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Growth, Saturation, and Burst of Edge-Localized Filaments in KSTAR

G.S. Yun[1], W. Lee[1], M.J. Choi[1], J. Lee[1], H.K. Park[1], B. Tobias[2],
C.W. Domier[3], N.C. Luhmann Jr.[3], A.J.H. Donné[4,5], and KSTAR team[6]

[1]POSTECH, Pohang, Republic of Korea
[2]Princeton Plasma Physics Laboratory, Princeton, NJ, U.S.A.
[3]University of California at Davis, Davis, CA, U.S.A.
[4]FOM-Institute for Plasma Physics Rijnhuizen, Association EURATOM-FOM, P.O. Box 1207, 3430 BE Nieuwegein, The Netherlands*
[5]Eindhoven University of Technology, Dept. of Applied Physics, The Netherlands
[6]National Fusion Research Institute, Daejon, Republic of Korea

Dynamics of filamentary structures localized in the edge of the high-confinement mode plasmas have been studied with a high resolution (temporal and spatial) 2-D Electron Cyclotron Emission Imaging System. Multiple filamentary structures were observed to emerge simultaneously and grow semi-exponentially in the pedestal region during the period of edge-localized mode (ELM) instabilities. The filaments have a net poloidal flow (~1 km/s) as well as toroidal rotation (~10 km/s). The filaments typically grow to a size ~ 5cm and often reach a quasi-steady state after the initial growth. Later, all filaments start to elongate in the poloidal direction and one of the filaments develops a finger-like structure extruding radially. As the finger grows to the separatrix, the filament bursts through the finger, leading to fast heat convection from the pedestal into the scrape-off layer, i.e., ELM crash. The observations indicate that the bursting filament has multiple burst zones (i.e., fingers) at random positions along the length and each burst zone is toroidally localized.