PFS Commissioning and Open Use Status

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Subaru Users Meeting FY2025 at NAOJ Mitaka HQ
2025.10.30

Contents and Summary

- Instrument status
  - Open-use observation started in March 2025.
  - Fiber throughput variation: suppressed below 1% by applying index matching gel.
  - Flux non-uniformity: improved to 0.11 mag in run 23 (June 2025).
  - Fiber configuration accuracy: stabilized to 20-50um.
  - Fiber cleaner development: prototype assembled and tested in Oct. 2025.
  - Autoguiding: AG1 adjustment improved guiding stability, although up to 100um camera instability remains.

- DRP status
  - Scattered light correction: newly implemented in the DRP.
  - Sky subtraction: throughput variation of a few percent were found across each fiber patrol region
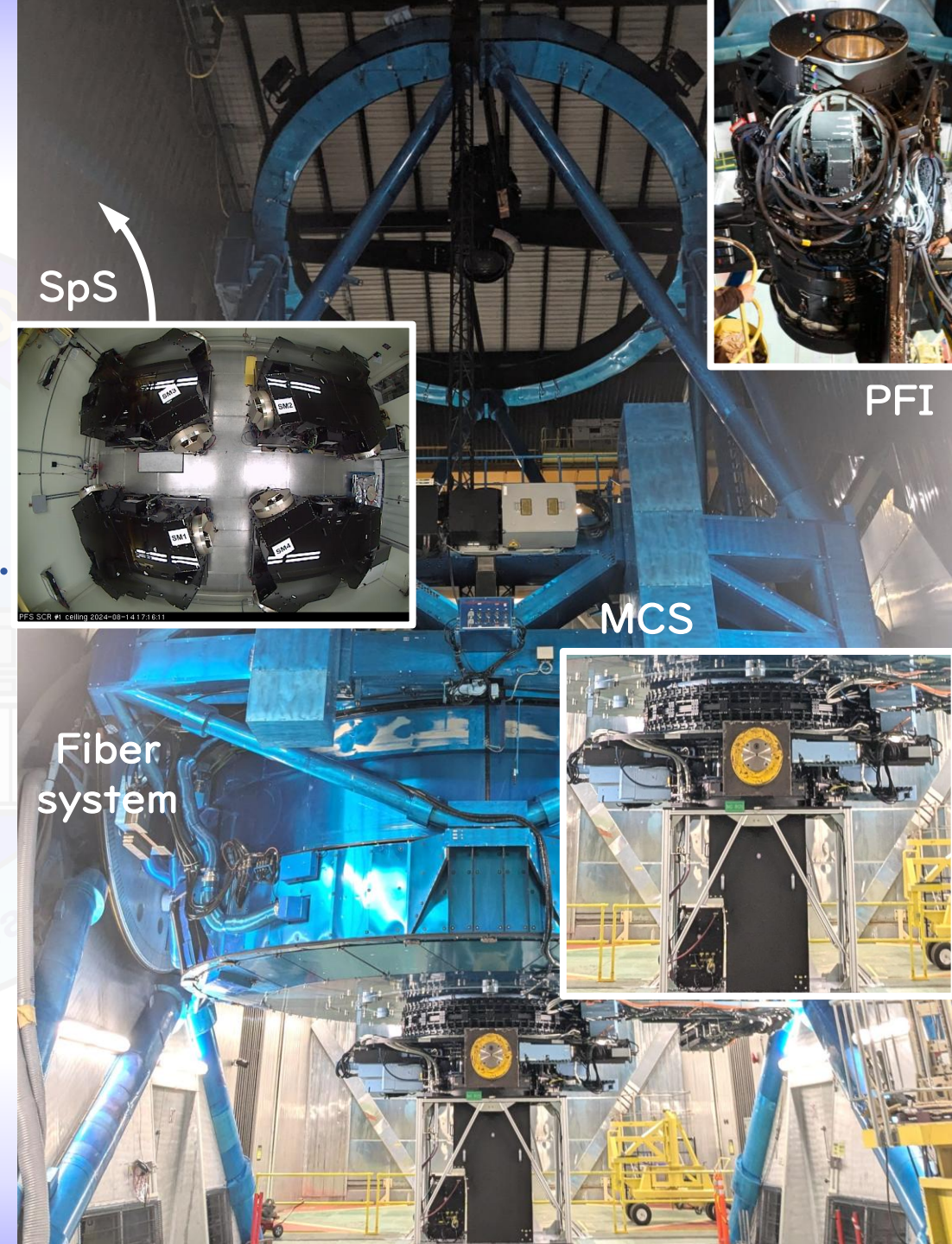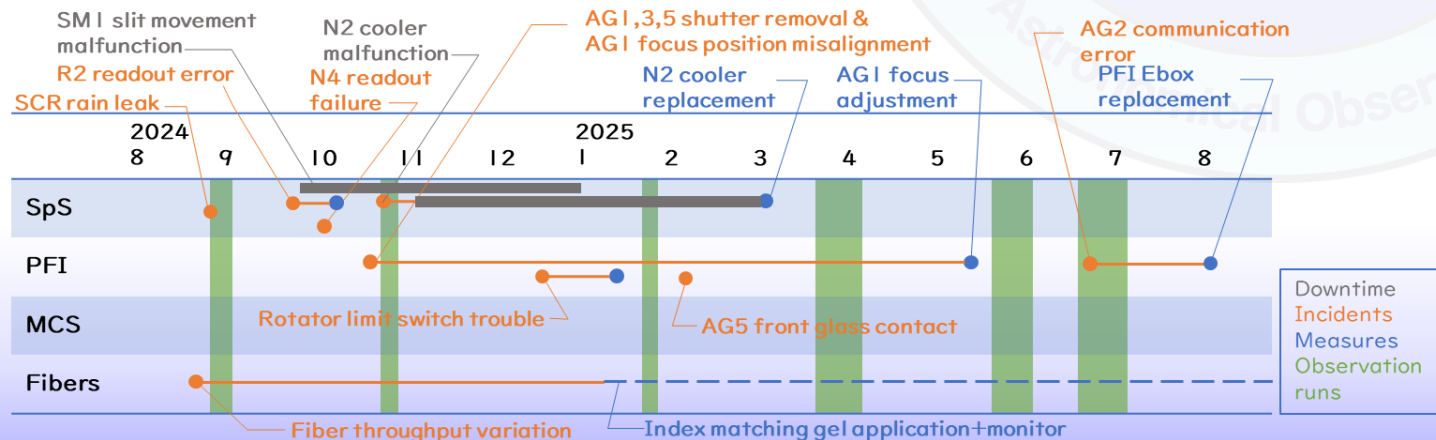 - NIR data: non-linearity for N3 detector characterized.

- Open-use status
  - Open-use operation in S25A were successfully completed, with nearly 100% completion rate.
  - Target duplication issue: duplication of S25A science targets as flux standards or observatory fillers caused partial data ownership conflict; resolved for S25B.
  - IFU-like mode: available from S26A (as announced in the CfP)
  - Others: queue progress page opened for PIs; operation software updates continue.

Instrument Status

- Operation with full subsystems at Subaru Telescope since August 2024.

- PFS continues stable operation
  - Very few downtime which affected the observation runs
    - SM1 malfunction with the fiber slit movement (9/2024~1/2025)
    - SM2 NIR camera cryocooler issue (10/2024 to 3/2025)

- Open use observation started in March 2025 (S25A).

- Detailed status –> Moritani-san's poster (P09)

SpS

PFI

MCS

Fiber system

Instrumentation history at Subaru since full installation

SM1 slit movement malfunction
R2 readout error
SCR rain leak
N2 cooler malfunction
N4 readout failure
AG1,3,5 shutter removal & AG1 focus position misalignment
N2 cooler replacement
AG1 focus adjustment
AG2 communication error
PFI Ebox replacement

	2024				2025							
	8	9	10	11	12	1	2	3	4	5	6	7	8

SpS
PFI
MCS
Fibers

Rotator limit switch trouble
AG5 front glass contact
Fiber throughput variation
Index matching gel application+monitor

Downtime
Incidents
Measures
Observation runs

Fiber throughput variation

The variation stays low and stable less than 1% level through a run.
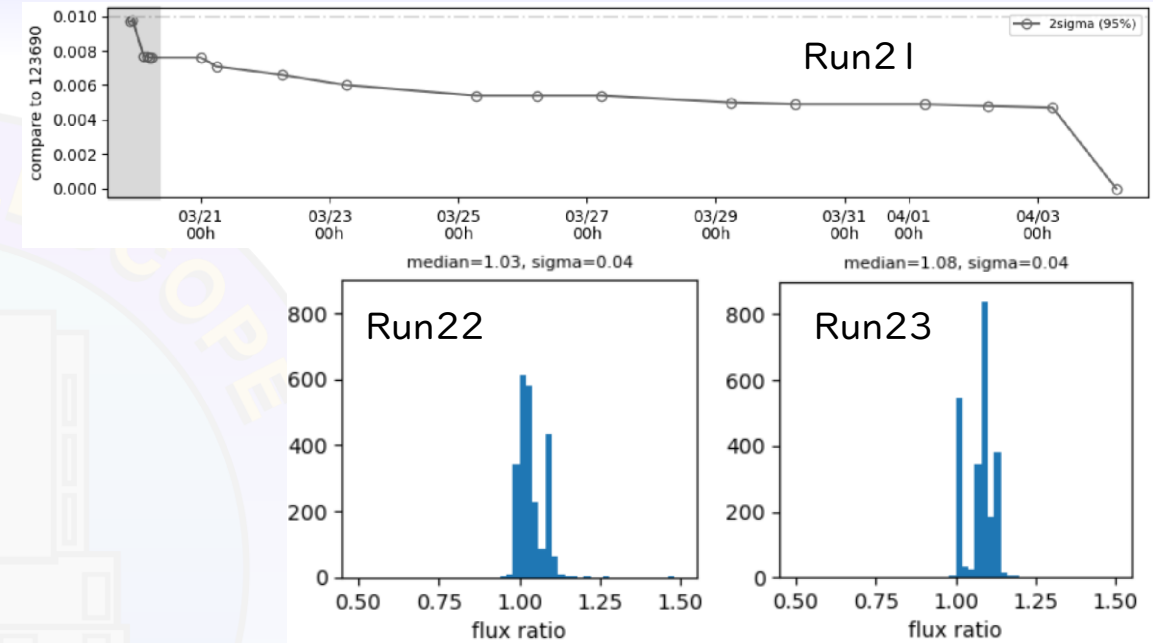
- At Cobra Home position, with InR=0

- Thanks to the index matching gel application

- The throughput can vary 5–10% between runs probably due to fiber disconnection/reconnection and gel cleaning/application
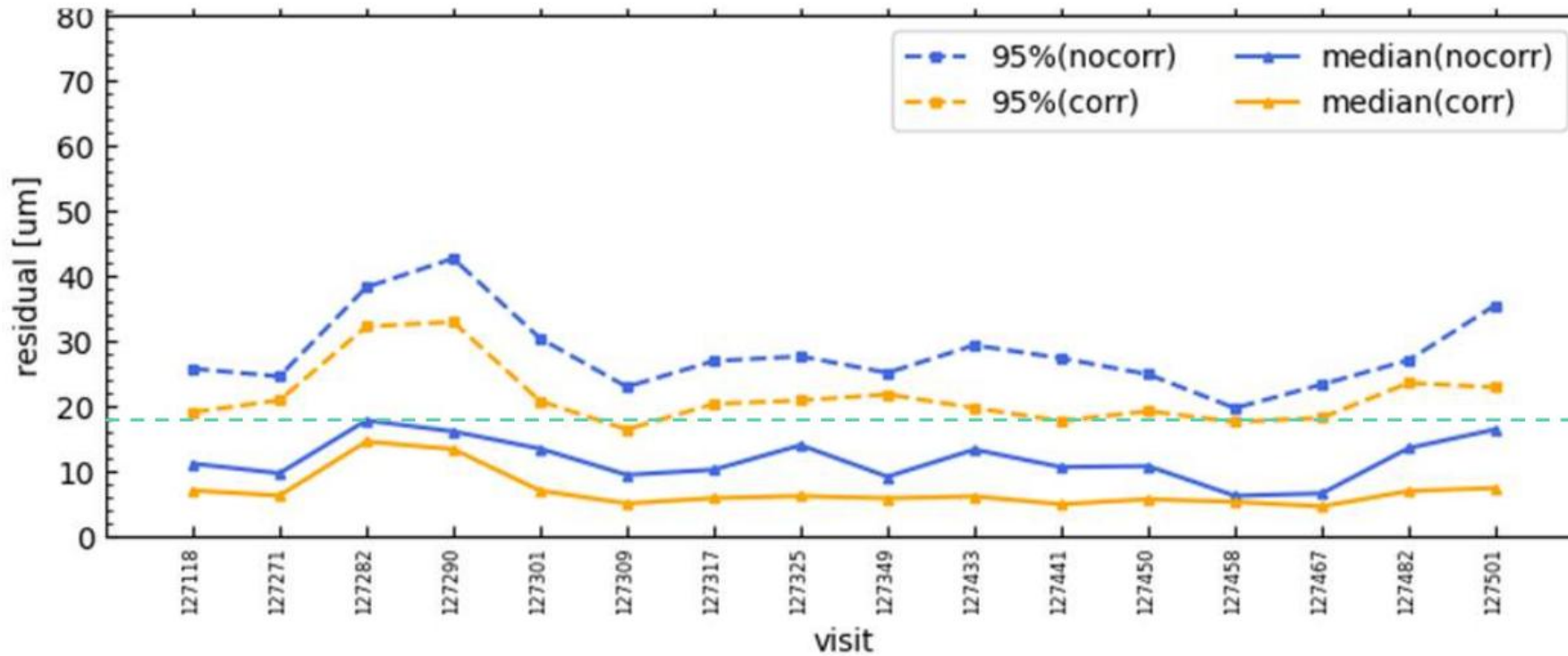

Fiber throughput variation through run 21 (upper) and its distribution of run 22 and 23 in comparison to run 21.
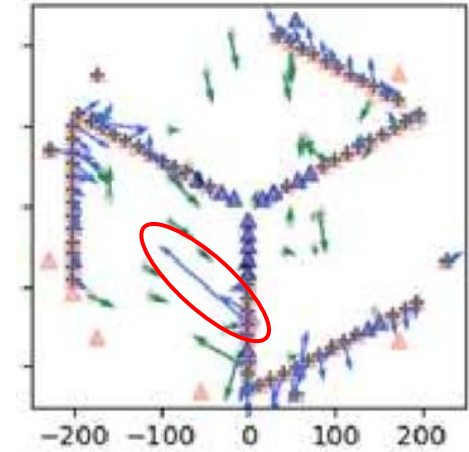
Acquisition/guiding accuracy

Autoguiding achieved 0.1 arcsec accuracy at best conditions

- AG1 mechanical positions were updated.
  - Additional optics for focal position adjustment
  - Updated lateral position definition in the software with latest measurement.

Focus position of AG cameras after AG1 adjustment (left) and lateral positions (right).
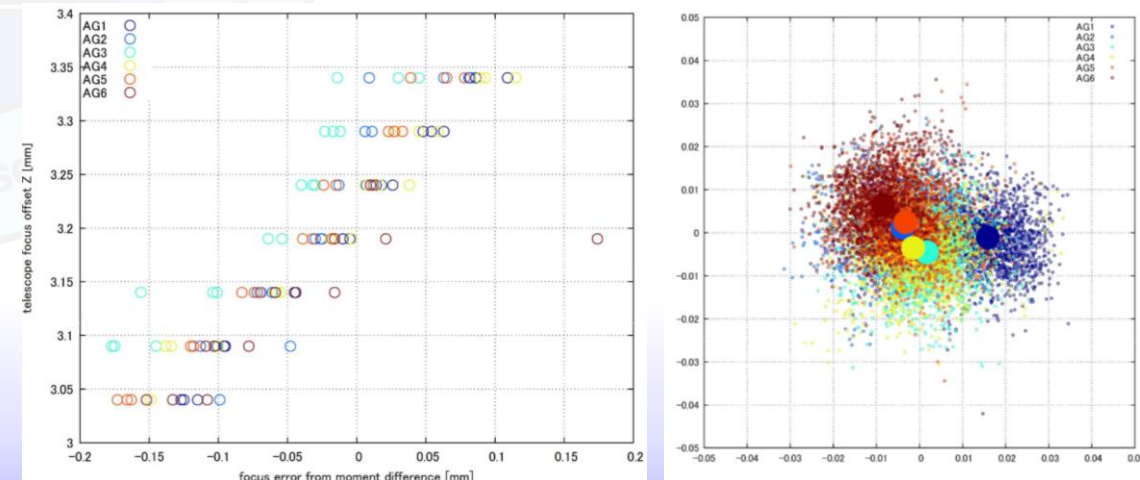
Fiber Configuration accuracy

- 20–50um with 95% of fibers according to raster scan

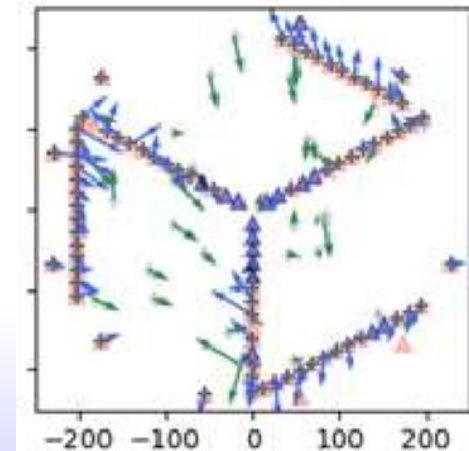- Excluded fiducial fibers showing outlying movement during the fiber configuration process from run 23.

Run 22 (2025.05)

Run 23 (2025.06)

18um: ~5% flux loss

Fiber configuration accuracy measured by raster scan. 95%–ile of raw measurement stayed in a range of 20–50um.

An example of outlying FF exclusion

Remaining Action Items on Instruments

- Flux uniformity
    - Detailed distortion study
- Fiber configuration degradation?
- Development of fiber connector cleaner
- Upgrade of AG mechanical mounts
- N2 detector replacement
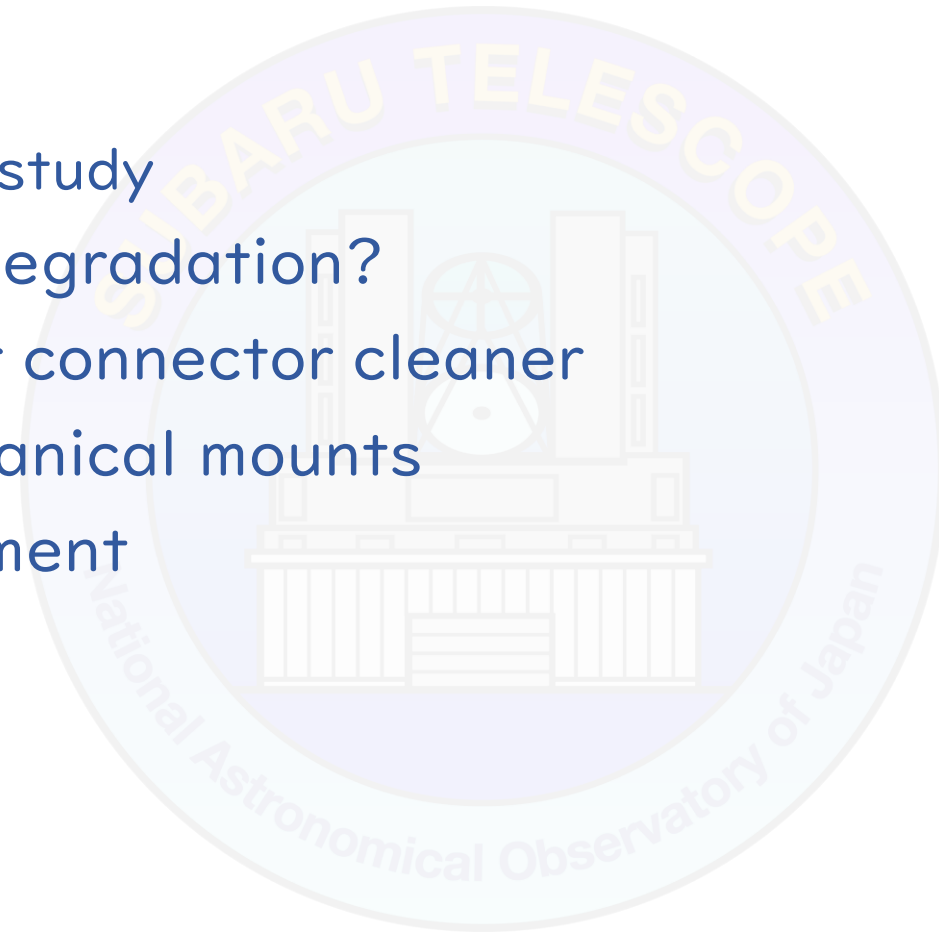
Flux non-uniformity

- Fluxes over a field of view have scatters of ~0.14 mag (in March 2025 run, run21)
  - Mostly from the fiber positioning issues?
- Various efforts to suppress the non-uniformity have been carried out.
  - Fiber configuration: outlying FF clipping, detailed study on coordinate transform
  - Acquire-field/Auto-guide: AG camera focal/lateral position
- Non-uniformity dependency on the telescope elevation still exists.

Histogram of flux non-uniformity in run 21 (upper) and 23 (lower).
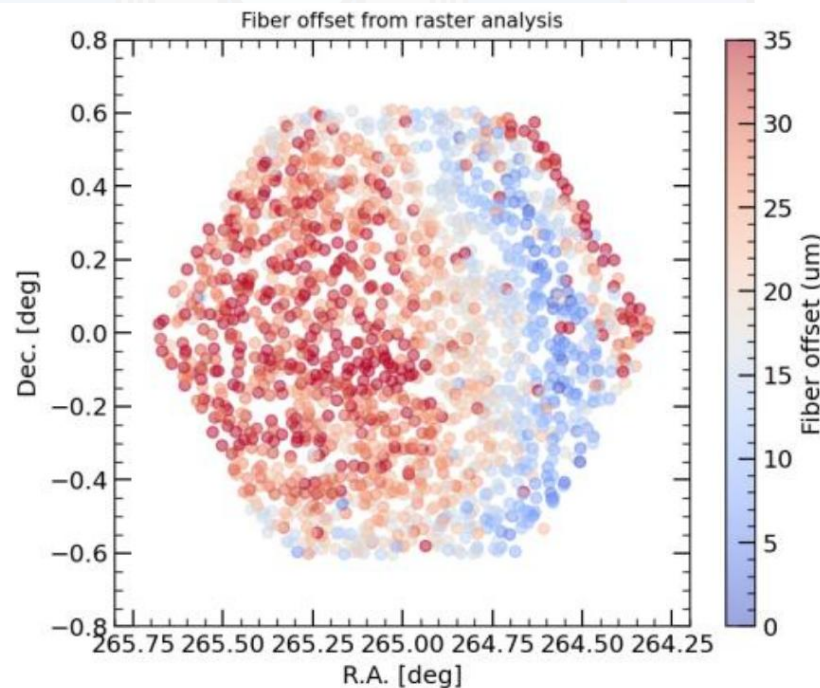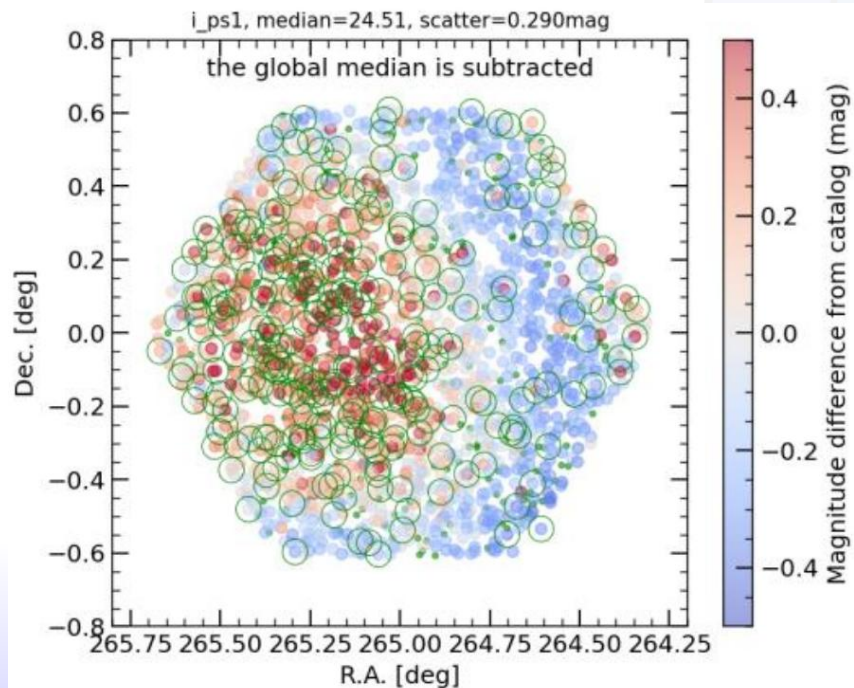
Flux non-uniformity example in a FoV (left) and comparison with the fiber offset pattern
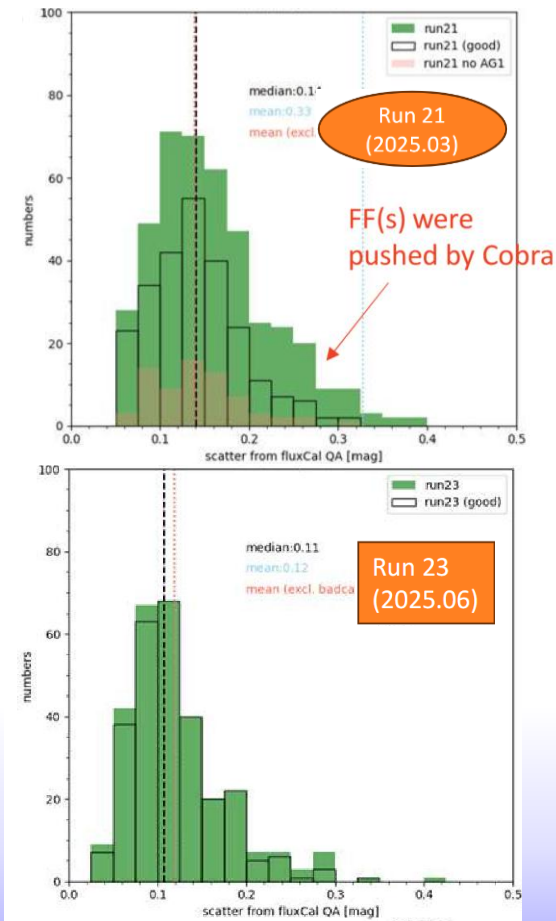
Fiber configuration degradation

- Fiber configuration accuracy seems deteriorating through past years
  - More Cobras with convergence worse than 50um.

- Possible causes
  - Cobra actuator movement calibration got outdated? (motorMap, geometry)
  - Some Cobras are jammed with collisions?

- Measure
  - motorMap was updated recently and it improved convergence.
  - Visual check of Cobra movement
   - Only 1 Cobra jammed
 - Full calibration of Cobras is ongoing
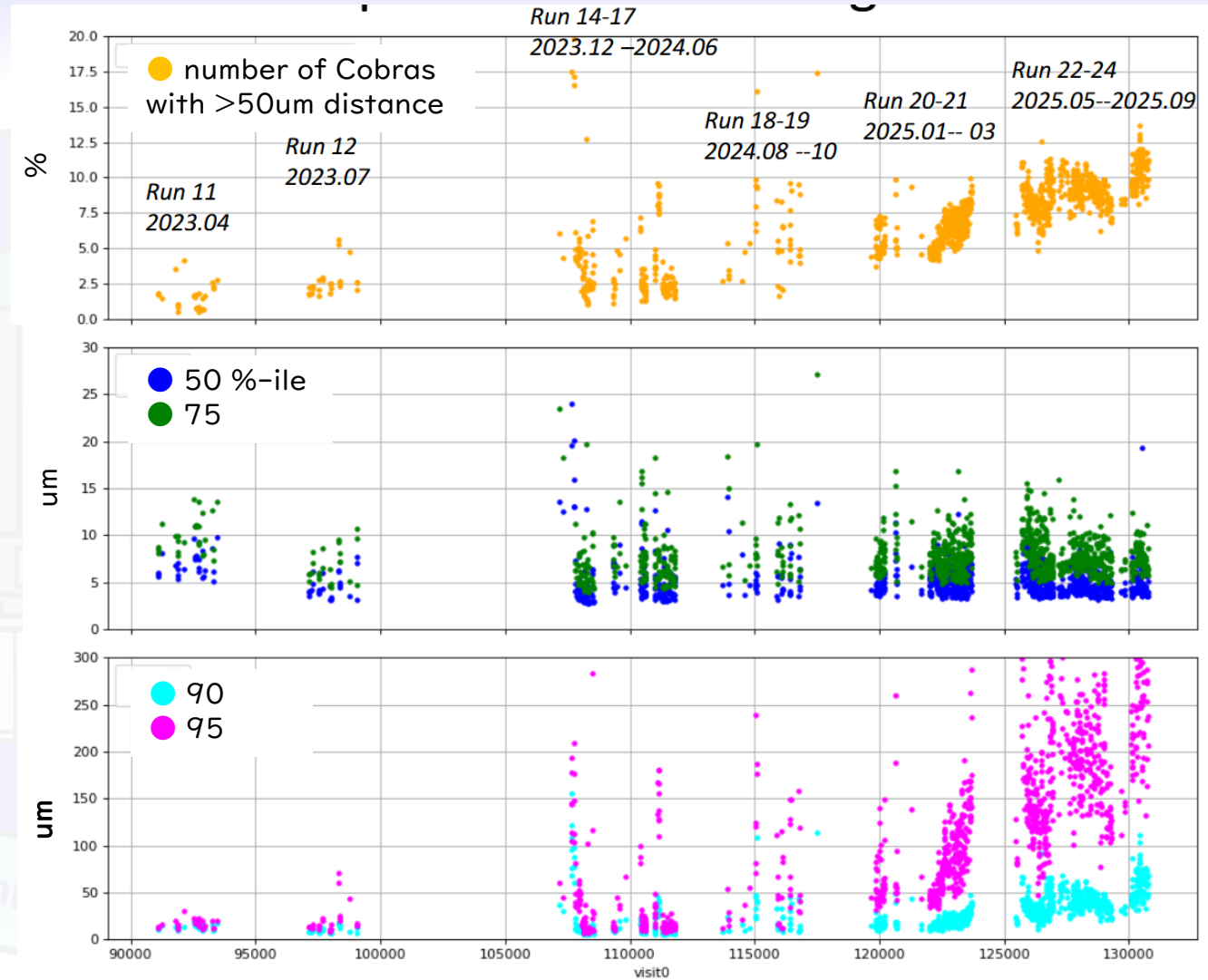
Cobra convergence deterioration. Two lower panels shows the distance of each Cobras from the target position of 50, 75, 90, 95 %-ile while the upper panel shows the numbers in % of the Cobras which was further than 50um from targets.

Index matching gel cleaner

- **The index–matching gel cleaner** for fiber connectors is under development
  - Cleaning the Tower connectors at the telescope spider.
  - Key equipment for more PFS runs in a semester.

- **Assemble and test of prototype (Oct. 2025, at PU)**
  - Body part (by PU) and interface part (by OiO, Brazil) worked well together.
  - Blow IPA from nozzles with pressured N2 gas and wash the connector surfaces
  - Vacuuming out of the waste liquid seemed unnecessary.
  - Working on the updated design.
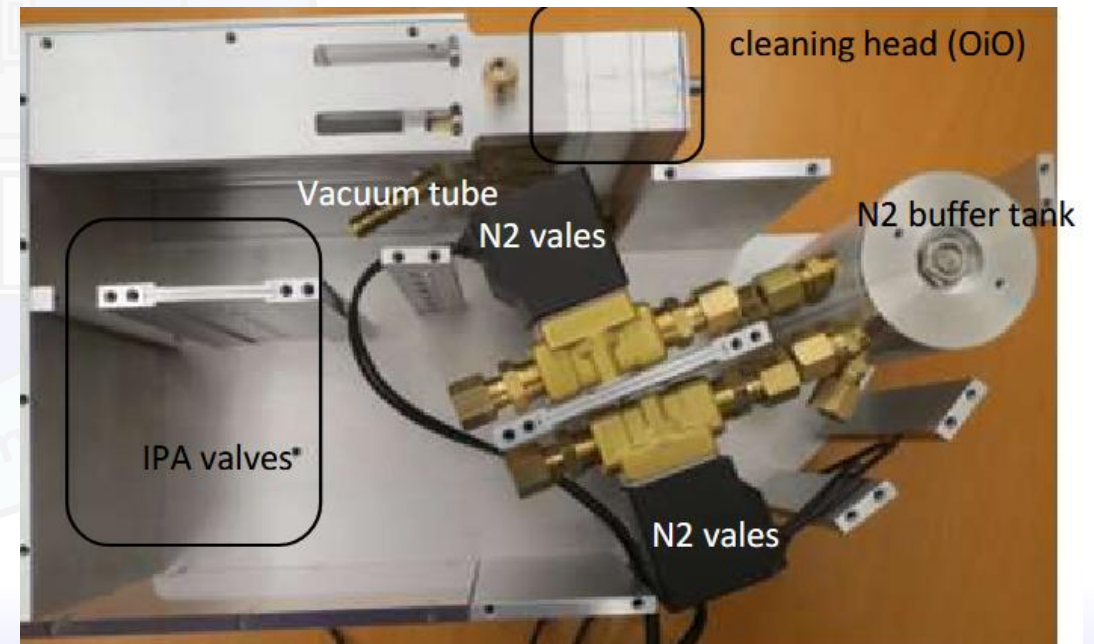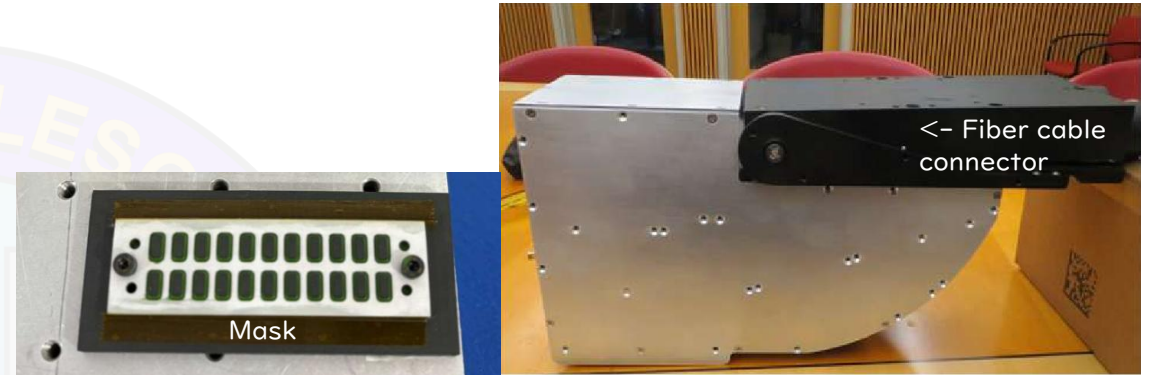
Prototype of the index matching gel cleaner for CableB connectors.

AG camera mechanical mounts upgrade

- ˜100um position variation found even after AG1 adjustment.
  - Varies along telescope/InsRot positions
  - Current mechanical support of cameras is not sufficient.

- New mechanical design of AG camera mounts with ASIAA and PU
  - Will be tested with 2 cameras in Jan 2026. If it works, the rest will be upgraded in S26A.
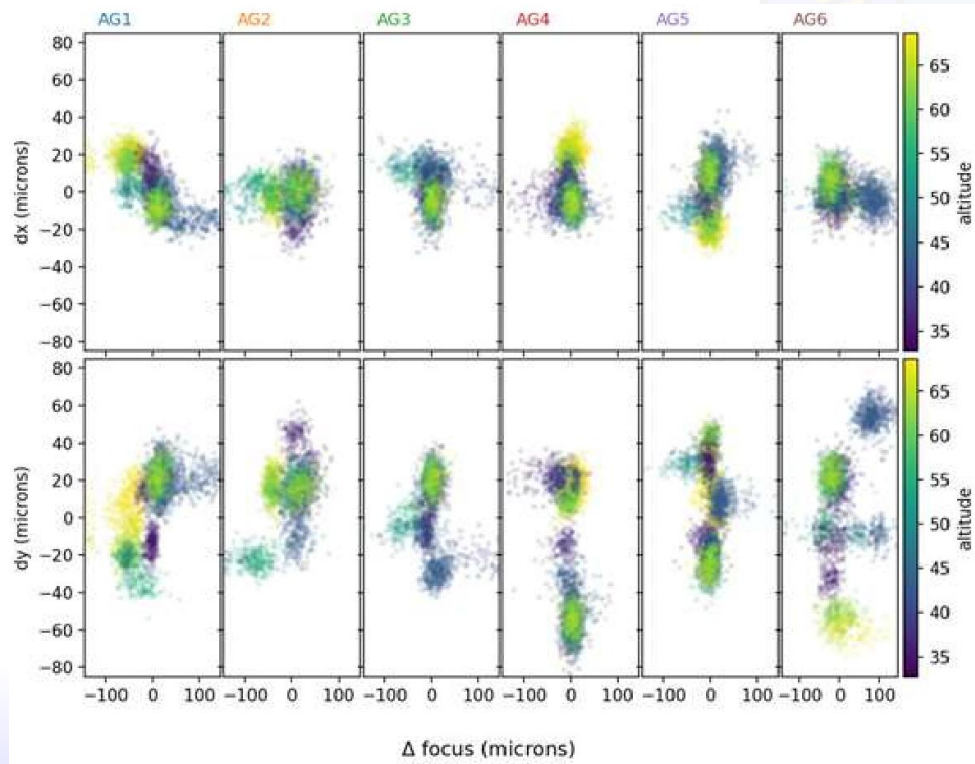
Displacement of AG cameras in PFI plane (dx, dy) and in focal axis (Delta focus) at various telescope altitude (color bar)

New design of the mechanical support of AG cameras. The AG cameras occupy the volume red dashed line shows.

Designs: Shian-Yu Wang (ASIAA)
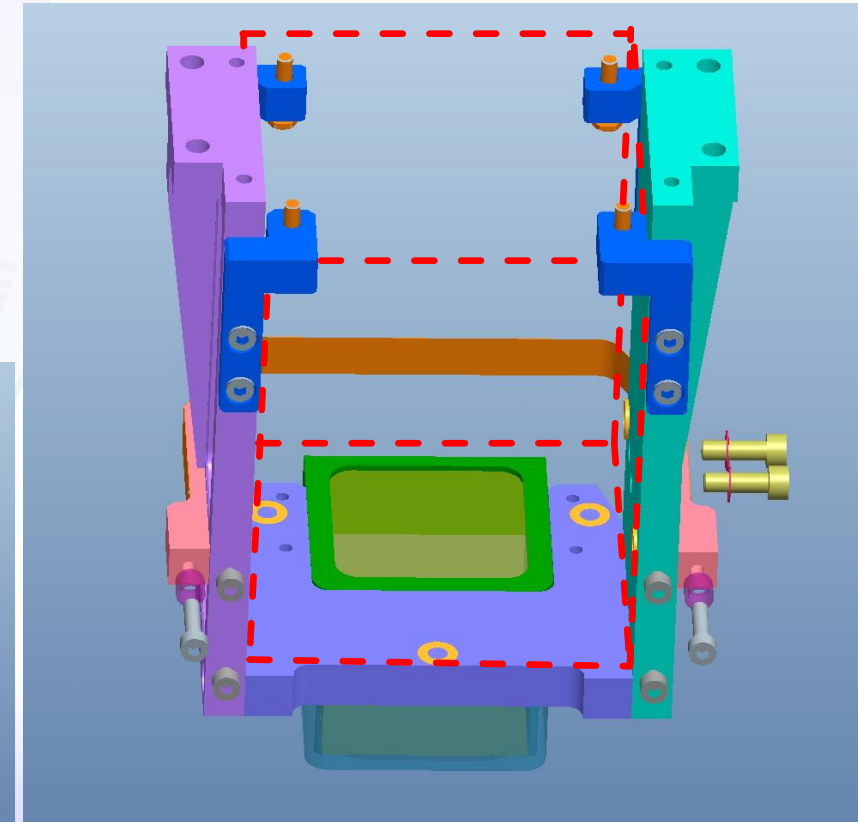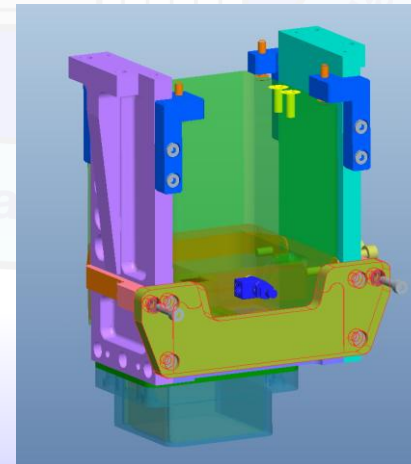
n2 detector replacement

- Current H4RG for n2 has strong and long-lasting persistence.
  - Replace with a spare detector: less persistence, comparable QE, and a little worse cosmetics

- Schedule (TBC)
  - N2 camera removal: Feb. 2026
  - Replacement at JHU: Mar. to Jun. 2026
  - Reinstallation at Subaru: Aug. 2026

- Observation down time of the camera in S26A
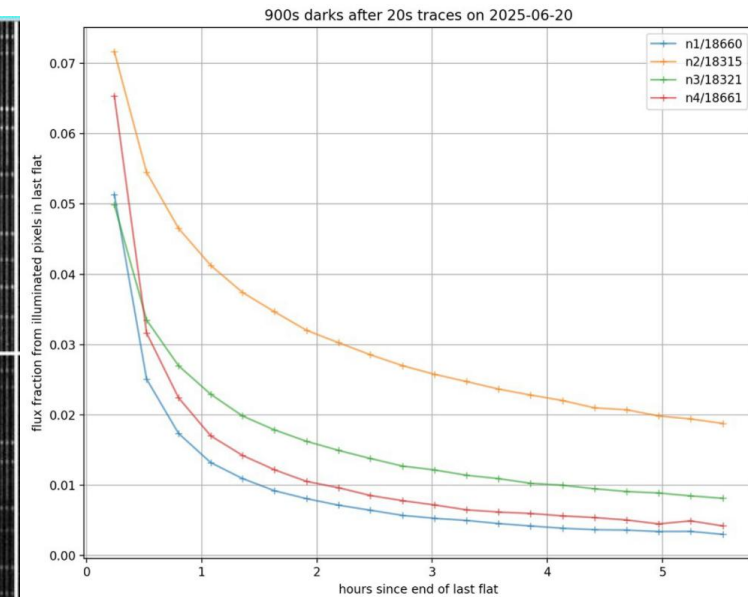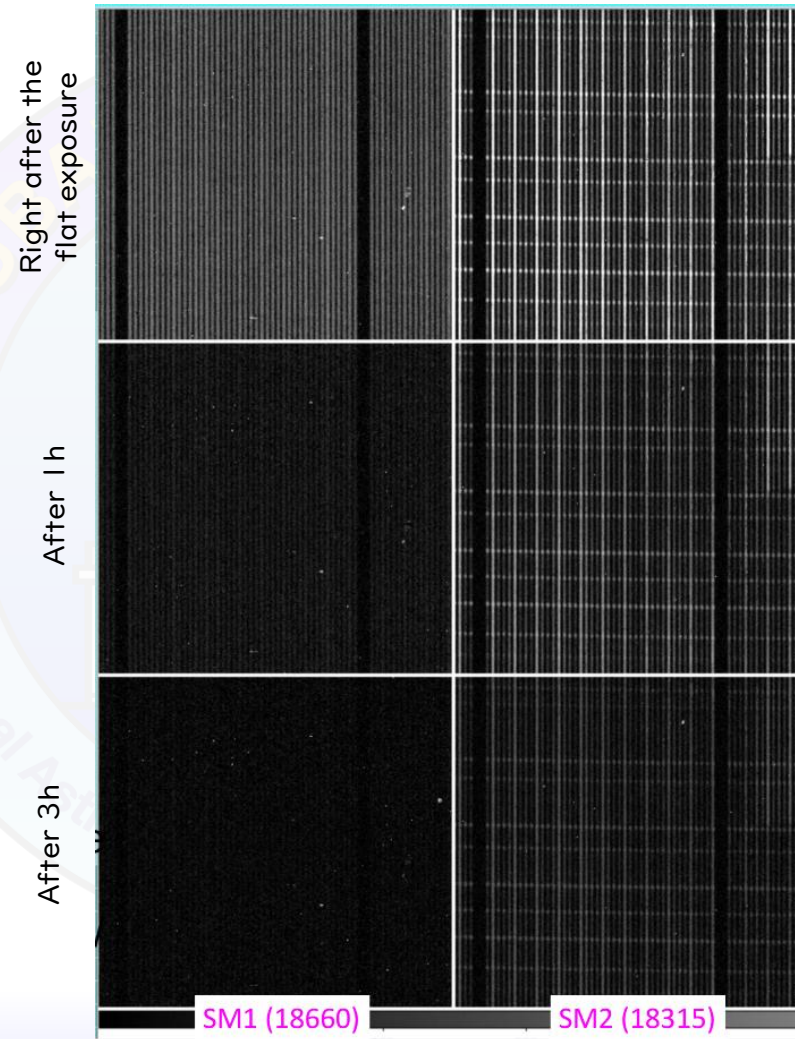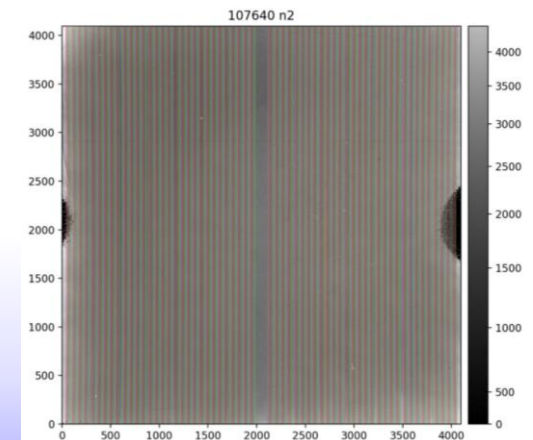 - The observation efficiency in NIR will be reduced to 3/4 of S25A/B

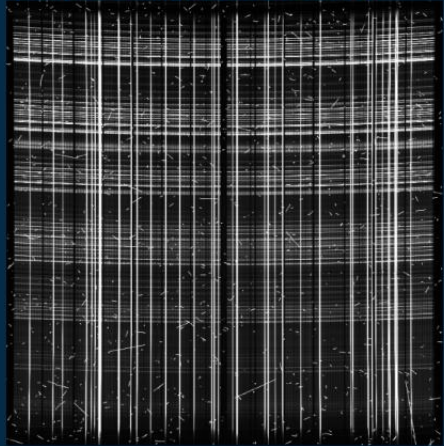Image of persistence pattern of NIR detectors with SM1 and 2 (left) and their attenuation (right)

Image of new NIR detector)

Figures: Jim Gunn (Princeton)

Data Reduction Pipeline status

- DRP
  - **2D DRP**: 2D image reduction with basic reduction, sky subtraction, spectral extraction, merging arm, flux calibration, coadding etc.
  - **LAM 1D**: Spectrum data analysis such as redshift and line flux measurement, etc.

- Start working in the open-use operations
  - **Onsite QA (2D):** Processing data right after its acquisition and calculate effective exposure times (EETs)
  - **The Science Platform (2D+1D):** run-wide batch processing at Mitaka for data distribution.

- Upgrades continue mostly on..
  - Scattered light subtraction
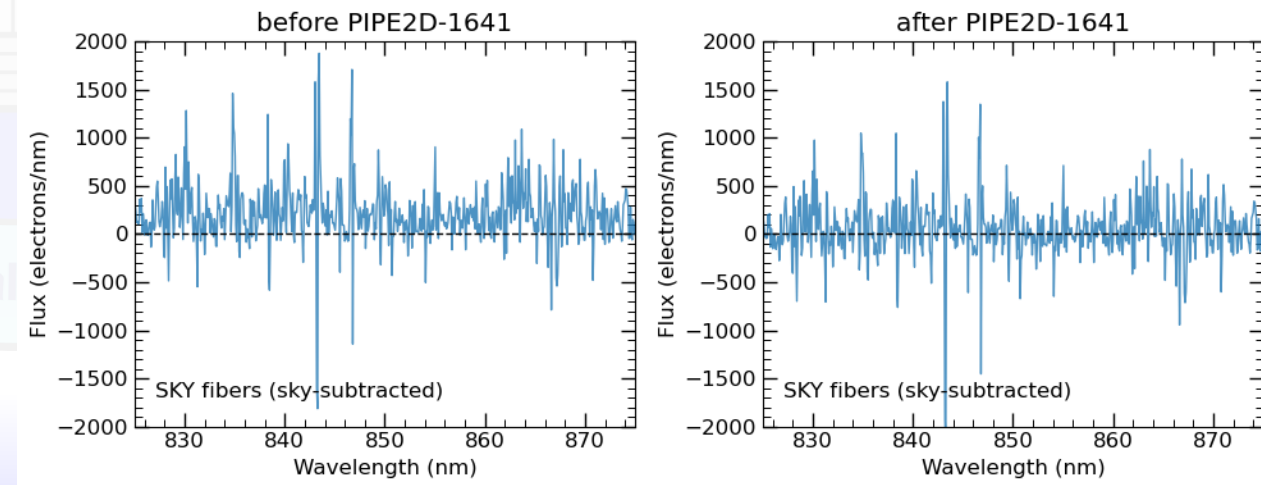 - NIR data reduction
  - Sky subtraction

- Details -> Yabe-san's poster (P11)

Scattered light correction

- Scattered light correction
  - In each SpS arm, scattered lights are seen in 2D images.
  - Model fitting and subtraction
    - Manual parameter adjustment has been completed with all cameras (b, r, n, and m) and included in the pipeline.
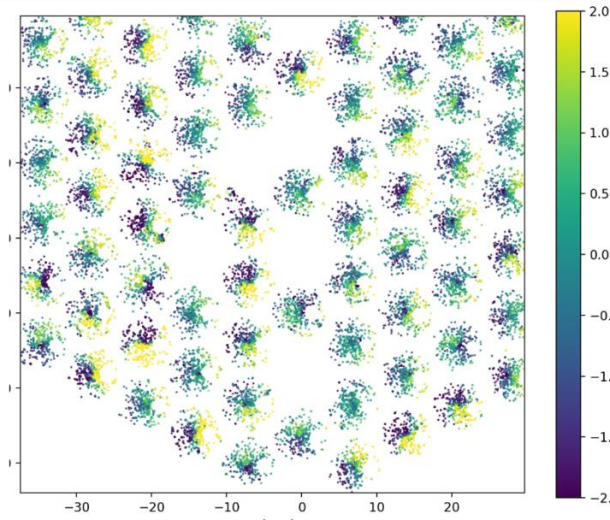   - Investigation continues on cases of over subtraction in N–arms
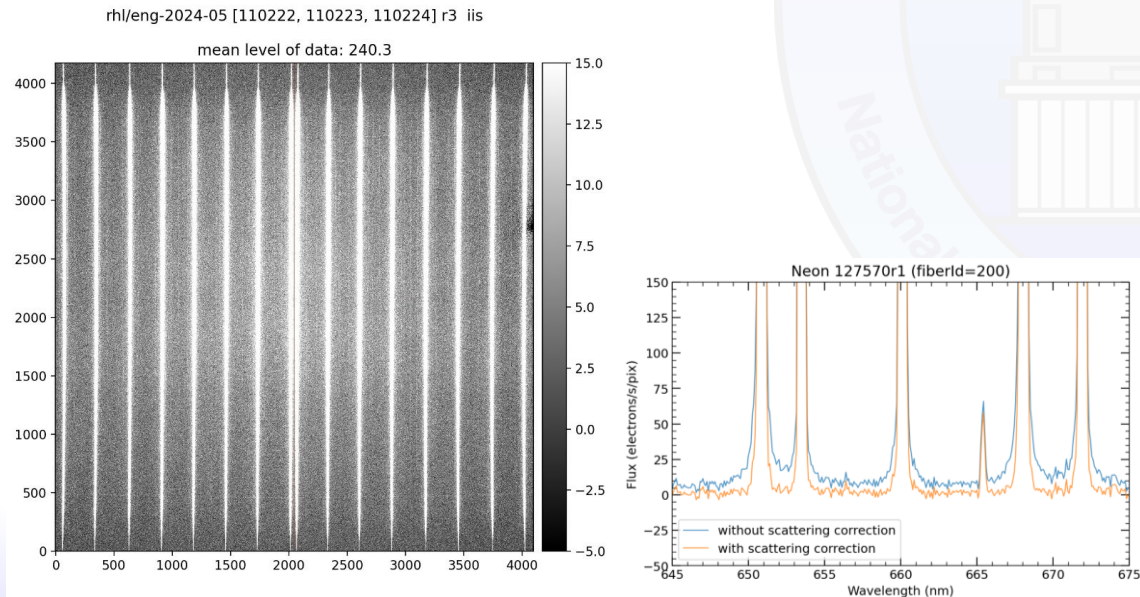
Scattered light pattern (left) and example of subtraction with a Neon spectrum (right)

Example of sky subtraction before (left) and after (right) the scattered light correction
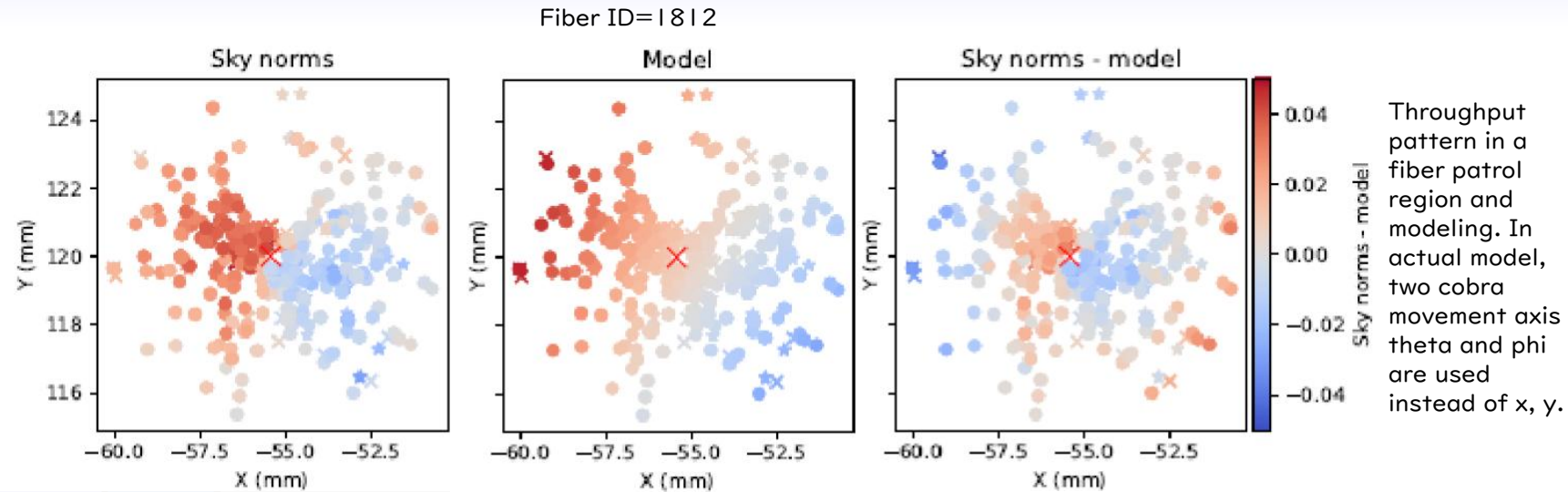
Sky subtraction

Throughput variation of each Cobra in their patrol regions

Fiber ID=1812

Throughput pattern in a fiber patrol region and modeling. In actual model, two cobra movement axis theta and phi are used instead of x, y.

- Fiber throughput patterns found in each Cobra patrol region
  - Tilt of the Cobra rotation axis or fiber orientation from the telescope optical axis: ~5mrad ?
  - Pattern fitting and subtraction can reduce the variation from several % to 0.5%.
  - The correction was implemented to 2D DRP
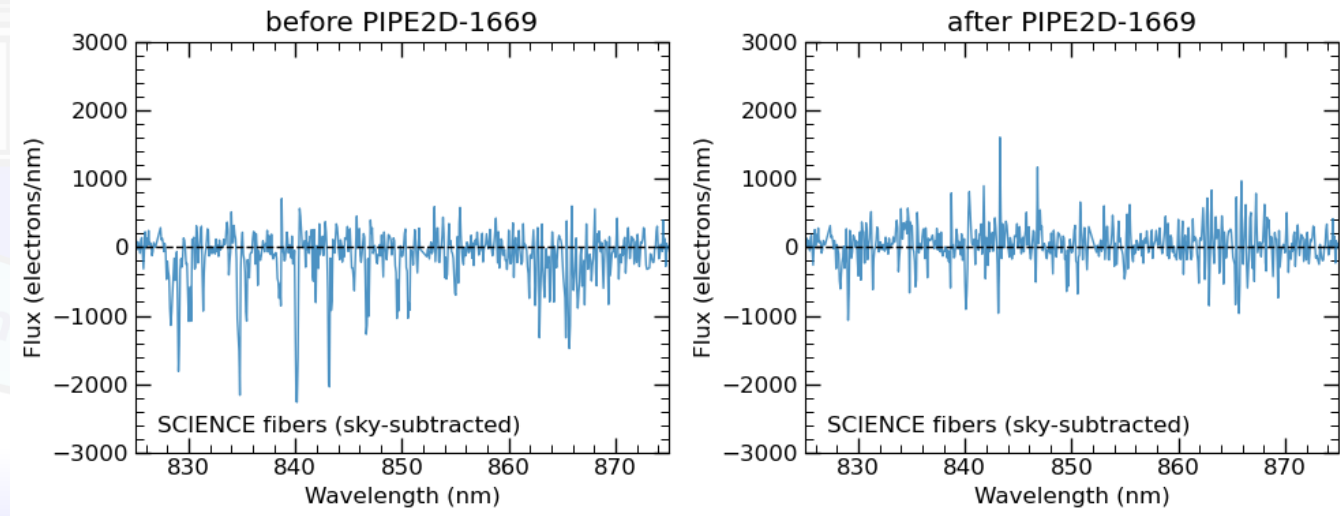
Sky subtraction before (left) and after (right) the pattern correction
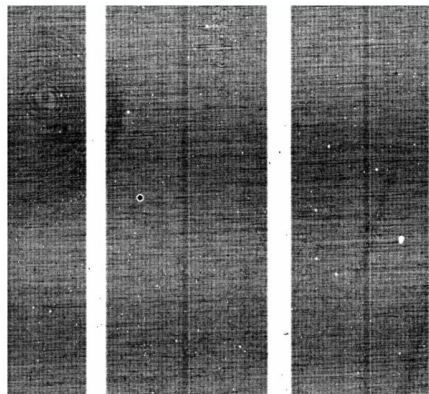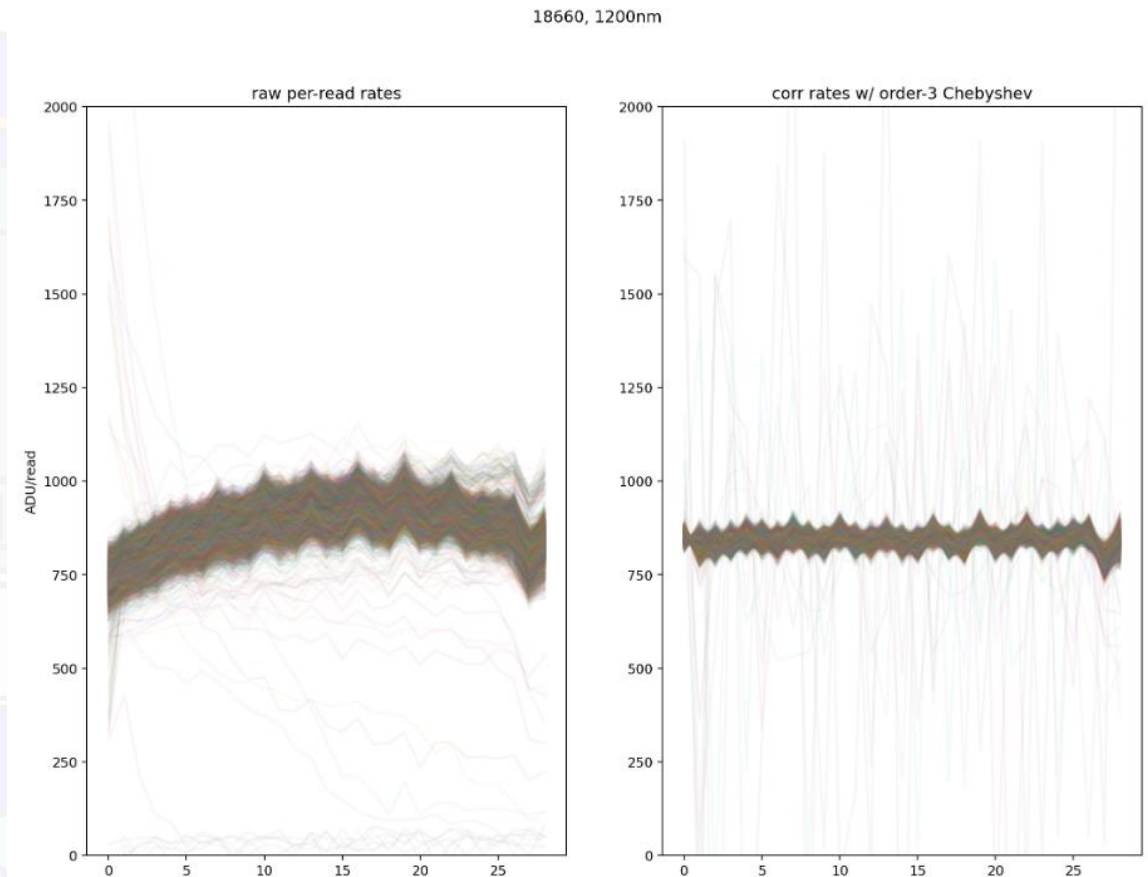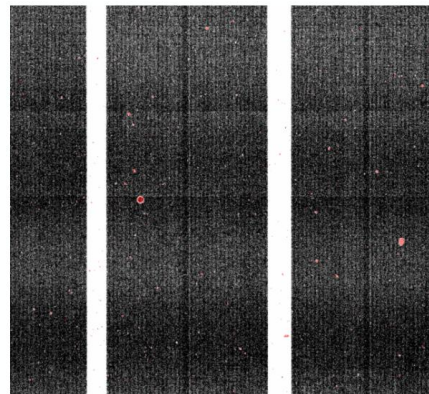
NIR data

- **Non-linearity correction** with NIR detectors
  - NIR cameras in SM3 (n3) was characterized using flat data taken at the JHU laboratory.
  - For better characterization including other NIR cameras, new dataset should be acquired at Subaru.
- Persistence correction by DRP will be tackled after the stable non-linearity correction is established.

Raw | Corrected. Same stretch.

Test with the drift flat data taken at Subaru. Before correction (left) and after (right)

18660, 1200nm

raw per-read rates | corr rates w/ order-3 Chebyshev

Non-linearity per pixel measured with the laboratory data (left) and correction with 4th polynomials (right)

Figures: Craig Loomis (Princeton)

Open-use Status

S25A allocation	
Queue	15 night
Classical ToO	1.5
SSP	14
UH	5.5

- PFS started Open-use operations since Mar. 2025 in the risk-share mode

- S25A operation achievement
  - Open use operations in queue, classical, SSP, and ToO modes are successfully done.
  - About 100% completion rate for grade B programs
    - Note that S25A had very conservative time allocations.

- Data access
  - Raw data at STARS are accessible after each run
  - Pipeline products at the Science Platform are accessible after a couple of months from a run.
  - For S25A, all run-wide processing products are available. The semester-wide processing comes soon.
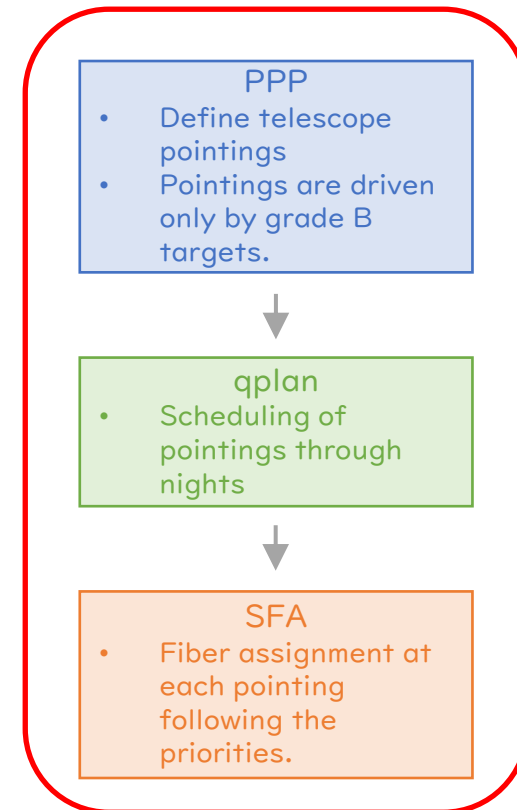
- The runs in S25B are ongoing.

Completion Rates for Grade B & C Programs

Target duplication issue

- The observatory filler/flux standard star lists included common targets with some science program
  ->led to mishandling of priority/proprietorship in fiber assignment process in the "Integration Code" (He-san's poster, P16).

- A systematic investigations revealed three types of duplication happened in S25A.
  - Some targets in science programs were observed as flux standards
  - Some targets in science programs were observed again as observatory fillers after completion of science program.
  - Science filler targets were observed as observatory fillers

- Mitigation measure:
  - A duplication check routine was implemented in the integration code and all those duplications are avoided in the observation planning in S25B and after.
  - The exposures of the duplicated targets were transferred to the science programs in the coming semester-wide processing.

- Details will be in the discussion session after this presentation.

The Integration Code

PPP
- Define telescope pointings
- Pointings are driven only by grade B targets.

qplan
- Scheduling of pointings through nights

SFA
- Fiber assignment at each pointing following the priorities.

IFU-like mode

- IFU-like mode is open from S26A.
  - Request for this mode already came up in CfP of S25A.
  - A demonstration of this mode was made firstly in the previous engineering runs inS25A.

- Taking exposures assigning fibers to each position of the "sampling pattern"
  - A triangle or a hexagonal pattern is available.

- Classical mode only.
  - Repetitive exposures at one pointing center is required.
  - One sequence takes a long time -> about 2 hours (900s, hexagonal).

- DRP provides spectra and other common products only for each exposures.
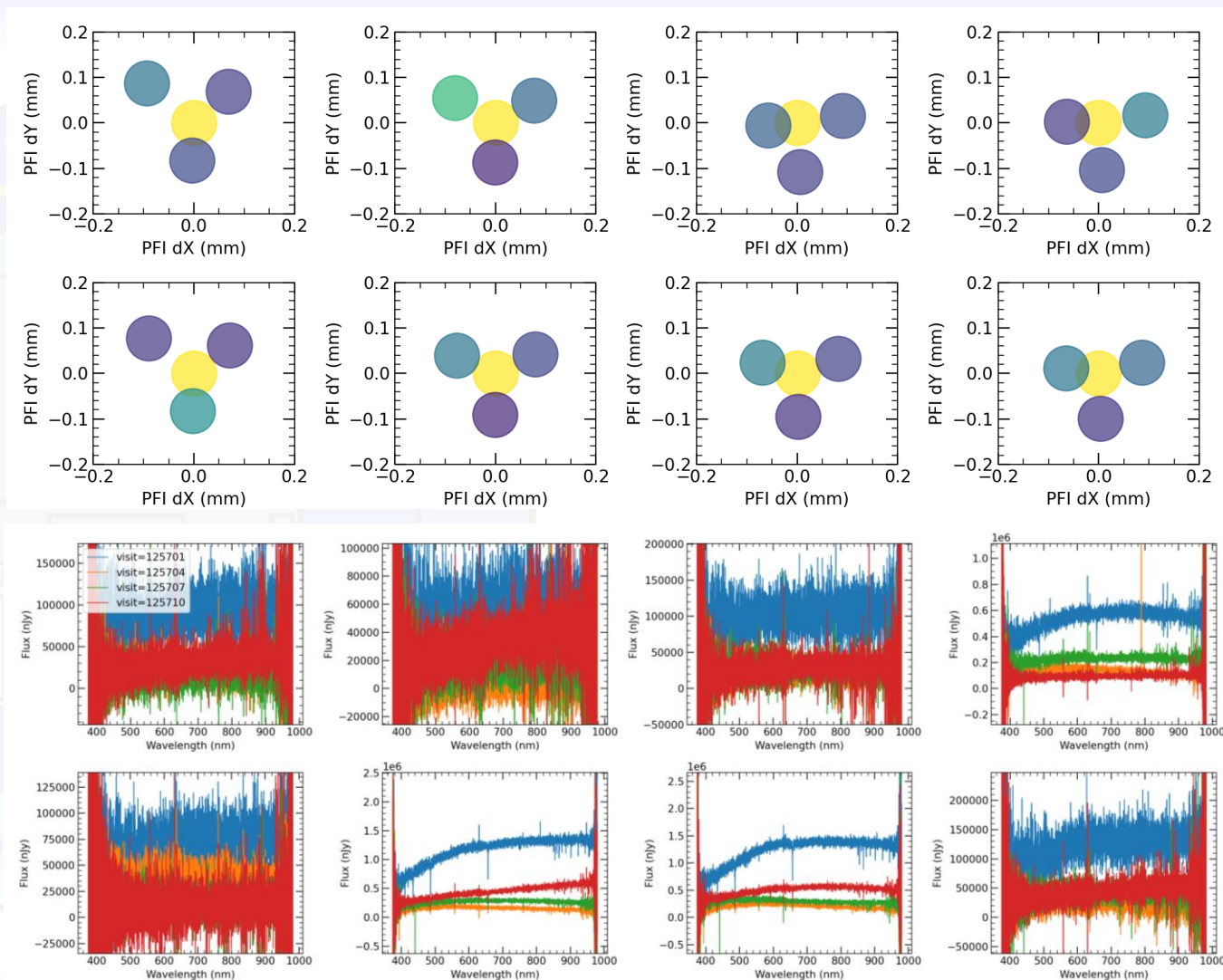
IFU-like mode demonstration in the engineering run in Jun. 2025.
Actual fiber positions of selected fibers in IFU mode (upper panels)
and the obtained spectra (lower panels)

Other Updates

- Queue progress pages is open to PIs
  - PIs can monitor progress of their program nightly.

- Continuous updates of operation software
  - Rotator handling: Adjustment of Gen2 to especially narrow InR range of PFI (-174~174 deg)
  - Overhead time reduction by realizing telescope slew during SpS data readout
  - Etc.

Screen shot of the queue progress page