SA/84/750/mp/H
4 October 1984

MINUTES OF THE TENTH MEETING

OF THE HIPPARCOS SCIENCE TEAM

ESTEC, 2-3 Oct., 1984

Attendance:

HST:	Dr. M.A.C. Perryman, Chairman Dr. M. Crézé Dr. A.M. Cruise Professor F. Donati Dr. M. Grenon Professor M. Grewing Dr. E. Høg Professor J. Kovalevsky Dr. L. Lindegren Mr. C.A. Murray Mr. R.S. Le Poole Dr. C. Turon
ESA:	Mr. L. Emiliani (part time) Mr. R. Bonnefoy (part time) Mr. K. van Katwijk (part time) Mr. M. Schuyer Dr. S. Vaghi Dr. R.D. Wills
ESOC:	Mr. H. Laue
MATRA:	Dr. E. Zeis
ST ScI:	Dr. J. Russell (3 October)

1. Adoption of the Agenda

The agenda as shown in Annex I was adopted.

2. Report by the Project Manager

Emiliani noted that the project was now some 20% into Phase C/D. Immediate issues under consideration included a coordination of the project schedule, finalisation of the contracts and the necessity to place some emphasis on the activities going on outside the immediate circle of the ESTEC/MESH activities, in particular the work of ESOC and of Arianespace. Despite delays in the Optical Support Program (OSP) activities (see payload status report), a launch was still foreseen in the period April-June 1988. This date would be finalised next year.

3. Report by the Project Scientist

Perryman reviewed the outcome of the Inter Consortium meeting discussions held the previous day (attended by Dr. Turon, Kovalevsky and Hog):

- comments made on the Agreement were discussed. A fourth draft would be circulated to the HST immediately and comments would be invited. The mechanism for the distribution of data within the consortia was agreed in principal by NDAC, FAST and INCA. No comments had been made by TDAC (Grewing).

- it was noted that, in addition to the regular consortia meetings, FAST planned a Thinkshop in Marseilles 21-25 January 1985 (TBC), and INCA planned one for 3-7 June 1985. ESA would sponsor the proceedings for the latter conference. Concerning the forthcoming IAU General Assembly, Høg would approach Commissions 8 and 24 with a view to organising a presentation of Hipparcos.

- comments were made on the Specifications drawn up for the ESOC data formats (ESA-HIP-05976). Consortia leaders stressed the urgency in getting more complete information on the data formats and contents. The Project Team would attempt to produce a revised text by 30 November, and a dedicated meeting could be held in mid-December.

- IRS stars: Turon was waiting for additional data from Clayton Smith (USNO). Høg passed data on the observing 'histories' of the IRS stars from a compilation by U. Bastian.

- other conclusions are noted in the relevant places in these minutes.

4. Payload Status Report

Bonnefoy presented a status overview, referring to the hardware development status, status of documentation especially of the P/L budget reports, a performance overview and details of the optics, grid and detector status (see Annex II).

Of the engineering model (EM) IDT tubes procured, one had been set aside as a flight candidate. Grenon stressed the importance of INCA working with a response curve which was as realistic as possible rather than an arbitrary specification, especially for the purposes of magnitude transformations. Further details would be supplied, but this would be for the consortia's use only and should be considered as subject to change.

5. Accuracy Status Report

(a) Overall System Spec. (SY.Ø.ØØ.Ø)

Wills presented a summary of changes incorporated in OSS issue 3, rev. 5 (Annex III). It was noted that a nominal sense of satellite rotation had now been defined. Rotation in either sense was permitted by the hardware, but at present there were no plans by the Project to implement the necessary supporting software, either on-board or at ESOC (PSF preparation, etc.). Perryman would distribute the next issue of the OSS when available.

Schuyer explained the revised formulation of the attitude modelling specification (for dynamic smoothing).

(b) GOP Studies

No progress was reported, although studies would be initiated before 15 December with a view to assessing constraints on the Input Catalouge, both in view of the final mission accuracy and the RTAD.

(c) Simulated Data

The SOS was being incorporated by Logica. Vaghi would distribute a proposed plan for data simulation by ESTEC. Kovalevsky would draw up a note describing the FAST simulation software.

(d) IDT Time Response

Perryman drew attention to MAT-HIP-11713 which predicted a small accuracy degradation due to the time response of the IDT, especially when switching from bright to faint stars. The subject is on the Agenda of the next SAG.

(e) Scanning Law

An agreement on the form of the scanning law had been reached between MATRA (Zeis) and Lindegren. Zeis would propose a definition in a technical note, for eventual inclusion in the Satellite/GSE Ground Segement ICD.

(f) Attitude Control Law

Van Leeuwen's note had been reviewed by the Project Team (Schuyer/Gleadle). Attention was drawn to the use of an old BAe report by van Leeuwen, but the comments on the actuations about the z axis would be communicated to Matra. However it was noted that the actuation interval was now rather good, and it was unlikely that modifications to the AOCS control laws would now be possible.

(g) Documentation

Schuyer distributed to the four consortia leaders copies of the OBC specification (SY.6.00.0, issue 4), CBSS specification (SS.6.01.0, issue 4, rev. 1) and the Satellite/GSE ICD (issue 4, rev. 2).

6. INCA Status

(a) Turon said that 94% of stars were in the catalogue in June. Some 50% of the remainder were in SIMBAD under different names. Proposers would be requested to clarify the other discrepancies. Some delays would be experienced due to the computer and dome problems at Bordeaux. La Palma would observe some 5000 stars in the critical declination range 0 to - 25^{o}.

(b) Crézé presented the current status of the catalogue simulations, and his present approach to the preparation of the PSF at ESOC (Annex IV). The project team would provide detailed comments on the proposal, and Perryman invited the comments of the HST/DRC also.

7. Raw Data Treatment

Presentations were made by Matra (Zeis, Annex V.I), NDAC (Lindegren V.II, Cruise V.III, Murray V.IV) and FAST (Kovalevsky V.V, Donati V.VI).

Kovalevsky had passed simulated data to Cruise for a preliminary analysis. Both MSSL (Cruise) and CSS (Donati) would determine phases with their present software, with a view to comparing their results, perhaps providing a presentation of the preliminary results at the next HST.

Lindegren suggested a convention for the decoding of the compressed data should be drawn up. No conclusions were drawn in the meeting. Other actions resulting from the discussions are attached to the minutes (items 7-10).

8. Actions from May HST

(a) P/L IFOV Profile

A technical note containing the present specifications, and updating the July telex, is near completion in Matra. Zeis will send this directly to Kovalevsky when available.

(b) FAST Star Flux Model

Kovalevsky presented the results of his investigation into the discrepancies between the FAST and ESTEC/Matra results (Annex VI). The following points were noted by Grenon:

- the Sun is not well known in B-V, the associated error could result in a 3% error on the counts;
- the tabulation of B-V versus Teff given by ESA is not fully consistent, and this gives rise to a discrepancy increasing with increasing B-V
- a more appropriate calibration (for V = B-V = 0 at 550 nm) may be 1005 photons/cm^2/sec/Å.

The conclusions of this study are:

- the instrument models used by FAST and ESA are consistent (see Le Gall and Ratier's black body results)
- the stellar flux model used by ESA/Matra is not realistic and appears to lead to overestimates of the expected counts by up to 15%, or more in the case of Grenon's determination for B-V = 0.5 (28%).

(c) Tycho Discrepancies

Wills presented the results of his investigations (Annex VII). Since the cause of the discrepancies between the Matra/NDAC results has not been identified work on this will continue. Wills would assess the sensitivity of his results to the window size used, and both Wills and Høg would produce histograms of their results in case the use of the rms errors is being affected by the number of false detections.

(d) Sun Straylight

Bonnefoy reported that no further analyses had been made, and recommended TDAC to bear in mind that instances of very low straylight would be found, depending on the satellite orientation.

(e) SOS and MSC

Vaghi described the introduction of a new flag into the SOS algorithm, in order to allow the present SOS to handle the requirements of MSC calibration.

(f) Photometric Standards

Grenon presented the results of his recent work (Annex VIII).

Wills would make a revised proposal concerning the availability of S and C stars (provisionally suggested as 4000 and 8000 respectively). On the basis of this work, including a study of the distribution of the standards as a function of magnitude and colour, Grenon would conti his studies of the available standards, summarising the results in a technical note and including effects of multiple systems, Hipparcos and Tycho requirements, etc.

(g) Tycho Dichroic Optimisation

Zeis present the current study status (Annex IX). Run KTYA4 was baselined - this uses irradiation resistant glass, no separation filter, but a low pass filter. Optimisation yielded a balance in the counts in BT and VT at about B-V = 0.7 with a good correspondence between the effective wavelengths and those of the Johnson system. Both criteria would be affected if the non-resistant glasses could be used (run KTYA5). Perryman invited interested members to prepare their recommendations in case the latter option could be adopted (see actions 12-13).

(h) Requirements of GRTAD

Høg and Kovalevsky confirmed that there were no scientific requirements on GRTAD, in addition to those on RTAD.

(i) Solar Flares

Bonnefoy confirmed that such flares were expected to produce an increase in the background level in the photomultipliers (Cerenkov radiation produced by photons in the glasses). Studies of the effects (duration, possibility of shielding, operation of the AOCS during such flares) were continuing (action 14).

Grenon and Grewing were requested to provide more details of the effects of a soft X-ray flux before the Project Team studies possible effects (action 15).

(j) Telemetry Content and Data Interface

This aspect was covered in the Inter Consortium Meeting. ESTEC would provide a revision of the relevant specification following recommendations given by the Consortia.

9. Calibration/Commissioning

(a) Wills provided an overview of the present documentation status (Annex X). Comments from the HST on the OOCR, distributed previously, were invited.

(b) FAST and NDAC (Kovalevsky and Høg) were in principal willing to consider participation in the commissioning/calibration tasks. No comments were made by TDAC (Grewing) on the possibility of their involvement during commissioning.

The Project Team would draw up its specific requirements to present to the Consortia following the release of the 'Calibration Operational Software Requirements Document' by Matra.

Kovalevsky noted that FAST were presented investigating the possibility of calibration the MSC within FAST.

(c) Background Determination Accuracy

Zeis presented Matra's reaction to the present specification on the background determination (summarised in Annex XI). Comments from the DRC were invited.

10. ST GSSS Status

Dr. J. Russell provided an overview of the GSSS status, with special emphasis on its impact on the Tycho Input Catalogue. Some of the major points addressed were:

- the limiting magnitude has been confirmed to be about 14 mag at the NGP
- internal plate errors are better than about 0.3 arc sec. Systematic errors at the plate edges amounted to some 3 arc sec
- a classification of images into stellar/non-stellar will be made
- a cross-identification to CSI will be made
- J2000 is used as the coordinate system
- information on neighbours for the pruposes of veiling glare studies may be generated from the catalogue
- some 300 plates out of a total of 1500 had so far been scanned. The target completion date is about March 1986.

11. Any Other Business

(a) Consortia reports would be submitted at the end of October.

(b) A next HST meeting was provisionally arranged for mid-March 1985 (possibly 14-15 or 21-22 March) with the provision for an inter-consortium meeting on the preceeding (Wednesday) afternoon. HST members would communicate impossible dates to Perryman before the end of October.

(c) Perryman thanked all members for their detailed presentations and their thorough preparation and response to the outstanding action items.

M.A.C. Perryman.

esa estec

HIPPARCOS

MEETING HIPPARCOS HST

PLACE ESTEC 1-3 Oct. 1984

REF.

DATE

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ACTION No		DESCRIPTION (not more than 4 lines)	CLOSING DATE	ACTIONNEE Person/firm	INITIATOR Person/firm
		INTER CONSORTIUM MEETING			
✓	1	Revise draft Agreement and distribute to HST	6/10/84	MdeP	Consortia leaders
✓	2	Revise specn for Data Exchange (ESA-HIP-05976)	30/11/84	SV/KC	Internal
✓	3	Investigate GOP/final accuracy (inputs from Crézé, Zeis), including effects of attitude reconstitution.	15/12/84	MS/SV	Internal
		HST Meeting			
✓	4	Investigate sensitivity of IDT/P/L at <400nm and >800nm and provide tabulation of the specified tube and the current best performant tube (shown (□) in RB's annex to minutes) as a function of wavelength.	15/12/84	RB / KvK	M. Grenon
✓	5	Produce note, on definition of scanning law to incorporate in satellite/ground segment ICD, based on Lindegren proposal	31/10/84	E. Zeis	M. Schuyer
✓	6	Provide comments on Crézé's PSF construction proposal.	30/11/84	MS/ESOC/ORC	M. Crézé
✓	7	Investigate FAST's request to send ~10hr data per week also to Utrecht, for first look data	30/11/84	MS/ESOC	J. Kovalevsky
✓	8	Specify geometry of the primary and star mapper grid systems (i.e. frames in which the slits are parallel).	15/12/84	E. Zeis	M. Perryman

Signatures

esa estec

HIPPARCOS

MEETING HIPPARCOS HST (cont)

PLACE

REF.

DATE

PAGE 2/2

ACTION No	DESCRIPTION (not more than 4 lines)	CLOSING DATE	ACTIONNEE Person/firm	INITIATOR Person/firm
9	Provide any information on noise properties of the analogue mode of the IDT if available	next HST	RB/HE	L. Lindegren
10	(a) Provide details of effects of cosmic rays on the data, including frequency of occurrence and no. of samples affected	next HST	RB/HE	L. Lindegren
	(b) In the data format document, describe the quality indicator of the telemetry frames. Specify expected BER, also after coding	30/11/84	H. Laue	J. Kovalevsky
✓ 11	Continue investigation into NDAC/MATRA results for TYCHO, including histogram of distribution of results	15/12/84	Wills/Høg	E. Høg
✓ 12	TDAC to coordinate preparation of recommendations on dichroic optimisation if non-hardened glasses are adopted by MATRA; state optimisation criteria.	15/12/84	M. Grewing/ M. Grenon	M. Perryman
13	Provide details of effects of aging on transmittance and chromatic response	15/12/84	K.v. Katwijk	M. Grenon
✓ 14	Continue investigation into solar flares – duration, shielding, operation of AOCS	—	RB/MS	Internal
not settled → 15	Continue investigation into effects of soft X-ray flux on photomultiplier noise	—	M. Grenon/M. Grewing	Internal
✓ 16	Provide comments on Annex XI (background determination accuracy requirements) and MAT-HIP-11019	30/11/84	HST/ORC	Perryman

Signatures

ANNEX I

Delegates Lounge 09.30 hr

Tenth Meeting

of the

HIPPARCOS SCIENCE TEAM

2-3 October 1984

AGENDA

1. Status Report (Emiliani)

2. Status Report (Perryman)

3. Past/Future Meetings (FAST, NDAC, INCA, TDAC)

4. Payload Status Report (Bonnefoy)

5. Accuracy Status Report (Schuyer):
   - Overall System Specification (incl. dynamic smoothing spec.)
   - GOP Studies
   - Simulated Data Status
   - IDT time response and phase determination (MAT-HIP-11713)
   - Scanning Law (Lindegren/MATRA)
   - Attitude Control (van Leeuwen)

6. INCA Status:
   - Overview (Turon)
   - Ground PSF Preparation (Creze)

7. Raw Data Treatment:
   - MESH/LOGICA approach to Phase Extraction (Zeis)
   - NDAC Presentation (Hoeg, Lindegren, Murray, Cruise)
   - FAST Presentation (Kovalevsky, Donati)
   - Discussion

8. Actions from May HST:
   - P/L IFOV profile (MATRA)
   - FAST star flux model (Kovalevsky)
   - TYCHO astrometry/photometry discrepancies (Wills)
   - Sun straylight (Bonnefoy)
   - SOS and MSC (Vaghi)
   - Photometric Standards status (Grenon)
   - TYCHO dichroic optimisation (MATRA)
   - Requirements of GRTAD (Hoeg, Kovalevsky)
   - Effects of solar flares (Bonnefoy)
   - Telemetry content and data interface (Perryman)

9. Calibration/commissioning:
   - Calibration status & On-Orbit Calibration Report (Wills)
   - In-Orbit Calibration and the Role of the DRC (Perryman)
   - Amount of commissioning data required by DRC (Zeis)
   - Background Determination Accuracy (Zeis)

10. ST GSSS Status (J. Russell)

11. Any Other Business, Next Meeting, etc.

Room 16133, 14.00 hrs

Inter-Consortia Meeting

ESTEC

1 October 1984

AGENDA

1. Agreement (Third Draft)
2. Forthcoming Consortia Workshops & Plans for IAU
3. Primary stars and double stars: DRC requirements on INCA
4. IRS stars
5. Transformation B/V/MH
6. Possible involvement of INCA/DRC at ESOC during commissioning
7. Consortia views on mission progress:
   - reporting/relationships with ESA and other consortia
   - critical paths for consortia
8. In-Orbit Calibration and the Role of the DRC (ESA-HIP-06006)
9. Data Formats: ESTEC/ESOC status
10 Limiting magnitude of the INCA Survey and GOP studies
11. Any other business

Date 1ST OCTOBER 1984

HIPPARCOS

SCIENCE TEAM MEETING

2ND - 3RD OCTOBER 1984

PAYLOAD STATUS

PREPARED BY:

R. BONNEFOY
K. v. KATWIJK
G. RATIER
H. EGGEL

ANNEX II

Date 1ST OCTOBER 1984

P / L OVERVIEW

MAJOR EVENTS SINCE LAST H.S.T.

A) SCIENTIFIC PERFORMANCES: NO MAJOR CHANGE

B) HARDWARE DEVELOPMENT:

1) DIFFICULTIES IN -
- BEAM COMBINER (TECHNICAL)
- TELESCOPE OPTICS (PLANNING)

LEADING TO DELAYED START OF OPTICAL SUPPORT PROGRAMME.

2) EQUIPMENT PRELIMINARY DESIGN REVIEWS HELD IN SUMMER, EXCEPT FOR:
- DETECTION ELECTRONICS BOX (PLANNED 2/3 OCTOBER)
- RELAY OPTICS (PLANNED MID OCTOBER)
- GRID ASSEMBLY (PLANNED MID OCTOBER)

C) DOCUMENTATION:
- PAYLOAD SYSTEM SPECIFICATION: ISSUE 3, REV. 4 DATED 30 APRIL 1984
- PERFORMANCES BUDGETS (NEXT CHART)

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Date 1ST OCTOBER 1984

STATUS OF P/L BUDGET REPORTS PER 1.10.84

PRIMARY BUDGET REPORTS	MAT-HIP	ISSUE	UPDATE
PNE	3486(5)	23.03.84	-
Basic angle stability	3571(3)	24.04.84	-
Distortion	3567(3)	20.07.84	-
Chromaticity	3617(3R1)	22.08.84	-
P/L IFOV profile	3426(2)	07.02.84	Sept '84
IFOV pointing accuracy	4948(2)	03.01.84	Sept '84
Third harmonic	7571(1)	12.01.84	Sept '84
Tycho performances	6488(1)	02.11.83	Sept '84
SM distortion + chromaticity	7697(1)	25.01.84	Sept '84
Grid geometry + calibration	4803(1)	22.04.83	15 Oct '84

INTERMEDIATE BUDGET REPORTS	MAT-HIP	ISSUE	UPDATE
Optical transmittance	4184(5)	20.04.84	-
MTF degradation	4435(3)	20.01.84	Sept '84
FPA defocus	6803(2)	17.07.84	-
Background noise		-	Sept '84

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

Date 1ST OCTOBER 1984

PRESENT PAYLOAD PERFORMANCES OVERVIEW

PRIMARY BUDGETS		P/L SYSTEM REQU'T	"CURRENT" SUBSYSTEM REQU'T	"BASIC" H/W PERFORMANCE	COMMENTS
PHOTONNOISE ERROR	mas	7,10	7,14	6,7-7,0	
BASIC ANGLE STABILITY	mas	1,00	0,95	0,64	
DISTORTION STABILITY	mas	1,00	0,99	0,97	
CHROMATICITY - Cc	mas	2,70	2,30	-	
- Cv	mas	1,50	1,10	-	
P/L IFOV PROFILE	-	-	-	-	TO BE UPDATED
IFOV POINTING	as	3,00	2,00	-	
THIRDHARMONIC - M3	%	5,00	9,00	-	) SPEC.RELAXATION REQUESTED
- Q3	degr.	5,00	11,20	-	) BY MATRA
TYCHO PERFORMANCES	-	-	-	-	DICHROICS TO BE OPTIMISED
SM - DISTORTION	mas	25	> 25	-	) SPEC. RELAXATION REQUESTED
- CHROMATICITY	mas	1,00	< 1	-	) BY MATRA
GRID GEOMETRY + CALIB.	-	-	-	-	TO BE UPDATED

INTERMEDIATE BUDGETS		P/L SYSTEM REQU'T	"CURRENT" SUBSYSTEM REQU'T	"BASIC" H/W PERFORMANCE	COMMENTS
OPTICAL TRANSMITTANCE	1	-	-	within spec	IRRADIATION EFFECT UNDER STUDY
MTF DEGRADATION (M1)	%	7,4	7,3	-	REDUCED REFOC. MECH. STEPSIZE TO BE CONSIDERED
FPA DEFOCUS	µm	145	136	-	-

Date 1ST OCTOBER 1984

B E A M C O M B I N E R D E V E L O P M E N T

1) FLAT BREADBOARD MODEL =

- AFTER APPROPRIATE CORRECTIVE ACTIONS, CUTTING PROCESS IS NOW UNDER CONTROL - (BETTER THAN $\lambda/60$ RMS).
- BONDING AT $\gamma = 58°$ AND THERMAL CYCLING TESTS HAVE BEEN PERFORMED IN AUGUST.
- FOLLOWING THESE TESTS, MIRROR SURFACE EXHIBITED A "TWISTED" DEFORMATION, INDUCING A CHROMATICITY EFFECT OF 10 MAS APPROX.
- ASSESSMENT OF THE ORIGIN OF DEFORMATIONS HAVE BEEN UNDERTAKEN - PRELIMINARY CONSIDERATIONS ARE SHOWING THAT CHROMATICITY EFFECT COULD BE DUE TO THE PRESENT GEOMETRY OF GLUE LAYER - AND REMOVED BY OPTIMIZATION OF THE SHAPE OF THE BONDING AREA.
- FINAL ASSESSMENT IN OCTOBER 1984.

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Date 1ST OCTOBER 1984

BEAM COMBINER DEVELOPMENT (CONT'D)

2) OSP MODEL =

- OPERATIONS COMPLETED:
  - POLISHING (FLAT $\lambda/8$ PTV)
  - CUTTING
  - COATING
- BONDING OPERATION IS WAITING FOR RESULTS OF ON-GOING ACTIONS ON FLAT BREADBOARD MODEL.

3) OTHER MODELS =

- POLISHING OF ASPHERICAL MODEL IS CLOSE TO COMPLETION BUT WAITING FOR FINAL ACCEPTANCE OF WFE TESTING SET-UP.
- VIBRATION TEST WILL BE PERFORMED ON MECHANICAL MODEL (BONDED WITH THE OPTIMIZED GLUE GEOMETRY).
- NORMAL PROGRESS ON EM.

Date 1ST OCTOBER 1984

T E L E S C O P E   O P T I C S

1) SPHERICAL AND FOLDING FLAT MIRRORS =

- DELAYS EXPERIENCED ON OSP MODELS DUE TO PROBLEMS WITH PADS BONDING PROCEDURE AND VALIDATION OF TESTING METHODS (AT THE LEVEL OF $\lambda/60$ RMS).
- CORRECTIVE ACTIONS HAVE BEEN INITIATED NOT TO PENALIZE START OF OSP ACTIVITIES RESCHEDULED FOR OCTOBER '84.
- EM MODELS ARE EXPECTED BEGINNING OF 1985.

2) RELAY OPTICS (IDT & PMT) =

- FINAL OPTO-MECHANICAL DESIGN SHOULD BE APPROVED IN OCTOBER '84 (EQPDR)
- POTENTIAL PROBLEMS DUE TO IRRADIATION HAVE BEEN INVESTIGATED -
  - IDT R.L. WILL RECEIVE AN APPROPRIATE SHIELDING
  - PMT R.L. - NORMAL BK7 WILL BE REPLACED BY A RADIATION RESISTANT GLASS -
    FINAL CHOICE (DOPPED BK7/SUPRASIL) WILL DEPEND ON TYCHO OPTIMIZATION.

Date 1ST OCTOBER 1984

G R I D   T H D

- ONE INCOMPLETE SAMPLE (ABOUT 1000 LINES) MANUFACTURED IN MAY
- REPORT & SAMPLE SENT IN JUNE TO ESTEC.
- TESTS ON SAMPLE IN LEIDEN.
- TEST EQUIPMENT (ASTROSCAN) NOT FULLY SUITABLE.
- FURTHER TESTS PROPOSED BY THD IN PROGRESS.
- CONCLUSIONS OF THD REPORT INDICATE A LARGE AMOUNT OF MODIFICATIONS TO EXISTING SETUP FOR COMPLETE SUITABILITY WITH HIPPARCOS NEEDS.
- IN VIEW OF

    1) THE STATUS OF THD TECHNOLOGY

    2) THE PROGRAMMATICS IMPACTS

  IT HAS BEEN DECIDED TO CONCENTRATE ON EBPG TECHNOLOGY.

D E T E C T I O N

PERFORMANCES

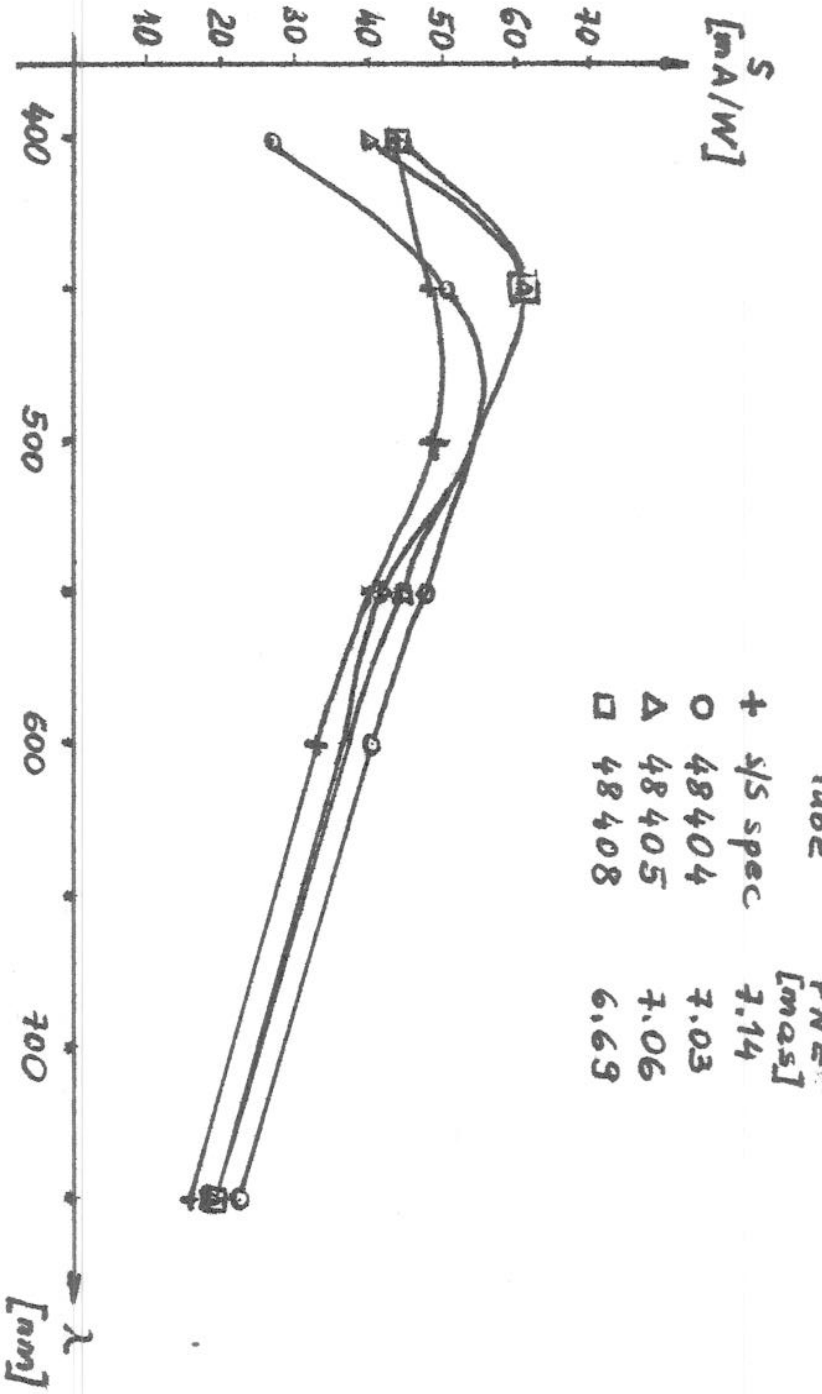
NO CHANGE SINCE LAST REPORT TO HST (LONG TERM PILOTING STABILITY SETTLED)

TUBE PROCUREMENT

IDT's :	EM TUBES (X 3)	° DELIVERED TO SRU END JUNE ° ALL TUBES ARE WELL WITHIN SYSTEM SPECIFICATION ON PNE, BLEMISHES, UNIFORMITY, BACKGROUND COUNTS. ° ONE TUBE SET ASIDE AS FLIGHT CANDIDATE.
	PFM TUBES (X 5)	° PRODUCTION UNDER WAY ° FIRST BENCH TEST RESULTS NOT YET AVAILABLE (DUE AROUND END OCTOBER '84).
	SUPPLEMENTARY PFM TUBES	° NOT CONSIDERED PRESENTLY IN THE BASELINE. ° SITUATION TO BE REVIEWED IN THE LIGHT OF BENCH TESTS OF PFM TUBES (NOVEMBER '84).

PMT's : EM BATCH DELIVERY EXPECTED IN DECEMBER.

Date 1ST OCTOBER 1984



Sensitivity of HIPPARCOS IDTs (LOT 1)

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

ANNEX III

OVERALL SYSTEM SPECIFICATION ISSUE 3
CHANGES INCORPORATED IN REVISION 5

P.P.	§	
35-36	4.2	DEFINITION OF REFERENCE FRAMES IN LINE WITH P/L SYSTEM SPECIFICATION
64	5.1.1.4.1	RELAXATION OF A-PRIORI KNOWLEDGE OF POSITIONS OF REFERENCE STARS
66-67.4	5.1.1.5	INTRODUCTION OF MODEL DISTRIBUTIONS OF S AND C STARS
74-76-82	5.2	DEFINITION OF NOMINAL SENSE OF ROTATION
80	5.2.2.6	TYCHO PASSBANDS DEFINED ACCORDING TO SRD
89	5.2.4.1	INCREASED IFOV DIAMETER
89/90	5.2.4.3	INCLUSION OF OBC PILOTING APPROXIMATIONS IN IFOV POINTING ERROR BUDGET
91	5.2.5.1	INCLUSION OF OBC ERRORS IN RTAD ERROR BUDGET
92/92.1	5.2.5	NEW FORMULATION OF ATTITUDE MODELLING REQUIREMENTS
96	5.2.7.1.4	REMOVAL OF CONFUSION BETWEEN ISP AND CCCM IN IDT PILOTING MATRIX CALIBRATION
97-98	5.2.7.3	COMPLETE REVISION OF PHOTOMETRIC CALIBRATION REQUIREMENTS
128/129	8.1	REVISED MASS ALLOCATION
130	8.2	REVISED POWER ALLOCATION

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NUMEROUS EDITORIAL CORRECTIONS AND REFINEMENTS

overall distribution of Candidate Stars (preliminary) -
total observing time required (years)
by Stars brighter than ...
and with higher priority than ...

P \ m_H	<7	7-8	8-9	9-10	10-11	>11
1	8407	10551	24061	13732	3584	726
1RF	680	2564	5682	13013	5022	2558
	0.09	0.25	0.75	1.38	1.66	1.83
1S	3134	9180	8648	72	1	1
	0.12	0.40	1.05	1.68	1.96	2.13
2	1	3	670	1077	76	226
2RF	–	136	1653	3460	1277	170
	0.12	0.40	1.09	1.88	2.15	2.34
2S	7	284	2679	318	–	–
	0.12	0.41	1.14	1.88	2.21	2.41
3	–	–	1	121	112	60
3RF		53	1923	7102	1613	209
	0.12	0.41	1.22	2.15	2.53	2.74
3S	1	159	2915	674	–	–
≥4	715	99	9635	30992	23510	4689
	0.13	0.42	1.40	3.05	4.18	4.60

208230 *, faint close companions (ρ<30") are not separated.

ANNEXE 3 -

Etude à plat : Calcul du paramètre de pression;

objectif : situer chaque étoile candidate à l'input catalogue par rapport à son environnement de manière à évaluer ses chances d'être observée convenablement.

procédure : Soient N étoiles candidates (dans L2V sur N = 212296) on examine successivement l'environnement de chacune de ces étoiles. Elles sont numérotées i : $i = 1, N$.

1° on établit la liste des $n(i)$ étoiles situées dans un cercle de 0.9° d'ouverture autour de l'étoile i. L'étendue de la région ainsi délimitée est $s = 2.545$ degrés carrés.
Le choix de la valeur 0.9° est arbitraire ; un tel cercle contient toutes les étoiles qui pourront être présentes dans le champ en même temps que l'étoile i pendant un laps de temps significatif. (une valeur un peu plus faible pourrait être adoptée).

2° les $n(i)$ étoiles sont classées suivant leur priorité ESA (1, 1R ou 1F, 1S, 2 ....) dans chaque classe de priorité on hiérarchise suivant la magnitude. Les $n(i)$ étoiles sont numérotées j : $j = 1, n(i)$ suivant cet ordre. Le rang de l'étoile centrale i dans ce classement est j_i.

3° on calcule la somme des temps cibles pour cette région en arrêtant la sommation à l'étoile centrale puisque les suivantes sont moins prioritaires.

$$T_i = \sum_{j=1}^{j_i} \bar{\tau}(j) \qquad (1)$$

on suppose ici que $\bar{\tau}$ est un temps cible* par passage, c'est à dire le temps d'observation que l'étoile devrait recevoir chaque fois qu'elle se présente dans le champ pour atteindre en fin de mission la précision souhaitée.

T_i mesure donc le temps d'observation dont il faudrait disposer lorsqu'on observe la région étudiée pour que l'étoile i puisse être observée normalement.

Le temps disponible par passage pour une région du ciel de s degrés carrés est proportionnel à s. La vitesse de balayage permet de disposer de 19.2 secondes pour deux champs de 0.81 degrés carrés soit un temps disponible

$$u = 9.6 / 0.81 = 11.85 \text{ secondes d'observation par}$$

degré carré. Soit pour la surface s

$$s \cdot u = 30.16 \text{ secondes.}$$

* l'annexe 1 donne les conventions adoptées pour le calcul de $\bar{\tau}$.

on obtient ainsi un coefficient

$$p_i = T_i / s \times n \qquad (2)$$

qui mesure la <u>pression</u> des demandes d'observations exercée par les étoiles qui entourent l'étoile i.

Ce coefficient reste associé à l'étoile aussi longtemps que la liste et les priorités des étoiles environnantes (de plus basse priorité) ne sont pas modifiées.

La signification de p_i est immédiate.

Si $p_i < 1$ la demande de temps d'observation par des étoiles plus prioritaires que i est faible en moyenne quand l'étoile i est observable. Cette étoile sera donc en générale observée.

Si $1 < p_i < 2$ la demande est supérieure en moyenne au temps disponible pour les étoiles d'un champ, l'étoile i ne sera observable que si la demande de temps dans le champ conjugué est plus faible.

Si $p_i > 2$ la demande de temps d'observation sera en moyenne supérieure à celle disponible pour les 2 champs. L'étoile ne peut donc être observée régulièrement.

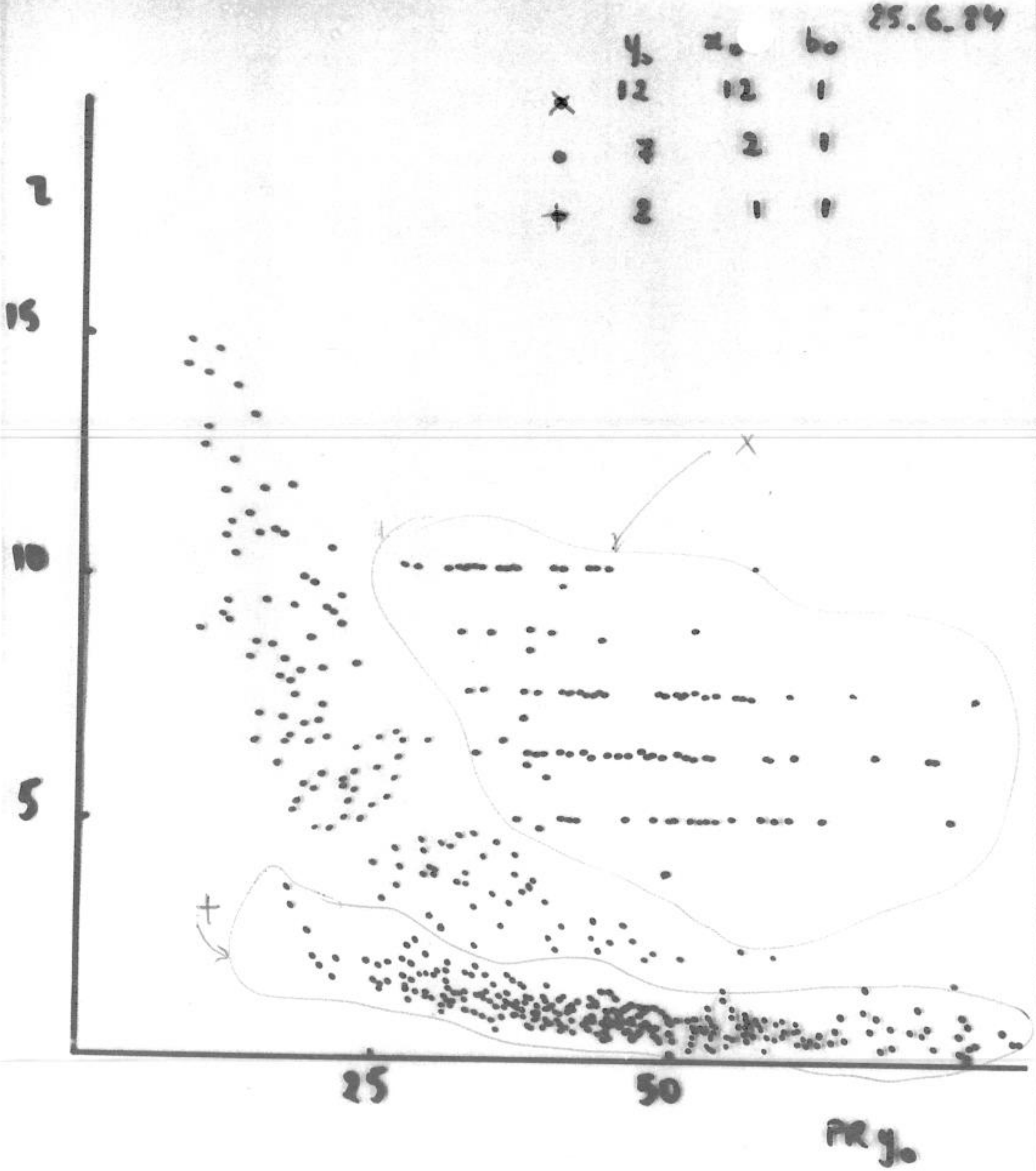
INCA / L2U sup / 30.9.84
Source Nicolet Genève

% of Stars accepted at pressure threshold 1.

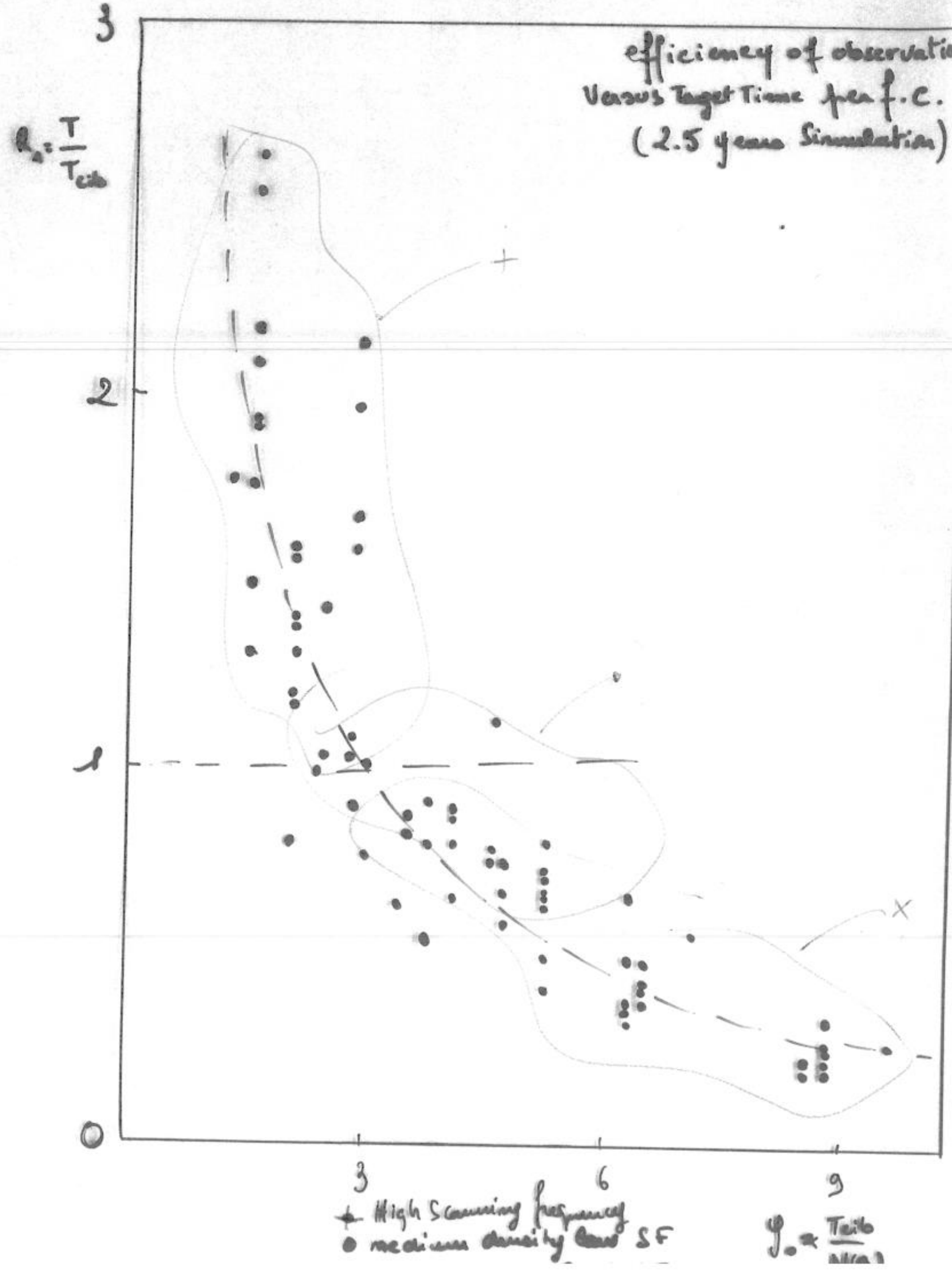
98	97	96	91	[64]	[45]
87	88	84	73	[52]	[36]
[70]	[64]	[65]	44		
		38	30	25	31
	49	46	32	36	27
	41	53	46		
		26	13	13	
		48	44		
54	22	24	16	11	5

% of Stars accepted at pressure threshold 2.
(Veiling Glare)

98 (98)	97 (98)	97 (97)	97 (97)	93 (95)	80 (84)
96 (98)	97 (98)	95 (97)	95 (97)	89 (95)	75 (82)
95 (98)	93 (90)	96 (99)	96 (98)		



Response of O.S.
for 3 Stars with different
sets of parameters x_0, y_0



ANNEX V

MATRA PHASE DETERMINATION PROCESS

. INITIAL PHASE EXTRACTION :

- METHOD : FOURIER ESTIMATION
- PURPOSE : ROUGH ESTIMATION OF THE IDT MODULATED SIGNAL PARAMETERS

. FINAL PHASE EXTRACTION :

- METHOD :
  * MAXIMUM LIKELIHOOD METHOD BASED ON TWO HARMONICS
  * THE WEIGHTS USED ARE BASED ON THE SIGNAL PARAMETERS AS ESTIMATED BY THE FOURIER METHOD
  * THE SCAN VELOCITY IS ASSUMED FIXED AND KNOWN

. WEIGHTED PHASE :

- THE PHASE ESTIMATE IS OBTAINED AS THE WIEGHTED COMBINATION OF THE 1ST AND 2ND HARMONICS PHASES :

$$\phi = \frac{M_1^2}{M_1^2 + 4 M_2^2} \phi_1 + \frac{4 M_2^2}{M_1^2 + 4 M_2^2} (\phi_2 / 2)$$

- THE MODULATION FACTORS M1 AND M2 USED IN THE ABOVE WEIGHTS ARE ESTIMATED VALUES.

IDT Signal Model

LINDEGREN

V.II

Astr. par.
Ephem. etc. } Proper direction $\underline{u}$

Attitude ξ, ν, Ω

} Field coord. w, z, f

LSD
B-V

} smooth grid coord. $\bar{G}$

SSD
(MSD)

} Grid coord. G

OTF
A, B

} $E(N_\ell)$

$w = \cos\xi \cos\eta$

$z = \sin\xi$

$$E(N_\ell) = B + A\left[1 + M_1 \cos(2\pi G_\ell) + M_2 \cos(4\pi G_\ell - v_2)\right]$$

NDAC/LL/1

SM Signal Model

.... Field coord. w, z, f

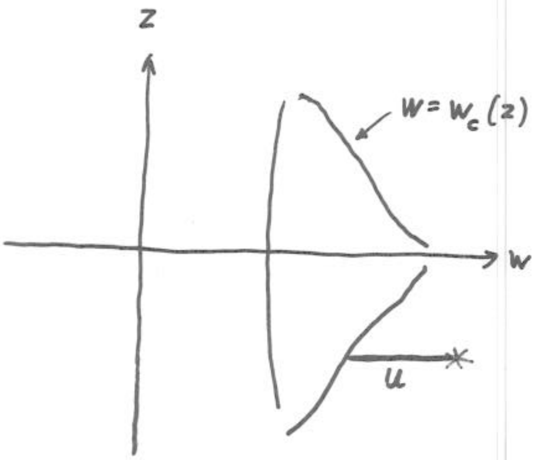
Center line equation $w_c(z)$

} $u = w - w_c(z)$

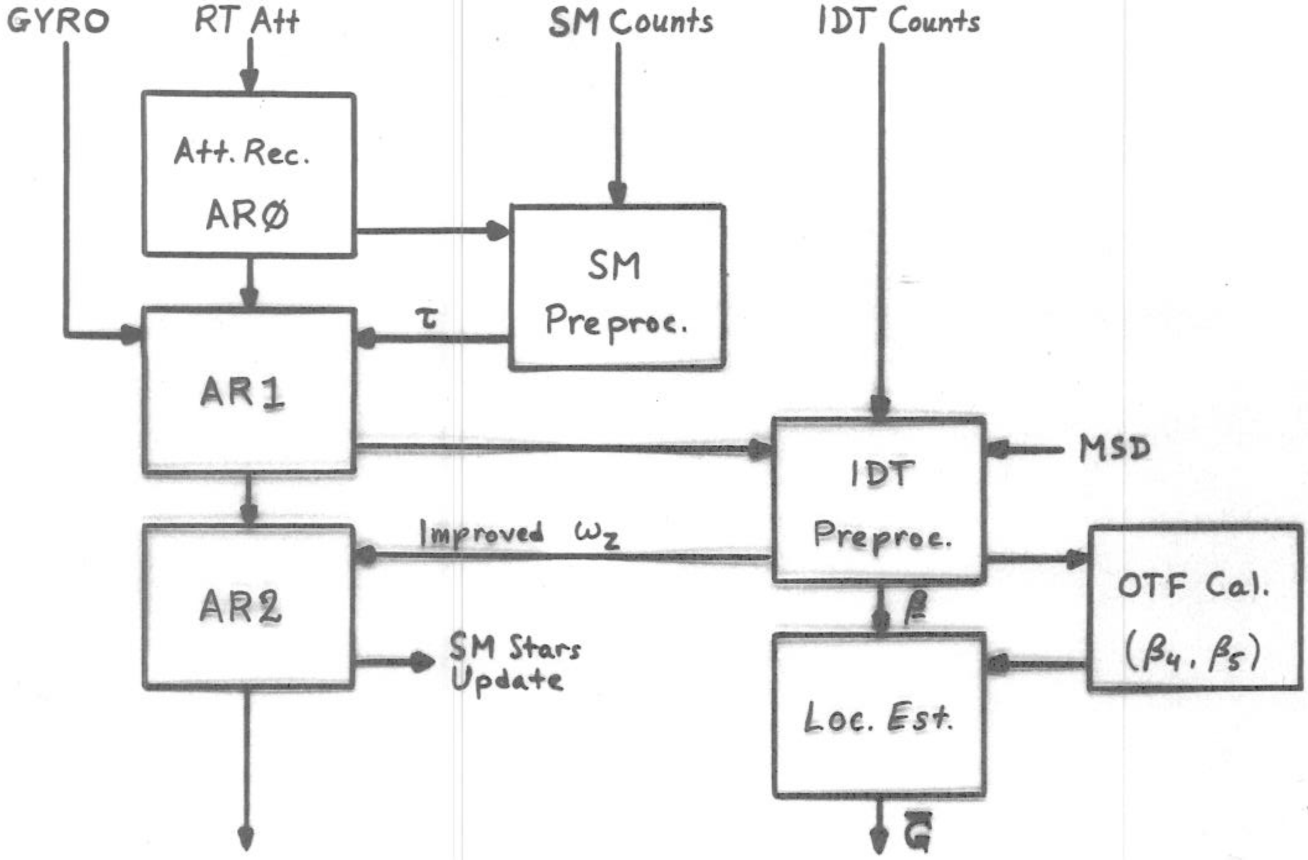
Response function $S(u)$

a, b

} $E(N_\ell^*)$

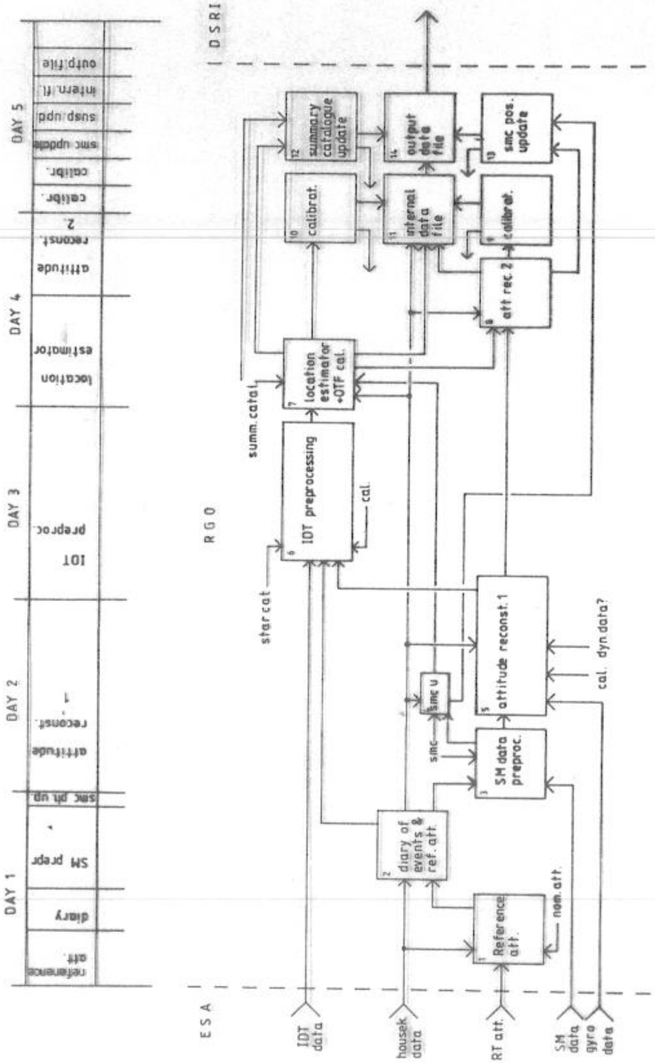


$$E(N_\ell^*) = b + a\,S(u)$$



GYRO
RT Att
SM Counts
IDT Counts
Att. Rec.
ARØ
SM
Preproc.
τ
AR1
IDT
Preproc.
MSD
Improved ω_z
AR2
OTF Cal.
(β_4, β_5)
β
SM Stars
Update
Loc. Est.
G

NDAC/LL/2



IDT AND STARMAPPER PREPROCESSING

PLANNED PROGRAMME OF WORK (PRE-LAUNCH)

1) DEVELOP SIMULATION SOFTWARE
2) TEST SIMULATION SOFTWARE
3) DEVELOP PREPROCESSING ALGORITHM
4) TEST ALGORITHM WITH SIMULATED DATA
5) TEST DATA INTERFACE WITH RGO
6) TEST PREPROCESSING OUTPUT AS INPUT TO RGO ALGORITHMS

SM PREPROCESSING ⟶ ATTITUDE RECONSTRUCTION

IDT PREPROCESSING → LOCATION ESTIMATOR

7) INSTALL ALGORITHMS ON RGO COMPUTER (VAX 11/750)
8) TEST ALGORITHM AGAINST TIMING BUDGET
9) SUPPORT SYSTEM TEST (END OF 1985)

CRUISE

V.III

PROGRAMME ARCHITECTURE

- FORTRAN-77 SOURCE
- MODULAR STRUCTURE
- S/R AND FUNCTIONS COMMUNICATE WITH MAIN PROGRAMME VIA COMMON BLOCKS
- CONTROL DATA, INITIAL CONDITIONS AND INPUT DATA ON DISK FILE
- OUTPUT TO DISK FILE
- INSTRUMENT MODELS IN FORM OF SUB-PROGRAMMES ACCESSING DISK PARAMETERS
- PROGRAMMES HIDS IDT SIMULATION

  FSTSMP SM SIMULATION

  SMPP SM PREPROCESSING

  HIPP IDT PREPROCESSING

IDT SIMULATION

STAR CATALOGUE

CONTAINS STAR NAME, ASTROMETRIC AND PHOTOMETRIC DATA

ATTITUDE MODEL

SIMULATES MOTION OF SATELLITE IN SPACE IMPLICITLY INCLUDES EPHEMERIS AND REAL-TIME ATTITUDE

(A) 2-D SCAN + NO JITTER
(B) 3-D SCANNING + SINUSOIDAL JITTER

STAR SPECTRUM

(A) BLACK BODY

POINT-SPREAD FUNCTION
(SPATIAL RESPONSE OF TELESCOPE)

(A) ACHROMATIC BI-DIMENSIONAL GAUSSIAN
(B) PROPER DIFFRACTION PATTERN
(C) PROPER CHROMATIC

GRID DATA

(A) LSD - TO FIRST ORDER TO SIMULATE ROTATION AND OFFSET FROM FIELD CENTRE(SSD - ZERO)

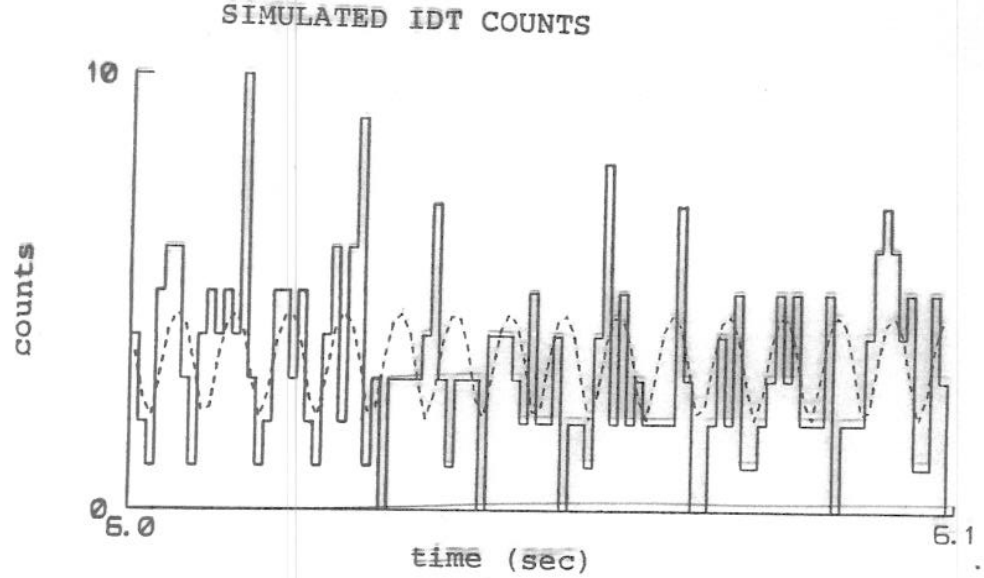
(B) LSD - TO HIGHER ORDER
SSD - RANDOM ON GIVEN SCALE

GRID TRANSMISSION

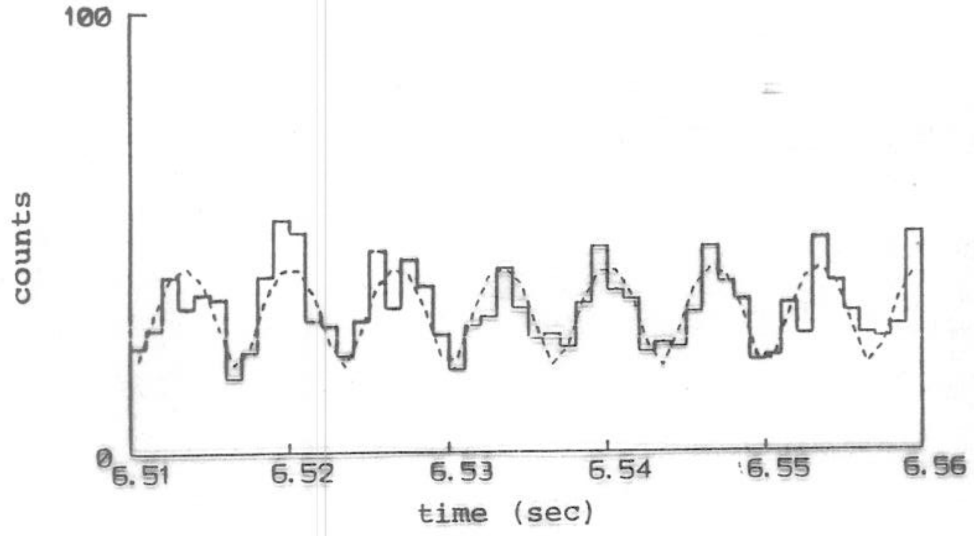
(A) 'TOP HAT' FUNCTION

STATISTICAL MODEL

(A) POISSON DISTRIBUTION GENERATED FROM PSEUDO-RANDOM NUMBER GENERATOR WITH UNIQUE STARTING POINT FOR EACH RUN

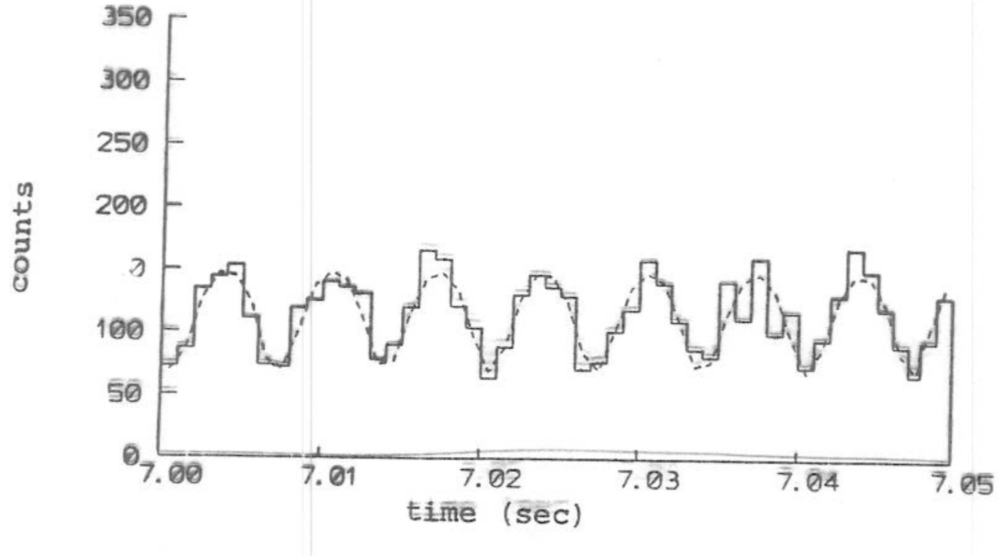


(a)



100
counts
0
6.51
6.52
6.53
6.54
6.55
6.56
time (sec)

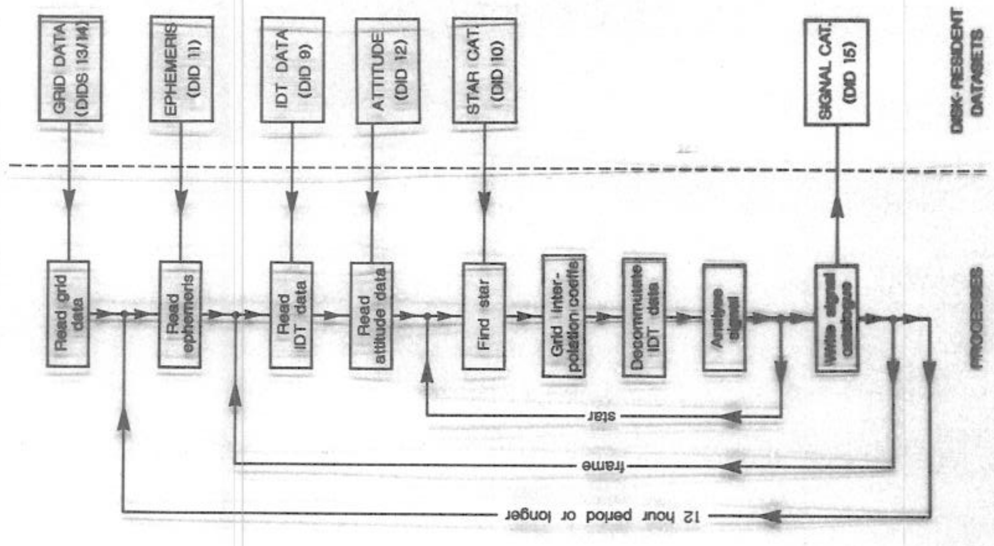
(b)



350
300
250
200
counts
100
50
0
7.00
7.01
7.02
7.03
7.04
7.05
time (sec)

(c)

FIG 1 IDT PREPROCESSING OVERVIEW



IDT SIGNAL MODELIZATION

$$E(N_k) = \beta_1 + \beta_2 \left[COS(H_k + \beta_3) + \beta_4\ COS(2H_k + 2\beta_3) + \beta_5\ SIN\ (2H_k + 2\beta_3) \right]$$

WHERE $H_k = 2\pi\ FRAC\ (\tilde{G}_k)$

IDT SIMULATION RESULTS

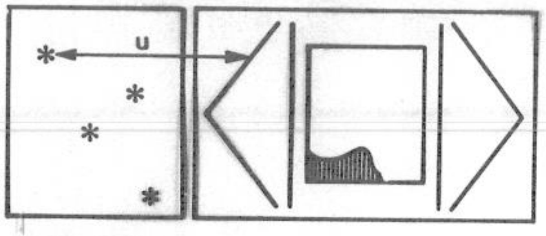
- STAGE 8 HAS BEEN REACHED
  [ALGORITHMS (PREPROCESSING AND SIMULATION) ARE RESIDENT AT RGO)]
- TIMING TESTS ARE BEING RUN
- CURRENT TARGET IS ONE 8 HOUR SHIFT FOR IDT PREPROCESSING OF ONE WEEK'S REAL TIME DATA
- SPEED REQUIREMENTS HAVE REDUCED THE NUMBER OF MAXIMUM LIKELIHOOD ITERATIONS TO <u>ONE</u>.
- TO FURTHER IMPROVE SPEED THE IDT DATA ARE ACCUMULATED INTO N PHASE BINS (N ≤ 512) BEFORE ANALYSIS.

TABLE A

ALGORITHM	N	σ (mas)	LOSS OF ACCURACY	CPU TIME
A	512	35	- -	1300
B	12	38	8%	90
B	18	36	3%	100
B	24	36	3%	120

σ IS THE UNCERTAINTY IN THE ESTIMATE OF β_3 AVERAGED OVER 100 STARS WITH $5 < BMAGN < 11$

STAR MAPPER SIMULATION



PRE-FIELD FOCAL PLANE

- USE RANDOM NUMBER GENERATOR TO GENERATE STARS WITH

1) η, ξ COORDINATES IN PRE-FIELD

2) B MAGNITUDE

3) B-V

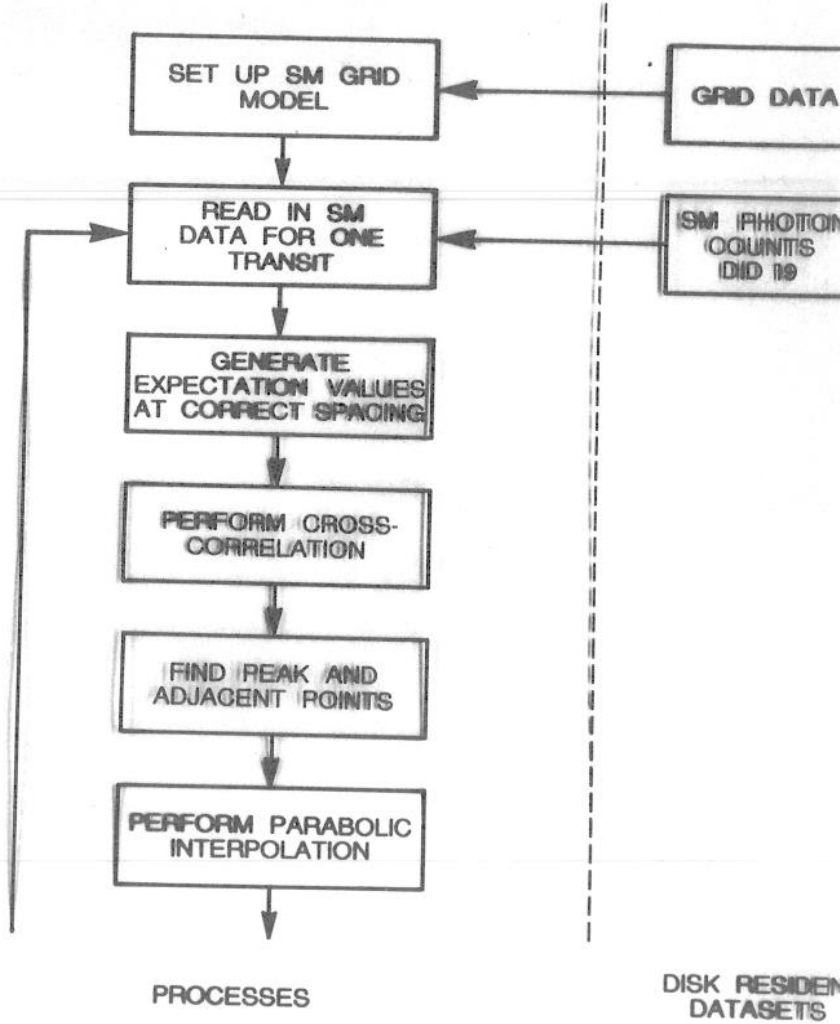
4) FIELD OF VIEW

5) SM

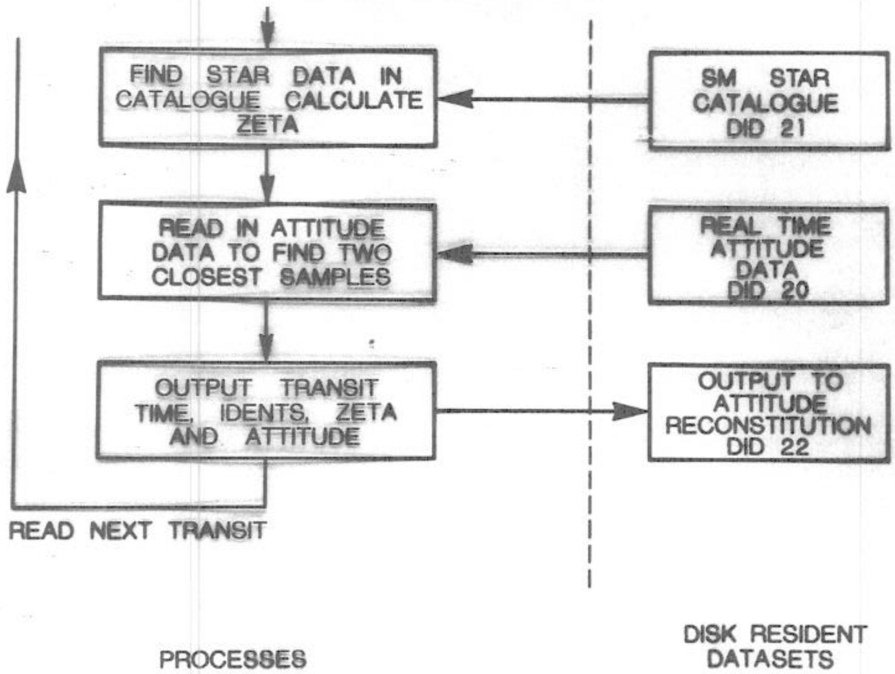
WRITE THESE TO STAR CATALOGUE

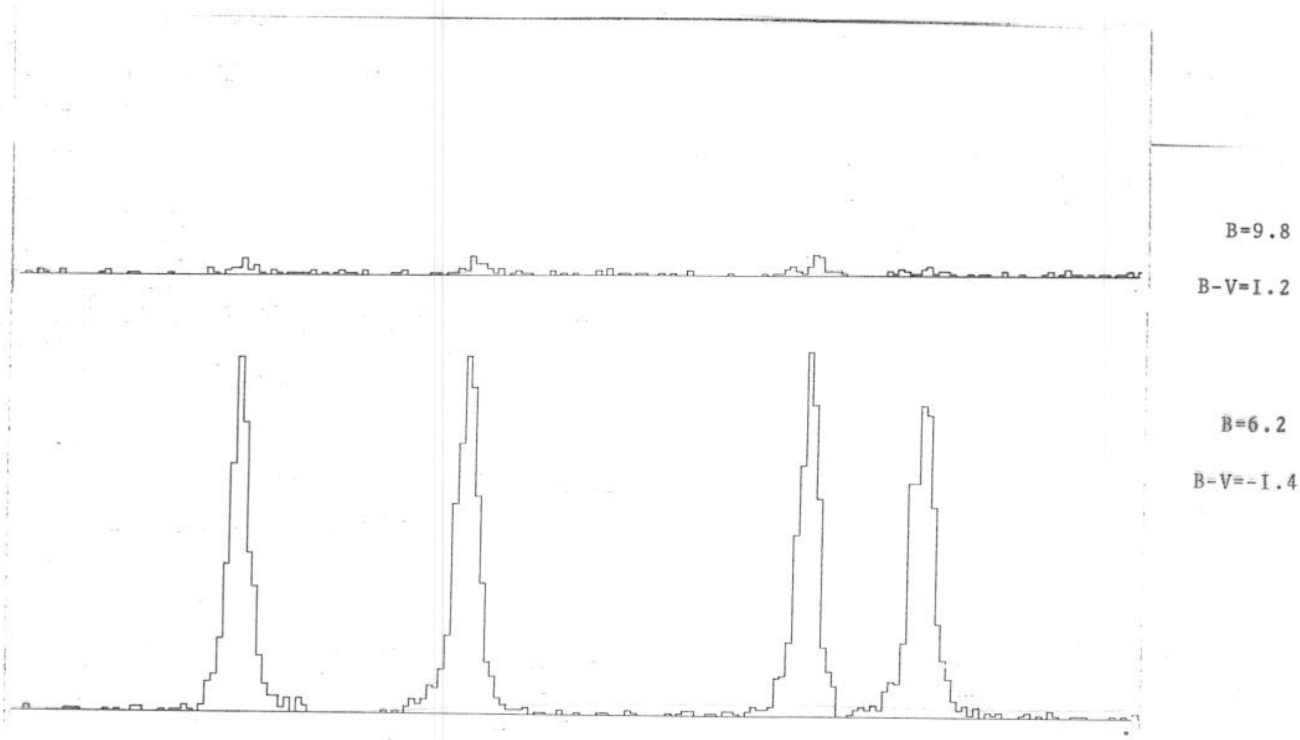
- CALCULATE U FOR EACH STAR AND SLIT GROUP
- ORDER U-VALUES TO DETERMINE SEQUENCE OF TRANSITS
- POISSONIANIZE COUNTING RATE FOR EACH SAMPLE WITHIN SLIT GROUP

STAR MAPPER PREPROCESSING

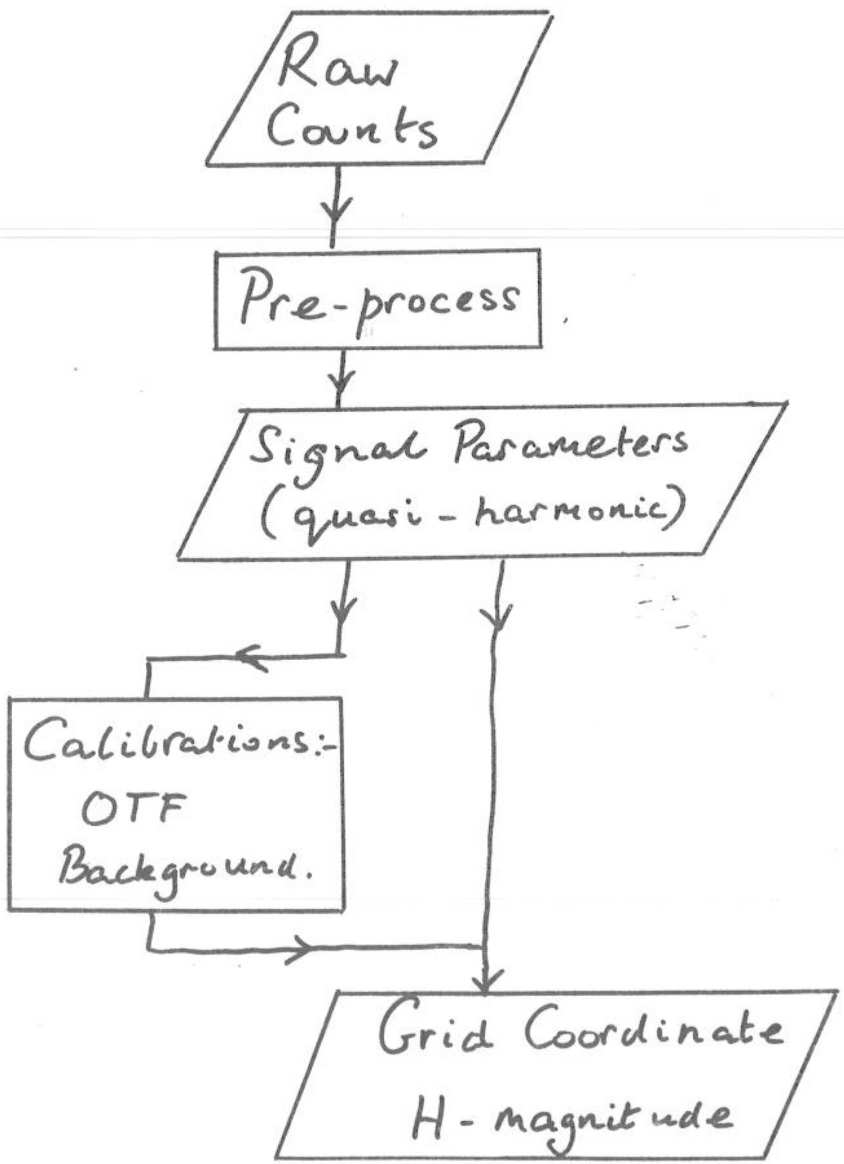


STAR MAPPER PREPROCESSING CONT'D





IDT Data



Photon count model (non-multiple star)

$$N = \beta_1 + \beta_2 \left[\cos(H + \beta_3) + \beta_4 \cos(2H + 2\beta_3) + \beta_5 \sin(2H + 2\beta_3) \right]$$

$$H = 2\pi G \quad \text{(reference phase)}$$

Photometric parameters :-

$\beta_1 = (B + I)\Delta t \ ; \quad \beta_2 = M_1 I \Delta t$

Astrometric parameter :-

$$\beta_3 = 2\pi \Delta G$$

OTF parameters :-

$\beta_4 = \frac{M_2}{M_1} \cos v_2 \ ; \quad \beta_5 = \frac{M_2}{M_1} \sin v_2$

MURRAY

V. IV

Estimator $\hat{\underline{\beta}}$, and covariance matrix $\underline{\underline{\Phi}}$ obtained in pre-processing of IDT counts for each star/frame transit

Objective :-

To derive estimators of I, ΔG from $\hat{\underline{\beta}}$, $\underline{\underline{\Phi}}$, for each transit.

Requires calibration of

B, M_1, β_4, β_5

General solution

Star constants (2)

$$\delta c = I\Delta t - c_0 \; ; \quad \delta\beta_3 = \beta_3 - \hat{\beta}_3$$

parameter vectors

$$\delta\underline{B} \quad \delta\underline{M}_1 \quad \tilde{\underline{\beta}}_4 \quad \tilde{\underline{\beta}}_5$$

Observation equation:-

$$\left[\begin{array}{cc:cccc} 1 & 0 & \underline{V}_B' & \underline{0} & \underline{0} & \underline{0} \\ M_{10} & 0 & \underline{0} & c_0\underline{V}_M' & \underline{0} & \underline{0} \\ 0 & 1 & \underline{0} & \underline{0} & \underline{0} & \underline{0} \\ 0 & 0 & \underline{0} & \underline{0} & \underline{V}_4' & \underline{0} \\ 0 & 0 & \underline{0} & \underline{0} & \underline{0} & \underline{V}_5' \end{array}\right] \left[\begin{array}{c} \delta c \\ \delta\beta_3 \\ \hdashline \delta\underline{B} \\ \delta\underline{M}_1 \\ \tilde{\underline{\beta}}_4 \\ \tilde{\underline{\beta}}_5 \end{array}\right] = \left[\begin{array}{c} \hat{\beta}_1 - c_0 \\ \hat{\beta}_2 - M_{10}c_0 \\ 0 \\ \hat{\underline{\beta}}_4 \\ \hat{\underline{\beta}}_5 \end{array}\right]$$

Restricted Solution

star constants (3)

$$\delta\beta_i = \beta_i - \hat{\beta}_i \qquad i = 1, 2, 3$$

parameter vectors

$$\underline{\tilde{\beta}}_4 \quad \underline{\tilde{\beta}}_5$$

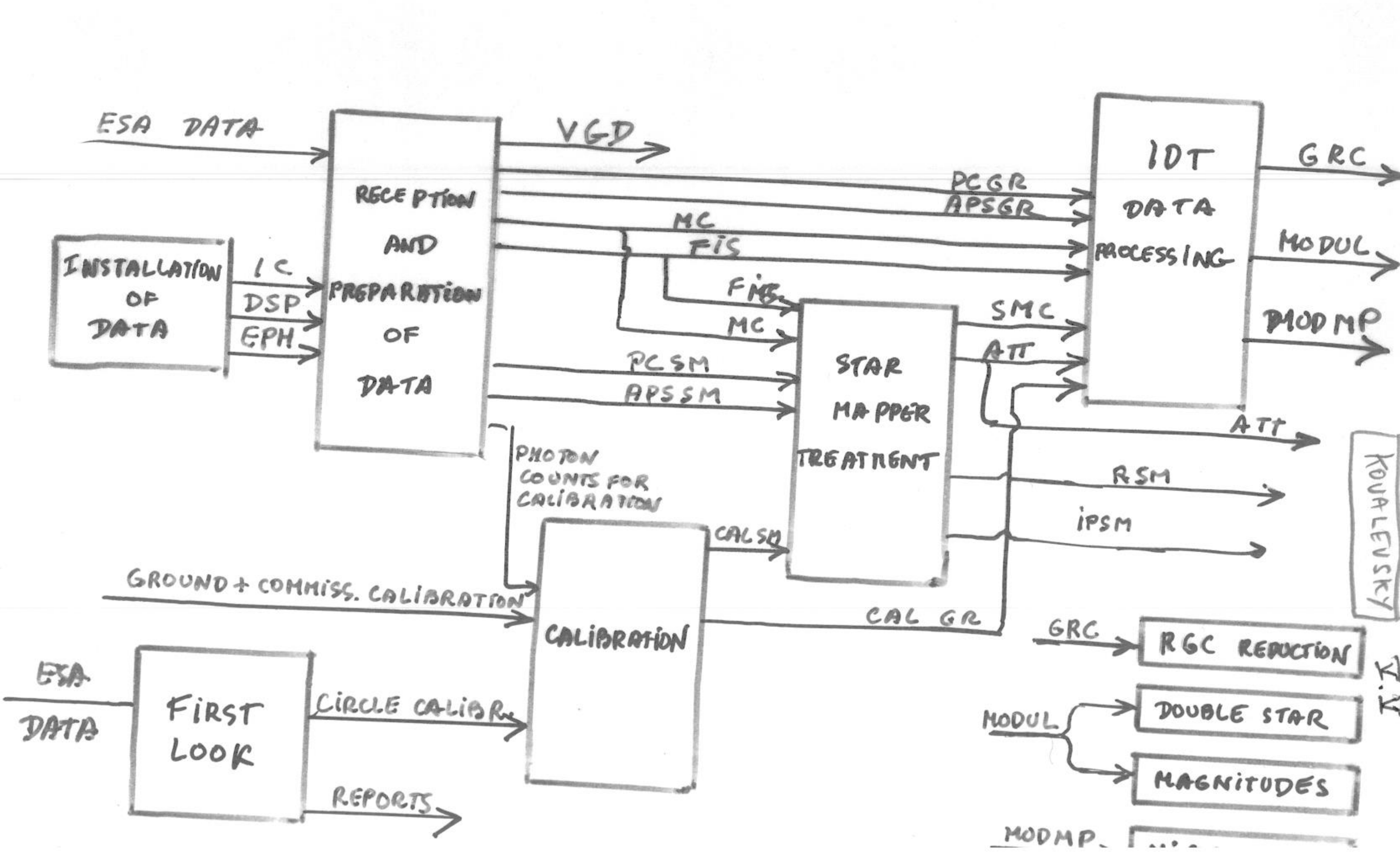
Observation equation :-

$$\left[\begin{array}{ccc|cc} 1 & 0 & 0 & \underline{0} & \underline{0} \\ 0 & 1 & 0 & \underline{0} & \underline{0} \\ 0 & 0 & 1 & \underline{0} & \underline{0} \\ 0 & 0 & 0 & \underline{v}_4' & \underline{0} \\ 0 & 0 & 0 & \underline{0} & \underline{v}_5' \end{array}\right] \left[\begin{array}{c} \delta\beta_1 \\ \delta\beta_2 \\ \delta\beta_3 \\ \hline \underline{\tilde{\beta}}_4 \\ \underline{\tilde{\beta}}_5 \end{array}\right] = \left[\begin{array}{c} 0 \\ 0 \\ 0 \\ \hat{\beta}_4 \\ \hat{\beta}_5 \end{array}\right]$$

Photometry :-

$$\left[\begin{array}{c|cc} 1 & \underline{v}_B' & \underline{0} \\ M_{10} & \underline{0} & c_0 \underline{v}_M' \end{array}\right] \left[\begin{array}{c} \delta c \\ \hline \delta\underline{B} \\ \delta\underline{M} \end{array}\right] = \left[\begin{array}{c} \beta_1 - c_0 \\ \beta_2 - M_{10} c_0 \end{array}\right]$$

FAST : RAW DATA TREATMENT



IIDT DATA PROCESSING

A) FIVE PARAMETERS MODEL

$$E[N(t_i)] = \underline{b_0} + \underline{b_1} \cos(\psi_1(t_i) - \underline{\varphi_1}) + \underline{b_2} \cos 2(\psi_2(t_i) - \underline{\varphi_2})$$

$\psi_1(t_i)$, $\psi_2(t_i)$ } given functions

$b_0, b_1, b_2, \varphi_1, \varphi_2$ unknown parameters

B) THREE PARAMETERS MODEL

$$E[N(t_i)] = \underline{b_0} + \underline{a} + \underline{a} M_1 \cos(\psi_1(t_i) - \underline{\varphi}) + \underline{a} M_2 \cos(\psi_2(t_i) - \underline{\varphi})$$

M_1, M_2 given parameters

$\psi_1(t_i)$, $\psi_2(t_i)$ } given functions

DONATI

V. VI

$\psi_1(t_i)$, $\psi_2(t_i)$ are the grid coordinates of the 1[th] and the 2[nd] harmonic computed on the basis of the present knowledge:

- apparent star position
- attitude reconstitution
- Transformation from field to grid coordinates (large and medium scale)

φ_1 and φ_2 (or φ) are the "mean" error in the a priori knowledge of $\psi_1(t_i)$ and $\psi_2(t_i)$

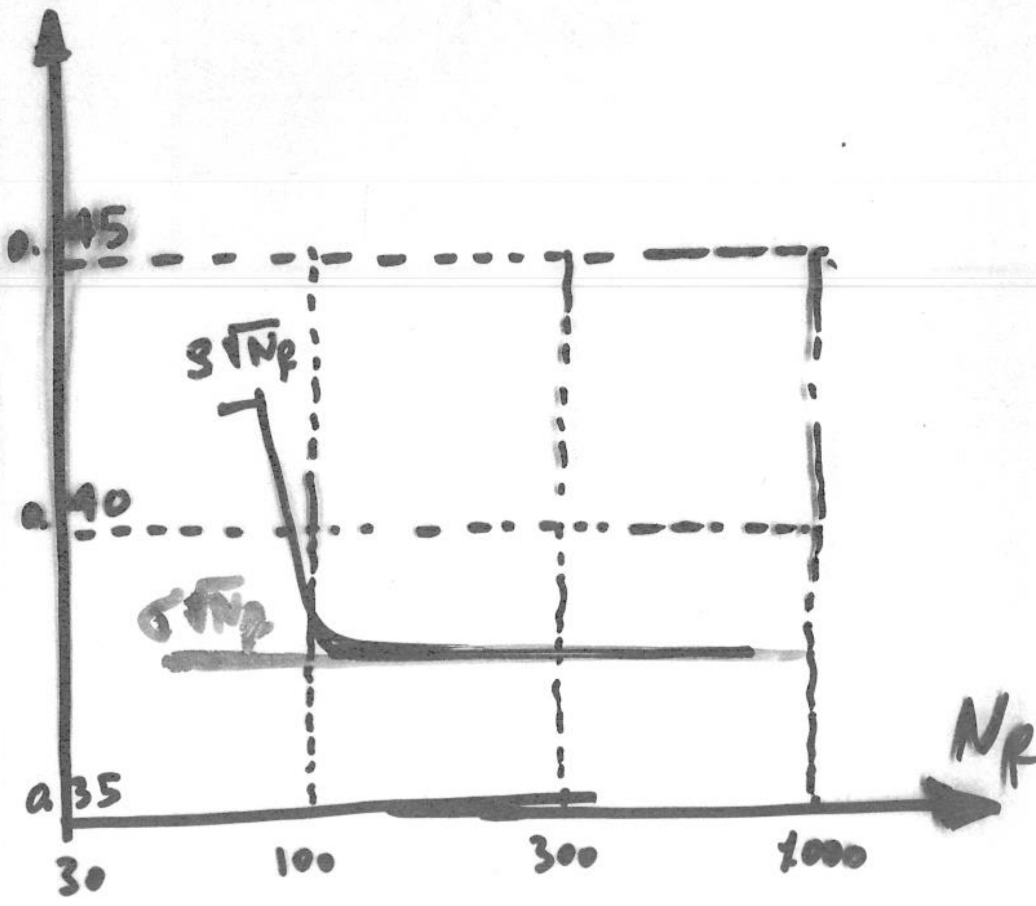
All the data collected from the same star during a frame are simultaneously processed

The estimated phase is attributed as error to the a priori knowledge of the grid coordinate at the central time of the frame.

The estimation procedure followed is the maximum likelihood criterion for all the estimated parameters.

It has been verified ~~that~~ by Montecarlo method that the actual variance is not significantly different from the Cramer-Rao limit until the total number of the photon collected is larger than 200

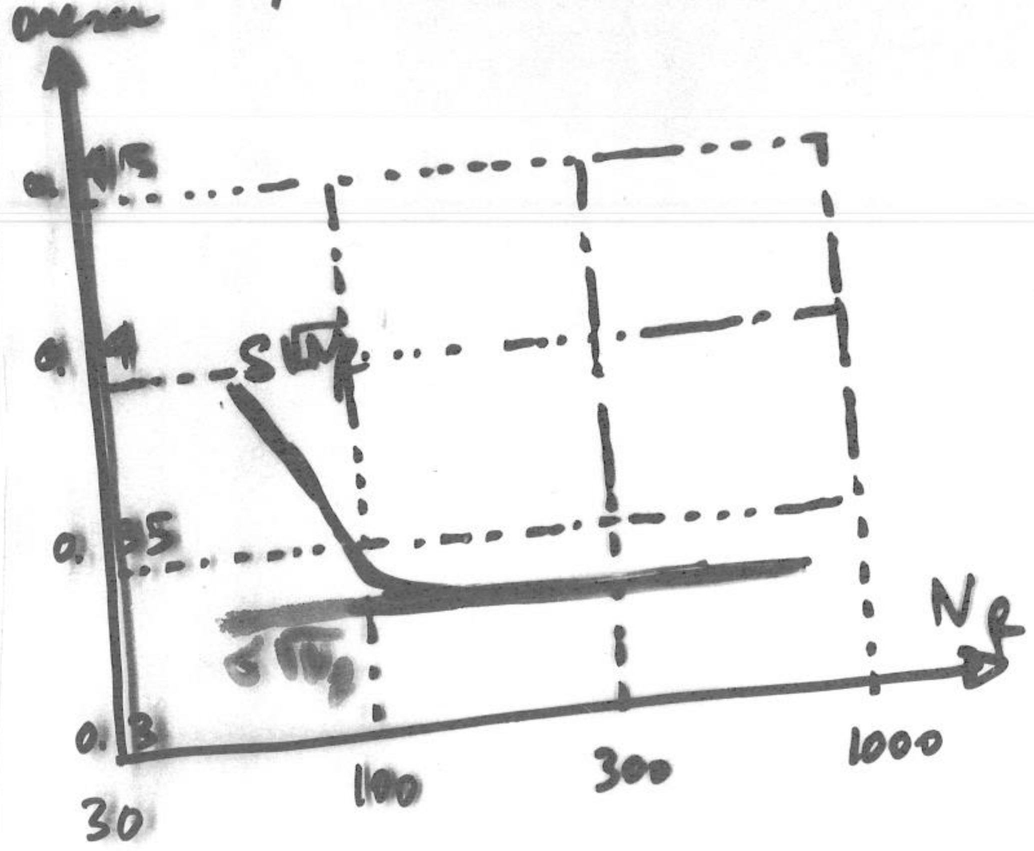
φ_1 dispersion



Star intensity 1000 Hz

NOISE 200 Hz

φ dispersion



Star intensity 1000 Hz
Noise 100 Hz

STAR MAPPER MODEL

$N(t_i)$ signal

$$E[N(t_i)] = b + a\, w(t_i - \varphi)$$

$\underline{b}$ = dark counts and background

$\underline{a}$ = star intensity

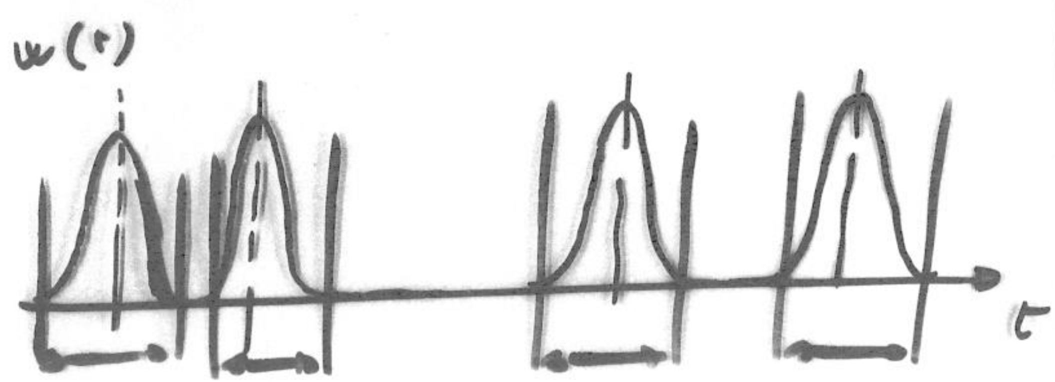
$\underline{w(t)}$: modulation function

$\underline{\varphi}$: star transit time

b, a, φ unknown parameters

$w(t_i)$ given function

The modulation function $w(t)$ is computed from the single slit response given the sampling interval ($\frac{1}{600}$ s) and the rotation speed



one modulation function function is considered for each slit system and each channel

Estimation Procedure

1st step

$$\hat{\varphi} = \arg \max_{\varphi} \sum_i N(t_i) \lg[1 + w(t_i - \varphi)]$$

$\hat{\varphi}$ is estimated

2nd step

$$(\hat{a}, \hat{b}) = \arg \min_{(a,b)} \sum_i \left(N(t_i) - b - a\,w(t_i - \hat{\varphi})\right)^2$$

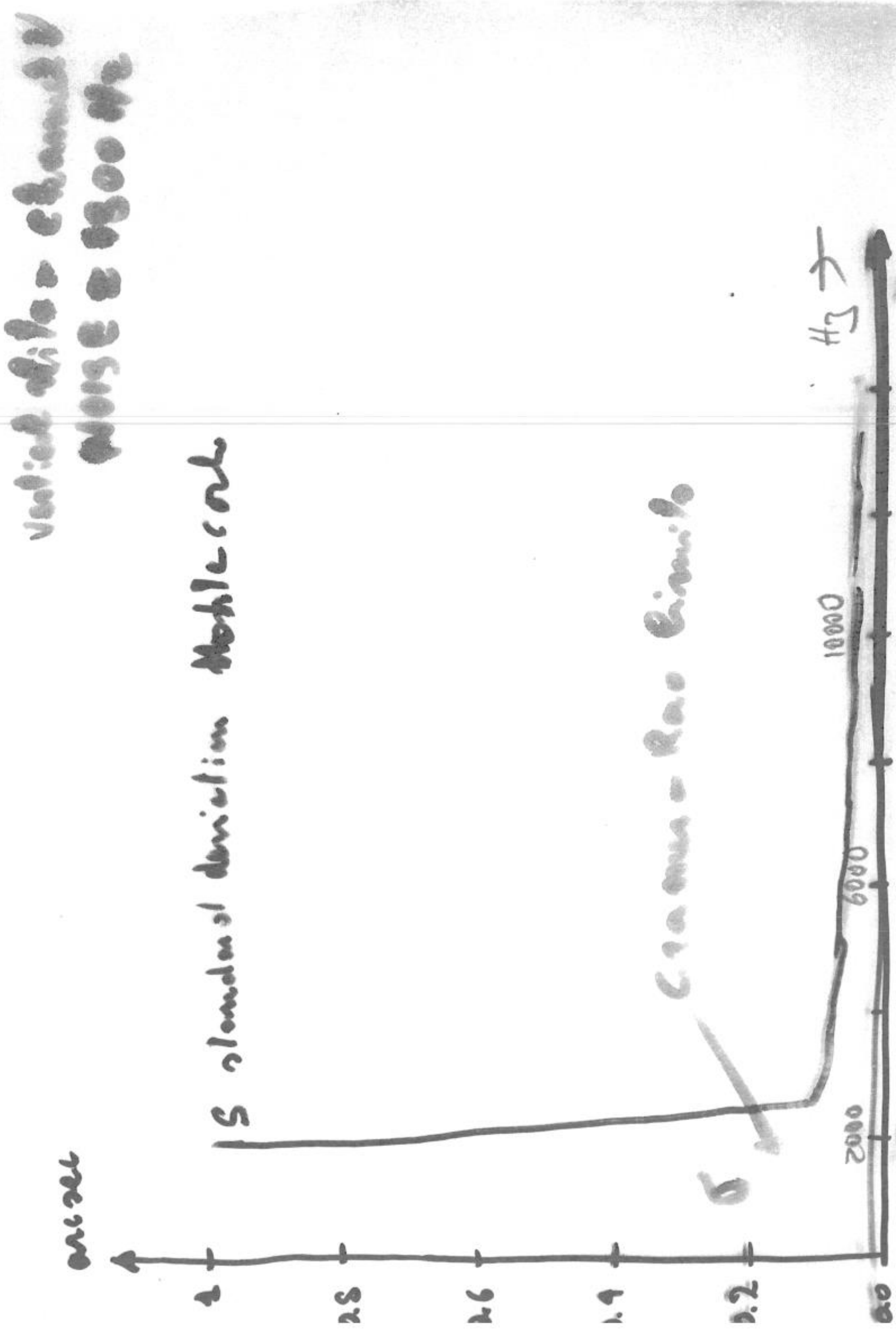
$\Downarrow$

$$(\hat{\hat{a}}, \hat{\hat{b}}) = \arg \min_{(a,b)} \sum_i \frac{(N(t_i) - b - a\,w(t_i - \hat{\varphi}))^2}{\hat{b} + \hat{a}\,w(t_i - \hat{\varphi})}$$

$\hat{\varphi}, \hat{\hat{a}}, \hat{\hat{b}}$

If the star intensity is sufficiently larger than the background noise the actual variances are not significantly different from the Cramer-Rao limits.

The Cramer-Rao limits are computed together with the estimated values



Two possibilities

- Each channel is processed independently.

  Two transit time estimates are obtained having different variances.

- The photon counts of the two channel are firstly summed in order two estimate the transit time.

  Then each channel signal is separately processed for estimating the star intensity and the background noise.

ANNEX VI

IDT PHOTON COUNTS

(F. MIGNARD)

Let:

$$I = I_0 \left(1 + M_1 \cos(\ldots) + M_2 \cos(\ldots) + \ldots\right)$$

Adopted formula:

$$I_0 = 6.6\ 10^6 \times 10^{-0.4H}$$

H: Hipparcos magnitude.

$$H - V = 0.455(B-V) - 0.200(B-V)^2 + 0.008(B-V)^3$$

- Spectral flux:
  - Kurucz (model) $T_{eff} > 6000\,K$
  - Straizys $T < 6000\,K$

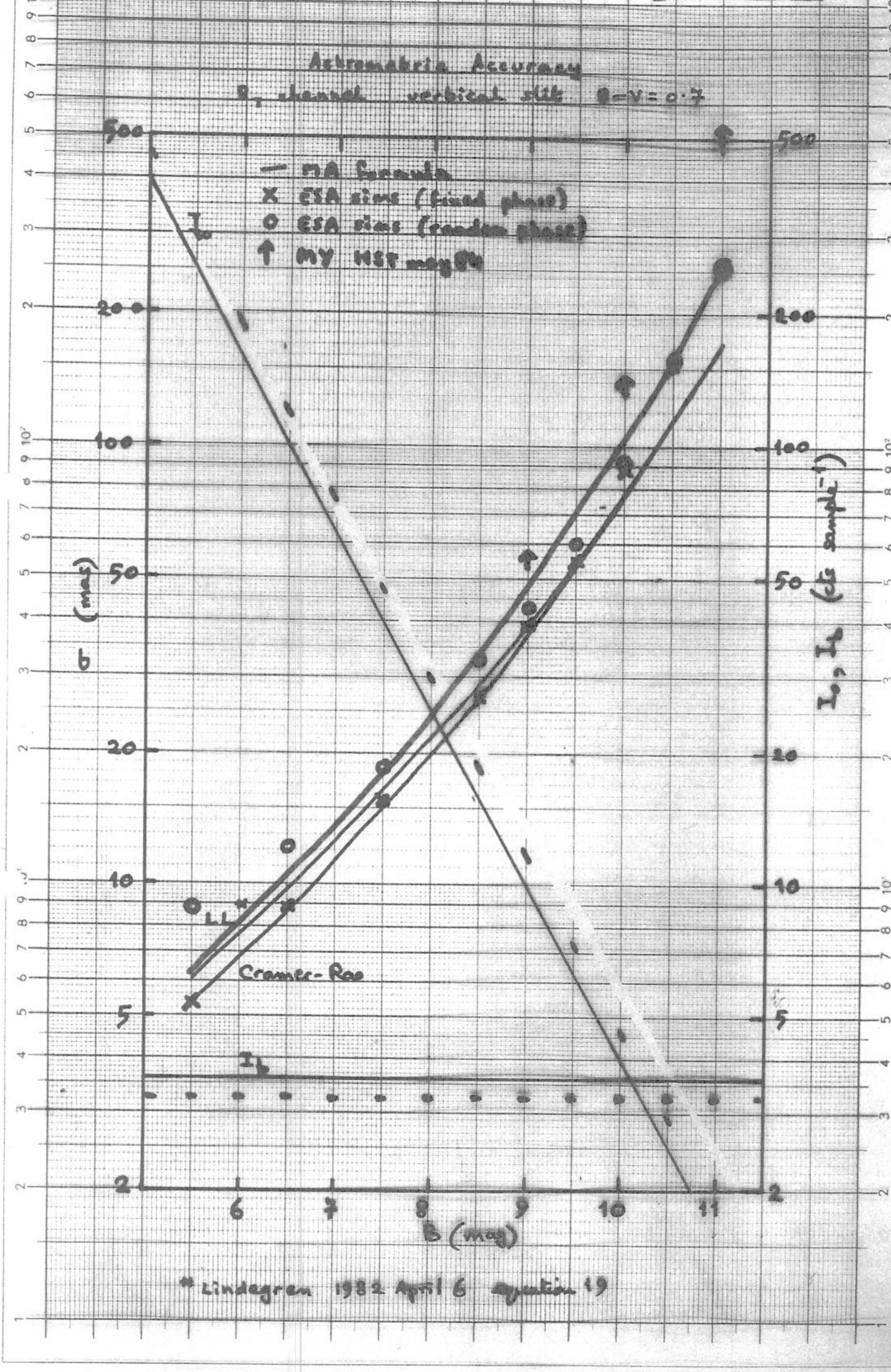
- Filter and instrument. of Le Gall
- Calibration from B-V and Magnitude of The Sun (not Allen)

I_0(Hertz): RESULTS for $B = 9$

B-V	Mignard	Grenon	Le Gall (Black body)	Ratier* (Black body)
-0.25	1484	1500	1729	1770
0.5	2226	1900	2426	2457
1.25	4088	3780	4359	4237

* tube 4 (not spec^{n})

ANNEX VII



X-as log. verdeeld 1-10³ Eenheid 90 mm. Y-as verdeeld in mm.

No. 17 H

meetpapier - wormerveer

ANNEX VIII

MAIN MISSION

FIRST QUALITY STANDARDS

s.e mv ≤ 0.007 mag.
s.e col ≤ 0.005 mag. $p \leq 1.00$

MAGNITUDE & COLOUR DISTRIBUTION

(0.3 mag. intervall in [B-V])

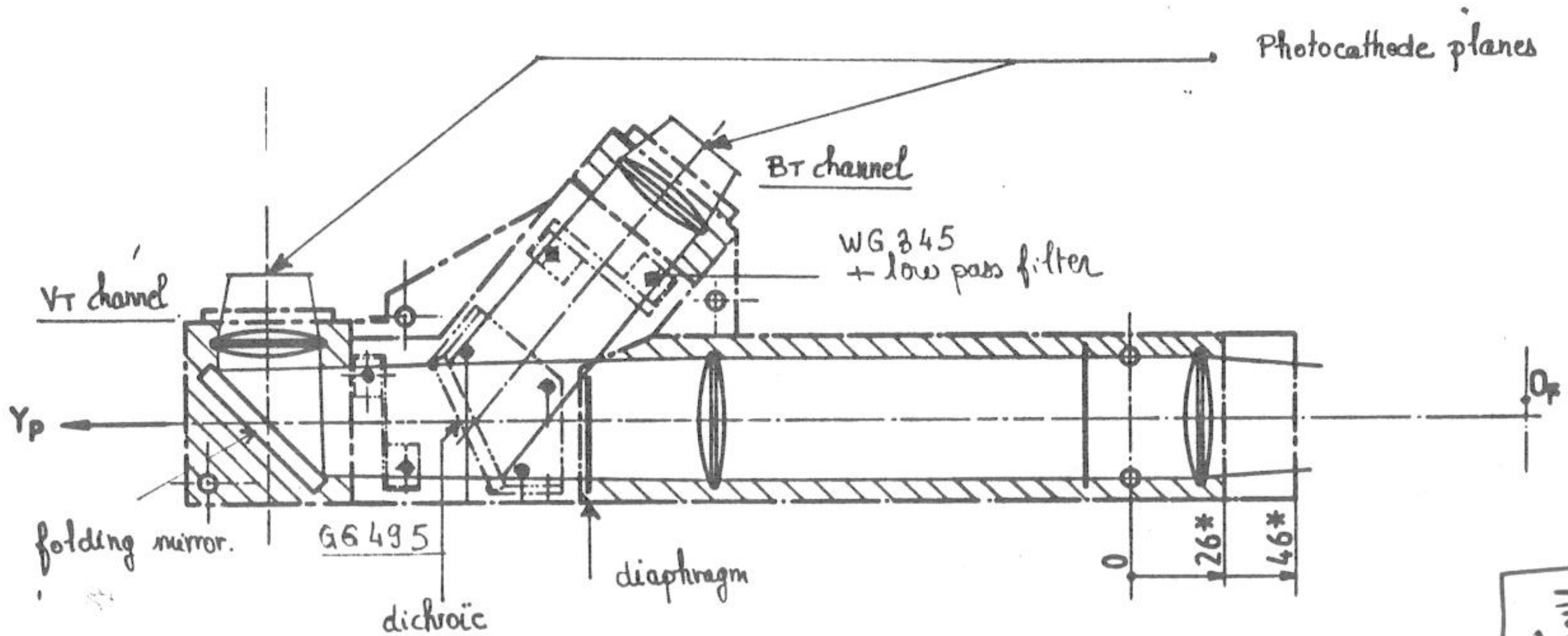
mv	1 (−.25)	2	3	4 (0.50)	5	6	7 (1.25)	8	Colour	all σ, p
≤ 1	15	4	2	0	2	1	1	0	Σ 25	40
2	26	10	2	3	6	4	1	2	54	106
3	66	18	13	5	27	35	8	6	178	314
4	189	78	56	18	60	75	45	17	538	877
5	468	242	215	85	167	198	99	65	1539	2283
6	517	369	302	159	159	194	71	24	1795	2907
7	182	165	145	178	66	59	22	4	821	1798
8	126	113	163	166	110	63	24	2	767	1858
9	47	61	79	116	82	53	40	4	482	1112
10	12	7	11	26	18	11	10	7	102	367
11	1	0	1	3	2	1	0	1	9	84
12	0	0	0	0	0	0	0	0	0	14
13	0	0	0	0	0	0	0	0	0	1

ΣΣ 6310 *

$m_v \geq 5$: > 5515 *

→ Selection criteria too severe for faint stars. > 11781 *

STAR MAPPER CHANNEL :
DEFINITION AND MODELLING.



ANNEX IX

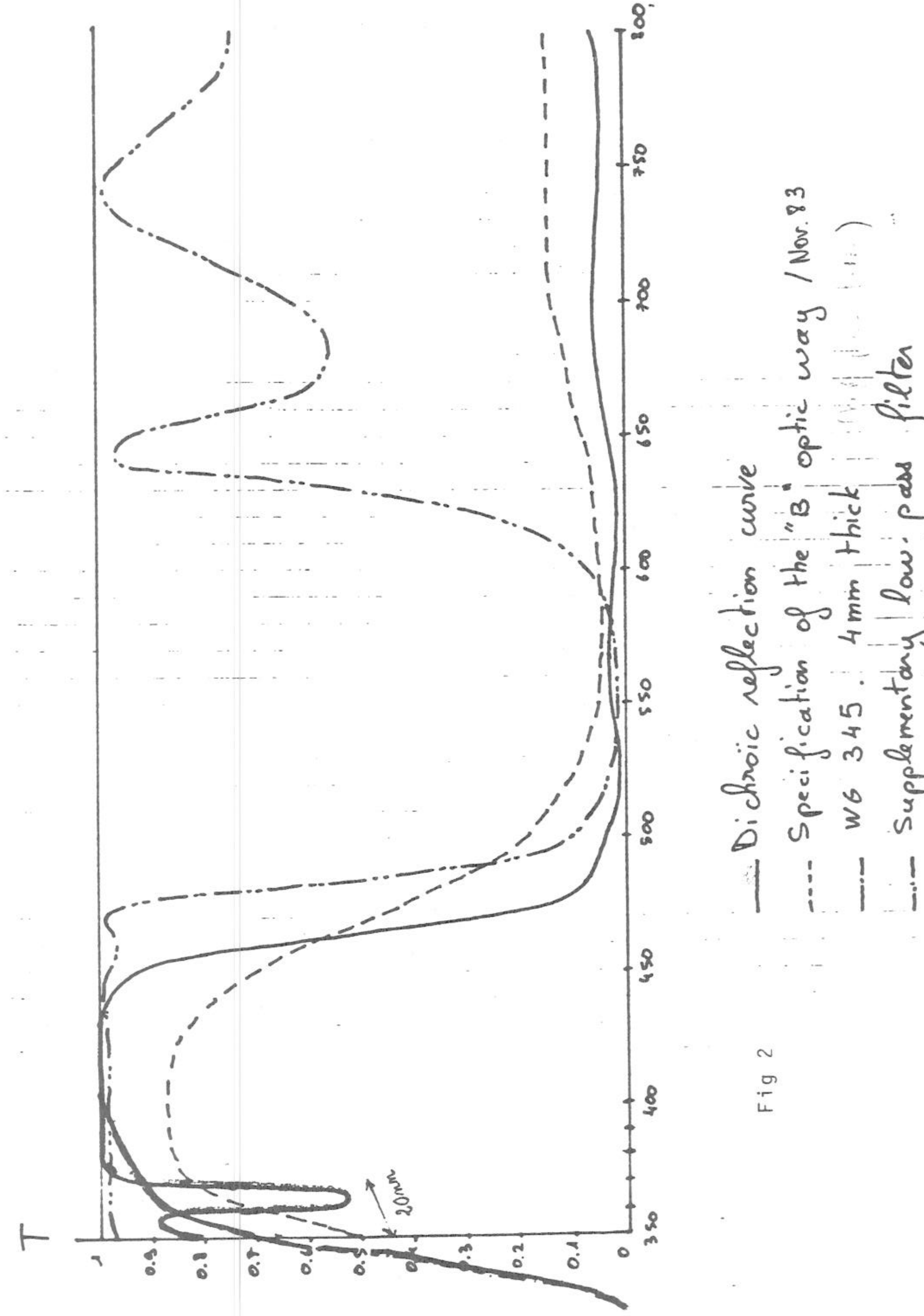

T
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
350
400
450
500
550
600
650
700
750
800
20mm
Dichroic reflection curve
Specification of the "B" optic way / Nov. 83
WG 345 . 4mm thick
Supplementary low. pass filter

Fig 2

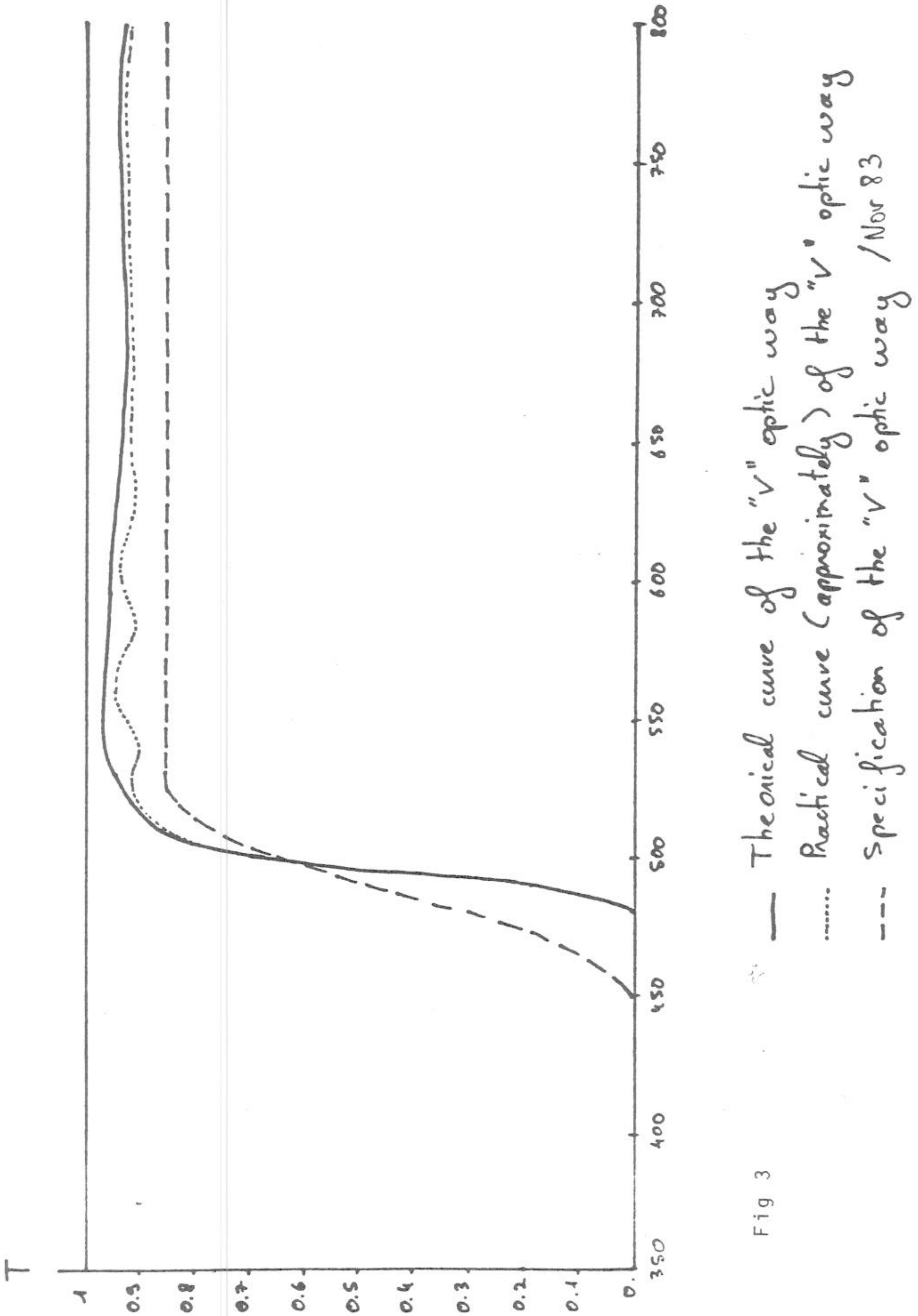

T
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.
350
400
450
500
550
600
650
700
750
800
— Theorical curve of the "V" optic way
...... Practical curve (approximately) of the "V" optic way
--- Specification of the "V" optic way /Nov 83

Fig 3

PHOTON COUNTS BUDGETS AND SPECTRAL SEPARATION

RUN NUMBER	Last grid results	Irradiation resistant glass	separation filter	low pass filter	COUNTS : (B+V)/2 = 9.65 BT/VT (vertical slit)			λ eff (nm) BT/VT	Δλ (nm)
					B-V = 0	B-V = 0.7	B-V = 1.5		
KTYA1	No	No	Yes	Yes	3820/1534	2402/1792	1841/2345	419/538	119
KTYA2	Yes	Yes	Yes	Yes	3239/1526	2099/1782	1324/2330	423/538	115
KTYA3	Yes	No	Yes	Yes	4323/1568	2634/1828	1582/2388	414/538	128
KTYA4	Yes	Yes	No	Yes	3239/1796	2099/2037	1324/2585	423/531	108
KTYA5	Yes	No	No	Yes	4323/1983	2634/2145	1582/2671	414/522	108
KTYA7	Yes	Yes	No	No	3276/1796	2158/2037	1422/2585	427/531	105

Date..........

ANNEX X

ON-ORBIT CALIBRATION DOCUMENTATION

OOCR	ON-ORBIT CALIBRATION REPORT		JUL. 84	FEB. 85	AUG. 85
COSRD	CALIBRATION OPERATIONAL SOFTWARE REQUIREMENTS DOCUMENT			DEC. 84	AUG. 85
OOCM	ON-ORBIT CALIBRATION MANUAL	APR. 85	OCT. 85	APR. 86	OCT. 86

DATES ARE DELIVERY TO ESA (OOCR AND COSRD)
OR INPUT TO HIPPARCOS USERS´ MANUAL (OOCM).
DELIVERY FROM CAPTEC TO MATRA ONE MONTH EARLIER.

ANNEX XI

BACKGROUND COUNT RATE DETERMINATION ERROR

. PRESENT SPECIFICATION : THE BACKGROUND COUNT RATE, I_{BK} , AVERAGED OVER 15 MINUTES MUST BE DETERMINED WITH AN ACCURACY OF 2 % RMS OF Io (B = 12 / B - V =-0.25) WHICH MEANS A RELATIVE ACCURACY OF ABOUT 2.5 % ON I_{BK} .

. ESTIMATION METHOD :

- METHOD No 1 : OBSERVE "DARK" REGIONS OF THE SKY AND EXTRACT THE AVERAGE COUNT RATE ; THIS WOULD REQUIRE ABOUT 0.5 MINUTE OF DARK REGION OBSERVATION (I.E EXCLUSIVE OF ANY STAR UP TO MAG 17) EVERY 15 MINUTES (THE REPRESENTATIVITY OF SUCH REGIONS MAY BE DEBATABLE).

- METHOD N_O 2 : ESTIMATE I_{BK} AS A BY-PRODUCT OF FAINT STARS OBSERVATION

  * DETERMINE THE MODULATED SIGNAL DC COMPONENT $(I_O + I_{BK})$ AND AMPLITUDE OF THE FIRST HARMONIC (IoM1) BY USING A MAXIMUM LIKELIHOOD METHOD.

  * ESTIMATE I_{BK} ON THE BASIS OF AN A-PRIORI KNOWLEDGE OF M1

$$\tilde{I}_{BK} = (\widetilde{Io + I_{BK}}) - (\widetilde{IoM1}) / \overline{M1}$$

BACKGROUND COUNTS RATE DETERMINATION ERROR (CONT'D)

. ESTIMATION ERROR :

$$\left(\sigma_{I_{BK}} / I_{BK}\right)^2 = \frac{(2 + M_1^2) + (I_0 + I_{BK})(2 + M_2 - M_1^2)}{I_{BK} \, M_1^2 \, T} + \left(\frac{I_0}{I_{BK}}\right)^2 \left(\frac{\sigma_{M_1}}{M_1}\right)^2$$

- ONE MUST USE ALL PROGRAMME STARS AND CANNOT RELY ON A-PRIORY KNOWLEDGE OF STAR COLOUR.

- IGNORING DOUBLE STARS, A MINIMUM OBSERVATION PERIOD OF ABOUT 17 MINUTES IS REQUIRED TO REACH THE 2.5 % RMS ACCURACY.

. CONCLUSIONS

- UNLESS METHOD No 1 CAN BE USED (INPUTS FROM DRC NEEDED), THE BACKGROUND SPEC APPEARS TOO TIGHT AND MUST BE RELAXED BY A FACTOR OF ABOUT 2.5

- ALTERNATELY, THE BACKGROUND SPEC CAN BE REFORMULATED AS A VERIFICATION TASK, I.E. I_{BK} MUST BE LOWER THAN A GIVEN THRESHOLD, IN WHICH CASE THE ACCURACY OF DETERMINATION IS NOT SO CRITICAL.