Status and Plans for C-Mod Lower Hybrid and Advanced Tokamak Program

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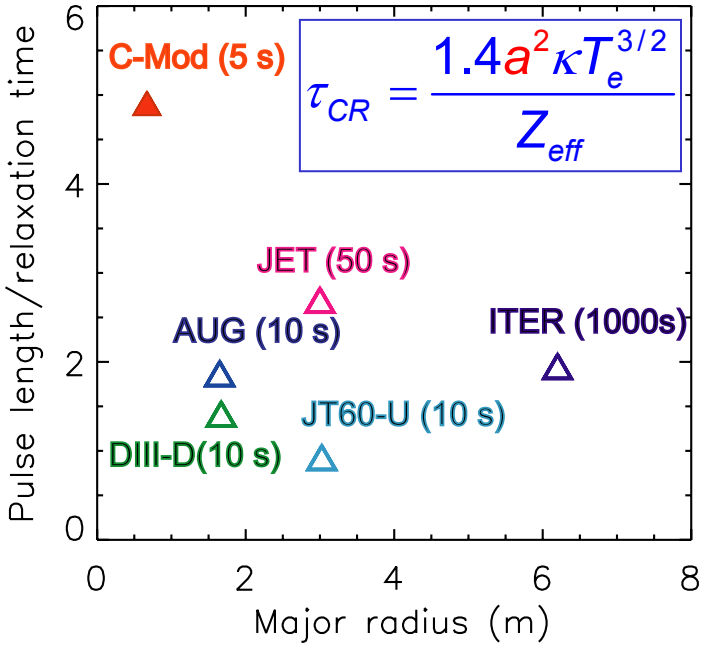
Unique Features of C-Mod for AT research

- In physics terms, "Steady-state" current drive implies pulse lengths >> current relaxation time τ_{CR}. **C-Mod can run 5 second pulses, longer normalized time than other divertor tokamaks.**

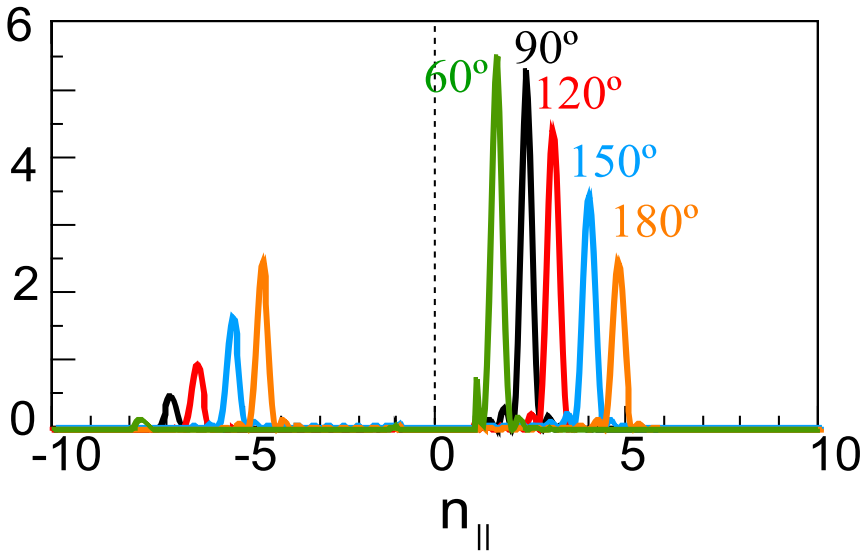
- Other reactor-relevant features, particularly important for **internal transport barriers,** are
  - Strongly coupled ions and electrons. $\tau^{e-i} << \tau_E$ ($T_e \sim T_i$),
  - No core fuelling or momentum drive.
  - All RF heating and CD.



Assumed: Z_{eff}=2, T_e=6 keV (ITER 19 keV).

Note: C-Mod has already run 3 sec pulses. Some pulse lengths are upgrades.

Current Profile Control:
Lower Hybrid Current Drive system

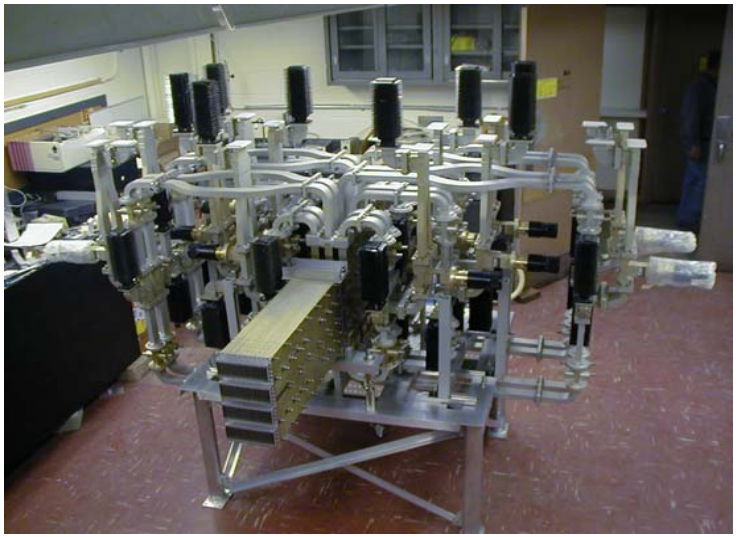


	2003	2005
Frequency	4.6 GHz	4.6 GHz
Source Power	**3 MW**	**4 MW**
Antenna	1 grille (4x24 guides)	2 grilles (4x24 guides each)

- Designed for **well controlled spectrum**.
- Each antenna will have **flexible $N_{//}$**, variable over range 2-4.
- **Variable between or during discharges** using phase shifters.
- 2 launchers can have different spectra.
- Allows us to tailor spectrum for desired wave accessibility (depending on n(r), B), and to **control deposition and current drive profiles, including CD far off axis.**

LH System nearly complete

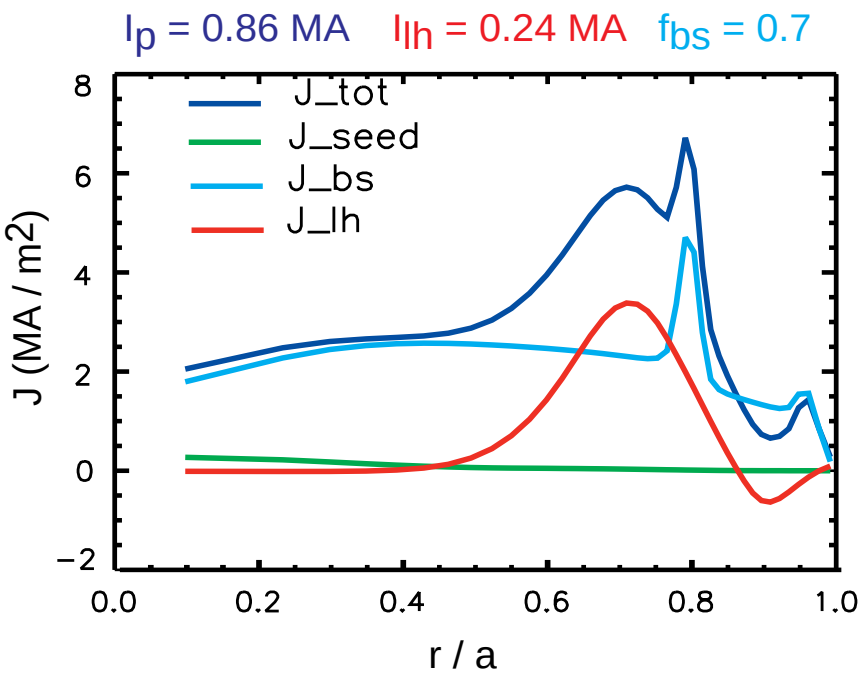
- **RF sources, power supplies, WG prepared by MIT.**
- 12 Klystrons (3 MW) installed, tested in the C-Mod cell.
- **LH Coupler and splitter fabricated by PPPL.**
- Will be commissioned late 2003, following high power testing.

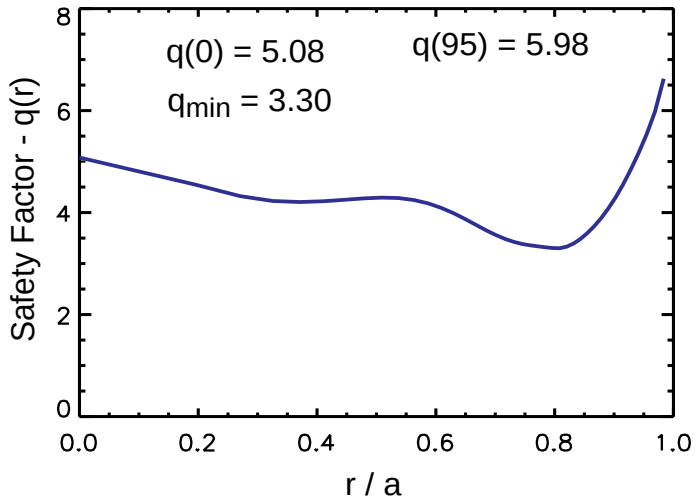


Example of an AT target scenario

- **One of many optimized scenarios modelled with ACCOME.**
  - **I_p=860 kA, non-inductive.**
  - I_{LH}=240 kA
  - **I_{BS}=600 kA (70%)**
  - **β_N=2.9**

- **Double transport barrier**
  - B_T=4 T
  - ICRH: 5 MW
  - LHCD: 3 MW, $N_{//0}$=3
  - $n_e(0)$= 1.8e^{20} m^{-3}
  - $T_e(0)$=6.5 keV **(H=2.5)**
- **Scenarios without barrier, or only an ITB, have similar performance.**





P. Bonoli, Nucl. Fus. 20(6) 2000.

Summary

Alcator C-Mod

- Advanced Tokamak research will be an increasingly important part of the C-Mod program.
- Focuses on **RF control of current, transport and pressure profiles** in **high density regime**, for **t >>** τ_{CR}, B_T = *4-8 T,* $T_i \sim T_e$, $n_e \sim 1\text{-}5 \times 10^{20}\ m^{-3}$.
- **Initial LHCD system is nearly complete** - 1st current drive and profile control experiments in 2004.

- **AT research program also includes:**
  - Internal Transport Barrier experiments (in progress).
  - Density control upgrades, including new cryopump.
  - Tests of mode conversion current and flow drive.
  - Divertor power handling at ITER-like fluxes.
  - Exploring and optimizing no-wall MHD stability limits.