

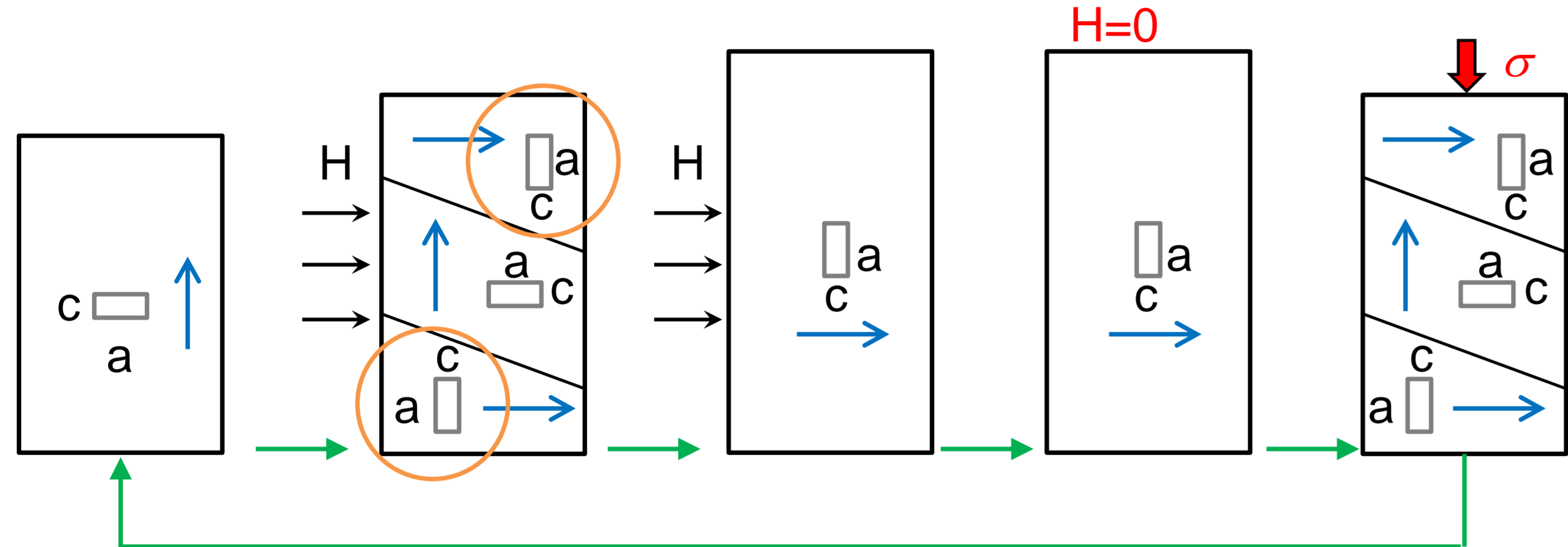
Study on Starting Performance of Ni-Mn-Ga Magnetic Shape Memory Alloy Linear Actuator

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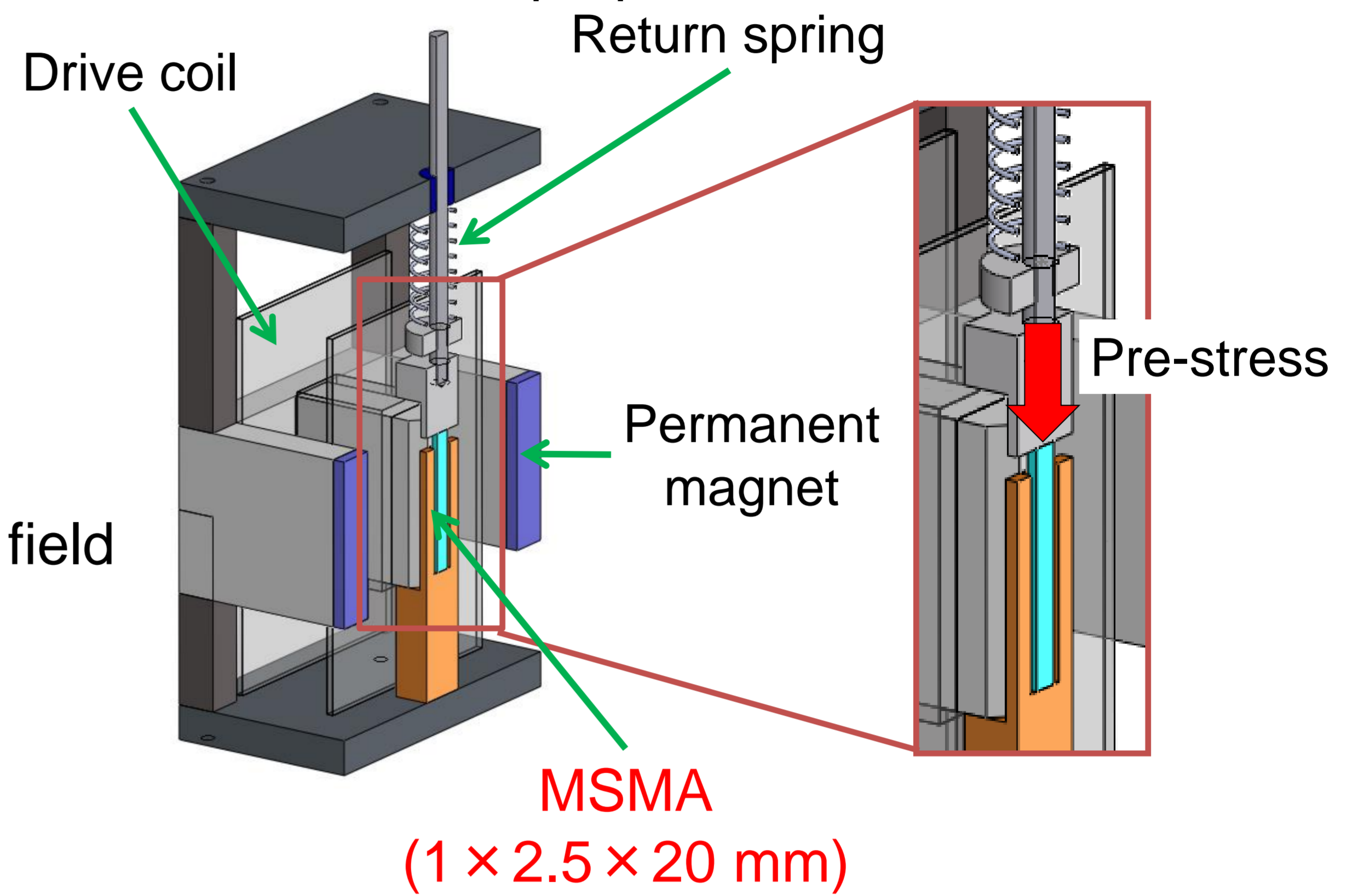
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Introduction

- Operating mechanism of the Ni-Mn-Ga magnetic shape memory alloy (MSMA)

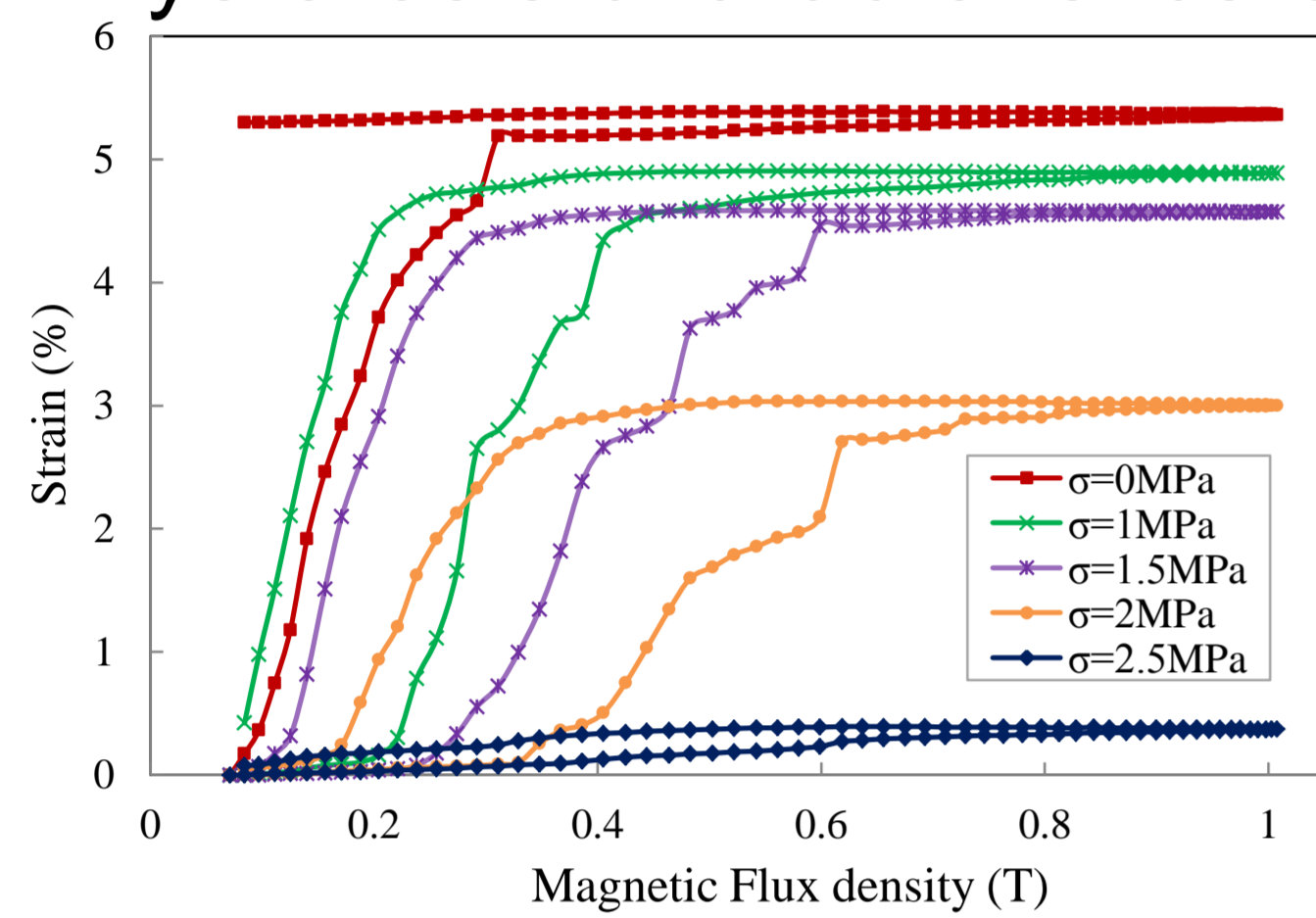


- Whole model of the proposed MSMA linear actuator



- Current problem

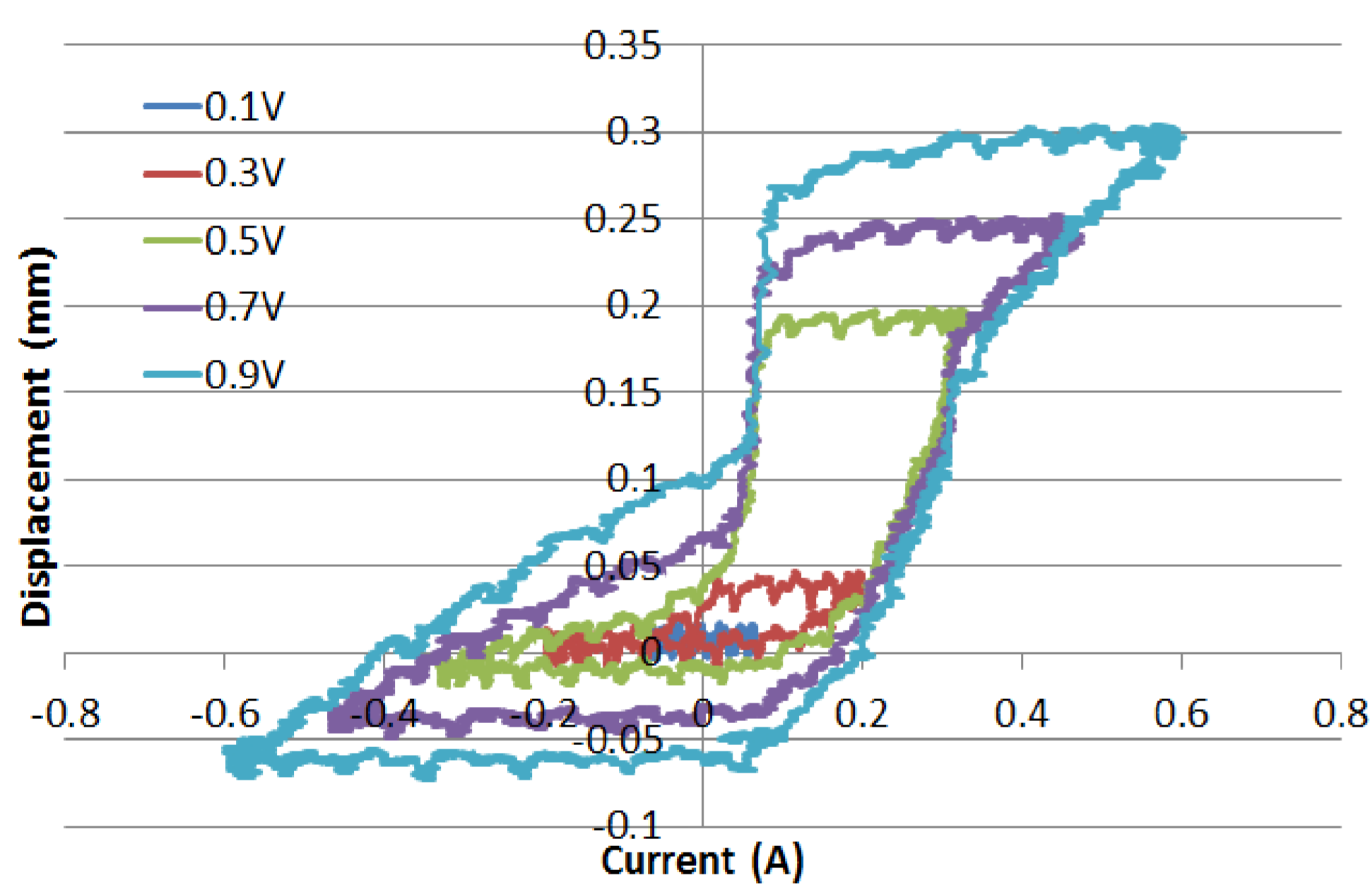
Hysteresis characteristics between the magnetostriction and magnetic field



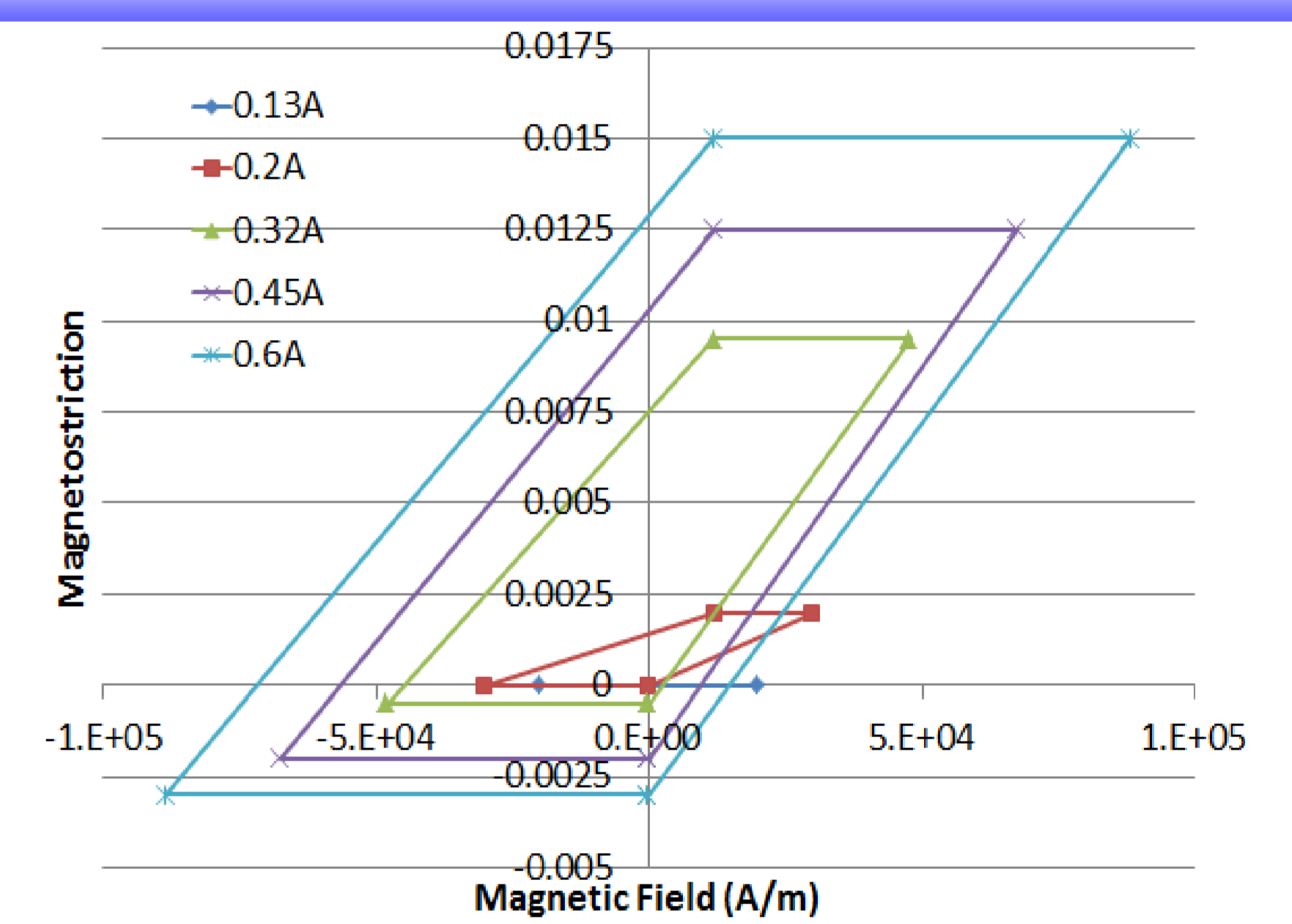
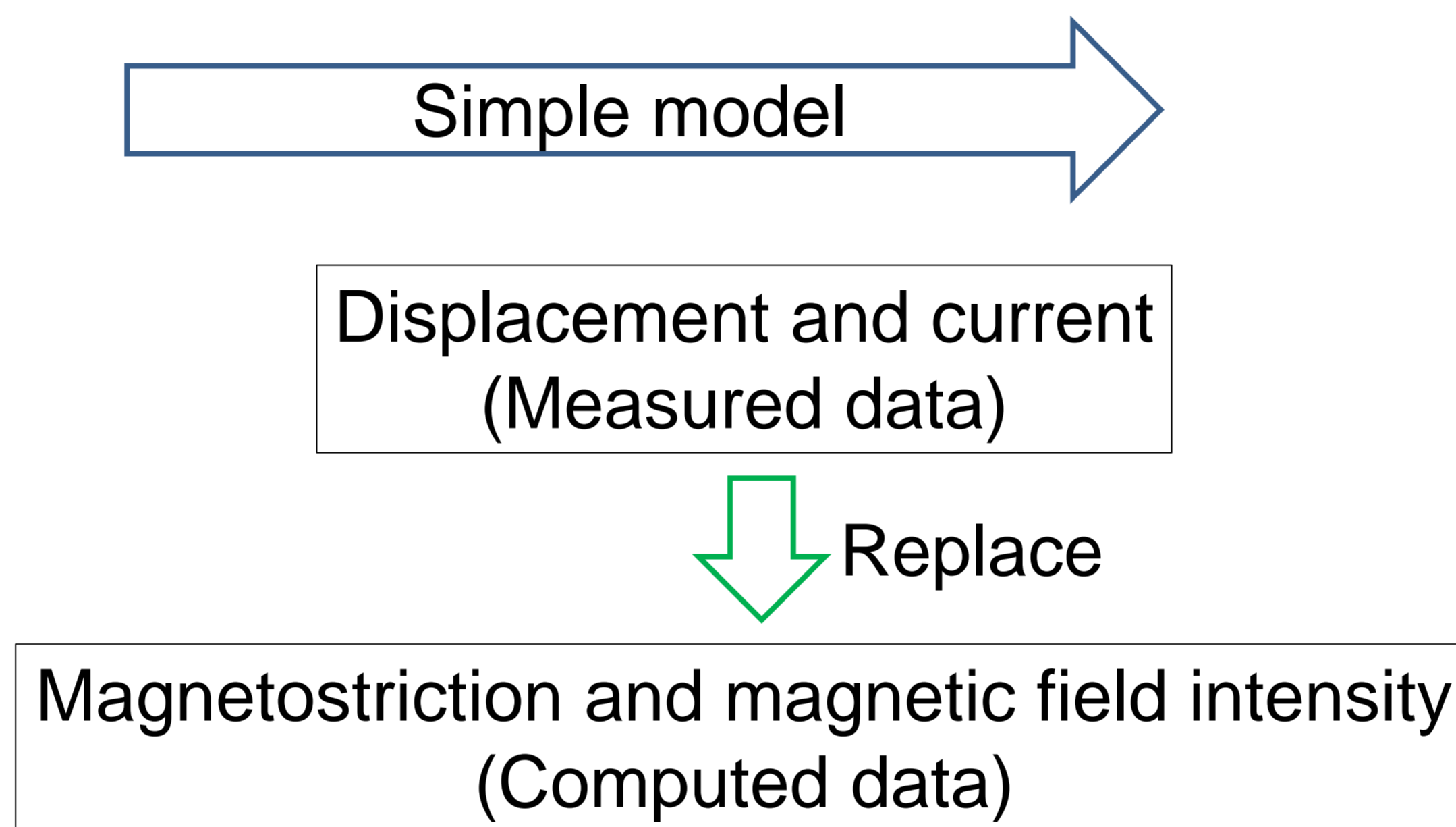
Difficult to design by measurement

Predict the starting performances by coupled analysis

Ni-Mn-Ga MSMA Characteristics



Displacement vs. Current (Measured data)



Magnetostriction vs. Magnetic field intensity

Coupled Analysis by Finite Element Method

Electromagnetic analysis

$$\text{rot}(\mu \text{rot } \mathbf{A}) = \mathbf{J}_0 - \sigma \left(\frac{\partial \mathbf{A}}{\partial t} + \text{grad } \phi \right)$$

$$\text{div} \left\{ \sigma \left(\frac{\partial \mathbf{A}}{\partial t} + \text{grad } \phi \right) \right\} = 0$$

$$V = RI + \frac{d\Psi}{dt}$$

Magnetic field intensity



Weak coupling



Displacement

Structural analysis

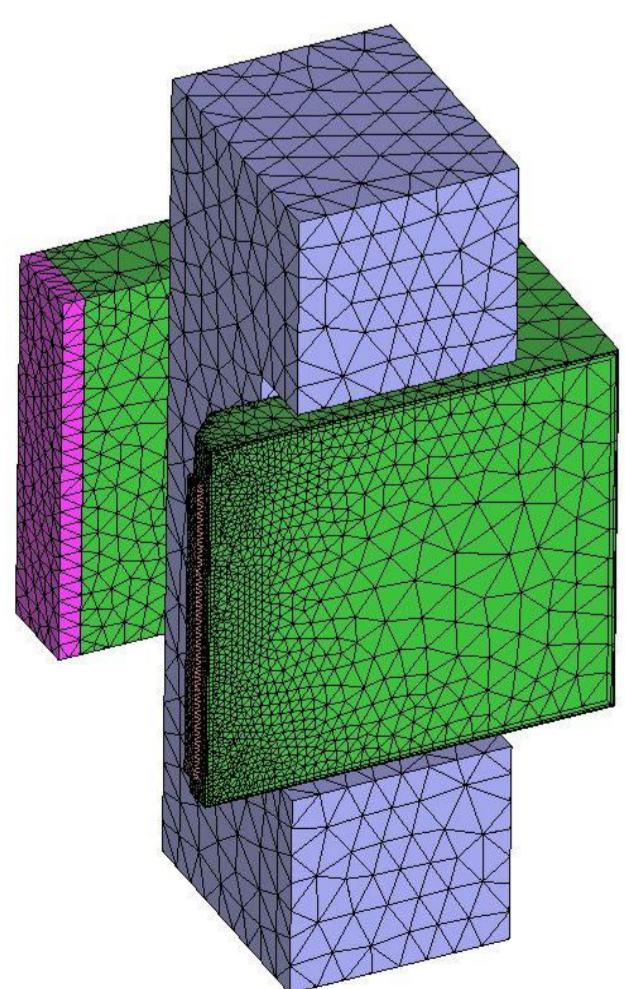
$$M \frac{d^2 u}{dt^2} + C \frac{du}{dt} + Ku = f$$

- Rayleigh damping
- Newmark-beta method

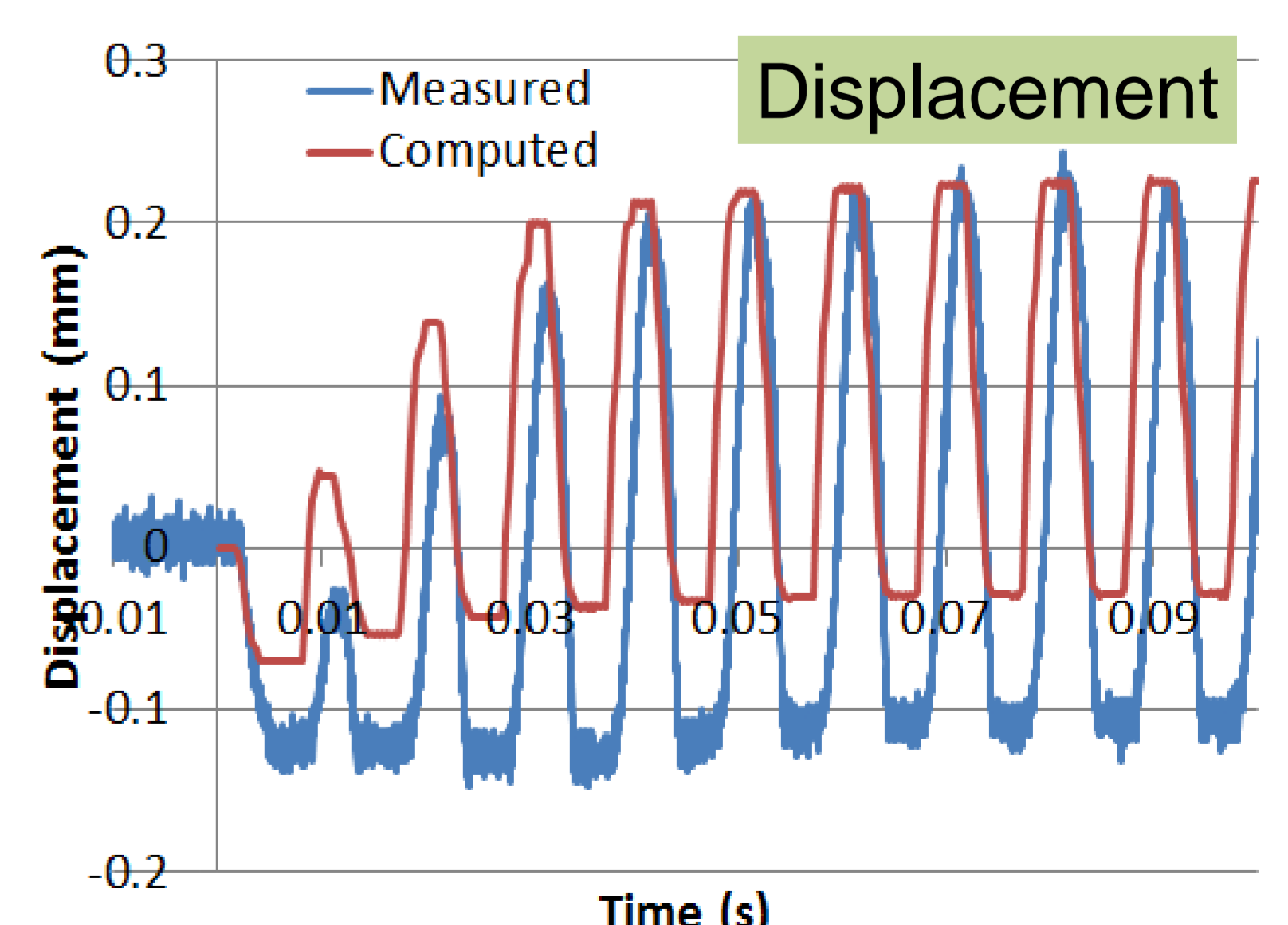
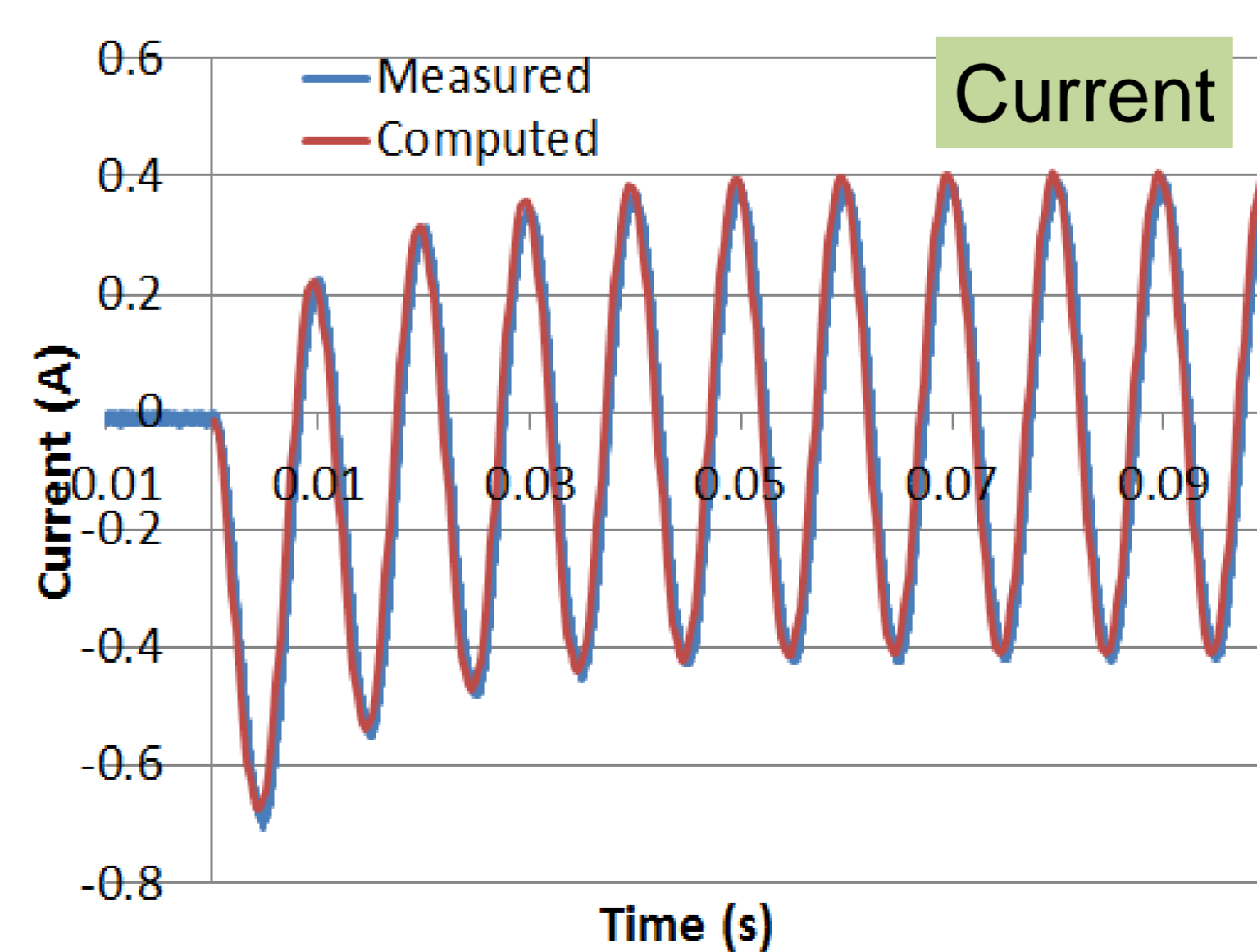
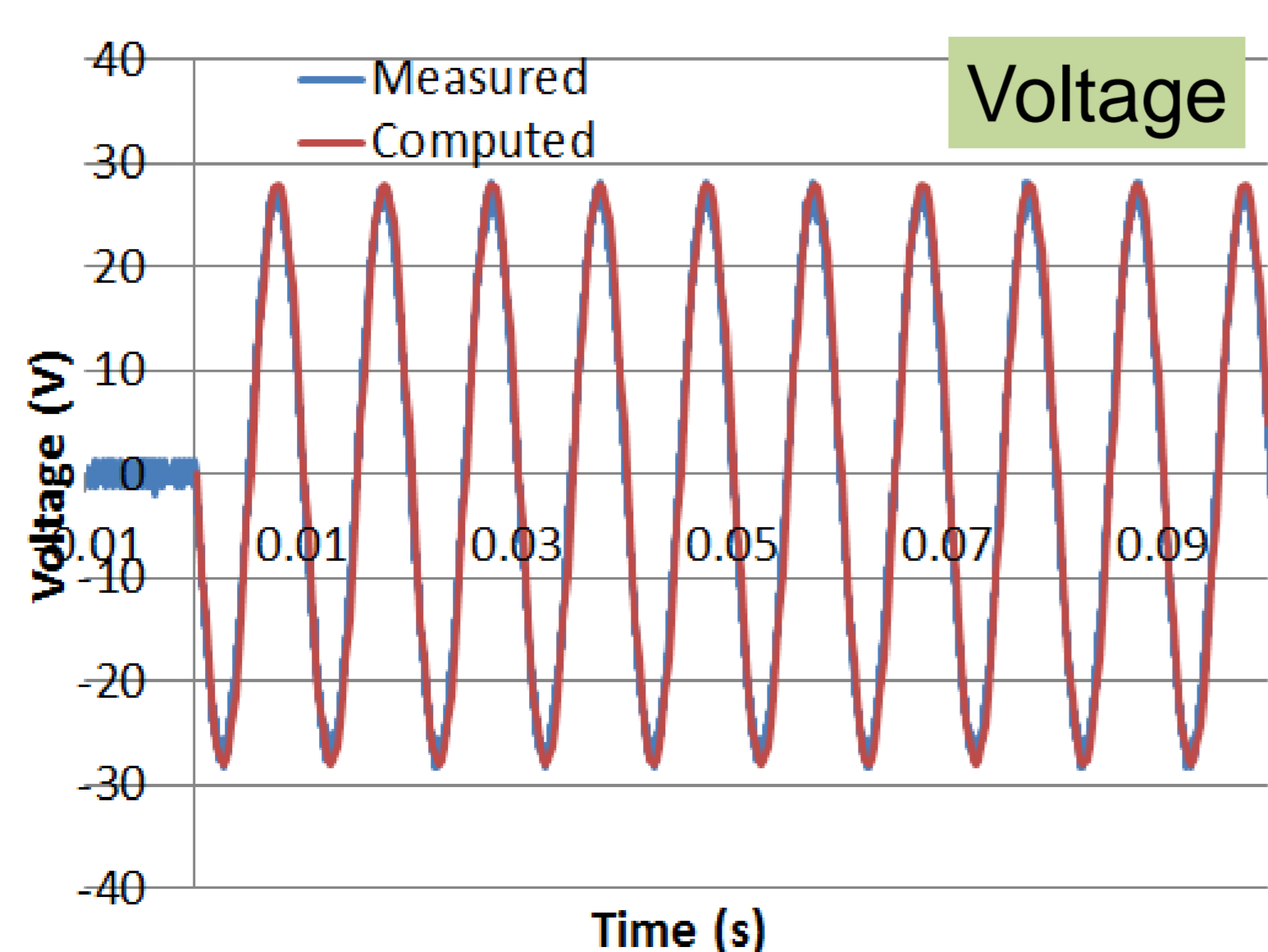
Ni-Mn-Ga MSMA

- Magnetically isotropic
- Mechanically isotropic
- No temperature dependency

Results and Conclusion



FEM model



- The computed and measured results of transient displacement and current show a good agreement.
- The displacement during contraction are different. (This is due to the measurement errors)
- The modeling of the Ni-Mn-Ga have to be further investigated.