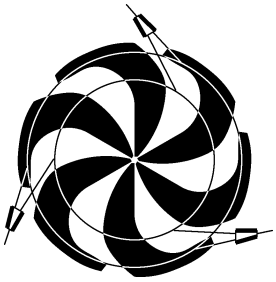
TRIUMF



ANNUAL REPORT
SCIENTIFIC ACTIVITIES
1998

CANADA'S NATIONAL MESON FACILITY
OPERATED AS A JOINT VENTURE BY:

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SIMON FRASER UNIVERSITY
UNIVERSITY OF VICTORIA
UNIVERSITY OF BRITISH COLUMBIA

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UNDER A CONTRIBUTION FROM THE
NATIONAL RESEARCH COUNCIL OF CANADA

APRIL 1999

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

In 1998 the TRIUMF laboratory achieved major successes in all of the components of its program. Perhaps the most visible and outstanding highlight was the delivery of the first radioactive beam from ISAC on November 30. Under normal circumstances this may have been sufficient for a banner year, but 1998 brought an additional crop of achievements at CERN, in our infrastructure role, and in the basic program at the cyclotron.

In the first phase of TRIUMF's "in kind" contribution to the Large Hadron Collider (LHC) at CERN there had been a concentration on the provision of components for the CERN PS complex, involving an upgrade to the energy of the PS Booster and refurbishing of ageing components in general; all in preparation for PS operation as a part of the injector chain of LHC. The delivery schedules set by CERN were tight, with components required for installation into the CERN accelerator complex during the 1997/98 winter shutdown. All of the Canadian components were operational for the machine startup in March, 1998, and have operated without fault throughout the year. The degree of professionalism exhibited by the TRIUMF accelerator physicists and engineers has been much appreciated by their CERN counterparts, who eagerly pursue continued collaboration on other aspects of the LHC project.

The role of TRIUMF as a provider of infrastructure to Canadian subatomic physicists also produced some notable successes, which provided TRIUMF with excellent visibility in some of the world's major laboratories. The drift chamber for the BaBar experiment on the B-Factory at the Stanford Linear Accelerator Centre (SLAC) was delivered to SLAC in March, actually on the day promised a year earlier. The chamber has had a successful commissioning run on cosmic rays and has managed to remain one of the "most ready" subsystems in the BaBar detector. First collisions are currently anticipated for May, 1999. The stringing of this chamber was an excellent example of collaboration between Canadian university physicists, their collaborators from the US and Italy, and TRIUMF staff.

As the BaBar chamber moved out of the cleanroom at TRIUMF, the ATLAS experiment moved in. ATLAS is a large collaboration at LHC, which includes Canadian physicists from the University of Alberta, Carleton University, CRPP, UBC, University of Toronto, University of Victoria, York University and TRIUMF. TRIUMF engineers were responsible for the mechanical design of the hadronic end-cap calorimeter (HEC) and modules of this calorimeter will be built and tested in TRIUMF over the next three and a half years. During 1998 all aspects of tooling and quality assurance have been put in place and module production is scheduled to commence early in 1999.

TRIUMF has had a long-standing engagement in the rare decay experiment BNL E787, which has been performed at the AGS in Brookhaven National Laboratory. This experiment set out to determine the branching ratio for the process $K^+ \rightarrow \pi^+ + \nu\bar{\nu}$. A result was reported last year which is consistent with the prediction of the standard model in the region of 10^{-10}. There was the possibility of revealing new physics had the branching ratio been larger than predicted. Sadly this seems not to be the case. BNL E787 collected its final data in 1998 and will re-emerge in a modestly upgraded version known as BNL E949, which will aim to measure the $\mid V_{td} \mid$ element of the Cabbibo-Kobayashi-Maskawa quark mixing matrix. The single event sensitivity of the proposed measurement is in the region of $(8 - 14 \times 10^{-12})$. BNL E949 measures again the decay $K^+ \rightarrow \pi^+\nu\bar{\nu}$ but with a target of obtaining some 10 events.

In addition to providing infrastructure support for experiments performed away from TRIUMF, the laboratory is providing significant support to two major projects at TRIUMF. One of these is the experiment aimed at making precise measurements of the Michel decay parameters of the muon, Expt. 614, and the other is DRAGON, the recoil spectrometer which is an essential tool for the nuclear astrophysics program which will commence at ISAC towards the end of the year 2000.

At the cyclotron the so-called parity experiment achieved an initial result. The experiment measures the parity-violating longitudinal analyzing power in $p - p$ elastic scattering at 221 MeV, using a 200 nA beam which is $\sim$80% polarized. Enormous demands have been placed on the operating characteristics of the machine and the group has clearly demonstrated that systematic errors are understood and under control at the level of less that 10^{-7}. The early result is in line with theoretical predictions, and a further good data run in 1999 should complete the long and challenging program. The other workhorse at the cyclotron has been the CHAOS spectrometer which has pursued a series of experiments using pions, both elastic and inelastic scattering, with particular emphasis on tests of chiral pertubation theory. The spectrometer is working well and producing good science. Sadly, during 1998, the assigning of priorities within the overall TRIUMF scientific program impinged upon the CHAOS program. This should not be the case in 1999.

Experiments in condensed matter physics and

chemistry, using the μSR technique, have continued vigorously in the laboratory with no signs of a diminishing appetite for beam time. The menu of the basic program continues to include a small but extremely interesting series of experiments in the life sciences.

As mentioned at the beginning, 1998 was really the year that ISAC "came to life". When the first radioactive beam of ^{38m}K was delivered to two experiments before the shutdown at the end of the year. TRINAT, which completed a very successful run at TISOL, was moved, rebuilt, and trapped potassium in its new location at ISAC. TRINAT will continue its search for evidence of scalar currents in the decay of ^{38m}K through a study of $\beta - \nu$ correlations in the detection trap, where the positron and argon recoils are measured. A second experiment received beam briefly at ISAC. It aims to make precision measurements of half lives of nuclei which are of interest in the study of super allowed Fermi transitions in β-decay. Initially ^{36m}K will be studied but later ^{74}Rb becomes the nucleus of interest.

The production of an exotic beam at ISAC was a superb performance by the ISAC project team. Many aspects of the facility had to work reliably in order to achieve the end result, and the science program with the low energy beams can now be confidently anticipated. In parallel, significant progress was made on the accelerator front; for example, very successful tests of the RFQ proved the validity of the design and alignment procedures. These elements can now move into production and accelerated beams of 1.5 MeV/u will be available for experiments before the end of the year 2000.

When TRIUMF received its five years of funding in 1995 a review procedure was put in place such that during the fourth year of the plan a major review of the work of the laboratory would take place. TRIUMF would be assessed on how it had performed in all aspects, and also would receive a critical appraisal of the laboratory's plans for the next five years – on this occasion 2000–2005. In the late summer, with input from the TRIUMF Users and the broader subatomic physics community including IPP, the management produced a plan which initially was presented to the Advisory Committee on TRIUMF (ACOT). The main ingredients of the proposal were an increase in the energy of ISAC to around 6.5 MeV/u, a further contribution "in kind" to the LHC at CERN, and also a modest "in kind" contribution to the ATLAS detector. In order to achieve the goals of the first five years much of the laboratory's infrastructure, including refurbishing of main systems at the cyclotron, had been hit. In the new plan these steps would be slowly reversed. The raising of the energy of ISAC above the Coulomb barrier will provide TRIUMF with an unparalled position in North American radioactive beam physics.

NRC selected the international review group under the chairmanship of Professor Stewart Smith of Princeton University. The group met at TRIUMF, October 21–23.

Initial indications are that the report on TRIUMF's past performance and future plans will be extremely positive. This will give TRIUMF an excellent platform from which to seek additional funding and all of the laboratory staff who have contributed to this strong position should feel very proud.

In July TRIUMF enjoyed a very important, but pleasant privilege. For the first time Canada was host to the Rochester Conference. This is a very prestigious series of meetings where over the years practically every major discovery in high energy physics has been announced. The UBC campus was the selected venue for the XXIX International Conference on High Energy Physics. The speakers and weather cooperated to make the meeting a memorable occasion for delegates who had come from all over the world. The TRIUMF staff who were engaged in the local organization have, in essence, set new standards for the series of meetings.

It is hard to imagine a better year for TRIUMF. It would be easy to lapse. We cannot possibly maintain the peak achieved in 1998 over the long term, but we can sustain the excellence of performance which we learned to enjoy and which is bringing us world recognition for our achievements.

A. Astbury,
Director