



# Nancy Grace Roman Space Telescope (Roman)

## Technical Report

Title: Roman SOC Science Validation Report for SOC Release 1 PSS	Doc #: Roman-STScI-000457, SC-01 Date: January 25, 2023 Rev: -
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### Abstract

**Table 1: Executive Summary of PSS requirements and their science validation status.**

Requirement ID	Level 4 Requirement	Validation Result
SOC-228	WFI Observation Parameter Selection	Pass
SOC-229	WFI Observation Absolute Constraint Specification	Pass
SOC-231	WFI Calibration Observation Creation	Pass
SOC-234	WFI High Latitude Survey Observation Creation	Pass
SOC-501	GO and DD WFI Observation Creation	Pass
SOC-520	Target Specification Reference Frame	Pass
SOC-608	WFI Microlensing Survey Observation Creation	Pass
SOC-609	WFI Supernova Survey Observation Creation	Pass

### Introduction

Two related reports are being published to document the science validation of requirements for the Roman Space Telescope Science Operations Center (SOC) Release 1.0. This report covers the Roman Planning and Scheduling System (PSS), and the companion report covers the Data Management System (DMS; see Desjardins, 2023). In the following sections, we describe the PSS requirements being tested, the data (science programs) used, and the validation results.

This report also pairs with another concurrent report describing the sample science programs used here (see Table 3) in greater detail, including their science drivers (see Mutchler, 2023).

### Scope of PSS Testing

The SOC/RPSS requirements being tested and validated are summarized in Table 2.

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**Table 2: RPSS requirements being validated, with descriptions.**

<b>Requirement ID</b>	<b>Level 4 Requirement</b>
SOC-228	WFI Observation Parameter Selection - The PSS shall enable observers to select science instrument parameters for WFI observations.
SOC-229	WFI Observation Absolute Constraint Specification - The PSS shall enable observers to specify absolute constraints on WFI observations.
SOC-231	WFI Calibration Observation Creation - The PSS shall enable the creation of WFI calibration observations.
SOC-234	WFI High Latitude Survey Observation Creation - The PSS shall enable creation of observations for the WFI High Latitude Survey.
SOC-501	GO and DD WFI Observation Creation - The PSS shall enable creation of observations for WFI GO and DD proposals/programs.
SOC-520	Target Specification Reference Frame - The PSS shall accept target coordinates in the International Celestial Reference System (ICRS).
SOC-608	WFI Microlensing Survey Observation Creation - The PSS shall enable creation of observations for the WFI Microlensing Survey.
SOC-609	WFI Supernova Survey Observation Creation - The PSS shall enable creation of observations for the WFI Supernova Survey.

### **PSS Functionality Tested**

All of the PSS requirements being tested can be validated by demonstrating that they can be fully expressed within the Astronomer's Proposal Tool (APT). In all cases, the test data utilized is an APT version 2022.4 sample science program (see Table 3). The resulting xml files have been provided on Central Store as artifacts (see Appendix). Beyond simply exercising the APT parameters associated with each requirement, these 12 programs reflect realistic calibrations and science cases expressed by the astronomical community in recent years, and include a variety of program sizes (Mutchler, 2023).

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**Table 3: Summary of 12 Roman APT test programs utilized for PSS science validation.**

ID	Target/s	Description
901	Internal	Calibration: periodic dark current (imaging and spectroscopy) and flat fields
903	LMC Star Field	Calibration: geometric distortion
911	Perseus Cluster	Small program, one pointing, no dithers/requirements
912	M81 and M82	Small program, one pointing, multiple filters, orient requirement
913	5 Globular Clusters	Small program, scattered targets, multiple filters, mosaics
933	M33 Triangulum Galaxy	Medium program, one target, mosaic
939	Oort Cloud	Medium planetary program, Director's Discretionary
941	20 Nearby Galaxies	Medium survey, scattered targets, mosaics
951	3 Ultra-Deep Fields	Large deep program for 3 target regions
991	Large High Galactic Latitude Region	High Latitude Wide Area Survey (HLWAS) core community survey enabling cosmology (weak lensing, baryon acoustic oscillations)
992	Small Region in the Galactic Bulge	Galactic Bulge Time Domain Survey (GBTDS) core community survey enabling exoplanet microlensing (precision astrometry)
993	GOODS-N and Euclid Deep South	High Latitude Time Domain Survey (HLTDS) core community survey enabling cosmology (supernovae 1a)

### 1.1 PSS Requirement SOC-228: WFI Observation Parameter Selection

*The PSS shall enable observers to select science instrument parameters for WFI observations.*

All of the sample programs, with the exception of the internal calibration program (PID 901), involve the selection of several science instrument parameters, including target and pointing definitions, filter selection, exposure parameters, and special requirements. Although program 903 is also a calibration program, it utilizes an external target and has commonality with science observations.

### 1.2 PSS Requirement SOC-229: WFI Observation Absolute Constraint Specification

*The PSS shall enable observers to specify absolute constraints on WFI observations.*

All of the sample programs, with the exception of PID 911, exercise absolute timing or orient constraints. The calibration programs 901 and 903 use timing constraints to monitor dark current and flat fields on weekly and monthly cadences, respectively. Small and medium science programs typically have preferred orientations tailored to specific targets. Time domain programs include timing constraints to return to targets over defined intervals. Program 911 is kept very simple as an uncomplicated “test particle”, with no constraints selected.

### 1.3 PSS Requirement SOC-231: WFI Calibration Observation Creation

*The PSS shall enable the creation of WFI calibration observations.*

Program 901 is a sample calibration program for conducting weekly dark current monitoring, and monthly flat field monitoring for one year. Program 903 is a sample calibration program for monitoring geometric distortion over 5 years.

### 1.4 PSS Requirement SOC-234: WFI High Latitude Survey Observation Creation

*The PSS shall enable creation of observations for the WFI High Latitude Survey.*

Program 991 represents one possible instantiation of a High Latitude Wide Area Survey (HLWAS, was known as HLS), which is one of the Core Community Surveys. It is based on the Design Reference Mission (DRM, Akeson, 2019), plus reports and presentations by the Science Investigation Teams in recent years. It is worth noting that the actual HLWAS design will be defined through a community process over the coming years before launch. The HLWAS is the largest of the Core Community Surveys, which is described by a nearly 2000 square degree region target. In addition to typical science parameter selections in the Pass Plans, the Region Planner tool is used to define a simplistic region (polygon on the sky), which is then filled by replicating user-defined segments, and the result is

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an array of target coordinates for each segment of the survey. Both imaging and spectroscopic components are included, as well as spectroscopic deep fields.

### **1.5 PSS Requirement SOC-501: GO and DD WFI Observation Creation**

*The PSS shall enable creation of observations for WFI GO and DD proposals/programs.*

Programs 912, 913, 933, 939, 941, and 951 are all implementations of possible General Observer (GO) and/or Director's Discretionary (DD) programs. They constitute a representative sample of the proposals we expect to be submitted by the community in response to Call for Proposals, peer-reviewed by a Time Allocation Committee (or Telescope Time Review Board), and allocated observing time. It is anticipated that the community will propose a range of small, medium, and large proposals in terms of the resource usage (hours), so the sample reflects this size range. Although harder to predict than the Core Community Surveys at this point, they are based on presentations, white papers, and publications by the astronomical community in recent years (for an in-depth description see Mutchler, 2022).

### **1.6 PSS Requirement SOC-520: Target Specification Reference Frame**

*The PSS shall accept target coordinates in the International Celestial Reference System (ICRS).*

All of the sample programs, except the internal calibration program 901, include external target specifications.

### **1.7 PSS Requirement SOC-608: WFI Microlensing Survey Observation Creation**

*The PSS shall enable creation of observations for the WFI Microlensing Survey.*

Program 992 represents one possible instantiation of a Galactic Bulge Time Domain Survey (GBTDS, was known as EML for Exoplanet Microlensing), which is one of the Core Community Surveys. It is based on the Design Reference Mission (DRM, Akeson, 2019) and reports and presentations by the Science Investigation Teams in recent years, but the final GBTDS design is expected to be defined through a community process over the coming years. In addition to typical science parameter selections in the Pass Plans, the Mosaic Planner is used to define the L-shaped mosaic, with 7 tiles, for the survey. This program also includes strict timing and orientation constraints during observing "seasons" where it will be the only Roman program executing for long periods of time.

### **1.8 PSS Requirement SOC-609: WFI Supernova Survey Observation Creation**

*The PSS shall enable creation of observations for the WFI Supernova Survey.*

Program 993 represents one possible instantiation of a High Latitude Time Domain Survey (HLTDS, was known as SNS for Supernova Survey), which is one of the Core Community Surveys. It is based on the Design Reference Mission (DRM, Akeson, 2019) and reports and presentations by the Science Investigation Teams in recent years, but the final HLTDS design is expected to be defined through a community process over the coming years. This program includes strict timing and orientation constraints over several years, with hundreds of observations repeated on a 5-day cadence. Program 993 contains Pass Plans for both the wide and deep surveys, in both the North and South. However, the current Survey Plan only includes a small representative example of the 5-day timings over one month, to validate this capability. These timings will be fully fleshed out in a future version.

## Results and Conclusions

A summary matrix of PSS requirements and the sample APT programs (by ID) that validate them is provided below in Table 4. Most requirements are validated multiple times for different science cases.

**Table 4: Matrix of SOC requirements and their testing within sample APT programs (by ID).**

ID / Req	SOC-228	SOC-229	SOC-231	SOC-234	SOC-501	SOC-520	SOC-608	SOC-609
901		X	X					
903	X	X	X			X		
911	X					X		
912	X	X			X	X		
913	X	X			X	X		
933	X	X			X	X		
939	X	X			X	X		
941	X	X			X	X		
951	X	X			X	X		
991	X	X		X		X		
992	X	X				X	X	
993	X	X				X		X
Pass/Fail	Pass	Pass	Pass	Pass	Pass	Pass	Pass	Pass

The following Discrepancy Reports were filed in Jira as a result of this testing, but they did not prevent the science validation of the requirements covered in this report:

- <https://jira.stsci.edu/browse/RSOCDR-54> (Mosaic tool tile labelling)
- <https://jira.stsci.edu/browse/RSOCDR-56> (Mosaic tool skew parameter)
- <https://jira.stsci.edu/browse/RSOCDR-57> (Visit Planner default timeline)
- <https://jira.stsci.edu/browse/RSOCDR-58> (Region Planner tool usability)

## References

Akeson, R., et al., 2019, *The Wide Field Infrared Survey Telescope: 100 Hubbles for the 2020s*, <https://arxiv.org/abs/1902.05569>

Desjardins, T., et al., 2023, Technical Report Roman-STSci-000456, *Roman SOC Science Validation for SOC Build 1 DMS*

Mutchler, M., et al., 2023, Technical Memo Roman-STSci-000479, *Roman APT sample science programs for ground system testing*

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## Appendix: Accessing Roman APT and sample science programs

Roman APT features can currently be accessed only by launching the latest APT from a command-line (APT 2022.4 was used for this testing):

- Download and install the latest version of APT (from [apt.stsci.edu](http://apt.stsci.edu))
- In a terminal, go to the APT bin directory and type the following command to activate Roman features:
  - `cd /Applications/APT_2022.4/bin`
  - `./apt -P feature.roman=true`
- The sample programs can be downloaded from a Box folder, and they are also staged on Central Store as PSS validation artifacts. Sometime in early 2023 they will be submitted and can then be opened from within Roman APT:
  - Box folder: <https://stsci.box.com/s/3zw2nmnfrjyib8mjn6nqopxv4jl1yswdk>
  - Central Store: `/grp/roman/SCIENCE_VALIDATION/RELEASE_1/PSS`
  - APT File menu: Retrieve from STSci using ID number
- The APT files for the sample Roman science programs have been submitted along with this report. Each program title includes a “test program” suffix to make it immediately clear that these are not real programs. They have filenames which include the program ID and a descriptive keyword:
  - `roman_901_darkflat.appt`
  - `roman_903_distortion.appt`
  - `roman_911_perseus.appt`
  - `roman_912_m8182.appt`
  - `roman_913_globulars.appt`
  - `roman_933_m33.appt`
  - `roman_939_oort.appt`
  - `roman_941_galaxies.appt`
  - `roman_951_deepfields.appt`
  - `roman_991_hlwas.appt`
  - `roman_992_gbtlds.appt`
  - `roman_993_hltds.appt`
- For help, see the Roman APT User’s Guide (RAUG), and/or contact the Help Desk:
  - <https://roman-docs.stsci.edu/raug>
  - [help@stsci.edu](mailto:help@stsci.edu)

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