

A - Introduction

The Queued Service Observing (QSO) Project is part of a larger ensemble of software components defining the **New Observing Process** (NOP) which includes NEO (acquisition software), Elixir (data analysis) and DADS (data archiving and distribution). The semester 2006B was the second semester in the history of QSO that two instruments were fully offered in that mode: MegaPrime and WIRCam. The latter was offered as a regular instrument even if several nights in the time scheduled were still used for engineering purposes. The semester for MegaCam was **extremely successful**, our best yet since we started QSO in 2001! Indeed the completion of all MegaCam programs reached a level never achieved before. For WIRCam, it was more difficult because one run was lost due to a technical problem with the camera and weather was not so good at all during the other runs.

They are again several very positive developments that occurred during this semester: 1) The efficiency on the sky for MegaCam is fully optimized, the camera is performing more reliably and when weather is good, the amount of data gathered is staggering; 2) WIRCam in QSO mode is working really well, is efficient and produces great data; the observing efficiency is constantly improving. For 2007A, about 150 nights of QSO time are scheduled again... another challenge ahead!

B - General Comments

MegaPrime

The 2006B semester for MegaPrime was incredibly successful. The first three months of the semester were so-so due to unstable weather but the end of the semester was, unexpectedly, very productive! We had again long periods of very bad, unpredictable and unstable seeing but we were able to adapt well, although our validation rate suffered a bit. The semester 2006B included very difficult scheduling issues with time critical observations from several PI programs and, of course, CFHTLS. A positive aspect of the 2006B was a good observing efficiency and even more importantly, improvements in the reliability of the camera which resulted in very little downtime. the only significant downtime due to technical issues was the few nights lost due to earthquake damages in October. Due to this very high efficiency and good weather, the global statistics on all programs for 2006B is extraordinary: **A + B + C programs were done at 94%!!** The balance the Agency time at the end was also excellent.

Some general remarks on QSO in general for the semester 2006B with MegaPrime:

1. Technically, the entire chain of operation, QSO --> NEO --> TCS, is efficient and robust. The time lost to the NOP chain is completely negligible. This is a complex system and we have worked real hard to reduce the overheads on this. The system is quite reliable and very efficient.
2. The QSO concept is sound. With the possibility of preparing several queues covering a wide range of possible sky conditions in advance of an observing night, a very large fraction of the observations (>90%) are done within the

specifications. The ensemble of QSO tools allows also the quick preparation of queues during an observing night for adaptation to variable conditions, or in case of unexpected overheads. The introduction of the CFHTLS and several other PI programs with time constrained observations on a large-scale adds significant complexity to queue scheduling and requires much more work on planning of the runs. For 2006B, the global validation rate (validated/observed) for MegaCam is excellent (section C). For the last run of the semester, we had some RA ranges for which we had very limited options for the targets; some discretionary time was used and we had to start a few observation groups for a few programs for the 2007A semester.

3. QSO is well adapted for time constrained programs. The Phase 2 Tool allows the PIs to specify time constraints. Two of the components of the CFHTLS have very restrictive time constraints. We can handle those easily if the weather is cooperative (of course!) although the introduction of time constrained observations on a large-scale adds up definitive complexity in the scheduling process.

4. Very variable seeing and non-photometric nights represent the worse sky conditions for the QSO mode. In 2006B, we were a bit short on "shapshot" programs or regular programs requesting mediocre conditions (1" to 1.2"), although the situation was better than usual. As a result, we were sometime forced to try observing some programs in conditions worse than requested. Again, we were able to calibrate all the fields requesting photometry but originally done during non-photometric conditions. The availability of Skyprobe and real-time measurements of the transparency is extremely valuable and regularly used to decide what observations should be undertaken.

WIRCam

We offered WIRCam as a fully commissioned instrument for 2006B. Some time was in fact used for engineering, mostly for improvements made on the guiding and focusing from a model instead of exposure sequences, but we were able to get good quality data for lots of program. Unfortunately, we lost an entire run of 8 nights due to a problem with the cryogenic head and weather conditions were very so-so for a good fraction of the WIRCam nights in 2006B... Despite these difficulties, the statistics given in the later section are pretty good! This is due to clear improvements in observing efficiency made on the sky, which is usually found in the 80 to 85% for a given night. Due to a more restricted number of nights and those problems, the balance of agency time is a little bit off.

For WIRCam, several conclusions regarding can already be drawn from 2006B:

1. Technically, the entire chain of operation, QSO --> NEO --> TCS, is efficient and robust. The time lost to the NOP chain is already quite small for WIRCam. In fact, there was still a lot of optimization work done to minimize operational overheads. This is a complex system but reliable and efficient. At the moment, most of the overheads are related to guiding and dithering patterns. Certain operational modes specific to WIRCam, like nodding (target-sky-target...) and chip-to-chip dithering, have longer overheads but some of them are charged during Phase 2; those modes have been tested and work very well. Real-time analysis is working well although the image quality analysis is sometime faulty on fields with lots of galaxies and few stars.

2. The QSO concept is sound. As with MegaCam, the possibility of preparing several queues covering a wide range of possible sky conditions in advance of an observing night result in a very large fraction of the observations done within the specifications. For WIRCam, the sky background is more of a factor although its global variation through the night in Mauna Kea is fairly well known. Seeing is of course another important parameter but variations during the night in the near-IR are generally not as brutal as in the visible. Planning of the queue nights with WIRCam was easier than with MegaCam (less time-critical programs) although the pool of programs being smaller and the pressure at certain RAs being uneven, it is sometime difficult to optimize the scheduling.

3. Non-photometric nights represent the worse sky conditions for the QSO mode with WIRCam. An important difficulty of near-IR astronomy is the removal of the sky background. Non-photometric conditions make that operation a more difficult one. Nodding for instance cannot be done. The availability of Skyprobe and real-time measurements of the transparency is extremely valuable and regularly used to decide what observations should be undertaken. Also, the real-time analysis through Elixir provides a direct estimate of the extinction through the 2MASS catalog, helping even more the observing process.

C - Global Statistics, Program Completeness, and Overheads

1) Global Statistics

MegaPrime

The following table presents some general numbers regarding the queue observations for 2006A (C, F, H, K, L, and T, D-time, **excluding** snapshot programs). Note: 1 night is 9.5 hours.

Parameter	Number
Total number of Nights	101
Nights lost to weather	~ 20.5 (~20%)
Nights lost to (engineering + technical) problems	~ 7 (~7%)
QSO Programs Requested	36 (+ 4 snapshots)
QSO Programs Started	36
QSO Programs Completed	22
Total I-time requested (hr.) (A+B+C)	597
Total I-time validated (hr.) (A+B+C)	566 (95%)
Completion A+B Programs	95%
Queue Validation Efficiency	~ 92 %

Remarks:

- The fraction of time lost during QSO nights in 2006B due to weather and technical problems is **about 27%**. This is high but about what's expected. Note that most of the technical downtime is due to the major earthquake in October which resulted in several nights lost and time on the sky to repair the damaged RA encoder.
- The global validation rate (validated/observed) is excellent ~92%. Part of this comes from the now excellent focus model with automatically adjust the focus between exposures and keep the image quality optimized. The most difficult conditions come from very rapidly changing seeing; we were faced with several nights like that during 2006B.
- The total number of hours VALIDATED during the semester is ~566 hrs. However, the total number of hours is in fact much higher than this because we spent quite a bit of time on engineering programs for calibrating MegaPrime. If we count everything, the total number of hours validated is 630 hrs.

WIRCam

The following table presents some general numbers regarding the queue observations for 2006B (C, F, H, and T, D-time, **excluding** snapshot programs). Note: 1 night is 9.5 hours.

Parameter	Number
Total number of Nights	45
Nights lost to weather	~ 11 (~24%)
Nights lost to (engineering + technical) problems	~10 (~22%)

QSO Programs Requested	28 (+ 2 snapshots)
QSO Programs Started	24
QSO Programs Completed	9
Total I-time requested (hr.) (A+B+C)	271
Total I-time validated (hr.) (A+B+C)	189 (72%)
Completion A+B Programs	79%
Queue Validation Efficiency	~ 94 %

Remarks:

- The fraction of time lost during WIRCam QSO nights in 2006B due to weather and technical problems **is about 46% of the semester**. This is significantly larger than the global fraction expected (~20%). This number is about the same as with the semester 2006A and in direct contrast with the numbers seen for MegaCam for the same semester. The weather lost is about what it should have been but the run lost to the cryohead issue was very costly. Despite this time lost, the statistics are quite good, indicating high observing efficiency when the sky is clear (see below)
- The global validation rate (validated/observed) is excellent ~94%. The most difficult conditions for WIRCam come from clouds and higher than expected sky background. We were able to adapt quickly to these conditions. If we remember that during good nights, 350 to 400 cubes of data (so ~1000 exposures) can be taken, this high validation rate is excellent.
- The total number of hours VALIDATED during the semester is ~189 hrs. We then find [189 hrs / (45)] ~ 4.2 hours /nights of observations. This is very low and entirely due to the time lost to technical issues and bad weather. It is interesting to see how we are doing when we can observe, in order to evaluate the overheads and observing efficiency. We have ~189hrs / 24 nights = 7.9 hrs validated per clear night. In 2007A, an automated focus model has been implemented and has improved the observing efficiency significantly.

2) Program Completeness

MegaPrime

The figure below presents the completion level for all of the programs in 2006B, according to their grade:

Focus Sequence	~ 0 / night	200s / seq	0 seconds
Dome Rotation > 45 d	5 ?	120s	< 600 seconds
Guide Star Acquisition	20 - 30 ?	20 s / acq	< 600 seconds

Remarks:

- Overheads to filter changes are large and constitute the main difference with CFH12K. The total time for a filter change is about 127 seconds but this is done in parallel during readout or while the telescope is moving (so, we do not always have an overhead for a filter change). The global overheads also depends strongly on the number of standard stars observed for a given night and also if switching from a queue to another is necessary (since overheads due to filter change are minimized within a specific queue). Until we have another system, this overhead will remain with us....
- Focus sequences have been almost completely removed from our operations. The auto-focus model is available and contributes to significantly increase the time we spend observing instead of focusing. We take a few sequences during the first nights of a run to confirm the zero points of the model; other than that we just operate with the focus model.
- Overheads due to dome rotation are again minimized as much as possible within a specific queue. Note that a lot of rotation is necessary to reach standards stars on the equator when we observe northern targets. Hopefully, the use of the Deep survey fields from CFHTLS as secondary standards will help on this. Rotation of the dome is now optimized and cannot be made faster.
- Guide star acquisition is fully automated and except from some rare problematic acquisitions, it works really well. Acquisition tends to take longer when the seeing is bad or cirrus are present. Programs with frequent guide star acquisition with short exposure strategy (e.g. sequences for the Very Wide survey) increase the global overheads). The main overhead related to the guide star acquisition has been reduced dramatically in 2005A by accelerating the probe motions. Dithering patterns offsets for instance are now completely hidden in the readout time, which was not the case in the past.

Note that overheads for calibrations (standard stars and Q98 short exposures for photometric purposes) are not included in this table. For 2006B, we observed about 2 standard star fields during a photometric night (12 minutes / fields due to filter changes).

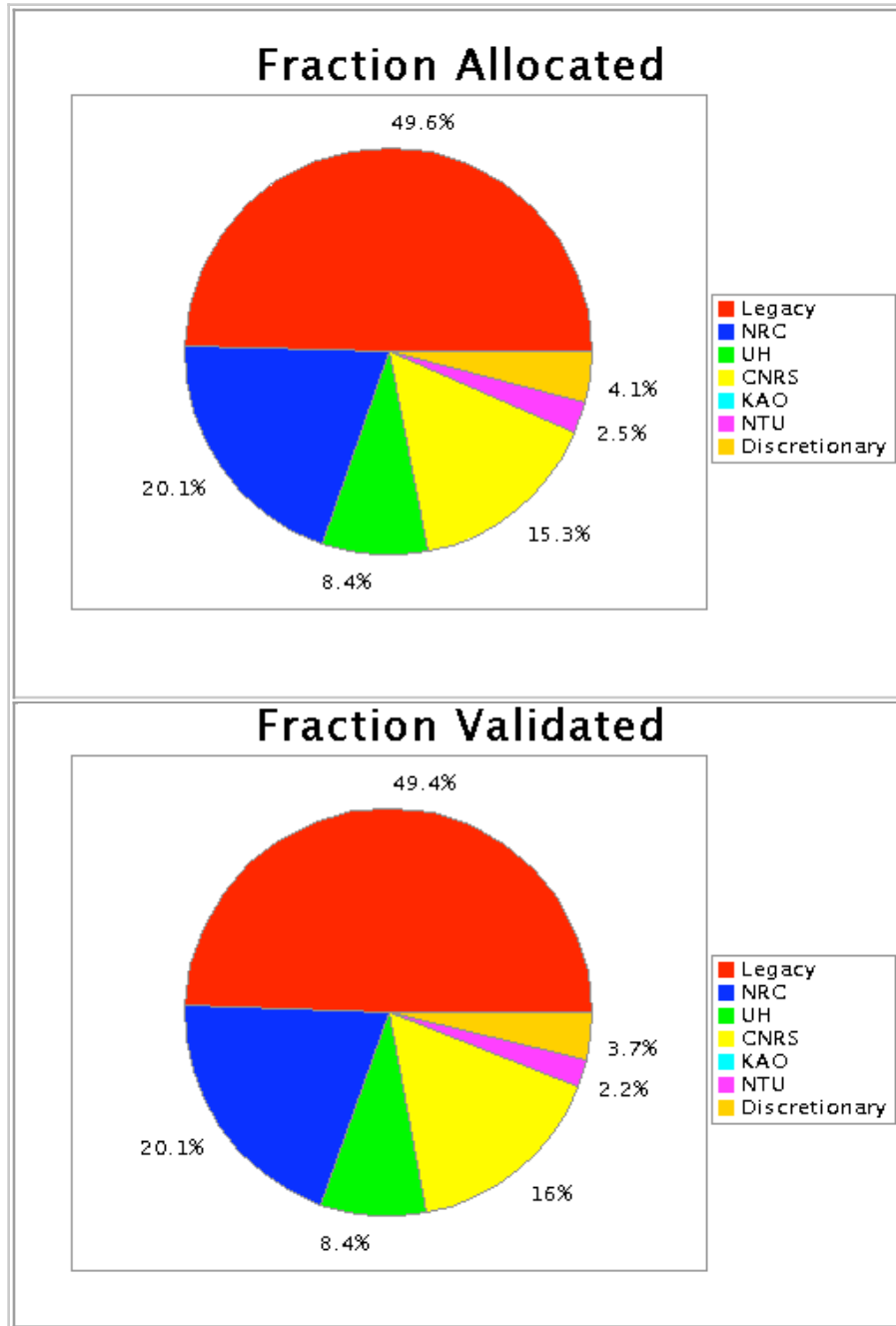
WIRCam

Gigantic efforts have been made to reduce the overheads for WIRCam during the past semesters. For 2006B, the main overheads include two-step focus sequences (~ 8 per night; to be removed with focus model), guiding acquisition and pointing correction, and telescope offsets for dithering patterns. During 2006B nights, those overheads accounted for 20-25% of an observing night. Since 2006B, an automated focus model has been implemented and it's saving us about 30 minutes per night. We will continue working on diminishing overheads although at this point, we seem to have reach the limit of what is technically feasible. Observing efficiency during the best nights now is 85-90%.

D - Agency Time Accounting**1) Global Accounting**MegaPrime

Balancing of the telescope time between the different Agencies is another constraint in the selection of the programs used

to build the queues. The figure below presents the Agency time accounting for 2006B. The top panel presents the relative fraction allocated by the different agencies (program A + B), according to the total I-time allocated from the Phase 2 database. The bottom panel represents the fraction of observations validated (programs A+B+C) for the different Agencies, that is, $[\text{Total I-Time Validated for a given Agency}] / [\text{Total I-Time Validated}]$. As showed in the plots, the relative distribution of the **total integration time of validated exposures** between the different Agencies was relatively well balanced at the end of the 2006A, although not perfect due to the bad weather.



Remark:

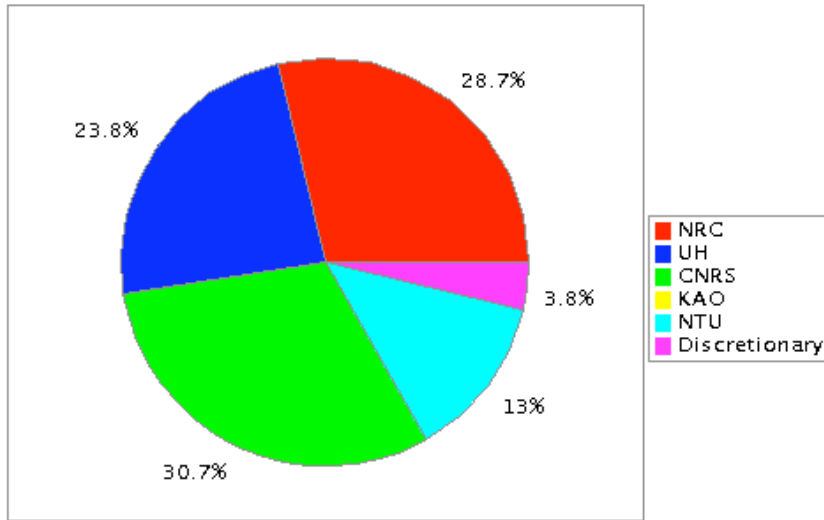
- The global distribution between the Agencies is excellent. Both Taiwan and D-time are a bit late due to the program

targets being mostly distributed at the beginning of the semester, when weather was not so good.

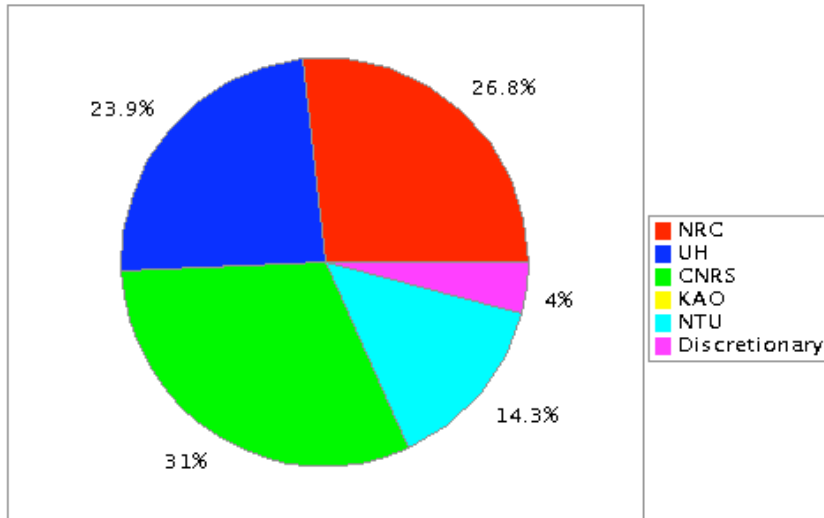
WIRCam

As with MegaCam, balancing of the telescope time between the different Agencies is another constraint in the selection of the programs used to build the queues for WIRCam. The figure below presents the Agency time accounting for 2006B. The left panel presents the relative fraction allocated by the different agencies (program A + B), according to the total I-time allocated from the Phase 2 database. The bottom panel represents the fraction of observations validated (programs A+B+C) for the different Agencies, that is, [Total I-Time Validated for a given Agency]/[Total I-Time Validated].

Fraction Allocated



Fraction Validated

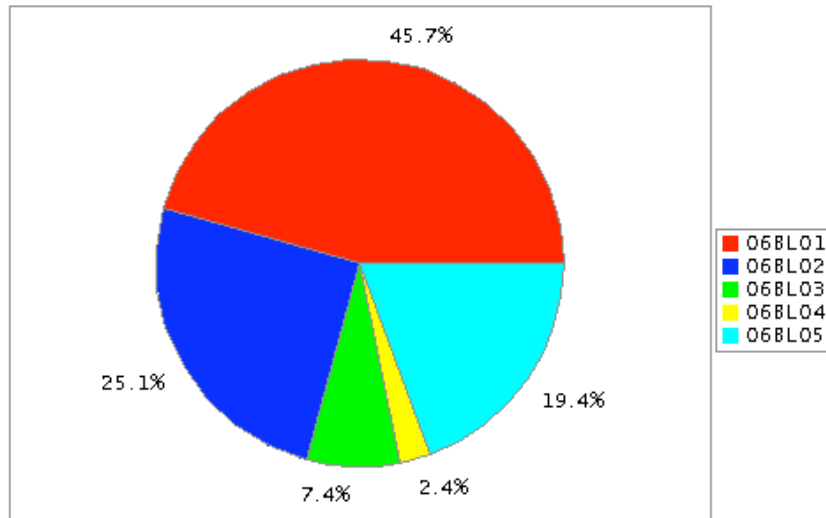
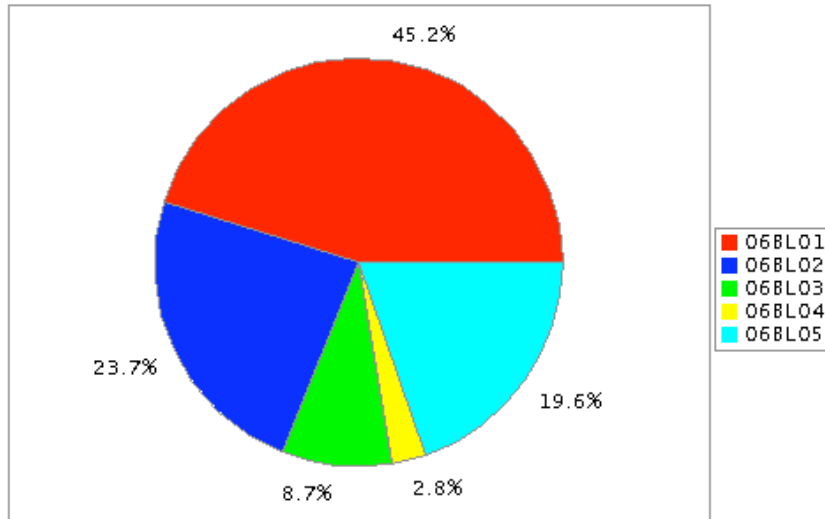


Remark:

- As showed in the plots, the relative distribution of the total I-time between the different Agencies was acceptable for WIRCam at the end of the 2006B, although not perfect. Since the time lost was significant, this is not too surprising.
- The time allocated for D programs seems a bit large. This is because we ran out of targets in certain RA ranges at the end of the semester and mostly because we badly needed programs requesting mediocre seeing (not snapshots but more in the 1" range).

2) CFHTLS Accounting

CFHTLS occupies a large fraction of the I-time allocated for QSO for MegaCam. The following figures show the time accounting for the different CFHTLS components for 2006B (left: allocated; right: validated):



Since each component of the survey is divided into two programs, the global fractions are given in the following table:

Survey	Programs	Fraction Requested	Fraction Validated for 2006B
<i>Deep Synoptic</i>	L01 + L04	45.2 % + 2.8% = 48.0 %	45.7% + 2.4% = 48.1 %
<i>Wide Synoptic</i>	L02 + L05	23.7% + 19.6% = 43.3 %	25.1% + 19.4% = 44.5 %
<i>Very Wide</i>	L03	8.7 %	7.4 %

Remark:

- The final time distribution of validated data within CFHTLS is very close to the respective allocation of each survey before the semester. A good reason for this is that the pressure coming from the PI programs on the Very Wide W1 field was lower than usual. Also, the Wide has relaxed some airmass constraints on some filters which greatly helped in scheduling more observations. The opening of the W4 field was crucial also to maintain that balance within CFHTLS and also, between CFHTLS and the other Agencies.

E - Conclusions

MegaPrime

Our eight semester with the queue mode with MegaPrime was very excellent, our best ever with QSO. The fraction lost to bad weather was better than usual and the camera was worked really so the downtime was not very large. Balance of the Agencies was excellent. The balance between the LS surveys was also quite good.

WIRCam

The semester 2006B with WIRCam was quite successful although significant time was lost to bad weather and technical problems. We were able to gather good, high quality data during 2006B and the statistics are surprisingly good despite the time lost. Observing efficiency has continuously improved during the semester. Reducing overheads remain a major objective. Balance of the Agency time was acceptable.

