Issue 02_Spring 2006

Coalition for Canadian Astronomy Newsletter

Building on Canada's Excellence in Astronomy:

House of Commons Standing Committee on Finance – 2005 Pre-Budget Hearings

On Thursday, October 27, 2005 the Coalition for Canadian Astronomy presented "Building on Canada's Excellence in Astronomy" to the House of Commons Standing Committee on Finance. Coalition co-chairs Michael Jolliffe and Gretchen Harris gave the presentation together.

"Canada ranks as a world leader in astronomy and our accomplishments have even been recently noted in the New York Times," begins Jolliffe. "That success would not have been possible without the Federal Government's initial investments of $35.9 million in the 2001 Budget and $20 million in the 2003 Budget."

These investments represent one third of the resources required to successfully launch the Long Range Plan (LRP) for Canadian Astronomy. This is why Jolliffe and Harris, on behalf of the Coalition, came forward to ask the Federal Government to fund the remainder of the plan.

The Coalition for Canadian Astronomy focuses all of Canada's astronomy stakeholders' goals and expertise. "By focusing our efforts, we made it easier for Government to do the same," states Harris.

Coordination and focus is the reason behind Canada's success in astronomy. Canadians now have access to the world's leading astronomy projects, providing unparalleled research opportunities. A crucial element for the Canadian economy, as it keeps our best and brightest here at home. New astronomy departments have been created at several universities and enrollment is booming. Lastly, the economy has benefited from a two-to-one direct return on every dollar invested in astronomy so far. The indirect return is estimated to be as high as ten-to-one – since there are so many spin-offs in the astronomy market.

"It is because of these successes that the Federal Government should continue its investments in astronomy," states Jolliffe.

"We are contributing to Canada's productivity performance through new jobs, new technologies, skills development and innovation. Not only that, we are furthering our scientific understanding and offering opportunities for young Canadians to be the best in their fields right here at home," he adds.

To walk away – without re-investing – would be a waste. The initial investments would be lost and Canada's partnerships in the international projects would be threatened.

Canada is poised to maintain its world leadership position in astronomy, and to reap its benefits, so long as the Federal Government continues to invest in astronomy research through the LRP.

Jolliffe's parting thought: "Canadian astronomy is, quite literally, the size of the universe. We urge you to support these initiatives. You past support has kept us in the game. Your future support will ensure when the world looks into the universe, they'll see it through Canadian eyes."

"Canadian astronomers are stirring up cosmic dust" Macleans

Coalition co-chairs Michael Jolliffe and Gretchen Harris

LRP UPDATE

The Long Range Plan (LRP) is a comprehensive, national strategy designed to maintain and expand Canada's leading position in the areas of astronomical and astrophysical research. Since 2000, the Coalition for Canadian Astronomy secured $88.8 million for the goals and objectives outlined in the LRP.

The funding has led to increased Canadian involvement on international astronomy projects, economic advantages for related Canadian industry and improvements to our education system – resulting in Canada's number one rank in astronomy worldwide.

In order for Canada to maintain this ranking – additional funding is required to continue the efforts of the LRP. The plan requires a total of $235.7 million for these areas: world facilities, education and outreach, computing, people and other moderate projects. World facilities include ALMA, TMT and SKA observatories. Without this additional funding, Canada's previous investments in the LRP will be lost. Canada will be impacted at both the scientific and economic level – as Canadians would be replaced as a partner on significant international projects.

"We invest in facilities and projects that build upon our existing strengths and then focus most of our research on the big scientific questions of our time." Greg Fahlman, director general of the Herzberg Institute of Astrophysics in Ottawa

SKA UPDATE

The international radio telescope for the 21st Century, The Square Kilometre Array (SKA), will probe the gaseous component of the early Universe. With its million square metres of radio-wave collecting area, SKA is 50 times more sensitive and 10,000 times faster, than any imaging radio telescope array ever built. SKA will be used extensively in planetary studies.

Last year, the Canadian SKA Consortium was established. The consortium is a partnership between the National Research Council (NRC), the Association of Canadian Universities for Research in Astronomy (ACURA), and three industrial partners. Currently, the Canadian SKA Consortium is working with the Coalition for Canadian Astronomy to secure funds for the SKA technology development as part of the Long Range Plan for Astronomy.

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THE GIST OF THE JWST

The study of astronomy is a process that builds on its previous discoveries. To date, astronomers have made astounding discoveries, expanded our knowledge of the universe and increased our view beyond what the human eye can see. Consequently, our knowledge of how the cosmos was created has increased significantly in the last 50 years. But, concerning the history of our universe, many questions continue to remain unanswered.

And so, Canadian astronomers, alongside NASA and the European Space Agency, are creating the James Webb Space Telescope (JWST) to get a closer look into the beginning of time. JWST is a large, infrared orbiting telescope, able to focus into a time when galaxies and stars were younger.

From our current vantage point, these earliest stars and galaxies are undetectable with the world's existing observatories. These faraway stars have a longer wavelength or red-shift, making them much harder to see. To get a better view, JWST will use infrared technology to peer into the dusty corners of the universe and observe the formation of stars, galaxies and planets.

Canada will provide the guiding camera to hold the telescope. With a sensitivity level of one millionth of a degree, this camera will enable the instruments to observe with the required precision. The Canadian hardware contains a tunable narrow band imaging instrument that provides a unique and powerful science capability to JWST.

JWST's mirror is large, at 6.5 meters across, and light-weight, as it is made out of beryllium. Never before has a telescope of this size been launched into space. The mirror will fold up to fit into the rocket, only to unfold in outer space. The proposed launch date for the observatory is June 2013 and the mission is expected to last from five to ten years.

Photo courtesy of John Hutchings, NRC

WHAT THE LRP MEANS TO QUEBEC

Astronomy skyrocketed in Quebec with the establishment of the Mont Méganitc Observatory in 1978. In just two short years, the number of astronomers grew from two to 18. Similarly, with the implementation of the Long Range Plan (LRP) in 2000, the number of astronomers province-wide has continued to soar.

Today, Quebec houses a large population of Canada's astronomers, both amateur and professional. Quebec's professional astronomers make notable efforts to fully engage with their amateur counterparts. And it shows – there are over 3,000 amateur astronomers in Quebec, compared to 5,000 in the rest of Canada. Also, 20 per cent of Canada's CASCA members and 35 per cent of its student members reside in Quebec.

Four of Québec's top universities are involved in astronomy: Bishop's, McGill, Université Laval and Université de Montréal. The four have joined the Association of Canadian Universities for Research in Astronomy (ACURA), an association of 23 universities that works to highlight the priority of astronomy in the academic plans for Canada's research intensive universities.

Federal government investments in the LRP have had a profound impact on Quebec's universities. Quebec has one of the fastest rates of growth in Canada in attracting graduate students, hiring new professors and developing astronomy programs and departments. The number of graduate students and post-doctoral fellowships has doubled and five new professors have been hired. Nine of the 23 Canada Research Chairs are established in Quebec.

Funding of LRP projects has also had a profound impact on Québec's economy and reputation abroad. Companies, like INO and TeraXion, have reaped the benefits. Sainte-Foy's INO will study the development of the advanced, super-durable coatings needed for the Thirty-Metre Telescope mirrors. INO is also participating in the conceptual design for

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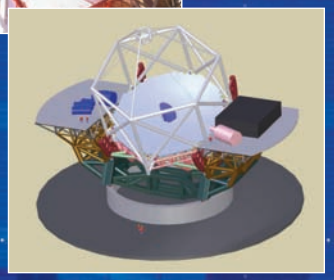
Site proposals for SKA's location were submitted at the end of 2005 by Australia, China, Argentina and South Africa. Later this year, the International SKA Steering Committee will select a site based on land availability, affordability, radio quietness, infrastructure development, and atmospheric conditions. Basically, whichever location can offer a site where there is the ability to do the best science at an affordable cost.

TMT UPDATE

Canadians are proud partners in the development of the world's next largest telescope – the Thirty-Metre Telescope (TMT). TMT will consist of 700 hexagonal-shaped mirror segments that stretch a total of 30 meters in diameter, making it three times larger than any existing observatory worldwide. With its large surface area, TMT will provide greater resolution and finer detail in galaxies far, far away.

Recent rapid developments in the project require additional funding. Canadians have now taken on a larger role in TMT's development, but we need $125 million for the 2005-2011 funding period to maintain our significant position.

TMT is currently surveying site prospects in Northern Chile, Northern Mexico and on top Mauna Kea in Hawaii. TMT is conducting an unbiased, science-based survey on all potential sites. To determine the location, testing is underway to provide information about clouds, water vapour, winds and atmospheric turbulence.



"The World's largest telescope: ambitious project made in Canada. If Canada is to have a future in astronomy, it's through projects like the Thirty-Metre Telescope." The Hill Times

ASTRONOMY: BENEFITS TO INDUSTRY

TeraXion: Canadian high-precision laser technologies for the Atacama Large Millimeter Array (ALMA)

BY: JEAN-FRANÇOIS CLICHE AND MICHEL TÊTU

DiCOS Technologies - now part of TeraXion - was founded in 2000 as a spin-off of the Center for Optics, Photonics and Lasers (COPL) from Université Laval in Québec City. DiCOS was created to offer unique technical and scientific expertise in highly accurate laser frequency control and metrology. Since 2003, DiCOS has been awarded contracts to design and deliver high performance laser sources for the Atacama Large Millimeter Array (ALMA) radiotelescope. The development of the unique laser technologies required for such an ambitious astronomy project proved to be instrumental in the technological and commercial growth of the company.

ALMA is an international radio astronomical facility currently under construction in Chile. When completed, the facility – an array of up to 50, 12-meter parabolic antennae spread over 25 kilometers – will detect millimeter and sub-millimeter wavelength radio waves. At these wavelengths, the radiotelescope array will be able to reveal the structure of the cold regions of the universe with unprecedented sensitivity and resolution.

ALMA's exceptional resolution and sensitivity is due to its 50 antennae that are connected to an interferometer array. Basically, an interferometer array monitors the exact instant a signal arrives at each antenna and uses this information to determine the direction of the radio signal. All 50 antennae must receive the same low-noise microwave reference signal to make an accurate measurement. A problem is that the transmission link, over which this reference signal is transmitted, may change in length due to thermal expansion. To cope with this problem, ALMA uses a Master Laser to apply a unique interferometric Line Length Correction System, which controls the movement or expansion of the transmission line.

The Master Laser must have a long coherence length and high frequency stability while adapting to all variables. Not to mention, these lasers must operate in remote, high-altitude environments while maintaining their reliability and accuracy.

At first, lasers meeting these requirements were not available commercially. In 2003, the National Radio Astronomy Observatory (NRAO) awarded the first contract to DiCOS to develop these lasers.

In the following months, DiCOS designed, developed and delivered two prototypes of a Master Laser that meets the ALMA aggressive requirements. In addition to its long coherence length and high frequency stability, the laser features automatic operation, self-monitoring, and computer remote-control.

Such development contracts are very significant for an early start-up company, like DiCOS. The technologies, expertise and tools developed for ALMA were applied to custom products in other fields such as aerospace and laser sensing. It also allowed for the continued growth and international recognition DiCOS received.

In March 2005, TeraXion, a manufacturer of optical filters based on in-fiber Bragg gratings technology for high-speed communication networks and industrial applications, acquired DiCOS Technologies to expand the products and services offering, and to address new photonic markets.

TeraXion is now pursuing the development of subsystems for ALMA. The pair of Master and Slave Laser prototypes is one example currently being used at the ALMA test site in Socorro, New Mexico. TeraXion is actively involved in ALMA's technical activities to ensure success of the tests. Plans are in progress to provide the highly integrated and reliable System-Ready Master Laser and Slave Laser units to be installed in the final array in Chile.

Astronomy projects, such as ALMA, involve a staggering amount of technologies, many of which are not available at the time of conceptual design, but need to be developed and produced. This story of DiCOS/TeraXion is one example where Canadian high tech companies can grow by contributing to these developments and pushing the limits of the technology.

Figure 1: Artist's rendition of the Atacama Large Millimeter Array (ALMA) radio telescope. Image courtesy of NRAO/AUI.

ALMA UPDATE

Located in Chile, the Atacama Large Millimeter Array (ALMA) is designed to detect and study the earliest, most distant galaxies – while taking a closer look into star and planet formation. ALMA is a synthesis radio telescope that operates at millimeter and submillimeter wavelengths using its 50 12-meter antennas.

Canada's largest contribution to ALMA's construction is the design, development, and construction of the "Band 3" receiver cartridges. On a radio telescope, the receivers detect the radio waves collected by the telescope and convert the incoming signal to frequencies below a few GHz to make it easier to amplify, process, and transmit the information.

The Band 3 cartridges were designed and developed by the Herzberg Institute of Astrophysics (HIA) of the National Research Council. Tests show that the Band 3 receiver cartridges meet ALMA's demanding sensitivity specifications. ALMA requires eight complete cartridges for the initial phase. Ultimately, all of the ALMA antennas must be equipped with these cartridges.

HIA is working hard to involve Canadian industry as much as possible in the construction of the initial eight receivers to prepare for a larger industrial role in the main production contract.

"CANADA IS A PLANETARY LEADER WHEN IT COMES TO ASTRONOMY"

International Academic Rating Agency (CBC News)

COALITION FOR CANADIAN ASTRONOMY
190 O'Connor Street, 5th floor
Ottawa, Ontario
K2P 2R3

The Coalition for Canadian Astronomy, formed in 2000, was created to secure new money from the Federal Government to fund the LRP for Astronomy and Astrophysics.

Made up of academics, astronomers – both amateur and professional – universities and various industry members; the Coalition is an umbrella-like organization that encompasses all of Canada's major players in astronomy.

Edited by Lucy Meffe

SPOTLIGHT ON THE UNIVERSITY OF LETHBRIDGE

ACURA member, University of Lethbridge in Alberta, is a proud partner in the Thirty-Metre Telescope (TMT). TMT's potential sites are undergoing various unbiased, science-based surveys to determine the best possible location. The possible sites, located in Chile, Mexico and USA, are all equipped with an array of instrumentation that will measure different atmospheric parameters in the area.

An important atmospheric parameter, yet the most difficult to measure, is the amount of water vapour in the air. Only a handful of instruments worldwide have the technology necessary to provide these water vapour measurements. The University of Lethbridge provided TMT with the equipment, otherwise known as Infrared Radiometer for Millimeter Astronomy (IRMA) water vapour radiometers.

Under the leadership of Professor David Naylor, the Astronomical Instrumentation Group (AIG) at the University of Lethbridge produced these unique instruments – which are now in operation for the world's largest optical telescope. The IRMA instruments are unusual, as the method used for measuring water vapour is through the atmosphere's infrared emission.

IRMA is about the size of a shoe box – it is a light weight, compact, reliable system with low power requirements; making it ideal for testing sites.

In February, the new IRMA units were tested alongside the European Southern Observatory – VLT, to confirm that all units operate correctly. By March, the units traveled to various areas in Chile, to test the atmosphere in order to determine the appropriate location in that specific region. Here, the units will remain, testing for the area with the lowest preciptable water vapour. The location will be determined late in 2007.

The IRMA project is an excellent example of how research at a relatively small Canadian university can be carefully focused in specialist areas.

The new IRMA units testing the atmosphere in Chile. Photos courtesy of Robin Phillips, University of Lethbridge.

ACURA

The Association of Canadian Universities for Research in Astronomy (ACURA) is an organization made up of 23 Canadian universities dedicated to the advancement of research and teaching in astronomy and astrophysics in Canada. It assists in coordinating large-scale national initiatives of its member institutions, advocates for the priorities of the LRP for astronomy, and is a liaison between Canadian member universities and international partners in international and world observatories.

WHAT THE LRP MEANS TO QUEBEC

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an extreme adaptive optics return. TeraXion, in Quebec City, will provide the Master Laser System for ALMA. Many jobs have been created through the design, construction and operation of astronomical facilities and instruments.

Astronomy research has also generated incredible spin-offs businesses in Quebec. Students collaborating with Mégantic Observatory started a small company, Matrox, to produce electronic cards for storing images. Now this company is a world leader in video cards. A digital movie producer in Montréal developed his first product on the Université de Montréal system for astronomical images display. His company, Softimage, has grown into an industry leader in computer visualization and video production.

Québec scientists, engineers, universities and industry members wish to be fully involved in the exciting LRP projects. Collectively, they see the LRP as a crucial aspect in maintaining the current renewed expansion of astronomy in Quebec, along with all the benefits that flow from it.