The Astronomical Event Observatory Network

Multi-messenger and Time-domain Astronomy
Partnership to create an extended network of follow-up observing facilities

A. Adamson, J.P. Blakeslee, B.W. Miller - Gemini Observatory/NSF’s NOIRLab
R.D. Blum, Vera C. Rubin Observatory/NSF’s NOIRLab
A.S. Bolton, C-H. Lee, S. Ridgway, Community Science and Data Center/NSF’s NOIRLab
C. Briceno, J. Elias, SOAR Telescope/NSF’s NOIRLab
S. Heathcote, Cerro Tololo Inter-American Observatory/NSF’s NOIRLab
D.R. Silva, The University of Texas at San Antonio
LCO global telescope network

twenty-three telescopes
seven sites around the world
working together as a single instrument
Las Cumbres Observatory is unique

- global telescope network
- robotic operations
- dynamic queue observation scheduling
- rapid delivery of processed data

US Community access to LCO facilities provided through support from the National Science Foundation
Robotic Operations

internet | weather stations | status database

software brain to run it
Dynamic Scheduling • Rapid Data Delivery

- Entire network rescheduled every 5 minutes
- Support multiple timing constraints
- Submit observations programmatically
- Data available within minutes of shutter close
Example: kilonova AT 2017gfo

Only one gravitational wave event, GW170817, has had a detected electromagnetic counterpart, resulting in the discovery of the first kilonova, AT 2017gfo.

Abbott et al., 2017
LCO observations were key for constraining the peak of the light curve to be a few hours after the merger.

Arcavi et al., 2017
Facilitate efficient access to the follow-up resources that astronomers need for their science.
Astronomy Discovery Engines

Astronomical surveys are producing greater data volumes and many issue alerts in near-real time.
Telescope Allocations in Astronomy

Normally allocated in 6 month semesters by competitive proposal

Block scheduling of contiguous nights is common
Characterization observations are required to achieve the science with major surveys

• almost all scientific use-cases require follow-up with a range of facilities

• imaging and spectroscopy

• alert follow-up can be disruptive to telescope schedules

Observing Use Cases

- Single-shot
- Time constrained
- Repeated monitoring
- Rapid response
Infrastructure Requirements

Software-enabled dynamic queue scheduling

Programmably accessible telescopes
Dynamic Queue Scheduling

Queue: Interleave observations from different programs

Dynamic: schedule regenerated at regular intervals to allow for changes in conditions and/or observing requests
Programmably accessible telescopes

- Online interface or client that allows users to specify their own observation requests
- Provides traceability
- Enables monitoring by user/observatory staff
- APIs* enable requests submitted by software, such as Target and Observation Manager systems

*API = application programmable interface – software intermediary allowing two packages to communicate with each other
SOAR 4m Telescope

Interface via existing programmatic portal when they choose

Available as a queue-scheduled node on LCO network when in AEON-mode
• Traditionally scheduled the rest of the time - SOAR controls the schedule

Human operators on-site

Programmatic submission of observations provided by LCO portal
• Automatic TOM compatibility provided through LCO portal

Operating in AEON mode since August 2019

Elias et al. 2018, SPIE: Observatory Operations, 107040B
Facility’s own scheduling system with compatible interface

Gemini 8-meter Telescopes

• Queue-scheduled observations
• Programmatic submission of observations with an existing API

• Gemini observing TOM Toolkit available module plugin (built by Bryan Miller, Gemini)

• Ongoing re-design of operations software designed with AEON and new automated scheduling system
Full-featured observatory control system

Provide a community-ready OCS that can be adapted for new and existing observatories around the world.

- Fully open source
- Well-documented
- Provide community support
Future Development

AEON’s request language is designed to extend to new instruments

A diverse network, spanning all longitudes, latitudes, and wavelength regimes will enable science

New AEON partners are welcome
Lisa Storrie-Lombardi
lisa@lco.global
thank you