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5. Autor(en) (Name, Vorname(n))

Schwenn, Rainer; Rosenbauer, Helmut

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8. Durchführende Institution (Name, Adresse)

Max-Planck-Institut für Aeronomie
Postfach 20
3411 Katlenburg-Lindau

9. Ber.Nr.Auftragnehmer

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18.abridged version

The four instruments of the HELIOS plasma experiment to examine the properties of the interplanetary plasma.This report, which immediately adjacent BMFT-FB-W81-015 on the technical description in the report (whose understanding is assumed), describes the extraction of plasma parameters.In doing so, we assume that the raw data and explain all necessary intermediate steps up to the presentation of data in various formats.The main programmes are reproduced and explained their most important properties.

19. Schlagwörter

Sonnensonden HELIOS 1/2, Plasmaexperiment, Protonen, Elektronen, Datenauswertung.

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18. Abstract

The instruments of the HELIOS plasma experiment investigate the characteristics of the interplanetary plasma. In this follow-up report of the technical description given in report BMFT-FB-W81-015 we describe the data evaluation procedure in some detail. We start from the raw data tapes, explain most of the intermediate steps and finally show the resulting data plots in their various forms. The most important computer programs are enclosed, together with some basic explanations.

19. Keywords

HELIOS solar probes, plasma experiment, protons, electrons, data evaluation.

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Table of contents

This is an English translation of the original German document. It includes pages 3-71 and 204, but excludes extensive computer code, which has not been translated.

The work was carried out by Imperial College London using computer translation with limited further copy editing, with the goal producing a technically useable English document for understanding the operations of the Helios E1 experiment. It is not intended to be a perfect translation; if you find errors however, please send corrections to Tim Horbury (t.horbury@imperial.ac.uk).

Our thanks to the original engineers, Eckart Marsch (provision of the document), U. Kiel (document scanning), Chadi Salem (provision of the PDF), Sophie Albosh (copy editing) and Ingo Muller-Wodarg and Christoph Larndorfer (German expertise).

Tim Horbury, Chris Chen, Lorenzo Matteini, David Stansby

Imperial College London, October 2016

Preface

This final report describes the more technical part of the scientific evaluation of the data of the experiment of plasma on the HELIOS-solar probe.The data analysis is not yet complete; because the data reception from HELIOS 1 is still running, now at the end of the seventh Mission year.The computer programs for the routine evaluations are done of course for a long time and are used all the time.However, still today continue working on them.According to the current physical problems changes are necessary, namely time and again especially when it comes to the calculation of "Mixing parameters", E.g.the Plasma pressure $p = n_p kT_p + n_\alpha kT_\alpha + n_e kT_e$, or the Alfvén speed

$$v_A = \sqrt{B^2/4\pi(n_p + 4n_\alpha)} .$$

Because of the special value of the HELIOS data and also due to their massive size special safeguards are needed, E.g.Summaries, mean value calculation, compress, duplicating etc.. These programmes, which we also consider part of the routine evaluation (in the sense of the support project), are still under construction, it will be reported later.

In this report, we will present the most important elements of the fairly extensive evaluation architecture in the form of block diagrams, programs and examples of details.

The entire structure is adapted to the computer plant existing at the MPP in Garching and its operating system (AMOS) as well as the associated input and output units. So it can therefore not be sense of this report to describe the procedures as General and at the same time so completely that a reader alone could repeat this analysis on another system.On the other hand have a number of core programs that put in many places in any subprograms, a special value.To the actual evaluation based on certain physical assumptions and also subjective assessments (e.g., the statistical significance of count rates), which certainly have influences on the evaluated variables, and we therefore want to disclose.On the other hand, many subprograms are very universal and can therefore again in completely different contexts are used (E.g.Calculation of mean values, conversion to Carrington lengths, modular plot routines etc.).

And last not least we want to give all those who work daily with these data, this report a comprehensive compendium of the hand.To allow them - and there are not few – to continue to use the extensive tools that we have compiled, and it should also allow them, any problems that ever occur in the interpretation, to go to the ground.

So much for the explanation of the special nature of this report.It is written for professionals and requires the knowledge of experts.The applies to both FORTRAN IV programming and data technology in General, as well as for the technology of E-1 instruments. Reference is also made repeatedly on the technical final report W-81-015.

The present report the BMFT as final report for the resources presented, within the framework of the funding grant from section 3006, title 89320 of the BMFT for the projects 'scientific data analysis of the first HELIOS-A and B, experiment 1" under the code 01 QC 106 A - ZA 24 - WRS - 0108 have been granted.

1.Overview

The two HELIOS solar probes have among other things depending on a set of almost identical plasma instruments (the "plasma experiment", E1) on board.A description of the HELIOS mission as well as the plasma instruments was report W81-015 of the BMFT (in the following always A called, each followed by a page number) given.The description of the Mission (A11 to A17), as well as the terms of reference of the plasma instruments (A18-A24) consider as part of this report and want to forego their repetition here.

Figure 1 shows a diagram of the data flow in the HELIOS project.The subinstruments of experiment provide their data to the central processing unit of your experiment.There, the data are mapped, before selected, and possibly, coded.Each of the experiments passes the so processed data to the telemetry system of HELIOS.There they are according to the agreements previously reached in various commandable telemetry formats (FM1 to FM5) pro rata collected and finally transmitted using the directional antenna towards the Earth.There they captured distributed ground stations from all around over the world.In the Mission control center of the DFVLR (the GSOC), the engineering data are immediately sorted out from the telemetry frame and placed on screens.So, the technical function of all systems can be monitored continuously.This also applies to E1 (A112ff).The scientific data from each experiment can be issued for a short time in real time via a printer.In the normal case this data are on bands but first recorded and later after experiments sorted on individual bands split up.The EDR (experiment data records) then go post on the institutions that care for the experiments. There the actual evaluation can then start, here the discussion should be.

We explain the process of evaluating using the schema of Figure 2.The EDR are prepared first, i.e.in a practical preparation form.Lots of additional information about the technical condition are made on a few bit compressed, time allocations, quality tested, and decodes data.This treatment is done

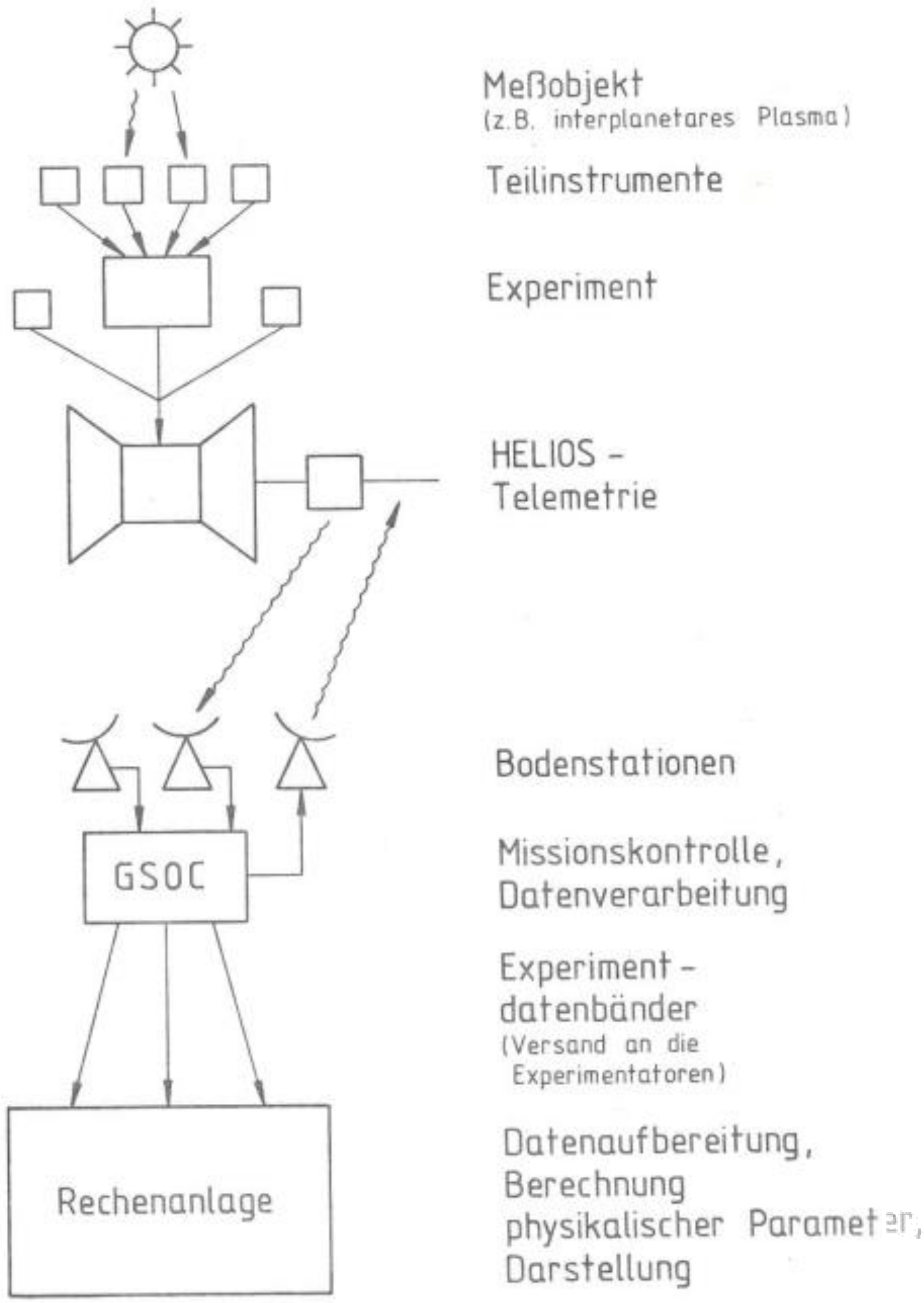

Figure 1: Scheme of the data flow in the HELIOS project.

Meßobjekt = measurement object
z.B. = e.g.
Teilinstrumente = subinstruments
Telemetrie = telemetry
Bodenstationen = Ground stations
Datenverarbeitung = data processing
Datenbänder = data tapes
Versand an die Experimentatoren = Shipping to the experimenters
Datenaufbereitung, Berechnung physikalischer Parameter darstellung = Data preparation, calculation physical parameters presentation
Rechenanlage = computer system

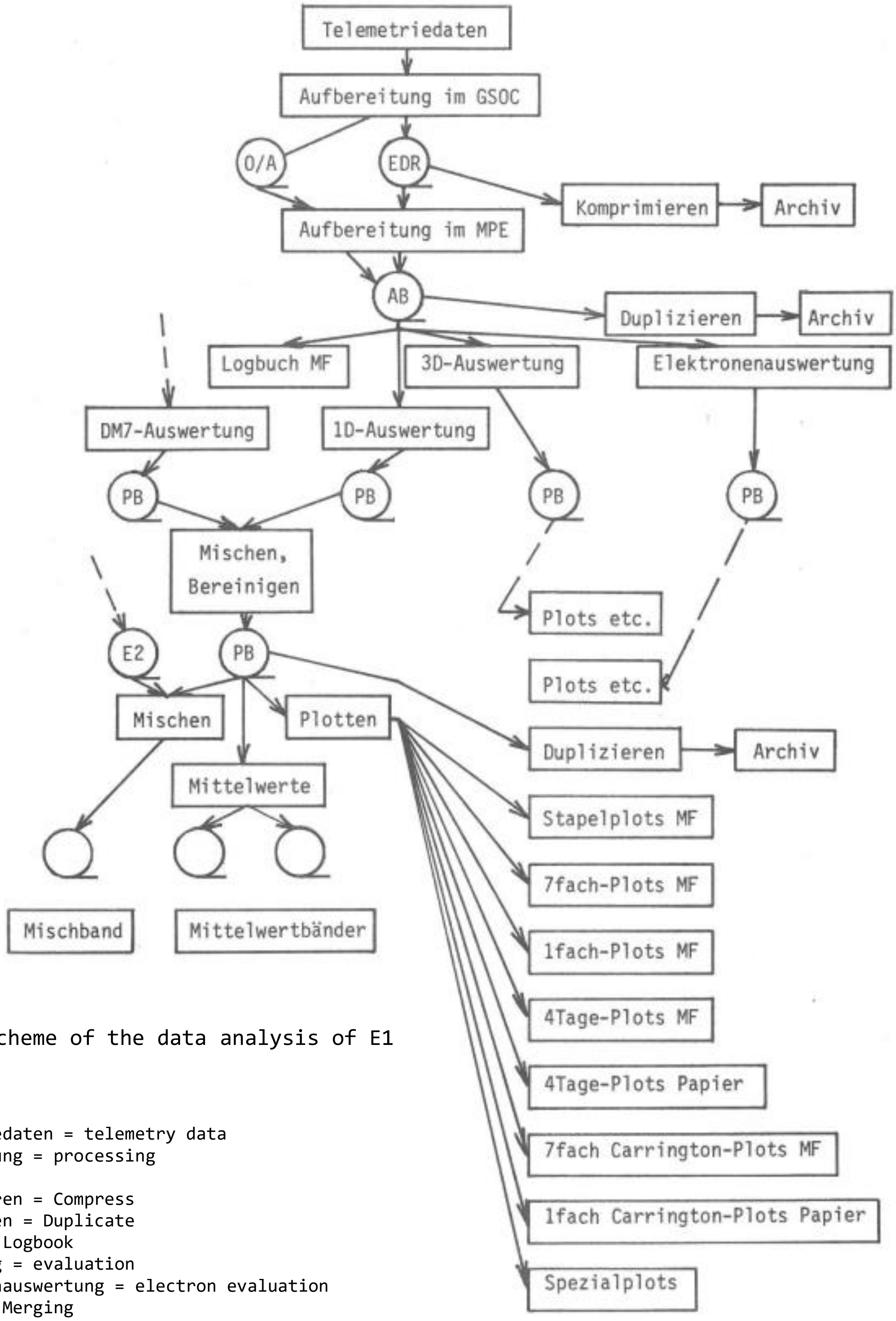

Figure 2: Scheme of the data analysis of E1

Telemetriedaten = telemetry data
Aufbereitung = processing
Im = in
Komprimieren = Compress
Duplizieren = Duplicate
Logbuch = Logbook
Auswertung = evaluation
Elektronenauswertung = electron evaluation
Mischen = Merging
Bereinigen = clean
Mittelwerte = average values
Mischband = mixed tape
Mittelwertbänder = Averaging tapes
Stapelplots = stack plots
fach-Plots = subject-plots
Tage-Plots = Days-plots
fach Carrington-Plots = subject Carrington plots

on an HP 2100 system in the MPE Garching. Each of the resulting from (analysis tapes) multiple EDR, which greatly facilitates the work contains the content.

AB are starting points for different evaluation methods.The "logbook" will be made first.This is a continuous index on microfiche, the deterioration of the power-up state of E1 and data errors etc can be seen.

There are three in basically similar, but independent evaluation course, using other data of the experiment:

- The 1DP (a-dimensional program).It is routinely applied on all the data, but is still the "cheapest" program. It is applied to the integrated data from I1a and in a very similar form also on to I1b and I3.
- The 3DP (three-dimensional program).It evaluates the 3D data of I1a and I3 to a necessarily pretty elaborate process, but reasons of cost only a fraction of all this data.
- The ELP (electronic program).Also the evaluation of I2 data is expensive and requires preselection of data to be treated.

All three methods require accurate data on path and location of HELIOS by a whether supplied separately by the GSOC (orbit band) can be played to.The 3DP and the ELP need also the magnetic field data from E2 (magnetometer instrument of the Technical University of Braunschweig).

The further procedure is explained on the basis of the 1DP: in a typical production run with the 1DP, the calculated sizes on a belt are cached.Alongside is a printed Protocol, which allows the monitoring of jobs.Usually we produce an expression of plasma parameters on microfiche for this run also.The output files of several productions, as well as also the separately processed DM7 data (from the HELIOS board storage, measured during gaps in the ground station coverage) are then mixed together; It also time jumps are corrected, eliminating overlapping and identifiable

"Outliers" sorted out.Thus arises the PB (parameter band) finally.This PB is once again the starting point for all plots in a variety of variations and for the production of special bands (E.g.with hours mean values for the data exchange with selected sizes for special requirements), as well as mixing tapes (with other sizes from the ELP, 3DP and E2).Of course, PB serves above all as a basis for scientific research.

2.The experimenter bands (EDR)

The structure of the Earth has been negotiated with the GSOC in detail. It is deposited in the document HGOS 13 ("German MDR/EDR data processing plan"). Only the most important should be mentioned here.

The band structure is seen in Figure 3.The "actual" data stuck in the SDB (science data block), and form the TLMF (telemetry files) alternating with the HKB (house-keeping block). The TLMF be completed each or newly opened, if there is a change of bitrate or data mode.Then, an OACF (orbit-attitude-Command file) in between is always pushed which relates to the previous TLMF (we do not use these OACF at all, let us give the O/A-data on separate tapes.).Otherwise, only various control data and file marks are available on the EDR.

The structure of the data shown in table 1 is within a TLMF.The E1 data is available on the courts 27 up to 278 (or also 315 up to 602, 603-890 and 891-1178).These are always 252 words 16 bits, which record exactly the 504 words an E1 EDF.Thus, each TLMF contains the data of a whole S/C-mainframe (A83).These are four EDF from E1 (or 16 in FM3).Except for information on telemetry modes, reception and all HK data there are also the mean values from E2 determined by the GSOC (the calculation scheme was indeed delivered from the TU Brunswick, this routine procedure of course could not compete with the own evaluation of the Brunswick and delivered especially bad values when "Special tricks" were needed).Even the "flag bits" in W18 to 26 are important, in which for every single telemetry frame within the respective main frame appears, whether data is present or not. When individual frames are missing, the entire EDF therefore didn't always needs to be thrown away, but only the data of the currently affected instrument.

The O/A-data we get a block on additional bands, for each hour of the Mission respectively.We need to calculate intermediate values, that we of course need through appropriate interpolation.The contents of such O/A-data blocks is listed in table 2.

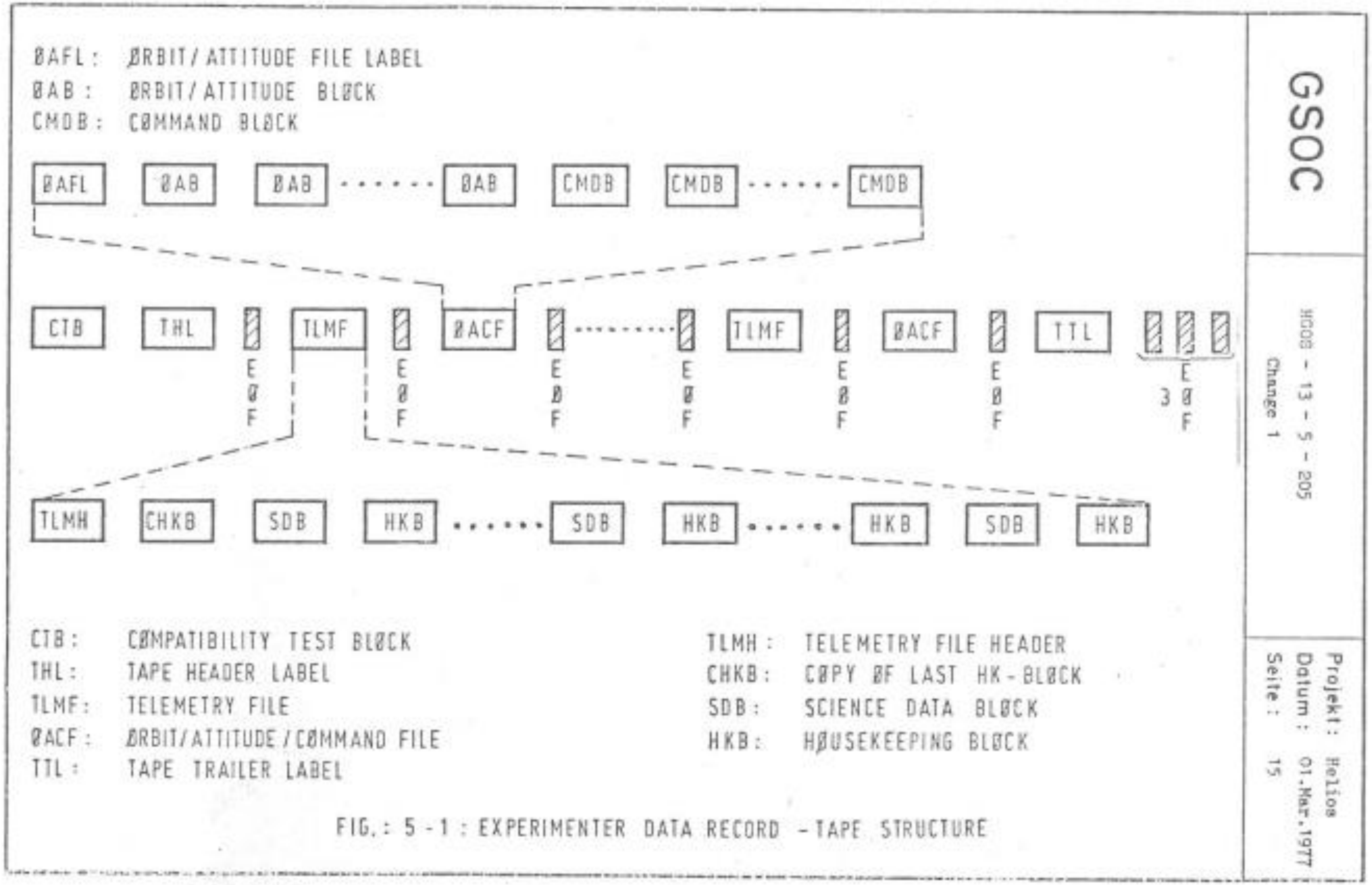

Figure 3: Data structure of the EDR

DFVLR GSOC	HGOS 13 - 5 - 201 Change 1	Projekt: Helios Datum: 01.Mar.1977 Seite: 9

TABLE 5-5 TELEMETRY DATA BLOCK FORMAT

WORD	TYPE	CONTENTS		VALUE
0	A	BLOCK IDENTIFICATION		10
1	A	SEQUENCE-NUMBER OF BLOCK IN FILE		VARIABLE
2	A	TELEMETRY FORMAT-MODE		1,2,3 OR 5
3	A	BITRATE-GROUND (BITS/SECOND)		VARIABLE
4	A	NUMBER OF MISSING E1-DATA IN RECORD		VARIABLE
5	A	NUMBER OF E2-VALUES IN AVERAGE		VARIABLE
6	A	DISTRIBUTION-MODE (D4) (OUT OF LAST EVEN AND VALID FRAME)		VARIABLE
7	A	BITRATE-S/C (BITS/SECOND)		VARIABLE
8	A	GROUND RECEIPT TIME (GMT)	(D)	1 - 366
9	A	GROUND RECEIPT TIME (GMT)	(H)	0 - 23
10	A	GROUND RECEIPT TIME (GMT)	(M)	0 - 59
11	A	GROUND RECEIPT TIME (GMT)	(MS)	0 - 59999
12	A	S/C-TRANSMIT TIME (GMT)	(D)	1 - 366
13	A	S/C-TRANSMIT TIME (GMT)	(H)	0 - 23
14	A	S/C-TRANSMIT TIME (GMT)	(M)	0 - 59
15	A	S/C-TRANSMIT TIME (GMT)	(MS)	0 - 59999
16	A	GROUND RECEIPT TIME YEAR (GMT) (OUT OF LAST VALID FRAME)		VARIABLE
17		SPARE - NOT DEFINED		
18-26		FLAG BITS, ONE BIT FOR ONE FRAME 0=OK 1=NOT EXISTG.		
27-278	B	ONE E1-EDF OF UP TO 504 BYTES		
279	A	E2 - AVERAGE X-COMPONENT (IN TENTH OF GAMMA)		
280	A	E2 - AVERAGE Y-COMPONENT (IN TENTH OF GAMMA)		
281	A	E2 - AVERAGE Z-COMPONENT (IN TENTH OF GAMMA)		
282	A	E2 - SIGMA X		
283	A	E2 - SIGMA Y		
284	A	E2 - SIGMA Z		
285-287	A	E2-OFFSET VALUES C1, C2 AND C3 (IN TENTH OF GAMMA)		
288-302		SPARE - NOT DEFINED		
303-304		DOUBLE - WORD (32 BITS) BINARY MILLISECONDS OF DAY (GRT)		
305-306		SPARE - NOT DEFINED		
307-308		DOUBLE - WORD (32 BITS) BINARY MILLISECONDS OF DAY (SCET)		
309-310		SPARE - NOT DEFINED		
311	A	BIT-ERROR-RATE IN PERMILLE OVER SYNCWORDS IN RECORD		
312-314		SPARE - NOT DEFINED		
315-602		REPETITION OF WORDS 27 TO 314 FOR SECOND E1-EDF		
603-890		REPETITION OF WORDS 27 TO 314 FOR THIRD E1-EDF		
891-1178		REPETITION OF WORDS 27 TO 314 FOR FOURTH E1-EDF		
1179-1184		SPARE - NOT DEFINED		
1185-1190	A	6 TIMES CHANNEL A-001		
1191-1196	A	6 TIMES CHANNEL A-002		
1197-1202	A	6 TIMES CHANNEL A-003		

Table 1: Arrangement of data in a telemetry block

TABLE 5-5 TELEMETRY DATA BLOCK FORMAT (CONTINUED)

1203-1204	A	2 TIMES CHANNEL B-002
1205-1206	A	2 TIMES CHANNEL B-003
1207-1208	A	2 TIMES CHANNEL B-004
1209-1210	A	2 TIMES CHANNEL B-015
1211-1212	A	2 TIMES CHANNEL B-017
1213-1214	A	2 TIMES CHANNEL B-018
1215-1216	A	2 TIMES CHANNEL B-019
1217-1218	A	2 TIMES CHANNEL B-020
1219-1220	A	2 TIMES CHANNEL B-021
1221-1222	A	2 TIMES CHANNEL B-022
1223-1224	A	2 TIMES CHANNEL B-023
1225-1226	A	2 TIMES CHANNEL B-035
1227-1228	A	2 TIMES CHANNEL B-040
1229-1230	A	2 TIMES CHANNEL B-000
1231-1232		SPARE - NOT DEFINED
1233	A	CHANNEL C-000
1234	A	CHANNEL C-001
1235	A	CHANNEL C-002
1236	A	CHANNEL C-003
1237	A	CHANNEL C-005
1238	A	CHANNEL C-015
1239	A	CHANNEL C-016
1240	A	CHANNEL C-017
1241	A	CHANNEL C-018
1242	A	CHANNEL C-019
1243-1244		SPARE - NOT DEFINED
1245	A	CHANNEL D-58
1246	A	CHANNEL D-059
1247	A	CHANNEL D-060
1248	A	CHANNEL D-061
1249-1250		SPARE - NOT DEFINED
1251-1316		REPETITION OF WORDS 1185 TO 1250 (DEFINED FOR FM3 ONLY)
1317-1382		REPETITION OF WORDS 1185 TO 1250 (DEFINED FOR FM3 ONLY)
1383-1448		REPETITION OF WORDS 1185 TO 1250 (DEFINED FOR FM3 ONLY)
1449-1499		SPARE - NOT DEFINED

TIME TAGS ARE ASSOCIATED WITH THE FIRST BIT OF THE FIRST TELEMETRY FRAME CONTAINING VALID DATA FOR THIS DATA BLOCK.

Table 1: (continued)

DFVLR GSOC	HGOS - 13 - 4 - 100 Change 1	Projekt: Helios Datum: 01.Mar.1977 Seite : 3

2.1.2 GROUP NUMBER 2

THIS GROUP CONTAINS THE ORBIT/ATTITUDE INFORMATION.THE FIRST RECORD OF THIS GROUP IS AGAIN A HEADER RECORD.

1.HEADER RECORD

THE FIVE INTEGER WORDS CONTAIN THE FOLLOWING NUMBERS

ISIZE = 317

ITYPE = 2 (DOUBLE PRECISION)

ISINGL = 2 (MORE THAN ONE DATA RECORD IS FOLLOWING)

KEY1 = NO MEANING

KEY2 = NO MEANING

2.DATA RECORD

AS ALREADY KNOWN,THE LEADING WORD OF EACH OF THESE RECORDS IS AN INTEGER INDICATING THE ITEM COUNT.THE VALUE OF THIS INTEGER IS ALWAYS 158,BECAUSE ALL RECORDS HAVE IDENTICAL LENGTH. THE REST OF THE RECORD CONTAINS THE ORBIT-ATTITUDE INFORMATION. EACH RECORD CONTAINS DATA FOR ONE TIME POINT.THE INTERVAL BETWEEN TWO TIME POINTS IS

- 6 MINUTES FOR THE DAY OF LAUNCH AND THE FOLLOWING DAY
- 60 MINUTES FOR THE REST OF THE MISSION

THE ITEMS(ALL DOUBLE PRECISION) ARE LISTED BELOW IN THEIR ORDER.

TIME BLOCK

1.JULIAN DATE IN EPHEMERIS TIME(ET)

2.TIME IN SECONDS PAST JANUARY 1,1950 IN EPHEMERIS TIME

3.YEAR

4.MONTH

5.DAY IN GREGORIAN CALENDAR DATE

6.HOUR

7.MINUTES

Table 2: Arrangement of data on the O/A Band

DFVLR GSOC	HGOS - 13 - 4 - 100 Change 1	Projekt: Helios Datum: 01.Mar.1977 Seite : 4

8.SECONDS

9.TIME FROM LAUNCH IN SECONDS

10.ET - UTC,IN SECONDS

HELIOCENTRIC BLOCK
----

11. X	POSITION COORDINATES	
12. Y	OF HELIOS IN A.U.	
13. Z		
14. UX	VELOCITY COORDINATES	
15. UY	OF HELIOS IN A.U./DAY	
16. UZ		MEAN ECLIPTIC AND EQUINOX OF 1950.0
17.- 22.	SAME AS ABOVE FOR MERCURY	
23.- 28.	SAME AS ABOVE FOR VENUS	
29.- 34.	SAME AS ABOVE FOR EARTH	
35.- 40.	SAME AS ABOVE FOR MARS	
41.- 46.	SAME AS ABOVE FOR JUPITER	
47.- 52.	SAME AS ABOVE FOR THE MOON	

53. ECLIPTICAL LONGITUDE OF HELIOS COUNTED FROM MEAN EQUINOX

54. ECLIPTICAL LONGITUDE OF HELIOS COUNTED FROM EARTH-SUN LINE

55. ECLIPTICAL LATITUDE OF HELIOS

56. DISTANCE SUN - HELIOS IN A.U.

57.- 60.	SAME AS ABOVE FOR MERCURY
61.- 64.	SAME AS ABOVE FOR VENUS
65.- 68.	SAME AS ABOVE FOR EARTH
69.- 72.	SAME AS ABOVE FOR MARS
73.- 76.	SAME AS ABOVE FOR JUPITER
77.- 80.	SAME AS ABOVE FOR THE MOON

81. RADIAL VELOCITY OF HELIOS IN A.U./DAY

Table 2: (Continued)

82. NORMAL VELOCITY OF HELIOS IN A.U./DAY

83. HELIOGRAPHIC LONGITUDE OF HELIOS,COUNTED FROM THE ASCENDING NODE

84. HELIOGRAPHIC LATITUDE OF HELIOS

NUMBER OF ROTATIONS OF THE SUN,SINCE LAUNCH,
AT 16 HELIOGRAPHIC LATITUDE
85. AS REFERRED TO THE EARTH

86. AS REFERRED TO HELIOS

GEOCENTRIC BLOCK
----

87. RIGHT ASCENSION OF HELIOS

88. DECLINATION OF HELIOS

89. DISTANCE OF EARTH-HELIOS IN A.U.

90.- 92. SAME AS ABOVE FOR THE MOON

93.- 95. SAME AS ABOVE FOR THE SUN

TRUE EARTH EQUATOR AND EQUINOX OF DATE

96. RADIAL
97. NORMAL

VELOCITY OF HELIOS IN A.U. PER DAY

98. X
99. Y
100. Z

POSITION COORDINATES OF HELIOS IN A.U.

101. VX
102. VY
103. VZ

VELOCITY COORDINATES OF HELIOS IN A.U. PER DAY

MEAN ECLIPTIC AND EQUINOX OF 1950.0

104. - 109 SAME AS ABOVE FOR THE SUN

110. SOLAR ECLIPTICAL LATITUDE OF HELIOS

111. SOALR ECLIPTICAL LONGITUDE OF HELIOS

112. X
113. Y
114. Z

SOLAR MAGNETOSPHERIC COORDINATES OF HELIOS

Table 2: (Continued)

DISTANCES BLOCK (IN A.U.)

115. HELIOS - MERCURY

116. HELIOS - VENUS

117. HELIOS - EARTH

118. HELIOS - MARS

119. HELIOS - JUPITER

120. HELIOS - MOON

121. HELIOS - MOON ORBIT

ANGLE BLOCK (IN DEGREES)

122. EARTH - HELIOS - SUN

123. HELIOS - SUN - EARTH

124. SUN - EARTH - HELIOS

125. HELIOS - EARTH - MOON

126. ECLIPTIC PLANE - EARTH-HELIOS-LINE

127. RIGHT ASCENSION OF ORBIT POLE

128. DECLINATION OF ORBIT POLE

ATTITUDE BLOCK (ANGLES IN DEGREES)

129. DUMMY

130. SOLAR ASPECT ANGLE

131. 3-SIGMA VALUE OF THE SOLAR ASPECT ANGLE

132. PITCH ANGLE

133. 3-SIGMA VALUE OF THE PITCH ANGLE

134. ANGLE BETWEEN Z-AXIS AND ORBIT-PLANE

135. MERCURY ASPECT ANGLE(ANGLE BETWEEN Z-AXIS AND HELIOS-MERCURY LINE)

136. VENUS ASPECT ANGLE

Table 2: (Continued)

137. MEAN SPIN RATE (RPM)

138. ECLIPTICAL LONGITUDE OF S/C-SPIN AXIS

139. ECLIPTICAL LONGITUDE OF S/C SPIN AXIS COUNTED FROM EARTH-SUN LINE

140. ECLIPTICAL LATITUDE OF S/C-SPIN AXIS

141.- 149. TRANSFORMATION MATRIX FROM ATTITUDE REFERENCE COORDINATES TO SOLAR MAGNETOSPHERIC COORDINATES

150.- 158. TRANSFORMATION MATRIX FROM ATTITUDE REFERENCE COORDINATES TO SOLAR ECLIPTIC COORDINATES

3. TRAILER RECORD

THE LAST RECORD OF THIS GROUP AND OF THE TAPE IS THE TRAILER RECORD. IT CONTAINS TWO ITEMS, FIRST AN INTEGER WORD COUNT WITH THE VALUE 1 AND SECOND A DOUBLE PRECISION ZERO (0.000).
THE TAPE CONTAINS NO END-OF-FILE MARK.

Table 2: (Continued)

The data in the DM7 receive extra treatment. These are the data that are read with DM4 in the HELIOS Board store - E.g.If no ground station is available - and which then later be read with DM7.The "event time" this data is therefore possibly far before the upper transmission time and therefore also before the event time of then just occuring measurements. So, there is time jumps in the data stream, which must only be cleaned up with the help of the onboard clock.This is insofar difficult, not always the memory is read fully, so that then older "leftovers" remain standing in there.Also be input and reading mostly with strongly different bit rates.So a considerable confusion can arise.To bring order here, the GSOC sorted out the DM7 data and produces adjusted DM7-EDR.

The EDR arrive usually about three to six months after the measurement by mail with us DM7-EDR and the O/A-bands often even later.Only then, the processing can begin.

3. Preparation the EDR to analysis bands (AB)

First, the raw data in the form of a practical evaluation must be made.This is essentially done by copying, omitting orstrong compression of insignificant additional data.So on average about five EDR on 1 AB fit with equal writing density.

The content of the housekeeping words (AHK and DHK, see A112ff), the flow of words in the EDF (A101 ff) and EDF itself be checked for it in terms of data quality.The results of this evaluation are then a total of five "quality words" (QW), the individual for each instrument describe bit for bit the data state.This shows the table 3. The "Important" bits are each up front, the less important the rear (the LSB is here bit 1).If the conditions are met, the bits are set to 1. Error-free data have 1 are everywhere.

Table 3

QWO General quality word

Bit	1	High-gain antenna is made
	2	TC 2 not running (Al14ff)
	3	TC not running
	4	not 1st EDF after TC
	5	1
	6	HK-C-words available (A112ff)
	7	HK-B words available (A112ff)
	8	Digital electronics 1 or 2 on (from DHK, A113)
	9	Tail o.k. (E.g. W 433 to 504, if NDM, A89)
	10	Code word o.k. (A101)
	11	Digital electronics is 1 or 2 (from AHK, A115)
	12-14	All zero

Table 3 continued

QW1 instrument 1a

Bit 1	W 11 = W 5 and W 12 = W 6 (advance, A103)	
2	I1a integration counter: No frame is missing	
3	I1a integration counter: No decoding error	
4	I1a/I3 CEM-HV is on	(from DHK, A113)
5	I1a on	(from DHK, A113)
6	I1a/I3 CEM-HV on	(from AHK, A115)
7	I1a on	(from AHK, A115)
8	I1a on	(from fast forward, W 9/1, A106)
9	I1a - 3D data: no decoding error	
10	I1a - 3D data: All frames available	
11-16	All zero	

QW2 instrument 2

Bit 1	I2 in program A (from DHK, A113)	
2	I2 in program A (of lead, W 9/8, A106)	
3	1	
4	I2 CEM-HV on	(from DHK, A113)
5	I2 on	(from DHK, A113)
6	I2 CEM-HV on	(from AHK, A115)
7	I2 on	(from AHK, A115)
8	I2 on	(of lead, W 9/3, A106)
9	I2 data: no decoding error	
10	I2 data: all frames available	
11 – 16	All zero	

Table 3 continued

QW3 instrument I3

Bit	1	W 11 = W 5 and W 12 = W 6 (advance, A103)
	2	I3 integration counter: no frame is missing
	3	I3 integration counter: no decoding error
	4	I1a/I3 CEM-HV is on (from DHK, A113)
	5	I3 on (from DHK, A113)
	6	I1a/I3 CEM-HV on (from AHK, A115)
	7	I3 on (from AHK, A115)
	8	I3 on (of lead, W 9/4, A106)
	9	I3 - 3D-Data: No decoding error
	10	I3 - 3D-data: all frames available
	11-16	All zero

QW 4 instrument 1b

Bit	1	1
	2	1
	3	1
	4	1
	5	I1b on (from DHK, A113)
	6	1
	7	I1b on (from AHK, A115)
	8	I1b on (of lead, W 9/2, A106)
	9	I1b-Data: No decoding error
	10	I1b-Data: All frames available
	11-16	All zero

Examples for such QW can be found at various places in the two reports (E.g.A206, A216)
Those QW have proven themselves extremely well.You can for example very well recognize the switching of I1a to I3.These are usually connected to circuits of the CEM-HV-steps.So, there's some spectra, which are completely unusable as a result.It is easy to see but not for the computer in the data only for expert eyes.Here the QW where also the AHK processing help, so also the analogue values of currents, and CEM-HV. In the course quite clearly say what instrument really runs, and when the switching is done.

When creating the AB the 8 bit words are converted again to 16-bit words, according to the encoding (A141ff).If this illegal numbers are discovered, a marker in the QW appears (nice to see in A206) for the instrument concerned.

Also the real event time (SCT) is calculated from the time information of the GSOC.This is back to at least 1 EDF (i.e. 40.5 s) behind the transmission time, because each EDF once is stored temporarily in the E1 store (A147ff).To get even smaller corrections, E.g.due to the temporal distance between See-Sun-pulse and the first measuring channel, etc...This should not be discussed.

AB-production takes place in the MPE in Garching on the HP 2100 system (the central unit had previously served in the E1 Tester (A185)).During this pass, error on the EDR are discovered occasionally, which can be reclaimed immediately.The EDR we return later to the GSOC, where she on high density tapes (6250 BPJ) along copies (compression approx. 20:1) and will be kept in custody.From the off, we make copies which we retain for security reasons on the MPAe in Lindau.

4. Log position of the AB

Starting from the off, we first create the "logbook".This is a list printed on microfiches of all E1 data. It provides information on the operating condition of E1 at any time of the mission, as well as on the data quality.For the logbook, only the QW will be recovered on the AB and mode data (bit rate, format, mode) and the SCT. Figure 4 is an example.It is only then printed out a line if anything has changed.At this point a small horizontal arrow will appear.So has risen from No.46521-46525 (the numbers are in the penultimate column) nothing changed, first in 46526 is switched at I2 program A. You can also easily see the frequent switching between I3 and I1a. From No. 46548a test cycle runs, what is easy to recognize on the QWO.Data errors are due to missing part E.g.in no.46496 (almost all useless) or in 46584 (only I2 and I3 - disturbed 3D) to see.

The print-outs of all test cycles, belong to the logbook on microfiche.The format is almost identical to that produces the GSOC for the quick look data (E.g.A116, 118).

On the playback of the programs for the logbook creation should be omitted.

```
SCT-TIME AUS EDF            ↑ ALLGEMEINES QW  ↑     QW         ↑ I2 QW          ↑ I3 QW         ↑ I1B QW ↑  BAND NR.HOS1:12  ↑  G?T
DAY HR MI SC  B/R F/D MD    ↑                 ↑                ↑                ↑               ↑        ↑  PR5559  :14.02..8
---------------------------↑-----------------↑----------------↑----------------↑---------------↑--------↑--------------------------
118   7 37 51  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC      ↑ FC O←←SC W ↑ FC OSS ↑   46414     ↑ 119  7 18
118   7 40 33  128 2/1 ND   ↑ CFT D HBC     A ↑         6C CF W ↑ FC OSCSC      ↑ FC O  ←C W ↑ FC OSS ↑   46466     ↑ 119  7 18
118   7 41 54  128 2/1 ND   ↑ CFT O HBC     A ↑ FE 06 SC CF W ↑ FC OSCSC      ↑ ←← ←    C W ↑ FC OSS ↑   46467     ↑ 119  7  3
118   7 44 36  128 2/1 ND   ↑ CFT D HBC     A ↑ FC OS6SC CF W ↑ FC OSCSC      ↑         C W ↑ FC OSS ↑   46469     ↑ 119  7  3
118   7 48 39  128 2/1 ND   ↑ CFT D HBC     A ↑ FC O←←SC CF W ↑ FC OSCSC      ↑         C W ↑ FC OSS ↑   46472     ↑ 119  7  9
118   7 50  0  128 2/1 ND   ↑ CFT D HBC     A ↑ ←← O  SC CF W ↑ FC OSCSC      ↑         C W ↑ FC OSS ↑   46473     ↑ 118  7  9
118   7 51 21  128 2/1 ND   ↑ CFT D HBC     A ↑     ←  ←C CF W ↑ FC OSCSC      ↑ F6 8  6C W ↑ FC OSS ↑   46474     ↑ 118  7  9
118   7 52 42  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC      ↑ FC O6 SC W ↑ FC OSS ↑   46475     ↑ 118  8  4
118   7 55 24  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC      ↑ FC OS6SC W ↑ FC OSS ↑   46477     ↑ 118  8  4
118   8  4 51  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ ←← OSCSC      ↑ ←← OSCSC W ↑ FC OSS ↑   46484     ↑ 118  8 15
118   8  6 12  128 2/1 ND   ↑ ←←T D HBC     A ↑          C ←← ← ↑ F6 OSCSC      ↑ F6 OSCSC ← ↑ ←← OSS ↑   46485     ↑ 118  8 15
*118  8  6 12 506-118  8   6 12 506 (DIF      0.0  SEC) SOLL:  81.00 LUECKENFEHLER IN ID ODER SC 25227 26533(      81.63)
118   8  6 12  128 2/1 ND   ↑ 6FT D HBC     A ↑          C 6F W ↑ FC OSCSC      ↑ FC OSCSC W ↑ F6 OSS ↑   46486     ↑ 118  8 15
*118  8  6 12 506-118  8   8 54 587 (DIF   162.00 SEC) SOLL:  81.00 LUECKENFEHLER IN ID ODER SC 26533 27826(      80.81)
118   8 19 41  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC      ↑ ←← OSCSC W ↑ FC OSS ↑   46495     ↑ 118  8 31
118   8 21  2  128 2/1 ND   ↑ ←←T D H←←     A ↑          C ←← ← ↑ ←← OSCSC      ↑ F6 OSCSC ← ↑ ←← OSS ↑   46496     ↑ 118  8 31
118   8 22 23  128 2/1 ND   ↑ 6FT D H       A ↑          C 6F W ↑ F6 OSCSC      ↑ FC OSCSC W ↑ F6 OSS ↑   46497     ↑ 118  8 31
118   8 23 44  128 2/1 ND   ↑ CFT D HB      A ↑          C CF W ↑ FC OSCSC      ↑ FC OSCSC W ↑ FC OSS ↑   46498     ↑ 118  8 31
118   8 26 27  128 2/1 ND   ↑ CFT D HB6     A ↑          C CF W ↑ FC OSCSC      ↑ FC OSCSC W ↑ FC OSS ↑   46500     ↑ 118  8 37
118   8 37 15  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC      ↑ FC O←←SC W ↑ FC OSS ↑   46508     ↑ 118  8 47
118   8 39 57  128 2/1 ND   ↑ CFT D HBC     A ↑         6C CF W ↑ FC OSCSC      ↑ FC O  ←C W ↑ FC OSS ↑   46510     ↑ 118  8 47
118   8 41 18  128 2/1 ND   ↑ CFT D HBC     A ↑ F6 06 SC CF W ↑ FC OSCSC      ↑ ←← ←    C W ↑ FC OSS ↑   46511     ↑ 118  8 53
118   8 44  0  128 2/1 ND   ↑ CFT D HBC     A ↑ FC OS6SC CF W ↑ FC OSCSC      ↑         C W ↑ FC OSS ↑   46513     ↑ 118  8 53
118   8 48  3  128 2/1 ND   ↑ CFT D HBC     A ↑ FC O←←SC CF W ↑ FC OSCSC      ↑         C W ↑ FC OSS ↑   46516     ↑ 118  8 58
118   8 50 45  128 2/1 ND   ↑ CFT D HBC     A ↑ FC O  ←C CF W ↑ FC OSCSC      ↑        6C W ↑ FC OSS ↑   46518     ↑ 118  8 58
118   8 52  6  128 2/1 ND   ↑ CFT D HBC     A ↑ ←← ←    C CF W ↑ FC OSCSC      ↑ F6 06 SC W ↑ FC OSS ↑   46519     ↑ 118  9  4
118   8 54 48  128 2/1 ND   ↑ CFT D HBW     A ↑          C CF W ↑ FC OSCSC      ↑ FC OS6SC W ↑ FC OSS ↑   46521     ↑ 118  9  4
118   9  1 33  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC AA ↑ FC OSCSC W ↑ FC OSS ↑   46526     ↑ 118  9  9
118   9  9 39  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ ←← OSCSC AA ↑ ←← OSCSC W ↑ FC OSS ↑   46532     ↑ 118  9 20
118   9 11  0  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ F6 OSCSC AA ↑ F6 OSCSC W ↑ FC OSS ↑   46533     ↑ 118  9 20
118   9 15  3  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC ←A ↑ FC OSCSC W ↑ FC OSS ↑   46536     ↑ 118  9 25
118   9 16 24  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC  ← ↑ FC OSCSC W ↑ FC OSS ↑   46537     ↑ 118  9 25
118   9 31 15  128 2/1 ND   ↑ CFT D HBC F   A ↑          C CF ← ↑ FC OSCSC      ↑ FC OSCSC ← ↑ FC OSS ↑   46548     ↑ 118  9 41
118   9 32 36  128 2/1 ND   ↑ CFT D HBC T2  A ↑          C CF   ↑ FC OSCSC      ↑ FC OSCSC   ↑ FC OSS ↑   46549     ↑ 118  9 41
118   9 33 57  128 2/1 ND   ↑ CFT D HBC F←← A ↑          C CF W ↑ FC OSCSC      ↑ FC OSCSC W ↑ FC OSS ↑   46550     ↑ 118  9 41
118   9 35 18  128 2/1 ND   ↑ CFT D HBC ←   A ↑          C CF W ↑ FC OSCSC      ↑ FC OSCSC W ↑ FC OSS ↑   46551     ↑ 118  9 47
118   9 36 39  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC      ↑ FC OS←SC W ↑ FC OSS ↑   46552     ↑ 118  9 47
118   9 38  0  128 2/1 ND   ↑ CFT D HBC     A ↑          C ←F W ↑ FC OSCSC      ↑ FC OS SC W ↑ FC OSS ↑   46553     ↑ 118  9 47
118   9 39 21  128 2/1 ND   ↑ CFT D HBC     A ↑          C 6F W ↑ FC OSCSC      ↑ FC O← SC W ↑ FC OSS ↑   46554     ↑ 118  9 47
118   9 42  3  128 2/1 ND   ↑ CFT D HBC     A ↑ F6 8  6C CF W ↑ FC OSCSC      ↑ ←← ←   ←C W ↑ FC OSS ↑   46556     ↑ 118  9 52
118   9 43 24  128 2/1 ND   ↑ CFT D HBC     A ↑ FC O66SC CF W ↑ FC OSCSC      ↑         C W ↑ FC OSS ↑   46557     ↑ 118  9 52
118   9 47 27  128 2/1 ND   ↑ CFT D HBC     A ↑ FC O←←SC CF W ↑ FC OSCSC      ↑         C W ↑ FC OSS ↑   46560     ↑ 118  9 58
118   9 50  9  128 2/1 ND   ↑ CFT D HBC     A ↑ FC O  ←C CF W ↑ FC OSCSC      ↑        6C W ↑ FC OSS ↑   46562     ↑ 118  9 58
118   9 51 30  128 2/1 ND   ↑ CFT D HBC     A ↑ ←← ←    C CF W ↑ FC OSCSC      ↑ F6 06 SC W ↑ FC OSS ↑   46563     ↑ 118 10  3
118   9 54 12  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC      ↑ FC OS6SC W ↑ FC OSS ↑   46565     ↑ 118 10  3
*118  9 55 33 528-118  9  57 56 144 (DIF   142.62 SEC) SOLL:  81.00 LUECKE IN SC (ID BAD)          64677 65973
118   9 57 56  128 2/1 ND   ↑ ←←T D HBC     A ↑          C ←← ← ↑ ←← OSCSC      ↑ ←← OSCSC ← ↑ ←← OSS ↑   46567     ↑ 118 10  9
118   9 59 17  128 2/1 ND   ↑ 6FT D H←←     A ↑          C 6F W ↑ F6 OSCSC      ↑ F6 OSCSC W ↑ F6 OSS ↑   46568     ↑ 118 10  9
118  10  1 59  128 2/1 ND   ↑ CFT D HB      A ↑          C CF W ↑ FC OSCSC      ↑ FC OSCSC W ↑ FC OSS ↑   46570     ↑ 118 10  9
*118 10  1 59 152-118 10   2 18 528 (DIF     19.38 SEC) SOLL:  81.00 LUECKENFEHLER IN ID ODER SC  4312  5621(      81.81)
118  10  3 39  128 2/1 ND   ↑ CFT D HB6     A ↑          C CF W ↑ FC OSCSC      ↑ FC OSCSC W ↑ FC OSS ↑   46572     ↑ 118 10 14
118  10 11 45  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC      ↑ ←← OSCSC W ↑ FC OSS ↑   46578     ↑ 118 10 19
118  10 13  6  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ FC OSCSC      ↑ F6 OSCSC W ↑ FC OSS ↑   46579     ↑ 118 10 25
118  10 18 51  128 2/1 ND   ↑ CFT D HBC     A ↑          C CF W ↑ ←← OSCSC      ↑ ←← OSCSC W ↑ FC OSS ↑   46584     ↑ 118 10 30
118  10 21 12  128 2/1 ND   ↑ CFT D HBO     A ↑          C CF W ↑ F6 OSCSC      ↑ F6 OSCSC W ↑ FC OSS ↑   46585     ↑ 118 10 30
```

Figure 4: Copy of a logbook page (from the microfiche)

5. 1D-Evaluation

The actual calculation of the plasma parameters from the raw data of instruments is carried out at the processing plant of MPP in Garching.All programs are written in FORTRAN IV and adapted to the operating system of the MPP.
Most of the programs and subprograms are used continually translated into object-decks and are also loaded when the production jobs only.There are also still some control cards, which specify the band numbers, etc., and some data cards. Then a series of logical variables are set, which then control program flow and, above all, nature and scope the issue. Also input from start and end time of the production are made here.

In addition to this rigid routine programs, there are also versions that allow to omit individual sub programs, E.g.Print to tape.As a result, a significantly higher priority for processing at the processing plant can be reached at special jobs.Then, there are also versions in which certain subroutines not present as object decks but each must first be compiled.Although it takes time, but on the other hand, only changes in the program can be tried out.And changes are occasionally necessary even after years of use.It has indeed again and again proved that the reality exceeds all expectations and Universal programs that can handle all extremes, just not doable and usually not even are useful.These comments should illustrate why all programs exist in a multitude of variations, which were necessary and appropriate in the course of time. They differ very little from the principle, but in organizational details are also strongly tied to the system of the MPP system.That's why they here no longer should be discussed.

The FIT programs

We want to introduce only the source programs for something near the current routine evaluations (1D-Evaluation) the one-dimensional plasma parameters in more detail.In this program (the "core programme" means FIT1) integrated on Board about any angle of incidence are essentially

Processed energy per charge spectra of I1a (A85ff) to relatively simple procedures.A very similar program (FIT1B) can be applied also on I1b that integrates also already over all the angles and has almost the same E/q channels as I1a.There are only minor changes to make (FIT3) integrated data from I3.

These core programs FIT1, FIT3 and FIT1B are on pp. 73 ff, p. 95 ff and p. 88 ff.We want to explain what these programs make here only on the basis of FIT1 in rough outline.

The sub program FIT1 receives the necessary raw data already in edited form. So are E.g.at HDM (A80ff) the individual HDM-blocks already summarized for a spectrum; also dead time corrections have been made already.

First again useless data is sorted out (Z6600 - 8400)
(If the maximum count rate RATINT is no more than 50, if RATINT is more than five times greater than or less than over the previous spectrum, if the E/q channel MAXINT, in the RATINT occurs, too close to the edge of the area etc.).

From Z11900, the each one-dimensional checksum over the 3D data are made, if they are available.So get as angular distributions, and it then later the flow of protons (Z38700 - 49000).This is the only contribution of the 3D data to this routine evaluation.This part is only of secondary importance in this program.If, for exampleData error alone in the 3D part occur or when the angles for other reasons are not to determine, the affected 1D-Spectra evaluate anyway.

From Z15900 to 20200 the zero count rate is determined, from parts of the spectrum in which no 'real' count rates occur.If MAXINT is >13, to take as the count advise in the EN1 to 5, but otherwise 27-32.From this we make a moving average over 10 Spectra and remove it from all counting rates.Here also all count rates are divided by $(v/v_0)^2$ (v_0 is the speed that corresponds to the

EN-channel of the maximum).This from the count rates, which represent Yes particle flows, produced sizes are proportional to the speed distribution function in the respective places.

Determining the Proton parameters according to three independent methods:
1.) Peakfit method (Z22100 - 25600): here we create a parable only by the three logarithmic values to the maximum of distribution and calculate their determinants ("POLFIT", p. 147). By induction of calibration data (A178ff) we obtain the values from it for speed, density and temperature.This very simple process is based on the concept of the also simple model, the distribution function is a Maxwell distribution which is already sufficiently exactly through the center of the distribution.

2.) Numerical integration (Z25800 - 33300): in this process each model should try not to use it. Therefore is integrated over all shares of the distribution - same as it looks-.Previously, shares, which does not include must be cut off.Therefore where it amounts to less than 10% of the maximum, we will cut the packaging division.This also interference components dropped by a particle, usually well below 10% of Proton maximum.The data grid is complemented by each intermediate point.It is calculated by linear interpolation between the two neighbouring (formerly logarithm) Count rates or in the area of maximum by supplementing the already previously-expected parabolic.Then is appropriately integrated, and finally a second set for the Proton parameter arises.This model independent sizes are the basis for any further work.

3.) "More fit" over the entire distribution (Z33500 - 38500): here we take same points as above (without the interpolated) and fit a parabola.The quality of this adjustment is given by the sum of the squares ("Chi").This size is pretty useful because it tells us, is how "well" any distribution by a Maxwell to describe distribution.

The calculation of the flow direction from the 3D data (Z38700 - 49000) was already mentioned.Also here is a "wider fit" set on the respective point grid.We prefer this procedure of numerical integration, because it is less sensitive to edges cut off.To a such truncating of the edges happens grid (especially in the NDM, A77ff) in the limited angle - quite often.

α-particle parameters are evaluated according to the same procedure as when the protons.The only problem with this is the need to separate the α-share of the interference components of the very much more common Proton.This can not be done in all cases.We waive already from the start in the attempt, if we don't find a clear depression after the Proton peak, which is at least 20% lower than the following α-peak.If this depression even at 10% goes down of α-peak, as at this point the share of Proton simply cut off and evaluate a distribution without further correction. If the depression between 10% and 80% of α-peak, then we create a parable of the three last front (in logarithm) counting rates of Proton share, extrapolate them into the range of α-spectrum, and pull off then there corresponding shares. On the other hand, we do not limit the range like when the protons through a 10% clause, but absolutely, i.e.We set the limit at E/q = 1.33 on the α-peak to eliminate interference components by heavy ions as far as possible.This whole the cutting process is extremely complex and certainly not perfectly resolved.We therefore treat this data with utmost care and apply in case of doubt rather special proceedings.

The numerical integration procedure was applied to the α-particles directly by the protons.However, flow directions are not determined.

Finally, a correction of all plasma parameters using the orbital data is.Serves the subroutine "KORORB" (p.132).Is the track vector must will be deducted from the previously calculated flow vector of HELIOS.Also the relative location of the spin rate is taken into account.The spin rate - it changes constantly as we know during the mission - influenced the measuring time in each channel and therefore the measured particle density.

When all this is done, eventually return to the main program.

The corresponding programs FIT3 and FIT1B are derived from FIT1.We want to mention only the most important variances.

FIT3

- Due to the much lower sensitivity (A59), there is no minimum requirement for the count rate of the maximum.
- There are no zero counts rates calculated and deducted.
- There is no 10% clause for the delimitation of the area.
  Starting from the maximum of distribution we take each yet the channel, in which for the first time, the count rate is less than 3.
- Since I3 Proton mode can never see α-particle, there is also no separation or evaluation of α-particle.

FIT1b

- In I1b is the zero count rate or its variation very much larger as compared to the zero count rate than at I1a and I3.This applies in particular to HELIOS-1 (A47, A127, A203, A214).Therefore, the prerequisites for the availability are defined differently.
- For this reason, also no α-parameter are evaluated.
- The flow direction can be with the integral I1b of course not be determined.

In the fit programs write commands are always to find, which can be activated with "IDRUCK".This is done by setting the switch "LMIKE" in the main program.In this case, these all intermediate results are printed out, so that an accurate diagnosis of any evaluation process is possible.Of which we have made use of everything during the development phase but also later repeated.

The main program

We have previously called the "core" of the evaluation FIT programs and therefore somewhat more detail described.So that these procedures on a mass evaluation in part quite different data can be attached, which is then always faultlessly and without to increase, a number of preparations must be made.These require as much effort as the core programs.This one can be read at the periphery of the main program (p. 104).We have taken this program with this report, because it is representative of all other evaluations, and because we believe that a lot it is of general interest.

It consists of many sub programmes (UP), which most here just if are printed with.It can be explain everything in detail here.The savvy Viewer will find their way with the help of the comments in the Programmes to some extent.Some general hints may help him, we want to give him a "dry run" through the program.

Initially deploy in Z4900 - 5100 the UP INIT, INIT3 and INIT1b called, the calibration data of the three affected instruments (on p. 114, p. 115, p. 116) (A71/72, A172ff). In "INITB" (p.118) these values apply for HELI0S-2.

Then must be read a whole series of parameters into Z6300ff, which specifically entered for each run on some data cards, because they control the whole process.Most of them are 'Switch', i.e.logical variable, which must be entered with F (FALSE) or T (TRUE).You mean in detail:

IEXP		1: I1a/I1b data; 2: I2 data; 3: alone 4: All instruments
IHEYE	E.g.	1 78 means: data from HELIOS-1 from 1978
ITSTR		Start the evaluation, but only when IEXP negative!
ITEND		End of the evaluation
EDFPRI	F/T	Expression of all raw data

ISHORT	F/T	Print only QW and supply of all raw data
LPAOUT	F/T	Output of the parameter on tape
LDM7	F/T	DM7 to evaluate data and output to tape
LPAR	F/T	Paper copy of the parameter (or microfiche)
LSPEC	F/T	Expression of the corrected count rate of I1a/I3/I1b
LMIKE	F/T	Expression of all intermediate values in FIT1 FIT3, FIT1B
LPPDM7	F/T	Paper expression of DM7 parameter (or microfiche)
ISTAPE		Number of AB in this job
LONG	F/T	Two expression of the parameter
TIMDEL		Expression of the parameters at a distance of TIMDEL seconds
START END	}	Start or End of the orbit data
LFICHE	F/T	Total heading on microfiche
IHOS		Indication whether, HELIOS 1 or HELIOS 2 on microfiche
ITAPE		Archive numbers the AB

Z15000 called the "HOSINP" UP.This is the actual reading program (p.153).It draws itself on other sub programmes.Here is also the reading of data from AB.This nesting he seems indeed complicated, allows but finally one trouble-free production process over several from across and provides an accurate and clear log management when evaluating.Also, very few - but really useless - data are discarded.About the time when a range is not unique or is even incorrect, the UP "TIMEO" (p. 166) offers a helping hand. If times at all absent - also occurs frequently- a "flywheel" is thrown which assigns reasonable times to the spectra.On the other hand it happens at high bit rates and operating in NDM that Spectra are read twice or even four times.Then compares the UP "NDMBL" (p.177) that identical data on data quality and passes only the best for evaluation.This whole process is because of the many data modes of HELIOS (A86) very complex.

In "HOSINP", also the HDM blocks are composed of several EDF to a set.This many spectra can be saved, although individual parts maybe are missing or incorrect.

From Z17700 (p.107) is checked which of the instruments is just turned on.Here, the availability of the data only using the QW is checked.This makes the function "TINT" (p.111).Here compare with our minimum requirements such as the QW.For the 1D-evaluation require rating very little, only, that the appropriate instruments are ever turned on.It's enough that the AHK for current consumption and CEM-HV show the correct values (A115 and p. 24, tab.3).We take so missing frames and decoding error in purchase; We not know yet whether the part of the spectrum, we need is ever affected.(The requirements are considerably sharper in the evaluations by I1a/I3 - 3D and I2.Here only complete and error-free data can be processed).If the AHK due to data errors are missing, we first use the previous next ("flywheel").

Here also the test cycles are sorted out, the Yes very different be treated must (A114ff).

In Z 25200 (p.108) we call on "SUB1" (p.124).Here, we now examine the data quality in the data frame itself, determine the address of the maximum, etc..Here is the function "C165" (p.129) a correction to the count brought off by the quasi logarithmic compression (A141ff) is required.The tab.34 on the A143 shows, that for example the transfer of number "120" does not indicate whether it has been measured in reality 121, 122 or 123."C165" we change "120" in the more probable value "122", and accordingly at all other levels.

Finally concerned the UP "C0RIN" the other still necessary corrections the count rates.The counting results in the integration counter can be falsified by dead time effects. Firstly, the real measuring time in a channel is effectively shortened by summed up dead times (A124). We compensate for this.Similar occurs when their standard pulse want to simultaneously deliver two or more CEM on the integration counter.Also this "interference", which occurs only in extremely high count rates and therefore rarely, is also adjusted.The effectiveness and accuracy of this correction is also good to check: the always simultaneously measuring

I1b has no dead time problems, and also I3 hardly, due to the significantly lower sensitivity.As a result we could make precise cross calibrations of instruments for such extreme cases.And in all other cases, this correction plays a completely subordinate role.

In Z26200 from p. 108 we call on the UP "AZIM" (p. 121).Here, the shift of the Azimuth channels is incorporated that can be triggered through the CMD 130-1AVL (A110) at HELIOS-2 (see also A68, A72, A181b).

In Z26300 on p. 108 we provide the necessary O/A-data with the UP "ORINT"."ORINT" (p.130) calculated from the corresponding values of O/A-band (that includes a complete set for every hour of the Mission) by linear interpolation the O/A-values for each desired time.

Finally, everything is prepared so that the core programs can record their work.(Z27000, 27100, 27200 on p. 108).After evaluating the calculated quantities yet must be issued according to the wishes of the user (see table3).It may be the parameter by "PRINT" (p.133) either to have printed paper or microfiche.He can through "PRIDM7" (p.138) that print memory data.And of course he is all data through "PAR0UT" (p.140) can spend on tape.This is the (provisional) parameter band (PB).In normal case we use only "PAR0UT".When printing the parameter on microfiche we assume then the PB and use the program "PRINTPAR" (p.143), which in turn draws on the UP "PRINT".In this way, we decouple the production by the quite interference prone microfiche output.Figure 5 shows an example of a parameter expression by "PRINT".It is the rear magnification of a computer print on microfiche, as we routinely invariably make them for all the evaluated data.In this way, the results of not less than 1 million measurements fit - as much as HELIOS-2 in 4 years has delivered mission time - just in a single Lever arch folder, and this in a very clear form.

HELIOS 1 1977 PARAMETER DER POSITIVEN KOMPONENTEN IM SONNENWIND

BAND: 1:118 JOB:HOS306 12.02.78

	PROTONEN			ALPHATEILCHEN			WINKEL (PROTONEN)				INSTRUMENT	PROTONEN			MODE	ORBIT	
	VP KM/S	TP 1000K	NP CM**-3	VA KM/S	TA 1000K	NA CM**-3	AZIMUT GRAD	TAZ 1000K	ELEVAT GRAD	TEL 1000K		VP KM/S	TP 1000K	NP CM**-3		RS AU	HSE GRAD
29 10 3 46 *	487.0	99.	46.60 *	0.0	0.	0.0 *	1.97	163.	9.19	151.	*I1A* *I1B*	485.7	121.	47.09 *	512/1/3/N	.951	323.1
29 10 4 27 *	483.9	119.	44.98 *	477.7	318.	0.877*	2.09	141.	8.34	143.	*I1A* *I1B*	481.4	117.	46.28 *	512/1/3/N	.951	323.1
29 10 5 7 *	485.3	99.	46.14 *	0.0	0.	0.0 *	2.29	148.	8.58	132.	*I1A* *I1B*	483.4	117.	47.34 *	512 1/3/N	.951	323.1
29 10 5 48 *	488.5	152.	50.23 *	0.0	0.	0.0 *	1.83	160.	8.57	200.	*I1A* *I1B*	486.7	176.	51.28 *	512/1/3/N	.951	323.1
29 10 6 28 *	482.8	128.	47.86 *	0.0	0.	0.0 *	1.42	167.	7.81	155.	*I1A* *I1B*	483.7	137.	48.62 *	512/1/3/N	.951	323.1
29 10 7 9 *	486.2	136.	48.10 *	0.0	0.	0.0 *	1.57	164.	7.87	163.	*I1A* *I1B*	483.8	128.	48.26 *	512/1/3/N	.951	323.1
29 10 7 48 *	487.6	181.	50.29 *	0.0	0.	0.0 *	2.05	200.	8.04	198.	*I1A* *I1B*	486.0	157.	49.05 *	512/1/3/N	.951	323.1
29 10 8 29 *	489.7	167.	48.97 *	0.0	0.	0.0 *	1.17	193.	7.66	201.	*I1A* *I1B*	488.2	190.	51.20 *	512/1/3/N	.951	323.1
29 10 9 10 *	481.9	183.	43.60 *	0.0	0.	0.0 *	2.14	187.	7.18	191.	*I1A* *I1B*	478.7	186.	43.87 *	512/1/3/N	.951	323.1
29 10 9 50 *	483.2	145.	45.84 *	0.0	0.	0.0 *	2.87	177.	7.73	185.	*I1A* *I1B*	479.7	147.	44.87 *	512/1/3/N	.951	323.1
29 10 10 30 *	482.6	175.	44.09 *	0.0	0.	0.0 *	2.78	191.	8.07	181.	*I1A* *I1B*	479.4	174.	43.39 *	512/1/3/N	.951	323.1
29 10 11 11 *	482.1	141.	52.18 *	0.0	0.	0.0 *	3.27	164.	7.10	156.	*I1A* *I1B*	478.5	140.	52.86 *	512/1/3/N	.951	323.1
29 10 11 51 *	481.4	144.	44.55 *	0.0	0.	0.0 *	2.91	192.	8.63	156.	*I1A* *I1B*	479.7	168.	44.76 *	512/1/3/N	.951	323.1
29 10 12 32 *	490.0	158.	44.51 *	0.0	0.	0.0 *	2.01	218.	8.64	149.	*I1A* *I1B*	488.6	181.	44.57 *	512/1/3/N	.951	323.1
29 10 13 12 *	489.5	171.	62.18 *	496.5	329.	0.985*	0.84	193.	10.16	182.	*I1A* *I1B*	487.7	154.	59.77 *	512/1/3/N	.951	323.1
29 10 13 53 *	487.5	151.	57.45 *	0.0	0.	0.0 *	1.53	190.	10.23	192.	*I1A* *I1B*	486.8	176.	59.00 *	512/1/3/N	.951	323.1
29 10 14 33 *	486.8	176.	50.86 *	0.0	0.	0.0 *	0.81	199.	9.69	201.	*I1A* *I1B*	486.5	155.	49.52 *	512/1/3/N	.951	323.1
29 10 15 14 *	482.0	129.	21.16 *	0.0	0.	0.0 *	-0.60	162.	5.91	126.	*I1A* *I1B*	481.6	132.	20.63 *	512/1/3/N	.951	323.1
29 10 15 54 *	477.8	134.	20.28 *	0.0	0.	0.0 *	-1.42	144.	7.07	115.	*I1A* *I1B*	480.2	131.	19.41 *	512/1/3/N	.951	323.1
29 10 16 35 *	486.0	129.	21.77 *	0.0	0.	0.0 *	-1.99	196.	8.26	159.	*I1A* *I1B*	485.2	155.	21.59 *	512/1/3/N	.951	323.1
29 10 17 15 *	476.9	142.	25.37 *	0.0	0.	0.0 *	-2.01	126.	8.50	124.	*I1A* *I1B*	480.5	141.	25.83 *	512/1/3/N	.951	323.1
29 10 17 56 *	494.9	131.	22.17 *	0.0	0.	0.0 *	-2.16	281.	9.66	165.	*I1A* *I1B*	497.1	131.	22.22 *	512/1/3/N	.951	323.1
29 10 18 36 *	492.4	124.	24.13 *	0.0	0.	0.0 *	-1.05	173.	10.68	157.	*I1A* *I1B*	488.6	127.	23.16 *	512/1/3/N	.951	323.1
29 10 19 17 *	496.8	195.	27.55 *	718.8	1007.	0.069*	-1.98	291.	11.01	219.	*I1A* *I1B*	494.7	195.	28.48 *	512/1/3/N	.951	323.1
29 10 19 57 *	500.2	154.	34.80 *	0.0	0.	0.0 *	0.0	0.	12.42	314.	*I1A* *I1B*	496.2	156.	34.70 *	512/1/3/N	.951	323.1
29 10 20 38 *	494.4	168.	31.60 *	717.8	359.	0.380*	0.06	183.	12.08	346.	*I1A* *I1B*	492.6	189.	31.30 *	512/1/3/N	.951	323.1
29 10 21 18 *	473.7	38.	38.83 *	672.2	750.	0.685*	5.36	39.	5.91	44.	*I1A* *I1B*	470.3	25.	40.85 *	512/1/3/N	.951	323.1
29 10 21 59 *	470.1	16.	29.64 *	663.9	255.	0.238*	4.68	35.	6.12	22.	*I1A* *I1B*	465.4	27.	20.41 *	512/1/3/N	.951	323.1
29 10 22 39 *	481.9	16.	16.75 *	462.6	53.	1.504*	5.04	33.	6.35	20.	*I1A* *I1B*	476.3	13.	19.33 *	512/1/3/N	.951	323.1
29 10 23 20 *	468.0	14.	6.03 *	462.5	304.	0.071*	3.45	29.	6.40	57.	*I1A* *I1B*	458.9	16.	12.11 *	512/1/3/N	.951	323.1
29 10 24 0 *	474.9	26,	12.93 *	461.0	73.	0.728*	0.51	29.	1.81	33.	*I1A* *I1B*	470.9	16.	21.16 *	512/1/3/N	.951	323.1
29 10 24 41 *	472.7	14.	30.11 *	480.0	46.	2.760*	0.96	16.	1.53	21.	*I1A* *I1B*	474.2	25.	14.81 *	512/1/3/N	.951	323.1
29 10 25 21 *	486.7	10.	30.78 *	495.0	322.	0.143*	-0.62	8.	1.69	15.	*I1A* *I1B*	480.3	32.	7.03 *	512/1/3/N	.951	323.1
29 10 26 2 *	473.5	12.	15.51 *	479.5	51.	1.299*	0.88	13.	2.11	20.	*I1A* *I1B*	481.0	15.	11.03 *	512/1/3/N	.951	323.1
29 10 26 42 *	481.2	16.	8.85 *	460.7	53.	0.443*	1.10	30.	1.90	22.	*I1A* *I1B*	470.7	13.	18.88 *	512/1/3/N	.951	323.1
29 10 27 23 *	471.3	11.	16.71 *	475.7	61.	0.454*	1.02	10.	1.89	19.	*I1A* *I1B*	476.6	23.	6.21 *	512/1/3/N	.951	323.1
29 10 28 3 *	475.0	20.	3.94 *	460.9	86.	0.056*	2.37	33.	2.62	37.	*I1A* *I1B*	470.4	10.	18.86 *	512/1/3/N	.951	323.1
29 10 28 44 *	471.0	10.	14.75 *	478.1	74.	0.113*	2.08	8.	2.19	22.	*I1A* *I1B*	467.7	23.	8.52 *	512/1/3/N	.951	323.1
29 10 29 24 *	478.1	22.	4.44 *	463.0	67.	0.229*	2.68	32.	2.18	26.	*I1A* *I1B*	472.8	10.	22.71 *	512/1/3/N	.951	323.1
29 10 30 5 *	470.6	11.	13.01 *	477.9	92.	0.051*	1.81	7.	2.41	22.	*I1A* *I1B*	465.6	34.	8.44 *	512/1/3/N	.951	323.1
29 10 30 45 *	472.9	28.	3.07 *	460.9	76.	0.085*	1.93	33.	2.41	36.	*I1A* *I1B*	471.4	13.	21.02 *	512/1/3/N	.951	323.1
29 10 31 26 *	469.2	13.	14.86 *	477.6	101.	0.038*	1.29	12.	2.47	25.	*I1A* *I1B*	466.9	25.	10.80 *	512/1/3/N	.951	323.1
29 10 32 6 *	466.8	27.	12.55 *	464.8	68.	0.361*	1.97	32.	2.95	40.	*I1A* *I1B*	469.4	17.	27.48 *	512/1/3/N	.951	323.1
29 10 32 47 *	469.7	15.	32.39 *	667.3	307.	0.236*	1.35	18.	2.42	23.	*I1A* *I1B*	466.1	24.	25.88 *	512/1/3/N	.951	323.1
29 10 33 27 *	478.7	17.	46.88 *	661.2	148.	0.141*	-1.42	18.	2.27	34.	*I1A* *I1B*	475.1	16.	47.38 *	512/1/3/N	.951	323.1
29 10 34 8 *	477.3	26.	15.22 *	473.8	160.	0.179*	-1.48	32.	3.64	47.	*I1A* *I1B*	480.4	21.	35.57 *	512/1/3/N	.951	323.1
29 10 34 48 *	487.0	16.	26.01 *	686.4	367.	0.205*	-1.61	17.	2.98	44.	*I1A* *I1B*	484.1	26.	48.77 *	512/1/3/N	.951	323.1
29 10 35 29 *	482.1	22.	24.69 *	685.0	458.	0.485*	-2.25	41.	2.42	28.	*I1A* *I1B*	485.9	17.	30.72 *	512/1/3/N	.951	323.1
29 10 36 9 *	494.1	23.	20.33 *	697.5	429.	0.412*	-3.77	41.	2.49	68.	*I1A* *I1B*	496.4	26.	28.60 *	512/1/3/N	.951	323.1
29 10 36 50 *	501.0	18.	11.12 *	689.2	584.	0.344*	-4.69	26.	4.44	61.	*I1A* *I1B*	490.6	16.	30.67 *	512/1/3/N	.951	323.1
29 10 37 30 *	484.4	22.	21.83 *	676.8	743.	0.697*	-3.07	33.	3.26	53.	*I1A* *I1B*	479.8	22.	38.63 *	512/1/3/N	.951	323.1
29 10 38 11 *	469.8	19.	19.40 *	673.2	694.	0.715*	-0.86	35.	4.04	43.	*I1A* *I1B*	466.2	24.	40.53 *	512/1/3/N	.951	323.1
29 10 38 51 *	484.7	16.	56.95 *	674.6	786.	0.640*	-1.49	18.	2.40	25.	*I1A* *I1B*	484.5	28.	29.84 *	512/1/3/N	.951	323.1
29 10 39 32 *	479.6	21.	42.20 *	700.3	325.	0.789*	-2.87	21.	2.26	35.	*I1A* *I1B*	484.3	16.	55.72 *	512/1/3/N	.951	323.1
29 10 40 12 *	473.3	28.	23.58 *	677.7	318.	0.788*	-1.42	22.	4.20	46.	*I1A* *I1B*	472.2	16.	44.20 *	512/1/3/N	.951	323.1

Figure 5: Routine expression of 1D plasma data

Creation of the parameter band (PB)

Each production run generates a data set that is deposited as a closed file on a provisional PB.The DM7 data are generated in additional productions.So we finally get a uniform, time ordered and complete PB, the files from the provisional PB must be together copies or be mixed.First, we edit the DM7 files; because here there may be due to the memory organization of HELIOS considerable confusion in the chronological order (p.23).Because multiple reads some data be (simply because the old memory contents is often not fully overwritten), the restoration of temporal order is quite a chore. Only in the next passage is the final PB mixed together then. Here too must still clean overlaps and eliminates doppelganger (E.g. the transition from DM7 to DM4 and vice versa).Then the PB is cleaned up once again: with a special search programme outliers are detected and finally to expert inspection also eliminated, if necessary.

PB contains a number of other data besides all evaluated plasma parameters.This includes of course the O/A-data as well as information about bit rate, format, etc..In addition, we find the (preliminary) Magnetic field data of E2.To keep in mind is that even the corrected and adjusted count rates of I1b and the integration counter I1a and I3 (so in exactly the form used by the FIT programs) still stand on the PB. Thus, the PB is a universal starting point for any further work.
You will find the exact description of the PB on p. 149.

The various representations of results

We have great importance attached by beginning to skillful and comprehensive representation of the results.That seemed huge amount of data and also because of their diversity especially given the as particularly important.Many occur only rarely and briefly phenomena would otherwise escape our notice and be buried in the archives.So the discovery of some very unusual effects in fact we succeeded, we could have easily overlooked.

Our most important tool in the presentation of the results is a very extensive range of plot (which like can be provided upon written request of interested reader).It allows the display of all parameters in different orders and scale heights, variable time scales and with variable averaging intervals.A "module" is assigned to each parameter, together with the scale and label.The modules can be arranged at any scale height and in any order, with each other, also on multiple pages.We often make use of this variability.

For the representation of routine we use fixed output formats.
All of these plots are set on microfiche (MF).An example shows Figure 6 in the original size.

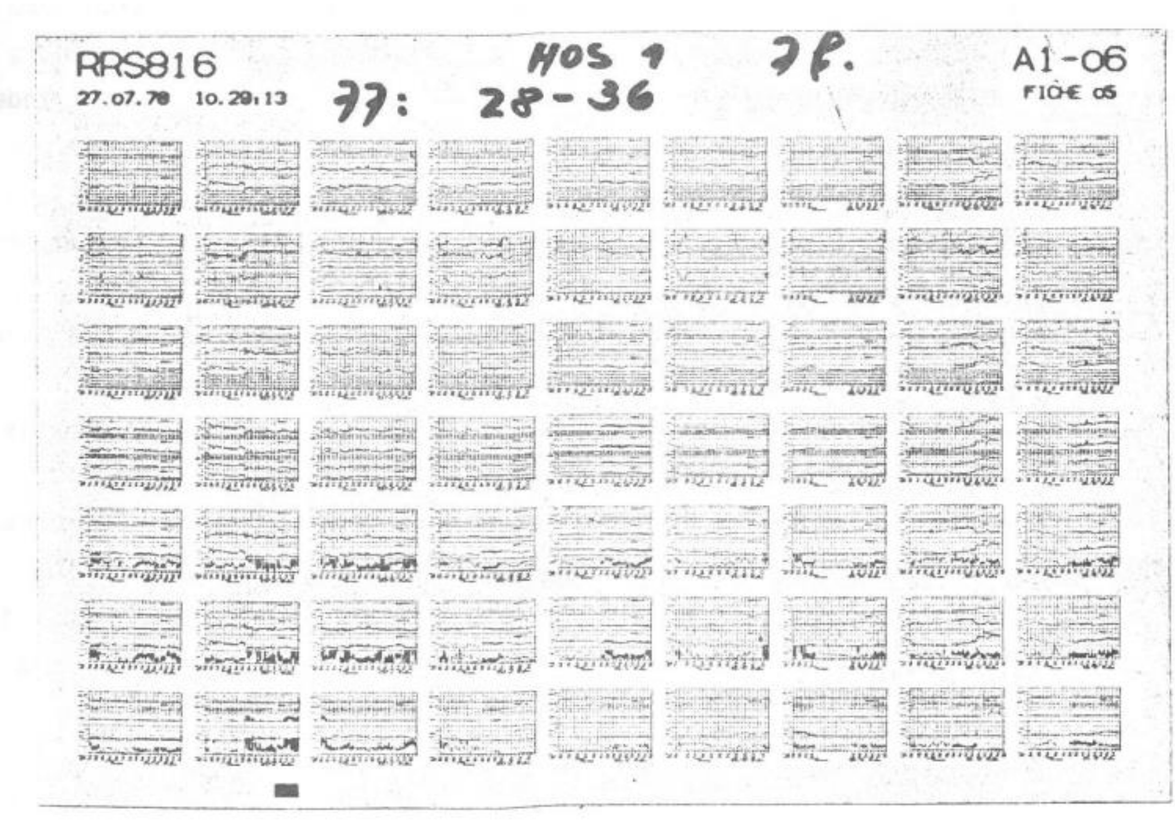

Figure 6: Image of a microfiche in original size.In this "7 x-plot" include seven below each each other plots for a day

Such a fiche contains therefore 63 images (or even 63 pages of computer expression).On a DIN A4 archive map (sliced) ever 20 inserted Fiche offset in a row, so that both its upper edge with the caption remains readable.A double-sided archive map thus includes already 2520 plots in a very clear form.In each a Lever arch folder we hold six cards, 15120 plots.It is no wonder that a single drawer can hold approximately 180000 plots with 12 such hanging folders.This corresponds to a paper shock by approx.18 m height!
And really the entire data archive of our HELIOS plasma experiment, where invariably every data point is now recorded 7 years HELIOS Mission (including 4 years double mission) and shown in at least 5 different representations, effortlessly in a single drawer in a normal office desk space.The Fiche system has still the infinitely important advantage that each point in each representation in direct access is easy to find.The average access time is less than 10 seconds - with some practice-Then one has the desired image before on the screen of the viewer and can if necessary in another 12 seconds.in normal size make a copy of it.All following images are copies of such return enlargements of microfiche.

The chart shown in Figure 6 is a "7 x-plot", as we call it.
It is created on the first plot pass the PB must go through.Seven lying with each other plots include the 24 hours of the same day and of all sizes, which has determined the 1D-evaluation, but already summarized to 3 min.-mean values.These can include already up to 4 measuring values.The images of 7 to 13 show these plots for a typical mission day (the 29.1.1977) by HELIOS-1.The scale was chosen so that the reenlargement just results in the agreed scale of 24 cm / day between the HELIOS-experimenters. What sizes are each represented, is explained on the images.Some of the modules contain two parameters, so that you can compare them directly.

In most cases, one is not interested in the details of the 1D-evaluation, but would like to pursue only the most important dimensions.Therefore we have grouped together (it shows the model independent protons and α-particle parameters) only the plots according to figure 8 in a further set of fiches ("1 x-plots").

So goes a full year of mission on 6 fiches.This is a "weight"point of major importance especially for travel to colleagues that you want to compare data.

In the next step, we create "4 day-Plots" on microfiche.This time scale is very useful to detect certain structures in the solar wind.Here are the same data as in Figure 8 to 10 min.-averages combined.Figure 14 shows an example of which in turn contains the 29.1.77.In addition, we can manafacture such 4 day-Plots as paper plots, because they are needed very much and many different employees.However, the currently six Lever arch folder for these plots are housed in a second drawer of the same desktop (two more drawers in this solely as a data archive desk are still empty...).

Finally, we summarize the data to 1hr.-averages and play them back on "Carrington-Plots", i.e.for each a complete revolution of the Sun (fig. 15).Seen from the Earth a Carrington rotation 27.25 days, takes by HELIOS from, however, varying lengths because HELIOS in the Perihelion passages with fast moves with the Sun.Therefore, the Carrington plots have no fixed time scale, but a scale defined in degrees of solar longitude.We spend also the Carrington plots as 7 x plots on microfiches, quite similar to the 1 day-plots (Figure 6-13).We also of course have them as paper plots (according to the pictures of 8, 14, 15) available.

The same averages us can also print as numbers, because they are often used for quantitative research.This serves the program on p. 199 with its sub-programs.According to Z3200, also an arbitrary class width for the averaging can be enter in addition to start and end times.Specifies the size of CREFF, at what distance from the Sun (in AU) the data should be involved.If CREFF = 0 is used, the measured data are transferred unchanged.Otherwise, the particle densities according to a quadratic function of the distance to the Sun are converted.

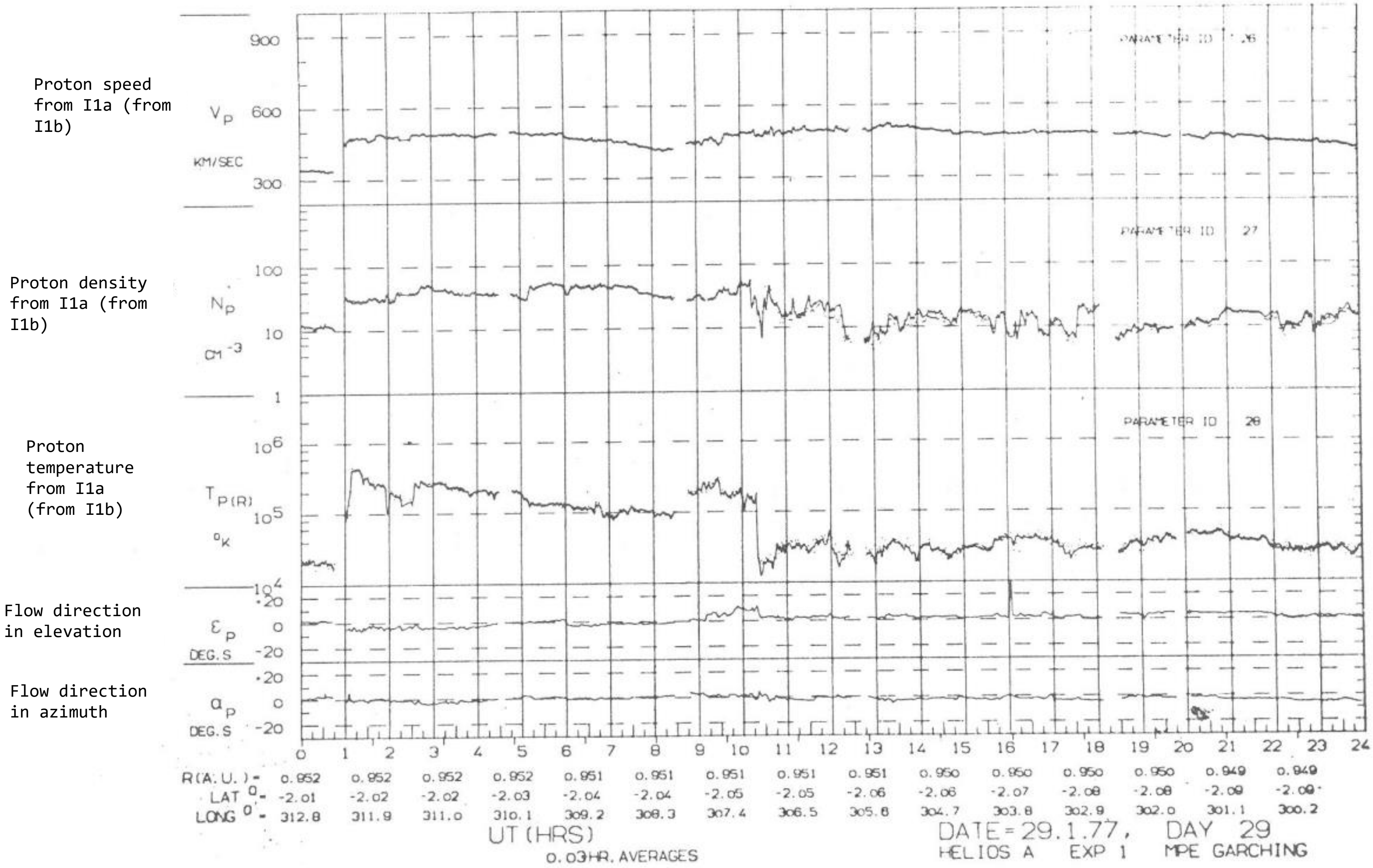

Figure 7: 7 x-plot, 1st Image
The point always refer to the parameters specified in parentheses.

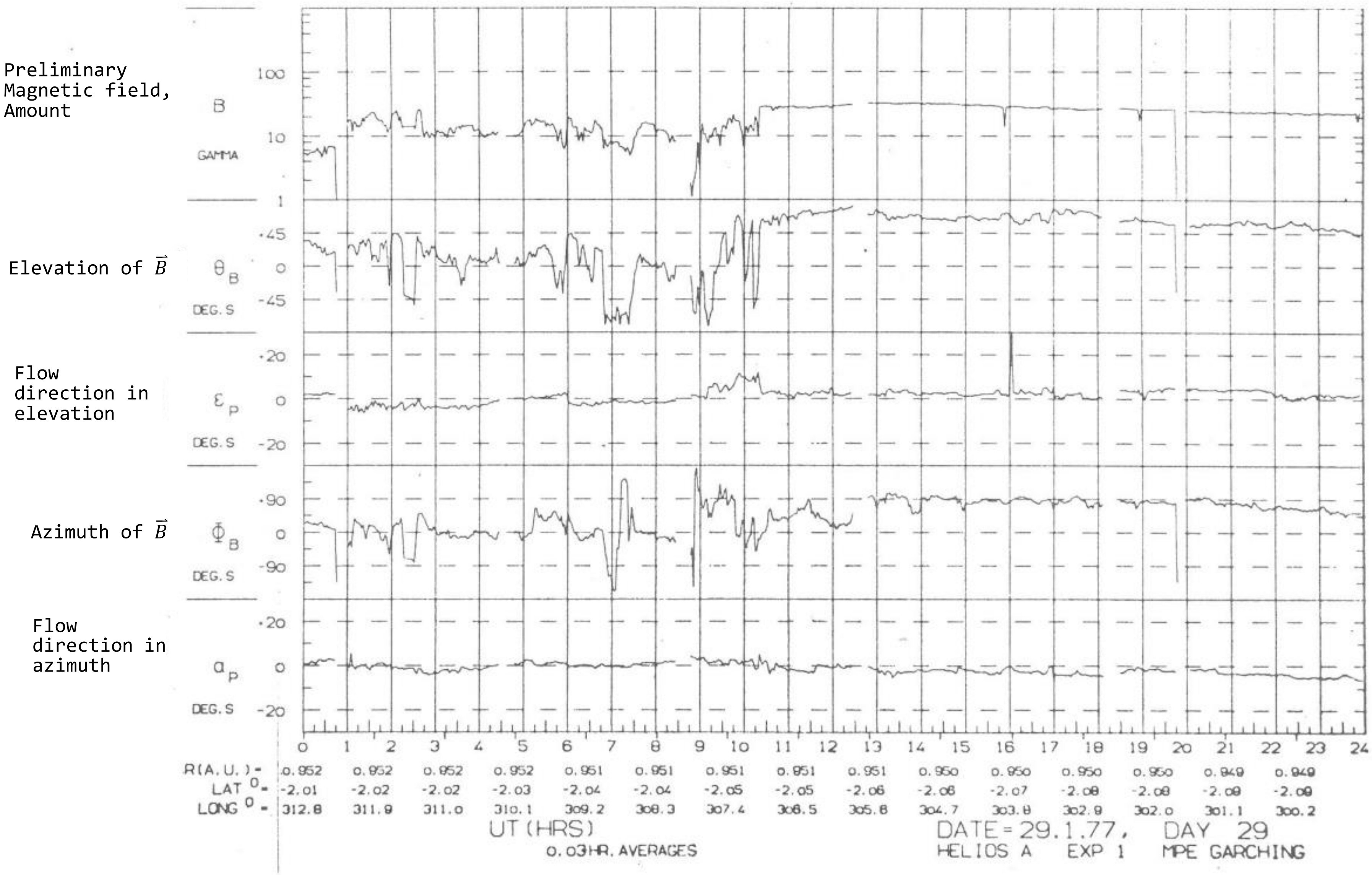

Figure 8: 7 x-plot, 2nd Image

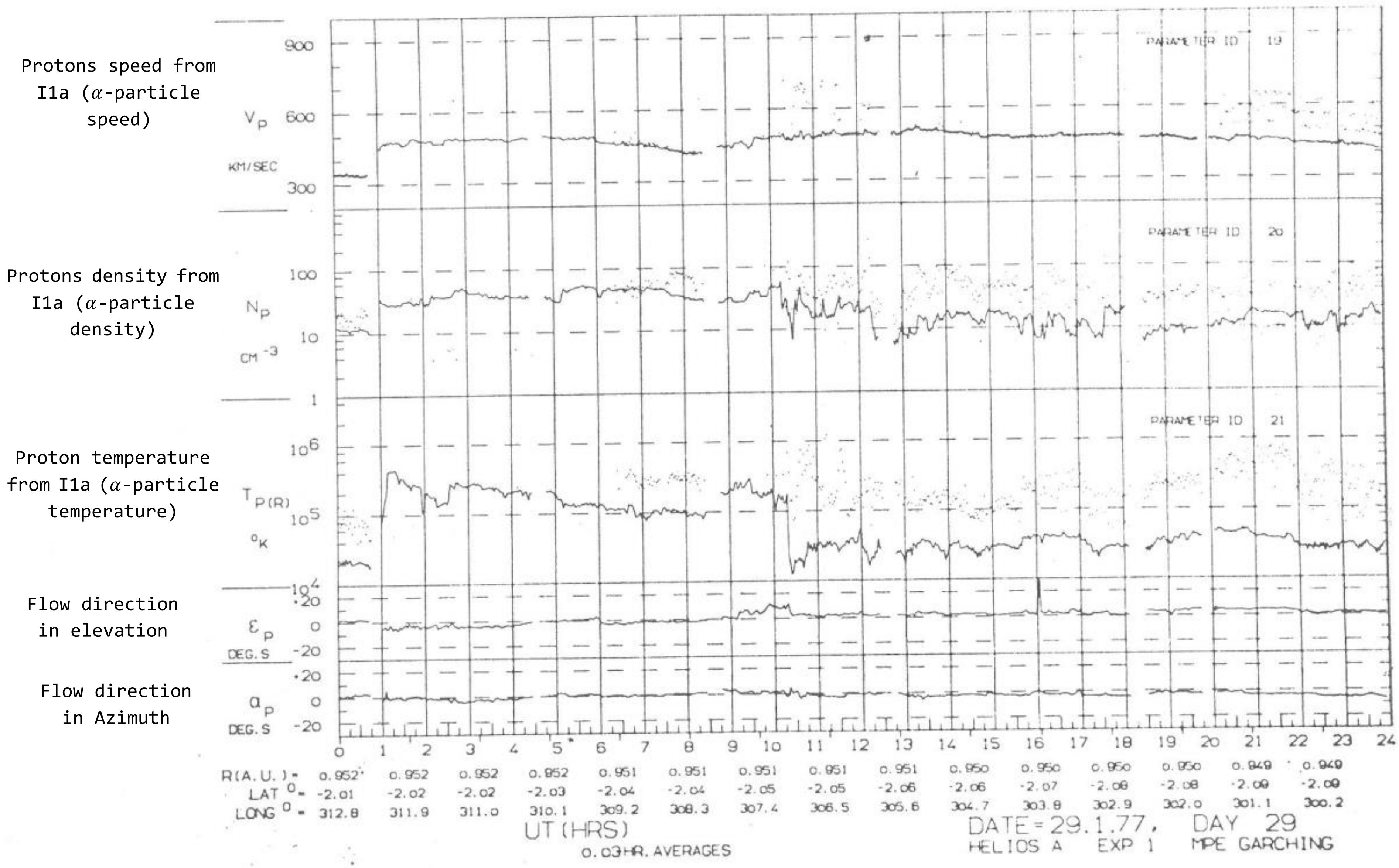

Figure 9: 7 x-plot, 3rd Image

Proton temperature
(Temp. In Azimuth)

Proton temperature
(Temp. In elevation)

Proton temperature
I1a (peak fit temp.
I1a)

Proton temperature
I1b (peak fit temp.
I1b)

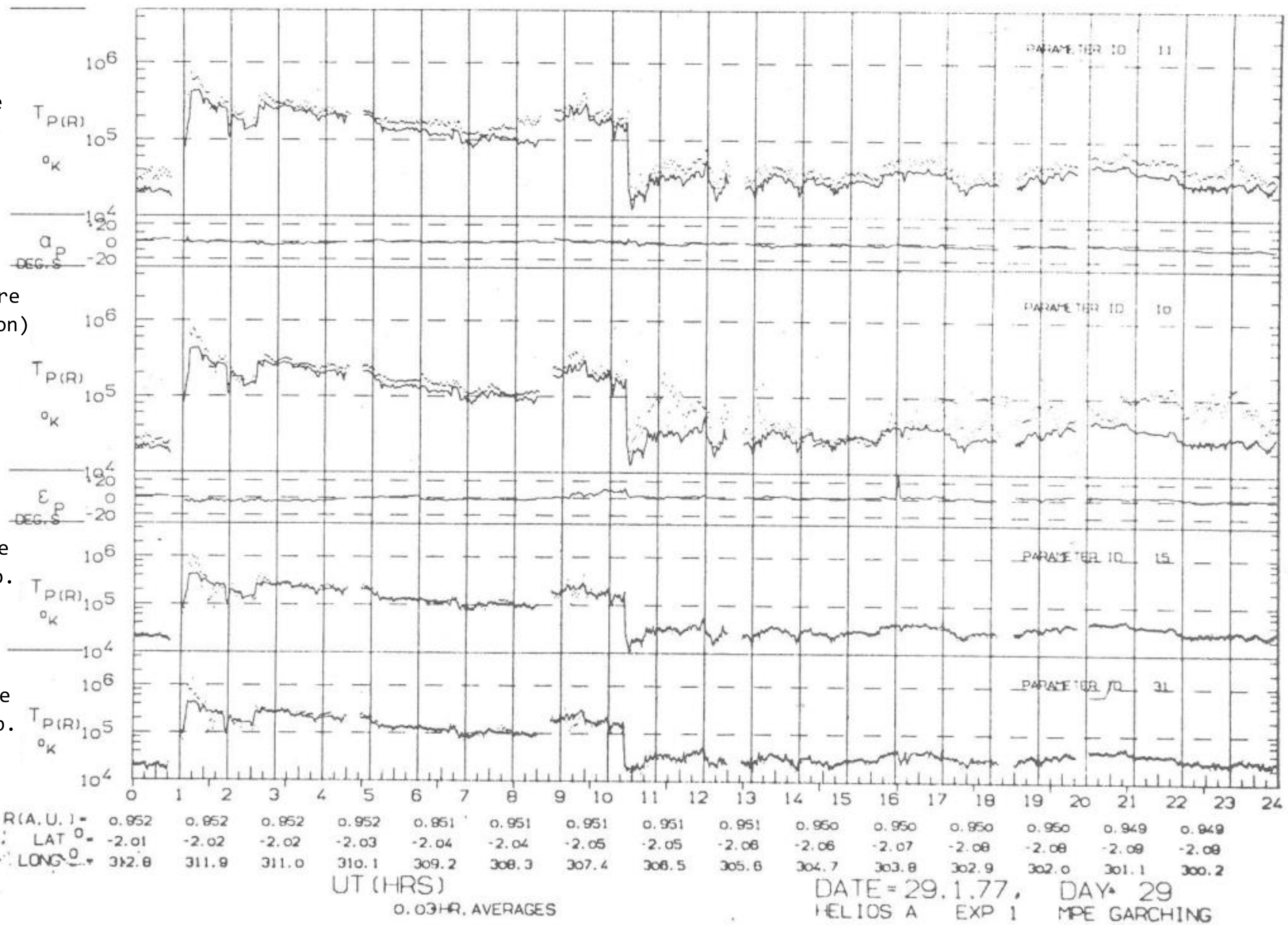

Figure 10: 7 x-plot, 4th Image

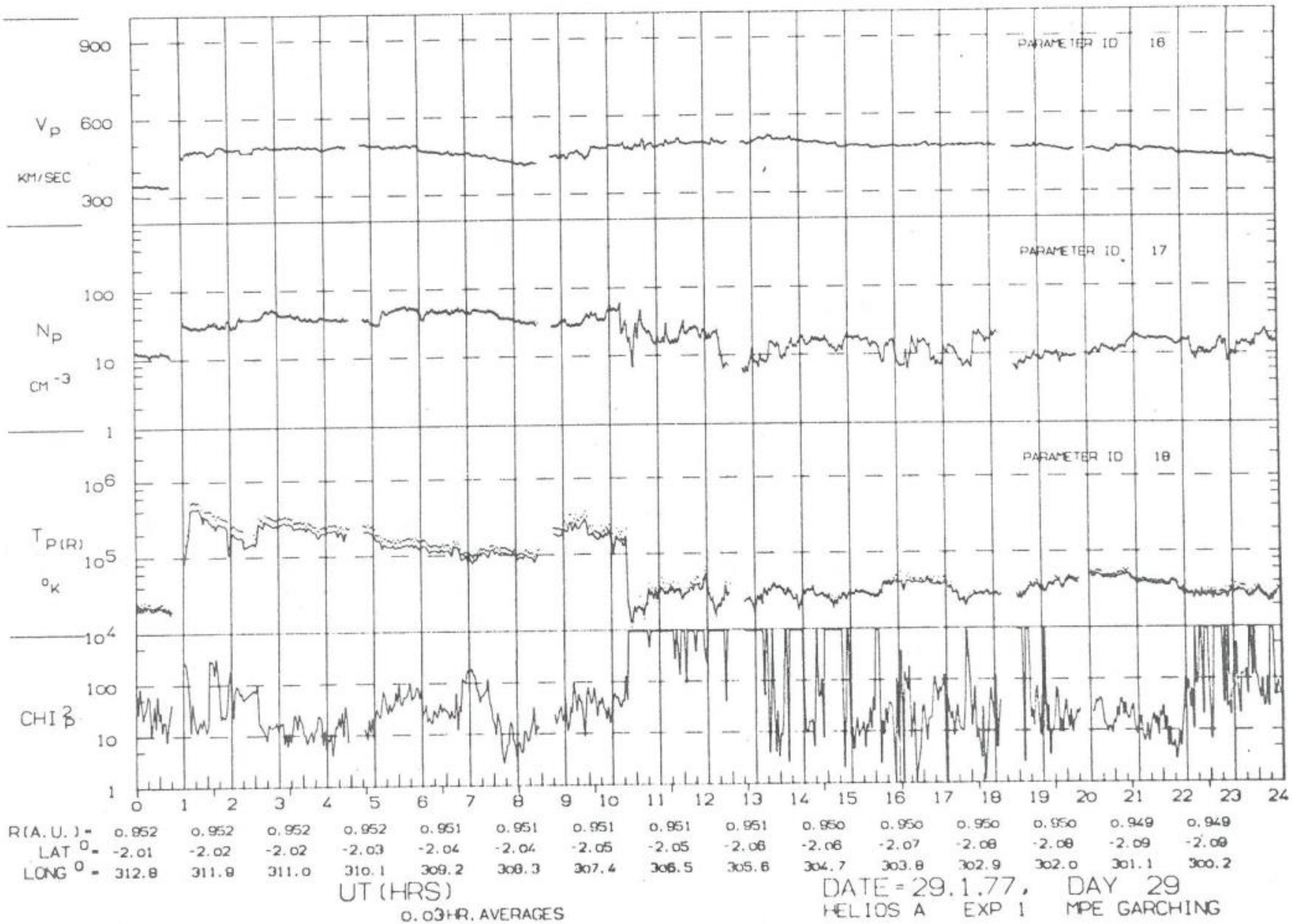

Figure 11: 7 x-plot, 5th Image
Comparison of Numerical Integration with "wide Fit" (points) at I1a

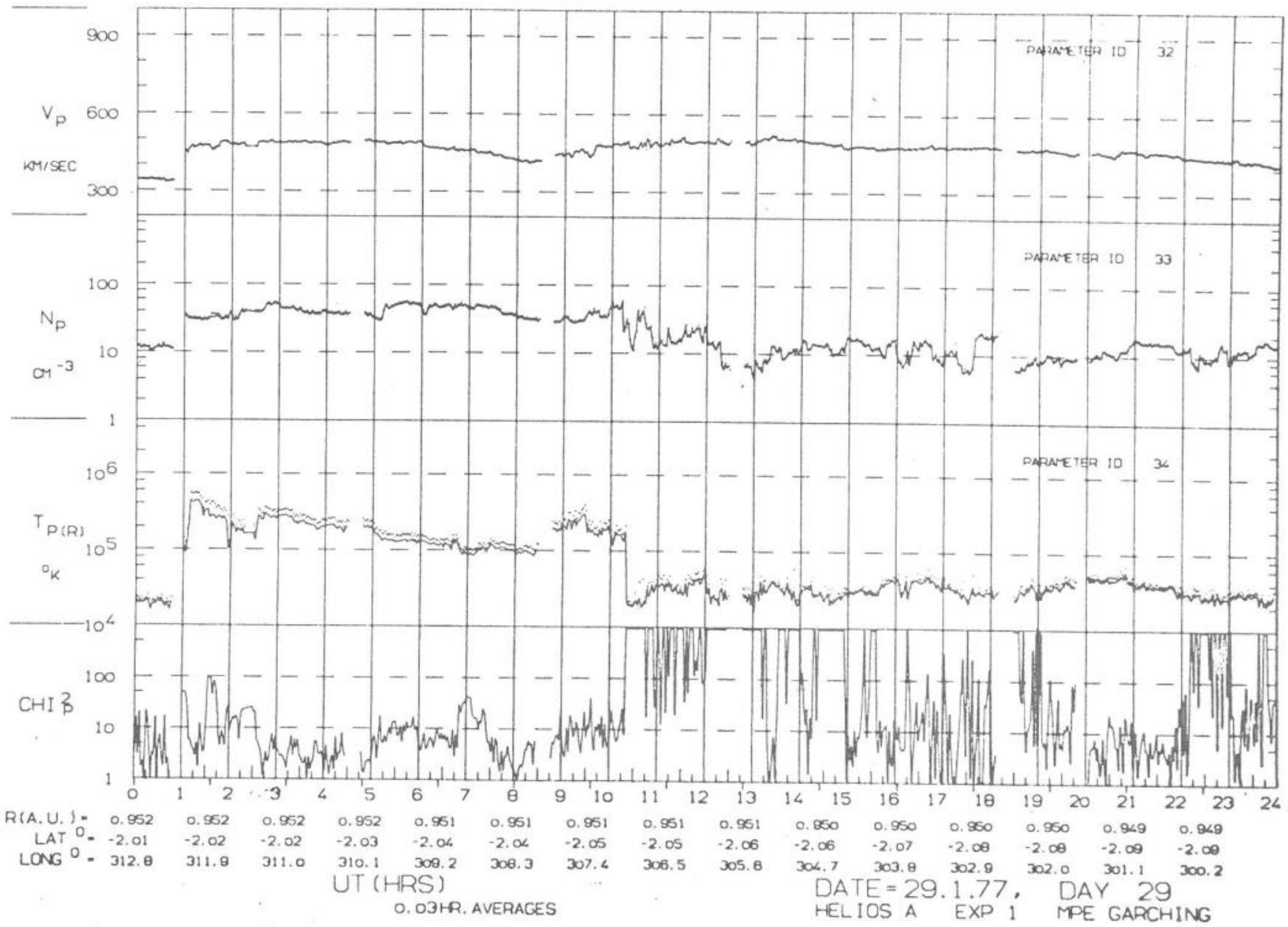

Figure 12: 7 x-plot, 6th Image
Comparison of Numerical Integration with "wide Fit" (points) at I1b

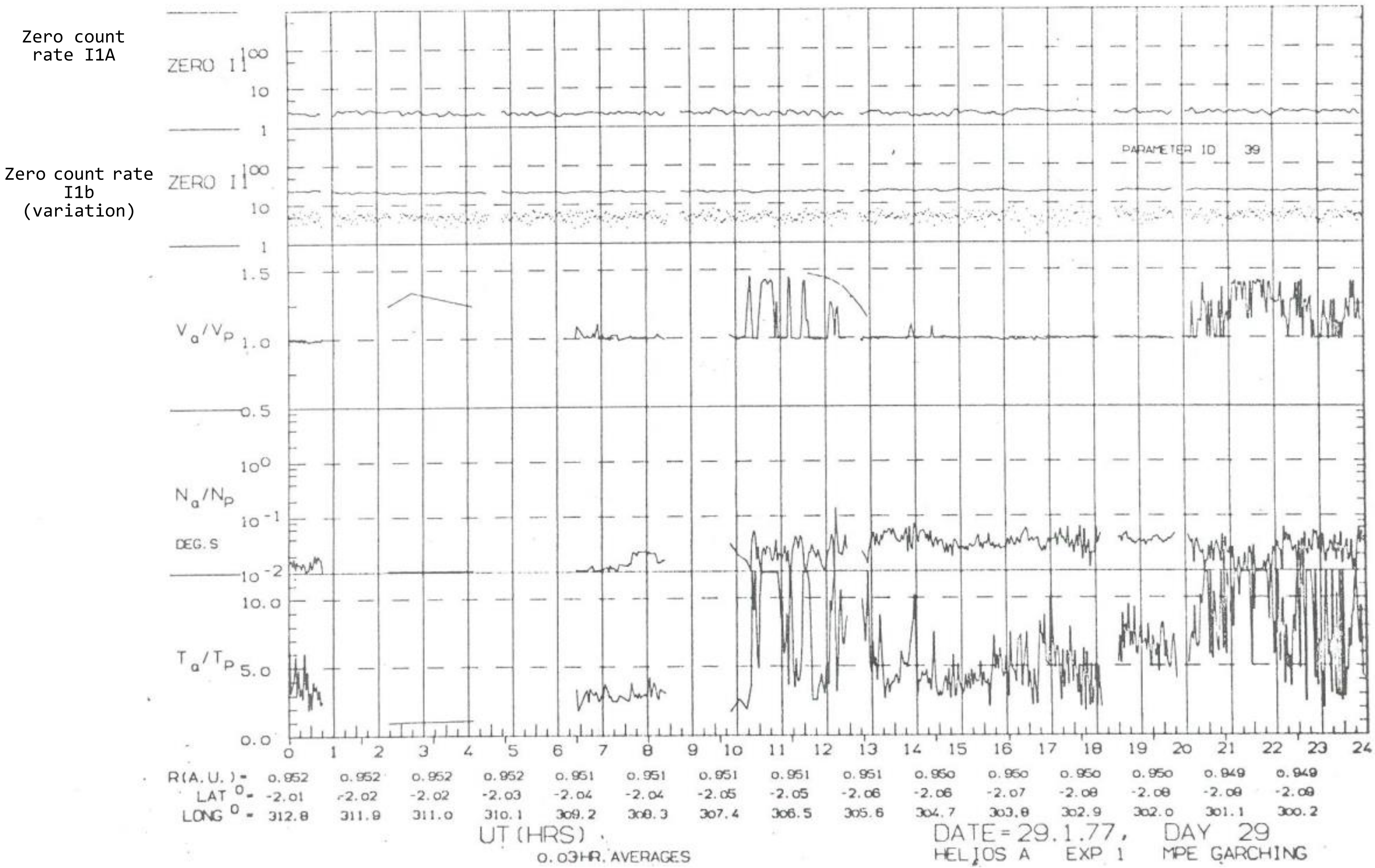

Figure 13: 7 x-plot, 7th Image

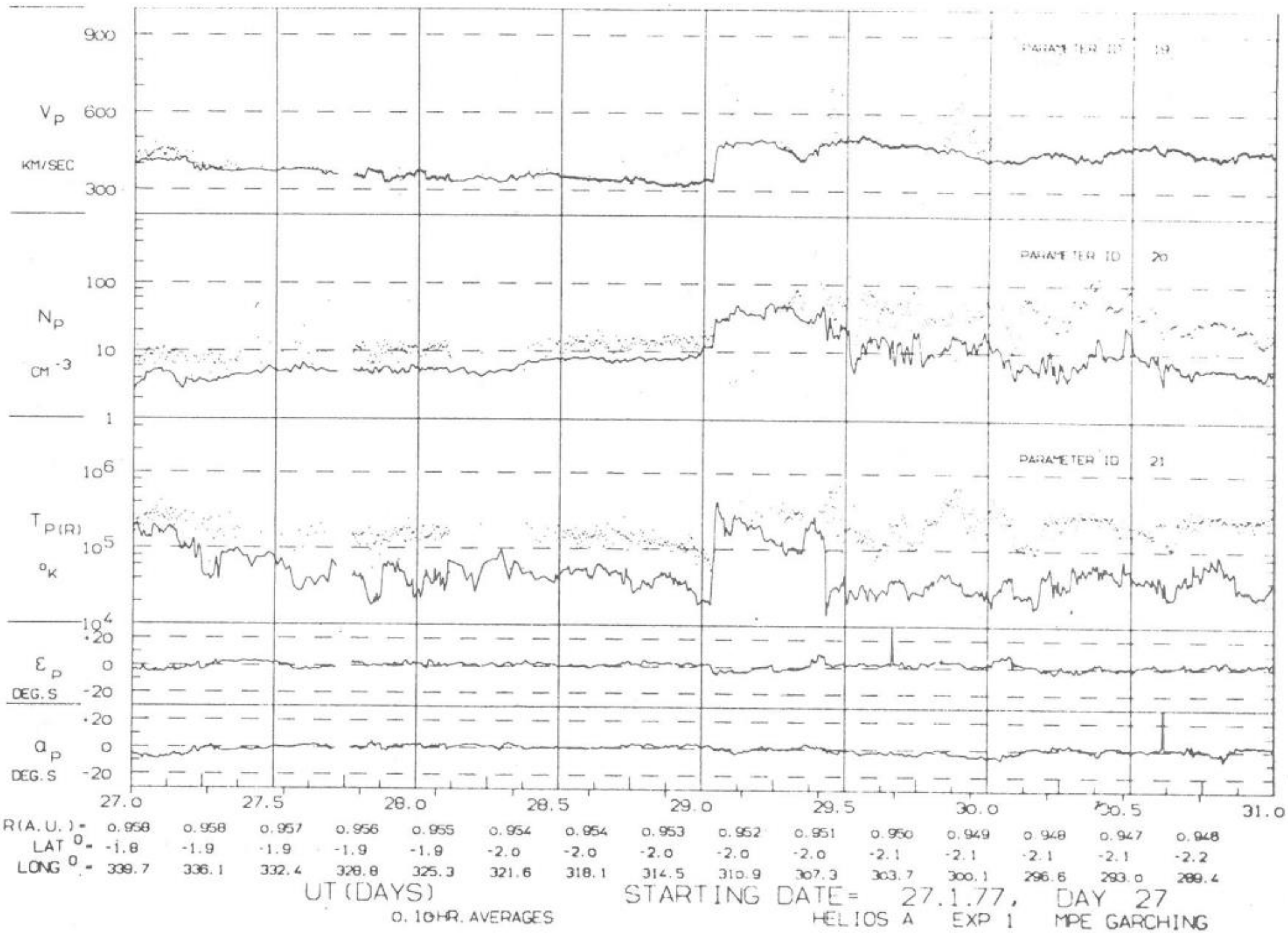

Figure 14: 4 Day-Plot of the 1D parameter as 10min.-averages

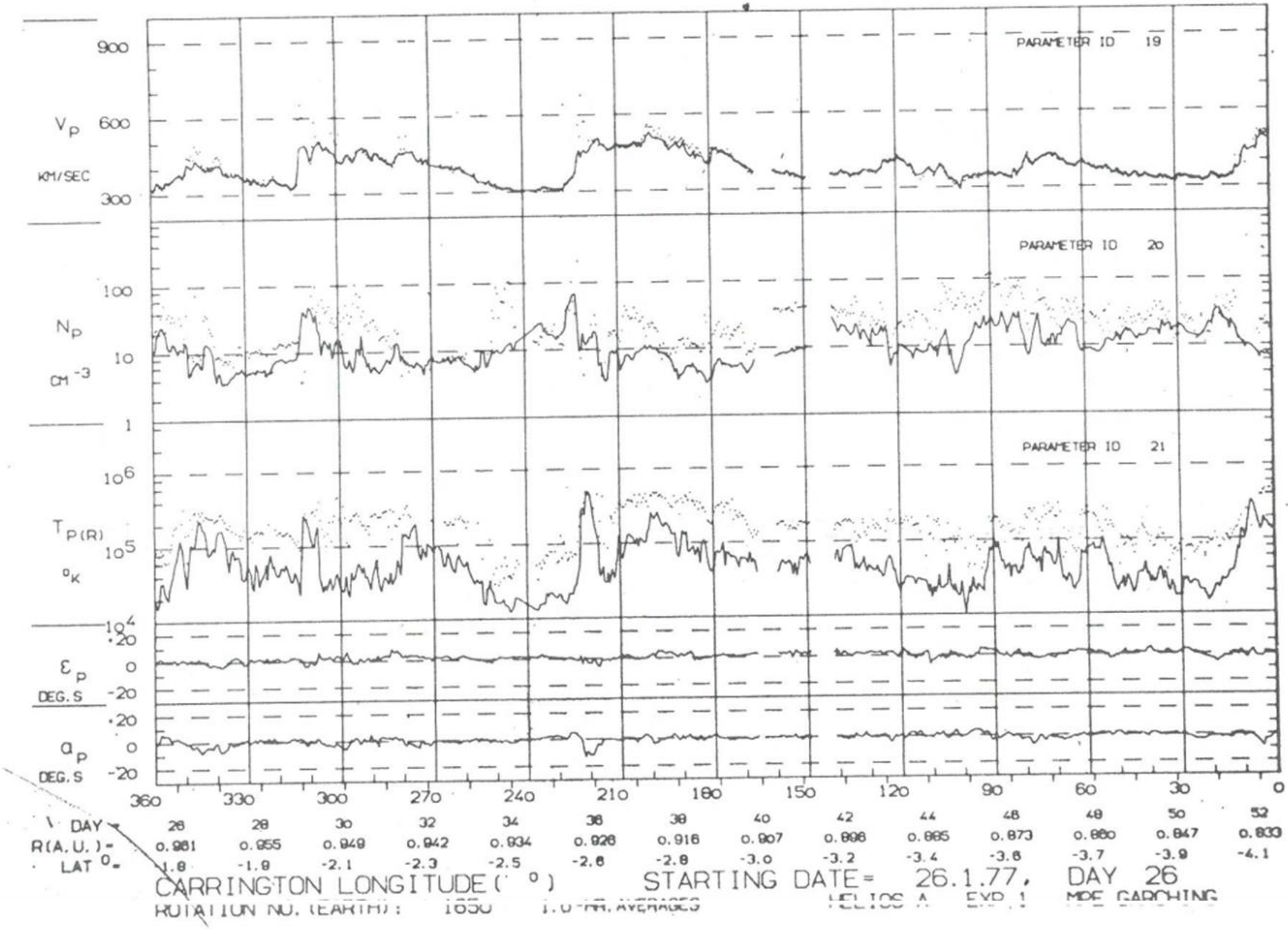

Figure 15: Carrington-Plot of the 1D parameter as
1hr.-averages

Also is the time of arrival (orStartup) calculated from the measured plasma at the desired distance to the Sun.Thereby, we assume that the currently measured speed is constant.This procedure enables in this simple approximation, to produce references between the HELIOS-measurements and other observations, E.g.in the Sun's Corona, at the Earth, Jupiter etc. From image 16 and 17, for example, see that the plasma arrives at HELIOS-1 on the 29.1.77 between 0 and 1 UT (Carrington-length 312.51 °) with 341.8 $\pm$ 3.5 kms^{-1}, already on 24.1. at 16:43 UT at 0.1 AU must have started (at Carrington length 9.38 °). This average - so the second row tells us - produced from 86 Proton spectra.In 85 cases were able to also determine α and ϵ, the α-particle parameters only in 60 cases.

By means of the switch LTAPE, we can arrange that the output of averages is on tape.So, we produce in particular also the strips that we routinely send the HELIOS experimenters.What is on these exchange tapes, shown in Figure 18.In a similar way, we create a tape with a selection of the most important and best protected sizes also in 1hr-averages that we transmit the world data center.

In addition to the above-mentioned issue and display techniques, there are a number of other methods, the in some caseswere developed only recently.So compressed versions created as by the PB, which contain only the most important parameters, but in the highest time resolution.They served as bases for some joint work with the Brunswick colleagues (U. Denskat, F.M. Neubauer) about Alfvén waves.We have also produced mixed tapes, where the E1 data of PB with the E2 data evaluated by the TU Brunswick are played together.While the E2 data about the respective measuring period of E1 must be suitably averaged. Meanwhile, there is also a "Super mixed tape". Here, even the E1 data of the 3D-data capture are, as well as the electronic data of I2 included.These mix tapes are extremely useful for manipulating some physical problem.

Mittelwerte ueber Koordinaten = averages by coordinates

eindimensionale Auswertung von = one dimensional evaluation of

protonen = protons

Alpha-teilchen = Alpha particles

Datum = date

HELIOS 1-E1 MITTELWERTE UEBER KOORDINATEN 60 MIN. EINDIMENSIONALE AUSWERTUNG VON I1A-DATEN JOB: H05636 26.09 ROTATION: 1651.

DATUM				KOORDINATEN R AU	LONG GRAD	LAT GRAD	PROTONEN I1A:VP KM/S	TP 1000K	NP CM**-3	ALPHA GRAD	EPS GRAD	ALPHA-TEILCHEN VA KM/S	TA 1000K	NA CM**-3	I1B:VP KM/S	TP 1000K	NP CM**-3
77	28	21	0	0.9527	314.19	-2.003	324.0	42.1	7.88	1.94	2.54	320.8	111.5	0.150	322.3	37.3	7.74
				86	0 85	60	4.2	6.7	0.27	0.85	0.45	7.6	31.5	0.039	4.4	6.4	0.39
77	28	22	0	0.9525	313.61	-2.007	325.2	34.6	8.09	2.20	2.04	320.3	110.9	0.138	323.8	31.3	8.02
				88	0 87	66	5.4	4.6	0.51	0.95	0.69	7.6	41.1	0.034	5.2	5.1	0.59
77	28	23	0	0.9524	313.09	-2.010	332.7	25.8	8.96	2.93	1.89	329.1	104.8	0.139	331.2	23.1	8.85
				77	0 76	73	4.2	5.1	1.02	0.68	1.01	8.0	45.1	0.043	4.6	4.5	0.89
77	29	0	0	0.9523	312.51	-2.014	341.8	21.3	11.90	1.94	2.05	339.0	79.7	0.178	340.7	20.2	11.58
				69	0 68	66	3.5	1.9	0.69	0.81	0.33	5.5	41.0	0.056	3.8	2.6	0.69
77	29	1	0	0.9521	311.93	-2.018	473.2	294.1	29.88	0.03	-3.59	0.0	0.0	0.0	472.6	293.2	31.23
				85	0 83	0	11.1	102.8	2.59	1.31	2.45	0.0	0.0	0.0	11.3	105.6	2.43
77	29	2	0	0.9520	311.41	-2.021	482.0	221.3	39.55	-2.15	-3.27	622.5	225.8	0.037	482.1	224.7	41.16
				73	0 71	2	7.9	51.8	7.51	1.34	1.56	39.9	85.3	0.001	8.1	52.9	7.38
77	29	3	0	0.9518	310.83	-2.025	485.4	235.0	39.26	-2.05	-3.76	0.0	0.0	0.0	485.4	235.3	40.27
				90	0 89	0	3.5	31.7	3.21	0.85	0.58	0.0	0.0	0.0	3.5	33.2	3.38
77	29	4	0	0.9517	310.25	-2.029	487.9	203.0	35.79	-0.22	-1.37	602.0	239.6	0.054	487.2	201.8	36.25
				64	0 63	1	6.3	17.1	1.86	0.96	1.27	0.0	0.0	0.0	5.6	14.9	1.91
77	29	5	0	0.9516	309.73	-2.032	487.7	140.8	46.09	1.19	0.89	0.0	0.0	0.0	486.4	138.8	46.00
				90	0 89	0	3.7	18.0	8.40	0.78	0.75	0.0	0.0	0.0	3.2	17.3	8.27
77	29	6	0	0.9514	309.15	-2.036	463.7	116.2	46.00	-0.27	-2.33	474.9	308.1	0.448	463.4	116.9	46.62
				89	0 88	19	6.8	15.3	3.80	0.56	0.91	31.7	78.6	0.135	6.5	14.9	4.18
77	29	7	0	0.9513	308.58	-2.040	442.1	102.1	42.49	0.34	-1.53	438.0	297.3	0.688	441.6	103.6	43.04
				90	0 89	47	11.2	11.2	4.87	0.83	0.46	14.2	39.6	0.155	11.3	10.7	4.92
77	29	8	0	0.9512	308.05	-2.043	424.9	118.1	30.43	2.01	-0.71	418.3	306.6	0.659	423.2	120.5	31.06
				64	0 62	23	13.2	42.4	2.08	0.99	1.34	4.9	56.1	0.127	12.3	44.4	1.96
77	29	9	0	0.9510	307.47	-2.047	459.5	207.2	33.85	1.71	5.39	484.6	329.2	1.043	458.8	212.8	34.43
				88	0 86	1	15.9	43.1	5.18	1.02	3.03	0.0	0.0	0.0	15.8	47.0	5.15
77	29	10	0	0.9509	306.90	-2.050	484.4	67.7	28.49	0.25	4.92	597.7	401.1	0.490	482.8	70.3	30.22
				89	0 88	61	10.8	63.6	15.68	2.00	3.34	105.9	284.8	0.424	10.7	64.8	15.10
77	29	11	0	0.9507	306.37	-2.054	492.4	34.4	20.75	-1.57	2.38	522.8	290.3	0.420	492.3	35.9	18.02
				90	0 89	89	8.0	8.5	5.74	1.26	1.18	79.8	301.5	0.229	7.7	8.9	4.85
77	29	12	0	0.9506	305.80	-2.058	493.4	25.4	13.07	-0.64	1.89	521.5	190.8	0.451	492.6	27.5	9.62
				64	0 63	62	6.9	8.3	7.28	0.90	0.50	71.0	122.9	0.714	7.7	9.3	4.62
77	29	13	0	0.9505	305.22	-2.061	506.0	29.4	11.47	-2.86	2.69	506.0	144.6	0.509	506.3	31.1	9.59
				90	0 88	89	6.8	6.8	3.63	0.94	1.03	16.4	66.2	0.424	6.9	8.4	2.54
77	29	14	0	0.9503	304.69	-2.065	487.5	27.6	15.16	-2.12	2.23	486.6	108.0	0.553	488.0	27.8	13.01
				80	0 88	89	8.6	4.6	2.85	0.75	0.45	17.4	55.0	0.325	8.8	5.4	2.21
77	29	15	0	0.9502	304.11	-2.069	474.9	31.6	14.80	-2.52	2.06	472.0	138.2	0.436	475.1	32.7	13.90
				82	0 81	81	4.2	4.8	3.27	0.78	0.81	5.5	63.9	0.151	4.3	5.2	2.62
77	29	16	0	0.9500	303.54	-2.072	477.0	38.7	10.56	-2.02	7.71	472.0	209.3	0.382	477.6	39.5	11.05
				22	0 21	21	4.0	2.8	3.85	1.15	21.51	5.2	75.9	0.200	4.4	6.2	3.40
77	29	17	0	0.9499	303.01	-2.076	477.3	29.1	12.64	-3.81	1.25	475.8	149.1	0.444	478.5	31.9	12.41
				24	0 23	23	2.4	4.8	4.88	0.56	1.24	3.3	86.9	0.302	2.3	5.0	5.66
77	29	18	0	0.9497	302.44	-2.079	469.3	31.0	8.85	-1.85	3.28	471.9	211.1	0.329	469.1	31.9	8.38
				49	0 47	48	4.4	5.5	3.69	1.24	1.25	28.8	67.5	0.187	3.6	5.9	3.82
77	29	19	0	0.9496	301.86	-2.083	463.9	37.5	8.17	-1.71	3.66	460.1	237.5	0.333	463.8	37.0	8.95
				72	0 71	71	6.7	4.6	0.91	0.53	1.62	7.8	54.7	0.069	6.8	5.4	0.91
77	29	20	0	0.9495	301.33	-2.086	460.2	46.6	12.24	-2.00	4.19	514.9	418.0	0.300	460.2	46.0	11.48
				83	0 82	82	7.8	4.5	2.07	0.92	0.41	85.1	204.6	0.181	8.3	5.4	2.09
77	29	21	0	0.9493	300.76	-2.090	457.4	36.7	16.08	-3.45	4.09	609.8	516.6	0.197	458.4	36.8	15.35
				90	0 89	89	5.4	3.4	1.53	0.29	0.57	72.9	238.1	0.221	5.3	3.8	1.72
77	29	22	0	0.9492	300.18	-2.094	437.5	27.2	12.18	-4.55	1.10	526.5	246.3	0.378	438.8	27.9	10.57
				90	0 89	88	4.0	4.2	3.18	0.75	0.87	91.2	234.5	0.382	4.0	4.9	2.63
77	29	23	0	0.9491	299.65	-2.097	425.7	27.8	14.89	-4.99	1.72	487.7	193.6	0.396	426.6	28.2	13.42
				89	0 87	88	8.5	3.9	3.58	0.78	0.46	85.4	204.9	0.339	8.1	4.4	2.53
77	30	0	0	0.9489	299.08	-2.101	422.7	24.2	12.29	-5.33	3.53	538.7	343.7	0.294	423.8	24.3	11.29
				70	0 68	69	4.3	4.9	2.52	0.48	1.99	82.8	239.9	0.315	3.7	4.7	2.32
77	30	1	0	0.9488	298.50	-2.105	419.8	39.9	7.84	-4.40	7.84	425.8	269.8	0.249	420.7	38.7	7.92
				[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Figure 16: 1hr.-Averages the 1D-data as microfiche printout (CREFF = 0)

Mittelwerte ueber Koordinaten = averages by coordinates

eindimensionale Auswertung von = one dimensional evaluation of

Bezogen auf = in relation to

protonen = protons

Alpha-teilchen = Alpha particles

Datum = date

HELIOS 1-E1 MITTELWERTE UEBER 60 MIN. EINDIMENSIONALE AUSWERTUNG VON I1A-DATEN , BEZOGEN AUF 0.100 AU JOB: KZM626 11.1.

	KOORDINATEN				PROTONEN				ALPHA-TEILCHEN				ROTATION: 1650.	
DATUM	R	LONG	LAT	I1A:VP	TP	NP	ALPHA	EPS	VA	TA	NA	I1B:VP	TP	NP
	AU	GRAD	GRAD	KM/S	1000K	CM**-3	GRAD	GRAD	KM/S	1000K	CM**-3	KM/S	1000K	CM**-3
77 29 0 0	0.9523	9.38	-1.491	341.8	21.3	10.79	1.94	2.05	339.0	79.7	0.162	340.7	20.2	10.50
24 16 53	69	0 68	66	3.5	1.9	0.63	0.81	0.33	5.5	41.0	0.051	3.8	2.6	0.63
77 29 1 0	0.9521	353.02	-1.641	473.2	294.1	27.08	0.03	-3.59	0.0	0.0	0.0	472.6	293.2	28.31
25 22 39	85	0 83	0	11.1	102.8	2.35	1.31	2.45	0.0	0.0	0.0	11.3	105.6	2.20
77 29 2 0	0.9520	351.72	-1.652	482.0	221.3	35.84	-2.15	-3.27	622.5	225.8	0.034	482.1	224.7	37.30
26 1 3	73	0 71	2	7.9	51.8	6.80	1.34	1.56	39.9	85.3	0.001	8.1	52.9	6.69
77 29 3 0	0.9518	350.84	-1.658	485.4	235.0	35.57	-2.05	-3.76	0.0	0.0	0.0	485.4	235.3	36.48
26 2 34	90	0 89	0	3.5	31.7	2.91	0.85	0.58	0.0	0.0	0.0	3.5	33.2	3.06
77 29 4 0	0.9517	350.05	-1.664	487.9	203.0	32.42	-0.22	-1.37	602.0	239.6	0.049	487.2	201.8	32.83
26 3 57	64	0 63	1	6.3	17.1	1.69	0.96	1.27	0.0	0.0	0.0	5.6	14.9	1.73
77 29 5 0	0.9516	349.53	-1.667	487.7	140.8	41.73	1.19	0.89	0.0	0.0	0.0	486.4	138.8	41.65
26 4 56	90	0 89	0	3.7	18.0	7.60	0.78	0.75	0.0	0.0	0.0	3.2	17.3	7.49
77 29 6 0	0.9514	351.01	-1.652	463.7	116.2	41.64	-0.27	-2.33	474.9	308.1	0.405	463.4	116.9	42.20
26 2 12	89	0 88	19	6.8	15.3	3.53	0.56	0.91	31.7	78.6	0.122	6.5	14.9	3.78
77 29 7 0	0.9513	352.49	-1.637	442.1	102.1	38.45	0.34	-1.53	439.0	297.3	0.622	441.6	103.6	38.85
25 23 29	90	0 89	47	11.2	11.2	4.50	0.83	0.46	14.2	39.6	0.140	11.3	10.7	4.45
77 29 8 0	0.9512	353.71	-1.625	424.9	118.1	27.53	2.01	-0.71	418.3	306.6	0.596	423.2	120.5	28.10
25 21 15	64	0 62	23	13.2	42.4	1.88	0.89	1.34	4.9	56.1	0.114	12.3	44.4	1.78
77 29 9 0	0.9510	349.69	-1.660	459.5	207.2	30.62	1.71	5.39	484.6	329.2	0.843	458.8	212.8	31.14
26 4 32	88	0 86	1	15.9	43.1	4.69	1.02	3.03	0.0	0.0	0.0	15.8	47.0	4.66
77 29 10 0	0.9509	346.95	-1.684	484.4	67.7	26.67	0.25	4.92	597.7	401.1	0.443	482.8	70.3	27.32
26 9 30	89	0 88	61	10.8	63.6	14.19	2.00	3.34	105.9	284.8	0.384	10.7	64.8	13.66
77 29 11 0	0.9507	345.76	-1.693	482.4	34.4	18.76	-1.57	2.38	522.8	290.3	0.380	492.3	35.9	16.29
26 11 41	90	0 89	89	8.0	8.5	5.19	1.26	1.18	79.8	301.5	0.207	7.7	8.9	4.38
77 29 12 0	0.9506	345.13	-1.698	493.4	25.4	11.81	-0.64	1.89	521.5	190.8	0.408	492.6	27.5	8.69
26 12 51	64	0 63	62	6.9	8.3	6.58	0.90	0.50	71.0	122.9	0.645	7.7	9.3	4.17
77 29 13 0	0.9505	343.53	-1.711	506.0	29.4	10.36	-2.86	2.68	506.0	144.6	0.460	506.3	31.1	8.66
26 15 39	90	0 88	89	6.8	6.8	3.28	0.94	1.03	16.4	66.2	0.383	6.9	8.4	2.30
77 29 14 0	0.9503	344.49	-1.701	487.5	27.6	13.69	-2.12	2.23	486.6	108.0	0.499	488.0	27.8	11.75
26 14 0	90	0 88	89	8.6	4.6	2.67	0.75	0.45	17.4	55.0	0.294	8.8	5.4	2.00
77 29 15 0	0.9502	344.95	-1.695	474.9	31.6	13.45	-2.52	2.06	472.0	138.2	0.394	475.1	32.7	12.55
26 13 6	82	0 81	81	4.2	4.8	2.86	0.78	0.81	5.5	63.9	0.137	4.3	5.2	2.37
77 29 16 0	0.9500	344.16	-1.701	477.0	39.7	9.53	-2.02	7.71	472.0	209.3	0.345	477.6	38.5	9.97
26 14 27	22	0 21	21	4.0	2.8	3.48	1.15	21.51	5.2	75.9	0.180	4.4	6.2	3.07
77 29 17 0	0.9499	343.64	-1.704	477.3	29.1	11.41	-3.81	1.25	475.8	149.1	0.401	478.5	31.8	11.20
26 15 30	24	0 23	23	2.4	4.8	4.48	0.56	1.24	3.3	86.9	0.273	2.3	5.0	5.11
77 29 18 0	0.9497	343.72	-1.701	469.3	31.0	7.98	-1.85	3.28	471.9	211.1	0.297	469.1	31.9	7.58
26 15 15	49	0 47	48	4.4	5.5	3.33	1.24	1.25	28.8	67.5	0.177	3.6	5.9	3.45
77 29 19 0	0.9496	343.62	-1.701	463.9	37.5	8.27	-1.71	3.66	460.1	237.5	0.300	463.8	37.0	8.07
26 15 23	72	0 71	71	6.7	4.6	0.82	0.53	1.62	7.8	54.7	0.063	6.6	5.4	0.82
77 29 20 0	0.9495	343.45	-1.701	460.2	46.6	11.04	-2.00	4.19	514.9	418.0	0.271	460.2	46.0	10.33
26 15 47	83	0 82	82	7.8	4.5	1.87	0.92	0.41	85.1	204.6	0.163	8.3	5.4	1.89
77 29 21 0	0.9493	343.08	-1.703	457.4	36.7	14.49	-3.45	4.09	609.6	516.6	0.177	458.4	36.8	13.84
26 16 20	90	0 89	89	5.4	3.4	1.38	0.28	0.57	72.9	238.1	0.198	5.3	3.8	1.55
77 29 22 0	0.9482	344.46	-1.689	437.5	27.2	10.95	-4.55	1.10	526.5	246.3	0.340	438.8	27.9	9.53
26 13 50	90	0 89	88	4.0	4.2	2.85	0.75	0.87	91.2	234.5	0.344	4.0	4.9	2.37
77 29 23 0	0.9491	345.16	-1.681	425.7	27.8	13.41	-4.89	1.72	487.7	193.6	0.357	426.6	28.2	12.09
26 12 38	89	0 87	88	8.5	3.9	3.22	0.78	0.46	85.4	204.9	0.306	6.1	4.4	2.28
77 30 0 0	0.9488	344.90	-1.682	422.7	24.2	11.07	-5.33	3.53	538.7	343.7	0.264	423.8	24.3	10.13
26 13 2	70	0 68	69	4.3	4.9	2.27	0.48	1.89	82.8	239.9	0.284	3.7	4.7	2.86
77 30 1 0	0.9488	344.63	-1.683	419.8	39.9	7.05	-4.40	7.64	426.8	269.8	0.224	420.7	38.7	7.13
26 13 28	84	0 83	81	6.7	8.1	1.24	2.03	1.36	41.5	115.0	0.129	6.7	7.5	1.32
77 30 2 0	0.9486	344.21	-1.686	418.7	28.0	4.87	-2.55	3.21	417.6	128.9	0.207	419.1	27.1	5.85
26 14 16	90	0 89	86	3.3	8.2	0.94	1.76	3.57	17.3	67.2	0.143	2.8	7.6	0.83
77 30 3 0	0.9485	341.78	-1.707	435.8	23.3	5.80	0.89	1.60	434.0	107.6	0.503	434.7	24.8	5.07
26 18 35	90	0 89	89	5.6	4.5	1.01	0.62	0.31	6.5	31.3	0.135	5.7	6.0	1.81
77 30 4 0	0.9483	338.86	-1.723	449.3	35.6	5.77	0.97	-0.59	446.7	178.4	0.358	449.8	35.5	[illegible]

Figure 17: 1hr.-Averages same data as figure 16, but for CREFF = 0.1 AU. The time in each second line is the starting time at 0.1 AU.

```
*KZM:AMOSOUT.M4                 LAST MODIFIED 12.10.81               PAGE   1

C-------------------------------------------------------MIM:HELIOS.M4
C***   MITTELWERT PROGRAMM :  MAIN
C...................................................................
C   MITTELUNG DER PARAMETER
C                 01.8 80  KZM
C                 10.10.81
C
C                 VOM E1E2 MERGETAPE
C...................................................................
C...................................................................
C   * H E L I O S *       MITTELWERT-TAPE
C                          PLASMAPARAMETER + MAGNETFIELD DATA
C
C        AB 10.10.81 MIT AZIMUT-WINKEL KORR
C                   I1B ( WENN I1A NICHT VORHANDEN ) DICHTE KORR.
C
C   FORMAT:  DCB=(RECFM=FB,LRECL=320,BLKSIZE=6400)
C   ZAHLEN:  IBM BINARY FLOAT SINGLE PRECISION
C
C   INHALT:
C   WORDNR \     CONTENTS
C-----------\----------------------------------------------
C       1    \   YEAR (WITHOUT 19 )      + HELIOS 1      TIME OF FIRST
C            \                           - HELIOS 2      POINT IN INTERVAL
C       2    \   NUMBER OF DAY OF YEAR
C       3    \   MILLISECOND OF    DAY
C       4    \   ECLIPT.LONG OF HOS  (EARTH-SUN-LINE)
C       5    \   DISTANCE OF HOS FROM SUN (AU)           MEAN  OF INTERVAL
C       6    \   CARRINGTON LONGITUDE
C       7    \   CARRINGTON LATITUDE
C       8    \   CARRINGTON ROTATION NUMBER
C            \                   (Z.T.FEHLERHAFT,SOLLTE FUER
C            \          HOS-WINKEL=180 GRAD UM EINE ROTATION SPRINGEN)
C       9    \   MITTELWERT AUS  :: I1A=1 / I1B=-1 /  I3=+2 (AB 1980)
C      10    \
C-----------\--  P L A S M A   P A R A M E T E R S
C      11    \   PROTON VELOCITY        ( KM / SEC )
C      12    \          TEMPERATURE     ( K )
C      13    \          DENSITY         ( CM-3 )
C      14    \   ELEVATION ANGLE
C      15    \   AZIMUTH   ANGLE
C            \                   LESS 0 : PARTICLES COMING FROM
C            \                   RIGHT(NORTH) AS SEEN FROM HELIOS
C      16    \   ELEV.TEMPERATURE
C      17    \   AZIMUT TEMPERATURE
C      18    \   ALPHA PARTICLES: VELOCITY      ( KM / SEC )
C      19    \                    TEMPERATURE   ( K )
C      20    \                    DENSITY       ( CM-3  )
C            \
C-----------\--  M A G N E T I C   F I E L D   D A T A
C      21    \   FIELD COMPONENT IN +X IN 1/100 GAMMA
C      22    \                      +Y IN 1/100 GAMMA
C      23    \                      +Z IN 1/100 GAMMA
C-----------\-------------------
C      24    \   ENTHALPIE
C      25    \   KINETISCHE ENERGIE
C      26    \   GRAVITATIONERG.
C      27    \    N * V
C      28    \    VX                          KM / SEC
C      29    \    VY                          KM / SEC
C      30    \    VZ                          KM / SEC
C      31    \    ALFEN FLUSS
C      32    \    B                   GAMMA
C      33    \    B   PHI             GAMMA
C      34    \    B   EPSY            GAMMA
C            \
C-----------\--------------------------------------------------------
C  41-60     \    STANDART DEVIATION OF WORD 11 - 30
C-----------\-------------------
C      71    \    N1A :ANZAHL DER MITTELWERTE
C      72    \    N  WINKEL
C      73    \    N ALPHAS
C      74    \    N MAGNETFIELD
C-----------\-------------------
C
C      77    \    JEAR              START TIME OF AVERAGE INTERVAL
C      78    \    DAY
C      79    \    HOUR
C      80    \    MINUTE
```

Mittelwert = Average

Mittelung = averaging

Winkel = Angle

wenn I1a nicht vorhanden = if I1a does not exist

dichte = density

zahlen = numbers

Anzahl der mittelwerte = Number of averages

Figure 18: Content of the average bands for the Data exchange with the HELIOS experimenters

Last not least, still a plot representation to be mentioned which is a very simple but nevertheless very is instructive. This representation have we used first in our field of expertise and therefore such interesting results, that she now also routinely used by other groups.

There are the "stack plots", Figure 19. Here, only the intagrated E/q-spectra, which are still on the PB, plotted among each other over time. This, lots of raw data can be easily see through on special features.In fact, in the distribution functions there are often real specifics, which so to speak "smoothed off" by the usual integration process when evaluating. Figure 19 shows one of the most beautiful examples of this: A third peak, in addition to protons and α-particle!

We now know that here is simply charged helium ions, the existence of which is extremely unusual in the solar wind, and their discovering must therefore certainly be interpreted as sensation.The routine evaluation had shown nothing special for this 29.1.77 to 10:38 UT except for greatly increased α-particle speed, as it occurs more often (see the pictures 5, 9, 13, 14 and 15). Here but they stemmed from that "FIT1" had assigned the third peak to the α-particles. Only the stack plots that we routinely apply to all data have revealed this strange effect (and some others). It is natural to add that this routine appearance on stack plots and their sighting only by the microfiche system are possible.

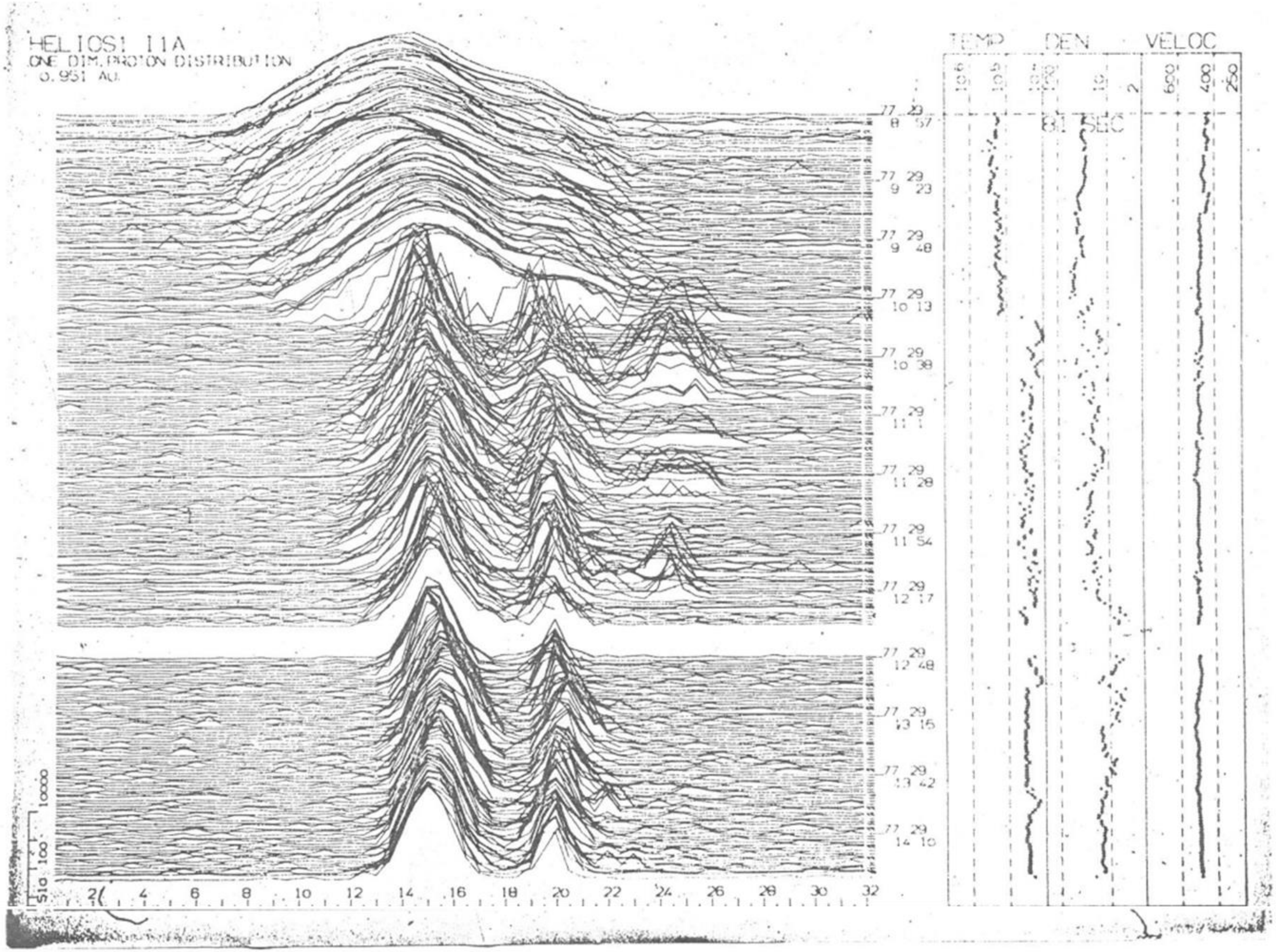

Figure 19: Example of "stacked plots"

6.The 3D-evaluation of protons and α-particles

The two instruments I1a and I3 made it due to their sophisticated technology for the first time, to measure the speed distribution function of protons and α-particle in full spatial resolution.The raw data include a three-dimensional grid of reference points: elevation (ϵ), azimuth (α) and energy (i.e.Amount of the velocity vector).From this, the distribution function without the adoption of any model can be calculated and presented using appropriate interpolations.These procedures are numerically very costly.So the full evaluation of a single Proton spectrum needed already 4 seconds Computing time on the IBM 360/91 of the MPP (compared with 40.5 seconds real measurement time!).This evaluation can of course not routinely be applied on all data. We restrict ourselves usually on a time interval of 10 minutes between the two evaluations, and differ only if certain physical tests require.

The details of this evaluation with many examples, as well as a number of results have been described recently in three detailed publications (Marsch et al., 1981a, b, c).Therefore, we want to refrain from repeating here.The core program itself has a size of approx.200 pages, to in turn get a number of organizational and plot programs. Print and explanation of these programs is beyond the scope of this report. Interested readers would however always happy to contact the authors.

In the following we show on three images look like the results in General. A basic problem is to represent a three-dimensional figure - this is the distribution function - in two dimensions.This can be for example cut the figure in all parallel planes, and then draw the contours of these layers as the contour lines of a region on a map. Such our distribution features contour plots show the pictures of 20 to 22. In these cases, we have chosen the location of the section planes so that both the magnetic field vector and the velocity vector are parallel to these levels (of course, we can choose any other location of the section planes).

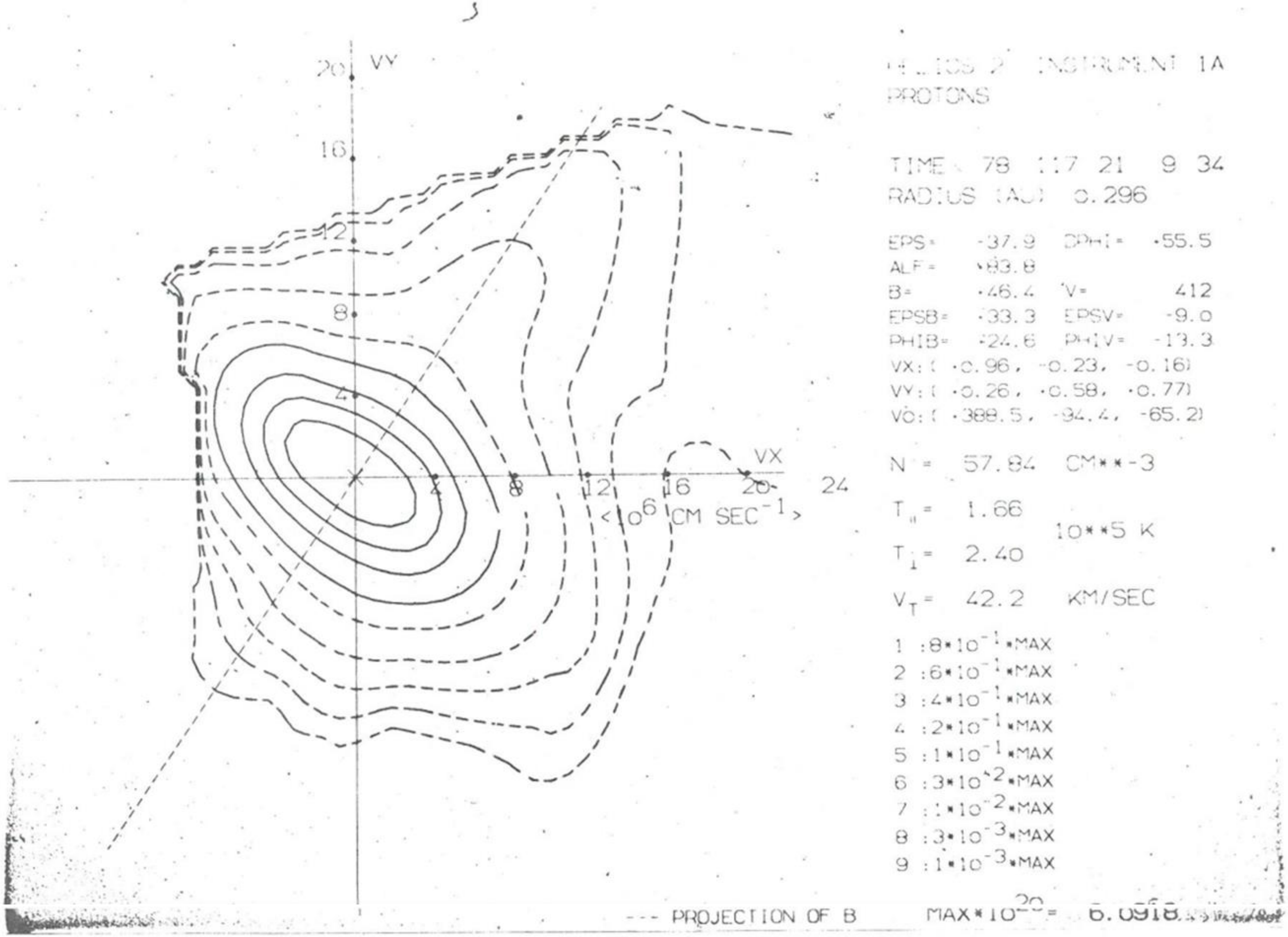

Figure 20: contour plot of Proton distribution function. The cuts were made along such levels holding also the vector of magnetic field and velocity.

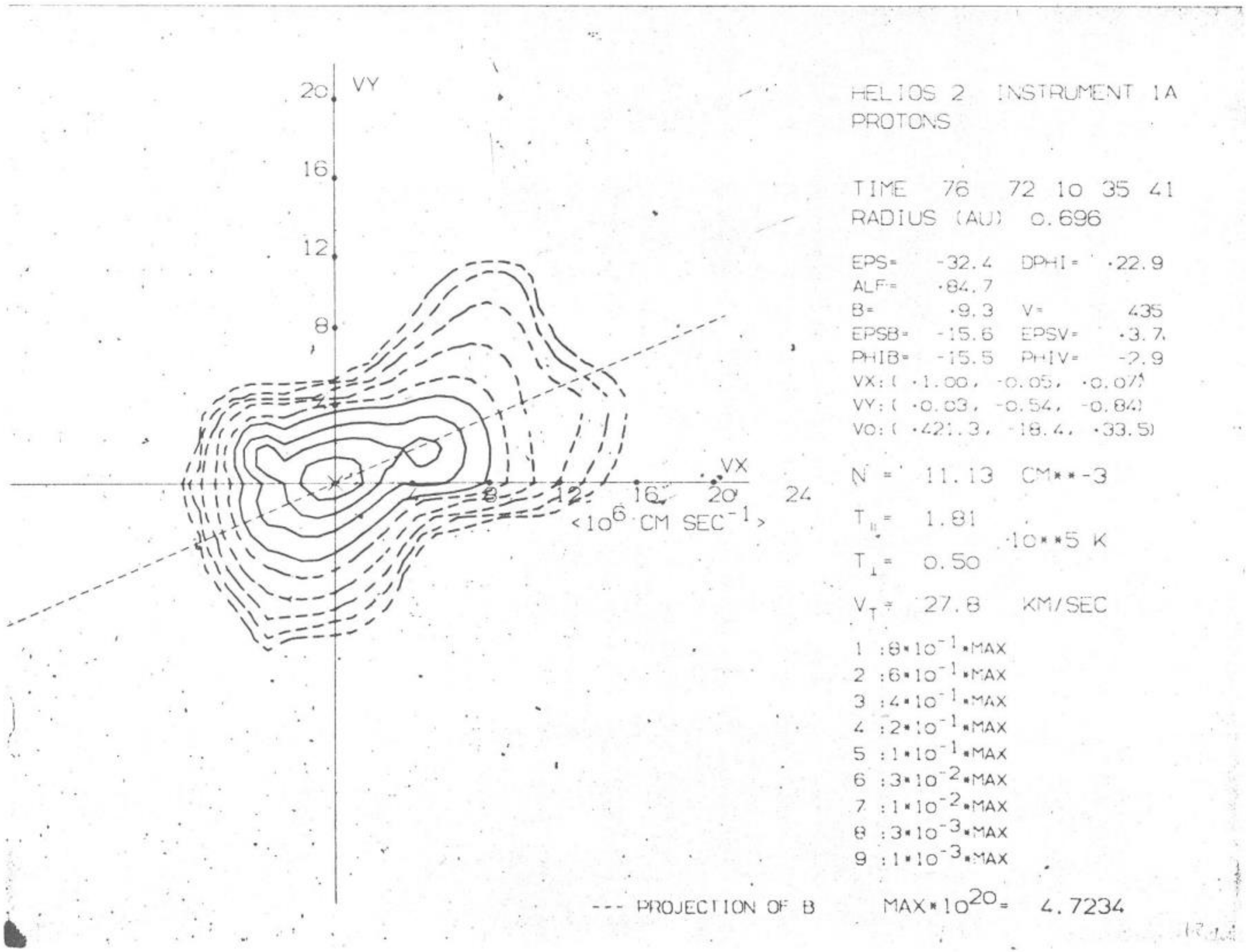

Figure 21: Similar contour plot as shown in Fig. 20

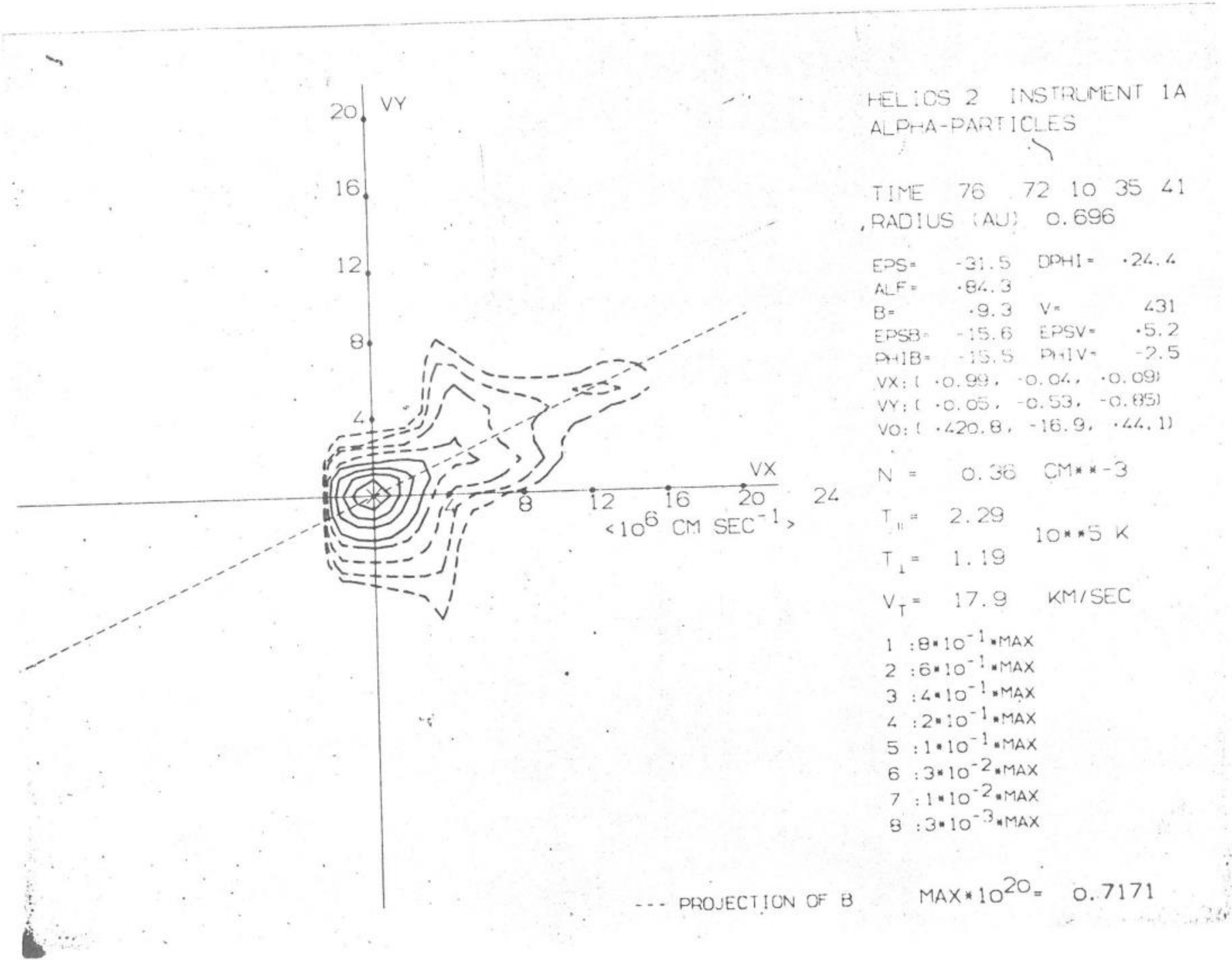

Figure 22: contour plot of α-particle distribution, It belongs to the same measurement as picture 20

Picture 20 shows a Proton distribution, which is typical of 'quick' solar wind close to the perihelion. The innermost dashed line corresponds to an intensity of 10% of the maximum. Here, the lines of lower intensity are cut by the finitely large measuring range.

The distribution is striking among other things:

- the symmetry to the direction of the magnetic field (dashed line),
- the greater extent transverse to the field in the core of distribution,
- the "shoulder" parallel to the magnetic field,
- Although typical of 'quick' solar wind, this distribution was measured in "slow" plasma of 412 kms^{-1}.

Figs. 21 and 22 show similar cuts by the protons, as well as the distribution of α-particles from a single spectrum. Both again demonstrate symmetry to the magnetic field direction, also a "shoulder" also occurs in two distributions, which are shaped at the protons even to a veritable second peak.

Here, the question immediately arises: what does that mean? In fact a tremendous fascination is just this 3D plots, which hardly anyone can resist. At this point we must confine ourselves but on the note to the mentioned publications.

7.The analysis of the electron data I2

The novel instrument I2 measures the energy spectrum of plasma electrons with angular resolution on the azimuth angle α. The second angle ϵ is not resolved, but rather the field of I2 is on an angle of incidence of $\Delta\epsilon = \pm 10°$ to the equatorial plane of HELIOS around limited (A182).

To evaluate this thus two-dimensional distribution function of electrons, we have developed procedures which are the 3D-evaluation in principle similar to those.The functions themselves are however fundamentally different, and a number of other difficulties arise.The most significant problem is the electrostatic potential, which adopts HELIOS compared to the surrounding plasma, because it affects the low-energy electrons (A31). An important part of the evaluation of the electron is therefore the identification of this potential and the corresponding corrections. A further complication arises from the fact that we need to include the direction of the magnetic field in the evaluation.

This program requires considerable computational time, so that we must limit ourselves also to a meaningful selection of data. Because the electron Spectra usually not change in very short time scales, we evaluate them only every 10 minutes. Also, there are exceptions. So we evaluate always all Spectra, where the magnetic field is located within the mentioned ϵ-field, as well as in cases of special physical interest.

The appearance of the I2-data will also be in contour plots (fig. 23). Here you can see clearly a high spot in the direction of the magnetic field, the "beam" discovered by these measurements in the distribution function.

Figure 24 shows an example a microfiche expression of the electron parameter. Also here are different evaluation methods are compared with each other, much like for "FIT1" described on page 31.

Also this evaluation program is so extensive and intricate that it has no place in this report. But also it is true that we would like to give personally interested parties information about it.

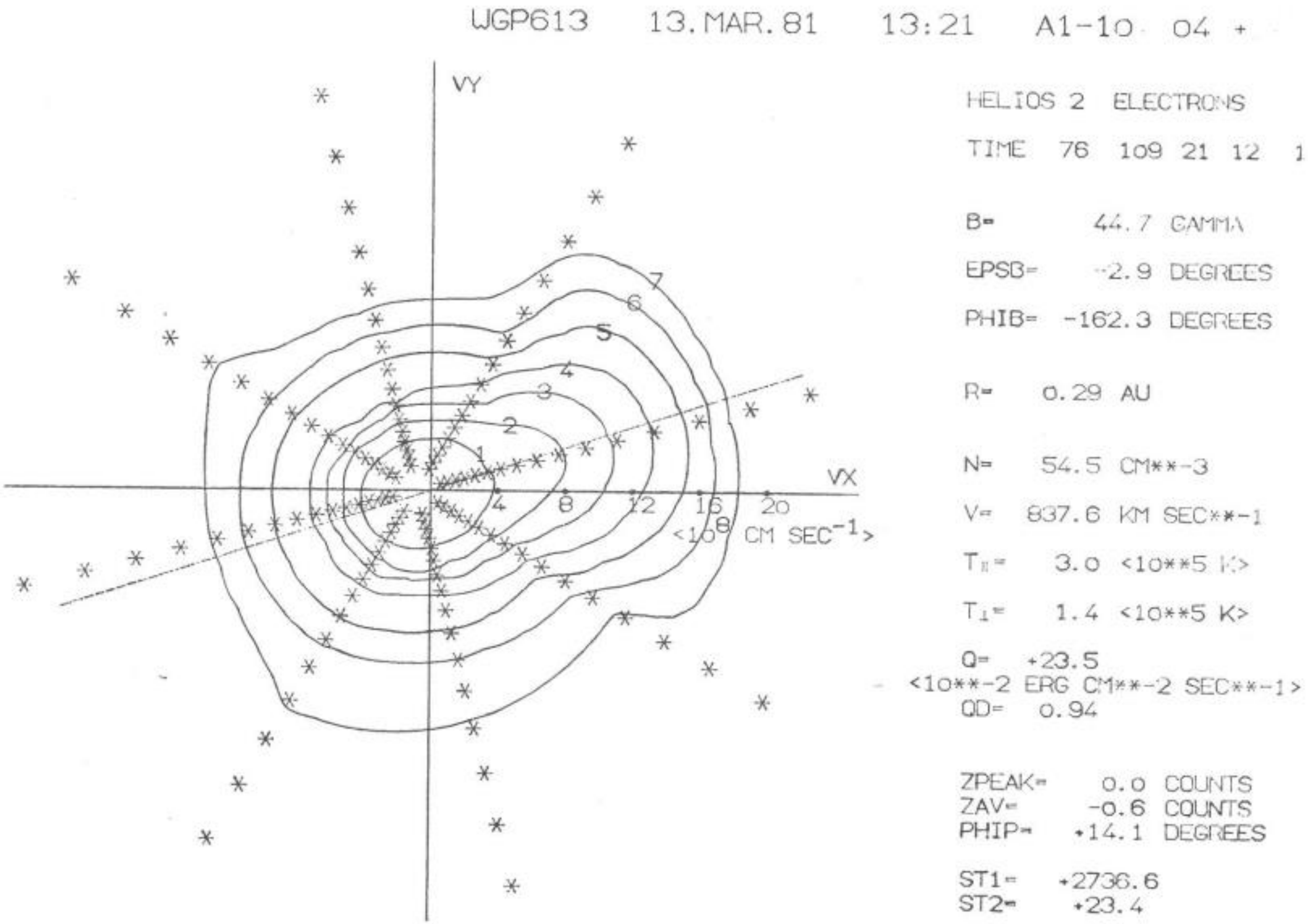

Figure 23: contour plot of electron spectrum.
The cuts are made in a plane parallel to the equatorial plane of HELIOS is located in its proximity in this case also the magnetic field vector.

Zeit = Time
Tag = Day
Ausgabe = Output

JOB WGP819 09.12.78 00.35:06 HELIOS 2 1976 ANALYSIS-BAND NR. 524 AUSGABE-BAND NR. CA7401 FILE NR. 9

ZEIT				ORBIT	FIT-PARAMETER						NUM.-PARAMETER					PROT.-P.		STR.-P.					MODE	
TAG	ST	MI	SK	RS AU	DF CM**-3	VF KM/S	T1F 1E5K	T2F 1E5K	DN CM**-3	VN KM/S	ALF GRAD	EPS GRAD	TP 1E5K	TS 1E5K	Q 1E-2 ERG/(CM**2*S)	DPP CM**-3	VPP KM/S	ST	EPOT VOLT	OP VOLT	EPSB GRAD	DPHI GRAD	BIT/F/DM	A/D/U
121	2	31	37	.408	87.7	133	3.5	3.0	86.4	454	-2	3	4.5	3.4	28.8	44.2	354	70	0	2	5	8	2048/1/3	1/H/1
121	2	32	17	.408	83.0	147	3.2	2.8	87.3	440	-3	3	4.3	3.4	27.3	42.6	357	25	0	3	4	-13	2048/1/3	1/H/1
121	2	32	58	.408	76.1	120	2.9	2.5	87.2	439	1	3	4.5	3.3	28.1	44.8	357	39	156	2	4	9	2048/1/3	1/H/1
121	2	33	38	.408	81.0	126	3.2	2.8	87.1	437	-5	4	4.4	3.4	29.5	42.6	357	40	110	3	5	-12	2048/1/3	1/H/1
121	2	34	19	.408	80.0	115	3.3	2.8	85.2	450	4	4	4.6	3.3	29.2	43.3	357	27	110	2	6	10	2048/1/3	1/H/1
121	2	34	59	.408	85.7	134	3.3	2.9	88.0	439	-3	4	4.4	3.4	28.9	44.6	356	53	110	2	6	-18	2048/1/3	1/H/1
121	2	35	40	.408	85.2	157	3.5	3.0	84.9	445	1	4	4.6	3.3	27.8	42.5	354	97	110	2	6	9	2048/1/3	1/H/1
121	2	36	20	.408	84.1	147	3.6	2.9	86.0	437	-6	3	4.4	3.4	29.0	41.9	357	27	155	3	5	-13	2048/1/3	1/H/1
121	2	37	1	.408	92.0	203	3.6	3.4	85.3	435	-3	3	4.6	3.3	28.0	42.1	354	50	155	3	5	10	2048/1/3	1/H/1
121	2	37	41	.408	71.6	142	2.8	2.5	84.9	438	-4	3	4.5	3.4	28.4	43.1	357	92	156	2	5	-12	2048/1/3	1/H/1
121	2	38	22	.408	80.9	48	2.9	2.8	84.7	478	-3	6	4.3	3.3	31.2	43.2	357	60	110	2	6	12	2048/1/3	1/H/1
121	2	39	2	.408	81.5	52	3.0	2.8	85.0	441	-1	6	4.1	3.3	30.0	42.0	355	49	0	3	6	-10	2048/1/3	1/H/1
121	2	39	43	.408	82.5	188	3.1	2.9	88.8	419	4	4	4.6	3.3	26.2	43.1	352	49	155	3	7	11	2048/1/3	1/H/1
121	2	40	23	.408	85.5	83	3.4	2.9	87.3	443	-9	5	4.3	3.4	32.4	44.7	356	30	110	2	7	-15	2048/1/3	1/H/1
121	2	41	4	.408	83.1	38	3.1	2.6	89.6	447	3	-7	4.4	3.3	35.0	44.9	357	48	111	0	7	9	2048/1/3	1/H/1
121	2	41	44	.408	87.2	58	3.1	2.9	90.8	437	-2	6	4.3	3.3	31.7	46.5	349	57	110	1	7	-13	2048/1/3	1/H/1
121	2	42	25	.408	78.5	188	3.0	2.6	88.5	453	3	4	4.6	3.3	28.2	44.3	354	58	110	2	7	11	2048/1/3	1/H/1
121	2	43	5	.408	88.5	333	3.1	2.8	92.2	423	-4	0	4.2	3.3	22.0	44.9	356	51	155	3	0	-10	2048/1/3	1/H/1
121	2	43	46	.408	84.2	305	2.8	2.7	90.9	417	0	0	4.4	3.2	22.5	46.0	357	68	156	2	0	11	2048/1/3	1/H/1
121	2	44	26	.408	89.2	266	3.1	3.0	89.9	415	-5	1	4.3	3.4	23.3	44.8	354	64	156	3	3	-11	2048/1/3	1/H/1
121	2	45	7	.408	90.0	225	3.1	2.9	93.4	398	5	0	4.5	3.3	24.1	46.8	358	50	157	0	0	13	2048/1/3	1/H/1
121	2	45	47	.408	93.0	276	3.3	3.1	90.2	411	-1	-2	4.3	3.3	23.6	45.8	356	48	156	2	-6	-9	2048/1/3	1/H/1
121	2	46	28	.408	82.5	301	2.9	2.8	88.0	418	3	-1	4.4	3.2	22.5	44.9	355	67	156	2	-2	12	2048/1/3	1/H/1
121	2	47	8	.408	85.5	356	3.4	3.0	85.8	412	0	0	4.3	3.4	21.1	43.6	352	37	156	2	0	-11	2048/1/3	1/H/1
121	2	47	49	.408	90.9	268	3.3	3.0	90.0	406	2	0	4.5	3.3	22.8	45.2	352	48	157	0	-1	11	2048/1/3	1/H/1
121	2	48	29	.408	82.5	305	3.2	2.9	86.2	420	0	0	4.3	3.4	22.1	43.6	353	53	156	2	-2	-11	2048/1/3	1/H/1
121	2	49	10	.408	83.1	233	3.2	2.8	86.6	397	4	0	4.4	3.2	21.1	42.8	351	32	155	3	-1	11	2048/1/3	1/H/1
121	2	49	50	.408	88.0	247	2.9	2.7	86.7	435	-3	0	4.1	3.3	23.0	43.2	353	34	155	3	-1	-12	2048/1/3	1/H/1
121	2	50	31	.408	81.6	258	2.9	2.7	87.8	402	6	-1	4.4	3.2	20.2	44.5	353	67	156	2	-3	12	2048/1/3	1/H/1
121	2	51	11	.408	85.4	203	3.1	2.9	91.8	415	-9	2	4.4	3.4	26.9	45.1	352	42	156	3	4	-12	2048/1/3	1/H/1
121	2	51	52	.408	84.2	209	3.0	2.8	91.4	422	2	1	4.6	3.2	27.3	46.2	354	83	156	2	2	12	2048/1/3	1/H/1
121	2	52	32	.408	92.5	184	3.4	3.1	90.8	414	-3	1	4.4	3.3	28.6	44.1	352	62	155	3	2	-11	2048/1/3	1/H/1
121	2	53	13	.408	92.6	183	3.2	3.1	92.5	429	0	2	4.5	3.2	28.2	47.2	351	55	156	1	3	11	2048/1/3	1/H/1
121	2	53	53	.408	85.6	156	3.3	2.8	90.8	405	-5	2	4.3	3.4	26.6	45.6	352	72	0	2	3	-11	2048/1/3	1/H/1
121	2	54	34	.408	87.0	114	3.0	2.5	95.2	442	-4	-1	4.4	3.3	31.1	48.0	352	49	112	0	2	12	2048/1/3	1/H/1
121	2	55	14	.408	90.4	84	3.3	2.9	92.4	428	-4	2	4.3	3.3	29.6	46.3	351	48	110	2	3	-11	2048/1/3	1/H/1
121	2	55	55	.408	87.3	103	3.0	2.6	94.7	445	3	-2	4.5	3.3	30.3	47.8	350	28	112	0	3	12	2048/1/3	1/H/1
121	2	57	16	.408	91.9	187	3.5	3.1	90.1	423	1	2	4.6	3.3	25.6	45.5	353	49	156	2	4	12	2048/1/3	1/H/1
121	2	57	56	.408	82.7	221	3.0	2.8	90.0	411	-6	3	4.4	3.4	25.3	45.4	353	69	156	2	6	-10	2048/1/3	1/H/1
121	2	58	37	.408	75.3	226	2.7	2.5	87.3	425	-1	3	4.4	3.3	22.8	44.6	351	40	156	2	7	14	2048/1/3	1/H/1
121	2	59	17	.408	79.7	257	2.6	2.5	89.4	402	-1	2	4.2	3.3	20.7	44.6	356	93	156	3	5	-12	2048/1/3	1/H/1
121	2	59	58	.408	103.2	87	2.9	2.3	99.8	460	5	3	3.6	3.0	32.9	46.0	357	21	0	3	3	7	2048/1/3	1/H/1
121	3	0	38	.408	91.0	114	2.8	2.6	93.2	466	-9	2	3.8	3.2	28.0	46.4	351	19	0	3	2	-16	2048/1/3	1/H/1
121	3	1	19	.408	97.4	138	2.9	2.8	96.4	445	-6	0	4.0	3.2	29.4	48.5	350	22	0	0	0	6	2048/1/3	1/H/1
121	3	1	59	.408	90.9	306	2.9	2.8	93.8	424	0	0	4.1	3.2	20.4	47.8	351	43	156	1	-1	-15	2048/1/3	1/H/1
121	3	2	40	.408	103.0	206	3.0	2.6	101.0	373	-3	-4	3.5	3.1	18.3	45.1	353	16	0	4	-8	-2	2048/1/3	1/H/1
121	3	3	20	.408	119.1	129	2.5	2.2	118.3	450	-10	4	3.3	3.0	27.1	60.6	333	16	0	-1	-6	-22	2048/1/3	1/H/1
121	3	4	1	.408	124.1	182	2.5	2.5	118.0	458	-8	-1	3.4	2.7	27.2	60.1	332	17	0	1	-1	-2	2048/1/3	1/H/1
121	3	4	41	.408	120.6	125	2.5	2.1	121.1	423	-11	0	3.2	2.9	27.4	59.6	330	26	0	2	0	-16	2048/1/3	1/H/1
121	3	5	22	.408	119.1	145	2.3	2.2	119.7	418	0	3	3.3	2.8	27.8	60.7	328	14	0	1	4	0	2048/1/3	1/H/1
121	3	6	2	.408	127.6	147	2.5	2.3	123.8	445	3	4	3.2	2.8	26.0	62.2	329	17	0	0	5	21	2048/1/3	1/H/1
121	3	7	23	.408	131.7	120	2.5	2.2	122.0	421	-10	-4	3.2	2.9	29.5	62.3	325	24	0	-1	5	-16	2048/1/3	1/H/1
121	3	8	44	.408	126.0	132	2.5	2.1	124.2	405	-1	6	3.2	2.9	28.6	61.6	325	14	0	2	8	-22	2048/1/3	1/H/1
121	3	14	49	.408	86.7	204	2.9	2.7	92.1	429	-1	6	4.4	3.3	22.9	45.5	349	43	156	3	10	17	2048/1/3	1/H/1
121	3	15	29	.408	85.8	275	2.6	2.5	96.3	422	0	2	4.1	3.3	18.7	48.9	351	56	219	1	5	-13	2048/1/3	1/H/1

Figure 24: Example for the microfiche expression of the electron parameter

Final word

Analysis of plasma data from HELIOS continues in full swing at all levels.The system here described proven been excellent.For one there is the progress of individual work us always an exact overview.On the other hand, it allows the output of all sizes interested in very clear, complete and user-friendly form.The scientific work with these diverse results is never hindered by people until long would have to rummage, through coils micro film role looking after certain data in large bursts of paper and even run special of jobs. This system receives a new quality due to any data at multiple time scales on microfiche: it can be very concentrated in a short time large amounts of data to certain characteristics, similarities etc. and scan. This has enabled us already some discoveries that would otherwise have been overlooked.

The structure of this whole system is in almost all details the work of one man, namely Karl-Heinz Mühlhäuser by the MPE in Garching, which we can never thank enough for this. There are only a few parts in the whole diagram (fig. 2), the he's not either fully or substantial part would have programmed. Expertise, skill, and seemingly unshakable peace he maintained even today the routine evaluation and helping intervenes when problems arise.

A few more names of employees, in which we also want to thank you, must be called. This includes H. Antrack, who wrote the programs for the raw data processing in the MPE. The broad to FIT programs come from Michael D. Montgomery. Eckhard Marsch has created the moment program of 3D-evaluation based on previous programs by Werner Pilipp. This in turn has developed the electron program, which initially Hans Miggenrieder has participated. The universal-plot program comes from wife Sandra Zink, who recycled the experiences and routines by Norbert Sckopke build modular plots while in their present form.

And finally we thank especially Miss Ida Lipp, on whose shoulders rests the burden of daily routine work. She has several times between the archive and the calculators back and dragged her, sorted, catalogued all the previously 3000 data tapes and sent even the most routine jobs, with occasional support from H. Kipp.

Also, we want to not miss in turn to thank the BMFT (here representing the German program scientist H. Otterbein) for the financing of the data analysis. Only in this way the scientific yield of the size and importance of the HELIOS project could be fine.

In addition, we thank very Lord Dr. Kempe, our project coordinator at the DFVLR BPT, for his unparalleled commitment to the completion of this report, and finally also in turn Mrs Ute Spilker for the prompt completion of the artwork.

Literature

In addition to the literary quotations on A221ff mentioned here should only the following more recent works are mentioned:

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List of Abbreviations

AB	Analysis tape
AG	Contracting Authority
AHK	Analogue house-keeping data
AN	Contractor
BM	Bitrate mode
BMFT	Federal Ministry for research and technology
BPI	bit per inch
BPS	bits per second
BPT	Area for project funds in the DFVLR
BSP	bit shift pulse
BTC	block transfer clock pulse
CEM	channel electron multiplier ("Channeltron")
CMD	Telemetry command
CP	Amendment
DFVLR	German Research and testing institute Aerospace registered association
DHK	Digital house-keeping data
DM	distribution mode
E1	experiment 1
E1A	Box containing I1a, I1b, and electronics
E1B	Box containing I2 and electronics
E1C	Box containing I3 and electronics
E1D	Box that contains digital electronics
EDF	experiment data frame
EDR	Experimenter band
EM	Engineering model
F1	Flight unit for HELIOS-1
F2	Flight unit for HELIOS-2
FM	format (telemetry format)
GB	large block length
GfW	Society for space research at the DFVLR
GMT	Greenwich Mean Time
HAN	prime contractor (MBB)
HDM	high data mode

HGOS	HELIOS ground operation system
HP	Hewlett Packard
HTS	HELIOS test set
HV	High-voltage
I1a	3D-Ion instrument with CEMs
I1b	1D-Ion instrument with electrometer
I2	2D-Electron instrument
I3	3D-Ion instrument with CEMs, dynamic mass spectrometer
IABG	Industrial plants operating company in Ottobrunn
IBM	International business machines Co.
IST	integrated system test
JPL	Jet Propulsion Laboratory
KB	small block length
KSC	Kennedy Space Center, Florida, USA
KV	No shift (KV ≡ NS)
LSB	least significant bit
MB	Average band
MBB	Messerschmitt-Bölkow-Blohm in Ottobrunn
MF	Microfiche
MPP	Max Planck Institute for plasma physics
MV	with shift (MV ≡ WS)
NDM	normal data mode
NS	without shift
NZR	Zero count rate
O/A	orbit/attitude
OB	Orbit band
P	Prototype
PB	Parameter band
PHA	Pulse height analysis
S/C	Spacecraft
SCT	spacecraft event time
SDB	science data block
UHV	Ultra high vacuum
UP	Sub programme
UT	Universal time
UV	Ultraviolet (UV)
WS	with shift
WTC	Word transfer clock pulse

The authors of this report are happy to provide upon written request of interested readers more program lists.