A new discovery of edge localized modes suppression using ICRH

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The high-confinement mode (H-mode) is very important for the fusion performance of ITER and future fusion reactors [1]. The H-mode pedestal is a region featuring strongly reduced turbulence and transport just inside the limiting flux surface with strong plasma gradients, which drive edge localized modes (ELMs) in tokamaks [2]. The ELMs, however, are quasiperiodic relaxations of the pedestal, resulting in a series of hot plasma eruptions similar to magnetospheric substorms, solar and stellar flares, which could potentially damage the ITER divertor plates and first walls. To mitigate and suppress the ELMs in H-mode plasmas, the fusion community has tried to develop effective actuators over the past two decades. Two separate excellent inventions have been awarded to recognize their achievements. The 2018 APS excellence award in Plasma Physics Research was given to Drs. Todd E. Evans, Max E. Fenstermacher, and Richard Alan Moyer for their first experimental demonstration of the stabilization of ELMs in high-confinement diverted discharges by application of very small edge-resonant magnetic perturbations, which led to the adoption of suppression coils in the ITER design (<https://www.aps.org/publications/apsnews/updates/fall-prizes18.cfm>). The 2018 Fusion Technology Award from the IEEE's Nuclear and Plasma Science Society (NPSS) was given to Dr. Larry Baylor for his work designing the fueling, pumping and disruption mitigation system for the US ITER Project and for the implementation of pellet ELM mitigation for ITER (<https://sofe2019.utk.edu/awards.html>).

In ref. [3], a new active and effective means of ELM suppression using ion cyclotron resonant heating (ICRH) has been demonstrated on the experimental advanced superconducting tokamak (EAST) and in BOUT++ two-fluid ELM simulations. The authors measured, for the first time, the radial extension of RF sheath induced by ICRH deeply into the edge plasma covering the entire pedestal region and the scrape-off layer (SOL). The poloidal velocity shear rate associated with $E \times B$ velocity in the SOL and pedestal regions increased significantly with an increase in the RF sheath potential, which led to the ELM suppression, as explained by simulations.

Their results [3] show the potential for a new simple approach to access the ELM suppressed regimes in plasmas with low torque input, as ITER baseline discharges will have and certainly motivate further work into ICRH as a new actuator for plasma control in future fusion reactors.

- 1 F. Wagner, G. Fussmann, T. Grave, M. Keilhacker, M. Kornherr, K. Lackner, K. McCormick, E. R. Müller, A. Stäbler, G. Becker, K. Bernhardt, U. Ditte, A. Eberhagen, O. Gehre, J. Gernhardt, G. Gierke, E. Glock, O. Gruber, G. Haas, M. Hesse, G. Janeschitz, F. Karger, S. Kissel, O. Klüber, G. Lisitano, H. M. Mayer, D. Meisel, V. Mertens, H. Murmann, W. Poschenrieder, H. Rapp, H. Röhr, F. Rytter, F. Schneider, G. Siller, P. Smeulders, F. Söldner, E. Speth, K. H. Steuer, Z. Szymanski, and O. Vollmer, *Phys. Rev. Lett.* **53**, 1453 (1984).
- 2 H. Zohm, *Plasma Phys. Control. Fusion* **38**, 105 (1996).
- 3 X. J. Zhang, C. Zhou, X. L. Zou, T. Y. Xia, Y. L. Li, C. M. Qin, X. Z. Gong, Q. Zang, M. H. Li, T. Zhang, S. X. Wang, H. Q. Liu, G. Urbanczyk, A. Liu, Y. M. Duan, Y. P. Zhao, J. P. Qian, R. I. Pinsker, M. Y. Ye, and B. N. Wan, *Sci. China-Phys. Mech. Astron.* **65**, 235211 (2022).

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