DPP20-2020-000941

Abstract for an Invited Paper
for the DPP20 Meeting of
the American Physical Society

3D Radiation Analysis Following Shattered Pellet Injection in JET and Progress Towards Understanding the Radiation Shortfall[1]

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Shattered-pellet-injection (SPI) shutdowns of high-performance ITER discharges must radiate large fractions of the plasma thermal energy uniformly to prevent damage. Analysis of the radiation in JET SPI experiments indicates that as the ratio of the plasma thermal energy to the poloidal magnetic energy increases, the assumed-axisymmetric radiation efficiency $\langle f_{rad}\rangle$ decreases, consistent with massive-gas-injection experiments. However, an asymmetry in the radiation is found that increases as $\langle f_{rad}\rangle$ decreases. Measurements from four toroidally displaced bolometers are consistent with a helical radiation source. The negative correlation of the asymmetry with $\langle f_{rad}\rangle$ might result from a systematic error that underestimates the radiated energy when the asymmetry is large. Assuming the post-SPI thermal quench radiation is field aligned, the bolometers constrain a helical structure that passes near the injected neon plume. By tracing this structure to two toroidally displaced bolometer fans, errors in the local radiated energy are reduced by tens of percent, though the toroidal distribution is largely unconstrained. Assuming a Gaussian centered about the injection produces favorable toroidal peaking factors less than two but increases the radiation efficiency only marginally. More peaked distributions would further increase the radiation efficiency, reducing conducted heat loads at the expense of radiation peaking. The JOREK code qualitatively reproduces the temporal evolution of the bolometer fans and will be compared with the experiment.

[1]Supported by US DOE DE-SC0014664, DE-FC02-04ER54698, DE-AC05-00OR22725, DE-FG02-07ER54917, DEAC52-07NA27344, the ITER Organization (TA C18TD38FU), and the EUROfusion Consortium framework, Euratom research and training programme under grant No 633053.