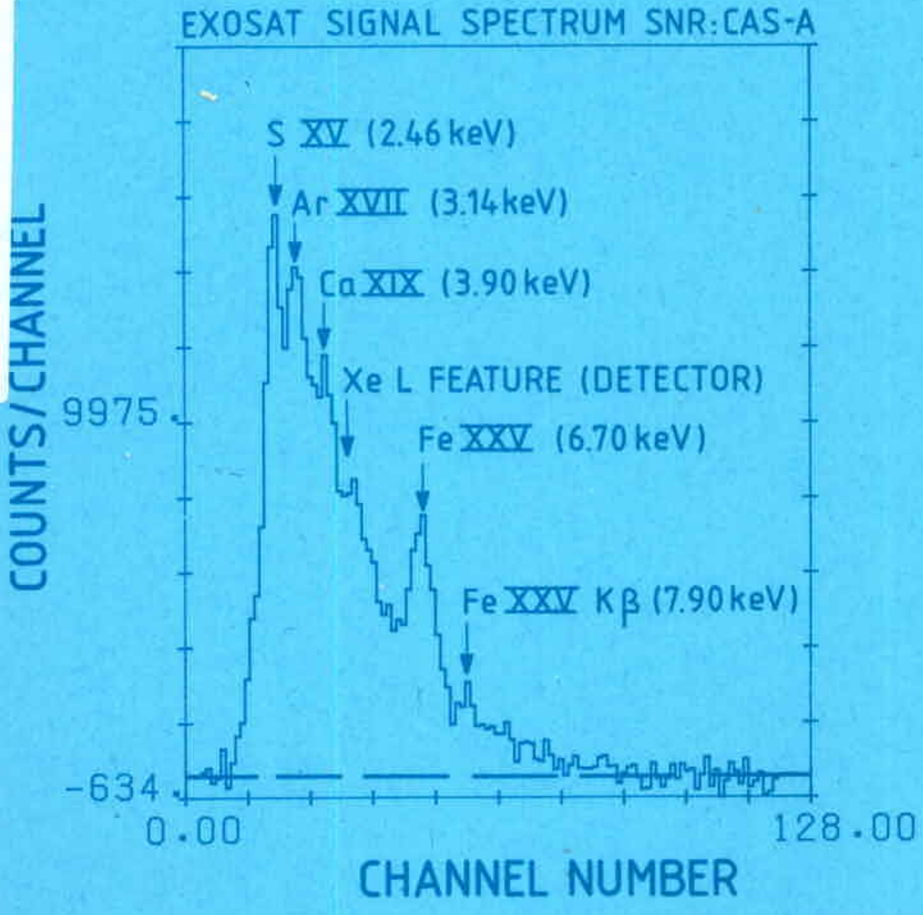
exosat esa

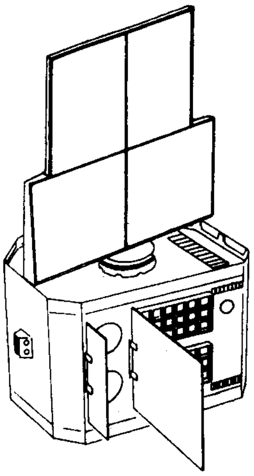
EXOSAT EXPRESS


EXOSAT SIGNAL SPECTRUM SNR:CAS-A

EXOSAT
EUROPEAN X-RAY ASTRONOMY SATELLITE

No. 4

April 1984



esa

EXOSAT EXPRESS

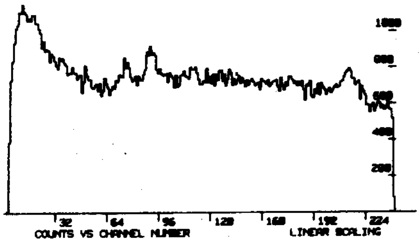


TABLE OF CONTENTS

No. 4 April 1984

Front Cover:

A counts spectrum of the supernova remnant Cas-A, as measured by the GSPC, showing the main contributing element for each of the prominent line complexes.

Courtesy: A. Peacock

FOREWORD

Issue 4 of the EXOSAT EXPRESS contains the usual status report, performance characteristics etc. together with special features on count rate underestimation in the LE automatic analysis, an update to the LE CCF, GSPC gain shift calibration, GSPC/ME collimator response and an article by the Spacecraft Operations Manager, A. Parkes, on 'The EXOSAT Ground System and In-Orbit Performance of the Spacecraft'. Attention is drawn to the paragraph on p.32 concerning EXOSAT orbit control and the possibility to increase the orbital lifetime by slightly more than 1 year (re-entry into the earth's atmosphere is predicted for early May 1986) provided that all orbit control fuel is used in an optimal manner.

Changes in the Observatory Team structure and the facilities provided for observers' use, reported in Express No. 3 p.8, have been initiated and will continue throughout the summer months. Of particular interest to all P.I's is the re-arrangement of mission planning duties, already partially implemented as noted on p.29, whereby with the departure of Mike McKay on 1.6.84 to take up an ESA staff position, Anne Fahey will be responsible for scheduling the approved AO programmes and Paul Barr will have the responsibility for mission planning overview, science content and special areas such as galactic plane scan or raster scans. Further details of Observatory Team members' responsibilities will be given in the EXPRESS as and when changes take place.

Readers are reminded of the intention to maintain a bibliography of all EXOSAT related publications and a list of all new 'EXOSAT-discovered' X-ray sources (p.25).

Note that formal documentation is to be found in the handbooks of the Observatory, such as the FOT Handbook, but extracts will be printed from time to time in the EXPRESS to disseminate information as rapidly as possible to the X-ray community.

EXOSAT EXPRESS

Editor: David Andrews

Published by: EXOSAT Observatory, ESOC, Robert Bosch Straße 5, 6100 Darmstadt, West Germany.
Tel : 06151-886-704
Telex : 419453/49441
Telefax : 886-628/622/611

OBSERVATORY STATUS AS OF 30TH APRIL 1984

EXOSAT operations are approaching a triple milestone of '1 year in orbit, 1000 attitude manoeuvres and orbit number 100'. The programme of observations approved by the Committee on Observation Proposal Selection (COPS) in response to AO-1 is roughly 90% complete (about 700 observations), with a further 70 scheduled in the period up to 29/5. Subject to COPS approval the AO-2 programme should start on 30/5 and will include a small number of outstanding AO-1 observations.

1. Hardware

1.1 Spacecraft

Reference is made to the article on p.30 for information on the spacecraft hardware status. Note that the only combination of Reaction Control Equipment (RCE) and Attitude and Orbit Control Electronics (AOCE) units which has so far proved problem free is AOCE2/RCE1.

Erroneous OBC CPU overload errors, which normally have little impact on operations, have on two occasions in the period 1/3/84 - 30/4/84 resulted in the planned halt of the processor followed by a failure to re-initialise one of the spacecraft application programs and hence a re-load of the complete software system (duration approx. 90 minutes). For further operations a modification has been introduced to overcome the initialisation problem and avoid the necessity of re-loading. Additional testing and analysis is required to determine the origin of these spurious errors.

1.2 Payload

1.2.1 LE1

PSD1 operations have been suspended following a degradation in the behaviour of the 'LEP' (low energy pulses) first reported in Express No. 3 p.5. Seven PSD1 observations were carried out in the period 1/3/84 to 30/4/84, viz. NGC 5548 day 62, Her X-1 day 64, CRAB day 73, IC 443 day 78, IC 443 day 80, Zeta Pup day 81 and GKP SNR day 114, giving an integrated on-time since reactivation of about 30 hours, but showing a progressive decrease in the times to LEP instability and increase to the arbitrary safety limit (ref. section 2 p.4) of 6 c/s.

Operational procedures continue to ensure satisfactory performance of CMA1. Note that observations are scheduled preferentially for solar aspect (ß) angles between 90° and 130° but some degree of latitude is possible to accommodate co-ordinated or otherwise constrained observations.

There is no operation of the grating at present because of the partial jamming of the mechanism.

1.2.3 LE2

All attempts (5) to re-activate CMA2 following the 'partial' operation reported in Express No. 3 p.4 have proved unsuccessful. Although no explanation exists for the failure, ideas of temperature effects and mechanical contact problems have led to a strategy of maintaining a cool detector (28V power supply line switched off) and operating the detector exchange mechanism from time to time, so far to no avail.

PSD2 has remained non-operational.

As a functional test, the LE2 grating was successfully moved into and out of the telescope FOV on 20/3/84.

1.2.3 ME

All sixteen proportional counters continue to operate satisfactorily.

Analysis of data from a repeat calibration observation of the CRAB NEBULA on day 85 (note that the day 73 observation was affected by a high background rate as a precursor to the solar storm on day 74) suggests that slight gain increases ($\lesssim$1-2%) of the Argon detectors have occurred since the PV/Cal phase observation on day 275 (Xenon data is still in the process of analysis). Leakage of gas from the detector is a possible explanation; however this rate should have no significant detrimental effect on the instrument performance during the mission lifetime. Additional analysis is in progress and an electronic gain adjustment may be incorporated. P.I's should at present assume a linear gain change throughout the period between the two CRAB calibrations. Further information will be provided in an update to the FOT Handbook and/or in a forthcoming issue of the Express. Regular calibrations on the CRAB will be instituted.

1.2.4 GSPC

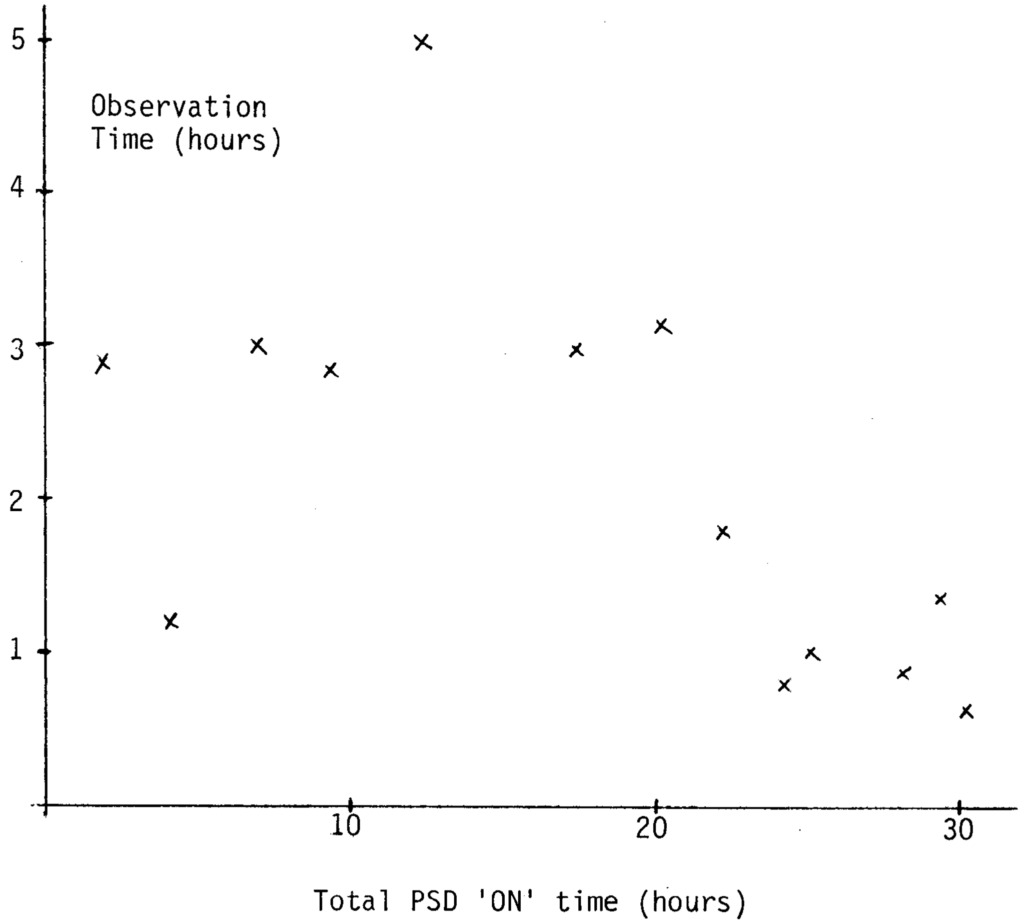
The GSPC hardware status remains stable and the detector continues to operate satisfactorily.

A note on the gain variations introduced by the procedure of switching off the 28V power supply line to LE1 in order to maintain a low detector temperature is given on p.44.

2. Performance and Operations

Tables 1 and 2 on pp.9/10 give the current performance parameters of the EXOSAT instruments based on the latest analyses of PV/Cal phase data.

PSD1 operations since re-activation total approximately 30 hours, however each successive observation has shown a decrease in the useful observing time as shown below:



Note that the first few observations (up to about 12 hours of total 'ON' time) were completed normally after the allotted observing time, whereas all recent observations were terminated when the LEP count rates increased above an arbitrarily defined 'safe' limit of 6 c/s. Similar procedures, clearly unsuccessful, of detector 'bake out' using the gas system solenoid valves to raise the temperature (typically by 25°C) together with a 'hot' gas fill and drain have been carried out between each observation with the aim of maximising the period of stable LEP (2 c/s) and the time to increase to 6 c/s. From day 114 (GKP SNR) to the next PSD observation scheduled on day 138 (NGC 6964) the detector will remain drained in order to eliminate any effect of gas decomposition in the orbital radiation environment.

Observatory operations were suspended on several occasions, during the period 1.3.84 - 30.4.84. Two solar 'proton' events caused considerable disruption to the planned time line. The first occurred on 14.3.84, 28 days ± a few hours after the event on 16.2.84 reported in Express Issue 3 p.5, and reached a maximum particle density (>10 MeV) at satellite altitudes of 100 cm^{-2} s^{-1} sr^{-1} ie. a factor 6 down on the earlier activity from the same region. Background activity remained high for about 24 hours after the maximum. However, in comparison to this event and its predecessor, EXOSAT detected on 25/4 the onset of a huge solar 'proton' event, which reached a maximum particle density (>10MeV) of 2500 cm^{-2} s^{-1} sr^{-1} approximately one day later and prevented normal operations for a period of 8 days. One sun safety mode trigger (see p.34) and the erroneous OBC CPU overload errors (section 1.1) caused additional loss of observing time.

A successful test of the orbit control system was carried out on 17/4 (ref. p.33). Certain restrictions will nevertheless apply for occultation planning because of AOCS operational problems with the use of Reaction Control Equipment (RCE) unit 2 which indicate that only RCE1 in conjunction with AOCE2 is problem-free thus limiting the orbit control to one thruster.

To avoid unnecessarily high integrated dosage rates in a limited number of channels of CMA1, the mission planning software now 'randomises' the position of point sources in the FOV of LE1 within a ± 30 arc sec. square of the normal pointing.

3. On-Board Software

Operational efficiency has been improved by the incorporation of a new Basic-In-Flight Software system (BIF 25) which allows all commonly used spacecraft sub-system programs to be core resident thus providing the maximum 6 slots for payload data processing programs. A further system update (BIF 26) will contain more powerful diagnostic facilities to aid the investigation of spurious CPU overload errors (section 1.1).

Difficulties have been experienced with the operation of two new application programs (MHER5/MHER6: Express Issue 3 p6), involving triggering of telemetry overload errors under certain combinations of workspace parameter definition and in conjunction with other application programs. Further modifications incorporated in the software have solved the problem, although precise limitations on time resolutions and telemetry load can only be defined after sufficient operational use.

Since the launch of EXOSAT, 6 system updates (BIF 20 - BIF 25), 10 payload application program modifications (update or new software) and 3 spacecraft application program modifications have been carried out in response to changing requirements as a result of the observational data analysis and operational experience. It is anticipated that this level of activity will shortly decrease.

4. Observation Output

Production of Final Observation Tapes (FOT's) is now routine and the goal of approximately 20 days between observation and tape availability at ESOC has been reached. Because of the iterative process of filing, analysis and checking the data generated by modified OBC application programs, production of certain FOT's containing eg. MPULS2, MHER5 (modified version, Express No. 3 p6) data does incur a delay with respect to the above 20 days.

Please note that P.I's are kindly requested to disregard the statement in AO-2 Section 2 concerning copying and return of FOT's. ESOC do not require return of the original tapes.

In response to requests from some users, the satellite attitude during slew manoeuvres will be made available both in near real time to support search of the ME/GSPC slew data for transient sources and unexpected variability of known sources and on the FOT to allow observers to reconstruct the pointing history throughout the manoeuvre. Slew auxiliary data will be generated immediately after a manoeuvre and an algorithm will be provided to determine the satellite attitude using an interactive facility operated from a terminal in the DCR. This auxiliary data will be stored on the FOT and a similar algorithm will be supplied to enable users to extract the attitude data using the relevant housekeeping telemetry format. Accuracy will be $\lesssim 5$ arc minutes and the facility should be available within 2 to 3 months. Details will be provided in an update to the FOT Handbook and/or in a forthcoming issue of the Express. Note that it is not feasible to re-create the pointing history systematically for manoeuvres carried out prior to the above implementation but an analysis of archive tapes should in principle give the attitude for specific requests only.

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There have been one or two recent examples of mis-interpretation of scientific data because of incorrect use of the real time EX2 graphics facilities and observers are urged to treat all real time 'results' with extreme caution. For example, integration of ME counts data will show a significant excess of counts in low channels if the period of integration covers detector switch-on or switch-off times when the gain is low. EX2 images, which are not linearised, should also be interpreted carefully, particularly in view of the grey level scaling available and the known off-axis point spread function.

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Automatic analysis of all AO-1 data is proceeding although it is proving difficult to reduce the backlog reported in Issue 3 of the Express. Currently, most observations up to day 307 have been fully analysed (omissions because of tape parity errors/data filing anomalies/repeat analysis) together with about 20 equivalent days of priority observations between day 307 and day 120 (1984), an overall backlog of approximately 160 days.

Our general policy now is to perform the automatic analysis in three priority categories viz:

a. Backlog from day 307 of observations for non-hardware group P.I's (the hardware groups being Leiden, Leicester, Milan/Palermo, MSSL, Munich, Utrecht and SSD).

b. All current observations.

c. Remaining backlog.

Note, however, that software modifications are required before data from new OBC modes such as MHER5, MHER6, GDIR, MPULS(1) and MPULS(2) or from PSD1 observations can be analysed, implying that not all category (b) analyses can proceed immediately.

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Chapters 1-5 of Revision 1 of the Final Observation Tape Handbook have been despatched to each institute on 19.4.84. It is planned to complete by the end of May the final sections containing automatic analysis documentation and descriptions of data analysis techniques. In addition an "AO-1 orbit and calibration history, April 1st 1984" tape has been generated and contains the most up-to-date calibration data available. Each institute will receive one copy of this tape and P.I's are advised that orbit and calibration data from this history tape should be used for analysis of AO-1 data and not the equivalent data on the FOT. Once the FOT Handbook is complete, copies will be despatched to all EXOSAT users.

5. Future Plans

AO-1 timelines have been published approximately one month in advance up to the 'final' schedule covering the period 1/5-29/5. Note that Anne Fahey has been assigned to mission planning duties as a full time task and has been practically responsible for the preparation of all recent time lines. Further changes in the division of responsibilities within the Observatory Team are expected and will be described in forthcoming issues of the

Express. Considerable re-scheduling of omitted or disrupted observations (eg. solar storms on 14/3 and 25/4) plus inclusion of previously constrained AO-1 targets or coordinated observations have led to a solid timeline to the end of May. A number of AO-1 observations will be outstanding as of 29/5.

AO-2 proposal selection was undertaken by the COPS at their meeting from 25/4 - 27/4 in ESTEC. Note that the total AO-2 response represents an over-subscription for observing time of a factor of 9 for the six month observation period. Successful proposers will be informed within the next week or two.

Procurement of computer hardware and the definition of detailed requirements for the interactive analysis system to be provided to enable visiting observers to undertake a fuller analysis of their data immediately post-observation is in progress. It is planned to give a description of the present and proposed observatory computational facilities in the next issue of the Express. Our goal is to have a working analysis system available for observers' use by the end of September 1984.

TABLE 1

PERFORMANCE CHARACTERISTICS (LE)

LE1	Characteristics			
Energy Range	0.04-2 keV (6-300 A) CMA* 0.3 - 2 keV PSD			
Energy resolution	Five filters are available for broad-band spectroscopy (CMA) $(\Delta E/E) = 41/E(\mathrm{keV})^{0.5}$ %FWHM (PSD)			
Field of view	2.2° diameter (CMA) 1.5° diameter (PSD)			
Effective area (cm^2)	Thin Lexan Filter	Al/P Filter	Boron Filter	Open position (PSD)
.05 keV	0.4	2.6	-	-
.1 keV	11.1	0.4	-	-
.5 keV	4.5	3.3	0.4	1.9
1.0 keV	3.2	2.5	2.0	13.5
1.5 keV	2.2	1.6	1.8	9.7
2.0 keV	0.6	0.5	0.6	1.9
Spatial resolution (Line spread function HEW)				
On axis :	18 arc sec (CMA)	3 arc min (PSD)		
20 arc minutes off-axis:	40 arc sec (CMA)	3.5 arc min (PSD)		
Average steady residual background**	1.8 cnts/sec/cm^2 (CMA) 0.7 cnts/sec/cm^2/kev (PSD)			

* Subject to UV contamination between 900 - 2600 A

** Background rate subject to flaring

TABLE 2

PERFORMANCE CHARACTERISTICS (ME & GSPC)

Medium Energy Experiment	Characteristics
Total effective area	1500 cm^2 (all quadrants co-aligned)
Effective energy range	1-20 keV (Argon proportional counters) 5-50 keV (Xenon proportional counters)
Energy resolution ($\Delta E/E$)	51/E (kev)$^{1/2}$ % FWHM (Argon counters) 18% for 10 keV$\leq E \leq$30 keV (Xenon counters)
Field of view	45 arc minutes FWHM, triangular response with a 3' flat top
Total residual background	4 cnts/sec/keV (2-10 keV Argon counters co-aligned)
Gas Scintillation Counter (GSPC)	
Total effective geometric area	150 cm^2
Effective energy range	2-18 keV or 2-40 keV, depending on gain setting
Energy resolution ($\Delta E/E$)	27/E (kev)$^{1/2}$ % FWHM
Field of view	45 arc minutes FWHM triangular response with a 3' flat top
Total residual background rate	1.3 cnts/sec/keV (2-10 keV)

AO-1 OBSERVATIONS: 17.8.83 - 30.4.84

Day	Time	Target	RA	Dec	SAA	Duration h m	Principal Investigator
198	01.42	GX339-4	16 59 02	-48 43 06	137	6 19	Illovaisky
213	02.40	Jupiter	15 53 50	-19 42 05	113	14 40	Schnopper
221	03.22	GK Per	03 27 46	+43 44 24	76	7 0	Watson
228	08.47	3C120	04 29 59	+05 15 00	76	23 53	Chiappetti
229	21.45	1514-241	15 14 45	-24 11 22	89	9 28	Maccagni
230	09.25	Algol	03 04 53	+40 46 00	90	34 0	White
231	21.40	4U1223-62	12 23 50	-62 29 37	80	8 15	Re
232	07.51	NGC1316	03 23 00	-37 12 00	103	4 45	Machetto
232	14.18	NGC1360	03 31 07	-26 02 20	100	3 27	De Korte
232	19.32	Hyades Field	04 19 09	+14 19 30	81	5 59	Schnopper
233	15.00	T Tau	04 19 04	+19 25 04	81	2 52	Brown
233	18.58	Hyades Field	04 25 29	+15 46 29	80	4 38	Schopper
234	02.00	Feige 24	02 32 30	+03 30 59	110	9 43	Heise
234	13.00	Feige 31	03 01 59	+02 45 59	104	3 57	Heise
234	17.56	NGC 1068	02 40 07	-00 13 31	110	12 37	Lawrence
235	07.28	NGC 1090	02 43 59	-00 27 24	109	2 9	Fricke
235	11.45	FA 71	20 14 48	-57 43 00	129	5 23	Fricke
235	19.29	NGC 5506	14 10 42	-02 58 00	62	9 7	McHardy
236	07.25	GK Per	03 27 45	+43 44 24	89	13 03	TOO
238	19.25	Her X-1	16 56 02	+35 25 03	91	3 5	TOO
238	23.35	MKN 506	17 20 42	+30 55 59	97	3 30	Bleeker
239	04.26	2S1957+115	19 57 02	+11 34 15	138	6 59	Pakull
239	13.13	MSH 15-22	15 09 59	-58 56 57	90	3 49	Aschenbach
239	18.02	RCW 86	14 29 26	-62 01 59	87	4 25	Peacock
239	22.57	RCW 86	14 40 01	-62 12 00	87	5 19	Peacock
240	05.21	1543-475	15 43 49	-47 33 35	91	2 3	TOO
241	05.09	G191 828	05 48 46	+00 11 12	69	2 42	Heise
241	10.37	MSH 15-52	15 09 59	-58 56 57	99	4 28	Aschenbach
241	17.39	HD 149499B	16 34 19	-57 22 13	99	2 13	Heise
241	22.20	1617-155	16 17 04	-15 31 15	90	6 10	Peacock
242	05.05	1617-155	16 17 05	-15 29 16	90	4 55	Peacock
242	10.35	1617-155	16 17 05	-15 27 15	90	5 24	Peacock
242	16.30	1617-155	16 16 57	-15 26 54	90	2 24	Peacock
242	21.14	4U1626-67	16 27 14	-67 21 16	98	7 52	Mason
243	09.05	3A1246-588	12 46 38	-58 51 00	73	4 0	Warwick
243	14.51	40 Eri-B	04 13 00	-07 44 00	96	5 57	Heise
243	22.27	2A0316+413	03 19 10	+41 20 00	98	7 06	Branduardi
244	23.40	NGC 1685	04 50 03	-03 01 00	98	4 39	Pounds
245	07.10	MKN 1040	02 25 17	+31 05 21	114	1 33	Pounds
245	09.46	MKN 1040	02 20 20	+31 57 43	114	1 22	Pounds
245	13.55	0241+622	02 41 01	+62 15 27	96	5 9	Warwick
246	06.55	Roph (C)	16 24 00	-24 20 00	88	17 46	Montmerle
247	03.14	NGC 6814	19 39 54	-10 26 59	133	5 50	Branduardi
247	11.47	ESO141-G55	19 16 57	-58 45 52	115	3 32	Branduardi
247	17.02	ESO103-G35	18 33 22	-65 28 17	107	8 06	Pounds
248	18.51	NGC 7314	22 33 01	-26 18 00	160	3 58	Pounds

Day	Time	Target	RA	Dec	SAA	Duration h m	Principal Investigator
249	01.58	Fairall 9	01 21 51	-59 03 59	121	2 51	Scarsi
249	07.35	3A0234-526	02 36 41	-52 24 30	116	3 14	Pye
249	13.16	NGC 526A	01 22 00	-35 18 00	136	6 20	Turner
249	22.40	1978 Nov 19	01 16 32	-28 53 00	140	22 53	Hurley
251	00.20	1803+78	18 03 39	+78 27 54	87	7 18	Biermann
251	09.16	AKN 120	05 13 38	-00 12 16	87	2 44	Pounds
251	13.20	NGC 2110	05 49 47	-07 28 06	78	3 48	Pounds
251	19.43	VW Cep	20 38 03	+75 24 52	96	5 06	Heise
252	15.3	IC 443	06 13 45	+22 40 00	73	5 40	Bleeker
252	22.19	IE0630+1748	06 30 00	+17 47 59	68	9 49	Caraveo
253	10.23	NGC 2264	06 38 17	+09 42 19	67	14 17	Charles
254	02.51	LP658-2	05 52 42	-04 09 00	80	5 54	Heise
254	11.30	4U1715-39	17 15 07	-39 19 12	93	1 21	Van Paradijs
254	14.13	HR 5999	16 05 12	-38 58 22	79	7 8	Brown
254	22.46	4U1705-32	17 05 40	-32 13 12	90	1 30	Van Paradijs
255	03.17	3C 382	18 33 12	+32 39 15	103	5 56	Perryman
256	07.44	SU Uma	08 08 04	+62 45 36	68	3 15	Evans
256	18.12	BD 75-325	08 04 44	+75 06 48	76	2 17	De Korte
256	22.50	Cyg X-2	21 42 37	+38 05 28	132	2 27	Treves
257	04.18	WW Cet	00 08 52	-11 45 27	166	4 22	Beuermann
257	11.15	RCW 86	14 36 48	-62 23 33	76	3 54	Peacock
257	17.04	GX5-1	17 58 03	-25 04 39	99	1 54	Kendziorra
257	21.40	H2252-035	22 52 43	-03 26 40	171	7 19	Pietsch
258	07.48	3U1809+50	18 15 08	+50 00 55	95	1 30	Heise
258	10.05	3U1809+50	18 15 08	+49 30 55	95	6 19	Heise
258	19.20	Cyg X-2	21 42 37	+38 05 28	132	2 3	Treves
258	23.46	GR 372	17 48 53	+70 52 42	89	7 55	Heise
260	04.25	H2252-035	22 52 43	-03 26 40	169	6 17	Pietsch
260	12.58	XB1916-05	19 16 00	-05 19 51	115	7 57	White
260	22.38	V 566 Oph	17 54 23	+04 59 31	94	3 18	Heise
261	04.03	MKN 504	16 59 12	+29 29 00	80	2 43	Bleeker
261	09.13	4U1909+07	19 09 12	+07 37 30	112	1 10	Van Paradijs
261	12.41	4U1812-12	18 12 26	-12 07 48	98	1 25	Van Paradijs
261	16.26	Cyg X-2	21 42 37	+38 05 28	131	1 55	Treves
261	20.46	HD 209943	22 00 13	+82 37 51	95	2 4	Heise
262	09.00	Tau-Cl Fl	04 26 14	+26 03 30	106	5 18	Bleeker
262	16.37	3A0656-072	06 56 00	-07 12 00	72	2 33	Warwick
262	23.15	NGC 1535	04 11 48	-12 51 33	105	8 16	Osborne
263	23.35	Cyg X-2	21 42 37	+38 05 28	131	1 10	Treves
264	03.29	NGC 1832	05 09 47	-15 44 48	100	2 5	Fricke
264	07.44	HD 497985	06 47 29	-43 59 55	81	1 51	De Korte
264	12.04	AM Her	18 14 57	+49 50 54	93	1 46	Heise
264	14.22	AM Her	18 15 35	+49 50 19	93	7 10	Heise
265	00.03	0A01653-40	16 57 16	-41 34 45	80	8 18	Parmar
265	09.48	G357.7-0.1	17 36 59	-30 57 00	87	3 19	Aschenbach
265	16.12	Cyg X-2	21 42 37	+38 05 28	130	2 17	Treves
265	20.40	GX13+1	18 11 37	-17 10 16	94	3 1	Taylor
266	03.12	1803+78	18 03 39	+78 27 54	90	7 59	Biermann

Day	Time	Target	RA	Dec	SAA	Duration h m	Principal Investigator
266	13.02	4U1744-26	17 44 49	-26 32 49	87	10 39	D'Amico
267	13.03	GX1+4	17 28 58	-24 42 44	83	12 52	Hall
268	04.15	Cyg X-1	19 56 28	+35 03 55	117	5 40	Page
268	12.20	Tycho SNR	22 29 59	+63 51 38	114	3 0	Davelaar
268	17.47	Tycho SNR	00 22 30	+63 51 38	114	10 8	Davelaar
269	06.01	3C58	02 01 51	+64 35 23	122	4 10	Davelaar
269	12.55	TAU-C2F1	04 52 39	+30 31 12	106	8 38	Bleeker
270	00.15	4U1728-16	17 28 49	-16 55 32	81	12 21	Charles
271	11.20	D143631	16 12 48	+33 59 03	66	27 32	Brinkman
272	20.21	4U2129+47	21 29 35	+47 04 08	122	3 13	Pietsch
273	02.11	NGC 3031	09 48 29	+69 00 00	75	4 24	Bleeker
273	08.50	PSR 0833-45	08 33 39	-45 00 19	66	9 36	Zimmermann
273	18.49	PSR 0833-45	08 33 28	-45 01 04	66	5 21	Zimmermann
274	03.13	G21.5-0.9	18 30 47	-10 36 55	91	3 56	Davelaar
275	04.18	Beta Ori	05 12 08	-08 15 29	109	5 43	UV 1
275	12.23	Crab Nebula	05 31 31	+21 58 54	105	12 37	Brinkman
276	02.13	1st Pnt ME Raster	05 24 26	+23 38 20	107	0 47	Brinkman
277	14.15	End Pnt ME Raster	05 31 46	+20 25 29	107	0 47	Brinkman
277	15.46	Crab Nebula	05 31 31	+21 58 54	107	2 11	Brinkman
277	19.58	4U2129+47	21 29 35	+47 04 08	121	9 32	Pietsch
279	02.06	EY Cygni	19 52 40	+32 13 39	107	7 39	Beuermann
279	13.10	MR 2251	22 51 25	-17 50 54	144	24 5	PV/CAL
280	15.17	1822-371	18 22 22	-37 08 03	81	5 32	Mason
280	23.20	CN Ori	05 49 39	-05 25 34	93	3 51	Mason
281	14.40	1803+78	18 03 38	+78 27 54	64	6 25	Biermann
281	23.26	0851+202	08 51 57	+20 17 57	65	2 04	Willmore
282	16.34	Fairall 9	01 21 47	-58 59 00	114	3 21	Scarsi
282	21.21	WX Hyi	02 08 17	-63 28 13	109	4 0	Mason
283	03.53	1928+73	19 27 37	+73 51 14	98	8 6	Biermann
283	14.35	MK509	20 41 12	-10 50 34	113	4 21	Molteni
283	21.50	H0850+13	08 41 31	+12 59 15	67	1 25	Sims
284	04.11	H225-086	22 15 21	-08 31 38	135	5 32	Maraschi
284	12.45	Fairall 9	01 21 47	-58 59 00	114	2 3	Scarsi
284	16.50	V1223 SGR	18 52 02	-31 17 50	84	7 14	Osborne
285	02.59	H2003+22	20 03 09	+22 31 39	106	6 15	Maraschi
285	11.50	W Uma	09 40 42	+56 07 40	76	7 20	Heise
286	12.16	Fairall 9	01 21 47	-58 59 00	113	7 25	Scarsi
286	22.40	SS433	19 09 02	+04 52 00	89	12 19	Watson
287	14.39	0A0538-66	05 37 23	-66 58 26	91	9 5	TOO
288	03.10	SS433	19 09 32	+04 52 00	89	10 49	Watson
288	16.15	Fairall 9	01 21 47	-58 58 59	112	3 26	Scarsi
288	21.48	MR2251-179	22 51 21	-17 46 00	135	2 54	Pounds
289	02.50	SS433	19 09 32	+04 52 00	88	12 17	Watson
290	09.05	V410TAU	04 16 15	+28 22 43	135	3 7	Brown
290	14.34	Fairall 9	01 21 47	-58 59 00	112	3 1	Scarsi
290	20.35	HR1009	03 34 05	+00 30 14	147	3 4	Barstow
291	02.32	HD45348	06 22 19	-52 38 13	92	7 25	UV2

Day	Time	Target	RA	Dec	SAA	Duration		Principal Investigator
						h	m	
291	11.34	EPS ORI	05 33 28	-01 09 49	118	5	1	UV3
291	18.21	LMC X-4	05 32 04	-66 21 31	92	6	39	Pakull
292	03.25	Sirius B	06 43 44	-16 38 45	98	25	29	Heise
293	21.40	HD37128	05 33 28	-01 98 50	120	14	3	Bianchi
294	19.07	Alpha CM	07 36 21	+05 22 28	92	5	3	Mewe
295	03.00	4U2030+40	20 30 11	+40 48 04	106	0	40	Van der Klis
295	05.57	4C59.08	07 03 37	+59 33 34	104	2	41	Strom
295	12.10	MK509	20 41 12	-10 50 34	102	2	7	Molteni
295	16.57	Her X-1	16 55 44	+35 21 35	65	3	20	Trumper
295	22.10	3A1954+319	19 53 38	+31 57 37	97	3	15	Warwick
296	02.37	NGC 6853	19 57 04	+22 34 53	97	3	44	Osborne
296	08.08	GR 288	20 32 37	+18 50 20	104	5	57	Heise
296	16.22	1803+78	18 02 09	+78 25 42	96	10	42	Biermann
297	21.57	Capella	05 13 00	+45 55 18	125	24	58	PV/Cal
299	01.24	Cygnus X-3	20 30 03	+40 47 57	104	10	13	Peacock
299	14.22	IC 4997	20 17 30	+16 35 16	97	2	13	Parmar
300	01.40	YZ CNC	08 07 51	+28 17 24	95	2	11	Heise
300	05.56	E0135.1-7122	01 35 10	-71 27 14	96	2	50	Pye
300	10.17	E0121.9-7335	01 21 52	-73 40 45	94	3	8	Pye
300	15.45	MR 2251-179	22 51 21	-17 46 00	124	5	54	Pounds
301	14.15	H0850+13	08 49 48	+12 36 00	83	5	45	Sims
301	21.31	YZ CNC	08 07 51	+28 17 24	96	2	16	Heise
302	02.45	E0112.0-7059	01 12 02	-70 59 46	95	2	1	Pye
302	05.54	E0101-3-7301	01 01 20	-73 01 23	93	3	17	Pye
302	10.20	E0101.5-7226	01 01 33	-72 26 34	94	3	21	Pye
302	14.14	E0059.0-7228	00 59 04	-72 28 56	93	3	52	Pye
302	18.26	E0057.6-7228	00 57 39	-72 28 02	93	5	34	Pye
303	01.27	LMC X-4	05 32 47	-66 24 13	92	4	35	Pakull
303	08.30	SU Uma	08 08 04	+62 45 36	103	3	21	Evans
303	14.04	E0049.4-7339	00 49 26	-73 39 27	92	2	51	Pye
303	19.37	YZ CNC	08 07 51	+28 17 23	98	1	40	Heise
304	00.45	PKS2155-304	21 55 58	-30 27 52	103	15	27	Maccagni
305	08.21	3C120	04 29 59	+05 15 00	147	5	29	Tanzi
305	16.28	4U0033+58	00 33 12	+58 50 59	131	3	47	Horstmann
305	22.41	YZ CNC	08 07 51	+28 17 24	100	2	14	Heise
306	03.28	ES0141-G55	19 16 56	-58 45 52	69	4	26	Branduardi
306	10.30	PKS0521-365	05 21 14	-36 30 12	114	4	30	Maccagni
306	16.52	PKS0548-322	05 48 49	-32 16 56	113	3	8	Maccagni
306	22.13	NGC 6814	19 30 53	-10 27 00	74	10	52	Branduardi
307	07.25	MK 509	20 41 26	-10 54 17	90	4	14	Molteni
307	14.25	AM Her	18 14 57	+49 50 55	82	5	1	Heise
307	21.56	YZ CNC	08 07 51	+28 17 24	102	2	4	Heise
308	04.26	NGC 6853	19 57 25	+22 34 45	88	2	30	Pakull
309	00.02	4U2030+40	20 30 38	+40 47 13	99	3	7	Van der Klis
309	05.25	MKN 335	00 03 45	+19 55 30	143	3	24	Pounds
309	11.48	NGC 7469	23 00 44	+08 36 18	126	3	4	Pounds
309	23.13	YZ CNC	08 07 51	+28 17 24	104	1	34	Heise
310	02.59	NGC 7213	22 06 14	-47 25 00	92	3	50	Pounds

Day	Time	Target	RA	Dec	SAA	Duration		Principal Investigator
						h	m	
310	09.06	NGC 526A	01 21 39	-35 19 00	125	6	28	Turner
310	18.26	MR 2251-179	22 51 26	-17 50 54	114	1	58	Pounds
310	22.49	MCG2-58-22	23 02 07	-08 57 19	120	3	23	Pounds
311	03.56	PHL 380	22 40 12	-04 30 00	116	1	53	Heise
311	11.08	NGC 4151	12 08 00	+39 40 50	67	6	34	Perola
311	20.18	PG0026+129	00 26 38	+12 59 29	146	3	7	Maraschi
312	02.15	YZ CNC	08 07 51	+28 17 24	106	1	11	Heise
312	21.04	MCG8-11-11	05 51 10	+46 25 55	132	1	42	Maraschi
313	01.40	Ton 524A	10 28 47	+29 02 27	78	8	5	Fink
313	11.38	Praesepe	08 37 00	+20 10 00	99	7	35	Schnopper
313	21.25	YZ CNC	08 07 51	+28 17 24	108	11	57	Heise
314	11.57	Abell 78	21 33 20	+31 28 13	106	3	4	Osborne
314	18.01	MKN 205	12 19 34	+75 35 15	96	2	55	Zimmermann
314	23.31	MKN 618	04 34 00	-10 28 36	144	4	40	Fink
315	06.43	SS Cygni	21 40 44	+43 21 18	109	1	13	Watson
315	10.56	NGC 4151	12 08 00	+39 40 50	70	3	51	Perola
315	17.31	YZ CNC	08 07 51	+28 17 24	110	2	24	Heise
316	13.57	PKS0735+178	07 35 14	+17 49 09	116	5	22	Willmore
316	21.50	1928+73	19 28 49	+73 51 44	100	7	38	Biermann
317	07.17	3A2056+493	20 56 00	+49 19 48	101	3	21	Warwick
317	14.32	PKS0735+178	07 35 14	+17 49 09	117	3	54	Willmore
317	21.10	YZ CNC	08 07 51	+28 17 24	112	1	11	Heise
318	05.04	LMC X-4	05 34 47	-66 24 13	91	1	43	Pakull
318	09.34	PKS0735+178	07 35 13	+17 49 09	118	4	23	Willmore
318	16.25	VW Hyi	04 09 29	-71 25 23	90	3	21	TOO
318	22.30	3C111	04 15 01	+37 54 20	156	1	19	Briel
319	02.46	MKN 352	00 57 08	+31 33 30	146	1	2	Fink
319	06.03	VW Hyi	04 09 28	-71 25 23	90	2	4	Heise
319	11.16	NGC 4151	12 08 00	+39 40 50	73	6	29	Perola
320	08.21	G0921+06	09 22 02	+06 20 45	92	5	28	Pounds
320	16.53	2A1348+700	13 51 52	+69 33 16	90	3	55	Fink
320	23.17	RU Peg	22 11 36	+12 27 11	105	2	42	Beuermann
321	04.20	MR2251-179	22 51 26	-17 50 54	103	1	33	Pounds
321	08.22	KT Per	01 33 48	+50 41 25	141	1	26	Heise
321	12.45	LMC X-4	05 34 15	-66 38 56	92	32	58	Pakull
323	01.17	NGC 4151	12 08 00	+39 40 50	76	5	58	Perola
324	04.36	V0332+53	03 31 05	+53 00 36	146	6	26	TOO
324	12.36	NGC 3587	11 11 54	+55 17 31	94	2	54	De Korte
324	16.44	EG 71	10 38 33	+43 12 38	93	2	20	De Korte
324	20.25	Ton 524A	10 28 48	+29 06 00	90	3	31	Bleeker
325	01.11	XY Leo	09 58 57	+17 40 00	92	1	50	Heise
325	04.46	NGC 2811	09 13 48	-16 06 12	91	3	40	Fricke
325	10.15	Vela SNR	08 16 00	-44 00 00	91	3	0	Smith
325	15.32	V0332+53	03 31 05	+53 00 35	147	3	17	TOO
325	21.20	VW Hyi	04 09 29	-71 25 23	89	3	1	Heise
326	01.44	NGC 7293	22 26 55	-21 05 40	92	2	27	Van der Klis
326	06.00	BPM 97859	23 09 48	+10 31 00	113	1	10	Heise
326	10.00	A0543-68	05 43 49	-68 23 40	89	6	36	Pakull
326	17.28	LMC X-4	05 32 46	-66 24 13	91	5	11	Pakull

Day	Time	Target	RA	Dec	SAA	Duration h m	Principal Investigator
327	01.15	KT Per	01 33 48	+50 41 24	139	1 15	Heise
327	21.53	PHL 5200	22 25 54	-05 34 17	96	14 2	Schnopper
328	14.47	IRAS I	04 09 42	+05 25 08	165	5 10	TOO
328	22.47	IRAS II	04 13 47	+12 17 36	171	3 58	TOO
329	05.40	V0332+53	03 31 14	+53 00 16	147	6 8	TOO
329	14.23	OX 169	21 41 13	+17 29 49	91	5 4	Perryman
329	21.38	VW Hyi	04 09 28	-71 25 23	88	6 21	Heise
330	06.20	3A0020-260	00 18 12	-25 59 00	108	3 33	Pye
330	12.10	OX 169	21 41 13	+17 29 49	91	4 58	Perryman
330	19.16	0A0526-328	05 27 33	-32 51 19	123	5 59	Brinkman
331	14.45	MR 2251-179	22 51 26	-17 59 54	93	2 30	Pounds
331	18.47	OX 169	21 41 13	+17 29 49	90	4 32	Perryman
332	01.33	2A0526-328	05 27 33	-32 51 19	123	6 16	Brinkman
332	09.50	MR 2251-178	22 51 26	-17 50 54	92	5 55	Pounds
332	18.10	V0332+53	03 31 14	+53 00 17	147	5 24	TOO
333	02.32	2A0311-227	03 12 00	-22 46 49	133	4 7	Watson
333	08.11	HD 22049	03 30 34	-09 37 34	147	7 8	Horstmann
333	18.47	PKS2155-304	21 55 58	-30 37 52	75	2 49	Maccagni
333	23.39	VW Hyi	04 09 29	-71 25 23	87	7 57	Heise
334	10.06	PKS0521-365	05 21 14	-36 30 11	120	4 52	Maccagni
334	16.56	PKS0548-322	05 48 50	-32 16 56	122	2 44	Maccagni
335	23.44	V0332+53	03 31 05	+55 00 36	146	6 43	TOO
336	08.40	1156+295	11 56 57	+29 33 24	83	3 58	McHardy
336	14.48	2223-05	22 23 10	-05 12 23	86	3 37	McHardy
336	20.04	TT Ari	02 03 09	+14 58 00	144	2 31	Beuermann
337	00.56	4U2030+40	20 30 38	+40 47 13	83	1 39	Van der Klis
337	05.21	VW Hyi	04 09 29	-71 25 23	86	1 24	Heise
337	07.55	A0538-66	05 36 44	-67 17 56	90	9 58	McKay
337	20.00	2109-09	21 09 28	-09 01 56	66	3 25	TOO
338	01.49	SS Cygni	21 40 44	+43 21 18	95	6 35	Watson
338	10.52	PG1012-029	10 12 37	-02 53 34	95	6 00	Mason
339	07.01	PG1257+279	12 57 03	+27 54 23	74	2 23	Mason
339	11.02	BE Uma	11 55 10	+49 13 06	96	5 36	Schrijver
339	19.04	Lamda AND	23 35 05	+46 11 14	114	1 51	Gronenschild
339	23.50	Feige 4	00 17 24	+13 36 00	116	2 40	Heise
340	05.25	1156+295	11 56 17	+29 33 24	87	3 23	McHardy
340	11.19	VW Hyi	04 09 29	-71 25 23	86	1 33	Heise
340	15.00	2223-05	22 23 10	-05 12 23	82	3 41	McHardy
340	21.01	TT Ari	02 03 09	+14 58 00	140	2 42	Beuermann
341	00.46	0235+164	02 35 53	+16 24 03	148	5 9	McHardy
341	08.11	2200+420	22 00 39	+42 02 09	96	9 12	Maccagni
341	19.48	0851+202	08 51 57	+20 17 57	124	6 47	Willmore
342	22.34	1156+295	11 56 17	+29 33 24	89	3 16	McHardy
343	05.25	MR2251-179	22 51 26	-17 50 54	81	1 14	Pounds
343	09.01	0235+104	02 35 53	+16 24 05	145	3 19	McHardy
343	14.53	2223-05	22 23 10	-05 12 22	79	3 28	McHardy
343	20.44	CW1103+253	11 02 58	+25 22 42	99	4 41	Beuermann
344	04.08	1928+73	19 28 49	+73 51 44	99	7 21	Biermann

Day	Time	Target	RA	Dec	SAA	Duration h m	Principal Investigator
344	13.52	MKN 382	07 52 03	+39 19 10	141	7 57	Fink
345	01.06	LMC X-3	05 38 40	-64 06 34	93	6 3	Treves
345	09.25	0235+164	02 35 53	+16 24 05	143	3 26	McHardy
345	16.07	2223-05	22 23 10	-05 12 22	77	2 45	McHardy
345	21.09	1156+295	11 56 57	+29 33 24	92	3 00	McHardy
346	18.20	2S0921-630	09 21 25	-63 04 45	81	8 19	Corbet
347	05.05	PSR0031-07	00 31 36	-07 36 33	104	2 55	Bell-Burnell
347	10.45	NGC3783	11 36 33	-37 37 41	73	7 57	Bell-Burnell
347	19.58	MCG5-23-16	09 45 24	-30 43 00	97	4 13	Pounds
348	05.09	0235+164	02 35 53	+16 24 05	141	2 36	McHardy
348	08.53	HT Cas	01 07 01	+59 48 26	123	5 49	Mason
348	17.09	A1202+31	12 02 05	+31 27 00	95	3 41	Pye
348	23.25	NGC 246	00 44 32	-12 08 44	102	3 5	De Korte
349	03.44	II ZW 1	01 19 30	-01 17 59	116	4 31	Bleeker
349	11.42	NGC 3227	10 20 46	+20 07 08	112	5 44	Lawrence
350	17.44	0241+622	02 41 01	+62 15 27	132	5 50	Warwick
351	02.02	NGC 4151	12 08 01	+39 41 01	98	6 29	Pounds
351	09.47	HZ 21	12 11 24	+33 12 00	96	2 15	Heise
351	13.14	HZ 34	12 53 00	+37 34 00	90	2 2	Heise
351	17.10	3C273	12 26 33	+02 19 26	20	7 50	Turner
352	03.13	4U2030+40	20 30 38	+40 47 13	15	1 23	Van der Klis
352	07.20	MR2251-179	22 51 26	-17 50 54	72	2 9	Pounds
352	11.02	III ZW 2	00 08 00	+10 42 00	100	3 55	Bleeker
352	17.45	NGC2922	09 43 17	-14 05 42	110	6 4	Turner
353	01.58	1215+303	12 15 21	+30 23 40	95	7 57	Maccagni
353	12.35	NGC 6888	20 10 17	+38 12 15	70	3 00	Wendker
354	01.53	NGC 6888	20 10 17	+38 12 15	70	8 02	Wendker
355	02.33	4U0115+634	01 15 14	+63 38 38	120	11 1	Staubert
355	15.33	Cas A	23 21 11	+58 52 00	106	15 27	PV/Cal
356	09.30	X Per	03 51 15	+30 54 01	151	2 4	Robba
356	13.55	HD 121130	13 49 58	+64 58 11	100	3 7	Bedford
356	19.01	NGC 4096	12 03 29	+47 45 13	107	3 3	Gioia
356	23.34	NGC 4490	12 26 09	+41 54 56	100	3 37	Gioia
358	12.49	V0332+53	03 31 14	+53 00 24	138	3 23	TOO
358	19.08	M82	09 51 52	+69 54 58	123	20 44	Biermann
359	18.40	V0332+53	03 31 14	+53 00 24	138	3 50	TOO
360	00.37	NGC 5005	13 08 38	+37 19 25	94	2 55	Gioia
360	05.17	NGC 4244	12 14 59	+38 05 06	104	1 58	Gioia
360	08.46	NGC 4656	12 41 33	+32 27 00	97	1 54	Gioia
360	11.52	NGC 4395	12 23 21	+33 49 22	101	3 13	Gioia
360	16.19	HD 111812	12 49 16	+27 48 44	94	1 28	Zwaan
360	18.51	NGC 4559	12 33 29	+28 14 23	97	4 01	Gioia
361	19.20	MR 2251-179	22 51 26	-17 50 54	63	1 32	Pounds
361	22.56	NGC 693	01 47 54	+05 54 53	112	3 9	Peacock
362	03.04	PG0134+070	01 34 28	+07 01 09	109	2 51	Mason
362	08.26	EG 187	12 54 36	+22 18 00	92	5 6	Heise
362	17.20	NGC 3991/4/5	11 54 57	+32 37 39	109	11 30	Gavazzi
363	07.40	HT Cas	01 07 01	+59 48 26	115	4 50	Osborne

Day	Time	Target	RA	Dec	SAA	Duration h m	Principal Investigator
363	14.49	NGC 4725	12 48 00	+25 47 20	96	1 27	Gioia
363	17.27	NGC 4565	12 33 52	+26 15 50	99	2 3	Gioia
363	22.08	V0332+53	03 31 14	+53 00 24	135	2 33	TOO
364	03.22	3A1146-118	11 46 29	-11 51 22	96	3 10	Pye
364	07.29	3A1030-346	10 33 36	-35 42 00	99	7 30	Pye
364	19.53	SU UMA	08 08 05	+62 45 36	135	3 07	Evans
365	12.56	MKN 290	15 34 45	+58 04 00	89	1 52	Bleeker
365	16.07	MKN 474	14 53 05	+48 52 47	90	2 51	Bleeker
365	20.56	SA57	13 06 00	+29 30 00	96	28 2	McKechnie
002	03.25	II ZW I	01 19 30	-01 18 00	98	2 20	Bleeker
002	08.24	V0332+53	03 31 15	+53 00 24	133	2 56	TOO
002	13.20	HD 224801	23 58 12	+44 58 00	98	4 2	Ferrari
002	19.05	3A0316-442	03 16 12	-44 16 34	97	2 44	Pye
003	00.11	NGC 988	02 33 00	-09 34 30	100	2 59	Fricke
003	05.43	MKN 590	02 12 05	-00 59 57	108	3 29	Bleeker
003	13.06	4U2030+40	20 30 38	+40 47 13	68	4 26	Van der Klis
004	08.52	A1060	10 34 30	-27 16 00	107	7 8	Schnopper
004	18.47	3A0729+103	07 28 43	+10 02 46	165	5 48	Pye
005	02.32	NGC 4361	12 21 55	-18 30 31	90	3 17	Osborne
005	08.08	A1367	11 41 53	+20 06 59	115	8 51	Schnopper
005	18.35	HD 115383	13 14 18	+09 41 06	90	2 49	Pallavicini
005	23.01	3C273	12 26 33	+02 19 43	99	14 16	Grewing
006	15.32	4U0033+58	00 33 12	+58 51 00	105	1 2	Van Paradijs
006	21.34	CW 1103+253	11 02 58	+25 22 42	128	8 5	Beuermann
007	08.40	V0332+53	03 31 15	+53 00 24	129	3 22	TOO
008	02.19	3C120	04 30 31	+05 15 00	137	1 33	Tanzi
008	05.55	Lamda AND	23 35 06	+46 11 14	91	6 31	Gronenschild
008	23.55	CW 1103+253	11 02 58	+25 22 42	128	7 12	Beuermann
009	09.40	NGC 4581	12 35 36	+01 43 00	100	6 15	Peacock
009	18.46	4U0352+309	03 52 15	+30 54 01	133	1 40	Robba
009	23.01	1928+73	19 28 49	+73 51 44	96	7 30	Biermann
010	08.45	V0332+53	03 31 15	+53 00 24	127	5 46	TOO
010	19.15	4U0352+309	03 52 15	+30 54 01	132	1 8	Robba
010	22.55	HD 127762	14 30 04	+38 31 34	91	2 03	Zwaan
011	20.54	0109+49	01 09 05	+49 12 40	103	1 23	Miller
012	01.31	HD 4614	00 46 03	+57 33 03	103	2 16	Pallavicini
012	08.08	4U1036-56	10 36 10	-56 33 00	93	0 35	Van Paradijs
012	10.51	E0336-358	03 36 54	-35 41 00	100	7 35	Mason
012	20.53	HD133029A	14 58 54	+47 38 00	92	2 24	Ferrari
013	00.37	OQ 208	14 04 46	+28 41 29	94	4 29	Cavaliere
013	07.36	Puppis A	08 21 39	-42 49 00	115	11 31	Aschenbach
013	21.46	1309-057	13 09 02	-05 36 07	94	13 34	Schnopper
014	13.00	HD 115521	13 15 04	+05 43 58	98	9 25	Bedford
015	18.51	HD 13174	02 06 34	+25 42 15	104	0 54	Zwaan
015	22.18	4U0115+63	01 15 14	+63 28 38	106	4 45	Staubert
016	06.44	1147+245	11 47 44	+24 34 34	125	8 51	Willmore
016	17.26	E1352.2+1830	13 52 12	+18 20 58	96	5 49	Stewart
017	00.39	HD 124897	14 13 23	+19 26 30	92	5 26	Pallavicini
017	09.20	1147+245	11 47 44	+24 34 34	126	6 21	Willmore

Day	Time	Target	RA	Dec	SAA	Duration h m	Principal Investigator
017	17.37	HD 118100	13 32 07	-08 05 06	92	2 42	Pallavicini
017	22.55	HD 20630	03 16 44	+03 11 18	110	1 47	Pallavicini
018	04.00	BE Uma	11 55 10	+49 13 03	125	1 49	Cole
018	09.43	1147+245	11 47 44	+24 34 34	127	5 21	Willmore
018	17.56	BE Uma	11 55 10	+49 13 03	125	1 17	Cole
019	09.30	3A0004+725	00 04 17	+72 31 19	101	4 13	Pye
019	15.52	V0332+53	03 31 15	+53 00 24	119	2 59	TOO
019	21.48	BE Uma	11 55 10	+49 13 03	126	1 12	Cole
020	01.40	PKS1103-006	11 03 58	-00 36 36	131	6 9	Bergeron
020	10.39	NGC 4690	12 46 00	-41 02 02	90	27 45	Manzo
021	15.15	NGC 4507	12 32 54	-39 38 02	95	5 45	Bergeron
021	23.41	HD 81799	09 25 01	-22 07 25	134	1 10	Zwaan
022	04.00	HD 18322	02 53 59	-09 05 52	96	2 30	Bedford
022	08.56	V0332+53	03 31 15	+53 00 24	117	4 41	TOO
023	03.34	PSR1055-52	10 55 49	-52 10 44	100	13 16	Brinkmann
023	20.58	V0332+53	03 31 15	+53 00 23	116	9 34	TOO
024	09.22	4U0316+41	03 16 30	+40 50 00	112	6 2	Branduardi
024	16.33	NGC 1275	03 16 30	+41 20 11	112	9 51	PV/Cal
025	03.32	3A0316+414	03 12 50	+41 20 00	111	6 51	Branduardi
025	11.58	A426	03 16 30	+42 04 59	111	7 8	Branduardi
025	23.10	4U0352+309	03 52 15	+30 54 01	117	7 08	Robba
027	01.33	MCG8-11-11	05 51 10	+46 25 55	137	1 10	Maraschi
027	05.37	MKN 348	00 46 04	+31 41 04	79	8 54	Bergeron
027	17.4	3C111	04 15 02	+37 54 21	121	2 15	Briel
027	22.47	MKN 205	12 19 34	+75 35 15	116	2 8	Zimmermann
028	04.00	PKS 1136-13	11 36 38	-13 34 09	125	11 36	Bergeron
028	18.30	2A1348+700	13 51 52	+69 33 16	111	3 17	Fink
029	00.44	PKS 1217+23	12 17 38	+02 20 21	125	3 55	Zimmermann
029	07.08	0916+86	09 16 17	+86 25 15	111	2 52	Witzel
029	12.10	3A1344-325	13 44 58	-32 35 02	91	3 50	Pye
029	18.24	3C 273	12 26 32	+02 19 27	123	4 01	PV/Cal
030	16.38	EPS CRA	13 55 21	-37 10 26	89	3 7	Heise
030	22.20	PKS1136-13	11 36 39	-13 34 08	128	5 57	Bergeron
031	08.07	HD 16157	02 32 28	-44 00 36	74	1 43	Pallavicini
031	13.57	HD 72905	08 34 46	+65 11 41	132	1 50	Pallavicini
031	18.22	HD 2905	00 30 08	+62 39 22	91	2 50	Zwaan
031	23.35	2A1219+305	12 18 33	+30 23 24	131	3 13	Warwick
032	04.38	NGC 5548	14 15 42	+25 22 00	106	3 50	Branduardi
032	11.04	MKN 421	11 01 39	+38 28 00	145	3 54	Warwick
032	17.45	MKN 501	16 52 13	+39 47 00	80	3 53	Warwick
033	01.01	LMC X-2	05 21 17	-72 00 22	84	6 57	Pakull
033	11.44	MKN 421	11 01 39	+38 38 00	145	2 36	Warwick
033	17.17	2A1219+305	12 18 34	+30 23 24	133	12 53	Warwick
034	12.02	MKN 501	16 52 14	+39 47 00	81	2 23	Warwick
034	16.30	NGC 5033	13 11 09	+36 52 00	122	3 5	Pounds
034	22.01	NGC 4593	12 37 01	-05 04 00	123	2 38	Pounds

Day	Time	Target	RA	Dec	SAA	Duration h m	Principal Investigator
035	23.47	VV Pup	08 12 52	-18 53 54	142	3 54	Osborne
036	05.46	2S1254-690	12 54 21	-69 01 07	86	6 17	Peacock
036	14.03	PG 1524+438	15 24 10	+43 51 59	99	2 14	Mason
036	17.45	MKN 501	16 52 14	+39 46 59	82	4 5	Warwick
037	00.55	MKN 421	11 01 40	+38 27 59	147	2 55	Warwick
037	06.24	2A1219+305	12 18 34	+30 23 25	135	3 21	Warwick
037	13.08	MKN 79	07 38 47	+49 55 50	141	1 22	Pounds
038	05.48	0851+202	08 51 03	+20 09 26	172	4 45	Willmore
038	14.32	MKN 876	16 13 48	+65 50 00	98	8 18	Pounds
039	00.48	0014+81	00 14 03	+81 18 27	99	3 11	Witzel
039	06.35	0851+202	08 51 03	+20 09 26	171	4 25	Willmore
039	13.34	HD 20902	03 20 44	+49 41 06	101	6 48	UV 4
039	22.40	2353+81	23 53 58	+81 36 11	98	2 52	Witzel
040	06.20	0851+202	08 51 03	+20 09 26	170	4 24	Willmore
040	14.07	0I417	07 10 03	+43 54 26	139	5 29	Cavaliere
041	00.05	4C55.16	08 31 04	+55 44 41	138	1 45	Cavaliere
041	04.25	IE0643-1648	06 43 04	-16 48 25	128	5 19	Beuermann
042	01.10	Omega Cen	13 23 48	-47 23 00	99	13 45	Koch-Miramond
042	18.09	4U1323-62	13 23 04	-61 48 00	92	2 5	Van Paradijs
042	21.20	3A1239-599	12 39 07	-59 55 47	97	2 19	Warwick
043	02.12	IE0643-1648	06 43 04	-16 48 25	127	0 44	Beuermann
043	06.07	0754+100	07 54 23	+10 04 39	154	7 29	Maccagni
043	16.47	IE0643-1648	06 43 04	-16 48 25	127	2 22	Beuermann
043	21.47	E1149.4-6209	11 48 15	-62 15 00	100	5 21	Bignami
044	05.28	4U1322-42	13 22 32	-42 45 30	104	11 7	Molteni
044	18.25	3A1431-409	14 33 34	-40 59 32	94	13 25	McHardy
045	19.32	4U0115+63	01 15 14	+63 28 38	86	4 14	Staubert
046	05.15	Vela X-1	09 00 13	-40 21 25	125	2 30	Peacock
046	10.53	0300+470	03 00 10	+47 04 33	91	2 17	Biermann
046	15.45	Cen X-3	11 19 02	-60 20 57	105	11 44	Peacock
047	06.05	Vela X-1	09 00 13	-40 21 25	125	2 48	Peacock
047	11.30	4U1547-49*	15 43 34	-47 30 59	84	5 30	Peacock
048	19.22	Vela X-1	09 00 13	-40 21 25	125	1 54	Peacock
049	08.52	Vela X-1**	09 00 13	-40 21 25	125	3 38	Peacock
049	14.18	Pleiades	03 45 00	+23 58 00	90	13 5	PV/Cal
050	05.35	Vela X-1	09 00 13	-40 21 25	125	2 49	Peacock
050	11.22	SN1006 West	14 59 07	-41 51 23	94	7 7	Pye
050	18.53	SN1006 East**	15 00 14	-41 39 47	94	9 36	Pye
051	05.50	RCW 86**	14 38 11	-62 12 00	90	4 55	Peacock
051	12.38	HD 127493*	14 29 08	-22 29 35	108	2 0	De Korte
051	16.44	A2147*	15 58 56	+16 05 00	96	6 5	Morini
052	00.23	MKN 29845*	16 03 22	+17 56 06	95	3 1	Peacock
052	06.23	Vela X-1**	09 00 13	-40 21 25	125	2 5	Peacock
052	10.39	MKN 291*	15 52 54	+19 20 19	98	5 57	De Korte
053	07.10	Vela X-1**	09 00 13	-40 21 25	125	2 15	Peacock
053	12.30	RCW 86**	14 39 36	-62 22 00	91	3 43	Peacock
053	17.46	H1626+01	16 23 12	+01 52 11	89	1 45	White
053	21.17	G292.0+1.8	11 22 20	-58 58 59	109	7 34	Fitton

Day	Time	Target	RA	Dec	SAA	Duration		Principal Investigator
						h	m	
054	07.15	1538+149	15 38 31	+14 57 25	102	9	7	Maccagni
054	18.55	HD 30945	04 45 22	-17 01 23	92	2	50	Bedford
058	00.49	3C279	12 53 35	-05 31 07	139	8	21	Cavaliere
055	10.55	M13A	16 39 54	+36 33 01	93	4	35	Birkinshaw
055	18.15	4U0352+309	03 52 15	+30 54 01	87	2	3	Robba
055	22.40	4U0115+63	01 15 14	+63 28 37	79	3	29	Staubert
056	04.43	E0731.4+3158	07 31 26	+31 58 47	133	6	21	Horstmann
057	00.55	N2146	06 10 45	+78 22 30	104	3	25	Fricke
057	06.00	H1659+44	16 59 00	+44 28 12	91	1	48	White
057	08.38	Her 1/2	17 15 00	+50 13 00	90	24	07	McKechnie
058	15.58	MKN 291	15 52 54	+19 20 20	103	5	02	Willmore
059	23.06	GR 275	16 20 30	+26 02 24	98	6	19	Heise
059	09.06	H1642+11	16 42 05	+11 51 00	92	1	24	White
059	13.18	1308+326	13 08 08	+32 36 54	138	4	4	McHardy
059	19.45	RCW 86	14 38 11	-62 22 20	96	3	24	Peacock
061	02.55	NGC 5506	14 10 42	-02 58 00	128	5	53	McHardy
061	11.30	Her X-1	16 56 02	+35 25 03	93	9	36	Trümper
062	00.10	1020+40	10 20 13	+40 03 30	146	2	36	Miller
062	05.19	0615+82	06 15 33	+82 03 56	100	2	21	Witzel
062	09.43	HD 35296	05 21 30	+17 20 18	99	1	59	Pallavicini
062	14.35	1038+52	10 38 43	+52 49 19	134	3	27	Miller
062	21.14	NGC 5548	14 15 42	+25 22 00	128	8	5	Branduardi
063	08.15	I ZW 186	17 27 04	+50 15 30	90	12	31	Maccagni
064	16.31	0954+55	09 54 14	+55 37 17	129	2	53	Miller
064	22.41	Her X-1	16 56 02	+35 25 03	95	11	22	Trümper
065	12.33	4U1624-49	16 24 18	-49 05 18	91	5	16	Watson
065	21.11	0945+40	09 45 50	+40 53 44	140	2	53	Miller
066	06.07	Orion	05 32 50	-05 24 00	96	12	50	PV/Cal
066	21.53	1308+326	13 08 07	+32 36 54	141	3	55	Miller
067	05.08	RCW 103	16 13 48	-50 55 05	94	13	13	Peacock
068	07.53	AM Her	18 14 58	+49 50 55	84	3	35	Heise
068	13.30	1308+326	13 08 07	-32 36 54	141	3	9	McHardy
068	19.18	Her X-1	16 56 02	+35 25 03	97	2	41	Trümper
069	00.06	SN1006 East	15 00 14	-41 39 47	111	14	22	Pye
069	17.46	1308+326	13 08 07	-32 36 54	142	3	7	McHardy
069	23.07	G191 B2B	05 01 31	+52 44 48	90	4	23	Heise
070	06.00	Puppis A	08 22 10	-42 45 00	118	16	30	Aschenbach
071	02.37	Sco X-1	16 17 04	-15 31 15	105	4	27	Peacock
071	10.00	Her X-1	16 56 02	+35 25 03	98	4	01	Trümper
072	03.12	Sco X-1	16 17 04	-15 31 35	106	4	30	Peacock
072	10.07	GX339-4	16 59 02	-48 43 06	92	5	57	Illovaisky
072	18.45	E0718-312	07 18 28	-31 17 22	111	3	7	Mason
073	00.48	Sco X-1	16 17 04	-15 31 15	106	1	43	Peacock
073	02.51	Sco X-1	16 17 04	-15 30 55	107	1	53	Peacock
073	06.55	HD 168454	18 17 48	-29 51 05	78	1	18	Zwaan
073	10.49	HD 99967	11 27 42	+46 55 59	136	2	9	Zwaan
073	15.17	Crab Nebula	05 31 31	+21 58 53	90	4	58	PV/Cal
073	23.04	H1557+08	15 56 51	+08 00 35	114	1	30	White
074	03.10	1510+70	15 10 11	+70 57 09	103	14	48	Miller

Day	Time	Target	RA	Dec	SAA	Duration		Principal Investigator
						h	m	
075	22.10	1003+83	10 03 23	+83 04 38	98	3	8	Witzel
076	02.02	1053+81	10 53 39	+81 30 31	100	4	0	Witzel
076	07.27	1150+81	11 50 22	+81 15 10	100	3	21	Witzel
076	13.24	HD 159532	17 33 43	-42 58 04	90	2	18	Zwaan
076	18.06	Her X-1	16 56 02	+35 25 02	100	5	54	Trümper
077	02.06	HD 155555	17 12 18	-66 53 40	92	5	24	Barstow
077	09.22	4U1538-52	15 38 39	-52 13 35	107	9	37	Molteni
077	21.35	SU Uma	08 08 05	+62 45 36	106	1	33	TOO
078	02.02	IC 443	06 14 30	+22 45 00	96	18	00	Jansen
079	19.11	VW Cep	20 38 03	+75 24 58	81	7	49	Heise
080	07.00	IC 443	06 14 00	+22 20 00	94	4	35	Jansen
080	14.40	Her X-1	16 56 02	+35 25 03	102	3	9	Trümper
080	19.50	HD 161471	17 44 05	-40 06 35	93	1	59	Zwaan
081	00.13	Zeta Pup	08 01 49	-39 51 41	112	10	56	Den Boggende
081	13.55	4U1743-28	17 43 26	-28 30 27	94	5	15	TOO
081	21.10	Gamma Gem	17 21 11	-56 19 59	96	5	27	UV 5
082	09.19	IC 443	06 12 40	+22 30 00	91	12	02	Jansen
083	10.35	E1013-477	10 13 57	-47 43 12	127	3	9	Maraschi
083	16.31	T Pyx	09 02 37	-32 10 47	126	2	4	Duerbeck
083	21.10	Z Cam	08 19 43	+73 16 36	97	1	9	Mason
084	02.05	E1405-451	14 05 58	-45 03 06	129	7	25	Maraschi
084	11.57	Her X-1	16 56 02	+35 25 03	104	5	57	Trümper
084	21.00	3A1431-409	14 33 34	-40 59 32	129	3	21	McHardy
085	04.15	HD 65339A	07 57 30	+60 28 00	100	2	44	Ferrari
085	09.07	MKN 40	11 22 48	+54 39 26	122	4	8	De Korte
085	16.10	Crab Nebula	05 31 31	+21 58 54	78	15	20	PV/Cal
086	12.00	MKN 501	16 52 12	+39 50 22	105	2	31	Warwick
087	05.00	PKS 1934-63	18 34 48	-63 49 35	90	2	32	Peacock
087	10.36	NGC 31185	10 04 17	+33 16 00	131	2	52	Peacock
088	00.12	Her X-1	16 56 02	+35 25 03	106	9	48	Trümper
088	13.00	DW 0839+18	08 39 14	+18 46 27	119	3	0	Kollatschny
088	18.50	H1504+65	15 01 17	+66 23 59	105	3	58	White
089	04.02	HD 133029A	14 58 54	+47 28 00	119	2	46	Ferrari
089	09.40	0752+258	07 52 35	+25 50 36	106	3	0	Biermann
089	16.00	HD 10029	11 28 27	+69 36 25	106	10	38	Bedford
090	05.00	MKN 79	07 38 47	+49 55 50	97	4	23	Pounds
090	23.59	Vela SNR	08 15 59	-47 00 24	109	7	2	Smith
091	09.15	A1058+45	10 58 42	+45 55 33	125	2	45	Peacock
091	14.27	SY CNC	08 58 15	+18 06 25	121	1	43	Mason
091	18.10	H0850+13	08 55 46	+12 12 12	122	3	3	Sims
092	00.00	MKN 291	15 52 55	+19 19 59	127	4	50	De Korte
092	07.42	H1658+44	16 58 25	+44 04 38	105	3	8	White
092	13.06	Her X-1	16 56 04	+35 25 19	108	15	18	Trümper
093	11.00	A2147	15 58 56	+16 05 00	128	4	59	Morini
093	20.35	0923+39	09 23 35	+39 06 44	115	7	30	Miller
094	22.14	PSR0833-45	08 33 38	-45 00 19	112	13	47	Zimmermann
095	13.00	Vela SNR	08 40 59	-47 00 05	112	3	50	Smith
095	19.06	Vela SNR	08 40 59	-43 00 13	114	4	49	Smith

Day	Time	Target	RA	Dec	SAA	Duration h m	Principal Investigator
096	03.39	Her X-1	16 56 04	+35 25 00	110	14 45	Trümper
096	22.34	NGC 2992	09 43 20	-14 02 12	131	5 55	Turner
097	07.30	3C382	18 33 09	+32 38 50	92	5 58	Perryman
097	16.20	1003+35	10 03 05	+35 08 48	121	2 12	Miller
098	11.54	E0731.4+3158	07 31 25	+31 58 26	92	6 50	Horstmann
098	23.18	NGC 4151	12 08 01	+39 41 33	131	5 42	Pounds
099	07.34	HD 89025	10 13 56	+23 40 15	128	1 55	Zwaan
099	12.07	H1914-27	19 14 51	-27 36 04	91	1 22	White
099	15.27	H1626+01	16 26 46	+01 35 35	129	2 55	White
099	21.37	NGC 4051	12 00 37	+44 49 18	126	8 16	Lawrence
100	08.30	NGC 1961	05 36 55	+69 19 44	75	8 53	Shostak
100	20.09	W50	19 08 58	+05 14 29	90	7 35	Brinkmann
101	06.25	M82	09 50 30	+69 54 56	95	9 56	Biermann
102	08.25	1630-47	16 30 11	-47 16 12	124	6 17	TOO
102	18.26	1221+80	12 21 42	+80 56 43	90	2 54	Witzel
102	23.35	AN Uma	11 01 35	+45 19 26	117	14 18	TOO
103	17.17	E1652.2-0815	16 52 49	-07 57 15	128	3 0	Horstmann
103	23.11	3A0656-072	06 56 02	-07 11 45	84	5 19	Warwick
104	07.39	RCW 86	14 37 17	-62 00 11	125	7 56	Peacock
104	18.01	4C05.38	09 11 24	+05 19 25	114	5 27	Kollatschny
105	05.59	HD 32918	04 59 45	-75 21 18	90	4 43	Bedford
106	00.15	OY Car	10 05 20	-69 59 15	111	4 6	Mason
106	07.16	W 50	19 06 31	+04 59 52	95	5 50	Brinkman
106	15.25	G357.7-0.1	17 36 59	-30 57 00	120	3 14	TOO
106	21.15	1323+79	13 23 25	+79 57 59	90	3 1	Witzel
107	01.07	1304+79	13 04 09	+79 11 07	90	4 20	Witzel
107	08.15	HD68351	08 10 05	+29 48 28	92	3 6	Ferrari
107	14.21	RCW 86	14 38 14	-61 47 45	127	12 25	Peacock
108	05.33	PG1717+413	17 17 03	+41 18 51	108	2 40	Mason
108	17.05	SS 433	19 09 20	+04 54 02	97	12 31	Watson
109	20.24	NGC 4151	12 08 03	+39 40 56	124	7 20	Pounds
110	06.30	ES0103-G35	18 57 15	-65 53 42	105	3 14	Pounds
110	10.52	ES0103-G35	18 33 17	-65 28 38	108	9 37	Pounds
110	21.23	ES0103-G35	18 10 17	-64 49 54	110	4 27	Pounds
111	04.12	Nova Muscae	11 49 33	-66 55 12	121	5 37	Beuermann
111	13.10	NGC 3991/4/5	11 54 59	+32 37 38	127	7 0	Gavazzi
111	23.03	4U1223-62	12 23 48	-62 29 07	127	6 59	Re
112	08.45	0851+202	08 52 26	+20 25 15	98	9 07	TOO
113	20.45	4U1223-62	12 23 48	-62 29 32	127	1 17	Re
114	00.32	HD187642	19 48 21	+08 44 41	92	6 35	UV 6
114	08.48	HM SGE	19 39 41	+16 37 19	92	9 12	Allen
114	19.20	4U1907+09	19 07 15	+09 44 41	101	2 28	Van Paradijs
114	23.20	GKP SNR	19 32 52	+29 59 47	91	2 52	Charles
115	03.06	GKP SNR	19 25 59	+30 00 00	91	2 54	Charles
115	06.55	GKP SNR	19 34 00	+30 59 47	90	3 25	Charles
115	11.81	GKP SNR	19 31 00	+31 59 47	91	2 36	Charles
115	15.05	GKP SNR	19 35 00	+31 59 47	90	3 35	Charles

Day	Time	Target	RA	Dec	SAA	Duration		Principal Investigator
						h	m	
115	21.21	4U1223-62	19 23 50	-62 29 37	127	2	1	Re
116	01.48	LMC X-4	05 34 15	-66 38 56	88	9	5	Pakull

SAA : Solar Aspect Angle
UV1-6 : UV Star observations: calibration of filter UV Sensitivity
TOO : Target of Opportunity
IRAS I : Strong unidentified IRAS Source) EXOSAT 'blank field'
II : NGC 2982, large IR excess detected by IRAS) calibration
PV/Cal : Performance Verification/Calibration target
* : LE1 only because of solar proton event of 16.2.84
** : LE1/GS only because of solar proton event of 16.2.84

Note that observation durations are the times from outer loop closure to outer loop opening (ref. p.33) and should not be considered as necessarily definitive.

EXOSAT X-RAY SOURCES

'New' X-ray sources are discovered by EXOSAT serendipitously in the FOV of the telescope or in the offset quadrants of the ME or from an analysis of ME/GSPC 'background' data recorded during manoeuvres. We intend to maintain a list of published 'new' sources and readers are encouraged to report 'discoveries'.

It is recommended that the following convention be used when referring to EXOSAT sources in publications; in any case, this format will be adopted for any list maintained by the Observatory Team.

EXOSAT Source Nomenclature

EXOhhmm.m ± ddaa

where hh : hours of RA (Epoch 1950)
mm.m : minutes of RA
dd : degrees of declination
aa : hundredths of degrees of declination

IAU (EXOSAT) TELEGRAMS

Circular No.	Title	Comment	Authors
3841	Hercules X-1	Anomalous X-ray behaviour	EXOSAT Team
3842	Supernova in NGC 5236	Multi-waveband observations	W. Wamsteker
3850	GK Persei	351s periodicity during an outburst	M. Watson, A. Smith EXOSAT Team
3854	MXB 1730-335	Active, type 1 bursts	G. Pollard, N. White P. Barr, L. Stella
3858	4U 1543-45	Accurate position, ultra-soft spectrum	R. Blissett, EXOSAT Team
3872	GX 1+4	Unexpected low X-ray state: $\lesssim$ 4 UFU	R. Hall, J. Davelaar EXOSAT Team
3882	4U1755-33	Periodic dips in intensity	N. White, A. Parmar K. Mason
3887	4U2129+47 = V1727 Cygni	Unexpected low X-ray and optical state	W. Pietsch, H. Steinle M. Gottwald
3893	V0332+53	Accurate position, and flux	J. Davelaar, R. Blissett, L. Stella M. McKay, N. White, J. Bleeker
3902	V0332+53	Discovery of 4.4s period	L. Stella, N. White
3906	V0332+53	Unexpected brightening	A.N. Parmar R.J. Blissett T. Courvoisier L. Chiappetti
3912	V0332+53	Orbital parameters determination	N. White, J.Davelaar, A.N. Parmar, L. Stella M. van der Klis

Circular No.	Title	Comment	Authors
3923	Her X-1	Her X-1 'on' again at ~ 80 Uhuru flux units, 1.24s pulsations (March 1.5 - 1.8)	J. Trümper, P. Kahabka H. Ögelmann, W. Pietsch, W. Voges, M. Gottwald, A. Parmar
3932	2S1254-690	Discovery of type 1 Burst and an absorption 'event'.	T. J.-L. Courvoisier, A. Peacock, M. Pakull
3939	VW HYDRI	Discovery of X-ray pulsations during superoutburst	J. Heise, F. Paerels, H. van der Woerd

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OBSERVATORY TEAM

		Ext.
David Andrews	Observatory Manager	705*
Julian Sternberg	Observatory Software	703
Julian Lewis	System Software/HP Computers	702
Christine Durham	On-board Software	712
Mike McKay	Mission Planning/Duty Scientist	707
Anne Fahey	Mission Planning	707
Paul Barr	Duty Scientist	715
Lucio Chiappetti	"	717
Thierry Courvoisier	"	711
Jaap Davelaar	"	710
Paolo Giommi	"	715
Manfred Gottwald	"	758
Julian Osborne	"	714
Arvind Parmar	"	716
Luigi Stella	"	716
Susanne Ernst	Data Assistant	713
Margit Farkas	" "	709
Linda Osborne	" "	713
Sandra Andrews	Secretary	704

*Direct dialling to any extension, prefixed by 886, is possible, eg. 06151-886-705

Personnel Changes (from 01.03.84 to 30.04.84)

- Margit Farkas has been recruited as a data-assistant.

The EXOSAT Ground System and In-Orbit Performance of the Spacecraft

1. INTRODUCTION

The aim of this article is to give a summary of the ESOC Ground System support for the EXOSAT spacecraft and to present some details of the in-orbit performance of the principal spacecraft subsystems.

2. EXOSAT GROUND SYSTEM

2.1 Facilities

The EXOSAT facilities comprise three areas, namely the Ground Station, the Communications and the Operations Control Centre (OCC) at ESOC, Darmstadt.

The dedicated EXOSAT Ground Station, located at Villafranca del Castillo near Madrid, consists of a 15-metre S-band antenna, telemetry, telecommand and ranging equipment located in the station Main Equipment Room, a Monitor and Control (M&C) Computer and a communications computer. With the exception of the antenna, all equipment is duplicated for redundancy. The station equipment is controlled on a 24-hour per day basis from a centralised M&C console by an operator in continuous voice contact with the EXOSAT Spacecraft Controller at ESOC (see 2.2). A local commanding capability together with display facilities for selected telemetry parameters is provided by the station computer. This facility is only used as a back-up in the event of failure either in the communications system or in the OCC computer system and, in any case, strictly under voice control by the EXOSAT Spacecraft Controller.

Communications with the OCC for telemetry and telecommand transmission comprise three full duplex data lines, driven by high-speed modems, and routed by the Deutsches Bundespost and the Spanish PTT. Telemetry is routed in parallel on two of these lines to ESOC where the front-end computer in the OCC performs automatic line selection based on data quality checks. Telecommands are routed from ESOC on the third data line. A fourth line, which serves as a back-up for the telecommand line is used for all voice communication between ESOC and Villafranca (multi-project).

At the OCC, there is a Dedicated Control Room (DCR) housing 5 consoles, 4 of which are at the disposal of Observers and the Observatory Team and the fifth is manned on a 24-hour per day basis by the EXOSAT Spacecraft Controller (SPACON). All consoles have CRT's for alphanumeric display of telemetry and, in addition, the Observatory consoles have colour graphics displays for presentation of payload data. There is a large area "wall display" at the rear of the DCR which is telemetry-driven and gives a synoptic overview of the status of the instruments and the spacecraft subsystems.

EXOSAT support is provided by the computer system shown in Figure 1; the computers on the left of the dotted line are EXOSAT-dedicated while those on the right are shared with other Projects (the so-called Multi-Satellite Support System, MSSS). MSSS concurrently supports OTS, MARECS-A and GEOS; METEOSAT has a dedicated computer system.

To the maximum extent possible, EXOSAT has made use of previously existing MSSS software, mainly in the areas of housekeeping telemetry, processing and display tasks and telecommand handling. Special purpose software was however developed to support, in particular:

- processing and display of payload data (EX1/2)
- OBC commanding (DT)
- Mission planning (SEL)
- Manoeuvre planning and execution (SEL)
- FOT production (Siemens 7865)

2.2 Operations Support

Operational control of the ground system is carried out within ESOC on a multi-satellite basis. 24-hour per day support is provided for MSSS operation, network control and data routing control under the responsibility of a Shift Co-ordinator. Maintenance of the ground facilities, hardware and software, is done during normal working hours, with call-out emergency support available at all other times.

EXOSAT Spacecraft Operations are undertaken by a team of engineers, technicians and Spacecraft Controllers. The SPACON position is manned on a 24-hour per day basis; he is responsible for all routine EXOSAT monitoring and control activities. Timelines for EXOSAT operations are determined from the Planned Observation File (POF) and certain other auxiliary subsystem activities such as perigee and eclipse preparation. Each POF is constructed on an orbit by orbit basis from the Observatory Team's schedules which are produced in roughly 4-8 orbit blocks from the list of approved AO observations. Payload and OBC configuration is determined for each observation by the Observatory team and is implemented by the SPACON on the request of the Duty Scientist. Preparation, execution and monitoring of attitude manoeuvres is a primary task of the SPACON.

Monitoring of all telemetry data is performed automatically and continuously by the MSSS and the SPACON is alerted if any limit - or status - check fails. Contingency procedures exist for many out-of-limit and failure conditions, however in the event of an unforeseen problem for which no procedure exists, the SPACON will summon call-out engineering support.

The tasks of the other members of the team include:

- Operations planning: Preparation of the POF and the timeline for execution by the SPACON.
- Maintenance of data files and co-ordination of operational software modifications with other ESOC departments.
- Analysis of spacecraft data for troubleshooting of anomalies and performance assessment.
- Logging and reporting of spacecraft operations.

3. IN-ORBIT PERFORMANCE

3.1 The Orbit

At 15.59 GMT on 26th May 1983, a Thor Delta 3914 launcher placed EXOSAT into an orbit with the initial elements shown below:

ORBIT ELEMENTS	INITIAL 29.5.83	PRESENT 21.4.84
Height of perigee	346.6 km	3869 km
Height of apogee	191708.7 km	188330.4 km
Eccentricity	0.93433	0.900004
Inclination	72.47°	71.46°
R.A of Ascending Node	184.78°	188.45°
Argument of perigee	286.36°	274.49°
Orbit Period	90.6 hours	90.7 hours

This orbit is perturbed principally by Solar and Lunar gravitation and Earth oblateness and the evolution of the orbital elements since launch has been computed by the ESOC Orbit/Attitude Division. Figures 2 and 3 show the main effect of a steady increase in the height of perigee with a nearly corresponding decrease in the height of apogee. This trend will, however, soon reverse and the perigee height will reduce such that, without intervention, the satellite would re-enter the Earth's atmosphere some 2.95 years after launch. With the active orbit control system on-board EXOSAT, the possibility exists to use some (or all) of the available hydrazine to increase the perigee height towards the end of life thus extending the orbit lifetime. The total 'delta-V' capability is of the order of 173 metres sec^{-1} and, used optimally, lifetime extension of slightly more than 1 year is possible. The orbit control system has been recently commissioned and calibrated (17th April 1984) by performing a test manoeuvre of 2 metres sec^{-1}.

Satellite visibility from Villafranca is about 86 hours per orbit although in the worst case geometry, loss of signal (LOS) has lasted nearly 16 hours. In general, the LOS periods coincide wth the times that the satellite is below 70,000 km altitude (when the payload would in any case be mostly non-operational because of passage through the radiation belts).

The orbit determination process is based on ranging measurements from Villafranca which are made throughout the orbit by the SPACON. Ranging is carried out on a non-interference basis with telecommanding with a profile of approximately once per hour close to perigee reducing to once per six hours around apogee.

3.2 The Attitude and Orbit Control Subsystem (AOCS)

Attitude control in pointing mode is achieved using gyros for attitude measurement and to control a (nominally) ± 1 arcsecond limit-cycle on each axis by issuing commands to a cold-gas (propane) thruster system. The gyros have a drift correction applied from inertial measurements made by a star-tracker and, in some cases, a fine sun sensor. The limit-cycle control is the so-called "inner-loop" and the updating of the gyros from inertial references is the "outer loop". Slewing from one X-ray source to the next is performed under gyro control with the outer-loop opened.

Several problems have been encountered with the AOCS during the first 11 months of operation, the more significant of which are described below. Notwithstanding these problems, we are now approaching manoeuvre/observation no. 1000. Pointing stability of the satellite over extended periods is illustrated in Figure 4, which shows the excursion of the limit-cycle over a typical 10-hour observation period as yielded by the error co-ordinates of the star-tracker. The units on both axes are one-third arcseconds showing that, throughout this period, the pointing direction was maintained within approximately ± 2-3 arcseconds. A 5 arcsecond offset on the abscissa is always superimposed on the limit cycle (see later).

On four occasions, spurious "thruster-on" conditions have occurred spontaneously, resulting in the opposing thruster also coming on to counteract the rotation. This fault has always occurred with the +Y thruster which has a moment arm 16% greater than that of the -Y thruster. With both thrusters on, the 16% inbalance causes the satellite to spin-up until the rate exceeds a threshold (480°/hr) at which Safety Mode circuits cause an autonomous switch to the redundant Reaction Control Equipment (RCE) and place the satellite into a (safe) Y-axis sun-pointing mode. The RCE switch-over clears the "thruster-on" condition. Since this fault has occurred with both RCE's it is thought not to be an intermittent thruster hardware failure. After the third occurrence and some detailed circuit analysis by the spacecraft contractor, it was believed that the fault lay in a component of the prime Attitude and Orbit Control Electronics (AOCE-1) and the decision was taken to switch to the redundant unit, AOCE-2.

AOCE-2 was soon discovered to have a fault of a different nature, whereby the gyro drift correction applied to the Y-axis was occasionally erroneously computed. This error caused significant short-term depointing of the satellite (typically one arcminute) and excessive fuel consumption. Analysis of the problem showed that it occurred only when the error co-ordinate from the star-tracker was changing sign on that axis and an operational "fix" was improvised which introduces a 5 arcseconds offset of the Y-axis limit-cycle (see Figure 4).

The fourth "thruster-on" event occurred recently during preparation for the orbit control test, with AOCE-2 in operation. It is therefore clear that the fault is not isolated to AOCE-1 and although no explanation has emerged, the problem is under investigation by the spacecraft contractor with highest priority.

X- and Z-gyros have shown a progressively increasing drift rate, more or less since launch, which is now of the order of 0.5°/hr in both cases. The gyros can be "trimmed" by selection of a drift bias equal and opposite to the known drift such that the residual drift-rate seen by the AOCE is close to zero. However, the maximum bias which can be applied is ca. ± 0.3°/hr, which means that the drift compensation computed by the AOCE for the X- and Z- axes is no longer close to zero. Because of the manner in which this is computed (floating-point arithmetic), the accuracy of the compensation decreases as the drift-rate increases. This leads to a progressive degradation in "open-loop" performance on these axes ie. the attitude offset after manoeuvres and during perigee passage will increase with time. Procedures are being modified to accommodate this behaviour and include an increase in the guide star search areas of the star-tracker. At present the operational impact of this problem is minimal.

During several perigee passages in August 1983, spurious triggerings of one of the Safety Mode circuits (circuit B) caused wastage of propane and some impact on the observation programme as a result of the reconfiguration operations. The triggering is believed to be due to an external influence (discharging or radiation) and the Safety Mode circuit has therefore been disabled; no similar problem has been encountered with the Safety Mode A circuit.

Other spurious effects have occurred during perigee passage including jumps in the level of the gyro drift bias on the Z- and S- gyros (skewed). The S-gyro is not "active" in the control loop, however the Z-gyro drift bias jumps lead to a de-pointing of the satellite which has to be rectified immediately following acquisition of signal (AOS) at Villafranca.

3.3 Power Supply Subsystem

The Solar Array, consisting of 3312 solar cells provides the necessary power to the on-board subsystems and the payload. The 4-panel array is rotated such that it is always pointing towards the sun, whatever the viewing direction of the payload.

Figure 5 shows the available Solar Array Power during the first 11 months of the mission; the variation is caused by the eccentricity of the Earth's orbit (perihelion being in January!), superimposed on which is a long-term degradation of the solar cells resulting from ageing and irradiation effects.

Power is distributed via a regulated main bus and an unregulated sun bus to various users, and all power lines are protected against shorts in the loads. Excess power is dissipated in a shunt and adjusted regularly to match the demanded power requirements.

Two rechargeable nickel-cadmium batteries of 7 Ah each are used to support the eclipse periods, the second of which has just been successfully completed.

No problems have been encountered with the performance of the power supply sub-system.

3.4 Radio Frequency Subsystem

Communication with the satellite is via one of two S-band transponders (6W), each connected via an RF switch to one of two conical antennas. Each transponder consists of a transmitter, receiver and power supply and performs all required communications, namely telemetry down-link, telecommand uplink and ranging operations. Although the two antennas provide between them omni-directional coverage, the active transponder has to be commanded via the RF switch to the antenna within coverage of the Villafranca ground station. Measurements of the downlink made at Villafranca show a margin of between 2.8 db and 3.7 db (depending on the propagation conditions) at apogee with the 8 Kbps^{-1} downlink bit-rate. The performance of the sub-system is well within its specification, which called for 4 kbps^{-1} nominal and 8 kbps^{-1} whenever the downlink margin allowed.

3.5 Data Handling Subsystem (DHS)

The DHS supports the following functions:

- distribution of telecommands from the decoder (and the OBC) to the on-board users.
- the collection of housekeeping telemetry data from the Remote Terminal Units (RTU's) and pre-processed payload data from the OBC. This process is controlled by the Central Terminal Unit (CTU) which then routes the data to the transmitter for downlink to the Ground Station.
- Collection of payload and housekeeping data for processing within the On-board Computer (OBC) under the control of Executive and Applications software.
- On-board timing.

No problems have been encountered with the DHS hardware. The only significant anomaly has been within the OBC, where intermittent errors in parity bits in the OBC memory occur for reasons as yet unexplained. This anomaly however has no effect on the operation of the OBC.

The software system is the backbone of the science data collection process and has undergone continuous modification and improvement since launch. Several new Application Programs have been developed and the Basic In-flight Software System (BIF) has been re-organised on several occasions to optimise the resources available for the Applications software.

A. Parkes

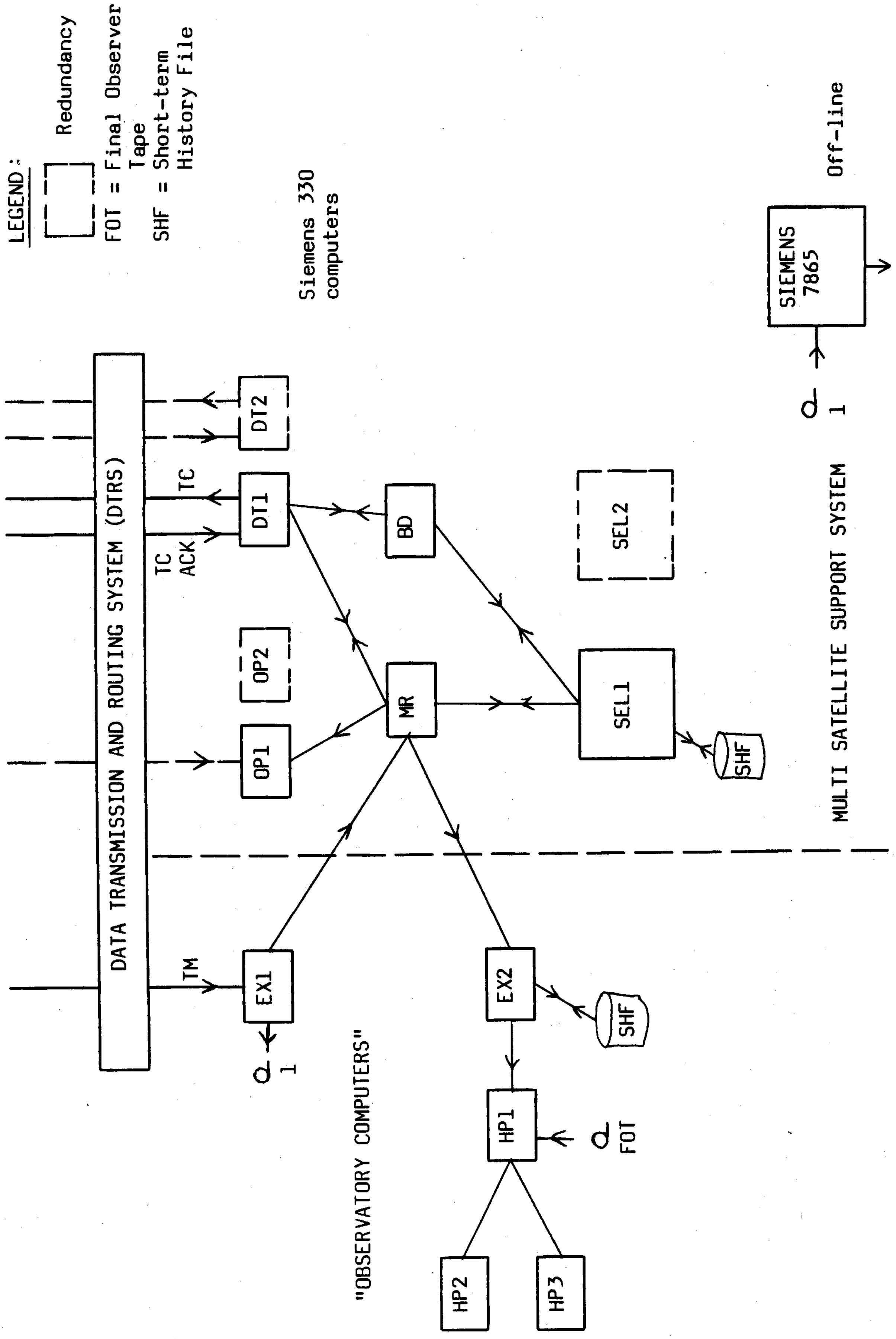


FIGURE 1: EXOSAT Computer Support

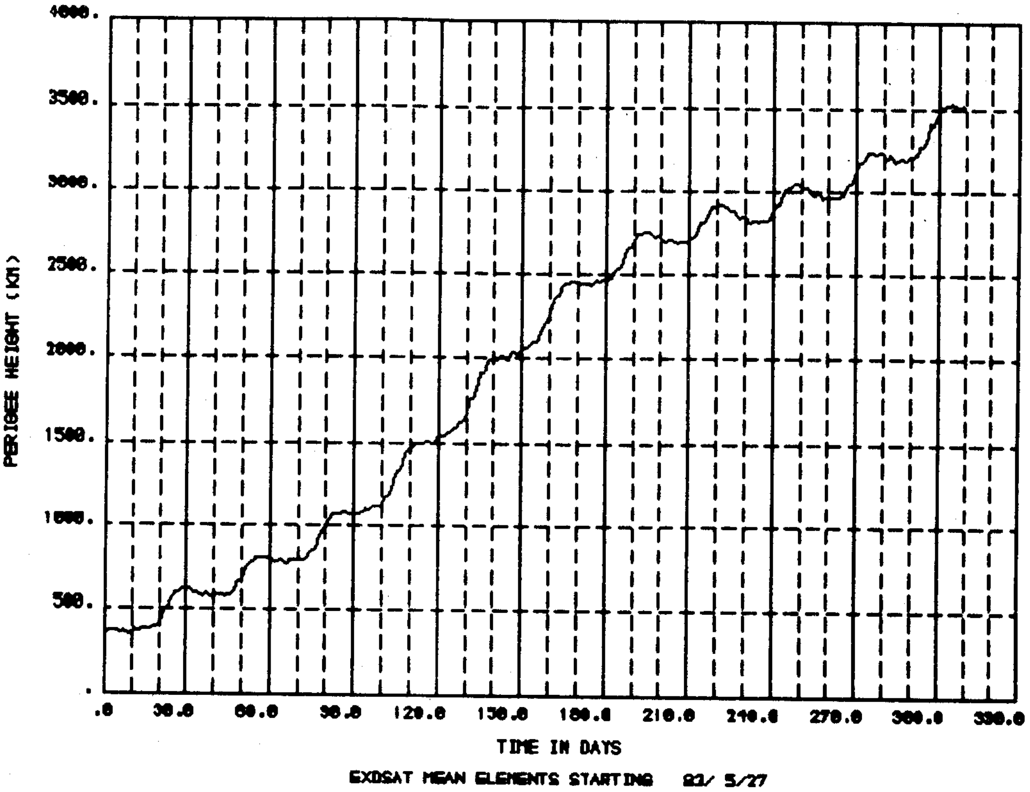


FIGURE 2: Evolution of perigee height

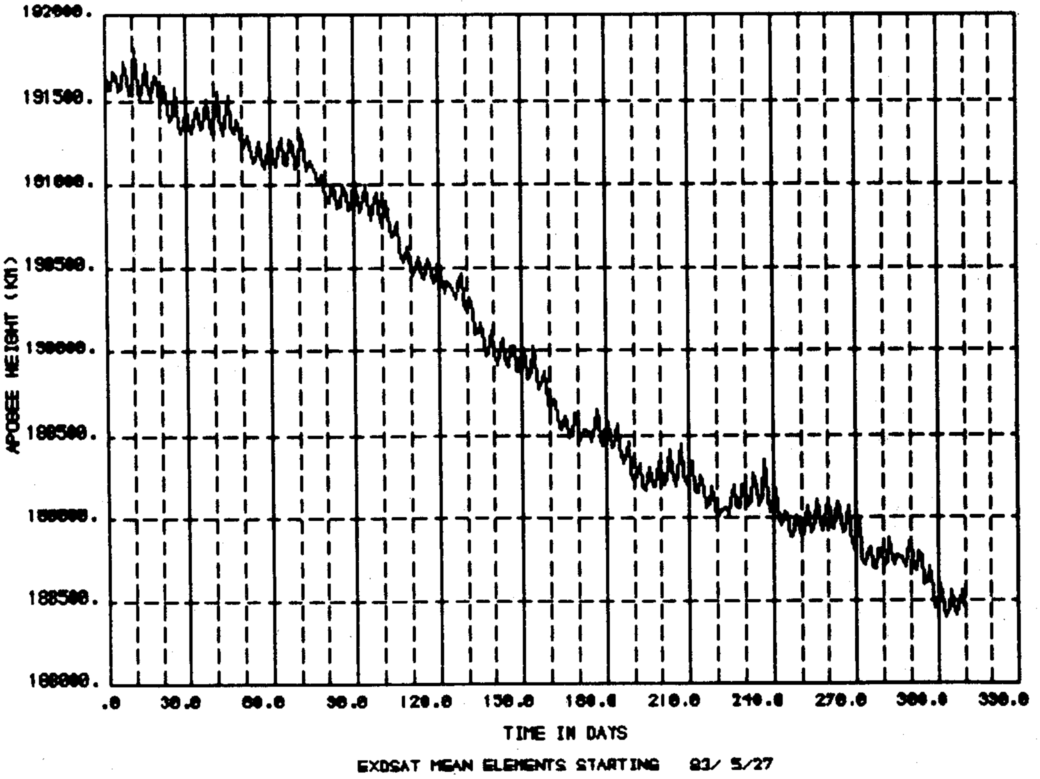


FIGURE 3: Evolution of apogee height

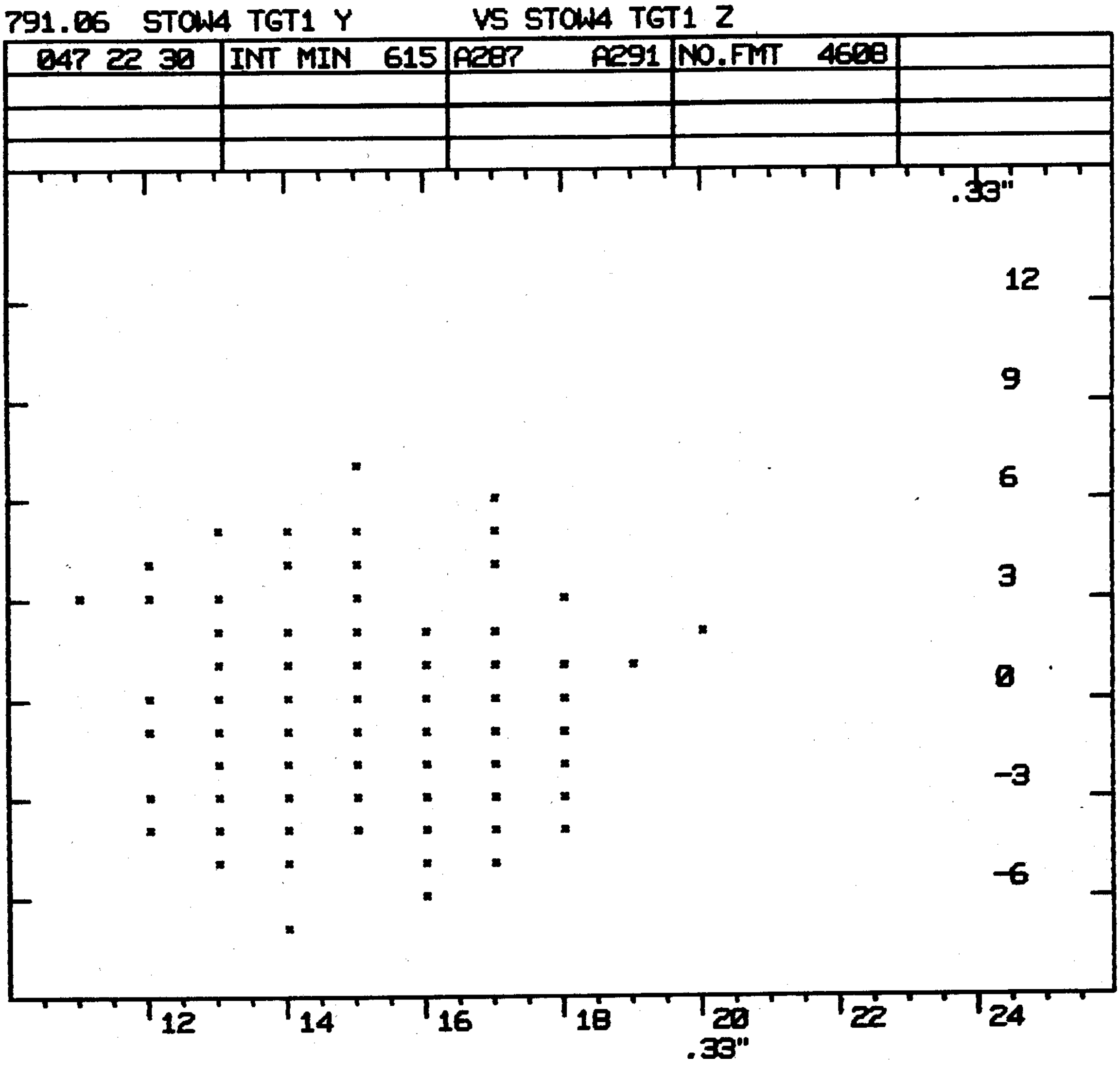


FIGURE 4: Stability of pointing

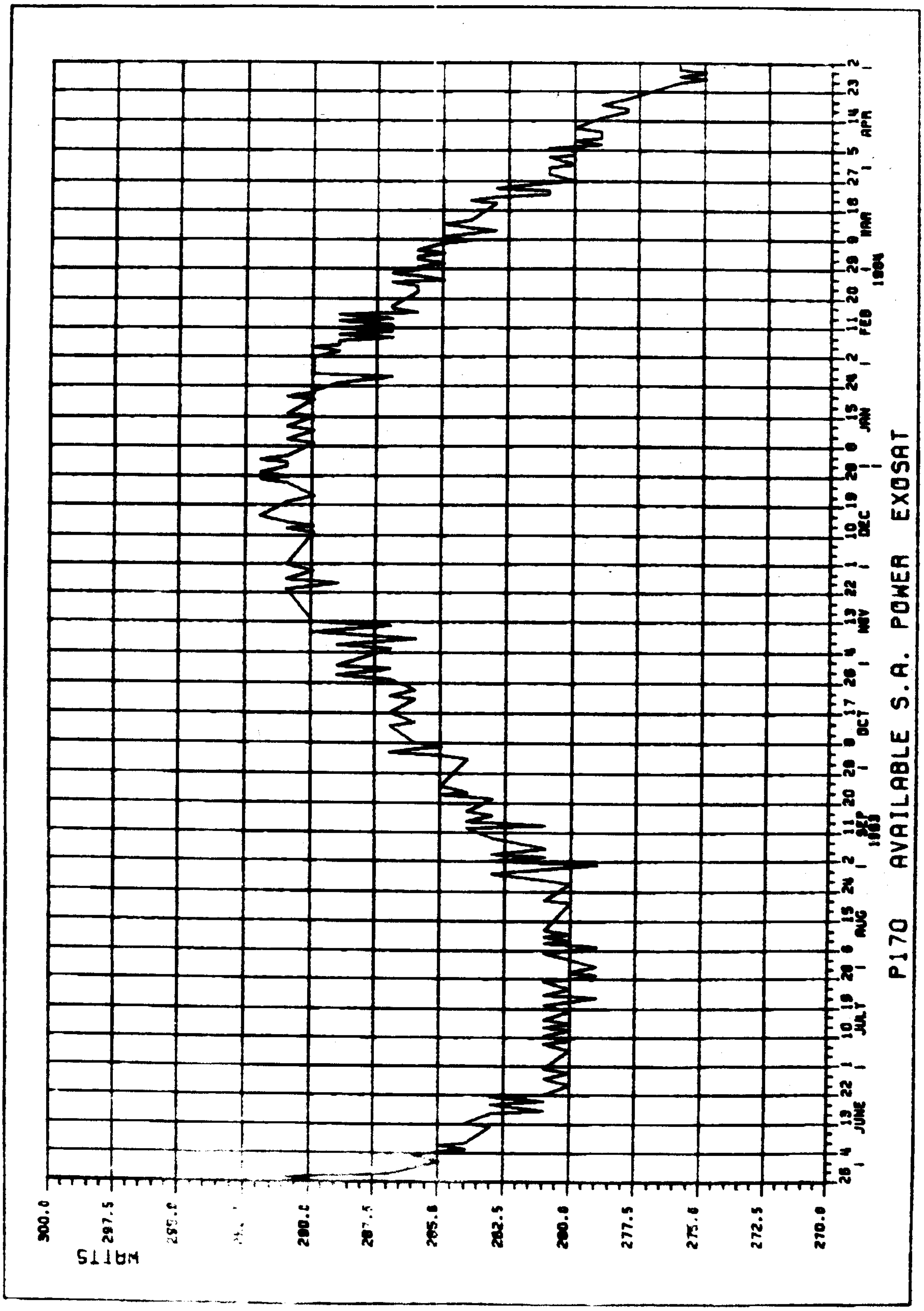

P170 AVAILABLE S.A. POWER EXOSAT
WATTS
300.0
297.5
295.0
292.5
290.0
287.5
285.0
282.5
280.0
277.5
275.0
272.5
270.0
28 4 13 22 1 10 19 28 6 15 24 2 11 20 29 8 17 26 4 13 22 1 10 19 28 6 15 24 2 11 20 29 9 18 27 5 14 23 2
JUNE
JULY
AUG
SEP
1983
OCT
NOV
DEC
JAN
FEB
1984
MAR
APR

Figure 5

Correction of LE source count rates determined by the LE automatic analysis

(NB. Applies only to automatic analysis produced prior to 1.3.84)

A simple way of determining whether a source intensity has been underestimated is to check the background/sec/4 arcsec pixel given in the box at the right of the full resolution image in the automatic analysis output. If this number is $\gtrsim 2 \times 10^{-5}$ the source count rate is likely to be underestimated; the count rate is almost certainly wrong if the background is $> 5 \times 10^{-5}$.

Information contained in other parts of the LE automatic analysis output can be utilised to obtain an approximate estimate of the correct count rate using the following formula:

$$c/r = \frac{CT - R_2^2 . \pi . b.t}{t}$$

where c/r is the corrected count rate.

CT is the total number of counts within a circle of radius R_2 and can be calculated by summing the numbers given in the 3rd and 4th lines of the "parameter summary" in the box at the right of the full resolution image. (CT = EVENTS within radius R_1 + EVENTS within $R_1 < ch < R_2$ ref. p.42).

t is the total exposure time in secs, given in the first page of the Scientific Data Analysis. b is the true background/sec/4 arcsec pixel and can be estimated as follows:

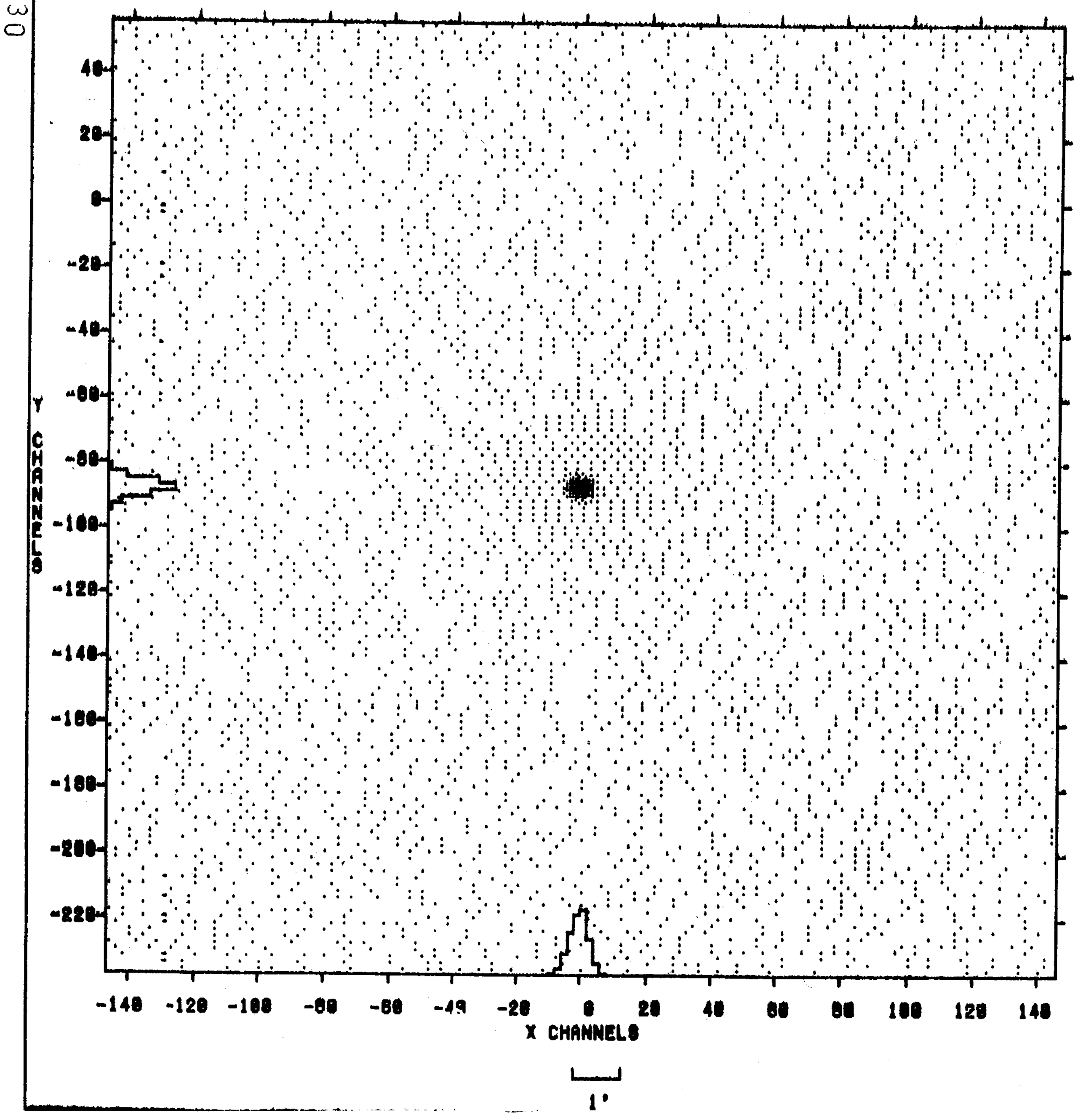
$$b = \frac{\text{BACKGROUND}}{t \times 121}$$

BACKGROUND is given in the box at the right of the main image.

If MAX QE RATE (second number in second page of output) is equal to 800, b is expected to be in the range $6 \times 10^{-6} - 4 \times 10^{-5}$.

P. Giommi
L. Stella

SOURCE A FULL RESOLUTION IMAGE



GREY SCALE COUNTS PER PIXEL

PARAMETER SUMMARY

```
   X CENTROID    -.33 +/-    .02 CHAN OFST
   Y CENTROID -87.83 +/-    .02 CHAN OFST
 * EVENTS WITHIN RADIUS CH   9    19706
** EVENTS      CH   9  <  CH  24     2728
   EST. SOURCE EVENTS  19259.6 +/-  140.6
   BG  1.17E-04 EVENTS/SEC/4 ARCSEC PIXEL
   SOURCE SIGNIFICANCE    845.039 S DEV
   PIXEL SIZE   8.0 X  8.0 ARCSEC**2
```

* R_1 : ** $R_1 \rightarrow R_2$

LE CCF Update Note No. 1

With reference to the status described in the Guide to the LE CCF (EXOSAT Express No. 3 p.36) the following changes have been applied to the LE Current Calibration Files.

Data Type	Status
C1	All spare values are currently set to -1 (both L1 and L2). For LE2 the CMA efficiency is in its final (ground based) form.
CG	Co-ordinates of the hot spots (as used by the Automatic Analysis for hot spot removal) are included for both L1 & L2.
D1	All spare values are correctly set to -1 (both L1 and L2).

Using the terminology introduced in the original article, this CCF is defined as CCF3. The overall SHF key is set to 1983 day 150, and the "last update of cal history" to 1984 day 91.

CCF3 has been distributed with the recently despatched calibration history tape and should be used instead of older versions. It is referred to in the latest issue of the FOT handbook.

L. Chiappetti

GSPC Gain Calibration

A precise calibration of the GSPC gains is required because the current procedure of switching off the 28V LE1 power supply line whenever possible to maintain a low average CMA1 temperature causes gain variations of the GSPC photomultiplier. Note that use of the in-flight radioactive calibration source (Fe^{55}/Cd^{109}) has been suspended following two occasions of 'malfunction' of the telecommand to move the source from the 'closed' to the 'open' position. In each case, re-transmission of the command was successful, however with no clear explanation of the 'failure' the policy has been to play safe and not exercise the mechanism.

The following features may be used to achieve a calibration of detector gain.

LED stimulation: This has been performed regularly since day 40 1984 at the beginning and at the end of each observing period (ie. after the end of the manoeuvre to a source and before the HT switch off at the beginning of the manoeuvre to the next source). The LED line has a width less than that of the detector resolution because the photomultiplier only is stimulated but since practically all gain variations are believed to occur in the photomultiplier tube the data is therefore sufficient to monitor the gain changes. A precise determination of the equivalent energy requires further analysis and observers will be informed of the figure as soon as possible. As of 1.5.84 the gain calibration data in the CCF will be calculated from the LED stimulation at the start of each observation according to the following:

The gains gp and gc are defined, as in the FOT Handbook, by:

$$E = N.gp + gc$$

where E = Energy in keV
N = Channel number
gc = -0.035 keV for electronic gain setting = 2
-0.105 keV " " " " = 1

Therefore, for LED stimulations :
$$gp = \frac{E_{LED} - gc}{N_{LED}}$$

where E_{LED} = Energy equivalent of the LED (to be determined)
N_{LED} = Mean fitted peak in channels of the LED line

Observers should check the stability of the gain during the observation by comparing the LED stimulation data before and after the observation period.

A FOT production problem occurred between day 40 and day 100 and resulted in omission of LED 'observations' from the FOTs. This problem has since been solved and P.I's with prime GSPC observations between these dates will, on request, receive a corrected FOT.

Note that an LED stimulation 'observation' is characterised in the observation directory and the telecommand monitor by the In-Flight Test bit being set (or by the telecommand for In-Flight test being on Energy preamp. stimulation) at the same time as the HT's are on.

In weak source observations and during slews two Bi lines at energies of 10.75 keV and 13.05 keV are seen. Gaussian distributions may be fitted to these lines to calibrate the detector. The formulae are the same as for LED stimulation with E_{LED} and N_{LED} replaced by the Bi line values. A relatively long exposure time is needed to obtain a reasonable fit (>1h) and the lines are therefore not suitable for checking detector stability (except for long slews before and after an observation), nevertheless as a test of the complete detector they provide a useful supplement to the LED data.

The 4.7 keV feature: This feature observed in the GSPC spectra is a function of the detector. It has an equivalent width of ~60 eV, a true width of ~100 eV and is believed to result from X-ray photon interaction with the Xe L shell of the detector gas. For strong sources and where no other method is available it may be used to determine the gain, and in any case it provides a good consistency check on the other methods. Note that source spectral features may distort the detector feature.

Observers should as far as possible utilise all three methods described here to give consistent results and hence confidence in the gain calibration.

T. J.-L. Courvoisier

ME AND GSPC COLLIMATOR RESPONSE PROFILES

A Crab Raster scan (69 observations with a typical exposure time of 10-20 minutes) was carried out on days 276/277 to determine the in-orbit ME and GSPC collimator response profiles. Most of the pointings placed the source in the 3rd (in spacecraft co-ordinates $z < 0$, $y > 0$) and 4th ($z > 0$, $y < 0$) quadrants, concentrated around the expected origin of the collimator response at $z = y = 0$.

Collimator elements are identical in design for all ME detectors and the GSPC and pre-launch calibration measurements demonstrated that the response profile is best represented by a rectangular-base pyramid defined by 4 parameters. These are the flat top (FT) and the FWHM in z- and y- directions (fig. 1). In the special case of a square base $z_{FT} = y_{FT}$, and $z_{FWHM} = y_{FWHM}$.

For a given point (z,y) and a collimator origin at $z = y = 0$ the response $f_c = f_c\ (z,y)$ can be defined as:

$$f_c\ (z,\ y) = f_z . f_y$$

with

$$f_z = 1.0 \qquad \text{for } |z| < \frac{z_{FT}}{2}$$

$$f_y = 1.0 \qquad \text{''} \quad |y| < \frac{y_{FT}}{2}$$

$$f_z = 0.0 \qquad \text{''} \quad |z| > z_{FWHM} - \frac{z_{FT}}{2}$$

$$f_y = 0.0 \qquad \text{''} \quad |y| > y_{FWHM} - \frac{y_{FT}}{2}$$

$$f_z = \frac{z_{FWHM} - \frac{z_{FT}}{2} - |z|}{z_{FWHM} - z_{FT}} \qquad \text{''} \quad \frac{z_{FT}}{2} \leqslant |z| \leqslant z_{FWHM} - \frac{z_{FT}}{2}$$

$$f_y = \frac{y_{FWHM} - \frac{y_{FT}}{2} - |y|}{y_{FWHM} - y_{FT}} \qquad \text{''} \quad \frac{y_{FT}}{2} \leqslant |y| \leqslant y_{FWHM} - \frac{y_{FT}}{2}$$

Since each detector is not perfectly aligned with respect to the spacecraft system (star tracker x-axis $\neq$ detector 'optical' axis) $|z|$ and $|y|$ must be substituted by $|z - z_M|$ and $|y - y_M|$ where z_M, y_M define the misalignment of the detector.

The unknown parameter of the collimator response together with the flat top count rate can be derived by a simple minimum χ^2 analysis of the raster scan data.

All results are corrected for systematic effects caused by misalignment in the 'co-aligned' position between the ME array halves and undersampling of the data for the strong CRAB source.

Figure 1: Collimator response model.
Table 1: Results of collimator response fit.
Figure 2: Typical ME Ar detector amd GSPC collimator responses.
Figure 3: Misalignment ME/GSPC/LE1 with respect to spacecraft reference system.

M. Gottwald

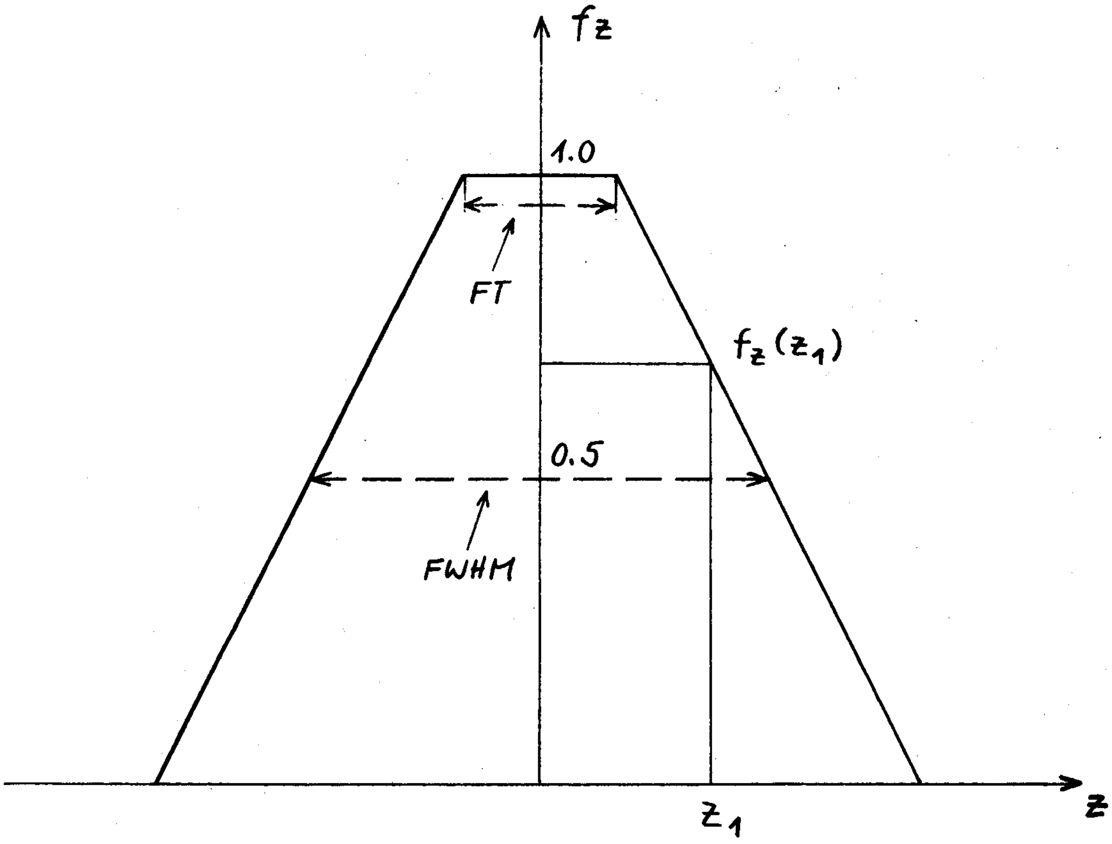
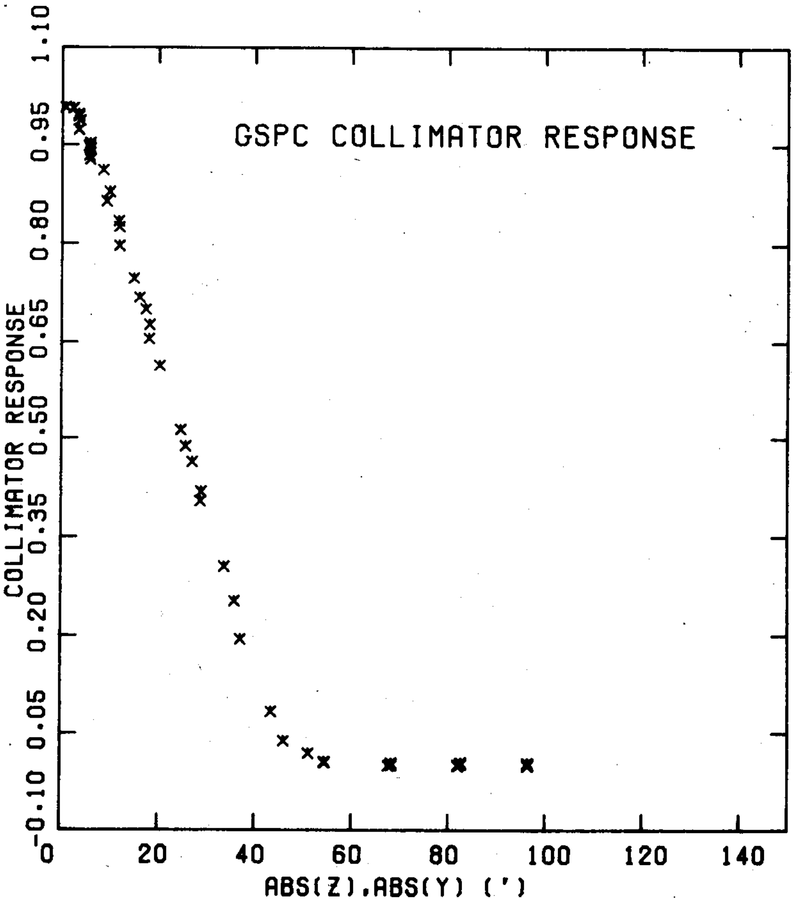


Figure 1

RESULTS OF COLLIMATOR RESPONSE FIT

	FWHM (')		Flat top (')		Misalignment (')		Flat top rate for Crab
	z	y	z	y	z	y	(cnts/sec)
GSPC	51.0	50.0	8.0	5.0	0.1	-3.4	205.9 (gain 1)
ME Ar 1	50.0	51.0	7.0	7.0	-4.7	-1.6	478.6
Xe 1	52.0	51.0	6.0	7.0	-4.4	-1.5	65.8
Ar 2	51.0	52.0	9.0	8.0	-6.1	-2.6	443.6
Xe 2	55.0	54.0	7.0	9.0	-6.9	-2.1	67.8
Ar 3	50.0	51.0	8.0	7.0	-6.3	-3.8	521.4
Xe 3	52.0	51.0	6.0	8.0	-5.7	-3.6	66.9
Ar 4	49.0	49.0	7.0	6.0	-6.4	-2.6	544.7
Xe 4	51.0	49.0	7.0	6.0	-6.4	-2.9	65.5
Ar 5	49.0	49.0	6.0	7.0	-5.0	0.6	470.5
Xe 5	50.0	47.0	8.0	7.0	-5.2	1.4	65.6
Ar 6	50.0	49.0	7.0	5.0	-5.7	-1.8	475.8
Xe 6	53.0	52.0	7.0	7.0	-5.5	-2.2	69.8
Ar 7	46.0	49.0	5.0	7.0	-4.2	-1.7	483.9
Xe 7	50.0	49.0	7.0	6.0	-4.8	-1.8	60.6
Ar 8	50.0	50.0	6.0	8.0	-4.4	0.1	519.9
Xe 8	52.0	50.0	9.0	9.0	-4.2	0.5	63.1

TABLE 1


GSPC COLLIMATOR RESPONSE
COLLIMATOR RESPONSE
-0.10
0.05
0.20
0.35
0.50
0.65
0.80
0.95
1.10
0
20
40
60
80
100
120
140
ABS(Z),ABS(Y) (')

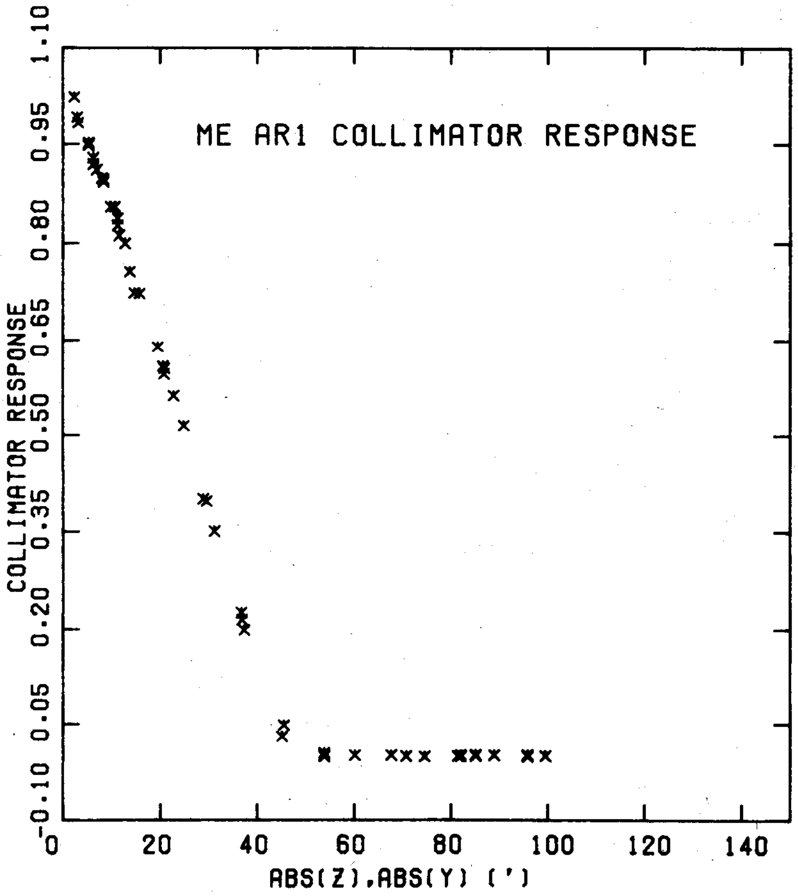

ME AR1 COLLIMATOR RESPONSE
COLLIMATOR RESPONSE
-0.10
0.05
0.20
0.35
0.50
0.65
0.80
0.95
1.10
0
20
40
60
80
100
120
140
ABS(Z),ABS(Y) (')

Figure 2.

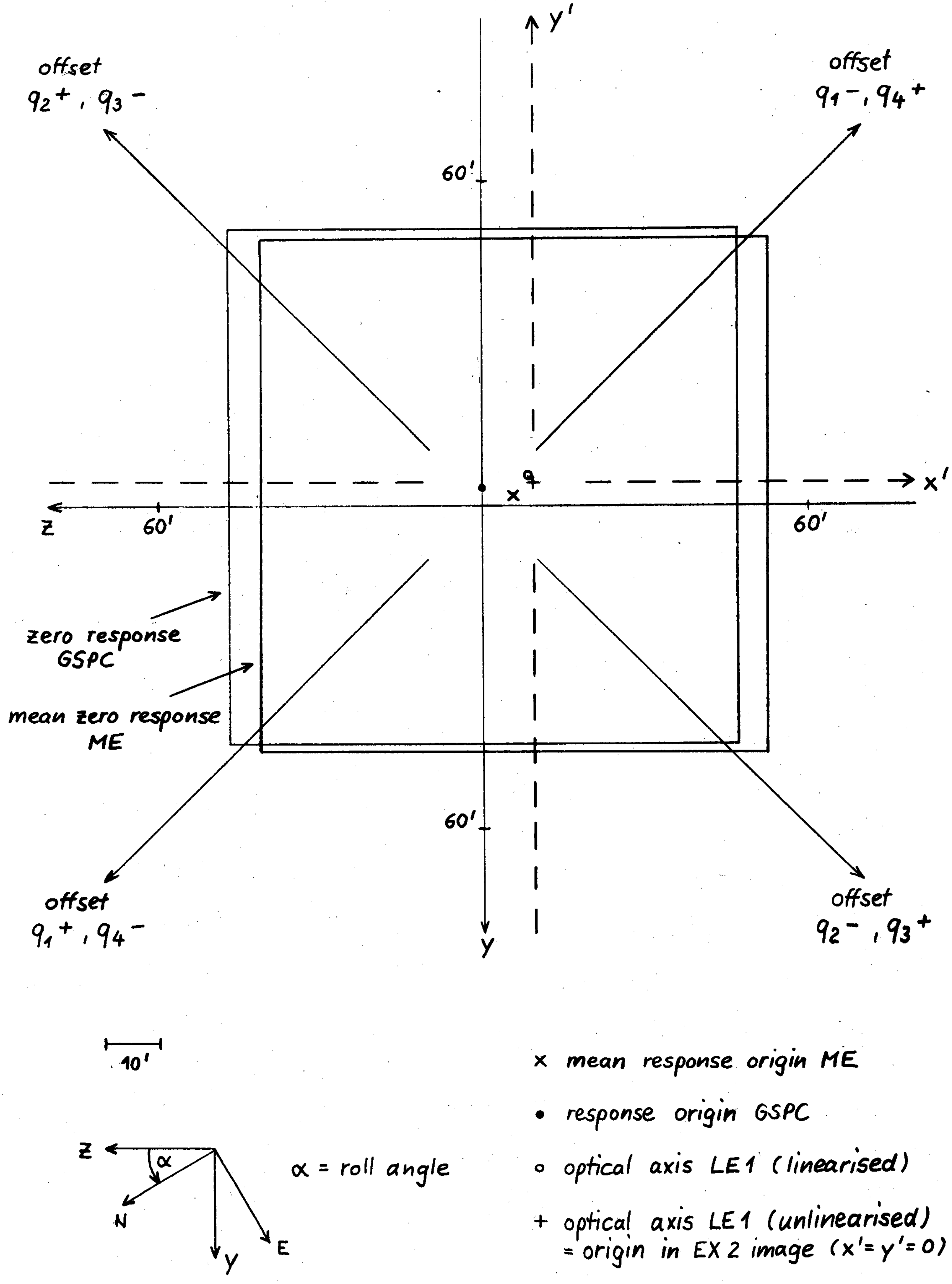

y'
offset
q_2^+, q_3^-
offset
q_1^-, q_4^+
60'
x'
z
60'
60'
zero response GSPC
mean zero response ME
60'
offset
q_1^+, q_4^-
y
offset
q_2^-, q_3^+
10'
× mean response origin ME
• response origin GSPC
∘ optical axis LE1 (linearised)
+ optical axis LE1 (unlinearised)
= origin in EX 2 image (x' = y' = 0)
z
α
N
y
E
α = roll angle

Figure 3.

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