IUE Orientation

Unlike ground telescopes, IUE has three axes of freedom. Because of this additional degree of freedom, the orientation around the line of sight, which is measured by the roll angle of the spacecraft, is not determined uniquely by the spacecraft pointing.

Fortunately, this roll angle is fixed by spacecraft considerations. For reasons of power and thermal stability the spacecraft must be oriented around the line of sight such that the solar panels are most normal to the sun line. Thus the target's location and the sun's location define the three axis orientation of the spacecraft.

The knowledge of the spacecraft roll orientation is useful to you, an IUE user, as with it you can determine the orientation of celestial coordinate frame with respect to the instruments, which are fixed in the spacecraft. Moreover, by predicting the spacecraft orientation you can select the most appropriate dates for an observation both with respect to target-aperture alignment and with respect to target-sun alignment.

To perform all these fun things you need to compute two angles: beta, which is the angle between the spacecraft pointing and the anti-sun direction, and roll, which is the angle between the pitch axis and north when projected on the sky. As the equipment is fixed in the spacecraft, the relation between spacecraft roll and instrument orientation is constant. Likewise as the roll of the spacecraft with respect to the sun is fixed by power and thermal considerations, the date and target location determine spacecraft roll while the beta angle alone defines the heating or cooling due to sun impingement, the availability of power, and the availability of targets. In this note, I give first information on how to use beta and roll, and second instructions on how to compute them.

Let the orientation angle be defined such that 0° points north and 90° east then the orientation angle is related to the spacecraft roll by -

orientation = position angle - spacecraft (S/C) roll angle

where the position angles are defined in the following table.

Aperture	Position angle
LWLA long axis	$73^{\circ} \pm 3^{\circ}$
SWLA long axis	$73^{\circ} \pm 2^{\circ}$
LWLA to LWSA	238°
SWLA to SWSA	242°
LWLA to SWLA	275°
LWSA to SWSA	279°

The spacecraft roll angle can be gotten from the image scripts for images after LWR 6528 and SWP 7549, where it is listed as "S/C Roll". For those scripts where the roll is not given it maybe calculated by the method given below. Note there is another roll (FSS Roll) given on the scripts which is the roll with respect to the sun and is not equivalent to the S/C roll.

For availability of targets you can use the beta angle. This angle has been recorded on all the image scripts since image 1350 (both LWR & SWP), however, its real use is in predicting for future observations. After the method given below is used to calculate the beta, the values can be interpreted by noting

$\beta < 15^{\circ}$	No sun in Fine Sun Sensor; difficulties in maneuvering. Observations will require larger operational overhead than normal.
$\beta < 30^{\circ}$	Cool Betas. Maintaining telescope focus not possible over long time spans. Maneuvering complicated by the need to maneuver back to $\beta = 90$ before maneuvering to next target.
$\beta > 55$ and $\beta < 95$	Hot Betas. On Board Computer (OBC) temperature limits may force observer out of this range.
$\beta > 60$ and $\beta < 80$	Heating Betas. OBC temperature may reach operating limits in this range forcing the observer out of Hot Beta ranges.
$\beta > 135^{\circ}$	Solar avoidance zone. No object may be observed in this region.
$\beta < 5$ or $\beta > 130^{\circ}$	available power from the solar arrays may be insufficient for normal operations.

To calculate β and roll for the spacecraft on a specific date:

Use the Ephemeris to locate solar position on the date and precess it to the epoch of your target attitudes.

$\alpha_\odot$ = Right ascension of the sun

$\delta_\odot$ = Declination of the sun

α = Right ascension of the target

δ = Declination of the target

$$\beta = \cos^{-1}\left(-\sin\delta \sin\delta_\odot - \cos\delta \cos\delta_\odot \cos(\alpha - \alpha_\odot)\right)$$

$$\gamma = \cos^{-1}\left(-\sin\delta_\odot / (\sin\beta \cos\delta) - \tan\delta / \tan\beta\right)$$

If $\sin(\alpha - \alpha_\odot) < 0$, then roll = 180 + γ

If $\sin(\alpha - \alpha_\odot) > 0$, then roll = 180 - γ

These calculations can be performed easily using a scientific hand calculator.

Example:

sun 10 Aug 1979 at 12:00 UT

$\alpha = 9^{hr}\ 17^{m}\ 15.^{s}8$ $\delta = 15^{\circ}46'\ 56.''7$ (1950)

target η UMa

$\alpha = 13^{hr}\ 45^{m}\ 34^{s}$ $\delta = 49^{\circ}\ 33'\ 44''$ (1950)

Compute $\beta = 116.^{\circ}75$ roll = $97.^{\circ}00$

Thus η UMa was in a safe β region

The SWLA and LWLA apertures were oriented 24° west of North to 24° East of South.

The LWSA was 51° South of East from the LWLA

The SWSA was 55° South of East from the SWLA and the SWLA was 2° East of South from the LWLA.

Francis H. Schiffer, 3rd