

# Getting Started on the LCO Global Telescope Network

(February 2025 edition)

[Purpose](#)

[Overview of the Las Cumbres Observatory \(in 2025\)](#)

[Supported Instruments](#)

[Functions of the LCO Observation Portal](#)

[Communicating with LCO through APIs](#)

[Creating a User Account](#)

[Creating a Proposal](#)

[Elements of a Proposal](#)

[Observation Planning Tools](#)

[Creating an Observation Request](#)

[General Information](#)

[Request](#)

[Configuration](#)

[Instrument Configuration](#)

[Target](#)

[Constraints](#)

[Window](#)

[Features](#)

[Results of Submitted Observation Requests](#)

[Interactions with the Scheduler](#)

[Managing Proposals](#)

[Pipeline processing and access to data products](#)

[Getting Additional Support](#)

[Appendix A: Intra-/Inter-Proposal Priority Factor](#)

[Appendix B: Observation Overheads](#)

[Appendix C: LCO site codes](#)

[Appendix D: The Cassegrain derotators on the 2m telescopes](#)

[Appendix E: Time refunds](#)

## Purpose

This document explains the basic procedures for interacting with the LCO Network through the Observation Portal at <https://observe.lco.global/>. Its primary purpose is to describe to users how to request scientific observations with the network through the Portal's Graphical User Interface (GUI). For a general overview of the Portal, see the [Observation Portal](#) section of the [Observatory Control System](#) documentation. If you are not an astronomer, the information on [LCO's website](#) may be more appropriate for you.

For a one-page “cheat sheet” to using the system, see the [LCO Network Jump Start](#).

## Overview of Las Cumbres Observatory (in 2025)

Las Cumbres Observatory (LCO) is a global telescope network consisting of two 2-meter telescopes, thirteen 1-meter telescopes, and ten 0.4m telescopes.

The 2-meter network includes one telescope at Haleakala Observatory on Maui and one telescope at Siding Spring Observatory (SSO) in Australia.

The 1-meter network comprises five telescopes in the northern hemisphere and eight telescopes in the southern hemisphere. There are two telescopes at Siding Spring Observatory (SSO) in Australia, three at South African Astronomical Observatory (SAAO), one at Wise Observatory in Israel, two at Teide Observatory in Spain, three at Cerro Tololo Inter-American Observatory (CTIO) in Chile, and two at McDonald Observatory in Texas.

The 0.4-meter network includes ten telescopes: two at Haleakala Observatory on Maui, two at SSO, one at SAAO, two at CTIO, one at McDonald Observatory, and two at Teide Observatory.

The LCO network is dedicated to time-domain observations at optical and near-IR (silicon cutoff) wavelengths. The types of phenomena typically observed include supernovae, exoplanets, near-Earth objects, variable stars, and gamma ray bursts. LCO's technical capabilities and operations model are designed to enable observations for which a global network is uniquely suitable. Examples of specialized observation modes include 1. continuous monitoring over 24 hours, 2. rapid response to alerts, and 3. reliable long-term monitoring at any cadence. For details on the network, instrumentation, or science goals see [Las Cumbres Observatory Global Telescope Network](#) in Publications of the Astronomical Society of the Pacific, 125, 1031, July 2013, also available at <http://arxiv.org/abs/1305.2437>.

## Supported Instruments

The general system for requesting observations, tracking the status of requests, and viewing and downloading data is the same for all three telescope aperture classes. The instrumentation differs among the three aperture classes. Basic characteristics of the supported instruments are given in the table below. For additional information, consult the [Instruments](#) section of the LCO website.

Telescope aperture class	Instrument	Field of view	Pixel size or wavelength range	Approximate magnitude range
2-meter	MuSCAT (multi-channel imager)	9' x 9'	0.27" (binned 1x1)	10-22
2-meter	FLOYDS (low dispersion spectrograph)	30" slit; width selectable	320-1100 nm	10-19
1-meter	Sinistro (single-channel imager)	26' x 26'	0.39"	8-19
1-meter	NRES (high dispersion spectrograph)	3" diameter fiber	390-860 nm	5-12
0.4-meter	QHY600 (single-channel imager)	1.9° x 1.2°	0.73" (binned 1x1)	6-18

Exposure times and S/N ratios for the imagers can be estimated using the [exposure time calculator](#). (See the [Observation Planning Tools](#) section below.)

## Functions of the LCO Observation Portal

The url for LCO's Observation Portal is <https://observe.lco.global/>. The Portal allows users to do the following tasks:

- Create a user account;
- Write and submit observation proposals;
- Plan, compose, and submit requests for observations for approved proposals;
- Track the status of submitted requests;
- Identify and download completed observations;

- Monitor the hours used for approved proposals;
- Report problems, ask questions, and make suggestions.

## Communicating with LCO through APIs

The Portal interacts with software hosted by Amazon's Web Services (AWS) through a set of Application Programmable Interfaces (APIs). A high-level overview of the Portal that describes the component API endpoints is available in the [Observation Portal](#) section of the [Observatory Control System](#) documentation. Detailed descriptions of the Portal's APIs (including Python and Javascript code samples!) are available on LCO's [Developers pages](#). Various sections there describe how to:

- Schedule observation requests,
- Obtain information on the status of submitted requests, and
- Retrieve data stored in the Science Archive.

***We strongly encourage users to write their own code to use the APIs and customize their communications with LCO.*** A good starting point for many science collaborations is to create a Target and Observation Manager (TOM) using the tested and ever-expanding architecture of the [TOM Toolkit](#). *This Guide is not intended to describe programmatic interactions with the Portal's APIs.* This Guide describes how to interact with the Portal through the GUIs at <https://observe.lco.global/>.

## Creating a User Account

Anyone may create a user account through the Portal. If you are eligible to use the network (check the description of [LCO's Time Allocation Process](#) for the eligibility requirements) and would like to submit a proposal, you should begin by creating a user account. Only registered users with an approved proposal (i.e. one to which time has been allocated) can submit requests for observations. Co-investigators on proposals must also create user accounts before they can submit observation requests or retrieve data.

To create a new user account:

- Go to the URL for the [Portal](#), and click on the large green button that says "Register an Account".
- Complete the registration form. The Username that you will select will be inserted into the `USERID` header variable of any data that are acquired for your approved proposals. Review LCO's [Terms of Service](#). Click the Register button.
- You will receive confirmation via e-mail.

## Creating a Proposal

Three types of proposals can be submitted through the Portal: Standard proposals, Key Project proposals, and proposals for Director's Discretionary Time. For information on the three types of proposals, and who is eligible to apply for network time, consult the description of LCO's [time allocation process](#) on the LCO website. Guidance on [writing proposals](#) is also available on the website.

To create a proposal in the Portal:

- Go to the [Portal](#) and login.
- Click on the "Manage Proposals" link in the header.
- The new page will show a list of Your Proposals (described in the ["Manage Proposals"](#) section below.) If you've never submitted a proposal before, the list will be empty. Click on the "Submit Proposal" link in the upper-right.
- The subsequent page lists all active Calls for Proposals. Select the Call for which you want to submit a proposal and click the corresponding "Apply" button.
- Fill out the form. A description of each element in the proposal form is given below.
- A draft proposal can be saved by clicking on the Save button. When you next login to the portal and click on the "Submit proposal" link, your draft will be shown in a "Your Proposals" list. Click on the title of the draft proposal to resume writing the proposal. Drafts for multiple proposals can be saved.
- The information in a draft proposal can be succinctly displayed (i.e. without the explanatory text of the proposal form) by clicking on the Preview button. The proposal can be viewed in its final format, i.e. the format that the TAC will actually read, by clicking the "View pdf" link in the upper-right corner of the preview.
- When the proposal is complete, click the Submit button. Confirm your submission in the popup window by clicking OK.
- After submission, the "Calls for Proposals" page will now include your proposal on the "Submitted Proposals" list. To view the completed proposal again, click on the pdf icon in the right-most column. To print the pdf of the proposal, click on the printer icon.

## Elements of a Proposal

For a standard proposal, information on all of the elements listed below must be included. Additional information on [Writing Proposals](#) is available on the LCO website.

### Title

Limit the proposal title to 100 characters.

### Abstract

Limit the proposal abstract to 1500 characters.

### Principal Investigator

If this is not the author, add the PI's email address, name, and institution.

### **Co-investigators**

Email addresses, names and institutions of the proposal's Co-Is.

### **Observing Budget**

Requested observing time in hours for the duration of the semester. If requesting time for more than one type of instrument, click "add another" for each new instrument. Time requests for Rapid Response and Time Critical observations (described below) must be specified in separately.

The balance of the proposal should be included in a single file (pdf format). The style and formatting of the file is up to the author, but the file must conform to the following rules:

- The font size must be 11 pt or larger.
- The margins on all edges must be at least 1 inch.
- Line spacing must be 6 lines-per-inch or greater.

The file should include the following elements:

### **Science Justification**

Scientific justification for the time requested, which should include the scientific background, the goals of the project, and pertinent references (which should be listed in full at the end or on the figures page). The results of any previous time allocated for this project should be discussed.

### **Experimental Design**

A description of the observations and constraints, and justification for the amount of Rapid Response or Time Critical hours requested. Rapid Response observations will interrupt regularly scheduled observations. Time Critical observations do not interrupt scheduled observations, so their use is restricted to cases where this is the only mode in which these targets can be observed. Time Critical mode is reserved for observations that must be made at tightly constrained times.

### **Related programs on other telescopes**

A concise account of other programs which relate to this proposal.

### **Report on past use of LCO in the last 3 years**

A concise account of time used on LCO network in the past 3 years.

### **Applicant's related publications**

Up to 10 relevant publications from the past 3 years.

In the proposal form for discretionary time, several fields (Related programs, Report on past use, and Publications) are omitted. In their place is one additional field:

## Justification of discretionary time

An explanation of why the observations must be carried out immediately, rather than waiting for the next semester's proposal and review process.

## Observation Planning Tools

A variety of software tools have been created to assist in planning observations. The tools can be accessed through the [Observatory Tools](#) page of the LCO website or by clicking on the "Planning Tools" link in Portal header.

### Exposure Time Calculator

A tool for estimating the exposure time needed to achieve a particular S/N ratio on a target of known brightness. The calculator can be used for any filter on any of the imagers on the three telescope aperture classes. For estimating exposure times on the FLOYDS and NRES spectrographs, consult the [FLOYDS](#) and [NRES performance](#) pages, respectively.

### Target Visibility Calculator

A tool that displays the visibility of a (user-specified) set of coordinates from the LCO sites. The visibility can be displayed either as a range of UT hours over a range of dates ("Seasonal Visibility"), or as a range of altitude/airmass on a particular date ("Daily Visibility"). A version of the Daily Visibility plot is generated in the [Window section](#) of the Portal's Observation Request Form (see below).

### Network Contention Plots

A "pressure" plot shows the number of requests "competing" in the global schedule as a function of time from "now", i.e. the time when the plot is generated. "Contention" plots for each telescope class show the total hours of requested observations broken down by target RA.

## Creating an Observation Request

Requests submitted to LCO are *most commonly* created for a single type of observation (image or spectrum) of a single target with a single instrument. Each observation is defined by four sets of information describing 1. the target, 2. the configuration of the instrument, 3. the time window, and 4. the observing constraints.

The target parameters determine the location on the sky to which the telescope is pointed. The






configuration parameters identify the details of the type of observation, for example the filter, the number of exposures in a sequence and their duration, and the binning of pixels on the CCD. The time window parameters specify when the observation should occur. Lastly, requests can be defined by various constraints, for example, the maximum airmass at which the observation can be scheduled and the minimum angular separation from the moon to which the telescope can be pointed when making the observation.

Requests on the LCO network do *not* identify specific sites or telescopes. With the exception of the telescope at Wise Observatory, the telescopes of each aperture class are identical. LCO's scheduling software ("the Scheduler") assigns each observation request to the best telescope available, and reassigns it to the next available telescope if the initial attempt fails (due to weather or technical problems).

Although observation requests are *most commonly* created for a single target, it is possible to create multiple requests within a single RequestGroup. An advantage of doing so is that the statuses of the requests are tracked together. However, the scheduling of the requests is completely independent, and the overall RequestGroup is not complete until either all individual requests have been successfully completed or the time window has closed.

## The Observation Request Form: General Information

To compose a request for an observation, first login to the [Portal](#), then click on the "Submit Observation" link in the header. The default display is the request composition form. The top section of the form, labeled "General Information", is displayed in Figure 1. The tabs and buttons along the top of the form are described in the [Features section](#) below. The  in the upper-left corner indicates that the request is not ready to be submitted. When the request is complete, the  will be replaced by a .

The "Duration of Observation Request" shown in the General Information section is the amount of time that will be deducted from the science project's allocation when the observation is complete. The duration includes the science exposures and all accompanying overheads. It is set to "0 hrs 0 min 0 sec" until details of the observation request are entered into the compose form.

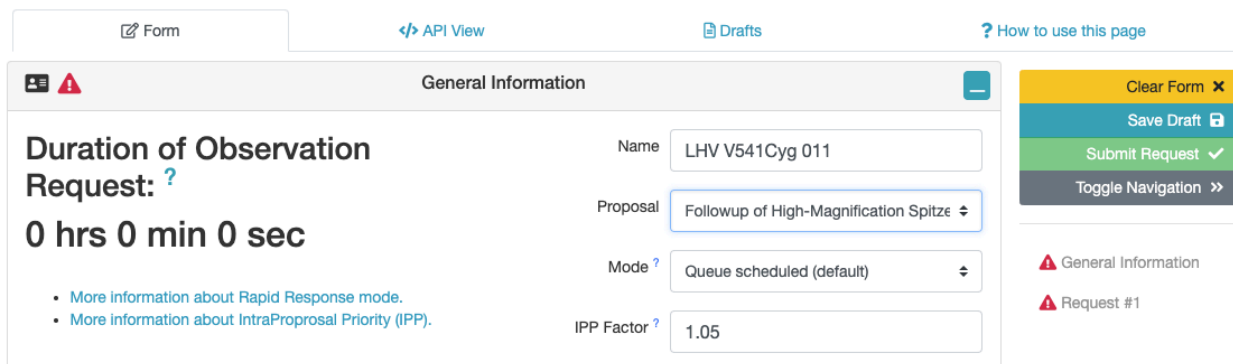


Figure 1.

**Name.** Begin by selecting a name for your request. In any image acquired for the request, the name will be recorded under the `GROUPID` keyword in the image header. Because this request will appear in lists of other requests, its name should be unique and meaningful. For example, a useful title might be “ABC V541Cyg 001”, where ABC are a PI’s initials, V541Cyg is the target, and 001 is a sequence number.

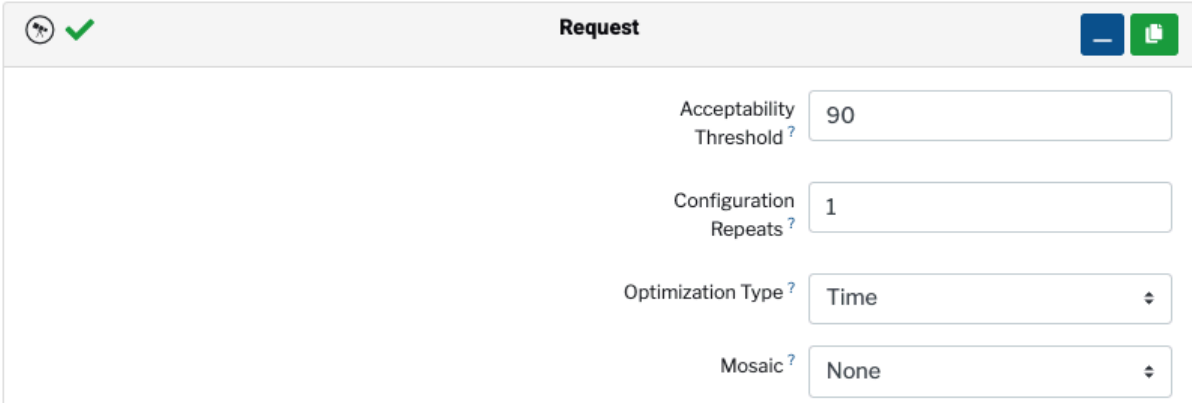
**Proposal.** Select the proposal for which you are making the request. In the drop-down menu, the titles of the active proposals for which you are the PI or a Co-I are displayed. Time expended for this request (even if the observations are not completed) will be deducted from the proposal that you select. Time is deducted when an exposure begins on a telescope, not before.

**Mode.** LCO offers three modes for processing observation requests: standard Queue-scheduled, Time Critical, and Rapid Response mode. LCO’s scheduler typically produces a new schedule in about 2 minutes. Rapid Response mode is reserved for observations for which this cycle time is not fast enough. Rapid Response requests circumvent the normal scheduling process and are carried out “immediately” upon submission. If a Rapid Response request cannot be executed immediately, it is executed as soon as possible, up to 24 hours after submission. For more information, please see the [Special Scheduling Modes page](#) in the [Documentation section](#) of the LCO website. Time Critical and Rapid Response observations may only be selected if these modes were approved for your research proposal.

**IPP Factor.** The Intra/Inter-Proposal Priority (IPP) Factor allows you to boost or demote the priority of your request, thereby communicating the relative importance of this request relative to other requests in your observing program to the Scheduler. If you are a novice LCO-user, it is best to leave the IPP Factor set to its default value. For more information on the IPP Factor, see [Appendix A](#).

## The Observation Request Form: Request

The next section in the composition form is the Request section (Figure 2). This section includes multiple subsections that will be described below. The four options at the Request level are **Acceptability Threshold**, **Configuration Repeats**, **Optimization Type**, and **Mosaic**.



The screenshot shows a web form titled "Request". It contains four input fields, each with a question mark icon next to its label:

- Acceptability Threshold**: A text input field containing the value "90".
- Configuration Repeats**: A text input field containing the value "1".
- Optimization Type**: A dropdown menu with "Time" selected.
- Mosaic**: A dropdown menu with "None" selected.

Figure 2.

**Acceptability Threshold.** If the observation is interrupted before all exposures are acquired, the request will still be marked “Complete” if the percentage of the acquired exposure time (relative to the total time requested) exceeds this threshold. In this case, you agree to accept the exposures already acquired as sufficient to meet the science goal of the request, and the request is not rescheduled. If, on the other hand, the percentage of the acquired exposure time does *not* exceed the threshold, then the request is marked “Failed”, and it *is* rescheduled. The threshold should be specified as a percentage (between 0 and 100). The default value is 90%. For FLOYDS observations, the default threshold is 100%, i.e. the science spectrum and all accompanying calibrations must be acquired.

The Acceptability Threshold is particularly relevant for requests of multiple exposures. It is intended to primarily benefit users who request long-duration (multi-hour) observations that might get interrupted. Users who would prefer to get, say, 90% of the full observation rather than have the full request rescheduled (and thus drain more time from the allocation) can communicate this preference to the scheduler with the Acceptability Threshold.



**Configuration Repeats.** Configurations are the “outermost loop” for observations. If you want to repeat observations of different targets (see below) with different instrument configurations (see below) and subject to different observing constraints (see below), all within the same request, you would specify the number of repetitions here. The typical use case for repeating entire configurations is to “nod” the telescope between widely separated targets that must be observed within the same time window.

**Optimization Type.** A request's priority (assigned by the TAC) has the greatest effect upon scheduling, but the Optimization Type sends a preference to the scheduling software. The (default) **Time** option favors placing requests earlier in an observing window. The **Airmass** option favors placing requests at lower airmass (i.e. higher altitude) at the cost of a slightly lower overall chance of being completed.



**Mosaic.** An image mosaic consists of multiple exposures where the shift in position between exposures is less than the full FoV of the camera. Adjacent exposures overlap at their common edge, to create a "mosaic" or "map" of an extended target. The goal of a mosaic is to monitor targets in a similar environment, e.g. a stellar cluster or a nearby galaxy. Two pre-defined mosaics are available:

**Line.** Pointings advance along a line described by the *Number of Points* in the pattern, the *Point Overlap Percent* (in percent of the imager's field-of-view), and the *Orientation* of the line in degrees West of North. The *Center* parameter is a Boolean that indicates whether the science target should be at the start or the center of the line.

**Grid.** Pointings fill a rectilinear grid described by the *Point Overlap Percent* (in percent of the field-of-view in the DEC direction), *Number of Rows* (in the DEC direction), *Line Overlap Percent* (in the RA direction), *Number of Columns* (in the RA direction) and *Orientation* of the grid in degrees West of North. The *Center* parameter is a Boolean that indicates whether the science target should be at the first point or the center of the grid. An example of a Request for a Mosaic Grid is shown in Figure 3.

**Request**

Acceptability Threshold ?

Mosaic ?

Grid

⌵

Line Overlap Percent ?

Point Overlap Percent ?

Orientation ?

Number of Rows ?

Number of Columns ?

Center ?

True

⌵

Generate Mosaic

Figure 3. The Request section for a 3 x 2 mosaic, with rows overlapping by 33% of the field-of-view and columns overlapping by 10% of the field-of-view. The entire grid is rotated 45° west of north, and the mosaic is centered on the target.

Clicking on the “Generate Mosaic” button pops-up a window in which the offsets can be inspected and approved. Figure 4 shows the portion of the inspection window that displays the expected mosaic (from the parameters shown in Figure 3). If you click “OK” in the inspection window, the mosaic offsets are translated into separate Configurations (see below) for the Request. Thus, a dither pattern with 6 pointings will yield 6 Configurations.

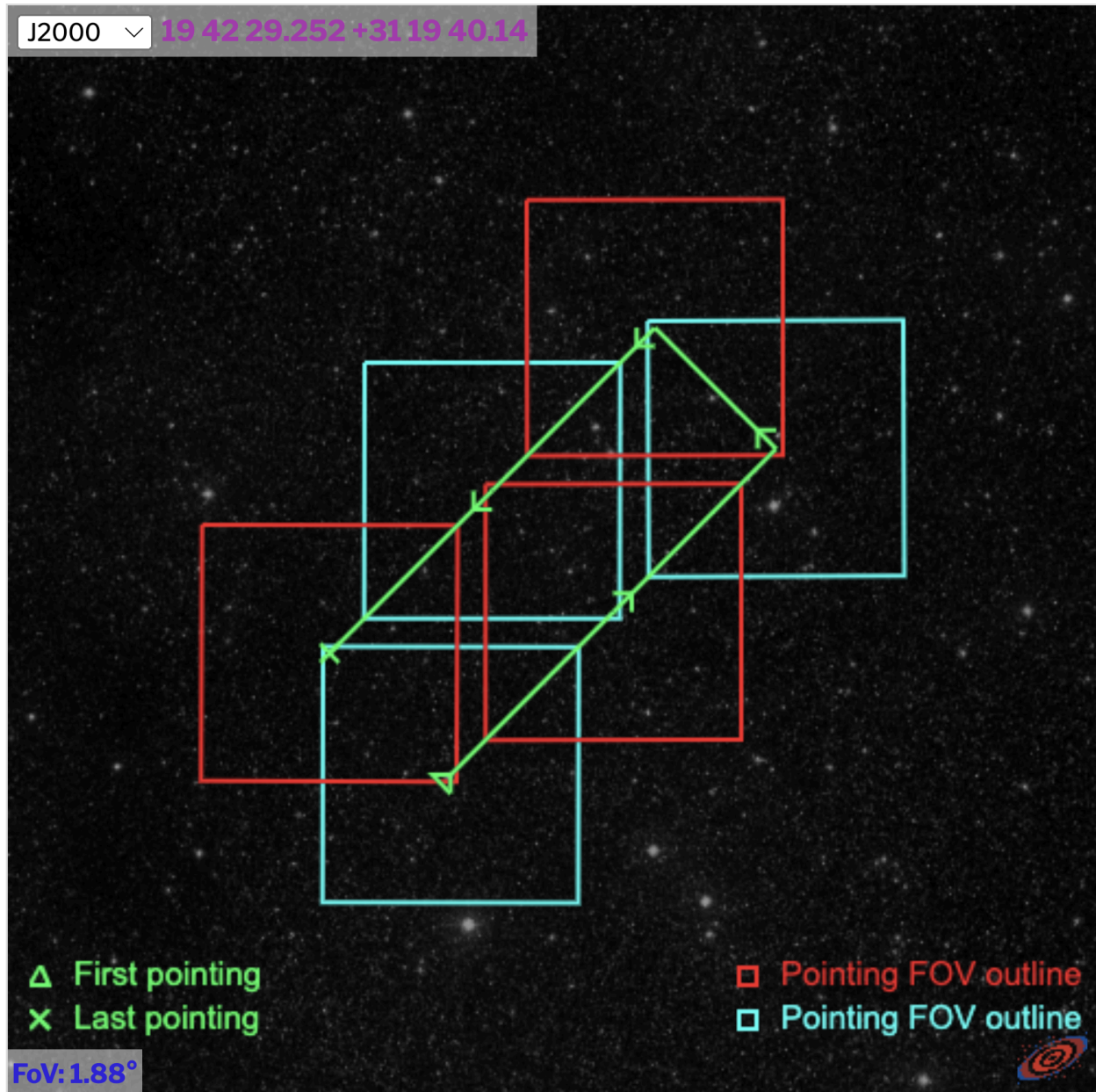


Figure 4. The mosaic created by the parameters shown in Figure 3. The cyan and red boxes represent the full FOV of a Sinistro imager.

## The Observation Request Form: Configuration

Instructions for where the telescope should be pointed, how the instrument should execute the exposures and other details should be entered in the Configuration section (Figure 5) and its three subsections: Instrument Configuration, Target, and Constraints.

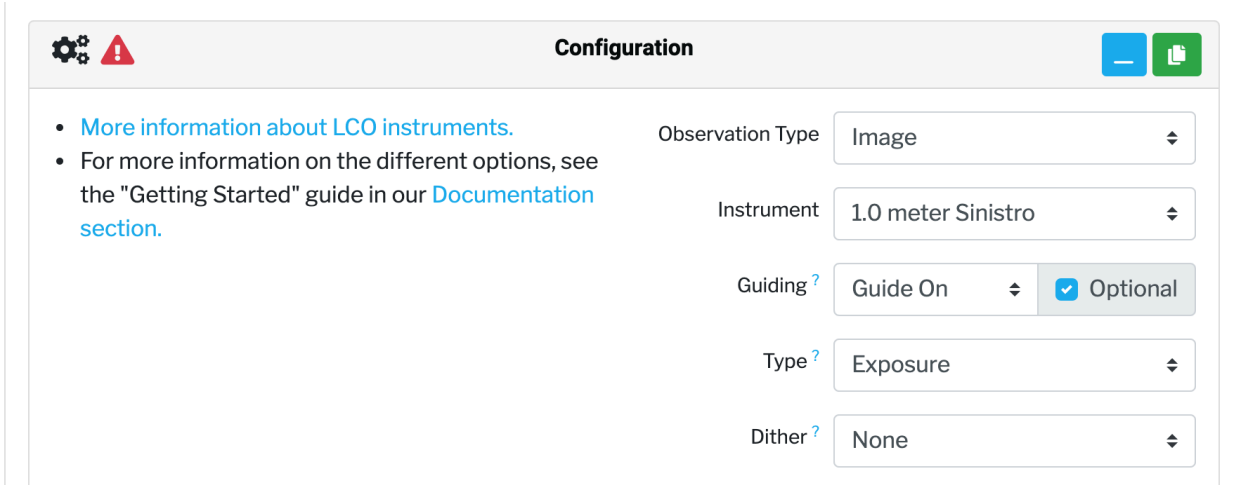


Figure 5. The Configuration section of the compose form when the Observation Type is set to Image.

**Observation Type.** The only options are Image and Spectrum.

**Instrument.** If you set the Observation Type to *Image*, then there are 5 options: 0m4 SCICAM QHY600, 1.0 meter Sinistro, 2.0 meter MuSCAT, Goodman Spectrograph BlueCam Imager, and Goodman Spectrograph RedCam Image. (The Goodman Spectrograph is on the 4.1 meter SOAR Telescope). If you set the Observation Type to *Spectrum*, then there are 5 options: 1.0 meter NRES, 2.0 meter FLOYDS, Goodman Spectrograph BlueCam, Goodman Spectrograph RedCam, and SOAR TripleSpec. Be careful to only select an instrument on the telescope class for which your proposal has been allocated time. If you select an instrument for which you have not been allocated time, your observation request will yield an error message that says, “You do not have sufficient time allocated on the resource you're requesting for this proposal.” In other words, you’ve been granted 0 hours for the instrument you’ve selected.

The appearance of each (sub)section will vary depending on whether your Observation Type is an *Image* or *Spectrum*. If you selected *Image*, then the basic options in the top-level Configuration section will be **Guiding**, **Type**, and **Dither**.

**Guiding.** LCO’s telescopes are equipped with guide cameras. (On the 0.4m telescopes, the science cameras are used to acquire guide images.) When a telescope “guides,” an algorithm compares consecutive guide camera images and corrects the telescope’s pointing so that the pattern of sources in the images matches within a specified tolerance. The most common reason for guiding to fail is that there are too few stars in the guide camera’s field-of-view. For observations with imagers, guiding is not essential, but for exposures longer than approximately 5 minutes, we recommend that observations be guided. If the **Guiding** parameter is set to *Off*, then a guide image is never acquired, and exposures are carried-out without guiding. If **Guiding** is set to *On*, then subsequent behavior depends on whether the adjacent Optional box is checked. If **Guiding** is set *Optional* (the default), then guiding is attempted, but the observation



is carried-out even if the pattern-matching algorithm fails. If **Guiding** is not *Optional*, then the pattern-matching algorithm *must be successful* for the exposure to be carried-out. [For FLOYDS and NRES observations, guiding is required for the spectrographs to acquire a target, so guiding is automatically set to *On* when the Instrument (in the Request section) is a spectrograph.]

**Type.** If the configuration type is set to *Exposure*, then the observation, as defined by the selections in the Instrument Configuration subsection, will be executed once. If the configuration type is set to *Exposure Sequence*, then the observation will be repeated, and a **Duration** parameter (see Figure 6) must be specified:

**Duration.** The period, in seconds, over which the Instrument Configurations are to be repeated. If the *Fill* button is clicked, the **Duration** is set to the longest interval over which the target is visible in the observing window. The start and end times of the observing window are specified in the Window section, further down on the form. The overheads for LCO instruments are listed in [Appendix B](#) below.

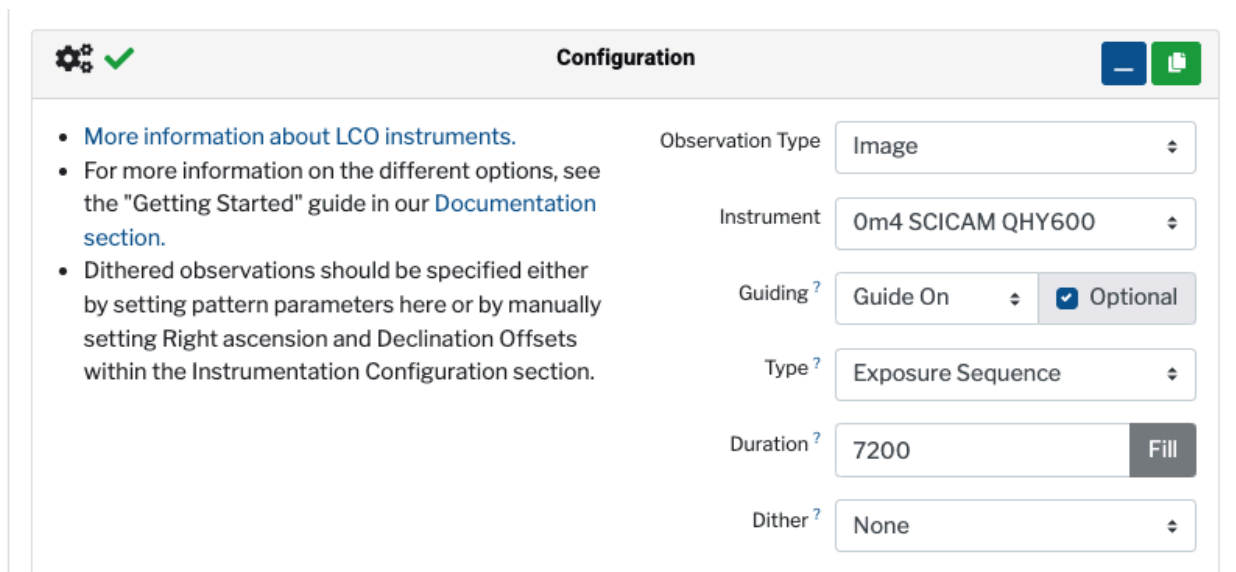


Figure 6. The Configuration section of the compose form when the *Exposure Sequence* type has been selected for an imager.

**Dither.** In dithered observations, the science target is placed on different pixels in each exposure in a series. The exposures can later be aligned and stacked so that artifacts (like hot pixels and charge persistence from bright stars) can be removed. Dithered observations can be specified in two ways: either by creating multiple Instrument Configurations at Offset positions (described in the Instrument Configuration section below) or by selecting a dither pattern and parameters in the Configuration section. Specifying a dither pattern also ultimately results in the creation of multiple Instrument Configurations.





Dithering is intended for small offsets from the base target. Offsets are limited to 40% of the telescope's guide camera's field-of-view. Three pre-defined patterns are available:



**Line.** Pointings advance along a line described by the *Number of Points* in the pattern, the *Point Spacing* in arcseconds, and the *Orientation* of the line in degrees West of North. The *Center* parameter is a Boolean that indicates whether the science target should be at the start or the center of the line.

**Grid.** Pointings fill a rectilinear grid of described by the *Point Spacing* (separations in the DEC direction), *Number of Rows* (in the DEC direction), *Line Spacing* (separations in the RA direction), *Number of Columns* (in the RA direction) and *Orientation* of the grid in degrees West of North. The *Center* parameter is a Boolean that indicates whether the science target should be at the first point or the center of the grid. An example of a Configuration for a Grid dither pattern is shown in Figure 7.

**Spiral.** Pointings follow a spiral centered on the science target described by the *Number of Points* in the spiral and the *Point Spacing* in arcseconds. After the first few pointings, the pattern approaches an Archimedean spiral with a radius that increases by approximately a *Point Spacing* factor with each loop.

**Configuration**

- [More information about LCO instruments.](#)
- For more information on the different options, see the "Getting Started" guide in our [Documentation section](#).
- Dithered observations should be specified either by setting pattern parameters here or by manually setting Right ascension and Declination Offsets within the Instrumentation Configuration section.

Observation Type

Image

Instrument

1.0 meter Sinistro

Guiding ?

Guide On

↕

☒ Optional

Type ?

Exposure

Dither ?

Grid

Point Spacing ?

15

Line Spacing ?

10

Orientation ?

10

Number of Rows ?

4

Number of Columns ?

2

Center ?

True

Generate Dither

Figure 7. The Configuration section for a 4 x 2 grid dither pattern, with row spacings (15 arcsec) greater than column spacings (10 arcsec). The entire grid is rotated 10° west of north.

Clicking on the “Generate Dither” button pops-up a window in which the offsets can be inspected and approved. Figure 8 shows the portion of the inspection window that displays the expected dither pattern (from the parameters shown in Figure 7). If you click “OK” in the inspection window, the dither pattern offsets will be translated into separate Instrument Configurations (see below) for the Request. Thus, a dither pattern with 8 pointings will yield 8 Instrument Configurations.

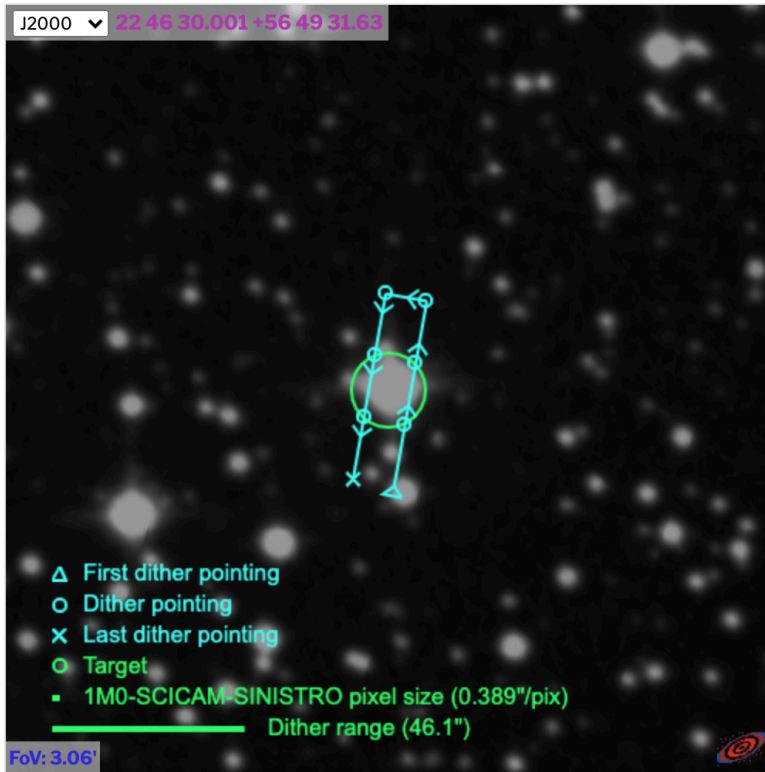



Figure 8. The pointing grid created by the dither parameters shown in Figure 7.

*Zoomed in to the dither pattern. The pixel size of 1M0-SCICAM-SINISTRO is 0.8% of the dither range.*



If the Observation Type is set to Image and the Instrument is set to 0m4 SCICAM QHY600, two additional options are revealed, as shown in Figure 9.

**Sub expose.** A Boolean to indicate whether the **Exposure Time** (set in the Instrument Configuration section, below) should be divided into sub-exposures. When the request is scheduled, the software controlling the instrument splits the observation into sub-exposures. The number of sub-exposures is determined by dividing the full **Exposure Time** by the **Sub exposure time**. If the full **Exposure Time** is not evenly divisible by the **sub exposure time**, then the final exposure will have a shorter exposure time than the others.

**Sub exposure time.** The minimum **Sub exposure time** is 15 s. The maximum is one-half of the full **Exposure Time**. We recommend a **Sub exposure time** no greater than 30 s.

 ✓

Configuration



- [More information about LCO instruments.](#)
- For more information on the different options, see the "Getting Started" guide in our [Documentation section](#).
- Dithered observations should be specified either by setting pattern parameters here or by manually setting Right ascension and Declination Offsets within the Instrumentation Configuration section.

Observation Type	<div style="border: 1px solid #ccc; padding: 2px 5px;">Image</div>
Instrument	<div style="border: 1px solid #ccc; padding: 2px 5px;">0m4 SCICAM QHY600</div>
Guiding ?	<div style="display: flex; align-items: center;"> <div style="border: 1px solid #ccc; padding: 2px 5px; margin-right: 5px;">Guide On</div> <div style="margin-left: 10px;"> <input type="checkbox"/> Optional         </div> </div>
Type ?	<div style="border: 1px solid #ccc; padding: 2px 5px;">Exposure</div>
Dither ?	<div style="border: 1px solid #ccc; padding: 2px 5px;">None</div>
Sub expose ?	<div style="border: 1px solid #ccc; padding: 2px 5px;">true</div>
Sub exposure time ?	<div style="border: 1px solid #ccc; padding: 2px 5px;">20</div>



Figure 9.

The justification for splitting long exposures into sub-exposures is the inadequate tracking performance of the 0.4 m telescopes over timescales of minutes. For details of the **Sub expose** option, as well as descriptions of sub-exposure guiding and stacking, please read the ["Stacking of DeltaRho/QHY600 Sub-exposures"](#) document.

If the Observation Type in the Configuration section is set to *Spectrum* and the Instrument is set to *2.0 meter FLOYDS*, it will look like Figure 10, with three Configuration parameters. Guiding was described above.

Configuration

- [More information about LCO instruments.](#)
- For more information on the different options, see the "Getting Started" guide in our [Documentation section](#).

### Calibration frames

We recommend that you schedule calibration frames with a spectrum type configuration. Click 'Create calibration frames' to add four calibration configurations to this request: one arc and one flat before and one arc and one flat after your spectrum.

Create calibration frames

Observation Type ▾  

Spectrum

Instrument ▾  

2.0 meter FLOYDS

Guiding ? ▾ ☐ Optional  

Guide On

Type ? ▾  

Spectrum

Acquire Mode ? ▾  

Target Coordinates Floyds

Figure 10. The Configuration section of the compose form when the Instrument is the FLOYDS spectrograph.

**Type.** FLOYDS exposures may be made either on a target in the telescope's field-of-view (the *Spectrum* option), on a Tungsten-Halogen filament lamp (the *Lamp Flat* option), or on a HgAr wavelength calibration lamp (the *Arc* option). Typically, the science and calibration spectra should be acquired in a series, with the science spectrum bracketed by flat and arc spectra. The Configuration parameters for all five of the spectra in this series (flat + arc + science spectrum + arc + flat) can be created by clicking on the "Create calibration frames" button on the left side of the Configuration section. FLOYDS spectra of science targets must be guided, so for the *Spectrum* option, *Guiding* must be *On*, and the *Optional* box cannot be checked.

To request multiple FLOYDS exposures on the target, the *Spectrum Sequence* option may be selected. In this case, spectra will be made, according to the parameters of the Instrument Configuration sub-section, until the **Duration** has elapsed. The **Duration** parameter works the same way as for an imaging observation: either it must be specified (in seconds), or the *Fill* button can be clicked to select the longest visibility interval within the observing window. Caution: for a *Spectrum Sequence*, the target will *not* be re-acquired between exposures.

**Acquire Mode.** When set to *Target Coordinates* (the default), the slit is centered on the position of the target. The alternative mode, *Brightest Object*, places the slit on the brightest object near the target coordinates, and one additional parameter must be specified:

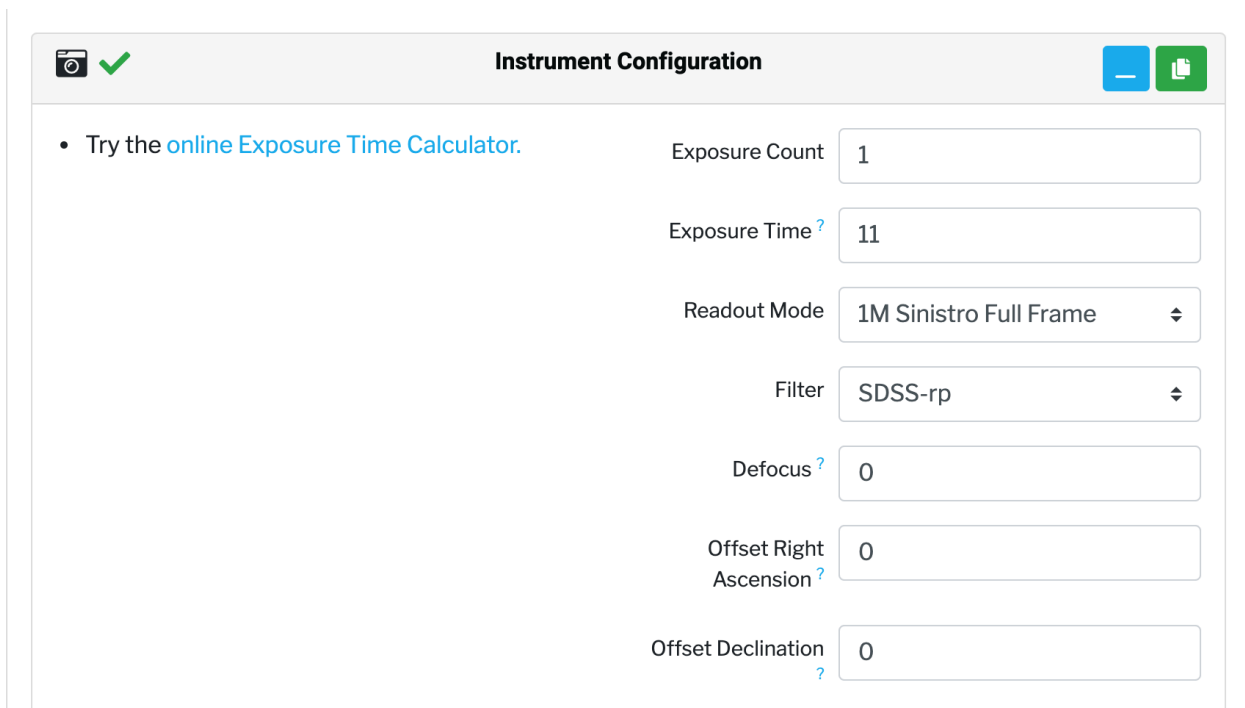
**Acquire Radius.** The radius (in arc-seconds) around the target coordinates within which to search for the brightest object.

If the Instrument in the Request section is set to *1.0 meter NRES*, the default Acquire Mode is to

place the pinhole on the brightest object in the guide camera's field-of-view. Only if the target doesn't meet certain brightness criteria is the pinhole placed according to a WCS solution to the guider image. Guiding cannot be optional for NRES science spectra.

## The Observation Request Form: Instrument Configuration

Instrument-specific instructions should be included in the Instrument Configuration section (Figure 11). The options vary, depending on whether the instructions are sent to an imager or a spectrograph. For all instruments, the **Exposure Count** and **Exposure Time** must be set.



The screenshot shows the 'Instrument Configuration' section of a web form. At the top, there is a header bar with a camera icon and a green checkmark on the left, the title 'Instrument Configuration' in the center, and a minus sign and a document icon on the right. Below the header, on the left side, is a bullet point: 'Try the [online Exposure Time Calculator](#).' To the right of this text are several input fields arranged vertically. Each field has a label to its left and a text input box to its right. The fields are: 'Exposure Count' with the value '1', 'Exposure Time' with the value '11' and a small blue question mark icon to its left, 'Readout Mode' with the value '1M Sinistro Full Frame' and a dropdown arrow icon to its right, 'Filter' with the value 'SDSS-rp' and a dropdown arrow icon to its right, 'Defocus' with the value '0' and a small blue question mark icon to its left, 'Offset Right Ascension' with the value '0' and a small blue question mark icon to its left, and 'Offset Declination' with the value '0' and a small blue question mark icon to its left.

Figure 11. The Instrument Configuration section of the compose form when the Sinistro imager is selected.

**Exposure Count.** The number of exposures to be made.

**Exposure Time.** The open-shutter time for each exposure, in seconds. The time does not include overheads. The minimum is 0.01s.

For single-channel imaging observations, in addition to the exposure count and duration, the **Filter** parameter must be set. Further options are **Defocus**, **Offset Right Ascension**, **Offset Declination**.

**Filter.** The desired filter for the exposure (or series of exposures). The pulldown menu displays only the filters available on the instrument chosen in the Configuration section. The set of filters for each instrument is uniform throughout the network. LCO's [filters page](#) lists which filters are

available on which instruments.


**Defocus.** Photometric observations of bright targets may be deliberately defocused to prevent the CCD from saturating. The **Defocus** parameter controls the offset of the telescope's secondary mirror from the optimal focus position. The units are millimeters. Typical offsets are 1.0-2.0 mm; offsets of 3mm (the limit) will transform point sources into rings.

**Offset Right Ascension, Offset Declination.** Requests for dithered observations may be created without invoking the pre-defined dither patterns in the Configuration section by creating multiple Instrument Configurations (see below) and setting offsets for each.



For observations with the 1.0 meter Sinistro imagers and 0.4 meter QHY600 imagers, the **Readout Mode** may be selected.

**Sinistro.** The default, *Full Frame*, uses the full (4K x 4K) field-of-view, and the pixels are not binned (1x1). The alternative, *Central 2x2k binned*, reads out the central 2K x 2K pixels and bins the pixels 2x2, resulting in a 1K x 1K pixel image.



**QHY600.** The default, *Central 30x30 arcmin*, reads out only the pixels in the central 30x30 arcmin square of the image. The alternative, *Full Frame Readout*, reads out the entire 1.9° x 1.2° field-of-view. For both readout modes, the pixels are not binned (1x1).

It is possible to request multiple Instrument Configurations within the same Configuration by clicking on the  (copy) symbol to generate multiple Instrument Configuration sections.

Observations with the 2.0 meter MuSCAT multi-channel imagers require that exposure times be set for each of the four ( $g'$ ,  $r'$ ,  $i'$ ,  $z_s$ ) channels (Figure 12). For a thorough description of the parameters associated with MuSCAT observations, consult the [“Getting Started with MuSCAT API & Portal Requests”](#) document.

Instrument Configuration

- Try the [online Exposure Time Calculator](#).

Exposure Count

Exposure Mode ?

Exposure Time g ?

Exposure Time r ?

Exposure Time i ?

Exposure Time z ?

Readout Mode

Diffuser r position

Diffuser i position

Diffuser g position

Diffuser z position

Defocus ?

Offset Right Ascension ?

Offset Declination ?

Figure 12. The Instrument Configuration section of the compose form for asynchronous MuSCAT observations.

**Exposure Mode.** In Synchronous mode, all channels begin exposing at the same times. In Asynchronous mode, each channel acquires exposures at its own pace.

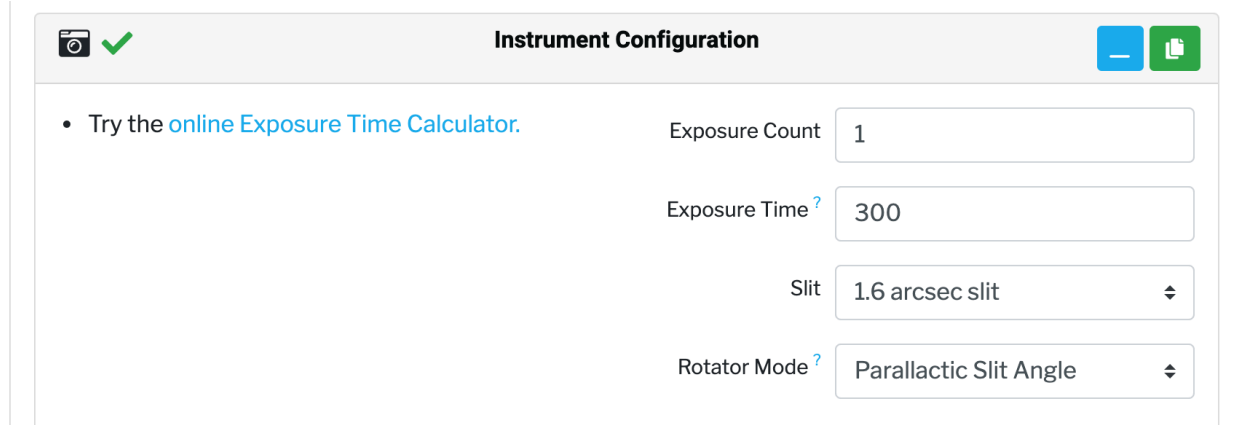
**Readout Mode.** In MuSCAT Fast Readout mode, the readout time is < 6 s. The penalty for the fast readout is a higher read noise (~12 e<sup>-</sup>). In MuSCAT Slow Readout mode, the readout time is



approximately 46 s, but the read noise is lower ( $\sim 3.5\text{ e}^-$ ). For more information, consult the [MuSCAT3 Release Notes](#).

**Narrowband position.** For photometric observations of bright targets, narrow-band filters can be inserted into the beam. For more information, consult the MuSCAT [Release Notes](#).

For FLOYDS spectra, the Filter and Defocus parameters are not applicable. Instead, the additional fields are the **Slit** and position, i.e. **Rotator Mode** (Figure 13).



The screenshot shows a web form titled "Instrument Configuration". At the top left is a camera icon and a green checkmark. At the top right are two buttons: a blue minus sign and a green plus sign. Below the title bar, there is a list item: "Try the [online Exposure Time Calculator](#)." To the right of this list item are four input fields:

- Exposure Count:** A text input field containing the value "1".
- Exposure Time:** A text input field containing the value "300".
- Slit:** A dropdown menu showing "1.6 arcsec slit".
- Rotator Mode:** A dropdown menu showing "Parallactic Slit Angle".

Figure 13. The Instrument Configuration section of the compose form for a FLOYDS spectrum.

**Slit.** FLOYDS North and South have identical sets of slits with widths that project to 1.2, 1.6, 2.0, and 6.0 arcseconds on the sky. For arc spectra, the default exposure time is 60 s, regardless of slit width. For flat spectra, the default exposure times are 70 s (1.2" slit), 50 s (1.6" slit), 40 s (2.0" slit), 15 s (6.0" slit).

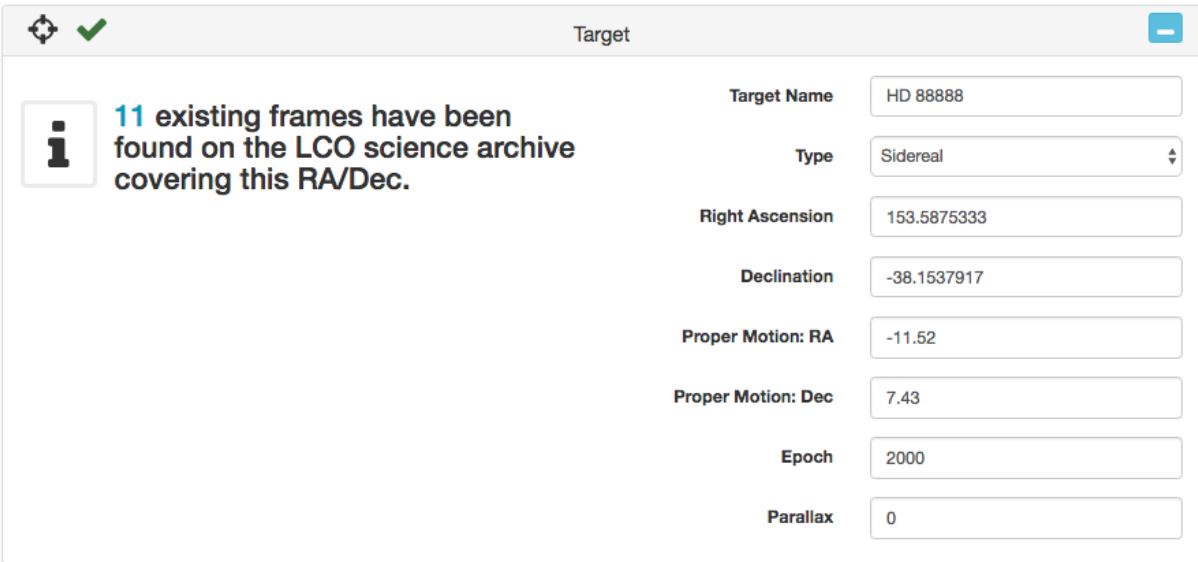
**Rotator Mode.** The default (and most-commonly used) mode is *Parallactic Slit Angle*, which places the spectrograph slit at the parallactic angle at the start of the exposure and maintains that angle for the duration of the exposure. Fixing the slit at the parallactic angle minimizes the effect of atmospheric dispersion. The other possible mode is *Slit Position Angle*; if selected, the following field appears:

**Rotator Angle.** The user-specified fixed angle of the spectrograph slit. The Position Angle of the slit is measured in degrees East of North and is fixed for the duration of the exposure.

If multiple Instrument Configurations are created within a FLOYDS Configuration, the **Rotator Mode** must be identical for all Instrument Configurations.

## The Observation Request Form: Target

Details about the target to be observed should be entered in the Target section of the composition form (Figure 14).






Target		
 <b>11 existing frames have been found on the LCO science archive covering this RA/Dec.</b>	Target Name	HD 88888
	Type	Sidereal
	Right Ascension	153.5875333
	Declination	-38.1537917
	Proper Motion: RA	-11.52
	Proper Motion: Dec	7.43
	Epoch	2000
	Parallax	0

Figure 14.

**Name.** The name may be anything, but if you enter a name that can be found in common astronomical databases, several of the subsequent fields will be populated automatically.

**Type.** The options are *Sidereal* or *Non-Sidereal*.

For **sidereal** targets, telescope pointing is determined according to the following parameters: Right Ascension, Declination, Proper Motion (in RA & DEC), Epoch, and Parallax. If parameters of known targets extracted from the database are out-of-date, they can be modified. Target coordinates are in the format HH:MM:SS.SS, +DD:MM:SS.SS. The Proper Motion terms are in units of milli-arcseconds per year, the Parallax term is in milli-arcseconds, and the Epoch is in Julian years.

Target

Name

C/2014 UN271

Type

Non-Sidereal

Scheme ?

MPC Comet

Epoch of Elements ?

59600

Orbital Inclination ?

95.43613

Longitude of Ascending Node ?

189.9106333

Argument of Perihelion ?

326.33338

Eccentricity ?

0.9993226

Perihelion Distance ?

10.9377938

Epoch of Perihelion ?

62891.4444

Fractional Ephemeris Rate ?

Figure 15.

For **non-sidereal** targets, a set of orbital elements must be specified, so the Target parameters section changes. The **Scheme** parameter is used to identify the target as either a Minor Planet, a Major Planet, or a Comet. LCO supports the set of elements given by the Minor Planet Center (MPC); these elements can be obtained from e.g. [http://www.minorplanetcenter.net/db\\_search](http://www.minorplanetcenter.net/db_search). Selecting the Non-sidereal **Type**, then either **MPC Minor Planet** (for asteroids), **MPC Comet** (for comets) or **JPL Major Planet** scheme, and then entering the designation for a comet or asteroid into the **Name** field, will query the selected database and fill out the form with the required elements (Figure 15). The Epoch of the elements must be given as a Modified Julian Date (MJD). For the **Minor Planet** scheme, the orbital elements are Orbital Inclination (in

degrees), Longitude of the Ascending Node (in degrees), Argument of Perihelion (in degrees), Eccentricity, Mean Distance (Semimajor Axis in AU), and Mean Anomaly (in degrees). For the **Major Planet** scheme, one additional element, the Daily Motion (in degrees), must be specified. For the **Comet** scheme, the Mean Distance and Mean Anomaly terms are replaced by the Perihelion Distance (in AU) and the Time of Perihelion passage (Epoch of Perihelion in Modified Julian Date). Care must be taken to differentiate the *epoch of the elements set*, which is normally given as a Julian Date rounded to the nearest multiple of 200 days (e.g. 2457400.5), and the *epoch of perihelion*, which is not rounded-up (e.g. T = 2457462.77852 JDT). Both the 'epoch JD' and 'perihelion JD' given by the MPC must be converted to Modified Julian Dates by subtracting 2400000.5, giving an epoch of elements of 57400.0 and an epoch of perihelion of 57462.27852 for the above examples.

**Fractional Ephemeris Rate.** For *non-sidereal* targets only, where the telescope will track the moving target, the user may enter a floating point number between 0 and 1 (inclusive) to control the fraction of the moving object rate that should be used for telescope tracking. This number is entered into the **Fractional Ephemeris Rate** field. Some possible options are:

- **1.0** (Target tracking; default): The telescope will track the moving target at the full rate of motion as predicted by the elements during the observation. Depending on the rate of motion and the length of the exposure, stars in the field will elongate into streaks, while the target will stay round.
- **0.5** (Half-rate): The telescope will track the moving object at half (0.5x) the rate of motion predicted by the elements. This will elongate both the target and the field stars equally but to a lesser degree than either the 1.0 or 0.0 options.
- **0.0** (Sidereal tracking): The telescope will not track the moving object and track the sky at the normal sidereal rate. Depending on the rate of motion and the length of the exposure, the target will elongate into a streak, while the stars in the field will stay round. This may be a desirable option for slow-moving (few arcseconds/hour) objects such as Trans Neptunian Objects.

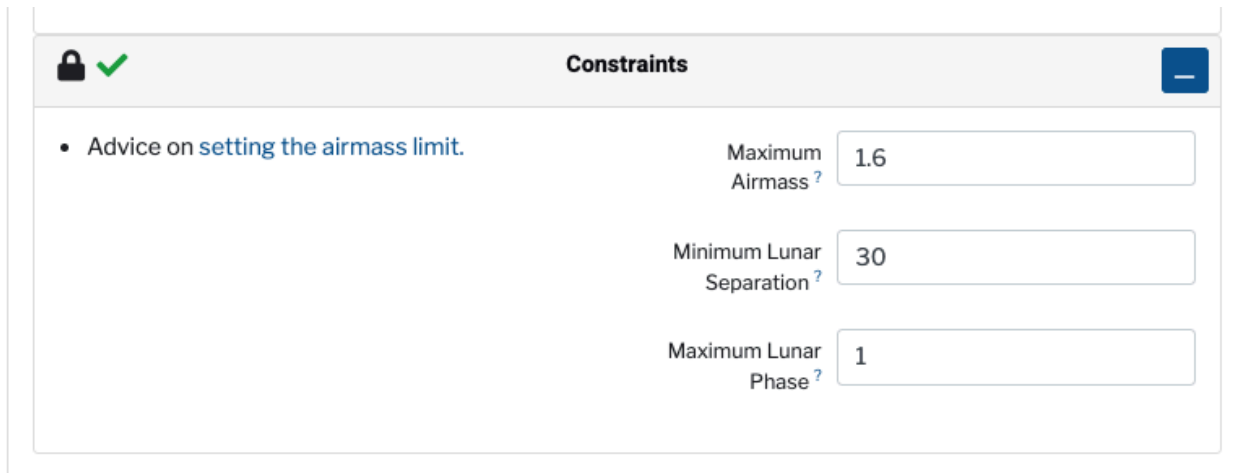
N.B. Observation Requests using a Fractional Ephemeris Rate other than the default value (1.0) allow for the possibility that the non-sidereal target will leave the field-of-view before the Request is complete. The likelihood depends on the on-sky motion of the non-sidereal target, how long the requested exposures will take, and the field-of-view of the requested instrument. **It is the responsibility of the user to determine whether this situation can occur for their targets and split their desired number of exposures among additional Configurations within the Observation Request.** (Including additional Configurations will trigger the telescope to recenter on the new predicted position once all the exposures in a Configuration are completed.) As an example, if a user wishes to observe a target moving at a rate of 60"/minute with the Sinistro instrument on a LCO 1m telescope (full field-of-view = 26') using the half-rate option, then the target will leave the field of view in:

$$(\text{half Sinistro FOV}) / \text{half rate} = 13' / (0.5'/\text{min}) = 26 \text{ minutes}$$

If the user wanted to observe this target for 60 minutes, they should break the total number of exposures in the Request into 3 Configurations.

## The Observation Request Form: Constraints

Opportunities for scheduling requests may be further influenced by imposing constraints, as shown in Figure 16.



The screenshot shows a web interface for setting observation constraints. At the top, there is a header bar with a lock icon and a green checkmark on the left, the title "Constraints" in the center, and a blue minus button on the right. Below the header, there is a list of constraints. The first item is "Advice on [setting the airmass limit](#)." followed by three input fields: "Maximum Airmass" with a value of 1.6, "Minimum Lunar Separation" with a value of 30, and "Maximum Lunar Phase" with a value of 1. Each input field has a small question mark icon next to its label.

Figure 16. The Constraints section of an observation request.

**Maximum Airmass.** The maximum acceptable airmass at which the observation can be scheduled. A plane-parallel atmosphere model is assumed, so the airmass is the secant of the zenith angle. The default limit is 1.6, which corresponds to approximately 38.7 degrees above the horizon. The telescopes can track targets at 15 degrees above the horizon (airmass ~3.86). The 1-meter and 0.4-meter telescopes have Hour Angle limits of 4.6 hours east and west; the 2-meter telescopes have Alt-Az mounts, thus no hour angle limits.

**Minimum Lunar Separation.** The minimum acceptable separation angle between the target and the moon. The default limit is 30 degrees, independent of lunar phase. Observations will only be scheduled when the target is further from the moon than this limit.


**Maximum Lunar Phase.** The lunar phase constraint can be set between 1.0 (full moon, the default) and 0.0 (new moon, not recommended). Observations will only be scheduled during nights/hours when the lunar phase is less than this limit.

Decreasing the maximum airmass or increasing the minimum lunar separation shortens the time window for the observation, thus decreasing the opportunities to schedule the observation. Ultimately, the constraints you choose should strike a balance: strict enough to ensure that the data have satisfactory quality, and lenient enough to ensure that the observations can be scheduled. For advice on setting the maximum airmass, read the [Airmass Limit webpage](#) on the

LCO website.

## The Observation Request Form: Window

The final section of the form that must be completed before the request can be submitted describes the time window within which the observation should be made. An example is shown in Figure 17. The Scheduler will determine the rise and set times of the target for each available telescope within the time window. In general, an observation is scheduled at the earliest possible time. If an observation fails (due to, for example, bad weather or a technical malfunction), it is automatically rescheduled on another telescope at another time within the time window.

If the exact time of an observation is not critical (for example, to make an occasional measurement of the brightness of a target), create a single large time window. If, however, exact timing is critical (for example, to observe the ingress of an exoplanet transit), the time window must be made sufficiently narrow. It's also possible to request multiple time windows for the same observation by clicking on the  (copy) symbol to generate multiple Window sections. New **Start** and **End** times can be set for each new window. *In general, specifying a larger time window gives the Scheduler more opportunities to place the observation. Conversely, a narrow time window may restrict the observation to a single site or may even make it unschedulable.* Regardless of its duration, a time window must always include sufficient time for the observation itself *plus* the mechanical and software overheads. A description of the overheads associated with LCO observations, as well as example calculations, are presented in [Appendix B](#).

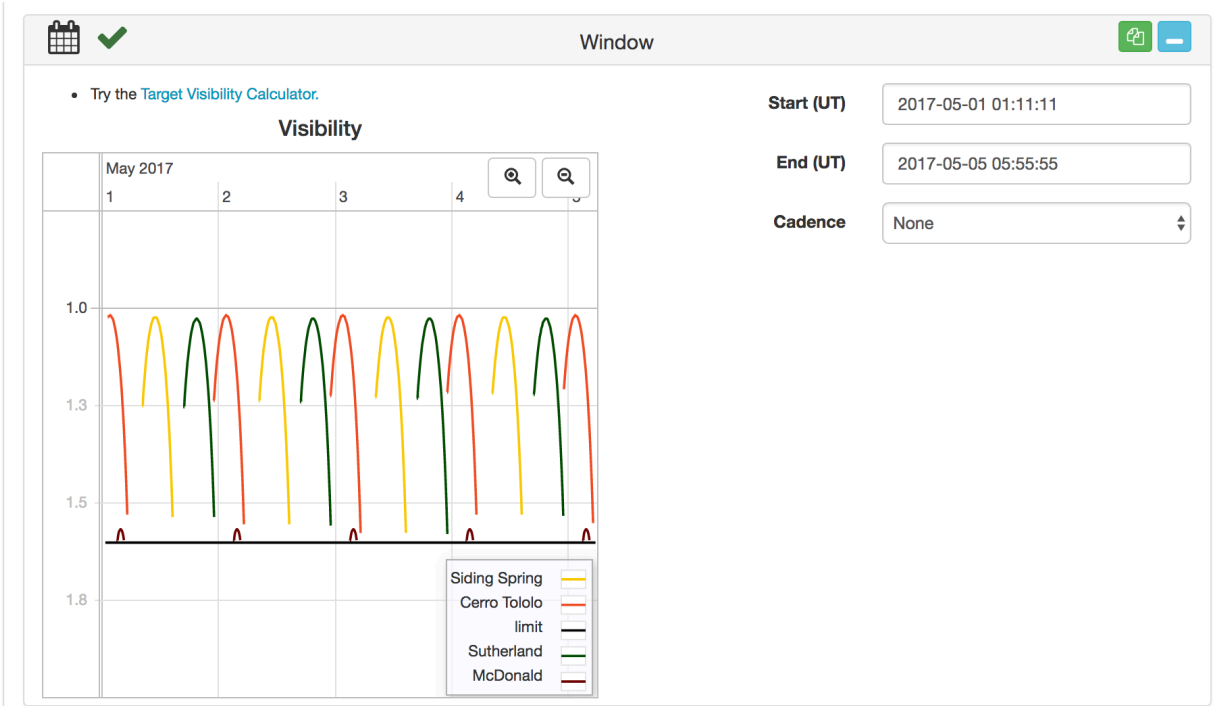


Figure 17.

**Start (UT).** The time at which the observing window opens. The start time can be specified either by writing it out (format = YYYY-MM-DD HH:MM:SS) or by selecting the date and the hour and minute from the pop-up calendar and clock. Times are in UTC, so no time zone conversion is necessary.

**End (UT).** The time at which the observing window closes.

It is advantageous for many science programs to observe a target repeatedly with an (approximately) fixed interval between observations. Rather than requiring users to create multiple time windows, the portal offers the **Cadence** feature. A cadence with a *Simple Period* is the only type currently supported. We plan to make other cadences available as science programs require them.

**Cadence.** When set to *None*, only a single observation (as described in the Configuration section) is carried out within the time window. Setting **Cadence** to *Simple Period* allows you to request multiple observations within the time window by specifying two new parameters:

**Period.** The time interval (in decimal hours) between individual observations, i.e. how often the observation should be rescheduled.

**Jitter.** The dispersion (in decimal hours) around the period during which it's acceptable to schedule the observation. The jitter must be long enough to contain one observation request, including overheads.

Observations will be scheduled every  $(\text{Period} \pm \text{Jitter}/2)$  hours. For example, if the **Period** of the cadence is set to 18 hours and the **Jitter** to 4 hours, each observation may be scheduled to start as many as 2 hours before or 2 hours after the strict 18-hour period. Thus, the spacing between two successive observations may be as small as 16 hours or as great as 20 hours. Note: the *first* observation will have a window with a duration of  $\text{Jitter}/2$ , i.e. half the duration of the others, because the Jitter can't extend the window before the initial **Start (UT)** time.)

Clicking on the **Generate Cadence** button will produce a window (Figure 18) which shows blocks representing all of the time windows in the cadence. Depending on the phase offset between solar rise/set times and the cadence period, some of the windows may become too short for the observation and overheads to fit. These particular windows will be omitted from the cadence. If the cadence represented by the blocks is accepted, then the single request on the compose form will be replaced by a series of sub-requests (and affiliated sub-sections), one for each of the numbered blocks in the time window. The Start and End times of the overall time window vanish; the Window section for each sub-request in the series will have its own Start and End time. Parameters describing each sub-request in the series can be modified before the overall series of requests is submitted.

Generated Cadence

The blocks below represent the windows of the requests that will be generated if the current cadence is accepted. These requests will replace the current request.


Press cancel to discard the cadence. Once a cadence is accepted, the individual generated requests may be edited.

1	2	3	4	5	6
	Mon 1 May 2017	Tue 2	Wed 3	Thu 4	


Cancel
Accept



Figure 18.

## Features of the Observation Request Form



Any section on the request form (General Information, Request, Configuration, Instrument Configuration, Target, Constraints, Window) may be collapsed by clicking on the  in the upper-right corner of the section. When a section is collapsed, all values are arranged horizontally rather than vertically, allowing more of the compose form to be shown on screen. To





expand a section again, click on the  appropriate for that section.


The contents of any section can be copied by clicking on the  symbol in the upper-right corner. All of the values in the original section will be duplicated in a new section with an incremented index number. For example, if you've completed the Instrument Configuration section to request three 22-second exposures with the Bessel-V filter, and you want to add three 22-second exposures with the Bessel-I filter (on the same target, within the same time window), you simply click the  icon in the Configuration section, and then select Bessel-I in the section labeled Configuration #2.


If you want to remove a duplicated section, click on the  button.


On the right edge of the page is an index of the sections in the compose form. (The index can be hidden by clicking . The section of the form on which you're currently working, i.e. where the cursor is located, is highlighted in blue. More importantly, if there is a problem with your request (and it therefore cannot be submitted), the index will show a  next to the section with the error. Moving the cursor to the problem section will cause an error message to be displayed in red. Common reasons why a request may not be valid are:


1. The target is not above the telescope's horizon limit during the time window;
2. The proposal does not have time allocated on the resource requested (for example, a request for an observation on a 2-meter telescope for a proposal that's only been granted 1-meter hours);
3. The requested observation requires more time than the proposal has remaining in its allocation;
4. The observing constraints are too restrictive (for example, the minimum lunar separation angle is set to 90 degrees, but the target will always be closer to the moon than this during the time window).

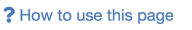
When the request is valid, then all fields in the index will have  next to them, and the request can be sent to the Scheduler by clicking  at the top-right corner of the compose form. After a request has been submitted, it can no longer be edited. Canceling the request must be done by selecting it from the list of submitted requests (see below).

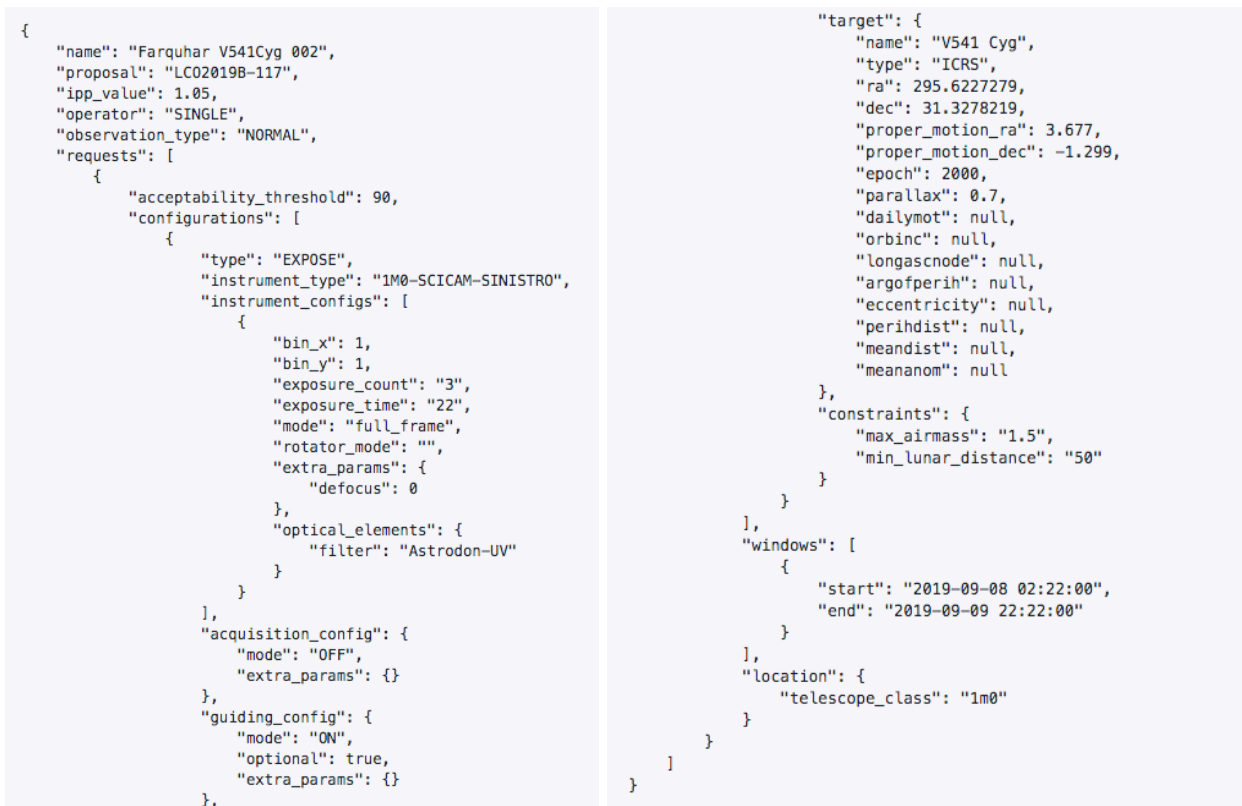
An observation request can be saved at any time during the composition process by clicking the  button. Only the General Information section (Title and Proposal) must be filled out to save a draft. The draft does not have to be error-free.

The  button clears the entire form. This feature can be useful after you've loaded a draft (to see how you've done a particular observation before) but then decide you want to "start fresh" on a new target.

Clicking on the  tab will show you what an observation request looks like in JSON format (see Figure 19). This is the code that is sent to the Scheduler when the submit button is clicked. Many experienced LCO users obviate the Portal's user interface by writing their own code to generate requests in JSON format and submit them through LCO's web service API. All LCO users, but especially PIs of large programs, are encouraged to read the documentation describing the request service API, beginning with the [Data Format Definition](#).

Clicking on the  tab will show you a list of your draft observation requests. Submitted requests are removed from the Drafts list.

The  tab provides general information on the Compose Form, the API View and draft requests.



```
{
  "name": "Farquhar V541Cyg 002",
  "proposal": "LC02019B-117",
  "ipp_value": 1.05,
  "operator": "SINGLE",
  "observation_type": "NORMAL",
  "requests": [
    {
      "acceptability_threshold": 90,
      "configurations": [
        {
          "type": "EXPOSE",
          "instrument_type": "1M0-SCICAM-SINISTRO",
          "instrument_configs": [
            {
              "bin_x": 1,
              "bin_y": 1,
              "exposure_count": "3",
              "exposure_time": "22",
              "mode": "full_frame",
              "rotator_mode": "",
              "extra_params": {
                "defocus": 0
              },
              "optical_elements": {
                "filter": "Astrodon-UV"
              }
            }
          ],
          "acquisition_config": {
            "mode": "OFF",
            "extra_params": {}
          },
          "guiding_config": {
            "mode": "ON",
            "optional": true,
            "extra_params": {}
          }
        }
      ]
    }
  ],
  "target": {
    "name": "V541 Cyg",
    "type": "ICRS",
    "ra": 295.6227279,
    "dec": 31.3278219,
    "proper_motion_ra": 3.677,
    "proper_motion_dec": -1.299,
    "epoch": 2000,
    "parallax": 0.7,
    "dailymot": null,
    "orbinc": null,
    "longascnode": null,
    "argofperih": null,
    "eccentricity": null,
    "perihdist": null,
    "meandist": null,
    "meananom": null
  },
  "constraints": {
    "max_airmass": "1.5",
    "min_lunar_distance": "50"
  },
  "windows": [
    {
      "start": "2019-09-08 02:22:00",
      "end": "2019-09-09 22:22:00"
    }
  ],
  "location": {
    "telescope_class": "1m0"
  }
}
```

Figure 19. An example of the “API view” of a simple observation request.

## Results of Submitted Observation Requests

After an observation request is submitted, it's re-displayed in a compact form (Figure 20). The

full details can be viewed again by clicking on the (blue) request ID number. The Options button in the upper-right corner can be used to either cancel the request, so that it is no longer considered by the Scheduler, or duplicate the request, so that it can be used as a template for another observation.

## Farquhar V541Cyg 001

Tracking # 393664

State	Last Update	Submitted	Proposal	Submitter	IPP	Options
 PENDING	2017-04-27 17:53:28	2017-04-27 17:53:28	LCO2017AB-116	nvolgenau	1.05	Options -

Sub-requests			
# 1064393	 PENDING ⌚ Duration: 288 seconds ⌚ Fail Count: 0	 PENDING 📅 2017-04-27 17:53:28	<a href="#">View in API</a> No scheduling information found

Figure 20.

All of the submitted requests, for which the user is the PI or a Co-I, are listed on the user's home page. An example of (the top of) a list of submitted requests is shown in Figure 21. Each entry on the list displays the following:

- the Title;
- the ID of the user who submitted the request (👤);
- the ID of the proposal for which the request was made (👥);
- the status of the request: PENDING, CANCELED, SCHEDULED, COMPLETED, or WINDOW\_EXPIRED;
- the time when the request was submitted (📅);
- and columns showing the number of sub-requests submitted, pending, failed, and completed.

To search for a particular request, click on the “Filter List” button in the upper-right. The window that pops up (Figure 22) allows you to refine the request list according to various filters:

- the State of the request (PENDING, SCHEDULED, etc.) to include or exclude;
- words included in the request Name;
- words included in the Target Name;
- the Proposal for which the request was made;
- the Semester for which the request was made;
- the date and time at which the request was submitted;
- the ID of the user who submitted the request.

## Submitted Observation Requests

Filter List

























User Info	State Info	# Requests / Pending / Failed / Complete			
<b>Gaia17awv</b>  roger_pickard  FTPEPO2014A-004	 COMPLETED  2017-04-03 15:24:09	1	0	0	1
<b>MWSC 3301</b>  roger_pickard  FTPEPO2014A-004	 COMPLETED  2017-04-03 15:03:26	3	0	0	3
<b>Berkeley 86</b>  roger_pickard  FTPEPO2014A-004	 COMPLETED  2017-04-03 14:40:36	3	0	0	3
<b>IC4603</b>  malcolm_beckford  FTPEPO2014A-004	 COMPLETED  2017-04-03 13:59:16	1	0	0	1
<b>NGC 3521</b>  ole_ahlgren  FTPEPO2014A-004	 COMPLETED  2017-04-03 11:41:58	1	0	0	1
<b>M60</b>  ole_ahlgren  FTPEPO2014A-004	 COMPLETED  2017-04-03 20:57:50	1	0	0	1

Figure 21.

When a particular request has been found, clicking on the request's Title opens a new page like Figure 20. Then, clicking on the (blue) request ID number reveals the full details of the scheduling and execution of that request, broken down into four tabs: **Details**, **Scheduling**, **Visibility**, and **Data**.

**Details** Tab. A compact display of the parameters entered into the observation request form: target coordinates, time window, constraints, etc.

**Scheduling** Tab. A plot of the history of the times when the request was inserted into the network schedule. If the request has not yet been (or was never) scheduled, the plot will be blank. *The presence of a bar of any color indicates that the request was scheduled.* Each row of the plot shows the result of one run of the scheduling software. A new row is displayed, with its corresponding run number, only when the status of a scheduled request changes, i.e. it is scheduled with a new location or time. The length of a bar shows the duration of the observation request. The color of a bar indicates the status of the scheduled request (Figure 23). The status 'Superseded by a new schedule' (gray) indicates the normal operation of the scheduler to

Sort

State

PENDING

COMPLETED

FAILURE\_LIMIT\_REACHED

Exclude State

PENDING

COMPLETED

FAILURE\_LIMIT\_REACHED

Name Contains

Name contains

Target Name Contains

Target Name Contains

Proposal

Semester

Submitted After (Inclusive)

mm/dd/yyyy

Submitted Before (Inclusive)

mm/dd/yyyy

Username Contains

Username Contains

Filter Results

Clear All Fields

reschedule all pending blocks after each run. Observations marked as ‘Not Attempted’ (olive) did not start (for example, because of an interruption for bad weather) within 10 minutes of their scheduled start times and were removed from the schedule. The removal prevents observations which cannot meet their completion criteria from starting and clears the schedule for observations that can complete successfully. The ‘Not Attempted’ observation is immediately eligible for rescheduling.

**Visibility Tab.** The *top* plot shows the visibility of the target at the eligible Network sites over the duration of the observing window. Visibility is shown as the change in airmass of the target with time, and each site is coded with a different color. “Eligible” sites are those that have the type of telescope (e.g. 2-meter) or instrument (e.g. Sinistro) requested by the user. Only telescopes with visibility above the airmass limit of the request (default = 1.6), and within the window of the request, are shown. The *bottom* plot shows the status of each eligible telescope over the duration of the observing window. The condition of each telescope is indicated by a color (Figure 24). The time when a request was actually carried out is coded in green.

Figure 22. Request filtering options.

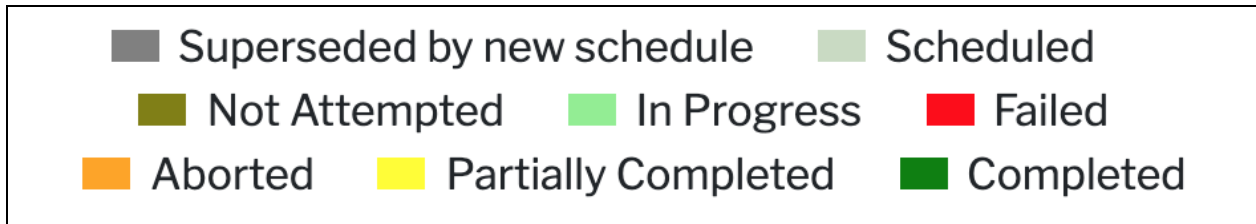


Figure 23. Scheduled observation history legend.

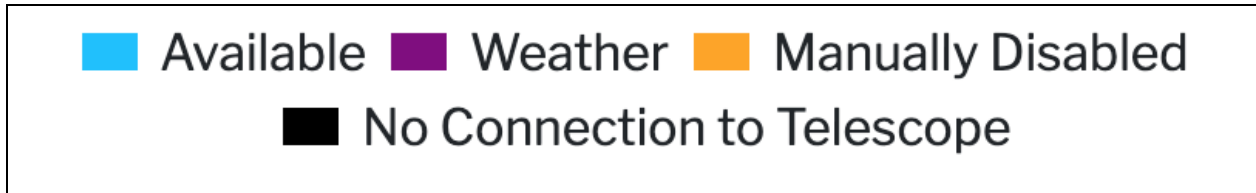


Figure 24. Telescope Status Legend

**Data Tab.** A list of the files, observing times, filters, and corresponding reduction statuses of all of the observations made as a result of the request (see Figure 25). The data can be downloaded directly from this page, without having to search in the Science Archive. Most users will click the “Download Selected” button after selecting the subset of files for which the reduction status is “reduced”.

**# 1056375**

⌚ Duration: 482 seconds

⌚ Fail Count: 0

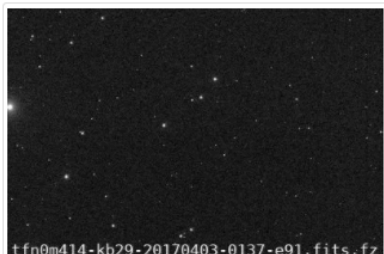
✓ COMPLETED

📅 2017-04-04 00:17:15

🔗 View in API

📄 Download

Details



Click a file in the data table to preview

Scheduling      Visibility      Data

✓ Download Selected

📄 Download All

➔ View on Archive

filename	DATE_OBS	filter	obstype	Reduction
<input type="checkbox"/> tfn0m414-kb29-20170403-0134-e00.fits.fz	2017-04-03 17:00:44	B	EXPOSE	raw
<input type="checkbox"/> tfn0m414-kb29-20170403-0134-e91.fits.fz	2017-04-03 17:00:44	B	EXPOSE	reduced
<input type="checkbox"/> tfn0m414-kb29-20170403-0135-e00.fits.fz	2017-04-03 17:02:25	B	EXPOSE	raw
<input type="checkbox"/> tfn0m414-kb29-20170403-0135-e91.fits.fz	2017-04-03 17:02:25	B	EXPOSE	reduced
<input type="checkbox"/> tfn0m414-kb29-20170403-0136-e00.fits.fz	2017-04-03 17:04:14	V	EXPOSE	raw
<input type="checkbox"/> tfn0m414-kb29-20170403-0136-e91.fits.fz	2017-04-03 17:04:14	V	EXPOSE	reduced
<input type="checkbox"/> tfn0m414-kb29-20170403-0137-e00.fits.fz	2017-04-03 17:05:25	V	EXPOSE	raw
<input type="checkbox"/> tfn0m414-kb29-20170403-0137-e91.fits.fz	2017-04-03 17:05:25	V	EXPOSE	reduced

Showing 1 to 8 of 8 rows

Figure 25. Data download options.

## Interactions with the Scheduler

If the state of a request is PENDING, it does not mean that the observation is currently underway. It means that not all observations created as a part of that request have reached a final state.

Any submitted requests that haven't reached a final state (WINDOW\_EXPIRED or COMPLETED) can be canceled. Canceled requests can be copied, modified, and resubmitted.

If an observation is started but not completed, the request has failed, and the Scheduler will try to reschedule the entire observation again (if the time window hasn't closed). The rescheduling will be attempted *whenever the acceptability threshold is not met*, and will be repeated until either the acceptability threshold is met (i.e. the request is completed successfully) or the time window closes. Time is deducted from a science project's allocation every time a request is attempted, not when it's successfully completed. It is clearly in a user's interest to make sure that all requested exposures plus overheads (see Appendix B) can be completed in the time window. Users are also encouraged to monitor the status of their requests, and if they receive enough data for a request that fails, they can cancel the request and prevent further attempts.

## Managing proposals

To see a list of all of the proposals for which you are the principal investigator (PI) or a co-Investigator, click on the "Manage Proposals" link in the header. The default display shows your "active" proposals, i.e. the proposals for which you may currently submit observation requests. You can switch to displaying "inactive" proposals (or all proposals), or proposals for a particular semester, using the drop-down menus in the upper-right corner, and then clicking the "Filter" button.

To see the summary of a particular proposal, click on the proposal code in the list. You can also get to the summary by clicking on the proposal code (🔗) in the list of Submitted Observation Requests. The summary (Figure 26) displays the following information:

- proposal code;
- title;
- abstract;
- name and email of the PI;
- number of observation requests submitted for this proposal;
- number of hours used, broken down by semester, telescope class, and observation type;
- number of IPP hours still available (see [Appendix A](#)), also broken down by telescope class.



If you are the PI of the proposal, then you will also see a list of the names and email addresses of all Co-Is.

## NOAO2017AB-015 Physical Properties of Near Earth Asteroids

For over 15 years there has been clear evidence for an asteroid spin barrier, where asteroids larger than 150 m in diameter ( $H=22$ ) do not rotate faster than 11 rev/day ( $P=2.2$  hours). However, the asteroid population near the spin barrier has not been well studied because these objects are fainter than what the amateur community can typically observe. Additionally, until recently, there has not been enough meter-class telescope time available to conduct a large scale population study. This proposed work will almost double the number of quality rotational studies of asteroids between  $H=20$  (300 m) and  $H=23$  (100 m). The LCO network provides a unique opportunity to provide physical characterization of medium sized near Earth asteroids soon after discovery. While the discovery rate of these asteroids will greatly increase with LSST, the window available for their characterization will remain unchanged. Therefore, an infrastructure like the one proposed here is required to be able to process LSST alerts in real time and submit time domain observations.

### Total Observation Requests: 9

Semester	Telescope Class	Hours	Used/Allocated
2017AB			
	1m0		
		Standard	8.8/20.0
		Rapid Response	0/0.0
		IPP	Available: 10.0 Limit: 20.0
	2m0		
		Standard	0/20.0
		Rapid Response	0/0.0
		IPP	Available: 1 Limit: 2.0

Figure 26.

In the upper-right corner of the proposal summary page is a box labeled “Notifications enabled.” By checking the box and then clicking the “Save” button, you will receive an email every time an observation for this proposal is completed. [To enable notifications for **all** proposals for which you are a PI or co-I, you must click the “Notifications enabled” checkbox on your portal Profile page.]



## Pipeline processing and access to data products

The raw data from the telescopes are transferred to LCO's archive in the Amazon Cloud and immediately processed through the [BANZAI](#) pipeline, which performs the standard steps to produce a reduced data set. In addition to an instrumental-signature-removed image, BANZAI produces an object catalog of detected sources and a bitmap image. These data, along with the master calibration frames that are produced by the pipeline, are available for download from the [LCO Science Archive](#). Data from the NRES spectrographs are processed through the [BANZAI-NRES pipeline](#), which extends the BANZAI framework to NRES data.

Data from the FLOYDS spectrographs are processed through a separate [FLOYDS pipeline](#).

Data taken on the LCO Network is normally proprietary for 1 year from time of observation. This means that all users of a proposal will need to be registered with the Science Archive (which will be handled by LCO, based on the proposal information received) and be logged into the archive in order to see, manipulate, plot, and download data.

To access their data, users should open a link to the [Science Archive front page](#) in a separate tab in their browser and login with their email address and password. Once logged in, users can search for datasets using the archive front page - more detailed instructions are given in the archive [Users Guide](#). Alternatively, once logged into the archive, users can return to the Observation Portal and use the 'Image Archive' links to jump to the specific set of images for their observations on the LCO network.

## Getting Additional Support

Clicking on the "Help" link in the header takes you to an overview of the Portal, that includes many hyperlinks to various pages within the Portal itself and on the LCO website. The most important link on that page is the one at the bottom labeled "Email Science Support." Clicking on that button will open a compose page in your native email application.

To report a bug, make a suggestion, or ask a question, please send an email to LCO's Science Support team at [science-support@lco.global](mailto:science-support@lco.global). You should receive an acknowledgment of your email within 24 hours (on business days). *If you want to point out a problem with a particular observation request or a particular image, please include your proposal code and the tracking ID number of the observation request in your email.*

## Appendix A: Intra-/Inter-Proposal Priority Factor

Users have the ability to adjust the priority of their requests so that they have some control over the outcome. This is known as the Intra-/Inter-Proposal Priority (IPP), and it is controlled by a single multiplicative number (the IPP Factor) that is applied to each request. Over a semester, the increases and decreases have to average out, and the quantitative degree of change in priority is such that this value is mostly beneficial to users who have large target lists with a range of internal priority levels. A comprehensive explanation of how IPP works is given in the document [“Increased Flexibility for Prioritizing Targets at LCOGT”](#) by Iair Arcavi.

Allowed values for IPP are between 0.5 (decreasing a request’s priority by a factor of 2) and 2.0 (increasing a request’s priority by a factor of 2). For bookkeeping reasons, the default value is 1.05. The maximum and minimum value allowed will change as different IPP values are applied to requests during the semester to ensure that a proposal’s priority averages to the value it received from its TAC review.

Users who don’t want to tangle with the IPP Factor can just leave it at its default value.

## Appendix B: Observation overheads

Most observations will not need to consider overheads. It’s good practice to create time windows that are sufficiently long to cover your observations. *The system does not deduct time based on the duration of a window, only by the duration of the actual observations made.*

However, if your observation requires a finite window (for example, a NEO passing into sunlight from behind the Earth), the start and end times must be set so that the time window accommodates the exposure times plus overheads.

The term “overhead” refers to the time required to set up for and complete an observation request. The minimum duration of a time window is the exposure time plus overhead. Calculating the overhead can be complicated; it depends on how complex a request is and how far the request is broken down by the Scheduler. **Note:** Exact overhead provisions are managed programmatically and are subject to change as equipment, processing, and other factors change.

The overheads for LCO’s instruments are as follows:

### 2.0-meter / MuSCAT imager in SLOW readout mode

Per-pointing setup time for slewing, etc.	180 sec
Per-configuration overhead	30 sec

Plus per-frame readout	
1x1 binning	46 sec
Plus per-frame overhead time	0 sec
<b>2.0-meter / FLOYDS spectrograph</b>	
Per-pointing setup time for slewing, etc.	120 sec
Acquisition time	90 sec
Configuration change overhead for FLAT	60 sec
Configuration change overhead for ARC	100 sec
Configuration change overhead for SPECTRUM	0 sec
“Per-molecule” (software) overhead	16 sec
(SPECTRUM+ARC+FLAT = 3 molecules)	
Exposure times (60 sec default for ARC, default for FLAT varies with slit width, X sec for SPECTRUM)	
Plus per-frame readout (1x1 binning)	25 sec
Plus per-frame overhead time	1 sec
<b>1-meter / Sinistro imager</b>	
Per-pointing setup time for slewing, etc.	90 sec
Per-configuration overhead	16 sec
Per-frame filter change (minimum of 1)	2 sec
Plus per-frame readout	
1x1 binning	27 sec
Plus per-frame overhead time	1 sec
<b>1.0-meter / NRES spectrograph</b>	
Per-pointing setup time for slewing, etc.	180 sec
Acquisition time (exposure + processing)	430 sec
Exposure time (X sec for SPECTRUM)	
Plus per-frame readout	
1x1 binning	57 sec
Plus per-frame overhead time	1 sec
<b>0.4-meter / QHY600 imager</b>	
Per-pointing setup time for slewing, etc.	90 sec
Per-configuration overhead	5 sec
Per-frame filter change (minimum of 1)	2 sec
Plus per-frame readout	
Full Frame readout	6 sec
Central 30x30 readout	4 sec
Plus per-frame overhead time	1 sec

Example 1. For a request of 9 x 30s exposures on a Sinistro imager with a single filter, the observation time is:

Setup	90 sec
Configuration overhead	16 sec
Filter change	2 sec
Exposure (9 exp x 30 sec =)	270 sec
Readout (9 exp x 27 sec)	243 sec
Overhead (9 exp x 1 sec=)	9 sec
<b>Total time =</b>	<b>630 sec</b>

Example 2. For a request for one 120 sec exposure on a Sinistro imager in each of the B, V and I filters, the observation time is:

Setup	90 sec
Configuration overhead	16 sec
Filter change (3 filters x 2 sec =)	6 sec
Exposure (3 exp x 120 sec =)	360 sec
Readout (3 x 27 sec =)	81 sec
Overhead (3 x 1 sec=)	3 sec
<b>Total time =</b>	<b>556 sec</b>

## Appendix C: LCO site codes

The filenames of all data acquired with LCO telescopes begin with the three-letter code for the site at which the telescope is located. For LCO staff, these site codes are part of the lingo used to discuss network operations. For LCO users, however, the codes can be cryptic. Here's a list of the codes and the Observatory sites to which they correspond:

- COJ = Siding Spring Observatory, near Coonabarabran, Australia
- TLV = Wise Observatory, near Mitzpe Ramon, Israel
- CPT = South African Astronomical Observatory, near Sutherland, South Africa
- TFN = Teide Observatory, on Tenerife, Canary Islands, Spain
- LSC = Cerro Tololo Inter-American Observatory, near La Serena, Chile
- ELP = McDonald Observatory, near Ft. Davis, Texas, United States
- OGG = Haleakala Observatory, on Maui, Hawai'i, United States

## Appendix D: The Cassegrain derotators on the 2m telescopes

LCO's 2-meter telescopes have Alt-Az mounts, so as the telescope tracks a position on the sky, the orientation of an image rotates as the telescope azimuth changes. To prevent objects from getting smeared-out in images, a derotator above the Cassegrain focus counters the telescope's azimuthal motion. The derotators have a range of motion slightly greater than one full rotation.

For FLOYDS spectra, users may specify a position angle; for MuSCAT images, position angle selection is not available. For most position angles, only one starting derotator position is possible, so the telescope control system is unable to prevent the derotator from tracking into a limit during long exposure sequences. LCO intends to add a derotator limit into the portal's visibility calculations in the future, but until that limit is imposed, *we advise users to break long series of exposures into multiple subrequests*. By breaking-up long observations, the telescope control system can unwrap the derotator between subrequests. We recommend that subrequests be limited to no longer than 1 hour.

## Appendix E: Time refunds

If some or all of the data acquired during an observation are unusable because of a technical problem with LCO's hardware or software, then the author of the observation request (or the PI of the science program) must report the unusable data to LCO's Science Support team to be eligible for a refund. The report must include the Request number or RequestGroup number that generated the unusable data. If, after review, a refund is granted, the time will be added to the proposal's total allocation.

The [Time Refund Policy](#) and details of the review process are published on the [LCO website](#).

## Revisions to this document

Added Data Archive access instructions.	2013 08 28
Added line of instructions to data access description.	2013 08 28
Major overhaul to capture beta comments, V1 orientation.	2013 10 31
TAL: Moving objects are now supported. Changed links to website versions of documents and updated email addresses.	2014 01 23
TAL: Update to reflect SBIG and Sinistro mixed network. Reworked overhead calculations. Documented moving object target support.	2014 03 26
TAL: Small tweaks for V1.0.	2014 04 15
TAL: Updates for change of archive host from IPAC to Amazon. Add Comet examples, update overhead numbers.	2016 03 23
NV: Updated "Observatory Capabilities" section.	2016 05 11
TYB: Combine 2m and 1m documents; add 0.4m; update to 2017	2017 01 30
NV: Rewritten for Valhalla UI.	2017 04 28
NV: Added NRES-specific information.	2017 07 28
NV: Add Acceptability Threshold. Revise NRES overheads.	2017 10 16
NV: Update Spectral imager overheads, NRES guiding requirement.	2018 01 17
NV: Reduced 2.0-meter per-pointing setup time to 120s.	2018 03 06

NV: Acceptability threshold for FLOYDS is 100%.	2018 08 21
NV: Updated overheads for Sinistro, NRES, Spectral, SBIG.	2018 12 13
NV: Increase “front padding” for Spectral imager.	2019 01 14
NV: Sinistro camera readout time decreased from 37s to 27s.	2019 03 11
NV: Add Appendix D.	2019 04 23
NV: Description of Time Critical mode.	2019 05 23
NV, EHJ: Updated for the new Observation Portal (new compose form, new request language).	2019 06 19
EHJ, NV: Multiple Instrument Configurations	2019 11 01
NV: Add Exposure Sequence, Spectrum Sequence; remove NRES Acquire mode	2019 12 17
NV: Add configuration overhead; reduce filter change	2020 08 13
NV: Updates to overview, figures that show new OCS organization, ‘Not Attempted’ status, BANZAI processing. Add details of MuSCAT3 and dithered observation requests.	2021 08 23
NV: Mosaic requests.	2021 09 24
TL: Add fractional ephemeris rate section. Expanded non-sidereal target name section with instructions on how to have elements autofill.	2022 01 28
NV: FLOYDS lamp flat defaults exptimes, FLAT & ARC overheads. Time Refund Policy.	2022 03 31
NV: Enable notifications. MuSCAT overheads.	2023 01 06
NV: Remove Spectral imager. Add QHY600-specific information. Update Request, Config, Constraints sections.	2023 10 03
NV: Remove references to SBIG-6303 imagers. Add new mosaic.	2024 07 24
NV: Description of DeltaRho/QHY600 sub-exposure stacking.	2025 02 24