OPTIMIZATION OF OPEN MIDPLANE DIPOLE DESIGN FOR LHC IR UPGRADE*

Superconducting Magnets Division www.bnl.gov/magnets

High power density operation regime of open midplane dipole magnets for LHC luminosity upgrade presents a hostile environment for superconducting magnets due to large amount of particle spray from pp collisions and large beam forces acting on magnets. "Dipole First Option" reduces long term beam effects and makes correction of field errors in quadrupole needed.

• Particles from IP (mostly at midplane), pass through without hitting anything before hitting the warm target.
• Start research paves a significant challenge, both in terms of magnetic performance and in terms of economical operation of LHC magnets.
• The present optimization is focused on midplane gap design for avoiding inquadrupole (see Table I). The paper summarizes the basic design strategy, challenges and a number of limitations carried out over a period of a few years.

Table I: Summary of Design Iterations

<table>
<thead>
<tr>
<th>Design</th>
<th>Iteration</th>
<th>Asymmetry</th>
<th>Peak Field (T)</th>
<th>Relative Deflection (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNL 12 T Common Cell Dipole Refigure</td>
<td>A</td>
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<td>11.4</td>
<td>0.00</td>
</tr>
<tr>
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<td>B</td>
<td>0.00</td>
<td>11.2</td>
<td>0.00</td>
</tr>
<tr>
<td>BNL 12 T Common Cell Dipole</td>
<td>C</td>
<td>0.00</td>
<td>11.2</td>
<td>0.00</td>
</tr>
<tr>
<td>BNL 12 T Common Cell Dipole</td>
<td>D</td>
<td>0.00</td>
<td>11.2</td>
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<tr>
<td>BNL 12 T Common Cell Dipole</td>
<td>E</td>
<td>0.00</td>
<td>11.2</td>
<td>0.00</td>
</tr>
</tbody>
</table>

The other key design parameters of the dipole design summary are:
- Power density isocontours at 161, 198, 215, 148, 151, and 125

Horizontal deflections in "Design F" in mm.
Relative deflection are ~0.1 mm at design field.

SUMMARY
The "Open Midplane Design" will present a good technical and an economical option for LHC luminosity upgrade in "Dipole First Option." The challenging requirements of the design have been met:
- A design that can accommodate a large gap between upper and lower coils with no structure in between.
- A design with good field quality despite a large midplane gap.
- Energy deposition on the SS coils can be kept below quench limits and the component distance can be kept over 10 times.
- Heat can be economically removed at a higher temperature with a warm structure within cost constraints.
- A good starting design has been developed and many iterations have been carried out to optimize the overall parameter space.
- The design takes a significant new addition to magnet technology.