Resistive Wall Mode Study in a Line Tied Screw Pinch

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The Resistive Wall Mode Has Been Found in The UW-RWM

Magnetic Diagnostics used to analyze the coherent MHD fluctuations seen in the experiment.
The RWM growth rate has a characteristic dependence on the boundary material wall time.
Spatial Fourier decomposition analyses specific MHD modes to be tracked in time.
The mode is obscured by an error field that must be subtracted.

A Rotating Wall is Under Construction

The mechanical design parameters for the spinning shell are:
- Max speed = 7500 RPM = 180 mph
- Radius = 10 cm, Length = 1m

Ferritic Wall Has Been Shown to Affect RWM

Ferritic steels are a candidate first wall for future devices.
A MoMetall® boundary was added, with µ ≈ 1200, which alters the RWM dispersion relation (green curve)
Magnetic amplification tends to destabilize the RWM

Theory Predicts Rotating Wall can Stabilize RWM

A standard linear ideal MHD analysis is presented:
\[ \frac{\partial B}{\partial t} + \nabla \times (B \times \mathbf{E}) - \mu_0 \nabla \times \left( \frac{\nabla \times B}{\mu_0} \right) + \mathbf{F} = 0 \]

Combining the momentum & induction equation:
\[ \frac{\partial \mathbf{v}}{\partial t} + \mathbf{v} \cdot \nabla \mathbf{v} = -\nabla p + \mu_0 \nabla \times \mathbf{E} + \mathbf{J} \times \mathbf{B} - \frac{\nabla \times B}{\mu_0} \]

Look for m/2, line tied solutions: \( \Delta n = \Delta n(t) \nabla \times \mathbf{E} = \frac{\nabla \times B}{\mu_0} \)
The PDE that yields the dispersion relation:
\[ \Delta n = \Delta n(\Delta \mathbf{B}) \]

\[ \mathbf{E} + \mathbf{B} \mathbf{v} = \frac{\nabla \times B}{\mu_0} \]

For low speeds, very little effect is seen.