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FTP/P1-25: ECH-assisted Startup using ITER Prototype of 170 GHz Gyrotron in KSTAR

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The newly installed electron cyclotron heating and current drive (EC H&CD) system with a frequency of 170 GHz was successfully commissioned and used for the second-harmonic ECH-assisted startup in 2011 operational campaign of the KSTAR. As a RF power source, ITER pre-prototype of 170 GHz, 1 MW continuous-wave gyrotron was loaned from the Japan Atomic Energy Agency (JAEA). The Gaussian beam output from the gyrotron passes through an edge-cooled diamond window and is coupled to an HE₁₁ corrugated waveguide via two phase correcting mirrors in a matching optics unit (MOU). The power coupled to the HE₁₁ corrugated waveguide is delivered to the launcher by the transmission total length of 70 meters. For the first 1 MW EC H&CD system, 1-beam based 1 MW equatorial launcher is installed in the KSTAR Bay E-m. The launcher has been designed and fabricated in collaboration with both Princeton Plasma Physics Laboratory (PPPL) and Pohang University of Science and Technology (POSTECH). During the KSTAR 2011 campaign, 10-s pulse at 0.6 MW EC beam was reliably injected into the plasma. Also, 170 GHz second harmonic ECH-assisted start-up was successful leading to reduce the flux consumption at toroidal magnetic field of 3 T. In this experiment, the flux consumption until the plasma current flat-top was reduced from 4.13 Wb for pure Ohmic to 3.62 Wb (12 % reduction) for the perpendicular injection. When the EC beam is launched with toroidal angle of 20 deg with respect to the outward radial direction at the steering mirror, more reduced magnetic flux consumption was obtained with 3.14 Wb (24 % reduction) compared with pure OH plasmas. After the 2011 campaign, the gyrotron has been fully commissioned with the output power of 1 MW at the diamond window and the frequency of 170 GHz by precise alignment of the magnet to the gyrotron axis.

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