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Observation of Runaway Electron Related Relaxation Phenomena during Disruptions in the EAST Tokamak

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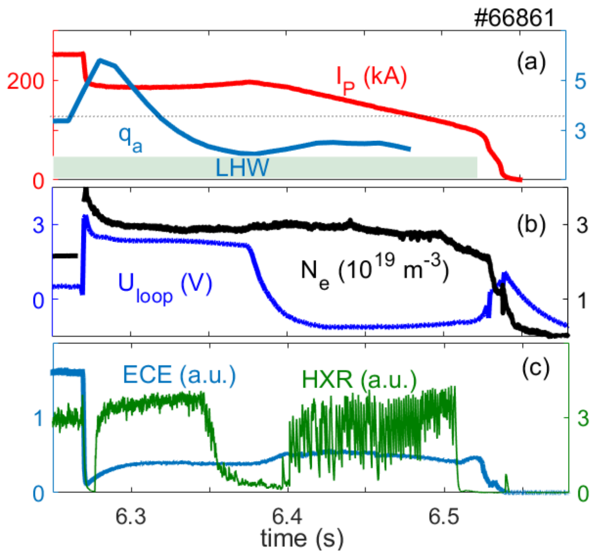
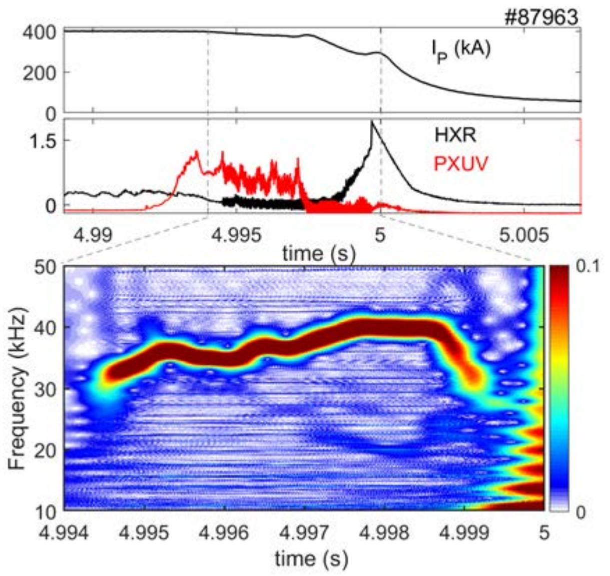
Runaway electron (RE) currents of several mega amperes are expected to be generated in ITER disruptions due to avalanche multiplication. An uncontrolled loss of these high-energy electrons to the plasma facing components might cause serious damage. We present here observations of the RE-related relaxation phenomena during disruptions in the EAST tokamak.



Burst-like relaxations during the RE plateau cause large RE losses, which is seen by the spikes in the signals of magnetic coils. Two distinct types of RE-related relaxation phenomena are distinguished on the basis of the amplitude of magnetic fluctuations. Large-amplitude magnetohydrodynamic activity with indications of RE loss covering the entire energy range is observed during the RE plateau when the edge safety factor decreases to less than 3, and the external kink mode is discussed to resolve this anomaly. Burst-like relaxations with small-amplitude magnetic fluctuations and ~0.6 kHz frequency are confirmed from the spikes in the hard X-ray array signals under a negative loop voltage, and REs with medium energy are significantly lost at the same time. A possible mechanism for the instability is that due to the negative loop voltage, electric field de-accelerates REs and decrease the energy in the medium energy region, and finally, the modification of RE energy spectrum excites this kinetic instability.



An oscillation is observed at the beginning of the current quench, which is detected by the HXR signals and related to strong RE losses. Note that the oscillation is found in the disruptions triggered by amount of argon and neon injection but not helium injection, suggesting that the oscillation should be driven by REs generated during disruptions. The frequency of the mode, in the range from 20 to 40 kHz, strongly depends on the amount of injected impurity and its evolution is suggested to be consistent with the evolution of REs. Besides, at the end of the current quench, multiple TAEs driven by runaway electrons are observed with frequency in the range from 100 kHz to 500 kHz.

These results will further deepen the understanding of RE losses in EAST and be an important part of RE mitigation or avoidance research in future.