Helical Magnetic Self-Organization in the RFX-mod and MST devices

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Abstract

- Self-organization of the reversed field pinch with large helical structure (QSH regimes) is predominant as plasma current is increased.
- In RFX-mod, the persistence and strength of the QSH state increases markedly above 1 MA. An internal transport barrier appears, and plasma thermalization within the helical magnetic surfaces reflects improved confinement.
- The QSH regime is also obtained in MST plasmas, which operates with plasma current up to nearly 0.6 MA.
- Analysis of the common database from the two devices should help reveal key physics for QSH onset and dynamics.
- We report here a statistical analysis of the tearing mode behavior in MST (e.g., amplitudes and QSH persistency) that reveals a trend with plasma current similar to that observed in RFX-Mod.
- This trend supports an expectation for universal behavior that depends on parameters such as the Lundquist number that vary with the plasma current.

Quasi Helical Regimes

- Self-organization of the reversed field pinch with large helical structure (QSH regimes) is predominant as plasma current is increased.
- The effect of chaos healing by separatrix expulsion is believed to favor the formation of internal transport barriers in the quasi helical RFP.

Statistical comparison MST - RFX

- Duration values (and Persistence too to a less degree) range rather wide intervals for each plasma current, nevertheless the large range of Ip operated in RFX-mod provides a clear indication of a positive trend with plasma current.

Database

- We report here a statistical analysis of the tearing mode behavior in MST (e.g., amplitudes and QSH persistency) that reveals a trend with plasma current similar to that observed in RFX-Mod.
- Sustained discharges have been analyzed with same criteria in RFX-mod and MST. Each point corresponds to a QSH period and each quantity is averaged over that period.
- QSH periods are defined according to the criterion $N_e<2$. The dominant tearing mode is $m=1,n=5$ for $F=0$ plasmas and $m=1,n=6$ for $F=0.2$ ones.
- Thomson scattering measurements and transport analysis on MST will be important to compare with the confinement behavior established for RFX-Mod.

Conclusions – open issues

- Helical magnetic self-organization is observed on a clear statistical basis in both MST and RFX, with similar qualitative trend.
- Magnetic bifurcation and thermal properties (i.e. presence of transport barriers, density control & refueling ...) still need a detailed diagnosis, in particular concerning the temporal behavior/dynamics within QSH stages in both machines.
- What dimensionless parameters rule the experimental bifurcation?
- Impact of mode locking.
- Impact of PPCD (QSH has been systematically stimulated by OPCD, see D. Terranova et al., Phys.Rev.Lett. 99, 095001 (2007)).