

## P4.1053 Energy balance during disruptions

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See full abstract here

<http://ocs.ciemat.es/EPS2019ABS/pdf/P4.1053.pdf>

One of the major threats for the integrity of future fusion devices are disruptions [1], i.e. events during which the plasma energy content is lost on a very fast time scale and can be released under various forms to the structures circumventing the plasma. Consequently, significant heat

loads, particle loads, electromagnetic loads may arise on the surrounding structures, which may cause non negligible damage. It is hence fundamental to study and quantify the energy exchange between the plasma and the structures, which is the focus of the present paper. Being a fusion plasma an intrinsically multiphysics system, particular care must be taken when deriving an overall energy balance. Supposing that the one-fluid MHD equations describe the system [2], the following equations must be considered:

Poynting theorem. This is a direct consequence of Maxwell's equations only and can be interpreted in terms of electromagnetic power balance, involving toroidal and poloidal magnetic energy,  $W_{\text{mag, pol}} + W_{\text{mag, tor}}$ , and the flux  $\Phi$  of Poynting vector.

Kinetic energy balance. This is derived from the momentum balance equation and states that kinetic energy varies due to work done both by pressure force and by Lorentz force.

Internal energy balance. From thermodynamics, we know that plasma internal energy may vary due to deformation work, heat flux (bremsstrahlung, radiation losses, external heating, etc.) and Joule losses. None of these equations can be considered alone, since each is coupled to the others by one or more terms. Adding up all these relations, we obtain the energy balance over a fixed volume (see equation at <http://ocs.ciemat.es/EPS2019ABS/pdf/P4.1053.pdf>)

This relation will be used first of all for deriving some theoretical consequences on the required closure conditions (e.g. adiabatic equation), also considering that some differences arise in the proposed approach as compared to available results [2]. Secondly, it will give hints about the

possibility of "conversion" among the various forms of energy during disruptions, supporting the interpretation of results of detailed simulations [3] of present day and future devices.

[1] T. Hender et al, Nucl. Fusion 47 (2007) S128 [2] K. Miyamoto, Plasma Physics and Controlled Fusion, Springer (2005) [3] F. Villone et al., Plasma Phys. Control. Fusion 55 (2013) 09500

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