# AbstractID: 12593 Title: Optimizing a 3-stage Compton camera for imaging prompt gammas during proton irradiation

**Purpose:** Due to the intrinsic range uncertainties in proton therapy and its potential impact on the dose delivery, secondary prompt gamma ray emitted during proton treatment delivery is being explored as a dose verification tool. In this work, we investigate the use of a 3-stage Compton camera to measure secondary prompt gamma emission. The purpose of this study was: (1) to develop an optimal 3-stage Compton camera specifically designed to measure prompt gamma rays from tissue and (2) to determine the feasibility of using this 3-stage Compton camera to measure and image prompt gammas emitted from irradiated tissues during proton beam irradiation.

**Method and Materials:** The 3-stage Compton camera was modeled in Geant4 as three high-purity germanium detectors arranged in parallel-plane geometry. Initially, an isotropic gamma source ranging from 0.1 to 15 MeV was used to determine the detector dimensions (width and thickness) that provided the optimal detection efficiency. Then, the gamma source was replaced by a proton beam irradiating a tissue phantom to calculate the overall efficiency of the optimized camera during proton beam irradiation.

**Results:** Using the isotropic gamma source, the optimal dimensions chosen for the 3-stage Compton camera were 3 cm thick by 10 cm wide for the first detector, 3 cm thick by 10 cm wide for the second, and 10 cm thick by 10 cm wide for the third. The overall efficiency of the 3-stage Compton camera varied from 2.4 to 10.5 x $10^{-6}$ prompt gammas detected per starting proton over the range of proton energies.

**Conclusion:** Based on the overall efficiency results and the typical number of protons emitted during a treatment (about 1 x $10^{11}$ protons), the 3-stage Compton camera should detect a sufficient number of prompt gammas to allow for image reconstruction of the dose deposition within the tissue phantom.