Design Optimization and Experimental Verification of an Electromagnetic Turnout for HTS Maglev Systems

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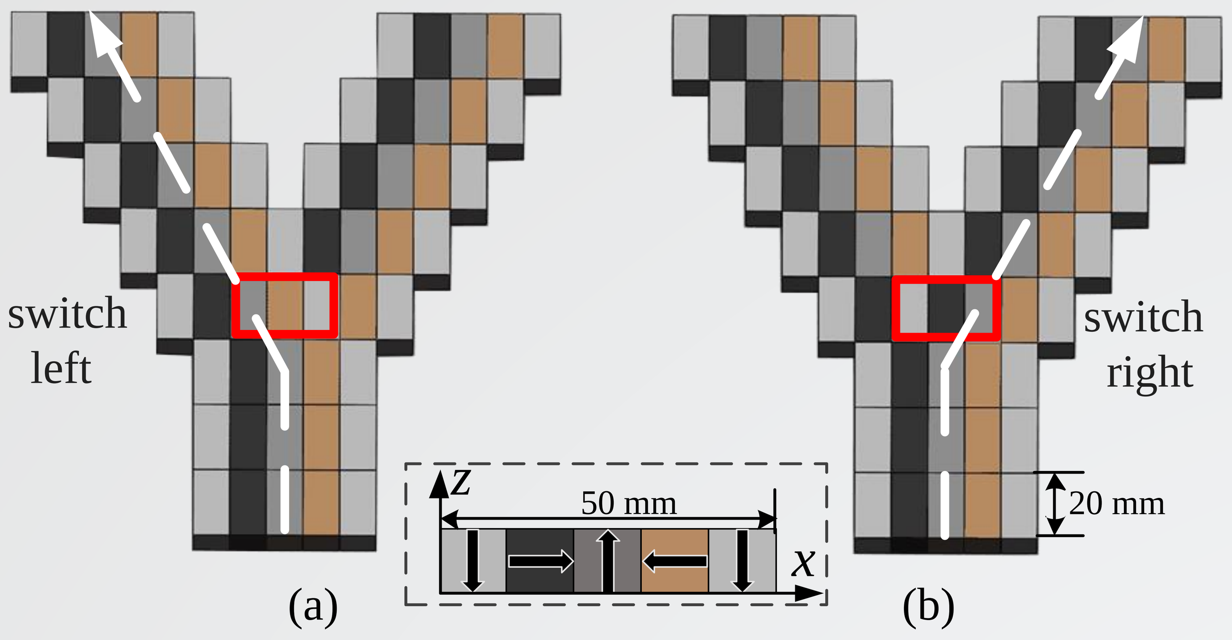
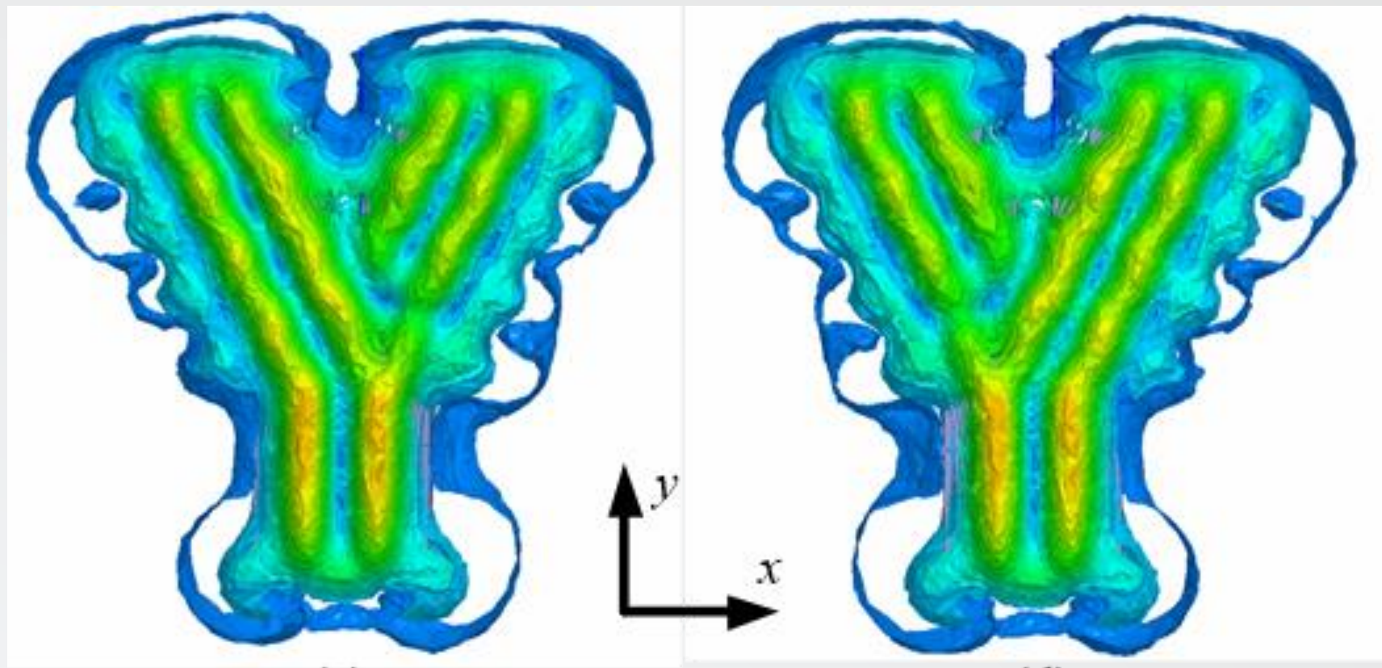
1. Introduction of the switch principle of Halbach PMG

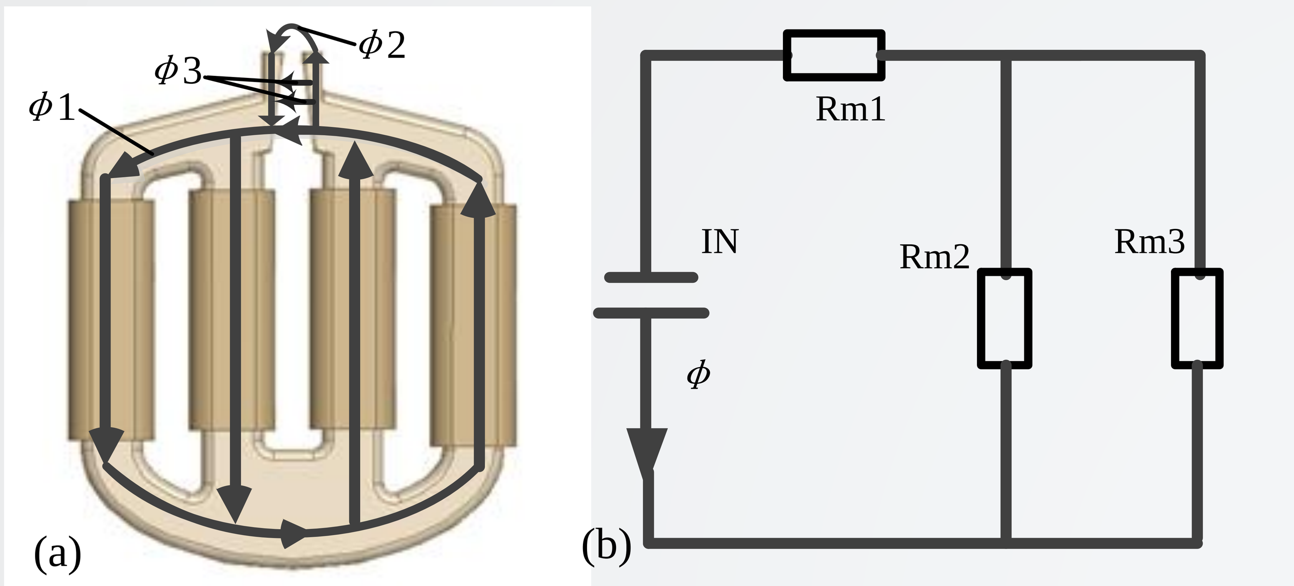


(a) and (b) show the switch principle of the turnout for Halbach-type PMGs to turn left and right. The inset in black frame indica-tes the magnetization direction of each PM, and the cross section of each PM is 10mm ×10mm.

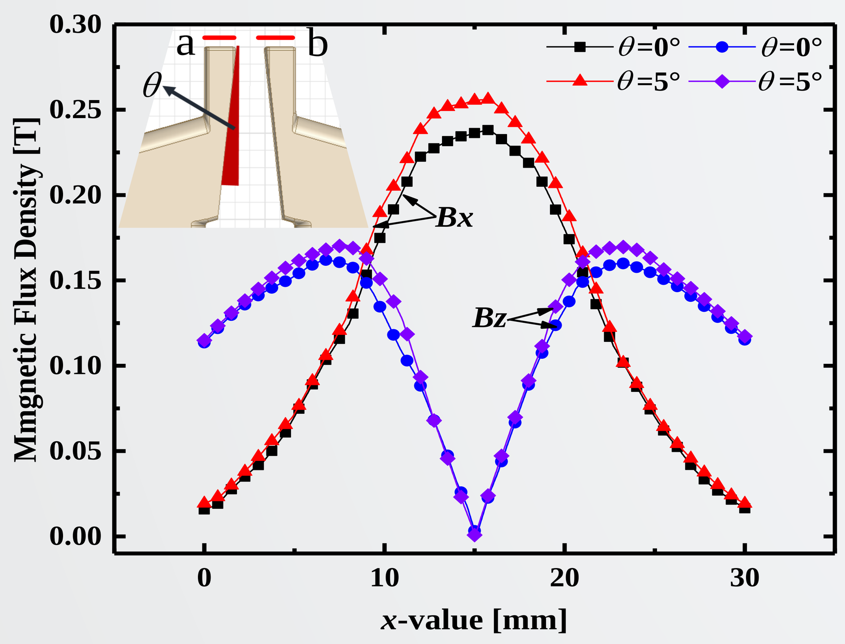
(c) and (d) present the magnetic field configuration of the permanent turnout to turn left and right. The magnetic flux density is continuous and homogeneous in general along the target tracks.



2. Design and optimization of electromagnetic turnout

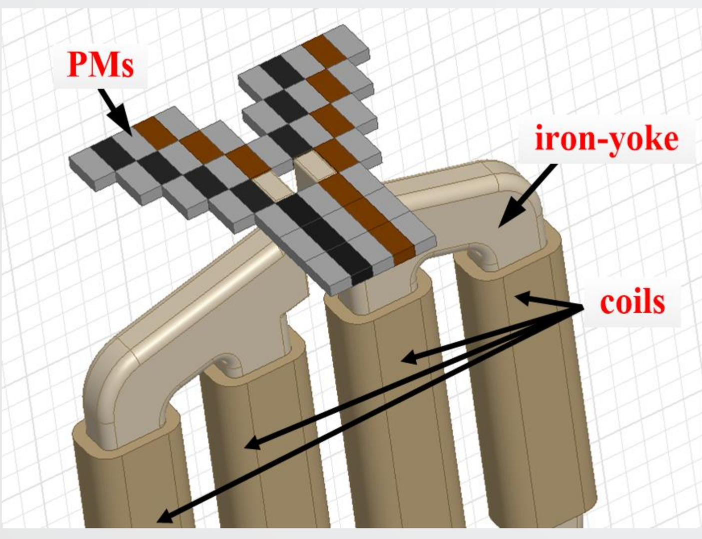


(a) Illustrative diagram of the electromagnet; (b) Equivalent circuit of the electromagnet.



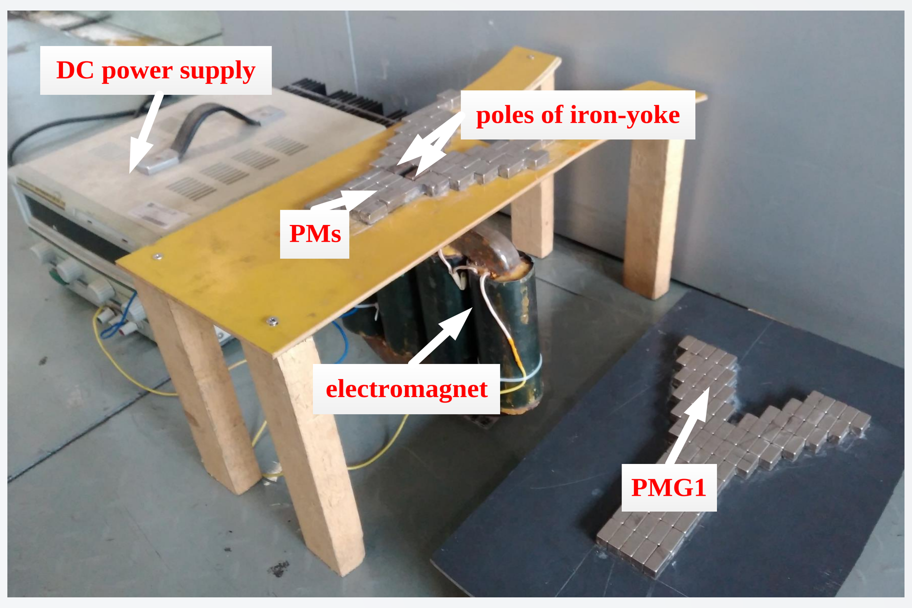
Magnetic flux density of the electromagnet with oblique angles of 0°, 5° at a levitation height of 5mm. the oblique angle is shown in the inset. x-value indicates the position from point ‘a’ to ‘b’ in the inset.

Obviously, with the oblique angle θ=5°, both the *Bx* and *Bz* have a considerable improvement.



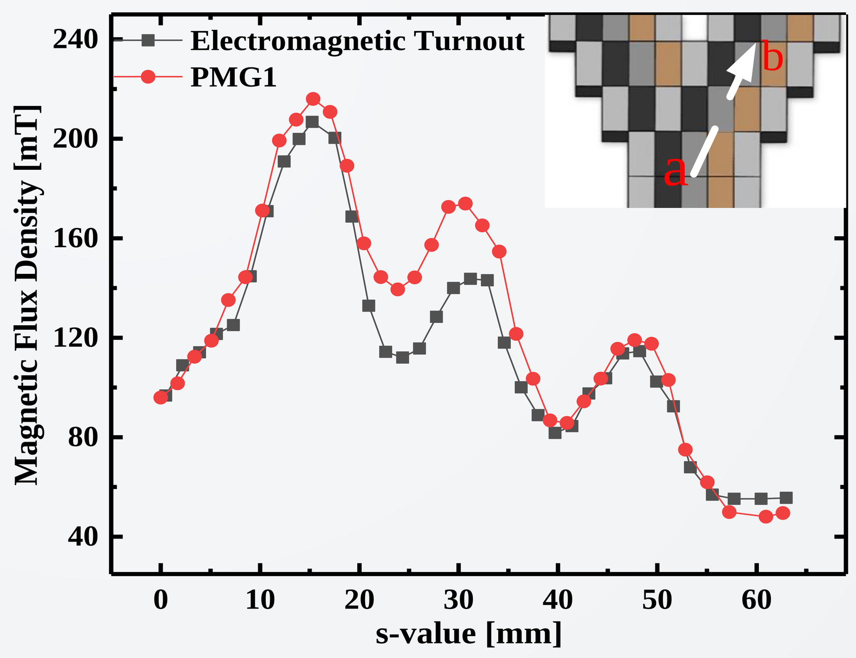
By replacing three change-able PMs of PMG turnout, the simulation model of electroma-gnetic turnout consisting of the electromagnet (iron-yoke and coils) and PMs. The turnout can switch by changing the input current direction of the electro-magnet.

3. Fabrication and measurement of electromagnetic turnout

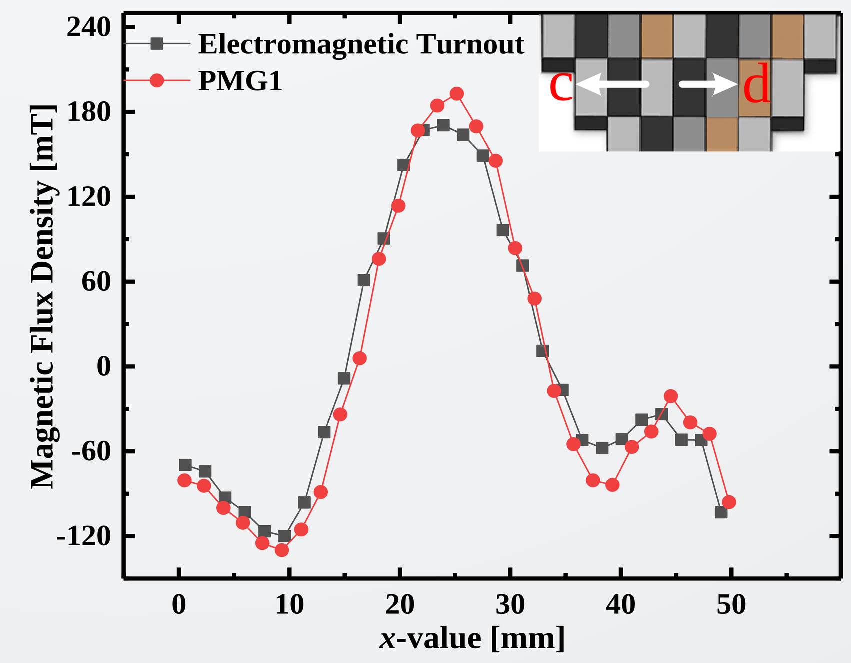


Two toy-sized models

Models of the toy-sized ‘Y’-shaped electromagnetic turnout and the PM turnout PMG1. Two poles electromagnet are set oblique angle of θ=5°, and the electromagnet is driven by DC power supply, the PM turnout can only switch to the right.

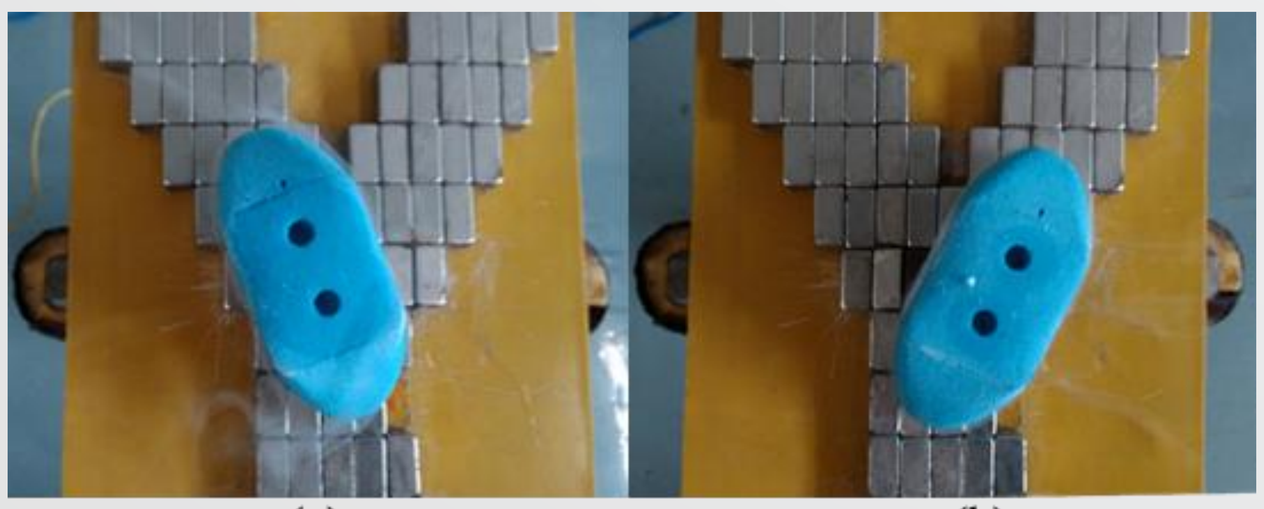


Magnetic flux density of the turnouts along the idealized way at a distance of 5 mm above the model. The white arrow in the inset shows the idealized path. The s-value indicates the position from point ‘a’ to ‘b’ of the inset in the direction of motion. The curves indicate that the magnetic flux density of electromagnetic turnout agrees well with that of PMG1, except the difference at s-value from 20 mm to 40 mm, which is comprehensible because that the magnetic poles of electromagnet are simplified compared with the replaced PMs.



Magnetic flux density of the turnouts above the switch part at a distance of 5 mm. x-value indicates the position from point ‘c’ to ‘d’ of the in-set. The curve of the electromagnetic turnout agrees well with PMG1 at the segment where x-value from 0 to 50 mm. This confirmed that the magnetic flux density generated by the electromagnet could satisfy the requirement of the re-placed PMs.

4. Experimental verification



By changing the input current direction of the electromagnet, the levitated HTS maglev vehicle model runs above the electromagnetic turnout to switch left (a) and right (b.

5. Conclusions and summary

- Firstly, the structure of the electromagnet is optimized by finite element software, and simulation result indicates that an oblique angle θ=5° is able to improve the field performance of the electromagnet.
- Then a toy-sized ‘Y’-shaped electromagnetic turnout model is fabricated, and its magnetic field is measured and compared with PMG1. Experiments show that the magnetic flux above the electromagnetic turnout agrees well with that of PMG1 and indicate the feasibility of the electromagnetic turnout.
- Finally, a HTS maglev vehicle model was levitated above the electromagnetic turnout model. The turnout shows good operation performance no matter which direction to switch.

Reference

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