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ITR/P5-33: ITPA Assessment of ITER Microwave Diagnostic Design Issues

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The microwave-based diagnostic suite proposed for ITER includes Electron Cyclotron Emission, Reflectometry, Collective Thomson Scattering and Refractometry. Their common feature is the use of simple in-vessel metallic antennas and waveguide transmission lines (front-end components) which are relatively insensitive to radiation damage. However, once installed they will be difficult to replace or modify, hence, their careful design is a pressing issue. In contrast, the back-end microwave transceivers (which are well developed and can employ the latest technology) will be accessible and less problematic. Here, several topics critical to the overall diagnostic designs and component selection are assessed. These include the provision for in-situ component and system calibration. E.g., initial performance measurements (losses, reflections, mode-conversion) are required to allow identification of component degradation. All the microwave diagnostics will be susceptible to stray radiation damage from non-absorbed ECRH and CTS gyrotron beams or from fast electron generated Bremsstrahlung. Various options and techniques, such as combinations of fast acting shutters, waveguide filters, fuses etc. have been identified to protect the sensitive diagnostic electronics and TL components, such as polarization splitters etc. The Low-Field-Side Reflectometer system is at a crucial design phase - systematic studies of the design drivers as well as the placement and alignment of the antennas using beam-tracing codes have been performed. A major issue is the sensitivity of the probing beam to vertical movements of the plasma column, which is linked to the selection of antenna gain and placement, monostatic vs bistatic antenna arrangements, and fixed antenna alignments vs steerable antennas. The timely assessment of these diagnostic issues has directly impacted the detailed diagnostic designs - which will shortly be placed in the hands of the respective ITER domestic agencies.

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