Twenty Third Meeting of the Hipparcos Science Team

ESOC, 11-12 December 1989

Attendance:

HST: Prof. P.L. Bernacca, Dr M. Crézé, Dr. M. Grenon, Prof. M. Grewing. 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 C. Turon.

ESTEC: M.A.C. Perryman, R. D. Wills

ESOC: J. van der Ha, A. Schütz, P. Davies; O. Ojanguren, D. Heger, C. Sollazzo (part time)

MATRA: I. Asseman, J.P. Gardelle

Apologies for absence were received from F. Donati.

The agenda given in Annex I was adopted.

1. Introduction

Perryman reported on the November SPC meeting, and Turon reported on the letter of intent she had submitted to ESA on behalf of the consortia leaders and the HST, concerning Hipparcos 2. Høg reported that he had been approached by Dr. Khromov, Vice President of the Astronomical and Geodetic Society of the USSR, offering a free launch of Hipparcos 2.

2. Satellite Status

Heger reported on the satellite status (Annex II). One of the multiplexers had failed on the payload RTU, leading to a loss of telemetry data on day 336 (2 December, 1989). No effect had been observed on the satellite.

On the solar array degradation, no clear picture had yet emerged—voltage degradation had been steep over the last week, even though no excessive solar activity had been reported over this interval. HST members were not happy that (a) errors on data points seemed to be unknown, (b) no explanation of the degradation mechanism had been presented. Le Poole stressed that little effort seemed to be given to estimating the lifetime of the satellite, which was a major cost driver.

Heger summarised the operations which had been conducted since early November (Annex II). Previous results had led to about 31 per cent data recovery. Presently, with Kourou, 56 per cent data recovery is being achieved.

3. Calibration Results

Davies updated the calibration status since the last mini-HST meeting of 16 November (Annex III):

M3: typically $M_3 < 0.01$.

Piloting improvements: Matra had modified the CCCM, and the transverse offset residuals are now < 0.5 arcsec, but longitudinal offsets are still around 2 arcsec. This could be further improved once the grid rotation (and axis) are better known.

IFOV profile: the average profile is very close to that specified. Beyond 180 arcsec there is great difficulty separating the response from the background effects.

Chromaticity: Wills presented results of the chromaticity calibration (see Annex IV) ($C_c = -0.27 \pm 0.06$ milli-arcsec, $C_v = 0.79 \pm 0.06$).

Refocusing Strategy: Davies proposed that refocusing monitoring is done with a certain frequency, and adjustments are made when the grid is two steps from the optimum focus, moving to two steps in the new direction, i.e. changing focus every 16–20 days. After discussions, it was agreed that the focusing would be monitored every week; on the basis of the history, movements would be made so that the grid would always be within ± 0.5 steps of best focus. It was agreed to do this around perigee ± 1 hour, so that RGC's would not have a changing scale factor during the RGC reductions. After the meeting, Davies provided further details of the focusing requirements—these are included in the status report ESTEC.STATUS.05.

Basic Angle Stability Check Points: The identified dates for verification of the basic angle stability were: 25 November - 10 January; 4 December - 25 February; 12 December - 17 February. None of these pairs can be used presently, so basic angle stability checks could only be made using this procedure after the eclipse hibernation phase.

Goldstone: van der Ha reported that NASA will support the Hipparcos project through use of the Goldstone antenna (Annex V). Of the 70m, two 34m and the 26m antennae at Goldstone, it is the latter that will be used for Hipparcos. Datation will be performed at the Goldstone station, before propagation of the data to ESOC via three satellite links.

The station should be operational by end-March. The plan is to keep the Kourou station until further notice, principally because of the perigee coverage.

4. Results of Consortia Evaluation

Van Leeuwen presented results of the RGO analysis so far (Annex VI).

Basic Angle: 58 deg 00 arcmin 31.212 arcsec was found by RGO (31.254 arcsec found by Utrecht). The basic angle had been determined to an accuracy of 6–7 milli-arcsec from 7 hours of data. The star mapper rotation was found to be 5 arcmin 59 ± 1 arcsec. Attitude reconstitution is good to 0.1–0.2 arcsec for the fainter stars.

IDT reductions had gone well for the data interval covering about three satellite revolutions. For the phase shift between the first two harmonics, RGO find (very provisionally) 15.9 milli-arcsec for the preceding FOV, 14.1 milli-arcsec for the following FOV. M2/M1 = 0.343 for the preceding FOV, 0.329 for the following FOV, cf the ESOC value of about 0.304 (but note that ESOC do not correct for the presence of background). A tape is expected to be sent to Copenhagen (for the GRC step) around 15 December.

Kovalevsky reported on the attitude and IDT analysis in FAST (Annex VII). The same grid rotation angle had been found as RGO. After star position correction, the smoothed attitude is good to 80–150 milli-arcsec. For the main grid, IDT reductions had been made on a 5×5 matrix, with preliminary results consistent with those from ESOC (Annex VII). For the photometry, the in-orbit results are consistent with the on-ground predictions.

Van der Marel reported on the great-circle work carried out at Utrecht. Grid rotation and basic angle correction derived so far have been determined from the star mapper data and may not be final values. Instrumental terms have been determined by Hans Schrijver at Utrecht (except for y-dependence and basic angle) from the IDT analysis (the following results were updated during the meeting on 12 December).

Component	P	F
y	2428	2800
y^2	9	7
y^3	20	32
x	−874	−872
xy	0	−5
xy^2	40	44
x^2	4	5
x^2y	−3	−1
x^3	23	26

with an rms error of 15 milli-arcsec, and a basic angle as given above.

Concerning feedback to ESOC, van der Marel/Schrijver will forward updated parameters (scale factor, basic angle, single grid rotation) by 15 December to be updated by ESOC and verified through CCCM calibration.

Tycho: Høg reported on the Tycho analysis at Heidelberg. Grewing reporting on the analysis work at Tubingen. He presented results on the transits of Venus. A document was passed to ESTEC/MATRA on the potential impact of ghost images. (Results were presented at the TDAC meeting the following day which showed that the data has been propagated through the PGC and photometry tasks).

Spikes: TDAC (Grewing/Høg) will send details of spikes found in Tycho data (counts, duration etc.) to be sent to ESTEC/MATRA (Action 6).

Strategy for Choice of ν_0: Crézé presented results of his studies on uniformity of sky scanning. Presently, a value of $\nu_0 = 40°$ would be replaced by a value of $\nu_0 = 80°$ after the first hibernation period.

5. DDID Discussions

van Leeuwen requested clarification of *d* (see Action 8). Provisional tape 4 went out on Wednesday 6 December, using day 315, with three ground stations. All errors should have been corrected on this tape. Some further comments had been received from Pieplu, and these will be studied by ESOC. Tape 5, with good focus, would be sent out by 15 December. Tape 6 will also be sent out based on one week of data. Feedback from tapes 4–6 is expected from the DRC before the data tapes are sent out routinely. Courier will continue to be used for series 4-6. In future, until further notice, ESOC will send tapes by courier to ESOC and to RGO.

6. Input Catalogue

Schütz had received 109 900 updates: 54 stars suppressed, 6 stars added due to alternate observation strategy, and 179 changed due to revised positions. Turon reported that updated catalogues had been sent to CNES, RGO, Utrecht, and one would be sent to Lund. The catalogue was put into operation at ESOC on 1 December (IC6). The relevant changes to the Annexes were made at the same time.

Modulation of the observation strategy will not be carried out until at least after the eclipse period, as agreed between Crézé and Schütz.

Minor planets: Schütz/Davies will check a few minor planets for signal modulation and send reports to Perryman (Action 4). Similarly, Davies will put into action the reporting of variable star magnitudes.

Publication of Input Catalogue: Turon still foresees this for the end of 1990.

Charts Status: Grenon now has optical disk reader in Geneva, and will be ready to prepare charts in April. Approximately 10 000 stars will be included: all faint stars in the catalogue ($V > 10.5$ mag), plus stars throughout the catalogue with 'confusing' neighbours, using laws similar to those used for flagging veiling glare. 15×15 arcmin fields would be used, with approximately 24 charts per page.

Turon reported that the INCA data base computer and software will be changed in mid-1990.

7. Hibernation Policy

A strategy/policy paper wass requested from ESTEC (Action 9).

Photometry: use of TDAC to be considered by Høg for the next meeting (Action 10).

Comparison: will be done on Tape 5—Perryman to coordinate.

Next HST meeting: subsequently confirmed for 21–22 February 1990 at ESOC.

M.A.C. Perryman

14 December 1989

Distribution: Participants, H. Hassan, K. Van Katwijk, K. Clausen, B.G. Taylor.

esa estec

HIPPARCOS

MEETING HIPPARCOS 23rd HST

PLACE ESOC

REF.

DATE 11/12/89 | PAGE 1

ACTION No	DESCRIPTION (not more than 4 lines)	CLOSING DATE	ACTIONNEE Person/firm	INITIATOR Person/firm
✓ 1.	Update theoretical report on solar array degradation. Present errors bars on V_{oc} measurements.	31 JAN 90	KLAUSEN/ FIEBRICH	
→ 2	ESOC will distribute hardcopy printout of times at which RTAD convergence has been achieved, to all ARC.	from now	Heger	
✓ 3	ESOC/MATRA to update CCCM on basis of known grid rotation (~5 arcmin).			
4	Verify minor planet / variable star signal modulation and magnitudes	asap	Schutz / Davies	
✓ 5	Updated geometric transformation parameters	20 Dec.	Schrijver/v.d.Marel/ESOC.	
✓ 6	Provide statistics of spikes in SM and IDT data		Høg / Grewing	
✓ 7	Perryman to inform Dale about possibility of Soviet launcher for Hipparcos 2.			
8	Clarify definition of d (p 4/10 of DDID)	asap	ESOC/v.d.Ha/Schutz.	
✓ 9	Make proposal for observation time usage during hibernation period.	end January	Klausen/ ESOC	
→ 10	Consider use of TDAC colours for main mission.	next HST	E. Høg	

Signatures

ANNEX I

Twenty Third Meeting

of the

HIPPARCOS SCIENCE TEAM

ESOC, 11-12 December 1989

(Portacabin 1, 14:00 hrs on 11 December
VIP Room, 09:00 hrs on 12 December)

AGENDA

1 Debrief of SPC Meeting (Perryman) and 'revised mission' status

2. Satellite status (Heger)
   (orbit, payload status, power degradation, ground station coverage)

3. Calibration results (Davies, Wills)
   - review of all calibration results
   - CCCM (transverse and longitudinal offset)
   - chromaticity results
   - IFOV profile
   - refocusing strategy
   - basic angle stability 'check points'

4. Results of Consortia evaluation:
   - Utrecht first-look
   - FAST/NDAC/TDAC reports
   - strategy for choice of nu0, omega0
   - 'spikes'

5. DDID discussions:
   - comments on data tape
   - status of DDID 6/7 (for nominal mission)
   - tape sending policy

6. Input Catalogue aspects (Schutz/Turon)
   - updated catalogue
   - minor planets/variable stars
   - modulation strategy
   - publication and charts status

7. Miscellaneous:
   - hibernation policy and data reductions
   - comparison activities
   - next HST meeting
   - photometry aspects

ANNEX II

PAYLOAD
11.12.1989

P/L SUBSYSTEM NOMINAL WITH FOLLOWING EXEPTION:
- FAILURE OF MUX 8 OF IMX2 OF THE P/L RTU ON DAY 336 AT 13:16:40z (AR 17)

P/L THERMAL CONTROL IS NOMINAL
IDT CHAIN 2 SELECTED
TYCHO CHAIN 2 SELECTED
MDE1, TCE1, AND INVERTER 1 ON

CALIBRATIONS SCHEDULED AND PERFORMED:
- REFOCUSING
- ISP
- GRM
- TRANSVERSE OFFSET
- LONGITUDINAL OFFSET
- SINGLE SLIT RESPONSE
- JITTER
- STRAYLIGHT
- IFOV
- CHROMATICITY

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DCS  Ø.1 STATUS=USER NAME=USER      S/C=HIPPARCO                    337:Ø9:15:18
ØØØ /P/L STATUS                           RETRV          PKT.TIME:336.13.16.29.362
/S= Ø  /SRCE=SRCA/GDGT/OPT= DP SC FS LI FI VA AL             PKT.ID=HHR .HK /    Ø

ID    DESCRIPTION          VALUE       UNIT  ID    DESCRIPTION          VALUE      UNIT
ØØ9 P/L INVERTER1 ST ON                      IØ1Ø P/L INVERTER2 ST OFF
'11Ø P/L INV1 DBUS ST CONNECTED              P112 P/L INV2 DBUS ST DISCONNECTED

ØØ1 DEB1 AC BUS 1 ST OFF                     HØØ1 DEB2 AC BUS 1 ST ON
ØØ2 DEB1 AC BUS 2 ST OFF                     HØØ2 DEB2 AC BUS 2 ST OFF
ØØ6 DEB1 IDT STATUS                          HØØ6 DEB2 IDT STATUS  ON
Ø14 DEB1 IDT HVPS ST                         HØ14 DEB2 IDT HVPS ST ON
Ø27 DEB1 ISPA      ST OFF                    HØ27 DEB2 ISPA      ST OFF
Ø26 DEB1 GRM STATUS  OFF                     HØ26 DEB2 GRM STATUS  OFF

ØØ9 DEB1 TYCHO ST.    OFF                    HØØ9 DEB2 TYCHO ST.    ON
Ø25 DEB1 TYC.CAL. ST OFF                     HØ25 DEB2 TYC.CAL. ST OFF
Ø17 DEB1 TYC.B HV ST OFF                     HØ17 DEB2 TYC.B HV ST ON
Ø26 DEB1 TYC.V HV ST OFF                     HØ2Ø DEB2 TYC.V HV ST ON

.Ø01 P/L TCE1 PWR  ST ON                     MØØ1 P/L TCE2 PWR  ST OFF
.ØØ3 PL TCE1 RANGE ST NARROW                 MØØ3 PL TCE2 RANGE ST WIDE
.ØØ5 PL TCE1ASAFEM ST ENABLED                MØØ5 PL TCE2ASAFEM ST DISABLED

ØØ3 MDE1 POWER     ST ON                     KØØ3 MDE2 POWER     ST OFF
ØØ2 MDE1 CONTROL   ST ON                     KØØ2 MDE2 CONTROL   ST OFF
ØØ4 MDE1 RES/EXE   ST EXECUTE                KØØ4 MDE2 RES/EXE   ST EXECUTE
254 MDE1 IDT1SHUTTER CLOSED                  K254 MDE2 IDT1SHUTTER
256 MDE1 IDT1CFM POS WIDE BAND               K256 MDE2 IDT1CFM POS
253 MDE1 IDT2SHUTTER OPEN                    K253 MDE2 IDT2SHUTTER
255 MDE1 IDT2CFM POS WIDE BAND               K255 MDE2 IDT2CFM POS
252 MDE1 TYC1SHUTTER CLOSED                  K252 MDE2 TYC1SHUTTER
251 MDE1 TYC2SHUTTER OPEN                    K251 MDE2 TYC2SHUTTER
25Ø MDE1 SW MIRR.POS TOWARDS IDT2            K25Ø MDE2 SW MIRR.POS

Ø29 MDE1 EMERG.SQ.ST ENABLED                 KØ29 MDE2 EMERG.SQ.ST DISABLED
Ø35 MDE1 A.SWOFF  ST NO AUTO OFF             KØ35 MDE2 A.SWOFF  ST

HOLD     2 ON                                                              Ø9:15:13
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TABLE 1

(Before Anomaly)

HDCS Ø.1 STATUS=USER NAME=USER S/C=HIPPARCO 337:Ø9:15:27
7ØØØ /P/L STATUS RETRV PKT.TIME:336.13.16.4Ø.Ø29
D/S= Ø /SRCE=SRCA/GDGT/OPT= DP SC FS LI FI VA AL PKT.ID=HHR .HK / Ø

ID	DESCRIPTION	VALUE	UNIT	ID	DESCRIPTION	VALUE	UNIT
IØØ9	P/L INVERTER1 ST	ON		IØ1Ø	P/L INVERTER2 ST	ON	
P11Ø	P/L INV1 DBUS ST	CONNECTED		P112	P/L INV2 DBUS ST	DISCONNECTED	
GØØ1	DEB1 AC BUS 1 ST	OFF		HØØ1	DEB2 AC BUS 1 ST	ON	
GØØ2	DEB1 AC BUS 2 ST	OFF		HØØ2	DEB2 AC BUS 2 ST	ON	
GØØ6	DEB1 IDT STATUS			HØØ6	DEB2 IDT STATUS	ON	
GØ14	DEB1 IDT HVPS ST			HØ14	DEB2 IDT HVPS ST	ON	
GØ27	DEB1 ISPA ST	OFF		HØ27	DEB2 ISPA ST	OFF	
GØ26	DEB1 GRM STATUS	OFF		HØ26	DEB2 GRM STATUS	OFF	
GØØ9	DEB1 TYCHO ST.	OFF		HØØ9	DEB2 TYCHO ST.	ON	
GØ25	DEB1 TYC.CAL. ST	OFF		HØ25	DEB2 TYC.CAL. ST	ON	
GØ17	DEB1 TYC.B HV ST	OFF		HØ17	DEB2 TYC.B HV ST	ON	
GØ[illegible]	DEB1 TYC.V HV ST	OFF		HØ2Ø	DEB2 TYC.V HV ST	ON	
LØ[illegible]	P/L TCE1 PWR ST	ON		MØØ1	P/L TCE2 PWR ST	ON	
LØØ3	PL TCE1 RANGE ST	NARROW		MØØ3	PL TCE2 RANGE ST	WIDE	
LØØ5	PL TCE1ASAFEM ST	ENABLED		MØØ5	PL TCE2ASAFEM ST	ENABLED	
JØØ3	MDE1 POWER ST	ON		KØØ3	MDE2 POWER ST	ON	
JØØ2	MDE1 CONTROL ST	ON		KØØ2	MDE2 CONTROL ST	ON	
JØØ4	MDE1 RES/EXE ST	EXECUTE		KØØ4	MDE2 RES/EXE ST	EXECUTE	
J254	MDE1 IDT1SHUTTER	CLOSED		K254	MDE2 IDT1SHUTTER	INTERMEDIATE	
J256	MDE1 IDT1CFM POS	WIDE BAND		K256	MDE2 IDT1CFM POS	INTERMEDIATE	
J253	MDE1 IDT2SHUTTER	OPEN		K253	MDE2 IDT2SHUTTER	INTERMEDIATE	
J255	MDE1 IDT2CFM POS	WIDE BAND		K255	MDE2 IDT2CFM POS	INTERMEDIATE	
J252	MDE1 TYC1SHUTTER	CLOSED		K252	MDE2 TYC1SHUTTER	INTERMEDIATE	
J251	MDE1 TYC2SHUTTER	OPEN		K251	MDE2 TYC2SHUTTER	INTERMEDIATE	
J25Ø	MDE1 SW MIRR.POS	TOWARDS IDT2		K25Ø	MDE2 SW MIRR.POS	INTERMEDIATE	
JØ29	MDE1 EMERG.SQ.ST	ENABLED		KØ29	MDE2 EMERG.SQ.ST	DISABLED	
JØ35	MDE1 A.SWOFF ST	NO AUTO OFF		KØ35	MDE2 A.SWOFF ST	NO AUTO OFF	

HOLD 2 ON Ø9:15:26

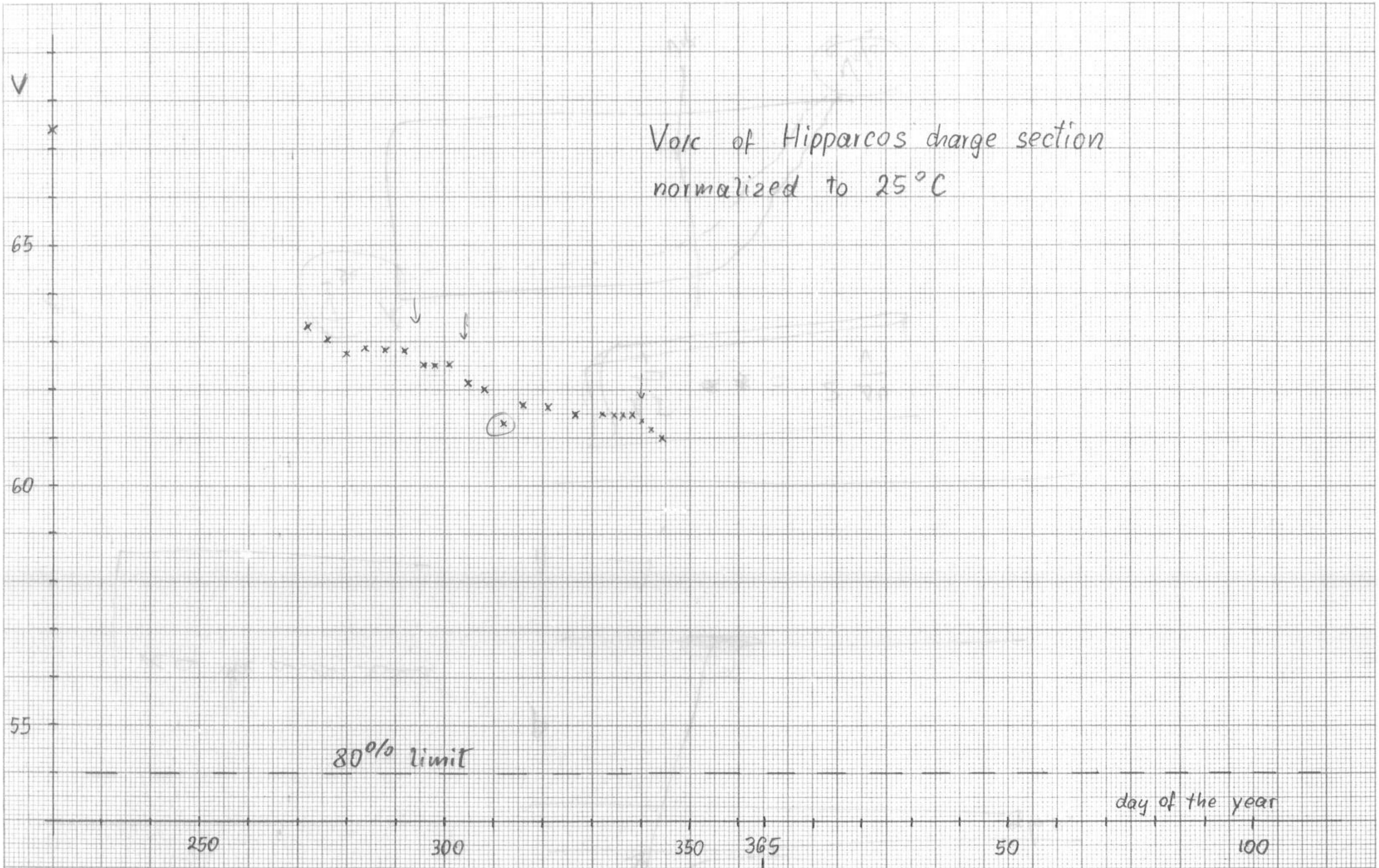
TABLE 2

(After Anomaly)

MUX	GROUP	CHANNEL	UNIT	TM IDENT.
7	1	224	P/L RTU	D002/D078
		225	"	D006
		226	"	D076
		227	"	D008
	2	228		
		229		
		230		
		231		
	3	232	P/L INV	I002
		233	"	I004
		234		
		235		
	4	236		
		237		
		238		
		239		
8	1	240	MDE	K002
		241	"	K003
		242	"	K004
		243	PINV	I010
	2	244	DEB2	H001
		245	"	H002
		246	"	H006
		247	"	H014
	3	248	DEB2	H009
		249	"	H017
		250	"	H020
		251	"	H025
	4	252	TCE	M001
		253	TCE	M005
		254	Baffle	I007
		255	Baffle	I008

TLM VALUE = ∅

TABLE 3.5.4.4 : CONTINUED


Vo/c of Hipparcos charge section
normalized to 25°C
V
65
60
55
80% limit
day of the year
250
300
350
365
50
100

SOLAR ARRAY DEGRADATION

DAY	Vo/C
272	63.29
276	63.04
280	62.78
284	62.88
288	62.86
292	62.82
296	62.51
298	62.51
301	62.53
305	62.13
308	62.01
312	61.27
316	61.73
321	61.64
327	61.50
332	61.52
334	61.50
336	61.51
338	61.51
340	61.37
342	61.18
344	61.00

<u>SUMMARY OF HIPPARCOS OPERATIONS</u>

FOR THE PERIOD DAY 313 TO 329

DAY 313 9.11.89
UPDATE OF STAR MAPPER THRESHOLDS LAMBDA MAX/MIN
(REJECTION CRITERIA AS A FUNCTION OF STAR MAGNITUDES)

DAY 319 15.11.89
CBS/ACS TRANSFER DISABLE/ENABLE CHANGED FROM 22K TO 18K
GYRO 3 DESTORAGE

DAY 321 17.11.89
CHANGE UOP FROM 90 mins. TO 10 mins

OPEN SHUTTER 1 min 30 sec AFTER OCCULTATION
CLOSE SHUTTER 1 min 30 sec BEFORE OCCULTATION
NO PSF DURING SHUTTER CLOSURE TO AVOID 'FALSE'
STAR IDENTIFICATIONS

DAY 322/323 18/19.11.89
MISSION PLAN (AUTO COMMAND) OPERATIONAL

DAY 324 20.11.89
ACS/CBS TRANSFER ALWAYS ENABLE DURING PERIGEE
(NO ALTITUDE CONSTRAINS)

DAY 325 21.11.89
INNOVATION THRESHOLD FOR EXTENDED WINDOW 10 arcsec.
INNOVATION THRESHOLD FOR NARROW WINDOW 5 arcsec.

DAY 326/327 22./23.11.89
TIME-TAG BUFFER FULL (117 CMD'S) AND STILL CMD's
TO BE LOADED.
AS A CONSEQUENCE THE IDT SHUTTER REMAINED OPEN
DURING AN EARTH OCCULTATION. OBSERVED COUNT RATES
WERE IN THE ORDER OF 10**4 COUNTS /SEC.
(SIRIUS COUNT RATES ARE ABOUT 10**7)

FINAL STAR CATALOGUE RECEIVED ON DAY 327 15:00 L
(OVER 90% CHANGES), BUT NOT IMPLEMENTED YET.

DAY 328 24.11.89
INNOVATION THRESHOLD FOR EXTENDED WINDOW 30 arcsec.
INNOVATION THRESHOLD FOR NARROW WINDOW 10 arcsec.
(REASON: AFTER OCCULTATIONS RTAD HAS BEEN LOST SEVERAL
TIMES)

NARROW WINDOW TO BE USED ALWAYS, UNLESS FD REQUESTS
A CHANGE; i.e. PRIOR TO T-B ANGLES/DRIFTS UPLINK

'NEW' SINGLE COMMANDS FOR SHUTTER OPEN/CLOSE BACK ONTO
THE SYSTEM (MISSION PLAN)

DAY 329 25.11.89
GYRO 5 DESTORAGE

SUMMARY OF HIPPARCOS OPERATIONS

FOR THE PERIOD DAY 330 TO 345

DAY 330	26.11.89 START OF ROUTINE SCIENCE DATA COLLECTION
DAY 336	02.12.89 FAILURE OF MUX 8 OF IMX 2 OF P/L RTU (AR 17)
DAY 339	05.12.89 KOUROU TAKEN OUT OF SUPPORTING NETWORK DUE TO REED SOLOMON DECODER MALFUNCTIONING
DAY 341	07.12.89 UPLINK OF NEW CALCULATED COEFFICIENT TORQUE PARAMETERS
DAY 344	10.12.89 TEST OF KOUROU TO SUPPORT DOWNLINK TELEMETRY
DAY 345	11.12.89 KOUROU SCHEDULED FOR ACTIVE SUPPORT

HIPPARCOS DATA RECOVERY COMPARED TO GEOSTATIONARY ORBIT AND POSSIBLE DEGREE OF SCIENCE EXPLOITATION.

DAY 310 TO 313 (incl.) 6-11-89 TO 9-11-89 (incl.)

THE PASS PATTERN REPEATS EVERY FOUR DAYS WITH ONLY SLIGHT VARIATIONS. THE PERIOD DAY 310 TO 314 WAS CHOSEN SINCE IT INCLUDES KOUROU FOR THE FIRST TIME.

GEOSTATIONARY		96 HOURS	100%
PRESENT DATA RECOVERY KOUROU, PERTH, ODENWALD	16.25 H	79.75 H	83%
DATA LOST DUE TO: - KOUROU SPOT PASS TDF DATA FLOW	6.2 H	73.55 H	76.6%
- NOT SCHEDULED - LATE A.O.S. (LINES) OR BAD LINES - STATION OVERLAP - GROUNS STATION OR HDCS PROBLEMS	6.2 H	67.35 H	70.1%
NO SCIENCE DATA DUE TO 21 OCCULTATIONS	5.3 H	62.05 H	64.6%

BECAUSE OF ACTIVE VAN ALLEN BELTS (SOLAR FLARES) FURTHER SCIENCE DATA AVAILABILITY AS FOLLOWS:

RTAD IN CLOSE LOOP (CBS/ACS TRANSFER ENA.) > 22 K ALTITUDE	10 H	52.05 H	54.2%
DURING REFERENCE PERIOD NO CONVERGENCE HAS BEEN ACHIEVED ON DAYS 310 & 311, 3 PASSES; AND CONVERGENCE FOR THE 5 REMAINING PASSES ON DAYS 311, 312 AND 313 HAS TAKEN PLACE AFTER 1 H AVERAGE AND > 22 K ALTITUDE	22 H	30 H	31.25%
RUNNING AVERAGE			
RUNNING AVERAGE			31.25%

THE FOLLOWING IS A SUMMARY OF ADDITIONAL OPERATIONAL ACTIVITIES WHICH HAVE BEEN UNDERTAKEN TO TRY AND IMPROVE THE QUANTITY OF USEFUL SCIENTIFIC DATA.

- VAN ALLEN BELT ACTIVITIES
  (ACS/CBS TRANSFER ENABLED/DISABLED AT 22K, 18K, 0)
- RTAD INITIALISATION AFTER LOS
  (BEST ACHIEVEMENT TO DATE 30 TO 45 MINS.)
- IMPROVEMENT TO GROUND RTAD MONITORING S/W
- UPDATING OF A.O.S./L.O.S. PROCEDURES
- LAMBDA MAX/MIN VALUES
- INNOVATION THRESHOLD CHANGES
- REFOCUSSING
- SINGLE SLIT RESPONSE FOR A FOCUSSED TELESCOPE
- MISSION PLAN (AUTOMATIC COMMAND IMPLEMENTATION)

SOME OF THE ABOVE ACTIVITIES ARE STILL UNDER INVESTIGATION, AND FUTURE CHANGES MIGHT BE REQUIRED.
IN ADDITION TO THE ABOVE, OTHER WAYS OF IMPROVING THE PROPORTION OF SCIENCE DATA GATHERED IS BEING INVESTIGATED.

DAY 334 TO 337 (incl.) 30-11-89 TO 03-12-89 (incl.)

GEOSTATIONARY		96 HOURS	100%
PRESENT DATA RECOVERY KOUROU, PERTH, ODENWALD	17.86 H	78.14 H	81.39%
DATA LOST DUE TO: - KOUROU SPOT PASS TDF DATA FLOW	-.- H	--.-- H	--.-%
- NOT SCHEDULED - LATE A.O.S. (LINES) 3 H OR BAD LINES - STATION OVERLAP - GROUNS STATION OR HDCS PROBLEMS	4.68 H	73.46 H	76.5%

BECAUSE OF ACTIVE VAN ALLEN BELTS (SOLAR FLARES)
FURTHER SCIENCE DATA AVAILABILITY AS FOLLOWS:

RTAD IN CLOSE LOOP (CBS/ACS TRANSFER ENA.)	--.-- H	73.46 H	76.5%
NO SCIENCE DATA DUE TO 17 OCCULTATIONS	5.95 H	66.54 H	69.31%
DURING REFERENCE PERIOD NO CONVERGENCE HAS BEEN ACHIEVED	12.5 H	54.04 H	56.29%

ANNEX III

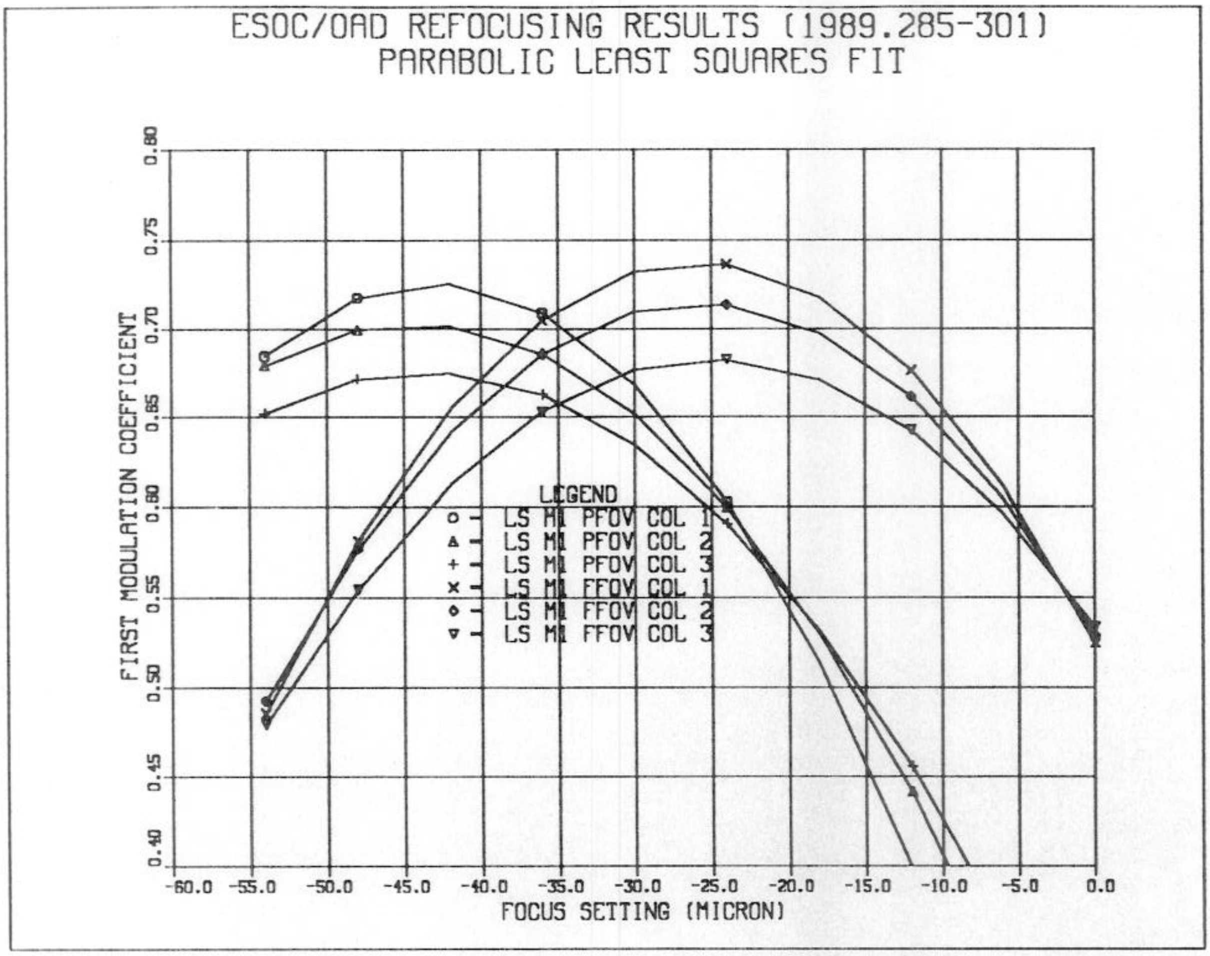
Calibration Status on 8-DEC-1989

- Status presented previously to special calibration meeting held at ESOC on 16-NOV-1989
- Results were presented on the following topics:
  - Detector Noise
  - SSR
  - IDT Piloting - focusing, M_1, M_2, $\Delta\phi$
  - Transverse Offset
  - Longitudinal Offset
- New results mainly concerned with:
  - M_3 determination
  - Transverse-/Longitudinal- offset corrections
  - IFOV Profile
  - Chromaticity

Brief Summary of 'Old' Results

- Detector Noise
  - Acceptable for SM data above 20000 km (7.5 hours/orbit)
  - Very high for SM during solar flares
  - Fairly low for IDT in all cases
- SSR - Filter computed and now used on-board
- IDT Processing
  - M1 values for 10 focus settings fitted by parabolae for 3 colours and 2 FOV (M1=0.69, M2=0.21 for B-V=0.5)
  - $\Delta\phi$ between 1st and 2nd harmonics approximately 21 mas and fairly independent of colour and position
  - Differential defocus approximately $\pm 10\mu$m
  - Focus changes by about 1 step/ 4 days
- Transverse Offset
  - Mean over PFOV=-3.8 arcsec, FFOV=-4.3 arcsec
  - Residual offset dependent on position in FOV $\in$ (-3.1,+3.2)
- Longitudinal Offset
  - Mean over PFOV=-1.0 arcsec, FFOV=-0.4 arcsec
  - Residual offset dependent on position in FOV $\in$ (-3.2,+1.7)
  - Total piloting budget gave bias<3.4 arcsec everywhere. Now improved.

TELESCOPE REFOCUSING



- **Collect 45 minutes IDT Data per focus /setting**
- **Compute M1 for 3 colour groups in each field-of-view**
- **Fit results using least squares to a parabola**
- **Differential defocus of +- 9 microns**

IDT 3rd harmonic

- Calibrated over central portion of grid for 3 colours and 2 FOV
- Stars used brighter than B=6, 92 observations reduced using a weighted least squares 7 parameter estimator
- Results distributed asymmetrically i.e. M3 is low and M3>0
- Phase change not well determined but all means < 22 mas

PFOV			FFOV		
COL1	COL2	COL3	COL1	COL2	COL3
0.009	0.009	0.008	0.010	0.009	0.005

Piloting Improvements

- CCCM modified to empirically remove calibrated residuals (MATRA recommendation)
- Transverse offset residuals now < 0.5 arcsec
- Longitudinal offset residuals still biased by about 1 arcsec (in opposite direction) but always less than 2.8 arcsec. However, these results are not well determined as not many observations were made.
- Overall rms bias of piloting residuals is about 1.1 arcsec
- Grid rotation and drift angle may explain most of the original residuals, therefore, when we get an accurate grid rotation we should:

    1. uplink the grid rotation to the spacecraft
    2. uplink a CCCM that is NOT empirically corrected to the spacecraft
    3. repeat the transverse and longitudinal offset calibrations as a verification the the piloting is good

Piloting Residuals

Transverse Offset (determined to 0.07 arcsec)

```
       +------+------+------+
PFOV:  !-0.05 ! 0.00 !-0.39 !
FFOV:  !-0.08 ! 0.10 !-0.38 !
       +------+------+------+
       !-0.02 !-0.14 !-0.20 !
       !-0.17 !-0.11 !-0.39 !          +------->G
       +------+------+------+          !
       !-0.22 !-0.43 !-0.35 !          !
       ! 0.32 ! 0.27 ! 0.30 !          v
       +------+------+------+          H
```

Longitudinal Offset (determined to 0.50 arcsec)

```
       +------+------+------+
PFOV:  ! 0.66 !-0.02 ! 2.48 !
FFOV:  ! 0.67 ! 1.18 ! 2.76 !
       +------+------+------+
       !-0.09 ! 2.42 ! 1.28 !
       ! 0.43 ! 0.87 !-0.19 !          +------->G
       +------+------+------+          !
       ! 1.58 ! 1.66 !-0.11 !          !
       ! 0.69 ! 0.92 ! 0.44 !          v
       +------+------+------+          H
```

IFOV Profile

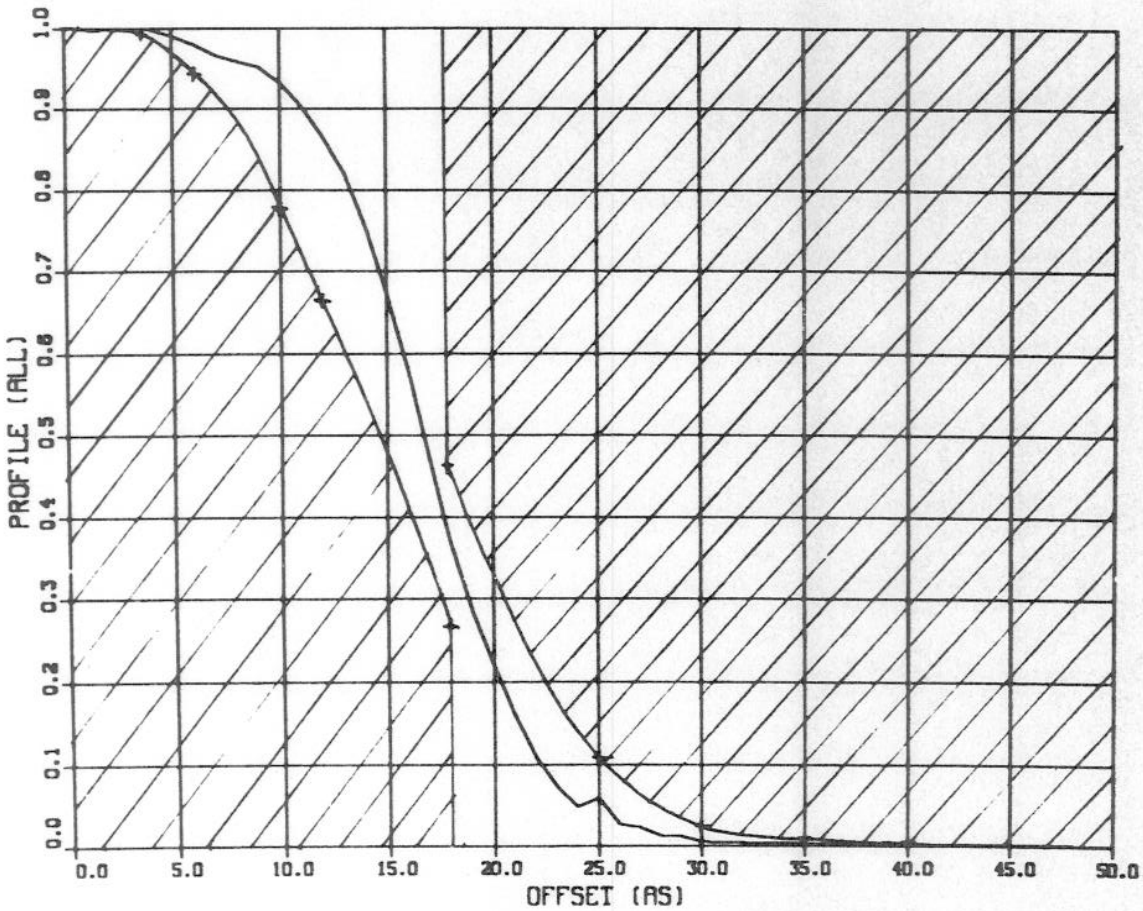
- Calibrated over 12 days from 9-NOV to 21-NOV i.e. a lot of telemetry
- Some cases (large offsets) not well covered
- Individual observations highly sensitive to RTAD convergence, this is a problem as we can't easily tell when RTAD is converged
- Following profiles computed:
  - 15 individual profiles (5 zones, 3 colours)
  - 5 profiles averaged over colour for each zone
  - 3 profiles averaged over zone for each colour
  - 1 profile averaged for zone and colour
- Needs some work to remove statistical 'outliers' when RTAD was not properly converged
- On ground results better for large offsets

Averaged Profile Compared with Specification

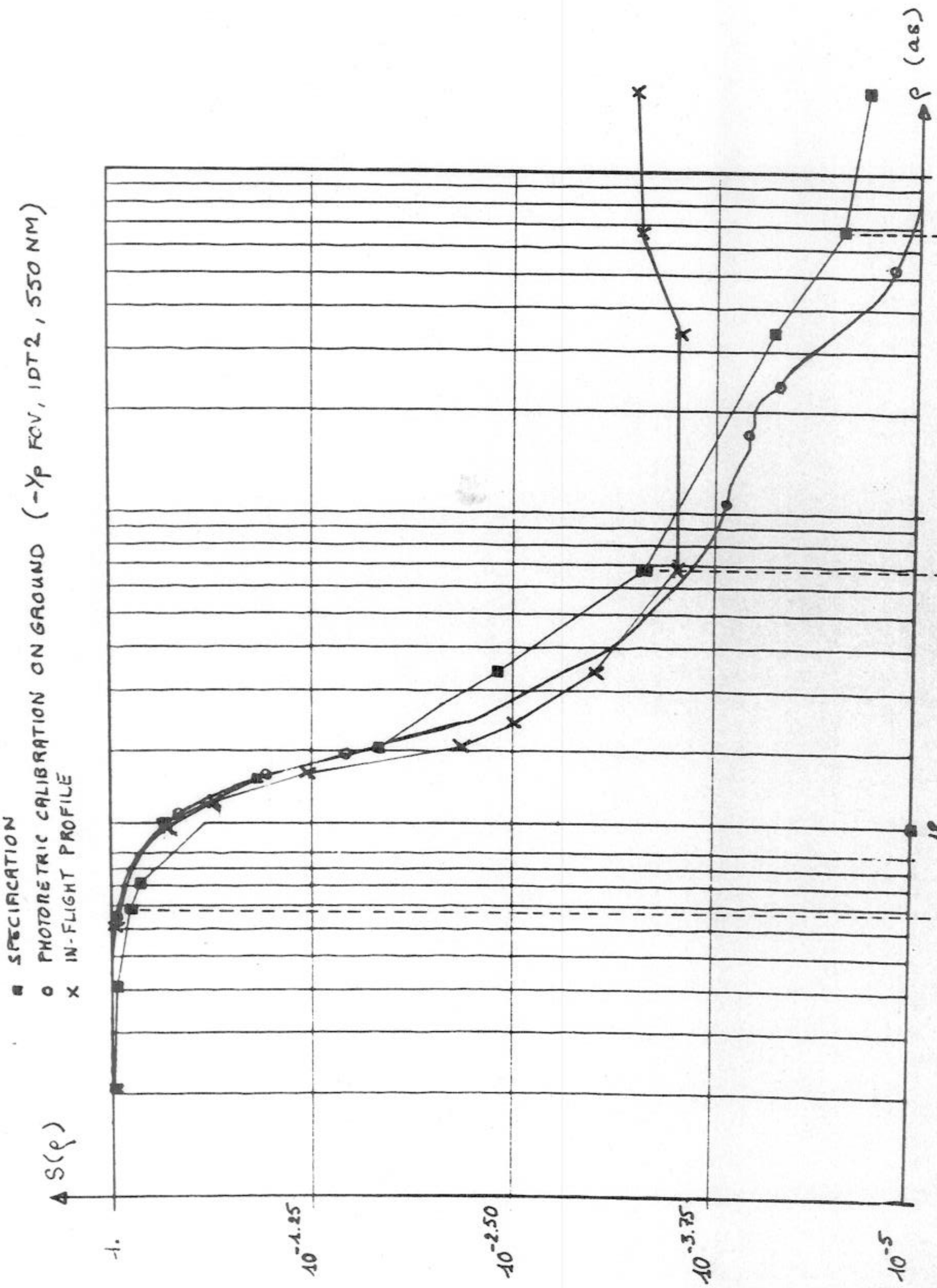
OFFSET (arcsec)	PROFILE (0..1)
0.0	1.0
4.0	0.99829
7.0	0.96741
9.0	0.95235
11.0	0.90[illegible]7[illegible] (*)
13.0	0.82165
14.0	0.75424 (*)
15.0	0.67294 (*)
16.0	0.57774 (*)
17.0	0.46865
18.0	0.36637 (*)
19.0	0.28342 (*)
20.0	0.21981
21.0	0.15970 (*)
22.0	0.10838
23.0	0.07335
24.0	0.04874
25.0	0.05920
26.0	0.02753
27.0	0.02364
28.0	0.01315
29.0	0.01191
30.0	0.00653
32.0	0.00429
35.0	0.00315
50.0	0.00096
100.0	0.00032
500.0	0.00028
1000.0	0.00050
2500.0	0.00057

(*) Values marked are not observed but interpolated from other points

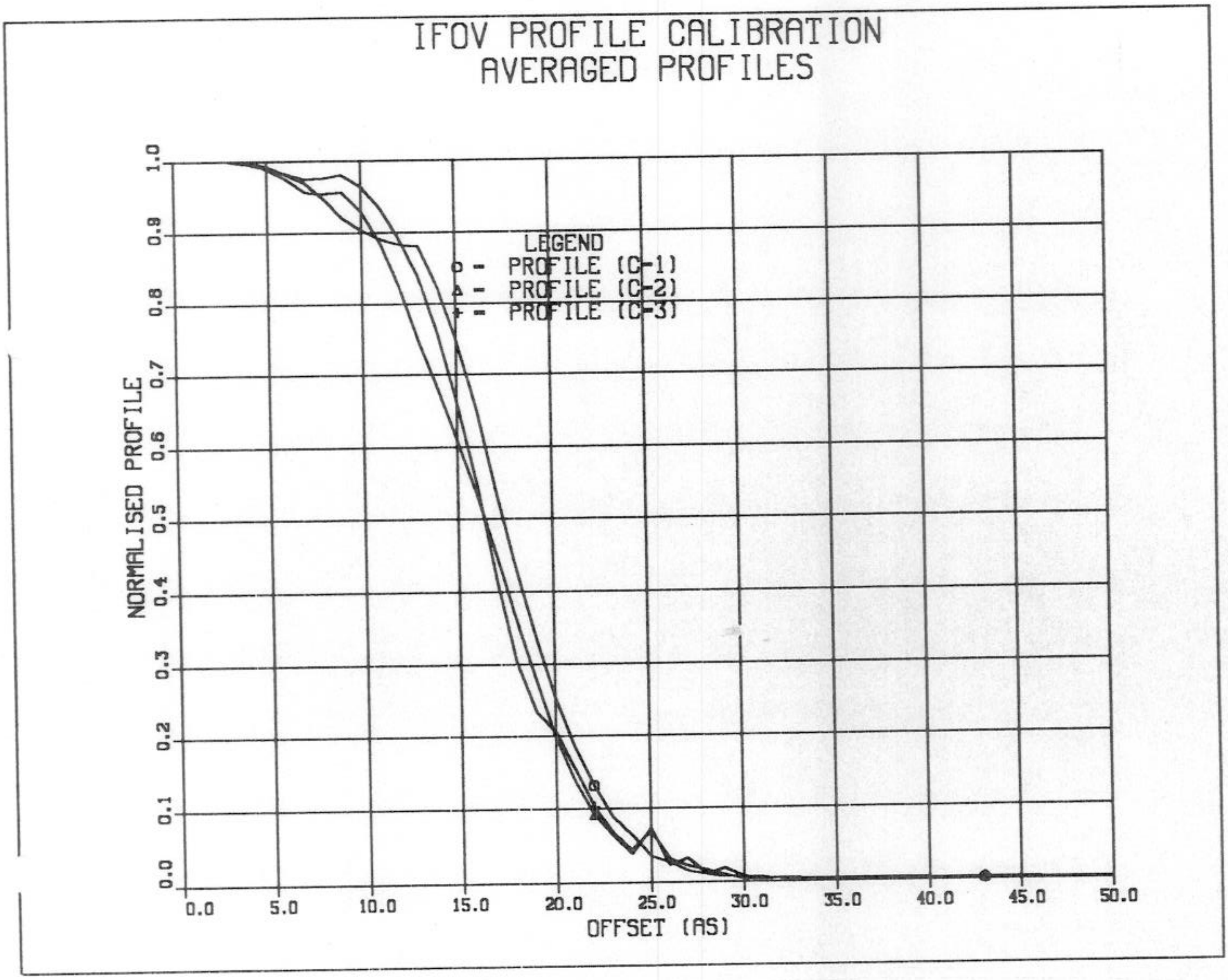
IFOV PROFILE CALIBRATION
AVERAGED PROFILES



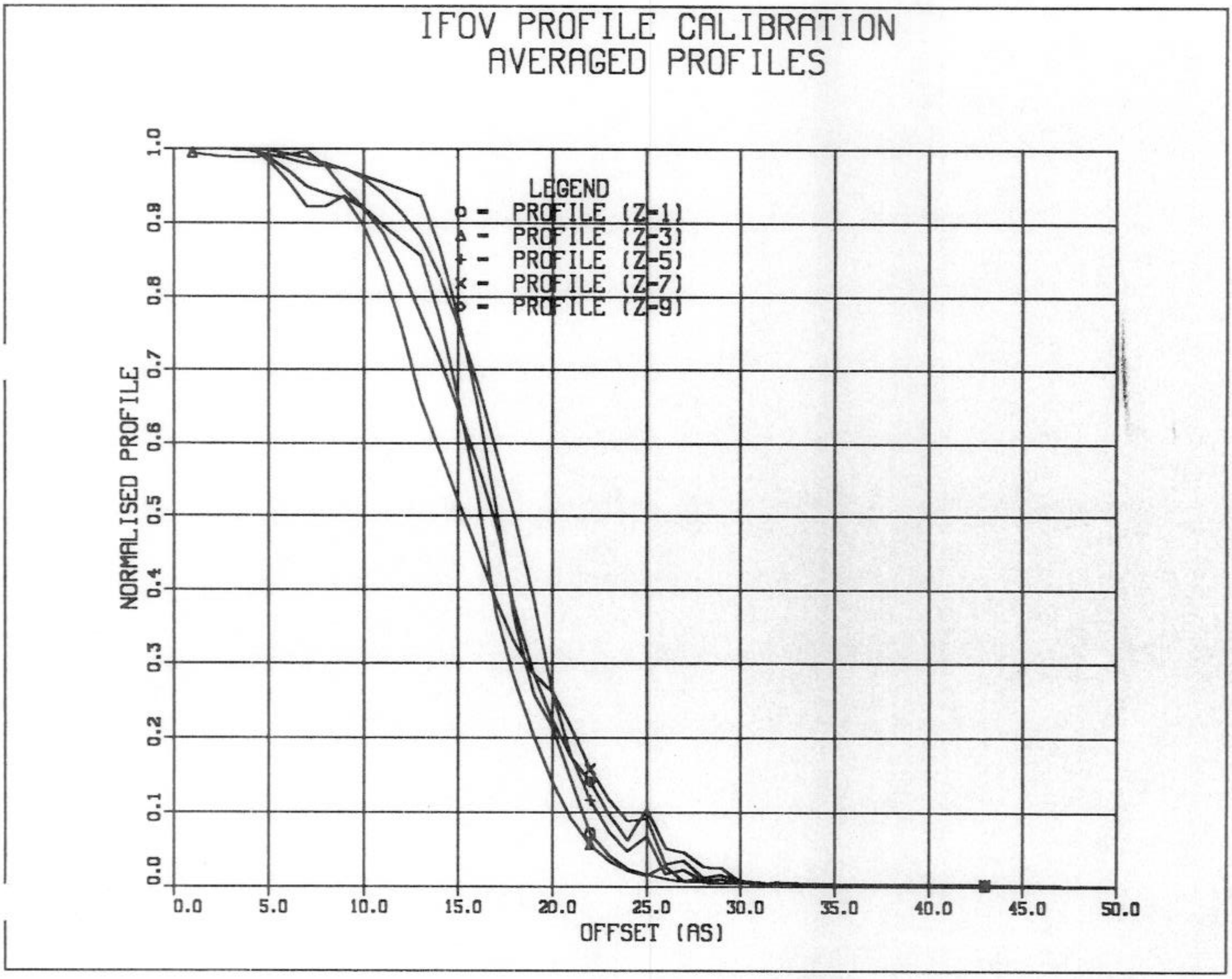
Averaged Profile Compared with Specification



Profiles by Colour Group



Profiles by Zone



Chromaticity Calibration Day 329

Coordinates of spots (arcsec):

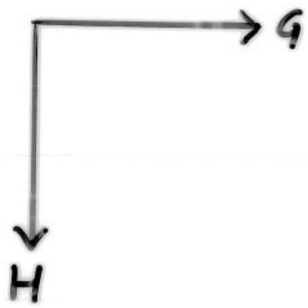
		Predicted	Measured
Blue	(PFOV)	(+45, −8)	(+44, +8)
	(FFOV)	(+43, −8)	(+45, +8)
Red	(PFOV)	(−16, +13)	(−17, −13)
	(FFOV)	(−13, +13)	(−16, −13)

ANNEX
IV

Measured Chromaticity from 961 observations

PFOV

+0.03 ±0.29	+0.17 ±0.28	−0.01 ±0.29
−0.48 ±0.25	−1.24 ±0.20	−2.03 ±0.21
+0.33 ±0.30	−0.46 ±0.23	−1.32 ±0.22



FFOV

+1.12 ±0.27	+0.72 ±0.26	−0.52 ±0.33
+0.84 ±0.20	−0.17 ±0.22	−0.86 ±0.27
+0.42 ±0.23	−0.74 ±0.24	−0.71 ±0.31

"Constant chromaticity" $C_c = -0.27 \pm 0.06$ mas
"Variable chromaticity" $C_v = 0.79 \pm 0.06$ mas
} (spatial averages only)

ANNEX V

GOLDSTONE SUPPORT FOR HIPPARCOS RECOVERY MISSION

89-12-01

Jozef C. Van der Ha

HIPPARCOS Ground Segment Manager
ESOC, Darmstadt, FRG

GOLDSTONE SUPPORT for HIPPARCOS RECOVERY MISSION

GROUND STATIONS VISIBILITY STATISTICS

SINGLE STATIONS:

- **Odenwald (ODN): 34.2 % (ratio of visibility relative to full)**
- **Perth (PER): 35.2 %**
- **Kourou (KRU): 39.0 %**

TWO & THREE STATIONS:

- **ODN + PER: 61.8 %**
- **ODN + PER + KRU: 81.1 %**

PERTH IS FULLY OPERATIONAL (since mid September)

KOUROU IS FULLY OPERATIONAL (since begin November)

Maximum Non-Visibility:

...... ODN + PER + KRU: 11 Hrs ......

ADDING GOLDSTONE as FOURTH STATION:

1. **Total Coverage: 93.6 %**
2. **Maximum Non-Visibility: 1 hr; 18 min**

COVERAGE CHARACTERISTICS OF NETWORK OPTIONS

Network	Coverage Percentage	Maximum Gap
ODN + PER + KRU	81.1	almost 11 hrs
ODN + PER + GDS	91.4	1 hr 27 min
ODN + PER + KRU + GDS	93.8	1 hr 13 min

Table 2. COMPARISON OF COVERAGE CHARACTERISTICS OF NETWORK OPTIONS

ACTUAL COVERAGE SCHEDULE STATISTICS (4 DAY PERIOD)

DAY	ODN	PER	KRU
1	11.5	0.5	-
2	9	3.5	6
3	5.5	8	10
4	7.5	13	2.5
Total	33.5	25	18.5

Table 3. ACTUAL TOTAL STATION COVERAGE INTERVALS (HRS) IN 4-DAY PERIOD

IN TOTAL: ABOUT 77 HOURS OUT OF 96 HOURS (i.e. 80 %)

GOLDSTONE will Add:

About 11 Hours (Single Coverage)

+ About 21 Hours (Redundant Coverage)

GOLDSTONE (SINGLE) VISIBILITY INTERVALS OVER YEAR 90

PERIOD	DAY 1	DAY 2	DAY 3	DAY 4
Mid April	10 - 14	11 - 11.5	-	6.5 - 17
Begin June	2 - 3 & 6 - 12.5	-	-	5 - 9.5
End July	0.5 - 2 & 4.5 - 11	-	-	3.5 - 7
End Sept	1.5 - 8.5	-	-	2 - 4 & 22.5 -24

Table 4. **Intervals (in GMT) of Goldstone SINGLE Coverage over Year**

Band of Goldstone Visibility Shifts Backward in Day over Year:

from: **2 - 16 (in April)**
to: **20 - 8 (in Sept)**
Trend: **- 1.5 hr / Month**

~3 min/day

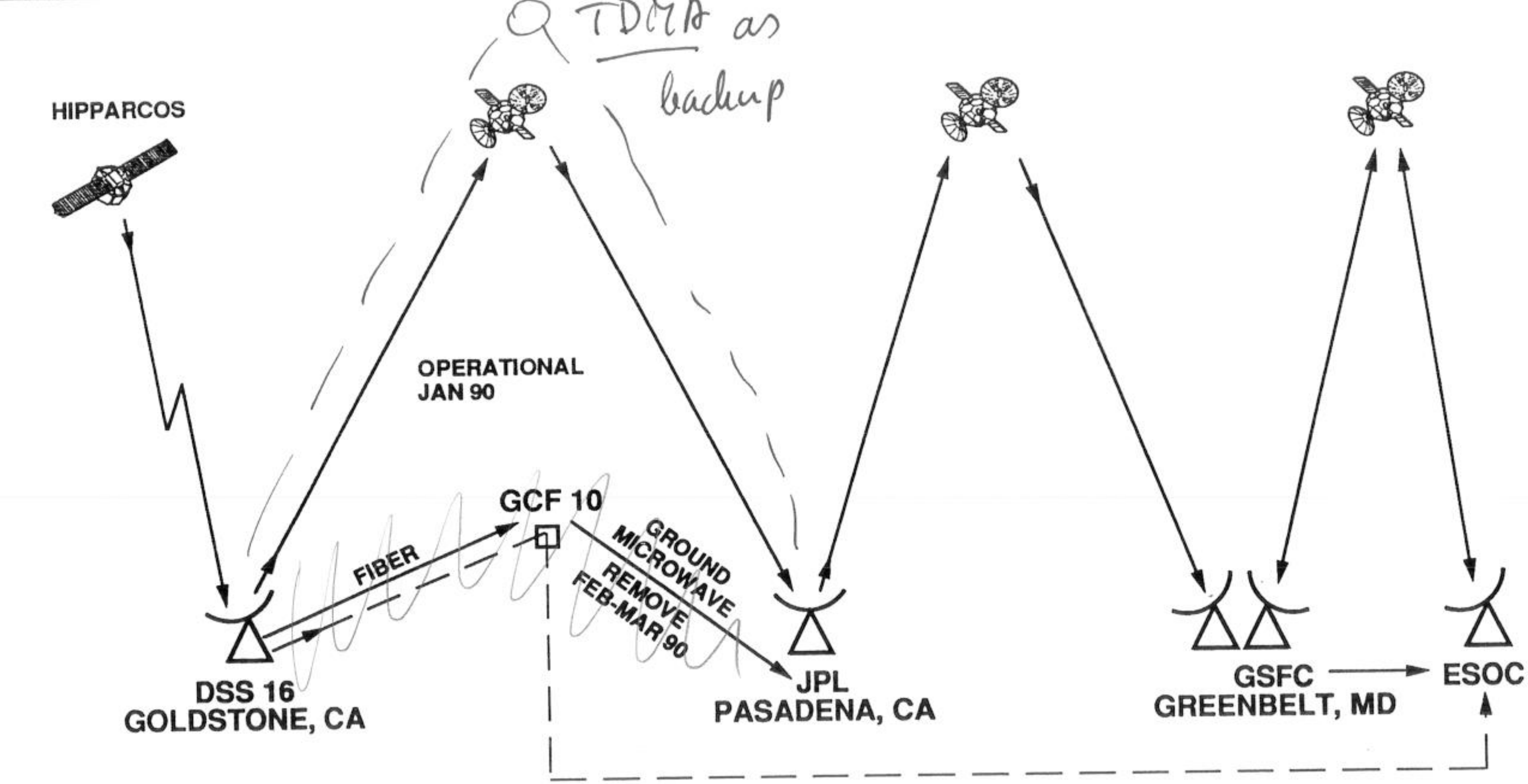
GOLDSTONE (REDUNDANT) VISIBILITY INTERVALS OVER YEAR 90

PERIOD	DAY 1	DAY 2	DAY 3	DAY 4
Mid April	4.5 - 9.5	1 - 11	3.5 - 7.5 & 10.5 - 12	12 - 15
Begin June	3 - 7	0 - 10	1.5 - 6	9.5 - 12
End July	2 - 4.5 & 21.5 -24	0 - 8	0 - 4.5	7 - 9.5
End Sept	0.5 - 2 & 20 - 24	0 - 6 & 20 - 24	0 - 3	4 - 7

Table 5. Intervals (in GMT) of Goldstone REDUNDANT Coverage over Year

HIPPARCOS 56 KB/S DATA ROUTING

JPL



LEGEND:

COMMUNICATION SATELLITE

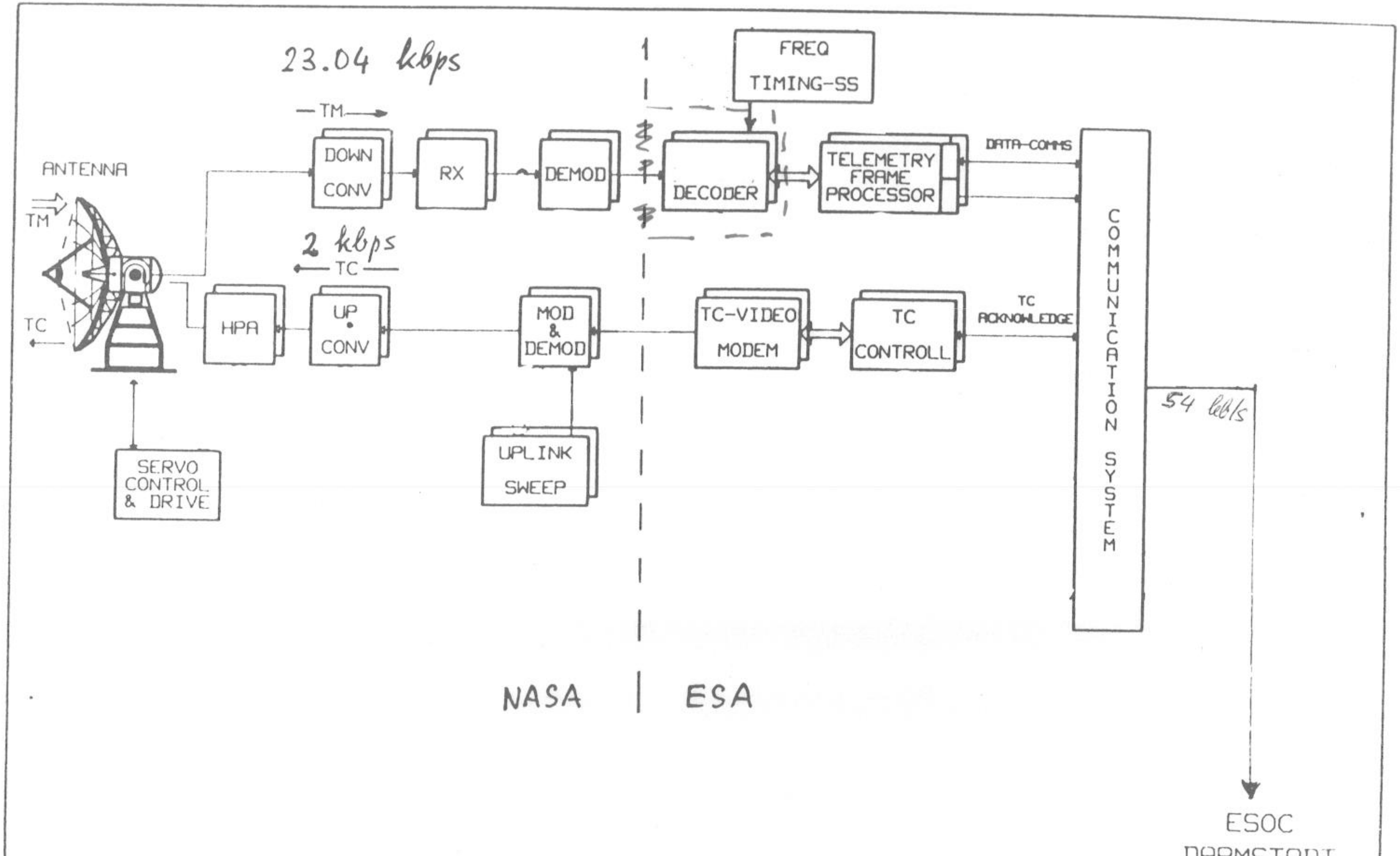
EXPECTED FINAL ROUTING (COM SAT)

TECHNICALLY POSSIBLE ROUTING (ESOC TO GCF 10 DIRECT)

CARRIER TERMINAL INTERFACE

JPMc
12-6-89

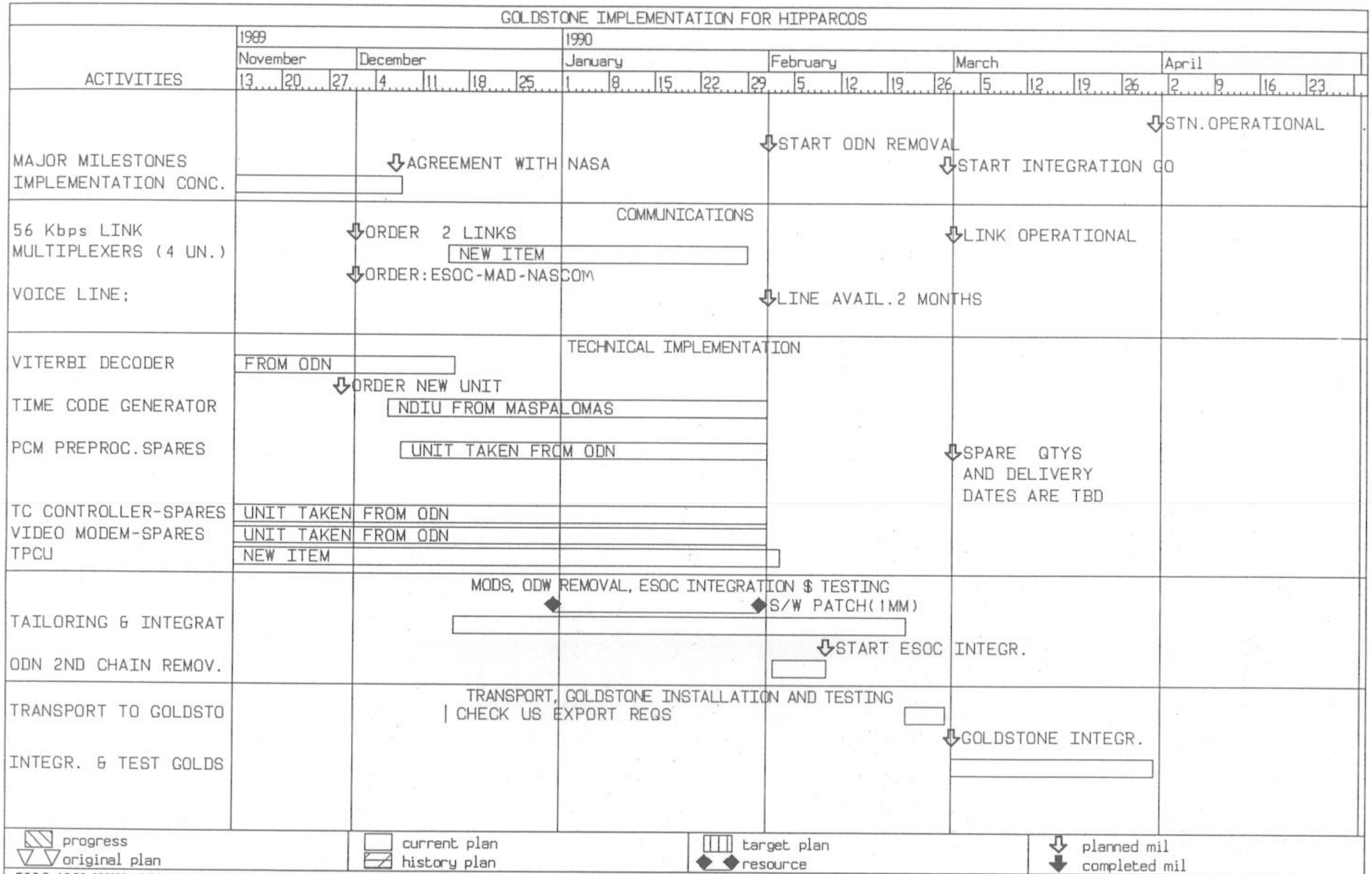
6485-19011ai



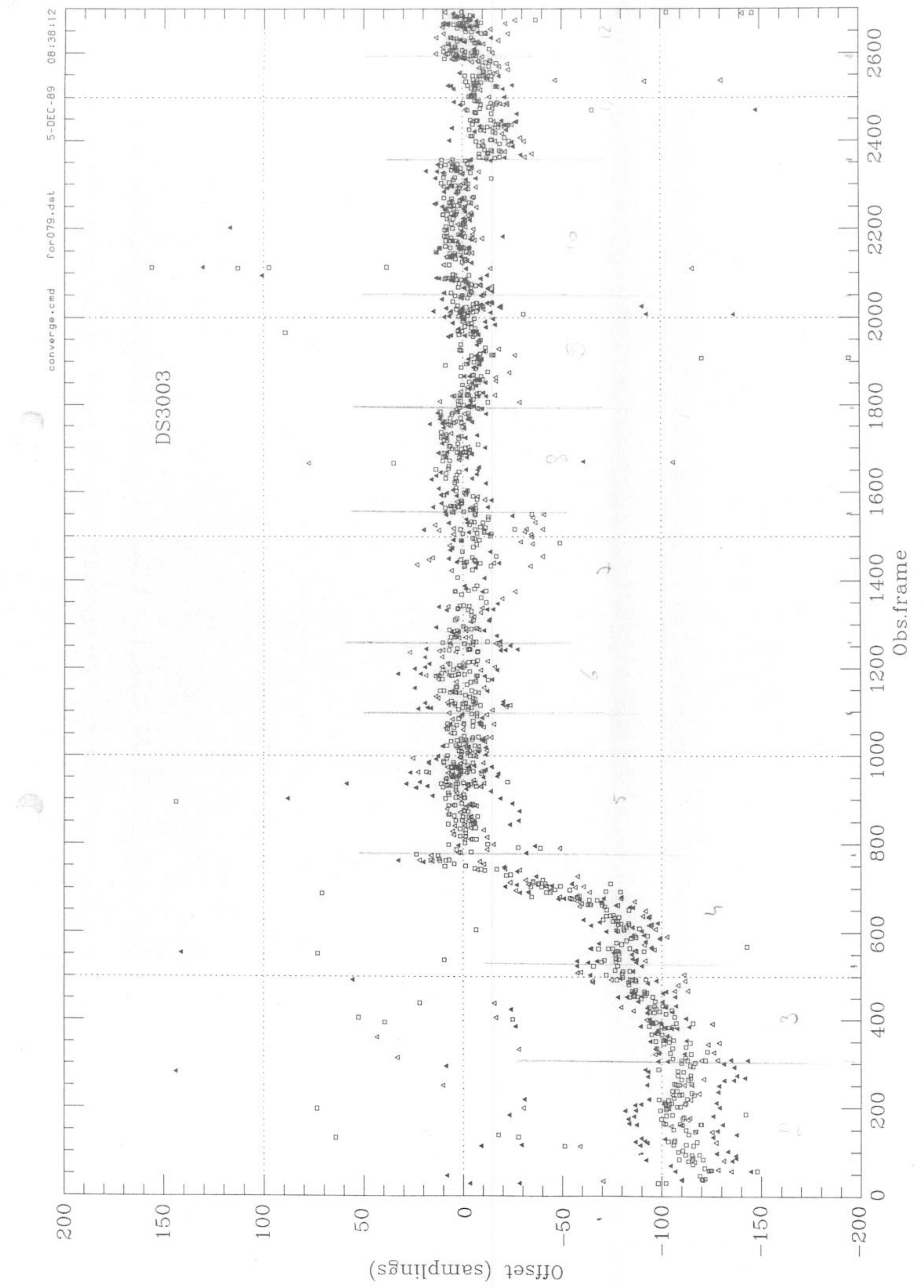
Ground Station Subsystems

Schedule of Implementation

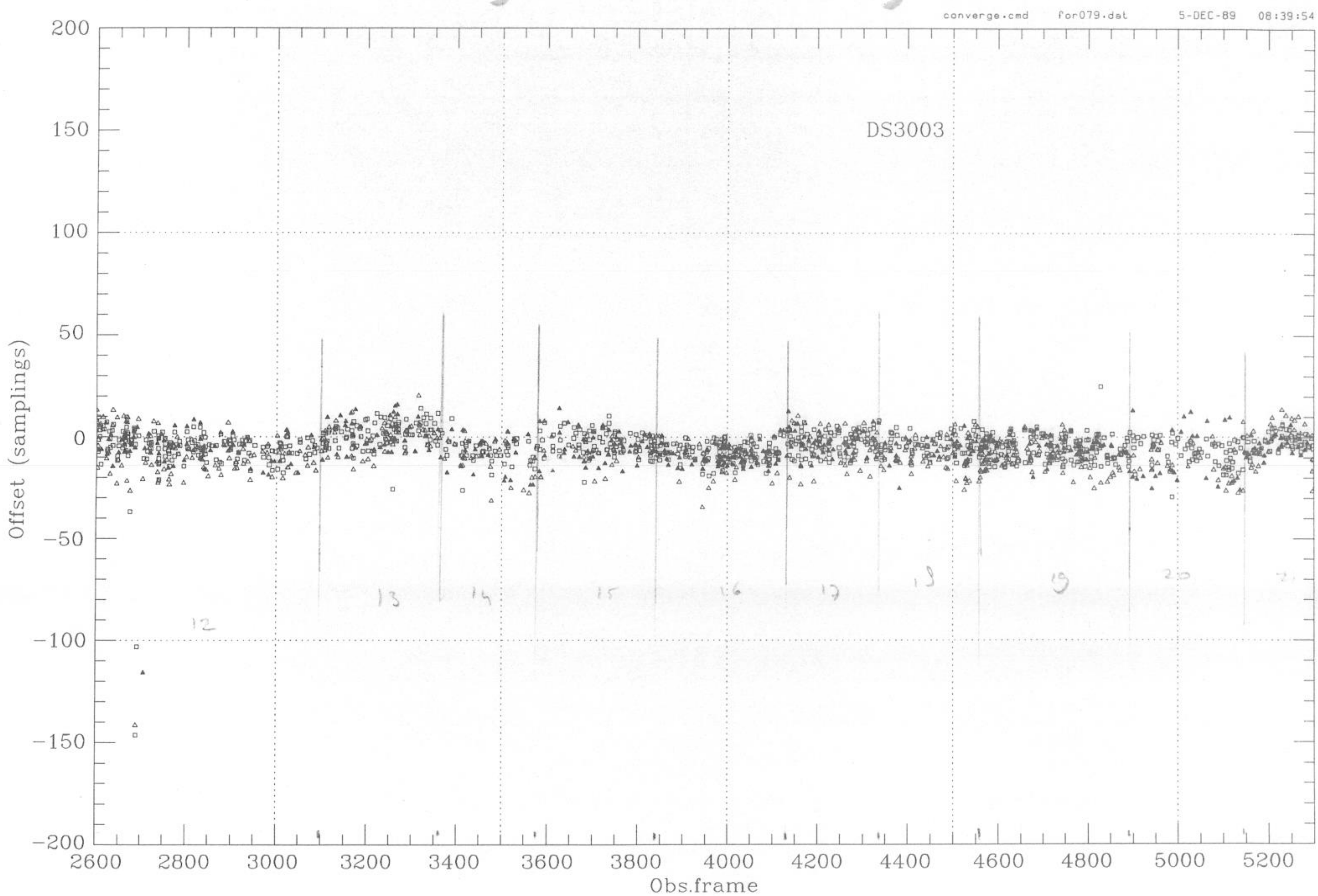
until end Nov:	Finalisation of Implementation Concept
begin Dec:	Discussion and Agreement with NASA/JPL
Dec:	Procurement of Necessary Equipment
Dec/Feb:	Tailoring/Integration of Equipment (at ESOC)
Begin Feb:	Dismantling of ODN Redundant Chain
End Feb:	Transport of Equipment to USA
March:	Integration/Testing at Goldstone
End March:	Goldstone Operational


GOLDSTONE IMPLEMENTATION FOR HIPPARCOS
ACTIVITIES
1989
1990
November
December
January
February
March
April
13 20 27 4 11 18 25 1 8 15 22 29 5 12 19 26 5 12 19 26 2 9 16 23
MAJOR MILESTONES
IMPLEMENTATION CONC.
AGREEMENT WITH NASA
START ODN REMOVAL
START INTEGRATION GO
STN.OPERATIONAL
COMMUNICATIONS
56 Kbps LINK
MULTIPLEXERS (4 UN.)
VOICE LINE;
ORDER 2 LINKS
NEW ITEM
ORDER:ESOC-MAD-NASCOM
LINK OPERATIONAL
LINE AVAIL.2 MONTHS
TECHNICAL IMPLEMENTATION
VITERBI DECODER
FROM ODN
ORDER NEW UNIT
TIME CODE GENERATOR
NDIU FROM MASPALOMAS
PCM PREPROC.SPARES
UNIT TAKEN FROM ODN
SPARE QTYS
AND DELIVERY
DATES ARE TBD
TC CONTROLLER-SPARES
UNIT TAKEN FROM ODN
VIDEO MODEM-SPARES
UNIT TAKEN FROM ODN
TPCU
NEW ITEM
MODS, ODW REMOVAL, ESOC INTEGRATION $ TESTING
S/W PATCH(1MM)
TAILORING & INTEGRAT
START ESOC INTEGR.
ODN 2ND CHAIN REMOV.
TRANSPORT, GOLDSTONE INSTALLATION AND TESTING
| CHECK US EXPORT REQS
TRANSPORT TO GOLDSTO
GOLDSTONE INTEGR.
INTEGR. & TEST GOLDS
progress
original plan
current plan
history plan
target plan
resource
planned mil
completed mil

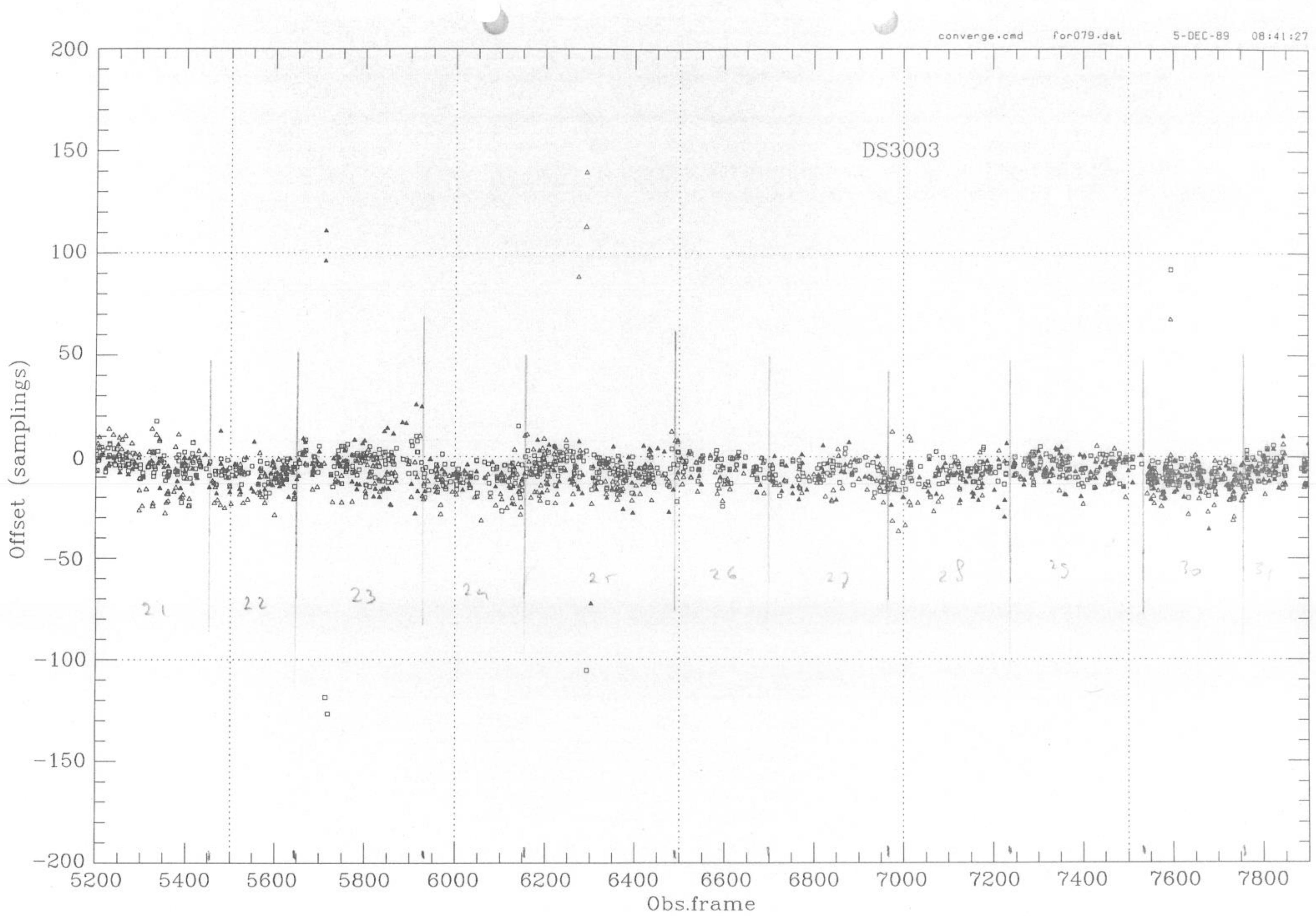
ANNEX VI



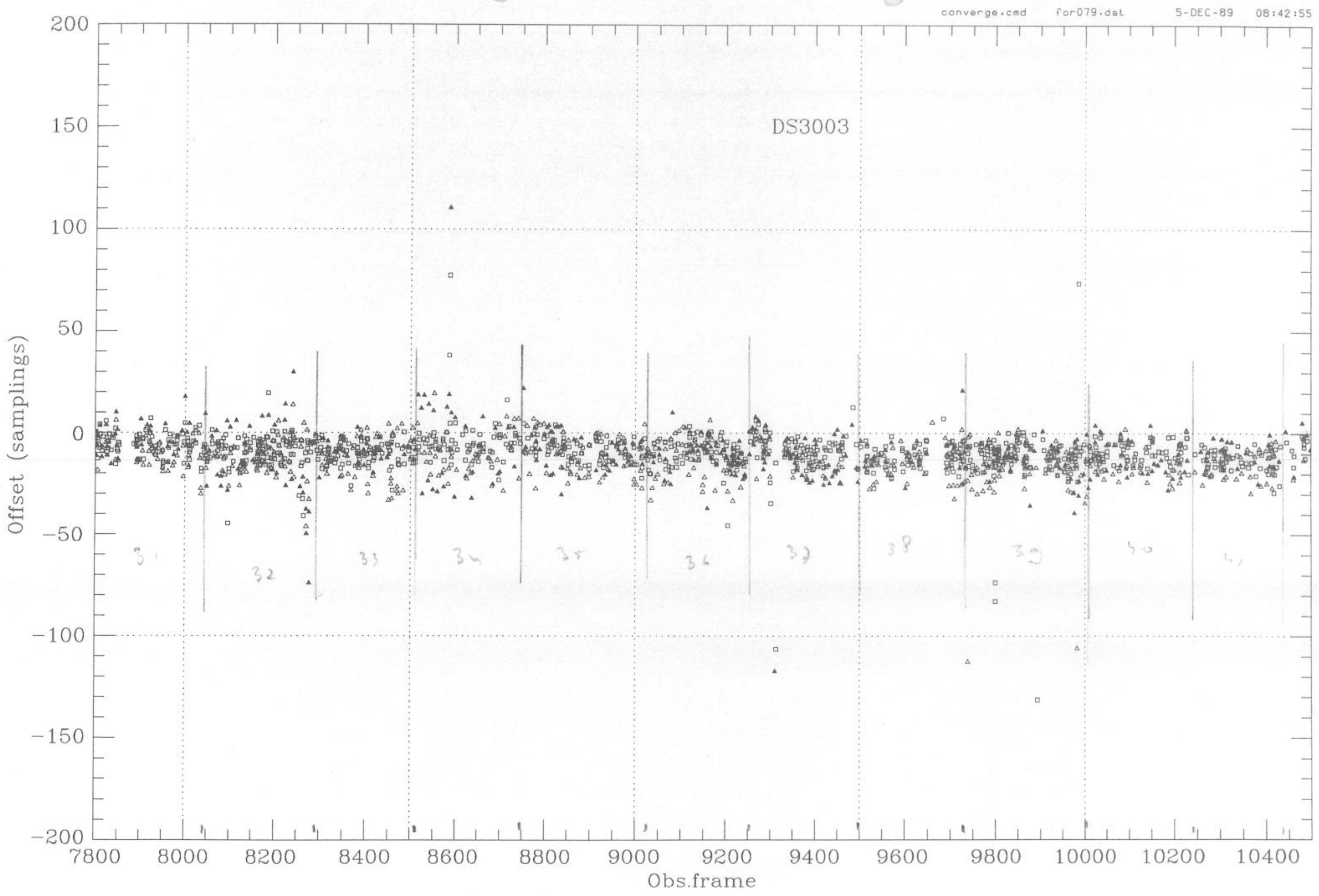
converge.cmd
for079.dat
5-DEC-89 08:38:12
DS3003
Obs.frame
Offset (samplings)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
200
150
100
50
0
-50
-100
-150
-200



converge.cmd for079.dat 5-DEC-89 08:39:54
DS3003
Offset (samplings)
200
150
100
50
0
−50
−100
−150
−200
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
5200
Obs.frame



converge.cmd for079.dat 5-DEC-89 08:41:27
DS3003
Offset (samplings)
200
150
100
50
0
−50
−100
−150
−200
5200
5400
5600
5800
6000
6200
6400
6600
6800
7000
7200
7400
7600
7800
Obs.frame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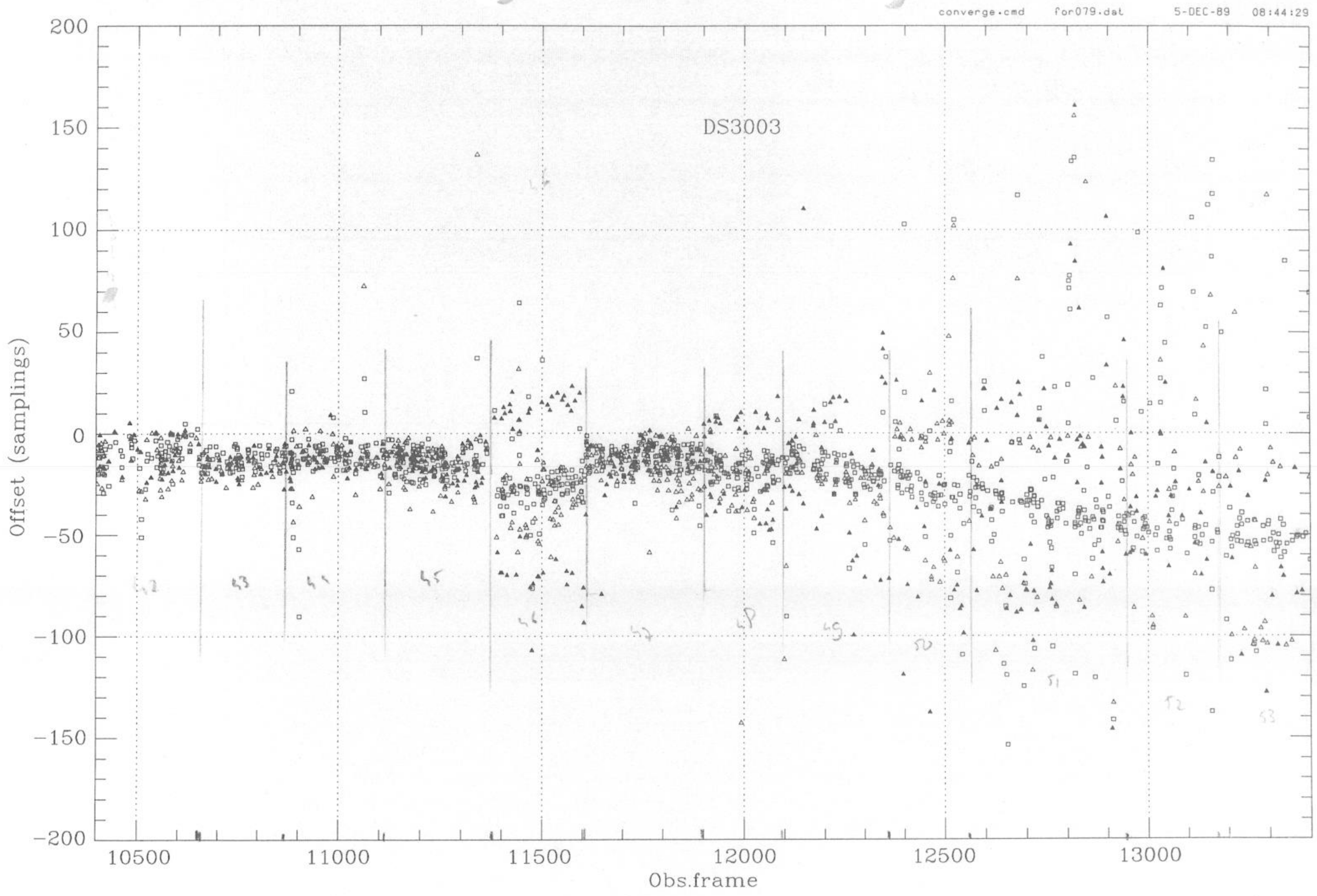
DS3003
Offset (samplings)
Obs.frame
200
150
100
50
0
−50
−100
−150
−200
7800
8000
8200
8400
8600
8800
9000
9200
9400
9600
9800
10000
10200
10400


converge.cmd for079.dat 5-DEC-89 08:44:29
DS3003
Offset (samplings)
200
150
100
50
0
-50
-100
-150
-200
10500
11000
11500
12000
12500
13000
Obs.frame

CERGA. FIRST CALIBRATION OF M_1

MEAN PRECEDING FIELD 0.713 ± 0.007

MEAN FOLLOWING FIELD 0.656 ± 0.007

MEAN VALUES OVER THE FIELD

H^+ ↑ → G^+

0,705	0,701	0,698	0,695	0,693	0,698
0,695	0,690	0,687	0,682	0,675	0,686
0,687	0,687	0,682	0,677	0,672	0,681
0,679	0,681	0,678	0,681	0,671	0,678
0,672	0,679	0,681	0,677	0,674	0,677
0,688	0,688	0,685	0,682	0,677	

RMS per square ≃ 0,030

CERGA. FIRST CALIBRATION OF M_2

MEAN PRECEDING FIELD 0,219 ± 0.004

MEAN FOLLOWING FIELD 0,213 ± 0.004

$M_2 / M_1 \simeq$ 0.297 prec
0.326 foll

MEAN VALUES OVER THE FIELD

G^+ →

H^+ ↑

0,224	0,227	0,221	0,223	0,225	0,224
0,215	0,214	0,211	0,210	0,209	0,212
0,216	0,213	0,207	0,208	0,210	0,211
0,214	0,214	0,210	0,212	0,214	0,213
0,218	0,218	0,214	0,219	0,225	0,219
0,217	0,217	0,213	0,214	0,217	

RMS per square ≃ 0.024

CERGA FIRST CALIBRATION OF $\varphi_1 - \varphi_2$

(m.a.s)

MEAN PRECEDING FIELD $-19.2 \pm 5,6$

MEAN FOLLOWING FIELD $-20,3 \pm 4.4$

MEAN VALUES OVER THE FIELD

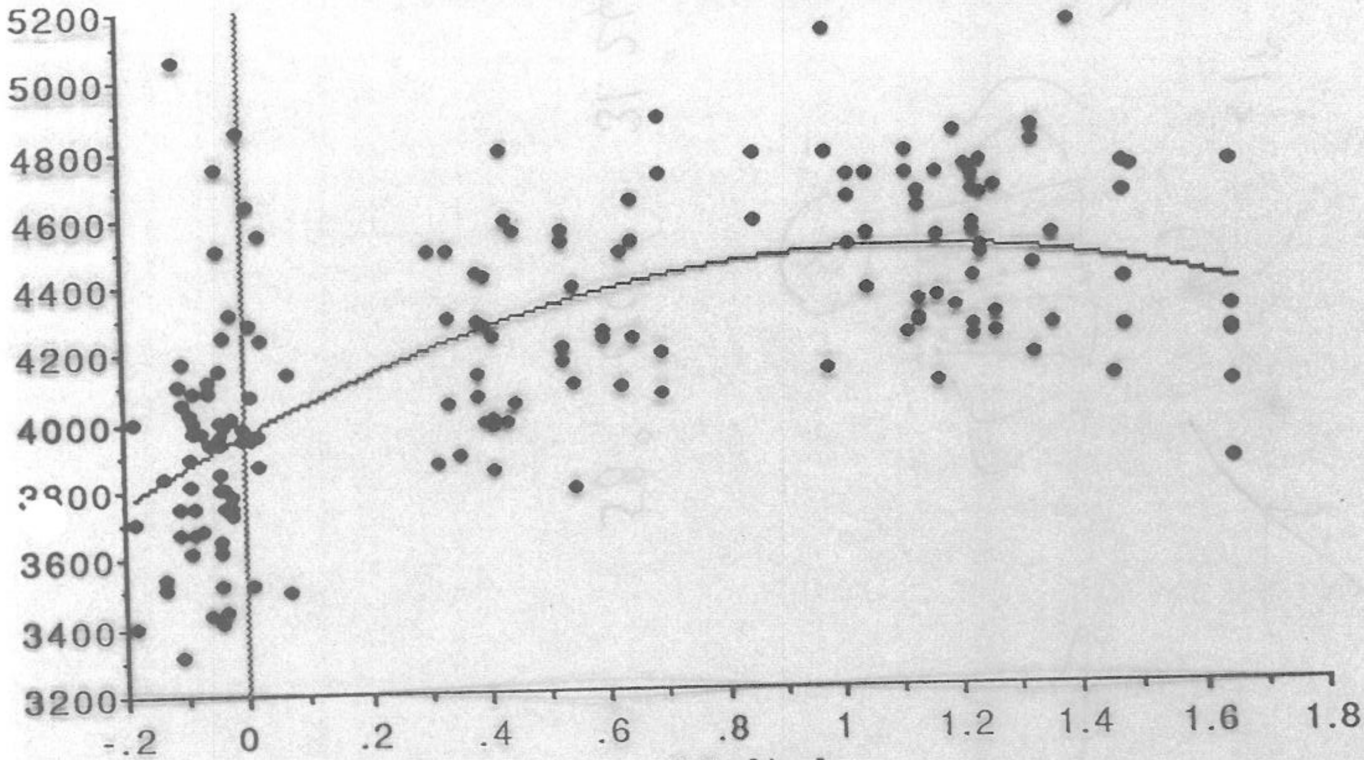
H^+ ↑ → G^+

					MEAN
-20.7	-19,4	-18,5	-17,8	-18.6	19.0
-21.5	-20.9	-20,3	-18.4	-18,1	19.8
-21,9	-21.3	-20,2	-18,9	-16.8	19.8
-21,5	-20,9	-19.9	-18,8	-16,0	19.4
-19.6	-19,3	-20,1	-17,5	-16,9	18.7
21.0	20.4	19.8	18.3	17,3	

RMS per square ≃ 12 mas

V Vertical

$$y = 3965.209 + 938.384x - 418.066x^2$$



V Inclined

$$y = 5787.861 + 1577.183x - 678.215x^2$$