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Isolation of Ho-163 from Dy target material by HPLC for Neutrino Mass Measurements

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The rare-earth isotope Ho-163 is of interest for neutrino mass measurements. The experimental evidence for neutrino and antineutrino oscillations between flavor states is compelling, with extensive implications for astrophysics, nucleosynthesis, the origin of dark matter and cosmology [1]. The goal of our experiment is to investigate the electron neutrino mass by a high precision and high statistics calorimetric measurement of the Ho-163 electron capture spectrum. This microcalorimetric experiment requires production of Ho-163 at high rate with high isotopic and chemical purity. Currently, there are no fully validated methods for production and isolation of Ho-163 at purities and quantities required.

Ho-163 was produced by proton-irradiation on the University of Wisconsin 16 MeV cyclotron via the (p,n) and (p,2n) reactions using a dysprosium target as suggested in [2]. Separation of the desired elemental holmium (Ho) from irradiated dysprosium (Dy) was performed by high performance liquid chromatography (HPLC). Initial test separations were performed with an analytical-sized column filled with a cation-exchange resin, AG50W-X8, and alpha-hydroxyisobutyric acid (α-HIBA) eluent with varying concentration and pH. The separation was optimized using on-line UV/VIS detection and post column derivatization with PAR (4-(2-pyridylazo)resorcinol). Next, scale up from the analytical column to semi-preparative HPLC column was performed to accommodate the large 55 mg Dy target mass. The Ho fraction was collected and a 2-step process was employed to remove the chelating agent α-HIBA from the final product. Preliminary data from ICP-MS analysis of the purified holmium fraction indicated that the one step HPLC purification process resulted in 99.9997% removal of Dy. Successfully isolated Ho-163 is being encapsulated in an absorber for the first microcalorimetric measurement. Detailed information on Ho-163 production, isolation and characterization will be presented.

1 G. Drexlin, V. Hannen, S. Mertens, C. Weinheimer, Current direct neutrino mass experiments, Advances in Higher Energy Physics 2013 (2013) 39.

2 J.W. Engle, E.R. Birnbaum, H.R. Trellue, K.D. John, M.W. Rabin, F.M. Nortier, Evaluation of 163Ho production options for neutrino mass measurements with microcalorimeter detectors, Nuclear Instruments and Methods in Physics Research B 311 (2013) 131–138.

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