Proposal for TRIUMF Commitment (5YP 2015-2020)

Date: 2012/10/18

PROJECT/COMMITMENT TITLE: Geant4 Collaboration and Application Development

PROPONENT: F.W. Jones **TRIUMF CONTACT: Fred fwj@triumf.ca**

PRINCIPAL COLLABORATORS: P. Gumplinger, R. Baartman, Y.-N. Rao

PROJECT DESCRIPTION:

(1) To continue TRIUMF's participation in Geant4 (http://cern.ch/geant4/) as an institutional member and through individuals including Frederick Jones, who is a contributing member in the Geant4 Hadronics and Visualization working groups, and Peter Gumplinger, who is a contributing member in several groups, notably as a specialist in optical photon transport in the Electromagnetic Physics working group. Further contributions in these areas are planned.

(2) To develop and maintain Geant4 applications for TRIUMF experiments and facilities, and to support the use of the Geant4 software by researchers at TRIUMF and its partner institutions.

The activities include the following.

TRIUMF applications in Experimental Physics:
To design and develop Geant4-based simulation frameworks for detector development programs as well as specific experiments based at TRIUMF and our partner institutions (e.g. UCN, PIENU, wavePET, T2K/ ND280 and ALPHA). To develop new Geant4 capabilities (e.g. neutron spin tracking for UCN) needed by the TRIUMF community (this overlaps with collaboration activities outlined below). To provide consultation and user support to Geant4 users in the TRIUMF community, for technologies developed at AAPS, and in general to researchers across Canada.
To keep users informed about existing and planned capabilities in Geant4, deploy development versions where appropriate, and consult about emerging high-level Geant4-based tools (e.g. WCSim and musrSim). In general to promote awareness and effective use of what Geant4 provides.

TRIUMF applications in Accelerator Physics:
To develop comprehensive and accurate simulations of accelerators and beam lines, in a modelled 3D geometry, in order to study and quantify beam behaviours in these systems that are not accessible through other simulation and beam optics codes. Particular applications are to TRIUMF's primary and secondary beam lines to better understand and control beam losses, efficiency, and secondary beam production and transport. To collaborate with accelerator and beam line groups at TRIUMF to pursue new Geant4 applications, by providing expertise in problem definition, software development, and post-processing analysis and graphics. To consult with all Geant4 users on installation and configuration issues.

TRIUMF activities within the Geant4 Collaboration:
To develop and maintain software modules for the Geant4 toolkit and perform other tasks to satisfy our membership obligations in the Geant4 Collaboration. These will include developments in optical photon transport models, hadronics (cross section data and validation) and visualization (3D interactive viewing and instrumented navigation), as well as participation in the Steering Board (P.Gumplinger) and other planning and support activities.

SCIENTIFIC JUSTIFICATION:

Geant4 is an essential simulation tool which is broadly applied across a range of experimental programs at TRIUMF and at our collaborating institutions. There are too many to list here, but current examples include Atlas, T2K near detector, HYPER-K (proposed), PIENU, TIGRESS, EMMA, TRINAT, Mu+H2, UCN, DEAP/CLEAN, and the ALPHA antihydrogen experiment at CERN. The large number of users and scope of applications is a reflection of the success of Geant4 in providing a versatile, extendable, and scalable application toolkit to which many physics and computing experts have contributed their knowledge. Geant4 is developed, distributed and supported by an active collaboration, with significant resources and expertise being devoted to refinement, advancement and diversification of physics models, as well as their validation against experimental data.

In the field of Accelerators and Beam Lines, the Geant4 software is unique in its ability to model complex 3D geometries and to accurately track particles through electromagnetic fields and materials over a wide range of distance scales. For TRIUMF this allows both a much more comprehensive, and yet more detailed, picture of beam transport and losses in our facilities. The range of potential new applications is large, with one example being the secondary muon lines where state-of-the art physics models and fully 3D geometry and tracking can replace the limited Fortran codes that are currently in use.
TRIUMF expertise in graphics and visualization allows us to develop advanced visualization techniques which are welcomed by the Geant4 collaboration and are well-adapted to the needs of beam simulations, in fact with viewing capabilities not commonly found in beam physics codes. These facilities are crucial to developing a correct simulation and to understanding the results, as well as having educational value.

RELATIONSHIP TO BROADER CANADIAN RESEARCH COMMUNITY:

In addition to the many groups at TRIUMF using Geant4 there are users across Canada, including notably the Atlas collaboration, underground physics experimenters at SNOLAB, medical physics researchers at Ulaval/CHUQ and McGill, and scientists at AECL. TRIUMF is known as the “go-to” place in Canada for advice and consultation about Geant4, as well as to discuss the simulation needs of new experiments and facilities being planned.

TRIUMF membership helps to maintain a strong Canadian presence in the Geant4 Collaboration as well as allow us direct access to the experts in many fields that make up the collaboration. It is by membership that we are able to maintain real expertise in how the software works and how to apply it effectively. The best understanding of complex software comes from actually working on it and through communications with other team members. Our membership in the steering board and numerous working groups gives us influence on where developments are going and what new initiatives are being pursued.

Canadian researchers receive much from Geant4 and this is our opportunity to “give back” most effectively.

BROADER IMPACTS:

As a member of Geant4, TRIUMF has made many important contributions to this international collaboration for the development of advanced simulations of particle transport and particle interactions in matter, enabled by our strengths in particle and nuclear physics, optical physics, detector development, Monte Carlo physics models, computing and graphics. We are well regarded within Geant4 and within its user community, which spans high energy and nuclear physics, medical physics, space and underground physics, and a growing presence in accelerator physics.
The open-code and liberal licensing policies of Geant4 provide opportunities for the commercial and non-profit business sectors, examples being Geant4 Associates (http://www.g4ai.org/) and the G4Beamline product from Muons Inc (http://www.muonsinc.com).

MAJOR MILESTONES:

Description	Date

RESOURCE REQUIRMENTS:

CASH FLOW REQUIREMENTS						
\YEAR SOURCE \	ONE	TWO	THREE	FOUR	FIVE	TOTAL
TRIUMF						
EXTERNAL						
TOTAL	$10K	$10K	$10K	$10K	$10K	$50K
TRIUMF NON-CASH RESOURCES						
\YEAR RESOURCE\	ONE	TWO	THREE	FOUR	FIVE	TOTAL
FTE Accel Div	0.25	0.25	0.25	0.25	0.25	1.25person-yr
FTE Science Div	0.25	0.25	0.25	0.25	0.25	1.25person-yr

EXTERNAL FUNDING INFORMATION:

ONGOING OPERATIONAL REQUIREMENTS:

DECOMMISSIONING REQUIREMENT:

Accepted: Date:

Instructions for Proposals for TRIUMF Commitment 5YP 2015-2020

Date: Date the form was submitted to TRIUMF.

Title: The title the commitment will be known by.

Proponent: Name of the spokesperson or principle investigator for the proposal.

Local Contact: Name of a person located at TRIUMF who can act as a liaison person between TRIUMF and the project if different than the proponent

Principal Collaborators: A list of the principal faculty and professional collaborators (both TRIUMF and external). The list should only include collaborators who will devote more than 20% of time to the project or who will make a major contribution.

Scientific Justification: What is the scope of the activity? What science questions will be pursued? How is this topic activity "ripe" for exploitation?

Relationship to Broader Canadian Research Community: How does the activity fit into the broader Canadian university-research program? How does this project draw upon or expand TRIUMF's core capabilities? How does the activity fit into the international context (is it collaborative or competitive and with whom)?

Broader Impacts: In terms of three federal government "advantages," (people, knowledge, and entrepreneurial), what broader impacts would this activity have? Please be as specific as possible.

Milestones: A list of the major milestones for the project including the delivery date for each major deliverable. The uncertainty in the dates should be indicated. This should also include proposal deadlines and external funding agency decision dates. For Project Summary Sheets completed after the Gate 1 Review include milestones already reached.

Cash Flow Requirements: The cash flow for the project broken down by year. Please identify the uncertainty in the estimates (e.g. ± 10%).

From TRIUMF: This should include all cash contributions required from TRIUMF but should not include salaries that are captured on the bottom part of the table.

External: The total cash contribution from non-TRIUMF sources. This includes NSERC, CFI and foreign contribution.

Total: Total cash flow for the commitment. For the last column the total should include funding for all years not just those years in the table.

TRIUMF Non-Cash Resources: Indicate the TRIUMF resources required by type and year. For manpower, the resource name should be taken from the Skill List and used in the form: Administration.Communications for example. In most cases the appropriate unit will be FTE-weeks. If different units are used please indicate.

Where appropriate also include none manpower resources such as beam time. For projects the **TOTAL** should include all years not just those in the table.

External Funds: List the amount of all external funds and their source. Indicate the current status of the funding requests: funded, requested, application planned. If the external funds are yet to be awarded indicated the expected date of the funding decision.

Operational Requirements: If the project involves building a device or bringing one to TRIUMF, what operational requirements will it place on TRIUMF after it is commissioned? For ongoing commitments what are the steady state resource requirements.

Decommissioning Requirements: If the project involves building a device or bringing one to TRIUMF what are the resources required to decommission the device after its useful lifetime.