

Current status of Science Operations for ‘Ōnohi’ula Prime Focus Spectrograph (PFS)

Akira ARAI³, Masayuki TANAKA^{1,2}, Wanqiu HE¹, Miho N. ISHIGAKI^{1,2}, Eric JESCHKE³, Russell KACKLEY³, Shintaro KOSHIDA³, Yuki MORITANI^{3,2}, Masato ONODERA^{3,2}, Vera Maria PASSEGGER³, Tae-Soo PYO³, Yuhei TAKAGI³, Naoyuki TAMURA³, Ichi TANAKA³, Kiyoto YABE^{3,2}, Sadman S. ALI¹, Javier Gracia CARPIO⁴, Maximillian FABRICIUS⁴, Wilfred GEE³, James E. GUNN⁵, Michitaro KOIKE¹, Arnaud LE FUR⁵, Zhuoming LI¹, Yongming LIANG⁶, Craig LOOMIS⁵, Robert LUPTON⁵, Sogo MINEO¹, Takahiro MORISHIMA¹, Sakurako OKAMOTO^{3,2}, Yuki OKURA¹, Paul PRICE⁵, Martin REINECKE⁴, Michael A. STRAUSS⁵

1. National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan.

3. Subaru Telescope, National Astronomical Observatory of Japan, 650 North A’ohoku Place, Hilo, HI 96720, USA

5. Department of Astrophysical Sciences, Princeton University, 4 Ivy Lane, Princeton, NJ 08544, USA,

2. Graduate Institute for Advanced Studies, SOKENDAI, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan

4. Max-Planck-Institut fuer extraterrestrische Physik, Giessenbachstrasse, D-8574 Garching bei Muenchen, Germany

6. Institute for Cosmic Ray Research, The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8582, Japan

Abstract

The ‘Ōnohi’ula Prime Focus Spectrograph (PFS) successfully started science operations, including Openuse, time exchange, and UH time, beginning in semester S25A. Current semester, S26A, in its third semester of operation, the instrument’s operational frameworks for all observation modes (Queue, Classical, and ToO) have been thoroughly established and optimized for increased efficiency. This poster presents a comprehensive overview of the science operations framework, encompassing the entire workflow from the Call for Proposals (CfP) and observation planning to on-site execution and data release. Furthermore, we share initial operational statistics, review current policies, and discuss future prospects to maximize scientific data productivity and ensure stable operations.

1. Observation modes and Call for proposal (CfP) [for all non-SSP programs]

Please check our web page for all users first before starting preparation of your proposal. Minor policies changes and instrumental status will be updated for every semesters.

Queue [Standard observation mode of PFS]

- Fiber design is made with the **fiber sharing** policy.
- Priority will be determined Score, visibility, completion rates, among observable Queue targets.
- Fixed exposure time (450s x 2) for all fiber design.
- Daily updates of fiber design based on previous observations to achieve allocated completion rates (based on EETs, and FHs, see Observation).
- Nightly results can be checked from Queue progress web page
- Observation time will be allocated based on ROT in proposal with weather factor.

Classical [Special observation mode, including ToO]

- Pls can set exposure time (up to total 1800s, e.g., 900s x 2).
- Pls can set pointing center coordinates using via Target uploader at proposal submission.
- Classical mode is justified only for ToO, IFU-like mode, or strong science reasons. So, very competitive mode.**
- ToO programs**
 - We can have a few ToO programs in each semesters. Workload for preparation is larger than other classical programs. So we will consider the reasonable policy depending the situations and demands from users.

Community Filler [call for every 2 semesters]

- Targets can be observed with only Queue programs (as of S26A).
- Referring process is different from Queue or Classical.
- Basically, observation process is the same as Queue mode

Required Justification in proposals for Queue and Classical

- Science justification
- Technical Justification
 - ETC results
 - Target list, and tentative planning results to estimate ROT

Proprietary period

Queue/Classical/Community filler targets has a standard proprietary period (1.5 years)

Observatory fillers

PFS will use observatory fillers for the non-allocated fibers for all observation modes. Data of observatory fillers will be public at the data release on PFS Science platform. Observatory filler are taking from Gaia and SkyMapper catalog.

PFS takes multiple frames for cosmic-ray rejection

For cosmic-ray rejection process, PFS is taking multiple frames for each fiber configuration.

Elevation restrictions in operations with 32 deg < EL < 75 deg to ensure the accuracy of fiber position.

2. Reviewing process & time allocation by TAC

Science reviewer and Support astronomers will check justification in the descriptions on proposals

- Science justifications** by science reviewers
- Technical justifications** by Support astronomers (SAs)
 - Especially, we will check following information at technical justification**
 - ETC results, from, Simulation ID**
 - Target Upload ID with simulation results for your target list**
- General process for time allocation**
 - After closing CfP, reviewing process will take about 1.5 months, and starting discussion by TAC members.
 - Arranging the night schedule based on discussions by TAC and Science operation staff for the coming semesters ~ 1 months
 - Inform allocated plans will be inform all Pls at 1.5 months before the next semesters
 - After fixing the time allocation, instrumental work or night crew shift can be fixed

3. Planning of fiber designs for observations

For all PFS observations, fiber design (PFS Design) file must be prepared before observation. Fiber design can be made by operation members for non-SSP observations, and SSP team for SSP observations.

PFS Subaru Strategic programs (PFS-SSP)

- SSP program will be carried out with Classical observations.
- Planning for SSP program is made by SSP team. This is different from all other programs.
- Planning process before run
 - SSP team will make all fiber designs and observation operation file (OPE file).
 - Planning software are taking care by PFS software team and Mitaka operation members
 - SSP team will complete the planning for each run ~1 week before starting date of the run
 - Reviewing design and OPE file by PFS operation members
- During run
 - SSP team can update the OPE file every nights based on results of previous nights.

Openuse (CfP of Subaru), and other observation time

Queue

- Before runs
 - Insert into target database after screening target list for all allocated or non-accepted programs.
 - Run-wide planning will be completed around 1 week before the run (by Mitaka planning team)
 - Reviewing all design (by SAs)
- During a run (everyday)
 - Updates fiber designs to reflect the observation results in the previous night (by Mitaka planning team).
 - Reviewing all updated fiber design by 15:00 (by SAs)

Classical (incl. ToO)

- Before runs
 - Starting planning process between Pls and planning members
 - SAs will send email 6 week before the starting of the run, which includes PI’s observation
 - Pls have chance to change priority setting and rejection of target (not possible to add targets)
 - PI have to finalize the target list at 5 weeks before the run, and planning will start
 - Iteration will be done (ideally, a few times)
 - At least 1 week before the run, we should complete the planning for classical observations
- During runs
 - Pls can only change ordering to use fiber designs, and exposure time during the observation night

For non-Openuse programs [UH time, time exchange programs with Gemini, Keck, Rubin, Roman and etc.]

These program (UH time and Time exchanges) is not Openuse program. However, PFS’s operation policy is applied, and we have the same procedures for planning for these programs.

Basically, these programs will be allocated with Classical depending on requests by their TAC or Pls. Queue can be allocated if Pls requested, and Subaru’s TJ can approve, but might be adjusted due to scoring among openuse programs. For ToO programs, we are now discussing on the maximum numbers.

References and relevant links

Instruments (latest summary)

Naoyuki Tamura et al., "Prime Focus Spectrograph (PFS) for Subaru Telescope: progressing final steps to science operation", SPIE 13096, 1309605 (2024)

Paper of Overview of Science Operation

M. Tanaka et al. 2026, submitted to PASJ (<https://arxiv.org/abs/2606.14012>)

FluxStd and Observatory fillers

Gaia catalog

Gaia collaboration, et al. (2016), A&A, Volume 595, id.A1, 36 pp.
Gaia collaboration, et al. (2023), A&A, Volume 674, id.A41, 33 pp.

Pan-STARRS1 Survey

Chambers, K. C., et al. (2016), <https://arxiv.org/abs/1612.05560>
Flewelling, H. A., et al. (2020), ApJS, Volume 251, Issue 1, id.7, 62 pp.

SkyMapper DR4

Onken et al. 2024, PASA, submitted (<https://arxiv.org/abs/2402.02015>)
DOI for the DR4 release: 10.25914/5M47-5621

PFS web page

<https://subarutelescope.org//Instruments/PFS/index.html>

Target uploader

<https://pfs-etc.naoj.hawaii.edu/uploader/>

PFS Spectral Simulator (ETC)

<https://pfs-etc.naoj.hawaii.edu/etc/app>

PFS Science Platform

<https://subarutelescope.org//Instruments/PFS/data.html#pfs-science-platform>

4. Instrument and software preparations for each observation run

Instruments preparations for each run

- Telescope top unit works before/after the PFS run by TelDiv, Day crews, and PFS instrumental members (1 day for each)
- Fiber gel cleaning (Telescope and PFI sides) by PFS instrumental members (at least 2 days)

Software preparation (Software development team)

Before every runs, software will be improved, and is essential for planning and observations.

- Updating and version control of core software modules
- Planning software (Integrated code)
 - After fixed software version for a run, planning software, “integrated code”, will be update.
- ETC and On-site data reduction system
 - Before CfP, ETC will be updated to adjust with current instrumental situations.
 - Also, calculation of EETs will be updates as needed.
- Observation system
 - As needed, telescope commands relevant to PFS operations, user interfaces, and data acquisition commands will be updates

5. Observations process

Daytime preparations

- As shown in Section 3, a daytime SA will check and confirm the plan on the night.

Night operation of PFS

- One SA will take a responsibility of night operation at Hilo remote room as usual.
- Total 6 SAs (3 primary SAs and 3 sub SAs) can take shift of the night operation of PFS (as of S26A).
 - All SAs are also in charge of other instruments.
- Two telescope operators taking care the telescope operations and monitor the summit condition.
- From S26A, SAs have been started training to telescope operators to be able to care for Queue mode observation in future runs.
- During the engineering nights in each run, instrumental members will join at the site, Mitaka remote or zoom.

Effective Exposure Time (EET) by on-site reduction system

- EETs during the night will be monitored by operation team
- EETs is essential for calculating fiber hours (FHs) to see completion rates of Queue programs
- Also, EETs helps to decide to next exposure or next night plan for Classical, SSP programs.

Sharing Observation log of Classical observations

- SAs will send observation log to Classical observers next morning

6. Data release

Delivery via STARS (Hawaii)

- STARS system is delivering data only for Classical observers
- Queue, CF users, we are not sharing information because of fiber sharing (as of S26A)

Delivery via PFS Science Platform (PFS-SP) by PFS DRP team

- We are strongly recommend that Pls will take analyzed data via PFS Science Plat form
- Basically, we will release data after run-wide analysis via PFS-SP after a few months of each run.

7. Guidelines of acknowledgements for all publications based on PFS data

Guideline are showing on our web page.

Please read carefully it and regard the guideline for all publications based on PFS data.

8. Discussion and open questions for future operations

Queue mode

- Classical mode proposals except for very special cases should be move to Queue mode in future run to make more efficient operations and reduce workflow regarding iterations among Pls and PFS operation team.
- Besides, openuse and other observation is different scoring manner (UH, Time exchange will be given highest score). Considering fairness among Openuse and non-Openuse time, we need to consider carefully on this point.
- ToO may be able to be implemented into Queue mode. This should be considered how to have preparation phase (e.g., automatic planning for ToO without iteration with Pls).

ToO observations

- We can care a few standard ToO and time-allocated ToO programs by PFS.
- Short time ToO can be proposed, but we will not guarantee to execute now.
- Additional workloads are expected for caring ToO programs, and this is problematic for stable operations.
- Some future programs will be expected to propose in ToO programs. We will discuss with ToO users.