Proposal for TRIUMF Commitment (5YP 2015-2020)

Date:
October 2, 2012

PROJECT/COMMITMENT TITLE: IRIS: ISAC charged particle reaction spectroscopy station

PROPONENT: Rituparna Kanungo **TRIUMF CONTACT:** Greg Hackman

PRINCIPAL COLLABORATORS: Greg Hackman, Reiner Kruecken, Barry Davids, Chris Ruiz, Alan Chen, Corina Andreoiu, Roby Austin + foreign collaborators

*(only NSERC eligible collaborators from Canada are mentioned)

PROJECT DESCRIPTION:

The IRIS project is a newly commissioned experimental facility for charged particle reaction spectroscopy at ISACII. It was funded by the CFI New Initiatives Fund competition in 2009, moved into budget finalization with CFI in fall of 2010 and completed in 2012.

The project is an international collaboration having partnership with Japan. IRIS pioneers in successfully developing a thin solid hydrogen target for low-energy nuclear reactions of rare isotopes. The use of the solid hydrogen target is important to enhance the reaction yield for experiments with the most neutron-rich (or proton-rich) isotopes that have a very low beam intensity. The commissioning experiment, was done using stable beam of ^{18}O but only using beam intensity of ~ few thousand per second. It is expected that we will be able to perform experiments beam intensities down to ~ 100/sec. This will greatly enhance our scope to study nuclei that were difficult to reach for reaction spectroscopy thereby pushing the limit of our knowledge on their unknown properties.

Yet another innovative aspect, of IRIS is the development of a low-pressure transmission ionization chamber for identifying the atomic number of the incoming beam. This is important for beams of heavy nuclei, that are likely to have isobaric contaminants.

The reaction products are detected and identified using annular arrays of segmented silicon detectors and CsI(Tl) scintillators.

The successful implementation of the facility in summer 2012 has now opened the possibility to perform challenging reaction experiments. We expect from now onwards IRIS will step into a vigorous experimental program.

SCIENTIFIC JUSTIFICATION:

The main scientific program of IRIS is the quest to unveil the unknown characteristics of the nuclei with large neutron to proton asymmetry. This addresses the fundamental question on what aspects of the nuclear interaction leads to a change in our known knowledge beyond the limited handful of stable isotopes. These isotopes are exhibiting marked deviation in our traditional knowledge of the nucleus. One of the strikingly new features is the existence of a thick skin of neutrons on the surface or in extreme cases formation of a thin halo. The experimental determination of the unexpected characteristics of these isotopes and the related reaction probabilities eventually should allow us to understand natures secret on synthesizing the vast majority of the heavy elements on earth and in the universe.

IRIS will address these questions using direct nuclear reactions. The nucleon transfer reactions that have been traditionally known to be highly efficient ways to probe the internal structure of the nuclei will be a major program at IRIS. To find both bound and unbound excited states in these nuclei, inelastic scattering will be used. One of the objectives is to find the existence of soft dipole resonant states if any in the neutron-rich nuclei. Such resonances are predicted to occur due to an oscillation of the neutron-rich surface against the more compact core nucleus. The two-neutron transfer reactions will be used as a probe to understand correlation and pairing between nucleons in the surface of neutron-rich nuclei.

RELATIONSHIP TO BROADER CANADIAN RESEARCH COMMUNITY:

The scientific program is strongly aligned to the priorities on studies of rare isotopes that have been outlined in the Subatomic Physics Long Range Plan.

BROADER IMPACTS:

The project has a strong component for training of highly qualified personnel at various levels.

MAJOR MILESTONES:

Description	Date
Continuing IRIS Operations	2015-2020

RESOURCE REQUIRMENTS:

CASH FLOW REQUIREMENTS						
\YEAR SOURCE \	ONE	TWO	THREE	FOUR	FIVE	TOTAL
TRIUMF	3000	3100	3500	4000	5000	18600
EXTERNAL						
TOTAL						

TRIUMF NON-CASH RESOURCES (Weeks or FTE-Weeks)						
\YEAR RESOURCE\	ONE	TWO	THREE	FOUR	FIVE	TOTAL
Admin:OA:Visitors	0.2	0.2	0.2	0.2	0.2	1
IT:DAQ:Programming	4	4	4	4	4	15
IT:SysAdmin:Linus	1	1	1	1	1	5
Phsx:Exp:Det	6	6	6	6	6	25
Phsx:Exp:Nuc	28	28	28	28	28	140
Tech:Mech:Cryo	1	1	1	1	1	5
Tech:Mech:Det	2	2	2	2	2	10
Tech:Mech:Vacuum	2	2	2	2	2	10
Tech:Mech:Align	2	2	2	2	2	10
Tech:Mech:Assembly	20	20	20	20	20	100
Tech:Mech:Gas	4	4	4	4	4	20
Tech:Mech:CNC	0.2	0.2	0.2	0.2	0.2	1
Tech:Mech:Manual	0.1	0.1	0.1	0.1	0.1	0.5
Tech:MechDes:Mech	0.2	0.2	0.2	0.2	0.2	1
Tech:Plant:CraneOp	0.5	0.5	0.5	0.5	0.5	2.5
ISAC Stable Beam	4	4	4	4	4	20
ISAC RIB	6	6	6	6	6	30

EXTERNAL FUNDING INFORMATION:

Scientific operations (post-doctoral fellows, travel, target supplies, Si detector replacements, equipment repair and replacement) will be funded by the IRIS NSERC project grant. University faculty.

ONGOING OPERATIONAL REQUIREMENTS:

TRIUMF funding request is for nominal items not NSERC eligible, e.g. electrical upgrades, parts and supplies for infrastructure components, etc.

DECOMMISSIONING REQUIREMENT:

No decommissioning requirements beyond those covered by the TRIUMF operating license.

Accepted: Date: