Notable events for the GAC in the last 6 months:

- A recommendation was issued on CFHT long-programs following a request from the Canadian representative on the CFHT Board.
- The GAC met to discuss the Astro2020 report, and has agreed ongoing actions regarding getting further information relevant to a number of facilities before recommendations can be made.
- Many recommendations cannot be made public immediately given their nature. We will archive recommendations when they are no longer sensitive.

Facility: Atacama Large Millimetre/submillimetre Array (ALMA)
Contact person for GAC: James Di Francesco [NRC]
Operation dates: 30 September 2011 (start of Cycle 0) - present (Cycle 8); year-round observing except for an annual February-long maintenance shutdown
Funding status (total): ALMA is fully funded via a Trilateral Agreement between the National Science Foundation (NSF, US), the European Southern Observatory (ESO; Europe), and National Institute of Natural Sciences (NINS, Japan) on an annual basis
Funding status (Canada): Canada's contributions to ALMA are managed by the National Research Council (NRC) via direct cash payments to NSF for Chilean operations from the Treasury Board of Canada and in-kind contributions for North American operations by NRC.
Cost (total): The 2022 ALMA Operations budget is $87.1M (USD) plus 71.2 FTEs deployed at the ALMA Regional Centres, subject to appropriations by the US and Japan and approval by the ESO Council.
Cost (for Canada): Canada's annual contributions are 7.25% of the North American shares of Chilean (cash) and North American (in-kind in FTEs) ALMA operations support.
International competition: ALMA is the premier observatory in the world for millimetre/submillimetre observations of the universe. Its closest competitors include the SAO's Submillimetre Array (SMA) and IRAM's Plateau de Bure Interferometer (now NOEMA), which have far less collecting area than ALMA but are making up some ground in continuum sensitivity by using very wide bandwidth correlators (and of course they have northern locations as well).
Access for Canadians: As part of the agreement between the NRC and NSF, Canadians have full access to the 33.75% share of ALMA time via North America. With 4300 hours of observing time typically allotted per Cycle, this percentage translates to approximately 1450 hours of time. Canadian PIs generally lead ALMA projects each Cycle that require a total time that is more-or-less consistent with our annual 7.25% share of operations costs.

Project news: Proposals for ALMA's Cycle 8 were evaluated over the summer. Projects requesting less than 25 hours were reviewed following a new Distributed Peer Review (DPR) method, where each proposal PI is sent 10 other proposals to rank from 1 to 10. Those requiring more than 25 hours, including Large Project proposals, were reviewed via the previous panel method, although remotely. The DPR method was well received by the community, but the Joint ALMA Observatory still intends to improve it in various ways. For example, Cycle 9 proposals will likely requiring a minimum length of reviewer feedback, though the incidence of too-terse comments from reviewers was small. All Cycle 8

proposals were also newly reviewed in a dual-anonymous fashion, where the proposal team is not revealed and the proposal itself is written in a manner to prevent identification of the team as well. This approach appears to have removed biases in gender and career seniority. The Cycle 9 proposal review is likely to occur in the same remote manner as for Cycle 8's review, given continuing uncertainties about travel amid the ongoing COVID-19 pandemic.

For Cycle 8, the community was encouraged to request more time, and it responded. For example, the mean time request for 12-m Array projects that received either Grade A or B increased to 16.8 hours, the highest yet seen. (NB: the median was 12.7 hours.) Given the fixed amount of available observing time of 4300 hours to schedule and some carryover Grade A projects from Cycle 7, the numbers of Grade A or B 12-m Array proposals went down to 233. ALMA continues to be in high demand, and it is hoped that the increases in sensitivity and frequency reach afforded by increases in instantaneous bandwidth stemming from the ALMA2030 development process will help ease pressure.

ALMA's Cycle 7, which was interrupted in March 2021 for nearly on year due to a COVID-19-related facility shutdown, continued until the end of September 2021 with at least 41 antennas in the 12-m Array. Despite difficult weather conditions in austral winter, ALMA's 12-m Array was finally moved in early September into a very wide configuration that was a hybrid of its Configurations 9 and 10 for two weeks. This step was crucial for ALMA to observe several projects that need its very highest resolutions, as the array is not scheduled to return to such a configuration for nearly two years. Cycle 8 began on 01 October in a slightly less extended configuration, and observing has been proceeding well, despite still-decreased staff numbers at its Operations Support Facility. The high observing rate is thanks in part to the initiation of observing from a new remote Control Room Extension in the Santiago ALMA offices. As of today, Cycle 8 continues though some issues have been recently reported with the ACA's correlator, which may require routing the ACA's signals to the current 12-m Array correlator in the near future while the causes are investigated.

At the November 2021 meeting of the ALMA Board, the Phase 1 of NRAO's project to replace the existing Band 6 receiver suite with new receivers was approved. The goal of this project is to enable a bandwidth that is at least a factor of two wider than the current Band 6 receivers and allow a much wider frequency range of line emission to be observed simultaneously, all at higher sensitivity. NRAO's Central Development Laboratory in Charlottesville, VA will lead the project, the first of the ALMA2030 upgrades, and over the next five years they will develop a production-ready Band 6v2 receiver. Phase 2 of the project (not yet approved) will involve production of 73 Band 6v2 receivers over the following five years.

Finally, new Cycle 9 capabilities for ALMA have been determined by the Joint ALMA Observatory and will include:

- a Solar Total Power Array regional mapping capability with a double circle pattern in Bands 3, 5, 6, and 7.
- Very Long Baseline Interferometry (VLBI) band 7 continuum capability
- VLBI band 3 spectral scan capability (in a single baseband, at fixed frequency)
- High-frequency and long baseline capability; activating the band-to-band observing mode in Band 8 (for Configurations 8, 9, and 10), Band 9 (for Configurations 8 and 9), and Band 10 (for Configuration 8).

Canada specific news: Despite the intense competition for Cycle 8 ALMA time, six proposals with Canadian PIs requiring 148.7 hours of time on the 12-m Array or ALMA Compact Array were awarded

either Grade A or B. In addition, four Canadian PI-led projects that require 93 hours of 12-m Array time were awarded Grade C. Congratulations to the PIs and their associated teams!
Meanwhile, the NRC submission for the Cycle 8 ALMA Development Project proposal call, which involved the construction of a versatile, second generation correlator for the ALMA 12-m Array, was accepted this fall by NRAO and the US National Science Foundation. The new correlator will enable an instantaneous bandwidth for ALMA that is a factor of 2 wider that the current correlator's capability, with a further upgrade path to enable a factor of 4 increase over current capability in future. The new correlator design is based on the TALON Frequency Slice Architecture developed at NRC's Dominion Radio Astrophysical Observatory (DRAO). Note that this approval is only the first step to making this project a reality - a full proposal for the second generation correlator will be considered by the ALMA Board for approval at its April 2022 meeting.
Finally, the first Canada-led ALMA Large Project, the Virgo Environment Traced in Carbon Monoxide (VERTICO), will have its first paper published in December 2021 in the Astrophysical Journal Supplement Series. The study, led by Dr. Toby Brown of NRC, involves high-resolution CO 2-1 data of 51 galaxies within the Virgo Cluster and allows a probe of the impact of the hot intra-cluster environment on the continuation of star formation in those galaxies. Amazingly, the ALMA data reveal that the hot external gas can indeed affect the molecular gas content deep within these galaxies, effectively 'killing' them as star-forming entities. The upcoming publication of the paper was highlighted on the ALMA webpage and its associated press release was picked up widely by the media. The VERTICO team will continue to work on further exploitation of the remarkable dataset.

Facility: Canada France Hawaii Telescope
Contact person for GAC: Laura Parker (incoming CFHT SAC chair)
Operation dates: 1979 – present
Access for Canadians: 42.5% partner share

Project news: CFHT continues to operate with 5 instruments with 60% of Canadian time (70% of French time) dedicated to large programs. The current generation of large programs are wrapping up and there may soon be a call for the next round of large programs. A first announcement will be made soon about the 2022 CFHT User's Meeting, which will be held in a hybrid format hosted by the Observatory of Strasbourg. In recent months the CFHT board has been busy with the search for a new Executive Director (ED). The search is now in the final stages and a new (ED) should be in place sometime in 2022. MSE remains the future vision for CFHT and is well matched to the need for massively multiplexed optical spectroscopy identified in the Astro2020 process through the new NSF mid-scale strategic funding line. This is a critical time to step-up the work at CFHT and in partners, in view of possible new funding opportunities. The interim ED, Andy Sheinis, has started these efforts and the future ED will be instrumental to pushing this forward.

Canada specific news: N/A

Facility: CHIME
Contact person for GAC: Tom Landecker
Operation dates:
Funding status (total):
Funding status (Canada):
Cost (total):
Cost (for Canada):
International competition:
Access for Canadians: The CHIME teams together comprise 83 people in Canada (14 senior scientists, 21 postdocs, 36 graduate students, and 12 staff). In addition there are 14 people at US institutions (5 senior scientists, 2 postdocs, and 7 graduate students), and a team of 4 at an institution in India (1 senior scientist, 1 postdoc, and 2 graduate students). These numbers, correct in July 2021, fluctuate with time. The cross-Canada, and now international, teams working on these fronts collaborate through many internet sessions covering scientific, operational, and development aspects of the project.
Project news: CHIME has three major thrusts – the investigation of cosmic expansion (the theme that motivated its construction), the study of Fast Radio Bursts, and the study of pulsars. To this has been added Galactic foreground science, development of a dedicated data-processing pipeline to search for HI absorbers, and development of algorithms for searching for slow pulsars. Steady progress is being made on all fronts.
Operational efficiency of CHIME is high, with science runs of duration several months, interspersed with upgrade campaigns where software improvements are installed and tested. The software backend for the HI absorber search was installed in early 2021; data have been successfully collected for 75% of the time since installation. A roster of individuals from the cosmology and FRB-pulsar groups serve as "data tsars", remotely checking operation and data quality. CHIME operates unattended, and continues full operation through the COVID-19 pandemic. This is possible because software and hardware were designed to enable remote scrutiny of key parameters and diagnosis of problems. Major improvements to waterproofing of the focal-line electronics were made in the fall of 2021, leading to improved data quality. The overall efficiency of CHIME operations in 2021 has been 95%.

The CHIME/FRB system continues to function normally, running continuously, detecting, on average, three FRBs every 24 hours. CHIME is the undisputed world leader in FRB detection thanks to its wide field of view (about 200 square degrees), large collecting area, and low noise. A real-time alert system now posts events to the Virtual Observatory (see chime-frb.ca). The first catalog of FRBs, recording more than 500 events, has been published, together with accompanying papers analysing the catalog content. The CHIME/FRB team is working towards a third major report on repeating FRBs. Comparison of FRBs from the CHIME/FRB catalog with photometric galaxy catalogs has produced a statistically significant correlation with galaxies in the redshift range 0.3 to 0.5.

The CHIME team received the Governor General's Award for Innovation in 2020. The American Astronomical Society awarded the Lancelot M. Berkeley Medal for meritorious work in astronomy to the CHIME team, to be presented in January 2022.

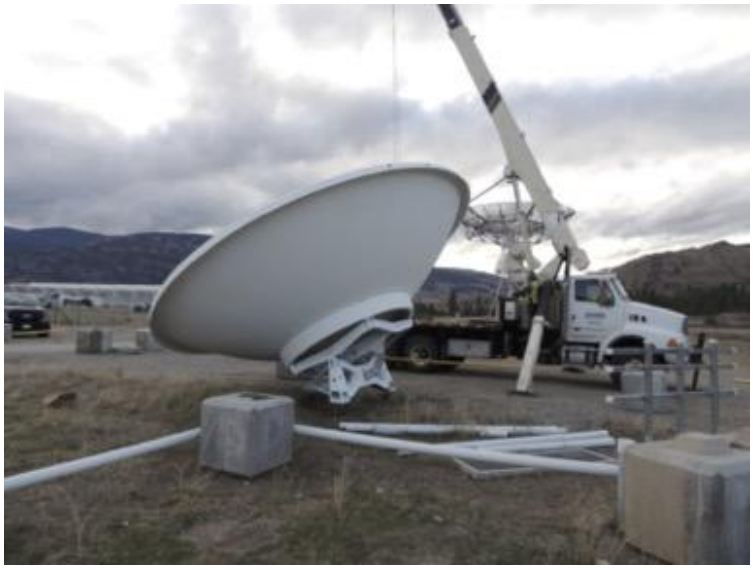
The CHIME/FRB Consortium has obtained funds to build three outrigger telescopes with the purpose of localizing bursts to high precision. Long-baseline interferometry techniques will be used between the main CHIME instrument and the outriggers to provide localization with precision of the order of 50 milliarcseconds. The remote receivers will be triggered by the detection of a FRB at CHIME. Operation was successfully demonstrated in 2021 on long baselines between CHIME and test antennas at the Algonquin Radio Observatory and at the Green Bank Observatory. An ongoing program using the US VLBA is establishing positions for several hundred pulsars, which will be the calibrators for the Outrigger VLBI observations.

The first outrigger, near Princeton, BC, is 90 km west of DRAO. Construction is complete, analog and digital equipment is now being installed, and operation will begin in early 2022. At the Green Bank Observatory, foundations are in place for the second outrigger. Construction will start in Spring 2022. Agreements are now in place for construction of the third outrigger at the Hat Creek Observatory in California.

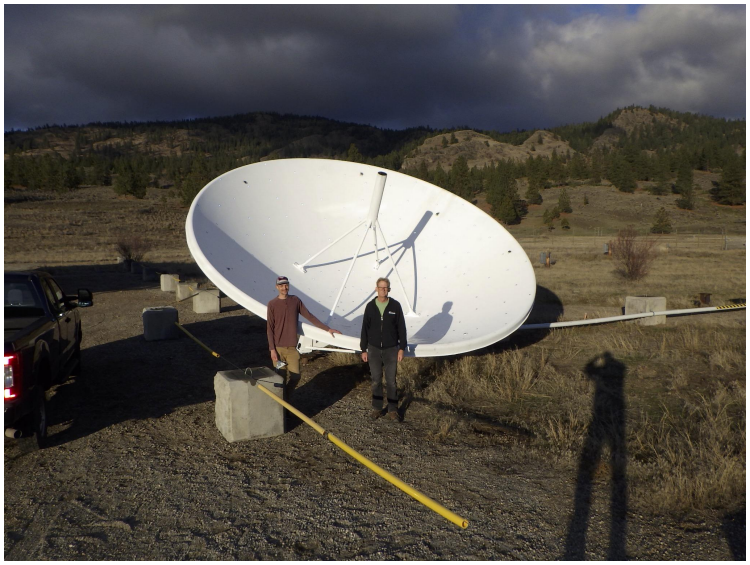
Facility: CHORD
Contact person for GAC: Matt Dobbs
Operation dates: First light in 2024
Funding status (total): Full funding from CFI approved, awaiting final project finalization before funds can flow. Hopefully in Q1 2022.
Funding status (Canada): see above.
Cost (total): The project is $23M, including 40% CFI, 40% provincial, and substantial in-kind cash from partners.
Cost (for Canada): $23M
International competition: Nothing on planet earth will compete directly with CHORD. CHIME is the closest competitor, and CHORD is a successor to CHIME. DSA2000 appears similar in technology (and is very similar in the technology needed), but it is a broadly distributed array, rather than a close-packed array - so it is optimized for different science. DSA excels for imaging and timing of known sources, whereas CHORD excels for large sky area mapping and search/discovery of transients.
Access for Canadians: CHORD is designed as an observatory that targets key science (21cm intensity mapping, fast transients and fundamental science including pulsars and neutrinos). The telescope and science team is developed to enable this science. The collaboration structure includes members from across Canada including those from institutions that did not contribute from their CFI envelope. As an observatory, membership in science groups will be inclusive and Canadians willing and able to make meaningful contributions to the project (including service work, development, etc) are expected to be welcome. The collaboration agreement that defines membership and data access is being developed now. All data products (maps, catalogs of transients, etc) will eventually be made public to astronomers across the world.
Project news: Rapid progress is being made on the technology front, with the first end-to-end prototypes of the CHORD dishes being built now. Design of the main telescope site, including

environmental assessment and surveying is underway. Design of the fabrication facilities, including the temporary building and infrastructure where the CHORD dishes will be built, is nearing completion. The CHORD collaboration hosted virtual community workshops in Q3 and Q4, 2021 including a cross-correlation workshop, DSA-CHORD science workshop, and SETI workshop - attendance was strong and there was keen community interest both inside and outside of Canada.

Canada specific news: All CHORD news is Canadian news!



The first prototype 6m CHORD dish is being lifted on to its custom mount, November 10, 2021.



The first CHORD prototype 6m dish, with its feedleg support, is shown at DRAO just before being instrumented with the broad-band custom feed. CHORD will have 512 six-meter dishes. It will have double the collecting area, 3 times the bandwidth, and about 40% better system temperature as compared to CHIME.

Facility: CCAT-prime (FYST telescope plus instruments Prime-Cam and CHAI)
Contact person for GAC: Michel Fich, Waterloo
Operation dates: April 2024 – March 2029
Funding status (total): ~$60M received to date
Funding status (Canada): ~$10M received to date, primarily through CFI and provincial matching grants
Cost (total): pre-Covid ~$58M, current estimate ~$66M (includes instrumentation for which proposals have not yet been submitted in the US)
C**ost (for Canada):** ~$11M
International competition: no competition at highest frequencies (>400 GHz) for ultra wide-field (1.3 degrees at 860 GHz, 8 degrees at lowest frequencies) survey facilities. At lower frequencies some of the CCAT-prime instruments are unique in the world.
Access for Canadians: full access to all science data is available to any Canadian on any of the science teams.

Project news: manufacturing of FYST structures will be completed in the first quarter of 2022. FYST will undergo a "test assembly" and preliminary commissioning in Germany before being shipped to Chile late in 2022. Assembly, factory acceptance testing, commissioning, and installation/commissioning of first light instruments will take up to a year. This is a delay of a year – almost entirely due to Covid. This has caused an unexpected increase in the budget; funds to cover part of the shortfall have been identified and the CCAT-prime team is continuing to search for a source of (relatively) small amount of additional funds.

Canada specific news: Both UBC and UAlberta are currently hiring staff for work on Prime-Cam. Purchase orders have been issued or are "in-process" by UBC and Dalhousie for parts of pCam350 (at 860 GHz, the central module for Prime-Cam). The Prime-Cam science team has prepared a detailed plan of the science program and submitted this for publication. Three of the eight survey teams for CCAT-prime are led by Canadians (Scott Chapman [galaxy evolution], Laura Fissel [galactic polarization], and Doug Johnstone [transients]).

Facility: CMB-S4
Contact person for GAC: Renée Hlozek
Operation dates: 2028 to 2035
Funding status (total): highly ranked in US decadal, US cost to be split NSF+DOE
Funding status (Canada):
Cost (total): $660M (USD) capital + $40M/year operations
C**ost (for Canada):**
Access for Canadians: Canadians have traditionally been involved in separate CMB experiments (SPIDER, SPT, ACT, Simons Observatory), and 8 Universities are currently CMB-S4 institutional members, with 10

Canadian researchers participating in the Survey paper for the Decadal review. Participation in CMB-S4 was also encouraged by the CASCA Long Range Plan for 2020.

Project news: CMB-S4 is the main cosmology project highlighted in the US Decadal Report, and seems very likely to be going ahead with roughly the planned scope, timescale and budget.

Canada specific news: While there is currently no explicit plan to contribute Canadian hardware to the CMB-S4 project, individuals and groups of Canadians may make contributions and instrumental HQP could receive useful training as part of the project. There is scope for data analysis and data archiving contributions. The coming few months will see broader conversations with CMB-S4 leadership about planning Canadian contributions to the project. In order to bolster the Canadian contributions to CMB-S4, it is important for Canadians to become involved in leading efforts within CMB-S4, in order for Canadian HQP to be fully engaged in the science from CMB-S4. There is also synergy with the (space-based) LiteBIRD mission, for which the Canadian contribution is expected to be significant. An explicit MoU is being worked out between CMB-S4 and LiteBIRD for such contributions. There is also overlap in expertise from groups involved in other ground-based current and planned projects, like the Simons Observatory, SPT3G, BICEP-Keck, the Fred Young Submillimeter Telescope, the Canadian Galactic Emission Mapper, and balloon experiments like SPIDER and the proposed TAURUS experiment. A summary of Canadian involvement in these projects is given in the LRP white papers on CMB Science in Canada (https://www.zenodo.org/record/3825611 and https://www.zenodo.org/record/3827103).

Facility: Gemini Telescopes
Contact person for GAC: Stephanie Cote
Operation dates: 2000 -
Funding status (total): The renewed International Agreement amongst Gemini partners is to start January 2022 and end on December 31 2027. At an Assessment Point to be held in 2024, partners are to decide if they wish to renew further their partnership past 2027 and at what level.
Funding status (Canada): Canada, through NRC, has signed on the new Agreement, ensuring our full participation in Gemini through 2027 at the 17.8% level.
Cost (total): The two Gemini Telescopes were originally built for 184M US$.
Cost (for Canada): Canada's original 15% share costed 28M US$. Our Annual Operations & Maintenance contribution for our current 17.8% share is 5.5M$US.

International competition: Gemini has by far the best cost per observing night of all 8m-class telescopes, due to its streamlined operations costs. The Gemini Telescopes are optimized to deliver good image quality and are leaders in adaptive optics, delivering more AO papers than any other telescope. They have very flexible scheduling, enabling them to excel for time-critical follow-ups and target-of-opportunities observations.

Access for Canadians: Canadians have access to PI queue time via two annual Call for proposals, in March and in September, roughly 200 hours per telescope per semester; once a year there is also a Call

for Long and Large programs (LLP) to which Canada dedicates 20% of its available time. Finally 10% of the time is allocated through monthly Fast Turnaround Calls. Canadians can also apply to Director's Discretionary time. There are also up to 5 nights per semester available on Subaru via the Gemini-Subaru Exchange time.

Project news: Many major new instrumentation projects are in the pipeline:
GHOST, the high-resolution optical spectrograph partly built at HAA, is planning to start its commissioning, as soon as travel can resume in late 2022A.
The new GNIRS integral-field units (one for natural seeing, another fed by Altair adaptive optics, to effectively replace NIFS due to retire) are about 6-months delayed due to COVID.
GPI-2, the upgraded Gemini Planet Imager, is moving forward well, with efforts at HAA. Of great interest too in Canada is GNAO (Gemini North AO): a Request for Proposals for the AO bench has gone out, as has the Real-Time Controller, awarded to HAA.
GNAO will primarily feed GIRMOS, a UofT-led pan-Canadian collaboration to build a four-channel multi-object IFU, to come online in the 2027/28 timeframe.
In the near term, SCORPIO, a wideband 8-channel imager and spectrograph, is still on track for readiness by the start of Rubin operations.
Meanwhile Gemini is getting ready to roll out the Gemini Program Platform (effectively the new proposal tool, observation tool, and telescope operational software to replace the current PIT and OT) intended to greatly speed up observation preparation and triggering, which will especially benefit time domain science.
The Dragons reduction pipeline in Python is progressing, with GMOS optical spectroscopy just released.
Long awaited is the Flamingos-2 Multi-Object Spectrograph mode, to be offered in 2022A first in Fast Turnaround (FT).
Also newly approved Subaru 'service observing' mode through the time exchange will enable Canadians to apply for short proposals <4h on Subaru (which so far was restricted to half nights or full nights proposals).

Canada specific news: As described above a large number of Gemini instrumentation projects are currently going on in Canada (GHOST, GPI-2, GNAO, GIRMOS). For the first time for the Call for Proposals 2022A CanTAC has adopted the dual-anonymous review process for Gemini proposals, with success (out of 38 proposals only 2 did not follow the guidelines.) The first Subaru Exchange Intensive Program (equivalent to Gemini LLP) was won by a Canadian-led program (PI=Mike Hudson, Waterloo) for the "UNIONS" survey, to cover 4400 square degrees in the gband with HSC in support of the Euclid mission.
This year (2021) Canadians have already published a record number of Gemini refereed publications (55 and counting). Laura Ferrarese (HAA) is currently the Gemini Board Chair.

Facility: JCMT
Contact person for GAC: Sarah Sadavoy

Funding status: Fund for the JCMT is mainly split between the East Asian Observatory (EAO) and the UK. The funding situation is difficult due to complications from COVID-19, but the EAO Board is working toward a stable solution. Total cost is $~3.5M (USD).
Funding status (Canada): Cash contribution were made from 5 universities and ACURA that covered the 2021A and 2021B observing semesters ($~ 50k). Canada continues to provide in-kind contribution of archive hosting by CADC.
Access for Canadians: Canadian PIs had access in 2021 due to the cash contribution, but this will end January 31, 2022. Canadians still continue to have access to co-PI Large Program in the current 2022 semesters. Canadian PIs had several successful proposals in the 2021B semester, with proposals involving or being led by students and postdocs.
Project news:

1. The observatory continues to function during the pandemic. Operations are fully remote from Hilo and proposal pressure remains high (factors of 3-4 oversubscription rates). The SCUBA-2 polarimeter has been fully commissioned with both the 450 micron at 8" resolution and 850 micron at 14" resolution detectors.
2. The JCMT participated in the EHT mm-VLBI observing campaign in ALMA Cycle-8 in spring 2021.
3. Thailand has joined the EAO as a partner as of 2021.
4. Several large programs have completed their science observations, including JINGLE (the final large program from the 2015 batch) and HASHTAG (a SCUBA-2 map at 850 and 450 microns of M31).
5. Four new large programs using Band 4 and 5 weather were recently approved by the JCMT Board, but results were not yet published at the time of this report. A number of key staff have already retired or left, or will be retiring/leaving soon.

Canadian specific news: Steve Mairs (UVic Ph.D., now EAO staff) recently published a decade of SCUBA-2 calibration data and >10 year light curves for calibrator sources. Several proposed large programs have Canadian co-PIs or are Canadian led (large program results still forthcoming).

Facility: MSE
Contact person for GAC: Pat Hall
Operation dates: 2030s
Funding status (total): currently supported by CFHT, NRC, France, and mostly in-kind support from partners; proposals underway for CFI & U.S. MSIP; private foundation support being investigated.
Funding status (Canada): CFI Envelopes approved by Waterloo, Western, SMU; pending at York, Toronto, UBC, Manitoba
Cost (total): US$420M + $25M/year operations (2018 dollars)
Cost (for Canada): Goal of 20% share = C$110M + C$7M/year (2018 dollars)
International competition: ESO SpecTel, MegaMapper (6.5m for cosmology), PFS (8m but not a dedicated facility)

Access for Canadians: anticipated SDSS-style partnership in that all partners above a certain contributing share have access to all data

Project news: The Astro2020 report is favorable to U.S. participation in a WFMOS facility in the 2030s, and conversations with NSF confirm that they will accept proposals in the 2020s to fund design work for such facilities. Relevant Astro2020 text: "There is very strong support for massively multiplexed spectroscopy across many sectors of the science community. … A dedicated facility would of course provide advantages over relying solely on existing infrastructure. Most glaring is the lack of high spectral resolution (R~20,000) multi-object spectrographs. … MSE and SpecTel presented plans to the panel for such a mode. … In all cases, the United States could envision playing a significant role in these projects through a MSRI-2-level investment, which could provide up to about 20 percent of the cost of a project like MSE, SpecTel, or up to about 50 percent of MegaMapper, perhaps split with DOE."

CFHT is developing a U.S. MSIP (Mid-Scale Innovations Program) proposal for an MSE pathfinder fiber-fed, R~10k to ~15k spectrograph to be mounted on CFHT. The pathfinder aim is to retire most of the high-level technical risks for MSE by demonstrating on-sky the ability of the major components of MSE and the major software packages in parallel with producing an initial science product that can be shared with the community.
Canada specific news: A CFI proposal led by York and UBC is being developed for $7.2M CFI funds + $7.2M provincial funds + $3.6M in-kind to fund work widely applicable to WFMOS projects: software ($8.3M), enclosures ($2.6M), fiber-optics ($4.2M), spectrographs ($2.4M). The goal of the proposal is to develop widely applicable expertise, not solely to advance the MSE project. E.g.: 1) modular software for designing surveys for multiple WFMOS facilities, simulating their execution, and studying the effects of survey design and/or hardware changes on survey efficiency to enable optimization given desired metrics; and 2) enclosure design studies for the MSE concept at CFHT, the MSE concept on a new base elsewhere, and for SpecTel concept.

Facility: ngVLA
Contact person for GAC: Brenda Matthews
Operation dates: Astro2020 recommends construction start on 2030, with operations underway in 2035.
Funding status (total): The full project is not yet funded. Funds for development of the prototype antenna have been allocated to NRAO.
Funding status (Canada): Not funded.
Cost (total): Astro2020 TRACE analysis estimates the total capital cost to be $3.2B USD (FY2020).
Cost (for Canada): $192M USD (based on 6% contribution, as recommended by LRP2020)
Access for Canadians: Canadians *currently* access NRAO facilities (except ALMA) via an Open Skies policy.

Project news: The big news is that the US "Astro2020" decadal survey report was released, and the ngVLA project was selected as one of the three top priorities for ground-based astronomy in the US in this decade. This result was incredibly gratifying to see, after over five years of intense effort to define

the project. Specifically, the Astro2020 panel highlighted that "it is essential to astronomy that the...JVLA and...VLBA, which have been world-leading radio observatories, be replaced by an observatory that can achieve roughly an order of magnitude improvement in sensitivity compared to those facilities. The Next Generation Very Large Array (ngVLA) will achieve this ..." The Astro2020 report further recommended that NSF consider funding design, development, cost and prototyping studies for most of this decade, with potential to begin construction at the end of the decade. Astro2020's cost estimate of ngVLA construction is $3.2B of which NSF would provide $2.5B, and annual ngVLA operations of $98M/year of which NSF would provide $73M/year, all in USD 2020. This cost makes ngVLA the most expensive project ever recommended to NSF, and it is a testament to ngVLA's potential that Astro2020 was not willing to descope it. NRAO intends to pursue ngVLA design and development aggressively, so the project can continue to mature and be poised for any opportunities to fund construction that come along toward the end of the decade. Note that Astro2020 predicted ngVLA would go online in 2035, which is consistent with NRAO's own timeline for full operations.

Canada specific news: In Canada, Astro2020's recommendation of ngVLA is a great sign as our own LRP2020 report wanted to see clarity about ngVLA's future from the Astro2020 process. Canada is well positioned to support instrumentation needs for ngVLA given DRAO's extensive history in radio astronomy. The ngVLA SAC is still planning to host a joint ngVLA-SKA meeting here in Canada (likely in 2023) as we could be members of both projects and it would be a good way to promote their synergies. With the Astro2020 process complete, the ngVLA is now refreshing its Science Advisory Committee (SAC). To date, Brenda Matthews (NRC), Erik Rosolowsky (U Alberta), and James Di Francesco (NRC) have served on the ngVLA SAC, with Brenda and James serving on its Executive. James is stepping down from the SAC, but Brenda has agreed to step into the role of co-chair of the SAC, with David Wilner of CfA. Canada also has strong representation on the Technical Advisory Committee, with two members from NRC, Lewis Knee and Michael Rupen (co-chair).

Facility: Vera C. Rubin Observatory
Contact person for GAC: Renée Hlozek
Operation dates: Ten years from late 2023
Funding status (total): Rubin Observatory funding is secured for construction, and operations funding comes from a mix of NSF, DOE and international in-kind contributions
Funding status (Canada): Canada has developed a proposal for in-kind contributions (supported through funding from the Dunlap Institute, the University of Waterloo and NRC and will be supplemented through proposed funding from the CFI) which has been accepted by the Rubin Observatory.
Cost (total): Rubin has a total construction cost of USD 473M and camera fabrication cost of USD 168M
Cost (for Canada): The current cost to Canada is through in kind contributions. This is expected to total around 3M per year
Access for Canadians: Through the in-kind contributions program, Canadians have secured data rights for 32 PI positions and 128 Junior Associate (JA) positions

Project news: Recent developments include the celebration of the running of the LSST Camera cooling system together with the camera, and the arrival of the last six Rubin Observatory LSST Camera filters arrived at SLAC National Accelerator Laboratory in September, completing years of work by Lawrence Livermore National Laboratory (LLNL) engineers who designed and managed the fabrication of the camera's lenses and filters.
The 2nd Rubin Observatory Survey Cadence Optimization Workshop took place in November. The workshop provided an opportunity for the community to engage with the draft Phase 1 Survey Cadence recommendations, and a detailed discussion of proposed survey simulations. The Cadence recommendations will be finalized by December 15, 2021 and the simulations will be delivered by Mar 1, 2022. Their analysis will inform the SCOC phase 2 survey strategy recommendation which will define the baseline survey strategy for Rubin.
Rubin has started a data preview process (dp0 - https://dp0-1.lsst.io/) where some members of the community will preview and test the data delivery of simulated Rubin-like data. There will be additional opportunities to engage with the data preview process.

Canada specific news: As part of our in-kind contributions, the Canadian consortium is advertising for 5 postdoctoral positions which jointly support Rubin science software pipeline development and for Rubin science. These include positions at Waterloo, Toronto, UVic and Bishop's. These are advertised here: https://academicjobsonline.org/ajo/jobs/20564 with a deadline of December 17 to apply.