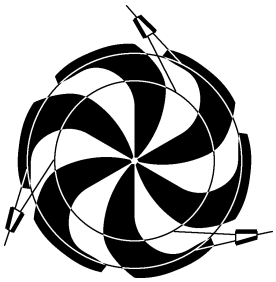
TRIUMF



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CANADA'S NATIONAL LABORATORY FOR PARTICLE AND NUCLEAR PHYSICS

OPERATED AS A JOINT VENTURE

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UNDER A CONTRIBUTION FROM THE
NATIONAL RESEARCH COUNCIL OF CANADA

DECEMBER 2006

The contributions on individual experiments in this report are outlines intended to demonstrate the extent of scientific activity at TRIUMF during the past year. The outlines are not publications and often contain preliminary results not intended, or not yet ready, for publication. Material from these reports should not be reproduced or quoted without permission from the authors.

INTRODUCTION

Over the past few years, TRIUMF has made great strides in retaining and enhancing its premier position as one of Canada's leading scientific institutions. The Five-Year Plan for the period 2005–10 that was submitted for review in 2003 was based on the need to ensure the laboratory maintains its premier position well into the next decade and beyond. The plan was enthusiastically endorsed by various international review bodies. The final outcome for government funding for the period 2005–10 was that the laboratory was awarded a level of funding based on the funding levels for 2000–05. This funding level was significantly lower than recommended by the international review bodies and as a consequence decisions had to be made to delay some major components of the plan. Nevertheless, other funding routes were actively sought during the year to minimize the delays.

The main thrusts of the laboratory during the last few years have been the development of a major facility at TRIUMF for the production of intense radioactive beams, continuing improvement of muon beams for materials science and chemistry, expanding the influence of the life sciences program, and providing resources and expertise to support Canadian teams to lead or significantly contribute to major experimental programs in particle physics both in Canada and at laboratories in other countries. In all these areas, significant progress was made during the year.

The production of intense radioactive beams is technically very demanding. For each isotope requested by the experimenter, a separate development program must be undertaken that involves issues of materials science, chemistry and atomic physics. However, much of the information needed is unknown so the development must begin at a very basic level. In particular, during the year, much progress was made in developing production targets to handle high powers from the primary 500 MeV proton driver beam and developing laser resonant ionization schemes to selectively ionize particular isotopes of interest. The work during the year culminated in the production of the most intense radioactive beams ever produced. In particular, the production of a ^{26}Al beam of several nanoamps enabled measurement of some nuclear parameters relevant for the production of ^{26}Al observed in the galaxy.

The ISAC-I accelerator system accelerates ions $A \leq 30$ up to 1.8 MeV/u. The ISAC-II accelerator under construction will accelerate ions up to 6.5 MeV/u; this accelerator is being built in two phases. The first phase, using superconducting medium-beta rf cavities, was completed during the year and will be ready for first accelerated beams early in 2006. The successful construction of this accelerator is a significant milestone since the technology required was completely new to TRIUMF.

The μSR program at TRIUMF has a high international profile partly due to the limited world wide sources of intense muons, but also due to innovative use of experimental instrumentation to probe the material environment where the muon comes to rest. Picking just two examples from this report shows how diverse and powerful this technique is. A team from Simon Fraser University used this technique to provide a unique insight into the properties of magnetic vortices in type II multiband superconductor $NbSe_2$, and another team from the same university used muons as a surrogate for hydrogen to study chemical evolution processes such as the complex thermal rearrangement of azulene to naphthalene. Both these examples illustrate how the muon probe provides unique insights into the behaviour of materials.

Much of the work TRIUMF has been undertaking over the last ten years in support of the LHC construction at CERN has now come to a successful conclusion. In particular the two largest projects, the 52 twin aperture quadrupoles and the two LHC injector kicker magnet systems, are now completed and all components have been delivered to CERN and successfully tested. These projects were technically very demanding and it speaks volumes for the quality of TRIUMF staff that the projects were completed on time and on budget. Canada has been involved in the management and engineering of the hadronic end cap calorimeters of the ATLAS detector at CERN. Again, this project is drawing to a successful conclusion with the final assembly of the two large hadronic endcaps completed, cold tested and transported to the ATLAS pit.

Other particle physics programs have also made significant progress during the year. The TWIST experiment at TRIUMF involves the precision measurements of the decay parameters associated with muon decay. As with all precision measurements, the dominant concern is understanding and controlling systematic errors and much progress has been made in this area. The group published first results during the year that pinned some of the decay parameters down with two or three times smaller errors than previously published. This success is just reward for many of the experimenters who have been working so hard over several years.

The HERMES experiment at HERA had a successful running period in 2005 producing data that ultimately will yield unique information concerning the proton distribution in the nucleon and how this relates

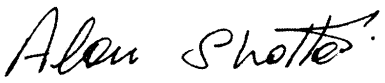
to the spin structure of the nucleon. Preparations continued during the year for two future particle physics programs, one at the TJNAF laboratory in the U.S. ($G\emptyset$ and Q_{weak} experiments) and the other at the J-PARC laboratory in Japan (T2K experiment).

The Theory group at TRIUMF continues to research a wide variety of problems that directly link to the research of various Canadian experimental groups or which are related to some of the leading questions in subatomic physics. I am very pleased that Achim Schwenk agreed to join the permanent staff. His expertise in many-body theory should significantly strengthen several areas of great interest to TRIUMF and university based scientists.

An important aspect of TRIUMF's mission is to transfer its skills and knowledge to society where this is appropriate. Over the years, TRIUMF has achieved major successes for this part of its mission. Of particular note during the year, the 100^{th} patient was treated for ocular melanoma using a special proton therapy treatment at TRIUMF. Also for the past few years, TRIUMF has been collaborating with the BC Cancer Agency to establish a clinical and research PET facility at the Vancouver Cancer Agency headquarters. This collaboration has been very successful and has enabled the agency to rapidly establish the facility using expertise and facilities at TRIUMF. In the years to come, this collaboration will touch the lives of thousands of people in a beneficial way.

Another part of TRIUMF's mission is to nurture and develop the scientific curiosity of young people. Tours of the TRIUMF facilities have been a staple part of this mission and the student summer school program and scientific summer schools are particularly effective ways of developing young people's scientific abilities. In the past few years, TRIUMF has been working with BC science teachers to develop a program that aims to provide them with new ways to arouse the enthusiasm of their students. In particular, this year TRIUMF produced its first educational video for schools that essentially takes a TRIUMF scientific research topic and translates it into basic science concepts that the students learn in the classroom. The relevance of the basic concepts to advance scientific ideas excites students' imaginations. This first educational video is in such demand that it is now circulated to many schools across Canada. This success has resulted in TRIUMF being awarded an NSERC grant to produce further videos.

In a brief account of the year, I can only mention a few highlights, but there has been great progress in many other areas. I would like to thank all TRIUMF staff for their efforts because it is only through their dedication and hard work that TRIUMF is the success it is.



A. Shotter,
Director