[P08] Tiling tool for Subaru/PFS open-use programs: PFS Pointing Planner (PPP)

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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 plan to **share fibers** among multiple open-use programs

- Problem: **WHERE TO POINT the TELESCOPE?** —> different programs can have different science priority, spatial density/distribution, exposure time, etc.
- In this poster, we introduce **PFS Pointing Planner (PPP)**, the tool to optimize pointing centers for PFS open-use programs**.** It incorporates with a flexible weighting scheme, which considers the science priority, local density, and exposure time of each target. The tool enables**:**
  - to ensure the allocated fiberhours of each proposal can be fully achieved, with the high-user-priority targets reaching high completion rates

The general flow-chart

Target DB: Read all targets

ob_code, RA, DEC, exposure time, science rank (given by science review), inner priority (defined by PI), requirements (e.g., resolution), proposal_id, allocated_time…

STEP1: Determine initial tiling pattern

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**

No, loop for the next **peak**

*one pointing = 15 min

all targets observed?

Yes

run Netflow (fiber assignment tool) with **N** pointings

*weight is regarded as the cost of each target

For Uploader (see [P07])

check fiber assignments of proposals

$*U = T_{\mathrm{miss}} + T_{\mathrm{waste}} + N_{\mathrm{ppc}}/N_{\mathrm{ppc,TAC}}$

*incompletion rate:

$$T_{\mathrm{miss}} = \frac{1}{n(\mathrm{proposal})} \sum_{i}^{\mathrm{proposal}} [(T_{i,\mathrm{request}} - T_{i,\mathrm{done}})/T_{i,\mathrm{request}}]$$

*un-used fiber fraction:

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

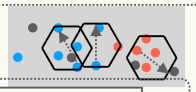
No, loop over **(a, b, c, N)**

minimal U? + >90% of the allocated fiberhour achieved?

Yes

INITIAL Pointing centers determined!

STEP2: Local perturbation



separate pointings into different groups by clustering algorithm

*linking length = 1.38 deg (diameter of FoV)

For each pointing in the group:
-assign a distance penalty to nearby un-allocated targets within 2FoV;
-get the mean (ra, dec) weighted by the weight + penalty of nearby un-allocated targets

move the pointings towards (ra, dec)

run Netflow with new pointing centers

estimate fiber assignment of all targets → minimal U?

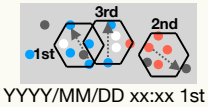
No, loop for the next **perturbation**

Yes

FINAL Pointing centers determined!

Add fillers, F-stars, sky positions & scheduling

Generate PFSdesign files



YYYY/MM/DD xx:xx 1st
YYYY/MM/DD xx:xx 2nd..
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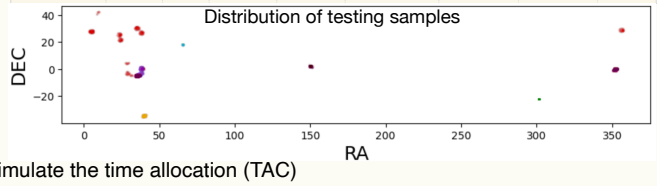
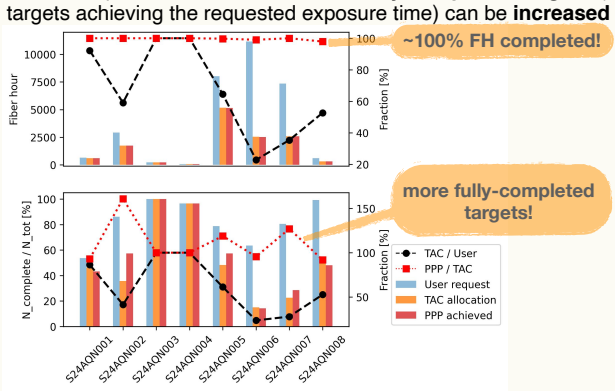
Simulation

- construct 8 mock proposals from science working groups
  - simulate the submission of each proposal through uploader
    - assume the classic mode
    - users define the requested fiberhours (FH) and time (ROT) by dragging the slider in uploader (see [P07])
  - simulate the science review, and assign a rank for each proposal

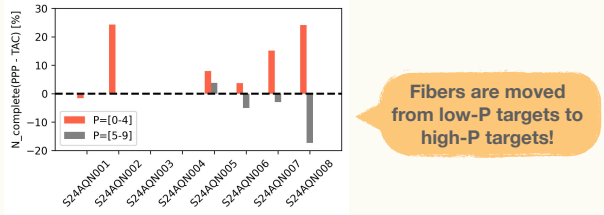
Proposal	type	N_tg	resolutio	FH_tot	FH_request	FH_TAC	FH_PPP	rank
S24AQN001	star	5510	L&M	1377.5	**646**	**595.5**	**595.5**	10.0
S24AQN002	galaxy	4093	L	3247.75	**2929.5**	**1730**	**1729.75**	8.8
S24AQN003	star	565	M	234.5	**234.5**	**234.5**	**234.5**	9.1
S24AQN004	star	258	M	64.5	**62.25**	**62.25**	**62.25**	8.2
S24AQN005	galaxy	11433	M	9683.5	**8017.25**	**5166**	**5151.5**	7.5
S24AQN006	AGN	8451	L	16902	**11157.25**	**2542.25**	**2517.5**	7.0
S24AQN007	galaxy	9000	L	9000	**7341.25**	**2594.5**	**2594.5**	6.5
S24AQN008	cluster	306	L	612	**608**	**320**	**313.25**	5.6



- simulate the time allocation (TAC)
  - assume 7 nights ~ 220 pointings
  - prioritize high-rank proposals
    - for low-rank proposals, the allocated FH might be highly reduced compared to the requested one
- simulate the optimization with PPP
  - assume **fiber-sharing** among proposals
  - constraints: allocated FH of each proposal
  - results:
    - only 197 pointings are needed
      —> less time required = more space for bad weather
    - **~100% of the allocated FH can be achieved** no matter for high- or low-rank proposals
    - after the optimization, the fraction of **fully-completed targets** (i.e., targets achieving the requested exposure time) can be **increased**



    - after the optimization, **more high-P targets can be completed** in each proposal compared to those expected by the classic mode



  - Future prospects:
    - we are testing PPP with different science cases
    - we plan to generate PFSdesign files for end-to-end simulation