# Step-by-Step ETC Guide for NIRCam Time Series Imaging Science Use Case

Instructions are provided for filling out the APT observing template for the JWST NIRCam Grism Time Series Observations of HAT-P-18 Science Use Case.

## Exposure Time Calculator

*Main article: JWST Exposure Time Calculator*

*See also: NIRCam Bright Source Limits, NIRCam Detector Subarrays, NIRCam Time-Series Imaging Target Acquisition, NIRCam Readout Patterns*

Our strategy is to use the JWST ETC to estimate the signal level of HAT-P-18 and determine the detector MULTIACCUM ***readout parameters***. We enter the following values into the ETC and determine the signal-to-noise ratio (SNR) in a single ***integration***, and then we will convert this to the SNR over the secondary eclipse observation and assess how it will be detected. For detailed help with using the ETC, see the online help pages.

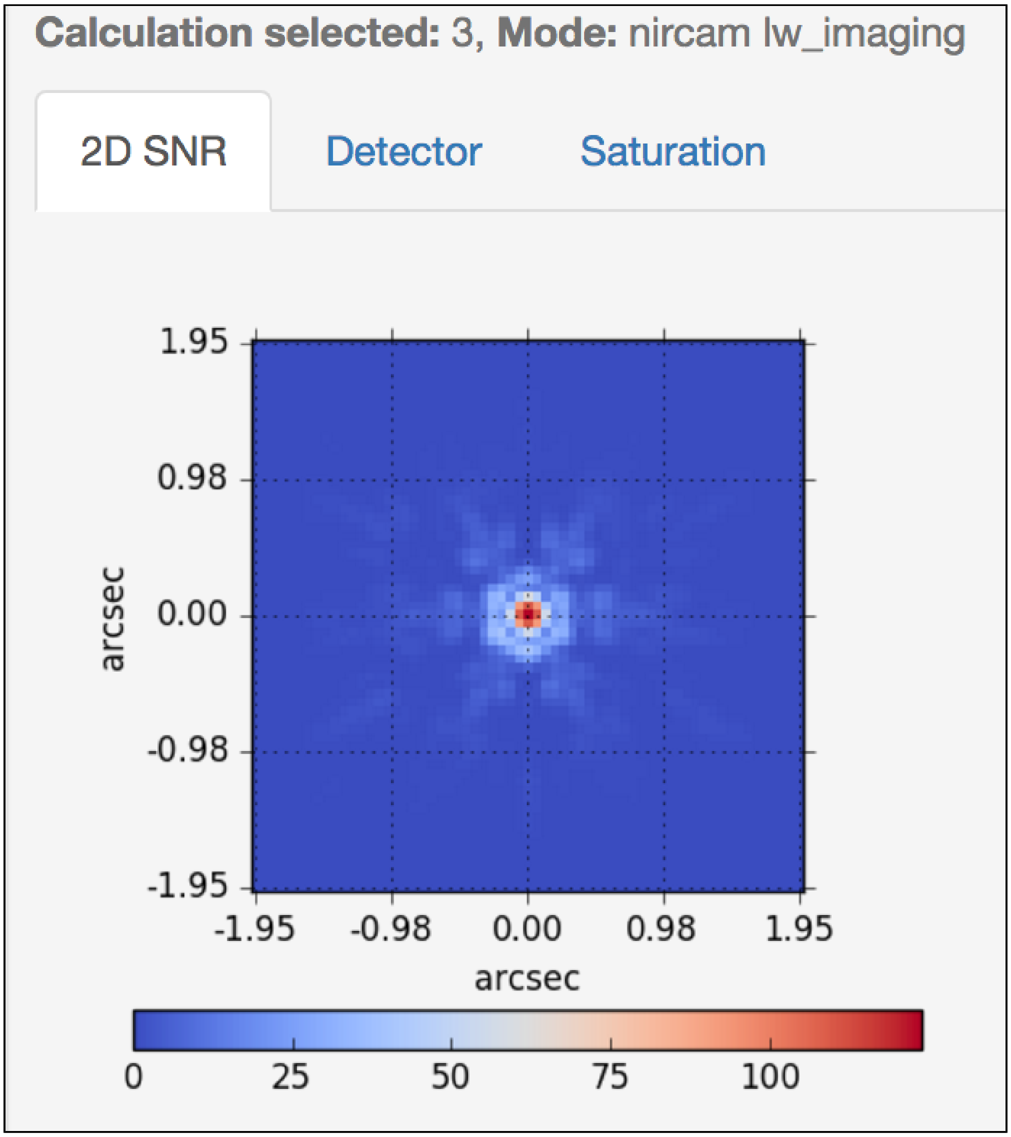
We entered the following parameters into the JWST ETC short-wave (SW) Imaging, long-wave (LW) Imaging, and target acquisition **calculations**:

- Source: To emulate HAT-P-18, select a Phoenix K2V star, normalized to a K = 10.23 Vega mag.
- **Calculation**: ETC has no SW weak lens available (future versions will include them), so we'll use regular SW imaging.
- Detector setup: Select the ***SUB64P*** **subarray**, ***RAPID readout***, 10 groups per ***integration***.
  - F210M filter has peak flux < 60,000 $e^-$ / pix / int (not saturated).
  - F444W filter has peak flux < 45,000 $e^-$ / pix / int (not saturated).
- Target acquisition:
  - ***Filter***: F335M
  - ***Subarray***: SUB32
  - ***Readout: RAPID***, 17 groups
  - Output: SNR = 214 in 0.26 s, Peak: ~23,000 $e^-$ / pix / int.

The above parameters give a source ***integration*** time of 0.54 s (10 groups). The ETC predicts that one F444W ***integration*** will have SNR = 391, and the SNR pixel map is shown in Figure 1.

To track the eclipse, we will repeat the ***integration*** 18067 times (in time-series mode), each with a duration 0.54 s. This fits within the total transit time of 2.71 hours, leading to SNR = 52,555 if SNR increases with the square root of the ***number of integrations***. Assuming that the secondary eclipse will last the same length of time (true if eccentricity is near 0), we integrate for 2.71 hours during the expected secondary eclipse period and an equal amount of time outside of the eclipse. The secondary eclipse signal is the difference between these 2 periods ((star + planet dayside) - star only), which we estimate will be measured with SNR = 52,555 / √2 = 37,162 or a precision of 27 ppm. Therefore we expect to detect the secondary eclipse at SNR ~ 16. This is sufficient for determining whether the planet day-side temperature is close to its predicted equilibrium value, and this result will constrain the efficiency of day–night circulation on the planet.

**Figure 1. ETC SNR for F444W in 0.5 s integration**




***The 2D-SNR map of HAT-P-18 for the F444W filter in a 0.5s integration.***