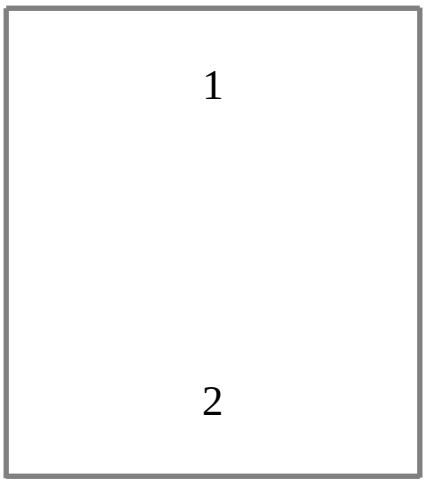
2011 R&D Report

University of Lethbridge
Faculty of Arts & Science

ATIC
Alberta Terrestrial Imaging Centre
University of Lethbridge



Front cover:

1. The University of Lethbridge, Lethbridge, Alberta, Canada
2. ATIC team members in front of the Alberta Water and Environmental Science Building

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Alberta Terrestrial Imaging Centre 2011

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Overview

Mandate

The purpose of ATIC is to advance scientific knowledge in remote sensing and imaging spectroscopy and apply this knowledge to the monitoring of natural resources and the environment in the context of global sustainability. In particular, the Centre integrates strategic research and development (R&D) in these areas at the University of Lethbridge. The Centre's R&D supports new applications utilizing cutting-edge remote sensing technologies developed at the Centre. The terrestrial focus encompasses R&D on the remote sensing of surface and atmospheric properties. While the primary emphasis is on imaging, the Centre's R&D involves a wide variety of non-imaging measurements and methodologies, including field spectroradiometry, atmospheric spectroscopy, and scene physics and analysis.

Due to its increased knowledge and expertise in remote sensing, the Centre has the capacity to collaborate consultatively with all levels of governments and industry, especially in the area of imaging spectroscopy, which is neglected at the Canadian national level. This enlarged capacity is also used to enhance training and teaching programs at the undergraduate and graduate levels to develop highly-qualified personnel (HQP). Within this framework, the Centre further enhances national and international collaboration to augment its research, training and teaching capabilities.

Scope of Activities

- *Methodology Research*: Undertaking research and development on methodologies in the remote sensing and imaging spectroscopy of the Earth's surface and atmosphere.
- *Applications Development*: Finding new applications in remote sensing and imaging spectroscopy to resource and environmental monitoring, neuro-imaging, kinesiology, computer science, and other disciplines.
- *Imaging Science Driver*: Creating and maintaining structured and multi-disciplinary institutional approaches to imaging science research and education from undergraduate to post-graduate levels.
- *Research Training*: Providing enhanced multi-disciplinary learning experiences that enable graduates to pursue science and technology careers in industrial, government or academic settings.

Primary Research Areas

- Analysis of atmospheric trace gases
- Atmospheric correction of satellite image data
- Automation of data preprocessing and information extraction chains
- Bidirectional reflectance properties of Earth surfaces
- Development of dedicated mapping/monitoring systems
- Development of remote sensing applications in agriculture, rangeland, forestry, oil sands, water resources
- Hyperspectral imaging / imaging spectroscopy
- Image classification, texture analysis, and spectral mixture analysis
- Image processing and analysis methodologies
- Investigations of molecular structures
- Remote sensing laboratory and field analyses
- Remote sensing instrumentation (field/airborne/atmospheric sensors)
- Sensor radiometric calibration
- Vegetation canopy reflectance modeling and inversion

NSERC CREATE AMETHYST Program

The University of Lethbridge received a prestigious NSERC Collaborative Research and Training Experience (CREATE) grant for an Advanced Methods, Education and Training in Hyperspectral Science and Technology (AMETHYST) Program. The AMETHYST Program will provide excellent support for research training over a six year period (2010-2016). It is designed to expose students to the broader context of imaging science and technology, with research foci in remote sensing methodologies, resource and environmental monitoring, greenhouse gas studies, and neuro-imaging. Student internships are offered at the undergraduate and graduate levels, including research placements in academic laboratories, government agencies and industry settings. In addition to periodic and ongoing research and training events, AMETHYST features two types of workshops. The annual multi-day Workshop on Hyperspectral Imaging Science and Technology (summer) provides an intensive interdisciplinary research training experience. The annual single-day Workshop on Career Development and Workforce Preparation (winter) offers trainees a unique and diverse training experience, allowing them to acquire a full scope of individual and team-oriented professional skills that are highly valued and optimized for today's job market. Both workshops are open to participants from across Canada and internationally. More information is available on the AMETHYST web site: www.ulethbridge.ca/artsci/amethyst/.

Multi-Disciplinary Major in Remote Sensing

The University of Lethbridge has initiated a new Multi-Disciplinary Major in Remote Sensing, combining the strengths of the university's Department of Geography and Department of Physics and Astronomy. The program is designed to prepare B.Sc. graduates for a broad spectrum of job opportunities as well as graduate education and research.

Major R&D Funding Sources

Agriculture and Food Council of Alberta
Alberta Ingenuity New Faculty Award
Canadian Foundation for Innovation Infrastructure Operating
Government of Alberta
Natural Sciences and Engineering Research Council of Canada Grants: Discovery, Strategic, CREATE
Oil Sands Research and Information Network (OSRIN)
Tecterra, Inc.
University of Lethbridge Faculty of Arts and Science

Laboratories

The ***Remote Sensing Laboratory*** in the Alberta Water and Environmental Science Building (AWESB) consolidates various elements of the University of Lethbridge remote sensing research. Methods of spectroradiometric measurement and imaging are developed and tested for real-world application. The laboratory provides space and lighting for the measurement of samples in a controlled environment. It is the home base for the University of Lethbridge goniometer systems, a variety of laboratory and field-deployable sensors and experimental target systems, 3-D structural measurement devices, and other specialised field equipment.

The ***Remote Sensing Calibration Spectrometry Laboratory*** is a highly-specialized critical facility unique to Canada. The laboratory carries out spectroradiometric calibration of instrumentation used to support a variety of Earth and environmental science studies. There are four rooms that make up this laboratory space: a dark calibration room, a spectrometer room, a goniometer room, and a field preparation room. The laboratory houses a wide array of new spectroradiometric instrumentation for remote sensing research in the laboratory as well as equipment for use in field campaigns. It also offers equipment calibration services to the remote sensing community and will be equipped to seek contract opportunities that support space missions.

The ***Atmospheric Spectroscopy Laboratory*** in University Hall undertakes laboratory spectroscopy of terrestrial and planetary atmospheric molecules. The main instrument is a three-channel home-made laser spectrometer, tuneable from 1.48 to 3.8 micrometers. A variable-temperature single-pass absorption gas cell was designed and built in-house for the spectroscopic study of gases. This setup enables highly sensitive line shape studies and fundamental spectroscopic studies of molecular interactions. Tuneable diode laser absorption spectroscopy has also been used to develop an instrument capable of high-accuracy measurements of greenhouse gases such as N_2O, CO_2, and CH_4. The field-portable instrument can be deployed in remote locations and used to measure greenhouse gas concentrations in real time.

Instrumentation

- Airborne Multispectral Camera System
- ASD mercury argon calibration source assembly ALZSOLO
- ASD RTS-3ZC Reflectance/Transmittance Integrating Spheres (2)
- ASD spectrometers (4): ASD FieldSpec 3 (2), ASD FieldSpec 3 Hi-Res, and ASD FieldSpec Pro
- Campbell Scientific Weather Stations (2)
- Cimel CE-318 AERONET/AEROCAN node autonomous Sun-tracking photometer
- Cimel CE-318 Science mode autonomous Sun-tracking photometer
- FEL irradiance standards (2)
- HEMI digital hemispherical photography system
- Labsphere USS-1200C integrating sphere
- Labsphere reflectance standards (6)
- LAI-2000 plant canopy analyzer system
- Microtops sun photometers (2)
- Ocean Optics VNIR spectrometer
- Pulnix AccuPiXEL cameras (6)
- SVC HR-1024 field spectrometer
- SWIR imaging spectrometer: Specim VN25E / MCT camera / Specim mirror scanner
- TRAC (Tracing Radiation and Architecture of Canopies) system
- Trimble TSCL and ProXRS DGPS receivers
- VNIR imaging spectrometers (2): Specim V10E / Hamamatsu C8484 / Specim mirror scanner
- Yankee Environmental Systems SPUV sun photometer

Field Goniometer Systems

The University of Lethbridge Goniometer System version 2 (ULGS-2) apparatus has a unique design that incorporates a number of advancements over other goniometers for measuring bi-directional reflectance data that are used to support remote sensing analyses. It is the most advanced field goniometer system in the world. The ULGS 2 uses a quarter circle positioning arc with a 2-m radius and no part of the apparatus touches the ground in the target area. This new design reduces the weight of the apparatus, increases portability, allows positioning over a wider variety of surfaces, and facilitates significantly faster data acquisition. ULGS-2 incorporates a computer-controlled motor-

driven instrument payload that rapidly samples target bidirectional reflectance distribution functions.

Under contract from the US Army Corps of Engineers, a revised version of the manual goniometer system was developed. The new manual instrument has 10-degree resolution in both zenith and azimuth and is light weight and portable. After development and testing, this new instrument was deployed in Afghanistan.

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2011 Professional Activities, Alberta Terrestrial Imaging Centre

Conferences, Workshops and Specialist Meetings

- 2011 Forest Pest Management Forum, Ottawa, Ontario
- 23rd Colloquium on High-Resolution Molecular Spectroscopy, Dijon, France
- 32nd Canadian Symposium on Remote Sensing, Lennoxville, Québec
- 4th IUPAP International Conference on Women in Physics, Stellenbosch, South Africa
- 5th Annual University of Lethbridge GSA Conference, Lethbridge, Alberta
- 6th International Symposium on Intelligent Information Technology in Agriculture (ISIITA2011), Beijing, China
- 8th Meeting of the EnMAP Scientific Advisory Group, Munich, Germany
- 9th Meeting of the EnMAP Scientific Advisory Group, Potsdam, Germany
- ABBY - Alberta-Bavarian Research Network Workshop, Munich, Germany
- Annual Users Meeting, Canadian Light Source, Saskatoon, Alberta
- Earth Observation Monitoring of the Oil Sands Workshop, Edmonton, Alberta
- Geospatial World Forum, Hyderabad, India
- IEEE International Spaceborne Imaging Spectroscopy (ISIS) Working Group Meeting, Vancouver, BC
- IEEE International Geoscience and Remote Sensing Symposium 2011, Vancouver, BC
- Prairie University Physics Seminar Series, Saskatoon and Regina, Saskatchewan

Service Activities and Memberships

- Alberta Geomatics Group
- American Society of Agronomy
- American Society of Photogrammetry and Remote Sensing
- Canadian Association of Geographers
- Canadian Association of Physicists
- Canadian Institute of Forestry, Rocky Mountain Section Council Member, Program and Membership Committees
- Canadian Remote Sensing Society
- Canadian Society of Agronomy
- Co-Chair, IEEE International Spaceborne Imaging Spectroscopy (ISIS) Working Group
- College of Alberta Professional Foresters
- Editorial Board, *Canadian Journal of Forest Research*
- Editorial Board, *Canadian Journal of Physics*
- Editorial Board, *Canadian Journal of Remote Sensing*
- Editorial Board, *Physics in Canada*

- Editorial Board, *Remote Sensing of Environment*
- Editorial Board, *The Forestry Chronicle*
- Environmental Mapping and Analysis Program Scientific Advisory Committee (EnSAG) for a spaceborne hyperspectral mission, German Aerospace Centre, Germany
- IEEE Geoscience and Remote Sensing Society
- Member, EnMAP Review Panel in support of applications development for the Hyperspectral EnMAP Mission, German Aerospace Centre, Bonn, Germany
- Past-Chair, Canadian Remote Sensing Society
- Scientific Advisory Committee (SAC), Tecterra, Canadian Networks of Centres of Excellence (NCE) and Alberta Innovates – Technology Futures
- Society of Range Management
- Technical Program Committee, 32nd Canadian Symposium on Remote Sensing, Lennoxville, Québec
- Technical Program Committee, Conference on Sensors and Models in Photogrammetry and Remote Sensing, Teheran, Iran
- Technical Program Committee, SPIE Conference on Remote Sensing for Environmental Monitoring, GIS Applications, and Geology, Berlin, Germany
- Technical Program Reviewer, 2011 IEEE International Geoscience and Remote Sensing Symposium, Vancouver, BC
- Vice-Chair, Canadian Remote Sensing Society

Courses Taught

- Advanced Computer Mapping, Geography 4700
- Advanced Remote Sensing, Geography 4725/5725
- Advanced Remote Sensing Field Techniques, Geography 5710
- Geographic Data and Analysis, Geography 2700
- Geographical Information Systems, Geography 3740
- Geography Field Experience, Geography 3850
- Imaging Science and Technology in Today's World, Physics 2850
- Introduction to Geographical Information Science, Geography 2735
- Introduction to Geography, Geography 1000
- Optics, Physics 3650 and 7650
- Quantum Mechanics, Physics 2150
- Remote Sensing Field Techniques, Geography 4710
- Remote Sensing, Geography 3720
- Seminar in Remote Sensing, Geography 4753/5753


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