Las Cumbres Observatory in the Landscape of the 2020’s

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Why LCO?

- LSST follow-up is an important component of the Gemini strategic plan
- LCO has built and now operates a global network of optical telescopes for time domain follow-up
  - Target-of-opportunity ≠ interrupts
  - Dynamic scheduling
  - End-to-end automated data flow
  - Observatory API's
- NSF funded LCO's MSIP proposal with the intent of preparing community for LSST follow-up
- LCO is expanding this network in partnership with existing telescopes – perhaps including Gemini
Our telescopes in the field

- 2-meter telescopes
- 1-meter telescopes
- 40-cm telescopes
How does it work?

- **Allocation**
  - Submit a request for an observation
    - Single or cadence
    - Queue, Time-critical, or rapid-response
    - Tools for optimization

- **Scheduler makes it happen**

- **Telescope operates robotically**
  - Acquisition and guiding

- **Calibrations done automatically**

- **Data returned to headquarters**

- **Pipeline processed and ingested into archive within 10 minutes of shutter close**

- **API’s for request submission, request status, and retrieval of data**
  - Automated management on user side (TOM toolkit)
Operating the entire global network
Observation windows

Target coordinates
RA and Dec may be entered as a float value (nn.nnn) or hours, minutes, seconds (hh:mm:ss.ss).

Right ascension 21:00:00 \( \square \) Declination -23:00:00 \( \square \) Maximum airmass 1.6

Seasonal visibility
Start date 2018-07-01 \( \square \) End date 2018-08-26 \( \square \) Show visibility
Observation windows

Daily visibility

Solid lines represent the visibility window; dotted lines represent daytime or hour angle $> 4.6$. The angle in the legend is the average moon-target distance during the selected night.
Network Pressure

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).

This plot excludes moving targets.

Instrument: .4m SBIG  Site: All

- KEY2017AB-005
- LCOEPO2014B-010
- CON2018A-004
- auto_focus
- LCO2018B-006
- UTX2018B-002
- LCO2018B-002
- CLN2018B-006
- CON2018B-001
- IAC2018B-005

The chart shows the pressure distribution with time for different sites across the globe, including:

- Tenerife, Canary Islands (thn)
- Sedgwick Reserve (sqa)
- Maui, Hawaii (ogg)
- Cerro Tololo, Chile (isc)
- McDonald, Texas (elp)
- Sutherland, South Africa (cpt)
- Siding Spring, Australia (co)
Scientific Performance (imaging)

- Filters include Bessel-Johnson, Pan-STARRS, SDSS, Hα, Hβ
- 1-meter telescopes used to $m=20$ (imaging)
- 2-meter telescopes used to $m=22$ (imaging)
- For bright objects, achieve 2 mmag precision
- For faint objects, achieve photon-limited S/N

Multiple longitudes allow more frequent – or even continuous – monitoring than a single site.
Scientific performance (spectroscopy)

Stellar Spectra from CTIO

HD7140: A5IV, Vmag=5.15, ExpTime=600s

HD115383: G0V, Vmag=5.22, ExpTime=600s

Alpha Ori: M2Ia, Vmag=0.42, ExpTime=30s

Vacuum Wavelength (nm)

Flux (kADU)

Wavelength (angstroms)
The future – LCO & Gemini?

- Complete northern ring
- Incorporate Wise 1m (NRES/100%) into network
- Begin to expand network in partnership with SOAR 4m (Goodman Spec/?%)
- Discussions with other observatories (Gemini, CFHT, SALT)
  - Degree of integration is still being discussed
- Development of software infrastructure (TOM toolkit)
- Lots of remaining questions
  - How will time allocation work?
  - What modes will be supported for dynamic scheduling?
  - How will time-domain and non-time-domain fit together?
  - Is there advantage to joint scheduling?
  - Can we automate the process end-to-end?