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A Diagnostic Approach for the Detection of Spatially Distributed Low Energy Confined Runaway Electrons in the ADITYA-U Tokamak by means of Synchrotron Emission Imaging in the Sub-millimetre Wavelength Band

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In recent years, the studies of Runaway Electron (RE) generation and energy dynamics in tokamaks have gained great importance from the theoretical and experimental perspective. The generation of high power RE beam during the plasma disruption may damage in-vessel components. Therefore, it is important to study and to suppress the REs for the safe operation of the large size tokamaks, such as ITER tokamak. This demands an improved, robust and sensitive RE diagnostic methods to provide essential observations of confined REs when they are in the early stage of their energy and population growth. The RE-diagnostic data can be utilized for validation of the theoretical models and also to study the efficiency of the RE mitigation techniques. Out of several RE diagnostic methods, observation of the synchrotron radiation emission (SRE) from REs is an established method to detect the confined REs and studied in the several tokamaks using the Visible and IR cameras where the lower observed energy of the REs was reported typically more than 20MeV. Signature of REs and supra-thermal electrons in the cyclotron emission range is often reported from several tokamaks where the energy is in the sub-MeV range. Measurements of REs in the intermediate range from 0.5 MeV to 20 MeV is always been performed by the HXR and Gamma-Ray spectrometers. Non-imaging SRE measurements of the low energy REs (~2-7 MeV) performed in the FT-2 tokamak in the range of 106-156 GHz. This motivates to design a diagnostic that can detect SRE from the low energy confined REs in the sub-millimetre band (THz-band). In this paper, a imaging diagnostic approach has been proposed for the first time to capture spatiotemporally resolved SRE pattern of the low energy confined REs in the ADITYA-U tokamak. In order to design the diagnostic, a detailed forward modelling of the RE dynamics in the momentum space performed considering the experimental evolution of the plasma parameters. The simulated RE parameters were utilized to predict SRE signal level at the given detector location and the diagnostics parameters were optimized. Expected spatial distribution of the SRE brightness images as seen by the THz-camera has also been modelled. From the modelling results, it has been established that the proposed design can provide spatiotemporally resolved SRE images of the confined REs in the energy range 1-20 MeV.

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