KPIC Facility Mode Calibration Procedure

Edit Log		
Name	Date (mm/dd/yyyy)	Comment
Daniel Echeverri	05/29/2024	Initial release (to Keck)
Daniel Echeverri	08/05/2024	Handed over for Facilitization
Daniel Echeverri	12/17/2024	Added flatten_bmc() step and generally freshened up the procedure based on SA feedback.
Greg Doppmann	12/29/2024	Added troubleshooting actions for initial startup
Elijah.AB	2/25/2025	Added the option to use kpic_lightsrc_gui
Daniel Echeverri	4/1/2025	Updated for OCAM2K and NIRSPEC slit fix

(NOTE: When viewed online, figures may land in odd places. Thus, we recommend opening locally)

Overview

This procedure should be performed during the daytime before KPIC on-sky science operations for the Phase I Facility Mode. Its goal is to ensure proper alignment of all KPIC stages and maximal throughput for "direct spectroscopy" observations in K band using the facilitized Phase I mode of the instrument. It is adapted from the procedure developed and used by the KPIC team in the PI mode, with modifications to streamline steps while ensuring reliability and stability.

From a top-level, the procedure strives to:

- Ensure the front-end of the instrument (FIU – fiber injection unit) is aligned and calibrated to optimally inject light into the K band fibers. This is done in Steps 0-III.
- Ensure that the back-end of the instrument (FEU – fiber extraction unit) is aligned and calibrated to optimally send light into the NIRSPEC slit with appropriate sampling on the "SPEC" detector. This is done in Steps IV-VIII.
- Place the system in a stable "standby" mode after cals from which it can be quickly switched to an observing mode shortly before going on-sky. This is done in Step IX.
- Set the spectral order alignment to the tried-and-tested KPIC positions. Then take NIRSPEC backgrounds before going on-sky. This saves time at the end of the night and ensures that we capture all background light from the FEU before moving it out of the beam (where the bundle is not seen by SPEC). This is done in Step X.

The appendices of this document include:

- A1: Lexicon – Useful acronyms and other terms
- A2: Common debugging steps for daycals
- A3: Optional and supplemental procedures
- A4: Schematic Diagrams of KPIC
- A5: Breakdown of related software functions

Syntax Notes:

- `Orange machine font` is for commands to be sent in a normal terminal
- `Purple machine font` is for commands to be sent in the kpython3 instance

Description of Procedure

This section describes each step in the procedure. The descriptions have been moved here to de-clutter the next section so that it just shows the relevant steps to perform. As such, refer back to this section when confused about what a step is trying to achieve.

0. K2AO Bench Setup and nfiuserver Connection:
   Description: This makes sure that the K2AO bench is ready for KPIC-specific daycals. It also opens the relevant code and GUIs for KPIC daycals.

I. Initial Setup:
   Runtime: <5 min
   Description: This checks that all KPIC devices are connected and set to the right position for K-band Facility operations. It then turns on the main calibration light sources, using one of the KPIC MIR lamps plus a bright 2μm laser at the input of K2AO, to get strong signal on our calibration PD. This source setup is used for the front-end (FIU) cals (Steps II-IV).

II. Fiber Finding:
   Runtime: 5 minutes
   Description: This registers the position of the 4 science fibers in the CRED2 pixel coordinates so that we can optimally inject light and bounce between fibers at night. We do this, and the NCPA scans (next step) with the K2AO SHWFS loops closed to ensure the AO system is running the same way it will at night.

III. NCPA Scans:
   Runtime: 10 minutes
   Description: This uses the BMC DM to reduce non-common path aberrations (NCPA) in the system, thereby optimizing light injection into the fibers. We do this by scanning the first few Zernike mode aberrations and maximizing the signal on our calibration PD at the output of the bundle. It is done on only a single science fiber since we've demonstrated that there is no noticeable NCPA between the science fibers.

IV. NIRSPEC Setup:
   Runtime: <5 minutes
   Description: This sets up NIRSPEC for KPIC observing.

V. Send Light to NIRSPEC SPEC Detector:
   Runtime: <5 minutes
   Description: The KPIC 2 μm laser would be very bright on SPEC/SCAM, and the main KPIC MIR light cuts off at around 2.2μm, so we perform the rest of our cals with the Keck calibration lamp in the SFP. Here we switch sources and take a test exposure on SPEC to make sure light is getting through to the detector.

VI. Slit Alignment Scan:

Runtime: 15 minutes

Description: This centers the re-imaged bundle PSF onto the NIRSPEC slit to ensure maximum throughput to the SPEC detector. We use the KPIC slit alignment mirror (SAM) in the FEU (on the NIRSPAO plate) to scan the PSF over the slit plane.

VII. PSM Focus Scan (first night only):

Runtime: <5 minutes

Description: This ensures that the PSM focus is set to properly sample the fiber traces on NIRSPEC. This stage is very reliable, so the scan is only needed on the first night of an observing run.

VIII. Confirm NIRSPEC headers are working:

Runtime: <2 minutes

Description: This double-checks that the NIRSPEC headers are correctly pulling the KPIC keywords. The headers have not been an issue since early 2023, but we keep the step in here since it's fast and frozen headers would cause DRP issues.

IX. Set KPIC to Standby:

Runtime: <5 minutes (does not include backgrounds)

Description: This puts KPIC in a standby state where all lights are off and all stages are ready to go on-sky, but the BMC DM voltages are zeroed for safety. It also has an option for a standby mode where the SAM rotator is out of the NIRSPAO beam in case there are normal NIRSPAO observations before KPIC goes on-sky.

X. Check Spectral Order Alignment and Take Backgrounds:

Runtime: ~5-10 minutes (depends on how far off it is)

Description: This step ensures that we line up with the previous wavelength solutions to cover important spectral features (eg. CO 2-0 bandhead at 2.29um). Doing this also makes the data reduction easier since it gives the DRP a better starting condition for the wavelength solution. Finally, the step provides some instructions for how to take valid backgrounds with KPIC.

XI. In the KPIC standby state, what can we NOT do?:

Runtime: N/A

Description: This section provides a list of the actions that *cannot* be done after calibrations are complete. The actions would affect the state of the calibrated instrument and are non-repeatable, i.e. parts of the calibration procedure will have to be repeated if these actions are performed.

Daytime Calibration Procedure

0. K2AO Bench Setup and nfiuserver Connection

1. In the k2aoserver-new:2 VNC, right click on the blue desktop background and under "NGS-AO Control", select "Start NGS Calibrations". This opens all K2AO cal GUIs.
2. **On first night only:** do K2AO NIRC2 NGS calibrations (link) to correct for aberrations in K2AO (since KPIC doesn't have its own image sharpening routine). After the check, leave the SHWFS and RTC in "NORMAL".
    a. Alternative: do a closed loop image quality check on NIRC2 using a previous NIRC2 SHWFS cog file. If the PSF quality looks good (FWHM ~4.5 pix or 45 mas in K band with little-to-no high frequency aberrations), you can probably skip the NIRC2 cals and just re-use the old cog file.
3. **If this is a subsequent night:** Do the normal "calibration setup" for K2AO/NIRC2-NGS from the "Keck II calib" (Calibration Tools) GUI on k2oaserver-new.
4. Open a VNC to nfiuserver from a NIRSPEC VNC window. Pick a window you can share via a virtual desktop (e.g. a pane in NIRSPEC control1 is convenient).
    a. Open an xterm and run: `vncviewer nfiuserver:5901`
    b. Note: this may close existing nfiuserver VNC's. If so, just reopen those.
5. Open a kpic terminal (from "Activities" at top-left of KPIC desktop) and run `kpic_reset_tracking_for_facility`. This makes sure that the tracking loop settings are set correctly for facility operations.
6. In a terminal (can be same as step 5), run `start_kpic_cals`. This starts the main KPIC GUI (Viewer), the KPIC stage status GUI, and another terminal with a kpython3 session with the KPIC calibrations code imported and ready to run.
    a. Note: `start_kpic_cals` does not actually run any steps of the procedure, it just opens things, so it is okay to execute the command at any time.

I. Initial Setup

1. In the kpython3 session, run the function: `calib_setup_sfp()`
    a. If this hangs for any reason, you can `ctrl-c` and just rerun.
    b. If it continues to hang after 2 attempts. Issue these commands in a nfiuserver terminal:
        i. `KPIC_shutdown -rmsems -V`
        ii. `KPIC_init`
        iii. Then rerun in a kpython terminal: `calib_setup_sfp()`
    c. Note: **the PSF may not look great at this point – that's okay**. The Keck DM probably hasn't been set yet after the Calib Setup and we haven't loaded the BMC DM map yet. That's done in a later step.

d. This [`calib_setup_sfp()`] should set all KPIC stages to the positions for FIU calibrations. The full list is given in the table at the end of A4.
e. If you don't see light on the CRED2, follow the debugging steps in A2.
f. If the PSF is saturated, run `calib_setup_sfp()` again and make sure after it's done, the GUI shows the CRED2 FPS = 400 and Tint=0.1. If not, select 'Custom' next to 'Hmag' and enter 400 for the FPS, *then* 0.06 for the Tint.

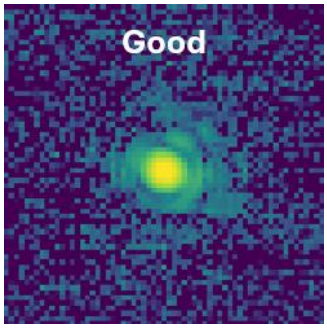
Notes:

- If this is the first night of a KPIC run, you can *optionally* follow the procedure in A3 to check that the PSF and pupil are well-centered. This is less important now that the PyWFS is not in use, as the PSF should consistently be well-centered. We include the procedure only for completeness, but you should very rarely have to do it.

II. Fiber Finding

1. Close the loop on the SHWFS
    a. In the AO Acq Sim GUI, set up bench using the following options:
        i. Set up for a magnitude 7 source (use the mR text box, and make sure to hit "Enter" on your keyboard to have the value accepted)
        ii. AO Mode: NGS-AO
        iii. Ref: KPIC *(do NOT use NIRC2 or OPT AXIS)*
        iv. WFS Background "no"
        v. Select "Setup Bench".
        vi. Note for SAs: The SFP will stay at "KPIC-silica" until we move to FEU cals (ie. in Step V we will switch to 'pws' on the SFP). Do not move the SFP manually to some other position.
    b. Turn off KPIC lights so you can take a background: `turn_off_kpic_lights()`.
    c. Take a SHWFS background. This is done with the "Record bkgd only" button in the "WFS Intensity – Keck II" GUI.
    d. Turn the KPIC lights back on: `kpic_sfp_source('on')`
    e. Explicitly load the K2 (Xinetics) DM shape using the DM Control GUI.
        i. DM control GUI can be opened with the "DM Control" button in the "Keck II calib" GUI.
        ii. Click the "Load voltages from file" button, then select the latest shape – the one determined in Step 0.2 above.
    f. Confirm that you have an acceptable number of counts on the WFS Intensity GUI. Somewhere between 500 and 6,000 is fine with the new OCAM2K detector. (As of March 2025, we were getting about 700 cts).
    g. Select "Acquire Star" on the AO Acq GUI

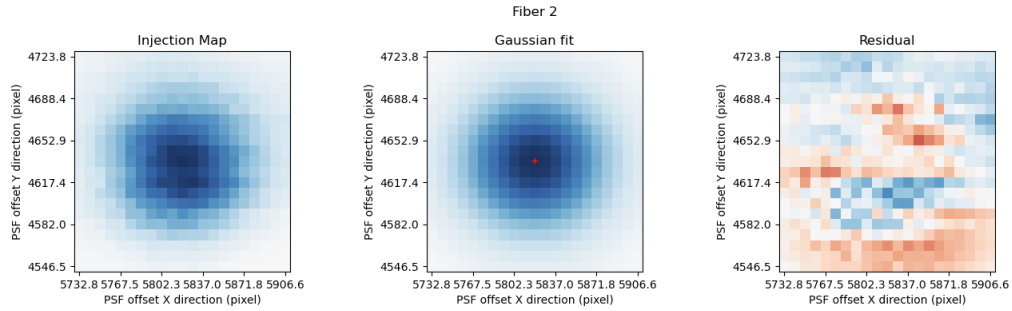
2. Load the KPIC BMC DM map using `flatten_BMC()`
    a. This will suggest loading the most-recent BMC DM map and will show you the filename for this map.
        i. Check that the filename follows this format: `NCPA_map_ds_sf2_<date>.npy` . If it does, accept that suggested map by typing '`y`'. **The suggested most-recent map is usually good**, so you will almost always just accept it.
        ii. If the filename format does not match (this is rare), or you want to use a different map, type '`n`' and provide the alternative map. See the "Finding a good starting DM map" section in A2 for more details about where maps are saved and how to load one manually.
    b. Now that the AO loops are closed and the KPIC DM map is loaded, you should have a reasonable PSF.
        i. For reference, here is an example of a very nice PSF once the AO loops are closed and BMC DM map has been loaded. It does not need to look this good; as long as you have a reasonable Airy-core, it is fine.



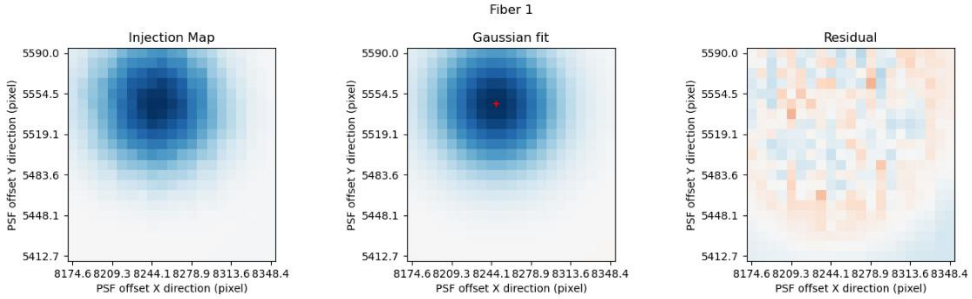
3. Run the function: `fiber_finding()`
    a. This will prompt you after scanning each fiber to confirm if the fiber positions should be updated. Type `y` if the Gaussian fit looks good on the plot (see examples below). If it does not look good, or you have seemingly no signal on the left plot, type `n` and proceed to the next fiber, then once the other fibers are done, see A2 for debugging steps for the bad fiber.
4. If there's been a large shift, or if you would like to validate the result, you can re-run the function to validate that coordinates were updated correctly: `fiber_finding()`

Notes:

- Here is a screenshot of a good fit (next page).



- Here is another screenshot of a case where there was a small shift in the fiber position. The shift is still within the capture range of the scan (we can see a clear peak in the "Injection Map" plot) and the "Gaussian fit" plot is a nice match to the injection data. So *this is also good and you can accept* the new fiber position with `y`.



- Note: as of 12 Dec 2024, the fiber_finding() function now tries to compensate for low PD power for you. It automatically performs the related SAM scan to get you higher power. As such, you shouldn't have to worry about low PD power anymore. However, we keep the note below just in case for reference.
    a. If you get a warning about "PD power is low" and the plot shows a large shift in the fiber positions, rerun the scan to confirm the fiber positions. The warning is based on the initial PD read, which can be lower than expected if the fiber has shifted more than usual. Rerunning the scan with the improved positions might not trigger the warning again and will verify that the large move was performed correctly. If the warning persists, follow the procedure in A2.

III. NCPA Scans

1. Run the function: `flat = ncpa_scan_tests()`
    a. Note: plots may freeze while the script is still running. **IGNORE any "Figure not responding" popups** as long as the function seems to still be running (ie. is still periodically loading new plots and printing to terminal). *Only if* it goes for >4 min without any updates at all, then you may want to `ctrl-c` the function.

b. This will run through aberrations from defocus to first order spherical. The status will be printed to the terminal, and corrections automatically applied.
c. *At the end* of the scan, plots of each mode will come up. If the fits look good (see examples below), close the plots and continue. Otherwise, rerun the scan for that specific Zernike (see notes section in bold below).
    i. Note that the first plot may be blank until the second plot is drawn, this appears to be a python issue**. Similarly, ignore any "Figure not responding" popups**, they should resolve themselves.
d. The final power should ideally be >1. *However, if it's low, it may be okay*:
    i. Consider the plots shown for each Zernike. There are several examples below in the "Notes" section of this step. If the plots looked similar to the examples, with decent fit curves and a clear peak, then do not worry about the low final power. It's likely that the SAM was not perfectly-aligned but it was close enough to still provide good scans and hence will not adversely affect the final on-sky performance.
    ii. If the final power was low, and the plots at each Zernike look very noisy or have bad fits, then the SAM was likely too-poorly aligned and this may have limited our ability to sense the correct NCPA DM shapes. In this case, it may limit our on-sky performance, so try the "PD power is low" procedure in A2. Then retry this scan.

2. The function will print the resulting DM map filename. Note it down somewhere in case you need it later (see note below).

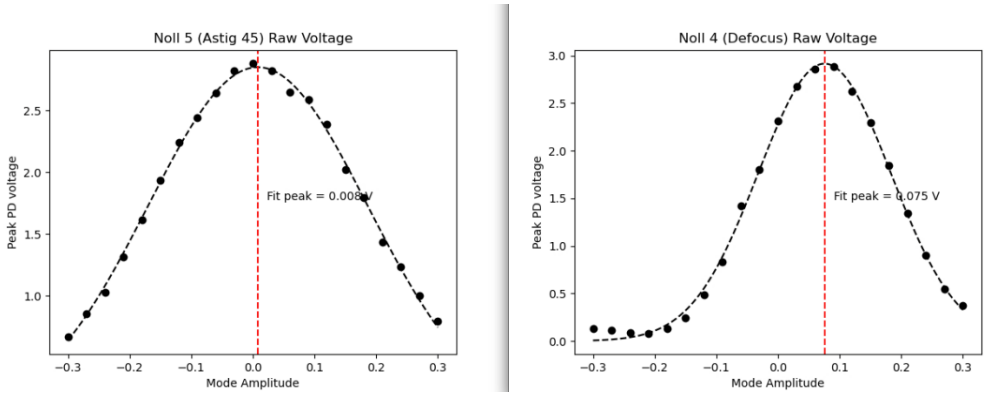
3. **If SHWFS loops were closed, open them now.**
    a. Hit the "open" button in the MAORI GUI that opens both DM and TT loops at once.
    b. After opening the loops, double-check that the Xinetics (K2AO Bench) DM is set to the right map (same that you applied at the beginning and which was calibrated for KPIC/NIRC2, e.g. 2025Mar11_<timestamp>.dm).

4. **Turn down the SHWFS sensitivity to avoid saturating and triggering protection mode:**
    a. In the AO Acq GUI on k2aoserver-new, set the Target magnitude to 2.3 (using the mR box). Make sure to hit Enter.
    b. Hit the "Setup Bench" button.
5. With the NCPAs done and the SHWFS set to a safe sensitivity, run `kpic_sfp_source('off')` to turn off the KPIC light sources before doing anything with

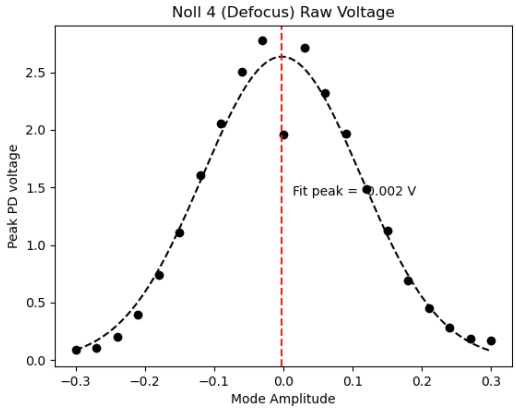
NIRSPEC. **This will also turn on the Keck source**, so you will still see a PSF on the CRED2 but this is now from the Keck lamp, not from a KPIC laser/lamp.

Notes:

- As of 12 December 2024, this function no longer asks about DM map loading; as a starting point, it will always use whatever map is on the BMC DM when you call it. If you want to start with a different DM map, use `flatten_BMC()` or explicitly load it manually. See "Finding a good starting DM map" in A2 for more details.
- Here are some example screenshots of what a good fit looks like. If the fits (black dashed lines) roughly match the measurements (black dots), and the red dashed line is roughly at the peak of the fit (as shown below), then it's a good fit.

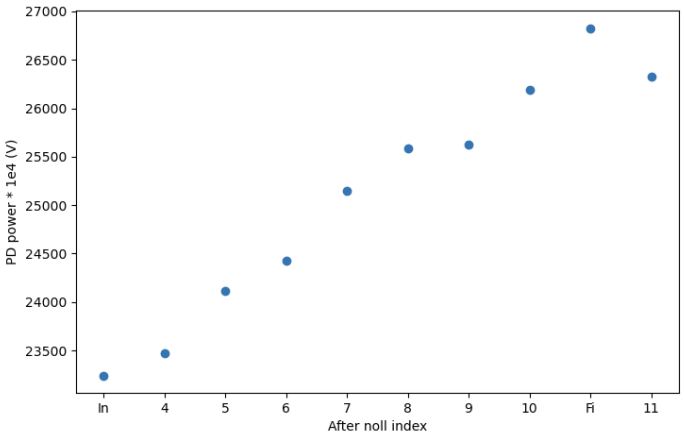


- And here's a screenshot where things look a little wonky but are fine. In this case the best-fit correction is ~0 and is visually ok, so a rescan isn't necessary.



- The code prints the final DM map file. For reference it is saved as: `/nfiudata/rtcdata/calibration/BMC/NCPA_map_ds_sf2_<date>.npy`
- The final plot shows the PD power after each noll index was tuned. **It is okay for it to not monotonically increase**, but very large drops **(>15% of value)** between

steps merit repeating the NCPA scan. See screenshot below for an example (though the units for your plot will be in raw Volts, so they will be ~1 to 5V, rather than something in the tens of thousands as shown here).

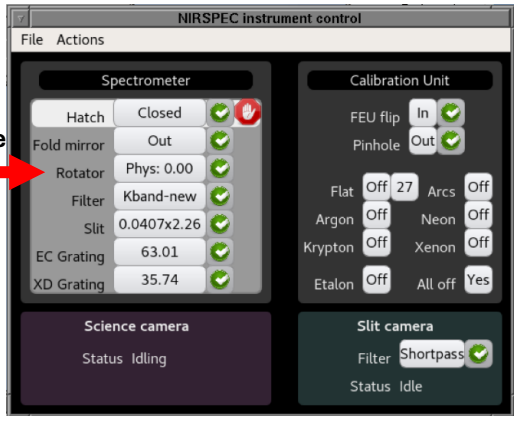


- To run a single Zernike, specify the noll keyword argument, e.g.: `flat = ncpa_scan_tests(noll=4)` will scan only noll 4 (defocus), and will require manual confirmation that the scan looks ok.
- To save the map with a specific filename, update the date keyword argument, e.g.: `ncpa_scan_tests(date='240520a')` This is usually only needed for non-facility operations, but can be useful if you want to re-run the scan while preserving the current solution.

IV. NIRSPEC Setup

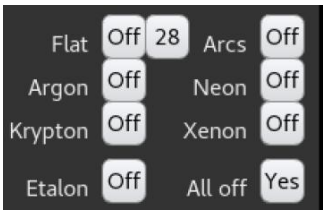
1. Open the NIRSPEC instrument control GUI: "right-click" on the background, then select "NIRSPEC GUI"
2. In the "NIRSPEC instrument control" GUI (see screenshot), set following:

**** Rotator should be -1.00 ****



   a. Fold Mirror (CALFOLDNAM) = "out"

b. FEU Flip (FEUFLIPPOS) = “in”
c. Rotator (IROTPOS) = “Phys: **-1.00**”
    i. Note: This value was updated on March 2025 based on the new, fixed NIRSPEC slit position and orientation.
d. Filter (SCIFILTPOS) = “Kband-new”
e. Stop (SCIFILTSTOP) = “FEU” (ALWAYS CHECK THIS!!)
    i. Note that the Stop is not shown in the default GUI, so you need to click on the button next to “Filter” which opens a smaller GUI which shows the current filter *and* stop.
f. Slit (SLITNAM) = 0.0407x2.26
g. Echelle Grating (EC Grating) = 63.00
h. Cross Disperser (XD Grating) = 35.8
i. All cals off

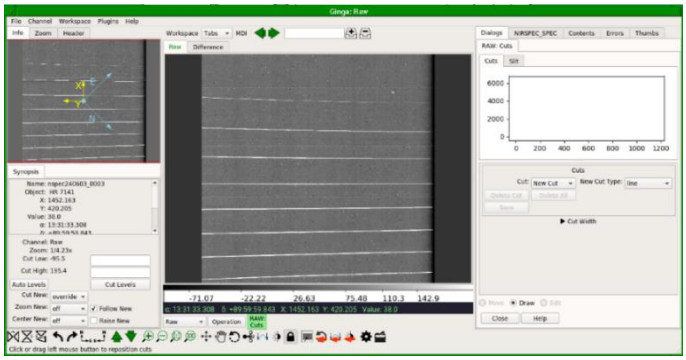


j. Slit Camera Filter: “Shortpass”

3. Type `newdir` **in a NIRSPEC terminal** to update the directory for the night.

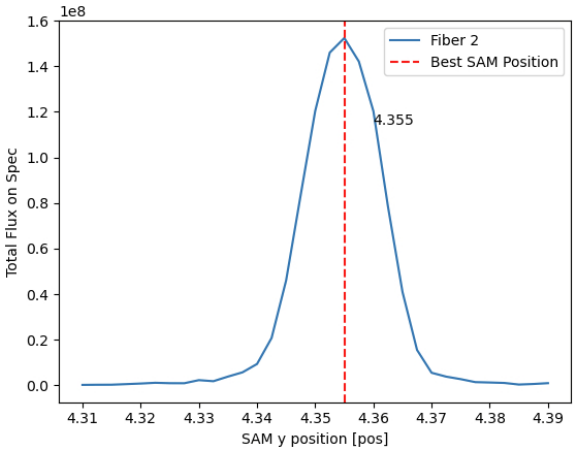
V. Send Light to NIRSPEC SPEC Detector

1. Note: make sure you’ve run `kpic_sfp_source('off')` to turn off the KPIC 2μm laser before opening the hatch to NIRSPEC.
2. Manually open the NIRSPEC hatch using the NIRSPEC GUI
3. Run `setup_for_spec()` to set the system to send Keck light through KPIC to NSPEC
    a. If this gets stuck, go to NIRSPEC VNCs and take an image manually (see procedure in A2).
    b. If you do not see light on SPEC (should roughly look like the screenshot below with fiber traces), then follow the debugging steps in A2.



VI. Slit Alignment Scan

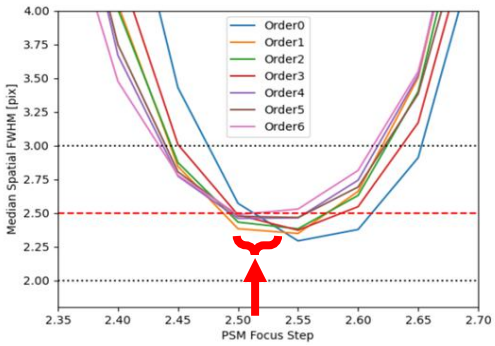
1. Run `sam_scan()`. This will print the best-fit SAM y position and show a Python figure. The plot should have a clear peak.
    a. If the peak is at the edge of the scan, rerun with a larger range using `sam_scan(scan_range=0.06)`
    b. Here is an example of a "good" plot. Note the clear peak.



2. During the analysis, the scan will compare the new optimal SAM position to the value saved for on_slit in SAM.ini. If the value has changed, the code will print a reminder to update the position in this file. To save the new position in the SAM.ini, edit the file and make install it:
    a. `cd $KROOT/src/kss/kpic/devices/SAM/SAM_ini`
    b. `vim SAM.ini`
    c. change the on_slit preset to your newly determined position (type "i" to edit)
    d. quit vim and save the file (can use Escape – shift – zz)
    e. `make install` in that SAM_ini subdirectory
3. Once the physical scan is done, the code will automatically take a few NIRSPEC frames at the new position and print the flux value to the terminal. If the flux on NIRSPEC after the move differs from the peak of the scan by >10%, the code will print a warning and suggest rerunning the scan. If that happens, consider using `sam_scan(sam_y_step=0.0015)` for a finer scan in this case.
4. **Critical:** The SAM XY is not completely repeatable. As such, completely avoid moving this stage once this step has been performed. *If* the stage absolutely *must* be moved, you should consider re-running just this SAM XY scan (step 1 in this section) to ensure optimal throughput to SPEC.

VII. PSM Focus Scan (first night only)

1. **If this is not the first night of a run**, and you already determined the optimal focus:
    a. Set the focus to the previously-determined optimal position by entering the value in the KPIC GUI: Devices tab → FEU → "Pupil Steering Mechanism Focus". After typing your value, hit the right arrow to move the stage.
        i. NOTE: the keyword for this stage is `PSMFPOS` (including in the NIRSPEC headers)
    b. Note: this PSM focus scan takes <3 min so it may be faster to just re-run if you don't know the focus value from the night before.
    c. Now skip the rest of this Step and proceed to Step VIII.
2. **If this is the first night of a run,** proceed with the rest of this section.
3. Run `focus_scan()`
4. When plot pops up, pick a point where all orders show about **2.5 pixels** sampling. Here is an example of the output plot. Note that most orders overlap w/ ~2.5pix around a focus of 2.50 to 2.52 mm. Any value around here is fine (ie. 2.51 is good). Precision isn't critical here.



5. After the scan, if the new focus you've chosen is different than what is printed in "Pupil Steering Mechanism Focus" in the KPIC GUI: Devices tab → FEU → "Pupil Steering Mechanism Focus", edit the value by clicking the box with the number, then hit the arrow to the right to send the stage there.

VIII. Confirm NIRSPEC headers are working

1. Check that NIRSPEC headers are updating with the latest KPIC keywords. There are many ways to do this; here are two:
    a. From an nspec terminal in the `cdata` directory: `fitsheader -f -k FAMX nspec240521_013?.fits`
    b. Using the NSPEC Ginga: navigate to the "Header" tab and scroll down to the KPIC keywords (towards the bottom, starting with many that have an "FIU" prefix). Now toggle through a few NIRSPEC frames and check that the values were changing between frames. Here are a few good values to check:

i. FAMX and FAMY are good ones to look at since they change relatively often.
ii. If you just did the SAM or focus scans, you could also check SAMY or PSMFPOS.
iii. For frames with tracking set to different science fibers, FIUGNM is another good one; it should say 'science fiber X' where 'X' is the fiber number.

2. If the keywords are not updating, follow the procedure in A2 to restart the nsheaders service.

IX. Set KPIC to Standby

1. Run kpic_offsky(sam_rot_out=?). There are 2 choices here:
    a. Scenario 1: If KPIC is on-sky for the first part of the night, or the full night, OR the first-half is NIRC2, use sam_rot_out=False.
        i. In this case, you can proceed to the next section for the echelle spectral order check and can then take backgrounds.
    b. Scenario 2: If the first-half night is a regular NIRSPAO night (not KPIC): set sam_rot_out=True to make sure the SAM rotator is 'out' and hence does not block the beam for NIRSPEC in side the NIRSPAO plate. In this case you:
        i. can proceed to the spectral order check.
        i. DO NOT take backgrounds (they will be invalid since the SAM rotator is out).
        ii. remind observers to take backgrounds at the end of the night (in the morning).
2. On k2aoserver click the "Shutdown AO Bench" button at the bottom of the "Keck II calib" gui. This will turn of the OCAM2K to prevent damage.
    a. When prompted about:
        i. Setting WFS to Standby : Click 'yes'
        ii. Warming OCAM2K: Click 'okay'
        iii. Sending SFP to Telescope position: Click 'No'

Notes:

- **Critical:** The SAM rotator is not completely repeatable, though it is more reliable than the SAM XY stage. As such, moving the rotator is inadvisable after calibrations are complete, unless truly necessary. If there is NIRSPAO science before KPIC science, you'll need to move the SAM rotator out of the beam. This may lead to a small throughput hit but is unavoidable. If there is no NIRSPAO science before KPIC science, we strongly encourage you to avoid moving the stage.

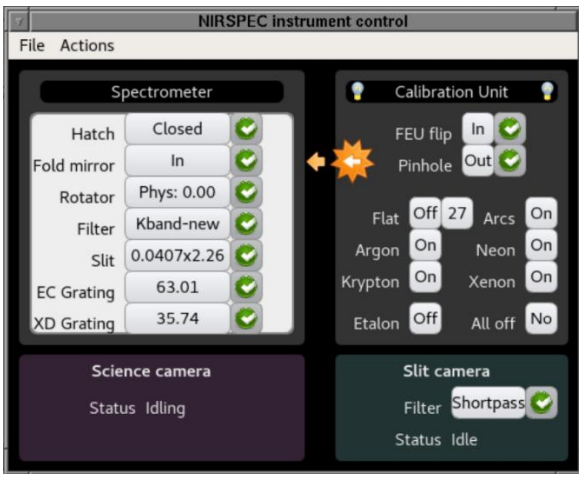
X. Check Spectral Order Alignment and Take Backgrounds

NOTE: This may be something that your observers should do instead of the SAs. However, we put it here as a reference for how these steps can be performed

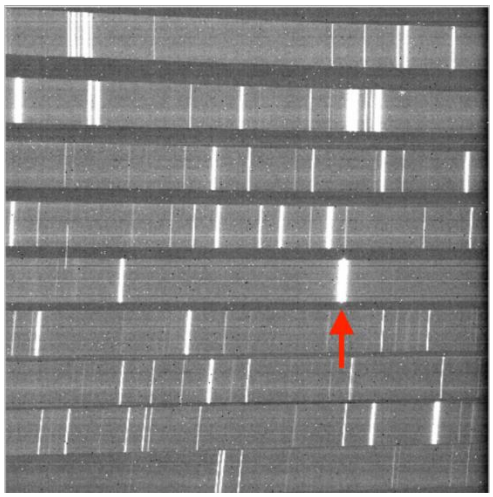
Spectral Order Check:

Note: The following assumes the standard K-band setup used by the KPIC team. Observers can choose different grating settings (provided they're within the K-band), but this is untested. Such a setup should work but will require additional effort by the observers to determine the wavelength solution for the instrument.

1. In the NIRSPEC control 0 window (not the nfiuserver VNC), find the "NIRSPEC Instrument Control" GUI. Set the "Fold mirror" to "In" and turn the four gas lamps 'on' using the 'Arcs' button. (see screenshot below)



2. In a NIRSPEC SPEC terminal (Control 2), use "`atint 10`", "`coadd 1`", and then "`goi`" to take an arc lamp exposure, you will see a spectrum like the figure below. Change



'XD Grating' to align the following Krypton line indicated by the red arrow to be around (x, y) = (807, 624). Note: +/-5pix should be okay. These positions are for the bottom middle of the line (where the red arrow is pointing).

- Revert the NIRSPEC settings back. Fold mirror → out; lamps → off.

Notes:

- You might need to change the EC (echelle) grating (controls mostly the spectral direction) on the "NIRSPEC Instrument Control" GUI. In general, change a little bit (by 0.01 deg) to see if the Krypton lines up to the location in the figure (within 5 pixels would be okay).
- While you mostly will not need to change the EC grating, sometimes the NIRSPEC motor fails and the spectral direction will be shifted by 1/3 of the detector. The troubleshooting procedure is listed in "Large shift on the spectra" https://www2.keck.hawaii.edu/inst/nirspec/troubleshooting.html#bad_spectra.

<u>Take Backgrounds:</u>

1. Double check that the SAM rotator is set to "in" and that the NIRSPEC hatch is OPEN. Confirm that no lights are on in the AO bench.
2. Take backgrounds for the settings that you/observers expect to use that night. Here is a set of recommended backgrounds that the KPIC team usually uses. You can let your Observers decide which ones they want.
    a. **NOTE: Make sure to leave the NIRSPEC hatch open and SAM rotator 'in' when taking backgrounds!**

b. atint 1.5; goi 10; atint 10; goi 10; atint 30; goi 10; atint 60; goi 10; atint 90; goi 10; atint 120; goi 10; atint 180; goi 10; atint 300; goi 10

3. Similarly, if your observers want to take flats, this would be a good time to take them.

XI. In the KPIC standby state, what can we NOT do?

- Do not move the SAM XY stage in KPIC. If you do, you'll need to rerun the SAM scan (Step VII).
- Try to *not* move the SAM rotator (unless there is NIRSPAO science on-sky before KPIC, in which case you should have set the `sam_rot_out=True` argument to move the rotator out of the beam in Step X). If you unintentionally move the SAM rotator, you can (optionally) rerun the SAM scan (Step VII) but you could also go on-sky without having rerun it, and that would just lead to a minor throughput hit on-sky.
- While KPIC backgrounds and flats are being taken, you *must not* turn on any lights inside the K2AO bench (since the NIRSPEC hatch is open for these in KPIC mode).

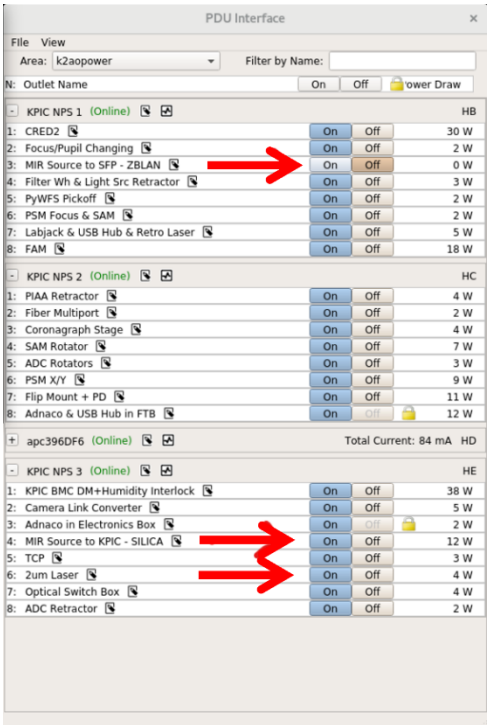
Appendix 1: Lexicon – Useful acronyms and other terms

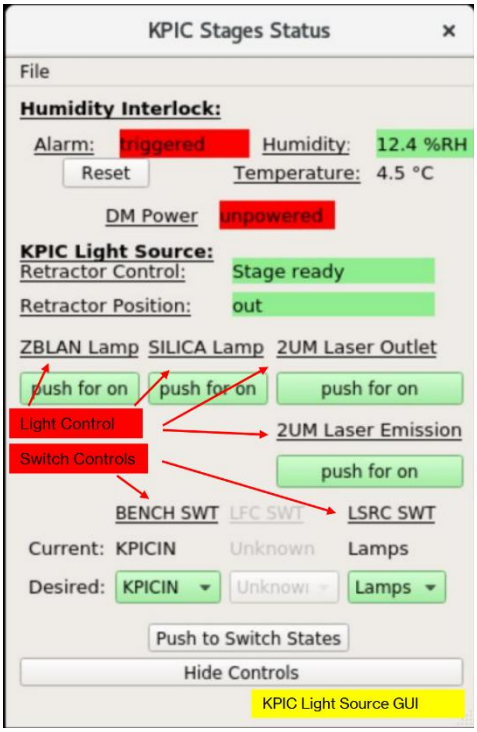
ADC	atmospheric dispersion corrector
BMC	the KPIC DM
CRED2	the KPIC tracking camera
DM	deformable mirror
DS	direct spectroscopy
DFB	stage that picks off light from NIRC2 to send to KPIC
DRP	data reduction pipeline
FAM	fiber alignment mirror
FEU	fiber extraction unit
FIU	fiber injection unit
FSM	field steering mirror (in K2AO) OR fast steering mirror (within KPIC)
GUI	graphical user interface
K2AO	Keck's adaptive optics system, which feeds KPIC
LSRCSWT	light source switch to change between KPIC and K2AO sources at the front of the AO bench
MIR	mid-infrared, refers to 2 KPIC calibration lamps
NCPA	non-common path aberrations
NIRC2	Keck's imaging detector
NIRSPEC	Keck's high-resolution spectrograph
PD	Photo-diode or photodetector
PIAA	Phase-induced amplitude apodizer
PSM	pupil steering mirror
PyPO	pyramid pickoff dichroic
PyWFS	pyramid wavefront sensor
SCAM	a camera we use for aligning to NIRSPEC
SFP	the light source holder at the front of Keck
SHWFS	Shack-Hartmann wavefront sensor
SPEC	spectrograph camera for NIRSPEC
TCP	tracking camera pickoff mirror
PD	photodetector located at the output of the bundle for calibrations
VNC	virtual network computing (remote access to desktops)
SAM	slit alignment mirror

Appendix 2: Common debugging steps for daycals

(For Step I) If after calib_setup_sfp you don't see light on the CRED2

- First, try re-running `calib_setup_sfp()` once or twice more. If this fixes it, move on with the normal procedure.
- If you still don't have light on the CRED2, check that the light sources have been set correctly by `calib_setup_sfp()`. The correct light settings would be:
    - MIR Lamp 2 (SFP ZBLAN – NPS 1 Port 3) = 'off'
        - You can check this and the MIR Lamp 1 (below) using the `pdu_gui or kpic_lightsrc_gui`. See the screenshot below for what the GUIs should look like at this part of the script. Note that the two arrowed outlets are the important ones on the pdu_gui and 2UM Laser control and switch controls is the main benefit of using the lightsrc_gui.
        - If SFP ZBLAN is not 'off' turn it off (can use `pdu_gui or kpic_lightsrc_gui`)
    - MIR Lamp 1 (KPIC SILICA – NPS 3 Port 4) = 'on'
        - If KPIC SILICA is not 'on', turn it on (can use `pdu_gui or kpic_lightsrc_gui`)





    - KPIC 2um Laser (2um Laser – NPS 3 Port 6) = 'on'
        - If not 'on', turn it on (can use `pdu_gui or kpic_lightsrc_gui`)

        - Should also be enabled and at 250mA of power. Running `set_kpic_laser('on')` inside the python terminal, should print several lines, with the last two reporting:
            - *b'current=250\r< '* (this means power is at 250mA)
            - *b'enable=1\r< '* (this means emission is enabled)
    - Keck Light Source:
        - Filter should be at 'open'
        - But Keck source should be 'off'
        - Note: the Keck Light Source control GUI sometimes get out of sync, so you may have to restart it.
- If all the lights are on correctly, double check the stage positions against the values in the table at the end of A4.
- If you still don't have light, then the KPIC optical switches may be out of sync with their true state. This has can happen after a mode change (from PI to Facility) or after a full KPIC instrument reboot (where the labjack is rebooted). Either way:
    - You can re-synchronize the switches using their keywords. Toggle between the two states on each switch. **Toggle each one twice** to resynchronize. ie:
        - `modify -s kpic LSRCSWT=LFC`
        - `modify -s kpic LSRCSWT=Lamps`
        - `modify -s kpic LSRCSWT=LFC`
        - `modify -s kpic LSRCSWT=Lamps`
        - `modify -s kpic BENCHSWT=KPICIN`
        - `modify -s kpic BENCHSWT=K2AOIN`
        - `modify -s kpic BENCHSWT=KPICIN`
        - `modify -s kpic BENCHSWT=K2AOIN`
    - This can also be done through the `kpic_lightsrc_gui` by selecting the appropriate states on switches and clicking "push to switch states"

(For Step II) Finding a good starting DM map:

- Calling `flatten_BMC()` will load a BMC DM map from the last round of calibration. The PSF should look pretty good. If the PSF is quite aberrated, the loaded map is likely incorrect. You can manually load a DM map with the following:
    - BMC DM maps are saved in `/nfiudata/rtcdata/calibration/BMC/`. The latest map is usually the correct one, with naming convention e.g. `NCPA_map_ds_sf2_240520.npy`.
    - `ini_flat = np.load('/nfiudata/rtcdata/calibration/BMC/NCPA_map_ds_sf2_240520.npy')`
    - `DM.setSurf(ini_flat)`

- Also make sure to double check the K2 (Xinetics) DM map if you are concerned about a bad PSF and the KPIC BMC DM is already set to a map that should look good. The Keck AO Acq and Calib Setup tools seem to reset the map often. If you are in closed-loop on the SHWFS, and still see a bad PSF but are fairly certain that the KPIC BMC DM is set correctly, then double check that the SHWFS is set up for NIRC2/KPIC operations. Also double check the defocus setting on the SHWFS.

(For Step II) Debugging a bad Gaussian fit in the fiber finding:

- Try to increase the grid size of the scan. This can be done with increasing the start and stop parameters in the function. The default values are `fiber_finding(start=-5, stop=5, step=0.5)` Values are in CRED2 pixels. If you need to rescan, we recommend starting with `fiber_finding(start=-10, stop=10, step=1)`, and then further increasing the star/stop as needed. Step > 1 may under-sample the PSF.
- If a larger (e.g. +/-10 pixel) scan does not show any signs of the fiber, proceed to the procedure below to adjust the SAM position for the fiber

((For Steps II and III) "Low PD Power" reported in fiber finding or NCPA:

If you see a warning that PD power is low (<0.3 V), or if the coupling plots look very noisy to the point that you get a bad fit, it's possible that KPIC back-end (FEU) is misaligned.

This is most likely due to the SAM X/Y which points the fibers onto the calibration PD. Follow the procedure below to realign the back-end SAM position for that fiber:

- Make sure the KPIC tracking is on.
- Run `sam_finding()` in the kpython3 calibration session.
    - Running without any input arguments will scan for all fibers. This can take up to 10 minutes but will make sure all fibers have good SAM starting values.
    - Alternatively, if only a single fiber (for example fiber 2) had low power/signal or a bad fit, you can just scan that fiber using `sam_finding(fibers=[2])`.
- At the end of the scan for each fiber, the function will show you a plot and ask for your input about whether to update the SAM position for the given fiber.
    - Look at the plot. It should show a pixelated bright region corresponding to where the SAM was well-pointed at the PD. There should be a red "X" at the brightest pixel (within the bright region). If the "X" is on the brightest pixel, type "`y`" to accept and update the SAM position. Note that it is okay for bright region to be near the edge as long as the peak is correctly identified.
    - If the plot seems to have no clear bright region spanning at least 2 pixels, type "`n`" and try running again with a larger scan size: `sam_finding(fibers=[2], start=-0.07, stop=0.07, step=0.01)`.

- If the fiber position changed significantly (ie. if the brightest pixel was at the very edge of the scan), consider re-running to double-check the result.
- If wider scans still result in all-noise plots, and you're certain the 2um laser is on, check that the PDPO (PD Pickoff/flip mirror) is in the "IN" position. This is shown in the "Devices", "FEU" tab of the KPIC Viewer. If this still gives no signal, the fiber goals or SAM position may have changed too significantly (this is very rare). Reach out to a KPIC team member (Dan, Elijah, Luke, Jerry, etc.) for more assistance.
- When you hit "`y`" to accept the new SAM pd position for a given fiber, this automatically updates the SAM.ini file *and* does a make install. As such, you can proceed directly to running any calibration steps and you don't need to do anything within the SAM.ini or makefiles yourself.
- Optional: Confirm that power has improved.
    - In a normal terminal: `SAM goto pd_sfX` (where X=fiber number)
    - then in the kpythone session do `tools.read_pd(100).mean()` to check that the power indeed increased.

If the power is still low, consider scanning the PSM focus. However, this is a very stable and repeatable stage, so it is very unlikely that this is the issue (ie. make sure to try a SAM scan on the PD – previous procedure above – *before* assuming it is a focus issue).

- Set the tracking script and SAM to point to the desired fiber (see beginning of previous block of steps for how to do that).
- Now try explicitly commanding the PSM focus to the approximately the right position. For Facility mode K-band, the focus on the PD should be about 2.54mm (as of May 2024). Note that this is slightly different than the optimal focus when working with SPEC (which is closer to 2.51mm as of May 2024).
    - PSM focus can be set from the "Devices", "FEU" tab of the GUI.
    - Check the power at this focus position (`tools.read_pd(100).mean()` in a spec_scans_combined instance).
    - If this fixed your power issue, go back to the main daycals procedure and proceed with your normal scan (fiber_finding or NCPA scans).
    - If commanding the PSM focus to the approximately-right position didn't fix the flux, do a PSM focus scan following the remaining steps here.
- Execute the PSM focus scan: `ret = tools.psmf_PD_scan(start=-0.2, stop=0.2, nsteps=7, start_psmf=2.50)`. The arguments are hopefully self-explanatory, the units are in stage-native units (mm) and start_psmf is the center point of the scan.
- Once the scan is done, plot the result: `tools.plot_psmf_PD_scan(ret[0], ret[2], ret[1])`.

- The plot should show a peak. The X-axis is the PSM focus position with that optimal peak. You can then command the PSM focus stage to that position (can use the GUI to do this). This stage has no backlash issues, so once you move it there, you should be at the optimal focus.
    - NOTE: if the optimal focus has changed significantly (>0.05mm) from the default (2.54mm as of May 2024), let the KPIC team know, as we will have to update the default position that the daycals script.
    - However, once you command the PSM focus to this new position, you can proceed with fiber_finding and NCPA scans since neither of these functions moves the stage; only calib_setup_sfp, setup_for_spec, and focus_scan do.

(For Steps V-VII) How to take exposures on SPEC and SCAM manually:

- For SPEC: exposure time is set using `atint <time>` with a minimum of 1.5s (use nd1). Time is given in seconds, but may not be exact due to the NIRSPEC readout. You can take an exposure with `goi`.
- For SCAM: exposure time is set using `tint2 <time>` with a minimum of 0.67s (use nd6). Time is given in seconds, but may not be exact due to the NIRSPEC readout. You can take an exposure with `goi2`.
    - **Never** do `atint2` – this breaks SCAM. If SCAM seems weird, check the NIRSPEC troubleshooting section below.

(For Step V) NIRSPEC troubleshooting:

- If you see an error on SCAM that reads “Request for integration less than the minimum (7864 msec).” Usually accompanied by a weird SCAM image:
    - Right-click on a NIRSPEC GUI → NIRSPEC Tools Menu → Stop SCAM detector
    - Then, → NIRSPEC Tools Menu → Start SCAM detector
    - This takes 1-2 mins, so wait to see “status = Idle”, then it’s ready to expose

(For Step V) No light seen on SPEC after setting up for NIRSPEC:

- First: check that the NIRSPEC hatch is open – this has tripped us up many times!
- Also check that you see light on the CRED2 and that it is being pointed to one of the fibers (should be SF2 by default). If you don’t see light on the CRED2, try decreasing the FPS to 2 (using the FPS setting under the image display in the GUI). If still no light on CRED2, try centering the FAM. If still no light on CRED2, make sure the Keck source is on and you have ND1. You presumably had light on the CRED2 in the previous steps of the procedure, so one of these checks should have fixed things.
- Manually take a SCAM image. If the light is off the slit as seen on SCAM, then the SAM on_slit position is likely off by more than normal. Proceed to the SAM scan in step VI, but use a larger range (**e.g. set range=0.05 or 0.06**).

- If there's no light on SCAM, double-check that the NIRSPEC hatch is open and the filter/grating settings are correct.
- If NIRSPEC is set correctly, check that the NIRC2 dichroic (DFB stage in K2AO SC GUI) is in the correct position ("mirror"), so that all light goes to KPIC, not NIRC2.

(For Step VII) NIRSPEC headers not updating

- To restart the keyword service, open an nspec xterm as nspeceng@nirspecserver and run:

```
>> nirspec stop! nsheaders
>> nirspec start nsheaders
```

- After it restarts, you can check that it's running with `nirspec status nsheaders`
- Note: If your local xterm name looks like "[nspec4 @nirspec nspeceng]", you will likely see an error "Won't try to run script nsheaders, because host nirspec is not in its runhost…" To fix this:
    - In the same terminal, type `ssh -X nspeceng@nirspecserver`
    - Enter password `.metoa*`
    - Run the commands 1, 2, 3 above from this xterm.

Appendix 3: Optional and supplemental procedures

Verifying the Pupil and PSF alignment for first night of a run:

Description:

Sometimes, the PSF or Pupil fed from the Keck SFP is not well-centered on KPIC. Field shifts (ie. PSF not centered) eat up stroke on the KPIC FAM, limiting our tracking and offsetting capabilities. Pupil shifts (ie. pupil not centered) can cause reduced throughput due to the clipping on the pyramid FSM or on the KPIC pupil mask. Furthermore, pupil shifts can mis-register us on the BMC DM, leading to a bad NCPA correction on-sky.

Both these issues (PSF or pupil misalignment) are often due to the pyramid FSM (`ao pmcf2x`, and `ao pmcf2y`) not being set to the right position for feeding KPIC on-axis with the mirror on the Keck DFB. As such, we need to ensure that FSM2 is set to the right position. This is most relevant on the first night of a KPIC run, if the pyramid FSMs may have been set to feed light to a different position/offset.

This procedure provides instructions for checking both the PSF and pupil alignments on KPIC. It also provides steps for moving the FSM2 to fix any shifts.

Steps:

1. Make sure the FAM (Fiber Alignment Mirror) is set to the "center" position (numbers should be close to 5000, 5000). This is in the KPIC GUI: Devices tab → FIU → FAM.
2. Make sure the SFP is set to `kpic_cal` and that you are using the MIR KPIC – Silica lamp. This is the default state of the system after running `calib_setup_sfp()`.

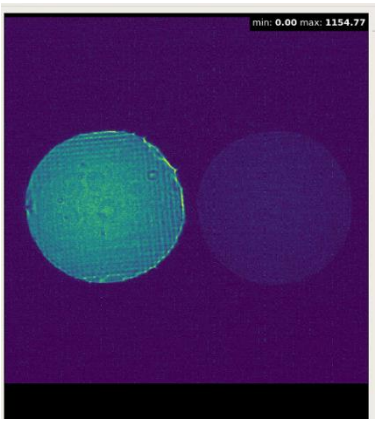
<u>Checking the PSF</u>

3. With steps 1&2 complete, the PSF should land near the center of the CRED2. The center is ~320, 256. Note that +/- about 30 pix is okay, it doesn't need to be perfect.
4. If the PSF does not land near the center, you can command the FSM2 to a new position.
    a. If you know the new position (for example, by referring to old notes about where the FSM2 has been in the past), you can run the following command in the kpython3 instance: `execute_fsm_move(fsm_xposition, fsm_yposition)`
    b. If you don't know where it needs to go from the start, use the following commands in a regular nfiuserver terminal:
        i. `show -s ao pmcf2x; show -s ao pmcf2y` to show current FSM positions
        ii. `modify -s ao pmcf2rx=delta_x` where delta_x = (the goal x - the current x position) shown by the previous command.

iii. `modify -s ao pmcf2ry=delta y` where delta_y = (the goal y - the current y position) shown by the previous command
iv. `modify -s ao pmcf2gr=1` (apply offset)
v. Continue to iterate this process until the PSF is close to center

Checking the Pupil: note that the pupil should rarely need to be checked unless the FSM2 has moved drastically.

5. Set the CRED2 to pupil viewing mode:
    a. Move the "Mode Change" stage (GUI: Devices tab → FIU → Pupil/Focus Changing) to the "pupil" position. Also set the FPS = 2 to have plenty of signal
6. Check that both pupils are relatively round and not clipped. The screenshot below shows roughly what the pupil should look like.



7. If the pupil looks clipped, move the FSM2 to get it rounder (see step 4b above for how to move the FSM2).
   NOTE: you shouldn't have to move it far and if you do move it too far, you'll end up off-center on the PSF so you want to avoid that.

Scanning the KPIC PSM:

Description:

The KPIC FEU re-images the output of the KPIC bundle onto the NIRSPEC slit. This requires aligning the image not only in the focal plane (slit plane) but also in the pupil plane. The regular daycals procedure already accounts for the focal plane alignment in Step VII, since the SAM XY stage is not completely repeatable. However, the normal procedure omits the pupil plane alignment since the stage that controls this is incredibly reliable. That stage (the PSM - pupil steering mechanism) can position to better than 100um and the pupil in

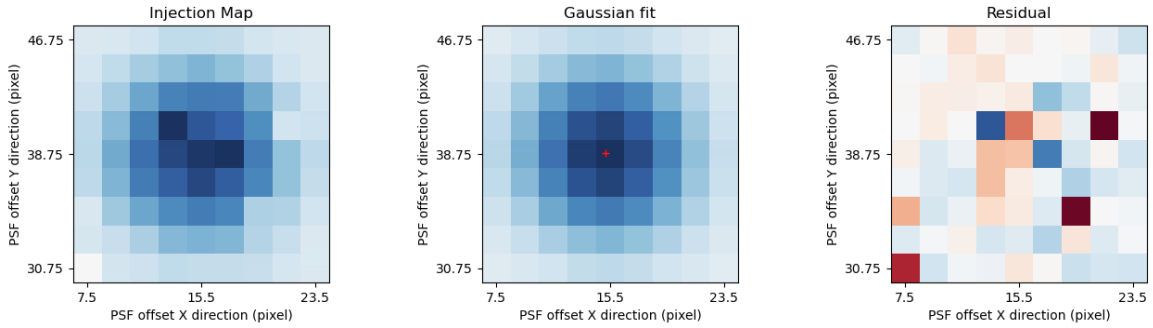
this plane is on the order of millimeters. As such, we have not noticed any noticeable drift in the required PSM position even over the course of months.

However, if the NIRSPAO plate/FEU is removed from K2AO bench, the PSM stage is usually removed along with it. Thus, this can cause a small shift in the required PSM position. This is mitigated by mechanical references but, we have a procedure to realign the PSM if necessary.

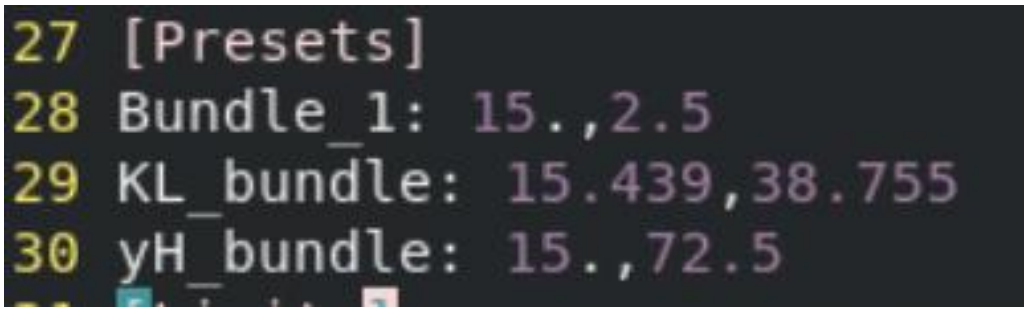
Therefore, the procedure below should be run if the NIRSPAO plate/FEU are physically removed, or if you suspect the PSM position may need to be tweaked to realign with the NIRSPEC pupil stop.

Steps

1. Complete the procedure through step IV – NIRSPEC setup
2. Note: make sure you've run `kpic_sfp_source('off')` to turn off the KPIC 2μm laser before opening the hatch to NIRSPEC.
3. Run `setup_for_scam()` to put light on SCAM
4. Note: DO NOT resize the window during the scan. For some reason this causes a comms crash. If it happens, just rerun the scan.
5. Run `PSM_Scan_XY()` to scan the PSM. Scan takes ~15 min. When the scan is done, a plot should pop up. I
6. If it looks good (see plot below, 2D Gaussian, small residuals), update to the best fit position with `PSM.set_pos([<x>,<y>])` with the best-fit positions. Note that SCAM is pretty inconsistent so "good" is a low bar (see plot)



7. If positions were updated, change the presets in PSM.ini:
    a. `cd $KROOT/src/kss/kpic/devices/PSM/PSM_ini/`
    b. `vim PSM.ini`
    c. change the KL_bundle presets to your newly determined position (type "i" to edit, see screenshot below)
    d. quit vim and save the file (Escape – shift – zz)
    e. `make install` in that in that PSM_ini subdirectory

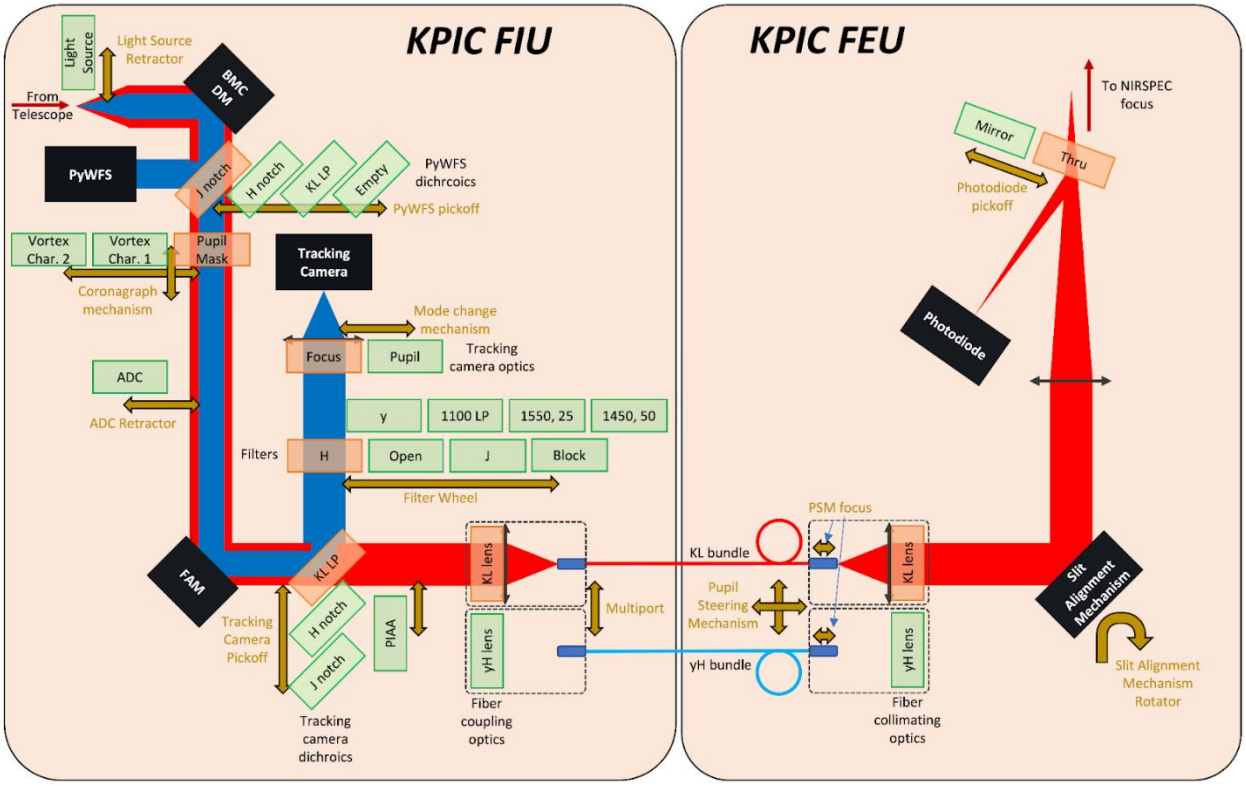


8. If you update the PSM position, you'll want to have all the code recognize this update. This can be done by restarting the KPIC code
    a. Close your open kpython3 terminals and the viewer. Run the `KPIC_shutdown -rmsems -V` command. (Don't worry, this won't move anything, it just kills the code). Then run `KPIC_init` to restart the code. Then run `start_kpic_cals` to re-open your various calibration terminals and GUIs.

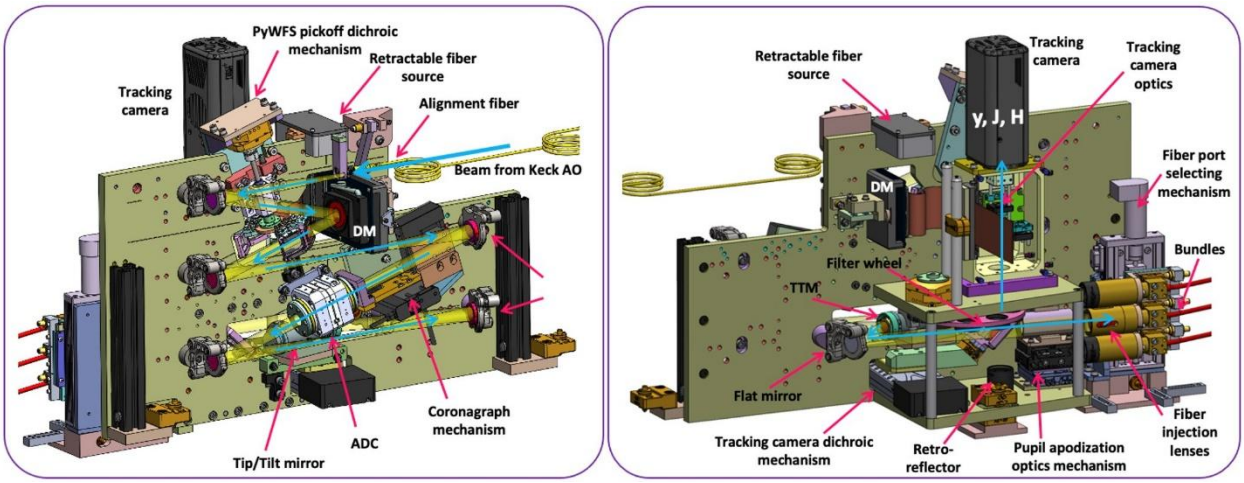
Appendix 4: Schematic Diagrams of KPIC

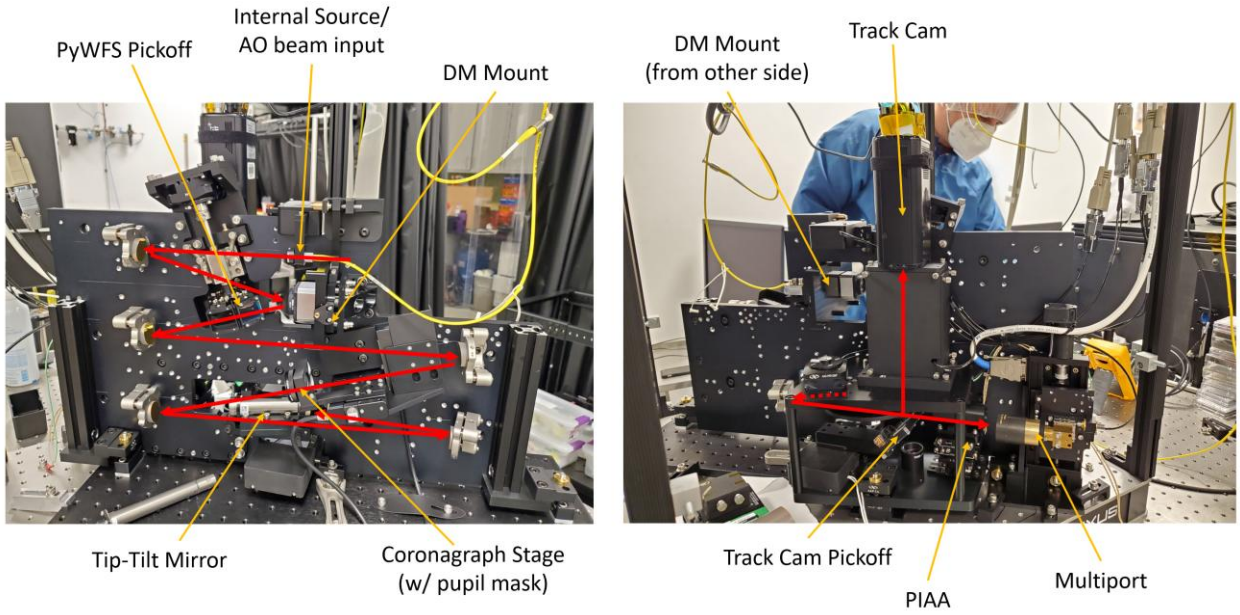
For additional details, see the technical description [in this document]

Schematic Diagram

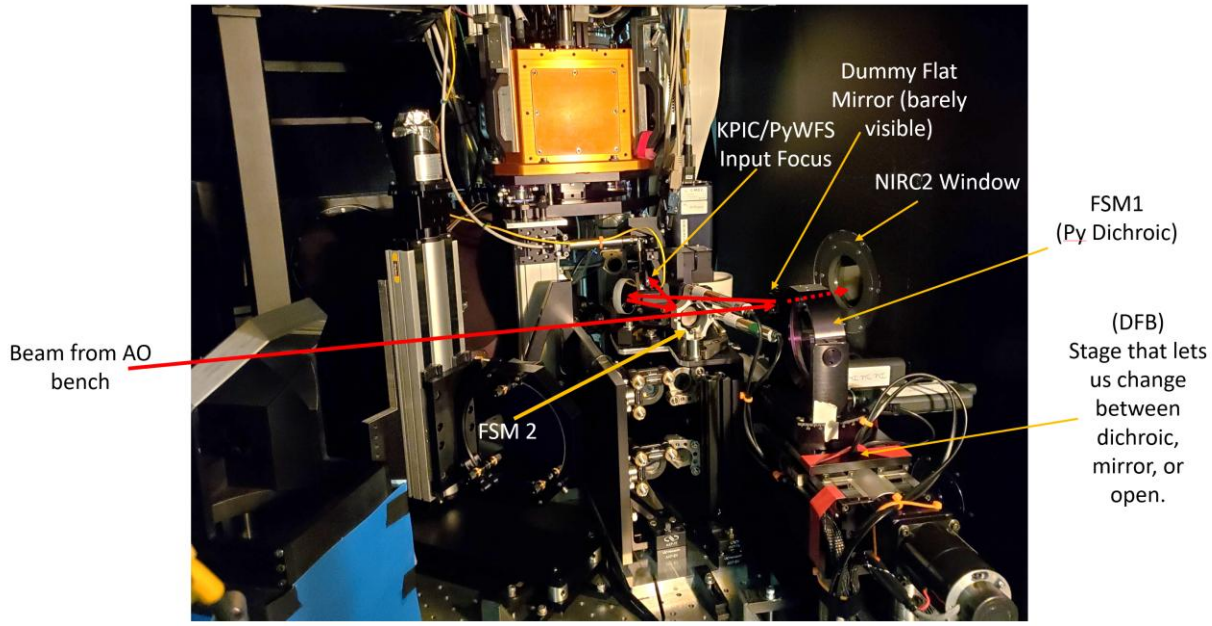


Fiber Injection Unit (FIU) Optical Diagram and Pictures:

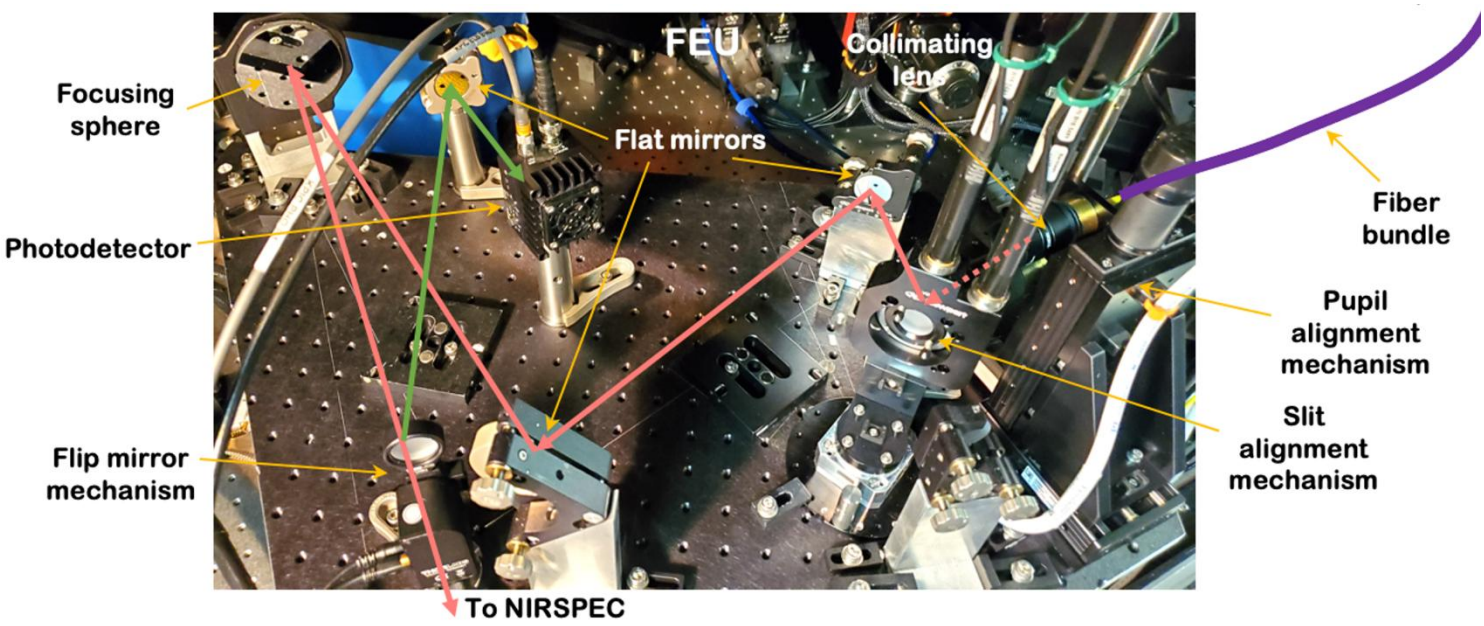




FIU Location inside AO bench:



Fiber Extraction Unit (FEU) and NIRSPAO Plate:



List of positions for KPIC during facility operations

The table below lists the position of all the relevant KPIC stages for science observations and daytime calibrations. Note that if a value is omitted, it is the same as for the KPIC science column.

Stage	KPIC Science	Daycals FIU	Daycals FEU
Stages in the "Devices", "FIU" tab of the GUI			
Light Source Retractor	out		
PyWFS Pickoff	jband		
Coronagraph	pupil_mask		
ADC Retractor	out		
ADC	(does not matter)		
Track Cam Pickoff (TCP)	ds		
Filter Wheel	h		
Pupil/focus changing (Mode Change)	focus		
PIAA *	out		
Multiport	kl_bundle		
Stages in the "Devices", "FEU" tab of the GUI			
Pupil Steering Mechanism (PSM)	kl_bundle		
PSM focus **	~2.51	~2.54 (for PD)	~2.51
Slit Alignment Mirror (SAM) ***	on_slit	pd_sfX	on_slit
SAM rotator ****	in		
PD Pickoff (PDPO)	nirspec	PD	nirspec

* Note – The PIAA "more" button will be yellow in the GUI. This is **fine**. It is kept in open loop most of the time. The daycals code opens/closes the loop if needed. If you need to move the PIAA yourself: click on "more", close the loop, move it, then open the loop.

** Note - the PSM focus may change slightly, this is what the `focus_scan()` optimizes for. The values above are as of June 2024.

*** Note - For the SAM positions:

- Should be on slit for NIRSPEC calibrations
- Should be pd sfX (where X is a science fiber number) when scanning that sf during FIU calibrations.
- Should be off slit for PSM XY Scan.
- Sometimes one fiber is close enough to on slit that it reports on slit as the position instead, and vice-versa, or it'll report a different fiber position.

**** Note – the SAM rotator should be set to 'out' for regular NIRSPAO observations.

Appendix 5: Breakdown of software functions

This section provides a breakdown of what stages and lights are modified by each function used for the procedure above. This is useful for debugging as well as for letting users know what they should expect to happen at each point. Functions which modify something on the K2AO bench are indicated in the function name and AO bench devices are bolded.

calib_setup_sfp (modifies AO bench)

- Checks that all KPIC stages are ready for operations (have their control scripts running, are connected, and have loops closed as needed). Checked stages include:
    - Multiport, Light source retractor, PyWFS Pickoff, Tracking camera pickoff, tracking camera filter, coronagraph, PSM XY, PSM focus, ADC retractor, PIAA, Pupil/focus view, SAM, SAM rotator, PD pickoff, KPIC MIR source, KPIC 2um laser, BMC DM, Keck SFP, FAM.
- Commands all stages to the right position for FIU calibrations. For Facility mode, the positions are shown in in the table above. This function puts the stages into the "Daycals FIU" positions.
- **Queries user to know if they are good to move things in the AO bench. If so:**
    - **Moves the DFB to mirror**
    - **Sets AO light source to off**
    - **Sets AO light source blocker to open**
    - Sets KPIC MIR lamp and 2um laser to on
    - **Sets SFP to kpic-silica**
    - **Sets KPIC light source retractor to out**

kpic_sfp_source (modifies AO bench)

- Checks the light source switch is in the KPIC position
- **Sets the K2AO light source to open**
- **Moves the KPIC light source retractor out**
- Sets the FAM to the center position
- If run with `'on'` or `source='on'`:
    - **Moves the light source switch to put KPIC sources at the front of the AO bench**
    - Checks that the KPIC MIR2 lamp is off
    - Turns on the KPIC MIR1 lamp
    - Turns on the KPIC 2um laser
    - **Moves the SFP to KPIC-silica**
- If run with `'off'` or `source='off'`:

    - **Moves the light source switch to put Keck source at the front of the AO bench**
    - Turns off the KPIC 2um laser
    - Turns off the KPIC MIR lamps
    - **Turns the K2AO source on**
    - **Moves the SFP to pws**

fiber_finding

- Moves FAM to scan around fiber positions
- Moves BMC DM to apply a map
- Moves SAM to align with each science fiber
- Scans SAM if low PD power is detected

ncpa_scans_tests

- Moves FAM to stay on the desired fiber
- Moves BMC DM to apply modes
- Moves SAM to align with the science fiber
- Scans SAM if low PD power is detected

setup_for_spec (modifies AO bench)

- **Sets the K2AO light source to nd1**
- Modifies the tracking camera settings to appropriate values for ND1
- Moves the FAM to take a cred2 background and return to center
- Moves the PD pickoff to NIRSPEC
- Moves the SAM to on slit
- Moves the PSM to focus to 2.54
- **Moves the light source retractor to out**
- Takes an image with SPEC

sam_scan

- Sets K2AO light source to nd1 if not already set
- Sets NIRSPEC integration time and number of reads
- Moves SAM to scan across nirspec slit
- Takes exposures with NIRSPEC
- Moves FAM to maintain position on science fiber

focus_scan

- Moves PSM focus
- Takes exposures with NIRSPEC

- Moves FAM to maintain position on science fiber

kpic_offsky (modifies AO bench)

- **Moves light source retractor out if not already there**
- Moves pupil/focus viewing to focus if not already there
- **Moves SAM rotator to out if `sam_rot_out=True`, otherwise leaves it in. Move the rotator out if doing NIRSPAO before KPIC**
- Checks that the filter wheel is in h and warns if not.
- Checks that PD pickoff is out of the beam and moves it if not
- Confirms/turns off KPIC 2um laser, KPIC MIR sources, and K2AO light source
- Zeros the BMC DM

kpic_onsky (modifies AO bench)

- Turns on KPIC DAR
- **Confirms/moves light source retractor out**
- **Confirms/moves SAM rotator in**
- Confirms/moves pupil/focus viewing to focus
- Checks tracking filter is h and warns if not
- Confirms/moves PD pickoff out of the beam and powers it off after
- Confirms/turns off all calibration sources

setup_for_scam (modifies AO bench)

- **Sets the K2AO light source to nd6**
- Modifies the tracking camera settings to appropriate values for nd6
- Moves the FAM to take a cred2 background and return to center
- Moves the PD pickoff to NIRSPEC
- Moves the SAM to off slit
- Moves the PSM to focus to 2.54
- **Moves the light source retractor to out**
- Takes an image with SCAM

PSM_Scan_XY

- Moves PSM XY position to scan
- Moves tracking camera to take backgrounds/stay on fiber
- Sets SCAM integration time and takes SCAM exposures