LION/COSTEP

Level-2 Data Format Specification

for SOHO Archive

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1. Data Product

The LION instrument (Low energy ION and Electron instrument) forms part of the COSTEP experiment (COmprehensive SupraThermal and Energetic Particle Analyser) within the CEPAC collaboration on bord of the SOHO spacecraft (SOlar and Heliospheric Observatory). For a detailed description of the SOHO mission and the COSTEP experiment see *Solar Physics*, **162**, 1995.

The LION instrument produces scientific and housekeeping data at a constant rate of 49 bit/s or 4.3 megabit per day (Level Zero data). This data set is processed at the University of Kiel in two steps yielding Level 1 and Level 2 products. The Level 2 data set is organized in 1 file per day, containing housekeeping and counting rate information (~ 2.6 megabyte per day) together with its detached header file. These two files are archived in the SOHO archive at GSFC.

CAVEAT: **Due to detector noise problems which started shortly after switch-on, the instrumental background rate is high and careful analysis is required!**
In particular, telescope T1 (the telescope without a magnet) is producing unreliable data. See Section 5 for a detailed performance history.

Data File:

File Contents	Name Convention
LION housekeeping and counting rates	LIxyydoy.SL2 1995 - 1999: x=O since 2000: x=P

Detached Header File:

File Contents	Name Convention
File header for data file	LIxyydoy.MS2 1995 - 1999: x=O since 2000: x=P

- Housekeeping data are given in physical units.
- Counting rates are given as intensities in units of counts/cm^2 s sr MeV, a subset of counting rates (called *event counts*) is given as counting rates in units of counts/s. The factors which were used to convert counting rates into intensities are given in chapter 4.
- Time resolution is 15 seconds (exact accumulation period is 14.988 seconds).
- The file names include year and day of year. The character “x” must be replaced by the letter “O” or “P” before or after 2000.

2. Data Format Description

2.1 Housekeeping and counting rates file: LIxyydoy.SL2

One LION data set consists of 5 records: one housekeeping record and four 15-second counting rate records, thus covering 1 minute. Housekeeping parameters alternate from minute to minute between a valid reading and a zero (= invalid) reading.

First record:

Item	Label	Data Type	Data Contents		Units
1	PB5 Year	integer	year		year 4 digits
2	DOY	integer	day of year		day 1 ... 366
3	MS	integer	milliseconds of day		ms 0 ... 86,400,000
4	S / C Epoch	float (double)	ms since year 0		ms 14 digits
5	Ground potential	float	0.	GND1	mV
6	Ground potential	float	0.	GND2	mV
7	Bias current	float	CurT1D2	0.	nA
8	Bias current	float	CurT2D2	0.	nA
9	Reference voltage	float	0.	Ref1	mV
10	Reference voltage	float	0.	Ref2	mV
11	Power rail current	float	Cur+5V	0.	mA
12	Power rail current	float	Cur+6V	0.	mA
13	Bias current	float	0.	CurT1B	nA
14	Bias current	float	0.	CurT2B	nA
15	Power rail current	float	Cur-6V	0.	mA
16	Temperature	float	Temp	0.	°C
17	Bias current	float	CurT1D1	0.	nA
18	Bias current	float	CurT2D1	0.	nA
19	Power rail voltage	float	0.	+6V	V
20	Power rail voltage	float	0.	+5V	V
21	Discriminator threshold	integer	1st acquisition period		binary
22	Discriminator threshold	integer	2nd acquisition period		binary
23	Discriminator threshold	integer	3rd acquisition period		binary
24	Discriminator threshold	integer	4th acquisition period		binary
25	Test pulse generator	integer	1st acquisition period		binary
26	Test pulse generator	integer	2nd acquisition period		binary
27	Test pulse generator	integer	3rd acquisition period		binary
28	Test pulse generator	integer	4th acquisition period		binary

Note: Related to the detector noise problem, the bias current readings in this record are not reliable and the following housekeeping parameters may show persistently a zero value: items 5, 8, 9, 17, and 19.

Second record:

Item	Label	Data Type	Data Contents	Units
1		integer		hour
2	Time Tag	integer	1st acquisition period	minute
3		integer		second
4	T2D1 p 300 - 750 keV	float	intensity	/cm^2 s sr MeV
5	T2D1 p 0.75 - 2 MeV	float	intensity	/cm^2 s sr MeV
6	T2D1 p 2 - 6 MeV	float	intensity	/cm^2 s sr MeV
7	T2D1 He 7 - 26 MeV	float	intensity	/cm^2 s sr MeV
8	T2D2 p 300 - 750 keV	float	intensity	/cm^2 s sr MeV
9	T2D2 p .75 - 2 MeV	float	intensity	/cm^2 s sr MeV
10	T2D2 p 2 - 6 MeV	float	intensity	/cm^2 s sr MeV
11	T2D2 He 7 - 26 MeV	float	intensity	/cm^2 s sr MeV
12	T2D1 p 40 - 80 keV	float	intensity	/cm^2 s sr MeV
13	T2D1 p 80 - 125 keV	float	intensity	/cm^2 s sr MeV
14	T2D1 p 125 - 200 keV	float	intensity	/cm^2 s sr MeV
15	T2D1 p 200 - 300 keV	float	intensity	/cm^2 s sr MeV
16	T2D2 p 40 - 80 keV	float	intensity	/cm^2 s sr MeV
17	T2D2 p 80 - 125 keV	float	intensity	/cm^2 s sr MeV
18	T2D2 p 125 - 200 keV	float	intensity	/cm^2 s sr MeV
19	T2D2 p 200 - 300 keV	float	intensity	/cm^2 s sr MeV
20	T1D1 p+e 40 - 80 keV	float	intensity	/cm^2 s sr MeV
21	T1D1 p+e 80 - 125 keV	float	intensity	/cm^2 s sr MeV
22	T1D1 p+e 125 - 200 keV	float	intensity	/cm^2 s sr MeV
23	T1D1 p+e 200 - 300 keV	float	intensity	/cm^2 s sr MeV
24	T1D2 p+e 40 - 80 keV	float	intensity	/cm^2 s sr MeV
25	T1D2 p+e 80 - 125 keV	float	intensity	/cm^2 s sr MeV
26	T1D2 p+e 125 - 200 keV	float	intensity	/cm^2 s sr MeV
27	T1D2 p+e 200 - 300 keV	float	intensity	/cm^2 s sr MeV
28	T1D1 p 300 - 750 keV	float	intensity	/cm^2 s sr MeV
29	T1D1 p 0.75 - 2 MeV	float	intensity	/cm^2 s sr MeV
30	T1D1 p 2 - 6 MeV	float	intensity	/cm^2 s sr MeV
31	T1D1 He 7 - 26 MeV	float	intensity	/cm^2 s sr MeV
32	T1D2 p 300 - 750 keV	float	intensity	/cm^2 s sr MeV
33	T1D2 p 0.75 - 2 MeV	float	intensity	/cm^2 s sr MeV
34	T1D2 p 2 - 6 MeV	float	intensity	/cm^2 s sr MeV
35	T1D2 He 7 - 26 MeV	float	intensity	/cm^2 s sr MeV
36	T1D1 Event Counts	float	single detec. channel	counts/s
37	T2D1 Event Counts	float	single detec. channel	counts/s
38	T1D2 Event Counts	float	single detec. channel	counts/s
39	T2D2 Event Counts	float	single detec. channel	counts/s
40	T1B Event Counts	float	single detec. channel	counts/s
41	T2B Event Counts	float	single detec. channel	counts/s
42	Spare			

Third record:

Item	Label	Data Type	Data Contents	Units
1 2 3	Time Tag	integer integer integer	2nd acquisition period	hour minute second
4 - 42	see second record			

Fourth record:

Item	Label	Data Type	Data Contents	Units
1 2 3	Time Tag	integer integer integer	3rd acquisition period	hour minute second
4 – 42	see second record			

Fifth record:

Item	Label	Data Type	Data Contents	Units
1 2 3	Time Tag	integer integer integer	4th acquisition period	hour minute second
4 - 42	see second record			

2.2 Header for HK and counting rates file: LIxyydoy.MS2

Example:

St. Patrick`s College, Maynooth, Ireland
Department of Experimental Physics
PI: H. Kunow
Program: LL2_2.PRO
Program_Version: 2.0
Data_Version: V01
Project: SOHO-COSTEP
Instrument: LION
Data_Type: H/K-Data and Science-Data (Intensities)
Data_File_Name: LIO96252.SL2
Data_File_Type: ASCII
Generation_Date: Wed Sep 25 16:10:16 1996
Data_Period_Start: 1996-09-08 00:00:38
Data_Period_End : 1996-09-08 23:59:31
Parameter_File_Name: -

3. LION Status Word

The LION status word in words 21 - 24 and 25 - 28 of the HK and counting rates file is implemented by hardware in the onboard LION electronics and telemetered to ground. It contains two flags, one to indicate whether the discriminator thresholds have been raised by 10 %, and one to indicate whether the inflight test pulse generator is in operation. These two flags are sampled in each of the 4 accumulation periods. Nominal status is all zero.

Label	1st period	2nd period	3rd period	4th period
Discriminator threshold	0	0	0	0
Test pulse generator	0	0	0	0

4. LION Intensity Factors

Most part of the Level-2 counting rates are already converted into intensities [counts/(cm^2 s sr MeV)] by dividing the counting rates [counts/s] through the intensity factor:

Intensity Factor = Geometry Factor • Energy Window [cm^2 sr MeV]

Channel	**Geometry factor**	**Energy window**	**Intensity factor**
p or p+e or He	cm^2 sr	MeV	cm^2 sr MeV
40 – 80 keV	0.174	0.0374	0.0065
80 – 125 keV	0.174	0.0460	0.0080
125 – 200 keV	0.174	0.0637	0.0111
200 – 300 keV	0.174	0.1158	0.0201
300 – 750 keV	0.174	0.4508	0.0784
0.75 – 2 MeV	0.174	1.229	0.2138
2 – 6 MeV	0.174	4.048	0.704
7 – 26 MeV	0.174	19.15	3.33

5. LION performance 1996-2007

T1D1 p+e

1996	DOY 5-90	40-80 keV background higher (1000 vs. 200 p/cm^2 s sr MeV), other channels normal
	DOY 90-365	normal
1997		normal
1998	DOY 0-175	normal
	DOY 280-350	all channels lower by a factor of 10 (reason unknown)
1999	DOY 30-365	40-80 keV high (1000), others normal
2000	DOY 0-230	40-80 keV high (1000), others normal
	DOY 230-240	data gap
	DOY 240-257	all channels very high
	DOY 257-365	normal
2001	DOY 0-34	normal
	DOY 36-92	all channels very high and noisy
	DOY 92-135	normal
	DOY 142-177	all channels very high and noisy
	DOY 177-222	still high but events can be seen
	DOY 222-267	very high and noisy
	DOY 276-365	normal
2002	DOY 0-98	normal
	DOY 98-155	all channels very high and noisy
	DOY 155-195	normal
	DOY 195-280	all channels very high and noisy
	DOY 280-365	normal
2003		all channels: high fluxes but events are seen
2004		bad data
2005		bad data
2006		bad data
2007		bad data

T1D2 p+e

1996	DOY 50-365	40-80 keV backgr. increases from 500 to 4000, then levels off at 2000, other channels normal
1997		40-80 keV high (2000), others normal
1998	DOY 0-175	40-80 keV high (3000), others normal
	DOY 280-350	40-80 keV incr. to 1e4, others lower by ~10
1999	DOY 50-75	very high fluxes in all channels
	DOY 50-300	40-80 keV high (1e5), other channels also elevated by ~10
	DOY 300-365	extreme fluctuations in all channels
2000	DOY 0-170	high background in all channels. large fluctuations
	DOY 170-365	40-80 keV high (4000), others normal
2001		40-80 keV high (4000), others normal
2002	DOY 0-98	normal
	DOY 98-140	all channels abnormally high and noisy
	DOY 140-227	normal
	DOY 227-365	all channels abnormally high and noisy
2003	DOY 0-30	all channels abnormally high and noisy
	DOY 30-365	all channels: elevated background but events are seen
2004	DOY 0-125	40-80 keV high (3000), others normal
	DOY 125-250	all channels high
	DOY 250-365	40-80 keV high (3000), others normal
2005	DOY 0-175	40-80 keV high (3000), others normal
	DOY 175-205	all channels abnormally high and noisy
	DOY 205-365	40-80 keV high (3000), others normal
2006	DOY 0-135	40-80 keV high (3000), others normal
	DOY 136-234	all channels abnormally high and noisy
	DOY 235-365	40-80 keV high (3000), others normal
2007	DOY 0-129	40-80 keV high (4000), others normal
	DOY 152-233	all channels abnormally high and noisy

	DOY 242-365	40-80 keV high (3000), others normal

T2D1 p

1996	DOY 75-	40-80 keV increases from 100 to 1e5, then levels off at 1e4
		80-750 keV incr. by a factor of 2 to 5
1997	DOY 0-250	40-80 keV decr. from 1e4 to 200, then remains normal
1998	DOY 0-175	40-80 keV incr. from 200 to 1000
	DOY 280-350	all channels lower by ~10
1999		normal
2000		normal
2001		normal
2002		normal
2003		normal
2004		normal
2005		normal
2006		normal
2007		normal

T2D2 p

1996	DOY 100-	40-80 keV incr. from 100 to 2e4
		80-750 keV incr. by a factor of 2 to 5
1996	DOY 325-350	40-80 keV incr. from 1e4 to 2e5
		80-125 keV incr. from 100 to 1000
1997	DOY 0-350	40-80 keV decr. from 1e5 to 1e4
	DOY 0-100	80-125 keV high (1000) then decreases to normal
1998		40-80 keV high (1e4)
1998	DOY 280-350	higher channels lower by a factor of 10
1999		40-80 keV high (5000), others normal
2000		40-80 keV high (5000), others normal
2001		40-80 keV high (between 2000 and 4000), others normal
2002		40-80 keV high (2000), others normal
2003		40-80 keV high (3000), others normal
2004		40-80 keV high (3000), others normal
2005		40-80 keV high (3000), others normal
2006	DOY 1-2	40-80 keV high (3000), others normal
2006	DOY 3-365	bad data (all zero)
2007		bad data (all zero)