Choosing a Grating/Central Wavelength

The grating you choose is the main optical element that decides the spectral resolution of your observations. The following Table gives the details of the various gratings, the corresponding wavelength coverage, spectral resolution, etc. Note that all COS wavelengths are vacuum wavelengths.

### COS Spectroscopic Modes

<table>
<thead>
<tr>
<th>Grating</th>
<th>Useful wavelength range (Å)</th>
<th>Bandpass per exposure (Å)</th>
<th>Resolving Power R = ( \frac{\lambda}{\Delta \lambda} )</th>
<th>Dispersion (mÅ pixel(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FUV Channel</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G130M</td>
<td>1150 - 1450</td>
<td>292</td>
<td>20,000 - 24,000</td>
<td>9.97</td>
</tr>
<tr>
<td>G160M</td>
<td>1405 - 1775</td>
<td>360</td>
<td>20,000 - 24,000</td>
<td>12.23</td>
</tr>
<tr>
<td>G140L</td>
<td>1230 - 2050</td>
<td>&gt;820</td>
<td>2,000 - 5,000</td>
<td>80.3</td>
</tr>
<tr>
<td><strong>NUV Channel</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G185M</td>
<td>1700 - 2100</td>
<td>(3 \times 35)</td>
<td>16,000 - 20,000</td>
<td>37</td>
</tr>
<tr>
<td>G225M</td>
<td>2100 - 2500</td>
<td>(3 \times 35)</td>
<td>20,000 - 24,000</td>
<td>33</td>
</tr>
<tr>
<td>G285M</td>
<td>2500 - 3200</td>
<td>(3 \times 41)</td>
<td>20,000 - 24,000</td>
<td>40</td>
</tr>
<tr>
<td>G230L</td>
<td>1700 - 3200</td>
<td>((1 \text{ or } 2) \times 398)</td>
<td>1,550 - 2,900</td>
<td>390</td>
</tr>
</tbody>
</table>

You must choose an appropriate central wavelength so that the wavelength of interest falls on an active area of the detector. The tables below present the nominal wavelength setting ranges for both the FUV and NUV detectors. If the wavelength of interest falls between the segment or stripe gaps or it is not in the supported wavelength range for the chosen grating, the ETC will generate an error page. In addition, calculations performed at wavelengths that fall at the edge of the detectors will generate a warning message urging users to redo the calculations at wavelengths further away from the edge. To avoid performing a calculation near the edge of the detector choose a wavelength in the range \( \lambda_{\text{min}} + 0.5 < \lambda < (\lambda_{\text{max}} - 0.5) \); where \( \lambda_{\text{min}} \) and \( \lambda_{\text{max}} \) are the minimum and maximum values for the wavelength ranges given below. Note also that for the G140L 1105 Å central wavelength setting the segment B detector is turned down to the HVLOW state and does not see any light; for the 1230 Å central wavelength setting the only counts coming from segment B are those associated with dark current.
### Wavelength Ranges for FUV Gratings

<table>
<thead>
<tr>
<th>Grating</th>
<th>Nominal wavelength setting (Å) ¹</th>
<th>Recorded wavelengths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Segment B</td>
</tr>
<tr>
<td>G130M</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1291</td>
<td>1132 - 1274</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>1141 - 1283</td>
</tr>
<tr>
<td></td>
<td>1309</td>
<td>1150 - 1292</td>
</tr>
<tr>
<td></td>
<td>1318</td>
<td>1159 - 1301</td>
</tr>
<tr>
<td></td>
<td>1327</td>
<td>1168 - 1310</td>
</tr>
<tr>
<td>G160M</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1577</td>
<td>1382 - 1556</td>
</tr>
<tr>
<td></td>
<td>1589</td>
<td>1394 - 1568</td>
</tr>
<tr>
<td></td>
<td>1600</td>
<td>1405 - 1579</td>
</tr>
<tr>
<td></td>
<td>1611</td>
<td>1416 - 1590</td>
</tr>
<tr>
<td></td>
<td>1623</td>
<td>1428 - 1602</td>
</tr>
<tr>
<td>G140L</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1105</td>
<td>&lt;300 - 970</td>
</tr>
<tr>
<td></td>
<td>1230</td>
<td>&lt;300 - 1095</td>
</tr>
</tbody>
</table>

¹ The nominal wavelength setting has been chosen to be the shortest wavelength that is adjacent to the gap on segment A so that the indicated wavelength is an actually recorded one.

### Wavelength Ranges for NUV Gratings
<table>
<thead>
<tr>
<th>Grating</th>
<th>Nominal wavelength setting (Å)</th>
<th>Recorded wavelengths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stripe A</td>
<td>Stripe B</td>
</tr>
<tr>
<td>G185M</td>
<td>1786 - 1705</td>
<td>1769 - 1804</td>
</tr>
<tr>
<td></td>
<td>1817 - 1736</td>
<td>1800 - 1835</td>
</tr>
<tr>
<td></td>
<td>1835 - 1754</td>
<td>1818 - 1853</td>
</tr>
<tr>
<td></td>
<td>1850 - 1769</td>
<td>1833 - 1868</td>
</tr>
<tr>
<td></td>
<td>1864 - 1783</td>
<td>1847 - 1882</td>
</tr>
<tr>
<td></td>
<td>1882 - 1801</td>
<td>1865 - 1900</td>
</tr>
<tr>
<td></td>
<td>1890 - 1809</td>
<td>1872 - 1907</td>
</tr>
<tr>
<td></td>
<td>1900 - 1818</td>
<td>1882 - 1917</td>
</tr>
<tr>
<td></td>
<td>1913 - 1831</td>
<td>1895 - 1930</td>
</tr>
<tr>
<td></td>
<td>1921 - 1839</td>
<td>1903 - 1938</td>
</tr>
<tr>
<td></td>
<td>1941 - 1860</td>
<td>1924 - 1959</td>
</tr>
<tr>
<td></td>
<td>1953 - 1872</td>
<td>1936 - 1971</td>
</tr>
<tr>
<td></td>
<td>2010 - 1929</td>
<td>1993 - 2028</td>
</tr>
<tr>
<td>G225M</td>
<td>2186 - 2105</td>
<td>2169 - 2204</td>
</tr>
<tr>
<td></td>
<td>2217 - 2136</td>
<td>2200 - 2235</td>
</tr>
<tr>
<td></td>
<td>2233 - 2152</td>
<td>2215 - 2250</td>
</tr>
<tr>
<td></td>
<td>2250 - 2169</td>
<td>2233 - 2268</td>
</tr>
<tr>
<td></td>
<td>2268 - 2187</td>
<td>2251 - 2286</td>
</tr>
<tr>
<td></td>
<td>2283 - 2202</td>
<td>2266 - 2301</td>
</tr>
<tr>
<td></td>
<td>2306 - 2225</td>
<td>2288 - 2323</td>
</tr>
<tr>
<td></td>
<td>2325 - 2243</td>
<td>2307 - 2342</td>
</tr>
<tr>
<td></td>
<td>2339 - 2258</td>
<td>2322 - 2357</td>
</tr>
<tr>
<td></td>
<td>2357 - 2276</td>
<td>2340 - 2375</td>
</tr>
<tr>
<td></td>
<td>2373 - 2291</td>
<td>2355 - 2390</td>
</tr>
<tr>
<td></td>
<td>2390 - 2309</td>
<td>2373 - 2408</td>
</tr>
<tr>
<td></td>
<td>2410 - 2329</td>
<td>2393 - 2428</td>
</tr>
<tr>
<td>Grating</td>
<td>Nominal wavelength setting (Å)</td>
<td>Recorded wavelengths</td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td></td>
<td>Stripe A</td>
<td>Stripe B</td>
</tr>
<tr>
<td>G285M</td>
<td>2617 2480 − 2521</td>
<td>2596 − 2637</td>
</tr>
<tr>
<td></td>
<td>2637 2500 − 2541</td>
<td>2616 − 2657</td>
</tr>
<tr>
<td></td>
<td>2657 2520 − 2561</td>
<td>2636 − 2677</td>
</tr>
<tr>
<td></td>
<td>2676 2539 − 2580</td>
<td>2655 − 2696</td>
</tr>
<tr>
<td></td>
<td>2695 2558 − 2599</td>
<td>2674 − 2715</td>
</tr>
<tr>
<td></td>
<td>2709 2572 − 2613</td>
<td>2688 − 2729</td>
</tr>
<tr>
<td></td>
<td>2719 2582 − 2623</td>
<td>2698 − 2739</td>
</tr>
<tr>
<td></td>
<td>2739 2602 − 2643</td>
<td>2718 − 2763</td>
</tr>
<tr>
<td></td>
<td>2850 2714 − 2755</td>
<td>2829 − 2870</td>
</tr>
<tr>
<td></td>
<td>2952 2815 − 2856</td>
<td>2931 − 2972</td>
</tr>
<tr>
<td></td>
<td>2979 2842 − 2883</td>
<td>2958 − 2999</td>
</tr>
<tr>
<td></td>
<td>2996 2859 − 2900</td>
<td>2975 − 3016</td>
</tr>
<tr>
<td></td>
<td>3018 2881 − 2922</td>
<td>2997 − 3038</td>
</tr>
<tr>
<td></td>
<td>3035 2898 − 2939</td>
<td>3014 − 3055</td>
</tr>
<tr>
<td></td>
<td>3057 2920 − 2961</td>
<td>3036 − 3077</td>
</tr>
<tr>
<td></td>
<td>3074 2937 − 2978</td>
<td>3053 − 3094</td>
</tr>
<tr>
<td></td>
<td>3094 2957 − 2998</td>
<td>3073 − 3114</td>
</tr>
<tr>
<td>G230L</td>
<td>2635 1334 − 1733(^1)</td>
<td>2435 − 2834</td>
</tr>
<tr>
<td></td>
<td>2950 1650 − 2050</td>
<td>2750 − 3150</td>
</tr>
<tr>
<td></td>
<td>3000 1700 − 2100</td>
<td>2800 − 3200</td>
</tr>
<tr>
<td></td>
<td>3360 2059 − 2458</td>
<td>3161 − 3560</td>
</tr>
</tbody>
</table>

1. The wavelengths listed for central wavelength 2635 Å in stripe A are listed for completeness only and also in case a bright emission line falls onto the detector. Note that the NUV detector’s sensitivity at these wavelengths is extremely low. To obtain a low-resolution spectrum at wavelengths below about 1700 Å we recommend G140L and the FUV channel.

2. The values in shaded cells are wavelength ranges as seen in second-order light. In these cases the achieved dispersion is twice that for first-order mode.
Selecting an Aperture

There are two circular science apertures, 2.5 arcsec in diameter. The primary science aperture (PSA) transmits > 95% of the light from a well-centered aberrated point-source, and is expected to be used for most normal science observations. A Bright Object Aperture (BOA) containing a neutral density (ND2) filter that attenuates the flux by about a factor of 200 at 2000 Å is also available for use with all gratings. The BOA may be particularly useful to avoid the Bright Object Protection (BOP) limit with the detectors. It will, however, significantly degrade the spectral resolution. See Section 3.2.2 of the COS Instrument Handbook.

Detector Count Rate Screening Limits

Note that the count rate screening limits currently used by the COS ETC for NUV spectroscopy are different from those given in Section 11.5 of the COS Instrument Handbook. The previous limits resulted from a misinterpretation of the procedures executed by the flight software. Observations that exceed any of the count rate screening limits below will trigger a warning message on the output page. The currently used count rate screening limits for the COS detectors are as follows (see also “Phase II Update”):

### COS Count Rate Screening Limits

<table>
<thead>
<tr>
<th>Detector</th>
<th>Source type 1</th>
<th>Type of limit</th>
<th>Limiting count rate 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Predictable</td>
<td>Global</td>
<td>15,000 per segment</td>
</tr>
<tr>
<td>FUV</td>
<td></td>
<td>Local</td>
<td>40 per resel 3 (0.67 per pixel)</td>
</tr>
<tr>
<td>Irregular</td>
<td></td>
<td>Global</td>
<td>6,000 per segment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local</td>
<td>40 per resel 3 (0.67 per pixel)</td>
</tr>
<tr>
<td></td>
<td>Predictable</td>
<td>Global</td>
<td>30,000 per stripe</td>
</tr>
<tr>
<td>NUV</td>
<td></td>
<td>Local</td>
<td>50 per pixel (imaging) or 70 per pixel (spectroscopy)</td>
</tr>
<tr>
<td>Irregular</td>
<td></td>
<td>Global</td>
<td>12,000 per stripe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local</td>
<td>50 per pixel (imaging) or 70 per pixel (spectroscopy)</td>
</tr>
</tbody>
</table>

1 "Predictable” means the brightness of the source can be reliably predicted for the time of observation to within 0.5 magnitude.

2 Entries are counts per second.

3 An FUV resel is 6 pixels wide by 10 pixels high.
Exposure Time and the S/N Ratio Calculations

To specify the exposure parameters, you can give the exposure time (in seconds) and the wavelength of interest, in which case the program will calculate the count rates due to the source, background, and the resulting S/N ratio. Alternatively, given the required S/N ratio and the wavelength of interest, the ETC will calculate the required exposure time to achieve this S/N ratio and the corresponding integrated counts. Further details follow.

If you give the exposure time and wavelength of interest:

In this case the calculations are simple. The expected counts in the given exposure time are calculated for the source, the sky background, and the detector background. These calculations are done over the entire wavelength range that is covered in this particular wavelength setting.

If you give the S/N ratio and wavelength of interest:

In this case, the calculations involve one extra step. The program calculates the required exposure time so that the observed spectrum will have the specified S/N ratio at the specified wavelength. (Details about the number of pixels used in the S/N ratio calculations are explained in the next section). This exposure time is then used to calculate the count rates from the source and different backgrounds over the entire wavelength range. The S/N ratio at each wavelength step is also calculated over the whole wavelength range.

Selecting the source type:

Select either a point source or an extended source with the diameter of the source in arcsec. The spectroscopic extraction region is the same for both point and extended sources: 47 pixels high and a 6 pixel wide resolution element for the FUV; 8 pixels high and a 3 pixel wide resolution element for the NUV. Note that the NUV spectroscopic extraction height used in ETC 17.2 (current version) is 8 pixels in contrast with 25 pixels used in the previous COS/ETC version (17.1). This change leads to more realistic S/N calculations for faint sources and allows a more fair comparison between the COS and STIS capabilities in the background noise limited regime.

THE OUTPUT:

The results contain the following:

1. A text page which gives the exposure time, S/N ratio at the wavelength of interest, the buffer time, some count rate analysis and the input. The page will also include the counts from the source, the various backgrounds, and the noise.

2. A link to a plot with the counts vs. the wavelength

3. A link to a plot with the S/N ratio vs. the wavelength
4. A link to a plot with the source spectrum
5. A link to a plot with the throughput vs. wavelength for the spectroscopic mode chosen.

**The counts in the output table and the first plot assume the following:**

- The ETC output gives counts in a rectangle that is 1 pixel wide in the dispersion direction. In the cross dispersion direction the rectangle is 47 pixels high for FUV spectra and 8 pixels high for NUV spectra. For point sources these extraction heights will capture essentially all the light that falls on the FUV detector and approximately 80% of the light that falls on the NUV detector. Note that in the previous version of the COS ETC (17.1) the extraction height used for NUV was 25 pixels. The smaller extraction height currently used leads to more realistic S/N calculations for faint sources and allows a more fair comparison between COS and STIS in the background noise limited regimes.
- For extended sources the counts are given in the same size boxes as described above. For FUV spectra, the extraction box is tall enough to again capture essentially all the light falling on the detector. For NUV spectra, about 8% of the light will be collected.
- In the dispersion direction a resolution element is 6 pixels wide for FUV spectra and 3 pixels wide for NUV spectra.

**S/N calculations assume the following:**

The basic formula used for the calculation of S/N is:

\[
S/N = \frac{C_{Source} \cdot t}{\sqrt{C_{Source} \cdot t + N_{pix} \cdot (C_{BG} + C_{Det}) \cdot t}}
\]

Where:

- \( C_{Source} \) is signal from the astronomical source, in counts sec\(^{-1}\)
- \( C_{BG} \) is the sky background in counts sec\(^{-1}\) pixel\(^{-1}\)
- \( C_{Det} \) is the detector dark count rate in counts sec\(^{-1}\) pixel\(^{-1}\)
- \( t \) is the integration time, in sec
- \( N_{pix} \) is the total number of detector pixels integrated to achieve \( C_{Source} \)
Specifying Your Wavelength

The program assumes that this is the wavelength of interest. Accordingly, you should specify the supported central wavelength that will place the wavelength of interest on an active area of the detector.

Selecting a Spectral Model

Here you can either enter your own input spectrum for the source, the details of which are given in the next section, or you can choose one of the following (fits and ascii files for all the spectral distribution models described below are available at ftp://ftp.stsci.edu/cdbs/grid/):

- **Castelli and Kurucz Models:** The atlas contains about 4300 stellar atmosphere models for a wide range of metallicities, effective temperatures and gravities. These LTE models with no convective overshooting computed by Fiorella Castelli, have improved upon opacities and abundances previously used by Kurucz (1990).

- **Pickles Models:** This library of wide spectral coverage, consists of 131 flux calibrated stellar spectra, encompassing all normal spectral types and luminosity classes at solar abundance, and metal-weak and metal-rich F-K dwarf and G-K giant components.

- **Kurucz Models:** There are 24 stellar spectra available. All are Kurucz models calculated from the Kurucz database (R. Kurucz, CD-ROM No. 13, GSFC) which have been installed in CDBS. These are the same spectra used as input spectra by Leitherer et. al. (1996) in ISR STIS 96-024, MAMA Bright Object Limits for Astronomical Objects.

- **Bruzual Synthetic Stellar Spectra:** There are 77 stellar spectra available. These spectra are frequently used in synthesis of galaxy spectra, and have been provided by Gustavo Bruzual.

- **HST Standard Star spectra:** 21 HST Calibration Standards are available. These spectra are available in CDBS and most were chosen from the paper by Turnshek et al. (1990): “An Atlas of HST Photometric, Spectrophotometric, and Polarimetric Calibration Objects”. This section also includes a spectrum of the Sun. Note that some of these standard spectra are contaminated by geo-coronal Lyα emission which can have a significant impact on the source count rate (some of these stars were observed with IUE). To avoid this problem we recommend you do not use the following standards when performing calculations using the FUV gratings that cover the Lyα region at 1216 Å: G93-48, LB227, LDS749B, HZ4, GD50, GD108, GRW +70 5824, and HZ21.

- **Non-Stellar Objects:** There are also a few model spectra of non-stellar objects available from CDBS: elliptical galaxy, Orion Nebula, spiral galaxy, NGC 1068, and Planetary Nebula. A word of caution is necessary on the use of these model spectra. These are only “typical” examples, and
individual cases may well have very different spectra. For example, the PN spectrum is that of NGC 7009, but other PNe with different excitation classes may have very different spectral characteristics.

- **QSO**: with user supplied redshift. The QSO spectrum refers to the average of a sample of QSOs, transformed to $z = 0$. Other QSOs may have very different spectral characteristics and some caution is advised in using these model spectra. Two QSO spectra are currently available. One is based on SDSS data and covers the wavelength range 800 - 6000 Å, the other is based on FOS data and covers the wavelength range 100 - 3387 Å. Users should be aware that high redshifts may put the SDSS-based QSO spectrum beyond the wavelength region of the grating bandpass, thereby causing the ETC to return an error. In this case the FOS-based QSO spectrum should be used.

- **Black-body**: with a user specified temperature.

- **Power-law**: The flux distribution is given by $F(\lambda) = \lambda^n$, where $n$ is specified by the user.

- **Flat continuum**: This is a special case of the power law, where $n = 0$. This distribution is so named because the spectrum has constant (flat line) energy per either wavelength or frequency units. Please note that count rate calculations use photons per wavelength unit. Users may choose either $F(\lambda)$ or $F(\nu)$.

- **No continuum**: This option may be used only for the Spectroscopic ETC, and only if emission lines are added explicitly on the input form. In this case, the flux normalization for the continuum will be ignored. Note: you must ensure that the reference wavelength for the S/N ratio calculation coincides with one of the emission lines!

### Supplying Your Own Spectra

One of the prime features of this ETC is its ability to accept a spectrum supplied by the user. In section 3 of the ETC input form simply check the box next to “User Supplied Spectrum”. You may then either type the path of the file in the input box or use the “browse” button next to the box and then navigate through the local file system to the file.

### Notes regarding the resolution of user input spectrum:

No spectral convolution of user-supplied input spectra is performed by the COS ETC. Users should then be aware of the following:

- If supplying a high-resolution spectrum from another instrument, such as STIS, in order to estimate an exposure time with COS, be sure to smooth the spectrum to a resolution listed in Table 5.1 of the COS Instrument Handbook.
Failure to do so could cause the ETC to falsely indicate that a narrow emission line violates the local count rate limit.

- If adding an emission line in part 3 of the ETC, choose a width that is the quadrature sum of the intrinsic line width and the instrumental width, or the same problem described above could occur.
- If supplying a low-resolution spectrum from another instrument, IUE for example, with intrinsically narrow emission lines, the ETC will calculate a lower count rate than COS will actually record, and could lead to a bright object protection violation. A robust estimate of the true emission line width must be provided and used in the ETC, in order to properly estimate the local count rate. The safest way of estimating the local count rate is to consider the flux within one COS resolution element (6 pix for FUV and 3 pix for NUV)

**Prepare your file**

First, prepare your input spectrum in the form of a file with 2 columns: the first column should be the wavelength in Å, and the second column should be the relative flux (in erg cm$^{-2}$ sec$^{-1}$ Å$^{-1}$ for point sources, and in erg cm$^{-2}$ sec$^{-1}$ Å$^{-1}$ arcsec$^{-2}$ for diffuse sources). The wavelengths in the first column must be in increasing order. If there are any extra lines without data points, make sure that they start with “#”, so that the ETC can ignore them.

The file should be in one of the 2 formats:

- an ASCII table with the extension .dat
- a FITS table with an extension .fits or .fit

SDAS tables (files with the .tab extension) are no longer supported. If you attempt to use an SDAS table file you will get an error.

**Spectrum File Formats**

**ASCII**

If the file is an ASCII file, it must contain the following 2-columns:

- column 1: wavelength (in Å)
- column 2: flux in erg cm$^{-2}$ sec$^{-1}$ Å$^{-1}$ for point sources, and in erg cm$^{-2}$ sec$^{-1}$ Å$^{-1}$ arcsec$^{-2}$ for diffuse sources

Any comment lines in the file must start with “#” in order to avoid confusion when it is used in the calculation.

**SDAS**
The SDAS table file format is not portable to different machine architectures and so support for it has been discontinued. We recommend using the TTools command “tcopy” to convert all SDAS files to FITS format.

If the file is an SDAS table, it should have one column labeled as “WAVELENGTH” and another column labeled as “FLUX”, with the units specified appropriately for each column. The TABLES.ttools task tcpl will list the column names of an SDAS table along with the units. The output for an input spectrum’s SDAS table should contain lines similar to this:

```
WAVELENGTH     R   %15.7g angstroms
FLUX            R   %15.7g flam
```

**FITS**

If the file is a FITS binary table, it should have two columns labeled “WAVELENGTH” and “FLUX”, again with the units specified for each column. The header of the FITS table should then include lines similar to these:

```
PCOUNT =                    0 /
GCOUNT =                    1 / Only one group
TFIELDS =                    2 / Number of fields per row
EXTNAMES = ‘f4v_v15_flam.tab’ / Name of extension
TTYPENAMES = ‘WAVELENGTH’ /
TBCOL1 =                    1 /
TFORM1 = ‘E15.7   ‘           /
TUNIT1 = ‘angstroms’          /
TDISP1 = ‘G15.7   ‘           / %15.7g
TTYPES = ‘FLUX    ‘           /
TBCOL2 = 17 /
TFORM2 = ‘E15.7   ‘           /
TUNIT2 = ‘flam    ‘           /
TDISP2 = ‘G15.7   ‘           / %15.7g
```

**Your spectrum**

In section 3 of the ETC input form simply check the box next to “User Supplied Spectrum”. You may then either type the path of the file in the input box or use the “browse” button next to the box and then navigate through your local file system to the file.
**E(B-V) and the Extinction Law**

The COS ETC currently supports 4 different extinction relations:


The extinction can be applied either before or after the normalization.

**Adding Emission Lines (optional)**

To add emission lines to the source spectrum enter the line center and FWHM in Angstroms and the integrated flux in erg/cm$^2$/s. Note: integrated flux units are per arcsec$^2$ for extended sources. All three of the parameters (line center, fwhm and integrated flux) must be specified for an emission line to be included.

**Normalizing the Source Flux**

If you use your own input spectrum, or you use one of the model spectra for the source, you may choose to normalize the source’s continuum flux at some wavelength. This normalization wavelength does not have to be within the wavelength region of your observation, but must be within the wavelength range of the input spectrum. The ETC will use it only for normalization and calculate the appropriate flux values for the wavelength range of the observations. Note, however, that the normalization does not need to be specified for the Spectroscopic ETC if “No Continuum” is selected and emission lines are added explicitly in the input form. In this case, the normalization will be ignored.

Your object can be normalized to a magnitude either at a particular Johnson band (using VEGAMAG) or to either GALEX FUV or GALEX NUV bands (using ABMAG). Alternatively, your spectrum can be normalized to a flux (erg cm$^{-2}$ s$^{-1}$ Å$^{-1}$) value at a given wavelength.

For diffuse objects, you have to give the extent of the source, and the surface brightness either in magnitudes per arcsec$^2$, or flux value per arcsec$^2$. The information on the extent of the source is used not only to calculate the counts and the S/N ratio, but also to calculate the global count rates since there is a maximum global count rate limit for both the detectors. Please refer to the “COS Count Rate Screening Limits” table above for updated screening limits.

If you supply your own spectrum or use one of the HST calibration sources, you can either normalize this spectrum to a fixed value, or you can use the “Do not renormalize” option on the form, in which case the flux values are assumed to
have the units \([\text{erg cm}^{-2} \text{ sec}^{-1} \text{ Å}^{-1}]\) for point sources and \([\text{erg cm}^{-2} \text{ sec}^{-1} \text{ Å}^{-1} \text{ arcsec}^{-2}]\) for diffuse sources.

**Specifying the Appropriate Background**

When calculating expected signal-to-noise ratios or exposure times, the background from the detector must be taken into account. For COS, the detector background is quite small.

The sources of sky background which will affect COS observations include:

- Earthshine,
- Zodiacal light, and
- Geocoronal emission.

The ETC allows the user to select among several levels of intensity for each of these backgrounds, corresponding to different observing environments.

**Earthshine**

There are four intensity levels to choose from in the ETC, with the following relative scaling factors:

\((\text{shadow, average, high, extremely high}) = (0.0, 0.5, 1.0, 2.0).\)

The earthshine is for a target which is 24 degrees from the limb of the sunlit Earth. Use **Figure 10.2** of the COS Instrument Handbook to estimate background contributions at other angles. The zodiacal contribution corresponds to a helio-ecliptic latitude and longitude of 30° and 180°, respectively, which corresponds to \(m_V = 22.7\) per square arcsec.

The upper limit to the [OII] 2471 intensity is shown. Note that the geocoronal day glow line intensities are integrated fluxes (units of \(10^{-15} \text{ erg cm}^{-2} \text{ sec}^{-1} \text{ arcsec}^{-2}\)).

**Zodiacal Light**

Away from the airglow lines, at wavelengths between about 1300 and 3000 Å, the background is dominated by zodiacal light, and is generally lower than the intrinsic detector background, especially for the NUV detector. **Figure 10.1** of the COS Instrument Handbook shows the zodiacal light for the “average” level in the ETC. The selectable levels and the factors by which they are scaled from this are:
The contribution of zodiacal light does not vary dramatically with time, and varies by only a factor of about three throughout most of the sky. For a target near ecliptic coordinates of (50,0) or (-50,0), the zodiacal light is relatively bright at $m_V = 20.9$, i.e. about 9 times the faintest values of $m_V = 23.3$.

The user is cautioned to carefully consider sky levels as the backgrounds obtained in HST observations can cover significant ranges. See Section 10.3.3 of the COS Instrument Handbook for more information.

**Geocoronal Airglow Emission**

In the ultraviolet, the sky background contains important contributions from airglow lines. These vary from day to night and as a function of HST orbital position. The airglow lines may be an important consideration for spectroscopic observations at wavelengths near the lines, and may be quite important for NUV imaging observations. For more information see Section 10.3.4 of the COS Instrument Handbook.

The brightest geo-coronal line is Ly$_\alpha$ at 1216 Å, the only other detectable lines being O I 1302 Å, O I 1356 Å and O II 2470 Å lines. The strength of the O I 1302 Å line rarely exceeds 10% of Ly$_\alpha$; the other lines are significantly weaker. The strength of the geo-coronal Ly$_\alpha$ varies between about 2 to 20 kiloRayleighs, depending on the time of the observations and the position of the target relative to the Sun, and can be kept low by the special requirement “SHADOW”. The ETC uses a value of 20 kiloRayleighs ($6.1 \times 10^{-13}$ erg cm$^{-2}$ sec$^{-1}$ arcsec$^{-2}$) for the geo-coronal Lyman emission when the background is specified as “High”.

**Detector Dark Background**

The following table lists the dark count rate and read noise characteristics of the COS detectors as measured in ground tests.

**Detector background count rates (per second) for COS**

<table>
<thead>
<tr>
<th>Detector</th>
<th>FUV XDL</th>
<th>NUV MAMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark rate (counts sec$^{-1}$)</td>
<td>0.5 per cm$^2$</td>
<td>34 per cm$^2$</td>
</tr>
<tr>
<td></td>
<td>$7.2 \times 10^{-7}$ per pixel</td>
<td>$2.1 \times 10^{-4}$ per pixel</td>
</tr>
<tr>
<td></td>
<td>$4.3 \times 10^{-5}$ per resel</td>
<td>$1.9 \times 10^{-3}$ per resel</td>
</tr>
<tr>
<td>Read noise</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
The ETC ID Number

For every calculation performed with the ETC, an ID number is provided at the top of the output page. Users who report problems, or seek help on the use of this simulator should mention this ID number, which will help us to track down the problem. COS GOs will be asked to do a calculation with the ETC, which will be used for bright-object protection screening at STScI.