**Real time evaluation of gas fueling efficiency for density feedback control**

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1. Understand the nuclear fusion and tokamak principles. In particular, focus on impact of plasma density and its control on the machine operation and understand the characteristics of actuators that affect plasma density (gas injection, pellet injection).
2. Describe the physics model of tokamak gas fueling including ionization and recombination terms. Learn how to use existing simulation tools where this model is implemented.
3. A major common weakness of the density feedback controllers using gas is that they do not take into account the fueling efficiency, which largely depends on time varying plasma parameters. This thesis shall propose a method(s) on how to evaluate this parameter in real time and exemplify this on a few AUG discharges

The thesis should be written in English.

**Recommended literature:**

[1] J. Wesson, Tokamaks, Oxford University Press, 2004

[2] T. Ravensbergen et al, Density control in ITER: an iterative learning control and robust control approach, Nuclear Fusion 2017

[3] T. Blanken et al, Control-oriented modeling of the plasma particle density in tokamaks and application to real-time density profile reconstruction, Fusion Engineering and Design, 2018

[4] T. Bosman et al, Kalman filter density reconstruction in ICRH discharges on ASDEX Upgrade, Fusion Engineering and Design 2021

[5] W. Treutterer et al, Concepts of the new ASDEX Upgrade flight simulator, Fusion Engineering and Design 2019