

by Richard Fitzpatrick

**Reply to Referees' Comments**

First, let me thank both referees for their careful reading of the paper, and their helpful comments. In response to these comments, I have made the following major changes to the paper.

1. I have taken the material in the Appendix relating to the natural frequency, and have converted it into a preliminary section in the main text. The remainder of the Appendix has been discarded, because it was not germane to the argument of the paper. The new section allows me to state the first and second aims of the paper right next to one another (at the end of the Introduction), and also helps to frame the discussion of the three calculations that are described in the paper.
2. I have improved the figures, in that I have made the axes labels larger, and have added legends to Figs. 4–13.
3. I have added the neutral particle profile to Fig. 3.
4. I have added a summary figure (Fig. 14) that helps to compare and contrast the results of the three calculations that are described in the paper.
5. The new summary figure makes it apparent that the results of the calculation with the linear natural frequency are not as bad as I had originally thought. Hence, I have amended the discussion in the paper relating to this calculation.
6. I have tried to make it clear throughout the paper that, in the absence of the RMP, the EPEC code uses profile information to reconstruct the natural frequencies of tearing modes that are unmodified by RMP-induced electromagnetic torques in the plasma. In the presence of the RMP, the EPEC code calculates how these frequencies are modified by the torques. Because it is clear, from a comparison of EPEC simulations made with and without the RMP, that the natural frequencies are not appreciably modified by the torques, except in those relatively short time intervals in which a mode locks to the RMP, it is not unreasonable to use the profiles outside these intervals as inputs to the code.

The following gives responses to specific queries from Referee 1 that are not covered by the previous discussion (all reference numbers refer to references in the original manuscript):

1. p. 3: I have made it clear that the maximum practical currents that can be driven in RMP coils render the coils incapable of locking tearing modes except when the natural frequencies of the modes are comparatively small (i.e., 5 krad/s, instead of the usual 100 krad/s, in DIII-D).
2. p. 4: I have replaced references to the “guiding-center fluid” by references to the  $\mathbf{E} \times \mathbf{B}$  velocity.
3. p. 4: I have added the Lyons (2017) reference.
4. p. 5: I have added more asymptotic matching references.
5. p. 5: I have made it clear that the observation that the driven widths of non-locked magnetic island chains exceed the linear layer widths actually applies to DIII-D discharge 158115, and have argued that it is not unreasonable to assume that the same holds true in discharge 145380. I have also explained why I think that this state of affairs will persist in ITER.
6. p. 5: I did mean Ref. 12 instead of 14.
7. p. 7: If the density pump-out modifies profiles in a manner that is not associated with the generation of electromagnetic torques at the various rational surfaces in the plasma then the pump-out modified profiles would be the appropriate profiles to use as the starting point of the calculation.

8. p. 7: EPEC does not modify the plasma equilibrium.
9. p. 8: I have replaced “actual widths” by “shielded widths”.
10. p. 9: The  $1/3$  power is correct in Ref. 22. If you read the final section of Ref. 49 you will see that when you take into account the fact that parallel transport in high-temperature tokamak plasmas is convective, rather than conductive, then the critical island width scales as  $\chi_{\perp}^{1/3}$ , rather than  $\chi_{\perp}^{1/4}$ . I have added an additional reference to make this clear. I have also made it clear that the generic  $\chi_{\perp}$  used in Ref. 22 has been replaced by separate diffusivities for momentum, energy, and particles in the present paper.
11. p. 10: Because the  $m = 11$  ELM suppression window only differs from the other two windows by the presence of a single ELM in the middle of the window, I do not think that it makes sense to make a significant distinction between the  $m = 11$  window and the other two.
12. p. 12: Unfortunately, I do not know how to run the EPED model.
13. Fig. 1: The thin grey line seems to be a “feature” of the interaction of obsolete versions of Powerpoint and the Mac operating system. Because the line does not actually occur in the figure, I cannot delete it. (I also cannot redraw the figure, because I did not generate it in the first place. I think that it is a pretty old figure.) I can only hope that the line does not appear in the published version of the paper.

The following gives responses to specific queries from Referee 2 that are not covered by the previous discussion:

1. EPEC, like GPEC, uses a flux-coordinate system, and is essentially spectral in the poloidal and toroidal directions. Thus, EPEC cannot treat an X-point exactly, but it can get asymptotically close to an X-point by making the cutoff surface arbitrarily close to the LCFS.