

Disruption consequence on metal wall tokamaks

At this moment in time we cannot guarantee the development of disruption free tokamak plasma. The first non-disruptive tokamak pulse was obtained on the TM-2 tokamak in 1962. Thus, the TM-2 experiments manifested Shafranov's predictions for MHD stable plasmas. Disruptions were undesirable but tolerable on small and medium scale machines. However, during the 1971-73 runaway electrons (RE) study on the T-4 tokamak (which had a stainless-steel wall and W-limiter) RE, that were generated during breakdown and remained in the plasma until disruption, melted and evaporated large parts of W-limiter. RE were found to hit the W-limiter just before disruption events. Disruptions became the most irritating ancestral tokamak feature on larger sized JET-like machines. Moreover, disruptions are likely to be a big issue for the operation of ITER, since disruptions can damage machine components because of the large electro-magnetic forces in the conductive structures and large power loads onto the plasma facing components (PFCs).

Since 2011, JET-ILW has been operating with an all metal Be/W composition wall which is planned for ITER. In JET-ILW, high heat fluxes (or alternatively runaway electrons or arcs) have led to damage of PFC by beryllium melting and thermal fatigue of tungsten.

C-Mod had 20-mm thick molybdenum tiles covering most of the first wall and all of the divertor. The worst C-Mod damage was done by a relativistic RE beam. In this discharge the RE started during breakdown and remained inside the plasma. The discharge disrupted, which dumped the RE directly onto one of diagnostic cables, spraying out approximately 2 cm³ of stainless steel and copper. C-Mod disrupted plasmas also create massive thermal loads on the divertor tiles resulting in sprays of molten molybdenum. Badly melted molybdenum tile edges, and even entire tiles, on the misaligned edges of divertor modules have been observed. Disruptions also create large forces that have deformed divertor structural support hardware on C-Mod. AUG first wall tiles are (almost) all graphite covered with tungsten. Arc "spots" were clearly observed in the divertor.

The detailed disruption consequences on metal wall tokamaks will be presented and discussed.

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