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10.52 Millimeter-wave system-on-chip advancement for fusion plasma diagnostics

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RF system-on-chips permit mm-wave fusion plasma diagnostics to address major challenges: space inefficiency, inflexible installation, performance, and prohibitively high cost of conventional discrete component assemblies as higher imaging resolution and data accuracy are required and achieved by significant increases in numbers of channels. Today, CMOS technology can operate at >hundreds of GHz which is suitable for millimeter-wave diagnostics on current and future tokamaks. The Davis Millimeter Research Center (DMRC) team has extensive experience in designing fully customized square millimeter scale ICs for fusion science applications and has developed V-band (50-75 GHz) transmitter and receiver chips for Microwave Imaging Reflectometry (MIR). The transmitter can illuminate 8 different frequencies simultaneously. With the MMIC chip approach upgrade, the receiver has the capability to amplify the reflected signal (> 30 dB) while offering 20x reduction in noise temperature compared to current MIR processing. Plasma diagnostics requires ultra-wideband (>20 GHz) operation- x9 larger bandwidth than the recent commercial impetus for communication systems. Finally, current efforts are underway for GaAs MMIC receiver chips at W-Band (75-110 GHz) permitting measurements at higher fields.

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