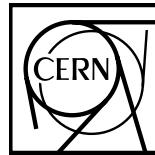# EVOLUTION OF THE DIPOLE CROSS-SECTION FROM THE "YELLOW BOOK" VERSION TO THE PRE-SERIES DESIGN

Stephan Russenschuck
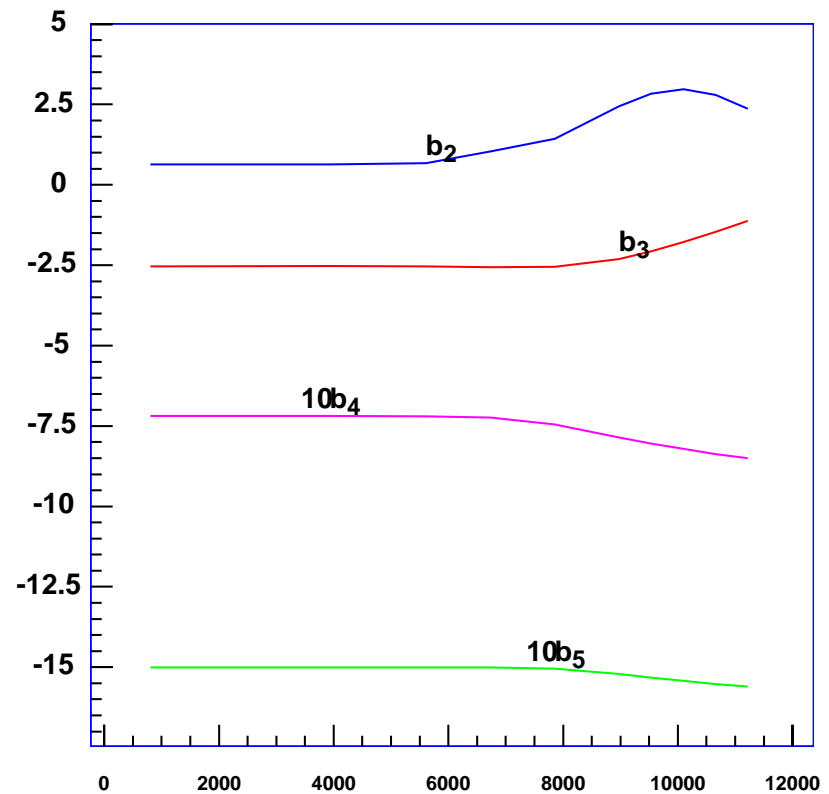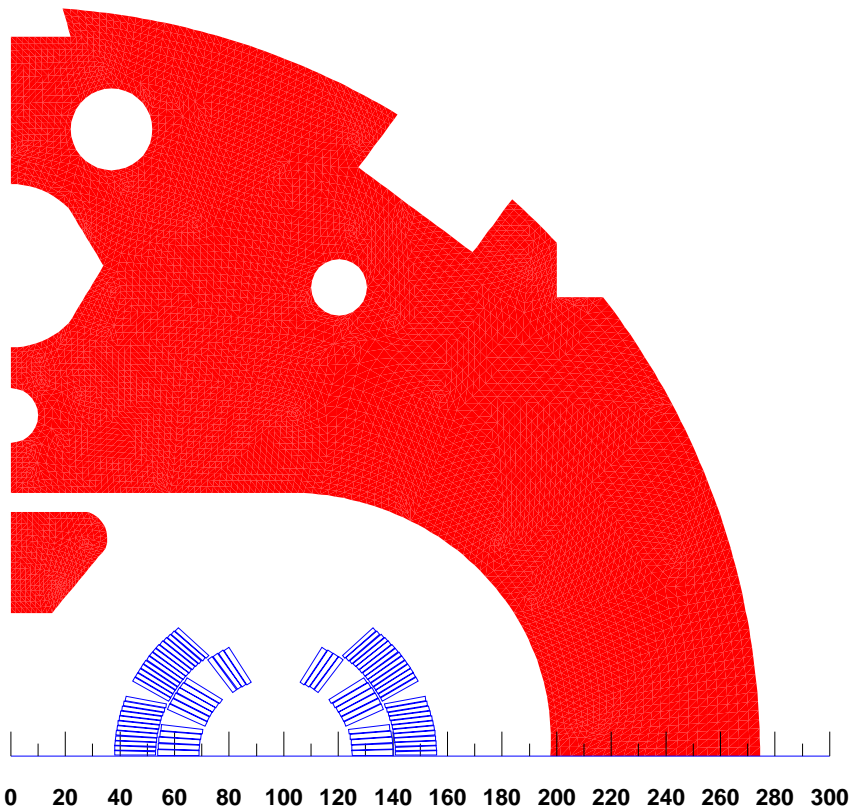
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WORKSHOP ON FQ STEERING OF THE MB PRODUCTION 20.03.2003

"Yellow book" Design (1995)

5-block coil design
(org. designed for separate collars [white book] and for max. average quench margin)
194 beam separation distance, combined collars with insert (MBP1)

The "V6-1" Coil (1997-1998)

In 1996 request for part-compensation of persistent currents
(b_3 (inj.) from -4.8 to - 4.0 units (at 10 mm) $\equiv \Delta b_3$ of 2.3 units at 17 mm).

Changes in ground plane insulation, narrow edge of cable, conductor insulation, and yoke (insert) had made the 5-block coil design too inflexible.

Lower b_{11}, increase quench margin, better mechanical support, lower sensitivity to manufacturing tolerances.

V6-1 coil design found using genetic optimization algorithms (unchanged since autumn 1998).
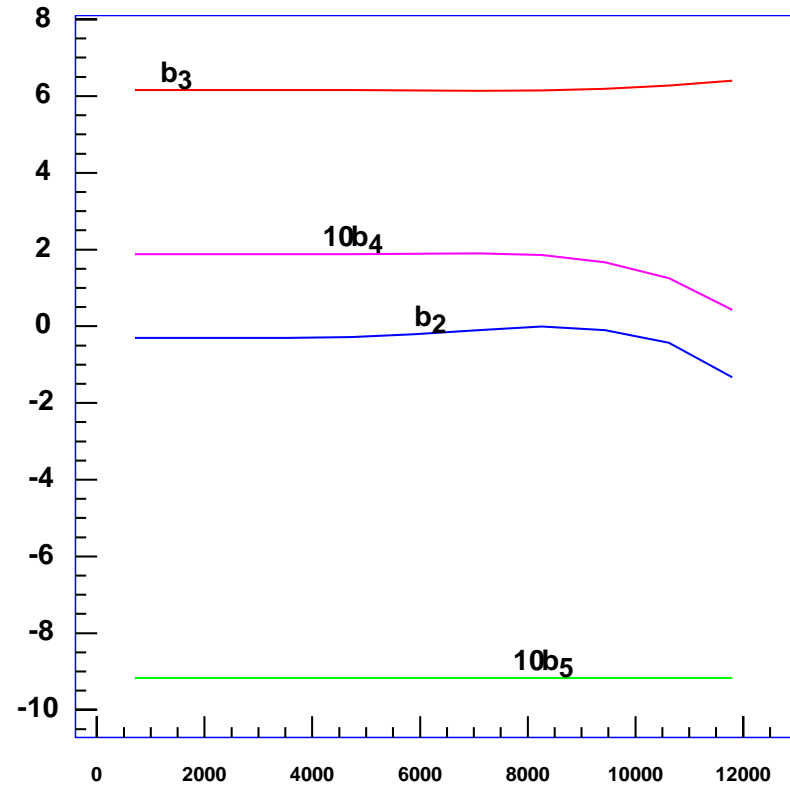
"V6-1" Coil in MBP1 Yoke
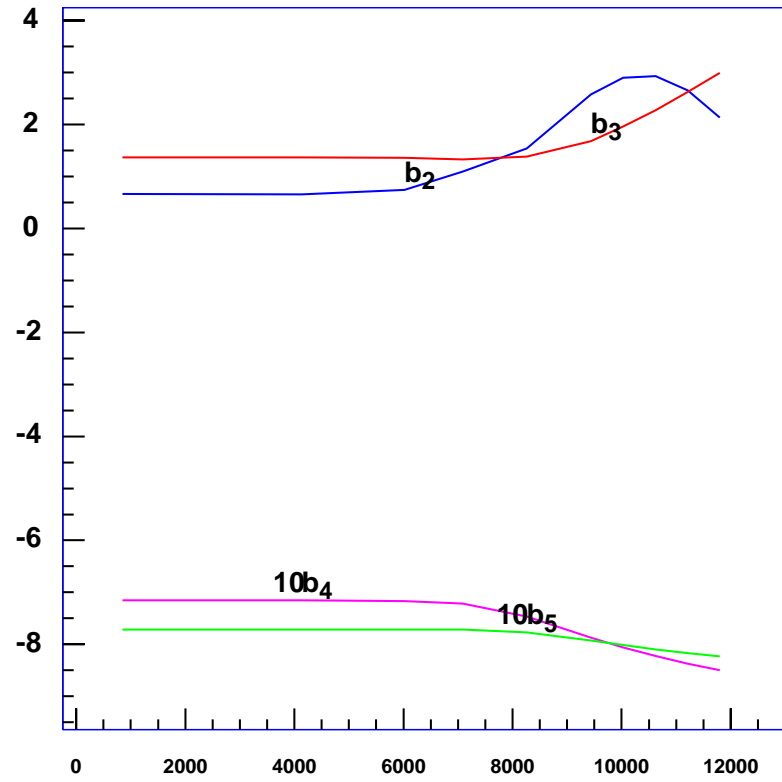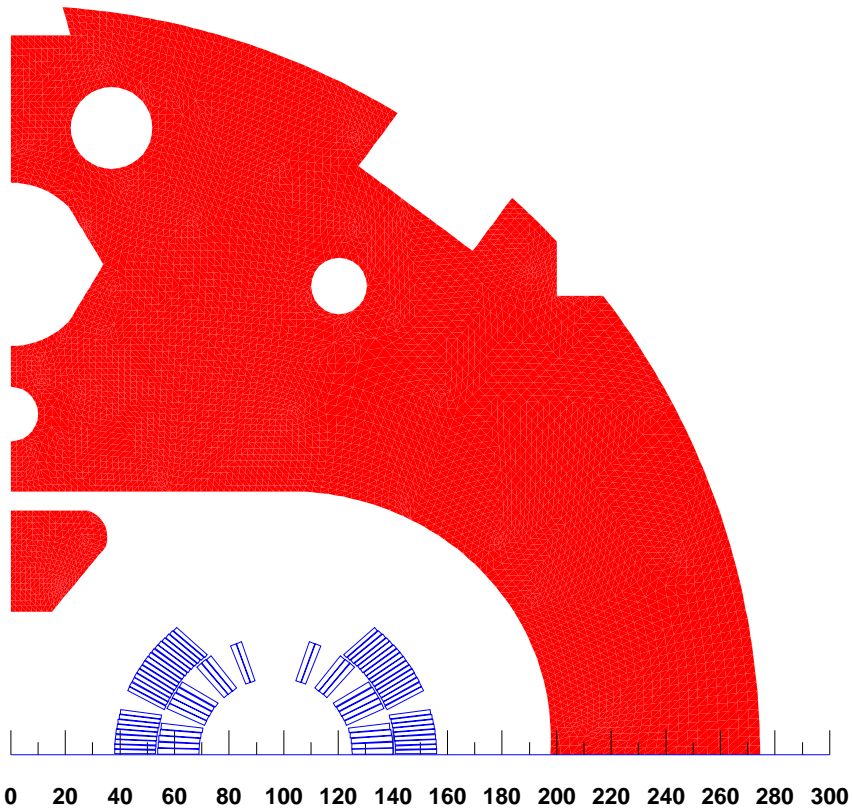
The MBP2 Yoke Design (1999)

Re-design of the yoke triggered by mechanical considerations.
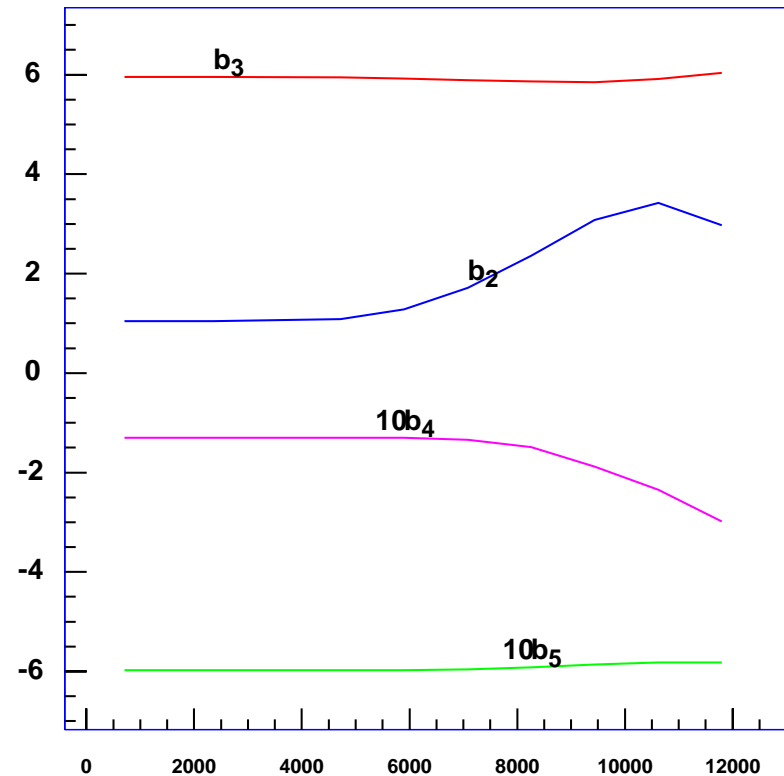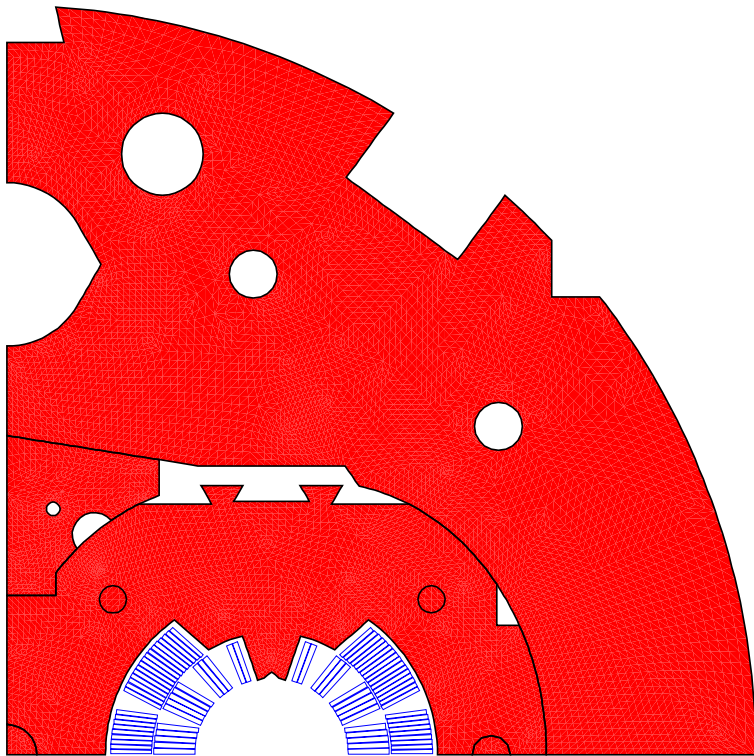Objectives: Lower the variation of b_2 and b_3, lower b_4.
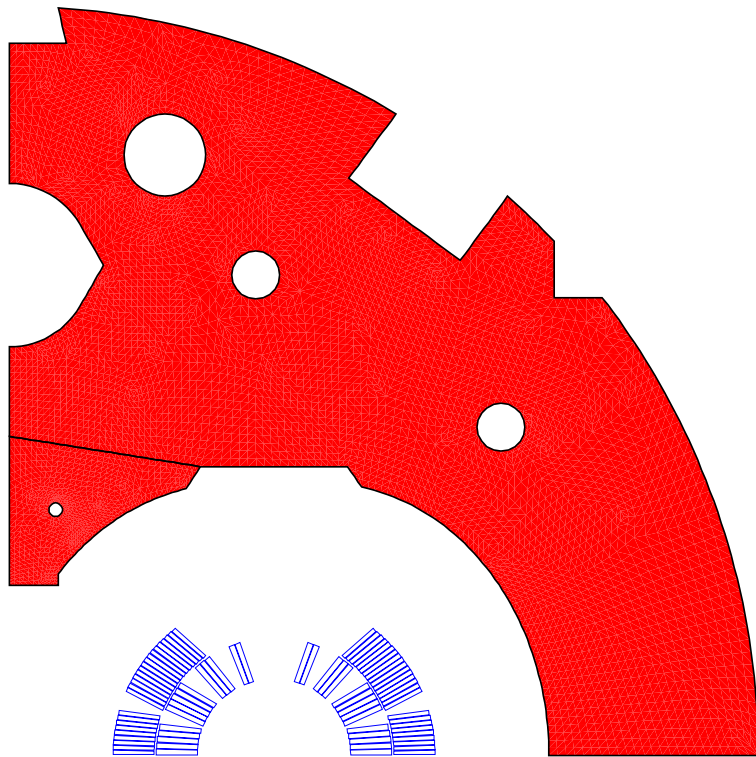
The Pre-Series Magnets

Increased "nose" in insert (mechanical reasons), increases b_3, b_2, b_4.
Cut-offs for the b_2, b_4 compensation, increases b_3.
Stainless-steel collars, decreases b_3 decreases b_2.
Still no consideration of beam-screen (decreases b_3).

The Beam-Screen
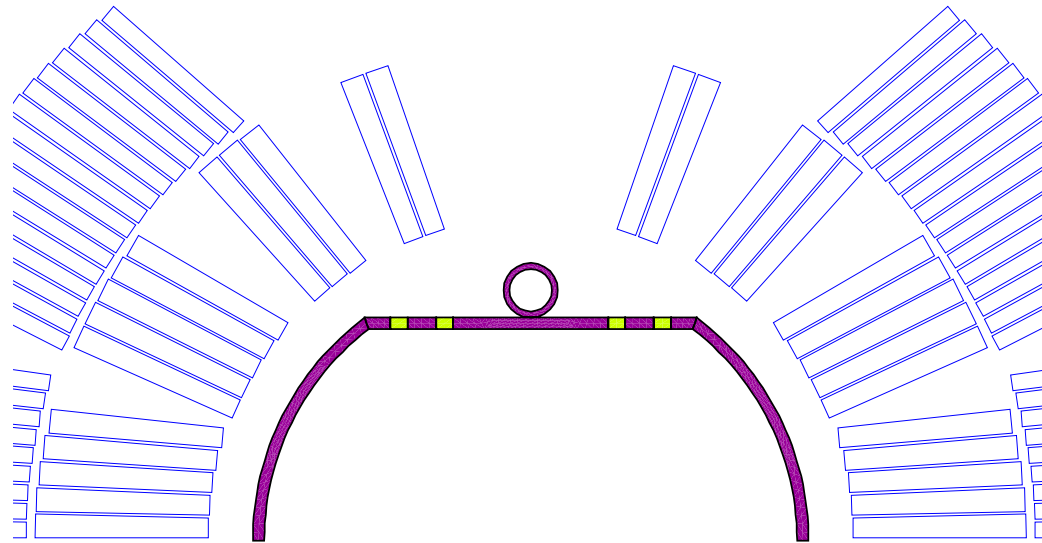
	Beam screen no slots	Beam screen with slots	Measured (0.6 mm)	Measured scaled
Δb_3	-0.402	-0.424	-0.3	-0.5
Δb_5	0.299	0.386	-0.25	-0.42
Δb_7	-0.167	-0.244	-0.18	-0.3

The Integrated Design Process

Although the Integrated Design Process is well established (considering persistent currents, iron magnetization, 3d end-effects, beam-screen, stainless-steel collars, eccentricity of vacuum vessel etc.)
it was never applied (always to late).

At least for the FQ steering we should stop to disentangle the effects and establish with the correct dimensions, permeability (of ss-collars, coil-protection sheet, iron yoke, beam screen), yoke filling factor and fit of critical current density the numerical reference for the magnets.
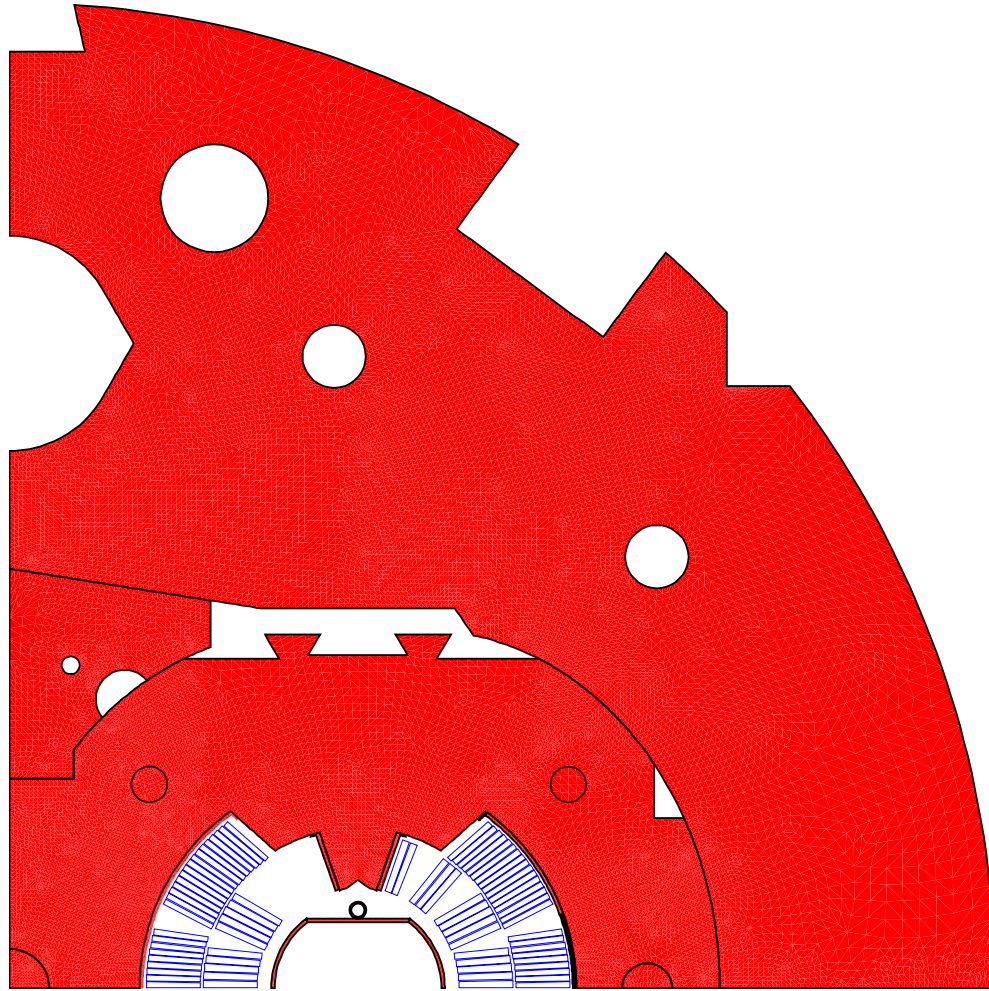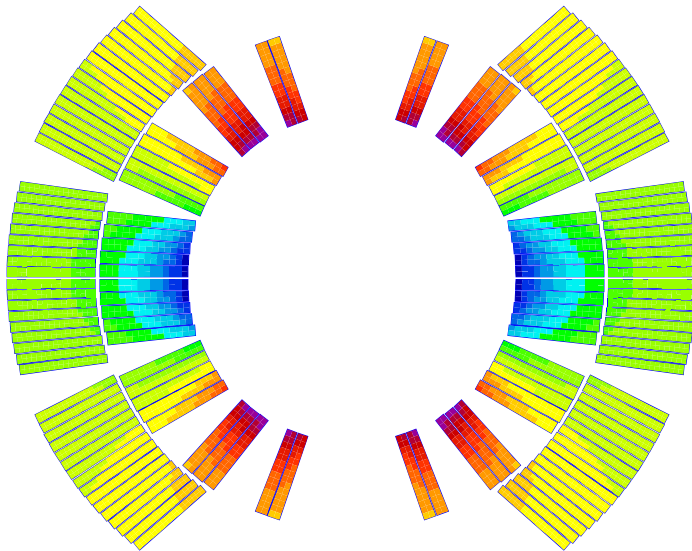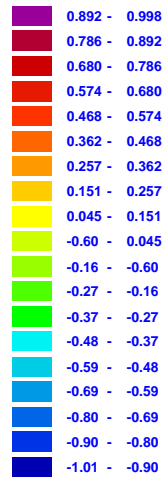
BEMFEM * ROXIE 9.0

The Sources of Field Errors

$$B_n(r_0) = -\frac{\mu_0 I}{2\pi} \frac{r_0^{n-1}}{r_i^n} \cos n\Theta$$

B3 CONTR. (T)

(*E-3)

0.892 -	0.998
0.786 -	0.892
0.680 -	0.786
0.574 -	0.680
0.468 -	0.574
0.362 -	0.468
0.257 -	0.362
0.151 -	0.257
0.045 -	0.151
-0.60 -	0.045
-0.16 -	-0.60
-0.27 -	-0.16
-0.37 -	-0.27
-0.48 -	-0.37
-0.59 -	-0.48
-0.69 -	-0.59
-0.80 -	-0.69
-0.90 -	-0.80
-1.01 -	-0.90

B7 CONTR. (T)

(*E-3)

0.113 -	0.126
0.099 -	0.113
0.086 -	0.099
0.073 -	0.086
0.059 -	0.073
0.046 -	0.059
0.033 -	0.046
0.020 -	0.033
0.006 -	0.020
-0.63 -	0.006
-0.19 -	-0.63
-0.32 -	-0.19
-0.46 -	-0.32
-0.59 -	-0.46
-0.72 -	-0.59
-0.85 -	-0.72
-0.99 -	-0.85
-0.11 -	-0.99
-0.12 -	-0.11