Cassiopeia

Solstice

d'été 2007 Summer Solstice

NO. 132
ISSN 0715-474

A publication of CASCA Une publication de la Casca

On the Cover

This is in part a reprint of the image used for the September 2001 issue of E-Cass. These inquisitive and bright faces also form the back drop for the coming INternational Year of Astronomy. Over the next few issues Jim Hesser will keep us up to date on preparations for IYA 2009. See Jim's article (IYA Update) for details.

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Welcome to summer and the summer solstice issue of E-Cass. Thanks once again to the many contributors to this issue. Included are the usual informative reports as well as features on the Square Kilometre Array telescope as well as a LOT update. Be sure, also to check out Jim Hesser's update on plans for IYA-2009.

Wishing you a safe and productive summer!

Brian Martin (bemart1@gmail.com or brian.martin@kingsu.ca)

President's Message

Patrons.

"*Any person who has rendered conspicuous service to the Canadian astronomy community beyond purely scientific contributions may be elected by resolution of the Directors to be a Patron of the Corporation.*" The CASCA Board is pleased to recognize two remarkable people on your behalf, Michael Jolliffe of AMEC, founding co-chair of the Coalition for Canadian Astronomy, and Pekka Sinervo of the University of Toronto, a key figure in establishing ACURA and on-going co-chair in the Coalition. Certificates noting this election as Patron were presented to Michael during the Town Hall meeting in Kingston, and to Pekka at the subsequent ACURA meeting.

Achievements.

Our members are busy: the splendid science results presented at the recent CASCA meeting reflect this. Faced with reading all the posters, I wrote to our sponsoring agencies asking them to reduce our funding. Our members are successful internationally and ambitious: this is reflected in the programs that exploit our existing facilities and efforts toward future facilities. In a separate article, I have noted the 40th anniversary of VLBI.

Coalition.

The "Big science, Big money" requirements in the current Long Range Plan present a considerable challenge. I don't think there is any question that Canadian talent and leadership are there, but if we are to succeed, it will cost more than has historically been spent. Convincing the government and its ministries and agencies of this is the explicit goal of the Coalition for Canadian Astronomy. CASCA is an essential component of the Coalition, and we are really fortunate to have such strong support from ACURA and from industry. This is a pre-requisite but no guarantee. Perhaps it is the nature of science funding in a political environment to be precarious and chaotic. Probably the coming year will test this in more critical terms than we've faced before. So don't stand back from the Society and assume things will unfold. They might unravel instead; there is no birthright or entitlement here.

Balance.

We need to strike a balance, exploiting current facilities as we look ahead to the next. My view is that as the new facilities come on-line (SCUBA-2, Herschel, Planck, ALMA, JWST), in addition to CFHT, Gemini, and other opportunities that continue to attract many of our number, that we will find that we are lacking enough people to fully exploit them. The flip side is that this presents fabulous opportunities for training HQP. The LRP, of course, recognized such manpower issues, but there is some distance to go, through uncharted territory, to realize and implement those aspects of the new funding. Another area requiring balance is between collective initiatives on a national and international scale and initiatives that strike individuals as interesting and worth pursuing. A Plan can be valuable in finding consensus and setting priorities on the large projects, but I don't think we want to stifle entrepreneurial activities either. That said, even if this is not a zero-sum-game, there are limits to funding; priorities do have to be set and expectations managed and aligned, so that our talent pool is not dissipated over too many activities that will fall short of the necessary funding to be effective and maintain Canadian astronomy's high profile.

The next LRP.

We need a system of facilities, large and small, multi-wavelength, ground and space based, and as a Society, CASCA has a Long Range Plan, which embodies our collective aspirations. Even though we are in the midst of the current plan, the Board has noted that a new Plan will be needed and has tentatively proposed that this be completed and released by the AGM in 2011; 2010 or 2012 might be better, we'll see. Opinions on the timing are welcomed. A related issue is "ownership" of the Plan, by which I mean such broad responsibilities as planning and setting of priorities in a transparent fashion, advocating and raising the funding, and then implementation and generally keeping things on track as outside factors change. The first aspect can be led by CASCA and the Coalition is engaged in the second, in cooperation with the agencies. The present dependence on so many agencies creates challenges and so, as was clear from the Working Group report, funding and the third aspect, implementation, are still quite a muddle. We need to evolve an appropriate system of governance, one that is both responsible and responsive, with effective advisory mechanisms that provide co-operative interactions with the astronomical community, and one that embraces on-going peer review.

EPO/IYA.

I sense that despite our many individual efforts, we are collectively falling short on delivering the full potential of EPO envisioned in the LRP: again we have more ideas than resources, especially resources for coordinating activities at a beyond-local level. While LRP funding is sorely needed, in the meantime the CASCA

Board is working with the E&O committee to try to break the logjam. International Year of Astronomy 2009 provides us with a unique opportunity. This is a time-critical issue. We have strong leadership through Jim Hesser and Jayanne English and the committees. This is exciting. Read about their work and get involved.

Society.

Out Society is run through volunteer efforts. There are many committees through which members can become pro-active. The Board is considering the committee structure to make sure that it best serves the evolving needs of the Society and the next LRP. The Society has a Board, another opportunity for members to step up. I'd like to thank Rene Plume for his contributions, as his term comes to an end. Particularly crucial roles are played by the Secretary and Treasurer, both of whom are finishing their long terms this year. Thank you sincerely to Secretary John Rice and Treasurer Dave Hanes for your remarkable contributions and for your willingness to make the transition for the incoming officers as smooth as possible. Finally, thank you Nadine Manset and Gregg Wade for stepping into these important roles.

Peter Martin

Looking towards the future of space astronomy in Canada

by Matt Dobbs and Mark Halpern

Canada plays a active role in space astronomy. Now is the time for new initiatives if we wish for this role to continue and to expand. With this article we would like to publicize opportunities in Space Astronomy and invite Canadian astronomers to become involved in defining our future role.

The Canadian Space Agency is making contributions to the major missions Herschel, Planck, and the JWST which are currently being constructed and commissioned. We have an ongoing role in the medium sized FUSE, launched in 1999, and in UVIT. Canada has been very innovative performing astronomy with small payloads. BLAST just completed a successful flight and the small satellite MOST is a flagship Canadian mission currently in operation.

While these missions establish a proud foundation for Canadian space astronomy, it has been many years since we have been involved through the Canadian Space Agency (CSA) in any new Space Astronomy missions. The time is ripe for new initiatives in Canada and the landscape that will allow this to happen is developing. We wish to publicize recent and upcoming opportunities for new initiatives in Space Astronomy and invite Canadian astronomers to involve themselves in this process.

It should be noted that no line item exists in the CSA budget for a space astronomy mission, and as you read the list of opportunities below you will not find an explicit call for large missions. But historically such a line item has never existed in advance of good ideas maturing and gaining a consensus in the community. Even so, the CSA has committed roughly $100M to Planck, Hershel and JWST in the current long range plan in astronomy, half of the full value in the LRP. With strong ideas, a developed mission concept, and community consensus, the astronomy community will be in a good position to lobby the CSA and federal government for the resources necessary to achieve its goals. The next Canadian Astronomy long range plan is roughly 2 years away. It will be a good forum for moving towards consensus. The interim period should be a time when many ideas flourish and even the unlikely crazy ones are explored.

Here is a list of opportunities in Space Astronomy.

- The CSA has awarded several "Discipline Working Group" (DWG) grants. These small (~$10K/year) grants are meant to allow groups to travel to develop their ideas for future missions and build communities interested in space astronomy. Five such grants were awarded – some formalities remain before the contracts are finalized. The rules of the DWG grants allow new members to be added. Contact the DWG chairs if you are interested in any of these.

    - Cosmic Microwave Background (Chair Matt Dobbs <Matt.Dobbs@mcgill.ca>)
    - Far Infrared (Chair Michel Fich <fich@uwaterloo.ca>)
    - Wide Field Imager (Chair Henk Hoekstra <Hoekstra@uvic.ca>)
    - UV Spectroscopy (Chair Laurent Drissen <ldrissen@phy.ulaval.ca>)
    - High Energy Astrophysics (x-ray, gamma-ray) (Chair Vicky Kaspi <vkaspi@physics.mcgill.ca>)
- The CSA has committed to fund design studies for Canadian contributions as a part of any successful response to the European Space Agency Cosmic Visions call for proposals. There are several Canadian groups involved in this process.
- A small missions Announcement of Opportunity (AO) from the CSA is currently posted on MERX (9F007-07AOSM). Small payloads missions include balloon flights and low-cost satellite missions (nano-sats) typically in the $2M range. As examples, BLAST and MOST were funded under this program. The submission deadline is August 24, 2007 and Letters of Intent are due June 29, 2007. The small missions AO is expected to be bi-annual.
- The CSA has committed to release a micro-satellite / small-satellite concept studies announcement of opportunity in fall 2007. These contracts would likely provide funding at the level of roughly $150K for one year to explore mission concepts. A micro-satellite / small-satellite mission opportunity is expected to follow.

If the science you want to do requires instrumentation in space, use these opportunities to make it happen!

(Note that the CSA has chosen to post all of its AOs on the MERX website, consistent with the Office of Public Works policy. This means that to read the AOs you need to register for MERX (www.merx.com). All of the CSA opportunities can be downloaded for free from MERX after you have registered. Unfortunately, in order to register on MERX you must enter credit card information even though there is no charge for any of the relevant CSA material. This is an awkward feature of listing these opportunities in a system which also handles the government's commercial transactions. The JCSA has complained to the CSA about the awkwardness of this system and we are searching for an alternate way to disseminate this material - but for the time being there is no way around it. We hope that the CSA will work with Public Works to fix this flaw soon.)

Matt Dobbs and Mark Halpern
on behalf of the Joint Committee on Space Astronomy (JCSA)

[*The JCSA acts as an advisory body for space astronomy to the CSA and CASCA. We have a mandate*

to convey the concerns of the scientific community to the CSA. If you have concerns or comments about space astronomy in Canada you can contact any of the committee members, refer to http://www.space.gc.ca/asc/eng/sciences/committees-jcsa.asp]

40 years of VLBI

by Peter Martin

Forty years ago, Broten et al. (1967a) heralded in the new field of VLBI: *"The measurement of the diameter of radio sources in the range 0.01 sec of arc or less has recently been made possible by a new technique on radio astronomy. Independent stable local oscillators are used to convert the signals at the two stations to frequencies which are recorded on magnetic tapes. In principle, these long baseline interferometers can operate at any separation."* As an undergraduate summer student employed at NRC, I remember the excitement when the results were presented at the URSI meeting in May, but as a novice was unaware of the drama that had played out over the previous months, indeed right up to days before the meeting, when the first fringes on a transcontinental baseline (3100 km, Algonquin Park to Penticton) were finally detected. Insight into this momentous accomplishment can be gained from the review by Kellermann and Moran (2001) and the more anecdotal account by Broten (1988).

Broten recalls the making of documentary film "To the edge of the universe" ("Aux confins de l'univers") by the National Film Board of Canada (released in 1969), and the added chaos that the filming caused for the researchers. The film contains interesting footage of the construction of the 150-ft radio telescope at the Algonquin Radio Observatory, but was made more "on spec" that the VLBI experiment would indeed work and so provide a dramatic story line for the film! A re-enactment has Allen Yen, the project leader, and colleagues gathered round a chart recorder saying excitedly "look, fringes". To mark this 40th anniversary, we showed the film at the recent CASCA meeting in Kingston; those interested in celebrating and preserving this historic time in Canadian astronomy can acquire a DVD from the NFB (www.nfb.ca/trouverunfilm/fichefilm.php?id=11351&v=h&lg=en&exp).

Broten summarizes by noting that "*A team effort by individuals from Canadian universities and government laboratories prevailed to bring success.*" He also notes that a pre-requisite was "*that the political attitude be favorable to basic or "curiosity-oriented" research which may not have immediate results,*" something that does not always obtain in synchronism with other pre-requisites, like having the skilled team and engaged leadership. In the late 1970s, as CFHT was coming on line, the Canadian Astronomical Society began developing an ambitious plan for the Canadian Long Baseline Array, building on Canadian leadership and expertise, and costing $70 M (Legg 1984). In the end it was never built, a bitter disappointment to many. In addition the 150-ft telescope was soon closed for radio astronomy (its non-identical twin, the Parkes

telescope in Australia, is still being productive).

That did not spell the end of VLBI activities and innovations by Canadians, however. As is clear from the written historical accounts and the film, the tape systems and the post-observation correlation were technically very challenging. One approach was to eliminate the tapes altogether, using satellite communications, at the same time boosting the sensitivity by employing a broader bandwidth. This was demonstrated by Yen et al. (1977) using the Hermes satellite. Another approach was to improve the reliability, capability, and cost-effectiveness of the tape-based systems. Kellermann and Moran (2001) write: "*A major breakthrough occurred in the late 1970s with the introduction of the remarkably inexpensive home Video Cassette Recorder (VCR). Allen Yen, who had engineered much of the Canadian VLBI system, was intrigued by the potential opportunities of using consumer electronics for VLBI. During a series of visits to Caltech, the Max Planck Institut fur Radioastronomie (MPIfR) in Bonn, and the NRAO, Yen succeeded in recording MK II-compatible data on a standard VCR. As the sensitivity of the MKII VLBI system was restricted by the limited bandwidth of 2 MHz (4 Mbps), Yen began a program to develop a VCR-based system that would allow reliable digital recordings over a 6-MHz bandwidth.* [Such a system was used in the new Canadian geophysical long baseline interferometer (Yen 1991).] *Following Yen's untimely death in 1993, Canadian radio astronomers continued this work, which led to the development of the inexpensive S2 record system based on professional-model VCRs*." S2 recording systems have been very productive, for example in the Japanese-led VSOP, in which Canadians participated with support from the CSA. A powerful correlator for the S2 system was developed at DRAO.

Even without new radio telescopes on Canadian soil, Canadian radio astronomers continue to innovate. The challenge is to have these innovations incorporated in the future facilities being developed by large international collaborations, like the SKA.

Bibliography

Broten, N. W. et al. 1967, Nature, 216, 44-45. Diameters of Some Quasars at a Wavelength of 66.9 cm (See also Broten et al. 1967, Nature, 215, 38, and Broten, N. W. et al. 1967, Science, 156, 1592-1593.)

Broten, N. W. 1988, JRASC, 82, 233-241.Early Days of Canadian Long-Baseline Interferometry - Reflections and Reminiscences

Kellermann, K. I. and Moran, J. M. 2001, ARAA, 39, 457–509.

The Development of High-resolution Imaging in Radio Astronomy

Legg, T. H. 1984, IAU Symposium 110, 383-389. The Canadian Long Baseline Array

Yen, J. L. et al. 1977, Science, 198, 289-291.Real-Time, Very-Long-Baseline Interferometry Based on the Use of a Communications Satellite

Yen, J. L. et al. 1991, Radio Science, 26, 89-99 The Canadian geophysical long baseline interferometer

MIRANdA: A First Step to the Square Kilometre Array

by Russ Taylor

The future of cm and m-wave astronomy lies with the Square Kilometre Array (SKA), a telescope under development by a consortium of 17 countries that will be 100 times more sensitive than any existing radio facility. The SKA will be built in a staged program, beginning with Pathfinders at the 1% scale, on the 2008 – 2012 time frame, evolving to construction of SKA Phase I around 2015 (10% of the collecting area of the SKA) which will be expanded over time to the full SKA by around 2020. The Pathfinders are being designed to prototype and demonstrate at a significant scale the new science enable by the SKA and technologies that will enable it.

The SKA will impact a wide range of science from fundamental physics to cosmology and astrobiology. Compelling questions that will be addressed as key science investigations include:

- understanding the cradle of life by imaging the environments of the formation of earth-like planets, the precursors to biological molecules, and carrying out an ultra-sensitive search for evidence of extra-terrestrial intelligence,
- carrying out fundamental tests of the theory of gravity by using radio waves to measure the strong space-time warp of pulsars and black holes and timing of arrays of pulsars over large areas of the sky to detect long-wavelength gravity waves propagating through the Galaxy,
- tracing the origin and evolution of cosmic magnetism by measuring the properties of polarized radio waves from galaxies over cosmic history
- charting the cosmic evolution of galaxies and large-scale structure, the cosmological properties of the universe and dark energy the imaging of atomic hydrogen emission from galaxies and the cosmic web from the present to time of the first galaxies, and
- probing the dark ages and the epoch of reionization of the Universe when the first compact sources of energy emerged.

In November 2006 the President of National Research Council of Canada and the Chief Executive Officer of the Australian Commonwealth Science and Industrial Research Organization signed an understanding declaring their intention to collaborate in the construction of MIRANdA; an SKA Pathfinder constructed on the site in Western Australia that is the proposed Australian site for the SKA – one of the most radio quiet regions on Earth. MIRANdA, which is expected to grow into SKA Phase I, will be based on the Reference Design of the SKA, a large number of small parabolic dishes equipped

with new feed and receiver technology to expand the instantaneous field-of-view.

Figure 1. The Site in Western Australia for the MIRANdA SKA Pathfinder is one of the most radio-quiet locations on the Earth, allowing radio observations outside of the protected frequency bands.

The Science

A majority of the key science for the SKA can be addressed at the mid-frequency range of the SKA from 300 MHz to a few GHz. The Phase I SKA targets this frequency range for the initial operation. MIRANdA is aimed squarely at this frequency range, coupled with the development and deployment of phase-array feed systems. This combination will produce a powerful synoptic survey instrument that will make substantial advance on three of the SKA key science projects; the origin and evolution of cosmic magnetism, the evolution of galaxies and large scale structure, and strong field tests of gravity. A low-frequency array prototype of the all-sky monitor component of the SKA reference design is being built at the same site, and will target the epoch of reionization and the dark ages.

Headline goals for MIRANdA are:

- The detection of a million galaxies in atomic hydrogen emission across 80% of the sky out to a redshift of 0.2 to understand galaxy formation and gas evolution in the nearby Universe.
- The detection of synchrotron radiation from 60 million galaxies to determine the evolution, formation and population of galaxies across cosmic time and enabling key cosmological tests.
- The detection of polarized radiation from over 500,000 galaxies, allowing a grid of rotation measures at 10' spacing across the sky to understand how the Milky Way generates and maintains coherent magnetic fields on huge scales, and allowing our first steps in the exploration of the evolution of magnetic fields in galaxies over cosmic time.

- The understanding of the evolution of the interstellar medium of our own Galaxy and the processes that drive the chemical and physical evolution of matter through observations of interstellar matter in atomic, molecular, ionized and magnetized forms.
- The characterization of the radio transient sky through detection and monitoring of transient sources such as gamma ray bursts, radio supernovae and intra-day variables.
- The discovery and timing of a thousand new radio pulsars.
- The high-resolution imaging of intense, energetic phenomena by enlarging the Australian and global Very Long Baseline Array networks.

These scientific programs constitute a significant initial step toward the SKA science goals. This science in enabled by the unique radio quiet location in Western Australia and the innovation that prototype the key SKA reference design technologies. MIRANdA will be a world-leading radio astronomy facility that will uniquely pathfind the scientific and technical direction to the SKA.

The Telescope

MIRANdA will be located at Boolardy Station in Western Australia, approximately 1000 km northeast of Perth. The collecting area of MIRANdA is initially a few percent of that of the SKA and is designed with an upgrade path to SKA Phase I and to the full SKA.

Figure 2. Focal-plane phase-array feeds coupled with 12-m diameter parabolic reflectors will give MIRANdA an unprecedented instantaneous field of view.

MIRANdA will initially consist of a central core of 45 12-m diameter dishes spread over an area of about 10 km in size. A remote station, a few thousand kilometres away in NSW, will be used to prototype the long-baseline functionality of the SKA. Focal plane phased-array technology, under development in Canada and Australia, will produce 30 simultaneous beams on the sky, providing a field-of-view of 30 square degrees. The initial frequency range will be 0.8 to 1.7 GHz, with instantaneous bandwidth 0.3 GHz and 16,000 spectral channels.

The large field-of-view makes MIRANdA an unprecedented synoptic radio telescope. The area of the field-of view is over 100 times larger than that of the Very Large Array. Images of very large areas of the sky to sensitivities currently only achievable in very small regions will be routine. New ways of observing the Universe in radio waves will become possible that allow us detect radiation instantaneously from large volumes of the Universe and mine the scientific information it contains about the physics, original, evolution and fate of the Universe.

The Canadian SKA Science Advisory Committee
www.ska.ca

ALMA Update

1 Recent news

1.1 Construction Progress

On 2007 March 10, a ceremony was held at the Operations Support Facility (OSF) to celebrate the completion of the roof structure on the OSF technical facility building. Held in the nascent OSF warehouse, the crowd of workers and others hear speeches from, among others, the Mayor of San Pedro de Atacama, Sandra Berna. The facility, which will host about 100 people during operations, consists of three main buildings: the technical building, hosting the control centre of the observatory; the antenna assembly building, including four antenna foundations for testing and maintenance purposes; and the warehouse building, including mechanical workshops. The building is slated for completion by January 2008.

The major pieces of the first ALMA production antenna have arrived at the OSF and the antenna is under construction. This is the first major ALMA hardware to arrive in Chile.

Figure 1: The first ALMA production antenna at the Operations Support Facility (11,000 ft elevation) near San Pedro de Atacama in Chile. Photo was taken 14 May 2007.

With routine delivery of receivers to the Front End Integration Center in Charlottesville, Virginia, the instrumentation teams have learned a great deal about the capabilities these instruments will have through the production run, during which time one receiver will need to be produced about every month. There are a few change requests for the receivers underway but none with significant changes to the capabilities of ALMA. It appears that most of the receiver technology has achieved the stringent goals of the ALMA project.

Internet connections have been established to the technical building at the Array Operations Site (5000 m elevation). Holography and optical pointing tests are continuing with the two ALMA prototype antennas at the VLA site. Leonardo Testi has been appointed as the new European ALMA project scientist. Both the new offline software (CASA) and the ALMA pipeline have recently completed a round of user tests. A new version of the Design Reference Science Plan that includes the new receiver capabilities being contributed by Japan is nearing completion and will be available starting 22 June 2007. The DRSP can be found at

http://www.strw.leidenuniv.nl/~alma/drsp.shtml

2 ALMA Meetings

2.1 ALMA Science Advisory Committee

Doug Johnstone attended his first ASAC meeting this May in Tokyo, Japan. The two day meeting consisted of many presentations on the construction and operations of ALMA, reports from each of the regional science advisory committees (Europe, North America, and East Asia), as well as a very impressive tour of the ALMA technology labs at NAOJ. In addition, the ASAC took up the task of responding to four detailed charges from the ALMA Board: consideration of the Design Reference Science Plan (DRSP) 2.0; combined operations of ALMA and the Compact Array; the need for molecular line databases; and the desire for a comprehensive and coordinated Education and Public Outreach plan. Some key points from the discussions are summarized below; the final report itself should be available on the ALMA web site in early July.

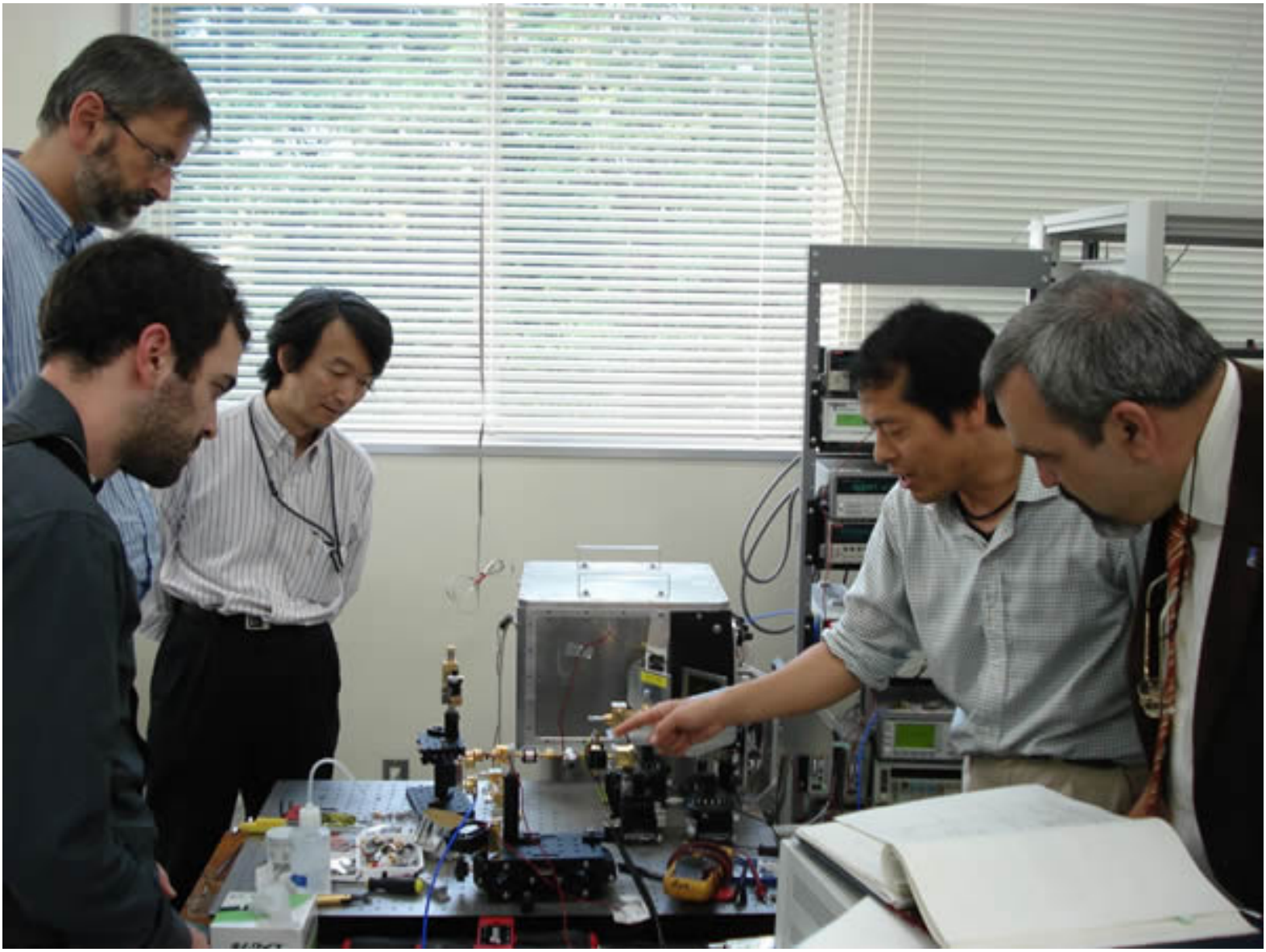


Figure 2: ASAC members checking out the development of ALMA Band 10 mixers (950 GHz or 350 microns) at NAOJ in Japan.

Considering the charges to the ASAC, the DRSP 2.0 showed that all projects planned for the baseline ALMA (DRSP 1.0) are still possible with the rebaselined array, although at a cost in time and/or sample size. There is a significant desire for Compact Array measurements to supplement the main array, with around a third of the projects requesting these observations. It remains to be seen how many require the observations to be taken simultaneously. Much work has progressed toward planning for a combined use of ALMA with the Compact Array and it is clear that, when possible, such observations would be of great benefit to programs requiring detail across many spatial scales. Further testing of simulations, however, is needed to determine if there is a rule of thumb for observing strategy. As well, while combined array use is possible, there will be a requirement for separate observations as well and continued effort at optimizing such image reconstructions is ongoing.

ALMA, along with Herschel and SOFIA, will be strongly affected by the severe lack of molecular

line identifications for less abundant species, such as methanol (and its isotopomers). It is clear that such measurements require detailed laboratory work and that such research is not extremely urgent for most molecular spectroscopists. A coordinated plan to find funds to purchase this information is most likely the necessary approach, including allowing ALMA development funds to be available for such research.

Finally, it is exciting to note that the ALMA Project is considering carefully the task of Education and Public Outreach. For a multinational project, however, the perfect approach is unclear and much work remains to be completed to define the appropriate role of the various institutions, nations, and Executives. This work is being addressed at present through the leadership and coordination of an ALMA Working Group studying EPO. As a member of the ASAC, Doug Johnstone has agreed to observe this group.

2.2 Canadian ALMA Science Advisory Committee

The Canadian ALMA Science Advisory Committee (formerly known as the Canadian ALMA Science Steering Committee, an unpronounceable acronym), met at Queen's University June 3-4, 2007. Current committee members are Stephane Courteau, James Di Francesco, Mike Fich, Doug Johnstone, Douglas Scott, Chris Wilson, and T. Webb. The main focus of the meeting was to discuss various options for ALMA operations, outreach to the Canadian community, and the recent meeting of the ASAC. The committee also heard reports on the status of ALMA construction and the Canadian contributions to ALMA construction. Since the report has not yet been finalized, I will give a more detailed summary of our discussions in my next update.

2.3 Upcoming Science Meetings

In Canada, we are organizing an ALMA workshop to be held in Calgary May 26-27, 2008 (after the CASCA meeting in Victoria). The title of the meeting is "Observing with ALMA" and the focus will be on the science to be done with ALMA and on becoming familiar with the software tools that ALMA PIs will need to use. The workshop is limited to 50 people, and the first 20 students to register will get substantial travel support. Registration opens in January 2007, but I encourage you to sign up to the email list as soon as possible if you are interested in this meeting. More information is available at.

http://www.phas.ucalgary.ca/alma

NRAO is holding a science workshop on "Transformational Science with ALMA: Through Disks to Stars and Planets"

http://www.cv.nrao.edu/naasc/disk07/

in Charlottesville, Virginia June 22-24, 2007. The ANASAC is beginning to discuss possible topics for scientific workshops in 2008. If anyone has any suggestions for future workshop topics, please pass them on to Doug Johnstone or Chris Wilson, who are the two Canadian members of the ANASAC.

3 ALMA Developments in Canada

3.1 Band 3 Receiver Development

The Band 3 Receiver Development Team is on pace to complete the eight pre-production phase receivers by the end of 2007. Three cartridges have already been sent to the Front End Integration Center in Charlottesville, and a further three are nearing completion. The team is performing a series of tests on the receivers to determine important characteristics such as gain compression, beam profile, and vibration modes.

Figure 3: Four ALMA Band 3 receiver cartridges that are under construction at HIA.

The next major milestone for the team will be the Critical Design Review planned for late September, which will finalize the Band 3 design before entering the production phase. Later in the year, a Manufacturing Readiness Review will be scheduled to examine the plan for the production phase of receiver assembly, with one cartridge being produced each month! The team is preparing for these events by finalizing the schedule and production model, determining the relevant industrial partnerships, and considering any changes that may be necessary to achieve steady production.

Additionally, the Receiver Team has been contacted by both CARMA and ARO to provide mixers for their own telescopes. It appears that the hard work and significant expertise that has accumulated at NRC-HIA is being well recognized within the larger international astronomical community.

For more information on the ALMA Band 3 Receiver Project contact Keith Yeung (Project Manager, keith.yeung@nrc-cnrc.gc.ca), Stephane Claude (Project Engineer, stephane.claude@nrc-cnrc.gc.ca), or Doug Johnstone (Project Scientist, doug.johnstone@nrc-cnrc.gc.ca).

3.2 Software

Software development work in Canada continues at HIA and the University of Calgary. Since the previous report, Raymond Rusk has continued to spend some time working on the User Reference Manual converting Glish examples for the quanta, measures, coordsys and image tools to "live" Python code. He has also converted the image and coordsys assay tests, which are used for integration and unit testing, from Glish to Python. A framework for assay testing of casapy hasn't been defined yet, so this work is groundbreaking in the area of assay tests.

Following this work, which is needed for the CASA Sept 2007 Beta release, he will refocus on tasks that add new functionality to CASA in the area of image analysis task development.

Shannon Jaeger has continued to work on MSPlot. In early June, she visited Socorro to meet with the NAUG members to discuss changes needed on the plotter and completed handling of plotting of spectral windows with different sized data and added in time averaging. Also while in Socorro, she initiated work on supporting source detection in CASA with image fitting.

Arne Grimstrup is settling in to his work on ACS in Calgary. After training at ESO, he has assumed responsibility for the maintenance and continued development of the ACS Python APIs, Notification Service, Event Browser, and support for the American ALMA teams. He also contributes to the maintenance of other ACS subsystems as directed by the ACS Team Leader. Recently he has been involved with ACS/CASA integration issues. The big news in the areas of ACS software development is that Gianluca Chiozzi, ACS Team Leader, is moving to a new role as the Head of the Control Software Department at ESO. Joe Schwartz will become the new ACS team leader at the end of June and Arne Grimstrup will then report to Joe.

Chris Wilson spent a week in Socorro working on VLA data and took the opportunity to run some new data through the ALMA pipeline script. The script performed very well on the VLA data and a detailed comparison between the pipeline results and images produced by hand showed very good agreement. She also finished the report from the pipeline user test which was held this winter and submitted it to the project. The pipeline team is now preparing for their first test of the reduction heuristics for single dish ALMA data, which is expected to be held later this summer.

Chris Wilson wilson@physics.mcmaster.ca

Canadian ALMA Project Scientist

(with input from Arne Grimstrup, Shannon Jaeger, Doug Johnstone, and Raymond Rusk as well as material from Al Wootten)

Milestones at NRC's HIA (2007 March- June)

edited by:

Dr. Jacques P. Vallée

In April, NRC and HIA issued a Press Release on Band 3, the world's most sensitive radio detector. HIA further posted a backgrounder with pictures and links. **Stéphane Claude, Keith Yeung & Doug Johnstone** fielded a dozen media requests for interviews.

CADC's latest offer is **MegaPipe**, which is a MegaCam image stacking pipeline. It takes many MegaCam images of a patch of sky, calibrates them, combines them into a single deep image, and extracts a source catalogue. The astronomer still has to write the paper...

The JCMT Archive at the HIA's CADC is now delivering public & proprietary raw data with the ACSIS spectrometer to the community, completing another major milestone in this project. The next step would be to deliver processed data.

In mid-March, the Plaskett Fellowship competition drew 69 applications from 23 countries. **Dr. Chien Yi Peng** accepted our offer and is expected to start in September in Victoria. His research area include the development of GALFIT to measure optical images of galaxies, and studies of formation of supermassive black holes, supernovae, and galaxy evolution.

The colourful URSI Canadian Radio Astronomy 2007 report by **Andrew Gray & Ken Tapping** to the URSI Canadian National Committee celebrates the Canadian achievements in this endeavour, and it addresses the issues of spectrum management up to 3000 GHz (100 micrometres, in near-infrared astronomy).

Congratulations to **David Crampton & Ev Sheehan** who both attained 40 years of service (starting at EMR), to the **CADC** for reaching 20 years of operations, to **Susan Firestone** who accumulated 15 years of service at NRC, and **Tom Burgess & Bruce Veidt** who reached 10 years of service at HIA.

Over 50 children and adults participated actively in a two-day outreach program called "Astronomy & Engineering for Kids", hosted at the HIA's DRAO campus in Penticton.

Once again, HIA helped to celebrate International Astronomy Day 2007, held in Victoria at the Royal BC Museum and at HIA's Centre of the Universe, on April 21. Astronomers involved included **James DiFrancesco, Thomas Puzia & Eric Peng**.

New staff at the Centre of the Universe include **Stasia Ferbey, Katrina Au-Yong, Annie Ladéroute & Lauren Stieglitz**. In addition, **Eric Chisholm** steps in as Interim Coordinator to replace **Jacqueline Porter**, departing to pursue new opportunities.

154660 Kavelaars, an asteroid (a.k.a. minor planet) discovered in 2004 by U.Vic's David Balam, was officially named thus by the IAU and announced during the CASCA AGM's Banquet in June. **JJ Kavelaars** is the co-discoverer of several dozen irregular satellites of the outer planets.

Du neuf à l'IHA du CNRC (mars - juin 2007)

édité par:

En avril, le CNRC et l'IHA ont sorti un Communiqué de Presse sur Bande 3, le plus sensible détecteur radio au monde. L'IHA a aussi mis sur le web un document informatif avec photos et liens utiles. **Stéphane Claude, Keith Yeung & Doug Johnstone** ont répondu aux questions et entrevues d'une douzaine de média.

MegaPipe, un outil du CCDA de l'IHA, est un pipeline du CCDA de l'IHA qui empile les images de MegaCam de la même partie du ciel. Il les calibre et les additionne ensemble pour faire une seule image dont il extrait les sources qu'il met dans un catalogue. L'astronome n'a qu'à écrire le manuscrit...

Les archives du TJCM au CCDA de l'IHA peuvent livrer les données brutes du spectromètre ACSIS au public ou aux propriétaires. Ceci complète une borne importante dans ce projet. La prochaine borne sera de livrer des données traitées.

À la mi-mars, 69 personnes de 23 pays ont appliqué pour la Bourse Plaskett. **Dr. Chien Yi Peng** a accepté notre offre et devrait arriver en septembre à Victoria. Ses recherches incluent le développement de GALFIT pour mesurer les images optiques de galaxies, et ses études portent sur la formation de trous noirs supermassifs, de supernovae, et l'évolution de galaxies.

Le rapport en couleurs sur la Radioastronomie canadienne pour URSI 2007 par **Andrew Gray & Ken Tapping** au Comité National Canadien d'URSI célèbre les succès canadiens dans ce domaine, et il addresse les points d'intérêt du management du spectre électromagnétique jusqu'à 3000 GHz (100 micromètres, dans l'astronomie infrarouge-proche).

Félicitations à **David Crampton & Ev Sheehan** qui ont atteint 40 ans de service (débutant à EMR), au **CCDA** pour leurs 20 ans d'opérations, à **Susan Firestone** qui a accumulé 15 ans de service au CNRC, et à **Tom Burgess & Bruce Veidt** pour leurs 10 ans de service à l'IHA.

Plus de 50 enfants et adultes ont participé activement dans un programme d'ouverture au public appelé "Astronomie & Ingénierie pour Enfants", qui s'est tenu à l'OFRA de l'IHA de Penticton.

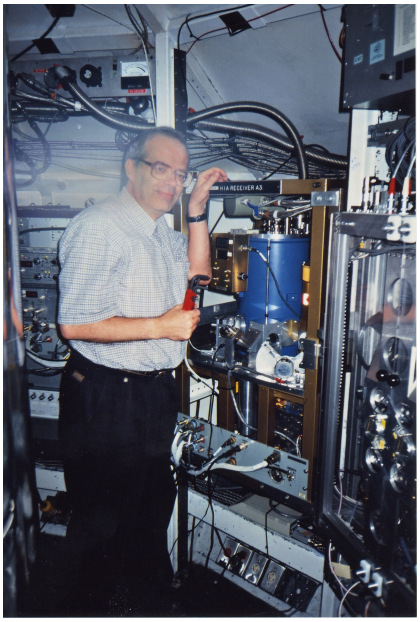
Une fois de plus, l'IHA a contribué à la célébration du Jour International de l'Astronomie 2007, tenu à Victoria au Royal BC Museum et au Centre de l'Univers de l'IHA, le 21 avril. Nos astronomes impliqués étaient **James DiFrancesco, Thomas Puzia & Eric Peng**.

Les nouvelles figures au Centre de l'Univers sont **Stasia Ferbey, Katrina Au-Yong, Annie Ladéroute & Lauren Stieglitz**. De plus, **Eric Chisholm** est nommé Coordinateur Intérimaire en remplacement de **Jacqueline Porter**, partie poursuivre de nouvelles opportunités.

154660 Kavelaars, un astéroide (c-à-d planète mineure) qui fut découvert en 2004 par David Balam de l'U.Vic., fut officiellement nommé de ce nom par l'UAI et l'annonce en fut faite durant le Banquet de la CASCA en juin. **JJ Kavelaars** est le co-découvreur de plusieurs douzaines de satellites irréguliers autour des planètes supérieures.

Jacques Vallée
Information Officer and Astrophysicist for HIA.

Jacques is a Research Council Officer at NRC/HIA in Victoria, BC. Much of Jacques's research involves magnetic fields in various starforming regions, in spiral galaxies, and in the Universe.



Jacques Vallée
Agent d'information et astrophysicien pour l'IHA.

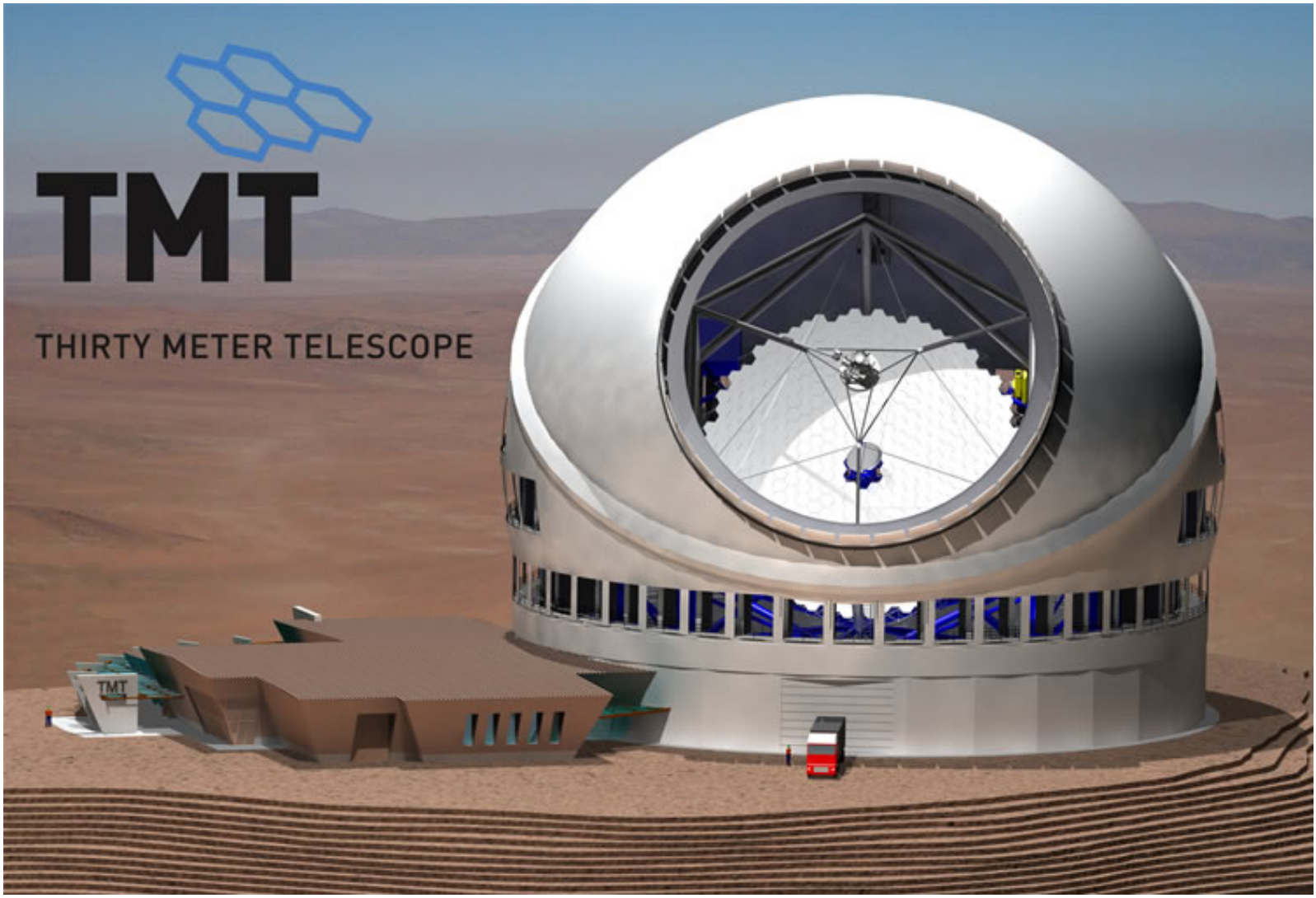
Jacques est un Agent du conseil de recherches à l'IHA du CNRC à Victoria, CB. Les recherches de Jacques touchent les champs magnétiques dans les crèches d'étoiles, dans les galaxies spirales, et dans l'Univers.

TMT Update June 2007

Ray Carlberg, LOT Project Director

Project News

The project has just prepared an overall construction proposal in preparation for raising funds. The proposal is a “short” 200 pages. Scott Roberts of HIA was the lead author, pulling together the documents produced by hundreds of people. The proposal summarizes several thousands of pages of other documents, beginning with science requirements, which lead to observatory requirements which lead to technical requirements on all the subsystems, for which detailed engineering designs are presented along with modelling demonstrations that the designs meet the specs. The designs have sufficient detail in materials, components and labour to allow the project to estimate costs and reserve funds. And there is an overall operating plan that will deliver a basic level of observing support (a more or less classically scheduled system, but time-sharing is possible) at a cost of about US$25M per year, which is statistically in line with most other astronomical facilities on this scale. The review approved the design changes that largely brought the telescope into line with the Board cost cap, to a current cost of about US$750M in base year 2006 funds.



Canadian work in TMT is highlighted in a short video, either TMT movie small or big at http://qold.astro.utoronto.ca/carlberg/lot/indexx.html (note the extra x). Empire Dynamic Systems (DSL, the former AMEC Dynamic Systems) is continuing to lead this critical path work. HIA is leading the NFIRAOS first light AO system work. ACURA is currently

acquiring the $1M tip-tilt stage which will be first tested then integrated into the system. ACURA is also acquiring four test mirror blanks on behalf of the project. One blank will be cast in Japan on June 26. David Crampton and Luc Simard are the TMT Instrument Managers that are currently beginning planning of the next stage of instrument design and how multi-partner teams will be pulled together to get the immense amount of work done. We expect to draw Canadian industries into this work as the design plans firm up. Our official lot website is getting a make-over thanks to Chris Acconcia, a summer student from McMaster University.

The entire TMT Scientific Advisory Committee will meet in Victoria at the end of July under Paul Hickson's leadership. The TMT SAC is a very powerful group that advises the board directly on all scientific requirements for the telescope. Paul has served with distinction in this role for nearly two years which has seen the project resolve a whole host of difficult debates over priorities in a limited budget environment.

One interesting instrumentation development is that it turns out that TMT in AO mode has nearly the same basic optical characteristics as Keck. This means much of the MOSFIRE instrument being developed for Keck can be "cloned" (designed at incremental cost) for a first light IR multi-object slit spectrograph behind the NFIRAOS AO system. This will complement the powerful on-axis IRIS integral-field unit, fully diffraction limited spectrograph, and, a relatively high spectral resolution optical multi-object spectrograph. Together these will be able to contribute to studies of planets, star formation, galaxy formation and even probe the physics of inflation (through small scale clustering in the IGM).

Getting TMT funded

TMT remains technically on track to initiate construction in 2009. The project team will now spend a lot of time going into greater detail with the design, with a strong emphasis on "value engineering" to reduce costs and risk. With a contingency budget of nearly $200M, risk reduction alone can generate very significant returns. We plan to select a site in the late spring of 2008 and expect that we will have a number of sites with legal access well underway. For instance we are in the process of finalizing the overall agreement with Chile to give us legal status as a scientific observatory.

We now start to fund raise with the goal of having commitments in place about a year from now. The cash is not required until spring 2009. The Gordon and Betty Moore Foundation is expected to continue to play an important role in supporting our US partners. AURA and the NSF have initiated a post-senior review process to determine how they can engage in a "Giant Segmented Mirror Telescope" (GSMT), their generic name for TMT and GMT. Japanese astronomers have their own national planning process which is in the initial stages of a national engagement with TMT.

In Canada astronomy funding has been running on a five year basis, with 2007-12 being the next funding period. Canadian TMT design money is now completely in place through CFI and NSERC peer-reviewed awards with NRC providing matching funds. Canadian contributions to TMT will require approximately C$116M to March 31, 2012, under the assumptions of 1C$=0.90 US$ and 2.5% inflation. A second award of approximately $173M will be required to complete our share of the work. Under these assumptions our contributions will lead to an ownership of 25.9% of TMT. There are bound to be lots of details in exactly how this works but overall we continue to live within the budget we laid out back in 2003.

Fund raising on the scale of TMT necessarily involves direct contact with senior federal government managers and their ministers. The Canadian Coalition for Astronomy leads these discussions in support of the Long Range Plan for Astronomy. If the TMT project is to proceed smoothly, which is a key element in minimizing TMT costs and in allowing progress on all elements of the LRP, we need to secure the 2012 funding commitment, if that remains the governments preferred time-frame, over the next year. It is safe to say that this will be an interesting year for all partners. The challenge of funding the DDP alone was quite significant but had the significant benefit of putting in place a conversation between the requests of astronomers and the needs and limits of the sponsors. It would be wonderful if this all proceeded smoothly on the basis of our well prepared plans, however everyone understands that the smoother it looks from the outside relatively more effort is being expended and more goodwill is being built behind the scenes.

The Calibration of the Hubble Space Telescope Wide Field Camera 3

André Martel (JHU), Howard Bushouse (STScI), and the WFC3 Team

The Wide Field Camera 3 (WFC3) is a fourth-generation instrument that will be installed in the Hubble Space Telescope (HST) during Servicing Mission 4, currently scheduled for September 2008, and will replace the Wide Field Planetary Camera 2 (WFPC2). The camera includes two observation channels: a UV/Visible (UVIS) channel and an infrared (IR) channel. The UVIS detector consists of two butted 2kx4k CCDs (160″x160″ field-of-view, 3 e- rms noise) and the IR detector is a 1kx1k HgCdTe array (120″x140″) cooled thermoelectrically. The camera possesses a large complement of narrow-, intermediate-, and broad-band filters (62 in UVIS, 15 in IR, and 3 grisms) distributed among 12 separate wheels for the UVIS and a single wheel for the IR. With WFC3's unprecedented sensitivity, extensive wavelength coverage (200-1700 microns), and large discovery space, astronomers will tackle a wide range of astronomical problems and produce exciting new discoveries.

Fig. 1: WFC3 is moved from the clean room to the vacuum chamber. Credit: H. Bushouse

WFC3 recently began a ~70 day thermal vacuum campaign at the Goddard Space Flight Center to validate its flight worthiness. In late May, WFC3 and the Calibrated Stimulus from Leftover Equipment (CASTLE) were moved into the large Space Environment Simulation Chamber (8.5mx12m). CASTLE delivers external light stimuli into WFC3, in particular monochromatic and broad-band point source and flat field illumination, by using a combination of fibers, lamps, and laser diodes while closely simulating the HST optical path and its aberrations. After system functional tests, alignment of the detectors, and throughput measurements were completed in ambient environment on June 10-14, the chamber underwent pumpdown to a $\approx 10^{-6}$ torr vacuum and calibration activities were initiated early in the week of June 18. For the entire campaign, all teams involved (calibration, thermal and CASTLE team support, control operations, etc...) rotate through three 8-hour shifts every day.

Fig. 2: The vacuum

In the simulated space environment of the vacuum chamber, WFC3 will be subjected to a series of cold and hot cycles as in HST's aft shroud to verify its thermal control systems. At each temperature plateau and during transitions, the science team will acquire calibration data to fully characterize the instrument's optics and detectors. The data will permit the identification, diagnosis, and resolution of potential problems before launch. The vast majority of the images are acquired via a series of scripts written in the form of HST command sequences - some will be executed several times to verify stability and repeatability. The calibration activities

chamber where WFC3 resides for the summer 2007.

can be divided into several broad categories. Some of these include: dark rate versus temperature, bias and super-bias, absolute and relative gains, linearity, PSF encircled energy, flat fields and stability, grism dispersion, readnoise, electronic crosstalk, image ghosts, shutter performance, throughput, internal lamp calibration, and charge transfer efficiency. These activities also offer an opportunity to verify the flight software as well as the transfer and processing of the data. After this campaign, WFC3 will undergo several more tests in ambient environment as well as a shorter thermal vacuum campaign in early 2008 for final check-out - it will then be fully certified for launch and installation in HST.

More information on WFC3 can be found at the Web sites of STScI/WFC3 and GSFC/WFC3.

Update on the Square Kilometre Array

Sean Dougherty, Herzberg Institute of Astrophysics
Ingrid Stairs, University of British Columbia
Russ Taylor, University of Calgary

International Developments

SKA Implementation Plan

The International SKA Steering Committee (ISSC) meeting took place from 26-31 March in San Juan, Argentina. A major outcome of the meeting was an agreed plan for the phased implementation of the SKA. The plan recognizes that four of the five key science goals of the SKA (probing the dark ages and the epoch of reionization, the origin and evolution of cosmic magnetism, the evolution of galaxies and large scale structure, and strong field tests of gravity) are enabled by a telescope operating at the low (~100 to 300 MHz) and mid (300 MHz to a few GHz) frequency ranges. See the most recent SKA Science Case book (http://www.skatelescope.org/pages/page_sciencegen.htm) for details of key science. The mid-frequency range science is enabled by the wide fields-of-view capabilities of focal-plane, phased-array feed technologies on 10-15 m class parabolic reflector antennas. The agreed implementation plan is a phased development of the full SKA,

1) with the “regional demonstrators” initially leading to a Phase 1 SKA to be constructed on the 2012-2015 timescale with a target construction cost goal of €250 M.
2) Phase 1 will consist of 10% of the collecting area of the full SKA over the mid-frequency range from 300 MHz to a few GHz (the upper frequency to be defined by design studies currently in progress).
3) The scientific and technical outcomes during Phase 1 rollout will guide the development and construction of the full SKA on the 2015-2020 time scale.

Two funding proposals, the European FP7 Preparatory Phase (PrepSKA) Proposal and the US Technology Development Program (TDP) Proposal have been submitted for funding the final stages of planning for the SKA. Major funding has been allocated in Australia and South Africa for SKA pathfinder “regional demonstrator” telescopes at each of the proposed sites to be constructed from 2008 to 2012.

FP7 Preparatory Phase Proposal (PrepSKA)

The 2006 European Strategy Forum on Research Initiatives (ESFRI) Roadmap for Research Infrastructures [1], lists the Square Kilometre Array as the next generation radio telescope for Europe, to become operational on the 2014-2020 time frame. As a result, the European SKA Consortium was invited to submit a Preparatory Phase Proposal to the European Union for FP7 Infrastructures. The proposal, “A Preparatory Phase Proposal for the Square Kilometre Array” or “PrepSKA”, was submitted on 2 May 2007. The proposal was coordinated by the United Kingdom Science and Technology Facilities Council and includes seven major work packages with participation by 20 organizations from the international SKA collaboration, including several funding agencies The National Research Council of Canada and the University of Calgary are named participants from Canada.

The principal objectives of PrepSKA, as listed in the proposal, are:

- to produce a deployment plan for the full SKA, and a detailed costed system design for Phase 1 of

the SKA;

- to further characterize the candidate SKA sites in Southern Africa and Australia and to analyze the various risks associated with locating the SKA at each of the sites;
- to develop options for viable models of governance and the legal framework for the SKA during its construction and operational phases;
- to develop options for how the SKA should approach procurement and how it should involve industry in such a global project;
- to investigate all aspects of the financial model required to ensure the construction, operation and, ultimately, the decommissioning of the SKA;
- to integrate all of the activities, reports and outputs of the various working groups to form an SKA implementation plan.

The duration of PrepSKA is 4 years, from 2008-2011. Including the contribution from the European Community (EC) and matching funds from national entities, the cost of the Work Packages in PrepSKA total €22.2 M.

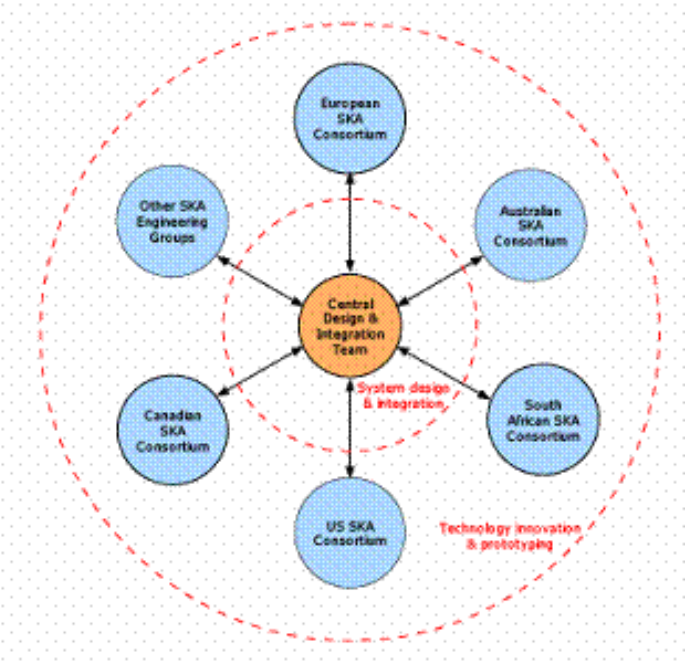


Figure 1. The EU FP7 SKA Paraparatory Phase Proposal is coordinated by a central team in Europe with collaboration from the international entities that are represented on the International SKA Steering Committee.

US Technology Development Program (TDP)

The US SKA Consortium has recently been awarded $12 M USD by the National Science Foundation a "Technology Development Project for the Large-N/small-d Square Kilometre Array Concept". The TDP proposal was submitted by Cornell University on behalf of the US SKA Consortium, and includes international collaborators. The TDP takes specific note of the European FP7 preparatory phase proposal, and states that the US TDP is the "mechanism for US participation in the international design effort". The funding is for five years (2007-2011). Included in the study is an analysis of the cost/performance as a function of operating frequency to help define the technical constraints on the upper limit of the mid-frequency range of the SKA. A main technical thrust of the proposals is the research and development of

10-15m class parabolic antennas for the SKA. The scope of the proposal is to span the current SKA reference design up to an engineering design for construction of Phase I of the SKA in 2012.

Canadian participation in the form of contributions from the NRC and the University of Calgary, as outlined in the TDP proposal, is aligned with current collaborative R&D programs with the Australian MIRANdA project and with FP7 PrepSKA work packages, and forms part of the international convergence around R&D for the SKA.

The Canadian-Australia Collaboration on MIRANdA

The Mileura International Radio Array (MIRA) is the Australian SKA Pathfinder (ASKAP) to be constructed in the Mid West region of Western Australia. MIRA comprises two instruments - MIRANdA and MWA. Together they form an SKA science and technology pathfinder, initially covering the frequency range ~80MHz to ~3 GHz. MIRANdA is being developed as an international partnership between Australia (CSIRO) and Canada (NRC) to build an array of dishes capable of high dynamic range imaging and using wide-field-of-view phased array feeds.

The agreement between NRC and CSIRO to collaborate toward the realization of MIRANdA was established in November 2006. The Australian Government recently announced an additional allocation of $56.6 M AUD to MIRANdA, bringing the total of Australian Government commitment to $101 M AUD for the 2007-2011 time period (see http://www.dest.gov.au/ministers/bishop/budget07/bud34_07.htm for details of the May 8, 2007 announcement).

South African Demonstrator

South Africa recently informed the ISSC that the SA government will fund development of an SKA pathfinder, the “Karoo Array Telescope” (KAT) at the proposed SA site, at a level of about $100 M Euro. At this point in time the technical specifications for KAT are in transition. However, the KAT planners do not intend to pursue focal plane array technology or a low-frequency aperture plan array. Thus degree of alignment of the KAT with the SKA reference design is uncertain.

Canadian Developments

Canadian Science Activity

The Canadian SKA Science Advisory Committee (chaired by Norbert Bartel) has produced a Canadian science document for the MIRANdA telescope, ranging from Galactic HI and polarization studies through compact objects to galaxy evolution and cosmology, and emphasizing what would be gained from various possible upgrade and expansion paths for MIRANdA. Our Australian counterparts have also producd their own document, and we are now finalizing a merger of the two science cases to arrive at a case with the strongest possible international appeal and concerted plan for future development.

In March there was a meeting held at ATNF in Sydney, Australia on Focal-Plane Array technology for the SKA, followed by a two-day meeting on Science with MIRANdA. There was strong Canadian participation in both these meetings, with eleven attendees from Canada, including engineers from HIA and scientists from both the university community and HIA. The science meeting covered topics in both the Canadian and Australian science plans, and was a catalyst in developing the combined science case.

Following the science meeting, there was a face-to-face meeting of the Australia/Canada MIRANdA collaboration. A result of this meeting was a joint Communique, a highlight of which was the affirmation that

MIRANdA is on -- and remains on -- the international science and technology path to the SKA.

Formation of The University of Calgary Centre for Radio Astronomy

In June the Office of the Vice-President Research of the University of Calgary approved the formation of a Centre for Radio Astronomy at the University of Calgary. The Centre for Radio Astronomy combines groups in the Faculty of Science and the Schulich School of Engineering and builds on a long-standing research partnership between the University of Calgary and the National Research Council of Canada, Herzberg Institute of Astrophysics. As part of establishing the Centre, the University of Calgary will provide $2.1 M of direct cash and in-kind support toward a mandate to promote and facilitate Canadian participation in the next-generation international radio astronomy facilities prioritized in the Canadian Long-Range Plan for Astronomy, including the Square Kilometre Array.

Canadian SKA Technology

In Canada, SKA-related technology development is targeting low-cost, high-performance solutions in three areas vital to the SKA: wide field-of-view, low system-temperature, and large collecting area. These three areas are being addressed respectively by phased focal-plane array feeds (the PHAD project), novel CMOS LNAs, and reflector antennas fabricated with composite materials (the CART project).

PHased-Array Demonstrator (PHAD)

Steady progress is being made on the PHased-Array Demonstrator (PHAD), a prototype engineering demonstrator of a phased focal-plane array at the Herzberg Institute for Astrophysics (HIA). PHAD will not have the sensitivity or bandwidth of a science-capable feed system, but will be sufficient to demonstrate the technology and to explore design issues applicable to a science-ready system. One of the key design features is the ability to store all the data from all of the elements in the array. This enables tremendous flexibility, both in system diagnostics, and in beamformer algorithm development. Initial beamformer design will be done off-line with a software beamformer that will work with stored data. Once the algorithm has been tuned, it can be uploaded into the FPGA-based data acquisition system and real-time beamforming can then be used for deep integrations.

The PHAD array has 180 elements (90 for each orthogonal linear polarization) along with a row of "dummy" elements around the periphery of the array (Fig. 1). The array is 76 cm wide (or 5 wavelengths at 2 GHz) with element spacing of half-wavelength at 2 GHz. The elements are "Vivaldi" antennas, working over the frequency range 1--2 GHz. There are no active components on the antenna element boards. The array is modular and is assembled by sliding antenna elements into slotted posts supported by the backplane.

The receivers used in PHAD take advantage of modern radio frequency integrated circuits which provide a large amount of functionality with a small number of components. For example, on the receiver chip there is, in addition to the usual chains of amplifiers and mixers, a complete synthesizer to tune the receiver. Low-noise amplifier chips are also on this board.

PHAD is now built, and an extensive series of tests and measurements have started, beginning with array radiation patterns measured in an anechoic chamber. Ultimately, we are aiming to test the system on a radio telescope.

Figure 2 - The 180-element PHAD array

CMOS Low-Noise Amplifiers

The availability of very-low-noise amplifiers operating at room temperature is key to producing sensitive, low-cost, phased-array receiver systems, since they do not require potentially costly cooling systems. Although traditional HEMT technology has had little improvement over the past decade, the CMOS technology used in computer chips has been advancing at an exponential rate described by Moore's Law. As transistors are made smaller, they not only work at higher frequencies, but they also have lower noise.

Although this reduction in noise has been predicted for some time, only recently has it been demonstrated. Fig. 2 shows an amplifier fabricated with 90 nanometre CMOS that has achieved a noise temperature of less than 14K between 800 and1500 MHz, operating at room temperature. This has been attained through a combination of clever circuit design and careful layout of the chip. This very promising result suggests that as CMOS technology progresses to smaller device geometries, there are excellent prospects for room temperature CMOS amplifiers to be competitive with traditional cooled low-noise amplifiers. Leo Belostotski and Jim Haslett at the University of Calgary are leading this work.

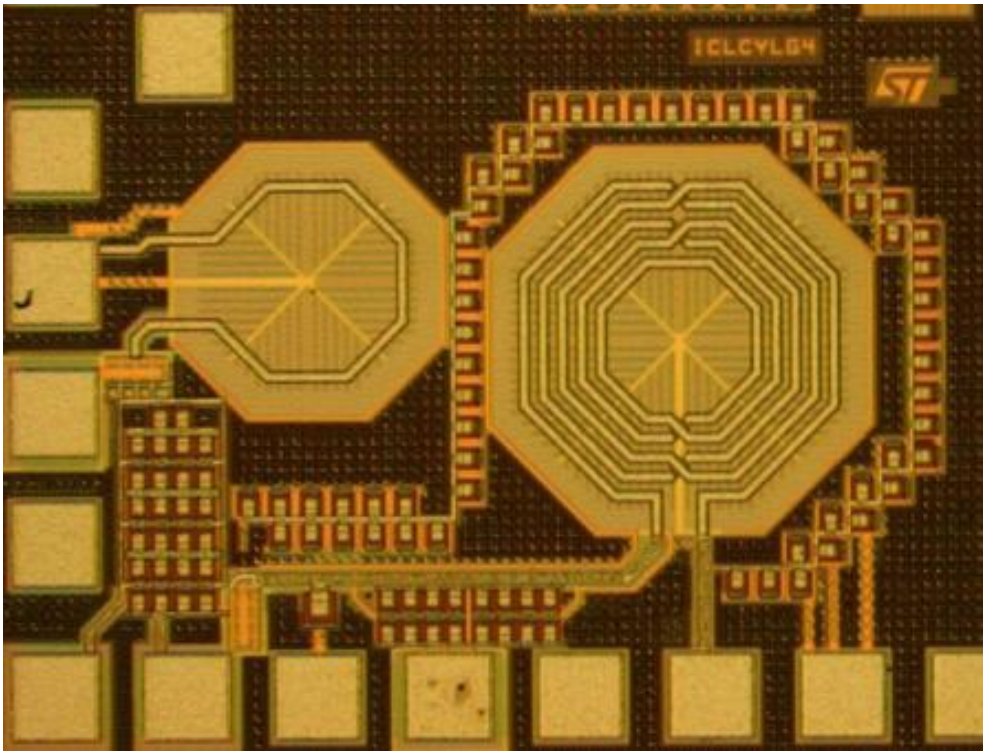


Figure 3 – Die photo of a CMOS LNA that has attained a noise figure of less than 14K between 800 and 1500 MHz. The actual size of the device is approx 1mm.

Composite Reflector Antennas

The ability to build large collecting areas with cost-effective reflectors having excellent radio-frequency performance remains a significant technology challenge for future radio telescopes. At HIA, the CART project (Composite Applications for Radio Telescopes) is addressing this challenge by applying composite materials and fabrication techniques to low cost-per-unit-area radio-telescope applications.

Work on a 10-m prototype is progressing well. In the past three months, the 3-piece mold for the reflector surface has been installed in our fabrication facility – a renovation of the hanger used to house “BOB”, the aerostat used in testing for the Large Adaptive Reflector. To ensure the fabrication process would work as designed, a section of the integrated reflector surface and beam structure was successfully built. This prompted the lay-up of the first full 10-m reflector, now well underway. The reflector surface has been laid (Fig. 3), and the team are currently installing the structural beams on to the mold (Fig 4). It is anticipated the reflector will be ready for pulling from the mold by mid-July.

Once off the mold, the reflector will be placed on a telescope mount for testing. The mount that will be used is from the MV-1 mobile antenna formerly located in Yellowknife, in the Northwest Territories, as part of the Canadian geodetic VLBI array. The opportunity to acquire this antenna arose during the winter months, and one of our engineers spent a week in –30°C temperatures supervising the dismantling of the antenna for shipment to the DRAO site (Fig. 5). It arrived in late March and is now undergoing a refit for the CART project.

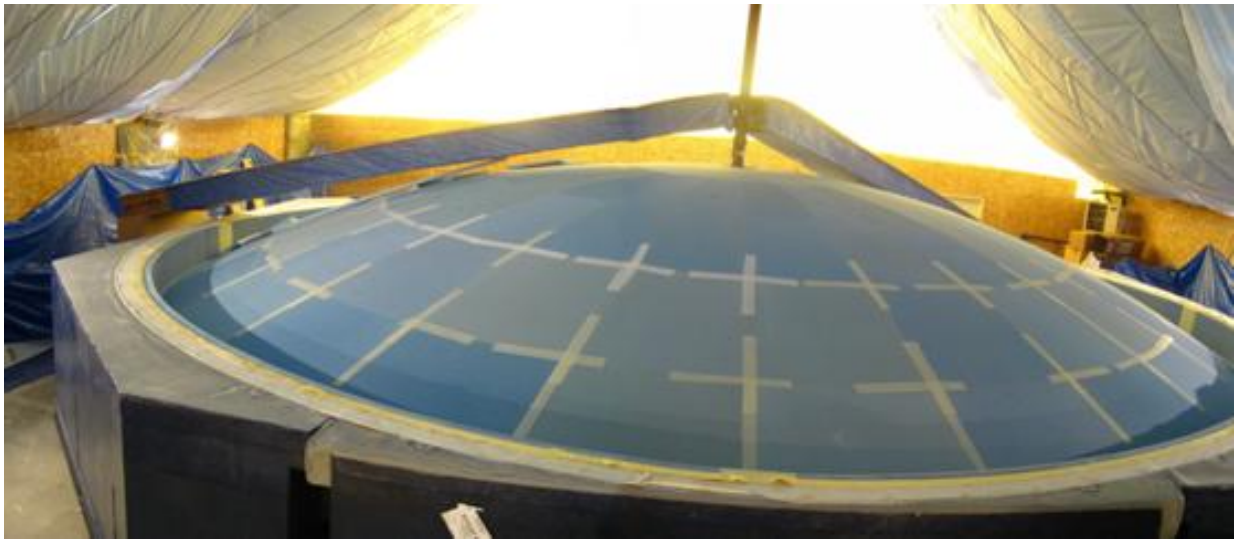


Figure 4 - The reflector surface of the 10-m prototype laid in the mold. The blue material is foam core.

Figure 5 - The integrated structural beams are put into place.

Figure 6 - The MV-1 antenna being disassembled in -30C conditions in Yellowknife. At least it was sunny!

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[1] Office for Official Publications of the European Communities, 2006, IBN 92-79-02694-1, (http://cordis.europa.eu/esfri)

June 2007 Report on International Year of Astronomy 2009 (IYA2009)

THE UNIVERSE
YOURS TO DISCOVER

INTERNATIONAL YEAR OF
ASTRONOMY
2009

An Update From the IYA Canada Committee
June, 2007

Goal: To offer an engaging astronomy experience to every person in Canada, and to cultivate partnerships that sustain public interest in astronomy.

How do we envision doing this? By

- Celebrating 4 centuries of telescopic observation
- Sharing our passion & achievements with taxpayers & their children through creative partnerships
- (Re-)connecting Canadians with the heavens
- Providing national co-ordination, encouragement & support for ***your*** local, regional and national initiatives
- Creating or supporting broadly conceived programmes with some legacy or sustainability elements
- ***Seeking highly leveraged activities arising from the community: initiatives welcome & encouraged – this is not a top-down process*** and…
- having fun!

Who are we?

- Organizations:
  - CASCA, RASC, FAAQ in partnership and working closely with
  - Planetaria & Science Centres, and the informal education community
  - NRC, CSA (and plans to approach NSERC, CIAR, CITA, PI and others)

- First Nations & Inuit Communities
- Media & Communications experts
- And we are you, members of CASCA

Interested in participating? Contact jim.hesser@nrc.gc.ca

Our Programme Working Group is presently sifting the initial round of ideas and suggestions and grouping them (tentatively) into four broad themes. They are, along with some of the ideas proposed to date:

1. Observing the sky
   - 1 million (or a couple million more?) Canadians look through a telescope
   - $1 telescope kits widely distributed (an IAU objective)
   - Sidewalk astronomy, Rooftop Astronomy, Astronomy Day, solar viewing…
   - Mobile telescope vans
   - Jupiter opposition & Jupiter's moons (Galileo did it!)
   - Total solar eclipse in Asia
   - …..(insert your ideas here)

2. Sharing discoveries and promoting astronomy as a hobby
   - New Canadian planetarium, TV, radio shows
   - Sundials in city parks with explanatory material
   - Articles, public lectures (parks, communities)
   - Hands-on experiences for youth in schools, camps
   - Children's art in early 2008 for 2009 calendars
   - Posters complementing NRC's *Canadian Skies*
   - Public observing opportunities on Canadian telescopes
   - …..(insert your ideas here)

3. Astronomy Everywhere: Arts, Culture, History
   - Traditional First Nations & Inuit knowledge of heavens
     - Book for children
   - Musical events (existing or commissioned)
     - Opera, symphonic, jazz, popular
     - Are there CASCA members with special contacts in the arts or popular entertainment communities?
   - Theatre

  - Brecht's Galileo
  - Galileo impersonators (script needed)
- Images in parks, galleries
- …(insert your ideas here)

4. Legacies: Near and Long Term
   - Dark Sky Preserves in every region (First Nations, National or Provincial parks)
   - Lower, more cost-effective public illumination
   - New books, musical or theatrical scores
   - New or enhanced EPO partnerships
   - Deeper appreciation of the Earth in context
   - Canadian postal stamp series
   - …..(insert your ideas here)

Our IYA Canada Committee and associated Working Groups continue to slowly accrete additional, talented volunteers from CASCA ranks, with several people having offered to help during the recent meetings in Kingston. We are still short on people at ease with (read "experienced") Communications and Fund Raising activities. The Graduate Student Committee indicated their strong interest in working on IYA-related activities, where their enthusiasm and familiarity with interests of younger people will be tremendous assets.

A rough time line for immediate activities would include:

- Summer 2007:
  - CASCA, RASC GA discussions, volunteers solicited
  - National goals & budgetary estimates established
- Fall 2007:
  - Fund raising for adopted goals begins
  - Canadian Aboriginal S&T Conference
  - IAU Symposium on IYA2009
- Winter 2007-08: educational system initiatives
- Quarter1,Q2 2008: FAAQ, CASCA, RASC AGMs

Your observations, suggestions and – most of all – participation are welcome!

Jim Hesser on behalf of the IYACC:

Cheryl Bartlett (First Nations co-chair)
Jeffery Crelinsten (The Impact Group)
Jayanne English (CASCA EPO)
Jim Hesser (NRC, CASCA)
Peter Jedicke (RASC)

Remi Lacasse (FAAQ)
Pierre Lacombe (Programme Committee co-chair)
Phil Langill (Programme Committee co-chair)
Lindsay Marshall (First Nations co-chair)
Bob McDonald (CBC)
Ruth Ann Chicoine (CSA)
John Percy (CASCA EPO)
Andy Woodsworth (NSERC)
Scott Young (RASC & Science Centres)

AstronomyCanada.ca: "Strut your (space) stuff" Contest

Jayanne English (U.Manitoba), Jim Hesser (NRC-HIA), John Percy (U.Toronto), Dennis Crabtree (Gemini) & Robin Kingsburgh (OCAD, York U.)

Who: You! Any astronomer, including students, PDFs, and research associates who wish to promote Canadian professional astronomical research and activities. You can work independently or as part of a team. Public outreach is an activity often done by professional astronomers -- it allows astronomers to communicate almost directly with the lay public, piquing their interest in our endeavours. This is your opportunity to share your passion.

When: Submit by October 10, 2007

How: Submit to Jayanne_English@UManitoba.ca. Put "Space Stuff Contest" in the subject line.

Why: Not only have astronomers requested support for promoting their work, the Canadian media desire a clearinghouse website containing Canadian astronomy content. This would make it easier for them to describe our work to the public. AC.ca can be considered both a method and material for accomplishing this. Once a viewer's interest has been piqued, say in the broadcast media, they typically search online for more detail. Thus AC.ca will play an on-going role, informing and inspiring Canadians about astronomy. The bulk of AC.ca's activity will be selecting, creating and disseminating material.

A proposed budget for AC.ca includes a project coordinator, image and writing specialists, and web design. Unfortunately the LRP/MTR financial request for education and public outreach is not currently funded by the government. However, even without these outreach specialists, Canadian astronomers can make AC.ca into a reality.

We can start by establishing the content which will be disseminated on the website. This contest is a first step to promote awareness of the need for content and an endeavour to acquire content. This contest will also build the infrastructure that facilitates the collaboration between image-makers and authors which is necessary if astronomers are going to reach a new level in public outreach.

We hope that you are inspired to participate!

The proposed AstronomyCanada.ca website is meant to serve as a central resource for communicating the achievements, activities and aspirations of Canadian astronomy to the public and Canadian media. The Long Range Plan/Mid-term Review considers such a website to be of the highest priority. In Calgary last year CASCA members enthusiastically endorsed our concept. Now you can help us launch AC.ca by participating in our "Strut your (space) stuff" Contest which is open to all CASCA members, including graduate students and post-doctoral fellows. The website needs content. That is, it needs expressions of your results and enthusiasm for astronomy. So submit one or more of the following items which you've designed to appeal to the general public: an astronomy image or illustration; a brief article; or an outline for a podcast. The winners will have their stuff highlighted on the AC.ca website when we launch it.

Where: Each month, AC.ca plans to simultaneously release an astronomy image, along with an associated short article and illustration. Winners' contributions will be disseminated to the media and available to the general public via this website. One of the unique features of AC.ca, compared to other public outreach sites, is that each astronomy image will have a graphic illustration of the associated phenomenon or concept. If your image or article is selected, a graphic illustration will be created for it by students at the Ontario College of Art and Design.

What: Images, stories and podcast outlines describing exciting discoveries and ongoing explorations that you would like to share with the public and the media. AC.ca is meant to promote Canadian astronomy so these items should be either created by Canadians or use Canadian data or facilities Canadians participate in. To facilitate the media's understanding, and promotion, of your work, entries should be associated with a recent professional publication or a presentation expected to occur in 2008.

Astronomy Images:

- -- Judges will be looking for images in which the object is convincing; for images that are more like photographs than like contour plots. However the subject need not be like any objects that the public is already familiar with – the image can be a vehicle for the experience of making a discovery.
- -- The image should be 330dpi and use as many pixels as is naturally possible.
- -- The submission states the principal image maker's name, affiliation, and contact information; similar information for all contributors; the telescope and instrument; exposure time and date acquired; wavelength regime; filters and colour assignments to filters; computer equipment if simulations are submitted, etc.
- -- Information on how to create striking colour images can be found at http://www.physics.umanitoba.ca/~english.
- -- If possible, please also submit an article describing the image (see below).

Astronomy Articles:

- -- Articles about research can describe news or ongoing endeavours. However news articles will be much appreciated by our media friends. Articles about Canadian astronomy history, portraits of Canadian astronomers or facilities will also be considered.
- -- All articles should be accompanied by a succinct 25 word summary.
- -- In order to determine if your material is newsworthy see the CASCA press release guidelines site http://www.astro.umontreal.ca/~casca/prguidelines.html.
- -- Feature length articles should be less than 2500 words. Suggestions for images associated with the material should accompany the article.
- -- Articles meant to describe a submitted image should be about 700 words.
- -- Include the author(s) affiliations and contact information.

Podcasts:

- -- A detailed outline of ideas, and motivation, for a podcast of about 5-10 minutes in length.
- -- Topics include profiles of astronomers, facilities, news, the upcoming International Year of Astronomy, philosophical thoughts about doing astronomy, upcoming celestial events or indepth coverage of currently popular topics.
- -- Include your strategies for producing the podcast and mention any volunteers or other support; include the producer(s) affiliation and contact information.

For advise on how to produce winning entries contact Jayanne_English@UManitoba.ca
The following websites display some material that would be considered successful: Hubble Heritage, CFHT Image of the Month, Astronomy Picture of the Day, Gemini Observatory's Astronomical Images.

Breaking the Teaching Barrier: Moving from Professing to Teaching

by Heather Theijsmeijer

To profess, is to acknowledge something publicly. In reality, anyone can profess, and as professors, it is often tolerated because of one's credibility. But teaching – to bring understanding through experience – requires more than simply lecturing publicly. As it turns out, the difference between professing and teaching is closely linked with the difference between student learning and student understanding. We can bridge the gap between learning and understanding by becoming better teachers, and understanding the student learning process.

Any student, while learning science, passes through three stages: Assimilation, Disequilibrium and Accommodation. As they are presented with new information, science students of all ages first compare it with previously-learned – and sometimes incorrect – knowledge on the subject (assimilation), wrestle with whether the new idea is indeed correct and how it is superior to their previous knowledge (disequilibrium) and finally accept the new knowledge as the correct theory (accommodation).

Some students make this transition quickly and smoothly, while many others need more time to explain away inconsistencies between their ideas and reality, as well as connect what they are learning to their current values.

It is in recognizing this process that we realize the transition between professing and teaching must be made in order to benefit the greatest number of students. It is also important to recognize the difference between learning, and actually understanding. Almost anyone can learn by rote memorization, however to answer questions such as "what do you think will happen next" or "justify/predict why this happened the way it did" requires a fuller understanding.

The mainstay of professing is the lecture. Most would agree that lecturing is perhaps the most common form of teaching that occurs in a post-secondary setting, and there are good reasons for that. Lecturing is very effective at communicating a large amount of

material to a large number of people. It is also an excellent way to introduce a topic, and relate the facts and details of a more complex concept or idea.

However, if you tend to lecture, you may have noticed that students often become passive learners, waiting for the information to come to them instead of actively reasoning their way through the material. Also, during a lecture, learning moves at the speaker's pace, and not at the pace of those who are actually doing the learning. Using the above terminology, if a lecturer moves particularly quickly, students do not have the time to assimilate – they are instead forced to accommodate information without questioning or comparing to what they already know. Finally, and perhaps most importantly, lecturing cannot address higher-level thinking skills, a critical part of truly understanding.

So what's to be done? Transitioning from professing to teaching is actually quite easy, and breaking down the "front podium barrier" is the first step. Students who see their instructors as humans who appreciate the learning process, demonstrate passion for their teaching subject and demonstrate commitment to their students are more likely to take an active role in learning. This may include having the confidence to ask questions, helping with demonstrations and going above and beyond curriculum expectations.

The front podium barrier that is automatically created while lecturing can be broken down simply by making eye contact, greeting your students (both in and out of the classroom), asking for student participation and including variety in your lessons. There have been many ideas presented on the CASCAed website regarding student involvement and teaching activities (for example, see *7 Habits for Highly Effective Astronomy Teachers*).

Addressing the higher levels of knowledge (concepts, generalizations and applications) in class engages the students and forces them to take charge of their own learning. One way to do this is to teach using a top-down approach: present a unit centered around a big idea, question, concept or generalization. In addressing this larger concept (which will hopefully get the students thinking), the usual vocabulary, basic facts and details all get covered. In answering the question at the end of the unit, students should be able to use their new knowledge just as well as if they had they memorized it all from the

professor's notes. The difference in the end result here, is that they didn't just learn the material, they also worked toward understanding it.

In summary, switching our viewpoint from professing to teaching encourages us to teach to the whole student, addressing many learning styles and levels of knowledge along the way. This allows us to encourage students to make sense of science using their current ideas, make their ideas explicit by making predictions or stating concepts in their own words, justify their ideas and connect subject matter to experiences. All of which help to bring understanding through experience – the proper role of a teacher.

Education Notes

Report of the Education Session at CASCA 2007, Kingston

This year saw an unprecedented number of education and outreach contributions to the CASCA AGM in Kingston, with five oral presentations and five poster presentations. This was wonderful to see, as much of astronomy is tied in with outreach, and is becoming increasingly important with the International Year of Astronomy (IYA) quickly approaching in 2009.

The Education and Public Outreach Session, chaired by Jayanne English, began on that very topic, with Jim Hesser speaking on the Canadian plans for the IYA. Jim represented volunteers from CASCA, the RASC and the FAAQ as well as various science centres and planetaria across the country, in sharing the themes for IYA2009: Observing the Sky; Sharing discoveries and promoting astronomy as a hobby; Astronomy everywhere; and Near- and Long-term legacies. If you have any ideas on how we can “offer an engaging astronomy experience to every Canadian,” please forward your ideas to Jim, or any of the other IYA committee members. Dennis Crabtree also presented a poster on the IAU’s global efforts for IYA2009.

Two talks focused on how teaching can move from basic lecturing into lessons involving active student learning. Magdalen Normandeau spoke on how role-playing activities in the classroom place emphasis on how science is done as a process, allowing students to gain more of an appreciation for science as a research field. The role-playing model, developed by Paul Francis of ANU, effectively combines problem-solving with peer instruction. More information is available at http://msowww.anu.edu.au/~pfrancis/roleplay.html

Meanwhile, Heather Theijsmeijer spoke on moving away from lecturing processes in order to teach the whole student, as well as the difference between professing vs. teaching/learning vs. understanding scientific concepts. More on this topic can be found in this issue of E-Cass, and

online shortly at the CASCAed website.

David Turner presented a talk on “Observing Exercises for Advanced Astronomy Specialists,” paired with a poster on the joys of astronomical discoveries with small telescopes. Tying in nicely with a theme of moving away from traditional methods of teaching, David presented a variety of exercises and projects that can be carried out at the campus telescope to give students both observing experience and research challenges. Many of these projects, such as asteroid observing, open cluster HR diagrams or stellar spectroscopy could be continued for summer work or graduate-level work.

Similarly, Paul Delaney presented a poster on the recent results of undergraduate students observing transiting exoplanets using the telescope at the York University campus. The project placed emphasis on students collecting and reducing their own data, and linking their results with other topic such as planet formation, gravitational lensing and Doppler shift.

Also related to educational practices, a poster by Alison Sills outlined the effectiveness of inquiry-based learning in an upper level undergraduate astronomy course. Beginning with an introductory question or concept, in-class groups propose and refine questions in order to complete a research project using real data, analysis software or research code.

On the topic of public outreach, Phil Langill presented an introduction to the location and suite of telescopes of the University of Calgary’s Rothney Astrophysical Observatory. Their newly-renovated interpretive centre serves both the public and the Calgary school system through outreach activities, virtual tours and live streaming webcasts of talks and astronomical events. More information on the RAO is available at http://www.phas.ucalgary.ca/rao

Two more public outreach initiatives were presented in poster form. Alyssa Moldowan wrote on the University of Western Ontario’s new astronomy

outreach program “Exploring the Stars” (http://www.astro.uwo.ca/exploringthestars) and their success with newly-developed activities and presentations.

Jayanne English presented the AstronomyCanada.ca “Strut Your (Space) Stuff” contest – a chance for you to share your recent research and activities in a way that appeals to the public. Submit your image/illustration, brief article or outline for a podcast for a chance to win, and in the meantime, pique the interest of the lay public, increasing their knowledge of Canadian Astronomy. This is open to ALL CASCA members, including graduate students and post-doctoral fellows. Be sure to contact Jayanne for more information.