A Description of the NMB File Format

Version 1.0

M.A.J. Snijders

Internal report
31 March 1995

The NMB (Nic2 Multi-Byte) format was introduced as part of the work by the Max Planck Institut für Radioastronomie at Bonn (hereafter MPIfR) on data acquisition software for the IRAM telescope at Pico Veleta. We are currently planning to use this NMB format as part of the data acquisition software for the new multi-beam bolometers. An accurate description of this format as currently used at IRAM Grenoble was both urgently required and essential. In addition we found it necessary to add a number of parameters for a full description of the multi-beam bolometer data from Pico Veleta which are fully described here as well.

Acknowledgements are due to my colleagues at MPIfR in Bonn and at IRAM Grenoble, in particular D. Broguiere, G. Haslam, R. Lemke, and R. Neri, who greatly contributed to this document.

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Contents

1 Introduction

The NMB format is a quasi-FITS format (Wells, Greisen, Harten 1981). It has an ASCII readable header followed by the data written in binary integers. The header section does not conform fully to the FITS standard, there are in particular no fixed length records and the majority of the header parameters does, presently, not have 'keywords'.

In section 2 we discuss the astronomical meaning of the various header parameters and the data. In section 3 we give the technical details of the mathematical coding of the information. Finally in section 4 we discuss the improvements we hope to introduce this summer after the current observing period with a 19 beam bolometer is finished.
The history of the NMB bolometer data format at IRAM currently looks as follows:

Table 1.

version	date	Description
0.0	6- 6-1993	An example of an NMB file received from Roland Lemke (MPIfR/Bonn).
	26- 1-1994	First description of this format at IRAM (Toon Snijders).
0.1	11- 5-1994	Addition of the wobbling parameters, read the GAIN parameter(s).
0.2	18- 6-1994	Use off the 2-byte in stead off 3-byte format for count rates between -25000 and +25176 counts.
0.3	27- 6-1994	Addition of the details of the scan coordinate parameters for pointing and focus observations.
1.0	16-11-1994	Addition of scanning parameters for on-the-fly observations and of the computer program version number.
1.1	summer 1995	Simplify the header and add Keywords to all header parameters. Move all scanning coordinates together in the observing records. Remove the 0.25 sec timing inconsistency from the data records.

A version number for the computer program which generated an NMB file was added at IRAM Grenoble 16-11-1994 and Table 1 includes a list of the appropriate version numbers. We have assigned to the first NMB file which was available in June 1993 at IRAM in Grenoble version nummer 0.0. It appears however that the second byte in the file , an 'A', is also a version number in use at MPIfR. We now use this 'A' as a version number for the output file format not for the computer program which wrote the file.

2 The NMB file, an astronomical discussion

2.1 The ASCII header parameters

In Table 2. we present for each variable in the NMB file header a short description. The way this is coded in bytes follows in section 3. The header is split in 2 parts: the first part, the pre-header, contains basic data and is always written by the Pico Veleta VAX computer. The information in the second part

Table 2. The header parameters.

nr	Record	Format	Description
1		char	The NMB code version marker, currently A.
2	DATE	char	Observing date coded as: MM-DD-YEAR,
	GAIN	int	Electronic gain: $1 - 9$.
	PROCESSED BY	char	Computer program, program version and process date eg: VAX-to-NMB Version 1.0 21-11-1994.
3	TELESCOPE	char	eg: Pico Veleta 30m MRT.
4	RECEIVER	char	eg: BOLOMPI1 for the 7 channel instrument used in April/May 1994.
5	WAVELENGTH	char	eg: 1.3 mm.
6	FORMAT	char	e.g.: LST AZ EL SIGNAL.
7	INTEGRATION	int	Number of chopper cycles that drumbeat collects before calculating the actually stored count rates. Currently with the improved data storage possiblities we always use INTEGRATION = 1.
8	CHANNELS	int	The number of receiver channels. This information is supplied by the acquisition VAX computer (e.g. IRAMEA).
9	DUMPS	int	For each specification of LST, AZ and EL there are 'DUMPS' readout(s) of the bolometer counters done.
10	DOUBLE	char	Scale factor, currently 2, for coding LST/UT, AZ and EL with the necessary precision as binary integers.
11	CLOCK	char	Specifies the type of time: LST for data recorded by CAMAC UT for data recorded by DRUMBEAT.
	-99999		End first part of the header.
12	ScanNumber	int	The number of the current observation,
	SourceName	char	The name of the object, maximal 40 characters.
13	Frequency	real	The central frequency of the observation (GHz).
14	Gain	int	Electronic gain: $1 - 9$.
15	Paddle	char	1 = Paddle in: The chopper is used for modulating the signal, 2 = Paddle out: the wobbler is used for modulating the signal.
16	Channels		The number of receivers from either DRUMBEAT or the VAX computer.
17	Phases	int	See comments.
			The following, emphasized parameters are more fully described in IRAM document 'OBSINP' by Schraml (1986)
18	*SLAM*	real	The longitude in the selected coordinate system (specified by SBAS) in decimal degrees.
19	*OLAM*	real	Longitude offset in decimal degrees.
20	*VLAM*	real	Telescope drift velocity in degrees/minute in SLAM.
21	*LAMSTAR*	int	If LAMSTAR is 0 the offset is: OLAM * cos(SBET), if LAMSTAR is 1 the OFFSET is OLAM independent of the latitude SBET.
22	*SBET*	real	The latitude in the selected coordinate system (specified by SBAS) in decimal degrees.
23	*OBET*	real	Latitude offset in decimal degrees.
24	*VBET*	real	Telescope drift velocity in degrees/minute in SLAM.
25	*SAZM*	real	The telescope azimuth, in degrees, for the center

Table 2. The header parameters (cont.).

nr	record	Format	Description
			of the scan.
26	*OAZM*	real	The offset in azimuth to the start of the scan pattern in degrees.
27	*VAZM*	real	The scan velocity in the azimuth direction in degrees/minute.
28	*AZMSTAR*	int	If AZMSTAR is 0 the offset is: OAZM*cos(SBET), if AZMSTAR is 1 the OFFSET is OAZM independent of the latitude SBET.
29	*SELV*	real	The telescope elevation, in degrees, for the center of the scan pattern.
30	*OELV*	real	The offset in elevation to the start of the scan pattern, in degrees.
31	*VELV*	real	The scan velocity in the elevation direction in degrees/minute.
32	*SFCX*	real	The focus setting for the X-axis in mm.
33	*SFCY*	real	The focus setting for the Y-axis in mm.
34	*SFCZ*	real	The focus setting for the Z-axis in mm.
35	*SPHX*	real	The rotation angle for the subreflector about the X-axis in degrees.
36	*SPHY*	real	The rotation angle for the subreflector about the Y-axis in degrees.
37	*SPHZ*	real	The rotation angle for the subreflector about the Z-axis in degrees (not implemented).
38	*SINT*	real	The distance between 2 SCAN lines in arcseconds.
39	*SBAS*	int	SBAS is an integer between -1 and $+21$ specifying the coordinate system or the selected solar system object.
40	*EPOCH*	real	The epoch of the coordinates for the coordinate system specified by SBAS.
41	*DAZM*	real	Pattern width in the azimuth direction in degrees for a map, or for on/off mapping the offset (allways in azimuth) for the off position.
42	*SRP1*	int	Number of repeats of a scan pattern for a map or for on/off observing the number of repeats of on target observations.
43	*SRP2*	int	Parameter for the definition of the scanning method, permitted values: 1 = for normal on/off, focus and skydip observations, 2 = for telescope pointing observations, N = for a map where N is the number of parallel subscans.
44	*SR1OPTFLAG*	int	1 = skydip observations, 0 = otherwise.
45	*SR2OPTFLAG*	int	1 = pointing observations, 0 = otherwise.
46	*SDC*	int	Scan Direction Code, permitted values: 2 = skydip observations, 3 = for all normal observations and telescope pointing tests, 8 = focus determination.
47	PRESSURE	real	Ambient pressure in millibars.
48	TEMPERATURE	real	Ambient temperature (deg C).
49	HUMIDITY	real	Ambient relative humidity (%).

Table 2. The header parameters (cont.).

nr	record	Format	Description
50	REFRACTION	real	Atmospheric beam bending (″).
51	*NULA*	real	Correction of zeropoint error in Azimuth(″).
52	*NULE*	real	Correction of zeropoint error in Elevation(″).
53	*COLSTAR*	int	Collimation correction (″).
54	Year	int	The year of the observation.
55	Month	int	The month of the observation.
56	Day	int	The day of the month the observation started.
			If the Wobbler is not used the last 4 parameters are set to zero.
57	WobblingDevice	int	1 for the current wobbler.
58	WobblingAmpli	real	The wobbler throw (″).
59	WobblingPeriod	real	The wobbler period in seconds.
60	WobblingMode	int	1 = a square wobbling pattern, currently this is the only mode in use.

of the header comes either from the Pico Veleta VAX or from a combination of the PC to which DRUMBEAT (a digital data acquisition system from MPIfR) writes data and the VAX. The result of this setup is that some information is written twice, for instance the bolometer gain, the observing date and the number of bolometer channels.The second part of the header contains all the information on the detector, the telescope pointing and scanning, the atmosphere and the wobbler. The parameters which specify the coordinate systems used and the methods the telescope uses to scan its targets are extensively described by Schraml (1986). In fact Table 3 and Table 4 and header parameters 18 to 46 and 51 to 53 are more fully described there.

Now follow some comments on specific items in the NMB format as listed in Table 1. The information for the telescope scanning coordinates start with variable 18. However the coordinate system used is specified in variable 39 'SBAS'. The reader is advised to read the description of parameter 'SBAS' before the description of parameters 18 to 38.

- point 2: The gain factor is actually an attenuation factor. For a gain factor gg the attenuation factor is 2^{gg-1}.
  The details of the version number of the computer program which constructs the NMB files were added with version 1.0.

- point 6: Specification of the output format of the data records. The example given is for on/off observations. For focus or pointing tests or on-the fly observations the format for the scanning coordinate(s) have to be added.

LST/UT	For the bolometer data this is either local siderial time (LST) or universal time (UT) both in seconds. Normally each measurement takes half a second. It is not known where in this half second Time, AZ and EL were exactly taken. The relative time is however accurate to 60 milliseconds.
AZ	Azimuth in decimal degrees.
EL	Elevation in decimal degrees.
SIGNAL	The counts for the bolometer channels normally per half second. The wobbler operates with a frequency of only 2 Hz but the chopper with a frequency of up to 9 Hz. Observations of the Vertex for instance can be encountered at this higher data rate.

- point 7: Number of chopper cycles that drumbeat collects before calculating the final count rates. For on/off observations if the on and off count rates are A and B and INTEGRATION is 3 than the count rates are A1 B1 A2 B2 A3 B3 and stored are (A1+A2+A3)/3 and (B1+B2+B3)/3.

Historically this parameter was used to save storage space. For all multi-beam bolometer scans taken recently at Pico Veleta we have set this parameter to 1.

- point 8: for bolometer files currently 1, 7 or 19 in the future 37.
- point 9: For each specification of Time, Azimuth, and Elevation in the data records (see point 62) normally only one readout of the counters is done. If the readout frequency is too high, later interpolations of Time, Azimuth and Elevation are necessary. Actually Time, Azimuth and Elevation are, virtually always (but see point 6) read every half second but the counters are read twice, every quarter second for $Phases = 2$. The counters are read once for the on and once for the off position on the sky and the count rates per half second are the differences of two quarter second count rates.

Table 3. Solar system objects.

nr	Object	Alignment of prime axis
11	Mercury	Planetary orbit
12	Venus	Planetary orbit
13	not used	————
14	Mars	Planetary orbit
15	Jupiter	Planetary orbit
16	Saturnus	Planetary orbit
17	Uranus	Planetary orbit
18	Neptunus	Planetary orbit
19	Pluto	Planetary orbit
20	Sun	Ecliptic
21	Moon	Lunar orbit

Table 4. Coordinate systems.

nr	Basis Coords.	Description of Basis System	Equatorial Plane and Origin of the Coordinates	
-1	RA, Dec (2000)	Mean equatorial	Mean equator, mean equinox, 2000.0	R
0	lII, bII	Galactic	New galactic plane, galactic center	R
1	RA, Dec (1950)	Mean equatorial	Mean equator, mean equinox, 1950.0	R
2	RA, Dec (EQ)	Mean equatorial	Mean equator, mean equinox, EQ	R
3	RA, Dec (TO)	Mean equatorial	Mean equator, mean equinox, TO	R
4	RA, Dec	Apparent equatorial	True equator, true equinox	R
5	H, Dec	Apparent hour angle and Declination	True equator (TO), and the meridian of the observers	L
6	Lam, Bet (1950)	Mean ecliptic	Mean ecliptic, mean equinox, 1950.0	R
7	Lam, Bet (EQ)	Mean ecliptic	Mean ecliptic, mean equinox,	R
8	Lam, Bet (TO)	Mean ecliptic	Mean ecliptic, mean equinox, TO	R
9	Lam, Bet	Apparent ecliptic	True ecliptic, true equinox	R
10	A, a	Azimuth and elevation	Horizon, north	L
		or Azimuth and air-mass	or OBET* for airmass	

Notes to Table 4: 'TO' is the present time. The standard equinox, 1950.0, and 'TO' do not need to be specified. Only for coordinate systems 2 and 7 does the observer have to state the equinox. The last column states whether the observing system is right handed (R) or left handed (L).

- point 14: The gain factor is actually an attenuation factor. For a gain factor gg the attenuation factor is 2^{gg-1}.
- point 16: Parameter 16 takes preference if the number of receivers as written in parameters 8 and 16 differ.

- point 17: Here it is used to indicate that we use the wobbler for on/off observations so Phases is 2. For the chopper Phases would be 4. However with a polarizer in the beam this parameter could also be used for polarization measurements.

- point 39: SBAS values between +11 and +21 set the telescope drive program to track solar system objects (Table 3). To each value of SBAS between -1 and $+10$ belongs an astronomical coordinate system (Table 4). As noted above Tables 3 and 4 are extensively described in 'OBSINP, Command language for the I.R.A.M. 30-M telescope' (Schraml, 1986).

2.2 The subscan format and the data

The remainder of the NMB file is nearly always written in binary.

- 61: Contains for mapping SRP2 times or for on/off observing 2*SRP1 times:
  - the SubScan Number,
  - the date the observation started coded as the year and the decimal fraction of the year, eg 1993.1397 for 1993 20 Feb. The decimal fraction of the year is expressed in units of 1/10000 of a year. Note that this is usually the same for all subscans but if a scan covers midnight this number increases.
  - the fraction of the day to the start of the observation of the current subscan in seconds since midnight expressed in units of $1/60 * DOUBLE$ of a second. For DRUMBEAT data files the start time is expressed in Universal Time (UT), for VAX data the start time is always expressed in Local Siderial Time (LST).

- The end of the header binary code: -88888.

- 62: The data records. First come time, azimuth and elevation followed by the NC count rates where NC is the number of receivers. For focus and pointing scans or on-the-fly observations this is followed by 1 or 2 scanning coordinates. Each measurement record contains:
  - The time in units of 1/30, $(1/60 * DOUBLE)$, seconds. For VAX files, where the data records come from the CAMAC, this is in LST and for DRUMBEAT data in UT.
  - Azimuth in units of 1/7200, $(1/(3600 * DOUBLE)$, of a decimal degree.
  - Elevation in units of 1/7200, $(1/(3600 * DOUBLE)$, of a decimal degree.
  - The NC countrates for the individual bolometer channels. If this is a focus determination, pointing test or on-the-fly observation this is followed by the appropriate scanning coordinate(s):
  - for focus determination the scanning coordinate is the focus step in micrometers.
  - for pointing tests and on-the-fly observations the scanning coordinates are the azimuth and elevation in units of $0.1''$.

There is an inconsistency in the data from the CAMAC: both LST and azimuth apply to the start of a measurement period while the count rates are measured in the middle of the measurement period. For a standard scan where the measurement period is 0.5 sec LST and azimuth refer to a moment 0.25 sec earlier than the count rates.

On the rare occasions that the subscan records and the data records are written in ASCII too the following formats are used:

- 61: for each subscan record: (I3,1X,F12.4,3X,F12.3).

- 62: and for each data record: (F10.4,1X,F10.5,1X,F8.5,ND*(1X,F15.5))
  Where ND is the number of receivers, or the number of receivers plus 1 or 2 scanning coordinates as appropriate.

2.3 How to obtain an NMB file

Currently the user receives his Bolometer data directly as NMB files, with binary subscan and data sections, at Pico Veleta. For observations done with DRUMBEAT for data acquisition an NMB file is produced for the user by a combination of the Pico Veleta VAX and the PC to which DRUMBEAT writes the data. For observations done with CAMAC for data acquisition an NMB file is produced for the user by the Pico Veleta VAX from the individual VAX generated subscan files.

There is one difference between the NMB files made for data acquired via DRUMBEAT and those acquired via CAMAC and made from VAX subscan files: the latter contain in header record 2 information on the software which generated the NMB file.

Before 1995 the user received his Bolometer data directly as NMB files, with binary subscan and data sections, at Pico Veleta for observations done with DRUMBEAT for data acquisition. For data produced by the Pico Veleta VAX computer with CAMAC for data acquisition the user received before 1995 for each subscan 2 VAX generated output files which are described by Brunswig (1990). Since 1 January 1995 the user receives his data as an NMB file, which is constructed for him at the observatory no matter if CAMAC or DRUMBEAT was used for data acquisition. For the pre-1995 data IRAM Grenoble provides a software package which contains 3 'C' programs for generating a single NMB file for each scan from the many, typically $2 * 4$ to $2 * 30$, subscan files. These NMB files are called *scan.nmb* or *scan.asc* where *scan* is the scan number. The actual binary output file which is normally used for further image processing is called *scan.nmb*. A *scan.nmb* file can be constructed from the VAX subscan output files using the program 'VAX_TO_NMB'. Normally all image processing is done with these binary files. In case of unexpected image processing problems trouble-shooting can be done with an ASCII readable file *scan.asc*. These *scan.asc* files can also be used for further image analysis in case the software to read the *scan.nmb* files is not available at the users home institute. The *scan.asc* file is constructed either from the subscan files using the program 'VAX_TO_ASCII' or from a *scan.nmb* file using the program 'NMB_TO_ASCII'.

If a user has problems with his *scan.nmb* files he should contact the IRAM people resposible for the *scan.nmb* output on the internet adres '*nic@iram.fr*'.

3 The byte structure of the NMB format

3.1 General description of the binary coding.

The files **scan.nmb**, where "scan" is the scan number, consist of 3 parts :

- - the header with the header parameters coded in ASCII,
- - the subscan section with information coded in 'multi-byte mode 3 bytes',
- - the data section with data coded both in 'multi-byte mode 2 bytes' and 'multi-byte mode 3 bytes'.

The subscan and data sections are coded in binary. The bytes with values less than 20 hexadecimal are used as control characters and are not used for the actual data. In particular the following hexadecimal numbers are used as such:

15	multi-byte Start of File
16	multi-byte End of record
17	multi-byte End of File
18	multi-byte Mode 1 (1 byte to process): not used for bolometer data
19	multi-byte Mode 2 integers: used for bolometer data
1B	multi-byte Mode 3 integers: used for bolometer data
1C	multi-byte Text Mode, used for text written as ASCII strings
1D	multi-byte Number Text Mode: used for numbers written as ASCII strings
0A	Line feed, when present in the file is ignored
0D	Carriage return, when present in the file is ignored

The first 20 hexadecimal byte values are reserved as control characters thus the decimal byte value must be greater than 32. The maximum value represented in one byte is $255 - 32 = 223$.

Table 5. Scan 7223 binary coding.

hexadecimal	ASCII	description
15	.	Start of the file
41	A	NMB code version number
the first part of the header		
1C	.	multi-byte Text Mode
3E 44 41 54 45 20 30 32 2D 30	>DATE 02-0	Date
34 2D 31 39 39 34 20 20	4-1994	
47 41 49 4E 20 31 20 20	GAIN 1	Gain
70 72 6F 63 65 73 73 65 62 20	processed	VAX_TO_NMB program version
62 79 20 56 41 58 5F 54 4F 5F	by VAX_TO_	1.0 of 24 November 1994
4E 4D 42 20 56 65 72 73 69 6F	NMB Versio	
6E 20 31 2E 30 20 32 34 2D 31	n 1.0 24-1	
31 2D 31 39 39 34	1-1994	
0A 0A	..	Line Feed, Line Feed
16	.	multi-byte End of Record
1C	.	multi-byte Text Mode
3E 54 45 4C 45 53 43 4F 50 45	>TELESCOPE	telescope
20 50 69 63 6F 20 56 65 6C 65	Pico Vele	
74 61 20 20 33 30 6D 20 4D 52	ta 30m MR	
T	T	
0A 0A	..	Line Feed, Line Feed
16	.	multi-byte End of Record
Follow another 7 parameters		
1C	.	multi-byte Text Mode
3E 43 4C 4F 43 4B 20 4C 53 54	>CLOCK LST	
0D 0A	..	Carriage Return, Line Feed
16	.	multi-byte End of Record
1D	.	multi-byte Number Text Mode
2D 39 39 39 39 39	-99999	End of header
the second part of the header		
0A	.	Line Feed
1C	.	multi-byte Text Mode
20 37 32 32 33 20 20 43 52 4C	7223 CRL	Scan number and Source name
32 36 38 38 20 20 20 20 20 20	2688	
follow another 25 times 20		
0A	.	Line Feed
16	.	multi-byte End of Record
1D	.	multi-byte Number Text Mode
32 34 33 2E 30 30 30 30 30 30	243.000000	Frequency
0A	.	Line Feed
Follows the description of another 40 parameters		
0A	.	Line Feed
1D	.	multi-byte Number Text Mode
32	2	Day
0A	.	Line Feed

Table 5. Scan 7223 binary coding (cont.).

hexadecimal	ASCII	description
16	.	multi-byte End of Record
	the subscan information	
1B	.	multi-byte Mode (3 bytes)
A1 E0 47	...	Subscan Number
8a E9 47	...	Subscan Epoch (year)
A1 EB 47	...	Subscan Epoch (1/10000 year)
26 A0 7A	...	Subscan StartTime (1/30 sec)
16	.	multi-byte End of Record
1B	.	multi-byte Mode (3 bytes)
A2 E0 47	...	Subscan Number
8A E9 47	...	Subscan Epoch (year)
A1 EB 47	...	Subscan Epoch (1/10000 year)
4F 7A A7	...	Subscan StartTime (1/30 sec)
16	.	multi-byte End of Record
	The same sequence is repeated until last subscan	
16	.	multi-byte End of Record
1B	.	multi-byte Mode (3 bytes)
BF E0 47	...	Subscan Number
8A E9 47	...	Subscan Epoch (year)
A1 EB 47	...	Subscan Epoch (1/10000 year)
36 E3 47	...	Subscan StartTime
1D	.	multi-byte Number Text Mode
2D 38 38 38 38 38	-88888	End of subscan information
0A	.	line feed
	Data section	
1B	.	multi-byte Mode (3 bytes)
26 A0 7A	...	LST ($1/60 * DOUBLE$ sec)
4A 33 70	...	AZ ($1/(3600 * DOUBLE)$ degrees)
B9 89 50	...	EL ($1/(3600 * DOUBLE)$ degrees)
19	.	multi-byte Mode (2 bytes)
71 95	..	1st channel (counts+25000)
C6 8C	..	2nd channel (counts+25000)
C9 86	..	3rd channel (counts+25000)
D6 89	..	4th channel (counts+25000)
97 97	..	5th channel (counts+25000)
BB 9A	..	6th channel (counts+25000)
9C 55	..	7th channel (counts+25000)
AA 8B	..	δ(AZ) in 0.1($''$)+25000
F0 8C	..	δ(EL) in 0.1($''$)+25000
16	.	multi-byte end of record
	The same sequence is repeated until the last record	
1B	.	multi-byte Mode (3 bytes)
30 E7 47	...	LST ($1/30 * DOUBLE$ sec)
70 81 E9	...	AZ ($1/(3600 * DOUBLE)$ degrees)

Table 5. Scan 7223 binary coding (cont.).

hexadecimal	ASCII	description
4F BE F0	...	EL ($1/(3600 * DOUBLE)$ degrees)
19	.	multi-byte Mode (2 bytes)
90 8B	..	1st channel (counts+25000)
88 7D	..	2nd channel (counts+25000)
81 4B	..	3rd channel (counts+25000)
86 BF	..	4th channel (counts+25000)
97 3D	..	5th channel (counts+25000)
D6 9F	..	6th channel (counts+25000)
C8 98	..	7th channel (counts+25000)
AF 93	..	δ(AZ) in 0.1($''$)+25000
60 92	..	δ(EL) in 0.1($''$)+25000
16	.	multi-byte End of Record
17	.	End of file

The part of the file with the subscan information (point 61: subscan number, subscan epoch, subscan start time) and the actual data (point 62: LST or UT, azimuth, elevation, the count rates from the channels and sometimes the scan coordinates) are coded in multi-byte modes 2 or 3. The data are always stored as integers, if necessary not the actual value is stored but a scaled value to preserve the required acuracy (Table 5). Minimum and maximum values are for 2-byte numbers: 0 and 50175 and for 3-byte numbers: -2000000 and 9239423.

To get a value from the 2 byte format use:
$value = (byte1 - 32) + (byte2 - 32) * 224$
For values less than 0 or greater than 50175 we use the 3 byte format
$value = (byte1 - 32) + (byte2 - 32) * 224 + (byte3 - 32) * 224 * 224 - 2000000$
As an example of the 3 byte format we will look at the first subscan start time in Table 5. The hexadecimal number, 26 $A0$ $7A$, translates into the decimal numbers, 38 160 122. Or the scaled subscan start time is:
$(38 - 32) + (160 - 32) * 224 + (122 - 32) * 224 * 224 - 2000000 = 2544518$
The actual start time is then: $2544518/30 = 84817.267$ seconds since midnight.
The first count rate in Table 5 is in 2-byte format, 71 95, or:
$[(113 - 32) + (149 - 32) * 224] - 25000 = +1289$

A count rate in 3-byte format eg: 64 58 48, translates into:
$[(100 - 32) + (88 - 32) * 224 + (72 - 32) * 224 * 224 - 2000000] - 25000 = -5348$
The 2-byte format is sufficient for normal count rates but occasionally, for instance observations of planets or large particle hits, the 3-byte format is required.

3.2 Description of the file 7223.nmb

In Table 5 the file 7223.nmb is described as an example. The first column gives the hexadecimal value of the bytes. The second column gives the ASCII representation (when it exists, else it is replaced by a '.'). The last column contains the name of the parameter or a short description. This is a VERSION 1.0 file, older files, Versions 0.0 to 0.3, have some differences. The lack of the processing date for instance and instead of the binary sequences $0A$ or $0A$ $0A$ as separators the sequence, $0D$ $0A$, might be present.

4 Future modifications

Since we started working with the NMB format at IRAM in January 1994 a number of changes have already been made (Table 1). Of particular importance are the use of the 2-byte format for the countrates (when possible) which saves storage space and the introduction of image processing information concerning the program which writes the files in the image header. A number of potential problems currently remain. After discussions with the people at MPIfR who constructed the original NMB format these were recently settled. Currently a 19 channel bolometer is operating at Pico Veleta till middle April. Thereafter we will introduce summer 1995 the following changes:

- 1: The updated NMB format will be version 'B' (parameter 1).
- 2: At present the headerrecords 2 and 12 contain more than 1 parameter and parameters 'GAIN' and 'CHANNELS' occur twice. Record 2 will be split in 2 new header records: 2 for the observing date and 3 for the computer program used. The 'GAIN' factor in the current record 2 and the parameter 'CHANNELS' in header record 8 will be eliminated. Record 12 will also be split in 2 new header records 12 and 13 with as Keywords: 'ScanNumber' and 'SourceName'. The current header parameters 13 to 60 will have the numbers 14 to 61 each with its own keyword which will be the parameter name as given in Table 2. Header record 6 will be modified to include the scanning coordinates. Currently header record 6 and the data records are inconsistent for pointing, focus and 'on-the-fly' scans.
- 3: Currently the number -99999 is used to separate the 'pre-header' from the second part of the header. The 'pre-header' is allways written by the Pico Veleta VAX computer and the header parameters each have a Keyword. The second part of the header is written either partly by the PC connected to DRUMBEAT and partly by the VAX computer or by the VAX computer alone and no Keywords are used. In the new version these differences will disappear and the 'End of header' symbol -99999 will be moved to the real end of the header after the header parameter 'WobblingMode'.
- 4: In the data section the current order is LST, AZ, EL, countrates plus additional scanning coordinates for the 'on-the-fly', pointing and focus scans. The new format will have all coordinates together and the order will be: LST, AZ, EL, coordinate 1, coordinate 2, countrates. For the 'on-the-fly' and pointing observations coordinates 1 and 2 will be δ(AZ) and δ(EL) in the current units. For the focus tests coordinate 1 will be the focus step, as currently in micrometers, and coordinate 2 will be 0. For all other observations coordinates 1 and 2 will be 0.
- 5: Currently for the data which come from CAMAC LST and azimuth in the data records are actually slightly earlier measured, usually 0.25 sec, than the count rates. This inconsistency will be removed. In the new version time and azimuth will be calculated for the moment the count rates are measured.

With these changes the header is more readable and at the same time the header parameters adhere closer to the original FITS definition of Wells, Greisen and Harten (1981).

The use in the data section of either the 2-byte or the 3-byte format at present while in the pre-1995 DRUMBEAT files only the 3 byte format is used should not give problems. Consistent use of either byte 19 or byte $1B$ as flags makes correct reading of the data section always possible.

References

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