AbstractID: 12901 Title: Linear energy transfer of proton clusters

Purpose: In conventional particle accelerators protons are produced in long pulses. Therefore, the radiobiology of conventionally accelerated protons is primarily governed by the interaction of a single proton with the cell. In the laser-plasma interaction scheme, the accelerated protons come as a single bunch of particles with interparticle distances that can be orders of magnitude shorter compared to those in conventional particle accelerators. As laser-accelerated protons traverse the medium, they not only interact with it but also with each other, which under certain conditions may lead to a coherent interference effect manifested by the increase in their linear stopping power that may eventually lead to higher relative biological effectiveness (RBE) of the cluster. Understanding the exact conditions under which such an effect becomes significant is the main goal of this work.

Method and Materials: The dynamic linear response theory of the medium is used to calculate the stopping power of the proton cluster. The proximity function is introduced that defines the enhancement effect in the energy loss of the cluster. The relation between the RBE and the LET is used to predict the cluster's RBE.

Results: When the average distance between protons in a cluster is smaller than certain threshold, the enhanced LET of the cluster is found. The increased stopping power is due to the interference effect between the induced fields. It is conjectured that the accelerated proton cluster will have larger RBE values compared to those accelerated through conventional methods.

Conclusions: The potential impact of this project lies in the development of a deeper understanding of radiobiology of particle clusters, a question that has not been addressed before. If the main conjecture of this project is experimentally confirmed, this may spawn the development of new proton sources for medical accelerators with increased RBE and thus higher tumor controls.