Plasma operation of Alcator at `low' magnetic fields

PLASMA OPERATION OF ALCATOR AT "LOW" MAGNETIC FIELDS[+]

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The motivation of the Alcator experiment is to produce and heat toroidal plasmas with high currents and high current densities. Initial plasma operation has been achieved with plasma currents up to 50 kA, limiter radius of 10 cm and toroidal magnetic fields of about 10 kG. The ratio of plasma radius to the copper shell radius is about 0.8. The major radius is 54 cm.

The toroidal equilibrium is maintained by a properly programmed vertical field supplementing the effects of the copper shell. The vertical field is excited by the outer compensating coils which are part of the air core transformer. The optimal value of this vertical field has been found to be about 150 G per 50 kA.

In this initial mode of operation two condenser banks are used to excite the air core transformer system corresponding to a magnetic flux of about 0.15 V sec; the plasma current pulse is limited to about 45 msec maximum duration.

After breakdown and plasma formation the measured loop voltage is typically about 1 V/m. Average plasma densities as measured with a 4 mm interferometer are in the range of 3 to 6 x 10^{13} cm^{-3} reaching a maximum when the plasma current goes through maximum. Filling pressures of 0.5 to 1 x 10^{-4} Torr have been used; the base pressure as yet amounts to 4 x 10^{-7} Torr.

During early operation the plasma behaviour was still dominated by impurity influx. Positive voltage spikes (on the average one per msec) were found to coincide with negative dI/dt spikes, horizontal displacement spikes and hard X-ray bursts. Presently the positive spikes tend to disappear (one per 20 msec) after a finite number of shots at high current. Small negative voltage spikes appear in the later phase of the discharge corresponding to measurable decreases of the major radius of the plasma.

Image currents in the copper shell are measured to decay as the programmed vertical field as mentioned above begins to provide for the equilibrium during the prolonged discharge pulse.

Experimental data are recorded on a 64-channel magnetic drum system (bandwidth 0.5 MHz); this system makes possible economical use of the many observations that are made during a discharge.

A nearly complete absence of damage to the limiter has been observed after approx. 3000 shots.

Provisions for operation with a 22 cm limiter opening at 20 kG toroidal magnetic field are now being made before switching to cryogenic operation of the system to reach higher toroidal magnetic fields.

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