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Activities of the Core

Nov. 5, 2024 Seto Inland Sea Carbon-neutral Research Center (S-CNC) Symposium (co-sponsored by HU-ACE)

Nov. 8, 2024 The 117th Hiroshima University Biomass Evening Seminar (co-organized by HU-ACE)

Nov. 9, 2024 The 6th Higashihiroshima-Ene/Eco Seminar (co-organized by HU-ACE)

Nov. 14, 2024 The 97th HU-ACE Steering Committee Meeting

Nov. 21, 2024 12th Asian Conference on Biomass Science (ACBS2024) (in Bangkok, Thailand) (co-organized by HU-ACE)

Operation data analysis of a Ground Source Heat Pump in J-Innovation HUB building

We are measuring the real operation data of a Ground Source Heat Pump (GSHP) system installed in the J-Innovation HUB building in Higashi-Hiroshima campus of Hiroshima University. The measurement in the 2023 winter season showed that ground-source temperature returned to the heat pump was generally maintained around 15℃, and above 10℃ even during large heat loads in the building. These were much higher than the ambient air temperature of 0℃ during the severe winter season in Saijo. The energy efficiency (COP) of the GSHP was much higher than that of a conventional air conditioner (1997), up to twice as high, resulting in large energy-saving effects (Fig.1). Currently we are investigating optimization of flow control for ground-source water circulation pumps to further improve the COP.

(The higher the COP, the more energy efficient)

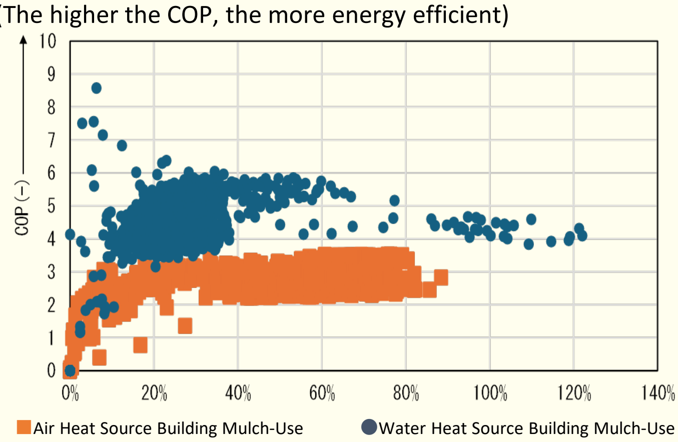

Fig. 1 Actual operating COP of geothermal heat pumps (winter 2023)
(Hoshi, Kindaichi, et al.: Presented at the 2024 Annual Conference of The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan [SHASE], in Saga, Japan)

Related Events

Jan. 11-12, 2025: The 13th Joint Conference of Renewable Energy and Nanotechnology (JCREN) at Fukuoka, JAPAN (co-organized by HU-ACE) (https://i-aeu.org/250111jcren/)
Contact us for more information : hu-ace-info@ml.hiroshima-u.ac.jp

Research consultation and joint research are welcome.

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Research Topics No. 58

Nonlinear interaction between turbulence and asymmetry

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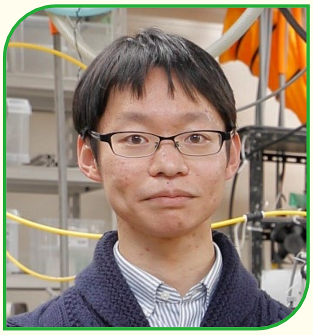

Reseach Field：Plasma engineering
Keyword：plasma diagnostics, turbulence, tomography

Abstract

Background: plasma turbulence hampers fusion power development

Massive efforts have been devoted to realizing fusion power generation to obtain access to clean and safe energy sources. One of the methods to harness the fusion energy, which is produced from the fusion reaction between hydrogen nuclei, utilizes a strong magnetic field to confine the hot and dense plasma. The seven countries (Japan, EU, US, Russia, China, Korea, and India) are collaborating to build a huge fusion facility, ITER, that aims to exhibit the feasibility of magnetically confined fusion power production. In addition to this international collaboration, some countries have declared some projects to build fusion power plants by themselves (China: BEST, UK: STEP, etc.). Furthermore, many startup companies have sprung up to commercialize fusion power (USA: SPARC, Japan: FAST). Some of these plans aim to achieve fusion power generation in the 2030s, indicating that expectations for the realization of fusion power generation are growing worldwide.

One of the significant obstacles that hamper the realization of magnetically confined fusion power generation is turbulence. The turbulence inside the plasma can expel the fuel particles out of it, but occasionally, it helps improve the confinement of the fuels and thermal energy. The turbulence in plasma appears as the fluctuation of density or flow with a wide range of frequency and wavelength. When the energy of this fluctuation accumulates in certain fluctuations with long wavelengths, it can degrade or improve the confinement of the fuels and thermal energy. The action of energy exchange among fluctuations is called nonlinear coupling. Many attempts have been made to analyze nonlinear coupling and to decipher the interaction between fluctuations in order to elucidate the phenomena produced by turbulence in plasmas.

Identification of nonlinear interaction between turbulence and skewness of the plasma

Conventional studies on turbulence have focused on the interaction among fluctuations. In this study, we focused on the variation of fluctuation, which the conventional context cannot fully explain. Using the tomography system in the cylindrical magnetized plasma device PANTA (Plasma Assembly for Nonlinear Turbulence Analysis) at Kyushu University, we found that the spatial structure of the nonlinear wave phenomena, called solitary wave, changes during the single period of its oscillation. Detailed analysis revealed that the deformation arises from the nonlinear coupling between turbulence and the skewness of the plasma density profile (see FIG. 1), which has not been considered previously. This finding suggests that the inhomogeneity of the fueling and heating of fusion plasma can affect the nature of turbulent transport.

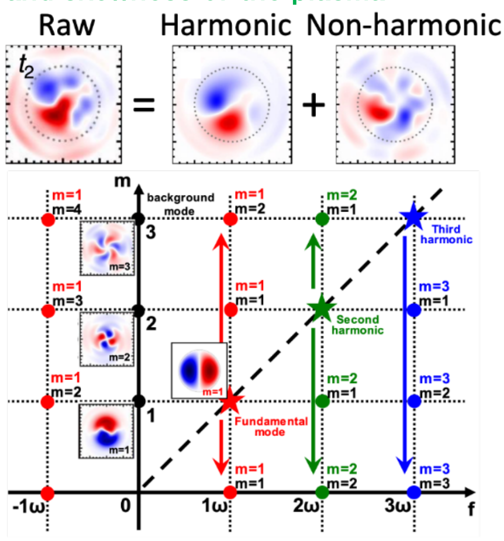

Figure 1. The spatial structure of solitary wave and its non-harmonic component produced by the nonlinear interaction with skewness of plasma.

References

1. T. Kobayashi, A. Fujisawa, Y. Nagashima, C. Moon, K. Yamasaki, *et al.*, Sci Rep **14**, 12175 (2024).