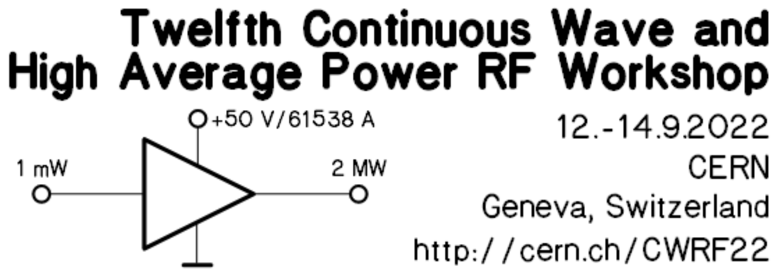

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Overview of the ITER high power CW Ion Cyclotron Range of Frequencies system and latest developments for its antennas

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In a steady-state nuclear fusion reactor of the tokamak type, high-power CW RF systems are envisaged, among other systems, to heat the plasma up to the required temperatures of 10-20 keV and to drive a non-inductive plasma-current which is required for the plasma confinement. This paper overviews the so-called Ion Cyclotron Range of Frequencies (ICRF) system of the International Thermonuclear Experimental Reactor (ITER). The ITER ICRF system is a 20 MW CW RF system operating at 40-55 MHz. It is designed to be upgradable to 40 MW CW. The system is based on two identical antennas or couplers. Each coupler is a 24-element phased array antenna. The radiating elements are grouped in 8 triplets and are oriented, spaced and phased such as to couple to the plasma with the right polarization and radiating plane wave spectrum while reducing parasitic interactions at the plasma edge. The triplets of an antenna are fed through a specific internal circuit with embedded, compact and robust service-stubs providing cooling to the internal conductors of the coaxes and broad-banding the antennas' response. The stubs also provide the necessary mechanical support for the antennas'internal components and allow positionning the vacuum RF feedthroughs at a location that is favorable from mechanical and neutronic points of view. Each antenna is fed by eight transmission lines that are connected to the RF sources through a specific decoupling & matching network. The RF sources are based on RF tubes as end-stage amplifier chain.
After overviewing the ITER ICRF system, the paper develops the RF design of the ITER ICRF antennas and details the strategy that has been adopted to optimize the antennas'power coupling within the operation frequency range (40-55 MHz) while ensuring compliance with the requirements on the maximum voltages (45 kV peak), and maximum electric fields (2-3 kV/mm depending on the location and orientation w.r.t. the tokamak magnetic field). The paper also develops the ongoing R&D and prototyping works for the antennas components (such as RF feedthroughs and their dedicated testbed, the 3D-printed radiating elements, etc.).

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