Proposal Code : PDF-Computational-0001	
Title	Numerical Modelling and Algorithm Development for Neoclassical Tearing Mode (NTM) Detection Using ECE Diagnostics in ITER
Abstract	The detection and control of neoclassical tearing modes (NTMs) are critical for the stability and performance of ITER plasma operations. NTMs, driven by perturbations in bootstrap current, can degrade confinement and even lead to disruptions if they are uncontrolled. The Electron Cyclotron Emission (ECE) diagnostic is one of the primary noninvasive diagnostics to detect these instabilities, offering real-time information on the electron temperature profile and temperature fluctuations associated with NTMs. The ITER ECE system employs both radial and oblique lines-of-sight, transmitting ECE emissions in the frequency range of 70–1000 GHz over 43-meter-long transmission lines in both X- and O-mode polarizations to the diagnostic instrumentation. The signal is processed using Fourier Transform Spectrometers (FTS) and multi-channel radiometers. The Indian Domestic Agency (IN-DA) is responsible for delivering the low-frequency radiometer, for monitoring core Te profiles and NTM structures in real-time. Following are the project objectives: 1. To simulate NTM island structures and derive width and phase as a function of time using plasma parameters of the ITER scenarios. 2. To model the ECE intensity profiles as a synthetic diagnostics for simulated NTM island parameters and given position of the island 3. By using the synthetic ECE intensity profile, generate the synthetic output of the radiometer channel 4. The radiometer output channel and synthetic Mirnov coils output will use to develop an NTM detection algorithm suitable for integration into ITER's I&C systems for the ECE diagnostic.

Research Focus Areas	A numerical NTM model would simulate island width and phase evolution as a function of time for several ITER scenarios. The model would take account for effects such as current profile, q-profile, bootstrap current, and mode number (m/n). ECE intensity will be computed by solving the radiative transfer equation for the relevant frequency range and viewing geometry. Inputs will include required plasma parameters, island width and radial position. The simulation will predict synthetic from radiometer channels, including effects of video bandwidth (Bv) and intermediate frequency bandwidth (BIF) The synthetic outputs of ECE can be used to develop a multi-channel NTM detection algorithm using available methods in literature. The algorithm will be optimized for integration with ITER's I&C architecture.
Qualifications	PhD in Physics
Desired Experience	Knowledge in Plasma physics and Fusion Science along with experience programming (e.g., FORTRAN, C++, Python..) and Scientific tools (e.g., MATLAB)
Other remarks	**Expected Outcome** ▪ A validated simulation code to generate synthetic ECE signals for various NTM scenarios. ▪ Realistic synthetic diagnostic outputs for ECE for all ITER-like conditions. ▪ A prototype NTM detection algorithm demonstrating high reliability and compatibility with real-time control needs.