THE UNIVERSITY OF BRITISH COLUMBIA

Department of Physics and Astronomy
6224 Agricultural Rd
Vancouver, B.C. Canada V6T 1Z1

Tel: 604-822-3853
Fax: 604-822-5324

21 November 2012

TO: Nigel Lockyer, Director, TRIUMF

The TRIUMF Policy and Planning Advisory Committee (PPAC) met on Nov 1 and Nov 2 to evaluate the proposals for projects to be included into the next TRIUMF Five-Year Plan (5YP). Each such project submitted a 3-page summary of the proposal, including a scientific overview, level of resources required (both from TRIUMF and from external sources), relation to the Canadian Research community and broad impacts of the proposal. 80 such proposals were submitted.

PPAC evaluated these proposals based upon the potential scientific impact (while taking into account an estimate of the resources needed as well), benefit to the Canadian research community, benefit to Canadian industry and society and finally technical feasibility, readiness and likelihood of success.

This report contains a summary of these discussions, and a rough priority ranking of the proposals based on the information available at the time. It is expected that as the details of each project are more fully developed, their relative priority might be adjusted as the resource needs, and ability to fit competing resource requests into a coherent 5YP, become more clear.

The proposals were grouped into broad categories – Accelerators, Business and Administration, Directors Office, Engineering, Nuclear Medicine and Science. Within the Science group the proposals were divided into subcategories to aid in relative ranking.

Many proposals indicate a plan to request outside funding, most often from CFI. As the status of this funding is not known at this point, we assume that such funding will be present. It should be noted that a recommendation to include a particular project in the 5YP is contingent on this funding – it is not a recommendation that the project should be undertaken even in the case that the external funding is not available and TRIUMF must bear the entire cost.

One of the difficulties faced at the start of the 5 year planning process is that proposals are solicited for projects that may be realized 7 or 8 years in the future. The level of development of the proposals submitted for review varied from those

having detailed estimates of funding and resource timelines, to those at a more conceptual stage or with limited information about which lab resources were being requested. A challenge for PPAC was to fairly assign priority recommendations taking these different levels of information and detail available into account.

Overview

The current 5-year program at the lab is, in many ways, a 10-year program. Several of the high-profile, high-cost efforts currently underway will see their scientific output materialize during the next 5-year span, though much of the technical innovation and effort is occurring now. As such, much of this next 5YP should reflect an ongoing commitment to the vision established at the outset of this process. While PPAC evaluated the proposals based upon several criteria, the most important was the quality and timeliness of the science that the proposal would generate, or would enable. A general theme of our recommendations is that proposals that were deemed essential for increasing the amount and range of science produced by the lab were highly favoured. This includes creating the new, high-quality beams required by many of the exciting experiments that will come online during this period, as well as dramatically increasing the availability of total running time for the experiments by enabling multiple users at once. Those projects which have demonstrated excellence in their scientific output and have promising research goals for the next 5 years were also highly recommended. Projects which enable more efficient operation, while extremely useful, generally had a slightly lower priority. Finally, there are a number of projects that are highly dependent upon outside factors – a new accelerator being constructed, approval of an experiment by an outside funding agency, etc. Given the lab is already highly constrained in manpower with the current commitments and a few new efforts, these projects tend to have a lower priority as well. However, given positive outcomes for the external decisions or construction, some could easily become high priority. This is clearly going to be one of the challenges during the next 5-year period – how to retain a level of flexibility to react to exciting new opportunities while completing the existing plan and maximizing the scientific impact of TRIUMF.

We report first on the Science priority rankings as the Science program is the driving force behind most of the lab's activities.

Science

Many of the science proposals contained two parts – a request for ongoing support for the existing research program, and request for resources to support an expansion, or upgrade of the effort. Generally, the ongoing support requests are modest, and are fully supported by PPAC.

Condensed Matter and Materials Science

There were 3 proposals in CMMS:

- Chemistry & CMMP research group
- CMMS infrastructure
- Lithium-8 backscatter facility

The high-priority proposal was:

- CMMS infrastructure – The CMMS capabilities of TRIUMF have expanded significantly, for example via CFI/BCKDF funded beamlines for MuSR. In addition, one of the major goals for the next 5YP should be to dramatically increase the beam availability for betaNMR as well. The highest priority for nuclear science applications in condensed matter physics and chemistry is to fully utilize these new capabilities in the meson hall and at ISAC. This requires a workable solution to vacuum problems in BL1A, upgrading the muSR spectrometers and providing additional manpower support for these unique capabilities.

Of lower priority were:

- Chemistry & CMMP research group – This proposal was for hiring 3 new TRIUMF scientists to spearhead an in-house condensed matter and chemistry group. This would bring TRIUMF in line with other major facilities of its type such as PSI, ISIS, and ILL all of which have a strong local group of scientists in addition to outside users. This is the ideal situation. However the priority for the lab should be to provide at least a minimum level of manpower support so that the facilities can support outside users. Given this situation the committee felt that it is very important for TRIUMF to strengthen its ties and broaden its user base with the Universities. We also support CMMS scientists having some fraction of their time available for research, similar to those in other fields at the lab.

- Beamline and instruments for studies of implantation, backscattering, diffusion and channeling of 8Li – This was considered an interesting idea that proposes to make use of the majority of charged unpolarized 8Li that is currently being wasted in the polarizer when betaNMR is running, since only neutralized Li can be polarized. Thus the proposed facility would operate parasitically with beta-NMR, thereby increasing science productivity without additional beamtime requirements. The prospect of measuring 8Li diffusion using it as a tracer is novel and could attract industrial users e.g. those producing Li batteries. However, the resource requirements need to be refined before it can be evaluated properly. Also the committee felt it is a higher priority to get the current facilities within the CMMS fully operational before any new project is started.

Nuclear Physics

The nuclear physics proposals were the following:

- EMMA
- Gamma-ray spectroscopy
- GRIFFIN compton shields
- High-res laser spectroscopy
- IRIS
- Laser spectroscopy
- Nuclear Astrophysics
- RF buncher for laser spectroscopy
- TITAN
- TRINAT

Several of these contain support for continuing operation during the next 5 year period for research programs that were started during the current 5YP and have been peer reviewed and approved. We fully endorse continuing this path and completing the scientific goals of each. Upgrades to these programs are broken out and addressed below.

The continuing proposals include:

- EMMA
- Fundamental Symmetry studies with laser trapped Francium atoms
- Gamma-ray spectroscopy (TIGRESS, GRIFFIN, DESCANT, SPICE)
- IRIS
- Nuclear astrophysics program (DRAGON, TUDA)
- TITAN
- TRINAT

All of these have reasonable resource requirements during the next 5-year period and PPAC supports their ongoing operation throughout this period.

For new projects, or upgrades to existing facilities, the recommendations follow.

The high priority projects are:

- Griffin Compton shields – These shields were part of the original Griffin design, and are essential for reducing room backgrounds to levels needed for studying beams with low fluxes of rare isotopes.

- Laser/high-res laser spectroscopy upgrade – This allows the measurement of many fundamental quantities of the new isotopes that will be produced and studied by various ISAC experiments, such as spin, charge radius, etc.

- TITAN: EMMA trap – This proposal adds an ion trap system behind the EMMA detector. This will allow the study of the new range of nuclei that are neutron rich that will be delivered by ARIEL.

Projects of lower priority:

- DRAGON upgrade – This would upgrade the acceptance of the detector by approximately a factor of 2 and would be a significant interruption to operation. The committee felt that allocating resources required to develop new beams for DRAGON was a higher priority than an acceptance improvement.

- Francium electron EDM (using fountain) – This project has great scientific interest, and if successful would fit in well with the exploration of fundamental symmetries that is a large part of the physics program planned. However, the proposal needs more detail on the resources expected, as well as comparisons to what competing experiments (such as the directly comparable CYRIC) will have accomplished by the time this experiment may run. If the bulk of the funding and manpower comes externally, this could be a very attractive option for adding a high-visibility experiment at a low cost to the lab.

Particle Physics

The particle physics proposals (in which we have included SNOLAB as well) were the following:

- ALPHA
- ATLAS Calorimeter Upgrade
- ATLAS Tier-1 Data Centre
- ATLAS Upgrade - thin gap chambers
- DEAP
- ILC
- Moller
- nEXO
- ORKA, DeeMee, Comet
- SuperB beam polarization
- SuperB computing facility
- SuperCDMS daq
- T2K and future

- UCN

Most of these experiments take place off-site from TRIUMF, though they may have a very substantial on-site presence.

The highest priority projects in this group are:

- ATLAS Tier-1 – This proposal included significant manpower requests (~10 FTE/yr) as well as capital costs for renewing the Tier 1 hardware that will be requested from CFI. ATLAS is one of the flagship experiments in particle physics, and continuing involvement is a priority for the Canadian research community. The Tier-1 contribution is an essential part of this effort.

- ATLAS upgrades – ATLAS Canada will take part in the detector upgrades required over the next several years, leading up to the High-Luminosity LHC. TRIUMF has played a key role in all aspects of the LHC program in Canada, from the accelerator to detector construction to an active research group to the Tier 1 computing facility. Though neither of the particular proposals submitted are necessarily high priority, continuing TRIUMF's support for detector upgrades through the next phase of LHC physics is recommended.

- ALPHA-2 --The success of ALPHA in trapping and probing anti-hydrogen was a major milestone in the physics program, and garnered much attention, including in the press. ALPHA-2 will allow precision laser spectroscopy on anti-hydrogen, which may provide the best test of CPT symmetry to date.

- T2K – TRIUMF, and the Canadian T2K group, have played leading roles in the design, construction, commissioning, operation and data analysis for the T2K beam and experiment. Continuing this involvement to maximize the science output from this investment is recommended (as high priority). Future involvement in Hyper-K, if approved, will position the group to possibly observe CP violating effects in the lepton sector, which has considerable experimental and theoretical interest.

- UCN -- The Ultracold Neutron project was one of the significant new directions the lab undertook during the current 5YP. Completing the facility and running the neutron EDM experiment during the next 5YP should be a priority.

Medium priority projects are:

- ALPHA-g – With the success of ALPHA, and assuming the success of the ALPHA-2 laser spectroscopy program, ALPHA-g represents another opportunity for an international, high-visibility experiment with strong Canadian leadership.

- DEAP – TRIUMF's main contribution to the construction of DEAP at SNOLAB will be complete in the current 5YP. Continuing support for the maintenance and operation of the electronics has little resource impact, and should be maintained.

- Moller – This experiment proposes to measure $\sin^2\theta_W$ at Jeffereson Lab with significantly improved precision. The resources requested are modest, and will enable the proponents to utilize TRIUMF's detector electronics expertise to collaborate on building the detector for the experiment. Fulfilling this type of role is one of TRIUMF's missions, and so this project is recommended (subject to the approval and funding of the experiment in the US).

- nExo – This proposal is for support constructing a next-generation neutrinoless double-beta decay experiment at SNOLAB using liquid Xenon. The experiment hopes to submit its full proposal to funding agencies at the start of the next 5YP. If approved, there may be overlaps with TRIUMF efforts in photosensor development, for example. The precise role and scale of a TRIUMF commitment was not clear at this point.

- ORKA/DeeMee/Comet – A group of three proposals (of which one would be picked depending on which are approved and funded) covering rare kaon decays and muon-electron conversion. These experiments probe high mass scale physics in a complementary manner to the LHC program. Support is requested to build the tracking chamber for the chosen experiment. Once again, this is an opportunity to enable a group to construct a key detector element that could not otherwise take on this task.

- SuperB Computing Facility – This proposal is for a new computing centre of a size comparable to the ATLAS Tier-1. The extent of the gain from sharing resources (space, manpower) with the ATLAS centre needs to be evaluated – the committee was concerned that the services required were not fully understood and so personnel requirements are unknown. A full study of the hardware and personnel implications of this project should be done. The committee does recognize that having TRIUMF host dedicated computing facilities needed by future experiments can be a cost-effective approach for managing such resources for the Canadian subatomic physics community.

- SuperCDMS DAQ and SiPM readout – SuperCDMS, if approved, would be one of the most sensitive dark matter experiments and would be located at SNOLAB. This proposal requests support for implementing the readout system based upon the MIDAS DAQ from TRIUMF. Most of the funding would come from external sources, and the TRIUMF resources needed are modest. Again, enabling such efforts is one of the core missions of TRIUMF.

Lower priority projects are:

- ILC – With the discovery of the Higgs at the LHC, interest in building a linear collider is increasing again. If approved, there would be substantial support in the Canadian research community. However at this point, the timescale of any approval is unclear and so plans to reserve resources for this are not possible. However, one challenge of any 5YP is retaining enough flexibility to react to such developments.

- SuperB beam polarization – Polarized beams are a powerful tool for doing precision electroweak studies at a B factory such as SuperB. This proposal is for a new TRIUMF scientist to take a leading role in developing and implementing the polarizing technique, which is still under discussion. Additional manpower resources from the Accelerator Division or Detector Group would be required. Most of the capital costs would be requested via CFI.

Detector Development / Infrastructure

- Detector Group infrastructure
- GEANT4
- ILIDD
- Computing Infrastructure

The highest priority projects are:

- Detector group infrastructure – Having access to a high-quality detector fabrication facility was considered an extremely important contribution to University research groups, which often do not have the specialized infrastructure or expertise available for such projects. Contributing to the design and construction of the apparatus (both for on-site and off-site experiments) is a core component of being a full partner in collaborations, and TRIUMF is uniquely suited to enable groups of all sizes across the country in this.

- GEANT4 – GEANT4 is an essential part of the simulation for many of the experiments and facilities used by Canadians. Collaborating on the codebase is both extremely useful in terms of keeping expertise in the area, as well as giving TRIUMF visibility across a wide range of fields. As this project also requires very modest resources, it was supported by the committee.

Medium priority:

- ILIDD – Many researchers from a variety of fields are interested in novel photon detectors. Adding technical expertise in this type of detector could be a valuable addition to the Detector Group's abilities, assuming CFI funding is successful. A specific application, targeted to a need at an approved experiment, is encouraged in order to guide the development effort.

- Computing infrastructure – Maintaining the general computing and communication infrastructure at TRIUMF is clearly required. This type of infrastructure needs continuous attention, but PPAC felt that the lab is in the best position to evaluate the timing and scope of any maintenance or upgrades as budget and manpower allows.

Theory

The proposals in this category were:

- Theory computing cluster
- Theory Group new hires

Medium priority:

- Theory Group new hires – The proposal suggest expansion of the theory group by 1 BAE per year. The group is performing valuable roles, including collaborations with experimental groups that have been very useful. Expanding beyond the current renewal should be subject to the availability of positions after the lab's high-priority needs have been met. This is a potential opportunity that might be met via the joint appointments with universities that are being explored.

Lower priority:

- Theory computing cluster – This proposal was to increase the local computing cluster size from 24 (12 core) compute nodes to 96, along with support staff for running the cluster. The committee recognizes the need for local computing for code development, and some quick turnaround jobs, but felt that projects of the size that require a cluster of this size for

significant amounts of time should explore Compute Canada resources, which are designed with this sort of usage in mind.

Accelerator

The proposed accelerator projects were:

- Accelerator education
- 4th gen light source (IR/THz FEL)
- Accelerators with CERN
- RF power for EBFGT + ADS
- SRF infrastructure upgrade
- SRF cavities & infrastructure develop
- VECC MOU3/MOU4
- 2nd gen 9-cell cavities for e-linac
- ARIEL II - 2nd front-end
- ARIEL II - BL4N
- ARIEL II - east target station convertor
- ARIEL II - e-linac 500 kW
- ARIEL II - Laser ion source
- ARIEL II - west target station for actinides
- ARIEL II - west target station for beta-NMR
- ARIEL proton target station beam dump
- CANREB CFI
- Energy doubler ARIEL RIBs
- SRF kicker for e-linac
- Accelerator controls enhancement
- BL1A refurbishment
- Cyclotron controls to EPICS
- Cyclotron upgrades
- TRIUMF Accelerator Control Centre
- Better beam raster on targets
- Ion-source test stand upgrade – I
- Ion-source test stand upgrade -- II
- ISAC mass separator + LEBT vacuum upgrade
- ISAC-I & -II facility upgrades
- RF power R&D for EBFGT and ADS
- Canadian Centre for Hadron Accelerator R&D
- OLIS upgrade
- TM5 & TM6
- VAST (moved from Science grouping)

The priority rankings in this section

High priority:

- ARIEL II West target station for betaNMR – The ARIEL accelerator project is one of the centerpieces of the current 5YP, and represents an enormous investment in resources from the lab, and Federal and Provincial sources. Continuing the vision of this project driving the next wave of science from TRIUMF is an essential part of the next 5YP, capitalizing upon the foundation that will be completed in the next few years. Establishing a beam to working experiments was ranked as the highest priority, and the most direct route to this was expected to be completing this new target station for the electron beam, with the goal of delivery to the betaNMR program as early as possible.

- ARIEL II West target station, actinides – This is a crucial step in enabling the start of much of the ISAC science program, and so is one of the highest priorities.

- ARIEL Laser Ion source – This is an integral part of the rare isotope beam production, and so has high priority.

- ARIEL II 2nd front-end – This allows two simultaneous electron beams, which will dramatically increase the science output, eg, from the betaNMR program.

- BL1A repair – The full scope of the repairs and refurbishments needed to recover proper operation of BL1A and much of the MuSR program has yet to be determined. TRIUMF has formed a task force to determine possible solutions, timelines and costs. As some muon beamlines are currently being blanked off in the affected area, that part of the materials science program is unable to reach its potential. Repairing BL1A will be extremely costly both in manpower and funds, but should be one of the lab priorities. Particular concerns are the effect that overlap of essential personnel between this effort and completing ARIEL and it's target stations will have on the start of the science program enabled by ARIEL, as well as the extent of the loss of beams to the MuSR program and subsequent loss of scientific productivity.

- CANREB – This addition to the ARIEL front-end will dramatically improve TRIUMF's ability to deliver clean beams of many exotic isotopes to the ISAC detectors, which will enable many measurements that may be difficult or impossible elsewhere. Assuming the CFI funding is successful, CANREB can be an important enabling technology for driving ISAC science in the next 5 years.

- BL4N – Adding in a new proton beamline for up to 3 simultaneous beams delivered to experiments will finally realize a long-standing goal at TRIUMF, and allow a dramatic increase in the science output of the lab. It also provides a different mix of possible beams than those produced by photofission from the electron beam, such as beams for the fundamental symmetries program.

- Cyclotron upgrades – The refurbishing of failing components was considered a high priority. The cyclotron is at the heart of much of the TRIUMF program, and of course maintenance is necessary to ensure continued smooth operation.

Medium Priority:

- Accelerator Education – The graduate-level program the TRIUMF accelerator group has established is fully supported by PPAC. It has close ties to the University community and there is considerable student interest in the program. The committee recognizes that some seed money is necessary to start up such a program, but encourages moving to a steady-state model in which the research project funding comes from the normal peer-reviewed channels in place for grant-eligible researchers.

- Accelerator collaborations with CERN – TRIUMF has a long-standing relationship with CERN that should continue to be maintained. The ATLAS Canada group, for example, is committed to taking a large part in the High Luminosity LHC upgrades and physics program. It is highly likely that Canada will be asked to participate in the upgrades to the LHC, and given TRIUMF's unique expertise, would be the natural partner for this. While the submissions to PPAC for collaboration with CERN were relatively small, we recommend that TRIUMF continue this collaboration, and leave open the possibility of a more significant project related to the LHC upgrade.

- Model based accelerator control – Improving the beam control and diagnostic capabilities will improve the performance and uptime of the TRIUMF beam system. Evaluating these potential gains against the manpower required to implement new control systems is a detailed investigation and best performed by the local accelerator experts.

- ARIEL proton target station beam dump – This proposal will enhance the range of beams available at ISAC, including ones of interest for the nuclear astrophysics programs at DRAGON and TUDA.

- ARIEL II East target station converter development – R&D to develop a converter for the e-linac beam will need to take place in anticipation of a full 500 kW electron beam. However, if the program during the next 5YP focuses on delivering new types and more simultaneous beams, and the front-end runs, eg, with an energy doubler but lower power, this development should not displace higher priority target projects.

- Cyclotron upgrades – The intensity upgrade of the cyclotron was not considered as high priority as, eg, a new beamline or new target station. While the statistical improvement in experiment results due to a higher beam rate is welcome, the committee felt that accelerator resources should first be spent on enabling the new experiments, and subsequently optimizing operation when resources permit.

- ISAC I & II upgrades – This consists of several projects, many of which are addressed separately (eg TM5 and TM6 new target modules below).

- TRIUMF Control Center and Convert Cyclotron controls to EPICS – These projects are currently underway, and must be completed, possibly in the first years of the next 5YP.

- ISAC Mass separator + LEBT vacuum upgrade – As beams from actinide targets become available, the resolving power of the current mass separator will become problematic. Improvements to this system will be needed as resources allow.

- TM5 and TM6 – New target modules for ISAC. Of the 4 current target modules, 2 are no longer functioning. Delivering reliable beam to ISAC is a high-priority recommendation. However, the estimates of the effective lifespan of the two remaining targets are technical details that can only be evaluated by the TRIUMF experts. If they are expected to last many years, the replacements can have a medium priority. However, if they are expected to fail soon, new modules would need to be fabricated even before the next 5YP.

- Canadian Centre for Hadron Accelerator R&D – This proposal contains significant industrial and international partnership components. It represents an opportunity to take TRIUMF accelerator expertise and apply it to projects such as a proton linac with potential future interest on-site or diversified off-site use (nuclear power plants). The commercialization and global reach of this proposal are in line with the TRIUMF mission statement, though the level of resources needed depend on details of these partnerships and external funding.

- VECC MOU3/MOU4 – Partnering with VECC is an important aspect in developing the lab's international connections and reputation. This should clearly continue through the next 5YP.

- Upgrade of the Ion Source Test Stands – There are two such proposals. One refers to upgrading the ISAC test stand to make it similar to the ARIEL front end, which can then be used to test optics, ensure operators are familiar with the setup, etc. This project was recommended with medium priority. The second project involves a development effort of a new target geometry involving backscattered neutrons from a target interacting with a second U target. As we expect the target group to be in great demand, this R&D was considered lower priority than other needs that the group will be addressing.

- Fast beam Rastering on targets – The resources for this were not specified, though they appear under the ISAC facility upgrade proposal. The need and benefit for a fast rastering is clearly a detailed technical question. However, it appears that a significant increase in the maximum power that may be delivered to the targets can be obtained for a small investment, and so is recommended.

- VAST – This R&D effort aims to develop a new target technology for producing many of the beams of interest for ISAC physics, specifically those needed for the nuclear astrophysics program. If successful, the technique would provide an alternative to the current sold-target program currently in place and would be a direct benefit to several ISAC measurements. Significant TRIUMF resources that are likely to overlap with other high-priority projects are involved, so a careful evaluation of the manpower envelope would need to be made by the lab in considering this project.

Lower priority:

- 4th Generation light source – This project would open up a new field of research for TRIUMF using IR light generated from an FEL frontend. While this would enable a different class of materials studies than the current program, the committee felt that there were many challenges in completing the highest priority projects during the next 5 years that take precedence. Further development of a plan for a user program of such a facility should also be explored before committing to a new major research direction for the lab.

- OLIS upgrade – This project has significant resource requirements. The upgrade would improve efficiency and perhaps lower other resource usage. While such gains are welcome, they did not appear critical for enabling the proposed science program.

- Energy doubler for ARIEL RIBs – The small recirculating ring this proposal adds to the e-linac front end would double the beam energy from 30 to 60 MeV, which can lead to enhanced production rates at the targets of approximately a factor of 2.7. While a useful increase, it does not fundamentally alter the science – statistical uncertainties would be lowered by less than a factor of 2. However, if this doubler can be coupled with an accelerating cavity that allows for a beam power of up to 300 kW, this factor is much higher, and the proposal should be ranked higher.

- ARIEL II 500 kW e-linac – This is a significant project in both manpower and cost. If a front-end with the energy doubler can achieve up to 300 kW operation, this reduces some of the need to upgrade ARIEL to the full 500 kW power. Much of the physics enabled by ARIEL will still be possible, albeit with slightly lower statistical precision. The committee felt that the benefits of multiple beamlines, eg, should be prioritized.

- SRF kicker for e-linac – A closer connection to particular science projects should be made for this item.

- SRF cavities and infrastructure development – Upgrading the TRIUMF infrastructure for treating SRF cavities may improve their quality which will facilitate future uses such as for the next-generation e-linac or ERL.

- 2nd generation 9-cell cavity for e-linac – Continuing improvements in manufacturing techniques for the SRF cavities is an important long-term goal, and should be pursued as resources allow.

Nuclear Medicine

The proposals under this category were:

- PET detector development
- Isotope production
- Radionuclide imaging @ UBC, CCM

The high-priority proposals were:

- Nuclear Medicine Centre of Excellence for non-reactor Isotope Research – This is an extensive proposal covering a wide range of needs – from new targets for radiometal production (solid and liquid salt-based), designing and synthesizing radiotracers, replacing the TR13 cyclotron, and adding 2 new scientists to the growing group. This is an area of particular focus for growth at TRIUMF that has clear industrial links and immediate benefits to Canadian society in terms of medical impact.

- Radionuclide imaging @ UBC, CCM – This long-standing program focuses on brain imaging as related to Parkinson's Disease and other neurodegenerative disorders, as well as imaging physics. TRIUMF support for the production of existing tracers and development and implementation of new radiotracers is requested. This area has a large potential for intellectual, technical and industry-related growth for TRIUMF due to the local (UBC) discovery of novel genetic targets and recent CFI funded acquisition of novel imaging equipment installed at CCM.

The medium-priority proposal was:

- PET detector development – This project, while not part of the core focus of the Nuclear Medicine group, could develop a PET compatible with MRI detector for brain imaging. The committee's support assumes both successful requests for external funds for the project, as well as an industrial partner to focus on producing a potentially commercializable product.

Directors Office, Engineering and Tech Transfer

We group together several disparate proposal categories here. The proposals under these categories were:

- Rad monitoring upgrades
- Rad waste management
- Replace transformers
- Replace Meson Hall roof
- PIF & NIF Upgrade
- Isototope Production upgrade
- STF-2 (Solid Target Facility)
- RF power R&D for EBFGT and ADS (moved from Accelerator section)

The monitoring and managing of radiation and waste is a critical aspect of the lab operations, and of course has the highest priority. The need and timescale for replacing the site transformers and Meson hall roof is best considered by the lab management. For the Tech Transfer proposals, again, the details of the financial arrangements, costs, resource needs and profitability, which are not available to PPAC, must determine how these can be accommodated in the next 5YP. For example, the new STF-2 proposal, which requires significant resources (10 FTE, $2.2M) notes "All efforts should be made to engage a commercial partner to share the cost of STF-2 construction". Identifying such partners for these

projects is clearly a priority for the lab's commitment both for financial reasons and as a contribution to Canadian society in general. Similarly, the RF power R&D project would be a partnership with PAVAC that could yield commercial benefits and global impact.

Summary

Ranking 80 projects both within categories of similar proposals and also between disparate fields allows for an unmanageable number of potential priorities. PPAC thus concentrated on finding recommendations for the top projects in each subcategory. However, even among the high-priority projects noted in this report there are several that stand out as being ranked by PPAC as the highest priority across all categories. These are driven by their importance in enabling the lab to continue to increase the amount and range of scientific output from the TRIUMF program.

- ARIEL II projects that are required for the needed beams to be delivered to the CMMS and ISAC programs, such as the ARIEL target stations, second ARIEL front-end, new proton beam line and related projects.
- Operation of the ISAC program
- ATLAS Tier-1 operation
- BL1A repair, though the importance may change based upon the task force findings of difficulty, cost, impact on oversubscribed resources and loss of science output expected.

The vision for the lab future that was introduced at the start of the current 5YP should be continued through the next 5YP. With the projects recommended in this report, significant diversification and increase in the science produced by the lab will be realized in this period, as well as growing the range of technology partners and global connections that the lab enables. Including input from the Canadian research community at the outset of the planning process is a valuable component in producing a plan that will impact a broad range of exciting research directions and technological innovations, and PPAC recognizes TRIUMF's leadership for promoting this involvement.

On Behalf of the TRIUMF Policy and Planning Advisory Committee,

Colin Gay (Chair)
Prof. of Physics, University of British Columbia