

Getting Started with MUSCAT API & Portal Requests

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This document provides an introduction to the MuSCAT settings for users who intend to submit observation requests via the LCO Portal or the API. **Familiarity with the LCO Web-Portal and API submission process is assumed.**

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Overview

The MUSCAT instrument consists of four separate cameras in the g', r', i', and z' bands capturing images of the same field of view. For MuSCAT, each of the four passbands is referred to as a 'channel'. [Refer to the LCO Muscat web page for more background information on the instrument design.](#) This guide describes the new configuration items for the MUSCAT instrument. Background material on API submission can be found on the [developers page](#) or in the [observation portal API submission examples](#).

As for all LCO observing requests, the following parameters have to be defined:

- An *Exposure Type*, which defines for repeated exposures if the number of repeats is driven by the number of exposures, or a time duration to fill. In the first case, a number of repeats is to be defined; in the latter case, a duration will need to be defined.

A Muscat observation request in particular must define the following parameters:

- An *Exposure Time* for each of the four channels.
- An *Exposure Mode*, which defines how repeated exposures are executed in different channels.
- A *Diffuser position*, which defines, for each channel, whether a photonic diffuser is to be inserted into the beam or not.

Portal submission

The following screenshots exemplify a portal submission form for a Muscat request. Refer to the explanation of the API requests later in this document for detailed discussion of the meaning of each parameter.

The Portal example #1 and API example #1 represent an identical request for 100 synchronously repeated observations with exposure times of 27s, 33s, 23s, and 30s in the g',r',i', and z' channels, respectively. The diffuser optical elements are in and out of the beam for some channels.

The Portal example #2 and API example #2 represent an identical request for asynchronous exposures with exposure times of 27s, 33s, 23s, and 30s in the g',r',i', and z' channels, respectively, that are to continue for 4 hours. The diffusers are to be in the beam.

Request
⏪ ⏩

- [More information about LCO instruments.](#)

Observation Type

Instrument

Acceptability Threshold

⏪

⏩

Configuration
⏪ ⏩

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

Type

⏪

⏩

Instrument Configuration
⏪ ⏩

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

Exposure Count

Exposure Mode

Exposure Time g

Exposure Time r

Exposure Time i

Exposure Time z

Diffuser g position

Diffuser r position

Diffuser i position

Diffuser z position

Defocus

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Muscat portal submission example #1

⌕ ⚠ Request
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- [More information about LCO instruments.](#)

Observation Type

Instrument

Acceptability Threshold

Observation Type

Instrument

Acceptability Threshold

⚙️ ⚠ Configuration
⌵ 📄

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

Type

Duration Fill

Type

Duration

📷 ✓ Instrument Configuration
⌵ 📄

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

Exposure Count

Exposure Mode

Exposure Time g

Exposure Time r

Exposure Time i

Exposure Time z

Diffuser g position

Diffuser r position

Diffuser i position

Diffuser z position

Defocus

Exposure Count

Exposure Mode

Exposure Time g

Exposure Time r

Exposure Time i

Exposure Time z

Diffuser g position

Diffuser r position

Diffuser i position

Diffuser z position

Defocus

Muscat portal submission example #2

API submission

The following two excerpts illustrate the Muscat specific JSON configuration for an API request submission. They represent the same requests as in the Portal submission section of this document. Note that the human-readable representation in the Portal and the notation in the API might slightly differ.

```
'configurations': [{
  'type': 'EXPOSE',
  'instrument_type': '2M0-SCICAM-MUSCAT',
  'guiding_config': {},
  'instrument_configs': [{
    'exposure_time': 33.0,
    'exposure_count': 100,
    'optical_elements': {
      'diffuser_g_position': 'in',
      'diffuser_r_position': 'out',
      'diffuser_i_position': 'in',
      'diffuser_z_position': 'out',
    },
    'extra_params': {
      'exposure_time_g': 27.0,
      'exposure_time_r': 33.0,
      'exposure_time_i': 23.0,
      'exposure_time_z': 30.0,
      'exposure_mode': 'SYNCHRONOUS'
    }
  }], ...]
}, ...]
```

Muscat API submission example #1

```

'configurations': [{
  'type': 'REPEAT_EXPOSE',
  'repeat_duration': '14400',
  'instrument_type': '2M0-SCICAM-MUSCAT',
  'guiding_config': {},
  'instrument_configs': [{
    'exposure_time': 33.0,
    'exposure_count': 1,
    'optical_elements': {
      'diffuser_g_position': 'in',
      'diffuser_r_position': 'in',
      'diffuser_i_position': 'in',
      'diffuser_z_position': 'in',
    },
    'extra_params': {
      'exposure_time_g': 27.0,
      'exposure_time_r': 33.0,
      'exposure_time_i': 23.0,
      'exposure_time_z': 30.0,
      'exposure_mode': 'ASYNCHRONOUS'
    }
  }], ...]
}, ...]

```

Muscat API submission example #2

The meaning of the individual requests are discussed in the following:

Exposure Type

Repeated exposures can be defined for LCO instruments in two ways, the the **type** keyword has to set according to the desired mode; for a single exposure, set the type keyword to 'EXPOSE'.

1. Take a defined number of repeated exposures. In this case, set the **type** keyword to 'EXPOSE', and set the **exposure_count** keyword in the instrument config to the number of requested exposures.
2. Fill a certain duration with as many exposures of the defined exposure time as can fit. In this case, you would set the **type** keyword at the configuration level to be REPEAT_EXPOSE instead of EXPOSE, and then set a **repeat_duration** keyword at the

configuration level to be the total observation time in seconds you want to repeat that set of `instrument_configs` for. It is recommended to set the `exposure_count` keyword to 1.

Exposure Times

Each camera is operated independently. An exposure time must be specified for each channel; the exposure times do not have to be identical, but can be. Customizable exposure times allow the sensitivity of each channel to be matched to the spectral energy distribution of a science target.

In the API, the four exposure times are specified in seconds by the `exposure_time_*` keywords in the `extra_params` section of the `instrument_configs` dictionary. (The * is a placeholder for the filter: g, r, i, z.) The base `exposure_time` at the `instrument_configs` level indicates the longest of the four exposure times. When the request is submitted, the `exposure_time` will be overwritten with the longest `exposure_time_*` value, if the values differ; the user does not have to define this keyword, but might want to be aware that it will be generated by the API interface for bookkeeping. The duration of the request is based on the longest `exposure_time_*`, as well.

Exposure Mode

MuSCAT can operate in either a synchronous or an asynchronous exposure mode. In synchronous mode (Figure 1), all channels complete an exposure before the next set of exposures start. In asynchronous mode (Figure 2), each channel acquires exposures as fast as it can.

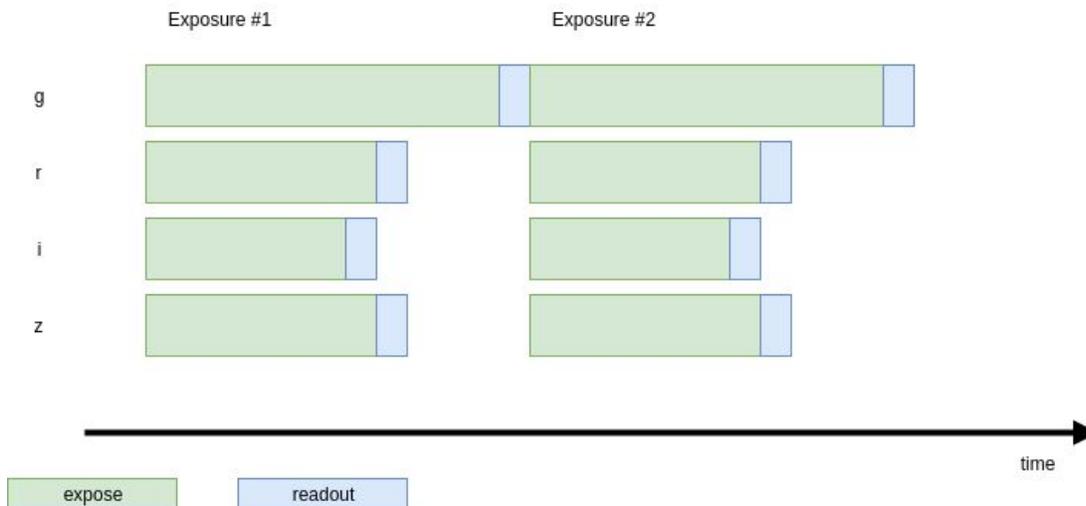


Figure 1: SYNCHRONOUS mode. The start time of each set of 4 exposures is synchronized, so the cadence will be determined by the longest exposure time among the 4 cameras (plus readout time).



Figure 2: ASYNCHRONOUS mode. The exposures for the 4 cameras happen independently and as quickly as possible.

The exposing mode is specified in the API by setting the `exposure_mode` keyword in the `extra_params` section to either **SYNCHRONOUS** or **ASYNCHRONOUS**. The default setting is **SYNCHRONOUS**.

Diffuser States

The MUSCAT instrument has a photonic diffusers for each of its cameras to enable high-precision photometry of bright stars. The diffusers support the boolean states of **in** or **out**. By default, the diffusers are **out** of the optical path. The diffuser states can be set in the API the same way filters are, using the `diffuser_*_position` key in the `optical_elements`, where the * denotes the channel for which the diffuser should be inserted [g, r, i, z].

Finer points

Use of **exposure_mode** and configuration **type**

The combination of **exposure_mode** and configuration **type** control the behaviour of repeated exposures. The typical use cases for the combinations are outlined in the following:

- Type: EXPOSE, exposure_mode: SYNCHRONOUS
Default multi-color photometry with a single or multiple exposures for cosmic ray rejection (e.g., Supernova follow up, pretty picture)
- Type: REPEAT_EXPOSE, exposure_mode: ASYNCHRONOUS
Planet transit with optimum signal-to-noise per channel.
- Type: REPEAT_EXPOSE, exposure_mode: SYNCHRONOUS
Fast cadence light curve where synchronous exposing is important, e.g. asteroid rotation curves.
- Type: EXPOSE, exposure_mode: ASYNCHRONOUS
No specific use case has been identified yet; listed for completeness.

Note on auto-guiding and diffusers

There is no need to specify an auto-guider option for Muscat at this time.

Until a dedicated auto-guider will be commissioned, Muscat will follow a very simple self-guiding schema: The channel with the exposure larger than 5 seconds, and closest to 10 seconds will be used to derive a guide signal for the telescope. If more than one channel will meet this requirement, the order of selection will be r', i', g', z'.

Subject to change during commissioning, there is no selection based on the state of the photonic diffuser in the beam.

Filter selection

There are no filters to select in MuSCAT.