FCC-hh: D1 and D2

Ezio Todesco
Technology Department
European Organization for Nuclear Research (CERN)

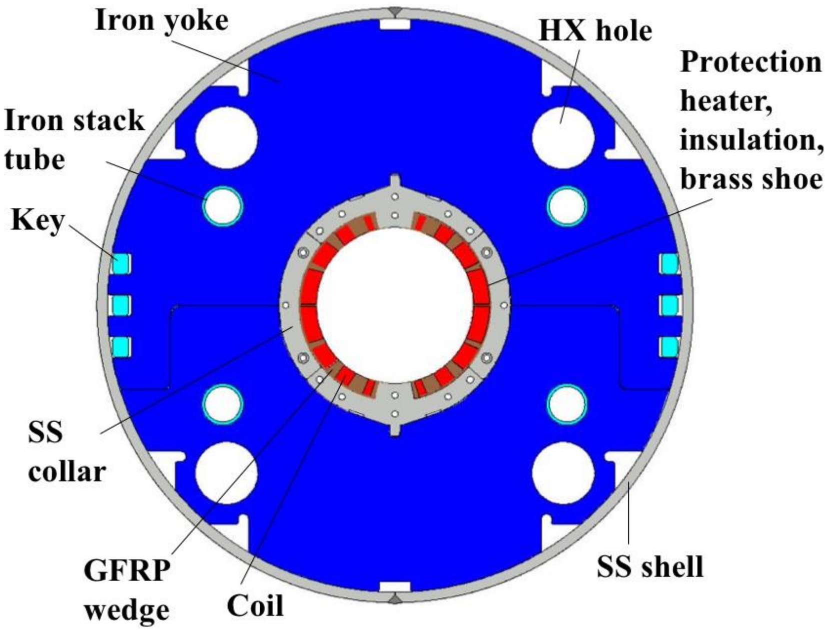
Acknowledgements to M .Giovannozzi

REQUIREMENTS

- Integrated field: 160 T m
  - 28 T m in LHC
  - 35 T m in HL-LHC
  - For the 80 TeV baseline it will be 128 T m
- D1 aperture: 116 mm
  - LHC: 80 mm
  - HL LHC: 150 mm
- D2 aperture: 80 mm
  - LHC: 80 mm
  - HL-LHC: 105 mm

D1 MAIN PARAMETERS

- First option: Nb-Ti version similar to HL-LHC D1 (5.6 T)
  - One layer magnet, Nb-Ti at 1.9 K
  - Total length: 28.5 m
  - Two modules of 14.25-m-long magnets (magnetic length)
  - For the 80 TeV baseline, two 11.6-m-long magnets

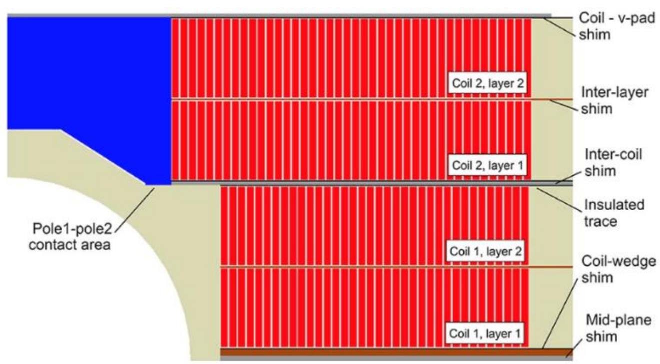


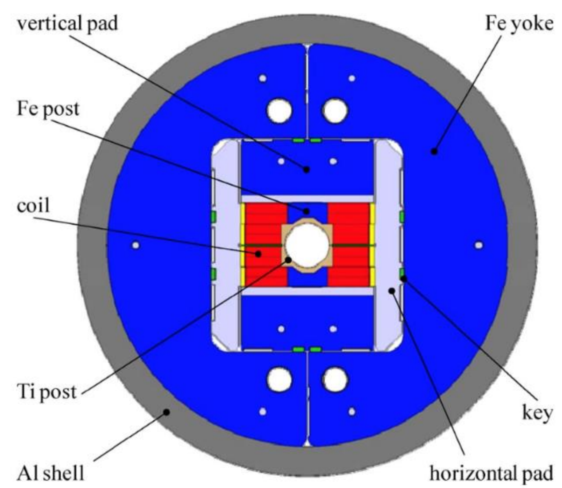
D1 MAIN PARAMETERS

- Second option: Nb-Ti version double layer à la LHC (7 T)
  - Stress is proportional to *jBr* - it will be lower than in the LHC dipole
    - 25% larger field (7 T versus 5.6 T)
    - 25% lower aperture (116 mm versus 150 mm)
    - 15% lower current density (380 A/mm^2 versus 450 A/mm^2)
  - Use a two-layer coil (double the coil width of HL-LHC D1) to have adequate margin
    - Short sample will be around 9.5 T, at 7 T we are at 70% of loadline fraction – it is a magnet similar to D1 as challenges
- Total length: 23 m
  - Two modules of 11.5-m-long magnets
  - 80 TeV baseline: 2 modules of 9.3-m-long magnets

D1 MAIN PARAMETERS

- Third option: Nb_3Sn à la Fresca2 (13 T)
  - Aperture is 116 mm, 15% larger than Fresca2
  - With the block design, the issue of accumulation of stress in removed
  - Fresca2 reached 14.5 T, 13 T is a challenging but reasonable operational point
- Total length: 12.3 m
  - One 12.3-m-long magnet
  - 80 TeV baseline: one 10-m-long magnet





D2 MAIN PARAMETERS

- First option: Nb-Ti version à la HL-LHC D2 (5 T)
  - The limiting factor if this magnet is field quality, dominated by the cross-talk
  - One layer magnet, Nb-Ti at 1.9 K
  - We can increase from 4.5 T (HL-LHC D2) to 5 T since the aperture is smaller (80 mm versus 105 mm) and the separation is larger (250 mm versus 192 mm)
  - Total magnetic length: 32 m
  - Three modules of 10.7-m-long magnets
  - For the 80 TeV baseline, two 13-m-long magnets

D2 MAIN PARAMETERS

- Second option: Nb-Ti version à la LHC MB (7 T)
  - One has to carefully check the field quality to see if this is viable – or add ad hoc correctors
    - One could probably push the field towards 7.5 or 8 T if needed
  - Two-layer magnet, Nb-Ti at 1.9 K
  - Total magnetic length: 22.8 m
  - Two modules of 11.4-m-long magnets
  - For the 80 TeV baseline, two 9.3-m-long magnets

- No space for having a design à la Fresca2

SUMMARY

D1			
Inspiring magnet	Field (T)	Lenght for 100 TeV (m)	Lenght for 80 TeV (m)
á la HL-LHC D1	5.6	2×14.3	2×11.6
á la LHC MB	7.0	2×11.5	2×9.3
á la Fresca2	13.0	12.3	10.0

D2			
Inspiring magnet	Field (T)	Lenght for 100 TeV (m)	Lenght for 80 TeV (m)
á la HL-LHC D2	5	3×10.7	2×13
á la LHC MB	7.0	2×11.3	2×9.3