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Helicon wave modelling for the Madison Awake Prototype MAP[1]

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— Next generation electron colliders need acceleration fields greater than 1 GV/m which is beyond the capabilities of superconducting RF cavities. A promising new acceleration concept is plasma wakefield acceleration for which plasma densities of order $10^{21}\ m^{-3}$ are needed. As part of CERN's AWAKE collaboration, UW-Madison is building the Madison Awake Prototype MAP. In MAP the plasma will be generated inside a 26 mm radius quartz tube, immersed in a 1000 G field. 30 kW RF power are used to excite a very high density helicon plasma. Starting with the HELIC code we model the EM fields inside a given plasma profile for different antenna geometries. This is the basis for modelling the Helicon wave in COMSOL which allows for arbitrary field geometries. Starting with measured plasma profiles we use a simplified transport and heating model to find equilibrium states for a given antenna configuration. Using this coupled model we optimize the antenna geometry for maximum core plasma density. Predicted RF fields and plasma profiles can then be compared to measurements. This research directly contributes to the qualification of a comparably sized cell at higher power density that is being qualified at CERN.

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