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Singlet Breakdown Optimisation to a Doublet Plasma Configuration on the TCV Tokamak

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This paper presents a fresh attempt on TCV to optimise plasma breakdown in the break-less (45 micro-Ohm impedance) vacuum vessel culminating in a double breakdown and the formation of a doublet configuration. A statistical analysis of legacy single pole breakdown and early plasma current ramp failures helped modify vessel current estimators together with PSU command and control issues to obtain reliable plasma initiation +/-30cm in TCV's 3:1 elongated vacuum vessel. Although precise control of the vacuum null was achieved, control of the high plasma ramp rate proved complex since the highest (~10v) loop voltage was necessary for reliable breakdown and, through trial, the acceptable range of pre-fill pressures was limited. A double breakdown with simultaneous, separated, magnetic nulls was then achieved. Initial ohmic heating alone was limited by lobe separation instabilities with the upper lobe merging into the lower lobe after ~15ms. Plasma multipole control was attempted using two X2 gyrotrons, aimed at each lobe's, core to modify each lobe's resistivity and thus current. A transport barrier in the mantle surrounding the doublet configuration was observed with both lobes seemingly heating independently of the ECH heating location. To date a combined plasma current of 260kA after 20ms was obtained for which Thomson density and temperature profiles indicate two clear plasma lobes. Doublets are predicted to offer increased Beta limits, vertical stability and the potential of a novel solution to divertor exhaust where the entire mantle, surrounding the plasma, may be available for exhaust dissipation.

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