Simulating JWST data with PandExo: How-To Guide

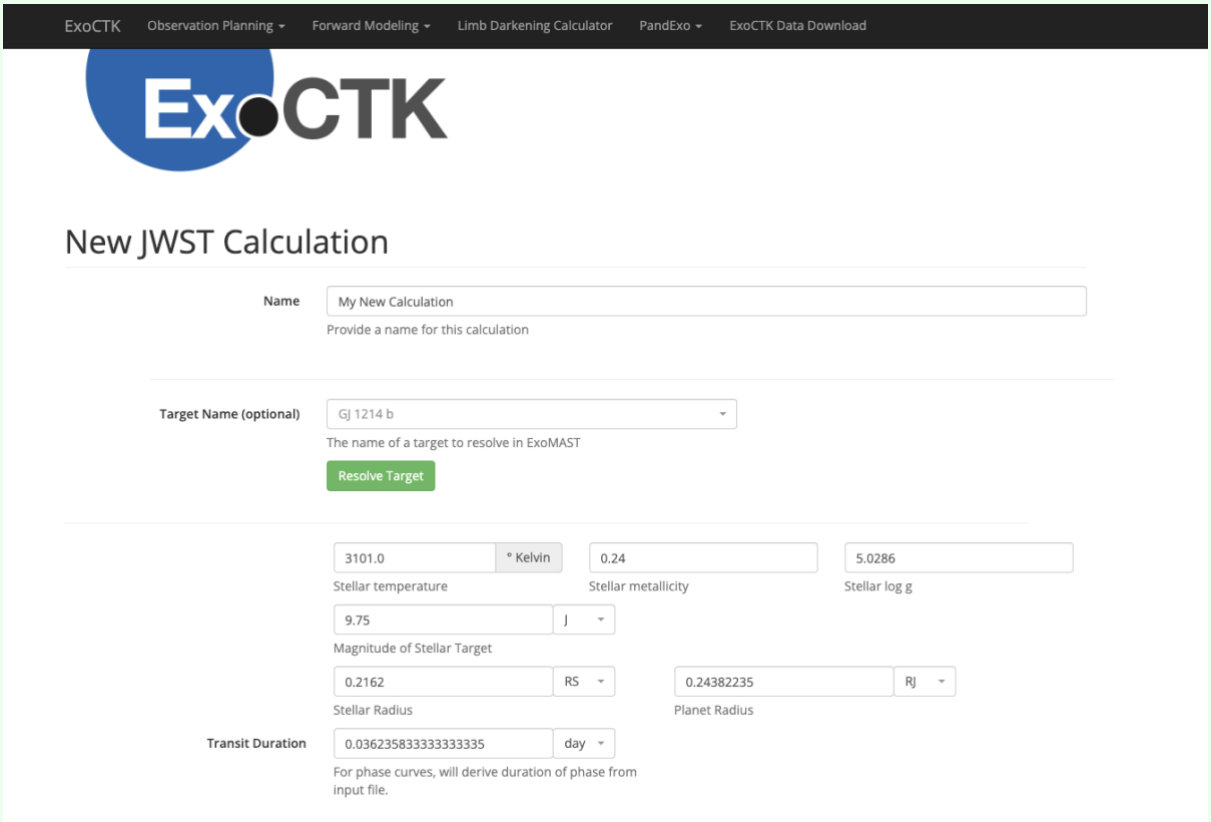
Once we have simulated a model transmission spectrum, we can use the PandExo tool to simulate the data points and error bars that JWST would observe.

The online version of PandExo can be found here: https://exoctk.stsci.edu/pandexo/

Here is some guidance on how to use the tool:

1) Select “New Calculation” in the JWST box

2) Name your calculation and input the name of your target in the “Target Name” box. If the software recognises the planet, it will automatically fill in the planetary and stellar information in the boxes below. If not, you will need to input these values manually from the NASA Exoplanet Archive. Even if PandExo fills in the values it’s a good idea to check/update them, as it can sometimes use outdated values. Here’s an example for GJ 1214 b:

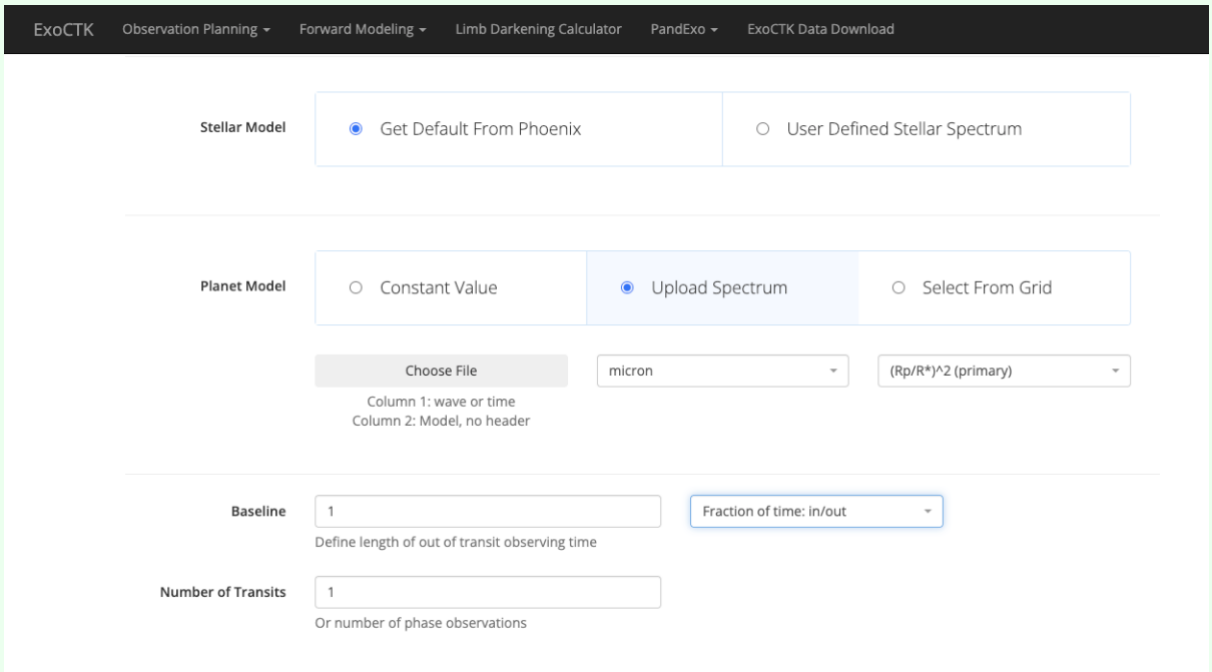


3) For the Stellar Model selection, choose “Get Default From Phoenix”. The Phoenix models are a grid of stellar models often used in the community – this is the paper to cite when you use these models: https://arxiv.org/abs/1303.5632

4) For the Planet Model, you can select “Upload Spectrum” and choose a file corresponding to your model spectrum. Tell PandExo which units the wavelengths are in (e.g. microns) and that the spectrum is in units of (Rp/Rs)^2. You should make sure that your model file is in these units!

5) The baseline sets how long JWST looks at the star before and after the transit. This is important, as the out-of-transit data sets the baseline level of flux to which you compare the transit. A standard value to choose is equal in- and out-of-transit time. For this, type “1” for the baseline, and select units of “Fraction of time: in/out”.

6) You can tell PandExo how many transits you are observing, and it will ‘stack’ the data (i.e. the uncertainties will get smaller by a factor of the square root of the number of transits). Alternatively, you can do the calculation for one transit and manually reduce the uncertainties later, in your own code. If you do this, make sure that you re-scatter the data points according to the smaller uncertainty.



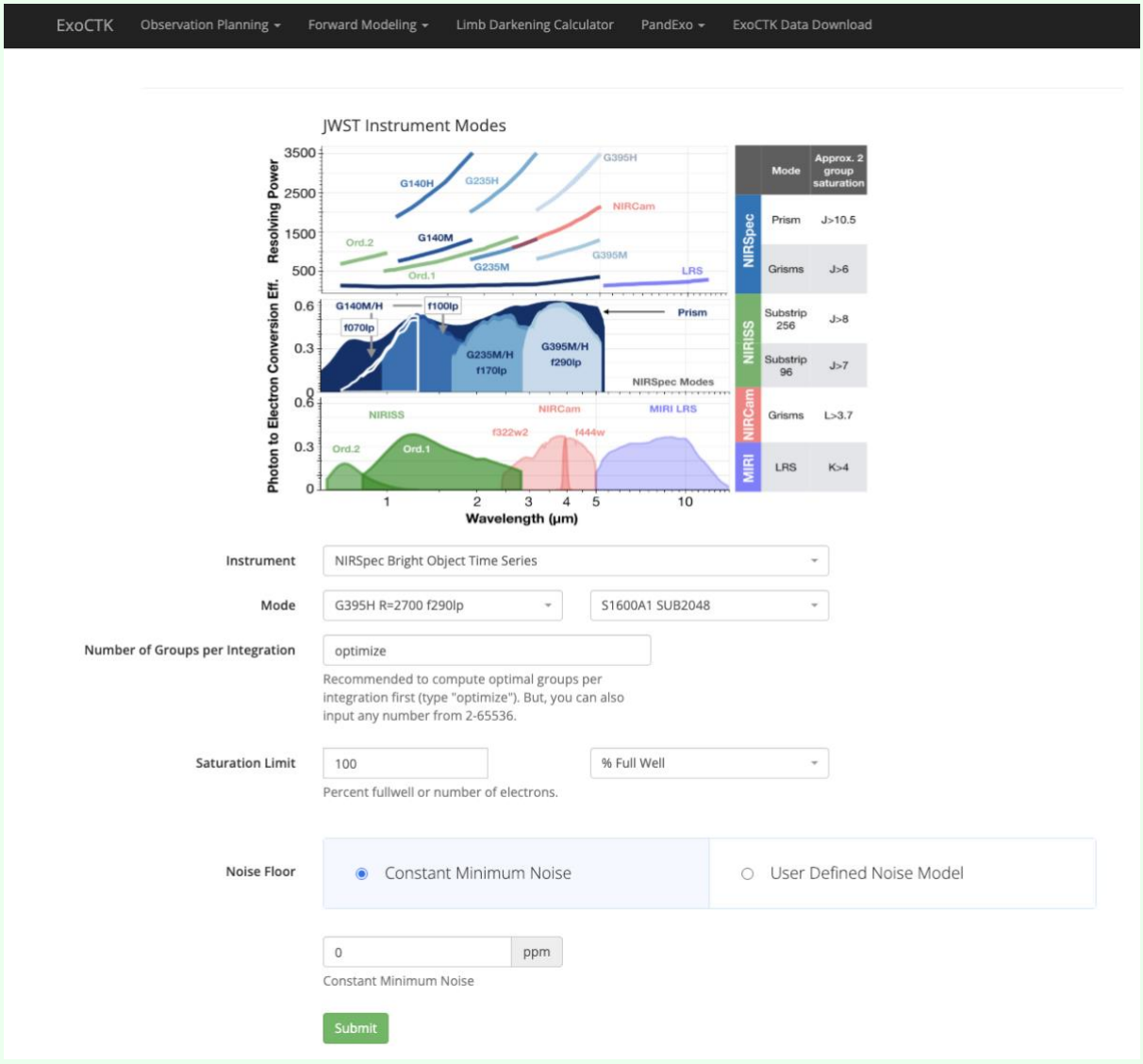
7) Now select the instrument and mode you would like to simulate data for. Check the JWST Pocket Guide (or the JWST Notes in the Resources List) to see the wavelength ranges of each instrument and mode. Another tip is to look at papers with JWST data and check which instrument settings they used.

8) For Number of Groups per Integration, select “optimize”. The number of groups should be >=3 as this helps to detect anomalies due to things like cosmic rays.

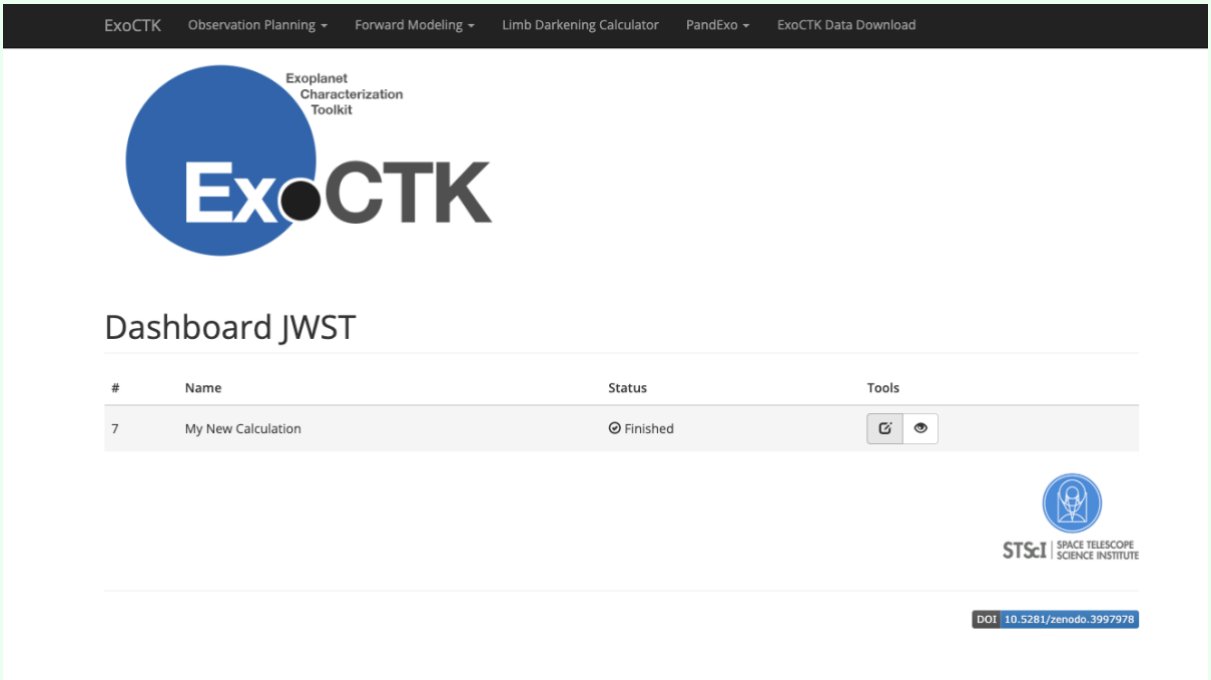
However, having too many groups can saturate the instrument. By selecting “optimize”, PandExo works out the maximum number of groups allowed that still avoids saturation. Double check the number of groups in the outputs, to make sure there are at least 3. If this is not the case, or if the instrument saturates, you may need to use a higher-resolution instrument or mode.

9) Set the saturation limit to 100% Full Well.

10) The noise floor is a background level of noise. You can set this to a constant value of zero for the purposes of this project.



11) Click “Submit”. It will take you to a dashboard, and when the calculation is ready you can view the outputs by clicking on the eye icon to the right of the calculation status.



12) In the outputs, you can view plots of the simulated data and vary the amount of binning or number of transits. You can also check whether any parts of the detector are saturated – scroll down to the "2D Images" and click the "Saturation" tab. If the image is all red, that means there is no saturation. You can also check the number of groups per integration in the "Timing Info" table, and check for any warnings.

13) To download a text file with the data, click "Download Simulated Data with Errors (text)".

14) Once you have the error bars and data points computed by PandExo, you can easily recalculate the error bars for the same planet but a different number of transits – just reduce the uncertainties for one transit by the square root of the number of transits. However, when you do this you need to move the data points, as they should be scattered around the model spectrum according to a Gaussian distribution where the width is the error bar on the data point.