PANEL DISCCUSSION

ON

Technology and R&D of High Field Magnets

"HTS Technology"

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The opinion presented here is my personal opinion and not of entire panel, but it ought to be!

Why Consider HTS R&D for LHC Luminosity Upgrade?

- ~10 years to LHC Luminosity upgrade. Must do both: "Low risk, definite result R&D" to "High risk, high reward R&D"

  LBL has made proof of principle 13.5 T cosine theta and 14.7 T common coil Nb_3Sn dipole. Forces and field in Nb_3Sn IR quads are sort of similar to D20 cosine theta dipole made 4 years ago.

  There should be room to look for other options beside turning LBL+Twente R&D magnets to machine magnets.

- HTS has potential to providing higher fields and higher temperature margins (very relevant to luminosity upgrade) and has a potential to significantly change the accelerator technology, as we know today. Conductor performance and results of BNL test coils have shown that credible R&D can now be carried out

  Only more R&D will tell its viability and "real" potential.

The HTS Option

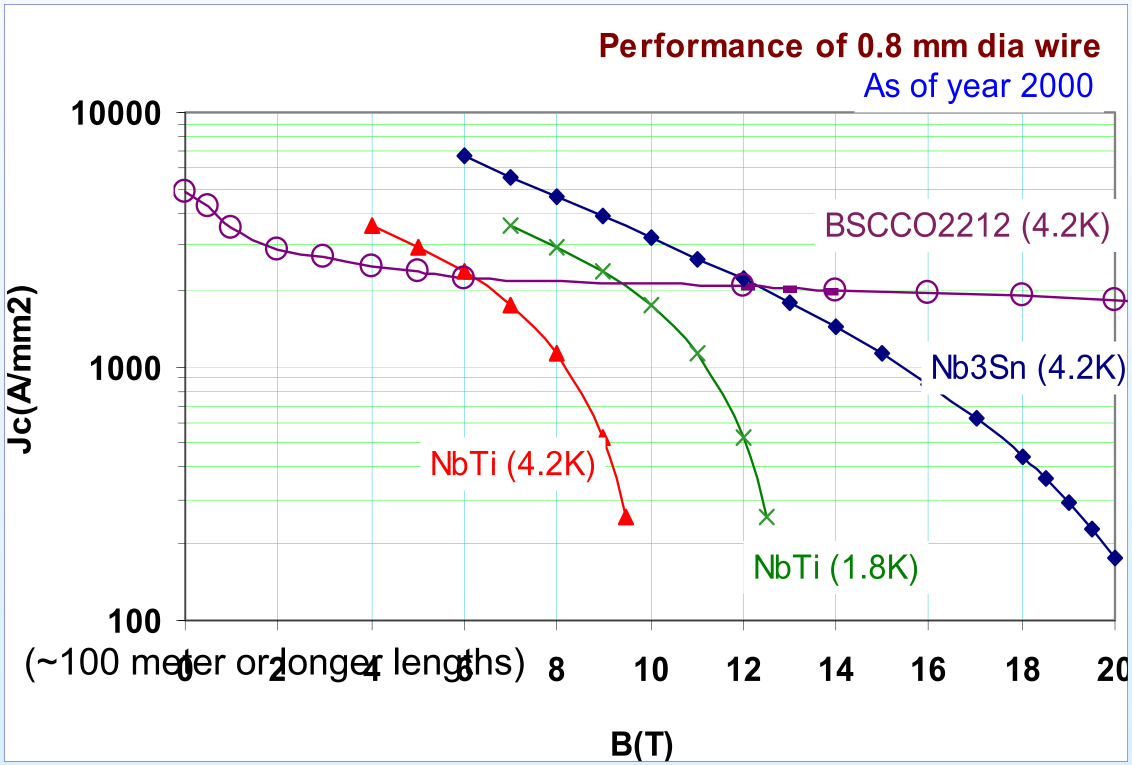
Magnet Technology:

- How to approach conductor development?
- How to approach magnet development?

Accelerator Technology (not discussed here):

- How to utilize high field/gradient potential?
- How to utilize high temperature allowance potential?

HTS Conductor Development Requirements



What really matters is Jo (current density in coil), not Jc (current density in superconductor).

Goal in Jc improvement should be a factor of 3, but even 2X makes HTS magnets as powerful as LTS magnets.

(HTS magnets will be more desirable because of higher temperature allowance)

Investment in 2212 has been much less than in 2223, there may be room for relatively more improvement.

Why High Field HTS Magnet R&D Now?

State of HTS is such that we can do small but credible magnet R&D

- Wire in long lengths available

  BNL purchased 1.5 km wire from Showa, LBL made ~100 m cable

- Hybrid magnets can create 15^{+}T to address HTS specific issues

Quite often when the magnet R&D is carried out together with the conductor R&D, it brings more energy, more progress, better direction and better compromises between various aspects of magnet & conductor research.

HTS Conductor Development and HEP

In the present economical situation, it appears that the progress in HTS will be driven by communities other than the High Energy Physics (HEP).

The most we can do is to support industries to encourage a few developments that are critical to accelerator magnets and keep the kind of product that matters to us viable.

In parallel, we develop the general technology of dealing with the issues posed by these challenging conductors.

HTS R&D at BNL

So far what we have done is to demonstrate that small HTS coils can be made without large degradation.

This is a significant progress (real and psychological) as it reduces "the intimidation factor" of brittle HTS materials.

But there is a long way to go to demonstrate that long coils and magnets can be made and behave well at high fields.

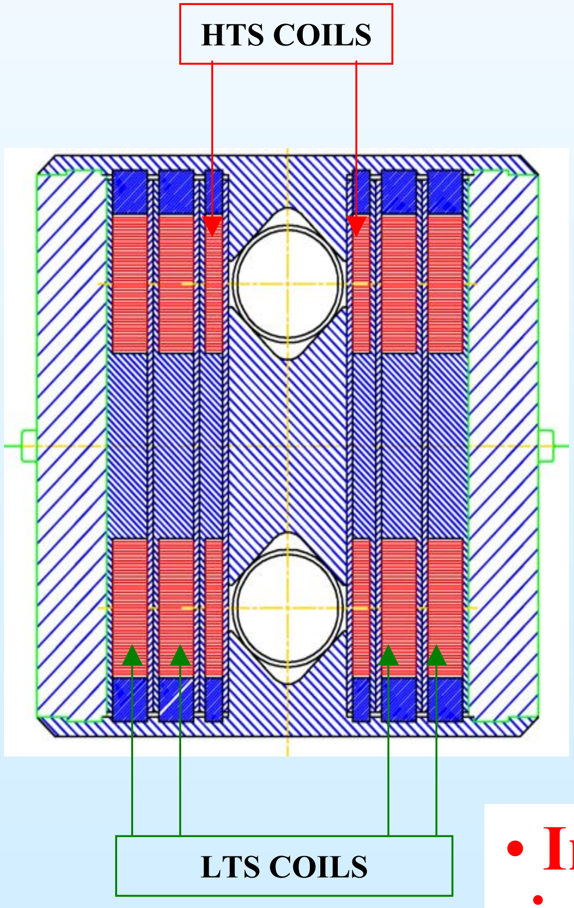
That R&D requires more resources than managed so far.

Next mini step in BNL R&D Program: Make 30 turn short coil (enough for quad) but still in short length.

HTS Coils in High Stress Environment

- Other major questions are how HTS coils + magnet materials (currently used or other options) will behave under high field, high stress environment of "High Field HTS magnets"?
- One must also simulate studies for high luminosity environment.

12 T Background Field Magnet: Important Next Step in HTS R&D

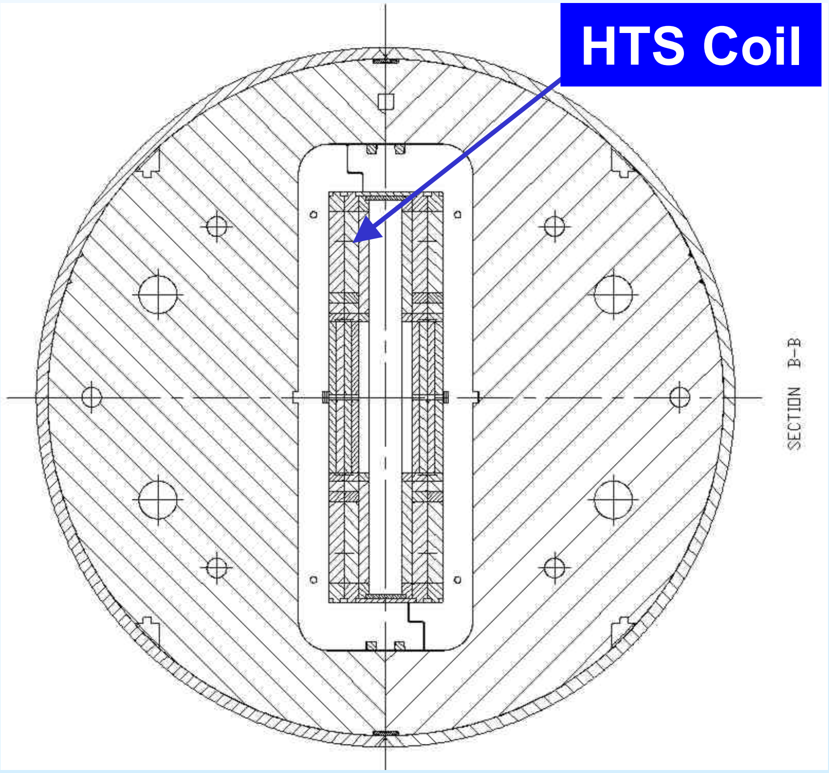


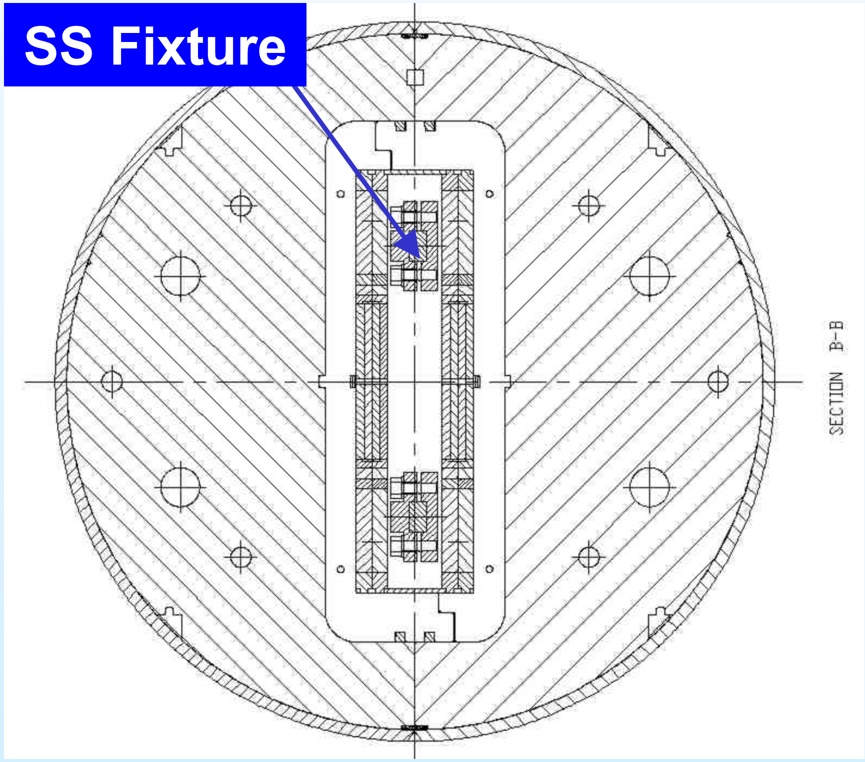
- At present, HTS alone can not generate the fields we are interested in.
- Nb_3Sn coils provides high background fields. The HTS coils will be subjected to high field and high stresses that would be present in an all HTS magnet. Therefore, several technical issues will be addressed.
- Since 12 T Nb_3Sn magnet uses similar technology (building high field magnet with brittle material), it also provides a valuable learning experience in building an all HTS high field magnet.

• Important design consideration: Allow a simple mechanism for testing HTS insert coils.

Insert Coil and Sample Test Scenarios

An interesting feature of the design, which will make it a truly facility magnet, is the ability to test short sample and HTS insert coils without disassembling it.





HTS insert coil test configuration

Short sample test configuration

SUMMARY

• Given the time scale of LHC IR upgrade, the HTS option should also be examined.

• A conceptual direction of the program is outlined here that can be carried out with modest resources.

• This allows minimum development of HTS technology and evaluates its viability in time for making a technology choice for next generation IR's.

• We ought to do more than turning Nb_3Sn R&D magnets to machine magnets in next 10 years. If such R&D can not be justified in such situation, then when can it be?