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Cost drivers for very high energy p-p collider magnet conductors

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VHEPP collider magnets are envisioned to be constructed from a baseline Nb3Sn conductor and a possible extension using high-temperature superconductors (HTS) Bi-2212, Bi-2223, or REBCO. In this presentation, we build upon past analyses of cost in view of recent procurement experience and university research. Real production conditions compel the procurement of about 70% more Nb3Sn conductor than given by the mass of conductor in magnets, with the chief drivers being:
(1) thermal margins of magnets;
(2) long cable unit lengths and associated mapping losses;
(3) production statistics and associated process control limits.
We argue that research into cost saving should therefore address thermal margin and protection, take into consideration cables with short or mixed unit lengths as well as novel winding ideas, and assess how the lower process control limits can be improved. While conductor R&D should result in gains in critical current at fixed field, the value of such gains are diminished when considered along the magnet load line, and any concomitant changes to temperature margin, piece length statistics, and performance statistics must also be weighed. This is especially important for emerging ideas that might replace the present RRP® and PIT mainstays. An additional impediment to Nb3Sn conductor cost reduction stems from the lack of a large commercial end-use market, which implies that scale-up must be pulled directly by science projects. Cost trade-offs also lie at basic levels to Nb3Sn conductor design, where metallurgical limits of materials impede reduction of sub-element diameter, and might require costly special conditioning to overcome. The impact of transformative improvements in HTS magnet conductors over the next decade could be more far-reaching for a VHEPP collider.

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