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An Evolutionary Algorithm of the Spot Sparsity Optimization in Proton Arc Therapy

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formalism introduced by TG51, the AAPM TG351 introduces a magnetic field dependent beam quality conversion factor k_Q,B that is a function of the magnetic field, the chamber model and orientation of the detector with respect to the radiation beam and the magnetic field. Another major deviation from the AAPM TG51 protocol is the use of TPR^{20}_{10} as the beam quality specifier, rather than $PDD(10)_x$. The draft report disseminates data from literature to provide the user with k_Q,B factors as a function of beam quality for various chambers appropriate for use with MR-linacs. **Conclusion:** Guidance on clinical implementation and the use of high-quality data for correction factors for clinical reference dosimetry in external MR-guided radiotherapy will enable accurate reference dosimetry measurements for these systems.

SU-I400-BReP-F3-05, Gamma Imaging Using Hybrid Coded-Aperture and Compton Scatter Imaging: B Montz[1]*, J Hayward[1], C Ramsey[1, 2],(1) University Of Tennessee, Knoxville, (2) Thompson Cancer Survival Center, Knoxville, TN

Purpose: Coded-aperture imaging and Compton scatter imaging are two techniques that can be used to localize source position. The purpose of this work was to investigate a hybrid approach for gamma imaging that combines the advantages of coded-aperture and Compton scatter imaging. The primary objective of this study was to investigate techniques to combine the data for one coherent image**. Methods:** Geant4 simulations were performed for a hand-held Germanium Gamma Imager (GeGI) modified with a coded aperture mask. The mask was created with a specific shadow pattern that will be seen on the detector depending on the angle of incident photons. The detector matrix was compared to the mask at every position with tallies generated based on how many matches occurred between a hole in the mask and counts on the detector. To demine the source location, Compton scatter cones were discretized into individual rays at equal angle intervals along a surface. These individual rays were traced to created geometries in 3D space**. Results:** A photon test source was used to successfully combine coded-aperture and Compton scatter images with greatly reduced noise and improved resolution. To improve image quality, the individual rays from the Compton scatter generated cones were weighted depending on their likely probability to have originated from the source. Areas where the coded aperture and Compton images both identify a source will be the most likely origin of the gamma, and thus were weighted higher. These images provide optimal clarity for spatial source location and spectral data that could be used for source identification**. Conclusion:** In this study, a novel technique was investigated to combine coded aperture and Compton scatter images for a modified hand-held gamma camera. The combination of these techniques improved spatial resolution.

Room 206: Therapy SNAP Oral; Treatment Planning and Delivery in Particle Therapy

SU-J-206-01, An Evolutionary Algorithm of the Spot Sparsity Optimization in Proton Arc Therapy: L Zhao*, G Liu, X Li, X Ding, Department of Radiation Oncology, Beaumont Health System, Royal Oak, MI

Purpose: Spot-scanning Proton Arc (SPArc) plan normally contains thousands of spot numbers in which is the delivery time is proportional to the number of spots. It is critical to find an optimal SPArc with a fast delivery speed while maintaining a good plan quality. Thus, we developed a novel evolutionary algorithm to directly search the optimal spot sparsity solution in the balance of plan quality and beam delivery time (BDT). **Methods:** The planning platform included a plan quality objective, a selector and a generator. A selector was designed to filter or add the spot according to the expected spot number, based on the user's input of delivery time. The generator is based on the MATLAB optimization toolbox trust-region-reflective solver. The selector and generator are used alternatively to optimize a spot sparsity solution. Two clinical cases, such as brain tumor and lung cancer, were used for testing purposes. Serials of user-defined BDTs from 15s to 120s were used as the inputs. The relationship between the plan's cost function value and BDT was evaluated in these two cases. **Results:** The evolutionary SPArc algorithm could optimize a SPArc plan based on clinical user inputs using treatment delivery time directly. The plan quality remains optimal in the brain and lung cases until the delivery time was shorter than 25s and 70s, respectively. The plan quality degraded as the input delivery time became too short, indicating that the plan lacked enough spot or degree of optimization freedom. **Conclusion:** This is the first SPArc planning framework to directly optimize plan quality with the delivery time as an input for the new generation of proton therapy systems. This work paved the roadmap for implementing such new technology in a routine clinic and provided a planning platform to explore the trade-off between the delivery time and plan quality.

SU-J-206-02, Biological Optimization of Peak-To-Valley Dose Ratio and Normal-Tissue Survival Fraction for Proton Minibeam Radiation Therapy: W Zhang*, W Li, Y Lin, F Wang, R Chen, H Gao, University of Kansas Medical Center, Kansas City, KS