ABSTRACT:
A novel concept for an Advanced Compact Carbon Ion Linac (ACCOL) that will deliver up to 1 pA of carbon ions with variable energy from 45 MeV/u to 450 MeV/u in a 45m footprint, has been developed by Argonne National Laboratory (ANL) in collaboration with RadiaBeam. The ACCIL will have a 35 MV/m real-estate accelerating gradients that became possible to achieve with the development of novel S-band high-gradient structures, capable of providing 50 MV/m accelerating gradients for particles with $\beta > 0.3$. In particular, a $\beta = 0.3$ structure based on the novel approach of operation at the first negative spatial harmonic with the increased distance between the accelerating gaps will be presented. This is the first attempt to reach such high gradients at such small velocities. RadiaBeam and ANL have demonstrated the feasibility of building this structure for accelerating carbon ions by means of advanced computer simulations and are currently working towards the fabrication of this structure for high power tests.

Higher Spatial Harmonics Structure

- Periodic structures have an infinite number of spatial harmonics.
- These harmonics have the same frequency but different spatial field distribution.
- An accelerating structure can be designed for the first negative harmonic $m=1$ instead of the fundamental harmonic $m=0$.
- Larger period allows implementing noses for higher shunt impedance

Summary:
The proposed acceleration with higher spatial harmonics has enabled the development of a novel high-gradient accelerating structure design for protons and carbon ions with low $\beta$. The prototype structure being developed will become the enabling technology for compact hadron therapy linacs. We have performed electromagnetic optimization of 50 MV/m $\beta = 0.3$ NHS cells to achieve mechanical stresses below the annealed yield stresses of 52 MPa. The design of a robust cooling system and the careful structural analysis helped to ensure the stable operation at high gradients in long-term applications. The NHS section is currently being built and is planned to be tested in 2019.
RadiaBeam Systems is a leading supplier of accelerator-based X-ray sources, security systems, and irradiators as well as large-scale accelerator technology for the research community. Our products include turnkey sterilization systems for medical device manufacturer and food processors, industrial radiography systems, security systems, OEM accelerating structures, and light source insertion devices.

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