Contribution ID: **1223** Type: **Regular Poster**

Intermediate n Mode Stability in the Negative Triangularity Tokamaks

Friday 14 May 2021 16:40 (20 minutes)

In this work, we investigate the stability of intermediate n modes in the negative triangularity tokamaks (NTT) in comparison with the positive triangularity tokamaks (PTT). Two types of scenarios are investigated: the D3D-NTT-experiment-like equilibria and the advanced tokamak scenario to address both the immediate D3D experimental concerns and the future prospect of the steady-state confinements. We study the intermediate n modes since the low n modes have been studied in the earlier works. The main results are summarized first with details described afterwards.

For the D3D-NTT-experiment-like equilibria, we found that the intermediate n modes can be stabilized by the perfectly conducting wall both for NTTs and PTTs. Nevertheless, the resistive wall modes (RWMs) with an intermediate mode number can develop. NTTs are found to be more stable than PTTs for RWMs of intermediate mode number. The stable wall position for the NTT case is large and acceptable. For the PTT case, however, RWMs remain unstable for considerably low wall position.

For the advanced steady tokamak scenario, it is also found that the intermediate n modes can be stabilized by the conducting wall. But, the RWMs of intermediate mode number can develop. NTT is also shown to be more stable than PTT in the advanced tokamak scenario. However, the RWM instabilities seem to linger even with the rotation and diamagnetic stabilization are taken into account. Large Shafranov shift in the high beta equilibrium seems to be helpful. But, it remains to be fully confirmed.

There is renewed interest in the negative triangularity tokamaks. Earlier NTT experiments in TCV have shown exciting results with improved MHD stability and reduced transport 1. Recently, discharges with negative triangularity were also created in the DIII-D tokamak. It is found that the NTT discharges exhibited H-mode-level confinement features with L-mode-like edge behavior without ELMs [2].

Theoretically and computationally, it has been shown in Ref. [3] that NTTs usually are more unstable than PTTs. This is confirmed by our earlier stability analyses with reconstructed D3D-NTT-experiment-like equilibria for low n modes [4]. Nevertheless, we found that NTT is more effective in creating the field line rotation transform, leading us to develop the advanced NTT scenario with high bootstrap current fraction, high poloidal beta, and peaked pressure profiles. It is found that in a certain parameter domain, the beta normal limit can reach about twice the extended Troyon limit for low n modes. This shows that NTTs are not only favorable for divertor design, but also can potentially be good for steady-state confinements [4]. Our earlier studies have focused on the low n modes, together with the high n ballooning mode studies. This leads us to consider the modes with intermediate n numbers (n = 4 - 10) in this work.

In the current studies, the equilibria are constructed using the VEMC code, with the bootstrap current package developed at IFS. The MHD stability is mainly computed using the AEGIS code, supplemented with DCON for double check. The conformal wall is used in the calculation.

We first consider the D3D-NTT-experiment-like equilibria. The typical PTT and NTT cross sections are shown in Fig. 1 in [5] with triangularity being 0.40 and -0.40, respectively. Other geometry parameters are similar to the D3D NTT experiment setup. The same type of pressure profiles is used for both PTT and NTT cases. They are the L mode type as in the D3D NTT experiments. Because of the shape difference, the edge q tends to be higher in the PTT case than in the NTT case. The typical pressure and safety factor profiles for the NTT case are shown in Fig. 2 in [5].

We found that the intermediate n modes can be stabilized by the perfectly conducting wall both in the NTT and PTT cases with any geometry-allowed wall distance (i.e., with the wall not touching the tokamak axisymmetry axis) for considerably high beta values. However, we found that RWMs with an intermediate mode number n can develop. The n = 5 RWM growthrates versus the normalized wall position for the NTT and PTT cases are plotted in Fig. 3 in [5]. The beta normals for both cases are about 3.3. Comparing the growthrates in Fig. 3 in [5], one can see that the PTT case is more unstable than the NTT case with similar beta. Since the unstable wall position for the NTT case is above 2.3, it is therefore not a big concern noting that the typical experimental wall position is about 1.5. For the PTT case, however, RWMs remain unstable for considerably low wall position, about 1.3. This is different from the low n mode case, in which the NTT case is more unstable.

For the advanced tokamak scenario with high poloidal beta, high bootstrap current fraction, and peaked pressure profile, it is also found that the intermediate n modes can be stabilized by the conducting wall with a geometry allowable wall position both for NTTs and PTTs with beta normal considerably above the Troyon limit. But, the RWMs can develop. NTT is also shown to be more stable than PTT in the advanced tokamak scenario. However, the RWM instabilities seem to linger even with the rotation and diamagnetic stabilization are taken into account. The wall has to be about 1.1 for RWM stability. Large Shafranov shift in the high beta equilibrium seems to help. But, it remains to be fully confirmed due to the numerical convergency for the high beta, self-consistent equilibria with bootstrap current taken into account.

This research is supported by Department of Energy Grant DE-FG02-04ER54742.

1 Y. Camenen et al., Nucl. Fusion 47, 510 (2007).
[2] M. E. Austin et al., Phys. Rev. Lett. 122, 115001 (2019).
[3] S. Yu Medvedev et al., Nuclear Fusion 55, 063013 (2015).
[4] L. J. Zheng, M. T. Kotschenreuther, F. L. Waelbroeck, et al. IAEA-FEC, TH/P1-30 (2018).
[5] https://sites.cns.utexas.edu/sites/default/files/lzheng/files/fig1-3-lzheng.jpg?m=1584328956

Indico rendering error

`Could not include image: Problem downloading image (https://sites.cns.utexas.edu/sites/default/files/l`

Country or International Organization

United States

Affiliation

University of Texas at Austin, Austin, TX 78712, USA

Authors: ZHENG, Linjin (University of Texas at Austin, Institute for Fusion Studies); KOTSCHENREUTHER, Mike (Institute for Fusion Studies); WAELBROECK, F. L. (University of Texas at Austin)

Presenter: ZHENG, Linjin (University of Texas at Austin, Institute for Fusion Studies)

Session Classification: P8 Posters 8

Track Classification: Magnetic Fusion Theory and Modelling