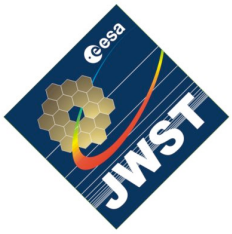
estec

European Space Research
and Technology Centre
Keplerlaan 1
2201 AZ Noordwijk
The Netherlands
Tel. (31) 71 5656565
Fax (31) 71 5656040
www.esa.int



NIRSpec Performance Report
NPR-2013-003 / ESA-JWST-RP-19655

Authors: T. Böker

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Duration of the NIRSpec Commissioning Activities

Abstract:

Motivated by the need to demonstrate that NIRSpec meets its allocated time for in-orbit commissioning, this report summarizes the status of the NIRSpec in-orbit commissioning plans, with special emphasis on the duration of the various activities required to ready NIRSpec for general science use. We conclude that NIRSpec meets the relevant requirement with ample margin.

1 INTRODUCTION AND SCOPE

This document serves to demonstrate that, following the launch of JWST, the NIRSpec instrument can be commissioned for general science use within the allocated time. The relevant requirements in the NIRSpec Functional Requirements Document (RD1) is:

NSFR-20 *NIRSpec shall complete its commissioning activities within 90 days of reaching operating temperature using no more than 25% of the available observatory time.*

Given that a final Commissioning Plan and timeline is not available at this time, we use the latest version of the commissioning planning as documented on the website of the STScI Commissioning and Calibration Working Group as the basis for this document.

1.1 Reference Documents

Table 1-1 List of reference documents

ID	Title	Document #
RD 1	NIRSpec Functional Requirements Document	JWST-RQMT-002060
RD 2	NIRSpec Operations Concept Document	ESA-JWST-TN-0297
RD 3	JWST Observatory Commissioning Plan	JWST-PLAN-002040

2 NIRSPEC COMMISSIONING ACTIVITIES

The sequence of activities required for the post-launch checkout, verification, and initial calibration of the JWST observatory and its science instruments are defined in the JWST Observatory Commissioning Plan (RD 3). A more detailed description of the individual activities can be found in the individual Commissioning Activity Requests (CARs). For convenience, Appendix A contains the full set of all CAR description sheets currently anticipated in order to enable NIRSpec operations and use by the general science observer. These description sheets contain the motivation for, and design of, all NIRSpec commissioning activities.

Table 2-1 lists the title and estimated duration of all NIRSpec CARs. Note that we have rounded up the listed time estimates to a full quarter hour in all cases, and that we have assumed a minimum duration of 30 min for all CARs involving external observations because they will require a target acquisition procedure which alone takes about 10 min. The CARs are color-coded according to the type of activity: NIRSpec engineering, NIRSpec science, and observatory-related.

Table 2-1 List of NIRSpec Commissioning Activity Requests (CARs). The color-coding denotes ownership of the CARs as follows: NIRSpec engineering, NIRSpec performance verification and calibration, observatory verification and calibration

CAR #	Title	Comment	Est. Duration
NIRSpec-002	NIRSpec MSS launch lock release		1 hr
NIRSpec-003	NIRSpec FPA tuning verification	after NIRSpec-004	8 hrs
NIRSpec-004	NIRSpec SCA checkout		0.25 hrs
NIRSpec-005	FWA characterization	run before **and** after NIRSpec-006	2 x 1 hr
NIRSpec-006	FWA Run-in		2.5 hrs
NIRSpec-007	GWA characterization	run before **and** after NIRSpec-008	2 x 1 hr
NIRSpec-008	GWA run-in		2.5 hrs
NIRSpec-009	RMA checkout		0.5 hrs
NIRSpec-010	RMA characterization	after NIRSpec-009	0.25 hrs
NIRSpec-011	NIRSpec FPA thermal stability		1.5 hrs
NIRSpec-012	NIRSpec CAA checkout		0.25 hrs
NIRSpec-013	NIRSpec CAA lamp brightness	after NIRSpec-004, -005, -007, and -012	6 hrs
NIRSpec-014	NIRSpec MSA shorts detection	after NIRSpec-002	24 hrs
NIRSpec-015	NIRSpec MSA shutter failure and contrast characterization	after NIRSpec-013	0.5 hrs
NIRSpec-016	NIRSpec target acquisition verification	after NIRSpec-018, -019, and -020	0.5 hrs
NIRSpec-017	NIRSpec bright object peakup target acquisition verification	after NIRSpec-016	1.5 hrs
NIRSpec-018	NIRSpec focus determination	after NIRSpec-009 and -015	1.25 hrs
NIRSpec-019	NIRSpec astrometric calibration	after NIRSpec-018	0.5 hrs
NIRSpec-020	FGS-NIRSpec alignment	after NIRSpec-018 and -019	0.5 hrs
NIRSpec-021	NIRSpec Darks	after NIRSpec-004	83 hrs (pure parallel)
NIRSpec-022	NIRSpec MSA internal spectral flatfield and wavelength calibration	after NIRSpec-012	27 hrs
NIRSpec-023	NIRSpec IFU internal spectral flatfield and wavelength calibration	after NIRSpec-012	3 hrs
NIRSpec-024	NIRSpec MSA sky flats	after NIRSpec-005-008, 013-016, -028, and -029	0.5 hrs
NIRSpec-025	NIRSpec ghosts, glints, and scattered light check	after NIRSpec-020	6.5 hrs
NIRSpec-026	NIRSpec MSA external wavelength calibration	after NIRSpec-016	4.5 hrs
NIRSpec-027	NIRSpec IFU external wavelength calibration	after NIRSpec-016	1.25 hrs
NIRSpec-028	FWA checkout	after NIRSpec-005 and -006	1 hr
NIRSpec-029	GWA checkout	after NIRSpec-007 and -008	1 hr
NIRSpec-030	NIRSpec line spread function characterization	after NIRSpec-016	13 hrs
NIRSpec-031	NIRSpec spectrophotometric sensitivity and absolute flux calibration	after NIRSpec-016	23 hrs
NIRSpec-032	NIRSpec MSA relative spectrophotometric sensitivity and flux calibration	after NIRSpec-016	6 hrs
NIRSpec-033	NIRSpec IFU spectrophotometric sensitivity and absolute flux calibration	after NIRSpec-016	1.25 hrs

total duration: 143.5 hrs

3 CONCLUSION

As can be seen from Table 2-1, the total duration of all currently planned NIRSpec commissioning activities sums up to about 6 days. This excludes the planned sequence of dark exposures, which can be obtained in parallel mode, and therefore are not taxing the JWST commissioning timeline. Even when including the dark exposures, the total duration (9.5 days) is well within the NIRSpec allocation of 22.5 days.

It should be noted that the commissioning planning for NIRSpec (and for JWST in general) is not yet finalized. On the other hand, the list of NIRSpec activities is already reasonably complete. Nevertheless, should upcoming revisions of the JWST commissioning plan result in additional NIRSpec activities, there is ample margin (in excess of 100%) to accommodate these without exceeding the available time.

We conclude that requirement NSFR-020 is met with sufficient margin to accommodate future revisions of the commissioning plan.

APPENDIX A COMMISSIONING ACTIVITY REQUEST DESCRIPTION SHEETS

The following pages provide a more detailed description of the NIRSpec CARs envisaged so far. They will be revised as the commissioning planning and timeline evolves, and are provided here for convenience and information only.

ACTIVITY TITLE: NIRSpec MSS launch lock release

ID: NIRSpec-002

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.3, NS.1.5

DESCRIPTION: The Micro Shutter Assembly magnet arm launch lock must be opened after launch by ground control under real time monitoring. Following MCE power on, commands will be sent to the MCE to select and set the current level for the launch lock motor. Then, a command from the MSFSW will be sent to the MCE to open the launch lock. The FSW will wait a time *TBD* for the launch lock closed limit switch to indicate NOT CLOSED and the open limit switch to indicate OPEN. The MCE should then be powered down.

ACTIVITY EXECUTION METHOD: Ground Command.

PRE-REQUISITES AND DEPENDENCIES: Must be done *after* completion of all shock-inducing events related to spacecraft deployment, and before all other activities involving the MSS.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? Yes

DURATION: ~1 minute for the launch lock sequence, *TBD* for the total MSA start up time.

DATA REQUIREMENTS: No data volume required, only telemetry.

ANALYSIS & EXPECTED RESULTS: The launch lock closed limit switch must indicate NOT CLOSED and the open limit switch must indicate OPEN for a successful unlocking. Success should be indicated by nominal script execution.

COMMENTS:

ACTIVITY TITLE: NIRSpec FPA tuning verification

ID: NIRSpec-003

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.4

DESCRIPTION: This activity will verify the tuning of the NIRSpec FPAs. The details of the procedure are *TBC* once the FM tests have been completed, but it is likely to include verification of the noise, dynamic range, linearity, and gain.

ACTIVITY EXECUTION METHOD: OPE commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the normal science operating range (T=36-40 K). NIRSpec-004 (SCA checkout) must have successfully executed.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: *TBD*

DATA REQUIREMENTS: *TBD*

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS:

ACTIVITY TITLE: NIRSpec SCA checkout

ID: NIRSpec-004

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.7.1, NS.1.7.2, NS.1.7.3

DESCRIPTION: This activity will verify SCA functionality and MULTIACCUM readout for both full-frame and subarray modes. One dark exposure with NGROUP=1 will be taken for each of the following settings: NRSRAPID and NRS readout modes with full-frame readout, NRSRAPID with subarray "ALLSLITS" and one of the 2048x64 subarrays such as "S200A1".

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: Science operating temperature (T=37 K) must have been reached. Must be completed before any other activity involving data from the SCA.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 1*10.6 seconds for the NRSRAPID full-frame exposure, 1*5.3 seconds for the NRSRAPID "ALLSLITS" subarray exposure, 1*1.3 seconds for the NIRSRAPID 2048x64 subarray exposure, and 1*42.4 seconds for the NRS full-frame exposure, plus *TBD* exposure and mechanism overhead, for a total of 60 seconds.

DATA REQUIREMENTS: 16.8 MB/frame for each of the full-frame exposures, 2.1 MB/frame for the ALLSLITS subarray exposure, and 0.5 MB/frame for the 64x2048 subarray exposure, for a total of 36.2 MB.

ANALYSIS & EXPECTED RESULTS: All images will be examined to ensure they are of the proper size and contain the correct header keyword values for NFRAMES, NGROUPS, NROWS, NCOLS, ROWCORNER, COLCORNER.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? Yes

COMMENTS: This assumes that the generic subarray readout functionality can be fully verified with a small subset of all possible subarray configurations. A more specific test of the correct positioning of all fixed slit subarrays may need to be done later using internal lamp illumination. The NRSSLOW readout pattern is expected to be disallowed, so it is not included here.

ACTIVITY TITLE: FWA characterization

ID: NIRSpec-005

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.9

DESCRIPTION: The purpose of this activity is to verify basic functionality of the FWA by using the characterization script. The procedure collects data on the filter wheel at each commanded position and provides a dump for inspection on the ground. The FWA starts in the launch position (OPAQUE). The FSW sends a series of mechanism move commands to step the FWA one position at a time through all 8 filter wheel positions in both the FORWARD and REVERSE directions. At each position, the HCBuffer is armed before a move and then dumped after the move.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: ICE On, FWA in the launch (OPAQUE) position. Must be performed once before and after NIRSpec-006, FWA run-in. Should be close to nominal operating temperature, 37.5 K (*TBC*), and well below the maximum value of the FWA operational range (*TBC*).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: A move of a single step takes about 14 seconds. Each HCBuffer dump takes about 163 seconds. Thus, the total duration is 8*2*(14+163) = 47.2 minutes.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: The FWA position telemetry will be monitored to ensure correct filter move sequence. Success should be indicated by nominal script execution.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS:

ACTIVITY TITLE: FWA run-in

ID: NIRSpec-006

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.10

DESCRIPTION: The NIRSpec Filter Wheel Assembly must undergo initial run-in cycling to ensure even distribution of lubricant after launch. The FWA starts in the launch position (OPAQUE). The FSW sends a series of mechanism move commands to step the FWA in a sequence to be repeated 49 times in both the FORWARD and REVERSE directions: perform a move of 3 positions forward/reverse, a second move 3 positions forward/reverse in the same direction, and then a third move 2 positions forward/reverse in the same direction (thus returning to the OPAQUE position). A total of 98 (49 clockwise and 49 counterclockwise) revolutions of the wheel will be made.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: ICE On, FWA in the launch (OPAQUE) position, FWA checkout successfully executed. Should be close to nominal operating temperature, 37.5 K (*TBC*), and well below the maximum value of the FWA operational range (*TBC*).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: A move of a single step takes about 14 seconds, 2 steps 24 seconds, 3 steps 34 seconds. Taking into account the 49 cycles in both directions and the stepping sequence, the total duration is then 2*49*(2*34sec + 24sec) = 150 minutes.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: The FWA position telemetry will be monitored by the ICSW to ensure correct filter move sequence. Success should be indicated by nominal script execution.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: The duration estimate includes the command execution time only. Additional wait times to prevent excessive warm-up of the wheels will probably need to be included, with values *TBD*. Early ground tests suggest that a different combination of sequential moves may also be necessary to avoid excessive heating; a finalized sequence awaits further testing.

ACTIVITY TITLE: GWA characterization

ID: NIRSpec-007

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.11

DESCRIPTION: The purpose of this activity is to establish a data basis for initial in-orbit grating wheel characteristics to support later anomaly analysis and troubleshooting. The procedure collects data on the grating wheel voltages, currents, temperature, and position for each movement and provides a dump for record and inspection on the ground. The GWA starts in the launch position (PRISM). The FSW sends a series of mechanism move commands to step the GWA one position at a time. The GWA will be commanded through all 8 grating wheel positions in both the FORWARD and REVERSE directions. At each position, the HCBuffer is armed before a move and then dumped after the move. The GWA tilt is also acquired after each step.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: ICE On, GWA in the launch (PRISM) position. Must be performed once before and after NIRSpec-008, GWA run-in. Should be close to nominal operating temperature, 37.5 K (*TBC*), and well below the maximum value of the GWA operational range (*TBC*).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: A move of a single step takes about 14 seconds. Each HCBuffer dump takes about 163 seconds, and acquisition of the GWA tilt takes about 29 seconds. Thus, the total duration is 8*2*(14+163+29) = 55 minutes.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: The GWA position telemetry will be monitored by the ICSW to ensure correct filter move sequence. Success should be indicated by nominal script execution.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS:

ACTIVITY TITLE: GWA run-in

ID: NIRSpec-008

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.12

DESCRIPTION: The NIRSpec Grating Wheel Assembly must undergo initial run-in cycling to ensure even distribution of lubricant after launch. The GWA starts in the launch position (PRISM). The FSW sends a series of mechanism move commands to step the GWA in a sequence to be repeated 49 times in both the FORWARD and REVERSE directions: perform a move of 3 positions forward/reverse, a second move 3 positions forward/reverse in the same direction, and then a third move 2 positions forward/reverse in the same direction (thus returning to the PRISM position). A total of 98 (49 clockwise and 49 counterclockwise) revolutions of the wheel will be made.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: ICE On, GWA in the launch (PRISM) position, GWA checkout successfully executed. Should be close to nominal operating temperature, 37.5 K (*TBC*), and well below the maximum value of the GWA operational range (42 K, *TBC*).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: A move of a single step takes about 14 seconds, 2 steps 24 seconds, 3 steps 34 seconds. Taking into account the 49 cycles in both directions and the stepping sequence, the total duration is then 2*49*(2*34sec + 24sec) = 150 minutes.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: The GWA position telemetry will be monitored by the ICSW to ensure correct filter move sequence. Success should be indicated by nominal script execution.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: The duration estimate includes the command execution time only. Additional wait times to prevent excessive warm-up of the wheels will probably need to be included, with values *TBD*. Early ground tests suggest that a different combination of sequential moves may also be necessary to avoid excessive heating; a finalized sequence awaits further testing.

ACTIVITY TITLE: RMA checkout

ID: NIRSpec-009

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.13

DESCRIPTION: This activity serves as an initial verification of the basic functionality of the NIRSpec Refocus Mechanism Assembly. The RMA starts in the launch position. First, a manual telemetry request is sent in order to check the TM acquisition chain. The Hall position sensor voltage must be checked to verify that it is in the expected range for the launch position. Then, the ICSW is commanded to move the RMA FORWARD 360 steps, with the HC buffer activated in order to get a first reference data set. Once the movement is complete and the buffer has been dumped, a manual telemetry request is made to confirm the position sensor signal. Next, the RMA is commanded to move FORWARD 10140 steps to a position just behind the MID position; a second command is sent to move it REVERSE to the MID position (this is done because testing has shown that moves are more repeatable in the REVERSE direction). Another manual telemetry request must be made to verify that the user increment counter is in the expected range (9200 +/- 100 steps; *TBC*), and then the counter should be reset.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: RMA temperature must be below the operational limit of 42 K *(TBC)*. ICE On, RMA in the launch position. Must precede the RMA characterization (NIRSpec-010).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? Yes

DURATION: 11800 steps / 60 steps/second RMA movement duration + 163 seconds HC buffer download = 26 minutes.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: The RMA position telemetry will be monitored from the ground. Each movement must be manually confirmed before the next one is commanded.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: Duration estimate does not include any delays in telemetry monitoring and response, which is likely to be longer than the actual mechanism movement and HBC dump.

ACTIVITY TITLE: RMA characterization

ID: NIRSpec-010

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.13

DESCRIPTION: This activity provides a more detailed test of the on-orbit RMA performance. There are two steps: motorization margin, which verifies the minimum operable drive current, and step loss characterization, which verifies that step losses are in an acceptable range. The RMA starts in the MID position. For step 1, the drive current is configured to 55 mA (*TBC*), and the RMA is then commanded to move with the following intervals: 360 steps FORWARD, 3000 steps FORWARD, 3000 steps REVERSE, 360 steps REVERSE. After each movement, the Hall position sensor and the increment counter are recorded and checked against the expected values. If the proper values are not obtained (e.g., the drive current was too low to provide proper movement of the mechanism), the drive current will be increased by 5 mA (*TBC*) and the run repeated. For step 2, the drive current is configured to the nominal operational value of 122 mA. The RMA is commanded to move to the MID position, followed by a REVERSE move of 230 steps, and the position sensor is recorded. A series of back-and-forth move commands are then sent in order to test for step losses: FORWARD and REVERSE 200 steps, FORWARD 20 steps and REVERSE 200 steps (repeated 10 times), and REVERSE 20 steps and FORWARD 200 steps (repeated 10 times). After each set of FORWARD and REVERSE movements, the position sensor value is compared to the value before the movement to verify that any step losses are in the acceptable range (< 1 mV, or about 5 steps; *TBC*).

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: RMA temperature must be below the operational limit of 42 K *(TBC)*. The RMA checkout (NIRSpec-009) must have successfully completed. Must precede the focus determination activity (NIRSpec-018).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? Yes

DURATION: 9780 steps / 60 steps/second RMA movement duration = 3 minutes.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: The RMA position and counter telemetry will be monitored from the ground and compared with expected values. Each movement must be manually confirmed before the next one is commanded.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: Duration estimate does account for any delays in telemetry monitoring and response, which are likely to be longer than the actual mechanism movement.

ACTIVITY TITLE: NIRSpec FPA thermal stability

ID: NIRSpec-011

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.6

DESCRIPTION: This activity will verify that the NIRSpec FPA temperature control is within the required limits (+/- 20 mK over a 1008s exposure). Dark exposures will be taken in NRS mode with total integration times of 1072 seconds, and 4 integrations per exposure for more robust statistics.

ACTIVITY EXECUTION METHOD: OPE commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). NIRSpec-004 (NIRSpec SCA checkout) must have successfully executed. Must be done before NIRSpec-021 (NIRSpec darks).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: (25+1 groups * 42.9 seconds/group + 1 minute readout overhead) * 4 integrations = 80 minutes

DATA REQUIREMENTS: 16.8 MB/group * 25 groups/integration * 4 integrations/exposure = 1.7 GB

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. The FPA temperature will be monitored from the telemetry stream to measure its variation over each exposure. The dark exposures will also be analyzed in order to check for any anomalous signal.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? Yes

COMMENTS:

ACTIVITY TITLE: NIRSpec CAA checkout

ID: NIRSpec-012

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.15

DESCRIPTION: This activity serves as an initial verification of the basic functionality of the NIRSpec Calibration Assembly (CAA). The ICSW will be commanded to switch on each of the CAA lamps in turn. The telemetry will be monitored to verify that the voltage and current of each lamp is nominal.

ACTIVITY EXECUTION METHOD: Ground command

PRE-REQUISITES AND DEPENDENCIES: CAA temperature must be below the operational limit of *TBD* K. Must precede any other activity that includes operation of the CAA.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No?

DURATION: 5 minutes CAA turn-on time + 0.3 minutes * 11 lamp on/off time +1.5 minutes instrument off time = 10 minutes.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: The CAA telemetry will be monitored from the ground to ensure nominal lamp current and voltages.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS:

ACTIVITY TITLE: NIRSpec CAA lamp brightness

ID: NIRSpec-013

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.7.1

DESCRIPTION: This activity will obtain test exposures with each of the CAA lamps to measure their brightness levels. FILTER set to OPAQUE. Data will be taken with the appropriate CAA continuum or line source and grating position (FLAT1/FLAT4/LINE1/SRS with G140M/H, FLAT2/LINE2 with G235M/H, FLAT3/LINE3 with G395M/H, FLAT5/LINE4 with PRISM), using the IFU and two MSA long slit configurations sampling different positions in the FOV. The TEST lamp will also be observed in IMAGE mode. For all of the dispersive elements, lamps, and apertures, a total of 55 exposures will be taken. The calibrations for each aperture should follow this sequence in order to minimize mechanism movement: select the aperture (IFU, MSA long slit, or MSA ALL OPEN), select a grating, cycle through all of the corresponding continuum and line lamps, move to the next grating and cycle through all corresponding lamps, and repeat until all dispersive elements have been used for each of the three apertures. NRSRAPID readout with exposure times of about 40 seconds will be used for all exposures.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). GWA and FWA characterization (NIRSPEC-005 and 007), CAA checkout (NIRSPEC-012), and SCA checkout (NIRSPEC-004) must have been completed. Must be done before any other activities involving use of the CAA.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 1 minute MSA configuration time * 3 configurations + 14s * 22 grating wheel movement time + 5 minutes * 55 CAA turn-on time + 0.3 minutes * 55 lamp on/off time + 1.5 minutes instrument off time + 42 s exposure time * 55 exposures = 5.7 hours total duration.

DATA REQUIREMENTS: 16.8 MB/group * 3 groups/exposure * 55 exposures = 2.8 GB

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. The brightness of each lamp will be characterized for each spectroscopic configuration and aperture by measuring the detected flux and comparing with ground data.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: These measurements are crucial to determining optimal exposure times for all subsequent observations involving CAA lamp exposures. Thus, a minimum of 48 hours needs to be included in the timeline between this activity and the next scheduled activity that uses the CAA for analysis of this data and any editing of subsequent exposure parameters.

ACTIVITY TITLE: NIRSpec MSA shorts detection

ID: NIRSpec-014

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.17

DESCRIPTION: The MSA shorts detection engineering script will be run to identify shorted pairs of adjacent shutter rows or columns, or shorts between rows and columns. The existing zero-potential and tri-state masks are used to avoid rediscovering previously known and masked shorts. In order of execution for each MSA quadrant: 365 side 0V short detection and masking, 171 side 0V short detection and masking, 365 side tri-state short detection, 171 side tri-state short detection. If less than 10 *(TBC)* new shorts are found, the script updates the mask file and sends it to the ground. If more than 10 *(TBC)* new shorts are found, the script will exit by safing the instrument (note that very few if any new shorts are expected through the lifetime of the mission). Tri-state shorts are identified but are not automatically masked; an assessment will be made on the ground whether they draw an unsafe amount of current.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: Must be done after MSS launch lock release. It is preferable, but not required, to be close to operating temperature (T=36-40 K).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: About 2 hours *(TBC)*.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: Success will be indicated by successful execution of the script.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? Yes

COMMENTS: This is not a high-priority activity. The script will be run during normal operations only if telemetry trending indicates elevated current that may be a result of new shorts. The activity should be done as a parallel; if that is not possible and there are scheduling constraints, it can be skipped with no consequence to instrument health or commissioning goals.

ACTIVITY TITLE: NIRSpec MSA shutter failure and contrast characterization

ID: NIRSpec-015

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.16, NS.1.17, NS.1.18

DESCRIPTION: Deep exposures with the CAA "TEST" internal lamp will be taken with the MSA configured to ALL CLOSED to determine the number and location of failed open shutters and measure the contrast ratio for all shutters. Exposure times must be long enough to enable characterization of contrasts as high as 10^4. Shallow exposures with the same lamp will be taken with the MSA configured to ALL OPEN to determine the number and location of failed closed shutters, as well as to provide reference images for the contrast measurements.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). CAA lamp brightness (NIRSPEC-013) must have successfully executed. Must be done before any other activity involving the MSA.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 1 minute exposure time for ALL OPEN configuration + 16 minutes exposure time for ALL CLOSED configuration + 1 minute * 2 MSA configuration time + 5 minutes CAA turn-on time + 0.3 minutes * 2 lamp on/off time + 1.5 minutes instrument off time = 30 minutes total duration.

DATA REQUIREMENTS: 16.8 MB/group * (3 groups * 1 exposure all open + 90 groups * 1 exposure all closed) = 1.6 GB

ANALYSIS & EXPECTED RESULTS: Success will be indicated by successful script execution. The images will be examined to identify all failed closed shutters and failed open shutters (those that do not meet the contrast spec). Contrast values for all shutters will be determined by comparing the deep exposure taken with the MSA all closed to the exposure taken with the MSA all open.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: This activity will provide a baseline for subsequent failed shutter checks to be done periodically throughout the mission in order to monitor the long-term health of the MSA. Note that these data will not provide any constraint on any wavelength dependence of the shutter constrast since the "TEST" lamp is a broad spectrum source (the other lamps are too bright); observations of celestial sources would be needed for that. This activity will also serve as a functional verification of MSA shutter operation.

ACTIVITY TITLE: NIRSpec target acquisition verification

ID: NIRSpec-016

APPLICABLE COMMISSIONING OBJECTIVES: NS.2.1

DESCRIPTION: During this activity we will perform observations to verify the default target acquisition (TA) procedure. The LMC calibration field will be observed in imaging mode (MSA set to ALL OPEN, GRATING=MIRROR, FILTER=110W). A set of 10-20 bright stars will be selected as reference stars to be used during target acquisition. The TA will be accomplished as normally part of a spectroscopic observation; however, we do not need spectroscopic data for this activity. After TA, a total of 4 imaging observations will be taken with a 2x2 dither pattern separated by 0.05" (roughly a quarter of the width of the open area of a shutter), in order to measure the average positional accuracy over the FOV. The TA confirmation image and subsequent dithered images will be compared with the commanded pointing to assess the overall accuracy of the TA procedure. The on-board TA script calculations will be checked using the acquisition images and the internal flat image used for the slit centroiding part of the procedure.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). Best instrument focus must have been determined and set (NIRSPEC-018). Astrometric calibration and FGS-NIRSpec alignment activities (NIRSPEC-019 and 020) must have successfully executed, with updated coordinate transformation tables uploaded to the on-board scripts and incorporated into the PPS in time for the final planning of this activity *(at least one week lead time)*. Must be done before any spectroscopic observations of external sources.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 10 min (*TBR*) TA sequence duration plus the dithered image exposure time 3+1 groups * 1 frame/group * 10.6 seconds/frame * 1 integration/exposure * 4 exposures = 13 minutes.

DATA REQUIREMENTS: 16.8 MB/group * 3 groups/integration * 1 integration/exposure * 4 exposures = 202 MB.

ANALYSIS & EXPECTED RESULTS: Point source positions and fluxes will be measured from the TA confirmation and dithered images and compared to the expected values. Point source positions will be measured in the acquisition images to test the TA script calculations.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS:

ACTIVITY TITLE: NIRSpec bright object peakup target acquisition verification

ID: NIRSpec-017

APPLICABLE COMMISSIONING OBJECTIVES: NS.2.2

DESCRIPTION: During this activity we will perform observations to verify the bright object peakup target acquisition (TA) procedure. A reasonably bright star, but one that will not saturate in a short imaging exposure, will be selected as a target. The procedure includes the following steps. (1) Using a coarse centering process, the target is placed at an offset position behind the MSA mounting plate 2" from the center of the 0.4" fixed slit; a "standard" TA is performed using decreased-accuracy SDSS or 2MASS catalog coordinates for 3-5 (*TBC*) reference stars to place the target within 0.1" of the offset position. (2) A grating (*TBD;* perhaps PRISM) is moved into the beam, and the target is offset to the center of the 0.4" slit. A dispersed peak-up is performed using 7 dither positions across the width of the slit (spacing *TBD*) and short single-frame exposures taken at each scan position in subarray mode. (Note that the exposure times may need to be longer than the default, since the target in this case will not be as bright. This will depend on the actual target brightness and choice of grating.) The on-board script measures the total intensity in the subarray images and calculates the position of maximum flux to a fraction of a scan position. The target is offset to this peak-up location. (3) Another dispersed subarray image is taken in order to measure the centroid position in the cross-dispersion direction and compute a corrective slew; the target is then fully centered in the 0.4" slit. (4) A final slew is made to move the target to the center of the 1.6" square aperture. Once this TA procedure is complete, the grating will be moved to "MIRROR", and a confirmation image of the target will be obtained (using the appropriate subarray) to verify that it is properly centered in the aperture. An imaging flat field should also be obtained immediately following the confirmation image for an accurate measurement of the wide aperture boundaries, to improve the accuracy of the stellar centroid determination. This entire observation should be repeated on a "typical" bright star that will saturate in imaging mode as a final test of the procedure (*TBC,* pending an analysis of the accuracy of measuring the centroid of a strongly saturated PSF).

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). Standard target acquisition verification (NIRSPEC-016) must have successfully executed.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: [15 minutes (coarse target acquisition) + 30 seconds/exposure * 9 exposures (peak-up and imaging) + 20 minutes dither/readout/mechanism movement overhead] * 2 targets = 80 minutes.

DATA REQUIREMENTS: 16.8 MB/group * 3 groups/integration * 1 integration/exposure * 9 exposures = 450 MB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. Point source positions and fluxes will be measured from the confirmation images and compared to the expected values.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: This activity is based on an **unofficial** preliminary procedure for bright star target acquisition, and is subject to change. A final prescription will not be available until sometime in 2011.

ACTIVITY TITLE: NIRSpec focus determination

ID: NIRSpec-018

APPLICABLE COMMISSIONING OBJECTIVES: NS.3.2
DESCRIPTION: The optimal focus position for NIRSpec will be determined. The MSA is first configured to all open, GWA to MIRROR, FWA to F140W (mitigating saturation and providing the best-defined PSF). A focus sweep is performed, in which images of celestial point sources are taken after each RMA movement. The LMC calibration field would be a good target, since it will provide reasonably bright stars over the entire FOV. The RMA is moved to the reference (mid-stroke) position, then moved in the FORWARD direction by 3 mm to the sweep start position. A full-frame exposure in NRSRAPID mode with 4 integrations will be taken. Then, the RMA is moved 300 μm in the REVERSE direction, and another exposure will be taken. These steps are repeated until the RMA position reaches the negative end of the full sweep range, -3 mm, a total of 20 moves (note, the actual move sequence and step sizes are *TBC*; the sequence given here assumes Robert Lemke's proposed alternative, which minimizes mechanism movement and utilizes the RMA preferred direction of REVERSE). Then, the RMA is moved back to the reference position. The RMA position corresponding to best focus will be commanded once data analysis on the focus sweep images has been completed; this is accomplished with a focus adjustment where the RMA is moved from its current position to the position of best focus, with an image of the same celestial field taken before and after the move. A final focus confirmation image will be taken by applying a small offset (measured from the focus sweep images) to place a suitably isolated star into the square fixed slit.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: The RMA checkout (NIRSPEC-009) (and run-in, if necessary), MSA shutter failure and contrast characterization (NIRSPEC-015), and OTE commissioning must have been completed. OA and FPA temperatures must be within the nominal science operating range, T=36-40 K. Must be done before any other activities involving imaging or spectroscopy of celestial sources.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: RMA movement duration (*TBD*) * 20 (sweep) + 2 (adjustment) movements, plus a total exposure time of 3+1 groups * 1 frame/group * 10.6 seconds/frame * 4 integrations/exposure * 23 exposures = 65 minutes. We will need a turn-around wait time of at least 72 hours for data analysis between the focus sweep and subsequent focus adjustment.

DATA REQUIREMENTS: 16.8 MB/group * 3 groups/integration * 4 integrations/exposure * 23 exposures = 4.6 GB.

ANALYSIS & EXPECTED RESULTS: The FWHM and/or encircled energy of point sources will be measured in each exposure. Best focus will be determined as the position where these quantities are optimized across the FOV. This analysis should be repeated on the focus adjustment and final confirmation images to confirm the change.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: We will need to check whether source crowding may be a problem. May need to use a bright star mask (i.e., close MSA shutters at the positions of saturating stars). Note that this crowded field observation is only meant for the very first focus measurement, since the astrometric calibration and aperture alignment will not have been done yet. However, for all subsequent focus measurements, the preferred method is to observe a well-isolated star placed in the square fixed slit.

ACTIVITY TITLE: NIRSpec astrometric calibration

ID: NIRSpec-019

APPLICABLE COMMISSIONING OBJECTIVES: NS.3.3, NS.3.4, NS.4.1, NS.4.4

DESCRIPTION: This activity will confirm the plate scale, orientation, and geometric distortion across both NIRSpec SCAs. The previously selected LMC calibration field will be imaged with the MSA set to all open, GRATING=MIRROR, FILTER=F140W. This same field will be observed by all the other instruments, providing important cross-calibration checks. A 4-point dither pattern with half-shutter offsets (0.1" x 0.22") (*TBC*) in the dispersion and spatial directions will be used to minimize systematic centroiding errors caused by vignetting from the MSA bars, as well as improve PSF sampling at short wavelengths. Short exposures will be necessary to avoid widespread saturation, with multiple integrations to improve S/N of fainter sources. Several thousand sources across the FOV (*TBC*) are expected to be detected with S/N>30 with an exposure time of 130 seconds in NRSRAPID mode; each exposure will be divided into 4 integrations to minimize saturation. The narrow target acquisition filter F140W will be used in order to further minimize saturation; a similar filter will be used in the NIRCam astrometric observations, which will provide further photometric cross-calibration.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). Best instrument focus must have been determined and set (NIRSPEC-018). Must be done before any spectroscopic observations.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 3+1 groups * 1 frame/group * 10.6 seconds/frame * 4 integrations/exposure * 4 exposures = 11 minutes.

DATA REQUIREMENTS: 16.8 MB/group * 3 groups/integration * 4 integrations/exposure * 4 exposures = 806 MB.

ANALYSIS & EXPECTED RESULTS: Stellar positions will be measured and compared with the HST-ACS reference frame coordinates to calculate the distortion solution, plate scale, and orientation of the NIRSpec FOV. The coordinate transformation tables in both the on-board scripts and in the planning tool software must be updated. PSF characterization as a function of position across the FOV should also be possible given the expected number (~2000, *TBC*) of reasonably bright sources in the field. Dithers may allow estimation of MSA bar vignetting as a function of distance from shutter centers. Saturated sources in the field will provide constraints on detector persistence characteristics as the source latents can be measured in each dithered image.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes

IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: Success of this activity is critical for any subsequent MOS observations, since the generation of MSA shutter configurations requires an accurate distortion solution. Target acquisition also requires this information in order to calculate all the necessary coordinate plane transformations between sky and FPA.

ACTIVITY TITLE: FGS-NIRSpec alignment

ID: NIRSpec-020

APPLICABLE COMMISSIONING OBJECTIVES: NS.3.1

DESCRIPTION: The alignment and orientation of the NIRSpec apertures relative to the FGS-Guider will be measured with observations of the LMC calibration field. NIRSpec imaging mode will be used with the MSA set to all open, GRATING=MIRROR, FILTER=F140W. The observations will be positioned such that the calibration field overlaps a portion of both NIRSpec and FGS fields of view. One of the two FGS channels will be dedicated to guiding while the other will simultaneously image the field. A second visit observing the same field is required so that the FGS channels dedicated to guiding and imaging can be switched. A 4-point dither pattern with half-shutter offsets (0.1" x 0.22") (*TBC*) in the dispersion and spatial directions will be used for the NIRSpec observations to minimize systematic centroiding errors caused by vignetting from the MSA bars, as well as improve PSF sampling. Short exposures and the narrow target acquisition filter F140W will be used to avoid widespread saturation.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). Best instrument focus must have been determined and set (NIRSPEC-018). The astrometric calibration (NIRSPEC-019) must have successfully executed. Must be done before any spectroscopic observations of external sources.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 3+1 groups * 1 frame/group * 10.6 seconds/frame * 4 integrations/exposure * 8 exposures = 23 minutes.

DATA REQUIREMENTS: 16.8 MB/group * 3 groups/integration * 4 integrations/exposure * 8 exposures = 1.6 GB.

ANALYSIS & EXPECTED RESULTS: Stellar positions and fluxes will be measured in both the NIRSpec and FGS images. The NIRSpec source positions will be corrected for distortion using the solution determined in the astrometric calibration activity, NIRSpec-0019. The NIRSpec coordinate system will then be mapped into the FGS frame by comparing to the stellar coordinates calibrated from the HST observations.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: Accurate relative astrometry requires completion of data analysis for the NIRSpec astrometric calibration activity, with a distortion solution having been determined.

ACTIVITY TITLE: NIRSpec darks

ID: NIRSpec-021

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.3, NS.4.5, NS.4.6

DESCRIPTION: This activity will provide a set of dark frames for measuring the detector dark current and read noise and constructing a dark calibration reference file. Given the expected low dark current signal, a total exposure time of 10^5 seconds would yield a dark current signal-to-noise per pixel ~30 (*TBC pending FM ground test results*). This is the absolute minimum data set required for a useful dark reference file; even more exposure time would be preferable if scheduling permits. To mitigate negative effects of an uncertain cosmic ray hit rate, individual integrations should be limited to ~3000 seconds. The arrays will be read out in NRSRAPID mode in order to best identify discrete cosmic ray events. The full-array data will also be used to estimate the cosmic ray hit rate and energy flux distribution and identify hot and high-noise pixels for constructing the bad pixel mask.

Similar data, with an appropriate number of multiple integrations to ensure the same total exposure time, must also be taken with a subset of the fixed slit subarrays ("ALLSLITS" 2048x256 and "S200A1" or the equivalent 2048x64) to provide dark reference files for the subarrays.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: Science operating temperature (T=36-40 K) must have been reached. SCA checkout (NIRSPEC-004) must have successfully executed.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: The total exposure time for each set of full-array, ALLSLITS subarray, and 2048x64 subarray exposures should be not less than 10^5 seconds, for a total time of 83 hours (plus *TBD* exposure and mechanism overhead).

DATA REQUIREMENTS: For the minimum required total exposure time, 16.8 MB/frame * 10^5sec / 10.6 sec/frame = 158 GB for the full-array data, 2.1 MB/frame * 10^5 sec / 5.3 sec/frame = 40 GB for the ALLSLITS subarray data, and 0.5 MB/frame * 10^5sec / 1.3 sec/frame = 38 GB for the 2048x64 subarray data, or a grand total of 236 GB.

ANALYSIS & EXPECTED RESULTS: The detector dark current will be determined by measuring the signal slope over the entire exposure. The detector read noise will be calculated by measuring the variance between the individual groups. Cosmic ray hits will be flagged as pixels with transient signal, and their energies estimated from the signal jump between adjacent groups. Hot and noisy pixels will be identified as those that deviate by more than 3 sigma (*TBC*) from the mean signal/rms across the array.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? Yes

COMMENTS: These data can and should be taken in parallel whenever possible. The exposures do not have to be contiguous in time. The ideal situation would be to take darks at *every* opportunity during commissioning once science operating temperature is reached, but this is *TBD* until all the SI parallel data needs and data volume constraints are better understood. The need for 10^5s data for *all* of the subarrays, not just the subset described here, is *TBD*.

ACTIVITY TITLE: NIRSpec MSA internal spectral flatfield and wavelength calibration

ID: NIRSpec-022

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.7.2, NS.4.7.3

DESCRIPTION: This activity will obtain a representative sampling of NIRSpec internal spectral flat field and wavelength calibrations in the MSASPEC operating mode. FILTER set to OPAQUE. Data will be taken with the appropriate CAA continuum or line source and grating position (FLAT1/FLAT4/LINE1/SRS with G140M/H, FLAT2/LINE2 with G235M/H, FLAT3/LINE3 with G395M/H, and FLAT5/LINE4 with PRISM). The MSA will be configured to a long slit pattern of open shutters, and each set of measurements will be repeated at 10 different positions of the long slit across the MSA. Thus, a total of 90 exposures will be taken for each of the sets of spectral flats and wavecals. To minimize mechanism movement, particularly MSA reconfigurations, the following sequence should be followed for each MSA long slit (specific grating order is not important): select a grating, cycle through all of the corresponding continuum and line lamps, move to the next grating and cycle through all corresponding lamps, and repeat until all dispersive elements have been used. The wavelength calibration exposures should be alternated with the flat field exposures since the line source lamps must be turned off for a minimum of 1000 seconds in order to maintain thermal stability. NRS readout with exposure times of roughly 1000 seconds will be used for the spectral flat fields, and NRSRAPID readout with exposure times of about 100 seconds will be used for the wavelength calibrations.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). CAA functionality activity (NIRSPEC-012) must have successfully executed. Must be done before throughput activities.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: (spectral flat field: 22+1 groups * 4 frames/group * 10.6 seconds/frame * 1 integration/exposure * 90 exposures) + (wavecal: 9+1 groups * 1 frame/group * 10.6 seconds/frame * 1 integration/exposure * 90 exposures) = 27 hours.

DATA REQUIREMENTS: (spectral flat field: 16.8 MB/group * 22 groups * 1 integration/exposure * 90 exposures) + (wavecal: 16.8 MB/group * 9 groups * 90 exposures) = 46.9 GB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. The spectral flat field and wavelength solution will be determined for each spectroscopic configuration at each MSA long slit.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: A minimum contiguous observation should be one full set of calibrations for a single MSA long slit, which would last approximately 2.7 hours. Calibrations for all the fixed slits are obtained for free in this activity.

ACTIVITY TITLE: NIRSpec IFU internal spectral flatfield and wavelength calibration

ID: NIRSpec-023

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.7.2, NS.4.7.3

DESCRIPTION: This activity will obtain a full suite of NIRSpec internal spectral flat field and wavelength calibrations in the IFUSPEC operating mode. FILTER set to OPAQUE. Data will be taken with the appropriate CAA continuum or line source and grating position (FLAT1/FLAT4/LINE1/SRS with G140M/H, FLAT2/LINE2 with G235M/H, FLAT3/LINE3 with G395M/H, and FLAT5/LINE4 with PRISM). The MSA is set to ALL CLOSED. One exposure is taken per source/grating combination, for a total of 18 exposures. The preferred sequence, which minimizes mechanism movement, is to select a grating position, cycle through all of the corresponding lamp sources, then move to the next grating position and repeat. The wavelength calibration exposures should be alternated with the flat field exposures since the line source lamps must be turned off for a minimum of 1000 seconds in order to maintain thermal stability. NRS readout with exposure times of roughly 1000 seconds will be used for the spectral flat fields, and NRSRAPID readout with exposure times of about 100 seconds will be used for the wavelength calibrations.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). CAA functionality activity (NIRSPEC-012) must have successfully executed. Must be done before throughput activities.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: (spectral flat field: 22+1 groups * 4 frames/group * 10.6 seconds/frame * 1 integration/exposure * 9 exposures) + (wavecal: 9+1 groups * 1 frame/group * 10.6 seconds/frame * 1 integration/exposure * 9 exposures) = 2.7 hours.

DATA REQUIREMENTS: (spectral flat field: 16.8 MB/group * 22 groups * 1 integration/exposure * 9 exposures) + (wavecal: 16.8 MB/group * 9 groups * 9 exposures) = 4.7 GB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. The spectral flat field and wavelength solution will be determined for each spectroscopic configuration.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS:

ACTIVITY TITLE: NIRSpec MSA sky flats

ID: NIRSpec-024

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.7.2

DESCRIPTION: This activity will obtain a sampling of NIRSpec flat field calibrations using observations of blank sky. A suitable field will be chosen, for example somewhere near the ecliptic plane but out of the galactic plane where the zodiacal background is highest and point source density is low. Images will be taken at each filter and grating combination (F070LP and G140M/H, F100LP and G140M/H, F170LP and G235M/H, F290LP and G395M/H, and CLEAR and PRISM). The MSA will be configured to a long slit pattern of open shutters, and each set of measurements will be repeated at 10 different long slit positions. A total of 90 exposures will be observed in NRS mode (**need estimate of sky brightness at each wavelength regime**).

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). FWA/GWA checkout activities (5-8, 28, 29), MSA characterization activities (13-15), and target acquisition verification (16) must have successfully completed. Must be done before throughput activities.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: xxx groups * 42.4 seconds/group * 18 exposures = 763 seconds, plus TBD exposure and mechanism overhead, for a total of about 13 minutes.

DATA REQUIREMENTS: 16.8 MB/frame * 18 exposures = 302 MB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. The spectral flat field will be determined for each spectroscopic configuration at each MSA long slit.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: A minimum contiguous observation should be one full set of flat fields for a single MSA long slit, which would last approximately xxx hours. Calibrations for all the fixed slits are obtained for free in this activity.

ACTIVITY TITLE: NIRSpec ghosts, glints, and scattered light check

ID: NIRSpec-025

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.2

DESCRIPTION: This activity will enable a limited search for scattered light effects such as ghosts and glints by imaging a very bright source both inside and just outside of the edges of the MSA and S1600A1 fixed slit fields of view. The MSA will be configured to ALL OPEN, GRATING=MIRROR, FILTER=110W. The target star brightness should be below the saturation limit for imaging; it will be measured by placing the star at the center of the S1600A1 slit ("square aperture") and taking a short exposure. Next, the star will be moved near the center of each MSA quadrant, where longer exposures will be taken in order to measure any ghost images. Three dither movements of about half a shutter pitch in each direction will be done in order to mitigate the effects of the MSA bars. Finally, the star will be moved to positions about 1" outside each edge of the square aperture and each MSA quadrant (20 positions total) in order to measure off-axis glints. Assuming a target flux near the saturation limit (~ 0.1 mJy), 300 second exposures should result in S/N ~ 15 of ghosts/glints that are at the required limit of 0.5% of the flux of the target star.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). FGS-NIRSpec alignment (NIRSPEC-020) must have successfully completed.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 329 seconds/exposure * 32 exposures + 211 minutes overhead (assuming a new guide star acquisition after each move > 20", and that target acquisition will not be needed) = 6.5 hours.

DATA REQUIREMENTS: 16.8 MB/group * 30 groups * 32 exposures = 16.1 GB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. The images at each position of the target source will be examined for scattered light. The glint/ghost fluxes will be measured relative to the target brightness, itself measured with the square aperture. Positions will be measured relative to the target position; in the case of the off-axis imaging, the target position will be reconstructed using nearby sources in the field of view.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS:

ACTIVITY TITLE: NIRSpec MSA external wavelength calibration

ID: NIRSpec-026

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.7.3

DESCRIPTION: This activity will obtain observations of a celestial emission line source to verify the wavelength calibration for the MOS and fixed slit spectral modes. A suitable extended gaseous nebula, such as NGC 6543, will be selected as the target. Data will be taken with all filter and grating combinations (F070LP with G140M/H, F100LP with G140M/H, F170LP with G235M/H, F290LP with G395M/H, and CLEAR with PRISM). The MSA will be configured to a long slit pattern of open shutters with length roughly equal to the angular extent of the target. Each observation will be repeated at 6 different positions of the slit across the MSA, for a total of 54 exposures. NRSRAPID readout will be used with exposure times of roughly 100 seconds (depending on the actual brightness of the source emission and its spatial extent).

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). Target acquisition verification (NIRSPEC-016) must have successfully executed.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 4.4 hours

DATA REQUIREMENTS: 16.8 MB/group * 9 groups * 54 exposures = 8.2 GB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. The wavelength solution will be determined for each spectroscopic configuration at each fixed slit and MSA long slit.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: Fixed slit observations obtained for free, depending on the spatial extent of the celestial source. Exposure times estimated to give S/N~100 given typical emission line strengths in planetary nebulae similar to NGC 6543. These are typically much more compact than the MSA FOV, so dithering may be necessary to sample a wide range of positions over the FOV.

ACTIVITY TITLE: NIRSpec IFU external wavelength calibration

ID: NIRSpec-027

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.7.3

DESCRIPTION: This activity will obtain observations of a celestial emission line source to verify the wavelength calibration for the IFU spectral mode. A suitable extended gaseous nebula, such as NGC 6543, will be selected as the target. Data will be taken with all filter and grating combinations (F070LP with G140M/H, F100LP with G140M/H, F170LP with G235M/H, F290LP with G395M/H, and CLEAR with PRISM). The MSA will be set to ALL CLOSED, one exposure per filter/grating combination for a total of 9 exposures. NRSRAPID readout will be used with exposure times of roughly 100 seconds (depending on the actual brightness of the source emission).

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). Target acquisition verification (NIRSPEC-016) must have successfully executed.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 1.1 hours

DATA REQUIREMENTS: 16.8 MB/group * 9 groups * 9 exposures = 1.4 GB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. The wavelength solution will be determined for each spectroscopic configuration for the IFU.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: Exposure times estimated to give S/N~100 given typical NIR emission line strengths in planetary nebulae similar to NGC 6543.

ACTIVITY TITLE: FWA checkout

ID: NIRSpec-0028

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.10

DESCRIPTION: This activity serves as an initial verification of the basic functionality of the NIRSpec Filter Wheel Assembly. The FWA starts in the launch position (OPAQUE). First, a manual telemetry request is sent in order to check the TM acquisition chain. Then, the ICSW will be commanded to perform 8 single step movements forward and 8 single step movements backward, cycling through all positions of the FWA. This activity will be performed with the HC buffer activated, to get a first reference data set before wheel run-in. After each step, the HC buffer will be downloaded.

ACTIVITY EXECUTION METHOD: Ground command

PRE-REQUISITES AND DEPENDENCIES: FWA temperature must be below the operational limit of 42 K *(TBC)*. ICE On, FWA in the launch (OPAQUE) position. Must precede the FWA run-in and characterization activities (NIRSpec-006 and NIRSpec-005).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? Yes

DURATION: Each filter move takes about 14 seconds. The HC buffer download takes 163 seconds per step. Stepping once through each of the 8 filter positions in both forward and reverse directions, the total execution time is (14s + 163s) * 8 filter steps * 2 = 47 minutes.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: The FWA position telemetry will be monitored from the ground to ensure correct filter move sequence. Each movement must be manually confirmed before the next one is commanded.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS:

ACTIVITY TITLE: GWA checkout

ID: NIRSpec-029

APPLICABLE COMMISSIONING OBJECTIVES: NS.1.10

DESCRIPTION: This activity serves as an initial verification of the basic functionality of the NIRSpec Grating Wheel Assembly. The GWA starts in the launch position (PRISM). First, a manual telemetry request is sent in order to check the TM acquisition chain. Then, the ICSW will be commanded to perform 8 single step movements forward and 8 single step movements backward, cycling through all positions of the GWA. This activity will be performed with the HC buffer activated, to get a first reference data set before wheel run-in. After each step, the HC buffer will be downloaded.

ACTIVITY EXECUTION METHOD: Ground command

PRE-REQUISITES AND DEPENDENCIES: GWA temperature must be below the operational limit of 42 K *(TBC)*. ICE On, GWA in the launch (OPAQUE) position. Must precede the GWA run-in and characterization activities (NIRSpec-008 and NIRSpec-007).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? Yes

DURATION: Each filter move takes about 14 seconds. The HC buffer download takes 163 seconds per step. Stepping once through each of the 8 filter positions in both forward and reverse directions, the total execution time is (14s + 163s) * 8 filter steps * 2 = 47 minutes.

DATA REQUIREMENTS: None, only telemetry monitoring.

ANALYSIS & EXPECTED RESULTS: The GWA position telemetry will be monitored from the ground to ensure correct filter move sequence. Each movement must be manually confirmed before the next one is commanded.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? No
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS:

ACTIVITY TITLE: NIRSpec line spread function characterization

ID: NIRSpec-030

APPLICABLE COMMISSIONING OBJECTIVES: NS.3.5

DESCRIPTION: This activity will carry out observations to characterize the NIRSpec line spread function for each aperture and grating. A suitable extended emission-line source with unresolved lines (e.g., a planetary nebula such as NGC 6543) will be selected as the target. For MSASPEC mode, the target will be observed with an MSA slitlet configuration at six non-overlapping positions across the MSA FOV. Exposures will be taken at three dither positions in the spatial direction in order to move the target spectra around the detector, and three dither positions with subpixel shifts in the dispersion direction in order to improve the spectral sampling. Spectra with all of the fixed slits will be obtained for free with the MSASPEC mode observations, provided the target is sufficiently extended. The target will be observed separately with the IFU with three pointings spread across the FOV, using a secondary dither pattern with two 1.5 slitlet offsets to improve spectral sampling. Data will be taken with all filter/grating combinations (F070LP with G140M/H, F100LP with G140M/H, F170LP with G235M/H, F290LP with G395M/H, and CLEAR with PRISM).

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). NIRSpec-016 (target acquisition verification) must have successfully executed.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 106 seconds/exposure * (81 MSA exposures + 81 IFU exposures) + (237 minutes MSA observation overhead + 236 minutes IFU observation overhead) = 13 hours.

DATA REQUIREMENTS: 16.8 MB/group * 9 groups * (81 MSA exposures + 81 IFU exposures) = 24.5 GB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. The line spread function will be determined for each spectroscopic configuration at each fixed slit, MSA slitlet, and IFU pointing.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: Exposure times were estimated to give S/N~100 given typical emission line strengths in planetary nebulae similar to NGC 6543. Observations should be contiguous for each MSA and IFU pointing at each grating/filter setting, but otherwise can be scheduled separately as needed.

ACTIVITY TITLE: NIRSpec spectrophotometric sensitivity and absolute flux calibration

ID: NIRSpec-031

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.7.4

DESCRIPTION: This activity will obtain observations of spectrophotometric standards with the NIRSpec fixed slits and IFU to characterize the spectrophotometric sensitivitiy and determine the absolute flux calibration. A subset of pre-selected stellar standards will be observed depending on scheduling constraints; preferably two stars of different types, for example a white dwarf and a solar-type star, should be observed. Data will be taken with all filter and grating combinations (F070LP with G140M/H, F100LP with G140M/H, F170LP with G235M/H, F290LP with G395M/H, and CLEAR with PRISM). Most of the current list of calibrated standards will saturate in prism mode with the IFU because full frame readout must be used, so for now only the faintest white dwarf standard is planned be observed with the IFU. Each star will be observed through one of the 0.2" fixed slits, the 0.4" slit, and the square aperture with a 3-point dither pattern, and through the IFU with a 3x3 dither pattern. To minimize mechanism movement and overhead, each grating setting should be observed at all apertures and dither positions before moving to the next setting. NRSRAPID readout will be used with exposure times sufficient to reach S/N > 50 per resolution element.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). Target acquisition verification (NIRSPEC-016) must have successfully executed.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: 2.4 hours for a moderately bright G-type standard (K band flux ~ 12 mJy) and 11 hours for the fainter white dwarf (K band flux ~ 0.5 mJy), for all settings for the fixed slits. 9.6 hours for the fainter white dwarf with the IFU (assuming 40% higher sensitivity than the 0.2" slit). Total duration is about 23 hours.

DATA REQUIREMENTS: Total data volume for the two standards at all settings and apertures is 152 GB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. Spectra will be extracted for each spectroscopic configuration for each slit, with dither positions combined, after basic calibration including dark subtraction, flat fielding, and sky subtraction. The extracted spectra for each mode will then be compared to stellar models to determine the spectrophotometric calibration for each slit and the IFU.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: The standard stars do not have to be observed contiguously. The final targets must be vetted to ensure a sufficient number of reference stars in the same field of view. The peak-up method of target acquisition should be used, if it has been implemented.

ACTIVITY TITLE: NIRSpec MSA relative spectrophotometric sensitivity and flux calibration

ID: NIRSpec-032

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.7.4

DESCRIPTION: This activity will obtain observations of a star with the MSA to characterize the relative spectrophotometric sensitivitiy and flux calibration over the MSA field of view. The same star will also be observed with the square aperture fixed slit in order to determine the relative throughput. Data will be taken with the PRISM and R=1000 gratings (F070LP with G140M, F100LP with G140M, F170LP with G235M, F290LP with G395M, and CLEAR with PRISM). The MSA will be configured with one 3-shutter "slitlet" open to the sky, and the target star will be positioned in each of the three shutters in turn for a 3-point "dither". Each observation will be repeated at 2 different positions of the slitlet across each quadrant of the MSA, one near the center and one closer to a corner of each quad. The fixed slit observation will include a 3-point dither in the spatial direction. To minimize mechanism movement and overhead, each grating setting should be observed at all apertures and dither positions before moving to the next setting. NRSRAPID readout will be used with exposure times sufficient to reach S/N > 50 per resolution element.

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K). Target acquisition verification (NIRSPEC-016) must have successfully executed.

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: Assuming a star with K~14, need 43 min per MSA slit and 29 min for the square aperture. Total duration 6 hours.

DATA REQUIREMENTS: Total data volume for all settings is about 8 GB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. Spectra will be extracted for each spectroscopic configuration at each MSA slitlet position and the square fixed slit, with dither positions combined, after basic calibration including dark subtraction, flat fielding, and sky subtraction. The square aperture absolute flux calibration, having been determined from standard star observations in NIRSPEC-031, will be applied to its spectrum. The MSA spectra at each field position will then be compared to the calibrated fixed slit spectrum of the same star to characterize the relative throughput as a function of position.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: The target does not have to be a standard, so scheduling is more flexible. It should be a relatively isolated star to avoid crowded field issues, and no brighter than about 1 mJy to avoid saturation in the MSA observations with the prism. The current scheme assumes that there is no difference in the flux calibration between full frame and subarray readouts. All observations for each grating/filter setting should be contiguous.

ACTIVITY TITLE: NIRSpec IFU spectrophotometric sensitivity and absolute flux calibration

ID: NIRSpec-033

APPLICABLE COMMISSIONING OBJECTIVES: NS.4.7.4

DESCRIPTION: This activity will obtain observations of spectrophotometric standards with the IFU to characterize the spectrophotometric sensitivitiy and determine the absolute flux calibration for the IFU spectral mode. A subset of pre-selected stellar standards will be observed depending on scheduling constraints, preferably the same as those used for the fixed slit flux calibration (NIRSpec-031); at minimum, a faint standard will be observed for prism mode, and a brighter standard for the other modes. Data will be taken with all filter and grating combinations (F070LP with G140M/H, F100LP with G140M/H, F170LP with G235M/H, F290LP with G395M/H, and CLEAR with PRISM). A 3x3 dither pattern will be used to sample a range of positions across the IFU field of view. NRSRAPID readout will be used with exposure times sufficient to reach S/N > 50 per resolution element. **Include internal lamp exposures??**

ACTIVITY EXECUTION METHOD: OPE Commanding

PRE-REQUISITES AND DEPENDENCIES: OA and FPA temperature must be stable and in the nominal science operating range (T=36-40 K).

CRITICAL START WINDOW? No

REAL-TIME CONTACT REQUIRED? No

DURATION: For the faintest standard with the prism:
3+1 groups * 1 frame/group * 10.6 seconds/frame * 1 integration/exposure * 9 exposures = 6.4 minutes.
For the brightest standard with R=1000, 2700:
3+1 groups * 1 frame/group * 10.6 seconds/frame * 1 integration/exposure * 9 exposures (all settings except F290LP with G395H) + 6+1 groups * 1 frame/group * 10.6 seconds/frame * 1 integration/exposure * 9 exposures (F290LP with G395H) = 56 minutes.
Total time for both standards is 63 minutes.

DATA REQUIREMENTS: 16.8 MB/group * (3 groups * 9 exposures * 8 grating/filter settings + 6 groups * 9 exposures * 1 grating/filter setting) = 4.5 GB.

ANALYSIS & EXPECTED RESULTS: Success should be indicated by successful script execution and receipt of the data. Data cubes will be constructed for each spectroscopic configuration at each dither position for each standard star, and compared to stellar models to determine the spectrophotometric calibration for the IFU.

IS YOUR INSTRUMENT DRIVING TELESCOPE POINTING? Yes
IS THIS ACTIVITY PREFERABLY DONE IN PARALLEL? No

COMMENTS: The two standards do not have to be observed contiguously.