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Design and test of a metamaterial accelerating structure for Wakefield acceleration

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Structure-based wakefield acceleration with nanosecond-long RF pulses is a promising advanced accelerator concept to mitigate the risks of RF breakdown. Advanced structures are required to satisfy the need of a high transient gradient with a short pulse length. A metamaterial (MTM) structure, as a subwavelength periodic structure exhibiting a negative group velocity, could have a higher shunt impedance, thus a higher gradient, compared to structures with the same but positive group velocities. An X-band 'wagon wheel'structure has been designed and tested as an accelerating structure for two-beam acceleration. Up to 200 MV/m of gradient has been achieved with an input power extracted from the 65 MeV drive beam at AWA, with a peak power of 115 MW, and a pulse length of 6 ns (FWHM). Evidence has been found towards a new accelerating regime, the breakdown insensitive accelerating regime (BIAR), where breakdown was only observed in the secondary pulse of the transmitted RF signal while the primary pulse (useful for acceleration) was not interrupted. This experiment could lead to high-gradient wakefield acceleration and new knowledge in the breakdown physics in the short-pulse regime.

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Footnotes

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