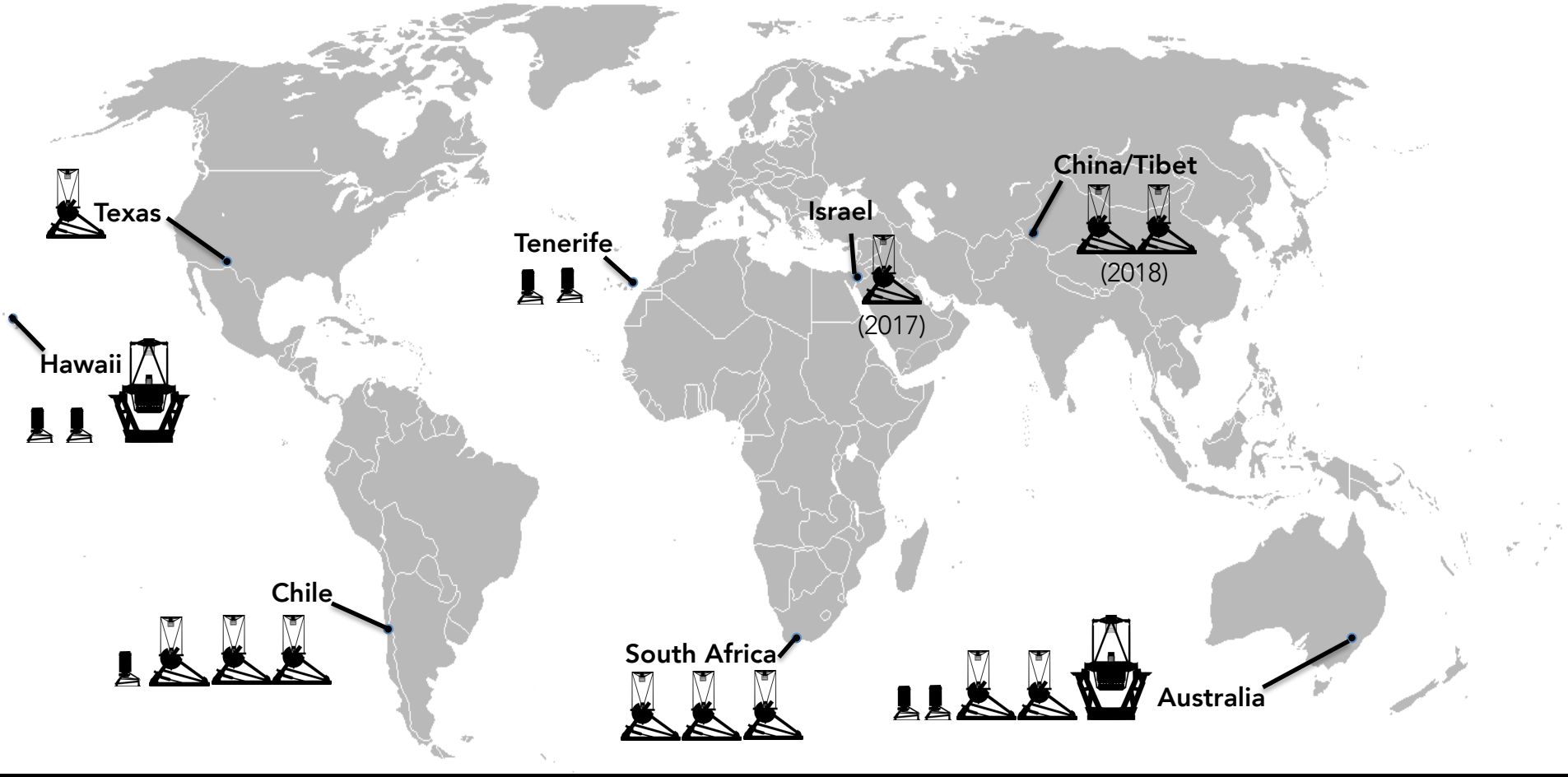
Las Cumbres Observatory operations report

(and a new opportunity)

Nikolaus Volgenau,
for the LCO operations team

Las Cumbres Observatory

Las Cumbres Observatory



What makes the LCO network different (and makes operating the network difficult)

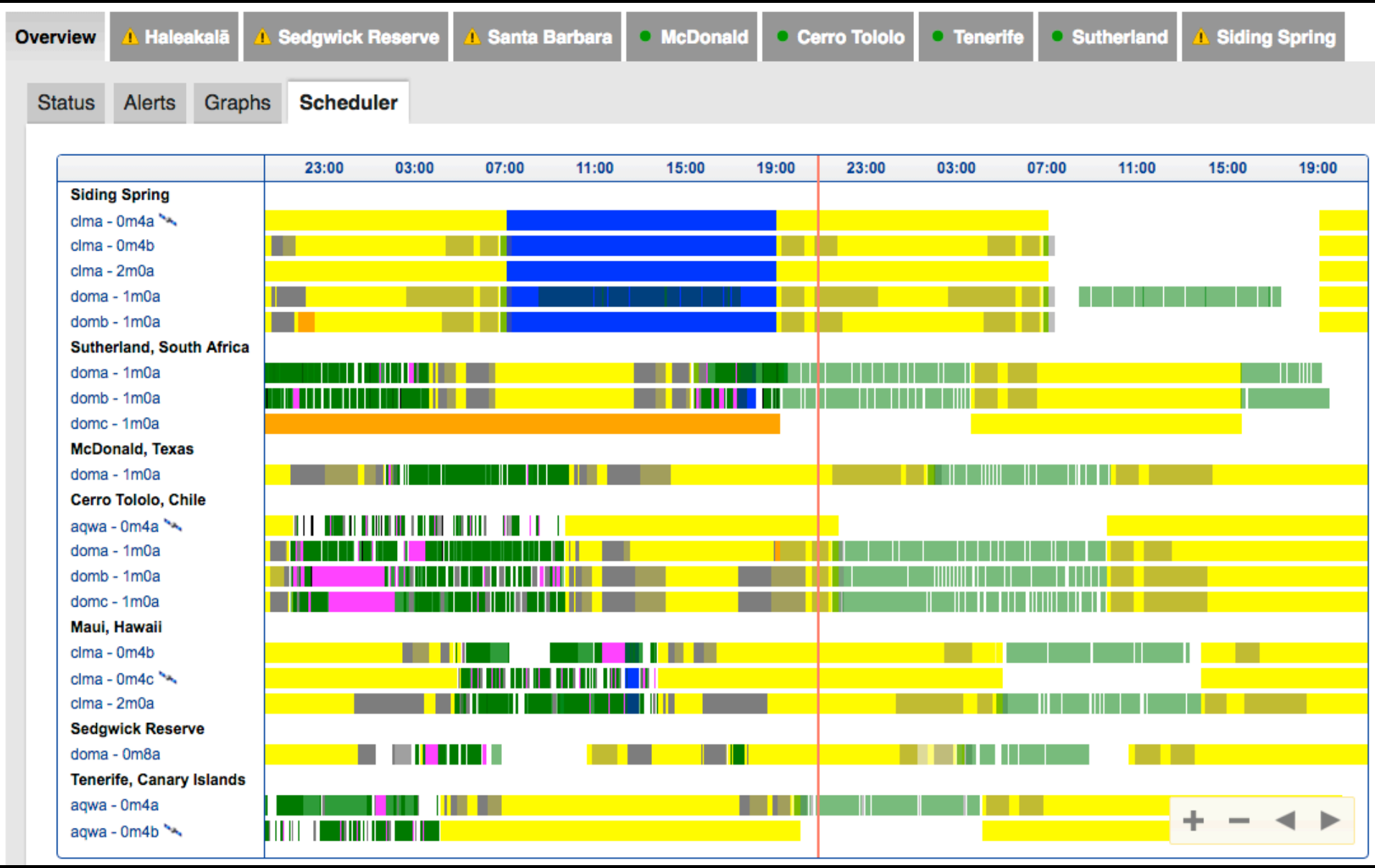
- Designed as a time-domain follow-up system.
- Global coverage in longitude in southern hemisphere. (Northern hemisphere coming soon.)
- Robotically-controlled telescopes.
- Duplicate resources at Network sites.
- Continuous operation.
- Science targets often unknown at time of proposal submission/review.
- Centralized scheduling.
- Quick access to data products.

Many telescopes, but one observatory

- All observations coordinated by software at LCO HQ.

- How Network scheduling works:
  - PIs/CoIs of accepted proposals submit observing requests, either through a web-based UI or programmatically through an API.
  - In addition to target coordinates, instrument type, exposure times, etc., users specify an observing window, cadence, and airmass limit.
  - Observing requests can be submitted at any time.
  - Schedulable "blocks" are created by intersecting observing constraints and observability criteria.
  - Scheduling software accepts Network status information continuously.
  - Observing schedule derived for all available Network resources at once.
  - Scheduling software optimizes the merit function $\Sigma \{P_{TAC} \times t_{window}\}$.
  - Because of the rate at which requests are received, a completely new observing schedule derived typically several times per hour.
  - "Rapid Response" observations circumvent the normal scheduling process.

Scheduler Visualisation



LCO's User Community

14 Science Collaboration partners:

- ANU (Australia),
- LJMU (UK),
- UCSB (USA),
- CNTAC (Chile),
- U. Colorado (USA),
- Faulkes Telescope Project (UK),
- IPAC (USA),
- U. Hawaii (USA),
- IAC (Spain),
- NAOC (China),
- SUPA (UK),
- SAAO (South Africa),
- Tel Aviv University (Israel),
- U. Texas (USA).

5 contract partners (in 2016B):

- U. Heidelberg,
- Ohio State U.,
- Queens U., Belfast,
- Nanjing U.,
- NYU, Abu Dhabi

2 unaffiliated education partners (in 2016B):

- Our Solar Siblings (Macquarie U.),
- Universe in the Classroom (UNAWE)

LCO's MSIP Opportunity

Through the Mid-Scale Innovations Program (MSIP), the NSF has purchased LCO access for the U.S. astronomical community: 1200 (1-meter) and 200 (2-meter) hours per semester, starting in 2017.

The NSF has stipulated the open access time be used to meet specific goals:

- Enable follow-up observations of time-domain phenomena discovered by current surveys,
- Allow users to gain experience carrying out real time-domain follow-up projects to prepare for LSST,
- Motivate the US community to develop the infrastructure needed for time domain follow-up in the LSST era.

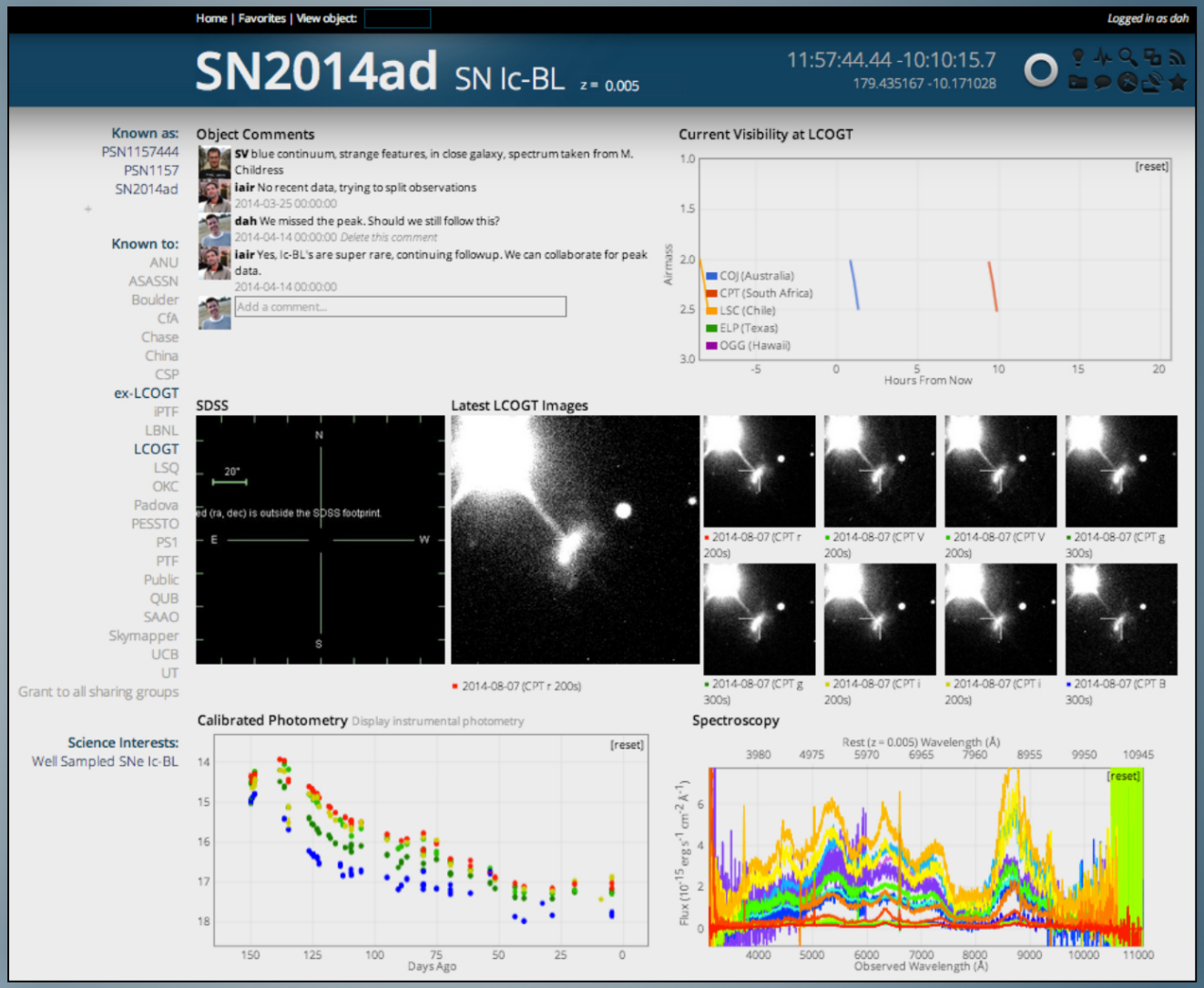
What Infrastructure?

- software to manage large time-domain science projects.
- interfaces between discovery surveys and follow-up facilities.
- brokers to "add value" to alert streams, select targets, and coordinate resources for follow-up.

Example: The SuperNova EXchange

SNEx
the SupernovaExchange

SNEx is the main tool used by the LCOGT Supernova Key Project to access, analyze, share and discuss real-time supernova data. It is also used to schedule observations, maintain regular cadences and to monitor existing observing requests.



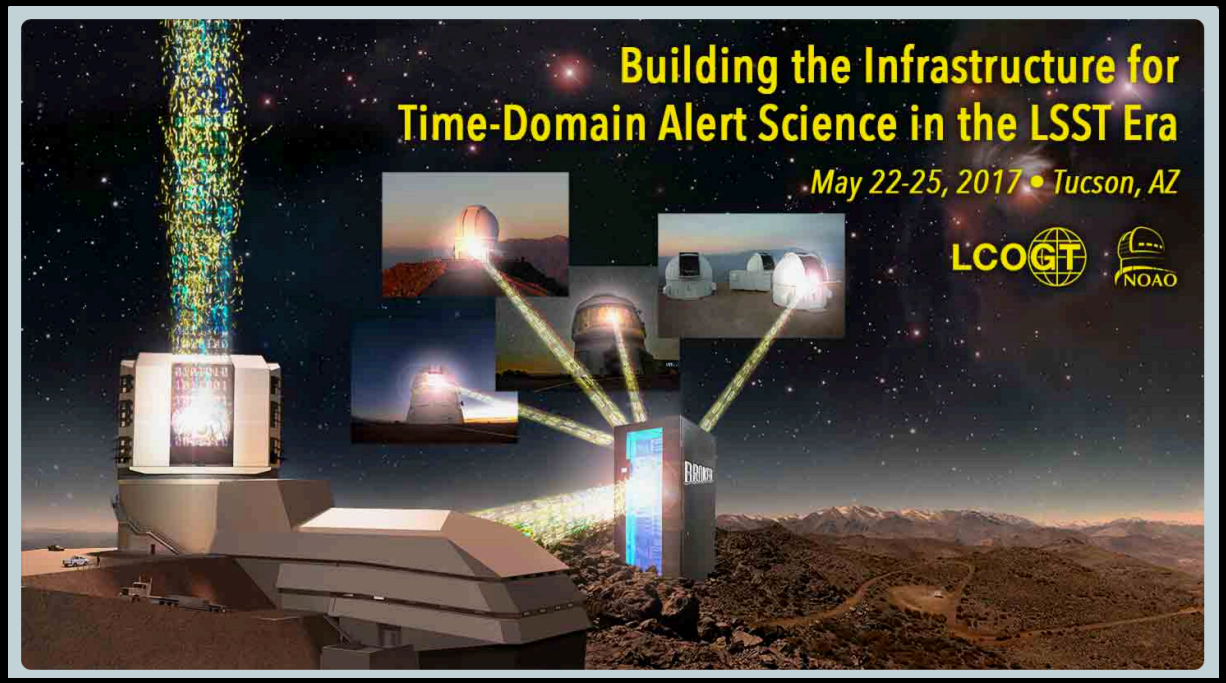
Object Overview ▸

LCO's MSIP timeline (2016-2017)

- November 1: deadline for Letters-of-Intent to submit a Key Project proposal.
- December 15: deadline to submit Key Project proposals.
- January 6: LCO hosts a special session at Texas AAS meeting.
- January 15: Decisions on Key Project proposals issued.
- February 10: deadline to submit regular proposals.
- April 1: Start of 2017A semester.
- May 22-25: NOAO/LCO joint workshop on time-domain infrastructure.

LCO's MSIP time will be administered by NOAO.

NOAO's TAC will be obliged to favor proposals that align with the NSF's goals.



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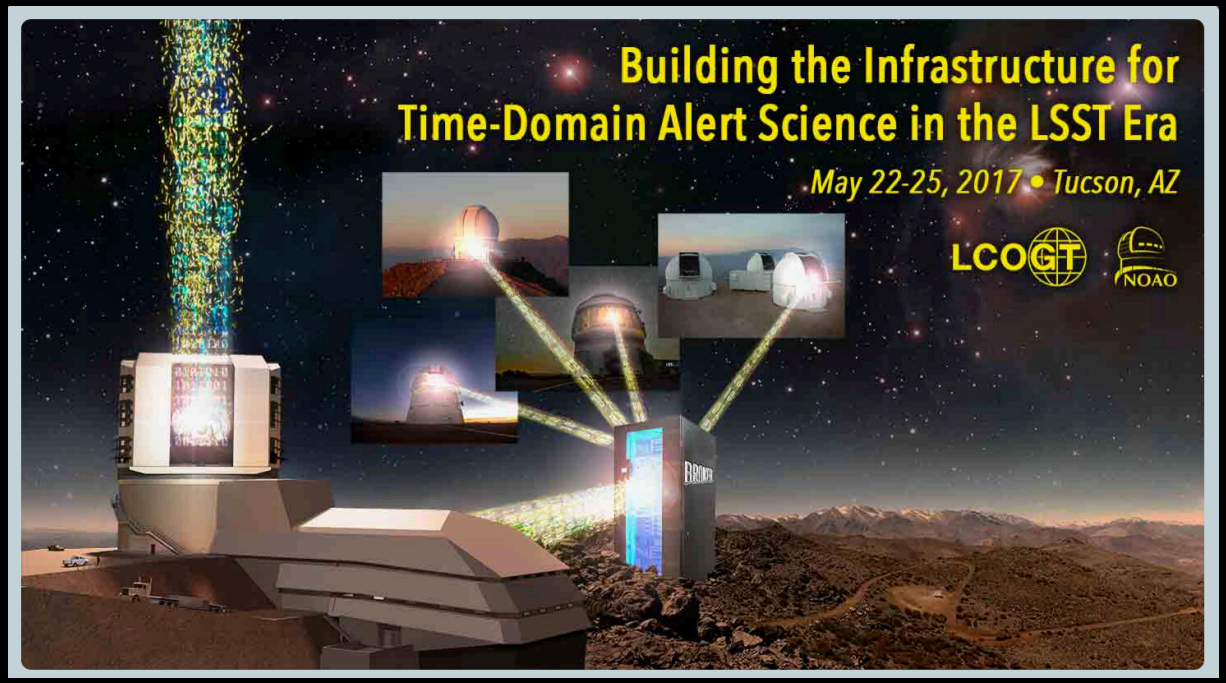

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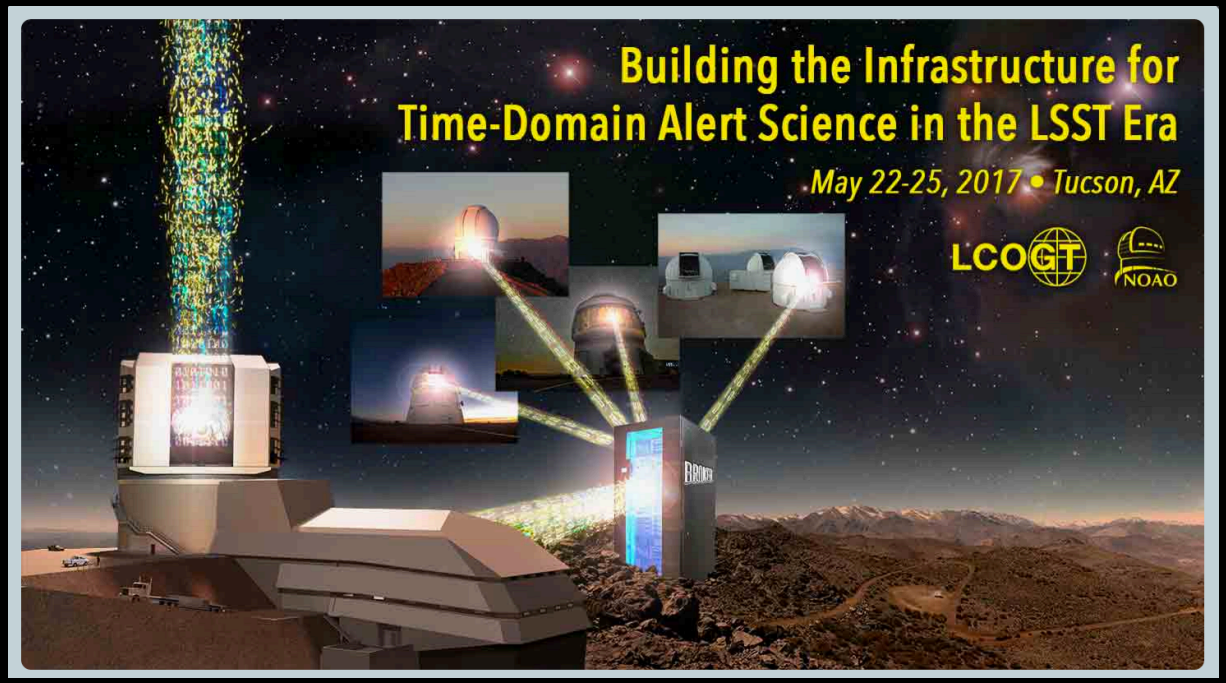

Improvements since start of operations (May 2014)

- "Rapid response" interrupt procedure.
- Scheduler taught to place requests "sooner" rather than "later."
- Tracking non-sidereal targets.
- Automatic calibration obs scheduling.
- Automatic selection of master flat fields.
- "Science support" (i.e. help desk) organized.
- FLOYDS dynamic slit position correction.
- Modify focus curve algorithm; begin non-disruptive focus checks during observing nights.
- Refine Nagios alert system.
- Update LCO website flow (2015, 2016).
- FLOYDS "acquire on brightest" mode.
- Imager "Fill observing window" mode.
- Asynchronous processing on site computers.
- Improved feedback on schedule cancellations.
- Determine HA, Dec encoder offsets at start-of-night ("zero pointing").
- Install shrouds on 1.0m telescope trusses to block moonlight (later removed).
- Fixed SBIG camera shutter problem.
- Deployment of Sinistro imagers.
- Installation of 0.4-meter telescopes.
- Updated zero points, fixed bugs in exposure time calculator.
- Improve sky sampling for pointing model derivation; include harmonic terms in pointing models.
- Use Elasticsearch/Logstash/Kibana for system monitoring.
- New data reduction pipeline, incl. image quality control tests.
- New cloud-based data archive.
- Regular "network status" reports for users.
- Publish network contention plots.
- Intra-/Inter-Proposal Priority factor.
- Expand feedback on observing requests in user portal.
- Increase scheduling speed.
- Email notification of completed observations.

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Monitoring system logs: Elasticsearch

- In 2015, Elasticsearch/Logstash/Kibana software was tested while investigating ways to improve scheduler performance.

- Now, Elasticsearch/Logstash/Kibana used to store, query, and display log information across many systems.
  - User request database
  - Scheduler
  - Instrument computers
  - Sequencers
  - Image headers
  - Science archive

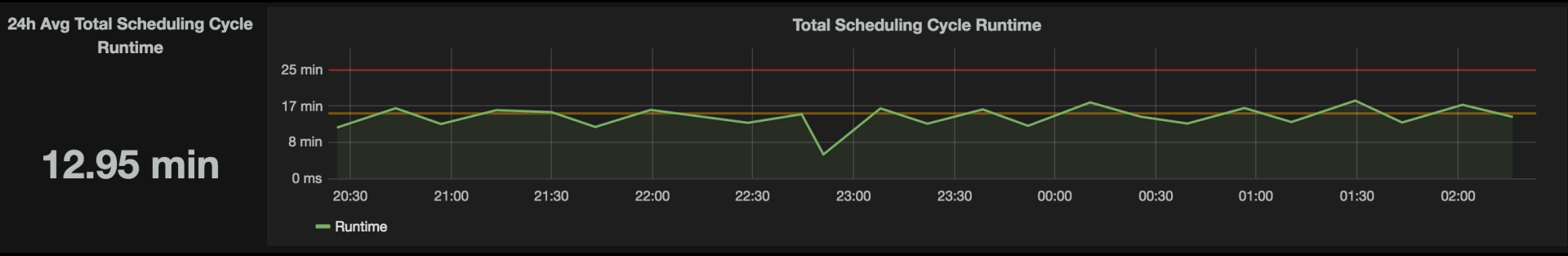
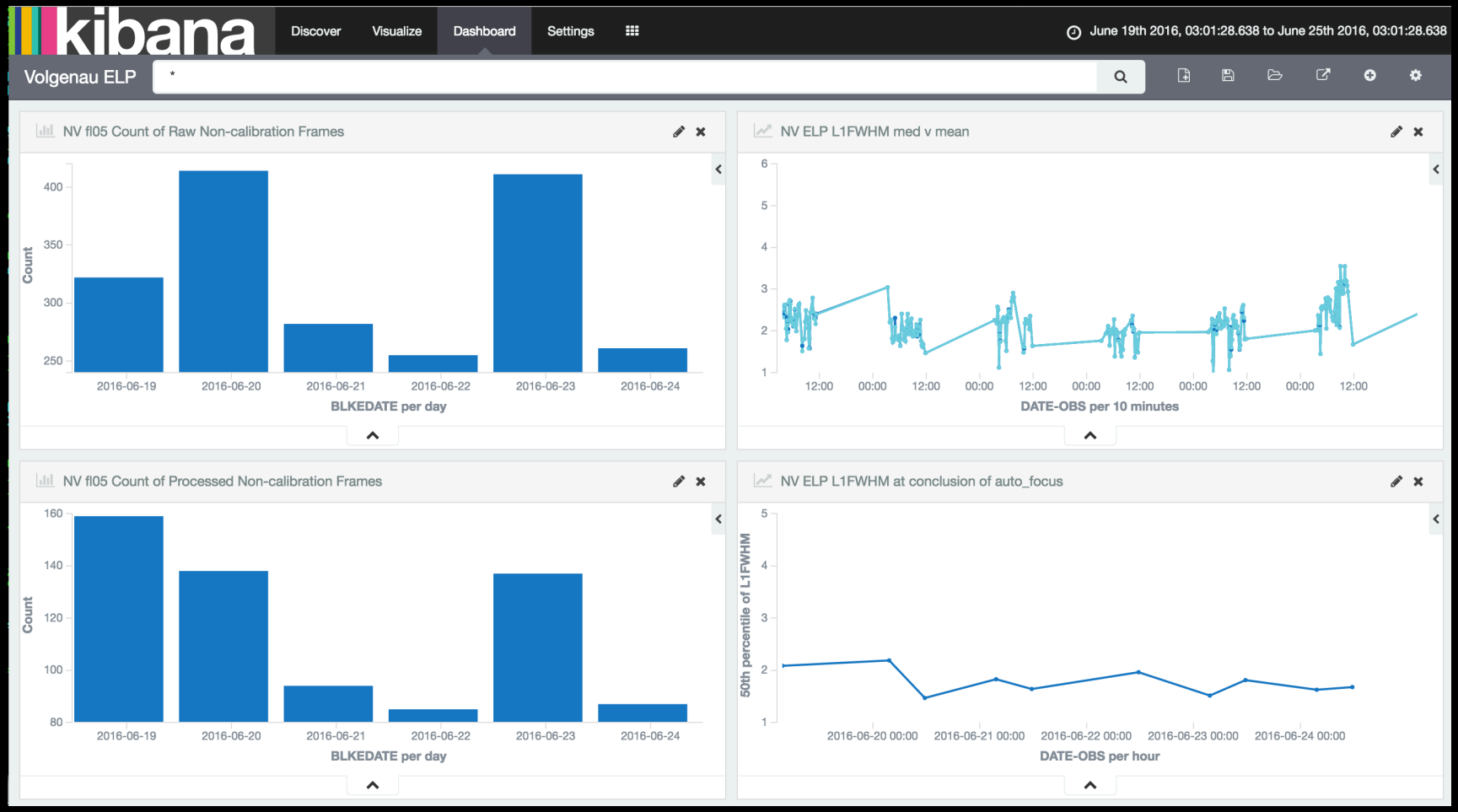


Image header information

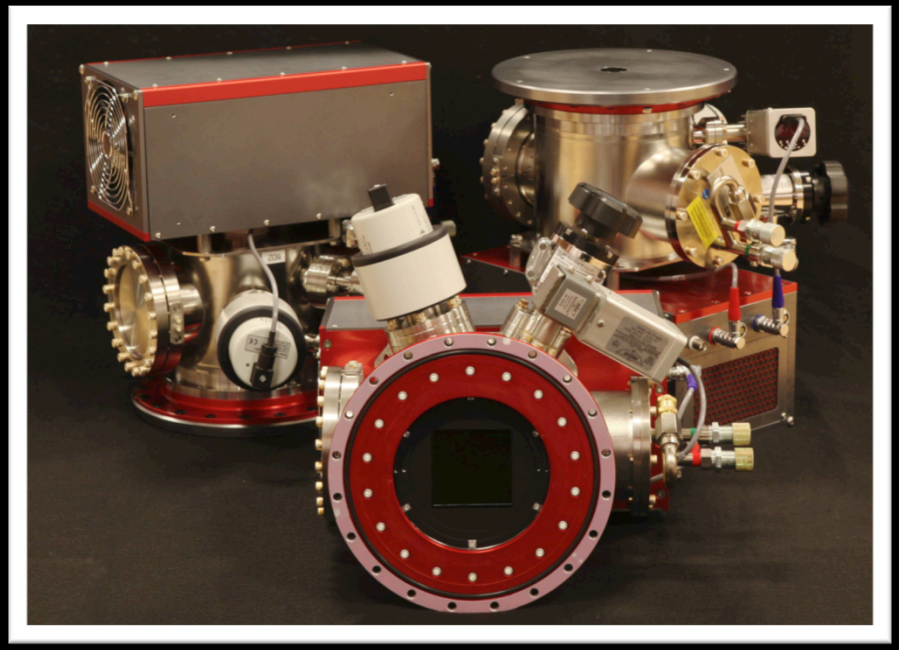
- Kibana visualizations organized into site-specific dashboards.
- Provides a "second line of defense" in monitoring telescope operations.
- Provides a window into data quality.



Sinistro cameras

- Designed and built (at LCO HQ) around a Fairchild CCD486 BI device.
- 4K x 4K, 15μm (0.39") pixels.
- 26.5' x 26.5' FOV.
- Fast readout (4 Mpix/s); low noise (<10 e-); stable, low-maintenance.
- S/N~45 for V=20.5 in 600s.
- Designed to replace off-the-shelf SBIG 15.8' x 15.8' imagers.
- Complemented by off-axis autoguide camera.
- Major developments in 2015: controller circuitry redesigned; faulty power supplies in controllers identified/replaced; CCDs resurrected.

- At start of operations: 2 Sinistros deployed (in Chile).
- 2016 deployments: Texas, South Africa, Australia (2x).
- Two Sinistros installed in South Africa yesterday!
- Final Sinistro in transit to Chile. Installation expected this month.



0.4-meter telescopes

- Seven 0.4-meter telescopes were installed/commissioned during 2015B.
  - Four reserved for SSA observations (satellites).
  - Three (Australia, Tenerife, Hawaii) made available for science observations in 2016A.

- 0.4m telescopes are undersubscribed in 2016B. (Shifting educational programs to 0.4m observations.)
- Additional deployments likely, but timescale uncertain.

Las Cumbres Observatory

Science archive

LCOGT Science Archive Documentation Api LCOGT.net nvolgenau@lcogt.net Logout

2016-04-01 00:00
2016-09-30 23:59

Proposal?
FTPEPO2014A-003

☑ Include public data

Basename

Point?
Lookup
RA Dec

Object?

Obstype
All

Reduction Level?
All

Site
All

Telescope
All

Instrument
All

Download 0

	Basename	Time	Proposal	Object	Filter	Type	Exp. Time	R.level
+	ogg2m001-fs02-20160626-0098-e00	2016-06-27 13:52:17	FTPEPO2014A-003	NGC7023	R	EXPOSE	40.000	Raw
+	ogg2m001-fs02-20160626-0098-e11	2016-06-27 13:52:17	FTPEPO2014A-003	NGC7023	R	EXPOSE	40.000	QuickLook (BANZAI)
+	ogg2m001-fs02-20160626-0098-e91	2016-06-27 13:52:17	FTPEPO2014A-003	NGC7023	R	EXPOSE	40.000	Reduced (BANZAI)
+	ogg2m001-fs02-20160626-0097-e00	2016-06-27 13:51:06	FTPEPO2014A-003	NGC7023	V	EXPOSE	40.000	Raw
+	ogg2m001-fs02-20160626-0097-e11	2016-06-27 13:51:06	FTPEPO2014A-003	NGC7023	V	EXPOSE	40.000	QuickLook (BANZAI)
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+	ogg2m001-fs02-20160626-0096-e00	2016-06-27 13:49:56	FTPEPO2014A-003	NGC7023	B	EXPOSE	40.000	Raw
+	ogg2m001-fs02-20160626-0096-e11	2016-06-27 13:49:56	FTPEPO2014A-003	NGC7023	B	EXPOSE	40.000	QuickLook (BANZAI)
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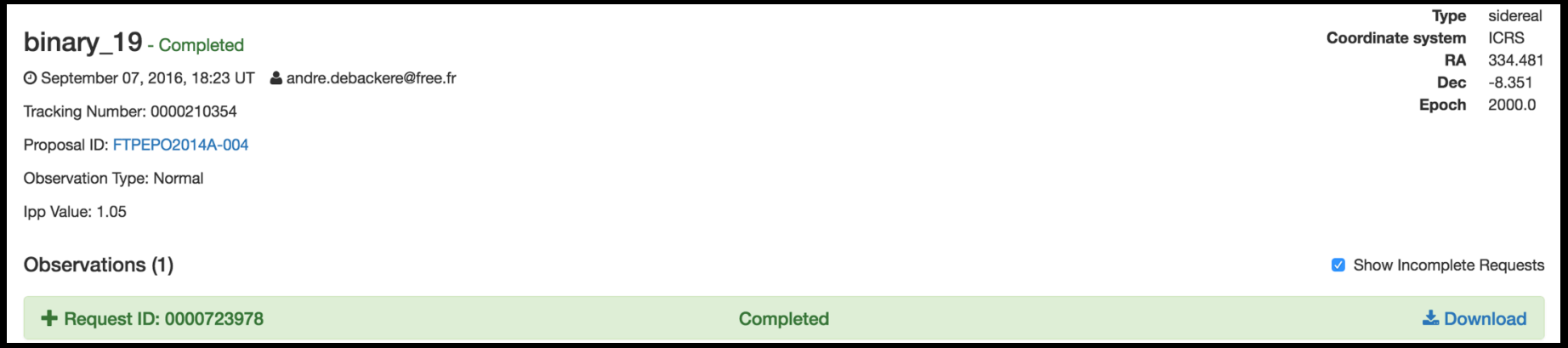
- Hosted on Amazon Web Services (cloud storage). Curated in-house.
- Superseded LCO's IPAC archive at start of 2016A semester.
- Data products transmitted to archive continuously, available in minutes.

Information on submitted observing requests

- Help LCO-users answer the question, “What happened to my request?” on their own.
- Impossible requests rejected at the point of submission.

- What’s provided?
  - Basic request information (coordinates, time of submission), including tracking ID.
  - Status of requests: Completed, Cancelled, In Progress, Not Observed.
  - Three plots: scheduling history, target visibility, telescope status.



Information on submitted observing requests

Target Name: FO Aqr

Windows

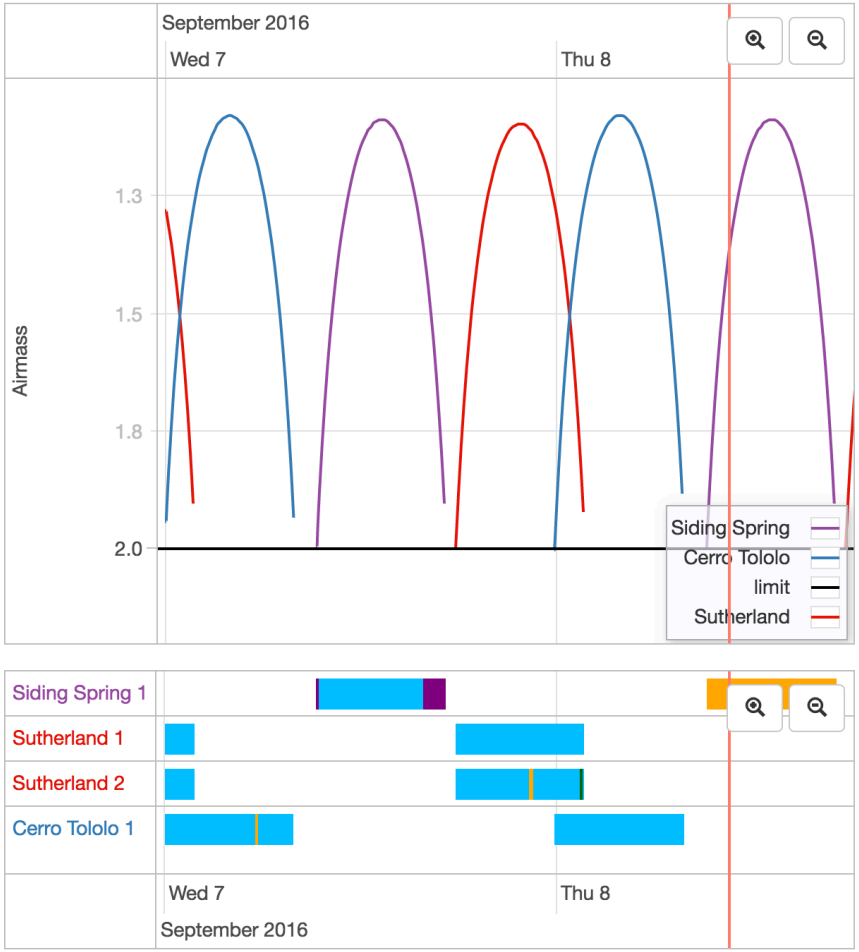
Start	End
September 07, 2016, 0:00:00 UT	September 14, 2016, 0:00:00 UT

Configurations

Instrument	Filter	Exp. Time	Exp. Count
1M0-SCICAM-SBIG	V	10.0	30

Scheduled Block History by Scheduling Run #

Visibility and Telescope Status



Documentation

Archive Documentation

Documentation relating to the LCOGT internal science archive.

Data Format & Pipeline

Documentation on our data format and the BANZAI data reduction pipeline.

Developer Documentation

Documentation, examples and code for working with LCOGT's extensive programmatic interfaces and APIs.

Getting Started Guides

- 1-meter Network (PDF)
- 2-meter Network (PDF)

1-meter Quick Reference PDF

A one-page description of how to use the 1-meter telescope Network.

Intra/Inter Proposal Priority (IPP) Factor

Iair Arcavi's description of the system for prioritizing observing requests.

Information on Submitted Observing Requests

A description of the information on submitted observing requests now available in the observatory portal.

How the Network Works

A guide to how the LCO network operates.

Documentation

Descriptions of the archive and data pipeline, "Getting Started" guides for new users, etc.

Instruments

About our science imagers, spectrographs and filter sets.

Observatory Status

Visualizing telescope and site status.

Sales

Buy network time, join our collaboration, or purchase equipment.

Sites & Telescopes

Information about the nodes and telescopes in the network.

Tools

Visibility calculator and other observation planning tools.

Welcome to the LCOGT Developer's page. Here you will find API documentation, sample code, tutorials and other resources to aid your development with LCOGT services.

Submit

Query the request service to schedule observation requests via an http endpoint. This will results in observation requests equivalent to using the frontend ui.

Documentation

Query

Query the request status api to get real time information about the state of your observation requests and receive your data once they are completed.

Documentation

Retrieve

Query the archive api for our extensive collection of scientific data containing the results of your observations as well as public data available for download.

Documentation

Thumbnail API Released

Posted on Tue 17 May 2016

LCOGT now provides a thumbnail service that converts fits files stored in the archive into jpegs. This allows for the quick preview of a file without the need to download any data or use any tools like ds9.

To learn more, head over to the thumbnails documentaion.

The source code is also available on github.

Request Status API Released

Posted on Wed 27 April 2016

LCOGT is pleased to provide a new web based api for querying observation requests and status.

We hope this api will improve our users' ability to programatically gain insight into the current state of their observation requests.

To lean more, head over the the Request Status API documentation

Contention plots

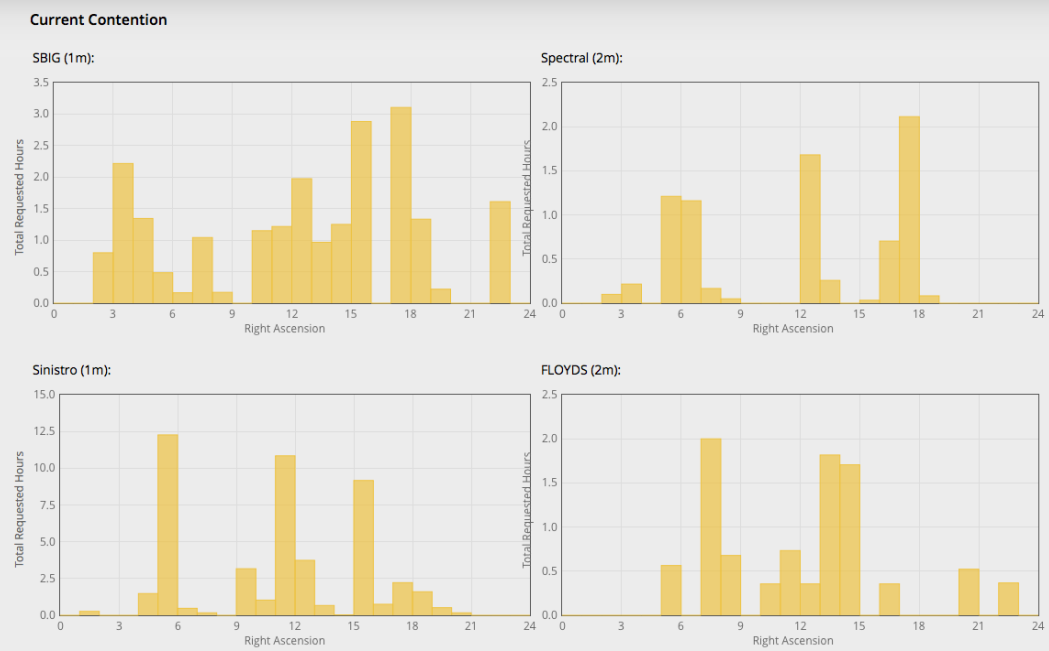
Plots developed by the SN team to show contention for RA, sites, and camera types.

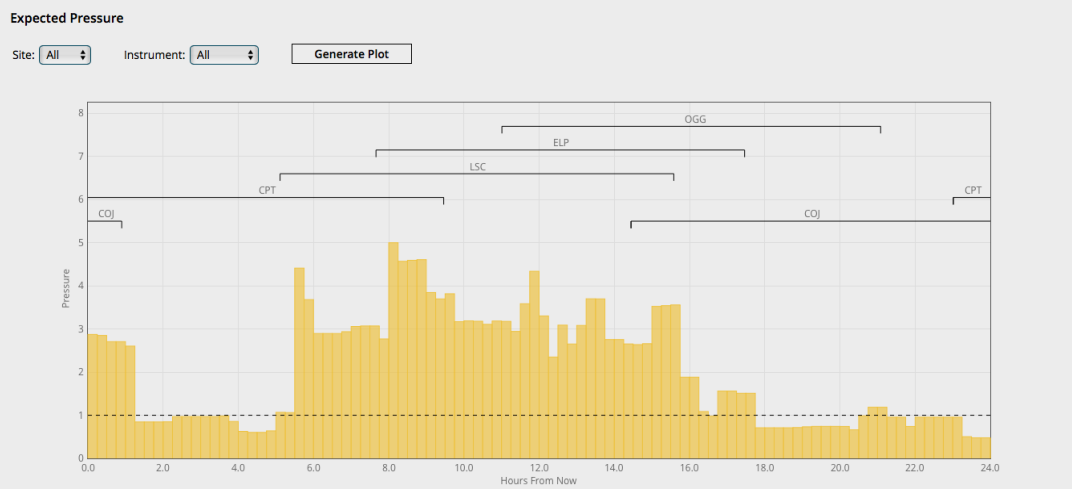
Top: requested hours v. RA.

Bottom: network "pressure" in next 24 hours.

Updated in 2016 to show "your" project among all other projects.

LCOGT Contention





The pressure of a block is defined as its length divided by the total length of time during which it is visible. For each time bin, this value is further divided by the number of telescopes from which the block is visible during that time bin.
An overall pressure of 1 (dashed line) means the network is perfectly subscribed on average (> 1 is over-subscription, < 1 is under-subscription).

* All plots on this page exclude moving objects and overheads

Intra-/Inter-Proposal Priority (IPP) factor

- Without IPP, scheduling merit function is the product of (TAC-assigned) priority and request duration.
- New "priority factor" gives additional flexibility:
  - Higher and lower priority observations for the same proposal.
  - Lower-ranked projects can "promote" more important requests.
  - Higher-ranked projects can "demote" less important requests.
- Initial "IPP hours" are 5% of originally allocated hours. Maximum is 10%.
- "Priority factor" range is limited to $0.5 < f < 2.0$
- IPP hours are debited at the point of submission, credited at the point of request completion.
- Rolled-out in June 2016. No results yet on the effects of IPP.

Improving communications with users

- Organized "Science Support" team to answer user questions.
  - Email-able "Help Desk" (science-support@lcogt.net).
  - Average question submission rate is 0.5/day.
  - Most common question is, "Why didn't I get my data?"
  - Education program participants submit most requests for assistance.
  - A source for an occasional suggestion, rare compliment.

- Issue regular "Network status" reports.
  - Recipients are "users and friends" of LCO (Google group).
  - Mechanism to announce new features, report technical problems.
  - Issued at least monthly.

- Overhaul public website.
  - Last revision in winter 2016.
  - Maintain "Current Status" page.
  - New url (lco.global) to be made public on October 14.

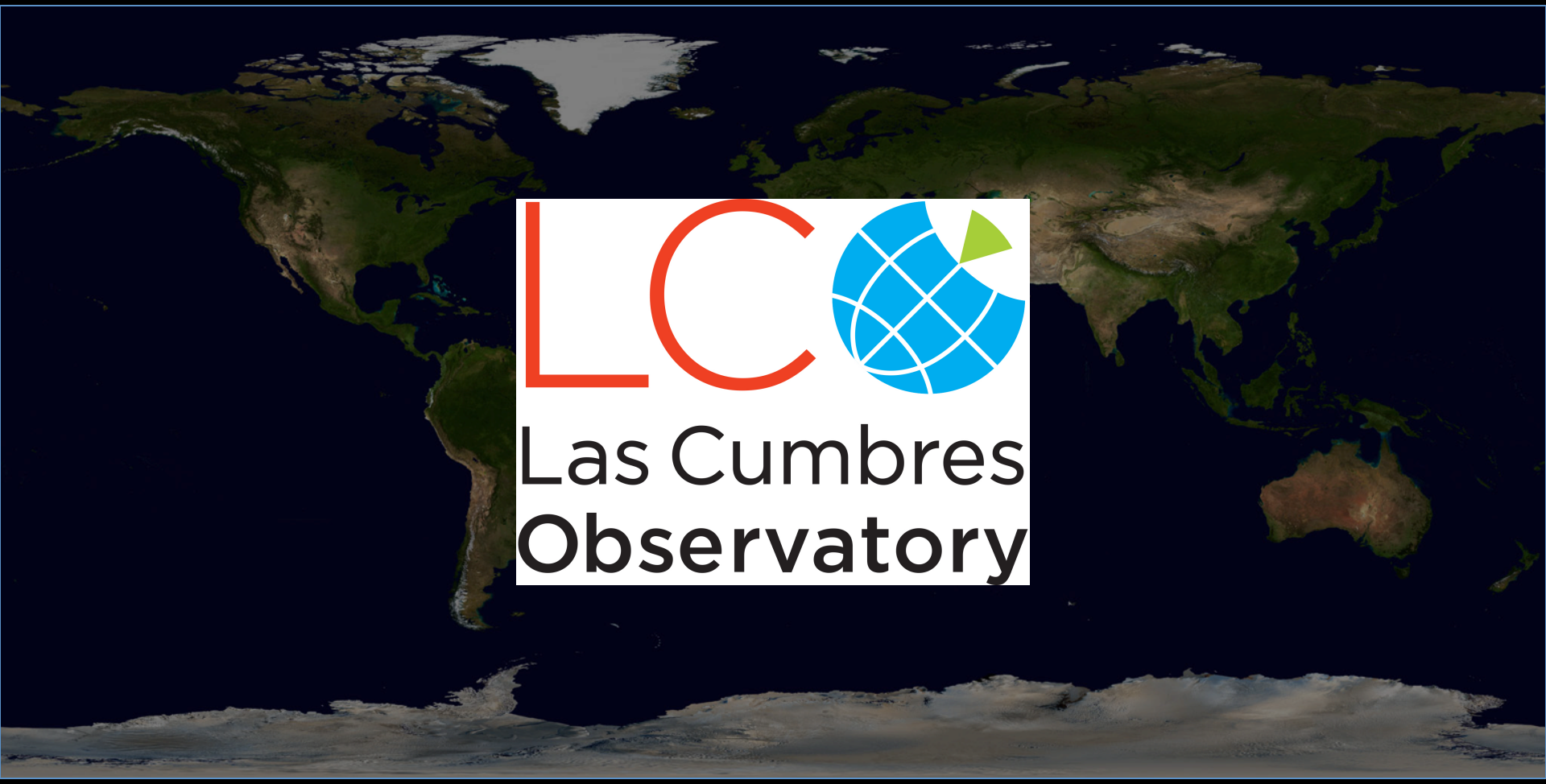
- Email notification when new data are available. (Optional)

Imminent New features.

- Impose observing constraints based on moon phase, angular separation.
- Ability to link multiple observing requests, e.g. “Only schedule observation B if observation A was completed.”
- Optimize and publish procedures for scheduling calibration observations (flat fields, standard photometric fields, etc).

Las Cumbres Observatory

Thanks!



We Keep You in the Dark