SSC-Preprint - 29

ABSTRACT

Vacuum-Gap Modes in Pulsed Solid-Core Ferrite Kicker Magnets

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Ferrite core magnets find routine use in pulsed extraction and injection systems to deflect high-energy beams in synchrotron and linear accelerators. When magnetic field risetime requirements in these kicker magnets fall below approximately 100ns, the transmission-line properties of the magnet becomes an important issue. Wave propagation through the device can be despersive and difficult to analyze if multiple modes are present. A solid-core, three conductor "H" core magnet has been analyzed and experimentally tested for an application requiring a 70 ns integrated magnetic field risetime. Experiments with this magnet have revealed significant non-ideal transmission-line behavior. The propagation delay through this magnet is significantly shorter than calculated from static, TEM modeling techniques. Several modes can propagate in this magnet due to the inability of the ferrite to charge in the time frame required to establish the TEM modes seen in rudimentary static modeling. A vacuum-gap mode, comprised of fields confined in the non-ferrite region where the beam resides, is free to propagate longitudinally down the device at a velocity which is a large fraction of the speed of light in vacuum. The behavior seen in this H-core magnet is also possible in other less complex magnet designs, such as the two conductor, solid C-core magnets which are in widespread use.

Experimental data will be presented as well as simulations from EMAS, a 3-D electromagnetic code. Techniques to prevent the establishment of vacuum-gap modes will be discussed along with travelling-wave magnet design.

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