Challenges and Opportunities to Assure Future Manufacturing of Magnet Conductors

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Abstract—What will be the next large science facility to require thousands of tons of superconducting wire? When will it begin construction? Since requirements of existing science facilities already exceed the performance limits of the Nb-Ti conductor technology shared by the multi-billion-dollar medical imaging market, and since there is no other billion-dollar market requiring performance beyond that of Nb-Ti at present, how can conductor manufacturing supply what is needed for the next billion-dollar facility, let alone other construction episodes beyond it?

The applied superconductivity community has contemplated the questions above for some time, reflecting on the episodic nature of large projects and the wide gap between project requirements and products in the marketplace. In this plenary presentation, I will draw upon experiences with public-private partnerships established by the US Dept. of Energy (DOE) in the late 1990s to sustain "warm" manufacturing over decades and support innovation. These partnerships were crucial to developing unprecedented performance in Nb_3Sn conductor for accelerator magnets leading up to the High-Luminosity upgrade of the Large Hadron Collider, presently under construction. The initial research period (2000–2013) led to innovative conductor designs scaled to pre-production (2014–2017) and full production (2017–2022, with a small supplement scheduled for 2023). Production data will be presented, and comparisons will be made to the excellent summary of the ITER Nb_3Sn strand production by Vostner *et al.* published in 2017 [1]. Both production runs illuminate critical areas of manufacturing readiness that were supported by public-private partnerships. The presentation will then report findings of a series of supply-chain workshops that were held in 2021–2022, under support from the DOE Office of Accelerator R&D and Production, to look explicitly at superconductor manufacturing for future science facilities. Partnership models that might support not only Nb_3Sn but also Bi-2212 and REBCO magnet conductors will be described, including aspects such as stockpiling conductor in a repository, promoting overlap between magnet research for science facilities and emerging markets, and exploring various approaches to manage intellectual property and collective development via consortia or innovation institutes. As the

community looks forward to future science facilities, synergy between science projects and the industrial product ecosystem will be essential for success.

[1] Vostner, A., M. Jewell, I. Pong, N. Sullivan, A. Devred, D. Bessette, G. Bevillard, N. Mitchell, G. Romano, and Chao Zhou. "Statistical analysis of the Nb_3Sn strand production for the ITER toroidal field coils." ***Superconductor Science and Technology*** **30, no. 4 (2017): 045004.**

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