Overview of Alcator C-Mod Research

Integrated Thrusts

Advanced Tokamak
High Bootstrap, High $\beta_N$
Quasi-Steady State

Reactor Relevant Regimes*

Burning Plasma Support
High Field, High Pressure

Physics and Technology

Transport
Edge/Divertor
RF
MHD

*Equilibrated electrons-ions, no core momentum/particle sources, RF $I_p$ drive

Work Supported by USDoE Office of Fusion Energy Sciences
SOL flows impose a toroidal rotation boundary condition for confined plasma

- Cross field transport-driven plasma circulation loop is evident in C-Mod
- X-points and/or limiter contact points set the // flow direction
- SOL apparently provides crucial boundary condition for core rotation
- *Potential explanation for the topology dependence of the L-H power threshold*

LaBombard Tues AM (invited); Greenwald Wed PM (O3)
New External Control Coils used to Study and Suppress Error Fields

- Set of external non-axisymmetric control coils installed
- Allow determination of intrinsic error field and mode-locking threshold
- Dimensionless identity experiments performed with JET, DIII-D
  - Weak size scaling found
  - Locked modes should not be worse for ITER than for current experiments
- Coils allow suppression of locked modes, 2 MA operation
ITB Control with 2-Frequency ICRF
Fluctuation Measurements and Simulations:
Picture of Control Mechanisms Emerging

• Off-axis heating flattens Te, begins to stabilize ITG
• With reduced diffusivity, Ware pinch causes density to peak
• Adding on-axis heating, Te peaks, TEM drives outward particle transport, balancing pinch

• Mode seen with Phase Contrast Imaging
• Non-linear GS2 simulations show good agreement: frequency and wavenumber (Ernst, IAEA 2004)

Fiore Wed PM (O4); Basse Wed PM (O5)
Edge Turbulence Dominated by Large Structures

- Edge turbulence visualized with ultra high-speed camera (4 µs/frame)
- Large, field aligned structures account for most edge turbulence and transport
- Analysis shows that turbulence moves poloidally inside separatrix and structures accelerate radially outside ($|v| \sim 10^3$ m/s)

Grulke Mon PM (invited); Terry Wed PM (O8)
Active MHD Antennas Drive Stable TAE Modes
Measure Damping Rate

\[ \gamma/w = 4.5\% \quad n = 12 \]
ICRF Fast Wave and Mode Conversion: Fast, Bernstein and Ion Cyclotron Waves all observed with PCI, Modeled with TORIC

TORIC Full-Wave Simulation in excellent agreement with experimental (PCI) measurements of both density fluctuations and wavenumber
TORIC with Massive Parallel Processing: First Ever LHRF Full-Wave Toroidal Simulations

$N_m = 1023, N_r = 960$ required for convergence

- $n_\parallel$ upshift from 2 (launch) to >4
  - power absorbed (electron landau damping) in narrow annulus between caustic and edge cutoff
- First LHCD Experiments: early 2005

Bonoli Fri AM (invited)
C-Mod Presentations

- Wolfe: Non-axisymmetric field effects on Alcator C-Mod (Mon AM)
- Grulke: Dynamics of spatiotemporal fluctuation structures in the scrape-off layer of C-Mod and NSTX (Mon AM)
- LaBombard: Transport-driven scrape-off layer flows and the x-point dependence of the L-H power threshold in C-Mod (Tue AM)
- Snipes: Active and passive fast particle driven Alfven eigenmodes in C-Mod (Thu AM)
- Wukitch: ICRF mode conversion physics in C-Mod – measurements and model validation (Fri AM)
- Bonoli: Full-wave electromagnetic field simulations in the Lower Hybrid Range of Frequencies (Fri AM)

- 9 contributed oral (this session)
- 21 contributed poster (Monday PM)

C-Mod FY2005 Ideas Forum: Dec. 2-3, 2004
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