A CASCA RAC Skypecon was held Tuesday, May 12, 2009, 4 pm EDT. Present were Sean Dougherty, Gil Holder, Martin Houde (chair), Ingrid Stairs, Ken Tapping, and Tracy Webb.

1) Old business.

The search to find someone within HIA to replace Ken Tapping as spectrum manager is still incomplete. According to previous plans, Ken's participation in spectrum management would have ended with the last fiscal year, and his role should now be to give help and advice to the new incumbent. However, so far no new person has been designated to succeed Ken. With a number of ongoing issues with Industry Canada and internationally, we cannot simply drop things. As a consequence, Ken is currently spending this year finishing some tasks and terminating others, and we are therefore throwing away momentum we have built up over the last few years. We ask for the Board's continued support of this increasingly urgent need.

2) Administrative changes.

We are pleased to inform the Board that Drs. Jo-Anne Brown (U. of Calgary) and Roland Kothes (HIA) have accepted to join the RAC starting in the fall of 2009 (i.e., for the next Skypecon). They were recruited as replacements for Drs. Ingrid Stairs and Sean Dougherty, respectively, who are both leaving the RAC after many years on the Committee. The RAC sincerely thanks Ingrid and Sean for their dedication and services. We hope that the Board will endorse Drs. Brown and Kothes appointment to the RAC.

Finally, we are also pleased to inform the Board that Dr. Gil Holder has accepted to become Chair of the RAC starting in the fall of 2009 (i.e., for the next Skypecon) for one year, replacing the current Chair (i.e., M. Houde). We hope that the Board will endorse Dr. Holder appointment as Chair of the RAC.

3) Reports.

A) Spectrum Management -- Ken Tapping

Spectrum Allocations to 3,000 GHz

This one is well developed and can evolve happily without our participation.

Radio Quiet Zones

As part of better understanding the evaluation and management of Radio Quiet

Zones, and also to better understand the protection environment and management process for DRAO, we have been in a joint study with the local, regional and national offices of Industry Canada. This involves making noise level measurements and the comparison of path loss measurements and theoretical calculations in defining Radio Quiet Zones. This issue is crucially important not only for the protection of observatories like DRAO, Jodrell Bank and Effelsberg, where one has to deal with non-optimal environments, but also for instruments such as the SKA, which might look well-sited now, but in a decade or so might not.

Most of the measurements have been made, and working with Industry Canada I am playing lead in drafting a report that we will table as a Canadian contribution to the ITU this September.

Passive Radio Sensing and Solar Radio Monitoring

Radio astronomy is only one type of passive radio sensing of our environment, atmosphere and space. Under the ITU Radio Regulations only radio astronomy is recognized as a ground-based passive radio sensing activity. My personal interest is to get the Solar Radio Monitoring Programme recognized by the ITU as an important activity. In addition I want to get riometers and other such instruments being deployed here and at DRAO recognized and protected under the Radio Regulations. Through the back door, any additional frequency allocations made for use by other passive services will automatically be available for radio astronomy.

I am working with Industry Canada on a contribution to take to the ITU in Geneva this September.

GLONASS and 1.6 GHz OH

Since the OH bands for radio astronomy were not allocated when the Soviet navigation system GLONASS was deployed, it has been rather unlucky for the Soviets and now the Russians. However, their current conduct makes one rather less sympathetic. Seeing that they cannot satisfy the protection rules for radio astronomy, they are lobbying very hard to change the rules, bringing in France and some other countries as allies [There are lots of political IOU's circulating in Geneva]. Discussions have been "extensive, candid and far-reaching". The reason the line must be held is that weakening the protection criteria will impact all the radio astronomy bands, not just the OH bands.

No specific action is planned, but in September I will contribute to discussions if appropriate.

Infrared and Near-Infrared Astronomy

Two years ago we (Canada) tabled in Geneva a report discussing the planned use of infra-red up and down-links for space<->Earth data communications and inter-satellite links. Everyone involved is really interested in bands where the atmospheric attenuation is low. The objective of the report was to establish a placeholder for astronomy. If the issue is considered early enough there are ways to avoid problems for astronomy (with Hawaii being potentially the most difficult case). The report came up for discussion and improvement at the last meeting and has now been approved and pushed one more layer up the pyramid.

I am planning no more work on this one. It should be OK.

Other Committees

IUCAF: I am a member of IUCAF. This is a nice international (actually heavily European) committee discussing spectrum management issues. This has been an important non-ITU forum to work with other radio astronomers on proposals and discussions outside the earshot of our administrations or delegations. I will be resigning my membership in this committee at the end of this year.

CORF: This is maybe a more serious issue than IUCAF. Some years ago I said to a member of the US Delegation that the Europeans have a pan-European forum for getting their ducks in a line before heading to the ITU, whereas the USA and Canada do not plan together or coordinate before having to respond in Geneva to European proposals coming from a bloc of nations. Rather than go along with being one-on-one with Canada, they made me a member of their national Committee on Radioastronomy Frequencies, CORF. This is an important forum for discussing our interests, although only being one vote in a dozen or so. The USA is prepared to discuss an alternate to me. There are surprising rewards in this committee. For example, last time I was invited to sit at the US Government side of the table when Iridium was asking for a new license.

I will of course be dropping out of CORF at the end of this year.

Radio Astronomy for Spectrum Managers

As part of getting the Industry Canada people up to speed on radio astronomy, I have put together a course: "Radio Astronomy for Spectrum Managers". A new generation of spectrum managers is coming together in Kelowna and Ottawa, and I think it would be cheap insurance for future awareness if I give this course one more time.

B) JCMT -- Martin Houde

SCUBA-2: The instrument came off the telescope in February, which signaled

the end of the first phase of instrument commissioning, and has been warm since. It is integrated into the observatory and those aspects of commissioning went well. One of the problems that were encountered was that the magnetic shielding of the instrument was found not to be sufficient and there was a lot of pick up on the SQUIDS from the Earth's magnetic field as the telescope slewed around. New magnetic shielding is being fabricated in Cardiff, which is anticipated will solve this problem. The first two science grade arrays have made their way around the fabrication chain and are currently in Cardiff undergoing testing. The results of the testing are soon expected, as is the confirmation of whether or not the science grade arrays are acceptable (and by what margin, i.e. NEFD measures, yield, etc).

SCUBA-2 commissioning: It is assumed that SCUBA-2 commissioning will start some time in August. On the current schedule the first two SG arrays will be inserted into the cryostat at the end of July. On-sky commissioning will then occur over the course of the next 3 months on a sparse schedule. The commissioning team will use somewhere between 3-4 half nights per week, giving them time to absorb and reflect on the commissioning data and to plan accordingly.

HARP: The instrument was warmed up in February in order to fix and replace the broken receptors in the instrument. In all 6 receptors were replaced. There are now 16 working mixers in the cryostat, which is good news. However, receptor H14 still suffers from oscillations and it is believe that the problem lies with the cabling within the cryostat. It is not clear at the moment when it will be possible to open the cryostat again to attempt a fix to this problem. There is clearly a risk in doing so. So the present situation is that we now have 15 working receptors and performance from the instrument has been good.

ACSIS: Work has been on going throughout the semester to take out and optimize the settings on the sampler boards that are fed by the receivers. This work has gone very well and observers are reporting that the baselines are now much improved and more stable.

RxWD: The instrument was declared commissioned in the winter and has been used quite frequently since when the weather has been appropriate. However, it was discovered that there was a misalignment between the D- and B-band arms of the instrument, such that the two beams of the instrument were not both aligned at the same time as one changed between B- and D-band. As such, to facilitate the recent eSMA observations RxWD is no longer properly aligned. Possible solutions to this problem are being considered.

e-SMA: There was a successful run in March using the eSMA for science demonstration. Several projects were chosen (from the instrument teams) to observe and demonstrate that the eSMA was ready for science. RxWB is still less sensitive than required (with just one channel operational) but despite this,

the run went well. There are still some commissioning runs anticipated to iron some final problems before a recommendation is made to the observatory Director's for the call for the eSMA Pilot Programme to be made. This will probably happen sometime in the summer.

RxA: This receiver is operating well and reliably. The Board considered a proposal at its last meeting for a project to upgrade it. Community support is present for the JCMT to maintain an A-band facility (an ad-hoc panel was convened by the Director to consider the future of A-band observing at the JCMT and its conclusion were that it should be maintained and instrumentation improved if at all possible). At the present time, the Board were not amenable to receive a proposal for a new instrument, but they would like to see a paper which describes the costs for a minimal upgrade (mixers etc) which would see an improvement in the sensitivity of the instrument. This paper is being prepared by Per Friberg to be presented at the next Board meeting.

ROVER: This project has suffered due to its low priority and, when it has got time on the telescope, it has suffered from poor weather conditions. It is anticipated that we can complete commissioning of ROVER with RxA in 09A so that it can be offered with the 10A call for proposals. In 09B, we will commence commissioning ROVER with HARP.

C) ALMA – Tracy Webb

ALMA Construction Progress:

Onsite construction is moving forward well. On April 30 ALMA obtained fringes (for the first time) at 104.2 GHz with two antennas at the OSF during observations of Mars. The goal is to have a working three-antenna interferometer by November of this year. In other construction news, the OSF is now occupied, there are roughly 14 antennas onsite with 3 accepted, and the testing of bands 3, 6 and 7 are going well. ALMA continues to work toward early science in Oct of 2011 (a small slip from June) and an inauguration in Aug 2012 (or roughly 14 months into early science).

Software Progress:

There is now a usable release of the CASA software package that has been successfully used in a recent software workshop in Garching, along with a very long cookbook. The Observing Tool is in a less usable format, but is available nonetheless.

ALMA Logistics:

There have been some initial decisions made regarding the observing and proposal process. The review and ranking of proposals will be done by a single

international superTAC without political considerations, and time will be charged entirely to the PI partner. Some oversight and reorganization may be required at the end of the process to ensure time is being allocated among the partners in the appropriate proportions, but the method by which this will happen is not yet clear. Nor is it clear how overlaps and conflicts will be handled.

Canadian Efforts and Involvement:

Canada is hosting an ALMA users workshop at the beginning of June that will bring together many international ALMA experts. This is intended for all levels, though most of the registrants are graduate students. The focus is end-to-end instruction on ALMA observing, including some basics of interferometry, using the ALMA Observing Tool and data reduction with CASA. As material for the conference Dough Johnstone and James DiFrancesco (and others) have put together an ALMA primer document that has since been adopted by the larger US/Canada ALMA community.

D) EVLA -- Sean Dougherty

NRC HIA-Penticton are designing and building the correlator for the upgrade to both the Very Large Array and MERLIN, using the NRC-patented WIDAR technique developed at HIA-Penticton for efficient correlation of broadband signals. This ~$20M CDN project will give the EVLA unprecedented capability for radio wavelength spectroscopy with a minimum of 16,000 spectral channels per observing band (up to 8 GHz in each of two polarizations). This will invigorate astrophysical research using radio spectroscopy, provide synergetic capability with ALMA, and its spectral dynamic range provides a ready means to deal with powerful narrow-band radio frequency interference that is increasingly prevalent today.

The EVLA project has had an excellent year, passing many milestones as the project transitions from prototyping to full production:

- 12000 custom-designed ASIC correlator chips were successfully produced and passed a series of industry-standard test to determine failure rates/modes and determine expected lifetime.
- All the correlator infrastructure was installed successfully at the VLA site in August 2008
- A proto-type correlator was deployed in July 2008, and first fringes were obtained August 7th. This correlator was used for Critical on-the-sky testing that were completed in late November 2008
- The Critical Design Review was held on Dec 2-3, 2008. The review was passed successfully though with two recommendations for further work prior to release of the designs for full production (see below).
- Station board was released for full production January 23rd, 2009
- First production station boards arrived in Penticton April 20th, 2009

- First eMERLIN fringes were attained on April 24th, 2009

Aside from first fringes, the Critical Design Review of the correlator hardware was the significant milestone for the EVLA in the past 12 months. The CDR committee of Roger Capello (MIT, chair), Dave Hawkins (Caltech), with Barry Clark and Mike Revnell (NRAO) met in Socorro, Dec 2-3, 2008 to review the complex hardware design and the subsequent proto-type tests before a commitment to full production. This committee was highly qualified, very thorough and ultimately helpful to the WIDAR team beyond their mandate. They produced two reports – a formal summary of their recommendations that were sent to the Director General directly and a detailed in-formal supplement of comments as an aid for the engineers.

They were “impressed by the design, the magnitude of the engineering effort encompassing that design, and the high level of technical competence shown by the design team. Also significant was the thought given to issues of manufacturability, reliability, and long-term maintainability”. The two major conclusions they reached were that it would be prudent to test more prototype baseline boards prior to production, and to fully understand station board power supply failure modes prior to production. The station board issue was addressed by the engineers over Christmas and the boards released for production on January 23rd, 2009. A batch of eight baseline boards are currently being produced (delivery target April 27th, 2009) for testing prior to full production release (target date May 25th, 2009)

Over the next 7 months, production hardware is scheduled to arrive at DRAO at a rate of 12 boards per week. Final assembly will then be done at DRAO before shipping to Socorro. Over the past year, we have enhanced and maintained consultations with the EVLA project management team at NRAO. This has enabled a transition plan to be drawn up that sets clear and very reasonable staged goals for hardware delivery that sees all hardware delivered to Socorro by December 2009.

With hardware moving into production, the focus of the project has moved to software. The goal is to have a beta version of the software control of WIDAR available by June 2009 that will provide, in a robust and user friendly manner, the capability of the old VLA correlator, scheduled to be turned off in January 2010.

The complexity of the hardware and the concomitant technical risk has been addressed through three stages of hardware proto-typing and rigorous testing. This approach has mitigated the technical risk but a consequence has been schedule slip. With all production hardware and parts purchased in USD, the project is exposed to currency fluctuations. This has been notable in the past year with a ~25% decrease in the value of CDN vs USD. However, on a positive note the major parts purchases (~$3M CDN) were made in FY 07-08 when the CDN dollar was at its highest value.

E) SKA -- Sean Dougherty

International Developments

The international SKA program has entered a design phase leading up to a proposed start of construction of the phase-1 SKA around 2014. Funded SKA design programs in Australia, Canada, Europe, US, and South Africa underpin his activity for the next five-years. Including:

1) the SKA Preparatory Phase Program (PrepSKA) funded by the European Commission under FP7 and several EU funding agencies,

2) the US SKA Technology Development Program (TDP) funded by the NSF,

3) the Canadian SKA program, and

4) the design and construction of SKA precursor telescopes at the two proposed SKA sites in Australia and South Africa.

The timeline for the SKA project leads to completion of the SKA operating at frequencies from a few 100 MHz to 10 GHz (so-called mid-frequencies) by 2020. Between 2008 and 2012, approximately $300M will be spent internationally on the design and prototyping of the SKA, including site development in Australia and South Africa and the construction of the SKA precursor telescopes. These are 1% SKA-scale telescopes based on the SKA reference design. They will prototype and demonstrate SKA technology and path-find survey projects for key-SKA science when they become operation post-2012.

PrepSKA is the umbrella program that coordinates the international R&D activity, with an outcome by 2013 of a costed design for the phase-I SKA and an implementation plan for the SKA operating at mid-frequencies. Phase-I SKA will be a build-out of an SKA precursor telescope on the selected site. A site selection decision is hoped for in 2011/12.

The international consortium developing the SKA involves over 50 institutes in 19 countries. For this final design phase, the governance and oversight of the program has been restructured through a new set of international agreements for the duration of PrepSKA. These agreements establish the following bodies:

1) The international SKA Science and Engineering Steering Committee (SSEC). The SSEC provides scientific and engineering oversight to the project from the international consortium. Canada has two members on the SSEC (Sean Dougherty, NRC-HIA and Russ Taylor, U. Calgary).

2) The PrepSKA Board that directs the PrepSKA program. The PrepSKA

Board has 20 members with 2 members from Canada (Dougherty and Taylor).

3) An SKA Program Development Office (SPDO) funded by the PrepSKA program funds from the European Commission and by a common fund of defined contributions from the international partners. The SPDO hosts the Central Development Team charged with coordinating the international engineering design activity toward a final SKA design.

4) Region Program Development Offices (RPDOs) that are the liaison between the SPDO and regional development efforts.

5) A funding Agency SKA Group consisting of funding agency representatives. Greg Fahlman, NRC-HIA, represents Canada on the Agency SKA Group.

The Preparatory Phase Program for the SKA was officially launched in April 2008 and meetings of both the PrepSKA Board and the SSEC took place as part of a series of SKA meetings in Australia (April 2008) and South Africa (February 2009). The next meetings are in Manchester in October 2009.

Canadian SKA Program Update

The Canadian SKA program plan for 2008- 2012 was reviewed and presented to the ACURA Board of Management at its meeting of 23 January 2008. The goals of the program are to participate in international planning for the SKA, meet the Canadian commitment to the international SKA design effort within the PrepSKA program, and the US TDP, demonstrate Canadian technology on the ASKAP SKA pathfinder, and provide Canadian scientists with access and leadership in the design and execution of SKA key science with ASKAP. It is proposed to fund the Canadian program through a combination of allocations of LRP funds to the NRC and NSERC funding for the university-based SKA design activity.

NSERC Special Research Opportunity Proposal

The Canadian SKA Consortium submitted a proposal to the NSERC Special Research Opportunity program on December 5, 2008 requesting $1.25M from NSERC as part of a $2.4 M cash program ($3.1 M including in-kind) to support the University component of the Canadian SKA design activity under the PrepSKA, our collaboration with the US TDP (under PrepSKA), and collaboration with Australia in ASKAP. NSERC notified the consortium in March 2009 that they have been awarded the full request. The funds support four projects in University groups. Including:

1) Simulation, calibration and processing for focal-plane array (FPA) receiver systems to develop methods and design requirements for high-dynamic range, wide-field, broad-band, polarimetric imaging with FPA systems (Calgary).

2) Design and prototype of low-noise room temperature amplifiers and fast, low-power A/D systems for receiver chain for FPA and other array systems (Calgary).

3) Adapt space-time digital filtering technology to digital beam forming and RF mitigation for FPA systems (Calgary, Victoria).

4) Pulsar survey science and data processing hardware design (UBC and McGill).

These projects complement the SKA design activity at NRC-HIA and in many cases are in collaboration with HIA.

Memorandum with CSIRO on the Australia SKA Pathfinder (ASKAP)

The original Memorandum of Agreement between CSIRO and the NRC on the Australia SKA Pathfinder expired in 2008. The Canadian Consortium has developed a new MoU that details an agreement on collaboration between Canada and Australia on SKA technology for ASKAP and the participation by Canadian scientists in the policy development, planning and execution of the ASKAP key science program. This MoU is based on the agreed set of collaboration principles approved by the Canadian SKA Board in May 2008 and reviewed by ACURA at its June 2008 meeting. This MoU was recently signed by NRC and is now being considered by the other signatories (University of Calgary and CSIRO).

Canadian Science Activities

A science case document has been developed by a joint Canadian-Australia team and has been accepted for publication as a special issue of Experimental Astronomy. Thanks to Jasper Wall (UBC) for a tremendous editorial effort. The on-line version was published by Springer in October 2008 (http://www.springerlink.com/content/e469g6h408xg17w6/). The paper version appears is Volume 22, Number 3.

A call for expressions of intent for an initial set of survey science projects for ASKAP was released in 2008 with a deadline of December 15, 2008. Canadian scientists collaborated on several proposals for HI, continuum and transient science. A Canadian scientist (Stairs) is the principal investigator on successful letters of intent and several others are co-applicants on proposals. The Expressions of Interest underwent technical evaluations in January, and those that passed were invited to move forward to the full proposal stage. Some merging of similar projects is happening during this process. A meeting was held at Curtin University (Perth) in April to discuss technical requirements for projects that will want to use fast-sampling modes on ASKAP; these projects will have to

address slightly different technical questions in their proposals. The proposals, due June 15th, are for Survey Science; successful proposals will enter a "design study" phase in which they will work with the ASKAP staff to finalize and implement the hardware and software configurations needed as well as gather test results from the BETA test array. Time allocation for ASKAP surveys will proceed only after this design phase, in 2012.

Reference science missions are being developed for the SKA as part of defining the technical specifications for the SKA. The University of Calgary team has lead responsibility for the deep polarization reference science plan, and Canadian scientists are contributors to several science chapters.

A special session on the SKA was organized for the USRI ANTEM meeting in Banff in February 2009. Invited presentations were given by Ingrid Stairs (UBC), Jeroen Stil (Calgary). Engineers from six SKA consortium institutes (ASTRON, SPDO, Cornell, Manchester, NRAO, Brigham Young) visited the micro-electronic laboratory in Calgary.

Canadian SKA Technology R&D

Composite Applications to Radio Telescopes (CART)

The CART project had a major milestone in 2008 with the successful completion of the Mark 2 version reflector and its deployment on the test mount at DRAO. Laser ranging measurements reveal a superb surface, with a 0.51 mm rms from a best-fit parabola – good for efficient 30-GHz operation. The Mk2 reflector has none of the large-scale deviations present in the Mk1 prototype as a result of changes in the manufacturing process.

The Mk2 is a great success, with significant advancements in design and production of high-performance cost-effective composite radio reflectors and represents a significant aspect of Canada’s PrepSKA contribution. NRC-HIA are active collaborators in the US TDP Antenna Working Group, working on a number of cost-effective, high-performance antenna solution for PrepSKA.

Focal Plane Phased Array Systems

The Phased-Array Feed Demonstrator (PHAD) at HIA-DRAO is mounted on the 10-m CART Mk2 dish for on-the-sky testing using satellite and astronomical sources. Initial tests have been done with 84 receiver elements, the largest active array in operation on a radio telescope. This is a dual polarization array, and the first dual-polarization observations attained with a FPA have been obtained. These show excellent system stability from element-to-element and also in time, suggesting that high quality, full polarization observations with FPA’s will be possible.

Focal Plane Array simulations

Tony Willis, Bruce Veidt and Andrew Gray of NRC-HIA have been simulating astronomical observations made with focal plane arrays (FPA) mounted at the focal point of a 10-m dish and operating at a frequency of 1500 MHz. This is an excellent test-bed for examining the behavior of an FPA from the viewpoint of reducing data obtained with an aperture synthesis radio telescope to attain high dynamic range imaging, as required by the SKA. This work has concentrated on comparing different beam forming schemes and calibration techniques. This work is being described in a series of SKA memos.

Room temperature Low-Noise Amplifiers

The group in the Electrical Engineering department at the University of Calgary (Leo Belostotski and Jim Haslett) have established a world-wide reputation with the excellent performance of their 90nm room temperature LNA designs, with noise temperatures better than 14K between 0.8 to 1.5 GHz. Designs for room-temperature LNAs in 65nm CMOS to operate between 700 and 1400MHz have been completed (Fig. 4). Uncertainties in CMOS MOSFET noise models demand careful noise measurements. This has been a major challenge over the past year, and the group has developed their own noise-measurement system that is now being used by other groups around the world.

Multi-dimensional Signal Processing.

The Multidimensional Signal Processing Group at the University of Calgary, led by Dr. Len Bruton, and the Digital Signal Processing Group at the University of Victoria, led by Dr. Pan Agathoklis have been investigating applications of high-performance IIR and FIR space-time multidimensional filters for enhanced radio astronomy signal detection. There are three main projects. The first involves the design, synthesis and poly-phase FPGA implementation of 3D FIR cone filters for selectively filtering both focal-plane array and aperture phased array space-time signals. The second project is an investigation of 3D IIR cone-type filters having hexagonal cross-sections and their implementation using FPGA circuits. The third project is a theoretical study of the 3D spectral characteristics of noise coupling, signal distortion and other interfering signals on focal plane arrays. Novel techniques for attenuating such signals are under investigation.

F) Radio astronomy support news – Ingrid Stairs

Two community-support proposals have been submitted in recent weeks. A Letter of Intent to submit an NSERC Major Resources Support grant proposal was led by Vicky Kaspi of McGill University, requesting support for Canadian usage of the Arecibo Observatory. A second proposal, to the Canarie Network-Enabled-Platforms-2 program, was led by Russ Taylor of the University of Calgary, requesting infrastructure to support Canadian radio survey operations,

at Arecibo for the time being but with an eye toward preparing for ASKAP and the SKA.

G) Education/Outreach -- Gil Holder

Discussions are ongoing as to various methods to raise the profile of radio astronomy, but the main priority of outreach these days is clearly within the broader context of IYA.

The website has its "permanent" home on the CASCA committee page: http://www.casca.ca/Links/Committee_Home_Pages/RAC/Web/. It is clearly a bit dated and could use some freshening. Some issues and questions have been discussed. For example:

Should we have an EPO component of the RAC, given the strong commitment to EPO already present within other CASCA communities?

What is the main purpose of the website: is it for the RAC, for CASCA members, for the public, or something for everyone? Defining a primary purpose will help a lot in updating it.