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MASTER

OBSERVATIONS OF ARCING IN THE ISX TOKAMAK^{*}

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(Reported by J. T. Hogan)

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MEU

Observations of Arcing in
the ISX Tokamak*

P. Mioduszewski:

(reported by J.T. Hogan)

ARC TRACKS IN ISX

12.5 mm

12.5 mm

Secondary Limiter

(SF)

Limiter

(SF - rod, ~1m long, 25mm ϕ)

- Arc tracks have been observed in ISX on the stainless steel and graphite limiters, on stainless steel and AL-probes and on parts of the first wall
- The amount of removed material corresponds to about 10^{16} - 10^{18} atoms per arc track
- To find out whether or not arcing occurs during critical phases of the discharge, a real time experiment with electrical and optical arc detection has been set up in ISX

EXPERIMENTAL SET UP

1. Conditioning Phase

- When the tokamak has been vented (up to air) and/or new components are installed (probes, limiters) strong arcing is being observed.
- After a conditioning phase (≈ 100 shots) the arcing probability decreases considerably.
- After the conditioning phase arcing is no longer being observed throughout the discharge but only during certain phases.

Unipolar core

Lot

shot # 7570

WATER

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

100

Arising at beginning and end
of discharge

unipolar arcing (justine) phase

shot # 2003

PLASMA CURRENT (A) ARC CURRENT (A) OPTICAL SIGNAL

Arcing during minor disruptions

2. Equilibrium State

Arcing is being observed during phases of poor plasma confinement :

- a) current rise phase
- b) minor and major disruptions
- c) discharge end

During these phases the plasma density and/or temperature at the limiter/wall exceeds presumably the conditioning parameters.

This behaviour is being maintained even after thousands of discharges.

Laboratory studies: Arcing as a function of time

AL22 Arcing rate as a function of time

Conditioning effect

Fig. 9. Arcing rate on a SS-304 sample as function of bias voltage.

Fig. 10. Arcing on a SS-304 sample, conditioned up to 400 V bias and then exposed to 100 mTorr air for 1 h.

NUMBER OF ARCS PER UNIT AREA AS FUNCTION OF SURFACE

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Supporting laboratory experiments to study the conditioning phase

Observations:

- a) At given plasma- and surface conditions the arcing probability decreases exponentially.
- b) A change of bias voltage (plasma conditions) and/or surface conditions produces additional arcing.
- c) The arcing behaviour is predominantly a function of the surface conditions.

Conclusions — conditioning phase

- The conditioning process seems to be very effective for type 1 cathode spot arcs (burning in surface contaminants)
- Raising plasma density/temperature above the conditioning parameters requires further conditioning at the new parameters.
- When the plasma conditions get severe enough to initiate type 2 arcs the conditioning might no longer be effective.
(higher densities and temperatures in future machines)

Conclusions - equilibrium state

- Impurities introduced during the current rise phase do not affect the main part of the discharge due to the short impurity confinement time ($\approx 20 \text{ ms}$).
- Arcing during disruptions does not seem to be a problem because the discharge is out of control, anyway.
- Arcing at the discharge end can obviously not affect the main portion of the discharge.

Medium- and high- Z impurity introduction can, however, turn a minor- into a major disruption or can turn a soft discharge termination into a major disruption.

→ number of disruptions of a 100 MJ plasma (INTOR)

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EXPERIMENTAL SET UP