Study of HOMs and Optimization of Dual Axis Asymmetric Cavity for High-Average Current ERL

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Abstract:

Electron-beam current in superconducting radiofrequency energy recovery linear accelerators (SCRF ERLs) is limited by beam break-up (BBU) instabilities which can affect the beam quality, energy recuperation and disrupt beam transportation. The instabilities originate from the accumulation of the high order modes (HOMs) in the SCRF cavity and positive feedback, which exists as the beam makes at least two trips through the same cavity's cells, between the beam and the HOMs. These are especially evident in multi-pass ERLs where beams travel several times through the same cavity. A dual axis asymmetric SCRF ERL has been proposed as a possible way to drive a high average current electron beam while avoiding the BBU instability excitation. Such high current ERLs can be attractive for the next generation light sources, beam cooling in electron ion collider (EIC) and different energy electron beam handling in the multi-pass machines. In this presentation the results of the studies of band-pass modes and HOMs observed in the original asymmetric dual axis aluminium cavity will be shown. The field distribution of the modes will be show and asymmetric field distribution of HOMs (i.e. confinement to one or another axis) will be demonstrated (figure 1a). Their excitations using dipole couplers will be discussed. The measurements confirm the numerical predictions and theory developed.

The original design of the dual axis asymmetric cavity has been optimised to minimize the peaks of magnetic and electric fields on the cavity surface, to increase the distance between operating mode and neighbouring parasitic mode as well as to reduce the cavity manufacturing cost. To reach the goals several solutions have been suggested leading to simplification of the manufacturing as well as bringing the fields amplitudes on the cavity surface to the acceptable values. Results of studies of HOMs observed in the new structures will be presented. The new design (fig.1b) of the cavity will be presented and discussed.

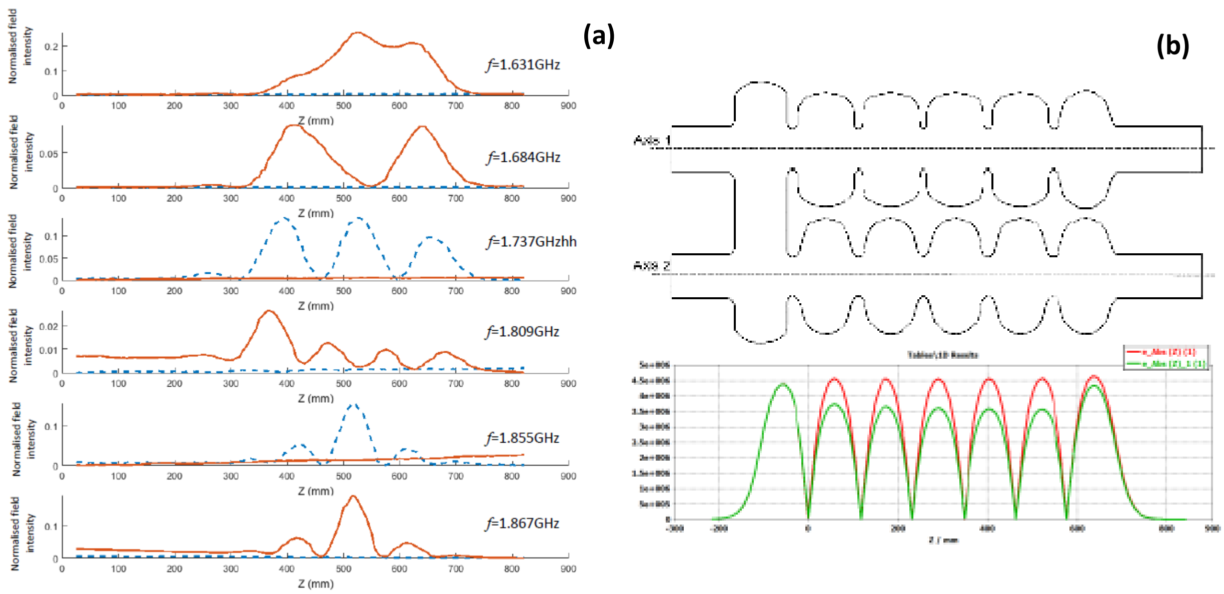

Figure 1 (a) Typical distribution of HOMs' field intensity on accelerating (blue) and decelerating (red) axes measured using bead pull technique. **(b)** Sketch of the new cavity design and operating field structure along accelerating and decelerating axes.