

# WESTINGHOUSE CICC TESTING

## Contributors

Ted Mallick

George Wagner

Carl Heyne

Dick Blaugher

Glenn Grabinsky

Ernie Ioriatti

Ron Scanlon

**And Many Others!**

# Superconducting CICC Testing

---

## Westinghouse Experience/Testing on CICC Conductors:

- Unpublished Data From LCP
- Recent Results on NHMFL Conductor

## What Kind of Tidbits?

- AC Loss Measurements of CICC Conductors With Respect to Sintering,  $\text{Cu}_2\text{S}$  Coating
- Uniaxial Strain Measurements on LCP
- Cryogenic  $\Delta p$  Measurements

# Superconducting CICC Testing

---

## Parameters of LCP Conductor

486 Strand Cable

3 x 3 x 3 x 3 x 6

Nb<sub>3</sub>Sm (Bronze) 0.7 mm Diameter

63% Copper

Bare With Lubricant Residue

37% Void Nominal

JBK75 Sheath

20.8 mm Square

1.7 mm Thick

Sample Size Used Depends on Facility

3<sup>4</sup> Subsize

# Superconducting CICC Testing

---

## AC LOSS MEASUREMENT

- Copper Cables
- Nb<sub>3</sub>Sn With Cu<sub>2</sub>S
- Nb<sub>3</sub>Sn Bare

### Conclusion:

Losses Are Reasonable if Sintering is Avoided

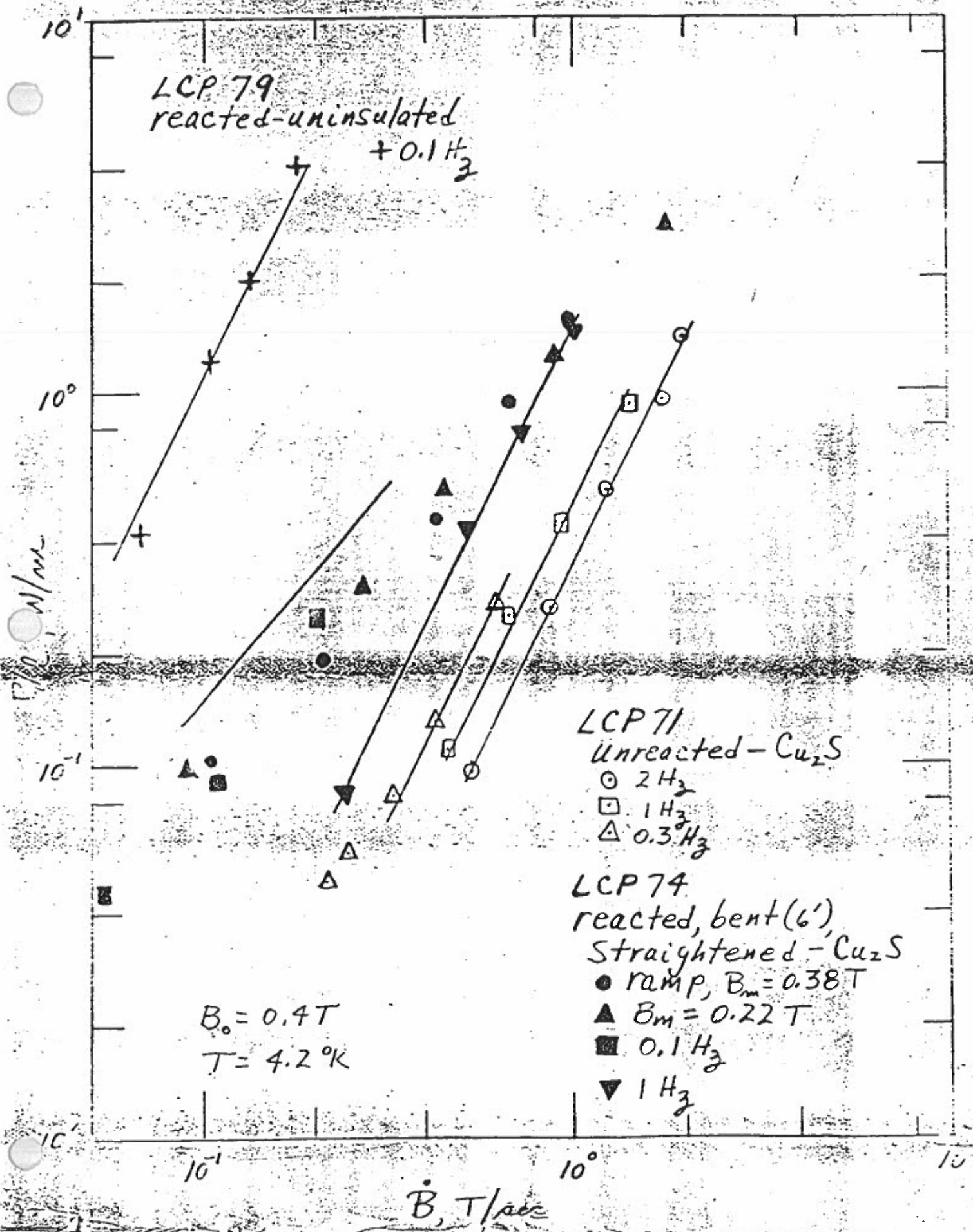
# Superconducting CICC Testing

Table 7.9-1

<u>Sample</u>	<u>Thermal and Mechanical History</u>
71	Unreacted and unbent; manufactured in straight length.
74	Bent on a six foot diameter, reacted, and straightened, insulated strands used in cable.
75	Bent on a six foot diameter, reacted, straightened, bent on a two foot diameter, and straightened; insulated strands used in cable.
79	Bent on a six foot diameter, reacted, and straightened; uninsulated strands used in cable.

All were 6 x 3<sup>4</sup> compacted to about 32% void fraction.





4

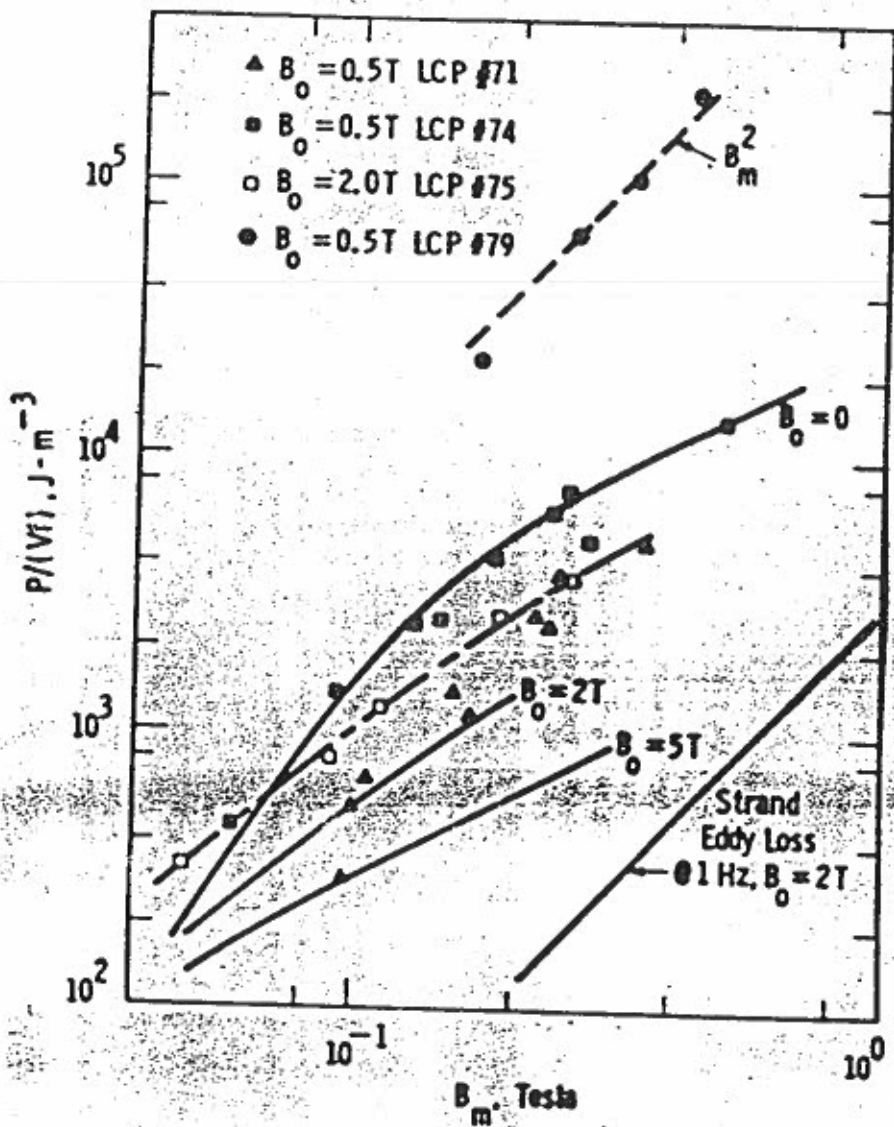
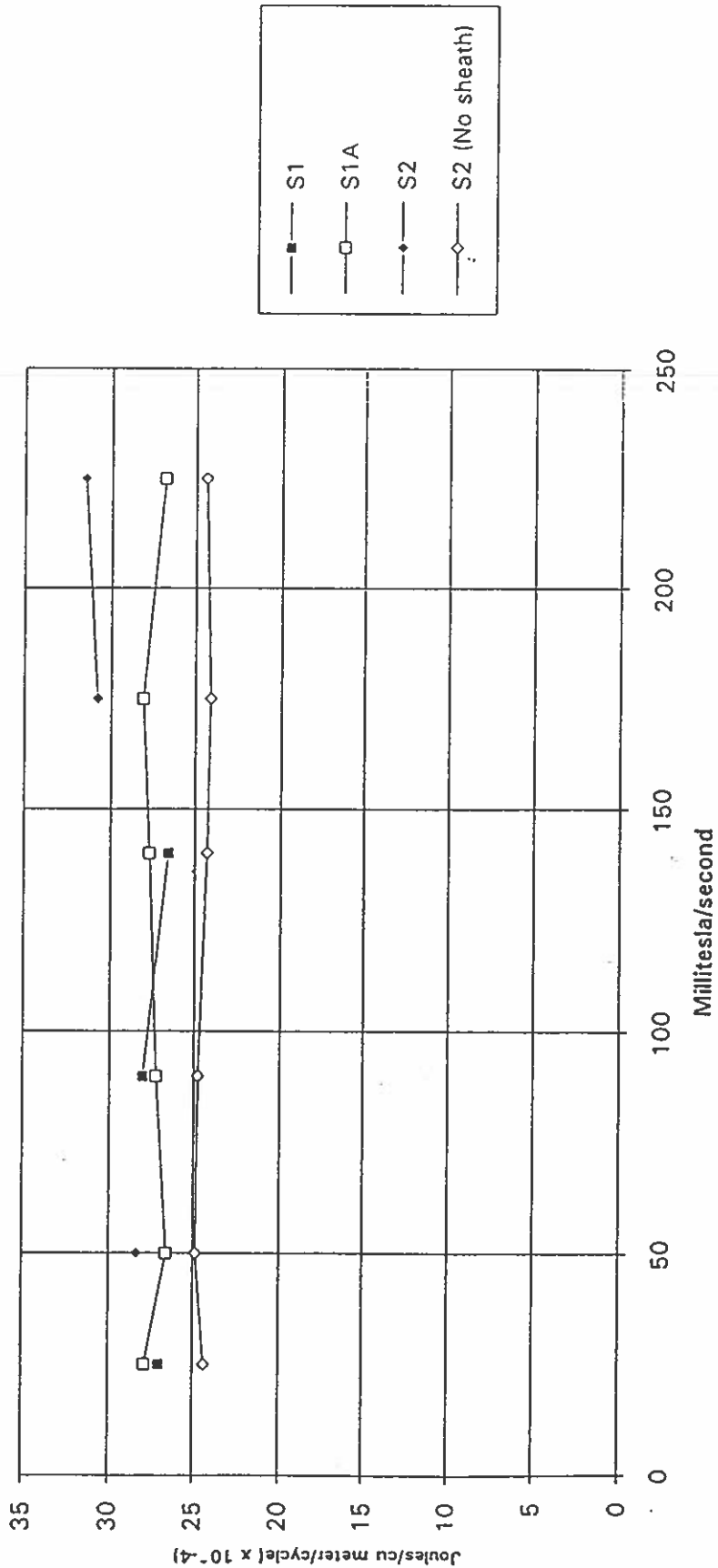


FIGURE 2.9-9 — TOTAL LOSS PER UNIT VOLUME OF STRANDS PER CYCLE MEASURED IN FOUR DIFFERENT LCP FULL-SIZE CONDUCTORS. SOLID CURVES SHOWN HYSTERESIS LOSS AND EDDY CURRENT LOSS FOR INDIVIDUAL STRANDS AT VARIOUS BIAS FIELD. DASHED CURVES ARE SHOWN DRAWN THROUGH DATA OF SAMPLES 75 AND 79.

# Superconducting CICC Testing

FSU CIT Ramp Rate Test





# Superconducting CICC Testing

---

## Uniaxial Strain Measurement

3<sup>4</sup> Cable

304L Stainless Steel

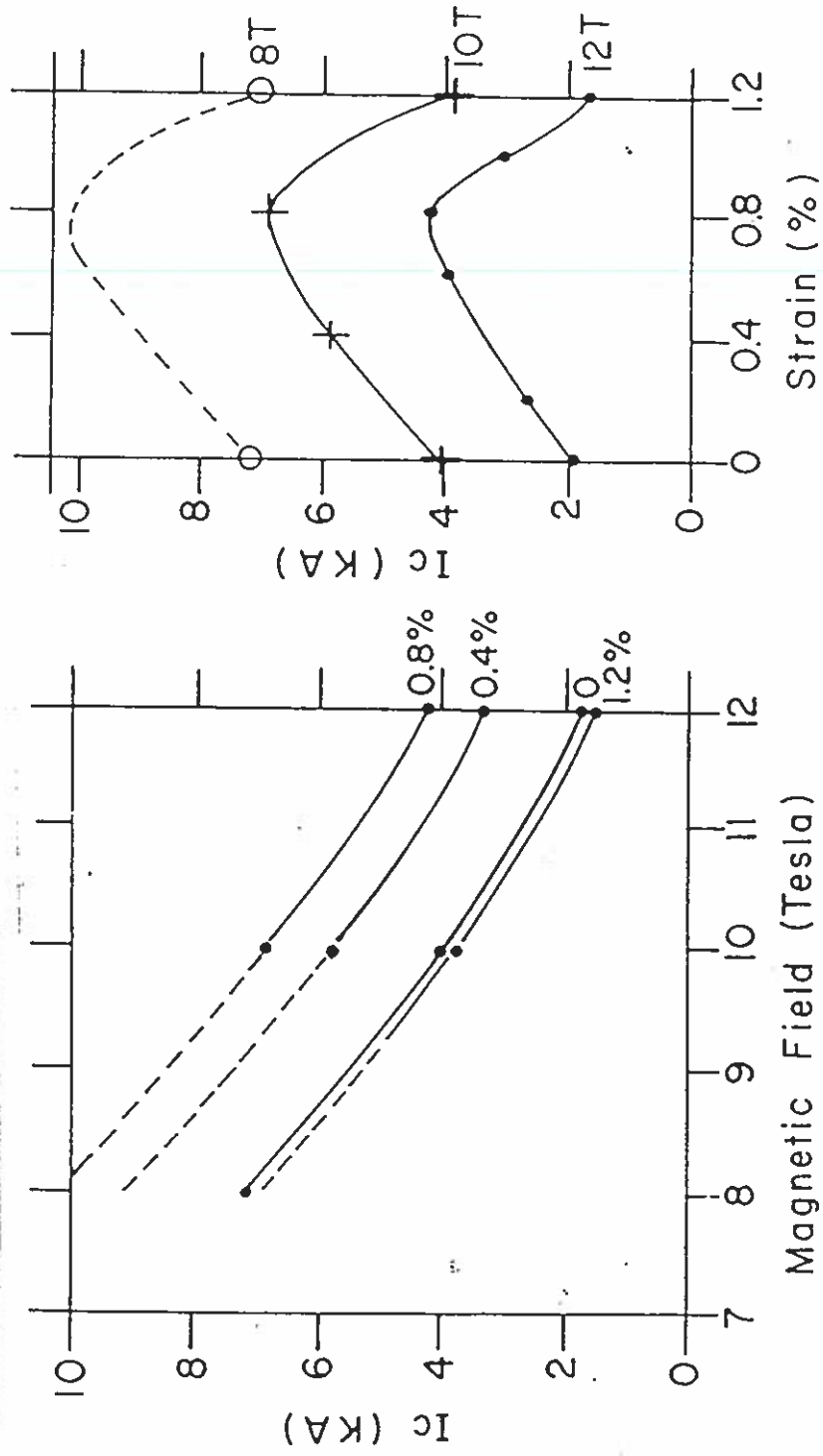
Approximately 12 mm Square

Performed in LLL Facility

## Results:

- Considerable Precompression of Nb<sub>3</sub>Sn  
Especially at High Field ~0.8%
- Bending Strain Effect Appeared to Be Additive

# Superconducting CICC Testing



Uniaxial Strain Behavior of the Nb<sub>3</sub>Sn Forced Flow Conductor

# Superconducting CICC Testing

Table 7.1-3

## Summary of Conductor Currents at 8 T

	<u>No Strain</u>	<u>Peak Current</u>	<u>Jacket Strain at peak</u>	<u>Current Increase</u>
Predicted	9720	10,264	> 2%	5.6%
Measured				
With copper jacket	9500			
With S.S. jacket	7250	10,200	0.8%	40%
With S.S. jacket (1.8% bend strain after reaction)	5800	8,100	0.8%	40%

# Superconducting CICC Testing

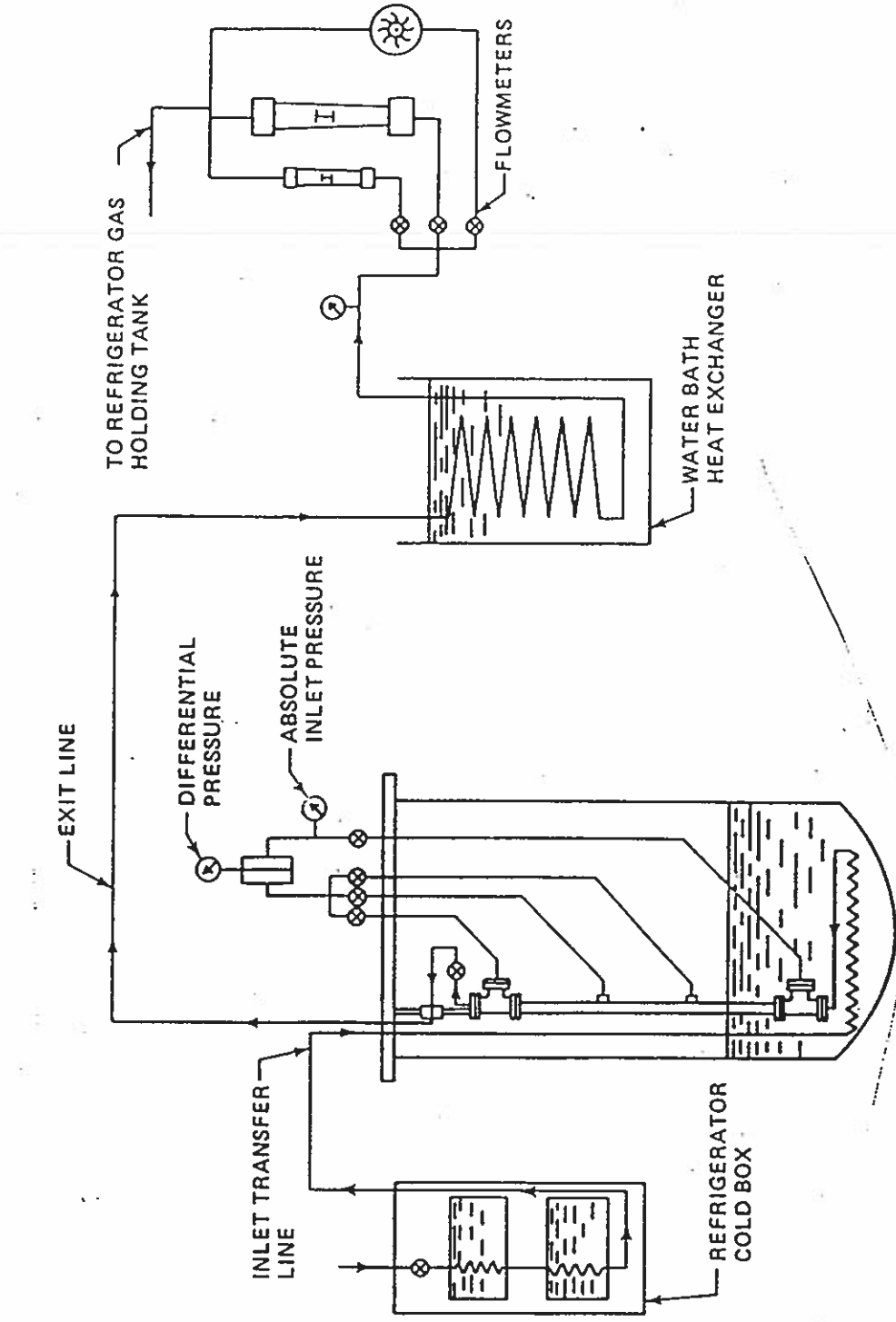
---

## PRESSURE DROP MEASUREMENT

Desired Characterization of the Voids Using the Friction Factor

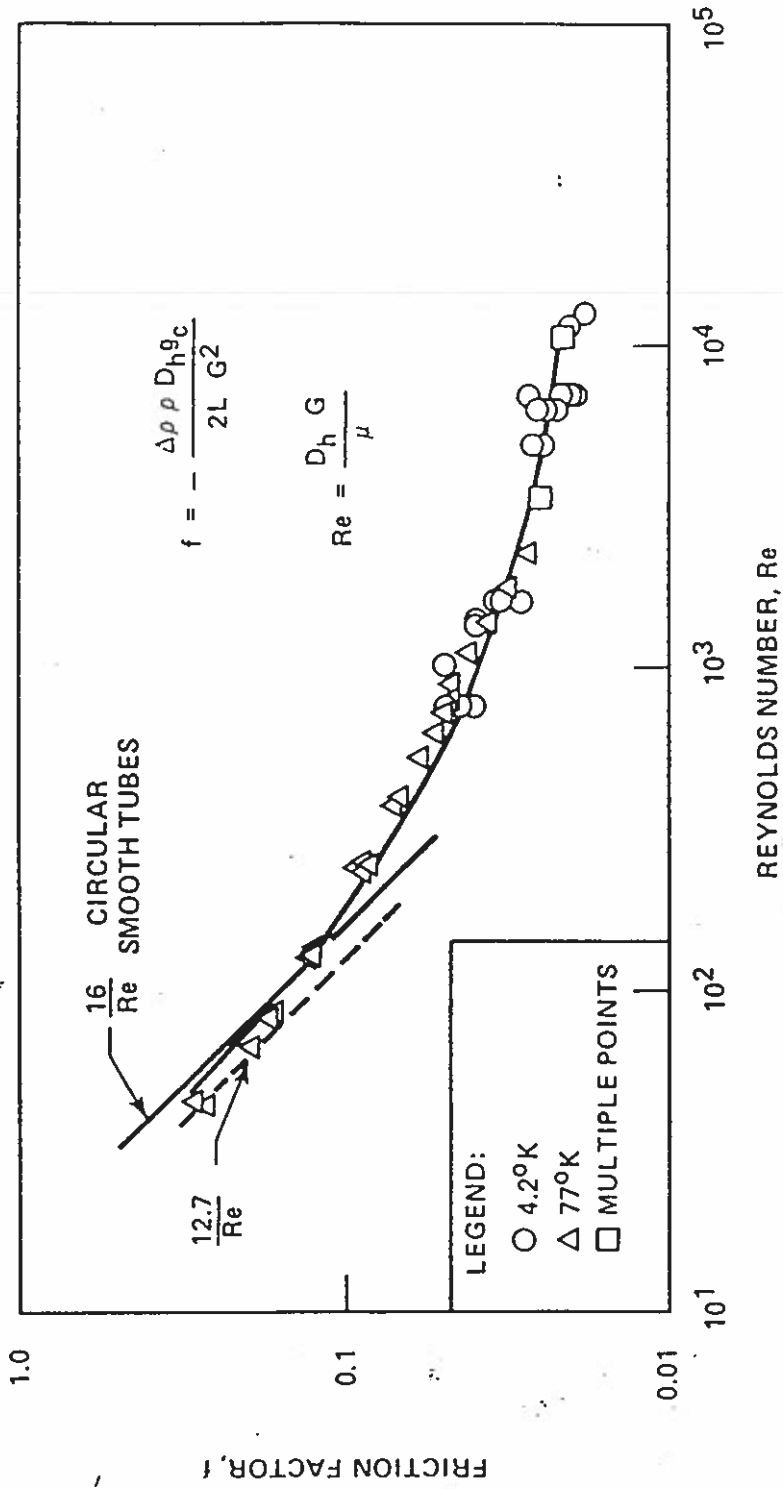
Nothing Surprising Useful Data  $f \rightarrow \sim 0.01 - 0.02$

# Superconducting CICC Testing



Pressure Drop Test - Helium Flow Schematic

# Superconducting CICC Testing



Comparison of Equation With the Experimental Data