Scope.csv: Reference Bank (Last Updated 10/05/19)

This document is intended to be a reference for the data used in Scope.csv, which underpins the pipeline. This information is widely scattered across various sources and sometimes contradictory, so it has become necessary to bring it all into one place as the table has become populated and the project has grown in complexity.

Scope.csv uses the following columns:

- **Telescope** - An appropriate name for the instrument, used for pipeline reference.
- **Lat** and **Long** - the latitude and longitude of the telescope, given in decimal degrees. North and East are taken to be positive. (A converter is hosted at [1].)
- **Alt** - The altitude of the telescope, in metres.
- **C_y** - this is the median empirical coefficient in the modified form of Young's approximation, which is used to describe atmospheric scintillation. The derivation of this approximation and several values of C_y are given in [2]; for sites not listed in that paper, C_y is taken as 1.5.
- **Aperture** - the aperture of the telescope in metres.
- **Element?** - are the zero-point magnitudes listed per dispersed element, or for a broad-band approach? This distinction is important for spectrographs.
- **mzp_** - These are zero-point magnitudes in the filters stated; an object of this magnitude will produce one detected photo-electron or ADU count (when calculating, pick a system and stick with it!) per second. If the instrument does not have a certain filter (eg. PROMPT-8 has no Sloan filters), the zero-point will be displayed internally as NaN.
- **m_5Sig** - this is the limiting broad band magnitude calculated for a point source of zero colour (A0V star) which would give a S/N of 5 in one hour (25 photons/pixel/hour) with dark sky, clear conditions and a seeing FWHM of Θ_{see}. This parameter is only relevant for spectrographs.
- **msky_** - the sky background in mag/arcsec^2. In an aperture of area 1 arcsec^2, the observer will detect photons equivalent to a star of this brightness. This parameter is band-dependent, and becomes particularly important for near and mid-IR observations, owing to the effects of water bands. These numbers are typically for dark skies; this record also hold some values for bright skies.
- **Res** - The spectral resolution R, calculated from:

$$R = \frac{\text{Lambda\_Cent}}{\Delta\lambda}, \tag{1}$$

where $\Delta\lambda$ is the resolution element (effectively the bin size). R will be unity for broad-band filters.

- **Lambda_Cent** - This is the central wavelength of the chosen spectroscopic grating in ångströms. Not needed for broad-band filters.
- **Lambda_Range** - the range that the grating can see over, also in Å.
- **Dispersion** - in ångströms per pixel. Spectrograph gratings disperse light across the CCD by wavelength; this quantity is needed to calculate how many pixels the dispersed spectrum falls on. Dispersion is not dependent on the slit-width used - it is inherent to the instrument optics.
- **Overhead** - This is the read-out time in seconds between exposures. This number does not include other overheads such as slewing to target or changing filters - see the documentation for the individual telescope for these, if applicable. For fast-readout cameras such as ULTRASPEC, this value is approximately zero.
- **Theta_see** - The average seeing in arcseconds from the observing site. (Of course, this number may vary on the night!) This is taken using the FWHM (diameter) of a Gaussian PSF.
- **Theta_DF** - The aperture diameter in arcseconds used for defocused observations.
- **(FoV_Rad)** - the radius of the field of view in arcminutes. Simbad queries around a target using a circle of this radius, necessary to find comparison stars.
- **Detector_Size** - The dimensions of the detector in pixels.
- **Pixel_Scale** - this is the length of one side of a single (square) CCD pixel in arcseconds. If not explicitly stated, it can be recovered from:

$$\text{Pixel Scale} = \left(\frac{\text{Detector FoV ('')}}{\text{\# of pixels along 1 dimension}}\right) \tag{2}$$

- **Omega_pix** - This is the area of 1 pixel in arcseconds square, given by:

$$\Omega_{pix} = \left(\frac{\text{Detector FoV ('')}}{\text{\# of pixels along 1 dimension}}\right)^2 = (\text{Pixel Scale})^2 \tag{3}$$

  Note that this value will be constant even for non-square detectors like that in SPRAT, mounted on the Liverpool Telescope.

- **Gain** - This is a factor in converting from raw photo-electrons to counts registered (and eventually used by imaging software). The relation is:

$$\text{Counts (ADU)} = \frac{\text{Photo-electrons}}{\text{Gain}}, \tag{4}$$

  assuming a CCD of 100% quantum efficiency.

- **Half_Well** - This is 50% of the depth of one CCD well, in electrons. Each well can only hold a fixed amount of charge (typically $2^{16} = 65536\ e^{-}$), after which it will become saturated. However, the response curve of a CCD will often become non-linear in the run-up to saturation, so observers must keep to the linear regime wherever possible.

- **texp_min** - some set-ups, like TNT/ULTRASPEC have a minimum exposure time.

Instruments

PROMPT-8 (Dark, Grey and Bright Profiles, New Camera for 2019)

- **Telescope** - PROMPT-8
- **Lat** and **Long** - -30.16966° N, 289.1935° E.[3] Consistent with values given on website.[4]
- **Alt** - 2286 m [3], revised upwards from 2203 m.[4]
- **C_y** - 1.42, given in [2].
- **Aperture** - 0.61m. [3]
- **Element?** - N (broad-band).
- **mzp_** - B=N/A, V=21.3, R=21.52, I=20.43, extrapolated from science frames.
- **m_5Sig** - N/A for photometry.
- **msky_** - U=22.1, B=22.8, V=21.8, R=21.2, I=19.8, from dark-sky values predicted by Eric Mamajek for 2012-2015 [5]. Note that these are not official values sanctioned by CTIO, but they are the best estimate we currently have.

  For grey skies, U=17, B=19.5, V=20, R=19.9, I=19.2 [6], and for bright skies, U=17, B=17.5, V=18, R=17.9, I=17.2 ([6] + 2 mags). These exist as three separate profiles, named PROMPT-8_Dark, PROMPT-8_Grey and PROMPT-8_Bright respectively.

- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 8 s, also extrapolated from science frames. (AIJ)
- **Theta_see** - Data given by NARIT[3] and extrapolation from conditions at nearby La Silla [7] suggest 1.5”, but science frames suggest 1.8”, so this is used. Grey and bright profiles use 2.2” and 2.5” respectively, extrapolated from science frames.
- **Theta_DF** - none at this time.
- **FoV_Rad** - 12.56’ [8].
- **Detector_Size** - 2048x2064, recovered from science frames.
- **Pixel_ Scale** - 0.736”, recovered from science frames.
- **Omega_pix** - 0.542”^{2}, recovered from science frames.
- **Gain** - 1.9, using 3MHz readout mode. Recovered from FITS header of science frames.
- **Half_Well** - 62225 photons - saturation occurs at 65K counts (16-bit detector).
- **texp_min** - 0.03s (from SkyNet portal for observation set-up).

TNO 0.5m (2x2 Binning)

- **Telescope** - TRT-TNO
- **Lat** and **Long** - 18.573722° N, 98.48225° E, from NARIT data.[3] Consistent to 3 d.p. with Dhillon et al (2014)[9], web co-ordinates are insufficiently precise.
- **Alt** - 2457 m.[3] Consistent with value given on NARIT website.[10]
- **C_y** - 1.5
- **Aperture** - 0.5m [3].
- **Element?** - N (broad-band).
- **mzp_** - B=N/A, V=22.34, R=22.56, I=21.47, extrapolated from science frames taken in I-band. NARIT’s website incorrectly lists the filters as BGRL [11].

- **m_5Sig** - N/A for photometry.
- **msky_** - B=22.5, V=21.9, given in Dhillon et al. [9]. Extrapolated to R=21.74, I=20.83 using the relations in Jordi et al [12].
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 3 s, extrapolated from science frames taken on 13/03/17, although this can be controlled through the controlling MaxImDL software.
- **Theta_see** - 2” (an approximation from science frames). Consistent with NARIT data of between 1” and 2.5” [3]. May have to be revised upwards. Inconsistent with median seeing given by Dhillon et al (2014) of 0.9” [9].
- **Theta_DF** - none at this time.
- **FoV_Rad** - 11.8’. NARIT’s website incorrectly lists the FoV as 58’ square.[11]
- **Detector_Size** - 2048x2048, which yields 1024x1024 when binned (recovered from science frames). NARIT’s website incorrectly gives the CCD dimensions as 3056x3056.[11]
- **Pixel_Scale** - 0.69”, from NARIT data.[3] Binning subsequently gives 1.38”.
- **Omega_pix** - 1.90”^{2}, recovered from NARIT data.
- **Gain** - 1 - this is a guess!
- **Half_Well** - 32,000 (defaut for a 16-bit detector). 55,000 was listed for the Apogee Alta U9000 CCD [11][13]; however, this CCD is no longer in use with this instrument. The exact nature of the current detector chip is unknown.
- **texp_min** - N/A.

Gao Mei Gu 0.7m, Lijang, China (Andor DW432 CCD)

- **Telescope** - Gao Mei Gu
- **Lat** and **Long** - +26.6955° N, 105.031° E, from NARIT data.[3] [14]
- **Alt** - 3193 m.[3]
- **C_y** - 1.5.

- **Aperture** - 0.7m [3].
- **Element?** - N (broad-band).
- **mzp_** - B=N/A, V=21.14, R=21.36, I=20.27, extrapolated from science frames in R taken on 08/04/17. Revised upwards from B=N/A, V=20.9, R=21.06, I=20 in 02/19.
- **m_5Sig** - N/A for photometry.
- **msky_** - Unknown.
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 6 s, extrapolated from science frames, although this can be controlled through the controlling MaxImDL software.
- **Theta_see** - NARIT data suggests seeing of between 1" and 2".[3], consistent with our own frames. Value of 2" is adopted here. A previous study found seeing of 0.7", although conditions are likely to have deteriorated somewhat since then.[15]
- **Theta_DF** - none at this time.
- **FoV_Rad** - 10.4'.
- **Detector_Size** - 2048x2048, recovered from science frames.
- **Pixel_Scale** - 0.612", from NARIT data.[3]
- **Omega_pix** - 0.375"^{2}, recovered from NARIT data.
- **Gain** - 1 - this is a guess!
- **Half_Well** - 30,000 - from discussions with Dr. Supachai Awiphan.
- **texp_min** - N/A.

Thai National Telescope (TNT) - ULTRASPEC camera

- **Telescope** - TNT ULTRASPEC
- **Lat** and **Long** - 18.573722° N, 98.48225° E, from NARIT data.[3] Consistent to 3 d.p. with Dhillon et al (2014)[9], web co-ordinates are insufficiently precise.
- **Alt** - 2457 m.[3] Consistent with value given on NARIT website.[10]
- **C_y** - 1.5.
- **Aperture** - 2.4m [3].
- **Element?** - N (broad-band).
- **mzp_** - u'=22.16, g'=25.28, r'=25.25, i'=24.55, z'=23.46. All values given in Dhillon et al (2014).[9]
- **m_5Sig** - N/A for photometry.
- **msky_** - B=22.5, V=21.9 given in Dhillon et al. [9]. Extrapolated to Sloan u'=22.02, g'=22.15, r'=21.75, i'=21.05, z'=20.59, using the relations in Jordi et al. [12].
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 0 - ULTRASPEC has negligible readout time.
- **Theta_see** - 0.9", median seeing given by Dhillon et al (2014).[9] Inconsistent with NARIT data of between 1" and 2.5".[3]
- **Theta_DF** - 10". Using this allows the recovery of bright targets.
- **FoV_Rad** - 3.8'. In practice, the CCD is windowed to just the targets of interest.
- **Detector_Size** - 1024x1024, given by Dhillon et al (2014)[9] and consistent with NARIT data.
- **Pixel_Scale** - 0.45", as part of NARIT data.[3]
- **Omega_pix** - 0.204"^{2}, using the FoV of 7.7'x7.7' given in Dhillon et al (2014).
- **Gain** - 0.8 [9].

- **Half_Well** - 40,000 [9].
- **texp_min** - 2s, due to the operating nature of ULTRASPEC. Exposure times shorter than this need an impractically small CCD window.

VLT FORS2 - Photometry, 200kHz Running Mode, 2x2 Binning, Standard Resolution

- **Telescope** - VLT FORS2 (200kHz)
- **Lat** and **Long** - -24.6275° N, 289.5956° E [16].
- **Alt** - 2635.4 m [16].
- **C_y** - 1.56, given in [2].
- **Aperture** - 8.2m [17]
- **Element?** - N (broad-band).
- **mzp_** - V=27.95, R=28.13, I=27.23, from measurements taken in the wake of the FORS CCD upgrade in August 2001[18]. Zero points are routinely re-measured for several FORS filters[19], but as the FORS2 manual notes[20], these are primarily as a system health check, and should not be used raw to do science with. Also note that these are not standard Johnson-Cousins filters, but wavelength details are published in the FORS2 manual.
- **m_5Sig** - N/A for photometry.
- **msky_** -B=22.4, V=21.7, R=20.8, I=19.9, z=19 [21]. These are the standard ETC brightnesses. Adjusted from B=22.3, V=21.4, R=20.7, I=19.3, z=18 [18] (2001 values) on 03/19. The MIT chipset is efficient in the NIR, meaning the effective wavelengths of the filters here are red-shifted, exacerbating these sky background values.
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 31 s [22]. The 200kHz setting with binning is preferred for exoplanetary study because of this lower overhead.

- **Theta_see** - Average DIMM seeing from 1990 to 2013 was 0.91" [23]. The new DIMM average seeing from 2016 to 2018 (using new hardware) is 0.69" [24], while [16] gives the FWHM seeing as 0.66".
- **Theta_DF** - none at this time.
- **FoV_Rad** - 3.4' (see below.)
- **Detector_Size** - 2048x2048 - FORS2 uses a mosaic of two 2Kx4K red-optimised MIT CCDs [25], but this record employs 2x2 pixel binning.
- **Pixel_Scale** - 0.25", for 2x2 binning. The Standard Collimator and Multi-Object Spectroscopy (MOS) unit restrict the FoV to 6.8'x6.8'. [25]
- **Omega_pix** - 0.0625"^{2}, from previous.
- **Gain** - 1.25 [18]
- **Half_Well** - 40,200 [26]. Saturation is controlled by ADU received (the ADU converter truncates at $\simeq$ 65K counts), and so the two modes will saturate at different times.
- **texp_min** - N/A.

VLT FORS2 - 200kHz Running Mode, 2x2 Binning, 600RI+19 grism, GG_435 order filter, Standard Resolution

- **Telescope** - VLT FORS2 (200kHz) 600RI+19
- **Lat** and **Long** - -24.6275° N, 289.5956° E [16].
- **Alt** - 2635.4 m [16].
- **C_y** - 1.56, given in [2].
- **Aperture** - 8.2m [17]
- **Element?** - N (broad-band). An appropriate internal conversion must be carried out to get correct exposure times for spectroscopy.
- **mzp_** - 27.68, averaged from R and I zero-points.
- **m_5Sig** - $\simeq$ 23.75 [25].
- **msky_** - Estimated at 20th mag.
- **Res** - 1000 [20].
- **Lambda_Cent** - 6777Å [20].

- **Lambda_Range** - 5120Å - 8450Å, giving a total range of 3330Å. [20].
- **Dispersion** - 1.66Å/pix.
- **Overhead** - 31 s [22]. The 200kHz setting with binning is preferred for exoplanetary study because of this lower overhead.
- **Theta_see** - 0.69" [24].
- **Theta_DF** - none at this time.
- **FoV_Rad** - 3.4', from previous.
- **Detector_Size** - 2048x2048, from previous. [25]
- **Pixel_Scale** - 0.25" [25]
- **Omega_pix** - 0.0625"^{2}, from previous.
- **Gain** - 1.25 [18]
- **Half_Well** - 40,200 [26]. Saturation is controlled by ADU received (the 16-bit ADU converter truncates at $\simeq$ 65K counts), and so the two modes will saturate at different times.
- **texp_min** - N/A.

VLT FORS2 - Photometry, 100kHz Running Mode, 2x2 Binning, Standard Resolution

- **Telescope** - VLT FORS2 (100kHz)
- **Lat** and **Long** - -24.6275° N, 289.5956° E [16].
- **Alt** - 2635.4 m [16].
- **C_y** - 1.56, given in [2].
- **Aperture** - 8.2m [17]
- **Element?** - N (broad-band).
- **mzp_** - V=27.95, R=28.13, I=27.23, from measurements taken in the wake of the FORS CCD upgrade in August 2001[18]. Zero points are routinely remeasured for several FORS filters[19], but as the FORS2 manual notes[20], these are primarily as a system health check, and should not be used raw to do science with.
- **m_5Sig** - N/A for photometry.

- **msky_** - B=22.4, V=21.7, R=20.8, I=19.9, z=19 [21]. These are the standard ETC brightnesses. Adjusted from B=22.3, V=21.4, R=20.7, I=19.3, z=18 [18] (2001 values) on 03/19. The MIT chipset is efficient in the NIR, meaning the effective wavelengths of the filters here are red-shifted, exacerbating these sky background values.
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 41 s [22].
- **Theta_see** - 0.69" [24].
- **Theta_DF** - none at this time.
- **FoV_Rad** - 3.4', from previous.
- **Detector_Size** - 2048x2048, from previous.
- **Pixel_Scale** - 0.25" [25]
- **Omega_pix** - 0.0625"^{2}, from previous.
- **Gain** - 0.7 [18]
- **Half_Well** - 22,500 [26]. Saturation is controlled by ADU received (the 16-bit ADU converter truncates at $\backsimeq$ 65K counts), and so the two modes will saturate at different times.
- **texp_min** - N/A.

VLT HAWK-I, Standard Running Mode, no GRAAL assist

- **Telescope** - VLT HAWK-I
- **Lat** and **Long** - -24.6275° N, 289.5956° E [16].
- **Alt** - 2635.4 m [16].
- **C_y** - 1.56, given in [2].
- **Aperture** - 8.2m [17]
- **Element?** - N (broad-band).

- **mzp_** - J=18.5, H=17.1, K=16.9, calculated from m_5Sig values below.
- **m_5Sig** - J=23.9, H=22.5, K=22.3 [27]. Scope.csv currently uses the K value for use with TEPCat. For laser guide star assistance with GRAAL, add 0.2 to these values.
- **msky_** - J=18, H=16.5, K=15.7 [21]. Backgrounds are brighter in the NIR, but the effect of the Moon is minimal.
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 9.6 s [27].
- **Theta_see** - 0.69” [24]. GRAAL can improve seeing to about 0.4” [27], but we don’t want this for bright targets.
- **Theta_DF** - N/A
- **FoV_Rad** - 3.75”.
- **Detector_Size** - 4096x4096 - HAWK-I uses a mosaic of four 2K CCDs, with a small separation between them. [27] (Hence, don’t point directly at the target, or you’ll lose it in the gap!)
- **Pixel_Scale** - 0.1064” [27]
- **Omega_pix** - 0.0113”^{2}, from previous.
- **Gain** - average of 1.855 - the four detectors have individual gains of 1.705, 1.87, 1.735 and 2.11 [27].
- **Half_Well** - 41,740 e^- - the detectors saturate at around 45K ADU. [27]
- **texp_min** - 1.6762 s [27].

VLT KMOS, HK Spectral Band

- **Telescope** - VLT KMOS_HK
- **Lat** and **Long** - -24.6275° N, 289.5956° E [16].
- **Alt** - 2635.4 m [16].

- **C_y** - 1.56, given in [2].
- **Aperture** - 8.2m [17]
- **Element?** - Y
- **mzp_** - HK=14.4, calculated from m_5Sig value below.
- **m_5Sig** - 19.8 [28].
- **msky_** - J=18, H=16.5, K=15.7, HK=16.1 [21]. Backgrounds are brighter in the NIR, but the effect of the Moon is minimal.
- **Res** - 1985
- **Lambda_Cent** - 19630Å [28].
- **Lambda_Range** - 14840Å to 24420Å, giving a total range of 9580Å [28].
- **Dispersion** - 4.89Å/pixel. [29]
- **Overhead** - 6 s [28]. Keep in mind that overheads for telescope movement and arm adjustment may be considerably longer.
- **Theta_see** - 0.69" [24]. Note that the ETC uses 0.31" as standard.
- **Theta_DF** - N/A.
- **FoV_Rad** - 3.6' [28].
- **Detector_Size** - 2048x2048. [28]
- **Pixel_Scale** - 0.2" [28].
- **Omega_pix** - 0.04"^{2}, from previous.
- **Gain** - 2.08 [28].
- **Half_Well** - $10,000e^-$ - this limit is deliberately set low in order to avoid persistent artefacts being created on the detectors, which can foul subsequent observations. [28]
- **texp_min** - 2.47 s [28].

Liverpool Telescope - RISE, 2x2 Binning

- **Telescope** - LT RISE
- **Lat** and **Long** - 28.7624° N, 342.1184° E [30]
- **Alt** - 2363 m [30]
- **C_y** - 1.3, given in [2].
- **Aperture** - 2m [30].
- **Element?** - N (broad-band).
- **mzp_** - RISE(720nm)=23.4, extracted from the source code of the LT's Exposure Time Calculator. [31] The longpass filter is approximately I + Z, installed 26th July 2017. Note that no nightly photometric standards are routinely taken with RISE, as it is mainly used only for differential photometry.
- **m_5Sig** - N/A for photometry.
- **msky_** - 19.3 [31].
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 0 - RISE has no read-out overhead. [32]
- **Theta_see** - 1.1" - estimate from DIMM at observatory. [33] Amended from 0.84" on 02/10/17 - it must have been a lucky night!
- **Theta_DF** - none at this time.
- **FoV_Rad** - 4.6'.
- **Detector_Size** - 1024x1024 pixels [32], which falls to 512x512 after our 2x2 binning.
- **Pixel_Scale** - 1.0752", recovered from science frames in April 2018.
- **Omega_pix** - 1.156"^{2}, from previous.
- **Gain** - 2.3 [32]
- **Half_Well** - 46,000 for 2x2 binning. Note that the 40,000 saturation limit quoted on the RISE webpage is for counts, and as such includes instrument gain. [32]
- **texp_min** - N/A.

Liverpool Telescope - SPRAT, Red Arm

- **Telescope** - LT SPRAT Red
- **Lat** and **Long** - 28.7624° N, 342.1184° E. [30]
- **Alt** - 2363 m [30]
- **C_y** - 1.3, as given in [2].
- **Aperture** - 2m [30].
- **Element?** - Y (per element).
- **mzp_** - V=16.5[34], Red Arm=17.7 [31].
- **m_5Sig** - 23.1, from the zero point of the red arm.
- **msky_** - 20.4 [31].
- **Res** - 350 [34].
- **Lambda_Cent** - 7000Å [31].
- **Lambda_Range** - 4000-8000Å [34], giving a range of 4000Å.
- **Dispersion** - 4.6Å/pix.
- **Overhead** - 10 s [34]
- **Theta_see** - 1.1" - estimate from DIMM at observatory. [33] Amended from 0.84" on 02/10/17.
- **Theta_DF** - none at this time.
- **FoV_Rad** - 3.8'(x)x0.9'(y).
- **Detector_Size** - 1024(x)x255(y) [34]
- **Pixel_Scale** - 0.44", from SPRAT web page, consistent with stated FoV and detector dimensions. This is inconsistent with the value of 0.48" used by the ETC[31].
- **Omega_pix** - 0.194"^{2}, using 0.44" from previous.
- **Gain** - 2.45 [34]
- **Half_Well** - 10,700 - this is a guess from example data count rates and the ETC. Assuming a standard 16-bit converter.
- **texp_min** - N/A.

Liverpool Telescope - SPRAT, Blue Arm

- **Telescope** - LT SPRAT Blue
- **Lat** and **Long** - 28.7624° N, 342.1184° E. [30]
- **Alt** - 2363 m [30]
- **C_y** - 1.3, from [2].
- **Aperture** - 2m [30].
- **Element?** - Y (per element).
- **mzp_** - V=16.5[34], Blue Arm=17.2[31].
- **m_5Sig** - 22.6, from the zero point of the blue arm.
- **msky_** - 21.4, estimated from data in Pedani (2004) [35].
- **Res** - 350
- **Lambda_Cent** - 4500Å [31].
- **Lambda_Range** - 4000-8000Å [34], giving a range of 4000Å.
- **Dispersion** - 4.6Å/pix.
- **Overhead** - 10 s [34]
- **Theta_see** - 1.1" - estimate from DIMM at observatory. [33] Amended from 0.84" on 02/10/17.
- **Theta_DF** - none at this time.
- **FoV_Rad** - 3.8'(x)x0.9'(y).
- **Detector_Size** - 1024(x)x255(y) [34]
- **Pixel_Scale** - 0.44", from SPRAT web page, consistent with stated FoV and detector dimensions. This is inconsistent with the value of 0.48" used by the ETC[31].
- **Omega_pix** - 0.2905"^{2}, using 0.44" from previous.
- **Gain** - 2.45 [34]
- **Half_Well** - 30,000 - this is a guess!
- **texp_min** - N/A.

Thailand - Nakhon Ratchasima (ROPNM/KORAT) Planewave CDK 700 0.7m, 2x2 Binning

- **Telescope** - ROPNM
- **Lat** and **Long** - 14.873472° N, 102.02861° E.
- **Alt** - 250 m, from NARIT data [3]
- **C_y** - 1.5
- **Aperture** - 0.7m [3] [36].
- **Element?** - N (broad-band).
- **mzp_** - B=N/A, V=20.92, R=21.2, I=20,25, recovered from science frames taken on 04/03/17 (V+R) and 07/02/18 (I).
- **m_5Sig** - N/A for photometry.
- **msky_** - Unknown.
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 6 s, but this can presumably be controlled through the controlling MaxImDL software, as with the TNO 0.5m and the 0.7m at Lijang.
- **Theta_see** - 2.5" [3]
- **Theta_DF** - none at this time.
- **FoV_Rad** - 25.8' (optimum value given by [36]).
- **Detector_Size** - 4096,4096, recovered from science frames. Inconsistent with 3056x3056 from discussions with Dr. Supachai Awiphan.
- **Pixel_Scale** - 1.512" (for 2x2 binning), recovered from previous values.
- **Omega_pix** - 2.285"^{2}, from previous.
- **Gain** - 1 - this is a guess!
- **Half_Well** - 30,000 - standard for 16-bit detector.
- **texp_min** - N/A.

New 0.7m telescope at Siding Brook Observatory, Australia (2x2 binning)

- **Telescope** - NARIT SBO
- **Lat** and **Long** - -28.1906° N, 153.27° E [37].
- **Alt** - 1165 m.
- **C_y** - 1.5
- **Aperture** - 0.7m - this instrument is identical to those at Gao Mei Gu and KO-RAT [37].
- **Element?** - N (broad-band).
- **mzp_** - B=, V=, R=, I=. Not known yet, using ROPNM values for now.
- **m_5Sig** - N/A for photometry.
- **msky_** - Unknown.
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 17 s, also extrapolated from science frames. (AIJ)
- **Theta_see** - 1.5", as for CTIO.
- **Theta_DF** - none at this time.
- **FoV_Rad** - 10.24'.
- **Detector_Size** - 4096x4096, as for ROPNM.
- **Pixel_ Scale** - $0.6''^2$, recovered from 2x2 binned science frames.
- **Omega_pix** - $0.36''^2$, recovered from previous values.
- **Gain** - 1 - this is a guess!
- **Half_Well** - 30,000 (standard for 16-bit detector).
- **texp_min** - N/A.

New Technology Telescope, La Silla - ULTRACAM

- **Telescope** - NTT ULTRACAM
- **Lat** and **Long** - -29.258917° N, 289.26625° E. [38]
- **Alt** - 2375 m [38]
- **C_y** - 1.5.
- **Aperture** - 3.6m [38].
- **Element?** - N (broad-band).
- **mzp_** - u'=24.15, g'=26.25, r'=25.7, i'=25.6, z'=24.77, recovered from ULTRACAM's exposure time calculator.[39]
- **m_5Sig** - N/A for photometry.
- **msky_** - U=21.9, B=22.7, V=21.9, R=21.1, I=19.9 [40]. This source also holds figures for Paranal and CTIO, but I'm unsure as to how valid these are now! Subsequently extrapolated to u'=22.44, g'=22.28, r'=21.1, i'=20.02, z'=20.73 using transformations in Jordi et al. [12].
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 24 ms - so approximately 0.[41]
- **Theta_see** - 0.8" [23].
- **Theta_DF** - none at this time.
- **FoV_Rad** - 2.5' (see below).
- **Detector_Size** - 1024x1024 [41]
- **Pixel_Scale** - 0.29" - the NTT itself has an FoV of 30'x30' [38], but ULTRACAM's CCDs are limited to a 5'x5' field, with a pixel scale as stated.[41]
- **Omega_pix** - 0.0858"^{2}, recovered from previous.
- **Gain** - $\simeq$ 1.[41]
- **Half_Well** - 50,000 [41]
- **texp_min** - unknown; as a sister instrument to ULTRASPEC, ULTRACAM presumably has a minimum practical exposure time.

Kottamia 1.88m (Photometry, Newtonian Focus)

- **Telescope** - Kottamia_Phot
- **Lat** and **Long** - 29.9265° N, 31.8294° E. [42],[43]
- **Alt** - 476m. [43] [42],[43]
- **C_y** - 1.5
- **Aperture** - 1.88m [42].
- **Element?** - N (broad-band).
- **mzp_** - R≃ 23, but no concrete information yet. This telescope is scarcely documented in Western science literature; will likely have to wait for science frames to recover these magnitudes.
- **m_5Sig** - N/A for photometry.
- **msky_** - B=22.4, V=21.5 [44]. Subsequently extrapolated to U=22.85, R=20.95, I=19.98 using transformations in Jordi et al. [12].
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 15s (from private communication)
- **Theta_see** - 2" [45], which is corroborated by the ESO report [44].
- **Theta_DF** - none at this time.
- **FoV_Rad** - 5.2 (see below).
- **Detector_Size** - 2048x2048, for new EEV CCD 42-40 CCD. [42]
- **Pixel_Scale** - 0.304", using Newtonian focus to yield 22.53"/mm over an imaging area of 27.6mm x 27.6mm. The FoV is subsequently 10.36' x 10.36'. [42]
- **Omega_pix** - 0.0924"^{2}, recovered from previous.
- **Gain** - 2.5 (from private communication)
- **Half_Well** - 60,000 e$^-$ [42]. The ADU received will be restricted by the 16-bit converter.
- **texp_min** - N/A.

1.52m Carlos Sánchez Telescope/MuSCAT2 (Dark/Bright Profiles)

- **Telescope** - MuSCAT2
- **Lat** and **Long** - 28.3005° N, 343.4891° E. [46]
- **Alt** - 2386.75m [47], consistent with the 2387m given in [46] and the 2390m given by [48].
- **C_y** - 1.3, given in [2].
- **Aperture** - 1.52m [47].
- **Element?** - N (broad-band).
- **mzp_** - g'=24.61, r'=24.57, i'=23.63 and z'=22.88. These values are intended for use as part of simultaneous 4-colour photometry; the metric can simply be re-run in the four different bands. Values for 600s exposures are g'=31.56, r'=31.52, i'=30.58 and z'=29.83, from which the correct mzps are extrapolated [47]. Previous values were g'=31.33, r'=31.38, i'=30.62, z'=29.24 (Narita & Palle, private communication).
- **m_5Sig** - N/A for photometry.
- **msky_** - g'=20.4, r'=19.8, i'=19.0, z'=18.2 [47]. Bright values are taken as g'=18, r'=17.5, i'=17, z'=16.5. These exist as two profiles named MuSCAT2_Dark and MuSCAT2_Bright.
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 0.58s (1x1 binning @ 2 MHz) [48] [49].
- **Theta_see** - 0.8". [47] Revised upwards from 0.76" [50] on 12/07/18.
- **Theta_DF** - Defocused diameter is taken as 14" [47].
- **FoV_Rad** - 3.7'. [48] gives the FoV as 7.2' x 7.2'.
- **Detector_Size** - 1024x1024 pixels. MuSCAT2 is comprised of four such detectors, for simultaneous photometry in griz bands [48] [49].

- **Pixel_Scale** - 0.434” for g and r (FoV 7.41’ x 7.41’), 0.435” for i (FoV 7.43’ x 7.43’), 0.436” for z (FoV 7.44’ x 7.44’) [51]. [47] uses 0.44” for all bands, so this value is adopted. These do not currently exist as separate records, but could do in future if needed.
- **Omega_pix** - 0.1936”^{2}, recovered from previous.
- **Gain** - Approximately 1 [47]. A variety of other settings are available [49].
- **Half_Well** - 32,000. [47] The CCDs are exceptionally linear, but are restricted by the 16-bit ADU converter.
- **texp_min** - N/A.

Sutherland 1.9m with SHOC1 Fast-Readout Camera @ 1MHz Read-out, 16-bit CON Amplifier

- **Telescope** - Sutherland_1.9_SHOC1
- **Lat** and **Long** - -32.379° N, 20.811° E [52].
- **Alt** - 1759m [52].
- **C_y** - 1.5.
- **Aperture** - 1.9m [53].
- **Element?** - N (broad-band).
- **mzp_** - U=20.77, B=23.57, V=23.92, R=23.37, extrapolated and gain-corrected from zero-points of the sister instrument STE4, mounted on the 1m telescope at the same site [54]. Extrapolated onwards for I=21.13, u’=21.21, g’=23.58, r’=22.81, i’=20.68 and z’=19.65 using transformations in Jordi et al. [12]. Note that this set-up has both a Bessell and a Sloan filter set.
- **m_5Sig** - N/A for photometry.
- **msky_** - V=21.7, from footnote in Coppejans et al. [55]. Can’t extrapolate with just one value!
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A

- **Overhead** - 0.5s for the slowest readout speed [53]. Using the 3MHz setting can reduce this time, but the 14-bit amplifier for this setting means the full well depth will be reduced by a factor of 4 [56]. The electron multiplier settings are not for conventional/inexperienced users, owing to the fact that they can damage the CCD.
- **Theta_see** - 1.5" [55].
- **Theta_DF** - none at this time.
- **FoV_Rad** - 1.4' (see below).
- **Detector_Size** - 1024x1024 [55] [53].
- **Pixel_Scale** - 0.163" when used with the focal reducer [53]. This only yields a small FoV of 2.79' x 2.79'.
- **Omega_pix** - 0.0266"^{2}, from previous.
- **Gain** - The 1MHz conventional amplifier offers gain settings of 0.63, 1.69 or 4.06 [55] [56]. Of these, only 4.06 will allow the 16-bit amp to convert all possible electrons to ADU. Restricting to half-well only, the 1.69 setting is also usable.
- **Half_Well** - 71,919 [55] [56]
- **texp_min** - N/A.

0.7m Telescope at Sierra Remote Observatory (NARIT-Managed)

- **Telescope** - Sierra Remote
- **Lat** and **Long** - 37.07° N, 240.6° E [57].
- **Alt** - 1405.1 m (converted from feet) [57].
- **C_y** - 1.5.
- **Aperture** - 0.7m [58]
- **Element?** - N (broad-band).
- **mzp_** - Unknown - science frames required.
- **m_5Sig** - N/A for photometry.
- **msky_** - B=N/A, V=21.78, R=22, I=20.91, from [57].
- **Res** - N/A for photometry.

- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A
- **Overhead** - 17s, assuming similar behaviour to PT8.
- **Theta_see** - 1.1" on average - 1" in summer, 1.2" in winter [57].
- **Theta_DF** - none at this time.
- **FoV_Rad** - 11.3'.
- **Detector_Size** - 2048 x 2048 - this telescope has a ProLine PL4240 CCD with 13.5μm pixels [59] [60]
- **Pixel_ Scale** - 0.662", assuming similar behaviour to PT8.
- **Omega_pix** - 0.438"^{2}, assuming similar behaviour to PT8.
- **Gain** - 1.34 [61].
- **Half_Well** - [60] lists the full well depth as 100K e$^-$, but their in-house quality control test [61] found an effective full well depth of 86500 e$^-$, using the gain of 1.34 and 2MHz readout mode. This corresponds to a half-well depth of 43250 e$^-$, yielding a max ADU consistent with the use of a 16-bit converter, which this camera has.
- **texp_min** - N/A.

NTT, La Silla - EFOSC2 Low-Resolution Spectrograph, GR01 Grism, 2x2 Binning

- **Telescope** - NTT EFOSC2 GR01
- **Lat** and **Long** - -29.258917° N, 289.26625° E. [38]
- **Alt** - 2375 m [38]
- **C_y** - 1.5.
- **Aperture** - 3.6m [38].
- **Element?** - N (broad-band).
- **mzp_** - U=24.39, B=26.16, V=26.28, R=26.36, I=25.48 [62]. This are revised from U=24.1, B=26, V=26.1, R=26.18, I=25.35 given at [63]. When used for low-res spectroscopy, this gives a channel zero-point of 21.44.

- **m_5Sig** - 26.84, extrapolated from the recovered zero-point.
- **msky_** - U=22.0, B=22.7, V=21.8, R=20.9, I=19.9 [62]. This is the same table as given in [6], and have superseded the figures given in [40]. For spectroscopy, this is approximately 21.5.

  For bright skies, U=17, B=19.5, V=20, R=19.9, I=19.2.
- **Res** - 52 [62].
- **Lambda_Cent** - 7063Å.
- **Lambda_Range** - 3185-10940Å, yielding a range of 7755Å [62].
- **Dispersion** - 13.32Å/pix, when using 2x2 binning.
- **Overhead** - 9s, when using 2x2 binning. 1x1 binning in the Normal mode has t_over of 70s. [62]
- **Theta_see** - 0.8" [23], [62].
- **Theta_DF** - none at this time.
- **FoV_Rad** - 2' [62].
- **Detector_Size** - 2048x2048 [62]. This will fall to an effective size of 1024x1024 for 2x2 binning.
- **Pixel_Scale** - 0.24" for 2x2 binning. [62]
- **Omega_pix** - 0.0576"^{2}, recovered from previous.
- **Gain** - 1.35 [62].
- **Half_Well** - 52,000 electrons [62]. However, the 16-bit converter limits this to effectively be 44,200.
- **texp_min** - N/A.

MeerLICHT

- **Telescope** - MeerLICHT
- **Lat** and **Long** - -32.379° N, 20.811° E. (At Sutherland.)
- **Alt** - 1759m [52].
- **C_y** - 1.5

- **Aperture** - 0.6m. The primary mirror is 0.65m, but this is to reduce vignetting at the detector edges, rather than for extra light collection. [64]
- **Element?** - N
- **mzp_** - u'=18.85, g'=20.95, r'=20.35, i'=19.75, z'=19.45, vr'=21.25, calculated from m_5Sig values below.
- **m_5Sig** - u'=19.8, g'=21.9, r'=21.3, i'=20.7, z'=20.4, vr'=22.2, for 60s exposures at 0.95" seeing [64].
- **msky_** - V=21.7, from footnote in Coppejans et al. [55]. Can't extrapolate with just one value!
- **Res** - N/A for photometry.
- **Lambda_Cent** - N/A for photometry.
- **Lambda_Range** - N/A for photometry.
- **Dispersion** - N/A for photometry.
- **Overhead** - 30s (Paul Groot, private communication.)
- **Theta_see** - 1.5" [55].
- **Theta_DF** - N/A
- **FoV_Rad** - 49.28' [64]. (These telescopes have big detectors!)
- **Detector_Size** - 10560x10560.
- **Pixel_Scale** - 0.56" [64].
- **Omega_pix** - 0.3136"^{2}, recovered from previous values.
- **Gain** - 1 - this is a guess!
- **Half_Well** - 32,000 (standard for 16-bit readout).
- **texp_min** - 60s - MeerLICHT is slaved to the MeerKAT radio telescope array, and a 60s exposure program has been adopted by those teams.

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