Simulation Tools for the Roman Space Telescope

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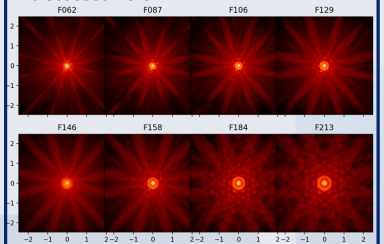
SOC Roman Simulation Tools

The Nancy Grace Roman Space Telescope (Roman) is set to launch in late 2026 and will survey large regions of the sky to help answer key questions in many areas of astrophysics, including dark energy and dark matter, galaxy formation, and exoplanets. In an effort to provide the community with tools to better understand and prepare for science with Roman's Wide Field Instrument (WFI), the Science Operations Center (SOC) at the Space Telescope Science Institute has developed a suite of simulations tools that we describe here. More information is available in the Roman documentation[1].

STPSF (formerly WebbPSF)

STPSF is a Python package that simulates point-spread functions (PSFs) for JWST and Roman. It relies on a high-fidelity optical model (NASA Goddard 2021) to generate field-dependent, polychromatic PSFs for a specified filter, detector, pixel position, and oversampling, albeit without any detector effects. **STPSF** is also the underlying PSF generator for the tools discussed here.

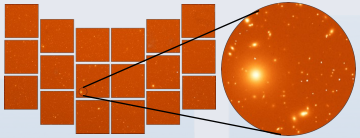


*Roman PSFs in all the imaging filters. **STPSF** can also simulate PSFs for the prism and grism. The field of view is 5" across.*

Use **STPSF** when interested in understanding and characterizing individual PSFs with high accuracy

Roman I-Sim

Roman I-Sim is a high-fidelity simulator that (1) handles realistic up-the-ramp signal accumulation and noise propagation and (2) outputs realistic **ASDF-formatted** products. This Python tool can generate (or ingest) a source catalog and output Level-1 "up-the-ramp" cubes and Level-2 calibrated (ramp-fitted) files in the format expected by the **Romancal** pipeline[2].

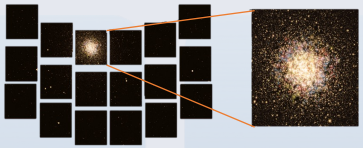


*Collage of **Roman I-Sim** level-2 simulated images for all 18 detectors through the F158 filter. The zoomed-in image inset is ~55 arcsec across.*

Use **Roman I-Sim** if interested in high-fidelity, pipeline-compliant simulated imaging products (L1 and L2)

STIPS

The Space Telescope Imaging Product Simulator (**STIPS**) can be used to simulate post-pipeline astronomical scenes as observed with WFI. **STIPS** includes calibration *residuals* (e.g. flatfields, dark currents, cosmic rays), estimates of Poisson and readout noise, and zodiacal and internal background. However, the output format is not compatible with the **Romancal** pipeline.



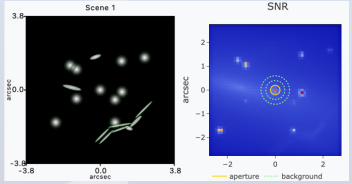
*Collage of **STIPS** simulated images of M13 for all 18 detectors through a combination of the F106, F129, and F158 filters.*

Use **STIPS** if interested in rapidly simulating many full-field images, albeit at lower fidelity, for analysis purposes

Roman WFI Exposure Time Calculator (ETC)

The SOC provides tools to perform exposure time and signal-to-noise calculations for Roman WFI, each with a different degree of fidelity. **Pandeia**[3] is the Python-based ETC engine and is intended for savvy users requiring the most flexibility and complexity in designing their observations. Users interface with **Pandeia** through Python scripting or notebook, which, for example, allows users to programmatically explore a parameter space. The other two tools, described below, while still relying on **Pandeia** internally, offer graphical interfaces and ease of use, at the expense of some flexibility in the design of observations.

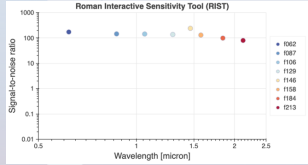
The **ETC Web Interface** enables users to estimate the signal in their planned WFI observations using the **Pandeia** engine through a browser interface. The interface provides considerable flexibility in designing observations and is a great option for most users.



*The **ETC Web interface** allows the users to set up complex observations (left) and calculate the SNR (right), all through a graphical interface.*

Use the **ETC Web Interface** if interested in high-fidelity calculations using *complex* setups and observations

Roman Interactive Sensitivity Tool (**RIST**) is used to quickly explore the feasibility of observations of individual point sources. It is provided in the form of a Jupyter notebook and uses a grid of pre-calculated **Pandeia** results that samples a limited set of observing setups. As a result, it also provides the least flexibility compared to other tools.



***RIST** can quickly display SNR results for simple, single-source observation setups, as shown above.*

Use **RIST** if interested in quick and simple SNR calculations for individual *point* sources only

Take Part in the Mission

- **Tune In**: sign up for news, listen to webinars, and read documentation.
- **Interact**: attend conferences, use simulated data and tools, and prepare to submit proposals.
- **Actively Contribute**: engage with formal committees, join the WFI working groups, and participate in workshops.

www.stsci.edu/roman/get-involved

References:
1 The Roman Documentation (RDox) https://roman-docs.stsci.edu
2 The Roman Space Telescope Calibration Pipeline https://roman-pipeline.readthedocs.io/en/latest/
3 Pandeia https://outerspace.stsci.edu/display/PEN/Pandeia+Engine+News