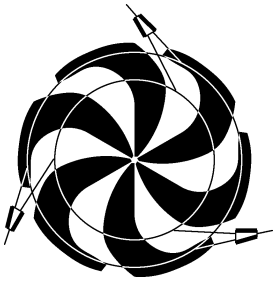
TRIUMF



ANNUAL REPORT
SCIENTIFIC ACTIVITIES
1997

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

UNIVERSITY OF ALBERTA
SIMON FRASER UNIVERSITY
UNIVERSITY OF VICTORIA
UNIVERSITY OF BRITISH COLUMBIA

ASSOCIATE MEMBERS:

UNIVERSITY OF MANITOBA
UNIVERSITÉ DE MONTRÉAL
UNIVERSITY OF REGINA
UNIVERSITY OF TORONTO

UNDER A CONTRIBUTION FROM THE
NATIONAL RESEARCH COUNCIL OF CANADA

APRIL 1998

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

The post KAON era for TRIUMF really commenced in June, 1995 when the federal government announced a funding package of $167 M over five years. Additionally the provincial government provided a sum of $9.7 M to be devoted for civil construction. With the mid 1995 hiatus of downsizing of the laboratory's staff numbers, and a redefining of programs to fit the finances, it could be said that TRIUMF did not finally embark on its five year plan until the beginning of 1996. The need for new funding to be put in place early in 2000 means that the end of 1997 effectively marks the completion of the first half in the existing foreshortened five year plan. It is therefore an appropriate time to take stock.

1997 was the year of civil construction for ISAC as the new building complex slowly grew from a sea of mud in the old parking lot. Vancouver enjoyed exceptional rainfall with 1,327 mm registered between October, 1996 and March, 1997. As a consequence, there were delays, and technical work did not commence in the building until August, some two months later than anticipated. The first evidence of ISAC amidst the dust of ongoing construction, was the installation of the RFQ tank and the off-line ion source. The off-line source produced a beam in October, a little ahead of the final throes of construction which had more or less subsided by November. The tunnel for beam line 2A, which delivers protons to the production target, was ready to receive components in October, although a successful test of the front end of 2A onto a 10 μA beam dump inside the cyclotron vault had been performed in May. The target date for delivery of low energy beam to a relocated TRINAT in November, 1998 still appears realistic.

The initial scientific program for ISAC began to take shape. In April the Workshop on Experiments and Equipment at Isotope Separators (WEEIS) was held in Harrison Hot Springs, B.C. It attracted some 80 physicists, with many from outside of Canada. In July emerging proposals from the meeting were reviewed by a specially convened panel of international experts on science at ISAC. The foundations of the science program are being laid, although final priorities concerning beams and targets remain to be settled.

ISAC is now very visible on the TRIUMF site, and the project is being pursued as vigorously as possible within a laboratory which, in parallel with construction of a new facility, has maintained an active basic program of science on the cyclotron. Inevitably some of the needs of ISAC for human resources have had to be compromised, and it is clear that the delivery of the high energy beam (1.5 MeV/amu) will be delayed until late in the year 2000. However, on completion, ISAC remains a uniquely attractive facility internationally for nuclear astrophysics.

1997 marked the completion of what might be considered as the first phase of TRIUMF's 'in kind' contribution to the Large Hadron Collider (LHC) in CERN, made on behalf of Canada. The total cost of the program is $30 M over the five years 1996–2000, of which $11 M is in salary costs with $19 M of equipment to be delivered to CERN and built into their accelerator complex. The Particle Accelerator Conference in May, which was hosted in Vancouver by TRIUMF, saw a number of presentations by the CERN/TRIUMF collaboration. At the time of this meeting the level of commitment stood at some $12 M out of the possible $19 M.

This first phase has engaged TRIUMF in the provision of components for the upgrade of the PS booster synchrotron and refurbishing in the PS complex. These two veteran machines make up important pieces of the injector complex of the LHC. The winter shutdown in December set the deadline by which all of the Canadian components had to be in CERN. Air freight was used to good effect in a few instances; in the end everything arrived on time and the subsequent post shutdown startup of the PS/PSB complex has shown the equipment to be reliable and in good working order. As a matter of interest some 75% of this equipment was manufactured in Canadian industry. This excellent performance by TRIUMF is much appreciated by the CERN accelerator community, and ongoing collaboration in the LHC is eagerly sought by the CERN management.

As mentioned above, TRIUMF has continued to operate essentially a full basic program around the cyclotron with approximately nine months of beam time per year available for users in the subatomic physics, μSR and life sciences programs. This effort, coupled with ISAC and CERN, has stretched the laboratory's human resources to unreasonable limits on occasion.

In subatomic physics the long standing parity experiment achieved a preliminary result. The quantity selected to be sensitive to parity inversion is a measurement of the longitudinal spin asymmetry in $p-p$ elastic scattering at 223 MeV. The early indications are that the result, which is $\sim 10^{-7}$, is right in line with theoretical predictions. A few further data collection runs with the daunting systematics under control should complete the measurement. The CHAOS spectrometer finally operated for the first time with a highly polarized frozen spin target. This enabled the group to revisit polarized asymmetry measurements in

$\pi^- - p$ elastic scattering over the energy range 30–140 MeV. Some of the existing historic data did not fit too comfortably with the phase shift analysis of the pion-nucleon system. It looks as if the CHAOS results will indeed help to clear up the discrepancies.

In addition to the cyclotron program TRIUMF enjoys an external science program in which some of the TRIUMF scientists are engaged in experiments at non-Canadian facilities in collaboration with university colleagues from across Canada. In August, one of these experiments, BNL Expt. 787, which has been relentlessly pursuing a measurement of the branching ratio for the rare decay $K^+ \rightarrow \pi^+\nu\bar{\nu}$ at the AGS machine in the Brookhaven Laboratory, New York, produced its first event. This project is some fifteen years on from the first proposal, and the result is a credit to the tenacity of all concerned. The decay has fascinated physicists for many years, and its suppression relative to the decay $K^+ \rightarrow \pi^o e^+ \nu$ led directly to the prediction of the charmed quark which was discovered in 1974. Experiment 787 'took over' the decay at the level of $\sim 10^{-7}$ and their one event yields a result of $4.2^{+9.7}_{-3.5} \times 10^{-10}$ for the branching ratio. The standard model predicts a result in the region of 10^{-10} and so appears to be vindicated yet again. The task for E787 is now to obtain a handful of events, which will result in a vastly improved measurement of V_{td} – one of the elements in the Cabbibo-Kobayashi-Maskawa quark mixing matrix.

1997 also saw the approval of Expt. 614, a new major project for the TRIUMF basic program. This experiment will make precision measurements of the Michel parameters which govern μ-decay. The aim is to achieve a precision of a part in 10^4, representing an improvement of approximately two orders of magnitude over existing results. The measurement will probe muon decay to unprecedented levels, but will not come easily. TRIUMF has now to assemble a dedicated team of physicists who can anticipate a decade of undistracted effort if the projected results are to be achieved.

TRIUMF provides important infrastructure support to the subatomic physics community of Canada. This aspect of the laboratory's program is run in close cooperation with the Subatomic Physics Grant Selection Committee of NSERC. Some approved projects are large scale, and TRIUMF has the ability to provide engineering and design effort, technical support, and assembly facilities not easily found in many universities. The stringing of the drift chamber for the BaBar experiment at the SLAC B-Factory was completed just before Christmas, and is an excellent example of a successful infrastructure project. The old HERMES clean room was upgraded by the TRIUMF Detector group to achieve class 200 conditions, and temperature control to $\pm 0.2°$C. Mechanical supports were designed and built in TRIUMF's shops, and 28,768 wires were inserted in fairly short order, using help from robots provided and installed at TRIUMF by BaBar's Italian collaborators. The clean room is currently being improved further, to provide humidity control in readiness for a major building project of calorimeter modules for the ATLAS experiment at LHC. This effort will occupy TRIUMF over the next three and a half years.

TRIUMF's most successful engagement in technology transfer continues to be the collaboration with MDS Nordion in the provision of isotopes for medical use. A strontium-rubidium generator was provided by TRIUMF to the Ottawa Heart Institute. The long lived $^{82}\mathrm{Sr}(\tau_{\frac{1}{2}} \sim 25d)$ is used to provide the short lived positron emitter ^{82}Rb for use in PET scans of the heart. During the year Nordion has been engaged in FDA clinical trials of a new pharmaceutical. A fatty acid labelled with ^{123}I is being used to survey the viability of the heart muscle prior to bypass surgery.

So here we are at half time! With the whiff of possible decommissioning in the air, prior to the funding award in June, 1995, TRIUMF definitely entered the game as an underdog. However, we have mobilized well a very large fraction of our resources. ISAC and CERN have given the laboratory good international visibility. We have delivered on CERN, at least in part; we have yet to deliver on ISAC, but the promise is there. The second half will be no easy ride, but one thing is clear, our future depends on our performance as a basic research facility. We need to get our whole team out on the field with everyone playing as hard as possible if we are going to win!

A. Astbury,
Director