An Overview of CICC Testing Experience

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Purpose of testing:

- CICC technology is appropriate for large, expensive magnets (or harsh operating conditions) where a level of certainty is required that the magnet will meet its performance goals before a commitment to construction can be made.
- An extremely valuable feature of CICC technolgy is that tests on a small scale accurately model the performance features of the magnet.
- For issues where direct modeling is difficult, extrapolation by computer codes with individual features validated in small-scale tests is natural.

Types of tests:

Short conductor (sc)

greater than one pitch length of the last cable stage

Long conductor (lc)

much greater than one pitch length
sufficient length to model some thermo-hydraulic features

Model coil (mc)

produces significant field
includes all features of the real coil that will affect its performance
does not necessarily use full-size conductor

Status of testing:

What's been done (d)

What's not (nd)

What needs repeating (nr)

Issues

- Electrical
- Thermo-hydraulic
- Stability
- Protection
- Structural

Steady-State Electrical

Issue	Type of Test	Status	Comments
$I_c(B,T,[\varepsilon])$	sc & lc	nr	Need special emphasis on T-dependence
			Scaling with N (correction for increased x-section?)
			[Initial strain state (correlation with composition and fabrication)]
			[Simulated operating conditions]

[] indicates Nb3Sn only

AC Electrical

Issue	Type of Test	Status	Comments
Coupling losses – transverse fields	sc & lc	nr	vs cable & subcable twist pitches vs strand coating or subcable wrapping for special geometries
Coupling losses – parallel fields	lc	nd	

Electrical Insulation Integrity

very little specific development done

Thermo-hydraulic characteristics

Issue	Type of Test	Status	Comments
Steady flow and heat extraction	lc	nr	Need more careful characterization of measurements in terms of conductor specifications: wire diameter, cable pattern, twist pitch, cable-space dimensions Comparison of special geometries

Stability

Energy margin vs temperature margin

Issue	Type of Test	Status	Comments
Thermodynamics of local helium	lc	d	confirmed to the accuracy presently required
Heat-transfer effects	lc & mc	nr	transient conduction
			transient flow (vs cooling-path length and dimensions of the disturbance)
			effective cooled perimeter
Heat-generation effects	lc	nr	current transfer among strands

Protection

Issue	Type of Test	Status	Comments
Quench propagation	mc	nd	
Temperature & pressure distribution	mc	nd	
Quench detection	mc	nd	alternate techniques are needed: uneffected by inductive signals, electrically isolated, faster response
Self-protection (internal discharge)	mc	nd	

Structural

Issue	Type of Test	Status	Comments
Individual components		d	more testing needed only clarify special sensitivities to process or extremes of operating conditions
Interaction of jacket, insulation, and cable	sc	nr	special concern for the insulation/jacket interface
			cyclic testing of winding pack models needed