# AbstractID: 2984 Title: A Fourier analysis of the dose grid resolution requirement in proton therapy IMRT fluence-map optimization

**Purpose:** We determine the minimum spatial sampling frequency required for proton beam dose computation so that the accuracy is guaranteed in the sampling phase and superfluous computational work is avoided. Our work is based on a previous analysis of photon beam IMRT resolution and we extend the work for arbitrary rotations of the beam about the dose grid. The accuracy criterion of the sampling is set up such that the dose distribution can be reconstructed from the sample within a specified error.

**Method and Materials:** Fourier analysis and the Nyquist-Shannon Sampling Theorem are employed in the analysis. By the distributive property of the Fourier transform, the analysis can be done with a single proton beamlet in lieu of a composite beam. The beamlet was modeled as a 3D analytical dose function of an infinitesimal and mono-energetic proton beam in water. Fourier transforms of the dose function were carried out analytically in 3D for arbitrary orientations of the beam with respect to the dose grid. The Nyquist-Shannon Sampling Theorem was used to judge the minimal sampling resolution required for a specified error. Since the steepness of a proton beam is known to depend on its range, due to multiple Coulomb scattering, the resolution was determined as a function of radiological depth.

**Results:** For proton beams with ranges from 3 to 30 cm, sampling resolutions from 0.8 to 8 mm are required for a worst case 2% error, and a near linear relation between range and required resolution was observed. The resolution requirement did not significantly change for small angulations with respect to the grid.

**Conclusion:** Accurate proton dose computation can be performed with millimeter-sized voxels that increase in size with increasing range. We present adaptive voxel schemes to take advantage of this feature for proton IMRT.