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Use of Actuator management in ASDEX Upgrade control

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The control experiments on ASDEX Upgrade so far were only able to use one gyrotron per controller to perform a control action (for example supply power for Te control). The power provided by one gyrotron is not sufficient for the control tasks described below. In order to overcome this issue, we have introduced a virtual actuator which combines arbitrary number of gyrotrons and is responsible for the controller command distribution. The concept of the virtual actuator is described in [1]. This contribution will discuss the use of the virtual actuator in the ASDEX Upgrade experiments, where it proved to be a powerful and useful method.
The first application of the virtual actuator is the ßp control in the I-mode experiment. In this case, ßp was controlled by a group of gyrotrons combined to a virtual actuator heating the plasma center.
The virtual actuator was also used in the Te profile control experiments [2]. This is important for example in fast particle studies or experiments studying the effect of He plasma confinement. In this case, the controller actuated the ECRH power at two different poloidal location to control the temperature profile. For this purpose, we have used two virtual actuators with 3-5 gyrotrons each (depending on the discharge settings) pointing to the desired poloidal locations.
The next application is the H-Mode density limit disruption avoidance experiments reported in [3], where the virtual actuator was used to supply central heating to keep the discharge away from the disruptive area.
Last, but not least, the virtual actuator is useful in gyrotron replacement strategies. Traditionally, the gyrotrons tripped during the discharge were replaced by the next gyrotron in the priority list. However, this approach does not guarantee that the replacement gyrotron will have similar features, such as power deposition or current drive efficiency. The virtual actuator concept allows to define more sophisticated replacement groups which contain gyrotrons with similar properties.

References:
[1] O. Kudlacek et al, Actuator management development on ASDEX Upgrade, accepted to FED.
[2] F. Felici et al, Model-based design, simulation and testing of an electron temperature profile controller on ASDEX Upgrade, submitted to NF.
[3] B. Sieglin et al, Rapid prototyping of advanced control schemes in ASDEX Upgrade, this conference.

Primary authors: Dr KUDLACEK, Ondrej; Dr TREUTTERER, Wolfgang (Max Planck Institute for Plasma Physics); JANKY, Filip (Max Planck Institut für Plasmaphysik); SIEGLIN, Bernhard (Max Planck Institut für Plasmaphysik); Mr GRÄTER, Alex; Mr ZEHETBAUER, Thomas; Dr MARASCHEK, Marc; Dr FELICI, Federico

Presenter: Dr KUDLACEK, Ondrej

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