

**Fermi National Accelerator Laboratory
LDRD Project Data Sheet - FY17**

Project ID: FNAL-LDRD-2017-020

Project title: Development of next-generation Nb₃Sn superconductors for accelerator magnets

Principal investigator: Xingchen Xu

Project description: (short description and explanation of cutting edge, high-risk, high-potential science or engineering)

This project seeks to develop a new generation of Nb₃Sn conductors with significantly enhanced performance for superconducting magnets. Such conductors cannot only increase the achievable field of accelerator magnets (to 16 T and above) and hence boost particle collision energy in search for new physics, but also greatly reduce their costs.

Tie to Mission: (explain the project's relevance or anticipated benefits to Fermilab's and DOE's missions)

Nb₃Sn strands are the workhorse to fabricate magnets above 10 T; their critical current density (J_c) determines the achievable field, which further determines the particle beam energy and luminosity. The PI (Xu) recently invented a novel technique that doubled the high-field J_c in proof-of-principle strands by forming ZrO₂ artificial pinning centers in Nb₃Sn via internal oxidation of Nb-1%Zr. Tripling of J_c is projected by further optimization of strands. This project aims to further optimize this new technique and to transform it into practical magnet-grade conductors. The planned energy upgrade of Large Hadron Collider or building of Future Circular Collider, both needing thousands of tons of Nb₃Sn strands, will significantly benefit from this technology as their costs will be reduced by billions of dollars if Nb₃Sn J_c is doubled.

Previous year's accomplishments: (as applicable)

N/A

Work proposed for current fiscal year and anticipated / desired results:

The objective of Stage 1 is to optimize the structure, precursor ratios, and heat treatments of dopant-free strands in order to obtain small subelements and maximized whole-wire J_c . The deliverables are optimized structures, parameters, and heat treatments for dopant-free Nb₃Sn strands that can be adopted in the next phase which will have titanium doping.

Project funding profile: (costs, budgets, projected budgets, and total)

Prior year(s) costs	FY17	FY18	FY19	FY20	Total
N/A	121,290	396,881	503,386	200,000	1,221,557

Project Start Data: 3/01/2017

Total Approved Project funds: \$ 1,221,557