Reliable & Uniform High-Pressure Furnaces for Superconducting Magnets

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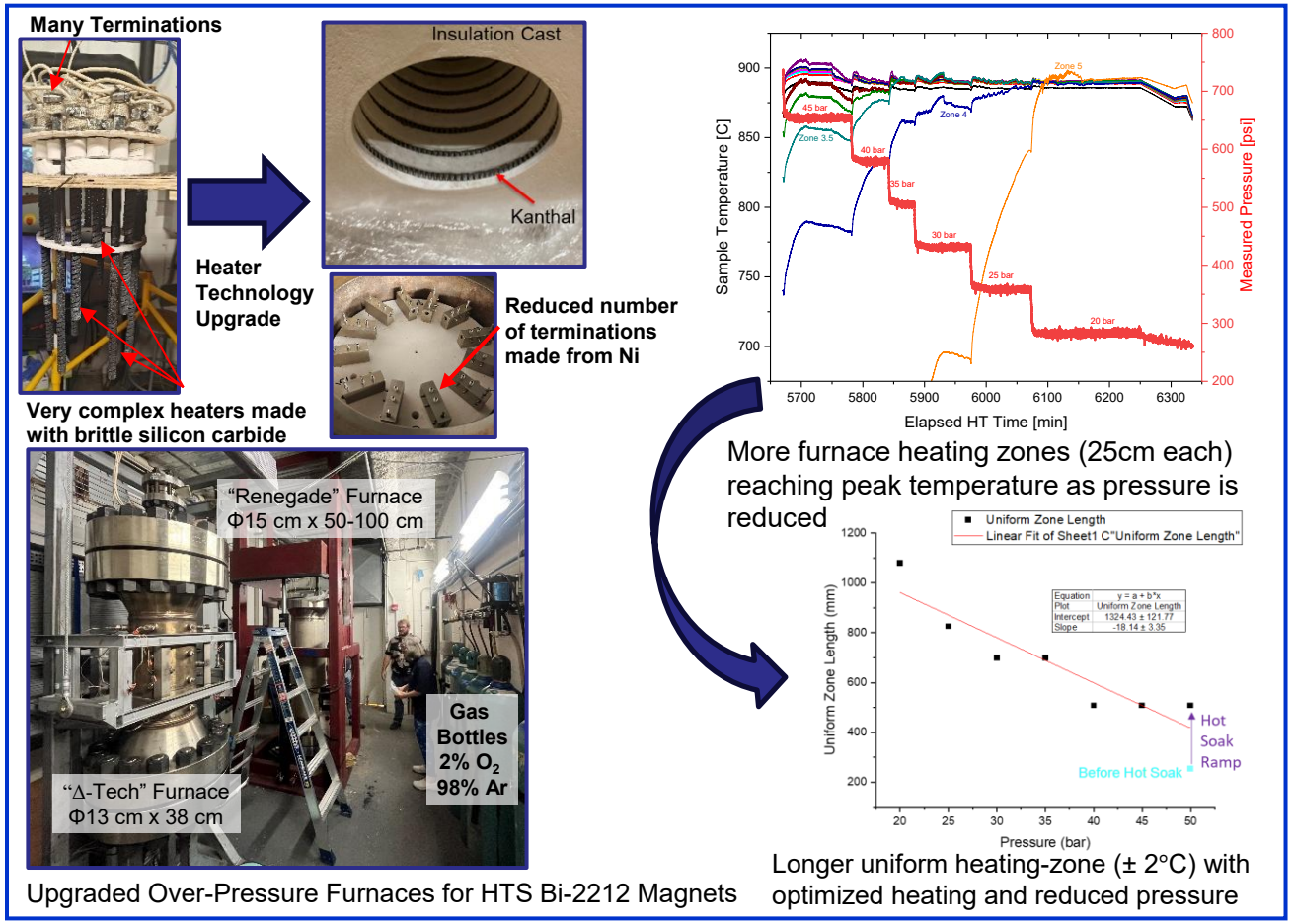
Most high field (> 8T) superconducting magnets are made with a wind-and-react conductor, including low-temperature-superconductor Nb_3Sn and high-temperature-superconductor (HTS) Bi-2212, that must undergo a heat treatment in final form due to strain limitations. Additionally Bi-2212, produced by powder-in-tube technology is reacted under high pressure to achieve dense filaments carrying high currents [1]. HTS Bi-2212 magnet technology is being developed for compact research magnets, accelerator magnets [2], nuclear magnetic resonance (NIH-R01-Trociewitz), and possibly fusion ohmic heating applications.

Scaling up high-pressure furnaces to meet the needs of these applications is critical but challenging due to the tight temperature tolerance (±2°C up to 900°C) and the need to maintain flowing oxygen to maintain 100kPa pO_2 within 5-10MPa Argon. We have recently completed the commissioning of two magnet scale furnaces designing and implementing a more robust heater technology to reduce maintenance down-time. These furnaces enable progress on multiple domestic and international collaborations developing Bi-2212 magnet technology. **This is the only facility in the world capable of Over-Pressure Heat-Treatment of Bi-2212 magnets.**

A significant advance is the demonstration of a 0.5m long uniform hot-zone in our larger furnace by optimizing the heating schedule. Additionally, a path to increasing this up to 1m at lower pressures that still achieve the benefits of over-pressure has been achieved. This is critical for our high energy physics partners, where sub-scale magnets begin at 1m lengths. This is motivating our continued efforts to partner with industry to produce a commercial large-volume furnace.



Upgraded Over-Pressure Furnaces for HTS Bi-2212 Magnets

Facilities and instrumentation used: Applied Superconductivity Center over-pressure-heat-treatment furnaces.

Citation: [1] Larbalestier, D., Jiang, J., Trociewitz, U. *et al.* Isotropic round-wire multifilament cuprate superconductor for generation of magnetic fields above 30 T. *Nature Mater* **13**, 375–381 (2014). https://doi.org/10.1038/nmat3887. **[2]** Shen, T.; Garcia Fajardo, L. Superconducting Accelerator Magnets Based on High-Temperature Superconducting Bi-2212 Round Wires. *Instruments*, *4*, 17 (2020). https://doi.org/10.3390/instruments4020017.