A Guest Observer's Guide to the IUE Image Processing Center

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I. Introduction

This guide is intended to provide some background information to our IUE Guest Observers by summarizing typical IUESIPS image processing activities and procedures. Comments are welcome. Please feel free to call me for further information or any other request.

This discussion centers on the operational aspects of the processing. The processing techniques and algorithms are described in the IUE Image Processing Manual (Version 2.0; available on request). A summary of IUESIPS reductions is given in the "IUE Data Analysis Guide" (Grady and Taylor, 1989, *NASA Newsletter* No. 39, Chapter 3). Updates to IUESIPS are described in various IUE newsletter articles. The major changes are the following.

- Extended line-by-line file. Munoz Peiro, J. R. 1985, *NASA IUE Newsletter* No. 27, pg. 2.
- High dispersion absolutely calibrated file. Martin, T. 1990, *NASA Newsletter* No. 41, pg. 155.
- New LWP ITF and absolute calibration. Cassatella, A., *et al.* 1988, it NASA IUE Newsletter No. 35, pg. 225; also Cassatella, A., *et al.* 1992, *A&Ap* **256**, pg. 309.

Other newsletter articles describe the chronology of changes to the IUESIPS software. The most recent is Martz and Imhoff, 1993, *NASA IUE Newsletter* No. 50, pg. 22. Of course these days we change the IUESIPS software very little, putting our efforts into the NEWSIPS software instead.

In recent years, we have also been putting "news" articles in the IUE Newsletter and the IUEDAC electronic newsletter concerning reprocessing, software and calibration changes, header formats, NEWSIPS processing, etc.

Note that the names IPC (Image Processing Center) and SIPS (Spectral Image Processing System) are used interchangeably below.

II. IPC Schedule

Image processing is carried out Monday through Friday, from 8 AM to 4 PM. The processing system runs on the IUE VAX computers located at GreenTec I. (GreenTec is the IUE off-site facility, located about 1.5 miles east of Goddard off Greenbelt Rd.) The software is written in Fortran with a MIDAS shell.

Note that the IPC processing hours have been substantially cut back due to resource limitations. This means that on occasion, such as around holidays, images may not be processed in our usual 1 to 2 day turnaround. When such backlogs arise, images may wait a week or more for processing.

III. Description of Daily IPC Activities

The following is a description of a typical processing "day".

The IPS picks up the available SOC tapes and scripts. The tapes are labelprinted (i.e. the raw image headers are printed out) to make sure they are readable. The labelprinting process also generates a file used by the DMC to create the IUE data base (which is used to create the Merged Log).

Special and priority processing requests are posted on a bulletin board in the IPC terminal room. The IPC staff checks this against the images and programs on the SOC tape. The work is prioritized as follows: (1) priority processing, (2) other current images, (3) test processing, and (4) archival reprocessing.

The IPS writes up the processing specifications for each image onto an Image Processing Log (IPL). To do this, he or she follows the GO's instructions on the scripts and refers to any special requests. Information which must be entered at this time includes DAC requests, priority processing, copies for collaborator, and image header corrections.

The processing scheme is specified on the IPL. The scheme name is codified to indicate the camera, dispersion, aperture, and registration method required (described below). These correspond to the choices given on the script.

Processing using automatic registration is performed in a batch queue. This is

usually preferred, when possible, since it is somewhat more accurate (the registration shift is computed to a small fraction of a pixel) and the processing runs faster.

Manual registration requires that the IPS inspect the image on the Gould DeAnza display and identify the center of the spectrum. A default location for the spectrum is shown using a wavelength overlay. The IPS then enters the number of pixels (usually only 1 or 2) that the overlay must be shifted to coincide with the spectrum. Once this is successful, the processing continues as usual.

If the DAC flag has been set in the system, the ELBL and MELO GO format files are copied to a special DAC account on the IUEGTC computer. This account is accessible to the DAC staff, who can then copy the files to the GO's DAC account.

Once all the images for a given program for that day have been processed, the files are written to a GO tape. If a GO is observing for 3 days, even if he or she takes only one image per day, they may receive 3 GO tapes. Once all images have been processed for the day, the files are written to an archive tape. All the output tapes are labelprinted to insure their integrity and contents.

The tapes and labelprints are delivered to the Data Management Center (DMC). The DMC sends the GO tapes to the GSFC Shipping Department to be sent to the PI. If the PI has so instructed, DMC sends the tape to Goddard for pickup or ships the tapes to a collaborator. The GO tape deliveries are normally performed once a week. The Shipping Department usually takes a week to ship the data, and the box of data takes a week to get to the GO (longer if overseas). So the data tapes usually take about 3 weeks to get from the TOC to the GO's home institution.

The archive tapes are delivered to NSSDC about once every other week. The data are proprietary for six months. Thus the data are not available through NSSDC until they are released.

IV. Description of the Processing Options

Before processing an image, the IPS xeroxes the observing scripts and fills out an Image Processing Log (IPL) form. Using the processing options listed in the upper right hand portion of the script, he or she chooses the appropriate scheme. For instance, the scheme name T3LLMC can be decoded as:

- T = standard processing
- 3 = camera 3 (1 = LWP, 2 = LWR, 3 = SWP, 4 = SWR)

- L = low dispersion (H = high)
- L = large aperture (S = small, T = trailed, E = extended, B = both point source, X = point source small and extended large, Y = point source small and trailed large)
- M = manual registration (A = automatic)
- C = current calibration (S = special)

In choosing the particular scheme, the IPS is guided entirely by the specifications on the script.

The registration step is required to locate the spectrum so that the extraction slits may be properly placed and so that the wavelength calibration can be applied to the spectrum. Expected locations are computed based on relations derived from WAVCAL images; these are functions of camera, dispersion, aperture, time, and temperature (THDA). (See also the discussion in the IUE Image Processing Manual, Version 2.0). The registration step is then performed with respect to these predicted locations.

How does one choose the registration scheme? In general, automatic registration is preferred if feasible, since it is more accurate and the processing is faster.

(1) Automatic. The automatic scheme uses software to locate the spectrum and compute the (hopefully) small shifts required (about 1 pixel or less if the target is well centered in the aperture) to register the wavelength scale with the spectrum. This works best on reasonably well-exposed continuum spectra, where the spectrum may be 100 DN or more over the background. However automatic registration does not work on heavily saturated spectra. If the program is unable to locate the spectrum, it will abort. The IPS will then rerun the routine using manual shift. Since having to rerun the routine means a waste of time, it is very helpful if care is taken to choose the correct registration method.

(2) Manual. The manual scheme displays the image and the predicted (default) location of the spectrum, using a wavelength scale overlay, on the image display. The IPS then inspects the spectrum and overlay to decide if any shift is required. If so, the amount of the shift is entered manually, generally an integral number of pixels. This scheme is used for relatively weak or emission-line spectra. Note that it requires a judgement on the part of the IPS, who generally has no astronomical background. They *do* know to ignore Lyman alpha.

(3) Do not shift. The "no shift" option uses the default, predicted location of the

spectrum in the spectral extraction and wavelength calibration. This is essentially the manual shift option with shift = 0. This is used for extremely weak or nonexistent spectra. The default location is based on a model of how the spectrum moves with time and temperature on the camera faceplate. If the object is well centered in the aperture, the model performs well.

Note that if both apertures are to be processed (B = both), only one registration type can be chosen (M = manual, A = automatic). In order for automatic registration to be run successfully, it must work on both spectra. Otherwise manual registration will be used for both spectra. Each spectrum will be individually registered.

In difficult cases, or if special centering on extended or multiple features is desired, a GO or RA may wish to ask to inspect an image during the registration step to insure that it is performed correctly. Such a request should be written prominently on the script. The person would have to go to GreenTec to do this. Sometimes SIPS will inform the TOC if a spectrum requires an abnormally large registration shift. An RA may need to investigate the image to see if such a shift is reasonable.

Multiple spectra are an interesting special case. They are normally processed using the trailed processing scheme. A study was performed to see whether automatic registration using the trailed spectrum template works properly for multiple exposures. The answer is "yes".

V. IUESIPS Output Products

The IPC staff handle various tapes and printouts.

(1) SOC tape. The raw image archive tape is verified and used to read the image into the VAX disk area, then passed on to the DMC. The SOC tapes are stored at Goddard's Tape Storage Facility.

(2) GO tape. The raw and processed versions of the data are written to tape on a daily basis. These tapes are delivered to the DMC to be shipped to the Guest Observer or sent to the DAC. The GO tape is normally generated at 1600 bpi; 800 or 6250 bpi may be generated by special request.

(3) Archive tape. This tape includes the day's output of raw and processed data. It is delivered to the DMC, who then delivers the tapes to NSSDC every other week.

(4) Tape listing. This is a one page summary of the contents of the GO tape. This is sent with the GO tape to the PI.

(5) Label prints. This is a printout of the image header record and processing history for each image. This is sent with the GO tape to the PI.

Note that the IPC (and most of the rest of the observatory) calls the operations archive tape the SOC tape (taken from the label "SOC 8124"). The tape that is sent to NSSDC is called the archive tape.

The SIPS archive tapes which are sent to NSSDC are the only complete version of the data which is retained on a permanent basis at NASA. NSSDC maintains the archives on tape; they also have most of the data on their optical disk system (NDADS). In addition, copies of the data are generated and sent to VILPSA and SERC by NSSDC.

The SOC tape is sent to the Goddard Tape Storage Facility after a month or so. In the past the SOC tapes were held in "deep storage" for 2 years, then they were recycled. Consequently we do not have most of the original SOC tapes.

VI. Special Requests

The IPS writes up the IPLs as soon as the scripts are received, so any special requests should come with the scripts (or beforehand) so that the appropriate flags are set during processing.

(1) Priority processing. Priority processing status is normally conferred by program ID for a given observing run. SIPS will process these images first so that the GO can analyze his/her data quickly.

(2) DAC access to the data. If the GO wishes to analyze his or her data at the DAC, the data can be transferred electronically from GreenTec to the DAC.

When the IPS writes up the IPLs at the beginning of the day, he or she sets the DAC flag where requested. The data will then be automatically copied into a special account on the GreenTec computers which can be accessed by the DAC assistants. The assistant will copy the data over into the GO/DAC user's account. It is important for the GO to contact the DAC so that the assistants can set up an account and copy the data into it.

(3) Duplicate data products. By Three Agency Agreement, NASA will produce duplicates of the data products for any collaborative exposure. A collaborative exposure is defined to be one which is started at one station and read down at the other (for us, started at VILSPA and read down at NASA). Only collaborative expo-

sures have blanket approval for duplicate data products. The VILSPA collaborator's address is needed so that DMC knows where to ship the data products.

(4) 800 or 6250 bpi tapes. Although 1600 bpi GO tapes are normally produced, it is possible to request either 800 or 6250 bpi tapes instead. A note to that effect should be entered in the "Remarks" box on the script for each of the GO's images. This request does not require special approval. Only 9-track tapes are available.

(5) Image header corrections. Occasionally an image will be archived with the wrong header information. SIPS corrects only the header information required for correct processing. These items are:

- Camera
- Image number
- Program ID
- Read day and time
- RA and DEC
- Exposure time

This procedure is known as the "labelmod". The corrected values are placed into a processing appendage in the image header (see article by Imhoff and Meylan, 1981, *NASA IUE Newsletter* No. 46, pg. 1). No changes are made to the comments typed in by the TO, by Project policy, because this is considered to be the original observing record.

(6) History replays. Images requiring history replays are not processed until the results of the replay are known. This may delay the processing of the image by a week or more.

History replays are performed by the OCC. The replayed image is archived on a new SOC tape, but the header information is missing or incorrect. SIPS is then notified that the replayed image is available. A TOC staff member inspects the image before processing. They may ask to have either the original or the replayed image processed depending on the success of the replay. He or she may also request that the original header be appended to the replayed image so that the header information is saved.

(7) Reprocessing. A researcher may ask to have an archival IUE image reprocessed using the current processing and calibrations. This is highly advisable for many of

the older images (see also the discussion in the IUE Data Analysis Guide). The appropriate information should be submitted to Don West, who will forward it to SIPS after approval.

The IPS obtains the raw image from NDADS. He or she uses the original processing specifications given on the script, unless the researcher requests otherwise. A GO tape with the reprocessed data is shipped to the requester, and the reprocessed data is sent to NSSDC.

Small reprocessing requests can generally be filled in a few weeks, while requests for hundreds of images will take a few months. The newly acquired images from the satellite, known as "currents", are processed first. Then archival images are reprocessed as time allows. The GO tapes are delivered to the DMC for shipment to the requester.

(8) No longer done. Data products that are no longer produced are CalComp plots and photowrites.

VII. IPC Contacts

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