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Design and evaluation of laser ion source in TITAN to measure 222Rn progeny product abundances

Radon is a radioactive gas that arises from the radioactive decay of uranium and thorium minerals. It emerges from the ground and can enter homes, where it can decay and attach to dust particles, both of which can be inhaled. The alpha emissions from radon decay can cause DNA damage in lung tissue, increasing the risk of lung cancer [1,2]. Assessing radon exposure is important as it is the leading cause of lung cancer for Canadians who do not smoke. Canadian national action thresholds for unacceptable radon exposure are 200 Bq/m3, with any levels at or above 100 Bq/m3 showing statistically significant increase in lung cancer risk [3]. A practical tool to assess lifetime radon exposure is being developed using the Multiple Reflection Time-Of-Flight Mass Spectrometer (MR-TOF-MS) at TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN) to measure the low amounts of 210Pb in biological samples [4].

This project aims to design and build a laser ablation ion source that will be coupled with MR-TOF-MS system to measure the abundance of long-lived and stable isotopes. It uses a UV laser that generates ions from different materials, the laser beam is focused on the sample surface with a spot size of tens of micrometers, and the sample is scanned using a motorized mirror. The ions produced are then directed to a quadrupole bender that bends the ion beam 90 degrees and then to an Einzel lens which focuses the beam into MR-TOF-MS for isotope abundance measurement.

The experiment uses isotope abundance ratio measurement, specifically the ratio of 210Pb to 208Pb, to calculate the abundance of 210Pb. The method involves independent measurement of lead stable isotopes using ICP-MS and MR-TOF-MS. The measurement error is reduced by this method and systematic bias is assessed by using standard reference material [5]. The goal is to develop a personalized radon bio-dosimeter by measuring the number of accumulated atoms in a person's biological tissue.

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