SA/85/203/macp/H
26 March 1985

ELEVENTH MEETING OF THE HIPPARCOS SCIENCE TEAM

ESTEC, 21-22 March 1985

Attendance:	HST	Dr. M. Crézé Dr. A.M. Cruise Prof. F. Donati Dr. M. Grenon Dr. E. Hoeg Prof. J. Kovalevsky Dr. L. Lindegren Mr. C.A. Murray Mr. R. Le Poole (Drs. Turon and Grewing were unable to attend)
ESTEC:		M.A.C. Perryman, M. Schuyer, R.D. Wills, S. Vaghi
Part time:		L. Emiliani, R. Bonnefoy, K. v. Katwijk, G. Ratier, H. Eggel, K. Clausen, H. Hassan
ESOC:		J. van der Ha, N. Head, J. Sternberg
Matra:		E. Zeis

AGENDA

The agenda given in Annex I was adopted.

1. STATUS REPORT (L. Emiliani)

The contract had been signed at the end of 1984. The recent bankruptcy of one of the sub-contractors (CRA) has had an impact on the schedule, and the Flight Acceptance Review is now foreseen for 18 January 1988. Main technical difficulties are presently the beam combiner, Cerenkov radiation, and single particle event impacts on the micro-processor.

Payload testing would commence in Liege in August 1985 which, combined with the Optical Support Programme, should give confidence in the accuracy budgets.

The launch contract with Arianespace would be set-up in the next 2 months, with a launch goal of mid-1988.

The Project is currently reviewing ESOC support requirements in the framework of the total Cost to Completion.

2. STATUS REPORT (M.A.C. Perryman)

Past and future meetings of the consortia were summarised (FAST: 24-25 April, TDAC: 11-12 June, NDAC: 13-14 June, INCA: 3-7 June). Kovalevsky would be coordinating the presentation of HIPPARCOS at the forthcoming IAU General Assembly.

3. DATA INTERFACE DOCUMENT

Sternberg presented the current status of the DDID. Van der Ha summarised the study that had been made on the extraction of program star samples from the TYCHO stream (Annex II). HST clarified the open points as follows: (i) both B and V channel samples are required, (ii) 200 sample window is optimal, (iii) transit time error data for RTAD stars are required, (iv) option 4 (all program star transits) are requested, (v) quality assessment is not required. Kovalevsky stressed that the orbital elements are needed for the first look analysis to be carried out at Utrecht.

These points will be addressed in the next version of the DDID to be produced by ESOC (Action 1).

4. PHASE EXTRACTION MEETING

The first meeting to analyse ESTEC and FAST simulated data took place on 20 March. Vaghi summarised the outcome and future plans (Annex III and Action 2). The next meeting would take place in Copenhagen at the start of June.

5. PAYLOAD STATUS REPORT

The detailed report of the Payload Section is given as Annex IV to the minutes. MAT-HIP-16278 (Selection Approach for IDT's) was distributed. The choices provisionally made are fully supported by M. Grenon. Grenon/Geneva are using tube 98403 (flight spare) characteristics for the INCA pressure computations.

The Project Team's approach to the problems of beam combiner chromaticity and Cerenkov radiation were presented and discussed.

Perryman would initiate coordination of optical studies taking place within FAST/NDAC/ESTEC with the aims of reviewing working assumptions, the available software and predicting results of expected load cases.

6. MATRA REPORT

Zeis summarised the TYCHO dichroic status. With silica now chosen, the count rates and bandpass separation are now satisfactory (Annex V). Grenon noted that care should be taken at short wavelengths to avoid UV contamination of the B_T channel. A plan of action (Action 3) was agreed to finalise the TYCHO response characteristics in the near future. Ratier pointed out that the EM filters had to be manufactured in May.

Zeis summarised the SM distortion and chromaticity status (Annex V). The distortion budget for the inclined slits is well out of specification. HST/ESTEC would await the expected technical note before commenting in detail.

7. ACCURACY STATUS

(a) Schuyer summarised selected features of the February Accuracy Report (Annex VI) covering beam combiner chromaticity, clock jitter, occultations, grid defects and star mapper.

Perryman invited HST to comment on the MATRA approach to simulations of the chromaticity impact (considering that stars may not be observed in both FOV's due to attitude, occultations) and the out-of-specification great circle interruptions (assessed by Matra to have little effect on the GCR rigidity). See Action 4.

(b) Schuyer summarised the orbit determination accuracy status (Annex VII). Appropriate actions, summarised in Action 5, will be undertaken by ESOC to permit HST to assess acceptability of the expected degraded performance. In particular, Lindegren stressed that the form of the attitude errors must be provided.

(c) Spin reversal: The impacts of keeping this option were summarised by Schuyer (on-board software, testing, operational complexity). Bonnefoy noted that the thermal driver is eclipse conditions, and thermal models do not indicate problems in this area. HST will attempt to quantify requirements for spin reversal (Action 6) otherwise this possibility will no longer be considered by the Project. This position was accepted by the HST.

(d) Attitude instability: Donati expressed concerns regarding attitude instability at near limit states which had been found in his simulations. Van der Ha and Zeis did not consider that this was a serious possibility in steady state conditions. Donati would quantify his concerns (Action 7) before this would be studied further by ESTEC.

(e) Scanning law phase: Kovalevsky presented his preliminary findings on the optimisation of the scan phase wrt lunar occultations. Kovalevsky plans to evolve this study into a proposal for the starting phase angle of the nominal scanning law. Crézé noted that he could verify the results of this study.

8. AOCS PRESENTATION

Clausen gave an overview of the AOCS hardware and organisation. A handout summarising the presentation was distributed and is not attached.

9. INCA STATUS

(a) A status report, including details of the recently completed iteration L3 was made by Crézé on behalf of C. Turon. A full report on the availability of star colours would be given at Aussois.

(b) Crézé reported results of his preliminary studies of the GOP which considers whether to have a uniform star density or a uniform accuracy by increasing the numbers of stars at intermediate ecliptic latitudes (Annex VIII). Crézé would produce a note on this to be studied by HST and ESA (Action 9). Perryman had already requested van Daalen to study these points from the DRC viewpoint (accuracy at the GCR level, not only at the sphere level; how time should be distributed according to magnitude and ecliptic latitude; what the star density distribution should be) but no results were yet available. Grenon stressed that decisions are needed to allow INCA to pursue the photometric tasks.

(c) Grenon presented some results of his studies of the photometric properties of the main mission payload, (Annex IX). It was agreed that the recommendation to use M_H would not be implemented for the in-orbit payload verification, but that this did not prevent it being used as the basis for the DRC's treatment of the photometry.

Grenon noted that INCA had now implemented the survey whose limiting magnitude is a function of the colour or spectral type.

Concerning faint stars, those with M_H less than 12.4 mag. (i.e. 70 Hz), recommended by Kovalevsky & Lindegren and supported by considerations of the Donati tests, would be included in the catalogue, those in the range 12.4-13.0 mag. would be flagged, and those with M_H greater than 13.0 would be rejected. This approach allows inclusion to be re-assessed when the payload performance is better known, and would allow stars whose magnitudes are not yet precisely known to be retained pending further investigations.

(d) Double stars: Kovalevsky reported on studies conducted independently by him and Lindegren, leading to the conclusion that the following double systems would be rejected from the Input Catalogue a priori: $\Delta m < 3.5$ mag. and $\rho > 25$ arcsec and $\rho > 5+5\ \Delta m$. These recommendations would be written up in the next INCA Newsletter.

(e) 2130 tasks: Perryman distributed Argue's minutes of the Bordeaux (18 Feb. 1985) meeting summarising the activities of this subgroup. Kovalevsky explained that Hemenway & Duncombe's guaranteed time as members of the FGS team will be partly devoted to observations of the less than 100 QSO/HIPPARCOS star links. Additional ST observations would be requested in open time proposals to be coordinated and submitted later in the year by A.N. Argue, Chairman of the 2130 subgroup.

(f) PSF preparation: Crézé presented the current status of his studies (Annex X). His proposed schedule is:

- tentative scheme available: September 1985
- detailed algorithm: December 1985
- extensive tests and implementation: July 1986

The proposed division of responsibilities between INCA and ESOC would be given in a future report.

Schuyer announced that a new bit will be available in the PSF for flagging high-quality astrometric stars for RTAD. This should be noted by INCA, but it is not expected to be a problem.

10. ACTIONS FROM OCTOBER HST

No actions were considered to remain outstanding.

11. PHOTOMETRIC ASPECTS

Hoeg presented results of his study of the background determination. Details may be found in the Marseille proceedings.

Bonnefoy/Eggel will consider obtaining data from Utrecht during the testing of the IDT's/PMT's in order to allow DRC's to assess effects of photomultiplier fatigue and the validity of the poisson nature assumptions critical to the phase extraction algorithms.

12. <u>COSRD</u>

Perryman would distribute Issue 2 of the OOCR and Issue 1 of the COSRD to the HST. DRC leaders and others in the HST would comment on the documents before the end of April (Action 13) to allow CAPTEC/MATRA to finalise issue 2 of the COSRD due in August 1985. This document will form the basis of the Call for Tender to be issued, where relevant, by ESOC.

Hoeg recommended that provisions for the tests of photomultiplier fatigue and the poisson nature of the counts are made.

Kovalevsky would investigate whether Le Gall could give special attention to the calibration documents as part of his foreseen work within FAST.

13. <u>NEXT MEETING</u>

Dates of 24-25 September were agreed for the next meeting of the HST. This would be preceeded/followed by coordination meetings if required.

M.A.C. Perryman,
Astrophysics Division.

esa estec **HIPPARCOS**

MEETING HIPPARCOS 11th HIPPARCOS SCIENCE TEAM

PLACE ESTEC, Delegates Lounge

REF.

DATE 21-22 Mar 85 **PAGE** 1

ACTION No		DESCRIPTION (not more than 4 lines)	CLOSING DATE	ACTIONNEE Person/firm	INITIATOR Person/firm
?	1.	ESOC to distribute ODID update considering: - Marseille meeting - Villenave & Kovalevsky + Schrijver inputs - HST recommendations (all programme stars, both colours) - availability of orbital elements for first look analysis (see Action 5)	30 April	ESOC (Head)	MACP
delayed ✓ 5th letter	2.	Phase extraction meeting: - DRC to provide poisson generators for ESTEC comparison - ESTEC to propose common output format - ESTEC to produce new tape: four files	15 April 15 April 15 April	FAST/NDAC Vaghi Vaghi	S. VAGHI MACP
✓ part (1) ✓ ✓	3.	- Make TYCHO responce curves available to M. Grenon (filters + PMT) - respond on acceptability of these curves - if considered unacceptable, arrange meeting between M. Grenon and MATRA/ESA as soon as possible after 15 April	29 March 15 April if relevant	E. Zeiss M. Grenon Zeiss/Grenon	MACP MACP MACP
✓	4.	DRC to comment on MATRA simulation of chromaticity at the great circle level (ref Accuracy Report Issue 2, pp. 18 – pp 23) and (out-of-spec) great circle interruptions on GCR accuracy (p 23-27)	30 April	Høg/Lindegren/Kovalevsky	MACP
✓	5.	Confirm orbital determination expected accuracies including: - properties of errors as a function of time, needed by DRC to assess acceptability. - availability w.r.t. requirements of quick look/first look analysis	15 May	ESOC/v.d.Ha	MACP/MS
✓	6.	Quantify requirements for spin reversal	15 April	Cruise/Le Poole/HST	MACP
Signatures					

esa estec **HIPPARCOS**

MEETING HIPPARCOS 11th HST (cont)

PLACE ESTEC

REF.

DATE 21-22 March **PAGE** 2

ACTION No		DESCRIPTION (not more than 4 lines)	CLOSING DATE	ACTIONNEE Person/firm	INITIATOR Person/firm
✓	7	Quantify concerns regarding attitude instability at near limit states including conditions found in simulations	15 April	Donati	MACP
	8	Continue investigation into scanning law/lunar occultations with the aim of recommending initial conditions for scanning	–	Kovalevsky	self-imposed
✓ note	9	Produce note describing studies of observing time/star density as a function of ecliptic latitude; to be studied by HST & ESA	15 April	Crézé	MACP
delayed	10	Produce revision of PSF preparation note, including proposed division between INCA and ESOC tasks	30 April	Crézé	MACP
✓	11	Send printout of program to derive count rates to Grenon	29 March	Wills	MACP
✓	12	Send details of IDT relay lens to J. Kovalevsky	asap	Ratier	MACP
no comments!	13	Comment on Issue 1 of COSRD and Issue 2 of DOCR	30 April	HST	MACP
2 x sent ✓ 29/3/85	14	Distribute to Kovalevsky/Høg document tabulating torques during mission/phases operations	30 March	Schuyer	MACP
Signatures					

ANNEX I

Eleventh Meeting

of the

HIPPARCOS SCIENCE TEAM

21-22 March 1985

AGENDA

1. Status Report (Emiliani)

2. Status Report (Perryman)
   - past/future meetings (FAST, NDAC, INCA, TDAC)
   - IAU Preparations
   - DCN #19
   - spin reversal
   - coordination of optical activities
   - GOP

3. Data Interface Document + SM/reference stars (v.d. Ha)

4. Report on Phase Extraction/Simulation meeting (Vaghi)

5. Payload Status Report:
   - P/L Budget status (KvK)
   - Cerenkov status (RB)
   - Chromaticity/beam combiner (GR)
   - relay optics (GR)
   - detection status (HE)

6. MATRA report (E. Zeis):
   - TYCHO dichroic optimisation
   - SM distortion

7. Accuracy Status Report (Schuyer):
   - Scanning Law Zero Point (Kovalevsky)
   - Orbit determination
   - Verification of Poisson statistics
   - Faint Star observability

8. AOCS Presentation (Clausen)

9. INCA Status:
   - Catalogue L3
   - Double star status
   - Ground PSF Preparation (Creze)
   - Photometric standards (Grenon)
   - 2130 activities

10. Actions from October HST

11. Photometric Aspects:
    - IDT Selection procedure (Grenon)
    - Background determination (Hoeg)
    - Photomultiplier fatigue (Hoeg)

12. Calibration Operational Software Requirements Document (HST comments)

13. AOB

ANNEX II

DIRECTORATE OF OPERATIONS

EXTRACTION OF
PROGRAM STARS SAMPLES
FROM TYCHO STREAM

BY

DR. JOZEF C. VAN DER HA

EUROPEAN SPACE OPERATIONS CENTRE (ESOC)

DARMSTADT, FRG

SM PROCESSING BY OBC

I) CALCULATION OF EXPECTED TRANSIT TIMES USING PSF AND RTAD INFORMATION

II) ACQUISITION OF 200 (BLUE) SAMPLES OVER 0.33 SECONDS WINDOW

III) ACTUAL TRANSIT TIME CALCULATION BY MATCHED FILTER CORRELATION

IV) REJECTION OF SUSPECT TRANSIT TIMES

V) TRANSMISSION OF RESULTS TO CLE FOR RTAD CALCULATIONS

VI) PREPARATION OF OBSERVATION REPORT TO BE DOWNLINKED.

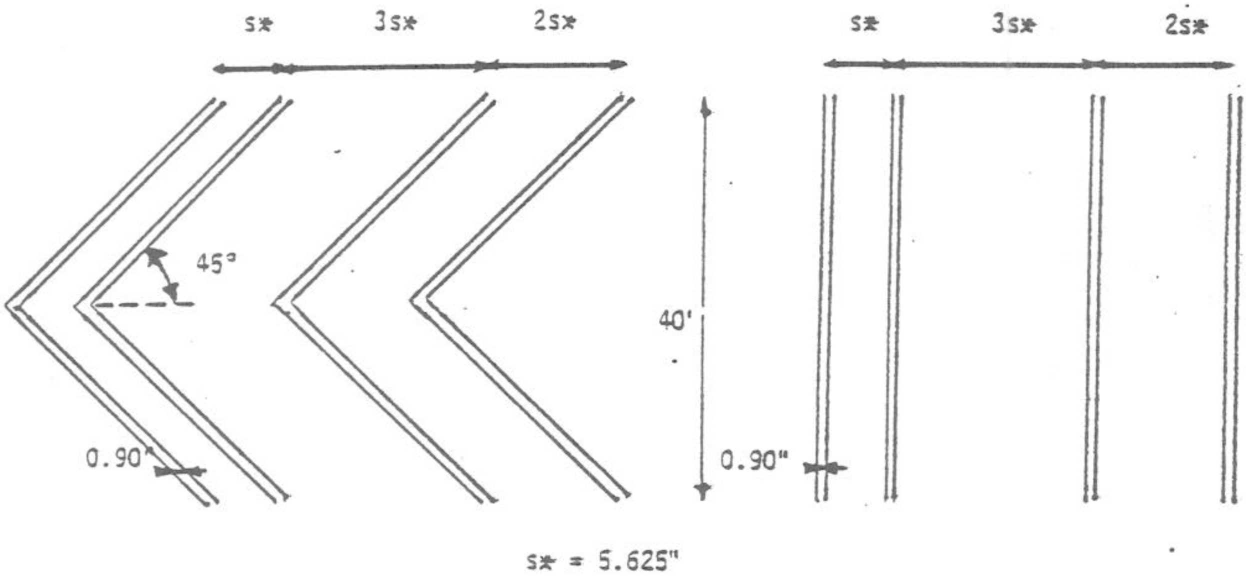


Fig. 3.1.a SELECTED STAR MAPPER CONFIGURATION

SYSTEM PARAMETER	NOMINAL VALUE
Grid Period	5.625"
Vertical Slit Width	0.90 "
Inclined Slit Width	0.90 "
Slit Height	40'
Number of slits	4
Inclined Slit Inclination	45°
Grid Pattern Signature	83
SM Sampling Period	(1/600) s
Maximum Count Rate	4.9 Mhz

B mag	non-degraded measurements	rejected measurements	degraded measurements
5	99.78 %	0.14%	0.08%
6	99.33	0.39	0.28
7	97.9	1.4	0.7
8	94.6	3.5	1.9
9	86.6	11.1	2.3
10	59.8	34.3	5.9

Table 1 Summary of Simulated On-Board Rejection Performance

B (mag)	RTAD stars	OGAR stars
5–6	2000	2000
6–7	5400	5400
7–8	14800	14800
8–9	29800	40800
9–10	5800	16000
total 5-10:	57800	79000

Table 2 Overview on Number of RTAD and OGAR stars within $5 \leq B \leq 10$.

PROPOSED ON-GROUND PROCESSING

I) Calculation of crossing times of all OGAR stars using PSF and downlinked RTAD information

II) Acquisition of 200 Blue (TBC) samples over 0.33 secs (TBC) window

III) Generation of an observation report and recording on Star Mapper File

OPTIONAL:

IV) Inclusion of downlinked transit time errors for RTAD stars crossing accepted by OBC.

AVAILABLE PROCESSING OPTIONS

SM SAMPLE EXTRACTION FOR:

1) THOSE RTAD STAR TRANSITS WHICH ARE PROCESSED ON-BOARD
2) ALL RTAD STAR TRANSITS
3) ALL OGAR STAR TRANSITS
4) ALL PROGRAM STAR TRANSITS

PREFERRED OPTION: 3

Option	Processing Requirements	% Available Transit Time Errors	% of full TYCHO stream	Data Access Requirements
1	1.00	87	2.4	TYCHO & SM reports
2	1.27	69	3.0	" + RTAD & PSF
3	1.73	50	4.1	"
4	2.19	39	5.2	"
5	0	-	100	only TYCHO

Table 3 Comparison of Available Processing Options

OPEN POINTS

1) SHALL ONLY B OR BOTH B AND V CHANNEL SAMPLES BE EXTRACTED FROM TYCHO STREAM?

2) IS THE PROPOSED 0.33 SEC SAMPLING WINDOW WIDTH OPTIMAL?

3) ARE TRANSIT TIME ERROR DATA FOR ACCEPTED RTAD STAR CROSSINGS DESIRED?

CONCLUSIONS

- SM EXTRACTION FOR ALL OGAR STARS SM TRANSITS ARE PROPOSED.
- ESOC PROCESSING AND TAPE VOLUME WOULD INCREASE BY 37% (COMPARED TO ALL RTAD STARS CROSSINGS).
- NO QUALITY ASSESSMENT, E.G. PRESENCE OF PARASITIC STARS, ASTROMETRIC OR PHOTOMETRIC CHECKS WILL BE PERFORMED.
- DELIVERY OF TRANSIT TIME ERRORS FOR ACCEPTED RTAD STAR CROSSINGS IS POSSIBLE.

ANNEX III

OUTCOME OF THE PHASE EXTRACTION MEETING

1. ESTEC WILL PERFORM INDEPENDENT STATISTICAL TESTS OF THE POISSON GENERATORS USED BY FAST, NDAC AND LOGICA

2. ESTEC WILL PROVIDE 4 INDEPENDENT SEQUENCES OF SIMULATED PHOTON COUNTS (90 FRAMES) :

   - WITHOUT NOISE
   - WITH PHOTON NOISE
   - WITH MTF POSITION DEPENDENCE
   - WITH ATTITUDE JITTER

3. ESTEC WILL PROPOSE A COMMON FORMAT FOR THE OUTPUT DATA TO FACILITATE THE COMPARISON OF RESULTS.

Date ....

HIPPARCOS

SCIENCE TEAM MEETING

21ST - 22ND MARCH 1985

PAYLOAD STATUS

PREPARED BY:
R. BONNEFOY
K.V. KATWIJK
G. RATIER
H. EGGEL

ANNEX IV

Date..........

CONTENTS

P/L OVERVIEW

MAJOR EVENTS SINCE LAST H.S.T.

A - SCIENTIFIC PERFORMANCES

- ON-GOING INVESTIGATIONS OF
  - BEAM COMBINER CHROMATICITY INDUCED BY BONDING
  - CERENKOV EFFECT
- ENCOURAGING RESULTS FOR
  - IDT & PMT's PHOTOMETRIC RESPONSE
  - GRID MANUFACTURING

B - HARDWARE DEVELOPMENT

- OPTICAL SUPPORT PROGRAMME (OSP) INITIATED IN OCTOBER 84 IN MATRA (TOULOUSE) AFTER DELIVERY OF
  - BEAM COMBINER (20' ANGLE)
  - SPHERICAL AND FLAT FOLDING MIRROR (SM & FFM)
  - SOME OPTICAL & MECHANICAL GROUND SUPPORT EQUIPMENT (OGSE & MGSE)
- INTEGRATION OF OPTICAL/STRUCTURAL/THERMAL MODEL (OSTM) STARTED IN FEBRUARY AFTER DELIVERY OF
  - PRIMARY STRUCTURE (CFRP)
  - MGSE
  - HARNESS

Date ....

P/L OVERVIEW (CONT´D)

- DELIVERY OF OTHER OSTM EQUIPMENT (MIRRORS, MECHANISMS, THERMAL HARDWARE) EXPECTED IN COMING WEEKS.
- ENGINEERING MODEL OF P/L UNITS BEING MANUFACTURED FOR DELIVERY IN SUMMER '85
- KEY DATES OF PAYLOAD PLANNING:

MECHANICAL TESTS :	JUNE '85
OPTO-THERMAL TESTS:	AUGUST '85
STRAYLIGHT TEST:	OCTOBER '85
MECHANICAL (S/C + P/L) TESTS:	DECEMBER '85
WFE TESTS:	FEBRUARY '86
FPA INTEGRATION & TESTS:	JUNE '86 - DEC '86

- DELAYS IN STARTING PAYLOAD ACTIVITIES DUE TO:
  - INDUSTRIAL DISPUTES (BAFFLES, SECONDARY STRUCTURES)
  - BANKRUPTCY OF A SUB CONTRACTOR (DETECTION BOXES)
  - TECHNOLOGICAL DIFFICULTIES (MIRRORS, OGSE).

Date ....

PRESENT PAYLOAD PERFORMANCES OVERVIEW

PRIMARY BUDGETS		P/L SYSTEM REQU'T	"CURRENT" SUBSYSTEM REQU'T	"BASIC" H/W PERFORMANCE	C O M M E N T S
PHOTONNOISE ERROR	mas	7,10	7,14	6,5-7,1	see MAT-HIP-16278(1)
BASIC ANGLE STABILITY	mas	1,00	0,95	0,64	
DISTORTION STABILITY	mas	1,00	0,99	0,97	
CHROMATICITY - Cc - Cv	mas mas	2,70 1,50	2,30 1,10	- -	) REF. TO BC PRESENTATION)
P/L IFOV PROFILE	-	-	-	WITHIN SPEC	SEE MAT-HIP-3426(3)
IFOV POINTING	as	3,00	2,52	-	TBC
THIRDHARMONIC - M3 - Φ3/3-Φ1	1 degr.	0,007 15,0	0,007 21,0	0,006 11,2	) FOR B-V = 0,5)
TYCHO PERFORMANCES	-	-	-	-	)
SM - DISTORTION - CHROMATICITY	mas mas	25 25	40 1 (?)	- -	) TO BE PRESENTED BY) MATRA)
FRAME ERRORS	-	-	-	-	REF. TO GRID PRESENTATION

INTERMEDIATE BUDGETS		P/L SYSTEM REQU'T	"CURRENT" SUBSYSTEM REQU'T	"BASIC" H/W PERFORMANCE	C O M M E N T S
OPTICAL TRANSMITTANCE	1	-	-	within spec	
MTF DEGRADATION (M1) (M2)	% %	7,4 -	7,3 -	< 7.3 -	REFOC. MECH. STEP SIZE 1,3 µM
FPA DEFOCUS	µm	145	136	-	TBC

Date..........

Date..........

STATUS OF P/L BUDGET REPORTS PER 20.3 85

PRIMARY BUDGET REPORTS	MAT-HIP	ISSUE	UPDATE
PNE	3486(5R1)	15.09.84	31.03.85
Basic angle stability	3571(3)	24.04.84	05.85
Distortion	3567(3)	20.07.84	09.85
Chromaticity	3617(3R1)	22.08.84	06.85
P/L IFOV profile	3426(3)	15.10.84	after H/W test
IFOV pointing accuracy	4948(3)	02.11.84	12.85
Third harmonic	7571(1R1)	30.11.84	07.85
Tycho performances	6488(2)	30.09.84	15.02.85
SM distortion + chromaticity	7697(1)	25.01.84	31.01.85
Grid geometry + calibration	4803(1)	22.04.83	31.01.85

INTERMEDIATE BUDGET REPORTS	MAT-HIP	ISSUE	UPDATE
Optical transmittance	4184(5)	20.04.84	15.02.85
MTF degradation	4435(3)	20.01.84	08.85
FPA defocus	6803(2)	17.07.84	02.85
Relay optics oversizing	17831(1)	26.02.85	-

SENSITIVITY ANALYSES	MAT-HIP	ISSUE	UPDATE
Due to mirror deformations	3553(3)	15.06.84	05.85
Due to optics displacements	3554(3)	30.04.84	SCDR
Telescope deformations	3559(2R1)	02.08.84	06.85

Date ....

D E T E C T I O N

IMAGE DISSECTOR TUBES

ALL 8 TUBES HAVE BEEN DELIVERED.

PRESELECTION HAS TAKEN PLACE BASED ON MANUFACTURER DATA.

THE MAIN CRITERION HAS BEEN PHOTOMETRIC PERFORMANCE AND STABILITY (CATHODE SENSITIVITY, SPECTRAL RESPONSE, PEAK TO VALLEY RATIO).

FURTHER CRITERIA SUCH AS DARK COUNT RATE, OUTPUT UNIFORMITY, NUMBER OF BLEMISHES DO NOT AFFECT THE SELECTION SINCE THERE IS HARDLY ANY DIFFERENCE BETWEEN TUBES (REF. MAT-HIP-16278, ISSUE 1).

FURTHER STEPS

MEASUREMENT OF DETECTION EFFICIENCY AND VEILING GLARE AT SRU.

FINAL SELECTION ON THE BASIS OF SRU MEASUREMENTS ON MATRA/ESA AGREEMENT.

IMAGE DISSECTOR TUBES

TUBE NO.	PNE B=9,B-V=0.5	CATHODE SENSITIVITY MA/W	REMARK
88407	6.50	52.9	FLIGHT 1
88412	6.79	48.7	FLIGHT 2
98403	6.79	47.8	FLIGHT SPARE
48408	6.69	45.6	SPARE 1
88409	7.16	40.1	EM
48404	7.03	45.3	LOW P/V RATIO
88411	7.12	49.2	RED SENSITIVE
48405	7.06	45.2	QUAL. TUBE
SPEC	7.1	40	-

THE EM TUBE HAS BEEN SELECTED DESPITE THE LOWEST PNE SINCE IT MATCHES THE SPECTRAL SENSITIVITY OF THE DESIGNATED FLIGHT TUBES AND HAS A GOOD PEAK TO VALLEY (P/V) RATIO WHICH IS FAVOURABLE FOR PHOTOMETRIC STABILITY (DISCRIMINATOR SETTING).

Date.........................

PHOTOMULTIPLIER TUBES

ALL EM(4) AND FOUR FLIGHT TUBES HAVE BEEN DELIVERED.

FM TUBES: QUANTUM EFFICIENCY OF CATHODE (%) (EMI DATA)

(NM)	SPEC	TUBE 54	TUBE 105	TUBE 181	TUBE 187
350	23	26.8	24.1	24.7	24.3
400	24	28.9	26.3	27.3	26.0
450	24	28.1	25.1	26.1	25.7
500	18	22.3	20.7	20.8	21.3
550	9.6	14.2	13.7	13.6	14.3
600	2.7	4.9	4.5	4.2	4.2
650	0.43	1.08	0.99	0.88	0.88
700	0.01	0.08	0.08	0.07	0.07

NO SPECIFIC SET OF CRITERIA HAS BEEN DEFINED SO FAR FOR THE SELECTION OF THE FINAL FLIGHT TUBES (4), AND FLIGHT SPARES (2) FROM A TOTAL OF 8 TUBES DELIVERED TO FLIGHT SPECIFICATIONS.

Date ....

CERENKOV EFFECT

PROBLEM

- OMNIDIRECTIONAL PARTICLE ENVIRONMENT IN GEOSTATIONARY ORBIT (MAINLY ELECTRONS) CREATE CERENKOV PHOTONS AND LUMINESCENCE IN OPTICAL ELEMENTS
- SENSITIVE ELEMENTS
  - MODULATING GRID ASSEMBLY
  - RELAY OPTICS (IDT & PMT), FILTERS, PRISMS
  - DETECTOR WINDOWS
- IN THE PRESENT CONFIGURATION, RADIATION INDUCED BACKGROUND NOISE WOULD EXCEED PRESENT TOLERABLE VALUE BY SEVERAL ORDERS OF MAGNITUDE
- DETECTION CHANNEL MOST CRITICALLY AFFECTED FOUND TO BE STAR MAPPER DUE TO POST-GRID COLLECTION OF PHOTONS

  I.E. PMT COLLECTING AREA AT GRID LEVEL OF 20MM DIAMETER VERSUS
  IDT COLLECTING AREA OF 0.25 MM (IFOV SIZE AT GRID LEVEL)

Date..

CERENKOV EFFECT

REMEDY

- IMPLEMENTATION OF SHIELDING ON FOCAL PLANE ASSEMBLY (FPA), BETWEEN 8 AND 15 MM EQUIVALENT ALUMINIUM THICKNESS
  - DETECTORS:
    = LOCAL SHIELDING AROUND BACK END OF TUBES (ALREADY IMPLEMENTED BY SRU)
    = ADEQUATE BAFFLING AROUND THE OPTICAL BEAM IN FRONT OF THE PHOTOCATHODES (NEW)
  - OPTICAL ELEMENTS:
    = INCREASE OF RELAY OPTICS HOUSING THICKNESS (NEW)
    = ADDITIONAL SHIELDING ON FPA COVER (NEW)

- THIS FIRST STEP PROTECTS THE MAIN MISSION PERFORMANCES WITH THE MINIMUM PROGRAMME IMPACTS, I.E. MASS, POWER, SCHEDULE, WHICH ARE BEING INVESTIGATED BY MATRA

- A VERY CRITICAL ITEM REMAINS: THE PROTECTION OF THE GRID FROM ELECTRONS PASSING THROUGH THE CENTRAL HOLE OF THE FLAT FOLDING MIRROR (45° ANGLE)

Date..........

CERENKOV EFFECT

PROTECTION OF GRID FROM THE "FRONT END" ELECTRONS

- MATRA HAVE STUDIED VARIOUS OPTIONS OF IMPLEMENTING 8 MM OF ALUMINIUM AROUND THE PAYLOAD
- ALL OPTIONS HAVE ENORMOUS MASS IMPACTS, RANGING FROM 25 KG TO 40 KG, WITH THE ASSOCIATED PROGRAMMATICS CONSEQUENCES: MECHANICAL QUALIFICATION, SCHEDULE, COSTS, ...
- E S A HAVE PROPOSED AN ALTERNATIVE SOLUTION, AMONGST OTHERS, CONSISTING OF
  * IMPLEMENTING 10 MM OF GLASS JUST IN FRONT OF THE STAR MAPPER GRID PATTERNS (GENERATION OF BACKGROUND PHOTONS <u>BEFORE</u> THE GRID AND USE THE SM PATTERN AS SPATIAL FILTER)
  * MODIFYING THE GRID SUBSTRATE
    - TO COMPENSATE FOR RELATIVE DEFOCUSSING MAIN GRID/SM GRID INTRODUCED BY THE ADDITIONAL GLASS
    - TO REDUCE THE THICKNESS OF GRID SUBSTRATE, I.E. SENSITIVITY TO CERENKOV EFFECT
    - TO POSSIBLY IMPLEMENT A MASK AT THE BACK OF THE GRID SUBSTRATE
- SUCH A SOLUTION IS BELIEVED (1) TO DEGRADE ONLY SLIGHTLY THE STAR MAPPER PERFORMANCES (SSR, CHROMATICITY): CONFIRMATION HOWEVER NEEDED FROM MATRA

  (2) TO MINIMIZE PROGRAMMATICS IMPACTS, I.E. LIMIT TO LOCAL REDESIGN OF THE PAYLOAD
- COMPLETE ASSESSMENT BEING DONE BY MATRA FOR PRESENTATION TO ESA ON APRIL 2ND.

Date.......................

Date..........

PAYLOAD CHROMATICITY

° LAST REPORT TO HST : 10 MAS CHROMATICITY DUE TO "TWISTED" DEFORMATION OF BEAM COMBINER (BONDING ON FULL AREA)

° EXTENSIVE INVESTIGATIONS SINCE LAST HST HAVE BROUGHT THE FOLLOWING CONCLUSIONS:

1 - MINIMIZATION OF MECHANICAL EFFECTS DUE TO GLUE CONTRACTION DURING POLYMERISATION BY:

- ° BONDING PATTERN MADE OF 64 DOTS (ø 12 MM) UNIFORMLY DISTRIBUTED ON THE COMMON AREA OF THE TWO HALVES.
- ° INCREASE OF THICKNESS OF BONDING FROM 0.12 MM TO 0.3 MM.

2 - EVALUATION OF CHROMATICITY FROM INTERFEROGRAMMES TO BE PERFORMED VERY CAREFULLY; I.E. AUTOCORRELATION OF PUPIL WFE INSTEAD OF LINEAR COMBINATION OF POLYNOMIAL COEFFICIENTS (USE OF "LASSO" SOFTWARE OF LAS OR NEW SOFTWARE "HIPOTF" DEVELOPED BY MATRA).

3 - EVALUATION OF SURFACE DEFORMATIONS REQUIRES SPECIAL CARE FOR $\lambda/60$ QUALITY LEVEL. I.E. AIR TURBULENCES, TEST HARDWARE, TEST SOFTWARE.

4 - COATING MIGHT INTRODUCE ADDITIONAL DEFORMATIONS.

5 - ASSEMBLY OF BEAM COMBINER BY BONDING IS KEPT AS BASELINE.

- OTHER TECHNIQUES HAVE BEEN DISREGARDED BECAUSE OF PROGRAMMATIC IMPACTS.

Date ....

PAYLOAD CHROMATICITY (CONT'D)

- PRESENT TENTATIVE BUDGET FOR BEAM COMBINER:
  - ASPHERICAL FIGURING 1.0 MAS
  - ASSEMBLY (CUTTING, BONDING) 1.5 MAS
  - COATING 1.0 MAS
  - MEASUREMENT INACCURACY 0.8 MAS
  - PREDICTED CHROMATICITY OF THE ORDER OF 3 MAS PER FOV.
  - OPPOSITE SIGN FOR THE OTHER FOV LIKELY TO OCCUR.
- ACTIONS IN PROGRESS:
  - PRIORITY FOR INCREASING WFE MEASUREMENT ACCURACY (H/W + S/W)
  - VALIDATIONS OF POLISHING METHOD FOR ASPHERIC PROFILE (REOSC)
  - COMPLEMENTARY TECHNOLOGICAL TESTS ON BONDING SAMPLES
- OVERALL PAYLOAD CHROMATICITY : 3 CASES HAVE BEEN STUDIED.

BEAM COMBINER		PAYLOAD	
FOV 1	FOV 2	Cc	Cv
+ 3 MAS	- 3 MAS	2.5 MAS	4 MAS
+ 3 MAS	- 1 MAS	3.5 MAS	3 MAS
+ 3 MAS	0 MAS	4 MAS	2.5 MAS
SPEC PAYLOAD		2.7 MAS	1.5 MAS

Date..........

BEAM COMBINER

1) DEVELOPMENT MODELS

- FLAT SOLID BREADBOARD MODEL
  - BONDED WITH A "RIBBON" OF GLUE (THICKNESS 0.15 MM)
  - THERMAL CYCLING TEST COMPLETED.
  - SURFACE DEFORMATION ASSESSED
- MECHANICAL MODEL ($\lambda/8$)
  - BONDED WITH A PATTERN OF 64 DOTS OF GLUE (THICKNESS = 0.30 MM)
  - THERMAL CYCLING TEST COMPLETED
  - SURFACE DEFORMATION ASSESSED
  - VIBRATION TEST COMPLETED
- ASPHERICAL BREADBOARD MODEL
  - POLISHING ACTIVITIES RESTARTED AFTER APPROPRIATE CORRECTIONS OF WFE TESTING SOFTWARE
  - DEVIATION OF ASPHERICAL PROFILE FROM NOMINAL PRESENTLY ESTIMATED AT $\lambda/30$ RMS.

BEAM COMBINER (CONT'D)

- MINI-BEAM COMBINER
  - BONDING PERFORMED WITH A "RIBBON" OF GLUE
  - THERMAL CYCLING COMPLETED
  - SURFACE DEFORMATION ASSESSED
- BONDING SAMPLES

2) OSP MODEL (γ = 20')
   - DELIVERY TO MATRA CMT - "FLIGHT REPRESENTATIVE" COATING
     - "RIBBON" LIKE BONDING GEOMETRY

3) EM MODEL
   - UNDER MANUFACTURING FOR DELIVERY IN SUMMER '85

4) PFM MODEL
   - AUTHORISATION TO START LIGHTWEIGHTING HAS BEEN GIVEN TO REOSC
   - DELIVERY FORESEEN SPRING 1986

Date

Date ....

TELESCOPE OPTICS

1) OSP MODELS

- ALREADY DELIVERED TO MATRA:
  - ° FFM AT $\lambda/70$ RMS
  - ° SM AT $\lambda/40$ RMS (TO BE SENT BACK TO ZEISS FOR FINAL POLISHING)

2) EM MODELS

- FLAT FOLDING MIRROR
  - POLISHING COMPLETED
  - STATUS BEFORE COATING = ° WFE $\lambda/100$ RMS
    ° CHROMATICITY 1 MAS (TBC)
  - ACCEPTANCE TESTS PLANNED END MARCH '85
- SPHERICAL MIRROR
  - VIBRATIONS TEST SUCCESSFUL
  - UNDER FINAL POLISHING (PRESENT STATUS $\lambda/46$ RMS)
  - PLANNED DELIVERY APRIL '85

3) PFM MODELS

- SHAPING HAS STARTED
- CDR PLANNED MID APRIL '85

MODULATING GRID

1) DESIGN & MANUFACTURING

- WORK PROCEEDING ON PILOT SERIES
- STAR MAPPER WRITING STRATEGY REVIEWED TO IMPROVE PERFORMANCES AND ON-GROUND CALIBRATION ACCURACY
- SUPER POLISH IS REQUIRED TO MINIMIZE GRID DEFECTS, BUT PRESENT QUALITY (ASTRON) HAS TO BE IMPROVED.
- PARTIAL REDESIGN OF SUBSTRATE IS CONSIDERED TO MINIMIZE CERENKOV EFFECT.

2) CALIBRATION

- MAIN FOV OF P5 SAMPLE HAS BEEN FULLY CALIBRATED WITH EBPG
- M.S.I. MATRIX (P.5) SHOWS A "SIGNATURE" RATHER INDEPENDENT OF THE H COORDINATE.

Date.................

GRID (CONT'D)

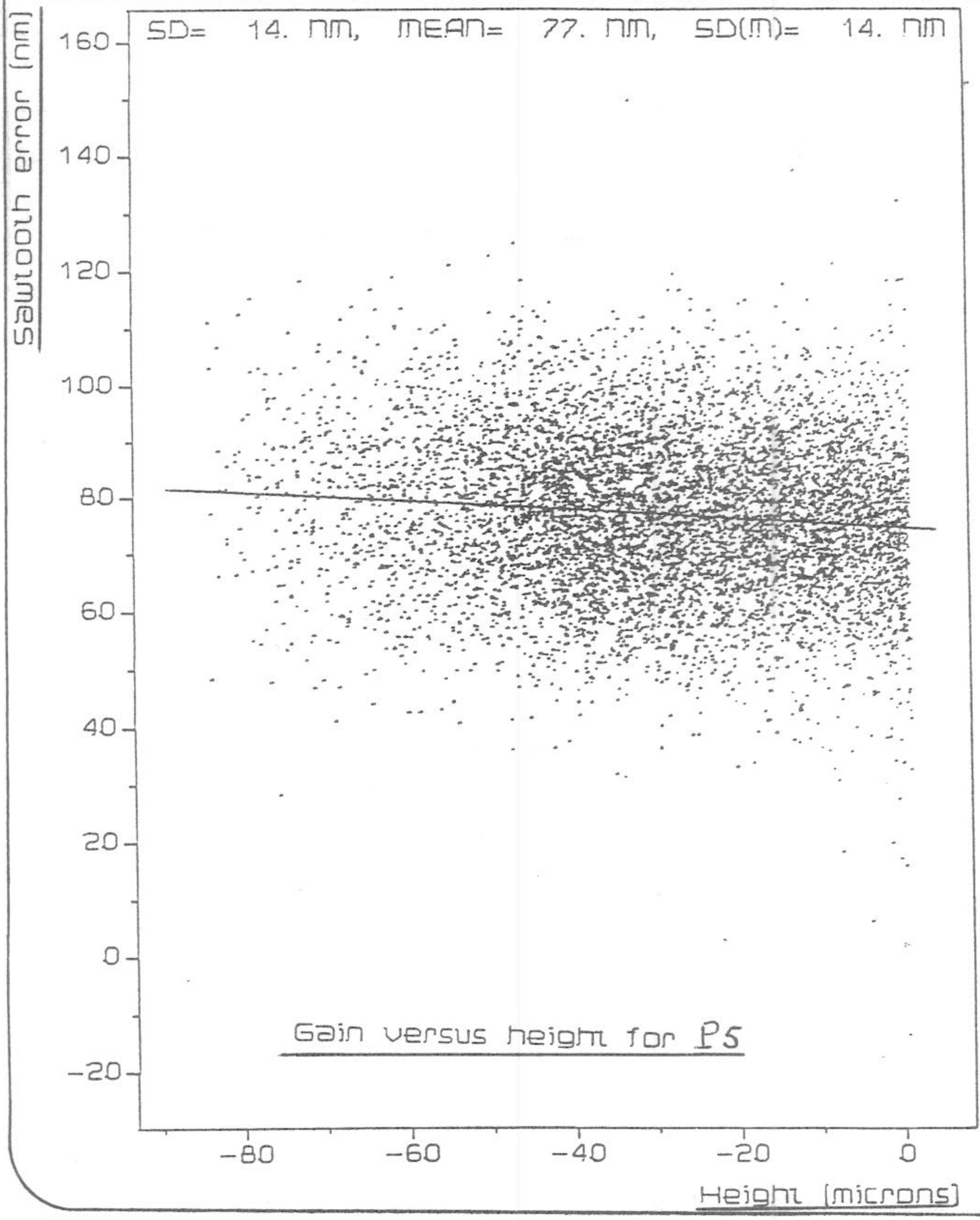
3) MAIN RESULTS (P2 & P5 SAMPLES)

	SPECIFIED	ACHIEVED
- STITCHING (SAW TOOTH)		
- REGULAR PART	17.6 MAS MAX	12.5 MAS MAX (P5)
- IRREGULAR PART	4.4 MAS RMS	3.2 MAS RMS (P5)
- SCANFIELD ROTATION		MEAN VALUE = 0.44 MAS
- NOT CORRELATED	= 5 MAS MAX	1 MAS RMS (P5)
- CORRELATED	= 1.76 MAS MAX	(PARTIAL CORRELATION)
- MEDIUM SCALE IRREGULARITIES (BEFORE CALIBRATION)	14.7 MAS MAX (DESIGN GOAL)	$-12.9 < MSI < +16$ MAS (P5)

Date....................

19

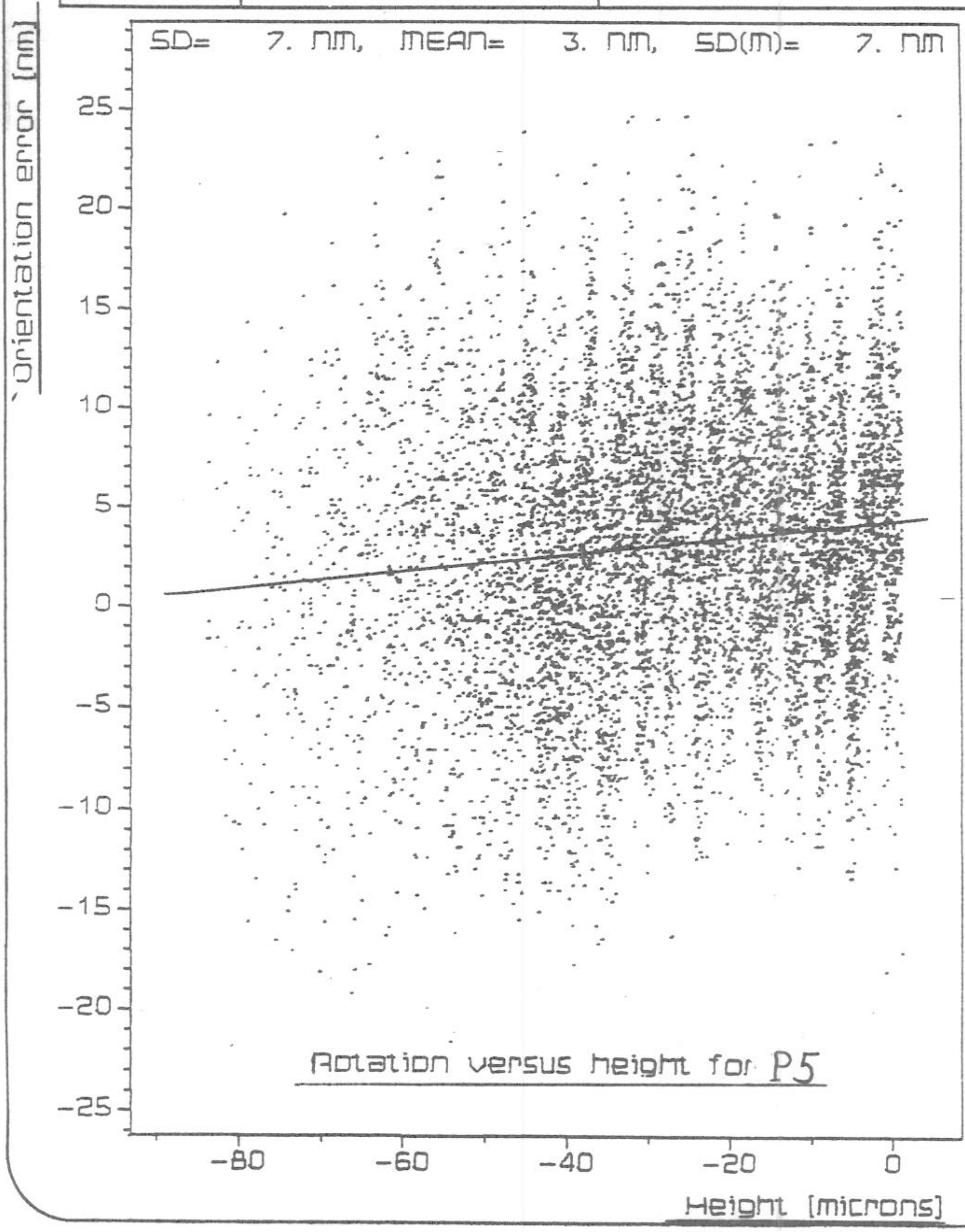
	HIPPARCOS	DOC-NR: TPD-HIP-GRD-MR-90 ISSUE : 1 DATE : 08-01-1985 PAGE : 13



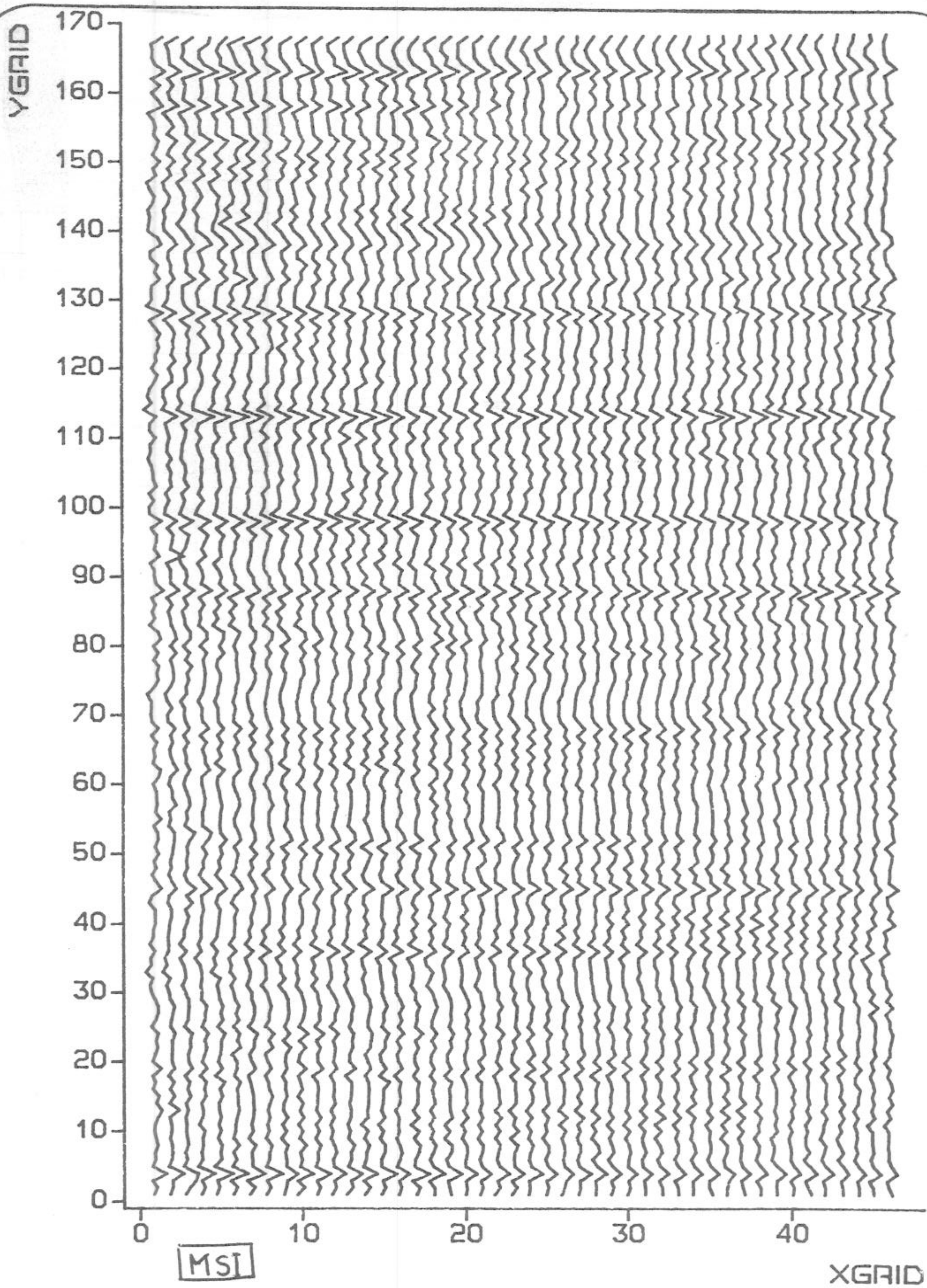
Date ....

20

TPD	HIPPARCOS	DOC-NR:	TPD-HIP-GRD-MR-90
		ISSUE :	1
		DATE :	08-01-1985
		PAGE :	15

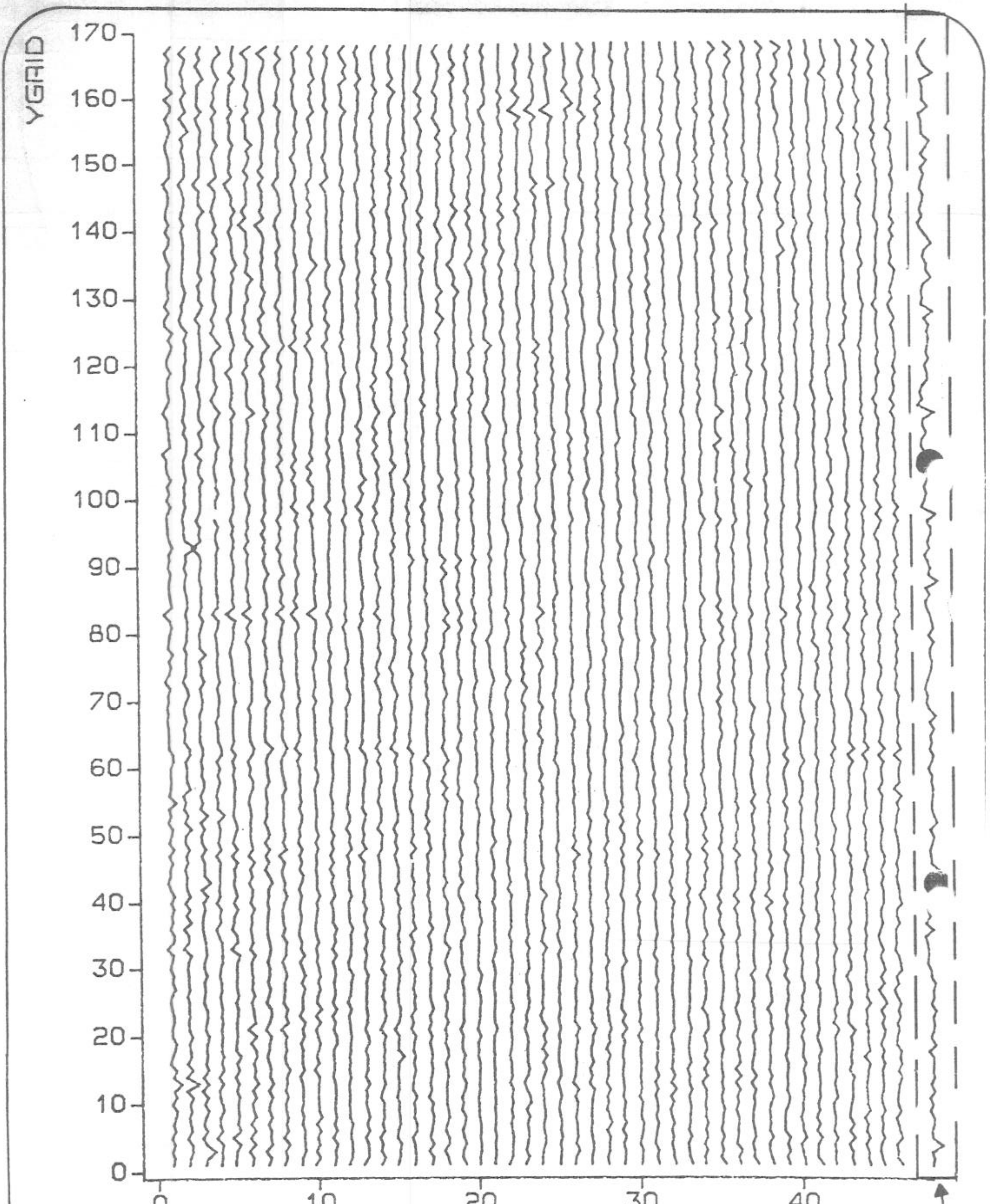


Date ....



D/P5/218 deviations 100 nm / div

Date..



D/P5/218 deviations 100 nm / div – mean value

Date ....

Date ....

PMT RELAY LENS

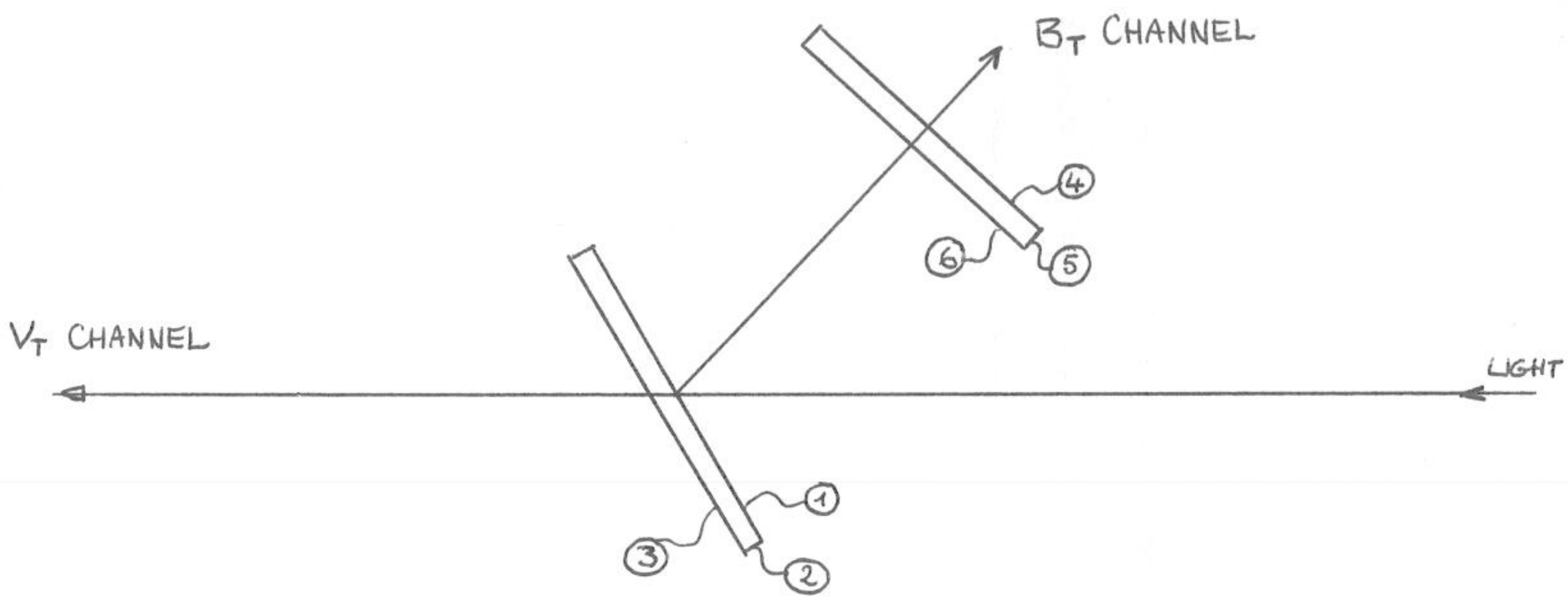
- LENSES MADE OUT OF SILICA
- SHIELDING TO AVOID CERENKOV EFFECT IS MANDATORY

  FORESEEN THICKNESS = 15 MM EQUIVALENT AL.
- BLOCKING FILTER ON V_T CHANNEL IS NOW INTEGRATED IN DICHROIC.
- DESIGN NOT YET AGREED BETWEEN ZEISS AND MATRA

  OPEN POINTS :

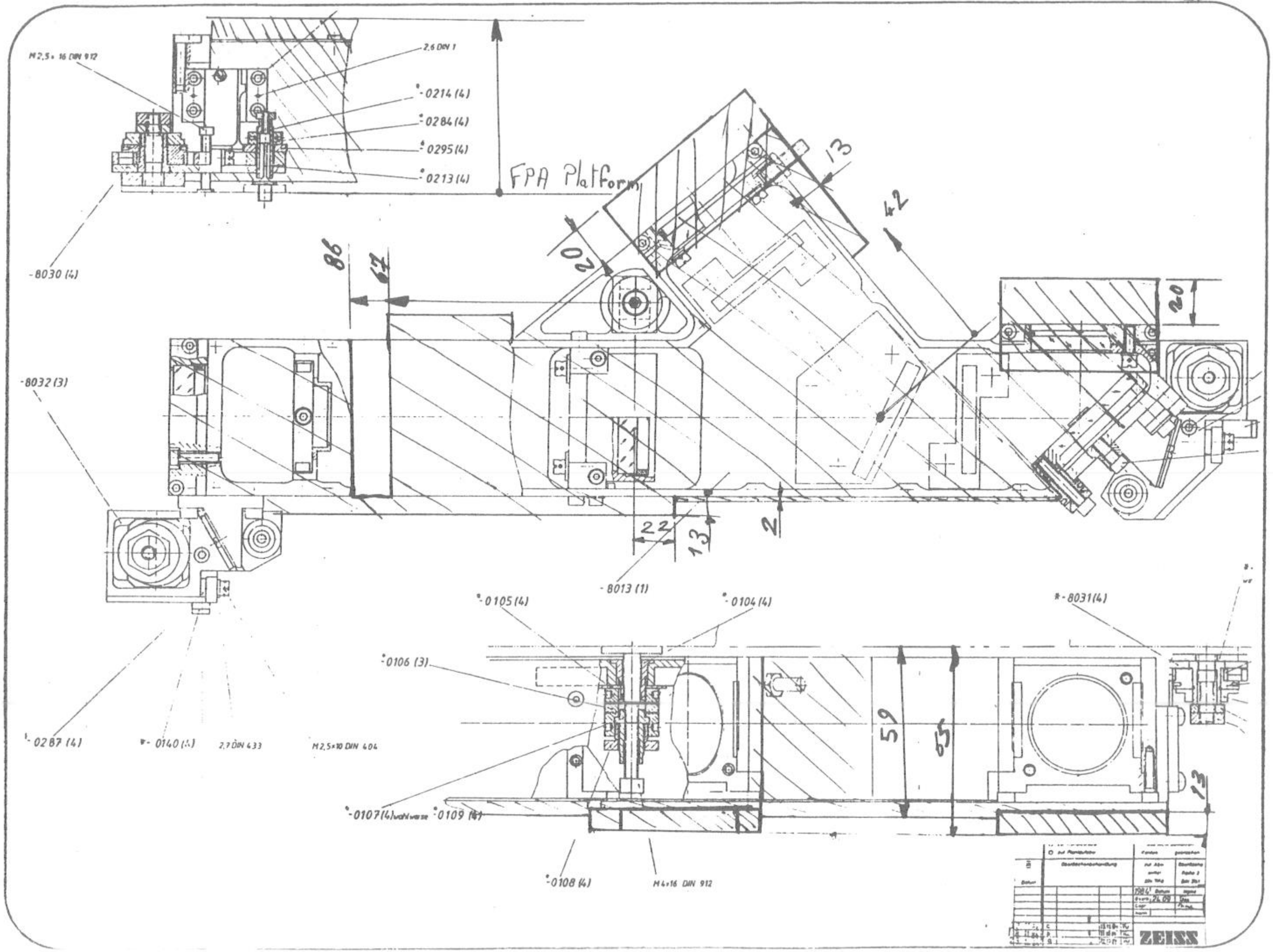
  - DIAMETER OF LENSES
  - EXACT SHIELDING REQUIREMENTS

Date............................



1. DICHROIC LAYERS
2. GG 475 – Th : 4 mm
3. A.R COATING (500-800 nm)
4. A.R. COATING (350-500 nm)
5. SILICA SUPRASIL – Th : 4 mm
6. LOW PASS FILTER.

NEW BASELINE
FOR
DICHROÏC FILTERS.


M 2,5 x 16 DIN 912
2,6 DIN 1
-0214 (4)
-0284 (4)
-0295 (4)
-0213 (4)
FPA Platform
-8030 (4)
-8032 (3)
86
67
20
13
42
22
13
2
-8013 (1)
-0105 (4)
-0104 (4)
-8031 (4)
-0106 (3)
-0287 (4)
-0140 (4)
2,7 DIN 433
M 2,5 x 10 DIN 404
59
65
13
-0107 (4) wahlweise
-0109 (4)
-0108 (4)
M 4 x 16 DIN 912
ZEISS

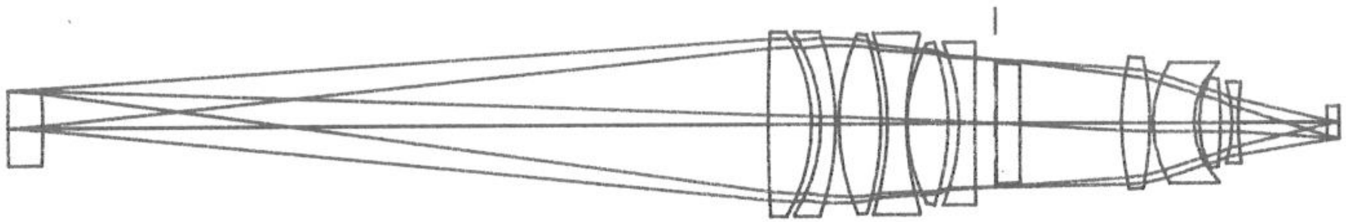
Date.................

Date

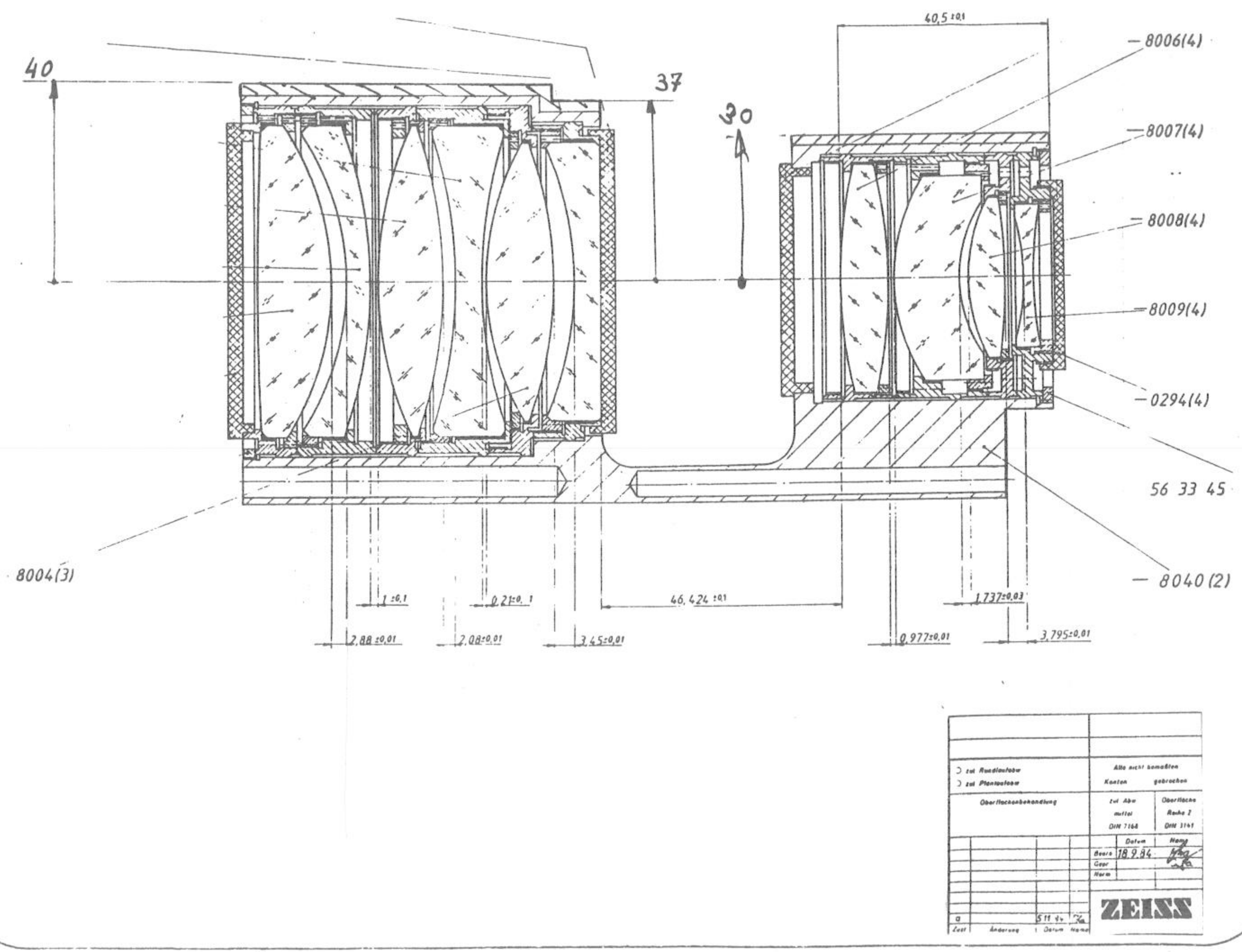
IDT RELAY LENS

- DESIGN FROZEN IN 3 CONFIGURATIONS =
  - NORMAL MODE
  - CHROMATICITY CALIBRATION MODE
  - ISPA MODE
- OVERSIZING FIXED TO 1.01 (NOMINAL VALUE) (USEFUL DIAMETER OF 42.0 MM)
- 8 MM (AL EQUIVALENT) SHIELDING IS FORESEEN IN ORDER TO AVOID:
  - GLASS DARKENING DUE TO IRRADIATION
  - CERENKOV EFFECT
- ENGINEERING MODEL IN MANUFACTURING

Date..........................



** IDT RELAY LENS ** #NORMAL MODE# (MARCH 85)
60.000000 LENS Y-Z PROFILE



40
37
30
40,5 ±0,1
8006(4)
8007(4)
8008(4)
8009(4)
0294(4)
56 33 45
8040 (2)
8004(3)
1 ±0,1
0,21±0,1
46,424 ±0,1
1,737±0,03
2,88 ±0,01
2,08±0,01
3,45±0,01
0,977±0,01
3,795±0,01
zul. Rundlaufabw.
zul. Planlaufabw.
Oberflächenbehandlung
Alle nicht bemaßten Kanten gebrochen
zul. Abw. mittel DIN 7168
Oberfläche Reihe 2 DIN 3141
Datum
Name
Bearb.
Gepr.
Norm
18.9.84
a
5.11.84
Zust.
Änderung
Datum
Name
ZEISS

TYCHO DICHROIC OPTIMISATION

NOMINAL CONFIGURATION :

- RELAY LENSES MATERIAL : SILICA
- DICHROIC : SPECTRAL SEPARATION = 465 NM
- V_T CHANNEL : SEPARATION FILTER (GG475)
- B_T CHANNEL : LOW PASS FILTER

PERFORMANCES :

CASE	PHOTON COUNTS (HZ) : (B+V)/2 = 9.65						Δλ (NM)
	B-V = 0		B-V = 0.7		B-V = 1.5		
	B_T	V_T	B_T	V_T	B_T	V_T	
LAST ACCURACY REPORT	3239	1796	2099	2037	1324	2585	108
NOMINAL	4406	2181	2636	2397	1565	2327	112
DICHROIC = 455 NM	3887	2203	2351	2418	1361	2546	114

STAR MAPPER DISTORTION

PRELIMINARY DEFINITIONS

G_1^1, H_1^1 : Actual Chief Ray Grid Coordinates

G_L, H_L : Estimated Chief Ray Grid Coordinates (from extrapolation of main grid LSC)

SM, SM_{nom} : Phase shift between the chief ray and the SM filtered signal correlation peak for the actual / nominal SSR

(Nota Bene: the SM digital filter is based on the reference SSR)

SM LARGE SCALE DISTORTION

- EXTRAPOLATION ERROR :
  - Vertical Slits : $\Delta G_1^1/_V = G_L - G_1^1$
  - Inclined Slits : $\Delta G_1^1/_I = (G_L - G_1^1) + \varepsilon (H_L - H_1^1)$ $(\varepsilon = \pm 1)$
- PHASE SHIFT WRT CHIEF RAY:
  - Vertical Slits : $\Delta G_1^2/_V = (SM - SM_{nom})/_V$
  - Inclined Slits : $\Delta G_1^2/_I = (SM - SM_{nom})/_I$

Nota Bene: The nominal large scale distortion is assumed to be known

STAR MAPPER DISTORTION (CONT'D)

SM MEDIUM SCALE IRREGULARITIES (MSI)

- MSI Calibration Accuracy :
  - Vertical Slits : 8.1 mas (rms)
  - Inclined Slits : 11.3 mas (rms)

SM SMALL SCALE IRREGULARITIES (SSI)

- RANDOM ERROR ON INDIVIDUAL SLIT POSITION : 7.4 MAS (rms)
- SCANFIELD ROTATION :
  - Vertical Slits : 2.9 mas (rms)
  - Inclined Slits : 5.0 mas (rms)
- MAGNIFICATION ERROR : NO IMPACT ON THE POSITION

STAR MAPPER DISTORTION BUDGET

	LARGE SCALE MAX (mas)	LARGE SCALE RMS (mas)	MEDIUM SCALE RMS (mas)	SMALL SCALE RMS (mas)	OVERALL RMS ERROR (mas) (20% margin)	SPEC (mas)
VERTICAL SLITS	17 (72/89)	15	8.1	4.7	2.2	2.5
INCLINED SLITS	184 (85/100)	101 *	11.3	6.2	12.2	2.5

* The main contributor is the defocusing (uncorrelated with main field distortion): some improvement might be achieved by a tightening of the SM defocusing budget (presently: mean defocus = 10 μm / grid rotation = 110 as)

<u>Nota Bene</u>: the defocusing-induced distortion depends on the FOV and sign of the inclination of the chevron slits

STAR MAPPER CHROMATICITY

SM CHROMATICITY DEFINITION

- REFERENCE POSITION : ARITHMETIC MEAN OF B_T AND V_T POSITIONS FOR A STAR OF COLOUR INDEX $B-V=0.7$
- CHROMATICITY EFFECT :
  - STAR OF COLOUR INDEX $B-V=0$: DEVIATION OF B_T POSITION FROM REFERENCE POSITION
  - STAR OF COLOUR INDEX $B-V=1.5$: DEVIATION OF V_T POSITION FROM REFERENCE POSITION
- SPECIFICATION : CHROMATICITY EFFECT < 25 mas (rms)

RESULTS

- WORST CASE IS OBTAINED AT THE APEX FOR $B-V=0.0$
- WORST CASE LOAD : -10.4 mas
- NOMINAL CHROMATICITY : -2.8 mas

TOTAL : -13.2 mas

ANNEX VI

SELECTED FEATURES FROM FEBRUARY 1985 ACCURACY REPORT

EFFECT OF INCREASED CHROMATICITY ON "BASIC" ACCURACY BUDGET

- THE "BASIC" ACCURACY BUDGET ISSUED BY MATRA HAS BEEN MODIFIED TO ACCOUNT FOR HIGH VALUES OF UNCORRECTED CHROMATICITY. RESULTS SHOW THAT FOR B = 9 MAG; B - V = 0.5 MAG. STARS, THE MARGIN W.R.T. REQUIRED PERFORMANCES IS LESS THAN 25% IN A FEW CASES.

CLOCK JITTER

- LOGICA HAS DEMONSTRATED THAT HIGH FREQUENCY (ABOVE 100 Hz) CLOCK JITTER EFFECT IS NEGLIGIBLE;
- LONG TERM CLOCK JITTER IS EXPECTED TO BE CANCELLED IN THE SAME WAY AS ATTITUDE JITTER. HOWEVER, IT SHOULD BE ASCERTAINED THAT PHASE VARIATIONS BETWEEN FRAMES REMAIN NEGLIGIBLE DESPITE POSSIBLE TEMPERATURE CHANGES OF THE CLOCK (STABILITY REQUIREMENT 10^{-5} OVER THE WHOLE TEMPERATURE RANGE);
- VERY LONG TERM CLOCK JITTER (TYPICALLY 5 MIN) SHOULD BE OF NO CONCERN BECAUSE GROUND TIME CORRELATION IS ENSURED TO 5 MICROSEC. RMS.

OCCULTATIONS

- THE FRACTIONAL DEAD TIME DUE TO EARTH/MOON OCCULTATIONS IS WITHIN SPECIFICATIONS;
- CONVERSELY, PERCENTAGE OF INTERRUPTED GREAT CIRCLES IS 33.4% (5% OF WHICH ARE DUE TO MOON) VS. A SPECIFICATION OF 28%
  - MATRA SIMULATIONS SHOW THAT MOON OCCULTATIONS DO NOT AFFECT GCR RIGIDITY
  - LOGICA SIMULATIONS (SETS OF 6 GC'S) SHOW SOME EFFECT OF EARTH INTERRUPTIONS (DISPERSIONS).

Date.....................

			SPECIFICATIONS	BASIC ACCURACY *			
				Performances		Margin	
				C = 2.5 mas V = 4 mas	C = 3.5 mas V = 3 mas	C = 2.5 mas V = 4 mas	C = 3.5 mas V = 3 mas
B = 9	B-V=-0.25	σa 1 (mas)	2.60	1.55	1.6		
		σa 2 (mas/yr)	2.60	2	2.0	23%	23%
		σa 3 (mas)	2.60	1.2	1.3		
		σa 4 (mas/yr)	2.60	1.75	1.75		
		σa 5 (mas)	2.60	1.8	1.7		
	B-V= 0.5	σa 1 (mas)	2.00	1.3	1.2		
		σa 2 (mas/yr)	2.00	1.9	1.7	7%	16%
		σa 3 (mas)	2.00	1.1	1.0		
		σa 4 (mas/yr)	2.00	1.55	1.4	16%	24%
		σa 5 (mas)	2.00	1.7	1.4		
	B-V=1.25	σa 1 (mas)	2.60	1.5	1.6		
		σa 2 (mas/yr)	2.60	1.95	1.9		
		σa 3 (mas)	2.60	1.2	1.2		
		σa 4 (mas/yr)	2.60	1.7	1.7		
		σa 5 (mas)	2.60	1.7	1.6		
B = 12	B-V=-0.25	σa 1 (mas)	5.20	2.6	2.6		
		σa 2 (mas/yr)	5.20	3.5	3.5		
		σa 3 (mas)	5.20	2.1	2.1		
		σa 4 (mas/yr)	5.20	2.9	2.9		
		σa 5 (mas)	5.20	3.1	3.1		
	B-V=0.5	σa 1 (mas)	4.00	2.2	2.2		
		σa 2 (mas/yr)	4.00	3.1	3.0	22%	25%
		σa 3 (mas)	4.00	1.8	1.75		
		σa 4 (mas/yr)	4.00	2.6	2.5		
		σa 5 (mas)	4.00	2.8	2.7		
	B-V=1.25	σa 1 (mas)	5.20	2.1	2.2		
		σa 2 (mas/yr)	5.20	2.9	2.8		
		σa 3 (mas)	5.20	1.7	1.7		
		σa 4 (mas/yr)	5.20	2.4	2.4		
		σa 5 (mas)	5.20	2.6	2.5		

Basic Accuracy Budget Results

(i.e. expected instrument performance, excluding 25% margin on data reduction)

* C = constant chromaticity error

* V = variable " "

Results taken from February '85 Accuracy Report, corrected by results of GCR simulations.

GRID DEFECTS AND POLLUTION

- MATRA ANALYSIS SHOWS THAT, IF SPECIFICATIONS ON MAIN GRID DEFECTS AND PARTICULATE CONTAMINATION ARE MET, INDUCED ERRORS ARE LOWER THAN 1 MAS;
- GRID DEFECTS ARE PRESENTLY OUT OF SPECS, BUT ACTIONS ARE UNDERWAY TO IMPROVE THE QUALITY OF SUBSTRATES;
- TEST RESULTS SEEM TO INDICATE THAT, MORE CRITICALLY, GRID POLLUTION EXCEEDS SPECIFICATION, BUT RESULTS ARE NOT COMPLETELY UNDERSTOOD (DISCREPANCY W.R.T. FOC), AND FURTHER CLARIFICATION IS PRESENTLY SOUGHT.

STAR MAPPER

- ANALYSES HAVE QUANTIFIED THE IMPACT OF STAR MAPPER DISTORTION, CHROMATICITY AND GRID IRREGULARITIES, ON THE PERFORMANCE OF OGAR AND RTAD;
- THE MOST SALIENT GRID IRREGULARITY, DUE TO STITCHING BETWEEN ADJACENT SCAN FIELDS, IS NOW REMOVED BY NEW WRITING STRATEGY;
- STAR MAPPER DISTORTIONS ARE IMPORTANT (100 MAS NON-NOMINAL DISTORTION FOR INCLINED SLITS)

  FOR RTAD, THE FORM OF NOMINAL DISTORTION ON INCLINED SLITS IS NOT YET KNOWN.

Date

ANNEX VII

Date ....

ORBIT DETERMINATION ACCURACY

- * PRELIMINARY INDICATIONS AT ESOC SHOW THAT, USING ODENWALD ANTENNA ONLY, TRACKING ACCURACY OF HIPPARCOS IS SUFFICIENT FOR SATELLITE EW STATION KEEPING
- * HOWEVER, THE ACCURACY REQUIRED IN SRD (PARA. 6.1.2.6.1) CANNOT BE GUARANTEED
- * BASED ON SHORT DURATION EXPERIENCE OF METEOSAT TRACKING BY ODENWALD, THE FOLLOWING RMS PERFORMANCE COULD BE PREDICTED WITH REASONABLE CONFIDENCE:

  - ° POSITION 4 KM
  - ° VELOCITY 0.3 M.~~5⁻¹~~ S^{-1}

- * STUDIES ARE PURSUED AT ESOC TO FURTHER REFINE THIS PREDICTION, MILESTONES BEING:

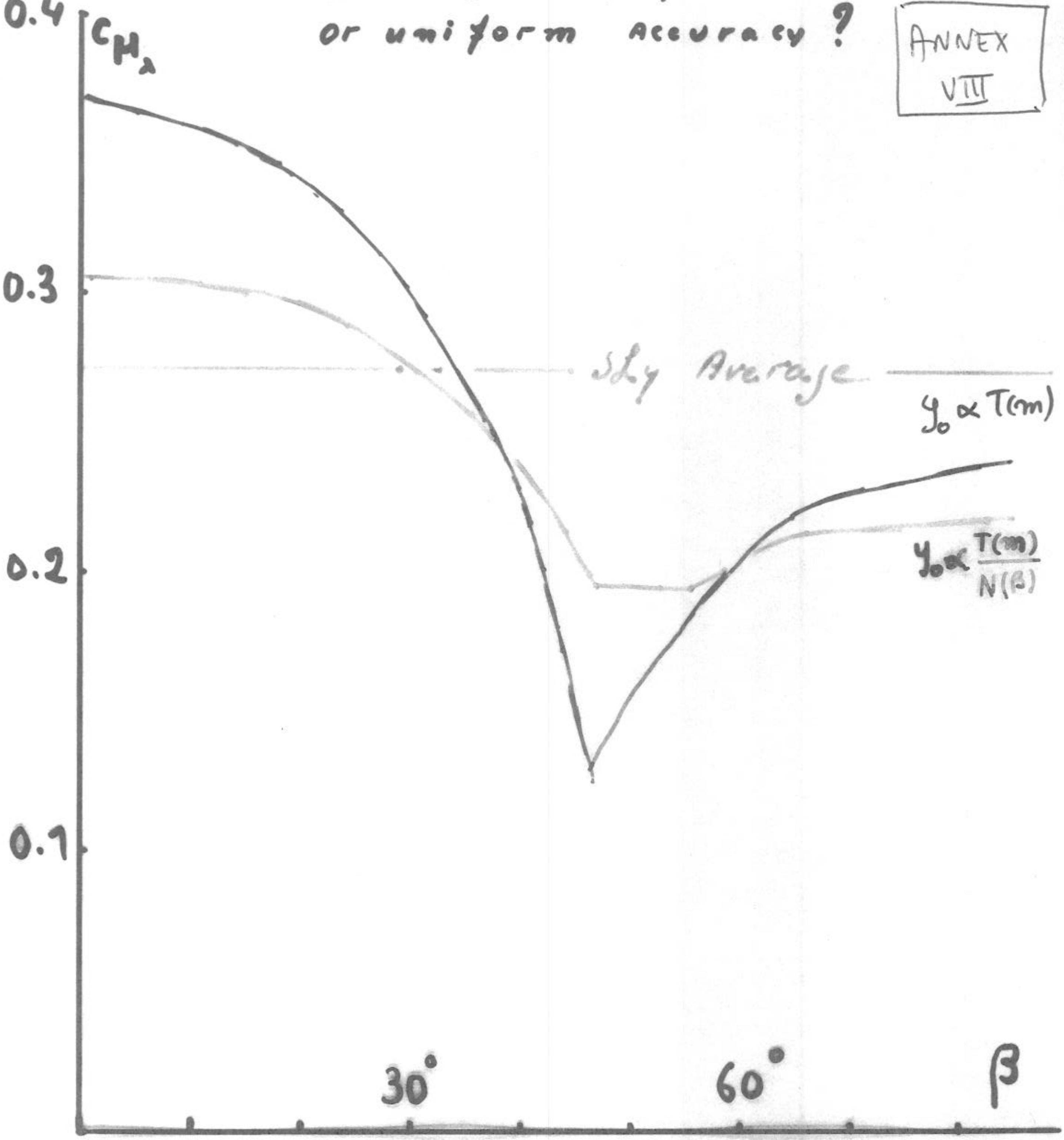
  - ° PRELIMINARY RESULTS MID-MAY 1985 (BASED ON 1 MO. EXTRA TRACKING)
  - ° FINAL RESULTS SPRING 1986 (BASED ON 1 YR. EXTRA TRACKING)

- * IN PARTICULAR, IDENTIFICATION OF 12-HR AND 24-HR PERIODICITIES IN TRACKING RESIDUALS WILL BE ATTEMPTED, IN ORDER TO ASSESS THE THERMAL DEPOINTING EFFECT
- * ALTERNATIVES TO GUARANTEE THE CURRENT ACCURACY INVOLVE EITHER OPERATIONAL COMPLEXITY (CALIBRATION BY ANOTHER ANTENNA AT CRITICAL, E.G. STORMY, PERIODS) OR INVESTMENT (E.G. SHORT BASELINE INTERFEROMETER AT ODENWALD).

M. CREZE 20/3/85

Should we privilegiate uniform star density or uniform accuracy?

ANNEX VIII



Trend of accuracy with latitude
As measured by improvement coefficient C_{H_β}
under two hypotheses

1 uniform star density, target time per field crossing is constant, Total observing time changes

2 uniform total observing time, target time per field crossing is $\propto T\sigma' / N(\beta)$
(current INCA working hypothesis)

ANNEX IX

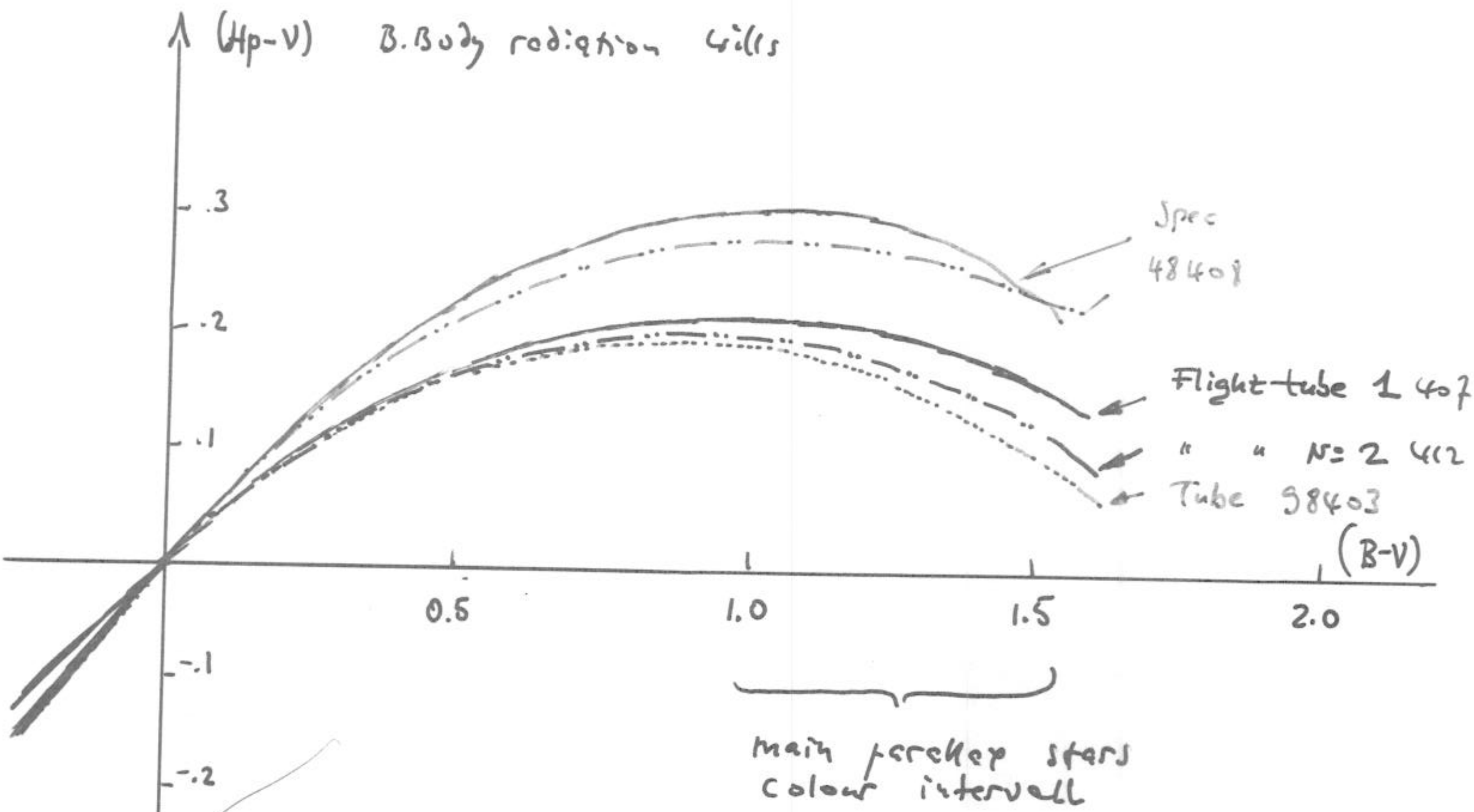
SOME PHOTOMETRIC PROPERTIES OF THE MAIN MISSION PAYLOAD with the IDT tube 98403

march 85

STAR PRESELECTION

for Input Catalogue

Selection rule: At equal ESA priority in a given area of the sky (0.6° radius) the brighter star, in terms of Hp mag. is retained in case of conflict



Flight tube n=1 optimizes the total number of counts

tube 98403 optimizes the selection of red parallax stars against hotter distant stars

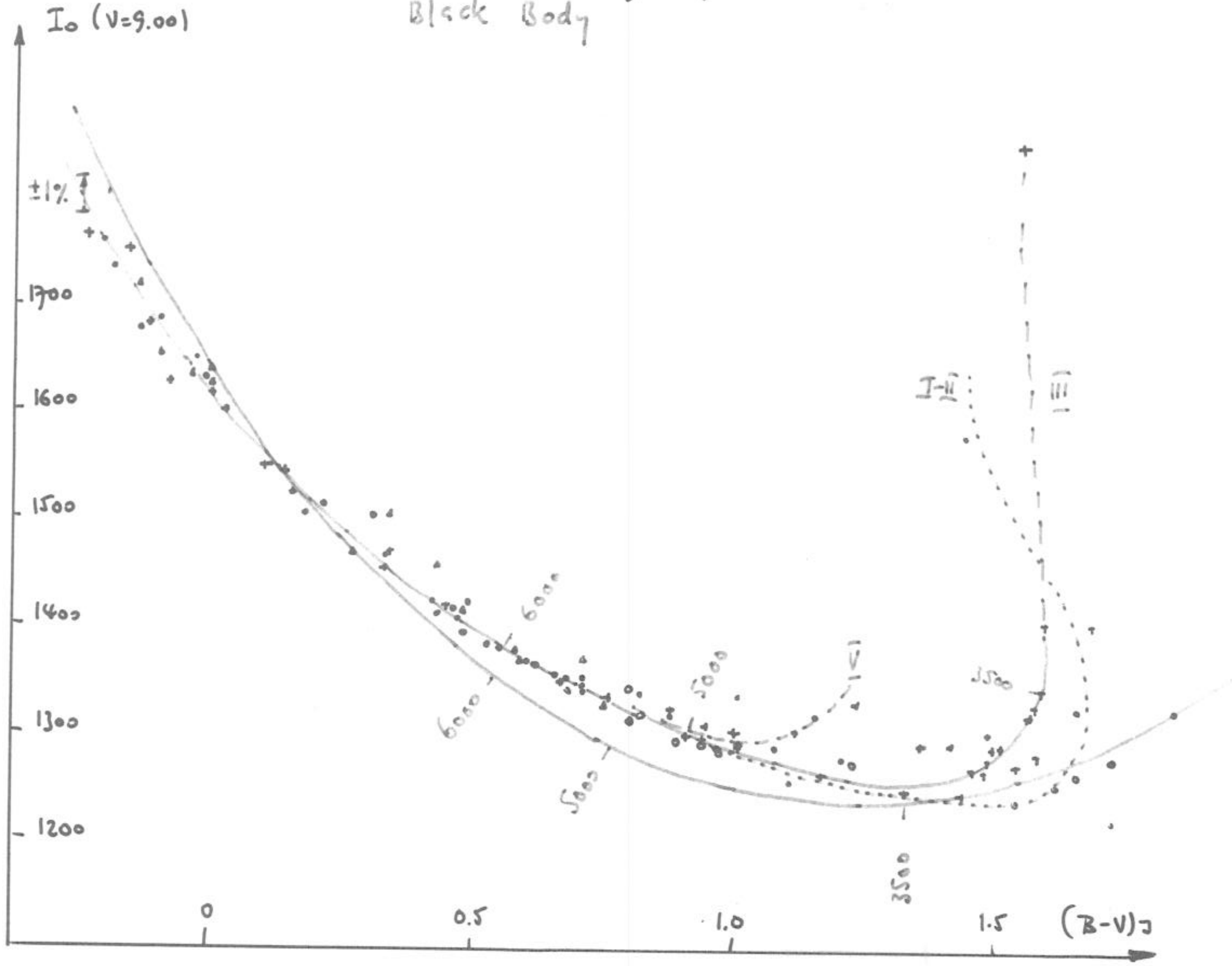
→ Q.E. response used for φ85 pressure computation

IDT tube 98403

RELATION Io / (B-V)J

+ : III • V ▲ IV ○ I-II

Red : Glušhevoi 1983
Black : Kiehling 1985
Black Body



Stars : Io (V=9.0 / B-V=0.0) = 1615 Hz

B.Body = 1626 Hz

20.03.85

Relation Io / (B-V)

Based on real stars : - blue stars Glušnevoi 83
- red stars Kiehling 85

Black Body for comparison.

	(B-V)	-.25	.00	.25	.50	.75	1.00	1.25	1.50	
stars	Io V=9.00	1797	1615	1491	1399	1334	1287	1258	1280	Hz
stars	Io B=9.00	1427	1615	1877	2217	2662	3233	3978	5096	Hz
B.B.	Io : Wills 98403	1590	-	-	2370	-	-	4380	-	Hz
B.B	Io Blackbody	1462	1626	-	2150	-	-	3879	4942	Hz
	Wills/Gr	1.088			1.102			1.129		

Adopted number of photons for $m_V = 0.000$ and $(B-V) = 0.000$, in the case of Black Body,

$\lambda \simeq 5550$ Å : $N = 997$ phot/cm^2.sec.Å

a weighted mean of several determinations

20.03.85

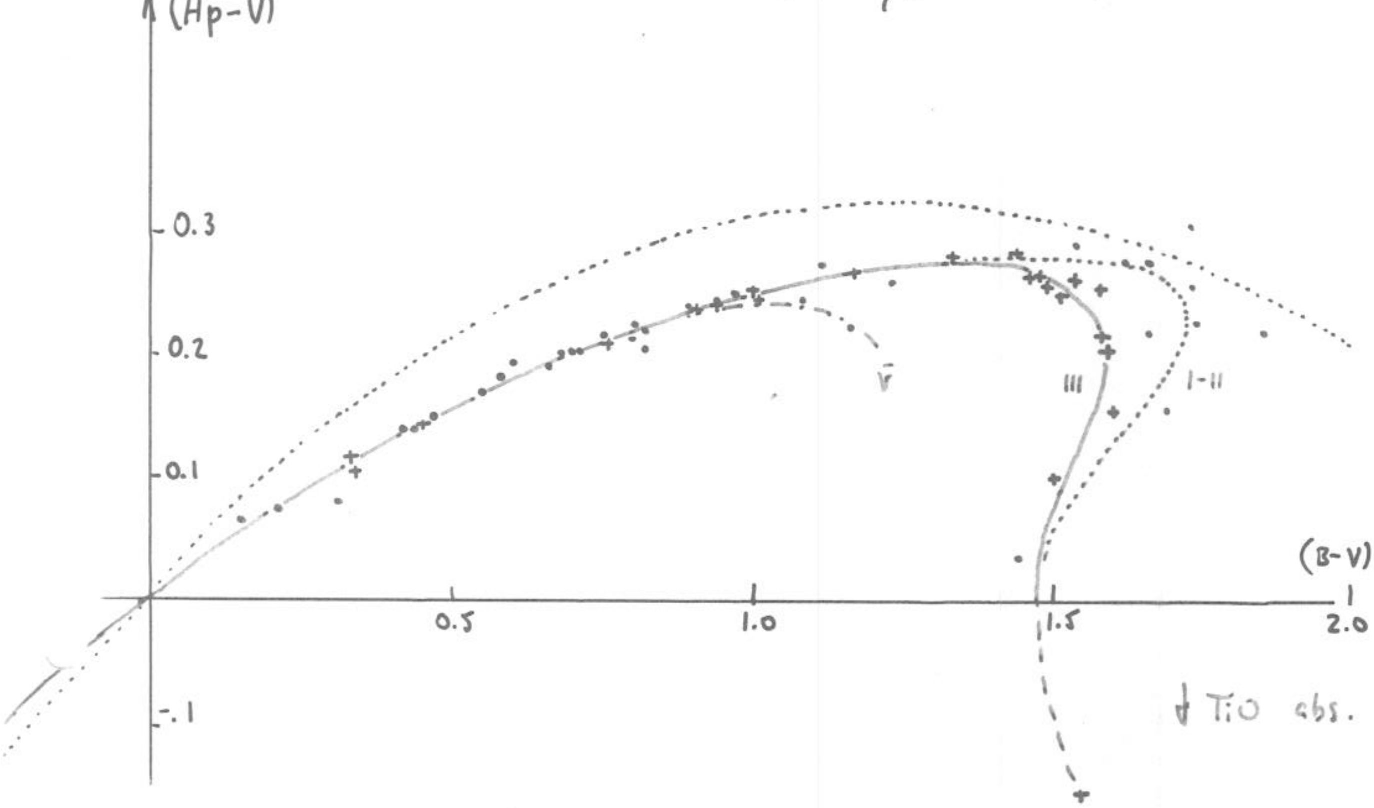
RELATIONS (Hp-V)/(B-V)

IDT tube 58403

(B-V) < 0.5 : Clušnesui stars
∈ 0.5 - 1.0 : all stars
> 1.0 : Red giants

Symbols : Kiehling 85 stars
• V, IV
+ III
• I - II

Black body : ......



For the computation of m_{Hp} from B & V on the L3 list (Spring 85) the following relation is adopted:

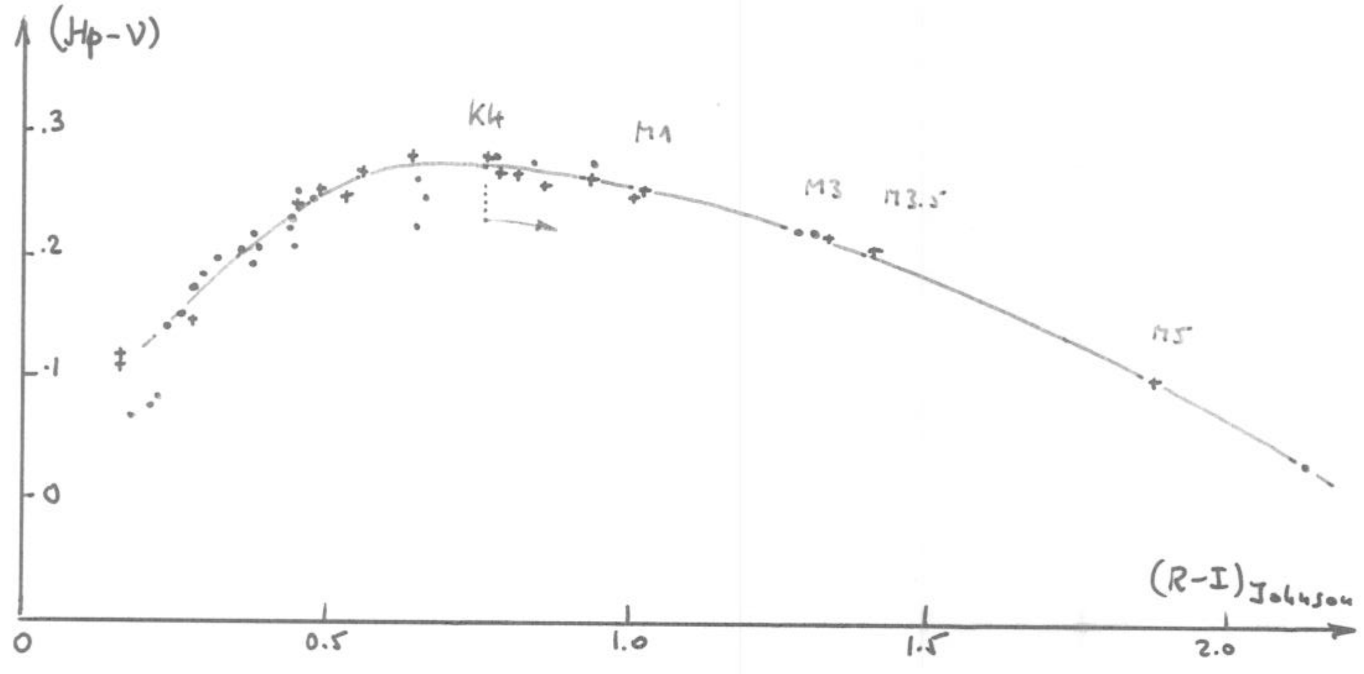
$$(Hp - V) = 0.380\,(B-V) - 0.130\,(B-V)^2$$

(Hp-V) shows a steeper dependance on (B-V) in the case of Black body radiation.

20.03.85

THE M Stars PROBLEM

For stars later than K5 the index (Hp-V) cannot be deduced from (B-V). Near IR colours have to be considered. The best is (R-I). for stars later than K4 III ((B-V) = 1.4))



- Several (R-I) systems are in use → distinct relations have to be established
  In blue : relation for giants & supergiants with the classical Johnson UBVRI system
- The relation for M dwarfs will be established using the new spectrophotometric data by Gunn & Stryker (1983).
- The new CCD measurements of faint secondaries of double stars made in (R-I) system

RELATION Total observing time / m_{Hp}

m_{Hp}	t_{obs}
≤ 5.0	270 sec
6.0	298
7.0	366
8.0	484
9.0	660
10.0	906
11.0	1230
12.0	1642
12.5	1884

$$t_{obs} = 270^{sec} \quad \text{if} \quad m_{Hp} \leq 5$$
$$t_{obs} = 1.606\, m_H^3 - 8.978\, m_H^2 - 19.32\, m_H + 390.2$$

NB : The phase A table m_B versus T_{obs}

is consistent with the specifications (SY 0.00.0 / 8.12.83) p. 61

i.e 600 sec for $m_B = 9$
1500 sec for $m_B = 12$

if the times correspond to $M + 0.6$ in the intervall $(M, M+1)$

The performances are optimized for $(B-V) = 0.5$
According to Spec. $I_0 [(B-V) = 0.5,\ B = 9] = 2172$ Hz
It is now 2217 Hz . At $(B-V) = 0.5$ $(Hp - B) = -.343$

The original table is scaled according to these new values.

On-orbit calibration

- At the 1-2% accuracy level the Hp magnitude cannot be derived from B & V magnitudes only.

- INCA will provide an Input Catalogue containing :

  1) m Hp X.XXX
  2) Hp s.e .XXX
  3) Code indicating how m_{Hp} is obtained
  4) (B-V) X.XX
     s.e .XX
  5) a flag S for standard stars.

- RECOMMENDATION :

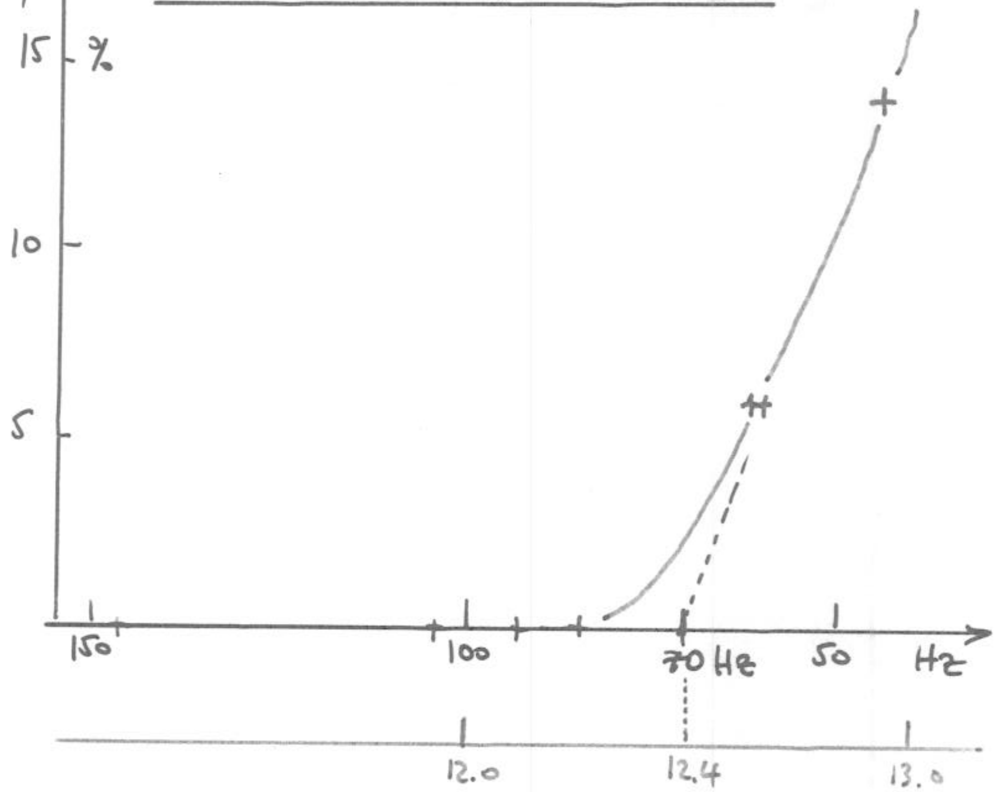
  For on-orbit calibration start from m Hp and not from B & V for standard stars. (Modify the proposal and notation in the relevant documentation).

RELATION m_{Hp} / N counts

m_{Hp}	counts / sec
7.0	10190
9.0	1615
11.0	256
13.0	40

$(B-V) = 0.5 \rightarrow (Hp - B) = -.343$

LIMITING MAGNITUDE



Decision : accept | Flag | Reject

NEED SIMULATIONS
including faint parasite stars distributions at some galactic latitudes e.g 0°, 15°, 90°

i.e. inclusion in I.C. to be confirmed after revision of photometry and of simulations.

here I_B = cst = 82.8 Hz

ANNEX X

1 CHANGING TARGET TIMES ALONG THE MISSION
WHY ?

- observing strategy tends to underobserve stars with large target times when total O.T. request (= pressure) is large.

- This can be partly compensated by over estimating large target times but compensation fails if "pressure" is large.

pressure can be reduced by "switching off" stars previously <u>over observed</u> or when observations would be <u>unefficient</u>
switch off = low y_0 or Obs. Index = 0 or...

- unefficiency refers to various types of situations:
  - proper motion stars
  - Nodes of scanning law
  - other systematic scanning law irregularities.

- However
  "the complexity of the algorithm eventualy implemented should be in reasonable proportions to its objective!"

VDH

- Bright stars may (should?) be excluded from modulation
  - marginal gain
  - need for "primary stars"

PSV
"in <u>crowded</u> star fields, some bright stars might be excluded from time to time"

2 Measuring data Acquisition

Improvement Coefficients
including observing time
allocation provide suitable tool.

Measuring phase during one field
crossing

→ 1 condition equation

$$\Delta y_i = \alpha_{1i}\,\Delta\lambda\cos\beta + \alpha_{2i}\,\Delta\beta + \alpha_{3i}\,\Delta\mu_\lambda\cos\beta + \dots$$

Let τ_i be the observing time
allocated during field crossing i

weight $p_i = P(m).\tau_i$

Normal equations after
N observations

$$a_{jk} = \sum_{i=1}^{N} \alpha_{ji}\,\alpha_{ki}\,p_i$$

$$A(N) = [a_{jk}] \quad k=1,5 \;;\; j=1,5$$

Covariance Matrix

$$B(N) = A(N)^{-1}$$

VDH
α_i should be spelled
explicitely

$\alpha_1 = \sin i$

$\alpha_2 = \cos i$

$\alpha_3 = (t-\bar{t})\sin i$

$\alpha_4 = (t-\bar{t})\cos i$

$\alpha_5 = \sin(\lambda_\odot - \lambda_*)\sin i$
$\quad - \cos(\lambda_\odot - \lambda_*)\cos i \sin\beta_*$

$\sin i = \sin\beta_z / \cos\beta_*$
$|i| < \pi/2$

Measuring data acquisition via $B(N)$ would involve separate tests of 15 parameters.

~~2.~~

curently used in INCA preliminary tests:

$$q(N) = \sqrt{b_{55}} \quad \text{(parallaxe)}$$

or

$$q(N) = \sqrt{b_{33}} \quad \text{(proper motion } \lambda\text{)}$$

PSV

$\sum b_{ii}$

JK

$\begin{Vmatrix} b_{33} & b_{34} \\ b_{43} & b_{44} \end{Vmatrix}, b_{55}$

or

b_{33}, b_{44}, b_{55}

- which minimum set of parameters should we watch over to be sure other ones follow rigidly?

- We will start with

  $b_{33}, b_{44}, b_{55}, b_{34}, b_{45}$

  and check afterwards that some of them may be droped.

- Differenciation between "proper motion stars" and others is achieved by releasing constraint on b_{55} -

in the following q will represent the minimum set of parameters b_{ij}

MC 20/3/85

3 Controling Data Acquisition

- the state of data acquisition $B(t)$ at a given date should be compared with some standard $\overline{B}(t)$

- the standard $\overline{B}(t)$ is derived from

  1 An Average Observation Calendar (AOC)

  average refers to some smoothing of small scale irregularities of the Scanning Law.

  2 A target time allocation T

- under or over observation is tested through

$$r = q(t)/\overline{q}(t)$$

the levels of significance (under/over) still to be tested

- the efficiency of the next observation to come should also be tested.

$$s = q(N) / q'(N+1)$$

defines the expected gain

r and s govern modulation

Amount of Processing and Storage:

Store AOC

Store $A(D-1)$

Store $\overline{A}(D-1)$

compute α_i's

inverse A and $\overline{A}$

derive q and $\overline{q}$

inverse A'

inverse q'

Possible Alternative test directly on Matrix A (Avoid inversions)

4 Practical Implementation

1 there is no evident need for ~~modulation~~ feedback at frequencies higher than one day

VDH suggests predictions based on 2 days periods due to feed back delay -

2 - MC defined an AOC concept based on cells for - 2 - reasons
- cells provide a natural unit for averaging
- it saves (little) storage ressources

VDH
AOC for each star simplifies procedure, wins efficiency, wins processing time.

OK

AOC =
list of observing dates and numbers of observation

it is sufficient for deriving $\overline{B}(t)$ but recomputing it once day would be monstruous

⇒ either store $\overline{A}(N)$ in addition to $A(N)$

VDH
INCA
or
ESOC
task?

⇒ ~~or recompute $\overline{A}$ on the basis of AOC each time~~

⇒ Better Solution
Compute $\overline{A}(t)$ once for All

THIS MAY BE PRODUCEC "OFF LINE" AND INTRODUCED PERIODICALY VIA MAG. TAPES

If INCA involved previous Agreement with CNES required
(~ 10 H CDC)

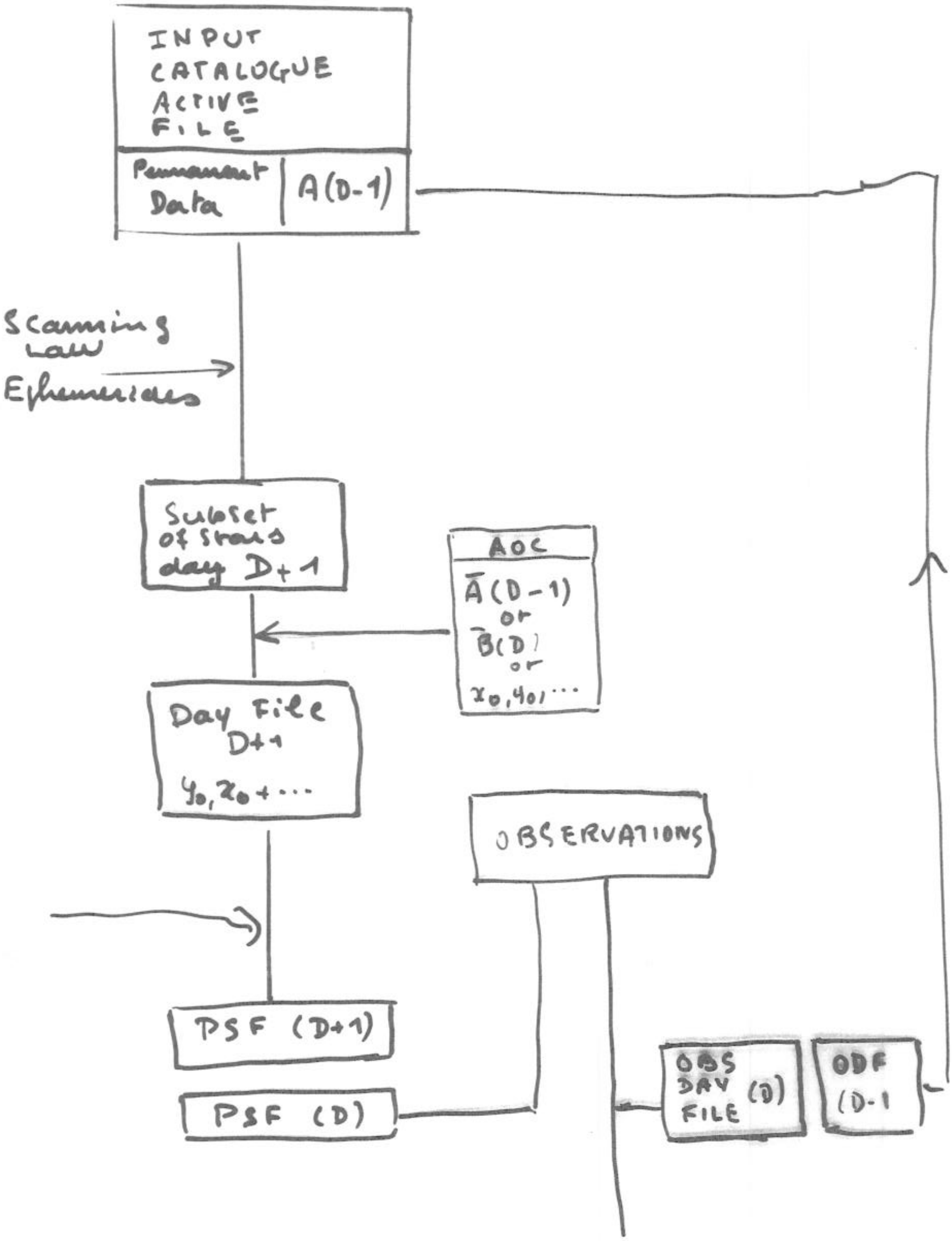
Feedback is only justified by <u>random</u> departures to nominal scanning law (+ accidental interuptions)

Such deviations involve little changes in the actual observing calendar of a given star (T.B. definitely checked)

However they may involve substantial changes in the effective pressure

Would those fluctuations be proved to have neglieable effect on the final result feedback would turnout useless.

Then modulation of observing strategy coefficients could be completely derived in advance



INPUT CATALOGUE ACTIVE FILE
Permanent Data
A(D-1)
Scanning law
Ephemerides
Subset of stars day D+1
AOC
$\bar{A}$(D-1)
or
$\bar{B}$(D)
or
$x_0, y_0, \cdots$
Day File D+1
$y_0, x_0 + \cdots$
OBSERVATIONS
PSF (D+1)
PSF (D)
OBS DAY FILE (D)
ODF (D-1