LARP Conductor, Cable, & Materials Development

D.R. Dietderich

LARP
LBNL
Feb. 26-27 2004

Cable and Materials -- Priorities and Plans

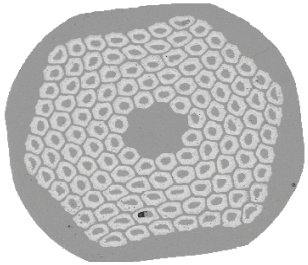
- Cable R&D
  - Deformation limits of existing strand
    - Oxford Strand
      - Restack Rod Process (RRP) & Hot Extruded Rod (HER)
    - Outokumpu
      - Internal tin
    - SMI and Supercon, Inc.
      - Powder in tube (PIT)
  - Keystone cables
      - Keystone angle (strain limit)
      - Mechanical Instability (winding issue)

Cable and Materials -- Priorities and Plans (cont.)

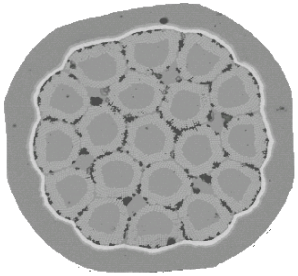
- **Increase Ic of cable**
  - Reduce Cu (Oxford) – more Nb_3Sn in cross-section
  - Improve Nb_3Sn – Intrinsic improvement of Jc_{Nb3Sn}
  - Thinner Insulation – Increase coil pack current density
    - Radiation hard materials
- Strand
  - Deff (50 μm) acceptable
  - Strand instability (FNAL base program)
  - Stress not yet and issue

Cables for D-20, RD-3, and HD-1

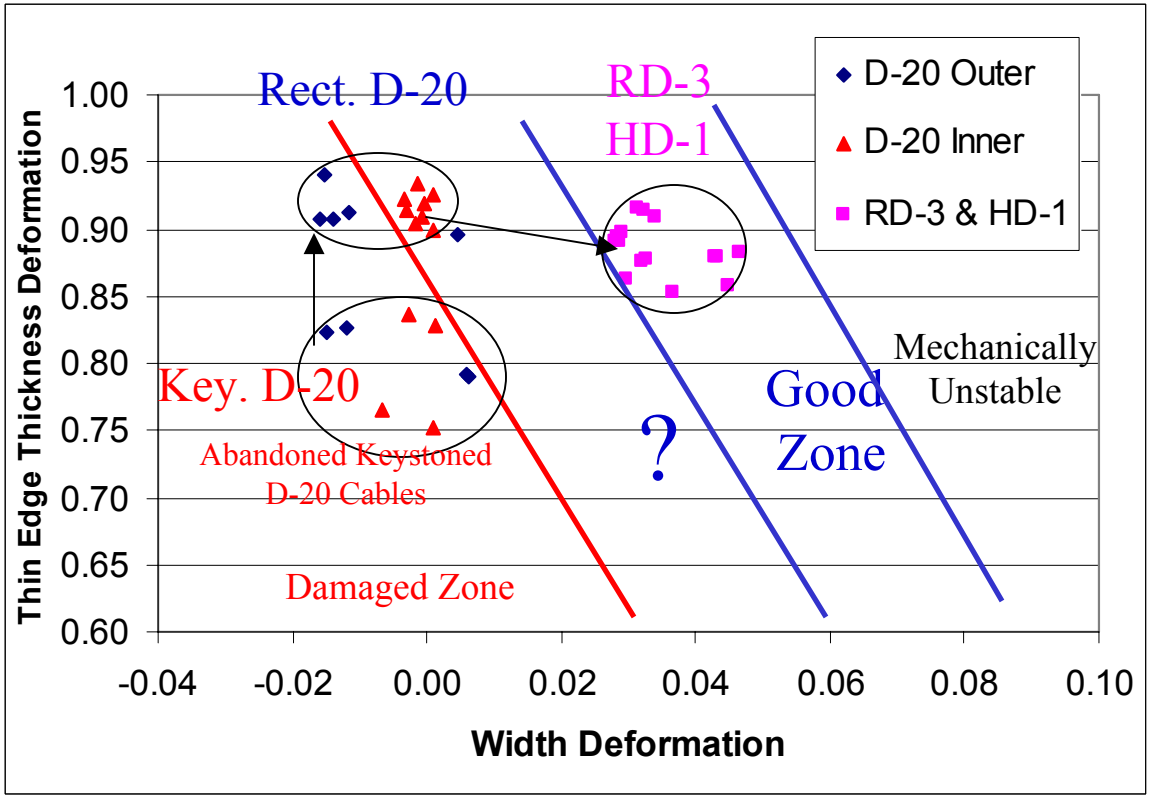
D-20



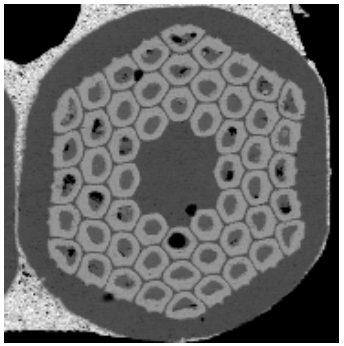
LBL Cable # 523
MJR-TWCA



LBL Cable # 522
IGC-Int. Tin

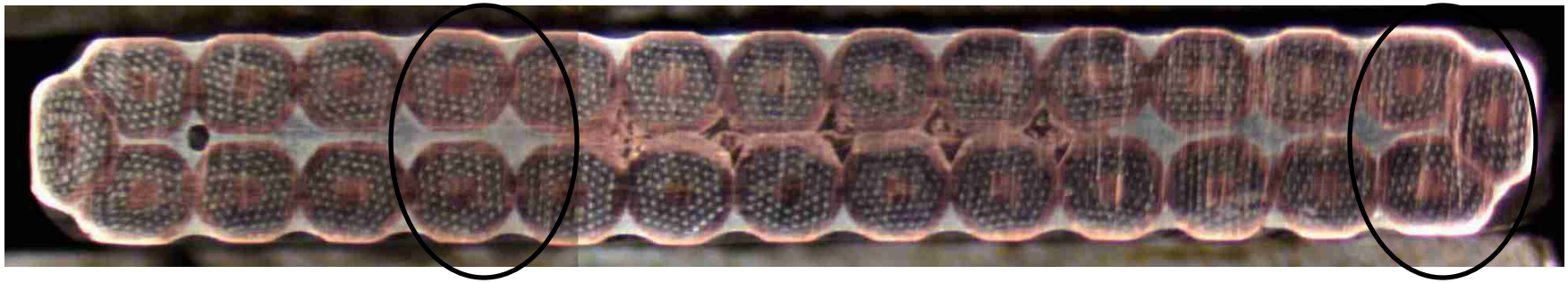


RD-3

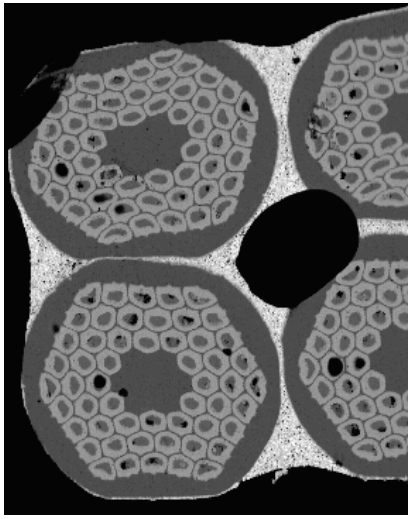


LBL Cable # 805R
Oxford-ORe

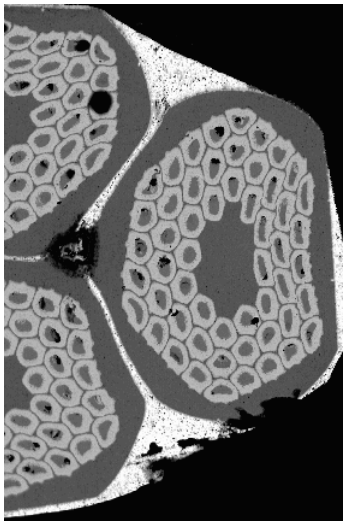
Rutherford Cable



Middle of cable



Edge of cable



New Deformation Parameters

- Thickness deformation (strain)

  t/2D

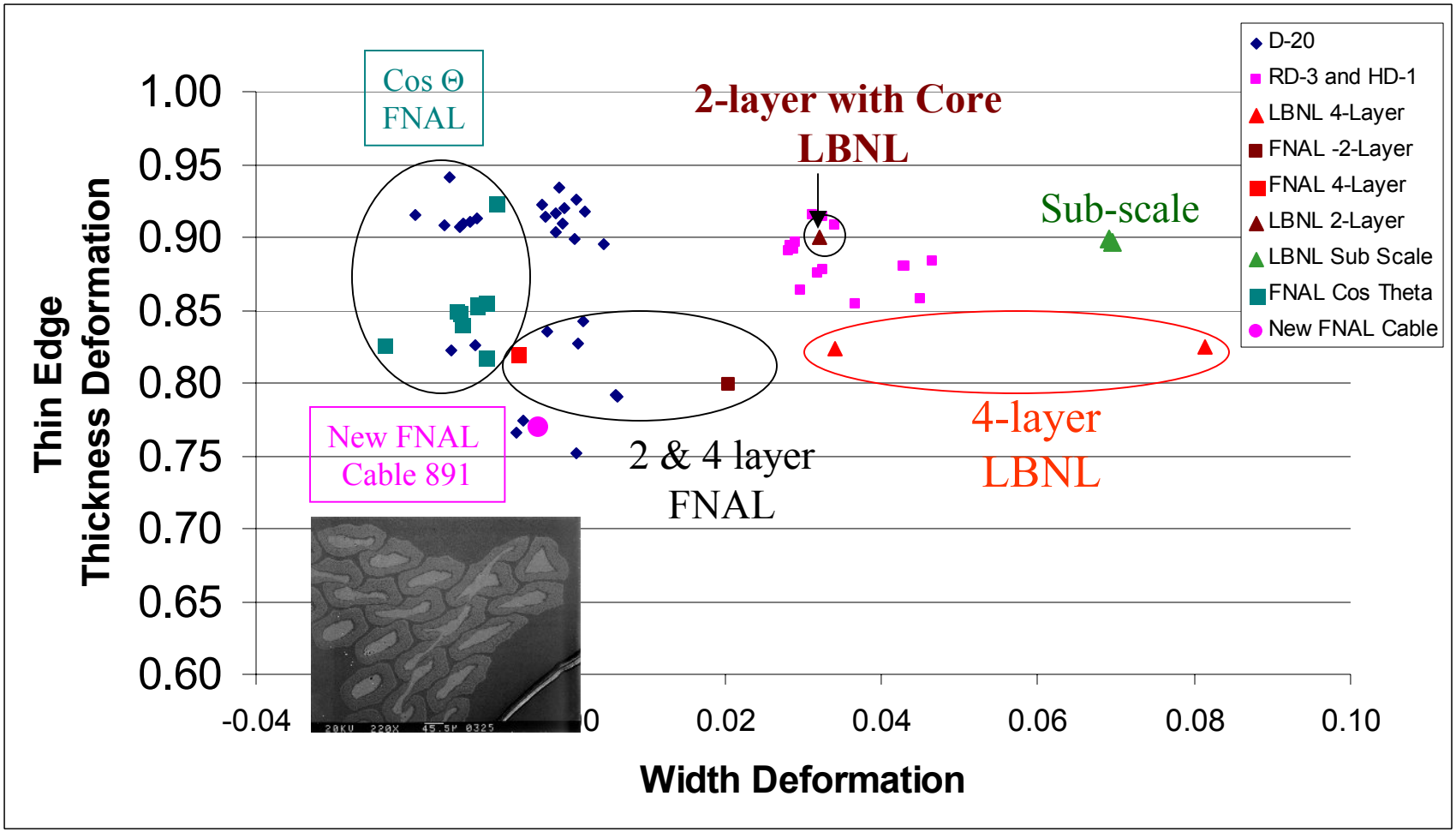
- Width deformation (strain)

  $(w - w_{th})/w$

  - Theoretical width (w_{th}) =

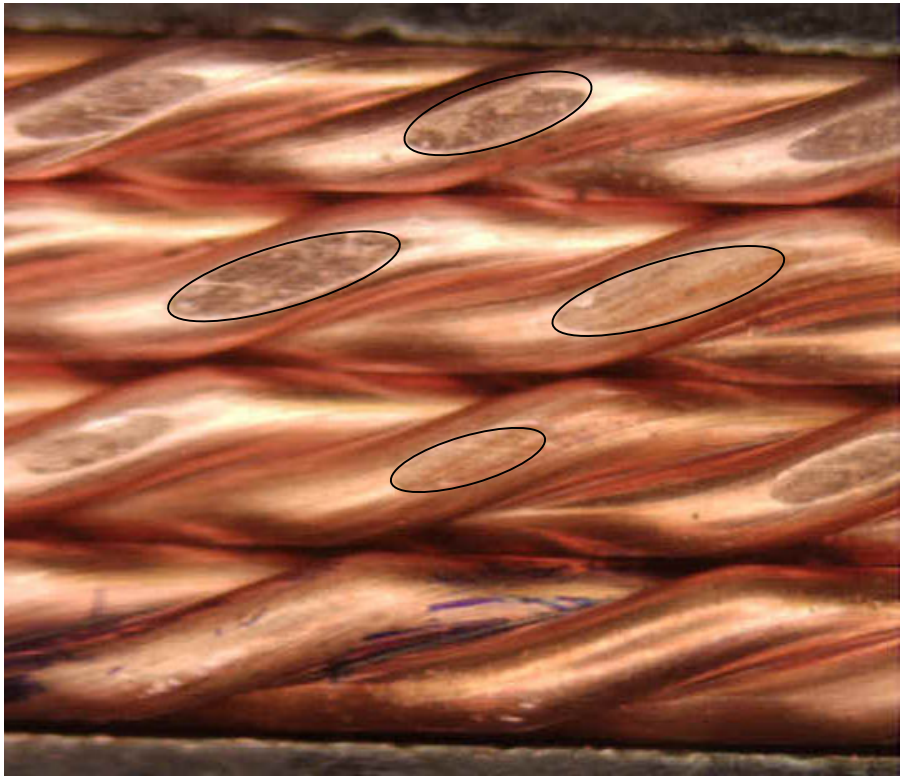
    (# strands/2) x (wire diameter) x (Pitch angle correction)

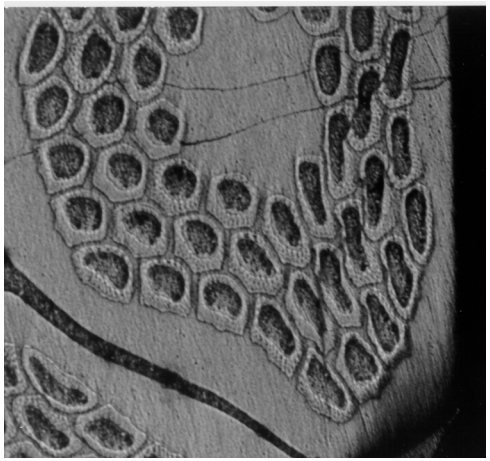
Fully Keystoned Cables for LARP

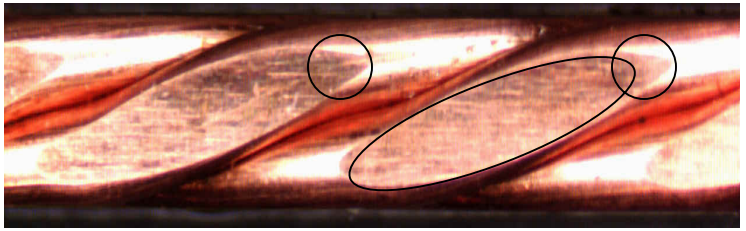


Quantify Cable Deformation

- Area of edge facet



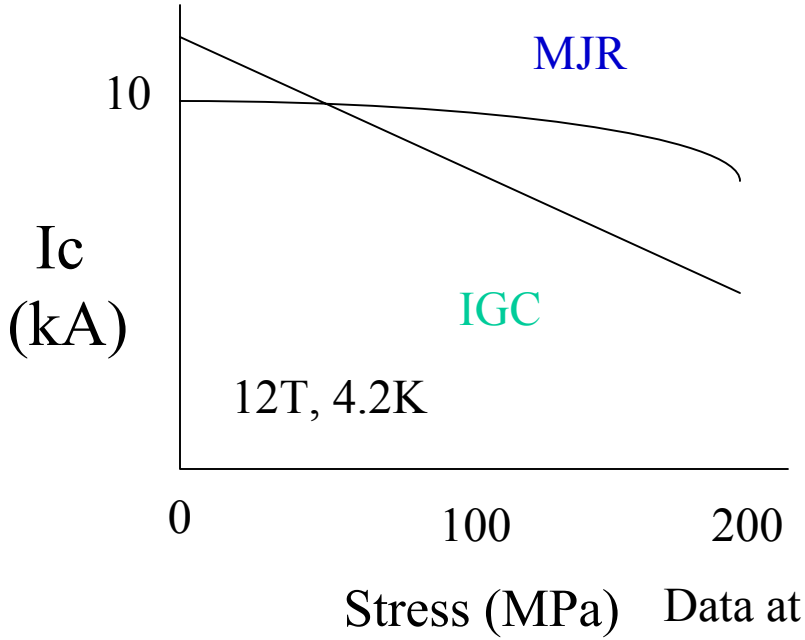




• Large facets: deformation too high
•Potential real time monitoring -- NEEW

Sensitivity of New Strand and Cable to Stress

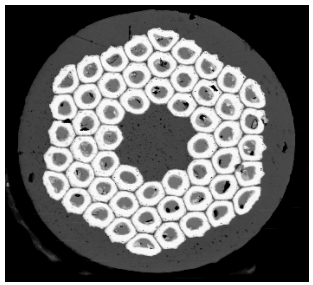
- Stress Not Issues?
  - New RRP comparison to D-20 MJR?
  - Less Cu more Nb_3Sn inside sub-element
    - Nb_3Sn filaments sinter



NHMFL Test
150mm uniform field
122mm load length

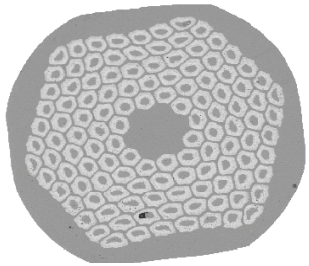
Data at end of handout

HD-1



RRP-Oxford

D-20



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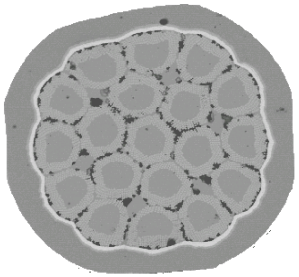
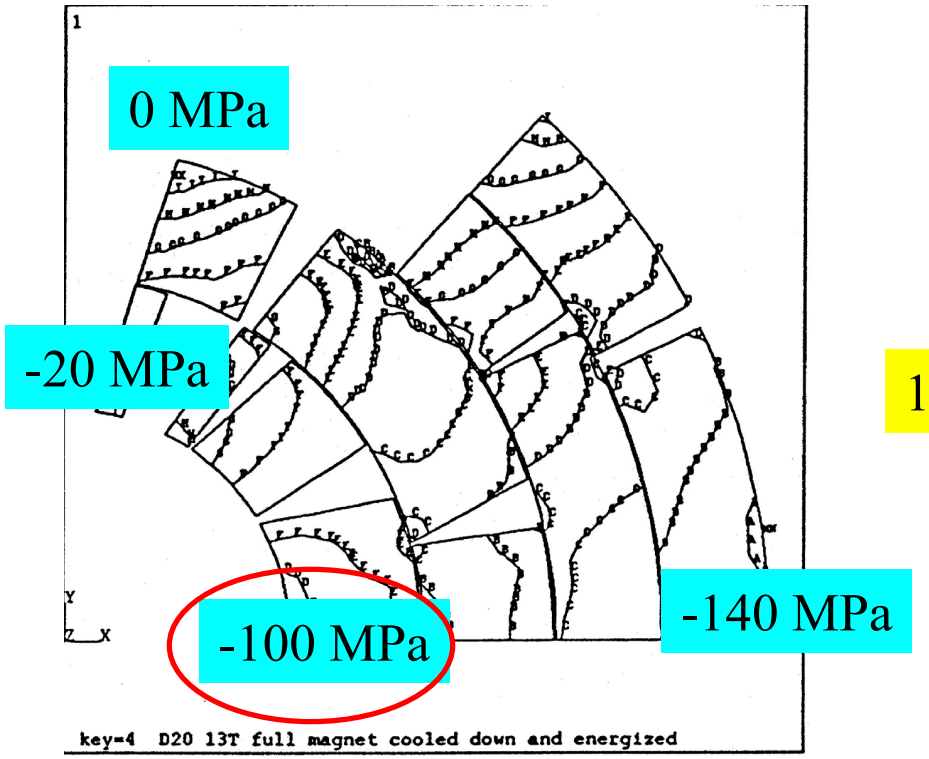
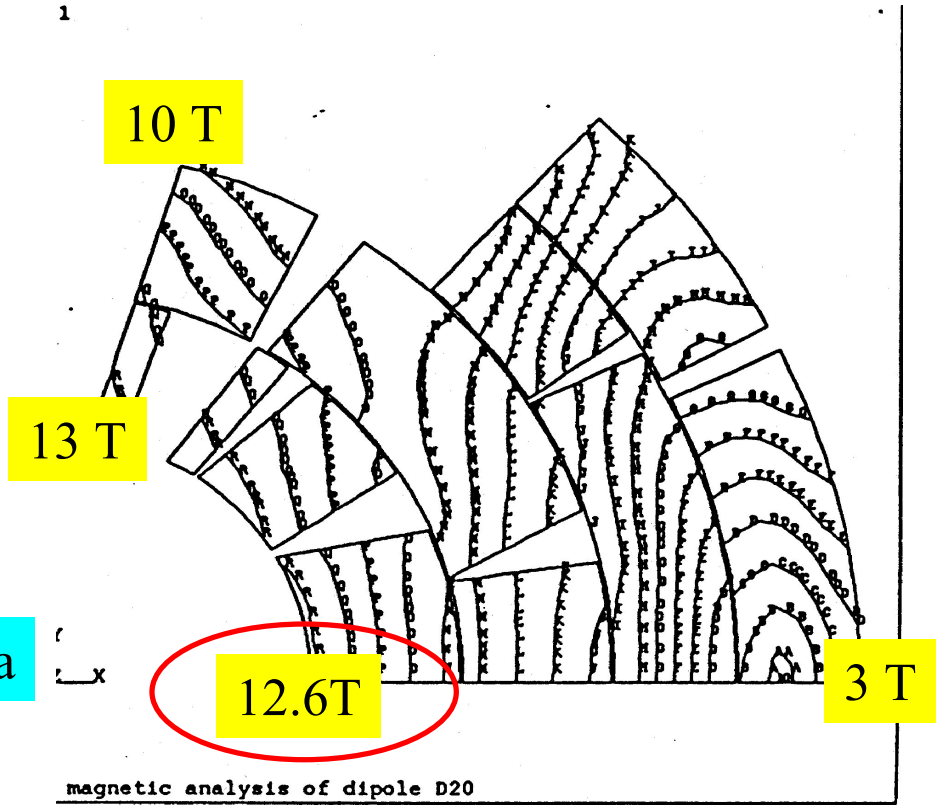


LBL Cable # 522
IGC-Int. Tin

D-20 Azimuthal Stress and Magnetic Field in Coils at 13T Peak





The **narrow edge** of a keystoned cable is located at high field and high stress point

Cable R&D Tasks: Modify Strand Mechanical Behavior

- Present Nb_3Sn cable processing at LBNL (Coils for RD-3b, RD-3c, HD-1)
  1. Fabricate cable
     1. Slightly under-size
  2. Anneal at 210°C/6h
     1. Softens Cu
     2. May harden Sn core
  3. Re-roll to decrease thickness by 25-50 μm.
     1. Compacts cable making it mechanically stable

FY-04: Effort of Cable R&D

- LBNL
  - 0.1 FTE — Fabricate Prototype cable for 4-layer design, (Oxford RRP strand)
  - $5k — Rolls, mandrels, misc. materials
- FNAL
  - 0.1 FTE — Jc & Magnetization tests of extracted strand

FY-05: Effort of Cable R&D

- LBNL
  - 0.3 FTE — Fabricate Prototype cables for 4-layer design, (Inner and outer)
  - 0.3 FTE — Fabricate Prototype cable for 2-layer design, requires development of a core
  - $5k — Rolls, mandrels, misc. materials
- FNAL
  - 0.3 FTE — Jc & Magnetization tests of extracted strand
  - 0.2 FTE — Cable Ic, (CERN)
- BNL/FNAL
  - ? FTE — Strands Jc, 4-Layer Cable Jc measurements
  - ? FTE — Thinner & radiation hard insulation

FY-06: Effort of Cable R&D

- Similar to FY-05
  - More if no new strand type needs to be studied
    - HER & PIT