

Bi-2212 High Field Magnet Development

with a focus on the Over-Pressure Heat Treatment

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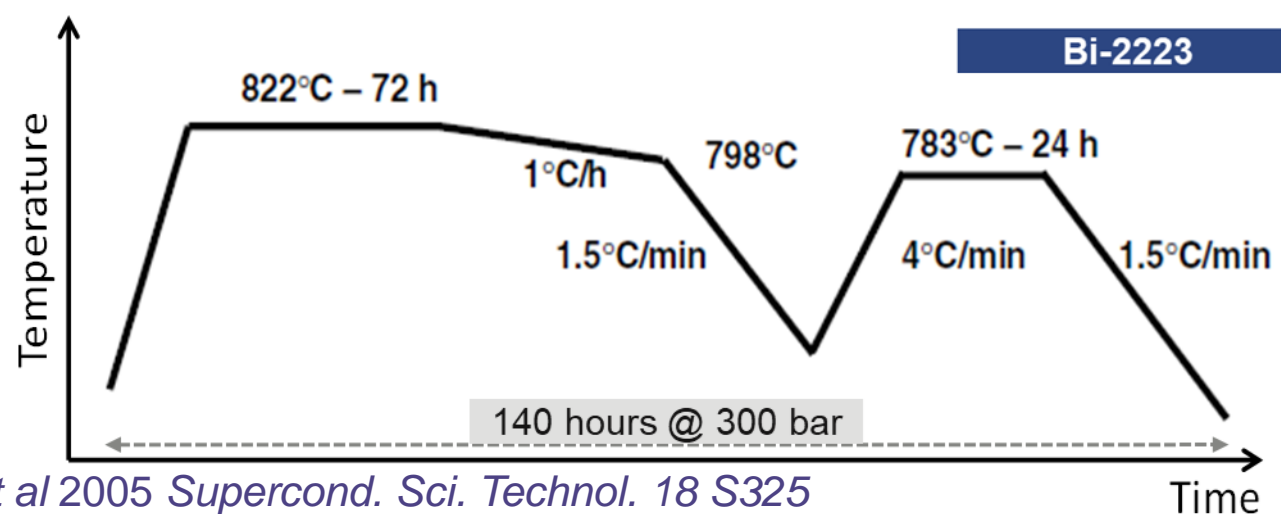
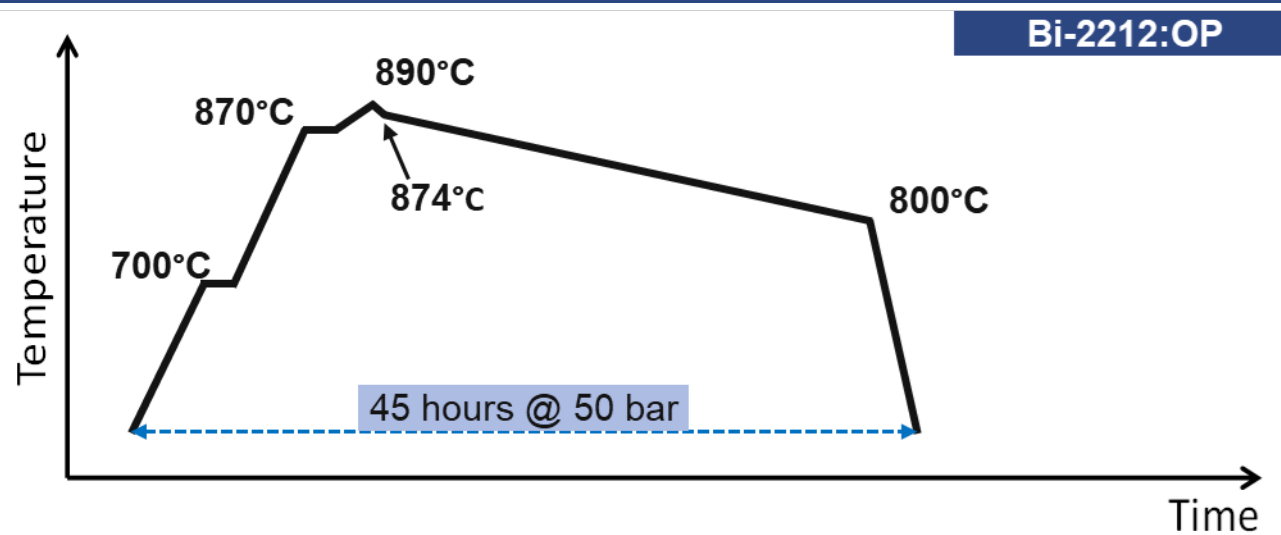
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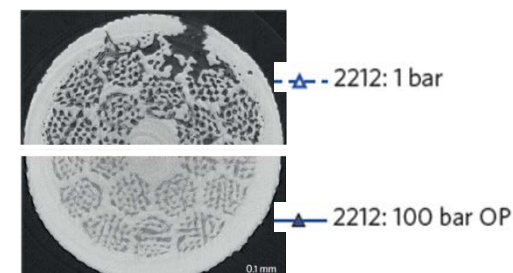
**U.S. MAGNET
DEVELOPMENT
PROGRAM**



Over-Pressure Heat Treatment Schedule in the Deltech



BSCCO needs a heat treatment to turn the powder-in-tube manufactured conductor into a superconducting wire

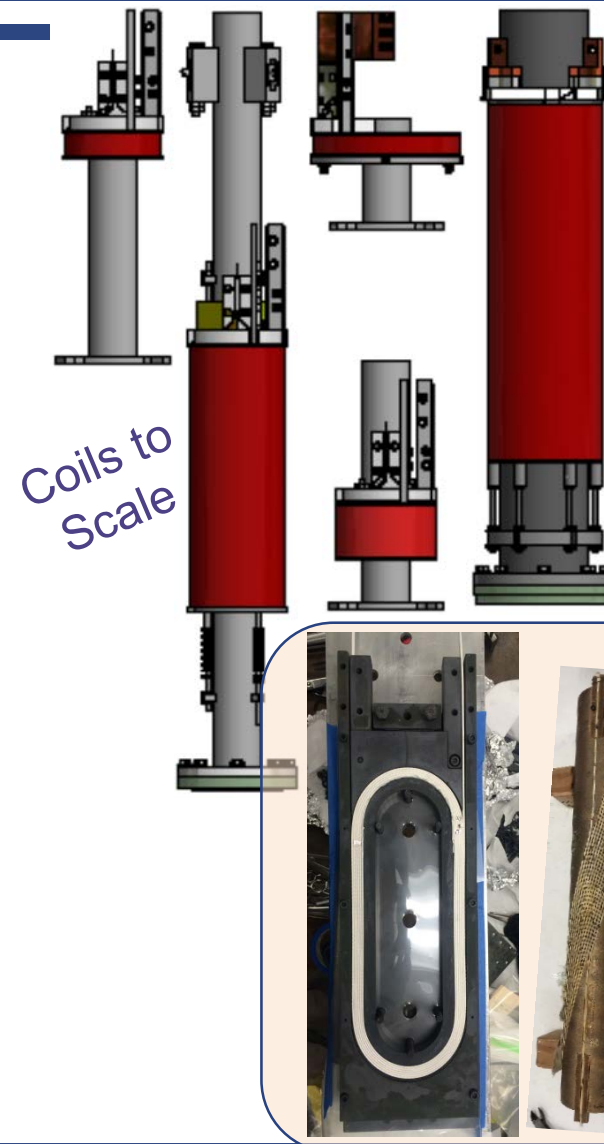
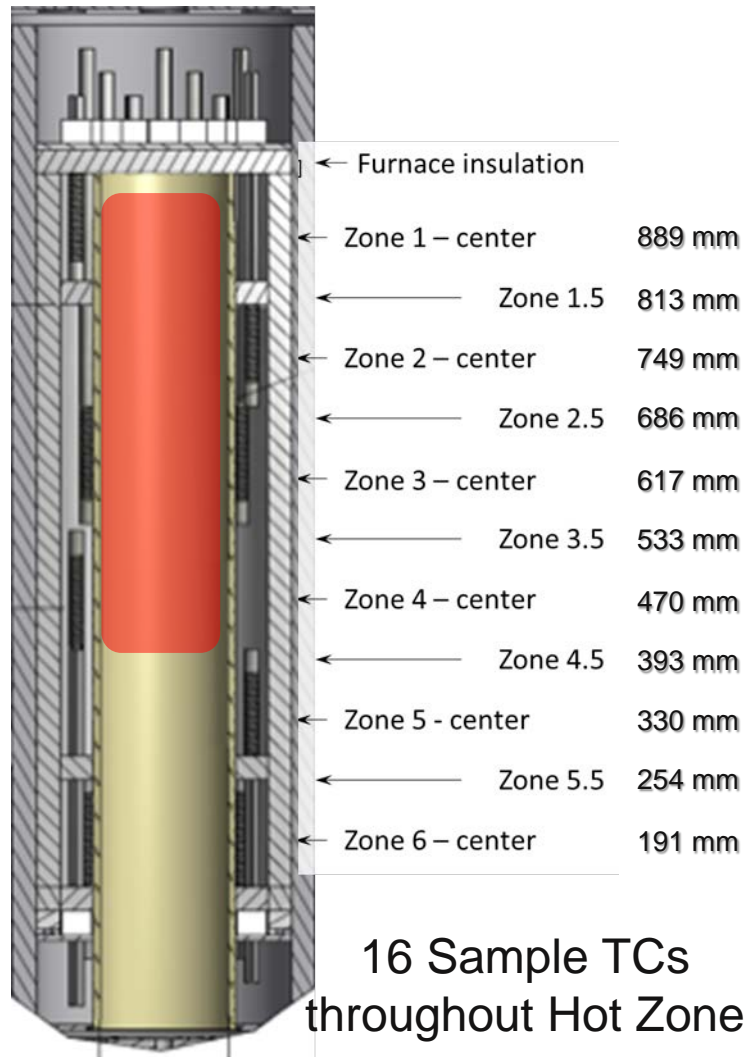
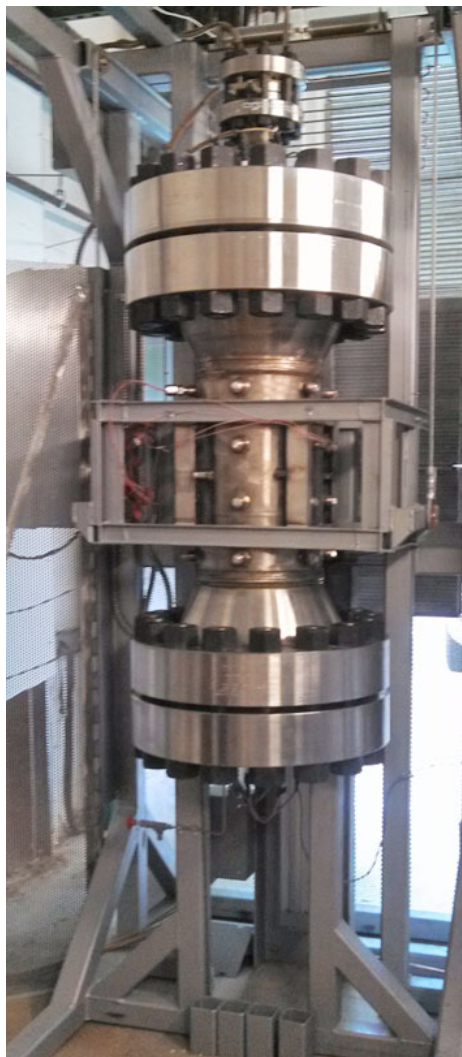


D.Larbalestier *et al.*, Nature Materials 2014

What I hear:
“The OP Heat Treatment is too complicated!”

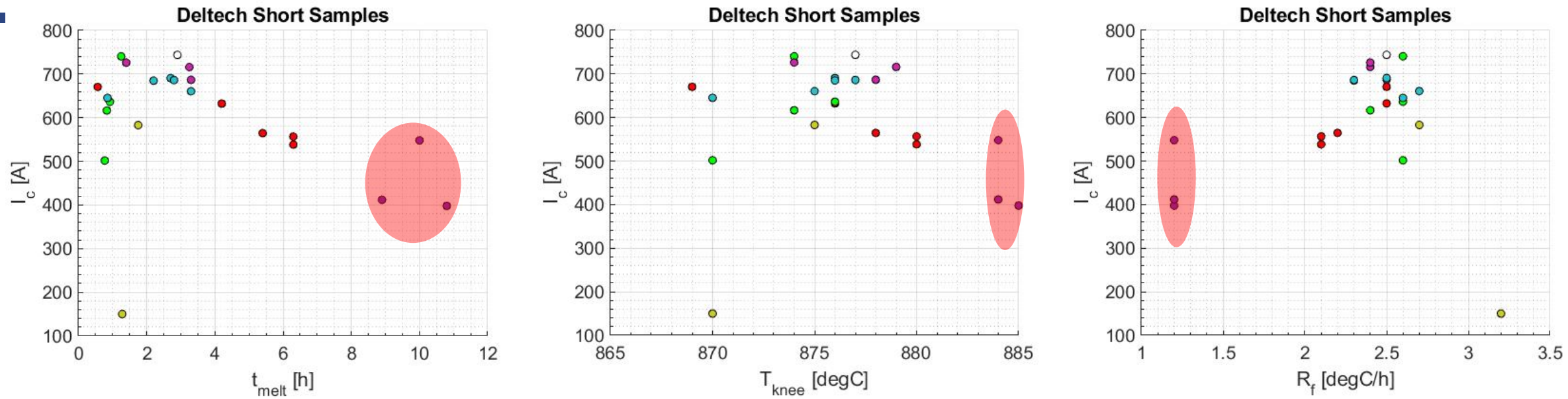
My response:
Comparatively not so, but in any case, we have plenty of experience!

Operating Over Pressure Furnace (Deltech)



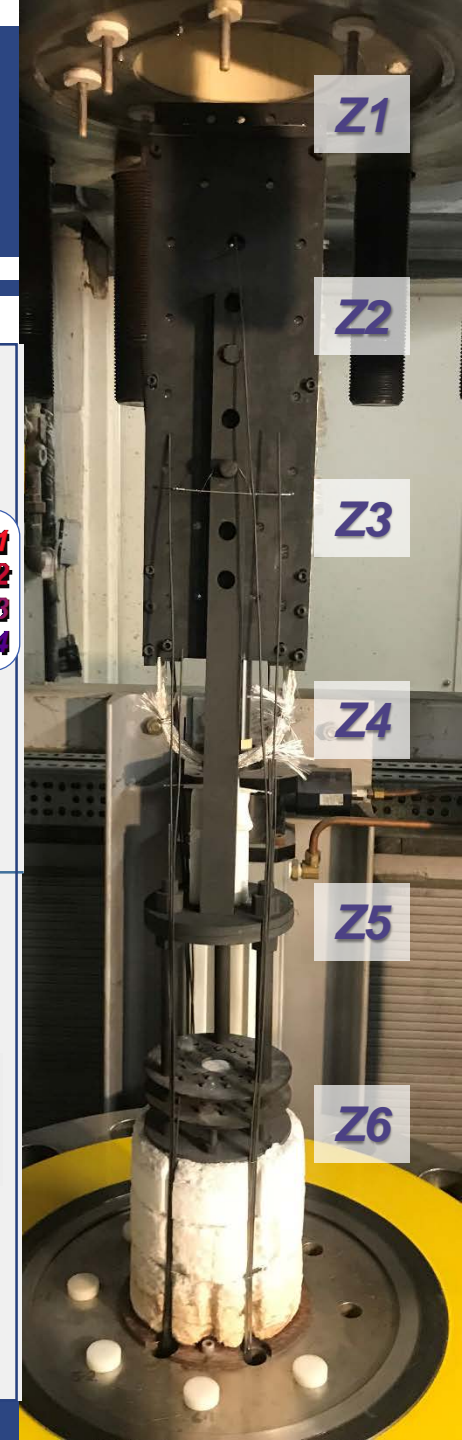
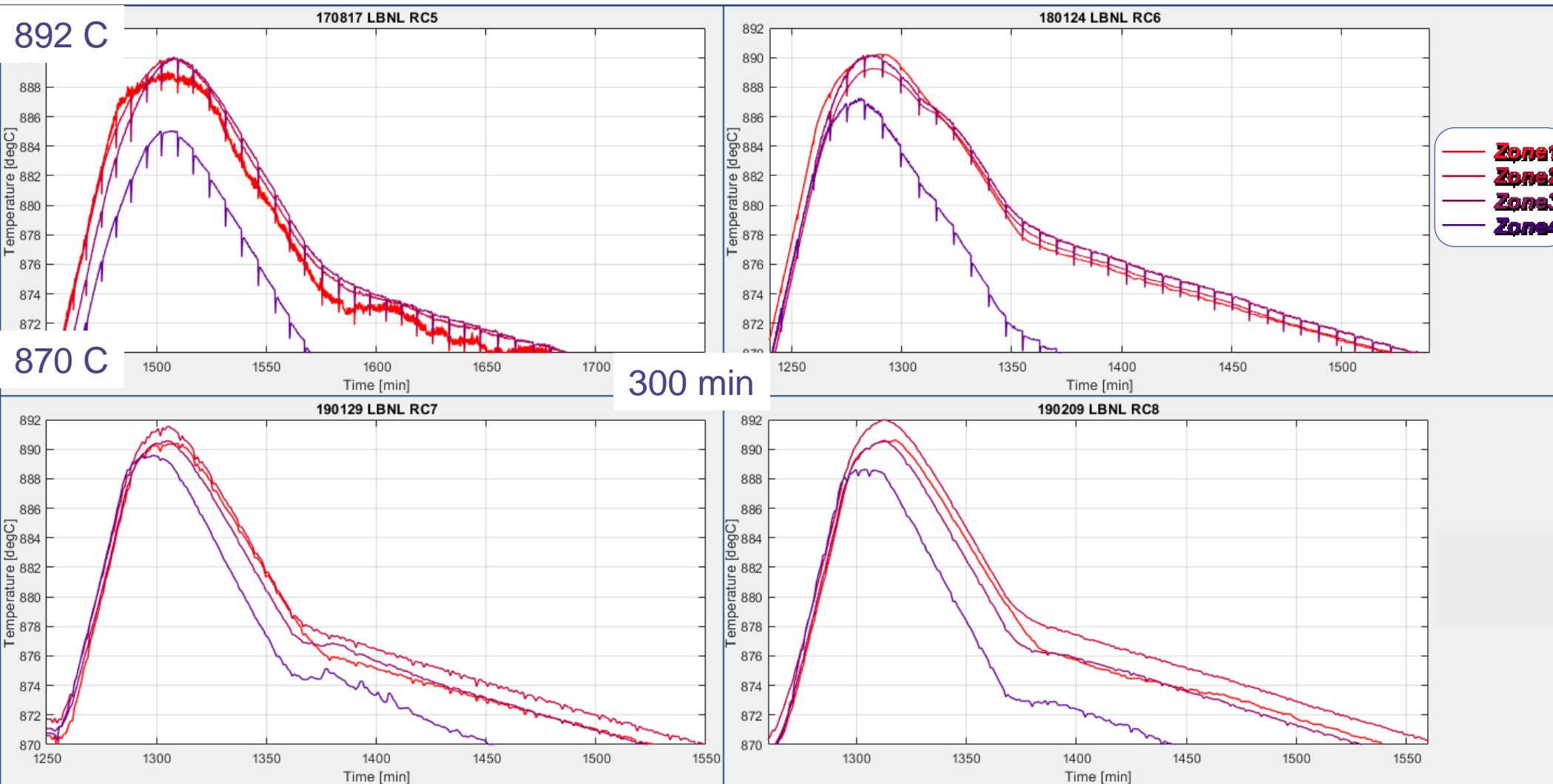
02/18/15	Pup1
02/23/15	Pup2
06/01/15	Pup3
06/23/15	Compression Coil
08/31/15	Platypus
04/01/16	Riky1
04/28/16	Riky2
06/09/16	LBNL RaceTrack1
07/26/16	LBNL RaceTrack2
10/25/16	RIKEN
01/07/17	CERN/Twente Rutherford Cable
01/12/17	OI Coil
02/27/17	Pup4
03/28/17	LBNL RaceTrack3
04/18/17	Riky3
04/26/17	Riky4
07/06/17	Platypus-II Dummy
08/14/17	LBNL RaceTrack4
08/17/17	LBNL RaceTrack5
12/05/17	Riky5 & Pup5
01/24/18	LBNL RaceTrack6
06/04/18	Riky6 & RikySRW2
09/10/18	Riky7 & Riky8
01/15/19	Pup6 & Cryomagnetics1
01/22/19	Cryomagnetics2
01/29/19	LBNL RaceTrack7
02/07/19	LBNL RaceTrack8
05/14/19	Pup7
05/22/19	LBNL CCT BIN5a-OL
05/26/19	LBNL CCT BIN5b-OL
09/12/19	Dingo

Investigating Key Parameters Affecting I_c



- Various Over-Pressure Heat Treatment witness sample - I_c 's plotted against schedule parameters (like colors indicate witness samples heat treated in the same run)
 - $t_{melt} = 883^\circ\text{C}$ until 874°C
 - T_{knee} = Temp at which rate slows through the melt
 - R_f = rate through freezing point of Bi-2212
- The process variable with the clearest relationship to I_c was t_{melt}
This variable is closely linked with R_f and T_{knee}

Recent LBNL Racetrack OPHT's



New Capabilities with New Furnace



	Deltech	Renegade
Commissioned	c. 2014	c. 2020
HT Pressure	100 bar (typically run at 50 bar)	50 bar
T_max	890 C	890 C
Partial O2 pressure	2%-O ₂ in Ar (target 1 atm O ₂)	2%-O ₂ in Ar
Hot Zone Diameter	130 mm	250 mm
Hot Zone Height	450 mm	1000 mm
# of Zones	6	6
# of Heaters per Zone	6 individual, spiral SiC elements	1 single element, embedded in ceramic
Power to Zones	1.2 kW per Zone w/ bottom Zone = 2 kW	3 kW per Zone w/ bottom 2 Zones = 3.8 kW



Summary

The Over Pressure Heat Treatment is not overly complicated

We have a great track record of producing successful Test Coils

Larger furnace for larger magnets online next year

Let's collaborate to get more Bi-2212 development!

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