

## **Report of the CASCA Ground-Based Astronomy Committee (GAC): May 2017**

### **Membership and Activities**

Craig Heinke, University of Alberta (chair, 2013-2017)

John Hutchings, National Research Council (2009-2017)

Jon Willis, University of Victoria (2014-2017)

David Patton, Trent University (2016-2019)

Roland Kothes, National Research Council (2016-2019)

James Di Francesco, National Research Council (2016-2019)

Els Peeters, Western (2016-2019)

Ken Tapping: Radio spectrum management

### **Future Facilities:**

#### **TMT:**

The overwhelming issues with TMT remain the site and funding, which are linked. Delays add to the total cost and construction costs are higher for MK than ORM. The TIO board have given a deadline for construction start in spring 2018, at ORM if the MK approval is not given. Work continues among the partners at the pace that they determine, given the delays.

ACURA and CASCA (via the LRPIC) appointed a TMT advisory committee (CATAC), whose initial task has been to report on the effects of the ORM site on Canadian science plans. An initial report has been posted for comment. LRPIC has held an open meeting to inform and discuss possibilities if TMT is no longer a viable option for Canada. LRPIC has also opened a mailing list (lrpic-discuss) for ongoing community information and engagement. All of the above activities will have open sessions at the CASCA AGM. Details of the non-TMT options are posted as a slide set on the mailing list archive.

#### **SKA:**

The SKA is in transition from its current organisation to the intended Inter-Governmental Organisation (IGO), which involves a treaty similar to ESO. The initial signing by some 6 founding members is planned for June 2017, but the full IGO may take until 2019 to exist formally.

Canada and several other countries are not proceeding given the undefined state of the project. Canada plans to continue in the project as an associate member, which still needs clear definition. Spain and Portugal are possible new members, while Germany, France, Japan and the USA are 'observers'.

There are difficulties meeting the SKA1 cost cap of 674M Euros (2016), and cost-saving changes have been identified. Savings up to 185M bring it closer to meeting the budget, but compromise some of the science. These measures remain under discussion. The Canadian possible contributions still fill our nominal 6% share. Canada is funded via NRC to continue participation without price increase, beyond this year.

SKA regional centres are being developed, with the Canadian one led by Severin Gaudet from CADC. There is also a Canadian advisory committee for this development.

There will be a meeting September 13-14 at McGill to discuss the future of Canada in radio facilities, that may include ngVLA as well as SKA.

**LSST:**

Construction of the 8.4-m Large Scale Synoptic Telescope on Cerro Pachón continues to progress. The United States plans to integrate the LSST administration with NOAO and Gemini into a new organization (NCOA: the National Center for Optical/Infrared Astronomy). Work continues on the legal agreement between the University of Toronto and Canadian partner institutions that will provide access to LSST for a Canadian Consortium.

**MSE:**

The Maunakea Spectroscopic Explorer has passed a number of important milestones in the past year. Successful conceptual design reviews have been performed for numerous observatory sub-systems including the telescope structure (IDOM, Spain), enclosure (Empire Dynamic Systems, Canada), high-resolution spectrograph (NIAOT, China), fibre transmission system (NRC-HAA, Canada), fibre positioner system (three studies from USTC-China, CSIC-Spain, and AAO-Australia), top end assembly (GEPI and INSU-DT, France) and the low-to-moderate resolution spectrograph (CRAL, France).

**CCAT-p:**

The Cerro Chajnantor Atacama Telescope project has proceeded with its plan to build a 6-m diameter ‘pathfinder’ telescope (named CCAT-prime, or CCAT-p for short) at the 5600-m site above the Llano de Chajnantor in Chile. The \$20M project will be mostly funded by Cornell University, though approximately 40 Canadian researchers across eight academic institutions are presently involved, as well as the Universities of Bonn and Cologne in Germany. Construction of CCAT-p aims to be complete by 2021 and will lay the groundwork for the original CCAT vision of a 25-m diameter telescope at the very high altitude site.

CCAT-p has a novel “crossed-Dragone” design, enabling a very wide field of view and flat focal plane that could accommodate  $>10^5$  detectors. For context, this design could enable CCAT-p to map the CMB across the sky a factor of 10 faster than current facilities. CCAT-p will be built by Vertex Antennentechnik GmbH of Germany.

CCAT-p will have routine access to the 350 micron atmospheric window with access to the 200 micron window during the best conditions. There are four major Legacy programs already in place: i) GEco, a “Galactic Ecology” program to study the ISM of the Galaxy and external galaxies in a variety of spectral lines; ii) SZ, a galaxy cluster survey using the Sunyaev-Zel’dovich Effect; iii) GEvo, a “Galaxy Evolution” continuum project, and iv) IM/EOR, an intensity mapping survey of the [CII] line at 158 microns.

Michel Fich (Waterloo) and Norm Murray (CITA) are the Canadian Board members of CCAT.

**ngVLA:**

The Next Generation Very Large Array (ngVLA) project is continuing to develop. Nominally, the idea is to construct a new interferometer with an observing frequency range of 1-115 GHz with about 10x the sensitivity and resolution of the current Jansky Very Large Array. The project is being led by the U.S. but they are seeking interested partnerships. NRAO recently formed a Science Advisory Committee (SAC) to engage the community and develop science cases of which over 70 had been produced as of 01 May. James Di Francesco and Brenda Matthews of NRC Herzberg are currently members of this SAC. In addition, NRAO has encouraged more detailed scientific and technical studies of ngVLA capabilities across the community. These cases and studies are being presently used to inform a preliminary ngVLA design that will be presented and debated at a special meeting to be held 26-29 June at NRAO in Socorro, NM. Coming out of that meeting, the ngVLA project will be then discussed within the wider U.S. radio community at the third "U.S. Radio/millimeter/submillimeter Science Futures" meeting to be held 2-4 August in Berkeley, CA.

**Current Facilities:****ALMA:**

Atacama Large Millimeter/submillimeter Array (ALMA) Cycle 4 observations continued over the past six months except during the planned maintenance shutdown for the bad-weather month of February. The backlog of ALMA data reduction by ALMA Regional Center staff has eased over this period, and data products are being delivered to PIs at a faster rate due to improved automation of the calibration and imaging pipelines. Of special note was the special VLBI campaign in April 2017, part of which aims to image the accretion disk of Sgr A\*, the supermassive black hole in the center of the Galaxy.

Proposals for Cycle 5 were due at 1500 UT on 20 April 2017. Of special note for Cycle 5 was the availability of Band 5 (157-212 GHz) receivers for the first time. A total of 1664 unique proposals were received from PIs around the world, a new record. Canadians were involved in 180 Cycle 5 proposals, 35 of which as either PI or co-PI. The global oversubscription rates for Cycle 5 for projects using only the 12-m Array, only the Atacama Compact Array (ACA), or both Arrays are 4.1, 4.7, and 4.4, respectively. Cycle 5 proposals will be read by the various subject-focused Proposal Review Committee (PRC) panels and debated at a meeting in Antwerp, Belgium in July, with an expectation that results will be delivered to PIs in late July. A special Supplemental Call for proposals to use only the 7-m antennas of the ACA was issued on 21 April 2017 and over 200 submissions were received before the Call was closed on 15 May 2017. A special committee made up of members of the Joint ALMA Observatory (JAO), the ALMA Regional Centers, and Chile are in the process of reviewing these proposals and making recommendations to the ALMA Director.

ALMA Director Pierre Cox has stepped down from his position. ALMA Deputy Director Stuart Corder will act in this role as a search for the next ALMA Director proceeds.

Christine Wilson (McMaster) has become the Canadian representative on the ALMA Science Advisory Committee, taking over from Douglas Scott (UBC). In this role, Prof. Wilson will also lead the Canadian ALMA Science Advisory Committee.

Lars-Ake Nyman, the Director of Science Operations at the JAO, will give a keynote presentation about ALMA during the International Union of Radio Science (URSI) General Assembly & Scientific Symposium Conference in Montreal, QC in August 2017. *(Thanks to Gerald Schieven for providing ALMA Cycle 5 proposal statistics.)*

#### **JCMT:**

The James Clerk Maxwell Telescope (JCMT) in Hawaii is now run by the East Asian Observatory, a coalition of astronomy efforts from Japan, South Korea, China and Taiwan. Canada remains a partner in the JCMT through efforts by a consortium of Canadian universities. In Spring 2017, an NSERC proposal to its Research Tools and Instruments Grants program for JCMT operations funding was successful, and will provide \$150K per year for two years. In addition, a modest annual cash contribution continues from Canadian universities for JCMT operations, but at a level lower than previous. Combined, these contributions enable individuals from any Canadian institution to propose for PI time, presently half the available time on the telescope (until January 2019). In addition, Canada continues to provide archive support for JCMT via the Canadian Astronomy Data Centre (CADAC).

The other half of available telescope time at JCMT is dedicated to Large Programs. In March 2017, the JCMT Board began an examination of the current slate of seven Large Programs, whose continuation beyond July 2017 will be contingent on a successful review. In addition, a call for new JCMT Large Programs was closed on 15 March 2017. That date also coincided with the closure of the call for regular PI proposals for semester 17B. SCUBA-2, POL-2, HARP, and RxA3 were available for observing. On the other hand, the instruments RxW and FTS-2, were not available for semester 17B. As of this writing, the statuses of current and new Large Programs and regular PI projects for 17B have not yet been determined.

The SCUBA-2 instrument was unavailable from December 2016 to early February 2017 after a period of planned maintenance and unplanned vacuum leak repair. It is now back and performing as usual.

Christine Wilson (McMaster) remains the Canadian Board member for JCMT.

#### **Gemini:**

The Gemini telescopes continue to produce major scientific results, with major press releases from a Large/Long Program using GMOS (on Kuiper Belt objects), a GPI study on Beta Pictoris B, and the GMOS discovery of the host of a Fast Radio Burst, each with Canadian lead scientists or major Canadian participation.

The next facility instrument has been announced; Octocam will perform imaging or grism spectroscopy simultaneously in 8 channels. With high observing efficiency, it will be a premier instrument for following up LSST discoveries on Gemini-South.

Gemini-North has now installed Hamamatsu CCDs, with improved red performance, in GMOS-N; this rollout is functioning more smoothly than that for GMOS-S, which had issues with unpredictable bias changes. GEMS has suffered serious problems with laser power (acquiring little data last semester). However, it is acquiring a new laser, scheduled to arrive in 2017B. Flamingos-2 multi-object spectroscopy mode is being implemented this semester. There is increased Japanese interest in Gemini, which is leading to more reliable availability of Subaru exchange time (now a minimum of 5 nights/semester for Gemini users). Gemini has fully implemented Base Facility Operations at both telescopes, remotely observing from Hilo and La Serena.

The US plans to establish a new organization, the National Center for Optical/Infrared Astronomy (NCOA), to run Gemini, NOAO, and LSST, achieving some economy through having access to key personnel for multiple projects. The Gemini Board will be discussing this at their November board meeting. Since the US is the majority stakeholder, it is unlikely that Canada could prevent this move, but if we recognize downsides to this move now is an appropriate time to discuss and ameliorate them. **The GAC recommends that the CASCA Board discuss the move to NCOA in some detail with Gemini and NOAO. What impacts on Gemini operations (e.g. through secondment of key personnel to other telescopes, and transfer of HQ for Gemini to Tucson) can be expected from this transfer? Are there considerations (e.g. further discounts for Canadian LSST participation?) that Canada could extract in exchange for our willingness to move forward with this?**

Looking farther to the future, Gemini has established a Strategic Vision for beyond 2021, with four key points:

Gemini should seek to be the premier facility for follow-up for the LSST.

Gemini should retain a significant fraction of time for PI science.

Gemini should be the premier hosting facility for visitor instruments.

The direction of the two Gemini telescopes should be allowed to diverge.

#### **CFHT:**

CFHT continues to provide high-quality and diverse observations to the Canadian community. Innovative upgrades to MegaCam continue, Sitelle is providing its first, high-impact science results and ESPaDOnS/GRACES continues a fruitful collaboration with Gemini. Five large programs (LPs) have recently been completed or are reaching completion - OSSOS, MaTYSSE, BinaMics, HMS and Luau - and should provide a considerable scientific return. Three new LPs began in 2017 and will run through to 2019: VESTIGE, CFIS and CIPP. The major new development on the horizon is the arrival of the SPIRou spectrograph at the observatory, projected to occur in July 2017. However, a full science-grade H4RG detector is not anticipated to be available for this instrument until the first quarter of 2018. This is a technically demanding

instrument, with sizeable Canadian involvement, and promises considerable scientific potential with its projected ability to detect and characterise Earth-mass planets around low-mass stars. Dependent upon successful delivery of the instrument at CFHT, the Board and SAC are anticipated to issue a call for SPIRou LPs up to 300 nights as early as the fourth quarter of 2017.

#### **CHIME:**

Construction of CHIME has been proceeding on pace. The first CHIME science paper (arXiv:1702.08040; a search for Fast Radio Bursts) has been submitted. A detailed report will be appended next week.

#### **Jansky VLA:**

The JVLA, operated by the National Radio Astronomy Observatory, continues to run normally and does not seem to be affected by any budget cuts like Arecibo or the VLBA. Currently the JVLA is observing the 17A semester which runs from February 10 2017 to May 15 2017 in D-configuration and from May 25 2017 to August 28 2017 in C-configuration. The last proposal deadline was February 1 2017 for the 17B semester, which will run from September 13 2017 through January 29 2018. During this time the JVLA will observe in B-configuration. The next proposal deadline is August 1 2017 for the observing period from March 2 2018 through June 11 in A-configuration and from June 29 to September 24 2018 in D-configuration. A summary of the status of the JVLA and the instruments available for the 18A semester please consult:

<https://science.nrao.edu/facilities/vla/docs/manuals/oss>

Future configuration plans and proposal deadlines can be found here:

<https://science.nrao.edu/facilities/vla/proposing/configpropdeadlines>

A guide to proposing for JVLA observations can be found here:

<https://science.nrao.edu/facilities/vla/docs/manuals/propvla/>

#### **DAO:**

The Plaskett telescope (1.8-m) will be 100 years old in 2018 and the McKellar (1.2-m) is over 50 years old. Both telescopes are fully utilized for programs suited to the instrumentation available, the site conditions and the large amount of time available for individual programs. However, Dennis Crabtree (NRC) is considering an alternative operations mode that could improve their impact.

Dr. Crabtree is considering fully automating both telescopes, with more flexible instruments that can be automatically configured. Currently, the 1.2-m's operation is robotic but the spectrograph still requires manual configuration (as it has limited wavelength coverage). Ideally, the spectrograph in the 1.2-m could either be configured automatically, or the spectrograph upgraded to an echelle, giving broader wavelength coverage. The 1.8-m telescope has the same issues wrt the spectrograph (single order, manual configuration), but also is manually operated (not robotic).

Dr. Crabtree is also considering joining the telescopes to the Las Cumbres Observatory (LCO) (lco.global), which is a world-wide network of robotic telescopes. First, this would make the DAO

telescopes available to users world-wide. Second, this would make the LCO network of telescopes available to Canadians for their research or for educational applications. Should there be community support for this project, Dr. Crabtree would seek capital funds from the NRC to support this work.

**The GAC agrees that automating the DAO telescopes would give significant science return. More importantly, the GAC is positively impressed with the capabilities of the LCO, and feels that obtaining access to these telescopes would be a significant benefit for Canadians. The GAC asks the Board to approve fully automating the DAO telescopes, and suggests performing a survey of CASCA members to determine whether joining LCO has broad approval. We attach information about the DAO telescopes' current use and productivity, compiled by Dennis Crabtree, to this report.**

*(Thanks to Dennis Crabtree for information)*

#### **Arecibo:**

Arecibo Observatory detected the first repeating fast radio burst (first seen in 2012, second burst seen in 2014 by Spitler et al. 2016) and was a major part (working with the European VLBI Network) of the successful effort to localize this fast radio burst to a distant galaxy, which also involved the Jansky VLA and Gemini (Chatterjee et al. 2017, Tendulkar et al. 2017, Marcote et al. 2017), with substantial Canadian involvement.

As described in more detail in the Dec. 2016 report, the Arecibo Observatory has  $\frac{2}{3}$  of its funding from the US NSF, which is seeking to divest in order to make funds available for new facilities such as the LSST. The NSF thus seeks new partners to contribute to Arecibo's operations. Proposals to fund a portion of Arecibo operations from April 2018 onwards were due May 4, 2017 to NSF; should no acceptable funding scheme be proposed, the NSF may be forced to close Arecibo operations.

The NSF is completing preparation of an Environmental Impact Statement describing the costs and effects of various alternatives (e.g. descope, mothball, raze), to be finalized in summer 2017, following which the NSF will consider all information and make a decision as to the future status of the observatory.

#### **Long Baseline Observatory (LBO):**

The LBO continues normal operations of the Very Long Baseline Array (VLBA). As discussed in the Dec. 2016 report, the NSF is partially divesting from LBO, as the US Naval Observatory has purchased half the LBO's time. At least  $\frac{1}{2}$  of time will remain available for general open-skies science proposals.

#### **Green Bank Observatory (GBO):**

Two new 3-mm wavelength instruments are having their first full season of observations; ARGUS, a 16-pixel spectroscopy front end, and MUSTANG-2, a 223-pixel feedhorn bolometer.

The new digital backend VEGAS is now offering pulsar modes, and the GUPPI pulsar-finding backend will be retired in 2018.

As discussed in the Dec 2016 report, the NSF is completing an Environmental Impact Statement for the GBO describing the costs and effects of various alternatives for continued operations or closure, though the GBO has attracted substantial outside funding support. On Oct. 16-20, the GBO is hosting a workshop on future plans, "Transformative Science for the Next Decade with the Green Bank Observatory".  
(*Thanks to the GBO Newsletter.*)

### **SOFIA:**

Cycle 4 was completed on Feb. 3, 2017 and contained a total of 646 research hours (386 General Observer, 106 GTO, 20 DDT, 134 Calibration), thus satisfying the level 1 requirement to provide 80% of planned research hours. Commissioning and first science flights of HAWC+ were finished in December 2016. HAWC+ has already produced impressive science ([see observations of W3](#)).

We are currently in the nominal cycle 5 observing period which runs from February 1, 2017 to January 31, 2018. Cycle 5 has a total of 758 research hours (505 General Observer, 100 GTO, 45 DDT, 108 Calibration). Cycle 5 includes a southern deployment with instruments upGREAT, FIFI-LS, and FORCAST to be executed June 21, 2017 to August 13, 2018 and likely observations of the Kuiper Belt Object (MU69) on July 10, 2017 in support of New Horizons Mission.

The Cycle 6 call for proposals was issued on May 1, 2017 with a US proposal deadline of June 30, 2017 and a German proposal deadline of July 1, 2017. The total number of hours available is approximately 570 (of which 70 hrs are available for the German Guest Observers via the German CfP). The nominal Cycle 6 observing period runs from 2 Feb 2018 to 1 February 2019. Cycle 6 will offer six instruments (EXES, FIFI-LS, FORCAST, FPI+, GREAT (upGREAT and 4GREAT), and HAWC+). A Southern deployment with two science instruments is planned for cycle 6.

### **DRAO:**

The Dominion Radio Astrophysical Observatory (DRAO) operates several observing facilities: the Synthesis Telescope (ST), a 7-element aperture synthesis array; the 26-m single-antenna John A. Galt Telescope; the 10.7cm solar radio flux monitor; and nearing completion is a "next-generation" solar radio flux monitor.

The ST is capable of simultaneous observations at 1420MHz and 408MHz. It offers wide-field continuum polarimetry and neutral hydrogen spectroscopy at the former frequency (1' resolution over a 2-degree field), and continuum total intensity only at the latter (3' resolution over a



6-degree field). Telescope time is allocated via a competitive, peer-reviewed process, with deadlines at both equinoxes each year. Both short-term and long-term proposals are undertaken, with past projects ranging from targets of opportunity to surveys aimed at wide sky coverage or deep integrations. Although best-known for its work on Galactic ISM, in particular the Canadian Galactic Plane Survey (CGPS), the ST is also used for targets from solar system to nearby galaxies. The telescope continues to be fully subscribed with projects for observers at Canadian universities, including graduate students, and also internationally.

The John A. Galt Telescopes is also open to external users via peer-reviewed proposals, but there are no proposal deadlines for this instrument, and the dominant use is long-term projects. The telescope has been used to observe in various bands from 400MHz to 8GHz, but the majority of experiments focus on neutral hydrogen spectroscopy at 1.4GHz. That said, the Galt telescope is currently fitted with a receiver covering the 400-800MHz band and is dedicated to calibration work related to the CHIME telescope presently under construction on the DRAO site. Once that work is done the Galt telescope will be upgraded to use a new cryogenic L-band receiver acquired from EMSS, who is providing similar receivers for the MeerKAT telescope in South Africa. Once commissioned, this receiver will be used to make exacting polarization measurements in a survey to learn about cosmic magnetic fields via the Zeeman effect in neutral hydrogen.

Solar radio monitoring is also flourishing at DRAO, with the long-running Solar Radio Flux Monitor experiment - operated in partnership with NRCan - continuing to provide thrice-daily measurements of the 10.7cm (2.8GHz) radio flux to the space environment community. Most non-mechanical systems of the two redundant telescopes are in the throes of an upgrade. So far the old Windows XP control computers are being replaced with linux-based ones, with new digital I/O modules. Upgrades to the signal path components will be proceeding over the next year. The "next-generation" instrument is nearly complete, and is now making regular flux measurements at 2.8GHz that compare well with the existing flux monitors, as well as thus-far uncalibrated ones at additional frequencies of 1.4, 1.7, 3.3, 5.0, and 8.3GHz. Work on calibration horns for those frequencies is progressing well. Note that the solar monitors are not available for external use, as they are dedicated, single-purpose instruments.