Queue Planning Tool Requirements

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V2.0

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V0.1 – 2006 April 13 – Bryan Miller
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Document Purpose
This document presents requirements for the development of the Gemini Queue Planning Tool. For work to be done in 2007 the Phase 2 of this plan is the science staff's recommendation for the work to be included in the Band 1 observatory task Focus on Queue Planning (ENG16; see page 6).

Intended Audience
The intended audience for this document is the scientific and software staff responsible for the development and testing of the OT and the OCS and the members of management responsible for setting observatory priorities.

Acknowledgment
This document is based in part on "Queue Planning Software Requirements" and "Observing Tool 05B" by Bryan Miller. The entire science staff, especially the queue coordinators, have provided input.

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1 Introduction

1.1 Abbreviations

CS – contact scientist
DA – data analyst
DHS – data handling system
IFU – integral field unit
IS – instrument scientist
FITS – flexible image transport system (astronomical image file format)
GCAL – Gemini calibration unit
GQPT -- Gemini Queue Planning Tool
GWS -- Gemini Weather Server
IRAF – Image Reduction and Analysis Facility
NGO – national Gemini office
OCS – observatory control system
OLDP – on-line data processing system for real-time data reduction
OT – observing tool
PI – principal investigator
PIT – phase I tool
SSA – system support associate
ToO – target of opportunity

1.2 Rationale

The Gemini Observatory is a pioneer in multi-instrument queue observing. This mode of observing matches the current conditions with the requirements of the programs in the queue to provide for the most efficient use of telescope time. Also, queue observing makes it easy to execute non-traditional types of programs such as rapid target-of-opportunity triggers or complex monitoring programs. However, the observers cannot be expected to be aware of the requirements for all 90-odd programs in the queue. Therefore, a tool is needed to help the queue planners and observers make the best and quickest decisions about what to execute. Therefore, we are developing the Gemini Queue Planning Tool (GQPT). The phases of this project are:

1. Manual queue planning tool with visualization that works on the ODB and has an easy-to-use interface.
2. Implementation of "assisted" queue planning. This involves using algorithms from the prototype tool to more rapidly assemble queue plans.
3. Incorporate the use of site monitoring information for more dynamic real-time use.
4. Work on advanced scheduling algorithms using constrained logic programming to minimize the need for manual manipulation of the plans.

The purpose of this document is to define the detailed requirements for this tool.

2 Intended Users

The users of the queue planning tools are the queue planners and the nightly observers.

Queue coordinators (QCs) make the daily queue plans. Plans have to be made for different conditions that may be encountered during the night. At least a dozen different are usually created but many more permutations are possible. In addition, every few days a longer-range plan is made for a limited set of conditions. The long-range, or multi-night, plans are useful for planning calibration, engineering, or instrument component changes (especially for GMOS). QCs are Ph.D. astronomers on staff who are familiar with the basics of all the instruments but they will only be an expert in one or two. There are four active QCs per site at a given time and they work in shifts of one or two weeks. In addition to making the plans they must do the time accounting from the previous night, attend coordination meetings, and interact with the daytime SSA and the engineering staff about instrument and telescope problems. The following are "personas" of typical QCs.

Lisa (queue coordinator)
Lisa has been a Gemini Science Fellow for the last two years. She knows how to run all the instruments but is an expert only in GNIRS. This is her first semester as a QC and is still learning the basic principles.

Henry (queue coordinator)
Henry is a tenured Gemini staff astronomer. He is familiar with all the instruments and is an expert in GMOS and NIRI. Having done queue planning for several years and is adept at making efficient plans.

Queue observers may be Gemini staff or visitors from the National Gemini Offices (NGOs). They are familiar with the basic principles of observing but will have a variety of levels of experience with Gemini software and the different instruments. They will not be as familiar with the programs in the queue as the QCs. A single observer usually is on the mountain for three to four nights at a time. The following personas represent typical observers.

Carlos (observer)
Carlos is a visitor from the Brazilian NGO. This is his second visit to Gemini and has received basic training from Gemini staff. He feels fairly confident with running Michelle and NIRI but not with the other instruments. He is familiar with the Observing Tool from doing PhaseII checks but is not proficient with other aspects of the observing system. He is not familiar with the queue in general.

Mary (observer)
Mary is a parallel-track (permanent) Gemini staff member who has been with Gemini for five years. She is an expert observer and has grown up with the system. She is adept at running all the instruments and wants to maximize the use of the telescope time. She has good knowledge of the queue programs for which she is contact scientist and can quickly pick up the details of other programs.

3 Planning Tool Requirements and Plan

3.1 Phase 1

Most of the Phase 1 work was carried out in 2006. In May 2006 the first version of the official Queue Planning Tool was released and there have been 4 updates as of 11 May 2007 (the current version is 1.0.4). This meets the requirements and the corresponding SCT item [SCT-13] has been closed. The QPT has been enthusiastic accepted by the queue coordinators. Two screen shots are given in Figures 6 and 7.

Base requirements

- Observation Selection
  - Programs Active
  - Observation status Ready or Ongoing
  - Classes
    - Science classes and associated calibrations within AND/OR groups
    - Ignore acquisition and daytime calibration classes during production of the nighttime plans
  - Select instruments that are available
  - Select instrument components that are installed (GMOS, Flam-2)
    - Manual option
    - Can be automatic (instrument configuration web page) for the current day
  - Select by conditions:
    - IQ, CC, WV, SB
    - Allow entry of wind speed and direction, warn if observation will be done within 20degrees of a wind >10m/s.
    - Warn if airmass or HA constraints to be broken
  - Time constraints
    - Don’t allow scheduling if within time constrain window
    - Alert of observations that are within the time constrain window
    - Automatic insertion of rapid ToO triggers
  - Be able to sort by ranking band and RA as in the Big Sheet (Fig. 1)
  - QC-adjustable weights on programs and observations visible to on-site (OTR) users only
- Create, store, and recall multiple scenarios
- Create single night plans
- The QCs “start of night” plans should be stored securely for comparison with what was done.
- Give ranked list by weight of all observations visible at a given date and time

Visualization

- Plan creation
  - Manually rearrange order of observations (add, remove observations etc)

    - Be able to stretch/compress the time window for an observation in units of the exposure times of the individual images
    - Have a 'no-obs' item than can be included in the plan, with editable title and duration so that events not included in the ODB can be included in the plan (e.g. an enforced break for engineering)
    - Be able to include comments (notes) about the plan
- Text visualization/reports (see Fig. 2)
    - Include ephemeris information
        - LST midnight
        - Sun rise/set times
        - Times of nautical (12 degree) twilights and the length of time between them
        - Moon rise/set/phase/position at local midnight
    - Information on scheduled observations
        - Local time of visit start
        - UT time of visit start
        - Visit duration
        - Obsid
        - Target name
        - Instrument and configuration
        - Mean parallactic angle during visit
        - Mean airmass during visit
        - Calculated SB from lunar phase, moon-source distance, and elevation
        - IQ, CC, WV, SB conditions of observation
        - Scheduling notes
- Graphic visualization
    - Histogram of RA distribution for all selected observations
    - Linear timelines for different scenarios (conditions) (see Fig. 3)
    - Plot of elevation vs. time for a night (see Fig. 4)
        - Complete track of object
        - Highlight scheduled period
        - Include track of moon
        - Plot sky brightness with time for selected observation
        - Warnings and alerts of the following events
            - SB constraint to be broken
            - HA or airmass constraint violated
            - Elevation track in telescope blind spot
            - Special time constraints

Supporting OT/OCS requirements

- Scheduling groups and organizational folders
- Additional fields in the OT conditions constraints component are needed for the PI to specify HA <u>or</u> airmass limits. [SCT-131]
    - Minimum and maximum HA (default INDEF or +/- 6 hr)
    - Airmass buttons like ITC: <1.2, <1.5, Any (default)
- Timing window constraints on observations [SCT-7]

- Improved support for non-sidereal targets with orbital elements [SCT-69,79]
- Instrument efficiency and overhead updates

3.2 Phase 2

The Phase 2 requirements constitute the 2007 observatory band 1 priority task ENG16, Focus on Queue Planning. A first implementation of these requirements should be in place by the end of 2007, or the release of the 2008A OT and OCS. Relative priorities are given by the labels High, Medium, or Low.

The OT work on adding timing constraints for groups and AND/OR logic is needed for good automatic planning. If development of these features leads to the conclusion that reorganizing the model for OT observations and sequences is needed first (see the OT Development Plan), then a re-evaluation of OT vs. QPT work will be needed.

Queue Planning Tool

- Implement observation ranking, or weighting, using algorithms similar to those described in the document Queue Planning Software Requirements - High
  - Plan makers (queue coordinators) should be able to manually adjust the weighting of a given observation. This weighting should be saved with the plan for future use.
  - The weightings should be visible to the queue planners
- Implement assisted planning using automatic scheduling algorithms - High
  - The observations weights should be used for observation selection
  - The automatic scheduling should be able to create an entire plan (variant) for a night or fill in the holes of an existing plan
  - The algorithms should be quick; creation of a complete plan (variant) should not take more than 5 seconds on the typical astronomer's workstation.
  - Allow plan to begin or end at arbitrary times (ToO just observed, the conditions just changed, or there was a technical problem; what is the best use of the rest of the night?)
  - It should be possible to block periods of time where an automatic plan is not created. These periods may correspond to engineering, commissioning, or other special periods of telescope use.
- Visualization
  - Alt-Az plots (like on TSD) - Low

Supporting OT/OCS work

- Propagate Band 3 information to the OT and database reports [SCT-204] - High
- Improvements to time accounting tools
  - Interactive nightly timeline for easier, graphical editing of time accounting [SCT-9] - High
  - Improved time accounting rules for better automatic time accounting [SCT-51] - Medium

    - Enhanced ODB reports for better program management and time accounting - Medium
- Development of timing constraints between groups [SCT-7] - High
- Development of AND/OR logic in groups [SCT-95] - High
- Identification of pre-imaging observations [SCT-234]
- Updates to efficiencies and overheads
    - Include overheads for calibration exposures [SCT-162]
    - Timeline bug when iterators have blank steps [SCT-185]
    - Other updates to instrument/mode overheads e.g. [SCT-218]

3.3 Phase 3

Phase 3 of this project should be an observatory priority in 2008. This work may depend on fundamental structural developments in the OT model.

This phase also depends on improvements to our climate monitoring system. In 2008 priority should be given to ensuring that we have DIMMs, water vapor monitors, and all-sky cameras at both sites and that the data is collected in a computer-usable form.

Queue Planning Tool

- Implement multi-night plans
- Improved calibration management
    - List calibrations needed for the observations in the plans - Medium
    - Check that calibrations for executed observations have been taken - Low
- Real-time mode
    - Observers interact with a special, dynamic version of QPT rather than with a static html page
    - Observations can be queued from the QPT and the QPT will know what is currently executing.
    - Site conditions and trends are monitored and the appropriate prepared plan is suggested. Warnings are given if the current conditions deviate from the currently executing plan
    - Plans may be modified or created by the observer. This will be especially useful if weather, other problems, or ToOs cause large deviations from the prepared plans and the observer needs to determine the optimal use of the remaining time.
        - Prepared plans will not be overwritten
        - The observer’s modifications and new plans can be saved separately, or in addition to, the prepared plans
- Visualization
    - Moving current time marker
    - Countdown timer until morning twilight
    - Multi-night plan graphic summary: time of night vs. date (Fig. 5)

OT/OCS Improvements

- Model changes for OT observations and sequences

- Development and implementation of timing constraints between groups [SCT-7]
- Development and implementation of AND/OR logic in groups [SCT-95]

Other

We need a fully functional and reliable climate monitoring system. The data from the sensors needs to be available to the software, probably via EPICS records. The requirements for the real-time planning are:

- Image quality
  - GS: DIMM ok
  - GN: DIMM needed – High priority
- Water vapor monitor
  - GS: IRMA dead, need a new system – High priority
  - GN: CSO tau meter ok
- All-sky cameras with extinction estimates
  - GS: CONCAM and SASCA
  - GN: Subaru 10um all-sky camera
  - Getting opacity information into GWS – Medium priority
- Wind speed and direction – ok via the Gemini weather towers

3.4 Phase 4

The need for and requirements in this phase are TBD for work in 2009 and beyond. This phase should include improvements identified during the earlier phases. This may include:

- Advanced scheduling algorithms or real-time features
- Improved long-range planning (expert system)
  - Optimization of instrument component changes (e.g. GMOS gratings)
  - Optimization of instrument changes

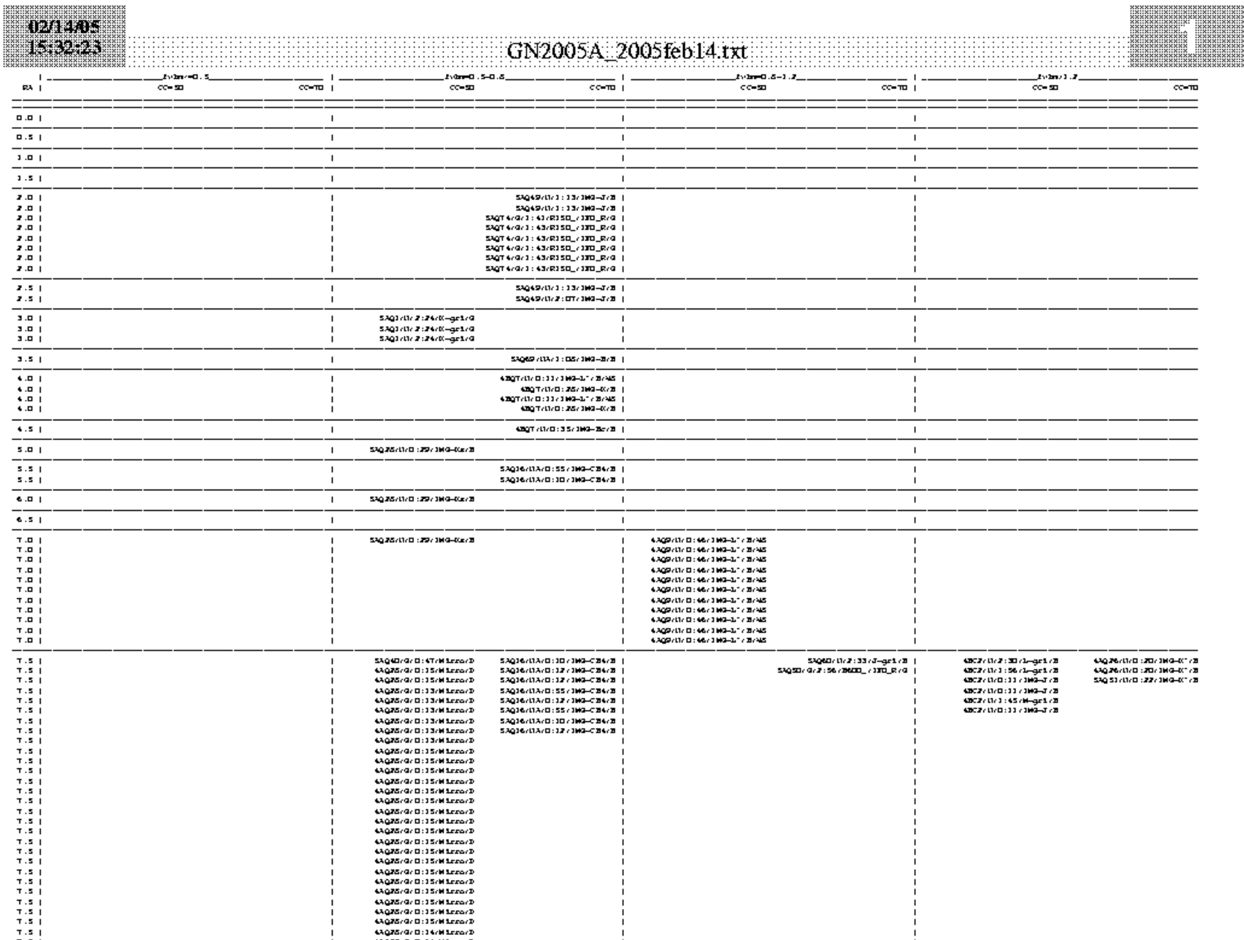

Figure 1. An example Big Sheet that shows available observations by conditions and RA.

```
### IQ=70%, CC=70%, WV=80% ###

----------------  2004-11-3 UT -------------------

Julian date at 0 UT:  2453312.5000
LST midnight: 01 07 58.1
Moon at    00 29 35.828  +27 41 26.80   (Equinox J2004.0082) at UT=3.00
Moonrise: 01:16:29.    Moonset: 11:37:11.
Lunar illumination: 69.7%
Time between twilights [hrs]: 8.80

Local  UTstrt  UTstop   ST    Prgid      Target          Inst    Airm    HA
ParAng | MoonH  MoonD  SB
-----  ------  ------  -----  ---------  --------------  ------  ----  -----
------ + -----  -----  ---
20:15   Sunset
21:02   Evening 12deg twilight
21:00   00:00   02:00  22:07    04B-Q-8    DMS2139-0405  GMOS-S  1.12    0.4
144.8 |  -9.1  138.0  20%
```

```
23:06    02:06    04:42  00:14    04B-Q-14         NGC 1399   GMOS-S  1.36    -3.4
-87.7 |  -7.1    82.3  20%
01:48    04:48    05:48  02:56    04B-Q-13          NGC0337    GNIRS  1.23     1.9
128.4 |  -4.5    99.6  80%
02:54    05:54    06:48  04:02    04B-Q-13          NGC1566    GNIRS  1.10    -0.3
3.3 |  -3.5    92.1  80%
03:54    06:54    08:48  05:03    04B-Q-13          NGC2915    GNIRS  1.75    -4.4
-59.9 |  -2.5  105.9  80%
05:50    Morning 12deg twilight
06:38    Sunrise
```

Figure 2. An example text representation of a nightly plan.

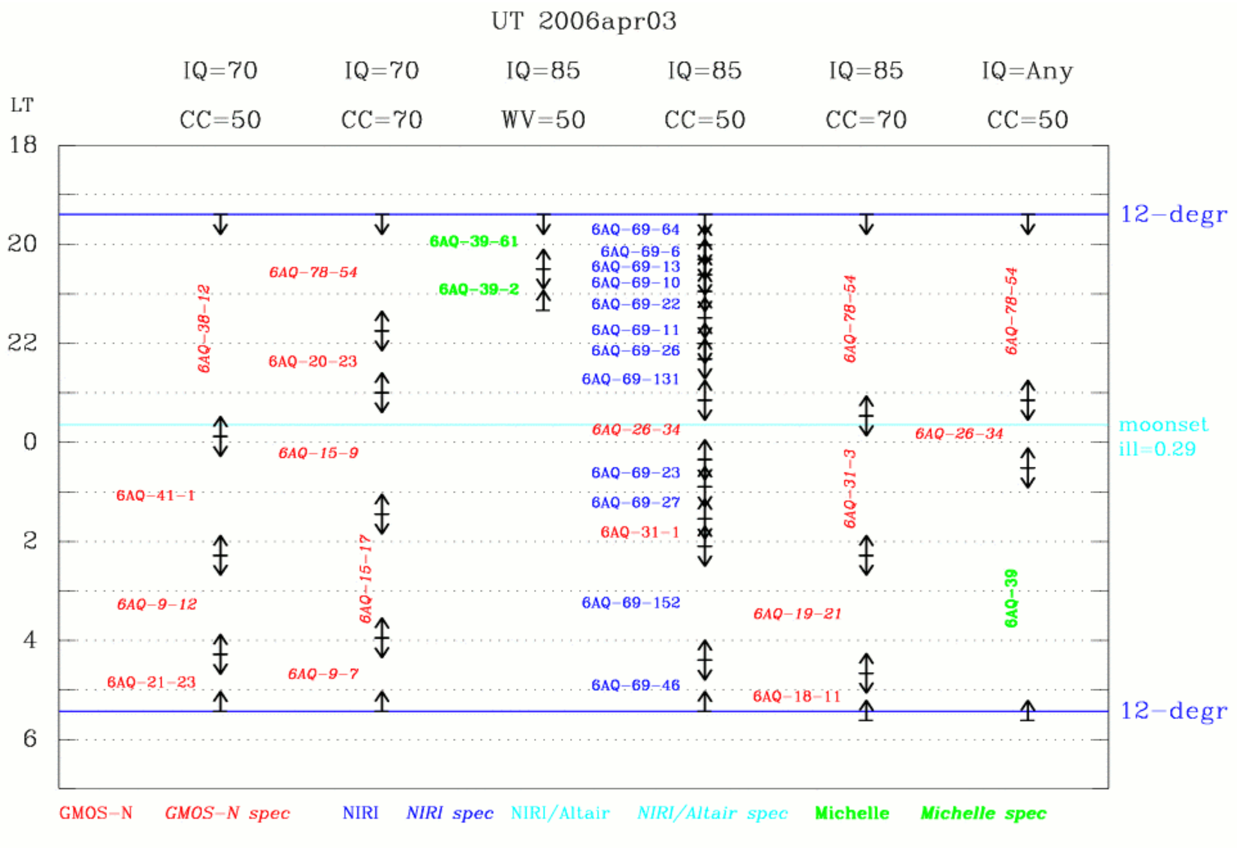

Figure 3. Example timeline visualization of multiple scenarios in a nightly plan.

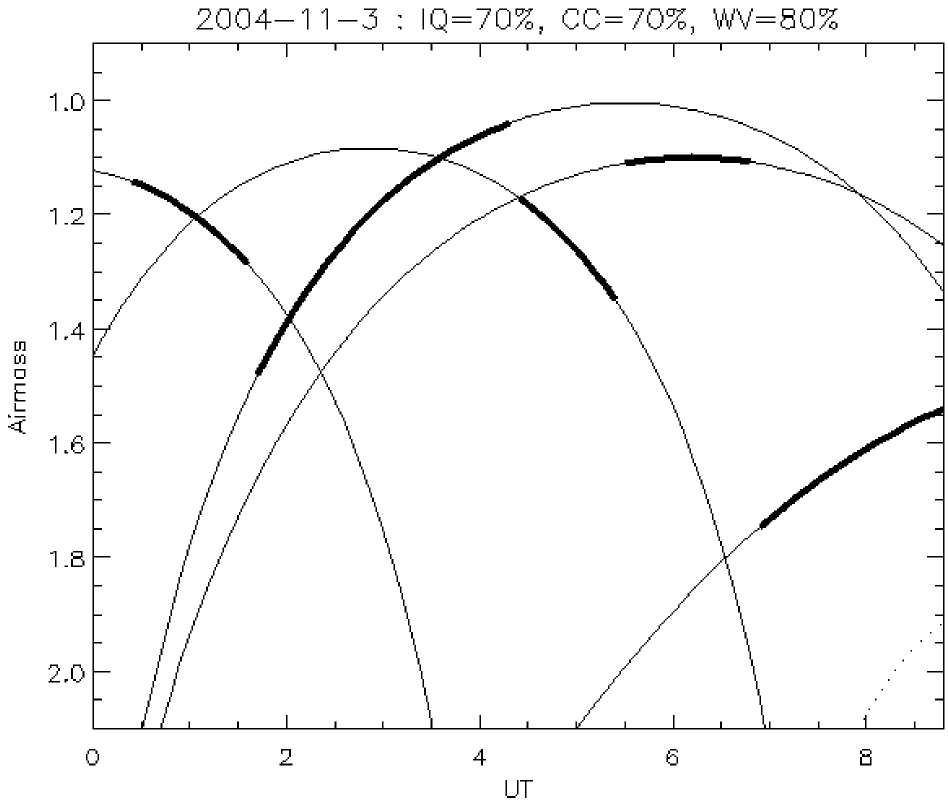

Figure 4. Airmass vs. time visualization of the nightly plan in Figure 2. Thick solid lines indicate then the observations are scheduled. The dotted line is the track of the moon.

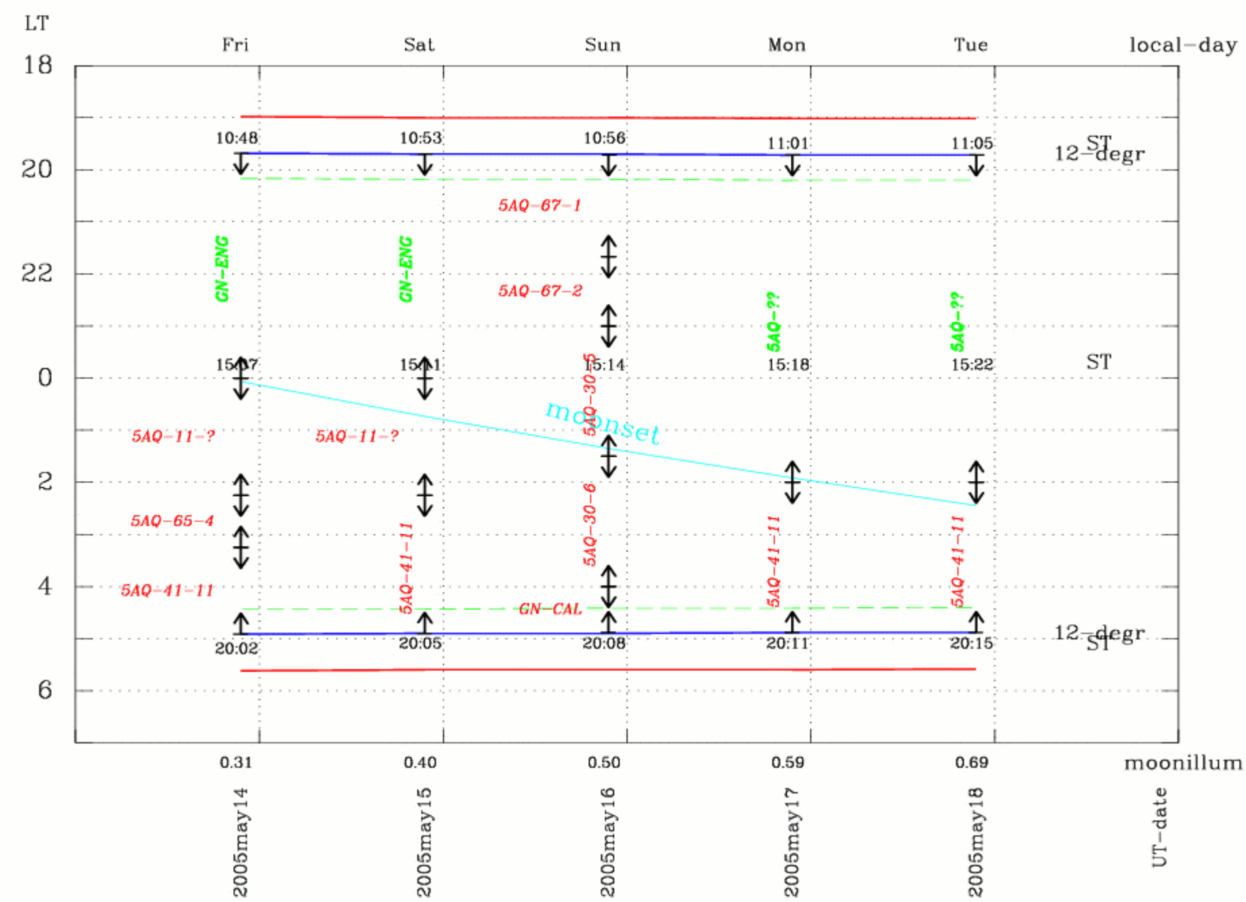

Figure 5. Example visualization of a multi-night plan.

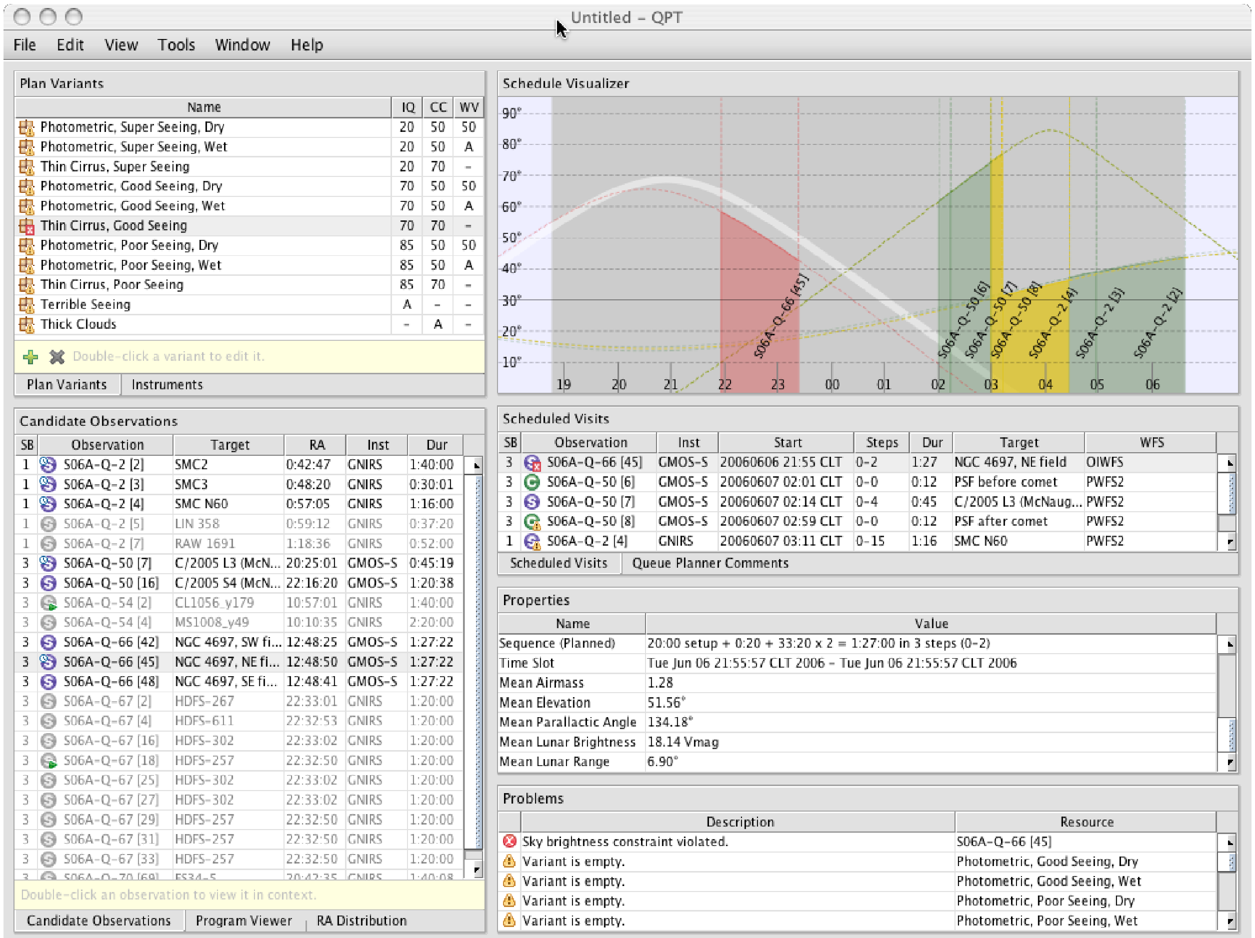

Figure 6. The main view of the Queue Planning Tool showing the variant window, observation list, elevation plot, plan list, and observation details.

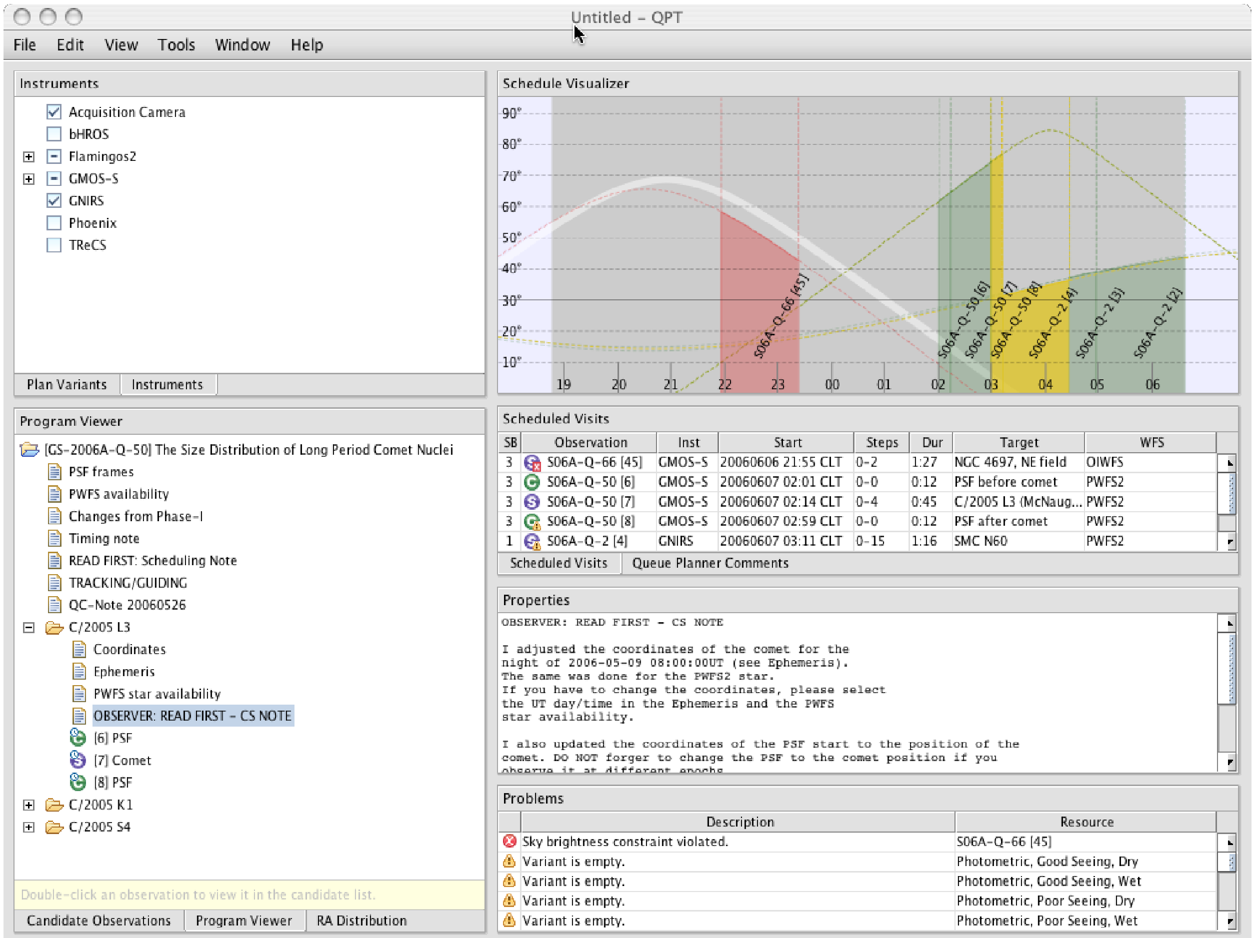

Figure 7. Alternate QPT view showing the selection of instrument configuration and the OT-like program viewer.