

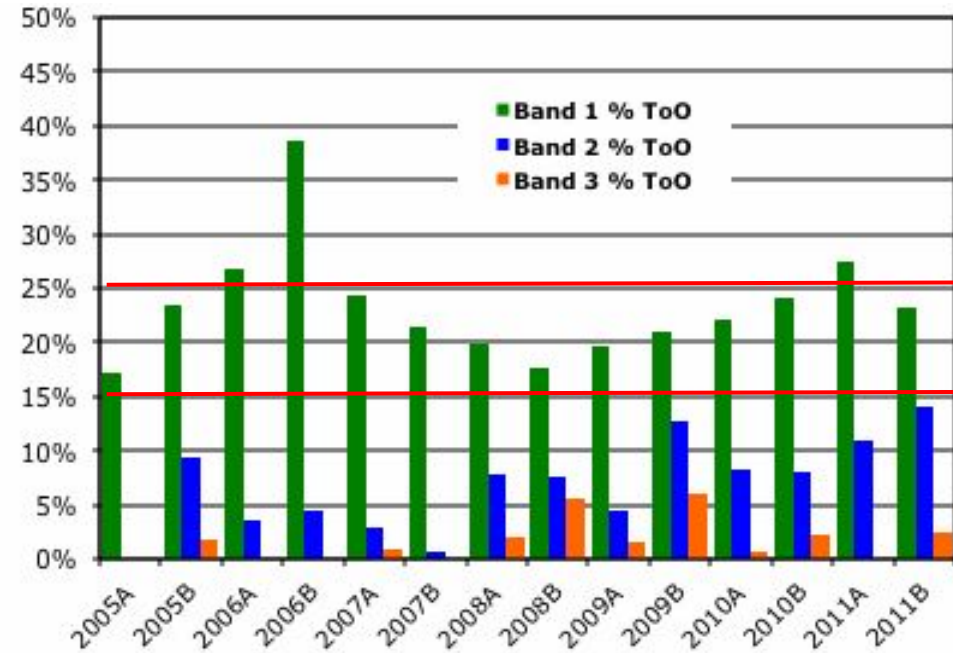
Next Generation TDA at Gemini: AEON, TOMs, GPP

Bryan Miller, Andy Stephens, and Arturo Núñez
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.



Alert streams

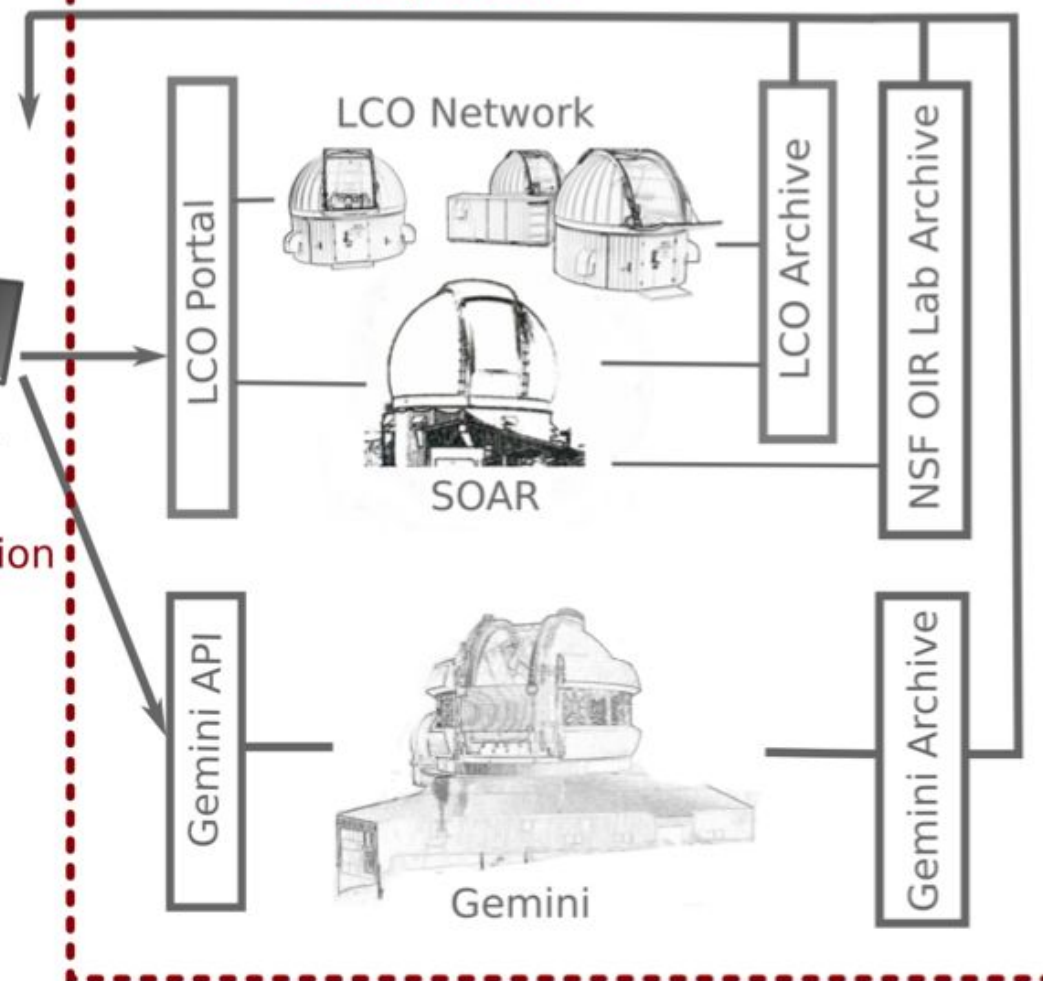
Data catalogues



Filtered alerts

Observation requests

Data products



Surveys

LSST
ZTF
Gaia
ASAS-SN
++more

Brokers & Catalog Servers

ANTARES, Lasair
ALeRCE, Simbad
Vizier, MAST, CADC,
++ more

TOM Systems

Astronomer-led
projects



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

Optical

GMOS-N

GNIRS

IGRINS-2

Near-IR

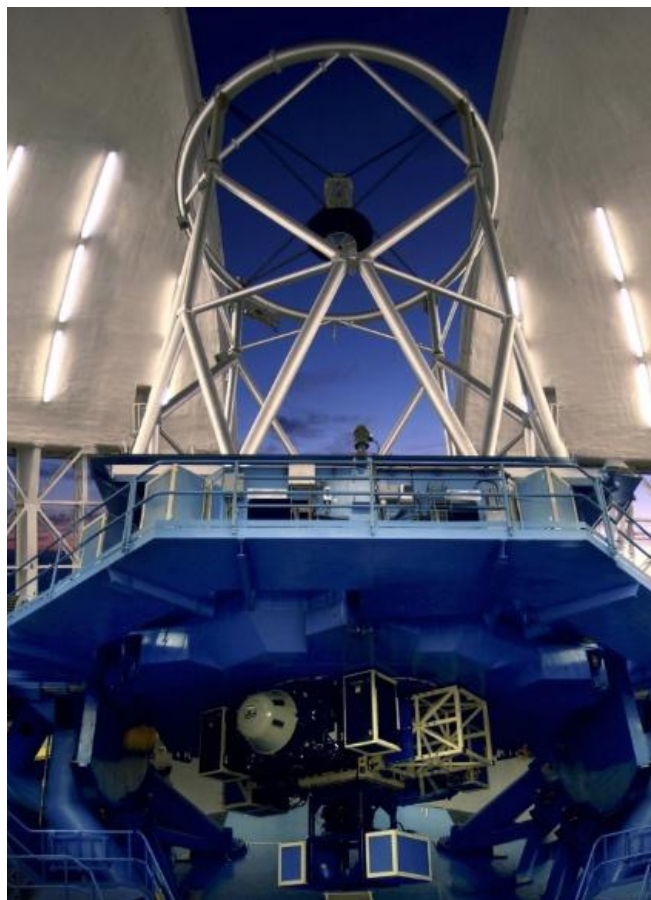
NIRI

GPI-2

AO

ALTAIR

NGS & LGS



Gemini South

GMOS-S

SCORPIO*

GHOST

FLAMINGOS-2

SCORPIO*

GSAOI

GeMS (MCAO)

LGS (5)

Mid 2020s facility instrumentation



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

TOM Toolkit Home Targets Alerts Observations Data Users

Query a Broker

Create a new query using MARS Lasair Scout TNS ANTARES Gaia MyBroker AutoBroker

Scout

Name	Broker	Created	Last Run	Run	Delete
Hoth	MyBroker	2019-10-03 21:10:15	2021-01-07 15:01:22	Run	Delete
Score >50	AutoBroker	2019-10-03 22:10:27	2019-12-05 18:12:56	Run	Delete
Soraisam	ANTARES	2021-01-07 15:01:52	2021-01-07 15:01:19	Run	Delete

TOM Toolkit Home Targets Alerts Observations Data Users Bryan (bmiller)

ANT2018c7igm

Update Target Delete Target

Names: ANT2018c7igm
 Target Type: SIDEREAL
 Right Ascension: 280.6927
 Declination: -12.9041

Tags

Recent Photometry

Timestamp	Magnitude
No recent photometry.	

Survey View

Observe Observations Manage Data Manage Groups Photometry

Spectroscopy Facility Status

Observe

LCO GEM SOAR LT

Plan

Start Time: 06/16/2021 ✓

End Time: 06/18/2021 ✓

Maximum Airmass: 2.0 ✓

Plan

Legend:

- (LCO) Siding Spring
- (LCO) Sutherland
- (LCO) Teide
- (LCO) Cerro Tololo
- (LCO) McDonald
- (LCO) Haleakala
- (GEM) Cerro Pachon
- (GEM) Maunakea
- (SOAR) Cerro Pachon

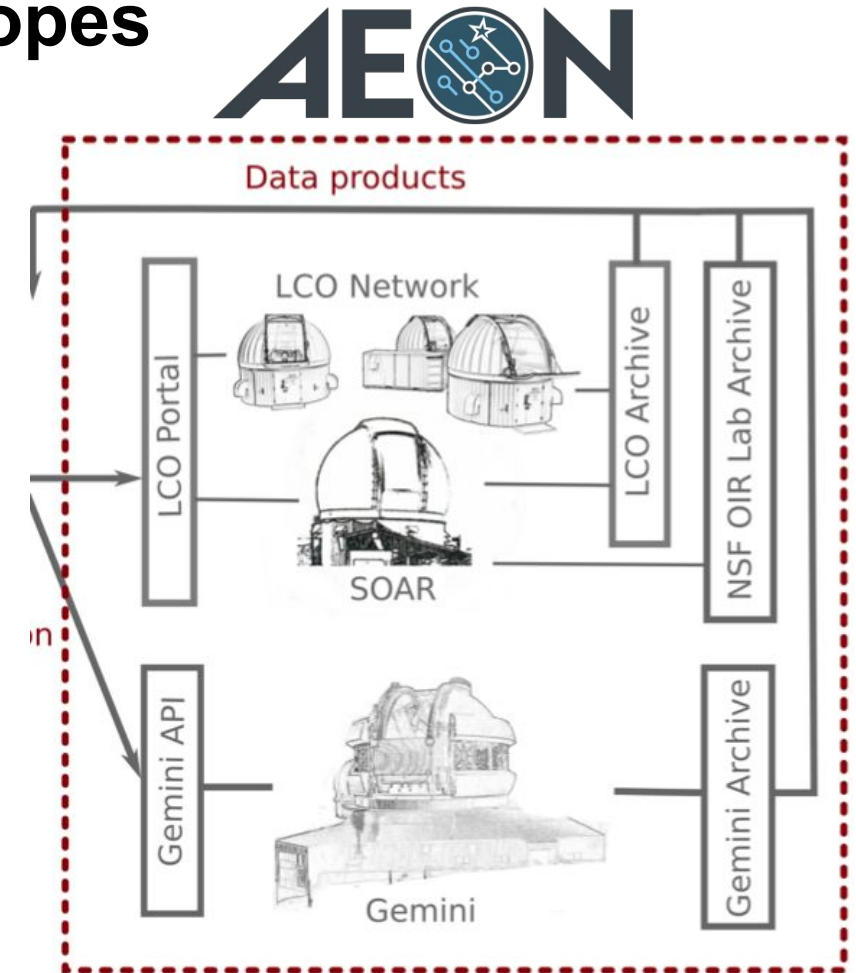
In use by SNe, exoplanet, NEO, AGN, and microlensing teams.

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)



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 JWST Synergy: Yes

Time Awarded: NaN Thesis: Yes Band 3 Minimal Time: 2.0 hr

Band 3 Acceptable: Yes Band 3 Time: 4.4 hr

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

Partner	Lead	PI Request Time	Min	NTAC Recommendation		
				Reference	Time	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	0.0 hr	0.0 hr	
Total Time				17.7 hr	10.0 hr	

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.

The screenshot shows the "Time Requests" dialog box with the following settings:

- Proposal Class: Queue Observing at Gemini
- Consider for Band 3: Yes (4.40 hr (2.00 hr minimum) requested)
- ToO Activation: Standard
- AEON/Multi-facility: Yes

The "Gemini Time Required" sub-dialog is open, displaying the following text:

Please indicate whether the time for each site/instrument is a required part of a multi-facility proposal, e.g. the project is infeasible without it. This information will be used for scheduling purposes and will not be shown to the TACs

Site	Instrument	Time	Required
Gemini North	MAROOX-X	1.0 h	<input type="checkbox"/>
Gemini North	GMOS North	6.0 h	<input checked="" type="checkbox"/>
Gemini North	GNIRS	13.0 h	<input type="checkbox"/>

Buttons: Ok, Cancel

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/gselect>
- [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

Submit an observation to GEM

[Gemini Observation](#)

Observation Parameters

Obsid* Ready*

S19ATOO1[1] Std: GMOS B600 1.0arcsec
S19ATOO1[2] Rap: GMOS B400 1.0arcsec
S19ATOO1[9] GMOS Acq 1.0arcsec
N19ATOO1[1] Std: GMOS B600 1.0arcsec

Yes

Position Angle in degrees [0-360] Exptime [sec]. If multiple, comma separate

90

900,30

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)

File Edit View Go Tools

Open Prev Back Forward Next

Observation

Group

Note

Component

Iterator

Observe

TOM TOO Trigger Tests

TOO Templates

[1] GMOS sToO 1.0

[2] GMOS rToO 1.0

TOM Toolkit | Target ZTF18acvvxsMARS - Las Cumbres Observatory

TOM Toolkit Home Targets Alerts Observations Data UsersLogout

24582683

Update TargetDelete Target

Observe

ObservationsData

Observe

LCOGEM

Plan

Start Time

2018-12-28 00:00:00

End Time

2018-12-30 00:00:00

Maximum Airmass

2.5

Plan

Comments

No comments yet.

Comment

Identifier

24582683

Name

ZTF18acvvxs

Target Type

SIDEREAL

Right

163.8799288

Ascension

Declination

-6.9325053

Epoch Of

None

Elements

Proper Motion

None

(Ra)

Proper Motion

None

(Declination)

Galactic

259.237934300125

Longitude

Galactic

45.8752653321367

Latitude

Distance

None

Distance Error

None

aimage

0.773999989032745

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

GPP - core of a new OCS

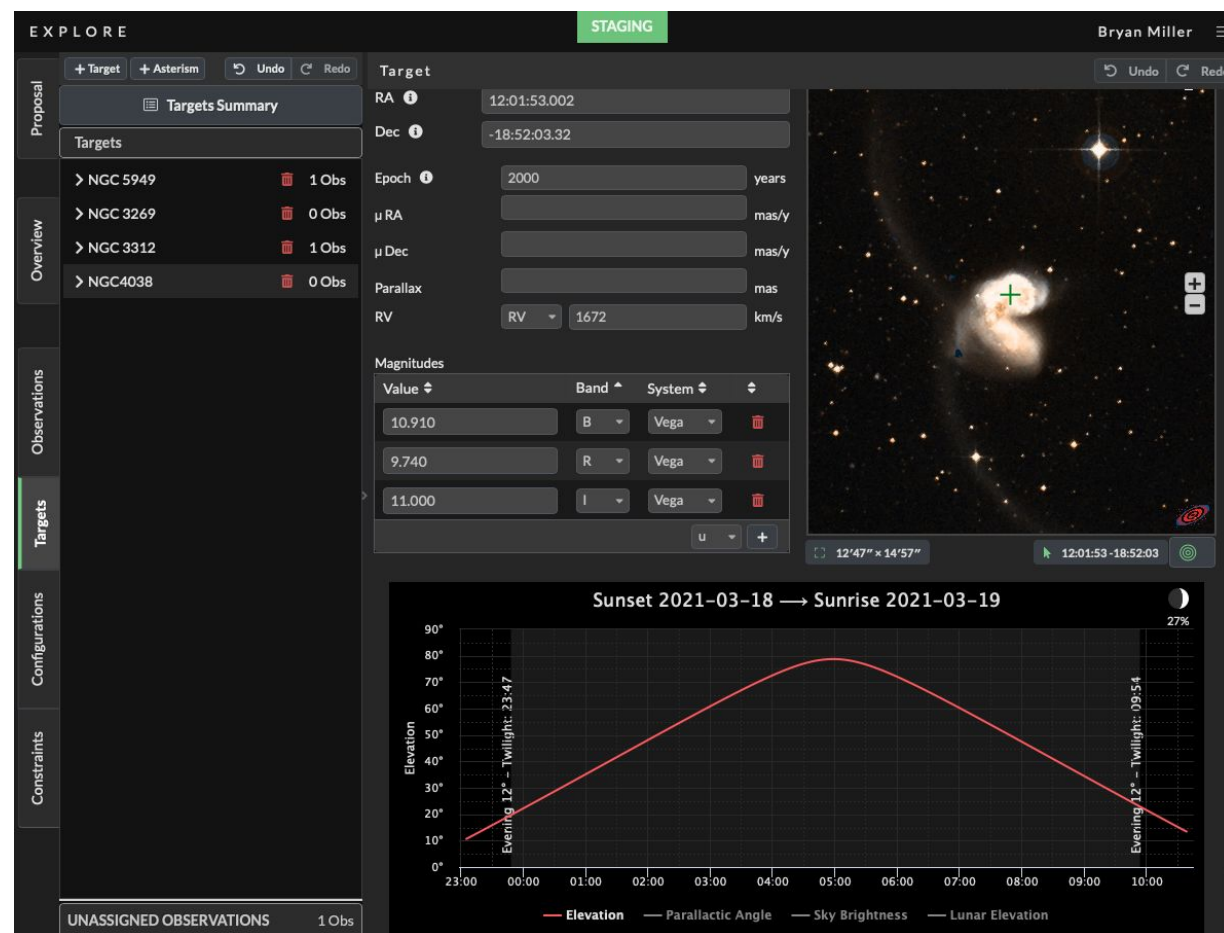
- Easier to use - replaces PIT, OT
- Web apps + APIs + database
- GN/GS observations in the same program
- Provides automation
- Constraints needed for the scheduler
- Makes code more maintainable

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 screenshot shows a 'Configuration' window with various search filters on the left and a table of results on the right. The filters include Position Angle (Fixed, 0.00 ° E of N), Mode (Spectroscopy), Wavelength (0.85 μm), λ / Δλ (2500), S / N (100 at μm), λ Coverage (μm), Focal Plane (Any arcsec), and Capabilities (None). The table on the right is titled '36 matching configurations' and lists 6 rows of data.

Instrument	Time	Slit Width	Slit Length	Grating	Filter	FPU	Coverage	λ / Δλ
GMOS North	43.30 min	0.75	330	R831	none	Single	0.732 - 0.967	2931
GMOS South	44.25 min	0.75	330	R831	none	Single	0.735 - 0.965	2931
GMOS North	1.12 hr	0.5	330	R831	none	Single	0.732 - 0.967	4396
GMOS South	1.15 hr	0.5	330	R831	none	Single	0.735 - 0.965	4396
GMOS North	1.17 hr	0.25	330	R400	none	Single	0.558 - 1.03	3836
GMOS South	1.20 hr	0.25	330	R400	none	Single	0.568 - 1.03	3836

Advanced Configuration

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

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



```
[34]: 1 targ = explore.create_target('p-2', 'GRB12345', ra='14:30:18.5', dec='-15:25:12.2')
       2 print(targ)
```

```
t-10
```

```
In [35]: 1 for t in explore.targets('p-2'):
          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
```



```
[36]: 1 obs = explore.create_observation('p-2', target_id=targ)
       2 print(obs)
```

```
o-8
```

```
In [37]: 1 for o in explore.observations('p-2'):
          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.

andrew.stephens@noirlab.edu

bryan.miller@noirlab.edu



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

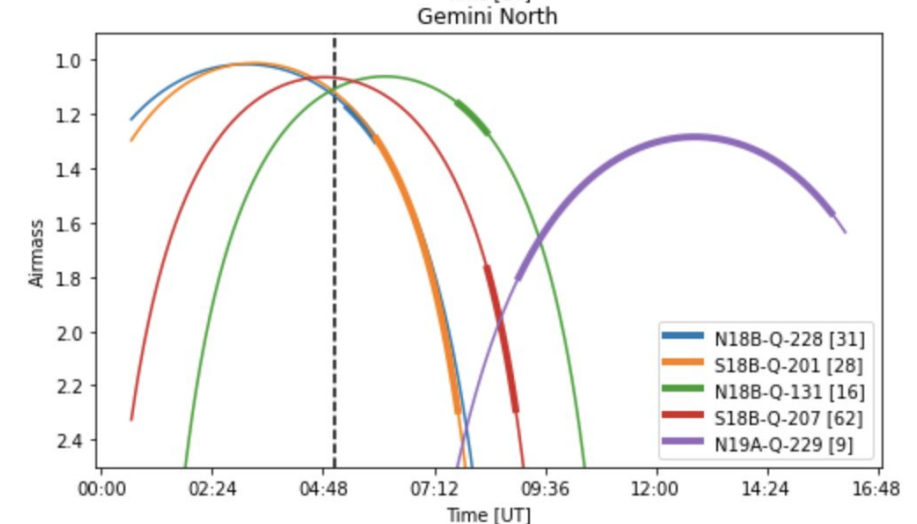
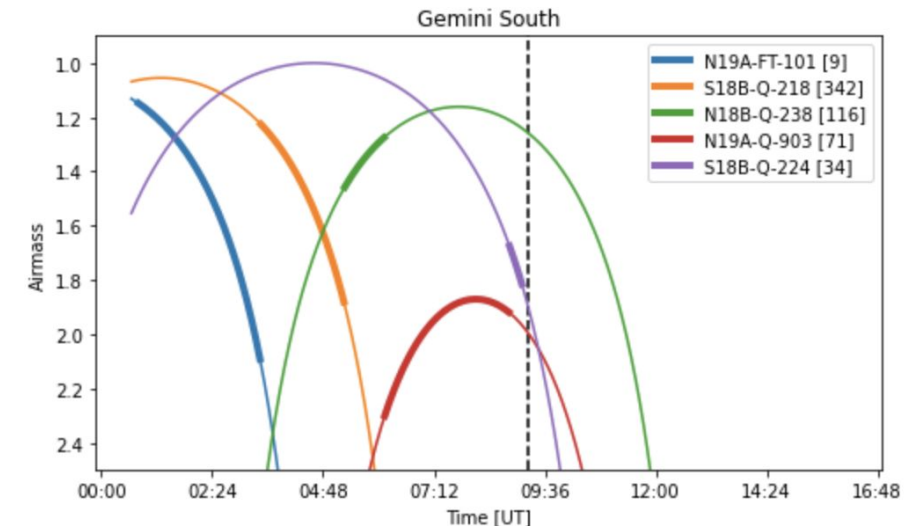
Real-time data reduction

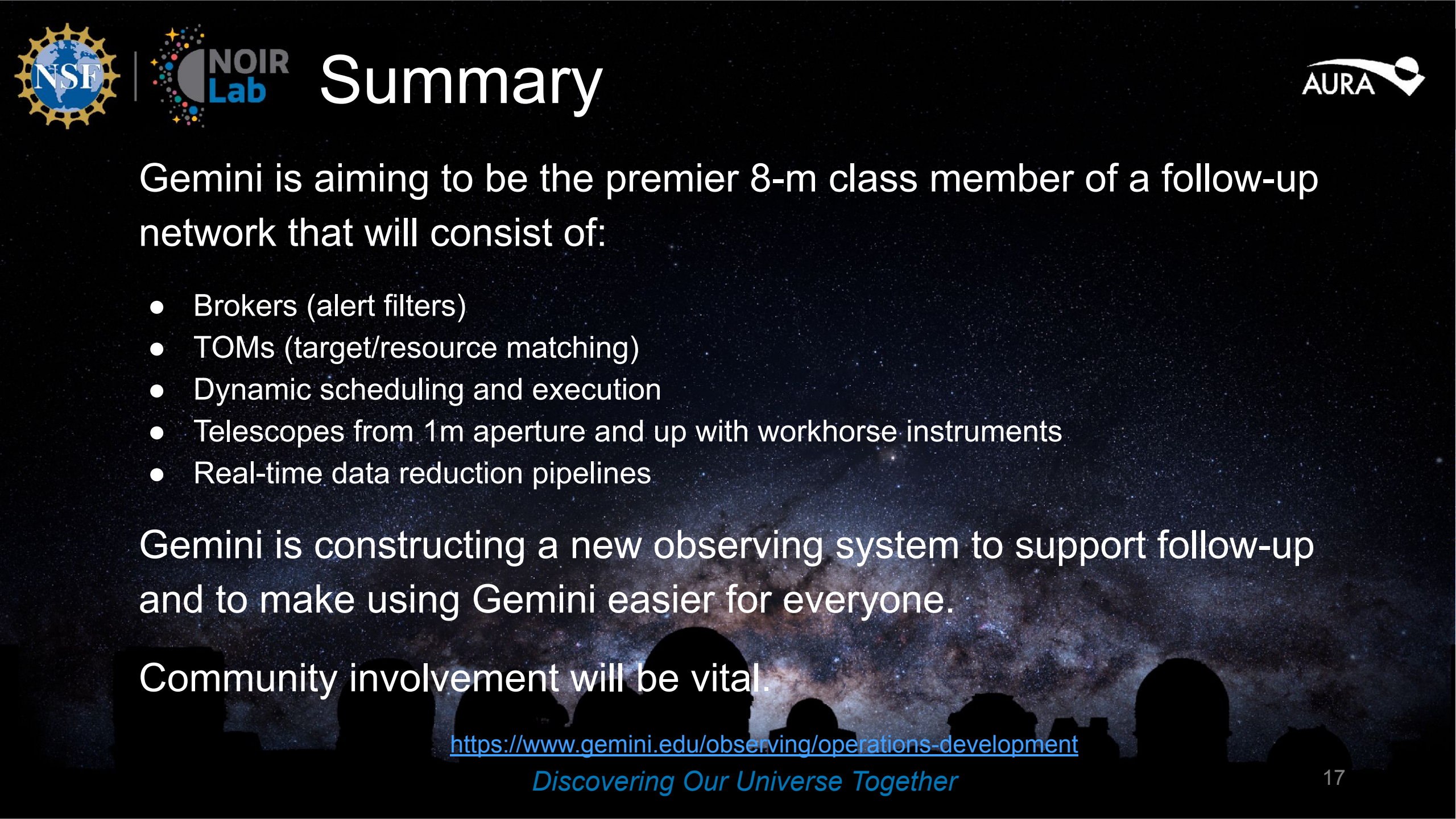
- DRAGONS pipeline (see talks by K. Labrie, M. Soraisam)
- GMOS imaging/longslit initially
- Quick look reduction for QA in use
- Science quality reduction for 2023
- Archive updates



<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>

Discovering Our Universe Together