13D: Brief Technical Paper

Rubi2040 Rubidium Filling Station

A brief summary of the project and technical aspects of TRIUMF's Rubidium Filling Station is summarized below.

Abstract

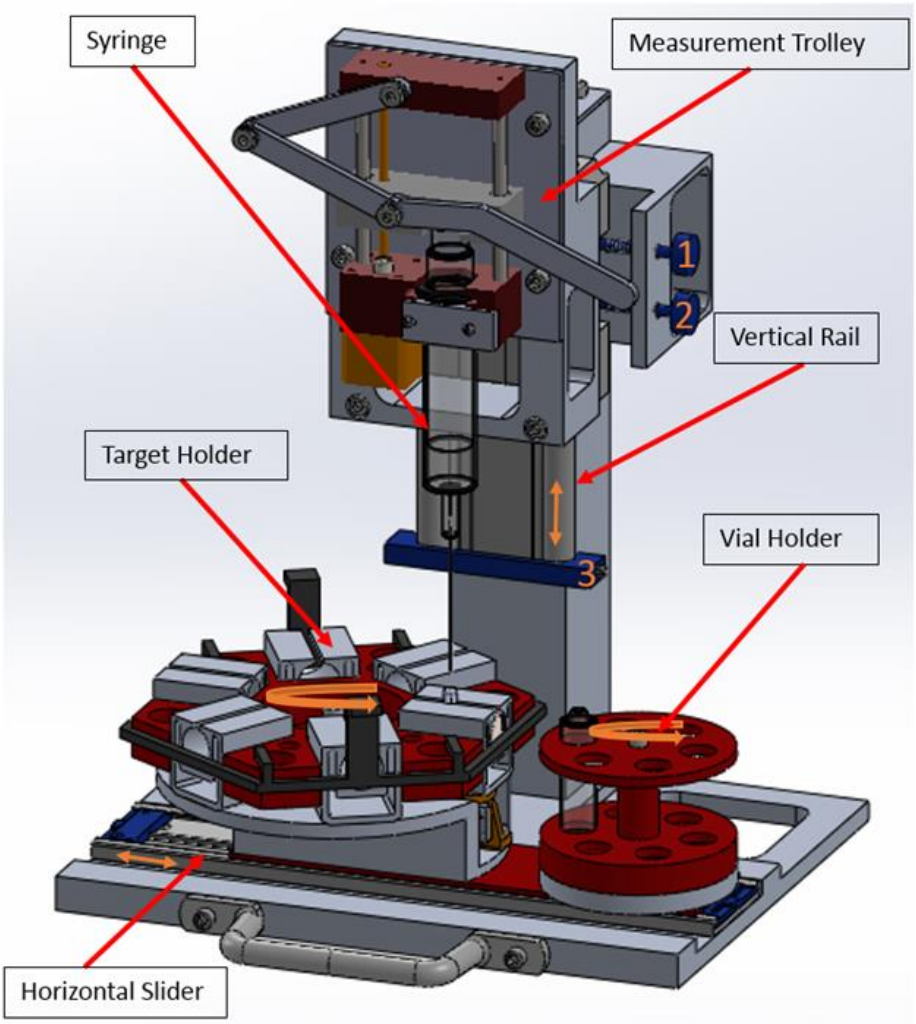
TRIUMF is one of Canada's leading national laboratories for particle and nuclear physics. The purpose of this project was to develop a new a new Rubidium transfer station to replace the current dated and problematic station.

Introduction

TRIUMF is involved in the production of radioisotope for the health sciences industry. Specifically, TRIUMF uses its facilities to produce Strontium-82 (SR-82) from solid Rubidium (Rubidium). In order to process the Rubidium, it must be transferred from the glass vials into stainless steel "targets". Complications arise due to the oxidizing nature of Rubidium in air and the explosive nature in the presence of moisture. For this reason all processes must be completed in a glove box filled with an inert gas (Argon), this means the user must be able to manipulate all components in a confined space with thick gloves. TRIUMF's filling station is in need of a redesign as it suffers from problems of spillage (and the associated clean-up and waster) and clogged transfer tubes. The minimum deliverable was to produce a complete drawings package of a new station that can be built within the $10 000 budget, which should yield annual savings of up to $5200 compared to the inefficiencies of the current stations. Ideally, the goal was to have a completed filling station that has been tested and validated. Upon completion the new station cost $5949.27 which was well within the allotted budget.

Design Overview

The new station is made up of four main components. The first is the syringe, which is mounted to the measurement trolley. Together, these two components are mounted on a vertical slider (with hard stops) to facilitate the transfer of measured amounts of Rubidium between the vials and targets (measured using a stepper motor and controls to actuate the syringe plunger). Next are the vial and target holders, each of which are mounted on a horizontal slider and have rotary indices to facilitate simple manipulation. Other features include heaters on the syringe, needle and vial holder to maintain the Rubidium in liquid state (above 39°C). To ensure filling accuracy, a load cell has been implemented in the target holder to measure and confirm the amount of Rubidium injected into the target.



Technical Analysis and Testing

Analysis included maximum accuracy of the stepper motor and syringe plunger combination, and heating of the syringe. The design of the stepper motor, in conjunction with the lead screw and syringe yields a theoretical accuracy of up to 0.016g of Rubidium. Heating of the needle was simulated using a CFD analysis. Upon construction and testing of the prototype, the test results were a bit lower than with the optimistic simulation and held the minimum temperature at the tip of the syringe of 39°C. This temperature, however, did not have a large enough safety factor and increasing base temperatures. An alternative fused cartridge heater was used instead. Testing and optimization of the final prototype was done at TRIUMF. The measurement trolley was calibrated, and used to dispense specific weight of rubidium ranging from 5g to 20g in increments of 5. The accuracy of these fillings was determined to be lower than the threshold of +/- 0.1g.

Discussion and Conclusions

The client's needs and design requirements were met. Testing of the final prototype was done by using water as a replacement fluid. The fillings were successful and the accuracy of fillings was as per client's requirements. Validation of the final prototype could not be done as TRIUMF does not have a filling session scheduled for a couple of months

Recommendations

We recommend that the user of the device familiarize themselves with the transfer process (training and user manual is provided) before attempting a filling with Rubidium. Due to time constraints, the load cell feature had been omitted by the client. We suggest re-producing the part (and feature) and re-integrating the load cell to ensure filling accuracy.