PFS Instrument Status

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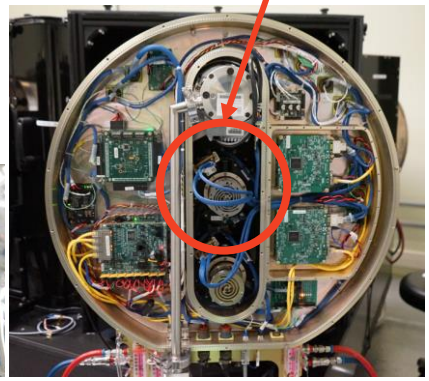
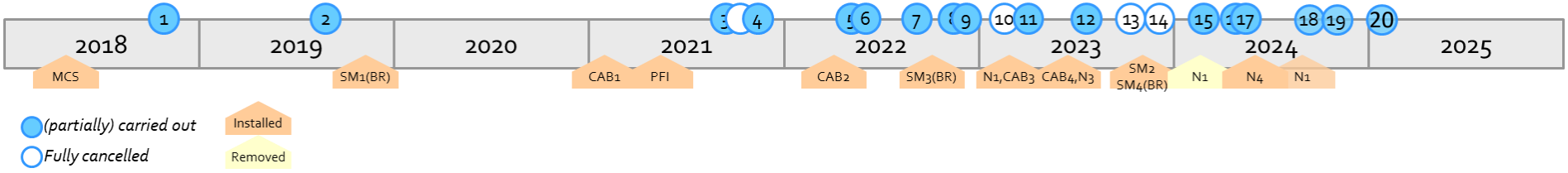
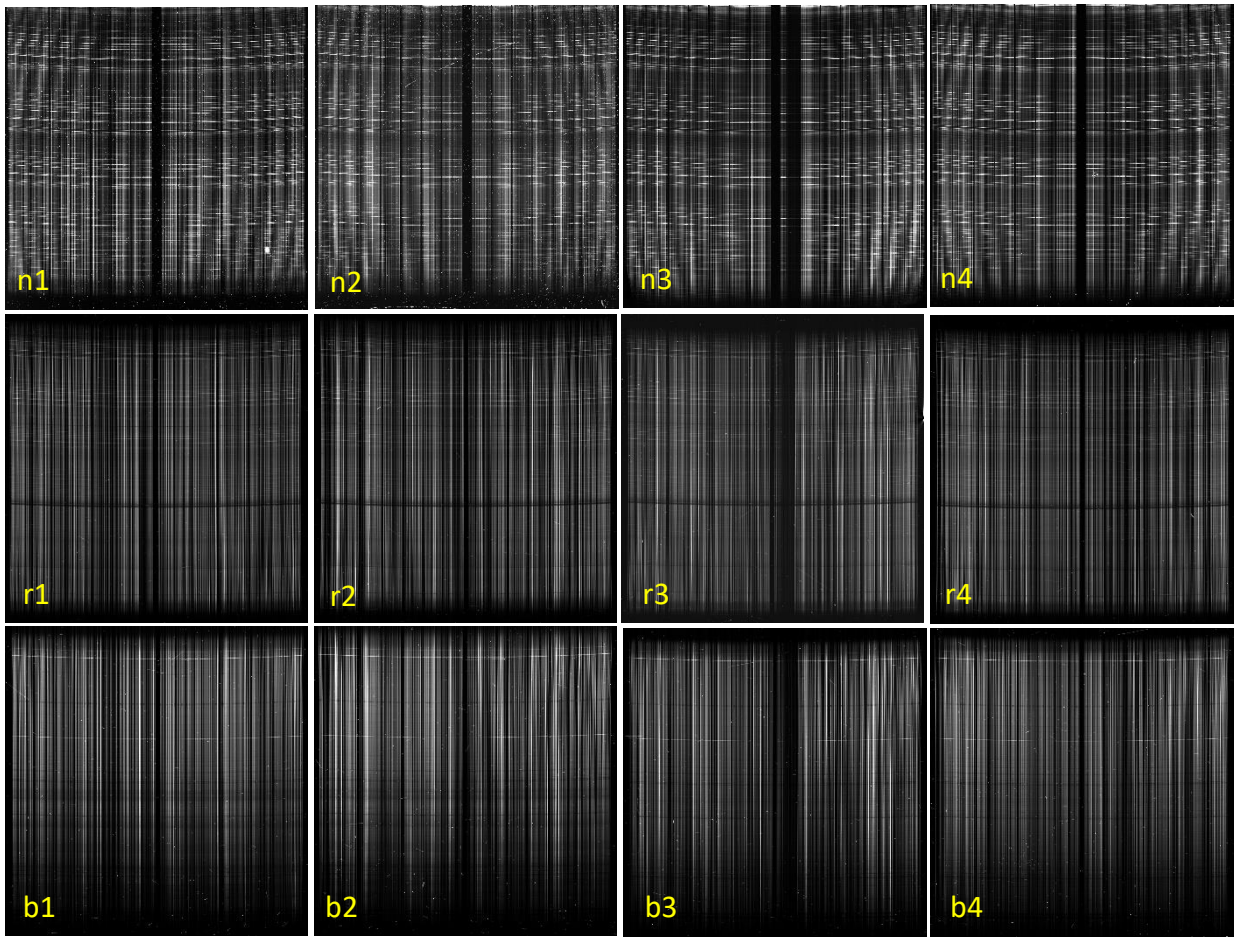
Completion of hardware delivery in 2024

- It was ~6.3 years to complete delivery of the all hardware.
  - Start with MCS in April 2018
  - Complete with NIR camera of SM1 in August 2024
  - A lot of effort by PFS technical members and supports by Subaru staff and DCs.
- Engineering observations along with hardware deliveries.
  - PFS technical team and PFS A-project members carried out integration work and engineering observation one after another.
- Upgrade and modifications of the instruments
  - MCS M1 support, PFI E-box stabilization, AG focal position correction, VPHG orientation correction
- Troubleshoot of the instruments
  - As of today, one SpS camera (NIR for SM2) has trouble with cryocooler. A project members/Inst Div have been consulting the PFS collaborator (JHU) and vendor.
  - Cooler replacement is scheduled in Feb.

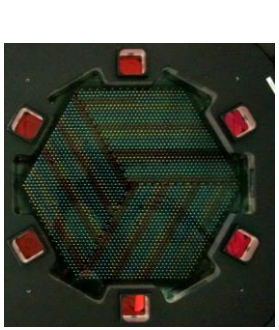


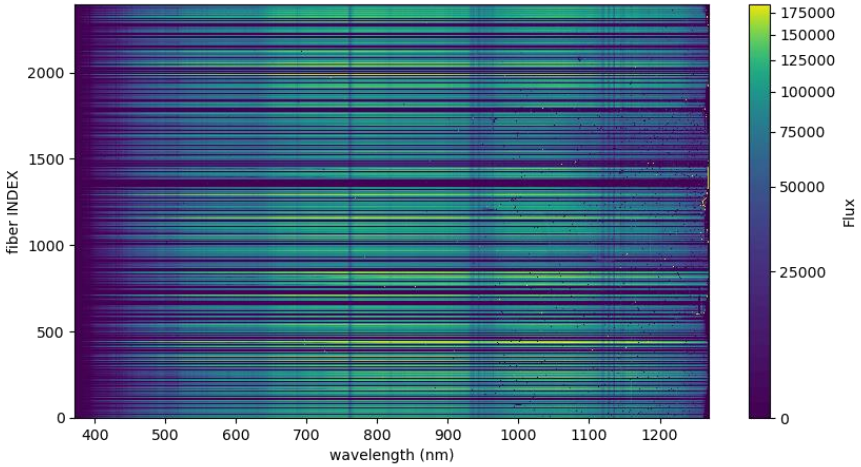


Spectra with the full system



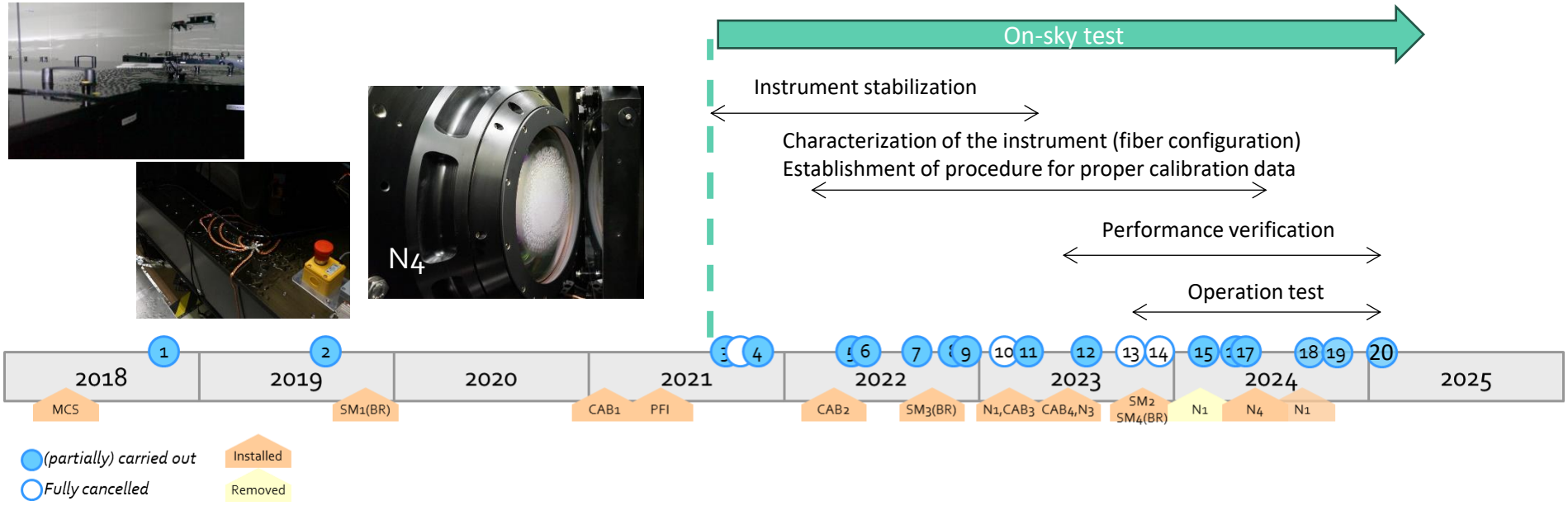
calExp images of the 12 cameras (left) and pfsMerged spectra for visit=115021 (a field of many flux-std stars)



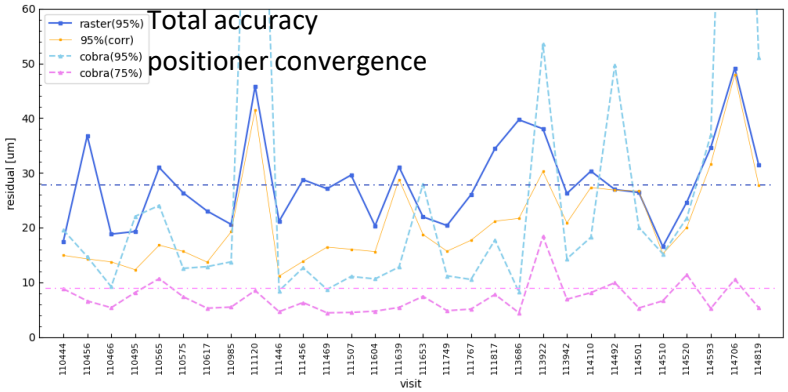


Engineering Observations

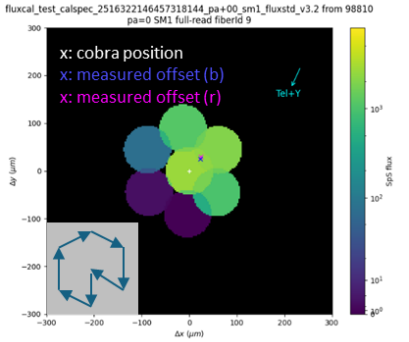
- Engineering run started in 2018
  - "On-sky" test started in 2021
- 20 runs (including on-telescope test during the telescope down time)
  - 150 nights
  - 39 nights (26%) were cancelled (= no access to the summit):
    - 14 nights (9%) due to instrument (PFI) trouble
    - 11 nights (7%) due to bad weather
      Note: it doesn't include time when the dome is closed
    - 14 nights (9%) due to telescope shutdown
  - On average, no on-sky data for 1 or 2 night per run due to bad weather
    - (Two big tropical storms "Calvin" and "Hone" came close to Hawaii. Those were the only one for each year.)

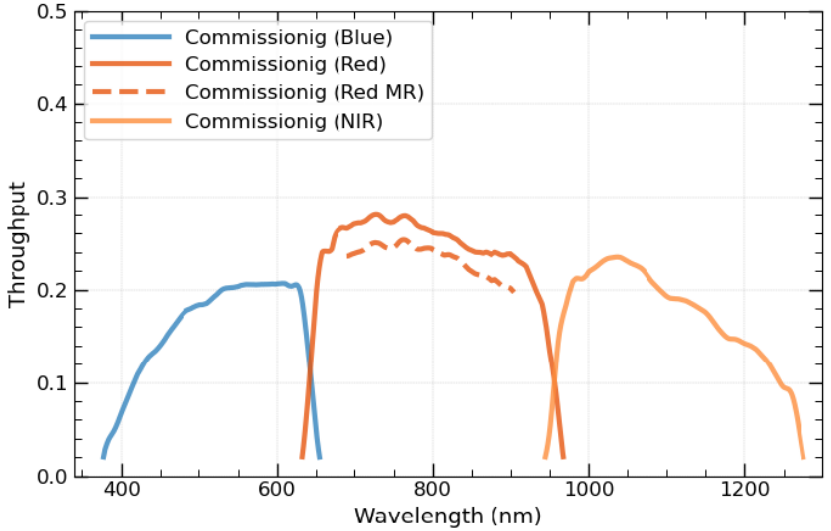


Fundamental Instrument Performance

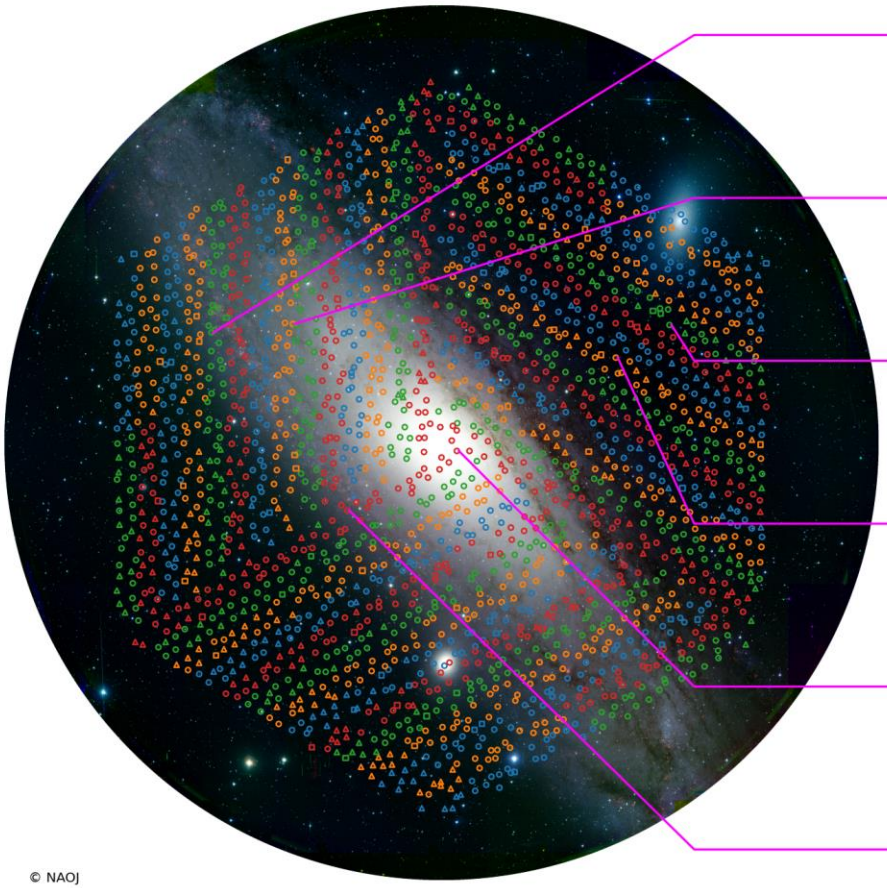


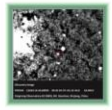
- Fiber configuration
  - Configuration time: 124s on average in the last two runs.
    - 8 iterations, skipping to move back to Home position first. 155s with Home position.
  - Accuracy of positioners' convergence:
    8.5 um (75%-tile)/ 74.8 um (95%-tile) in the last four runs.
    - Affected by dome seeing
  - Total fiber configuration accuracy : ~20-35 um (95%-tile) on average
    - Rather stable between run by run. We are monitoring for further optimization.
- Limited range of instrument rotator angle.
  - Instrument rotator: -174 -- +174 deg.
  - There is unobservable area for any given PA.
- Throughput
  - The system throughput was measured by observing CALSPEC stars as well as F-stars
  - It is comparable to expectation from the optics measurement and models (after VPHG correction).

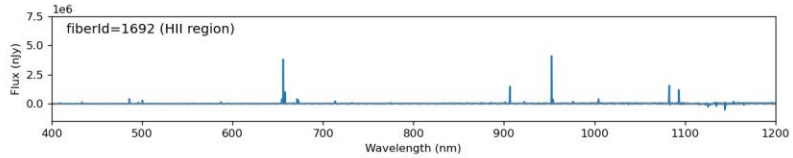


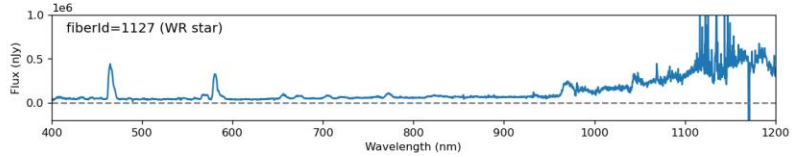


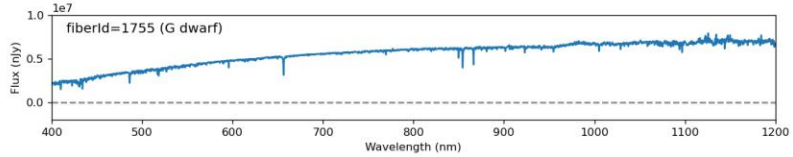
Example of spectra

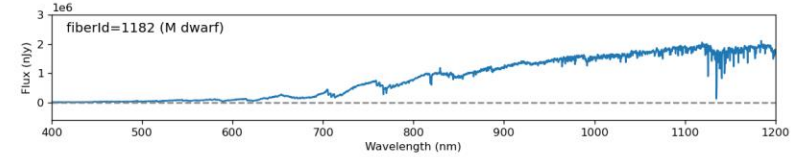


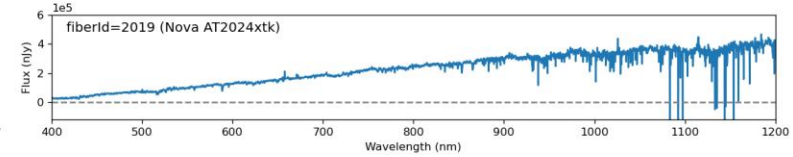


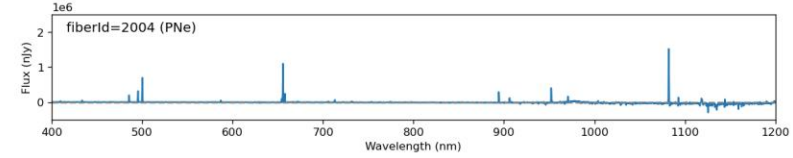






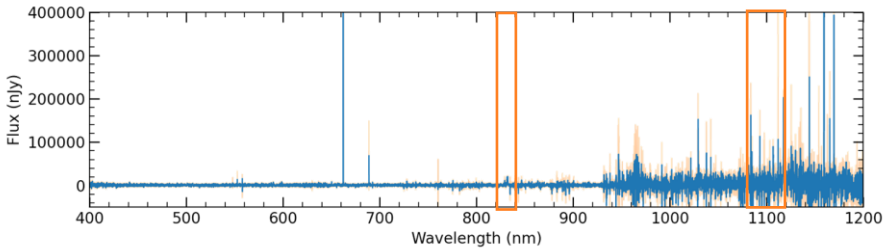


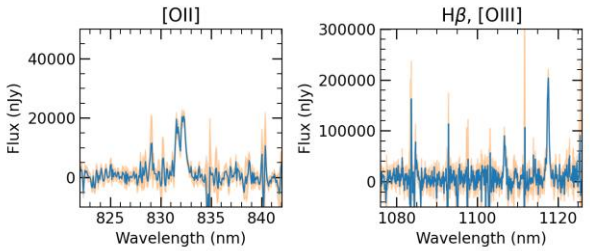




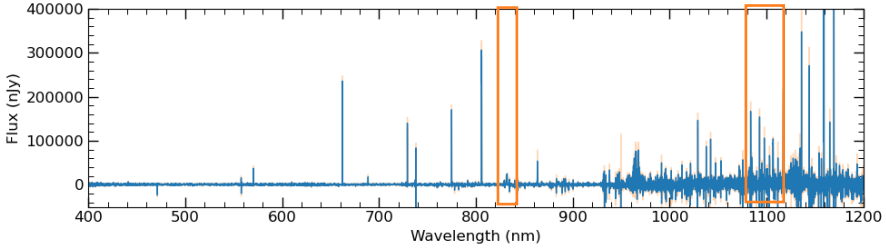
Example of spectra

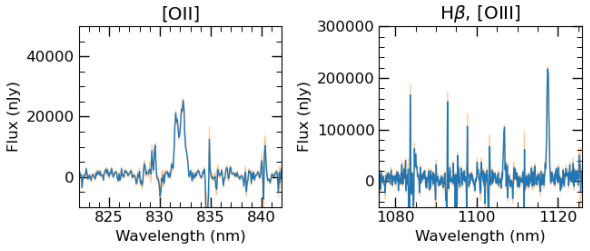
900s

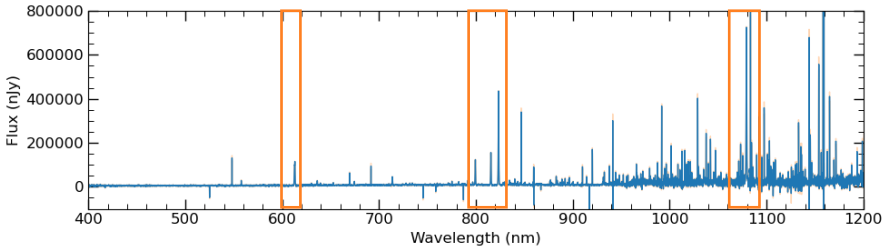


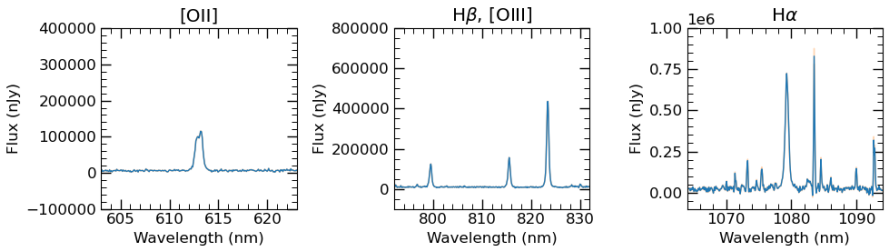


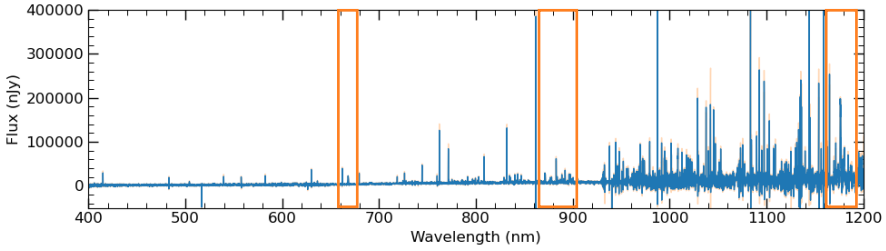
900sx4 (combined)

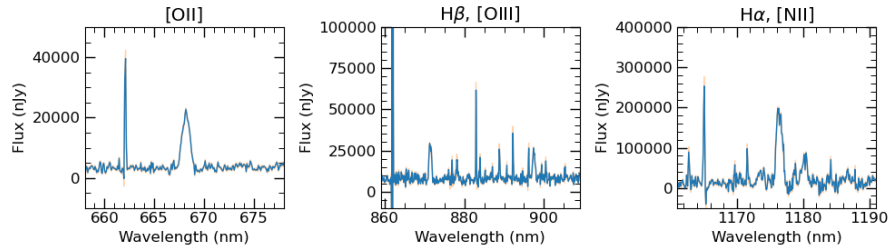






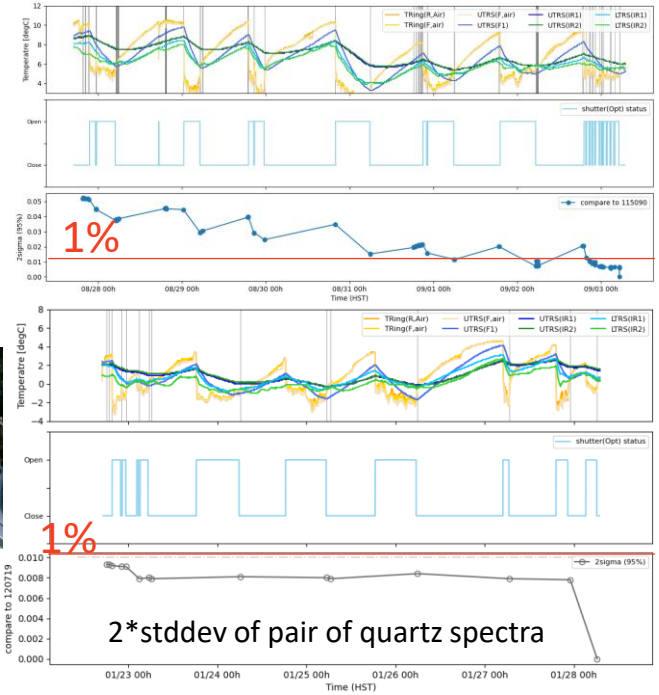






Fundamental Instrument Performance

- Fiber throughput variation (see P05 for details)
  - Relative throughput among the fibers changes rapidly (<night) which makes accurate sky subtraction impossible.
    - Significant change is seen when we open the dome.
  - To normalize the fiber throughput accurately, quartz data should be taken frequently
    - Worst case is every exposure.
    - High load on telescope and operation
  - In the last two runs, the effect of the index matching gel was tested.
    - If we apply the gel on the fiber connector on the telescope spider, the variation is improved.



- Software development status
  - Development of Data Reduction Pipelines (2D & 1D: see P12, P23 and P27)
    - Basic functionality of the processing were developed.
    - The quality is being improved using the on-sky data in the engineering observations.
      ← Development depends on instrument performance/stability
  - The team is putting a lot of effort on better handling the NIR data now (non-linearity, defect, persistence etc)
- To Do:
  - Improvement of field acquisition for high-galactic-latitude area
  - Detailed performance is under analysis
  - etc.