

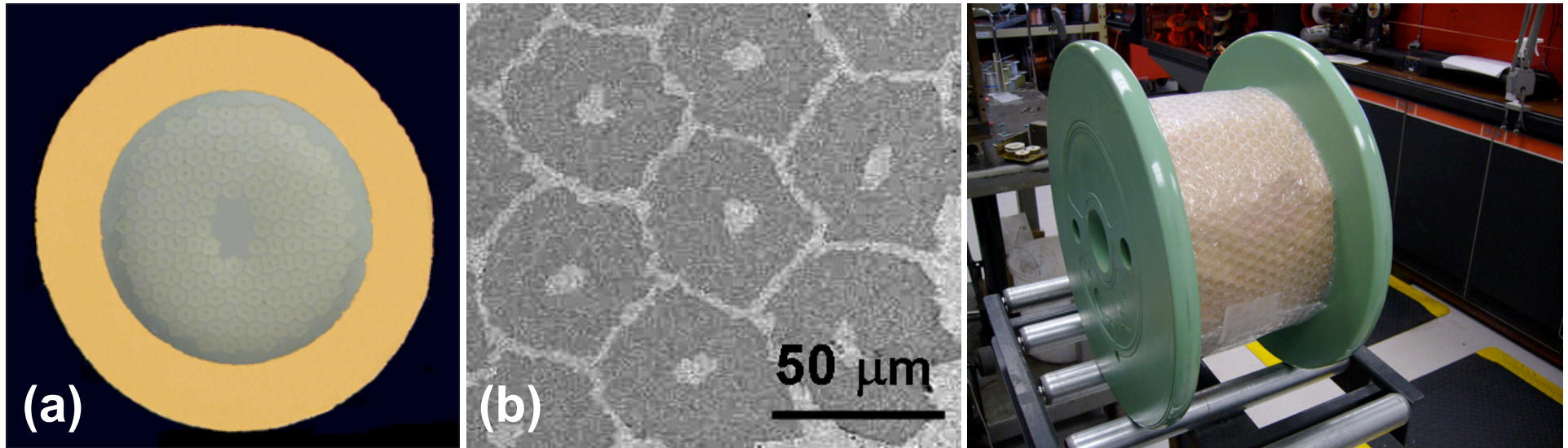


1 km long Nb₃Al strand

Recent activity

Akihiro Kikuchi
(NIMS, Japan)

February 2006, 1.2 km long round strand



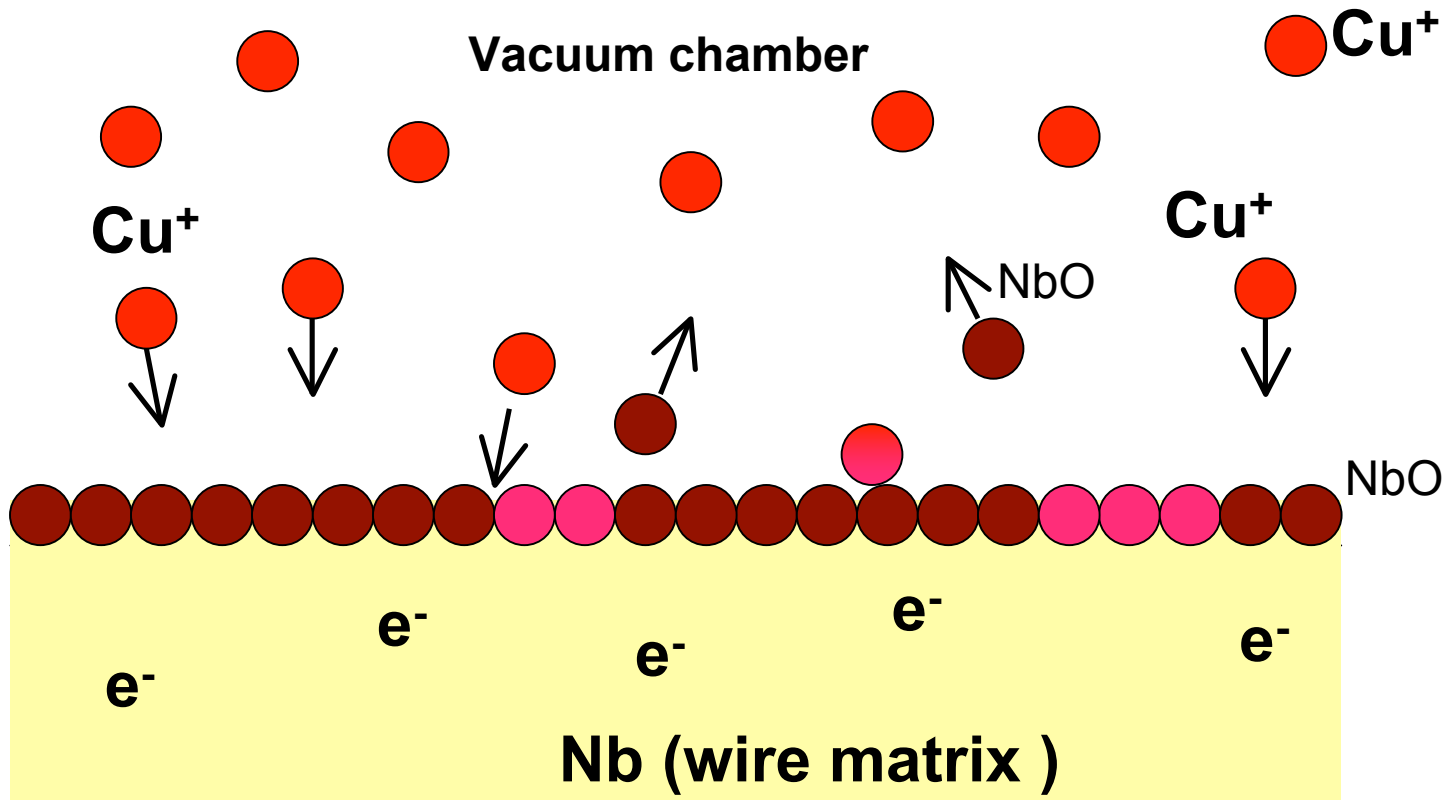
F1, 1.0 mm in diameter, Nb matrix

30 % Nb₃Al (144 Filaments, 50 μm)

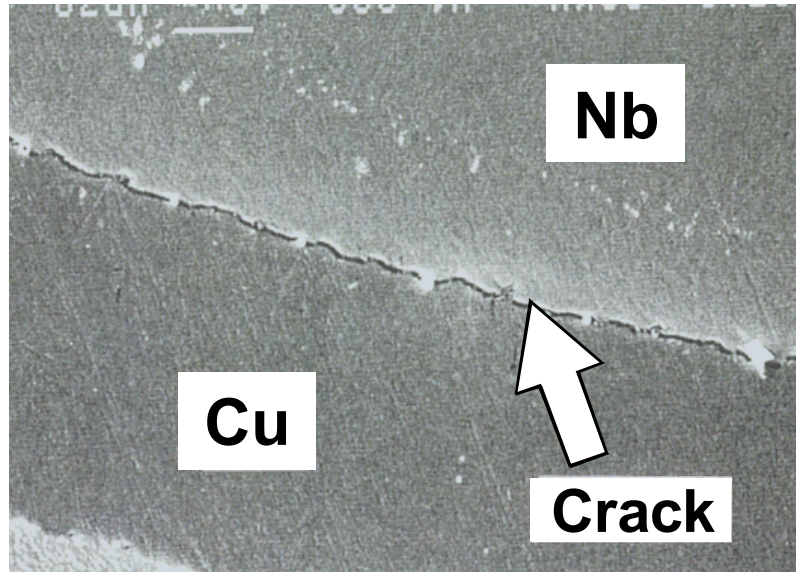
20 % Nb (low purity 99.89 wt%, RRR = 150~200)

50 % Cu (Electroplated, High RRR = 200)

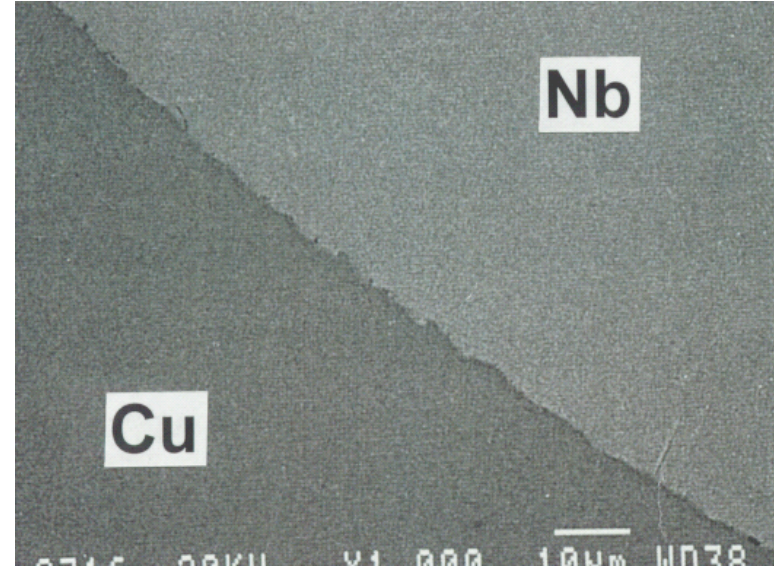
Cu ion plating



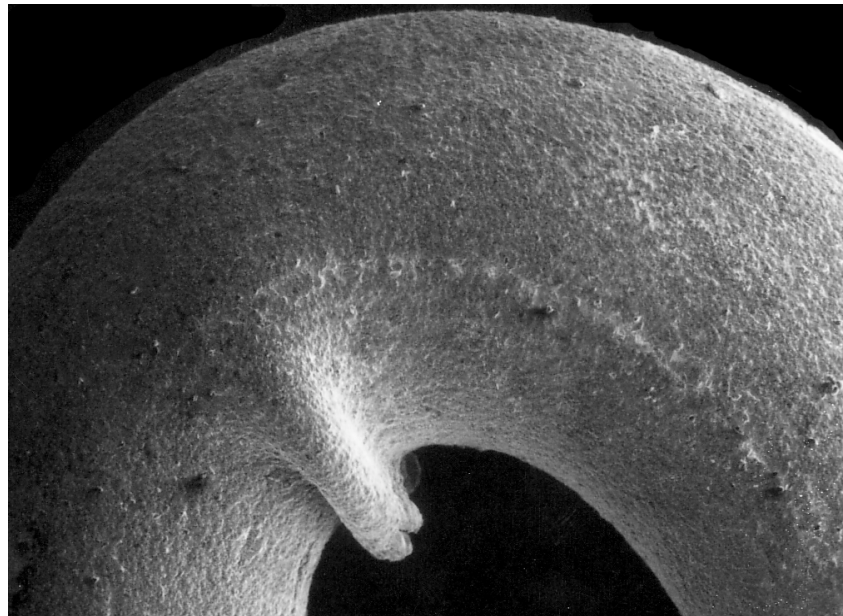
(a) without Ion-Plating



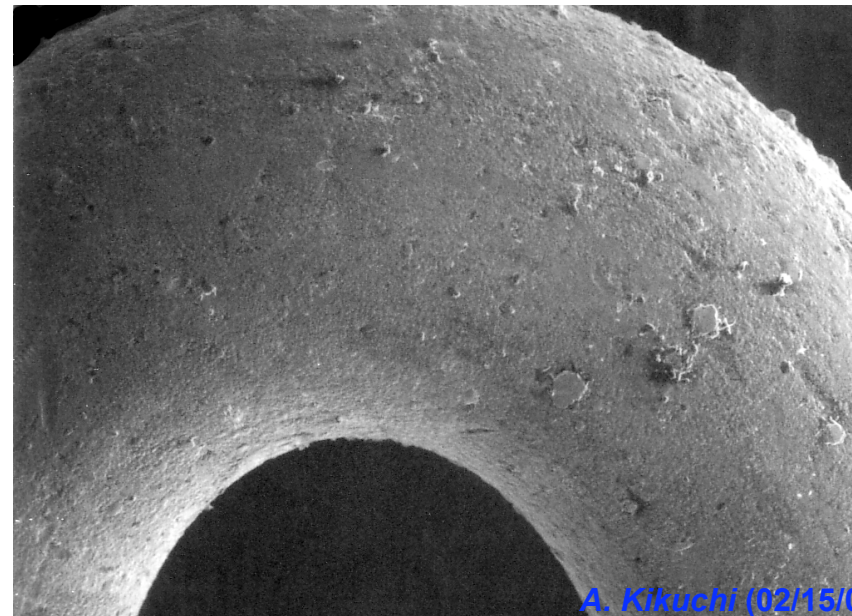
(b) with Ion-Plating



(a) without Ion-Plating



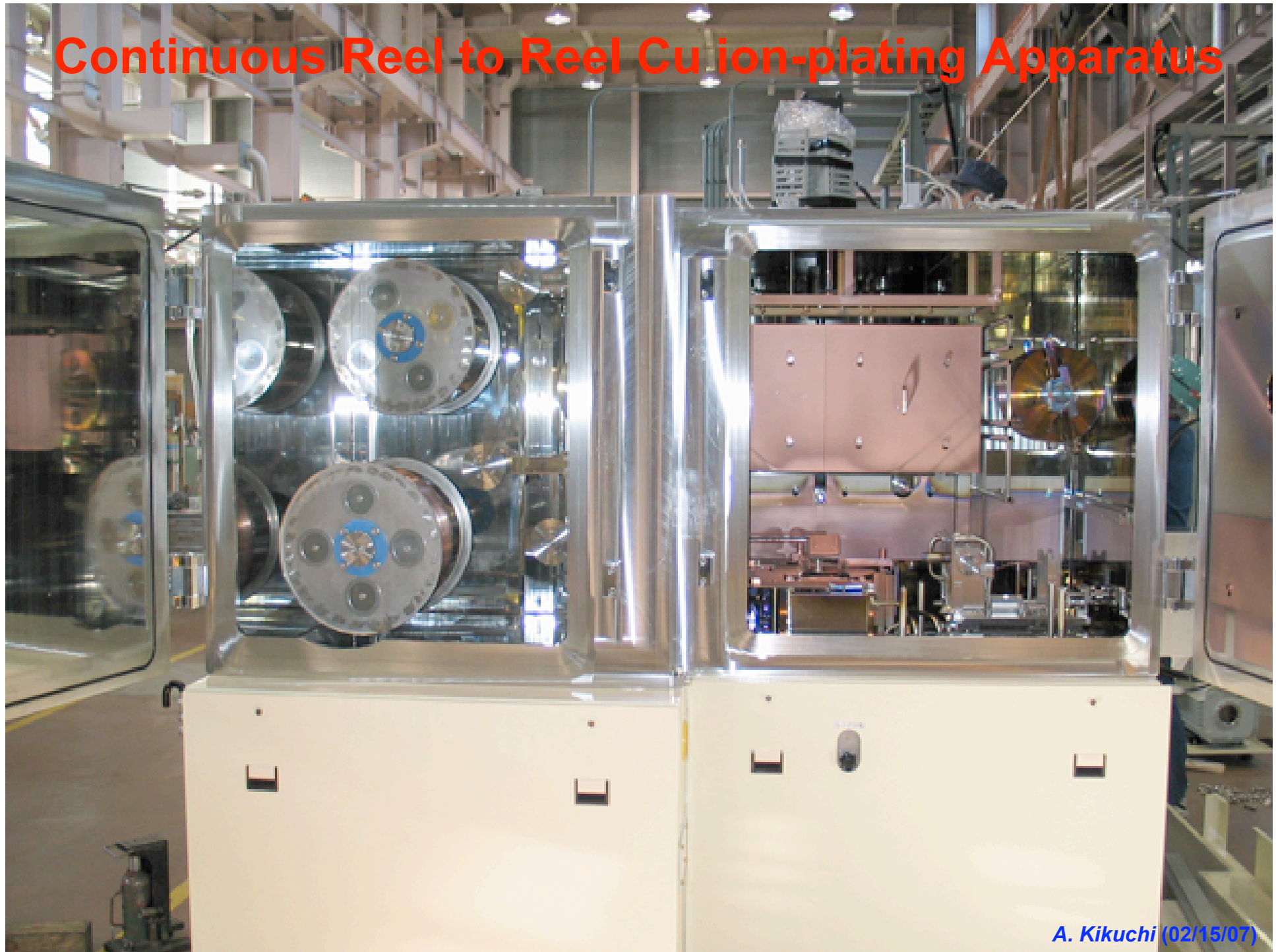
(b) with Ion-Plating



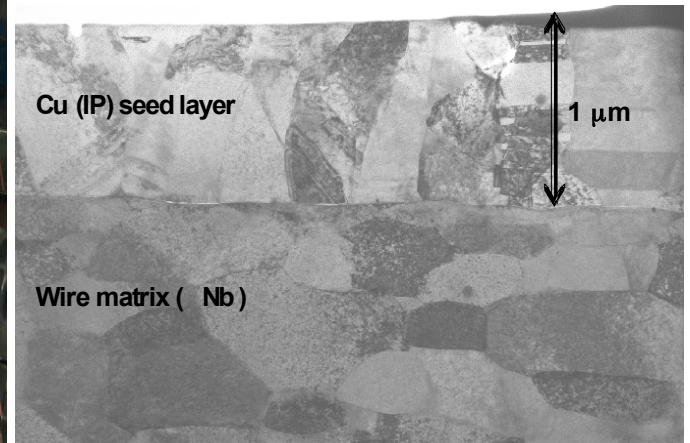
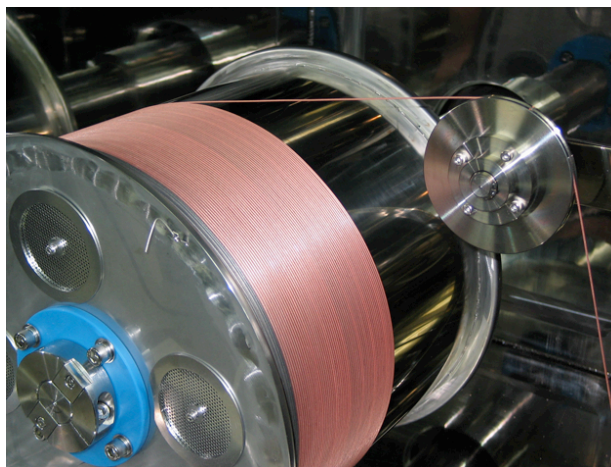
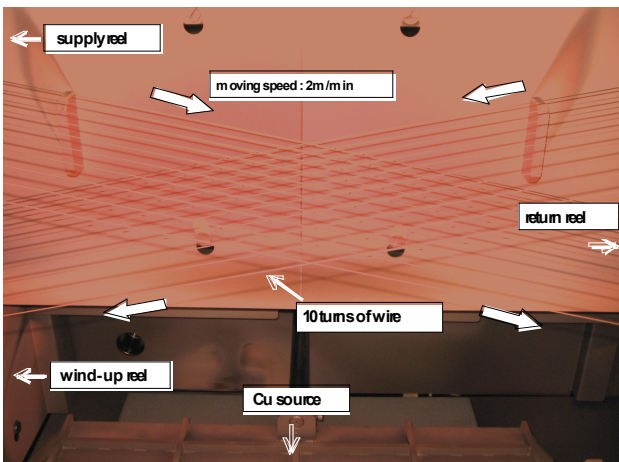
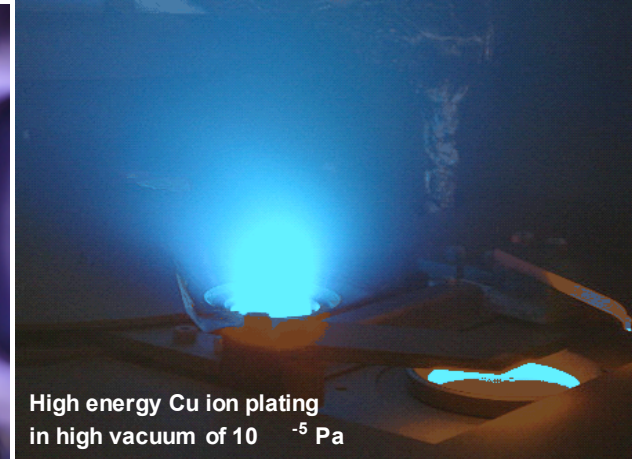
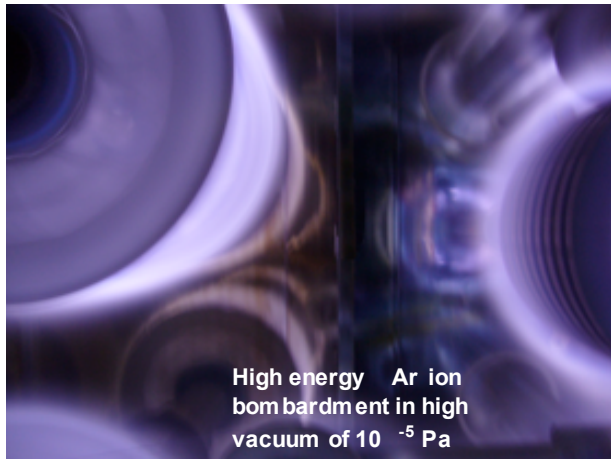
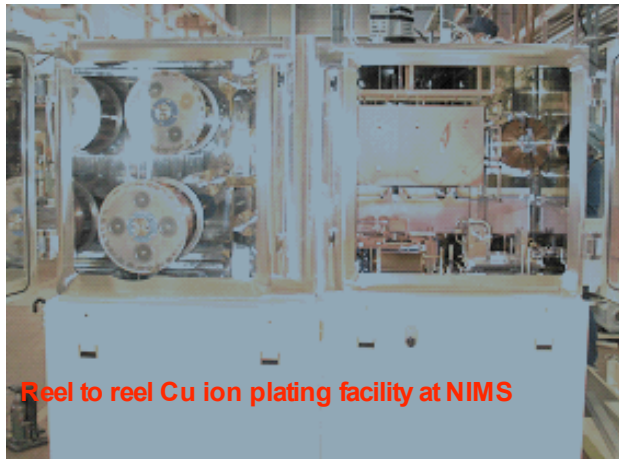
Continuous Reel to Reel Cu ion-plating Apparatus



Continuous Reel to Reel Cu ion-plating Apparatus



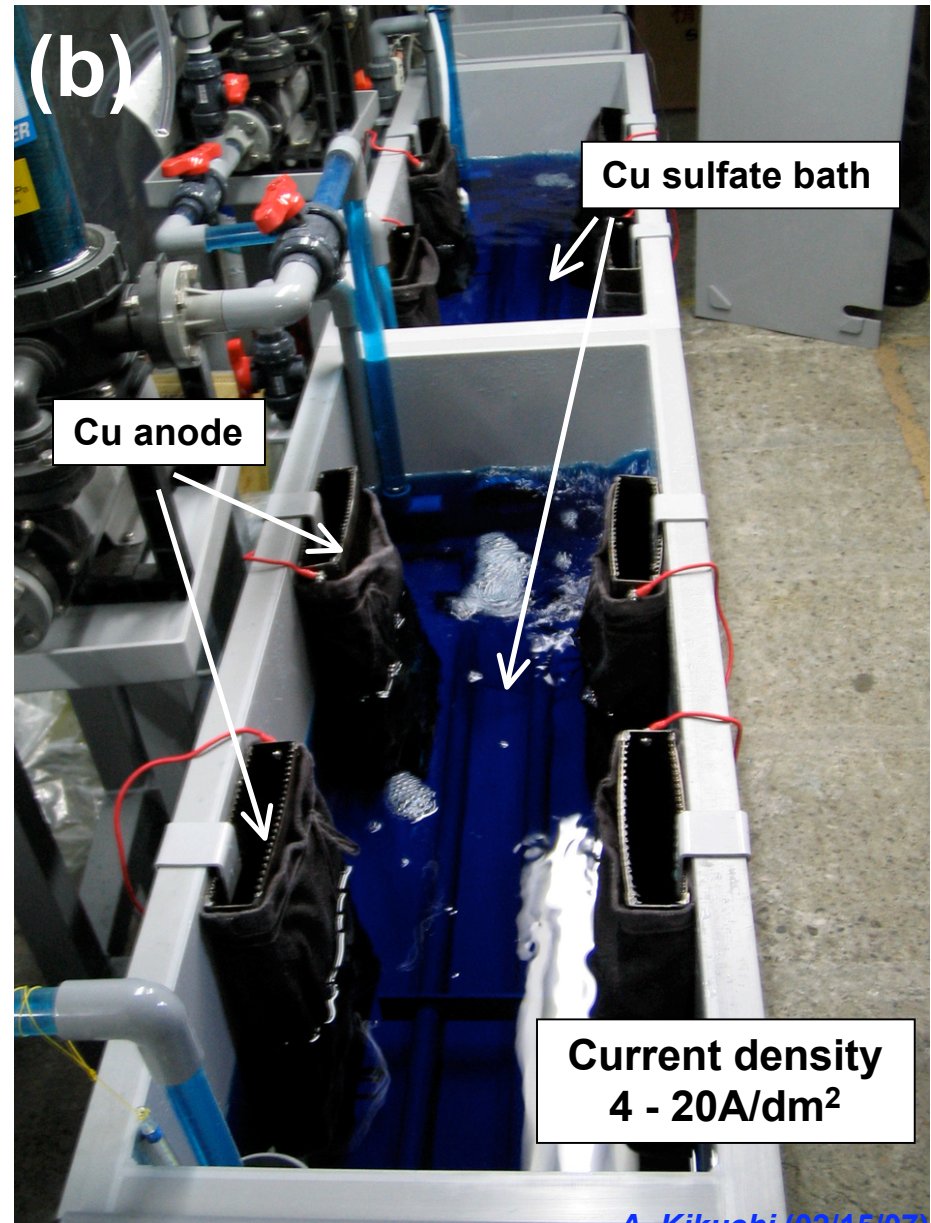
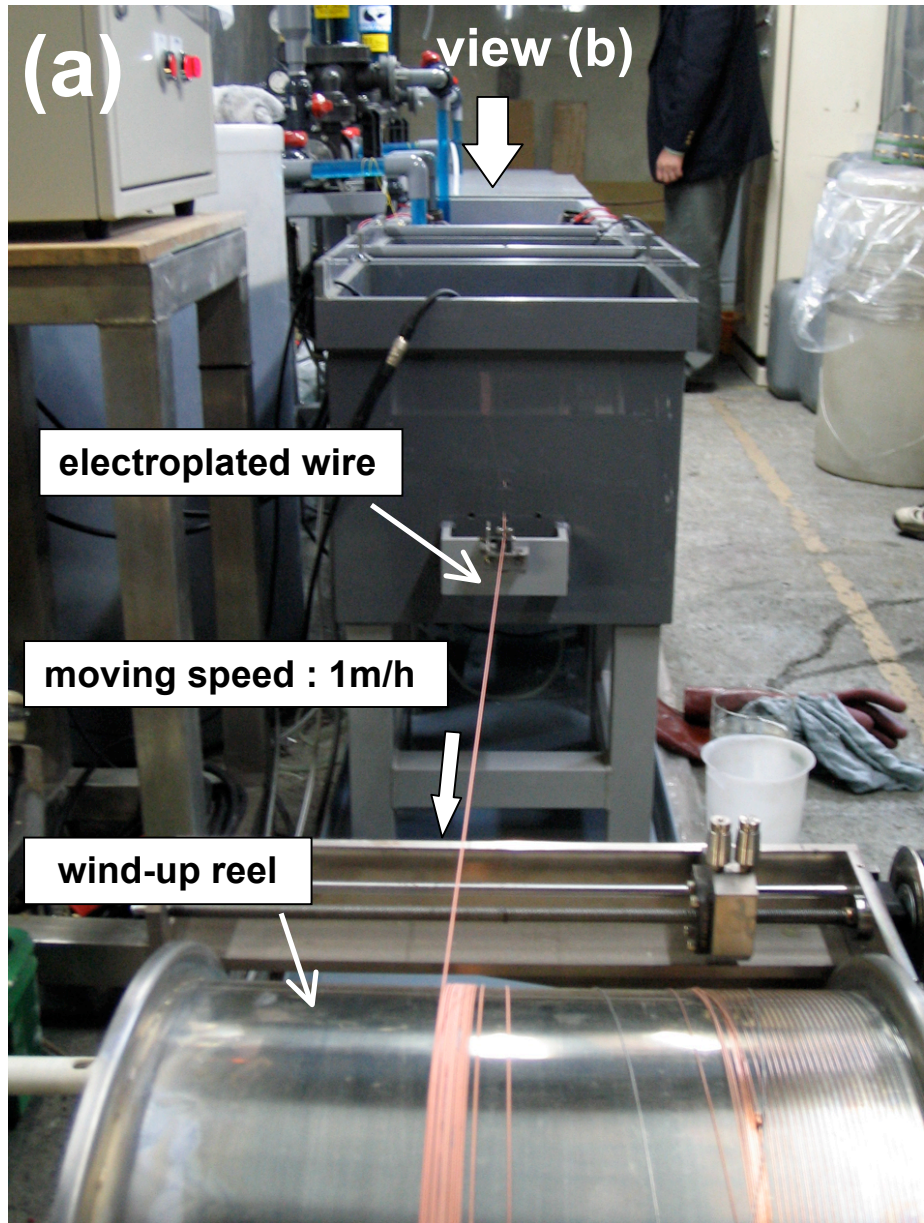
Continuous Cu ion -plating as Pre -coating



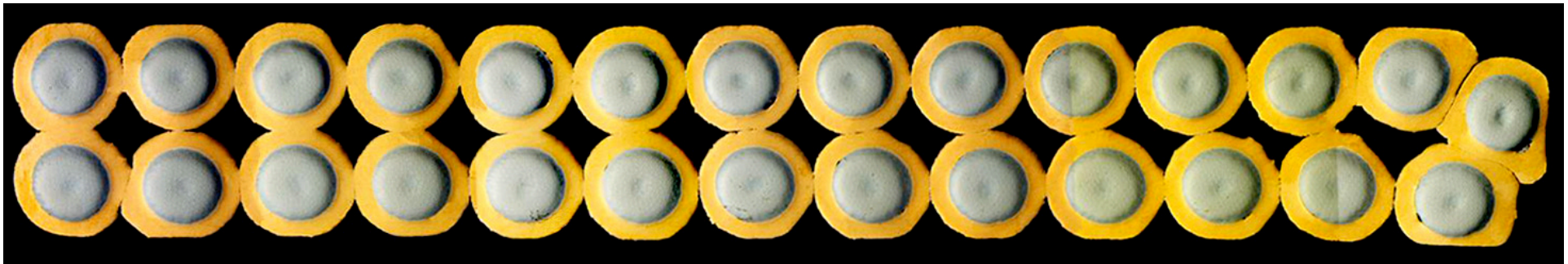
Max. length : over 1,200 m

Moving speed : 2 m / min

Reel to Reel Cu electroplating Apparatus



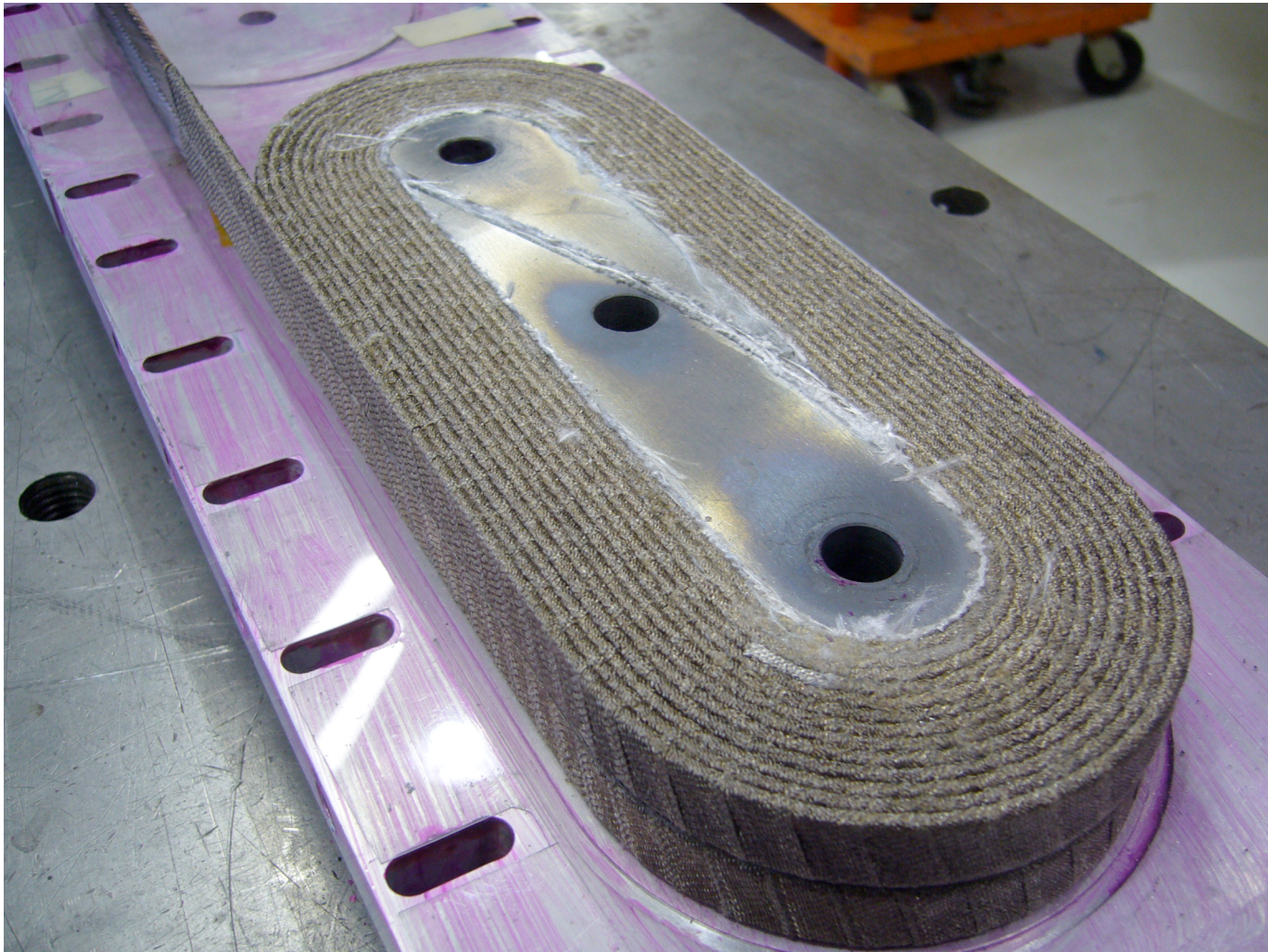
27 Strand Nb₃Al Rutherford Cable



- ✓ **Rectangular Cable** **Strand Dia = 1.03 mm**
- ✓ **Low Packing Factor = 82.5 %**
- ✓ **Size 14.17 mm x 1.993 mm** **Lay Angle 15°**

Small racetrack magnet (SR-04)

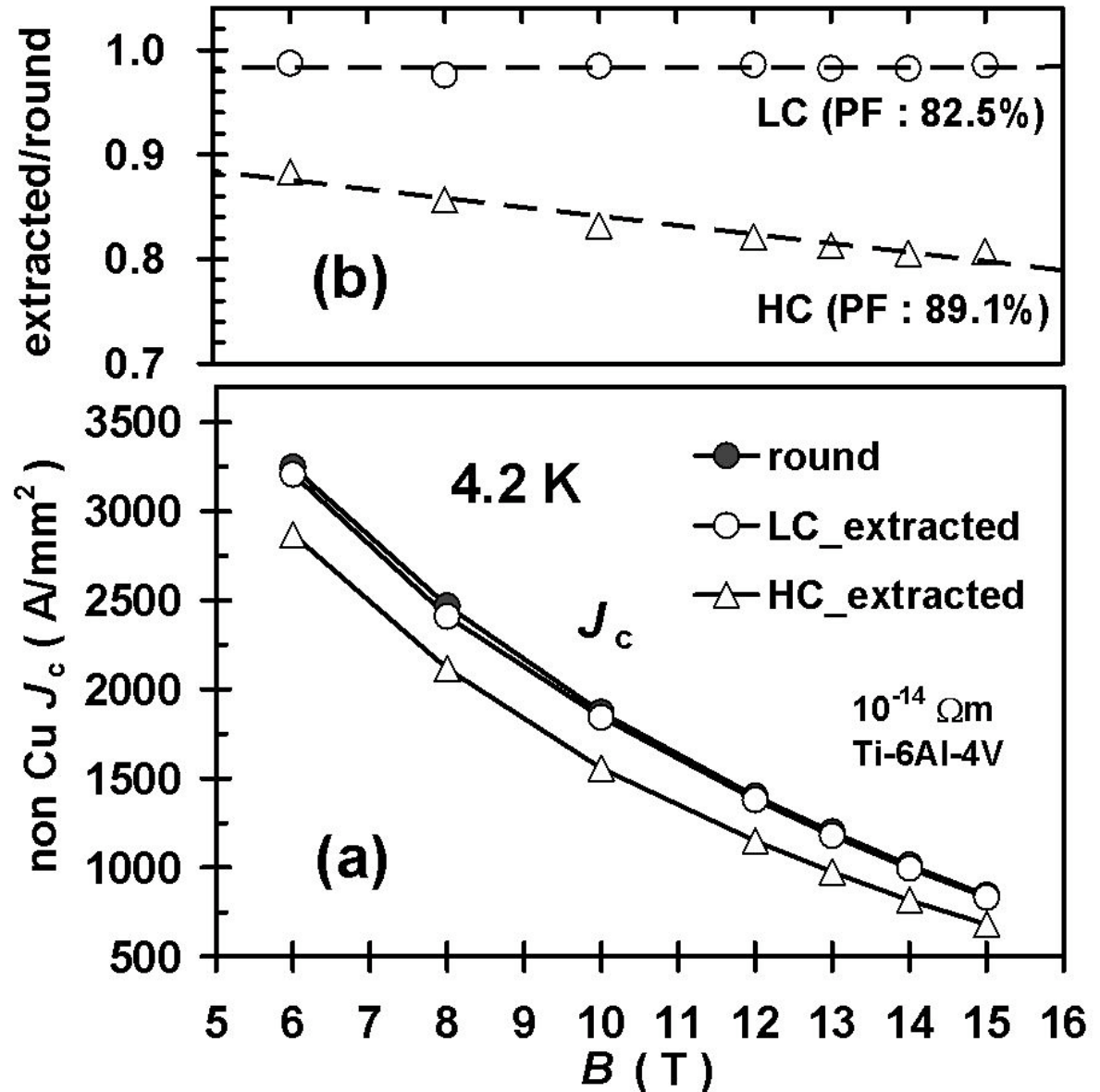
21.8 kA and 8.7 T at 3.95 K



Test results will be presented at MT20

A. Kikuchi (02/15/07)

Current Test of Round & Extracted Nb₃Al Strands

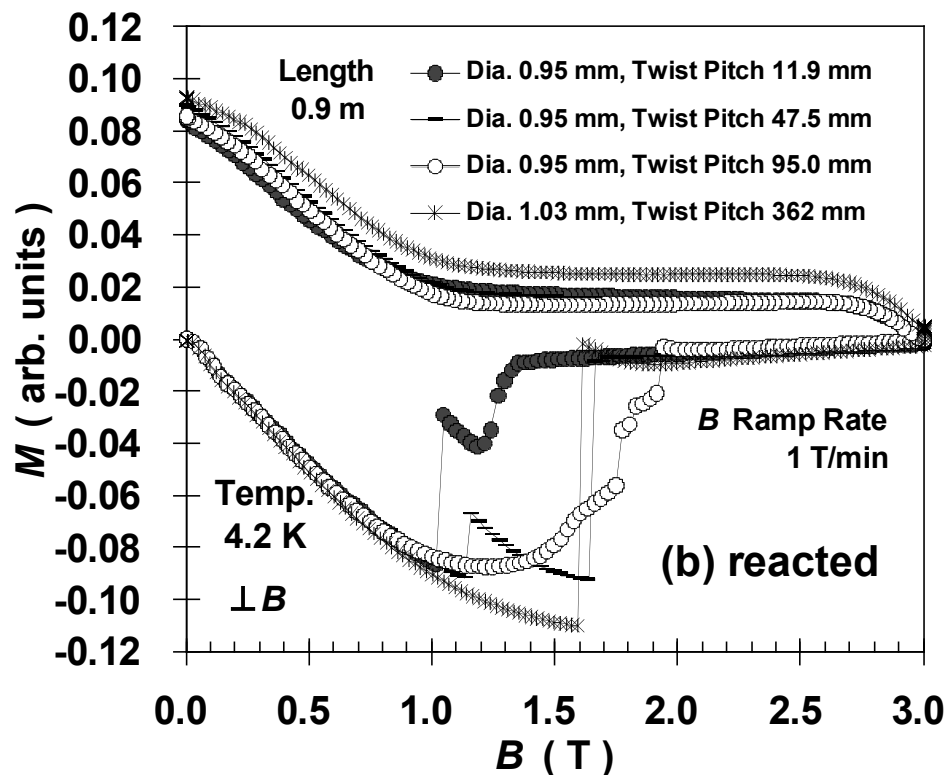


Critical Currents of Cu Stabilized Nb₃Al Strand : F1

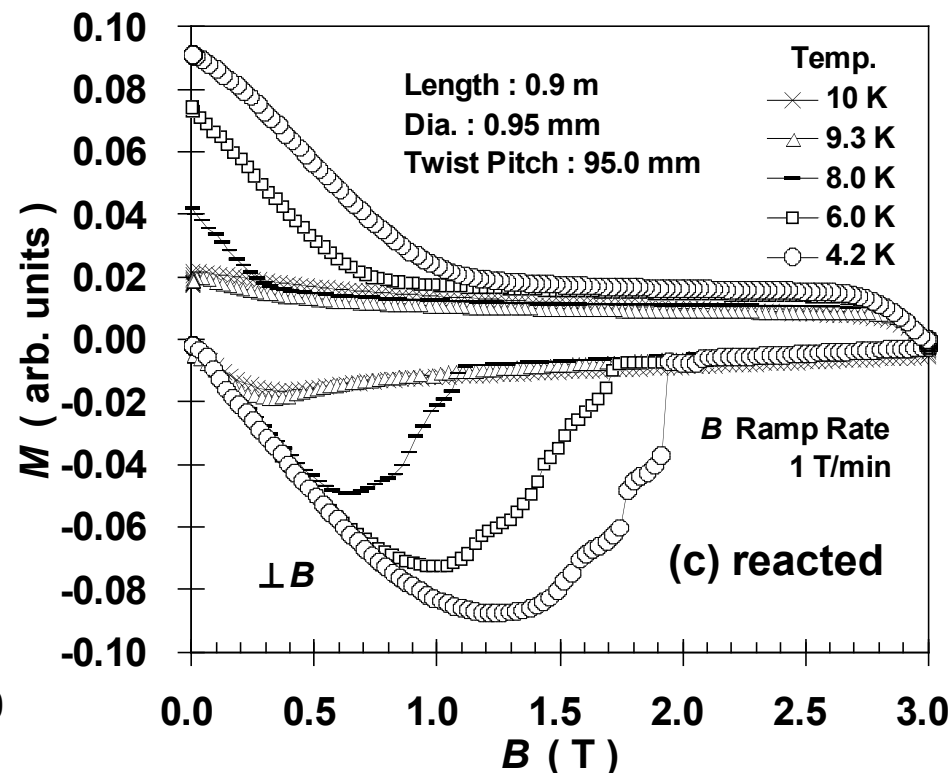
Strand ID	Virgin round	LC extracted	HC extracted
Cable packing factor	-	82.5 %	89.1 %
Heat treatment	15 h at 800 °C (in Ar atmosphere)		
I_c (4.2 K, 12 T)	582.9 A	574.7 A	478.8 A
I_c (4.2 K, 15 T)	351.5 A	346.4 A	283.8 A
non-Cu J_c (4.2 K, 12 T)	1,400 A/mm ²	1,380 A/mm ²	1,150 A/mm ²
non-Cu J_c (4.2 K, 15 T)	844.2 A/mm ²	832.0 A/mm ²	681.6 A/mm ²
n index (4.2 K, 12 T)	40.3	36.1	18.2
n index (4.2 K, 15 T)	35.5	32.1	18.0
RRR (20K/300K)	200	186	not measured



Flux jumps on F1 strand (Nb barrier)



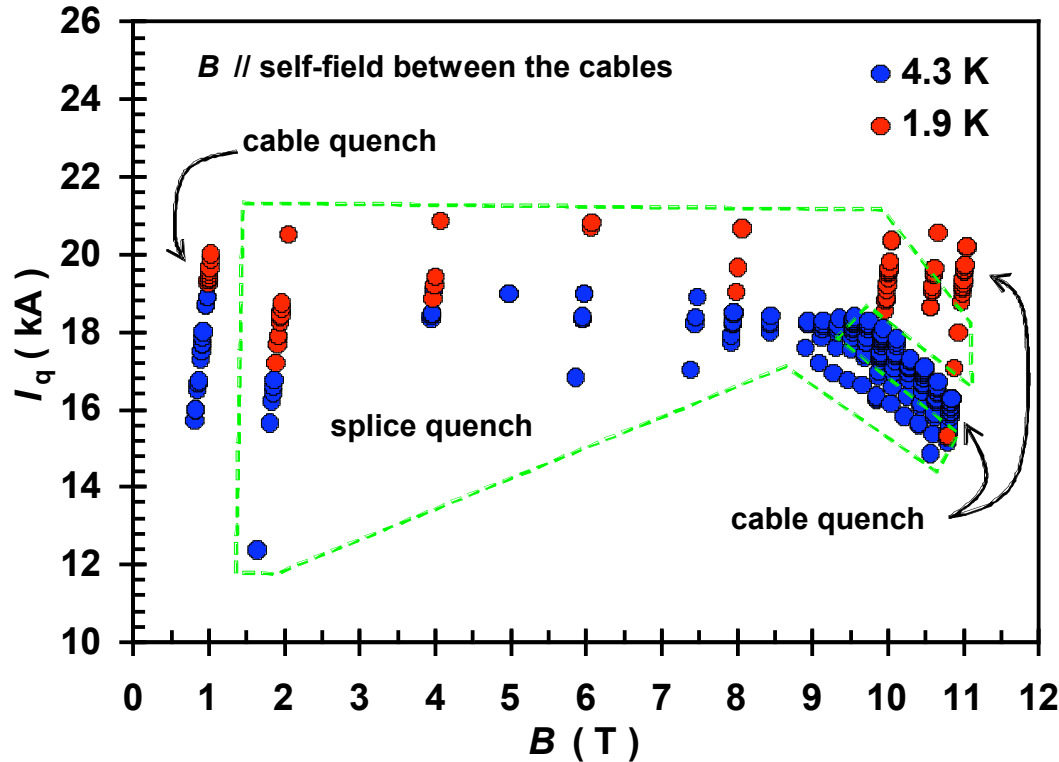
Big flux jumps were usually observed at 1-2T, which is much larger than B_{c2} of Nb



Big flux jumps were disappeared at 9.3K, which is the T_c of Nb.

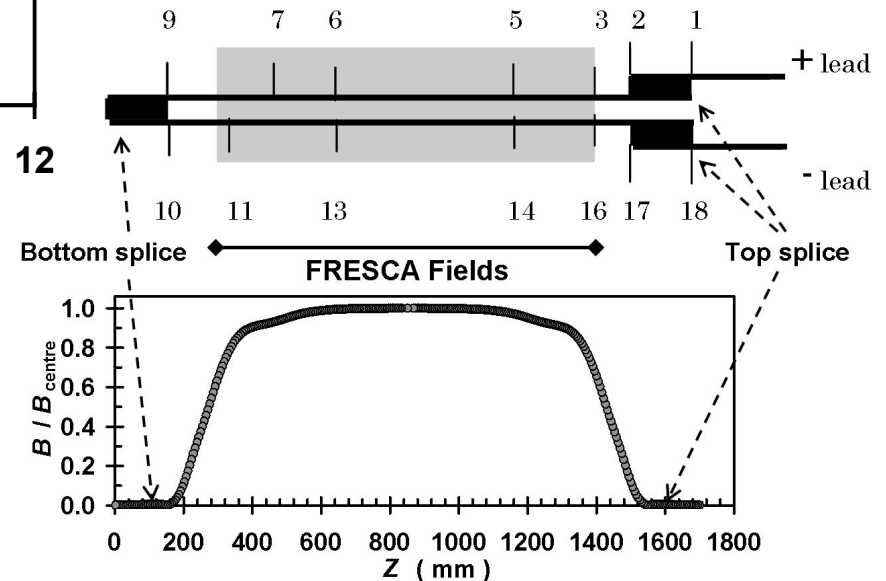


Instability at low fields

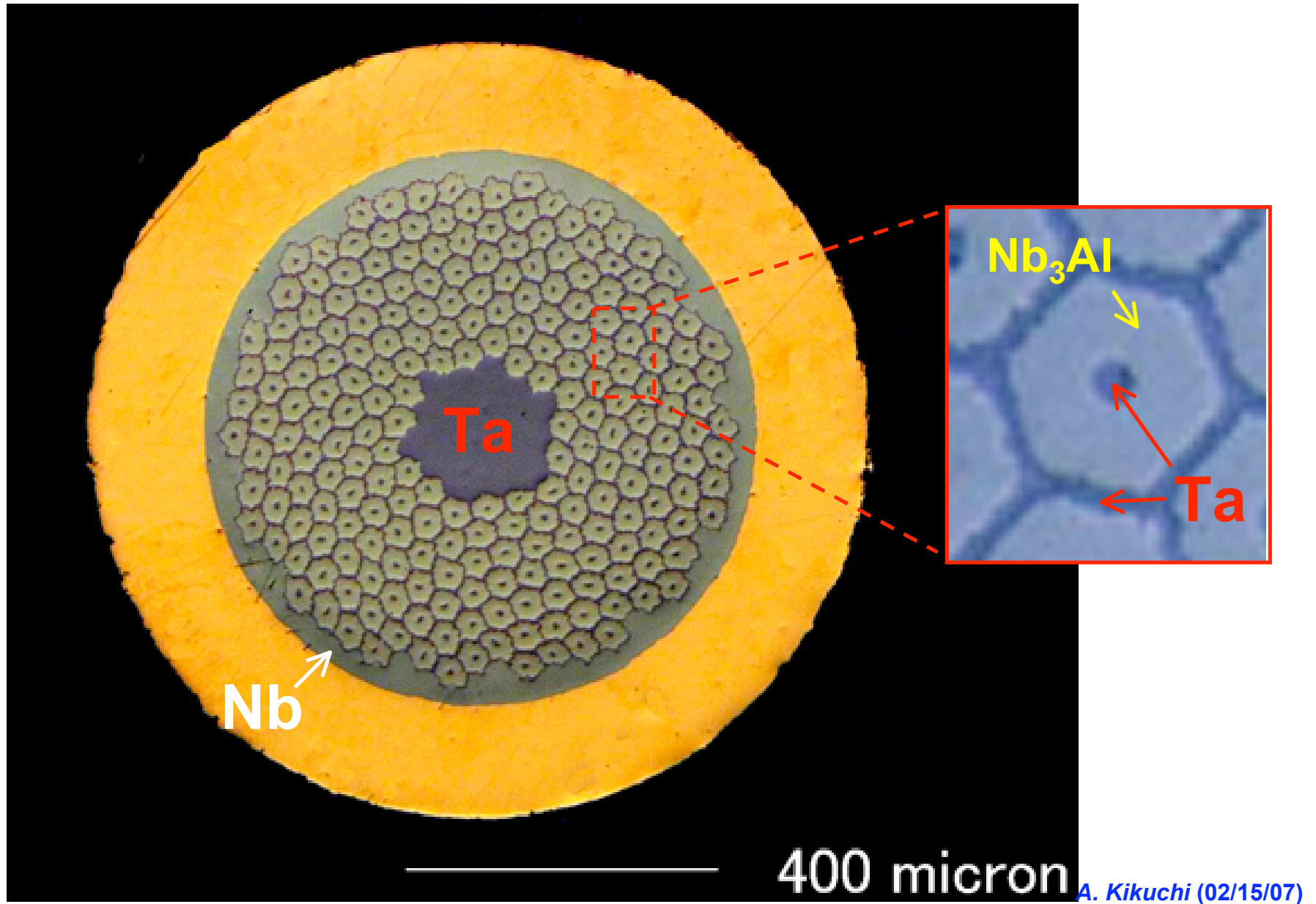


Quench happens at low field region of the cable (near or at the splice).

Cable test results at FRESCA



Ta barrier Nb_3Al strand (F3)



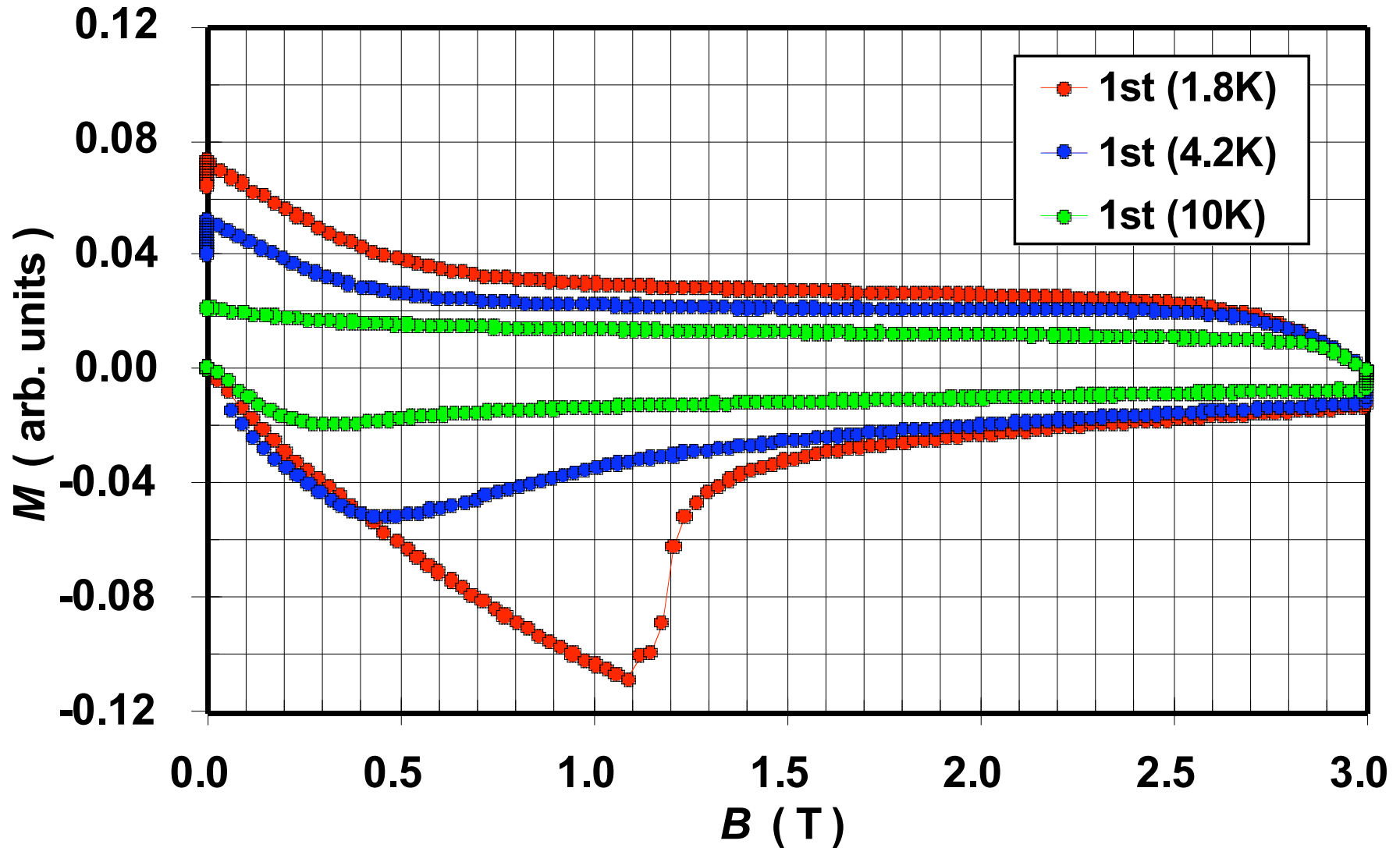


New Nb₃Al strand specification

Strand ID	F1	F3
Strand Dia. (mm)	1.03 (±0.01)	1.00 (±0.01)
Dia without Cu (mm)	0.71 (±0.01)	0.75 (±0.01)
SC Fil. Number	144	222
SC Fil. Dia. (μm)	50 (hexagonal)	38 (hexagonal)
Barrier Material	Nb	Ta
Core Material	Nb	Ta
Outer Material	Nb	Nb
Dummy Fil. Material	Nb	Ta
Dummy Fil. Number	19	19
Cu ratio	1.0 (50%Cu)	0.78 (44%Cu)
Twist pitch (mm)	362 mm	45 mm
Total length (m)	1,250 mm	700 m

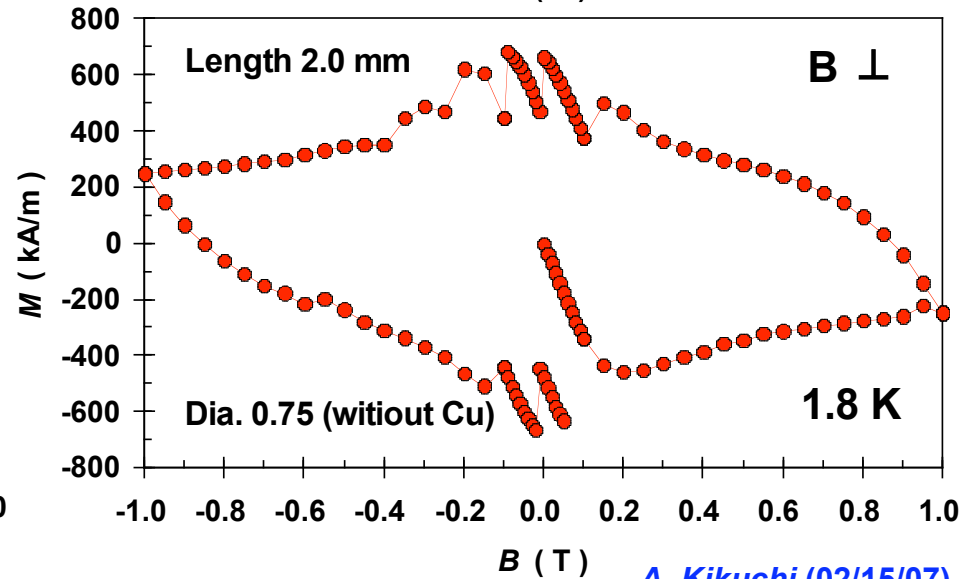
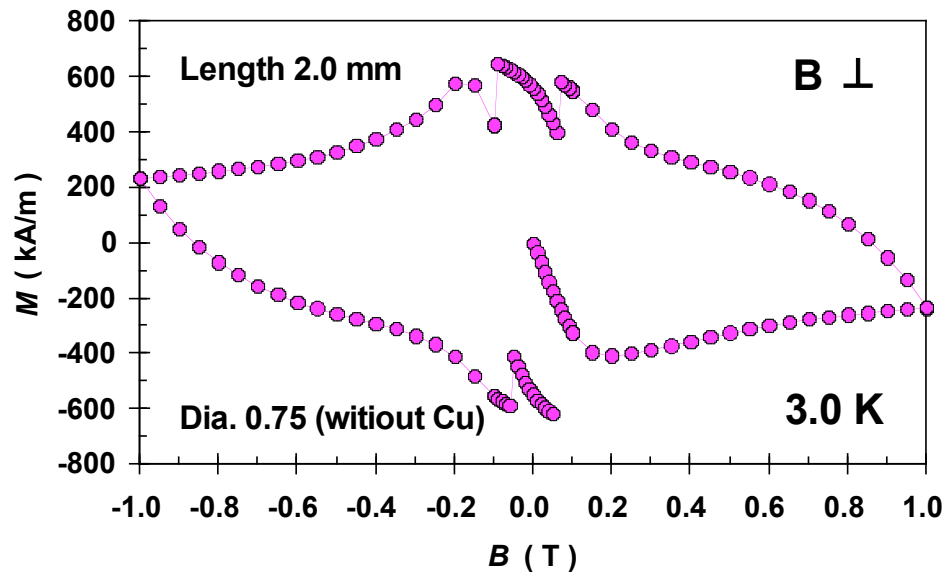
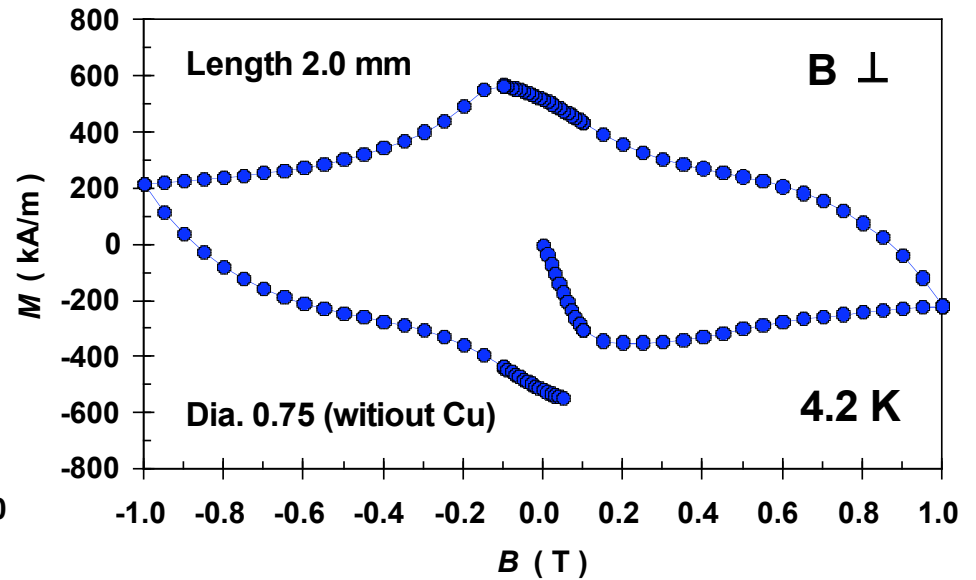
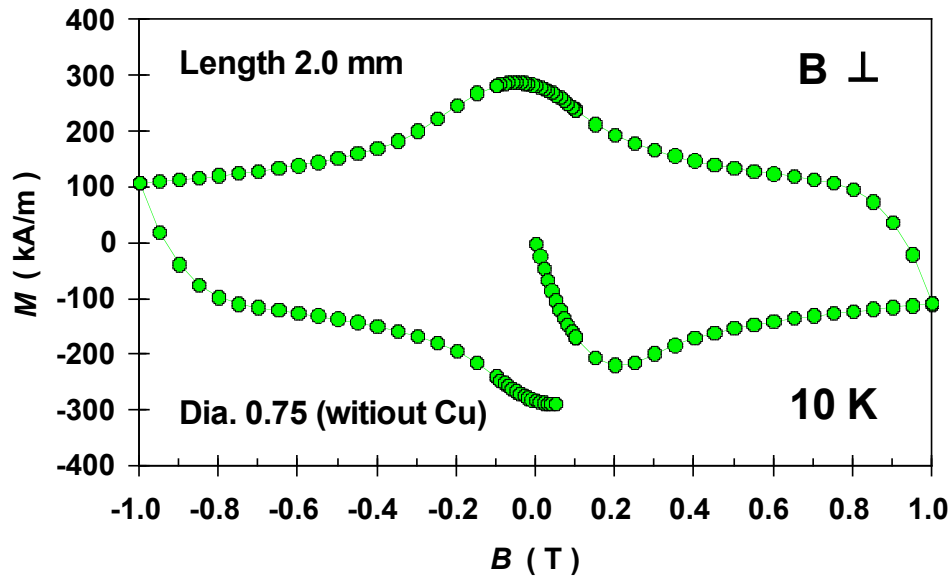


Magnetization curves of F3 strand (Balanced coil magnetometer)



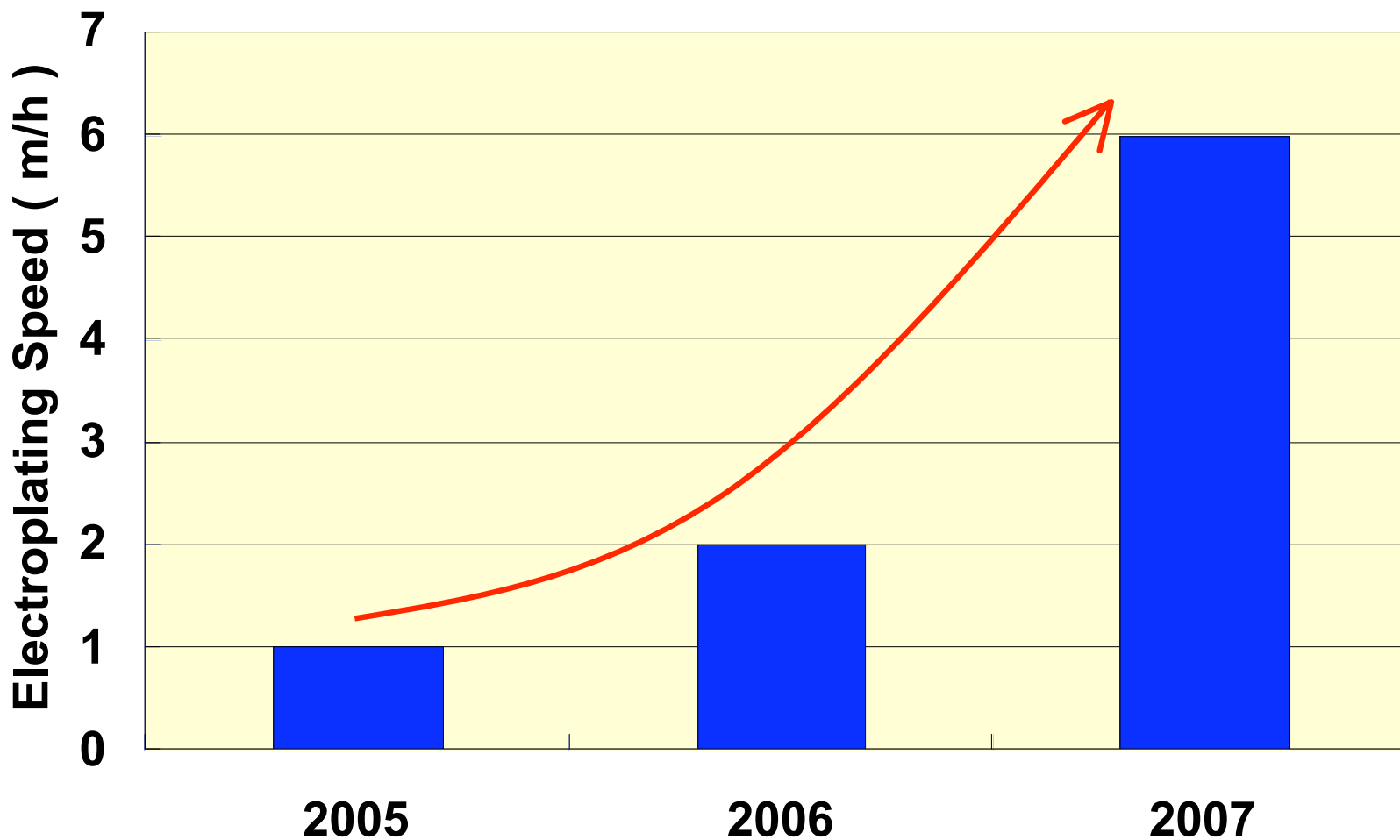


Magnetization curves of F3 strand (SQUID magnetometer)





High Speed Cu electroplating





Summary

- **Strand piece length : can make over 1 km**
- **Cu ion-plating speed : 2 m/min (easy, quick, 2 km possible)**
- **Cu electropating speed : 6 m/h (2007) ← 2 m/h (2006)**
- **Jc at 12 T,4.2K : 1500 A/mm**
- **Jc at 15 T,4.2K : 1000 A/mm**
- **Transversal Pressure : no Jc degradation at 220 MPa and more**
- **Min. Deff : can go under 30 μm**
- **Instability at low fields : can improve with Ta barrier**
- **High compaction cable : need study**
- **Improvement of non Cu Jc : need more study**
- **Fabrication cost : expect to be comparable with PIT**