LHCspin
Dipole Magnet

Marco Statera

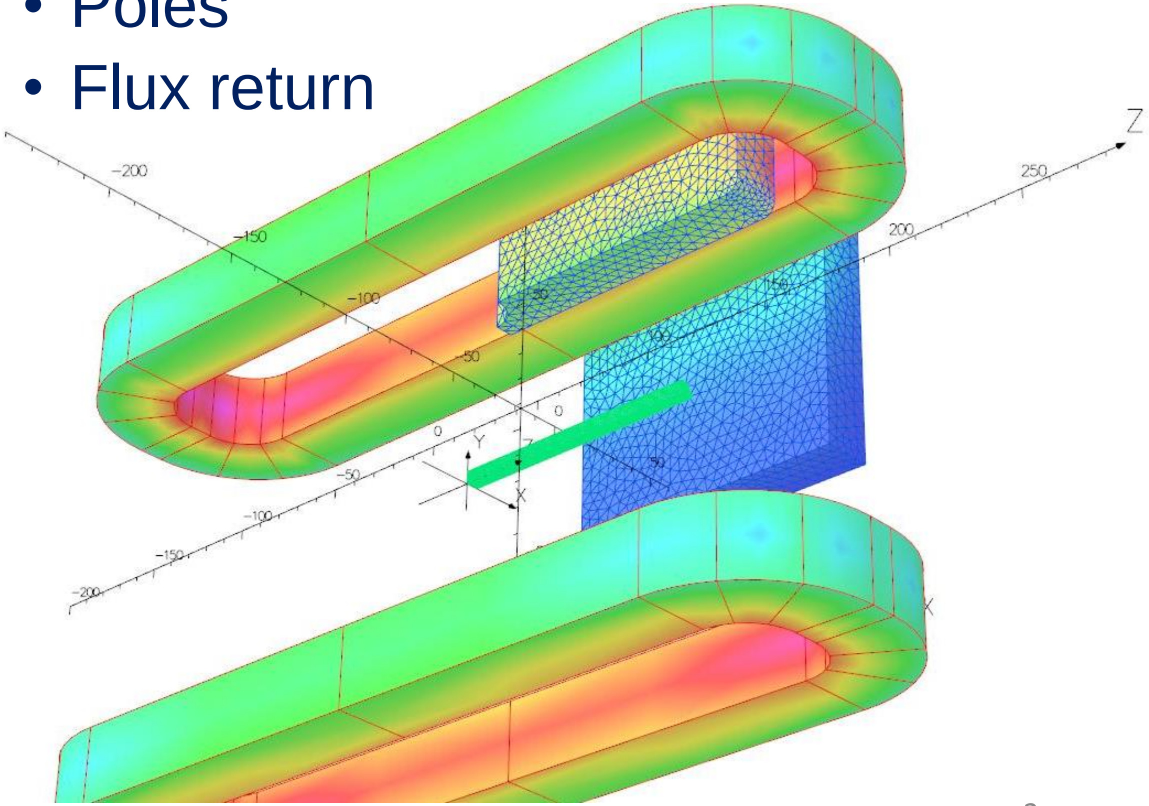
INFN Milano - LASA

A Magnet for LHCbSPIN

- Geometrical constraints
- Functional constraints
  - Lateral access for operation (openable)
  - Several feedthroughs (target)
- Liquid Helium maybe
- Field
  - 0.3 T static
  - ΔB/B 10%
  - Inversion

- Coils
- Iron
  - Poles
  - Flux return

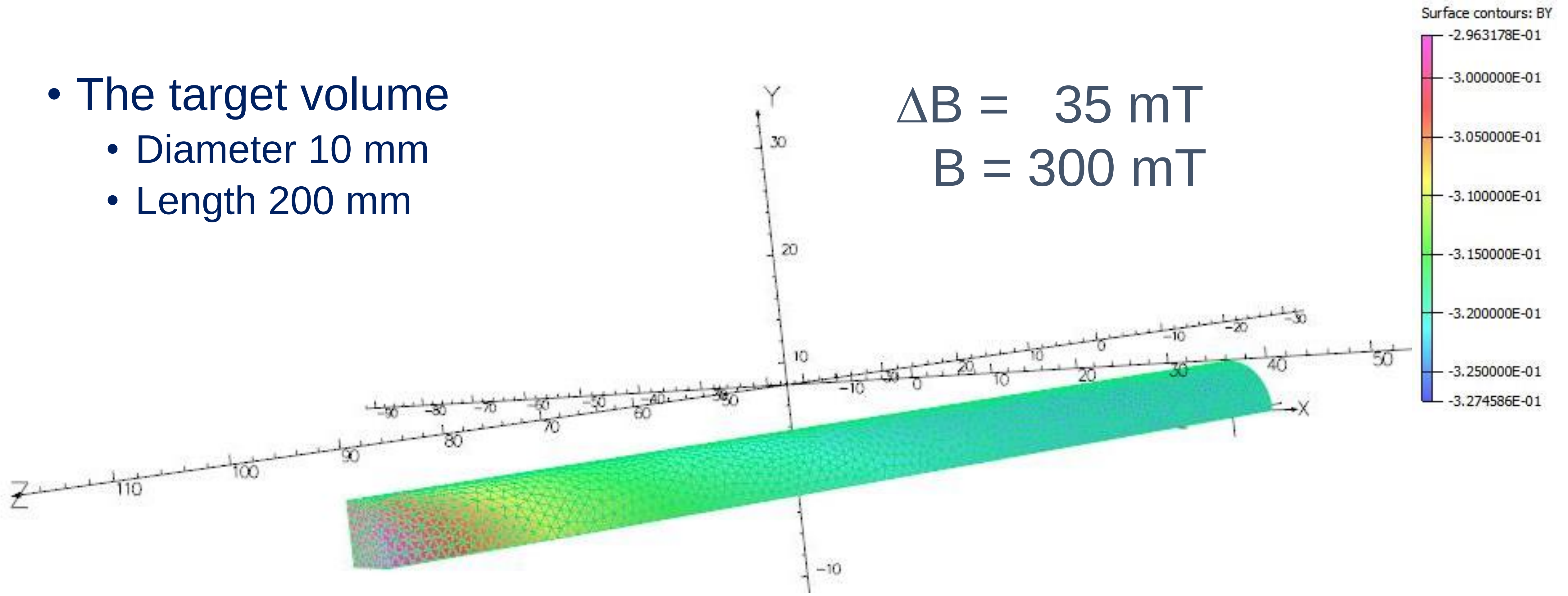
Resistive or superconducting?



Field on Target

- The target volume
  - Diameter 10 mm
  - Length 200 mm

$\Delta B = 35$ mT
$B = 300$ mT



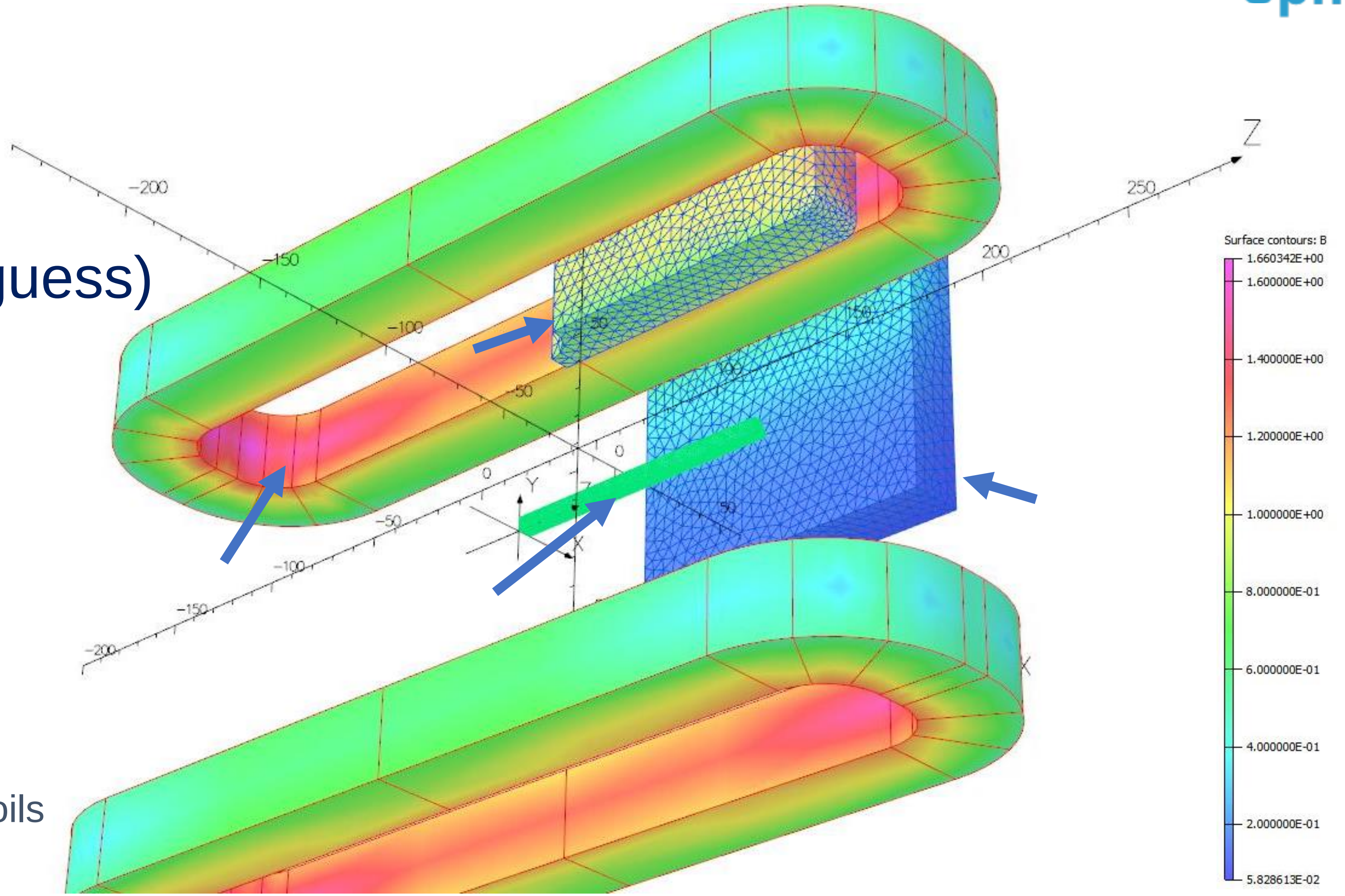
The Coils

- Ampere turns 9 kA
- Bmax 1.7 T
- Cross section (first guess) 30 mm x 30 mm
- Je = 100 A/mm^2

~~RESISTIVE~~

SUPERFERRIC

- Iron saturated
- Field by iron and SC coils
- Field shape by iron and SC coils



Which SuperConductor?

NbTi

- Cheap wire
- Mature technology (LHC)
- Requires liquid Helium
- Complex cryostat

Higher current density ϕ 0.7 mm
I_c at 1.6 T, 4.3 K = 760 A

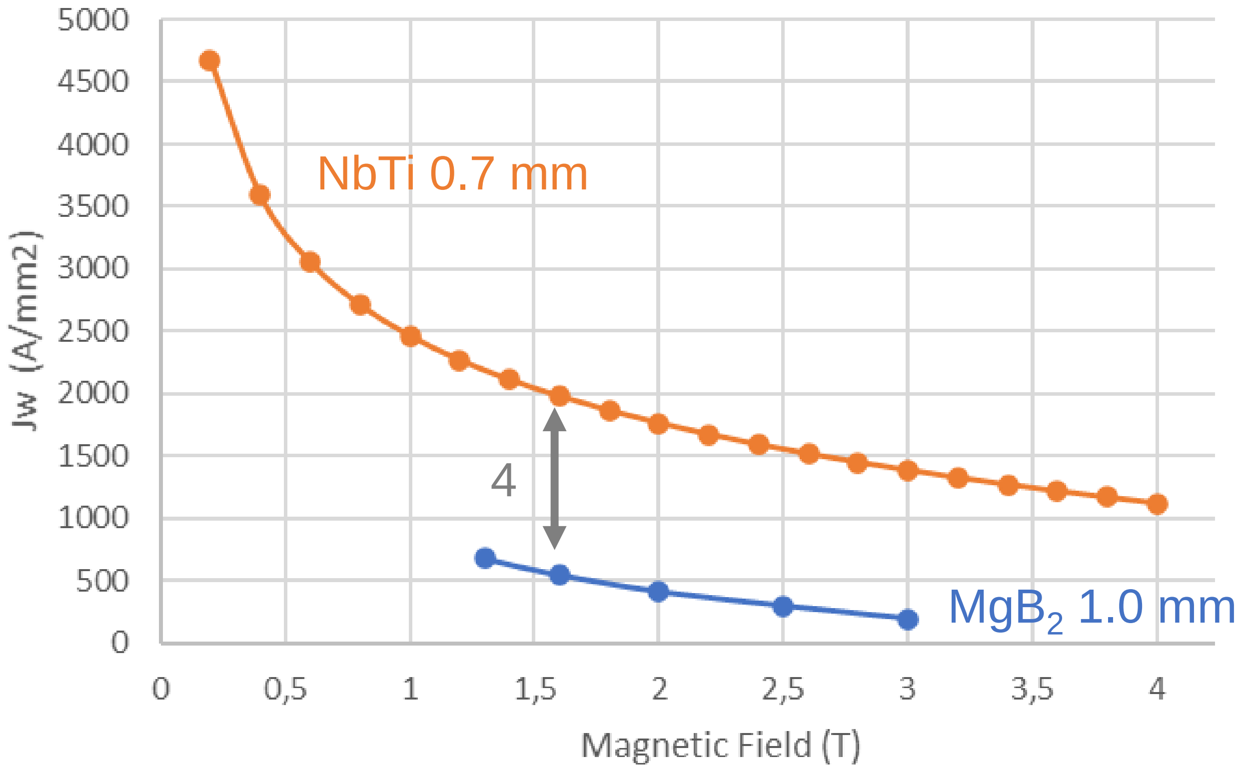
MgB_2

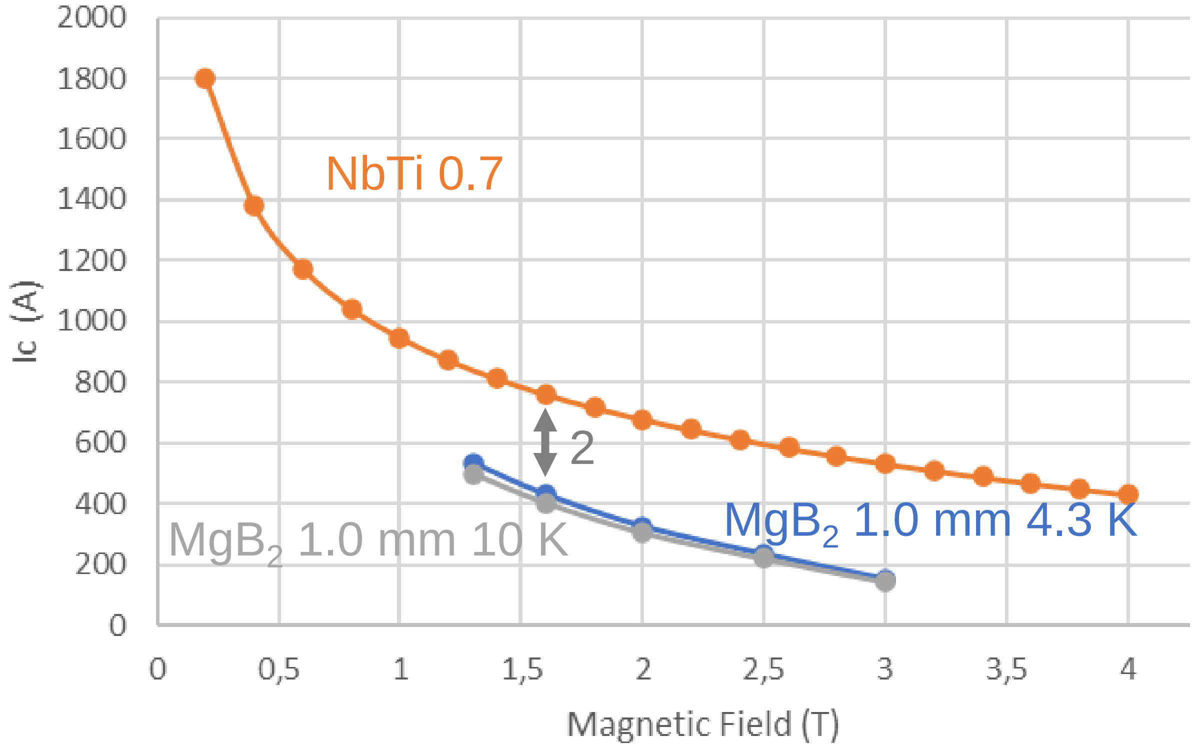
- Not very cheap wire
- Mature technology (HL-LHC power lines)
- Good performance at 10 K
- Cryocooler
- Conduction cooling
- Vacuum vessel and superinsulation

I_c at 1.6 T, 4.5 K = 430 A
I_c at 1.6 T, 10 K = 400 A

Easy to protect by energy extraction and a standard Quench Protection System
1 mm dim wire – 50% filling factor – current 130 A – Low inductance

Which SuperConductor?





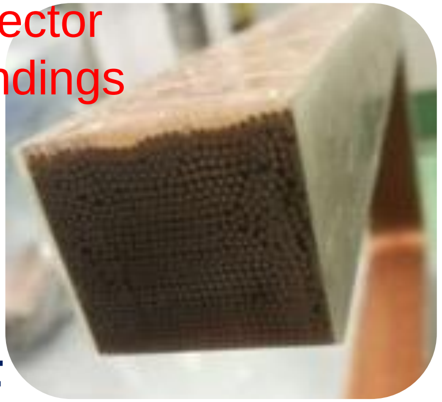
- Considering a factor 3 in cross section
- Operating at 10K – first guess 10% current reduction (MgB_2)

Conductor cost per coil

- NbTi 380 A - 237 windings - 0.15 kE
- MgB_2 200 A - 450 windings - 1.2 kE

Cost Evaluation

HL-LHC HO corrector
test coil - 750 windings



NbTi

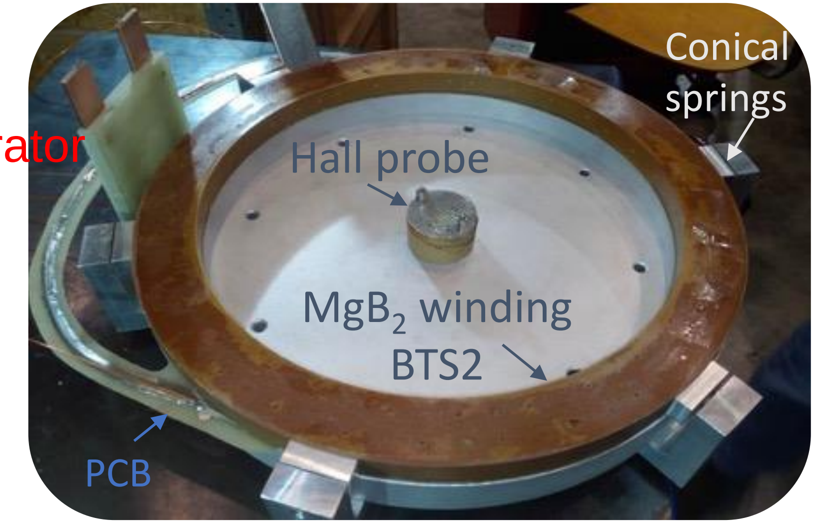
- Conductor 0.45 kE
- Winding and curing 20 kE
- Iron 20 kE
- Cryostat

(LHe + Thermal Shield) 30 kE

- Liquid Helium tbe

Reference tecnology

HL-LHC demonstrator
336 windings



MgB_2

- Conductor 3.6 kE
- Winding and curing 20 kE
- Iron 20kE
- Cryostat

(vacuum vessel + superinsulation) 15 kE

- Cryocooler (2) 50 kE

No cryogenic fluids

Conclusion

- As a first approximation a magnet based on coils and iron can fit the available space and the constraints
- The coils have to be superconducting
- Two option are available and feasable: Nbti and MgB_2
- One important difference is cryogenics
- This is just the starting point