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Long pulse operation with the JET ITER-Like Wall

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In the last experimental campaign of the JET tokamak in December 2023, long discharge operation (>30s) in deuterium plasmas was developed to assess the sustainment of the plasma performance over many resistive time scales and to address plasma-wall interaction physics in a full metallic environment with the ITER-like wall (ILW), with a W divertor and a Be first wall [1]. Two types of long duration discharges were successfully developed for this purpose: (i) a 30s ELMy H-mode with combined 12-14MW neutral beam heating (NBI) and 2MW of ion-cyclotron resonance heating (ICRH) and (ii) a 60s long pulse with 4-5MW of NBI and 2MW of ICRH. Both operational scenarios are based on previously developed hybrid-like plasmas at JET [2] with IP=1.4MA and B0=1.9T (q95˜4), the latter being compatible with central hydrogen minority ICRH at 29MHz. The 30s pulses had an averaged stored energy of WP=2.5MJ (betaN˜2), with ne0=3.5e19/m3 and core temperatures of Te0˜Ti0=4-5keV. The pulses were stationary from the radiation point of view with no sign of core impurity accumulation and featured regular type-I ELMs throughout the discharge with frequency fELM˜100Hz. The 60s pulses required significant technical adjustments in many subsystems, ranging from plasma shape control, machine protection and diagnostic systems settings [3]. A stationary 60s heated discharge was achieved for the first time in JET-ILW (the last of such pulses been done in the 90's with a C-wall and different divertor structure), with ne0=4.0e19/m3 and Te0˜Ti0=3.5keV (Wp=1.5MJ). This pulse achieved the maximum energy ever injected in a single pulse in JET, Ein=390MJ, and challenged the operational domain of the (passively cooled) divertor limits, reaching Ediv=315MJ. An overview of the main properties of these discharges in terms of stationarity, plasma-wall interaction and overall performance in the context of the international CICLOP database [4] will be presented. A more detailed analysis of the different topics will be given in dedicated papers [5].

[1] G. F. Matthews et al 2011 Phys. Scr. 2011 014001
[2] J. Hobirk et al 2023 Nucl. Fusion 63 112001
[3] D. King et al, "Technical and Engineering challenges for long pulses on JET ITER Like Wall", this meeting
[4] X. Litaudon et al 2024 Nucl. Fusion 64 015001
[5] S. Bresinzek et al, …, this meeting

Primary author: Dr LERCHE, Ernesto (Laboratory for Plasma Physics, ERM/KMS and UKAEA-CCFE Culham Science Centre)

Co-authors: EUROFUSION TOKAMAK EXPLOITATION TEAM; JOFFRIN, Emmanuel (CEA); JET CONTRIBUTORS; BREZINSEK, Sebastijan (Forschungszentrum Jülich); LITAUDON, Xavier (CEA); Dr KING, damian (UKAEA)

Presenter: Dr LERCHE, Ernesto (Laboratory for Plasma Physics, ERM/KMS and UKAEA-CCFE Culham Science Centre)

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