ION AND ELECTRON PARAMETERS IN THE
ALCATOR C TOKAMAK SCRAPE-OFF REGION

by

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ABSTRACT

Janus is a bi-directional, multi-functional edge probe used to diagnose the
ion and electron parameters in the Alcator C tokamak scrape-off region. Two
mirror image sets of diagnostics are aligned to face the electron and ion sides
(as defined by the plasma current, \( I_p \)) along magnetic field lines. Each set of
diagnostics consists of a retarding-field energy analyzer (RFEA), a Langmuir
probe, and a calorimeter. The RFEA can alternatively sample both the ion
and electron parallel energy distribution functions during a tokamak discharge.
From the Langmuir probe, one can infer electron temperature, density, and the
plasma floating potential. Simple Langmuir probe theory is found to yield the
best agreement between the measured Langmuir probe characteristics and the
RFEA-inferred \( T_e \). The calorimeter independently detects the total parallel heat
flux incident to an electrically floating plate. The measured sheath transmission
coefficient, however, is typically lower than the theoretically predicted value by a
factor of \( \sim 3 \). Together these diagnostics enable detailed, localized edge plasma
characterization on Alcator C.

Large electron side/ion side parameter asymmetries were observed. Higher
ion and electron temperatures and densities at the probe location occur on the
electron side when the toroidal field (\( B_t \)) is antiparallel to \( I_p \). The direction
of \( B_t \) with respect to \( I_p \), and variations of the plasma in-out positions, change
the magnitude of the asymmetry. Possible directional asymmetry mechanisms
include poloidally asymmetric perpendicular diffusion and parallel flow. \( T_i \) is al-
ways greater than or equal to \( T_e \). Minor equipartition contribution causes weakly
coupled ion and electron energies. Large anomalous perpendicular conduction is
necessary to balance the dominant parallel convection and compression losses
for both the ion and electron species. During an ICRF fast wave experiment,
evidence of direct edge heating in the immediate vicinity of the antenna is ob-
erved. Increasing rf power spreads the heating throughout the edge region,
forcing flat temperature profiles. Observation of increasing high-Z impurities can
be attributed to the increase in physical sputtering rate at both the antenna's
Faraday shields and the limiter surfaces.

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