STUDY OF RESONANT COUPLING USING MAGNETIC AND NEGATIVE REFRACTIVE INDEX MATERIALS

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OUTLINE

- INTRODUCTION
- PROBLEM STATEMENT
- USE OF COMSOL MULTIPHYSICS
  - ENVIRONMENT
  - RESULTS
- CONCLUSION
- REFERENCES

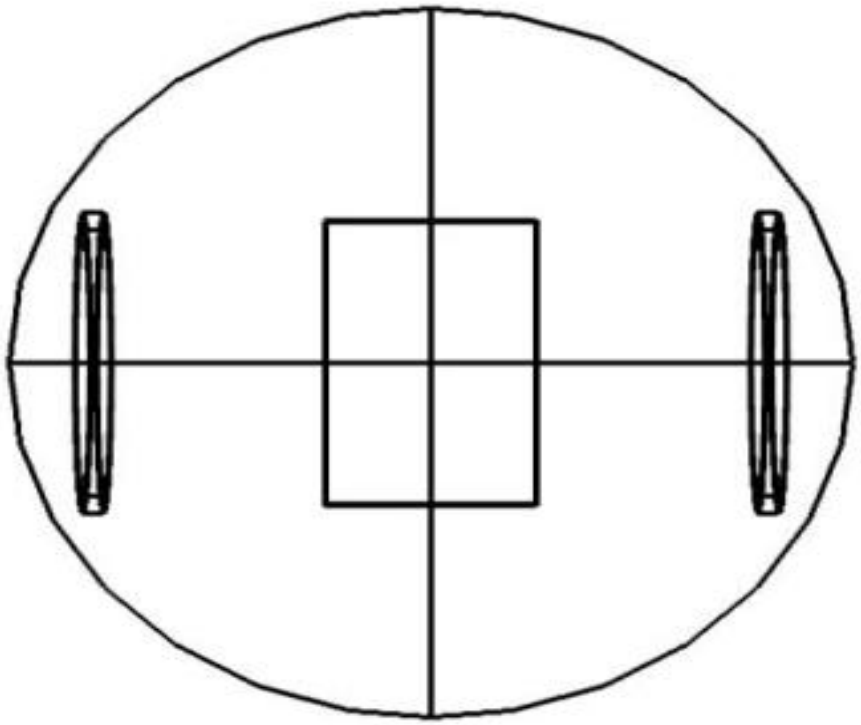
INTRODUCTION

- WIRELESS POWER TRANSFER
  - BIOMEDICAL IMPLANT (LOW POWER) TO
  - ELECTRIC VEHICLE (HIGH POWER)
- RADIATIVE
  - MICROWAVE
  - LASER
- NON RADIATIVE
  - MAGNETIC
  - RESONANT COUPLING

Energy transfer distance

- Energy transfer distance L_{TRANS}
- Characteristics size of the device L_{DEV}
- RADIATIVE
  - $L_{TRANS} >> L_{DEV}$
- RESONANT COUPLING
  - $L_{TRANS} \approx$ few * L_{DEV}
- MAGNETIC
  - $L_{TRANS} << L_{DEV}$

Schematic of Wireless Energy transfer system



Objective

- Transfer of magnetic flux density to a specific distance
- Conductor
  - Size: 1mm diameter
  - Current: 1A
- Negative refractive index material
  - Permeability: -1
  - Permittivity: -1
  - Size: 70 x 70 mm

Theory

- Biot-Savart Law

$$d\vec{H} = \frac{Id\vec{l} \times \hat{R}}{4\pi R^2} A/m$$

$$\vec{B} = \mu \vec{H}$$

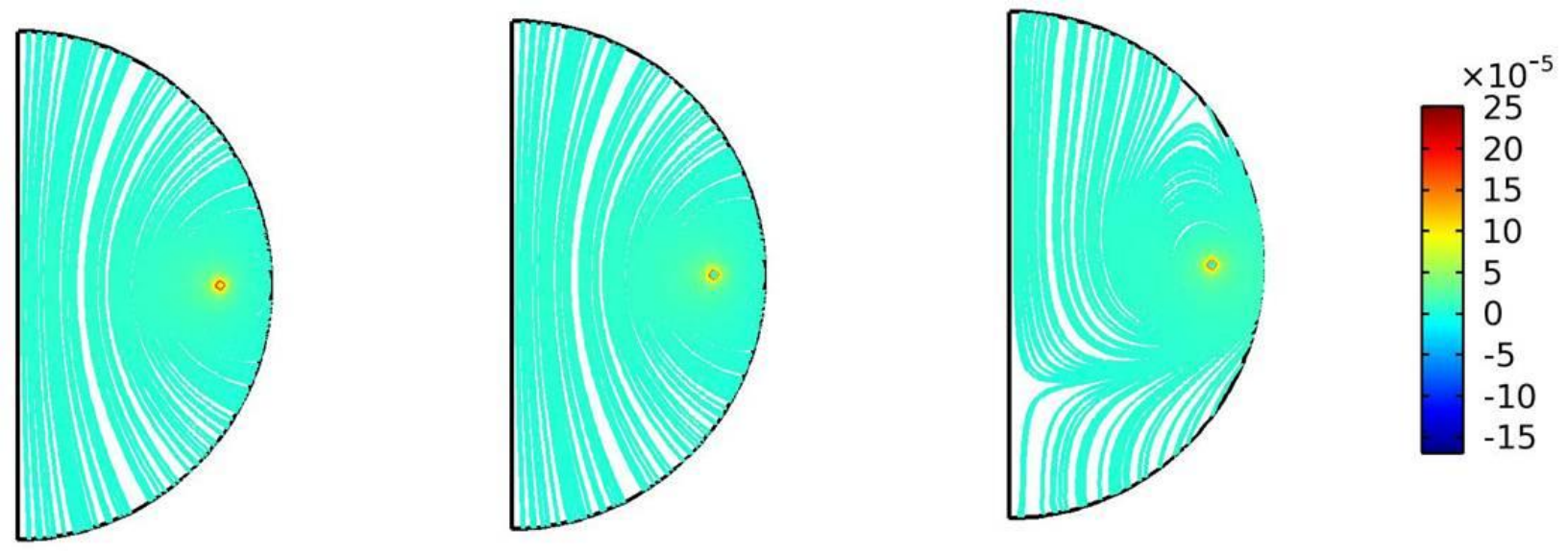
USE OF COMSOL MULTIPHYSICS

Environment

- SPACE DIMENSION
  - 2D
- PHYSICS
  - MAGNETIC FIELD
- STUDY
  - STATIONARY

RESULTS

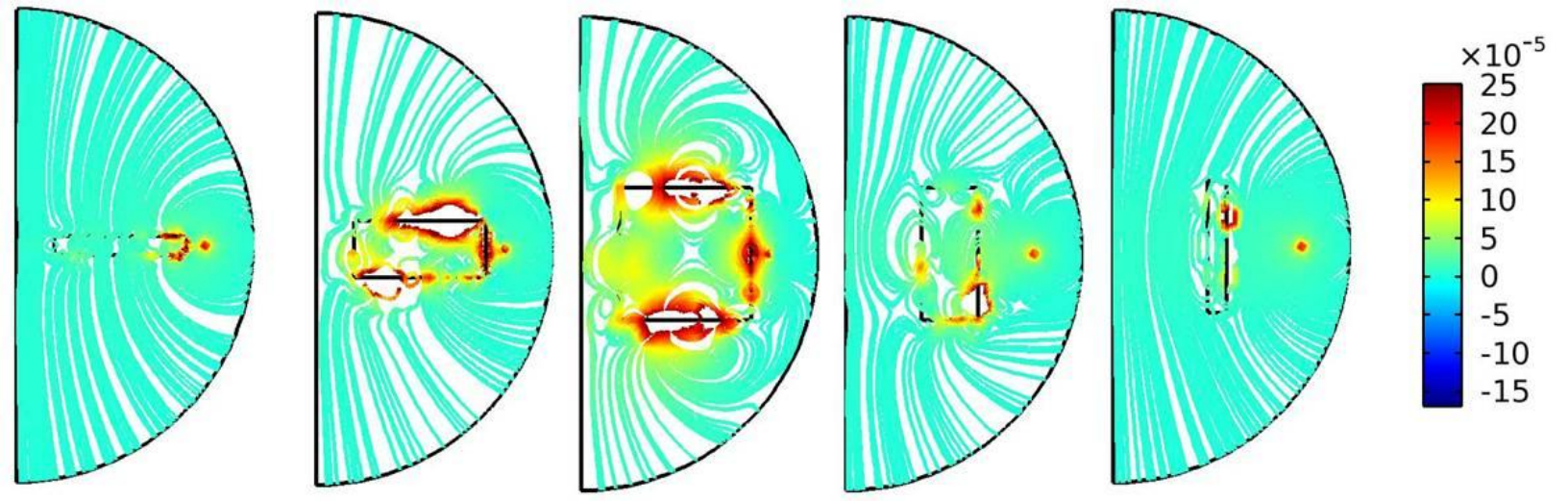
MAGNETIC FLUX DENSITY



DC 1 MHz 1 GHz units: Tesla

WITH METAMATERIAL

EFFECTS OF INTRODUCING METAMATERIAL

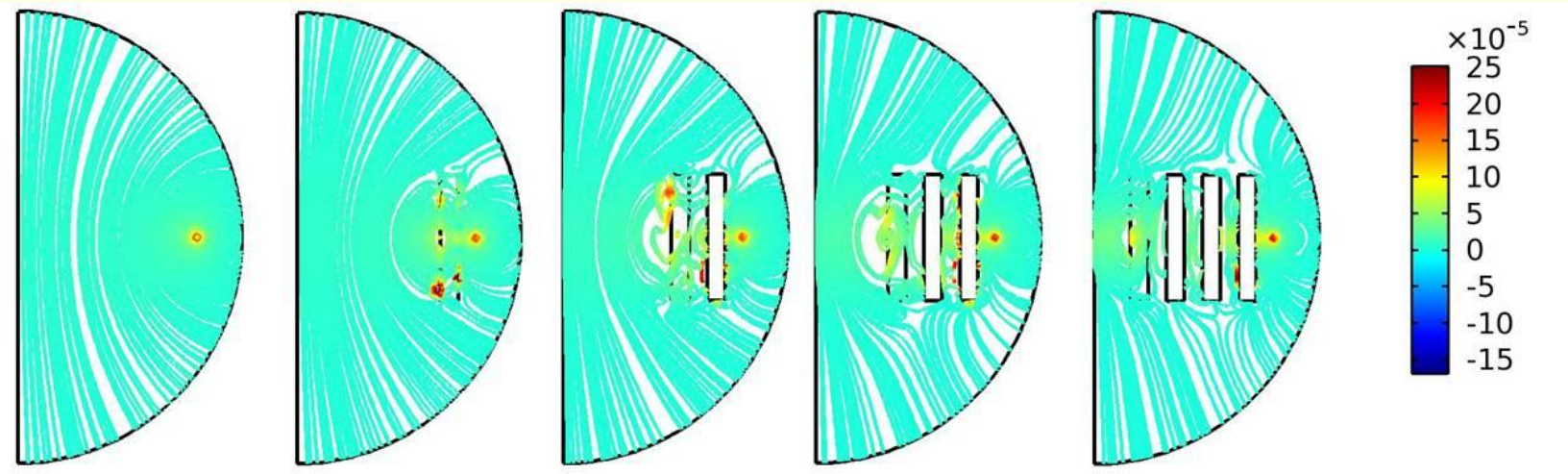


10 x 70 mm 30 x 70 70 x 70 70 x 30 70 x 10 units: Tesla

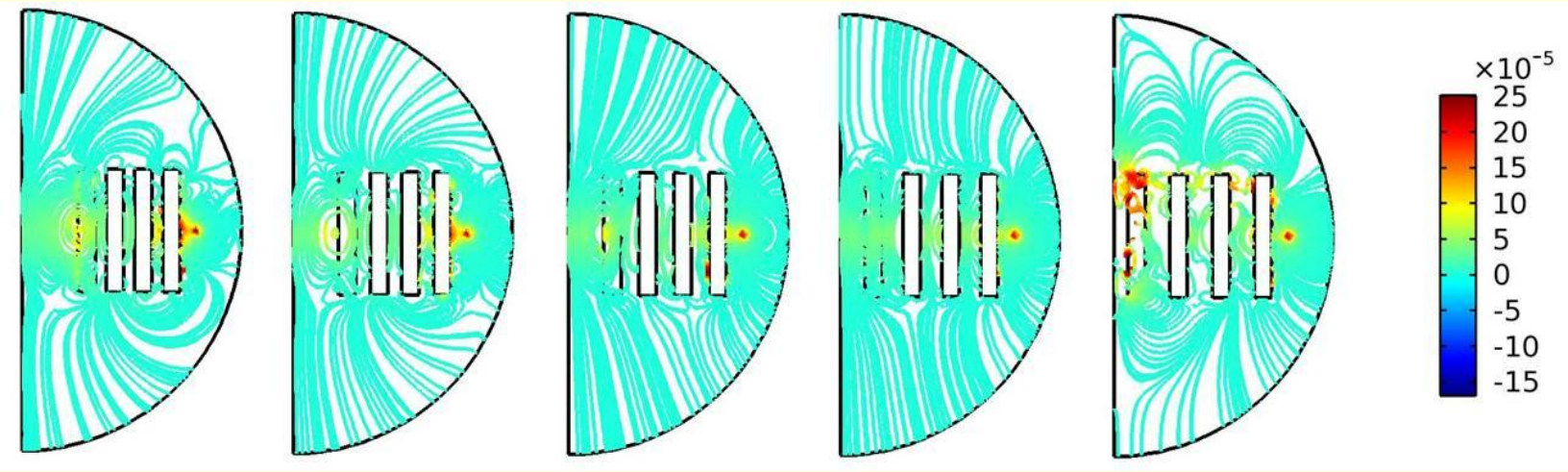
BULK TO ARRAY

6 mm 8mm 10mm 12mm 14mm units: Tesla

VARYING THE ARRAY SIZE



VARYING INTERMEDIATE SPACING



6 mm 8mm 10mm 12mm 14mm units: Tesla

CONCLUSION

- Magnetic field can be focused on a particular region
  - Varying the size of the NIM
  - Spacing between the NIM and
  - Distance between the NIM and excited coil
- Increase in the field gives rise to increase in induced voltage if the coil is excited with an AC voltage
- Distance enhancement can be done by inserting more number of elements which acts as a relay

References

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THANK YOU