ToO Follow-up Network: Gemini Perspective

Bryan Miller

Andy Adamson, Andy Stephens, Arturo Núñez, and the AEON team

"Beyond 2021, Gemini should exploit its geographical location and agile operational model in order to be the premiere facility for the follow-up investigation of targets identified by the Large Synoptic Survey Telescope." - Beyond 2021: Strategic Vision

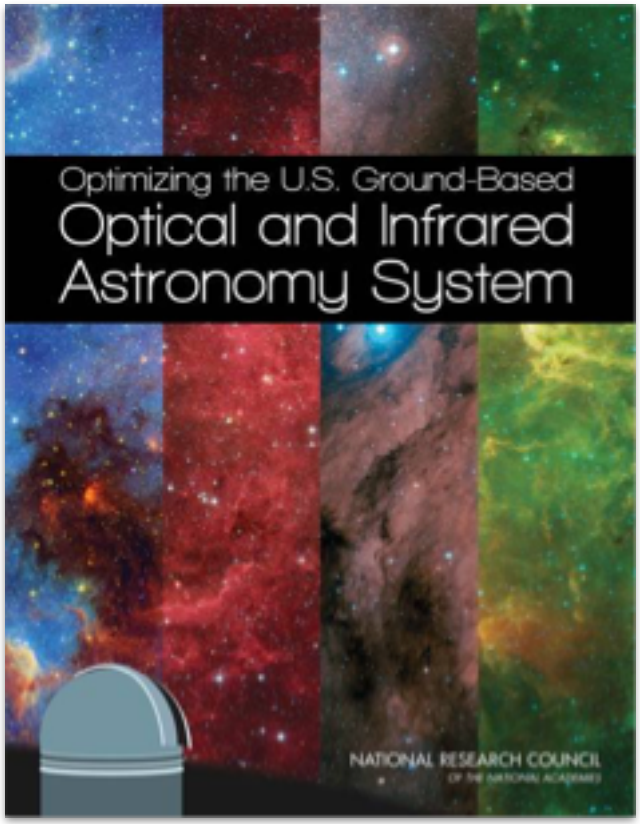
Gemini is following the recommendations of the 2015 "Elmegreen" report:

- Recommendation 4b: high throughput, broad wavelength spectrograph

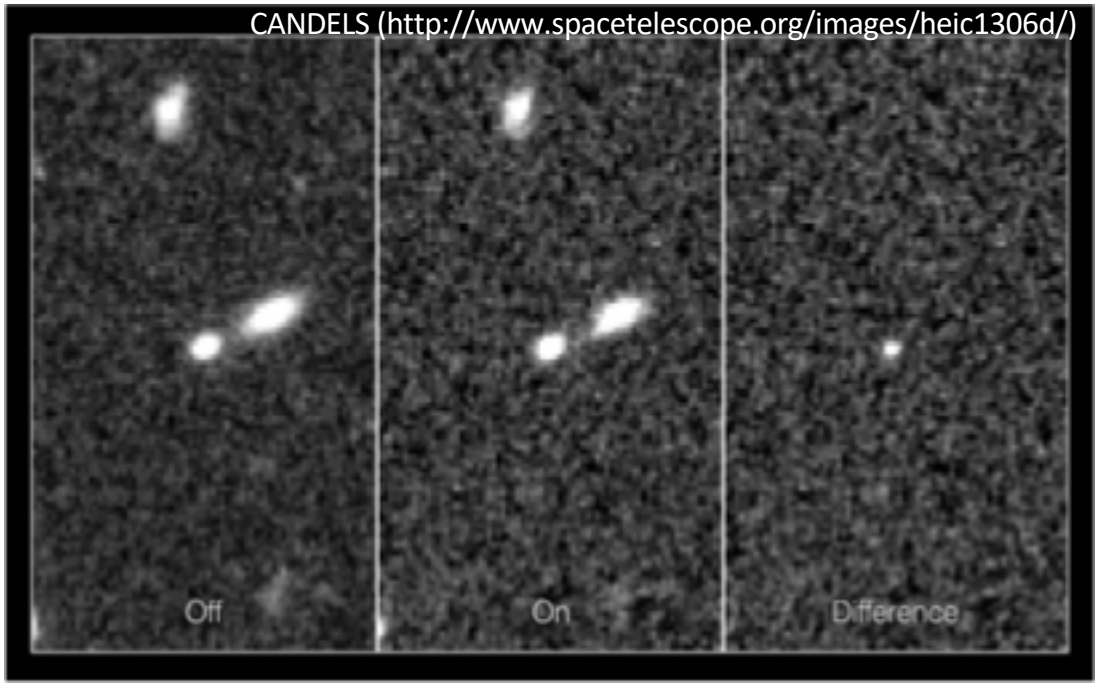
→ SCORPIO

- Recommendation 4d: coordination among NSF facilities, especially in Chile, to optimize LSST follow-up studies

→ AEON: NOAO/SOAR/Las Cumbres/Gemini collaboration to create a system for performing dynamic queue-scheduled observations and automating follow-up



Why all the fuss? In operation LSST will generate ~10^7 transient alerts per night!

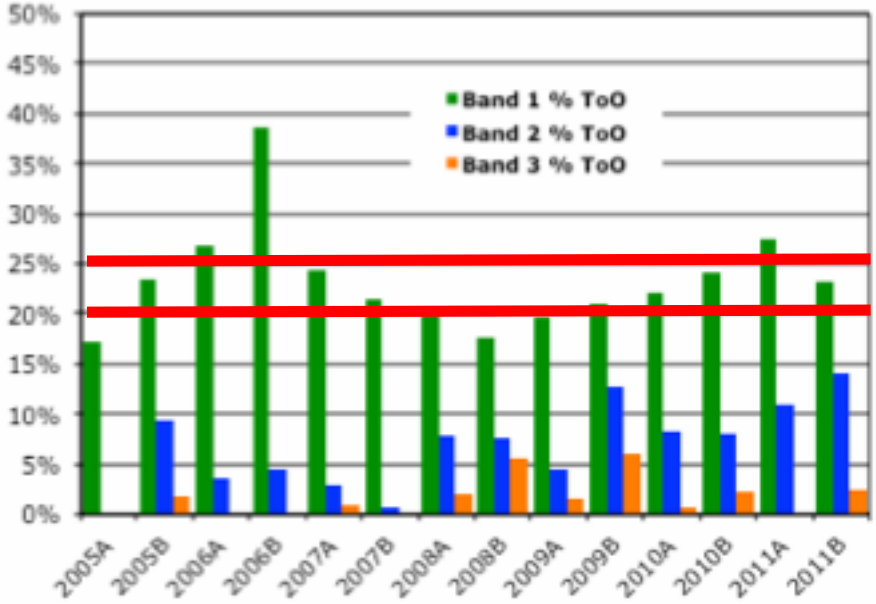


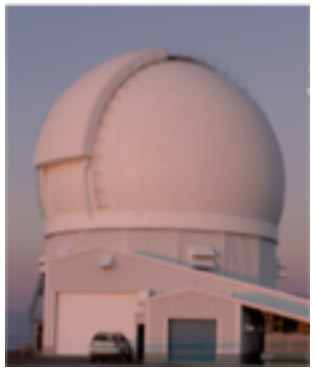
- 2 x 15 sec exposures/visit ⇒10^4 alerts within 60 sec
- Gemini must prepare for *Order(10-100)* triggers/night/tel plus regular queue

Such high event rates will likely swamp current ToO handling procedures

At Gemini, ToOs make up about 20-25% of the time in Band 1

- Max rates are 1-2/night
- Many more will overwhelm the manual scheduling process and observers





At CTIO/SOAR, ToOs interrupt visitor nights

- Many more will be disruptive to standard programs

A new solution is needed!

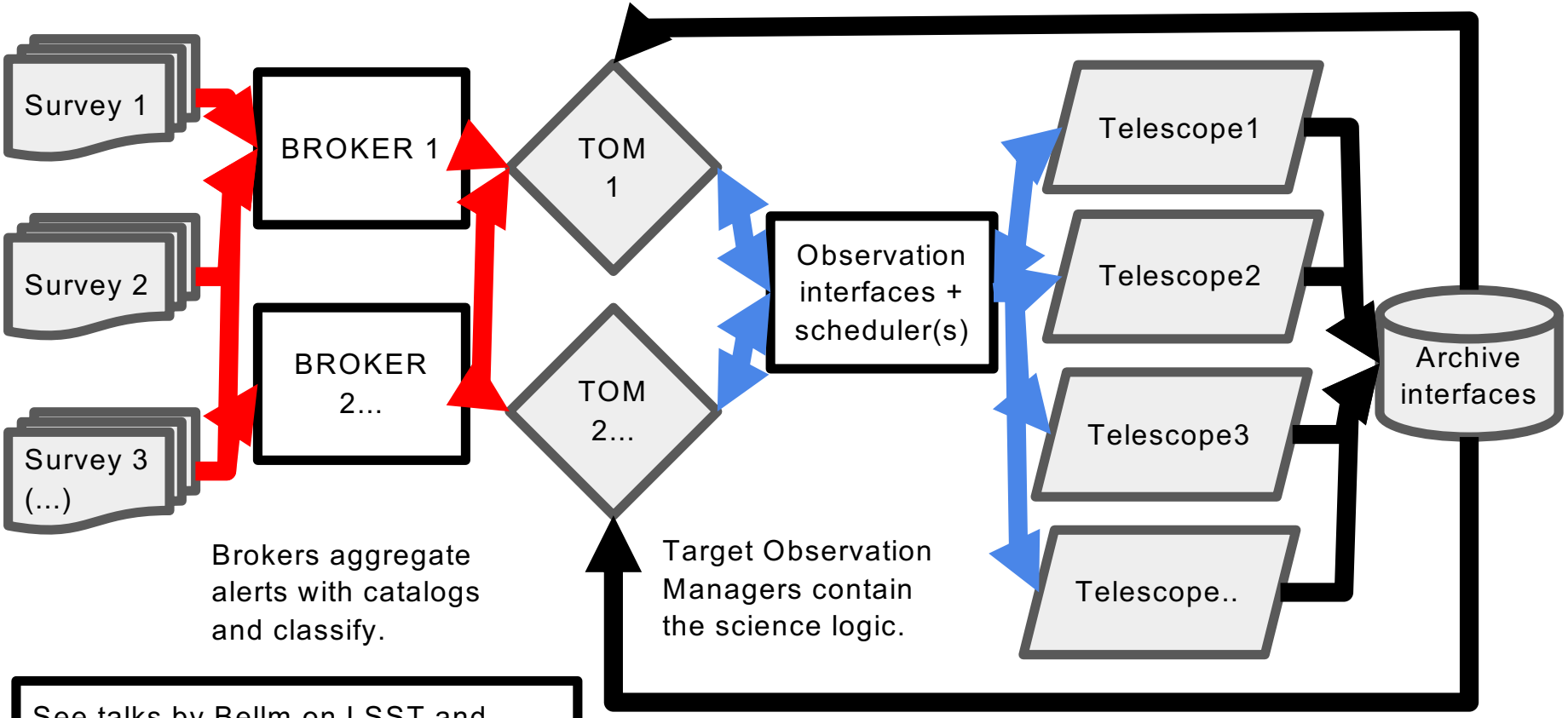
The proposed solution is a follow-up system that dynamically turns alerts into requested data.

"Here is an event"

"Request everything matching these criteria"
"Here is what I learned"

"Observe X with parameters Y"
"Tell me status of X"

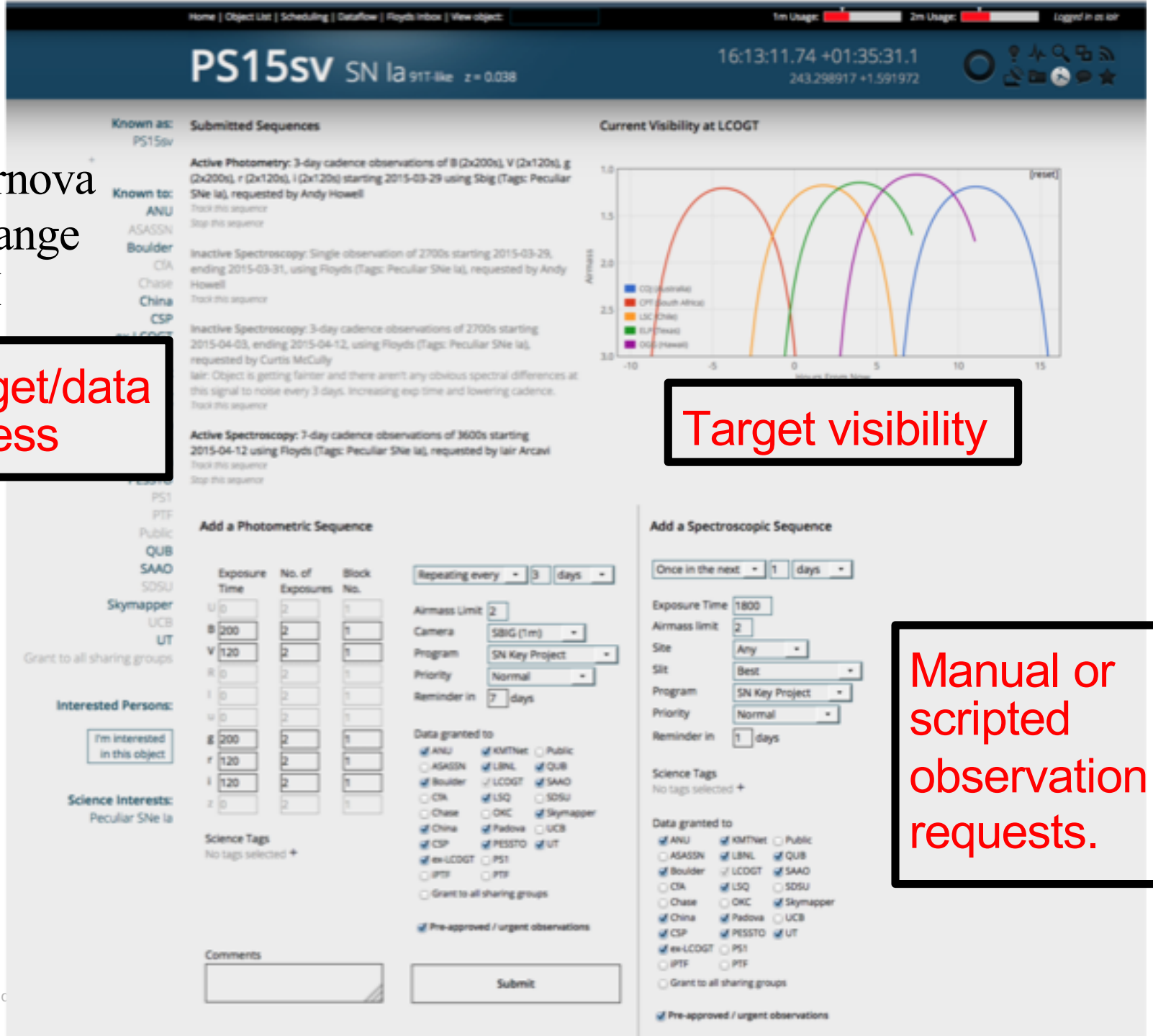
"Send me data of X"



See talks by Bellm on LSST and Matheson on ANTARES.

[Time domain infrastructure workshop](https://www.noao.edu/meetings/lsst-tds/)
(https://www.noao.edu/meetings/lsst-tds/)

Supernova Exchange TOM



Target/data access

Target visibility

Manual or scripted observation requests.

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

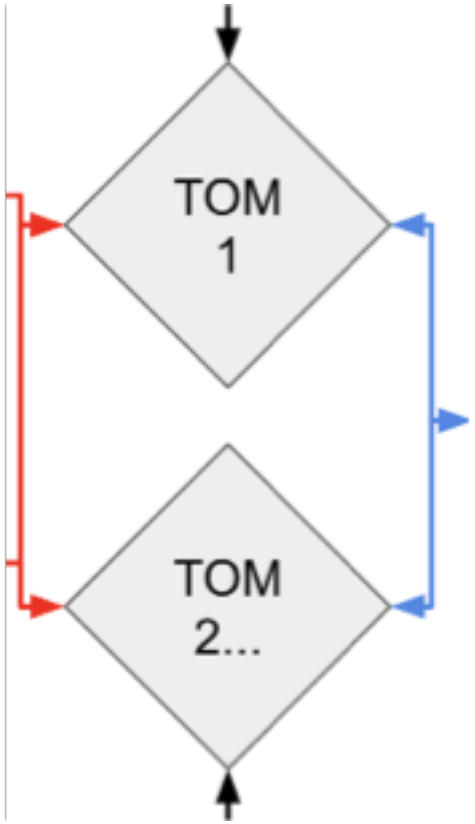
TOMs make up the main science layer:

- Collect and prioritize targets from alert streams (e.g. brokers)
- Are aware of available resources
- Request observations
- Collect and display the returned data
- Manage data access for members
- Share information between interested parties

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

Las Cumbres is developing “toolkits” to make these easier to create.

“Request everything matching these criteria”
“Here is what I learned”

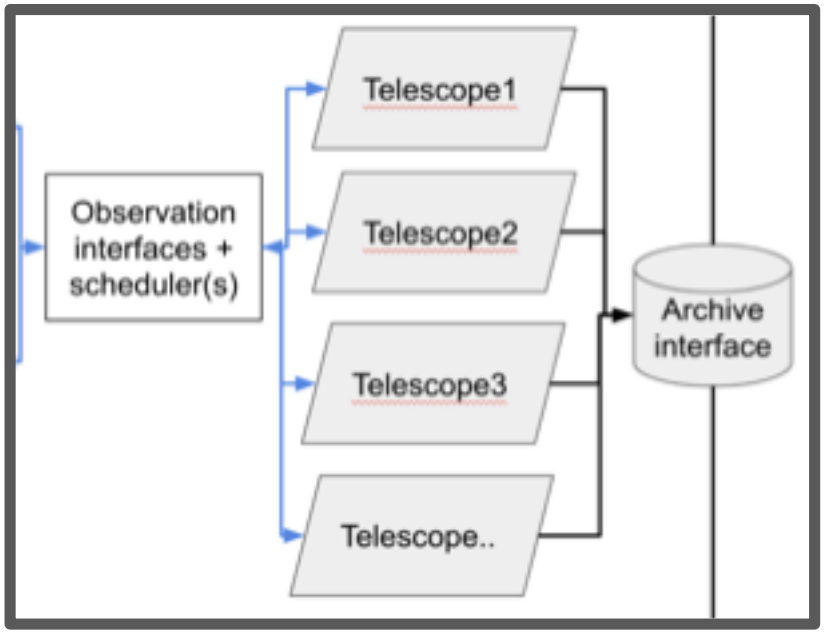


NOAO/SOAR/Las Cumbres/Gemini are working to dynamically schedule request from TOMs on SOAR, Gemini, Blanco, others...

Rachel Street (LCOgt, PS)
Bryan Miller (Gemini, PS)
Stephen Ridgway (NOAO, PS)
Cesar Briceno (NOAO/SOAR)
Andy Adamson (Gemini)
John Blakeslee (Gemini)
Adam Bolton (NOAO)
Bob Blum (NOAO/NCOA)
Todd Boroson (LCOgt)
Jay Elias (SOAR)
Steve Heathcote (NOAO)
Catherine Merrill (NOAO)
Joanna Thomas-Osip (Gemini)

Astronomical Event Observatory Network (AEON):

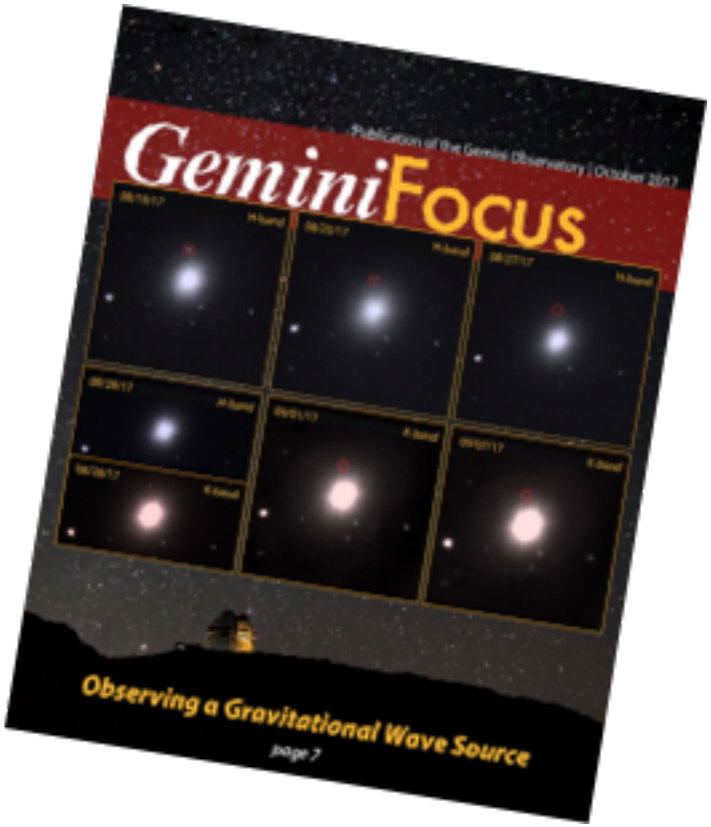
1. Develop interfaces (APIs)
   a. TOMs to send requests
   b. Send schedule
   c. Receive status
2. Incorporate SOAR into LCOgt network, execute observations on dedicated nights
3. Coordinate data pipelining and archiving efforts
4. Incorporate Gemini, modify scheduler to handle queue
5. Be ready to incorporate other facilities (Blanco, etc)



Gemini will support AEON observation interfaces and scheduling as part of the ongoing OCS Upgrades Program

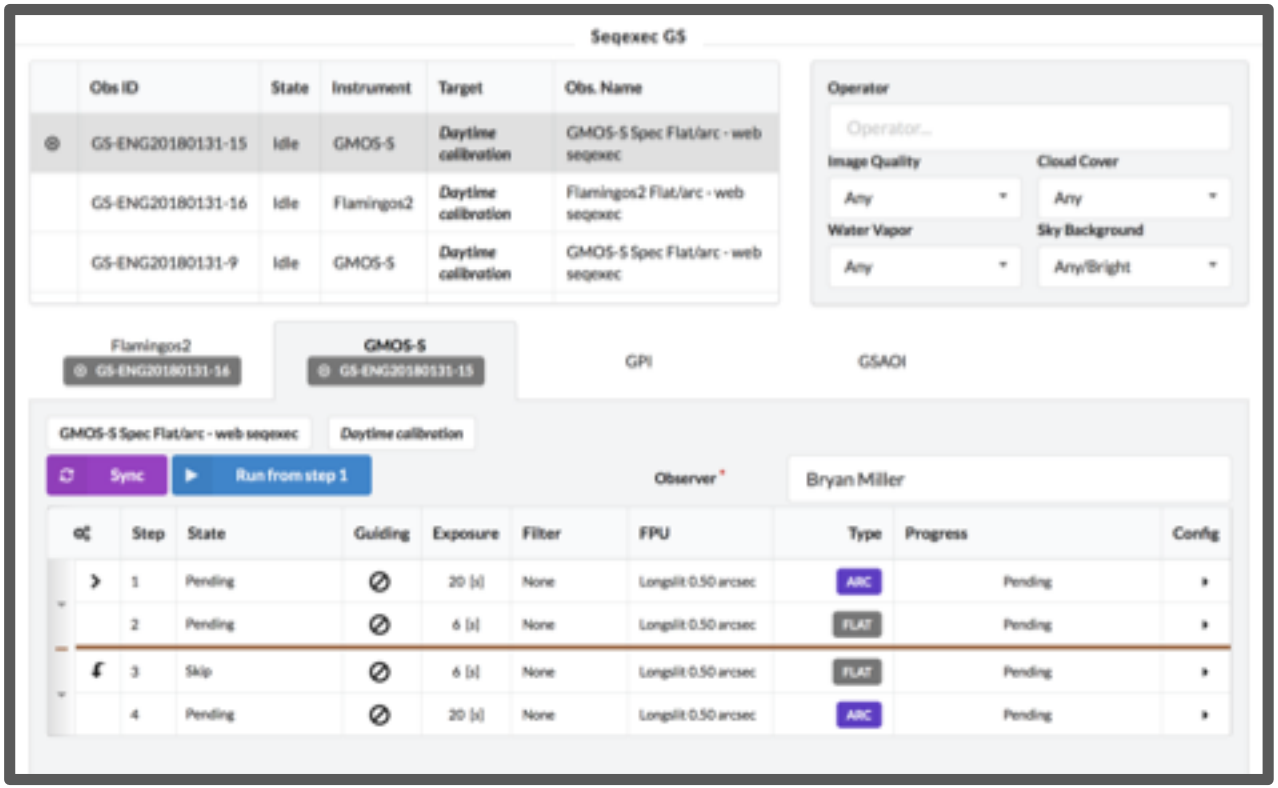
Goals:

- Rethink the purpose and UI from first principles
- Make Phase 2 preparation much easier
- Include new features that are not possible in the current code
- Make the code maintainable and scalable



See Oct 2017 Gemini Focus, pg. 20

The OCS Upgrades Program is currently developing infrastructure

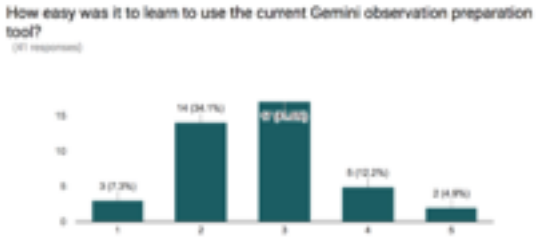


A new web-based seqexec can control F2, GMOS, GNIRS, GPI in *parallel*

The database is Postgres for speed, scalability

We are planning to move to web apps - future development will use the same technology

We are also preparing for a full Operations Concepts review in August



Research includes:

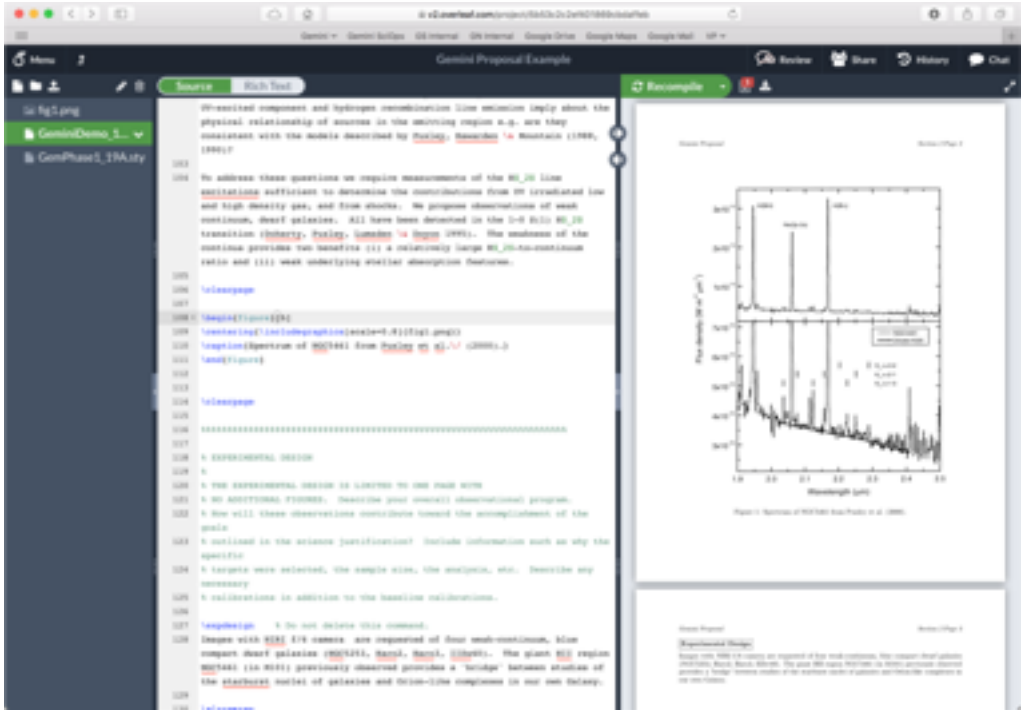
- Strategic planning documents and feedback from committees (Board, STAC, UCG, OpsWG)
- Internal operations reviews
- Helpdesk tickets

- User surveys
- One-on-one interviews with Gemini staff, NGO staff, and community users.
- Discussions by an OCS Upgrades Working Group (Gemini/NGO staff, community users)

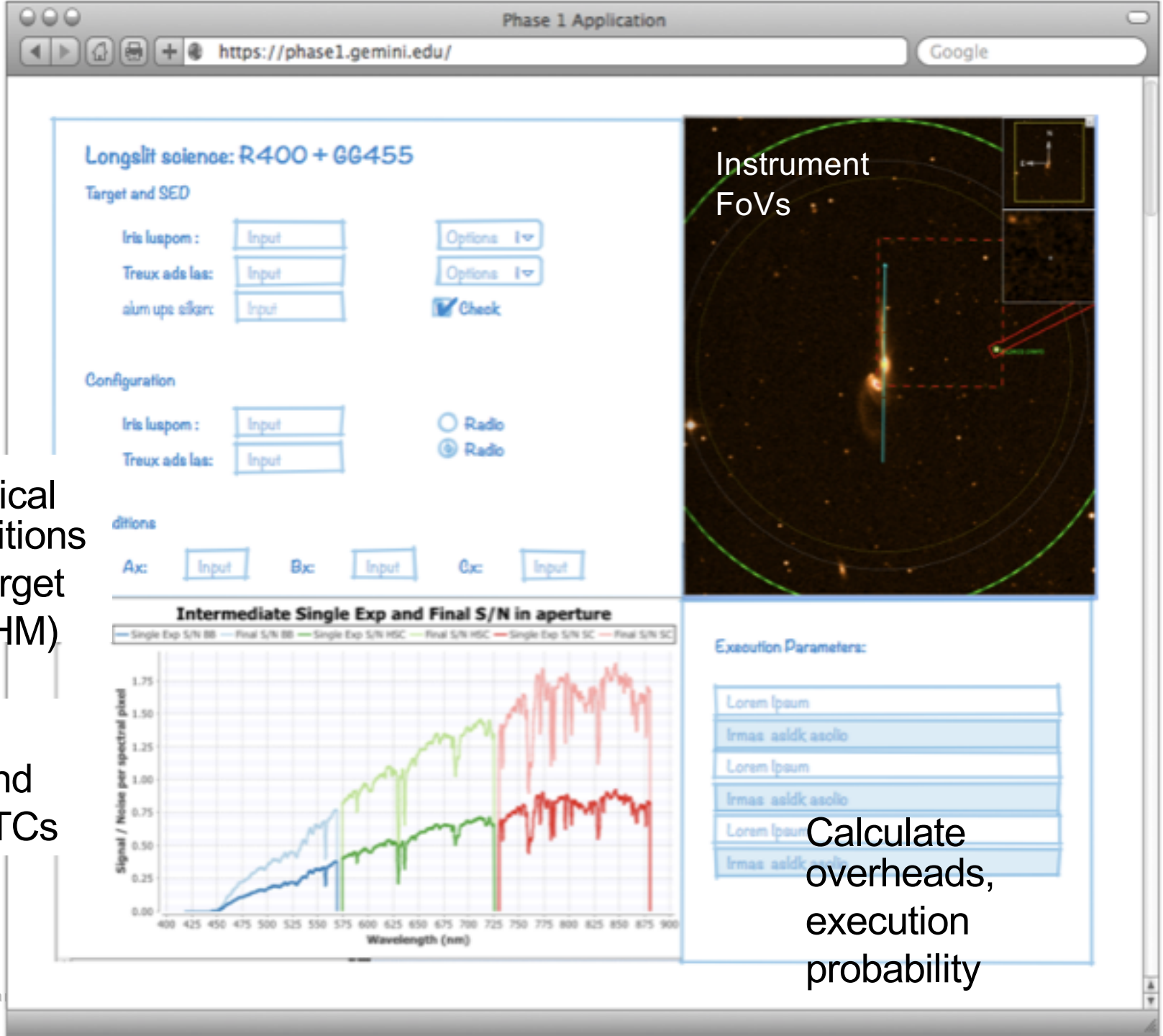
The proposal process should be collaborative and provide assistance with finding the right instrument

Have a Phase “0” tool for discovery of the appropriate instrument/mode for a project

- Near-IR spec, R~2000
  ⇒ F2, GNIRS
- Optical spec, R > 20000
  ⇒ GHOST, GRACES
- Imaging, FWHM < 0.1”
  ⇒ GSAOI, NIRI



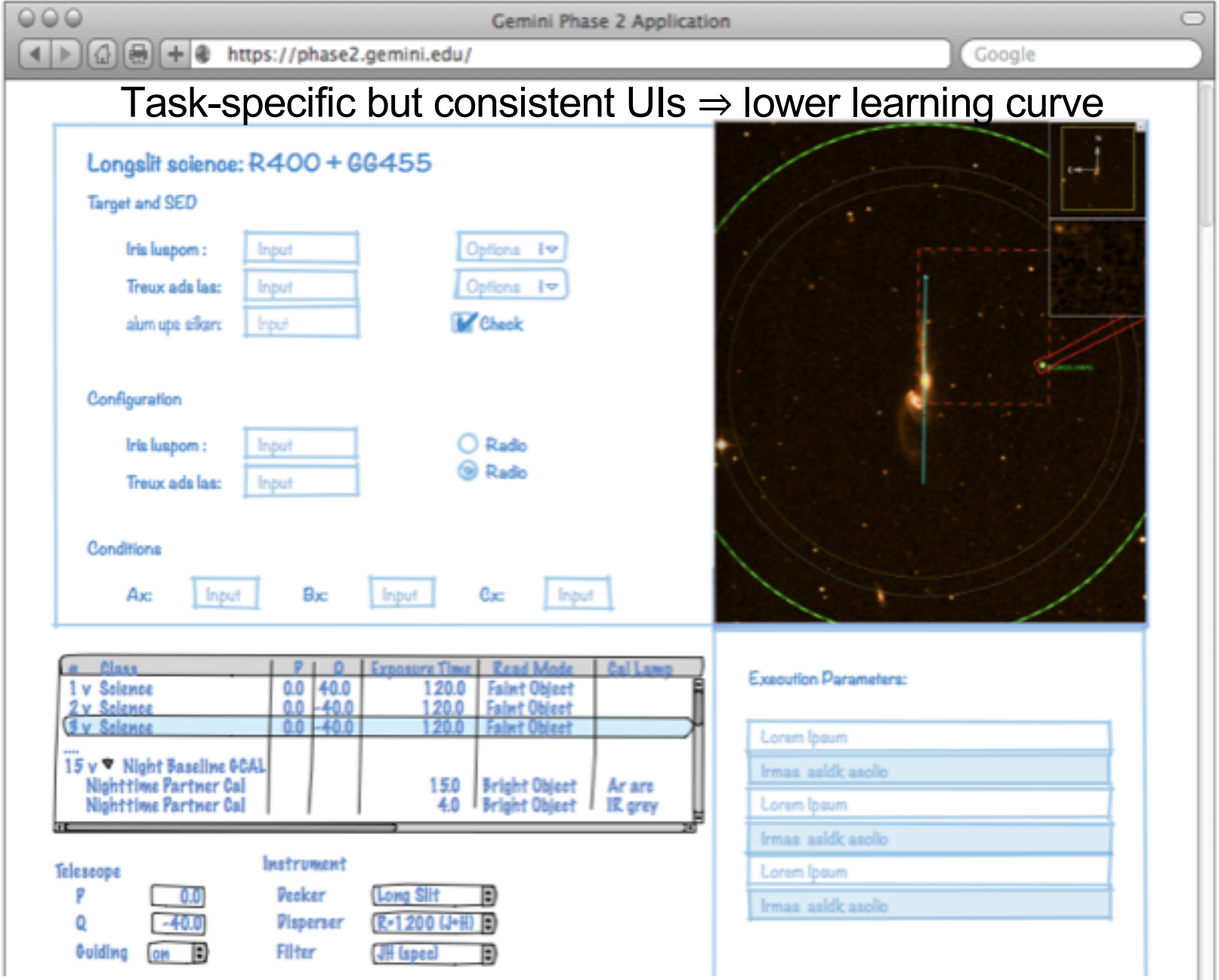
Collaborative editing using templates (e.g. Overleaf, Authorea, Google Drive, Github, …)



Physical conditions on target (FWHM)

Build around the ITCs

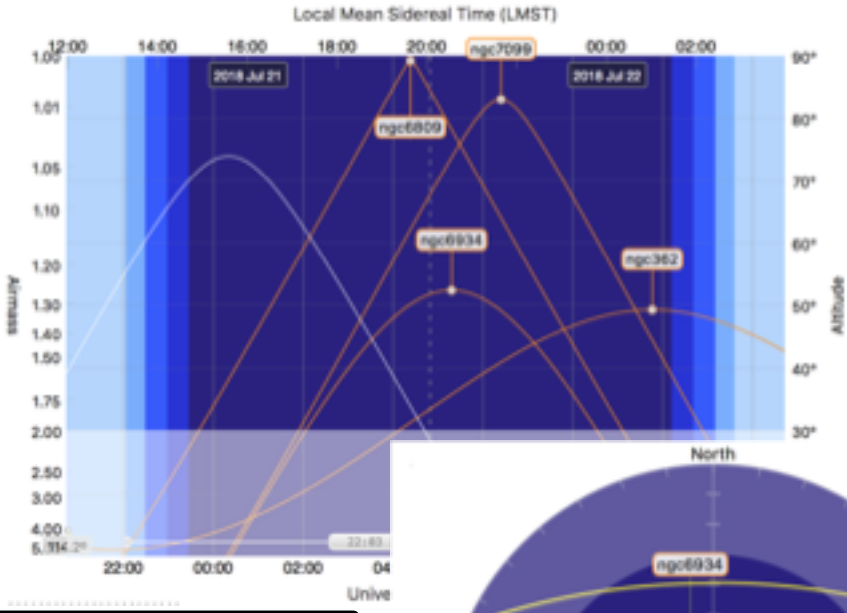
Calculate overheads, execution probability

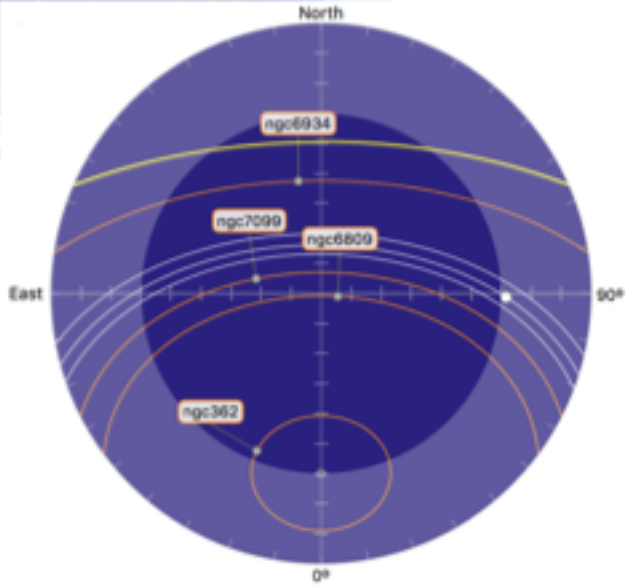


Calibration steps and observations automatically added, configs linked

The Phase 2 tool should be easier for new users, more capable for advanced users

Include tool for learning observing techniques (visibilities, planning, etc)



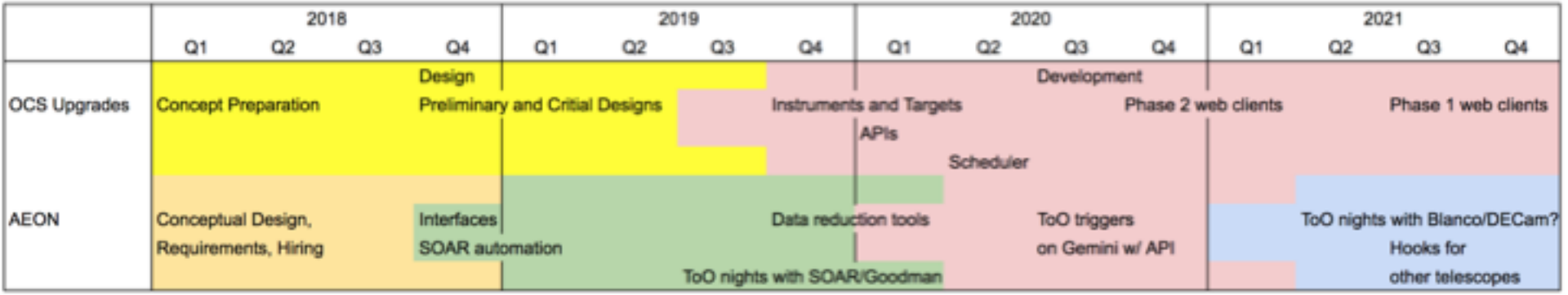



```
{ "target": { "type": "SIDEREAL", "name": "m42", "ra": 83.8220792, "d
ec": -5.3911111, "proper_motion_ra": 1.67, "proper_motion_dec": -0.3,
"parallax": 0.0, "coordinate_system": "ICRS", "equinox": "J2000", "epo
ch": 2000.0, }, }
```

Programmatic access (eg. APIs for scripts) for search, full control, and access to services (ITCs, AGS).

OCS Upgrades Program and AEON Timelines

2018 2021



Concepts & Design

Development

We close the loop by serving data via the Gemini Observatory Archive and providing tools for science quality reduction.

- IRAF to python transition
  - A pure python imaging package in 2019
  - Spectroscopy reduction in python starting in 2018 **in collaboration with SOAR**
- New instruments come with reduction tools that work in our pipeline environment (DRAGONS).
- Automated processing is a goal for the LSST era

The community should consider various issues related to increased follow-up.

Allocation options:

- PI projects through existing TACs (as now)
- Community campaigns?
- Increase the fraction of time in Fast Turnaround?
- Single, system-wide AEON TAC (e.g. LLP)?
  - Allocates time on all network resources
  - Avoids multiple jeopardy from different TACs

Should there be new modes?

- “follow-LSST”?
- Other?

Lots of user input and involvement will be needed to make these projects successful

Participate in focus or working groups to discuss specific aspects.

Fill in surveys or questionnaires

Testing, testing, testing

The development process will be iterative, so user feedback will be essential.

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
- Data reduction pipelines

Gemini is re-imagining the observing system to support follow-up and make the process easier for everyone.

Community involvement will be vital.

Get involved now!