GMACS Exposure Time Calculator, v2.0

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ABSTRACT

This document collects the assumptions, models, and references used in the GMACS exposure time calculator. Version 2 is based on the original GMACS ETC created by Ting Li.

Assumptions

1. Effective area of the telescope is 368 m^2 for full size (7 mirrors) and 222 m^2 for first light size (4 mirrors).
2. CCD readnoise is $2e^-$ px^{-1}, $15\mu m$ pixels.
3. GMACS consists of a blue channel (320-600 nm), and a red channel (500-1000 nm). Dichroic transition is at 558 nm.
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. Noise is a combination of sky background and CCD read noise.
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. For the default $0.7''$ slit, a resolution element is 12px (equivalent to 3.7Å for low resolution and 1.4Å for high resolution), binning options include 1×1, 2×2, 3×3, and 4×4 pixels.

Source Templates

1. **Star** templates are from Pickles 1998[1].
2. **Extended Source** templates are from Kinney et al. 1996[2]. Flux below 1300 Angstrom 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 wavelengths)
3. **Sky backgrounds** are from Steven Villanueva et al. 2012[3]. You can select the sky background for different moon phases.
4. **User-defined magnitudes** are computed with SDSS filters for ugriz (`http://www.sdss3.org/instruments/camera.php#Filters`), with Johnson/Bessell filters for UBVRI from Bessell et al. (1990)[4].

Throughput

1. **Telescope** The primary and secondary mirrors of the GMT are assumed to be coated with Aluminum. Reflectivity values taken from in situ measurements of the Subaru 8.3 primary mirror[5], `https://subarutelescope.org/Observing/Telescope/Parameters/Reflectivity/`
2. **Optics** throughput for the collimator and camera lenses are 0.60 (Blue) and 0.62 (Red).
3. **Dichroic** throughput is based on the SDSS-III BOSS dichroics that were coated by JDSU.
4. **Grating** throughput is based on low resolution VPH gratings designed by KAISER.
5. **Detectors** are assumed to be the e2v Astro Multi-2 (NIMO DD) CCD for the red channel and e2v Astro BB (NIMO std Si) CCD for the blue channel.

6. **Atmospheric extinction** is created by libRadTran[6] with the atmospheric parameters measured by aTmCam[7] at CTIO at airmass=1.0.

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The following software was used to develop the GMACS exposure time calculator. Python[8], Spectres[9], Astropy[10,11], Bokeh[12], Numpy[13], and Scipy[14].

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