US MDP and ARADP Bi-2212 activities updates

Tengming Shen (LBNL)
For the US MDP 2212 WG and ARDAP Bi-2212 project team
2024/07/17

Key summary and introduction for recent MDP Bi-2212 activities

- US MDP Bi-2212 WG has had six monthly meetings this year.
  - A decision is to convert the 2 km PMM191014 (0.8 mm) to 17-strand and 9-strand Rutherford cables.
- RENEGADE OP furnace reconfiguration (thicker insulation) is progressing. Recommissioning soon to start.
  - Three Bi-CCT1 coils are awaiting for heat treatments.
  - Bi-CCT1 cables are 17-strand (7.8 mm x 1.4 mm nominal, 0.8 mm strand)
- Bi-CCT2 cables have been made (23-strand, 12.3 mm x 1.83 mm, 1.0 mm strand).
- A study is commissioned to examine mechanisms of leakage in OPHT Bi-2212 Rutherford cable coils and methods of reducing it.

Two 10 kg billets have been used for cable fabrication and removed from the CPRD inventory

- ~~PMM191004~~
  - 0.8 mm, 55 x 18, at LBNL

Request to fabricate 17-strand Rutherford cables
For LBNL and Fermilab (15 m piece length).

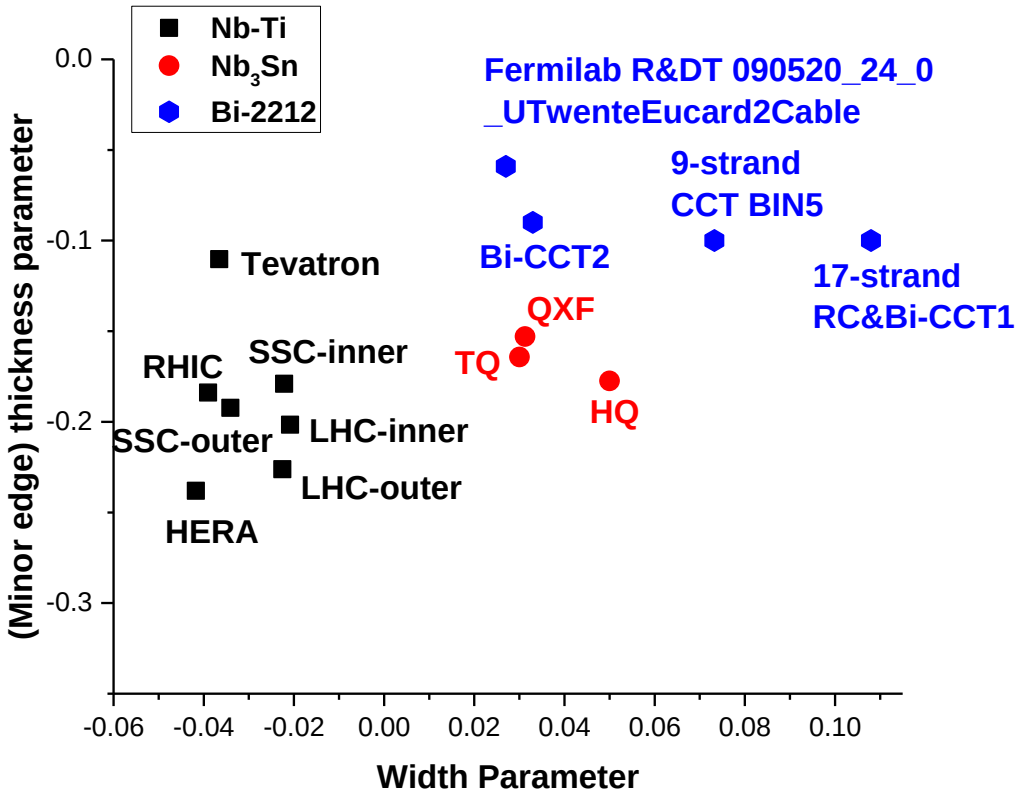
Request to fabricate 9-strand Rutherford cables
NHMFL cable solenoids (65 meters cables to achieve 20 T).

Length divisions – 1100 m and 1100 m.
Two cables have been made (LBNL 2005 (9-strand, ~100 m) and LBNL2006 (17-strand, ~50 m).
Both with planetary twisting so the strands were NOT twisted during cabling.

- ~~PMM211105, 1.0 mm, 55 x 18~~ has been used to fabricate the first cable for Bi-CCT2.

Cable fabricated.

Bi-CCT2 cables have given and will give us new experience and reference

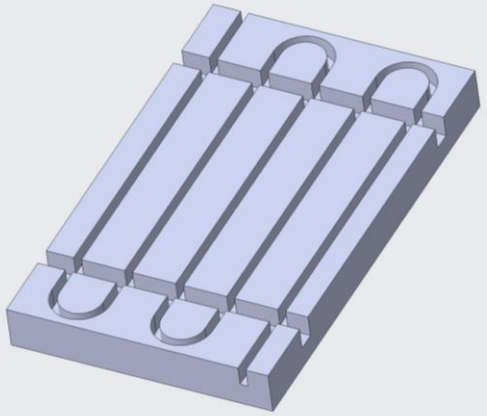


- 2009-1-4 (~4m): Initial startup cable. Available for coil winding testing and optimizing mandrel and CCT groove parameters.
- 2009-A (51.7m): t:1.83mm/w:12.33mm for coil fabrication.

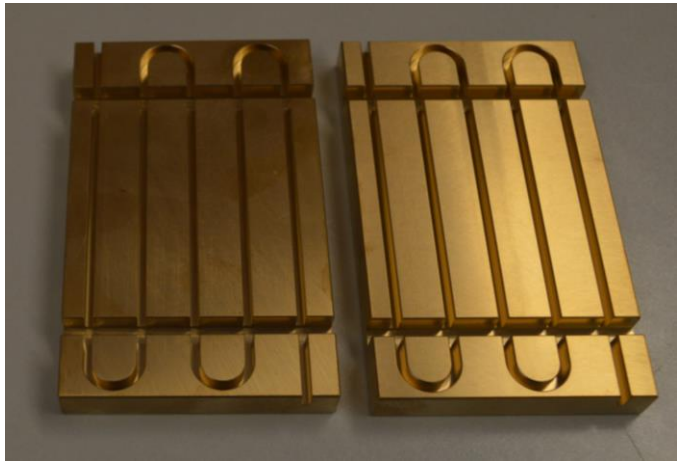
Project/Cable	Materials	Number of strands	Strand diameter (mm)	Cable dimensions (mm) (minor/major edge X width)	Overall packing factor (%)	Planetary twisting
HTS-SC/RC	2212	17	0.8	1.44 × 7.8	79	0
HTS-CCT_BIN5		9	0.8	1.44 × 4.0	81	0
R&DT 090520_24_0_UTwenteEucard2Cable		24	0.8	1.507 × 10.22	81.5	unknown
Bi-CCT2 cable 9A		23	1	1.8 x 12.3	83.72	-1

Ian Pong, Andy Lin, Elaine Burron, LBNL, Bi-CCT2 cable production

A new leakage study of Bi-2212 Rutherford cables has been commissioned



Marek Mosat



- Samples are Rutherford cables of ~0.6 m long.
- Questions: (1) Does wire twisting during cabling lead to leakage (planetary action = -1 versus 0 for cable 2005)? (2) What insulations works best? (3) What reaction barrier will block the reaction between Bi-2212 liquids and insulation?
- Start with 1 bar HT.

Insulation scenarios for Bi-2212 Rutherford cable CCT coils

Scenerios	Coating on Bi-2212 cables	Painting on insulation sleeves	Insulation sleeves
1	TiO_2	No	No sleeves
2	No	No	Mullite (2Al2O3 - SiO_2)
3	No	No	Pure alumina
4	TiO_2	TiO_2	Mullite (2Al2O3 - SiO2)
5	Al_2O_3	Al_2O_3	Mullite (2Al2O3 - SiO2)
6	TiO_2	TiO_2	Pure alumina
7	Al_2O_3	Al_2O_3	Pure alumina
8	Other	Other	Pure alumina/Mullite

ARDAP Bi-2212 project key summary

Private and public partnership supported by the DOE ARDAP office (now the accelerator and technology division, DOE-HEP).

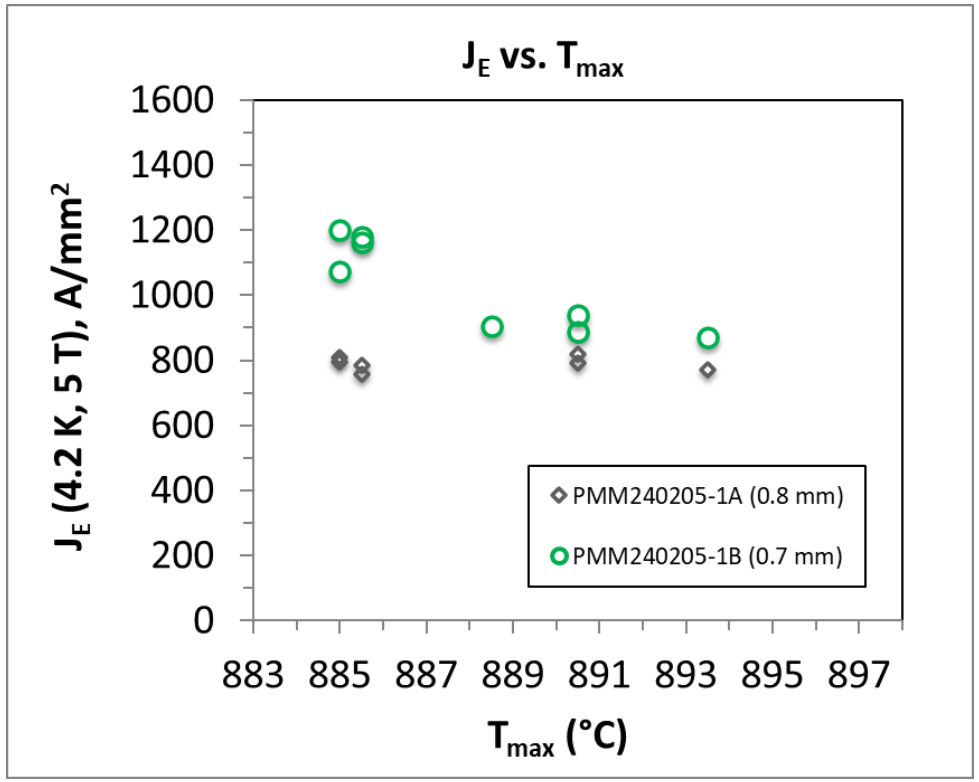
- Five 2 kg billets production targeting reproducibility.
  - First two 2 kg billets produced and received at LBNL, and turned into cables.
- Two 10 billets to scale up production. One 10 kg billets might be converted to four 2 kg billets to build reproducibility.
- Establish knowledge base and fundamental understanding.
- New cable and insulation technology and high field cable characterization and insert coil prototyping.

Powder and wire fabrication summary

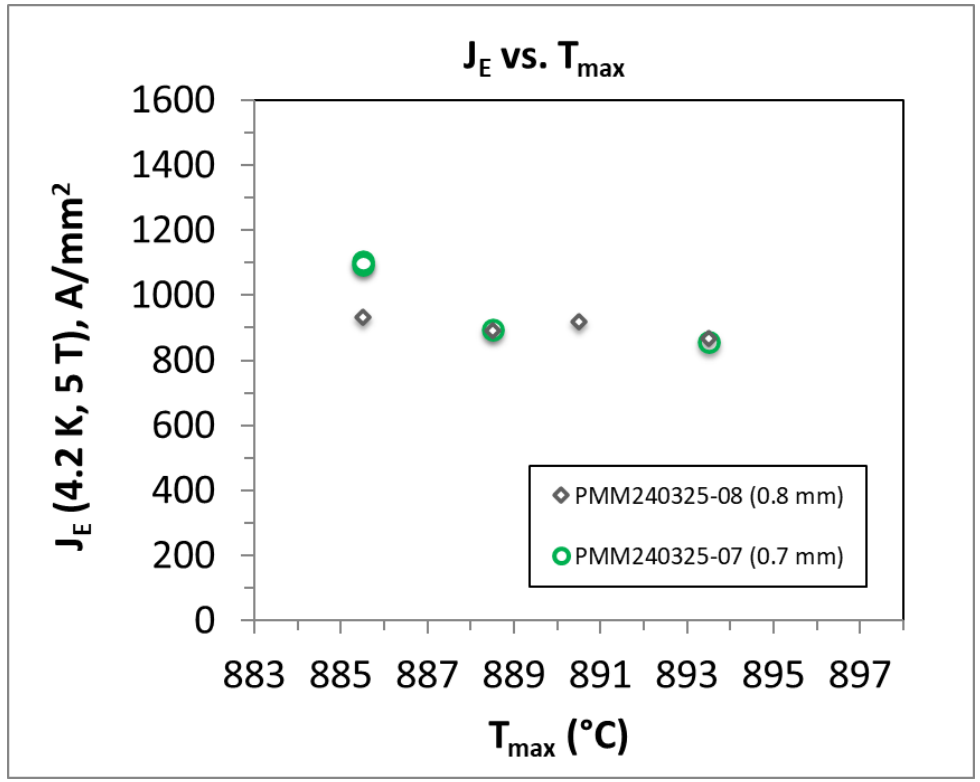
- **Eight batches of powder suitable for 2 kg conductor billets produced. All but one have been accepted.**
  - **Overall the reproducibility and powder quality is trending towards the right direction.**
  - **Three batches have been turned into three conductor billets.**
- **Wire production has not met any issues except that the billet #1 was delivered in two pieces.**

Two billets have been produced and the third billet in the final phase of wire drawing

ARDAP billet #1



ARDAP billet #2



- Both have 37 x 18 design.
- Possibility of end effects being assessed.

Daniel Bugaris, Claudia Goggin, Engi-Mat, power fab and characterization
Yibing Huang, Michael Brown, Bruker OST, wire fab
Jianyi Jiang, NHMFL, powder &wire characterization

The first two ARDAP billets have been turned into ~150 m cables of various thickness and ready for characterization and solenoid coil testing

Cable	Materials	Number of strands	Strand diameter (mm)	Cable dimensions (mm) (minor/major edge x width)	Planetary twist	Pitch angle (degrees)	Overall packing factor (%)	Length (m)
ARDAP cable 2007A	2212, Billet #1	6	0.7	2.35 x 1.22	-1	12	82.3	47
ARDAP cable 2007B	2212 Billet #1	6	0.7	2.35 x 1.16	-1	12	86.6	7.5
ARDAP cable 2007C	2212 Billet #1	6	0.7	2.35 x 1.12	-1	12	89.7	11

Ian Pong, Andy Lin, Elaine Burron, LBNL, Bi-CCT2 cable production

150 m 6-strand cable (strand d = 0.7 mm) fabricated@LBNL

High-field barrel test

Insert solenoid for 31T @ NHMF

Cable → High field coil

Daniel Davis, Ulf Trociewitz, Youngjae Kim, NHMFL

Thank you