IEEE-CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), Issue 53, July 2023.
Presentation given at Coated Conductors for Applications Workshop, Houston, TX, USA, April 2023.

CCA2023
International Workshop on Coated Conductors for Applications
UH Hilton Hotel & Rockwell Pavilion – University of Houston | APRIL 3-6, 2023

中部大学 Chubu University

上海超导 SHANGHAI SUPERCONDUCTOR

Coated Conductor R&D at Shanghai Superconductor Technology and discussion for fusion application

Y. Yamada*

J-M Zhu and B. Song

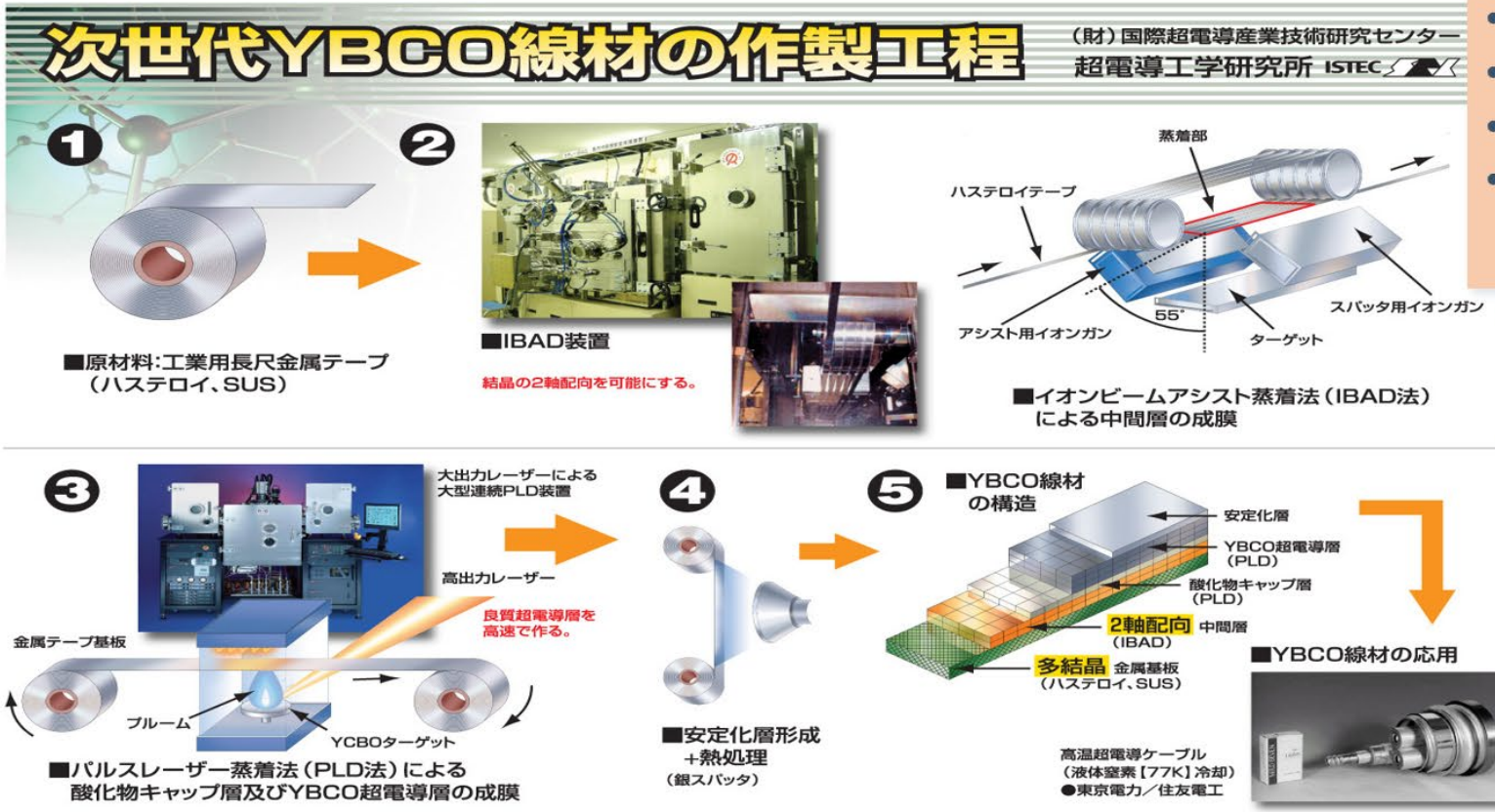
Shanghai Superconductor Technology Co., Ltd., China
***Chubu University, Japan**

and

HTS-CF R&D Committee in Japan, CSSJ(Cryogenics and Superconductivity Society of Japan)

IBAD+PLD history

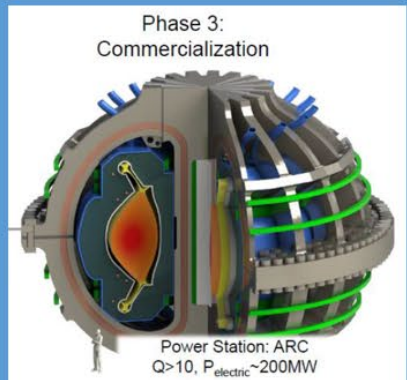
Continuous Long YBCO wire Production Line in Japan （2005, ISTEC)



- IBAD (Fujikura, Iijima)
- Multi-plume, Multi-turn (ISTEC, ...)
- IBAD-MgO (LANL,....)
- Artificial Pin (AFRL Haugan, Driscoll, Goyal, ...)

Private Company Leading

2035



2027

Early 200's National project leading

Outline

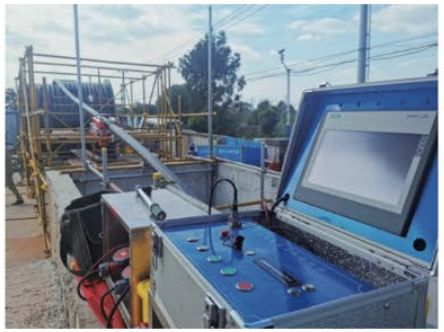
- **Current status of SST and HTS activity in China**
- **Technology at Shanghai Superconductor Technology (SST)**
  - Mass production
  - R&D
- **Activity of HTS-CF group in CSSJ Japan**
  - Important R&D for HTS-Fusion system
- **Conclusion**

Current SST Status in China

Visit & Survey in March 12 to 26, 2023

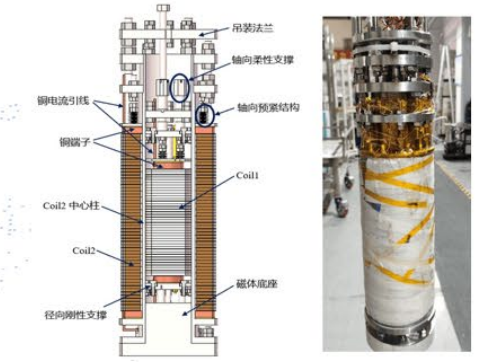
Guandong Electric Power Company

SC transport property measurement center

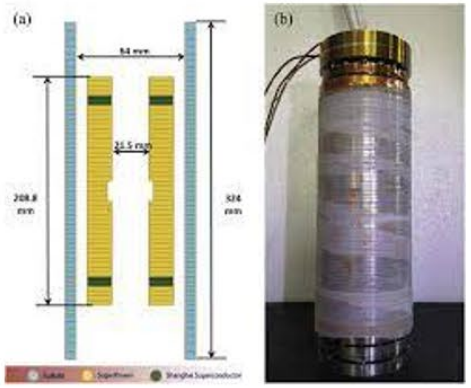


35 kV Shanghai HTS cable
1.2km→5km planning

World's first 160kV DC SFCL



CAS IPP --- 24.1T All REBCO Magnet Successfully running in 2022 October



World record 32.35 tesla DC all SC magnet

World's first MW-scale HTS induction heater

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Plant #1（Upgrading of existing plant）

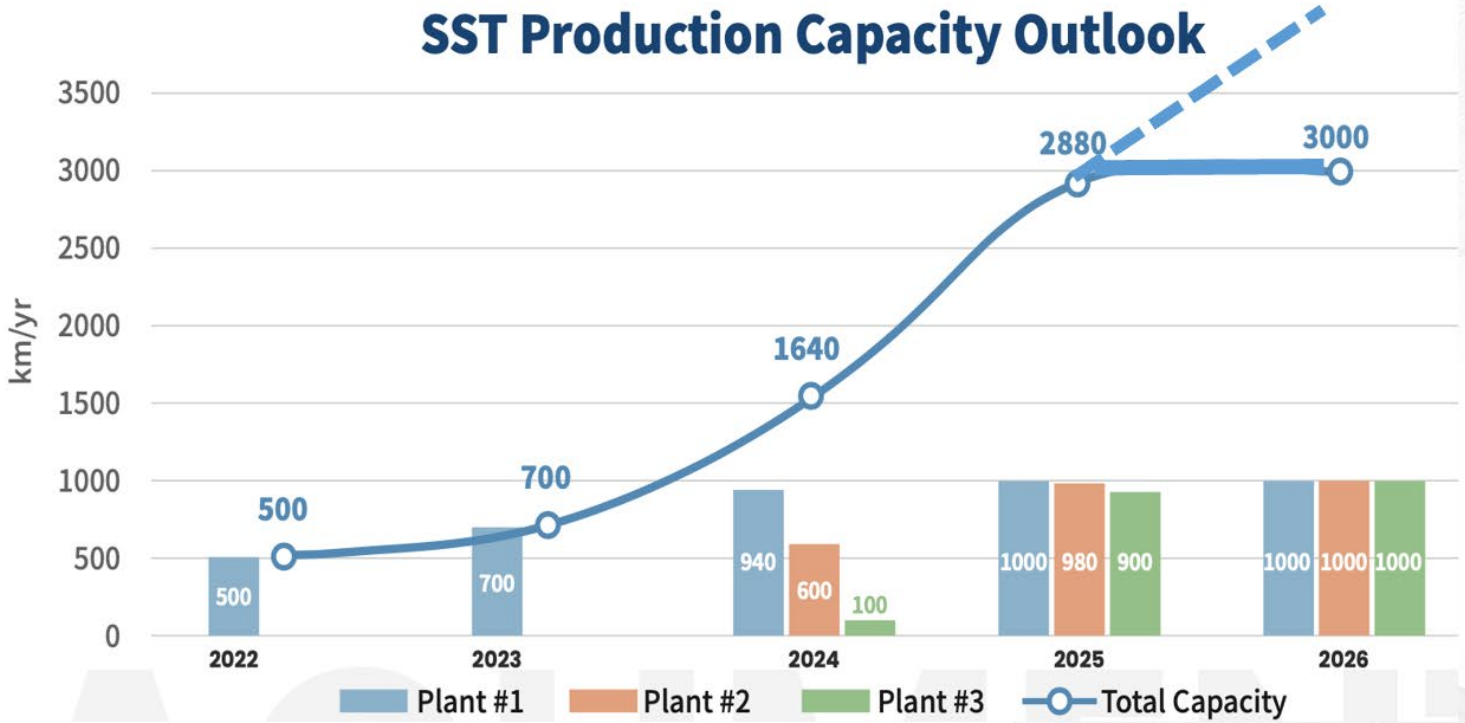
Zhangjiang Hi-tech Park, Shanghai

Plant #2（New)

Kangqiao Industrial Park, Shanghai

Plant #3（New)

Aviation Harbour Demonstration Park, Hefei



3 years Expansion

3 Plants

3000 km/yr Capacity

New Plant #2

Renovation Design and Work Underway

Plant #2

Small hotel for visitors

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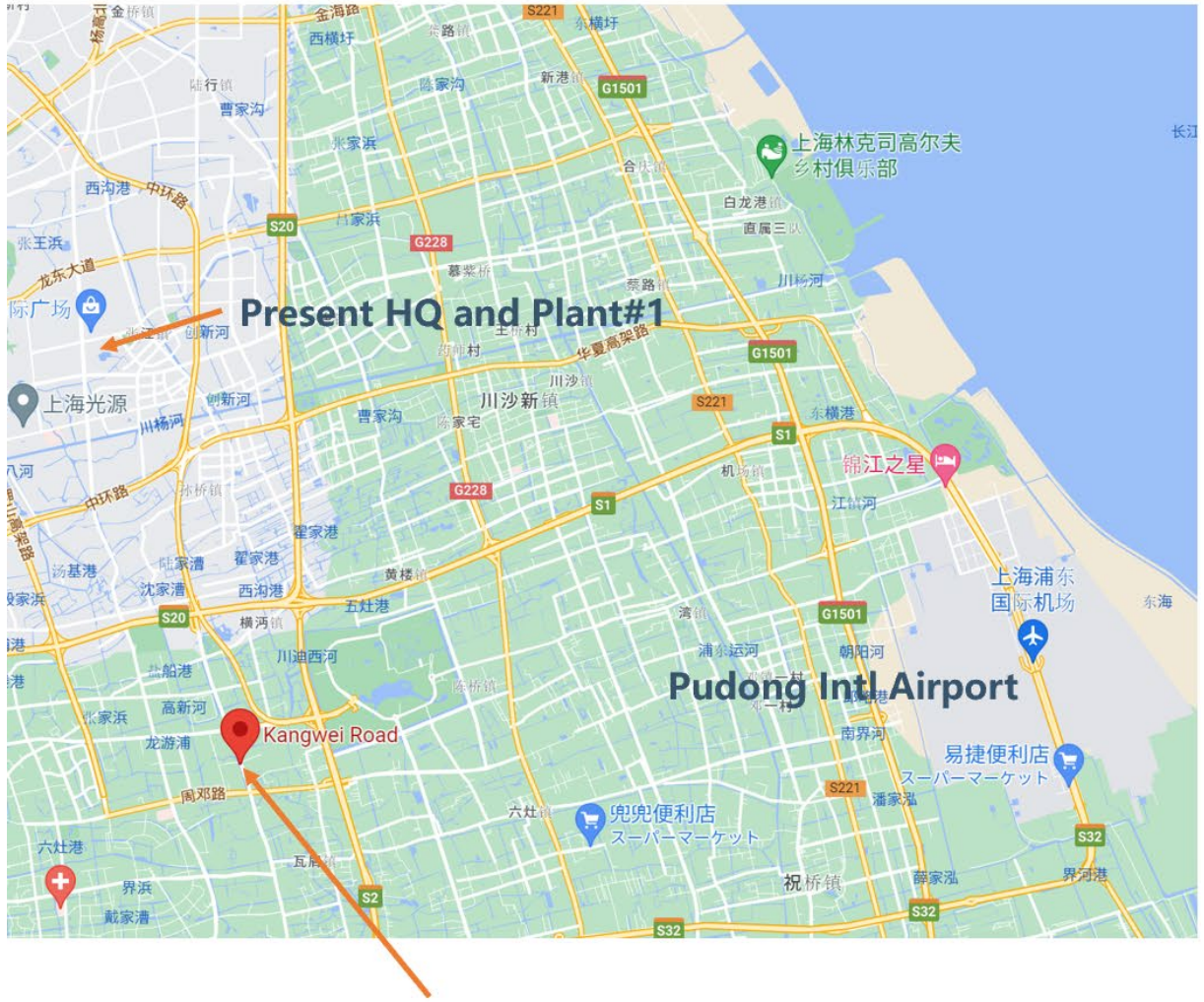
Map: SST Plant#2



Jinda (new investor)
(the largest special magnet wire producer in China)
is investing much to HTS and SST with promising markets.

1. Production expansion
   New factories #2,3 are being constructed.
2. Employee 70→120＋

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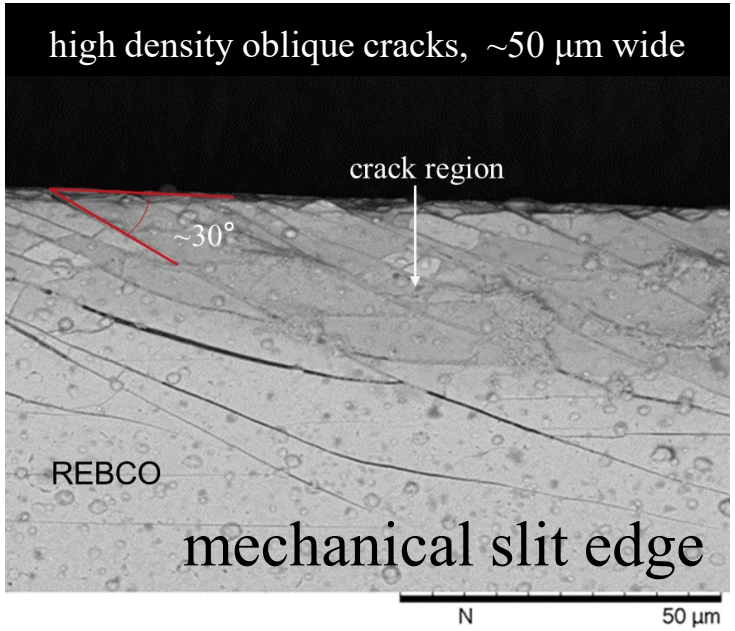
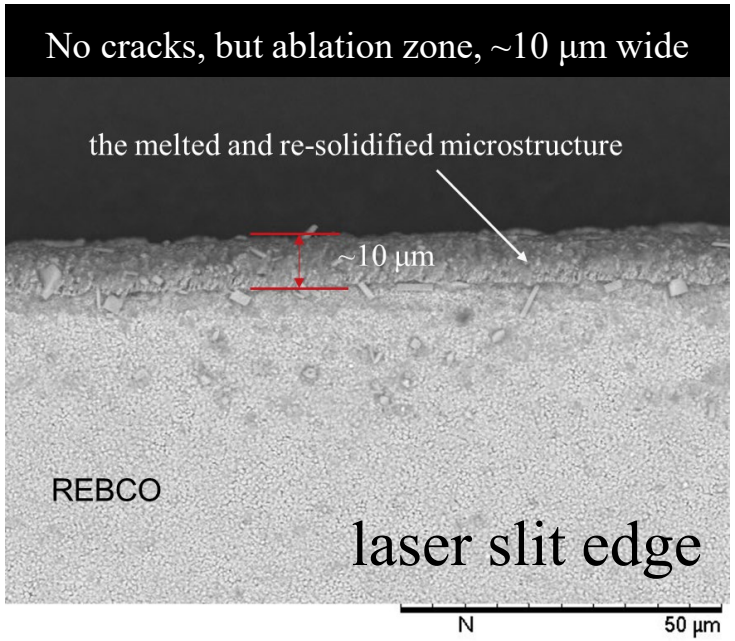
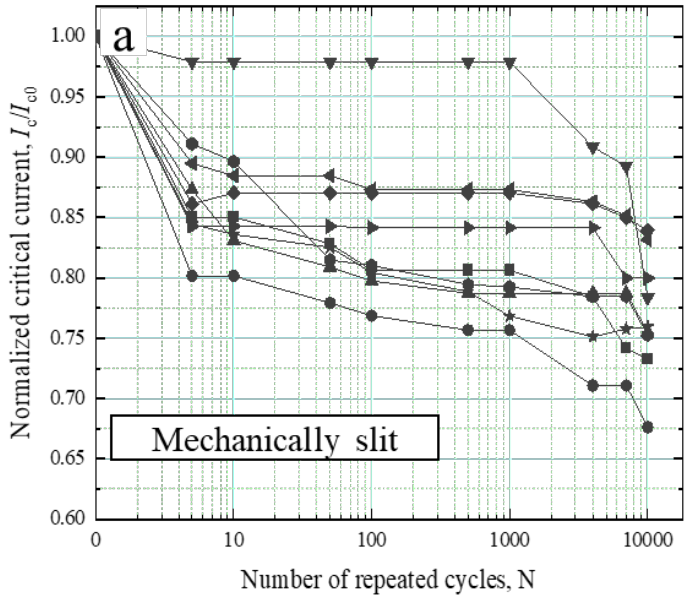
R&D

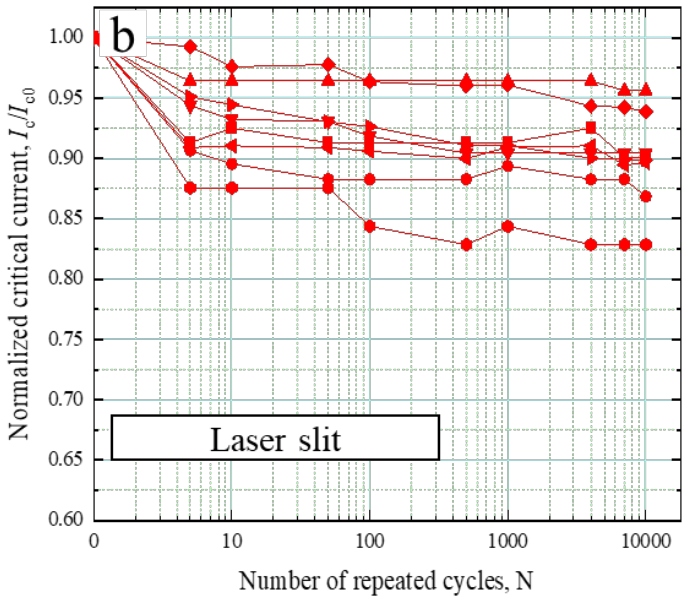
Laser Slitting with less cracks and better fatigue property





Laser Slitting
Less initial cracks
Less crack propagation





Relationship between normalized I_c and N, determined from tensile fatigue tests

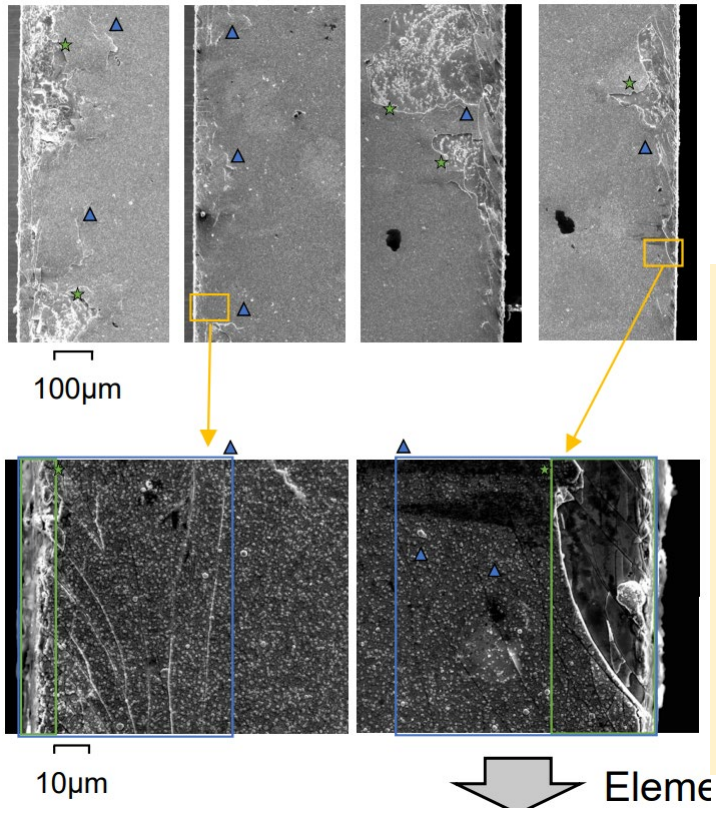
Less Ic degradation

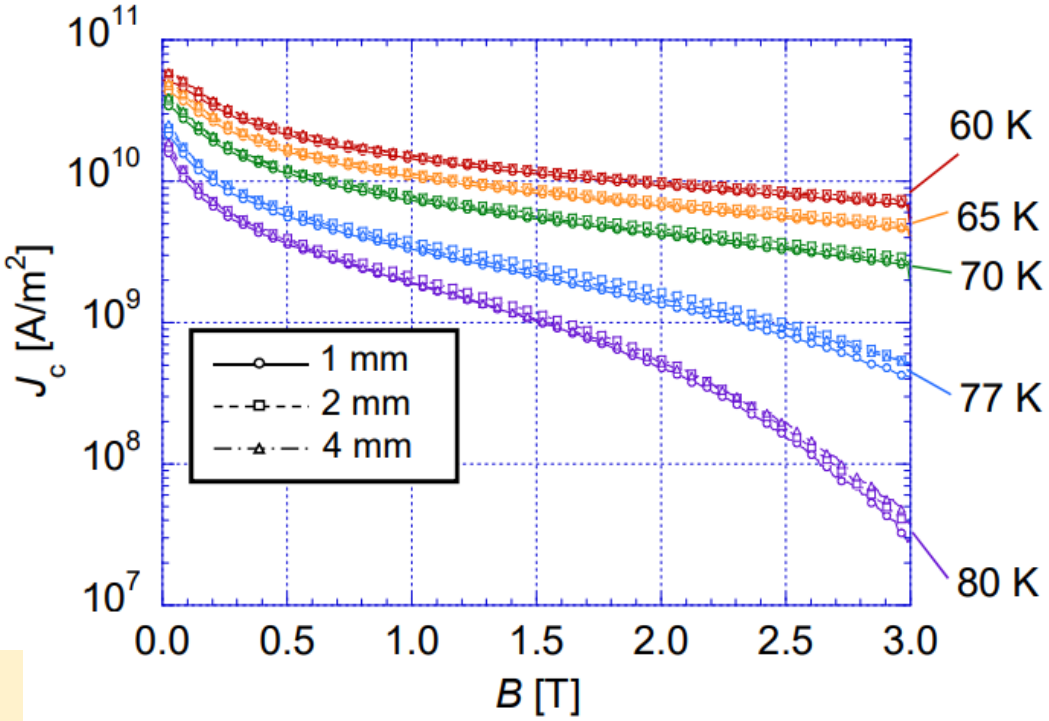
Guo CJ, et al. Supercond. Sci. Technol. 35 (2022) 115009;

1mm Thin Tape (mechanical slit)

by prof. Inoue of FIT

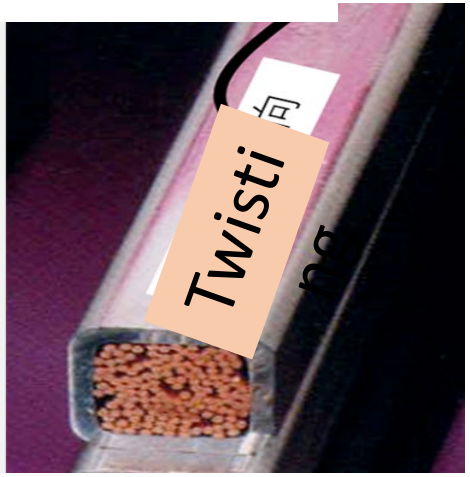
SEM Images



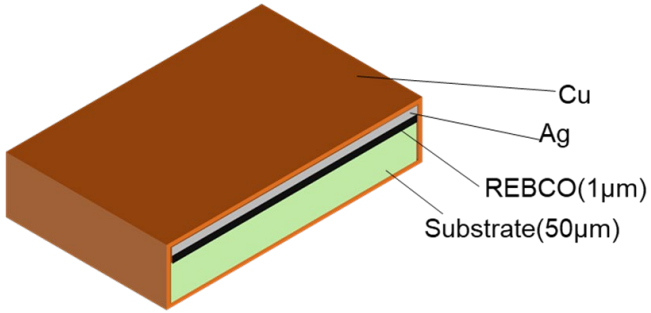


Jc at 77 K:

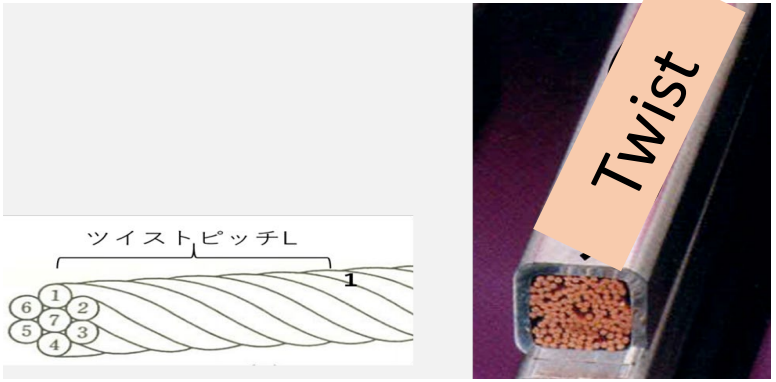
1mm 2.23 MA/cm^2,
2mm 2.43 MA/cm^2,
4mm 2.61 MA/cm^2



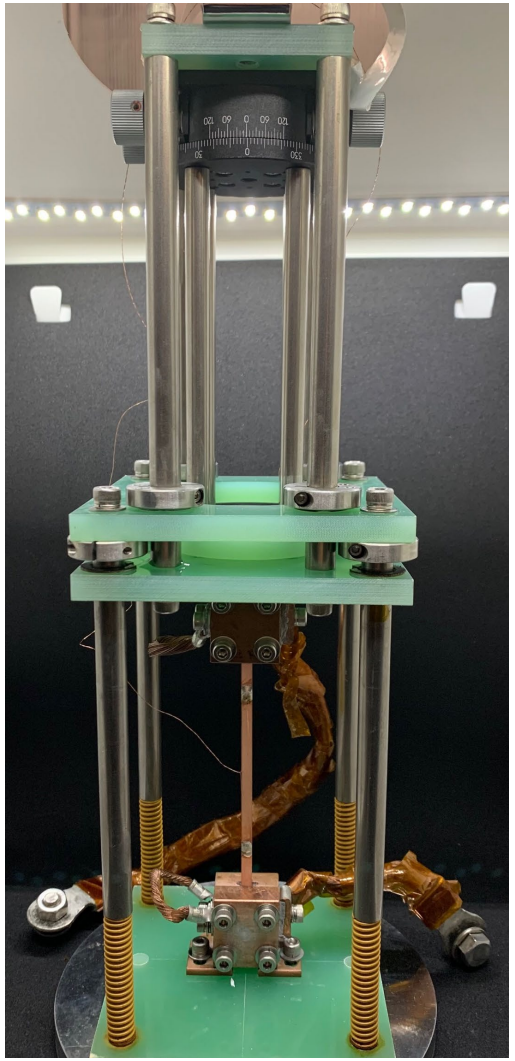
Effect of twist (torsion angle) on critical current, I_c in REBCO CCs

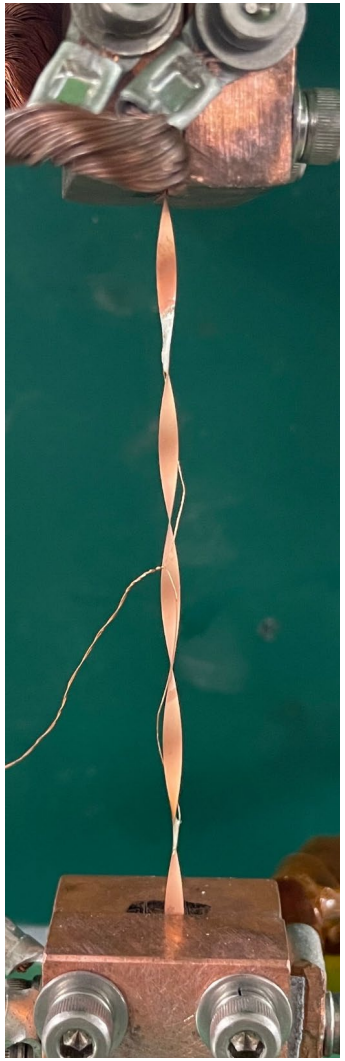


HTS	REBCO CC (SST)
stabilizing layer	Ag + Cu coating
current lead distance	100mm
voltage tap distance	55～60mm
temperature	77K (Liquid N)



Slitting method	Tape width	ID
Mechanical	4mm	#1
	2mm	#2
Laser	4mm	#3

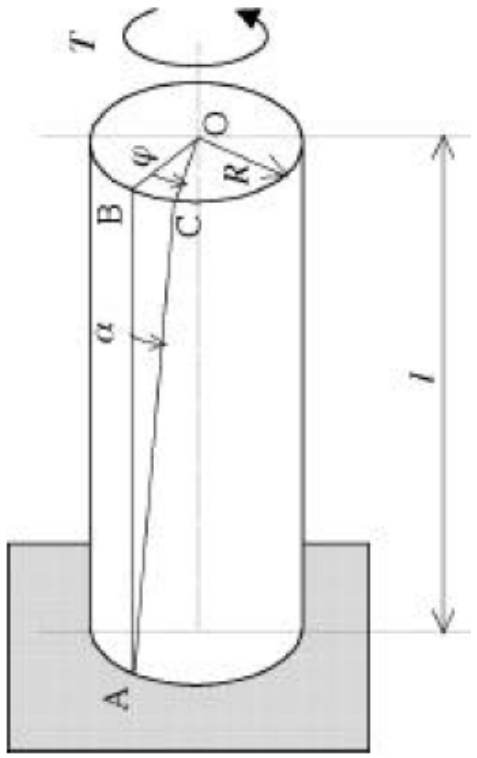




by prof. Inoue of FIT

Twisting Test

Ic starts to degrade at 280, 200 degree for 2, 4mm wide tapes.



Shear Strain

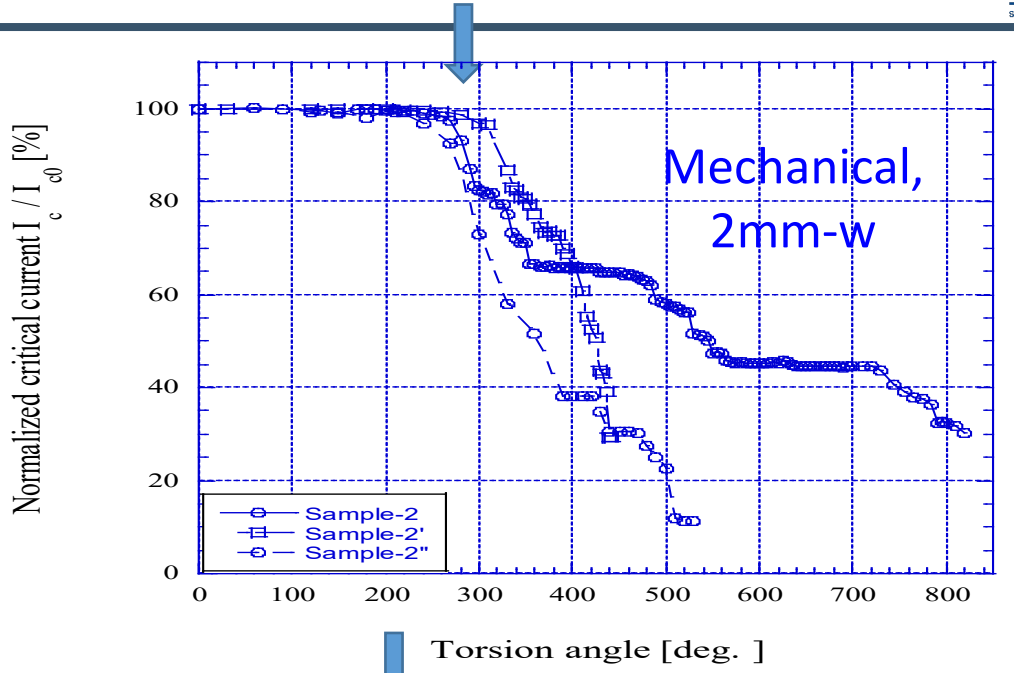
$$\gamma_R = \frac{BC}{AB} = \frac{R\varphi}{l}$$

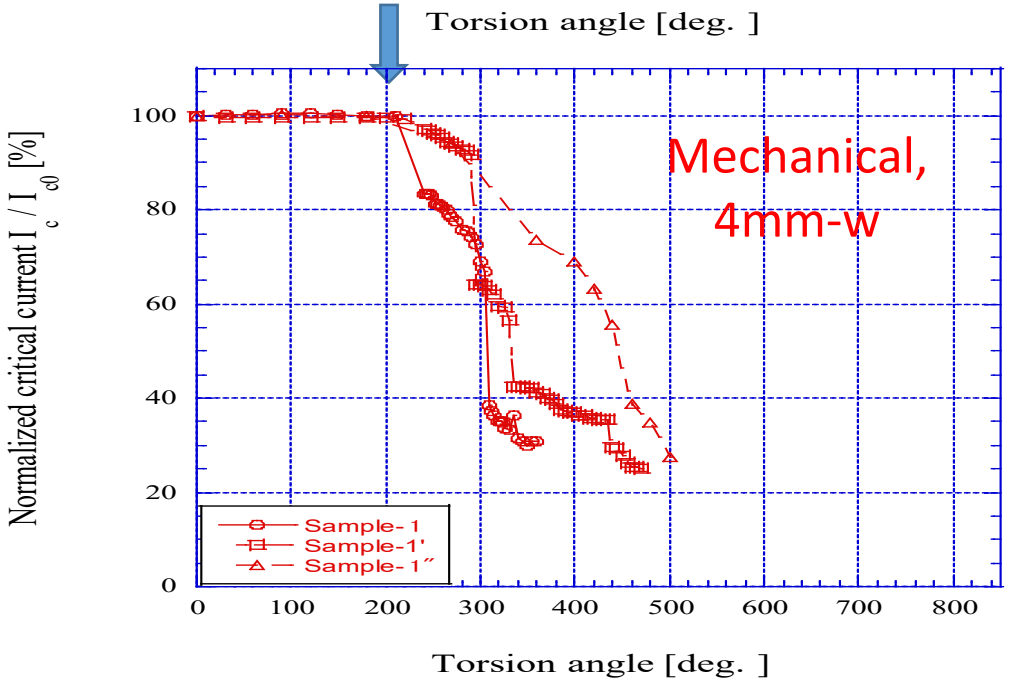
Edge distance l=100mm

Maximum twist pitch 128mm
For 2mm tape

Maximum twist pitch 180mm
For 4mm tape.

1mm tape
Less pitch because of shear strain





by prof. Inoue of FIT

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For HTS Fusion Possibility

CSSJ (Cryogenics and Superconductivity Society of Japan*)
HTS Compact Fusion R&D committee

https://www.csj.or.jp/en/index.html

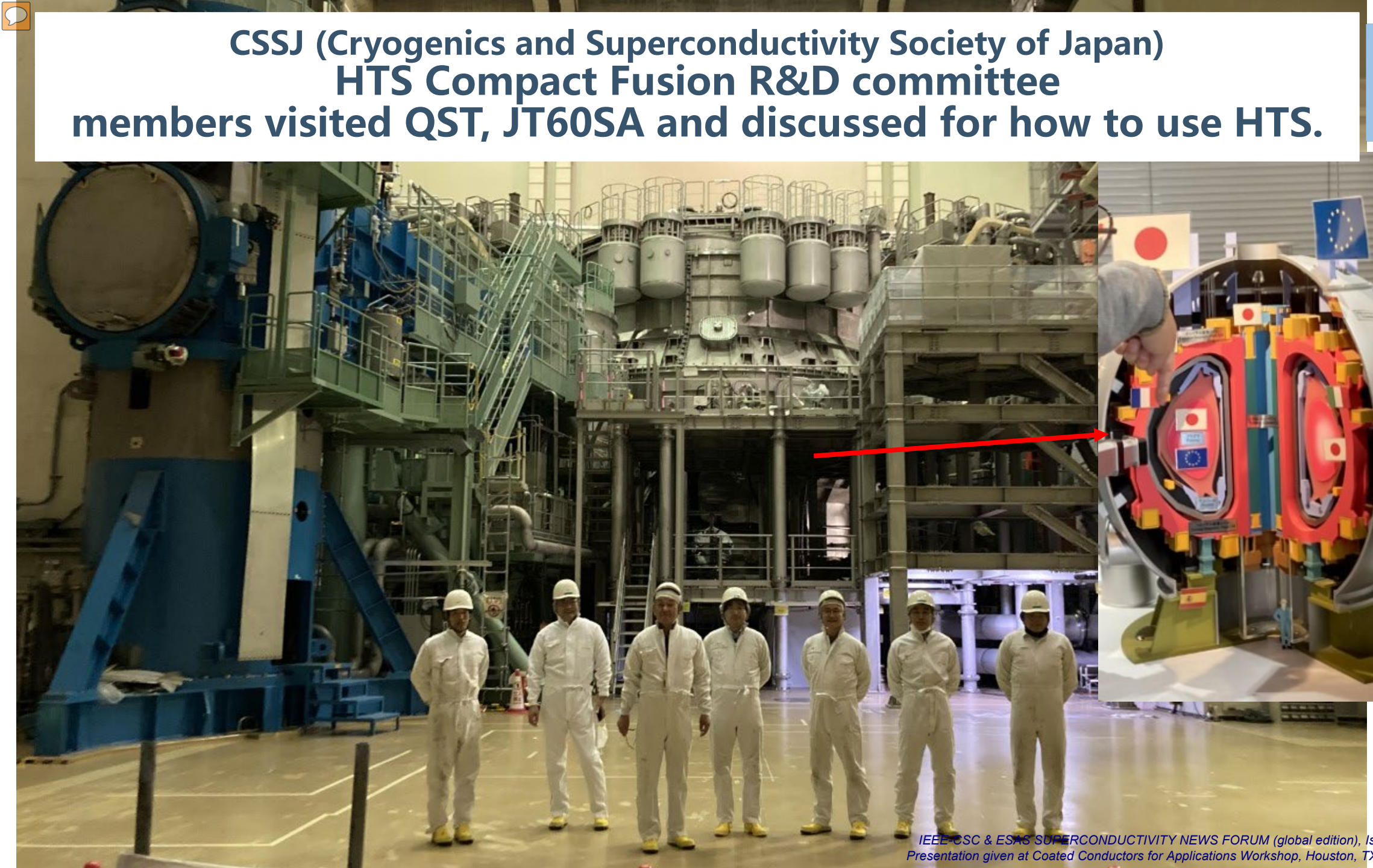
HTS-CF Japan in CSSJ

Name	Affiliation		Field
Yutaka Yamada	Chubu University	Chair	Materials, Conductor
Hiroshi Ueda	Okayama University	Managing secretary	Stability, Loss
In ABC order of Surname			
Satoshi Awaji	Tohoku university	member	High-field ref. cooled magnet
Masayoshi Inoue	FIT	member	Conductor, Ic
Hiroshi Miyazaki	Kyushu University	member	Magnet (ex Toshiba)
Hiroyuki Murakami	QST the National Institutes for Quantum Science and Technology	member	Magnet, JT60SA (LTS but compact fusion syste
Arata Nishimura	NIFS	member	System, Materials, LHD
So Noguchi	Hokkaido University	member	Magnet, Quench
Suwa Tomone	QST	member	Magnet, ITER
Tomonori Watanabe	Chubu Electric Power Company	member	Power application, Magnet, Conductor
----New Members are now being accepted.			

Key point;
/Young and next generation.
/System experts included.

CSSJ (Cryogenics and Superconductivity Society of Japan)
HTS Compact Fusion R&D committee members visited QST, JT60SA and discussed for how to use HTS.

HTS-CF Japan in CSSJ



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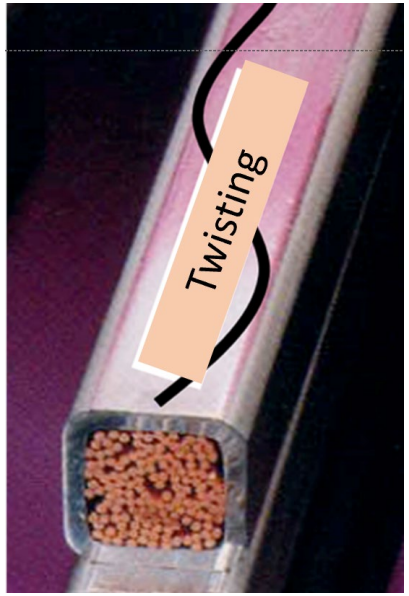
Conclusion and Outlook

■ 2G-HTS business outlook：

- Now compact fusion is also a trigger for a big HTS industry.
- Also, many demonstration projects of power cable, FCL, high speed maglev train, magnets, are being conducted: Shanghai Cable 5km length planning.
- Commercial 2G-HTS tapes with low price are highly anticipated.
- Further of R&D should be progressed for HTS fusion: irradiation, thin, multifilamentary wire, strength, cooling-stability-quenching, AC loss

■ Technological developments:

- Large volume production by IBAD + PLD,
  scope: annual production in 2025 > 3000 km/12mm (I_c=150-200A) ;
- Advanced slitting method: laser slitting with less damage at the edges
- Basic R&D for fusion composite conductor:
  Thin tape: 1mm wide tapes, also 30 μm in thickness in progress.
  Twisting effect, AC loss,… will be discussed in more detail with our colleagues.



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