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Analysis and Design of Electromagnetic Pump

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Introduction

- MHD and Corrosion studies related to flow of liquid metals in presence of high magnetic field are required in development of Test blanket modules for ITER(International Thermo-nuclear Experimental Reactor) coming up in France of which India is a collaborative partner.
- These fluids operate at high temperature, needs high purity level and are invariably toxic in nature.
- Moving parts makes the system unsafe, increases chances of leakage and adds impurity to the liquid.
- These requirements need non-intrusive pumping methods.

Theory Involved

Lorentz Force per unit volume

$$J \times B$$

Physical requirements(in liquid metal)

1. *Current*
2. *Magnetic field*
3. *Current and magnetic field shall be perpendicular to each other*

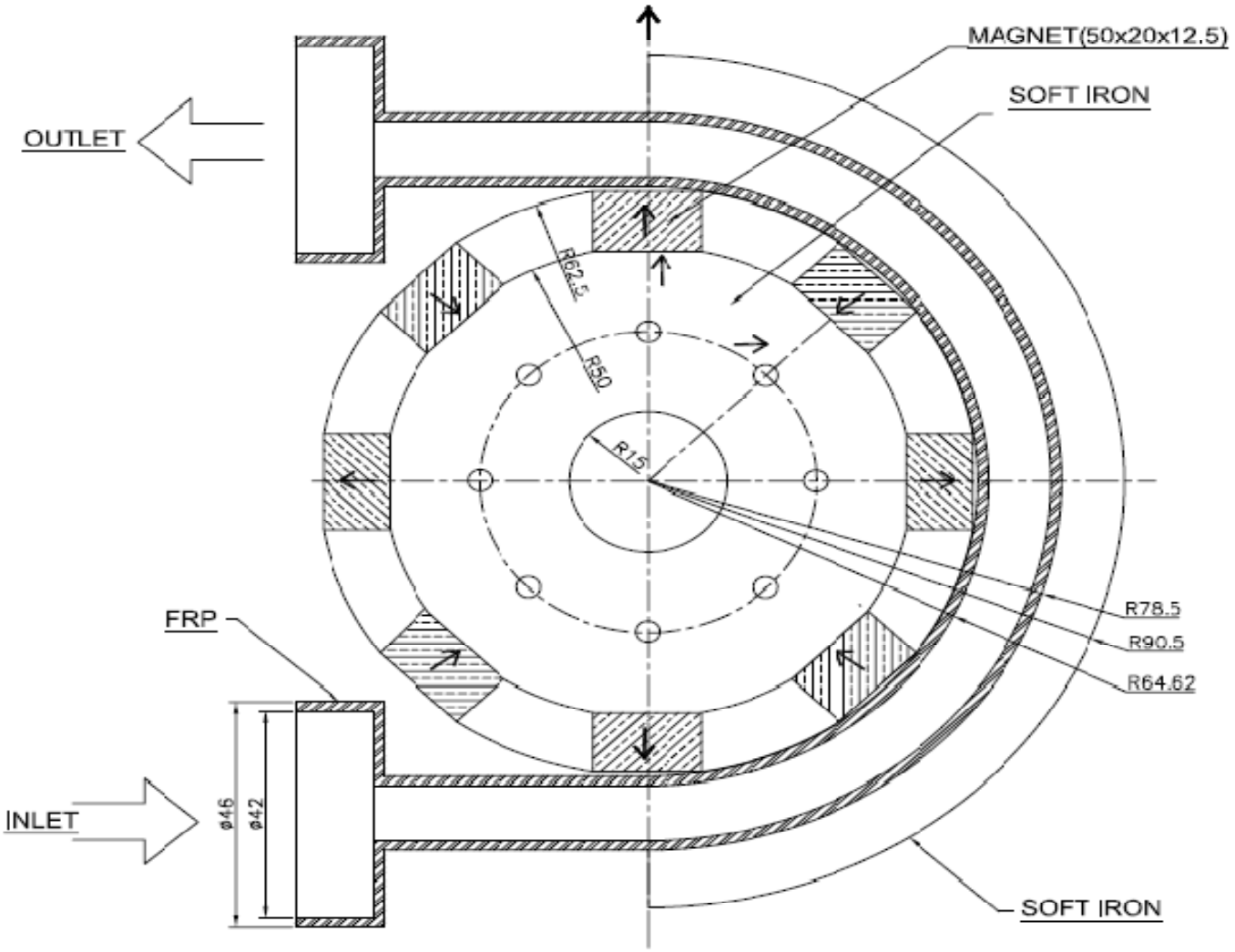
Fulfillment of requirements

A time varying magnetic field is all that is required (B)

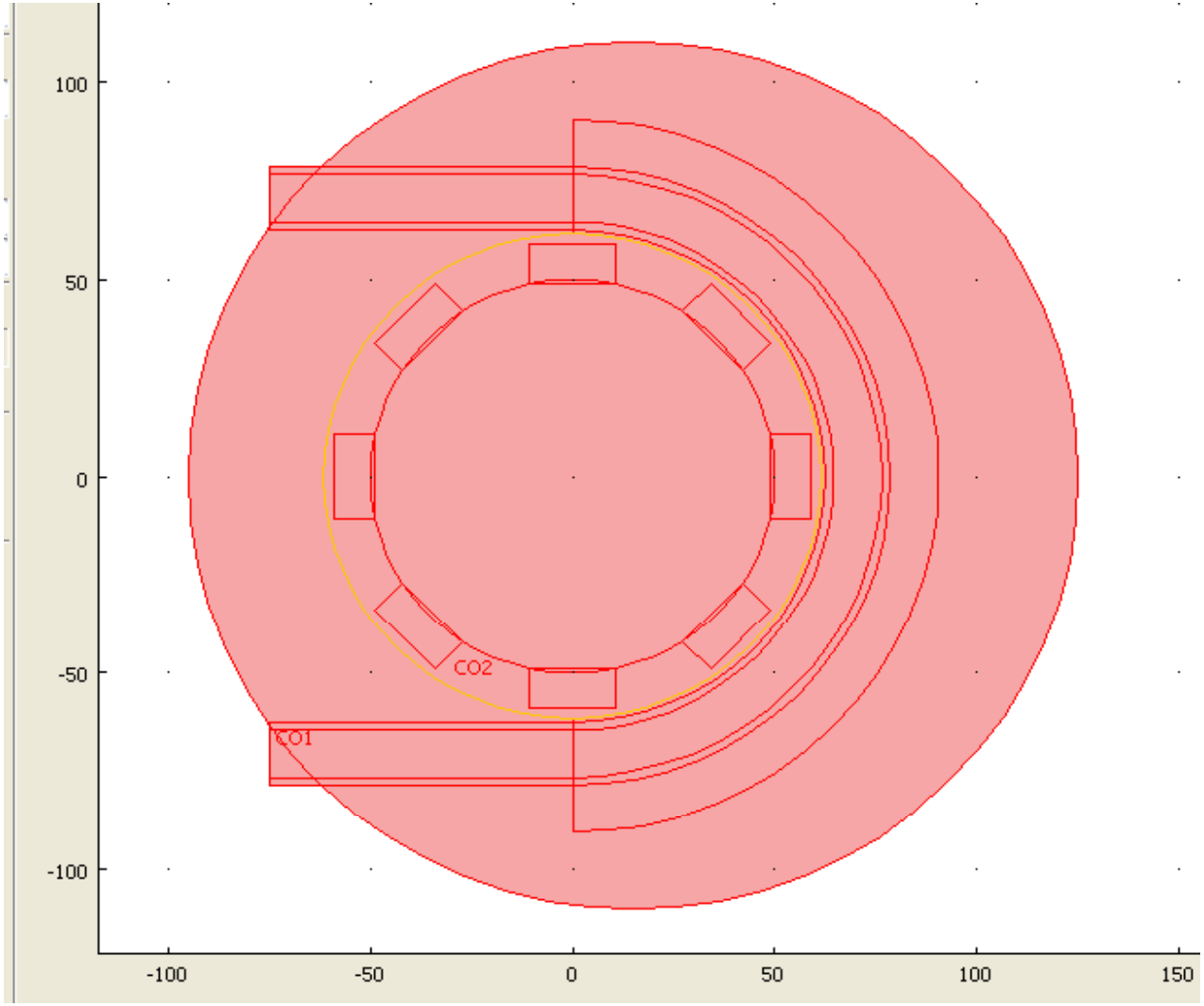
A time varying magnetic field produces induction current in the liquid metal (J)

Interaction of B and J gives required Lorentz force

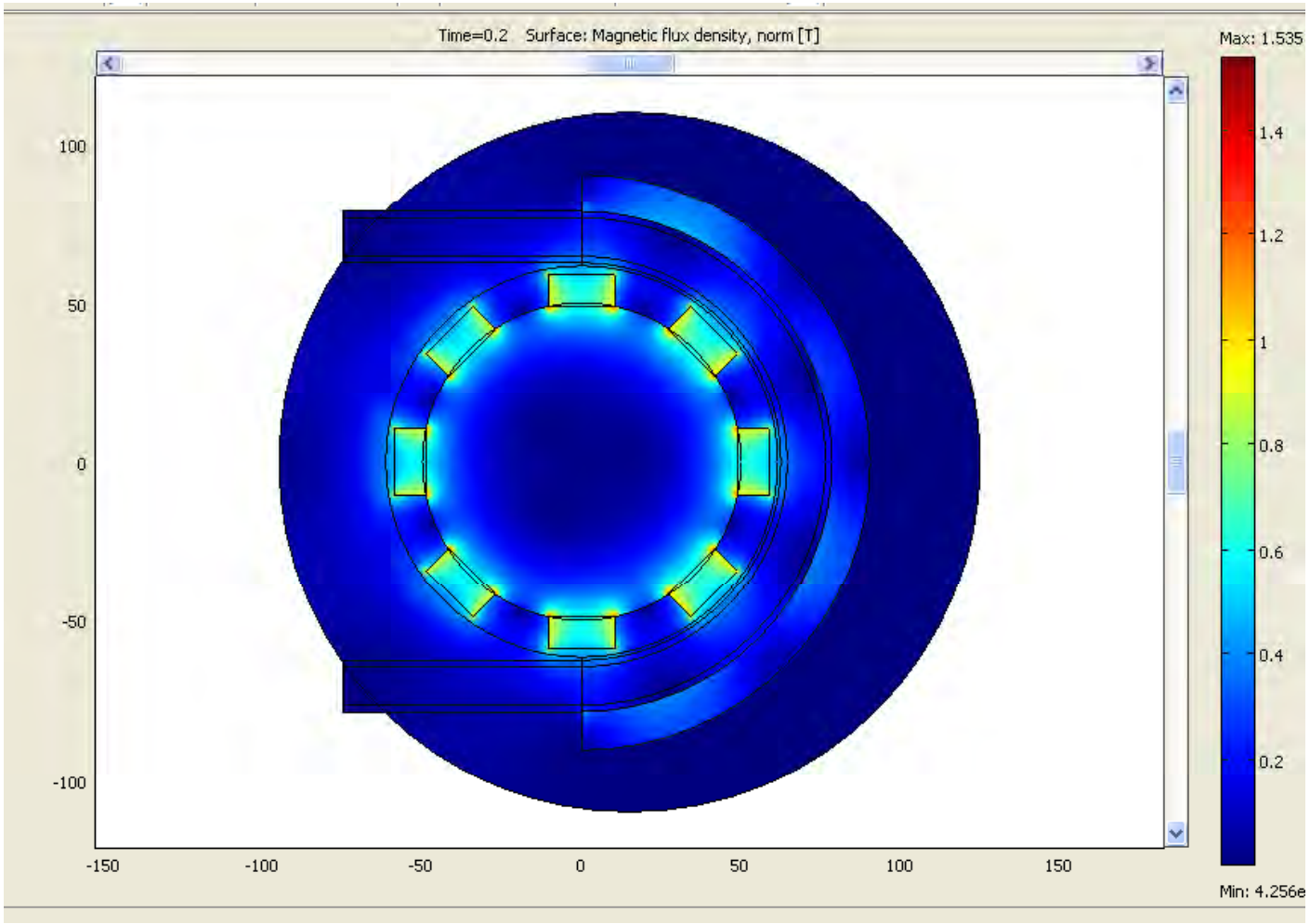
Attaining a time varying magnetic field



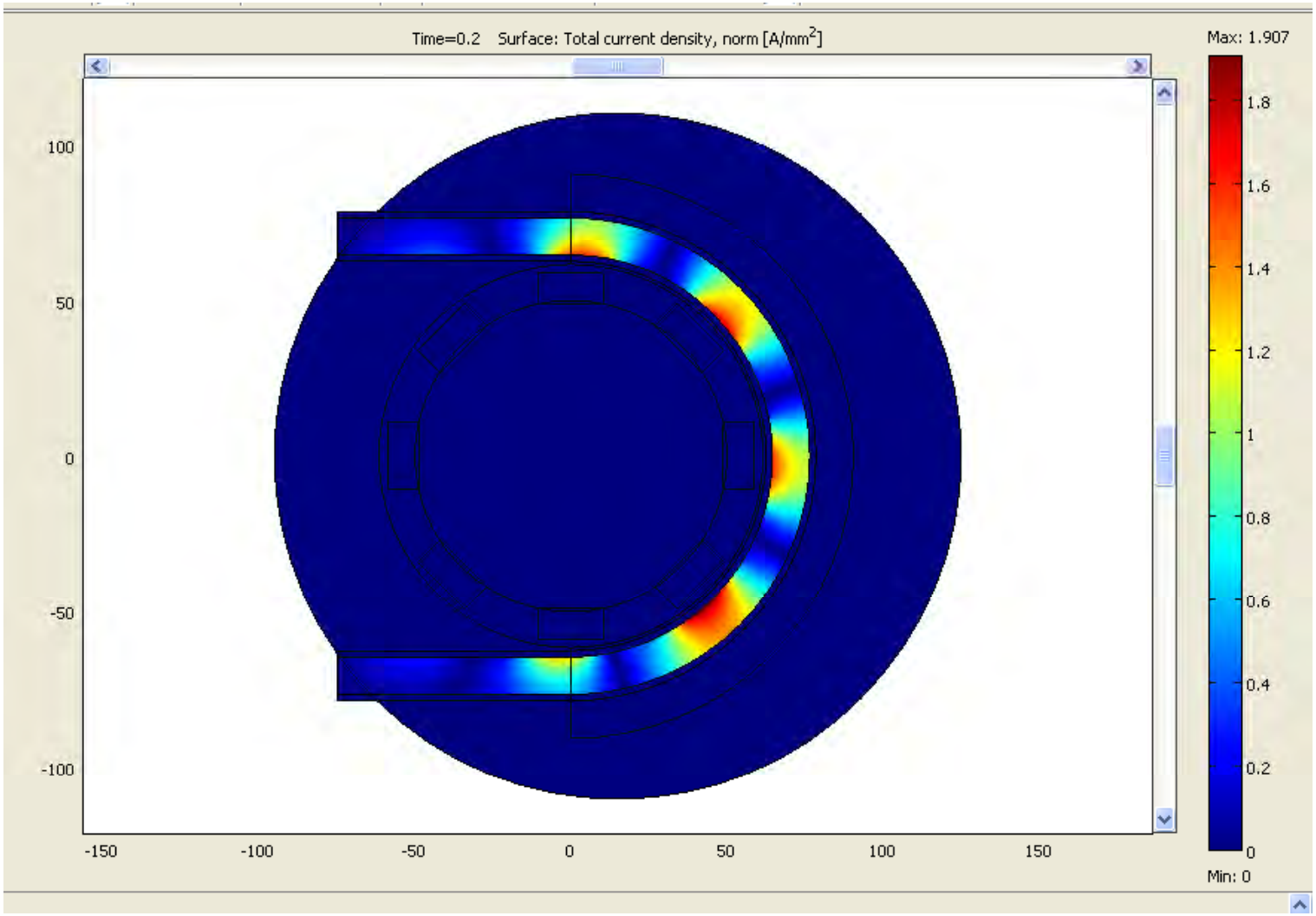
Modeling in COMSOL



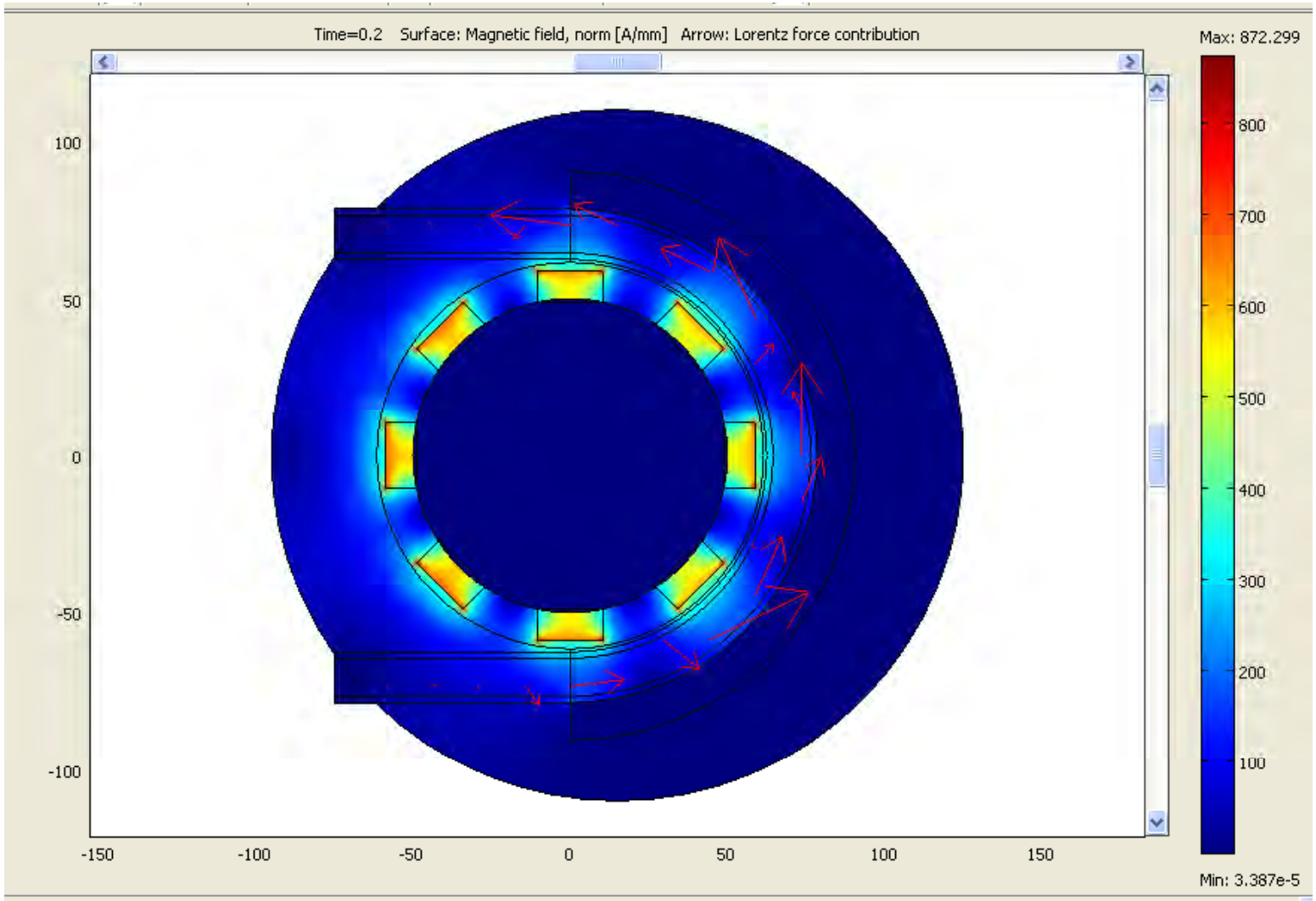
Distribution of magnetic flux density



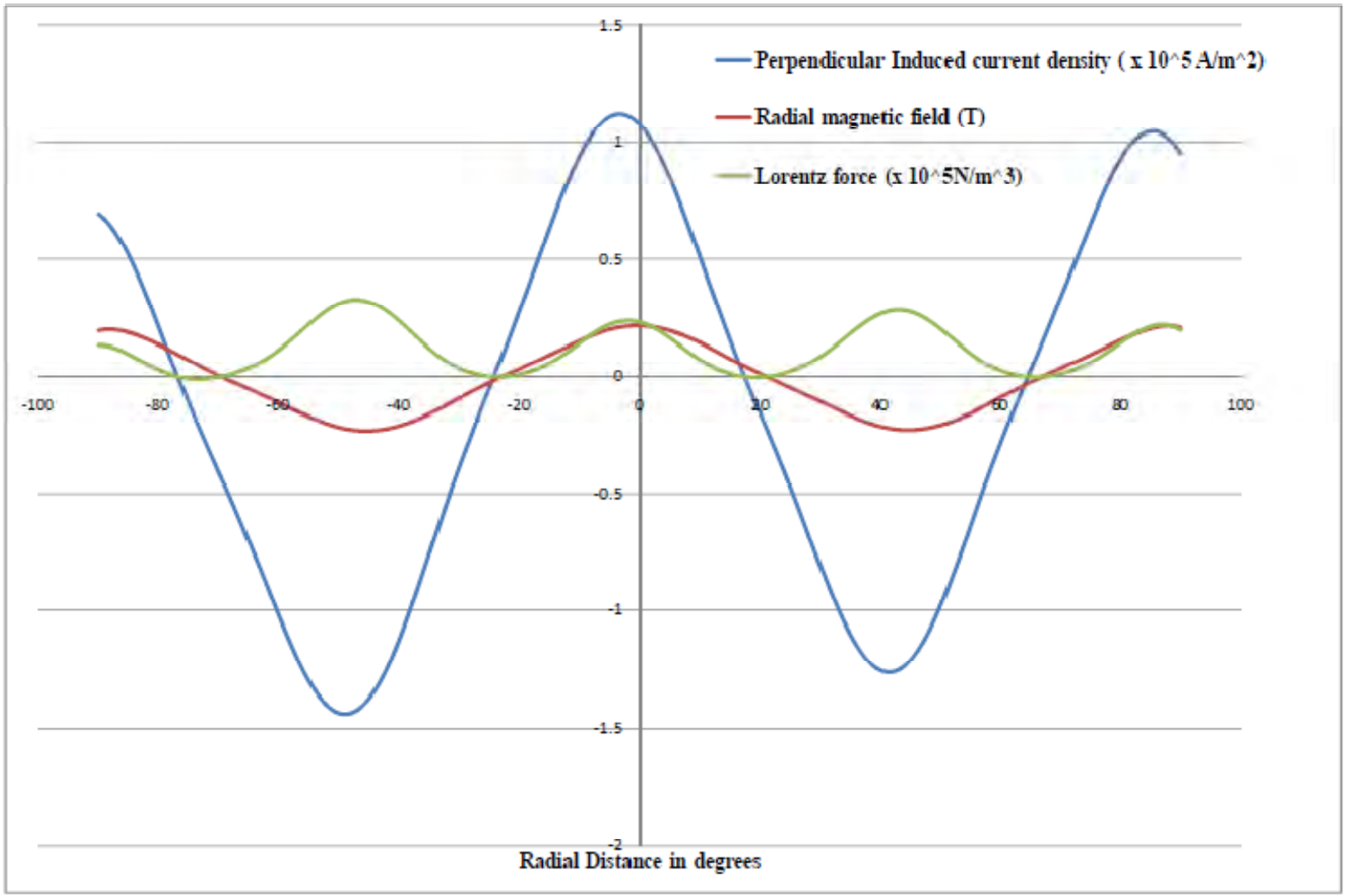
Induction current density distribution



Lorentz force distribution and direction



Magnetic flux density, induction current density and Lorentz force developed along circumference of duct

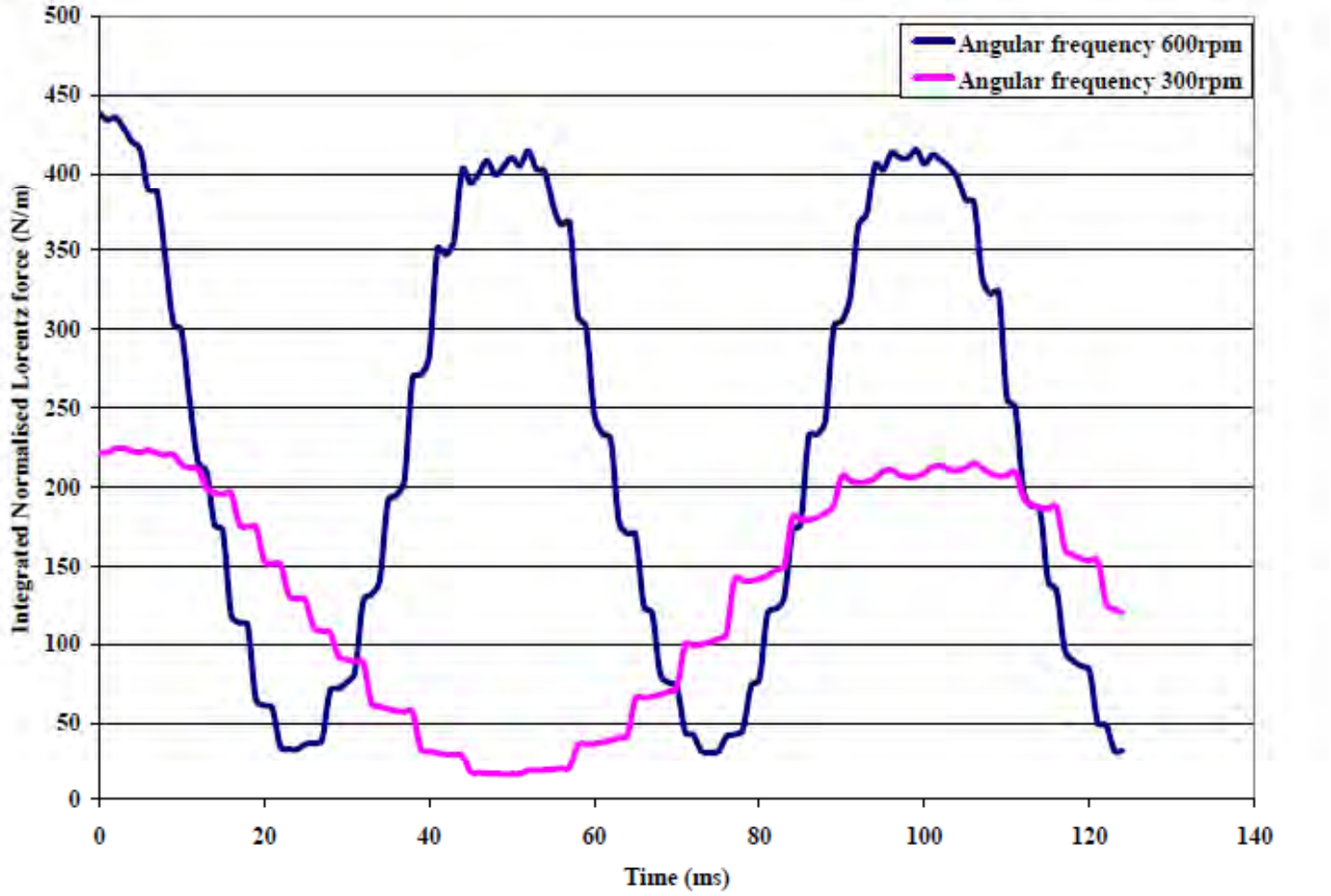


Factors affecting EM pump's performance

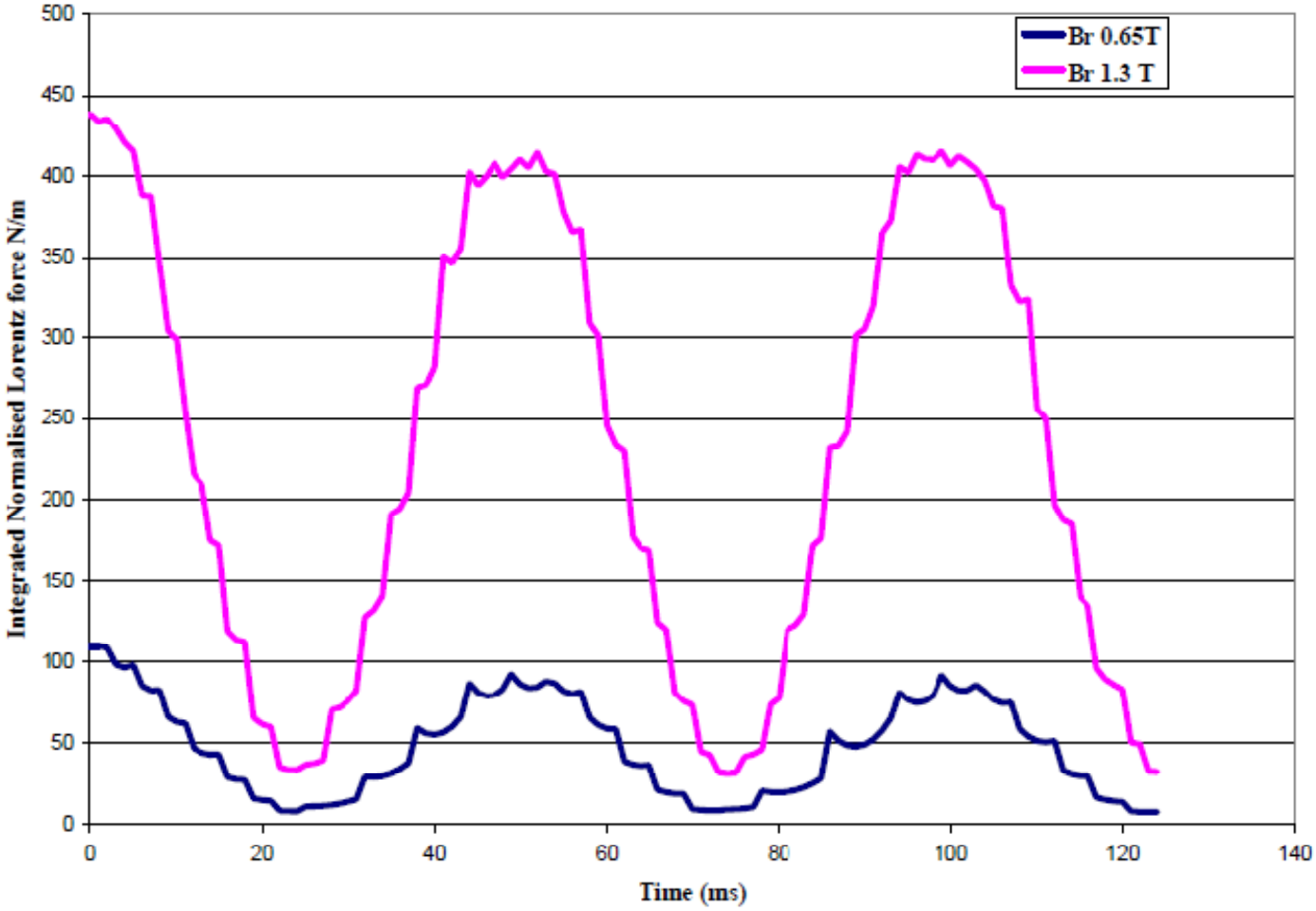
Maximum pressure developed by the pump depends on

- Directly proportional to angular velocity of rotor
- Proportional to square of strength of permanent magnets
- Depends on magnetic pitch. Magnetic pitch is angular distance between two permanent magnets

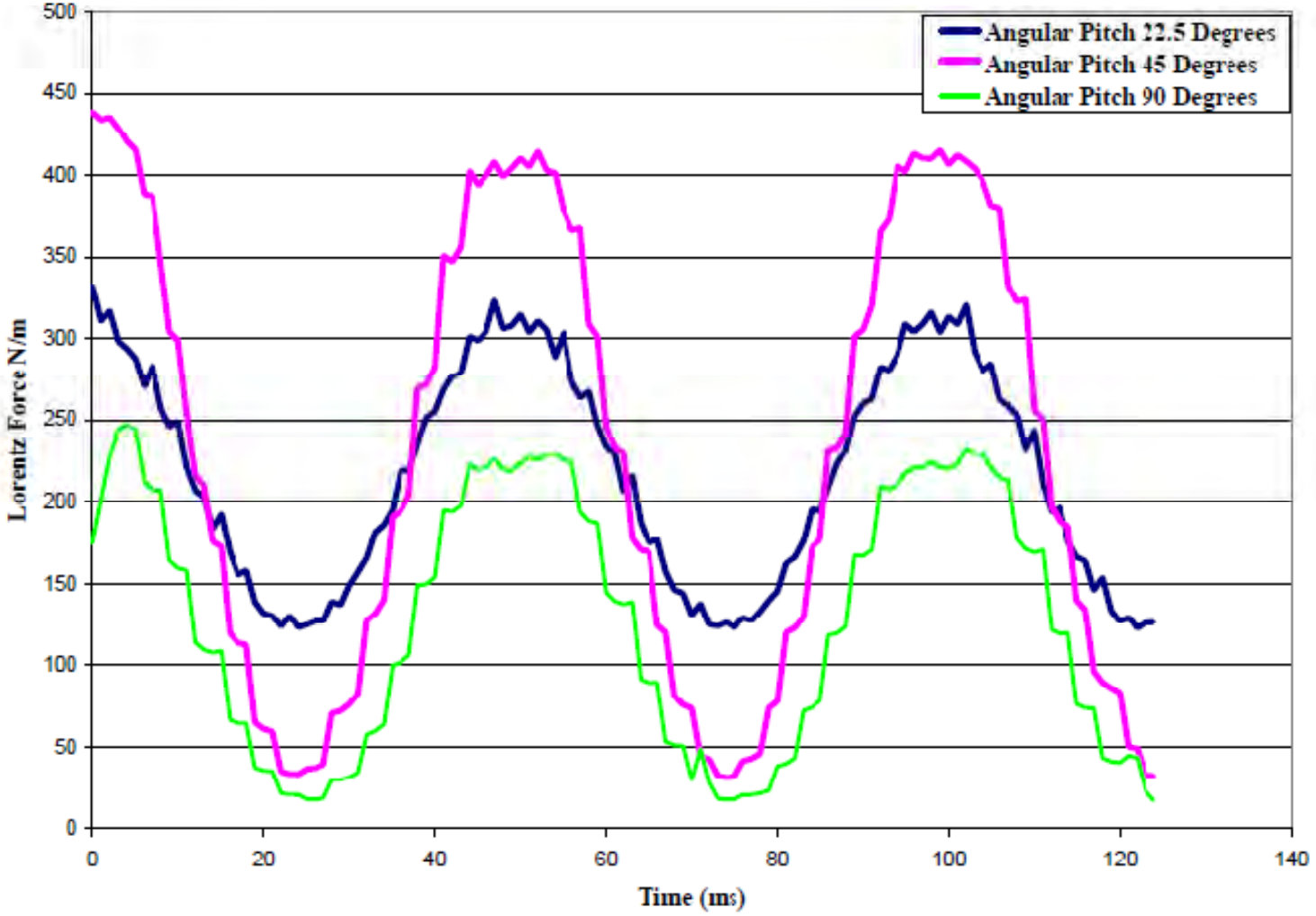
EM Pump performance due to rotor angular speed



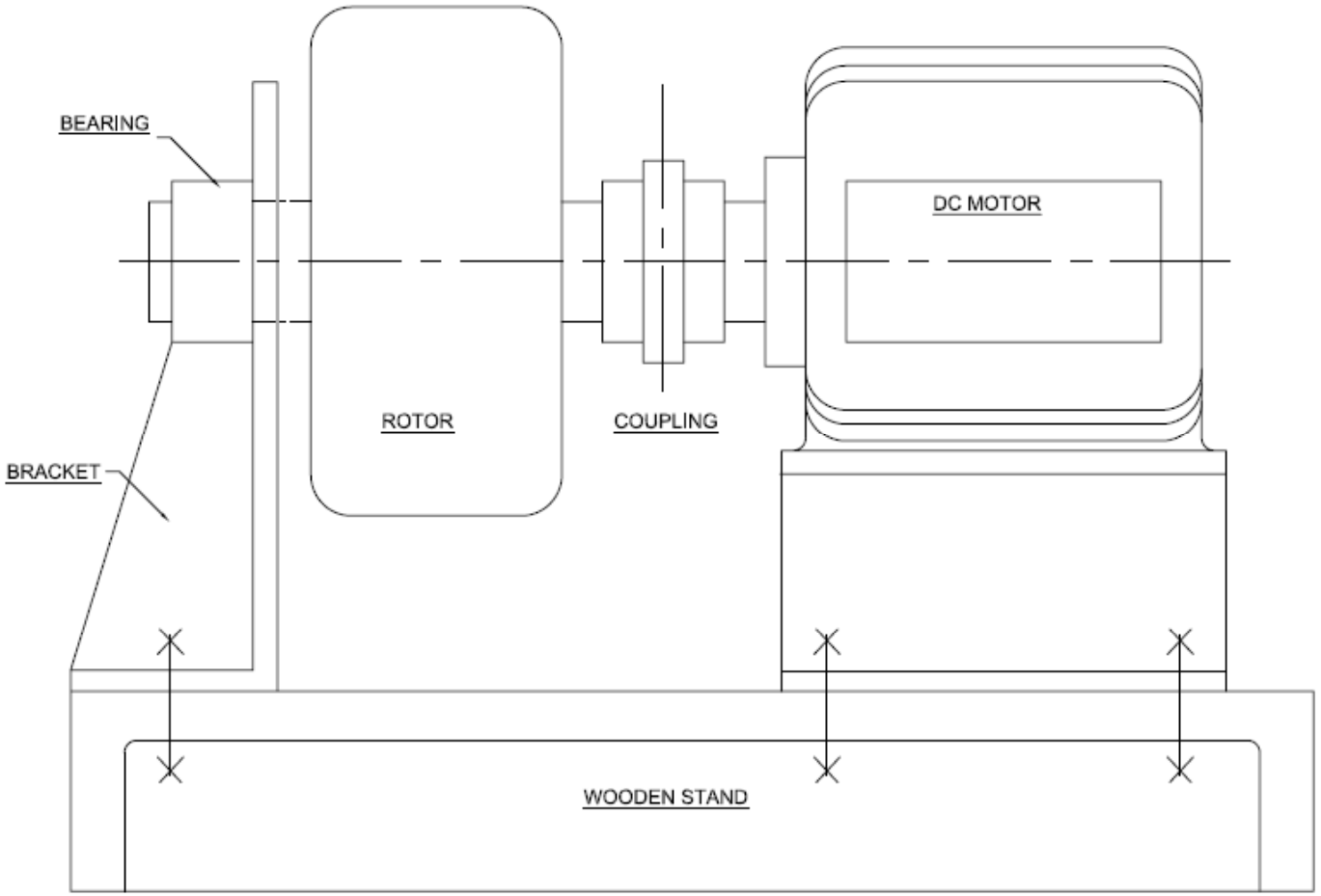
EM Pump performance due to strength of permanent magnet



EM Pump performance due to magnetic angular pitch



Drawing of EM pump

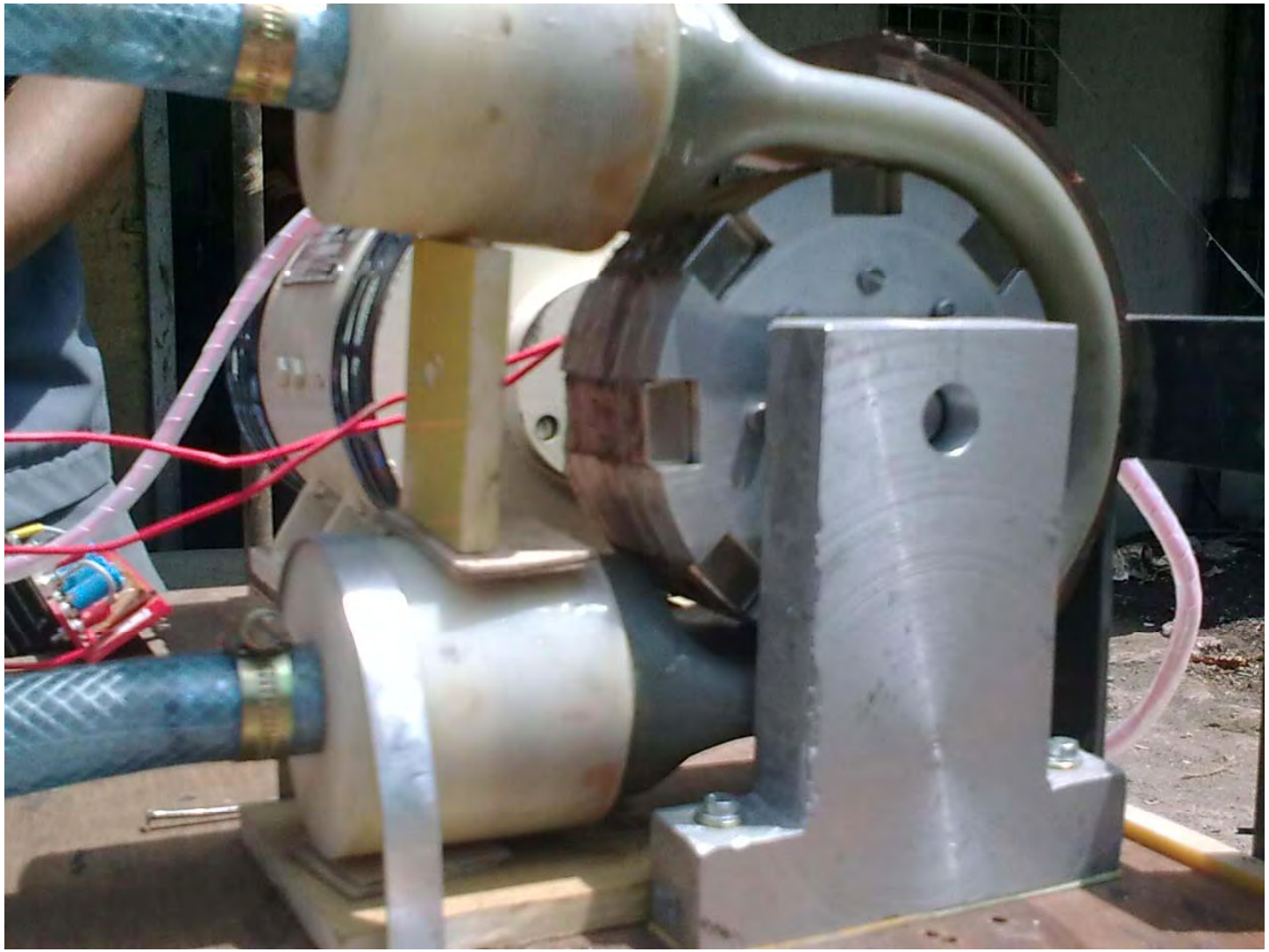


Summary

Prototype pump establishing the proof of concept is running successfully in BARC.

EM pump needs optimization in terms of magnets and magnetic pitch.

Prototype EM pump developed in BARC



Thank You for your attention

Forum is open for discussions !