0.1 Finding the necessary Ampere turns

Using the equation

$$NI = \frac{Bh}{\eta\mu_0}\,, \tag{0.1}$$

the Ampere turns necessary can be found, where h is the vertical gap and η is the magnetic efficiency, typically > 0.95. Using $\eta = 0.98$ (reasonable guess), along with $B = 0.06\,\mathrm{T}$ and $h = 0.07\,\mathrm{m}$ (tentative parameters for the main dipoles shown in the table below), this gives $NI = 3428\,\mathrm{AT}$.

0.2 Sketch of the magnetic circuit

Proposed design based on slender C dipole, using busbars (metallic strip or bar for conducting). At first guess, a current density $j \approx 1\,\mathrm{A/mm^2}$ can be considered. Using this approximation the area of the busbars can be considered. To achieve the half NI needed per busbar, $1714\,\mathrm{A}/(1\mathrm{A/mm^2}) = 1714\,\mathrm{mm^2}$. This gives the size of the busbars. Other dimensional quantities are shown in the figure below, which are used as a starting point.

Table 1. Tentative parameters for FCC-ee main dipoles.

field	[T]	0.060	175 GeV
vertical gap	[mm]	70	
width of GFR	[mm]	20	
harmonics in GFR	[10^{-4}]	1	b_2 excluded
length	[m]	10	magnetic length
quantity	[/]	6528	per ring

For these parameters, the width of the pole can be found by using the relation.

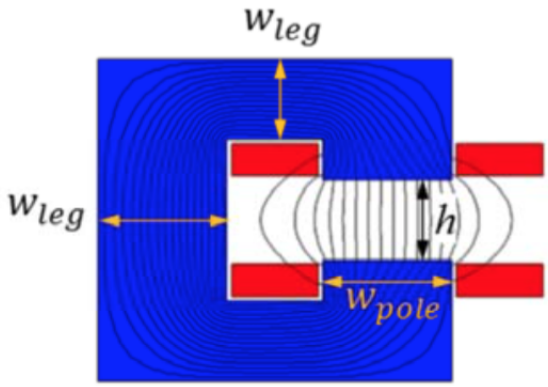
$$w_{pole} \cong w_{GFR} + 2.5h\,. \tag{0.2}$$

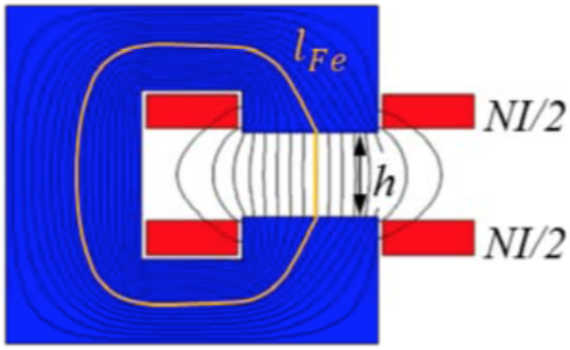
With the values from the table above, $w_{pole} = 195\,\mathrm{mm}$. As a first attempt, taking a guess for $w_{leg} = 2h$ should be sufficient, but when it comes to iteratively improving these values, the relations

$$B_{leg} \cong B_{gap}\frac{w_{pole} + 1.2h}{w_{leg}}\,, \tag{0.3}$$

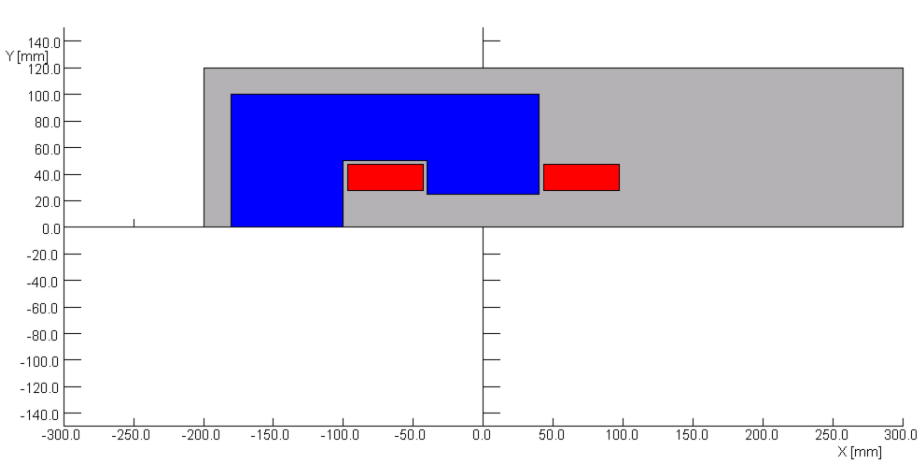
$$l_m \cong l_{Fe} + h\,, \tag{0.4}$$

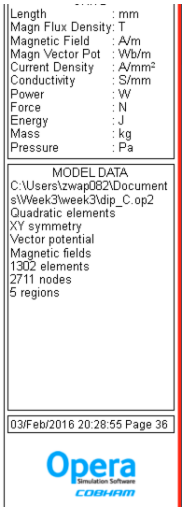
and Equation 0.2 may be useful to arrive at the necessary w_{leg}. Finally, the material of the conductors will either be Cu or Al (to be determined), with the yoke being made out of iron. The general form of the magnetic circuit is shown below, although not drawn to scale (pictures taken from slides).





0.3 My dip_C.comi





0.4 To do

- Read the literature on previous large colliders with weak dipoles (LEP) and potentially implement features into FCC-ee dipole design.
- Translate above parameters into simulation using dip_C_Full.comi as a guide/template.
- Make adjustments as necessary to the design of the dipoles.