Progress and Challenges in Planning for Subaru PFS Open-Use Programs

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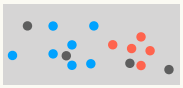
Introduction

Subaru Prime Focus Spectrograph (PFS) is a fiber-fed multiplex system, which enables acquisition of around 2000 spectra of science objects simultaneously over a wide hexagonal field of 1.38 deg on the sky. In order to efficiently utilize all fibers, we **share fibers** among multiple open-use programs

- We have developed the **PFS Pointing Planner (PPP)**, an algorithm that balances target priorities and allocation efficiency to optimize fiber assignment across different programs.
- Planning for queue, classic and SSP observations have been carried out successfully in S25A and S25B

1. The general flow-chart

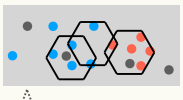
Query targets, and remove complete targets and programs



Proposal 1
Proposal 2
Proposal 3

ob_code, RA, DEC, exposure time, science rank (given by science review), inner priority (defined by PI), resolution, proposal_id, allocated_fiberhour…

PPP: determine pointing centers



Proposal 1
Proposal 2
Proposal 3

Pointings would be determined to:
- maximize achieved fiber hours for grade B programs
- maximize fiber usage fraction

assign **weight** to each target

W1	Science rank	P1 = 0 (lowest) - 9 (highest), float	W1=pow(**a**, P1+0.1*P2)
	internal user priority	P2 = 0 (lowest) - 9 (highest), int	
W2	requested exposure frame (1 frame = 15 min)	N(exp)	W2=pow(N, **b**)
W3	count of all targets in the surrounding 1 sq.deg field	N(target)	W3=pow(N, **c**)
Final	partially observed?	P3=2 (yes) or 1 (no)	P3*W1*W2*W3

put pointing at the **Kernel Density Estimate (KDE) peak**

*one pointing = 15 min

do local perturbation using Nelder–Mead method

run Netflow (fiber-to-target assignment tool) for the pointing

*weight is regarded as the cost of each target

check assigned targets of each proposal

achieve allocated fiberhours (FHs) of all proposals?

No, loop for the next **peak**

Yes

re-run Netflow for all pointings

check fiber assignments of proposals

*$U = T_{\rm miss} + T_{\rm waste} + N_{\rm ppc}$

*incompletion rate:

$$T_{\rm miss} = \frac{1}{n(\rm proposal)} \sum_{i}^{\rm proposal} [(FH_{i,\rm allocate} - FH_{i,\rm observed})/FH_{i,\rm allocate}]$$

*un-used fiber fraction:

$$T_{\rm waste} = \frac{1}{n(\rm point)} \sum_{i}^{\rm point} [n_{i,\rm blank-fiber}/2394]$$

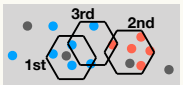
No, loop over (**a**, **b**, **c**)

minimal U?

Yes

Pointing centers determined!

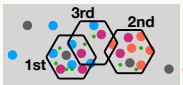
QPlan: schedule pointings according to visibility and weight



Proposal 1 YYYY/MM/DD xx:xx 1st
Proposal 2 YYYY/MM/DD xx:xx 2nd
Proposal 3 …

pointings with more high-priority (high science rank + high inner priority) targets would be observed earlier

Add fillers, Fluxstds, sky positions & guide stars



Proposal 1
Proposal 2 YYYY/MM/DD xx:xx 1st
Proposal 3 YYYY/MM/DD xx:xx 2nd
Calibrators …
Fillers

filler targets from grade C, users and observatory are used to fill up blank fibers (but they do not determine pointings)

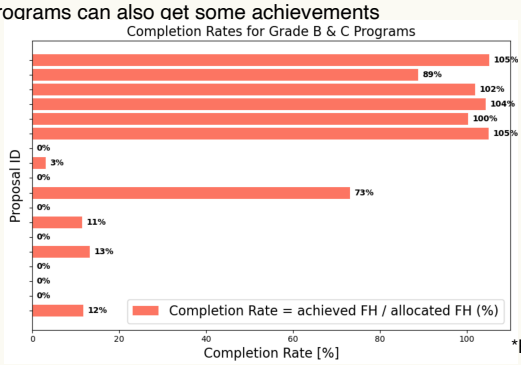
Generate design & ope files for night operation

Validation

- number of calibrators, uniform distribution of calibrators
- elevation and rotator angle of pointings
- whether there are bright sources < 13 mag in the design
- whether there are bright guide stars < 12 mag in AG Cameras
- whether there are bright sources < 12 mag around blank fibers

2. Progress

In S25A, most of grade B programs can achieve 100% completion, and some grade C programs can also get some achievements



*FH: fiber hour

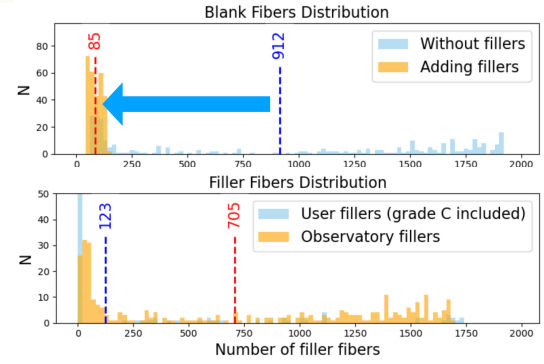
3. Challenges

Blank fibers and fillers

In S25A, the mean fiber usage fraction is 61.9%; after adding fillers, the fraction increases to 96.5%

- Fillers are important in increasing fiber usage fraction
- There are around 800 blank fibers filled with fillers on average
- It is expected that user fillers, which have higher priority than observatory fillers, can get more blank fibers; however, they get much less fibers

  -> We attempt to improve it by multi-stage assignments, which could increase the number count of user fillers to 307 on average in simulation, and we would test it in November run



Adding fillers highly reduce blank fibers!

User fillers get much less fibers…

Duplication checks among programs

In S25A, we have found duplicates between fluxstds and science targets, also between observatory fillers and science targets (for details please see Masayuki Tanaka-san's talk)

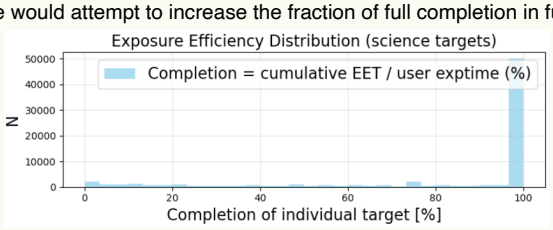
In S25B, we have implemented the function to remove these duplicates

- In September run, 112 fluxstds and 231 observatory fillers duplicated with science targets (grade B + C + F) could get assigned
- After implementing the function, none of them could get fibers; we would keep it for future runs

Partial observation of science targets

In S25A, 68% of science targets can fully achieve their requested exposure time; however, 18% among them have low completion rates of less than 50%

- We would attempt to increase the fraction of full completion in future runs



Meanwhile, 56% of fillers get more than 900-sec exposure time, and 12% of fillers can get exposure time longer than 2-hour exposure time

- We should avoid multiple assignments to the same fillers