Report of the 8th ACOT Meeting

Version 1.1

June 18, 2000

1 Executive Summary

The Advisory Committee on TRIUMF held its 8th meeting on April 14-15, 2000 at TRIUMF. The commitee heard reports on funding, progress on ISAC construction and initial science results, the base subatomic physics programme, materials research, infrastructure support for subatomic physics, the CERN LHC contributions, and technology transfer activities. Overall, the committee is impressed with the accomplishments of the laboratory in all areas.

As this was the first meeting of ACOT since TRIUMF had received a new five-year funding commitment of $200M from the federal government, the focus of the meeting was on the plans for the laboratory to 2005. Since the total amount received was $14M less than requested, the laboratory had developed a new budget for its various activities that ensured the ISAC radioactive beam programme would be fully supported, that the next generation accelerator facility, ISAC-II, would commence construction with completion one year beyond the five-year period, and that the base programme in subatomic physics and materials science would receive adequate support. These represent the core of TRIUMF's research activities over the next five years, and ACOT strongly endorses this prioritization. In meeting its total funding envelope, TRIUMF regretably will have to reduce its proposed second contribution to the LHC collider facility being built at CERN, and similarily will have to reduce the total level of support that it will be able to provide for the ATLAS detector construction.

The initial science results at ISAC show the rapidly evolving potential of the facility. Experiments using radioactive beams directly from the ion source without further acceleration are already making preliminary measurements that rank among the most precise in the world. At the same time, construction of the accelerator components and beamlines that will provide accelerated beams (1.5 MeV/nucleon) for nuclear astrophysics studies are making excellent progress, with commissioning of these components expected by the end of the year. The first experiments that will make use of these accelerated beams are taking form in the ISAC acccelerator hall and are scheduled to be ready by the time accelerated beams are available. Both the base programme in subatomic physics and the materials research effort continue to be scientifically productive, with researchers making innovative use of existing facilities while at the same time developing the next generation of experiments.

TRIUMF continues to make excellent progress on its commitments to furnish components for the Large Hadron Collider (LHC). The focus of activity has been on the production of 52 warm quadrupoles and the fabrication of additional power supplies and electronics. Support for the life science programme continues, though this currently places modest demands on TRIUMF resources.

Plans for the TRIUMF economic impact and technology transfer programme for the next five years are under development. Its mandate has been broadened to be national in scope, and TRIUMF is appropriately developing plans for this activity, building on the success of the last five years.

TRIUMF plans to replace a significant number of retirements over the next five years, while at the same time hire approximately five new staff each year. The success of this effort will depend on a focussed complement plan and hiring strategy. Laboratory management is aware of the complex human resources issues this challenge will present and are beginning the neccesary planning.

2 The Five-Year Plan

TRIUMF received a $200M funding envelope for the period 1 Apr 2000 to 31 Mar 2005. This represents a significant increase to the overall resources of the laboratory and responds constructively to the proposed five-year plan that received strong peer review support. However, this funding level is $14M less than requested, and the laboratory has had to make a number of difficult choices to develop a five-year budget consistent with TRIUMF's resources.

The highest priority of the laboratory will be to complete construction of ISAC and support the science programme using the 1.5 MeV/u accelerated radioactive ion beam (RIB). The laboratory will at the same time build a significant extension to the RIB accelerator, known as ISAC-II, that will provide beams over a much wider energy and nuclear mass range, extending the science focus of this facility significantly. ACOT strongly supports the laboratory's recognition that significant resources ($2M) will be required to refurbish the aging proton cylcotron and the associated beam lines. TRIUMF also plans to complete its commitment to the CERN LHC ($15M of equipment funds during the next five-year period) and continue its infrastructure support role for subatomic physics. ACOT was presented with a draft five-year budget that appeared to be a reasonable compromise between the proposed budget of $214M and what is available.

In addition, ACOT also recognizes the rather difficult hiring and retention challenges TRIUMF faces, and supports its plan to begin to address market forces with modest increases in overall salary levels. In this regard, TRIUMF proposes to make approximately 12 hires per year (this includes the replacement of approximately seven retirements per year). Given the current staff complement of just over 300 full-time equivalents (FTE), this level of hiring requires TRIUMF to develop a comprehensive complement plan that will ensure that the highest priority personnel needs are addressed. ACOT encourages TRIUMF management to complete this plan as soon as practical.

ACOT notes that the province of British Columbia has been approached to secure its commitment to fund the new building construction associated with ISAC-II. Every effort should be made to conclude a funding agreement with the province as quickly as possible in order that the civil construction work on ISAC-II can proceed.

In summary, ACOT endorses the laboratory's priorities and funding allocations for the next five-year period. The committee congratulates the laboratory on its success in securing federal government funding for this period of time.

3 Status of ISAC

ACOT was impressed with the progress on construction of ISAC: Most benchmarks are being met either on schedule or before, and the accelerator should be ready for experiments very close to the original predicted date. By contrast, ACOT was concerned that delays in completing ISAC-II (projected to be one year after the original proposed schedule) could result in missed scientific opportunities. The most significant sources of delay currently arise from uncertainty in the timing of the provincial government's authorization of funds for construction of the required buildings and from the lower NRC five-year funding level for TRIUMF than expected in the ISAC-II proposal, both of which are largely out of TRIUMF's control. ACOT is confident, given the laboratory's

effective management of the ISAC project and the expectation that provincial funding will be made available expeditiously, that TRIUMF will be able to maintain the ISAC-II schedule presented to the committee.

ACOT found the physics program that has already begun with the non-accelerated radioactive beams from ISAC to be very impressive, with new measurements impinging on the very important suggested unitarity violation in the CKM matrix and the TRINAT tests of the fundamental nature of the β-decay process. The nuclear astrophysics program slated to begin as soon as accelerated beams from ISAC are available to experiments in early 2001 also is poised to produce cutting edge science, especially when interfaced with results from observational and x-ray astronomy. ACOT heard little discussion of the physics to be done with ISAC-II, but looks forward to hearing more about this programme at a future meeting.

One concern noted by ACOT is respect to the rapidly dwindling floor space in the non-accelerated beams target area at ISAC. ACOT suggests the TRIUMF directorate manage this space aggressively, lest it be so completely consumed in the early stages of ISAC as to prohibit new initiatives with high scientific priority from being mounted in later stages of the project.

ACOT also discussed its concerns about the manpower associated with the astrophysics program. With the advent of ISAC, TRIUMF has the capability to become a major player in astrophysics. However, that will not be done without more in-house research scientists who will use the facilities and assist outside users in their experiments. ACOT also discussed the need for theoretical support of the astrophysics program. The committee believes that several permanent positions in experiment and theory (possibly created jointly with Canadian universities) are important investments if TRIUMF is to assume a leadership role in the world's astrophysics community.

4 The Base Science Programme

4.1 Subatomic Physics

ACOT was given a review of the base experimental programme by the Associate Director for Research, Dr. Jean-Michel Poutissou, and was given updates on the two largest projects currently underway, a precision measurement of μ decay kinematics (Experiment E614) and a detailed measurement of π-nucleon interactions (using the CHAOS spectrometer). A number of ongoing experiments are in various stages of completion, with the future programme focussing its activities in the meson hall area.

E614, an experiment to measure to unprecendented accuracy the Michel spectrum (the energy distribution of the daughter electron) in polarized μ decays, is making good progress in its construction phase. Considered to be one of the principal efforts in TRIUMF's future subatomic physics programme, TRIUMF technical staff are currently fabricating the precision particle detectors required for the apparatus and commissioning the large superconducting magnet in which the decays will be measured. This remains a challenging experiment that will require significant commitment from the proponents and TRIUMF to be successful. The CHAOS experiment has a number of interesting measurements underway, and is making excellent progress on a detailed study of π-proton scattering. A number of other nuclear and particle physics experiments are in various phases of data collection or analysis, evidencing a focussed but sufficiently diverse science programme.

The committee did not have an opportunity at this meeting to review the life science programme, but was given a brief report indicating that this collaborative work continues to engage a number of TRIUMF research scientists in research involving radiochemistry, radiopharmaceuticals and PET imaging.

4.2 Condensed Matter and Materials Research

Prof. Rob Kiefl reported that ISAC is now the most intense source in the world of various low energy radioactive isotopes, including the alkalais. This opens up a broad range of applications in condensed matter physics. TRIUMF is developing a unique instrument based on β-detected NMR to probe local magnetic and electronic properties of ultra thin structures, interfaces, single crystals and crystals with dilute impurities. This instrument will extend the capabilities of the already very succesful condensed matter physics program based on MuSR.

The polarized beamline and first spectrometer were commissioned in early December 1999. The polarizer will be commissioned in May 2000 and the high voltage platform in July 2000. The experimental program will commence shortly afterward. Initial experiments, using radioactive ^{8}Li, will study the magnetic field distribution of vortices in superconductors. Beta-NMR, combined with MuSR techniques, will greatly broaden the range of capability for probing electronic and magnetic structure in solids at TRIUMF.

Users reported that the MuSR program is progressing well, now that problems with the beam dump have been fixed. This program receives substantial NSERC support through the Major Facilities Access (MFA) program, and technical staff supported by this grant facilitate the use of MuSR beamlines by a large number of users. The user group continues to grow and to better define its needs. Recently in response, TRIUMF has renovated additional working space for MuSR users.

5 Contributions to the LHC Programme

TRIUMF's contributions to the LHC programme fall into two categories: 1) contributions by the laboratory to the LHC Machine complex, and 2) contributions to the Canadian ATLAS project. Presentations were made to ACOT on both aspects, and in this section we describe progress on the LHC components.

The first phase of the LHC contributions consisted of work on the conversion of the Proton Synchrotron (PS) and the PS Booster (PSB). This work is now complete and the PS and PSB have delivered to the Super Proton Synchrotron (SPS), the injector to the LHC, proton beams of the right characteristics. The second phase consists of work on beam instrumentation, power supplies, magnets and beam dynamics. This work is quite advanced and in most areas it is either complete or nearing completion. The main remaining work is on the LHC cleaning insertion magnets and the beam injection kicker system. The order for the first 17 (of 52) of the complex 2-in-1 quadrupole magnets has now been placed with a Canadian company. The order for the remaining magnets should follow very shortly now that the budget for the next five years is assured. The work remaining on the kickers is on the resonant charging power supplies (RCPS) and on the pulse forming networks (PFN). A prototype RCPS was built at TRIUMF and delivered to CERN, and the five RCPS's needed for the machine are essentially complete and being tested. The PFN's of

which nine are needed by 2002-3 are proceeding on schedule. These contributions by TRIUMF to the LHC machine have been highly successful to date and are greatly appreciated by CERN. It is regretable that the TRIUMF's funding levels do not allow for the size of contribution originally proposed by TRIUMF.

6 Infrastructure Support for Subatomic Physics

The TRIUMF laboratory provides technical infrastructure support to NSERC-funded subatomic physics experiments. The largest effort at TRIUMF (15 FTE) continues to be support for the ATLAS detector construction projects, described in an earlier section. TRIUMF scientific and technical staff are assembling one complete endcap of the hadron calorimeter (HEC), with the machining of components for the device being performed at the University of Alberta. The HEC consists of two calorimeter detector layers, called wheels, each composed of 32 pie-shaped modules. The HEC component and module assembly work makes use of several different TRIUMF facilities including the large clean room. The HEC project is now well into production. In addition TRIUMF technical staff at the University of Victoria together with Victoria scientists have completed the development phase and are ready to begin production of the ATLAS liquid argon cryostat signal feedthrough system. The TRIUMF ATLAS group have started to explore possible follow-on projects in the trigger and offline calorimeter reconstruction areas. There are potential links to related work at Alberta and Victoria.

TRIUMF staff are also working on several other projects. The next largest effort involves 8 FTE preparing the equipment for the TRIUMF cyclotron high precision experiment E614 on muon decay. There are smaller TRIUMF efforts on some other current SAP experiments including detector upgrade projects for the second phase of the rare kaon decay experiment E949 at Brookhaven, scintillator counter work for the University of Manitoba part of the G0 experiment at Jefferson Laboratory in the U.S., and detectors for the new forward quadrupole spectrometer recently added to the HERMES experiment at DESY in Hamburg, Germany. TRIUMF also continues to work on selected projects for the Sudbury Neutrino Observatory project. ACOT received a separate presentation on the TRIUMF contribution (about 2 FTE) to the international collaboration developing the GEANT4 simulation software project.

7 Technology Transfer

Mr. Gardner presented ACOT with a status report on his group's activities, and also held private meetings with Drs. Paul Vincett and Jacques Yves Guigné. ACOT considers the changes associated with the new NRC contribution agreement to be strategically positive, as they remove the constraints to hold a Western Canadian preference for technology licensing activities and for the procurement of high technology components. This opens the way for a stronger national presence and for even higher returns for TRIUMF and for the Canadian economy. The emphasis will now be on assisting Canadian companies to become more involved in the commercialization of the technologies and opportunities from TRIUMF.

TRIUMF's technology transfer group now faces an increased workload, with greater cross-Canada demands. A business development plan is required that would outline the steps and targets

proposed to build on its already very successful commercialization efforts. ACOT recommends that the targets should principally involve actual estimated benefit to the Canadian economy and to TRIUMF, rather than the input-type measures that were used in the past. TRIUMF's technology transfer activities have created substantial economic benefits to Canada and to TRIUMF; however the effort requires extra resources to fully realize the potential returns from the technology spinoffs and from outside contracting. It appears likely that at least one additional person would rather quickly become self-financing, and ACOT recommends the laboratory consider addition of such a person (perhaps with some expertise in the Life Sciences area) as soon as possible. In addition, ACOT suggests that during the preparation of the business plan, TRIUMF should look broadly for ways to leverage these efforts. For example, the laboratory may wish to consider (i) whether NRC resources (such as the IRAP organization) could be of assistance in maximizing the effectiveness of this group, (ii) whether the technology transfer efforts could be assisted by some kind of innovative structure for the group, (iii) how to more effectively license the accelerator technology, (iv) whether the efforts would be assisted by establishing a relationship with a financing partner, and (v) how to address the shortage of technical people, perhaps by using retirees.

Appendix A: Membership of ACOT

- Professor Pekka Sinervo, Department of Physics, University of Toronto (chair)
- Professor John Berlinsky, Brockhouse Institute for Materials Research, McMaster University
- Professor Richard Boyd, Departments of Physics and Astronomy, Ohio State University
- Dr. Aaron Fenster,* Director, Imaging Research Laboratories, The J.P. Robarts Research Institute
- Dr. Jacques Guigné, Chief Executive Officer, Guigné International Limited
- Professor P. Gregers Hansen, National Superconducting Cyclotron Laboratory, Michigan State University
- Professor George Kalmus, Particle Physics Department, Rutherford Appleton Laboratory
- Professor Volker Soegel, Director, Werner-Heisenberg-Institut, Munich, Germany
- Professor Richard Taylor, Stanford Linear Accelerator Center
- Dr. Paul Vincett, President, FairCopy Services Inc., A Xerox Company
- Professor Robert Carnegie, Department of Physics, Carleton University (*ex-officio* as Director of the Institute for Particle Physics)
- Professor Colin Jones, Executive Director for International Relations, Simon Fraser University (*ex-officio* as Chair of the TRIUMF Board of Management)
- Professor Patricia Kalyniak, Department of Physics, Carleton University (*ex-officio* as Chair of NSERC Grant Selection Committee for Subatomic Physics)

- Dr. Dallas Santry, National Research Council (ACOT Secretary)

* Dr. Fenster was unable to attend the meeting.

Appendix B: Agenda for the 8th Meeting of ACOT

ADVISORY COMMITTEE ON TRIUMF (ACOT)
8th Meeting
April 14-15, 2000

TRIUMF Seminar Room
4004 Wesbrook Mall, UBC Campus
Vancouver, B.C. V6T 2A3

Tentative Agenda

Friday, 14 April 2000

8:30 a.m. 1. Introduction and Approval of Agenda (P. Sinervo)
2. Minutes of 7th Meeting (D. Santry)
3. Business Arising from the Minutes
4. Closed Session (Committee only)
4.1. Revised Terms of Reference
4.2. Membership

9:00 a.m. 5. Revised TRIUMF Five-Year Plan/ TRIUMF Funding (A. Astbury)

10:15 a.m. Coffee

10:30 a.m. 6. ISAC (P. Schmor) 20 minutes
6.1. Unaccelerated Beam
TRINAT (J. Behr) 15 minutes
GPS (G. Ball) 10 minutes
Polarized Li beam (R. Kiefl) 20 minutes
LTNO Facility (B. Turrell) 10 minutes
6.2. High Energy Beam
Status of accelerator (B. Laxdal) 15 minutes
DRAGON (J. D'Auria) 15 minutes
TUDA (L. Buchmann) 15 minutes

12:15 p.m. Lunch (Committee and TRIUMF Staff)

12:45 p.m. Tour

2:00 p.m. 7. CERN/LHC Contribution (E. Blackmore)
7.1. Current and Future Contribution (E. Blackmore) 45 minutes
7.2. LHC Kickers (G. Wait) 30 minutes

3:15 p.m. Coffee

3:30 p.m. 8. Infrastructure Support (J.-M. Poutissou) 15 minutes
8.1. ATLAS (C. Oram) 20 minutes
8.2. E614 (N. Rodning) 25 minutes

4:30 p.m. Breakout Sessions
5:30 p.m. Return to Hotel
6:30 p.m. Dinner for Committee and TRIUMF Guests

Saturday, 15 April 2000

8:30 a.m. 9. Basic Program (J.-M. Poutissou) 25 minutes
9.1 CHAOS (R. Tacik) 20 minutes
9.2 GEANT4 (P. Gumplinger) 15 minutes

9:30 a.m. 10.Technology Transfer Activities (P. Gardner)

10:30 a.m. Coffee

10:45 a.m. 11. Committee discussion (Closed Session)

12:00 p.m. Lunch

1:00 p.m. 12. Report to NRC Council (Closed Session)

2:00 p.m. 13. Final Discussion with TRIUMF Director.

2:30 p.m. Other Business

3:00 p.m. Adjournment

Concurrent Breakout Sessions
4:30 - 5:30 p.m. 14 April 2000

1. CERN/LHC Contribution
2. ISAC
3. Conventional Programme
4. Condensed Matter Program
5. Technology Transfer

APPENDIX C: List of Abbreviations

- ATLAS – A Toroidal LHC Apparatus at CERN
- CERN – European Laboratory for Particle Physics
- CKM – Cabibbo-Kobayashi-Maskawa
- CHAOS –
- EEC – Experimental Evaulation Committee
- HEC – Hadronic End Cap Calorimeter (for ATLAS)
- HEP – High Energy Physics
- ISAC – Isotope Separator and Accelerator
- LHC – Large Hadron Collider
- MNR – Magnetic Nuclear Resonance
- MuSR – Muon Spin Resonance
- PRC – Peer Review Committee for TRIUMF (November 1997)
- RFQ – Radio-frequency Quadrupole Accelerator
- RIB – Radioactive Ion Beam
- TRINAT – TRIUMF Nuetral Atom Trap
- TRIUMF – Tri-University Meson Facility
- TT – Technology Transfer