

Raw Data Release 1

A Raw Data Release consists of IBEX-Hi and IBEX-Lo direct event and histogram files and supporting files. These files can be used to generate maps similar to maps produced by the IBEX SOC.

Filename Description

Data files are named using keywords that indicate the type of data they contain:

- **hide-n** - IBEX-Hi direct events for energy step n
- **lode-n** - IBEX-Lo direct events for energy step n
- **hihb-n** - IBEX-Hi histogram events for energy step n
- **lohb-n** - IBEX-Lo histogram events for energy step n
- **star-spin-nep** – star sensor data
- **.attdba/.attd2a** - quaternions
- **ibex_state_GSE** - IBEX state vectors

File Column Descriptions

Description of the columns in the direct event and histogram files:

MET – The timestamp (MET) derived from the s/c clock which is set to the number of seconds in the GPS epoch near the perigee of each orbit. (The GPS epoch starts at Sat->Sun midnight on Jan 6, 1980, when the Global Positioning System was activated.) The IBEX clock is not well regulated, so the correlation with the times on other s/c or the ground is not likely to be better than a few minutes. For a DE, this time is the arrival time of the event. For a HB, it is the start of the interval over which the events were collected. Note that during this time, the electrostatic analyzer (ESA) sweeps through several energy steps (6 for Hi, 8 for Lo).

R.A. and Decl. – The celestial source (assuming a straight line-trajectory from the HS) of a single direct event (DE) or histogram bin (HB) is given as R.A. and Decl. in the J2000 celestial coordinate system. Obviously, the trajectory is not a straight-line, so these are really statements about arrival direction, bearing in mind that the collimator FWHM is about 14 degrees and the event timing limits accuracy to 0.1 deg or so. For the case of histogram bins, this is the center of a 6-deg sky bin.

ch – This two-digit hexadecimal value encodes two data elements. The high-order (left-most) digit is the species:

Hi	Lo
1	2 - Hydrogen
	4 - Oxygen

The low-order (right-most) digit is the ESA (1 - 6 for Hi; 1 - 8 for Lo).

ty – This two-digit hexadecimal value also encodes two data elements. The high-order (left-most) digit is the sensor type:

File	Value
Hi DE	0
Hi HB	1
Lo DE	4
Lo HB	8 – 6 degree histograms
	C – 60 degree monitors

The low-order (right-most) digit is the coincidence type:

Hi Direct Events						
Hex	type	octal	binary	abcABC	LongH	QualH
A	10	047	100111	a--ABC	L-ABC	Q-ABC
5	5	027	010111	-b-ABC	L-ABC	Q-ABC
E	14	067	110111	ab-ABC	L-ABC	Q-ABC
C	12	057	101111	a-cABC	L-ABC	-
F	15	077	111111	abcABC	L-ABC	-
7	7	037	011111	-bcABC	L-ABC	-
2	2	017	001111	--cABC	L-ABC	-
9	9	046	100110	a--AB-	L-AB	Q-AB
D	13	066	110110	ab-AB-	L-AB	Q-AB
4	4	026	010110	-b-AB-	L-AB	Q-AB
3	3	023	010011	-b--BC	L-BC	Q-BC
6	6	033	011011	-bc-BC	L-BC	-
0	0	013	001011	--c-BC	L-BC	-
8	8	045	100101	a--A-C	L-AC	Q-AC
B	11	055	101101	a-cA-C	L-AC	-
1	1	015	001101	--cA-C	L-AC	-

Events are named according to the bits present at the end of the short and long windows. The binary and abcABC notations are both in use; the type numbers are the order of the events expressed in octal (base 8) but appear in Hex in the event listings.

Event	Description
abc	the ABC pulses latched after the short window (3 bits)
ABC	the ABC pulses latched after the long window (3 bits)
L-???	Long count coincidence histogram group (named after the set of CEM bits present at the end of the long window, and independent of the bits present at the end of the short window)
Q-???	Qualified count coincidence histogram group (named after the set of CEM bits present at the end of the long window)

Hi Histograms	
0	Q-ABC
1	Q-AB
2	Q-BC
3	Q-AC
4	L-ABC
5	L-AB
6	L-BC
7	L-AC

There are 16 IBEX-Lo direct event coincidence types. They are classified based on whether the corresponding time-of-flight (TOF) measurement between the start/stop points in the detector are valid. There are 4 such points: a is a start, b0 and b3 are stops, and c is an intermediate surface where both stops and starts may be generated

There are two surfaces inside the TOF chamber through which ions pass and are eventually detected at the microchannel plate (MCP). When a negative ion hits the first foil it emits an electron which is almost immediately received at the MCP; that is the first start, 'a'. Next ions and neutrals reach the second foil, emit another electron which is immediately received as the second start, 'c'. Finally, ions and neutrals are received at the MCP as a stop 'b?' (? = 0,1,2,3). If there is one start and one stop for an event then it is a 'double' event. If there are two valid starts and a stop then it is called a 'triple' event.

TOF0=b0-a

TOF1=b3-c

TOF2=c-a

TOF3=b3-b0

Value	TOF Flags 0123	Note flag	Meaning
0	0000	\$	Triple (=> a,b0,b3,c; golden/all valid)
1	0001	-	Triple (=> a,b0,b3,c; TOF3 invalid)
2	0010	-	Triple (=> a,b0,b3,c; TOF2 invalid)
3	0011	-	Triple (=> a,b0,b3,c; TOF2 & TOF3 invalid)
4	0100	-	Triple (=> a,b0,b3,c; TOF1 invalid)
5	0101	.	Triple (=> a,b0, c; TOF1 & TOF3 invalid)
6	0110	\$	Double (=> a,b0,b3 ; TOF1 & TOF2 invalid)
7	0111	.	Double (=> a,b0 ; only TOF0 valid)
8	1000	-	Triple (=> a,b0,b3,c; TOF0 invalid)
9	1001	.	Triple (=> a,b3,c; TOF0 & TOF3 invalid)
A	1010	+	Double (=> b0,b3,c; TOF0 & TOF2 invalid)
B	1011	.	Double (=> b3,c; only TOF1 valid)
C	1100	-	Triple (=> a,b0,b3,c; TOF0 & TOF1 invalid)
D	1101	\$	Double (=> a, c; only TOF2 valid)
E	1110	x	Single (=> b0,b3; only TOF3 valid)
F	1111	x	Absent (=> ; nothing valid)

TOF Flags	
TOF Flag Position	Meaning
0	TOF0 not absent => a & b0 present & TOF valid
1	TOF1 not absent => b3 & c present & TOF valid
2	TOF2 not absent => a & c present & TOF valid
3	TOF3 not absent => b0 & b3 present & TOF valid

Note flags	
Note flag	Meaning
-	not likely, but still physical
.	one of b0 or b3 missing, (not likely but still physical)
x	useless events
\$	the most likely possibilities
+	good events with some outliers

Lo Histogram events	
1	Hydrogen
2	Oxygen

count – 1 for a DE; for HB, it is the approximate number of counts. (The telemetry system uses a compression scheme.)

selnbits – not used

phase - The phase column expresses the arrival time of the event (or center of a sky bin) expressed as the fraction of a spin between spin pulses. The spin pulse is triggered 3 deg before IBEX-Hi is pointed at the North Ecliptic Pole (NEP) and IBEX-Lo is pointed at the South Ecliptic Pole (SEP). Thus, the NEP is phase = 0.0083 in IBEX-Hi and 0.5083 for IBEX-Lo. (The R.A. and Decl values are derived from this together with the detailed s/c attitude information.)

loc-X/Y/Z-RE - The "loc-*-RE" columns record the position of IBEX relative to the Earth in Earth Radii in the same J2000 inertial reference frame as R.A. and Decl.

star-spin-nep file

This file contains star sensor voltage data. There is a column for each spin and the rows are NEP angles in 0.5 degree increments from -3 degrees to 357 degrees.

.attdba/.attd2a file

The first column is MET time; the following four columns are a quaternion.

If the file extension is .attd2a the orbit required despinning.

ibex_state_GSE file

The first column is MET time, the next three columns are the x/y/z value of the IBEX position vector (km) and the next three columns are the corresponding velocity vector (km/s). The state vectors are IBEX relative to Earth.