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アジョイント法を用いたRFPプラズマ平衡再構成
Equilibrium reconstruction for RFP plasmas using the adjoint method

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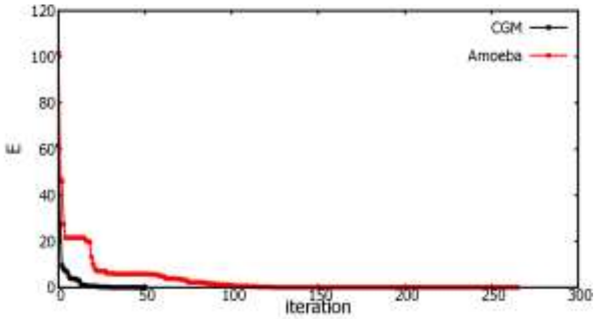
Equilibrium reconstruction is the process of using experimental measurement data to determine the MHD equilibrium properties of fusion plasma.
In axisymmetric toroidal systems, the MHD equilibrium is determined by the Grad–Shafranov equation, the solution of which requires knowledge of the toroidal magnetic field and pressure profiles. The equilibrium reconstruction determines these radial profiles and the shape of the flux surfaces by minimizing the mismatch between observed and modelled diagnostic signals. In previous studies, equilibrium reconstructions were applied to the RFP device, they used the non-gradient method[1] that there is no proof of convergence for it or adjust manually, and equilibrium reconstruction using a gradient method hasn't existed yet.

In this study, we developed a method of equilibrium reconstruction based on gradient based optimization for the REversed field pinch of Low Aspect ratio eXperiment (RELAX) [2,3] device and evaluated performance of reconstruction by a mock data and applied for the actual measurement data of RELAX. However, the disadvantage of the gradient method is that it takes time to calculate. Since differential information is required as many as the parameters used in the model, the accuracy of the model and the calculation time are usually in a trade-off relationship. Therefore, we adopted a method called an adjoint method so that gradient calculation can be performed without depending on the number of model parameters.

Fig.1 shows that an example of the result of equilibrium reconstruction using the adjoint method. Where, E is the objective function between observed and modelled diagnostic signals. The horizontal axis is iterative number of the calculation. The red and black lines are Amoeba method which is non-gradient method and our method applied the adjoint method. It can be confirmed that the convergence of the objective function in this method is faster.

In this presentation, we report the derivation and formulation of adjoint systems and the results of application to various measurements obtained with RELAX.



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