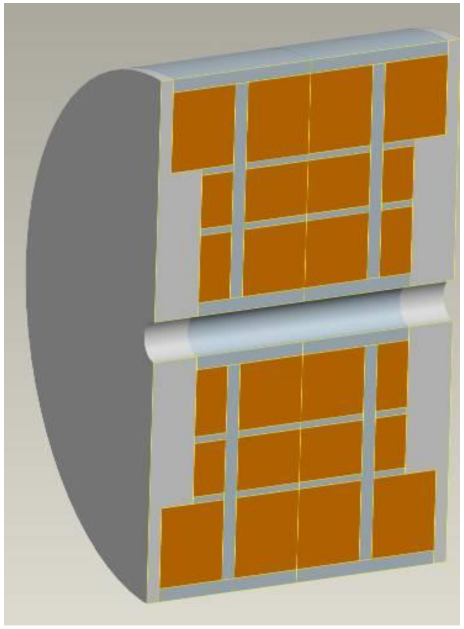
Overall Magnet Design

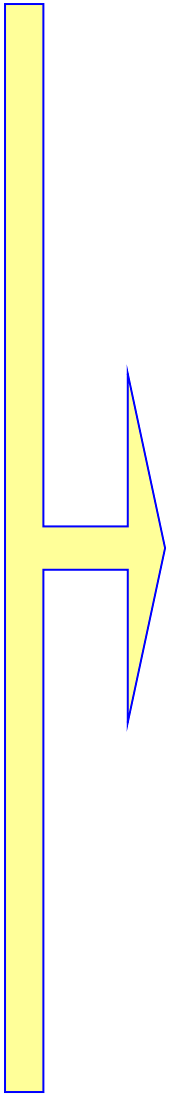
Design in Proposal



Parameter list of HTS Solenoid (28 T)

Design Field	28 T (target)
Inner Diameter	100 mm
Outer Diameter	432 mm
Length	220 mm
Current at Design Field	600 A
SuperPower Conductor (YBCO)	12 mm wide ~100 µm
Stored Energy	3.4 MJ
Inductance	18.8 H
Conductor length	~11 km

Conductor usage: 10 km + 1 km spare
(counted on more spare with price drop)



Current Preliminary Design

(in response to the reduced funding and more structural considerations)

Parameters that got revised:

- Field: ~25 T
- Outer Diameter: 324 mm
- Length: 400 mm
- Stored Energy: 2.5 MJ
- Inductance: 13 H
- Conductor: ~9 km (plus spare)

Revised aspect ratio (length vs. o.d.) allows better protection, better stacking, lower stresses and more testing option. However, it uses slightly more conductor for the same energy.

Attempt will be made to optimize and nearly finalize the overall design ASAP

Conductor Requirements

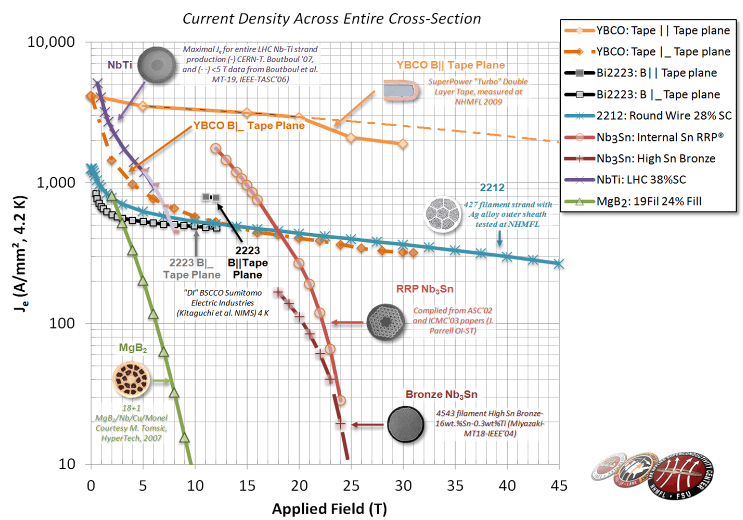
<u>Conductor specifications for SMES:</u>

- ➢ Min I_c = 600 A for 12 mm width (in magnet as per guidance from SuperPower)
- ➢ For magnet applications, I_c is typically defined for 0.1 μV/cm (or 10 μV/meter)
- ➢ For ~10 km wire, this means 100 mV which at 600 A means 60 W loss in magnet
- ➢ This (not including joints) may be significant and hence should review the criterion

➢ There is another reason to have a tighter tolerance. Above definition may allow a larger local defect to pass through the QA test when averaged over a length

➢ In fact, current experience suggests that avoiding local defect is very critical and is one of the biggest challenge before using 2G wire in demanding magnet applications

- In HTS, current carrying capacity depends not only on the magnitude of field but on the direction as well.
- This plays a role in designing magnets and defining specifications for the wire.



Quench Protection

Currently quench protection is one of the biggest issue in such 2G HTS magnets

Our strategy is as follows:

• For quench protection purpose, divide coil in many parts with a large number of voltage taps detecting quench in smaller sections. The amount of instrumentations is likely to be an order of magnitude more than those in most superconducting magnets.

• To minimize delay, detect small voltage signal (~mV) which indicates resistive voltage onset in a coil with large inductance - noise minimization will be a major undertaking

• Comprehensive strategy - detect quench, shut off power supply, dump energy outside the coil – do it all as fast as possible and limiting it in as small section as possible.

• *It will be beneficial that our electrical engineers interact with ABB engineers to remove potential conflicts and to better match the overall system*

• There are intermediate quench protection milestones to evaluate the progress

• The situation should improve as the HTS wire becomes more uniform (fewer defects)

• We start out R&D by making small coils with varying copper to determine what kind of conductor to be used in SMES coil (more Cu gives more protection but reduces J_e)