

Open letter to CASCA's Long Range Plan Implementation Committee

Following the 2016 CASCA meeting in Winnipeg, a group of interested parties convened a brief discussion on the status and future of Canadian submillimetre astronomy. We shared information on the current plans for the facilities most relevant to the Canadian community and discussed our future priorities. Our discussion focussed on ALMA, the JCMT, and CCAT. This letter updates the LRPIC about the relevant facilities and our priorities given discussions at the meeting. We further request an endorsement of our approach to facilitate discussions with our universities for continued participation in university-based initiatives.

The submillimetre waveband provides a critical view into processes vital to understanding galaxy evolution over cosmic time. Dust in galaxies reprocesses a large, often dominant, fraction of emission from stars into the submillimetre, revealing star-forming galaxies to very high redshifts. The setting and process of star formation are also best seen in the submillimetre, where molecular line tracers and dust emission highlight the earliest stages of stellar and planetary systems. The submillimetre is key to understanding our cosmic origins and a critical strategic component of our telescope complement. In this document, we focus on the strategic case and do not provide a further scientific case for a single-dish submillimetre facility. The LRP process and the LRPIC have already been informed on these points by extensive input from our community.

ALMA -- The community remains deeply engaged with ALMA as our flagship facility. ALMA is producing the highest impact science of any of our national facilities. Canadians participate in 15% of the approved projects for the telescope and 15% of the first 330 ALMA papers published up to May 2016. Roughly 3% of the observatory time is allocated to projects for which Canadians are PIs. While there is no specified fraction for Canadian time, Canadian oversubscription is in line with the global average: roughly 4:1. NRC and university researchers are actively working on ALMA hardware and software development through funding by the ALMA development program. Continued participation in ALMA remains the most important priority of the community.

JCMT -- The community participates in the JCMT through direct funding by a small consortium of Canadian universities (\$107k/year for 2 years) and support, in-kind, through the CADC hosting of the JCMT archive with no official involvement by NRC (valued at \$145k/year). This is 2% of the JCMT's \$5M annual budget. The East Asian Observatory (EAO) is two years into its first five year operations agreement with the University of Hawai'i, and EAO has stated a longterm commitment to the JCMT. There are no significant threats to JCMT's continued operations until the master lease comes up for renewal in 2033. The modest amount of direct funding has yielded outsized gains, notably access to and leadership roles in a new suite of legacy surveys. The JCMT TAC awards the top 10% of proposals time without charging a country's share of time, and Canadian proposals are routinely in this top portion. The oversubscription rate for Canadian JCMT time has been >6:1 since the transition to EAO. Canadian HQP trainees continue to lead work on the JCMT (4 lead-author articles in 2016). A Canadian polarimeter, POL-2, has been successfully commissioned and represents a unique observational capability for the JCMT, unmatched globally. The Canadian-built Fourier Transform Spectrometer (FTS-2) is undergoing commissioning and will provide another unique capability for the JCMT. EAO is at the beginning of the process of defining its needs for a next generation of JCMT instruments and there is likely a window of opportunity opening now for Canadian participation in that program.

CCAT -- The CCAT consortium remains committed to facility construction but the consortium has not been successful at securing funding for a full-scale telescope on Cerro Chajnantor. At present, there are no funding opportunities that have been identified that would lead to the construction of the facility. The CCAT board does not see a viable route to CCAT operations

before 2028. Given the long timescale, the CCAT board is now focusing on constructing *CCATprime* (CCAT-p), a 6-metre off-axis telescope at the Cerro Chajnantor high site. The primary goals of the CCAT-p initiative are to provide an “experiment-scale” telescope with a compelling science goal that also addresses concerns from the National Science Foundation in rejecting the previous CCAT proposal. Specifically, CCAT-p will (1) demonstrate the ability maintain low costs while working at high elevation, (2) develop the infrastructure needed to support a full telescope, and (3) provide a channel for instrument development. The CCAT consortium hopes that successful progress toward CCAT-p would support the case for a full CCAT in the 2020 decadal reviews and in ensuing funding requests to funding agencies. The present plan states that CCAT-p would begin operations in 2020 and be used for a few targeted science experiments. These experiments are currently focused around wide-area continuum surveys at wavelengths $\lambda \leq 350 \mu\text{m}$, representing a unique observational niche of particular relevance to cosmology. There remains substantial prior investment in CCAT, through establishing the legal framework for the organization and in securing the site on Cerro Chajnantor. However, this investment provides for ongoing access to the site at modest cost (\$100k/year) and an international management structure for the telescope, with funding and provisions for continuation until at least 2020.

Community Plan and Priorities

The release of the Report on the 2015 MTR was largely silent on ALMA and JCMT recommendations and gave the following recommendation for CCAT.

The MTRP reaffirms the importance of next generation single-dish sub-mm facilities, and recommends that Canadian astronomers continue to pursue participation in CCAT, subject to the project meeting its original science goals. Construction contributions that keep key scientific, technical, and/or engineering work in Canadian companies and universities will provide the most return on investment.

We see this announcement as an affirmation of the need for a facility that is complementary to ALMA. ALMA is realizing all its promised gains and provides unparalleled sensitivity and resolution in the submillimetre band. However, the field of view for ALMA is small by design. Two fields of particular interest to the Canadian community in the submillimetre -- the star-forming ISM and cosmology -- greatly benefit from wide-area mapping that ALMA cannot provide by itself. The observational synergy between an interferometer and a single-dish telescope designed for wide-area mapping is a huge advantage for studies in these domains. In general, single-dish observations provide estimates of signal brightness for ALMA targets, yielding stronger proposals in a competitive field.

Several considerations are shaping our future strategy. First, the timescale for a fully operational CCAT observatory is long and the route to construction of such a facility is uncertain. Given the recent negative outcomes of the most recent calls for NSF and CFI programs, there does not appear to be a funding route to begin work on CCAT until after the 2020 decadal surveys. By that point, the CCAT-prime initiative will also have more clarity. Second, there are other singledish submillimetre facilities being contemplated at this point (e.g., by CalTech, ESO, and NAOJ). Third, we can maintain a significant role in the JCMT with relatively small cost thanks to our established expertise and in-kind contributions from CADDC, with just a small amount of direct funding, currently from universities.

Given these considerations, the consensus that emerged from the Winnipeg meeting held the following principles:

• **Individual community members will continue to seek funding for participation in the JCMT from universities and other funding opportunities as they arise.**

Members of the university consortium wish to continue the status quo after the current agreement ends in January 2017. Our scientific return on investment is large, given the modest amount of funding supporting the facility. Maintaining continuous funding even at small levels (\$5k per university per year across at least 5 universities) is essential since allowing our status to lapse would require a far larger buy-in if we wanted to rejoin in the future (\$500k per year commitment). Furthermore, continued university participation also allows CADC to justify continuing to support the JCMT archive, which represents a significant contribution to our support for the JCMT. JCMT access also provides a channel for instrument development. While it has been made clear that NRC is unable to provide support for JCMT operations (other than CADC efforts) at this time, given the high scientific return on investment at this point, we enthusiastically welcome any support NRC is able to provide for continued participation in the JCMT. We will monitor whether the high scientific return continues.

• **Individual community members will participate where possible in the construction of CCAT-p through funding from their universities and possibly federal agencies for instrument support (e.g., NSERC or CFI).**

These community members will participate on a best effort basis where CCAT-p it aligns with their research goals, in particular through developing instrumentation expertise and targeted science explorations on CCAT-p. The Canadian CCAT consortium will continue to work in parallel towards the construction of the full-sized CCAT or comparable facility.

• **The community will defer the question of how to achieve access to a next generation submillimetre telescope until the next LRP process begins in 2019.**

The timing will be good to evaluate the position of CCAT and other facilities given the progress being made on CCAT-p and identify the major priorities going forward into the next decade.

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The LRPIC fully endorses this statement of priorities.

Given the uncertain way forward for the CCAT, we agree that access to the JCMT will remain very important to the community for some time to come, and likely for the rest of the current LRP decade.

We applaud the efforts of the Universities who have negotiated the present arrangement, and hope that it will continue to provide access to JCMT. We also support continued Canadian involvement as the CCAT plans evolve.