

# Invest in HTS magnet technology to enable sustainable energy-frontier colliders

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U.S. Magnet Development [Program](#)

P5 Townhall, SLAC, 4 May 2023

# Future energy-frontier colliders must be sustainable

nature > news > article

NEWS | 12 October 2022

## Energy crisis squeezes science at CERN and other major facilities

LHC to end 2022 data-taking season two weeks early to save on electricity, among other measures.

Brian Owens



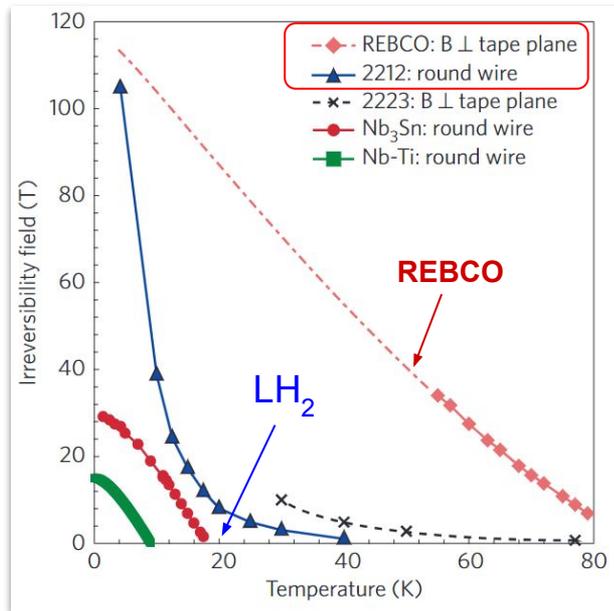
A pressure gauge at the Large Hadron Collider's cryogenics, which take up more than half of the accelerator's electricity consumption. Credit: Adam Hart-Davis/SPL

B. Owens, 2022, [Nature](#)

- What is the ultimate sustainability for our field?
- “Maximize science”
  - Higher energy → stronger dipole field
- Affordable → Lowest \$ / tesla
- Minimize environmental impact: power consumption
- Aspiration for young talents
  - A muon collider on the US soil

# From first principles, HTS magnets hold the promise for future sustainable colliders: higher performance and lower cost

High irreversibility field over a broad temperature range



Larbalestier et al. 2014. [Nature Materials](#)

- 20 T dipole/quad magnet operating at 20 K
  - Enable a MuC and beyond → maximize science
  - Improve x10 in cooling efficiency from 1.9 K → lower \$ / tesla
- HTS, especially REBCO, enables compact [fusion](#) reactor magnets
  - A *potential* conductor market → lower \$ / tesla
  - A dozen and counting tape vendors are competing

# Despite the potential, the HTS magnet technology is still at its infancy and faces significant challenges

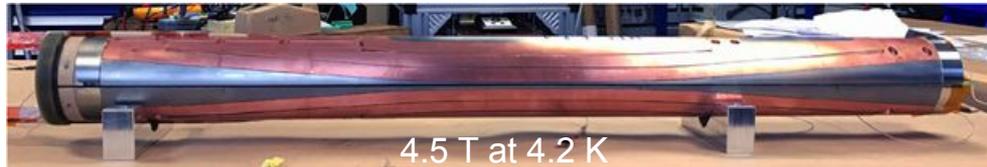
## Technical challenges

- Conductor and magnet architectures
- Strain sensitivity and conductor degradation
- Magnet performance and protection
- Optimal operation temperature

## Very limited resources

- Insufficient conductor to make mistakes
  - One magnet every few years
- Insufficient minds and hands

We have yet to make a 5 Tesla HTS dipole



Rossi and Senatore [2021](#)

# Invest now to make HTS technology *available within a decade* for a sustainable muon collider and our collective future



Burton Richter, [2014](#)

“I do not understand why there is as yet no program underway to try *to develop lower cost, high  $T_c$  superconducting magnets* done *on the scale of R. R. Wilson’s efforts at Fermilab* to successfully develop the first generation of *commercially viable superconducting magnets* that led to the Tevatron, HERA, and LHC.”

Magnet development requires time and resources and we need to start today so we are ready to move forward with the next collider.