

# **HTS wire development and industrialization at Sumitomo**

**Sumitomo Electric  
May 21, 2014**

**DESY@Hamburg**

# 1. Bi-2223 HTS wires produced by Sumitomo

Type H



4.3mm x 0.23mm

Type HT

HT-SS



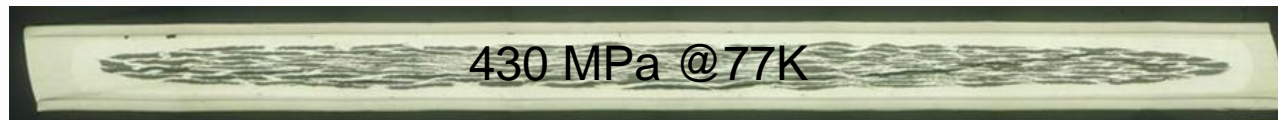
4.5mm x 0.30mm

HT-CA



4.5mm x 0.36mm

HT-XX



4.5mm x 0.28mm

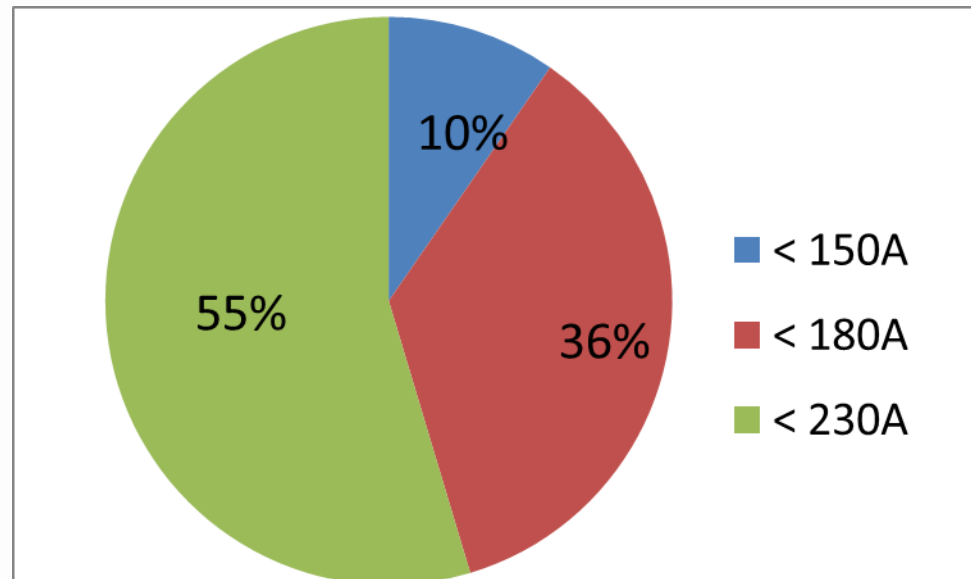
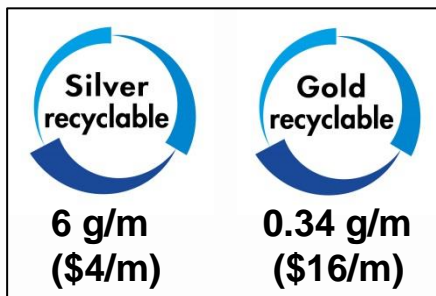
Type G



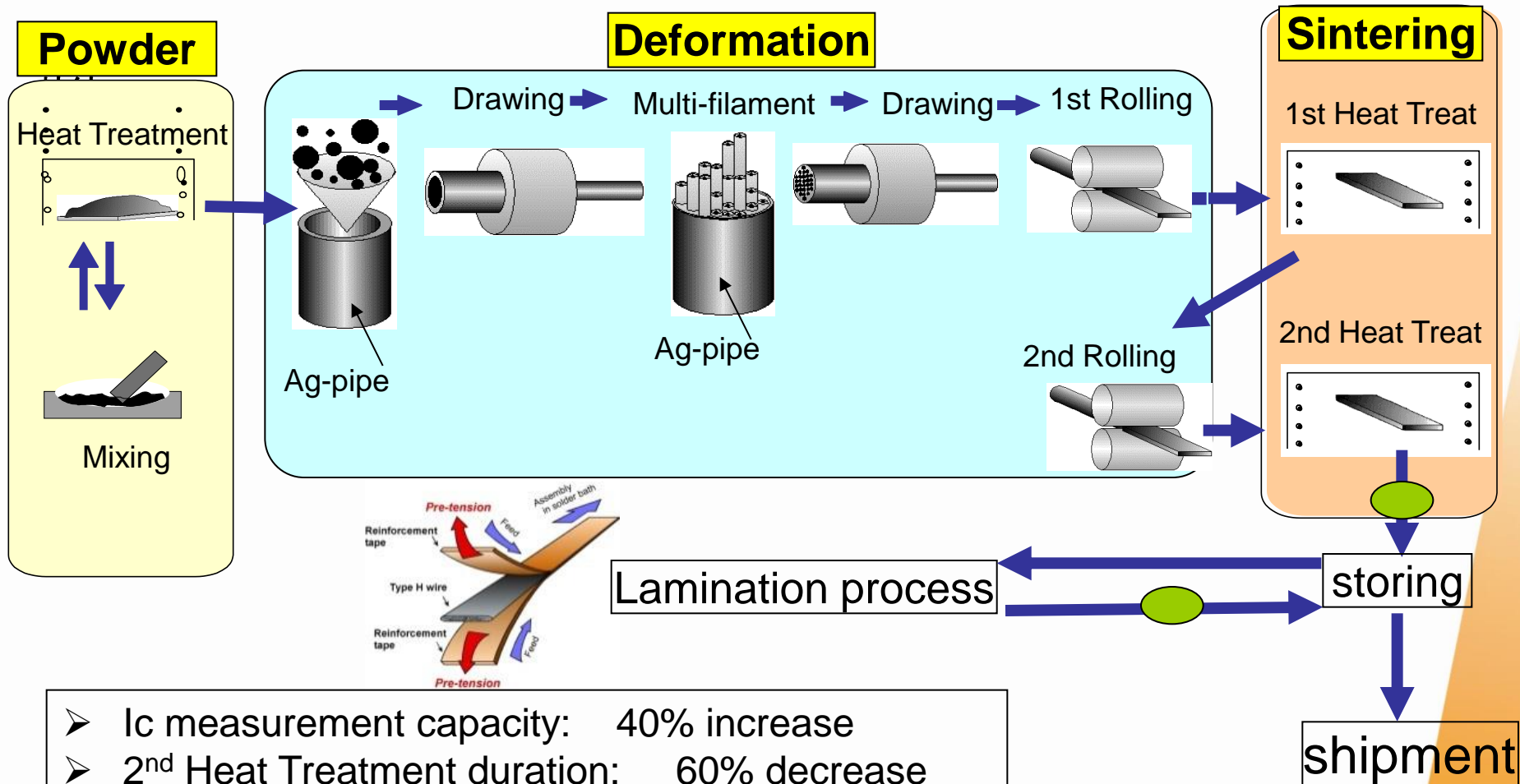
4.3mm x 0.23mm

## 2. Bi-2223 HTS wire production volume since 2010

- More than **1,400km** of Type **H** wire had been produced and stored in stock as good product (quality). Unit length less than 100m is not defined as salable product.
- More than **600km** of Type **HT** wire had been produced and stored in stock as good product (quality). Unit length less than 100m is not defined as salable product.
- More than **30km** of Type **G** wire had been produced and stored in stock as good product (quality). Unit length less than 10m is not defined as salable product.
- Ic distribution of those wires are .....



### 3. Bi-2223 HTS wire production capacity increase since 2010



- Ic measurement capacity: 40% increase
- 2<sup>nd</sup> Heat Treatment duration: 60% decrease
- Lamination capacity: 50% increase
- Current total production capacity: 1000km/yr

● : Ic measurement (QA dept.)

## 4. Sumitomo's direction of development beyond 2014

➤ Target wire design : Higher strength & Higher Je

### Higher strength

- ❑ we will improve HT-XX lamination technique and keep trying to improve the XX material itself.

- ✓ Unit length : 300m → 500m

- ✓ Tensile strength : 430MPa → 500MPa

### Higher Je

- ❑ we will pursue several different designs of DI-BSCCO.

- ✓ Type H (0.99mm<sup>2</sup>) → new H (0.86mm<sup>2</sup>) by reducing the thickness (4.3mm x 0.2mm, 180-200A)

- ✓ new H (0.86mm<sup>2</sup>) → R&D code #3 (0.72mm<sup>2</sup>) by reducing the width/thickness (3.8mm x 0.19mm, 140-160A)

- ✓ Type H (0.99mm<sup>2</sup>) → R&D code #2 (1.13mm<sup>2</sup>) by increasing the width (4.9mm x 0.23mm, 220-240A)

- ❑ no technology for making round wire & no superconducting joint.

➤ easy jointing: automatic and stable jointing quality



□ we developed automatic jointing machine and used them since 2010. More than 700 joints of spliced wire had been shipped.

- Adjustable pressure: 100N – 400N
- Adjustable temperature: 50-270 degree C
- 40kg, approx. 550 x 320 x 473mm

□ 17 minutes of operation time for one joint.

1. Preparation of wire : 1 min
2. Preparation of solder : 2 min
3. Setting up the wire and solder : 3 min
4. Automatic operation: 11 min.

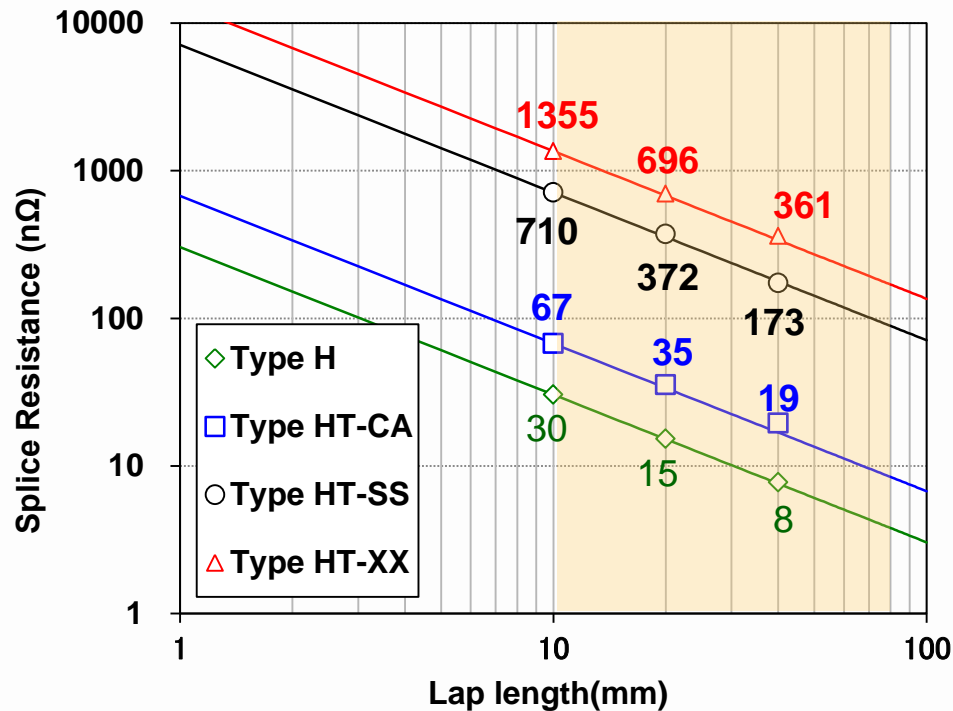


Splice length. 10mm-85mm



Tip length: < 10 mm

## □ jointing results



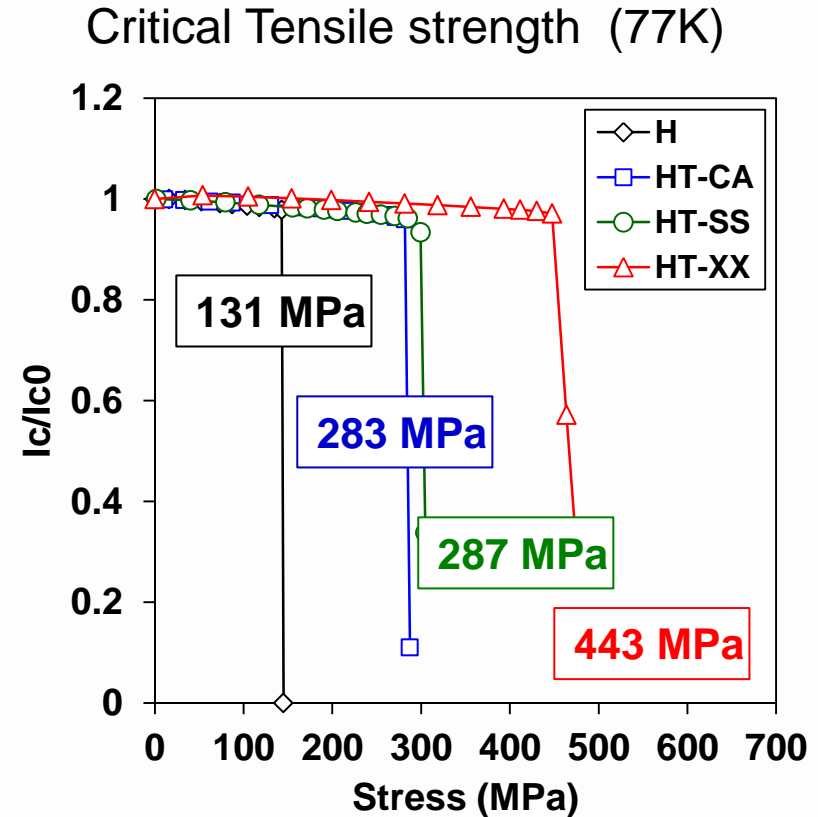
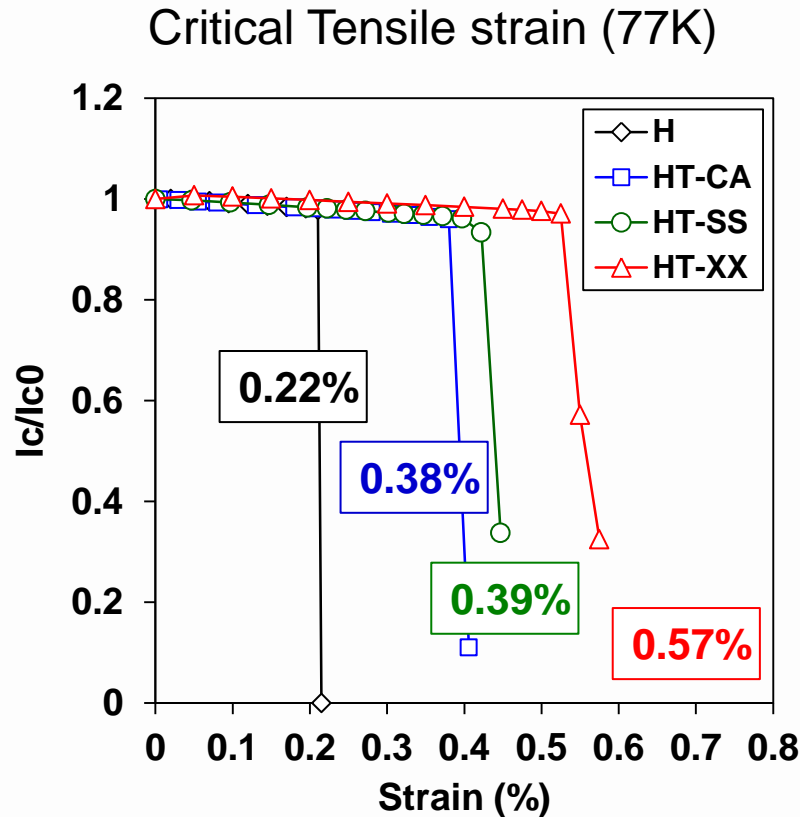
Type	H	SS	CA	XX
Lap Length (mm)	Splice Resistance (n Ω)			
mm	n Ω	n Ω	n Ω	n Ω
10 *	30 *	710 *	67 *	1355 *
80 **	4 **	89 **	8 **	169 **

\*experimental data

\*\* calculated data

## 5. Suitable DI-BSCCO wire (HT-XX) for high energy physics

a) Tensile strain and strength

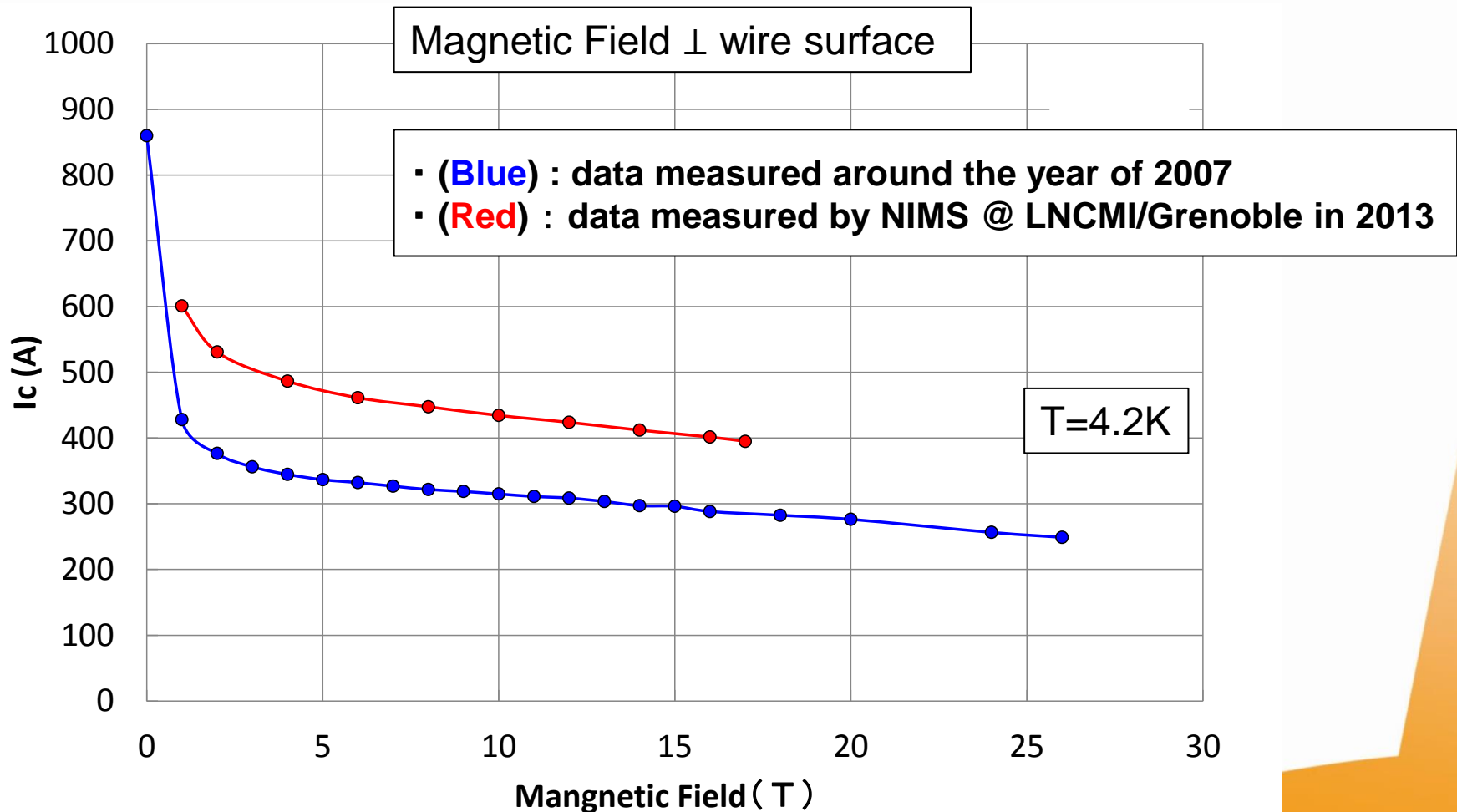


Width: 4.5 mm  
 Thickness: 0.28 mm  
 $I_c$ : 200A



## 5. Suitable DI-BSCCO wire (HT-XX) for high energy physics

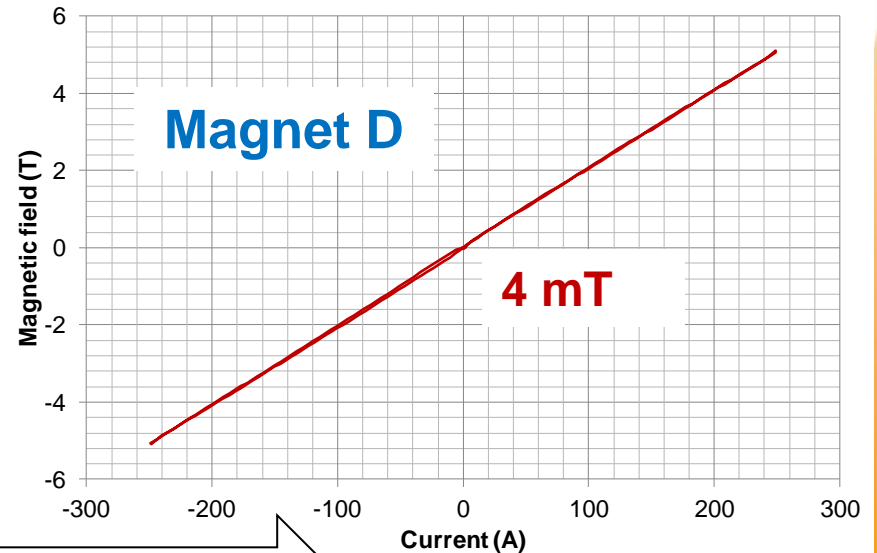
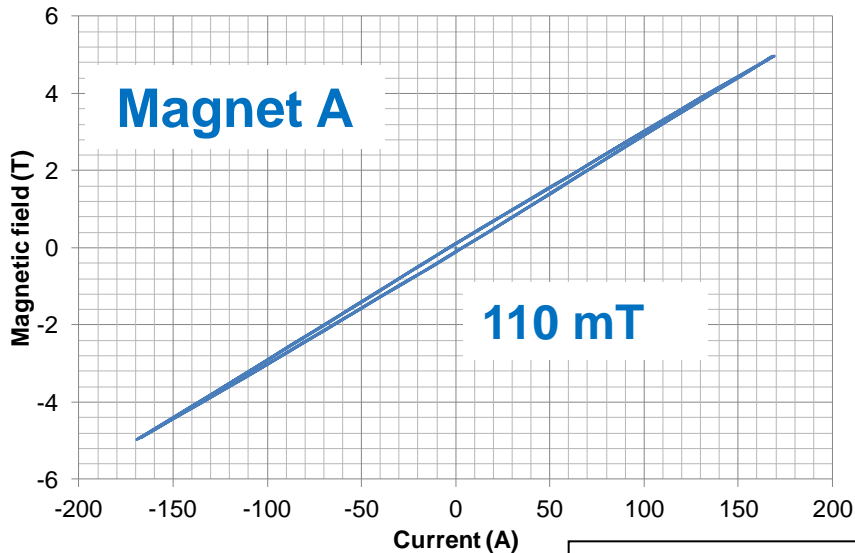
### b) Ic-B performance (@4.2K)



## c) Shielding current in the DI-BSCCO wire

- ✓ BSCCO wire has relatively small shielding current and manageable in some sense.
- ✓ Below are the example of shielding current before and after the treatment.

	A	B	C	D
Center field	±5 T	±5 T	±5 T	±5 T
R.T. bore	φ100 mm	φ150 mm	φ150 mm	φ300 mm
Fastest sweep rate to full field	5 T / 30 s	5 T / 50 s	5 T / 50 s	5 T / 180 s
Cryo-cooler cooled	✓	✓	✓	✓
Residual magnetic field	110 mT	80 mT	5 mT	4 mT



## 5. Suitable DI-BSCCO wire (HT-XX) for high energy physics

### d) Type HT-XX Product data

Average Width	4.5mm +/- 0.3mm
Average Thickness	0.28mm +/- 0.04mm
Reinforced Material	XX (30 $\mu$ m) --- non-magnetic
Unit length	100m - 300m
I <sub>c</sub> @77K, s.f.	180A - 200A (new H)
J <sub>e</sub> @77K, s.f.	140A/mm <sup>2</sup> - 155A/mm <sup>2</sup>
J <sub>e</sub> @4K, 17T	280A/mm <sup>2</sup> - 310A/mm <sup>2</sup>
I <sub>c</sub> variation over a unit length	< 3%
Tensile Wire Tension @RT	410N
Tensile Strength @77K	430MPa
Tensile Strain @77K	0.5%

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# Questions and Comments...

