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Numerical modelling of HTS tapes operating in PM linear motor

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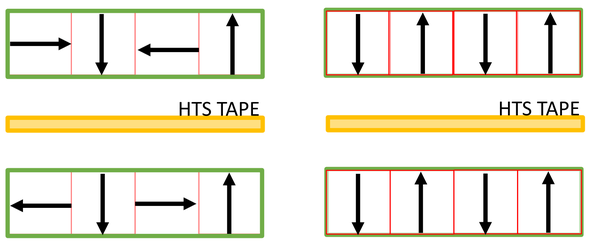
INTRODUCTION

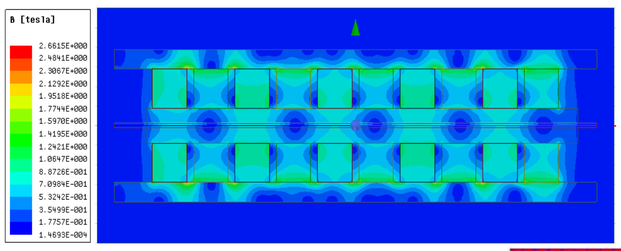
Recent development of transportation systems, particularly in highly urbanized areas, is focused on personal rapid transportation systems. Superconducting tapes are good candidates for coils in electrical motor used in such solution. The proposed solution is focused on analysis of properties of HTS tapes and driving systems based on linear DC motor with permanent magnets.



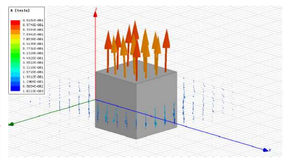
Example of two different arrangement of PM magnets in linear motor.

NUMERICAL MODEL

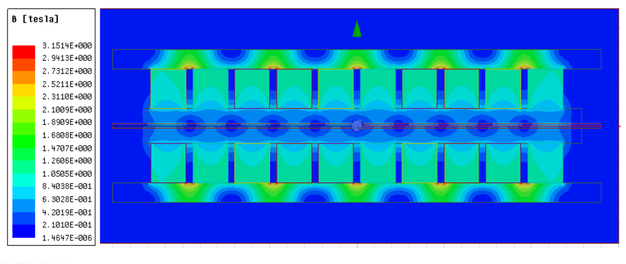
A FEM analysis has been carried out using ANSYS Maxwell software. Results are obtained by magneto-static calculations assuming the remanent magnetic flux density of 1.35 T and relative magnetic permeability of magnets equal to 1. The value of the magnetic field on the surface of the HTS tape is extremely important from the point of view of determination of critical current or critical current density.



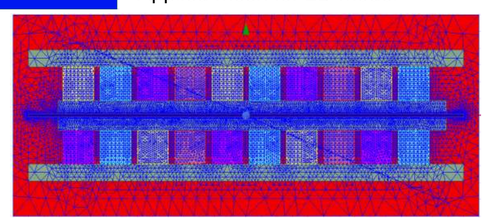
HTS tape placed between double Halbach arrays



Applied mesh for 2D model



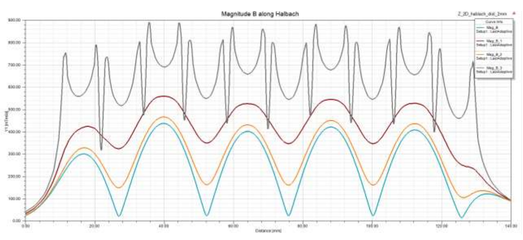
HTS tape placed between normal PM magnet arrangements

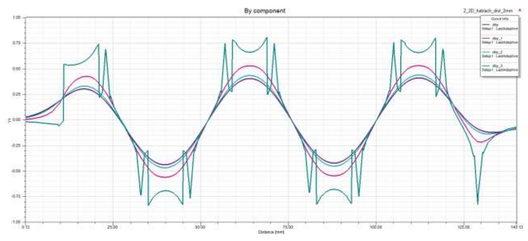


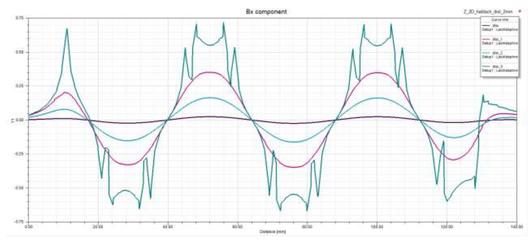
AIR GAP MAGNETIC FIELD ANALISIS

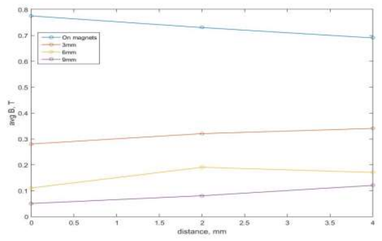
The analysis of the magnetic field in the airspace was carried out for two models (normal arrangement and Halbach's arrangement) and for the three distance between the individual magnets: 0 mm, 2 mm and 4 mm to find the best solution. The magnetic field was calculated on magnets surface and 3 mm, 6 mm and 9mm above the magnets, from the strongest side of the magnet.

Halbach arrangements

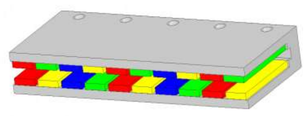




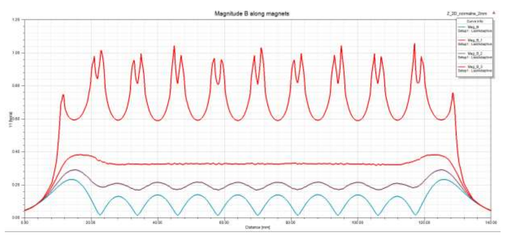


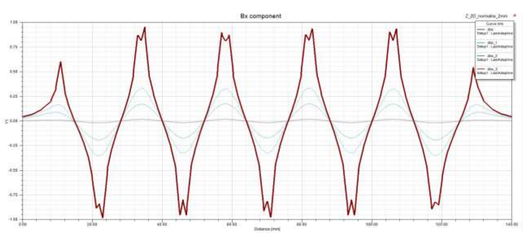


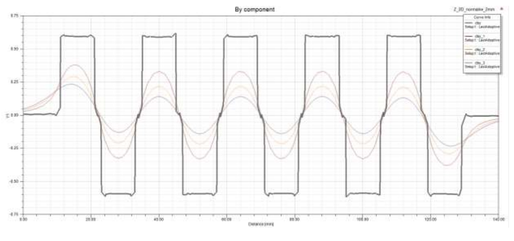
Halbach arrangements

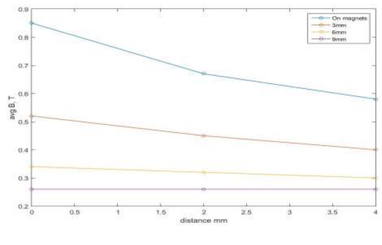


Normal arrangements

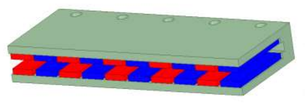






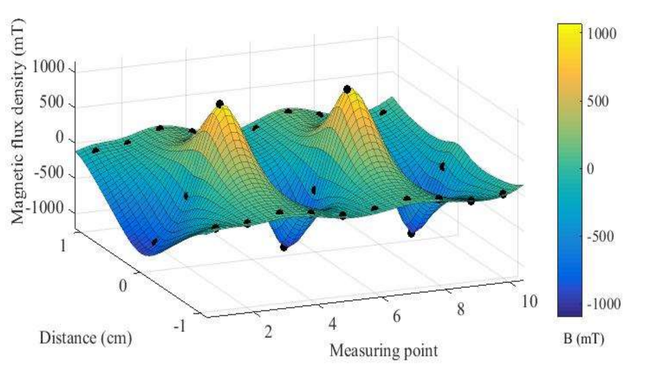


Normal arrangements



MAPPING THE MAGNETIC FIELD

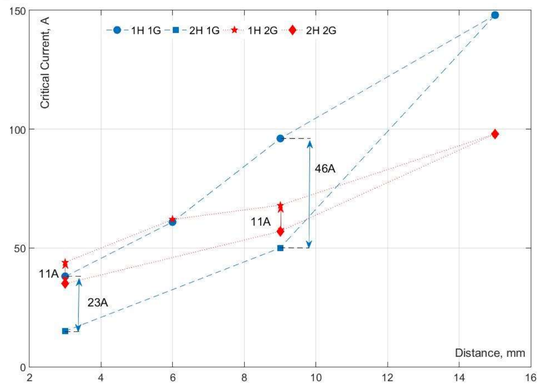
Measurements are carried out for single array of magnets using Magnet-Physic teslameter FH-54. The baseline for mapping with 10 measurement points was located in the mid on the top surface of magnets.



3D graph of the magnetic flux density on the horizontal plane over the Halbach array (the plane common with the upper surface of magnets).

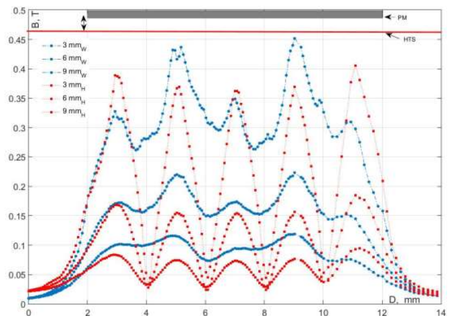
MEASUREMEMNTS OF CRITICAL CURRENT

The measurements were carried 14 mm long probe Measurements were carried out on a 4 mm long section of tape located in middle part between two Halbach arrays.



Results for critical current in HTS tape located betwen Halbach arrays

THE INFLUENCE OF TEMPERATURE



The PM materials have a temperature dependent properties. There is a shift about 30 deg in magnetization vector

CONCLUSION

- **HTS material are good candidates to operate in PM linear motor**
- **The external magnetic field inside a PM array are not constant dependence**
- **It is important to know how a properties of PM in LN**

KEYWORDS: HTS tape characterization; critical current; Halbach arrays

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