GMACS Exposure Time Calculator

Ting Li

Here I list the assumptions and models/templates that are used in this Exposure Time Calculator. If you have any questions, please contact Ting Li at sazabi@tamu.edu

1. Assumptions

1. Effective area of the telescope is 368 m^2 for full size and 222 m^2 for first light size.

2. Telescope throughput is 80%. (primary + secondary mirror)

3. GMACS consists a blue channel, a red channel and a potential J-band channel. There are 14 lens in GMACS for each channel and the transmittance is 98% for each lens.

4. All the sources, either stars or galaxies, are treated as point sources. (i.e. the angular extension in the sky only depends on the seeing.)

5. Only sky background is considered for the noise; that is, no electronic noise is considered.

6. PSF of the object is Gaussian and the seeing is the FWHM of the PSF.

7. The extraction aperture is equal to the seeing, and the extraction is assumed to be perfect at the center.

8. SNR is calculated for every pixel. One pixel is assumed to be one-third of the resolution element(i.e. $\frac{1}{3}\delta\lambda$). If you wants to plot S/N per resolution element instead, then you can simply change the "Binned pixel scale" to be the size of the resolution element in Angstrom ($\sim$3.7 for low-res and $\sim$1.4 for high-res). You can also calculate the S/N or simulated spectra in arbitrary binning size by changing the "Binned pixel scale" parameter.

2. Models, Templates, and Throughputs used for calculation

1. Templates for stars are from pickle's models. `http://cdsarc.u-strasbg.fr/viz-bin/Cat?J/PASP/110/863`. For J-band ETC, Vega J-band spectra is used as the A0V star template (Bohlin, 2007. `http://adsabs.harvard.edu/abs/2007ASPC..364..315B`)

2. Templates for Extended Sources are from Kinney et al. 1996. Flux below 1300Å is zero in rest frame. So the Flux for high redshift(z>4) at short wavelength will be also zero and thus is not correct. (For example, flux is zero in u band for an object at z=5; in this case, SNR is set to be zero at all wavelength)

3. The throughput of the instrument includes dichroic throughput, grating throughput, and the detector quantum efficiency.

For the two visible channels (blue and red),

a) Dichroic throughput is based on the SDSS-III BOSS dichroics that coated by JDSU.

b) Grating throughput is based on low resolution grating for GMACS designed by KAISER.

c) Detector is assumed to be the CCD from e2v deep depletion near IR CCD for red channel and e2v enhanced broadband CCD for blue channel.

For J-band chancel,

a) We don't have any information for the throughput of the optics, so we just assume the dichroic/grating throughput has the similar shape as the red channel, but has been shifted by 300nm towards the longer wavelength. We will change this when we get more information for the optics.

b) Detector is assumed to be HAWAII-2RG (H2RG) HgCdTe arrays. (see `http://www8.nationalacademies.org/astro2010/detailfiledisplay.aspx?id=537`)

4. For two visible channels, sky backgrounds are from Steven Villanueva (Villanueva, S., et al. 2012, SPIE). You can select the sky background for different moon phases.
For J-band channel, sky background is from Magellan/FIRE.(`http://pwsullivan.blogspot.com/p/papers.html`)

5. Atmospheric extinction is created by libRadTran with the atmospheric parameter measure by aTmCam at CTIO at airmass=1.0.(Li, T., et al. 2012, SPIE)

6. The user-defined magnitude are computed with SDSS filters for ugriz (`http://www.sdss.org/dr3/instruments/imager/index.html#filters`), with Johnson/Bessell filters for UBVRI from Bessell et al (1990), and with 2MASS filters for J-band (`http://www.ipac.caltech.edu/2mass/releases/allsky/doc/sec3_1b1.html`).

Finally, you could find more information about GMACS from *GMACS Conceptual Design Report*.(`http://instrumentation.tamu.edu/files/GMACS_CoDR_Report_web.pdf`)