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1P79 - An Eigenvalue Approach to Study SPIDER RF Oscillator Operating Space

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The SPIDER experiment features four radiofrequency (RF) circuits to heat the plasma generated in its inductively coupled ion source. Each circuit includes a tetrode-based Colpitts push-pull oscillator (200kW rated power) operating at 1 MHz frequency, a coaxial transmission line to feed the load composed of a couple of RF antennas and a resonant matching network. The SPIDER operation has shown two phenomena that affect the performance of the RF circuit: the so-called "frequency flip"that prevents the operation at the best load impedance matching condition and a limitation on the maximum RF power delivered by the RF generators.
Theoretical models of the SPIDER RF circuits have been developed able to predict the frequency flip occurrence, that has been also experimentally observed. By using the validated models, an operational setup to avoid the frequency flip occurrence has also been synthesized and successfully implemented. However, limitation in the maximum delivered RF power are still present, thus the RF circuit modelling approach has been further developed exploiting the state space analysis to achieve a deeper comprehension of its operation.
The results of the eigenvalue analysis of the circuit gives as outputs both the operating frequency of the system and equivalent load seen by the oscillator at that frequency. The equivalent load is used as input for an steady state electrical model of the push pull connection of the tetrodes, which exploits the algebraic model of the tetrode and permits the identification of the RF power delivered by the oscillator as a function of the tetrodes polarization voltages.
A validation of the models developed is presented on the base of the SPIDER experiments.

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