

HIGH RESOLUTION ABSOLUTE CALIBRATION:  
DATA FORMAT CHANGES \*

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The processing of an IUE high dispersion image produces three files on tape: Raw Image file, Photometrically corrected Image file and Merged Extracted Spectra file.

The only IUE output product affected by the implementation of the absolute calibration at high resolution is the Merged Extracted Spectra file (MEHI) of the G.O. tape.

The file structure is fully explained in the IUE Image Processing Information Manual v 2.0 but here we concentrate on changes brought about by the implementation of the high resolution absolute calibration. An MEHI file consists of two parts: label and data.

The label part is made up of between 20 and 30 physical records of 360 bytes each which contain data relevant to the observation and subsequent image processing.

The data part is composed of 360 records for SWP images or 325 records for LWP/LWR images. In both cases the first record of the data portion of the file is the scaling-factor record (also called Record Zero) and it contains information describing the data records that follow it. The remaining records of data are logically grouped in groups of six records, each associated with an order (Wave, Epsilon, Gross, Background, Net and Ripple-corrected Net).

Since SWP images contain 60 orders the total number of data records is:  $60 * 6 = 360$  (+ Record Zero = 361).

LWP and LWR images contain 54 orders, therefore the total number of data records in this case is:  $54 * 6 = 324$  (+ Record Zero = 325).

Each data record is 2048 bytes long providing 1024 data points for each order.

Figure 1 illustrates this structure.

\* Reprinted from ESA IUE Newsletter, 1989, No. 31, p. 25.

The structure of the MEHI file on the G.O. tape has been affected by the implementation of the Absolute Calibration as explained in the following paragraphs.

The main alteration is the incorporation of a new data record in each logical group of data records representing the absolutely calibrated net spectrum for that order.

Thus there is a new data record per order (now seven in total) and it is placed after the ripple-corrected net spectrum on the tape. This increases the data portion of the MEHI file as follows:

- The number of data records of SWP images changes from: 361 ( $60 * 6 + 1$ ) into 421 ( $60 * 7 + 1$ )
- The number of data records of LWP/LWR images changes from: 325 ( $54 * 6 + 1$ ) into 379 ( $54 * 7 + 1$ )

Now, since the size of the data portion of the file is reflected in the first record of the label (no. of lines - no. of samples), this has also been modified to the new value: 421 - 2048, or 379 - 2048.

The following entries of the Record Zero have also been altered:

- Entry no. 8 contains the number of data records per group (i.e. per order). This value has changed from 6 to 7.
- Entries no. 65 through 68 were spares in the previous version. Now they are assigned the following contents:
  - Entry no. 65 contains the scaled minimum flux for ABNET.\*
  - Entry no. 66 contains the scaled maximum flux for ABNET.
  - Entry no. 67 contains the scale factor J for ABNET.
  - Entry no. 68 contains the scale factor K for ABNET.

Note that the actual flux value = (tape value) \* J \* 2 \*\* (-K).

\* Net absolutely calibrated spectrum

The changes explained above affect several pages of the Image Processing Information Manual Version 2.0 (European Version):

Paragraph 8.2.2.2 of that manual which describes the

format of the Extracted spectra file (MEHI) needs to be updated where it references the number and type of spectra contained in MEHI file. Figure 8-8 of the Manual which illustrates the data records structure for MEHI file should be updated as indicated in Figure 2, here.

The Record Zero format given in table 8-2 of the manual is superseded by that one given in Table 1 of page 11-16 (in the chapter describing the ELBL implementation), but the latter should also be updated as indicated in Table 1 of this document.

Example:

As a test example two spectra of the same object were processed and then all orders of the two spectra were merged in the plot shown in Figure 3.

The images SWP 31635 and LWP 11474 of HD152270 were processed with the new s/w. Their absolutely calibrated spectra were merged using the Interactive Image Processing system IHAP and the results show good agreement between SWP and LWP data in the camera overlap region.

TABLE 1

Format of Scale Factor Record  
 (Record Sequence Number Zero - revised for inclusion  
 of absolute calibration of high dispersion)

Item (16-bit halfword)	Quantity
1	Zero (for record 0)
2	1022 (Maximum number of halfword entries in remainder of record 0)
3	Minimum wavelength (truncated to nearest A)
4	Maximum wavelength (rounded to nearest A)
5	Number of orders present
6	Camera Number
7	Image Number
8	Number of records per group (i.e. per order)
9	Year
10	Day Number of midpoint of
11	Hour observation (GMT)
12	Min
13-16	As 9-12 for time of image processing (GMT)
17	Target aperture (1=large, 2=small)
18	Total line shift (pixels*1000)
19	Total sample shift (pixels*1000)
20	+++ THDA 10 (C) used for reseau correction (normally at the time of read)
21	Scaled minimum flux for Gross
22	Scaled maximum flux for Gross
23	J for Gross where actual FN = data on
24	K for Gross tape * J * 2(-K)
25-28	as in 21-24 for Background
29-32	as in 21-24 for Net
33-36	as in 21-24 for Absolute Net (Low) or Ripple Corrected Net (High)
37	"Plate" scale factor for ELBL file (=1078) (Arcsec 1000)
38	(Julian Date - 2440000) at midpoint of observation
39	Fraction of Julian Date (*10000) at midpoint of observation
40-41	Spares
42-44	NI Minutes, seconds and milliseconds of exposure in target aperture
45	Hours
46	Minutes Right Ascension of target
47	Seconds * 10

48 Degrees  
 49 Arc Minutes Declination of target  
 50 Arc seconds  
 51-53 ++ (Vx, Vy, Vz) Velocity of Earth in celestial  
 coordinates (km/sec \* 10)  
 54-56 ++ (Vx, Vy, Vz) Same as 51-53 for IUE with respect  
 to Earth, at midpoint of exposure  
 57 ++ Net velocity correction applied (km/sec \* 10)  
 58 Omega angle (degrees \* 10) (Zero in High)  
 59 Wavelength scaling factor [5 = low, 500 = high,  
 where actual  $\lambda = (\lambda \text{ on tape}) / \text{scal. factor} + \lambda_0$   
 60 Background slit height - Low  
 61 Background distance - Dispersion  
 from dispersion line - only (pixels \* 100)  
 62 Dispersion constant shift mode (0 = no shift,  
 1 = auto shift, 2 = manual shift)  
 63 NI Bright Spot removal threshold DN  
 64 THDA \* 10 for dispersion constant correction  
 (normally at the end of the exposure)  
 65 Scaled minimum flux for ABNET  
 66 Scaled maximum flux for ABNET  
 67 J for ABNET where actual ABNET = data  
 68 K for ABNET on tape \* J \* 2 \* (-K)  
 69-70 Spares  
 71-102 For use of IUE Regional Data Analysis Facility  
 103-202 Offset wavelengths for each order  
 203-302 m, order number for each order  
 303-402 Number of extracted data points for each order  
 403-502 Slit height for each extracted order (pixels \* 100)  
 In the ELBL, only item #403 is used (pixels \* 1000)  
 503 Sign and first 4 digits after decimal of dispersion  
 constant A1  
 504 Sign and second set of 4 digits after decimal of  
 dispersion constant A1  
 505 Sign and third 4 digits after decimal of dispersion  
 constant A1  
 506 Exponent (including sign) of dispersion constant A1  
 where:  $A1 = [\text{item (503)} * 10^{(-4)} + \text{item (504)} * 10^{(-8)} + \text{item (505)} * 10^{(-12)}] * 10^{[\text{item (506)}]}$   
 507-538 As above, for dispersion constants A2 through A9  
 539-574 As above, for dispersion constants B1 through B9  
 575-1024 Spares

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++ High Dispersion only  
 +++ Currently used to correct reseau positions for the LWR and  
 LWP camera

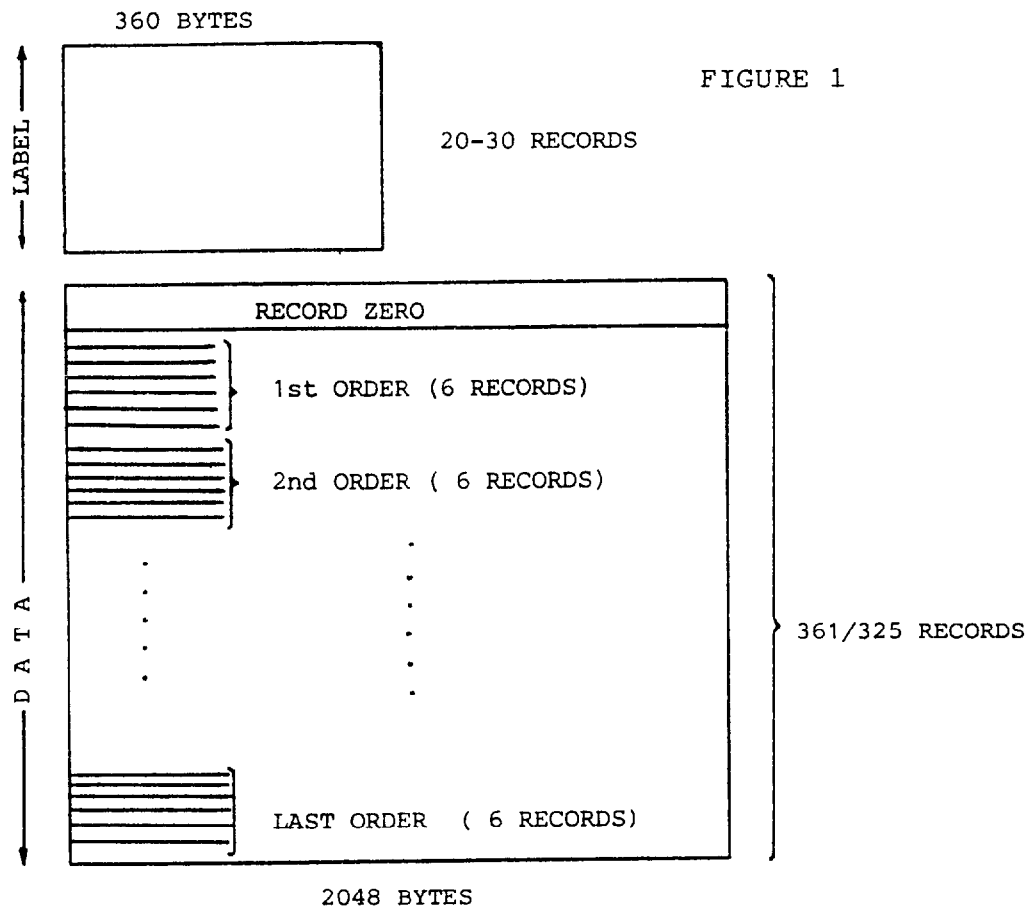
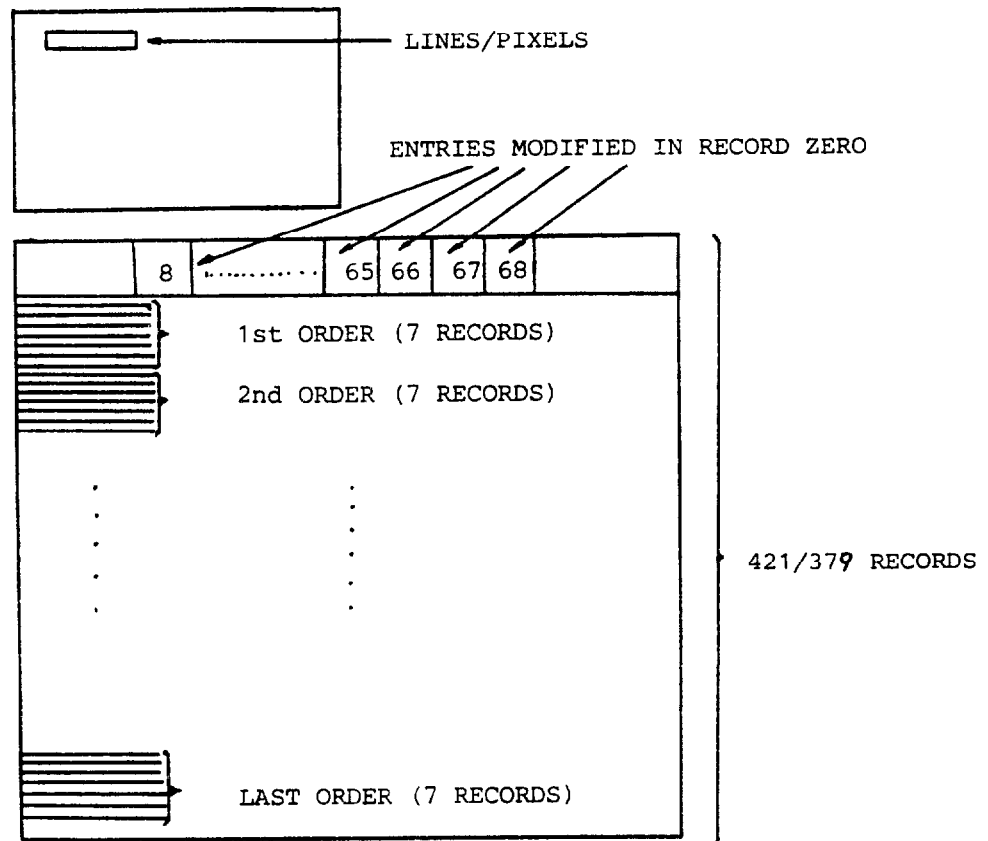


FIGURE 1

MEHI file old structure



MEMM file new structure

FIGURE 2

DATA RECORD STRUCTURE FOR MERGED HIGH DISPERSION SPECTRAL FILE (MHDF)

		2048 BYTES								
		HALFWORD	HALFWORD	HALFWORD	HALFWORD	HALFWORD	HALFWORD	.....	HALFWORD	
		1	2	3	4	5	6		1024	
RECORD 1		0	1022	$\lambda_{MIN}$	$\lambda_{MAX}$	CAM. NO.	IMAGE NO.	ETC.		SCALE RECORD
ORDER 125	RECORD 2	1	NO POINTS	$L_1$	$L_2$	$L_3$	$L_4$	ETC.		SCALED $\lambda$ 's
	RECORD 3	2	NO POINTS	$\epsilon_1$	$\epsilon_2$	$\epsilon_3$	$\epsilon_4$	ETC.		$\epsilon$ 's
	RECORD 4	3	NO POINTS	$G_1$	$G_2$	$G_3$	$G_4$	ETC.		SCALED GROSS
	RECORD 5	4	NO POINTS	$I_1$	$I_2$	$I_3$	$I_4$	ETC.		SCALED INTERORDER
	RECORD 6	5	NO POINTS	$N_1$	$N_2$	$N_3$	$N_4$	ETC.		SCALED NET
	RECORD 7	6	NO POINTS	$A_1$	$A_2$	$A_3$	$A_4$	ETC.		SCALED RNET
	RECORD 8	7	NO POINTS	$C_1$	$C_2$	$C_3$	$C_4$	ETC.		SCALED ABNET
	ORDER M	RECORD R-6	R-7	NO POINTS	$L_1$	$L_2$	$L_3$	$L_4$	ETC.	
RECORD R-5		R-6	NO POINTS	$\epsilon_1$	$\epsilon_2$	$\epsilon_3$	$\epsilon_4$	ETC.		$\epsilon$ 's
RECORD R-4		R-5	NO POINTS	$G_1$	$G_2$	$G_3$	$G_4$	ETC.		SCALED GROSS
RECORD R-3		R-4	NO POINTS	$I_1$	$I_2$	$I_3$	$I_4$	ETC.		SCALED INTERORDER
RECORD R-2		R-3	NO POINTS	$N_1$	$N_2$	$N_3$	$N_4$	ETC.		SCALED NET
RECORD R-1		R-2	NO POINTS	$A_1$	$A_2$	$A_3$	$A_4$	ETC.		SCALED RNET
RECORD R		R-1	NO POINTS	$C_1$	$C_2$	$C_3$	$C_4$	ETC.		SCALED ABNET

$$M = \left. \begin{matrix} 66 \text{ (SWP) (60 ORDERS)} \\ 72 \text{ (LWR)} \\ 72 \text{ (LWP)} \end{matrix} \right\} (54 \text{ ORDERS})$$

$$R = \left. \begin{matrix} 421 \text{ (SWP)} \\ 379 \text{ (LWR)} \\ 379 \text{ (LWP)} \end{matrix} \right\}$$

- NOTE:
- $G_i$  =  $i^{\text{th}}$  SCALED GROSS FLUX (IN EACH GIVEN ECHELLE ORDER)
  - $I_i$  =  $i^{\text{th}}$  SCALED INTERORDER FLUX (IN EACH GIVEN ECHELLE ORDER)
  - $N_i$  =  $i^{\text{th}}$  SCALED NET FLUX (IN EACH GIVEN ECHELLE ORDER)
  - $A_i$  =  $i^{\text{th}}$  SCALED RIPPLE CORRECTED NET FLUX (IN EACH GIVEN ECHELLE ORDER)
  - $C_i$  =  $i^{\text{th}}$  SCALED ABSOLUTELY CALIBRATED NET FLUX
  - NO POINTS = NO. OF EXTRACTED DATA POINTS (IN EACH GIVEN ECHELLE ORDER)

FIGURE 3

