Queued Service Observing with MegaPrime/WIRCam:

Semester 2007A Report

08/17/07

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 2007A was excellent for a "winter semester", the weather being better than usual. Unfortunately, MegaCam was affected by two major technical problems which resulted in 10 less nights of the sky than originally planned. These nights were used for WIRCam. This is one of the clear advantage of queue observing: the possibility to switch rapidly from one instrument to another and continue acquiring excellent science with the telescope, even if the main instrument is down. Because of these additional nights, statistics for the WIRCam programs are incredible: every single program was completed at 100%! We even started and completed several 07B programs during the July run while the major repair efforts for MegaCam was taking place. The good news is that even with 10 nights lost for MegaCam, the statistics pour the programs are quite good. The lost of the i band filter was a big hit for the LS surveys, however, as well as for several PI programs.

B - General Comments

MegaPrime

The 2007A semester for MegaPrime was scientifically successful, despite two major issues severely affecting the last 2 months of the semester. The first three months of the semester were good since weather behaved normally (meaning better than usual for an "A" semester!) but the end of the semester was quite difficult. Not only nights were lost but the instrument, after repairs, had to be used on nights when the Moon was very bright. Options were sometime limited since the i filter, which is a good option with the Moon, was of course destroyed in June. Early in the semester, we had again some periods of very bad, unpredictable and unstable seeing but we were able to adapt well, although our validation rate suffered a bit.

Some general remarks on QSO in general for the semester 2007A 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 2007A, 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 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 do decide what observations should be undertaken.

WIRCam

We offered WIRCam as a fully commissioned instrument for 2007A. Some time was in fact used for engineering,, mostly for improvements made on the crosstalk issues . The infamous negative crosstalk has now been completely eliminated. WIRCam efficiency on the sky is very high, reaching 85- 90% for most of the nights. With the additional nights obtained due to MegaCam, the good observing efficiency, and the unusually good weather for this semester, the statistics for 2007A are outstanding. **Everything was 100% completed!**

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

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 2007A (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	96
Nights lost to weather	~ 19 (~20%)
Nights lost to (engineering + technical) problems	~ 14 (~15%)
QSO Programs Requested	36 (+ 4 snapshots)
QSO Programs Started	35
QSO Programs Completed	21
Total I-time requested (hr.) (A+B+C)	549
Total I-time validated (hr.) (A+B+C)	447 (81%)
Completion A+B Programs	~ 85%
Queue Validation Efficiency	~ 92 %

Remarks:

- The fraction of time lost during QSO nights in 2007A due to weather and technical problems **is about 35%**. This is quite high but the 10 nights lost for Mega cam due to the jukebox issues are very significant. Not all of this time, of course, was not lost on the sky since WIRCam was used instead. Note also that even if MegaCam was used after the repairs, it was not always ideal since the Moon was a real issue.

- 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 in the first part of 2007A.

- The total completion rate is still very good for a semester with 35% time lost. A programs were done at 94%, not a small feat!

WIRCam

The following table presents some general numbers regarding the queue observations for 2007A (C, F, H, and T, D-time, **excluding** snapshot programs). Note: 1 night is 9.5 hours.

Parameter	Number
Total number of Nights	59
Nights lost to weather	~ 10 (~16%)
Nights lost to (engineering + technical) problems	~4 (~7%)
QSO Programs Requested	33
QSO Programs Started	31
QSO Programs Completed	31
Total I-time requested (hr.) (A+B+C)	322
Total I-time validated (hr.) (A+B+C)	322 (100%)
Completion A+B Programs	100%
Queue Validation Efficiency	~ 97 %

Remarks:

- The fraction of time lost during WIRCam QSO nights in 2007A due to weather, engineering and technical problems **is about 23% of the semester**. This is about the number we expect, although more engineering was needed than expected because we had to check changes made to the electronics for removing the crosstalk.

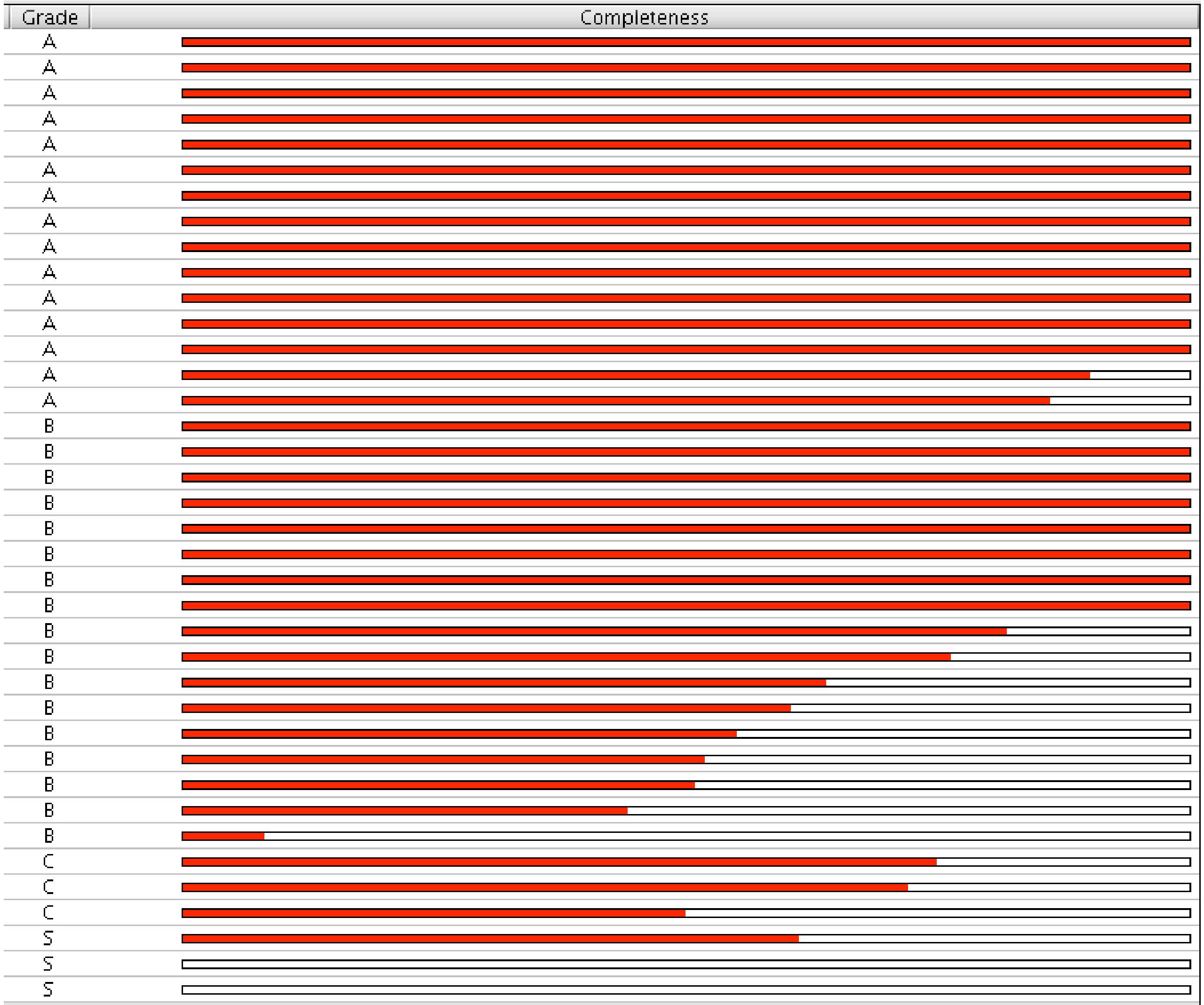
- The global validation rate (validated/observed) is excellent ~97%. This is the highest rate we have ever achieved with QSO. The most difficult conditions for WIRCam come from clouds and higher than expected sky background but since the weather was nice, the validation rate is very good. If we remember that during good nights, 350 to 400 cubes of data (so ~1000 exposures) can be taken, this high validation rate is excellent.

- The total number of validated hours does not include the programs from 2007B that were started and/or completed during the run in July. About 50 hours were validated. If we add all of this, we got ~ 6.5 hrs validated per night for WIRCam in 2007A.

2) Program Completeness

MegaPrime

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

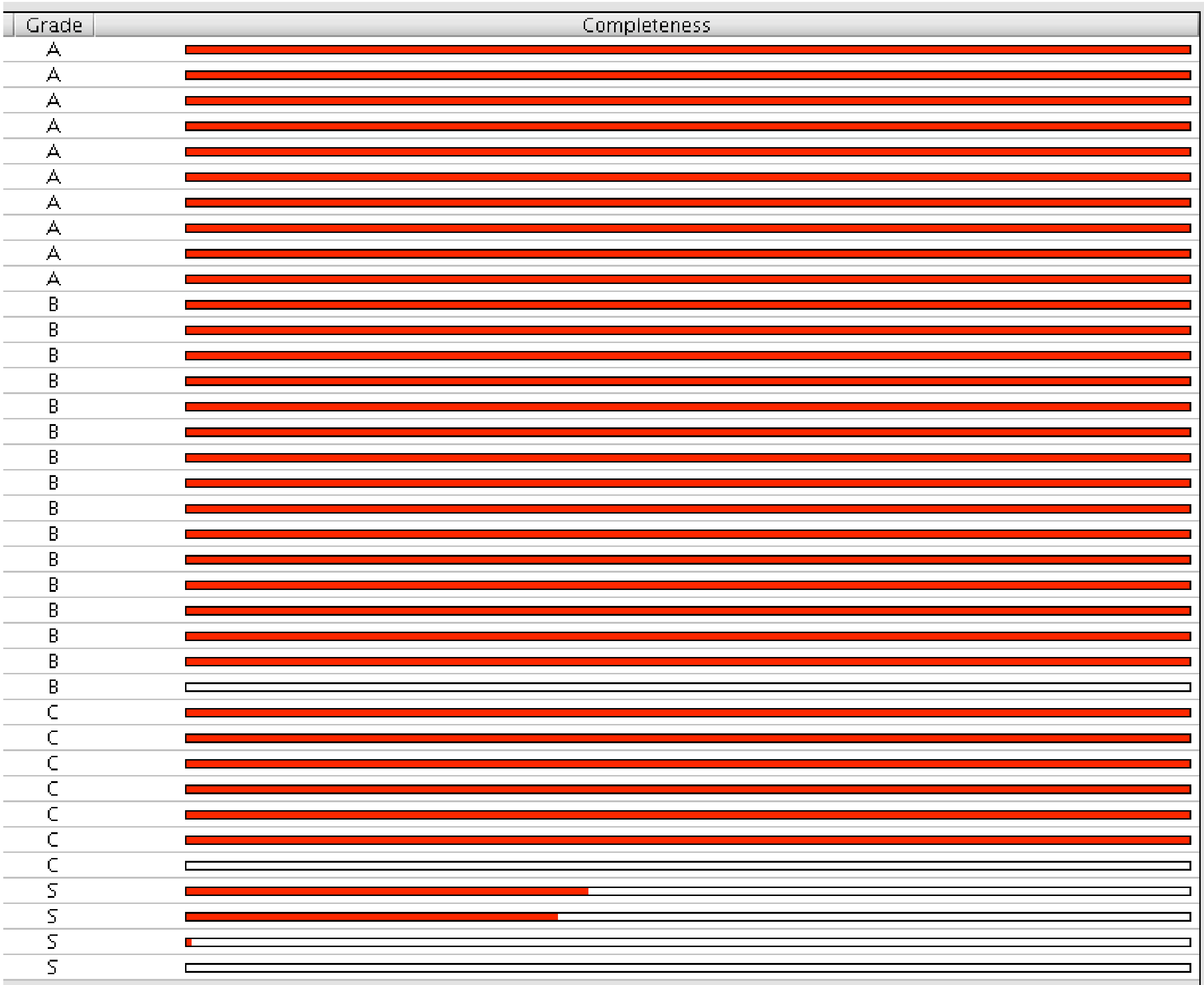


Remarks:

- The global completion level with MegaCam for A programs is ~95% while B programs were done at ~71% . These values are quite good, considering that such a large part of the semester was lost to bad weather and technical problems.
- Note: The completion programs for C and snapshot programs is not bad at all for 2007A. 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 2007A, according to their grade:



Remarks:

- The global completion level for A+B+ C programs is extraordinary: 100%! Of course, most of that is due to additional nights obtained for WIRCam during the MegaCam repairs. But it shows too that the instrument is behaving well and that the observing process is quite efficient. During extra nights in July, A programs from 2007B were started and given higher priority that C programs for 2007A but even then those, were eventually all completed.

- 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 2007A**. 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 2007A, we observed about 2 standard star fields during a photometric night (12 minutes / fields due to filter changes). For 2007B, this strategy will be changed since new stds fields, derived from the LS deep fields, will be observed.

WIRCam

Gigantic efforts have been made to reduce the overheads for WIRCam during the past semesters. For 2007A, the main overheads include two-step focus sequences, guiding acquisition and pointing correction, and telescope offsets for dithering patterns. During 2007A nights, those overheads accounted for about 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%.

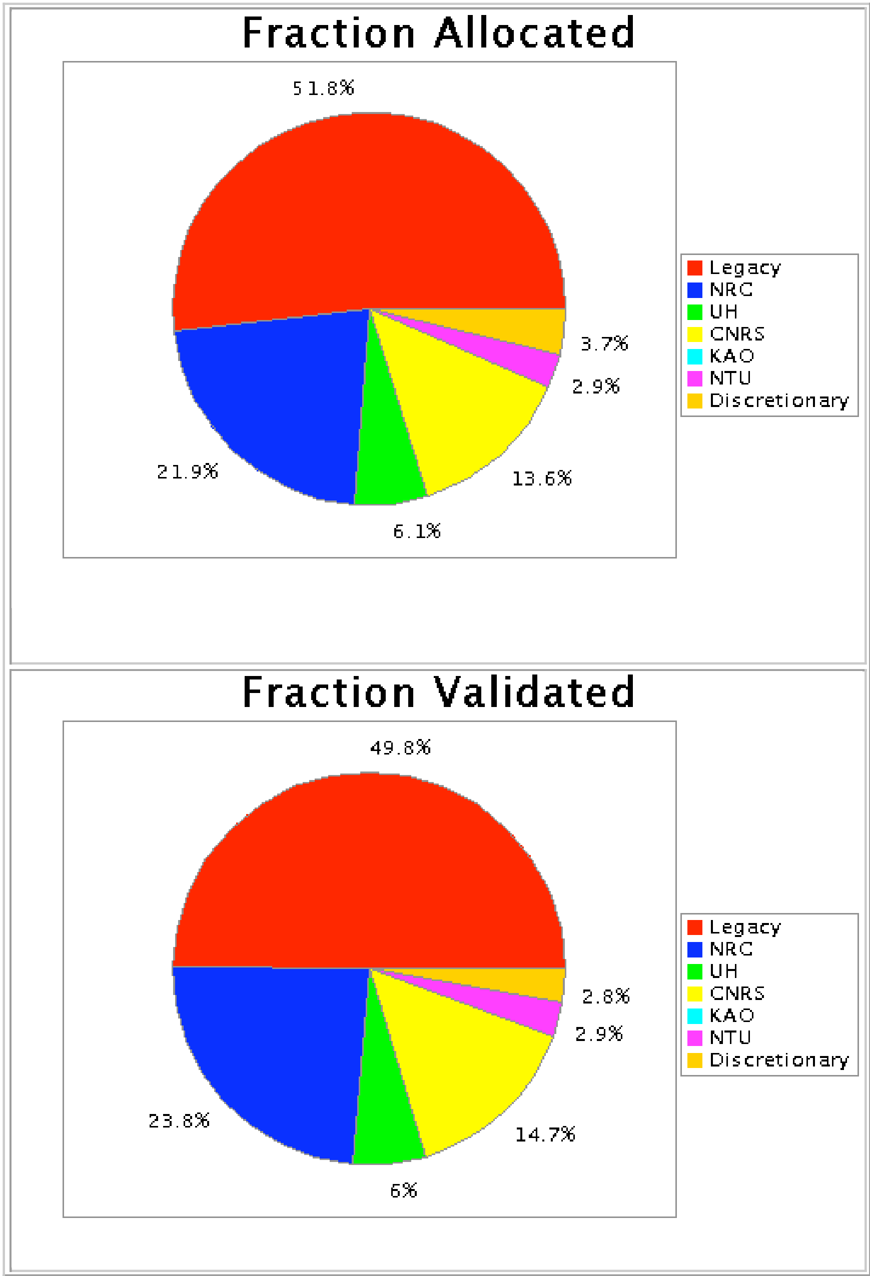
D - Agency Time Accounting

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 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, [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

2006A, although not perfect due to the bad weather.

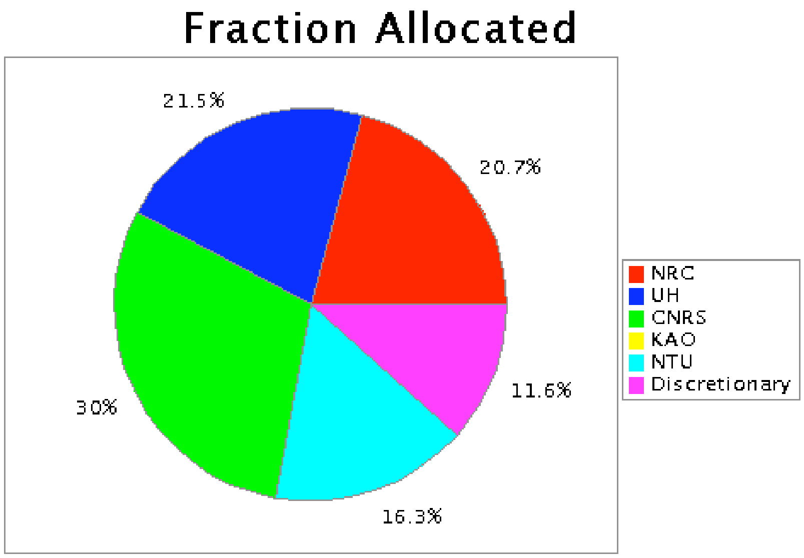


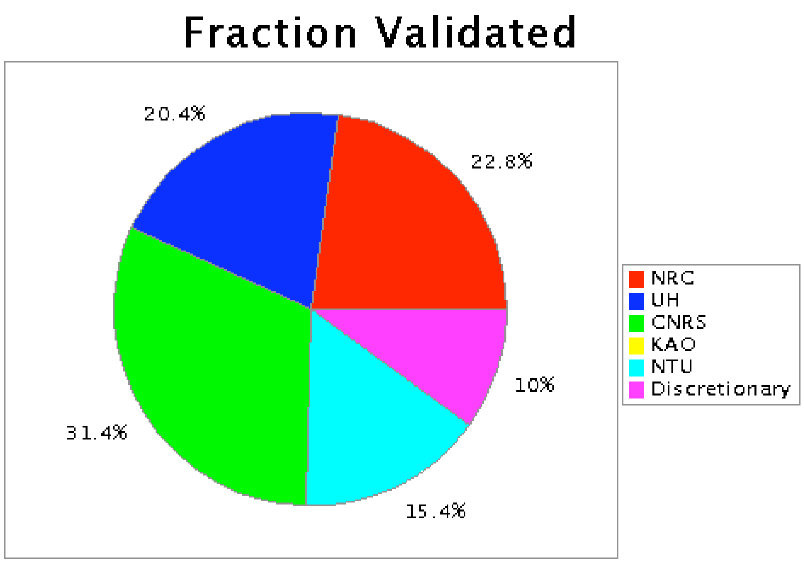
Remark:

- 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 as well as to have been obliged to observe with the very bright Moon in July when observations for the Wide were not really possible. Still, considering all the difficulties we have faced at the end of the semester, it's remarkable that agency time is quite balanced!

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 2007A. 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].



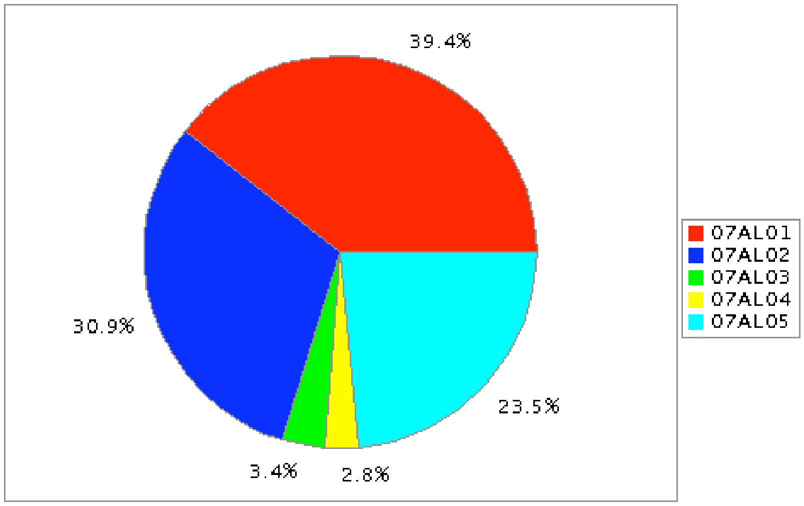


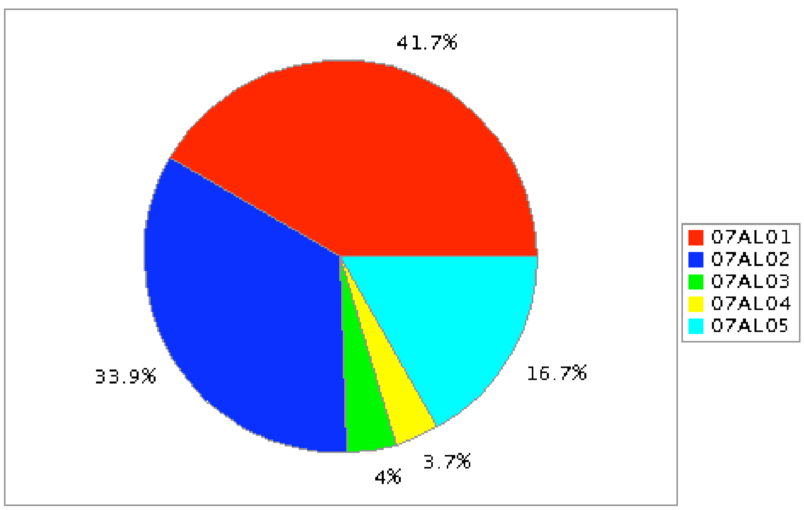
Remark:

- As showed in the plots, the relative distribution of the total I-time between the different Agencies was quite good for WIRCam at the end of the semester. We can ask why is it not perfect since all the programs were completed? It is because the time validated take into account the C programs, which were not distributed equally among the agencies (some agencies had none). Not a big deal.
- 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 due to the change of scheduling for MegaCam repairs. 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	39.4 % + 2.8% = **42.2%**	41.7% + 3.7% = **45.4%**
Wide Synoptic	L02 + L05	30.9% + 23.5% = **54.4%**	33.9% + 16.7% = **50.6%**
Very Wide	L03	**3.4%**	**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 was late compared to the Deep. The explanation is simple: the Wide was very severely affected by the lost of 10 nights, more so than the Deep since they only lost 3 iterations on two fields. Also, a lot of observations were in u band for the Wide and the Moon was an issue, again due to the change of scheduling because of MegaCam repairs.

E - Conclusions

MegaPrime

Despite 10 nights lost to technical problems with MegaCam and the fact that we operated the camera under skis with a bright Moon after the repairs, this semester was quite successful. It shows that queue can adapt quickly, even to the worse of problems with the instrument! Balance of the Agencies was excellent. The balance between the LS surveys was also quite good, although the Wide survey suffered the most from the MegaCam problems.

WIRCam

The semester 2007A with WIRCam was extremely successful. With 10 additional nights and good weather and observing efficiency, we were able to complete all the 2007A programs and even do a significant fraction of 2007B programs. Observing efficiency has continuously improved during the semester. Reducing overheads remain a major objective. Balance of the Agency time was acceptable. The removal of the negative crosstalk is also a very positive achievement for this semester.
