【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering Ⅱ)

Title of Project : Physics and macro control of particle circulation in a multi hierarchical complex-open system

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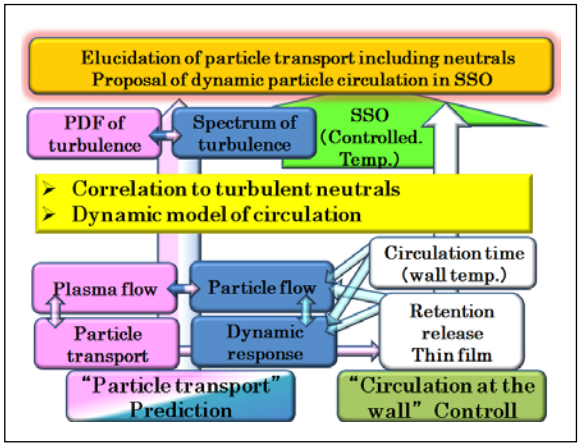
Research Area : Engineering, Nuclear Fusion
Keyword : Plasma-wall interaction, Steady state operation, complex-open system

【Purpose and Background of the Research】

Fusion reactor research and development via a half-century has progressed to a validation of engineering and physics of nuclear burning as a source of energy generation through the construction of ITER. Although "steady state operation (SSO)" is an indispensable prerequisite for a reactor, the immediate goal of ITER is 400 seconds. In SSO the circulation control of the fuel particles will be the subject of challenging studies due to plasma wall interaction, though it is not a problem in pulsed operation.

The present study is aimed at to clarify the particle circulation in three systems, core, boundary, and first wall. Elementary processes, the system interaction, a circulation model, and control of the particle circulation, are subjects to build the foundation for SSO. For this study the viewpoint of "Physics and macro control of particle circulation in a multi hierarchical complex-open system" is introduced. The elucidation of the circulation in each system and the mutual interference leads to the key macro control of the whole system.



【Research Methods】

Temperature controllable panels(HW) for 300-500 ˚C will be installed in the QUEST device, and the restraint of the circulation and reduction in time constant are studied. The heat balance of the entire system will be confirmed via following three steps, 1) HW (100 ˚C) + pulsed operation, 2) HW (>100 ˚C) + CW operation, and 3) controlled HW (300-500 ˚C) + CW operation. Under these conditions dynamic retention and release of particles, blob transport and density profiles in the core will be studied. Mutual interference of three systems will be investigated as a function of the HW temperature, discharge duration, and flux of neutral particles. Fluctuations in particles including neutrals will be measured in two dimension with high-speed cameras and ultral multi-points arrays. Based on these diagnostics a global model will be validated.

【Expected Research Achievements and Scientific Significance】

Model of hierarchical structure consisting of macro, meso, micro systems is becoming a success in recent years. However, to control the energy generation of fusion reactor, which is an open system for particle circulation, should be setting a new problem as a complex system with multi hierarchical structure. By constraining the outermost region, we will challenge whether it positively impacts the stabilization of the system. Thus, this project will contribute to the realization of steady-state reactor with academic standpoint.

【Publications Relevant to the Project】

H.Zushi, et al., "Steady-state tokamak operation, ITB transition and sustainment, ECCD experiments in TRIAM-1M", Nucl. Fusion, **45** (2005) 1-15

H.Zushi, et al.,"Active particle control experiments and critical particle flux discriminating between the wall pumping and fuelling in CPD tokamak", Nucl. Fusion, **49** (2009) 055020 (9pp)

【Term of Project】 FY2012-2016
【Budget Allocation】 154,800 Thousand Yen
【Homepage Address and Other Contact Information】

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