ALBERTA SPACE PROGRAM – BOUNDLESS OPPORTUNITY

Alberta is a national leader in space sciences – and that leadership starts at our universities. The Universities of Alberta, Calgary and Lethbridge are building unrivaled expertise in space instrumentation, physics, materials, imaging and more.

Partnerships with Alberta's Universities will be key to leading future Alberta space innovation in the decades to come. For example, the Institute for Space Imaging Science (ISIS), a joint initiative of the Universities of Calgary, Lethbridge, and Athabasca, employs space imaging technologies to better understand all aspects of space, from the near-Earth environment and space weather to the edge of the observable universe and the origins of the universe itself. At the University of Alberta, the Institute for Space Science, Exploration and Technology (ISSET) explores emerging and cross-disciplinary opportunities in space science and engineering. ISSET focuses on innovation in space physics and space weather, in space exploration, microgravity and planetary materials science, satellite-based Earth observation, and in space technology for instrumentation and robotics. Excellent synergies exist between ISIS and ISSET, current and expanding partnerships delivering pan-Albertan leadership in the global space endeavour.

Further diversification into aerospace is important for Alberta. As an industry sector, it is environmentally conscious and employs highly skilled workers. It also shares many of the same technologies used in other growing industry clusters in Alberta, including information and communication technology, advanced materials and nanotechnology.

Alberta is currently involved in many important aerospace initiatives that are attracting international attention and investment. Examples range from satellite missions poised to gather ground-breaking data to new infrared image technology and powerful radar systems. These projects, outlined in detail in this folder, are summarized below:

TeraHertz (THz) Instrumentation

Alberta scientists are foremost developers of exciting new astronomy instrumentation technologies that have broad relevance in medical, cosmetic and defence industries, including cancer detection.

Enhanced Polar Outflow Probe (e-POP)

Alberta is heading up development of e-POP, an innovative satellite devoted to the study of space weather in Earth's upper atmosphere. The mission features several firsts, including the first University-developed space science instruments on a Canadian satellite.

CEFIs & Swarm

Canadian Electric Field Instruments (CEFIs) are key components of the European Space Agency's upcoming Swarm mission, which will provide an unsurpassed survey of Earth's geomagnetic field and temporal evolution.

Resolute Bay Incoherent Scatter Radar

Alberta scientists are leading an international team in developing the second face of Resolute Bay ISR, a world-class physics observatory in Canada's arctic that will answer many questions related to the polar cap's relationship to Earth and space.

The Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS)

This Canadian Space Agency (CSA) proposed mission would study space weather and provide a better understanding of how to mitigate space radiation effects on satellite systems.

Phoenix Mission to Mars

The Phoenix Mars Lander Mission was a joint NASA/CSA mission to the North Polar Region of Mars probing water and geology on Mars. It led to the discovery of water, ice and snow fall in the Martian atmosphere.

Earth Observation

Spectral and hyper-spectral imaging from satellites and autonomous vehicles, combined with advanced imaging analysis tools can be used to address issues of resource management and exploitation, and to examine the impacts of climate change.

Iunctus Geomatics Corp

Iunctus is a case study in bridging the gap between different industry sectors and fostering international industrial and governmental partnerships to solve the challenges of today's Aerospace and Information and Communication Technology industries.

Motive Industries

Motive is an Alberta based full vehicle development firm focused on advanced materials, technology and innovations to create real world transportation solutions. Motive is involved in aerospace level design engineering programs including the SKA Radio Telescope project.

TERAHERTZ INSTRUMENTATION

Alberta is a leader in the development of state-of-the-art TeraHertz (THz) astronomical instrumentation, also known as far infrared technology. The rapid development of imaging detector arrays, commonly found in digital cameras, has continued at wavelengths beyond the limit of human vision. Combining a THz detector array with innovative spectrometer designs opens up hyperspectral imaging, a third, spectral dimension in imaging applications. Hyperspectral imaging provides far greater information in infrared images, similar to the difference between a colour and monochrome photograph. This will revolutionize spectroscopic applications.

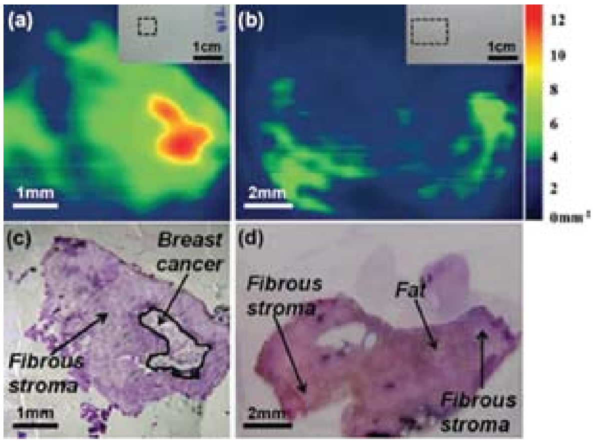
THz astronomical instrumentation is relevant to many industries beyond astronomy, including medical, cosmetic, security and defense applications. The so called "terahertz gap" encompasses frequencies from ~0.3 THz to ~10 THz in the electromagnetic spectrum, lying between microwave and infrared. Unlike X-ray radiation, THz radiation is intrinsically safe, non-destructive and non-invasive. Many modern technological developments in the industries mentioned can be traced directly to research being conducted in astronomical instrumentation laboratories.

The Institute of Space Imaging Science at the University of Lethbridge is working with researchers at the University of Calgary's medical faculty to explore the diagnostic power of the THz. It has recently been reported (Chiu et al Optics Letters 34, 1084-86 (2009)) that breast cancer can be detected using a THz near-field microscope. The top left panel in the figure below, taken from Chiu et al's paper, shows the cancerous area determined from THz microscopy. The bottom left panel shows the same sample after it had undergone time consuming pathological staining and testing – the current gold standard.

The distribution of breast cancer identified in the THz near-field image clearly matches well with the pathologic examination. The authors conclude that with further developments, a THz near-field imaging system would be a valuable tool for surgeons to aid in the detection and diagnosis of breast cancer tissues. Those further developments have already occurred; single detectors currently being used in ISIS laboratories are over 100,000 times more sensitive than the one used in Chui's work. Moreover, ISIS uses arrays of detectors, not just one. This increased sensitivity, which is equivalent to a factor of a -10 billion increase in speed, should lead to real time scanning of potentially cancerous tissue, removing the need for pathological staining and examination by a trained technician.

THz imaging spectroscopy is also set to play an important role in dermatology. The cosmetic appearance of skin is directly linked to the water content of its outermost layer – the stratum corneum. The role of skin-care products like moisturizers is to increase this retained water content, improving permeabililty and elasticity. THz imaging's ability to quantitatively measure the water content of the stratum corneum holds great promise for the lucrative cosmetics industry.

ISIS is leading the development of THz applications with collaborators in medical imaging at the University of Calgary's Faculty of Medicine, and industrial partners Blue Sky Spectroscopy, Lethbridge, Alberta and QMC Instruments, Cardiff, UK. It is clear that the THz industry, as a whole, is on the verge of significant growth. Whether it will be its applications in medicine, security or pharmaceuticals that take off first is hard to predict, but once THz technology has a toehold in one market, it is likely to spread rapidly to others.



ENHANCED POLAR OUTFLOW PROBE

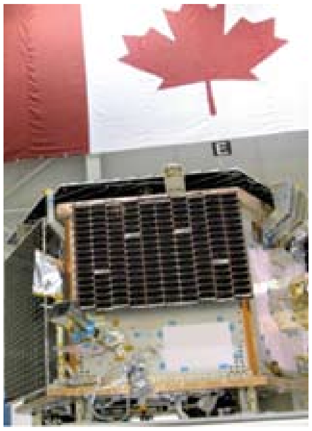
The Institute of Space Imaging Science at the University of Calgary (U of C) is leading the development and operation of Enhanced Polar Outflow Probe (e-POP), an innovative scientific satellite devoted to the research of space weather in the Earth's upper atmosphere. Part of the multi-purpose Canadian CASSIOPE small satellite mission, it is funded by the Canadian Space Agency (CSA) and the Natural Sciences and Engineering Research Council (NSERC).

The e-POP is scheduled for launch into a polar-orbiting low-Earth orbit in late 2011 / early 2012. It will carry a suite of eight state-of-the-art scientific instruments, including imaging plasma and neutral particle sensors, magnetometers, dual-frequency GPS receivers, CCD cameras, a radio wave receiver and a beacon transmitter. The e-POP instruments are designed for measurements at unprecedented (10 to 100 times the current) levels of resolution and details, to study plasma outflow (transport), radio wave propagation and neutral atmospheric escape. The U of C is leading the development of three of the six Canadian instruments and is supporting the development of the other three.

The e-POP mission will feature several firsts:

- The first scientific small satellite mission led by a Canadian university;
- The first Canadian multi-purpose satellite mission (CASSIOPE);
- The first Canadian-developed (designed and built) small satellite bus;
- The first University-developed (designed, built, tested and operated) space science instruments on a satellite in Canada;
- The first demonstration of the Cascade advanced communications technology;
- The first low-cost Global Positioning System (GPS) receiver array in orbit;
- The first high data capacity scientific satellite (terabyte onboard data storage and >300 megabits-per-second telemetry downlink);
- The first tri-sector (university-industry-government) partnership in a Canadian satellite mission.

ISIS' development of the e-POP mission is being done in collaboration with its several Canadian and international partners in industry, government and academe, including: MacDonald, Dettwieller and Associates (MDA), Magellan Bristol, and COM DEV; the CSA and Communications Research Centre Canada; the Universities of Alberta, Athabasca, Saskatchewan, Western Ontario, and New Brunswick, and York University; and the Japan Aerospace Exploration Agency (JAXA) Institute of Space and Astronautical Science (ISAS) and the US Naval Research Laboratory (NRL).



The ePOP scientific payload.

The ePOP ground telemetry station.

CANADIAN ELECTRIC FIELD INSTRUMENTS & SWARM

The European Space Agency's upcoming Swarm mission will provide the best ever survey of Earth's geomagnetic field and temporal evolution, while gaining new insights into our planet's interior and climate. The globally significant mission is made possible by technology that has been under development at the University of Calgary since 1996 – Canadian Electric Field Instruments (CEFIs). Predecessors of the CEFIs that will be used for Swarm have flown successfully on five sub-orbital rocket flights.

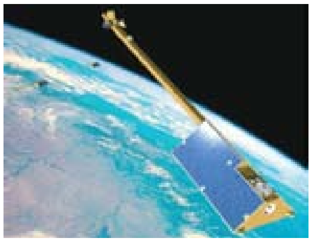
The CEFI design itself has been the subject of an intense five-year development led in industry by COM DEV Ltd. of Cambridge Ontario under a $14M contract from the European Space Agency. The Canadian Space Agency has provided an additional $1.5M in funding to carry out laboratory testing and calibration of the CEFIs at the University of Calgary.

The CEFI concept is a union of technologies developed over three decades at the National Research Council in Ottawa and at the University of Calgary, which provided the world's first images of the global pattern northern lights from space in the early 1970's. The CEFI is one of the first of a new generation of space instruments capable of providing highly detailed images of wind and temperature patterns in the ionized part of the earth's upper atmosphere. A close relative of the CEFI, the Suprathermal Electron Imager on the Enhanced Polar Outflow Probe (ePOP) satellite, will fly at about the same time as Swarm. The on-orbit performance of these two instruments will demonstrate the scientific potential and versatility of this new technology, leading to many future space applications and opportunities.

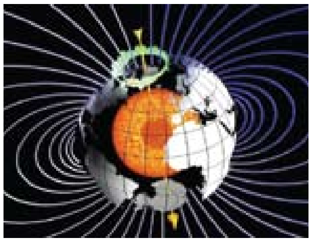
Swarm Mission Scientific Background

The Earth's magnetic field is dynamic and variable. Its pattern on a global scale reflects physical processes that originate deep with Earth's core and its regional variations are determined by – and serve as a sensitive probe of - crustal geology and mineralogy. The magnetic field's fluctuations in time reflect the intense flow of energy that couples the upper atmosphere and near-earth space to the solar wind and the sun itself. These fluctuating energy inputs can change over periods of minutes and can have profound and widespread effects on communications, navigation, power transmission, mineral/oil exploration and recovery, space-based technology assets and human spaceflight.

Proper characterization of Earth's geomagnetic field is best accomplished from polar-orbiting satellites that can regularly sample all points on Earth's surface. While several such satellites have been flown over the past decades, the European Space Agency's upcoming Swarm mission represents two significant advances. First, Swarm consists of three separate satellites configured to characterize the variability of the geomagnetic field in both space and time. This allows separation of signals originating internal to the earth from those imposed externally by the sun and solar wind. Second, and even more importantly, Swarm will be the first geomagnetic field-mapping satellite mission to include regular measurements of electric fields in space. Electric fields will be used to reveal the sources of magnetic field fluctuations measured in space and track the flow of electromagnetic power from space into the upper atmosphere. This power flow is substantial, at times exceeding the total electrical power usage in North America. It has a strong effect on the dynamics of the upper atmosphere and may ultimately play a role in determining the terrestrial climate itself.



Artist conception of three Swarm satellites in orbit.



Schematic of the Earth's magnetic field.

RESOLUTE BAY INCOHERENT SCATTER RADAR

For more than thirty years international space scientists envisioned a world-class space physics observatory in the Canadian High Arctic to carry out polar cap investigations. The observatory would involve dozens of small instruments deployed around a large Incoherent Scatter Radar (ISR). ISRs are powerful radars that probe upper atmospheric properties, a cornerstone of tools used in efforts to understand the physics of near-Earth space. These plans became concrete with the US National Science Foundation (NSF) decision to develop a fundamentally new type of ISR called an Advanced Modular Incoherent Scatter Radar (AMISR) and build it in Resolute Bay in the Canadian High Arctic.

Early on it was recognized that the AMISR program would be able to explore a broader range of science questions if there were two radar faces, which would extend the area of coverage and increase signal to noise. The University of Calgary is leading an international team to secure the funds for the second system. The overall project cost is approximately $25M, making this by far the largest Canadian space physics, ground-based infrastructure project to date. This includes a $5M in kind contribution from the US partners, as well as $10M from Canada Foundation for Innovation and $7M and $2M from Alberta and Saskatchewan respectively. This project, called Resolute Bay Incoherent Scatter Radar – Canada (RISR-C), is now entering its implementation phase.

With the second face, the Resolute Bay ISR (RISR, referring to the combined Canadian and US radars) will be the world's foremost ISR. The science will be world class and there will be significant and tangible benefits for Alberta. Through leadership of the second face, Calgary researchers are taking a primarily American initiative in our High Arctic and making it an equal partnership between Canada and the US. To date, ISRs have only been operated by institutions such as Cornell, MIT and Stanford. Alberta universities will be joining an elite club, creating significant international opportunities for Alberta students.

RISR-C will establish a major foothold that can support Alberta arctic research in other disciplines. Through it, Alberta space physicists will become world-leaders in an important aspect of arctic research and significant players in northern strategy, security and sovereignty.

Industry Opportunities

RISR-C will unfold over decades. It will begin with a multi-year implementation phase during which the radar will be built. The prime industrial contractor is expected to be SRI International of Menlo Park California. SRI International will be looking for Canadian subcontractors for nearly $10M of work, including the fabrication of aluminum frames for antenna elements and various radio frequency and electronic components. Alberta companies that succeed in these subcontract competitions will be well positioned to be the sole suppliers of key components of future ISRs that will be built worldwide.

Beyond this implementation phase, there are even more exciting opportunities for Alberta industries. For example, RISR-C will be a significant user of electricity, approaching 1 MW during operations that will be thousands of hours per year. The University of Calgary recently hired a Natural Sciences and Engineering Research Council (NSERC) Industrial Research Chair, sponsored by Enmax, to carry out research in wind power. Several Calgary institutes (ISEEE, AINA and ISIS) have identified the development of a clean power solution for RISR-C as a potential pathfinding exercise for developing wind power as a viable alternative to diesel generators in Canada's north. This has significant economic potential for Alberta industry.

RISR-C will also be the cornerstone of a research program that will investigate the physical processes that cause disruption of Global Navigation Satellite Systems (GNSS) signals in the north, with the objective of developing more robust strategies for sustaining GNSS accuracy. This project will utilize Novatel technology and hold the promise of providing a significant competitive advantage for Alberta manufacturers of GNSS technology.

Finally, the sensitivity and scientific impact of RISR-C critically depends on the ability to use a "phased array" to illuminate and image different parts of the sky simultaneously. Alberta researchers in ISIS are working to adapt next generation radio astronomy techniques to implement better software and data solutions for significantly increasing RISR-C performance. The opportunity exists for Alberta companies to market such solutions in future larger projects.

Scientific Background

The dynamics of the solar wind and Earth's magnetic field create the magnetosphere and the aurora. The aurora is impressed on the ionosphere, along magnetospheric magnetic field lines, forming an oval at high magnetic latitudes, typically between 65º and 75º magnetic latitude. As one goes north, one eventually ends up under the aurora (for example, the auroral oval is typically overhead cities like Yellowknife and Fort Churchill). Further north, one enters the polar cap where there isusually no aurora. This dark region is interesting for a number of reasons: for example, (1) the magnetic field lines that thread this region are open, meaning they connect directly to the solar wind, (2) space weather has its most direct effect on our atmosphere in the polar cap, and (3) around the edge of the polar cap, magnetic field lines are constantly breaking and rejoining via magnetic reconnection, a process by which all of the energy that powers near-Earth space dynamics is extracted from the solar wind. Ground-based remote sensing of polar cap auroral and plasma dynamics will provide new insights into dynamic Geospace processes, fundamental plasma physics and space weather. Interestingly, because of its very high latitude and relative inaccessibility, the polar cap remains the least explored region of Geospace.

Resolute Bay Incoherent Scatter Radar will address questions related to: the impact of space weather on the upper atmosphere and possibly climate; the role of reconnection in global magnetospheric dynamics; the physical nature of polar cap aurora; the nature of plasma instabilities in the polar cap; and the physical processes responsible for the degradation of Global Navigation Satellite System (GNSS) effectiveness at high latitudes. All of these topics figure prominently in NASA's recently released Heliophysics Roadmap.

Map showing auroral zone over Canada and Resolute Bay.

Superstructure for RISR-C.

THE CSA ORBITALS SMALL SATELLITE MISSION

The Outer Radiation Belt Injection, Transport, Acceleration and Loss Satellite (ORBITALS; www.orbitals.org) is a proposed $150M CAD Canadian Space Agency (CSA) Small Satellite mission currently under development. The ORBITALS is destined for the Van Allen radiation belt, a little-studied region that lies between 6,000 and 30,000 kilometres above the Earth's surface. The Van Allen radiation belt was discovered nearly 50 years ago at the beginning of the space race by a mission called Explorer 1, and the radiation belt takes the name of the man who discovered it – James Van Allen. The belt is characterized by intense radiation in the form of high-speed protons and electrons created in near-Earth space by solar wind, a stream of high-energy particles produced by the sun. When this wind hits the Earth, a poorly understood "cosmic particle accelerator" causes the electrons and protons to speed up to significant fractions of the speed of light wherein they can be damaging to Earth orbiting commercial satellites. On occasion, there are also explosions on the sun's surface, and when matter from these blasts reaches the Earth, it can whip up the "space weather" into severe space storms that are the equivalent of Category 5 hurricanes. What scientists have yet to figure out, and what the ORBITALS mission will solve, is exactly why the acceleration occurs.

Getting answers is important for the protection of orbiting spacecraft, including the numerous satellites upon which 21st Century economies increasingly rely. Space storms have disrupted and severely damaged satellites as happened in May 1998, when a satellite failure knocked out 80 per cent of pager traffic in the United States. More recently in April 2010, Galaxy 15 was similarly believed to have been disabled by space weather effects. Typical commercial satellites have a value of around $250M CAD, and as of 2005 there were 967 satellites operating with a replacement cost of around $190B USD.

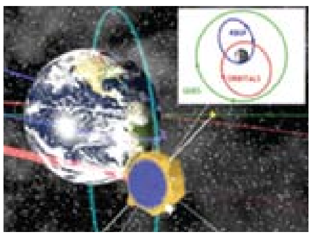
The ORBITALS will also target radiation in medium Earth orbits, like the Molniya orbits, which are used for GPS, communications, remote sensing, and Earth observation, which includes monitoring land use and environmental change, and in the future protecting arctic sovereignty. These orbits are most susceptible to intense space radiation effects and any satellites serving arctic communications, or monitoring conditions and shipping in the Northwest Passage, pass through the intense radiation belt four times per day. As the Canadian government and the developing commercial sub-orbital and orbital space industries increasingly look to exploit these orbits, mitigation of radiation effects will become key in their success for this and future space exploration missions to the moon, Mars, and beyond.

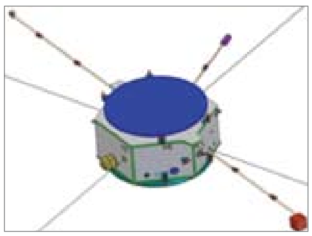
ORBITALS Industrial Involvement and Future Opportunities

The Canadian Space Agency's investment in the development of the ORBITALS already exceeds $5M CAD. The Mission is being led by the University of Alberta, in partnership with the University of Calgary and Canadian industry including: Bristol Aerospace Limited (Magellan), COMDEV Ltd, Best Medical Canada, DPL Science Ltd, Bennest Enterprises Ltd, and Magnametrics Ltd. The ORBITALS mission is also partnered with NASA ($1.5M USD investment to date) and U.S. universities and organisations including: The Aerospace Corp., The University of Colorado, The University of Minnesota, The University of New Hampshire, University of California (Berkeley).

As the $150M CAD ORBITALS mission is developed, the project offers exceptional opportunities for Alberta industry and Alberta employees to partner with mission management, systems engineering, communications and project development. Four of the science instruments will also be developed and at the University of Alberta and the University of Calgary, introducing opportunities for partnership with Alberta engineering firms and for the employment of Alberta engineers both within academia and industry.

Future spin-off opportunities are under consideration for two new satellite mission concepts and the development of the ORBITALS will help to secure Alberta as a leader in space science instrumentation. Data from ground-based versions of this space-based hardware, such as magnetic field measurements, are already in demand in advanced magnetic drilling applications, offering a commercial exploitation avenue within the existing Alberta economy. New partnerships with Alberta aerospace and related industries in advanced materials engineering, radiation effects, and radiation modelling and effects mitigation, and electronic parts and system qualification are also sought.





The ORBITALS Satellite Mission

PHOENIX MISSION TO MARS

The Phoenix Mars Lander mission, a joint NASA/CSA mission to the North Polar Region of Mars, led to major discoveries about the red planet. The Meteorological (MET) station, built by the Canadian Space Agency to record Martian weather daily during the mission, was instrumental in the discovery and verification of water ice on Mars, and included the discovery of snow fall in the Martian atmosphere – perhaps apt for a mission with a Canadian-US partnership! The University of Alberta (U of A) contributed to the development of the Canadian MET package, among other things, by designing the concept for the Telltale wind sensor, perched above the MET station. The U of A's Computational Fluid Dynamics (CFD) Lab was involved in modelling and verifying sensor responses in the Martian atmosphere, as well as the effect of winds on station measurements. Such advanced design conception and CFD modelling was key to the success of this mission, and will be applied to future planetary atmospheric missions. The CFD Lab continues to develop models, in collaboration with researchers from Canada, the US and Germany, to interpret the wealth of data produced by the mission and also to advance the development of the next generation of nano-scale planetary atmospheric sensors.

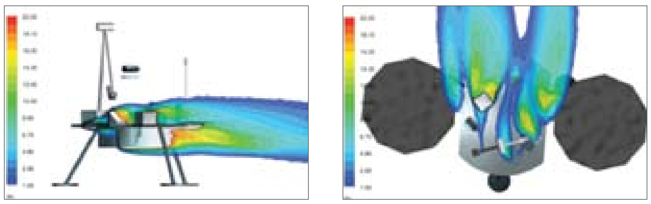
Key partnerships in the Phoenix mission, supported by a Canadian contribution of $37M CAD, included MacDonald, Dettwiler and Associates (MDA), Optek, York University and Dalhousie University.

Key technology spin-offs from such planetary space exploration missions include:

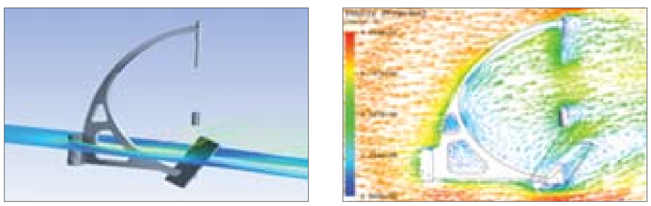
- Improving the efficiency of inhaled drugs
- Rapid detection and monitoring of trace gases using nano-technology
- Rapid real-time monitoring and control of dry processes in the chemical industry
- Discovery of the mucus properties of the human lung that moderate the emission of bioaersosol particles. In combination with a new class of pharmaceuticals under development and patented at the U of A to control the mucus properties, the discovery could help suppress the spread of airborne pandemic diseases such as SARS and H1N1.

Alberta industries are also taking advantage of the research and development technologies arising from the Phoenix Mars Lander mission.

The U of A's expertise in the Infrared (IR) monitoring of trace gases and its terrestrial applications led to the creation of the spin-off company Boreal-laser, whose instrumentation is known internationally and is used extensively in open path trace gas monitoring. For example, sensors in the market are now used in helicopter monitoring of natural gas pipelines and the search for leaks in the gas sector. The U of A is also now active in an ongoing industrial collaboration with Micralyne (Edmonton) and Feuchtemesstechnik (Germany) in the development of two different humidity sensors for Mars, which can also be used on Earth when high sensitivity and fast response times are needed. These sensors utilise nano-scale fibres to enable a very fast humidity reading which only requires a tiny volume for the measurement. Such rapid responses using small volumetrics are critical not only on Mars, but also for a number of dry process chemical and chemical engineering processes. In addition, leverage of partnerships with the National Institute for Nano-technology (NINT), the developing nanotechnology industry in Alberta, and dry process chemical companies in Alberta are now actively being sought. The open path IR spectroscopy expertise at the U of A will also be used to monitor the gases of planetary atmospheres and could be used in future missions to Mars. Industrial partnerships will be key to advancing this technology for space exploration.



Example of CFD simulation result showing how the Mars Lander temperature, heated by the sun and by dissipation of internal heating, may affect the atmospheric temperature readings of the meteorological mast MET.



Simulation results of wind flow around the Telltale wind sensor, revealing potential effects of its frame structure and inclined mirror.

EARTH OBSERVATION: SPECTRAL AND HYPER-SPECTRAL TERRESTRIAL IMAGING

Global Monitoring: Resources, Land Use, and Environment

Space and high-altitude platforms (in planes, unmanned airborne vehicles and stationary platforms) built for Earth observation have many applications in the resource and environmental sectors. Spectral and hyper-spectral imaging from satellites and autonomous vehicles, combined with advanced imaging analysis tools can be used to take time series images of dynamic phenomena over vast areas used to address issues of resource management and exploitation, and to examine the impacts of climate change. These tools typically fill a need for the massive collection of imagery either covering vast areas of the province or as time series of dynamic phenomena, and when imaged from space provide a complete picture impossible to obtain from the ground.

Specifically, the Universities of Alberta (U of A) and Lethbridge (U of L) have extensive capabilities in applications related to:

- Monitoring land use/cover change to support decisions regarding environmental use (U of A, U of L);
- Monitoring the environment and resources e.g., the thickness of sea ice, forest fire detection/fighting, biodiversity, habitat and agriculture monitoring, water resource, forest health, mineral exploration, mining environmental impact and mine site rehabilitation (U of A, U of L);
- Landscape trafficability for defense and homeland security applications (U of A, U of L);
- Detection of pipeline leaks or illicit drug laboratories (U of A); and
- Oil sands imaging (U of A).

Imaging is central to these monitoring activities and supporting numerical modelling work is key in the interpretation and exploitation of imagery. Coupled with integrated approaches to field data collection, return and analysis, this represents an exciting area of excellent future industrial partnerships.

For example, a recent Canada-California Strategic Innovation Partnership project led by the University of Alberta Centre for Earth Observation Sciences will use bioinformatics and Earth observation data to address climate change impacts on both Canadian and Californian ecosystems that threaten the sustainability of large industries such as fisheries, forestry, and agriculture. Industry partnerships are being targeted for delivery and commercialization of the results.

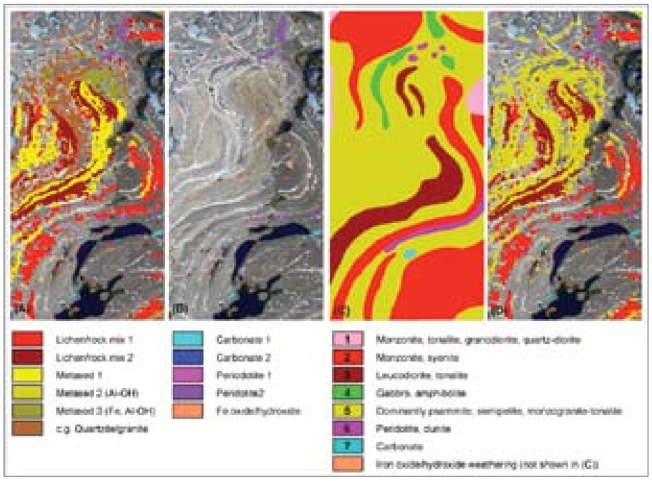
Similarly, the University of Alberta is using satellites (e.g., Japanese GOSAT) for monitoring carbon dioxide and methane both locally, in the oil sands for example, and globally. Using modeling, they are identifying the dominant sources of these gases.

In 2010 the University of Alberta was invited to participate in a satellite mission proposal to develop and launch mid- and thermal Infrared imagers to track Temperature Emissivity Signatures for the Geosphere and Pedosphere (TES-GAP). This mission concept was developed in partnership with DLR, the European Space Agency (ESA) as part of the ESA Earth Explorer program in industrial partnership with Kayser Threde (Germany).

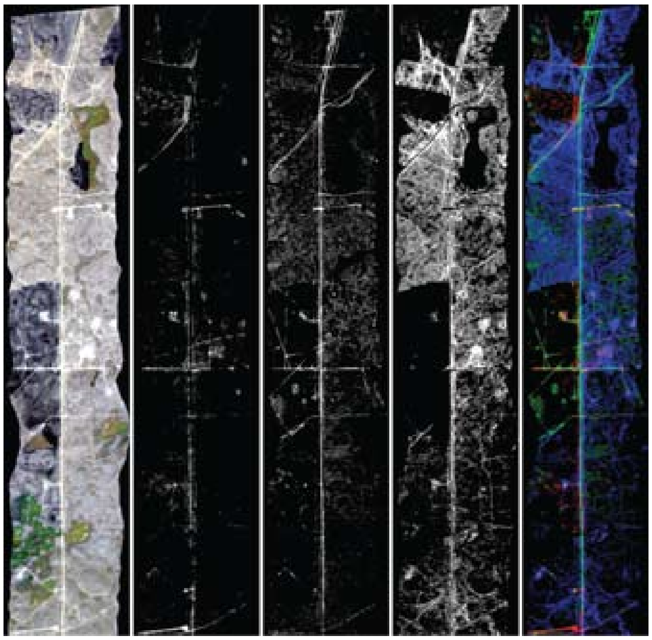
Industrial Involvement and Future Opportunities

The University of Alberta this year received in excess of $2.5 million dollars in research innovation funding (Canadian Foundation for Innovation, provincial and industrial) to develop and establish an environmental wireless sensing network and acquire innovative hyperspectral imaging capabilities. These imaging and wireless sensing technologies will continue to be developed at the University of Alberta in partnership with the University of Lethbridge, industrial partners in the oil sands, mineral mining, and wireless sensing sectors, the Canadian Centre for Unmanned Vehicles Systems (CCUVS) in Medicine Hat, and various government partners. Together these have contributed in excess of $1.2 million in additional research support. It is clear that Albertan innovation is well-placed to drive expansion in this critical sector.

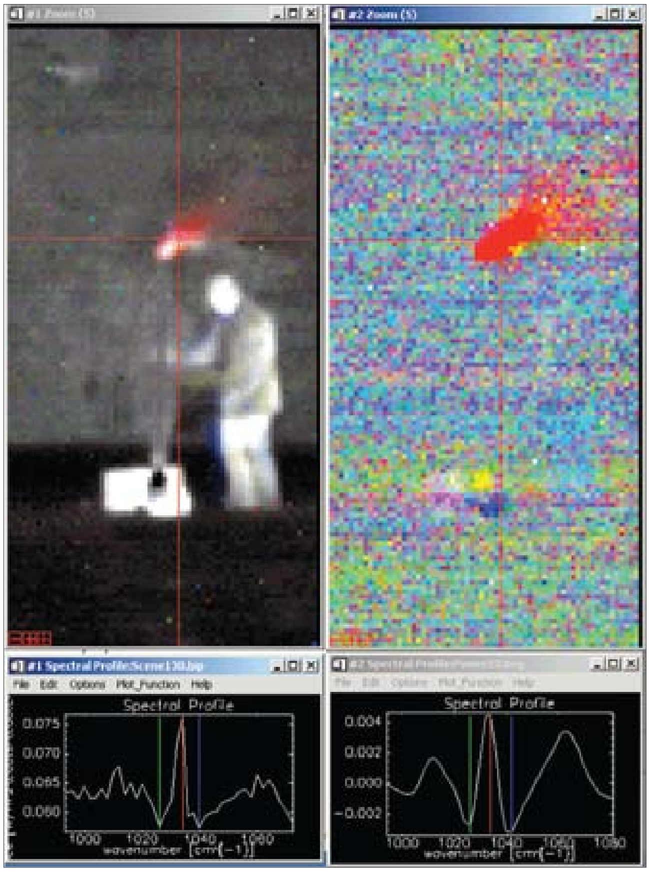
Future partnerships and collaborations will support growth of the $80B annual resource activity in Alberta, responding to global needs in energy, forestry and agriculture sectors that yield annual multi-trillion dollar revenues. They offer an Albertan solution to the demand for integrated resource management tools and solutions, and contribute to better land use and infrastructure decision-making for the province. This includes increasingly environmentally sound practices in the resource sector, ultimately leading to innovative tools for improved management and exploitation of resources such as in the oil sands, as well as opportunities in monitoring and managing global change in the arctic north, and in relation to sovereignty and security in the northwest passage. Export of these technologies for Canadian and international applications offers further excellent growth potential for the Alberta economy in the Aerospace and partner ICT and data management sectors.



Predictive maps to support northern geology and resource exploration:
Panel (C) published geology; panel (D) predictive map.



Homeland Security: Trafficability of landscape and detection of roadways.
Left to right: Colour image; major roads – disturbed soil (2 panels); minor roads; RGB colour code of classification of trafficability.



Detection of a methanol plume: Application to the detection of illicit laboratories, industrial spills, pipeline leaks and homeland security etc.

IUNCTUS GEOMATICS CORP

Bridging Aerospace and Information Communication Technologies (ICT) for Informed Decisions.

Lethbridge, Alberta is home to Canada's first commercial satellite receiving station. Satellite receiving stations allow comprehensive spacecraft communication services including Telemetry, Tracking and Control (TT&C), data reception and space operations. Completed in 2004 by Alberta based Iunctus Geomatics Corporation, the station is programmed to receive data from earth observation (EO) satellites, including the SPOT constellation through an international partnership with SPOT IMAGE, a subsidiary of EADS Astrium.

The success of this initial investment in satellite ground segment infrastructure, directed Iunctus north of the arctic circle to Inuvik, NT. (68º N. Latitude). The Inuvik site provides a distinct advantage in satellite reception capabilities over southern stations. Its location provides increased access to polar orbiting satellites and will meet Alberta's and Canada's public needs in areas such as security, sovereignty, environmental monitoring, and land use management. Through an international partnership with the Swedish Space Corporation (SSC), the German Aerospace Center (DLR - Deutsches Zentrum für Luftund Raumfahrt), and the Government of Canada, the first of eleven planned satellite ground stations was completed and operational as of September 15, 2009. This station supports TerraSAR-X and the future TanDEM-X missions owned and operated by DLR,. Future multi-mission ground station support for the French space agency, CNES (Centre National D'Etudes Spatiales) has also been confirmed.

This capacity for satellite mission support has fostered opportunities for Iunctus to build collaborative partnerships with the international space community (CNES, SSC, DLR) and to leverage distribution rights with satellite image data providers (SPOT). Iunctus is the exclusive provider of EO data from the SPOT constellation of satellites over Canada and it is through these distribution rights that they are able to provide an extensive product and services suite to serve the geo-spatial industry.

For example, through the international SPOT partnership and receiving station infrastructure, Iunctus is able to produce seamless high spatial resolution satellite coverage of the Western Canadian Sedimentary Basin (WCSB) on an annual basis. The WCSB is of great importance to Canada, and especially Alberta, as this sedimentary rock formation contains a large portion of the oil, gas, and coal reserves in Canada.

Iunctus provides data to clientele as an entire package and also through subscription-based TerraEngine Web Mapping Services (WMS). This geospatial information is used by the Alberta public and private sectors for environmental management and land use policy development in addition to planning, construction, and reclamation efforts.

Storage of terabytes of archived satellite data and value added products in addition to the computational requirements for serving these data to clients present many challenges and require a significant investment in ICT infrastructure. To manage these massive amounts of data, Iunctus is constructing a 10,000ft2 data center as part of a Technology Commercialization Campus in Lethbridge, Alberta. The Technology Commercialization Campus aims to provide an integrated cluster of high-tech firms in Aerospace, ICT and Geo-spatial industries as well as provide an incubation facility for start-up and spin-off businesses. This data center will support the high-tech business cluster and will scale to meet future requirements for archive services and geo-spatial data management. This new data center infrastructure has also generated industrial partnership interest in ICT services ranging from data and web hosting to completely managed services.

Iunctus Geomatics Corporation is a case study in bridging the gap between different industry sectors and fostering international, industrial, and governmental partnerships to solve the challenges of today's Aerospace and ICT industries. From satellite TT&C and reception capabilities to data center management, ICT and geo-spatial services and the creation of a cluster for incubating startup technology companies, Iunctus is strengthening Alberta's Aerospace, Geo-spatial and ICT industries on both national and international scales.

Satellite ground station in Inuvik, NT, completed and operational as of September 15, 2009.

MOTIVE INDUSTRIES INC. – DRIVING INNOVATION

Much of the transportation design and development work that Motive Industries Inc. performs has aspects of aerospace engineering, in particular their use of advanced materials and propulsion systems. This makes them amongst the world leaders in automotive composite materials application and in the design engineering programs used to complete these projects. Currently involved with several aerospace level design-engineering programs, one of their projects includes the SKA Radio Telescope.

Introduced to the program by the Institute for Space Imaging Science (ISIS) at the University of Calgary, Motive's initial role was to help with the development of mechanical aspects of the telescope. This role has expanded as the company is currently assisting in the development of the existing NRC dish and mounts design in addition to having invented several innovative ways to lighten, strengthen, and improve the performance of the telescope at a dramatically lower cost than conventional telescope design. Motive will also be constructing several scale models of the telescope as well as photo-realistic renderings and animations as part of their in-kind contribution towards the project. The SKA project is expected to result in valued Canadian intellectual property, and if successful Motive will be in a good position to bring a significant design and construction contract to Alberta.

Motive will also be supporting the ongoing efforts to strengthen and expand the SKA consortium within Canada. This includes utilizing the research into natural-fibre composites undertaken between Motive and Alberta Innovates – Technology Futures, and introducing new technology developed in Calgary such as screw-pile technology, advanced gimbals, direct drive mechanisms and advanced programming logic from companies such as James Klassen Consulting and Area 51 Machine Design.

The Canadian organizations that make up the existing consortium combine to create a network that spans academia, industry and government. The prime goal of this network is to transfer research outcomes in smart antenna technologies from the research labs to industry for the manufacture and performance verification of a prototype end-to-end smart antenna system. The network builds a pre-commercialization research and development collaboration between industry and world-leading research groups in the diverse technologies required. A list of network partners includes: University of Calgary, University of Victoria, National Research Council, Industrial Research Assistance Program, Dominion Radio Astrophysical Observatory, Area 51 Machine Design, James Klassen Consulting, Breconridge Corporation, Lyrtech Signal Processing, NAIAD Company Ltd., Profile Composites Inc., and IBM Canada.

Motive Industries envisions opportunities for Alberta businesses to join this project by providing:

- Advanced computer modeling and simulations;
- Advanced logic control programming
- Composites development and fabrication
- Advanced metal fabricating
- Utilisation of screw-pile foundation technology
- Transportation logistics support
- Long-term technical support

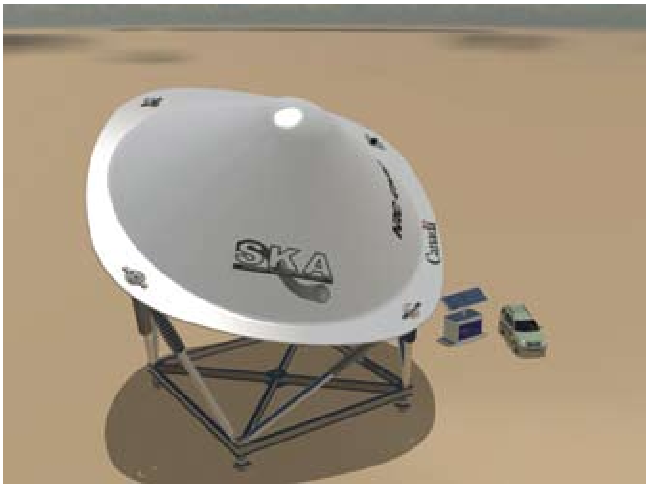
An additional goal of the project is to develop a strong academic and industry cluster in order to accommodate future projects such as securing the funding and managing the design and manufacture of a Canadian Radiotelescope Prototype for consideration at the international evaluation in New Mexico roughly two years from now.

As the SKA research and development program moves forward, Motive has a unique opportunity to demonstrate to the global science community our capacity to complete large scale, complex projects. Regardless of whether the Motive concept is chosen as the final design, it will demonstrate that the passion and resources exist to sustain a strong advanced design, engineering and manufacturing community within Canada.

Current NRC mount and dish design.

Motive base concept with NRC dish.

Motive & Klassen original design concept with overconstrained ballscrew drive.



Motive & Klassen original design concept with overconstrained ballscrew drive.