^{103}Pd production utilizing a liquid target set-up

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Introduction

The most common production route for the medically important radioisotope ^{103}Pd ($t_{1/2}$ = 17.0 days) is via the ^{103}Rh(p,n)^{103}Pd reaction which can be achieved using a 12MeV cyclotron. Currently, solid rhodium targets are used which require difficult pre/post-irradiation handling processes due to their chemical inactivity. A liquid target set-up made from soluble rhodium nitrate has the potential to not only remove these current challenges but also improve set up compatibility with medical cyclotrons in use for the production of ^{18}F. This work shows preliminary yields for first liquid rhodium target irradiations at the TR13 in TRIUMF.

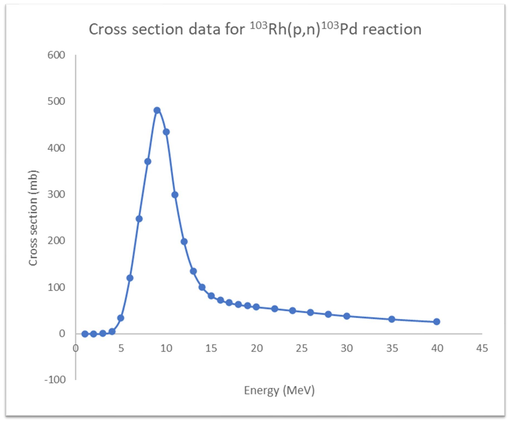

Figure 1: Cross section data for ^{103}Rh(p,n)^{103}Pd reaction. Data obtained from TENDL-2021 Nuclear Data Library.

Methods

- Rhodium nitrate powder is dissolved in water to form a solution which can be automatically loaded and unloaded into the target chamber (Figure 2) in the TR13.

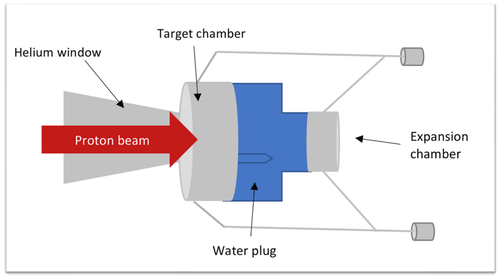

Figure 2: Target chamber used for irradiations of liquid targets at TR13.

- Irradiation parameters such as the current, irradiation time, initial target pressure and metal concentration are varied to maximize production yield whilst maintaining stability of the solution.

- The ^{103}Pd product can be separated from the rhodium solution via anion exchange chromatography (Figure 3) using a Dowex 1x8 200-400 mesh resin and NH_3+NH_4Cl (1:1) eluant. Rhodium can be released from the resin using 6M HCl where efforts will be made to recycle this for future irradiations.

- Radionuclic composition of the solution and fractions are analyzed using a HPGE gamma spectrometer.

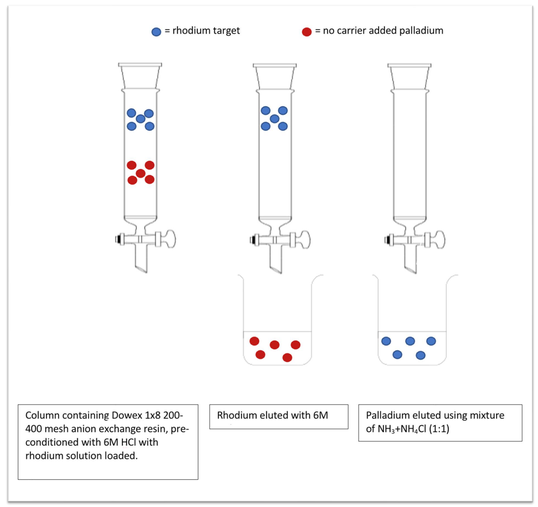

Figure 3: Simplified anion exchange chromatography scheme for separating palladium product from the rhodium solution.

Results

Preliminary results yield 0.25MBq (EOB) compared to theoretical expectation of 1.2MBq.This is based on 1.5ml of solution with 0.6mg/ml Rh concentration, irradiated with 30uA current for 1hr and 200psi initial pressure applied to the target. This yield is sufficient to test radiochemistry aspects and explore the chelation of ^{103}Pd and its decay product ^{103m}Rh($t_{1/2}$= 56 minutes). Applying an initial pressure has the effect of dampening the boiling effect and pressure rise during irradiation (Figure 4). In future runs, the irradiation time and concentration of the solution will be increased to produce higher activities.

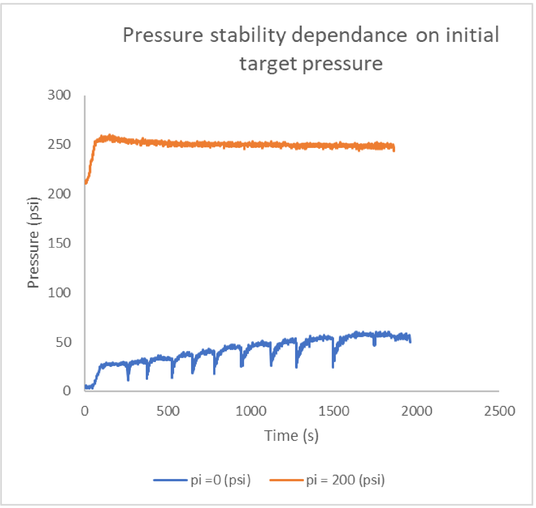

Figure 4: Pressure stability comparison for two irradiations where the current, irradiation time and solution concentration are the same, but for one, an initial pressure has been applied to the target.

Conclusion

A liquid rhodium target made from dissolving rhodium nitrate in water could overcome the current key challenges associated with solid rhodium target dissolution for the production of ^{103}Pd. Preliminary results show yields sufficient for radiochemistry studies, with room for certain irradiation parameters to be increased further to maximize yield at the TR13. Future irradiations will explore higher concentrations and longer irradiation lengths to determine stability limits for the solution, such that the full scope of application for this production route for ^{103}Pd can be determined.

Discovery, accelerated