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Optimization of RMP Spectrum on J-TEXT

Zhengkang Ren [1], Yonghua Ding [1], Nengchao Wang [1], Da Li [1], Feiyue Mao [1], Zhuo Huang [1], Ying He [1],Chengshuo Shen [1], Dongliang Han [1]

[1] Huazhong University of Science and Technology,

e-mail (speaker): ren_zk@hust.edu.cn

Numerical studies show that multiple locked modes flatten the temperature profile and enhance the plasma heat transport. It is found that the 3/1 island width is sensitive to the phase differences among the island chains, such as 2/1, 3/1 and 4/1 island.[1] Hence, the disruption might be influenced by the phase difference between adjacent islands. RMP is an effective method to produce multiple locked islands and acts as a flexible tool to study the disruption with various island. In this work, we calculate of RMP spectrum in flux coordinate, and study the RMP coils connections so as to produce RMP fields with large 2/1 and 3/1 components, especially the flexibility of varying the phase difference between 2/1 and 3/1 RMPs are studied.

A set of in-vessel RMP coils has been constructed on the J-TEXT tokamak.[2] The calculation and optimization of RMP spectrum is essential to produce a perturbed magnetic field with specific components.

The calculation of spectrum was carried out in cylindrical coordinate (r,θ,φ) in the past, in which the field line is not straight, RMP does not correspond to magnetic islands on resonant flux surfaces. In the flux coordinate (ρ,θ,φ) , the field lines are straight, the effects and the spectrum of perturbed magnetic field can be described more accurately.

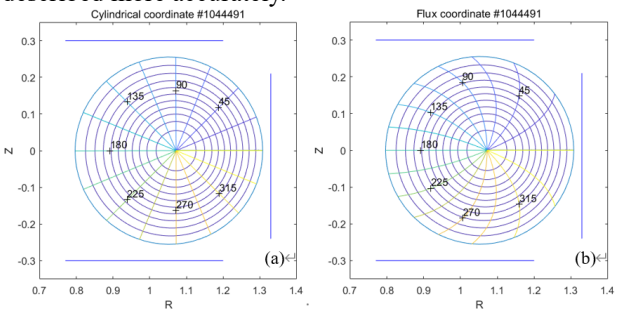

Fig 1. Two coordinates to calculate RMP spectrum

The spectrum can be adjusted by changing the coil connection. The spectrum control of 2−turns coils (port 3, 7, 10 and 14) with n=1 connection is discussed, each two coils with a 180 degree toroidal separation are connected with opposite current direction.

The connection of the upper and lower coils can be divided into two types. In the first type, $\Delta\varphi=\varphi_U-\varphi_L$=const, the amplitudes of components are unchanged, the phase of magnetic field can be changed. In the second type, $\varphi_U+\varphi_L$=const, the amplitudes of components change continuously with Δφ, namely Δφ scan.

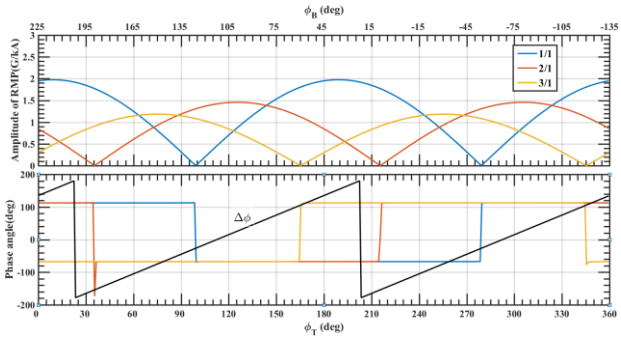

Fig 2. Δφ scan of upper and lower coils.

In the Δφ scan with φ_U increasing and φ_L decreasing, the RMP components produced by upper coils vary clockwise in the complex panel (Fig.3 red), while components produced by lower coils vary counter-clockwise (Fig. 3 green). The phases of 2/1 and 3/1 are always the same (or opposite), so it is difficult to adjust the phase difference between these two components at other values. If the LFS coils are added, the phase difference can be adjusted in a small range.

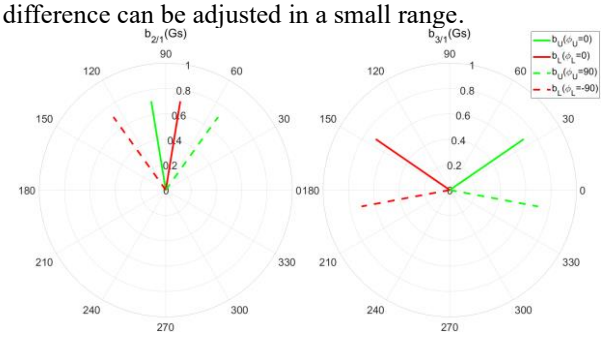

Fig 3. Phase relationship of 2/1 and 3/1 at Δφ scan

The phase differences between 2/1 and 3/1 components are always the same or opposite, can not be controlled in a flexible manner. The possible reason will be discussed in the conference.

References

[1] Q. Hu et al 2019 Nuclear Fusion 59 016005

[2] B. Rao et al 2014 Fusion Engineering and Design, 89(4): 378-384