OGIP Calibration Memo CAL/GEN/92-002a

The Calibration Requirements for Spectral Analysis Addendum: Changes log

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SUMMARY

This addendum to CAL/GEN/92-002 (available on-line as Portable Document Format (PDF) and html versions) lists the changes which have been made to the format & keywords of the `RSP_MATRIX` and `EBOUNDS` extensions of the OGIP RMF file, and the `SPECRESP` extension of the OGIP ARF file.
Intended audience: primarily OGIP programmers, hardware teams & authors of spectral analysis s/w.

LOG OF SIGNIFICANT CHANGES

Release Date	**Sections Changed**	**Brief Notes**
1993 Dec 02		Original Version
1995 Jan 11	All	Made compatible with `LaTeX2HTML` s/w
1998 Dec 21	All	Use of HDUVERS and update of RSP_MATRIX format
2004 Apr 1	All	made compatible with tth

1 INTRODUCTION

The memo CAL/GEN/92-002 (George *et al.* 1992, available on-line as pdf and html versions) described the general calibration requirements for spectral analysis, and gave formats for the so-called redistribution matrix file (RMF) and ancillary response file (ARF).

The RMF consisted of a FITS file with a 'null' primary array and the following BINTABLE extensions:

- the redistribution (`RSP_MATRIX`) extension
- the `EBOUNDS` extension containing the nominal energy bounds of each channel.

The ARF consisted of a FITS file with a 'null' primary array and a single `SPECRESP` extension.

The memo then gave the detailed format of each of these extension. Since the adoption of the format originally given in George *et al*, a number of conventions/rules have been introduced within the OGIP to help clarify & unify a multi-mission, multi-application approach to the design of FITS files. Specifically, the OGIP FITS Working Group (OFWG)

was created and started making recommendations. Many of the changes which have been made to the format of the spectrum extension reflect such rulings of the OFWG. In this addendum we list all such format changes along with the corresponding values of the HDUVERS keyword.

2 CHANGES TO THE RSP_MATRIX EXTENSION OF THE RMF

A summary of the changes which have been made to the format originally given in CAL/GEN/92-002 (George *et al.* 1992, available on-line as pdf and html versions) is listed in Table 1

2.1 HDUVERS1 = 1.0.0, HDUVERS2 = 1.0.0

This format, also commonly known as 'RMFVERSN=1992a', was described in the original version of the memo CAL/GEN/92-002 published in *Legacy* (George *etal* 1992). It was superseded by the HDUVERS2 = 1.1.0 format.

2.2 HDUVERS1 = 1.0.0, HDUVERS2 = 1.1.0

This format added the additional optional (although recommended) keywords :

Table 1: Log of changes to the OGIP format for a RSP_MATRIX dataset

HDUVERS	**Date**	**XSPEC version**	**Comments**
1.0.0	1992 Oct	>8.0	Original George *etal* format
1.1.0	1993 Sep	>8.0	Additional (optional) keywords suggested
1.2.0	1996 Oct	>9.0	Added TLMIN keyword for F_CHAN column
1.3.0	1998 Dec	>10.1	Use HDUVERS. Additional optional keywords and optional ORDER column

- `HDUCLASS = 'OGIP'` - indicating the organization which devised the file format in use
- `HDUCLAS1 = 'RESPONSE'` - indicating extension contains data relating to the response of the instrument
- `HDUVERS1 = '1.0.0'` - indicating the version of the HDUCLAS1 format in use.
- `HDUCLAS2 = 'RSP_MATRIX'` - indicating the type of data stored.

- `HDUVERS1 = '1.1.0'` - indicating the version of the `HDUCLAS1` format in use.
- `HDUCLAS3` - giving further details of the stored matrix
  Allowed values are:
  - `'REDIST'` for a matrix whose elements represent probabilities associated with the photon redistribution process only
  - `'DETECTOR'` for a matrix whose elements have been multipled by all energy-dependent effects associated with detector (eg detector efficiency, window transmission *etc*).
  - `'FULL'` for a matrix whose elements have been multipled by all energy-dependent effects associated with detector, optics, collimator, filters *etc*.

These keywords can be used by downstream software to help locate & understand the content of this dataset. The values also allow a number of checks to be performed by these tasks and the user warned if it appears that the user is attempting to use the dataset incorrectly (*eg* attempting to convolve the effective area of the mirror with a `'FULL'` matrix). This was superseded by the HDUVERS2 = 1.2.0 format.

2.3 HDUVERS1 = 1.0.0, HDUVERS2 = 1.2.0

This format added the mandatory TLMIN keyword for the F_CHAN column. The keyword specified the first channel used in the response matrix (usually either 0 or 1). This was superseded by the HDUVERS = 1.3.0 format.

2.4 HDUVERS = 1.3.0

This format replaced the HDUVERS1 and HDUVERS2 keywords by the single HDUVERS keyword. It is recommended that HDUVERS1 and HDUVERS2 are retained but with comments noting that they are obsolete and only included for the benefit of older software. The keywords HDUCLASS, HDUCLAS1, HDUCLAS2, and HDUVERS are now mandatory. RMFVERSN is no longer required.

Two new optional, but recommended, keywords have been added to the format.

- `NUMGRP` - the number of channel subsets. The sum of the N_GRP column.
- `NUMELT` - the number of response elements. The sum of the N_CHAN column.

These keywords may be useful for programs reading the file in that they specify the amount of memory various arrays will require.

A new column may be added for responses of grating instruments.

1. *Order*, a (fixed- or variable-length) INTEGER vector (array, each element within which is 2-byte) for each row containing the dispersion order of each 'channel subset' in the energy bin.
   The FITS column name is **ORDER**.
   (unitless).

This column matches the F_CHAN and N_CHAN columns and requires that every 'channel subset' be for a single order.

3 CHANGES TO THE EBOUNDS EXTENSION OF THE RMF

A summary of the changes which have been made to the format originally given in CAL/GEN/92-002 (available on-line as pdf and html versions) is listed in Table 2.

Table 2: Log of changes to the OGIP format for a EBOUNDS dataset

HDUVERS	**Date**	**XSPEC version**	**Comments**
1.0.0	1992 Oct	>8.0	Original George *etal* format
1.1.0	1993 Sep	>8.0	Additional (optional) keywords suggested
1.2.0	1996 Oct	>9.0	Added TLMIN keyword for CHANNEL column
	1998 Dec	>10.1	Using HDUVERS

3.1 HDUVERS1 = 1.0.0, HDUVERS2 = 1.0.0

This format, also commonly known as 'RMFVERSN=1992a', was described in the original version of the memo CAL/GEN/92-002 published in *Legacy* (George *etal* 1992). It was superseded by the HDUVERS2 = 1.1.0 format.

3.2 HDUVERS1 = 1.0.0, HDUVERS2 = 1.1.0

This format added the additional optional (although recommended) keywords :

- `HDUCLASS = 'OGIP'` - indicating the organization which devised the file format in use
- `HDUCLAS1 = 'RESPONSE'` - indicating extension contains data relating to the response of the instrument
- `HDUVERS1 = '1.0.0'` - indicating the version of the HDUCLAS1 format in use.
- `HDUCLAS2 = 'EBOUNDS'` - indicating the type of data stored.
- `HDUVERS2 = '1.1.0'` - indicating the version of the HDUCLAS2 format in use.

These keywords can be used by downstream software to help locate & understand the content of this dataset. The values also allow a number of checks to be performed by these tasks and the user warned if it appears that the user is attempting to use the dataset incorrectly. This format was superseded by HDUVERS = 1.2.0 (formerly HDUVERS1 = 1.2.0).

3.3 HDUVERS = 1.2.0

This format added the mandatory TLMIN keyword to the CHANNEL column. The keyword specified the first channel used in the response matrix (usually either 0 or 1). The HDUVERS keyword has replaced HDUVERS1 and HDUVERS2. It is recommended that HDUVERS1 and HDUVERS2 are retained but with comments noting that they are obsolete and only included for the benefit of older software. The keywords HDUCLASS, HDUCLAS1, HDUCLAS2, and HDUVERS are now mandatory. RMFVERSN is no longer required.

4 CHANGES TO THE SPECRESP EXTENSION OF THE ARF

A summary of the changes which have been made to the format originally given in CAL/GEN/92-002 (available on-line as pdf and html versions) is listed in Table 3.

Table 3: Log of changes to the OGIP format for a SPECRESP dataset

HDUVERS	Date	XSPEC version	Comments
1.0.0	1992 Oct	>8.0	Original George *etal* format
1.1.0	1993 Sep	>8.0	Additional (optional) keywords suggested
	1998 Dec	>10.1	Using HDUVERS

4.1 HDUVERS1 = 1.0.0, HDUVERS2 = 1.0.0

This format, also commonly known as `'ARFVERSN=1992a'`, was described in the original version of the memo CAL/GEN/92-002 published in *Legacy* (George *etal* 1992). It was superseded by the HDUVERS2 = 1.1.0 format.

4.2 HDUVERS = 1.1.0

The HDUVERS keyword has replaced HDUVERS1 and HDUVERS2. It is recommended that HDUVERS1 and HDUVERS2 are retained but with comments noting that they are obsolete and only included for the benefit of older software. ARFVERSN is no longer required.

The following keywords are now mandatory :

- `HDUCLASS = 'OGIP'` - indicating the organization which devised the file format in use
- `HDUCLAS1 = 'RESPONSE'` - indicating extension contains data relating to the response of the instrument
- `HDUCLAS2 = 'SPECRESP'` - indicating the type of data stored.
- `HDUVERS = '1.1.0'` - indicating the version of the format in use.

These keywords can be used by downstream software to help locate & understand the content of this dataset. The values also allow a number of checks to be performed by these tasks and the user warned if it appears that the user is attempting to use the dataset incorrectly.

REFERENCES

George, I.M, Arnaud, K.A, Pence, W. & Ruamsuwan, L., 1992. *Legacy*, **2**, 51. (CAL/GEN/92-002, available on-line as pdf and html versions).