**GAC Report**

**May 18, 2020**

GEMINI

Until the cessation of all operations due to COVID-19 in mid-March, Gemini Telescopes continued to produce state-of-the-art astronomical datasets and exciting results. Gemini North's NIRI and the technique of "lucky imaging" gave us some of the highest resolution ground-based images of Jupiter. In combination with Hubble and Juno observations, these images reveal that some of the largest storms on Jupiter form in the regions of large convective cells above the clouds of water ice and liquid. A Canadian-led team used GNIRS to detect the most energetic outflow from a quasar to date. GMOS-N follow-up observations of a rare localized source of repeated fast radio bursts discovered by CHIME revealed that its environment is a star-forming region of a nearby spiral galaxy (z~0.03). The analysis, led by a team that includes a number of Canadian researchers, has been published in Nature. At the time of writing this report both telescopes are in safe shut-down state (with Gemini North preparing to re-start operations, as noted below). Gemini staff at both locations and in the NOIRLab (previously NCOA) have been working from home. Instrumentation hardware work is on hold until further notice. In coordination with NOIRLab, the Observatory has developed a return-to-observations plan for when the health restrictions start getting eased. The operations will restart with minimal personnel on site and thus the first available instruments will be those that require minimal handling. There is a plan for delayed or staged Phase-2 deadlines for approved 2020B programs. Governor of Hawaii recently gave the observatories a permission to open. After an internal Operations Restart Readiness Review, Gemini-North has been given the green light to restart night-time observations on the night of 19 May. Re-start of operations on Gemini-South is currently unknown. The completely remodeled Observatory website was launched on 11 April. (We are grateful to Marcin Sawicki for providing the information from the latest Gemini Board meeting).

TMT

MT construction remains stalled as discussions continue with all stakeholders.  Both potential sites, at Maunakea and ORM, have significant issues with access that need to be addressed in a thoughtful and respectful manner.   In the meantime, off-site work continues and instrumentation projects including WFOS and NFIRAOS are progressing well.   The project continues to work closely with the Giant Magellan Telescope, and the National Science Foundation, to identify a viable route for US support and funding.  More detail is available in the CATAC report (Many thanks to Michael Balogh)

Here’s the LSST update for CASCA Ground-based Astronomy Committee (GAC)

The Large Synoptic Survey Telescope has been officially renamed the Vera C. Rubin Observatory (with preferred abbreviation as the Rubin Observatory, the acronym VRO should not be used). The renaming was chosen to honor Rubin, a pioneer in astronomy and dark matter science. For the first ten years of operation, Vera C. Rubin Observatory will perform the Rubin Observatory Legacy Survey of Space and Time (LSST).

From the Rubin Observatory news digest (see <https://www.lsst.org/news/digest/05may2020> for more information):

“Covid closures are still in effect for key Rubin Observatory locations, including the summit construction site. However, in compliance with local regulations, the Rubin team has been able to keep up with some essential activities to ensure that the sites are secure, with staff safety as a first priority. In parallel, the Project leadership team is working on plans to restart construction activities safely and in a phased way once it is deemed safe to do so. The plans will focus on priority technical areas but will also comply with government orders as well as health and safety department guidelines. All efforts will be coordinated with AURA and SLAC for an organized and safe return to construction.”

The participation of international partners in LSST and the associated issues around data rights for international partners are being assessed through a Contribution Evaluation Committee (CEC). The CEC has been appointed by Acting Rubin Observatory Operations Director Bob Blum, with a charge to oversee the evaluation of the proposed contributions. The CEC consists of a 15-member committee, with representatives of each of the 8 LSST Science Collaborations, and an additional 5 at-large members (including 2 Chilean representatives), the Science Collaborations Coordinator (Federica Bianco), and Phil Marshall. The full charge of the CEC can be found at: <https://community.lsst.org/t/international-in-kind-contribution-evaluation-committee-cec-update-charge-and-science-collaboration-representation/3998>

A Canadian Letter of Intent (LOI) was submitted by Renée Hlozek and J.J Kavelaars in response to a call from the LSST Project in November 2019. This LOI was based primarily on the science platform and data archive that will be provided by the Canadian LSST Advanced Science Platform (CLASP), which is currently proposed as a CFI-funded project, but will hopefully become a nationally-coordinated centre, pending LRP considerations of Canadian involvement in LSST. The CLASP CFI proposal is a CAD 13M proposal which will fund the development of a Canadian LSST data centre as part of the Canadian Astronomical Data Centre (CADC) and the development of software infrastructure to process LSST data and enable science with the associated data products.

On April 7, 2020, the CEC informed us that the Canadian LOI has been reviewed by the NSF and DOE and is approved for further development. The deadline for the full proposal has been extended to the end of June 2020 (although this extension was announced before the COVID-19 epidemic, and so further delays might be expected. Formal feedback on the LOI that was submitted in November is expected from the CEC in late May. Part of the CLASP LOI includes support for related science working groups (e.g. the Dark Energy Science Collaboration, DESC), and the CLASP contributions are being discussed within DESC to assess the value of the contributions and ways we can make the Canadian contributions most valuable to the Project and the science collaborations within the Rubin Observatory.  Finally, CLASP was also submitted a Letter of Interest to be a LSST community wide broker that will work in partnership with upstream LSST brokers that process the LSST alert stream directly (such as ANTARES, ALTAIR etc.)

(Many thanks to Renee Hlozek for this update)

**MSE**

Texas A&M University has joined MSE as an official partner after having observer status for the past year. Several MSE events were postponed or moved to video conference mode due to COVID-19.

MSE Management Group member Laura Ferrarese (NRC-Herzberg) is serving as Chair of the MSE MG in 2020.

France has signed the MSE preliminary design phase statement of understanding. Once a signature from the University of Hawaii is obtained, the SOU will come into force and guide how MSE is managed during PDP.  China and India have agreed to become affiliate partners with a reduced voice in project governance until they are able to join in signing the SOU.

Preliminary design work on the MSE Program Execution Software Architecture is getting underway with plans for Canadian contributions from St. Mary's University, Waterloo, York, Western, Toronto, McGill, and CADC, in conjunction with other contributors in France, the UK, China, the US, and Korea.

**CFHT**

CFHT and all observatories on the summit of Maunakea suspended nighttime observations due to the stay-at-home orders issued for Hawaii on March 23rd. As of the writing of this report (early May) CFHT remains closed, however, the low caseload in Hawaii seems to indicate that nighttime operations may restart in mid to late May.

CFHT has suffered several equipment failures in recent months, however, these have resulted in minimal delays in observing. In December 2019 the hydraulic system that runs the telescope drive failed. A workaround was quickly implemented. The drive was old and the company that built it no longer exists. CFHT commissioned a redesign of the system from a different company. That design is now finalized and ready for implementation. The workaround is functional, so the downtime for installing the new hydraulic system is TBD.

The observatory crane that performs changing of prime-focus instruments also failed at CFHT. Several parts failed but have now been replaced. The crane has an 18 ton capacity and this is the typical weight of current prime focus instruments, implying the crane is working near maximum capacity at all times. Testing of the capacity of the repaired crane is ongoing, and consideration is being made of a higher capacity replacement crane is being made with safety of both staff and instruments in mind.

SKA

There has been tremendous progress within the SKA project in the last six months amidst the global uncertainty due to the COVID-19 pandemic, as summarized in a recent public statement from the SKAO Director-General:

<https://www.skatelescope.org/news/statement-on-ska-project-status/>

A separate report will be submitted to the CASCA Board by the ACURA
Advisory Council on the SKA regarding these international developments as well as the status of the SKA project in Canada.

(Many thanks to Kristine Spekkens for this update.)

ngVLA

Work on the ngVLA project is continuing.  After providing the Astro2020 panel on Radio, Milliimetre, and Submillimetre (RMS) astronomy a detailed written response to questions, the NRAO team addressed the panel in person at an Astro2020 session at the University of California, Irvine in early February.  The input provided to the panel was regarded as very well organized and thorough.  The project hopes to receive an invitation to present ngVLA to the main Astro2020 panel in some fashion this fall.  Meanwhile, NRAO has also recently responded to an NSF invitation to submit a Letter of Intent to its MSIP program for funds to construct a prototype ngVLA antenna.  NSF accepted the LoI, and work is progressing on a full proposal.  This proposal is being prepared in collaboration with Caltech, and the antenna will be used for a CO intensity mapping experiment using a new Ku-band focal plane array developed by Caltech.  In other news, NRAO (and NRC) staff have been largely working from home since mid-March, due to the ongoing COVID-19 crisis.  Design work is still occurring, though on a more-limited basis.  A major impact of the crisis has been the delay until possibly next spring of the next large ngVLA conference, “Compact Objects and Energetic Pheonomena in the Multi-Messenger Era,” which was originally planned for July 14-16, 2020 in Saint Paul, MN.  In addition, plans for a F2F retreat for the ngVLA Science and Technical Advisory Councils this summer have also been put on hold.  To keep the community engaged, the project will probably hold science and project updates on a quarterly basis.  Finally, NRC’s Penticton team presented its attractive Trident Frequency Slice Architecture correlator design at an ALMA correlator workshop in Charlottesville, VA in mid-February.  Though not strictly ngVLA-related news, NRAO favours a similar correlator design for both ALMA and the ngVLA correlator itself.  Discussions about future collaboration are ongoing.

(Many thanks to James Di Francesco for this update.)

CHIME

CHIME has three major thrusts---the investigation of cosmic expansion that motivated its construction, the study of Fast Radio Bursts (FRBs), and the study of pulsars. Steady progress is being made on all fronts by the group of approximately fifty scientists involved in the three consortia. The cross-Canada teams working on these fronts collaborate through many telecons, and periodic face-to-face meetings.  Operational efficiency of CHIME is now high, with science runs of several months duration interspersed with upgrade campaigns where software improvements are installed and tested. A roster of individuals from the cosmology and FRB groups serve as “data tsars”, remotely checking operation and data quality.

CHIME operates unattended, and has operated at full potential through the COVID-19 pandemic. This success derives from software and hardware designed to enable remote scrutiny of key parameters and diagnosis of problems. In 120 consecutive days from 2019 December 08 to 2020 April 06 only 3.5 days were lost. During this period 95% of the GPU correlator nodes were in full operation.

The key to success with the cosmological goals is precise characterization of the telescope, in particular the properties of antenna beams and the stability of the signal path with temperature. Progress is good: sky maps integrated over more than 100 nights have been made, and noise continues to go down. There is continuous improvement in map-making algorithms.

Fast Radio Bursts are millisecond duration transients, arising at cosmological distances and therefore very energetic. Since 2018 July, CHIME/FRB has detected hundreds of events, placing CHIME as the undisputed world leader in FRB detection. Recording of baseband data from detected FRBs now enables improved positional accuracy and determination of Rotation Measures. CHIME/FRB has published details of seventeen repeating FRBs, a small fraction of the FRB population. Repeating FRBs can be studied with other telescopes to provide precise locations in order to identify host galaxies. Location of one of these repeaters (using long-baseline interferometry) to a galaxy at the relatively close distance of 154 Mpc has been reported in Nature. A periodicity of about 16.3 days has been detected in the probability of receiving bursts from this FRB (accepted for publication in Nature).

The scientific productivity of CHIME/FRB is high. Four papers have been published in 2019, and four have already been published in 2020 or are in press. Two papers from CHIME/pulsar were submitted to refereed journals in 2019.

The CHIME/FRB Consortium has obtained funds to build outrigger telescopes with the purpose of localizing bursts to high precision. Long-baseline interferometry techniques will be used between the main CHIME instrument and the outriggers to provide sub-arcsecond localizations. The remote receiver will be triggered by the detection of an FRB at CHIME. This has been successfully demonstrated between CHIME and the CHIME Pathfinder at DRAO. While this baseline, about 450 m, does not provide interesting angular resolution, the experiment has demonstrated the viability of the technique, and the equipment stands ready to be deployed to more distant sites.

The first outrigger site is located 90 km west of DRAO. The antenna structure has been designed and fabrication of receivers is underway. Construction is planned for 2020, with the target of operating within one year. A postdoctoral fellow is now working at DRAO on outrigger operations and science data.

(Many thanks to Tom Landecker for this update.)

JVLA

The JVLA, operated by the National Radio Astronomy Observatory, continues normal operation.  The array is in the C configuration for the duration of the 2020A semester through at least 2020 June 08 (originally scheduled for 2020 May 11, but pushed back due to difficulties in performing the array reconfiguration while maintaining COVID-19-related precautions).  The next proposal deadline is 2020 Aug 02 for the 2021A semester, which will span 2021 Feb 26 through 2021 Aug 30 and include the C and D configurations.

The VLA Sky Survey has completed first-epoch observations of the entire sky north of declination -40 degrees.  The second epoch of VLASS observations is planned to begin at the end of May 2020.

DRAO

COVID-19 situation: all staff are teleworking, and this has meant significant changes to telescope operations.  The Galt Telescope is stowed, as it is too risky to operate it unless staff are available on site to promptly address any issues that might arise.  The Synthesis Telescope can normally be operated remotely, but a maintenance issue that arose just prior to the start of teleworking was not resolved before staff left the site, so it too remains offline as we continue to try to diagnose and repair it.  On a more positive note, the solar telescopes are operating normally, as unattended observing is their normal mode of operation!

Galt Telescope: the Galt Telescope is a 26-m single-antenna telescope.  It is currently in an upgrade cycle, aimed at equipping it with a cryogenic wideband receiver (900-1800MHz) for Zeeman studies.  The new spectropolarimeter backend is largely complete, using a CHIME ICE board as the F-engine and a GPU-based X-engine.  Telescope monitoring and control software and hardware are also well-advanced.

Design of the cryogenic system has progressed well, with a gimbal mount for the cryogenic compressor devised to allow mounting on the rotating part of the telescope structure, removing the need to feed cryogenic lines through a rotating joint, thus greatly simplifying the cryogenic system.  Design of the focus box for mounting and environmental protection of the receiver is under way.  It is expected that commissioning of the new systems will occur by Fall this year.

Solar Telescopes: the Solar Flux Monitor program (SFM) at DRAO records and distributes the F10.7 solar activity index used worldwide.  The primary instrument employs redundant 2-m antennas  (FM1 and FM2) to measure the solar radio emission at 2.8GHz (10.7cm wavelength), with carefully calibrated measurements made thrice daily and distributed to the data service.  This system is undergoing upgrades to modernize the telescope control and data acquisition systems.  FM2 is currently running on the new linux-based system with a software-defined radio (SDR) receiver.  This system is being debugged at present, but comparisons with FM1 show that the new data from FM2 are closely comparable.  FM2 does not currently contribute fluxes to the data service except as a backup to FM1, which remains on the older Windows-based system.  The linux/SDR upgrade will be extended to FM1 once FM2 returns to normal operation.

The Next-Generation Solar Flux Monitor (NGSFM) is a single 4-m antenna with a wideband feed and receiver system that records data at 1.4, 1.6, 2.8, 3.3, 4.9, and 8.3 GHz.  This telescope is currently serving as a test bed for the new TANGO-based control system that will allow common control software to run on all DRAO telescopes.  Debugging of this system is nearing completion.  Pointing measurements are being obtained now, and once a pointing model has been put in place it will be possible to acquire accurate fluxes to supplement those from the SFM.

Synthesis Telescope: the Synthesis Telescope (ST) uses seven 9-m antennas in an interferometric array operating at 408 and 1420MHz, with a 256-channel spectrometer measuring the HI line.

In the last few months the ST underwent a review of electrical safety, resulting in a few minor changes to address some issues that were identified.  The power upgrade project is still awaiting a new site generator, which should be installed in the coming year. This will provide reliable power to the Blockhouse for critical systems.

The correlator project of Pamela Freeman (U. Calgary student) is now complete, with tests indicating that it produces output nearly identical to that of the existing continuum correlactor.  Pamela has now defended her thesis, so congratulations to Pamela!

Plans to further integrate Pamela's correlator into the observing system have been set aside with the big news that the NRC Small Teams proposal to explore novel radio interferometry technology on the ST was successful, and will proceed over the next 3 years.  The goal is to deploy systems to demonstrate new technologies under development by DRAO, including wide-band (400-1800MHz) feeds and LNAs, digital signal transmission and correlation (using Talon boards developed for the SKA), and Brent Carlson's novel incoherent clocking scheme.  This project officially kicked off earlier this month, but changes to the telescope are not expected for the first 2 years, so operations are nominally continuing as before for now.

(Many thanks to Andrew Gray for this update.)

**ALMA**

Following the period of civil unrest experienced in Chile in October 2019, ALMA executed two months of record observing hours, on the 12-m array in November and then on the ACA and Total Power arrays in December. Combined, these months are the two most successful observing months ever at ALMA with over 1000 total hours of observing. The focus was on high efficiency science operations, maintaining stability in the engineering and computing and an introduction of flexible technical time allocations to minimize interventions. The goal is to maximize time for science. From the onset of Cycle 7, the number of antennas typically was higher than the anticipated 43.

ALMA is keeping pace with delivery of data to PIs. The vast majority of datasets for December (90% of the 1124 pipeline-processed datasets) have been delivered within 30 days since they were fully observed*.* ALMA also saw a decline in the number of datasets failing quality assessment, from 12% during Cycle 6 down to 5% over the early months of Cycle 7.

ALMA was shut down in February for maintenance during the poorest weather season on Atacama. A few weeks after science operations resumed, the decision was made to undertake an operations shutdown of the site (18 March) in response to COVID-19. The observatory remains closed, and all antennas and receivers are powered down. The only instrument which is being powered is the master timing maser, via solar-charged batteries and a backup generator. The expected time to resume operations once the decision is made to restart is 6 weeks. A caretaker team remains on site to inspect the site and ensure safety and security. This team is rotating from week to week.

At the time of the shutdown, the Cycle 8 proposal deadline was shifted from April 15 to no earlier than 19 May, and on 17 April, the call was suspended indefinitely. The call has since been canceled and will be deferred a full year, to April 2021. The reasons include the uncertainty in the time of restart of operations, the time required to restart and the time required for full software testing prior to Cycle 8. There has been discussion of a possible supplemental call for the ACA in the fall, but this is not yet certain.

**JCMT**

The JCMT continues to be operated by the East Asian Observatory (EAO). The U.K. contributes financial support to JCMT operations as well. Canada continues to manage the JCMT archive through the Canadian Astronomy Data Centre (CADC). As a result, astronomers based at Canadian institutions continue to be eligible to lead and participate in JCMT Large Programs (>200 hours over several semesters). However, without a cash contribution to operations, Canadians can only be co-Is on smaller proposals submitted to the March 2020 proposal call.

In response to the COVID-19 situation, including the ‘stay-at-home’ order issued by the Governor of Hawaii, the JCMT has been on operational hiatus since March 13, 2020. The EAO is making initial plans for re-opening the observatory and getting back on the sky hopefully sometime in May, with the majority of the staff continuing to work from home. Additional on-sky operations are needed to complete the commissioning of the new receiver system Namakanui, which arrived in Hawai`i in July 2019. Its 230 GHz cartridge, U’u, is the replacement receiver for the old RxA3m that was retired from service in June 2018.

Planning continues to design and build a new 850 micron camera with 20 x faster mapping speed than SCUBA-2 and with permanent dual-polarization capabilities. Chris Wilson (McMaster) led a proposal that was submitted to the CFI 2020 Innovation Fund for part of the required funding; the other Canadian universities involved are the University of Manitoba, Universite de Montreal, Queen’s, and UBC.

**DAO**

The 1.2-m telescope was slightly undersubscribed for the first two quarters of 2020 with a subscription rate of 91%.  However, PI’s are always happy to obtain extra nights to make up for cloudy weather so the telescope continues to operate on every reasonably clear night.   About 70% of the time on the 1.2-m telescope is scheduled for unattended robotic operation.  The 1.8-m Plaskett Telescope had a subscription rate of 117% for the first two quarters. 66% of the time was scheduled for direct imaging, 18% for spectroscopy and 16% for spectropolarimetry.  A thorough search of publications for 2019 has not been conducted yet, but more than 40 publications (refereed and circulars) based in part on DAO telescope data have been found so far in ADS's database.

Substantial progress has been made in the effort to automate the operation of the Plaskett Telescope.  The first complete night of robotic operation in imaging mode was carried out successfully on 3 November 2019 and has now become routine since early March.   More work is needed to enable robotic operation of the telescope when it is configured for spectroscopic observations, including target acquisition software development, and fabrication of a new CCD dewar since the existing dewar used with the spectrograph is incompatible with the telescope’s closed-cycle cooler.

Because of the new robotic capability of the Plaskett Telescope, both DAO telescopes have continued to operate on every clear night despite COVID-19 concerns and NRC’s decision to have staff work remotely from home.  The Plaskett Telescope has remained in imaging mode even during bright time since this eliminates the need for more than one staff member to make instrument changes.   Dmitry Monin or myself visit the DAO site typically once or twice a week to make spectrograph configuration changes for the 1.2-m telescope, resolve simple operations problems, and perform maintenance tasks.  The restriction to imaging observations on the 1.8-m telescope has obviously resulted in a few PI’s losing their scheduled spectroscopy or spectropolarimetry time.  At this time it remains unclear when we will resume normal operations.

We are still awaiting a proposal from Dynamic Structures of Port Coquitlam, BC, to measure lateral loads on the Plaskett Telescope's dome wheels before continuing with efforts to refurbish or replace the 24 wheels.  This has been delayed because of their commitments to TMT activities and unfortunately will be delayed even further because of COVID-19 restrictions.   In the meantime we continue to operate the dome with a few temporary replacement wheels and inspect the wheels and rail regularly.

Software for the new TCS computer on the 1.2-m telescope continues to be updated to improve the reliability of dome control, telescope slewing, and autoguiding.  With more remote control of dome and telescope hardware now available, the frequency of trips to the site during the night has been reduced considerably.

As time permits we continue to add locally stored DAO spectra and images to the CADC's DAO archive after correcting and enhancing FITS header content.  At the time of writing Plaskett Telescope datasets from 2000 are being added to the pubic archive.

Unfortunately COVID-19 restrictions have meant that all public outreach activities at the Plaskett telescope and Centre of the Universe conducted by the Friends of the DAO (FDAO) with the support of RASC Victoria members have been suspended.  The annual Victoria Vox Humana chamber choir concerts originally planned for September have also been cancelled, although a discussion of possibly filming a performance late in the summer has begun.

Finally, as part of NRC’s review of all of their research facilities, we have recently completed self-assessment reports for both DAO telescopes.  These include discussions of future opportunities for both telescopes and we will begin soliciting the community for input on new instrumentation soon.

**CAT-prime** (with thanks to Michel Fich)

Construction of the CCAT-prime telescope is proceeding as scheduled, but the development of the instrumentation has been delayed due to university lab closures from the COVID-19 pandemic.  Depending on the length of these closures, the main camera (prime-Cam) may be delayed getting on the telescope or it may have fewer imaging modules ready at the scheduled time of first light.  The CCAT-prime team also held a virtual workshop from April 7-10 with over 100 registered participants.

**SOFIA** (with thanks to Simon Coude and Bill Reach)

SOFIA operations are on hold since March 19, 2020, due to the ongoing COVID-19 pandemic, but plans are already in motion to resume normal operations as quickly as possible after this unique situation is resolved.  Prior to the shutdown, SOFIA successfully completed several flight series since the beginning of the year.

Of particular note, SOFIA contributed three instruments (EXES, FIFI-LS, and GREAT) to the international monitoring effort of the unusual dimming event experienced by the star Betelgeuse between November 2019 and March 2020. The first EXES results from this campaign were recently published in the Astrophysical Journal Letters (Harper et al. 2020, ApJL, 893, L23), and the data from all three instruments will be made publicly available on the IRSA archive.

In addition, SOFIA's HAWC+ polarimetric camera observed magnetic field lines parallel to the spiral arms of the Messier 77 galaxy, which confirms a prediction of the density wave theory for spiral galaxies (Lopez-Rodriguez et al. 2020, ApJ, 888, 66). SOFIA also probed the mid-infrared properties of bright massive young stellar objects in the Messier 17 star-forming region using its FORCAST camera (Lim, De Buizer & Ramdoski 2020, ApJ, 888, 98).

Finally, Dr. Margaret Meixner joined the SOFIA program on April 13, 2020, as the new Director of Science Mission Operations. Previously the Project Scientist for JWST at the Space Telescope Science Institute, Dr. Meixner will work to maximize the scientific impact of the observatory.