11-18-98

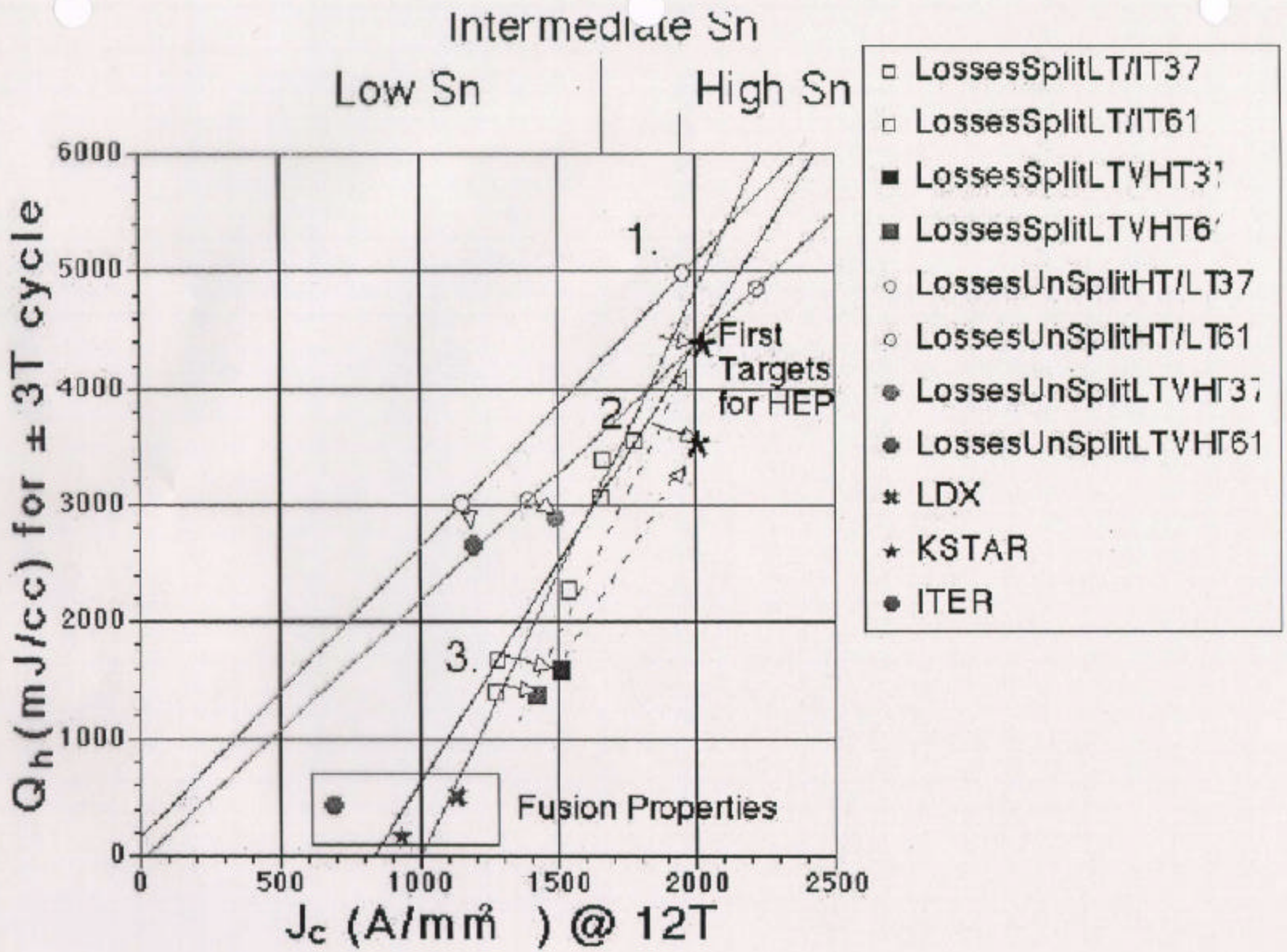
CONDUCTOR SUMMARY/DISCUSSION

Nb_3Sn – GOOD PROGRESS IN SOME AREAS:

- J_c (NON-COPPER, 12T, 4.2K) INCREASED FROM 650 A/mm² TO 1400 A/mm² (D20) TO 2200 A/mm²
- 20 TONS OF WIRE PRODUCED FOR ITER
- KILOMETER PIECE LENGTHS ARE BEING PRODUCED

BUT – SEVERAL PROBLEMS REMAIN

- J_c INCREASE MAINLY AT THE EXPENSE OF D_{eff}. (SPLIT GEOMETRY HELPS SOME)
- COST MUST BE REDUCED – PROCESS SCALE-UP?
- INTRINSIC J_c SHOULD BE INCREASED
- CABLE J_c VS STRAIN NEEDS MORE WORK
- CAN INDUSTRY REMAIN VIABLE?
  - COMMERCIAL MARKETS?
  - HEP SUPPORT?



ADVANCED SUPERCONDUCTORS
A DIVISION OF INTERMAGNETICS GENERAL CORPORATION

Target specification values for Nb_3Sn

Critical current density (12T, 4.2 K)	2000 A/mm^2
D_{eff} (Interim value for intrinsic stability)	less than 20 microns (less than 80 microns)
Wire diameter	0.8 mm LBNL 1.0 mm FNAL 1.3 mm TAMU 0.2mm - 0.4mm FOR REACT/BOND
Minimum piece length (Interim value for model magnets)	6000m (150 m)

Recent achievements in high Jc(12T,4.2K) Nb3Sn include:

- OST/TWCA--2100 A/mm2
- IGC--2200A/mm2
- EMI--1350 A/mm2
- Mitsubishi--1285A/mm2
- SMI--1400 A/mm2
- Vacuumschmelze(bronze)--680 A/mm2

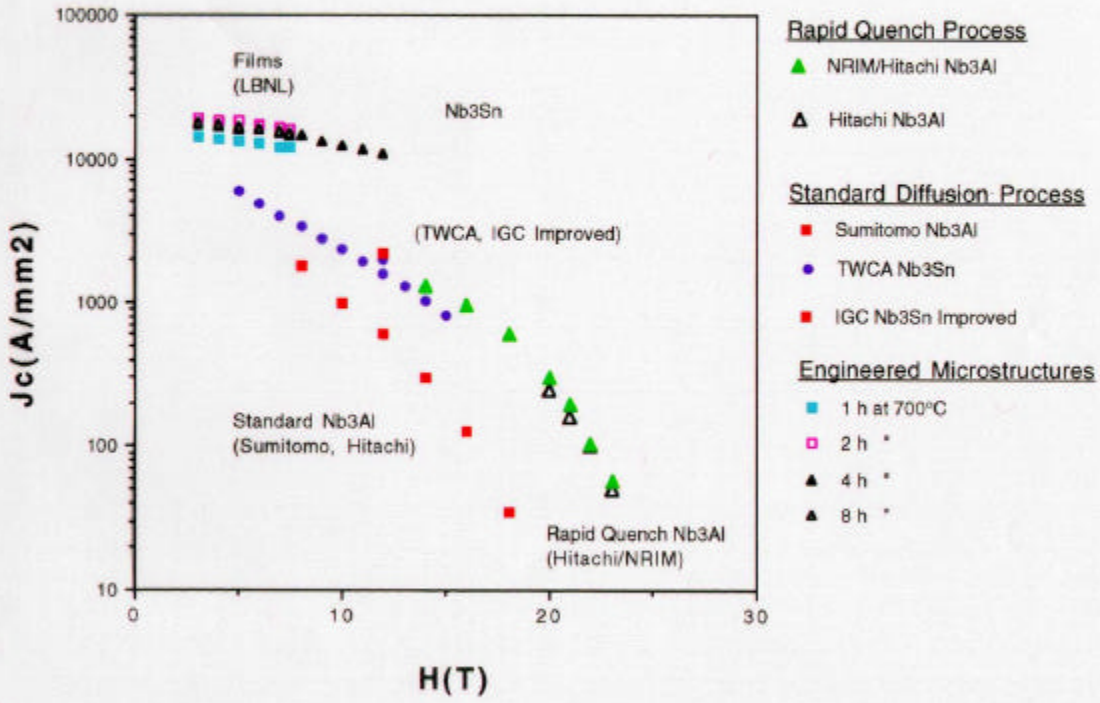
Nb_3Al – SHOWS PROMISE FOR ACCELERATOR MAGNETS

- RAPID QUENCH PROCESS PRODUCES GOOD T_c, H_{c2}. J_c COMPARABLE TO Nb_3Sn
- LOW STRAIN SENSITIVITY FOR RAPID QUENCH PROCESS MATERIAL HAS BEEN VERIFIED.
- EFFORT IN U.S. IS UNDERWAY, JAPANESE EFFORT IS CONTINUING.

<u>BUT</u> SEVERAL QUESTIONS REMAIN:

- CAN RAPID QUENCH PROCESS BECOME A VIABLE INDUSTRIAL FABRICATION PROCESS?
- WILL U.S. AND JAPANESE EFFORTS CONTINUE IN THE ABSENCE OF ITER AND/OR COMMERCIAL APPLICATIONS?
- IS THERE A TIME/PERFORMANCE NICHE FOR Nb_3Al, OR WILL HTS CONDUCTORS TAKE OVER?

Critical Current of LTS Conductor



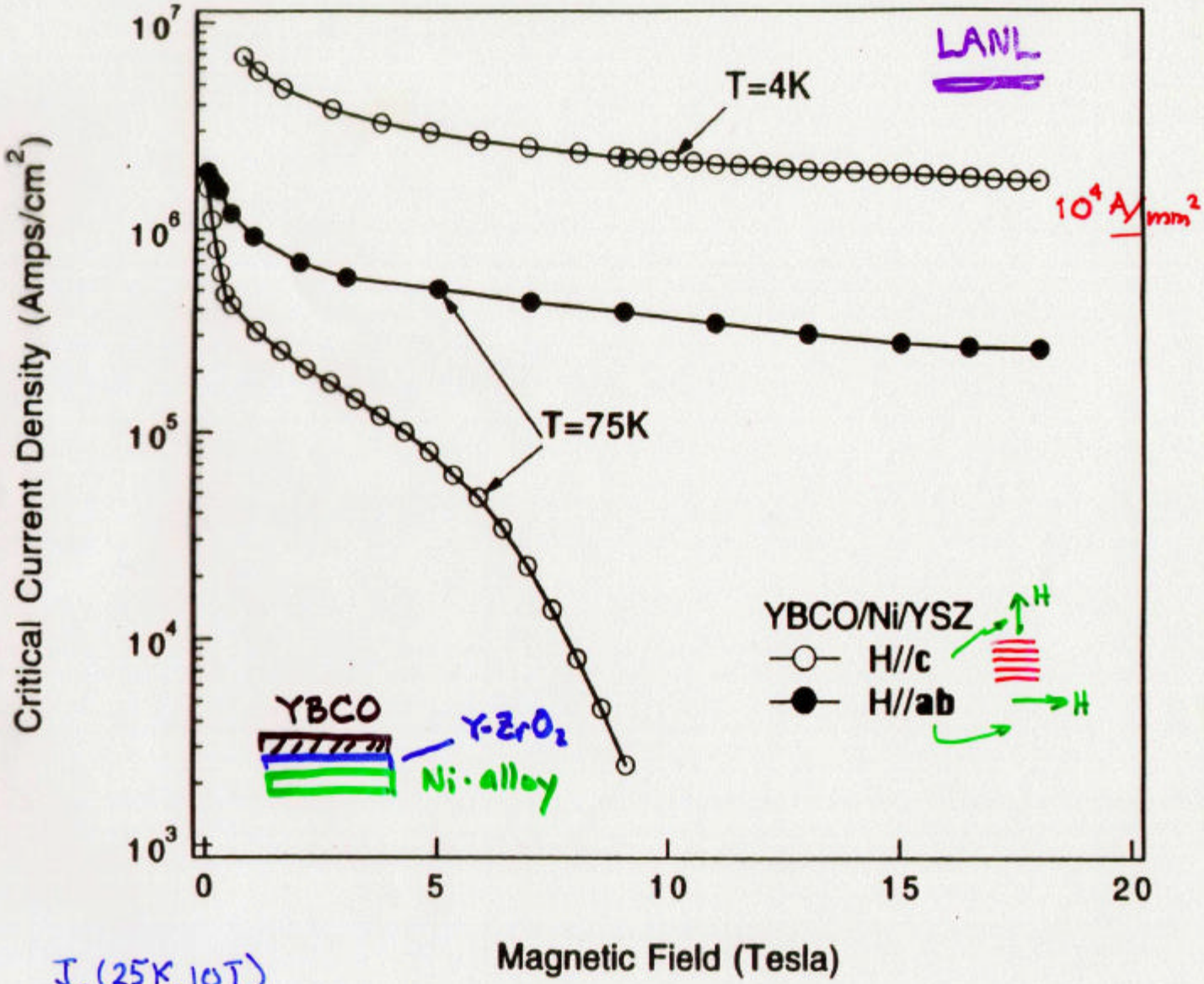
YBCO - GREAT INTRINSIC PROPERTIES!

- $> 10{,}000\ A/mm^2$ (4K, 15-20T)
- LENGTHS INCREASED FROM ~1 cm to 1 m
- STRAIN BEHAVIOR IS GOOD FOR THIN FILMS

BUT PRACTICAL LONG LENGTH FABRICATION PROCESS NEEDS TO BE DEVELOPED

- SUBSTRATES
- BUFFER LAYERS
- THICK FILMS

THESE PROBLEMS ARE THE FOCUS FOR MANY LARGE PROGRAMS IN U.S., JAPAN, AND EUROPE.

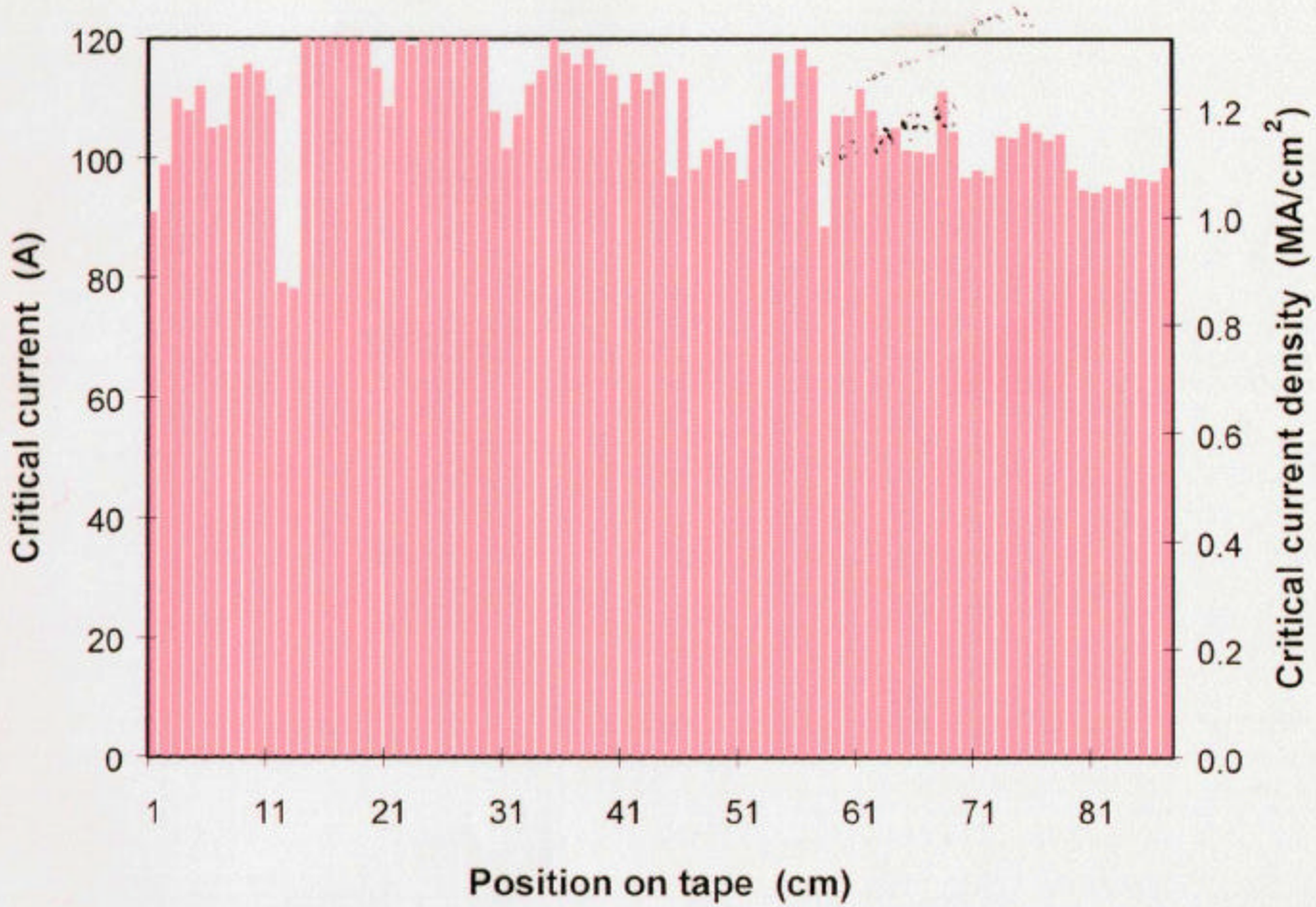


$J_c(25K, 10T)$

$\simeq (\frac{1}{2} \sim \frac{1}{3}) J_c(4K, 10T) \sim J_c(77K, 0T)$

Sept 98

YBCO/IBAD coated conductor with an end-to-end I_c of 96 A at 75 K, self field



BSCCO - GOOD, STEADY PROGRESS

2223 TAPE: $J_c \sim 230\ A/mm^2$ (4.2K, 10T) (R&D)

$J_c \sim 130\ A/mm^2$ (4.2K, 10T) (400 m TAPES)

J_c VS STRAIN MAY BE BETTER THAN EARLY DATA - ODS MATRIX HELPS

2212 TAPE: $J_c \sim 500\ A/mm^2$ (4.2K, 10T) R&D

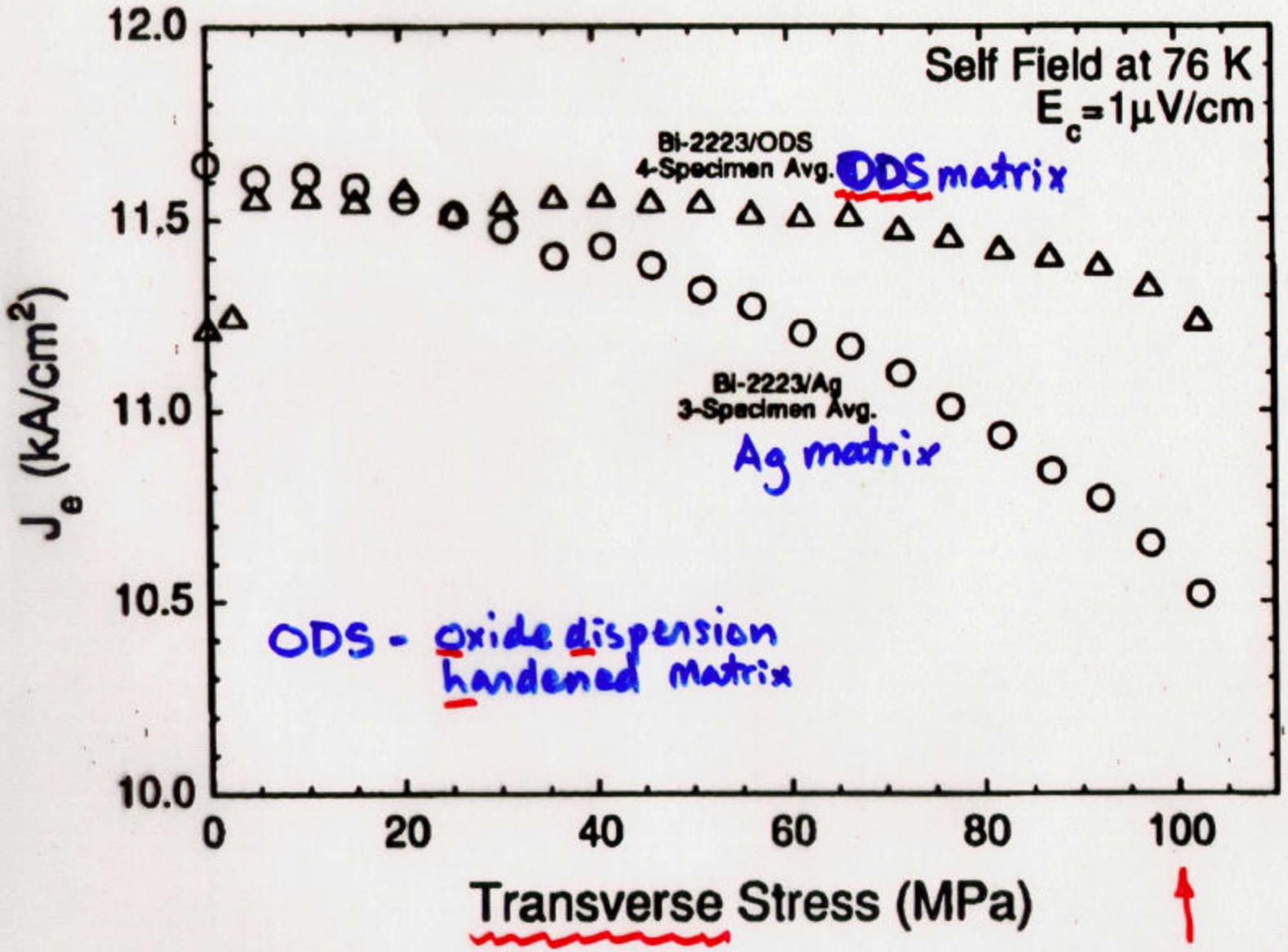
2212 WIRE: $I_c \sim 1600$ A AT 5T IN 19 STRAND RUTHERFORD CABLES ($670\ A/mm^2$)

<u>BUT</u> - PROGRESS STARTED AT A LOW BASELINE!

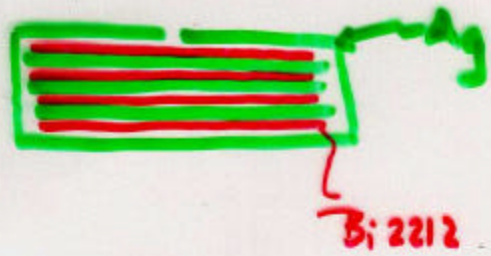
- J_c NEEDS TO BE IMPROVED
- UNIFORMITY AND REPRODUCIBILITY IN LONG LENGTHS NEEDS TO BE IMPROVED
- CONDUCTOR COSTS MUST BE REDUCED
- WE NEED MORE J_c VS STRAIN DATA

Bi 2223/Ag

Steve Bray & Jack Ekin
NIST, Boulder, CO



Bi(2212)/Ag



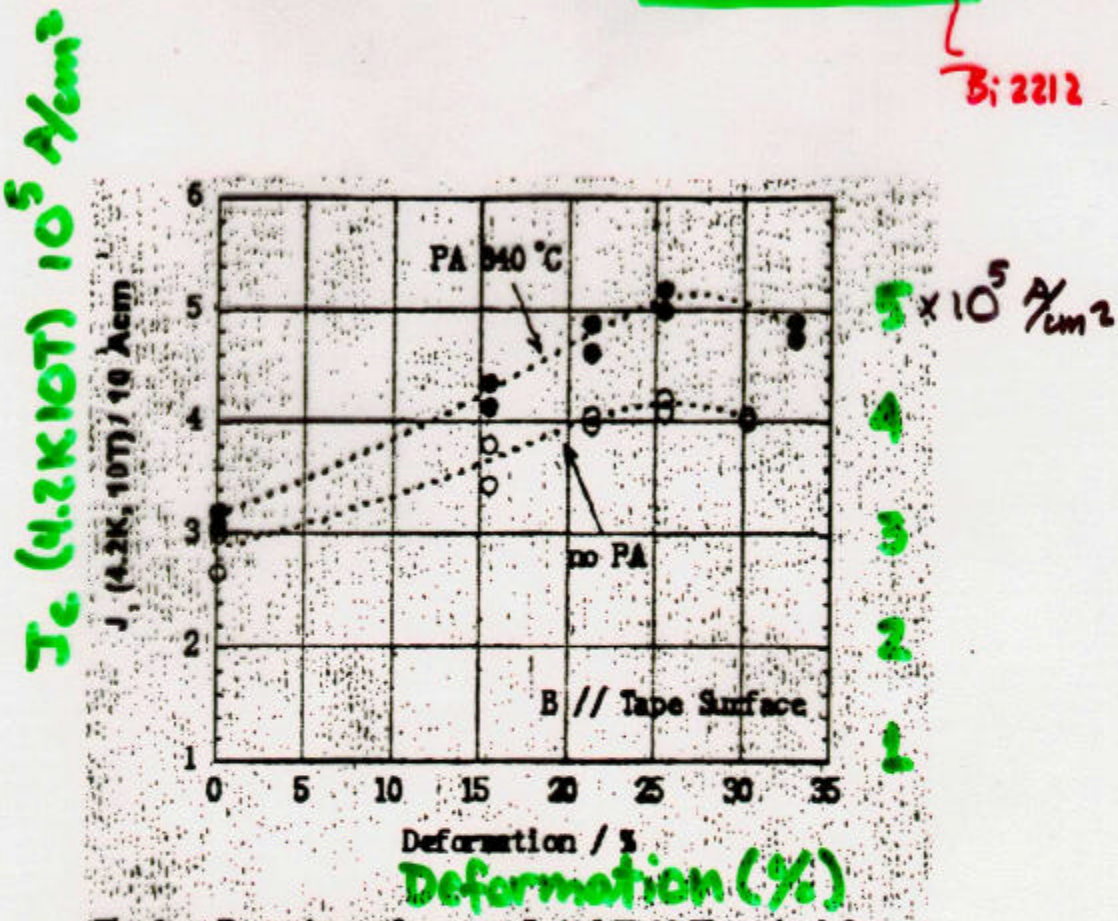


Fig. 6 Dependence of transport Je (4.2 K, 10 T) on the deformation for the tape #BW. The open circles denote samples without pre-annealing process, and the solid circles indicate samples with pre-annealing process at 840oC for 1h.

H. Miao, et al. NRIM

T. Hasegawa ... Showa Electric Wire & Cable, Co.

WHAT CAN M.E.P. DO TO SOLVE (SOME) OF THESE PROBLEMS?

-PERSONAL VIEW-

- PROVIDE SUPPORT TO INSURE THAT Nb_3Sn REMAINS A VIABLE MATERIAL FOR HIGH FIELD MAGNET R+D FOR THE NEXT 5-10 YEARS
- LOOK FOR WAYS TO INCREASE THE INTRINSIC J_c
- SUPPORT PROCESS IMPROVEMENTS AND SCALE UP WORK NECESSARY TO REDUCE Nb_3Sn COSTS [THIS WILL ALSO PROVIDE A MATERIALS PIPELINE TO KEEP R+D MAGNET PROGRAMS MOVING AHEAD AT FNAL, LBNL, TAMU]
- PROVIDE SUPPORT FOR A CRITICAL MASS PROGRAM TO EVALUATE RAPID QUENCH Nb_3Al.
- DEVELOP MAGNET FABRICATION TECHNIQUES TO USE NEW MATERIALS [TAPE CONDUCTORS, BSCCO CABLES, REACT & WIND].

"CONDUCTOR FRIENDLY" MAGNETS