OBSERVING WITH THE IUE

1. Pre-visit Preparations

Preparation for the IUE observations is quite similar to that required for using the ground based telescopes. From the sky maps provided by the IUE Observatory, one should check the solar and lunar constraint regions, and make observing plans accordingly. For stars fainter than 6^m, it is advisable that the Guest Observer (GO) bring finding charts. Finding charts in the form of slides or polaroid prints are adequate. The "finding telescope" (fine error sensor) views a field 16 arc-min or less in diameter and is sensitive to visible light. Slides are convenient because they can be rotated and flipped to match the rotated and reversed image from the Fine Error Sensor now is use. Use of the automatically produced finder fields is usually slightly slower than of hand held charts. A GO planning to use the automatically produced finder fields should verify their accuracy before coming to observe. If the visual magnitude of the target is below 13.5, then offsetting from a nearby brighter star will be necessary. This technique is discussed in more detail below.

Exposure time can be estimated by $t=E_\lambda/F_\lambda$. E_λ in erg cm^{-2} $Å^{-1}$ is given in the following table:

	High Dispersion small aperture	Low Dispersion large aperture
1300 Å	1.8×10^{-7}	1.1×10^{-9}
1800 Å	8.3×10^{-8}	5.1×10^{-10}
2700 Å	2.6×10^{-8}	2.0×10^{-10}

F_λ in erg cm^{-2} S^{-1} $Å^{-1}$ may be obtained from published results of OAO-2, Copernicus, TD-1 and ANS satellites or from some clever estimates. Guest Observers may get a better feeling for the exposure time by looking through the Observatory log and talking to the Resident Astronomers after arriving at the Observatory.

2. Overhead Time and how to Minimize It

We define overhead time as the amount of time, in addition to the exposure time, required to obtain a spectrum. Spacecraft hardware functions, software execution by the ground computer, and activities such as identifying the star field, computer crash and reinitialization, radar ranging for oribit determination etc., all contribute to the overhead. The breakdown of the overhead is roughly as follows:

(1) Ten minutes - compute maneuvers and configure the spacecraft for slewing

(2) One minute per 5^{o} - Slew

(3) Twenty minutes - prepare the camera

(4) Five minutes (or longer) - Obtain a star field image and identify the target.

(5) Ten minutes - Configure the scientific instrument for exposure and maneuver the target to the aperture

(6) Fifteen minutes - read down an image

Overhead is kept high because most activities must be executed sequentially.

There are ways to reduce the overhead per image, however. It is routine operational practice to prepare a camera during maneuvers, and to read and prepare one camera when the other is in a long exposure. Maneuvers to the next target can also be computed during an expsure. Operational software also exists which combines the functions of reading down an image and preparing the camera. The whole procedure takes about 23 minutes. If the exposure time of a given object is not well determined, and if low dispersion is desired, two spectra with different exposure times can be obtained on a single image to save time. First, the object can be put into the large aperture for the best guessed exposure time. Then the object can be put into the small aperture for some fraction, say 1/n, of the best guessed exposure time. Since only about 50% of the light from a star goes through the saml1 aperture, the effective exposure time is a factor of 2n less than that for the large aperture - a factor of 2n increase in dynamic range without paying the penalty of a test exposure.

3. Some Special Observing Techniques

a. Trailed Spectrum - The signal to noise ratio can be greatly increased by obtaining widened spectrum. The star is trailed along the long axis of the large aperture by slewing the spacecraft at a controlled rate. For the same exposure level, a trailed spectrum requires three to four times the exposure time of an untrailed spectrum. Slew rates depend on the exposure time, and one or more passes can be made through the large aperture.

b. Offset Observations for Faint Objects - At a telemetry rate of 5×10^3 bits S^{-1}, the limiting magnitude for a star to be detectable by the more sensitive fine error sensor (FES2) is 13.5. For fainter objects, lower telemetry rates will be necessary, but then sampling time for the whole 16' or partial 10' field of view will be long. So for objects between $13^m.5$ and $15^m.5$ (limiting magnitude for the longest sampling time), offset from a neighboring star is needed. The distance from the offset star to the target should be $\leq 0^o.5$ and ideally only a few arc-minutes. Before the slew, we center the offset star on a reference point in FES2. If accurate 1950 right ascension and declination for both the target star and the offset star are input to the computer for calculating the offset maneuver, the target star should be at the reference point after the slew. Then a small 1' X 1' portion of the sky around the reference point is mapped out with the longest sampling time to locate the target. From the small postage stamp FES2 map, we can command further small maneuvers until most of the light from the target falls on one FES pixel centered on the reference point. Then we can maneuver the target into the desired aperture by "canned" slews.

If the target is fainter than $15^{m}.5$, it cannot be seen by FES2 and offset will have to be done blindly. In this case, the offset star can be put in the large aperture before slewing to the target. After the slew, the target should be in the large aperture. Since the large aperture is only 10" X 20" oval (small aperture is 3" circular), positions accurate to one arc-second or better are necessary for the offset and target stars. Be sure to take the proper motion between 1950 and 1978 of the offset star into account.

c. Moving Targets - Solar system objects, except the outermost planets, are moving sufficiently fast that their motion has to be compensated. Usually it involves the trimming of the gyros to the drift rate of the target to minimize the drift of the telescope with respect to the moving target. During the exposure, the spacecraft pointing is held either by gyros or tracking on the light of the object spilled over the 3" aperture. The earth, the moon, and Venus are so bright that the fine error sensor is saturated when viewing them. A technique has been developed to use the fine error sensor image of scattered light to put Venus' image in an aperture, but both the moon and the earth would have to be observed by blind offset techniques and under gyro control. To observe the moon its parallax as seen from the spacecraft must be taken into account.

d. Double and Multiple Star Systems - Close bright companions will confuse the fine error sensor and prevent the light from the target from being placed in the aperture. Targets in multiple star systems have been observed by using the blind offset technique discussed above for faint objects. Again, accurate positions for both target and set star are essential.

C. C. Wu