Queued Service Observing with MegaPrime/WIRCam:

Semester 2007B Report

02/12/08

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 2007B was good but not as good as normal for a "fall semester", the weather being worse than usual. MegaCam observations were severely affected by bad weather and some technical problems, with more than 40% of the semester being lost. Despite this, statistics on A programs are excellent. For WIRCam, the time lost was also a bit worse than usual, in particular for the last run which was also the most needed for completing A programs. As a result, even if all the A programs combined reached more than 90% completion, some individual A program could not meet than completion level. Balance of the agencies for both instruments was acceptable. Globally, 2007B was still a successful semester, even if the weather was not so great.

B - General Comments

MegaPrime

The 2007B semester for MegaPrime was scientifically successful, despite the bad weather affecting a large fraction of the time allocated. The camera worked quite well during this semester, and the new i' band filter, which was delivered in October, is excellent. Some general remarks on QSO in general for the semester 2007B 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 2007B, the global validation rate (validated/observed) for MegaCam remains excellent (section C). For the last run of the semester, we had some RA ranges for which we had very limited options with the bright Moon; some discretionary time was used efficiently used.

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.* Bad seeing programs >1") are usually sparse. As a result, we are 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 do decide what observations should be undertaken.

WIRCam

The 2007B semester with WIRCam was quite good, despite the last run in December which was very severely affected by bad weather. WIRCam efficiency on the sky is very high, reaching 85 - 90% for most of the nights.

For WIRCam, several conclusions regarding can already be drawn from 2007B:

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 do 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 2007B (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	85
Nights lost to weather	~ 30 (~35%)
Nights lost to (engineering + technical) problems	~ 5 (~6)
QSO Programs Requested	28 (+ 3 snapshots)
QSO Programs Started	27
QSO Programs Completed	17
Total I-time requested (hr.) (A+B+C)	448
Total I-time validated (hr.) (A+B+C)	370 (83%)
Completion A+B Programs	~ 84%
Queue Validation Efficiency	~ 93 %

Remarks:

- The fraction of time lost during QSO nights in 2007B due to weather and technical problems **is about 42%**. This is quite high, especially for a B semester, and about twice the amount we are hoping for.
- The global validation rate (validated/observed) is excellent ~93%. 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 2007B.
- The total completion rate is still very good for a semester with 42% time lost. **A programs were done at 99%, not a small feat!** Of course, as seen below, the important time lost has mostly affected B programs.

WIRCam

The following table presents some general numbers regarding the queue observations for 2007B (C, F, H, and T, D-time,

excluding snapshot programs). Note: 1 night is 9.5 hours.

Parameter	Number
Total number of Nights	48
Nights lost to weather	~ 14 (~29%)
Nights lost to (engineering + technical) problems	~1 (~2%)
QSO Programs Requested	36 (+3 snapshots)
QSO Programs Started	34
QSO Programs Completed	28
Total I-time requested (hr.) (A+B+C)	338
Total I-time validated (hr.) (A+B+C)	297 (88%)
Completion A+B Programs	93%
Queue Validation Efficiency	~ 97 %

Remarks:

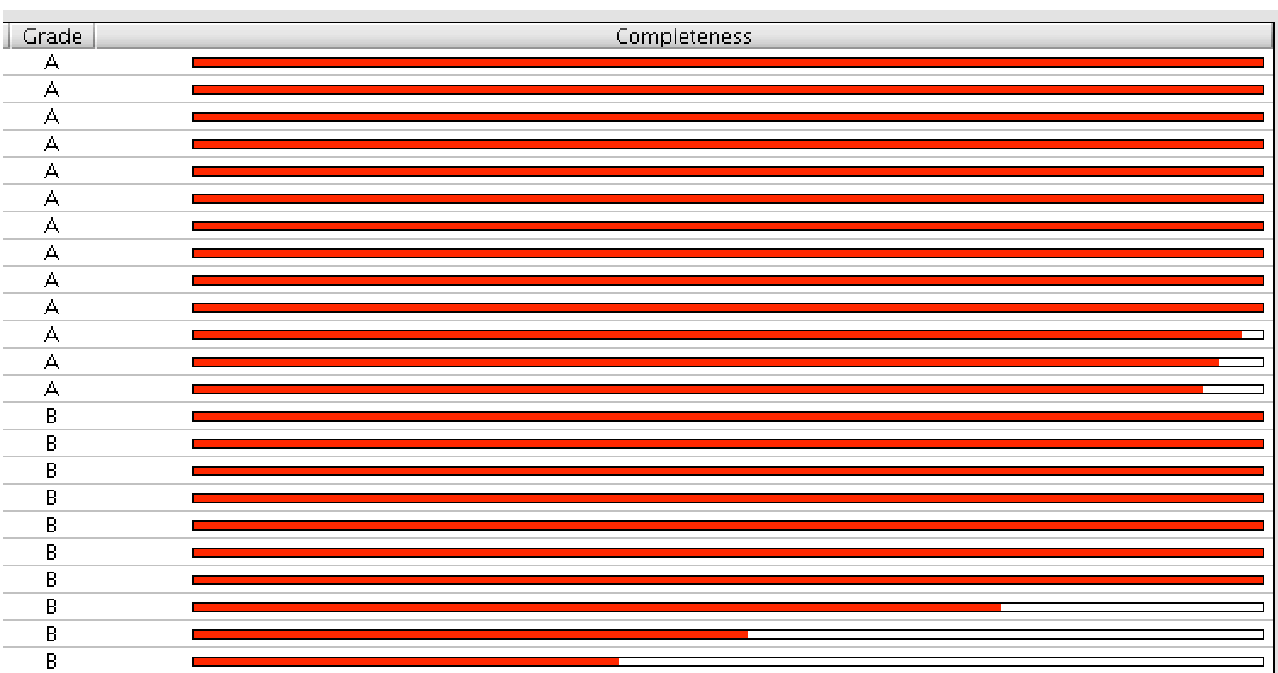
- The fraction of time lost during WIRCam QSO nights in 2007B due to weather, engineering and technical problems **is about 31% of the semester**. This is higher than what we expect. Most of the time lost to weather occurred during the run in December, when the pressure from A programs was quite high.

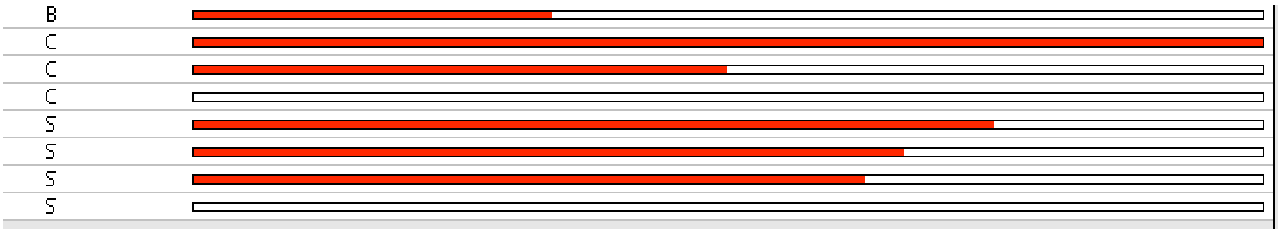
- The global validation rate (validated/observed) is excellent ~97%. This is similar to what we have achieved with QSO during the previous semester with WIRCam. The most difficult conditions for WIRCam come from clouds and higher than expected sky background but since the weather was not too bad, the validation rate is very good. 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.

2) Program Completeness

MegaPrime

The figure below presents the completion level for all of the programs in 2007B, according to their grade:



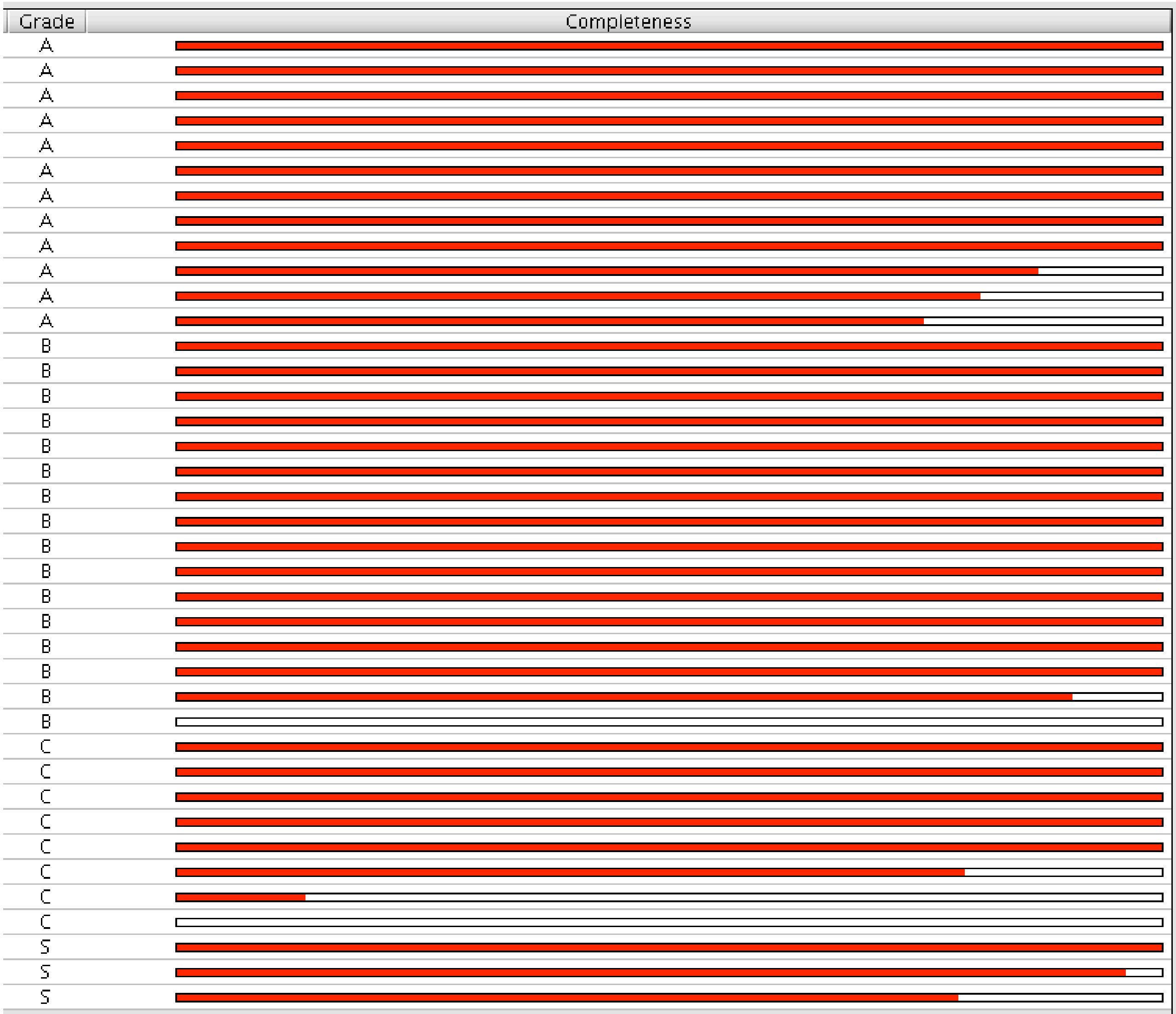


Remarks:

- The global completion level with MegaCam for A programs is ~99% while B programs were done at ~60% . These values are quite good, considering that such a large part of the semester was lost to bad weather. As expected, the completion of B programs suffered the most from the time lost.
- Note: The completion programs for C and snapshot programs is not bad at all for 2007B. These programs were also very useful for QSO since most of them requested modest conditions and targets not located in RA ranges too populated by other highly ranked programs. These programs were also used when the Moon was so bright that nothing else could be done for A and B programs.

WIRCam

The figure below presents the completion level for all of the programs in 2007B, according to their grade:



Remarks:

- The global completion level for A+B+ C programs is quite good: 92%. Grade A programs from 2007B were done at 93% although as seen above, not all the programs could reach the 90% level. These programs were mostly feasible in December, when the bad weather resulted in a lot of time lost.
- Two programs shows 0% completion. This is because observations were never requested during the semester by these PIs. Time from the B program was transfered to another program for the same agency during the semester and the latter was completed.

3) Overheads

<u>MegaPrime</u>

The following table include the main operational overheads (that is, other than readout time of the mosaic) with MegaPrime during **the semester 2007B**. This is given as a reference; overheads are highly variable during a given night depending on the conditions, complexity of science programs, etc. globally, the operational overheads constitute now about 10-15% of an observing night, the number originally expected before MegaPrime observations started.

Event	Events/night	Overhead	Total

			overhead per night
Filter Change	15 - 25/ night	90s /change	1500 - 2200 seconds
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 2007B, we observed new stds fields, derived from the LS deep fields.

WIRCam

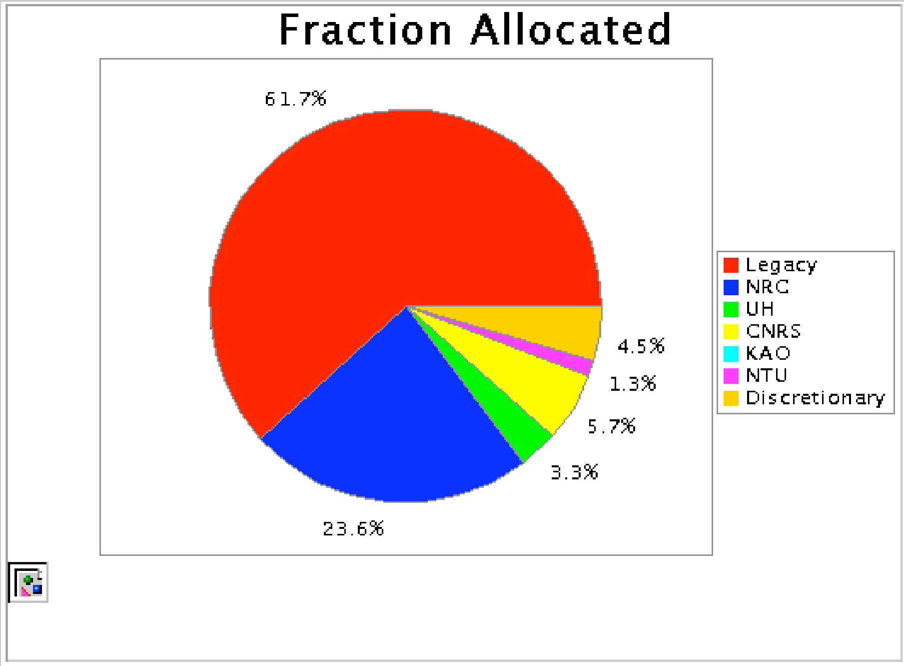
Gigantic efforts have been made to reduce the overheads for WIRCam during the past semesters. For 2007B, the main overheads include two-step focus sequences, guiding acquisition and pointing correction, and telescope offsets for dithering patterns. During 2007B nights, those overheads accounted for about 15-20% of an observing night, depending on the complexity of patterns used. Since 2006B, an automated focus model has been implemented and it's saving us about 30 minutes per night. At the end of the semester, an issue with slewing speed of the telescope was found and corrected and this should contribute again to make things more efficient. 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%.

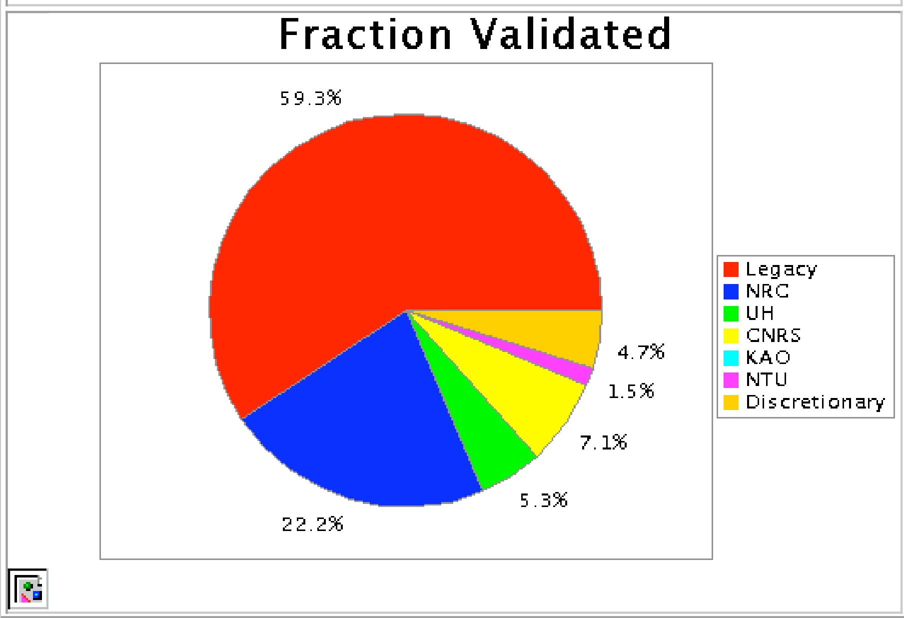
D - Agency Time Accounting

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 2007B. 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, [Total I-Time Validated for a given Agency]/[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 2007B, although not perfect due to the bad weather late in the semester.



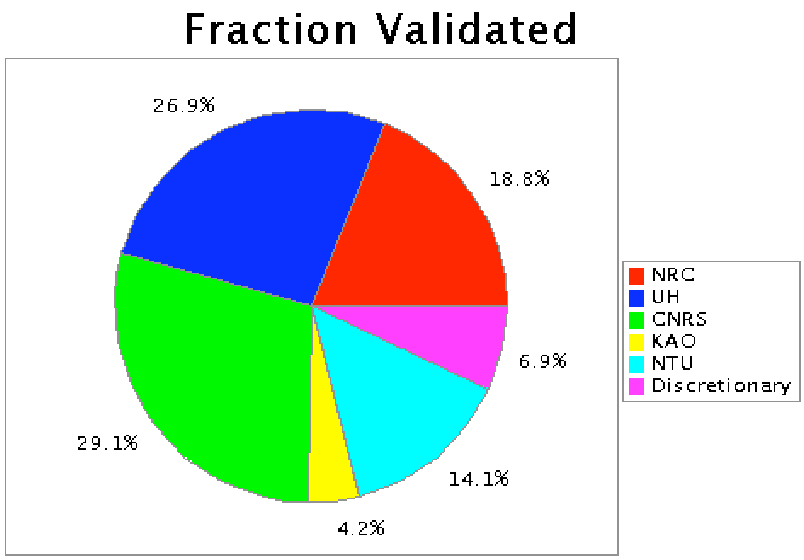


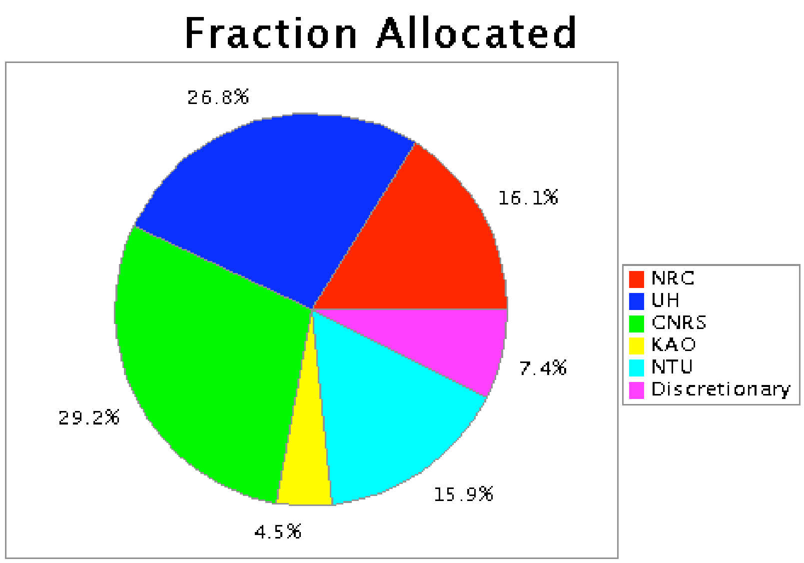
Remark:

- The global distribution between the Agencies is good although not excellent.The Legacy Agency is a bit late with respect to the other agencies. This is due to the high impact of losing the i band filter for the first couple of months of the semester as well as the bad weather. Still, considering the very large amount of time lost, it's remarkable that the agency time is balanced at all!

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 2007B. 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].



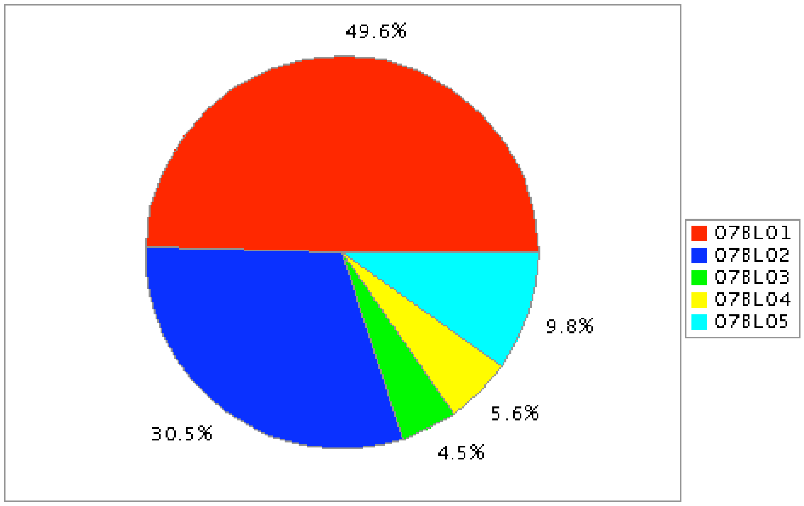


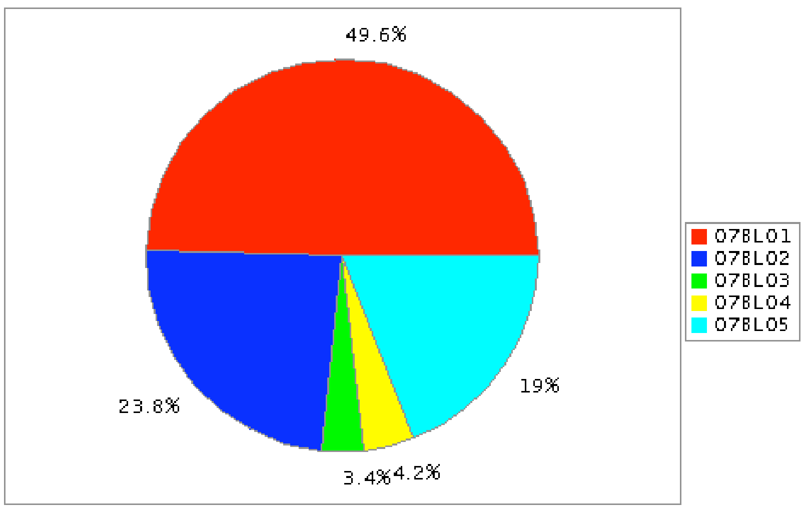
Remark:

- As showed in the plots, the relative distribution of the total I-time between the different Agencies was good for WIRCam at the end of the semester. We can see, however, that NRC is a little late. This is because two of their big programs could not be completed because of the adverse weather.
- 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. We mostly needed them too for 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 2007A (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 2007A**
Deep Synoptic	L01 + L04	49.6 % + 5.6% = **55.2%**	49.6% + 4.2% = **53.8%**
Wide Synoptic	L02 + L05	30.5% + 9.8% = **40.3%**	23.8% + 19.0% = **42.8%**
Very Wide	L03	**4.5%**	**3.4%**

Remark:

- The final time distribution of validated data within CFHTLS is close to the respective allocation of each survey before the semester, but not perfect. The Wide survey is a bit ahead compared to the Deep. Part of that might be the lack of i filter for two months, which affected the Deep more than the Wide survey.

E - Conclusions

MegaPrime

Despite a large amount of time lost to adverse weather and some technical problems, this semester was quite successful. Grade A programs were done at a very high completion level. Balance of the Agencies was good. The balance between the LS surveys was also quite good, although the Deep survey suffered the most from the lost of the i' band filter for the first couple of months of the semester.

WIRCam

The semester 2007B with WIRCam was very successful. With decent weather and great observing efficiency, we were able to achieve a very good completion level although some A programs could not reach 90% due to the adverse weather at the end of the semester. Observing efficiency has continuously improved during the semester. Reducing overheads remain a major objective. Balance of the Agency time was quite acceptable.
