

Follow-up Facilities for Time-Domain Astronomy

Date: Wednesday, August 10, 2022; 1:30-3:00 PM MST; Tortolita A

Title: "Follow-Up Facilities for Time-Domain Astronomy"

Organizers: Alessendra Corsi, Rachel Street, Jennifer Sobeck

Link: <https://project.lsst.org/meetings/rubin2022/agenda/follow-facilities-time-domain-astronomy>

Link to google folder to collect presentations and videos:

https://drive.google.com/drive/folders/1wrzgRFxEQIZdegSlljogH6BKeAPvGOW_?usp=sharing

Agenda

Nominal Duration	Topic	Speaker(s)
10min+2min	NOIRLab; In-kind Contributions of Telescope Time and Application Process; Associated Data Products	Dara Norman (confirmed)
10min+2min	Maunakea Spectroscopic Explorer; MSE Pathfinder	Jen Sobeck (confirmed)
10min+2min	Tools and Services for the Follow-up Ecosystem	William Lindstrom (confirmed)
30min	Talks from International In-Kind Teams <ol style="list-style-type: none">1. D. Buckley (SALT+SAAO; South Africa); 8 min2. J. Soon (DREAMS, Australia); 8 min3. C. C. Ngeow (Trans-Pacific 2mT; Taiwan); 6 min4. M. Botticella (VST; Italy)	
10min+2min	Swift Space Telescope	Jamie Kennea (prerecorded, confirmed)
10min+2min	Radio Facilities	Tony Remijan (confirmed)
Remaining time	Open Discussion	

Session Notes

Session Chair: Alessandra Corsi

Scribes: Rachel Street, Jennifer Sobeck

Alessandra introduced the session with a review of the friendly reminders and Code of Conduct, and reviewed the agenda for the session.

Dara Norman: NOIRLab; In-kind Contributions of Telescope Time and Application Process; Associated Data Products

Alessandra's Notes: Good to advertise the link to the website. 400 proposals per semester and 8 panels. Dual anonymous system implemented since last semester. AEON is a new mode incorporated in the last call and it is really geared to the ability to use multiple telescopes in a dynamical scheduling fashion. The collaboration is developing APIs so that different telescopes can be added to the network and scheduled through AEON.

Dara Norman is the Deputy Science Director for NOIRLab, and will review the resources that will be available for Rubin follow-up. She noted a session on Thursday which will cover the In-kind contribution program.

NOIR Labs perview includes all night-time facilities in the US, including Rubin and Gemini, Kitt Peak and Cerro Tololo Observatories.

They provide user support for the community as well as telescope operations, as well as supporting the ANTARES Broker.

NOIRLab will be responsible for running the telescope time allocation system for these facilities, and will also be responsible for time contributed through the Rubin In-Kind process on many international facilities.

Dara gave an overview of how the time allocation process works, noting that >10 facilities are available to observers this way.

Gemini proposals are currently handled through the Gemini PIT but will eventually be merged into a single system.

The review process divides proposals by scientific area for a dual-anonymous panel review (DARP) process.

NOIRLab also allocates time on an open-skies policy, meaning that anyone can apply for time on NOIRLab facilities, and international proposals are welcome.

The process supports a number of proposal types:

- Standard - every 6 months
- NOIRLab survey & Gemini Large and Long Programs
- Gemini Fast Turnaround
- Queue and Classical observing
- Astrophysical Event Observatories Network (AEON)

The AEON mode allows for dynamical observing and programmatic submission. Dara explained that networking the telescopes together in a collaboration between NOIRLab, LCO, SOAR and Gemini, allows users greater flexibility.

AEON enables observations to be requested through online interfaces and scheduled flexibly to support time-domain astrophysics. API portals for observation submissions enables users to make use of TOM systems to run their programs.

Michael Strauss commented that there is interest in the community in proposing for follow-up resources as soon as Rubin starts, but the uncertainty in the start of operations means there could be disruption in when they start.

Franz Bauer encouraged NOIRLab and AEON to make statements explicitly supporting flexibility in the scheduling of these programs.

Jennifer Sobeck: Maunakea Spectroscopic Explorer; MSE Pathfinder

Alessandra's Notes: big problem with dedicated spec capability for 10m-class telescopes. MSE is truly dedicated. MSE dedicated to trying to minimize footprint. Coverage with 3 windows across the wavelength regime. Limited prompt ToO follow-up capabilities.

Jennifer's goal is to galvanize coordination of follow-up spectroscopy.

She noted that there is currently no dedicated spectrograph on a 10-class facility.

Therefore the CFHT is considering two projects:

- Maunakea Spectroscopic Explorer (MSE): this will be dedicated to survey follow-up, but create new instrumentation on Hawai'i with a minimum footprint and cultural impact. 11m primary aperture.
- MSE Pathfinder: 4.0m diameter primary aperture, to be built under the current lease.

Jennifer reviewed the steps CFHT are taking to minimize their physical and cultural footprint. Structural alterations will be kept to <10%.

The conceptual design for MSE includes a 11.25m diameter telescope with a 1.5 sq. deg FoV. 4332 fibers, for a low/moderate resolution spectrograph $R \sim 3000-6000$, wavelengths from UV to H-band.

This design has been derived from a number of technical reviews.

MSE will perform limited prompt ToO follow-up, with a dedicated fiber allocation.

Jennifer pointed to numerous science cases requiring large-aperture spectroscopic follow-up as outlined in Najita et al. paper (2017) and the TVS Science Roadmap.

Jennifer encouraged the community to provide input into the science they would like to do with MSE.

Jennifer noted that the CFHT is a northern hemisphere telescope, but equatorial in location, with significant overlap with the Rubin visibility field.

MSE will have a desired zenith angle range of <50deg.

Jennifer summarized by posing specific questions to the community regarding the kind of follow-up programs they would like to do and their technical requirements.

Q Melissa Bruker: will there be an imaging replacement for CFHT's capabilities?
Also, there may be planetary defense asteroid science cases of Pathfinder
Jennifer encouraged the community to emphasize if this is a desired capability.

William Lindstrom: Tools and Services for the Follow-up Ecosystem

Alessandra's Notes: Encouraging more participation in AEON. Two technical requirements to participate: queue-schedulable and programmably-accessible. These requirements are to support the time domain follow-up. Can make observations remotely with a web browser. Non-robotic telescopes can use the available scheduler. Everything is open source and available for all observatories that want to go this direction but might now have the resources for the software etc. Downtown database: gives info when each telescope is available and is used by the scheduler. Scheduler optimizes observation requests over the whole network. Science archives are where science images go. The Observatory control system is all open source and on github. TOMs: Target and Observations Manager Systems (TOMs) have interfaces to data coming in via brokers and alerts system and manage the data products. There are also interfaces to facilities. Python web framework.

William (known as Lindy) introduced his goal of covering a number of the technologies available for coordinating follow-up.

Beginning with the AEON network, he described the AEON collaboration between the Gemini, SOAR and LCO Observatories, and emphasized that there are only two technical requirements for new facilities to join:

- Queue-schedulable
- Programmably-accessible

Lindy emphasized that dynamic queue scheduling enables all forms of observations, and in particular supports the needs of time-domain astronomy.

He also noted that observation requests being submitted through an API system also enables new modes of observing.

Lindy stressed that different observatories are able to participate in AEON in the way that is most appropriate to them - they can remain human-operated if this is preferred, and the system is designed to be easy and inexpensive for facilities to join.

Control over the time allocation process remains with the observatory.

Lindy's slides include links to further information.

Next Lindy moved on to discuss tools that may assist observatories.

The Open Observatory Control System is based on LCO's own observatory control software but is modularized and designed to operate independently. This package is now available open-source.

The package includes modules to provide:

- User observation portal
- Configuration database - holds information about the telescope facility
- Downtime database
- Adaptive scheduler - automatic telescope schedule generation software, used by the LCO network but adapted to operate for other facilities.
- Science Archive
- Open Search - stores telescope and weather telemetry

Lindy's slides include links for more information.

Lastly Lindy highlighted the role of Target and Observation Managers in running observing programs, and pointed out two packages available to build these systems: TOM Toolkit and SkyPortal.

These are powerful database-backed tools that can interface to brokers, observing facilities and data archives to allow users to manage their observations more easily.

Lindy highlighted SNEEx2 system as an example of a TOM system in operation for science.

Lindy noted that these systems are designed to work together in a follow-up ecosystem.

Q Lindi (Dragana Ilic): Will AEON operate with some specific TOM, e.g. like TOM Toolkit?
(edited)

Lindy confirmed that AEON-compatible facilities will be supported with a module in the TOM Toolkit.

David Buckley: South African Astronomical Observatory

Alessandra's notes: SALT 7-8.3m 8 arcmin FOV. NIR IFU new instrument. 50 hrs per year as part of the in-kind contribution program. It will implement the same review process currently in place. Data available typically the afternoon after the data are taken so ideal for TVS. Fully AEON compatible system. Intelligent Observatory great to maximize efficiency and use of telescope time.

David introduced the SAAO facilities that will contribute to Rubin follow-up.

He noted the unusual design of the 10m SALT telescope, which will support optical and NIR spectroscopic instruments plus imagers when Rubin is operational. SALT has a limited viewing annulus.

All instruments support high-time-resolution observations up to 10Hz.

Future instrumentation will include the NIR IFU spectrograph and an RSS dual-arm spectrograph.

SALT is contributing 50hrs per year to the Rubin In-kind Program.

All SALT observations are queue scheduled, and they will soon test and API for submitting observation requests. Reduced data products will be made available within ~24hrs from their data archive.

David illustrated the SALT proposal process with a flowchart.

He then moved on to discuss the other telescopes available for Rubin follow-up.

This includes both wide and narrow field telescopes in the 1-2m range, noting that the 1.0m Lesedi telescope was recently roboticized.

David also noted the new 1.8m IR PRIME telescope from Japan/US, with a 1.5deg FoV for the z to H band, as well as the 1.2m MONET telescope, which is also fully robotic in operation. He noted that this was automated using the OpenOCS software discussed by Lindy.

David described plans for the Intelligent Observatory, which will receive targets nominated for follow-up and determine the most appropriate telescope to perform the follow-up.

These facilities will provide 52hrs/year for Rubin follow-up.

David will show a video describing the Intelligent Observatory in more detail in the unconference session.

Dragana Ilic: Q David: could you share the link to the movie on intelligent observatories you just mentioned? Thx! :)

Jamie Soon: DREAMS, Australia

Alessandra's Notes: not yet officially in the in-kind program but lots of synergies. THE FOV of DREAMS matches very closely that of Rubin. Would be useful to know Rubin's pointings in real time. Not sure at the moment whether data will be proprietary for a certain period. Probably 1-2 years?

DREAMS will use a 0.5m NIR wide field all-sky surveyor telescope at Siding Spring in Australia. This was originally intended to follow-up GW. This is not an In-Kind Facility but will be available while Rubin is in operation, including the potential for contemporaneous operations.

Jamie described the DREAMS detector in more detail. It will cover Y, J, H(short) filters.

DREAMS is expected to go on sky around October 2022.

6 subfields will be selected within the FoV of 12 sq deg, giving a total FoV of 3.71 sq deg, leading to large detector gaps. They plan to use a tiling pointing pattern to fill in these gaps. The FoV of DREAMS is complementary to that of Rubin.

Rather than applying for time individually, the team are considering a 'shadow' survey observing strategy and are considering allowing ToOs. It is unclear whether the data products will be immediately public - this is TBD.

Current operations plan will be for 5yrs.

Michael Strauss: Asked whether the displayed strategy can be considered to be the default cadence.

Jamie confirmed this, and is considering DDFs and ToOs.

Tim Jenness 2:28 PM

We will be reporting telescope position along with upcoming schedule

Chow-Choong Ngeow: Trans-Pacific 2mT; Taiwan

Some issues with the talk so Jen read through the slides.

[Slides contributed]

Jennifer Sobeck reviewed the slides provided.

The 2mT is currently under construction in San Pedro Martir, as a trans-pacific partnership.

The telescope will be a Ritchey-Chretien design with an effective aperture of 2m, and the optical design will offer three instrumentation mounting points.

They expect to make 40 nights / year available for the Rubin In-Kind Program, and the time will be allocated through the NOIRLab TAC process. AEON flexible scheduling will be supported.

Data pipelines are currently being written and they expect to provide calibrated images and catalogs.

Michael Strauss noted that San Pedro Martir was originally considered as a site for Rubin.

Maria Teresa Botticella: VST, Italy

[Slides contributed]

Jennifer Sobeck reviewed the slides provided on behalf of Maria Teresa Botticella .

The VST is a 2.6m at Cerro Paranal in Chile, offering a Wide Field Imager (1 sqdeg), OmegaCam with 12 broadband filters.

The telescope time that will be available to the Rubin In-Kind Program is still to be finalized but are considering 120 nights during 2023-2025 to provide cross-calibration of the first Rubin images.

They are also considering 35 nights / year for Rubin follow-up.

65 nights / year will be used to execute surveys that may be complementary to LSST science in terms of temporal baseline and coverage, photometric depth.

Data product reductions will be performed at the VST Data Center, and they aim to release co-added and calibrated images for selected fields together with calibrated catalogs.

She noted other Italian facilities that will be available for follow-up, including time on the Large Binocular Telescope in AZ (2x 8.4m telescopes), and Son of X-Shooter (SOXS), a medium resolution spectrograph at the 3.6m NTT/ESO telescope in La Silla. INAF will deliver 2000 spectra from SOXS of LSST targets.

Jamie Kennea: Swift Space Telescope

Jamie began with an introduction to the Swift Space Telescope and instruments:

- BAT: Hard X-ray telescope
- XRT: Soft X-ray
- UVOT: UV/optical imager

The unique aspect of Swift is that these wavelengths can only be covered from space, and Swift offers rapid slew-to-target capabilities. It can perform high efficiency follow-up and offers a ToO capability with a response time in hours.

The team is working on automating this process, and Jamie noted that the ToO program is open to all and the data is made publicly available immediately.

Swift is in LEO orbit and can be observed for 42 mins of the 90 min orbit, due to passages through the South Atlantic Anomaly.

Typical observations take 1-5 ks. Any over 1.8Ks have to be spread over many orbits.

Swift received 1742 ToOs in 2021, and approved 99% of them.

ToOs are executed on a best-efforts basis.

PIs can also apply for ToO programs and Jamie noted an opportunity to propose is coming up in the next month.

Proposals coordinating with other observatories are given higher merit.

The rise in ToOs is felt to be a result of the rise in optical transient surveys, which will in future be dominated by Rubin.

Jamie reviewed the online form for the community to request ToOs, noting the several recognized levels of urgency. Most ToOs have levels 1-2.

However, Swift has recently implemented an API, allowing proposers to programmatically submit ToO observation requests. This shortens the timescale for observers to respond to survey alerts. API clients can be made in any language. The Swift API also provides access to Swift observation planning tools.

Jamie highlighted the `swifttools` Python module for interfacing with the Swift API.

In summary, Swift is ready to support Rubin with ToO follow-up, but noted that all Rubin targets can quickly overwhelm the observing time available. He encouraged community coordination.

Tony Remijan: Radio Facilities

Tony's goal for this talk is to give an overview of radio initiatives for time domain astronomy.

In particular, he highlighted the VLASS Survey which will cover the whole sky in 3 observing epochs, obtaining calibrated Stokes I, Q and U and cover the frequencies 2-4GHz with a resolution of 2.5arcsec.

The data are available publicly, and the 3rd epoch data taking underway
[note taking gap...technical difficulties...different note taker]

- GBT Rapid Response: available for investigating time domain objects
- Offer "realfast" system: available on VLBA and VLA
- Additional rapid response capability available
- Realfast on VLA can be used for highly accurate location determination for transient events
- VLA offers high resolution and accuracy
- An example VLA detection and monitoring was shown as well as location determination
- FRBs on the GLT; data show change of sign indications as well (interestingly)
- Interrupt capability; highly desired as interrupt would be immediate and automatic; with ngVLA construction likely not initially available but will be once ngVLA is fully online
- GBO 20-meter, initially a teaching; used for initial object follow-up which then can be passed to VLA
- VLASS program available over the next several years
- DDT program is healthy; 4 proposals received per month
- Establishing an interrupt capability for the future
- Thinking about high amounts of alerts/triggers
- Putting together a simple web form for trigger events

Question (A. Corsi): VLA time domain follow-up...

Answer: Thinking about interrupting without PI incited ToO; moving away from passive waiting (waiting for submitted ToO); interested in AEON capabilities

Open Discussion

All attendees were encouraged to continue the conversation at the unconference session later this afternoon and on the Slack channel.