

Manufacture and Test of a 3 T Class Insert Coil with YBCO-Coated Conductors

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Abstract

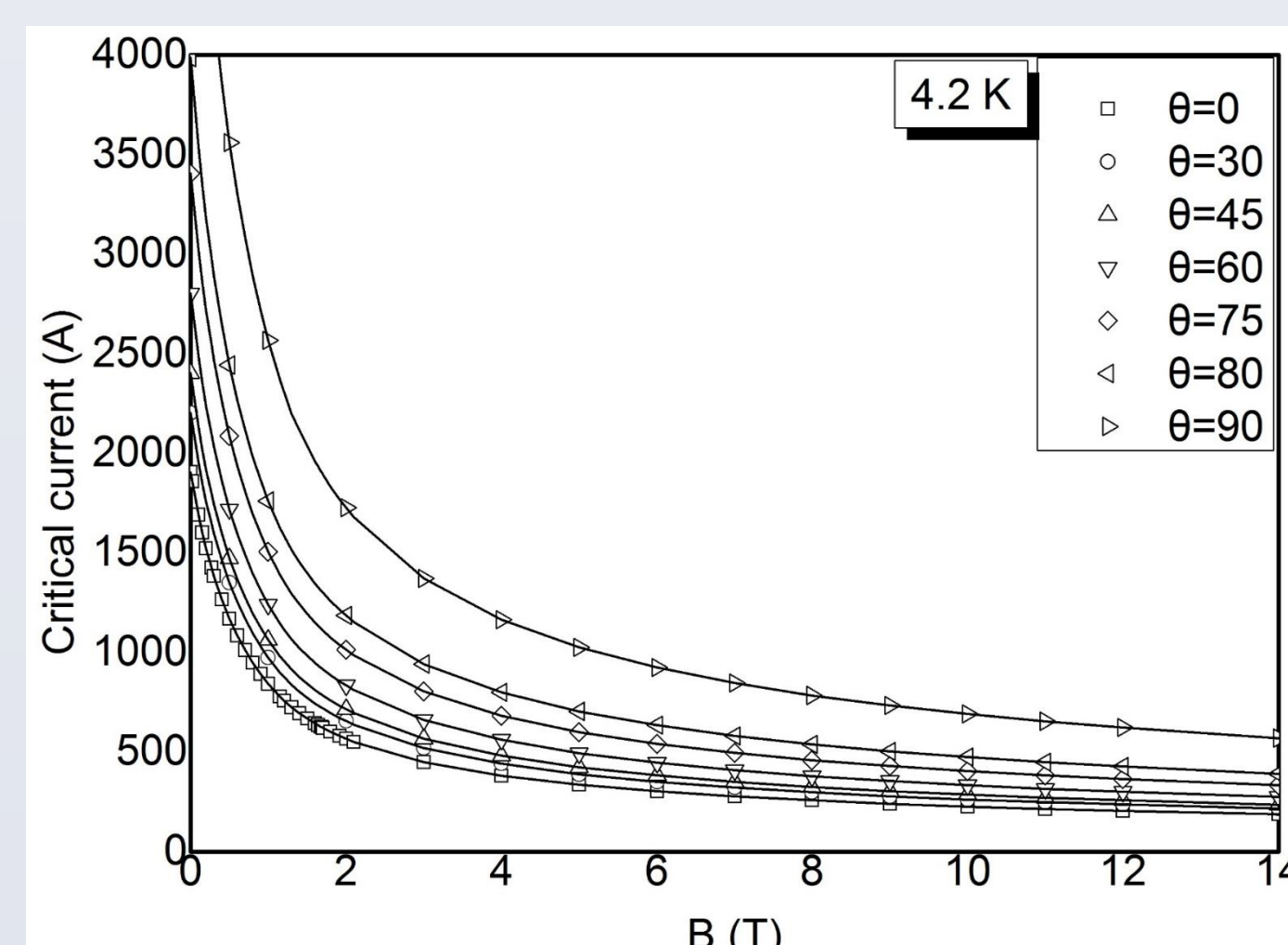
With the goal of generating a 17 T central field in our test facility for superconducting wires performance with a LTS-HTS hybrid magnet, a prototype 3 T high temperature superconducting (HTS) insert coil has been manufactured and tested at the Institute of Plasma Physics Chinese Academy of Sciences (ASIPP). The HTS insert coil consists of four identical double pancakes with 30 mm inner diameter made of YBCO tapes provided by Shanghai Superconducting Technologies Co. (SSTC) in China. In a background field of 14 T generated at ASIPP, the YBCO HTS coil successfully generated 3.45 T central field at 492 A critical current as an insert magnet. The total magnetic field of the test facility reached 17.45 T central field at 4.2 K. The detailed design, manufacture and test results of the insert YBCO coil at self-field and in-field are presented.

SSTC YBCO Tape

Presently a stable production capacity of the YBCO conductor has been possessed by Shanghai Superconducting Technologies Co. (SSTC) in China. In order to better investigate the potential application in high field magnet.

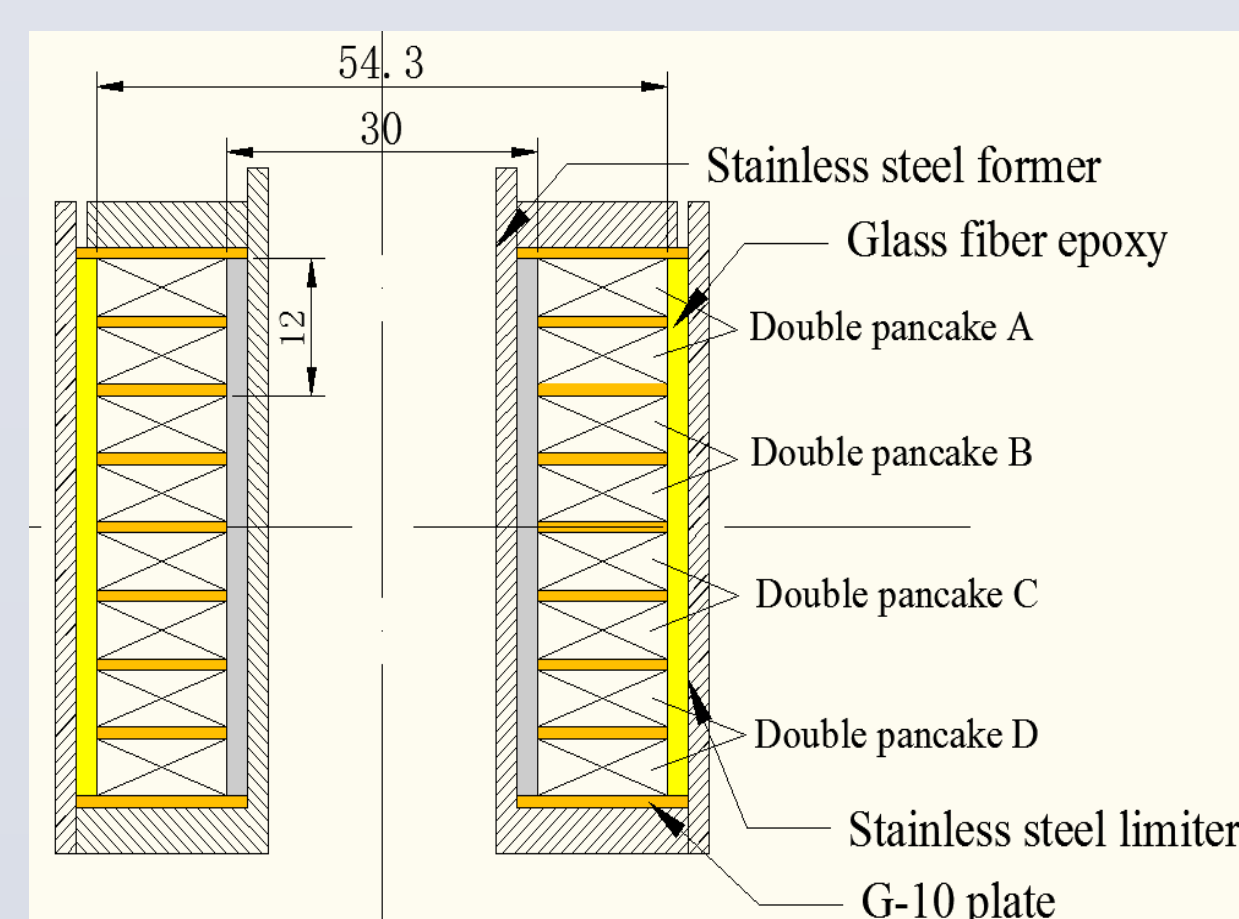
TABLE I
DETAIL PARAMETERS OF YBCO SSTC TAPE

| Property | Unit | Value |
|--------------------------|------|--------------|
| Conductor type | | YBCO |
| Vendor | | SSTC |
| Conductor width | mm | 4.80 |
| Conductor thickness | mm | 0.27 |
| Insulation | | no |
| HTS thickness | μm | 1.0 |
| Substrate / thickness | μm | Hastelloy/50 |
| Matrix / thickness | μm | Ag/1.0 |
| Stabilizer / thickness | μm | Copper/5.0 |
| Min. winding radius | mm | 15 |
| I_c @ 77 K, self-field | A | 105 |



YBCO Insert Coil Structure and Manufacture

Four double pancakes



PARAMETERS OF YBCO SOLENOID COIL

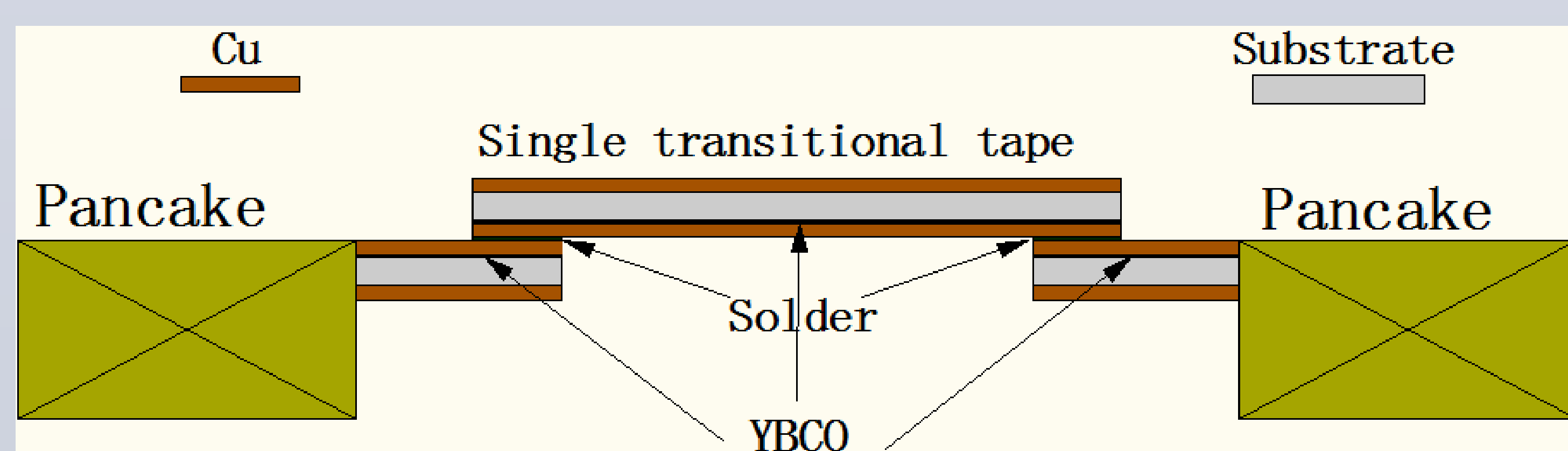
| Property | Unit | Module A | Module B | Module C | Module C |
|-----------------------|------|----------|----------|----------|----------|
| Free bore | mm | 24 | 24 | 24 | 24 |
| Winding ID | mm | 30 | 30 | 30 | 30 |
| Winding OD | mm | 54.3 | 54.3 | 54.3 | 54.3 |
| Turn | | 45 | 45 | 45 | 45 |
| Double pancake | | 1 | 1 | 1 | 1 |
| Winding height | mm | 12 | 12 | 12 | 12 |
| Distance to mid-plane | mm | 9 | 18 | -18 | -9 |
| Conductor length | m | 12 | 12 | 12 | 12 |
| Inductance | mH | | 2.67 | | |

Glass + epoxy resin curing
Stainless steel sheath

No-insulation winding

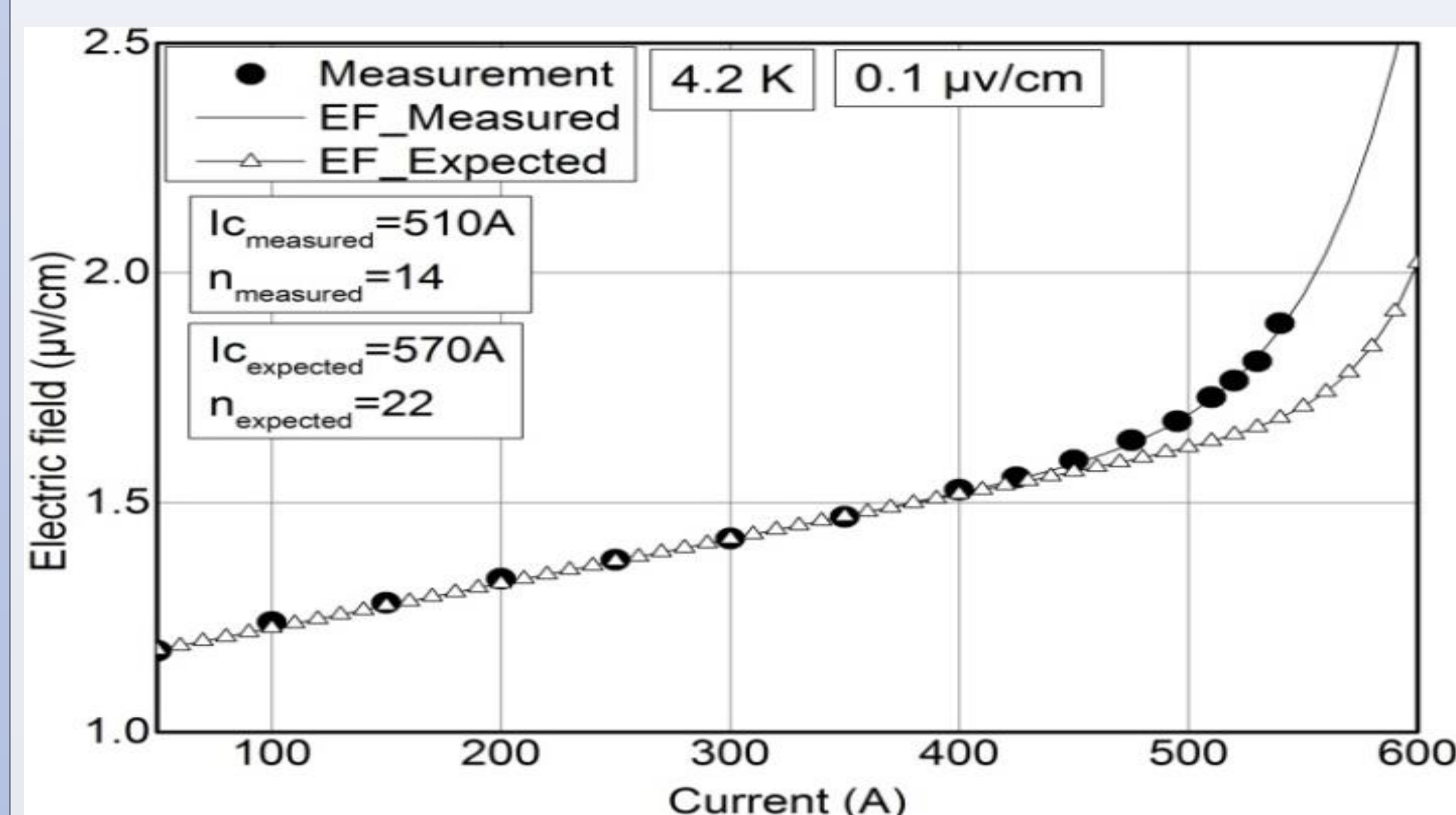


Separate bridging pieces of YBCO tape method is used to connect the each double pancake in this YBCO insert coil.



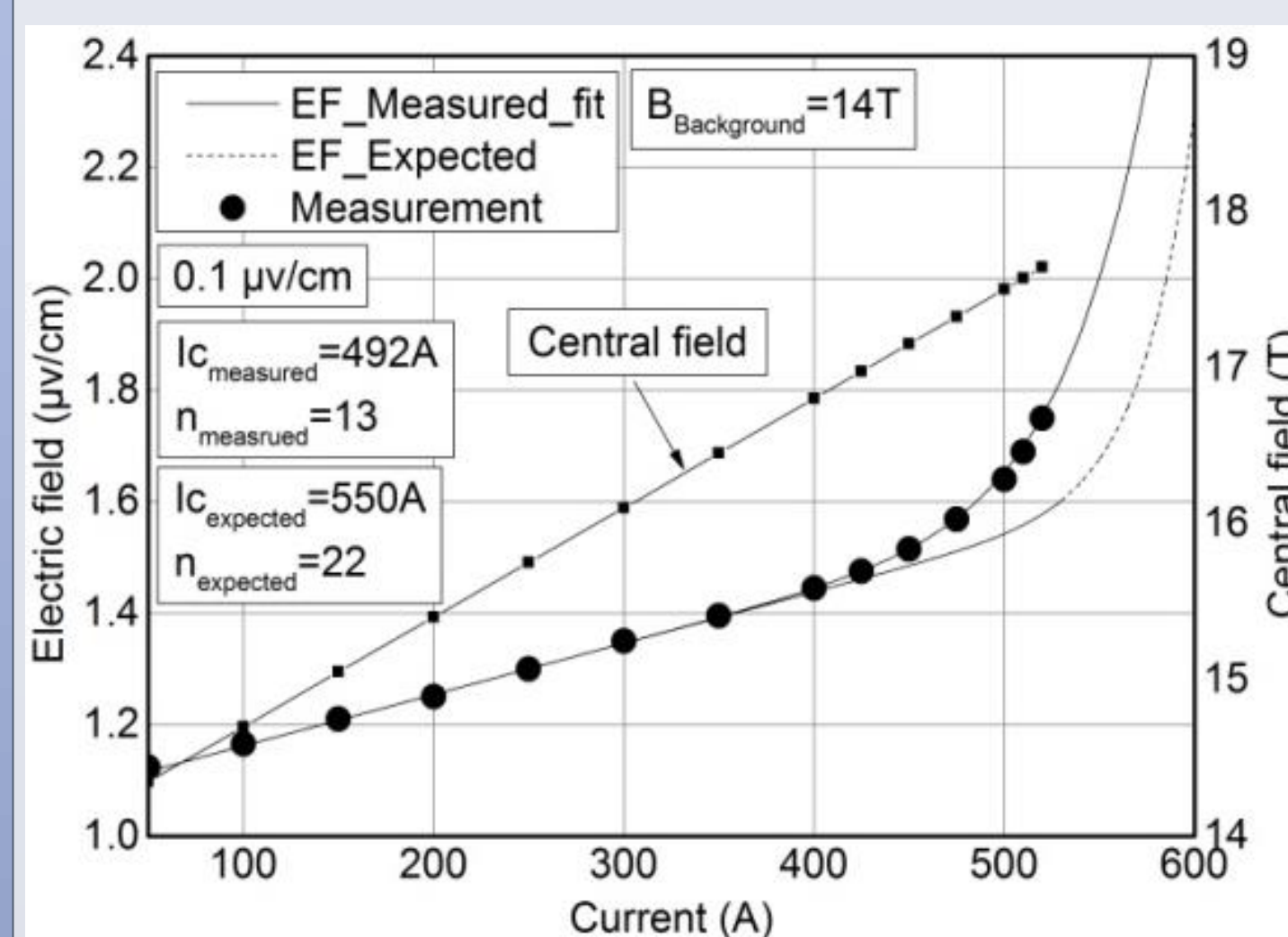
Performance at Self-field

Self-field critical performance of coil at self field as the preliminary assessment of the magnet technology.



Performance at 14 T Background Field

A Nb3Sn solenoid coil can provide the 14 T superconducting background field in the 70 mm diameter aperture at ASIPP.



$$V = V_0 + L \cdot \frac{dI}{dt} + I \cdot R + V_c \cdot \left(\frac{I}{I_c}\right)^n$$

$I_c = 492$ A

Max. self-field = 3.45 T

Max. central field = 17.45 T

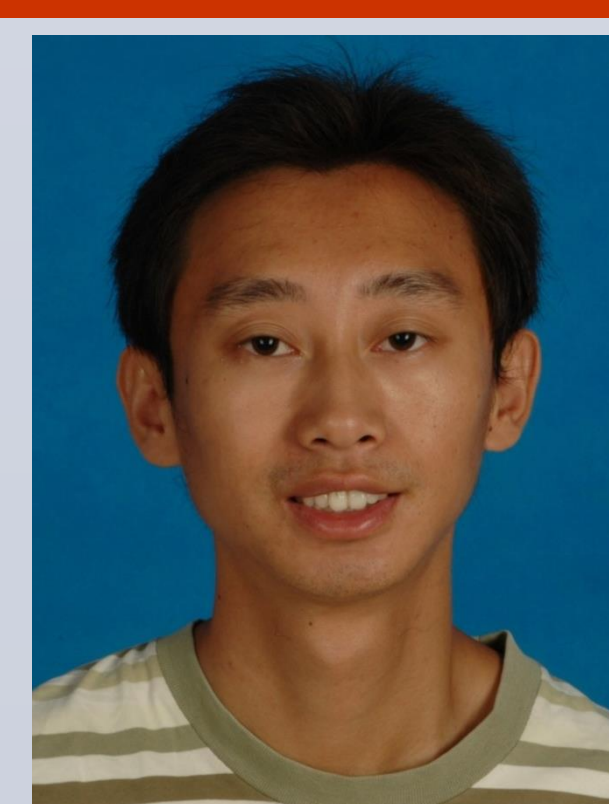
Conclusions

- A 3 T class YBCO insert coil has been manufactured and tested at self-field and 14 T background field using the SSTC YBCO tapes successfully.
- 17.45 T center magnetic field is achieved when the critical current of YBCO insert coil is 492 A. The I_c degradation of the YBCO insert coil is only 10.5 % at self-field and in-field.
- This is the first successful report on the high field magnet progress with the SSTC YBCO conductor which can reach up to 17 T field.

Acknowledgments

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Yi Shi was born in China at 1981 and received his Ph. D. in nuclear science and engineering at ASIPP. his major is superconducting magnet technology on nuclear Engineering and high field application .

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