Target of Opportunity Workshop

Bryan Miller
Gemini Science Meeting, August 25, 2021

NSF’s NOIRLab
Target of Opportunity (ToO) mode allows a PI/team to submit observations for new targets to the queue.

Most Gemini programs - targets included in proposals and approved by the NTACs, special approval needed to add new targets

**ToO mode** - target coordinates are not known or the time of the observation cannot be specified at the time of the proposal

- Useful for time-domain astronomy (TDA) but that is not necessary
- The observations are finalized and submitted once the targets/dates are known

The mode must be approved by the NTACs.

See [https://www.gemini.edu/observing/phase-i/too](https://www.gemini.edu/observing/phase-i/too)
Gemini has two flavors of Target of Opportunity (ToO) observations

- **Rapid (rToO)**
  - Observe the upcoming or current night (24 hour timing window)
  - Program must be in Band 1 (highest rank)
  - Must not have conditions constraints: IQAny/CCAny/SBAny/WVAny
  - It is possible to interrupt ongoing observations
    - Fastest time from trigger to start of science ~6 minutes
    - Specify in the proposal if you will need to do this, must have NTAC approval
    - The interrupting program pays for any lost time to the interrupted program

- **Standard (sToO)**
  - Scheduled in the next plan with the rest of the queue, no urgency to observe in <24 hours
  - Timing windows can be set (e.g. days to months)
  - sToO follow-up of rToOs must have conditions better than Any/Any/Any/Any
  - Possible with LGS, but the trigger must be submitted 4 days in advance (w/ rare exceptions)

See [https://www.gemini.edu/observing/phase-i/too](https://www.gemini.edu/observing/phase-i/too)
Workhorse instruments (available most of the time) are the most useful for ToOs.

ToOs for some visitor instruments are available on a more limited basis (see CfP): `Alopeke/Zorro, IGRINS

Recommended GMOS gratings:
- B600
- R400
Gemini’s experience with GW170817 follow-up led to a new policy for competitive ToOs

Pre-approved queue programs get priority over Director’s Discretionary (DD) programs.

If multiple ToO requests for the same target...

- Will work with PIs, if possible
- Rules for prioritization defined (e.g. first ToO wins...)
- If multiple requests for the same configuration, then data may be shared.

Policies for Competitive ToOs

Effective November 20, 2017, the policies described below will regulate the activation of Target of Opportunity (ToO) programs, the priorities for their execution as well as the data access rights for the acquired data when multiple teams activate ToOs on the same target and on the same or subsequent nights.

Approval of ToO Triggers and DD Time

1. To be activated, Queue ToOs must be scientifically aligned with the nature of the event for which they are requested. This is a general rule that applies to all ToO programs.
2. DD proposals will not be accepted if they effectively duplicate, in their observational setup, that which has been activated to observe the same target. DD proposals that are accepted prior to an existing Queue ToO will be subject to the Prioritization and Data Sharing Policies discussed below.

Prioritization for ToO Triggers and DD Time

1. In case of multiple Queue ToO triggers on the same target and night, the Gemini Observers will work with the PIs to prioritize the observations so that the science is maximized. If no consensus can be reached or if no coordination is possible, the Gemini Observatory reserves the right to prioritize the observation according to the following criteria: 1) how well the scientific justification of the proposal aligns with the new ITAC ranking of the proposals, if available; 2) the temporal order in which the triggers are activated; 3) considerations to maximize science, such as whether the Gemini observations are coordinate with observations at other observatories (e.g. Chandra, HST, other ground facilities).
2. As a rule, all DD programs will be given lower priority than Queue ToO programs. However, awarded to extend a Queue ToO program that has used all of its allocation during the course of the campaign will have higher priority than other DD programs.

Policies on Data Access Rights for ToO and DD Programs

https://www.gemini.edu/observing/policies
Before you trigger you can check the telescope and instrument availability

ToO Status Web Pages

Cerro Pachon at Thu Aug 19 15:57:21 2021 CST

Gemini South available for Target of Opportunity tonight

GMOS-S Flamingos-2

GMOS only available for Longslit mode.

See also the GMOS current configuration web page
http://www.gemini.edu/sciops/schedules/obsStatus/gmosS.html

Valid until 20-8-2021

http://www.gemini.edu/sciops/schedules/obsStatus/GS_Instrument.html
http://www.gemini.edu/sciops/schedules/obsStatus/GN_Instrument.html

GMOS configuration web pages

Pachón at Thu Aug 19 14:10:01 2021

Gratings currently available in GMOS-S today...

mirror
B600s_G5323
R150i_G5326
R400s_G5325

Slits currently available in GMOS-S today...

IFU_R
1.5arcsec
0.75arcsec
N50.5arcsec
0.5arcsec
2.0arcsec

http://www.gemini.edu/sciops/schedules/obsStatus/gmosS.html
http://www.gemini.edu/sciops/schedules/obsStatus/gmosN.html
And in case you need to check the weather...

It can be hard to tell, so trigger if in doubt...

**Maunakea**
Current conditions and cloud cameras
https://www.gemini.edu/sciops/telescopes-and-sites/weather/mauna-kea/cloud-cam/
Satellite images
http://mkwc.ifa.hawaii.edu/satellite/

**Cerro Pachón**
Current conditions and cloud cameras
https://www.gemini.edu/sciops/telescopes-and-sites/weather/ cerro-pachon/envmon/
https://www.gemini.edu/sciops/telescopes-and-sites/weather/ cerro-pachon/cameras/
Satellite images
http://www.ctio.noao.edu/sitetests/GOES/
The ToO observing request, or trigger, is done by adding a target to a template and then submitting.

Contact scientists will help define template observations, set to “On Hold”.

Trigger sequence:
- Copy/paste template
- Fill in target-specific information
- Put special instructions in a note
- Upload finding chart
- Set observation status to “Prepared”
- Sync (upload to Gemini, “trigger”)

This can be done manually with the OT.
Triggers may also be submitted programmatically via a URL API.

The details of the trigger are formatted as a URL string which can be submitted to Gemini using any browser or URL tool such as wget or the 'requests' package in Python. The following parameters are available.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>prog</td>
<td>program id</td>
</tr>
<tr>
<td>email</td>
<td>email address for user key</td>
</tr>
<tr>
<td>password</td>
<td>password for user key associated with email, site specific, emailed by</td>
</tr>
<tr>
<td>obsnum</td>
<td>id of the template observation to clone and update, must be 'On Hold'</td>
</tr>
<tr>
<td>target</td>
<td>name of the target</td>
</tr>
<tr>
<td>ra</td>
<td>target RA [J2000], format 'HH:MM:SS.SS'</td>
</tr>
<tr>
<td>dec</td>
<td>target Dec[J2000], format 'DD:MM:SS.SSS'</td>
</tr>
<tr>
<td>mags</td>
<td>target magnitude information (optional)</td>
</tr>
<tr>
<td>noteTitle</td>
<td>title for the note, &quot;Finding Chart&quot; if not provided (optional)</td>
</tr>
<tr>
<td>note</td>
<td>text to include in the note (optional)</td>
</tr>
</tbody>
</table>

The Observing Database takes care of the copy/paste/trigger actions.

Full API documentation and example scripts, including guide star selection, at https://github.com/bryanmiller/gsselect
While not required, checking for guide stars is recommended to ensure that the observation is feasible.

Guiding is needed (e.g. wind shake).

Many guiders (e.g. GMOS OIWFS) have limited FoVs.

GSselect allows guide star selection, similar to that done by the OT.

Has a 'find PA' feature never implemented in the OT. This will pick the best guide star available and set the PA so that it is reachable.
Currently the API does not support non-sidereal targets well

Gemini uses ephemerides, not orbital elements, for all non-sidereal targets

With current API:

- Give official Horizons name and approximate coordinates
- Use PWFS2 for guiding
- In note, indicate that this is a non-sidereal target and give the Horizons name and target type (Comet, Asteroid, MajorBody)
  - The observer or QC will then query Horizons to get the ephemeris, search for guide stars, etc.
  - Set the note title to ‘Nonsidereal target information’
- Or, in note, provide a link to an emphemeris file in the correct format that we can download.
Exercise: trigger with gsselect

Create a python environment

Decide on a working directory. I’m going to work in $HOME/python. This will work with Python 3.6+, but Python3.7+ is recommended if creating a TOM.

cd $HOME/python
mkdir gsm21_too
python3 -m venv $HOME/python/gsm21_too/tomenv
source $HOME/python/gsm21_too/tomenv/bin/activate

Install gsselect and example files

cd gsm21_too
pip install gsselect

curl -o urltrigger.py https://raw.githubusercontent.com/bryanmiller/gsselect/main/urltrigger.py

curl -o urltoo_readme.txt https://raw.githubusercontent.com/bryanmiller/gsselect/main/urltoo_readme.txt
Exercise: trigger with gsselect

Edit urltrigger.py

```
ready = 'true'                               # True => Prepared, False=>On Hold
email = 'gemswtest@gmail.com'    # Email associated with OT user key
progkey = '878886'                      # User key password
progid = 'GN-2019A-TOO-1'          # Program ID
server = 'https://gnodbtest.hi.gemini.edu:8443'

# optional (use your name)

l_pamode = 'find'                                           # Options: fixed, flip, find, parallactic
```

Run the script

```
python urltrigger.py
```

Close the matplotlib “Position Editor” window.

GN-2019A-TOO-1-12 triggered!

After syncing, the observation appears in the test OT.
Triggers can also be done with Target/Observation Managers (TOMs)

Being used for many TDA projects
Useful for non-TDA projects, e.g. lots of targets, large teams
LCOgt has developed a toolkit: https://tom-toolkit.readthedocs.io/en/stable/
Exercise: Trigger with TOM Toolkit

Install TOM Toolkit, ANTARES and tom_community_gemini plugins

```
pip install tomtoolkit
pip install tom-antares
pip install tom-gemini-community
pip install jupyterlab
```

django-admin startproject mytom
cd mytom
edit mytom/settings.py
  Add 'tom_setup', to INSTALLED_APPS

./manage.py tom_setup

Enter admin account information

Configuring your TOM to use the Gemini plugin

Customize the FACILITIES section of settings.py

```
'GEM': {
    'portal_url': {
        'GS': 'https://gsodtest.gemini.edu:8443',
        'GN': 'https://gnodtest.gemini.edu:8443',
        'archive': 'https://archive.gemini.edu/'
    },
    'api_key': {
        'GS': '214944',
        'GN': '878886',
        'archive': ''  # web cookie
    },
    'user_email': 'gemswtest@gmail.com',
    'programs': {
        'GS-2019A-TOO-1': {
            '1': 'Std: GMOS B600 1.0arcsec',
            '2': 'Rap: GMOS B400 1.0arcsec',
            '9': 'GMOS Acq 1.0arcsec'
        },
        'GN-2019A-TOO-1': {
            '1': 'Std: GMOS B600 1.0arcsec',
            '2': 'Rap: GMOS B400 1.0arcsec',
            '11': 'GMOS Acq 1.0arcsec'
        }
    }
},
```

**Server URLs (for testing)**
- Use gsodb/gnodb for production

**“User key” password associated with user_email, request using OT, see KeyChain Manager.**
Finally, we tell the TOM to use the ANTARES and Gemini community plugins

Not included in tom_base to reduce dependencies.

TOM_FACILITY_CLASSES = [

    # 'tom_observations.facilities.gemini.GEMFacility',
    'tom_gemini_community.gemini_gsselect.GEMFacility',
]

TOM_ALERT_CLASSES = [

    # 'tom_alerts.brokers.antares.ANTARESBroker',
    'tom_antares.antares.ANTARESBroker',
]

./manage.py migrate
./manage.py runserver

http://127.0.0.1:8000

Login with the username/password that you set before.

The TOM Gemini Community plugin supports guide star selection: gsselect. Commit your improvements to:
https://github.com/TOMToolkit/tom_gemini_community

Contact the ANTARES team to get API credentials.
We’ll make a broker query using MARS

Query a Broker
Create a new query using: ALeRCE, ANTARES, Gaia, Lasair, MARS, SCIMMA, Scout, TNS, Fink

MARS Query Form
Please see MARS help for a detailed description of available filters.

Query name*
ZTF20aakofgd

ZTF Object ID
ZTF20aakofgd
Run the query to find and enter targets

Query a Broker

Create a new query using: ALeRCE, ANTARES, Gaia, Lasair, MARS, SCIMMA, Scout, TNS, Fink

<table>
<thead>
<tr>
<th>Name</th>
<th>Broker</th>
<th>Created</th>
<th>Last Run</th>
<th>Run</th>
<th>Delete</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZTF20aakofgd</td>
<td>MARS</td>
<td>2021-08-25 15:08:13</td>
<td>None</td>
<td>Run</td>
<td>Delete</td>
</tr>
</tbody>
</table>

Query Result for ZTF20aakofgd

<table>
<thead>
<tr>
<th>Time</th>
<th>Name</th>
<th>RA</th>
<th>Dec</th>
<th>Mag</th>
<th>Score</th>
<th>View</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021-08-21 06:08:48</td>
<td>ZTF20aakofgd</td>
<td>223.406</td>
<td>9.469</td>
<td>18.894</td>
<td>0.801</td>
<td>View</td>
</tr>
<tr>
<td>2021-07-08 04:07:28</td>
<td>ZTF20aakofgd</td>
<td>223.406</td>
<td>9.469</td>
<td>19.442</td>
<td>0.621</td>
<td>View</td>
</tr>
<tr>
<td>2021-06-07 08:05:50</td>
<td>ZTF20aakofgd</td>
<td>223.406</td>
<td>9.469</td>
<td>19.289</td>
<td>0.713</td>
<td>View</td>
</tr>
</tbody>
</table>
And submit an observation to Gemini
And submit an observation to Gemini
And the result...
It is also possible to control the TOM from external scripts

```
./manage.py shell_plus --notebook
```

Triggering an observation from an ANTARES locus object with TOM


We can arrange follow up observations of intriguing ANTARES locus/alert using the facilities within the Astronomical Event Observatory Network (AEON). This can be conviently done with the TOM Toolkit as follows.

The first step is to define the target information (name, ra, dec, etc.)

```
In [1]: from antares_client.search import get_by_id, get_by_ztf_object_id
   #get locus by ANTARES ID
   locus = get_by_id("ANT2020bj3s4")
```

```
In [2]: print(locus.locus_id, locus.ra, locus.dec)
print(locus.lightcurve['ant_mag'].iloc[-1], locus.lightcurve['ant_passband'].iloc[-1])

ANT2020bj3s4 227.58436649043028 66.99700788920126
19.123262405395508 R
```

APIs are also available for the Gemini Observatory Archive for search and download

Easy for a human (or a script) to construct URLs that give useful search results directly

https://archive.gemini.edu/<FEATURE>/<SELECTION>

Feature of the system - eg:
- searchform: pre-filled search form (html)
- summary: data summary (search results, html)
- file: single file download
- download: tarball of matching results
- jsonfilelist: JSON file list
- jsonsummary: JSON search results
- calmgr: Calibration Association API (xml)

Data Selection /search criteria:
- Instrument name
- UT date (or range)
- Observation type
- Filename
- Project or Observation ID
- Data Label

https://archive.gemini.edu/searchform/20150123/F2
pyGOA Library and API Examples

See https://archive.gemini.edu/help/api.html for basic documentation and examples. These APIs are used to make the GOA accessible via astroquery:


An additional python library for the boilerplate archive communication is at

https://github.com/bryanmiller/pygoa_gemini

or

pip install pygoa-gemini

With additional help in TOM_Toolkit_Workshop-GOA.pdf
Gemini will improve our ToO capabilities as part of the ongoing Gemini Program Platform (GPP) and GEMMA projects

Goals:

- Make proposal and Phase 2 preparation much easier (replace PIT, OT, etc)
- Add new features that are not possible in the current code, more automation
- Make the system more API driven
- Make the code maintainable and scalable
- Produce an automatic queue scheduler
- Real-time data reduction

See Oct 2017 Gemini Focus, pg. 20, Jan 2021 NOIRLab Mirror, v2, pg. 42

https://www.gemini.edu/observing/operations-development
https://www.gemini.edu/gemma
A fundamental need/improvement for TDA is to make all relevant information accessible via APIs.

Programmatically available information:

- Telescope status (e.g. open/closed/accepting ToOs)
- Instruments/components available
- Weather (current, past, forecast?)
- Program/observation information and status
It will be possible to do everything programmatically that you can do with the Explore UI

- Query configurations that match requirements (e.g. wavelength, R, FoV,...)
- Run ITC calculations
- Run guide star queries for given instruments and wavefront sensors
- Create, modify, submit, and retract observations
  - ToO “On Hold” templates not required
  - Create observations from scratch using automation
  - Full nonsidereal target support
- Upload and download attachments such as ephemerides, mask design files, and finder charts
The native APIs will be in graphQL, flexible and useful for web applications.

GraphQL is quite different from RESTful APIs that many are familiar with.

Gemini will:

- Provide examples and training
- Provide Python libraries as needed
- Update the TOM Toolkit plugin
- Work with Las Cumbres on AEON API standards

Early testing to start next year, in operations expected in 2024.

*https://graphql.org/*

```
# Filter settings using a dictionary. This is all the user has to do.
variables = {
    "filters": {
        "searchString": "Q-10?",
        "instruments": ["GMOSN", "GMOS", "GNIRS"],
        "partners": ["CL", "US"],
        "completionPercentage": {
            "minPercentage": 30,
            "maxPercentage": 80
        }
    }
}

# Execute the query
result = browse_query(variables)

# Extract the programs from the result.
programs = result["data"]["programs"]

# For each program, print the pid and PI lastName
for p in programs:
    print(p["pid"] + " - " + p["pi"]["lastName"])
```
The current ToO ‘trigger’ process is based on adding targets to template observations

- Manual - OT
- Programmatic - simple API, TOM Toolkit, Jupyter notebooks

GPP will be API driven, allowing better programmatic interaction and more automation

See the talks tomorrow for the context of TDA at Gemini and more information about the new software.