Enabling the Future of Time-Domain Astronomy with Gemini Observatory

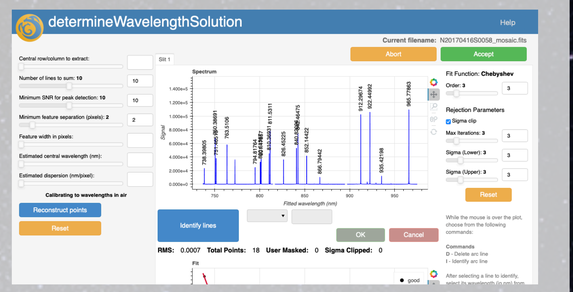
David Jones, Jen Andrews, Kathleen Labrie, Bryan Miller, & Monika Soraisam

Motivation: Rapid follow-up observations of astrophysical transients and multi-messenger events facilitate some of the highest-priority science goals in the Canadian Astronomy Long-Range Plan. But the discovery, triage, observation, data reduction, and analysis of those events currently requires a complicated workflow across multiple different tools and software interfaces. This poster presents a summary of Gemini Observatory's ongoing efforts to streamline the process of transient follow-up from discovery to publication. Gemini is working to build real-time, automated, quick-look reductions of target-of-opportunity observations, a new scheduling platform with full API access for submitting follow-up requests programmatically, and a pipeline that will connect each stage of the transient follow-up process. Our goal is to build cohesive, accessible tools that enable high-impact transient science from Gemini Observatory in the coming decade.

DRAGONS & FIRE

DRAGONS: Data Reduction for Astronomy from Gemini Observatory North and South (DRAGONS) is Gemini's Python-based data reduction platform. DRAGONS supports the science-quality reduction of data from GMOS, NIRI, GSAOI, and F2 imagers plus the GMOS long-slit spectrograph (including nod-and-shuffle observations).

Example of browser-based interactive tools for data reduction with DRAGONS



The goal of DRAGONS is to support Python-based data reduction for every Gemini instrument and observing mode, replacing and streamlining previous IRAF-based routines. Next up in 2024: GNIRS and Flamingos-2 long-slit spectra as well as GNIRS cross-dispersed spectra.

Documentation: & Tutorials
dragons.readthedocs.io

More Tutorials
https://gitlab.com/nsf-noirlab/csdc/usngo/DRAGONS_tutorials

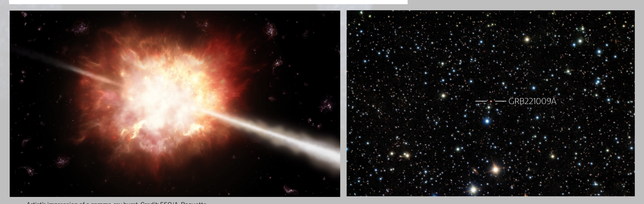
FIRE: For fast-evolving transients like kilonovae, fast data reduction can be critical. The Fast Initial Reduction Engine (FIRE) will support night-time quicklook reductions of Gemini target-of-opportunity data with immediate upload to the Gemini Science Archive. The development of FIRE is completed, incorporating FIRE into operations is TBD.

FIRE was successfully tested on GMOS longslit spectra of GRB 221009A, the brightest gamma-ray burst ever observed; reduced (quicklook) data were available within minutes following the end of the observing sequence.

OCTOBER 19, 2022 BY MATT WILLIAMS

Astronomers Just saw the Most Powerful Gamma-ray Burst Ever Recorded

Credit: NOIRLab, Universe Today



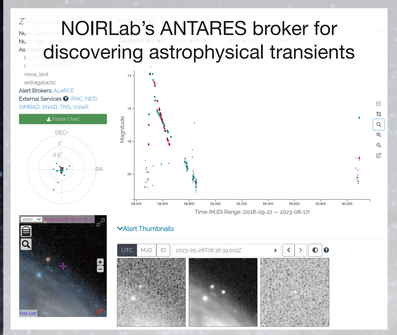
Artist's impression of a gamma-ray burst. Credit: ESO/A. Roquette

See our Capabilities Brochure to learn more about Gemini's workhorse instrumentation for time-domain astronomy

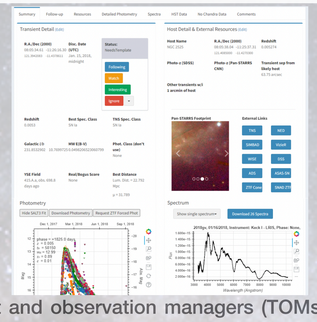
Gemini Observation and Analysis of Targets System (GOATS)

GOATS will connect the full Gemini ToO infrastructure from discovery to follow-up, data reduction, and publication. In this framework, new astrophysical transients will first be discovered from telescope data streams by "brokers" like NOIRLab's ANTARES.

NOIRLab's ANTARES broker for discovering astrophysical transients

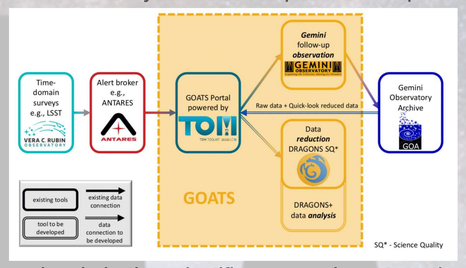


Example target & observation manager; synthesizes data, requests followup via APIs (Coulter+23, Jones+21)



Users can ingest those transients into target and observation managers (TOMs) and submit ToOs to Gemini at the click of a button, facilitated by the new Gemini Program Platform. Data will be uploaded to the Gemini Observatory Archive, automatically reduced with FIRE or interactively reduced by the user, and then ingested back into the TOM for analysis and subsequent follow-up observations.

Schematic of the full GOATS process

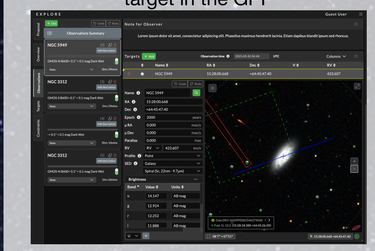


GOATS will reduce overheads in the scientific process by automating repetitive tasks (e.g., downloading observed data, data reduction, and even routine analyses like identifying a common transient's class by its spectral lines) and allow scientist to focus on interpreting their data. GOATS will be built using institutionally supported software to facilitate long-term maintenance and continued use throughout the astronomical community. It will be part of a suite of similar tools, built across NOIRLab for other telescopes and data streams.

Gemini Program Platform (GPP)

The Gemini Program Platform is a future tool to replace Gemini's Phase I Tool (PIT) and Observing Tool (OT). The GPP will fix longstanding over-complications in the Gemini proposal and observing process with a new browser-based interface that automatically creates full, executable observations, has a fully-integrated integration time calculator (ITC), employs automatic real-time scheduling, and has full API access for programmatic scheduling of observations.

View of an example target in the GPP



Target observability on a given night will be easily available

GPP will generate new schedules in under a minute as ToOs occur, creating schedules for Gemini North and South simultaneously as appropriate, and will have automated queues that can be evaluated via reproducible metrics to ensure they reflect the TAC's rankings.

Everything that can be done via the user interface can be done programmatically in GPP, and Python-based examples will be provided for the user community. Both the improved UI and programmatic infrastructure will mean a much quicker workflow from transient discovery to getting your data. GPP is expected to be available in 2024A.

Check out the live GPP demo yourself at explore.gemini.edu

In the meantime, we have new telescope status pages to help with triggering observations. The new format includes the status of the telescope, pertinent weather information, skycams at each site, and available instruments and their current configurations.

New status pages with more convenient real-time information for ToOs