Recent Results from the Alcator C-Mod Tokamak

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On behalf of the Alcator Group
Outline

• Physics
  – Internal Transport Barrier Formation
  – Turbulence in the scrape-off layer
  – Quasi-Coherent Mode and EDA
  – Long pulse experiments

• Engineering and Plans
  – Improvements to the J-Port ICRF antenna
  – New inner divertor installation
  – LH project status
  – C-Mod status and plans

There are 53 C-Mod related talks and posters at this meeting
Application of off-axis ICRF heating results in EDA H-mode followed by formation of the ITB.

Density is arrested by application of on-axis ICRF heating.

KI1.005 Wukitch
CO1.003 Fiore
CO1.004 Bonoli
KP1.002 Wukitch
KP1.003 Rice
ITB Formation and Control with Two-Frequency ICRF

- EDA H-Mode prerequisite
- TRANSP analysis indicates thermal transport reduced by an order of magnitude
- Both high and low field side off-axis heating promote formation of ITB

KI1.005 Wukitch
CO1.003 Fiore
CO1.004 Bonoli
KP1.002 Wukitch
KP1.003 Rice

Density Profiles plotted every .1 s
Ultra-Fast Imaging Measurement of Edge Density Fluctuations

(in collaboration with PPPL and Princeton Scientific Instruments)

• Deuterium gas puff imaging (GPI), reveals detailed evolution of bursty edge transport
  – strong candidate to explain fast cross-field transport which leads to dominant main-chamber recycling
• Computational modeling of data is ongoing

UI1.004 Zweben
CO1.008 Terry
KP1.004 Zweben
KP1.023 LaBombard
KP1.028 Hallatschek

Simulation of time-averaged $D_\alpha$ light in GPI by D. Stotler, PPPL
Ultra-fast images reveal bursty cross-field transport on open field lines

UI1.004 Zweben
CO1.008 Terry
KP1.004 Zweben
KP1.023 LaBombard
KP1.028 Hallatschek
Progress on the Quasi-Coherent Mode

- $k_\theta \approx 1.5 \text{ cm}^{-1}$ ($\lambda \approx 4 \text{ cm}$) near the outboard midplane
- Strong magnetic component within 2 cm of LCFS
- $k_r \approx k_\theta \Rightarrow$ mode decays rapidly away from LCFS
Long Pulse Experiments

- AT Physics Experiments will require longer discharges
  - Exceed L/R current relaxation time
- FY01 experimental goal was to extend discharge lengths beyond 3 seconds
  - Test all power systems
    - Magnets, power supplies, alternator performed as expected and according to simulations
  - Wall pumping/recycling, divertor heat loading investigated
    - Outer divertor develops “hot spots” reaching 800°C
    - Fueling characteristics evolve during shot
Successful Long Pulse Experiments
Inductive Flat-top nearly Doubled

Resistive Skin Time

Plasma Current (MA)

Central Electron Temperature (keV)

Central Electron Density (10^20 m^-3)

Loop Voltage (V)

Net ICRF Power (MW)

Toroidal Field (Tesla) $B_t = 5$ T

Time (s)
Substantial Modifications to 4-Strap Antenna Were Very Successful

- Power handling at the 3 MW level, voltage handling from 15 to 25 kV
- Reduced deleterious plasma interaction at front of antenna
- Discharges around stripline feeds and coax feedthroughs were completely eliminated

- Added BN septum (rf sheath rectification along field lines)
- Feeds rotated 90° and spacing increased (magnetic insulation)
New Inner Divertor

- Increase shape (triangularity) flexibility
- 2 MA, 8 T operation
- Increased heat load capability
- Upgraded halo, eddy current, TC, and probe array diagnostics

Interlocking inconel divertor structure
Lower Hybrid Components and Designs

• 3 MW, 4.6 GHz LH power available Spring 2003
• FDR complete on coupler July 2001 (PPPL)
• High power, control, protection, and data systems well underway (MIT)
C-Mod Status and Plans

• Inspection of machine in progress --- reassembly to begin Dec 2001
• Inner divertor installation complete March 2002
• Klystrons into dummy loads in the C-Mod cell by Spring 2002
• Installation of RFX DNB planned for Spring 2002
• Plasma operation May 2002
  – Continued investigation of ITBs
  – Study of H-Mode physics, EDA, QCM
  – Edge turbulence/transport --- high spatial/temporal imaging
  – Access to higher performance plasmas with increased ICRF power and system reliability
  – Development of DNB and related diagnostics
  – Continuation of long pulse experiments and preparations for AT program
• C-Mod Ideas Forum: December 12-14 2001
EOT