DEFINITION of OPTIMIZATION PROBLEM for ELECTROMAGNETIC LINEAR ACTUTOR

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Plan of the presentation

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2. Application
3. Experiment
4. Optimization criterion
5. Simulation of the model
6. Optimization process
7. Conclusion
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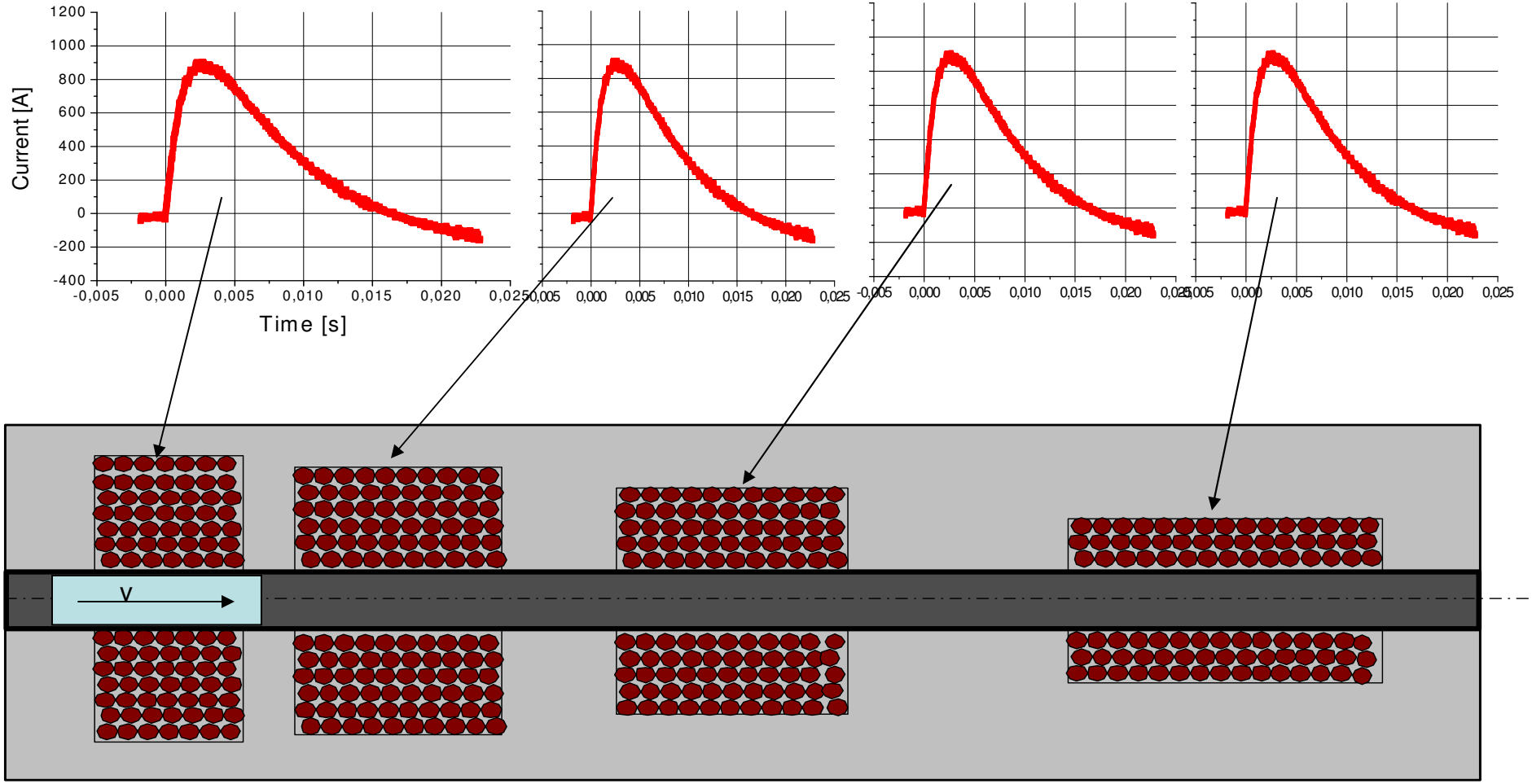
1. Introduction

electromagnetic linear actuators



The electromagnetic linear actuator is build from a series of coils and a ferromagnetic plunger.

The coils are supplied by a series of current impulses.

1. Introduction

electromagnetic linear actuators

Advantages

- simple design structure;
- the fast response for the input signal;
- a possibility to achieve a high linear acceleration;
- a low maintenance cost;
- linear motion is a natural output, so there is no need of any mechanical transmission.

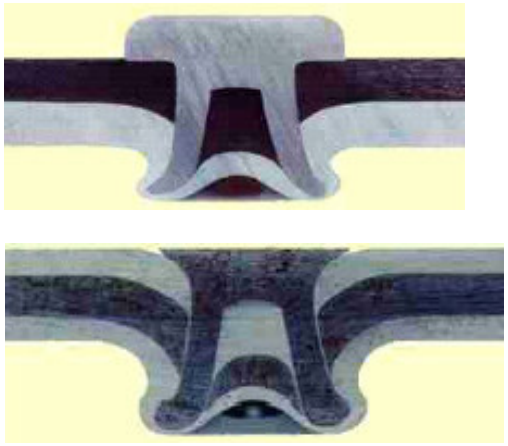
Drawbacks

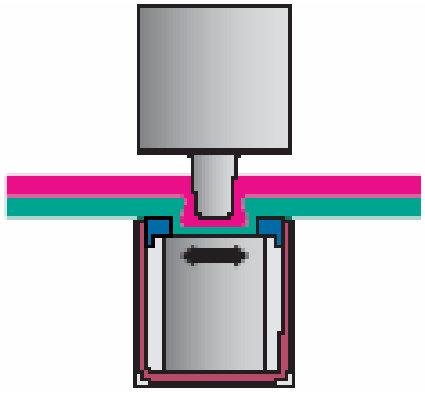
- a low energy efficiency;
- need of the great power current impulse source.

2. Applications

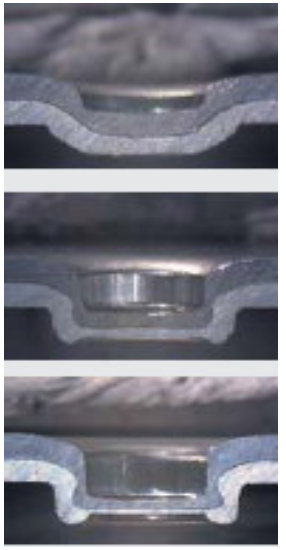
aim of our research

result

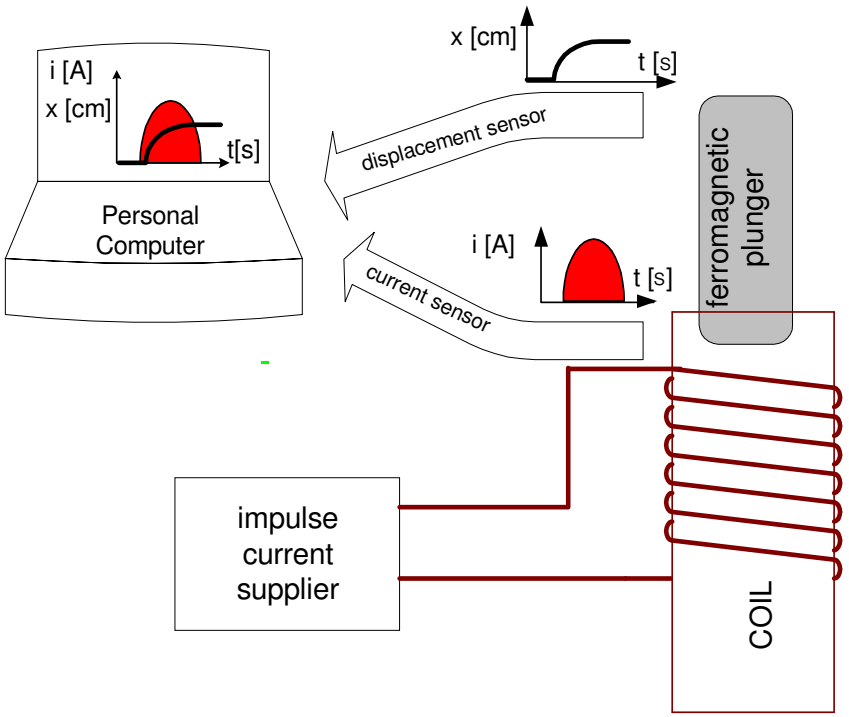


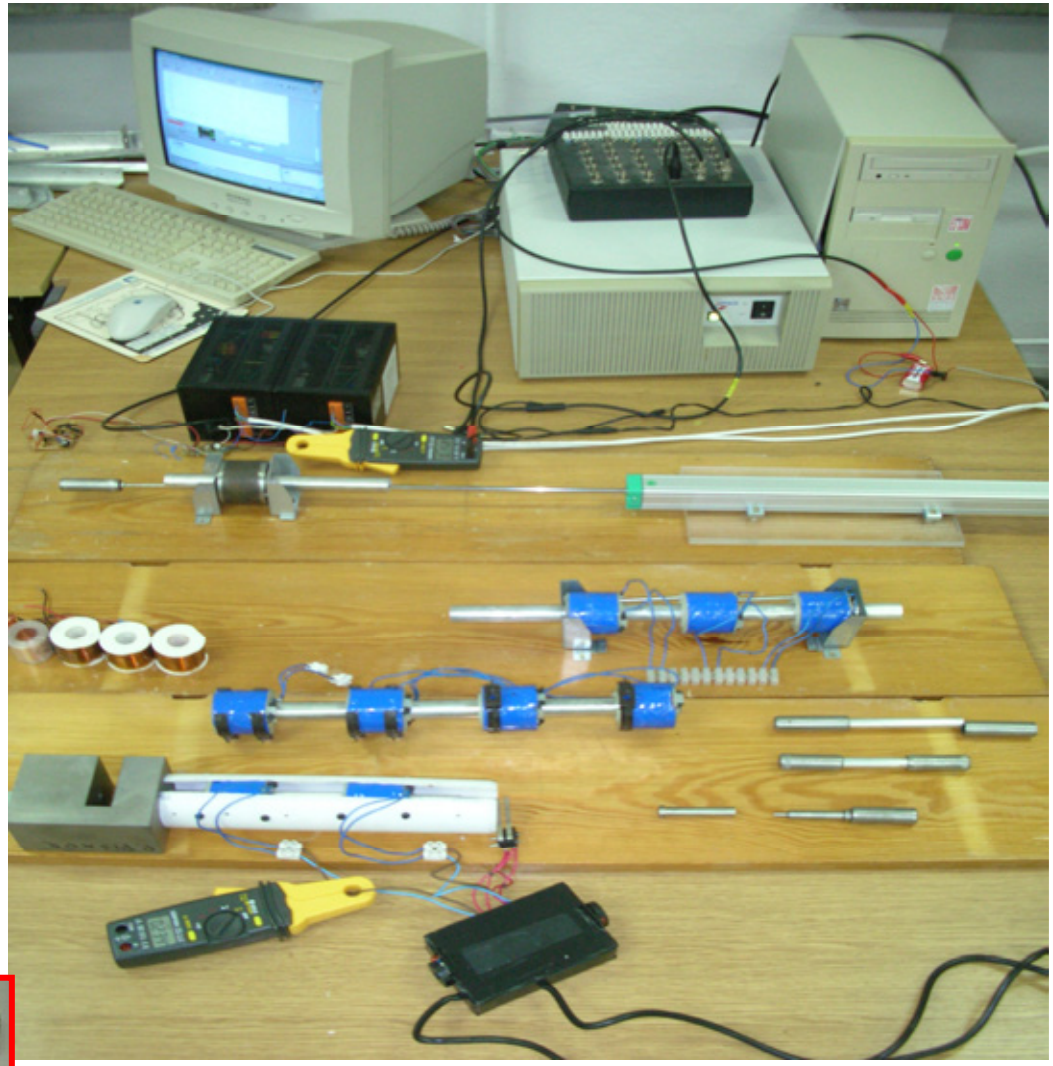


result



3. Experiment

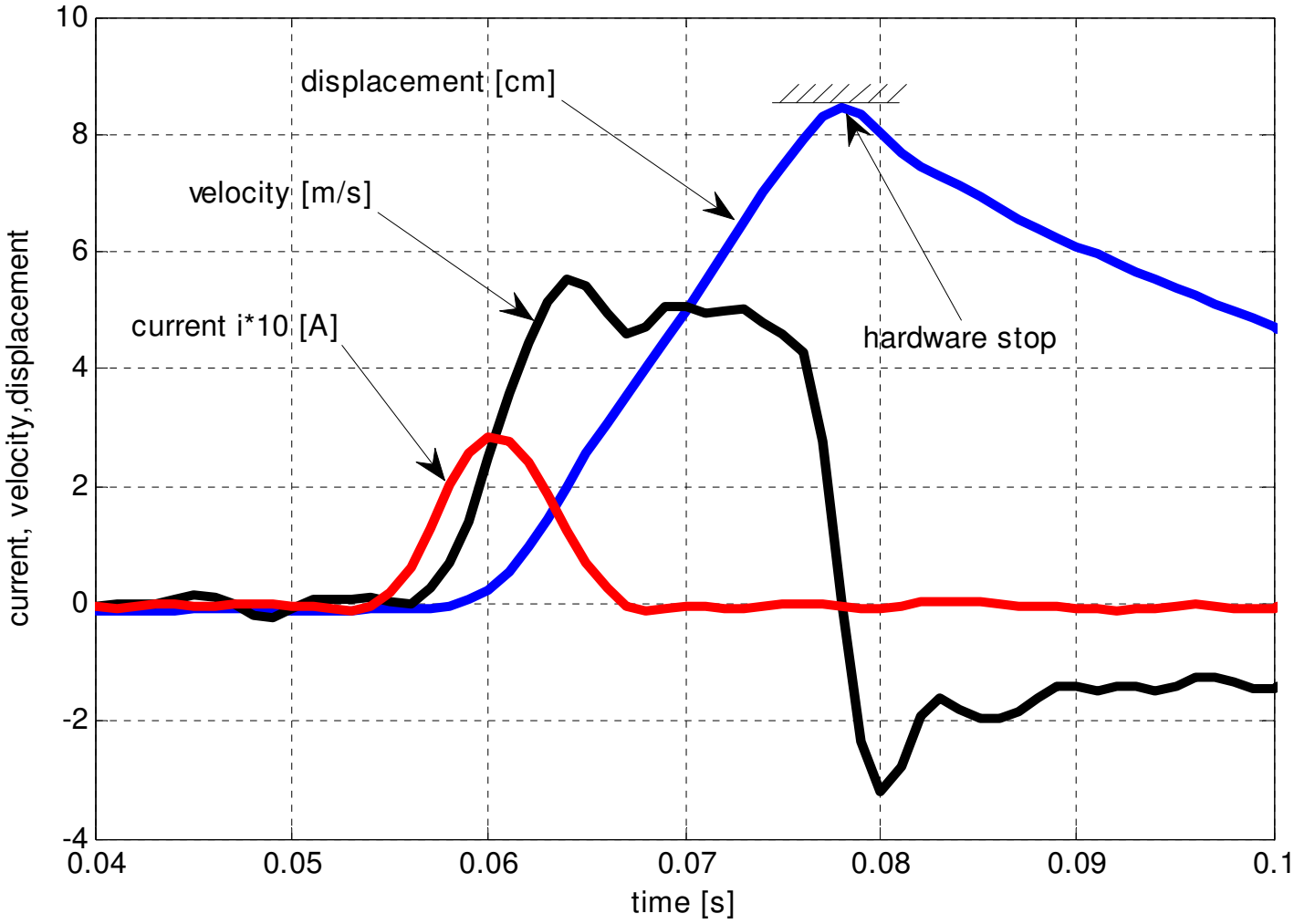




laboratory equipment set up

3. Experiment

data visualization for the single coil system



Energy efficiency = 5%

4. Optimization criteria

The primary optimization criterion is:

$$\eta = \frac{E_{KINETIC}}{E_{SUPPLY}} 100\%$$

The kinetic energy of the plunger – to be maximal:

$$E_{KINETIC} = \frac{1}{2} m_p \cdot v^2 \longrightarrow \mathrm{v} = \int \frac{\mathrm{F}}{\mathrm{m_p}} \mathrm{dt}$$

$\mathrm{F} \rightarrow \mathrm{max.}$

The electric energy supply to the coils – to be minimal:

$$E_{SUPPLY} = \int_{t=0}^{t=t_1} u(t) \cdot i(t) \cdot dt$$

$\mathrm{E_{SUPPLY}} = \mathrm{const.}$

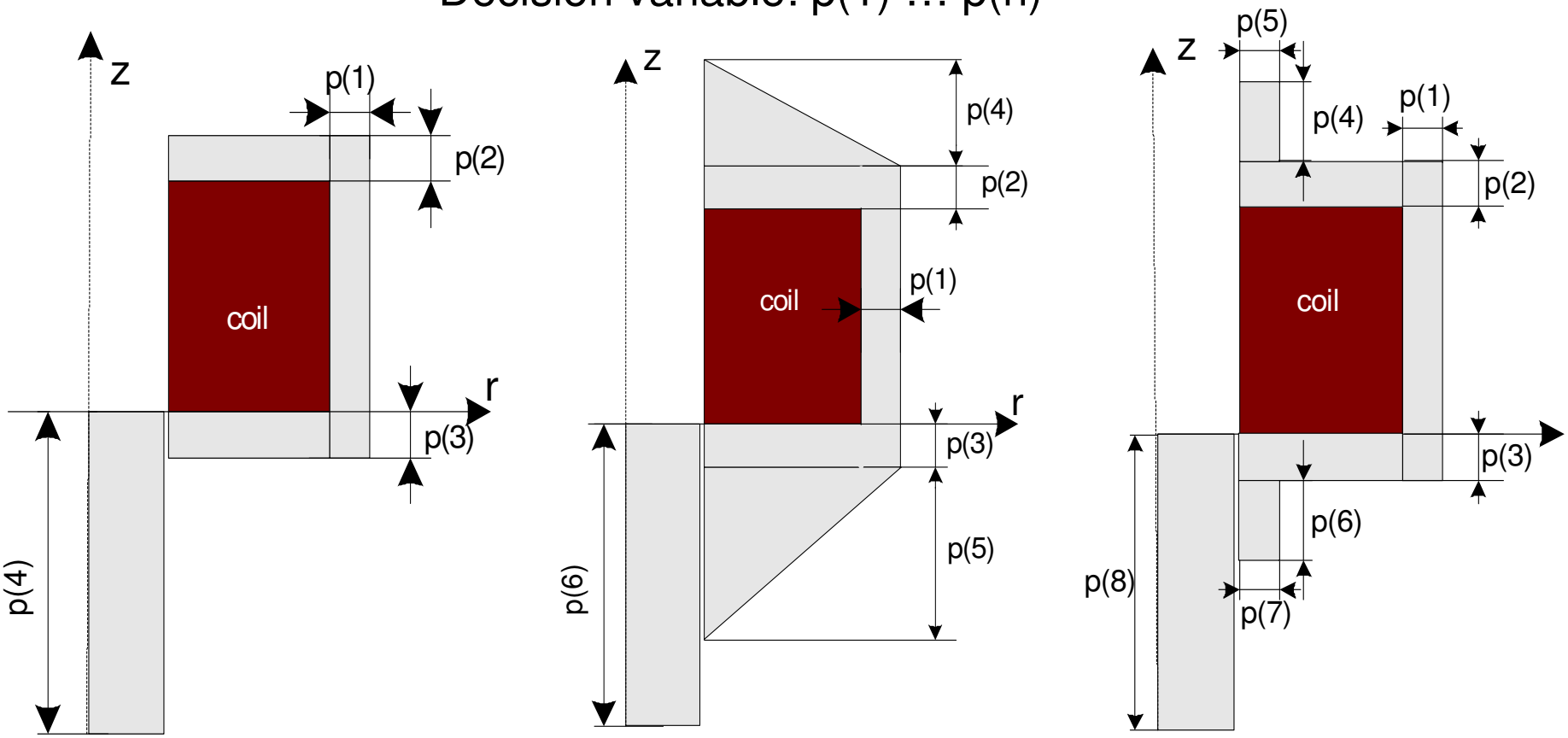
Total mass of the all device - to be minimal:

$$\mathrm{m} = \mathrm{m_p} + \mathrm{m_c}$$

$\mathrm{m} \rightarrow \mathrm{min.}$

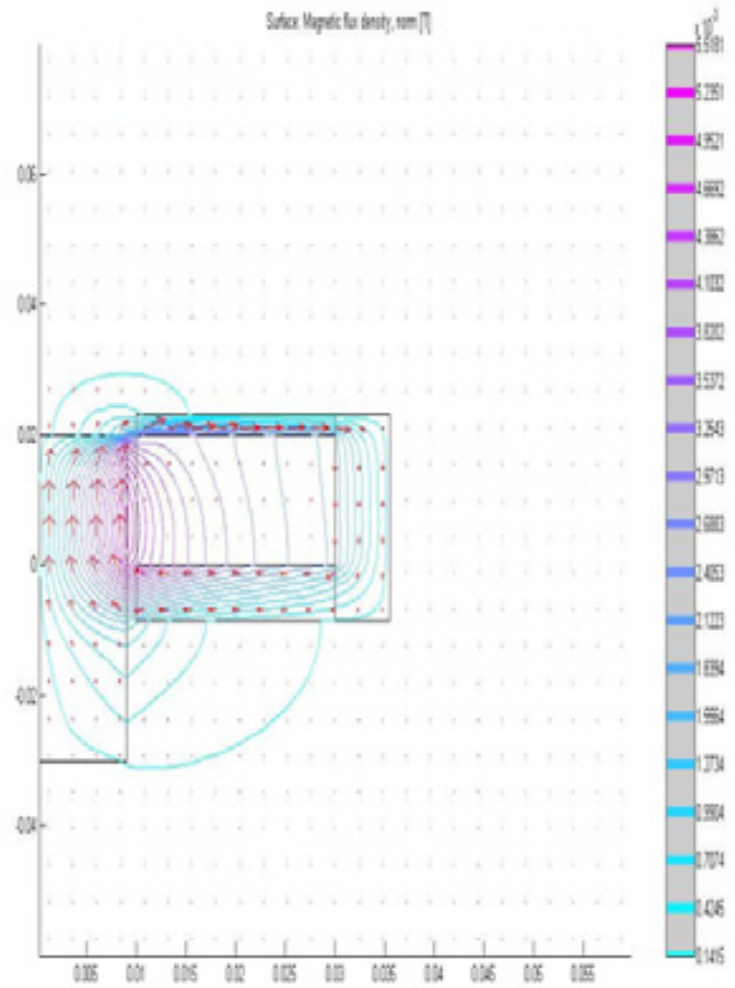
6. Optimization process

Decision variable: p(1) … p(n)



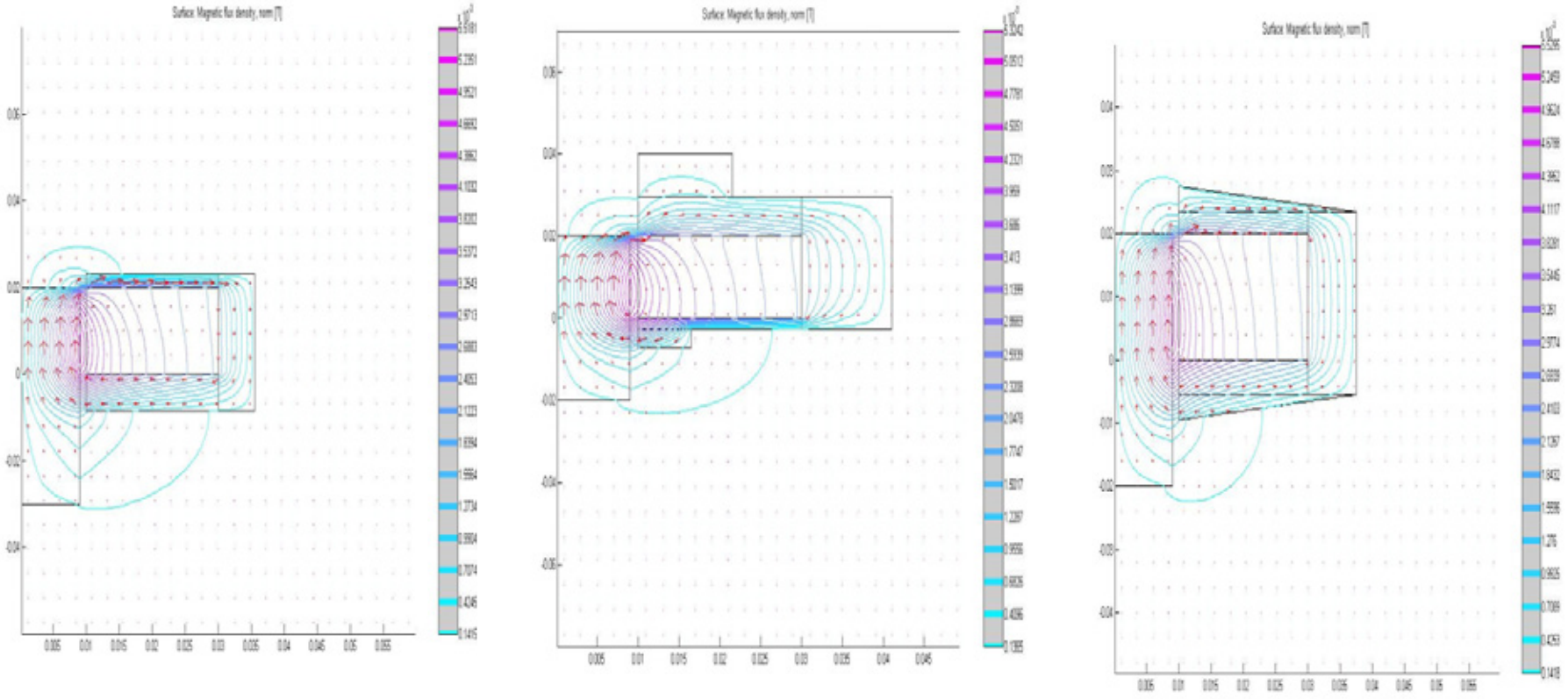
Three types of the cross sectional view of the case (half)

6. Optimization process



Model in Comsol Multiphysics for decision variables vector generated in Matlab program

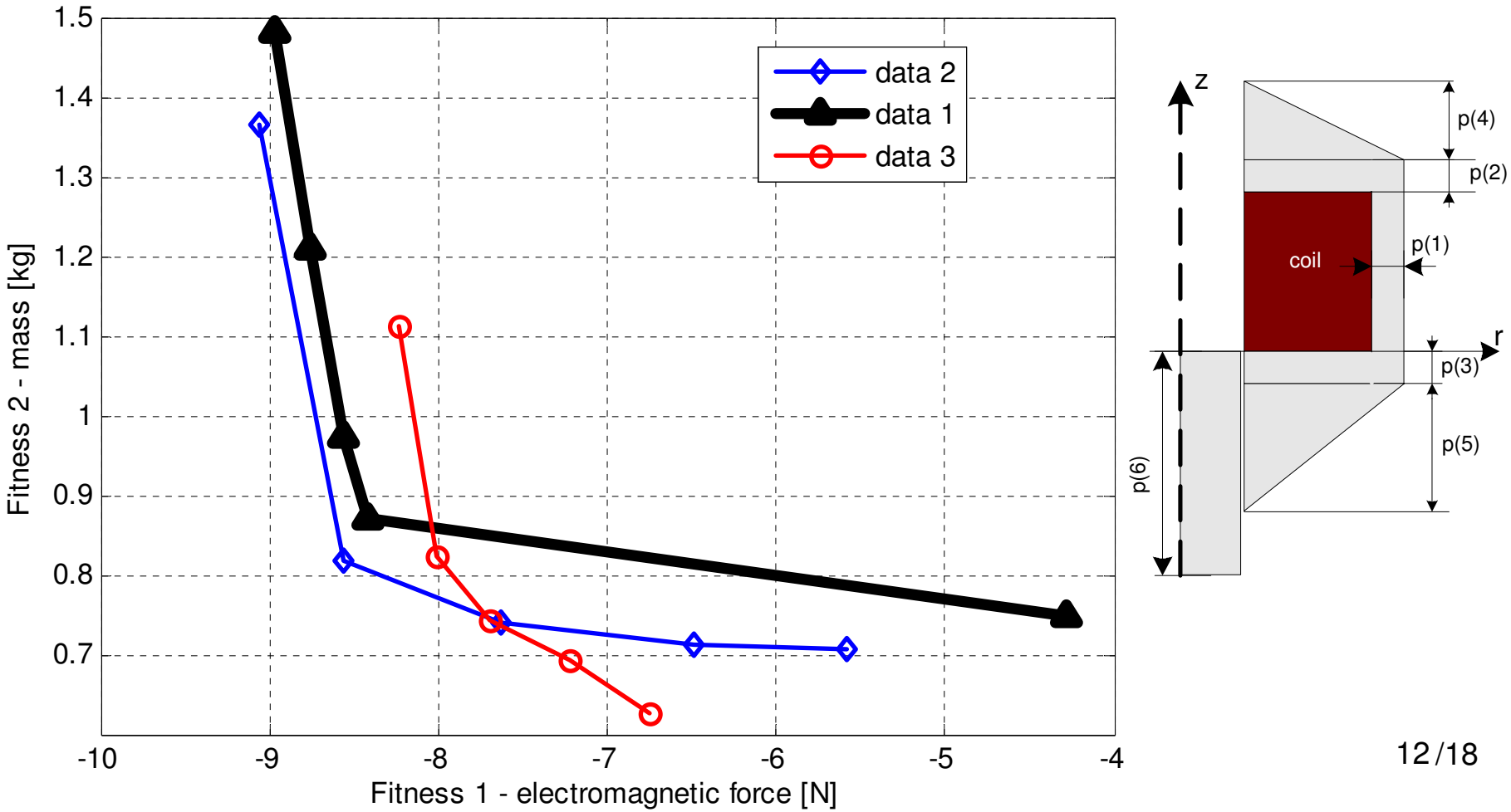
6. Optimization process



Model in Comsol Multiphysics for decision variables vector generated in Matlab program

6. Optimization process

Pareto-optimal solutions



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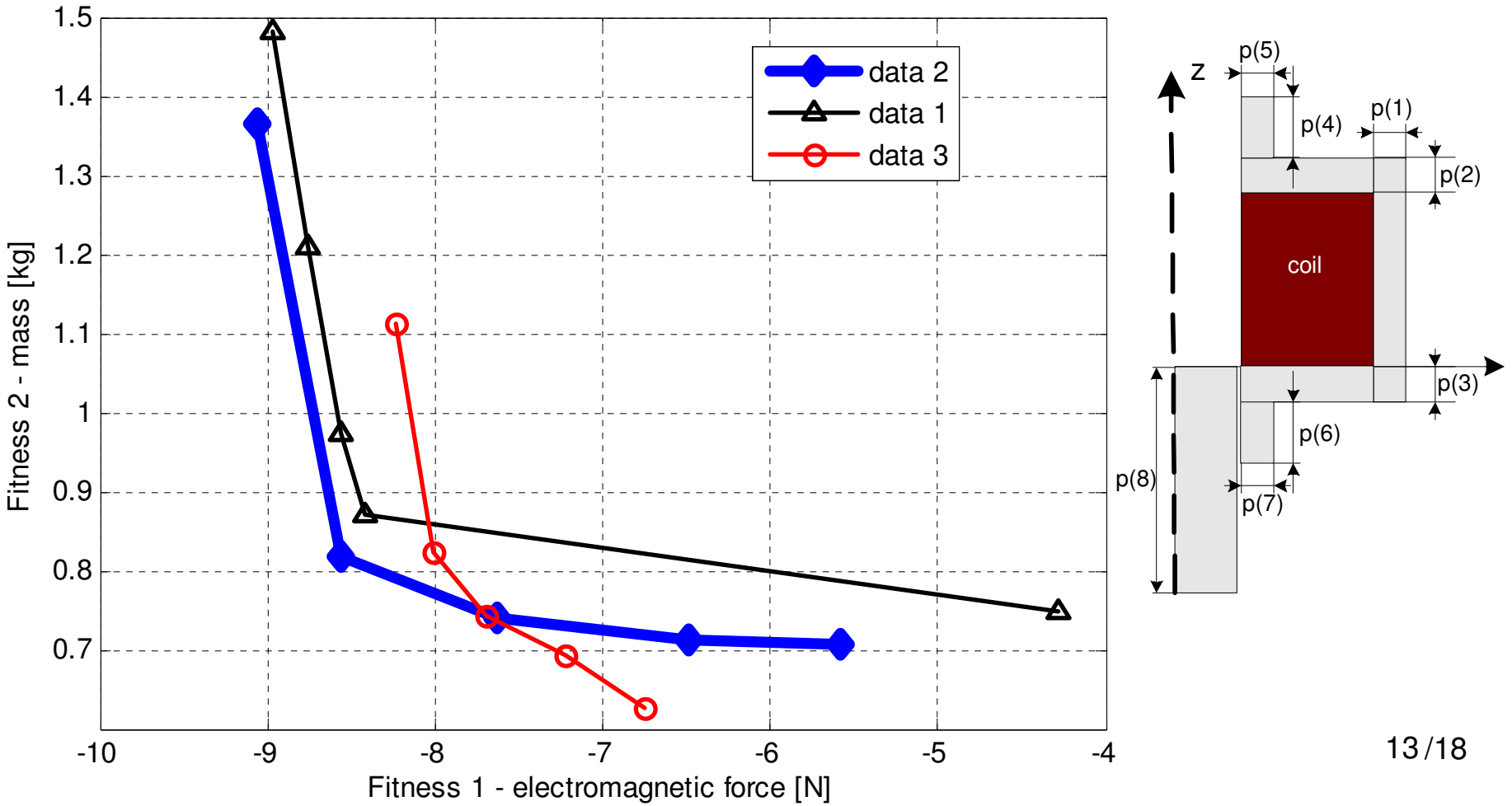
Pareto-optimal solutions



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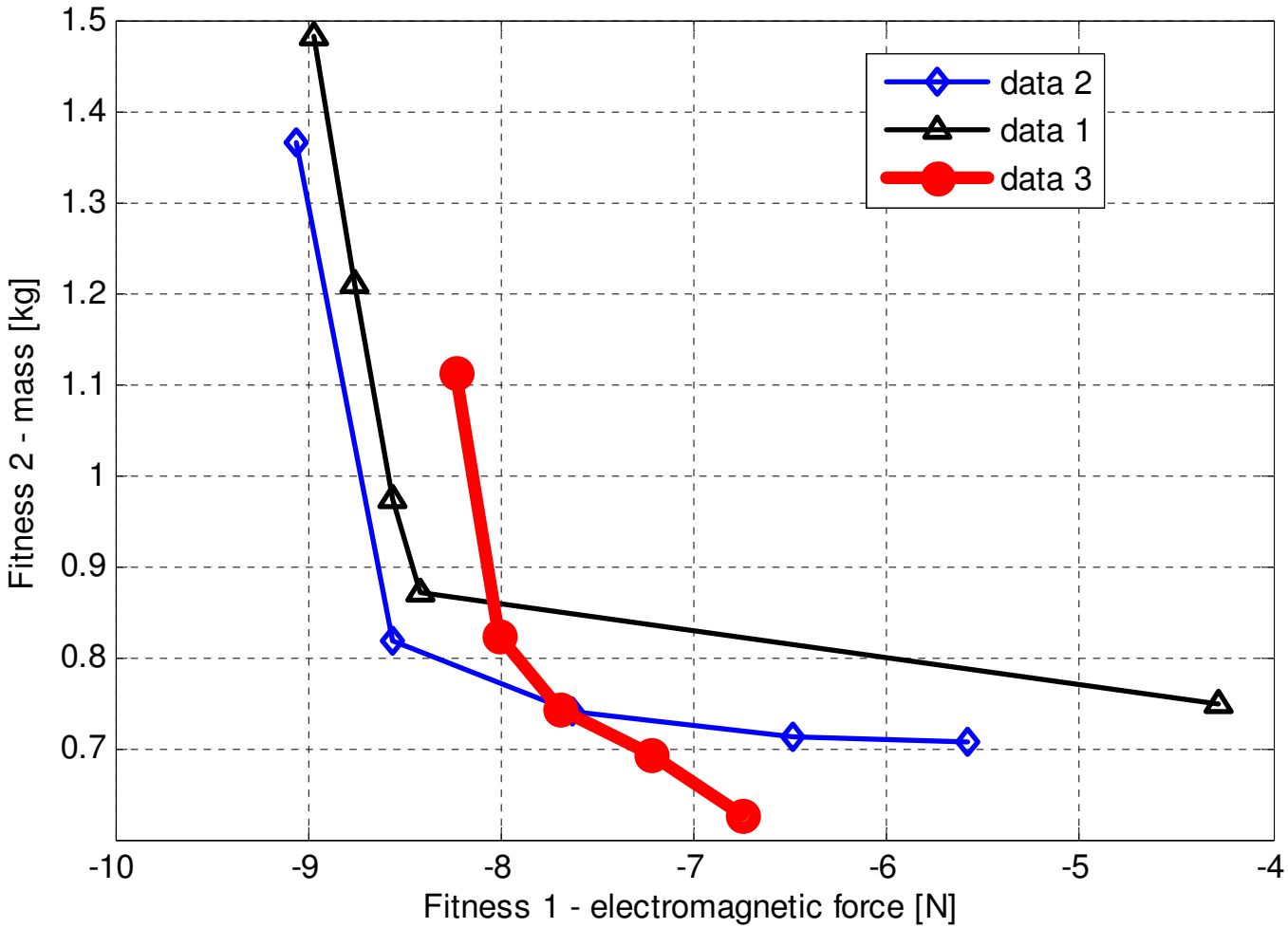
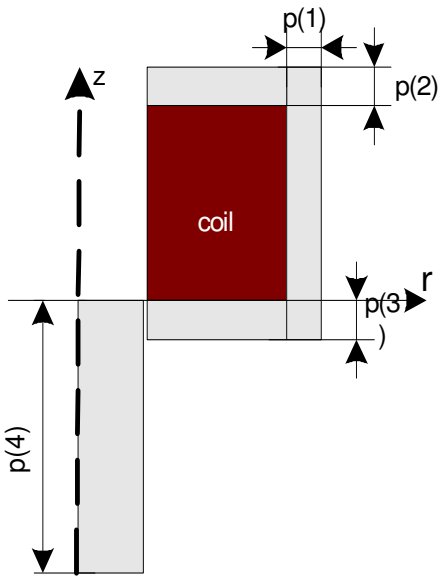
Pareto-optimal solutions

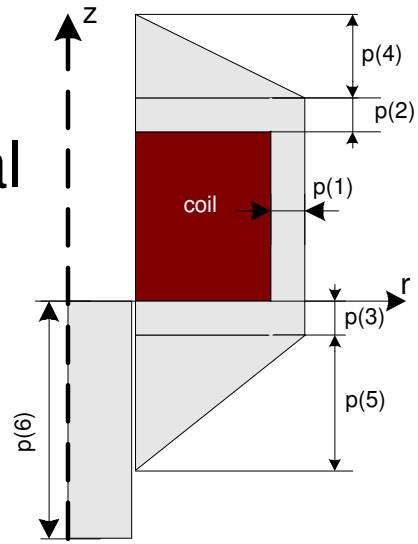




7. Conclusions

- The accurate simulation model can be built in the Comsol Multiphysics;
- A combination of the two programs (Comsol and Matlab) gives a posibility to optimize structure and parameters simultaneously;
- The case type presented is not rational on two criteria:

  force and mass.



8.Summary

- The electromagnetic device has been analyzed as the device for connection metal sheets process;
- The definition of optimization process has been defined;
- The Pareto-optimal solutions have been presented;

9. References

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- D. Howe “Magnetic actuators” Sensors and Actuators 81,2000, 268-274.
- S.J. Moon, T. Y. Chung, Ch.W. Lim, D.H. Kim “A linear motor dumper for vibration control of steel structure” Mechatronics 14, 2004, 1157-1181.
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Thank you very much for attention…

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