



Committee / Panel	19
Date	2002/09/23

**FORM 101**  
**Application for a Grant**  
**PART I**

Family name of applicant <b>Marshall</b>	Given name <b>Glen</b>	Initial(s) of all given names <b>GM</b>	Personal identification no. (PIN) <b>49910</b>
Language of application <input checked="" type="checkbox"/> English <input type="checkbox"/> French		Time (in hours per month) to be devoted to the proposed research / activity <b>180</b>	
Type of grant applied for <b>Subatomic Physics - Project</b>		For Strategic Projects, indicate the Target Area and Sub-area(s), if applicable	

Title of proposal  
**TWIST - Precision Measurement of Muon Decay Parameters (TRIUMF Experiment 614)**

Write a maximum of ten (10) key words that describe this proposal. Use commas to separate them.  
**muon decay, Standard Model test, Michel parameters, weak interactions, leptonic interaction**

Research subject code(s) Primary <b>3104</b>	Secondary <b>3106</b>	Area of application code(s) Primary <b>1202</b>	Secondary <b>1200</b>
--	--------------------------	---	--------------------------

**CERTIFICATION REQUIREMENTS**

If this proposal involves any of the following, check the box(es) and submit the protocol to the university certification committee.  
 Research involving humans     Research involving animals     Research involving biohazards

Does any phase of the research described in this proposal a) take place outside an office or laboratory, or b) involve an undertaking as described in Part 1 of Appendix B?  
 NO     If YES to either question a) or b) – Appendices A and B must be completed

**TOTAL AMOUNT REQUESTED FROM NSERC**

Year 1 <b>385,000</b>	Year 2 <b>475,000</b>	Year 3 <b>533,700</b>	Year 4 <b>562,363</b>	Year 5 <b>571,544</b>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

**SIGNATURES (Refer to instructions "What do signatures mean?")**

It is agreed that the general conditions governing grants as outlined in the NSERC *Program Guide for Professors* apply to any grant made pursuant to this application and are hereby accepted by the applicant and the applicant's employing institution.

\_\_\_\_\_  
 Applicant  
 Applicant's department, university, tel. and fax nos., and e-mail  
**Science Division**  
**TRIUMF**  
**Tel.: (604) 2227466**  
**FAX: (604) 2221074**  
**glen.marshall@triumf.ca**

\_\_\_\_\_  
 Head of department  
 \_\_\_\_\_  
 Dean of faculty  
 \_\_\_\_\_  
 President of university  
 (or representative)

Personal identification no. (PIN)

49910

Family name of applicant

Marshall

**CO-APPLICANTS**

I have read the statement "What do signatures mean?" in the accompanying instructions and agree to it.

PIN, family name and initial(s)	Research/ activity time (hours/month)	Organization	Signature
10983, Kitching, P	70	Alberta	
11018, Stinson, G	45	Alberta	
7443, Hasinoff, M	45	British Columbia	
7665, Depommier, P	60	Montréal	
15539, Mathie, EL	35	Regina	
127524, Tacik, R	50	Regina	
127911, Doornbos, J	90	TRIUMF	

**CO-APPLICANTS' ORGANIZATIONS AND/OR SUPPORTING ORGANIZATIONS (if organization different from page 1)**

It is agreed that the general conditions governing grants as outlined in the NSERC *Program Guide for Professors*, as well as the statements "What do signatures mean?" and "Summary of proposal for public release" in the accompanying instructions, apply to any grant made pursuant to this application and are hereby accepted by the organization.

Family name and given name of signing officer, title of position, and name of organization	Signature
Poutissou, J.-M. Associate Director TRIUMF	

Personal identification no. (PIN)	Family name of applicant
49910	Marshall

<b>CO-APPLICANTS</b>			
<b>PIN, family name and initial(s)</b>	<b>Research/ activity time (hours/month)</b>	<b>Organization</b>	<b>Signature</b>
11003, Gill, DR	200	TRIUMF	
127836, Helmer, R	40	TRIUMF	
154492, Henderson, R	100	TRIUMF	
12909, Macdonald, JA	70	TRIUMF	
49910, Marshall, GM	180	TRIUMF	
12905, Olin, A	80	TRIUMF	
17252, Poutissou, R	90	TRIUMF	
11034, Poutissou, J-M	50	TRIUMF	
7864, Shin, YM	80	TRIUMF	

Personal identification no. (PIN)

49910

Family name of applicant

Marshall

**SUMMARY OF PROPOSAL FOR PUBLIC RELEASE (Use plain language.)**

This plain language summary will be available to the public if your proposal is funded. Although it is not mandatory, you may choose to include your business telephone number and/or your e-mail address to facilitate contact with the public and the media about your research.

Business telephone no. (optional): 1 (604) 222-7466

E-mail address (optional): glen.marshall@triumf.ca

The TRIUMF Weak Interaction Symmetry Test (TWIST) is a search for tiny deviations from the pattern of muon decays predicted by the very successful Standard Model of particle interactions. The Standard Model, a theory which agrees with many observations over many years, is nonetheless believed by most subatomic physicists to be only an approximation to a more basic and precise model whose properties are as yet not known. The Standard Model is incomplete and leaves several questions unanswered, for example, why just three generations, and why do the particles have the masses they do?

The Standard Model classifies the most fundamental particles into three "generations"; only particles of the first or lowest generation make up the materials of our everyday lives. The muon is the lightest and most accessible fundamental charged particle of a higher generation. It nearly always decays into an electron and two very light, elusive, neutral particles called neutrinos. High quality beams of muons are produced at TRIUMF, and a very high precision detector system in a high solenoidal magnetic field is used to accurately measure the direction and energy of the positive electron (or positron) produced for each of billions of positive decays. The pattern or symmetry of these decays is precisely predicted by the Standard Model.

If found, a deviation from expectations based on the Standard Model would provide clues to the character of a more basic description of the smallest particles in our universe. On the other hand, if no deviation is found,

**Second Language Version of Summary (optional).**

Personal identification no. (PIN) 49910	Family name of applicant Marshall
--	--------------------------------------

**RESEARCH ACTIVITY SCHEDULE**

(Refer to instructions to see if this section applies to your application. Use additional page(s) if necessary.)

Milestone	Description of activities	Anticipated starting date	Anticipated completion date

Personal identification no. (PIN)

49910

Family name of applicant

Marshall

**REFERENCES**

Before completing this section, read the instructions on References. Your list of references must not exceed one page.

Personal identification no. (PIN)

49910

Family name of applicant

Marshall

Before completing this section, **read the instructions** and consult the *Financial Administration* section in the NSERC *Program Guide for Professors* concerning the eligibility of expenditures for the direct costs of research and the regulations governing the use of grant funds.

**PROPOSED EXPENDITURES FOR DIRECT COSTS OF RESEARCH (Include cash expenditures only)**

	Year 1	Year 2	Year 3	Year 4	Year 5
1) Salaries and benefits					
a) Students	49,500	49,920	78,435	103,680	103,680
b) Postdoctoral fellows	140,000	147,046	166,880	226,252	231,908
c) Technical/professional assistants	35,000	5,963	7,000	4,000	4,000
d)	0	0	0	0	0
2) Equipment or facility					
a) Purchase or rental	25,000	34,700	68,500	10,500	10,500
b) Operation and maintenance costs	50,200	185,000	109,893	112,954	116,321
c) User fees	0	0	0	0	0
3) Materials and supplies	30,000	78,000	72,000	70,000	70,000
4) Travel					
a) Conferences	23,600	9,618	28,750	32,500	32,500
b) Field work	40,000	36,621	35,525	35,525	35,525
c) Collaboration/consultation	23,000	22,132	20,900	20,900	20,900
5) Dissemination costs					
a) Publication costs	0	0	1,000	2,000	3,000
b)	0	0	0	0	0
6) Other (specify)					
a) Office, telephone	5,000	2,000	0	0	0
b) Connections	0	1,500	3,360	3,360	3,360
<b>TOTAL PROPOSED EXPENDITURES FOR DIRECT COSTS OF RESEARCH</b>	421,300	572,500	592,243	621,671	631,694
<b>Total cash contribution from industry (if applicable)</b>					
<b>Total cash contribution from university (if applicable)</b>					
<b>Total cash contribution from other sources (if applicable)</b>	36,300	97,500	58,543	59,308	60,150
<b>TOTAL AMOUNT REQUESTED FROM NSERC (transfer to page 1)</b>	385,000	475,000	533,700	562,363	571,544

Personal identification no. (PIN)

49910

Family name of applicant

Marshall

**RESEARCH SUPPORT**

**Before completing this section, read the instructions for Research Support. Applicants must provide clear and concise information on the conceptual budgetary relationship or difference between this application and all other support (currently held or applied for).**

This request is for continued support for the TWIST (TRIUMF Weak Interaction Symmetry Test) experiment at TRIUMF (E614) to measure with greatly improved precision the Michel parameters in muon decay. These parameters describe the positron distribution in energy and angle which results when a positive muon decays into a positron and two neutrinos. The main parts of the detector and spectrometer have been constructed and are operational. The experiment has just begun the data taking phase; substantial amounts of high precision data will soon be available.

The amounts requested in the current application is for three years, from April 2003 to March 2006, and comprises the major financial support for the ongoing project (see the section on Budget Details). It includes salaries for research associates (RA's), graduate students, undergraduate research assistants (co-op and summer students), and technical support. It covers operational costs including those of some smaller items of apparatus or equipment, materials and supplies, and travel.

The current application follows one year awards of NSERC SAP Project Grants of \$475,000 for 2002-2003 and \$385,000 for 2001-2002. Also awarded in 2002 was an Equipment Grant of \$90,000 to fund the purchase of a modest computer farm which is used in data analysis and Monte Carlo simulation event generation. Along with several other Canadian SAP projects, TWIST expects to benefit in the future from the establishment of the WestGrid computing network, funded by a CFI grant.

The history of TWIST begins 1991, when a group from the Kurchatov Institute led by Prof. V. Selivanov approached TRIUMF with a detector concept that would significantly improve on the results of a previous TRIUMF experiment (E185) on two of the four Michel parameters. A proposal (E614) was generated and reviewed by the Experimental Evaluation Committee (EEC) which gave support for beam tests and detector development. In 1993 a special ad-hoc committee of the EEC reviewed the proposal and made recommendations to the EEC which led to the development of the current effort. In 1995 a multinational collaboration was formed which includes the Russian group of Professor Selivanov, the Canadian group led by Dr. D.R. Gill and a US group led by Profs. C. Gagliardi and R. Tribble. A revised proposal was written and high priority approval was given to E614 by the EEC in July 1996.

In 1997 the NSERC SAP GSC approved a Major Installation Grant of \$466,000 for E614 projected to be spent over 1997-2001. The 1998-99 competition saw E614 - now known as TWIST - receive its first significant project grant of \$170,000.

In 1998 the Russian team completed all the required high precision glass components that they undertook to provide. These glass pieces form the foundation for the precision of the detector assembly which has since been constructed at TRIUMF. Also in 1998 the US team received funding from DOE (US\$306,000) for the components of the chamber electronics that they had undertaken to provide.

DOE still supports TWIST via a contribution to the common fund in addition to direct support of US collaborators. TRIUMF continues to provide substantial support in terms of infrastructure, beams, detector support, and some materials costs.