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Design of Stray Radiation Sensor for ITER ECE Diagnostic

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The Electron Cyclotron Emission (ECE) diagnostic has a primary role in the measurement of electron temperature profile and electron temperature fluctuations in ITER. This diagnostic shall be exposed to significant power due to unabsorbed Electron Cyclotron Heating (ECH) power in the plasma [1]. The expected stray power loads could be a few watts, and therefore, the protection of millimetre wave components is one of the design challenges of ITER ECE diagnostic. This protection system includes sensors, a band stop notch filter, and a shutter to stop the RF stray radiation from being incident on the sensitive components. The sensors will be positioned along the ECE transmission line, and shall be used for real-time power monitoring of the stray radiation.

Here, we describe a novel design of a sensor for monitoring the stray radiation power. This sensor is a Schottky Diode rectenna, known for high-power and high-speed millimetre wave detection capability [2], [3]. It consists of a 2x2 microstrip patch antenna array, a matching circuit, a diode, and a low pass filter. The antenna array is designed analytically and optimized in CST Microwave Studio, for wide reception angle, high gain, and low side lobe levels. Furthermore, the rectifying circuit is optimized using Agilent Advanced Design System (ADS) software to get better rectification and impedance matching of the signal, thereby improving its detection sensitivity. The ADS simulation results show that the detection sensitivity is about 1000V/W for input power of -30 dBm at 170 GHz, thereby achieving the required performance of the sensor.

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