

Electrical property measurement of long-length coated conductors

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Outline of presentation

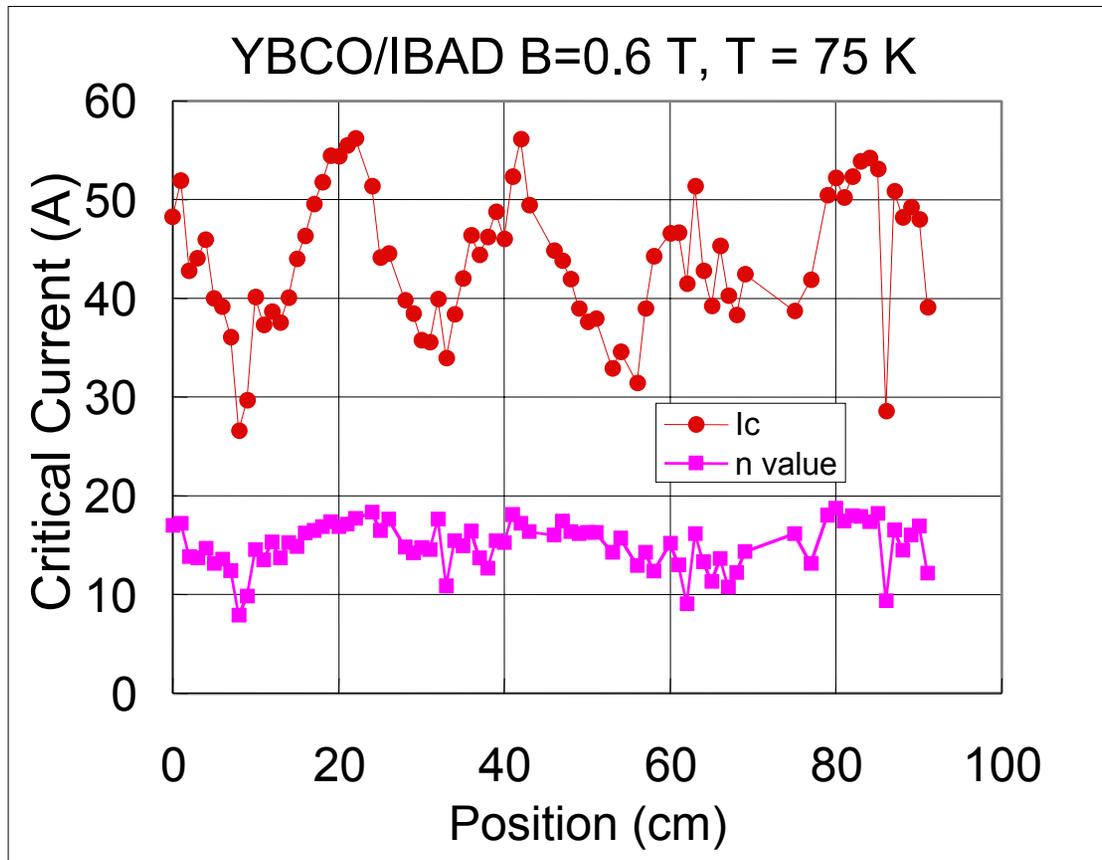
- **Transport critical current measurement**
 - End to end measurement
 - Position dependent measurement
- **Noncontact measurement techniques**
 - Ac inductive measurement
 - Hall probe profiling
- **Summary**

End to end critical current measurement

- Determine critical current end to end of ~10 m length tape
- Wind tape in loose (~1 cm gap between turns) helix on 15 cm ϕ tube
- Soldered or pressure current contacts at each end – >1 cm² contact area
- Pressure voltage contacts near each end and on each turn (~50-cm spacing) or half turn (25-cm spacing)
- Ambient temperature (75.3 K in Los Alamos) liquid nitrogen bath
- Electric field or resistivity criteria, as desired, with maximum current limited by limiting V to a few hundred microvolts to avoid possible local damage from overheating low I_c regions
- Yields end to end I_c and I_c distribution with 25 – 50 cm resolution
- These data can be used to focus on regions where finer scale I_c may be needed
- Summary: relatively straightforward measurement

Variation in I_c along tape increases measurement difficulty

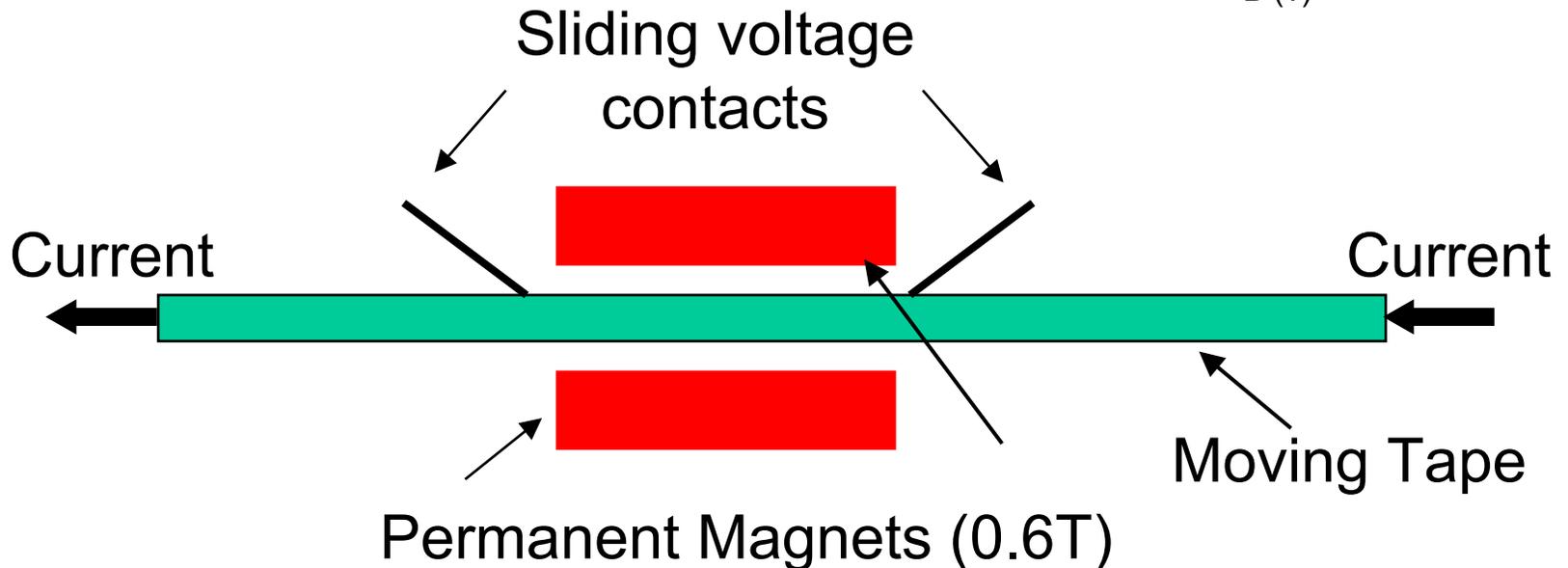
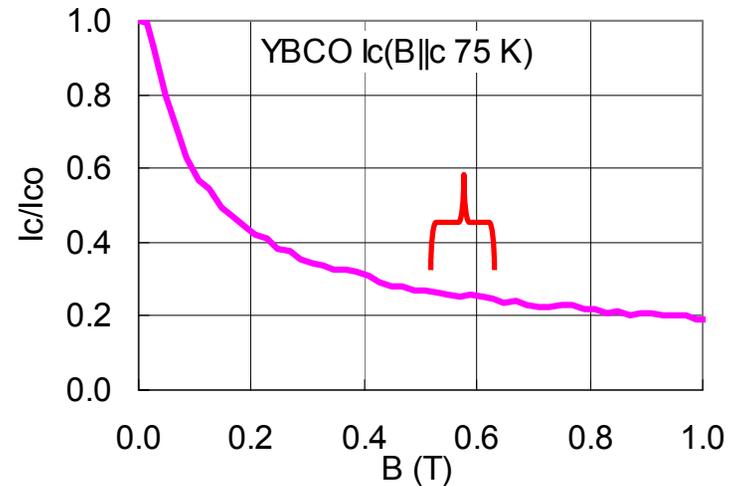
- Low I_c regions must carry current necessary to measure high I_c regions
Problem: avoid damage from heating ($V = I^n$)
- Nontrivial problem for $I_c > \sim 120$ A in cm width tape



Severely overdriven CC

Continuous transport measurement stage

- $B_{\text{perp}} \sim 0.6 \text{ T}$ reduces I_c by $\sim X5$, enough to avoid damage to lower I_c regions in sf
- $I = 0$ to $\sim 125 \text{ A}$; $V = \sim 0$ to $100 \mu\text{V}$
- Effective contact spacing is magnet length (1, 2, 5, 10 cm available)



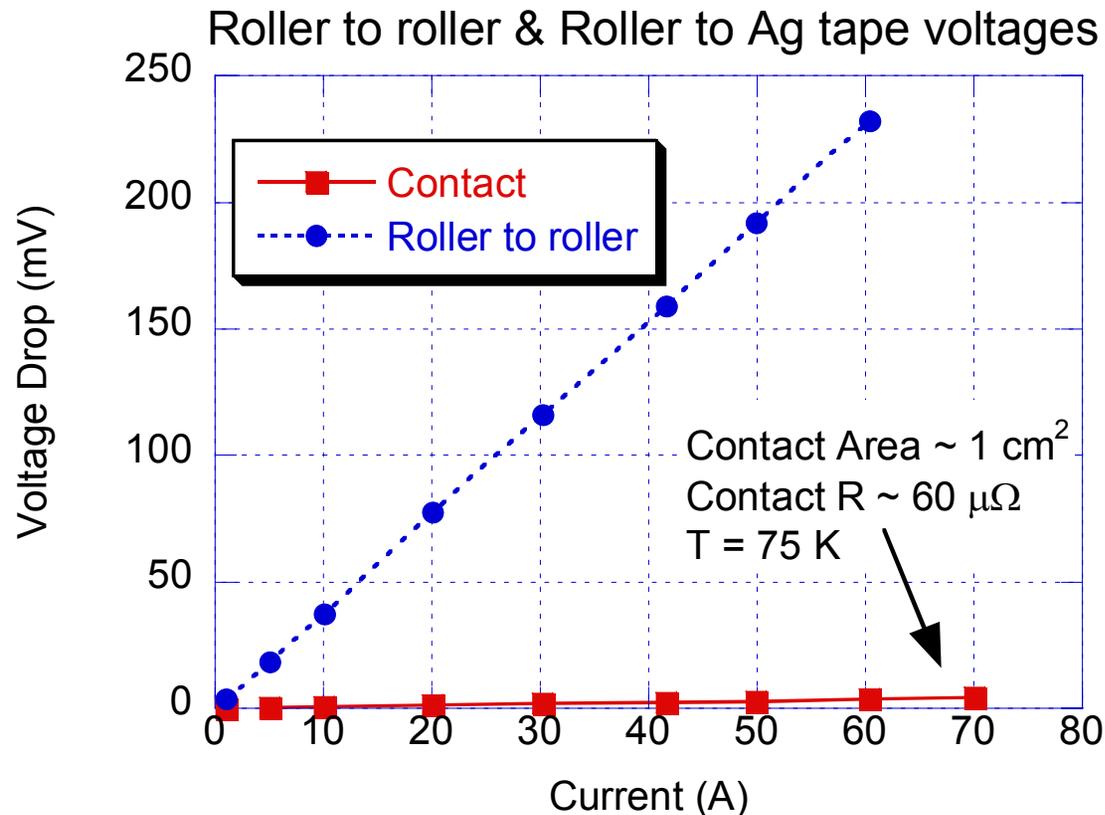
Continuous measurement system

- Mercury-wetted rotary current feedthrus to 4"/10 cm diam copper pulley current contacts with idler pulleys (for contact pressure)
- Flexible measurement space for magnets and voltage contacts, ac induction coil, or Hall probe array for measurement of I_c



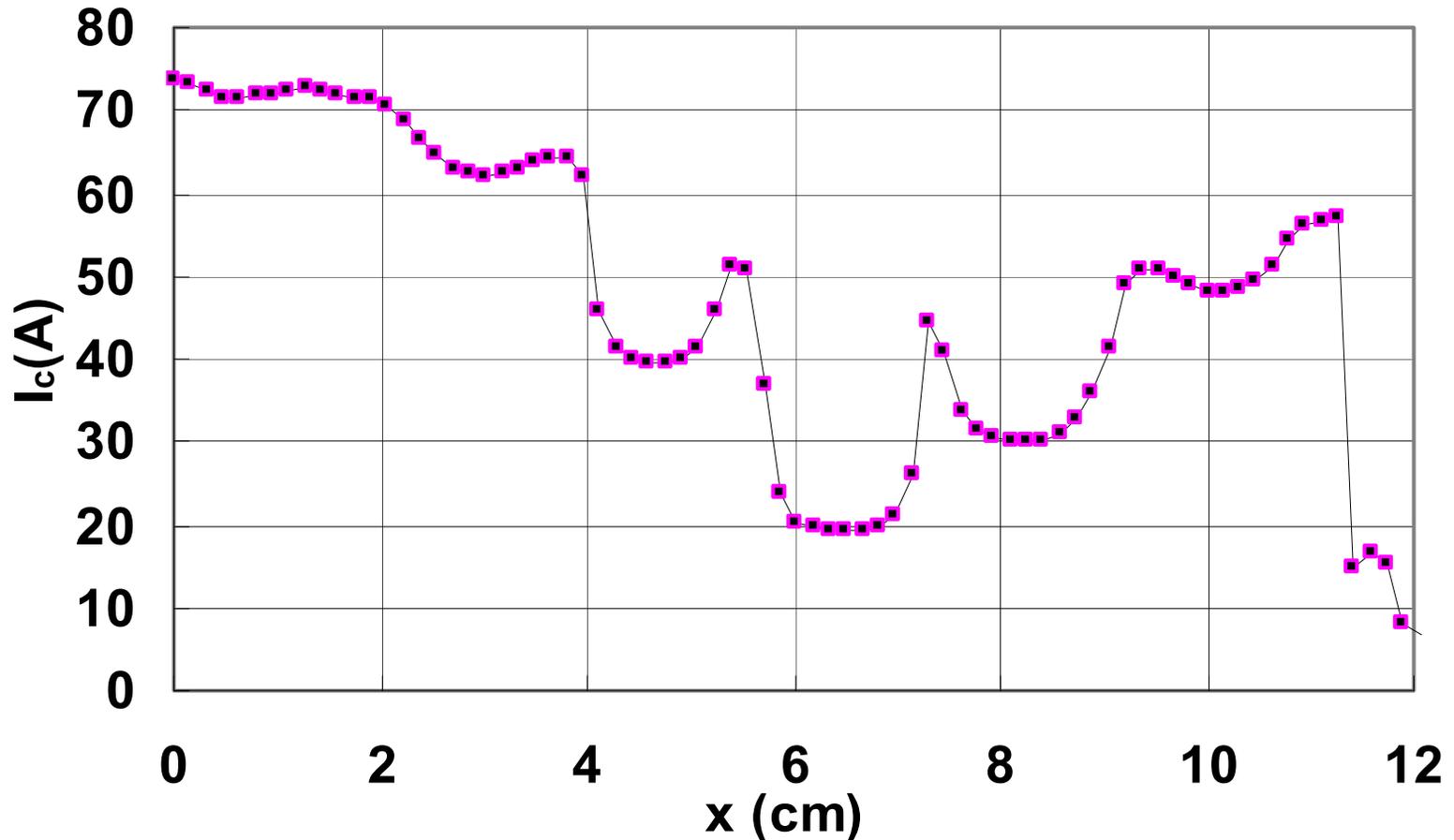
Contact resistance roller to tape

- Measured contact resistance from a 5-cm diameter gold plated copper roller to Ag coated tape with a $\sim 1 \text{ cm}^2$ contact area
- This R is sufficiently small ($\sim 60 \mu\Omega$) to transfer currents of at least 70 A



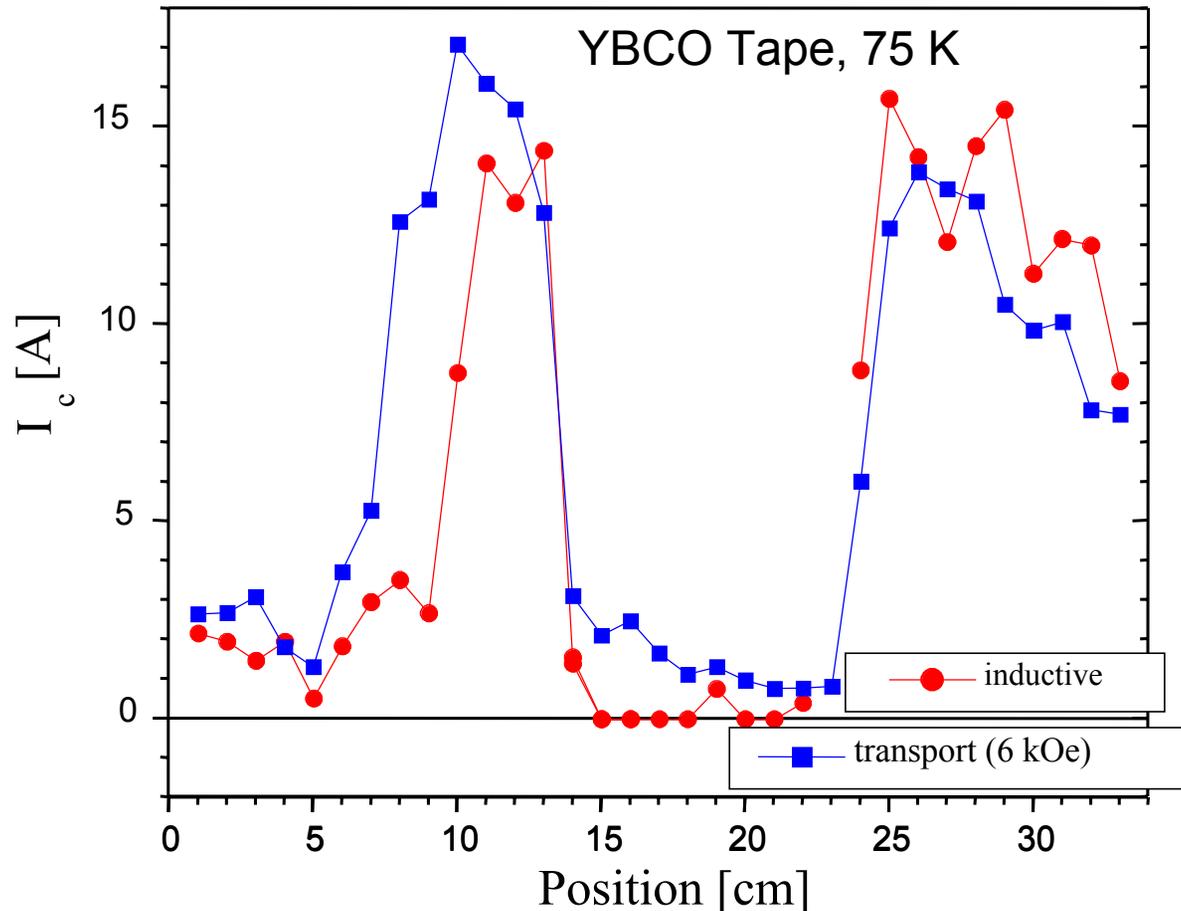
Step size (resolution) not limited by voltage contact spacing

- Smaller step size (0.2 cm below) can be used to localize defects at leading edge
- High resolution data can be deconvoluted to reveal fine structure of I_c variation



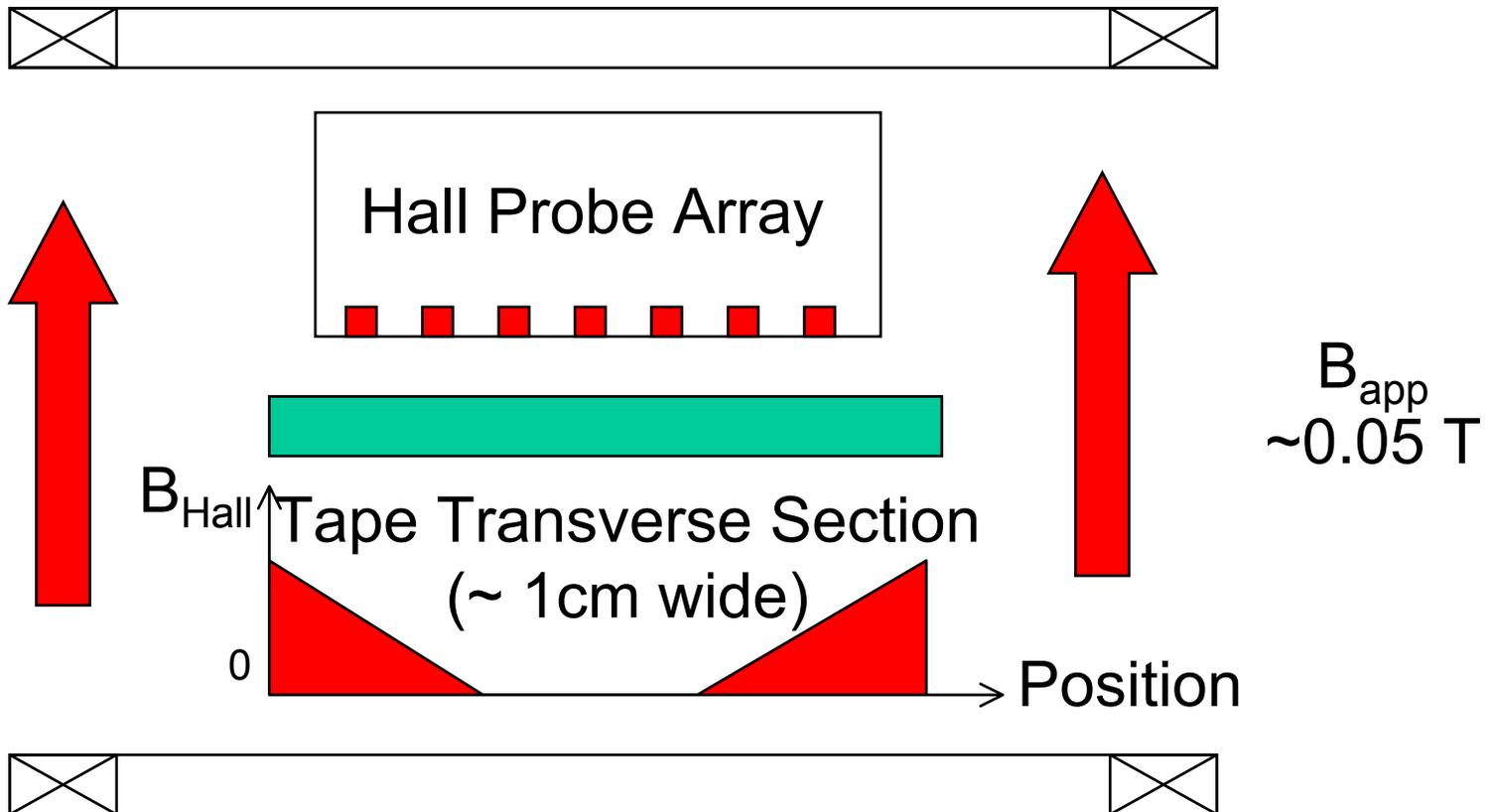
ac inductive measurement

- J.H. Claasen, et al., *RSI* **62**, 996 (1991) uses the third harmonic voltage of single small, flat coil placed close to a thin film or tape to determine I_c
- Good qualitative agreement between 3f inductive signal and dc transport I_c



Hall probe array to determine I_c

- Critical Current from Field Profile and Critical State Model Calculation
- Applicable to most conductors with adjustment of field
- Potential for continuous measurement (sample in motion)



Summary

- *End to end I_c measurements on long tapes:*
 - End to end and course position dependent (25-50 cm) critical current measurements are required for CC
 - The measurements are relatively straightforward, but care must be paid to avoiding damage to possible short, weak sections by overheating
 - Limit maximum voltage along tape to avoid possible damage
- *Position-dependent I_c :*
 - 1-10 cm scale position-dependent I_c data are required to assess quality and uniformity of tape so that it can be assessed by other means; resolution to < 1 mm is possible
 - Local magnetic fields can reduce I_c in the measurement region and avoid damage to lower I_c regions of tape
 - Noncontact (ac inductive coil, Hall probe array) methods can also be used to measure I_c nondestructively, even for tapes with no Ag overcoating, or with very large I_c variations.