

AbstractID: 10324 Title: A Feasibility study of using O-18 Enriched Water to Develop a Method of In-Vivo Range Verification in Proton Therapy.

Purpose: To report a feasibility study of using oxygen-18 (O-18) enriched water in combination with PET to develop a method of in vivo range verification in proton therapy. O-18 enriched water is non-toxic and non-radioactive and can be safely administered to patients before proton treatment. When protons interact with O-18, it is converted to F-18 which decays back to O-18 by positron emission with a half-life of 110min. For the $O18(p,n)F18$ reaction, the interaction cross-section is larger, the energy threshold lower, and the half-life longer compared to most other inelastic proton interactions in patients leading to positron decay.

Method and Materials: O-16 water, 98% O-18 enriched water, and 10% O-18 enriched water samples were placed inside a polystyrene phantom and irradiated with a modulated 149 MeV proton beam with a 6 cm wide Spread Out Bragg Peak (SOBP) at three depths (mid-entrance region, proximal, and distal third of the SOBP). The activity decay of each water sample was measured using a NaI detector for 1-2 hours. Additional information was obtained by scanning the irradiated water samples with a high-resolution animal PET scanner.

Results: As expected O-16 irradiated water had a higher initial activity than 10% O-18 and 98% O-18 enriched water at each depth. However, at later times, the activity in the O-18 samples was larger due to the short half-times of positron-emitting products resulting from O-16 irradiation. Furthermore, there was a larger reduction of activity of irradiated O-16 across the SOBP as compared to O-18 irradiated water.

Conclusion: Application of O-18 enriched water has features that make it an attractive method for in-vivo range verification of proton beams. It is likely that this method could also be useful for in vivo dose verification.