# AI-enabled data processing and surrogate model building for real-time monitoring and control in HTS Magnets

List of Collaborators

- Lead: MIT
- MIT PSFC
- FNAL
- LBL/NHMFL?

Focus area 13A: Enhancing Particle Accelerators for Discovery:
AI Driven Accelerator Facilities

# Project Overview

- Goal: **AI-enabled real-time quench detection for HTS magnets using digital twins**
- Challenge: Quench detection in HTS magnets is difficult and critical
  - small quench propagation velocity in HTS magnets
  - Quenches difficult to detect
  - Magnet may get damaged/burn out
- Approach:
  - develop AI-enabled surrogate model of quench propagation
  - Digital twin framework
- Impact:
  - Real-time monitoring & control
  - Safer, higher-performance magnets

Why this project is unique:

- Access to 20T all-HTS magnet (MIT PSFC)
- Real experimental quench data (rare)
- Industry links (CFS, TE)

# 9-months work plan

Month 0-3
- Digital twin design using experimental quench data
- Design of small-scale REBCO model coil

Month 3-6
- Train surrogate model of quench dynamics behavior
- Validate model

Month 6-9
- Preliminary integration of surrogate model in integrated real time control environment
- Design of small-scale REBCO model coil
- Experimental plan for the next Phase

# 9-months deliverables & Metrics

- Month 3:
  - First prototype of digital twin
  - Conceptual design of small prototype ReBCO coil
- Month 6:
  - Trained surrogate model of quench behaviour
- Month 9:
  - Preliminary integration of surrogate model in integrated real time control environment
  - Finalized design of small-scale REBCO model coil

# Workforce Development Plan

- FNAL: AI expertise
  - Scientist 0.5 FTE
- MIT: Magnet technology expertise, modeling
  - Engineer 0.35 FTE
  - Scientist 0.5 FTE

# Phase II

- **Demonstrate a validated, real-time, AI-enabled quench detection and control system on an instrumented HTS coil**

- Advanced instrumented test coil + experiments
- High-quality dataset (EM, thermal and mechanical signals)
- Validated surrogate + digital twin
- Real-time deployment
- Closed-loop control demonstration