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# Ac-225 production using TRIUMF's 500 MeV cyclotron

TRIUMF has begun production of Ac-225 (t<sub>1/2</sub> = 9.9 d) by irradiation of thorium metal with 480 MeV protons and has developed new methods for separating Ac-225 from these targets.

At TRIUMF's 500 MeV Isotope Production Facility, targets containing thorium metal (8 g, 60 mm diameter, 0.25 mm thickness) welded inside an Inconel capsule are irradiated by 480 MeV protons to an integrated current of 2640 μA*h, producing at end of bombardment (502 ± 11) MBq of Ac-225 and (64 ± 4) MBq of its parent Ra-225, (n = 2).

After irradiation the thorium is dissolved in 60 mL of 10 M HNO<sub>3</sub> + 12.5 mM HF and evaporated to a thorium nitrate salt. After redissolution in 80 mL of 1 M HNO<sub>3</sub>, thorium is precipitated as thorium peroxide by addition of 56 mL of 30% H<sub>2</sub>O<sub>2</sub> (>98% of thorium is precipitated). The resulting precipitate is easily filtered. The filtrate is diluted to 0.5 M HNO<sub>3</sub> and loaded onto a 10 mL cation exchange column (DOWEX 50WX8, 200-400 mesh). Washing the column with 450 mL of 1 M citric acid (pH 2.0-2.2) removes residual thorium and other spallation products. After washing with 50 mL of 0.5 M HNO<sub>3</sub>, Ra and Ac are then eluted in 60 mL of 8 M HNO<sub>3</sub>. This Ac and Ra fraction is then diluted to 4 M HNO<sub>3</sub> with 60 mL of deionized water and passed through a column containing 200-205 mg of DGA-normal resin. While Ra-225 passes through the column, Ac-225 is later removed from the column using 13 mL of 12 M HNO<sub>3</sub>. This initial "reagent-grade"Ac-225 product contains other Ac isotopes, most notably long-lived (t<sub>1/2</sub> = 22 y) Ac-227 (~0.2% relative to <sup>225</sup>Ac by activity).

However, after allowing the Ra-225 fraction to generate additional Ac-225, repassing this fraction through another DGA column produces a second "analytical-grade"Ac-225 product with reduced Ac-227 content. Both the reagent- and analytical-grade Ac-225 have demonstrated high radiolabeling ability (labeling at DOTA concentrations of 10<sup>-5</sup> M at 85 C and macropa concentrations of 10<sup>-7</sup> M at ambient temperature). Efforts to label bifunctional constructs are currently underway. This presentation will provide detailed results of these Ac-225 production efforts with a focus on a comparison of the reagent- and analytical-grade products in terms of radioactive and stable impurities.

In addition, anticipated production scale-up will be described. As the IPF is located immediately in front of the TRIUMF cyclotron's main beam dump, this facility continuously receives >80 μA of 480 MeV protons for >7 months per year and has potential as a potent future Ac-225 source.

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