Impact on PSB Main Dipoles

A. Newborough

Influence of BSW magnets on main dipoles

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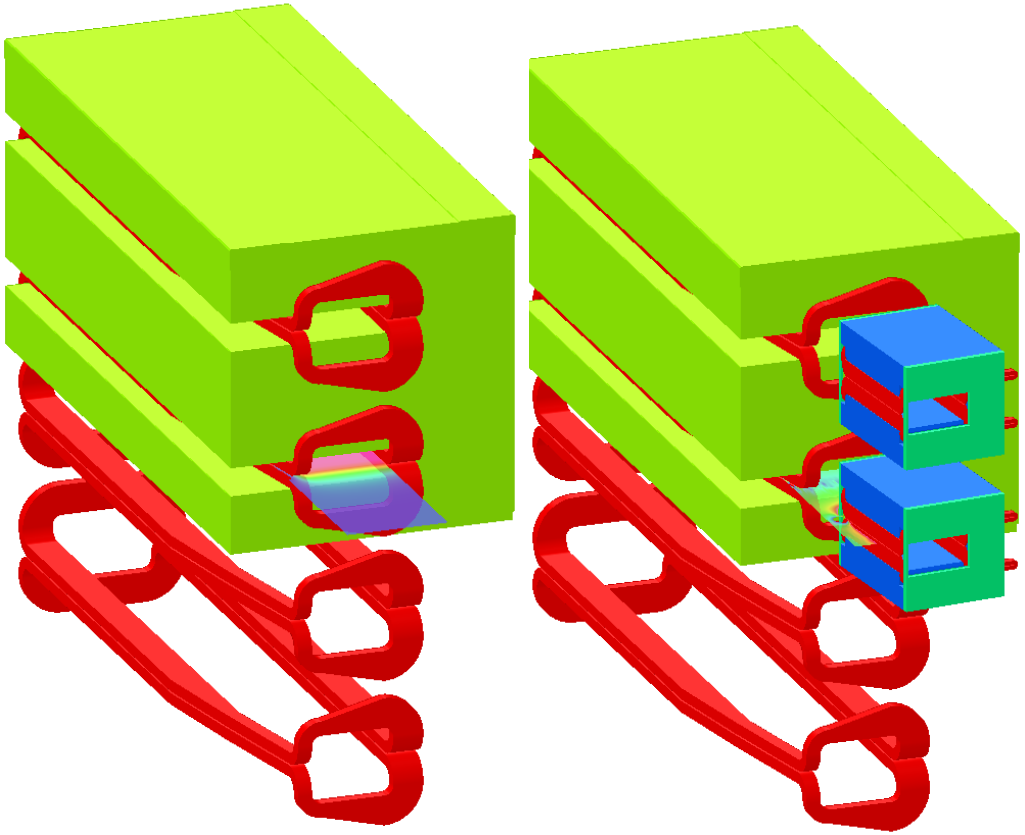
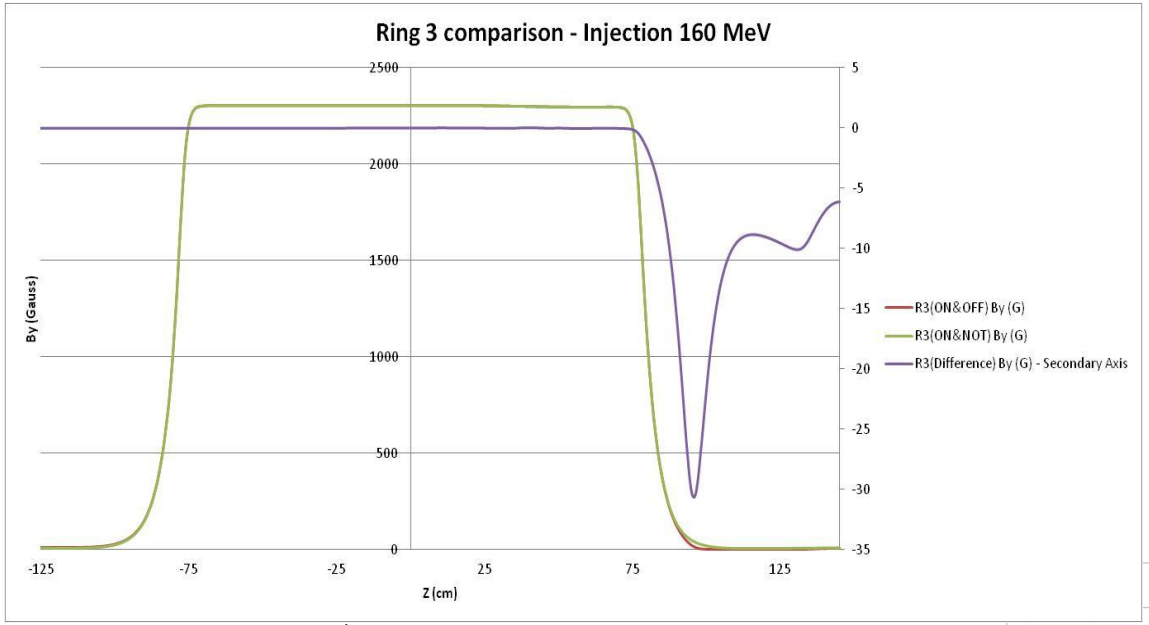
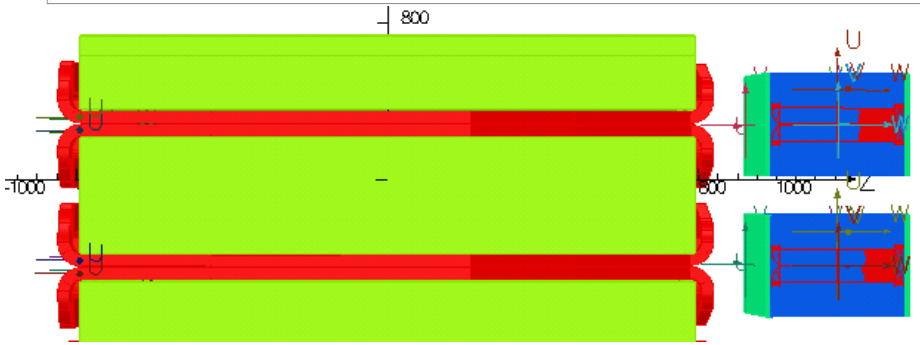


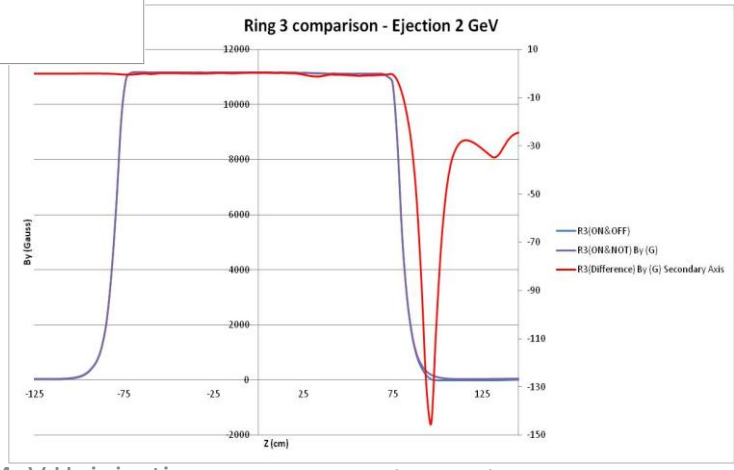
- Difference cases to be studied
  - Injection (BSW ‘ON’ & ‘OFF’)
  - Extraction
  - BHZ 162 and BHZ 11
- Shorter Dipoles

Influence of BSW magnets on main dipoles



Effect of adding the BSW1 (OFF) on the BHZ 162 (ON) reduces the integrated field by 0.3 ‰ at injection energy (160 MeV) and 0.25 ‰ at ejection (2 GeV), the effect is similar for Rings 3 & 4.





Influence of BSW magnets on main dipoles

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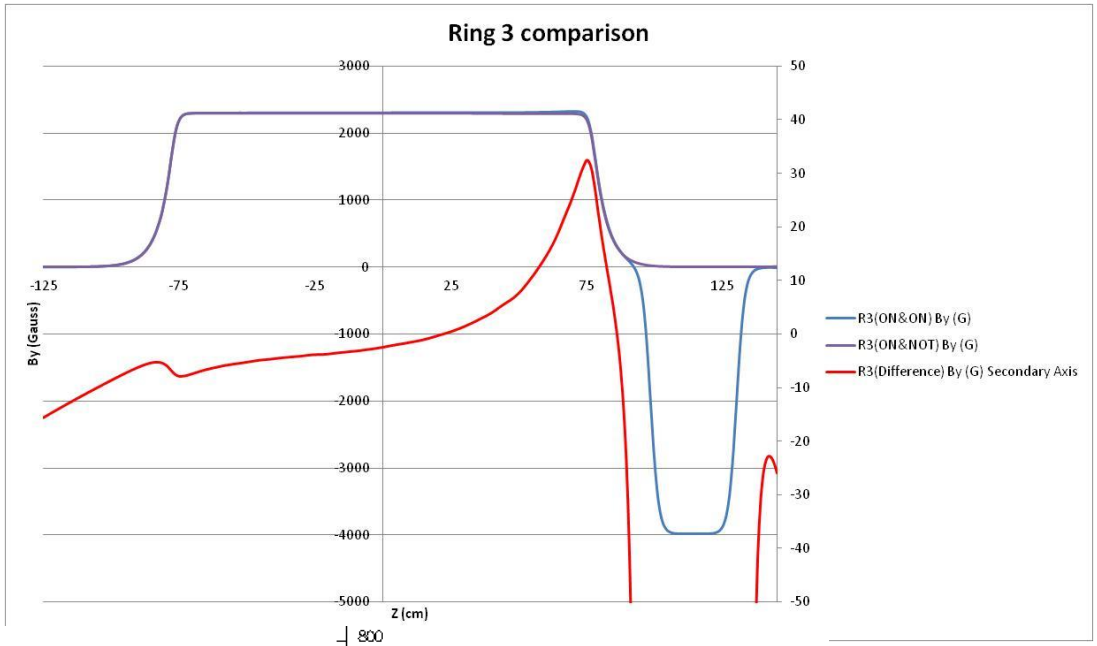
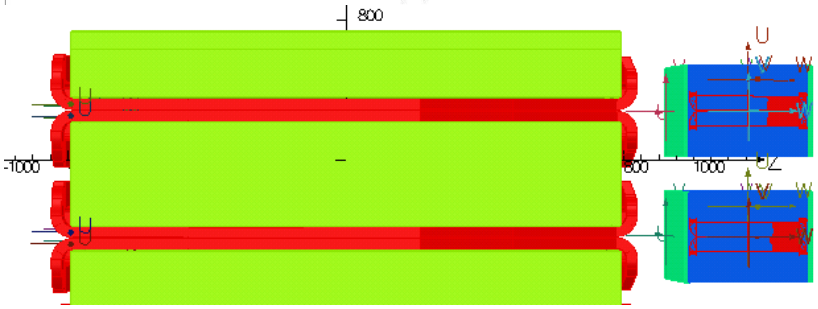
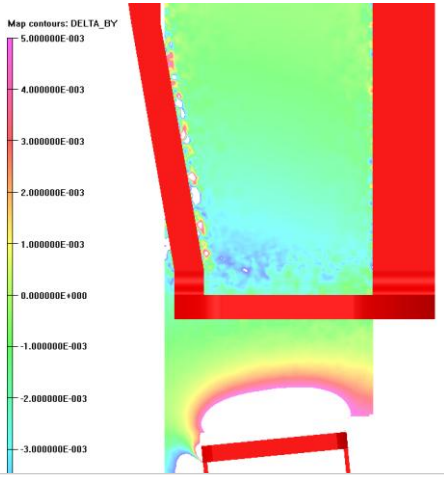
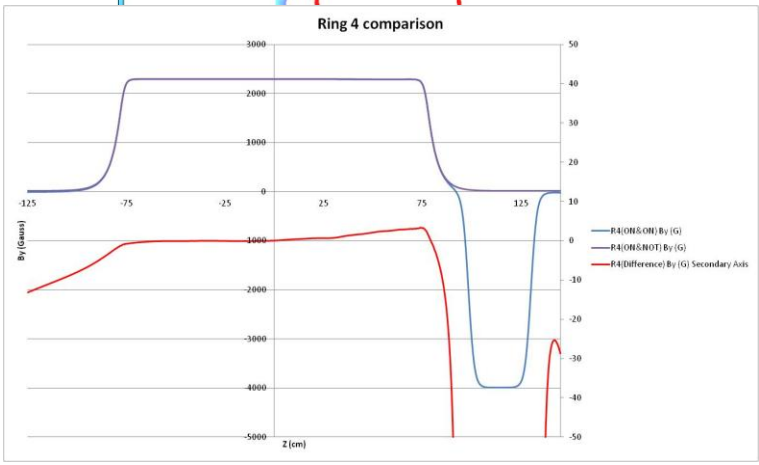
Effect of adding the BSW1 (ON) on the BHZ 162 (ON) introduces errors in the field homogeneity all the way through the magnet at the injection energy (160 MeV). The effects on Ring 3 are much greater than Ring 4!









Influence of BSW magnets on main dipoles

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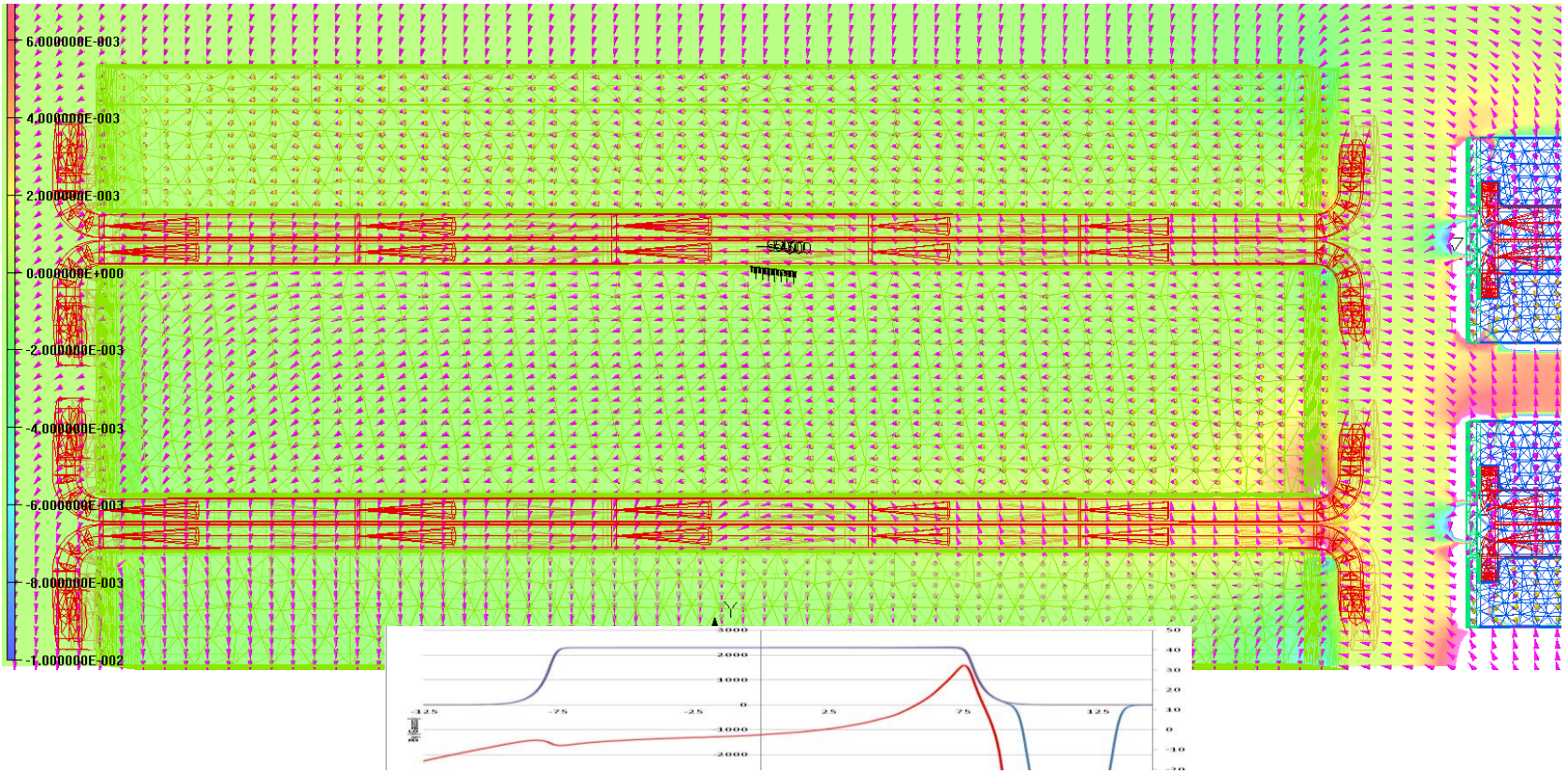
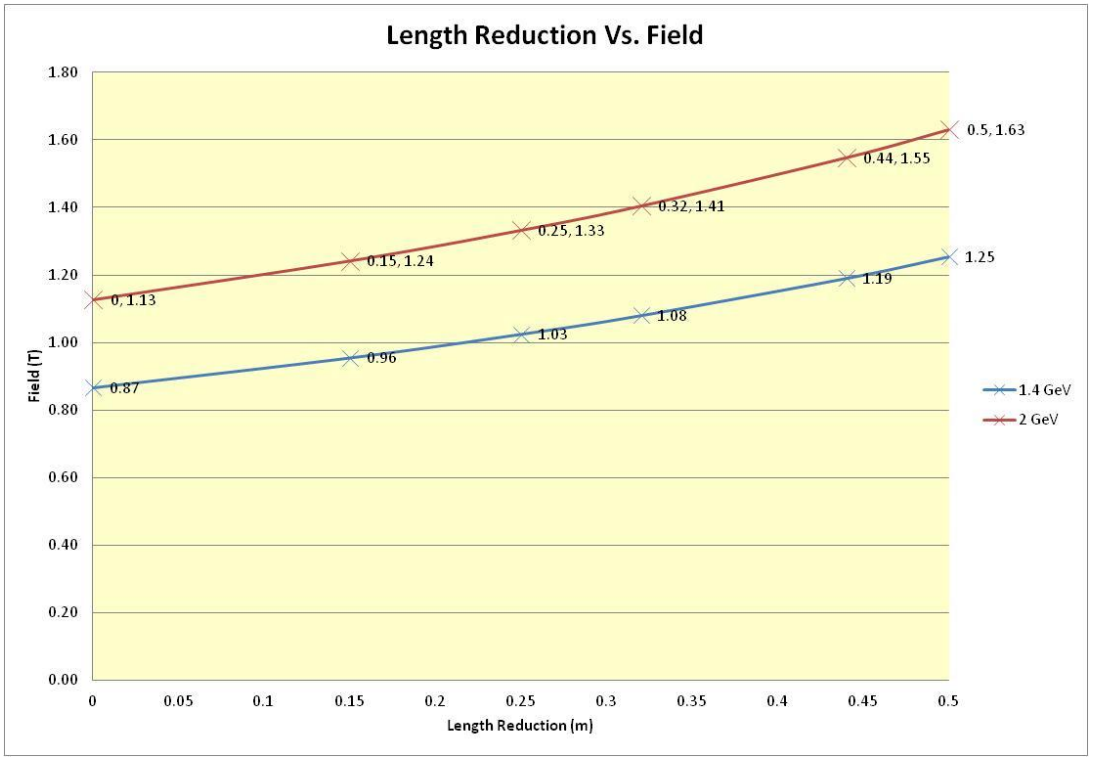
Effect of adding the BSW1 (ON) on the BHZ 162 (ON)

The coil end fields of the BSW1 magnet circulate in the opposed sense to the BSW1 aperture field acting to increase the field in the BHZ162 in close proximity, but the field slightly decreases at the opposite end as the field must close. It may be possible to reduce the effects by shielding, studies must continue!



Are shorter Dipoles feasible?



Length Reductions:

- 0.15 m to install vacuum valves
- 0.5 m (0.25 m) maximum requested (half requested if magnets centres could be off-set)
- 0.44 m (0.22 m) to allow for external dump (“ “)
- 0.32 m comfortable limit?

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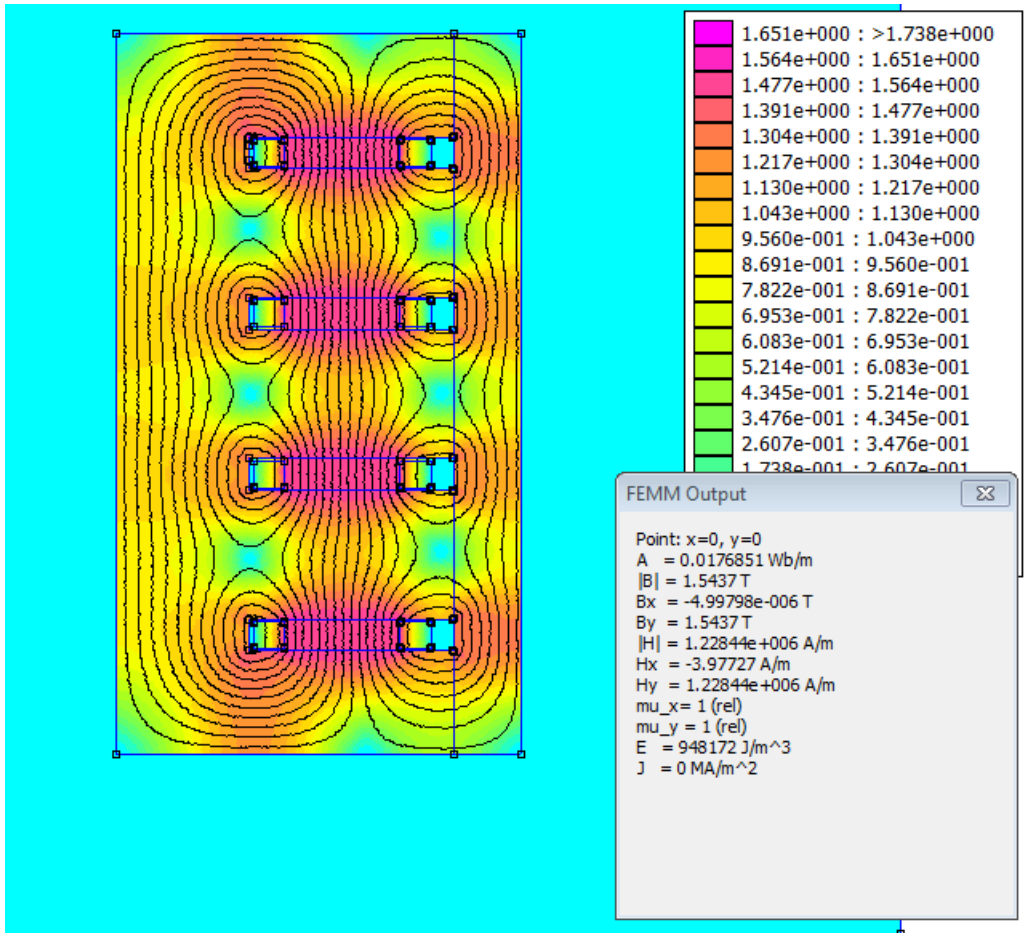
Are shorter Dipoles feasible?

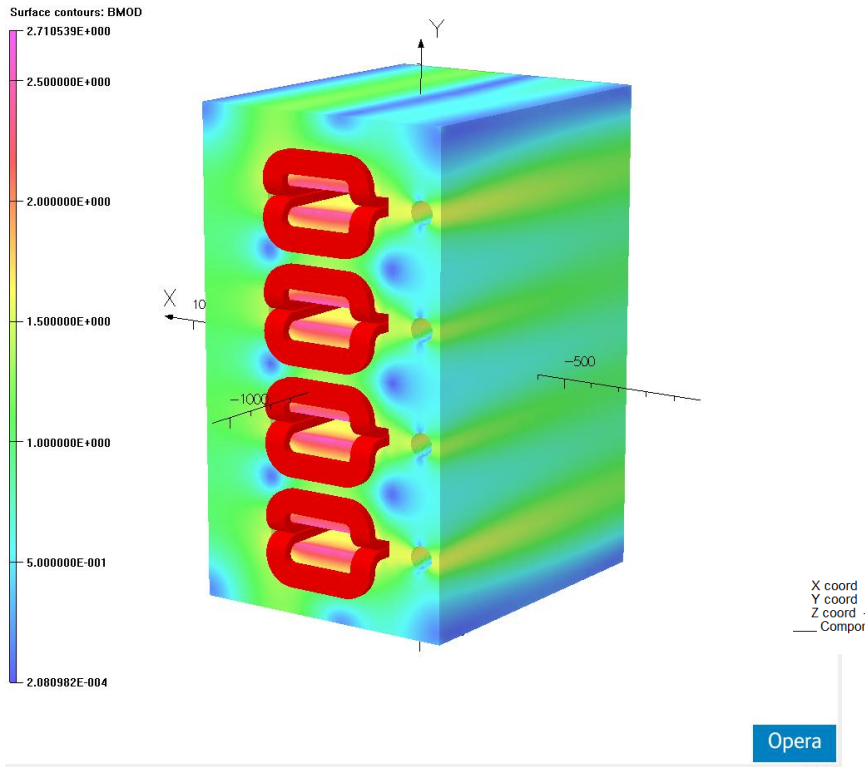


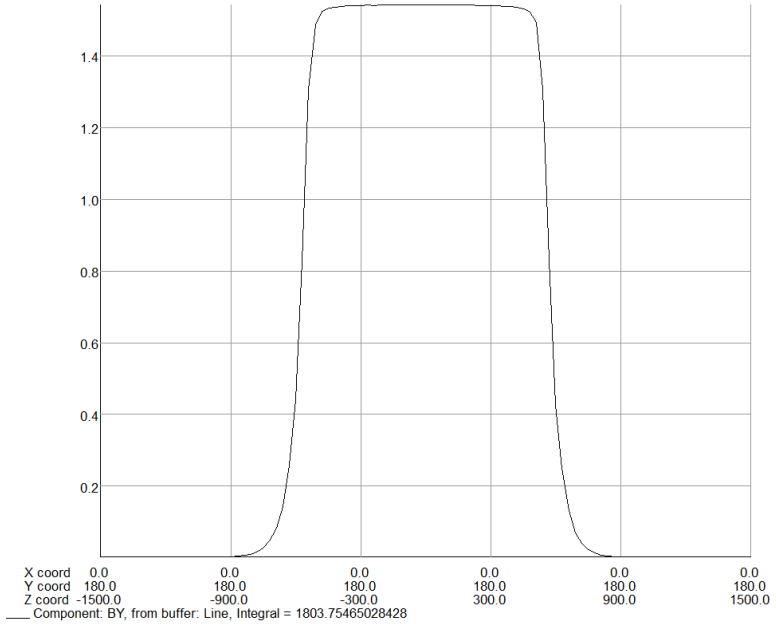
2D Study of 0.44 m reduction for the external dump scenario, 1.55 T at 2 GeV, maximum limit!

Magnetic circuit:
To achieve similar or lower field levels in the yoke an additional 0.15 m side plate (right) and 0.05 m on the other sides (top, bottom and left) is required.
For the BHZ 162 the injection vacuum chamber will have to pass through the entire length of the new side plate!

Coils:
For the BHZ 162 it is not possible to increase the copper section due to the ring and injection vacuum chambers (higher current density required).
For the BHZ 011 the copper section could be increased.

Are shorter Dipoles feasible?





Basic 3D study- shows approximately 1.2 % reduction in integrated field due to the heavily saturated pole ends.

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Are shorter Dipoles feasible?

		Now 1.4 GeV	Now 2 GeV	Short 1.4 GeV	Short 2 GeV
Iron length	m	1.54	1.54	1.10	1.10
Magnetic length	m	1.62	1.61	1.18	1.18
Gap	m	0.07	0.07	0.07	0.07
Length reduction	m	0	0	0.44	0.44
Magnetic field, B	T	0.867	1.127	1.191	1.548
Integrated field, BDL	T.m	1.403	1.824	1.403	1.824
Number of turns	#	12	12	16	16
Peak current (Mains)	A	4032	5200	4032	5200
Missing current for N + saturation (trim)	A			115	243
RMS current	A	2250	2500	2250	2500
Number of coils per gap	#	2	2	2	2
Resistance per gap	Ohms	0.006	0.006	0.009	0.009
Total resistance	Ohms	0.023	0.023	0.034	0.034
Power per gap	kW	28.6	35	43.6	54
Total power	kW	114.4	141.3	174.4	215.3
Number of cooling circuits per gap	#	2	2	8	8
Required cooling flow per gap	L/min	13.6	16.8	20.8	25.6
Total cooling flow	L/min	54.4	67.2	83.2	102.4
Pressure drop	bar	11	11	3.9	5.6
Current density (conductor)	A/mm	25.6	28.5	29	32.2
Current density (+solid)	A/mm	8.8	9.8	10.9	12.1
Cooling channel diameter	mm	6	6	4	4
Temperature rise	°C	30	30	30	30
Water velocity	m/s	4	4.96	3.45	4.25

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Summary

Effect of the BSW on the PSB bending magnets

- The introduction of the BSW magnets does effect the field in the main BHZ magnets, the impact needs to be understood. However, it may be possible to reduce the effects with additional magnetic 'shields' - the study is on going.

Are shorter Dipoles feasible? YES

- Maximum of 440 mm reduction in length possible.
- Trim supplies would be needed, 5 % of main supply would be needed in the case of a 0.44 m reduction. Minimum two supplies per magnet, ideally four.
- Possibly a dedicated B-train will be required.
- Cost of the magnets approximately - 1 MCHF – 2 units plus 2 spares + KCHF for others?