TRIUMF

ANNUAL REPORT
SCIENTIFIC ACTIVITIES
2000

ISSN 1492-417X

CANADA'S NATIONAL LABORATORY
FOR PARTICLE AND NUCLEAR PHYSICS

OPERATED AS A JOINT VENTURE

MEMBERS:

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

ASSOCIATE MEMBERS:

THE UNIVERSITY OF MANITOBA
L'UNIVERSITÉ DE MONTRÉAL
QUEEN'S UNIVERSITY
THE UNIVERSITY OF REGINA
THE UNIVERSITY OF TORONTO

UNDER A CONTRIBUTION FROM THE
NATIONAL RESEARCH COUNCIL OF CANADA

OCTOBER 2001

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.

SCIENCE DIVISION

INTRODUCTION AND OVERVIEW

The previous millennium ended on an excellent note for the Science Division with several notable achievements, as reported in this Annual Report. Just before closing year 2000, the full accelerator complex of ISAC delivered its first (stable) beam. This is the culmination of a four-year effort to develop a radioactive beam facility at TRIUMF which should trigger the data-taking phase of the nuclear astrophysics program next year.

On the way to that, ISAC has produced its first publication in Physics Review Letters from an experiment in the low energy area which measured the lifetime of the short lived ^{74}Rb isotope. Several beams were developed and provided to experiments in the low energy area. Experiment 715 completed its data-taking on the beta-neutrino correlation in the decay of ^{38m}K using the TRINAT facility. With an improved control of the systematic effects, a preliminary test of the standard model was obtained at the 0.5% precision level. Polarization of a ^{8}Li beam was observed and a soft landing test was realized at the beginning of July demonstrating that all the tools are in place to start a condensed matter program with light polarized ions. There is still some more commissioning to go through before routine high polarization operation can be achieved, but all the signs are encouraging and new proposals are being developed. The low temperature nuclear orientation fridge (LTNO) operated several times at temperatures well below 10 mK. Polarization was achieved for implanted ^{79}Rb ions; however, the test NMRON experiment was not successful and there may be good physics reasons for the non-observation of the resonance at the previously predicted location. The tape transport system used for the studies of ^{74}Rb was also used by the Yale group to search for multi-phonon excitations of deformed nuclei in the Er region.

There is also very good progress reported on the preparation for the nuclear astrophysics program, which is the ultimate objective for ISAC-I. The TUDA facility was completed and is ready to accept accelerated beam, while the DRAGON recoil spectrometer was entering its commissioning phase.

The visibility of ISAC has improved considerably and the large number of new proposals being submitted to our Experiments Evaluation Committee is a good measure of the attractiveness of our new facility. This in turn is placing great pressure on our ability to respond to users' requests so, late in the year, it was decided to change our priority to emphasize versatility and reliability rather than pushing on high intensity right away. The new east target station for ISAC has become a high priority item for 2001.

In the base program, our major effort is to install the spectrometer for the TWIST experiment (Expt. 614) which is aimed at a precision measurement of the Michel parameters describing the decay of polarized muons. The magnet, including the superconducting coil and its return yoke, made it to the M13 beam line by Christmas and the production and testing of the 52 high precision drift chambers is well under way. The first half of the tracking system should see beam in the spring of 2001.

Several experiments are in the final stages of analysis. The parity experiment produced its first preliminary result on the asymmetry in polarized proton scattering from protons at 221 MeV. The current precision is at the 3×10^{-8} level and shows a small positive effect. The analysis of the full data set is still in progress. The charge symmetry experiment (Expt. 704) is also in the final stages of the analysis and one can expect a result soon in the new year. A detailed study of the SASP spectrometer acceptance has been necessary and its dependence on the source size is such that one has to rely on the elastic scattering data to validate its simulation. CHAOS completed its data-taking for Expt. 778, the Coulomb nuclear interference experiment in low energy elastic pion scattering, which ran in both M13 and M11. The RMC spectrometer was also active with data-taking on the two-photon radiative capture reactions which could access the pion Compton scattering amplitudes. A collaboration from the UK and TRIUMF took data on the multiple scattering of low energy muons from light targets. This was a preliminary study to assess the feasibility of performing such a test on hydrogen targets, to validate the studies on cooling of muon beams in future muon colliders.

The condensed matter program was also very active, occupying two or three beam lines for most of the seven months of high intensity running. The main themes remain superconductivity and exotic superconductors, magnetism, behaviour of impurities in semiconductors, with a small program in chemistry on free radicals, supercritical water and gas phase reaction rates.

The life sciences program is also in good health and received a major grant from the Canadian Foundation for Innovation to purchase a new state-of-the-art PET tomograph. The demand for isotopes and for radiopharmaceuticals is increasing, as is the acceptance of PET as a clinical tool, placing a heavy load on our production facilities and crew. More efficient production of ^{18}F is being tested to alleviate such problems. Several high purity ^{7}Be targets were also produced and delivered to the University of Washington for the measurement of $^{7}\mathrm{Be}(p,\gamma)^{8}\mathrm{B}$. Preliminary data are available for energies around the resonance at 640 keV. A new phase to push the study towards much lower energies is starting.

A unique program runs at the UBC Botany Department based on the availability of ^{13}N from TRIUMF. This has been recognized internationally as a golden opportunity to study the dynamics of nitrogen uptake in plants. Several major publications resulted from this program this year and the prospects of extending the research to potassium uptake studies with ^{42}K isotopes produced at ISAC are very good.

Our Theory group, built around four staff members, is very active on many fronts thanks to a young group of eight research associates who rotate on a two-year cycle, allowing for wide coverage of theoretical questions. Linkages with the experimental program are sought-after in the hiring of these research associates. Currently the Theory group provides support for the radiative pion capture program, the $^{7}\mathrm{Be}(p,\gamma)$ experiment, and the weak decay studies.

A significant part of TRIUMF's activities is the support of experiments abroad for the benefit of Canadian researchers. The most visible effort at present is the construction of the Canadian contribution to the ATLAS detector at CERN. The hadronic end-cap calorimeter modules are being shipped regularly to CERN and this will continue for the next year-and-a-half. In Victoria, the project to provide the feedthrough connectors for the liquid argon vessel is well under way. TRIUMF's infrastructure is used to support an experiment at the Brookhaven AGS accelerator searching for rare decays of kaons, and to build components of a parity experiment in electron-proton scattering at the Thomas Jefferson National Accelerator Facility.

When you add the support from the service groups, you realize how effective the TRIUMF team can be at delivering science at an international level. This team spirit is key to being able to compete and the laboratory has now built a very strong, cohesive approach to science with the resulting focus and timely delivery which we can be proud of.