AbstractID: 11391 Title: Can Prompt Gamma Emission During Proton Therapy Provide in situ Range Verification?

Purpose: Prompt gamma rays emitted from proton-nucleus interactions in tissue present a promising non-invasive, *in situ* means of monitoring proton beam based radiotherapy. This study investigates the fluence and energy distribution of prompt gamma rays emitted during proton irradiation of phantoms. This information was used to develop a correlation between the measured and calculated gamma emission and the proton beam range, which would allow treatments to more effectively exploit the sharp distal falloff in the dose distributions of protons. **Method & Materials:** Measurements were performed at the Francis H. Burr Proton Therapy Center using a 5nA pencil proton beam, a homogeneous cylindrical Lucite phantom, and a lead collimated sodium iodide (NaI) detector arranged orthogonal to the beam. Emulating this experiment, a model of the phantom with a monoenergetic proton beam and an annular array of ideal photon tallies arranged orthogonal to the beam was developed using the Monte Carlo code MCNPX 2.6.0. **Results:** Experimental and computational results indicated a correlation between gamma emission and the proton depth-dose profile. Several peaks were evident in the calculated energy spectrum and the 4.44MeV emission from ^{12}C was the most intense line having any apparent correlation with the depth dose profile. Arbitrary energy binning of 4-5MeV and 4-8MeV was performed on the Monte Carlo data; this binned data yielded a distinct emission peak 1cm proximal to the Bragg peak. In all cases in the Lucite phantom the position of the Bragg peak's 80% distal falloff corresponded with the position of the 4-8MeV binned 50% distal falloff. **Conclusions:** The results are promising and indicate the feasibility of prompt gamma emission detection as a means of characterizing the proton beam range *in situ*. This study has established the measurement and computational tools necessary to pursue the development of this technique.