Relevant dates: 8 July 1979
1 August 1979

IUE DATA REDUCTION

V. WAVELENGTH ASSIGNMENTS FOR LARGE APERTURE SPECTRA

In both the low and high dispersion modes, IUE wavelength scales are established by Pt-Ne spectra obtained through the small entrance aperture. For small-aperture astronomical target spectra, the wavelength scales apply directly as measured; for large aperture spectra, the small-aperture scales are transplanted to a "standard" reference location within the large aperture by means of offsets in pixels, which are applied to the constant or zero-point terms of the dispersion relations. If a_o and b_o are the zero-point terms for the small-aperture sample and line dispersion equations, the corresponding zero points for the large aperture are $a_o + \Delta s$ and $b_o + \Delta L$. Δs and ΔL are the offsets defining the pixel displacements from the small aperture to the large aperture in the sample and line directions, respectively. The purpose of this memorandum is to describe recent changes in the "standard" values of Δs and ΔL and to quantify changes in the derived large aperture wavelength scales resulting from the new offsets.

Previously, the Δs and ΔL offsets to the "center" of the large aperture were values which had been measured on the EDS display screen for each camera, in geometrically corrected units, to an accuracy of about one pixel. As a result of several recent analyses of the entrance-aperture geometry and the placement of astronomical objects within the large aperture, however, a more refined procedure for defining Δs and ΔL has been developed. A. Holm has performed aperture-mapping for both the LWR and SWP cameras and measured, for both cameras, a small displacement between the physical center of the large aperture and the point at which the telescope operations proce- dures normally placed objects in the large aperture prior to August 1, 1979. On 1 August 1979 a change in telescope operations procedures was made to place objects nearer to the physical center of the large aperture; this is further discussed later in the text). Furthermore, more accurate measure- ments of the orientation of the physical centers of the large and small apertures have been made. Finally, the separation of the small aperture and the old object-placement point within the large aperture has been accurately determined by examination of the dispersion constants resulting

from the automatic-shift software (DSPCON) on images where both large and small aperture spectra exist. The results of all these studies have been combined, generating improved large-aperture offset values for both the physical centers and the old object-placement points. The new offsets are given in Table 1, along with the older, less accurate, offset values. The new offsets are estimated to be accurate to several tenths of a pixel unit.

Table 1. Separations and Line and Sample Offsets
to the Large Aperture for LWR and SWP
Cameras.

$$R = \left[(\Delta s)^2 + (\Delta L)^2 \right]^{\frac{1}{2}}.$$ All in pixel units.

	SWP			LWR		
	ΔL	ΔS	R	ΔL	ΔS	R
OLD OFFSETS	-20.0	-17.0	26.3	+19.5	-17.5	26.2
PHYSICAL CENTER	-19.7	-17.4	26.3	+19.4	-18.6	26.9
OLD OBJECT PLACEMENT (Prior to 1 August 1979)	-19.9	-17.1	26.3	+20.4	-19.0	27.9

Beginning 8 July 1979, the ΔS and ΔL for the "old object placement" points in Table 1 were the offsets used in the data reduction programs to provide the transplantation of wavelength scales for large aperture spectra. Because these offsets differ from the old values, particularly in LWR, there is implicit in all-large aperture spectra extracted prior to 8 July 1979 a systematic wavelength error. The magnitude and sign of the error depend on the camera and dispersion mode in a manner which can be visual-ized in Figures 1 and 2. These Figures show the relative locations of the

points defined by the three sets of offsets listed in Table 1, along with an overlay defining the dispersion directions for a) low dispersion, and b) high dispersion, echelle order m=100. In these Figures, the wavelength scales shown have been generated from typical dispersion relations. The scales used are given in Table 2. The high dispersion values are approximations obtained using dispersion relations including only terms linear in λ and the product $m\lambda$. (Such approximate dispersion relations are used as the "preliminary solution" or starting point in the standard dispersion-relation regression analysis, which, in its final form, allows higher-order terms quadratic in m or λ . The approximate relations shown here are generally accurate to the subpixel level and have the simplifying advantage that the Å/pixel values scale inversely with echelle order number m.)

Table 2. Approximate Dispersion Scales (Å/pixel along dispersion direction)

CAMERA	DISPERSION	Å/pixel
SWP	Low	1.667
	High (m=100)	0.035
LWR	Low	2.649
	High (m=100)	0.056

From Figure 1 it is evident that the old offsets caused a small zero-point error in the low dispersion large-aperture wavelength scale for SWP, but essentially no error in high dispersion. Figure 2 indicates that both high and low dispersion scales were affected in LWR. Table 3 lists the nominal

wavelength errors caused by using the old offsets instead of the correct offsets to the actual object placement points. The errors $\Delta\lambda$ are defined in the sense

$$\lambda\text{old} = \lambda\text{correct} + \Delta\lambda .$$

Several points are to be noted regarding the current analysis. For <u>point sources</u>, the relevant fiducial for the large aperture is the actual object placement point; for aperture-filling <u>extended sources</u> the more relevant fiducial is the physical center of the aperture. The standard wavelength scales have, since 8 July 1979, been referred to the object placement points. On 1 August 1979, the telescope operations procedures were modified

Table 3. Nominal Large-Aperture Wavelength Errors
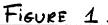Caused by Inaccurate Offsets Prior to
8 July, 1979

CAMERA	DISPERSION	$\Delta\lambda$ ($\overset{o}{A}$)
SWP	Low	+0.23
	High (m=100)· *	+0.0006
LWR	Low	-1.76
	High (m=100) *	+0.090

* For other orders, $\Delta\lambda$ is approximately 100/m times
the tabular value, where m = order number.

to make the object placement points coincide with the physical centers of the large apertures, and the offsets used in the data reduction for

all images acquired as of that date have been changed to the "physical center" values listed in Table 1. In this way, the assigned large-aperture wavelength scales will be correct for both point and diffuse sources.
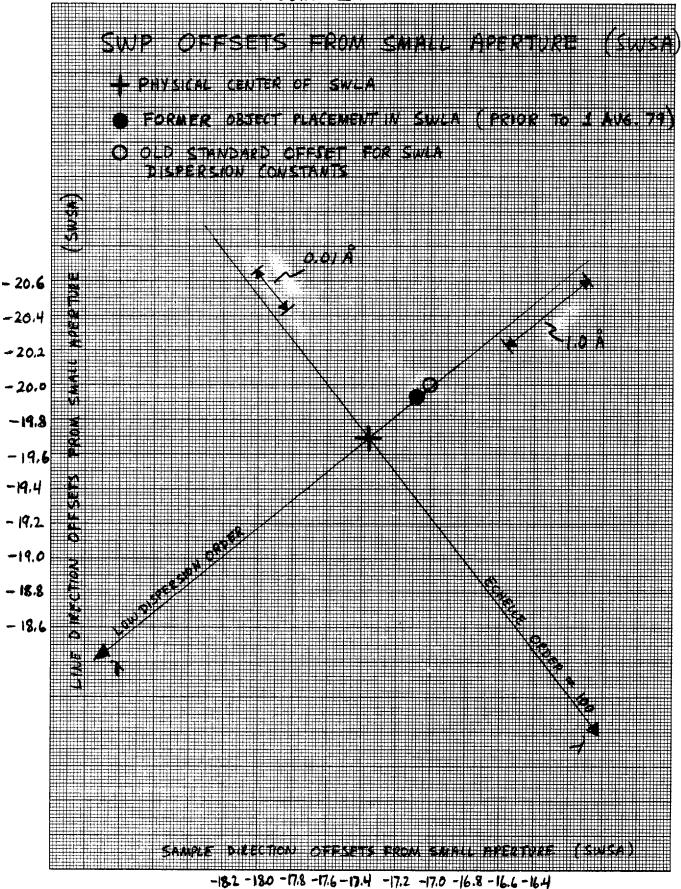
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FIGURE 1.

FIGURE 2.

LWR OFFSETS FROM SMALL APERTURE (LWSA)