# PROJECT CHARTER SHEET
## Version1

Project No.: 428

Date: 21-Sep-16

PROJECT TITLE: EMMATrap

PROPONENT: Thomas Brunner TRIUMF CONTACT: Daniel Lascar DIVISION: Science

PRINCIPAL COLLABORATORS: Thomas Brunner, Daniel Lascar, Barry Davids, Jens Dilling, Victor Varentsov, Corina Andreiou

PROJECT OBJECTIVES: Development of a Penning-trap system to measure the masses of nuclei far from the valley of β-stability that are only reachable via nuclear reactions. The system will be located downstream of EMMA to measure reaction products. The isotopes of interest are on the neutron-deficient side, $^{100}$Sn, $^{70,72}$Kr, and other isotopes close to the p-dripline that are of importance for *rp*-process network calculations. Also of interest are neutron-rich *r*-process nuclei that are made accessible via transfer reaction and neutron-rich beams from ARIEL (such as $^{136\text{-}138}$Sn and $^{133\text{-}139}$In) and cannot be produced with sufficient yields via ISOL methods and are not predicted to be produced at facilities like FRIB or FAIR.

PROJECT SCOPE: EMMATrap will consist of four main components to be built and commissioned in stages: A gas stopper cell will be located at the focal plane of EMMA and is designed to be easily removable to allow the installation of other type of detectors for different measurements, a Radio-Frequency Quadrupole ion guide and cooler/buncher (RFQ) which will either be fixed near the remainder of the EMMATrap system or fixed to the gas cell and be removable as well, a Multi-Reflection Time of Flight (MR-ToF) mass spectrometer that can both separate masses and measure masses to a precision of $\delta m/m \sim 10^{-5}$, and finally a precision Penning Trap mass spectrometer capable of making mass measurements to precisions on the order of $10^{-9}$. In a first stage the stopper cell, RFQ and MR-ToF will be commissioned in a proof-of-principle experiment to demonstrate the power of the presented system. In a second stage it will be coupled to the high-precision Penning trap mass spectrometer.

ASSUMPTIONS AND CONSTRAINTS: The two proponents of this experiment (Lascar and Brunner) have a vast background in the field of stopper cells, RF ion guides, and mass spectrometry. DL and TB are heavily involved in TITAN and nEXO developments, respectively, and will contribute their experience and knowledge gained in these experiments. However, this involvement also constrains the time that will be allocated to this project. Furthermore, Lascar is holding a temporary research associate position with the TITAN group. Lascar is pursuing a career at a research focused university and, once hired, will bring start-up funding to bear on this project allowing for initial design and fabrication of the gas cell. TB has funds for 1.5 graduate-student years from his start-up package to contribute to this project. The development of an RFQ and an MR ToF align very well with TB's Ba-tagging developments for nEXO. These developments also focus on the extraction of ions from noble gas and their identification afterwards. EMMA-trap will greatly benefit from these developments.

The bulk of the primary design and assembly of the major components will take place at DL's and TB's respective institutions. Once the individual components have been tested independently offline they will be moved to TRIUMF where postdocs and graduate students, at that time stationed at TRIUMF, will commission the devices *in situ*.

RISKS: The risks and environmental hazards are similar, if not identical, to those posed by TITAN. The radiological risk that does exist is primarily concentrated in the gas cell as it is the recipient of the largest fraction of the reaction products from EMMA. The bulk of the radiological risk generated by an EMMA experiment will be absorbed by EMMA. Standard high voltage hazards on the order of 10 kV DC and ~100 W of RF at ~100V AC will be present in the experiment. The gas cell will likely be cryogenically cooled and when energized, the Penning trap magnet will be made superconducting via the addition of LHe and LN2 which will need to be refilled from time to time.

MAJOR MILESTONES:

| Description | Date |
|---|---|
| Gas stopper cell designed | June 2018 |
| Gas stopper cell delivered to TRIUMF for commissioning | December 2018 |
| RFQ ion guide and cooler/buncher designed | December 2018 |
| Design of MR-ToF Completed | March 2019 |
| First beam test of gas catcher | June 2019 |
| RFQ assembly completed at TRIUMF | August 2019 |
| Penning Trap design completed | February 2020 |
| MR-ToF Commissioned at TRIUMF | June 2020 |
| Penning Trap Commissioned | June 2021 |

RESOURCE REQUIRMENTS:

| CASH FLOW REQUIREMENTS *(given in thousands of dollars)* | | | | | | |
|---|---|---|---|---|---|---|
| SOURCE | 2017 | 2018 | 2019 | 2020 | 2021 | TOTAL |
| TRIUMF | 10 | 40 | 30 | 30 | 20 | 150 |
| EXTERNAL | 50 | 120 | 650 | 80 | 60 | 1,200 |
| TOTAL | 60 | 160 | 780 | 110 | 80 | **1,350** |

| TRIUMF NON-CASH RESOURCES | | | | | | |
|---|---|---|---|---|---|---|
| RESOURCE | 2017 | 2018 | 2019 | 2020 | 2021 | TOTAL |
| Project Planning | 20 | 20 | 20 | 20 | 5 | 85 |
| Design office | 20 | 30 | 30 | 20 | 5 | 105 |
| Machine Shop | 10 | 10 | 15 | 10 | 5 | 50 |
| Assembly/Installation | 4 | 4 | 4 | 4 | 4 | 21 |
| Controls/Elec Shop | 15 | 20 | 20 | 15 | 5 | 75 |
| Elec/Mech Services | 4 | 4 | 4 | 4 | 5 | 20 |
| Cryogenics | | 5 | | | | 5 |
| | | | | | | |
| TOTAL | 73 | 93 | 93 | 73 | 29 | **361** |

EXTERNAL FUNDING INFORMATION: An application requesting operational funding will be submitted to the NSERC Discovery Program in fall 2017. The hardware will be requested in a NSERC RTI application to be submitted in fall 2017. CFI funding will also be sought. Finally, once DL secures a faculty position. project will be supported by applications for funding through the US DOE.

OPERATIONAL REQUIREMENTS: Laboratory space is required for assembly and staging. The Penning trap, MR-ToF and beamline connecting them will be a permanent fixture in the ISAC-II hall. The gas cell will need to be stored in a clean location (likely the lab space) between EMMA experiments.

DECOMMISSIONING REQUIREMENT: The gas cell is the only component of the experiment that might require storage until radiological contamination has decayed but with proper slit use from EMMA that need could be mitigated or even eliminated. The remaining components will likely not be exposed to sufficient radioactivity to require storage and can be disposed of after a cursory survey by TRIUMF radiation safety staff.

| Accepted: | Date: |
|---|---|
| | |

# Instructions
# For
# Project Charter Sheet

The Project Charter Sheets are public documents available to the TRIUMF community via the internal TRIUMF web pages.

**Project No.:** Number assigned by TRIUMF for project tracking purposes. For a new project, contact the TRIUMF project coordinator for a number.

**Date:** Date the form was submitted to TRIUMF.

**Project Title:** The title the project 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. For external projects, this person will help the project proponents understand what TRIUMF procedures are and will provide a contact for TRIUMF management to interact with the project on a timely basis. For TRIUMF internal projects it may be the same person as the proponent.

**Division:** The main TRIUMF division supervising the project.

**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.

**Project Objectives:** The main goals the project hopes to achieve and the scientific objective. For example: "To design and build a recoil mass spectrometer for use at ISAC II. Primarily for measuring nuclear reactions of astrophysical interest."

**Project Scope:** An outline of what is involved in bringing the project to a successful completion. It should include a list of deliverables.

**Assumptions and Constraints:** Discuss the major assumptions that effect timing, resource requirements and viability of the project. What are the major constraints on the project? For example: external funding, resource availability, and technical capabilities.

**Risks:** What are the safety and environmental risks?

**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.

**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 project. 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. In most cases the appropriate unit will be FTE-weeks. If different units are used please indicate. These TRIUMF resources include: Project Planning, Engineering/Design Work, Magnet Design, Machine Shop Work, Assembly and Installation, Controls/Electronics Shop, RF, Electrical and Mechanical Services, Remote Handling, Power Supplies, Vacuum, Cryogenics, Diagnostics, Beam Dynamics, Safety, Detector Facilities Conceptual Designer, Detector Facilities Machinist, and Detector Readout. 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?

**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.