Next Generation TDA at Gemini: AEON, TOMs, GPP

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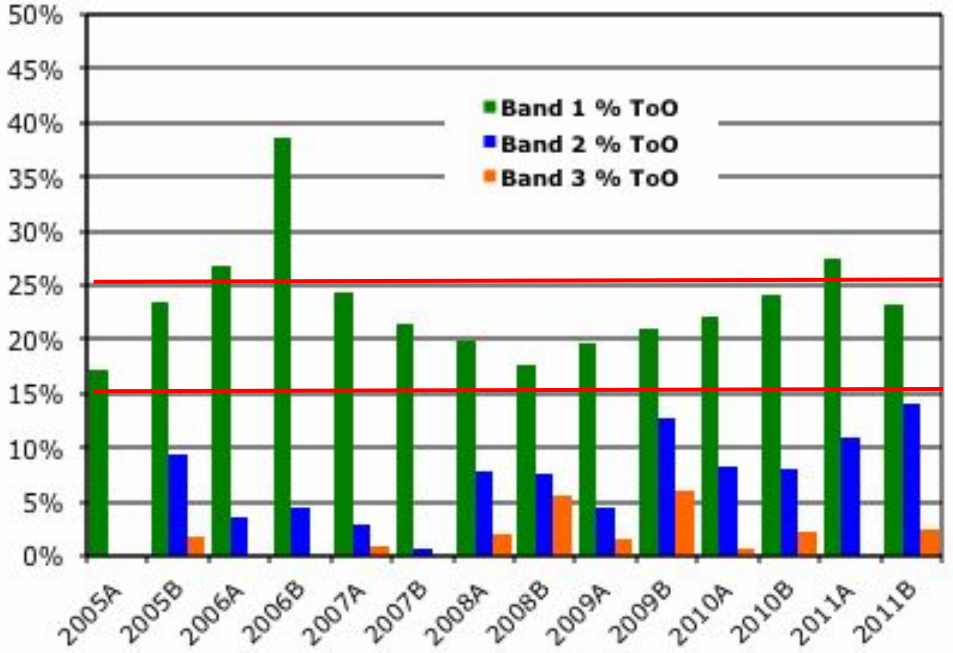
Gemini Science Meeting, July 28, 2022

Due to queue, Gemini has always done a substantial amount of time-domain astronomy (TDA).

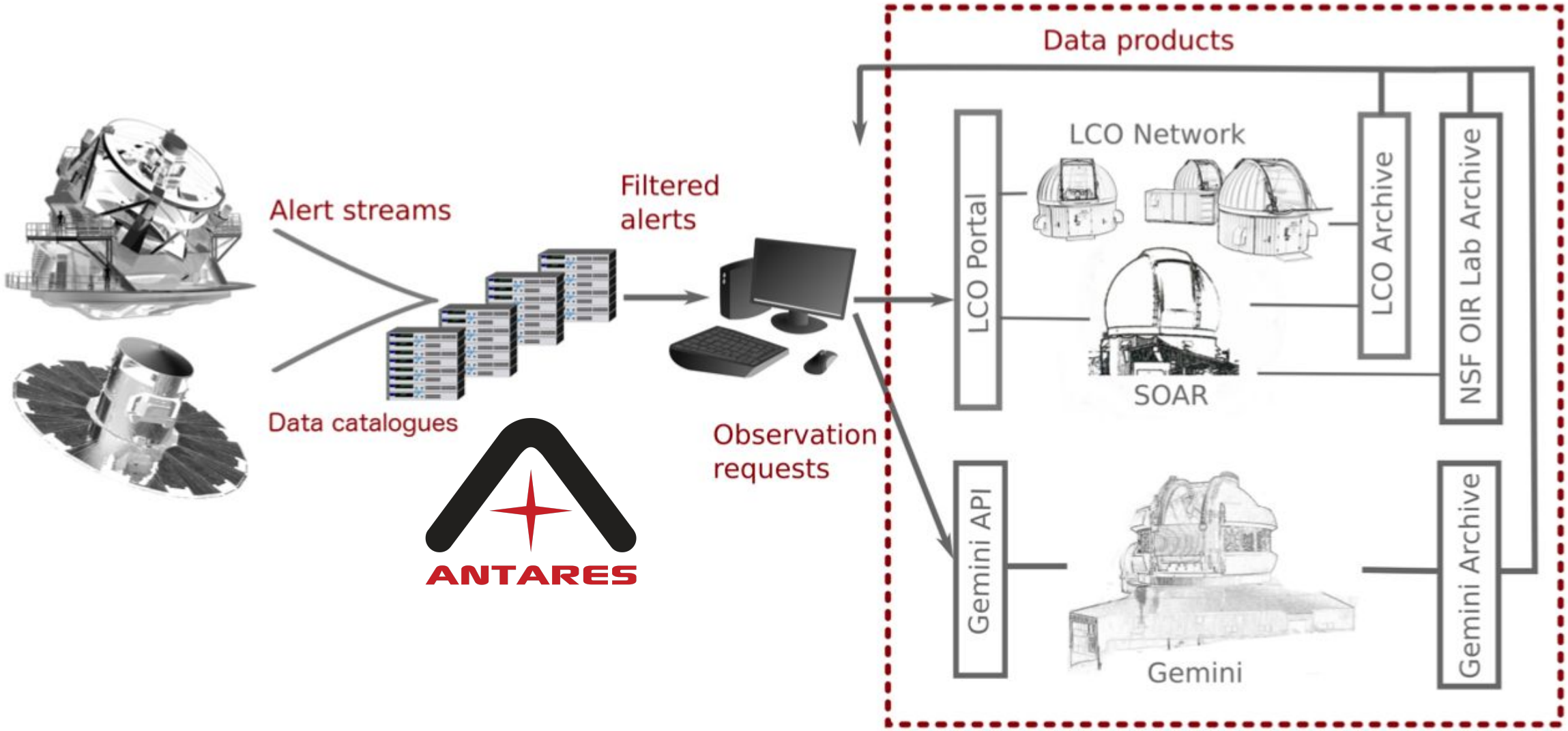
Target of Opportunity observations (ToOs) make up about 15-25% of the time observed in Band 1

- Max ToO rates are ~1-2/night
- The process is rather manual and not as efficient or capable as it could be



In the era of time-domain surveys (e.g. ZTF, Rubin/*LSST*) and MMA we must be prepared for a higher rate of ToOs.

Improvements are underway to attain Gemini's strategic goal of being the premier ToO follow-up facility while continuing to enable the breadth of PI research pursued by the Gemini community.



Surveys
LSST
ZTF
Gaia
ASAS-SN
++more

Brokers & Catalog Servers
ANTARES, Lasair
ALeRCE, Simbad
Vizier, MAST, CADC,
++ more

TOM Systems

Astronomer-led projects

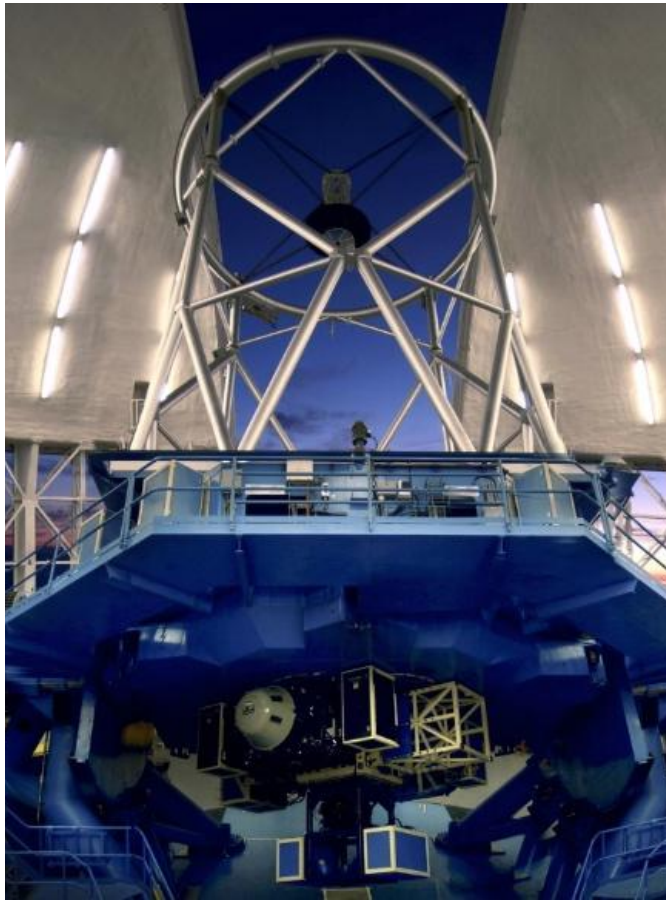
AEON
Astronomical Event Observatory Network

Extendable network of programmatically-accessible telescope facilities

Instrumentation for TDA and Follow-up

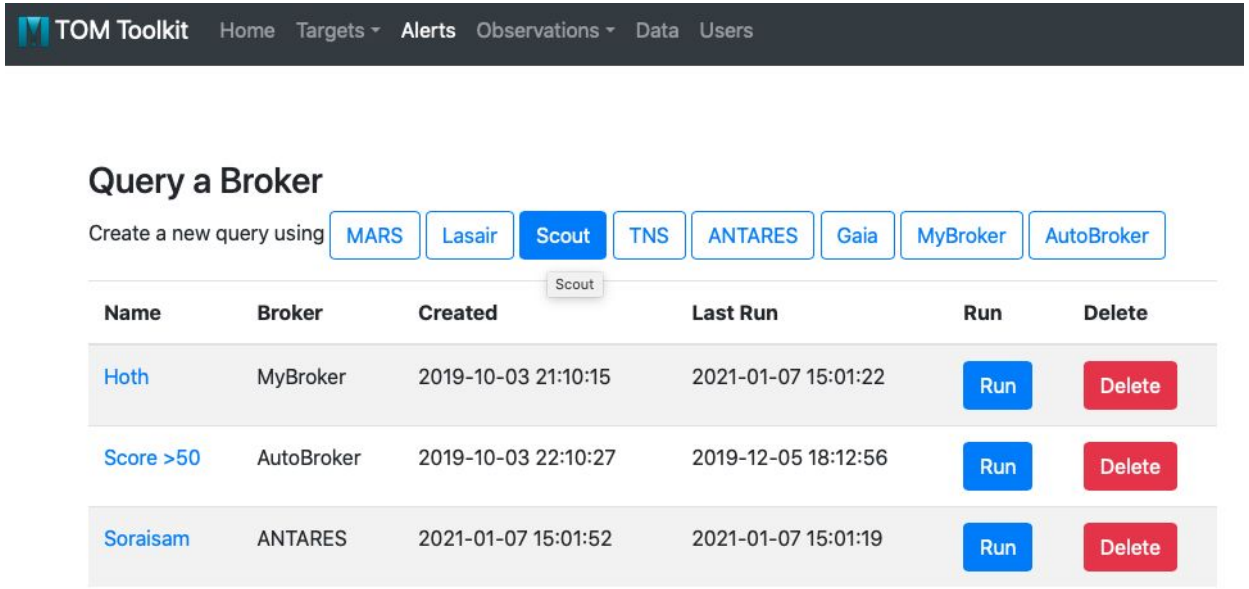
Most facility instruments can be used for ToOs. Workhorse optical/NIR instruments will be the most useful for follow-up.

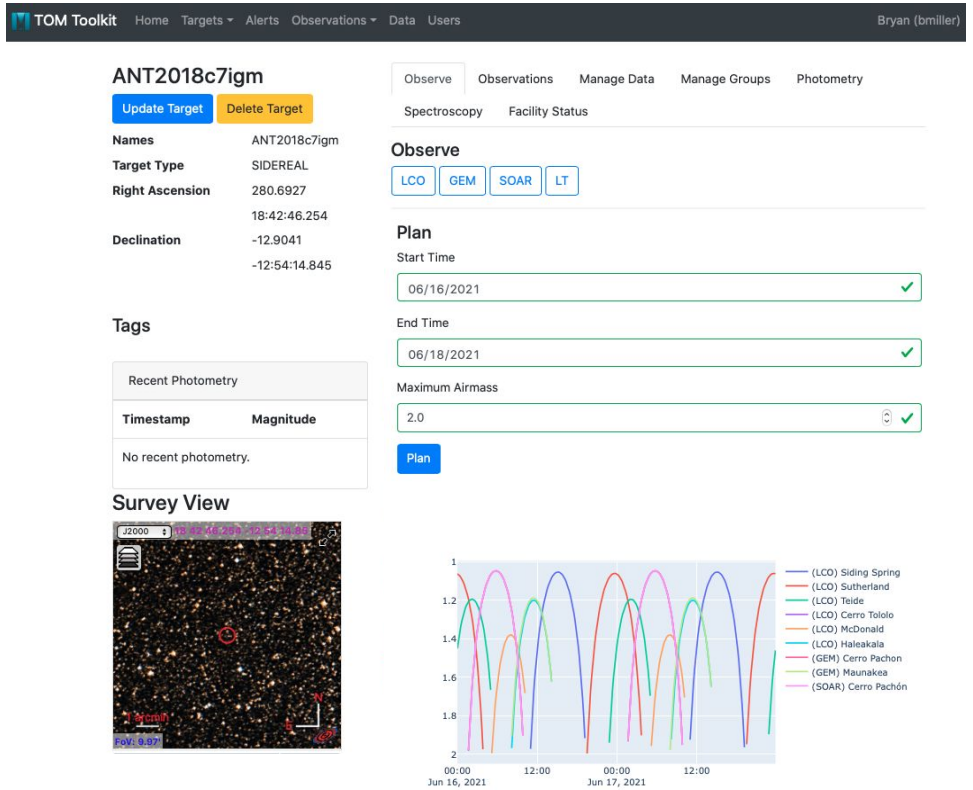
	Gemini North	Gemini South
Optical	GMOS-N GNIRS	GMOS-S SCORPIO* GHOST
Near-IR	IGRINS-2 NIRI GPI-2	FLAMINGOS-2 SCORPIO* GSAOI
AO	ALTAIR NGS & LGS	GeMS (MCAO) LGS (5)



Mid 2020s facility instrumentation

Target/Observation Managers (TOMs) match targets with telescopes, coordinate observations, and manage data.

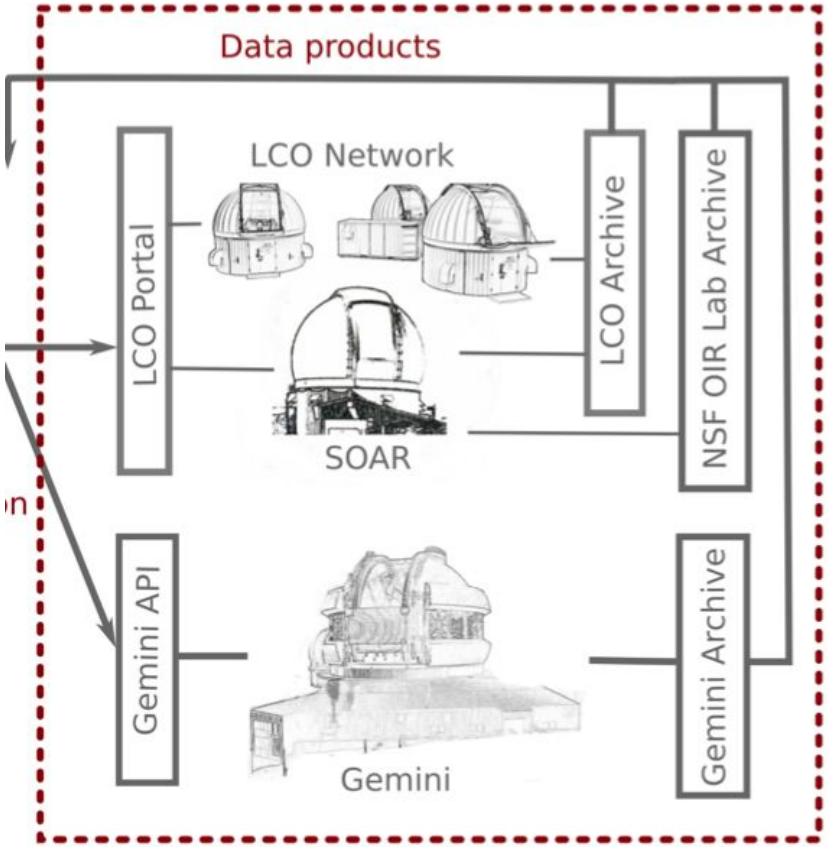




In use by SNe, exoplanet, NEO, AGN, and microlensing teams.
Useful for non-TDA projects, e.g. lots of targets, large teams
LCOgt has developed a toolkit: https://tom-toolkit.readthedocs.io/en/stable/

The Astronomical Event Observatory Network (AEON) is a collaboration between NOIRLab and Las Cumbres Observatory to develop and promote a network of programmatically accessible, dynamically scheduled telescopes

1. Develop interfaces (APIs)
2. Use SOAR as pathfinder facility, running with LCOgt scheduler, queue on dedicated nights
3. Incorporate Gemini, implement APIs and an automated queue scheduler
4. Investigate new TAC processes to enable the use of the network
5. Encourage data pipelining and archiving efforts
6. Be ready to incorporate other facilities (Rubin in-kind contributions, CTIO Blanco 4m, etc)



https://noirlab.edu/public/projects/aeon/
https://lco.global/aeon/

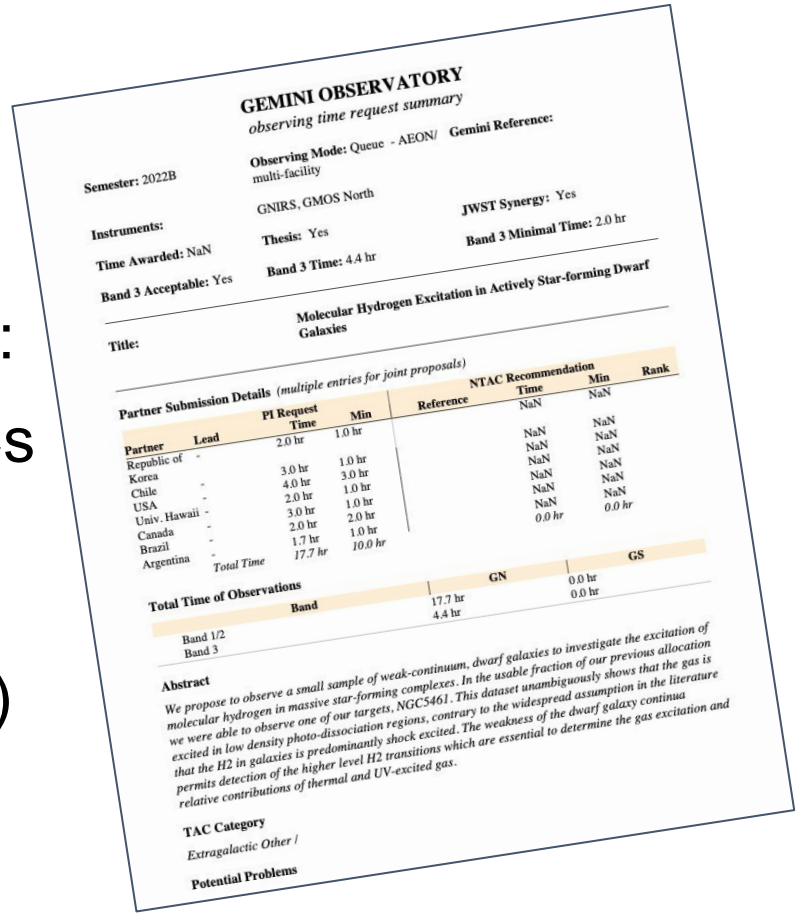
The AEON working group and Gemini Board discussed TAC processes for making use of the network

Need to meet participant requirements for proposal evaluation

Using the network requires proposals to multiple facilities:

- Proposals for Gemini time are evaluated by the NTACs
- Companion proposal(s) for non-Gemini time are evaluated by respective facility TACs (e.g. CSDC/NOIRLab for US time on Las Cumbres, SOAR)

AEON requirements lend themselves to handling multi-facility proposals in general.



GEMINI OBSERVATORY

observing time request summary

Semester: 2022B **Observing Mode:** Queue - AEON/ multi-facility **Gemini Reference:**

Instruments: GNIRS, GMOS North

Time Awarded: NaN **Thesis:** Yes **JWST Synergy:** Yes

Band 3 Acceptable: Yes **Band 3 Time:** 4.4 hr **Band 3 Minimal Time:** 2.0 hr

Title: Molecular Hydrogen Excitation in Actively Star-forming Dwarf Galaxies

Partner Submission Details *(multiple entries for joint proposals)*

Partner	Lead	PI Request Time	Min	NTAC Recommendation Reference	Time	Min	Rank
Republic of Korea	-	2.0 hr	1.0 hr		NaN	NaN	
Chile	-	3.0 hr	1.0 hr		NaN	NaN	
USA	-	4.0 hr	3.0 hr		NaN	NaN	
Univ. Hawaii	-	2.0 hr	1.0 hr		NaN	NaN	
Canada	-	3.0 hr	1.0 hr		NaN	NaN	
Brazil	-	2.0 hr	2.0 hr		NaN	NaN	
Argentina	-	1.7 hr	1.0 hr		NaN	NaN	
	Total Time	*17.7 hr*	*10.0 hr*		*0.0 hr*	*0.0 hr*	

Total Time of Observations

Band	GN	GS
Band 1/2	17.7 hr	0.0 hr
Band 3	4.4 hr	0.0 hr

Abstract

We propose to observe a small sample of weak-continuum, dwarf galaxies to investigate the excitation of molecular hydrogen in massive star-forming complexes. In the usable fraction of our previous allocation we were able to observe one of our targets, NGC5461. This dataset unambiguously shows that the gas is excited in low density photo-dissociation regions, contrary to the widespread assumption in the literature that the H2 in galaxies is predominantly shock excited. The weakness of the dwarf galaxy continua permits detection of the higher level H2 transitions which are essential to determine the gas excitation and relative contributions of thermal and UV-excited gas.

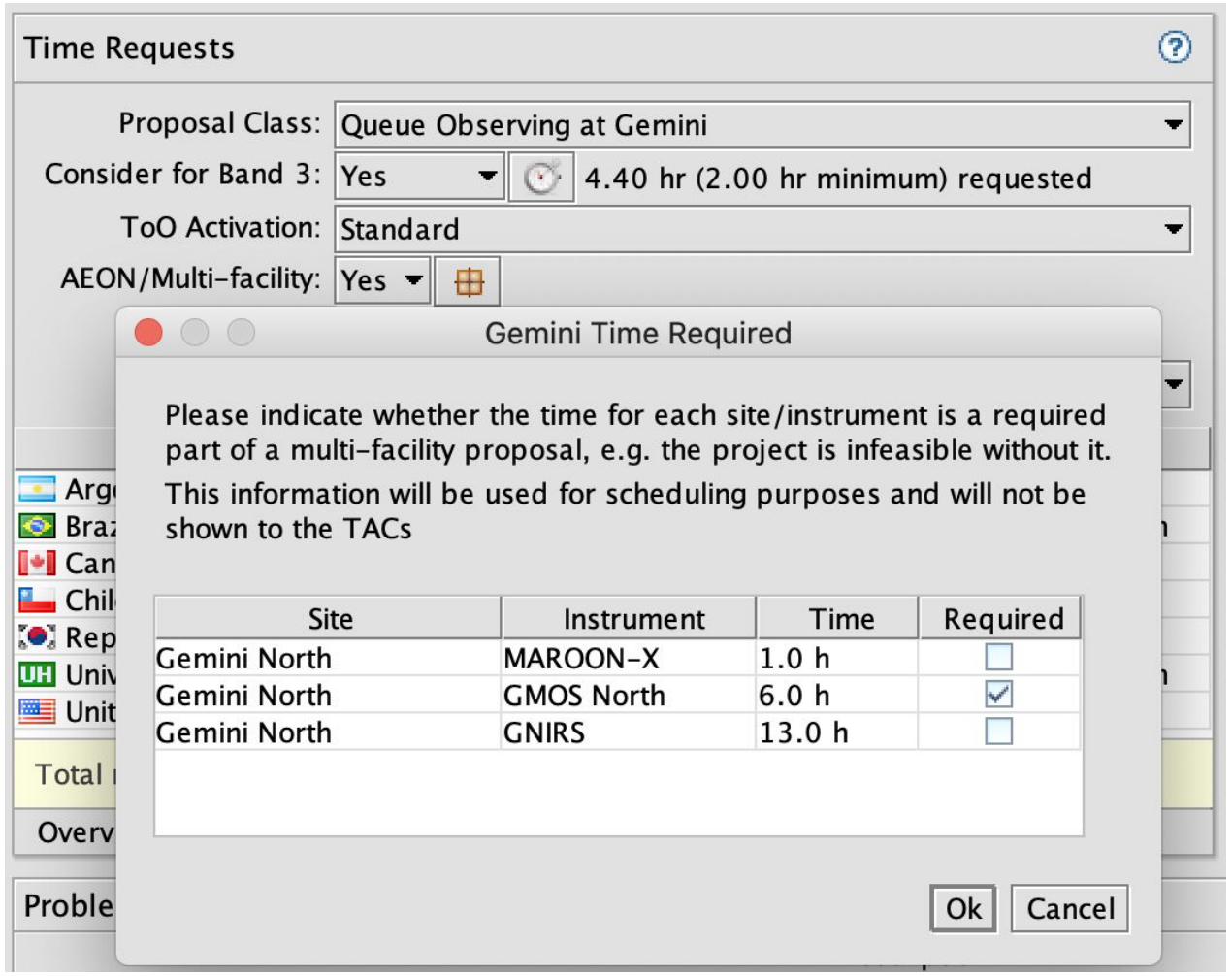
TAC Category

Extragalactic Other /

Potential Problems

An AEON/Multi-facility option has been added to Queue/Classical proposals starting with the 2022B PIT

- Set AEON/Multi-facility to yes if applying to more than one facility for the same project.
- If yes, then one can specify if any of the instruments are “required”. (not shown to the TACs)
- Describe and justify the roles of the other facilities in the Experimental Design and Use of Other Facilities section.



Gemini currently works within AEON via a plugin for the TOM Toolkit and existing APIs

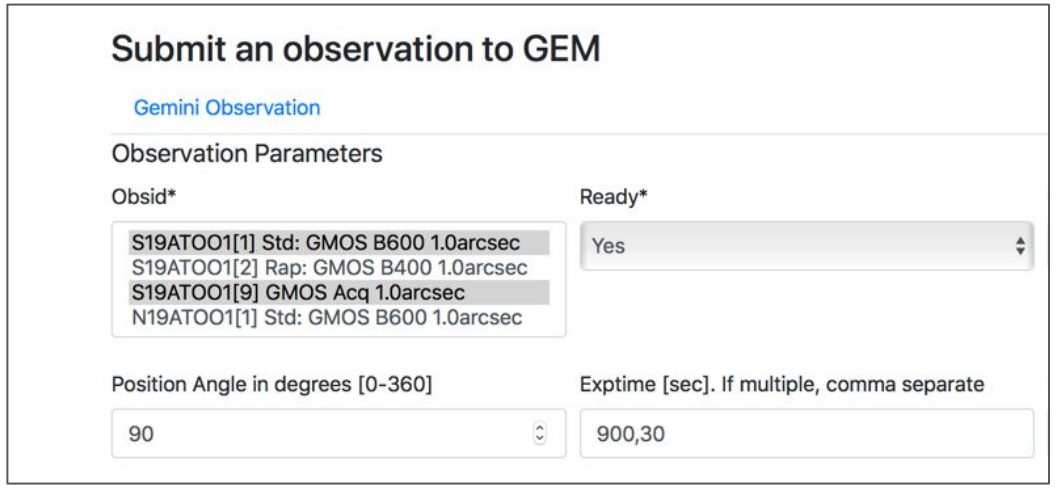
The plugin provides an interface for manual and automatic triggering of Gemini observations.

The ODB API allows programmatic submission of observation requests (ToOs) - but is limited

- https://github.com/bryanmiller/gsselect
- GSM21 ToO process workshop slides

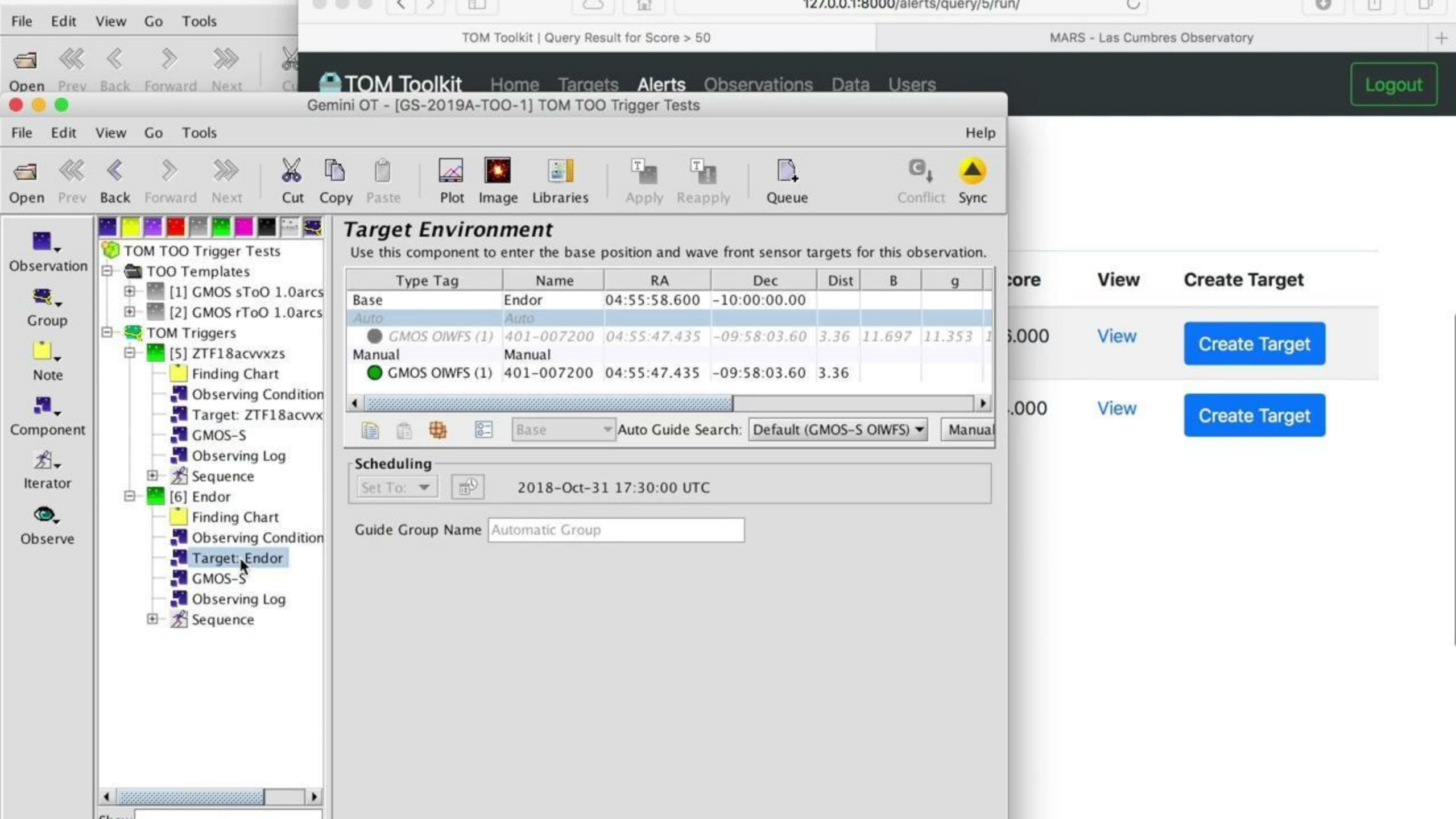
The Gemini Observatory Archive APIs allow the downloading of raw data

- https://archive.gemini.edu/help/api.html
- https://astroquery.readthedocs.io/en/latest/gemini/gemini.html
- https://github.com/bryanmiller/pygoa_gemini




```
The details of the trigger are formatted as an URL string which can be
submitted to Gemini using any browser or URL tool such as wget.  The
following parameters are available.

prog        - program id
email       - email address for user key
password    - password for user key associated with email, site specific
obsnum      - id of the template observation to clone and update,
              must be 'On hold'
target      - name of the target
ra          - target RA (J2000), format 'HH:MM:SS.SS'
dec         - target Dec(J2000), format 'DD:MM:SS.SSS'
mags        - target magnitude information (optional)
note        - text to include in a "Finding Chart" note (optional)
```


TOM Toolkit | Query Result for Score > 50
MARS - Las Cumbres Observatory
TOM Toolkit
Home
Targets
Alerts
Observations
Data
Users
Logout
Gemini OT - [GS-2019A-TOO-1] TOM TOO Trigger Tests
File
Edit
View
Go
Tools
Help
Open
Prev
Back
Forward
Next
Cut
Copy
Paste
Plot
Image
Libraries
Apply
Reapply
Queue
Conflict
Sync
Observation
Group
Note
Component
Iterator
Observe
TOM TOO Trigger Tests
TOO Templates
[1] GMOS sToO 1.0arcs
[2] GMOS rToO 1.0arcs
TOM Triggers
[5] ZTF18acvvxzs
Finding Chart
Observing Condition
Target: ZTF18acvvx
GMOS-S
Observing Log
Sequence
[6] Endor
Finding Chart
Observing Condition
Target: Endor
GMOS-S
Observing Log
Sequence
Target Environment
Use this component to enter the base position and wave front sensor targets for this observation.
Type Tag
Name
RA
Dec
Dist
B
g
Base
Endor
04:55:58.600
-10:00:00.00
Auto
Auto
GMOS OIWFS (1)
401-007200
04:55:47.435
-09:58:03.60
3.36
11.697
11.353
Manual
Manual
GMOS OIWFS (1)
401-007200
04:55:47.435
-09:58:03.60
3.36
Base
Auto Guide Search:
Default (GMOS-S OIWFS)
Manual
Scheduling
Set To:
2018-Oct-31 17:30:00 UTC
Guide Group Name
Automatic Group
View
Create Target
View
Create Target

Gemini will better support AEON via the Gemini Program Platform (GPP) and GEMMA projects

GPP - core of a new OCS

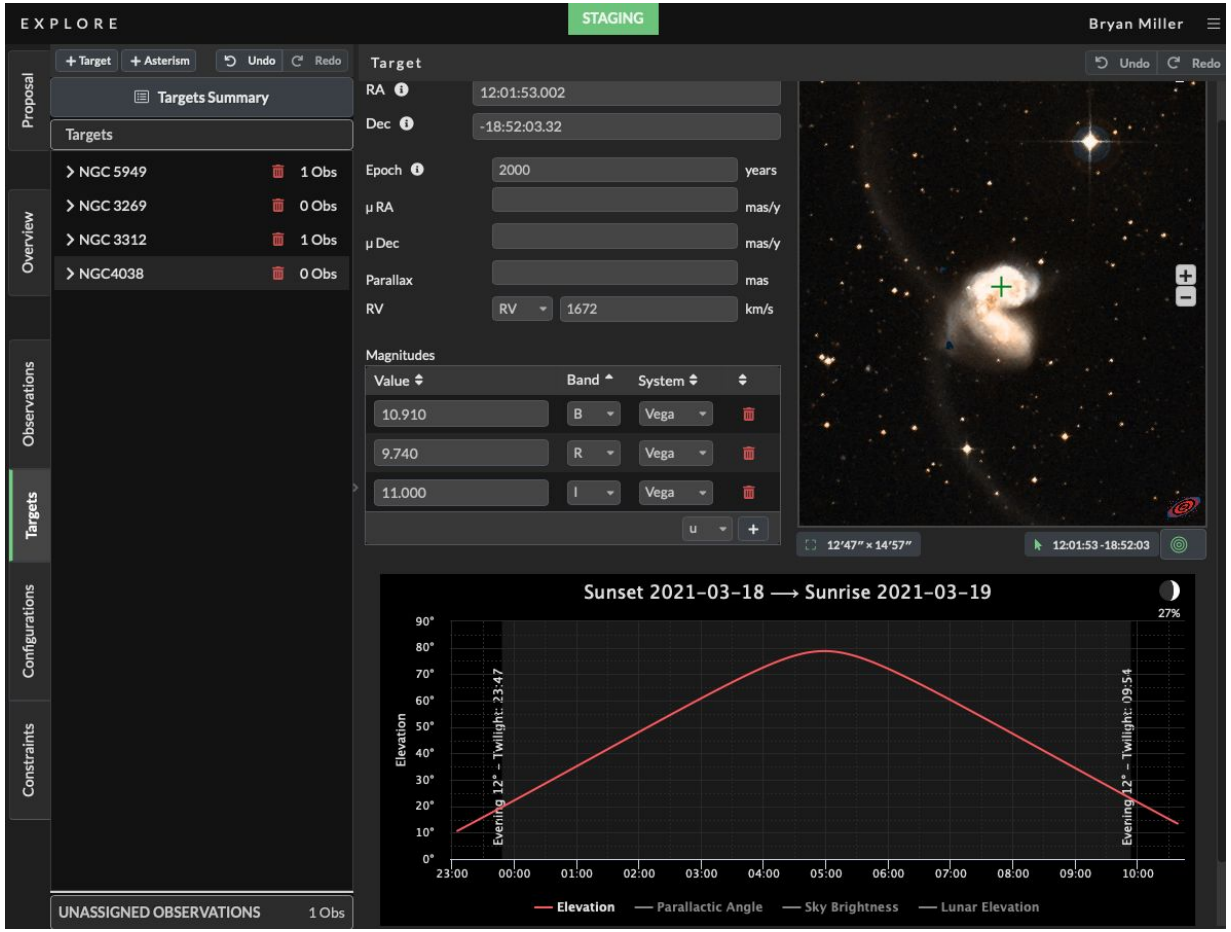
- Easier to use - replaces PIT, OT
- Web apps + APIs + database
- GN/GS observations in the same program
- Provides automation
- Constraints needed for the scheduler
- Makes code more maintainable

For more information:

GPP workshop this afternoon at 16:15.

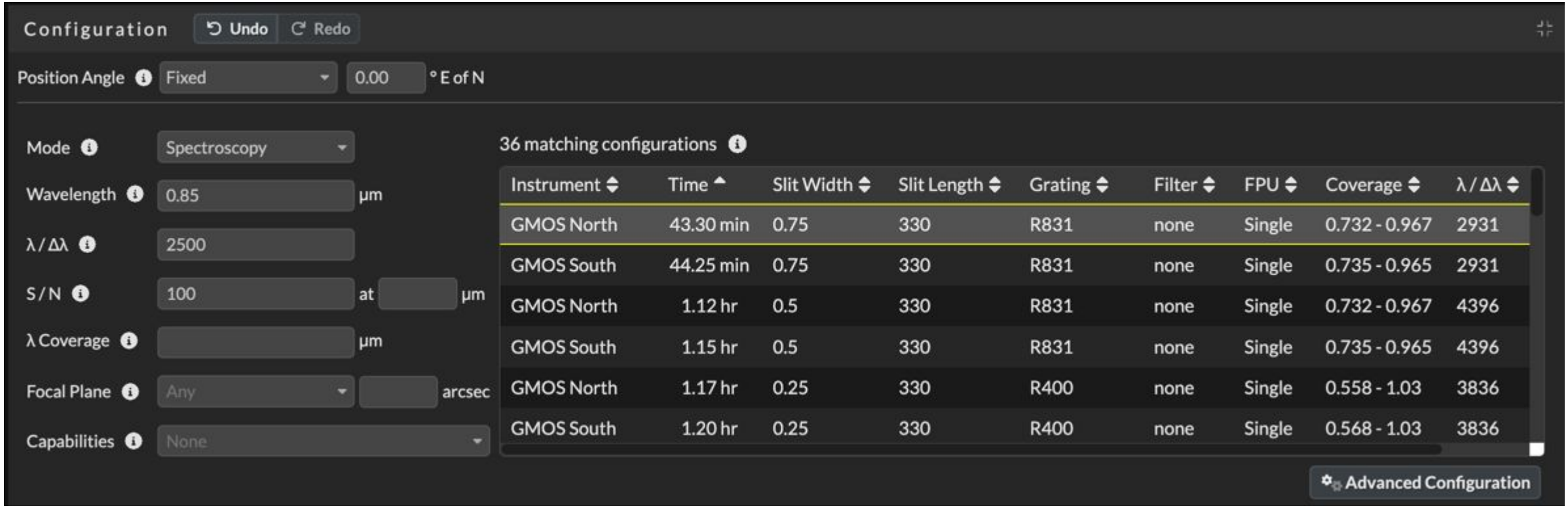
https://www.gemini.edu/observing/operations-development

https://noirlab.edu/public/products/mirro/mirror002/



GPP Explore web app

Explore will allow users to find the capabilities that meet their science needs w/o digging through web pages



The ITC calculates the integration time needed to reach the desired S/N.

Once a configuration is selected the sequence, including calibrations, is generated automatically

⇒ new way of doing future ToOs, template observations not required

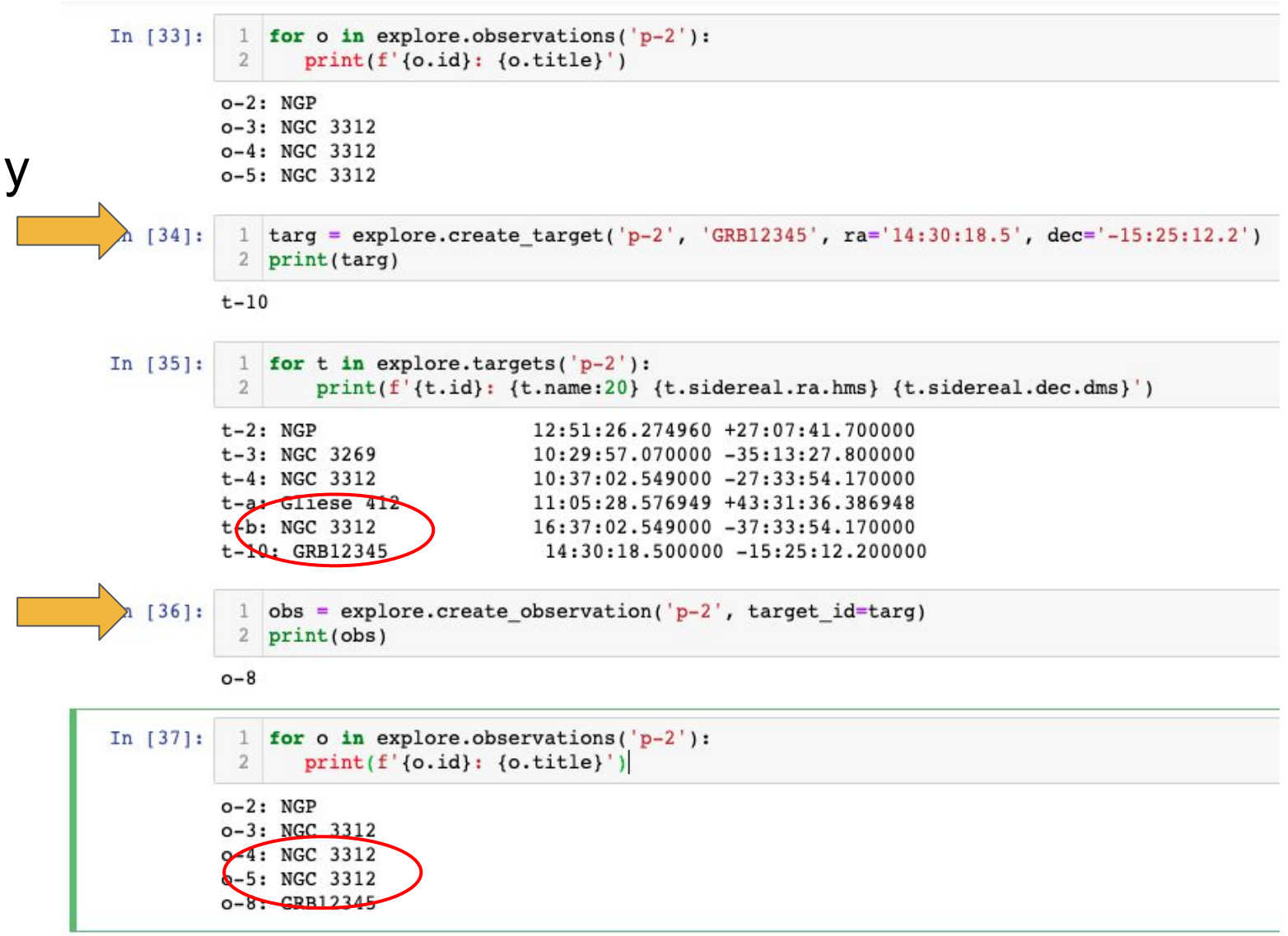
Everything that can be done with the Explore UI can be done programmatically…

Full program information can be accessed programmatically in scripts.

Targets/observations can be added, edited, and removed.

ToOs can be created from scratch using APIs and GPP automation

⇒ Not necessary to prepare ToO templates in advance



```
In [33]:
for o in explore.observations('p-2'):
    print(f'{o.id}: {o.title}')

o-2: NGP
o-3: NGC 3312
o-4: NGC 3312
o-5: NGC 3312
```

```
In [34]:
targ = explore.create_target('p-2', 'GRB12345', ra='14:30:18.5', dec='-15:25:12.2')
print(targ)

t-10
```

```
In [35]:
for t in explore.targets('p-2'):
    print(f'{t.id}: {t.name:20} {t.sidereal.ra.hms} {t.sidereal.dec.dms}')

t-2: NGP                  12:51:26.274960 +27:07:41.700000
t-3: NGC 3269             10:29:57.070000 -35:13:27.800000
t-4: NGC 3312             10:37:02.549000 -27:33:54.170000
t-a: Gliese 412           11:05:28.576949 +43:31:36.386948
t-b: NGC 3312             16:37:02.549000 -37:33:54.170000
t-10: GRB12345             14:30:18.500000 -15:25:12.200000
```

```
In [36]:
obs = explore.create_observation('p-2', target_id=targ)
print(obs)

o-8
```

```
In [37]:
for o in explore.observations('p-2'):
    print(f'{o.id}: {o.title}')

o-2: NGP
o-3: NGC 3312
o-4: NGC 3312
o-5: NGC 3312
o-8: GRB12345
```

We expect to start the GPP early science use and testing phase (XT) in early 2024.

XT1

- A special call for GMOS imaging/longslit (~Oct 2023)
- ~5% of telescope time (~100hr/tel) for a reasonable evaluation, scheduler testing

XT2

- Testing as new instruments/modes are implemented
- Convert existing programs, give PIs a time bonus as motivation

Full operations is currently expected in 2025.

We are gradually ramping up community testing as Explore becomes more complete.

Early testing will include:

- Filling in questionnaires on features and usability
- Mock use sessions
- Interviews
- Quantitative use tests (timed activities with old/new systems)

Let us know if you are interested in participating.

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GPP Demonstration and Testing Workshop
Today @ 16:15

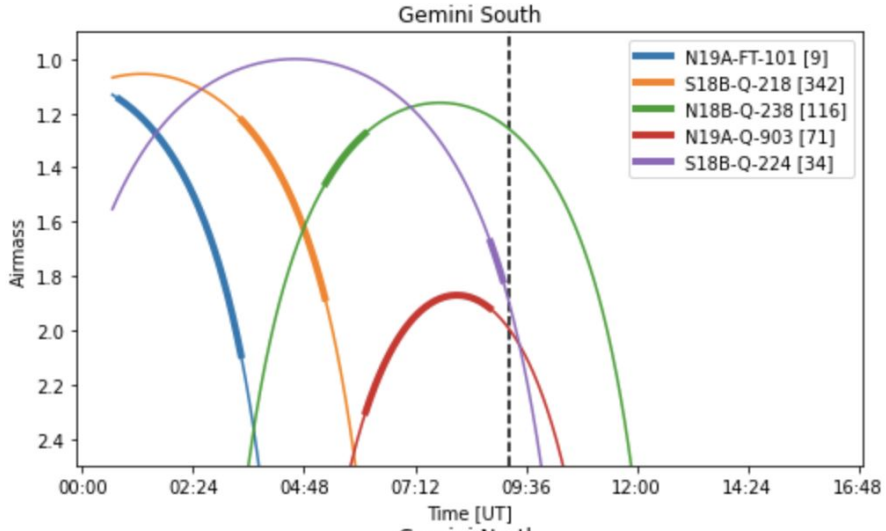
Gemini is implementing real-time scheduling and data reduction as part of the NSF-funded GEMMA (Gemini in the Era of Multi-Messenger Astronomy) project.

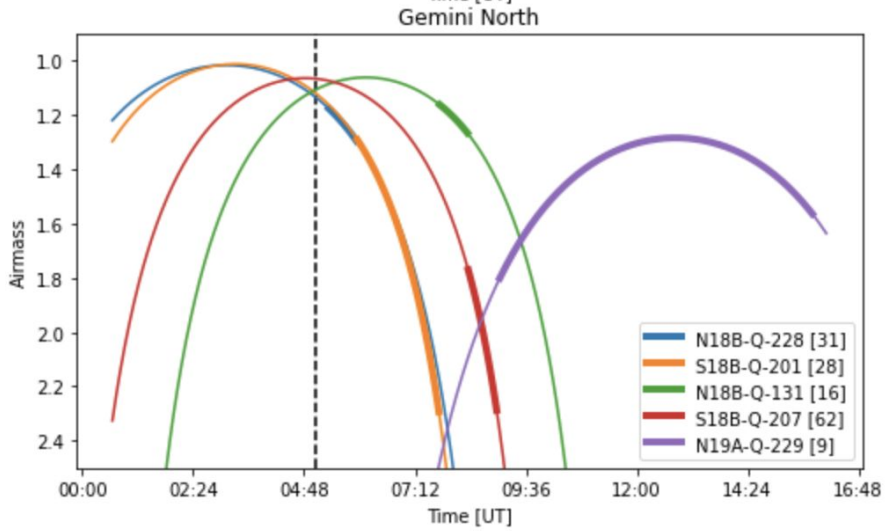
Scheduler - passed design review, under construction

- Updates plans in real-time (weather, ToOs, etc)
- Schedule Gemini North and South together
- More capable APIs

Real-time data reduction

- DRAGONS pipeline (see talks by K. Labrie, M. Soraisam)
- GMOS imaging/longslit initially
- Quick look reduction for QA in use
- Science quality reduction for 2023
- Archive updates





https://www.gemini.edu/gemma/
https://github.com/GeminiDRSoftware/DRAGONS

Summary

Gemini is aiming to be the premier 8-m class member of a follow-up network that will consist of:

- Brokers (alert filters)
- TOMs (target/resource matching)
- Dynamic scheduling and execution
- Telescopes from 1m aperture and up with workhorse instruments
- Real-time data reduction pipelines

Gemini is constructing a new observing system to support follow-up and to make using Gemini easier for everyone.

Community involvement will be vital.

https://www.gemini.edu/observing/operations-development