Preliminary 2-d and 3-d Designs of 90 mm Dipole

Ramesh Gupta
Comparison of 35 mm and 90 mm Aperture Dipoles

- Same conductor is chosen as in 35 mm dipole. The number of turns are adjusted.
- No. of turns: 16 (4 X 4) in 35 mm aperture and 40 (4 X 10) in 90 mm aperture.
- Make transfer function of this dipole of two dipoles similar (???) with a maximum ~1% deviation (???).

Note: 90 mm is a nominal aperture if the two magnet runs on same power supply. Adjust aperture to match transfer function better in the same power supply case.
Preliminary 2-d Design of ~90 mm Dipole

Both designs meet the following stated requirements:

- Nominal Field – Bo = 0.40T to 0.50T
- Field Homogeneity BX,BY=1x10^-4
- Good field region BX +/- 20mm, BY +/- 10mm
- Nominal Current density in the coil cross section 2 Amps/mm^2

- Yoke size increased due to mechanical concern.
- More increase (cost) should wait for mechanical analysis.
The maximum field in the yoke is 0.8 T for 0.4 T central field. Therefore, the need for an increase in yoke size must be justified on mechanical ground.
Iron Saturation in 90 mm Aperture Dipole

Iron Saturation Graph
- X-axis: Current (Amps)
- Y-axis: Field (T)

Transfer Function Graph
- X-axis: Field (T)
- Y-axis: Transfer Function (T/kA)

Design field
- 20% over the design field
- 60% over the design field

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April 27, 2007
Preliminary 3-d Analysis of ~90 mm Aperture Dipole

Circular Ends

Racetrack Ends

UNITS
Length mm
Magnet Flux Density T
Magnet Field A/m
Magnet Scalar Pot A
Magnet Vector Pot Wb/m
Electric Field Density C/m²
Electric Field V/m
Conductivity S/m
Current Density A/mm²
Power W
Force N
Energy J

PROBLEM DATA
note: 90mm aperture, 4T, 6T, or 8T
TOSCA Magnetostatics
Nonlinear materials
Simulation: 1 x 1
549368 elements
31744 nodes
3 conductors
Nodal interpolated field
Activated in global coordinates
Reflection in XY plane
Reflection in ZX plane
Field Point Local Coordinate System
Local + Global

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Comparison of Axial Field Profile of 90 mm and 35 mm Aperture Dipoles

The goal is to match the integral transfer function of the 90 mm aperture dipole with that of 35 mm aperture dipole for the same current (number of turns are different in two).

Also compare the end field profile of the two magnets.

As expected, the field of 35 mm aperture dipole falls slower than the field of 90 mm aperture dipole. End harmonics in both apertures will be optimized.
Review of End Fields in Various Designs

Blue: Conventional racetrack with significant space for coil ends
Red: New efficient end design with zero space for coil ends
Black: Latest design – efficient ends + shield (fastest field fall-off).

We can make attempt to match ends profiles of 35 mm and 90 mm aperture dipoles, if required.