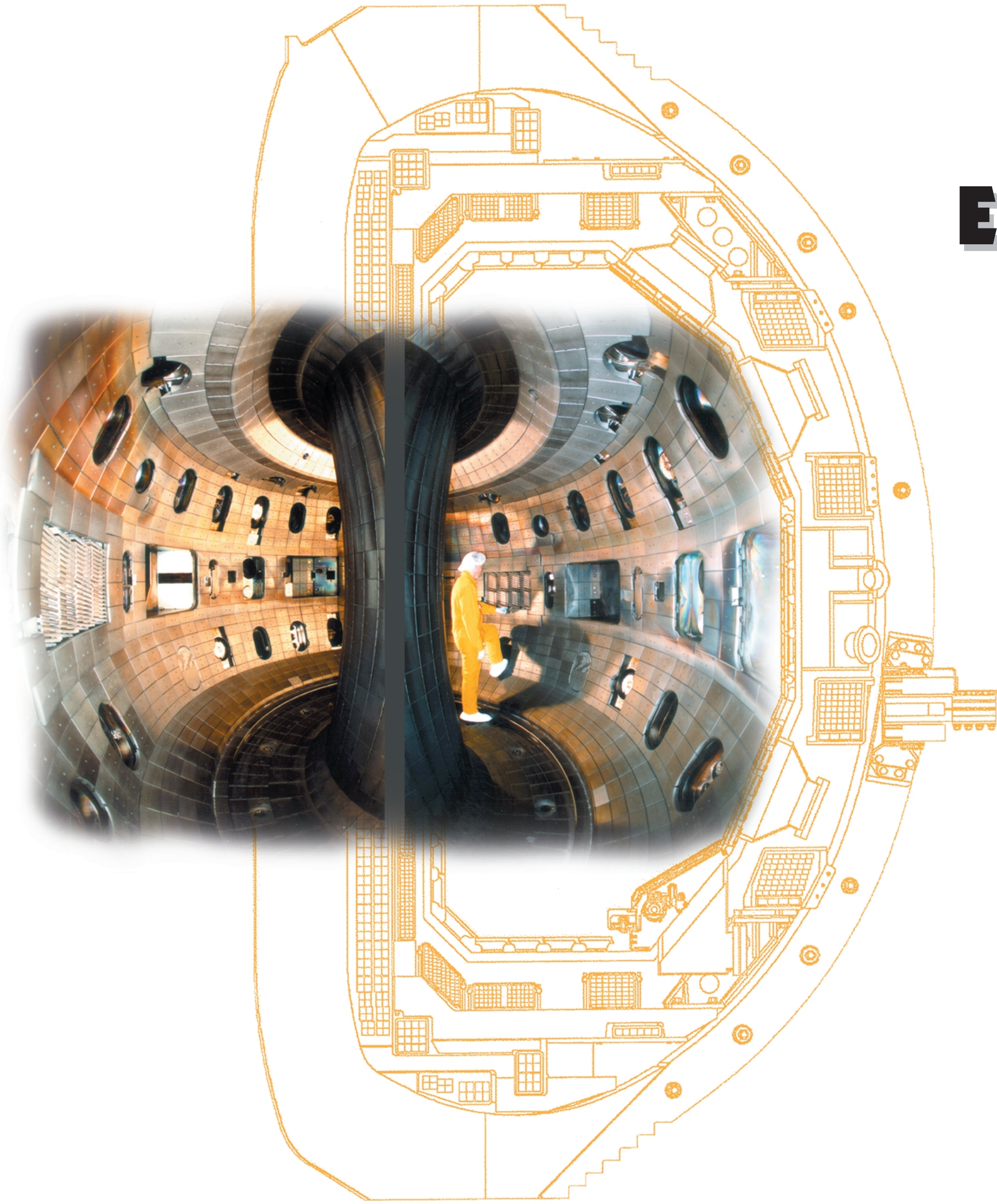
Overview of the 2000 DIII–D Experimental Campaign



by
J.S. deGrassie
and The DIII–D Team

Presented at
the American Physical Society
Division of Plasma Physics Meeting
Quebec City, Canada

October 25, 2000

DIII–D
NATIONAL FUSION FACILITY

263-00/JSdG/jy

DIII–D Mission: To establish the scientific basis for the optimization of the tokamak approach to fusion energy production

DIII–D Focus: Advanced Tokamak (AT) research

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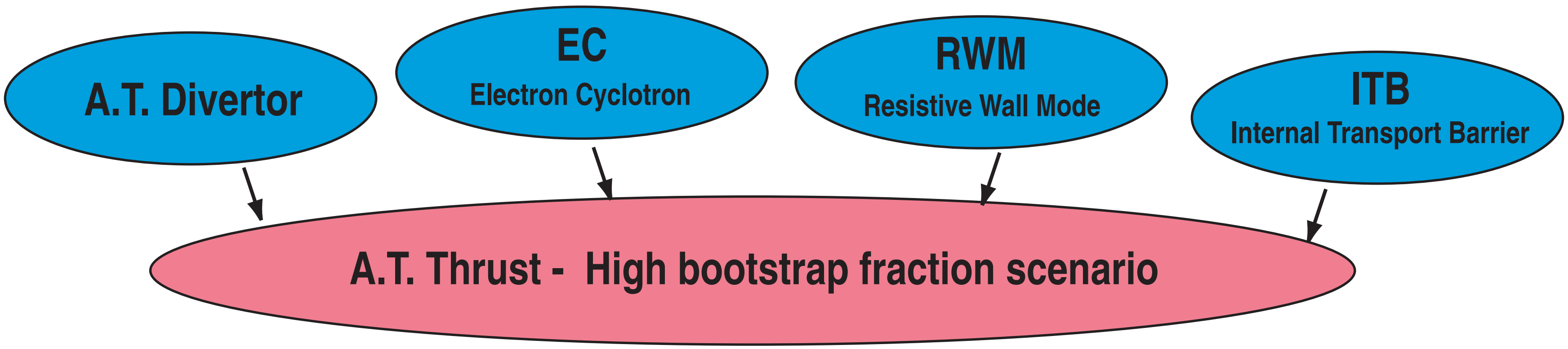
- Areas of focus on DIII–D have been defined as THRUSTS
- Year 2000 Research Areas



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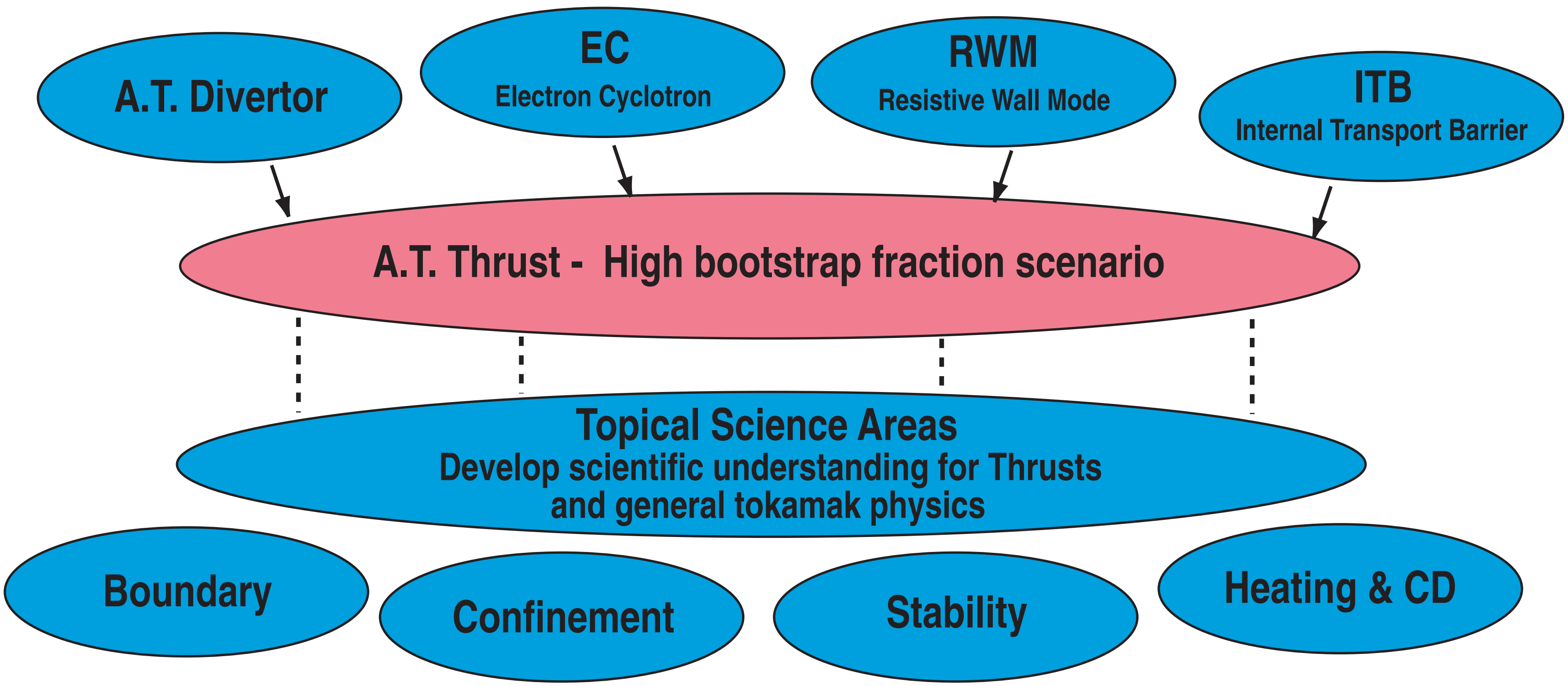

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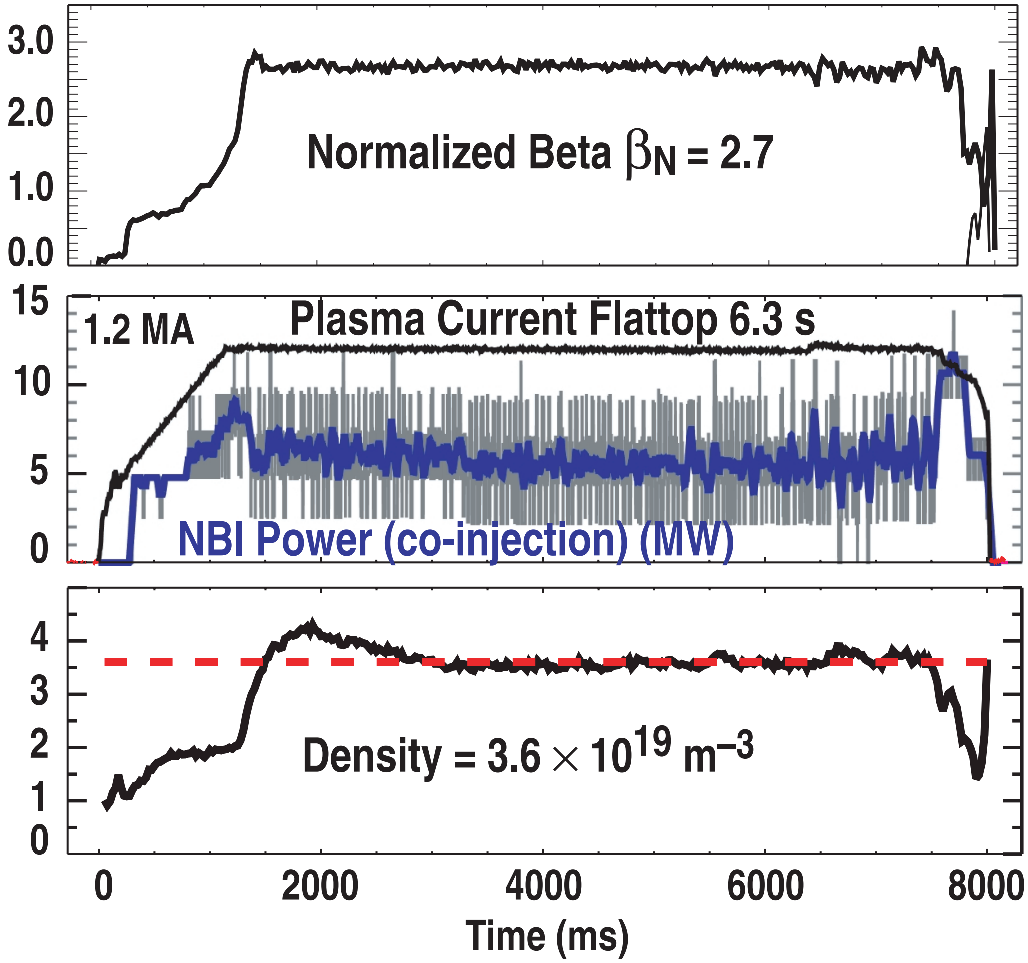
ADVANCED TOKAMAK PROGRESS
LONG PULSE, STEADY, ELMing H–MODE
$\beta_N H_{89P}$ ~7 τ/τ_E ~35



- NBI power is feedback controlled on plasma beta at β_N = 2.7
- Density is controlled with divertor pumping
- Luce MO1.002
- Wade CI2.001

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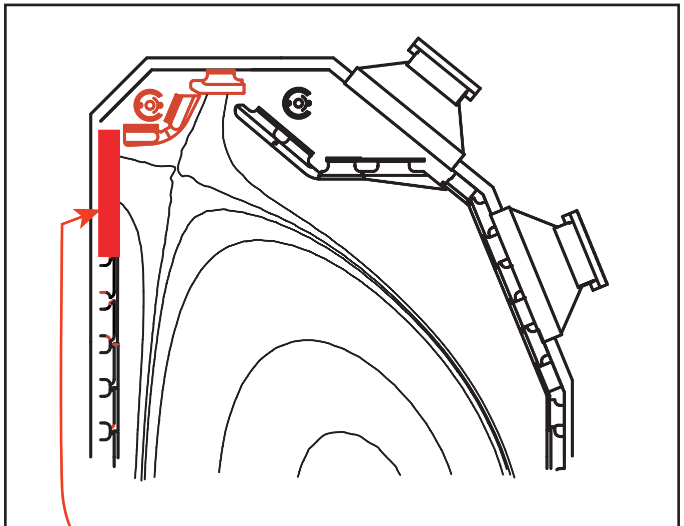
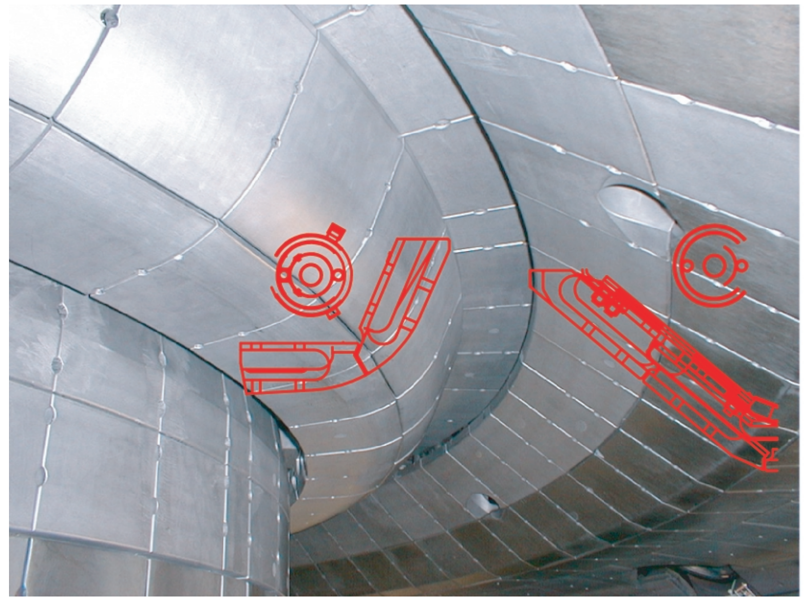
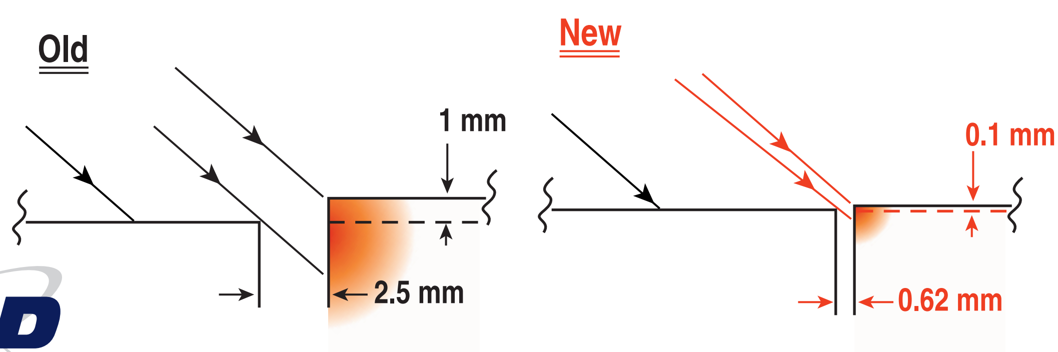
DIVERTOR-2000 CONTROLS DENSITY AND IMPURITY LEVEL



- Carefully contoured band of carbon tiles





- Accurate tile alignment prevents hot spots
- Reduced carbon

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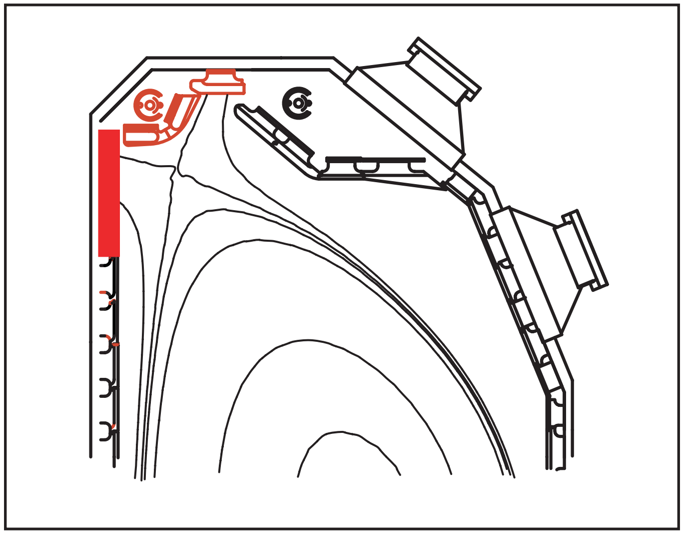
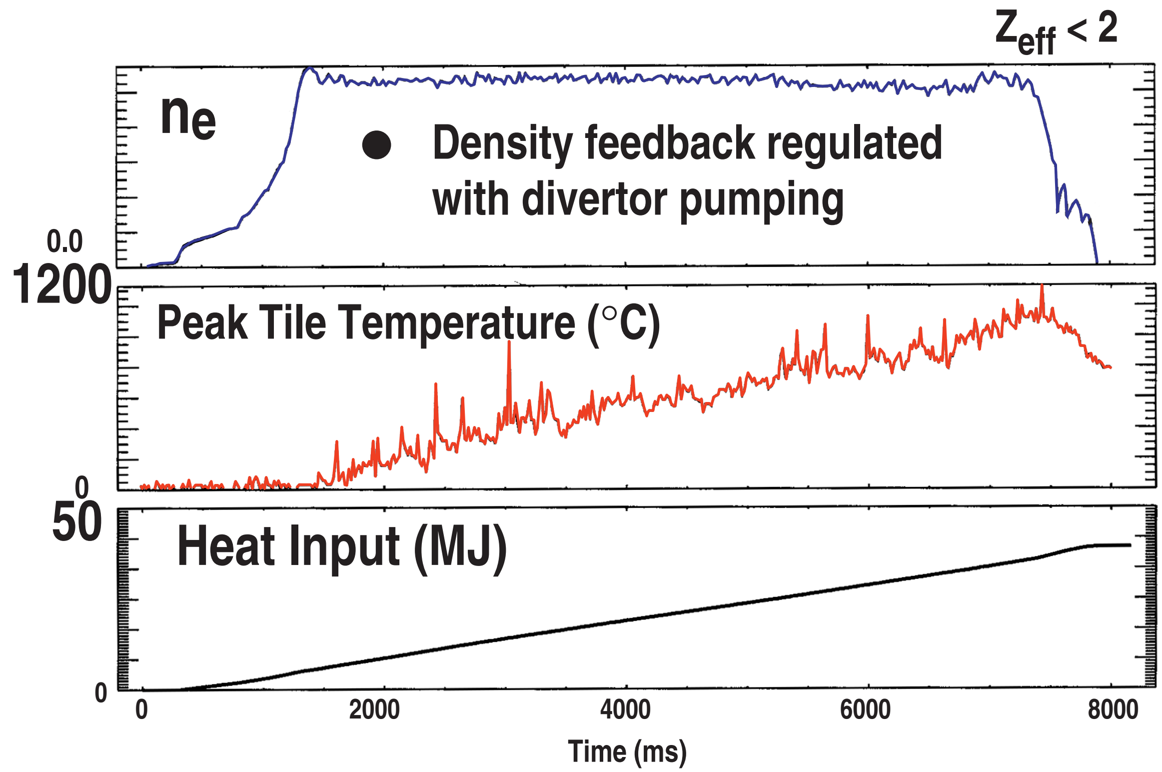
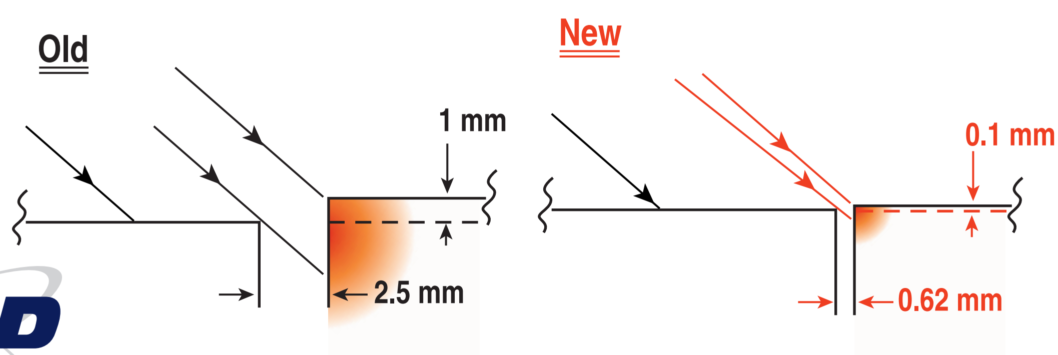
DIVERTOR-2000 CONTROLS DENSITY AND IMPURITY LEVEL — 50 MJ INPUT







- Lasnier MO1.013
- Isler MO1.014

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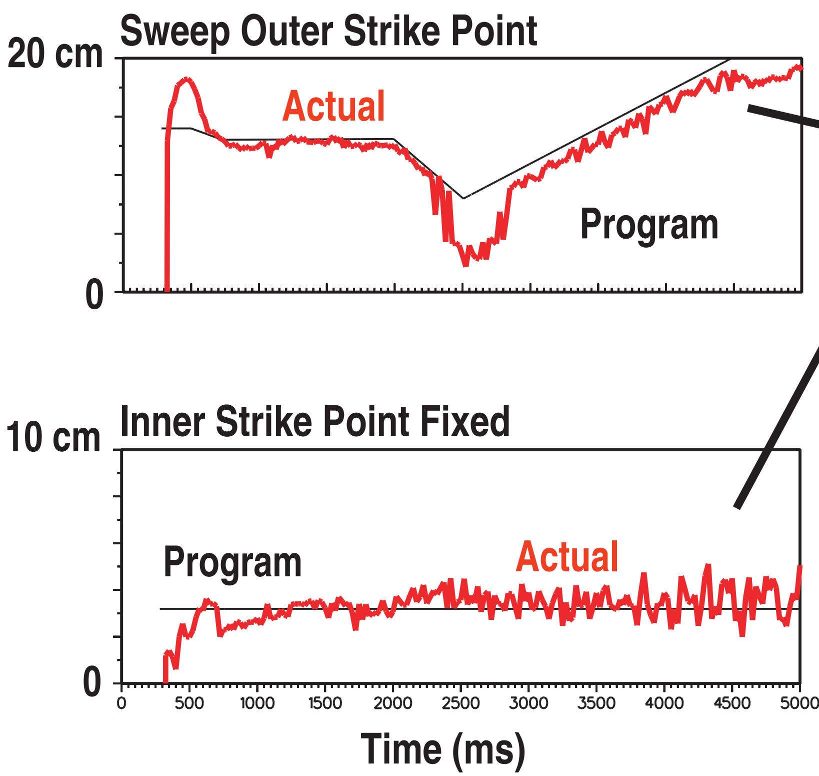
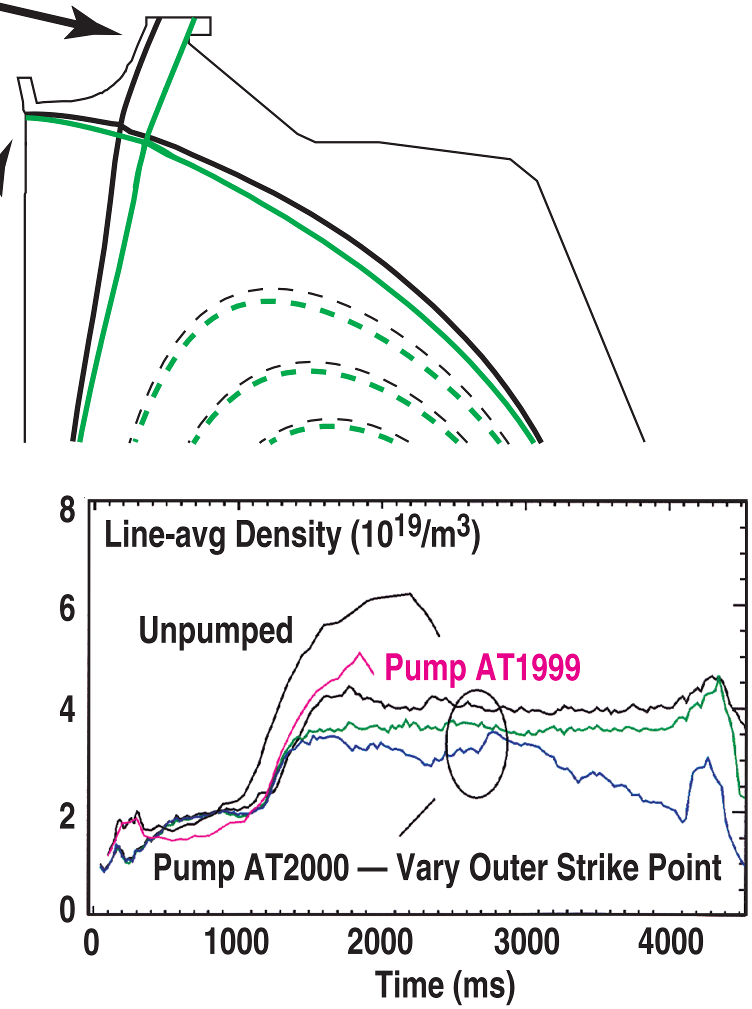
REAL-TIME STRIKE POINT AND SHAPE CONTROL ACHIEVED FOR DIVERTOR PUMPING

- Outer strike point sweep to control pumping





- Density exhaust depends sensitively on strike point locations

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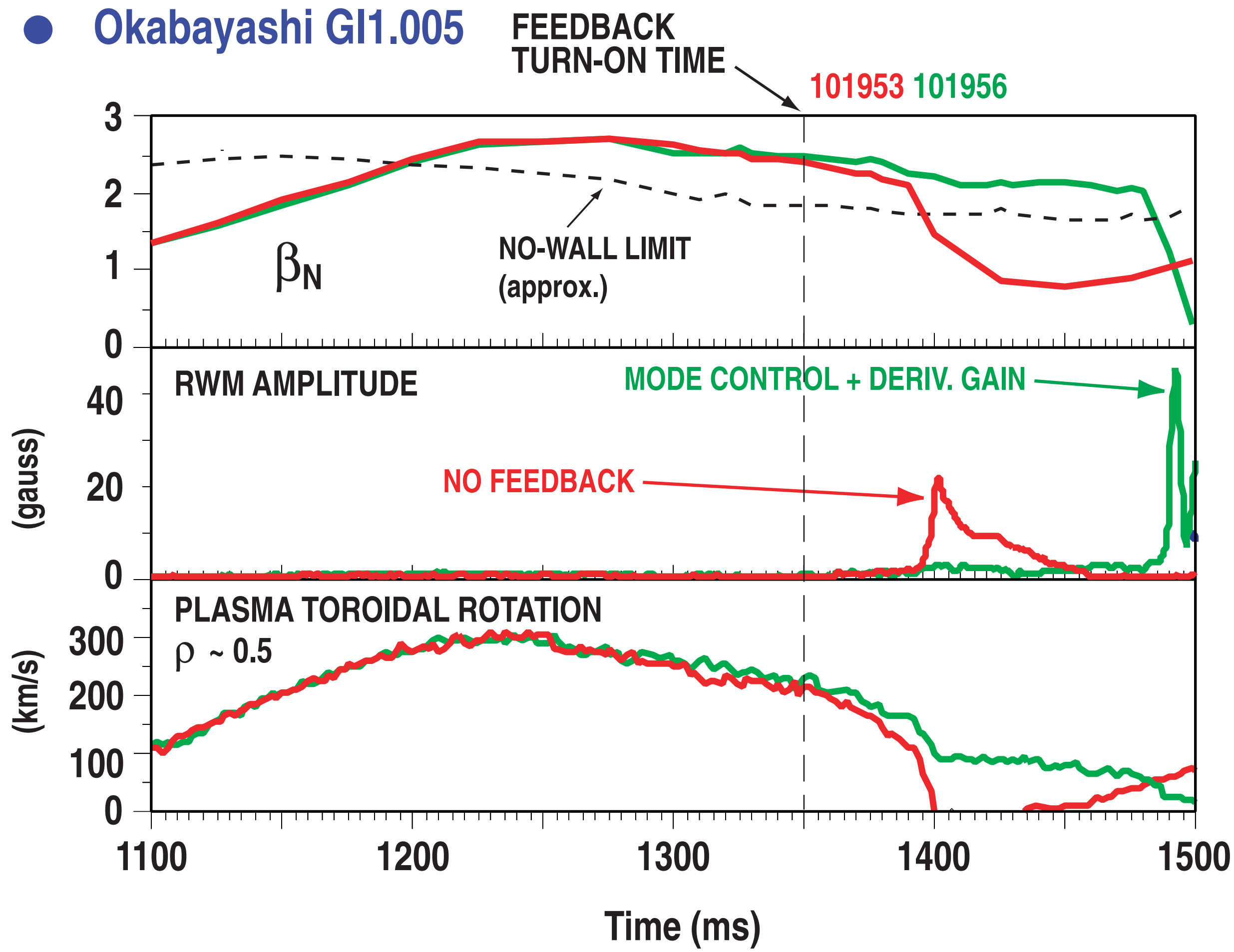
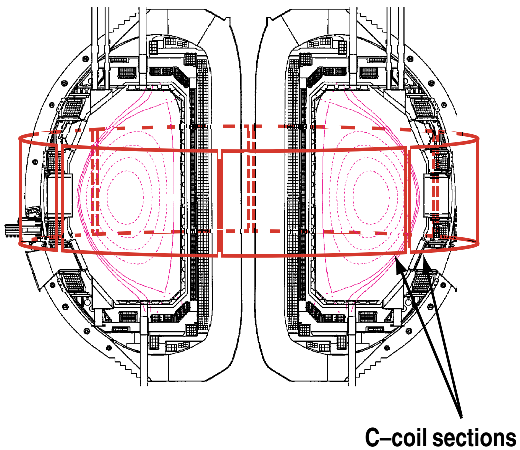
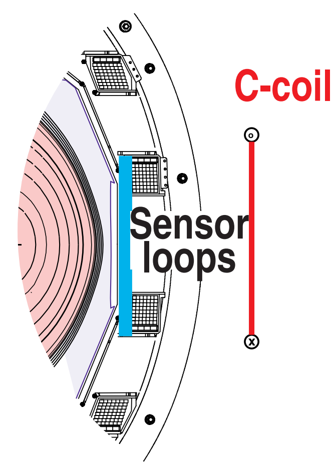
PROGRESS IN FEEDBACK STABILIZATION OF THE RWM

- Strait MO1.003
- Garofalo MO1.004
- Okabayashi GI1.005







- Modeling agrees with experiment
- Higher β_N with internal sensors, future upgraded C–coil

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HIGH POWER EC SYSTEMS (110 GHz) FOR AT PROFILE CONTROL COMING ONLINE

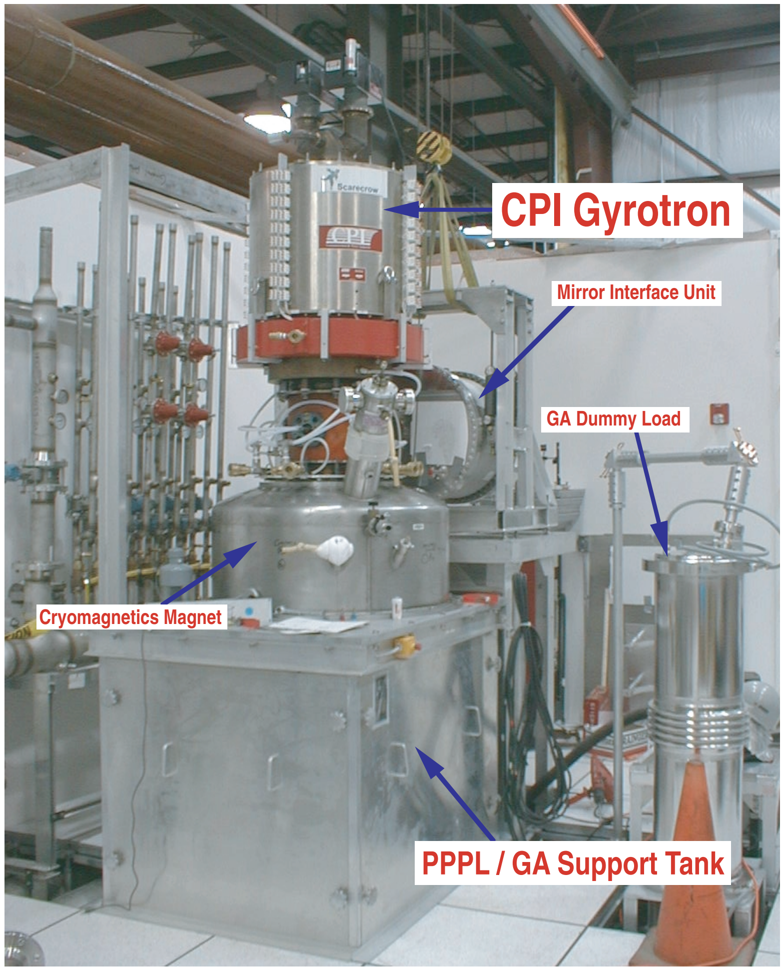
- J. Lohr MO1.005

New Diamond Window Gyrotron

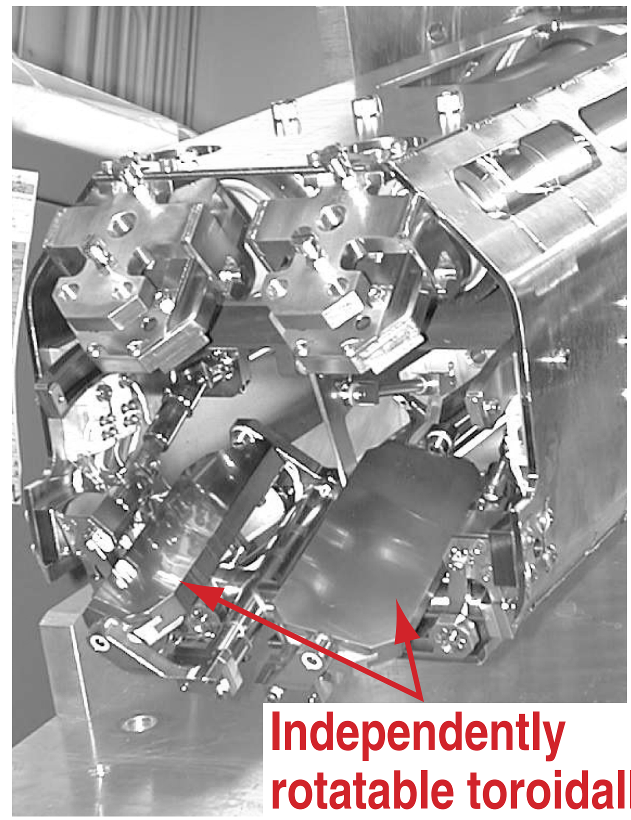
1 MW
Class
Gyrotrons

2000
Experiments with 2-3 gyrotrons

2001
Experiments with up to 6 gyrotrons



- PPPL articulating launcher invaluable for physics productivity – necessary to exploit EC as an AT tool



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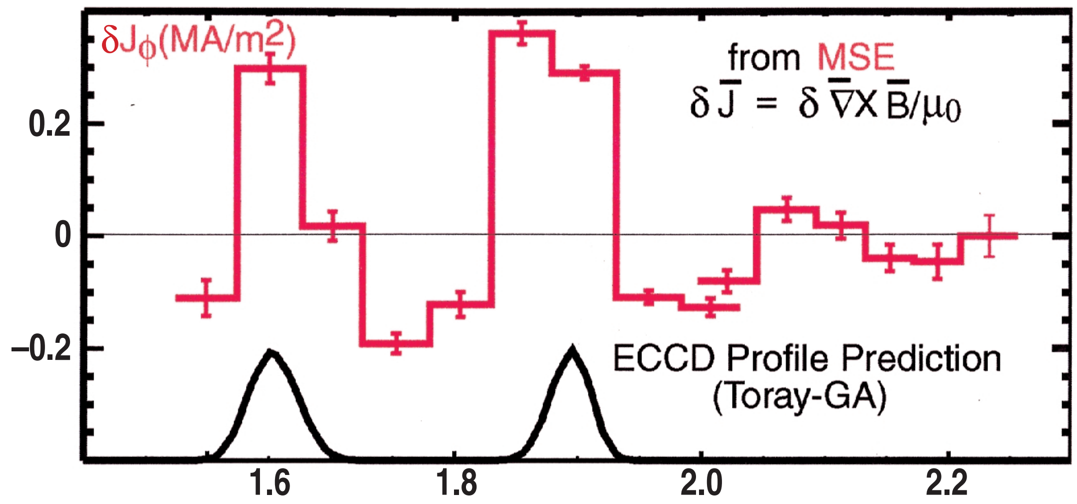
EC RESULTS INDICATE AN EFFECTIVE A.T. CONTROL TOOL

- **Localized, off-axis, current drive in ELMing H–mode discharges**

  R. Prater MO1.006
  Y.R. Lin-Liu MI1.003
  L.L. Lao NP1.079
  C.C. Petty NP1.080



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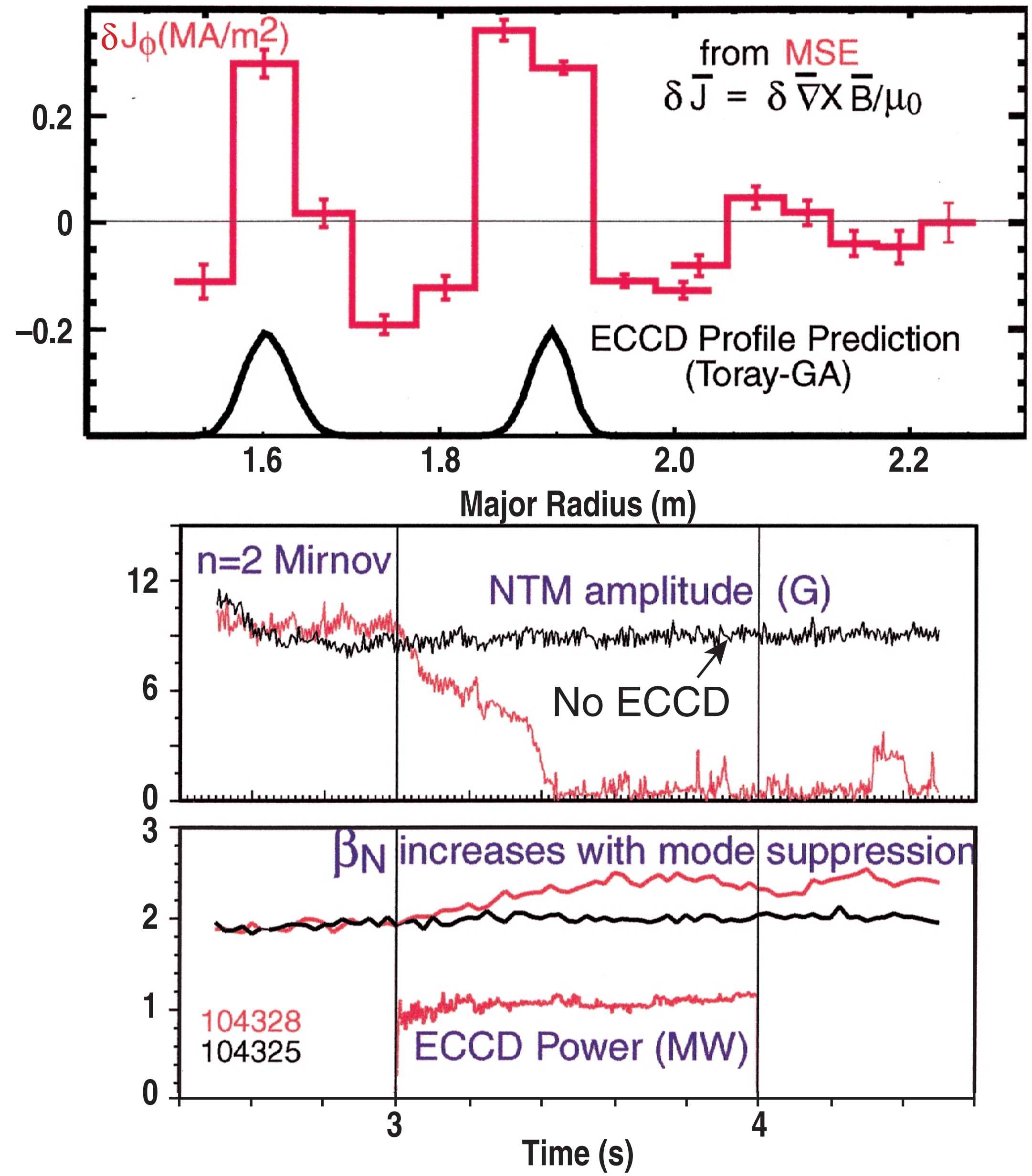
- **Complete suppression of neoclassical tearing mode (NTM) with Co-ECCD**

- **Precise localization of ECCD required for NTM stabilization**

  T. Strait MO1.003



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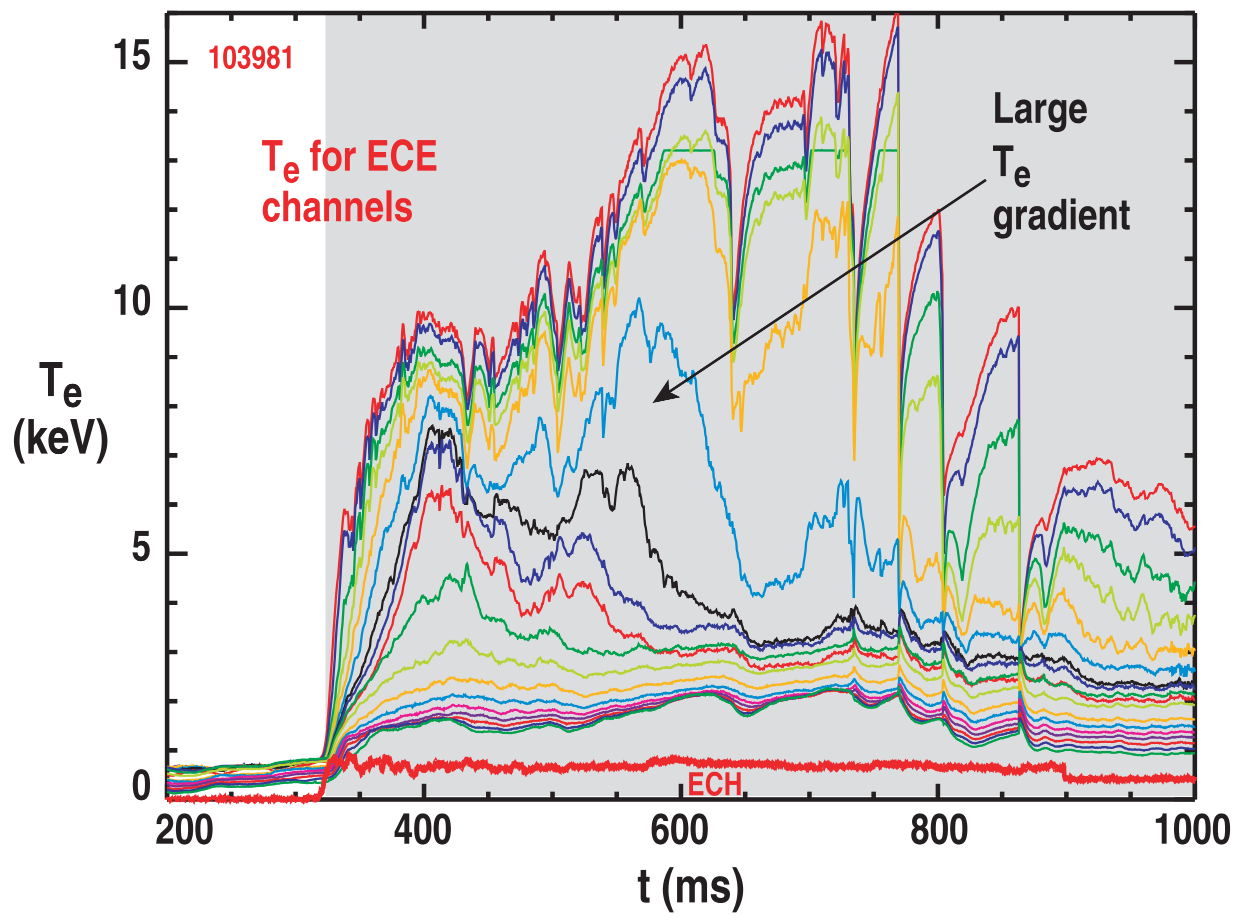
EC HEATING DRIVES ELECTRON ITB

- Prater MO1.006
- Doyle MO1.007
- Greenfield GP1.112

- 0.8 MW ECH applied at ρ ~0.4; no NBI
- Co–ECCD in this case; counter and radial ECH also drive ITB



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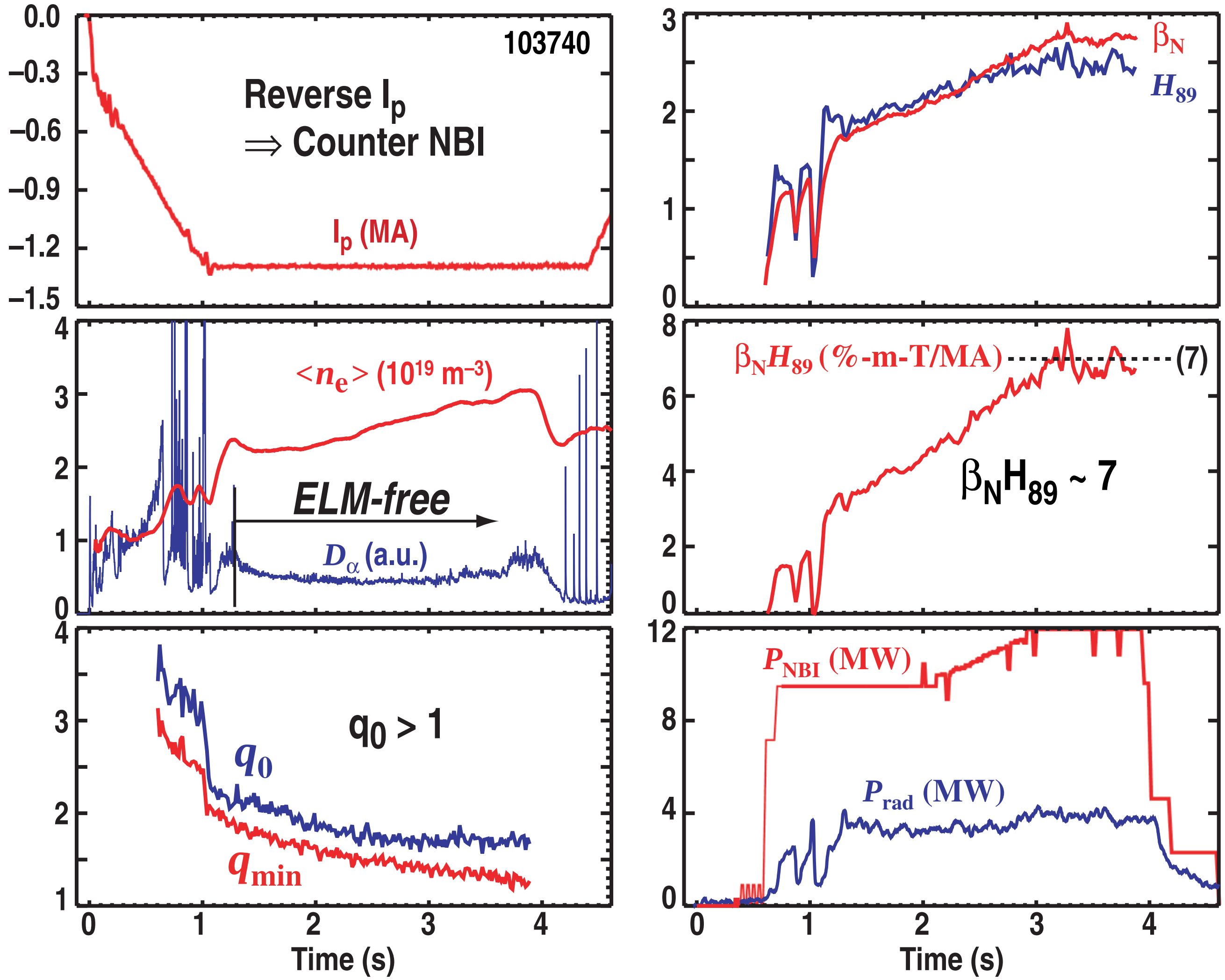
ITB THRUST USES COUNTER NBI - DISCOVERS NEW OPERATING MODE

QUIESCENT DOUBLE BARRIER (QDB)

TWO BARRIERS, NO SAWTEETH, NO ELMs (QH-MODE EDGE)



Doyle MO1.007
Burrell BI1.002
Greenfield GP1.112

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OTHER EXPERIMENTS DONE IN THE TOPICAL SCIENCE AREAS

BOUNDARY

- Mahdavi M01.011
  high density + good confinement

CONFINEMENT

- Fundamental tubulence studies
- H–mode physics
- Nondimensional transport studies
- Core transport physics

EXPERIMENT ON L->H TRANSITION

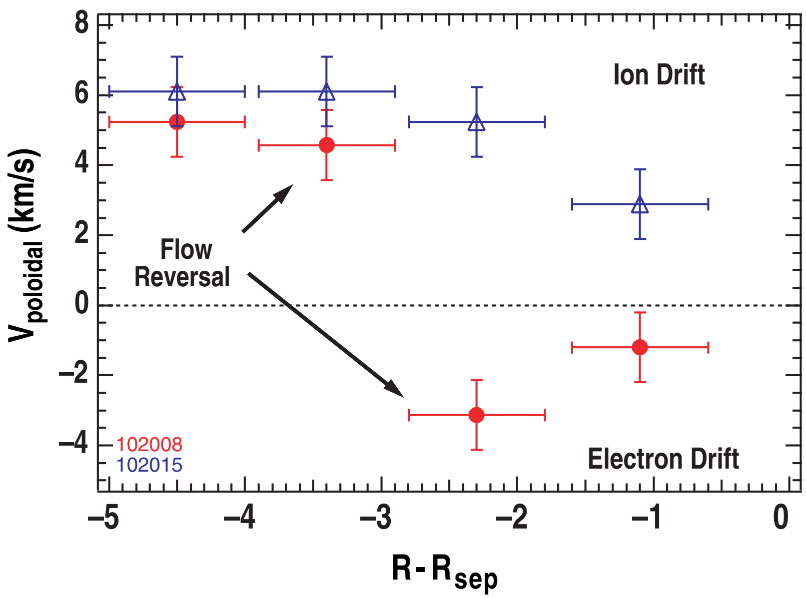
Edge flow reversal may hold key to old mystery of power threshold being lower with ion ∇B drift toward X–point

Carlstrom GP1.129

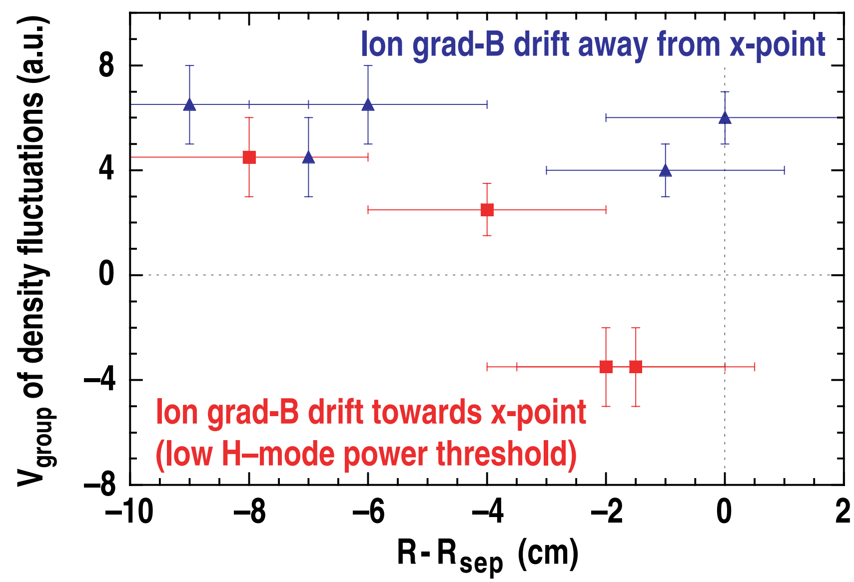
L–Mode discharges, 1 MA, 2.1 T, NBI = 1.9 MW

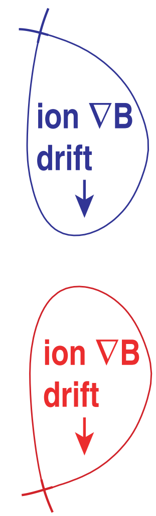
three turbulence diagnostics observe flow reversal in target discharge

BES measurement
(G. McKee, Univ. Wis.)



Correlation Reflectometer
(T. Rhodes, UCLA)





Midplane Langmuir probe also sees flow reversal (R. Moyer, UCSD)

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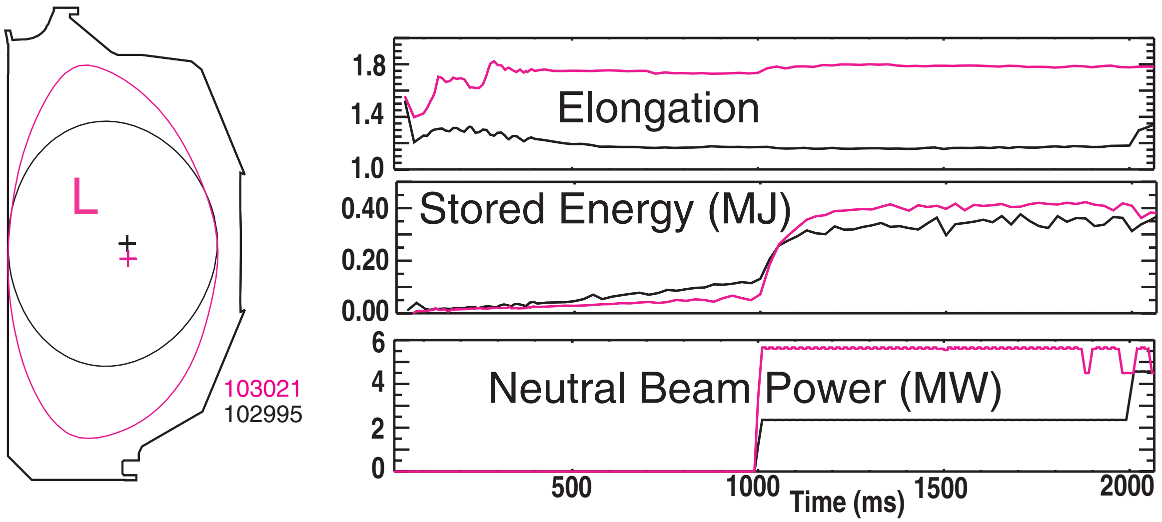
L–MODE CONFINEMENT DEGRADES WITH ELONGATION, H–MODE IMPROVES

Confinement TSA experiment - dimensionally similar discharges

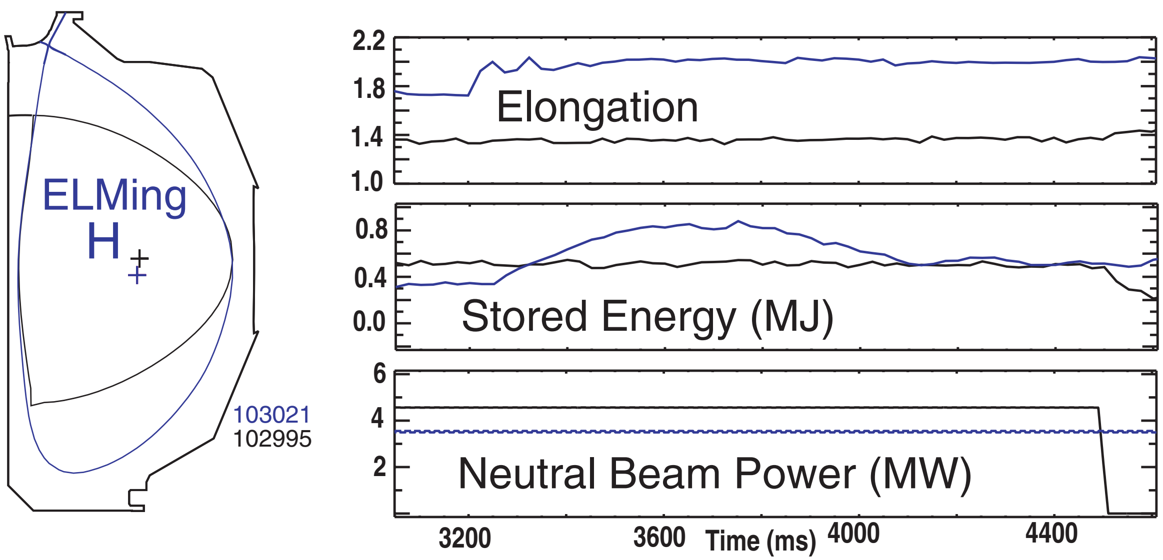
Each pair has same I, B, n, R, a, T(ρ) (Heating power varied)

κ	τ_{th}(s)
1.17	0.12
1.78	0.05



Larger κ => more NBI

κ	τ_{th}(s)
1.36	0.08
2.00	0.12



Larger κ => less NBI

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OVERVIEW OF THE 2000 DIII–D EXPERIMENTAL CAMPAIGN

- AT Thrust: control tools lead to $\beta_N H_{89P}$ ~7 for > $30\tau_E$
  - AT divertor pumping
    - β feedback controlled
      - Stationary discharge
- EC
  - Off axis ECCD in ELMing H–mode
  - ECH generated T_e barriers
  - NTM suppression with co–ECCD
- Progress in active RWM stabilization
- New QDB mode of operation
- Topical science area experiments

ADDITIONAL TOOLS FOR THE 2001 CAMPAIGN

- Increase to 6 gyrotrons
- Internal sensor loops to enhance RWM feedback control
- Edge J diagnostic   Snider NP1.099