ABSTRACT

Stabilization of n=1 resistive wall modes (RWMs) can allow stability at values of β_N above the resistive wall limit. A set of 12 internal coils is being installed in DIII–D, allowing fast feedback stabilization (~1 ms) of RWMs even when toroidal rotation is too slow to adequately stabilize these modes. VALEN3D modeling has shown that the growth rate of the RWM can be reduced to zero for values of β_N almost up to the ideal-wall limit using the internal coil, power, and feedback systems being constructed for operation in 2003. We will show the calculated toroidal mode spectrum of these new internal coils and discuss the various ways in which they can be interconnected for suppression of n=1 error field correction will also be presented. Currently two prototype internal coils have been installed and we will discuss their operation.

DIII–D
NATIONAL FUSION FACILITY
SAN DIEGO

MOTIVATION FOR AN INTERNAL COIL (I-COIL) SET

- Resistive wall modes (RWM) can limit maximum achievable β, especially in Advanced Tokamak plasmas
- In DIII–D, the RWM can be stabilized by plasma rotation but burning plasmas, with significantly lower rotation, may not have sufficient stability without additional compensation
- VALEN modeling has predicted that performance of internal coils is superior to that of the existing external coil set for RWM stabilization
- Modeling of 18 vs. 12 internal coils shows little difference in maximum achievable β_N
  - The 12 coil set was selected and has been installed
- Other experiments can also utilize the new I-coils
  - Improved static error field correction
  - Edge ergodization
  - I-coil induced plasma rotation
  - MHD spectroscopy

TWO PROTOTYPE I-COILS WERE INSTALLED IN DIII–D AND TESTED DURING THE 2002 CAMPAIGN

- Mechanical tests
  - I-coils exhibited no deleterious mechanical resonances
  - No j×B problems were observed
  - I-coils operated up to 4.5 kA. Thermal heat loads greed with calculations
- Electrical tests
  - Time response was measured at several current levels
  - Current ripple was at unacceptable levels until additional inductance was added for power amplifier stability
  - New power supply configurations were tested which will allow additional flexibility in future experiments with fewer new supplies
  - Preliminary tests of I-coil feedback at different system gains were performed with plasmas
  - No electrical short circuits were observed during testing or fabrication. Voltage isolation exceeds design specifications

TWELVE "PRODUCTION" I-COILS AND NEW SENSORS HAVE BEEN INSTALLED IN DIII–D

- Based on prototype testing and fabrication, the I-coil distance from the DIII–D wall was increased to 1.47 cm
- Water flow was increased, allowing 7 kA capability for 10 s
- New Bp sensor coils have been installed with higher (2x) NA, increasing effective system gain

I–COIL ELECTRICAL SYSTEMS ARE BEING INSTALLED

- A versatile patch panel allows I-coil connections in a variety of configurations
- Plasma control system upgrades will allow individual real-time control of all I-coils independently. B_p and B_r sensors associated with each I-coil allow flexibility for implementing feedback control algorithms
- Doubling of the SPA switching frequency ot 7 kHz will improve system response and reduce current ripple
- An additional switching power amplifier (SPA) and dc input supply will be added (March 2003) to allow individual I-coil operation

SUMMARY

- A set of 12 internal I-coils has been installed in DIII–D for RWM feedback experiments at high β_N
- VALEN modeling shows RWM stabilization near the ideal wall limit is possible without rotation using a set of 12 internal coils
- The spatial spectrum is better matched for the m/n = 3/1 RWM using internal coils than the present external C-coil set
- The I-coil can be used for other experiments including
  - Improved static error field correction
  - Edge ergodization
  - I-coil induced plasma rotation
  - MHD spectroscopy
- Initial operation is planned for February 2003