Abstract ID: 15004 Title: Reconstructing images of prompt gammas emitted during proton radiotherapy.

Purpose: Recent studies have shown that prompt gammas emitted during proton therapy are strongly correlated to the distribution of dose and proton beam range in the patient. This has led to an increasing interest in the measurement of prompt gammas as a means of providing in-vivo beam range verification. The purpose of this work was to investigate the feasibility of reconstructing images of prompt gamma emission from tissues irradiated during proton radiotherapy.

Methods: For this study we developed an iterative image reconstruction program based on the Stochastic Origin Ensembles (SOE) technique that used data calculated using a Monte Carlo (MC) model of prompt gamma measurement by a 3-stage Compton camera during proton irradiation. We studied the ability of the SOE technique to reconstruct 2D and 3D images that accurately reproduced the prompt gamma distribution in irradiated tissue phantoms as a function of image pixel size, number of measured prompt gammas, and number of iterations performed by the reconstruction program.

Results: Using data from our MC model, we were able to reconstruct images of the prompt gamma emission profile in tissue phantoms irradiated with a clinical proton beams (pencil beam, broad beam, and spread out Bragg peak). The beam range in the reconstructed images agreed with the prompt emission range to within 1-2 mm for reconstructions with 1 mm pixel size, 10,000 iterations, and using 1.5 million measured prompt gammas.

Conclusions: We conclude that it is possible to reconstruct both 2D and 3D images of prompt gamma ray emission during proton radiotherapy. Although, the reconstruction algorithm used in this study is not optimal and much more development is needed, we believe the image resolution (1-2 mm) achieved in this study shows the feasibility of prompt gamma imaging (PGI) as clinical technique for verifying in-vivo dose range for proton radiotherapy.

Funding Support, Disclosures, and Conflict of Interest:

This work was supported by award number R21CA137362 from the National Cancer Institute.