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Faint Object Spectrograph:
The Instrument

The FOS is used to obtain intermediate resolution spectra over the wavelength range 1150Å to 8500Å. It also has a polarizer to obtain spectropolarimetry over the entire wavelength range, but only the 1570Å to 3300Å range is calibrated.

The FOS has two Digicon detectors, one of which is included on the blue side (FOS/BL) and one of which is included on the red side (FOS/RD also called AMBER). The optical light path in the FOS is such that the light from the target passes through the aperture, the polarizer (which is clear for non-polarimetric observations) and is then dispersed from the filter-grating wheel by a concave grating, or a camera mirror plus a prism. This dispersed light is imaged onto the transmissive photocathode in the Digicon detector. The photocathode is a two dimensional detector which extends from +2048 Y-base units to -2047 Y-base units (256 Y-base units is approximately the height of the diode array). Each disperser produces its spectrum at a different location on the photocathode. The photoelectrons from the region of the photocathode where the image is expected are then accelerated to a linear array of 512 diodes. There the counts per diode are accumulated for an interval of time and read out and normally stored on the tape recorder. The FOS diode array is scanned in a pattern which determines the data acquisition mode. The different modes are:

- Spectrophotometry/Spectropolarimetry (ACCUM mode)
- Time Resolved Spectrophotometry (PERIOD mode)
- Rapid Readout (RAPID mode)
- Images (IMAGE mode)

Configuring the FOS:

The first step in observing with the FOS, is to choose the set of configurations that will allow the GO to accomplish his/her scientific objectives. This means the choice of

- aperture
- waveplate (if doing spectropolarimetry)
- disperser (grating/prism) to cover spectral range of interest
- detector to match the disperser

Apertures:
The FOS has a number of apertures: single aperture, paired apertures, barred apertures and a slit aperture.

The smallest apertures are suitable for isolating spatially resolved features (.1" - 0.25") and for spectroscopy of faint objects embedded in a bright background. Otherwise it is recommended that a GO use the 0.5 - 1.0" apertures to assure good positional accuracy and minimum loss of light from the point spread function (psf).
The paired apertures are suited to observe both sky and target if sky subtraction is necessary. Any

observation that uses a paired aperture invokes, by DEFAULT, star-sky "chopping." That is, half the specified exposure time will be spent accumulating data through the aperture admitting SKY and one-half will be spent on the OBJECT. This chopping is normally accomplished in a pattern of approximately 10 seconds on OBJECT, 10 seconds on SKY, 10 seconds on OBJECT, and so forth. Since one spends 50% of the exposure time on sky for a given observation with the paired apertures, the observations are inefficient and GOs have not used the paired apertures for this purpose. These apertures have mostly been used (by planetary astronomers) to obtain spectra from 2 separate portions of an extended source.
NOTE: There is NO WAY to spend less than one-half the specified exposure time on the SKY if chopping is used. Specification of STEP-PATT=SINGLE will turn off star/sky chopping. GOs commonly forget to specify STEP-PATT=SINGLE.

The barred apertures are best for observations of nebulosity near a bright point source (e.g. host galaxy of quasar). Position angle of the bar is important hence the GO should consult with an instrument scientist if a barred aperture is being used. The slit was meant to be used for spectroscopy of extended targets, but pre-COSTAR it was used for point sources to reduce effects of the bad psf.
NOTE: We now do not regularly calibrate the slit and the barred apertures, thus any GO who needs to use these apertures should contact an instrument scientist.

Waveplate:
Although the FOS has two waveplates (A & B), we only calibrate the waveplate B, so if a GO has spectropolarimetric observations he/she should use the waveplate B.

Dispersers:
The choice of gratings/prism depends on the wavelength range of interest and the resolution required to achieve the scientific objectives.

Detector:
This final step in configuring the FOS is to specify the digicon (FOS/BL or FOS/RD) that will best match the spectral sensitivity of the dispersers selected and the science requirements. For example suppose a GO wants to use the G130H and G190H gratings. The FOS/BL detector has to be chosen for the G130H grating because the FOS/RD is not sensitive to the far UV photons. However, for the G190H grating one could use either the FOS/RD or FOS/BL. If the GO is not concerned of pointing accuracy and is using the large apertures the FOS/RD may be used because of its higher quantum efficiency (and still get reasonable S/N), but if the GO is using a small aperture (smaller than 0.5), he/she may continue to use the FOS/BL to avoid the overhead time required to change detectors and do another set of peak-ups.

Data Acquisition.

Once the basic elements to configure the FOS are chosen the next step is to decide on the data acquisition mode.

The FOS data acquisition mode depends on the scan pattern used to acquire the data. The two techniques commonly used to acquire data are: substepping and overscanning. The substepping (moving a fraction of a diode) is used to better sample the spectrum in the wavelength direction, while overscanning (moving by a whole diode) is used to ensure that each pixel in the final spectrum contains data received from multiple diodes to smooth out the effects of dead diodes. Both substepping and overscanning are accomplished by magnetically differentially deflecting the photoelectrons on the diode array.

NOTE: For a standard FOS observation (ACCUM) with SUB-STEP=4 and OVERSCAN=5, although the number of diodes in the diode array are only 512, the number of pixels in an observation is given by the equation

$$\# \text{ of pixels} = (\# \text{ of diodes} + (OVERSCAN-1)) \times SUB\text{-}STEPS$$

This is equal to 2064 pixels for SUB-STEP=4 and OVERSCAN=5

Because of substepping and overscanning the exposure time for a given observation is different from the exposure time per pixel. Also a pixel is a fraction of a diode if SUB-STEP=1 is not used.

Spectrophotometry/Spectropolarimetry (ACCUM)

Most standard FOS spectra are obtained in this mode. ACCUM mode spectra with total exposure time lasting more than a few minutes are read out at regular intervals to the ground or to the onboard tape recorders. The frequent readouts are to protect against catastrophic loss of data. Since the data are read out at regular intervals, all observations longer than a few minutes are time resolved. Each readout is stored in the data files as follows: The first readout is stored as group 1, the next readout is added (accumulated) to the previous readout and the sum is stored as group 2, and so on. The last group contains the spectrum from the full exposure time of the observation. The number of groups per observation depends on the length of the exposure and the detector used (readout time is ≤ 2 minutes for the red detector and ≤ 4 minutes for the blue detector).

Optional Parameters:

Apertures and Gratings:

All FOS apertures and gratings can be used in this observation mode.

Data acquisition pattern (STEP-PATT):

Since the FOS data are acquired by magnetically deflecting the photoelectrons onto the diode array, one can sample different regions of the photocathode to get multiple spectra. The default step pattern for the single apertures or the barred apertures samples only a fixed region of the photocathode and a single spectrum is obtained (SINGLE). For the paired apertures two regions of the photocathode are sampled to obtain two spectra (OBJ-SKY, OBJ-OBJ) which usually will be of the target and the region 2.5" (the separation between the two apertures) from the target, which could either be the observed sky background or another target. There are other special cases given in the Phase II handbook which with change these default patterns for the single or the paired apertures.

NOTE: In the case of multiple spectra, since equal time is allotted to each individual spectrum, the procedure may be inefficient. There is no way the divide the time unequally.

Time per integration (STEP-TIME):
This is the amount of time that is spent integrating at each position of the step pattern. For example for a paired aperture OBJ-SKY observations are acquired normally in a pattern of approximately 10 seconds on OBJECT, 10 seconds on SKY, 10 seconds on OBJECT, and so forth. In this case the STEP-TIME is 0.5 seconds.
NOTE: The default time can be changed but this is not recommended.

Burst noise (REJLIM):
If a cosmic ray hits the photocathode it gives off a burst of one or more photoelectrons which are then detected by the diode array. This burst noise destroys the data, especially for the faint sources. A GO can reject a readout (i.e. not add it to the exposure) by using the optional parameter REJLIM to remove the effects of burst noise. The data are rejected if the total number of counts summed over all active diodes during a given sub-exposure (STEP-TIME) is greater than REJLIM. To determine this parameter and use it effectively, the GO must know the expected target count rate quite accurately so that REJLIM can be chosen carefully to avoid losing all the science data.
NOTE: An instrument scientist should be consulted if this option is being used.

Spectropolarimetry (POLSCAN):
FOS polarimetry data are also acquired in the ACCUM mode. The polarimetry data consist of a number of exposures (POLSCAN= 16, 8 or 4) with the waveplate set at different angles and taken consecutively (within one orbit). The Wollaston prism splits the light beam into two spectra corresponding to the orthogonal directions of polarization. Hence, each exposure consists of the two spectra at a given waveplate angle, which are alternately deflected to the diode array and recorded as two pass directions and stored as a single group in the raw data file. In the case of polarimetry data, a special STEP-PATT is used which samples both the polarized spectra and any STEP-PATT provided by the GO will be ignored.
NOTE: If the observation is spectropolarimetry the optional parameter POLSCAN has to be used and the waveplate (A or B) has to specified. Only waveplate B is calibrated. Also only the 4.3 and 1.0 single apertures with either the G190H or G270H gratings are calibrated. Any polarimetry observation with other than the 4.3 or 1.0 aperture should be discussed with an Instrument Scientist. Other more detailed polarimetry checks must also be made, but are beyond the scope of this summary. An Instrument Scientist must review ALL polarimetry proposals. All polarimetry spectra have the exposure time equally divided among the number of waveplate positions. Thus each exposure must be completes in a single visibility period and cannot be split.

Rapid Readout (RAPID is the OPMODE)
This mode is normally used for certain astronomical targets where rapid variability in flux has to observed. In this mode, the data are acquired as in the normal ACCUM mode, but the spectra are read out at much shorter intervals than the nominal 4 minutes (blue detector) or 2 minutes (red detector). The frequency of the readout is set by the GO's requirements. Each readout of the diode array is stored as a group, and is not co-added as in the ACCUM mode. RAPID mode generates a large volume of data, hence, this observation mode requires either a TDRSS link or enough onboard storage space on the tape recorders. The volume of data acquired can be adjusted using the many parameters available in this mode.
NOTE: In general an instrument scientist should be consulted to determine the best values for the

various options available in RAPID mode.

Optional Parameters:

Apertures and Gratings:

All FOS apertures and gratings can be used in this observation mode. If a wavelength range is specified, then only those specific diodes which correspond to that wavelength are read.

NOTE: If a wavelength range is specified, that range will be used whether or not there is room in the memory for a larger wavelength range. Thus restricting the wavelength range is not a good idea, unless absolutely necessary, because a larger wavelength range is often useful. Normally, the largest wavelength range, compatible with the READ-TIME, is automatically observed. In general, there should be NO ENTRY in the wavelength column of the logsheet. GOs commonly feel they are being helpful when they fill in this entry; this is a very common mistake. An Instrument Scientist should be consulted for RAPID mode.

READ-TIME:

The observation loop in the RAPID mode consists of a short integration, immediate read-out and automatic restart of the next integration. The time taken to execute one such loop is the READ-TIME. This time has to be carefully adjusted to balance the volume of data acquired to the capacity on the tape recorder and the science.

DATA-RATE:

This is the parameter which determines the tape recorder data acquisition rate.

Table 1: RAPID mode

READ-TIME	SUB-STEP
6.2	4
3.1	2
1.6	1

For a given SUB-STEP if the READ-TIME is less than the entry in column 1 above, then the HIGH data-taking rate is invoked. At the HIGH rate only 18 minutes of data-taking can be stored on EACH tape recorder.

NOTE: In general, an Instrument Scientist should be consulted as usage of the tape recorder HIGH rate can severely limit a proposer's science, may not be necessary, and can be avoided under certain circumstances.

All other optional parameters discussed for the RAPID mode are similar to those used in the ACCUM mode.

Time Resolved Spectrophotometry (PERIOD)

This mode is normally used for objects with known periodicity in the 50 msec to 100 sec range. It has been used only once so far. If a GO wants to use this mode, they should contact the instrument scientists for details.

NOTE: If a PERIOD mode is being used an Instrument Scientist should be consulted to verify all the optional parameters used in the mode.

Imaging the FOS apertures (IMAGE):

This observational mode is used to obtain images of the FOS apertures which are nonstandard images. This mode is normally used for engineering and calibration purposes and is hardly used by GOs.

NOTE: If an IMAGE mode is being used for a non-standard picture pattern (with MIRROR), then the observation must be reviewed by an Instrument Scientist to insure that the resultant amount of data will fit into onboard memory. Also if an IMAGE mode observation using a GRATING is specified, an Instrument Scientist should be consulted to verify all the optional parameters used in the mode.

Target Acquisition using the FOS:

Any target to be observed by the FOS can be acquired using one of the following four modes depending on the nature of the target and the pointing accuracy required. The three modes are: (1) Blind acquisition, (2) BINARY acquisition mode (ACQ/BIN), and (3) Peak-up acquisition (ACQ/PEAK). Assuming that the nature of the target is not one of the special cases described below, we have also generated tables showing efficient target acquisition patterns as a function of pointing accuracy for each of the FOS apertures. The exact target acquisition strategy used for any given object depends on the pointing accuracy required.

Nature of the Targets:

FOS target acquisitions can be divided into three broad categories: 1) those that utilize ACQ/BIN, at least for the first stage of acquisition; 2) those that require ACQ/PEAK; and 3) those that require consultation with an Instrument Scientist. The applicability of one or more of these categories to a particular acquisition is determined by many characteristics of the target, e.g., brightness, variability, surface brightness, geometry, target environment etc.

<u>ACQ/BIN objects:</u>

The first class of objects are those that can be acquired using ACQ/BIN as its first stage of acquisition. These objects include all single, not very bright, not highly variable (± 1mag) objects (e.g. Stars, QSOs, extragalactic planetary nebulae which are not extended, and AGN with dominant point-like nuclei in the 2000-5000Å range).

<u>ACQ/PEAK objects:</u>

The second class of objects are those that cannot be acquired by an ACQ/BIN in their first acquisition stage and require ACQ/PEAK. These objects include bright objects, variable objects, and AGN which do not have dominant point source nuclei in the 2000-5000Å.

<u>Objects requiring customized acquisition strategies:</u>

The third class of objects are those which require consultation with an Instrument Scientist. These objects can belong to any one of the following categories: (a) extended (>0.2") objects, (b) crowded fields (even 2 objects separated by <1.3"), (c) 0.1 aperture observations, (d) objects fainter than V=19 mag, (e) objects with emission lines, but hardly any continuum, (f) objects with E(B-V) > 0.1, or (g) acquisitions using offset stars.

Target Acquisition Modes and the Pointing Accuracy:
Blind acquisitions:
All objects can be acquired using a blind acquisition. This type of acquisition can be used only when observing with the 4.3" aperture because we find that in cycle 4 to date only ~60% of the targets have initial pointings better than 1". To use a blind acquisition the observer must know the target coordinates to better than 0.5" or be willing to lose the observation. Further, the observer must be cautioned that 50% of the time one could lose a target because of incorrect target coordinates. Considering these facts, a blind acquisition strategy is only recommended when a GO has a large sample and is willing to lose a few acquisitions. A snapshot survey proposal is a good example of a prudent use of this strategy.

Binary Acquisition (ACQ/BIN):
The binary search algorithm begins by mapping the 4.3" aperture (only the 12 central diodes which cover the 4.3" aperture are readout) with 3 Y-scans. The first scan is of the central region of the 4.3" aperture, the second scan is of the lower region of the 4.3" aperture, and the third scan is of the upper region of the 4.3" aperture. The binary acquisition program then compares the count rates in the three scans, and locates the target in one of the three scans by finding the total number of peaks in the scan and the number of counts in each individual peak. The brightest peak, representing the target, (whose brightness has been pre-determined by the GO) is then selected. If more than 5 peaks per scan are found by the binary search algorithm, the target acquisition fails. If two peaks (within a diode width) in two adjacent scans have the same number of counts the algorithm sums up the number of counts in the two peaks to determine the brightness of the target. The search program then continues (up to 8 more tries) to deflect the target (in the Y direction) until the target is on the edge of the diode array, i.e. until the number of counts in the peak is half the maximum number of counts observed in the initial 3 scans. For each deflection the data are scanned. If the target acquisition is successful the telescope slews to the nominal center of the 4.3" aperture and the science observations are conducted. If the binary acquisition fails the telescope **slews** to place the target at the nominal center of the 4.3" aperture, and the object is observed at the coordinates provided by the GO. Although ACQ/BIN is designed to select the nth brightest object in a crowded field, this option has not been used so far and has only been used to obtain the brightest target in the aperture.

Calibration data from cycle 4 show that the 1σ pointing accuracy of ACQ/BIN is different for the two FOS detectors. (0.08" for the blue detector, and 0.12" for the red detector - see Table 1). The ACQ/BIN pointing accuracy indicates that observations with the 4.3" and the 1.0" apertures may not require any further additional peak-up acquisition to improve the centering accuracy, *depending on the science needs of the observer.* Since the above pointing accuracies are only 1σ, observations in apertures smaller than or equal to 0.5 will require additional peak-up acquisitions to improve the pointing accuracy. Due to the difference in the binary acquisition pointing accuracy of the two detectors, the successive efficient peak-up acquisition strategies must be slightly different to acquire a given pointing accuracy.

FOS Peak-up/Peak-down (ACQ/PEAK):

The ACQ/PEAK algorithm uses a preloaded step and integrate pattern on the sky by slewing the telescope. At the end of the pattern the dwell point with the maximum number of counts is determined and the telescope is positioned to the center of the aperture corresponding to this dwell point. This mode has large overhead time depending on the nature of the pattern used. This acquisition mode has been used very often in the first 3 cycles.

ACQ/PEAK can be used for all stages of an acquisition or may be used to improve the pointing accuracy after an ACQ/BIN. The pointing accuracy of the ACQ/PEAK acquisition depends on the pattern used to acquire the target. In general, the pointing accuracy is determined by the SCAN-STEP-X (step size in the X-direction of the peak-up scan pattern) and SCAN-STEP-Y (step size in the Y-direction of the peak-up scan pattern) parameters of the search pattern. The accuracy is half the scan-step size and is the upper limit to the uncertainty. The pointing accuracy of a complete peak-up acquisition strategy is the pointing accuracy of the peak-up pattern of the last stage.

Table 2: FOS Target Acquisition Pattern Pointing Accuracies and Overheads

Aperture	Search-size-X	Search-size-Y	Step-size-X	Step-size-Y	Pointing Accuracy	Over-head	Mode Name
4.3	1	3	-	1.23	-	7	A
1.0	6	2	0.61	0.61	0.43	13	B1
0.5	3	3	0.29	0.29	0.20	11	C1
0.3	5	5	0.17	0.17	0.12	22	D1
0.3	5	5	0.11	0.11	0.08	22	D2
0.3	5	5	0.052	0.052	0.04	22	D3
0.3	4	4	0.17	0.17	0.12	16	E1
0.3	4	4	0.11	0.11	0.08	16	E2
0.3	4	4	0.10	0.10	0.07	16	E3
0.3	3	3	0.17	0.17	0.12	11	F
1.0-PAIR	6	2	0.61	0.61	0.43	13	B2
0.5-PAIR	3	3	0.29	0.29	0.20	11	C2
0.25-PAIR	5	5	0.17	0.17	0.12	22	P1
0.25-PAIR	5	5	0.11	0.11	0.08	22	P2
0.25-PAIR	5	5	0.052	0.052	0.04	22	P3
0.25-PAIR	4	4	0.11	0.11	0.08	16	P4
BINARY-RED	-	-	-	-	0.12	9	Z
BINARY-BLUE	-	-	-	-	0.08	9	Z

Table 3: Common Recommended Target Acquisition Strategies

Science Observation Aperture	Pointing Accuracy Required	Starting with ACQ/BIN				Starting with ACQ/PEAK	Over -head
		Detector RED	Over -head	Detector BLUE	Over -head		
4.3	>0.1	Z	9	Z	9	A+B1+C1	31
	<0.12	Z+E1	25	Z+F	20	A+B1+D1	42
	<0.08	Z+D2	31	Z+E3	25	A+B1+C1+E2	47
	<0.04	Z+D1+D3	53	Z+D1+D3	53	A+B1+D1+D3	64
1.0	>0.1	Z	9	Z	9	A+B1+C1	31
	<0.12	Z+E1	25	Z+F	20	A+B1+D1	42
	<0.08	Z+D2	31	Z+E3	25	A+B1+C1+E2	47
	<0.04	Z+D1+D3	53	Z+D1+D3	53	A+B1+D1+D3	64
0.5	<0.12	Z+E1	25	Z+F	20	A+B1+D1	42
	<0.08	Z+D2	31	Z+E3	25	A+B1+C1+E2	47
	<0.04	Z+D1+D3	53	Z+D1+D3	53	A+B1+D1+D3	64
0.3	<0.08	Z+C1+E2	36	Z+C1+E2	36	A+B1+C1+E2	47
	<0.04	Z+D1+D3	53	Z+D1+D3	53	A+B1+D1+D3	64
1.0-PAIR	>0.1	Z	9	Z	9	A+B2+C2	31
	<0.12	Z+E1	25	Z+F	20	A+B2+P1	42
	<0.08	Z+P2	31	Z+P4	25	A+B2+C2+P4	47
	<0.04	Z+P1+P3	53	Z+P1+P3	53	A+B2+P1+P3	64
0.5-PAIR	<0.12	Z+E1	25	Z+F	20	A+B2+D1	42
	<0.08	Z+P2	31	Z+P4	25	A+B2+C2+P4	47
	<0.04	Z+P1+P3	53	Z+P1+P3	53	A+B2+P1+P3	64
0.25-PAIR	<0.08	Z+C1+P4	42	Z+C1+P4	42	A+B1+C2+P4	53
	<0.04	Z+P1+P3	53	Z+P1+P3	53	A+B2+P1+P3	64
0.1-PAIR, 2.0-Bar, 0.7-Bar, Slit	SEE INSTRUMENT SCIENTIST						

Imaging Target Acquisition (ACQ, INTACQ):
This acquisition mode is typically used for early acquisition (INTACQ), or to obtain a verification image of the FOS large aperture to check the target position in the aperture (ACQ).

This mode is a special "canned" version of IMAGE mode using the MIRROR to take a picture of the field. In this mode the FOS Digicon is commanded through a sequence of X-steps and Y-steps which map the aperture. The the 4.3" aperture is scanned with 64 strips, each of which is the height of the diode array, beginning at the bottom edge of the aperture. Each scan reads out 20 diodes with the central 12 diodes spanning the 4.3" aperture. The substepping in both the X and Y directions, and the elongated shape of the diodes, blurs and stretches the image. A point source (which has the size of a PSF) on the photocathode is recorded by the same diode for 4 consecutive pixels in the X direction and 16 consecutive pixels in theY direction. Hence, the images are stretched with a ratio of X:Y which is normally 4:1. In an INTACQ the image is observed real time. It is restored and the position of the target measured. The small offset required to move the target into the center of the science aperture is uplinked and the slew is performed before the science observations are obtained. This acquisition is normally used for the 4.3" and the 1.0" apertures.
NOTE: An ACQ exposure time should be 6 times the length of the ACQ/BIN time to produce 300 counts in the most densely exposed PIXEL of the ACQ image line that cuts directly through the center of a point-source target. Actual exposures then should be adjusted to achieve proposer's desired S/N.
If a GO is using the ACQ mode to observe an extended object, for example, looking at "fuzz" around the edge of a brighter source, then such an observation is very difficult to do with ACQ - a common GO misconception is that FOS is a 2-dimensional detector with square pixels. It is NOT! Some observations of this nature can be made with FOS IMAGE mode, but typically with apertures other than the 4.3. An Instrument Scientist must be consulted if the mode is being used for non-standard requirements.

Acquisitions using offset stars:
Acquisitions using offset stars are used if the target is too faint, has a peculiar geometry, or ACQ/PEAK requires a lot of time. Many offset stars do not have well-established spectral types since such offsets are most frequently determined from EARLY ACQ WFPC images. Please refer to text above concerning poorly known target brightness and spectral types.
NOTE: These types of acquisitions require special attention hence an Instrument Scientist consulted.

If the offset small angle maneuver is to be greater than 15", then a post-slew positional uncertainty (introduced by differential coordinate uncertainties and *not* by the actual motion of HST) should be calculated from the following formula and an appropriate PEAKUP for re-centering must be included.
For WFPC1-derived offsets (note these are *still* usable!): 1 σ uncertainty (arcsec) = 0.00145 $\times$ length of slew(arcsec). For WFPC2-derived offsets the uncertainty is *unknown* because the WFPC2 astrometry is not accurate yet.

Checklist of the most commonly encountered concerns:

The following presents many of the items that FOS Instrument Scientists look for when performing a SIB Review. Since the FOS SIB Review is a complicated procedure involving many subtle points of interaction between instrumental capabilities, scientific goals, and SI safety, this is *not* intended to be an exhaustive list of all possible items that can be covered in a SIB Review, rather a checklist of the most commonly encountered concerns.

Basic Instrument Health and Safety:

Simplified overlight checking can be performed by comparing quoted target brightness (typically V magnitudes) and spectral energy distributions with the Brightness Limit Table 1.3.1 in the FOS Handbook Version 5. If the observation is of a crowded field it is relevant for BRIGHT OBJECT checking as the integrated magnitude of clusters and extended objects is often reported by our system.

NOTE: If a target has an E(B-V) > 0.10, then this Table is not valid, and an Instrument Scientist should be consulted.

Target Acquisition Strategy:

First a general note about FOS target acquisition (TA) positioning accuracies. A table listing typical accuracies for standard FOS target acquisition sequences, involving both ACQ/BIN and ACQ/PEAK can be used. PCs should be aware that any uncertainties introduced by the actual physical re-positioning of HST from one point on the sky to another (in the context of typical moves in an FOS acquisition) can be ignored. The only uncertainties that are important are those stemming from the FOS TA sequence and any associated with differential coordinate errors between an offset target and the science target (see TA involving offset star). The following are questions concerning target acquisition can be used to determine the correct strategy.

Is the object variable in brightness, or is its brightness poorly known, or is extended?

If yes, then ACQ/BIN may not succeed. This is a commonly encountered situation for QSOs and AGNs.

Are there multiple point sources near the target?

ACQ/BIN and ACQ/PEAK will pick out the brightest of them, *but* ACQ/BIN will fail if it finds more than 5 sources above its default FAINT limit. Crowded fields can limit the accuracy inherent to standard FOS target acquisition. Further, if objects are crowded more closely than the width of a diode (0.3 arcsec), then most standard FOS target acquisition schemes will fail and an Instrument Scientist must be consulted for such cases.

Is the object near a much brighter object?

If an object is very close to a much brighter object it can be very difficult to acquire directly and an offset may be necessary.

Is the target very faint? Has detector background been properly included in the determination of exposure times?

If V=19 or fainter an Instrument Scientist should be consulted to properly calculate exposure times.

Is the target significantly reddened?
If the object B-V is known to be redder than +0.3, then an approximation of exposure time can be made for ACQ/BIN by assuming a K5 spectral type. If bluer, but not accurately known, an Instrument Scientist should be consulted. For ACQ/PEAK on an object of unknown color, K5 can be used as a safe approximation, *but* may result in very long (hence more inefficient than warranted) exposures.

Does the acquisition or science require the 0.25-pair, 0.1-pair, or either of the barred apertures?
Any proposal requiring these apertures must be referred to an Instrument Scientist.

Does the specified target acquisition provide the pointing accuracy required by the science in the proposal?
In general, if high S/N requirements exist (S/N > 30), precision wavelength calibration is required, or high photometric accuracy is required, then highly precise target positioning (pointing accuracy of 0.06 arcsec or better) is required and at least one CRITICAL peakup (>10,000 counts) is necessary. If needed, the critical stage(s) is (are) the last of a peakup sequence.

Wavelength Accuracy:
In general if wavelength accuracies corresponding to 0.5 diodes or poorer are sufficient, then no special consideration need be given to wavelength calibration. If precise wavelengths are required, then a WAVE calibration lamp exposure *must* be taken either immediately before or after the science exposure, *without* any movement of the filter-grating-wheel (FGW). Typical types of programs that require such accuracies are those involving gravitational lenses or black hole searches.

Flat Fields and Photometry Accuracy:
If high S/N (> 30) is the goal of the science, then the target must sample as precisely as possible the same physical positions of the FOS photocathode as is done in FOS calibration observations. This requires target positioning accuracies of the order of 0.04 arcsec which will be achieved with a 5×5 critical peakup in the last stage of acquisition. Observations of extended objects with the 1.0-paired and circular apertures are particularly prone to large photometric uncertainties due to random FOS Y-base errors. We recommend the 4.3 aperture for more precise photometry on extended objects.

Scattered Light:
If the object is *red* in color (e.g., elliptical galaxies, later than A0, B-V > 0.00) scattered light can be a problem in the FOS ultraviolet gratings. Refer to Instrument Handbook Table C.1 and/or consult Instrument Scientist for more information.

Peculiar observing parameters:
Any unusual observing mode or parameter, such as REJLIM, IMAGE, TIMETAG, RAPID, POLARIMETRY, Paired apertures and others require Instrument Scientist consultation.

Some hints by type of object:

QSO's and luminous point-source AGNs: ACQ/BIN can often be used; treat as ν^{-1} power law.

faint AGN: Galaxy can influence the flux in the 2000 - 4000 Å range, so that ACQ/BIN is typically not recommended.

extended objects: poor photometry possible for 1.0 single and paired apertures; watch out for unintended SKY observing with paired apertures.

ISM and bright stars: often require high S/N, hence very precise pointing.

black hole searches, gravitational lens studies: often require highly precise wavelength calibration, hence must include WAVE observations.

red objects: watch out for influence of scattered light on UV gratings.