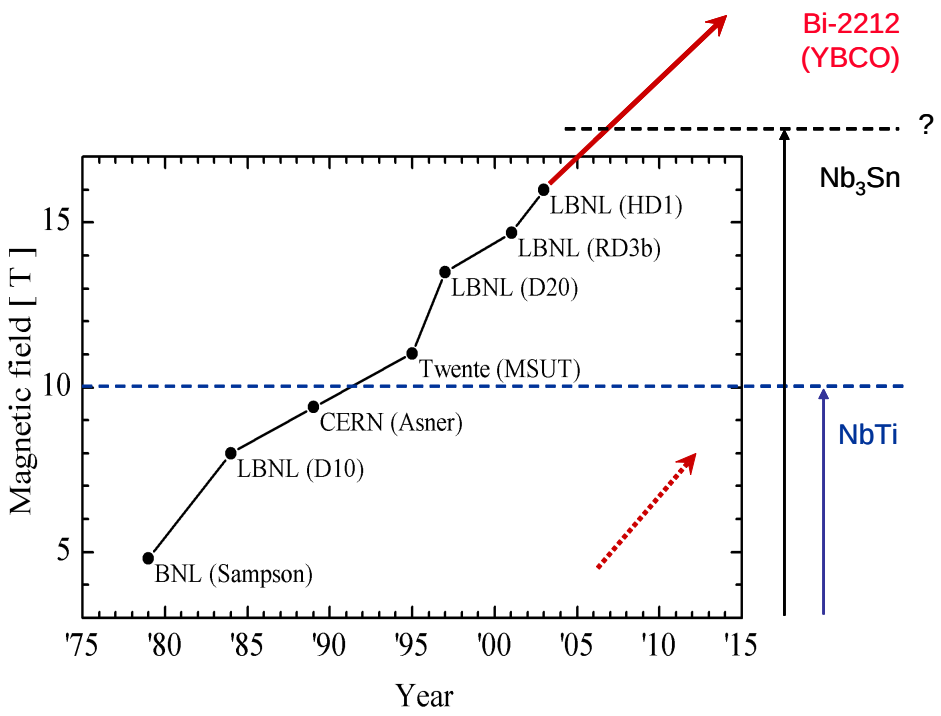
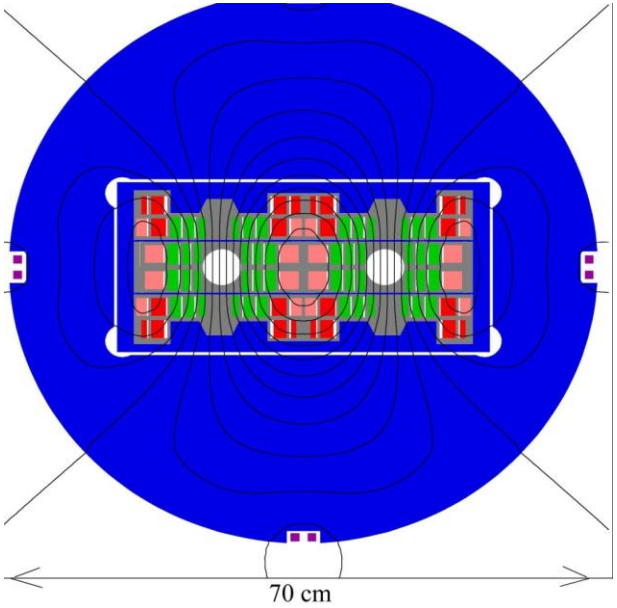
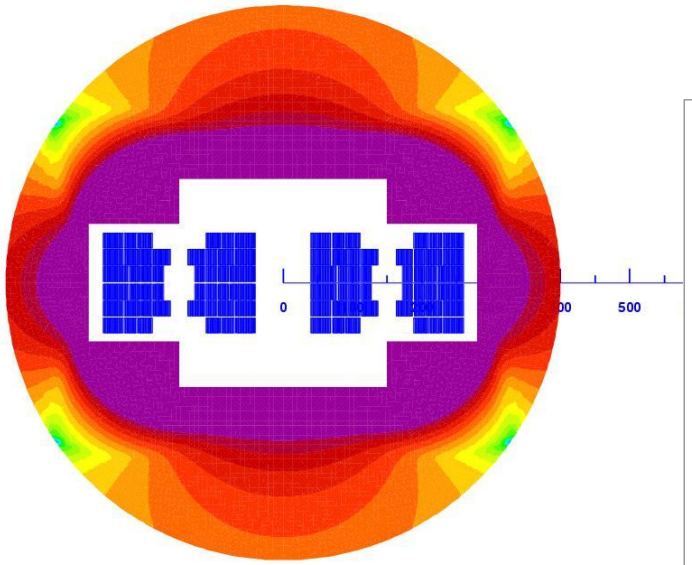
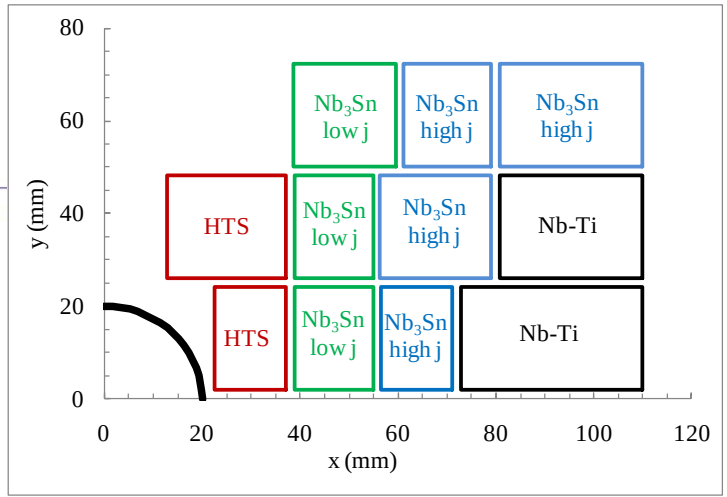
# Report from Session 2
# Main Dipoles




P. McIntyre 2005 – 24T ss Tripler, a lot of Bi-2212 , Je = 800 A/mm2

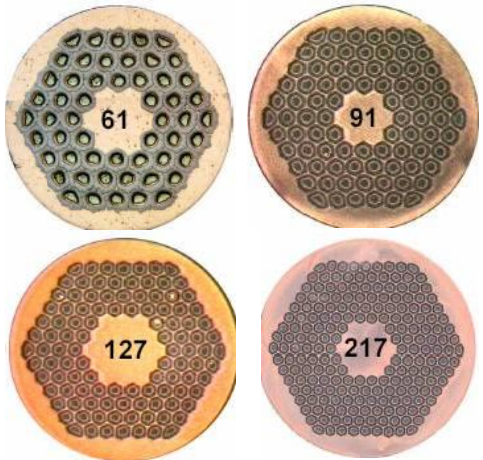





E. Todesco 2010
20 T, 80% ss
30% NbTi
55 %NbSn
15 %HTS
All Je < 400 A/mm2

# Conductor

- NbSn: 15- 16 T (**80% ss !!**)
  - Developed, existing in moderastre quantities (tons); for ITER (less Jc) 400 tons
  - Needs improvement in mechanical, stability
  - Instability is an issue but we can manage
  - A reduction 2 in – projected- cost is an asset
  - **2 manufacturers only: 1 at good level, 1 near**



# Bi-2212

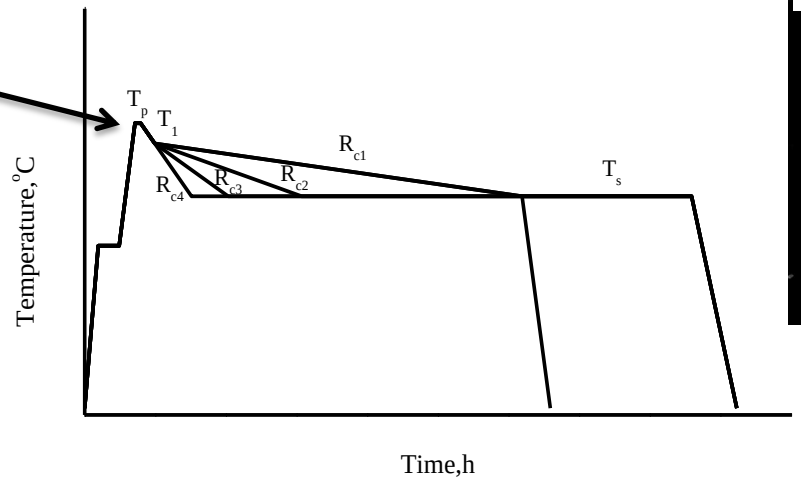
HTS (Bi-2212): needed for B > 16 T (at 80%)

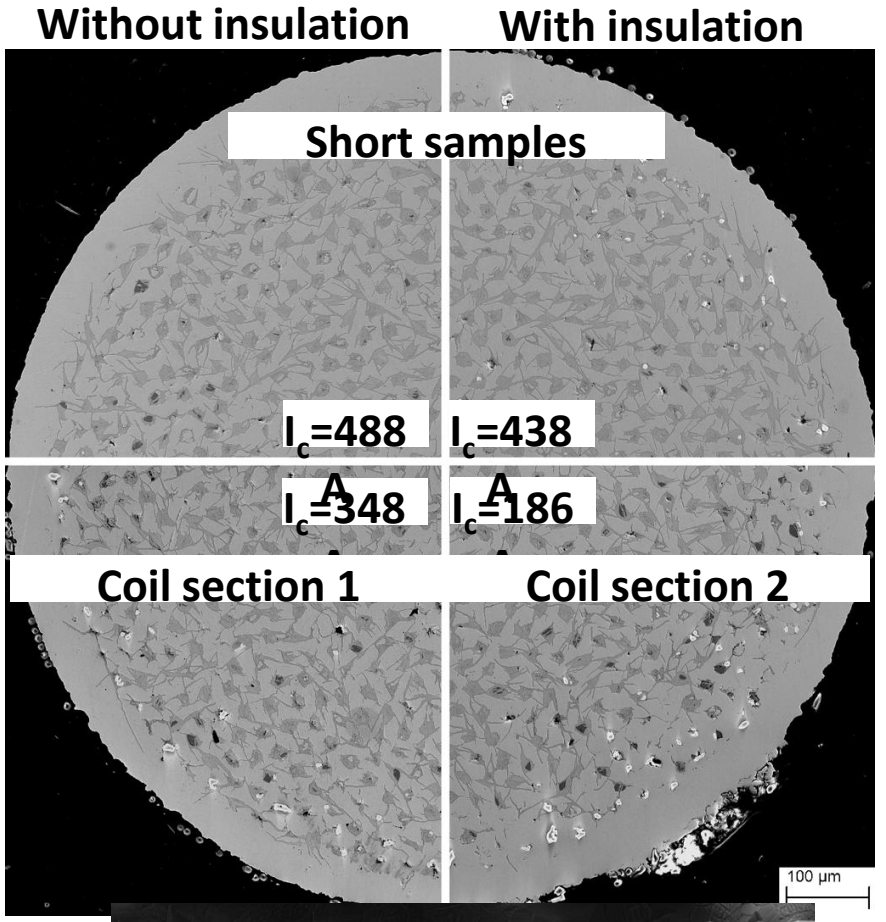
40% cost of material for 20% field

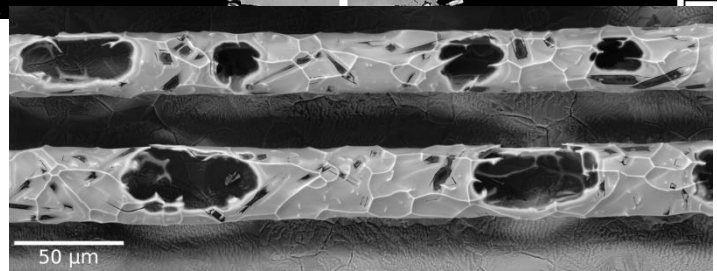
Je = 100-200 A/mm2 today; difficult material; HEP is almost only client…

**Either a strong program or very likely to be abandoned**

Key step!



# YBCO

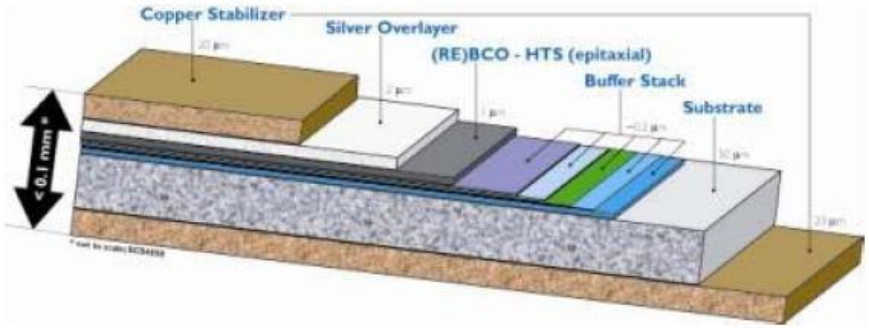
YBCO: may be a great hope: many developers

Cost is –still- stellar

Lack of multikA compact cable may be a killer…

The many developers guidfed by othertr applications (Power, electrical devices…)

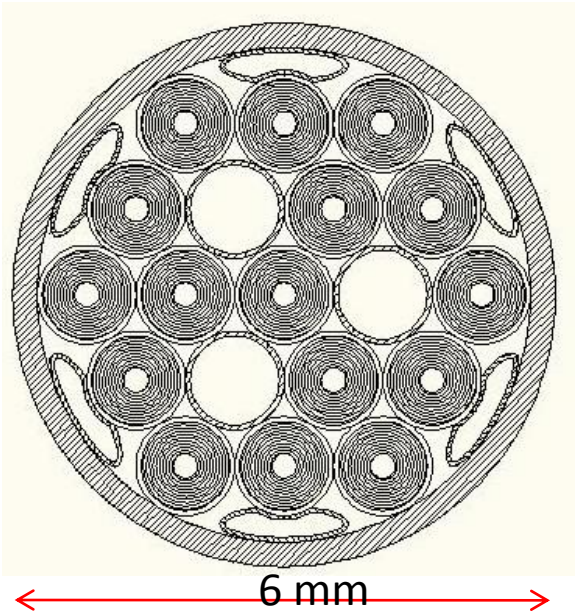
If we want gain we need to choose between Bi-2212 and Ybco, then push and guide development



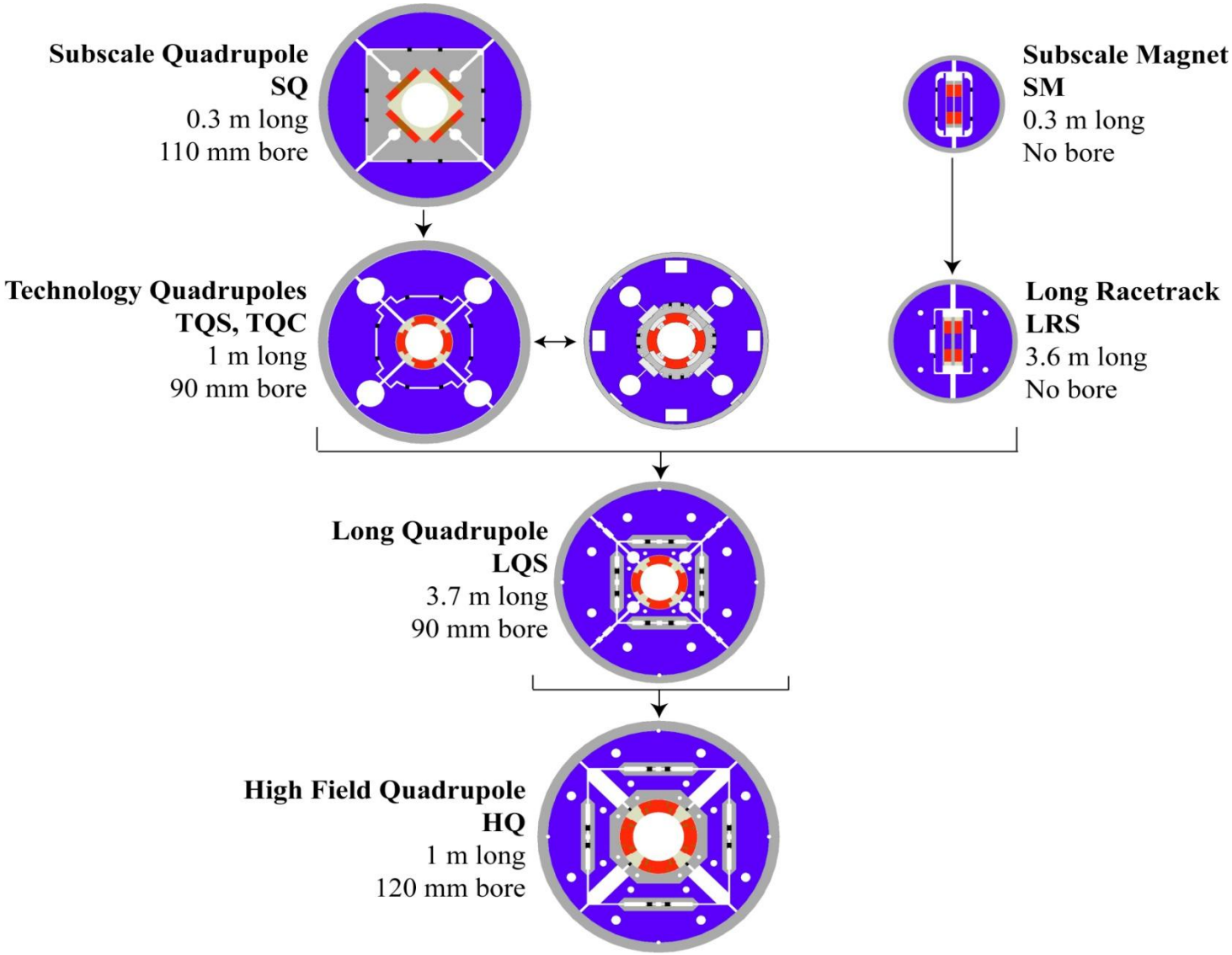
# New ideas needed…
# what do they need to be developed?

We might go far to eliminate all of these problems if we could fully texture the powder in the subelements:

But how to do it?

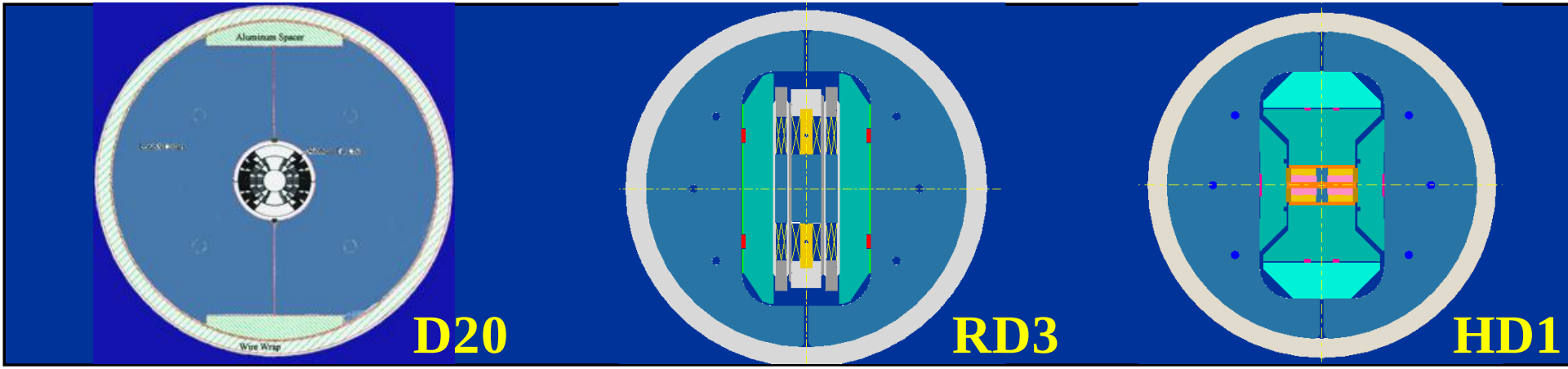


# Magnet Development Chart



# LBL:16 T reached with bladder system…

“cos-theta” “common-coil” “block”

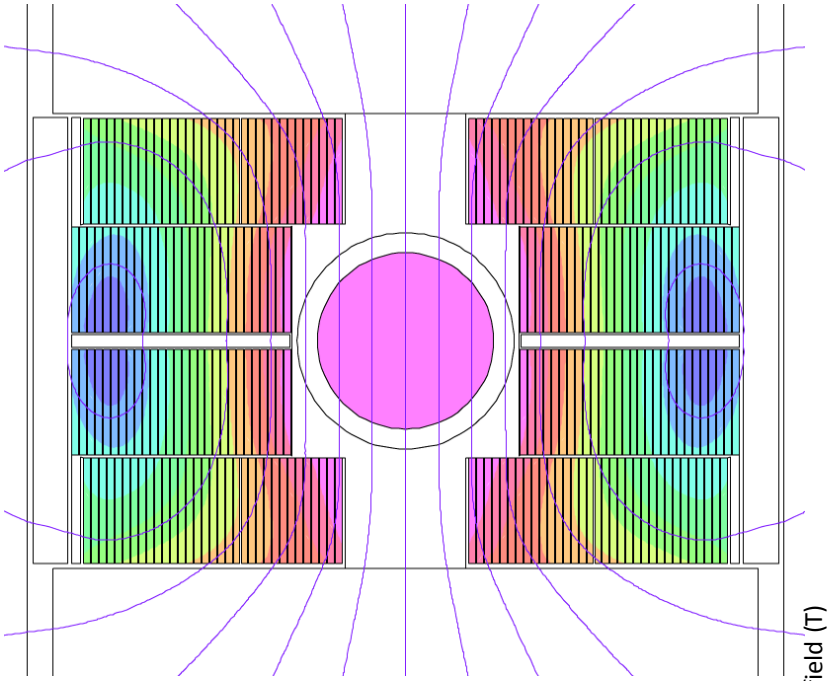


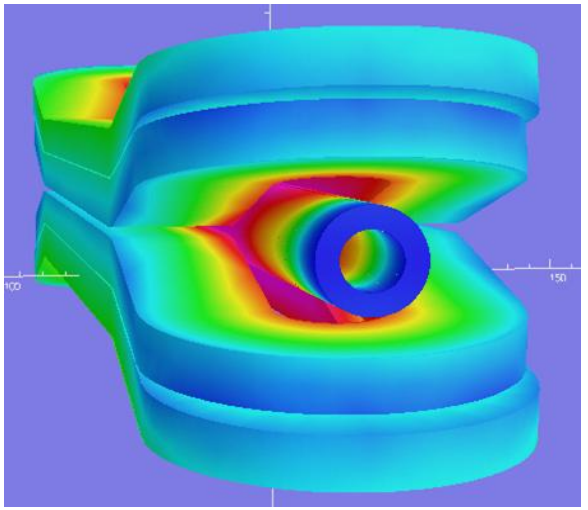

13.8T, 1997
50mm bore

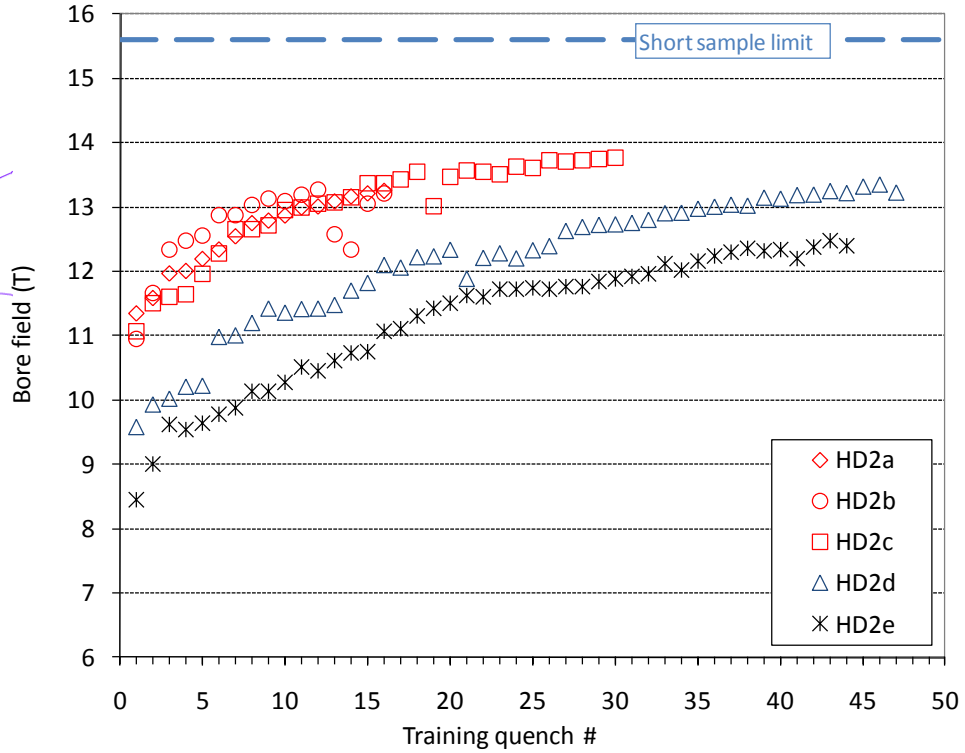
14.5T, 2001

16T, 2003

# Adding a bore…

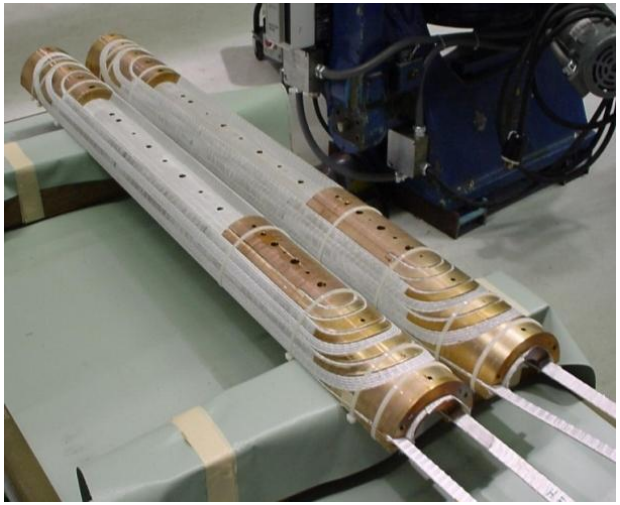


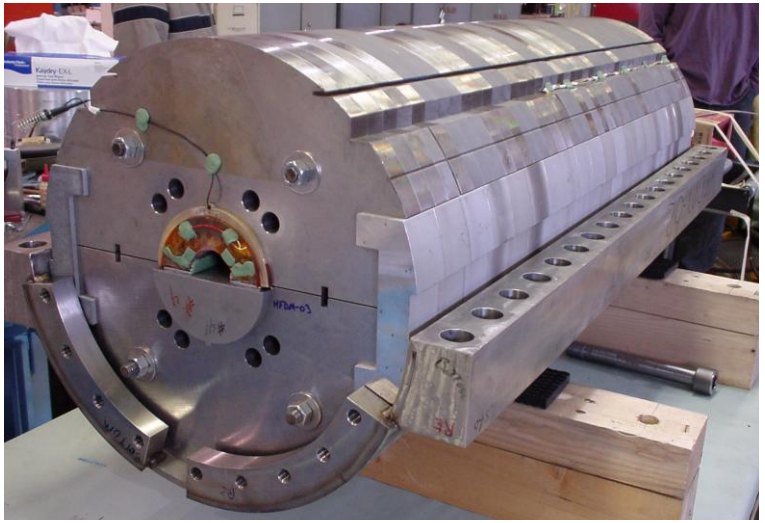





HD2: 43 mm bore
Target @ 4.2 K : 15.6 T

# Extensive investigation of superconductor and classical structure

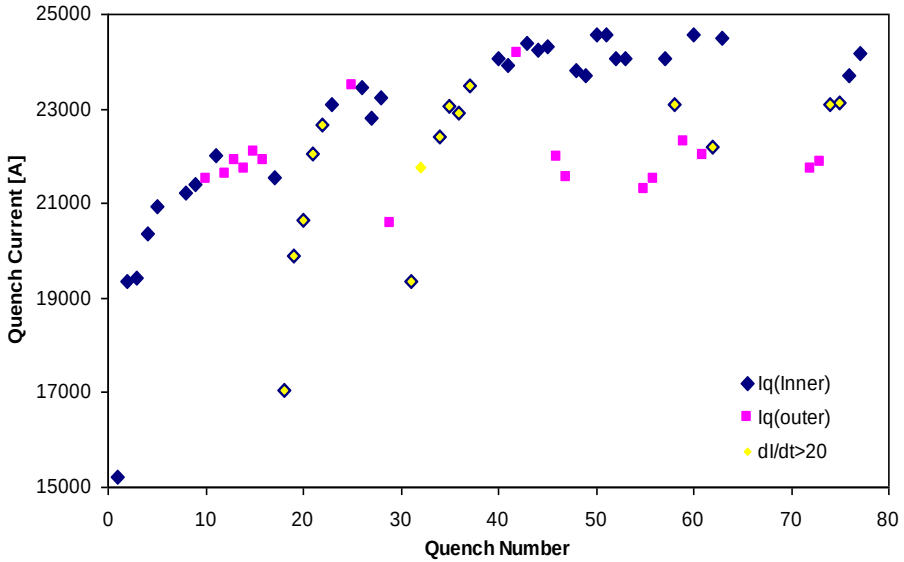




PIT Models: $B_{max}$=9.4/10.2T @4.5/2.2K (100% of SSL).

RRP-108/127 coil: $B_{max}$= 11.4T @4.5 K (97% of SSL)

instabilities at ~21kA



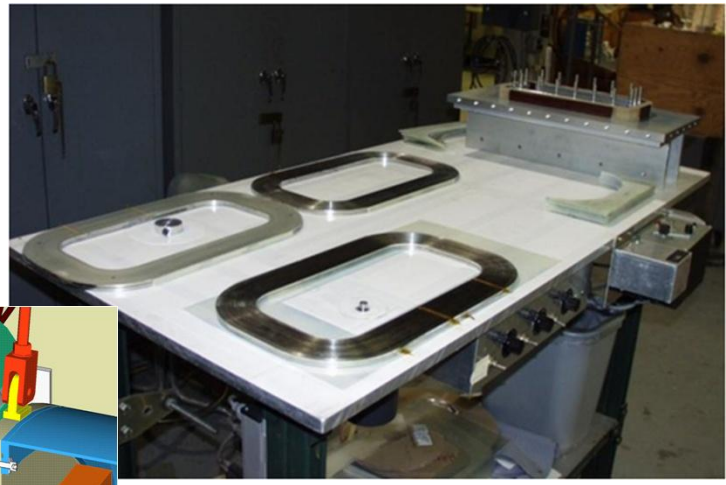
# Conclusion from NbSn US program…

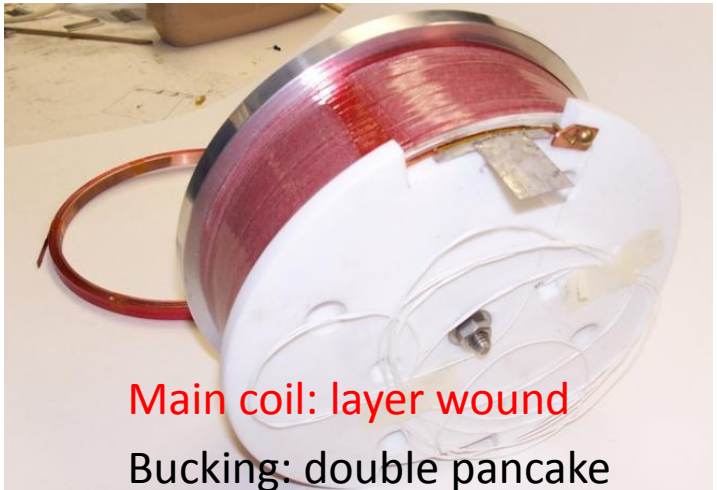
- @ FERMI
- 20 dipole and 35 quadrupole 1-m long coils
- Reasonable size reproducibility
- Short fabrication time
- 2 dipole and 14 quadrupole 4-m long coils
- From CORE programs + LARP
- 11 T in dipoles and quadrupoles: we can count on it (but development on conductor and structure still needed…)
- 13-15 T in view, but 3 years needed…

# Getting acquainted with HTS in special applications: BNL

- **We have successfully designed, built and tested a large number of HTS coils and magnets:**
  - **Number of HTS coils built: ~100**
  - **Number of magnet structures built and tested: ~10**
- **We are performing HTS magnet R&D on a wide range of programs:**
  - **High T, low B (several, in house)**
  - **Medium T, medium B (3 funded programs)**
  - **Low T, high B (>20 T, 2 funded programs)**

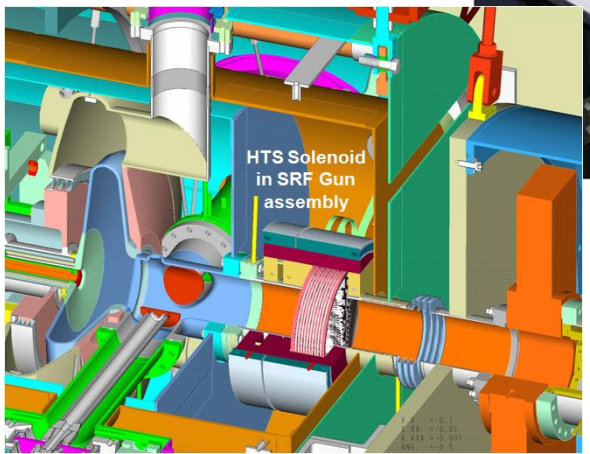
**FRIB**





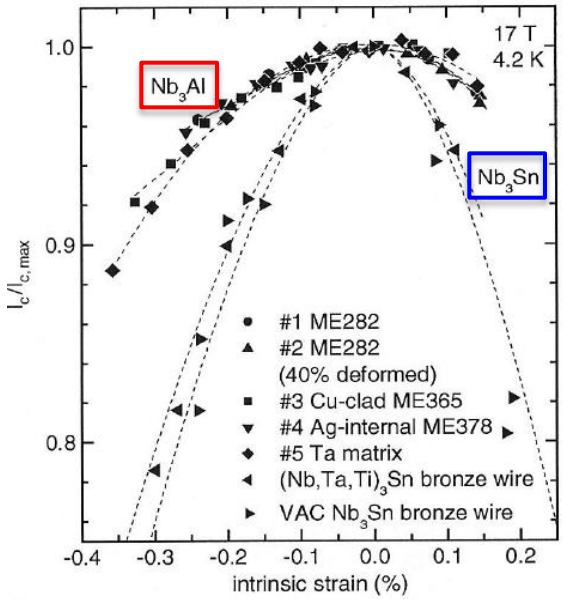
Main coil: layer wound

Bucking: double pancake

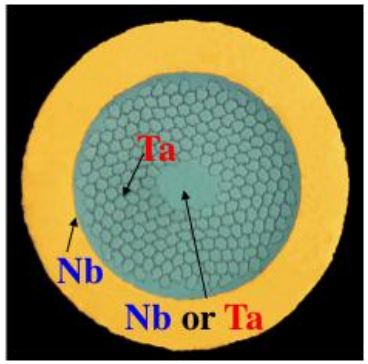


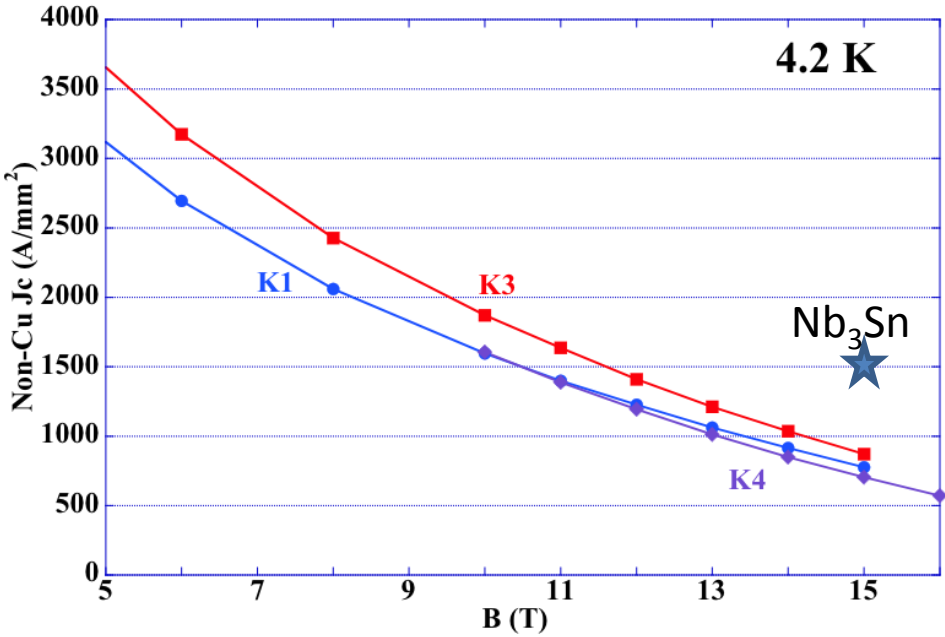

YBCO: 25 T – 100 mm solenoids for SMES…

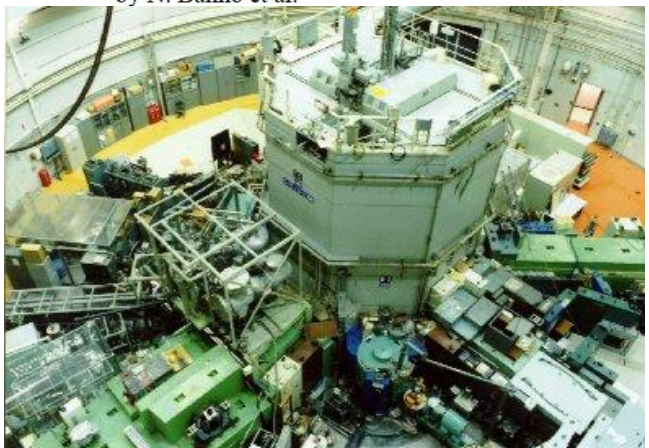
# KEK : $Nb_3Al$ and more…

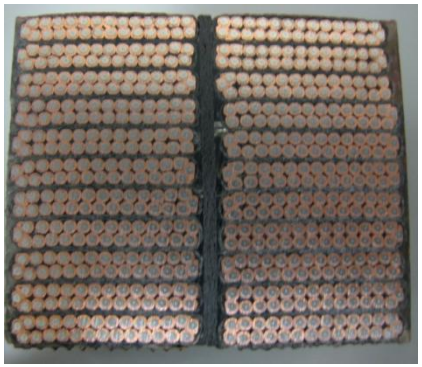



Supercond. Sci. Technol. 18 (2005) p. 284.
by N. Banno et al.

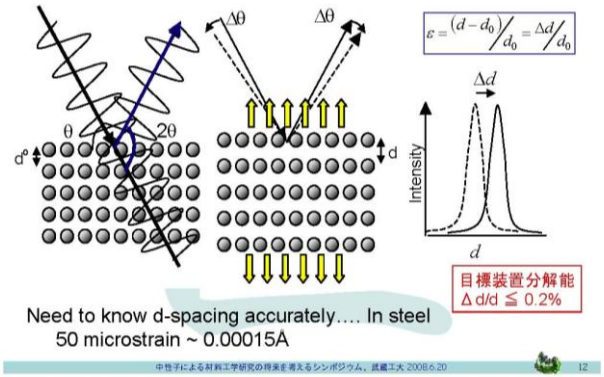


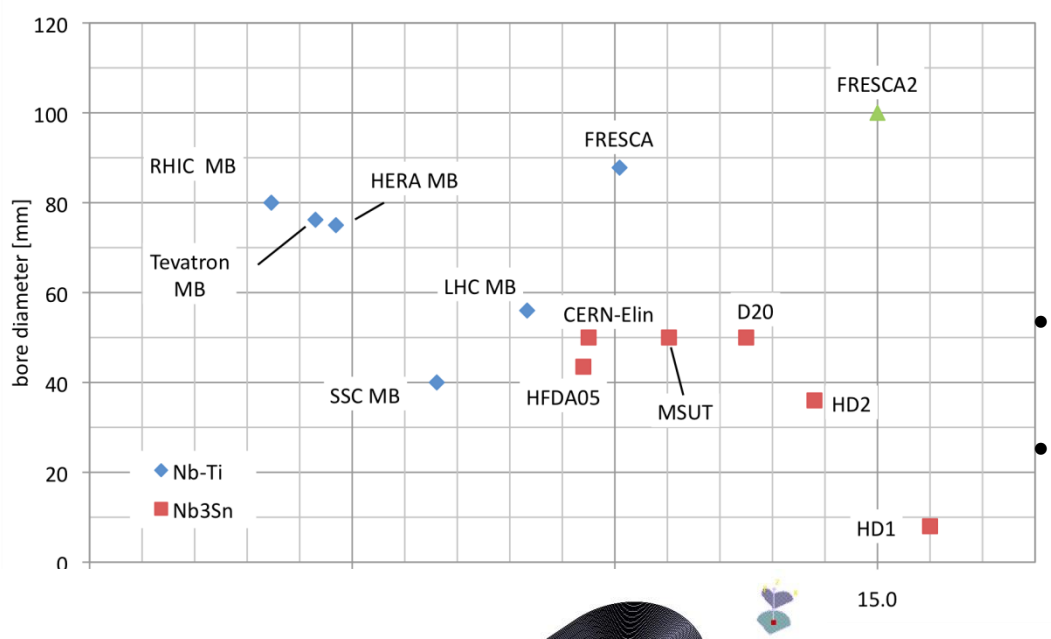





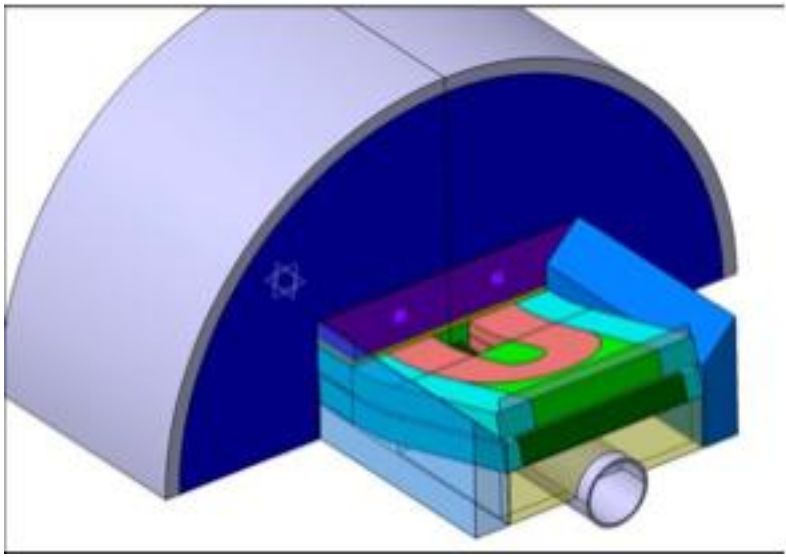
Compressive Load



# Europe: Fresca-2 (2013)




- Making a detailed 3D model is important: the devil is in the detail
- 3D turn by turn model



# Hot points…

- Radiation facility (HiRadMat @ CERN)
- Design : for B>13-14 T consensus toward block design. Proved ? Not yet!
- Aperture: needs more than educated guess (small aperture favor block vs cos$\vartheta$)
- **CONDUCTOR**
  - Is the performance driver
  - Is the cost driver
  - 20 T:  4 G(CHF-$-€)
    - Mitigation measure: 15-16 T range
    - Assess real margin (80%, 90%?)
    - Needs to drive (and finance) development: Ybco > Bi-2212
- HL-LHC (11 T DS dipole, IR magnets @ 13 T) is a valid test bed
- Other specific issues: protection & powering, stress management, small aperture, two-in-one design