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Queue Mode Software for Subaru Telescope

Eric Jeschke (eric@naoj.org), Russell Kackley (rkackley@naoj.org), Takeshi Inagaki (tinagaki@naoj.org),
Sherry Yeh (yeh@naoj.org), Tae-Soo Pyo (pyo@naoj.org), Fumiaki Nakata (nakata@naoj.org),
Ikuru Iwata (iwata@naoj.org), Francois Finet (finet@naoj.org), Shintaro Koshida (koshida@naoj.org),
Kristoph Helminiak (xysiek@naoj.org), Yusei Koyama (koyama@naoj.org), Masato Onodera (monodera@naoj.org),
Nobuo Arimoto (arimoto@naoj.org), Subaru Telescope, National Astronomical Observatory of Japan

Abstract

Subaru Telescope has operated under a classically-scheduled regimen since starting open use in Y2000. However, from semester 16A onward Subaru is transitioning to queue scheduling for the Hyper Suprime-Cam instrument and has plans to operate future instruments also in queue mode.

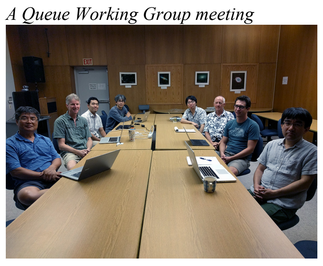
Subaru carefully studied the queue operation at Gemini, JAC and CFHT before settling on a model for Subaru. In this poster we discuss the rationale for moving to queue mode, the type of scheduling model adopted by the observatory, the design choices for the queue software layer and the current status after one semester of operation. Subaru favors the use of Python for building software, and the queue mode tools are no exception. We describe the architecture of the Python-based tools that were developed for this project.

Introduction

In 2012, the Director of Subaru Telescope Nobuo Arimoto laid out an agenda to move Hyper-Suprime Cam (HSC) open use observations from classical mode to queue mode by 2018.

HSC is a wide field camera operating at the prime focus of Subaru telescope on Mauna Kea, Hawaii, and offering an unprecedented combination of sensitivity and field of view. The rationale behind this move was to achieve the best science return on the new instrument by completing the top-ranked programs in the desired conditions using the best trained personnel. This is the basic premise of queue observing.

A Queue Working Group meeting



The Queue Working Group (QWG) was formed to guide the development of the queue policy, workflow and software development.

It consists of 12 members (see author list) including Subaru directorate members, staff scientists, Subaru fellows and software engineers.

The queue rollout plan as designed by Tae-Soo Pyo envisioned opening for queue observing in semesters 16A/B in a shared-risk mode with limited queue nights, increasing the share to 50% of open use nights in S17A/B, and by S18A to be operating primarily through queue mode.

Despite the optomistic schedule the Software Division has met the target deadlines and Subaru has now completed one semester of shared-risk queue operation and is in the middle of the second.

The Subaru HSC Queue Workflow

Before developing our own queue entities and workflow, the QWG visited and carefully studied the queue systems of Gemini, CFHT and JAC observatories.

One important design decision that we came away with was to try to employ automation in the queue process to reduce the large workload that we could see with manual queue scheduling and quality assessment processes.

Since HSC was already running in classical mode with an automated pipeline, the automated scheduling system used at JAC was a close fit to what we imagined.

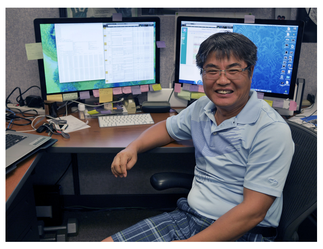
This is the queue workflow designed by the QWG that Subaru is using in S16B. It is the basis for all of the software pieces that were developed.

Phase 1

Subaru Observatory issues a call for proposals.

There is a separate call for dedicated bad weather (filler) proposals that specify very loose constraints on sky transparency and seeing.

Primary Investigator (PI) submits a queue proposal using the Phase 1 web site, including targets, filters and desired constraints by the deadline.



Subaru Time Allocation Committee (TAC) evaluates and ranks proposals. Accepted proposals are assigned a queue grade of A or B. Non-accepted proposals may be allowed to execute as filler programs in grade C. Bad weather filler proposals execute as grade F.

PI receives an acceptance letter with grade.

Phase 2

The *Queue Coordinator* assigns a *Support Astronomer* or an *HSC Fellow* to each proposal that could be executed as the primary contact with that PI.

Subaru prepares and sends a customized Phase 2 spreadsheet to the observers with accepted proposals.

PI fills out the spreadsheet with Observation Blocks (an *OB* is the minimum schedulable unit of observation) and submits it to the Subaru Phase 2 web site by the deadline.

Web site checks and gives feedback for many common errors. PI fixes and resubmits until everything passes.

As spreadsheets arrive, Queue Coordinator begins semester scheduling simulations with the scheduling software to discover any potential issues with the OBs. Any problems are reported to the SA or HSC fellow who is assigned to the proposal.

SAs/fellows interact with the PI to possibly change the OBs to meet the science goal or improve chances of execution, based on experience with the instrument, weather history and queue execution.

PI resubmits updated spreadsheet as necessary.

Queue Run Planning

The Queue Coordinator makes an overall plan for queue-mode observations before the beginning of an HSC run (runs are approximately two weeks long). Queue can be executed on dedicated queue time slots or during waiting time of classical observations when no targets or calibrations can be done.

For queue nights, Queue Coordinator will call a brief queue meeting with the SA/fellow who will be observing that night. Weather forecast is discussed. Queue Coordinator may adjust scheduling weights, skip certain programs or temporarily adjust program priorities in order to achieve expected semester outcomes of queue. The Queue Coordinator accesses the queue completion report web page to track the progress of the various programs.

An SA or HSC fellow other than the night's observer is assigned to do the Final Quality Assessment (FQA).

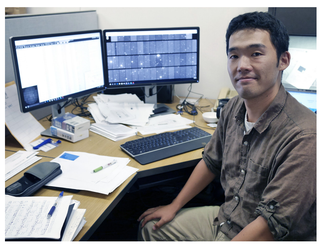
Queue Execution

An SA or HSC fellow conducts the queue observation, which involves running the queue scheduler to automatically build a schedule based on current conditions, executing the OBs and doing an Initial Quality Assessment (IQA) on each OB.

IQA is primarily based on the result from the HSC automated Data Reduction Pipeline, which reports on sky transparency and seeing of each exposure.

If conditions change, the observer may rerun the scheduler at any time to build a new schedule of OBs based on existing conditions and visible targets.

Final Quality Assessment

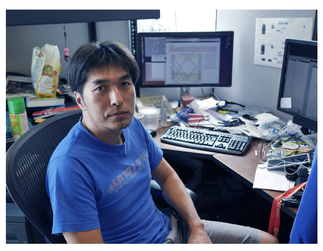


In the morning following the observation, the assigned SA/fellow conducts the FQA on the executed OBs.

Any OBs that do not meet the criteria will go back into the pool of executable OBs.

There is an implicit allowance for degradation in seeing (up to 0.1 arcsec) and sky transparency (up to 20%) from the start of the OB execution for an OB to still be considered "good".

Run Completion



After an HSC run is completed, the Queue Coordinator runs the queue completion software, which collects information about all exposures taken (including calibration frames) and automatically prepares the reports for each PI about observed OBs and the conditions under which they were observed. Each report summarizes the ongoing completion rate for the program.

When computing these data sets, exposures for data that do not match the criteria (i.e. "bad" OBs) are also included, in the chance that it may be possibly useful in some way to the PI.

Calibration data from the entire run that is not specific to a proposal (e.g. dome flats, biases, darks) is shared between PIs.

After reviewing, the queue completion reports are sent out by email by SA/fellows to each PI who had OBs taken.

Data Delivery

Special files generated by the queue completion software are submitted to the Subaru Data Archive (STARS) system to release the data to each PI as necessary.

STARS sends a data delivery email to each PI explaining how to retrieve the data.

PI executes a Python script to download the data.

End of Semester Wrap Up

Near the end of the semester, the program completion is assessed. Grade A programs, if not completed, are carried over for two semesters.

Preparations are made for the Phase 1 of the coming semester.

A final summary of the completion status for each program is emailed to each PI, including notifications of carry-overs for grade A programs.

Queue Software

Several key principles guided the software developed for the queue:

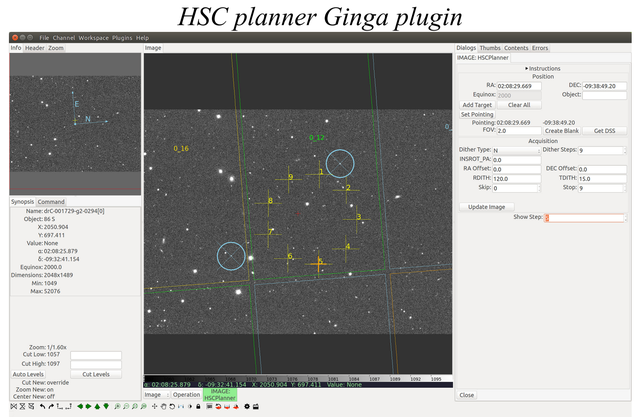
- Queue software should intrude as minimally as reasonable on the successful ongoing classical HSC observation mode
- The software would be written in Python when possible, keeping with the policy used by Subaru software staff
- We would leverage existing Subaru tools as well as open source packages as to meet the aggressive deployment schedule
- Employ the "KISS" philosophy (simple, when possible, is good)

For Phase 1, the existing submission web site was modified by the Computer and Data Management Division (CDM) to allow proposals to be submitted specifying queue and their strictest constraints.

For Phase 2, we decided to use a spreadsheet to specify OBs and configurations. HSC is a simple camera instrument with not very complex parameters. OBs are ultimately just records of data and a spreadsheet has the advantage that everyone already knows how to use one, so the training for the tool is minimal. Spreadsheet software such as LibreOffice are widely available for all the important platforms, which means our support requirements are minimal.

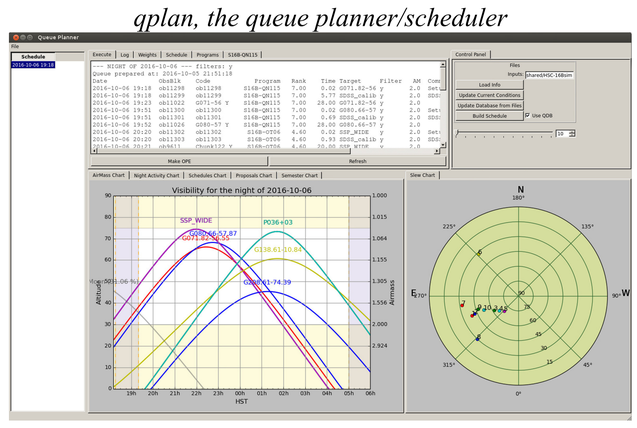
The Phase 2 spreadsheets are submitted to the Phase 2 web site, which checks the spreadsheets for common errors and gives feedback to the user as well as accepting the submissions once they have passed the check.

HSC planner Ginga plugin



For OB preparation, we provide a plugin for the *ginga* image viewer that visualizes the science field and shows where the targets will be imaged in the on the 112 CCD wide field HSC focal plane.

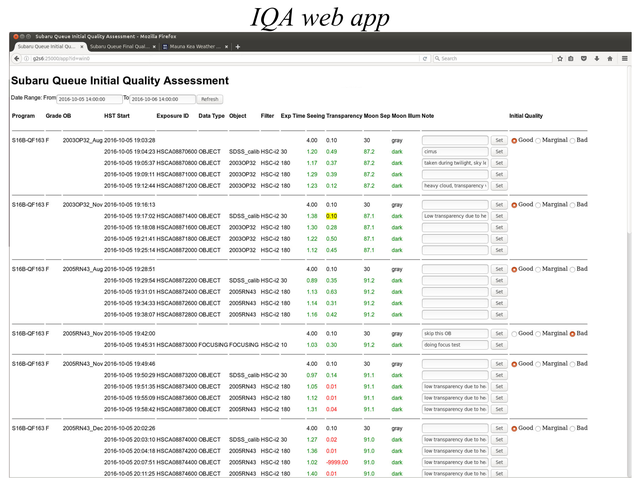
qplan, the queue planner/scheduler



For queue simulation, scheduling and execution we developed the *qplan* program which schedules OBs based on simulated or actual conditions. *qplan* uses a weighted criteria algorithm to support automated scheduling based on the PI's OB constraints as well as factors for observing efficiency.

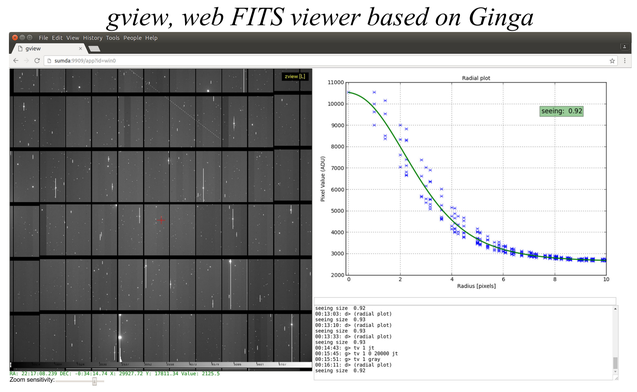
The queue schedules are translated into the same sort of observation scripts that are used in classical mode and are executed out of the existing observation control tools.

IQA web app



For IQA and FQA we developed a web browser-based tool that shows the OBs and exposures that have been executed, under what conditions and allows comments and grading. There is a companion tool under development that can load and browse the CCD mosaics in a full featured web-based FITS viewer and can run simple measurements to assist FQA, which can be done from a staff's workstation or laptop.

gview, web FITS viewer based on Ginga



For data delivery we asked CDM to modify their STARS archive service to provide an interface for distributing environment logs and to modify their data distribution and notification service to handle our FQA needs.

Conclusion and Future Work

Subaru has successfully established a queue observing mode with HSC. The decision to layer the queue tools on top of the existing workflow has made for a fairly smooth transition and training for our observing staff. We are proceeding with the plan to ramp up the number of queue nights in S17A with a target of 50% of open use nights operating under queue.

The QWG continues to work on establishing some necessary additions to the queue policy and software: support for cadence observations, custom dither patterns and grouped OBs. We are also beginning to think about a new instrument coming to Subaru in the next few years: PFS, the Prime Focus Spectrograph. PFS will contain 2400 fibers to 3 spectrographs and the plan is to operate it entirely in queue mode for open use.

For questions about the queue mode rollout and software please contact the Subaru Queue Working Group at queue@naoj.org .