ELECTRON CYCLOTRON HEATING POWER SUPPLIES ON DIII-D*

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The electron cyclotron heating (ECH) system on DIII-D currently has six gyrotrons supporting plasma physics experiments [1]. Each of these non-depressed collector gyrotrons has an 80 kV, 40 A electron beam. The six gyrotrons are connected to three ECH power supplies (ECHPS). ECHPS#1 and #2 have an 80 kV, 90 A modulator with a single CQK 200-4A tetrode, each operating two gyrotrons in parallel. ECHPS #3 [2] has three modulators, each with a single 4CPW1000KB tetrode, and can operate three gyrotrons asynchronously. Because of the limitations of the input high voltage dc power supply (HVDC PS), only two of the three gyrotrons can be pulsed simultaneously. The HVDC power supplies are located outdoors and supply the input voltage to the modulators via high voltage coaxial cables.

In order to meet the modulation requirements of up to 10 kHz, tetrode-based modulators are needed for the gyrotrons used in the DIII-D ECH system. If the modulation requirement were reduced to below 1 kHz, or if depressed collector gyrotrons were used on DIII-D, then a solid-state modulator can be used [3]. The proposed architecture for the solid-state power supplies had multiple gyrotrons connected to a single power supply, each with its own modulator to be able to maximize the flexibility and performance of the ECH system and to reduce the cost of the power system. The configurations of the ECHPSs on DIII-D with multiple gyrotrons on a single modulator in a power supply (as for ECHPS#1 and #2) or with multiple gyrotrons each with its own modulator on a single power supply (as for ECHPS#3) mimic the configurations discussed and demonstrate the disadvantages of the former and the benefits of the latter. This will be described in more detail, as well as the performance of ECHPS#3.

The ECH system on DIII-D is currently being expanded with the addition of a seventh gyrotron, with plans to add an eighth gyrotron in the near future, and more if the long-range plans come to fruition. These gyrotrons will have depressed collectors and generate 1.2 MW, or higher, rf power. A fourth ECHPS is being built for the next two gyrotrons and will have two modulators as in ECHPS#3. A solid-state crowbar [4] is to be installed in ECHPS#4, replacing the ignitron crowbar used in the other power supplies. The solid-state crowbar was temporarily installed in ECHPS#3 and tested to 100 kVdc. It triggered in less than 1.5 microseconds at full voltage. The tests and results will be described in more detail.

[1] J. Lohr, et al., Fusion Sci. Technol. **48** (2005) 1226-1237.
[2] B. McDaniel, et al., "Multiple High Voltage Modulators Operating Independently from a Single Common 100 kV dc Power Supply," Proceedings of the 23rd Symposium on Fusion Engineering, June 1–5, 2009, San Diego, CA.
[3] J.F. Tooker, et al, Fusion Eng. Design **84** (2009) 1857–1861.
[4] J.F. Tooker, et al, "Solid-State High-Voltage Crowbar Utilizing Series-Connected Thyristors," Proceedings of the 17th IEEE International Pulsed Power Conference 2009, June 28 through July 2, 2009, 1439–1443.

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