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Biosketch:

Dr. Seltzman is a research scientist at the Plasma Science and Fusion Center at the Massachusetts Institute of Technology where he works on Lower Hybrid Current Drive (LHCD) on DIII-D, additive manufacturing (AM) of nuclear components, and material science of AMed alloys. At MIT, he developed an AMed LHCD launcher that was the first AMed system to be installed in a fusion device, and the first monolithic AM of an LHCD launcher module as a single complete unit. His current work focuses on simulations of RF-plasma interactions, AM, and alloy development of nuclear materials. He received a MS in Electrical Engineering in 2012 and a Ph.D. in Physics in 2017 from the University of Wisconsin – Madison where he demonstrated the first RF heating of the reversed field pinch. He is a member of IEEE, American Nuclear Society, and the American Physical Society.

Additive Manufacturing for Fusion Power: What We Have Achieved, and Where We Are Going

Additive Manufacturing (AM) enables the production of components in geometries not achievable by conventional machining. AM for fusion power addresses the need of geometrically complex internal structures, including embedded cooling channels and RF components, while the rapid melting and solidification of the Laser Powder Bed Fusion (L-PBF) process is used to refine the material properties improving tensile strength of the Cu-Cr-Nb used as an L-PBF feedstock. New Nb-free alloys are developed to replace current Cu-Cr-Nb alloys in AM for fusion use, where neutron activation of Nb leads to long-lived nuclear waste. These alloys seek to maintain the favorable mechanical, AM, and electrical/thermal conductivity of Cu-Cr-Nb alloys by replacing Cr_2Nb precipitates with Cr_2Ta, Cr_2Ti, or V_2Ta precipitates in gas-atomized powders.

We present the development of an AMed Lower Hybrid Current Drive (LHCD), a method of driving plasma current with RF waves launched into the plasma, that was recently installed on the DIII-D tokamak. The LHCD launcher consists of an RF structure that divides a single waveguide input into a 6x4 output grill positioned at the plasma surface. Waveguides were designed for L-PBF AM with a pentagonal cross-section that self-supports the roof from the waveguide sidewalls to prevent downward collapse into the structure that occurs with the traditional rectangular cross-section. The LHCD launcher for DIII-D was AMed in segments that were laser-welded together (a); a monolithic AMed design enables L-PBF as a single unit (b), reducing build time and cost by eliminating multiple fabrication steps. A methodology was developed to simulate plasma-wave-physics to specify finite-element-modeling of RF designs that are converted to mechanical models of physical launcher structures for monolithic AM.

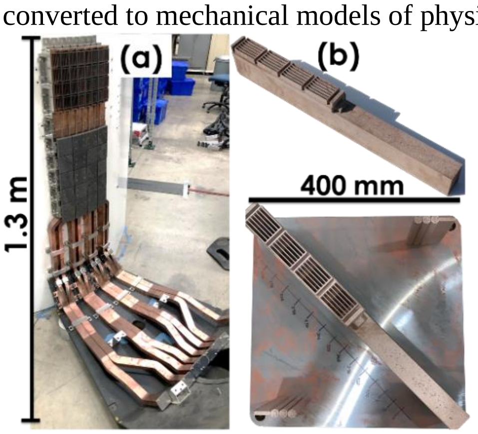

Fig 1. Segmented AM Launcher (a)
Monolithic AM Module (b)