Proposal for TRIUMF Commitment (5YP 2015-2020)

Date:
September 17, 2012

PROJECT/COMMITMENT TITLE: High resolution resonance ionisation laser spectroscopy

PROPONENT: M. Pearson **TRIUMF CONTACT:** M.Pearson

PRINCIPAL COLLABORATORS: F. Buchinger, J. Crawford, B. Cheal, J. Billowes

PROJECT DESCRIPTION:

Upgrade the collinear laser spectroscopy line to be able to efficiently perform high resolution resonance ionisation spectroscopy. This will enable both ion detection as well as decay spectroscopy to be performed upon the species that are under study thus enabling immediate and definitive assignment of nuclear states to the electronic hyperfine structure observed in fluorescence. The project will require the upgrading of the current polariser beamline to ultra high vacuum as well as installing an end station on the free end to include ion detection as well as the capability to detect emitted alpha and beta particles.

SCIENTIFIC JUSTIFICATION:

Collinear laser spectroscopy has long been known to be a powerful method of obtaining information on the ground and long lived isomeric states of exotic nuclei. Recent developments including the incorporation of radio frequency ion beam bunching techniques has significantly increased the sensitivity of the traditional technique. One step to take this even further, allowing efficient spectroscopy on beams of a few hundred ions per second within a cocktail beam of many tens if not hundreds of thousands of ions per second. The multiple step approach of neutralising the beam prior to using high resolution resonance ionisation followed by the detection of the resultant ion time correlated to a laser burst effectively reduces the accidental background as seen to zero as long as the ionisation due to residual gas collisions within the vacuum system can be ignored. This can then be coupled to the observation of the decay of the ion to positively and in general definitively match the electronic state observed to a nuclear state.

Utilising this idea will allow for the measurement of ground state nuclear properties out to the far extremes of the nuclear chart.

This idea has been shown to work with a broadband laser system at ISOLDE, CERN as well as using narrow linewidth lasers at Jyvaskyla, Finland.

RELATIONSHIP TO BROADER CANADIAN RESEARCH COMMUNITY:

Can be used not only as a spectroscopy tool in its own right but also as a beam purification system to deliver clean beams from a coctail delivered from ISAC to a spectroscopy system located after the polariser beamline. This will significantly reduce the backgrounds as seen by whatever detection system is installed allowing decay spectroscopy to be carried out on weakly produced ion beams that are unresolvable by means of the mass separator systems in place.
In certain circumstances it is possible to ionise from the single to doubly charged ions allowing for a separation via electrostatic optics already installed in the line. This system will also allow for optical pumping to be performed on the beam prior to ionisation therefore permitting pure, polarised beams to be delivered.

BROADER IMPACTS:

Further to the physics impacts this system will require the training of many students (both undergraduate and postgraduate) as well as postdoctoral research associates.

MAJOR MILESTONES:

Description	Date
Acceptance of the idea	2015 (+/-2years)
Upgrade of beamline	2016 (one year after above)
Installation of an end detector system	2016
Start to use	2016 (+/- 2years)

RESOURCE REQUIRMENTS:

CASH FLOW REQUIREMENTS						
\YEAR SOURCE \	ONE	TWO	THREE	FOUR	FIVE	TOTAL
TRIUMF	$100,000.00 (beamline)	$40,000.00	ALMOST ZERO	~0	~0	$140,000.00 (+/- 30%)
EXTERNAL	$100,000 (detectors + PDF/student)	$100,000.00				$200,000.00
TOTAL						
TRIUMF NON-CASH RESOURCES						
\YEAR RESOURCE\	ONE	TWO	THREE	FOUR	FIVE	TOTAL
DESIGN OFFICE	1FTE	0.3FTE	0	0	0	1.3FTE (20%)
Workshop	0.5FTE	0.5FTE	~0	~0	~0	1FTE
Detector facility	0.5FTE	0.5FTE	0	0	0	1FTE

EXTERNAL FUNDING INFORMATION:
NSERC or similar grant for detectors for the end station as well as personel to develop/ install. Not yet applied for.

ONGOING OPERATIONAL REQUIREMENTS:
After installation and initial commissioning this will be operated by the laser spectroscopy group therefore operational costs/ people will come from there.

DECOMMISSIONING REQUIREMENT:

No intention to decommission, if required then beamline may require radioactive disposal due to long lived contaminants embedded on the walls.

Accepted: Date: