Twenty Seventh Meeting of the Hipparcos Science Team

CERGA, 7-8 March 1991

Attendance:

HST: Prof. P.L. Bernacca, Dr M. Crézé, Prof. F. Donati, Dr. M. Grenon, Prof. M. Grewing (first day), Prof. E. Høg, Prof. J. Kovalevsky, Dr F. van Leeuwen, Dr L. Lindegren, Dr H. van der Marel, Mr C.A. Murray, Mr R.S. Le Poole, Dr H. Schrijver, Dr C. Turon.

ESTEC: M.A.C. Perryman

ESOC: D. Heger, A. McDonald

Invited: C. Petersen, M. Froeschlé, J.L. Falin, A. Guery

The agenda given in Annex I was adopted.

Actions agreed at the meeting are included as Annex II.

Perryman reported on the SPC discussions of 27 February in which the continuation of RGO participation to the data processing was discussed. The UK delegation had requested an independent review, which was presently ongoing (note added after the meeting: the report of the Review Committee was sent to the UK BNSC on 11 March). The SPC Chairman had requested a clarification of the UK position before the next ESA Council meeting on 20 March.

1. Satellite Status

Heger reported on the satellite status, including useful data fraction, and the outstanding anomalies (Annex III). Estimates of lifetime from cold gas (1450 gm in tank 1, 5000 gm in tank 2, with 4.5 gm used per day) is end 1994. The solar array degradation appears to be consistent with end 1994 operations.

Anomalies where redundant units are now in use (RTU, gyro 4/5, MDE, TCE) have been the subject of detailed contingency studies within ESOC and industry.

McDonald reported on the development of the on-board attitude control in the absence of gyro 4/5 (Annex IV). The tuning of the occultation limits had been completed, and a report issued (ESTEC.STATUS.14 Item 10, see also Annex V).

Van Leeuwen, Schrijver & Falin had examined data using the new ACS z-axis thruster inhibition logic (PT16 and first look data) and were satisfied with its quality; attitude smoothing results were not yet available.

2. TDAC Status

Høg reviewed the organisation and status of the Tycho processing (Annex VI).

ARI were now successfully performing predictions of group crossings using the TIC and the RTAD provided by ESOC. PT6 (3 days) results using NDAC attitude, IRS stars for calibration and monitor stars for statistics, were presented. Astrometry results at Copenhagen now provide the large and medium scale irregularities as a function of the inclined/vertical and preceding/following fields of view (MSI correction is not presently applied at ARI). The present results use the NDAC attitude and the most recent NDAC calibration (the intention is to implement the laboratory MSI in ARI). TDAC are baselining the use of the NDAC attitude and calibration for data stream C (i.e. all PTs). TDAC would still like to receive the FAST attitude and the associated geometric calibration for verification purposes. The schedule for the data stream C processing was presently: mid April, data due in Copenhagen; mid May, calibration results available.

FAST will in any case furnish a final attitude (but not necessarily an intermediate attitude, which could come from NDAC). The parallel attitude comparison task ongoing under Donati's responsibility is considered as a necessary input to gaining confidence in the attitude provided by NDAC/FAST.

Høg reported that TDAC verifications presently planned include (i) proper directions to be checked by Bastian and Schwekendiek using data coming from RGO (van Leeuwen) and Lund to the level of better than 5 milli-arcsec; (ii) CUO/Lund: positions derived by CUO (sphere) could be compared with the sphere solution. Perryman suggested that it would be useful to carry out a comparison at the RGC level, using RGC coordinates from the main mission, and the vertical SM slit abscissae results.

Minor planets were still giving problems at ARI regarding predicted transit times (Action 1). Høg did not consider that this would hold up mass processing since the data would be re-analysed for the minor planets.

Grewing presented the work ongoing at AIT. The detection and archiving process is now functioning, and ready for mass production, although some final verification is still planned. For photometry, many problems have now been resolved, although some biases still remain. The target date for starting photometry/detection is mid-April.

3. Double Star Processing

(a) NDAC: Lindegren presented the strategy and status of the IDT double star processing in NDAC (no Annex). Tests on provisional 'case history files' may be made in the near future. An automated system could be ready approximately one year from now. van Leeuwen reported on the double star results obtained with the star mapper (Annex VII).

(b) FAST: Bernacca presented the strategy and status of the FAST double star processing (no Annex): CNES passes the data to Tecnopolis for calibration/consolidation, and the data is then forwarded to Frascati, Tecnopolis, and Torino for further treatment.

From the first discussions on comparisons of double star processing, the following suggestions were made:

(i) Lindegren proposed to intercompare, for a subset of well-defined double stars with favourable separation (0.3-5 arcsec), relative parameters. For these observations there would be independent checks from the star mapper and from the ground.

(ii) Kovalevsky proposed a comparison of flags at RGC level to indicate which of the stars are considered double by both groups (Cerga could consider taking the responsibility for these comparisons).

(iii) Perryman proposed that, at sphere level (e.g. after the first 9 months of data processing) a comparison (for a range of INCA numbers) of which stars are single, double, multiple or uncertain, could be carried out, and parameters of these cases compared.

4. IC8 and INCA Status

IC8: Turon reported on the distribution of IC8 to the DRC. The file sent to ESOC by e-mail (update of positions and magnitudes) had, by mistake, negative declinations for all objects (48 candidate stars observed incorrectly for about 20 days—full details will be given in ESTEC.STATUS.15). Turon also reported that the PSF epoch had been incorrectly interpreted as 1989 (instead of 1990) since the start of the mission, giving rise to positional errors equal to the annual proper motion for all stars. However, van Leeuwen reported no evident problems with the 3 highest proper motion stars.

RGO catalogue (Annex VIII): INCA will pass on to ESOC all 46700 stars which pass the positional tests (within 3 arcsec, and with RGO errors smaller than those in IC8), independent of their magnitudes; also, the additional ISPR stars should be sent to ESOC end March 1991 (Annex IX).

Anomalous stars: INCA had taken into account all anomalous reports from Schrijver, up to report number 20, in the construction of IC8. Although further changes could be incorporated at ESOC and within the DRC, INCA now propose to 'ignore' further

ANNEX I

Twenty-Seventh Meeting

of the

Hipparcos Science Team

Cerga, 7-8 March 1991

Agenda

1. Satellite status report (Heger/Perryman)

2. TDAC status:
   - TDAC data flow (Hoeg)
   - status of PT processing (Hoeg)
   - status of photometry processing, photometric calibration & TIC (Grewing)
   - geometric calibrations for Tycho (Kovalevsky/Lindegren)
   - attitude for Tycho (Bernacca/van Leeuwen)
   - astrometry results (Hoeg)
   - SM MSI and validation of GCR abscissae

3. Double star processing status:
   - NDAC (Lindegren)
   - FAST (Bernacca)
   - comparisons

4. IC8 and INCA status (Turon)
   - treatment of anomalous stars
   - catalogue publication (including free copies)

5. Comments arising from PT15-16 (FAST/NDAC)

6. IDT/SM/attitude outstanding actions:
   - report of Utrecht comparison meeting of 16 January (Perryman)
   - FAST GCR tests on POS (van der Marel)
   - I0 (Lindegren/van Leeuwen)
   - SSRF
   - IDT and SM ITF/decompression tables (van Leeuwen)
   - TDAC discrepancies on timing and velocities (Grewing)
   - results using smoothed solutions (Donati)
   - calibration conclusions from attitude comparisons

7. GCR:
   - results from FAST/NDAC data (with/without catalogue updates) (Le Poole)
   - opposite poles data: results of new ESOC data (Schrijver)
   - use of 3rd-order terms in CUO processing (Lindegren/van der Marel)
   - instrument evolution: NDAC (Lindegren) and FAST (van der Marel)
   - instrument chromaticity derived by GCR and on-board strategy (Schrijver)
   - choice of NDAC/FAST end-points and effects on data quality

8. Status of photometric comparisons on IDT and SM

9. Miscellaneous:
   - A&A publications and other DDRT business (before DDRT discussion)
   - next meeting

ANNEX II: Actions

1. Høg: identify reason for error in TDAC PGC minor planet transit time

2. RGO/CERGA/TDAC/UTRECHT: implement revised RGO IDT and SM ITF

3.1 Schrijver: send SSRF to FvL: FvL to perform single transit tests

3.2 Schrijver: if needed after 3.1, HS defines RGC + stars: FvL/HS both construct SSRF

3.3 Høg: TDAC to use Utrecht/RGO SSRF and report on differences

4. ESOC (McDonald) to investigate RTAD/timing

5. FAST (Falin) to provide correlation of peak excursions as a function of sun angle

6.1 Falin to define comparison set 3 (NB completed 11-3-91) allowing >5000 frames from PT15/16 for:

6.2 IDT comparisons: van Leeuwen **and** Falin to send IDT data to Perryman

6.3 SM comparisons: Falin **and** Snijders to send SM data to van Leewuen

6.4 IDT magnitudes from RGO (van Leeuwen) to Mignard for comparison before 15 April

6.5 SM magnitudes from RGO (van Leeuwen) to Snijders for comparison before 15 April

(Photometry meeting: 15 April at Tubingen: van Leeuwen, Grenon, Snijders, Scales, Mignard, Perryman)

7.1 Falin to define five RGCs (NB completed 11-3-91)

7.2 CUO/Cerga to send SM, geometric, and smoothed attitude to Donati

7.3 CUO/Cerga to send abscissae to van der Marel

Other actions oustanding:

8. Kovalsevsky to report on tests of ground station propagation implementation

9. van Leeuwen to comment on procedures for RGC end-point selection

10. Høg to consider Tycho verification at RGC level

ANNEX III

HIPPARCOS

S/C STATUS REPORT

NOVEMBER 1990 - MARCH 1991

28/02/1991

1. GENERAL

- Science data collection averaged at 75% (72 hours) of that expected from a geostationary orbit.
- 2 eclipses/day of approximately 30 mins.duration
- 46 anomalies have been raised since launch. 41 anomalies have been closed and 5 anomalies are still open pending further analysis and/or deeper investigation.

  Following anomalies required reconfiguration to the redundant unit:

  : gyro 4

  : P/L RTU

  : P/L thermal control

  : P/L mechanism drive electronic
- None of these anomalies affect the science data collection at present
- The mission is controlled 24 hours per day from ESOC OCC located at DARMSTADT/GERMANY.

  The supporting GROUND STATIONS are ODENWALD (FRG) PERTH (AUS) and GOLDSTONE (USA)

2. MAINTENANCE & OPERATIONS

2.1 ROUTINE HIPPARCOS MAINTENANCE

CHROMATICITY CALIBRATION.....NONE

REFOCUSSING CALIBRATION.....~MONTHLY

GYRO DESTORAGES.....MONTHLY

ISPA (INTERNAL STAR PATTERN ASSEMBLY)..... EVERY 2 WEEKS

SOLAR ARRAY DEGRADATION TEST.....WEEKLY

GRM (GRID REFERENCE MARK) CALIBRATION.....DAILY

2.2 MAJOR SPACECRAFT OPERATIONS

NOVEMBER

DAY 318	gyro 3 destorage
DAY 319	gyro 4 destorage; (Addendum to AR. 35)
DAY 322	CBS reload

DECEMBER

DAY 339	MALINDI tested for BACK-UP support
DAY 352	gyro 3 destorage
DAY 354	gyro 4 destorage; (Addendum to AR. 35)
	gyro spins-up at 3rd attempt; gyro 4 remains on outside control loop

JANUARY

DAY 024	TCE 1 areas 19 & 20 decreased in temps to 0 counts
DAY 025	gyro 3 destorage
	change from TCE 1 to TCE 2 ; area 20 fail to operate
	(AR. 44 applies)

FEBRUARY

DAY 042	3rd workstation installed in DCR
DAY 049	CBS reload;
	symptoms of CBS anomaly similar as the last two failures
	(AR. 45 and 46 apply)
DAY 028	gyro 4 off (high noise and occasional spin-downs of the gyro
	caused attitude divergences)

3. LIFETIME PREDICTION

COLD GAS

remaining gas in tank 1:	1449 gr on 25.02.91
remaining gas in tank 2:	5080 gr
daily use:	5.1 gr with gyro 4 & 5 on
	4.8 gr with only gyro 4 or 5 on

assuming that gyro 4 will be switched off end April, more than 1300 days (3 years 8 month) of operation possible, leading to

end 1994

POWER (Fig. 1)

the solar array degradation predicts operations to

end 1994

4. ANOMALIES

A complete list of anomalies is given and updated in each S/C operations report.

46 anomalies have been raised since lift-off, 41 of those have been successfully closed.

The open anomalies are:

AR 1 SAS OUTPUT DURING HSA

AR 41 MDE ANOMALY

AR 43 NOISE BURSTS ON GYRO 5

AR 45/46 CBS ANOMALY

The anomalies which required reconfiguration the redundant unit are reviewed and the possible further redundancy is presented in 4.1 to 4.4

4.1 PAYLOAD REMOTE TERMINAL UNIT

Applicable Anomaly Report:

No. 26 - partial failure of PRTU 1

Note: all PRTU 1 analogue channels suffer from a negative offset of 50 (+/- 1) counts;

all other PRTU functions are nominal

Current Status:

- system reconfigured to redundant unit PRTU 2
- nominal performance

Possible further redundancy:

a) in case of PRT 2 failure of different nature than above

- reconfiguration to PRTU 1;
- use of recalculated analogue calibration data for payload thermal control purpose (TCE);
- modification of all PRTU 1 analogue parameters on ground taking offset into account

(monitoring and control of analogue parameters where the raw real telemetry value is below 50 counts is impossible)

4.2 GYRO 4 & 5

Applicable Anomaly Report(s):

No. 35 - intermittent spin down of gyro 4 rotor

No. 43 - noise burst on gyro 5

Current Status:

- gyro 5 replaced gyro 4

  (gyro 4 off; noise and spin-downs affected attitude control;

  Fig. 2 and 3)

- performance of gyro 5 acceptable, but occasional noise burst observed

Possible further redundancy:

a) if gyro 5 fails after end April

- special modifications on ground and on-board the S/C are in progress to operate the S/C without gyro 4 and 5;
  expected availability date of basic mods: end April

b) if gyro 5 fails before end April

- use gyro 4 and together with on-board implemented ACS software modification, which switches Z-thrusters off in case of gyro spin-down.
- wait for modification as per a)

c) if gyro 5 fails before end of April and b) proves not to operate as expected

- keep S/C at 43 Deg. (+/- 2 Deg.)
- wait for modifications as per a)

4.3 PAYLOAD MECHANISM DRIVE ELECTRONICS

Applicable Anomaly Report:

No. 41 - partial failure of MDE 1

Note: the secondary voltage drop from 2.44 V to 1.88 V
affects the read-out of the focus monitoring channel
and makes shutter operations suspect

Current Status:

- system reconfigured to redundant unit MDE 2
- nominal performance

Possible further redundancy:

a) detailed failure investigation and possible operational impact
still outstanding

b) in case of MDE 2 failure (i.e. not possible to operate shutter(s))
- reconfiguration to MDE 1
(if impact on MDE 1 is tolerable depending on results of
failure investigation)
or
- open shutter(s) by spring (if necessary) and switch
High Voltage on/off to cope with occultations
NOTE: REFOCUSSING MIGHT NOT BE POSSIBLE

4.4 PAYLOAD THERMAL CONTROL

Applicable Anomaly Report(s) :

No. 37 - failure of control area heater 19 of TCE 1

No. 44 - failure of control area heater 20 of TCE 1

Note: heaters 19 & 20 are mounted on the Focal Plane Assembly next to each other (see Fig. 4)

Current Status :

- reconfiguration to redundant unit TCE 2

(TCE 2 switched on; TCE 1 powered off)

- nominal performance of payload thermal control

Possible further redundancy:

a) if heater 19 or 20 fail on TCE 2

- no further redundancy

b) any other heater fails

- both TCE's to be powered
- CBS interrogations cycle modified such that the calculated heater power is directed to operational heaters of TCE 1 or 2

c) if thermistor fails to provide correct temperature reading

- both TCE's to be powered
- CBS interrogation cycle acquiring the 25 temperatures to be modified to read correct temperature(s) from TCE 1 or 2

5. ACS MODIFICATIONS

The following 2 modifications to the ACS software were uplinked and tested on the 4the Feb 1991:

1) Requirement for ACS modification1:

if computed Z On-time is less than Z On time threshold then no firing shall be performed on Z-axis.

The Z On-time threshold has an LSB of 1 RTC period (1/75 ms)

Performance:

- at present the threshold is set at 8 LSb's
- approximately 60 to 70 % less firings on Z-axis

(Fig. 5 shows Z-axis firings before and after modification))

2) Requirement for ACS modification 2:

to avoid excessive Z thrust in case of Z gyro failure, compute accumulated Z on-times and if above Z-limit, then inhibit Z Normal Mode control (Z-firing).

in addition monitoring of the accumulated +Z on-times and - Z on-times as well as the capability to authorize/inhibit the modification and to enable/disable the decision to inhibit Z Normal Mode control

the max value for accumulated on-time shall be at least 500 sec

the LSB is 1 RTC (1/75 sec)

reset of all accumulated Z On-times

Performance:

- at present the Z-limit is set to 6000 RTC's (80 sec)
- typical values of accumulated total Z On-times are between 1000 and 1350 RTC's
- reset of all Z On-times is once per orbit under ground control

(Table 1 shows Z On-times times related to different S/C alt. bands)

LIST OF FIGURES

LIST OF TABLES

Z-THRUSTER ON-TIMES RELATED TO ALTITUDE BANDS

DAY	S/C Height (KM)											
	06-20 KM			20-20 KM			20-06 KM			06-06 KM		
	+Z	-Z	tZ	+Z	-Z	tZ	+Z	-Z	tZ	+Z	-Z	tZ
045				150	167	317	30	38	68			
				118	124	242	32	35	67	284	467	751
046	50	19	69	125	132	257				110	117	227
047							20	31	51			
				135	137	272						
	108	27	135	130	136	266	30	35	65	324	285	609
048	53	16	69	102	99	201	29	52	81			
				147	139	286						
	43	60	103	129	125	254						
049							30	55	88			
				135	130	265	36	56	92			
050	18	12	30	125	124	249	31	43	74	279	585	864

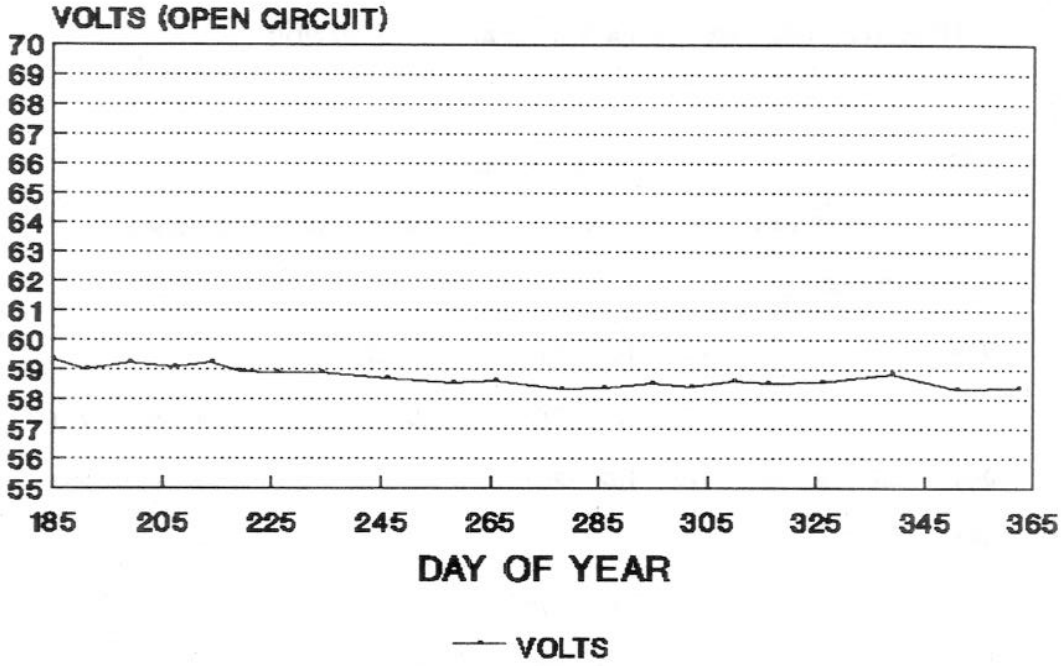
NOTE: +Z = +Z thruster on-times

-Z = -Z thruster on-times

tZ = total Z thruster on-times

TABLE 1

HIPPARCOS SOLAR ARRAY DEGRADATION
LAST 6 MONTHS OF 1990



HIPPARCOS SOLAR ARRAY DEGRADATION
FIRST 6 MONTHS OF 1991

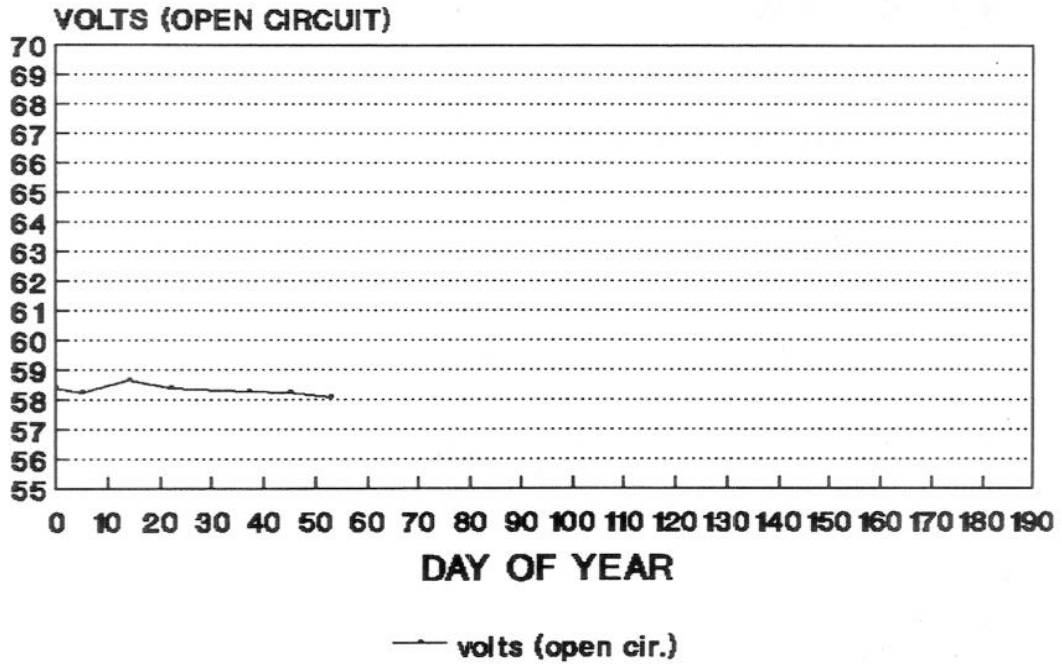
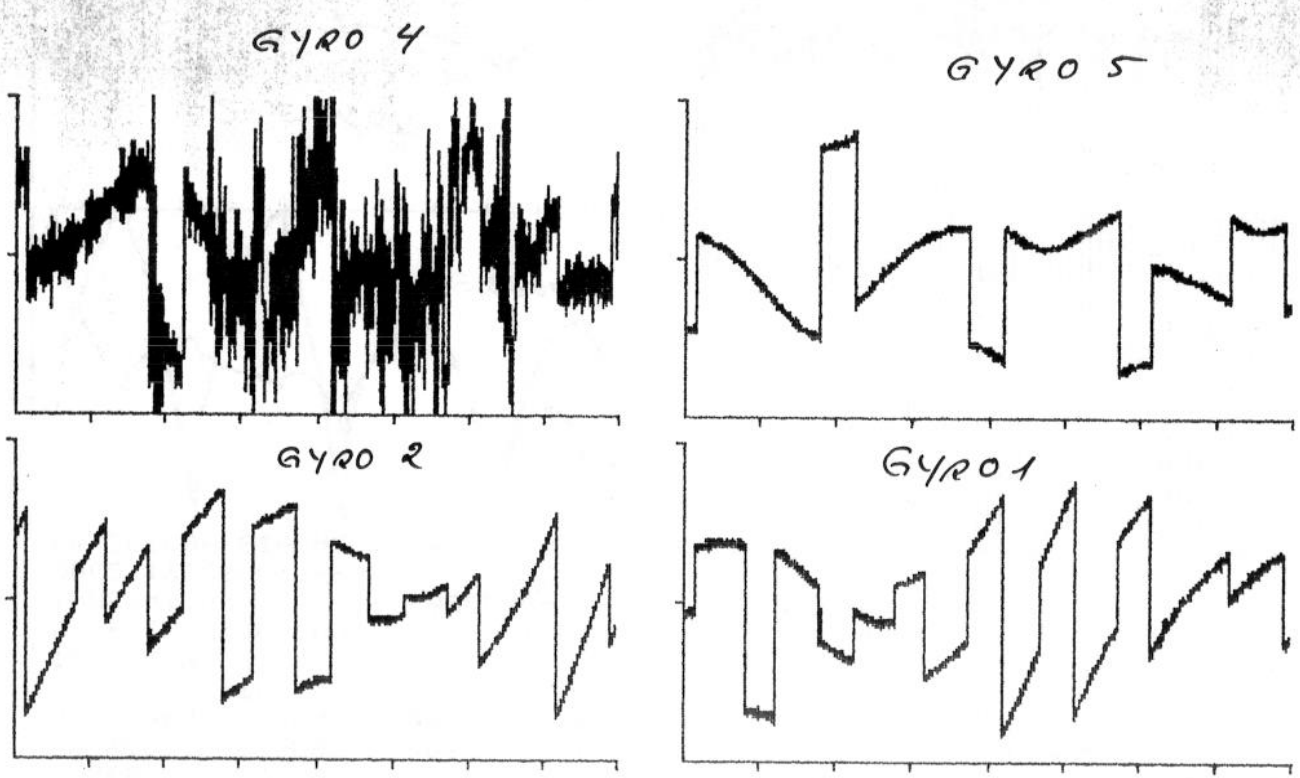


FIG. 1

HDCS 0.1 STATUS=USER NAME=USER2 S/C=HIPPARCO 60:04:00:38
1214 /GYRO 4/5 COMPARISON REALT PKT.TIME:060.04.00.15.751
D/S= 0 /SRCE=SRCA/GDGT/OPT= DP SC FS LI FI VA AL PKT.ID=AOCS.AF2/ 0

ID	DESCRIPTION	VALUE	UNIT	MIN	MAX	LINE
B251	GYRO 4 FINE O/P	169.6254	AS/S	167.0000	171.0000	
B253	GYRO 5 FINE O/P	-169.5677	AS/S	-171.0000	-167.0000	
B250	GYRO 1 FINE O/P	-.6340	AS/S	-3.0000	3.0000	
B252	GYRO 2 FINE O/P	-.4611	AS/S	-3.0000	3.0000	



SCHD_DSP D104 Job ARCHIVE-CHECKER dispatched to process SFS_BATCHSE 04:00:00

Fig. 2

```
HDCS  0.1 STATUS=USER NAME=HIPPUSER S/C=HIPPARCO                    60:04:01:19
9999 /AOCS CNTR & RTAD MONITORING        REALT          PKT.TIME:060.04.01.16.834
D/S= 0  /SRCE=SRCA/GDGT/OPT= DP SC FS LI FI VA AL            PKT.ID=SMP .01 /    0

  ID      DESCRIPTION        VALUE    UNIT      MIN          MAX          LINE
E042   NM XERROR SIGNAL  -.00039177 RAD   -.00200000    .00200000
E043   NM YERROR SIGNAL   .00069064 RAD   -.00200000    .00200000
N407   IDTS QUALITY              3                -1             3
N404   IDTS FOV                  1                 0             5
F203   OVERALL BACKGRND         12                 0          2000
B031   INNOVATION        -.00000644 RAD   -.00005000    .00005000
K251   MDE2 TYC2SHUTTER          2                 0            10
E044   NM ZERROR SIGNAL  -.00047570 RAD   -.00270000    .00270000
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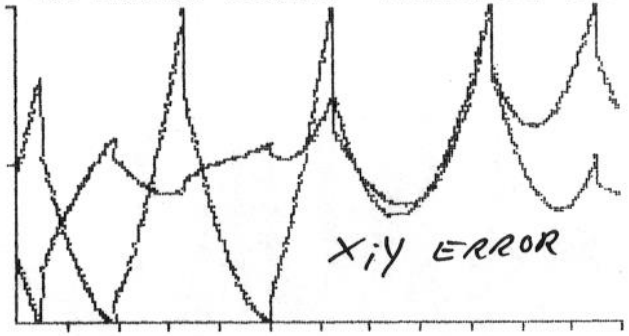
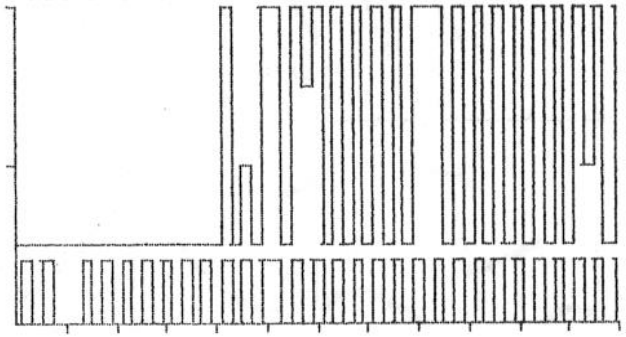
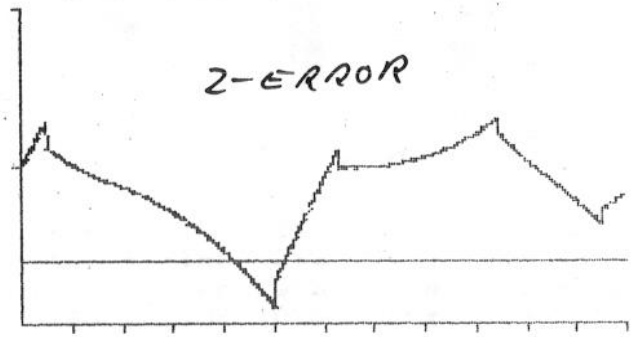
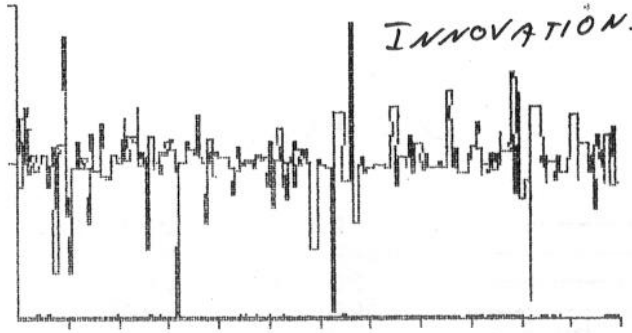




LOSS OF RTAD BECAUSE OF GYRO 4 SPIN-DOWN





91.060.03.01.18 TIME 91.060.04.01.18

SCHD_DSP D104 Job ARCHIVE-CHECKER dispatched to process SFS_BATCHSE 04:00:00

FIG 3

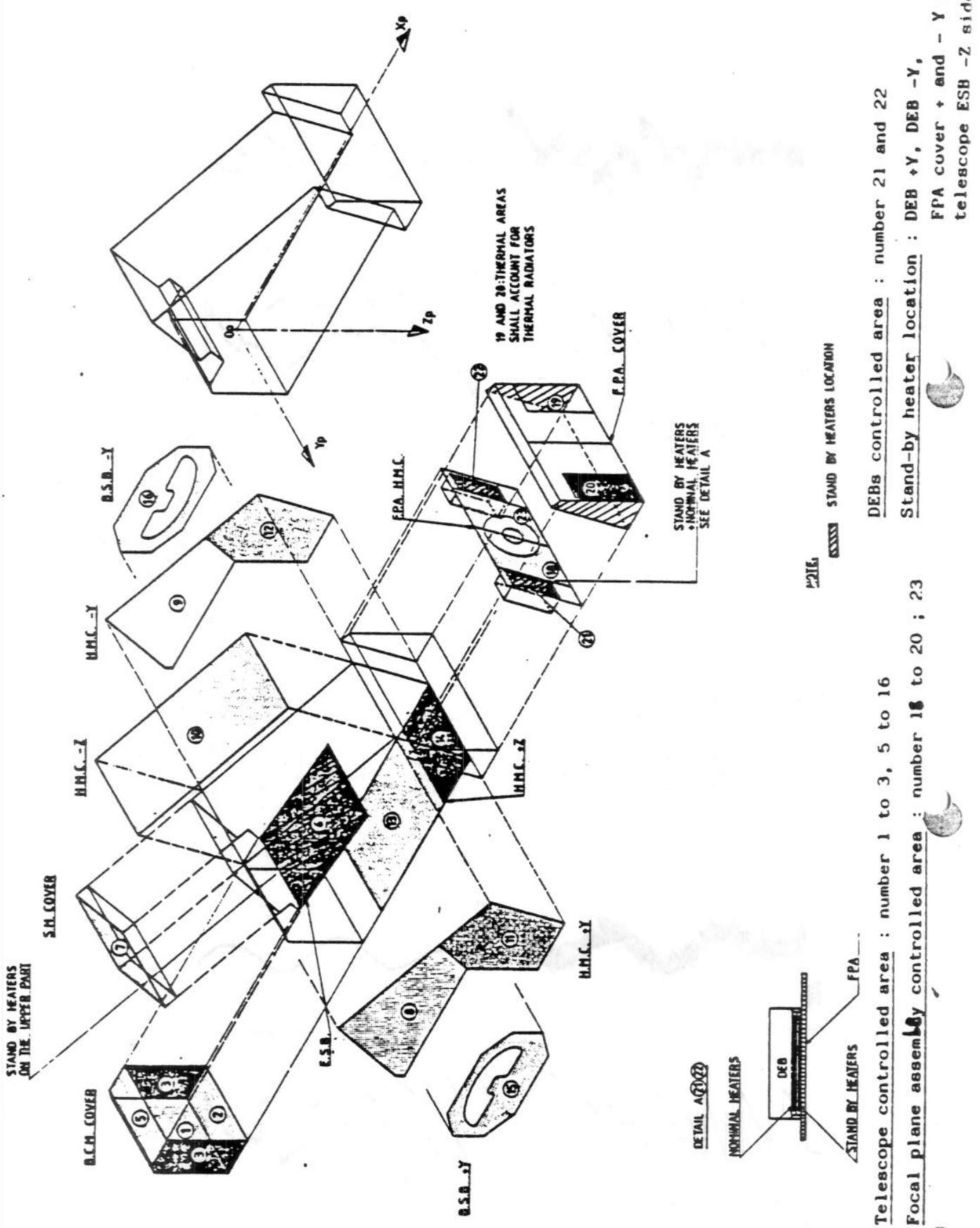


Figure 3.6.1.2/2 : THERMAL CONTROLLED AREA OVERALL LAYOUT

FIG. 4

```
HDCS  0.1 STATUS=SPAC NAME=SPACON    S/C=HIPPARCO                    34:14:21:59
#214  /GYRO 4/5 COMPARISON                REALT          PKT TIME:034.14.21.36.703
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  ID      DESCRIPTION        VALUE   UNIT      MIN          MAX          LINE
B251   GYRO 4 FINE  O/P   170.0288 AS/S    167.0000     171.0000  ----------
B253   GYRO 5 FINE  O/P  -170.0864 AS/S   -171.0000    -167.0000  ----------
B250   GYRO 1 FINE  O/P      .2305 AS/S     -3.0000       3.0000  ----------
B252   GYRO 2 FINE  O/P      .9510 AS/S     -3.0000       3.0000  ----------
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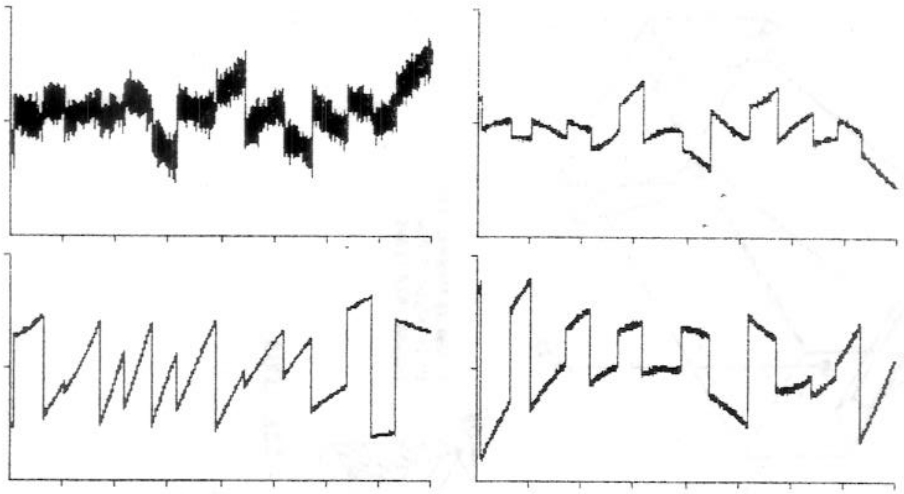

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VAX       2 TASK ENDED / ABORTED                                    14:21:55
```

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D/S= 0   /SRCE=SRCA/GDGT/OPT= DP SC FS LI FI VA AL          PKT ID=AOCS.AF2/     0

  ID      DESCRIPTION        VALUE   UNIT      MIN          MAX          LINE
B251   GYRO 4 FINE  O/P   169.3083 AS/S    167.0000     171.0000  ----------
B253   GYRO 5 FINE  O/P  -169.1931 AS/S   -171.0000    -167.0000  ----------
B250   GYRO 1 FINE  O/P    -1.3256 AS/S     -3.0000       3.0000  ----------
B252   GYRO 2 FINE  O/P     1.2680 AS/S     -3.0000       3.0000  ----------
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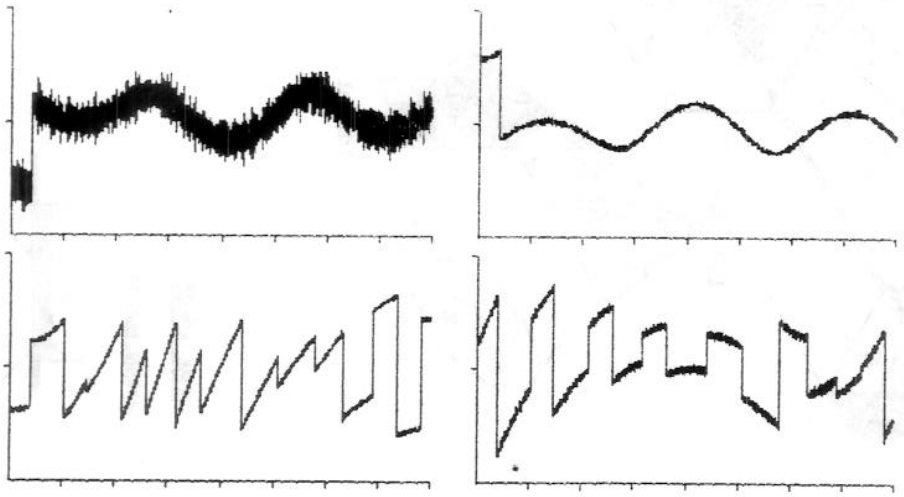

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91.038.10.12.40                    TIME                    91.038.12.12.40
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```

F16.5

Z-THRUSTER ON-TIMES RELATED TO ALTITUDE BANDS

DAY	S/C Height (KM)											
	06-20 KM			20-20 KM			20-06 KM			06-06 KM		
	+Z	-Z	tZ	+Z	-Z	tZ	+Z	-Z	tZ	+Z	-Z	tZ
045				150	167	317	30	38	68			
				118	124	242	32	35	67	284	467	751
046	50	19	69	125	132	257				110	117	227
047							20	31	51			
				135	137	272						
	108	27	135	130	136	266	30	35	65	324	285	609
048	53	16	69	102	99	201	29	52	81			
				147	139	286						
	43	60	103	129	125	254						
049							30	55	88			
				135	130	265	36	56	92			
050	18	12	30	125	124	249	31	43	74	279	585	864

NOTE: +Z = +Z thruster on-times

-Z = -Z thruster on-times

tZ = total Z thruster on-times

TABLE 1

RTAD CONTROL WITHOUT Z-GYROS

ON-BOARD RTAD

Proposal from MATRA

1. On-board sinusoidal model ψ_d as deterministic part of the evolution of the attitude about z-axis. Support required from ground to periodically reset on-board coefficients controlling amplitude and phase.

2. Revised gyro projection coefficients on-board to convert remaining transverse rates from input axes to spacecraft axes.

3. State vector in on-board Kalman filter to include:

   - (ϕ, θ, d_x, d_y) as before
   - ψ_1 - first order variation in ψ
   - ψ_2 - second order variation in ψ
   - d_z - error between measured and nominal z body rate.
   - Γ_z - angular acceleration about z-axis

   updated by star mapper measurements

   $$\psi = \psi_1 + \psi_2 + \psi_d$$

4. ψ_1 and d_z are corrected after actuations from calibrated thruster data and on-time.

5. Revised Kalman gain set to be produced

On-board algorithm to be verified with satellite data at ESOC.

ON-GROUND SUPPORT

The following activities are currently foreseen:

1. **Suspend NM controlled z thruster firings around perigee**

2. **Uplink time-tagged commands to fire z-thrusters to control z-rate. Number and duration of firings will depend on ability to predict behaviour in previous pass.**

   Accumulated on-times being studies for predictability. Possible control of spin rate to an accuracy of 5 - 10 ″/s after perigee.

3. **Fine accuracy spin-rate determination required for ground RTAD. Possible options for doing this are:**

   a. **Star mapper filtering**

      Single transit or averaged

   b. **Torque model**

      Third order harmonics plus higher order terms (?)

4. **Revised on-ground star pattern matching**

   Use revised input catalogue

5. **Revised Kalman filter for determination of eight element state vector.**

Support for on-board harmonic oscillator

Likelihood that full RTAD Initialisation required every pass due to drift in ψ being more than 1 or 2 degrees. Accurate drift estimates are not possible at this time.

OCCULTATIONS

To reduce frequency of shutter use, the FOV half limits for earth and moon occultations have been tuned.

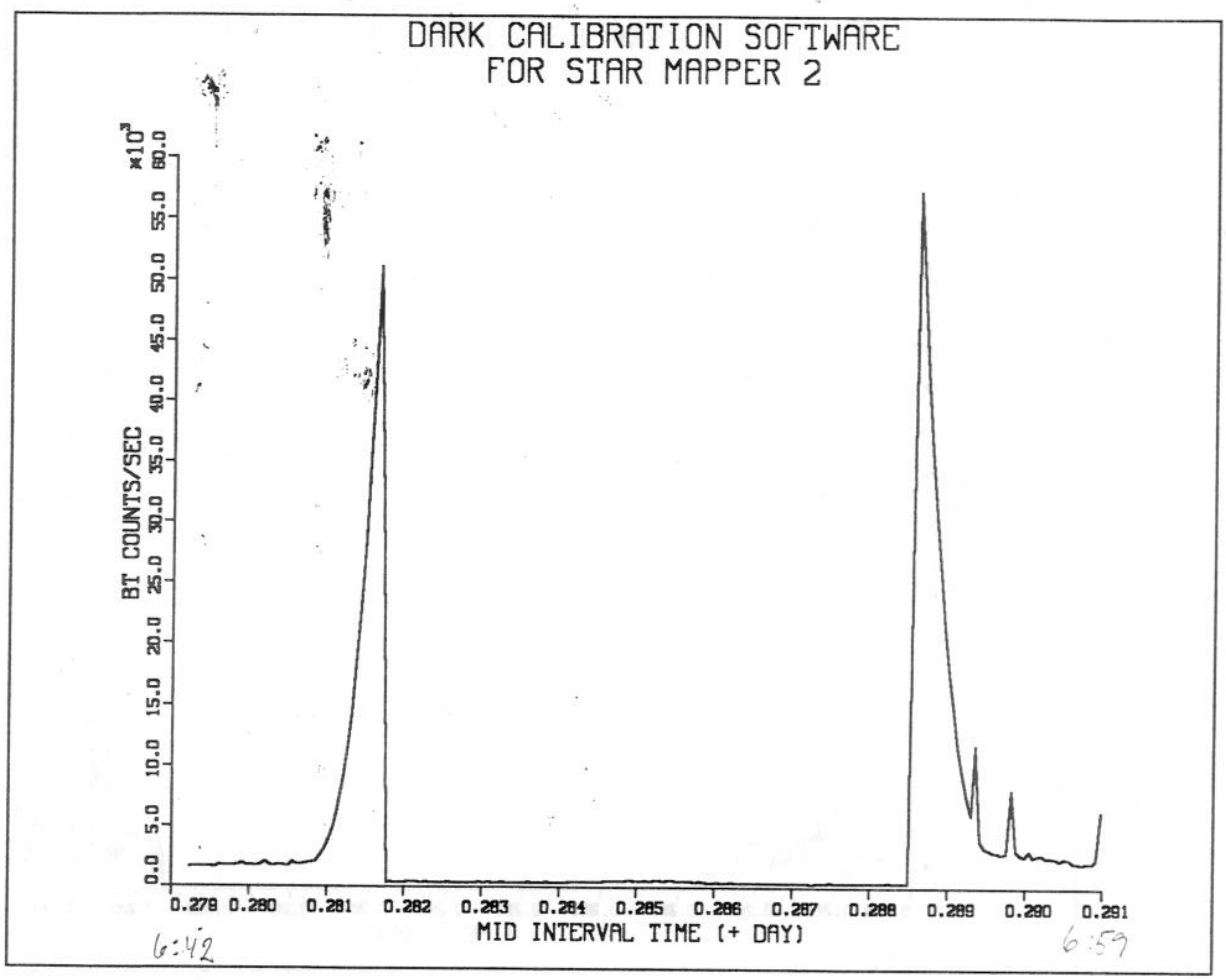
Earth :	Longitudinal	Transverse
Old (degs)	11.1	9.4
New (degs)	7.4	6.2
Moon :	Longitudinal	Transverse
Old (degs)	phase dependant	4.5
New (degs)	phase dependant	2.25

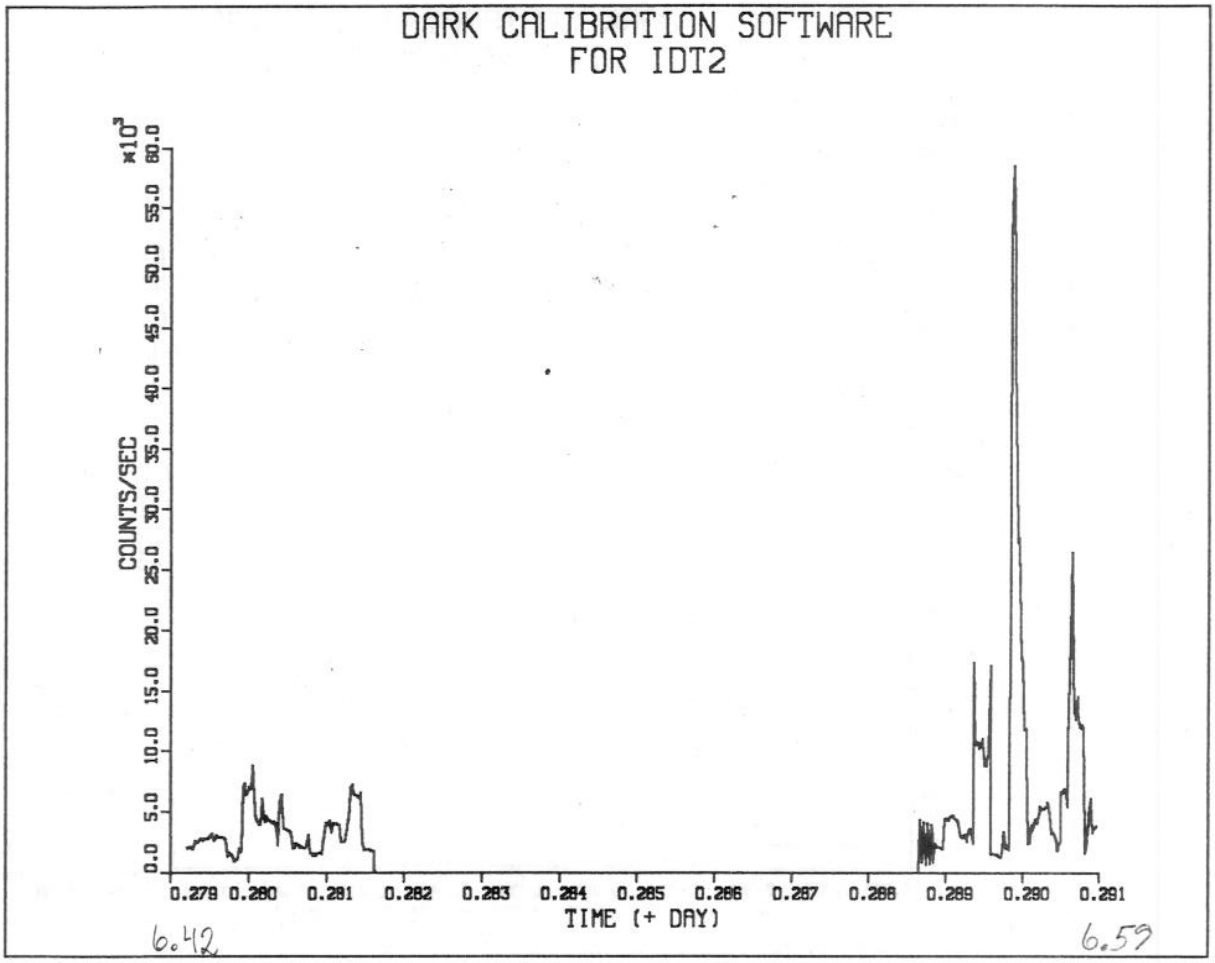
No problems with lunar occultations. However further reductions cause potential automatic shutter closures.

Earth Occultations give occasional rises in Star Mapper background of 50 000 counts/sec. No rise in IDT.

IS THIS ACCEPTABLE?

ANNEX V

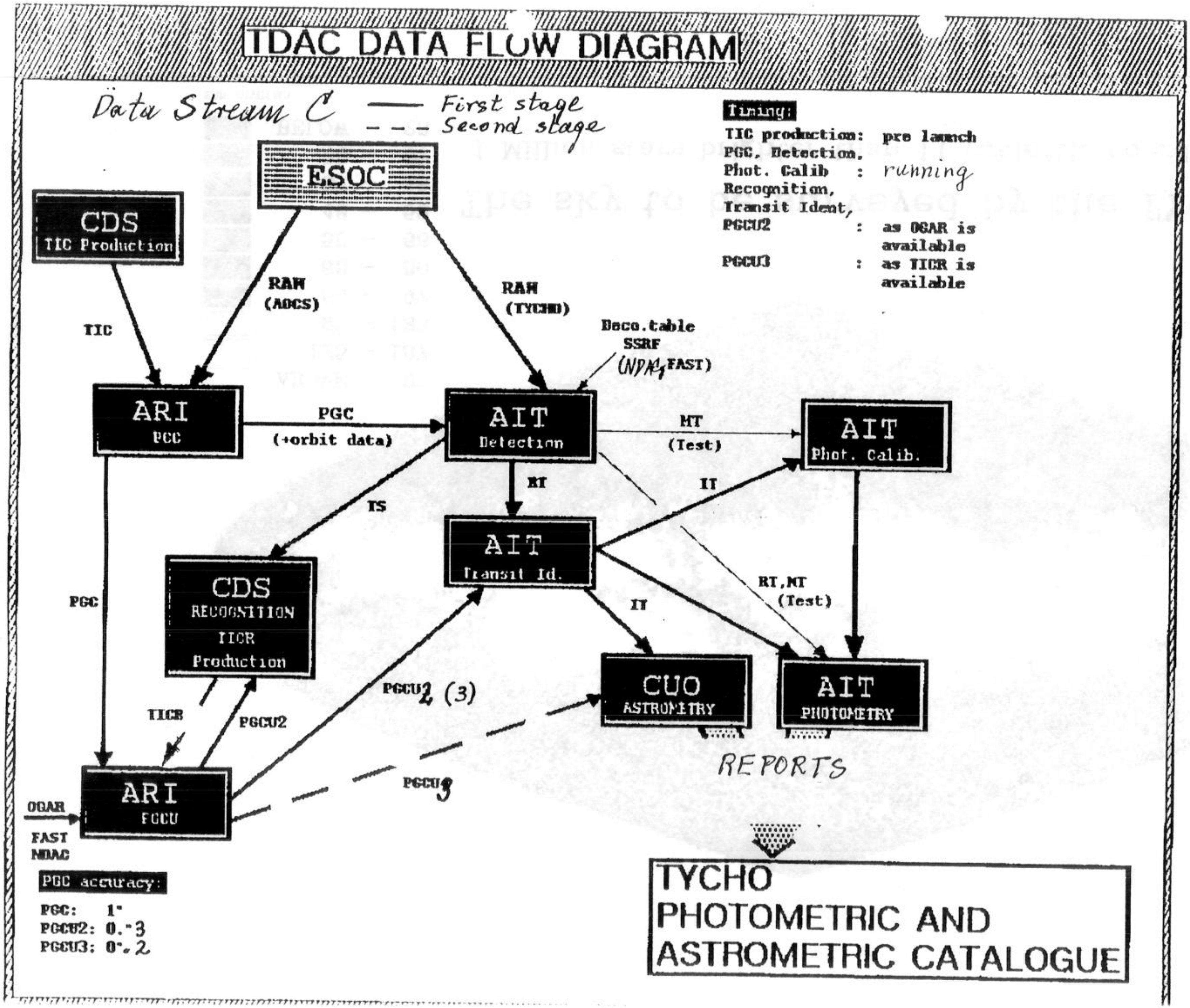

DARK CALIBRATION SOFTWARE
FOR STAR MAPPER 2
BT COUNTS/SEC
x10³
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
0.279
0.280
0.281
0.282
0.283
0.284
0.285
0.286
0.287
0.288
0.289
0.290
0.291
MID INTERVAL TIME (+ DAY)
6:42
6:59

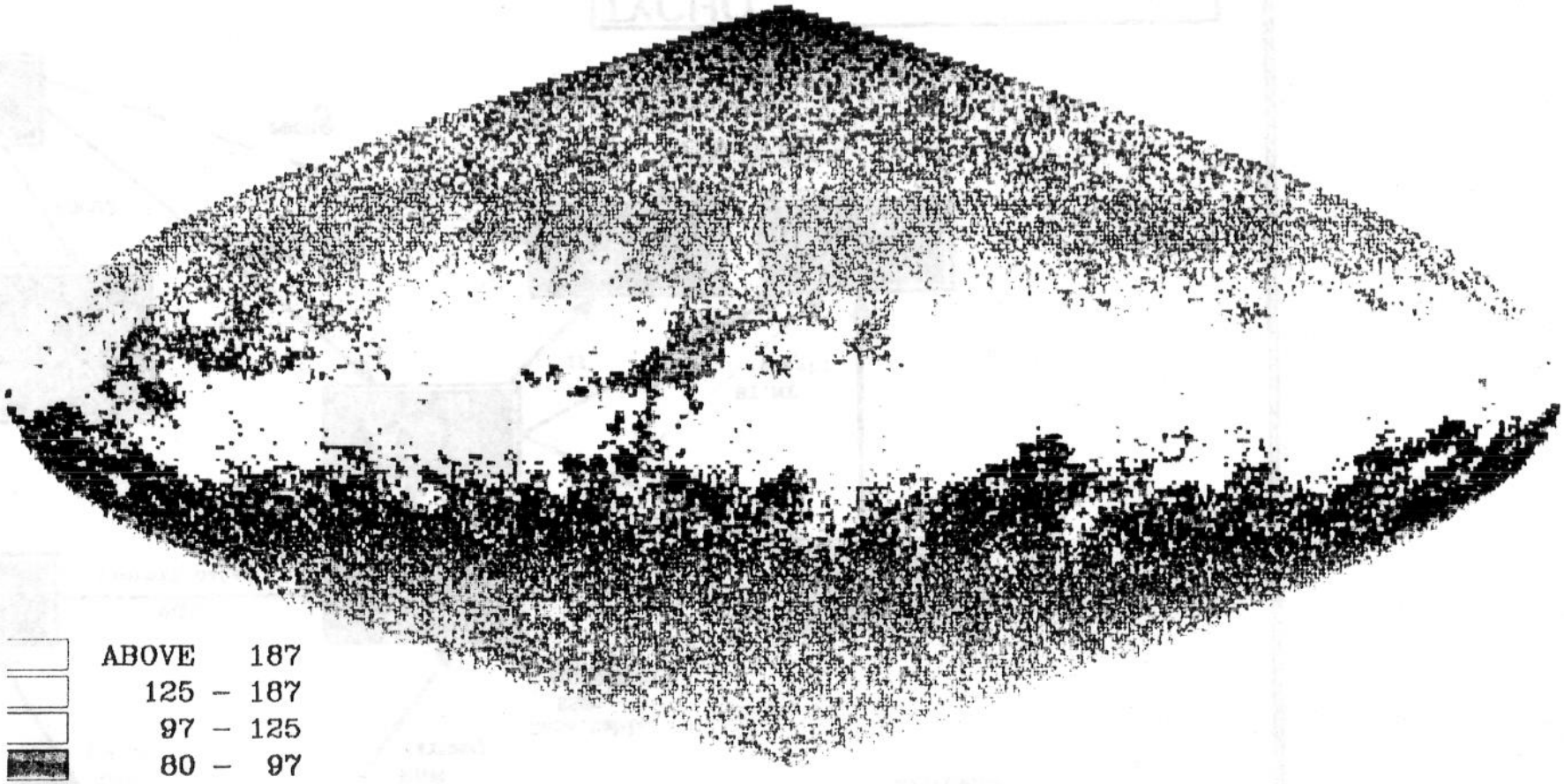

DARK CALIBRATION SOFTWARE
FOR IDI2
COUNTS/SEC
×10³
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
0.279
0.280
0.281
0.282
0.283
0.284
0.285
0.286
0.287
0.288
0.289
0.290
0.291
TIME (+ DAY)
6.42
6.59

To Wicenec
From Høeg 91.02.01

ANNEX VI

1c



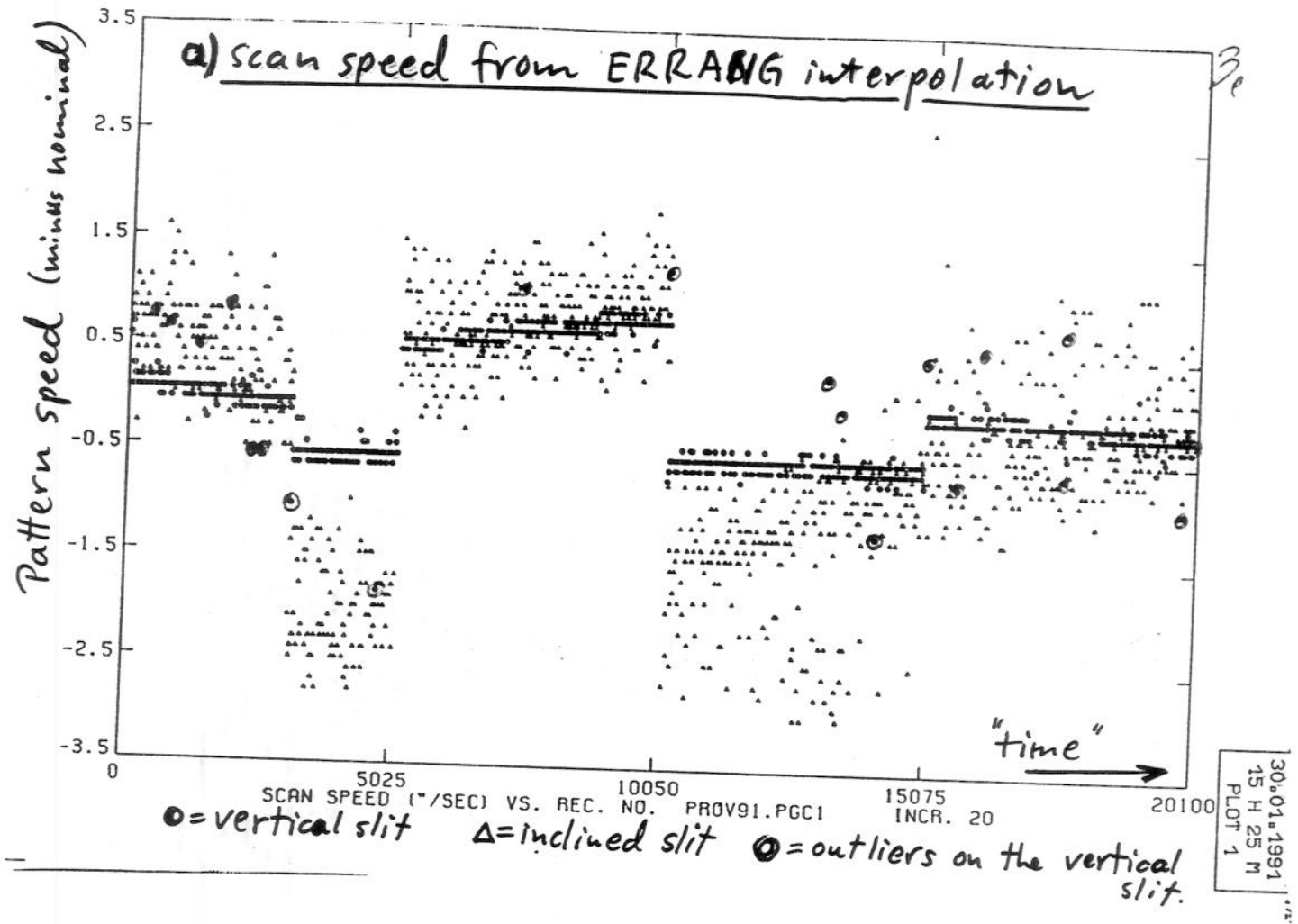


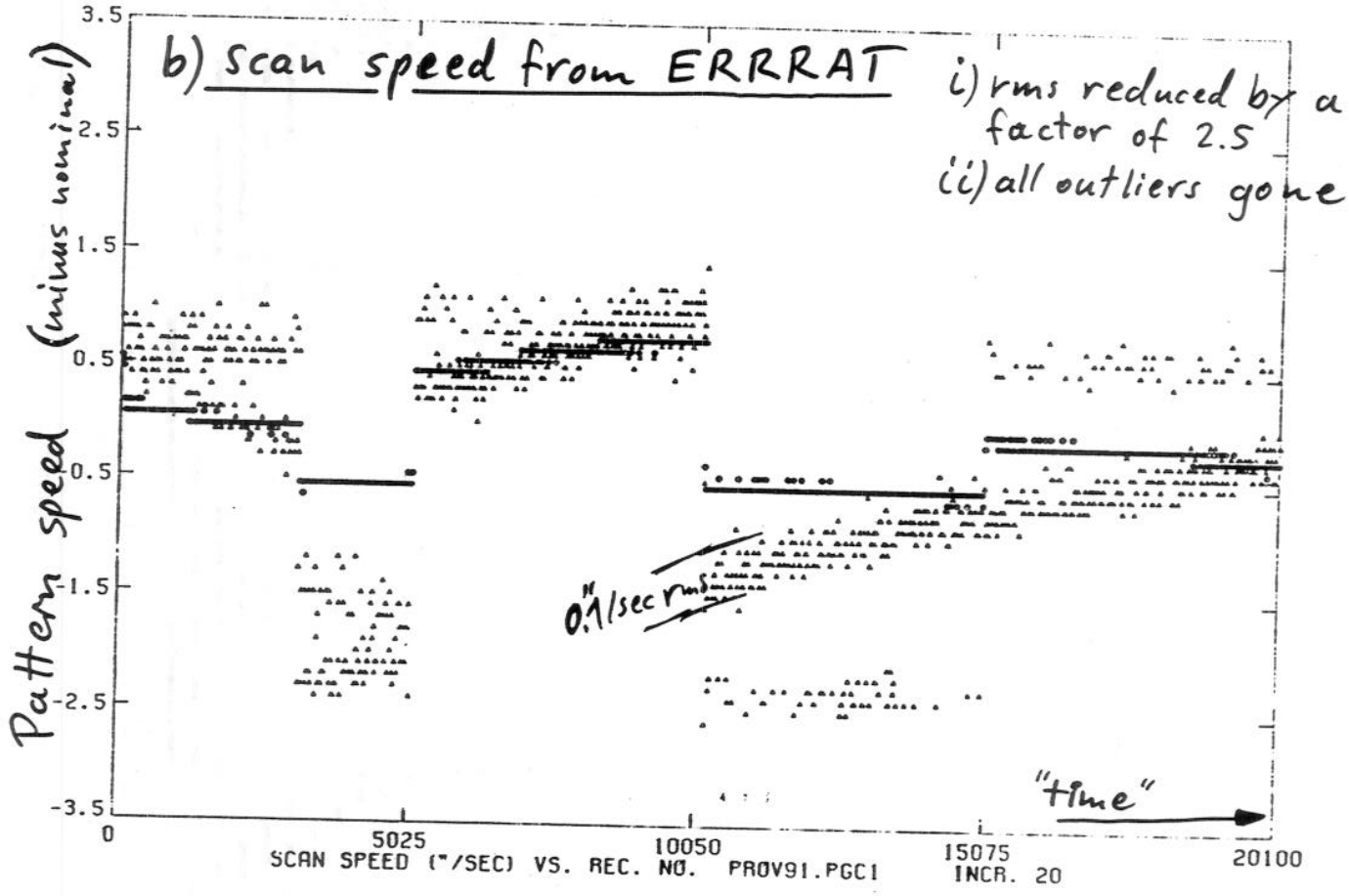
ABOVE	187
125 –	187
97 –	125
80 –	97
68 –	80
58 –	68
48 –	58
37 –	48
23 –	37
BELOW	23

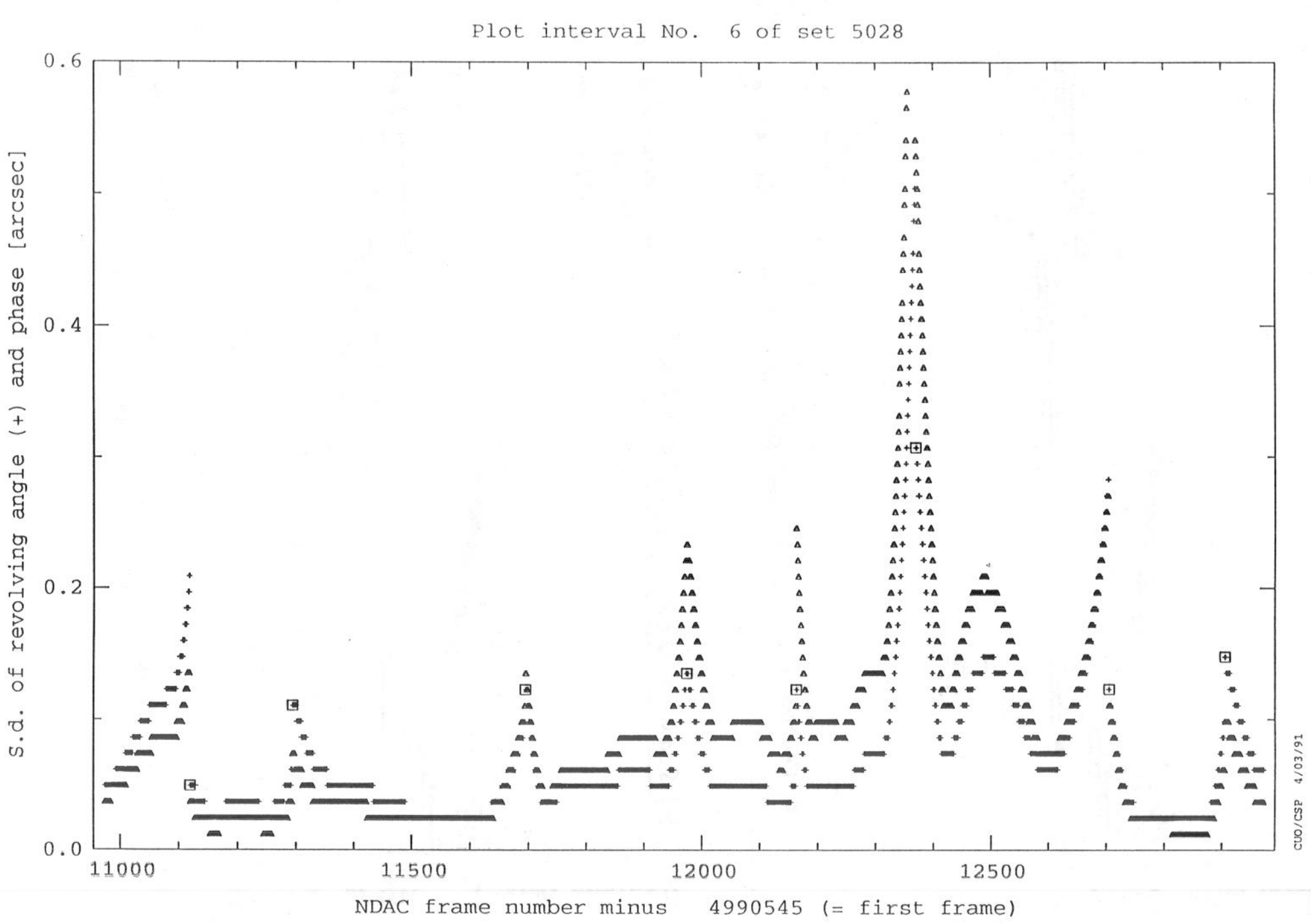
ERIC DIVETAIN

The sky to be surveyed by the TYCHO mission

1 Million stars brighter than 11 (Galactic coordinates)


a) scan speed from ERRANG interpolation
Pattern speed (minus nominal)
3.5
2.5
1.5
0.5
-0.5
-1.5
-2.5
-3.5
0
5025
10050
15075
20100
"time"
SCAN SPEED ("/SEC) VS. REC. NO. PROV91.PGC1 INCR. 20
30.01.1991 15 H 25 M PLOT 1
●=vertical slit Δ=inclined slit ◎=outliers on the vertical slit.


b) scan speed from ERRRAT
i) rms reduced by a factor of 2.5
ii) all outliers gone
Pattern speed (minus nominal)
3.5
2.5
1.5
0.5
-0.5
-1.5
-2.5
-3.5
0.1"/sec rms
0
5025
10050
15075
20100
"time"
SCAN SPEED ("/SEC) VS. REC. NO. PROV91.PGC1 INCR. 20


Plot interval No. 6 of set 5028
S.d. of revolving angle (+) and phase [arcsec]
0.6
0.4
0.2
0.0
11000
11500
12000
12500
NDAC frame number minus 4990545 (= first frame)
CUO/CSP 4/03/91

Tycho Astrometry

Data used: PT6 ~ 3 days, NDAC attitude
IRS stars for calibration
Monitor stars for statistics

Calibration:

MSI ~ ± 100 mas at inclined

Large scale, zero & 1st order in z, 10 terms:

vertical Δ_{max} = 17 mas 4 terms
inclined Δ_{max} = 54 mas 6 terms

Large scale, up to 2nd order, 13 terms:

vertical Δ_{max} = 40 mas
inclined = 130 mas

$\Delta_{max} \geq 3 * s.e.$

Astrometric parameters: next month

Statistics:

$\sigma_{TIC} < 0.''5$

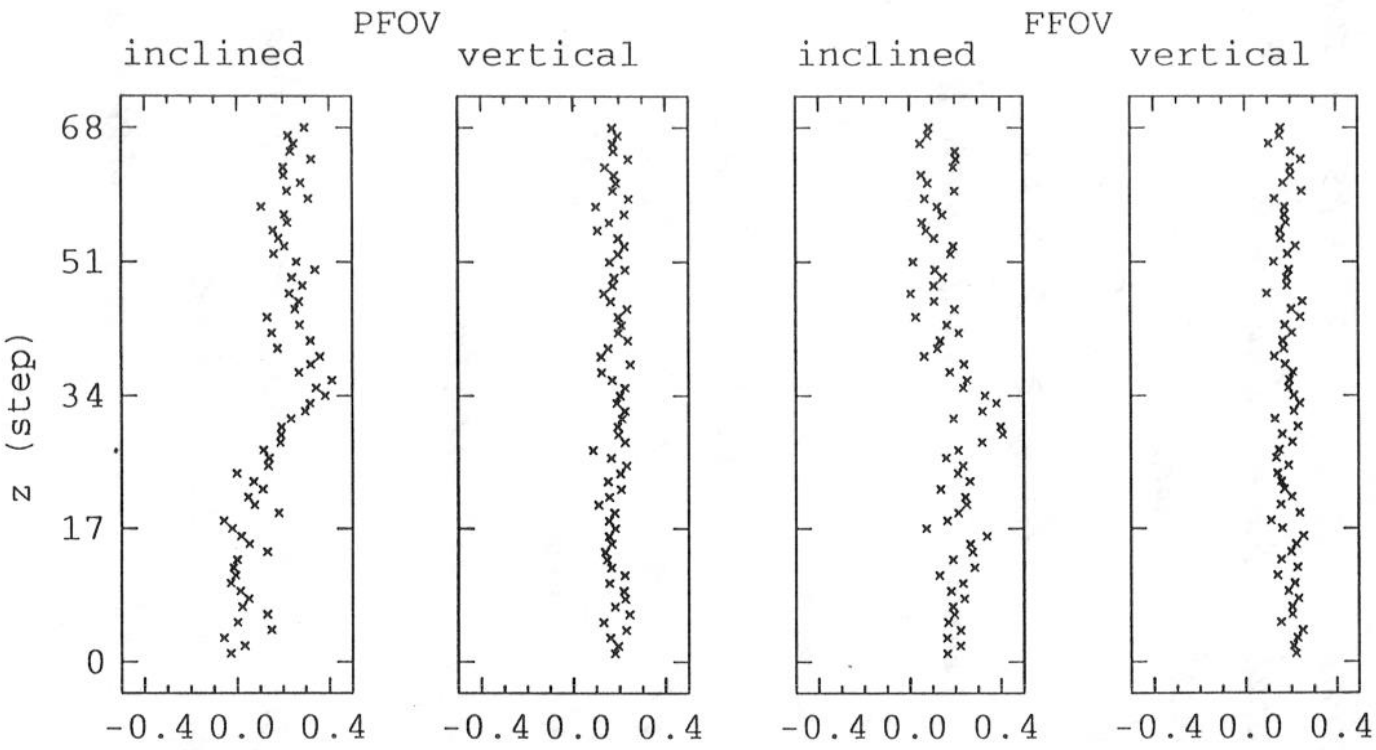
		vert.	incl.	
NDAC att.	σ	0.''06	0.''15	verif. ARI
$\sigma_{rel} = \sigma_{obs} / \sigma_{pred}$		1.4	1.7	at (B+V)/2 = 10.0 − 12.0

PGC Updating: Next month
Parasites : " "

Data Stream C: ready to calibrate

Verifications to be done:
1. ARI / RGO ~ 5 mas
2. CUO / Lund-sphere sol. ~ 50 mas

LMSI : Large + Medium Scale Irregularities (arcsec)



p0 = pp3 from PT6 IRS stars ≃10000 transits.
Using NDAC attitude from Oct. 1990 and no MSI at ARI.

```
Number of observations                17335
Number of skipped observations        12679
Total number of equations             4656
Total number of weight reductions     0
Number of stars, incl. skipped        2416

Solve for 10 calibration parameters
Condition number = 6.165578
Cal. parameter updates          at z=600 as  sigma
   CP                U                        u     sig(u)

 delta h       -0.0059726457 as      -0.006     0.003 as
 delta w_10     0.1734610498 as       0.173     0.004 as
 delta w_11    -0.0000018168 rad     -0.001     0.003 as
 delta w_20     0.2384565622 as       0.238     0.009 as
 delta w+_21   -0.0000395488 rad     -0.024     0.014 as
 delta w-_21    0.0001756314 rad      0.105     0.013 as
 delta h-_1    -0.0681132376 as      -0.068     0.016 as
 delta h+_1     0.0399927758 as       0.040     0.017 as
 delta h_11     0.0000037363 rad      0.002     0.003 as
 delta h_21     0.0000243681 rad      0.015     0.008 as
Standard deviation: sigma_CP =  0.5932264924

Results written in CPC set number 68
Normal termination of program
```

3 days:

Δ mark (mas)

vert	incl.
8	
17	
7	
	43
	24
	54
	50
	15
3	
	17

PT6. 1+2+3 monitor problim=0.5

mean, s_tot = mean and total s.d. of p0
N = total number of observations, nf = deg. of freedom
s_PA = s.d. due to photons and attitude, not TIC position
s_rel = s_PA/(s.d. from a,b)
p0 is measured along scan in arcsec, sequence: vert, incl
m=(B+V)/2 from TIC, 4.500 to 5.499 is bin m=5

m	v: N	mean	s_tot	i: N	mean	s_tot
1	0	0.000	0.000	0	0.000	0.000
2	0	0.000	0.000	0	0.000	0.000
3	0	0.000	0.000	0	0.000	0.000
4	0	0.000	0.000	3	0.333	0.492
5	18	0.026	0.471	16	0.143	0.400
6	71	0.154	0.328	69	0.005	0.345
7	264	0.098	0.213	254	0.143	0.370
8	566	0.145	0.235	554	0.178	0.326
9	928	0.133	0.247	882	0.120	0.375
10	460	0.118	0.264	442	0.159	0.405
11	137	0.128	0.379	92	0.060	0.521
12	72	0.127	0.446	42	0.051	0.568
13	0	0.000	0.000	0	0.000	0.000
14	0	0.000	0.000	0	0.000	0.000
Total n=	2516			2354		

σ_{TIC}

m	v: nf	s_PA	s_rel	i: nf	s_PA	s_rel
1	0	0.000	0.000	0	0.000	0.000
2	0	0.000	0.000	0	0.000	0.000
3	0	0.000	0.000	0	0.000	0.000
4	0	0.000	0.000	1	0.156	27.050
5	13	0.000	0.080	10	0.112	13.127
6	47	0.020	2.178	32	0.126	9.778
7	191	0.028	2.196	148	0.141	7.405
8	376	0.041	1.894	284	0.147	4.406
9	617	0.060	1.415	459	0.166	2.473
10	316	0.096	1.201	237	0.185	1.529
11	77	0.192	1.078	29	0.250	1.026
12	31	0.403	1.445	8	0.256	0.714
13	0	0.000	0.000	0	0.000	0.000
14	0	0.000	0.000	0	0.000	0.000
Total n=	1668			1208		

vert. incl.

NDAC atti +: ".03 ".14

relative σ 1.4 1.4 } incl. parasitics

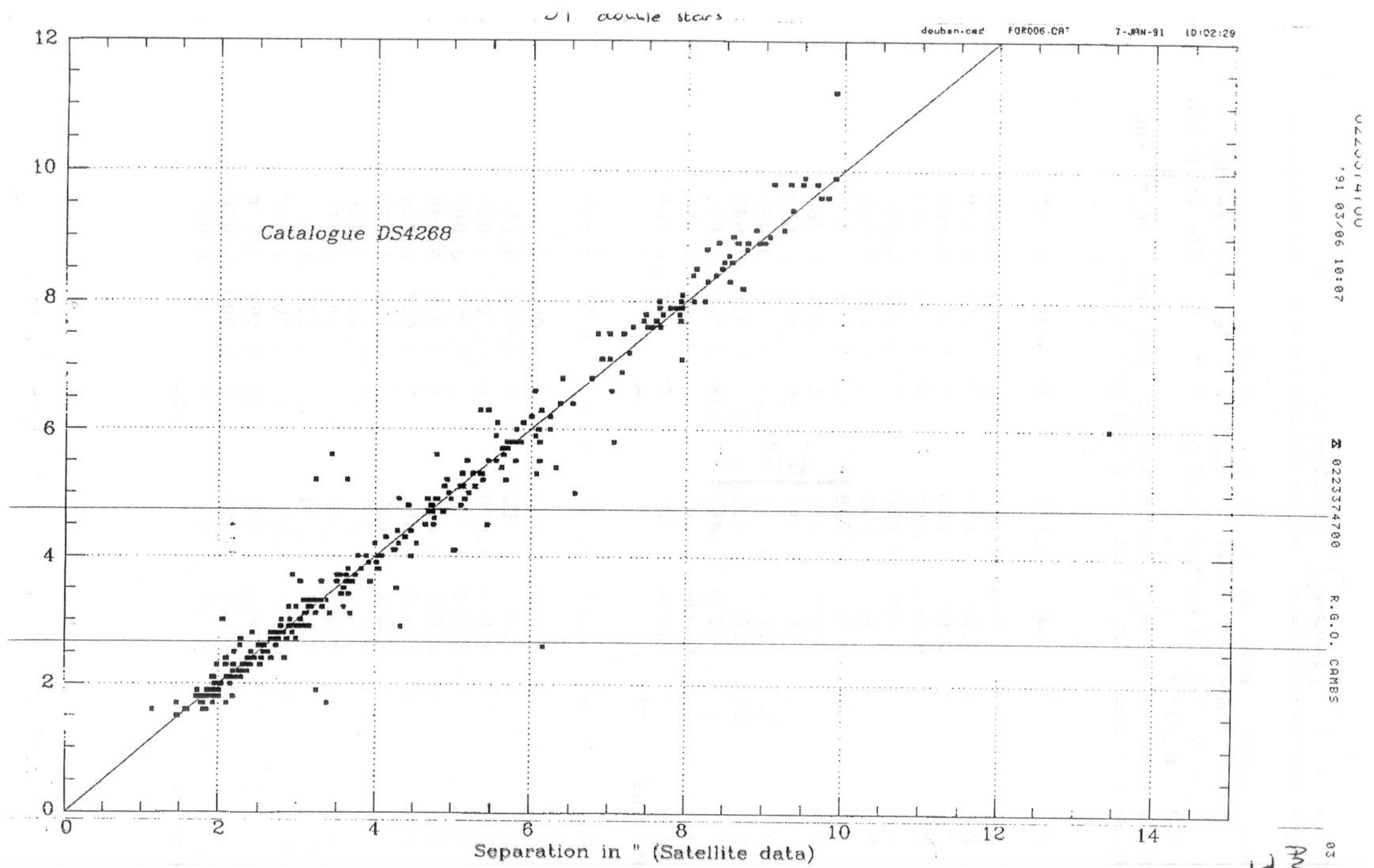
PT6 .2 .3 random problim=0.5 9₀

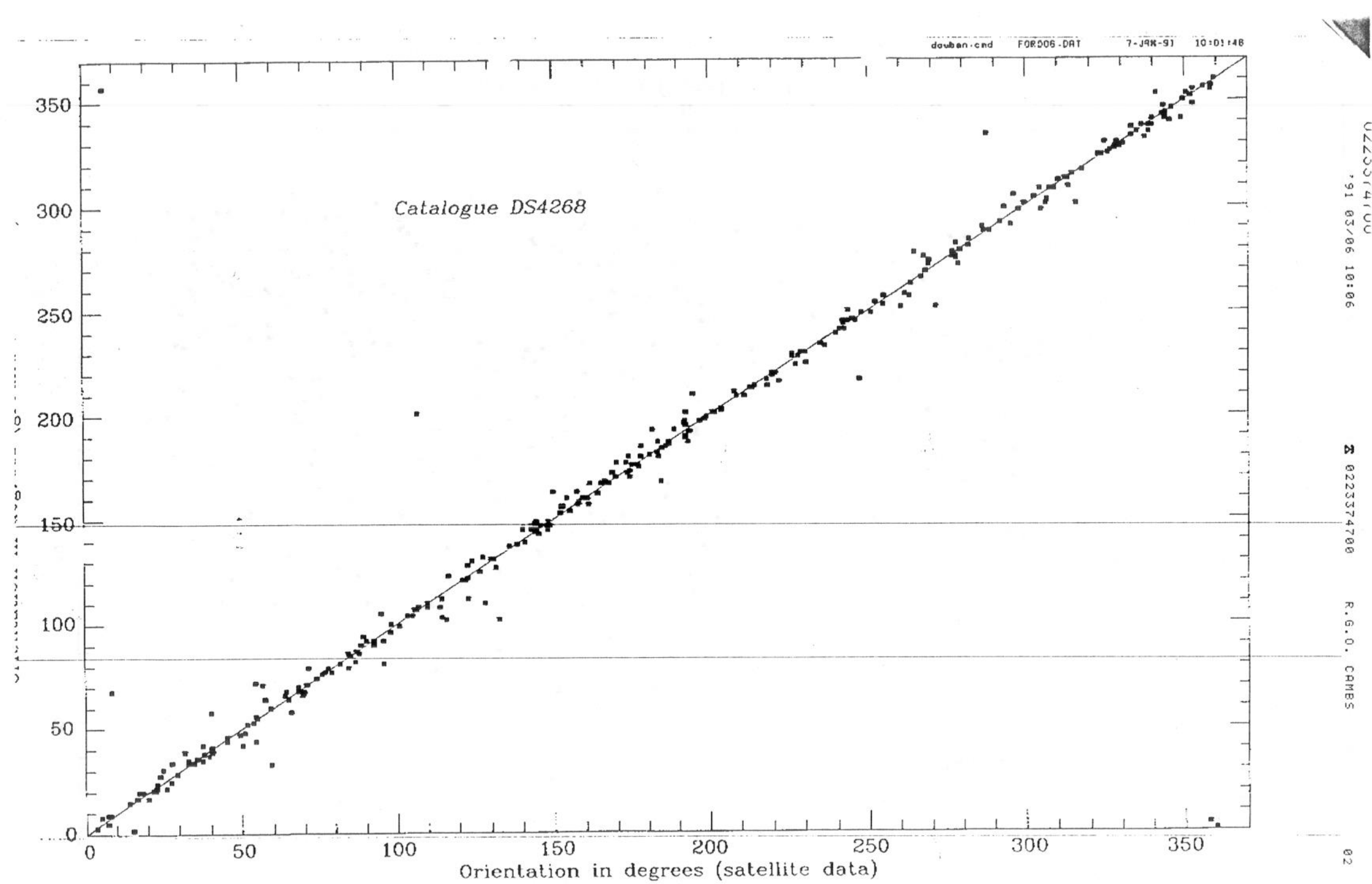
mean, s_tot = mean and total s.d. of p0
N = total number of observations, nf = deg. of freedom
s_PA = s.d. due to photons and attitude, not TIC position
s_rel = s_PA/(s.d. from a,b)
p0 is measured along scan in arcsec, sequence: vert, incl
m=(B+V)/2 from TIC, 4.500 to 5.499 is bin m=5

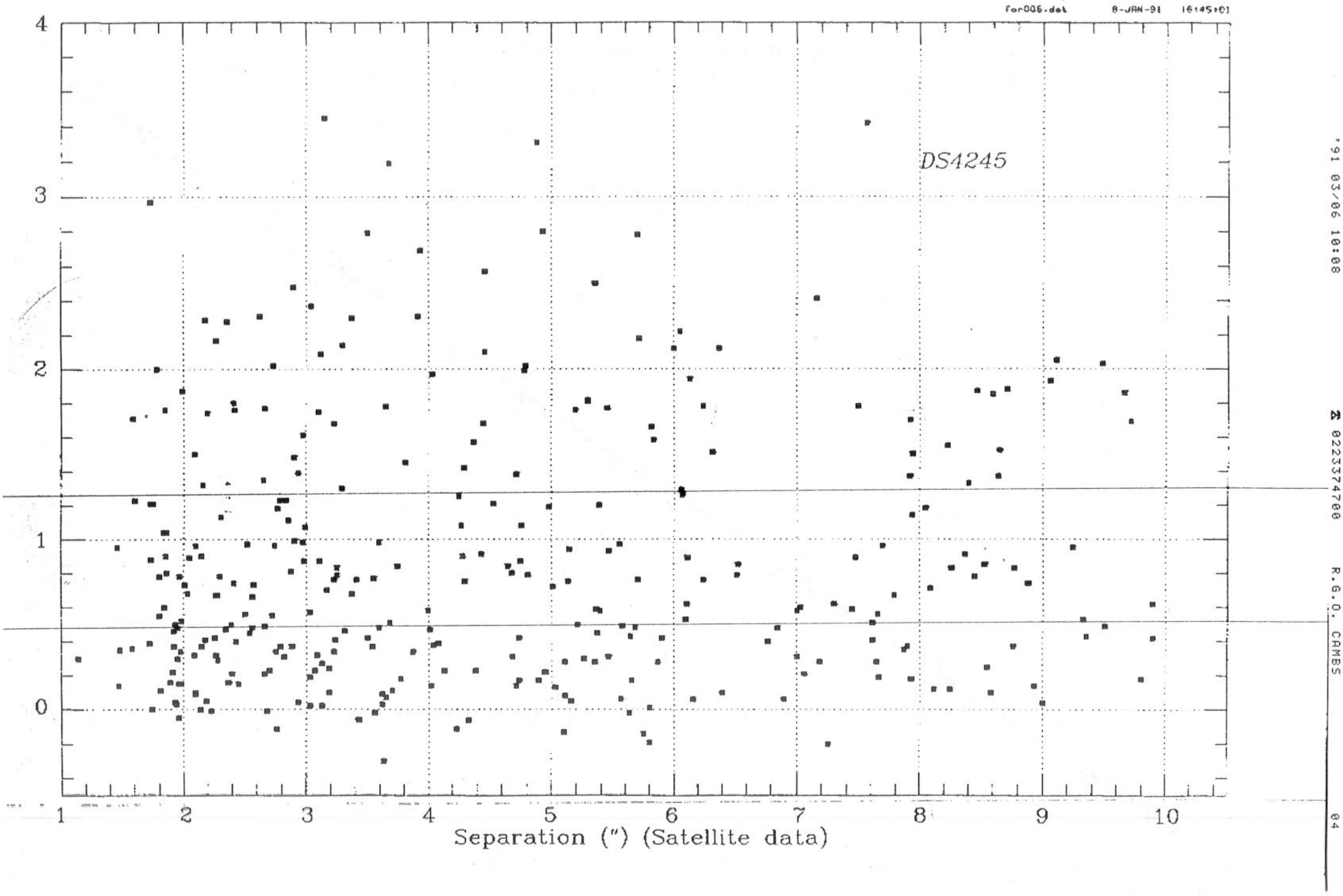
m	v: N	mean	s_tot	i: N	mean	s_tot
1	0	0.000	0.000	0	0.000	0.000
2	0	0.000	0.000	0	0.000	0.000
3	0	0.000	0.000	0	0.000	0.000
4	0	0.000	0.000	0	0.000	0.000
5	0	0.000	0.000	0	0.000	0.000
6	0	0.000	0.000	0	0.000	0.000
7	14	0.061	0.298	13	0.128	0.306
8	22	0.259	0.261	21	0.284	0.282
9	61	0.003	0.381	59	0.078	0.503
10	126	0.155	0.341	121	0.121	0.488
11	293	0.091	0.424	223	0.050	0.543
12	273	-0.030	0.489	178	0.005	0.674
13	0	0.000	0.000	0	0.000	0.000
14	0	0.000	0.000	0	0.000	0.000
Total n=	789			615		

σ_{TIC}

m	v: nf	s_PA	s_rel	i: nf	s_PA	s_rel
1	0	0.000	0.000	0	0.000	0.000
2	0	0.000	0.000	0	0.000	0.000
3	0	0.000	0.000	0	0.000	0.000
4	0	0.000	0.000	0	0.000	0.000
5	0	0.000	0.000	0	0.000	0.000
6	0	0.000	0.000	0	0.000	0.000
7	9	0.024	1.619	6	0.104	4.972
8	15	0.031	1.252	10	0.139	3.416
9	41	0.049	1.016	30	0.187	2.413
10	67	0.141	1.291	43	0.277	1.900
11	152	0.186	1.057	53	0.286	1.128
12	76	0.442	1.671	17	0.594	1.674
13	0	0.000	0.000	0	0.000	0.000
14	0	0.000	0.000	0	0.000	0.000
Total n=	360			159		




daubon.cmd FOR006.DAT 7-JAN-91 10:01:48
Catalogue DS4268
350
300
250
200
150
100
50
0
0
50
100
150
200
250
300
350
Orientation in degrees (satellite data)


for006.dat 8-JAN-91 16:45:01
DS4245
4
3
2
1
0
1
2
3
4
5
6
7
8
9
10
Separation (") (Satellite data)
'91 03/06 10:08
R.G.O. CAMBS

ANNEX VIII

RGO/NDAC 91.03

********** Updating Accuracy**********

Version: 1.1;	Date: 4-Mar-91;	Author: DWE

1. Introduction

These are the accuracies of the various updates carried out at the RGO. Systematic effects are not considered. This note is just intended to give you a broad idea of our random errors.

2. Positional accuracies of Star Mapper Reductions

TABLE 1, Right Ascension Accuracies

		Number of Observations			
		< 21	21–50	51–100	101+
	< 7	0.015	0.008	0.004	0.003
H	7–8	0.019	0.010	0.006	0.004
Magnitude	8–9	0.026	0.015	0.009	0.006
	> 9	0.049	0.024	0.013	0.008

TABLE 2, Declination Accuracies

		Number of Observations			
		< 21	21–50	51–100	101+
	< 7	0.014	0.007	0.004	0.003
H	7–8	0.018	0.009	0.005	0.004
Magnitude	8–9	0.023	0.013	0.008	0.006
	> 9	0.042	0.021	0.014	0.009

TABLE 3, Total Position Accuracies

		Number of Observations			
		< 21	21–50	51–100	101+
	< 7	0.015	0.008	0.004	0.003
H	7–8	0.019	0.010	0.006	0.004
Magnitude	8–9	0.026	0.015	0.009	0.006
	> 9	0.049	0.024	0.013	0.008

2. Photometric accuracies of Star Mapper Reductions

TABLE 4, B_T Accuracies

		Number of Observations			
		< 21	21–50	51–100	101+
	< 7	0.018	0.012	0.008	0.005
H	7–8	0.036	0.022	0.015	0.010
Magnitude	8–9	0.058	0.035	0.023	0.015
	> 9	0.076	0.046	0.030	0.018

TABLE 5, V_T Accuracies

		Number of Observations			
		< 21	21–50	51–100	101+
	< 7	0.014	0.009	0.006	0.004
H	7–8	0.028	0.016	0.011	0.007
Magnitude	8–9	0.048	0.028	0.018	0.012
	> 9	0.070	0.041	0.027	0.017

3. Photometric accuracies of IDT Reductions

TABLE 6, H_1 (dc) Accuracies

		Number of Observations			
		< 21	21–50	51–100	101+
	< 7	0.004	0.002	0.001	0.001
H	7–8	0.007	0.004	0.003	0.002
Magnitude	8–9	0.010	0.006	0.004	0.003
	> 9	0.016	0.009	0.006	0.004

TABLE 7, H_2 (ac) Accuracies

		Number of Observations			
		< 21	21–50	51–100	101+
	< 7	0.009	0.005	0.003	0.002
H	7–8	0.014	0.008	0.006	0.004
Magnitude	8–9	0.021	0.012	0.008	0.006
	> 9	0.036	0.019	0.013	0.009

Dafydd Wyn Evans, RGO.

ANNEX IX

Comparison IC8 / RGO

Received from RGO: 51 800 *
In common with IC8: 47 050

1. Test on position, positive if
$\Delta pos \leq 3''$ and $\sigma_{RGO} < \sigma_{IC8}$

	Positive tests	Negative tests	+ Tests magn. only
Without test on magnitudes	46 703	347	
2. $\lvert\Delta V_T\rvert \leq 0.7$	46 184	866	46 501
3. $\lvert\Delta V_T\rvert \leq 0.7$ and $\lvert\Delta B_T\rvert \leq 0.7$	45 794	1256	46 098
4. $\lvert\Delta V_T\rvert \leq 0.7$ and $\sigma_{V_T\,RGO} < \sigma_{V_T\,IC8}$	29 677	17 373	29 856
5. $\lvert\Delta V_T\rvert$ and $\lvert\Delta B_T\rvert \leq 0.7$ and $\sigma_{RGO} < \sigma_{IC8}$	28 619 (65 C, 75 S)	18 431	28 788
Case 4 includes a syst. error of 0.01 magn.	29 677	17 373	29 85
0.005	29 729	17 321	29 908
0.	29 977	17 073	30 157

ANNEX X

Proposed Distribution List for Complimentary Copies of ESA SP-1136

Version II, MACP/CT, 17 December

NB: 360 copies on IP list, including ESA Directors

EXEC --- INCA Executive Committee
EXEC Argue
EXEC Bec-Borsenberger
EXEC Creze
EXEC Dommanget
EXEC Egret
EXEC Gomez
EXEC Grenon
EXEC Jahreiss
EXEC Lederle
EXEC Mennessier
EXEC Mermilliod
EXEC Prevot
EXEC Requieme
EXEC Turon (5 copies for personal distribution)

HST --- Hipparcos Science Team
HST Bernacca
HST Donati
HST Grewing
HST Hog
HST Kovalevsky
HST Lindegren
HST Perryman
HST Schrijver
HST Van Leeuwen
HST Van der Marel

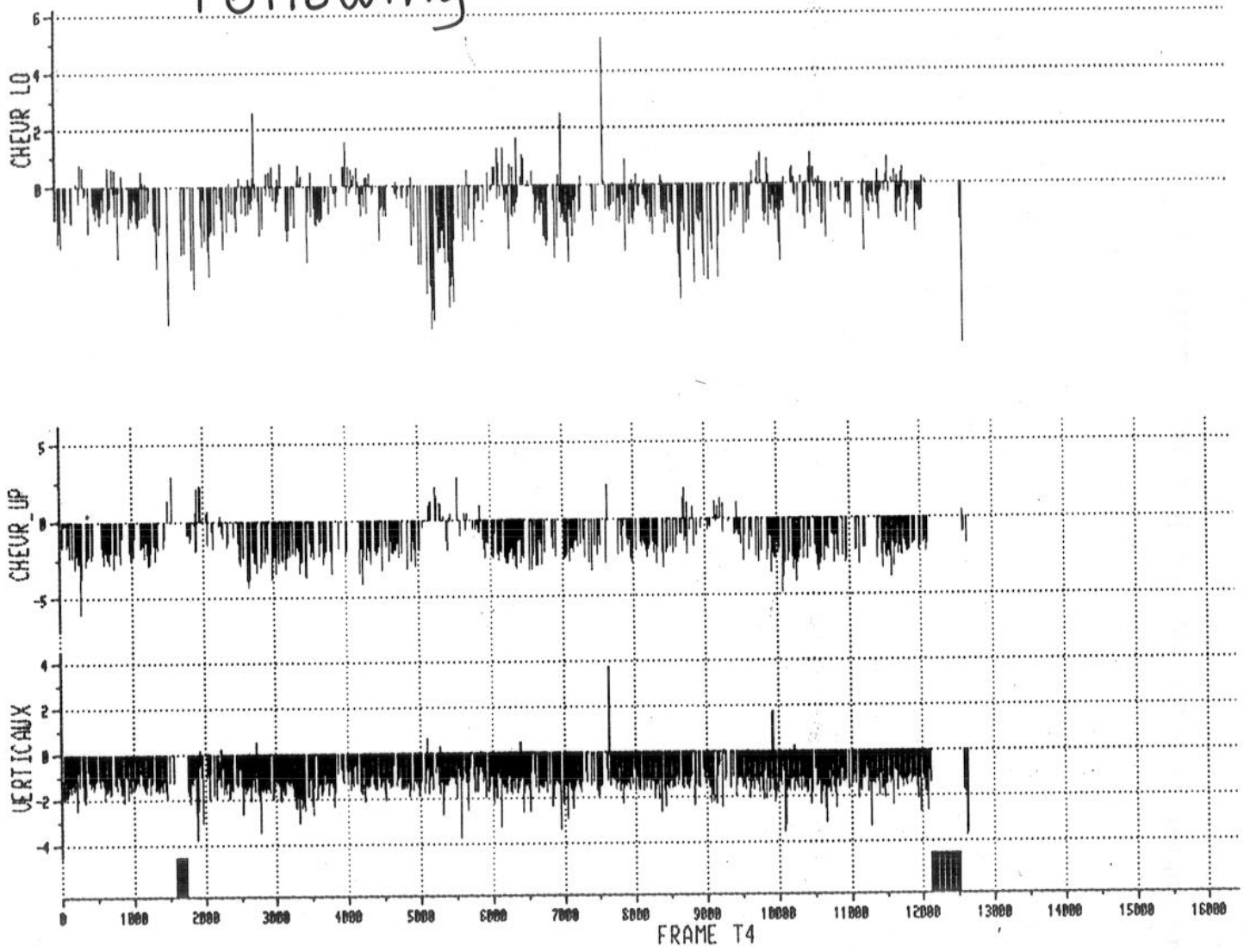
INCA --- other INCA members
INCA Arenou
INCA Brosche
INCA Crifo
INCA Helmer
INCA Hemenway
INCA Lub
INCA Marouard
INCA Mattei
INCA McLean
INCA Morin
INCA Morrison
INCA Nys
INCA Oblak
INCA Rousseau
INCA Sellier
INCA Torra
INCA Tuscholke

ISC --- INCA Steering Committee
ISC De Orus
ISC Delhaye
ISC Le Poole
ISC Mayor
ISC Murray
ISC Rufener
ISC Wielen

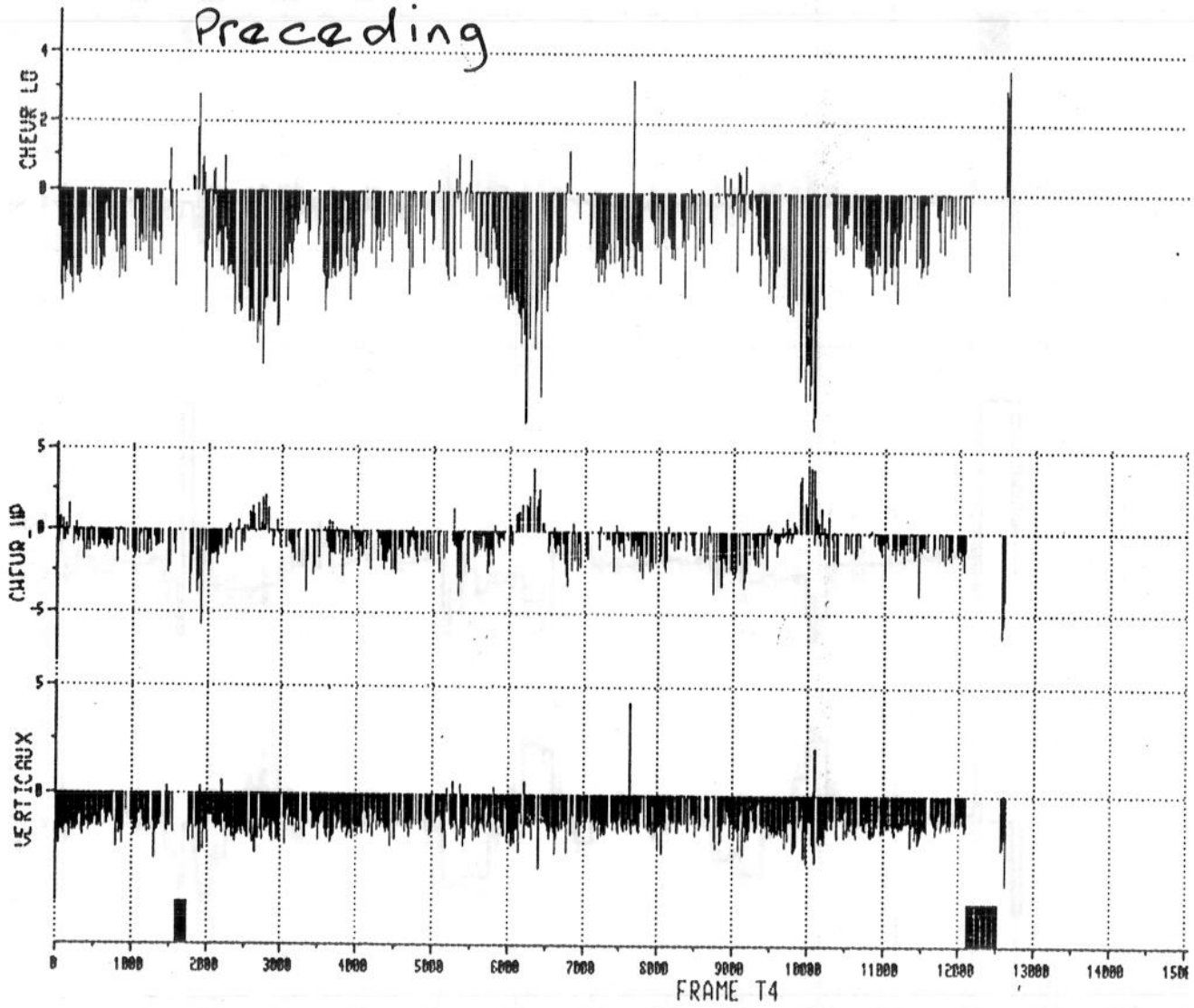
SSC --- INCA Scientific Selection Committee
SSC Blaauw
SSC Gliese
SSC Hack
SSC Jaschek
SSC Lequeux
SSC Lindblad
SSC Maeder
SSC Nissen
SSC Pagel
SSC Renzini
SSC Wayman
SSC de Vegt
SSC van den Heuvel

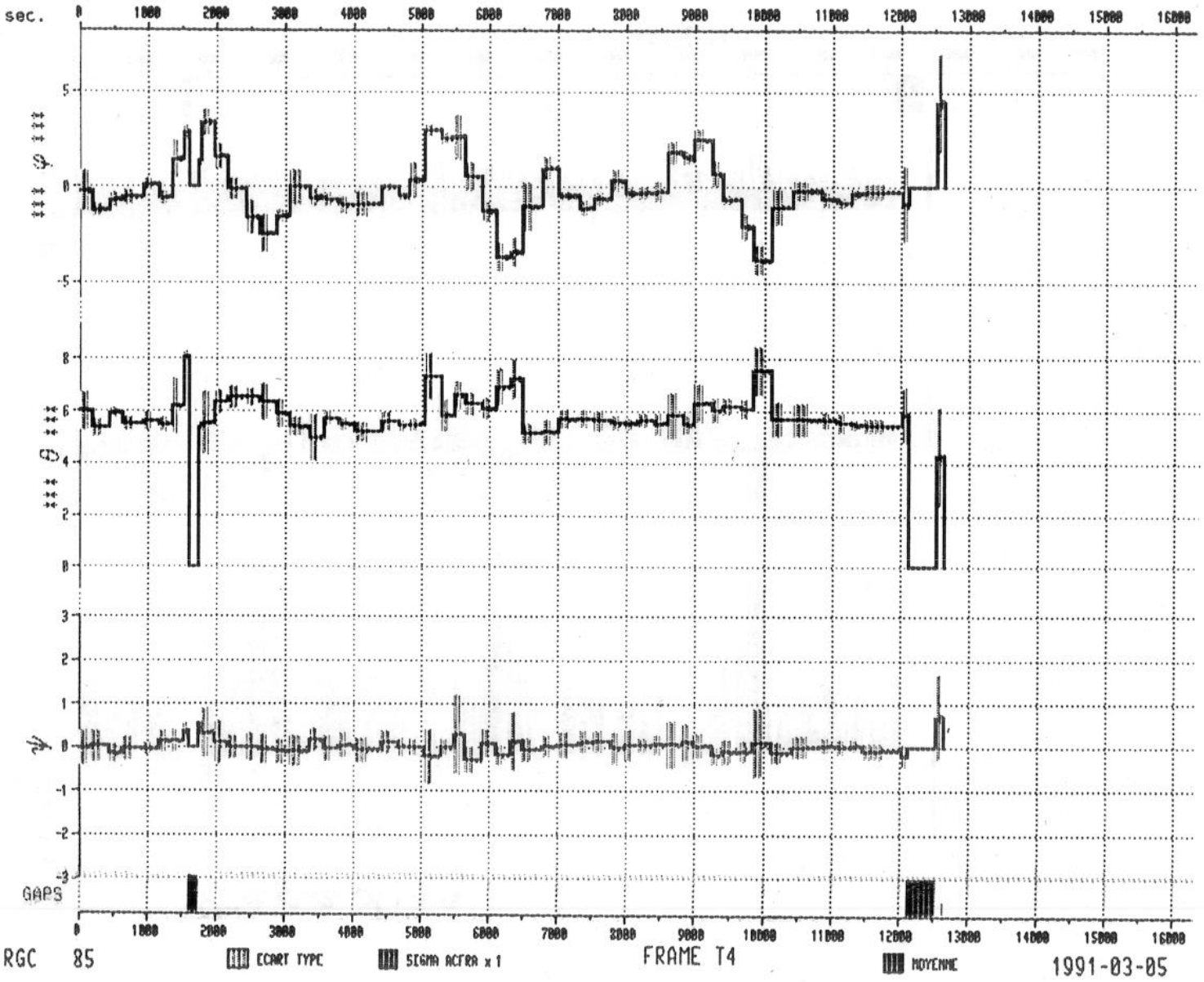
In addition: some copies to ESTEC/ESOC Project Team, Matra, etc.

Following



Annexe XI


Preceding
CHEVR LG
CHEVR_HD
VERTICAUX
FRAME T4


sec.
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
GAPS
RGC 85
ECART TYPE
SIGMA ACTRA x 1
FRAME T4
MOYENNE
1991-03-05

ANNEX XII

Hans Marel

8/13/91

Status of the g/c Comparison

A Comparison of 1035 FAST active stars with NDAC

SET2 - smoothing	3 mas rms	[-12, 27]
SET2 - geometric	3.4 mas rms	[-12, 25]

known single stars only.

B Comparison of 1301 FAST active stars with NDAC

SET2 - smoothing	4 mas rms	[-45, +45]
SET2 - geometric	3.9 mas rms	[-45, +45]

Now including double/multiple stars, except for 61 "flagged" stars. Includes more fainter stars than A.

C Comparison of FAST and NDAC large scale field to grid

D. Why are the g/c results different?

E. Residual maps over the field of view

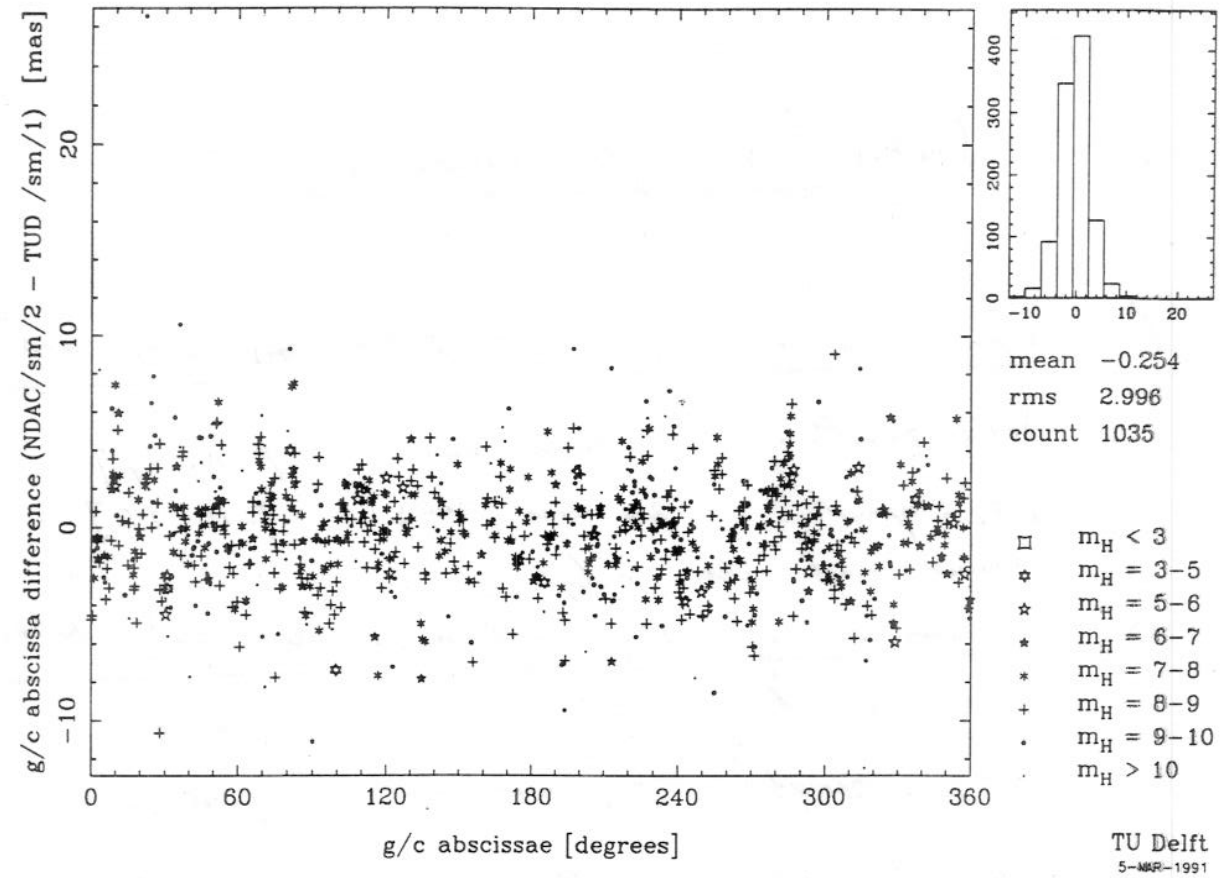
SET 2 - 14 May 1990

"AGC 10" - 21 May 1990

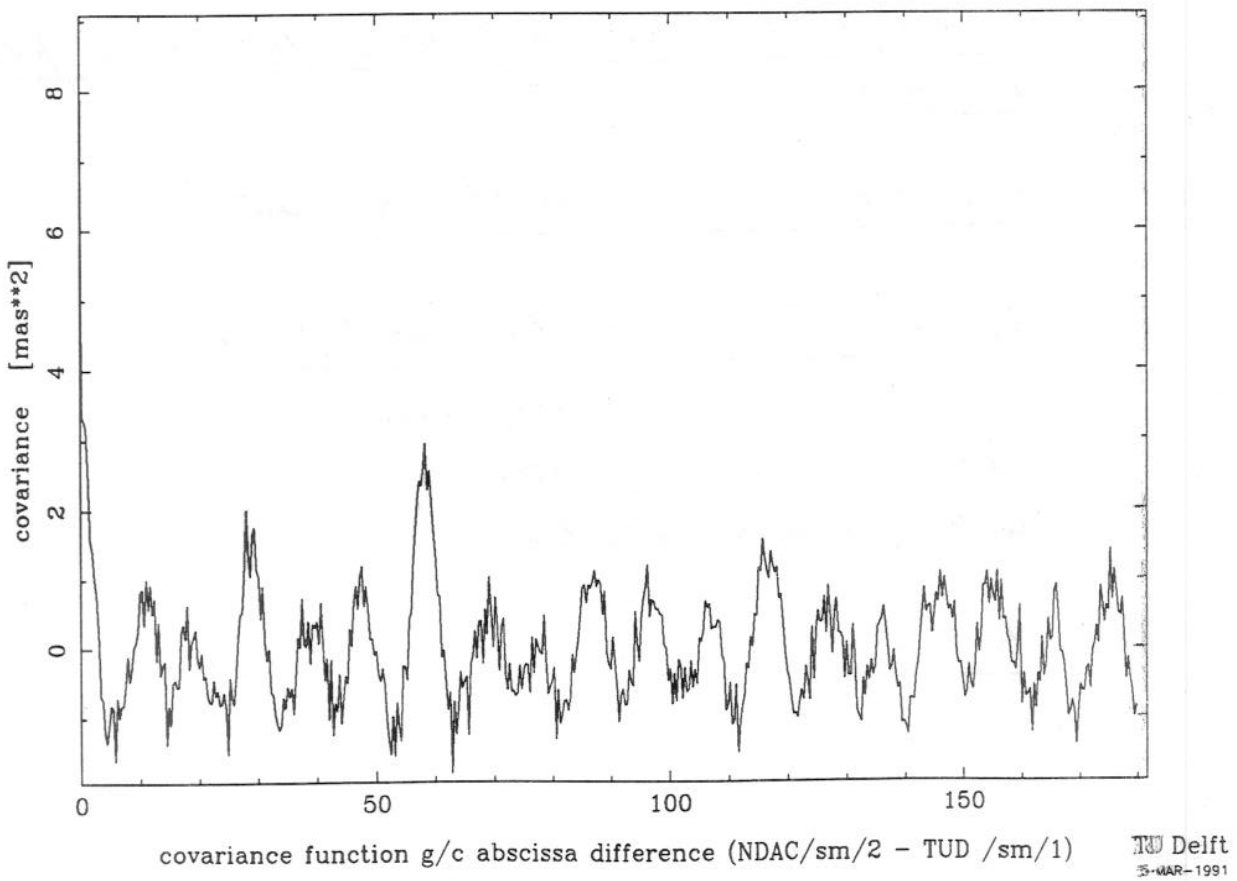
with attitude smoothing.

F. Actions

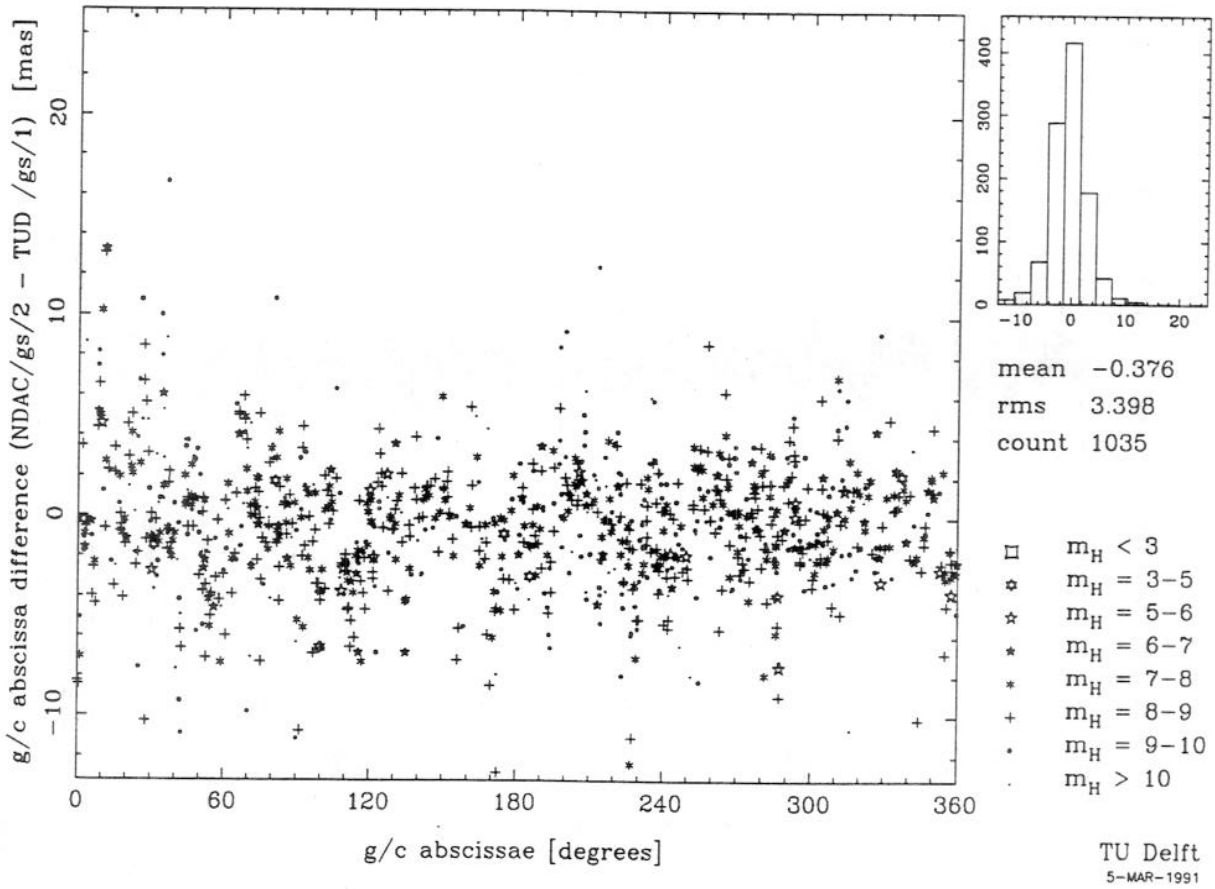
Set 2 – Delft (324+5 passive) vs. CU0



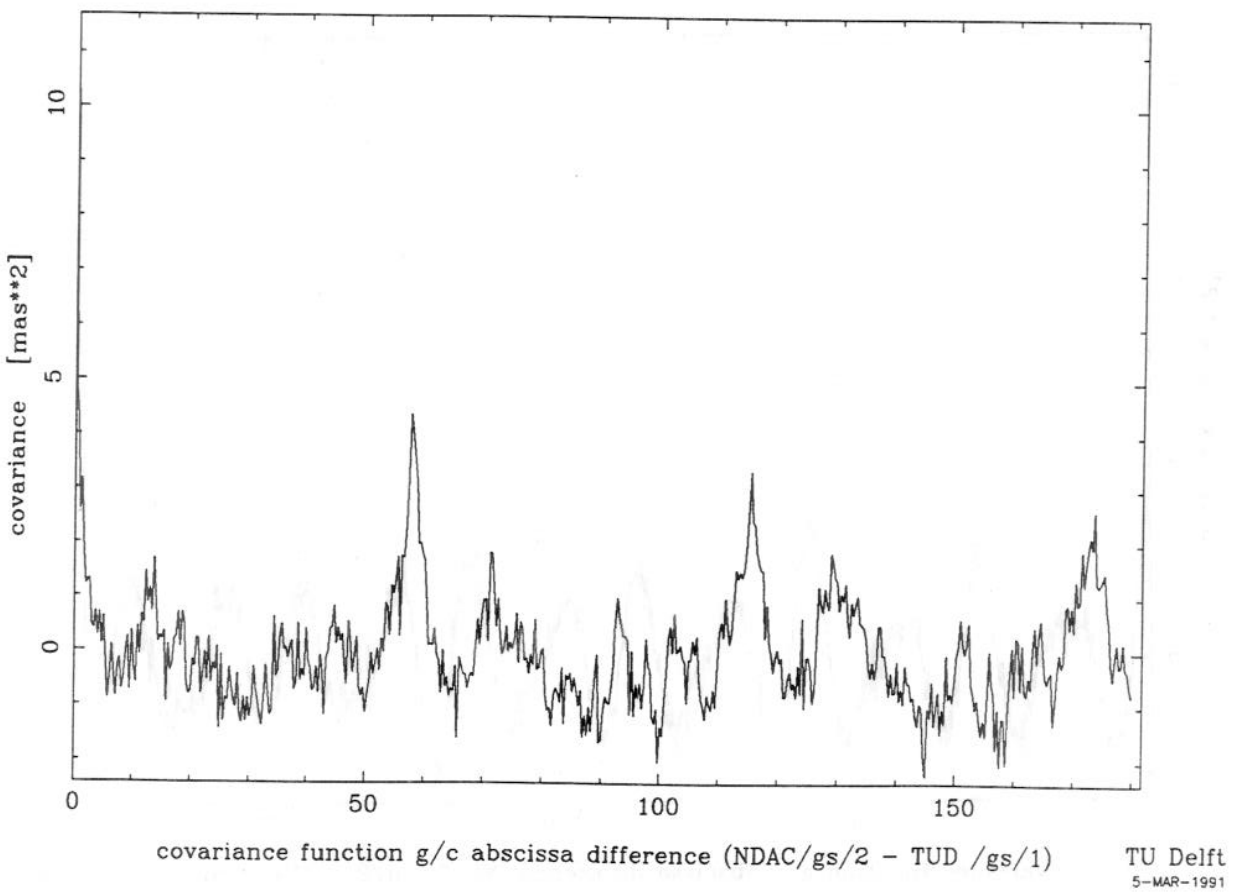
Set 2 – Delft (324+5 passive) vs. CU0



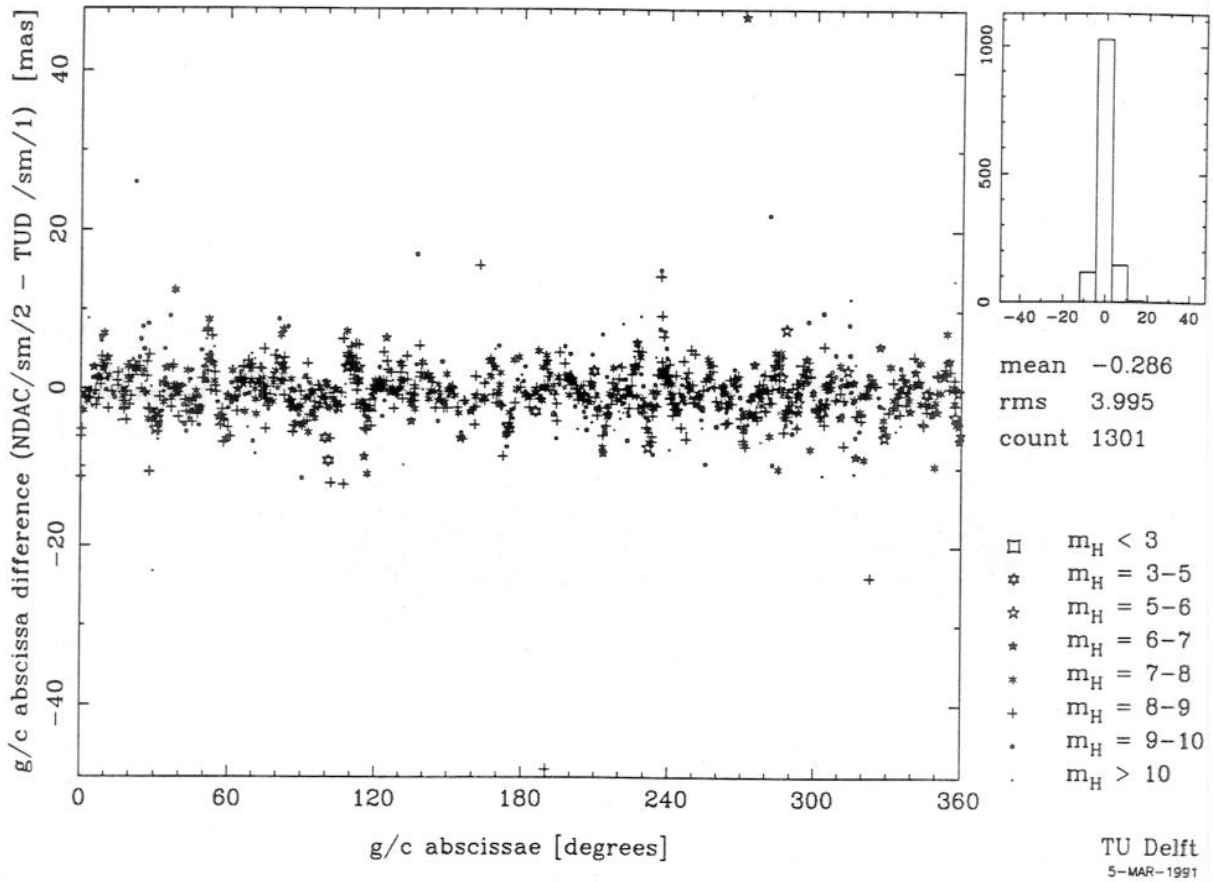
Set 2 – Delft (324+5 passive) vs. CUO



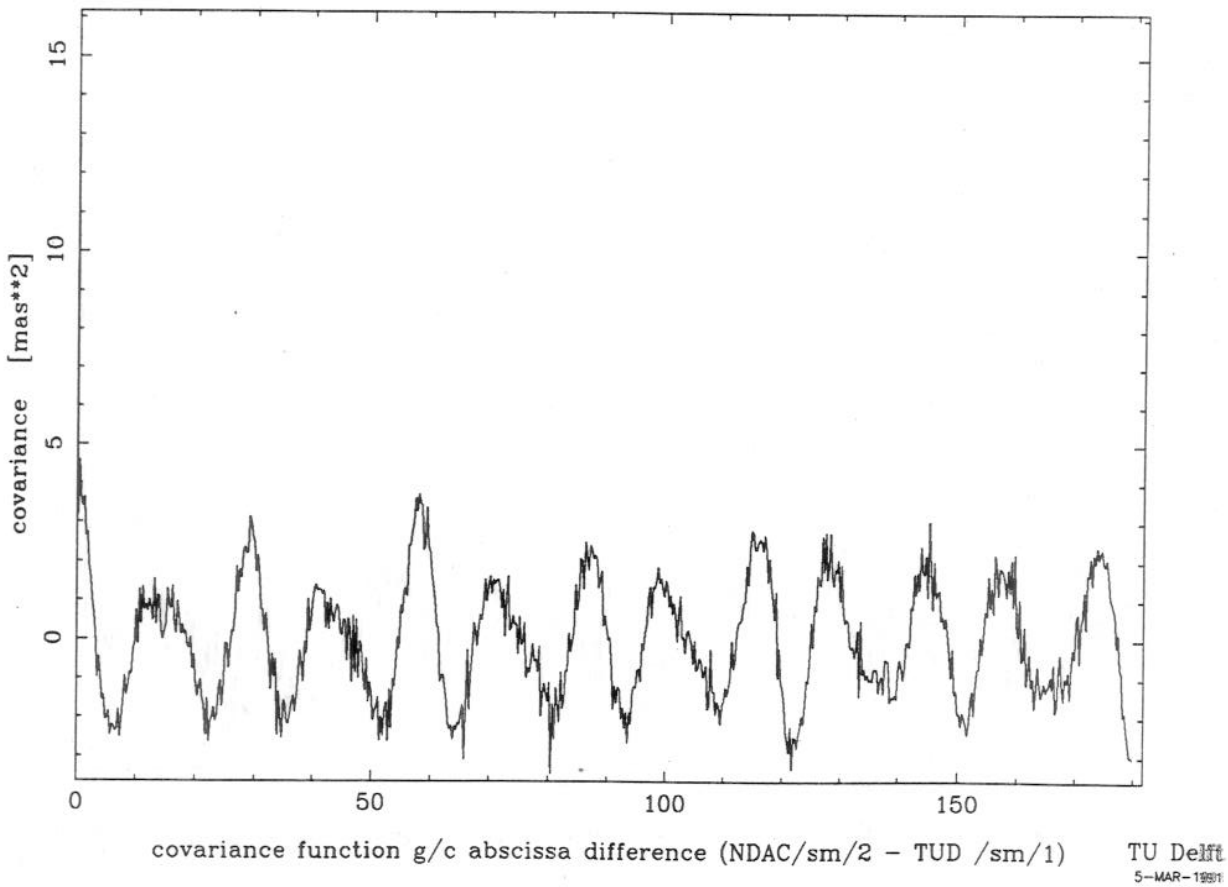
Set 2 – Delft (324+5 passive) vs. CUO



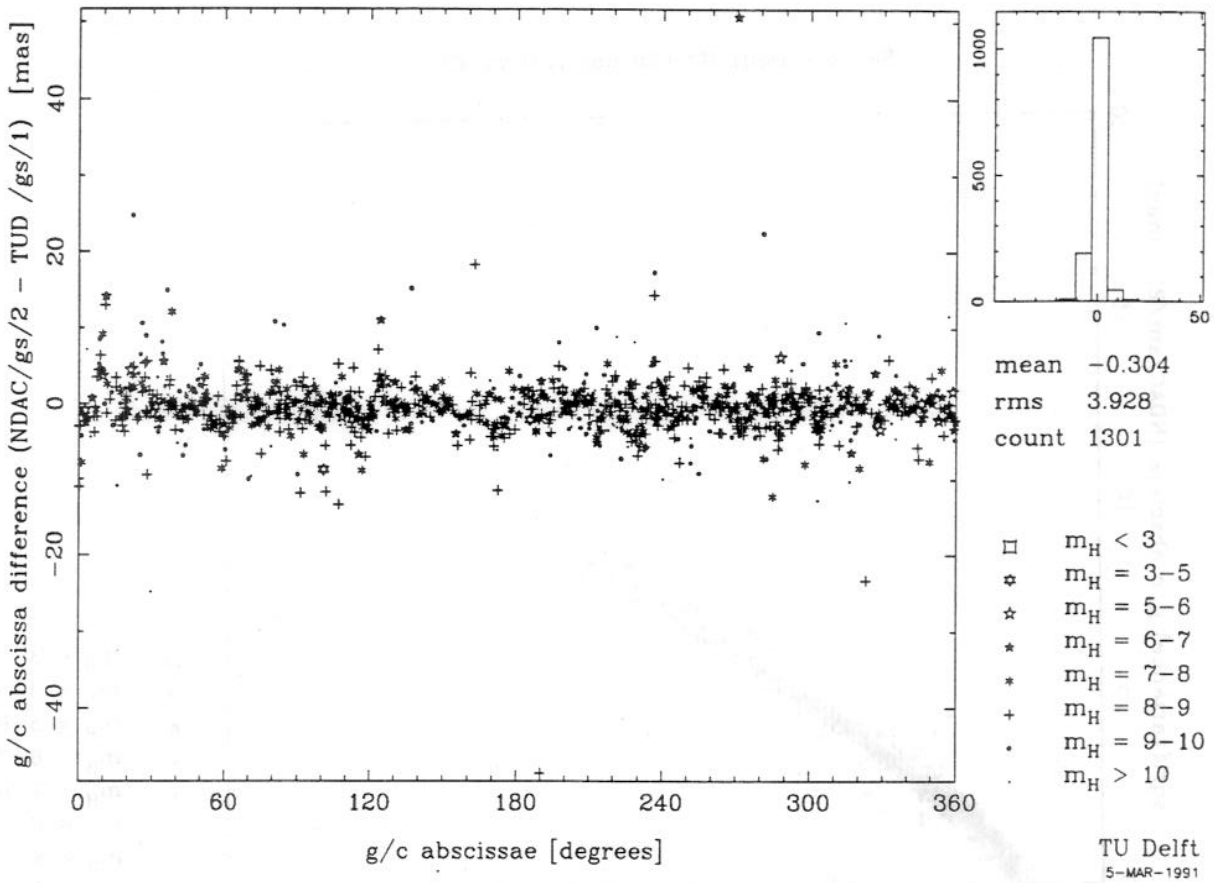
Set 2 – Delft (25+36 passive) vs. CUO



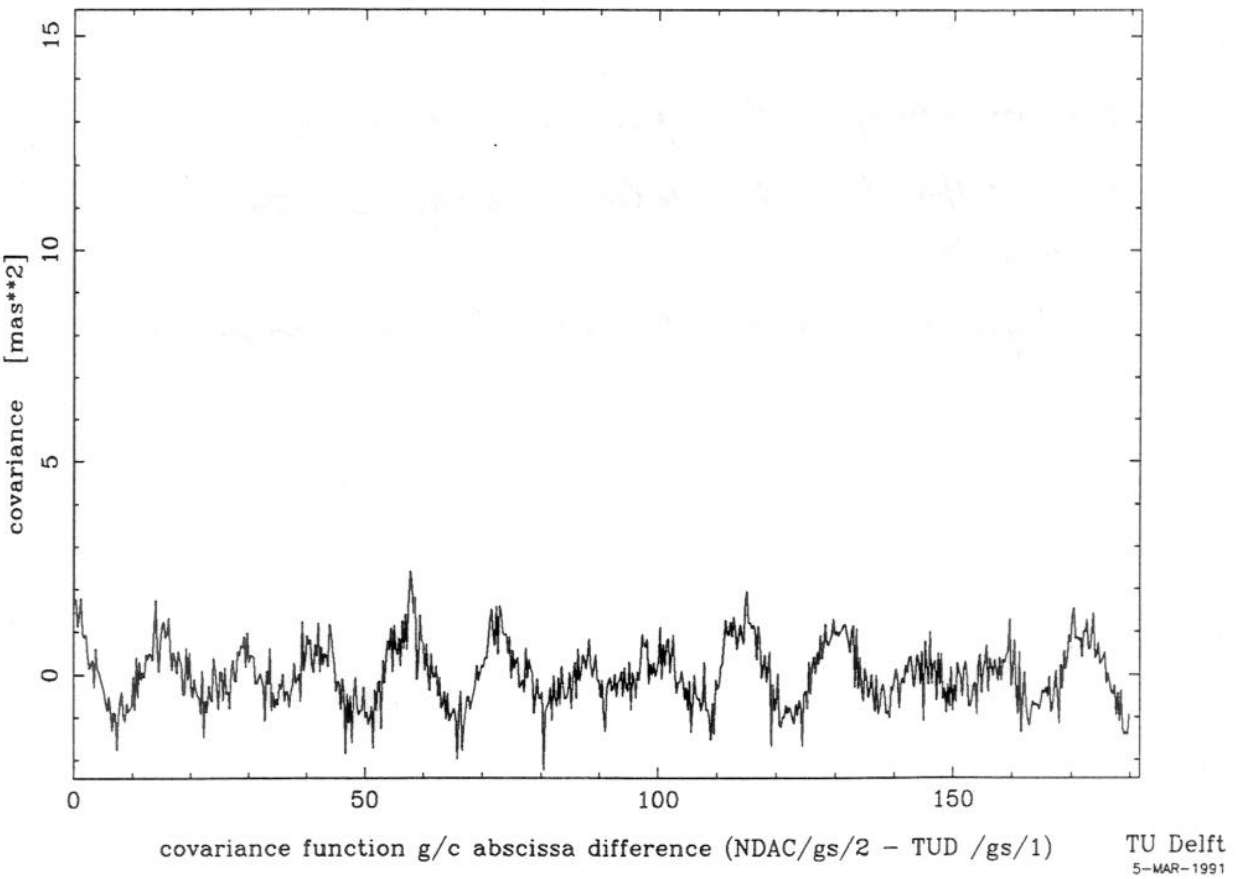
Set 2 – Delft (25+36 passive) vs. CUO

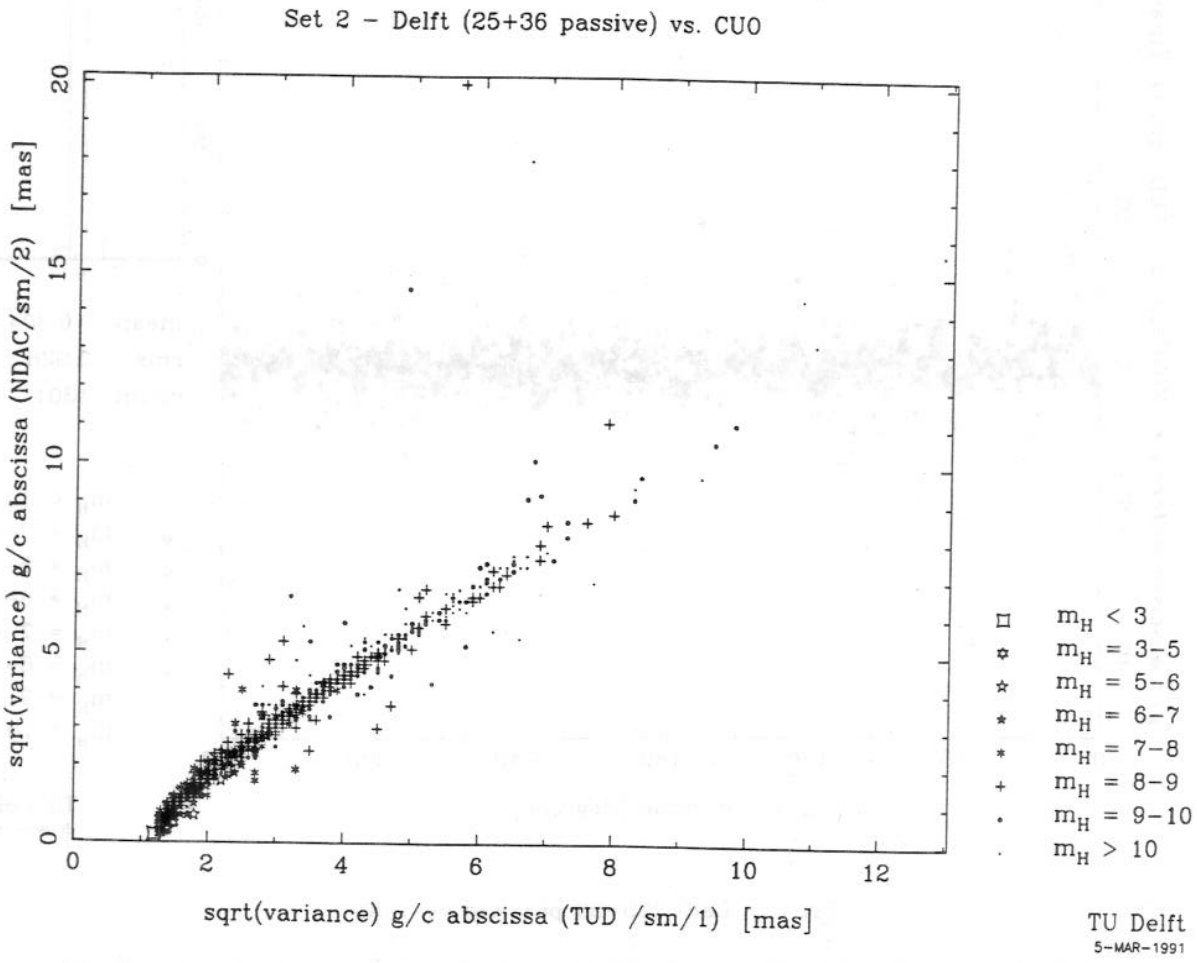


Set 2 – Delft (25+36 passive) vs. CU0



Set 2 – Delft (25+36 passive) vs. CU0





For smoothing the FAST and NDAC st. dev. are different I believe NDAC is too optimistic

For the orientation solution the st. dev are comparable.

Large scale instrumental parameters and standard deviation:

	TUD /gs	NDAC/sm	(2)-(1)	TUD /gs	NDAC/sm
h00	623.724	624.025	0.301	0.11	0.12
h00 c	-0.197	0.177	0.374	0.11	0.12
g10	-849.142	-848.524	0.618	0.25	0.28
h10	-7.135	-8.137	-1.002	0.24	0.26
g01	-2599.813	-2598.133	1.680	0.45	0.49
h01	181.299	181.645	0.346	0.28	0.30
g10 c	-0.837	-0.914	-0.077	0.18	0.20
h10 c	0.569	0.357	-0.212	0.17	0.17
g01 c	0.270	0.074	-0.196	0.36	0.38
h01 c	-0.195	-0.401	-0.206	0.19	0.19
g20	-4.011	-3.489	0.522	0.18	0.20
h20	-2.135	-2.449	-0.314	0.18	0.20
g11	-3.451	-3.672	-0.221	0.17	0.19
h11	0.981	-0.758	-1.739	0.17	0.18
g02	-7.035	-6.347	0.688	0.27	0.30
h02	-0.590	-0.605	-0.015	0.21	0.22
g30	-5.476	-6.688	-1.212	0.35	0.37
h30	0.631	0.966	0.335	0.35	0.37
g21	-3.472	-3.867	-0.395	0.33	0.35
h21	0.925	0.378	-0.547	0.33	0.35
g12	-6.725	-8.302	-1.577	0.33	0.37
h12	0.307	0.212	-0.095	0.33	0.36
g03	-0.337	-0.238	0.099	0.53	0.58
h03	0.894	0.835	-0.059	0.42	0.47

G-TERMS FIELD OF VIEW (10^{-1} M.A.S.):

* -50	-41	-35	-30	-27	-25	-22	-19	-15	-10	-2 *
* -38	-30	-25	-22	-20	-18	-17	-16	-13	-9	-3 *
* -29	-21	-17	-14	-13	-13	-13	-12	-11	-8	-3 *
* -21	-14	-10	-8	-8	-8	-8	-9	-8	-6	-2 *
* -15	-9	-5	-3	-3	-4	-5	-6	-6	-4	-1 *
* -11	-5	-1	1	1	0	-1	-3	-3	-2	1 *
* -9	-2	2	4	4	3	2	1	0	1	3 *
* -9	-1	3	6	6	6	5	4	3	4	6 *
* -10	-2	4	7	8	8	7	7	7	8	11 *
* -13	-4	3	7	9	10	10	10	10	12	15 *
* -18	-7	1	6	9	11	12	13	15	17	21 *

MEAN: -0.48 STANDARD DEVIATION: 1.27

CHROMATIC COMPONENT (D(B) = .75) :

* 4	4	4	4	4	4	4	5	5	5	5 *
* 3	4	4	4	4	4	4	4	4	4	5 *
* 3	3	3	3	4	4	4	4	4	4	4 *
* 3	3	3	3	3	3	3	4	4	4	4 *
* 3	3	3	3	3	3	3	3	3	4	4 *
* 2	2	2	3	3	3	3	3	3	3	3 *
* 2	2	2	2	2	3	3	3	3	3	3 *
* 2	2	2	2	2	2	2	2	3	3	3 *
* 1	1	2	2	2	2	2	2	2	2	2 *
* 1	1	1	1	2	2	2	2	2	2	2 *
* 1	1	1	1	1	1	1	2	2	2	2 *

MEAN: 0.28 STANDARD DEVIATION: 0.10

H-TERMS FIELD OF VIEW (10^{-2} M.A.S.):

*-191	-182	-159	-125	-80	-27	33	98	167	238	309 *
*-160	-155	-137	-108	-69	-24	28	84	143	204	263 *
*-129	-127	-113	-90	-58	-19	25	72	122	171	220 *
* -98	-99	-90	-71	-45	-13	23	62	102	141	178 *
* -66	-71	-66	-52	-32	-7	22	52	82	111	137 *
* -35	-43	-42	-33	-19	0	21	43	64	83	98 *
* -5	-15	-18	-14	-5	7	21	34	47	56	60 *
* 25	11	5	4	8	14	20	26	29	28	22 *
* 53	37	27	22	20	20	20	17	12	1	-16 *
* 80	61	48	39	32	26	18	8	-6	-26	-53 *
* 105	84	67	54	42	30	16	-1	-24	-53	-91 *

MEAN: 0.13 STANDARD DEVIATION: 0.88

CHROMATIC COMPONENT (D(B) = .75) :

* -28	-25	-22	-19	-16	-13	-9	-6	-3	0	3 *
* -32	-28	-25	-22	-19	-16	-12	-9	-6	-3	0 *
* -35	-31	-28	-25	-22	-19	-16	-12	-9	-6	-3 *
* -38	-35	-31	-28	-25	-22	-19	-16	-12	-9	-6 *
* -41	-38	-34	-31	-28	-25	-22	-19	-15	-12	-9 *
* -44	-41	-38	-34	-31	-28	-25	-22	-19	-15	-12 *
* -47	-44	-41	-37	-34	-31	-28	-25	-22	-18	-15 *
* -50	-47	-44	-41	-37	-34	-31	-28	-25	-22	-18 *
* -53	-50	-47	-44	-41	-37	-34	-31	-28	-25	-21 *
* -56	-53	-50	-47	-44	-40	-37	-34	-31	-28	-25 *
* -59	-56	-53	-50	-47	-44	-40	-37	-34	-31	-28 *

MEAN: -0.28 STANDARD DEVIATION: 0.14

CCINS1 - SUCCESFUL EXECUTION

Why the abcissa difference ≠ 0 (1) D1

I Projection error on the RGC

* different a-priori star positions (Updated RGO vs INCA)

effect star.cat.	abscissa difference rms	min	max	in strument "corner"	coeff.
CUO 1 (all **)	2.68	-40	+25	0.3	0.2
(act **)	1.56	-25	+8	0.5	0.2
CUO 2 (all **)	2.94	-70	+10	0.4	1.0

(catalog rms-error : UPO-RGO 185 mas, INCA 270 mas

* different SM-attitude (bias/noise)
no empirical results available

II Different sets of Stars

effect star set	abscissa difference rms	min	max	in strument "corner"	coeff.
CUO 1 (upd. cat)	2.32	-42	+10	0.4	
(INCA cat)	2.43	-42	+10		
CERGA (geometric)*	1.99	-10	+9	0.3	0.7
(smoothing)*	1.56	-4.5	+4.5	-	-

* 61 flagged stars removed

→ (2)

III Geometric v.s. Smoothing

CUO Set 1 2.38 mas (rms)
CERGA Set 2 2.43 mas (rms) max Δρ mas

Different attitude models (knots, gas-jets)

IV Choice of Instrument parameters

ex. Time dep. b.a. in/out +/- 1 mas, 0.36 rms

Instrument modelling (see examples)
FAST / NDAC the same?

V Phase data differences
- Partially observed stars
- Weighting
- (1st sample) Choice of slit #
- .....

VI Treatment of Outliers
- NDAC re-weighting
- FAST passive stars

RGC 982 (4/3/91) SET 2

active stars: 1306
passive stars: 25 (flagged by IDT)
36 (flagged by g/c)
smoothing

Weighted-mean residuals

number of data values: 36408
statistics: mean -0.7874914e-10 mas
standard deviation 1.020687 mas
minimum value -118.7249 mas
maximum value 131.8666 mas
number of classes in x 19 limits: -0.482 - 0.482
number of classes in y 18 limits: -0.452 - 0.450
number of elements out of bounds 2

mean values: in mas

	-0.457	-0.406	-0.355	-0.304	-0.254	-0.203	-0.152	-0.102	-0.508E-01	-0.604E-04
0.425	3.10	4.02	0.155	0.445	-1.50	-0.722	-0.425	0.236E-01	-0.322	1.02
0.374	4.02	2.68	-1.40	-3.14	-1.55	0.405E-01	-0.381	-0.388	0.543	0.322
0.324	0.751	0.733	1.54	-0.178	0.103	-1.11	-0.765	-1.04	-0.668	0.970
0.274	0.875E-01	1.32	-0.521	-1.18	0.253	-0.623	-0.504	-0.347	-0.461E-01	2.31
0.224	2.16	0.805	-0.320	-0.532	-0.485	0.704	-0.270	-0.174	0.607	0.608
0.174	1.89	-0.751E-01	-0.349	-0.605	0.832E-02	0.487	0.599	0.633	-0.410E-01	0.541
0.124	1.92	-0.709E-02	-0.439	-0.523	-0.336	0.673	-0.979	0.656	-0.447E-01	1.36
0.738E-01	-0.368	-0.234E-01	-0.444	0.730	-0.818	-0.440E-01	0.293	0.251	1.17	2.12
0.237E-01	-0.119	1.44	-0.317	-0.226	-0.852E-01	-0.133	0.973	-0.382	-0.945E-01	1.10
-0.265E-01	-0.726	-0.174	1.07	-0.913	0.648	-0.823	0.456	0.588	1.08	1.79
-0.766E-01	3.28	-0.286	-0.369	-0.385	0.279	-0.559	0.443	1.58	0.291	1.17
-0.127	1.42	-1.01	-0.669	-1.57	0.402	0.726	-0.200	-0.475	1.80	1.25
-0.177	1.48	-1.04	-0.480	-0.847	-1.26	-0.140	-0.216	0.778	1.91	1.14
-0.227	2.13	0.609	0.160	-0.966	-0.553E-01	-0.741	0.179	0.635	1.24	-0.137
-0.277	-1.26	-0.275	0.102	-0.975	-0.618	-1.38	0.168	-0.364	0.573	-0.543
-0.327	-0.919	0.223	-0.288	-0.160	0.706	0.248	-0.193	0.920	0.622	0.207
-0.377	-0.295	2.26	-0.218	-0.395	-0.316	0.621	-0.284	-0.888	0.714	-0.178
-0.427	5.20	1.55	-0.216	-0.124	0.296	0.145	-1.24	0.669	1.07	0.332

	0.507E-01	0.101	0.152	0.203	0.254	0.304	0.355	0.406	0.457
0.425	-0.660	-0.325	0.717	-0.391	0.913	-0.148	1.48	-0.807	0.999
0.374	0.238	-0.234	0.526	0.313	-0.206	-0.123	1.41	0.944	1.43
0.324	1.28	1.21	0.482	0.448	0.135E-01	-1.36	-0.400	-0.448	0.241
0.274	-0.449	-0.454	-0.801	0.309	-0.499	0.180E-01	-0.403	0.943E-01	-0.174
0.224	1.11	-0.367	0.941E-02	0.141E-01	-1.62	-0.777	0.333	0.868	0.464
0.174	-0.535	1.11	-0.613	0.542	0.769	-1.06	-0.145	-0.549	-0.371
0.124	0.932	-0.154	-0.290	-0.248	-1.30	-0.714	-0.481	-0.359E-01	-3.71
0.738E-01	0.420	0.137	0.416	0.388	-0.515	-0.423	-0.798	-2.40	-2.22
0.237E-01	-0.136	-0.140	-0.418E-01	-0.790	-1.34	-1.09	-0.334E-01	0.859E-01	0.556
-0.265E-01	0.712	0.293	0.928E-01	-0.878	-1.18	-1.02	0.403	-0.350	1.11
-0.766E-01	0.511E-01	-0.304	-0.765	-0.657	-0.579E-01	-1.19	1.53	0.652	1.44
-0.127	0.266	-1.28	-0.792E-01	0.114	-1.15	-0.935	0.587	1.33	0.438
-0.177	-0.213	-0.244E-02	-0.861	0.168	-2.06	-0.158	0.691	1.90	-1.21
-0.227	0.477	0.678	-0.340	-1.10	-0.329	0.531E-01	-0.755E-01	0.966	0.474
-0.277	-1.03	-1.19	0.989E-01	-0.953E-01	-0.209	0.325	2.50	1.60	1.37
-0.327	0.417	0.950E-01	-0.919	-1.01	0.233	-1.65	1.07	0.585	5.09
-0.377	-0.476	-0.197	-1.52	-1.48	-0.881E-01	-0.813	-0.785E-02	0.955	-0.737
-0.427	0.777	-0.449	0.292	-0.772	-0.296	-1.51	1.03	1.02	3.53

standard deviations: in mas

	-0.457	-0.406	-0.355	-0.304	-0.254	-0.203	-0.152	-0.102	-0.508E-01	-0.604E-04
0.425	21.6	13.9	17.3	16.0	15.4	16.4	12.0	15.9	13.4	18.1
0.374	22.0	17.5	13.0	15.4	15.6	13.6	13.3	14.0	13.9	11.3
0.324	25.6	15.9	12.0	16.8	13.7	12.6	12.5	12.4	15.5	13.0
0.274	22.5	17.1	11.9	12.5	13.7	17.0	15.1	14.1	13.7	13.7
0.224	24.5	14.1	13.6	14.3	12.5	14.9	16.0	14.5	10.9	15.4
0.174	19.2	11.3	12.4	12.6	10.4	12.1	13.7	12.3	10.5	12.7
0.124	22.0	13.7	11.7	14.4	11.8	13.1	11.8	14.2	11.8	13.5
0.738E-01	21.4	14.7	16.4	13.3	11.8	13.9	12.6	11.8	14.4	13.0
0.237E-01	17.8	13.0	15.2	11.2	13.5	12.7	13.9	10.5	14.4	13.5
-0.265E-01	22.7	13.3	12.0	13.9	11.5	12.7	12.6	14.8	12.7	16.4
-0.766E-01	19.9	17.6	13.2	12.0	13.8	14.0	11.1	15.1	12.6	11.8
-0.127	21.3	15.0	15.3	12.7	11.9	14.2	16.9	14.2	15.2	13.6
-0.177	20.1	14.7	12.6	12.8	12.3	12.4	14.9	12.6	14.1	11.6
-0.227	21.3	14.8	13.1	14.9	12.8	15.2	10.5	13.1	14.5	13.6
-0.277	18.3	15.5	15.1	14.1	13.3	14.7	10.6	13.0	13.2	14.0
-0.327	19.4	13.9	12.7	11.5	11.5	11.4	9.35	13.4	12.7	12.6
-0.377	21.5	17.1	17.9	13.4	12.4	13.7	15.5	17.5	14.1	13.0
-0.427	22.5	12.0	14.0	16.0	15.7	12.9	14.6	13.6	16.3	13.0

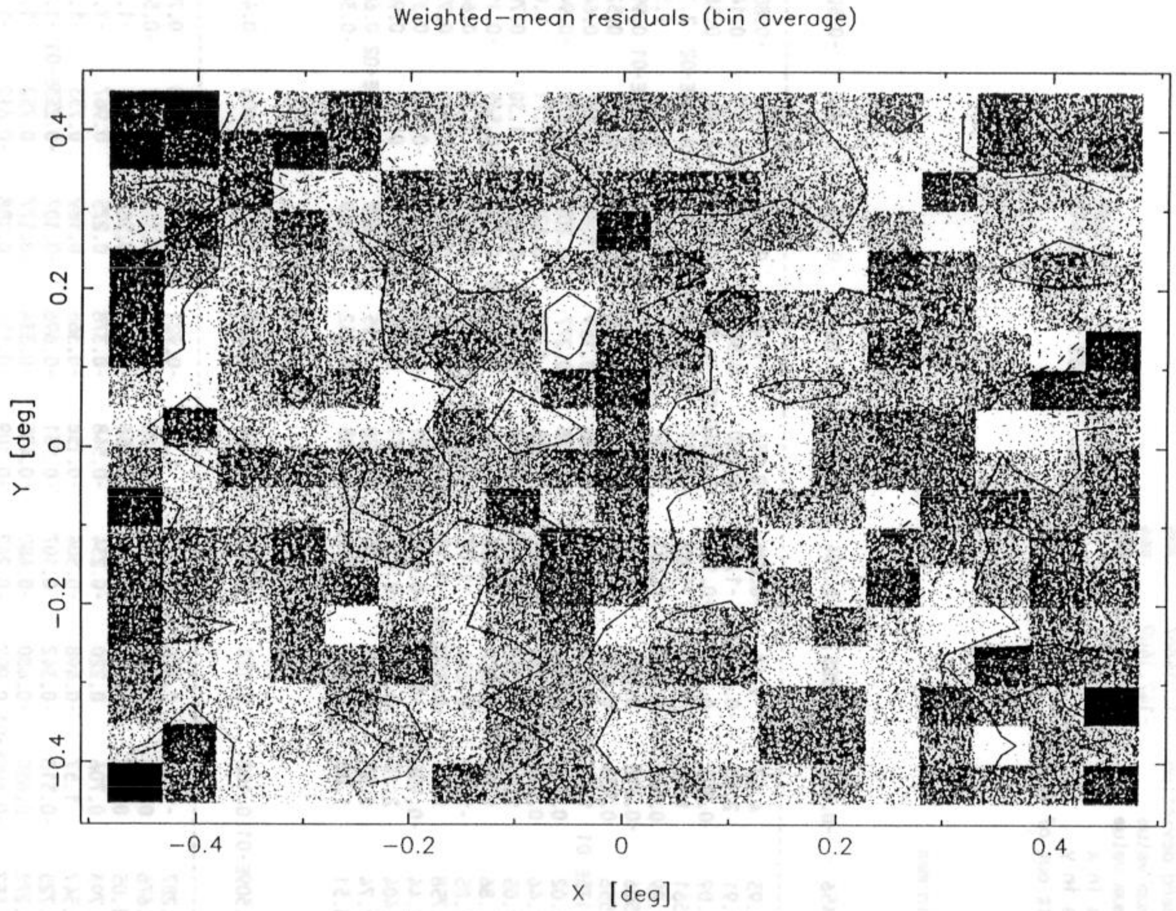
	0.507E-01	0.101	0.152	0.203	0.254	0.304	0.355	0.406	0.457
0.425	11.7	12.7	13.4	15.2	15.6	15.0	16.7	16.3	16.6
0.374	13.9	15.9	14.5	11.5	12.7	12.1	15.1	13.9	21.3
0.324	13.1	13.1	14.0	13.3	18.5	11.9	16.2	12.3	18.8
0.274	13.7	13.7	13.0	13.1	13.6	14.4	12.2	11.6	26.0
0.224	12.8	13.1	10.8	12.8	11.3	13.4	13.2	12.8	21.9
0.174	11.4	12.5	12.7	12.2	10.9	11.3	9.99	10.6	21.7
0.124	12.8	13.5	10.1	12.6	10.9	14.6	11.2	16.9	19.9
0.738E-01	13.5	13.8	11.9	10.8	13.2	12.4	13.2	13.7	16.2
0.237E-01	13.3	11.0	13.1	11.4	13.1	12.2	13.2	13.4	21.7
-0.265E-01	10.6	11.6	12.5	14.1	10.8	13.5	12.1	11.6	16.7
-0.766E-01	12.3	14.1	12.7	13.7	12.6	13.4	14.9	14.9	20.4
-0.127	11.7	14.6	17.3	14.0	11.0	14.5	12.3	13.5	19.5
-0.177	14.1	11.7	13.5	14.2	12.3	10.4	13.3	12.3	25.3
-0.227	16.2	10.2	16.5	11.7	13.2	11.7	13.2	14.0	23.0
-0.277	10.7	16.8	12.1	11.4	8.89	15.7	13.1	13.2	17.0
-0.327	13.4	11.1	11.9	13.0	11.4	11.3	17.2	12.3	16.4
-0.377	14.0	14.9	13.9	12.3	14.9	11.2	14.1	14.4	24.6
-0.427	16.8	14.0	14.9	12.0	14.1	14.7	14.8	15.0	20.1

number of elements:

	-0.457	-0.406	-0.355	-0.304	-0.254	-0.203	-0.152	-0.102	-0.508E-01	-0.604E-04
0.425	63	82	100	102	103	100	101	106	101	102
0.374	78	81	111	103	109	103	111	110	107	113
0.324	72	83	100	108	102	107	100	106	100	112
0.274	63	84	106	107	107	109	110	114	108	117
0.224	71	99	102	129	101	124	98	129	100	134
0.174	66	90	107	118	110	118	110	114	110	122
0.124	80	84	115	107	111	106	113	101	119	98
0.738E-01	86	106	126	139	127	135	130	138	128	133
0.237E-01	84	94	122	128	118	129	121	128	118	125
-0.265E-01	72	93	113	124	116	121	122	124	120	125
-0.766E-01	65	77	113	102	103	105	104	104	98	103
-0.127	73	91	112	110	112	115	112	113	117	109
-0.177	68	84	119	94	118	91	119	94	113	91
-0.227	68	98	115	122	119	122	119	119	122	123
-0.277	86	86	127	106	125	113	118	111	116	116
-0.327	80	94	112	112	110	114	113	112	116	116
-0.377	70	88	124	111	121	112	121	111	119	110
-0.427	86	82	129	99	134	95	134	96	134	100

	0.507E-01	0.101	0.152	0.203	0.254	0.304	0.355	0.406	0.457
0.425	107	101	105	100	104	99	102	81	72
0.374	106	111	105	109	108	104	102	84	70
0.324	101	107	100	114	96	112	98	100	66
0.274	107	109	110	108	113	109	111	85	79
0.224	92	137	88	140	85	135	89	113	54
0.174	101	120	98	122	95	117	97	96	73
0.124	116	107	115	111	112	112	116	96	79
0.738E-01	125	134	124	138	122	143	122	111	82
0.237E-01	118	123	119	122	120	123	113	103	71
-0.265E-01	128	124	126	123	126	121	125	95	78
-0.766E-01	102	105	101	105	100	105	100	86	64
-0.127	115	111	116	107	116	109	110	84	79
-0.177	121	89	116	91	113	90	106	69	59
-0.227	121	128	118	130	121	126	116	104	73
-0.277	113	116	118	109	117	115	112	95	67
-0.327	113	115	113	114	111	110	113	92	73
-0.377	121	107	116	108	119	109	116	86	76
-0.427	137	105	132	100	131	109	129	85	81

982



E.4

RGC 18 (4/3/91)
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active stars: 1493
passive stars: 21 (flagged by IDT)
27 (flagged by g/c)
smoothing

Weighted-mean residuals
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number of data values: 48225
statistics: mean 0.1541361e-09 mas
standard deviation 1.014867 mas
minimum value -147.1409 mas
maximum value 121.1402 mas
number of classes in x 19 limits: -0.482 - 0.482
number of classes in y 18 limits: -0.453 - 0.449
number of elements out of bounds 2

mean values: in mas

	-0.456	-0.406	-0.355	-0.304	-0.253	-0.203	-0.152	-0.101	-0.505E-01	0.207E-03
0.424	2.93	4.47	1.40	-0.625	-0.933	-1.40	0.816	-1.41	-0.808E-02	-0.368
0.374	1.91	2.06	-0.703	-1.20	0.220	-0.598	-1.61	-0.375	0.149	0.699
0.324	4.09	0.301	-0.743	-0.148	-0.556E-01	-1.72	-0.812	-0.390	0.581	0.557
0.274	0.561	1.95	-1.14	-1.03	-0.817	0.336E-01	1.09	-0.666E-02	2.15	0.997
0.224	3.29	0.661	0.229	-0.603	0.187	-0.257	-0.884	-0.334	1.32	1.12
0.174	-0.506	-0.316	0.287	-0.554	-0.963	-0.723E-01	0.304	0.937E-01	0.998E-01	1.18
0.124	-0.556	0.933	-0.469	-0.799	0.458E-01	-0.204	-0.808	0.251	0.521	0.645
0.735E-01	0.175E-01	1.26	-0.920	-0.142	0.336	0.159	1.66	0.391	0.643	-0.263E-02
0.234E-01	-2.02	0.522	-0.634	-1.08	-0.978	-0.277	0.205	0.675	-0.941E-01	-0.249
-0.267E-01	2.46	0.752E-01	0.380	-0.341	-0.225	1.39	0.128E-02	1.71	1.00	1.68
-0.768E-01	2.05	1.16	0.707	-1.58	-0.859	0.786	0.354	1.30	0.704	1.23
-0.127	-1.86	1.36	-0.847	-1.25	-0.424	0.267E-01	0.540E-01	0.565	-0.198	0.786
-0.177	1.85	-1.00	-0.236	-1.07	-0.219	-0.189	0.289	1.22	0.661	0.932
-0.227	0.758	1.28	-0.858E-01	-1.18	-0.751	-0.267	0.472	-0.276	0.931	-0.349
-0.277	-2.44	-0.106	-1.06	-0.570	0.321	-0.601	-0.179	-0.142	0.374E-01	1.73
-0.327	0.404	2.15	0.252E-01	-0.815	-1.11	0.652	-0.209	0.361	0.963	1.05
-0.377	2.74	1.37	0.206	-1.24	0.720	-1.15	-0.985	-0.101E-02	0.683	0.882
-0.428	3.51	1.00	0.587	-0.117E-01	0.185	0.352	0.559	0.442	-0.300	1.13

	0.509E-01	0.102	0.152	0.203	0.254	0.305	0.355	0.406	0.457
0.424	-0.287	-1.38	0.374	-1.84	1.10	-0.921	0.680	0.168	0.755
0.374	-0.676	0.374	0.281	-0.964	0.510	-0.660E-01	-0.392	1.41	-0.568
0.324	1.05	0.242	1.26	-0.462	0.256	-1.22	0.565	1.11	-1.04
0.274	-0.793	0.706	0.220	-0.234	-0.548	-0.378	0.275	0.967	-1.25
0.224	0.547	1.57	-0.498	-0.504	-0.158	-0.365	0.189	0.733	-1.44
0.174	0.725	-0.518	-0.342	0.107	-0.931	-0.696	-0.107	-0.233E-01	-1.26
0.124	-0.278	0.650	-0.480	-0.480	-0.435	-0.334	-0.177	0.752	1.45
0.735E-01	0.557	-0.695E-01	0.902	-0.242	-0.109	0.135	0.188	-0.610	-1.64
0.234E-01	0.195	-0.474E-01	-0.521	0.551E-01	-0.503	-1.02	0.498	-0.139E-01	-2.43
-0.267E-01	0.171	0.262	0.711	-1.01	-0.512	-0.559	-0.596	-0.101E-01	1.86
-0.768E-01	0.618	0.298	0.315	-0.976	-0.723	-0.826	-0.434	0.508	0.909
-0.127	0.187	0.686E-01	-0.852	-0.593	-0.185	-0.116	0.982E-01	-0.974	1.84
-0.177	-0.807E-01	0.365	-0.671	-0.666E-01	-1.68	0.357	0.428	1.70	0.365
-0.227	0.655	-0.959	-0.213	-0.829	-0.301	-1.07	0.749	1.72	1.21
-0.277	0.215	0.282	-0.944	-0.344	-0.526	-1.46	-0.167	2.20	1.01
-0.327	-0.160	-0.584	-0.315	-0.442	0.490	0.747	0.186	1.89	-1.18
-0.377	0.163	-0.959	-1.64	-1.91	-1.06	-0.463	0.651	1.84	2.50
-0.428	-0.488	-1.44	-0.899	-1.21	-0.553	-0.983	0.924	2.34	0.592

standard deviations: in mas

	-0.456	-0.406	-0.355	-0.304	-0.253	-0.203	-0.152	-0.101	-0.505E-01	0.207E-03
0.424	19.4	15.7	17.5	18.6	15.2	16.1	16.6	18.5	14.9	16.9
0.374	17.6	13.5	13.9	17.0	14.7	13.8	14.8	14.1	13.9	14.1
0.324	21.7	13.3	11.7	12.2	11.7	12.4	11.2	11.2	12.1	11.6
0.274	25.9	13.7	15.5	13.6	14.0	14.8	14.3	12.4	12.6	13.3
0.224	24.2	13.3	13.6	13.6	12.3	13.5	14.9	11.7	11.8	14.0
0.174	22.5	15.1	12.1	14.8	13.9	13.9	13.2	13.3	12.1	11.8
0.124	22.9	14.7	12.7	12.2	13.2	11.1	11.6	12.8	12.5	12.6
0.735E-01	22.4	17.0	12.9	12.4	12.2	12.6	14.0	12.0	11.3	12.2
0.234E-01	24.3	12.5	13.9	12.9	12.9	12.8	14.3	13.8	14.7	10.7
-0.267E-01	26.6	15.6	11.7	13.8	14.7	12.5	12.8	12.1	11.9	14.5
-0.768E-01	22.7	13.3	13.2	14.5	13.7	14.1	11.5	11.9	12.2	12.7
-0.127	18.3	13.9	14.5	13.9	11.6	12.3	13.7	15.6	13.8	14.9
-0.177	22.1	12.9	12.3	14.0	12.0	14.5	13.1	13.0	12.1	12.3
-0.227	22.9	14.2	12.9	13.4	12.8	15.0	14.2	10.8	13.4	11.2
-0.277	29.4	13.4	14.7	13.0	13.1	12.0	15.2	11.7	13.0	11.0
-0.327	25.0	13.6	13.3	16.8	14.5	13.5	13.2	12.8	15.1	13.2
-0.377	26.2	15.3	16.1	12.1	13.8	10.7	11.9	12.0	12.6	12.1
-0.428	23.4	17.2	13.3	14.9	15.7	15.1	13.5	13.4	15.5	13.0

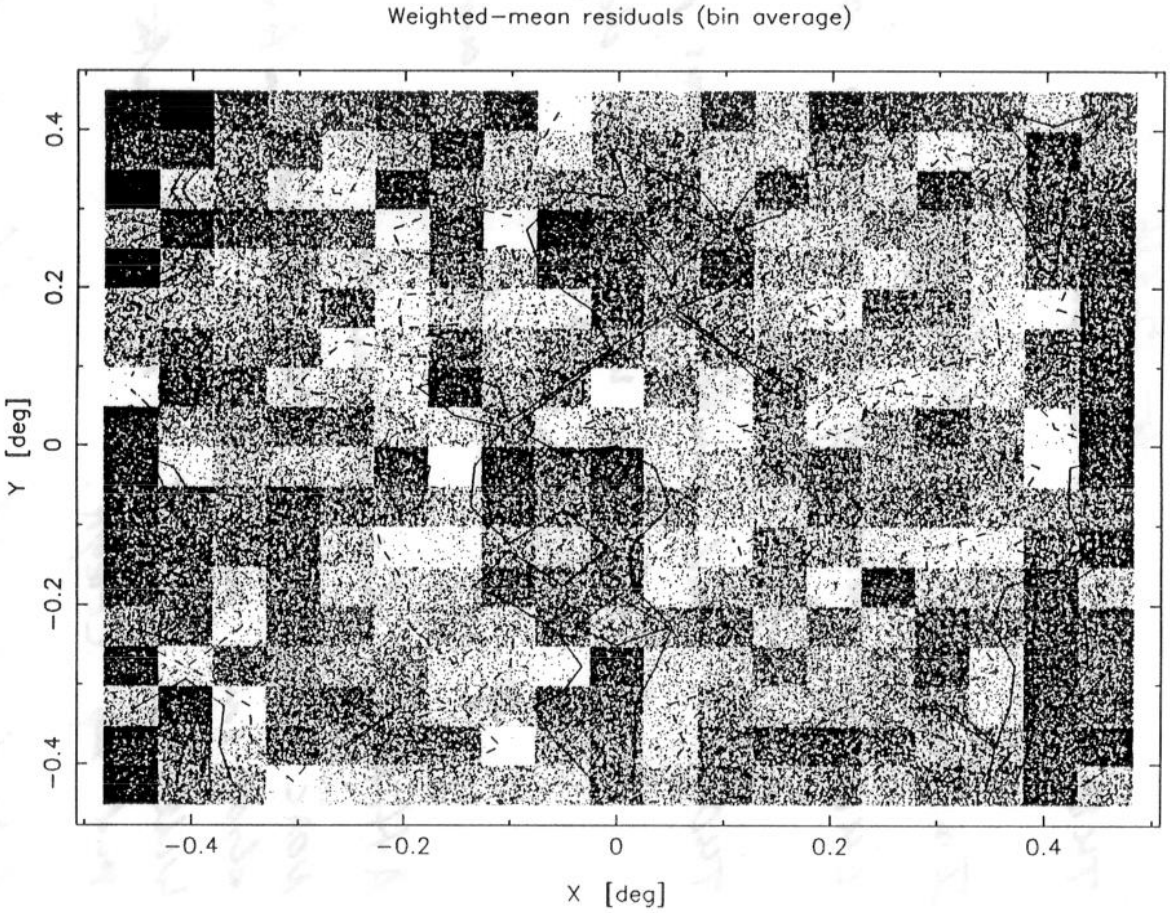
	0.509E-01	0.102	0.152	0.203	0.254	0.305	0.355	0.406	0.457
0.424	14.4	16.9	15.1	16.0	17.6	14.0	18.2	14.7	21.4
0.374	15.7	12.1	17.0	12.5	14.2	14.4	14.6	14.5	23.0
0.324	11.5	13.5	12.0	12.0	12.2	11.4	11.9	12.7	20.3
0.274	14.5	11.2	12.8	13.0	13.9	14.3	15.0	12.0	19.5
0.224	12.6	11.8	11.8	12.3	13.3	12.3	13.1	13.4	21.1
0.174	13.5	14.1	13.2	12.0	14.6	12.1	12.5	11.9	22.1
0.124	12.7	13.3	10.3	11.2	13.2	11.6	11.5	15.5	20.2
0.735E-01	11.9	13.3	11.4	11.8	11.7	12.4	13.0	11.8	21.4
0.234E-01	14.1	12.4	11.7	12.2	14.6	12.8	13.7	13.7	20.2
-0.267E-01	12.1	12.5	12.6	14.1	12.4	12.3	13.7	12.5	23.1
-0.768E-01	14.1	13.8	14.4	14.7	13.9	13.2	12.5	12.7	21.1
-0.127	12.3	13.3	12.4	13.4	11.7	14.8	11.8	14.1	18.9
-0.177	13.0	13.6	11.2	14.6	12.6	13.3	11.6	14.5	19.6
-0.227	13.3	12.5	15.0	11.9	12.2	11.0	17.6	14.3	23.4
-0.277	12.0	12.3	14.5	11.2	14.4	10.5	12.5	12.1	22.9
-0.327	13.4	13.5	15.4	13.4	16.5	14.1	13.6	14.0	23.4
-0.377	13.1	11.0	12.9	13.2	13.2	15.0	15.0	18.7	20.8
-0.428	14.7	13.2	14.0	15.5	14.4	12.4	16.1	17.0	23.6

number of elements:

	-0.456	-0.406	-0.355	-0.304	-0.253	-0.203	-0.152	-0.101	-0.505E-01	0.207E-03
0.424	87	129	148	156	151	154	148	160	154	158
0.374	92	101	140	128	140	131	140	133	142	126
0.324	109	140	143	171	140	178	135	171	140	169
0.274	81	122	131	156	134	160	132	160	130	159
0.224	100	132	152	162	149	168	148	169	143	173
0.174	113	126	171	161	172	160	177	162	172	165
0.124	109	115	163	146	163	148	162	145	160	155
0.735E-01	121	116	162	145	164	149	162	153	154	159
0.234E-01	101	117	152	146	154	147	152	141	153	140
-0.267E-01	92	114	139	149	138	151	140	146	149	146
-0.768E-01	86	118	144	162	145	160	141	165	143	160
-0.127	90	111	131	152	132	149	135	149	137	144
-0.177	100	125	151	148	147	157	143	157	142	159
-0.227	84	119	136	158	137	160	136	161	140	156
-0.277	103	113	160	157	157	154	159	153	158	156
-0.327	96	96	168	133	162	136	161	139	153	138
-0.377	86	118	148	145	144	148	146	146	148	149
-0.428	97	111	139	139	145	136	139	130	142	134

	0.509E-01	0.102	0.152	0.203	0.254	0.305	0.355	0.406	0.457
0.424	155	159	146	161	148	161	151	120	92
0.374	142	129	142	132	138	133	140	113	104
0.324	138	167	134	171	131	170	133	132	96
0.274	141	155	145	156	148	156	146	132	90
0.224	144	172	143	177	136	179	136	146	88
0.174	175	162	183	152	179	152	182	115	117
0.124	155	155	152	156	151	157	152	133	105
0.735E-01	152	163	150	167	148	164	150	127	103
0.234E-01	155	142	155	145	151	147	152	112	91
-0.267E-01	148	147	146	142	151	139	145	116	95
-0.768E-01	147	155	150	154	151	154	153	114	95
-0.127	141	145	136	151	130	152	132	130	83
-0.177	139	157	142	153	145	150	141	113	91
-0.227	146	152	148	149	149	145	152	113	90
-0.277	159	155	162	156	157	160	161	124	88
-0.327	155	133	153	136	148	135	148	97	85
-0.377	145	152	149	152	146	147	150	117	90
-0.428	143	131	146	129	147	128	144	110	89

Eqc 18
smoothing
4/3/91



E 8

Actions q/c comparison

1 Comparison of the "5 - RQC's."
(same RQC's as used for the attitude comparison)

CNO/CERQA - send comparison files to Delft
TUD - compare

2 Instrument Modelling

CNO - map of the residuals over the field of view
TUD - send results to various persons
Q: why do we estimate different coefficients?
Q: is the model good enough?

3 Attitude discontinuities
NOAC identified attitude discontinuities, also some indications in FAST.
Will be verified in Delft on data to be send by CERQA.

4 Effects of outliers, catalog and attitude errors.
Will be continued in Delft with existing data.