OVERVIEW OF RECENT RESULTS FROM ALCATOR C-MOD

ABSTRACT

Alcator C-Mod, a compact high magnetic field, high density, diverted and shaped tokamak has been operating at MIT since May, 1993. Unique ITER relevant features of the machine include a thick conducting vacuum vessel, all molybdenum plasma facing components, and a closed divertor geometry. An overview of recent results is presented, with particular emphasis on MHD studies including halo currents, confinement studies with ohmic and ICRF heating, and divertor research with emphasis on dissipative divertor operations. Key results presented include quantitative studies of halo current formation (up to 20% of $I_p$), effective ICRF heating (up to 2 MW) with well controlled metallic impurity generation, demonstration of dissipative divertor operation (both radiative and detached), and extension of the H-mode threshold database by more than an order of magnitude ($\tilde{n}_e B_T \sim 10^{21}T/m^3$, $P/S \sim 0.35$ MW/m$^2$).

1. INTRODUCTION

Alcator C-Mod is a high magnetic field, high current density, ICRF heated compact tokamak with flexible divertor and shaping capabilities (see Fig. 1). Its unique features include a thick conducting vacuum vessel, all molybdenum plasma facing components, and a closed divertor geometry, all of which may be prototypical of future devices including ITER and DEMO [1]. The design parameters are: $B_T \lesssim 9$ T, $I_p \lesssim 3$ MA, $\kappa \lesssim 1.8$, $R = 0.67$m, $a = 0.22$ m, $t_{\text{pulse}} \sim t_{L/R}$, and $P_{\text{ICRF}} \approx 8$ MW. With noninductive current drive added in the future, pulse lengths up to 7 sec (or $5t_{\text{skin}}$, at $T_e \lesssim 5$ keV) are feasible at 5 Tesla. With the full ICRF power the plasma surface power density is in the range 0.5-1.0 MW/m$^2$, the heat flux in the SOL is $q_{\parallel} \simeq 0.5 - 1.0$ GW/m$^2$, and the RF power density on the antenna surface is $P_{\text{ICRF}}/A \sim 10$ MW/m$^2$, which are comparable to those required for ITER and DEMO. A 20 shot deuterium pellet injector (with pellet speeds up to 1300 m/sec) is available for fueling and density profile control. The injector is configured to fire up to 5 pellets each of 4 different sizes. The present ICRF power capability is 4.0 MW at a frequency of 80 MHz, which is suitable for minority heating in deuterium majority plasmas at $B_0 = 5.3$ T (H$^+$ minority) and $B_0 = 7.9$ T (3He++ minority). This power will be increased to 8 MW in 1996 by adding 4 MW of 40-80 MHz variable-frequency power.

Alcator C-Mod commenced operation in May, 1993 and to date the following plasma parameters were achieved: $B_T \lesssim 5.3$ T, $I_p \lesssim 1.05$ MA, $\kappa \lesssim 1.7$, $t_{\text{pulse}} \lesssim 1.3$ sec, $n_{e0} \leq 1 \times 10^{21}m^{-3}$, $T_i \leq T_e \sim 3.2$ keV, $P_{\text{RF}} \leq 1.8$ MW. Some of the key research topics investigated during the past year and discussed in this paper include the following: