125
      IST(L)=0
      IS(L)=0
      IO(L)=0
      IC(L)=0
      IQ(L)=0
      IB(L)=0
      IX(L)=0
    2 IY(L)=0
      IE=0
      L=1
    3 READ(5,1006) KK,IST(L),X,Y
 1006 FORMAT(23X,I1,1X,I2,2F7.2)
      IF(X) 10,10,30
   30 IF(KK) 32,32,31
   31 X=X*100.0+0.1
      Y=Y*100.0+0.1
      IX(L)=IFIX(X)
      IY(L)=IFIX(Y)
      IS(L)=1
      IO(L)=1
      IC(L)=9
      ICQ(L)=IC(L)*10+IQ(L)
      IB(L)=+1
      L=L+1
      READ(5,1006) KK,IST(L),X,Y
      X=X*100.0+0.1
      Y=Y*100.0+0.1
      IX(L)=IFIX(X)
```

```
      IY(L)=IFIX(Y)
      IS(L)=1
      IO(L)=1
      ICQ(L)=IC(L)*10+IQ(L)
      IB(L)=2
      L=L+1
      GO TO 3
   32 X=X*100.0+0.1
      Y=Y*100.0+0.1
      IX(L)=IFIX(X)
      IY(L)=IFIX(Y)
      IS(L)=1
      IO(L)=0
      IC(L)=9
      ICQ(L)=IC(L)*10+IQ(L)
      IB(L)=0
      L=L+1
      GO TO 3
   10 NL=L-1
      MHD(15)=NL
C     STORE SURVEY DATA ON IBM TAPE IN SETS OF 16 BLOCKS WITH 125 STARS.
C     PERMITS 8 WORDS PER STAR. UP TO 125 STARS PER PLATE.
      MHD(14)=1
      WRITE(8) (MHD(I),I=1,20 ), (IST(L),IX(L),IY(L),IS(L),IO(L),ICQ(L),
     1 IE,IB(L),L=1,62)
      MHD(21)=2
      WRITE(8)  (IST(L),IX(L),IY(L),IS(L),IO(L),ICQ(L),IE,IB(L),L=63,
     1 125), (MHD(I),I=21,32)
      WRITE(6,1001) NL
 1001 FORMAT(10X,'IMAGES STORED ON IBM TAPE IS ',I4)
      WRITE(6,1002) MHD(14)
 1002 FORMAT(10X,'NO. OF RECORDS IS ',I4)
      GO TO 1
   99 CONTINUE
      STOP
      END
//GO.FT08F001 DD UNIT=2400,
//       DCB=)RECFM=VS,LRECL=2068,BLKSIZE=2072*,
//        LABEL=),NL,,OUT*,
//       DISP=NEW,
//                VOLUME=SER=AMA-01
//GO.SYSIN DD *
```

Details of transfer from IBM tape to DECtape.

With the survey on the IBM tape, the next step is to transfer it to the DECtape. First mount the survey tape on unit 7 and the program tape on unit 8. Mount the IBM tape on the TAPE TRANSFER UNIT (see instructions in App. O for mounting IBM tape).

Then set SW(1,7) on the PDP8 control panel denoted SURVEY: IBM to T7 and type G (return). Respond to questions presented by the teletype: starting record (SN) on tape unit 7 and the number of records (NS) to be transferred. These records may be of one field or ~~numerous~~ different fields. They are transferred in the same order as they were written onto the IBM tape.

Below is given the PDP8 computer program for the transfer. It is assumed that the survey on the IBM tape is at the beginning position (BOT).

(PROG. 16)

```
Ø3.Ø1 T "TRANSFER SURVEY FROM IBM TO T7",!
Ø3.1Ø X NAME(1);X RWND(Ø);S BI=16;S N=1
Ø3.2Ø A "TO TRANSFER SURVEY TO T7 STARTING AT REC SN=",SN;S SN=SN*16
Ø3.22 T !;A "NO. REC TO TRANSFER=",NS,!
Ø3.4Ø X PUTN(BI,Ø,Ø,16*129)
Ø3.42 X IBMR(BI);X IBMR(BI+8);X MPUT(BI,SN,16,7)
Ø3.44 I (NS-N)3.98,3.98;S N=N+1;S SN=SN+16;G 3.4
Ø3.98 T "DONE",!;Q
*
```

c) Typing survey by hand.

It is also possible to type the survey information by hand, assuming that a list of survey positions is available. The program for this operation may be acquired by setting SW(1,4) and typing G (return). This is denoted SURVEY: Type at the PDP8 control panel. This program is not of general application since some of the star codes are assumed to be the same for all images: it needs to be modified later for generalized use.

Assumed constant: S=1 (System), CQ=70 (Class, Quality), E=0 (Normal = no VAR or HPM).

To type: SC, XI and YI (in mm), O (order), B (Ø=central image, 1=S or W image, 2=N or E image). Actual coordinates for grating images must be typed here.

The program permits correction of typing errors before transferring to T7.

Below is given the PDP8 computer program. See Prog. 14 for details of a similar entry of plate data (statements 3.32 to 3.38).

(PROG. 18)

```
03.01 T "TYPE SURV ON T7 ";S BI=16
03.02 A "FILE ON T7 AT SN=",SN,!;S TX=SN*16;X PUTL(BI,34,-1234)
03.05 S S=1;S CQ=70;S E=0
03.07 F I=1,1,125;X SAVX(BI,I,0,0,0,0);X SAVY(BI,I,0,0,0,0)
03.08 G 3.3
03.10 T "TYPE SC,X,Y,O,B. END BY SC=-1"
03.11 S I=1
03.15 T !,%3 I;A SC;I (SC)3.6,3.6;A X;A Y;A O;A B
03.16 S XI=X*100;S YI=Y*100
03.20 X SAVX(BI,I,SC,XI,YI,S);X SAVY(BI,I,O,CQ,E,B)
03.22 S NI=I;S I=I+1;G 3.15
03.30 T "TYPE PL DATA",!
03.32 S N=0;A "FIELD",A;D 3.38;A " RAH",A;D 3.38;A " RAM",A
03.34 S A=A*10;D 3.38;A " DD",A;D 3.38;A " DM",A;D 3.38
03.36 A " PL NO",A;D 3.38;A " EP",A;S A=A*100;D 3.38;T !;G 3.10
03.38 X PUTL(BI,N,A);S N=N+2
03.52 A !" TO CORR I=",I;A " NEW SC=",SC;A " X=",X;A " Y=",Y
03.53 A " O",O;A " B",B
03.54 S XI=X*100;S YI=Y*100;D 3.2;A " MORE?",A;I (A-0Y)3.6,3.52,3.6
03.60 A !"FILE T7?",A;I (A-0Y)3.52,3.61,3.52
03.61 X PUTL(BI,28,NI)
03.62 X MPUT(BI,TX,16,7)
03.98 T "DONE",!;Q
*
```

d) Replace original survey (on T7) by AME measurements (on T8).

It is also possible to use a set of AME measurements as survey coordinates. For example, for a parallax field, having typically 24 plates, the first plate may be measured using survey positions obtained by one of the methods described in the preceeding paragraphs of this Appendix. Then it is possible to replace the original survey on T7 by the AME measurements by setting SW(1,4) and G (return). On the PDP8 control panel this position is denoted SURVEY:REPLACE. All that this does is to replace XI,YI by the AME measurements which are truncated to 0.01 mm. The original image numbers and codes are preserved.

In this program the AME data in record ST of tape 8 is stored starting at block 16, while the original SM information is taken from record SN of tape 7 and stored temporarily starting at block 32. When all the XI,YI have been replaced by new AME values, the whole record is returned to T7 at the original record SN.

Below is given the program for replacing the original survey. As seen here, more than one record may be replaced one by one.

(PROG. 16)

```
02.01 T "TO USE AME MEAS ON T8 AS SURVEY ON T7",!
02.10 A "FIRST REC ON T8 ST=",ST,!;S ST=ST*16
02.12 A "NO. OF RECS TO CONVERT=",N,!;S NN=1
02.14 A "FIRST REC ON T7 OF ORIGINAL SURVEY SN=",SN;S SN=SN*16
02.16 A ! " OK TO CONT?",A;I (A-0Y)2.1,2.2,2.1
02.20 X MTAK(16,ST,16,8);X MTAK(32,SN,16,7)
02.30 S I=1
02.31 S A=FTAKL(16,10);S B=FTAKL(16,12)
02.32 X PUTL(32,10,A);X PUTL(32,12,B)
02.34 S SC=FIN(32,I,1);S S=FIN(32,I,4);S O=FIN(32,I,5)
02.35 S CQ=FIN(32,I,6);S E=FIN(32,I,7);S B=FIN(32,I,8)
02.38 S X=FIN(16,I,2)/100;S Y=FIN(16,I,3)/100
02.40 S XI=FITR(X);S YI=FITR(Y)
02.50 X SAVX(32,I,SC,XI,YI,S);X SAVY(32,I,O,CQ,E,B)
02.60 I (125-I)2.7,2.7;S I=I+1;G 2.34
02.70 X MPUT(32,SN,16,7)
02.72 I (N-NN)2.98,2.98;S NN=NN+1;S ST=ST+16;S SN=SN+16;G 2.20
02.98 T "DONE",!;Q
```

APPENDIX C. ADDING, DELETING, AND CORRECTING IMAGES ON SURVEY TAPE

It may happen that an image on the survey tape needs to be deleted for one reason or another or a new image added. Also, it may occur that an error has been made in either the plate data or in the image survey which requires correction by the operator. Provision is made for these various possibilities which are normally encountered.

a) To add an image to the survey on T7 or T8.

Normally the survey is located on T7 but may be located temporarily on T8. In either case, it may happen that an image needs to be added. The PDP8 computer program may be acquired by setting SW(1,4) and typing G (return). On the PDP8 control panel this is denoted SURVEY:ADD.

To add a star to the survey, specify the I number after which the new image is to be inserted. Then type, as requested, the data for the image: SC,XI and YI (in mm), S, O, C, Q, and B and E. To avoid difficulty in counting current I values as images are inserted, always start by inserting the largest I value and working downwards to the smallest I. This way there is no confusion with the indices.

Below is given the PDP8 computer program valid for a single record that will not have over 125 images after the images are added. If there will be over 125 images, add the image at the end of the final record for the field.

(PR06.23)

```
05.01 A " TO ADD STAR TO T7 OR T8?",U," AT REC=",SN,!
05.10 X MTAK(16,16*SN,16,U)
05.20 S I=1
05.21 S NS=FIN(16,I,1);I (NS)5.22,5.22;S I=I+1;G 5.21
05.22 S NI=I-1
05.25 T "START WITH LARGEST I",!
05.26 A "TO ADD NEW STAR AFTER I=",II,!
05.30 A "SC=",SC," XI=",XI," YI=",YI," S",S," O",O," C",C," Q",Q
05.31 A " B",B," E",E;S XI=XI*100;S YI=YI*100;S CQ=70+Q
05.38 S I=NI;S NI=NI+1
05.40 G 5.61
05.45 S I=II+1
05.46 X SAVX(16,I,SC,XI,YI,S);X SAVY(16,I,0,CQ,E,B)
05.50 A ! " MORE STARS?",A;I (A-0Y)5.7,5.26,5.7
05.61 S A1=FIN(16,I,1);S A2=FIN(16,I,2);S A3=FIN(16,I,3)
05.62 S A4=FIN(16,I,4);S A5=FIN(16,I,5);S A6=FIN(16,I,6)
05.63 S A7=FIN(16,I,7);S A8=FIN(16,I,8);S IS=I+1
05.64 X SAVX(16,IS,A1,A2,A3,A4);X SAVY(16,IS,A5,A6,A7,A8)
05.66 S I=I-1;I (II+1-I)5.40,5.40,5.45
05.70 A "OK TO FILE ON T7?",A;I (A-0Y)5.7,5.72,5.7
05.72 X PUTL(16,28,NI);X MPUT(16,16*SN,16,U)
05.98 T "DONE",!;Q
*
```

b) To delete an image from the survey on T7 or T8.

An image denoted SC may be deleted from the survey tape T7 or from the temporary survey storage location on T8. When done the I numbers are "brought up" the list so that there remains no gap at the omitted image. This PDP8 computer program may be acquired by setting SW(1,4) and return. On the PDP8 control panel this is denoted SURVEY:DELETE. All that is required of the operator is to type in the SC number of the image to be deleted. Note that there may be some complication in connection with grating images or for images that are repeatedly measured, such as the parallax star at start, middle, and end of the plate: it must be treated in a special way (delete all SC and then add correct images by I number).

Below is given the PDP8 computer program valid for a single record with I from 1 to 125. Note that if the field has images in records following this one, the measurements will terminate early. Cure: Transfer very last image I to this record so that it will be filled up to 125 and permit measurements to continue to the next record.

(PROG.19)

```
04.01 A "DELETE STARS ON T7 OR T8?",U," IN REC=",SN,!;S I=1;S BI=16
04.04 X MTAK(BI,16*SN,16,U)
04.06 S NS=FIN(BI,I,1);I (NS)4.07,4.07;S I=I+1;G 4.06
04.07 S NI=I-1
04.12 S NS=NI;T !,%4 FTAKL(BI,0),FTAKL(BI,2)
04.24 T %4.01 FTAKL(BI,4)/10,%4
04.28 T FTAKL(BI,6),FTAKL(BI,8),FTAKL(BI,10),%5.02 FTAKL(BI,12)/100,!
04.30 A "OMIT SC=",SC,!;I (SC)4.98,4.98;S I=1
04.32 I (SC-FIN(BI,I,1))4.34,4.50,4.34
04.34 I (NI-I)4.30,4.30;S I=I+1;G 4.32
04.50 S NS=NS-1;X PUTL(BI,28,NS)
04.51 S M1=FIN(BI,I+1,1);S M2=FIN(BI,I+1,2);S M3=FIN(BI,I+1,3)
04.52 S M4=FIN(BI,I+1,4);S M5=FIN(BI,I+1,5);S M6=FIN(BI,I+1,6)
04.53 S M7=FIN(BI,I+1,7);S M8=FIN(BI,I+1,8)
04.55 X SAVX(BI,I,M1,M2,M3,M4);X SAVY(BI,I,M5,M6,M7,M8)
04.60 I (NI-I)4.30,4.30;S I=I+1;G 4.51
04.80 S I=1;S N=1;A "TYPE=T OR CRT=V?",B,!;I (B-0T)4.81,4.82,4.81
04.81 X SWIT(-1);X STAT(1,980,1)
04.82 T %4 I,FIN(BI,I,1),%7.02 FIN(BI,I,2)/100,FIN(BI,I,3)/100
04.83 F D=4,1,8;T %4 FIN(BI,I,D)
04.84 T !;I (NI-I)4.90,4.90;S I=I+1;G 4.88
04.85 I (20*N-I)4.86,4.82,4.82
04.86 X STAT(-1);A " CONT?",A;D 4.81;I (A-0Y)4.9,4.87,4.9
04.87 S N=N+1;G 4.82
04.88 I (FIN(BI,I,2))4.90,4.90;I (B-0T)4.85,4.82,4.85
04.90 X STAT(-1);A " OK TO FILE ON TAPE?",A;I (A-0Y)4.99,4.91,4.99
04.91 X MPUT(BI,SN*16,16,U);G 4.99
04.98 A " PRINT?",A;I (A-0Y)4.90,4.80,4.90
04.99 T " DONE",!;Q
*
```

c) To correct for error in survey of an image.

It may happen that an error has crept into the survey for an image. This could be an error in a switch setting or a position. The needed correction may be made as follows-

Type X CALL(16,5) and hit return. Upon request type the value of I having the error. Then type the correct values for X,Y,SC(=System),O(=Order),CQ(=Class,Quality), E(0 for normal,1 for HPM star, and 2 for VAR star), and B(0 for central, 1 for S or W, and 2 for N or E image). To terminate the process of correcting a set of images, type -1 for I. Then file back on the tape the corrected record on the disk. The program is listed below.

(PROG. 16)

```
05.01 T "SURVEY:CORRECT",!
05.08 S BI=16
05.10 A "ON T7 OR T8?",U," AT REC=",SN,!
05.11 X MTAK(BI,16*SN,16,U)
05.12 T "TYPE I FOR IMAGE WITH ERROR",!
05.16 T " I      SC       X        Y    S  O CQ   E   B",!
05.18 A I
05.19 I (I)5.5,5.5,5.2
05.20 T %3 FIN(BI,I,1),%7 FIN(BI,I,2),FIN(BI,I,3)
05.21 F J=4,1,8;T %2 FIN(BI,I,J)
05.22 A !,"      ",A1," ",A2," ",A3,A4,A5,A6,A7,A8,!
05.30 X SAVX(BI,I,A1,A2,A3,A4);X SAVY(BI,I,A5,A6,A7,A8)
05.33 G 5.18
05.50 A "OK TO FILE?",A,!;I (A-0Y)5.5,5.6,5.5
05.60 X MPUT(BI,16*SN,16,U)
05.70 T "DONE",!;Q
*
```

APPENDIX D. CHECKING AND CORRECTING AME DATA

After a plate has been measured, it is most useful to make checks against preexisting measurements in order to recognize poor measurements. Various programs have been provided as follows:

1) Simple check: to compare two plates measured in the same orientation (direct vs. direct or reverse vs. reverse) or the same plate measured repeatedly in one orientation. Note that in certain cases these residuals may be regarded as one-half of the proper motion displacement in microns.
2) Dir/Rev check: to compare direct against reverse measurements of the same plate, with precorrections for AME magnitude error and for quadratic index-line error (in X only).
3) TV image check: to go from image to image [where the diagnostic D≠0] and see if the correct image was measured and that no defect exists in the vicinity.
4) Photometry comparison on different records: to list star by star the photometer readings from different plates for a field.
5) Delete image from tape: to remove image from AME data tape.
6) Correct AME output: to enter correct values for AME measures of image on T7 or T8.

a) Simple Check

In the case where two or more plates of the same field are measured, it is possible to make at least a rough check for the quality of the measurements and to isolate images with excessively large residuals (X and Y coordinate measurements mainly). Normally there is no direct check for the first plate. The method involves, first, a linear least squares solutipn (App. J) that leads to a transformation of the system of coordinates of the first plate into that of the second plate. Then, the residuals VX and VY (half-value) in microns are computed as well as the full-value for the photometric differences (in PH units). The attachment of the cooredinates of the first to the second plate is based on about 4 or 5 stars (alignment

stars), so that the resulting comparison is only approximate. The observed residuals, besides depending on the errors of measurement and imperfect transformation of one to the other system, will also contain the effects of stellar proper motions and a differential AME magnitude effect if the exposure and photometer comparison iris settings are different.

The program may be acquired by setting the SW(1,1) and typing G (return). This switch position is denoted SIMPLE CHECK.

The program is given below. It is valid up to I = 1000 (8 records).

(PROG. 17)

```
02.01 A "SIMPLE CHECK. MEAS FROM T7 OR T8?",U," MIN RES=",ZZ,!
02.06 A "REC NO. OLD/CURRENT MEAS=",SX,SY;S TX=SX*16;S TY=SY*16;T !
02.07 X MTAK(16,TX,16,U);X MTAK(32,TY,16,U);T "FIELD" %4 FTAKL(32,0)
02.10 S NS=1;T "   ALIGN STAR"
02.12 A J;I (J)2.4,2.4
02.14 S XM(NS)=FIN(16,J,2)/10000;S YM(NS)=FIN(16,J,3)/10000
02.15 I (-XM(NS))2.20;T " NOT MEAS. GET NEW STAR",!;G 2.12
02.20 S XR(NS)=FIN(32,J,2)/10000;S YR(NS)=FIN(32,J,3)/10000
02.21 I (-XR(NS))2.30;T " NOT MEAS.GET NEW STAR",!;G 2.12
02.30 S NS=NS+1;G 2.12
02.40 S NS=NS-1
02.50 X CALL(15,2,1)
02.60 F N=1,NS;S LX(N)=LX(N)-AX*XR(N)-BX*YR(N)-CX
02.62 F N=1,NS;S LY(N)=LY(N)-AY*XR(N)-BY*YR(N)-CY
02.63 T !;F N=1,NS;T %4.01 LX(N)*500,LY(N)*500
02.64 S NS=125;A !" SOLUTION OK?",A;I (A-0Y)2.1,2.66,2.1
02.66 T !;S UX=1;S N=1;A "FIRST/LAST IMAGE=",J,Z;I (NS-J)2.83
02.67 A "TYPE=T OR CRT=V?",A;T !;I (A-0T)3.5,2.68,3.5
02.68 S XB=FIN(32,J,2)/10000;I (XB)2.9,2.9;S YB=FIN(32,J,3)/10000
02.70 S XA=FIN(16,J,2)/10000;S DX=XA-XB-(AX*(XB-250)+BX*(YB-250)+CX)
02.71 S YA=FIN(16,J,3)/10000;S DY=YA-YB-(AY*(XB-250)+BY*(YB-250)+CY)
02.72 I (XA)2.9,2.9
02.73 S PP=0.5*(FIN(16,J,6)+FIN(32,J,6));S DX=DX*500;S DY=DY*500;G 2.9
02.75 S DP=FIN(16,J,6)-FIN(32,J,6)
02.76 T %4 J+NS-125,FIN(32,J,1),%7.04 XB,YB
02.77 T %5.01 DX,DY,%5 PP,DP,!
02.80 I (A-0T)2.85,2.88,2.85
02.81 X CALL(23,6,1)
02.82 G 2.68
02.83 X CALL(23,7,1)
02.84 G 2.67
02.85 I (25*N-UX)2.86,2.86,2.88
02.86 X STAT(-1);A "C?",B;I (B-0Y)2.98,2.87,2.98
02.87 S N=N+1;D 3.50;G 2.88
02.88 I (Z-J-NS+125)2.98,2.98;S UX=UX+1;S J=J+1;I (125-J)2.81,2.68,2.
02.90 T %4 J+NS-125, FIN(32,J,1),!;G 2.8
02.92 S XD=FABS(DX);I (ZZ-XD)2.75,2.75;S YD=FABS(DY);I (ZZ-YD)2.75,2.
02.93 G 2.80
02.98 T "DONE",!;X STAT(-1)
02.99 Q

03.50 X SWIT(-1);X STAT(1,980,1);F I=1,150;S A=A
03.51 G 2.68
```

b) Dir/Rev Check

The check is applied to a single plate measured in direct and reverse orientations. Because of the presence of both AME magnitude effect and quadratic index-line errors, these have been removed from the reverse measurements before starting the linear least squares adjustment (App. J) that converts the reverse measurements approximately into the direct system and the subsequent calculation of residuals. These residuals VX,VY are half-values while the differences in photometer readings are the full values. The results of the study for the AME magnitude effect and quadratic effect for the index-line are given in App. L. The program for the direct/reverse check may be acquired by setting the SW(1,1) and typing G (return). It is denoted DIR/REV CHECK.

(PR06.2c) The program is given below. It is valid up to I = 1000 (8 records).

```
Ø3.01 A "D VS R MEAS. FROM T7 OR T8?",U,!
Ø3.06 A "REC NO. DIR/REV MEAS",SX,SY;S TX=SX*16;S TY=SY*16;T !
Ø3.07 X MTAK(16,TX,16,U);X MTAK(32,TY,16,U)
Ø3.08 T %4 "FIELD",FTAKL(16,Ø)
Ø3.10 S NS=1;T "  ALIGN STAR"
Ø3.12 A J;I (J)3.40,3.40
Ø3.14 S XM(NS)=FIN(16,J,2)/10000;S YM(NS)=FIN(16,J,3)/10000
Ø3.15 I (-XM(NS))3.20;T "NOT MEAS",!;G 3.12
Ø3.20 S XI=FIN(32,J,2)/10000;S YI=FIN(32,J,3)/10000;D 4
Ø3.22 S YR(NS)=500-YI
Ø3.24 S XR(NS)=500-XI+Ø.ØØ2636*(YI-250)*(YI-250)/10000
Ø3.30 S NS=NS+1;G Ø3.12
Ø3.40 S NS=NS-1
Ø3.50 X CALL(15,2,1)
Ø3.60 X CALL(23,8,1)
Ø3.64 S NS=125;A !" SOLUTION OK?",A;I (A-ØY)3.1,3.66,3.1
Ø3.66 T !;S UX=1;S N=1;A "FIRST/LAST IMAGE=",J,Z;I (NS-J)3.85,3.67,3.67
Ø3.67 A "TYPE=T OR CRT=V?",A;T !;I (A-ØT)Ø4.5Ø,Ø3.68,Ø4.5Ø
Ø3.68 S XI=FIN(32,J,2)/10000;I (XI)3.9,3.9;S YI=FIN(32,J,3)/10000;D 4
Ø3.69 S DD=-Ø.ØØ2636*(YI-250)*(YI-250)/10000;S XA=FIN(16,J,2)/10000;S XB=500-XI;S YB=500-YI
Ø3.70 S YA=FIN(16,J,3)/10000;S DX=XA-XB-(AX*(XB-250)+BX*(YB-250)+CX)+DD
Ø3.71 S DY=YA-YB-(AY*(XB-250)+BY*(YB-250)+CY)
Ø3.72 I (XA)3.9,3.9
Ø3.73 S PP=Ø.5*(FIN(16,J,6)+FIN(32,J,6));S DX=DX*500;S DY=DY*500
Ø3.74 I (A-ØT)4.60,3.75,4.60
Ø3.75 S DP=FIN(16,J,6)-FIN(32,J,6)
Ø3.76 T %4 J+NS-125,FIN(16,J,1),%7.04 Ø.5*(XA-XI)+250,Ø.5*(YA-YI)+250
Ø3.77 T %5.01 DX,DY,%5 PP,DP,!
Ø3.80 I (Z-J-NS+125)3.98,3.98;S UX=UX+1;S J=J+1;I (125-J)3.81,3.68,3.68
Ø3.81 X CALL(23,6,1)
Ø3.82 G 3.68
Ø3.85 X CALL(23,7,1)
Ø3.86 G 3.67
Ø3.90 I (UX-25*N)3.95,3.95;X STAT(-1);A "C?",B
Ø3.91 I (B-ØY)3.98,3.92,3.98
Ø3.92 S N=N+1;X SWIT(-1);X STAT(1,980,1)
Ø3.93 F I=1,150;S A=A
Ø3.95 T %4 J+NS-125,FIN(16,J,1),!;G 3.8
Ø3.98 T "DONE",!;X STAT(-1)
Ø3.99 Q

Ø4.10 S P=FIN(32,J,6)/250;I (P-16.5)4.2,4.2,4.3
Ø4.20 S XI=XI-(-Ø.64*(P-16.5))/1000
Ø4.22 S YI=YI-(+Ø.250*(P-16.5)*(P-16.5))/1000;R
Ø4.30 S XI=XI-(-1.60*(P-16.5)*(P-16.5))/1000
Ø4.32 S YI=YI-(+1.10*(P-16.5))/1000;R
Ø4.50 X SWIT(-1);X STAT(1,980,1)
Ø4.51 G 3.68
Ø4.60 I (UX-25*N)4.62,4.62;X STAT(-1);A "C?",B
Ø4.61 I (B-ØY)3.98,4.70,3.98
Ø4.62 G 3.75
Ø4.70 S N=N+1;D 4.5;G 4.62
```

c) TV Image Check

A program is provided which permits the operator to go from image to image where the differences ΔX and ΔY between measured and corrected survey coordinates exceed some specified value Z in microns. In this way it is possible to see why the larger differences exist. Most differences should be due to a combined effect of poor survey input and proper motion (if epoch difference and proper motion are enough). There is always a possibility of the wrong image being measured: this can be checked here before the plate is removed from the AME (and the plate constants are still available). Images with large residuals may be remeasured later manually and the AME positions corrected on the tape (see part f).

The program may be acquired by setting SW(1,1) and return. This switch position is denoted TV IMAGE CHECK.

The program is given below. It is valid up to I=1000 (8 records).

(PROG. 18)

```
02.01 A "TV IMAGE CK. REC ST=",ST,!;S Z=0.100;S BI=16;S BM=160
02.04 A " SURVEY ON T7 AT REC SN=",SN,!;S SN=SN*16;S I=1
02.06 X MTAK(BI,SN,16,7)
02.07 X CALL(4,6)
02.08 X MTAK(BM,ST*16,16,8)
02.09 S NI=FIN(BM,0,3)
02.10 I (FIN(BM,I,1))2.98,2.98
02.14 S SC=FIN(BI,I,1)
02.16 S X=FIN(BI,I,2)/100;S Y=FIN(BI,I,3)/100
02.17 S XM=FIN(BM,I,2)/10000;S YM=FIN(BM,I,3)/10000
02.22 I (FSWIT(3,7))2.26,2.26,2.24
02.24 S X=500-X;S Y=500-Y
02.26 S XI=X+AX*(X-250)+BX*(Y-250)+CX
02.27 S YI=Y+AY*(X-250)+BY*(Y-250)+CY
02.30 S DX=FABS(XI-XM);S DY=FABS(YI-YM)
02.32 I (XM)2.33,2.33;I (Z+.050-DX)2.40,2.40;I (Z-DY)2.40,2.40,2.71
02.33 D 2.40;D 2.41;G 2.80
02.40 T %3 I,SC;T %6.02 XI,"  ",YI,"  "
02.41 F J=4,1,8;T %2 FIN(BI,I,J)
02.54 T ! "        ",%8.04 XM,YM
02.56 T %5 FIN(BM,I,6),FIN(BM,I,8)
02.59 S XI=XM;S YI=YM;D 23
02.70 A " C?",A;T !;I (A-0Y)2.98,2.71,2.98
02.71 S I=I+1;I (125-I)2.72;G 2.1
02.72 X CALL(23,9,1)
02.73 G 2.1
02.80 T " NM",!;G 2.71
02.98 T "END",!;Q
[redacted]
23.10 X MOV(XI*100,YI*100);X MOV(XI*100,YI*100)
23.90 R
*
```

d) Photometry Comparisons

The program permits the listing of photometer readings for a set of stars measured on several plates (on successive records on T7 or T8). This check is not normally made but is of occasional use in special studies of the performance of the iris photometer.

The program may be acquired only by typing X CALL(22,4) and hitting return. The program is given below. It is valid for up to 71 records and up to 125 images per record.

(PROG. 22)

```
04.01 T "PHOTOMETRY COMPARISONS ON DIFF RECS",!
04.06 A " DATA FROM T7 OR T8?",U,!
04.08 A "STARTING REC=",SX;S TX=SX*16
04.12 A " NO. OF RECS=",NS,!;S N=1;S J=1
04.14 A " NO. IMAGES PER REC=",II;T !;S BI=16
04.16 X MTAK(BI,TX,16,U)
04.30 T !;F I=J,1,J+9;T %6 FIN(BI,I,6)
04.35 I (NS-N)4.4,4.4;S N=N+1;S TX=TX+16;G 4.16
04.40 I (II-I)04.98,04.98;S J=J+10;S TX=SX*16;S N=1;T !;G 4.16
04.98 T ! "DONE",!;Q
```

e) Delete Image From Tape

An image denoted SC may be deleted from the AME measures on T7 or T8. When done, the I-numbers are "brought up" the list so that there remains no gap at the omitted image. This PDP8 program may be acquired by setting SW(1,4) and typing G (return). On the PDP8 control panel this position is denoted SURVEY:DELETE (works for AME measurements also). All that is required of the operator is to type in the SC-number of the image to be deleted. Note that there may be some complication with grating images or for images that are repeatedly measured, such as the parallax star at the start, middle, and end of a plate: it must be treated in a special way (delete all SC and then add correct images at I).

Below is given the PDP8 computer program valid for a single record. If there are more records following this one for the field, it is well to transfer some other image from the very end so that this record will be filled up to 125 images.

(PROG.19)

```
04.01 A "DELETE STARS ON T7 OR T8?",U," IN REC=",SN,!;S I=1;S BI=16
04.04 X MTAK(BI,16*SN,16,U)
04.06 S NS=FIN(BI,I,1);I (NS)4.07,4.07;S I=I+1;G 4.06
04.07 S NI=I-1
04.12 S NS=NI;T !,%4 FTAKL(BI,0),FTAKL(BI,2)
04.24 T %4.01 FTAKL(BI,4)/10,%4
04.28 T FTAKL(BI,6),FTAKL(BI,8),FTAKL(BI,10),%5.02 FTAKL(BI,12)/100,!
04.30 A "OMIT SC=",SC,!;I (SC)4.98,4.98;S I=1
04.32 I (SC-FIN(BI,I,1))4.34,4.50,4.34
04.34 I (NI-I)4.30,4.30;S I=I+1;G 4.32
04.50 S NS=NS-1;X PUTL(BI,28,NS)
04.51 S M1=FIN(BI,I+1,1);S M2=FIN(BI,I+1,2);S M3=FIN(BI,I+1,3)
04.52 S M4=FIN(BI,I+1,4);S M5=FIN(BI,I+1,5);S M6=FIN(BI,I+1,6)
04.53 S M7=FIN(BI,I+1,7);S M8=FIN(BI,I+1,8)
04.55 X SAVX(BI,I,M1,M2,M3,M4);X SAVY(BI,I,M5,M6,M7,M8)
04.60 I (NI-I)4.30,4.30;S I=I+1;G 4.51
04.80 S I=1;S N=1;A "TYPE=T OR CRT=V?",B,!;I (B-0T)4.81,4.82,4.81
04.81 X SWIT(-1);X STAT(1,980,1)
```

```
04.82 T %4 I,FIN(BI,I,1),%7.02 FIN(BI,I,2)/100,FIN(BI,I,3)/100
04.83 F D=4,1,8;T %4 FIN(BI,I,D)
04.84 T !;I (NI-I)4.90,4.90;S I=I+1;G 4.88
04.85 I (20*N-I)4.86,4.82,4.82
04.86 X STAT(-1);A " CONT?",A;D 4.81;I (A-0Y)4.9,4.87,4.9
04.87 S N=N+1;G 4.82
04.88 I (FIN(BI,I,2))4.90,4.90;I (B-0T)4.85,4.82,4.85
04.90 X STAT(-1);A " OK TO FILE ON TAPE?",A;I (A-0Y)4.99,4.91,4.99
04.91 X MPUT(BI,SN*16,16,U);G 4.99
04.98 A " PRINT?",A;I (A-0Y)4.90,4.80,4.90
04.99 T " DONE",!;Q
*
```

f) Correct AME output on T7 or T8.

The program may be acquired by setting SW(1,1) and typing G (return). This switch position is denoted CORRECT DATA. The program is given below.

(pRog.3)

```
07.01 A "TO CORRECT AME OUTPUT ON T7 OR T8",U
07.10 A " REC NO. ON TAPE=",ST;S TX=ST*16;T !;S BM=160
07.11 I (TX)7.96,7.96,7.12
07.12 X MTAK(BM,TX,16,U);T %5 FTAKL(BM,0),FTAKL(BM,2)
07.13 T %4.01  FTAKL(BM,4)/10,%4 FTAKL(BM,6)
07.14 T FTAKL(BM,8),FTAKL(BM,10),%5.02 FTAKL(BM,12)/100
07.15 T %5.01 FTAKL(BM,14)/10,%5.02 FTAKL(BM,16)
07.16 T !
07.17 A " PLATE DATA OK?",A;T !;I (A-0Y)7.49,7.20,7.49
07.20 A " IMAGE I=",I;I (I)7.60,7.60
07.24 S XM(1)=FIN(BM,I,1);S XM(2)=FIN(BM,I,2)/10000
07.25 S XM(3)=FIN(BM,I,3)/10000;S XM(4)=FIN(BM,I,4)
07.26 S XM(5)=FIN(BM,I,5);S XM(6)=FIN(BM,I,6);S XM(7)=FIN(BM,I,7)
07.27 T %3 XM(1),%8.04 XM(2),XM(3),%2 XM(4),XM(5),%5 XM(6),XM(7)
07.28 T %3 XM(8)
07.29 T !
07.30 T "                    ";F NS=1,8;A XM(NS)
07.31 T !
07.40 X SAVX(BM,I,XM(1),XM(2)*10000,XM(3)*10000,XM(4))
07.41 X SAVY(BM,I,XM(5),XM(6),XM(7),XM(8))
07.44 G 07.20
07.48 I (D-4)7.55,7.53,7.55
07.49 A "HEADER WORD NO.=",D;S D=D*2-2
07.50 A " NEW DATA=",X;I (D-12)7.48,7.51,7.52
07.51 S X=X*100+0.1;G 7.55
07.52 I (D-16)7.53,7.51,7.55
07.53 S X=X*10+0.1;G 7.55
07.55 X PUTL(BM,D,X);T !;T %5 FTAKL(BM,0),FTAKL(BM,2),%4;G 7.13
07.60 A " OK TO TRANSFER BACK TO TAPE?",A;I (A-0Y)07.62,7.66,7.62
07.62 T !;G 7.01
07.66 X MPUT(BM,TX,16,U)
07.96 T " DONE",!;Q
```

f) Correct AME Output on T7 or T8

As a result of the checks made on the AME data it may result that an image needs to be remeasured. Assume that the plate is still in the AME and has not been disturbed. The image may be measured manually. Then this program is called to permit replacement of the original (poor) measurement with the new one.

First, when requested, give the record number (usually on T8) in which the original measurements are stored. Then, note whether the plate data that is typed out is correct (PLATE DATA OK?). If it is OK, then type Y and continue. If there is an error, type N and use the following table to make the corrections one at a time. The requested "header word number" is to be typed and then the "new data" for that word.

Word	Item	Format (integer unless noted otherwise)
1	FIELD	
2	RAH	
3	RAM	XX.X
4	DD	
5	DM	
6	PL.NO.	
7	EP	XX.XX
8	TEMP	±XX.X
9	PRESS	XX.XX
10	---	

When the header data is good, then type Y to go to the measurements. If there are no measurements to be corrected, type -1 for "Image I=" and then file back on the same tape the corrected record.

But if there are measurements to be corrected, type the I-number in that record (really IC). First this will be typed out the original data for the image in the following order (X,Y in mm):

I, SC, X, Y, B, (Zero), P, SOCQ, D

where B=0,1,2 for image measured and D=diagnostics. Type in the new X,Y,P and the original SC,B,SOCQ. For D always type 8 to denote a manual measurement that replaces an original measurement. When there are no more images to correct, type -1 for "Image I=". Then file the record back on the tape when requested.

APPENDIX E. PRINTING SURVEY OR AME DATA LOCATED ON DISK OR TAPE

a) Print data or survey from T7 or T8.

A program is provided for the routine printing of the contents of any PDP8 tape record having either survey or AME data. This may be either displayed on the CRT or printed by the teletype. Normally this program may be acquired by setting SW(1,4) and typing G (return). This is denoted PRINT T7/T8.

The program is given below. It is valid for up to I=1000 images (8 records).

(PROG. 22)

```
03.01 A "PRINT FROM T7 OR T8?",U;T !
03.10 A " REC NO.?"ST(2);S TX=ST(2)*16;S SC=10000;S BI=16
03.12 S N=1;S TX=ST(2)*16;A "SURVEY TAPE?",AX;S NS=125;S UX=1
03.15 A " FIRST/ LAST IMAGE",I,II;A !" TYPE=T OR CRT=V",A;T !
03.16 X MTAK(BI,TX,16,U);I (A-0T)3.17,3.18,3.17
03.17 X SWIT(-1);X STAT(1,980,1);F D=1,150;S A=A
03.18 T %4 FTAKL(BI,0),FTAKL(BI,2),%4.01 FTAKL(BI,4)/10,%4
03.19 T FTAKL(BI,6),FTAKL(BI,8),FTAKL(BI,10),%5.02 FTAKL(BI,12)/100,!
03.20 I (NS-I)3.65,3.21,3.21
03.21 S J=I+NS-125
03.22 I (AX-0Y)3.3,3.24,3.3
03.24 T %4 J, FIN(BI,I,1),%6.02 FIN(BI,I,2)/100,FIN(BI,I,3)/100;G 3.31
03.30 T %4 J,FIN(BI,I,1),%8.04 FIN(BI,I,2)/SC,FIN(BI,I,3)/SC
03.31 F D=4,1,8;T %4 FIN(BI,I,D)
03.32 T !;I (II-I-NS+125)3.4,3.4;S I=I+1;S UX=UX+1;I (NS-J-1)3.6;G 3.7
03.33 I (24*N-UX)3.34,3.21,3.21
03.34 S N=N+1;X STAT(-1);A "C?",B;I (B-0Y)3.40,3.35
03.35 D 3.17;G 3.2
03.40 T "DONE",!;X STAT(-1);Q
03.60 S NS=NS+125;S TX=TX+16;S I=I-125
03.61 D 3.62;I (A-0T)3.33,3.21,3.33
03.62 X MTAK(16,TX,16,U)
03.63 G 3.21
03.65 I (NS-I)3.67,3.21,3.21
03.67 D 3.6;G 3.65
03.70 I (A-0T)3.33,3.21,3.33
*
```

b) Print output details from disk.

As soon as a plate has been measured, it is possible to print the AME measurements in detail from the storage location starting at B0=144 on the disk. The specific items printed are the X and Y scanner and micrometer readings and photometry as well as the carriage position (XI,YI). All are in units of mm. This detailed output permits study of the functioning of the scanner and micrometer systems separately before the two readings are combined. This printing operation may be acquired by setting SW(1,7) and typing G (return). It is denoted PRINT: OUTPUT DETAILS. The program is listed below.

(PROG. 21)

```
02.01 T "PRINT OUTPUT DETAILS FROM DISK",!
02.02 A !"FIRST AND LAST INDEX I=",J,K;A " ALL?",A;T !
02.14 T !"          SC    XI    XM    XS    PH      YI      YM      YS"
02.20 F I=J,K;T ! %3 I;DO 2.82;DO 2.9;DO 2.92
02.30 Q
02.82 S SC=FOUT(BO,I,1);S ER=FOUT(BM,I,8);T %3 SC
02.90 F Q=2,8;T %5 FOUT(BO,I,Q)
02.92 IF (ER)2.94,2.95,2.94
02.94 T ER
02.95 C
```

c) Print final results from the disk.

It is possible to print out the AME measurements directly from the disk without first transferring to the tape (T8 or T7). This program is especially useful for manual measurements, which are normally not stored on tape when completed. The program may be acquired by setting SW(1,7) and typing G (return). It is denoted PRINT: FINAL RESULTS. The program is given below.

(PROG. 21)

```
03.01 T "PRINT FINAL RESULTS FROM DISK",!
03.10 A !"FIRST AND LAST INDICES",J,K;A " ALL?",A;T !
03.50 T !"  I    SC     X          Y        PHOT."
03.60 F I=J,K;DO 4
03.70 Q

04.10 S XI=FOUT(BO,I,2);S XM=FOUT(BO,I,3)
04.12 S XS=FOUT(BO,I,4)
04.14 S YI=FOUT(BO,I,6);S YM=FOUT(BO,I,7)
04.16 S YS=FOUT(BO,I,8)
04.20 S D=XI-100*FITR(XI/100);S M=XM;DO 14
04.22 S XI=XI+N
04.24 S SC=FOUT(BO,I,1);S ER=FOUT(BM,I,8)
04.30 S D=YI-100*FITR(YI/100);S M=YM;DO 14
04.32 S YI=YI+N
04.40 S XT=FITR(XI/100)+(XM+XS)/5000+FCOR(XI/100)/10000
04.50 S YT=FITR(YI/100)+(YM+YS)/5000+FCOR(YI/100,1)/10000
04.51 I (A-0Y)4.52,4.6
04.52 I (ER)4.6,4.9,4.6
04.60 T !%3 I,SC,%8.04 XT,YT,%6 FOUT(BO,I,5)
04.70 IF (ER)4.8,4.9
04.80 T %6 ER
04.90 R

14.10 S N=0
14.20 IF (D-90)14.3;IF (1000-M)14.9;S N=100;G 14.9
14.30 IF (30-D)14.9;IF (M-3000)14.9;S N=-100
14.90 R
```

d) Print contents (plate data only) of tapes: SPOT CHECK.

In order to provide a check on the contents of DECtapes and IBM tapes, programs are provided that give mainly plate data for the record. These are described in the following paragraphs. These programs do not give the full data: they are used only to spot check the contents.

1. Contents of T7 or T8: this program may be acquired by setting SW(1,7) and typing G (return). It is denoted LIST PLATE DATA. The program is given below. It is valid for up to 71 records.

(PROG. 5)

```
02.01 A "LIST PLATE DATA T7 OR T8?",U,!;S BM=160
02.10 A "FIRST REC=",RF," LAST REC=",RL," OK TO GO?",A,!
02.12 I (A-ØY)2.1,2.2,2.1
02.20 X MTAK(BM,16*RF,16,U);T %3 RF
02.24 T %4 FTAKL(BM,Ø),FTAKL(BM,2),%4.Ø1 FTAKL(BM,4)/1Ø,%4
02.26 T FTAKL(BM,6),FTAKL(BM,8),FTAKL(BM,1Ø),%5.Ø2 FTAKL(BM,12)/1ØØ
02.28 T %5.Ø1 FTAKL(BM,14)/1Ø,%5.Ø2 FTAKL(BM,16)/1ØØ
02.30 T %3 FTAKL(BM,18),FTAKL(BM,2Ø),!
02.40 I (RL-RF)2.98,2.98;S RF=RF+1;G 2.2
02.98 T "DONE",!;Q
*
```

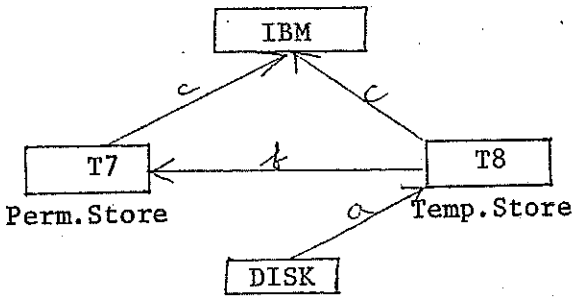
2. Contents of IBM tape: this program may be acquired by setting SW(1,10) and typing G (return). It is denoted READ IBM. The program is given below.

(PROG. 21)

```
15.01 T "READ CONTENTS OF IBM RECORDS."
15.02 S BI=16;A "  FIRST/LAST I="I,II,!
15.03 I (I)15.98,15.98,15.04
15.04 X NAME(1);X RWND(Ø)
15.06 A "NO. REC TO SKIP=",N;X ADV(2*N)
15.08 A "TYPE=T OR CRT=V?",A;I (A-ØT)15.12,15.14,15.12
15.12 X SWIT(-1);X STAT(1,98Ø,1)
15.14 X IBMR(BI);X IBMR(BI+8)
15.16 F D=Ø,2,1Ø;T %5 FTAKL(BI,D)
15.17 T !;F J=1,8;T %7 FOUT(BI,I,J)
15.18 I (II-I)15.19,15.19;S I=I+1;G 15.17
15.19 T !;X STAT(-1);G 15.Ø2
15.98 X STAT(-1);T "END",!;Q
15.99 Q
```

APPENDIX F. TAPE TRANSFERS FOR AME DATA

The available sequences for the transfer of AME data from tape to tape is shown in the following diagram.



a) From disk to T8: this transfer is done automatically during the process of measurement and no further steps by the operator are needed (once he specifies the record ST on T8). The storage of data on T8 (which is the AME/SM program tape) should be regarded as temporary.

b) From T8 to T7: this transfer is carried out by the operator who wishes to transfer from temporary storage on T8 to permanent storage on T7. This program may be acquired by setting SW(1,4) and typing G (return). This switch position is denoted DATA:T8 to T7.

The program is shown below which is valid for more than one record at a time. It is valid for up to 71 records.

(PROG.12)

```
02.09 T "TO TRANSFER AME DATA FROM T8 TO T7",!
02.10 A "STARTING REC ON T8",SX;T !;S TX=SX*16
02.12 A "NO. REC TO TRANSFER ",NS;T !;S N=1
02.14 A "STARTING REC ON T7",SY;T !;S TY=SY*16
02.40 S BI=16
02.60 A "FILE ON T7?",A;I (A-0Y)2.10,2.70,2.10
02.70 S N=1;S TY=SY*16
02.80 X MTAK(BI,TX,16,8);X MPUT(BI,TY,16,7)
02.82 S TX=TX+16;S TY=TY+16;S N=N+1;I (NS-N)02.91,2.80,2.80
02.91 T " DONE";A "   MORE?",A;T !;I (A-0Y)2.92,2.10,2.92
02.92 Q
*
```

c) From T7/T8 to IBM tape: this transfer is carried out by the operator who wishes to transfer to the IBM tape so that reductions at the IBM 360 computer may be performed later. The program is written so that the origin may be either T7 or T8 and more than one record may be transferred. This program may be acquired by setting SW(1,10) and typing G (return). This switch position is denoted DATA:T7/T8 to IBM.

The program is given below. It is valid for up to 71 records on one DECtape.

(PROG.19)

```
02.01 T "DATA FROM T7/T8 TO IBM TAPE";S BM=160
02.02 X NAME(1)
02.03 X RWND(0)
02.10 A !"START 0N IBM AT BOT?",J;I (J-0Y)2.12,2.2
02.12 IF (J-0N)2.1,2.3,2.1
02.20 X IBME(0)
02.21 G 2.4
02.30 X HUNT(0);X BAK(1,1);X ADV(1)
02.40 A !"FROM T7 OR T8?",U
02.50 A "FIRST/LAST REC="TB,RL,!;S TB=TB*16;S RL=RL*16
02.60 X MTAK(BM,TB,16,U)
02.62 X IBMW(BM);X IBMW(BM+8)
02.64 I (RL-TB)2.92,2.92;S TB=TB+16;G 2.6
02.92 A "MORE RECS?",A,!;I (A-0Y)2.98,2.50,2.98
02.98 X EOF(0);X EOF(0)
02.99 T "DONE",!;Q
*
```

APPENDIX G. PDP8 DISK SPACE ALLOCATION

For the various AME and SM operations the following standard assignment of disk storage locations is employed.

SYMBOL	BLOCKS	USE
(BR=8)	1- 15	(BR=8 gives measuring sequence)
BI	16- 31	Survey from tape
	32- 47	
	48- 63	
	64- 79	
	80- 95	
	96-111	
	112-127	
BN	128-143	Temporary storage (rarely used if at all)
BO	144-159	AME detailed output buffer
BM	160-175	AME final output buffer
BS	176-191	SM temporary storage buffer
BT	192-208	(general temporary storage)
	209-226	(no tape transfers permitted here)

Each of the above sets of 16 blocks represents one record, which has a capacity of 125 images (8 words of 24 bits each) plus plate data information (see App. H).

Storage of Constants Starting at Disk Block 1

COMMAND	USE
X STOR(1,4;AX) X STOR(1,8;BX) X STOR(1,12;CX) X STOR(1.16;AY) X STOR(1,20;BY) X STOR(1,24;CY)	Plate alignment constants
X PUT(1,28,1357)	Check word
X PUT(1,29,TO)	DECtape output record number
X PUT(1,30,I)	Image index
X PUT(1,31,IC)	Star index
X PUTL(1,32;UX)	Pi star:PMA
X PUTL(1,36;UY)	Pi star:PMD
X PUTL(1,40;UZ)	Pi star:Yes or no

APPENDIX H. AME AND SM FORMATS ON DECTAPE

Survey and Data Formats for an Image.

The content for each image is somewhat different for the survey and the AME data but both contain 8 words (24 bits each) each.

WORD	SURVEY	AME	DATA	
J=1	SC	SC	W1	Star number.
2	XI	XO	W2	Coordinate as integers.
3	YI	YO	W3	Coordinate as integers.
4	S	B	W4	S=system, B=0(central), 1(1st gr.), 2(2nd gr.).
5	O	--	W5	O=order.
6	CQ	PH	W6	CQ=10·C+Q. PH=photometry.
7	E	SOCQ	W7	E=0(normal), 1(HPM), 2(Var.).
8	B	D	W8	D=diagnostics code (See App.).

The value W for the word J for image I may be acquired by the command

W=FIN(B,I,J),

where B is the block-location on the disk where the information resides (see App. G). For convenience, we write SOCQ=1000·S+100·O+CQ. For survey coordinates (J=2 or 3), divide W by 100 and for AME data divide W by 10000 to obtain mm units.

Arrangement of Content of a Record.

Each record is subdivided into two equal halves of 8 blocks each for a total of 16 blocks.

First 8 blocks	20 words	496 words (62 stars)	516 words
Second 8 blocks	504 words (63 stars)	12 words	516 words

SUM = 1032 words

The total number of words allotted for plate information is 20+12=32 words and the number of words for star data is 496(=8x62)+504(=8x63)=1000 words. With 8 words per image, this permits 1000/8=125 images to be stored per record. Words are defined here as 24 bits each for double-precision integers throughout.

The plate data may be written by the command X PUTL(B,I,N) for image I and word content D and recovered by N=FTAKL(B,I). The star data may be written by the command X SAVX(B,I,W1,W2,W3,W4); X SAVY(B,I,W5,W6,W7,W8) where the W1, W2, . . . are defined in the table given above (all 24-bit integers).

Arrangement of Images on Several Records.

For a plate containing several hundred (>125) images the count for the image number I runs smoothly from one record to the next. There is another index IC that counts images within a record from 1 to 125. The first and last image for each record is given below.

RECORD	FIRST	LAST	BLOCK(SURVEY)
1	I= 1	I=125	16- 31
2	126	250	32- 47
3	251	375	48- 63
4	376	500	64- 79
5	501	625	80- 95
6	626	750	96-111
7	751	875	112-127
8*	876	1000	128-143

*Note: Be careful in storing over 875 images on the disk at ome time, i.e., in the 16 blocks from 128 to 143. This is the temporary storage location BN=128 which may be used in certain operations (rarely used if at all).

Arrangement of Plate Data in 20-Word Header of Record.

It is assumed here that all plate data consists of 24-bit words (2 PDP8 12-bit words), so that everything is given as double-precision (±) integers. There are 20 such double-precision words available at the beginning of each record for any information that the operator wishes to preserve. In addition, there are 12 more such words free at the end of each record after the 125th image space. The 12 words at the end are generally not used.

It is convenient to adopt a standard format as far as contents of these plate data words are concerned. Words D=28 (for number of images NI) and D=34 (constant - 1234 used as check in reading records) are essential for a record.

PDP8 WORD D	IBM WORD K	USE	NOTES
0	1	FIELD	
2	2	RH	
4	3	RM	XX.X*10
6	4	DD	
8	5	DM	
10	6	PLATE	
12	7	EPOCH*	XX.XX*100
14	8	TEMP	XX.X*10
16	9	PRESS	XX.XX*100
18	10	QUAL.	
20	11	COLOR	1=blue,2=yellow
22	12	ORIEN	1=0°,2=90°,3=180°,4=270°
24	13	--	
26	14	--	
28	15	NI	Total No. images for plate
30	16	--	
32	17	--	
34	18	-1234	Check word
36	19	--	
38	20	--	

PDP8 WORD D	IBM WORD K	USE	NOTES
1008	505	---	
1010	506	---	
1012	507	---	
1014	508	---	
1016	509	---	
1018	510	---	
1020	511	---	
1022	512	---	
1024	513	---	
1026	514	---	
1028	515	---	
1030	516	---	

*EPOCH from 1900 + XX.XX

Plate data may be written by the command X PUTL(B,D,N) for data N at starting block B on the disk. It may be acquired by the command N=FTAKL(B,D).

APPENDIX I. READING AME DATA FROM IBM TAPE WITH IBM 360 COMPUTER

The AME data when transferred to the IBM tape (see App. F) may be read from the IBM tape at the IBM 360 computer with the following simple Fortran program.

Example:

```
      DIMENSION I(1032)
      READ(8) (I(K), K=1,516)        ]
      READ(8) (I(K), K=517,1032)     ] Always go in pairs.
      WRITE(6,1001) (I(K), K=1,10)   ]
 1001 FORMAT(10X,10I8)               ] Write out plate information.
      WRITE(6,1001) (I(K), K=11,20)  ]
      WRITE(6,1005) (I(K), K=21,1020) Write AME measures(integers) (8 words
 1005 FORMAT(10X,8I8)                 per image).
   99 STOP
      END
```

The 8 IBM double-precision integer words for an image are given in the table of App. H. These are as follows for final AME output starting at K=21: 1=SC, 2=XO, 3=YO, 4=B(image), 5=zero, 6=PH, 7=SOCQ, 8=D.

Example:

A more specific write-out of the AME final output is given, for example, in the AMETST program described in App. L. A portion of that program is as follows for record N (of several records NN in all):

```
      N=1
 1    READ(8) (II(K), K=1,516)       ]
      READ(8) (II(K), K=517,1032)    ] Always in pairs.
      FIELD(N)=II(1)
      RAH(N)=II(2)
      RAM(N)=II(3)
      DD(N)=II(4)
      DM(N)=II(5)                        Plate data.
      PLATE(N)=II(6)
      EPOCH(N)=II(7)
        :
      LAST(N)=II(18)
      M=0
      I=1
C-AME final output for each image.
 2    SC(I,N)=II(21+M)
      XO(I,N)=II(22+M)
      YO(I,N)=II(23+M)
      B(I,N)=II(24+M)
      PH(I,N)=II(26+M)          <25 always zero.
      SOCQ(I,N)=II(27+M)
      D(I,N)=II(28+M)
      IF(125-I) 10,10,3
 3    I=I+1
      M=M+8
      GO TO 2

C-More records to be read (up to NN specified at beginning of program)
10    IF(NN-N) 99,99,11
11    N=N+1
      GO TO 1

99    STOP
      END
```

These examples should be adequate to demonstrate the manner in which the IBM tape may be read at the IBM 360 computer.

The standard IBM control cards may be found with existing FORTRAN programs.

APPENDIX J. LEAST SQUARES SUBROUTINE (Program 15)

At several stages of the AME/SM operations least squares solutions are made:

a) Plate alignment (Prog. 14): to correct survey positions to switch images on plate in AME.

b) Measurements check (App. D): to compare direct against reverse plate measurements.

c) Measurements check (App. D): to compare two plates measured in the same orientation (direct vs. direct or reverse vs. reverse) or the same plate measured repeatedly. Note that in certain cases the residuals in X and Y may be regarded as one-half the proper motion displacement in microns.

In each case the equation of condition, written separately for X and Y, contains three unknowns and may involve up to about 10 equations of observation (any more will result in exceeding the capacity of the core of the PDP8).

The way the programs are written is that the manipulations involving the observations are performed separately in the programs noted above and then the least squares subroutine is caled [X CALL(15,2,1)]. There the normal equations are formed and then solved for the two sets of three unknowns: a=AX, b=BX, c=CX in X and for d=AY, e=BY, f=CY in Y. The brackets[ ] are a standard means of denoting sums. Example: $[XX] \equiv \sum_{i=1}^{n} X_i X_i$.

Below is given the scheme for performing the least squares solution for three unknowns. Linear terms for only zero point, scale, and orientation are included. For the specific applications to which this program is applied, this form of the equation of condition is adequate.

Equations of condition --

$a \cdot X + b \cdot Y + c = L_x$ in X,

$d \cdot X + e \cdot Y + f = L_y$ in Y,

where L_x=X(measured)-X(surveyed) and L_y=Y(measured)-Y(surveyed).

Normal equations in X --

$[XX]a+[XY]b+[X]c=[XL_x]$

$[XY]a+[YY]b+[Y]c=[YL_x]$

$[X]a+[Y]b+N \cdot c=[L_x]$

Solutions for unknown constants a, b, c --

Set I:

$[XY][XX]a+[XY][XY]b+[XY][X]c=[XY][XL_x]$

$[XX][XY]a+[XX][YY]b+[XX][Y]c=[XX][YL_x]$

Set II:

$[XY][X]a+[XY][Y]b+N[XY]c=[XY][L_x]$

$[X][XY]a+[X][YY]b+[X][Y]c=[X][YL_x]$

Set III (differences of lines in Sets I and II):

$$\{[XY][XY]-[XX][YY]\}b+\{[XY][X]-[XX][Y]\}c=[XY][XL_x]-[XX][YL_x]$$

$$\{[XY][Y]-[X][YY]\}b+\{N[XY]-[X][Y]\}c=[XY][L_x]-[X][YL_x]$$

For convenience write the terms --

$A(1)=[XY][XY]-[XX][YY]$
$A(2)=[XY][X]-[XX][Y]$
$A(3)=[XY][XL_x]-[XX][YL_x]$
$A(4)=[XY][Y]-[X][YY]$
$A(5)=N[XY]-[X][Y]$
$A(6)=[XY][L_x]-[X][YL_x]$

Rewrite Set III as --

$A(1)\cdot b+A(2)\cdot c=A(3)$
$A(4)\cdot b+A(5)\cdot c=A(6)$

By elimination we get --

$A(4)\cdot A(1)\cdot b+A(4)\cdot A(2)\cdot c=A(4)\cdot A(3)$
$A(1)\cdot A(4)\cdot b+A(1)\cdot A(5)\cdot c=A(1)\cdot A(6)$

Finally the constants are --

$c=\{A(4)\cdot A(3)-A(1)\cdot A(6)\}/\{A(4)\cdot A(2)-A(1)\cdot A(5)\}$
$b=\{A(3)-A(2)\cdot c\}/A(1)$
$a=\{[XL_x]-b[XY]-c[X]\}/[XX]$

The solution in Y is identical: simply replace L_x by L_y throughout (not shown here):

$f=\{A(4)\cdot A(3)-A(1)\cdot A(6)\}/\{A(4)\cdot A(2)-A(1)\cdot A(5)\}$
$e=\{A(3)-A(2)\cdot f\}/A(1)$
$d=\{[XL_y]-e\cdot[XY]-f\cdot[X]\}/[XX]$

where now

$A(3)=[XY][XL_y]-[XX][YL_y]$
$A(6)=[XY][L_y]-[X][YL_y]$

In program 15 we use the following notation: ST(M) for M=1,11.

$ST(1)=[X]$
$ST(2)=[Y]$
$ST(3)=[XY]$
$ST(4)=[XX]$
$ST(5)=[YY]$
$ST(6)=[XL_x]$
$ST(7)=[YL_x]$
$ST(8)=[L_x]$
$ST(9)=[XL_y]$
$ST(10)=[YL_y]$
$ST(11)=[L_y]$

The corrected coordinates are computed from these (application a):

XI(corrected)=XI+{AX*XI+BX*YI+CX}
YI(corrected)=YI+{AY*XI+BY*YI+CY}

where XI=XI-250 and YI=YI-250 are given originally (in mm).

Below is given the least squares program.

(PROG. 15)

```
02.01 C-LEAST SQUARES
02.20 F M=1,11;S ST(M)=0
02.22 F N=1,NS;S LX(N)=XM(N)-XR(N);S LY(N)=YM(N)-YR(N)
02.24 F N=1,NS;S XR(N)=XR(N)-250;S YR(N)=YR(N)-250
02.26 F N=1,NS;S ST(1)=ST(1)+XR(N);S ST(2)=ST(2)+YR(N)
02.28 F N=1,NS;S ST(3)=ST(3)+XR(N)*YR(N)
02.30 F N=1,NS;S ST(4)=ST(4)+XR(N)*XR(N)
02.32 F N=1,NS;S ST(5)=ST(5)+YR(N)*YR(N)
02.34 F N=1,NS;S ST(6)=ST(6)+XR(N)*LX(N)
02.36 F N=1,NS;S ST(7)=ST(7)+YR(N)*LX(N)
02.38 F N=1,NS;S ST(8)=ST(8)+LX(N)
02.40 F N=1,NS;S ST(9)=ST(9)+XR(N)*LY(N)
02.42 F N=1,NS;S ST(10)=ST(10)+YR(N)*LY(N)
02.44 F N=1,NS;S ST(11)=ST(11)+LY(N)
02.50 S A(1)=ST(3)*ST(3)-ST(4)*ST(5)
02.52 S A(2)=ST(3)*ST(1)-ST(4)*ST(2)
02.54 S A(3)=ST(3)*ST(6)-ST(4)*ST(7)
02.56 S A(4)=ST(3)*ST(2)-ST(1)*ST(5)
02.58 S A(5)=NS*ST(3)-ST(1)*ST(2)
02.60 S A(6)=ST(3)*ST(8)-ST(1)*ST(7)
02.62 S A(7)=ST(3)*ST(9)-ST(4)*ST(10)
02.64 S A(8)=ST(3)*ST(11)-ST(1)*ST(10)
02.70 S CX=(A(4)*A(3)-A(1)*A(6))/(A(4)*A(2)-A(1)*A(5))
02.72 S BX=(A(4)*A(3)-A(4)*A(2)*CX)/(A(4)*A(1))
02.74 S AX=(ST(6)-ST(3)*BX-ST(1)*CX)/ST(4)
02.76 S CY=(A(4)*A(7)-A(1)*A(8))/(A(4)*A(2)-A(1)*A(5))
02.78 S BY=(A(4)*A(7)-A(4)*A(2)*CY)/(A(4)*A(1))
02.80 S AY=(ST(9)-ST(3)*BY-ST(1)*CY)/ST(4)
02.92 T !"ALIGNMENT DONE"
02.93 X END(0)
```

APPENDIX K. SPECIAL AME TEST PROGRAMS

1. Full Count Check (FCC).

The purpose of this program is to check that the full range of the X and Y scanner and micrometer read-out systems are up to the standard values. If not, it denotes some sort of hardware malfunction that needs attention.

This program may be reached by the switch on the PDP 8 control panel denoted FULL COUNT CHECK (FCC).

The printed output is the following (0=X, 1=Y):

FMICR(0), FMICR(1), FSCNR(0), FSCNR(1).

The expected values in units of "counts" (microns/2) are these:

5015 5008 1242 1250

The observed values should normally not depart more than one or two counts or so.

Below is given the computer program.

(PROG. 5)

```
29.60 X AME(0);X CLER(6)
29.75 A !"NO. FCC TRIALS =",N;S A=0;G 29.94
29.80 X GMIC(0,1);X GSCN(0,1)
29.82 F J=0,200;S A=A
29.83 S A=A+1
29.84 IF (FSCNS(MX)+FMICS(MX)-2*MX)29.84,29.86,29.84
29.86 X AME(0);X CLER(6)
29.88 IF (FSCNS(HM)+FMICS(HM)-2*HM)29.88,29.9,29.88
29.90 T !%4 ,FMICR(0),FMICR(1),FSCNR(0),FSCNR(1)
29.94 IF (A-N)29.8
29.99 R
```

2. Check Scanner and Micrometer Repeatability.

A short computer program is provided that gives automatically repeated values for X and Y scanner and micrometer measurements for a single image. Then, at the end when SW(3,2) is turned up, the averages are printed as well as the carriage position from the encoders. All figures are in mm units.

The program may be acquired only by calling as follows:

X CALL(1,6) or X CALL(1); G 6.01.

After the program is in core, make a setting with the joystick on some image when instructed by the printer: press SW(3,11) to initiate the measuring cycles. These repeat automatically until terminated by turning SW(3,2) to up. To continue a new set of measuring cycles on the same or different image (after using the joystick to center the image): press SW(3,11) again.

Below is given the computer program. (PROG. 1)

```
03.10 F J=1,200;S A=A

06.01 T !! "MEASURE CHECK (SWIT(3,2) TO STOP)",!"SET STAR!";X JOY(0)
06.02 T !"      MICR          SCANNER          SUM"
06.05 T !"    X      Y       X       Y       X       Y"
06.10 S N=0;S AX=0;S AY=0;S BX=0;S BY=0;S TX=0;S TY=0
06.12 X AME(0);X CLER(6);X AME(1)
06.15 S HM=2560
06.20 D 3
06.30 I (FMICS(HM)+FSCNS(HM)-2*HM+FPHOS(704)-512)6.31,6.35,6.31
06.31 IF (FSWIT(3,11))6.3,6.3;T !"RESET";X CLER(6);X JOY(0);G 6.1
06.35 S XM=FMICR(0)/5;S YM=FMICR(1)/5;S XS=FSCNR(0)/5;S YS=FSCNR(1)/5
06.36 S XM=XM*0.9943
06.40 S TX=TX+XM+XS;S TY=TY+YM+YS
06.50 S AX=XM+AX;S AY=YM+AY
06.60 S BX=XS+BX;S BY=YS+BY;S N=N+1
06.70 T !%5.01 XM,YM,XS,YS,XM+XS,YM+YS
06.80 IF (FSWIT(3,2))6.12,6.12
06.85 IF (N-2)6.92
06.90 T ! %5.01 AX/N,AY/N,BX/N,BY/N,TX/N,TY/N
06.92 T %5.02 FLOC(0)/40,FLOC(1)/40
06.94 T " -SET STAR",!,;X JOY(0);G 6.1
```

APPENDIX L. AME QUADRATIC INDEX-LINE AND MAGNITUDE ERRORS

The AME quadratic errors of the X and Y index lines and the magnitude effect have been investigated on numerous occasions in recent years. The IBM 360 computer program AMETST, now modified to accept IBM tape data input, has been used for this purpose. It involves the comparison of direct and reverse measurements of a test plate at the AME.

AME Quadratic Index-Line Error

The program AMETST is based on an equation of condition that involves the usual three linear terms, as well as the terms Y^2 in X and X^2 in Y. In earlier investigations other position-dependent terms in the comparison of direct and reverse plates were found to be not significant. No account is taken in the formula for the effect of the AME magnitude error. This is determined later from the residuals.

From the results of a number of reductions carried out in 1973, it was found that the X^2 term in Y was not significant. The Y^2 term in X is well-defined and appears to be unchanging over the period in which the plate measurements were made.

Direct and reverse measurements made with the AME may be corrected to obtain coordinates with no error by

$$X_D(\text{corr.}) = X_D(\text{meas.}) + \text{CORR},$$

$$X_R(\text{corr.}) = X_R(\text{meas.}) - \text{CORR},$$

where

$$CORR=0.001318*(Y_D(meas.)-250)*(Y_D(meas.)-250)/10000$$
$$=0.001318*(Y_R(meas.)-250)*(Y_R(meas.)-250)/10000$$

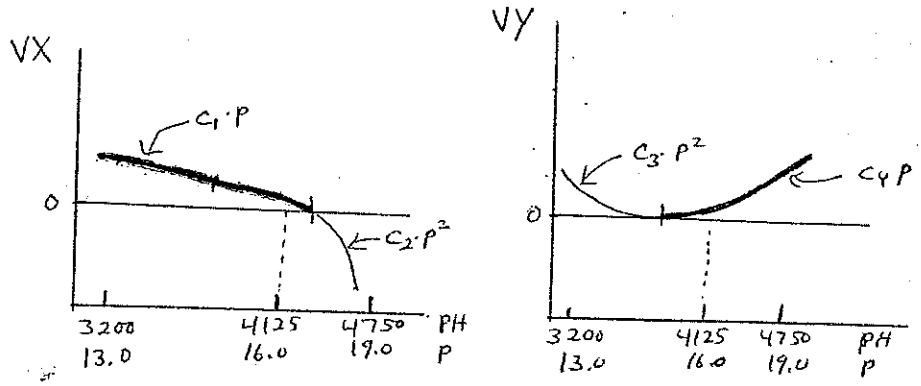
As can be seen here, the value of CORR may amount to 0.005 mm at a distance of 200 mm from the plate center.

AME Magnitude Error

The AME magnitude error in X(meas.) and Y(meas.) is found from plotting the residuals of the AMETST program against photometer reading. The correction may be divided conveniently in two parts at P=16.5 where P is related to the iris photometer readings RH by

$$P=PH/250-16.5.$$

The convenience of this division may be seen from the following schematic figures for the magnitude effect.



For VX vs. P the curve shortward of P=16.5 may be represented approximately by a term of the form $C_1 \cdot P$ and longward of it by $C_2 \cdot P^2$. For VY vs. P the curve shortward of P=16.5 is represented by $C_3 \cdot P^2$ and longward of it by $C_4 \cdot P$. For both VX and VY there is an interval around P=16.5 (PH=3800 to 4300) where the curves are flat and slowly changing (VX=0.0, VY=0.0 microns).

The results of numberous tests made during 1973 were averaged in order to form the table given below for the empirically defined error curves.

PH	PH/250	VX	VY	
3250	13.0	+1.1μ	+1.5μ	
3375	13.5	+1.0	+1.2	
3500	14.0	+0.8	+0.8	
3625	14.5	+0.6	+0.6	
3750	15.0	+0.5	+0.4	
3875	15.5	+0.3	+0.2	3800
4000	16.0	+0.1	0.0	
4125	16.5	0.0	0.0	FLAT
4250	17.0	-0.3	+0.1	4300
4375	17.5	-1.0	+0.6	
4500	18.0	-2.0	+0.8	
4625	18.5	-3.2	+1.0	
4750	19.0	-5.1	+1.4	

Over the whole range of 1500 units (3250 to 4750), or 6.0 magnitudes, the range of VX is 6.2 microns and VY is only 1.5 microns.

These curves may be represented by the following formulae where the numerical value of the coefficients were obtained by trial and error at the PDP 8 computer.

PH < 16.5 (bright images)

$X_D(\text{corr.}) = X_D(\text{meas.}) + (-0.32*P)/1000$

$Y_D(\text{corr.}) = Y_D(\text{meas.}) + (+0.125*P*P)/1000$

or

$X_R(\text{corr.}) = X_R(\text{meas.}) - (-0.32*P)/1000$

$Y_R(\text{corr.}) = Y_R(\text{meas.}) - (+0.125*P*P)/1000$

PH ≥ 16.5 (faint images)

$X_D(\text{corr.}) = X_D(\text{meas.}) + (-0.80*P*P)/1000$

$Y_D(\text{corr.}) = Y_D(\text{meas.}) + (0.550*P)/1000$

or

$X_R(\text{corr.}) = X_R(\text{meas.}) - (-0.80*P*P)/1000$

$Y_R(\text{corr.}) = Y_R(\text{meas.}) - (+0.550*P)/1000$

The above formulae are applicable for the correction of direct or of reverse measurements separately.

Correction of Reverse Measurements into Direct System

In the comparison of direct with reverse measurements (see App. D) the procedure is to apply the full correction for both the quadratic error and magnitude error to the reverse readings only. The result is the full reduction to the system of direct measurements. This involves simply the doubling of the coefficients in the formulae given above. Thse formulae are as follows:

$X_R(\text{corr.}) = X_R(\text{meas.}) - [(0.002636*(Y_R(\text{meas.})-250)*(Y_R(\text{meas.})-250))/10000$

PH < 16.5 (bright)

$X_R(\text{corr.}) = X_R(\text{meas.}) - (-0.64*P)/1000$

$Y_R(\text{corr.}) = Y_R(\text{meas.}) - (+0.250*P*P)/1000$

PH ≥ 16.5 (faint)

$X_R(\text{corr.}) = X_R(\text{meas.}) - (-1.60*P*P)/1000$

$Y_R(\text{corr.}) = Y_R(\text{meas.}) - (+1.10*P)/1000$

APPENDIX M. PUTTING TIMING MARKS ON NEW DECTAPES

Before a new DECtape is used, it is necessary to put "timing marks" on it. The steps for this operation are as follows.

a) Mount the DECtape called "Programs II" on the lower tape unit(=8) and then do the usual "bootstrap." The result is a typed period.

b) Transfer the "timing-mark program" from the lower tape (=8) to core by typing TOG8 (return). The result is a typed DTA? Remove the lower "Program II" tape (no longer needed), to prevent accidental wiping out of its programs. Turn off tape unit (from 8 to OFF).

c) Take fresh tape from box; remove from plastic bag; cut off the 2-3 inches of the sticky end. Mount it on the upper tape unit (then switch it to 8) -- be very sure that it is turned on by hand by no more than two or three turns. Turn upper switches to REMOTE and WRITE ENABLE. Remove the lower panel of the PDP 8 computer which contains the "lucite button."

d) Type 8 (return). The result is a typed DIRECT?

e) At the lower panel turn the switch from NORMAL to WRTM in order to write timing marks on the fresh tape.

f) Type MARK (return). The result is the typed message 0201 WORDS, 2702 BLOCKS. OK? [YES OR NO].

g) Type YES (return). The upper tape unit (called 8 now) turns through its full length. The result is the typed message SET SWITCH TO NORMAL. The operator sets it to NORMAL and hits "return" at the teletype. The tape then spins back and forth twice. There results the typed message DIRECT?. The operator then removes the tape.

h) If there are more tapes to be marked, then go to step c. NOTE: At step f type SAME instead of MARK for the repeated process of placing timing marks on tapes. When all is done, return the PDP 8 to its original status.

WHEN ALL IS DONE, BE ABSOLUTELY CERTAIN THAT THE LOWER PANEL SWITCH IS SET AT NORMAL AND NOT WRTM.

If this is not done, it will result in the wiping out of program and data tapes that are used later at the PDP 8.

```
.TOG8 (return)      ] To transfer program "8 from Tape "PROGRAMS II" to core.
                    < Remove Tape "PROGRAM II".
DTA? 8 (return)
DIRECT? MARK (return)
0201 WORDS, 2702 BLOCKS. OK?[YES OR NO]
YES (return)
SET SWITCH TO NORMAL (return)
DIRECT? SAME (return)
SETUP?

DTA? 8
DIRECT? MARK
0201 WORDS, 2702 BLOCKS. OK?[YES OR NO]
YES
SET SWITCH TO NORMAL
DIRECT? SAME
SETUP?

DTA? 8
DIRECT? MARK
0201 WORDS, 2702 BLOCKS. OK?[YES OR NO]
YES
SET SWITCH TO NORMAL
DIRECT? SAME
SETUP?
```

APPENDIX N. CARE IN HANDLING OF MAGNETIC TAPE

1. Contamination and Damage

Dust, dirt, or damage to the tape can reduce or prevent the necessary physical contact between the oxide surface or the tape and the read/write unit. Signal strength may be sharply reduced or recorded information may be completely obliterated.

Foreign particles, wear products, a crease, or any condition that causes the tape to be lifted as little as 1/1000 inch from the read/write head will cause the signal to fall below the effective sensitivity of the read/write unit.

Periodic cleaning of all tape units, particularly the read/write and transport mechanism is required.

2. Damage Prevention

Recorded information comes within 0.007 inch of the edge of nine-track tape. Tiny nicks and kinks caused by careless handling of the tape or reel may seriously affect the quality of magnetic reading or recording. Damaged tapes are as ineffective as chipped or broken phonograph records.

Tapes that contain useful information must not be exposed to magnetic fields with an intensity greater than 50 oersteds.

3. Irregular Winding

Tape will normally wind on the reel with some of its edges slightly protruding.

In itself, this condition will not interfere with proper operation of tape, but it requires that proper care in handling tape be exercised by all operating personnel. The exposed tape edges can be badly damaged by pinching the edges of the reel. Handle reels near the hub whenever possible. In picking up reels, grip the reel between the center hole and the outer edge.

4. Wavy Edge

Two conditions may give magnetic tape the appearance of having a wavy edge. One of these is curvature that occurs during the slitting of the tape. If a short length of tape is spread flat on a clean surface, its edge will not be perfectly straight but will show a slight curvature. This curvature should not exceed 3/16 inch in 36 inches of tape. A nominal curvature is present in almost all tapes.

Another condition that can cause magnetic tape to exhibit a wavy edge results from edge damage. The tape reel can be improperly mounted on some types of transports, causing the edge of the tape to receive undue wear and become burred. A warped reel can also cause this type of edge damage. This burr causes one edge of the tape to be slightly thicker than the other. When wound on a reel, the tape edge with the burr will wind to a larger diameter than the undamaged edge. In time, the edge of the tape with the burr will be permanently stretched. A tape in such condition proves unpredictable and generally unsatisfactory. Read errors, usually random and nonrepetitive, are encountered.

5. To clean Mylar tape, wipe it gently with a clean, lint-free cloth moistened with the recommended transport cleaner. Carbon tetrachloride and vythene must not be used for cleaning magnetic tape under any circumstances.

Periodic inspection of reel containers should be established. Remove any accumulation of dust by washing containers with a household detergent.

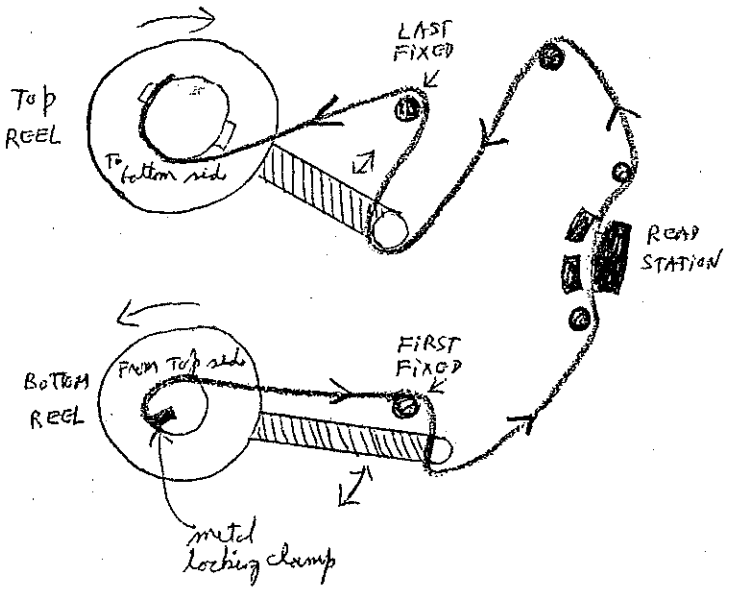
APPENDIX O. MOUNTING AND DISMOUNTING IBM TAPE

A. Mounting IBM Tape

1. Plug in 120 v AC cord to wall outlet (this acts as on-off switch).
2. Press LOAD FORWARD SW 1X in order to release drive so that the tape may be mounted in next step.
3. Remove the IBM tape from the plastic case: remove the red platic tape grip. If NO WRITING (OR ERASURE) is to be done, then remove the yellow protective ring; if WRITING (OR ERASURE) is to be done, leave the ring on. Mount the tape onto the lower drive: first pull out the metal locking clamp and then mount the tape so that the loose end is on the top side and free to be pulled to the right (see figure). Push back the metal locking clamp: if it is not done it can break the window of the door. Never force the tape reel to turn.

RULE: The first and last support points are those fixed in position. The ends of the two moveable arms are second from start and end.

METHOD: Starting at the lower reel run the tape as shown and end it on the bottom side of the upper reel -- using the finger in the hole to keep the tape from slipping off. Turn the reel two or three turns.



4. Press LOAD FORWARD SW for second time to bring up the tension in its looped tape.
5. Press LOAD FORWARD SW for third time to run tape to BOT ("beginning of tape") marker.
6. See that PDP 8 computer is on and ready to go. Then press ONLINE SW once (not more) so that tape is ready to read/write/erase. NOTE: If ONLINE SW is pressed a second time it will go "off-line."

B. Removal of IBM Tape

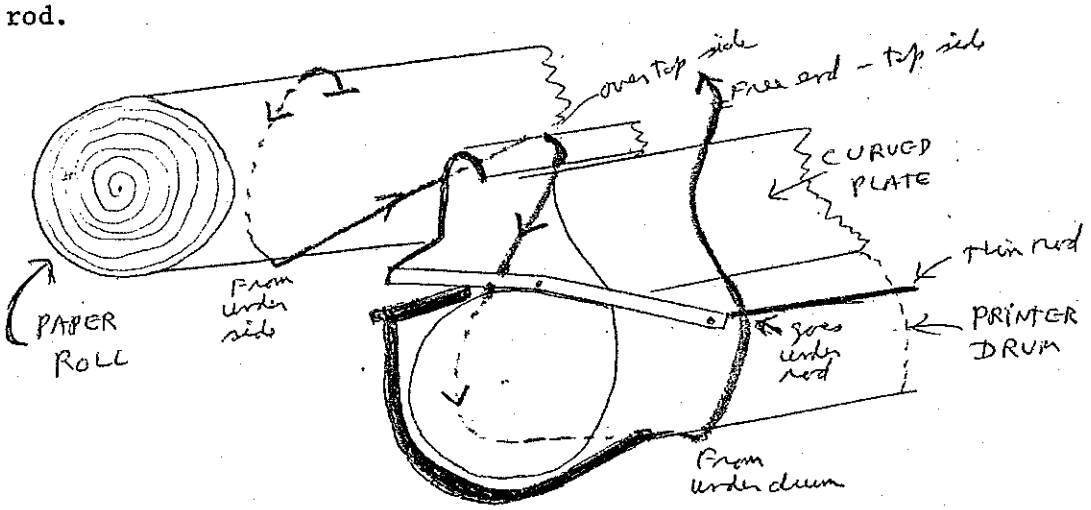
The PDP 8 computer may or may not be on to remove tape.

1. See that 120 v. AC cord is plugged to wall outlet [this acts as on/off SW].
2. Press ONLINE SW once to turn it off (if not already off).
3. Press REWIND SW once: wait until tape comes back to BOT.
4. Press REWIND SW once again: tape becomes free of upper reel.
5. Press LOAD FORWARD once: lower reel becomes free so that tape can be wound on by hand.
6. Pull out the "metal locking clasp" on the lower drive and extract the tape and return it to the plastic case [attach red plastic tape grip and yellow ring (if not yet on). Return the metal locking clasp to the flat position [so that the glass window of the door will not be broken].
7. Unplug the 120 v. AC cord from the wall outlet.

NOTE: The operators at the UCSC Computer Center wish that the yellow protection ring be left off when they use the IBM tape. If such a ring is required according to the instructions provided by the AME/SM person, the computer center operator will provide one (but is taken off and left by them after the IBM 360 job is done).

APPENDIX P. LOADING PAPER ROLL ON TELETYPE

Below is shown the proper way of loading the paper roll into the printer. The path for the paper is obvious. The only caution is that the paper should run under the thin rod.



APPENDIX D
FOCAL COMMAND SUMMARY

Command	Abbr	Example of Form	Explanation
TYPE	T	TYPE FSQT (AL ! 3+FSQT (B))	Evaluates expression, types out =, and result in current output format.
		TYPE "TEXT STRING"!	Types text. Use ! to generate carriage return line feed.
WRITE	W	WRITE ALL	FOCAL prints the entire indirect program.
		WRITE 1	FOCAL types out all group 1 lines.
		WRITE 1.1	FOCAL prints line 1.1
IF	I	IF (X) 1.2,1.3,1.4;	Where X is identifier or expression.

Control is transferred to the first, second, or third line number if (X) is less than, equal to, or greater than zero respectively. If the semicolon is encountered prematurely then the remainder of the line is executed.

MODIFY	M	MODIFY 1.15	Enables editing of characters on line 1.15

The next character typed becomes the search character. FOCAL will position itself after the search character; then the user may

a. type new text, or
b. form-feed to go to the next occurrence, or
c. bell to change the search character, or
d. rubout to delete backwards, or
e. left arrow to kill backwards, or
f. carriage return to end the line, or
g. line-feed to save the rest of the line.

QUIT	Q	QUIT or * or control-C	Returns control to user.
RETURN	R	RETURN	Terminates DO subroutines
SET	S	SET A = 5/B * SCALE(3)	Substitution statement
ASK	A	ASK ALPHA (I + 2 * J)	FOCAL types a colon for each variable; the user types a value to define each variable.

Command	Abbr	Example of Form	Explanation
COMMENT	C	C – compute area	If a line begins with the letter C, the remainder of the line will be ignored.
CONTINUE	C	C – ignore temporarily	
DO	D	DO 4.14	Execute line 4.14; return
		DO 4	Execute all group 4 lines, return when group is expanded or when a RETURN is encountered.
		DO ALL	Execute entire indirect text as a subroutine.
ERASE	E	ERASE	Erases the symbol table.
		ERASE 2	Erases all group 2 lines.
		ERASE 2.1	Deletes line 2.1.
		ERASE ALL	Deletes all user text.
FOR	F	FOR I = x,y,z; TYPE I	The command string following the semicolon is executed for each value; x,y,z are constants, variables, or expressions. x=initial value of I, y=value added to I until I is greater than z. y is assumed =1 if omitted.
GO	G	GO	Starts indirect program at lowest numbered line number.
GOTO	G	GOTO 3.4	Starts indirect program at line 3.4

C – The Fourteen (14) Functions are

FSQT ( ) – Square Root
FABS ( ) – Absolute Value
FSGN ( ) – Sign Part of the Expression
FITR ( ) – Integer Part of the Expression
~~FRAN ( ) – A Noise Generator~~
FEXP ( ) – Natural Base to the Power
FSIN ( ) and – FCOS ( ), FATN ( ) – Trig Functions
FLOG ( ) – Naperian Log

APPENDIX B

ERROR DIAGNOSTICS*

Table B-1
Error Diagnostics of FOCAL, 1969

Location	Code	Meaning
	?00.00	Manual Start given from console.
	?01.00	Interrupt from keyboard via control-C.
0250	?01.40	Illegal step or line number used.
0316	?01.78	Group number is too large.
0340	?01.96	Double periods found in a line number.
0351	?01.:5	Line number is too large.
0362	?01.;4	Group zero is an illegal line number.
0440	?02.32	Nonexistant Group referenced by 'DO'.
0464	?02.52	Nonexistant line referenced by 'DO'.
0517	?02.79	Storage was filled by push-down list.
0605	?03.05	Nonexistant line used after 'GOTO' or 'IF'.
0634	?03.28	Illegal command used.
1047	?04.34	Left of "=" in error in 'FOR' or 'SET'.
1064	?04.52	Excess right terminators encountered.
1074	?04.60	Illegal terminator in 'FOR' command.
1147	?04.:3	Missing argument in Display command.
1260	?05.48	Bad argument to 'MODIFY'.
1406	?06.06	Illegal use of function or number.
1466	?06.54	Storage is filled by variables.
1626	?07.22	Operator missing in expression or double 'E'.
1646	?07.38	No operator used before parenthesis.
1755	?07.:9	No argument given after function call.
1764	?07.;6	Illegal function name or double operators used.
2057	?08.47	Parenthesis do not match.
2213	?09.11	Bad argument in 'ERASE'.
2551	?10.:5	Storage was filled by text.
2643	?11.35	Input buffer has overflowed.
5042	?20.34	Logarithm of zero requested.
5644	?23.36	Literal number is too large.
6543	?26.99	↑ Power is too large or negative.
7111	?28.73	Division by zero requested.
7405	?30.05	Imaginary square roots required.
	?31.<7	Illegal character, unavailable command, or unavailable function used.

*The above diagnostics apply only to the version of FOCAL, 1969, issued on tape DEC-08-AJAE-B

LISTING OF COMPUTER PROGRAMS

X CALL ( )	PROGRAM
1,6	Measure check.
2,2	Survey plate alignment.
3,7	To correct AME output on T7 or T8.
3,10	View by Index I.
3,12	View by X,Y.
4,2	Survey: T7 to disk.
5,2	List plate data on T7 or T8.
5,3	List programs.
5,29	Initialize and full count check.
6,1	Dispatcher.
7	Measuring process.
8	Measuring process.
9	Measuring process.
10	Measuring process.
11	Measuring process.
12	Surveying process.
13	Surveying process.
14	AME plate alignment.
15	Least squares.
16,2	Survey: Replace by AME measures.
16,3	Survey: Transfer from IBM to T7.
16,5	Survey: Correct.
17,2	Simple check.
18,2	TV image check.
18,3	Survey: Type.
19,3	Data: Transfer T7/T8 to IBM tape.
19,4	Delete stars on T7 or T8.
20	D vs. R measures check.
21,2	Print: Output details from disk.
21,3	Print: Final results from disk.
21,15	Read contents of IBM records.
22,2	Data: Transfer from T8 to T7.
22,3	Print: From T7 or T8.
22,4	Photometry comparisons on different records.
23,3	Survey: Transfer from T7 to T8.
23,5	Add star to T7 or T8 (X,Y integers).
23,6	Pieces: Programs 17 and 20.
23,9	Pieces: Program 18.
24,3	Display positions on CRT.

```
31.01 C-PROG.1
01.02 X CALL(6,1)

03.10 F J=1,200;S A=A

06.01 T !! "MEASURE CHECK (SWIT(3,2) TO STOP)",!"SET STAR!";X JOY(0)
06.02 T !"      MICR          SCANNER        SUM"
06.05 T !"    X      Y       X      Y       X      Y"
06.10 S N=0;S AX=0;S AY=0;S BX=0;S BY=0;S TX=0;S TY=0
06.12 X AME(0);X CLER(6);X AME(1)
06.15 S HM=2560
06.20 D 3
06.30 I (FMICS(HM)+FSCNS(HM)-2*HM+FPHOS(704)-512)6.31,6.35,6.31
06.31 IF (FSWIT(3,11))6.3,6.3;T !"RESET";X CLER(6);X JOY(3);G 6.1
06.35 S XM=FMICR(0)/5;S YM=FMICR(1)/5;S XS=FSCNR(0)/5;S YS=FSCNR(1)/5
06.36 S XM=XM*0.9943
06.40 S TX=TX+XM+XS;S TY=TY+YM+YS
06.50 S AX=XM+AX;S AY=YM+AY
06.60 S BX=XS+BX;S BY=YS+BY;S N=N+1
06.70 T !%5.01 XM,YM,XS,YS,XM+XS,YM+YS
06.80 IF (FSWIT(3,2))6.12,6.12
06.85 IF (N-2)6.92
06.90 T ! %5.01 AX/N,AY/N,BX/N,BY/N,TX/N,TY/N
06.92 T %5.02 FLOC(0)/40,FLOC(1)/40
06.94 T " -SET STAR",!,;X JOY(0);G 6.1

31.98 W
31.99 X END(0)
```

```
31.01 C-PROG.2
01.02 X CALL(6,1)

02.01 T "SURVEY PLATE ALIGN",!;S BI=16;X SWTS(0)
02.02 A "SURVEY ON T7 OR T8?",U," FIRST/LAST REC=",SN,NN,!;S NR=NN-SN+1
02.04 X MTAK(BI,16*SN,16,U)
02.05 I (NN-SN)2.1,2.1;S BI=BI+16;S SN=SN+1;G 2.04
02.10 S BI=16;S NS=1;T !"TYPE I. FIND STAR.PRESS RECORD.",!
02.11 A !,J;I (J)2.2,2.2
02.13 S XR(NS)=FIN(BI,J,2)/100;S YR(NS)=FIN(BI,J,3)/100
02.14 T %6.02 XR(NS),YR(NS)
02.15 I (FSURV(-1))2.15,2.15;S XM(NS)=FSURV(0)/20
02.16 S YM(NS)=FSURV(1)/20;S NS=NS+1;F D=1,100;S A=A
02.17 X SWTS(0);G 2.11
02.20 S NS=NS-1;X CALL(15,2,1)
02.24 F N=1,NS;S LX(N)=LX(N)-AX*XR(N)-BX*YR(N)-CX
02.26 F N=1,NS;S LY(N)=LY(N)-AY*XR(N)-BY*YR(N)-CY
02.28 T !;F N=1,NS;T %4.01 LX(N)*1000,LY(N)*1000
02.30 A ! "SOLN OK?",N,!;I (N-0Y)2.10,2.40,2.10
02.40 S BI=16;S I=1
02.41 S SC=FIN(BI,I,1);I (SC)2.78,2.78
02.42 S X=FIN(BI,I,2)/100;S Y=FIN(BI,I,3)/100;S SS=FIN(BI,I,4)
02.43 S OO=FIN(BI,I,5);S CQ=FIN(BI,I,6);S EE=FIN(BI,I,7)
02.44 S BB=FIN(BI,I,8)
02.50 S XI=X+(AX*(X-250)+BX*(Y-250)+CX)
02.51 S YI=Y+(AY*(X-250)+BY*(Y-250)+CY)
02.60 X SAVX(BI,I,SC,XI*100,YI*100,SS);X SAVY(BI,I,OO,CQ,EE,BB)
02.65 S I=I+1;I (125-I)2.7,2.41,2.41
02.70 S BI=BI+16;S I=1;G 2.41
02.78 S SC=FIN(BI,I-1,1);X PUTL(BI,30,SC);X PUTL(BI,32,I-1)
02.80 S BI=16;S SN=NN-NR+1
02.82 X MPUT(BI,16*SN,16,0)
02.84 I (NN-SN)2.98,2.98;S SN=SN+1;S BI=BI+16;G 2.82
02.98 T "DONE",!;0
*
*31.98 W
*31.99 X END(0)
```

```
01.01 C-PROG. 3
01.02 X CALL(6,1)

07.01 A "TO CORRECT AME OUTPUT ON T7 OR T8",U
07.10 A " REC NO. ON TAPE=",ST;S TX=ST*16;T !;S BM=160
07.11 I (TX)7.96,7.96,7.12
07.12 X MTAK(BM,TX,16,U);T %5 FTAKL(BM,0),FTAKL(BM,2)
07.13 T %4.01  FTAKL(BM,4)/10,%4 FTAKL(BM,6)
07.14 T FTAKL(BM,8),FTAKL(BM,10),%5.02 FTAKL(BM,12)/100
07.15 T %5.01 FTAKL(BM,14)/10,%5.02 FTAKL(BM,16)
07.16 T !
07.17 A " PLATE DATA OK?",A;T !;I (A-0Y)7.49,7.20,7.49
07.20 A " IMAGE I=",I;I (I)7.60,7.60
07.24 S XM(1)=FIN(BM,I,1);S XM(2)=FIN(BM,I,2)/10000
07.25 S XM(3)=FIN(BM,I,3)/10000;S XM(4)=FIN(BM,I,4)
07.26 S XM(5)=FIN(BM,I,5);S XM(6)=FIN(BM,I,6);S XM(7)=FIN(BM,I,7)
07.27 T %3 XM(1),%8.04 XM(2),XM(3),%2 XM(4),XM(5),%5 XM(6),XM(7)
07.28 T %3 XM(8)
07.29 T !
07.30 T "                    ";F NS=1,8;A XM(NS)
07.31 T !
07.40 X SAVX(BM,I,XM(1),XM(2)*10000,XM(3)*10000,XM(4))
07.41 X SAVY(BM,I,XM(5),XM(6),XM(7),XM(8))
07.44 G 07.20
07.48 I (D-4)7.55,7.53,7.55
07.49 A "HEADER WORD NO.=",D;S D=D*2-2
07.50 A " NEW DATA=",X;I (D-12)7.48,7.51,7.52
07.51 S X=X*100+0.1;G 7.55
07.52 I (D-16)7.53,7.51,7.55
07.53 S X=X*10+0.1;G 7.55
07.55 X PUTL(BM,D,X);T !;T %5 FTAKL(BM,0),FTAKL(BM,2),%4;G 7.13
07.60 A " OK TO TRANSFER BACK TO TAPE?",A;I (A-0Y)07.62,7.66,7.62
07.62 T !;G 7.01
07.66 X MPUT(BM,TX,16,U)
07.96 T " DONE",!;Q

10.10 T "VIEW BY INDEX I. END BY -1"
10.12 IF (FIN<BI,0,6>+1234)10.14,10.2
10.14 T !"NO SURVEY ON DISK",!;Q
10.20 T !"TYPE INDEX I OF IMAGES. I="
10.30 A !I;S XI=FIN(BI,I,2)/100;S YI=FIN(BI,I,3)/100
10.32 IF (FSWIT(3,7))10.35,10.35
10.34 S XI=500-XI;S YI=500-YI
10.35 IF (I)10.9;D 23;G 10.3
10.90 T "END",!;Q

12.01 T "VIEW BY X,Y. END BY -1"
12.04 T !"TYPE X,Y"
12.10 T !;A XI;I (XI)12.50
12.12 A YI;I (YI)12.50
12.20 IF (480-XI)12.04;IF (XI-20)12.04;IF (480-YI)12.04;IF (YI-20)12.04
12.30 D 23;G 12.1
12.50 T "END",!;Q

23.10 X MOV(XI*100,YI*100);X MOV(XI*100,YI*100)
23.90 R

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG.4
01.02 X CALL(6,1)

02.10 A !"REC NO. ON 17 FOR SURVEY TO DISK SN=",SN
02.11 A "DO HPM/VAR?",B,!;S AZ=0
02.20 X MTAK(BI,SN*16,16,7)
02.30 S NI=FIN(BI,0,3);S N=0;S A=0
02.32 D 3
02.35 I (NI-125)2.9
02.40 S N=N+16;S A=A+1
02.50 X MTAK(BI+N,SN*16+N,16,7)
02.52 D 3
02.60 F J=0,15;S K=15-J;X SHFT(BI+N+K,89);C-PUT DATA AT START OF BLK
02.62 F J=1,16;X SHFT(BI+N+J,-89-64*A)
02.66 I (NI-A*125)2.9;G 2.4
02.90 T ! %4 NI," IMAGES LOADED.";A " SORT?",J
02.91 I (J-0Y)2.93,2.94,2.93
02.93 X PUTN(BR,0,0,512,1);G 2.98;C-USE INITIAL SEQUENCE
02.94 X NAME(5);X SORT(BI,0,NI,BR)
02.98 S I=0;S A=0;S XI=200;S YI=200;S AX=0;S AY=0;S BX=0;S CX=0
02.99 X END(0)

03.01 I (B-0Y)3.02,3.05,3.02
03.02 R
03.05 I (AZ)3.08,3.08,3.7
03.08 S I=1
03.10 S E=FIN(BI+N,I,7);I (E-1)3.38,3.2,3.4
03.20 S SC=FIN(BI+N,I,1);S XI=FIN(BI+N,I,2);S YI=FIN(BI+N,I,3)
03.22 T %3 "I=",I," SC=",SC;A " PMX=",LX," PMY=",LY,!
03.26 S XI=XI+LX*10000;S YI=YI+LY*10000
03.30 S AX=FIN(BI+N,I,4);S BX=FIN(BI+N,I,5);S CX=FIN(BI+N,I,6)
03.31 S AY=FIN(BI+N,I,8)
03.36 X SAVX(BI+N,I,SC,XI,YI,AX);X SAVY(BI+N,I,BX,CY,E,AY)
03.38 I (125-I)3.39,3.39;S I=I+1;G 3.1
03.39 R
03.40 D 3.2;D 3.3;D 3.31;I (BX)3.5,3.5
03.41 S YI=YI+50;S BX=0;S AY=0;D 3.36
03.42 S I=I+1;I (125-I)3.6,3.6;D 3.36;G 3.38
03.50 S YI=YI-50;S BX=2;S AY=1;D 3.36
03.52 S I=I+1;I (125-I)3.6,3.6;S YI=YI+100;S BX=2;S AY=2;D 3.36;G 3.38
03.60 S AZ=1;R
03.70 S I=1;S YI=YI+100;S BX=2;S AY=2;D 3.36;S AZ=0;G 3.38

04.01 C-STORE CONST
04.10 X STOR(1,4;AX);X STOR(1,8;BX);X STOR(1,12;CX)
04.11 X STOR(1,16;AY);X STOR(1,20;BY);X STOR(1,24;CY)
04.12 X PUT(1,28,1357);X PUT(1,29,TO);X VAR(VR);C-CLEAR EXTRA VAR
04.13 D 5;X END(0)

05.01 C-RECOVER CONST
05.10 S AX=FASK(1,4);S BX=FASK(1,8);S CX=FASK(1,12);S AS=1
05.11 S UX=FTAKL(1,32);S UY=FTAKL(1,36);S UZ=FTAKL(1,40)
05.12 S AY=FASK(1,16);S BY=FASK(1,20);S CY=FASK(1,24);S TO=FTAK(1,29)
05.13 S D=FTAK(1,28);R

06.10 D 5;X END(0)

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG 5-MISC. PIECES
01.02 X CALL(6,1)

02.01 A "LIST PLATE DATA T7 OR T8?",U,!;S BM=160
02.10 A "FIRST REC=",RF,"  LAST REC=",RL," OK TO GO?",A,!
02.12 I (A-0Y)2.1,2.2,2.1
02.20 X MTAK(BM,16*RF,16,U);T %3 RF
02.24 T %4 FTAKL(BM,0),FTAKL(BM,2),%4.01 FTAKL(BM,4)/10,%4
02.26 T FTAKL(BM,6),FTAKL(BM,8),FTAKL(BM,10),%5.02 FTAKL(BM,12)/100
02.28 T %5.01 FTAKL(BM,14)/10,%5.02 FTAKL(BM,16)/100
02.30 T %3 FTAKL(BM,18),FTAKL(BM,20),!
02.40 I (RL-RF)2.98,2.98;S RF=RF+1;G 2.2
02.98 T "DONE",!;Q

03.01 A !"LIST PROG NO.S AND END WITH -1",!,J
03.20 S N=1
03.30 X PUT(16,N,J);I (J)03.60
03.40 A J;S N=N+1;G 03.30
03.60 S N=0
03.70 S N=N+1;S J=FTAK(16,N)
03.80 IF (144-J)3.99
03.90 F Q=0,5;T !
03.92 X CALL(J,31)
03.94 G 03.70
03.99 Q

28.10 DO 29
28.20 X END(0)

29.01 C-INIT AND FCC
29.04 S I=0;S IC=0
29.08 I (DN)29.1,29.2,29.2
29.10 A "FIRST IMAGE NO.=",I;T !;S I=I-1
29.12 I (I)29.1
29.20 S IC=I-125*FITR(I/125)
29.25 I (DN)29.99
29.30 X PUTN(BO,40+IC*16,0,2024-IC*16)
29.32 X PUTN(BM,40+IC*16,0,2024-IC*16)
29.60 X AME(0);X CLER(6)
29.75 A !"NO. FCC TRIALS =",N;S A=0;G 29.94
29.80 X GMIC(0,1);X GSCN(0,1)
29.82 F J=0,200;S A=A
29.83 S A=A+1
29.84 IF (FSCNS(MX)+FMICS(MX)-2*MX)29.84,29.86,29.84
29.86 X AME(0);X CLER(6)
29.88 IF (FSCNS(HM)+FMICS(HM)-2*HM)29.88,29.9,29.88
29.90 T !%4 ,FMICR(0),FMICR(1),FSCNR(0),FSCNR(1)
29.94 IF (A-N)29.8
29.99 R

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG 6-DISPATCHER
01.10 E
01.20 X SWTS(0)

02.04 DO 13
02.10 S D=FSWIT(1,1)
02.20 X GO(2,40+D*2)
02.40 X JOY(0);C-JOYSTICK
02.41 Q
02.42 X CALL(3,12);C-VIEW BY X,Y
02.44 D 15;X AME(0);X CLER(6);X CALL(7,2);C-MEASURE
02.46 X CALL(17,2);C-SIMPLE DIFF CHECK
02.48 X CALL(20,3);C-DIR/REV CHECK
02.50 X CALL(18,2);C-TV IMAGE CHECK
02.52 X CALL(3,7);C-CORR AME DATA ON T8
02.54 S D=FSWIT(1,4);X GO(2,80+D*2);C-CONT
02.80 X CALL(22,3);C-PRINT FROM T7 OR T8
02.82 X CALL(16,2);C-REPLACE SURVEY BY AME MEAS ON T8
02.84 X CALL(19,4);C-SURVEY-DELETE IMAGE SC
02.86 X CALL(23,5);C-SURV:ADD IMAGE
02.88 X CALL(18,3);C-SURV:TYPE ON T7
02.90 X CALL(4,2);C-SURV:T7 TO DISK
02.91 Q
02.92 X CALL(22,2);C-DATA:T8 TO T7
02.94 S D=FSWIT(1,7);X GO(3,20+D*2);C-CONT

03.20 X CALL(3,10);C-VIEW BY IMAGE I
03.22 X CALL(5,128*29+60);C-FULL COUNT CHECK
03.23 Q
03.24 X CALL(16,3);C-SURVEY-FROM IBM TO T7
03.26 X CALL(21,2);C-PRINT-OUTPUT DETAILS FROM DISK
03.28 X CALL(21,3);C-PRINT-FINAL RESULTS FROM DISK
03.30 S AS=0;A "SURVEY ALONE. TYPE Y",A,!
03.31 X SWTS(0);X CALL(12,9);Q
03.32 X CALL(5,2);C-PRINT PLATE DATA ON T7 OR T8
03.34 S D=FSWIT(1,10);X GO(3,40+D*2);C-CONT
03.40 X CALL(5,3);C-LIST PROGRAMS
03.42 D 15;X CALL(7,12);C-MEAS USING SURVEY ON DISK. REPEAT MEAS
03.44 S DN=-1;X CALL(7,12);C-RESTART MEAS AT IMAGE I
03.46 X CALL(21,15);C-READ CONTENTS OF IBM RECORDS
03.48 X CALL(19,2);C-DATA:T7/T8 TO IBM

13.01 C-INITIALIZE
13.10 S I=0;S A=0;S J=0;S DA=-1;S IC=0
13.20 S XI=200;S YI=200
13.30 S BT=192;S BS=176;S BO=144;S BM=160;S BI=16;S BR=8;S BN=128
13.40 S NB=16;S HM=2048+512;S MX=1024+256
13.50 S R=40;S H=100
13.60 S AX=0;S BX=0;S CX=0;S AY=0;S BY=0;S CY=0
13.62 S UX=0;S UY=0;S UZ=0
13.99 R

15.10 A !"REC NO. ON T8 FOR AME OUTPUT ST=",J
15.12 IF (J)15.14;S TO=J*16;G 15.2
15.14 S TO=0;G 15.9
15.20 X MTAK(BT,TO,16)
15.30 S D=0
15.32 F J=0,25,500;S D=FTAK(BT,J)+D
15.34 X MTAK(BT,TO+16,16);DO 15.32
15.40 IF (D)15.5,15.9
15.50 Q
```

```
15.56 A  ***NOT EMPTY-USE YY ***
15.60 IF (J-0Y)15.1,15.9,15.1
15.90 X PUT(1,29,TO)
15.91 R

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG 7-INITIALIZE
01.02 X CALL(6,1)

02.01 C-GET SURVEY FROM T7 TO DISK
02.02 DO 13
02.03 X CALL(5,28);C-FCC
02.04 S AS=1
02.10 X AME(0);X CLER(6)
02.20 I (FSWIT(3,3))2.3,2.3;T !"MAN MEAS:AS BELL RINGS USE JOY",!
02.22 T "PRESS SW 3,11 TO MEAS",!; S I=I+1
02.24 GO 3.2
02.30 C
02.40 X CALL(4,2);C-GET SURVEY

03.01 C-ALIGN
03.04 S VR=FVAR(0)
03.10 X CALL(14,2)
03.12 X CALL(4,4)
03.20 IF (FSCNS(HM)+FMICS(HM)-2*HM)3.3,3.7
03.30 X CLER(6)
03.70 X CALL(8,3)

10.10 X CALL(5,28);C-FCC
10.20 Q

11.10 DO 13
11.90 X END(0)

12.01 C-MEAS USING SURVEY ON DISK. REPEAT PLATE.
12.02 X CALL(4,6)
12.06 I (D-1357)12.07,12.10
12.07 T !"ALIGNMENT LOST!"
12.10 DO 13
12.20 X CALL(5,28)
12.30 A !"REALIGN PLATE?",J
12.32 IF (J-0Y)12.4,3.01
12.40 G 3.2

13.01 C-CHECKING INDEX OK
13.04 DO 30
13.10 IF (-FPHOS<8>)13.3
13.20 X BUZ(10);F J=0,10;S A=A
13.30 IF (-FPHOS(4))13.5
13.40 X BUZ(20);F J=0,10;S A=A
13.50 IF (FPHOS(12)-12)13.6,13.9
13.60 G 13.1
13.90 R

30.10 IF (FPHOS(8)-8)30.15,30.6
30.15 T !!"CHECK 'AME DISABLED' SWITCH",!!
30.20 T !"X INDEX OFF"
30.60 IF (FPHOS(4)-4)30.7,30.9
30.70 T !"Y INDEX OFF"
30.90 R

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG.8;APR.18/74.
01.02 X CALL(6,1)

03.10 S TM=-130;C-30 SEC
03.14 S SQ=0;IF (-FSWIT<3,3>)3.25;C-MANUAL
03.20 S SQ=1000*FIN(BI,I,4)+100*FIN(BI,I,5)+FIN(BI,I,6);C-IMAGE 'I'
03.25 S XV=XI;S YV=YI
03.26 IF (FSURV(-1)+FSWIS(2,1))3.28,3.28;X CALL(12,9);C-SURVEYING
03.28 IF (AS)3.26,3.26
03.30 IF (FPHOS(704)-512)3.4,3.8
03.40 S TM=TM+1;IF (TM)3.26
03.50 X CLER(3)
03.60 S ER=FOR(ER,256+64+8)
03.70 IF (FPHOS(704)-512)3.7,3.8,3.7
03.80 IF (DA)5.1,5.1
03.84 S PH=FPHOR(0)+2532
03.90 IF (PH-2600)4.1;IF (5000-PH)4.1
03.94 G 5.1

04.10 S ER=FOR(ER,1);S RF=1
04.30 S DA=-1;X CALL(9,6);C-REPEAT FOR PHOTOMETER ERROR

05.10 S ER(1)=ER;S ER=0;S RF=0;S RC=0;IF (-FSWIT(3,3))5.4
05.30 S I=I+1;S IC=IC+1
05.35 D 21
05.40 IF (IC-126)5.5;G 6.1;C-END OF OUTPUT BLOCK
05.50 IF (XI-20)6.1,6.1;IF (YI-20)6.1,6.1,5.6
05.60 X CALL(9,6)

06.01 C-STORE DATA ON T8(AT TO) FROM DISK(FROM BM)
06.10 X CALL(9,18);C-PRINT LAST DATA
06.15 IF (TO)6.4,6.4;IF (IC-2)6.4
06.20 X MPUT(BM,TO,16);S TO=TO+16;X PUT(1,29,TO)
06.30 IF (IC-126)6.4,6.5,6.5
06.40 T !"END OF PLATE",%4 I-1," IMAGES RECORDED.";S AS=0
06.42 IF (FSURV(-1)+FSWTS<2,1>)6.44,6.44;X CALL(12,9)
06.44 X BUZ(30);F J=0,200;S A=A;S A=FSWIT(3,2)
06.46 IF (A)6.42,6.42,6.40
06.50 X PUTN(BO,40,0,2024);X PUTN(BM,40,0,2024)
06.60 S IC=1;G 5.35

21.01 C-GO TO NEXT SURVEY IMAGE D
21.04 S D=FTAK(BR,I)
21.06 IF (D)21.08,21.08,21.1
21.08 S XI=0;S YI=0;S SC=0
21.09 R
21.10 S SC=FIN(BI,D,1)
21.15 S UX=FTAKL(1,32)*0.01;S UY=FTAKL(1,36)*0.01;S UZ=FTAKL(1,40)
21.20 S X=FIN(BI,D,2)/100;S Y=FIN(BI,D,3)/100;I (X)21.30,21.30
21.21 I (UZ)21.22,21.22;I (SC-98)21.22;S X=X+UX;S Y=Y+UY
21.22 IF (FSWIT(3,7))21.3,21.3
21.24 S X=500-X;S Y=500-Y
21.30 S XI=X+AX*<X-250>+BX*<Y-250>+CX
21.40 S YI=Y+AY*<X-250>+BY*<Y-250>+CY
21.60 X PUT(1,30,I);X PUT(1,31,IC)
21.80 X SWIT(0,I)
21.90 R

31.98 W
31.99 X END(0)
```

```
04.18 X PUTL(BM,18,Z);T !;G 4.64
04.20 X PUTL(BM,N,A);S N=N+2
04.56 F D=0,2,20;S A=FTAKL(16,D);X PUTL(BM,D,A)
04.58 A "PL NO",A;X PUTL(BM,10,A);A " EP",A;S A=A*100;X PUTL(BM,12,A)
04.61 S E=(FTAKL(BM,12)-UZ)/1171;S C=C*100;X PUTL(BM,18,C)
04.62 A "PMA=",A;S UX=A*E*100;X PUTL(1,32,UX);X PUTL(1,40,1)
04.63 A "PMD=",A;S UY= A*E;S UY=UY*100;X PUTL(1,36,UY); G 4.65
04.64 X PUTL(1,40,0)
04.65 A " OK?",A;T !;I (A-0Y)04.06,4.98,4.06
04.98 R

23.10 X MOV(XI*100,YI*100);X MOV(XI*100,YI*100)
23.90 R

31.98 W
31.99 X END(0)
```

(15)

```
01.01 C-PROG.15
01.02 X CALL(6,1)

02.01 C-LEAST SQUARES
02.20 F M=1,11;S ST(M)=0
02.22 F N=1,NS;S LX(N)=XM(N)-XR(N);S LY(N)=YM(N)-YR(N)
02.24 F N=1,NS;S XR(N)=XR(N)-250;S YR(N)=YR(N)-250
02.26 F N=1,NS;S ST(1)=ST(1)+XR(N);S ST(2)=ST(2)+YR(N)
02.28 F N=1,NS;S ST(3)=ST(3)+XR(N)*YR(N)
02.30 F N=1,NS;S ST(4)=ST(4)+XR(N)*XR(N)
02.32 F N=1,NS;S ST(5)=ST(5)+YR(N)*YR(N)
02.34 F N=1,NS;S ST(6)=ST(6)+XR(N)*LX(N)
02.36 F N=1,NS;S ST(7)=ST(7)+YR(N)*LX(N)
02.38 F N=1,NS;S ST(8)=ST(8)+LX(N)
02.40 F N=1,NS;S ST(9)=ST(9)+XR(N)*LY(N)
02.42 F N=1,NS;S ST(10)=ST(10)+YR(N)*LY(N)
02.44 F N=1,NS;S ST(11)=ST(11)+LY(N)
02.50 S A(1)=ST(3)*ST(3)-ST(4)*ST(5)
02.52 S A(2)=ST(3)*ST(1)-ST(4)*ST(2)
02.54 S A(3)=ST(3)*ST(6)-ST(4)*ST(7)
02.56 S A(4)=ST(3)*ST(2)-ST(1)*ST(5)
02.58 S A(5)=NS*ST(3)-ST(1)*ST(2)
02.60 S A(6)=ST(3)*ST(8)-ST(1)*ST(7)
02.62 S A(7)=ST(3)*ST(9)-ST(4)*ST(10)
02.64 S A(8)=ST(3)*ST(11)-ST(1)*ST(10)
02.70 S CX=(A(4)*A(3)-A(1)*A(6))/(A(4)*A(2)-A(1)*A(5))
02.72 S BX=(A(4)*A(3)-A(4)*A(2)*CX)/(A(4)*A(1))
02.74 S AX=(ST(6)-ST(3)*BX-ST(1)*CX)/ST(4)
02.76 S CY=(A(4)*A(7)-A(1)*A(8))/(A(4)*A(2)-A(1)*A(5))
02.78 S BY=(A(4)*A(7)-A(4)*A(2)*CY)/(A(4)*A(1))
02.80 S AY=(ST(9)-ST(3)*BY-ST(1)*CY)/ST(4)
02.92 T !"ALIGNMENT DONE"
02.93 X END(0)

31.98 W
31.99 X END(0)
*
```

```
01.01 C-PROG. 16
01.02 X CALL(6,1)

02.01 T "TO USE AME MEAS ON T8 AS SURVEY ON T7",!
02.10 A "FIRST REC ON T8 ST=",ST,!;S ST=ST*16
02.12 A "NO. OF RECS TO CONVERT=",N,!;S NN=1
02.14 A "FIRST REC ON T7 OF ORIGINAL SURVEY SN=",SN;S SN=SN*16
02.16 A ! " OK TO CONT?",A;I (A-0Y)2.1,2.2,2.1
02.20 X MTAK(16,ST,16,8);X MTAK(32,SN,16,7)
02.30 S I=1
02.31 S A=FTAKL(16,10);S B=FTAKL(16,12)
02.32 X PUTL(32,10,A);X PUTL(32,12,B)
02.34 S SC=FIN(32,I,1);S S=FIN(32,I,4);S O=FIN(32,I,5)
02.35 S CQ=FIN(32,I,6);S E=FIN(32,I,7);S B=FIN(32,I,8)
02.38 S X=FIN(16,I,2)/100;S Y=FIN(16,I,3)/100
02.40 S XI=FITR(X);S YI=FITR(Y)
02.50 X SAVX(32,I,SC,XI,YI,S);X SAVY(32,I,O,CQ,E,B)
02.60 I (125-I)2.7,2.7;S I=I+1;G 2.34
02.70 X MPUT(32,SN,16,7)
02.72 I (N-NN)2.98,2.98;S NN=NN+1;S ST=ST+16;S SN=SN+16;G 2.20
02.98 T "DONE",!;Q

03.01 T "TRANSFER SURVEY FROM IBM TO T7",!
03.10 X NAME(1);X RWND(0);S BI=16;S N=1
03.20 A "TO TRANSFER SURVEY TO T7 STARTING AT REC SN=",SN;S SN=SN*16
03.22 T !;A "NO. REC TO TRANSFER=",NS,!
03.40 X PUTN(BI,0,0,16*129)
03.42 X IBMR(BI);X IBMR(BI+8);X MPUT(BI,SN,16,7)
03.44 I (NS-N)3.98,3.98;S N=N+1;S SN=SN+16;G 3.4
03.98 T "DONE",!;Q

05.01 T "SURVEY:CORRECT",!
05.08 S BI=16
05.10 A "ON T7 OR T8?",U," AT REC=",SN,!
05.11 X MTAK(BI,16*SN,16,U)
05.12 T "TYPE I FOR IMAGE WITH ERROR",!
05.16 T " I      SC       X        Y    S  O CQ   E   B",!
05.18 A I
05.19 I (I)5.5,5.5,5.2
05.20 T %3 FIN(BI,I,1),%7 FIN(BI,I,2),FIN(BI,I,3)
05.21 F J=4,1,8;T %2 FIN(BI,I,J)
05.22 A !,"      ",A1," ",A2," ",A3,A4,A5,A6,A7,A8,!
05.30 X SAVX(BI,I,A1,A2,A3,A4);X SAVY(BI,I,A5,A6,A7,A8)
05.33 G 5.18
05.50 A "OK TO FILE?",A,!;I (A-0Y)5.5,5.6,5.5
05.60 X MPUT(BI,16*SN,16,U)
05.70 T "DONE",!;Q

31.98 W
31.99 X END(0)
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```
01.01 C-PROG.17
01.02 X CALL(6,1)

02.01 A "SIMPLE CHECK. MEAS FROM T7 OR T8?",U," MIN RES=",ZZ,!
02.06 A "REC NO. OLD/CURRENT MEAS=",SX,SY;S TX=SX*16;S TY=SY*16;T !
02.07 X MTAK(16,TX,16,U);X MTAK(32,TY,16,U);T "FIELD" %4 FTAKL(32,0)
02.10 S NS=1;T "   ALIGN STAR"
02.12 A J;I (J)2.4,2.4
02.14 S XM(NS)=FIN(16,J,2)/10000;S YM(NS)=FIN(16,J,3)/10000
02.15 I (-XM(NS))2.20;T " NOT MEAS. GET NEW STAR",!;G 2.12
02.20 S XR(NS)=FIN(32,J,2)/10000;S YR(NS)=FIN(32,J,3)/10000
02.21 I (-XR(NS))2.30;T " NOT MEAS.GET NEW STAR",!;G 2.12
02.30 S NS=NS+1;G 2.12
02.40 S NS=NS-1
02.50 X CALL(15,2,1)
02.60 F N=1,NS;S LX(N)=LX(N)-AX*XR(N)-BX*YR(N)-CX
02.62 F N=1,NS;S LY(N)=LY(N)-AY*XR(N)-BY*YR(N)-CY
02.63 T !;F N=1,NS;T %4.01 LX(N)*500,LY(N)*500
02.64 S NS=125;A !" SOLUTION OK?",A;I (A-0Y)2.1,2.66,2.1
02.66 T !;S UX=1;S N=1;A "FIRST/LAST IMAGE=",J,Z;I (NS-J)2.83
02.67 A "TYPE=T OR CRT=V?",A;T !;I (A-0T)3.5,2.68,3.5
02.68 S XB=FIN(32,J,2)/10000;I (XB)2.9,2.9;S YB=FIN(32,J,3)/10000
02.70 S XA=FIN(16,J,2)/10000;S DX=XA-XB-(AX*(XB-250)+BX*(YB-250)+CX)
02.71 S YA=FIN(16,J,3)/10000;S DY=YA-YB-(AY*(XB-250)+BY*(YB-250)+CY)
02.72 I (XA)2.9,2.9
02.73 S PP=0.5*(FIN(16,J,6)+FIN(32,J,6));S DX=DX*500;S DY=DY*500;G 2.92
02.75 S DP=FIN(16,J,6)-FIN(32,J,6)
02.76 T %4 J+NS-125,FIN(32,J,1),%7.04 XB,YB
02.77 T %5.01 DX,DY,%5 PP,DP,!
02.80 I (A-0T)2.85,2.88,2.85
02.81 X CALL(23,6,1)
02.82 G 2.68
02.83 X CALL(23,7,1)
02.84 G 2.67
02.85 I (25*N-UX)2.86,2.86,2.88
02.86 X STAT(-1);A "C?",B;I (B-0Y)2.98,2.87,2.98
02.87 S N=N+1;D 3.50;G 2.88
02.88 I (Z-J-NS+125)2.98,2.98;S UX=UX+1;S J=J+1;I (125-J)2.81,2.68,2.68
02.90 T %4 J+NS-125, FIN(32,J,1),!;G 2.8
02.92 S XD=FABS(DX);I (ZZ-XD)2.75,2.75;S YD=FABS(DY);I (ZZ-YD)2.75,2.75
02.93 G 2.80
02.98 T "DONE",!;X STAT(-1)
02.99 Q

03.50 X SWIT(-1);X STAT(1,980,1);F I=1,150;S A=A
03.51 G 2.68

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG 18
01.02 X CALL(6,1)

02.01 A "TV IMAGE CK. REC ST=",ST,!;S Z=0.100;S BI=16;S BM=160
02.04 A " SURVEY ON T7 AT REC SN=",SN,!;S SN=SN*16;S I=1
02.06 X MTAK(BI,SN,16,7)
02.07 X CALL(4,6)
02.08 X MTAK(BM,ST*16,16,8)
02.09 S NI=FIN(BM,0,3)
02.10 I (FIN(BM,I,1))2.98,2.98
02.14 S SC=FIN(BI,I,1)
02.16 S X=FIN(BI,I,2)/100;S Y=FIN(BI,I,3)/100
02.17 S XM=FIN(BM,I,2)/10000;S YM=FIN(BM,I,3)/10000
02.22 I (FSWIT(3,7))2.26,2.26,2.24
02.24 S X=500-X;S Y=500-Y
02.26 S XI=X+AX*(X-250)+BX*(Y-250)+CX
02.27 S YI=Y+AY*(X-250)+BY*(Y-250)+CY
02.30 S DX=FABS(XI-XM);S DY=FABS(YI-YM)
02.32 I (XM)2.33,2.33;I (Z+.050-DX)2.40,2.40;I (Z-DY)2.40,2.40,2.71
02.33 D 2.40;D 2.41;G 2.80
02.40 T %3 I,SC;T %6.02 XI,"  ",YI,"  "
02.41 F J=4,1,8;T %2 FIN(BI,I,J)
02.54 T ! "          ",%8.04 XM,YM
02.56 T %5 FIN(BM,I,6),FIN(BM,I,8)
02.59 S XI=XM;S YI=YM;D 23
02.70 A " C?",A;T !;I (A-0Y)2.98,2.71,2.98
02.71 S I=I+1;I (125-I)2.72;G 2.1
02.72 X CALL(23,9,1)
02.73 G 2.1
02.80 T " NM",!;G 2.71
02.98 T "END",!;Q

03.01 T "TYPE SURV ON T7 ";S BI=16
03.02 A "FILE ON T7 AT SN=",SN,!;S TX=SN*16;X PUTL(BI,34,-1234)
03.05 S S=1;S CQ=70;S E=0
03.07 F I=1,1,125;X SAVX(BI,I,0,0,0,0);X SAVY(BI,I,0,0,0,0)
03.08 G 3.3
03.10 T "TYPE SC,X,Y,O,B. END BY SC=-1"
03.11 S I=1
03.15 T !,%3 I;A SC;I (SC)3.6,3.6;A X;A Y;A O;A B
03.16 S XI=X*100;S YI=Y*100
03.20 X SAVX(BI,I,SC,XI,YI,S);X SAVY(BI,I,O,CQ,E,B)
03.22 S NI=I;S I=I+1;G 3.15
03.30 T "TYPE PL DATA",!
03.32 S N=0;A "FIELD",A;D 3.38;A " RAH",A;D 3.38;A " RAM",A
03.34 S A=A*10;D 3.38;A " DD",A;D 3.38;A " DM",A;D 3.38
03.36 A " PL NO",A;D 3.38;A " EP",A;S A=A*100;D 3.38;T !;G 3.10
03.38 X PUTL(BI,N,A);S N=N+2
03.52 A !" TO CORR I=",I;A " NEW SC=",SC;A " X=",X;A " Y=",Y
03.53 A " O",O;A " B",B
03.54 S XI=X*100;S YI=Y*100;D 3.2;A " MORE?",A;I (A-0Y)3.6,3.52,3.6
03.60 A !"FILE T7?",A;I (A-0Y)3.52,3.61,3.52
03.61 X PUTL(BI,28,NI)
03.62 X MPUT(BI,TX,16,7)
03.98 T "DONE",!;Q

23.10 X MOV(XI*100,YI*100);X MOV(XI*100,YI*100)
23.90 R

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG.19
01.02 X CALL(6,1)

02.01 T "DATA FROM T7/T8 TO IBM TAPE";S BM=160
02.02 X NAME(1)
02.03 X RWND(0)
02.10 A !"START ON IBM AT BOT?",J;I (J-0Y)2.12,2.2
02.12 IF (J-0N)2.1,2.3,2.1
02.20 X IBME(0)
02.21 G 2.4
02.30 X HUNT(0);X BAK(1,1);X ADV(1)
02.40 A !"FROM T7 OR T8?",U
02.50 A "FIRST/LAST REC="TB,RL,!;S TB=TB*16;S RL=RL*16
02.60 X MTAK(BM,TB,16,U)
02.62 X IBMW(BM);X IBMW(BM+8)
02.64 I (RL-TB)2.92,2.92;S TB=TB+16;G 2.6
02.92 A "MORE RECS?",A,!;I (A-0Y)2.98,2.50,2.98
02.98 X EOF(0);X EOF(0)
02.99 T "DONE",!;Q

04.01 A "DELETE STARS ON T7 OR T8?",U," IN REC=",SN,!;S I=1;S BI=16
04.04 X MTAK(BI,16*SN,16,U)
04.06 S NS=FIN(BI,I,1);I (NS)4.07,4.07;S I=I+1;G 4.06
04.07 S NI=I-1
04.12 S NS=NI;T !,%4 FTAKL(BI,0),FTAKL(BI,2)
04.24 T %4.01 FTAKL(BI,4)/10,%4
04.28 T FTAKL(BI,6),FTAKL(BI,8),FTAKL(BI,10),%5.02 FTAKL(BI,12)/100,!
04.30 A "OMIT SC=",SC,!;I (SC)4.98,4.98;S I=1
04.32 I (SC-FIN(BI,I,1))4.34,4.50,4.34
04.34 I (NI-I)4.30,4.30;S I=I+1;G 4.32
04.50 S NS=NS-1;X PUTL(BI,28,NS)
04.51 S M1=FIN(BI,I+1,1);S M2=FIN(BI,I+1,2);S M3=FIN(BI,I+1,3)
04.52 S M4=FIN(BI,I+1,4);S M5=FIN(BI,I+1,5);S M6=FIN(BI,I+1,6)
04.53 S M7=FIN(BI,I+1,7);S M8=FIN(BI,I+1,8)
04.55 X SAVX(BI,I,M1,M2,M3,M4);X SAVY(BI,I,M5,M6,M7,M8)
04.60 I (NI-I)4.30,4.30;S I=I+1;G 4.51
04.80 S I=1;S N=1;A "TYPE=T OR CRT=V?",B,!;I (B-0T)4.81,4.82,4.81
04.81 X SWIT(-1);X STAT(1,980,1)
04.82 T %4 I,FIN(BI,I,1),%7.02 FIN(BI,I,2)/100,FIN(BI,I,3)/100
04.83 F D=4,1,8;T %4 FIN(BI,I,D)
04.84 T !;I (NI-I)4.90,4.90;S I=I+1;G 4.88
04.85 I (20*N-I)4.86,4.82,4.82
04.86 X STAT(-1);A " CONT?",A;D 4.81;I (A-0Y)4.9,4.87,4.9
04.87 S N=N+1;G 4.82
04.88 I (FIN(BI,I,2))4.90,4.90;I (B-0T)4.85,4.82,4.85
04.90 X STAT(-1);A " OK TO FILE ON TAPE?",A;I (A-0Y)4.99,4.91,4.99
04.91 X MPUT(BI,SN*16,16,U);G 4.99
04.98 A " PRINT?",A;I (A-0Y)4.90,4.80,4.90
04.99 T " DONE",!;Q

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG.20
01.02 X CALL(6,1)

03.01 A "D VS R MEAS. FROM T7 OR T8?",U,!
03.06 A "REC NO. DIR/REV MEAS",SX,SY;S TX=SX*16;S TY=SY*16;T !
03.07 X MTAK(16,TX,16,U);X MTAK(32,TY,16,U)
03.08 T %4 "FIELD",FTAKL(16,0)
03.10 S NS=1;T "  ALIGN STAR"
03.12 A J;I (J)3.40,3.40
03.14 S XM(NS)=FIN(16,J,2)/10000;S YM(NS)=FIN(16,J,3)/10000
03.15 I (-XM(NS))3.20;T "NOT MEAS",!;G 3.12
03.20 S XI=FIN(32,J,2)/10000;S YI=FIN(32,J,3)/10000;D 4
03.22 S YR(NS)=500-YI
03.24 S XR(NS)=500-XI+0.002636*(YI-250)*(YI-250)/10000
03.30 S NS=NS+1;G 03.12
03.40 S NS=NS-1
03.50 X CALL(15,2,1)
03.60 X CALL(23,8,1)
03.64 S NS=125;A !" SOLUTION OK?",A;I (A-0Y)3.1,3.66,3.1
03.66 T !;S UX=1;S N=1;A "FIRST/LAST IMAGE=",J,Z;I (NS-J)3.85,3.67,3.67
03.67 A "TYPE=T OR CRT=V?",A;T !;I (A-0T)04.50,03.68,04.50
03.68 S XI=FIN(32,J,2)/10000;I (XI)3.9,3.9;S YI=FIN(32,J,3)/10000;D 4
03.69 S DD=-0.002636*(YI-250)*(YI-250)/10000;S XB=500-XI;S YB=500-YI
03.70 S XA=FIN(16,J,2)/10000;S DX=XA-XB-(AX*(XB-250)+BX*(YB-250)+CX)+DD
03.71 S YA=FIN(16,J,3)/10000;S DY=YA-YB-(AY*(XB-250)+BY*(YB-250)+CY)
03.72 I (XA)3.9,3.9
03.73 S PP=0.5*(FIN(16,J,6)+FIN(32,J,6));S DX=DX*500;S DY=DY*500
03.74 I (A-0T)4.60,3.75,4.60
03.75 S DP=FIN(16,J,6)-FIN(32,J,6)
03.76 T %4 J+NS-125,FIN(16,J,1),%7.04 0.5*(XA-XI)+250,0.5*(YA-YI)+250
03.77 T %5.01 DX,DY,%5 PP,DP,!
03.80 I (Z-J-NS+125)3.98,3.98;S UX=UX+1;S J=J+1;I (125-J)3.81,3.68,3.68
03.81 X CALL(23,6,1)
03.82 G 3.68
03.85 X CALL(23,7,1)
03.86 G 3.67
03.90 I (UX-25*N)3.95,3.95;X STAT(-1);A "C?",B
03.91 I (B-0Y)3.98,3.92,3.98
03.92 S N=N+1;X SWIT(-1);X STAT(1,980,1)
03.93 F I=1,150;S A=A
03.95 T %4 J+NS-125,FIN(16,J,1),!;G 3.8
03.98 T "DONE",!;X STAT(-1)
03.99 Q

04.10 S P=FIN(32,J,6)/250;I (P-16.5)4.2,4.2,4.3
04.20 S XI=XI-(-0.64*(P-16.5))/1000
04.22 S YI=YI-(+0.250*(P-16.5)*(P-16.5))/1000;R
04.30 S XI=XI-(-1.60*(P-16.5)*(P-16.5))/1000
04.32 S YI=YI-(+1.10*(P-16.5))/1000;R
04.50 X SWIT(-1);X STAT(1,980,1)
04.51 G 3.68
04.60 I (UX-25*N)4.62,4.62;X STAT(-1);A "C?",B
04.61 I (B-0Y)3.98,4.70,3.98
04.62 G 3.75
04.70 S N=N+1;D 4.5;G 4.62

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG 21
01.02 X CALL(6,1)

02.01 T "PRINT OUTPUT DETAILS FROM DISK",!
02.02 A !"FIRST AND LAST INDEX I=",J,K;A " ALL?",A;T !
02.14 T !"          SC    XI    XM    XS    PH      YI      YM     YS"
02.20 F I=J,K;T ! %3 I;DO 2.82;DO 2.9;DO 2.92
02.30 Q
02.82 S SC=FOUT(BO,I,1);S ER=FOUT(BM,I,8);T %3 SC
02.90 F Q=2,8;T %5 FOUT(BO,I,Q)
02.92 IF (ER)2.94,2.95,2.94
02.94 T ER
02.95 C

03.01 T "PRINT FINAL RESULTS FROM DISK",!
03.10 A !"FIRST AND LAST INDICES",J,K;A " ALL?",A;T !
03.50 T !"  I    SC     X          Y        PHOT."
03.60 F I=J,K;DO 4
03.70 Q

04.10 S XI=FOUT(BO,I,2);S XM=FOUT(BO,I,3)
04.12 S XS=FOUT(BO,I,4)
04.14 S YI=FOUT(BO,I,6);S YM=FOUT(BO,I,7)
04.16 S YS=FOUT(BO,I,8)
04.20 S D=XI-100*FITR(XI/100);S M=XM;DO 14
04.22 S XI=XI+N
04.24 S SC=FOUT(BO,I,1);S ER=FOUT(BM,I,8)
04.30 S D=YI-100*FITR(YI/100);S M=YM;DO 14
04.32 S YI=YI+N
04.40 S XT=FITR(XI/100)+(XM+XS)/5000+FCOR(XI/100)/10000
04.50 S YT=FITR(YI/100)+(YM+YS)/5000+FCOR(YI/100,1)/10000
04.51 I (A-0Y)4.52,4.6
04.52 I (ER)4.6,4.9,4.6
04.60 T !%3 I,SC,%8.04 XT,YT,%6 FOUT(BO,I,5)
04.70 IF (ER)4.8,4.9
04.80 T %6 ER
04.90 R

14.10 S N=0
14.20 IF (D-90)14.3;IF (1000-M)14.9;S N=100;G 14.9
14.30 IF (30-D)14.9;IF (M-3000)14.9;S N=-100
14.90 R

15.01 T "READ CONTENTS OF IBM RECORDS."
15.02 S BI=16;A "  FIRST/LAST I="I,II,!
15.03 I (I)15.98,15.98,15.04
15.04 X NAME(1);X RWND(0)
15.06 A "NO. REC TO SKIP=",N;X ADV(2*N)
15.08 A "TYPE=T OR CRT=V?",A;I (A-0T)15.12,15.14,15.12
15.12 X SWIT(-1);X STAT(1,980,1)
15.14 X IBMR(BI);X IBMR(BI+8)
15.16 F D=0,2,10;T %5 FTAKL(BI,D)
15.17 T !;F J=1,8;T %7 FOUT(BI,I,J)
15.18 I (II-I)15.19,15.19;S I=I+1;G 15.17
15.19 T !;X STAT(-1);G 15.02
15.98 X STAT(-1);T "END",!;Q
15.99 Q

31.98 W
31.99 X END(0)
```

```
01.01 C-PROG.22
01.02 X CALL(6,1)

02.09 T "TO TRANSFER AME DATA FROM T8 TO T7",!
02.10 A "STARTING REC ON T8",SX;T !;S TX=SX*16
02.12 A "NO. REC TO TRANSFER ",NS;T !;S N=1
02.14 A "STARTING REC ON T7",SY;T !;S TY=SY*16
02.40 S BI=16
02.60 A "FILE ON T7?",A;I (A-0Y)2.10,2.70,2.10
02.70 S N=1;S TY=SY*16
02.80 X MTAK(BI,TX,16,8);X MPUT(BI,TY,16,7)
02.82 S TX=TX+16;S TY=TY+16;S N=N+1;I (NS-N)02.91,2.80,2.80
02.91 T " DONE";A "   MORE?",A;T !;I (A-0Y)2.92,2.10,2.92
02.92 Q

03.01 A "PRINT FROM T7 OR T8?",U;T !
03.10 A " REC NO.?"ST(2);S TX=ST(2)*16;S SC=10000;S BI=16
03.12 S N=1;S TX=ST(2)*16;A "SURVEY TAPE?",AX;S NS=125;S UX=1
03.15 A " FIRST/ LAST IMAGE",I,II;A !" TYPE=T OR CRT=V",A;T !
03.16 X MTAK(BI,TX,16,U);I (A-0T)3.17,3.18,3.17
03.17 X SWIT(-1);X STAT(1,980,1);F D=1,150;S A=A
03.18 T %4 FTAKL(BI,0),FTAKL(BI,2),%4.01 FTAKL(BI,4)/10,%4
03.19 T FTAKL(BI,6),FTAKL(BI,8),FTAKL(BI,10),%5.02 FTAKL(BI,12)/100,!
03.20 I (NS-I)3.65,3.21,3.21
03.21 S J=I+NS-125
03.22 I (AX-0Y)3.3,3.24,3.3
03.24 T %4 J, FIN(BI,I,1),%6.02 FIN(BI,I,2)/100,FIN(BI,I,3)/100;G 3.31
03.30 T %4 J,FIN(BI,I,1),%8.04 FIN(BI,I,2)/SC,FIN(BI,I,3)/SC
03.31 F D=4,1,8;T %4 FIN(BI,I,D)
03.32 T !;I (II-I-NS+125)3.4,3.4;S I=I+1;S UX=UX+1;I (NS-J-1)3.6;G 3.7
03.33 I (24*N-UX)3.34,3.21,3.21
03.34 S N=N+1;X STAT(-1);A "C?",B;I (B-0Y)3.40,3.35
03.35 D 3.17;G 3.2
03.40 T "DONE",!;X STAT(-1);Q
03.60 S NS=NS+125;S TX=TX+16;S I=I-125
03.61 D 3.62;I (A-0T)3.33,3.21,3.33
03.62 X MTAK(16,TX,16,U)
03.63 G 3.21
03.65 I (NS-I)3.67,3.21,3.21
03.67 D 3.6;G 3.65
03.70 I (A-0T)3.33,3.21,3.33

04.01 T "PHOTOMETRY COMPARISONS ON DIFF RECS",!
04.06 A " DATA FROM T7 OR T8?",U,!
04.08 A "STARTING REC=",SX;S TX=SX*16
04.12 A " NO. OF RECS=",NS,!;S N=1;S J=1
04.14 A " NO. IMAGES PER REC=",II;T !;S BI=16
04.16 X MTAK(BI,TX,16,U)
04.30 T !;F I=J,1,J+9;T %6 FIN(BI,I,6)
04.35 I (NS-N)4.4,4.4;S N=N+1;S TX=TX+16;G 4.16
04.40 I (II-I)04.98,04.98;S J=J+10;S TX=SX*16;S N=1;T !;G 4.16
04.98 T ! "DONE",!;Q

31.98 W
31.99 X END(0)
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01.01 C-PROG.23
01.02 X CALL(6,1)

03.01 T "TRANSFER SURVEY FROM T7 TO T8",!
03.02 A "START AT SN(7)=",SN," AND SO(8)=",SO,!
03.08 S BS=176;I (50-SO)3.1,3.1;T !"SET SO OVER 49",!;G 3.02
03.10 X MTAK(BS,16*SN,16,7)
03.14 S NI=FIN(BS,0,3);D 3.4;T %3 "NI=",NI;I (125-NI)3.16,3.98,3.98
03.16 S NI=NI-125;S SN=SN+1;S SO=SO+1;D 3.1;D 3.4
03.18 I (125-NI)3.16,3.98,3.98
03.40 X MPUT(BS,16*SO,16,8)
03.98 T !"LAST SO=",SO," DONE",!;Q

05.01 A " TO ADD STAR TO T7 OR T8?",U," AT REC=",SN,!
05.10 X MTAK(16,16*SN,16,U)
05.20 S I=1
05.21 S NS=FIN(16,I,1);I (NS)5.22,5.22;S I=I+1;G 5.21
05.22 S NI=I-1
05.25 T "START WITH LARGEST I",!
05.26 A "TO ADD NEW STAR AFTER I=",II,!
05.30 A "SC=",SC," XI=",XI," YI=",YI," S",S," O",O," C",C," Q",Q
05.31 A " B",B," E",E;S XI=XI*100;S YI=YI*100;S CQ=70+Q
05.38 S I=NI;S NI=NI+1
05.40 G 5.61
05.45 S I=II+1
05.46 X SAVX(16,I,SC,XI,YI,S);X SAVY(16,I,O,CQ,E,B)
05.50 A ! " MORE STARS?",A;I (A-0Y)5.7,5.26,5.7
05.61 S A1=FIN(16,I,1);S A2=FIN(16,I,2);S A3=FIN(16,I,3)
05.62 S A4=FIN(16,I,4);S A5=FIN(16,I,5);S A6=FIN(16,I,6)
05.63 S A7=FIN(16,I,7);S A8=FIN(16,I,8);S IS=I+1
05.64 X SAVX(16,IS,A1,A2,A3,A4);X SAVY(16,IS,A5,A6,A7,A8)
05.66 S I=I-1;I (II+1-I)5.40,5.40,5.45
05.70 A "OK TO FILE ON T7?",A;I (A-0Y)5.7,5.72,5.7
05.72 X PUTL(16,28,NI);X MPUT(16,16*SN,16,U)
05.98 T "DONE",!;Q

06.01 C-PIECES FOR PROG. 17 AND 20 (GROUPS 6,7,8)
06.10 S NS=NS+125;S TX=TX+16;S TY=TY+16;S J=J-125
06.11 D 6.5;X END(0)
06.50 X MTAK(16,TX,16,U);X MTAK(32,TY,16,U)
06.60 X END(0)

07.10 I (NS-J)7.12,6.50,6.50
07.12 D 6.1;G 7.1

08.60 F N=1,NS;S LX(N)=LX(N)-AX*XR(N)-BX*YR(N)-CX
08.62 F N=1,NS;S LY(N)=LY(N)-AY*XR(N)-BY*YR(N)-CY
08.63 T !;F N=1,NS;T %4.01 LX(N)*500,LY(N)*500
08.64 X END(0)

09.01 C-PIECES FOR PROG.18
09.02 T " ST=",ST+1,!
09.10 I (NI-I)9.98;S I=1;S NI=NI-125;S SN=SN+16;S ST=ST+1
09.12 X MTAK(BI,SN,16,7)
09.13 X MTAK(BM,ST*16,16,8)
09.14 X END(0)
09.98 T "END",!;Q

31.98 W
31.99 X END(0)
*
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01.01 PROG.24
01.02 X CALL(6,1)

03.01 T "TO DISPLAY POSITIONS ON CRT",!;S BI=16
03.03 A "ON T7 OR T8?",U," AT FIRST/LAST REC=",SO,ST;S NN=ST-SO+1
03.04 F SN=SO,1,ST;D 3.1;S BI=BI+16
03.05 S BI=16;S I=1;A "FOR GA,BR,OR AL?",K,!;G 3.12
03.10 X MTAK(BI,16*SN,16,U)
03.12 X SWIT(-1)
03.21 I (FIN(BI,I,1))3.98,3.98;I (K-0AL)3.22,3.3,3.22
03.22 I (K-0GA)3.6,3.24,3.6
03.24 S CQ=FIN(BI,I,6);I (CQ-20)3.3,3.38,3.38;C-FOR GAL
03.30 S A=1023-2*FIN(BI,I,2)/100;S B=2*FIN(BI,I,3)/100
03.35 X STAT(A,B,1)
03.36 T "*"
03.38 I (125-I)3.90,3.90;S I=I+1;G 3.21
03.60 S SO=10*FIN(BI,I,4)+FIN(BI,I,5);I (SO-12)3.38,3.61,3.38
03.61 I (FIN(BI,I,1)-FIN(BI,I+2,1))3.38,3.64,3.38
03.64 S SO=10*FIN(BI,I+2,4)+FIN(BI,I+2,5);I (SO-20)3.66,3.3,3.66
03.66 I (FIN(BI,I,1)-FIN(BI,I+4,1))3.38,3.68,3.38
03.68 S SO=10*FIN(BI,I+4,4)+FIN(BI,I+4,5);I (SO-20)3.38,3.3,3.38
03.90 I (NN*16-BI)3.98,3.98;S BI=BI+16;S I=1;G 3.21
03.98 X STAT(-1);T "DONE",!;Q

31.98 W
31.99 X END(0)
*
```