Contribution ID: **385** Contribution code: **WEZD1** Type: **Invited Oral Presentation**

Recent progress in high temperature superconductor magnet technology

Wednesday 10 May 2023 14:30 (30 minutes)

Firstly introduced in 2010 at the MIT Francis Bitter Magnet Laboratory, the so-called "no-Insulation (NI)" winding technique has been regarded as a "game changer"in high temperature superconductor (HTS) magnet technology, as it enables an NI HTS magnet to be highly compact and affordable, yet reliable to a level that has never been achieved with conventional systems. Significant progress in the NI-HTS technology has transformed future dream of HTS machines into reality, i.e., meet rigorous HTS system specifications that were infeasible mainly due to old technical challenges and high cost of HTS machines. The recent achievement of the record high direct-current magnetic field of 45.5 T by use of an NI HTS insert coil is an example, which was recognized as a "top 10 breakthrough for 2019"by Physics World of the Institute of Physics. Some industrial partners initiated innovative research programs, with over 2 billion US dollars of investment from private sectors, to develop a compact fusion system based on the NI HTS magnet technology, which was recognized as a "top 10 breakthrough technology in 2019"by the Bill Gates foundation. We are now at the threshold of a new era in which HTS will play an increasingly indispensable role in a number of applications that include biochemistry, high energy physics, medical diagnostics, fusion, electric propulsion and more. Not to mention, the "particle accelerator"is one of the key applications, where the compact and high field HTS magnet technology is expected to play a key role. This paper resents an overview of the recent progress in the NI HTS magnet technology with focus on the next-generation particle accelerators.

Funding Agency

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Session Classification: MC07.2 - Accelerator Technology and Sustainability (Invited)