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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 2004

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

2003 will be remembered as a year of intense activity, both in the current experimental program and in the shaping of TRIUMF's future through the development of the next five-year plan and the review of TRIUMF by a National Research Council (NRC) appointed international peer-review committee.

In the science program, a strong push for ISAC beams has resulted in a significant growth in publications and invited talks. ISAC science is getting on the mass shell. This is also coupled with two major investments by the Natural Sciences and Engineering Research Council (NSERC) which funded two new instruments: TITAN for ISAC-I and TIGRESS, mainly for ISAC-II. This is a testimony to the quality of the science, the quality of the team behind these projects, and the recognition of the potential of ISAC as the world's most advanced radioactive beam facility.

The challenge for the ISAC team is to produce and deliver intense or rare beams that users request. The operation of ISAC is extremely complex as nothing is routine nor easy and the potential disasters numerous. But, 2003 has seen new beams being delivered – the first major nuclear astrophysics experiment with DRAGON produced final publications and two Ph.D. theses.

The β-NMR team moved towards physics data-taking after a series of commissioning runs.

The 8π detector was improved with additional scintillator detectors and this allowed for coincidence β-γ correlation studies. New information was collected on the ^{11}Li decay using the Doppler broadened γ transition to infer the neutron emission energy. New isomeric states were searched for in the Lu isotopes; a new collinear laser spectroscopy group is starting a program of systematic studies of neutron deficient La isotopes. High precision data were obtained on the vector transition and small branches identified in the decay of ^{38m}K.

Amongst many other results, this shows that the nuclear physics community is now recognizing the opportunities offered by ISAC.

In the particle physics program, a major milestone was reached with the completion of a major contract to provide warm quadrupole magnets for the Large Hadron Collider (LHC), the completion of the endcap calorimeter modules for the ATLAS experiment at the LHC, and the beginning of their assembly and installation in the cryostats at CERN. These investments will be leading to exciting physics by 2007 when the LHC will turn on, and the next five-year plan will be aimed at positioning TRIUMF as a major ATLAS hub for the benefit of Canadian scientists.

A new experiment is being developed to search for the neutrino oscillation evidence with muon neutrinos to be produced at J-PARC. An international collaboration was formed and the Japanese government formally approved the experiment in December with a funding of US $156 million. This will present Canadians with a golden opportunity in science by 2008.

Locally, despite the tragic loss in May of a most valuable team member, J.A. Macdonald, the TWIST experiment made considerable progress towards a 10^{-3} precision determination of the Michel parameters which characterize the angular and energy distribution of positrons from surface muon decays.

Strong support has been received from the Theory group and their enthusiastic contingent of research associates.

Most of the available beam time in the meson hall is devoted to μSR studies of materials. Beam time is distributed amongst four main lines of research:

- studies of muonium as an isotope of hydrogen in semiconductors;
- studies of magnetic materials like frustrated magnets, spin-ice systems, molecular magnets, etc.;
- studies of superconductivity and phase diagrams of novel superconductors, and
- muonium chemistry with two main topics – studies of supercritical water and CO_2, studies of zeolite structures and associated chemical reactions.

The Life Sciences program has been dominated this year by the commissioning of two new PET tomographs funded through the Canadian Foundation for Innovation (CFI). These instruments have generated considerable interest in the community and more demands for specialized tracers are being made from the PET isotope production group.

In 2003, the Laboratory of Advanced Detector Development, also funded by CFI, started to take shape with the hiring of support personnel and the start of equipment purchases.

But the overall activities of the Science Division (and of TRIUMF as a whole) were focused on producing the next five-year plan for TRIUMF and in presenting a strong portfolio of achievements at the NRC International Review of TRIUMF which took place in September. A strong positive endorsement of TRIUMF's performance was achieved, thanks to a dedicated, competent and hard working staff. We are all grateful for the support of our personnel.