Quasi-Snowflake divertor configuration studies on EAST

G. Calabrò[1], B.J. Xiao[2,3], S. L. Chen[2], Y.M. Duan[2], Y. Guo[2], J.G. Li[2], L. Liu[2], Z.P. Luo[2], L. Wang[2], J. Xu[2], B. Zhang[2], R. Albanese[4], R. Ambrosino[4], F. Crisanti[1], V. Pericoli Ridolfini[4], F. Villone[4], B. Viola[1], L. Barbato[4], M. De Magistris, [4], G. De Tommasi[4], E. Giovannozzi[1], S. Mastrostefano[4], S. Minucci[4], A. Pironti[4], G. Ramogida[1], A.A. Tuccillo[1], R. Zagórski[5]

[1]ENEA for EUROfusion, via E. Fermi 45, 00044 Frascati (Rome), Italy
[2]Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, 230031, China
[3]School of Nuclear Science and Technology, University of Science and Technology of China, Hefei, 230026, China
[4]CREATE, Università di Napoli Federico II, Università di Cassino and Università di Napoli Parthenope, Via Claudio 19, 80125 Napoli, Italy
[5]Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland

E-mail contact of main author: giuseppe.calabro@enea.it

Heat and particle loads on the plasma facing components are among the most challenging issues to be solved for a reactor design [1, 2]. Alternative magnetic configurations may enable tokamak operation with a lower peak heat load than a standard Single Null (SN) divertor.

This papers reports on the first ever demonstration of the possibility of creating and controlling one of such alternatives, a two-null divertor configuration called quasi-Snowflake (QSF) [3], on a large superconducting tokamak, as EAST, and future steps. These configurations have been designed using the FIXFREE equilibrium code and optimized with CREATE-NL tools and will be discussed in the paper. Due to the location of poloidal field coils (PFCs) coils and target plates on EAST, the secondary null-point could be moved around from the primary one to form a magnetic configuration that features the Snowflake (SF) characterized by a contracting geometry near the plate [4] or single-legged X-divertor, characterized by a flaring geometry near the plate [5]. First experiments focused on investigating the configuration with a significant distance between the two nulls and a contracting geometry near the target plates. An increase of the connection length by ~30% and the flux expansion in the outer strike point (SP) region by a factor ~4 with respect the SN has been obtained, confirming the predictions of the optimization study set up in [3]. It has also been observed that in L-mode discharges the peak of the ion saturation current density in Langmuir Probes (LPs) drops once the QSF shape becomes stable compared to a SN case, which indicates a heat flux reduction, confirmed by Infrared (IR) measurements and verified by interpretative 2D edge TECXY runs [6]. The heat flux in the QSF discharge has been reduced by a factor of ~2, mainly due to the increase of the flux expansion. Plasma current has been purposely kept low (I_P~250kA) for safety reasons. However, these experiments have shown that I_P could be increased, by a further optimization, up to ~500kA. Moreover, the simplest form of plasma current and position control [7] has been used for these experiments, leaving the shape and the distance between the two nulls of the QSF configuration to freely evolve during the discharge. However, an upgrade of the ISOFLUX shape control has been successfully tested in a few QSF shots at the end of the last campaign. New features, as the control of the distance between the two nulls, will be implemented and allow to increase the additional heating power and to easily vary some of the characteristics of the topological QSF configuration, i.e. moving from a contracting to a flaring geometry near the target plates.

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