

Las Cumbres Observatory: around-the-world, around-the-clock.

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Las Cumbres Observatory (LCO) is a global network of telescopes that was developed specifically to support time-domain astronomy. The Observatory currently comprises 18 telescopes distributed over 6 sites and provides continuous coverage of the night sky. Science observations are coordinated by centralized software that dynamically optimizes a schedule for the entire network. These observations support investigations into a wide range of transient and variable phenomena, and several thousand hours per semester are devoted to key projects to study supernovae, AGN variability, and Galactic microlensing events.

Monitoring the site conditions, instrument performance, and data quality for an around-the-clock observatory is a challenge. The high-level TelOps interface, and the rich set of monitoring information that supports it, are described in Pickles, et al. (2014) and Volgenau, et al. (2016). In 2015, we began using Elasticsearch databases to store log information for many internal systems. The results from automated queries of these databases are organized into dashboards using the Kibana visualization software. The utility of the visualizations induced us to index data objects from a variety of network systems.

In the past year, LCO has made a dedicated effort to expand the capabilities of the Observatory and improve communications with our users. Perhaps the most obvious enhancement to Observatory capabilities is the deployment of Sinistro cameras in 2016. The Sinistros are $4K \times 4K$ CCD low-noise imagers that provide a $26.5' \times 26.5'$ field-of-view. At the start of operations in 2014, only two Sinistros were in the Network. Already in 2016, four additional Sinistros have been put into service, and two more were installed at LCO's South Africa site during the Hotwired V meeting. Also in 2016, LCO expanded its contingent of 0.4-meter telescopes to seven and made three of those telescopes (in Australia, Spain, and Hawaii) available for science observations.

LCO began processing all raw data through a new reduction pipeline, dubbed BANZAI (and described at Hotwired V by Curtis McCully), at the start of the 2016A semester. Raw images and pipeline products are now made available to users from a new cloud-based archive, hosted on Amazon Web Services. Data products are transmitted to the archive continuously and are available to users within minutes of an observation's completion. Even before users retrieve their data, LCO provides them with a rich set of information on submitted observing requests in the observatory portal. By clicking on a request, users can see where and when the science target is observable, the status of the relevant telescopes, and if and when the request is scheduled to be observed. In addition to the portal enhancements, we've provided users with network "contention plots", which display the demand for the various Network sites and instruments, as well as the RAs for which requests are made. We have also created a system, called Intra/Inter-Proposal Priority (IPP) that allows users to communicate the relative importance of an observation to the scheduling software.

Beginning in 2017, the US astronomical community will gain access to the LCO Network through the NSF's Mid-Scale Innovations Program. The Network access is intended to enable US astronomers to make follow-up observations of time-domain phenomena discovered by current and imminent surveys. The program's other goal is to motivate US astronomers to develop the infrastructure that will be needed to conduct time-domain follow-up projects when the LSST is in operation. The elements of this infrastructure include (1) management software for science projects with many contributors and multiple data streams, and (2) software brokers that break down alert streams and coordinate follow-up observations. LCO invites the participants of Hotwired V to attend the workshop "Building the Infrastructure for Time-Domain Alert Science in the LSST Era", co-hosted by LCO and NOAO, in Tucson on May 22-25, 2017.