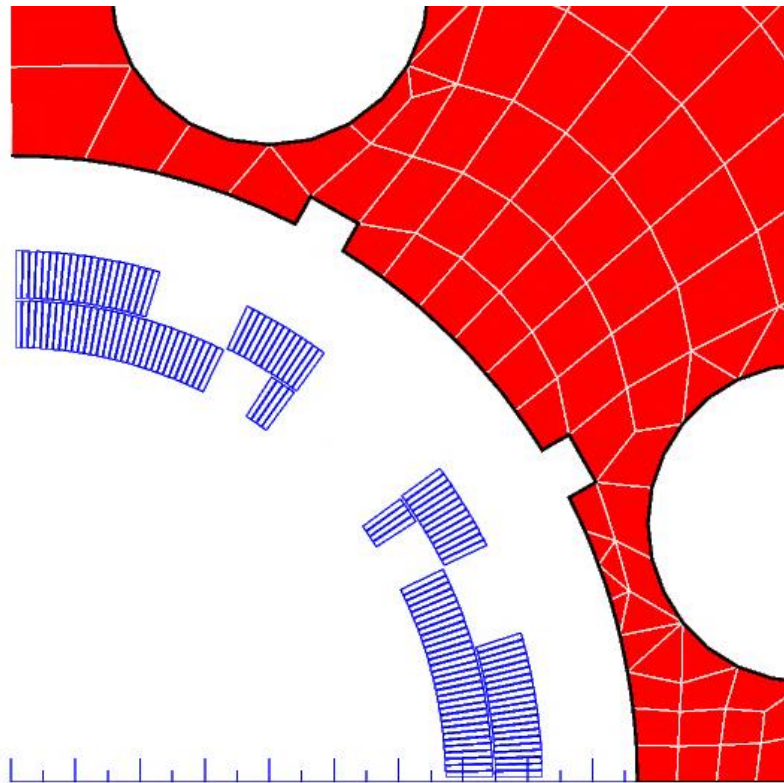# Investigation of Tuning Shims in Q2pF

Ramesh Gupta
August 1, 2023
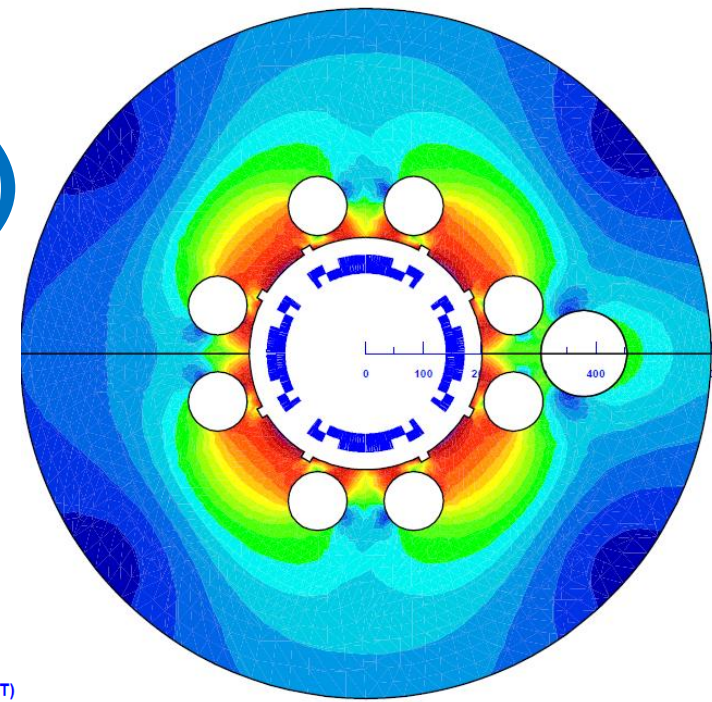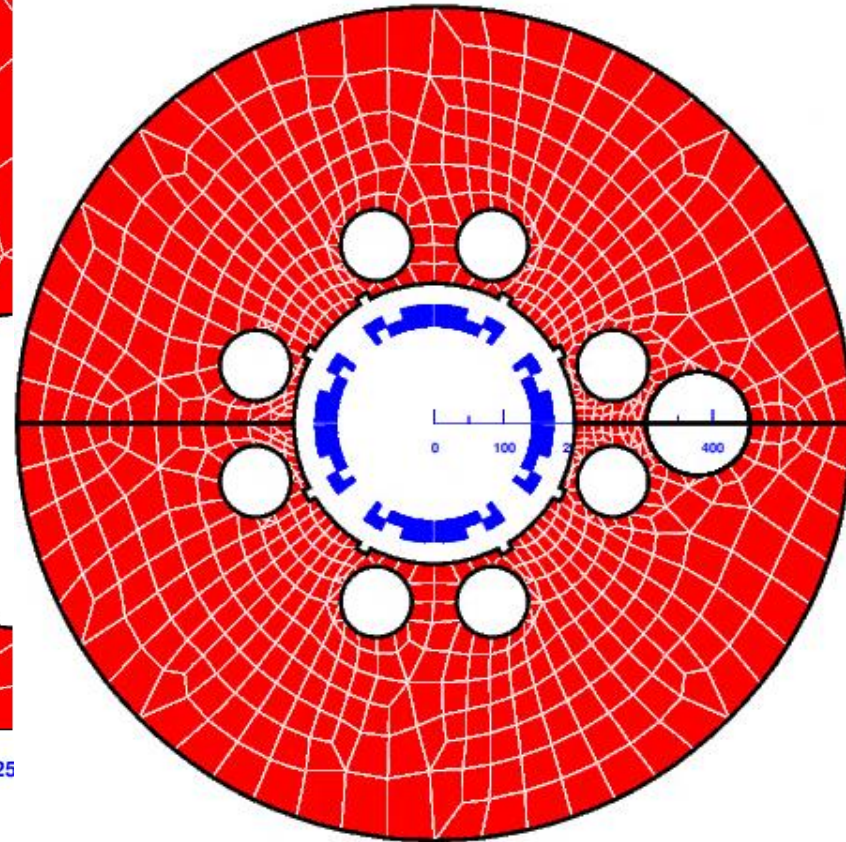
Slot for tuning shims starting at 27°
(10 mm deep, 5° wide, 8-fold symmetry)
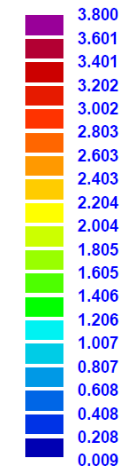
➢ **Several variations have been examined**

|Btot| (T)

Tuning Shims
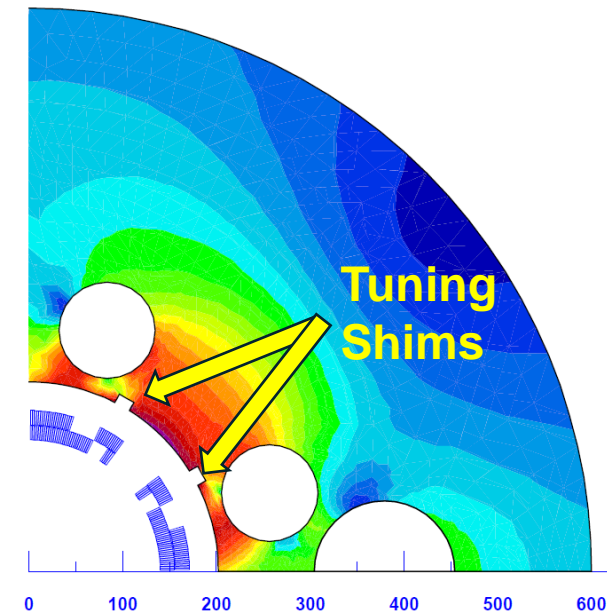
ROXIE 10.2

0   20.83 41.67 62.5 83.33 104.17 125 145.83 166.67 187.5 208.33 229.17 25

0   100 200 300 400 500 600

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Slot for tuning shims starting at 27º (10 mm deep, 5º wide, 8-fold symmetry)

➢ **Harmonics generated by slot (8 harmonics, in general, if no symmetry)**
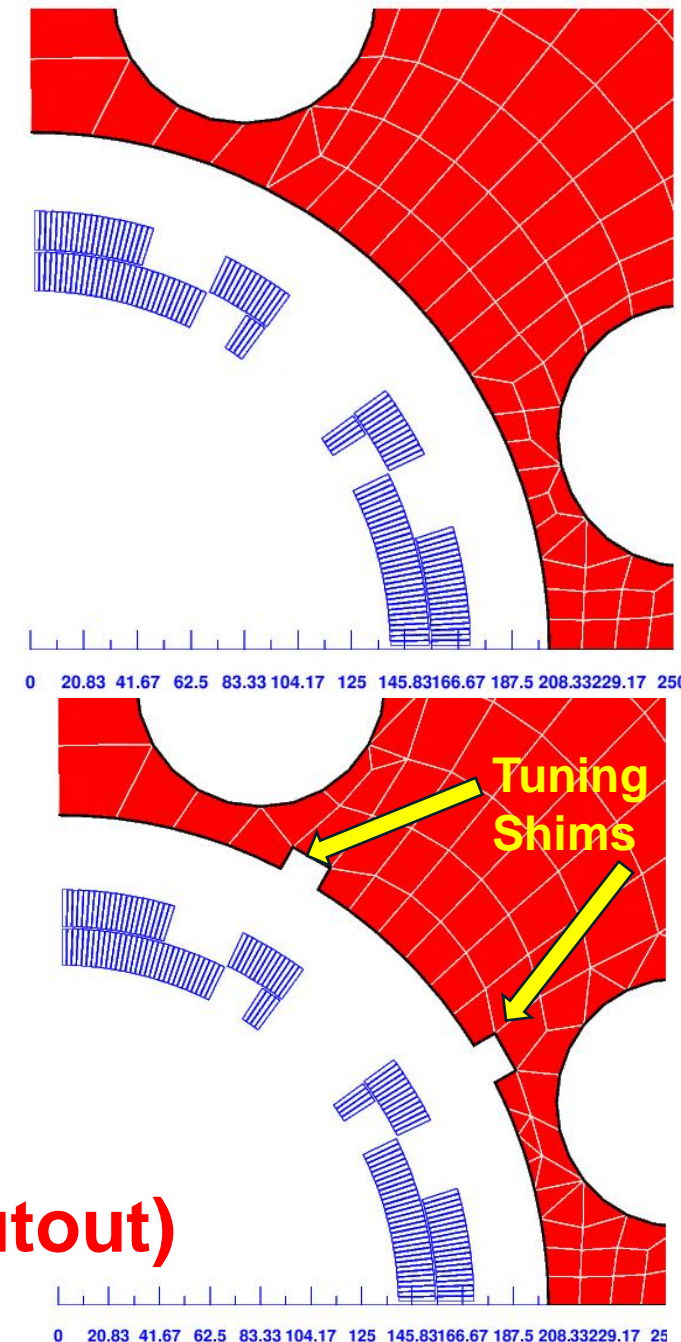

No Slot

```
NORMAL RELATIVE MULTIPOLES (1.D-4):
b 1:    -0.08998   b 2:   10000.00000   b 3:      0.00003
b 4:     0.00096   b 5:       0.00069   b 6:      0.15329
b 7:     0.00060   b 8:       0.00025   b 9:     -0.00004
b10:    -0.41354   b11:       0.00000   b12:     -0.00001
b13:    -0.00000   b14:      -0.43059   b15:      0.00000
b16:     0.00000   b17:       0.00000   b18:      0.00491
```

With Slot

```
NORMAL RELATIVE MULTIPOLES (1.D-4):
b 1:    -0.00811   b 2:   10000.00000   b 3:     -0.02208
b 4:     0.02027   b 5:       0.00193   b 6:      0.05101
b 7:     0.00012   b 8:      -0.00429   b 9:     -0.00010
b10:    -0.31203   b11:       0.00000   b12:      0.00007
b13:    -0.00000   b14:      -0.43523   b15:      0.00000
b16:     0.00001   b17:       0.00000   b18:      0.00489
```

Tuning Shims

➢ **Max correction in b6 & b9 = 0.1 units, need more (depends on the size, shape and location of the cutout)**

Slot for tuning shims starting at 27°
(10 mm deep, 5° wide, 8-fold symmetry)

➢ **Dependence of correction on field (values at the high or design field)**

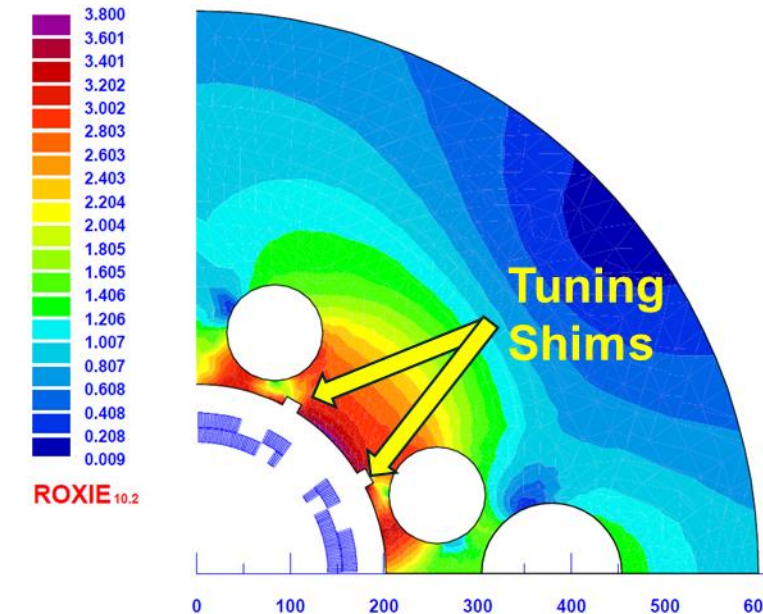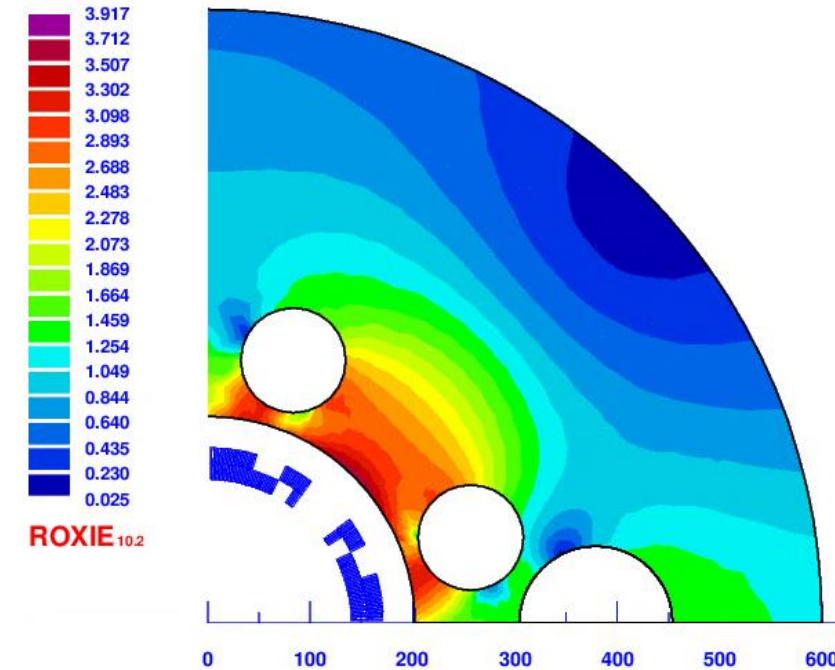**No Slot**

```
NORMAL RELATIVE MULTIPOLES (1.D-4):
b 1:      0.32327   b 2:  10000.00000   b 3:      0.28302
b 4:      0.00690   b 5:      0.08049   b 6:     -0.10286
b 7:      0.00191   b 8:      0.00107   b 9:      0.00306
b10:     -0.40846   b11:     -0.00033   b12:      0.00010
b13:     -0.00006   b14:     -0.46480   b15:     -0.00001
b16:      0.00001   b17:     -0.00000   b18:      0.00549
```
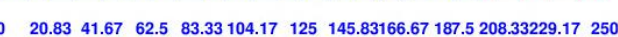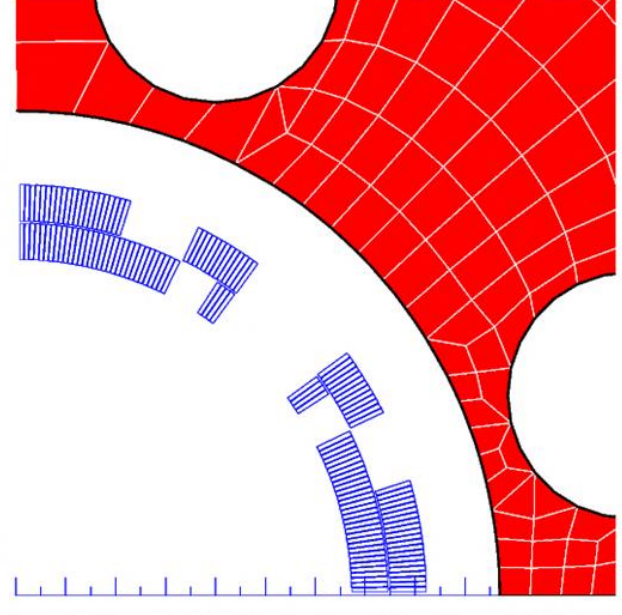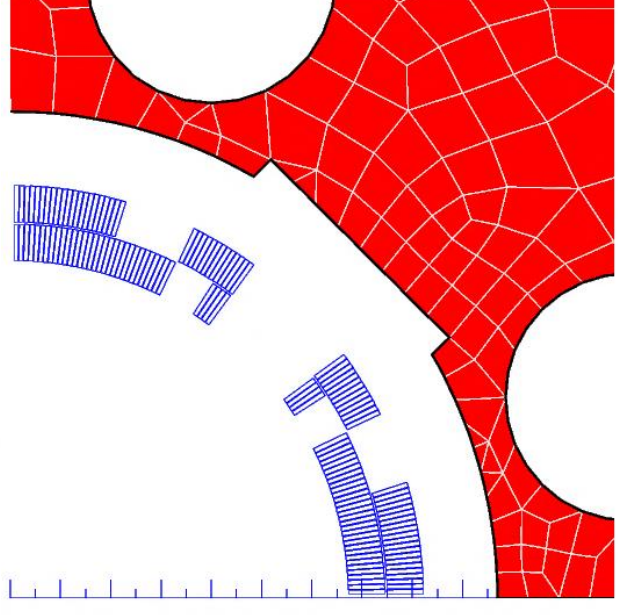
With Slot

```
NORMAL RELATIVE MULTIPOLES (1.D-4):
b 1:     -0.17883   b 2:  10000.00000   b 3:      0.03806
b 4:     -0.03333   b 5:      0.04160   b 6:      0.84519
b 7:      0.00806   b 8:     -0.00520   b 9:      0.00170
b10:     -0.32714   b11:      0.00004   b12:      0.00012
b13:     -0.00004   b14:     -0.47019   b15:     -0.00001
b16:      0.00001   b17:     -0.00000   b18:      0.00552
```


Tuning Shims

➢ **Max change in b6 ~1 units (different from LF) Can something be done to minimize the swing?**
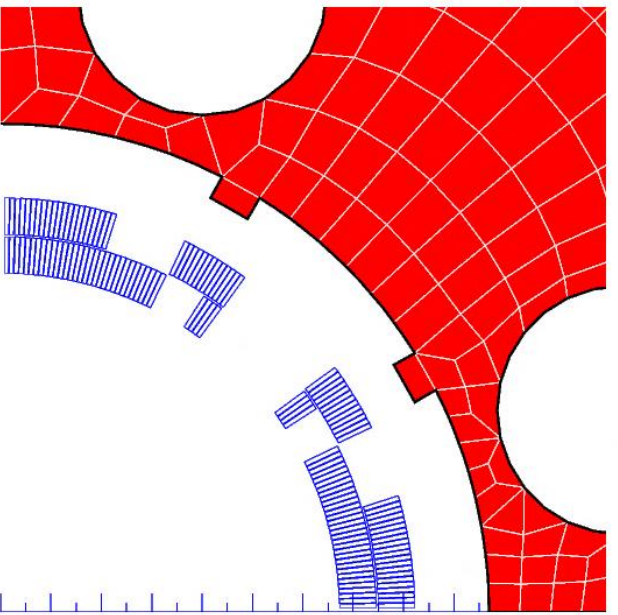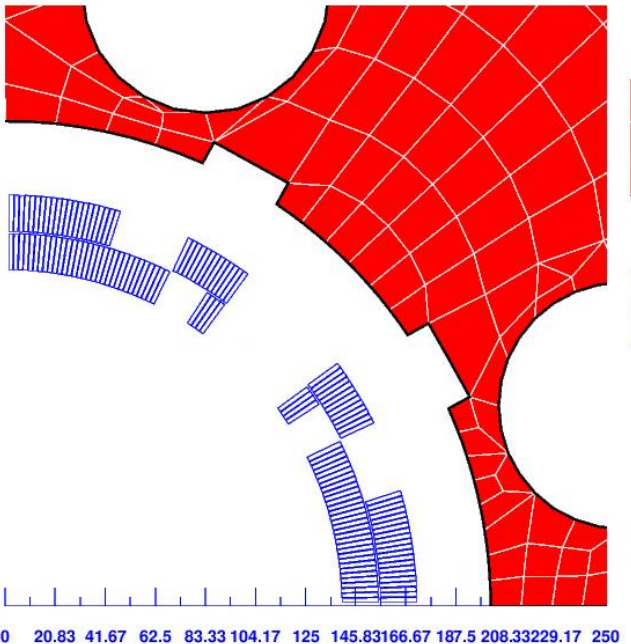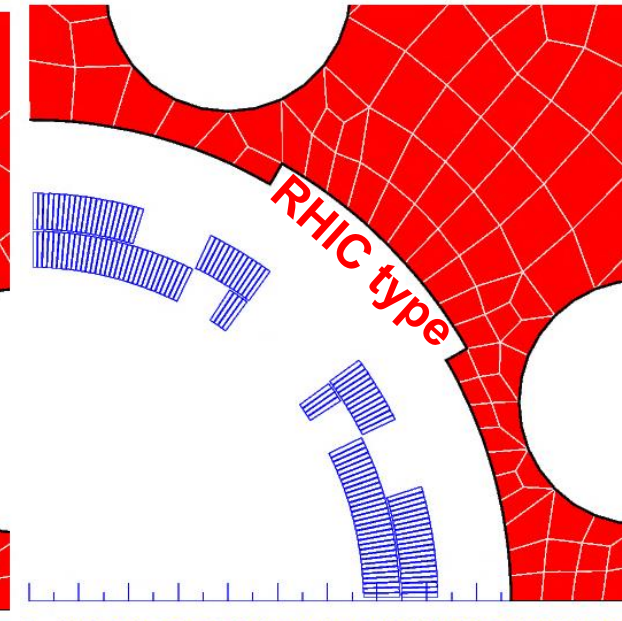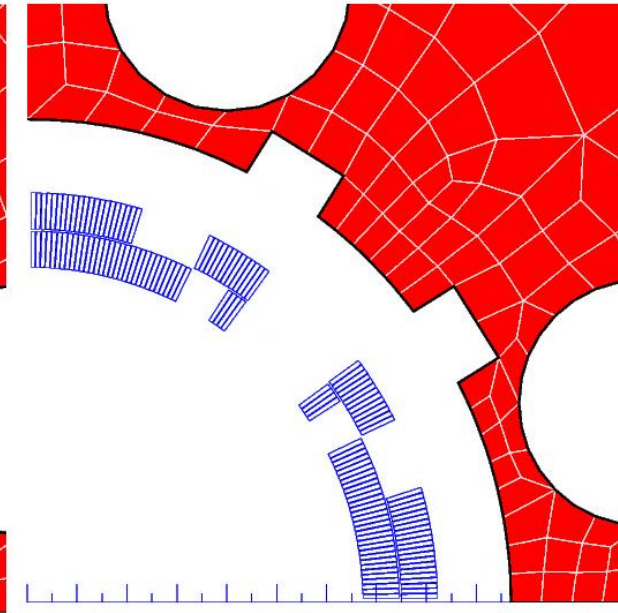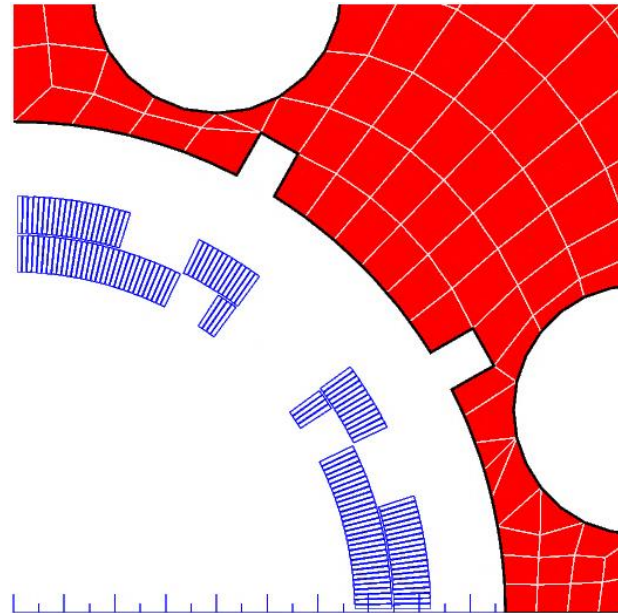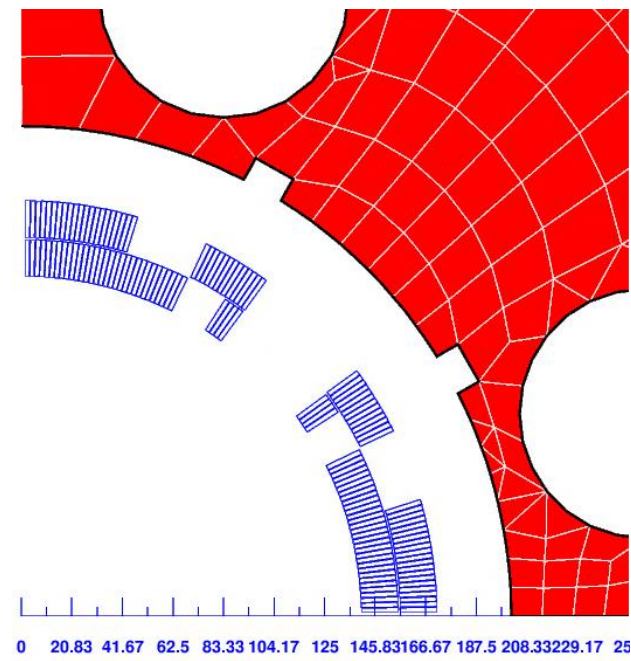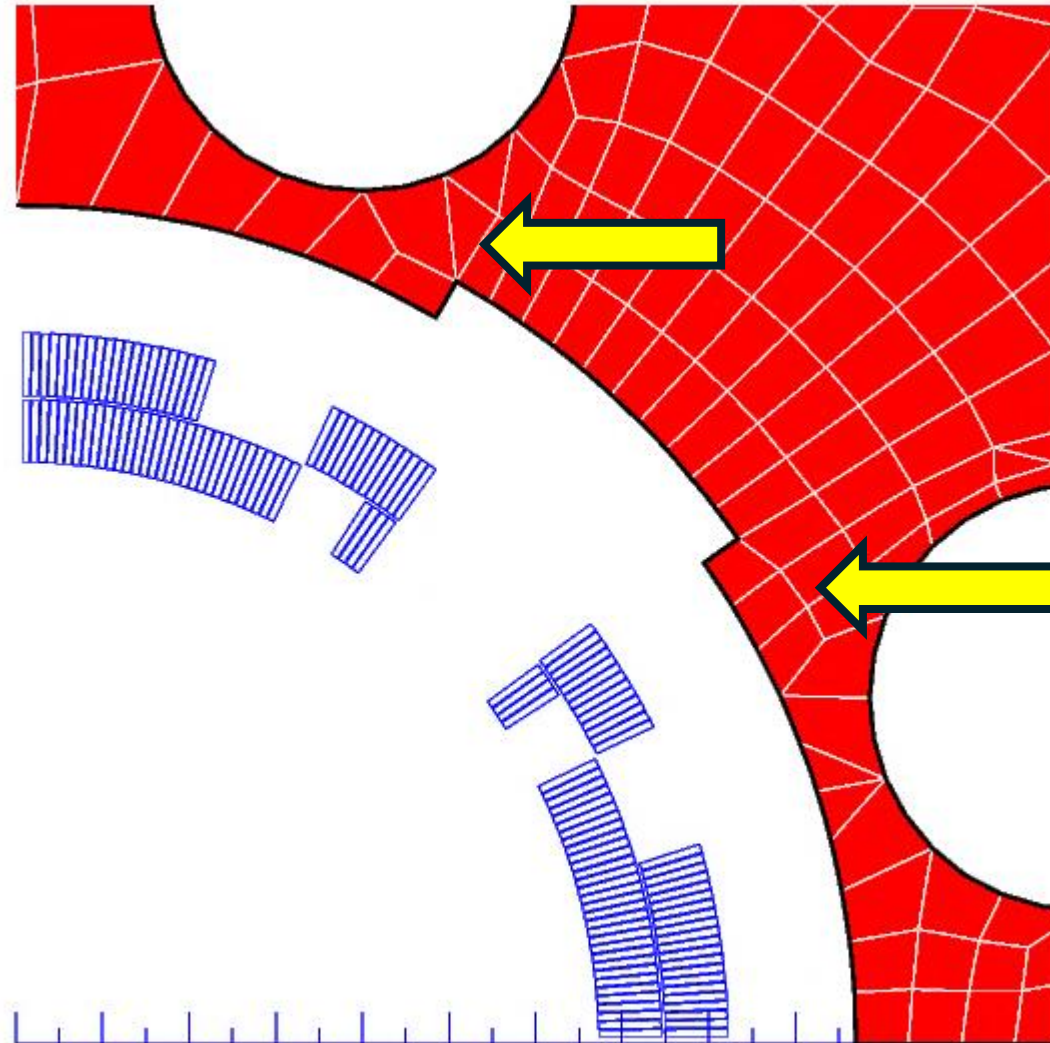
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RHIC type

Magnet Division   Ramesh Gupta   **Investigation of Tuning Shims in Q2pF**   August 1, 2023

Asymmetric Cutout (two tuning shims)

➢ **All bn expected (no skew harmonics due to top-bottom symmetry)**
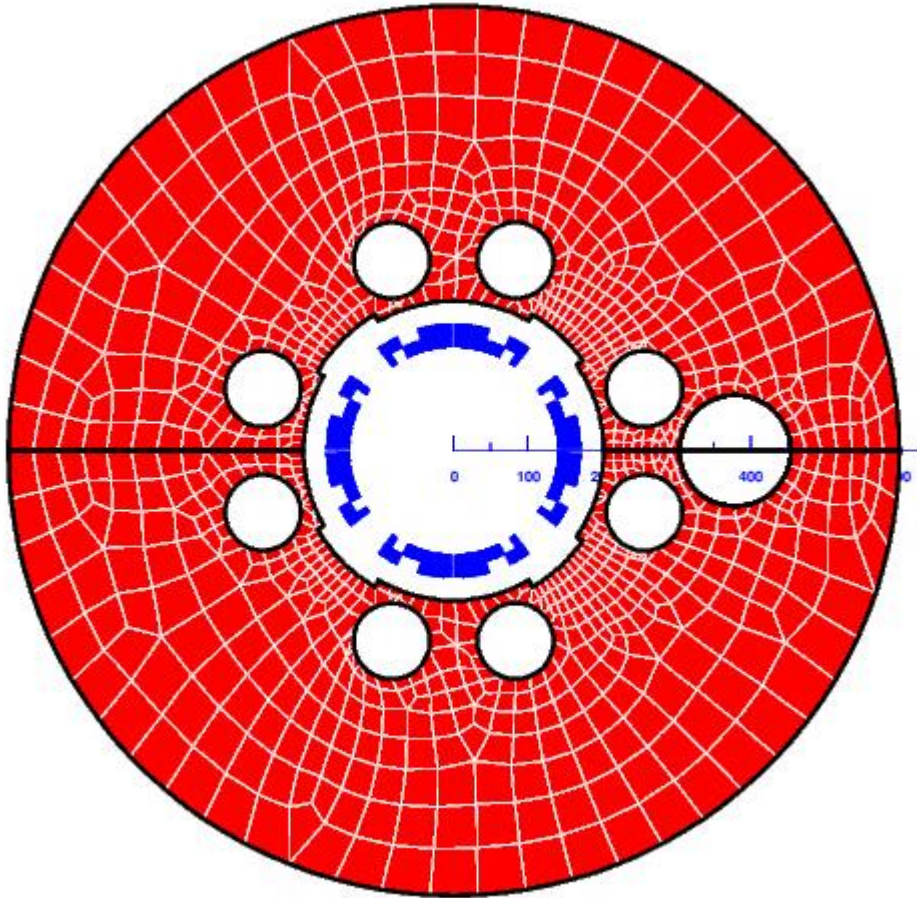
Cutout in octant 1 (and also in octant 8) is different from others

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No Slot

```
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b13:      -0.00000  b14:      -0.43059  b15:       0.00000
b16:       0.00000  b17:       0.00000  b18:       0.00491
```

With Slot

```
NORMAL RELATIVE MULTIPOLES (1.D-4):
b 1:      16.88367  b 2:   10000.00000  b 3:      13.86318
b 4:       4.94276  b 5:       0.27663  b 6:      14.05961
b 7:      -0.78771  b 8:      -0.39589  b 9:      -0.12957
b10:      -0.76165  b11:       0.01195  b12:       0.01225
b13:       0.00648  b14:      -0.43755  b15:       0.00053
b16:      -0.00006  b17:      -0.00014  b18:       0.00514
```
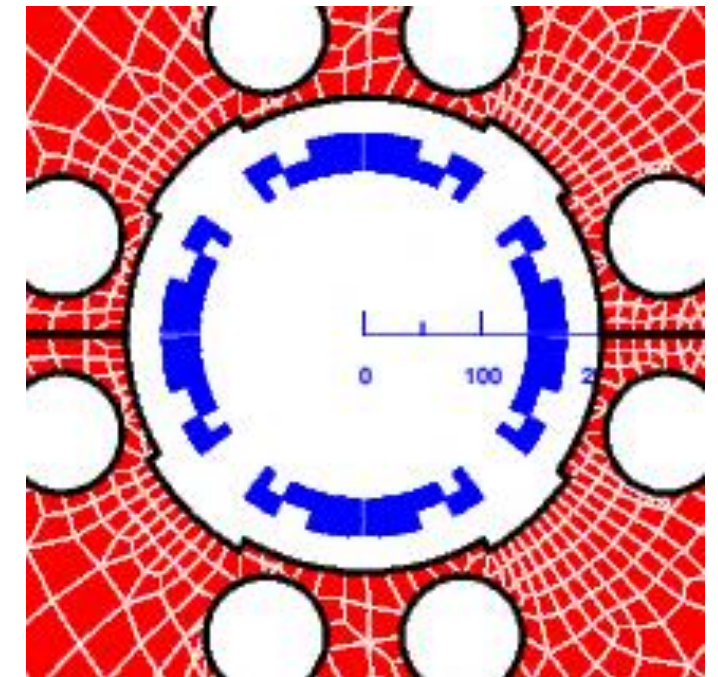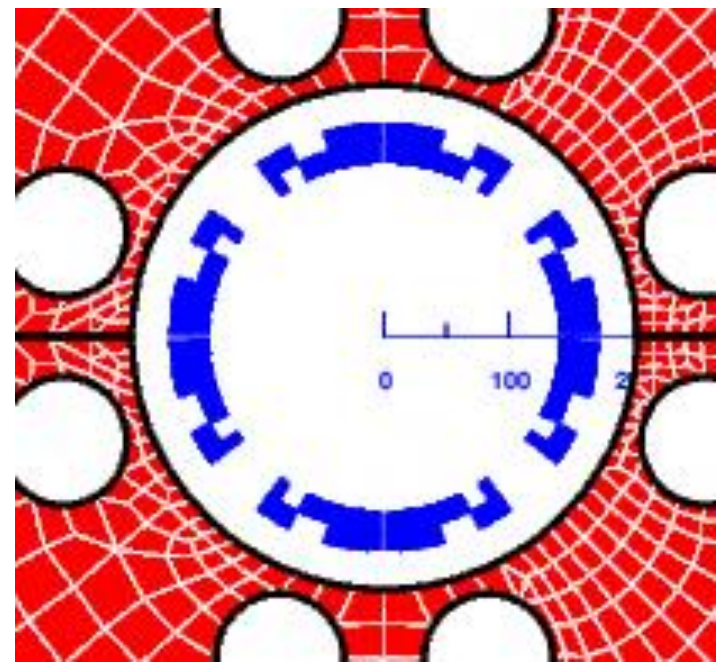
A healthy range for harmonic correction available