RECENT HIGHLIGHTS FROM C-MOD PROGRAM

APS-DPP October, 2003

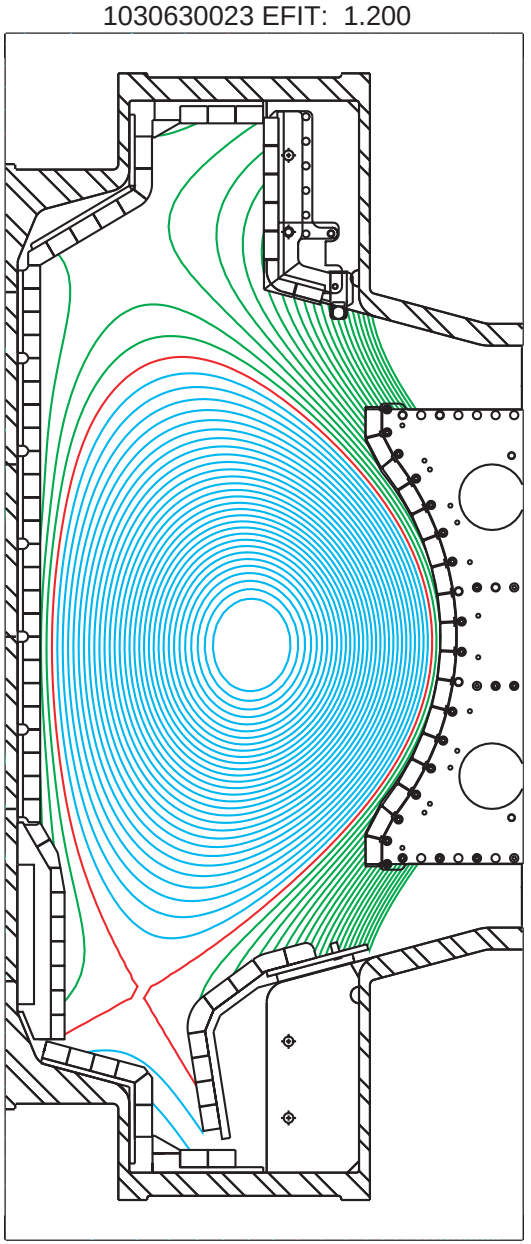
For National Alcator Team

Presented by Martin Greenwald

MIT – Plasma Science & Fusion Center

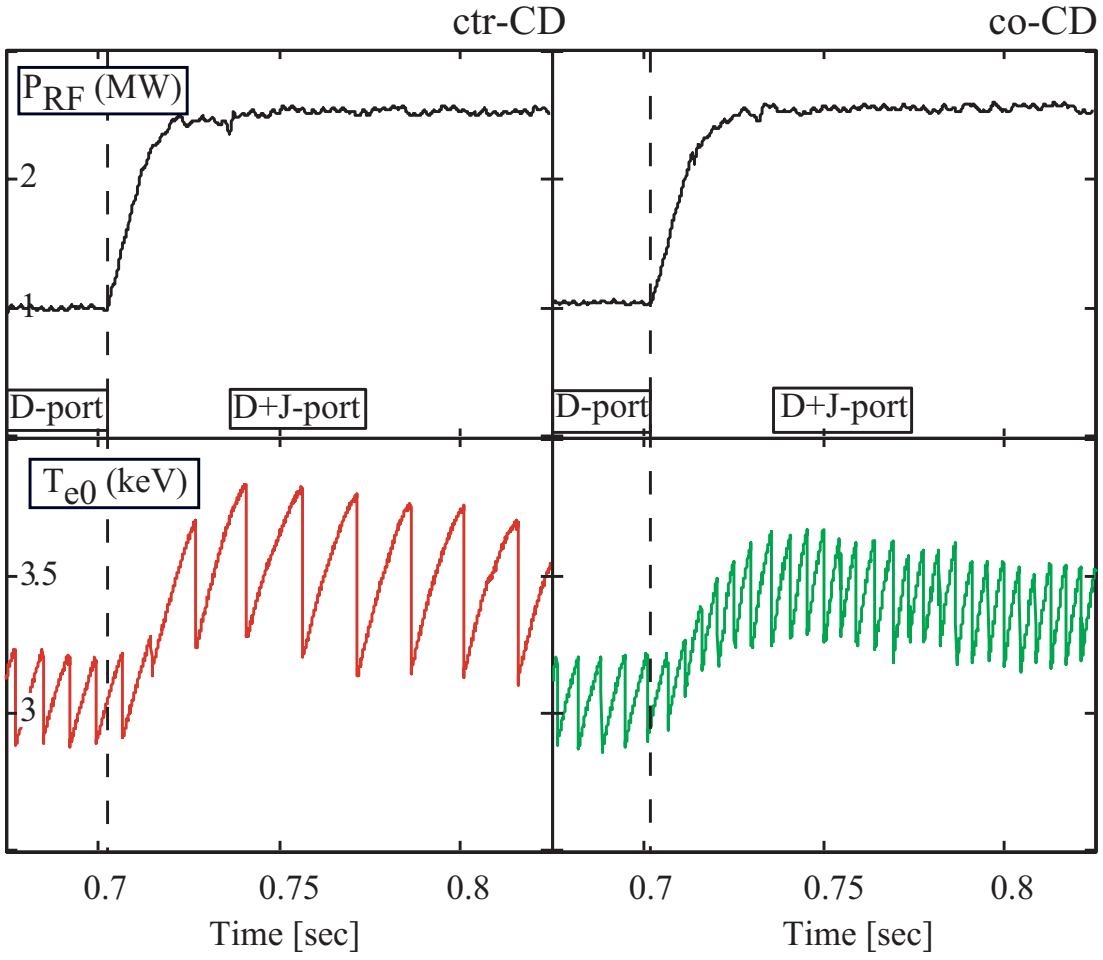
OUTLINE

- ICRF
- Transport
  - Core
  - Pedestal
  - SOL
- MHD
- LHCD & Near-Term Plans



ICRF Heating at Very High Power Density

- High power operation.
  - 5 MW operation for 0.5 sec.
  - Flexible phase operation for 4 strap antenna.
- Significant sawtooth modification
  - Depends on antenna phasing
  - Current Drive
  - Fast Ions
  - Power Deposition
- Target scenario for current and flow drive experiments.



Lin – GI2.005, Wright – GI2.006
Wukitch – CO1.006, Schilling – FP1.002
Parisot – FP1.003, Yuh – FP1.015

TRANSPORT STUDIES SPAN THE ENTIRE PLASMA

Alcator C-Mod

CORE

- Self-generated flows and momentum transport
- ITB Physics

Rice – BI1.003
Fiore – UI1.004
Ernst – UI1.005
Basse – CO1.010
Redi – KO1.007
Lin – FP1.005
Phillips – FP1.010
Rowan – FP1.014
Yuh – FP1.015
Zhurovich FP1.016
Bose – FP1.019
In – FP1.021
Scott – FP1.022

PEDESTAL

- Profiles & stability
- Neutral effects
- H-mode Threshold

Terry – CO1.004
Sampsell – CO1.005
Zweben – CO1.007
Lynn – FP1.009
Hughes – FP1.011

NEAR SOL

- Profiles & micro-stability boundaries
- In-out asymmetries
- Flows

LaBombard-CO1.002
Grulke – CO1.003
Smick – FP1.012
Graf – FP1.018

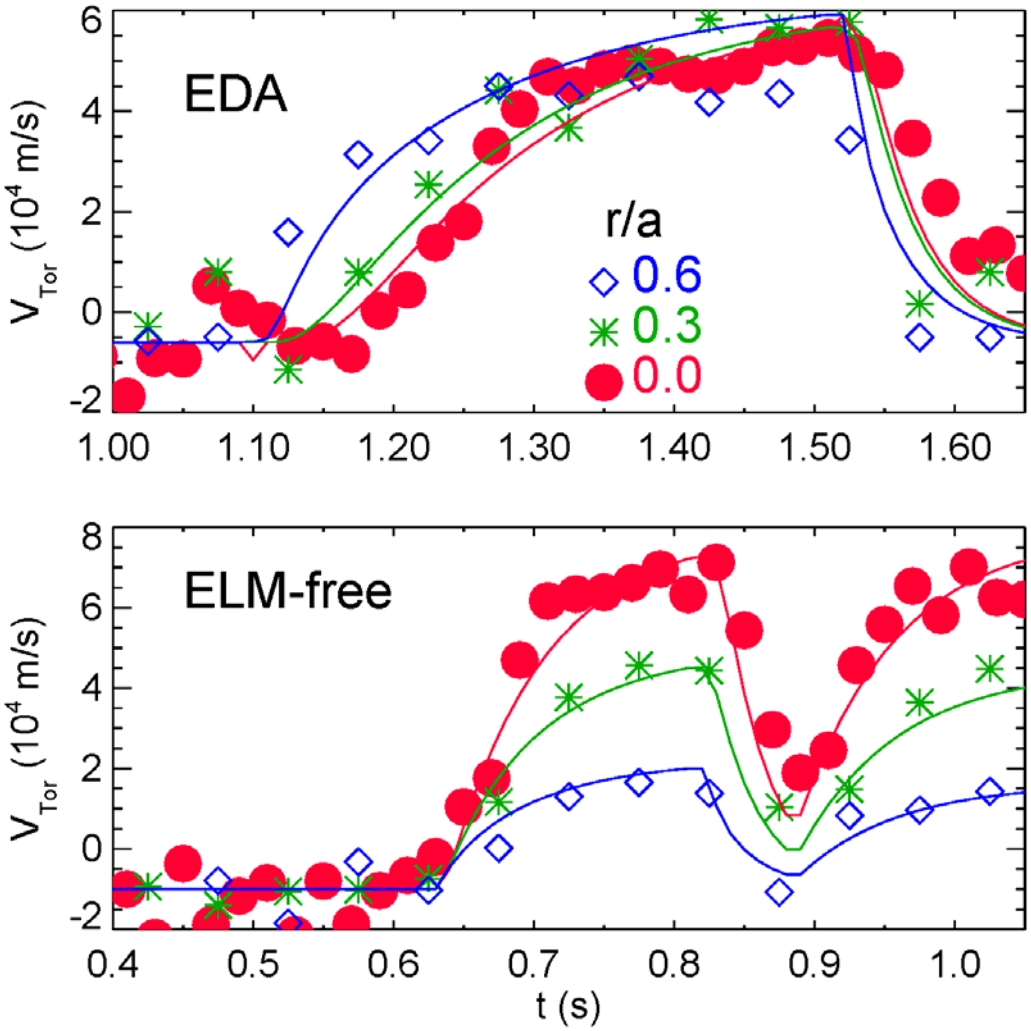
FAR SOL

- Convective transport - “Blobs”
- Particle & Impurity Sources

LaBombard-CO1.002
Grulke – CO1.003

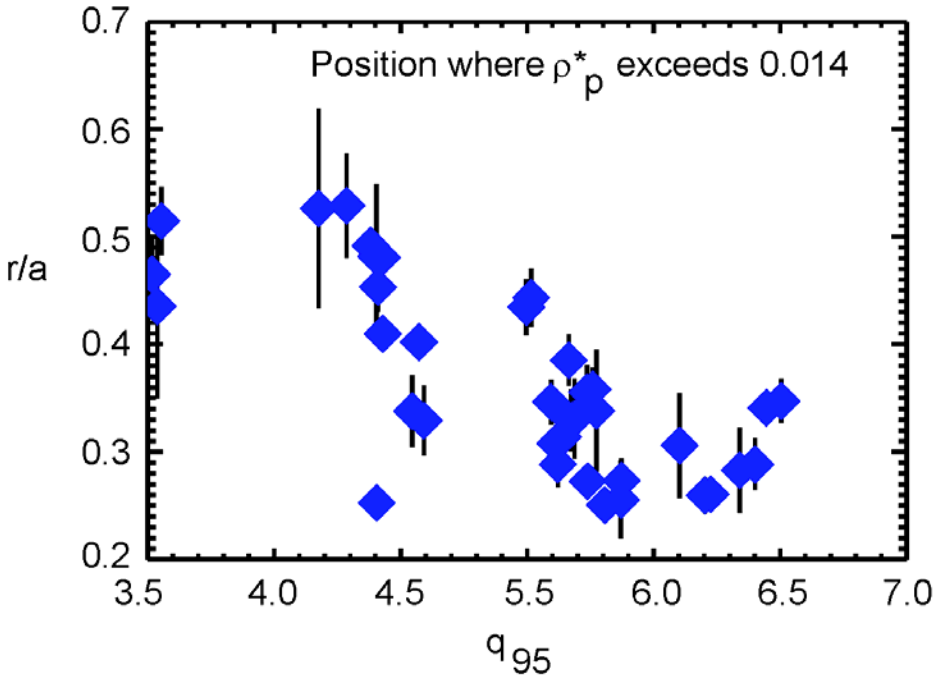
EVALUATION OF ROTATION PROFILES ALLOWS MOMENTUM TRANSPORT TO BE DETERMINED

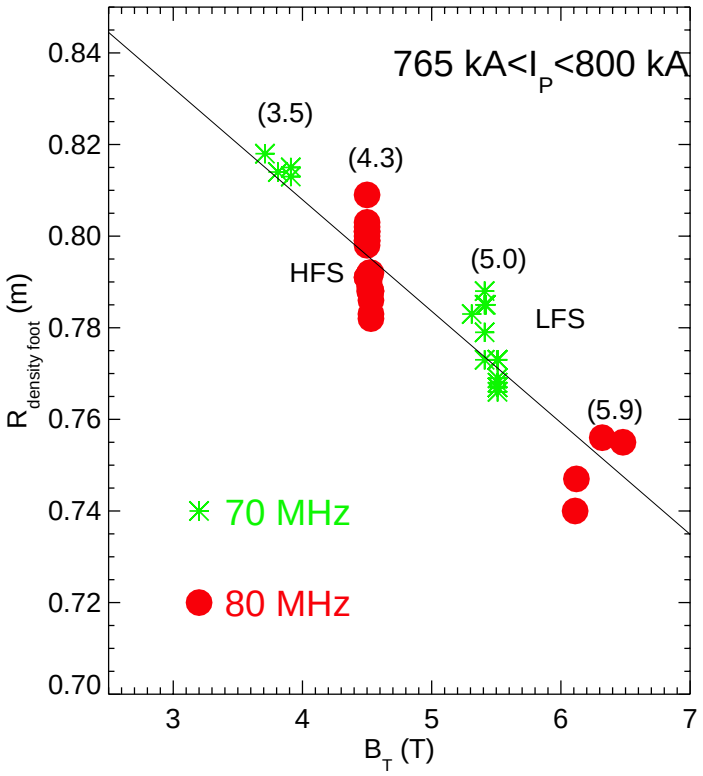
- Self-generated flow profiles vary dramatically in different regimes
- Rotation profiles are flat in EDA H-mode – momentum diffuses from edge
- Evolution in ELM-free plasma demonstrates inward momentum convection
- Some similarities to impurity, particle behavior
- Comparisons with theory



ITB Control – Location of Barrier

- Previous work focused on control of barrier strength through mix of on and off-axis ICRF heating
- Barrier location can apparently be controlled by varying B field





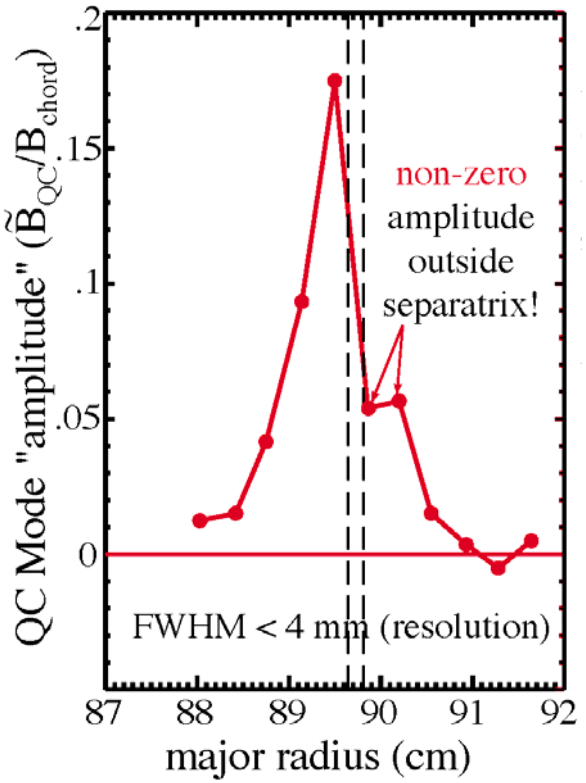
- Open question is this a q or q' effect (or something else)?

Fiore- UI1.004, Ernst – UI1.005, Redi – KO1.007

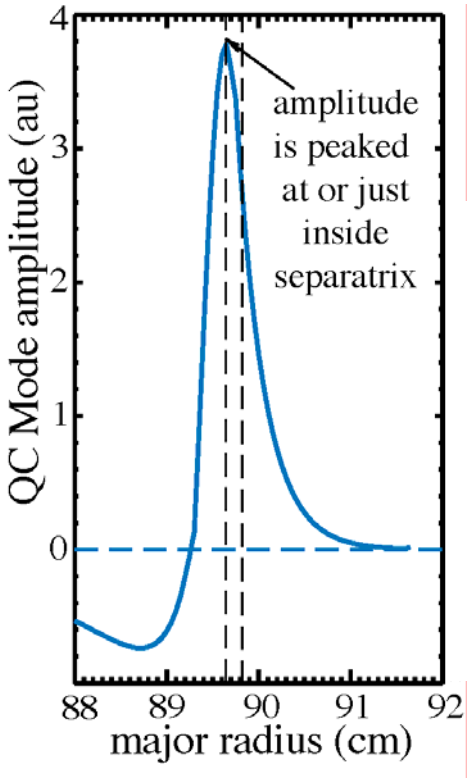
RADIAL EXTENT OF QC MODE INVESTIGATED WITH HIGH RESOLUTION OPTICAL ARRAY AND BES

Alcator C-Mod

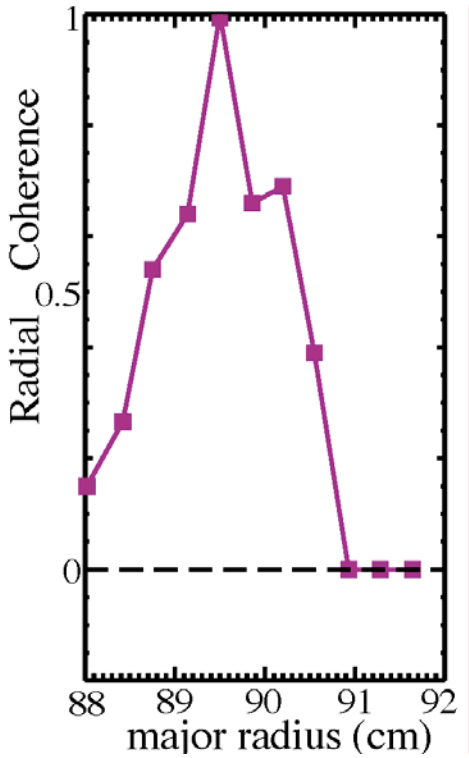
Chordal Amplitude



Abel Inverted Amplitude



Cross-Coherence

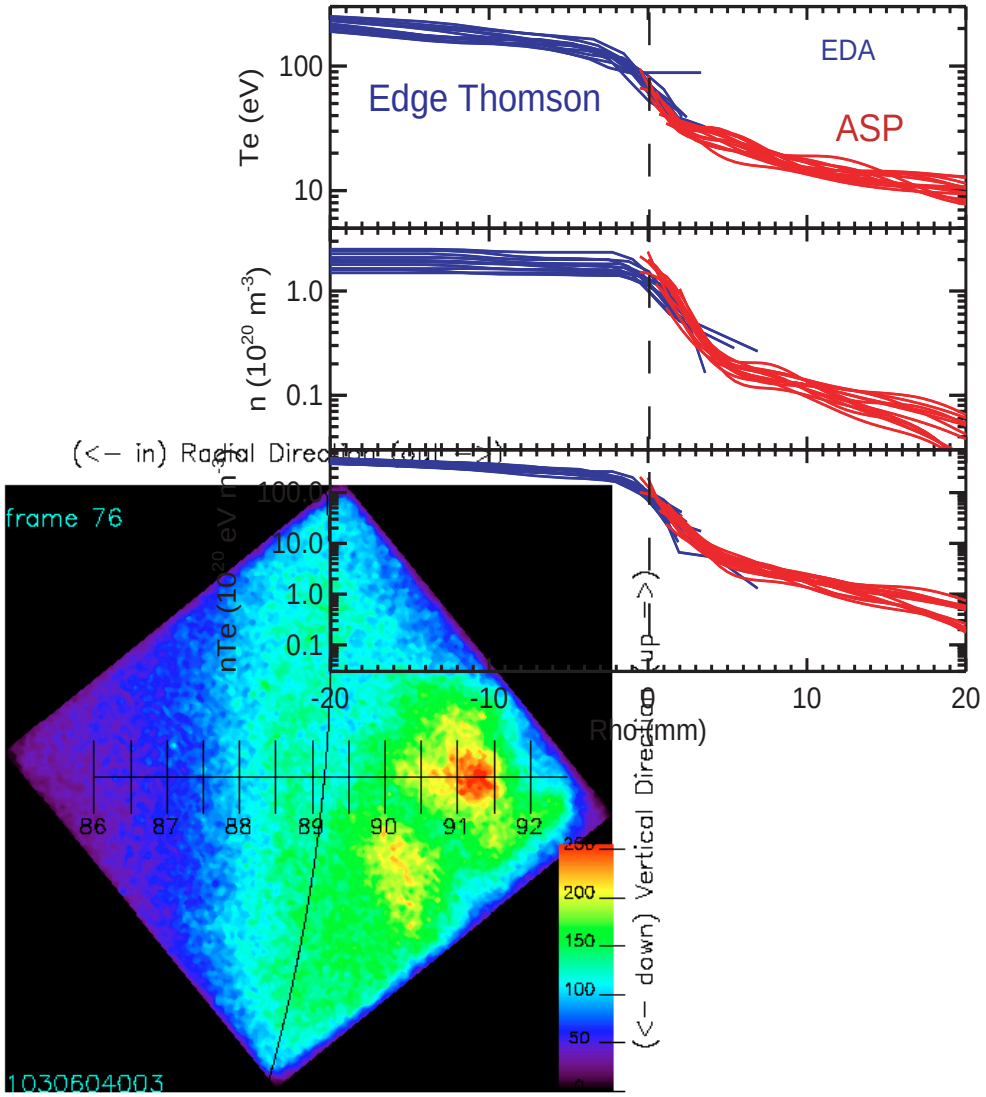


- Optical measurements show QC radial extent < 4 mm – resolution limited
- Probe measurements showed 1-2 mm but may perturb flux tube

CROSS-FIELD TRANSPORT IN SOL IS CRUCIAL FOR DYNAMICS OF EDGE PLASMA AND DIVERTOR

- Near-SOL – steep gradients, moderate fluctuations
  - Transport is not Bohm-like
  - Even in L-mode, shear layer with reduced transport is observed
  - Dependence on normalized pressure and collisionality space consistent with theoretical treatments (Rogers, Scott)
- Far-SOL – flat gradients, bursty or "blobby" transport

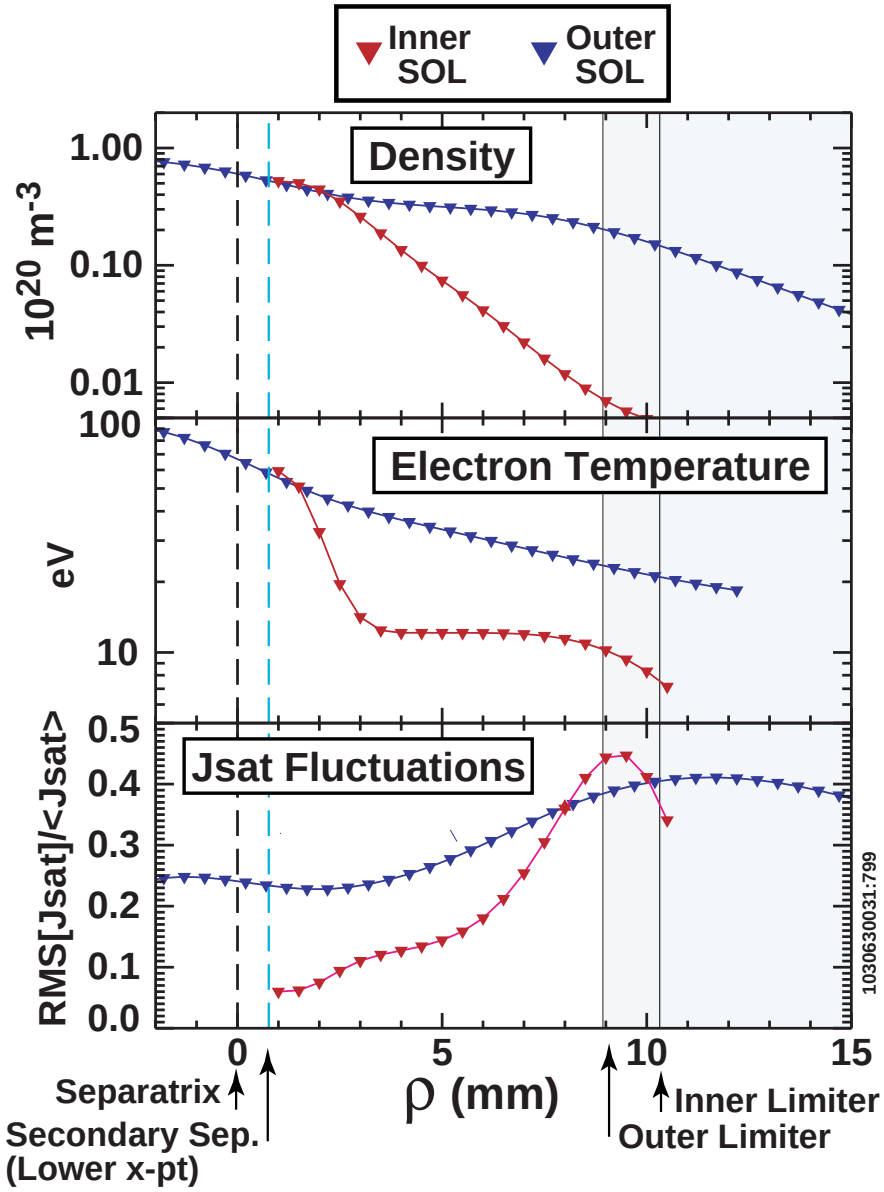
Low Power – Ohmic H-mode



LaBombard-CO1.002
Smick – FP1.012

LARGE POLOIDAL ASYMMETRIES IN SOL PROFILES AND FLUCTUATIONS ARE OBSERVED

- Scanning electrostatic probe and optical diagnostics are deployed at low-field and high-field locations
- Observations confirm ballooning nature of turbulence
- Lower levels of fluctuations and sharper profiles are seen in “good” curvature regions – especially in double null topology
- Significant flows are driven as plasma attempts to “re-symmetrize”

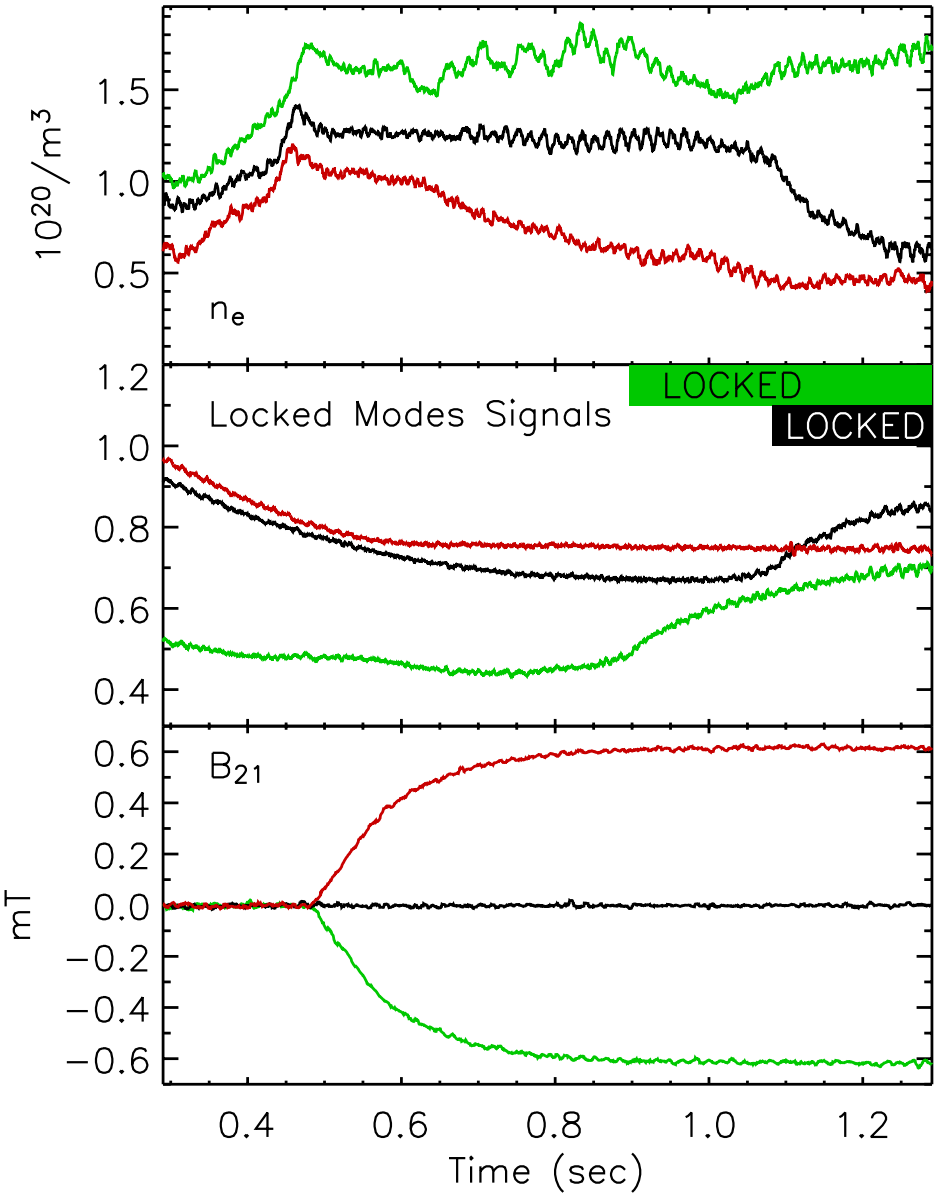


Smick – FP1.012, LaBombard-CO1.002

MODE LOCKING CONTROLLED BY NON-AXISYMMETRIC COILS

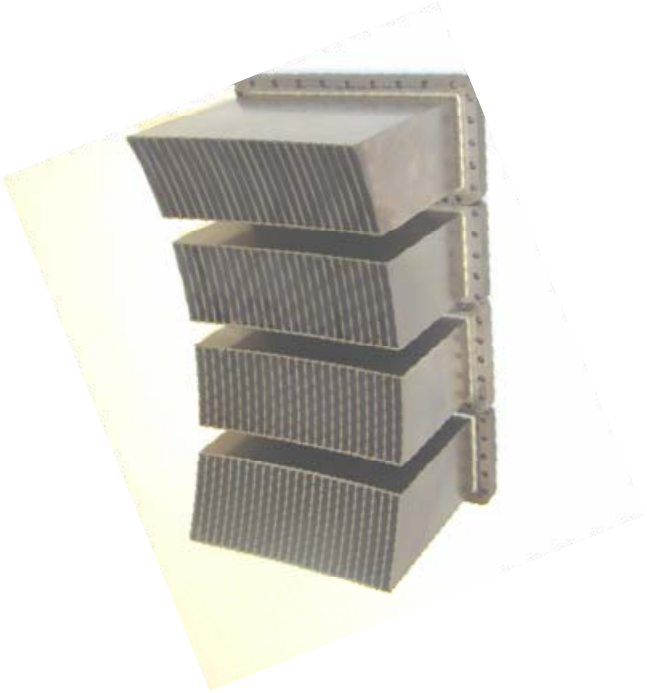
- Locked modes implicated in high-current disruptions on C-Mod
- 7 new coils (A-coils) to investigate error fields and locked modes

- Intrinsic error field ~0.35 mT n=1, m=2 component dominant
- Strong inverse size scaling of locking threshold (LaHaye '97) implied challenging sensitivity to error fields for ITER
  - Scaling Implications of C-Mod measurements



NEAR-TERM PLANS EMPHASIZE AT PROGRAM ENABLED BY LH CURRENT DRIVE

- Installation of 1st launcher this year – 3 MW source power at 4.6 GHz
- Waveguide phase control allows real-time control of launched spectrum
- High-efficiency off-axis current drive (r/a > 0.7)
- Goals are creation and control of AT regimes
  - For times longer than L/R time.
  - No core particle or momentum source
  - Coupled electrons and ions
  - High power density handled by metal first wall
- Enhanced core diagnostics (fluctuations, profiles)



Bonoli – CO1.008
Tang – FP1.006
Liptac – FP1.007