



Business Development Plan

Annual Report

April 1, 2006 – March 31, 2007



TRIUMF Annual Report: 2006-2010 Business Development Plan

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1. Introduction

TRIUMF, Canada's National Laboratory for Particle and Nuclear Physics, is a publicly funded research centre, operated as a joint venture by seven member universities and six associate member universities. The member universities are the University of Alberta, the University of British Columbia, Carleton University, L'Université de Montréal, Simon Fraser University, the University of Toronto, and the University of Victoria. The associate member universities are the University of Guelph, the University of Manitoba, McMaster University, Queen's University, the University of Regina, and St. Mary's University.

TRIUMF's ongoing operations continue to be funded by a contribution from the federal government, which is administered by the National Research Council of Canada (NRC). With the completion of the term from the previous Contribution given in 2000, the Federal Government initiated a third five-year funding program for TRIUMF on March 29, 2006. The commitment is \$173.8 million over four years, and, once again, the current Contribution Agreement between NRC and TRIUMF includes the requirement for TRIUMF to maximize its social and economic impact in Canada. Section 10.2 of the Agreement states:

TRIUMF shall develop a Business Development Plan to be implemented over the life of this Agreement, which will assist Canadian high technology firms and entrepreneurs to commercialize technology flowing from the Project and to sell the resulting products in the international scientific market. This Plan should outline measurable goals and targets for the commercialization of TRIUMF technology, and contain a procurement strategy and specific steps, such as the use of an 'open bidding system', designed to maximize benefits to Canadian firms. The Plan must be provided to NRC before 31 March 2006. TRIUMF must report regularly on its success in achieving the goals and targets of the Plan.

The *TRIUMF Business Development Plan 2006 to 2010* (BDP) was delivered to the NRC on March 31, 2006. As with the previous BDP, the current Plan continues to focus on measuring and enhancing the impact of TRIUMF on the entire Canadian economy. It also continues to employ indices which concentrate on and measure output effects from TRIUMF, rather than the traditional approach of measuring inputs. However, the targets themselves should be viewed as evolving challenges, which will be modified to reflect changes in TRIUMF's overall operational plan.

This report is the first in a series of annual reports reviewing the performance of TRIUMF during the past year in relation to the objectives and targets outlined in the BDP. TRIUMF's ongoing success in 2006/2007 is a reflection of the commitment of its entire management and staff to the spirit and objectives of the BDP. In order to fulfill both the requirements and intent of the BDP, the Technology Transfer Division (TTD) is constantly undertaking new commercial initiatives, and has continued with the numerous successful activities over the past year. Profiles on some of these new advancements are presented in the following pages, as well as ongoing enterprises that continue to disseminate TRIUMF's knowledge and technology within Canada.

2. Background - The Five-Year Business Development Plan

The intent of the Business Development Plan (BDP) is to evaluate and enhance the economic impact of TRIUMF in Canada. This requires focusing the indices and their measurement on output effects from TRIUMF, rather than the traditional approach of input measurement. For example, the economic impact of TRIUMF can be measured, in part, by the value of purchase orders placed in Canada during the year. This output may be unrelated to the effort invested by TRIUMF in trying to place such purchase orders in Canada. While the effort employed may be laudable, it does not identify the key factor that is the economic value to Canada of the orders placed. In this BDP, the measurement index is the output parameters; in the aforesaid example, it is the actual value of orders placed. No record will be reported on such input indices as the number of companies contacted, or the number of Canadian companies that remitted quotations.

Inherent in the current BDP is the retention of the systemic approaches that were identified in the previous BDP. TRIUMF has a procurement policy that requires all purchases to be made on an open competitive basis, with a preference for Canadian companies, but only if price and quality are comparable.

TRIUMF's Technology Transfer Division (TTD) is responsible for the commercial interactions in which the laboratory participates. The Technology Transfer Office (TTO) is a small staff that is dedicated to optimizing the commercialization of technologies emanating from TRIUMF's research. Additionally, the TTD is responsible for the Applied Technology Group (ATG), comprised of highly technical individuals who operate and maintain the on-site commercial cyclotrons for one of its major licensees, MDS Nordion, on a daily basis. The Technology Transfer Division's mandate includes the pursuit of all financially and technically viable opportunities for commercializing technologies derived from the research at TRIUMF.

The TTD's mandate recognizes the pre-eminence of scientific research at the laboratory, and seeks to optimize the benefit to TRIUMF and the Canadian economy while minimizing the impact on scientific activities at the facility. In evaluating the BDP targets, it is of paramount importance to remember that TRIUMF is primarily a facility for fundamental research in sub-atomic physics. Unlike commercial enterprises, TRIUMF does not produce "research products" at a constant rate, or with a constant rate of growth. If a target is either under- or over-achieved in one year, it should not be assumed that this has any implication regarding the possibility of under- or over-achieving in the following year.

A summary of the BDP targets for 2006-2010 is presented in Table 1 and further details of TRIUMF's performance on each target are presented in Section 3.

Table 1. Performance Targets: TRIUMF Business Development Plan – 2006 to 2010

Item	Description	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
1	Dollar Value of Sponsored Research for the Year	\$6,000,000	\$6,000,000	\$7,000,000	\$8,000,000	\$8,000,000
2	Number of Disclosures During the Year	10	10	11	11	12
3	Number of Disclosures Reviewed During the Year	9	9	10	11	12
4	Number of Disclosures Funded During the Year*	5	5	6	6	7
5	Value of Funding for Disclosures During the Year	\$60,000	\$65,000	\$65,000	\$70,000	\$70,000
6	Number of Patents Applied for During the Year	8	9	10	10	11
7	Number of Patents Granted During the Year	5	6	6	8	10
8	Value of Purchase Orders Expended by TRIUMF in Canada During the Year	\$12,000,000	\$12,000,000	\$12,000,000	\$12,000,000	\$12,000,000
9	Number of Start-up Companies During the Year	2	2	2	2	2
10	Number of Spin-out Companies During the Year	2	1	1	2	1
11	Number of Licenses Granted During the Year	3	2	2	3	4
12	Cumulative Number of Licenses	14	16	18	21	25
13	Royalty Income for the Year	\$1,200,000	\$1,250,000	\$1,500,000	\$1,750,000	\$2,000,000
14	Contract Income for the Year	\$150,000	\$250,000	\$350,000	\$450,000	\$500,000
15	Number of Students Employed by TRIUMF During the Year	100	85	90	80	95
16	Value of TRIUMF Sponsored Canadian Conferences During the Year	\$800,000	\$800,000	\$900,000	\$1,000,000	\$1,000,000

**An invention may be disclosed in one fiscal year and receive funding in the next fiscal year.*

The following sixteen indices, as reflected in Table 1 above, have been set to measure the economic impact of TRIUMF's activities on the Canadian economy.

1. **Dollar Value of Sponsored Research for the Year** - The annual dollar amount received by TRIUMF for research from the Natural Sciences and Engineering Research Council (NSERC), the Canadian Institutes of Health Research (CIHR), and other external sources.
2. **Number of Disclosures During the Year** - The number of novel inventions or ideas with commercial potential that are disclosed to the TRIUMF Technology Transfer Office during the year.
3. **Number of Disclosures Reviewed During the Year** - The number of possible commercial ideas that are disclosed to the TRIUMF Technology Transfer Office, and that proceed to the next step of formal review during the year.
4. **Number of Disclosures Funded During the Year** - The number of possible commercial ideas disclosed to the TRIUMF Technology Transfer Office that are reviewed and approved to receive development funding from TRIUMF during the year. (*Note: A disclosure that has been reviewed and approved for funding in the current fiscal year may have been disclosed in the previous year.*)
5. **Value of Funding for Disclosures During the Year** - The annual dollar amount invested by TRIUMF into the initial development of potentially commercial disclosures.
6. **Number of Patents Applied for During the Year** - This number reflects the number of inventions TRIUMF submits for patent protection during the year. Each application represents a potential family of patents. Each patent family relates to a single invention. Within each patent family, multiple patents can be sought to provide protection in various countries or jurisdictions.
7. **Number of Patents Granted During the Year** - The number of patents that are granted during the year for TRIUMF inventions. This figure includes patents issued in all jurisdictions. Some patents will correspond to new patent families and others will pertain to existing patent families. In the latter case, each new patent simply extends the number of countries where an invention is protected.
8. **Value of Purchase Orders Placed by TRIUMF in Canada During the Year** - The amount of TRIUMF purchase orders that are placed in Canada during the year, both in absolute dollars and as a percentage breakdown of total purchase orders.
9. **Number of Start-up Companies During the Year** - The number of companies that have been created by TRIUMF staff or students during the year, but without requiring any access to TRIUMF patents or technology.
10. **Number of Spin-out Companies During the Year** - The number of companies that have been created during the year using TRIUMF patents or technology.

11. **Number of Licenses Granted During the Year** - The number of licenses granted during the year by TRIUMF for commercial endeavours.
12. **Cumulative Number of Active Licenses** - The cumulative number of commercial licenses granted by TRIUMF.
13. **Royalty Income for the Year** - The royalty income from its licenses that TRIUMF received during the year.
14. **Contract Income for the Year** - The revenue that TRIUMF received during the year for commercial contract work. Examples include income from the Proton Irradiation Facility (PIF) and the Neutron Irradiation Facility (NIF).
15. **Number of Students Employed by TRIUMF During the Year**- The total number of all students employed by TRIUMF during the year.
16. **Value of TRIUMF Sponsored Canadian Conferences During the Year** - The estimated economic impact of conferences sponsored by TRIUMF. The conferences are broken down by the number of attendees, number of days of each conference and an estimate of the dollar value of the conferences (C\$425 per person day).

In addition, the following quantitative metrics based on **knowledge transfer** were added to the 2006 BDP:

17. **Number of Tour Guests** - The number of guests who attended TRIUMF's public tours during the year. (Statistics only kept for the calendar year)
18. **Number of Saturday Lecture Attendees During the Year** - The total number of students who attended TRIUMF's Saturday scientific lectures during the year.
19. **Number of Industrial Alliances During the Year** - The number of industrial groups with whom TRIUMF has interacted during the year.

The following table, Table 2, on Page 7 summarizes the goals set out for these indices in the BDP and the actual figures attained by TRIUMF for the fiscal year from April 1, 2006 to March 31, 2007. The Technology Transfer Division is constantly undertaking new initiatives in commercial interaction and development, and has continued with the numerous successful activities over the past year in order to fulfill both the requirements and intent of the Plan.

2. Targets and Results for 2006/2007

Table 2. Comparison of Business Targets and Achievements in 2006/2007

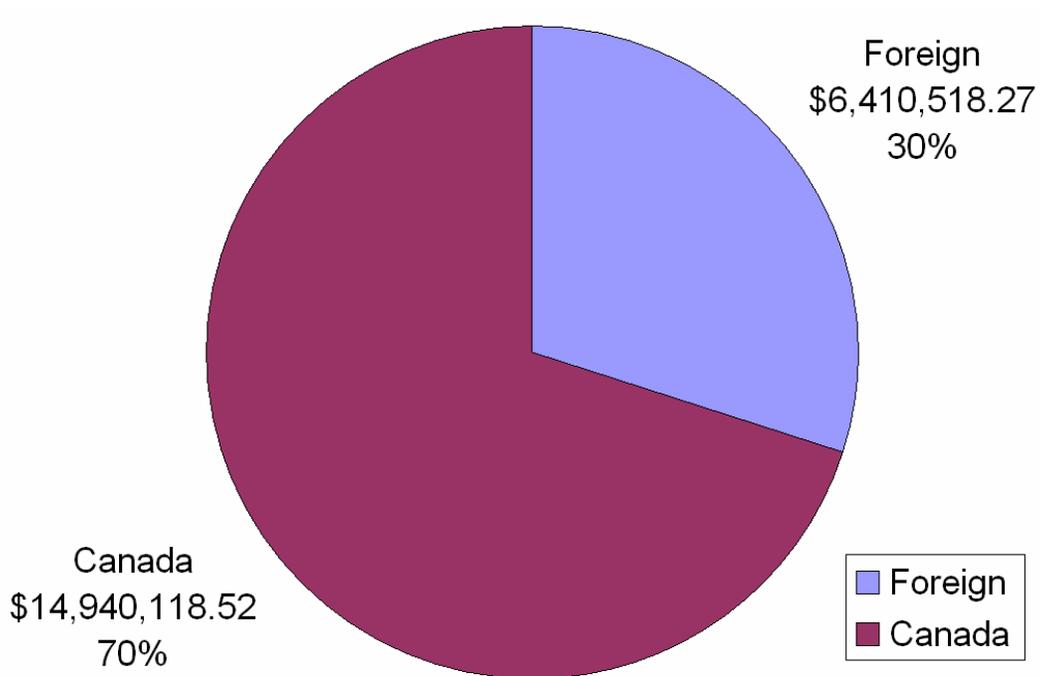
Item	Description	Target	Achievement
1	Dollar Value of Sponsored Research for the Year	\$6,000,000	\$5,766,630
2	Number of Disclosures During the Year	10	6
3	Number of Disclosures Reviewed During the Year	9	6
4	Number of Disclosures Funded During the Year*	5	3
5	Value of Funding for Disclosures During the Year	\$65,000	\$17,000
6	Number of Patents Applied for During the Year	9	35
7	Number of Patents Granted During the Year	6	11
8	Value of Purchase Orders Placed by TRIUMF in Canada During the Year	\$12,000,000	\$14,940,118.52
9	Number of Start-up Companies During the Year	2	0
10	Number of Spin-out Companies During the Year	1	0
11	Number of Licenses Granted During the Year	2	1
12	Cumulative Number of Active Licenses	16	10
13	Royalty Income for the Year	\$1,250,000	\$833,459
14	Contract Income for the Year	\$250,000	\$880,707
15	Number of Students Employed by TRIUMF During the Year	85	59
16	Value of the TRIUMF Sponsored Canadian Conferences During the Year	\$800,000	\$1,169,600
17	Number of Tour Guests (Statistics Only Kept for Calendar Year)	N/A	2067
18	Number of Saturday Lecture Attendees During the Year	N/A	~160
19	Number of Industrial Alliances During the Year	N/A	48

**An invention may be disclosed in one fiscal year and receive funding in the next fiscal year.*

Purchase Order Analysis 2006/2007

TRIUMF's purchasing has a direct impact on the Canadian economy. The following chart summarizes TRIUMF's total purchases, excluding expenditures on power and construction funded by the Provincial Government. TRIUMF's procurement policy gives preference to Canadian vendors, but only if price and quality are comparable. Given the highly specialized nature of certain purchases, foreign supply is sometimes the only viable option.

Chart 1. Purchasing Order Analysis – 2006/2007



TRIUMF Conferences and Workshops in 2006/2007

Conferences and workshops contribute to TRIUMF's scientific and economic impact. These events facilitate the transfer of knowledge and stimulate the economy. The following table summarizes the TRIUMF-sponsored conferences and workshops held during the fiscal year. A simple estimate of the economic impact as also presented.

Table 3. TRIUMF Conferences and Workshops in 2006/2007

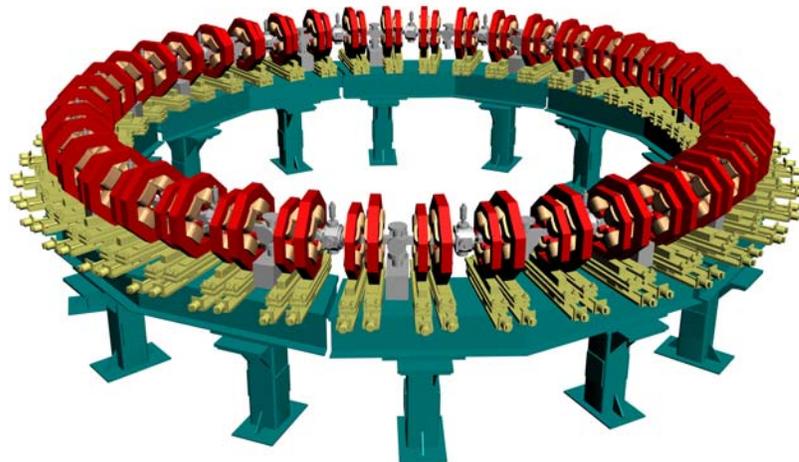
Conference Acronym	Conference	Dates/Location	# of Attendees	# of Person Days
FPCP	Flavor Physics and CP Violation Conference	April 9-12, 2006 Vancouver, BC	106	424
WATD	First Workshop on Actinide Target Development	April 27-29, 2006 Vancouver, BC	41	123
TSI	TRIUMF Summer Insititute - Collider and Energy Frontier Physics	July 10-21, 2006 Vancouver, BC	20	240
VLCW	Vancouver Linear Collider Workshop	July 19-22, 2006 Vancouver, BC	317	1268
TUG SM	TRIUMF Users' Group Summer Meeting	July 26-27, 2006 Vancouver, BC	75	2
TCP	Trapped Charged Particles Conference	September 3-7, 2006 Parksville BC	110	550
TUG AGM	TRIUMF Users' Group Annual General Meeting	December 6, 2006 Vancouver, BC	65	1
WNPPC	Winter Nuclear and Particle Physics Conference	February 16-18, 2007 Banff, Alberta	48	144
TOTALS			782	2752

Number of 'person days'	2,752
Multiplied by the estimated amount spent	\$425
Total amount spent	\$1,169,600

The final column in the table presents the number of 'person days' for each conference, which is calculated by multiplying the number of attendees by the duration of the conference. The estimated daily amount spent per person is \$425. This is likely a conservative estimate of the economic impact, as some attendees stay for extra days to collaborate with TRIUMF staff, to take advantage of inexpensive airfares, or to simply vacation in Western Canada. Thanks mainly to the reputation of TRIUMF scientists and researchers, but also partly to our location in Vancouver, TRIUMF continues to be a popular conference destination. As with other figures, the number of conferences and attendees in a given year will have little bearing on the number of conferences and attendees in subsequent years.

4. Technology Transfer Highlights

- TRIUMF's contract and royalty income for the 2006/2007 year totaled \$1,714,166. This commercial revenue supports Technology Transfer initiatives and further fundamental physics research activities.
- In 2006/2007, the Technology Transfer Division was granted 11 new patents and applied for 14 more. TRIUMF now holds patents representing 35 distinct patent families, and has filed over 174 patent applications in Canada and around the world.
- TRIUMF continues to provide Fluorine-18 to the BC Cancer Agency to support the operations of its PET/CT scanner, which was installed at its Vancouver facility in the Spring of 2005. This scanner is used for medical imaging in the diagnosis and treatment of cancer. TRIUMF is also providing advice to the BCCA on the construction of its own facility for housing its own PET cyclotron and radiopharmacy.
- Two of TRIUMF's researchers have begun collaborations with the British Accelerator Science and Radiation Oncology Consortium (BASROC) on a major international project to build a complete hadron therapy facility using a Non-Scaling Fixed Field Alternating Gradient synchrotron (NS-FFAG). This project has the potential for radiotherapy in the treatment of cancer, and TRIUMF has established an intellectual property agreement with BASROC.



Lattice of EMMA (Electron Model of Many Applications)

The Electron Model of Many Applications will be a 20MeV electron accelerator. It will be an entirely experimental machine used to learn how to design NS-FFAGs for a variety of applications, including hadron therapy for cancer.

5. Technology Transfer On-going Activities

- TRIUMF continues to assist current licensees and other small Canadian companies by providing consultation on technical, research and development issues. See section six for details.
- TRIUMF continues its policy of providing employment to students. There were 59 students employed during this fiscal year; 49 were undergraduate students and 10 were graduate students.
- The Technology Transfer Division continues to produce a regular Technology Transfer Bulletin that presents some of the major technical and scientific initiatives in which TRIUMF has a significant role. The Bulletins are mailed to more than five hundred government officials, industry representatives and university administrators, as well as interested members of the public. Five issues were published in the 2006/2007 fiscal year. Copies of all bulletins are available in PDF format on TRIUMF's public website.
- TRIUMF continues to follow the required procurement policy, which gives preference to Canadian companies where quality and price are comparable.
- The Technology Transfer Division also continues to act as a liaison between the numerous visiting dignitaries and TRIUMF staff. In 2006/2007, foreign delegations to TRIUMF included groups from China, South Korea, France and Italy.



Teachers and TRIUMF staff working with the portable cosmic-ray detectors at a July, 2006 QuarkNet workshop at TRIUMF

6. Transferring Knowledge from TRIUMF into the Canadian Economy

The goal of transferring knowledge from TRIUMF into the Canadian economy is achieved in a variety of ways. New collaborations are forged with companies, hospitals, and academic institutions throughout the country, and TRIUMF provides both technical and business advising to assist companies in commercializing TRIUMF's technologies. Moreover, TRIUMF continues to provide opportunities for the best and brightest students in Canada to work with world-class scientists. The following vignettes feature some of TRIUMF's activities in 2006/2007.

Pacific Parkinson's Research Centre

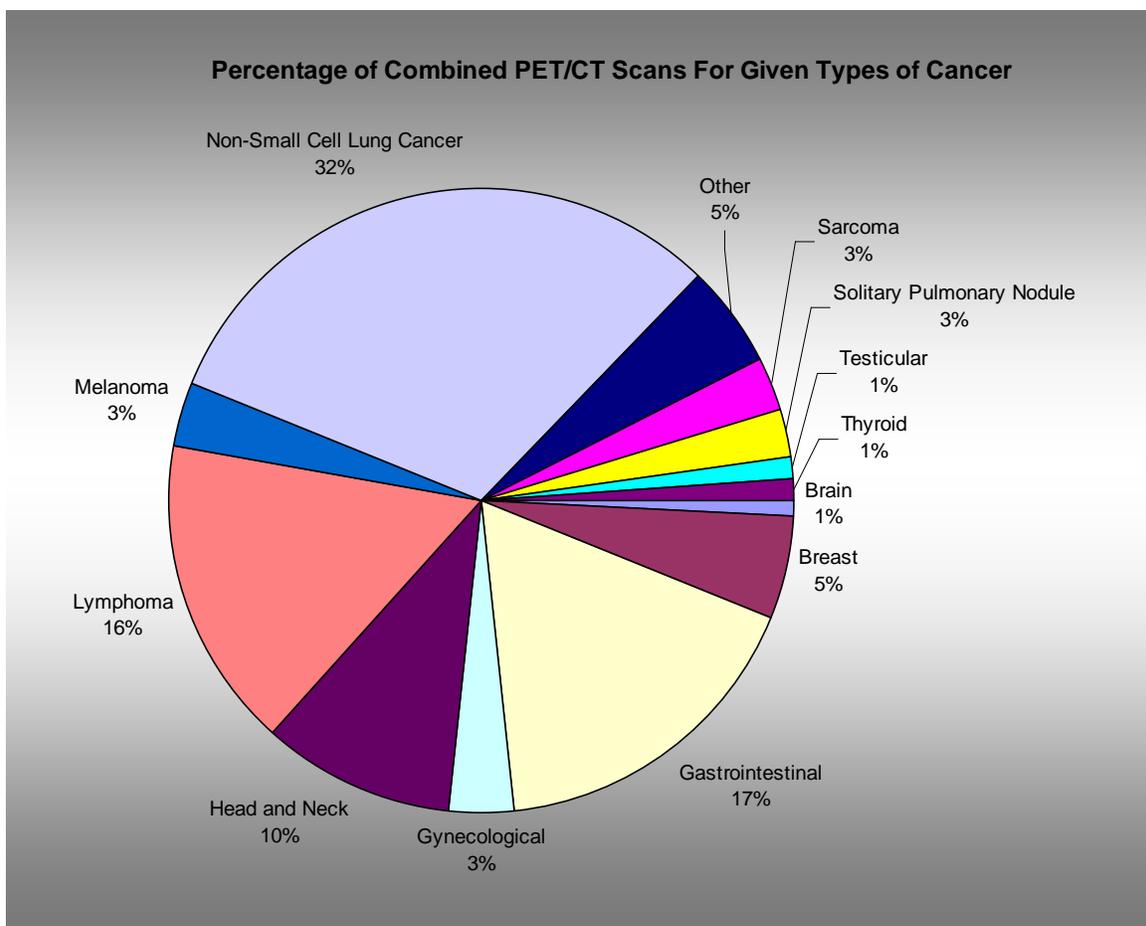
The TRIUMF Life Sciences team has been working closely with the Pacific Parkinson's Research Centre (PPRC) for a number of years. Using positron emission tomography (PET), PPRC manages an imaging program to study dopamine release and its effects in the development of Parkinson's disease (PD). TRIUMF's expertise in medical imaging, in collaboration with PPRC's clinical initiatives and resources, has allowed these organizations to make significant progress in certain areas of PD research. One of the team's highest profile findings was related to using PET to demonstrate that the placebo effect in PD is mediated by dopamine release. This was the most direct demonstration of a physiological basis for the placebo effect. The Canadian Institutes of Health Research (CIHR) Team on PD is an interdisciplinary group of researchers who endeavour to better understand the causes of PD, its complications, and its effects on the function of the brain. The team includes a number of TRIUMF researchers from its PET department, and it studies PD's psychiatric and cognitive components, particularly the high incidence of depression and pathological gambling in PD patients.

Using PET to Study the Regulation of Cortisol by Serotonin Receptors

Researchers at the University of Miami, led by **Dr. Danielle McDonald**, collaborated with TRIUMF's PET group and researchers at UBC to study the short term effects of cortisol on the binding potential of serotonin receptors. The gulf toadfish was selected as the model for this study because of its unique method of excreting distinct pulses of urea when stressed, a process controlled by cortisol and serotonin receptors, and which scientists can observe with relative ease. This will be the first attempt to make use of PET in fish. The experiments have also been designed to determine if the reaction to stress is different based on the location of receptors in different organs. The PET group at TRIUMF supports this research through the production of radiotracers required for the experiments, and also performs PET scans using its microPET small animal scanner. This research can further the understanding of the endocrine systems in vertebrates.

BC Cancer Agency Functional Imaging Program

In 2005, the BC Cancer Agency (BCCA) established a Centre of Excellence for Functional Cancer Imaging with several partner organizations, including TRIUMF. The Centre currently has BC's only publicly funded clinical Positron Emission Tomography/Computer Tomography (PET/CT) scanner. This brand new technology can be more helpful than conventional medical imaging in the pre-operative staging of certain cancer types and in localizing suspected cancer recurrence. To date, the Centre has performed over 4000 scans on both adult and pediatric patients from around the province. BCCA, with funding from the Ministry of Health, has also recently announced an expansion to its current imaging facility to include a cyclotron and radiopharmacy. When complete, this addition will provide BCCA with an increased capacity to produce clinical radiotracers and enable its researchers to develop new ones.



This pie chart shows the types of cancers and their relative percentages of total scans performed at BCCA from June 28, 2005 to March 31, 2007.

Electromagnetic Mass Analyzer (EMMA)

TRIUMF's ISAC-II facility will house a new Electromagnetic Mass Analyzer (EMMA), a device that combines electric and magnetic fields to uniquely identify and separate various nuclei according to their charge and mass. After a nuclear reaction has taken place, it can be used to identify and separate rare nuclei of interest from all other nuclei produced in different nuclear reactions and from the original beam used to initiate the reactions. Although other recoil mass spectrometers have been installed at other facilities in the world, it is projected that EMMA will be the most advanced device of its kind ever built.

The construction of EMMA is supported by a \$2.1 million grant from NSERC, by a \$1 million internal fund, and by seven contributing laboratories in the US, Germany and the UK. Components valued at roughly \$500,000 will be contracted to Canadian companies, and the overall construction is expected to finish in late 2009 or early 2010.

Tokai to Kamioka (T2K)

Scientists from 12 countries are partaking in the Tokai to Kamioka (T2K) experiment to study neutrino oscillations, or the change of flavour of neutrinos. The experiment proposes the projection of a neutrino beam by a high-intensity proton accelerator in Tokai, Japan to the 50 kiloton water detector, Super-Kamiokande, which is located about 1000 m underground in the Kamioka mine. By observing how the neutrinos have changed flavors during the 295 km travel, scientists hope to gain some insight into the nature of neutrinos and our universe as a whole.



Canada's contribution to the development of T2K is approximately 15% of the total collaboration. Canadian scientists are in charge of designing and building some of the most crucial parts of the experiment, such as the remote handling equipment for the neutrino beam line, the time projection chamber, and various detectors. Most of the development work for these parts is being carried out at TRIUMF, where over 50 scientists and technicians are heavily involved with the project. A BC

company was given a \$10,000 contract to extrude scintillator planks for the detector. Thanks to a grant worth over \$4 million from NSERC, Canadian scientists are fully funded for the project, and expect to complete their task in time for the scheduled launch of the neutrino beam on April 1, 2009.

Visitors to TRIUMF

In the 2006/2007 fiscal year, TRIUMF hosted groups of foreign diplomats and visitors from various organizations. They toured the facility and met with TRIUMF's management to establish commercial partnerships and scientific collaborations.

The **China Institute of Atomic Energy (CIAE)** and TRIUMF signed a Memorandum of Understanding in 2006 to share academic expertise for the construction of a 100 MeV cyclotron at CIAE. Between July and September, 2006, TRIUMF hosted **Ms. Hongjuan Yao, Dr. Tianjue Zhang, Mr. Yunlong Lu, and Mr. Bin Ji** to collaborate with TRIUMF's researchers.

Three scientists, **Dr. Jaehong Kim, Mr. Hyun Park, and Mr. Kwangsik Lee** from the **Korea Institute of Radiological and Medical Sciences (KIRAMS)**, came to TRIUMF and MDS Nordion in January, 2007, to visit and engage in discussions about isotope production and radioisotope processing.

In March, 2007, as part of their educational visit to the **Canada International College**, a group of medical doctors from China came to TRIUMF for a tour. They were particularly interested in TRIUMF's Life Sciences program and were given a presentation by **Mr. Jerry Porter**, General Manager of **MDS Nordion's** Vancouver Operations.



TRIUMF staff Philip Gardner (fourth from left, front row), Tom Ruth (fourth from right, front row), and Ann Fong (second from right, front row) accompany a group of medical doctors from Canada International College on their tour through TRIUMF.

Visitors to TRIUMF

TRIUMF's new neighbour, the **National Research Council's Fuel Cells Institute**, had its inauguration on September 12, 2006. As part of the celebration, some 30 guests and staff members of the NRC Institute, including **Dr. Sherif Barakat**, the Vice-President of Engineering, and **Dr. Blaise Champagne**, Director General of the Industrial Materials Institute in Boucherville, Quebec, visited TRIUMF.

On September 19th, 2006, the new French Consul General, **Luc Serot-Almeras**, visited TRIUMF. **Dr. Jean-Michel Poutissou**, TRIUMF's Associate Director and Science Division Head, led the Consul on a tour of the facilities. This gave the two an opportunity to engage in discussions on strengthening the ties with TRIUMF's French sister lab, **GANIL**, in Caen, France.

The new Ambassador of Italy to Ottawa, **Gabriele Sardo**, visited TRIUMF on September 27, 2006, continuing a tradition of fruitful communications between TRIUMF and the diplomatic Italian representatives in Canada.

On October 20, 2006, TRIUMF hosted its **3rd Professional Development Day for high school science teachers**. The 72 registered attendees were given an opportunity to gain hands-on experience with equipment that they would not have in the classroom, such as a cyclotron, radiation detectors, large electromagnets and magnetic field measuring devices. In addition, a group of physics teachers from the QuarkNet program came for a workshop in July, 2006. QuarkNet is a program in the US which supports physics teachers in furthering their knowledge of physics and modern laboratory equipment.



High school teachers at the October, 2006, Professional Development Day during a hands-on activity.

As part of their explorations of the roles that science and technology play in our society, students from **Simon Fraser University's Leonardo Summer Institute (LSI)** visited TRIUMF on June 15, 2006. In the second year of TRIUMF's participation in this program, the students toured through the facilities and attended a presentation given by the Technology Transfer Office. The purpose of the LSI is to provide senior postgraduate students with an exposure to interdisciplinary issues which will enable them to "become in their own careers, the leaders and creative agents for change".

TRIUMF Participates in Malaria Research

Research collaboration is underway between Dr. Mike Adam (left) of TRIUMF and Dr. Chris Orvig of UBC's Department of Chemistry in developing new drugs to combat malaria. They aim to synthesize a family of drugs by combining carbohydrates with a derivative of ferrocene, an organometallic compound. Preliminarily, three of the compounds have shown moderate anti-malarial activity against *Plasmodium falciparum*,



the most devastating of all strains. Malaria has been a long-time antagonist of tropical human populations, most commonly in sub-Saharan Africa. The disease, of which its protozoan parasite is transmitted via mosquitoes from host to host, causes fever, shivering, vomiting, and anemia leading to coma and death if left untreated. The prohibitive costs of mosquito nets and DDT sprays in some developing countries may be responsible for 300 – 500 million new cases reported annually, resulting in up to 2.7 million deaths per year.

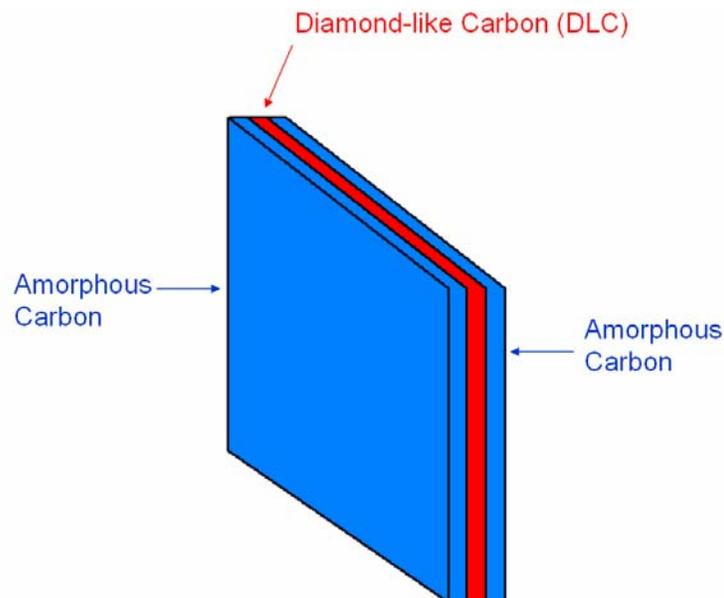
This inter-institutional research project included collaborators from Canada, the U.K. and South Africa. While Dr. Adam waits for results of the drug testing, he anticipates the opportunity to develop new compounds in pursuit of novel methods to fight malaria. “It is exciting that, even though we are as far removed from the ravages of malaria as you can possibly be in Vancouver, one can still make a contribution to its treatment.” The use of these drugs in commercial settings would represent another life science achievement for TRIUMF.

British Accelerator Science and Radiation Oncology Consortium

TRIUMF Researchers Shane Koscielniak and Mike Craddock joined an international collaboration that aims to build a hadron cancer therapy facility by using a novel accelerator technology. Based in the UK, the British Accelerator Science and Radiation Oncology Consortium (BASROC) is planning to use a non-scaling fixed field alternating gradient synchrotron (NS-FFAG), which provides beams of much higher intensity than what is currently available for many applications, including medical isotope production, cancer therapy, industrial materials processing, energy production and subatomic physics. Drs. Koscielniak and Craddock have played a leading role in the development of NS-FFAG's, and hope to maintain Canada's leadership in this field through their association with BASROC.

Innovative Diamond-Like Carbon Foils Made at TRIUMF

Carbon foils are being used at particle accelerators everywhere as extractor or stripper foils – as such, these are a very important part of many of the subatomic processes that take place at TRIUMF. Dr. Stefan Zeisler and Vinder Jaggi, two of TRIUMF scientists, have developed an innovative carbon film, that consists of alternating layers of nano-crystalline, diamond-like carbon and amorphous carbon. In their attempt to find an adequate film for MDS Nordion's cyclotrons, these two researchers and a colleague from Texas, Dr. Nalin Kumar, discovered the benefits of layering foils in a sandwich-like manner. These new films provide extreme hardness, optical transparency, chemical inertness, and high-wear resistance, all of which enable longer foil lifetime, decreased replacement time and cost, and the use of higher beam intensities. In addition, the desired performance of the composite film can be flexibly changed by varying the relative thickness of the each layer.



Official patent applications have been filed for this technology. For the future, these two researchers see applications in nuclear medicine, PET centres, the radiopharmaceutical industry or even a possible spin-off venture, in addition to providing TRIUMF's cyclotron users with high-quality, durable foils. They are excited about using laser ablation techniques to improve the production method, and hope that TRIUMF's recent laser purchase will continue to streamline their manufacturing process and inspire innovative foil production methods.

TRIUMF-MDS Nordion Projects

Building on the momentum from winning the 2004 NSERC Synergy Award for outstanding university-industry collaboration, TRIUMF and MDS Nordion have continued our successful partnership to make products in nuclear medicine for the diagnosis and treatment of a variety of diseases. In 2006/2007, significant upgrades were made to improve the facilities at TRIUMF for producing radioisotopes, and several studies were conducted to search for production of new isotopes and for the production of greater quantities of isotopes that are high in demand.

TR30-1 Hotcell Upgrade

A major project that lasted for two years was the upgrade of the TR30-1 transfer hotcell, one of the most heavily used of its kind at TRIUMF. This hotcell is used for remote handling of the radioisotope production targets, where robotic arms transfer the targets to and from the TR30-1 target stations. The reliability of the transfer was improved and the available space within the hotcell was expanded to greatly improve their utility. Moreover, transfers to and from the hotcell became fully vacuum-powered to improve its cleanliness and eliminate the possibility of spreading contamination.

2C4 Solid Target Facility Upgrade

Rubidium-82 is a radiotracer commonly used in a technique called PET perfusion imaging to identify regions of heart muscle that are receiving poor blood flow. It is produced for MDS Nordion at the Beamline 2C4 Solid Target Facility, which was recently upgraded to improve target handling, positioning, beam diagnostics and monitoring, and target cooling to increase the system's safety and reliability, and to increase the production of Rb-82.

Tin-117 Target

After being approached by a potential customer to make Tin-117, MDS Nordion enlisted the help of TRIUMF engineer **Roberto Pavan**, who studied aspects of the feasibility of producing the product.

Iodine-124/Copper-64 Production

Iodine-124 and Copper-64 are isotopes used in PET scans but are currently only available in small quantities. MDS Nordion and TRIUMF have collaborated to develop novel production methods to produce these two isotopes in commercial quantities. These assessments are on-going.

TRIUMF Summer Research Awards for Canadian Undergraduate Students

Every year, many undergraduate and graduate students are given the opportunity to spend a few months at TRIUMF to gain experience in learning and working in a national research laboratory. In 2000, TRIUMF introduced the annual Summer Research Award, which consists of \$2,000 and a paid four-month summer research internship. It is awarded to five Canadian undergraduate students majoring in either physics or engineering physics who have obtained first-class standings in their programs of study. Each student is assigned to a research project with consideration of his/her stated interests, and the \$2,000 scholarship is awarded upon the satisfactory completion of a work term report. TRIUMF is pleased to announce the winners of 2006.

Louis Gagnon



An engineering physics student from L'École Polytechnique de Montréal, Louis worked under Dr. Rich Helmer on the Tokai to Kamioka (T2K) experiment. He participated in data acquisition and in testing devices for the fine grain detector, which would be used in the T2K experiment in Japan. In his first trip to the West Coast, Louis relished his time in the beautiful mountains, especially through his participation in the TRIUMF hiking club. He hopes to use his experience at TRIUMF to explore the complexities of physics more deeply, and plans to pursue graduate studies and become a teacher.

Evan O'Connor

Under the supervision of Dr. Dave Hutcheon, Evan used a computer model to simulate the mechanism of DRAGON (**D**etector of **R**ecoils **A**nd **G**ammas **O**f **N**uclear **R**eactions), which calculates how fast new elements are formed through nuclear reactions. After completing his physics degree at the University of Prince Edward Island, he plans to obtain Master's and Doctoral degrees in astrophysics and eventually become a professor. Evan particularly enjoyed meeting so many students during his stay in Vancouver, and the friendships that he made were one of the most unforgettable parts of his experience at TRIUMF.



Prateek Khatri



Just before starting his medical degree at the University of Ottawa, Prateek worked with Dr. Tom Ruth on radioimmunotherapy, which involves the use of radiolabeled antibodies for cancer therapy at TRIUMF. His research centred on the efficacy of a rhenium-labeled antibody directed against the insulin-like growth factor (IGF) receptor, a protein which is overly expressed in tumour cells. Prateek aspires to become the President of the Canadian Medical Association, where he could engage in policy-making to strengthen our country's health care system.

Joel Zylberberg

Joel is a chemical physics major from Simon Fraser University in Burnaby, BC. He worked under Dr. Dave Hutcheon to write a computer program that models experiments done in DRAGON; this program will also help with the analysis of future experimental data at DRAGON and other similar facilities. He hopes to apply the modeling techniques that he learned at TRIUMF in future research. Being around other eager students and scientists has taught him a lot about nuclear physics and motivated him to continue in this field.



Peter Winslow



Studying mathematical physics student at the University of Winnipeg, Peter spent most of his time at TRIUMF learning C++ to write a program that will aid in monitoring the quality of data in the TWIST (TRIUMF Weak Interaction Symmetry Test) project. Researching under the tutelage of Dr. Art Olin, he found working with people on the cutting edge of physics to be very rewarding, as there is a sense of urgency at TRIUMF that he did not find in the regular university atmosphere. Previously considering philosophy for his academic path, Peter is exploring the best way for him to satisfy his curiosity, and he hopes to pursue research in physics in graduate school in the future.

Gabriel Lee

Gabriel is studying mathematics and physics at the University of Toronto. While working under the supervision of Dr. Gordon Ball, his main responsibilities were to assemble and test the components of the detector for TIGRESS (TRIUMF-ISAC Gamma Ray Escape-Suppressed Spectrometer), which is used for testing the nuclear shell model. The experience at TRIUMF helped him to gain a greater understanding of the rigours and intricacies of experimental science, especially in projects that involved many groups in various locations. In the long term, Gabriel plans to pursue research in theoretical and mathematical physics.



TRIUMF's High School Fellowship

In 2004, TRIUMF introduced its B.C. High School Fellowship program. This annual award is being offered to two students graduating from B.C. secondary schools and entering the first year of undergraduate studies in the sciences at a post-secondary institution. Administered by the British Columbia Innovation Council, the Fellowship attracts over 100 applications every year. The award includes \$3,000 and an opportunity to work with a research team at TRIUMF. The intent of the Fellowship is to give students who have a passionate interest in science the opportunity to experience a real-life research environment and become motivated to pursue a career in the sciences, especially physics.



High School Fellowship winners Aidan Chatwin-Davies and Elizabeth Du (centre and centre-right) accepted their awards from their supervisors Stefan Zeisler (centre-left) and Barry Davids (right), respectively, and TRIUMF Director Alan Shotter (left).

2006 High School Summer Fellowship Winners

Elizabeth Du

Elizabeth graduated from Churchill Secondary School in Vancouver, BC, and worked with Dr. Barry Davids on determining the reaction rate of an important reaction in the Standard Solar Model. Her main duties were to prepare and set up the experimental equipment and to install a detector in the experimental chamber. Elizabeth is now studying science at Yale University.

Aidan Chatwin-Davies

After completing his secondary school studies at Esquimalt High School in Victoria, BC, Aidan came to TRIUMF to work in the Applied Technology Group. Under the supervision of Dr. Stefan Zeisler, he created a numerical model and produced new design ideas for the construction of a new Oxygen-18/Water target. Aidan is now studying mathematical physics at the University of Waterloo, and he plans to enter doctoral studies in theoretical physics upon graduation.

In the past fiscal year, TRIUMF has pursued projects in both basic and applied science, which have advanced its mission of excellence in sub-atomic physics and provided social and economic benefits to the Canadian economy. Through the dedication of its staff, TRIUMF has continued to build its strong record within our country and throughout the world. With the caveat that expectations must be kept realistic and complementary to our overall mission, the next year promises continued improvements on the achievements to date.

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