

Thermal Design and Optimization of Active Cooling for High-Power ECRH Miter Bend

Abstract

Electron Cyclotron Resonance Heating (ECRH) is a major auxiliary heating system in tokamaks and fusion reactors, where high-power microwave beams are launched into the plasma. When these beams interact with metallic surfaces, a portion of their power is absorbed, generating localized heat fluxes that can exceed several MW/m².

This project aims to design an active cooling system capable of dissipating these high heat loads during the steady-state operation of a miter bend. Efficient thermal management is crucial for preventing material degradation and limiting thermally induced surface deformation, both of which can negatively affect microwave beam performance.

The project will concentrate on the thermal design and simulation-based assessment of water-cooling configurations subjected to non-uniform heat loads. It involves investigating cooling channel geometries optimized for Gaussian heat flux distributions and evaluating their performance using thermal and computational fluid dynamics (CFD) simulations. The feasibility of employing advanced thermal management features i.e. fins, vapour chambers etc. will be examined to increase cooling efficiency. The proposed designs will be assessed based on criteria including maximum temperature, temperature uniformity and structural deformation. The expected outcome is a set of preliminary design recommendations along with a better understanding of the key thermal design trade-offs involved in the development of an efficient miter bend cooling system.

Academic Project Requirements:

1) **Required No. of student(s) for academic project: 1**

2) **Name of course with branch/discipline: B.E./B.Tech. Mechanical Engineering**

3) **Academic Project duration:**

(a) **Total academic project duration: 6 Weeks**

(b) **Student's presence at IPR for academic project work: 5 Full working Days per week**

Email to: hardik.mistry@ipr.res.in[Guide's e-mail address] and project_me@ipr.res.in [Academic Project Coordinator's e-mail address]

Phone Number: 079 -079-2396-2147 [Guide's phone number]