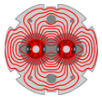
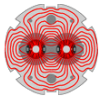


BNL -FNAL - LBNL - SLAC

LARP CM16
May 16-18, 2011

Nb_3Sn Conductor Status

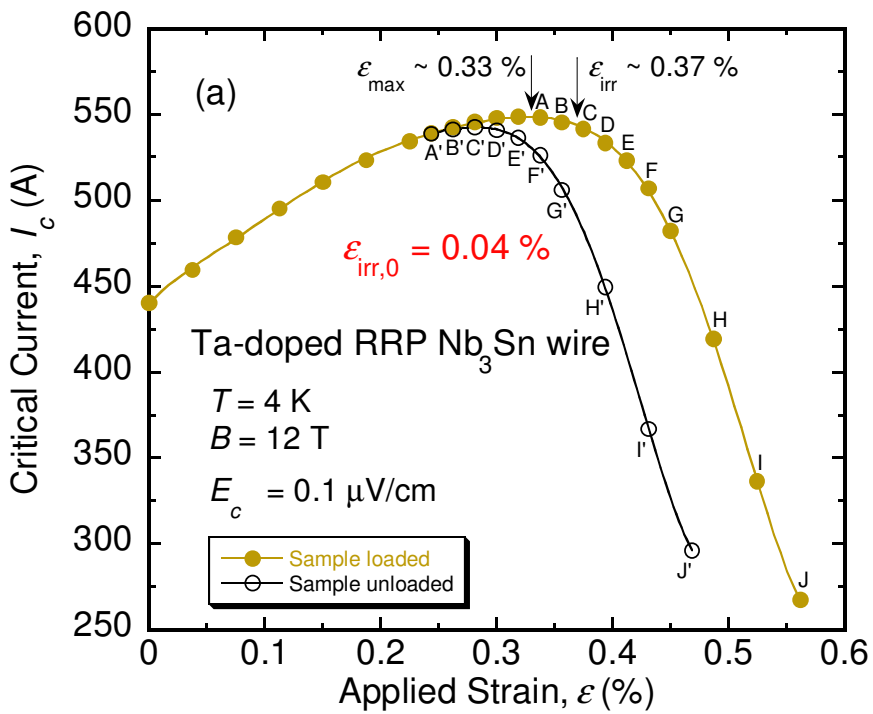
Arup K. Ghosh (BNL)

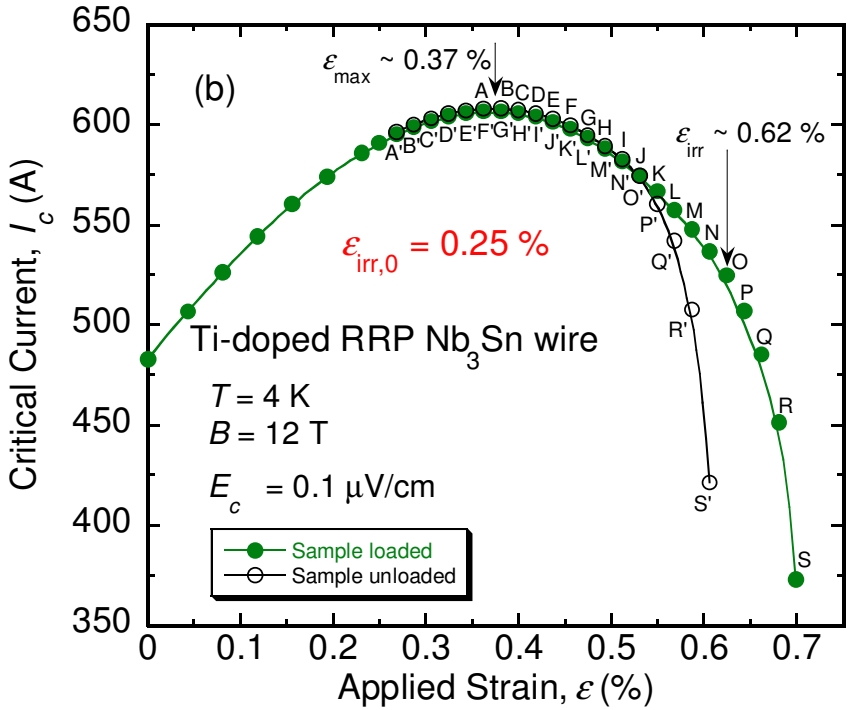


Outline

- Introduction
- Ti-Ternary strand
- Smaller Filament strand
- LARP Strand Inventory
- Production Plan for Strand and Cable
- Questions and Discussion

Ti-Ternary vs. Ta-Ternary





Ti-doped Nb_3Sn 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)

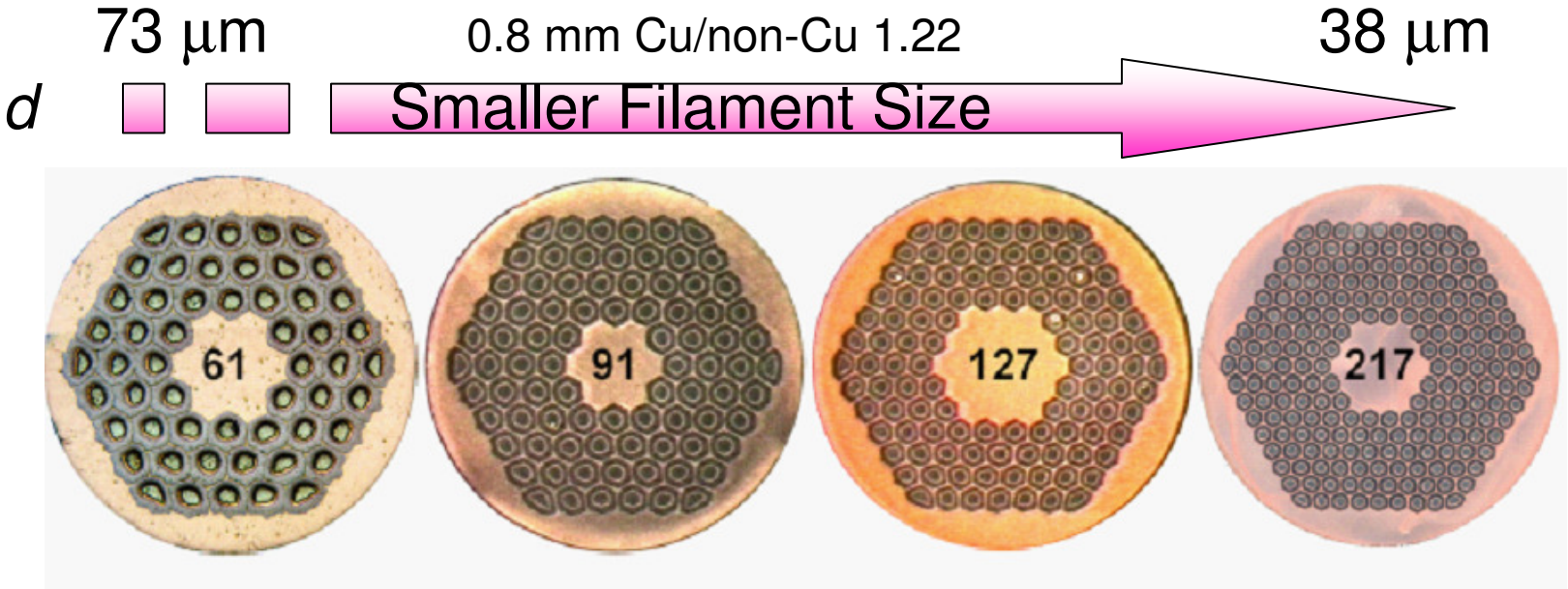
Ti-Ternary 108/127 RRP Strand CDP program

- In FY 2010 OST delivered two billets at 0.8 mm
  - 28 kg of 2.0 wt.% Ti (RRP12099)
    - Jc at 12 T ~ 2700 A/mm2, Jc at 15 T > 1500 A/mm2, RRR > 60
    - Cable B1010R HQ-C11
  - 22 kg (one piece) of 1.5 wt.% Ti (RRP11976)
    - Jc at 12T > 2900 A/mm2, Jc at 15 T > 1500 A/mm2, RRR > 60

- In FY 2011
  - 90 kg of 1.5 wt% Ti
    - Meets specification
    - Jc (12T) > 2650 A/mm2, Jc(15T) > 1400 A/mm2, RRR >60

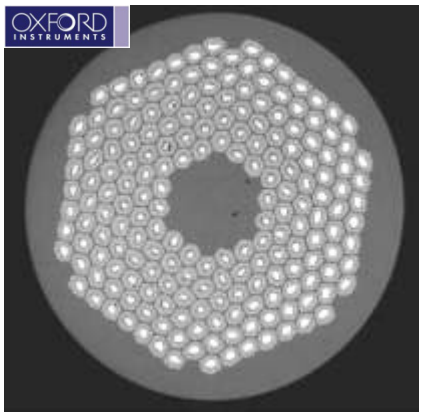
Pathway to smaller filament diameter

- Smaller sub-elements can minimize flux jumps and improve stability.
- Filament Magnetization decreases
- Main driver has been DOE- HEP Conductor Development Program
- And FNAL R&D Program



Higher Stack-Design

- So far OST has not been successful in producing a high-Jc 217 stack wire under the CDP program. Last year they made a lower Jc ~2400 A/mm^2-class Ti-Ternary 192/217 wire – RRP11500. Drew down in one piece to 1.1 mm. A high-Jc version billet broke up at large wire size. However, barrier integrity for 11500 was poor as RRR dropped to < 10 for the 665C reaction.
  - Very difficult to maintain High-Jc and RRR > 50 for smaller filaments
- Another option is 169-restack
  - First billets fabricated for FNAL, 2400A/mm^2 class 142/169 design
  - Two billets are being fabricated for CERN (Possible FRESCA 2 strand). Jc > 2500 A/mm^2, RRR >50



Conductor Inventory May-13-2011

- 34 kg of 54/61 - **0.7 mm** wire
- 60 kg of 54/61- **0.7 mm** wire from five billets available for practice coils and cable
- RRP 108/127 (increased spacing)
  - 17 kg at **0.7 mm**
  - 85 kg returned to FNAL

- RRP 108/127 (increased spacing)
  - 27 kg at 0.8 mm (some in short lengths)
  - 35 kg at 0.8 mm (in one piece)
  - 270 kg at OST at 0.84 mm waiting for decision on final wire size (0.778 or 0.8 mm).
- ➢ RRP 108/127 Ti-Ternary (from CDP)
  - ➢90 kg at 0.8 mm

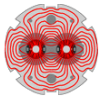
Strand Production and Cabling Plan

Month	108/127 Delivery, kg	Coil ID	Cable ID	Strand Req. kg	Cable Unit Lengths	108/127 0.8 mm kg	108/127 0.7 mm kg	108/127 0.778mm kg	Ti-108/127 0.8 mm kg
Nov-09						20			28
Dec-09						20			28
Jan-10	88					54	54		28
Feb-10						54	54		28
Mar-10						54	54		70
Apr-10		LQ-C17-C18	B1003R	51	2	54	3		70
May-10						54	3		70
Jun-10		HQ1 C11 HQ1 C13	B1010R B1008		1 1	54	3		47
Jul-10		HQ1 C12,Cxx	B1011 B1012C		1 1	54	3		47
Aug-10	68					63	62		47
Sep-10		LQ C15-C16	1013R	51	2	63	11		47
Oct-10		HQ1 Cxx	B1014	36	1	27	11		47
Nov-10						27	11		47
Dec-10	42				2	27	11	42	47
Jan-11						27	11	42	47
Feb-11	32					27	43	42	47
Mar-11	130	HQ1 Cxx	B1015	42	1	157	43	0	137
Apr-11	115	LQ-C19		26	1	272	17	0	137
May-11	57					329	17	0	137
Jun-11		HQ1 Cxx	B1016	18	1	311			
Jul-11		HQ1 Cxx-Cxx	B10xx	36	2	275			
Aug-11						275			
Sep-11	125	HQ4-C01	B10xx	72	1	328			
Oct-11	132					460			
Nov-11						460			
Dec-11	194	HQ4-C02		72	1	582			
Jan-12		HQ4-C03		72	1	510			
Feb-12		HQ4-C04		72	1	438			
Mar-12		HQ4-C05		72	1	366			
Apr-12		HQ4-C06		72	1	294			
May-12						294			
Jun-12						294			

As of Nov-2009

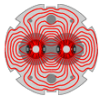
0.7 mm 54/61 kg	0.8 mm 108/127 kg	0.8 mm 54/61 kg
34	20	69

- Cable ID ending in R denotes cable made using standard 2-pass method
- Cable ID without R denotes cable made using 1-pass with annealed strand
- Cable ID ending in C denotes cable made with annealed strand with core.
- HQ1: 1 m HQ, HQ4 : 4 m LHQ
- 1 UL of HQ1 requires 18 kg, HQ4: 72 kg



Strand Production status

- In CY 2011, OST is producing ~ 785 kg of 108/127 strand wire
  - LARP- MAG-M-8002 Rev. E
    - ➢ Minimum Length 550 m
- Plan to place order for 380 kg in FY2011
  - Delivery in July-Dec 2012.



Questions and Discussion

- Do we phase in the Ti-Ternary production now ?
  - LARP- MAG-M-8002 Rev. F
  - Changes to Rev. E
    - (Nb-1.5wt%Ti) –Ternary
    - Jc(15T) > 1400 A/mm^2

- How much conductor is required for the LHQ magnets
  - Each coil requires ~ 72 kg
  - A complete magnet ~ 290 kg ~ 8 billets of 0.8 mm wire

- Is there a need for conductor with filament diameter much less than 50 μm.
  - 144/169 ⇨ 45 μm
  - 192/217 ⇨ 39 μm