Contribution ID: **138** Type: **Invited**

Off-normal event-detection and NTM-control for integrated disruption avoidance and scenario control

Active disruption avoidance and reliable off-normal event handling schemes need to be integrated in modern Plasma Control Systems (PCS) to predict the proximity to operational boundaries and to react activating different tasks according to the decisions taken in real-time (RT) by a supervisory layer. The access to high performance regimes, which requires to control at the same time several physics parameters such as q profile and β, makes the level of required integration even more complex. Advanced control of some of those quantities, especially in future long-pulse devices, will be based on a limited set of actuators, which need to fulfill different control tasks simultaneously, leading not rarely to conflicting actuator requests.
Recently, in some of the present devices, a significant effort has been devoted in studying disruptive boundaries restricting machine operational spaces, such as density limits [1] and β limits, as well as portable tools for disruption avoidance to be integrated in the PCS. In order to integrate real-time reliable decisions to control a scenario near these limits, several key ingredients need to be considered along with RT plasma state monitoring (plasma current and shape, kinetic profiles, etc.): off-normal events and departure from expected trajectories have to be detected and a proper reaction mapped to a specific control scenario, where a supervisor will prioritize the list of control tasks to be executed. Then an actuator manager, based on available resources, will select the list of controllers that will handle each specific task. All these elements need to be present in a future PCS and have been tested on TCV. Well defined interfaces between actuator manager, supervisory layer and advanced controllers facilitate disruption avoidance integration [2].
In this contribution we will look in particular at NTMs, which represent one of the most detrimental MHD instabilities, leading to lower achievable β, confinement degradation and eventually disruptions, in particular at low q_{95} values. This makes it crucial to secure their reliable control, especially for future long-pulse high-β devices like ITER, which is metastable for both 3/2 and 2/1 NTMs. RT-stabilization and prevention have been demonstrated on TCV and AUG. In addition, we will show how NTM RT-prediction can be used to enhance the plasma state description, off-normal event reaction and thereby the educated decision performed by the supervisory level. NTM control, as well as the detection of other physics mechanisms leading to different types of disruption, requires a high-level of integration, which makes the design of a robust and flexible PCS one of the most challenging tasks for the future.

[1] M Maraschek (this meeting)
[2] T. Vu et al, FED 2019

Member State or International Organization

Switzerland

Affiliation

Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH 1015 Lausanne, Switzerland

Primary authors: Dr PAU, Alessandro (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH 1015 Lausanne, Switzerland); Dr FELICI, Federico (EPFL-SPC); GALPERTI, Cristian (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH-1015 Lausanne, Switzerland); Dr GUDE, Anja (Max-Planck-Institut für Plasmaphysik, D-85748 Garching, Germany); KONG, Mengdi (École Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH-1015 Lausanne, Switzerland); Dr MARASCHEK, Marc (Max-Planck Institute for Plasma Physics); REICH, Matthias (Max-Planck-Institut für Plasmaphysik, Garching, Germany); Dr SAUTER, Olivier (SPC-EPFL); Dr SHEIKH, Umar (EPFL-SPC); SIEGLIN, Bernhard (Max-Planck--Institut for Plasma Physics); Dr VU, Trang (EPFL - Swiss Plasma Center); Dr ALESSI, Edoardo (ISTP-Consiglio Nazionale delle Ricerche, Milano, Italia); Dr GOMEZ, Igor (Max-Planck-Institut für Plasmaphysik, D-85748 Garching, Germany); KUDLACEK, Ondrej (Max-Planck Institute of Plasma Physics); Dr RISPOLI, Natale (ISTP-Consiglio Nazionale delle Ricerche, Milano, Italia); Dr SOZZI, Carlo (Istituto per la Scienza e Tecnologia dei Plasmi ISTP-CNR

Milano Italy); Dr TESTA, Duccio (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH 1015 Lausanne, Switzerland); Dr TREUTTERER, Wolfgang (MPG-IPP)

Presenter: Dr PAU, Alessandro (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC), CH 1015 Lausanne, Switzerland)

Track Classification: Prediction and Avoidance