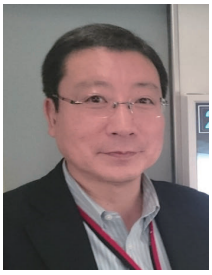
【Grant-in-Aid for Scientific Research (S)】

Broad Section C



Title of Project : Establishment of design principle and basic technology for next generation medical high temperature superconducting skeleton-cyclotron

Atsushi Ishiyama
(Waseda University, Graduate School of Science and Engineering, Professor)

Research Project Number : 18H05244 Researcher Number : 00130865
Keyword : Electrical machine, Superconducting material, Accelerator, Quantum beam, Cancer

【Purpose and Background of the Research】

For advanced cancer therapy, “targeted α-particle therapy" is very promising. To widely use the targeted–particle therapy, a large amount of Radio Isotope (^{211}At) which radiates α-rays must be stably produced. The final goal of this study is to develop an extremely compact and variable-energy HTS (High Temperature Superconducting) accelerator called “Skelton Cyclotron (HTS-SC)”. Until now, we have been working on the development of fundamental technologies that enable "5-High: high mechanical strength, high current density, high thermal stability, high magnetic field, and high precision magnetic field". In this research project, in order to realize a HTS multi-coil system for forming a magnetic field distribution indispensable for beam acceleration, we develop innovative magnet technology integrating the 5-High technology and we aim to establish the design principle and basic technology of HTS-SC.

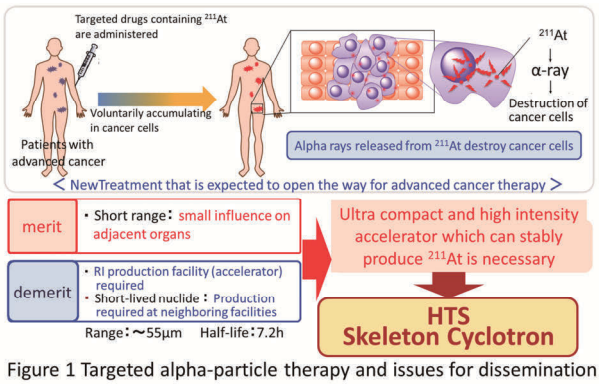


Figure 1 Targeted alpha-particle therapy and issues for dissemination

【Research Methods】

HTS-SC performs high “precision magnetic field necessary for beam acceleration with only a HTS multi-coil system consisting of air-core coils. As a result, in addition to reduction in size and weight, the magnetic field can be changed without being affected by the nonlinear magnetization characteristics of the iron core, and the output can be controlled. Therefore, multi-functionalization becomes possible. In this research, as innovative magnet technologies for the purpose of developing a multi-coil system for HTS-SC, 1)coil reinforcing structure for high mechanical strength, 2)technology to achieve both high current density and high thermal stability, 3)technology for generating high-precision magnetic field, and 4)optimal design technology of multi-coil system, will be established. And then, the feasibility and effectiveness (variable output energy) of HTS-SC will be demonstrated by a small model, "Baby HTS-SC coil system".

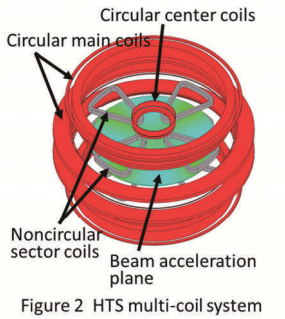


Figure 2 HTS multi-coil system

【Expected Research Achievements and Scientific Significance】

Through the development of HTS-SC, it can be expected to develop compact and lightweight heavy-particle accelerator for cancer treatment. Furthermore, if an innovative magnet technology is established, it can be applied to not only for medical use but also for unexplored stage applications such as coils for next generation compact nuclear fusion reactor and ultra-high density superconducting magnetic energy storage device.

【Publications Relevant to the Project】

・ A.Ikeda et al., “Transient Behaviors of No-Insulation REBCO Pancake Coil during Local Normal-State Transition,” IEEE Transactions on Applied Superconductivity, Vol. 26, No. 4, 4600204, 2016
・ H.Ueda et al., “Conceptual design of next generation HTS cyclotron” IEEE Transactions on Applied Superconductivity, Vol. 23, No.2, 4100205, 2014

【Term of Project】 FY2018-2022

【Budget Allocation】 148,800 Thousand Yen

【Homepage Address and Other Contact Information】

http:// http://www.eb.waseda.ac.jp/ishiyama/