Abstract Submitted
for the DPP17 Meeting of
The American Physical Society

Cherenkov-cyclotron instability in a metamaterial loaded waveguide for high power generation[1] XUEYING LU, MICHAEL SHAPIRO, RICHARD TEMKIN, Massachusetts Inst of Tech-MIT — This work presents the analytical theory for an S-band high power microwave experiment at MIT utilizing a metamaterial (MTM) structure. A 490 kV, 84 A electron beam travels through a rectangular waveguide loaded with two MTM plates in a DC magnetic field B_0. The excited waveguide mode is deflecting with a transverse E field on beam axis. Microsecond long megawatt level microwave pulses were generated under a low B_0 in the Cherenkov-cyclotron type of interaction. A linear theory has been developed to explain the high power generation due to the Cherenkov-cyclotron instability. The simplified model is a planar waveguide filled with a double negative dispersive medium, and in the mode being studied, the longitudinal E field has an antisymmetric pattern in the direction perpendicular to the MTM plates. We have proved that the Cherenkov-cyclotron instability can happen with a zero initial transverse beam velocity when B_0 is below a threshold. Also this instability is a unique feature of the left-handed MTM, since it requires a propagating mode below the cut-off frequency. The minimum beam current to start the instability is calculated, and the scaling law different from that of the traditional backward wave oscillators operated by longitudinal bunching will be discussed.

[1]This research was supported by the Air Force Office of Scientific Research within the Multidisciplinary University Research Initiative under Grant No. FA9550-12-1-0489 through the University of New Mexico.

Xueying Lu
Massachusetts Inst of Tech-MIT

Date submitted: 11 Jul 2017 Electronic form version 1.4