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The CFH12K Queued Service Observations (QSO) Project: Mission Statement, Scope and Resources

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Content

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1. The QSO Project: Mission Statement

The QSO Project main goal is to obtain astronomical data during the optimum sky conditions as requested by the investigators of a given science program.

2. Mission Objectives

The QSO Project has some very specific objectives:

- Main goal: Develop efficient *procedures* and *tools*, and assemble a well-trained *Observing Team* to produce high-quality data obtained in the optimum sky conditions for a program **to meet its science goals** while respecting the decision-making QSO rules.

- Rules definition and documentation: The QSO rules used for the decision-making process leading to the execution of the observing programs must be *clearly stated*, fully *respected* by the scheduling algorithm, and *understood* by the Observing Team.

- QSO Databases: The QSO Project must ensure that the *right* and *complete* information regarding the observing programs and their execution is transmitted and stored in local, *replicated* and *mirrored* databases. Complete means accurate enough to carry out the observations without the investigators being directly involved in their execution.

- Target instruments: The specification and implementation phases must concentrate the efforts on the CFH12K mosaic camera. The tools (including the databases), however, must be flexible enough to be upgraded to MegaPrime operations in a QSO mode.

- Tools: All tools provided by the QSO Project must be *robust*, *simple* and *flexible* and keep the spirit of a ground-based telescope operated by an experienced observer. In particular, QSO is considered as an observer and should as much as possible use the same observation scripts as a normal observer would.

- Calibration: Calibration exposures (e.g. Bias, Darks, Flat-Fields, Focus, and Photometry fields) constitute an independent and high-priority program for the QSO mode. A plan must be developed by the QSO/ELIXIR teams to ensure optimum calibrations for all the observing programs.

- Reduction Pipeline: Even if the Reduction Pipeline is *not* a component of the QSO Project (see Scope), the QSO Project must provide the support judged necessary for the science programs to be processed in a subsequent reduction pipeline. For instance, all the information (e.g. completion of a project) related to the data obtained (calibrations and science exposures) and needed for the pipeline must be included in the database.

- Data quality evaluation: The Observing Team must perform a *thorough evaluation of the data* obtained in the queue mode both during the observation execution and after data processing. During the night, the evaluation will be made using some specific pre-defined parameters (a "checklist"). During the extensive evaluation, when the data quality is judged insufficient to meet the science goals, the program is kept in the queue. In case of uncertainty, the Team will have the possibility to contact the investigators for consultation through a communication system.

- Feedback and communication: Communication between the Observing Team and the investigators is a high-priority for the QSO Project. Basic information about the programs executed for a specific night will be widely available on the Web, as will be some statistics regarding, for example, the observing efficiency of the queue mode. A communication *helpdesk* must also be available for interaction between the PI and Observing Team.

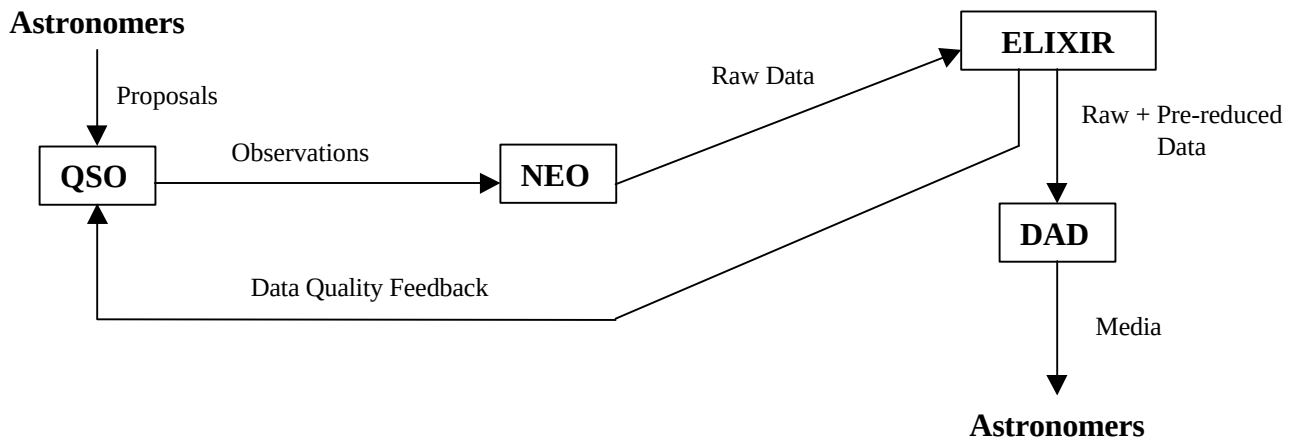
- Science Programs: Since the QSO mode can only be successful if the approved programs require diverse observing conditions, the QSO Team has for responsibility to give clear directions to the Time Allocation Committees in their evaluation of the QSO Proposals.

- Special Programs: The QSO Project must allow the possibility to execute special programs that are difficult or impossible to achieve in a classical mode of observing. For instance, long-term *monitoring* or *target-of-opportunity* must be considered in the QSO Rules and tool specifications. This includes the possibility to have special "snapshot" programs designed to cover periods of particularly bad sky conditions.

3. Purpose

3.1 The CFHT Big Picture

The QSO Project is a complex component of a broader observing system being developed at CFHT. To put the project into perspective, the major components of this chain identified to this day are illustrated below:



This chain is primarily formed from the following components:

- QSO: The **Q**ueued **S**ervice **O**bservations module has for main task to create a *prioritized list* of science programs submitted by the astronomers and execute them under the conditions specified.

- NEO: The **N**ew **E**nvironment for **O**bserving provides the necessary functions to control the instrument and the telescope following a set of parameters sent by the QSO module. NEO is the core of the observation process at the telescope and this critical component has a voluntarily simple design, taking parameters as input and producing FITS files as output, with no interaction with the QSO databases. It includes also a set of observing tools for rapid analysis of the images.

- ELIXIR: This module has for task to apply a set of procedures to deliver pre-reduced data, or a set of raw data and calibrations. The QSO Team performs quality control over these pre-reduced data.

- DAD: The **D**ata **A**rchiving and **D**istribution module ensures an efficient archiving and distribution of the raw and/or pre-reduced data (TBD) to the astronomers in form of data archiving media such as disks or tapes. This module might be located at CFHT or at another location (e.g. CADC for CFH12k; Terapix for MegaPrime)

The above diagram shows only the data flow regarding the execution of one observation. In reality, the architecture is more complicated since some modules need the information generated or stored from another component. A good example is ELIXIR, which will extensively use the information stored in the QSO databases. The interaction between the different modules is somewhat described below and in the ELIXIR scope document.

3.2. QSO Outline

The QSO mode can be divided into three very specific steps: the Proposal Submission, the Execution Phase and, the Data Evaluation.

- The Proposal Submission

The proposal submission process is divided into two distinct phases:

Phase I: The first tier corresponds to the normal submission procedure for the proposals at CFHT, which has for main goal to lead to the evaluation process performed by the TACs. It is done through a Web-based entry tool, the *Phase I tool*. This tool is populating a database system, the *Phase I database*. Both can be located at CFHT or at another location (i.e. CADC). All specific information relevant to QSO proposals at this stage must be found as entry fields in the Phase I tool (e.g. image quality and time constraints).

NB: At the moment, the Phase I tool (Poopsy) and the database (Sybase system) are provided and located at CADC. It is planned that following each proposal deadline, the Phase I database will be duplicated locally at CFHT. However, following the decision of Gemini to use PIT (NOAO) instead of Poopsy might strongly perturb this arrangement. We might have to import Poopsy to CFHT or develop another in-house Phase I tool.

Phase II: The second tier in all QSO models aims to create a pool of science programs that can be sorted out to form a prioritized list (the "queue") of plausible observations during the execution phase. It is crucial to get the right and complete information from the investigators to produce high-quality data meeting specific science goals. The Phase II is done through a Web-based entry field tool, the *Phase II tool*, populating also a database system, the *Phase II database*, which content and structure differ significantly from the Phase I database. Both tools are located at CFHT but a French-based mirror for the Phase II tool would be very convenient if testing revealed that database access to CFHT is efficient.

- The Execution Phase

The execution phase consists in a decision-making process followed by the actual observation. The decision-making is supported by the *Q Scheduler tool*, which has for main task to provide a prioritized list of plausible observations according to diverse rules, instrumental constraints, and sky conditions. The Q scheduler list resulting from all viable programs in the Phase II database is constantly reviewed by the QSO observer who has the final authority on the execution of an observation during an observing night.

The observation is executed through the *Observation Tool*, which is a software component grabbing all the relevant information for an observation selected by the Q Scheduler (that is, a set of parameters defined inside templates) and sending this information to the executable scripts residing in NEO. This Observation Tool could be integrated to the Q Scheduler.

Following the execution of an observation, an operational database consisting of a table of exposures is updated from the FITS headers of the current images. The observers can then write comments or other relevant information about the observation into this database using an *Electronic Logbook*.

- The Data Evaluation

The data evaluation is done in two specific steps:

1) A *quick-look* evaluation of each individual image is done using observing tools provided by NEO/ELIXIR. The main characteristics of the image (e.g. IQ, sky brightness) are measured and used to decide which following observation should be executed. A first "quality class" (A, B, C, D) is given to these images and included in the database through the electronic logbook. The observer can use these classes during the night to run the queue list in the most efficient way. For instance, if for three consecutive exposures of a given program, the class goes from A to B to C, it is time to re-evaluate the queue and run the scheduler again. These classes can be used later on for statistical studies on the efficiency of the QSO mode.

2) A member of the Observing Team performs an *extensive analysis* on the data following an observing night. Tools provided by NEO and/or ELIXIR are used to carry out this analysis. In particular, this evaluation includes a review of the "problematic cases" as flagged by the night observer. This step is the basis on the decision process leading to the status of an observing program (or part of it) in the Phase II database, for example, classifying it as "complete", "infeasible", etc.

4. Scope

- Submission tools: QSO provides all the necessary software tools for the entire proposal submission phase. These include the Phase I and Phase II entry tools, which could be already available (e.g. Poopsy), or developed in-house. An exposure time simulator, provided by NEO, should be made available for Phase I, and later integrated within the Phase II tool. The Phase II tool should also include a field locator and allow the selection of guiding stars from the investigators or the QSO observers.

- Databases: QSO provides all the necessary databases for the submission (Phase I and II) and execution phases of the observations. These databases will provide starting point information for the ELIXIR module and subsequently, for the DAD module. The QSO database will *not* be used to store data related to the Telescope Control System or other real-time statistics or information, except for the relevant information to the QSO program. As NEO is not aware of the database, QSO will feature a tool to extract the observational information stored in the individual FITS headers to populate the operational database.

- Execution tools: QSO provides the software tools for the execution phase, including a database browser/editor, a Q Scheduler, the Observation Tool, and an electronic logbook. A CFH12K exposure time simulator should have been developed by the NEO Team to be integrated into the Phase II entry tool by the QSO Team.

- Interaction with NEO: QSO provides all the necessary parameters to execute an observation through the NEO Director multi-agent software, which is the single point of contact for QSO to interact with the telescope and the instrument. QSO will interact with NEO through a specific set of observation scripts defined by the NEO Team. Templates that consist in a specific set of parameters needed by the observation scripts define the observations. Each observation will be executable through one of these scripts. Both the QSO and NEO teams will specify the main functionality and parameters of these scripts, which will be used to design templates offered to the investigators in the Phase II.

- Quick look and extensive data evaluation: The quick-look tool is essential for in-situ deciding what is the next exposure to take. It is used to evaluate some properties of the images for the quick snapshot analysis (e.g. image quality, sky background, and sky brightness) and must be provided by the NEO/ELIXIR Teams. Other tools judged necessary by the ELIXIR Team to assess the resulting data produced by the reduction pipeline should also be available to the QSO Observing Team. Both teams, of course, will define the specifications

for these tools, since a strong interaction with the Phase II and the operational databases is necessary.

- QSO/NEO agent: In a joint effort with the NEO team, the QSO Team will develop a QSO/NEO agent to be able to get feedback from NEO. The goal is to be informed that a new image has been taken and where it is available; other functions can be added in the future.

- Interaction with ELIXIR: The main interaction with the ELIXIR module will be done through the operational database. Development of the calibration plan (including specific templates) and the analysis tools must be done jointly by the ELIXIR and QSO Team.

- Interaction with DAD: All relevant information for the data distribution and archiving must be made available from the QSO databases. This includes data in the FITS headers and other information concerning, for example, the investigators. What is needed for the DAD module should be identified prior to the design of the QSO database.

- Data Organization: QSO has for aim to produce data and the requested calibrations for these data. QSO cannot take care of how the binary data are kept and archived. However, it can provide the FITS header information related to individual exposures or science programs through its databases.

- Training and Documentation: The QSO Team will train all the CFHT staff involved in the QSO execution phase, in particular the observers. The procedures will be detailed and reviewed by the science staff. QSO is also responsible for providing a complete documentation (reference and user's manual) for all the tools developed within the QSO Project.

Summary

The following table represents the diverse software components requested by the QSO Project that must be developed by the QSO, NEO and ELIXIR Teams:

Symbols: • (Specs + Implementation); ∗ (Specs only); ⊗ (No contribution); + (Integration)

Component	QSO	NEO	ELIXIR
Replicated Database System	•	⊗	⊗
Phase I Entry Tool	•,+ ?	⊗	⊗
Phase I Database Structure	•,+ ?	⊗	⊗
Phase II Entry Tool	•	⊗	⊗
Phase II Database Structure	•	∗	∗
Exposure Time Simulator	∗,+	•	⊗
Operational Database Structure	•	∗	∗
Q Scheduler	•	⊗	⊗
Observation Templates	•	∗	∗
Observation Tool	•	∗	⊗
Observation Scripts	∗	•	⊗

Calibration Plan	•	•	•
Electronic Logbook	•	⊗	⊗
QSO/NEO Agent	•	•	⊗
Analysis Tools	*	•	•
Communication System	•	⊗	⊗

5. Resources

5.1 Development: Software and Hardware

Software

Here is a primary list of identified software needs:

Software	Features	Products	Estimated Price
Database	• Runs on Unix • Allows replication	Sybase	• Linux: $22.2k[1] • Solaris: $47.4k
Web Server	• Allows middleware plugin	Netscape, Apache	• Netscape: $1.5k • Apache: free
Middleware	• DB capabilities	• ColdFusion • PHP	• ColdFusion: $3-5k • PHP: Free
Development Tools	• Cross-platform	• Java Integrated Dvt Envts: Jbuilder, PowerJ, etc. • Tcl/Tk	• Java IDE (any): ~ $1k • Tcl/Tk: Free
Communication System	• Web based	**?**	**?**
HTML Editor	• Middleware	Dreamweaver, Fireworks	• Dreamweaver: $0.4k

Hardware

Two servers are needed to implement the databases. The main server will be at the summit. A replicated server with mirrored disks will be installed in Waimea before the Phase II proposals submission. These servers might be Sun running Solaris or PCs running Linux, depending of our choice of OS for the database[1].

5.2 Manpower: Design, Implementation and Test Phases

The QSO Project Manager/Project Scientist is Pierre Martin. Pierre has experience with the implementation of the QS mode for astronomical observations, including designing templates, writing executable scripts, testing Phase II and observation tools, and participating in the execution of QS observations at the NTT. He is responsible for the specification phase of the tools and databases and will regularly review the progress done during the implementation with the "Big Picture" team but also the CFHT Executive, SAC and the astronomy

1 See detailed figures in document QSO-002

group. During the test phase, he will identify the test teams and review their suggestions. He is also responsible for transmitting the necessary instructions to the Time Allocation Committees in their evaluation of the proposals for the QSO mode and training of the observers. Pierre will spent about 60-75% of his time on the QSO Project during the development phase.

The QSO Project Engineer is Renaud Savalle. Renaud will spend 100% of his time working on the QSO project, including the interaction with the members of the other teams for the specification and implementation phases. He will be responsible for identifying the resources available for implementing the specifications. He will contribute and review all the specifications for the diverse tools of the QSO Project. He will participate but also supervise the coding phase of all the tools, including the databases.

It is planned that the Observing Assistants will closely participate in testing all the components of the QSO project, in particular the Phase II entry tool and the tools for the QSO observing environment (e.g. Q scheduler). An external team familiar with observations at CFHT will also be identified to test and make recommendations for the Phase II tool.

The complexity of the QSO project cannot be underestimated. For instance, it will be impossible with the manpower presently available to develop all the necessary tools in parallel. At least one other programmer would be necessary to achieve that, even if this person would have to share his/her time with the other teams. Help from another astronomer (TF?) will be also welcome during the specifications phases. On the longer term, support for the database maintenance (e.g. backups, upgrades) will have to be provided by a member of the software group (10-20% basis).

6. Timeline

A precise timeline for all the phases including reviews of the QSO Project is being prepared. The principal milestone dates are given in the following table.

Event	Date	Notes
General SAC Review	2000/04/01	
QSO Phase I Submission	2000/09/01	Normal deadline
TAC Evaluation	2000/10/31	
QSO Phase II Tool release	2000/12/01	2 months prior to first QSO run
First QSO Run	2001/02/01	

7. Glossary

Here are some terms used in this document:

Communication System: Software with two distinct functions: 1) Helpdesk and email system between the Observing Team and the investigators; 2) Web status display on progress of QSO observations.

Database: Structural ensemble of tables containing data and handled in a Relational Database Management

System. The tables are identified with a primary key, defined entry fields (e.g. runid, RA, DEC, filter) and can be related through specific relationships and constraints. Some tables in the databases for the QSO Project are operational; that is, the data they contained might be updated frequently during the observations.

Electronic Logbook: Software interacting with the content of the Phase II database and operational database used by the observers to report on QSO observations (NB: could be integrated to the Observation Tool).

QSO Observing Team: Group of individuals responsible for a QSO run. Their tasks include the database management (queue coordinator), execution of the observations (observers) and data evaluation.

Observation Tool: Software used during QSO observing to trigger the observations selected with the Q scheduler. This tool sends the parameters included in the templates to the scripts of NEO

Q Scheduler: Software used by the observers to obtain a prioritized list of plausible programs for a given set of constraints and sky conditions.

QSO/NEO Agent: Software component that provides information on the progress of the exposures (e.g. completion) to QSO from NEO.

Observation Scripts: Series of commands controlling the telescope and/or the instruments. For QSO, the scripts reside in NEO and are executed using parameters defined by the templates. For better efficiency, parallelization of the actions generated by the scripts in NEO would be preferable.

TAC: Time Allocation Committee. The tasks assigned to the TAC regarding the QSO proposals must be very well defined and understood to ensure that the pool of programs contains diverse and realistic constraints.

Templates: An ensemble of parameters designed for a specific action (e.g. target pointing, calibrations, observation). Each template is identified by a name id and its parameters are defined during the Phase II. Templates can be grouped together to form an observation sequence.