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Alcator C-Mod: Research in Support of ITER and Steps Beyond

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Alcator C-Mod studies high-field, high-performance diverted plasmas in support of ITER and steps beyond, focussing on RF and microwave tools for heating and current drive, with all metal high-Z plasma-facing components. Stability analysis of pedestals in the I-mode regime finds that pressures are well below the peeling-ballooning limit, as well as expected kinetic ballooning mode thresholds, likely explaining the generally observed lack of ELMs. Experiments using a new field-aligned ICRF antenna, which is rotated to align with the total local magnetic field, show dramatic reductions high-Z metallic impurity generation, and reduced core contanimation. This antenna also shows improvement in load-tolerance, particularly through edge transients. Implementation of novel "mirror-probe"electronics has enabled simultaneous measurements of Te, ne and phi with 1 micro-s time response using a single probe tip. Studies with this setup connected to a fast-scanning probe have revealed important properties of the Quasi-Coherent-Mode (QCM) which regulates edge particle transport in EDA H-mode. An Accelerator-based In-situ Material Surveillance diagnostic has been deployed, and the first between-shot measurements of surface evolution on areas of the inner-wall and above the divertor strike point have been made. Boron surface evolution and deuterium retention have been successfully tracked through a series of tokamak and wall-conditioning experiments. We have observed strong suppression of boundary turbulence and significant ⊠E improvement by injecting LH power into high-density H-modes, with H-factor increases up to 30%. An advanced lower hybrid RF (LHRF) actuator component has been implemented in the Integrated Plasma Simulator, and used to simulate modification of sawteeth via LHCD. Gyrokinetic simulations of TEM turbulence find a factor of two nonlinear upshift of the TEM critical density gradient, in close quantitative agreement with experiments. Upgrades which are ready for construction and operation in 2015 include: an actively heated (900 K) advanced tungsten DEMO-like outer divertor; an off-midplane LH launcher to test theories of improved penetration, absorption and current drive at high density, combined with LH source power upgrades to 4MW; and a second magnetic field-aligned ICRF antenna.

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Author: Mr MARMAR, Earl (USA)

Co-author: TEAM, Alcator C-Mod (Mass. Inst. of Technology)

Presenter: Mr MARMAR, Earl (USA)

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