



US LHC Accelerator Research Program

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LARP Collaboration Meeting 14

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Conductor Procurement and Qualification

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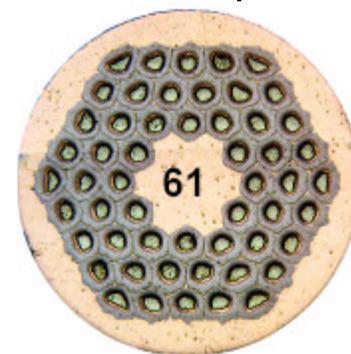
Outline

- Conductor Procurement
 - Specifications
 - Planned purchase
 - Present Inventory
- Conductor qualification
- Ti-Ternary conductor
- Summary



Nb₃Sn HQ-Strand Specification LARP-MAG-M-8002 Rev-B (54/61)

Process	Ternary RRP Nb ₃ Sn
Strand Diameter, mm	0.8 – 1.0 ± .003
J _c (12 T) at 4.2 K, A/mm ²	≥ 2650
J _c (15 T) at 4.2 K, A/mm ²	>1400
D _s , μm (subelement diameter)	< 100
J _s , A/mm ²	>3000
Cu-fraction, %	53 ± 3
RRR (after full reaction)	≥ 60
Twist Pitch, mm	14 ± 2
Twist Direction	right-hand screw
Minimum Piece length, m	350
High temperature HT duration, h	≥ 48



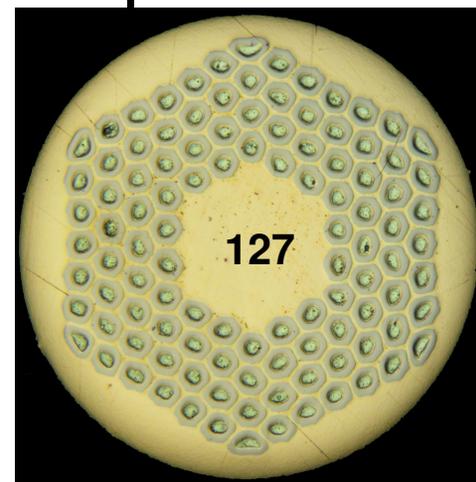
Increased Copper spacing



Nb₃Sn HQ-Strand Specification LARP-MAG-M-8002 Rev-D

RRP 108/127 with increased Copper

Process	Ternary RRP Nb ₃ Sn
Strand Diameter, mm	0.7 – 0.8 ± .003
Jc(12 T) at 4.2 K, A/mm ²	≥ 2650
Jc(15 T) at 4.2 K, A/mm ²	>1400
D _s , μm (subelement diameter)	< 60
J _s , A/mm ²	>3000
Cu-fraction, %	53 ± 3
RRR (after full reaction)	≥ 60
Twist Pitch, mm	14 ± 2
Twist Direction	right-hand screw
Minimum Piece length, m	350
High temperature HT duration, h	≥ 48





Conductor Procurement

- In FY09

- Took delivery of 160 kg of 54/61 at 0.8 mm
- Ordered 88 Kg of wire Mar'09
 - Initial spec for 54/61 ⇒ Changed to 108/127
 - Delivered in Jan'10
- On order 134 kg of 108/127 wire
 - 67 kg ⇒ Aug'10
 - 67 kg ⇒ Dec'10

- In FY10

- On order 295 kg of 108/127 wire
- Plan to order 200 kg by May'10
- Additional order for 400 kg (on request from contingency)



Conductor Inventory Summary

- 78 kg of 0.7 mm wire for 2-3 UL's of LQ
- 60 kg of 54/61- 0.7 mm wire from five billets available for practice coils and cable
- RRP 54/61 (increased spacing)
 - 69 kg at 0.8 mm
- RRP 108/127 (increased spacing)
 - 54 kg at 0.8 mm (some in short lengths)

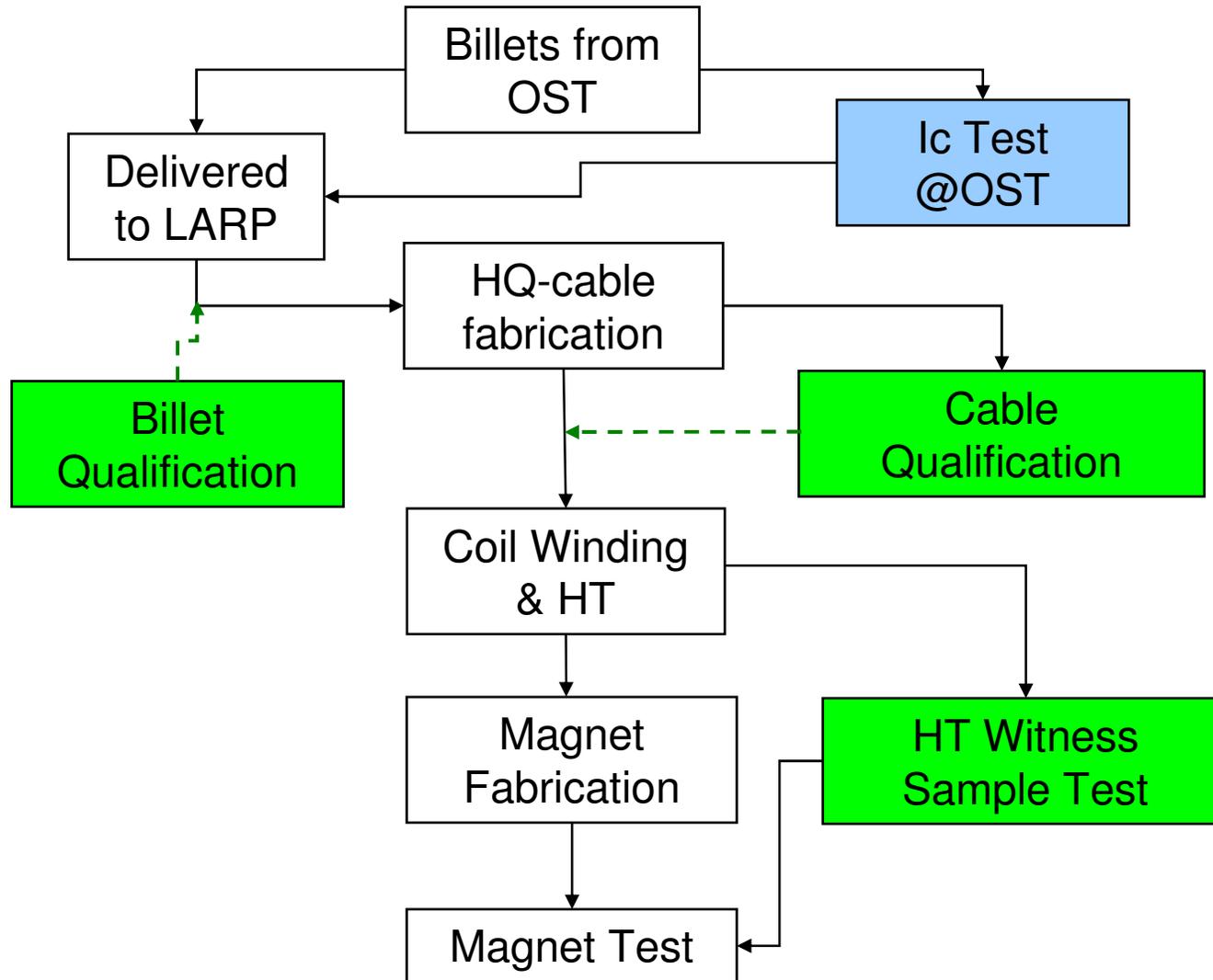


Strand Production

	108/127 Delivery, kg	Coil ID	Cable ID	Strand Req. kg	Unit Lengths	108/127_ 0.8 mm kg	108/127_ 0.7 mm kg
Nov-09						20	
Dec-09						20	
Jan-10	88					54	54
Feb-10						54	54
Mar-10						54	54
Apr-10		LQ C15-C16	1003R	51	2	54	3
May-10						54	3
Jun-10						54	3
Jul-10						54	3
Aug-10	68	HQ1-C15/16		36		86	57
Sep-10		LQ C17-18		51	2	86	6
Oct-10						86	6
Nov-10						86	6
Dec-10	68					124	36
Jan-11		LQ C19		26	1	124	10
Feb-11	180					304	10
Mar-11	115	HQ2 C01-04		144	4	275	10
Apr-11		HQ2 C05-08		144	4	131	
May-11	57					188	
Jun-11	200					388	
Jul-11						388	
Aug-11	200	HQ6 C01		120	1	468	
Sep-11						468	
Oct-11	200	HQ6 C02		120	1	548	
Nov-11						548	
Dec-11	300					848	
Jan-12		HQ6 C03		120	1	728	
Feb-12						728	
Mar-12		HQ6 C04				728	
Apr-12						728	
May-12		HQ6-C05		120	1	608	
Jun-12						608	



Conductor Qualification -1





Conductor Qualification -2

- Billet Qualification
 - Rely on OST data
 - Meets minimum performance specification
 - Low field stability current I_s not measured.
 - Does LARP need further testing ?
- Cable Qualification
 - This is important and needs to be completed prior to coil winding.
 - Minimum 3 extracted strand and one round wire
 - HT as specified for coil reaction
 - For TQ cables and for most of the LQ cables, LARP followed a formal procedure to qualify the cable prior to use
 - Cable acceptance document
 - Discontinued in FY09 and 10 as wire testing was limited to witness samples and testing at 1.9 K.
 - HQ cables were checked during the development phase and for the first few cable runs. No formal documentation.

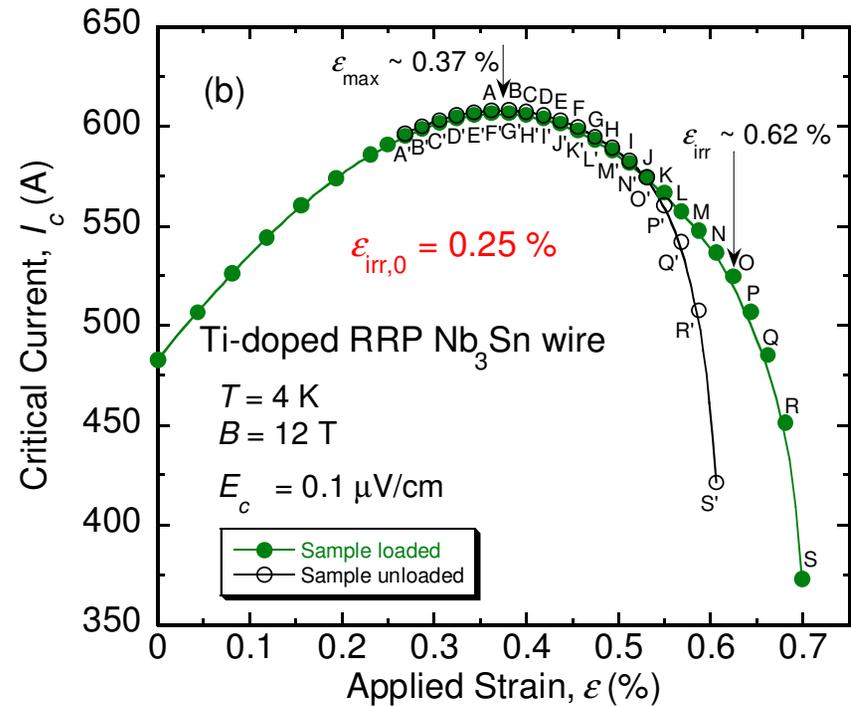
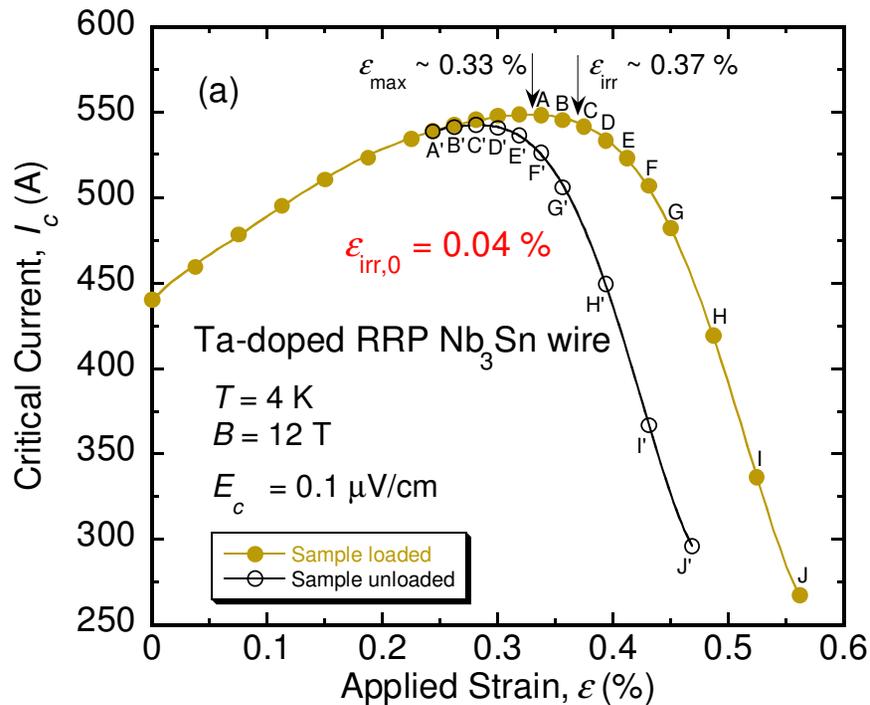


Conductor Qualification -3

- HT Qualification
 - Witness sample tests of extracted strands
 - Tests done at two measurement labs
 - Minimum of three extracted strand and one round wire at each site
 - 1.9 K tests ?



Ti-Ternary vs. Ta-Ternary



Ti-doped Nb₃Sn wire more strain tolerant than Ta-doped

Influence of Ta and Ti doping on the irreversible strain limit of ternary Nb₃Sn superconducting wires made with restacked-rod process*

N. Cheggour, L. F. Goodrich, T. C. Stauffer, J. D. Splett, and X.F. Lu, A. K. Ghosh, G. Ambrosio
Supercond. Sci. and Tech., 20, (2010)



Ti-Ternary RRP 108/127

- There are new results from a study of Ti-doped RRP wires that indicate that Ti-doped wires are more tolerant than Ta-doped wire in tensile strain
 - Wire for study used CDP developed billets
 - 54/61 (9415), 90/91 (8079), 108/127(9416) and 54/61 Nb-Ta-Ti-Sn (9362)
 - There are additional billets being produced by OST in FY10 under the CDP program
- What should be the strategy to qualify this type of conductor for the future ?



Summary

- Present Procurement Plan
 - All wire will be of the RRP 108/127 type 0.7-0.8 mm
 - The planned purchases will satisfy the needs of the HQ program.
 - Long term plan being developed to support long-HQ magnet development.
 - Lead time for strand is now 12-13 months
 - Note: OST has very significant ITER production work
 - Claim that they can handle 600-800 kg of RRP for LARP
- Conductor qualification plan needs to be formalized