A transverse magnet for LHCspin

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Outline

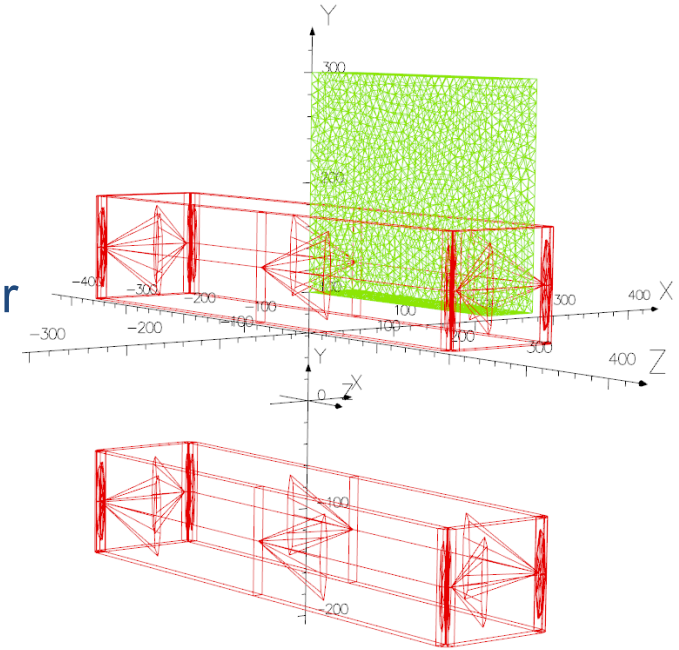
- Motivation
- A resistive option
- Some superconducting options
- Conlusions

Motivation

- A transverse magnetic field for
- 300 mm long 10 mm diam cell
- Field 0.3 T
- Field homogeneity: not required ⇨ 5% to 10% TBC
- Space constraints: not strict
- Length constraints: not severe

Resistive Option

- 150 mm wide iron
- 100 mm from the horizontal xz plane
- 80 kA
- 2000 mm2 water cooled conductor (J 20 A/mm2)

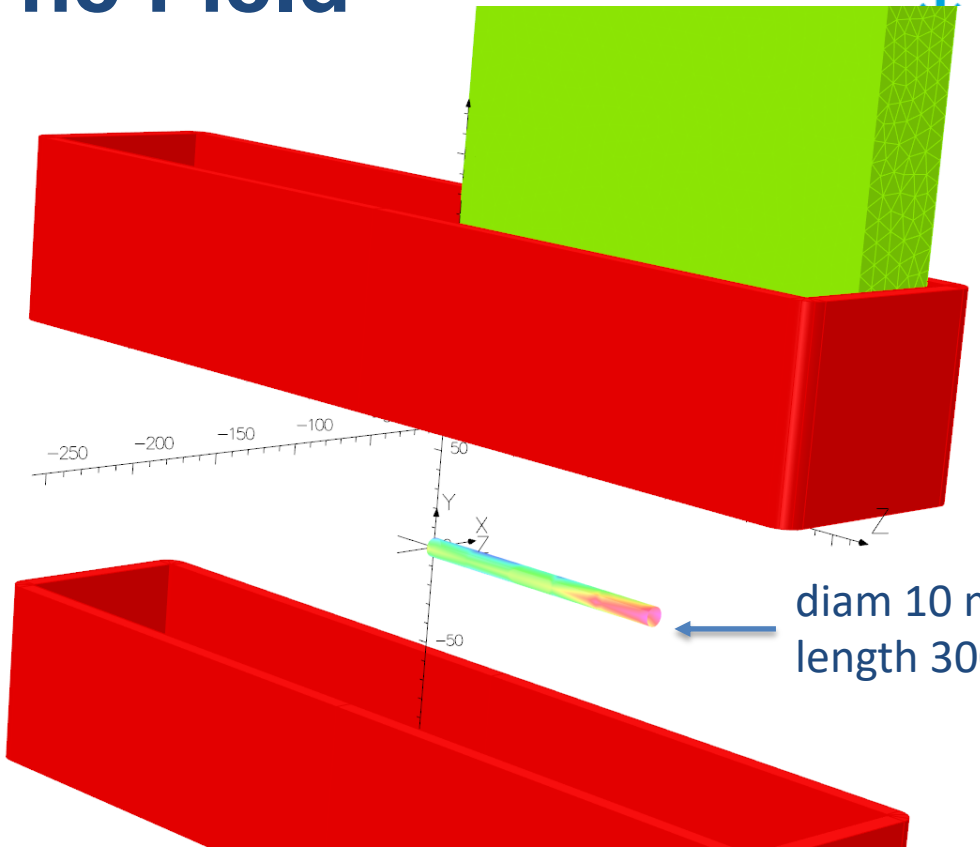


- ❑ Simple and standard
- ❑ water cooling required
- ❑ High voltage power converter
- ❑ bulky (heavy)

The Field

- outside the vacuum chamber diam 200 mm (TBD)
- length 540 mm
- iron 150 mm wide
- Itot 80 kA
- cross section 4000 - 8000 mm^2

- Bmax iron 3.2 T
- Bmax coils 1.5 T
- B cell 0.3724 T
- Delta B 242 mT
- integrated field 155 Tmm



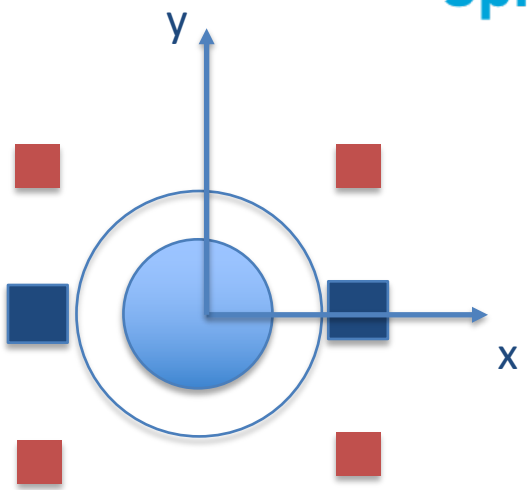
Superconducting Option

Why?

- smaller volume
- low voltage power converters

But

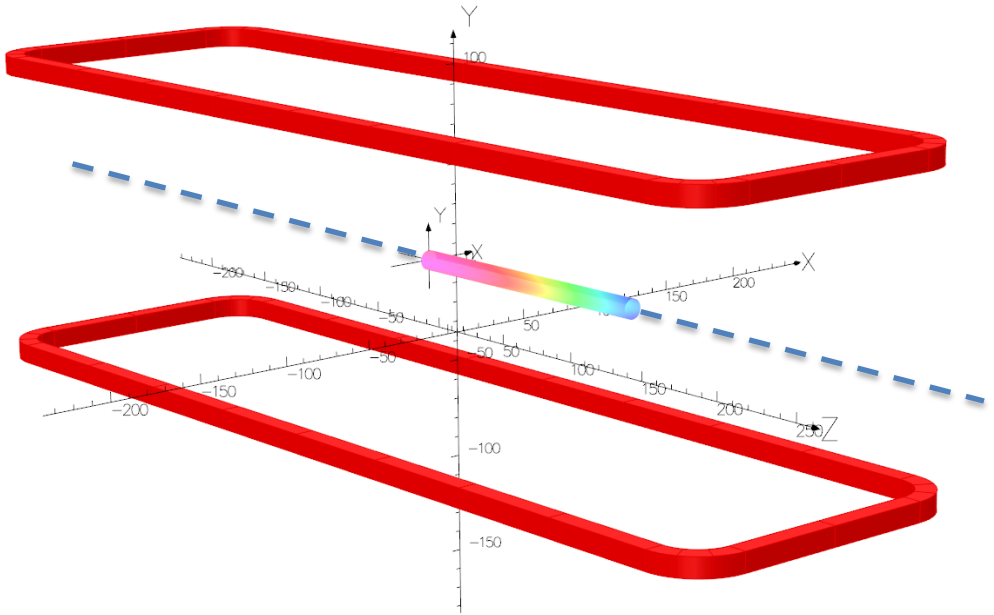
- cryogenics
- protection



Two possible configurations to trigger the discussion

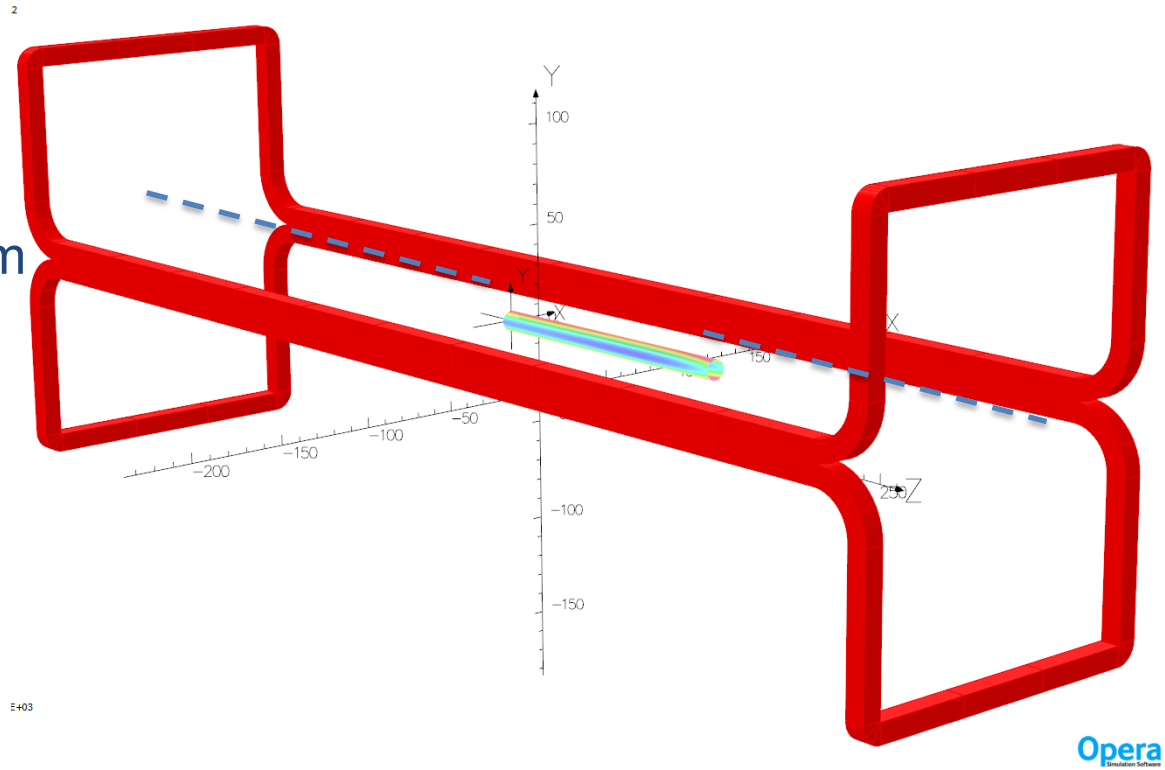
Racetrack Coils

- length 540 mm
- heigth 150 mm
- 150 mm wide
- cross section 10 mm x 10 mm
- current density 600 A/mm^2
- integrated field 170 Tmm
- B cell 0.3209 T
- Delta B 12 mT



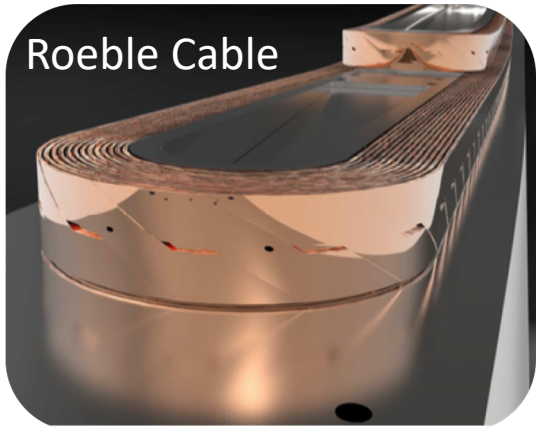
Bedstead

- length 700 mm
- 150 mm wide
- cross section 10 mm x 10 mm
- current density 300 A/mm2
- integrated field 200 Tmm
- B cell 0.3052 T
- Delta B 2.9 mT

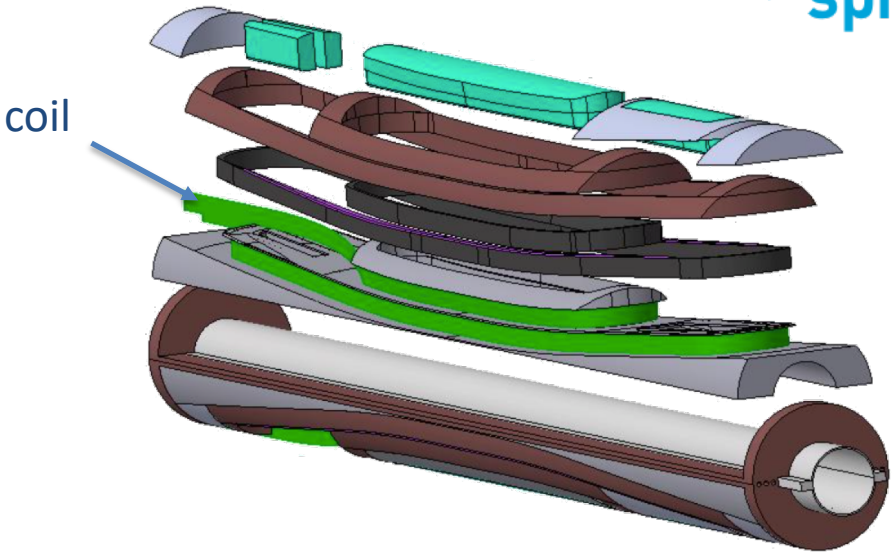


Flared Ends

- Very interesting option
- sligth bends on ends
- very suitable for HTS



by G. Kirby, CERN



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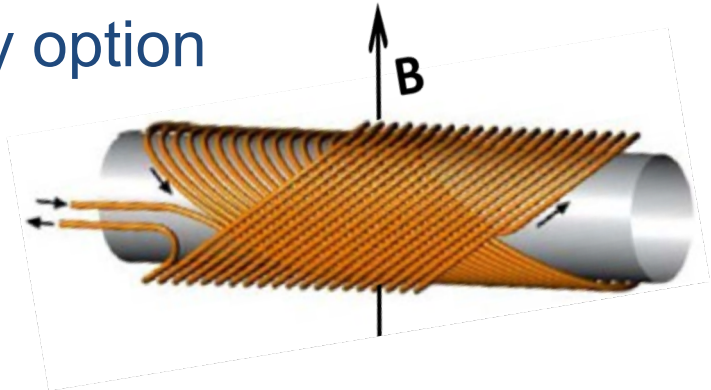
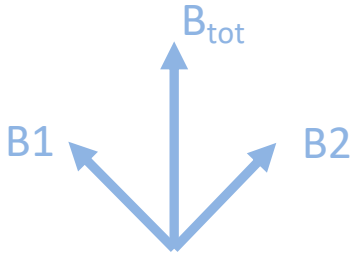
Configurations Vs Superconductors
RACETRACK fits all SC (wire and tapes), perfect for ReBCO
BEDSTEAD/FLARED wire (bending radius), roebel cable for tapes

Canted Cosin Theta

An interesting ad fancy option

- very good field
- Easy to wind
- Easy to assembly
- Holes for ABS and TGA
  (1 or 2 magnets)
- suitable for HTS?



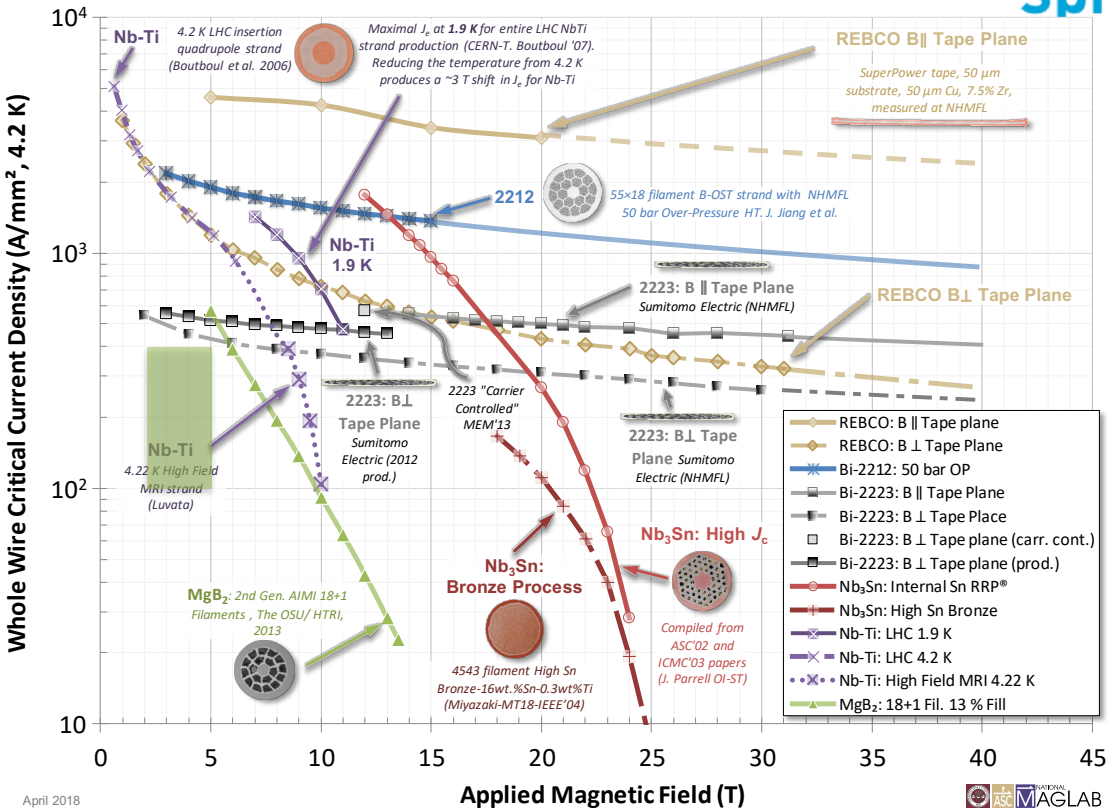


INFN GrV project BISCOTTO:
development of BiSCCO (Tc 96 K) and MgB2 (Tc 39 K) CCCT dipoles.
Winding machine by INFN

Which Superconductor?

Some reasonable numbers

- NbTi 4K J_{wire}=1000 A/mm^2, J_e = 600 A/mm^2
- ReBCO tape 77K 100 A/mm^2, J_e= 100 A/mm^2
- BiSCCO wire, small lengths procuded also by CNR-SPIN, 77K J_e= 100 A/mm^2
- HTS@ 1.9 o 4K more efficient (higher margin) at high field
- MgB2 is also an option good performance at low field, still expensive wrt NbTi



April 2018

Quench Protection

HTS requires fast triggering and reaction times,
it is possible thanks to

- FPGA

μV threshold, 10 ms triggering

- IGBT (solid state switch)

¼ ms opening time

FRESCA program showed that a cable is easy to protect

Cooling

Options (superconductor, space available, radiation, cost…)

- Classical liquid helium cryostat (1.9 K o 4.5 K)

bulky, mechanically complex, expensive

- 10-70 K closed circuit Gas cooling

flexible, mechanically easier, long insulated piping, He thigth

- Cryocooler

vibration (-> pulse tube), radiation?

Conclusion

- Showed some possible solutions for the transverse polarized target
- Considerations on conductors: copper, LTS, HTS
- A lot of work is required to select one option
  - schedule
  - space available
  - cooling and cryogenics environment
  - building and running costs

THANK YOU