Imperial College London

Science and Technology Facilities Council

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LhARA FFA magnet 3D design

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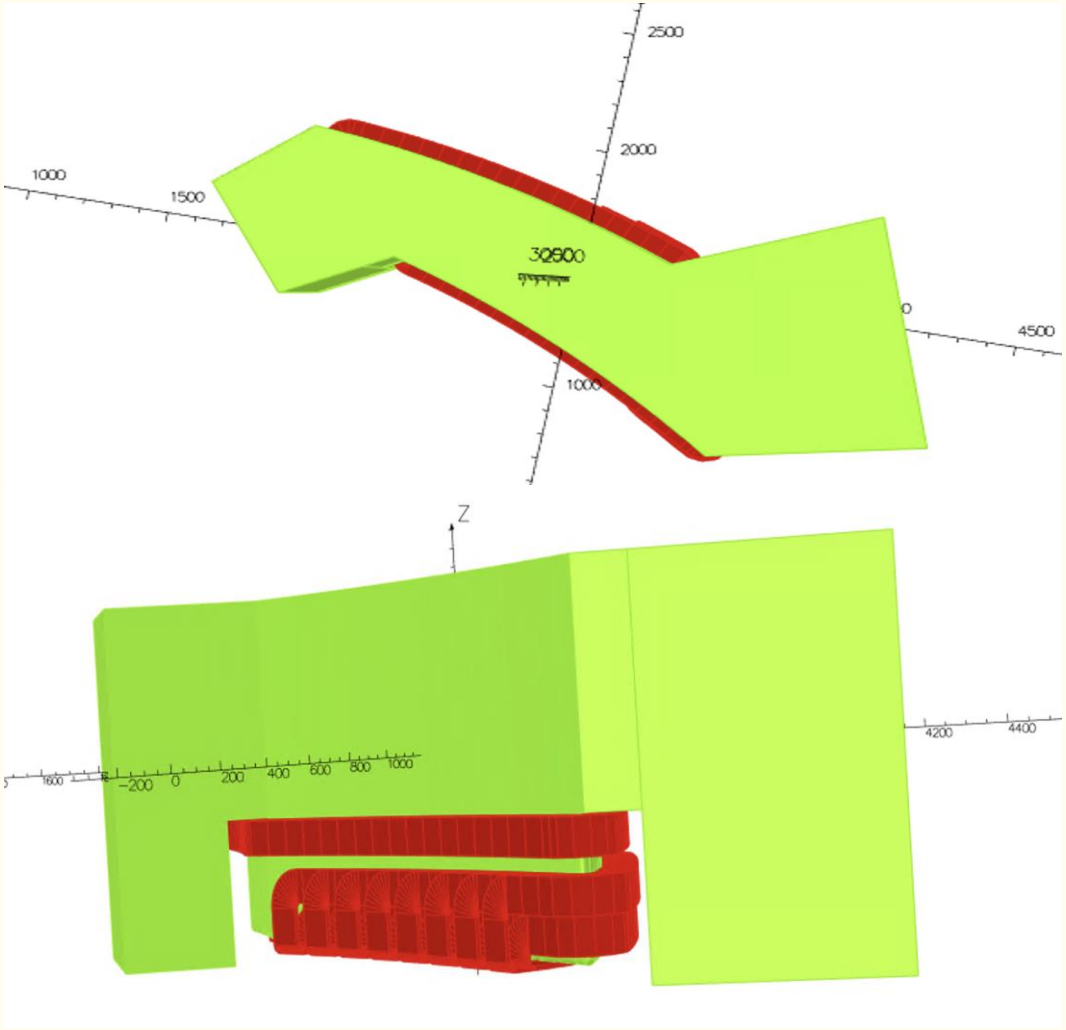
Pictures of the spiral magnet



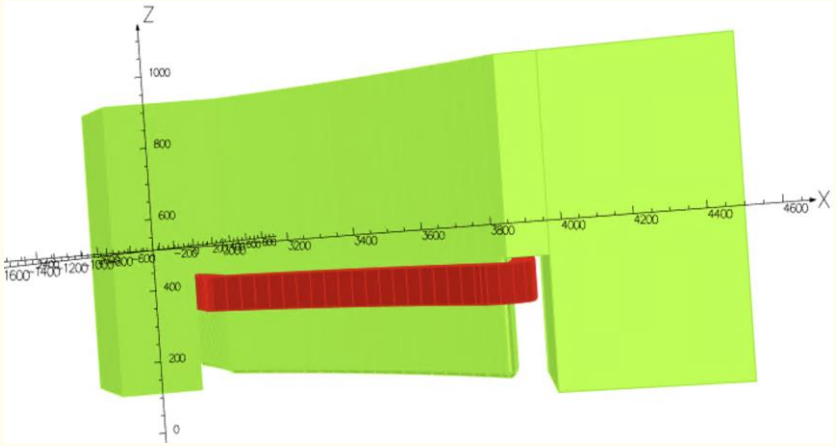
Top View

Conductors shown in red
Iron shown in green

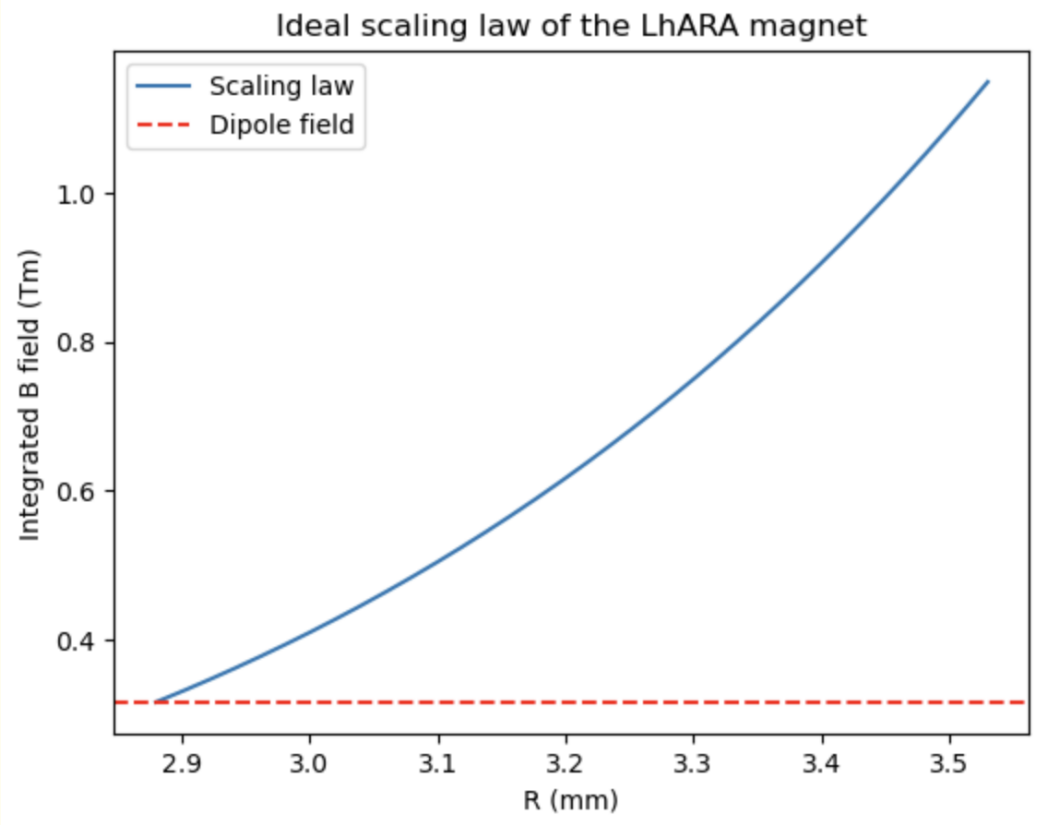
Side View
(Only top half of the magnet shown)

Pictures of the spiral magnet

The integrated B field should scale as: $BL = BL_0 \left(\frac{r}{r_0}\right)^{k+1}$, more details in the following slides

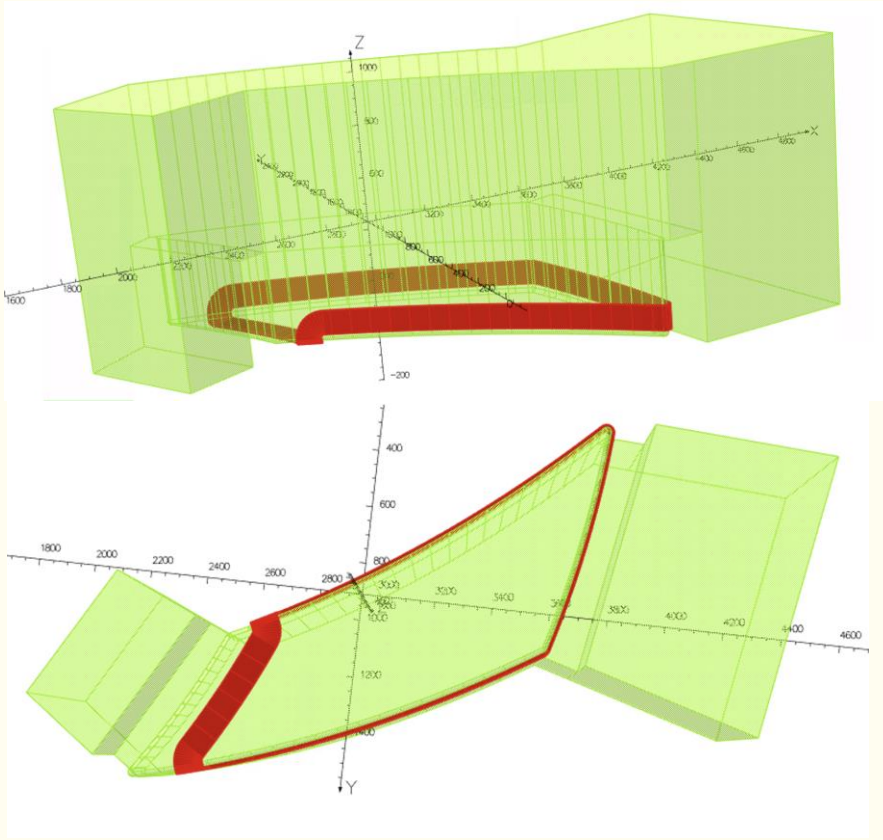


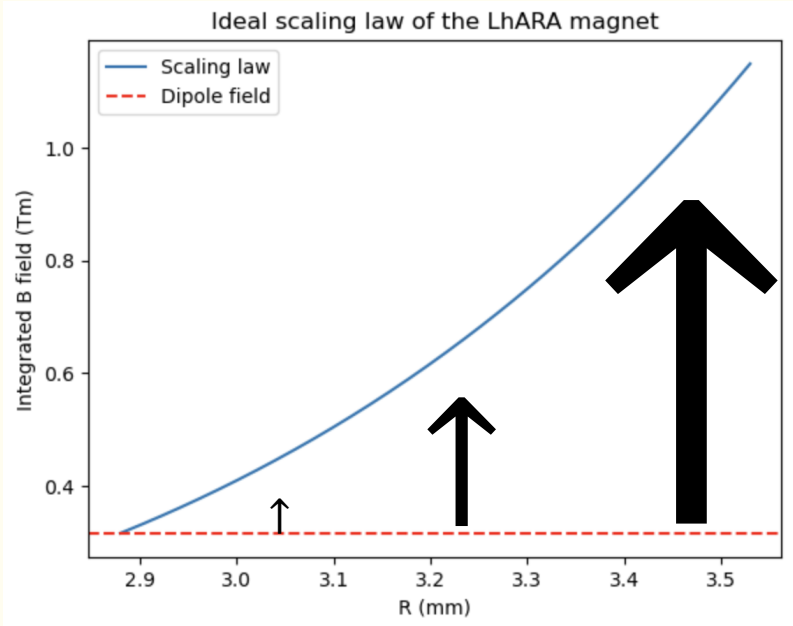
The main coil wraps around the side of the pole and provides the dipole field



Pictures of the spiral magnet

Trim coils cross the pole face at constant radii and return around the side of the pole. Gradient of the magnetic field achieved by adjusting the set of currents through the coils

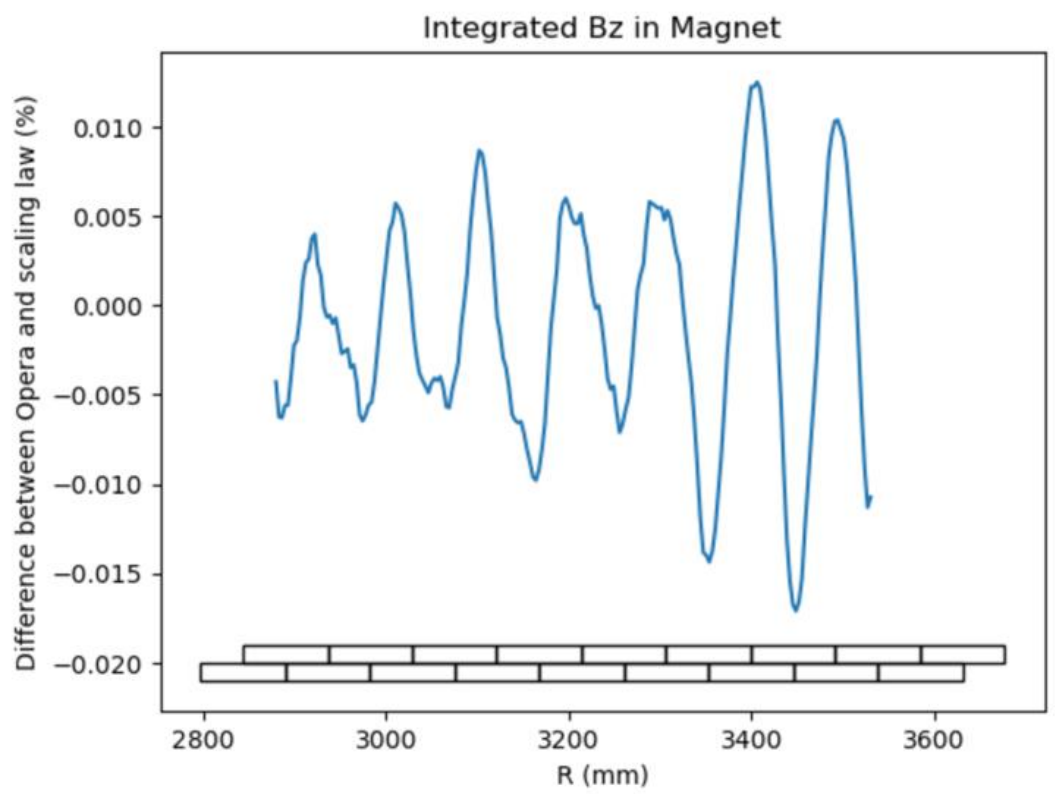




Integrated B Field

k-value=5.33, r_0 = 3.477m , B_0 = 1.405T, BL_0 = 1.044 Tm (Assuming hardedge model)

The integrated B field scales as: $BL = BL_0 \left(\frac{r}{r_0}\right)^{k+1}$, $where\ BL = r \int B_z\, d\theta$

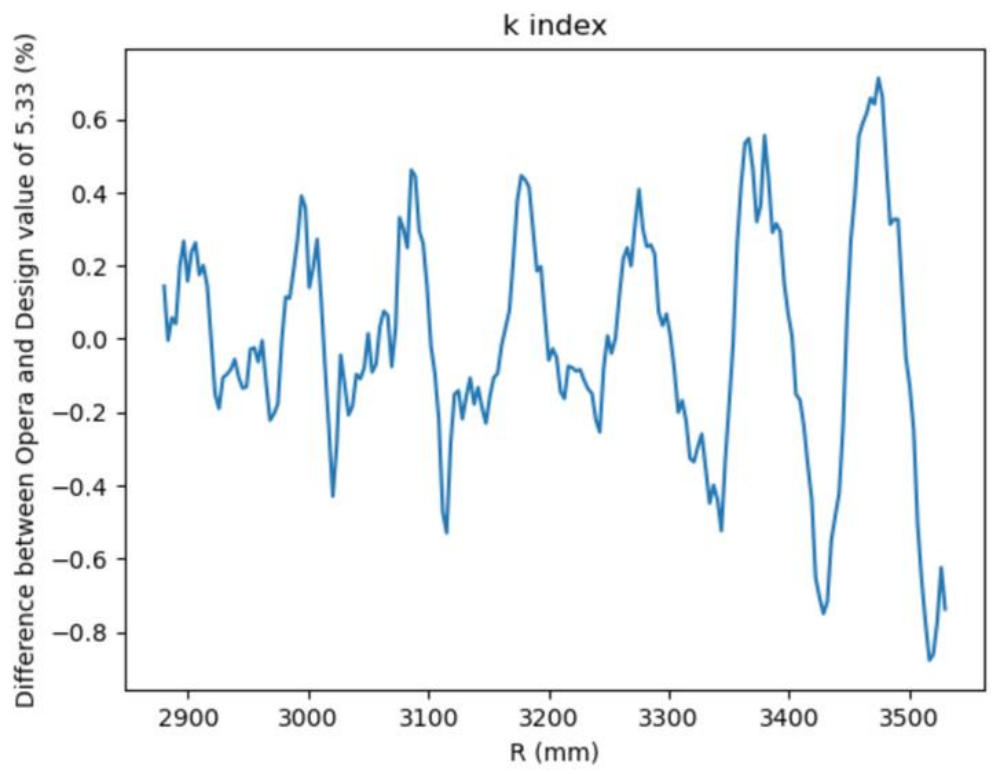


Coil Number	Current Values (Ampere turn)
0	14227.21
9	6220.45
8	4220.33
7	3416.29
6	2834.05
5	2411.90
4	2065.92
3	1774.55
2	1495.80
1	1183.96

Integrated B Field

k-value=5.33, r_0 = 3.477m , B_0 = 1.405T, BL_0 = 1.044 Tm (Assuming hardedge model)

$$k_{int} = \frac{r}{BL}\frac{\partial\, BL}{\partial\, r} - 1 \text{ , dk/k<1\%}$$



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Power estimation for current

Trim				Main			
Coil width	0.01	m		Coil width	0.075	m	
Coil height	0.0925	m		Coil height	0.117	m	
Coil area	0.000648	m^2		Coil area	0.006143	m^2	
Cu Resistivity	1.68E-08	Ohm.m		Cu Resistivity	1.68E-08	Ohm.m	

Trimcoil	Length (m)	Current (AT)	Resistance (Ohm)	Power (W)
0	4.479109	14227.21121	1.23E-05	2.48E+03
1	2.36	6220.449896	6.12E-05	2.37E+03
2	2.57	4220.325259	6.66E-05	1.19E+03
3	2.78	3416.294266	7.20E-05	8.41E+02
4	2.98	2834.051508	7.74E-05	6.22E+02
5	3.20	2411.899386	8.31E-05	4.83E+02
6	3.41	2065.924322	8.84E-05	3.77E+02
7	3.61	1774.553751	9.36E-05	2.95E+02
8	3.82	1495.803586	9.90E-05	2.22E+02
9	4.02	1183.955937	1.04E-04	1.46E+02
10	2.75	6220.449896	7.13E-05	2.76E+03
11	2.96	4220.325259	7.67E-05	1.37E+03
12	3.16	3416.294266	8.21E-05	9.58E+02
13	3.37	2834.051508	8.75E-05	7.03E+02
14	3.58	2411.899386	9.29E-05	5.40E+02
15	3.79	2065.924322	9.83E-05	4.20E+02
16	4.00	1774.553751	1.04E-04	3.27E+02
17	4.20	1495.803586	1.09E-04	2.44E+02
18	4.41	1183.955937	1.14E-04	1.60E+02
				Total Power (W)
				1.65E+04

16.5 kW for a half of the magnet

16.5 x 2 x 10 magnets = 330 kW
Overall power for current

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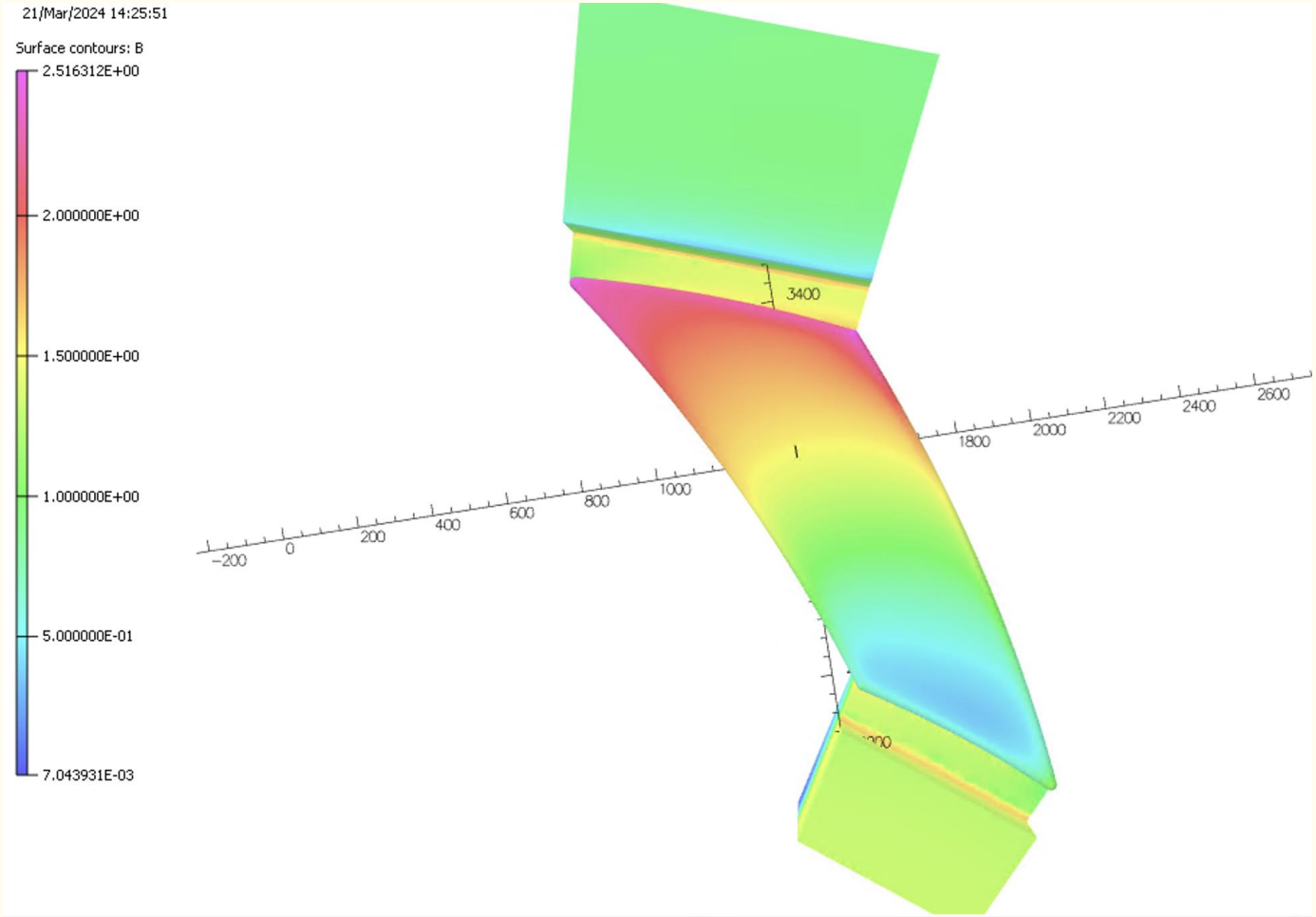
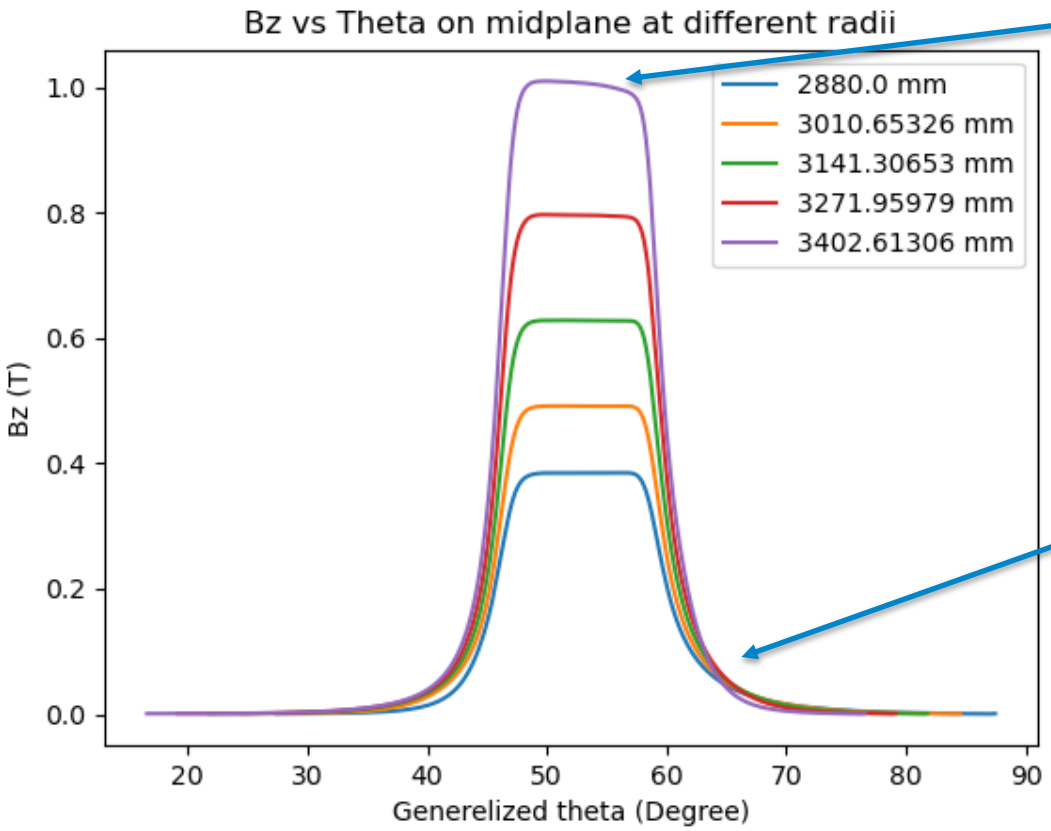
Saturation level of pole face



Reaches 2.5 T at the outer radii of the pole

Bz vs theta at different radii



Flat top of field slanted at higher Radii due to saturation

Fringe field extent not constant

Clamps yet to be added

Further Work

- Add in field clamps to control the fringe field extent
- Produce a field map and track the particles to investigate the tune variation