RABiTS: Status and Issues

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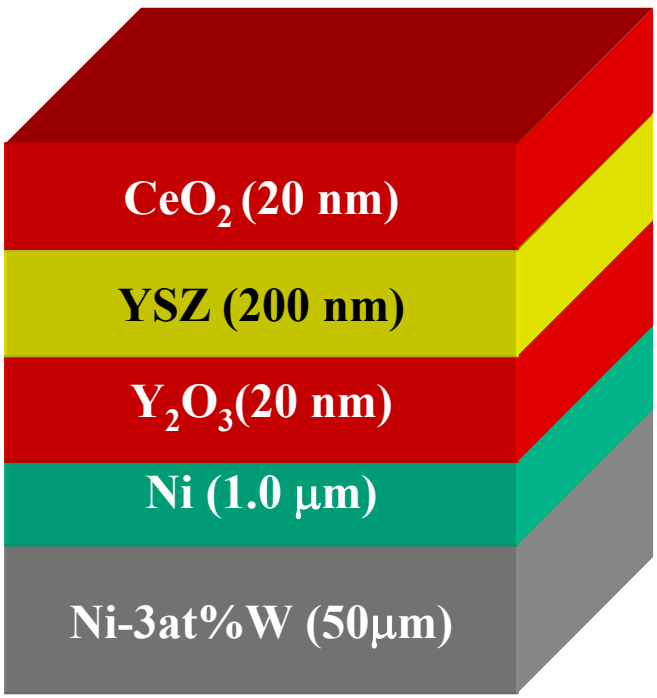
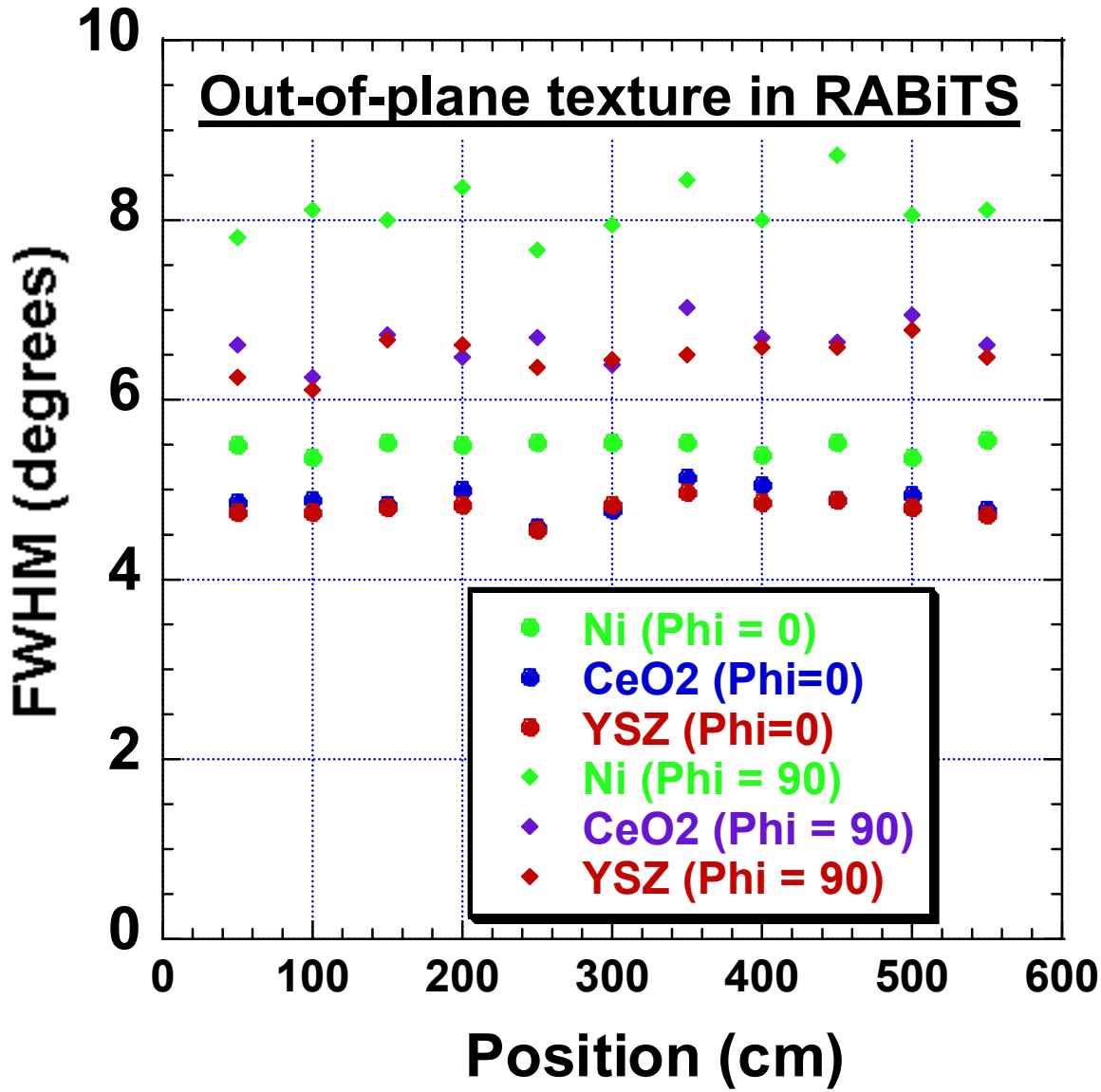
HTS Wire Development Workshop

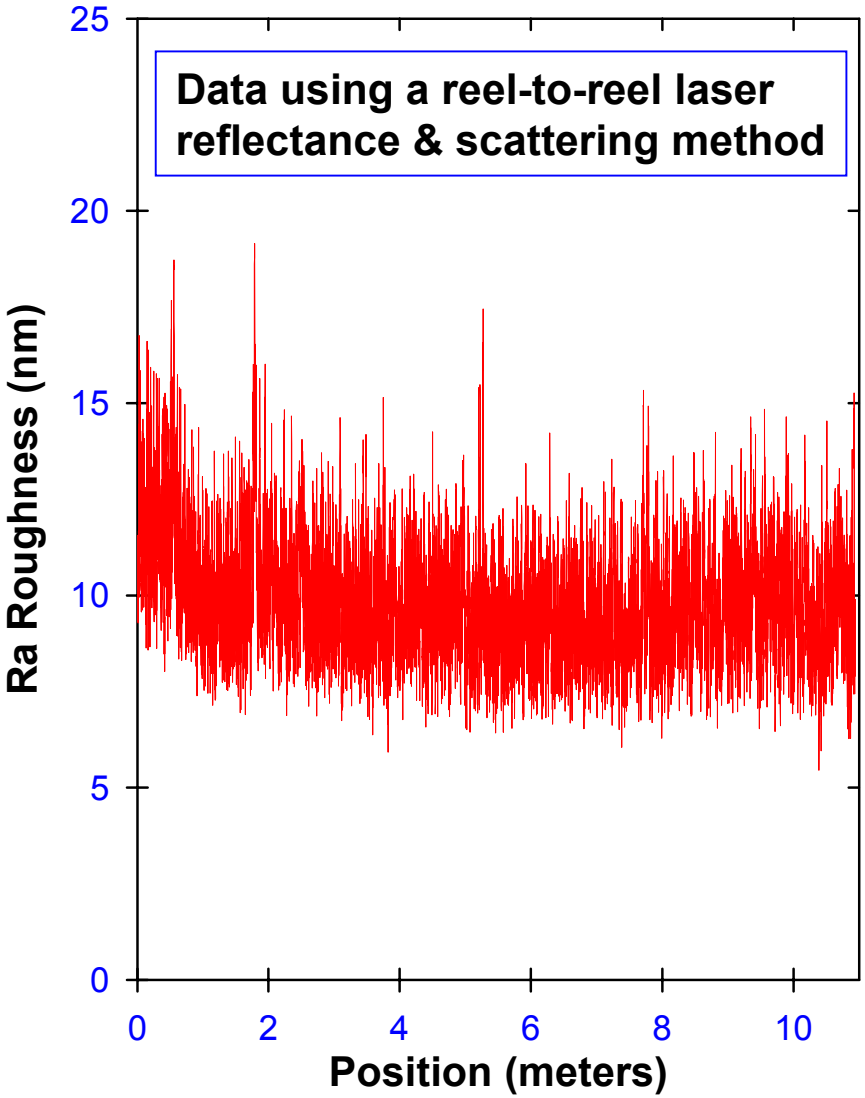
St. Petersburg, FL, January 21, 2003

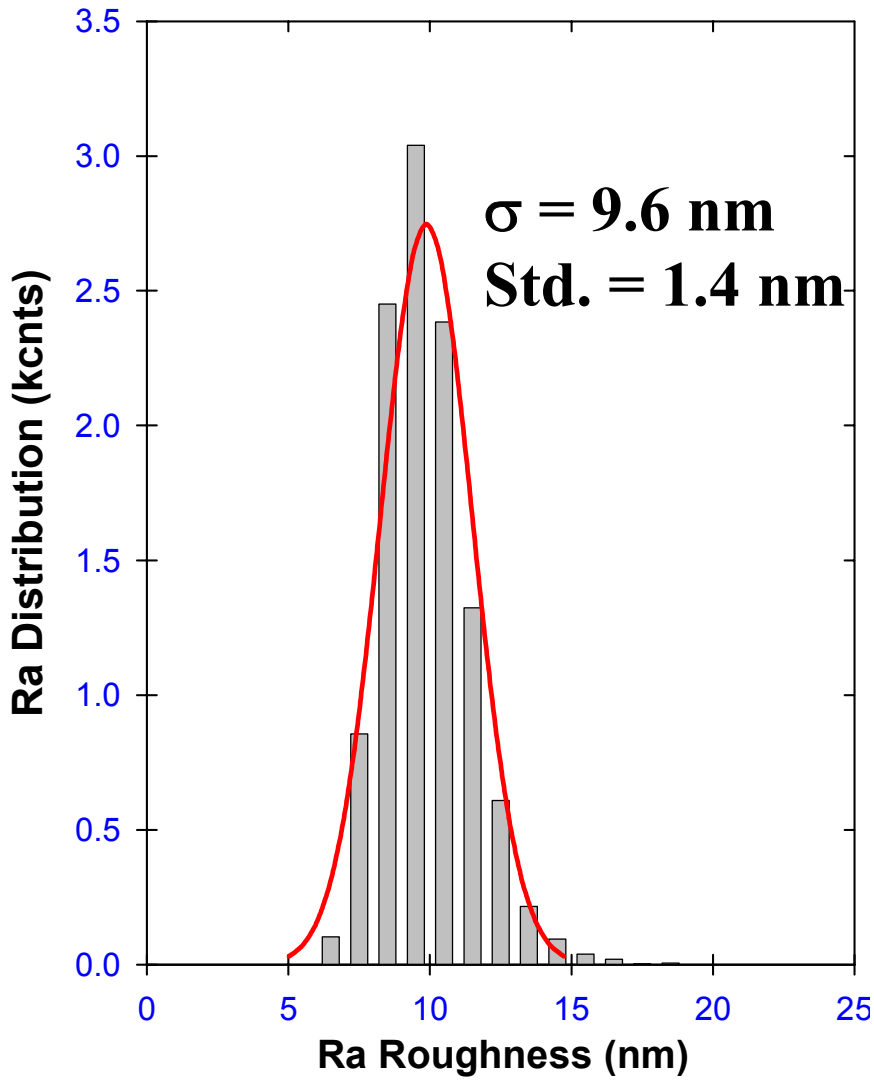
The Standard RABiTS Tape



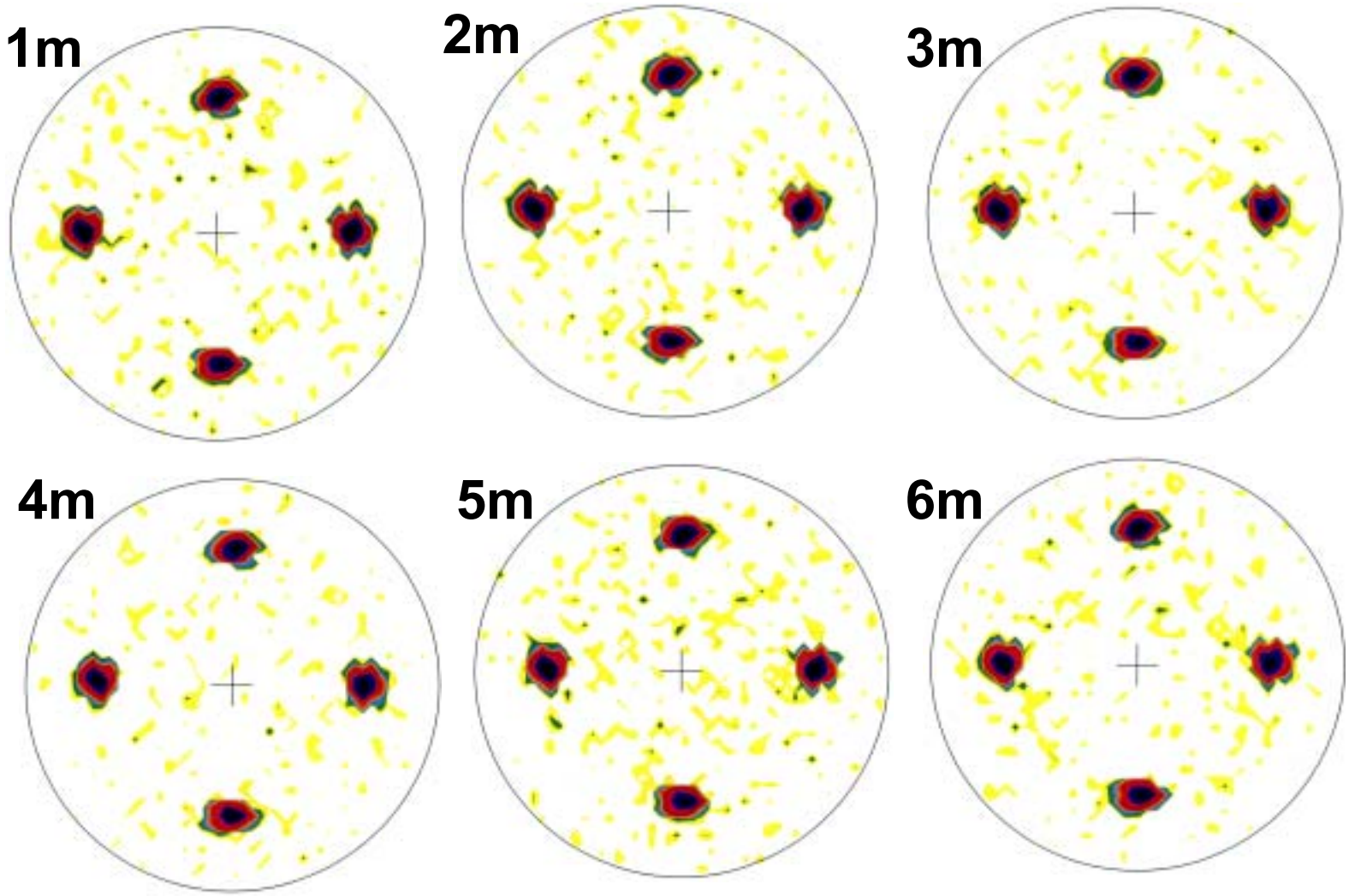


Surface roughness for an 11-meter length of ORNL buffered Ni-W (σ = 9.6nm; s = 1.4nm)





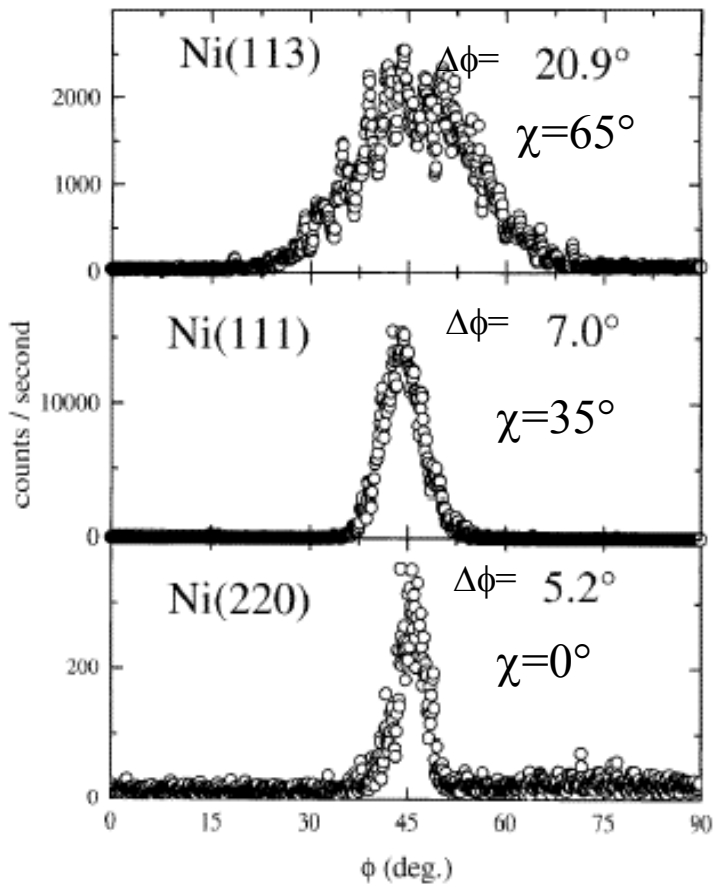
Log-scale (111) pole figures for YSZ along the length of tape show good homogeniety



Phi Scan Width Depends On The Reflection and on the FWHM of the Omega Scans

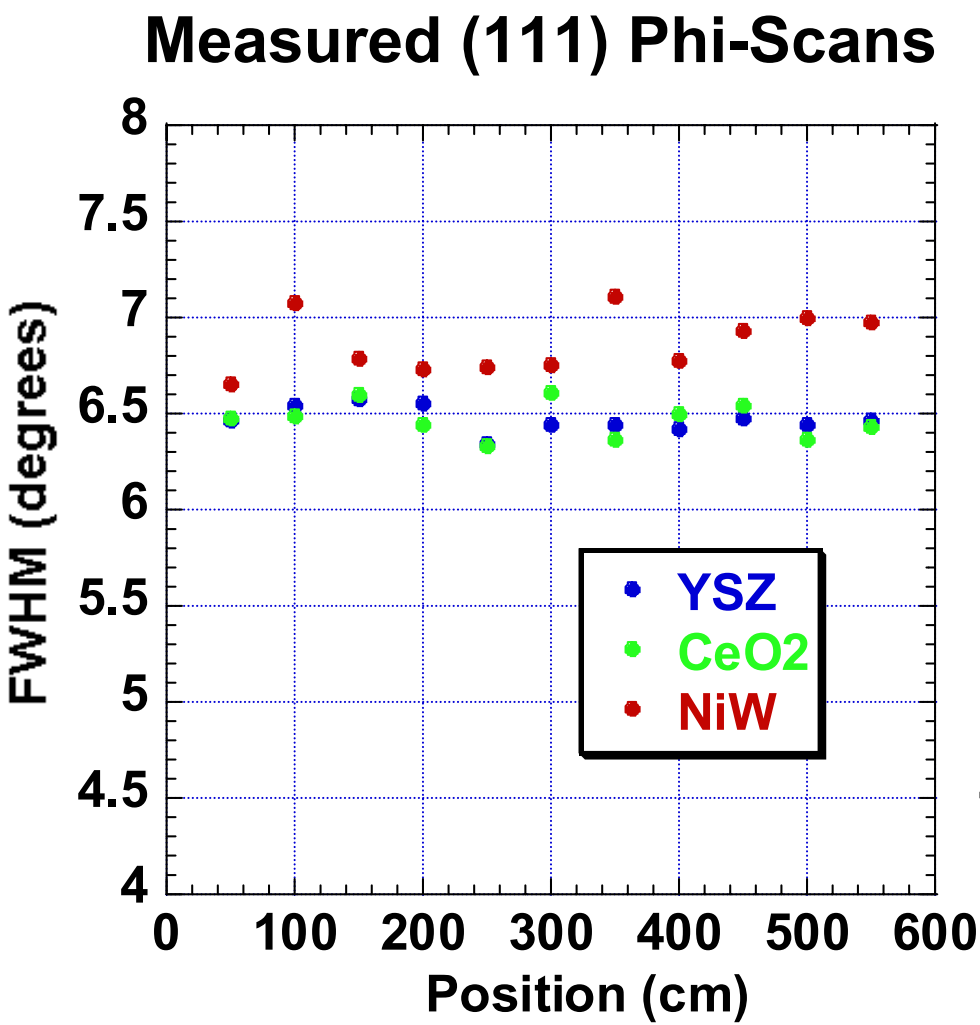
True in-plane FWHM is:

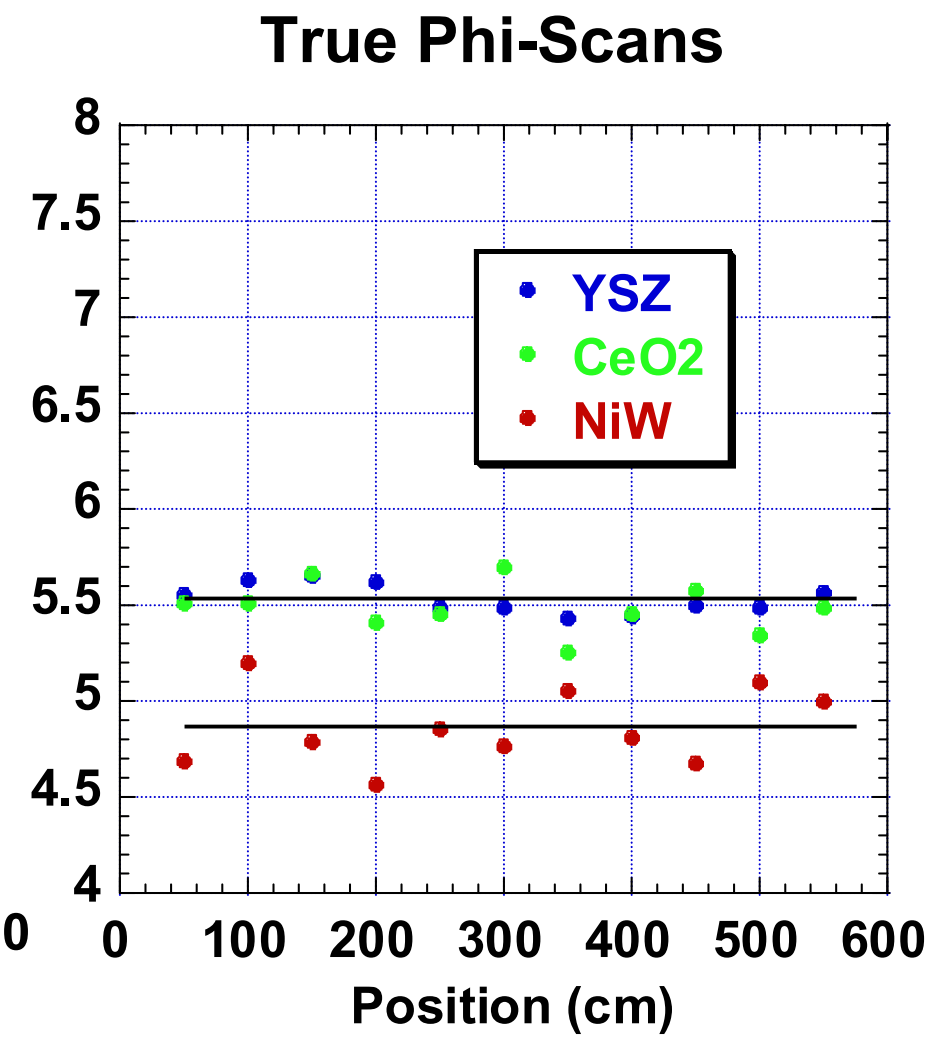
$$\Delta\Phi_{\text{true}} = \sqrt{\Delta\phi^2_{\text{observed}} - \tan^2\chi\left(\Delta\omega^2_{\phi=0}\cos^2\phi - \Delta\omega^2_{\phi=90}\sin^2\phi\right)}$$



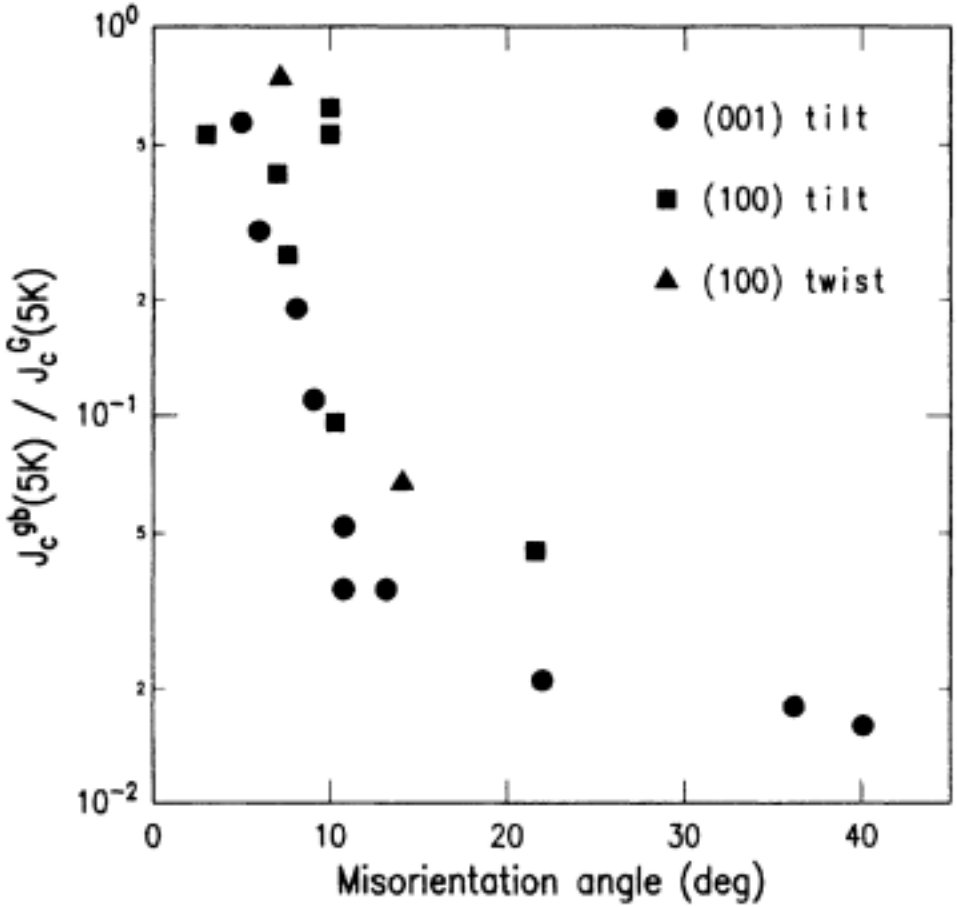
Notice the big difference in the FWHM!!!

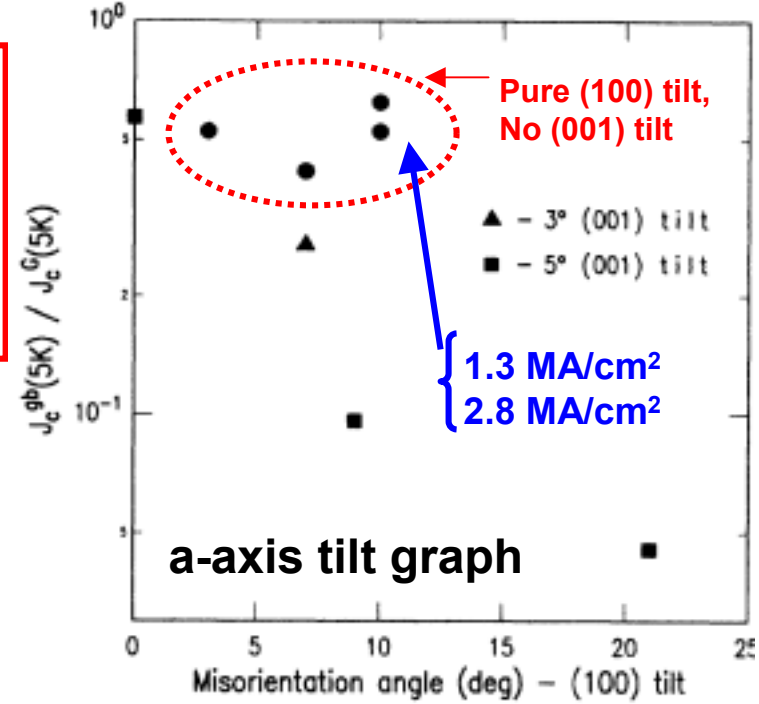
Measured (111) and True Phi Scans Of Standard RABiTS Tape

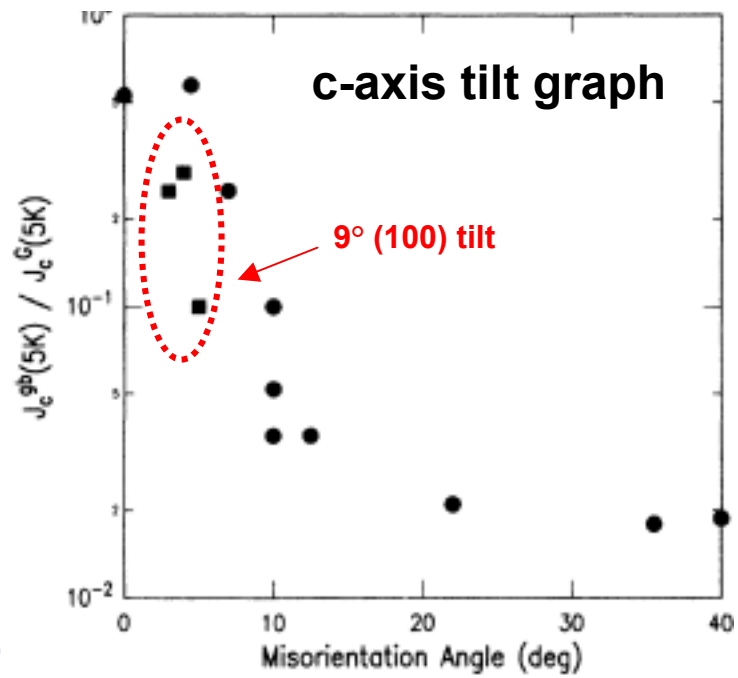




How do a-axis tilts or out-of-plane misorientations affect J_c?

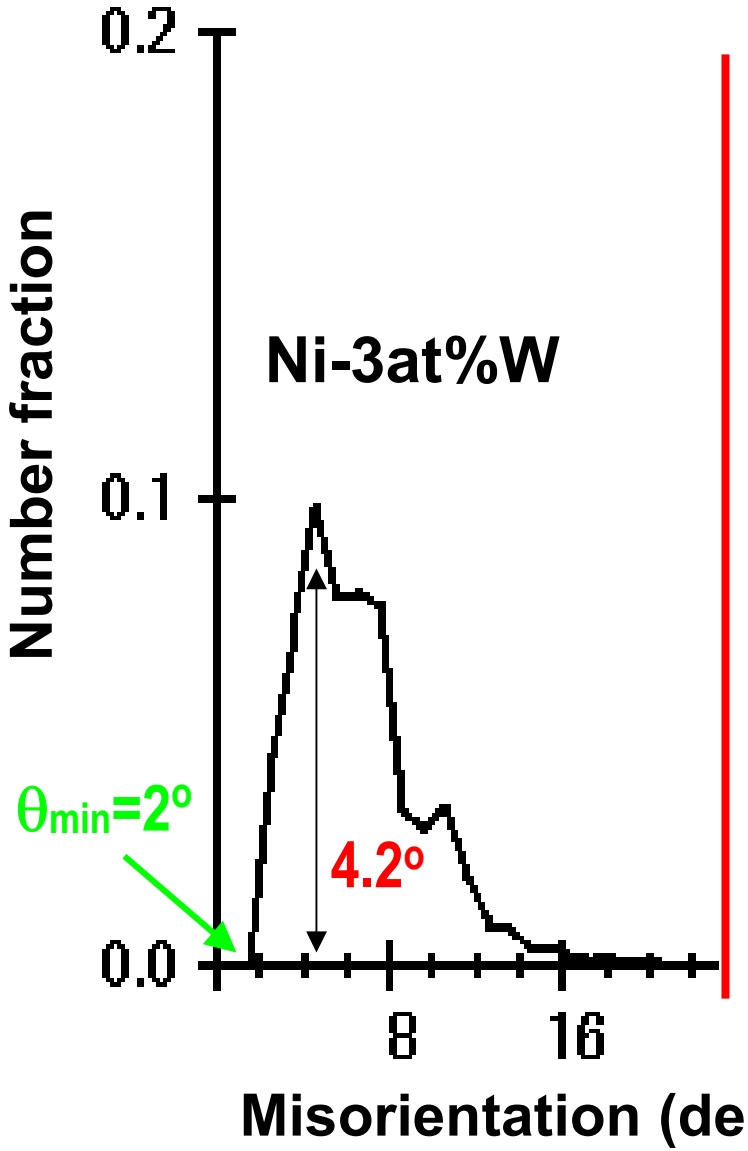




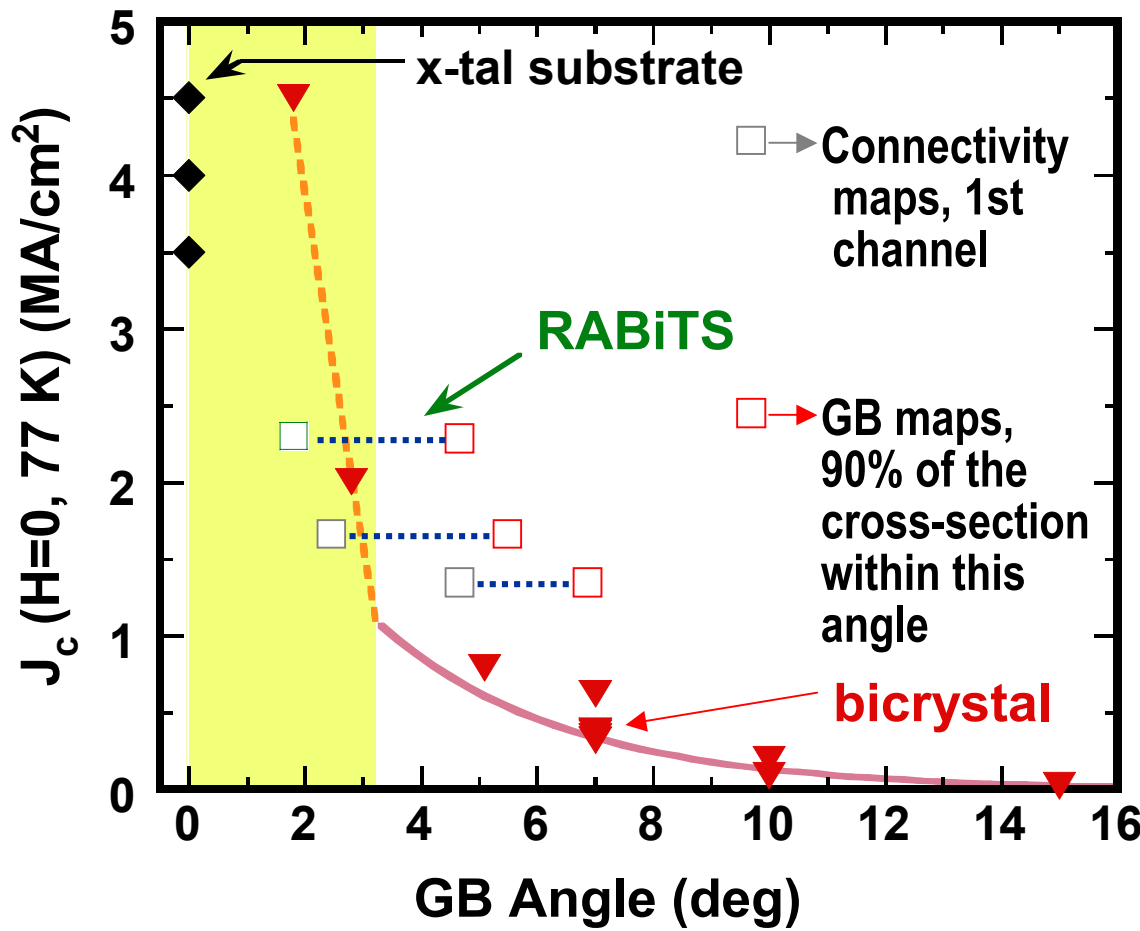


Ref: Dimos et al., Phys. Rev.B, 41, 4038 (1990)

Total misorientation & local correlations



Local correlations between grains



How much will we gain in J_c by further improvements in the macroscopic texture?

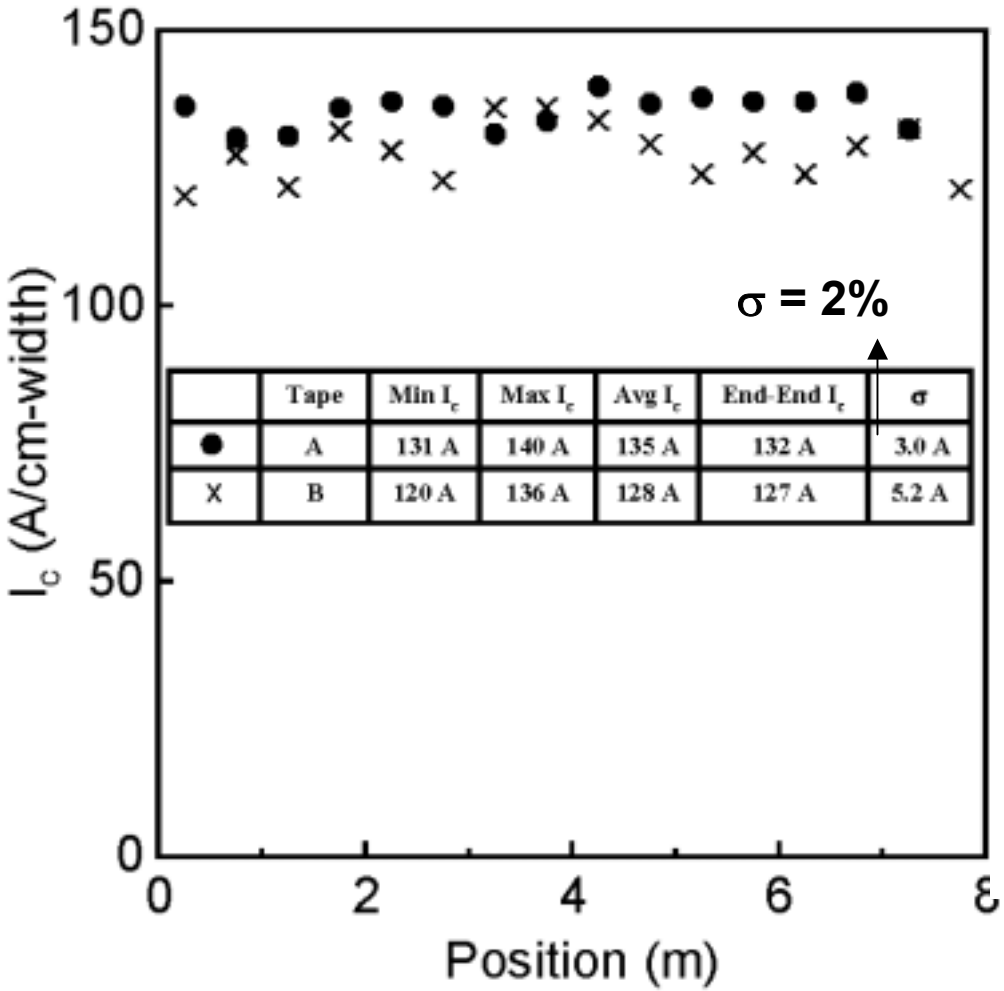
- The in-plane texture is already in the range of 5-6°
- The out-of-plane texture is in the range of 4.5-6.5°

Significant modification of the GBMD can be expected by further sharpening of the out-of-plane texture

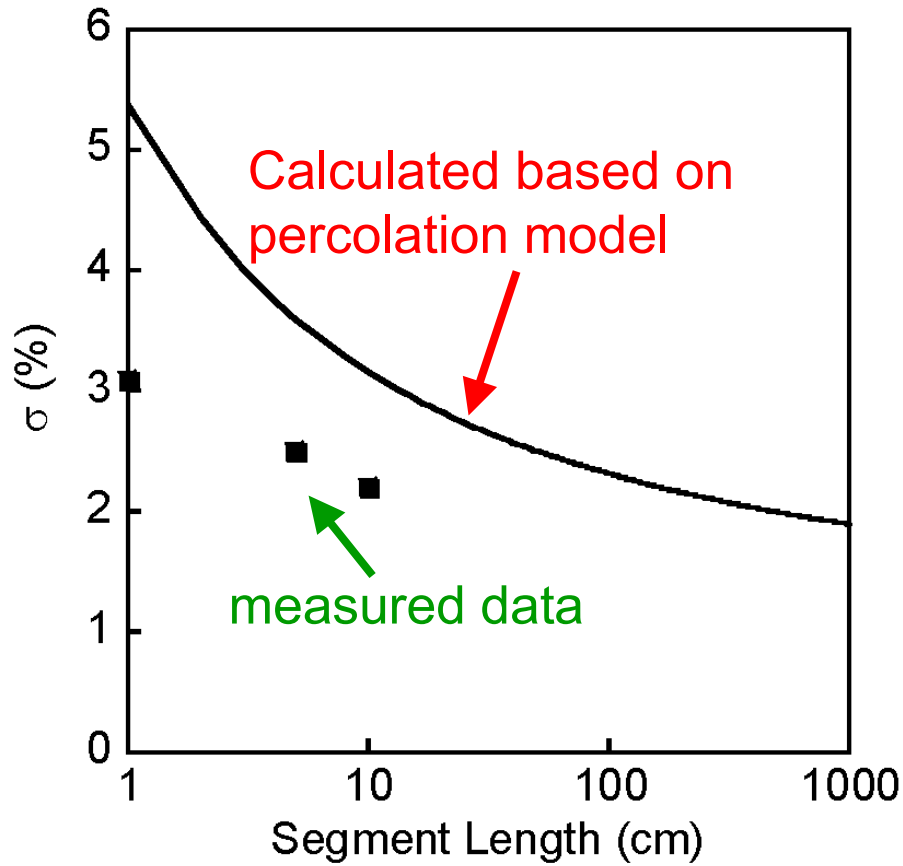
We need more bicrystal studies of the following:

1. Pure a-axis tilt boundaries
2. a-axis tilt boundaries with small c-axis tilts in the range of 1-6°
3. J_c versus GB angle plots in applied field
4. Same plots for thicker YBCO films

Are observed fluctuations of J_c in the best YBCO/RABiTS tapes process-related or statistical in nature?



	Tape	Min I_c	Max I_c	Avg I_c	End-End I_c	σ
●	A	131 A	140 A	135 A	132 A	3.0 A
X	B	120 A	136 A	128 A	127 A	5.2 A



American Superconductor

Oak Ridge National Laboratory
U.S. Department of Energy

Reduced magnetism and non-magnetic alloys have been cube textured

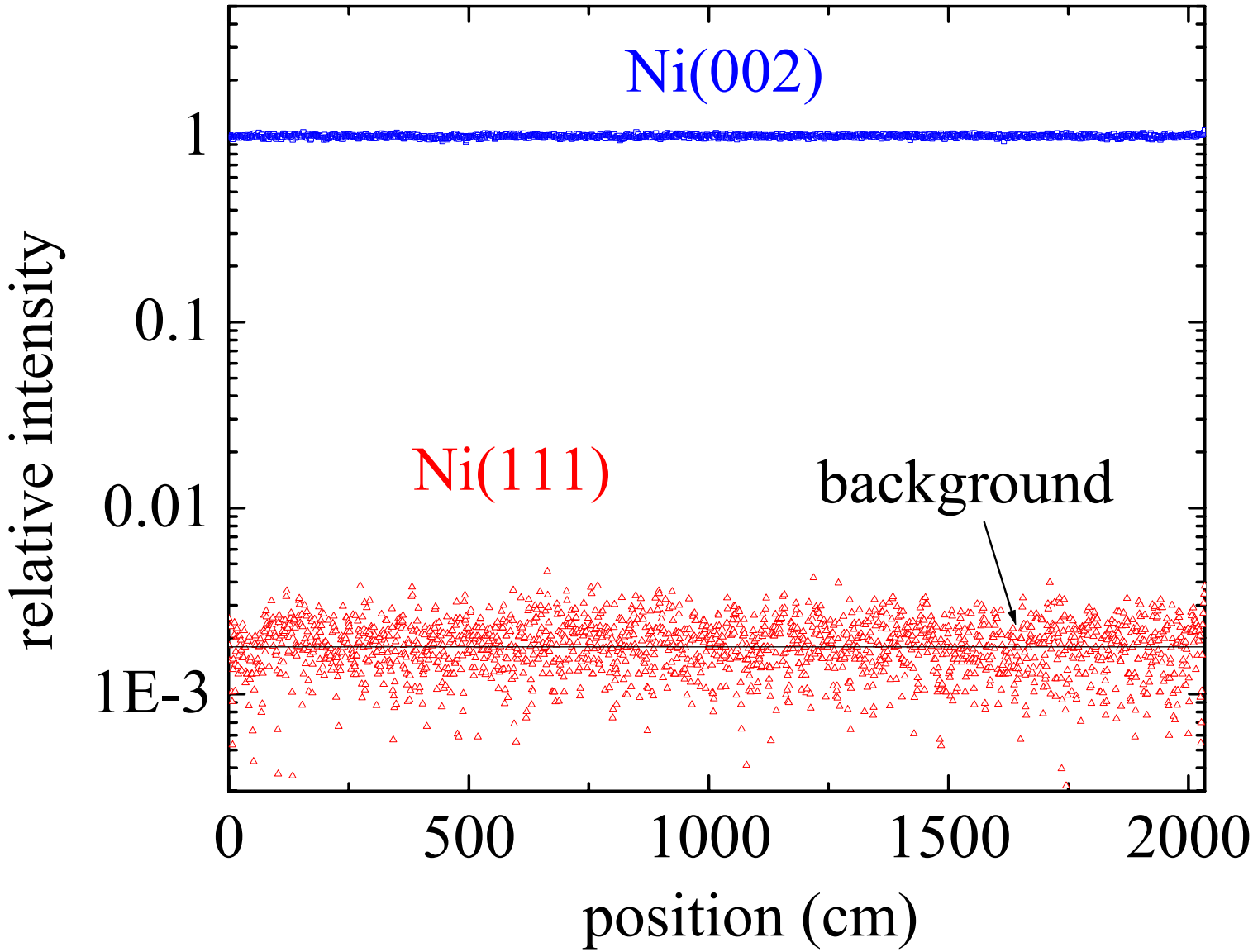
AC losses are significantly reduced

Alloy	YS (0.2%)	Curie Temp.
Ni	34 MPa	627 K
Ni-7at%Cr	64 MPa	250 K
Ni-9at%Cr	87 MPa	124 K
Ni-11at%Cr	102 MPa	20 K
Ni-13at%Cr	164 MPa	Non-magnetic
Ni-3at%W	150 MPa	> 400 K
Ni-5at%W	165 MPa	335 K
Ni-6at%W * (98%)	197 MPa	?
Ni-9at%W * (93%)	270 MPa	~25K

ORNL/AMSC CRADA

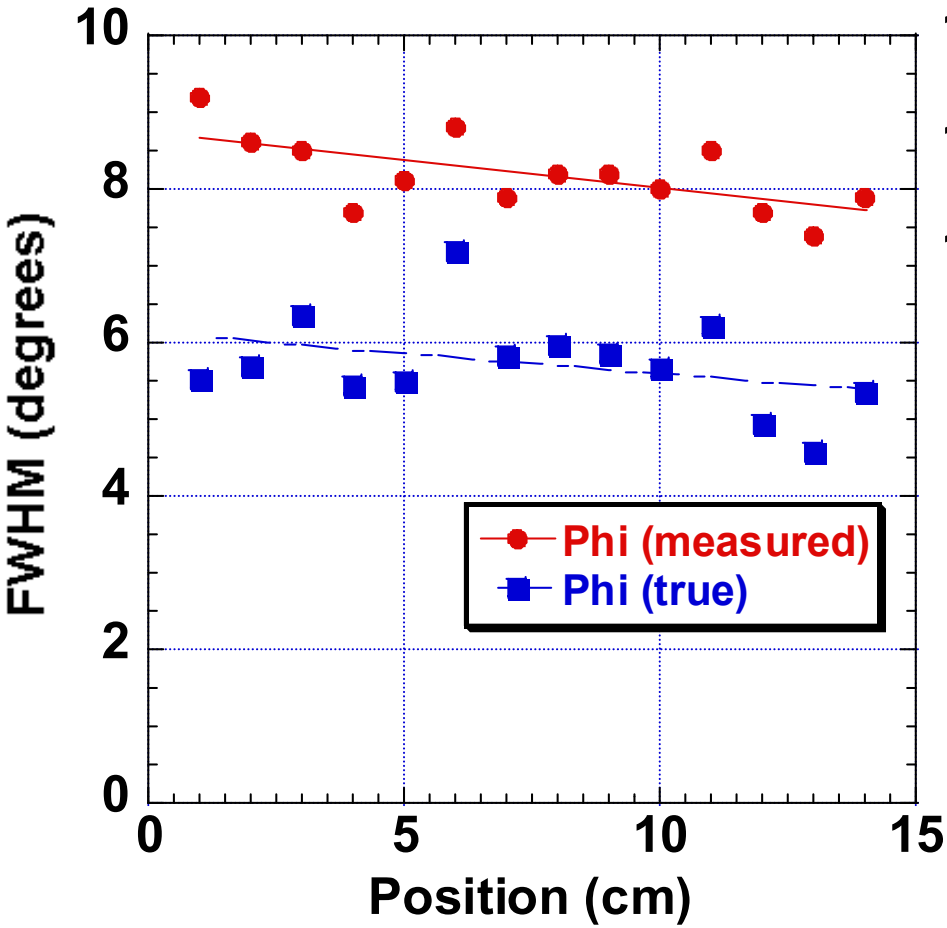
Ni-13at%Cr-4%Al *	228 MPa	Non-magnetic
Ni-Cr-W (1)	150 MPa	< 10 K
Ni-Cr-W (2)	202 MPa	Non-magnetic

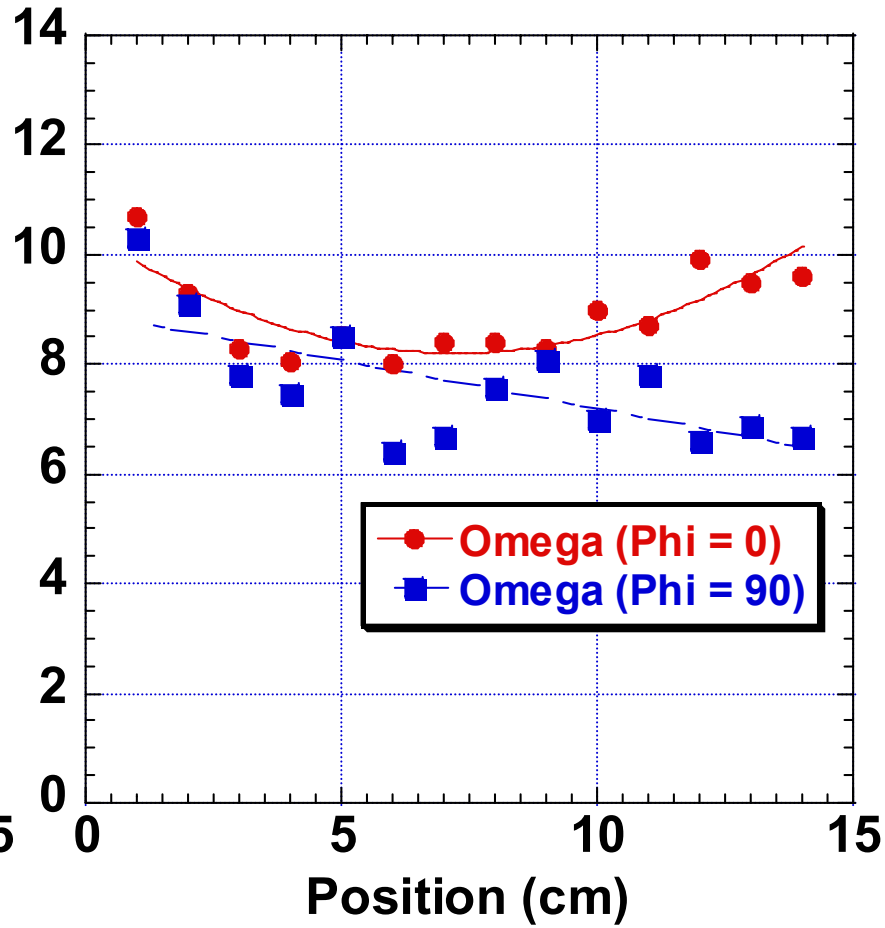
What about homogeniety of texture in longer lengths of metal tape?



What about homogeniety of texture along the width in *WIDE* metal tapes?

Experiment done on an old piece of 6” wide Ni tape





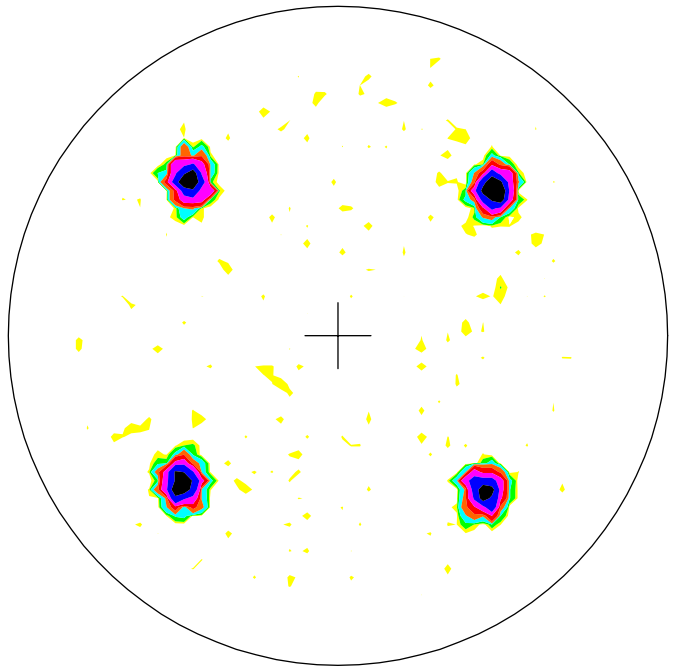
- Variation is smaller when samples along the width are cut prior to annealing

Cu-based Substrates: Potentially Inexpensive Substrates for CC's

Advantages over Ni-based substrates

- Cu is potentially a factor of *six* times cheaper than Ni on a per pound basis
- Cost of Cu coils may approach the per pound cost
- Cu is diamagnetic
- Cu has a resistivity a factor of five times lower than that of Ni
- Cu has higher heat capacity than Ni (about 20% higher)

Log-scale Cu(111) pole figure



Measured Phi: 5.3°
True Phi: 4.1°
Omegas: 4.1°; 5.5°

Summary

- Standard, fully buffered RABiTS substrates have a configuration of:

  Ni-3at%W / Ni / Y_2O_3 / YSZ / CeO_2
- Fairly sharp textures are routinely obtained for the CeO_2 layer:

  $\Delta\phi$ ~ 5.5°; $\Delta\omega$ ~ 4-6°; Clean pole figures
- Surface roughness in long lengths: σ ~ 9.6nm; Std. = 1.4nm.
- Fluctuations of J_c in the best, long YBCO tapes being produced on RABiTS appear to be statistical in nature
- Well textured Cu substrates can be fabricated:

  $\Delta\phi$ ~ 4.1°; $\Delta\omega$ ~ 4-5.5°; Clean pole figures
- Texture in long and wide metal tapes is fairly constant
- Use of "True in-plane phi" is important for coated conductors
- We need better understanding of J_c vs GB angle for (100) tilt GB's, J_c vs GB angle in fields, effects of intragranular J_c etc. in order to determine how much better texture is needed in the substrate.