Chapter 4

Raw Image Screening (*RAW_SCREEN*)

Certain operations performed by NEWSIPS may be categorized as screening or preprocessing operations which prepare the data for subsequent processing. The procedures of this nature which are performed on *IUE* data are described in this chapter.

4.1 Bright-Spot Detection

Long *IUE* exposures characteristically contain "bright spots", i.e., pixels with unusually high data number (DN) values which are comprised of discrete impulse noise often reaching the saturation level. Such bright spots are thought to be caused either by permanent blemishes in the target surface, by extraordinarily sensitive ("hot") pixels which result in recurrent bright spots at fixed locations, or by radiation-induced events within the UV converter which result in randomly placed, nonrecurrent bright spots (Ponz, 1980).

Ponz (1980) has described an algorithm for detecting in raw images bright spots of either kind on the basis of their limited spatial extent and unusual brightness values, primarily through a median filtering technique. The NEWSIPS bright-spot detection algorithm is based on the procedure used in standard IUESIPS processing, which incorporates this method to flag bright spots as described below.

Let DN (i,j) be the DN value of the pixel at line i, sample j. Further, let AVE and MED represent operators which return the weighted average and median values of their argument, respectively. Then the pixel at (i,j) is detected as a bright spot if:

$$DN(i,j) > AVE\{DN(k,l)\} + \Delta \quad \text{and} \quad DN(i,j) > MED\{DN(k,l)\} + \Delta$$

where Δ is a DN threshold value, and (k,l) are positional elements of a 7-pixel spatial window centered on the pixel at (i,j) and oriented on a diagonal (i.e., nearly along the dispersion direction). The condition in the first equation is included to reduce the number of times the median operation in the second equation is performed.

In practice, the spatial windows are weighted according to the weights (0, 0, 1, 0, 1, 0, 0), and a threshold value of $\Delta = 90$ DN is employed. The area of the image searched for bright spots corresponds to the entire camera faceplate regardless of dispersion. This differs from the IUESIPS approach, which only examined the regions containing spectral information. Pixel locations detected as bright spots are written to an output flag file (Chapter 3) subsequently read by the spectral extraction routines (Chapters 9 and 10) so that extracted fluxes derived from bright spot pixels may be flagged appropriately.

Several reports have been written that list the permanent or recurrent bright spots for the three cameras. These bright spots are not automatically flagged like the permanent ITF artifacts (see Chapter 6.4.3.1), but rather only if they trigger the bright-spot detection algorithm. Ponz (1980) has published partial listings of recurrent bright spots in the LWR and SWP cameras which are listed in Tables 4.1 and 4.2. The table entries include the line and sample positions in the raw frame of reference and the approximate corresponding wavelengths for the various dispersion modes and apertures. The “B” notation means the background spectrum is affected. This work has been supplemented by Imhoff (1984a), who provided positions of additional permanent blemishes in the LWP and LWR cameras, given in Table 4.3. Several publications by Crenshaw et al. detail the recurrent bright spots, which are labeled “camera artifacts”, in low-dispersion (Crenshaw et al. 1990) and high-dispersion (Crenshaw et al. 1996) spectra. These features appear at fixed locations in spectra with long exposure times yet are not detectable in spectra with exposure times shorter than an hour. They also determined that the artifacts appear to scale in intensity with the total background exposure level. Artifact positions of the more prominent features are listed in Table 4.4 (low dispersion) and Table 4.5 (high dispersion) as a function of wavelength.

4.2 Microphonic Noise Detection

LWR images are preprocessed in order to detect the presence of periodic noise interference (“microphonic noise”). In the SWP camera, this interference often covers all of the image and its amplitude is generally low (often only 1–3 DN) compared to random background noise (Northover, 1980), making detection difficult. Microphonic noise is also present in LWP images and is similar in appearance and amplitude to SWP microphonic noise. In the LWR, however, the microphonic noise has different characteristics, being localized chiefly in a small number of image lines, well-modeled by an exponentially dampened sinusoid, and with a peak amplitude typically in excess of 20 DN (Northover, 1980; Panek and Schiffer, 1981). The LWR microphonic noise is descriptively referred to as a “ping” because of its sudden onset and rapid decay. Unless an extended heater warm-up prior to image read is used as a ping avoidance technique, a given LWR image has about an 85% probability of suffering a ping, generally in the lower one-third of the image (Holm and Panek, 1982). If the heater warmup procedure is used, the ping is typically displaced to the top of the image where it does not impact the useful data.

Utilizing techniques developed by K. Northover (1980), the microphonics screening done by NEWSIPS for all LWR images is based on the characteristics of the image data in the last 32 samples of each image line. This area is outside of the target region, and pixel values are zero except for noise. Image lines affected by the microphonics are initially identified

Table 4.1: Hot Pixels in the LWR Camera
(Ponz, 1980)

Raw Image		Low Dispersion (Å)		High Dispersion (Å)	
Line	Sample	Lg. Ap.	Sm. Ap.	Lg. Ap.	Sm. Ap.
126	291			1919.3	1904.8 B/1920.5
170	200	1780	1775 B		
175	369			2172.5	2153.6 B/2173.9
178	610			2732.0	2733.8
208	391			2258.5 B/2280.0	2282.4 B
215	326		2130	2135.3	2117.0 B/2136.7
257	323	2190		2198.2	2199.7 B/2178.8
333	317			2288.9	2290.3/2268.0 B
412	385			2570.2	2543.8 B/2572.0 B
434	479			2818.7	2786.3 B/2820.5 B
518	545			3084.0	3086.0
532	307			2550.8/2579.2 B	2552.3
680	332			2838.0	2839.8

Table 4.2: Hot Pixels in the SWP Camera
(Ponz, 1980)

Raw Image		Low Dispersion (Å)		High Dispersion (Å)	
Line	Sample	Lg. Ap.	Sm. Ap.	Lg. Ap.	Sm. Ap.
292	413			1379.6 B/1393.6	1378.7 B/1392.6
352	501			1330.2 B/1343.0	1342.2
392	127	1795 B		1859.1	1857.8
398	521			1357.9 B/1371.4	1357.0 B/1370.4
410	535			1358.5/1372.0 B	1357.6/1371.0 B
482	342			1686.7	1685.6
568	127			2060.2	2058.9
611	387			1779.0 B/1756.5 B	1778.0 B/1755.3 B

Table 4.3: Permanent Blemishes in the LWP and LWR Cameras
(Imhoff, 1984a)

Camera	Raw Image Line	Raw Image Sample	Comments
LWP	101	525	
	205	319	
	396	384	Fuzzy Patch at λ ~2482Å in order 93
	409	208	Hole at λ ~2880Å in order 80
	426	435	
	455	35	
LWR	169	499	
	364	60	

Table 4.4: Low-Dispersion Camera Artifacts (Å)
(Crenshaw et al., 1990)

Camera	Source Type: Point	Source Type: Extended
LWP	None	None
LWR	2256	2256
	3087	3087
SWP	1279	1279
	1288	1288
		1491
		1535
	1663	
		1750

Table 4.5: High-Dispersion Camera Artifacts
(Crenshaw et al., 1996)

LWP		LWR		SWP			
Order Number	λ (Å)	Order Number	λ (Å)	Order Number	λ (Å)	Order Number	λ (Å)
93	2483.3	122	1888.3	119	1154.9	78	1757.7
80	2880.4	112	2067.3	119	1160.0	78	1762.4
		112	2074.4	118	1165.9	77	1790.1
		107	2167.1	118	1172.8	77	1795.5
		106	2171.7	116	1195.5	76	1810.1
		100	2303.2	116	1195.8	72	1914.3
		100	2322.3	115	1205.9	72	1916.0
		94	2450.1	108	1281.7	70	1975.0
		93	2501.1	106	1298.6	70	1980.6
		87	2670.1	104	1320.8	69	2005.0
		86	2694.4	103	1337.8	69	2009.5
		84	2756.2	101	1369.8	67	2059.1
		82	2808.4	95	1453.6	67	2059.5
		82	2829.0	93	1474.3		
		80	2900.6	93	1481.8		
		77	3010.7	93	1483.0		
		76	3029.6	93	1487.7		
		75	3066.4	92	1500.9		
		75	3083.1	92	1504.8		
		75	3100.0	92	1505.5		
		72	3194.3	90	1540.0		
		72	3195.2	89	1549.3		
				89	1552.0		
				88	1566.5		
				88	1573.0		
				87	1577.9		
				87	1583.9		
				87	1593.2		
				87	1593.5		
				86	1598.5		
				86	1603.6		
				82	1691.1		
				80	1725.9		
				79	1755.5		

by thresholding the variance of the last 32 samples; the interference amplitude is then estimated on the basis of the power spectrum of the sampled data, with successive image lines processed in pairs. Pixels in image lines with estimated noise amplitudes in excess of the chosen threshold (corresponding to a peak-to-peak noise amplitude of approximately 10 DN) are flagged in the data quality (ν) flag image with a value of -16. This condition, which is documented by a notation in the image processing history portion of the label (Chapter 12) and noted in the core data item ABNMICRO, is subsequently used by the spectral extraction routine (Chapters 9 and 10) to flag extracted fluxes derived from lines affected by the microphonic interference.

4.3 Partial-Read Image Preprocessing

"Partial-read" images are those for which only a portion of the target has been read. By not having a full 768×768 array readout, a substantial fraction of the operations overhead time associated with the camera readout and subsequent preparation for the next exposure is reduced. Partial-read images are used only in the low-dispersion mode and are read out such that a camera-dependent rectangular partial image, sufficient to encompass the entire region normally extracted in low-dispersion processing (Chapter 9), is generated. The partial-read images are preprocessed to imbed the partial-read area into a full 768×768 array for which DN values outside of the partial-read area are zero. This is done to enable the normal NEWSIPS processing, which works on 768×768 images, to occur without further special consideration of the partial-read nature of the images.

In order to prepare an image file in which to place the partial data, a zero filled blank image of 768 lines by 768 samples is generated. The partial-read data are inserted into the blank image using the positions tabulated by Imhoff (1991).

4.4 Missing Minor Frame Detection

Missing minor frames (MMFs) or "data dropouts" are flagged and recorded in the ν flag image, as well as noted in the output core data item keyword `ABNMINFR`. A minor frame consists of 96 consecutive pixel values read down in batch from the satellite. Minor frames are used to reconstruct the image, beginning at line 1, sample 1 by assigning values for incremental samples. Occasionally, one or more minor frames are corrupted or missing from the telemetry stream resulting in consecutive values of zero in the image. Such missing minor frames are detected automatically in the NEWSIPS system by screening the data for 96 consecutive values of zero. Only the target region is screened for missing minor frames; therefore, any MMFs outside the target area will not be detected or flagged. These 96 pixels are then flagged with a ν flag value of -8192. No attempt is made to interpolate across or correct for such data loss. A more detailed description of the *IUE* telemetry system can be found in *IUE Technical Note No. 30*.

4.5 DMU Corrupted Pixel Detection

A recent addition to the *RAW_SCREEN* process is the module that flags pixels which are potentially affected by the Data Multiplexer Unit (DMU) corruption which arose in late 1994. The DMU corruption of the raw image is such that pixels between a certain DN range may be assigned erroneously a DN value of 159. A raw image screening algorithm using statistical methods was developed by VILSPA which singles out images that have abnormally high numbers of pixels at DNs of 159 and thus are likely to have been affected by the DMU problem. This image screening process is only run on images taken after October of 1994. There is no way to tell which specific pixels with DN= 159 have been affected by the DMU corruption. As a result, in images which the screening process has identified as suspect, *all* pixels with DN values of 159 are flagged (with ν flag= -8) as possibly being corrupted.

4.6 Source-Type Determination

This preprocessing algorithm determines if large-aperture spectral data should be extracted either as a point or an extended source, as such information is needed in order to define certain extraction parameters. A quick rotation of the image to align the spectrum with the horizontal direction is performed using a nearest neighbor resampling algorithm and a two-dimensional (2-D) portion of the spectral/background region is sampled. Starting and ending at a point several pixels above and below the center of the spectrum, the DN values for every pixel along each line of the rotated image are averaged together. The resultant one-dimensional array of numbers represents an average cross-cut of the spectrum and by counting the number of pixels that are above the average background, NEWSIPS determines whether the spectrum is a point or extended source. If the number of such pixels exceeds a certain value (Table 4.6), then the spectrum is considered to be extended; otherwise it is

Table 4.6: Source Type Determination Values (number of pixels)

	Dispersion	
Camera	Low	High
LWP	15	8
LWR	15	9
SWP	15	11

considered a point source. The determination of point or extended source for low-dispersion large-aperture data is used to activate the detilting algorithm (see Chapter 7.2.3) in the geometric correction step for certain images and to set the width of the spectral extraction swath. If no flux is detected in the large aperture, the source type is set by default using an object class look-up table. Object classes 1–3 and 6–8 default to extended-source extraction.

All other object classes default to point source extraction, with one notable exception. If a low-dispersion large-aperture spectrum is designated a multiple or trailed exposure, it will always be extracted as extended, regardless of the results of the automated spectral width determination.

The source-type determination algorithm only sets a flux/no-flux flag for small-aperture data, as all exposures acquired in this aperture are considered to be a point source for the purposes of flux extraction.

4.7 Serendipitous Spectrum Recognition

Using the algorithm described in the previous section, the NEWSIPS software searches for low-dispersion spectral flux in both apertures, regardless of the information recorded on the original observing script as to which apertures were exposed. If flux is detected in an aperture that was not originally documented as having been exposed, the FITS keyword `SERENDAP` will appear in the output files for that image indicating that a serendipitous exposure was found and in which aperture.

When a serendipitous spectrum is detected with the NEWSIPS software, the aperture-dependent Core Data Items (CDIs) for the primary spectrum will be copied to the CDIs for the serendipitous spectrum. The coordinates for the serendipitous exposure will be calculated from the primary coordinates using the following algorithms:

$$RA(s) = RA(t) + \Delta RA \quad \text{and} \quad DEC(s) = DEC(t) + \Delta DEC$$

where $RA(s)$ and $DEC(s)$ are the coordinates of the serendipitous pointing, and $RA(t)$ and $DEC(t)$ are the coordinates of the target. ΔRA and ΔDEC are computed in units of arcseconds as follows:

$$\Delta RA = -0.2680(FESX(s) - FESX(t)) \cos\Psi + 0.2617(FESY(s) - FESY(t)) \sin\Psi$$

$$\Delta DEC = -0.2680(FESX(s) - FESX(t)) \sin\Psi - 0.2617(FESY(s) - FESY(t)) \cos\Psi$$

where Ψ = spacecraft roll angle + 28.31 deg, $FESX(s)$ and $FESY(s)$ are the FES x and y coordinates of the serendipitous aperture, and $FESX(t)$ and $FESY(t)$ are the FES x and y coordinates of the target aperture. The FES coordinates of the apertures are given in Table 4.7.

The target name for the serendipitous exposure will be NEAR XXX. The HISTORY portion of the label will reflect that the main object is in the other aperture and the `APERTURE` keyword will be changed to BOTH. In the case that the serendipitous exposure is in the small aperture and the large-aperture spectrum is trailed, the serendipitous exposure is considered a trailed overshoot. The large-aperture coordinates and object name are copied exactly to the appropriate entries for the small aperture, as well as the aperture-dependent CDIs. In this instance, the coordinates are not recalculated and the object name is not preceded by "NEAR".

Table 4.7: FES Coordinates of the Apertures

Aperture	FES x, y
SWSA	243, -89
SWLA	94, -90
LWSA	47, 65
LWLA	-106, 52

The NEWSIPS system also searches for unexpected spectral data in images classified as sky background. These images are usually acquired simultaneously with a pointed spectral exposure in another camera. If an image has an object class of 07 (sky background) and spectral data are detected with the algorithm described above, processing is terminated and the *IUE* staff attempts to identify the pointed observation obtained in another camera contemporaneously with the image. Assuming the associated image can be identified, the coordinates will be derived from those of the main object and the object class changed to that of the main object. The target name is "NEAR XXX". If the associated image cannot be identified, then the object class is changed to "UNKNOWN". A COMMENT line in the FITS header will say, "SERENDIPITY WITH CAMXXXXX". If no spectral flux is detected in the image, processing continues as for a large-aperture extended source.

4.8 Background and Continuum Intensity Estimation

This section of code determines the maximum continuum and average background DN levels for data utilizing the same rotated raw image as described in Chapter 4.6. This information is stored in the FITS header and history portion of the label as keywords. Although this information is not used in subsequent portions of image processing, it provides the user with a consistent quick-look estimate of the exposure level for a given image. The continuum levels for low- and high-dispersion wavelength calibration and flat-field exposures are set to zero, regardless of the output from the code.

The continuum level is determined in the following manner. Several predefined 2-D regions along the dispersion direction, encompassing both background and spectrum, are sampled. The sample areas are placed so as to avoid most emission lines and were carefully chosen after examining a variety of exposures of stars with different spectral types. The brightest pixels within each zone are averaged together to derive a peak continuum level for that region. The DN averages for each region are compared, and the maximum is chosen as representative of the continuum level. An image is considered to be overexposed (i.e., continuum level set to 255 DN) if 5 or more pixels in any single region are saturated. The approximate low-dispersion wavelengths for each sample area are listed in Table 4.8. A measurement of the high-dispersion continuum level is taken in a similar fashion. In this

Table 4.8: Low-Dispersion Wavelength Regions for DN Measurements (Å)

Continuum		
LWP	LWR	SWP
2120–2285	2405–2480	1255–1300
2595–2685	2565–2710	1310–1365
2850–2910	2850–2925	1830–1880
3070–3120	2985–3035	1925–1975

Background		
LWP	LWR	SWP
2120–3120	2405–3035	1255–1975

case, the samples correspond to areas centered about the peak of the echelle blaze and span several orders.

Low-dispersion background levels are calculated by averaging the DN values for a line of pixels (see Table 4.8 for the wavelength boundaries) sampled parallel to the dispersion and midway between the large- and small-apertures. For high-dispersion, a swath of interorder pixels adjacent to the respective continuum section is averaged. The background level corresponding to the maximum continuum region is recorded.

4.9 High-Dispersion Order Registration (*ORDERG*)

The extraction of high-dispersion spectral and background fluxes requires a precise knowledge of the placement of the echelle orders. Target centering errors and camera temperature (THDA) variations can shift an image potentially by several pixels. The *ORDERG* module in *RAW_SCREEN* computes an estimated shift that corresponds to the spatial direction in the high-dispersion resampled image (SI) geometry. Because *ORDERG* reckons this shift from the raw image, it uses raw DN values as the unit of flux. In addition, the computations are made from a simple rotation of the raw image (identical to the one described in Chapter 4.6) which is meant to approximate the high-dispersion SI geometry.

Studies of high-dispersion echellograms show that the order locations for individual images can differ not only by simple translational offsets but also by an expansion and contraction term (differential order shifts) as well. Because attempts to correlate such distortions with instrumental variables have been unsuccessful, *ORDERG* was designed to determine both the mean global shift of each image and, if possible, the differential order shifts, which can be as large as ±0.6 pixels. Note that similar shifts in the dispersion (spectral) direction cannot be corrected for in this manner because they are indistinguishable from wavelength shifts due to target centering errors or the radial velocity of the source. Shifts in the dispersion direction are addressed in Chapter 8, which deals with the wavelength calibration.

4.9.1 Order Registration Process

For images with high-signal continua, the derivation of spatial order shifts occurs in a two-step process. The first step figures an average global shift, while the second step determines the much smaller differential shifts.

4.9.1.1 Step 1: Global Shifts

This step generates a global spatial shift, which is an average of the individual shifts for each order that can be located successfully. The calculations are based on an 11-pixel-wide swath in the spatial direction of the crudely rotated raw image. Initially, the maximum and minimum DN values are computed in a predefined search window, which is expected to include the first (long-wavelength) order. These maxima and minima are assumed to be the "peak" flux of the order and the local "background" level, respectively. The local background (interpolated from pixels on either side of the order) is subtracted from the spatial profile, resulting in a "net-flux" profile. If the peak of the net-flux profile exceeds 5 DN, the algorithm proceeds to compute the centroid position of the order.

The centroid position of the order is computed using a least-squares gaussian fit to the net-flux profile within the preselected search window limits. Following the determination of an order centroid, *ORDERG* steps to the search window for the next order. This window is computed from the found positions of the preceding three orders (except for the first two orders). If an order does not have sufficient net flux for explicit centroid-finding, *ORDERG* steps to the estimated position for the next order, and an attempt is made to find that order. This process continues from the long-wavelength orders to the short-wavelength orders.

Following the determination of the order centroid positions, relative weights are assigned to each position according to the peak net flux. Found-minus-expected centroid position differences are computed for these orders and compared to the corresponding differences computed for orders from a fiducial image unique to each camera (LWP06316, LWR14996, and SWP13589). The order positions for these special images were calculated during the initial development of the *ORDERG* algorithm. A weighted least-squares solution of these pixel differences computes both a mean global shift and an rms statistic. The mean shift is the final value output from Step 1 and is the value applied to all lines in the image if any test in Step 2 fails (see below). However, two tests must first be passed before Step 1 is completed. The first is that a minimum number of orders (five for SWP, three for LWP/LWR) must be found with sufficient flux for order-centroiding. The second is that the rms statistic referred to above must be below a threshold (1.5 pixels). If either of these tests fails, a default value is adopted for the global spatial shift based on statistical predictions using time- and THDA-dependent spatial motions. Also, for either of these failure conditions, the noncontinuum keyword for the appropriate aperture is also set to "YES" in the HISTORY portion of the FITS header. Note that the setting of this keyword to "NO" (i.e., all tests in Step 1 are passed) denotes that the image is considered to have continuum flux and is treated as such by the background-extraction algorithm described in Chapter 10.

4.9.1.2 Step 2: Differential Shifts

Following the successful completion of Step 1, an attempt is made to refine the order shifts by determining systematic differential shifts across the image, e.g., due to an expansion/contraction term. A failure in the Step 2 tests described below results in the adoption of the global fit determined from Step 1. Differential shifts cannot be computed for these cases.

Order centroid positions and weights found above are used in Step 2. This step differs from Step 1 in two important respects. First, a sufficient number of orders containing flux must be found both in the short- and long-wavelength (spatial) ends of the camera. If this distribution test fails, the global shift from Step 1 is adopted and applied to all lines in the image. A second difference from Step 1 is that Step 2 computes order spacings from the found centroids. A least-squares solution is then determined from the differences of the logarithms of these spacings versus echelle order number (because of the expected $1/m^2$-dependence in order separation) and the logarithms of the corresponding order spacings for the fiducial image. A quadratic least-squares solution is attempted for SWP images because a curvature term is sometimes necessary. For LWP images the least-squares solution is linear, while for LWR images the solution is two joined line segments across the camera. As a quality-control check, *ORDERG* makes a test on the derived shifts at the end of Step 2. If any of the shifts exceed a threshold value of 4.0 pixels, Step 2 reverts to the solution from Step 1.

The found shifts resulting from Step 2 are defined literally only for the order centroid positions. As a practical matter, the final shift for a given order is applied uniformly to all lines associated with that order, including the adjacent lines containing background fluxes. Note that this can produce small shift discontinuities for lines located midway between the orders.

4.9.2 Potential Problem Areas

Because *ORDERG* operates by bootstrapping positions of previously located orders, a potential problem in finding the first order can occur. The SWP camera circumvents this problem by ignoring the first order ($m = 66$), as it describes a sinuous path on the raw image. As a result, *ORDERG* begins with order 67 for the SWP. The situation is more complex for the long-wavelength cameras because the gradient in camera sensitivity with increasing wavelength near the camera edge causes the identification of the first order to be sensitive to exposure level. If this identification is wrong, the window limits will be misassigned and large errors introduced into the mean global shift. This problem has been addressed for the long-wavelength cameras by starting the search at the (normally) third visible order.

A second type of problem involving order misidentification occurs for images having broad P-Cygni features with weak continuum (e.g., Wolf-Rayet spectra). If such broad features are common and distributed throughout the image, the true continuum orders may be too weak for *ORDERG* to use for registration. If the search for several such orders in a row is unsuccessful, errors in the search windows for new orders may become large enough to cause a misregistration of the next orders by an order. This problem was addressed by specifying that the search window positions be computed from the average of the positions of the previous three orders (per Step 1 discussion). A very large number of test images for these problems were checked, but there is no guarantee that the solutions for every image in the NEWSIPS archive will be accurate.

4.10 *RAW_SCREEN* Output

The *RAW_SCREEN* module does not generate any output data products (i.e., FITS file). Instead it produces a temporary (internal only) file which contains various ν flag conditions that are used by subsequent processing modules (e.g., *PHOTOM*).

The *RAW_SCREEN* module outputs the following information to the HISTORY portion of the image label:

- number of bright spots detected,
- number of missing minor frames (telemetry dropouts) detected,
- large-aperture extraction mode (if applicable),
- serendipitous-exposure information (if applicable),
- large- and/or small-aperture continuum DN levels,
- background DN level (An error was discovered in the reporting of this parameter, i.e. a value of 0 DN was recorded, which affects all SWP high-dispersion small-aperture images processed prior to June 14, 1997.)
- *ORDERG* global offset (high dispersion only), and
- *ORDERG* processing information (high dispersion only).