Proposal for TRIUMF Commitment (5YP 2015-2020)

Date:
September 17 1012

PROJECT/COMMITMENT TITLE: Radio frequency buncher for laser spectroscopy

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

PRINCIPAL COLLABORATORS:

PROJECT DESCRIPTION:

Include within the design and implementation of an linear, radio frequency buncher within the ARIEL facility the possibility of over lapping laser quality radiation with the trapped ions.

If implemented from the outset this will only require the addition of several optical ports in specific parts of the beamline. Therefore no additional manpower or resources above those already requested for the implementation of the RFQ.

This will require that the RFQ is located in a position that can be access whilst proton or electron beams are incident upon the ARIEL targets. Ideally access would be possible at all times whilst beam is running.

SCIENTIFIC JUSTIFICATION:

Collinear laser spectroscopy when coupled to radio frequency bunchers has been shown to be a very powerful method with which to extract ground state nuclear properties. Whilst stored within a linear paul trap the ions have too great a velocity spread to allow for high precision spectroscopy to be performed, however, this storage time does permit optical preparation of the electronic states prior to extraction.

State preparation is common place within atomic physics as, in general, the electronic population does not naturally lie in the state of interest or nor normally is spread across states. Whilst not often applied to laser spectroscopy for nuclear physics research it would allow for electronic populations to be moved from more abundantly populated lower states to high lying metastable levels. In certain circumstances, especially true in the rare earth region of the periodic table, electronic ground state tend to be of high spin and therefore have very little wavefunction overlap with the nucleus. However, higher lying states, often over 1eV above the ground state, can have lifetimes of the order of tens of milliseconds or greater and very low spins, hence large nuclear wavefunction overlap. Preparing the ions whilst they are being bunched within an RFQ can increase signal strengths from these higher lying states by many orders of magnitude. One such element that has been proposed and accepted by TRIUMF's EEC is for the light Lanthanum isotopes. Here there is a prediction of tri-axiality in the nuclear ground state. Whilst laser spectroscopy cannot confirm or deny the triaxial state it is possible to measure and compare the nuclear ground state moments with those predicted from this model. The most suited transition is from a state situated 1.3eV above the ground state that has been experimentally found to be naturally populated approximately 0.01% of the time. Optical pumping can increase this to several tens of percent without and affect on the beam properties.

RELATIONSHIP TO BROADER CANADIAN RESEARCH COMMUNITY:

This would be used throughout the laser spectroscopy programme being carried out at TRIUMF and in certain circumstances could be used to clean beams by performing resonance ionisation within the cooler from the singly to doubly charged state. A fast electrostatic kicker placed downstream would then discriminate the two charge states by time of flight.

BROADER IMPACTS:

MAJOR MILESTONES:

Description	Date
Milestones are the same as for the implementation of the cooler	

RESOURCE REQUIRMENTS:

CASH FLOW REQUIREMENTS						
\YEAR SOURCE \	ONE	TWO	THREE	FOUR	FIVE	TOTAL
TRIUMF	$10,000.00	0	0	0	0	$10,000.00
EXTERNAL						
TOTAL						
TRIUMF NON-CASH RESOURCES						
\YEAR RESOURCE\	ONE	TWO	THREE	FOUR	FIVE	TOTAL

EXTERNAL FUNDING INFORMATION:
Operationally the laser systems will be covered by the Laser Spectroscopy NSERC grant.

ONGOING OPERATIONAL REQUIREMENTS:
ongoing support for the laser spectroscopy laboratory in ISAC I.
The TRIUMF funding would be for optical fibres to transport the required light to the location of the buncher.
Once installed very little upgrading/ new equipment for upgrading is reuqired.

DECOMMISSIONING REQUIREMENT:
As per the RFQ the only additional equipment for decommissioning will be a couple of optical windows and several hundred meters of optical fibre.

Accepted: Date: