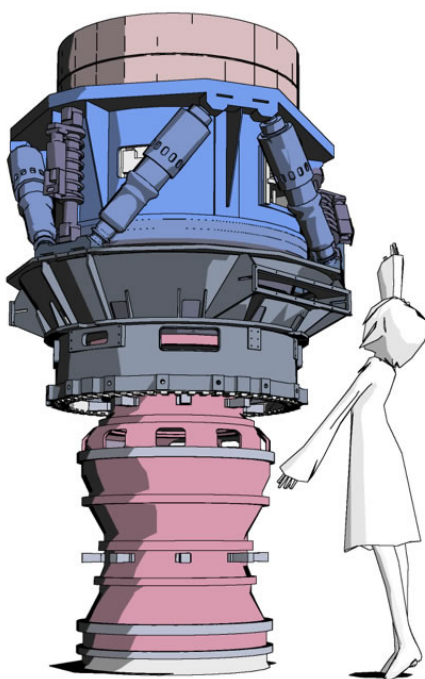


Subaru Telescope

Hyper Suprime-Cam (HSC) queue mode

Program PI Document

Ver. 1.0.0



National Astronomical Observatory of Japan

June 2015

Change record:

- 1.0.0 – June '15: First version prepared for the QM workshop in Mitaka [KH]

Contents

1	General information	6
1.1	Hyper Suprime-Cam	6
1.2	What is queue mode?	6
1.3	Semester S16A	8
1.4	Future implementation plan	8
1.5	Acronyms and terminology	8
2	Proposals (Phase 1)	10
2.1	Proposal preparation	10
2.1.1	Categories	10
2.1.2	Environmental Constrains	11
2.1.3	Filters	12
2.1.4	Dithering	12
2.1.5	ETC and overheads	13
2.1.6	Calibrations	14
2.2	Queue proposal template and submission via ProMS	14
2.3	Evaluation and ranking	15
2.3.1	Time allocation committee (TAC)	15
2.3.2	GRADE	16
2.3.3	Acceptance letters (AL)	16
3	Observing blocks (Phase 2)	17
3.1	What are OBs?	17
3.2	Phase 2 spreadsheet	17
3.3	OBs submission	21
3.4	Changes in OBs	21
4	Observations	23
4.1	Scheduling	23
4.2	Early execution	23
4.3	Sukima (dead time)	23
4.4	SSP time	24
4.5	Carry over	24
4.6	Quality assessment	24

5	Data delivery and feedback	25
5.1	Delivery package	25
5.2	Archiving at SMOKA	25
5.3	Feedback to the observatory	26

Preface

The purpose of this document is to describe the queue mode (QM) operations of the Hyper Suprime-Cam (HSC) from the users's perspective. Its intention is to present the queue mode itself, help the user to prepare the proposal and observations, explain how the observations are carried out, as well as how to access the data and other important information.

Important: *In this version the document is intended to work for the QM operation in the semester S16A only. The HSC QM observations will be done in a shared-risk mode, procedures and policies may be changed. In the future this document will be updated accordingly.*

Some details that need to be specified or confirmed are written in blue. They will be given once they are established, so updates to this document will be done before the CfP.

KH

General contact for QM users (questions, comments, suggestions):

- `queue [at] naoj.org`

The HSC Queue Working Group:

- Ikuru Iwata `iwata [at] naoj.org`
- Masatoshi Imanishi `imanishi [at] naoj.org`
- Tae-Soo Pyo `pyo [at] naoj.org`
- Fumiyaki Nakata `nakata [at] naoj.org`
- Eric Jeschke `eric [at] naoj.org`
- Russell Kackley `rkackley [at] naoj.org`
- Takeshi Inagaki `tinagaki [at] naoj.org`
- Sherry Yeh `yeh [at] naoj.org`
- Shintaro Koshida `koshida [at] naoj.org`
- François Finet `finet [at] naoj.org`
- Krzysztof Helminiak `xysiek [at] naoj.org`

Chapter 1

General information

1.1 Hyper Suprime-Cam

The Hyper Suprime-Cam (HSC) is a gigantic mosaic CCD camera, that is installed at the prime focus of the Subaru Telescope. The HSC uses 104 main science CCDs, which cover 1.5 deg FoV in diameter, with a pixel scale of 0.17", as well as 4 CCDs for auto guider, and 8 CCDs for auto focus. Information about the instrument can be found at:

<http://www.naoj.org/Observing/Instruments/HSC/index.html>

We recommend to read them first. For each observing run a set of filters is defined, and observations in these filters only are performed. Due to the construction of the instrument, changing filters during the night is time-consuming and is not done frequently.

Questions regarding the HSC should be directed to Dr. Satoshi Miyazaki ([satoshi \[at\] naoj.org](mailto:satoshi@naoj.org)) and/or Fumiaki Nakata ([nakata \[at\] naoj.org](mailto:nakata@naoj.org)).

1.2 What is queue mode?

Queue mode (QM) is a type of telescope operation, where the observations are carried out by the telescope and instrument operators, without a direct involvement of investigators (PI or Co-I). Targets are selected from a number of approved programs, on the basis of various criteria, such as: the rank of the program, the priority of the target, observing conditions (seeing, sky transparency, humidity, moon phase and distance), air mass, telescope slewing time, current telescope configuration, etc. The main differences from the classical mode are that the PI and Co-Is are not present during the observations (at the summit, nor remotely), and objects from various programs can be selected for a given night. Observations for a given program can be done any time during the whole run allocated for the QM. Higher priority is given to higher-ranked programs, and the observations are carried out in conditions that are expected and required by the PIs. The observing procedure is standardized which ensures uniformity of all the data. Appropriate selection of objects allows to increase the effective time spent on the target because of the reduced telescope slewing time and possibility of choosing programs that do not require certain strict criteria (for example, allow for worse seeing or

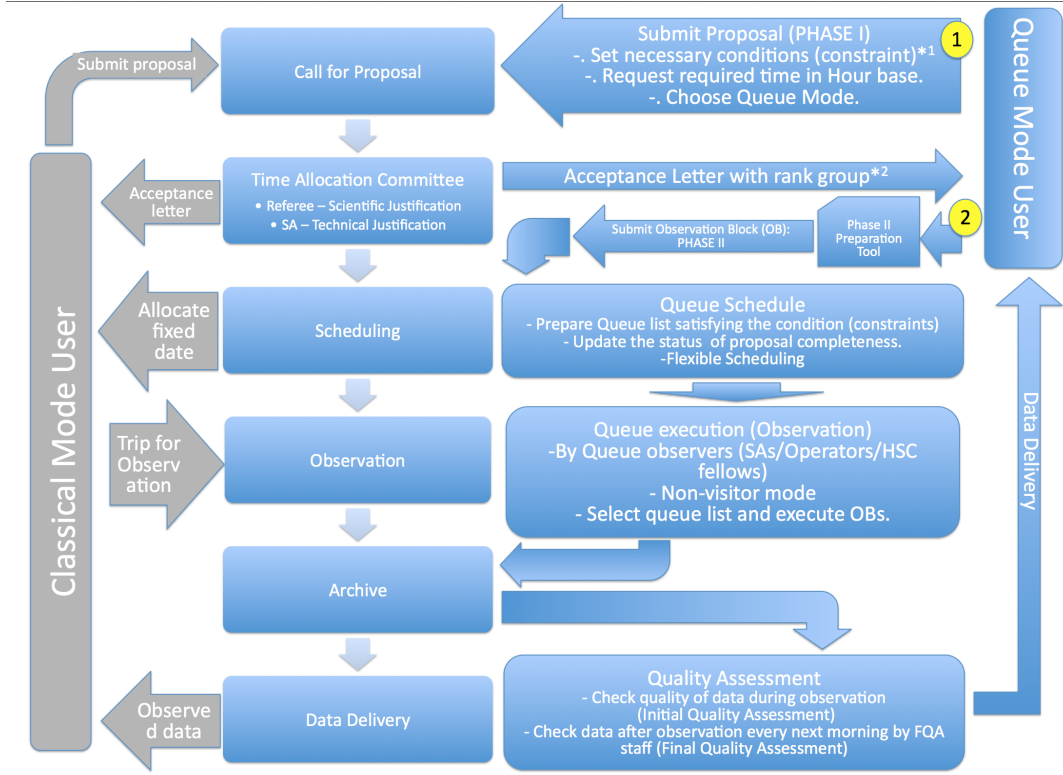


Figure 1.1: The flow of queue and classical modes from CfP to Data Delivery. The queue mode is right side blue diagrams and the classical mode is the left gray flow diagrams. Yellow circles mark Phase 1 and Phase 2.

sky transparency). The amount of data and scientific outcome of QM observations is thus typically higher than of the classical mode.

The difference between Subaru’s Service Program observations, available for some of the instruments¹, but not for HSC, is that the service programs have fixed allocation of typically $0.5n$, so their execution is dependent on many factors (like weather). Approved QM programs are executed during a common run that lasts several nights, thus there is more flexibility in observations and the probability of having the best-ranked proposals completed is much higher.

Queue operations are divided into several parts:

- Phase 1 preparation: proposal submission (incl. target selection, telescope configuration, constraints setting, etc.).
- Phase 2 preparation: observing blocks submission (detailed description of the observations).

¹<http://www.naoj.org/Observing/Proposals/Submit/service.html>

- Observations (execution of the observing blocks) and quality assessment (check if the data meet the proposal criteria).
- Data delivery (incl. raw science data, calibrations, logs).

This document describes these steps in more details.

1.3 Semester S16A

Semester S16A is the first stage of the HSC QM operation, which is performed in a shared-risk mode. The time dedicated for QM will depend on the number of accepted queue programs. Setting other time constraints is not allowed. Intensive, bad weather filler, strategic programs and Partner proposals (Univ. of Hawaii, Keck and Gemini time exchange) are not allowed for HSC QM observations in S16A. Some observations can be carried out during the dead time (so-called *sukima*) of the classical mode, and during the first and last nights of a Strategic Program run.

Important: The number of nights dedicated for QM in S16A is limited. Depending on the amount of time requested for QM, we may ask some observers to switch from queue to classical.

1.4 Future implementation plan

In the next semesters, the implementation of the QM for HSC observations will be as follows:

- Stage I (cont.): S16B – filler programs and dedicated proposal templates introduced.
- Stage II: S17A and B – 20-50% of total HSC time dedicated for QM, open use only.
- Stage III: S18A and B – 80% of total HSC time dedicated for QM, including SSP.

Details will largely depend on the efficiency of QM in the early stages and the feedback from the users. Communication between the PIs and the HSC queue group is strongly encouraged.

1.5 Acronyms and terminology

AL – acceptance letter

BBF – broad band filter

CfP – call for proposals

Constraints – observation constraints, limitations on seeing, sky transparency, moon phase, moon distance, air mass

GRADE – Priority level of the HSC queue mode proposal

FQA – final quality assessment

HSC – Hyper Suprime-Cam

IQA – initial quality assessment

NBF – narrow band filter

OB – observing block
Partner – University of Hawaii, Gemini Observatory or Keck Observatory
Phase 1 – period of proposal preparation and submission
Phase 2 – period of OB preparation and submission
PI – Principal Investigator, a person responsible for proposal and OB preparation and submission
QM – queue mode
QO – queue observer, a Subaru Telescope staff member who operates the telescope or instrument at QM night
QWD – queue mode working group
Run – period of time, when HSC is attached to the telescope
SOD – Science Operation Division
SA – support astronomer, a person who is supporting HSC operations
SSP – Subaru Strategic Program
Sukima – “dead time”, classical night time without any observable targets
TAC – time allocation committee
TO – telescope operator

Chapter 2

Proposals (Phase 1)

HSC queue mode proposals are submitted as Subaru Open Use programs, and all the basic policies of the Open Use apply to QM. For more information, see:

<http://subarutelescope.org/Observing/Proposals/Submit/policy.html>

The difference is that in QM the time is allocated in units of hours, where 7.0 hours = 1.0 night. PIs should first choose between classical and queue modes, and in QM calculate the number of required hours (on-source). The dates of HSC runs, including the QM run, will be given together with the call for proposals (CfP). Partners (UH, Gemini, Keck) may not apply for QM in S16A. Also, some additional limitations apply in S16A.

2.1 Proposal preparation

2.1.1 Categories

If the user decides to apply for time in the queue mode, the proposal may be of one of the following categories:

- **Normal program:** Proposal with total requested time of less than 35 hours, but with no lower limit of requested time. Same deadline as for Normal Open Use proposals.
- **Intensive program:** **This category is not available in S16A.** Proposal with total requested time of 35-70 hours per semester, or for multiple semesters. Same deadline as for Normal Open Use proposals.
- **Filler program:** **This category is not available in S16A.**¹ Short proposals which request less than 4 hours, and are *specifically intended for observations during bad weather*, i.e. seeing >1.2" and transparency <0.5 (see Section 2.1.2).

¹Except for Subaru Telescope staff and HSC developers. Separate call will be announced.

Table 2.1: Levels of sky transparency to be set in the proposal and OBs

Constrain	Best	Good	Possible	Bad
Description	Photometric (stable, clear)	Thin cirrus and patchy clouds	Cloudy	(Filler)
Transparency	$T > 0.90$	$T > 0.75$	$T < 0.75$	$T < 0.5$
Magnitude loss	$dm < 0.1$ mag	$dm < 0.3$ mag	$dm > 0.3$ mag	$dm > 0.75$ mag

2.1.2 Environmental Constrains

During the night, selection of targets to be observed depends on current conditions, especially seeing, sky transparency, sky brightness (Moon phase) and distance to the Moon. Night observing schedules will be adjusted accordingly, if weather changes. It is thus very important that these constrains are well defined already in the Proposal.

In their proposals, the PIs should explicitly give the following information:

- **Seeing:** the maximum value of seeing, at which observation may be performed, in arcsec.
- **Air mass:** the maximum air mass/zenithal distance (or minimum elevation) at which a target may be observed. The recommended value, set by default, is $z = 2$ (30° over the horizon), but PIs may request a lower limit, between 20° – 30° ($z \simeq 2$ – 3). Note, however, that the Atmospheric Dispersion Corrector will not work properly at $z > 2$.
- **Sky transparency:** the sky clearness and magnitude drop due to clouds, defined as a number between 0 (totally cloudy) and 1 (clear). See Table 2.1.
- **Moon phase:** the acceptable brightness of the sky, coming from the illumination of the Moon – “dark”, “gray” or “dark+gray” (“dark” means 0–3 days and “gray” 4–11 days to/from the new moon). HSC runs are not allocated during bright time.
- **Moon distance:** the minimum separation from the Moon, at which the target can be observed, in degrees. Only distances larger than 30 deg are allowed (to avoid significant contamination with stray light).

Note, that if a highly-ranked proposal is intended for restrictive conditions (for example seeing $< 0.6''$) that are not currently met ($\sim 0.8''$), this proposal will not be executed at such moment, and a lower-ranked one that allows for given conditions ($< 1''$) will be chosen. Relaxing the constrains increases the probability of having observations done. Defining different constrains for different targets is allowed.

In order to help to choose the optimum environmental constrains for your project, that will increase the probability of execution and still allow for the science you intend to make, please familiarize yourself with the statistical information on seeing and clear skies:

<http://www.naoj.org/Observing/Telescope/ImageQuality/Seeing/>.

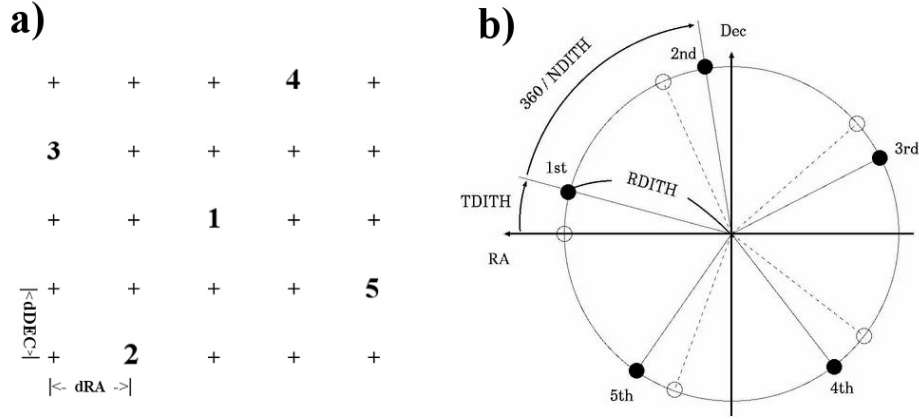


Figure 2.1: HSC dithering patterns. **a)**: the pre-defined 5-point pattern; **b)**: example of a circular pattern for $N = 5$ ($TDITH=\theta$, $RDITH=r_D$, $NDITH=N$).

2.1.3 Filters

The filter exchanger unit of the HSC can hold up to 6 filters in one observing run. Their list for given semester and given run, including QM runs, is published together with the CfP. See the following links for the availability and characteristics of HSC filters:

<http://www.naoj.org/Observing/Instruments/HSC/index.html>
<http://www.naoj.org/Observing/Instruments/HSC/sensitivity.html>

QM proposals requesting filters which are not scheduled for the given run will be rejected. Overall, there are 5 broad band filters (BBF) and 3 narrow band filters (NBF). Note, however, that NBFs are user filters, and to use them in your program you must first get the approval. For this reason the usage of NBFs is a subject to slightly different policies, regarding calibrations or carry-over, for example (see further Sections).

Note also that to change the filter during the night, the telescope has to be pointed to the zenith first. The whole filter changing procedure takes approximately 0.5 h, and in general we try to minimize the number of such operations. If your program requires observations of the same field in several filters, most likely they will not be done the same night.

2.1.4 Dithering

The chips of the HSC are separated by small gaps (up to 53 arcsec), so to avoid having a target in such gap and ensure complete coverage of the whole field of view, a dithering is used. Dithering procedures for HSC are similar to the ones available for Suprime-Cam². In particular,

²<http://www.naoj.org/staff/nakata/suprime/observing/opedir/opec.html#sec3.5>

there is a pre-defined 5-point dither pattern, customized N-position circular pattern, and no-dither option is allowed as well. [The pre-defined 5-point and 5-position circular patterns are recommended.](#)

In the pre-defined 5-point dither, user defines the steps dRA and $dDEC$, in arcsec, and the telescope points according to the scheme in Figure 2.1a. In the circular case, user defines the radius r_D in arcsec, initial angle θ in degrees, and number of steps N (5 recommended). Consecutive exposures are taken at positions that lay on a common circle of radius r_D , every $360^\circ/N$ from each other, as in Figure 2.1b. Note, that this is not done by rotation of the instrument, but by moving the telescope; the position angle of the instrument remains constant. The suggested values are 120" for dRA , $dDEC$ and r_D , and 15° for θ .

If one sequence, either pre-defined 5-point or any circular, takes a lot of time, it may be split in two or more, using the parameters $SKIP$ and $STOP$. For example, $STOP = 3$ means that the telescope will observe only in the first three positions, $SKIP = 3$ means that the telescope will start from the 4-th position, skipping the first three. $SKIP = 1$ and $STOP = 2$ will make the telescope move only to the second position. $STOP$ must *always* be larger than $SKIP$.

Without dithering, it may be necessary to introduce an offset to the target position, in order to avoid placing it in a gap between the CCDs.

2.1.5 ETC and overheads

In the Phase 1, the total requested time given in the proposal does not need to include overheads, *only the on-target exposure time*. No overheads (detectors readout, slewing time, calibrations, etc.) will be charged, as they are taken into account in the reduced number of hours per night (7 instead of 10, as in the classical mode). It is crucial for QM observations to properly estimate the required exposure time.

There is one common ETC tool for several imaging instruments available at Subaru:

http://www.naoj.org/cgi-bin/img_etc.cgi

This includes the Suprime-Cam, which is equipped in the same CCDs as the HSC, so can be used for exposure times estimation. Chose the instrument (Suprime-Cam FDCCD), the kind of source (point or extended), and number of days from new moon, to simulate the background level. Set the appropriate brightness of the object in proper units (Vega mag, AB mag or μJy), and filter – for HSC choose between g',r',i',z',Y for BBF [\[NBF?\]](#). Set the seeing and size of the aperture, in which the total flux will be calculated. It is assumed to be circular for point sources and square for extended. In “Require at least [] exposures”, you can also set how many exposures per target you want to have. Note that the recommended dithering patterns are set for 5 exposures.

To calculate the exposure time you need to get the desired signal-to-noise ratio (S/N), set the S/N and click “Calculate exposure time”. The ETC will then return the information about the required exposure and total time (which includes readouts), together with supplementary information about the background level, flux within the selected aperture, and saturation. If you have chosen to make more than one exposure, the integration time and S/N information will also be given per exposure. If multiple exposures are required (in order not to saturate

the CCDs for example), the ETC will tell you so, giving the recommended integration time and S/N per exposure

To calculate the S/N resulting from a given integration time, set the time and click “Calculate S/N ratio”. The ETC will then return the value of the final S/N, supplemented with information about the background, flux, and saturation. If more than one exposure is selected, the ETC will split the given time to the requested number of exposures, and will also give S/N per single frame. The ETC may again tell you that multiple exposures are required, giving the recommended integration time and S/N per exposure.

2.1.6 Calibrations

QM users will not be charged time (i.e. do not have to include it in Phase 1 or 2) for standard calibrations, which are:

- **Bias:** 10 frames per each run.
- **Dark frame:** 5 frames of 300 sec per run.
- **Dome flat:** for each run, dome flats for all 5 or 6 filters will be taken, but only one per night.
- **Standard stars:** every night at least 3-4 exposures of SDSS fields, 30 sec each. Additionally, a 30-sec exposure every time when proposal ID, filter or target is changed.
Important: it is the PI’s responsibility to assign a proper SDSS field to each science field (see Sect. 3.2).

Customized standard star calibrations (not an SDSS field, different exposure time, etc.) are allowed, but are treated as additional observations. They should be included in the proposal, separate OBs should be prepared, and time will be charged in the same way as if it is a science target.

The above procedure is not guaranteed for NBFs. Please contact SOD or QWG.

2.2 Queue proposal template and submission via ProMS

Submission of Subaru proposals is done on-line through the ProMS 2.0 system:

<https://proms.naoj.hawaii.edu/proms2/login.php>

It is a web form that has an embedded template, which is used to create a final pdf document that is sent to the referees. From this page one can also obtain current semester templates, which can be used to prepare proposals off-line. After login to the ProMS system, one can choose to create a new proposal from scratch, or load a tex file.

In the semester S16A the template for HSC queue mode will be the same as for other Normal Open Use programs. For general information on how to fill it, see

<http://www.naoj.org/Observing/Proposals/Submit/howto.html>.

12. Observing Run

Instrument	#Nights	Moon	Preferred Dates	Acceptable Dates	Observing Modes
HSC	0.52	dark			Queue

2nd choice:
comments:

Total Requested Number of Nights: 0.52 Minimum Acceptable Number of Nights: 0.28

13. Scheduling Requirements

Request Remote Observation ☒ at Hilo ☐ at Mitaka ☒ HSC-Queue

For HSC-Queue observers, please describe your observation constraints: Seeing (upper limit[""]), Transparency(lower limit: 0.0 - 1.0), Moon Distance (lower limit [degree]), Airmass (upper limit : 2.0 - 3.0)

Seeing < 0.7, T > 0.9, Moon Distance > 30 degree, Air mass < 2.0

Callouts:

- 1: Select HSC
- 2: Insert total nights
0.14 night = 1 hour
1 night = 7 hours
- 3: Moon: Choose dark/gray/dark+gray
- 4: Queue
- 5: Input Minimum nights
- 6: Check mark HSC-Queue Mode
- 7: Input observational constraints (most strict one):
Seeing, Transparency, Moon Distance, Air mass.

Figure 2.2: Proposal template for HSC QM in S16A, with major new features marked.

The main difference are Boxes 12 “Observing run” and 13 “Scheduling requirements” (Fig. 2.2). In Box 12 put “HSC” as the instrument, and in “#Nights” give the total requested time, assuming that 1.0 night = 7.0 hours, or 0.14 night = 1 hour. Fractions of nights are allowed, rounded up to two decimal places. In “Moon” choose the sky brightness/moon illumination. There will be no HSC run allocated in bright nights, so choose between “dark”, “gray” or “dark+gray” (do not put “any”, as the system will include “bright” in your selection). Do not fill the next two columns (“Preferred Dates”, “Acceptable Dates”), nor the “2nd choice” (they will all be ignored). Put “Queue” in “Observing Modes”. Set the “Total Requested Number of Nights”(=“#Nights”) and “Minimum Acceptable Number of Nights”. In Box 13 select the “HSC-Queue” option in the “Request Remote Observation” line. Give the *most strict* observational constrain you intend to set. For example: seeing<0.8”, T (transparency) >0.9, Moon distance >30 deg., Air mass < 2.0.

We would like to remind the PIs that the Intensive and Filler programs will be introduced in further semesters, and classical Service programs are not foreseen for HSC QM.

2.3 Evaluation and ranking

2.3.1 Time allocation committee (TAC)

HSC QM proposals will be reviewed by external referees, who will evaluate their scientific content, and by Subaru support astronomers (SAs), who will check the technical feasibility.

The time allocation committee (TAC) will then select and rank the proposals based mainly on the referee score³. Filler proposals (from S16B) will not be sent to referees, and only the TAC will review them and decide about their acceptance.

2.3.2 GRADE

The TAC will assign a GRADE to each of the submitted proposals.

- **GRADE A** will be given to QM proposals from the top 5-10% of all accepted HSC proposals (queue+classical). The observatory will put highest effort to complete these programs. If not completed, they will be carried-over to the next semester (see Sect. 4.5).
- **GRADE B** will be given to the rest of accepted HSC QM proposals.
- **GRADE C** will be given to the non-accepted proposals, which, however, will get the permission from the TAC to be observed. In this way the TAC will ensure that there is more programs than just to fill the time reserved for QM, which gives more flexibility and backup options during observations. GRADE C observations will be performed in good or reasonable weather, when there are no A or B targets.
- **GRADE F (not in S16A)** will be given to the Filler proposals, i.e. those intended for bad weather (cloudy, seeing $>1.2''$). Filler programs might also be observed during classical nights, if the current classical program has no adequate backup.

When the constraints of a GRADE A, B, or C proposal are found to be too severe, they become a subject of “relaxation”, in order to increase the probability of their execution. This may be requested by the TAC, or SAs during Phase 2, or even during the observing run (see Sect. 3.4).

2.3.3 Acceptance letters (AL)

After the proposal evaluation, each PI will receive an acceptance letter (AL), not later than two weeks after the TAC meeting. The AL will include such information as: acceptance judgment, referee score, GRADE, and comments from referees and SAs. For GRADE B and C proposals, in the AL the TAC may also ask to relax the environmental constraints. Moreover, the ALs will include the request for preparation of OBs (Phase 2), together with all necessary deadlines and web addresses, as well as the values of the total allocated time and environmental constraints (used for OB validity check, see next Chapter).

Note that the proposal GRADE may later be published, however the referee score and all comments will only be known to the PI.

³See also point 4 in <http://www.naoj.org/Observing/Proposals/Submit/policy.html>

Chapter 3

Observing blocks (Phase 2)

3.1 What are OBs?

Observing blocks (OBs) are the smallest units (quanta) of observations in the queue mode. They describe a single observation, defining the observed object or field, exposure time, dithering pattern (if applicable), and telescope and instrument configuration (filter, position angle, etc.). They also define the environmental constraints, which are used for scheduling the observations – if the current conditions do not meet the criteria given in an OB, such an OB is not executed. There are no limits of the number of OBs for a proposal.

Overheads are automatically included in an OB, but are not charged to the PI. One OB should not exceed 100 minutes (6000 sec) of on-source time. In case of Subaru observations one queue OB is translated into one command that is sent to the telescope control system. There is no lower limit for OB total time, and we strongly encourage to make them short, in order to minimize the probability of interrupting one by an emergency situation (sudden weather breakdown, telescope malfunction, etc.). If such situation occurs, the affected OB will be repeated from the beginning. However, the general policy is to finish an OB once it has been started.

Remember, that due to the specific filter changing procedure, expositions in two filters should be defined as two separate OBs. Two consecutive observations of different exposure times are also not allowed as one OB.

3.2 Phase 2 spreadsheet

In the semester S16A the OBs are prepared using a MS Excel .xlsx spreadsheet, and a basic knowledge of this program is required. A template will be sent to each PI no later than 2 days after the AL. It can be read and edited in OpenOffice, LibreOffice or similar program, but it should be saved in the .xlsx format.

The spreadsheet consists of five tabs: `targets`, `envcfg`, `inscfg`, `telcfg`, and `ob`, that include, respectively: definitions of targets, environmental constraints, instrument and telescope configuration, and the OB itself. Please do not change the names of tabs and columns. Comments and additional calculations can be done aside (out of the named columns). Do not put ad-

targets

	A	B	C	D	E	F	G	H	I
1	Code	Target Name	RA	DEC	Equinox	SDSS RA	SDSS DEC	Comment	
2	n1234	NGC1234	03:09:39.00	-07:50:47.00	J2000	24:12:54.00	-04:14:10.00		
3	IRAS3+5	IRAS01234+5600	01:23:40.00	55:00:00.00	J2000	01:00:00.00	23:18:03.40		
4	H9000	Hal9000	07:00:30.00	12:45:00.00	J2000	07:00:00.00	13:00:00.00		
5									
6									
7									

envcfg

	A	B	C	D	E	F	G	H	I	J	K
1	Code	Seeing	Airmass	Moon	Moon Sep	Transparency	Comment	Seeing Check	Phase 1 Seeing Constraint	Phase 1 Transparency constraint	
2	dark_s0.8_am2_trans0.8	0.8	2	dark	30	0.8		Seeing okay	0.8	0.8	
3	gray_s1_am2.5_trans0.5	1	2.5	gray	30	0.5		Transparency Check			
4								Transparency okay			
5											
6											
7											
8											

inscfg

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Code	Instrument	Mode	Filter	PA	Exp Time	Num Exp	Other	Guiding	Offset RA	Offset DEC	Dith1	Dith2	Skip	Stop	On-src Time	Total Time	Comment	
2	g_300x5	HSC	imaging	g	0	320	5	5	Y	0	0	120	120	0	5	1600	1775		
3	r_300x1	HSC	imaging	r	0	300	1	1	N	0	0	0	0	0	1	300	335		
4	i_300x4	HSC	imaging	i	0	300	4	N	Y	0	0	120	15	0	4	1200	1340		
5	z_300x6	HSC	imaging	z	0	300	5	N	Y	0	0	120	15	0	5	1500	1675		
6	y_300x6_1	HSC	imaging	Y	0	600	8	N	Y	0	0	120	15	0	4	2400	2540		
7	y_300x6_2	HSC	imaging	Y	0	600	8	N	Y	0	0	120	15	4	8	2400	2540		
8																0	0		
9																0	0		
10																0	0		

telcfg

	A	B	C	D	E
1	Code	Foci	Dome	Comment	
2	p_opt2	P-OPT2	Open		
3	p_closed	P-OPT2	Closed		
4					
5					
6					

ob

	A	B	C	D	E	F	G	H	I	J
1	Code	tgtcfg	inscfg	telcfg	envcfg	On-src Time	Total Time	Priority	Comment	
2	n1234_g1	n1234	g_300x5	p_opt2	dark_s0.8_am1.5_trans0.8	1600	1775	1		
3	n1234_g2	n1234	g_300x5	p_opt2	dark_s0.8_am1.5_trans0.8	1600	1775	1		
4	n1234_g3	n1234	g_300x5	p_opt2	dark_s0.8_am1.5_trans0.8	1600	1775	1		
5	n1234_i1	n1234	i_300x4	p_opt2	gray_s1_am2_trans0.5	1200	1340	1		
6	n1234_r1	n1234	r_300x1	p_opt2	gray_s1_am2_trans0.5	300	335	2		
7	This is OB y1	n1234	y_300x6_1	p_opt2	gray_s1_am2_trans0.5	2400	2540	3		
8	This is OB y2	n1234	y_300x6_2	p_opt2	gray_s1_am2_trans0.5	2400	2540	3		
9	This is OB y3	n1234	y_300x6_1	p_opt2	gray_s1_am2_trans0.5	2400	2540	4		
10	This is OB y4	n1234	y_300x6_2	p_opt2	gray_s1_am2_trans0.5	2400	2540	4		
11	#This is a line with comment					#N/D	#N/D			
12	10	H9000	g_300x5	p_opt2	dark_s0.8_am2_trans0.9	1600	1775	1		
13	11	H9000	g_300x5	p_opt2	dark_s0.8_am2_trans0.9	1600	1775	1		
14	12	H9000	g_300x5	p_opt2	dark_s0.8_am2_trans0.9	1600	1775	1		
15	13	H9000	i_300x4	p_opt2	gray_s1_am2_trans0.5	1200	1340	1		
16	14	H9000	r_300x1	p_opt2	gray_s1_am2_trans0.5	300	335	2		
17	15	H9000	y_300x6_1	p_opt2	gray_s1_am2_trans0.5	2400	2540	3		
18	16	H9000	y_300x6_2	p_opt2	gray_s1_am2_trans0.5	2400	2540	3		
19	17	H9000	y_300x6_1	p_opt2	gray_s1_am2_trans0.5	2400	2540	4		
20	18	H9000	y_300x6_2	p_opt2	gray_s1_am2_trans0.5	2400	2540	4		
21						#N/D	#N/D			
22						#N/D	#N/D			
23						#N/D	#N/D			

Figure 3.1: Example of an Excel spreadsheet used to create a set of queue OBs. Sample content of each of the tabs is presented. Blue columns are for time calculations and tables with green fields are for the on-the-fly validity check. Note two configurations that compose one long dither pattern in inscfg (rows 6 and 7), and the OBs that use them (in ob, rows 9 and 10 for example). Also, note a line introduced in the ob tab.

ditional columns or lines, except for lines in the **ob** tab. Some validity check solutions are implemented, but the spreadsheet will be double-checked after submission.

The targets tab

The first tab is to define the targets to be observed. Only the targets from the proposal are allowed, except for special cases of targets are approved by the SOD (Sect. 3.4). In the first column – **Code** – put an identifier, that will serve as a reference to this particular target later. Put your own name of the object in **Target Name**, and J2000 coordinates in **RA**, **DEC**. Use hh:mm:ss.ss and (-)dd:mm:ss.ss format respectively. Don’t change the **Equinox**. Give the coordinates of the SDSS calibration field in **SDSS RA** and **SDSS DEC**¹. This field will be used for photometric calibration, **IQA** and environmental constrains check. If the target field itself is in the SDSS, you put here the same coordinates as in **RA**, **DEC**. If you intend to use a customized calibration field, define it as a new target (new line), and leave **SDSS RA** and **SDSS DEC** blank for both. Add a **Comment** to which target should your calibrator be assigned.

The **Target Name** and **Code** (in any tab, not only this one) fields may contain blank spaces. The **Target Name** will be the name saved later in the fits file header in the **OBJECT** keyword.

The envcfg tab

The second tab defines the restrictions that will be used to decide if the OB can be executed at current observing conditions. Refer to the Sect. 2.1.2 for their explanation.

Your most strict constrain regarding the seeing and transparency from Phase 1 will be sent in the **AL**. Put it in the **Phase 1 Seeing Constrain** and **Phase 1 Transparency Constrain** cells. The column **Code** means an identifier, that will be later used to refer to a particular set of conditions. In further columns put the maximum allowed **Seeing** (in arcsec) and **Airmass** (default=2). Define the sky brightness in **Moon**, use dark/gray/any (where “any”=“dark+gray” from Phase 1, as HSC runs are not allocated during bright time). Then, give the minimum allowed separation from the Moon (**Moon Sep**, in degrees), and the sky transparency (**Transparency**, from 0=“cloudy”, to 1=“completely clear”). If any of the values in **Seeing** or **Transparency** will be more strict than the Phase 1 criteria, and error message will appear. Put any additional comments in the last column (**Comment**). More than just one set of constrains can be defined, but none of them can be more restrictive (lower seeing, better transparency, etc.) than what is in the proposal.

Note that when a non-SDSS calibrator is defined, to make it useful it needs to be observed in photometric conditions, i.e. $T > 0.9$. Such a calibrator will not be observed if this criterion is not met.

The inscfg tab

This tab defines the instrumental parameters used during an observation, such as filter, exposure time, or dithering pattern. In **Code** put an identifier, that will be later used to refer

¹<http://www.sdss.org/dr12/>

to a particular set of parameters. **Instrument** and **Mode** should be kept at “HSC” and “imaging”, respectively. Set the **Filter**, choosing from g/r/i/z/Y, or by putting the name of an NBF manually. **PA** is the position angle of the instrument². **Exp Time** is the exposure time for one frame, without overheads.

The dithering (Sect. 2.1.4) is defined by **Num Exp**, **Dither**, **Dith1**, **Dith2**, **Skip** and **Stop**. To set the 5-point pattern, put **Num Exp**=5, **Dither**=5, and desired values (in arcsec) of the steps *dRA* and *dDEC* to **Dith1** and **Dith2**, respectively. To set the circular pattern, put **Dither**=N, and the desired number of steps in **Num Exp**. We recommend to keep it around 5. Put the radius of the circle in arcsec as the **Dith1**, and initial angle θ in degrees as the **Dith2**. If you wish no dithering, put **Dither**=1. In such case the **Num Exp** column will define how many expositions will be done without moving the telescope (default is 1).

If you decide you need more than 5 points in your dither sequence, you can set higher **Num Exp** for the circular dither. However, we suggest to keep the total OB time relatively short, and it can’t be longer than 100 min (6000 sec) of on-source time. You may choose to split the configuration in two, doing some positions within the first one, and the rest within the other. For this, set **Skip** and **Stop** appropriately (Sect. 2.1.4). Remember that **Stop** may not be smaller than or equal to **Skip**. Both such configurations should have different codes, but the same number of **Num Exp**, which is the total desired number of positions in your sequence, and all the other dithering and instrumental parameters. If you prepare a single setting, do not change **Stop** – by default it should be equal to **Num Exp**.

Basing on the dithering settings and **Exp Time**, for each configuration the spreadsheet will calculate the on-source (without overheads) and total time (with overheads), and automatically put it in the **On-src Time** and **Total Time** columns, respectively. Please do not edit these columns. For the scheduling purposes, in Phase 2 the readout overheads need to be included in the OBs. However, they will not be charged to the PI, and need not to be added to the proposal (Phase 1).

Set **Guiding**=Y to turn on the guiding, and N to turn it off. If you wish to introduce the offset from the original position (for example to avoid having the target in a gap between CCDs), set it in **Offset RA** and **Offset DEC** columns, in the units of arcsec.

The telcfg tab

This tab defines two configurations, where the dome is open (**Code** = “p_opt2”) or closed (“p_closed”). You don’t need to change anything in this tab.

The ob tab

The last tab defines the complete OB, by gathering all the information defined in previous tabs. *One line is one OB*. Only in this tab the PIs may introduce new lines (but not columns). If you wish to put a text in such line, please do it in column A and start with a hash #.

The total time allocated by the TAC will be given in the AL, put it (in seconds) in the blue cell below **Total Allocated Time**, in the table aside. **Code** is the name of the OB, that will be later used by the scheduler and telescope control system, so it is advised to make it as unique

²See <http://www.naoj.org/Observing/Instruments/HSC/CCDPosition.20140811.png>

as possible. Use drop-down menus to fill the next four columns. Choose codes of the targets, instrument, telescope (“p_opt2” only) and environmental configurations defined in previous tabs. The same target can be observed in various configurations, and a separate line (=OB) is required for each combination. If you decided to split your dithering to two configurations, make sure you prepare separate OBs for each of them. The **On-src Time** and **Total Time** (in seconds) are automatically calculated for the chosen *inscfg*. Please do not edit these columns. For the scheduling purposes, in Phase 2 the readout overheads need to be included in the OBs. However, they will not be charged to the PI, and need not to be added to the proposal (Phase 1).

Finally, prioritize your OBs, by giving them appropriate numbers in the column **Priority**. The lower the number (the lowest is 1), the more important the OB is, and will most likely be executed earlier. Several OBs may have the same **Priority**.

The table on the right summarizes the total on-source time that has been programmed (sum over all values of the **On-src Time** column), and compares it with the total time allocated by the TAC. If the programmed time exceeds the allocated, an error message is shown in the red field to the right. Please do not edit these fields.

3.3 OBs submission

[\[TBD if mail or website\]](#)

The exact deadline for OB submission (end of Phase 2) will be announced, but it will be around end of December for semesters A, and end of June for semesters B. The submitted OBs will be checked for errors and consistency with the proposal, i.e. if they do not exceed the allocated time, if the constraints are the same, etc. If inconsistencies are found, the PI will be asked to correct the OBs.

We encourage the PIs to submit their observations as early as possible. This will give the observatory more time for consistency check, introducing necessary corrections, and will allow for possible earlier execution (see Sect. 4.2).

3.4 Changes in OBs

The PIs should be careful when preparing the OBs, as the possibilities of introducing any changes after the submission are quite limited. Until Phase 2 is finished, PIs can consult with SAs or SOD to change exposure times, if the total time remains within the amount allocated by the TAC. Under the same condition, they can request to remove an OB from their list, and ask to repeat another one, but only if the target to be repeated is already in the list of approved targets. The SAs and SOD may also contact the PI during Phase 2 and ask to relax the constraints.

Except for constraints relaxation, changes are not possible once the Phase 2 is finished and OBs are sent to the scheduler. However, during observation the SAs may adjust some parameters (like exposure time) to respond to the variable conditions, but the total time granted to a given program will remain unchanged. To relax the constraints after Phase 2

(in order to increase the probability of execution), the PI should contact the SOD first. If permission is granted, the PI should re-submit those OBs that were not executed yet.

Other changes are basically not allowed, except for special cases. If user wants to change an original target, it should be discussed with the SOD first. It may be allowed if the science goal is unchanged, there is no conflict with other programs³, and there is a good reason. Changing filters should also be discussed with SOD first.

³See also “Clearly Prohibited Case” in <http://subarutelescope.org/Observing/Proposals/Visit/policy.html>

Chapter 4

Observations

4.1 Scheduling

Before each night, a queue schedule will be made. OBs will be selected basing on the visibility of targets, currently installed filter, and priority of programs (based on their GRADE) and particular OBS of the same program (prioritized by the user). In principle, a GRADE A target will be observed if possible. Before starting an OB, current weather conditions will be checked, and the nights schedule can be instantly updated if they suddenly change. The scheduler will also take into account the position of targets on the sky, in order to minimize the telescope slewing time. The number of filter changes during the night will be minimized.

The schedule for the incoming night will also depend on the FQA of the previous night's data, and will be adjusted on the basis of completeness of programs (especially GRADE A). If a program's completeness is very low, the SAs or SOD may contact the PI and ask to relax the constrains.

4.2 Early execution

The OBs that will be delivered and accepted before the new semester starts, will have a chance to be executed in the semester that comes to an end. If, for example, users send their OBs early December before semester A, their execution will be possible for over a month. For the early execution, all GRADE ABCprograms will be assigned GRADE C temporarily. The original GRADE will be restored once the new semester begins.

4.3 Sukima (dead time)

The “dead time”, or sukima, is a time during classical mode observations when no target is available (due to weather, visibility, etc.). For HSC classical observations, queue programs may be executed in such cases, and will be given higher priority than classical backup targets. All GRADEs (ABC) are accepted for sukima, and the OBs will be prioritized in the same way as for night assigned to the QM. Sukima hours are not counted as queue hours, but part of the classical mode, so the QM users will not be charged time for such observations.

4.4 SSP time

Part of the HSC time is dedicated to Subaru strategic programs (SSP). Such programs will not be accepted for the queue mode until S18A, but the first and last nights of SSP time (usually gray) will be open for QM observations, with the same scheduling and priority rules.

4.5 Carry over

GRADE A programs that were not completed during a given semester, will be carried over to the next two semester (keeping three semesters in total). Programs assigned other GRADEs are not subject to the carry-over policy. There is no guarantee, that OBs using NBFs will get the chance to be completed later. It may happen only if in the future semester the same narrow band filter is installed. [Note that programs for which \$\geq 90\%\$ of total time has been executed and approved \(see next Section\), will be considered as completed, and will not be carried over.](#)

4.6 Quality assessment

The quality assessment is performed in two stages. The initial quality assessment (IQA) is done by a QA just after the observation. It includes a quick check of the currently taken data for seeing, sky transparency, detector noise, etc. The QA will then judge if current conditions are acceptable for the next scheduled OB. If not, the night schedule will be updated instantly. Note, that the transparency will be measured directly only on the SDSS fields. Execution of an OB is determined based on its latest available measurement.

The next day after observations, a final quality assessment (FQA) will take place. SAs will double-check the quality of the data, taking into account more factors, and compare with the PIs requests. Each program will have one SA delegated to deal the FQA. Comments will be assigned, and later delivered to the PI (together with other products). When an OB will pass the FQA, it will be considered completed. Otherwise, it will be repeated. Schedule for the next night will be updated accordingly.

Note, that weather may change during observations, so at each stage a tolerance of 0.1" for seeing and 20% for transparency will be applied. For example, if the PI asks for seeing $< 0.8''$, observations done with seeing $\sim 0.85''$ will be considered as completed. To minimize the probability of having the last exposure of an OB taken in significantly worse conditions than the first one, we encourage the PIs to use dithering sequences with small number of positions (recommended: 5). Even if only 1 of 5 exposures will not pass the FQA, such an OB may be considered as not completed.

Chapter 5

Data delivery and feedback

[Needs confirmation, will be changed if necessary]

5.1 Delivery package

In order to download her/his data, the PI will receive an email containing a python-based script for automatic download of the data package from MASTARS or STARS, and an instruction on its use. It will also enable to download the corresponding calibration data, and summary and weather logs. Run it whenever you receive a notification email.

The notification email will be sent to the PI after one or more OBs of the program pass the FQA. Note however, that the flat field frames, for example, can be taken the following night or later, so may not come together with all your observations. On the contrary to the policy regarding classical mode data, there will be no next day delivery, however all effort will be made to make the data available to the PI as soon as possible.

The notification email will also summarize the progress of the observation to date, i.e. which OBs have been executed and which are still waiting, or need to be repeated (identified by the Code given in the ob tab of the spreadsheet – Sect. 3.2). For the executed OBs, comments from the FQA for each OB and frame will be available. Finally, the notification email will indicate the weather logs and reports, in order to inform the PIs of the environmental conditions during the observations.

Because OBs of the same program might be executed over several nights (or even carried over to the next semester), the PIs should expect to get several such emails. Notification will be sent and data will be delivered also for OBs that were executed, but did not pass FQA and that are to be repeated. At the end of the semester the PI will also receive a final email summarizing the whole program, and notifying whether any blocks have been carried over to subsequent semesters.

5.2 Archiving at SMOKA

The HSC QM data are a subject of the same archiving policy as any other Subaru data. In principle, scientific data taken with the Subaru telescope are archived with 18 months

proprietary period. After that time they become publicly available at the Subaru Mitaka Okayama Kiso Archive (SMOKA) system:

`http://smoka.nao.ac.jp/`

[TBD] Extension of the proprietary period, may be granted in special cases to HSC queue programs that were highly ranked (GRADE A) and were carried over to the next semester or two. In such case, the corresponding request has to be justified in detail and submitted to the [...].

5.3 Feedback to the observatory

In order to ensure better, more efficient operations in the future, and satisfaction of the QM proposers, we ask for your feedback at any moment. We encourage to stay in touch and ask any questions, especially during the Phase 2 and observing runs. All the inquiries should be directed to:

`queue [at] naoj.org.`



Figure 5.1: Future astronomers already know the queue mode.