Ostfalia
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Transient Analysis of an EMVD Using COMSOL Multiphysics

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G. Stebner
C. Hartwig
Ostfalia University of Applied Sciences
Institute of Mechatronics
ge.stebner@ostfalia.de
ch.hartwig@ostfalia.de

Salzgitter
Suderburg
Wolfenbüttel
Wolfsburg

Transient Analysis of an EMVD Using COMSOL Multiphysics

- What is an EMVD?
- A typical EMVD concept
- Modeling the concept with COMSOL Multiphysics
- A few results of the transient analysis

What does an EMVD?

- Electromagnetic valve drives are used to replace the camshaft in combustion engines
  - It allows the control of the fuel-air mixture without the use of a throttle
  - It reduces the fuel consumption in a wide range
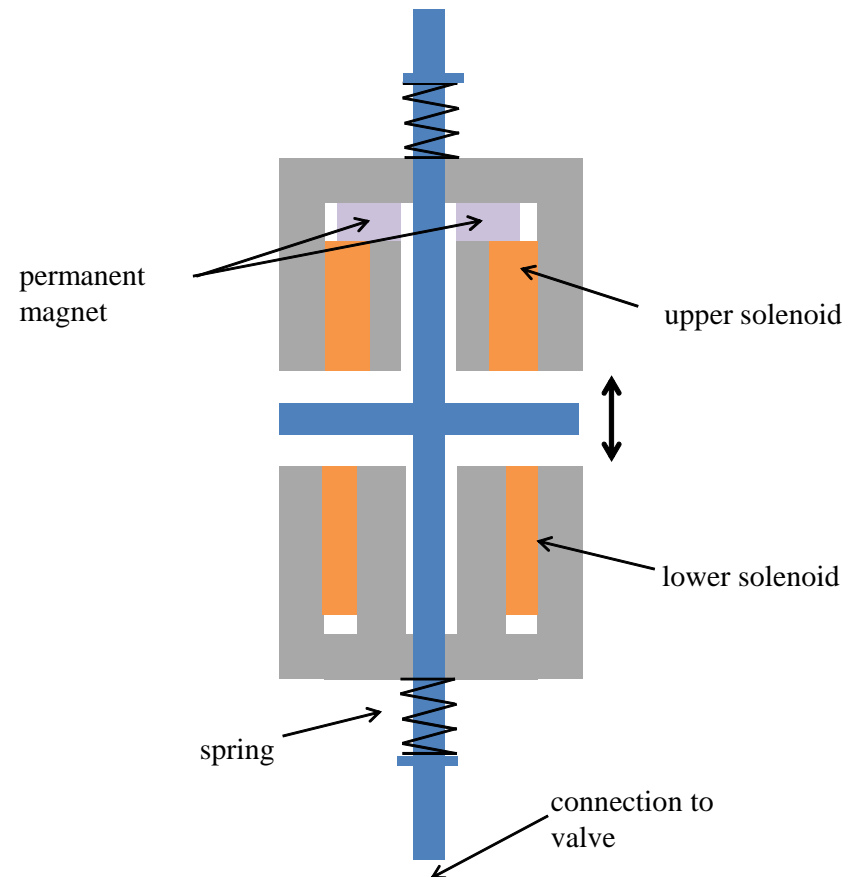 - It increases the torque of the combustion engine

A typical EMVD concept

- The equilibrium of the System is shown in the figure
- Moving the valve plate leads to spring forces which try to move the valve plate back to the point of equilibrium
- Two Solenoids attract the valve plate and hold it in the upper and lower position to open and close the valve
- The additional permanent magnet is used to attract and hold the valve. A fail-safe behaviour when power loss occurs should be guaranteed.
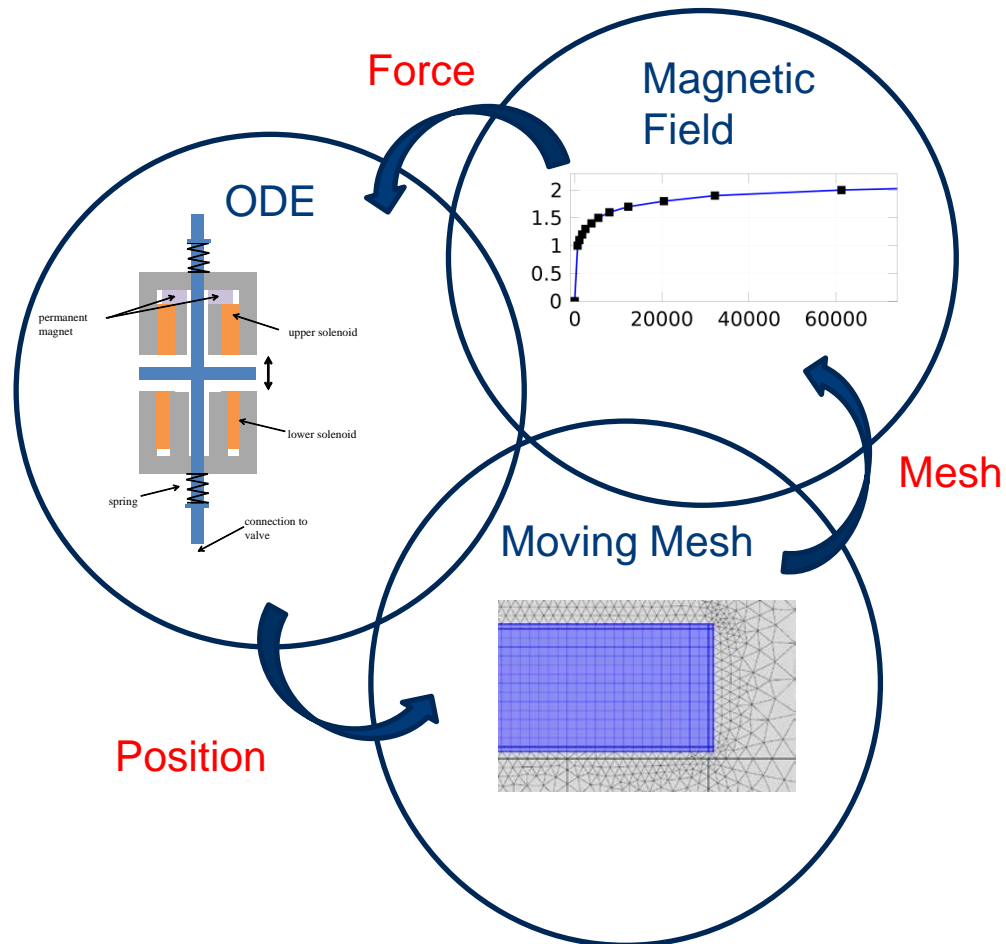
permanent magnet

upper solenoid

lower solenoid

spring

connection to valve
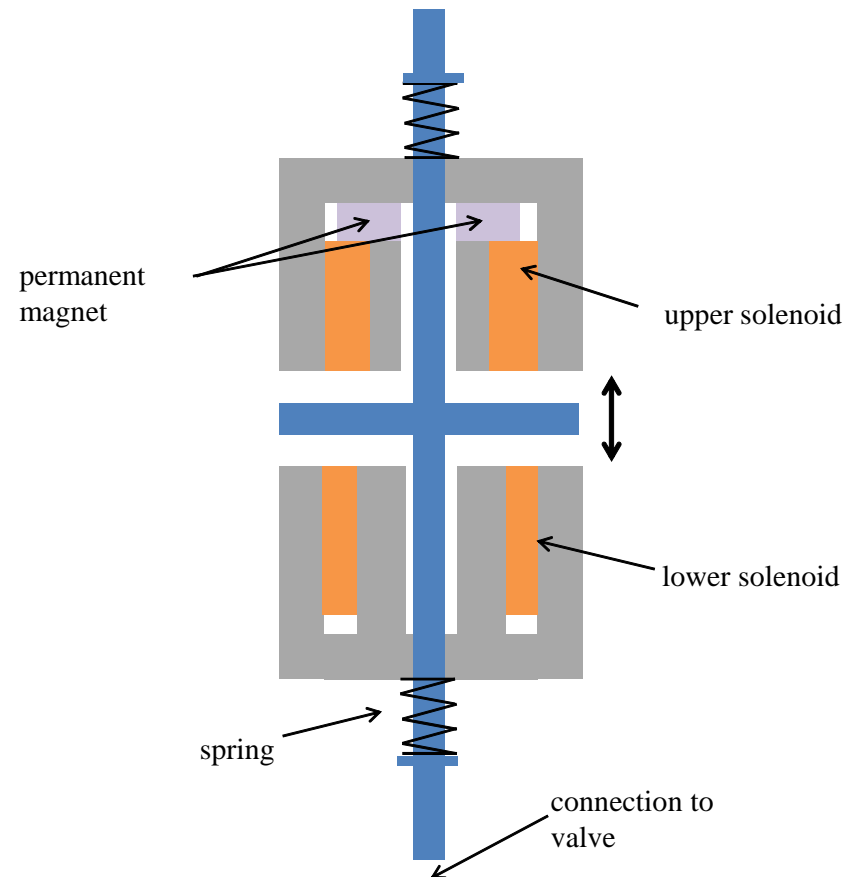
A typical EMVD concept

- What do we want to know?
  – Amplitude of the Forces
  – Seating velocities
  – Influence of eddy currents
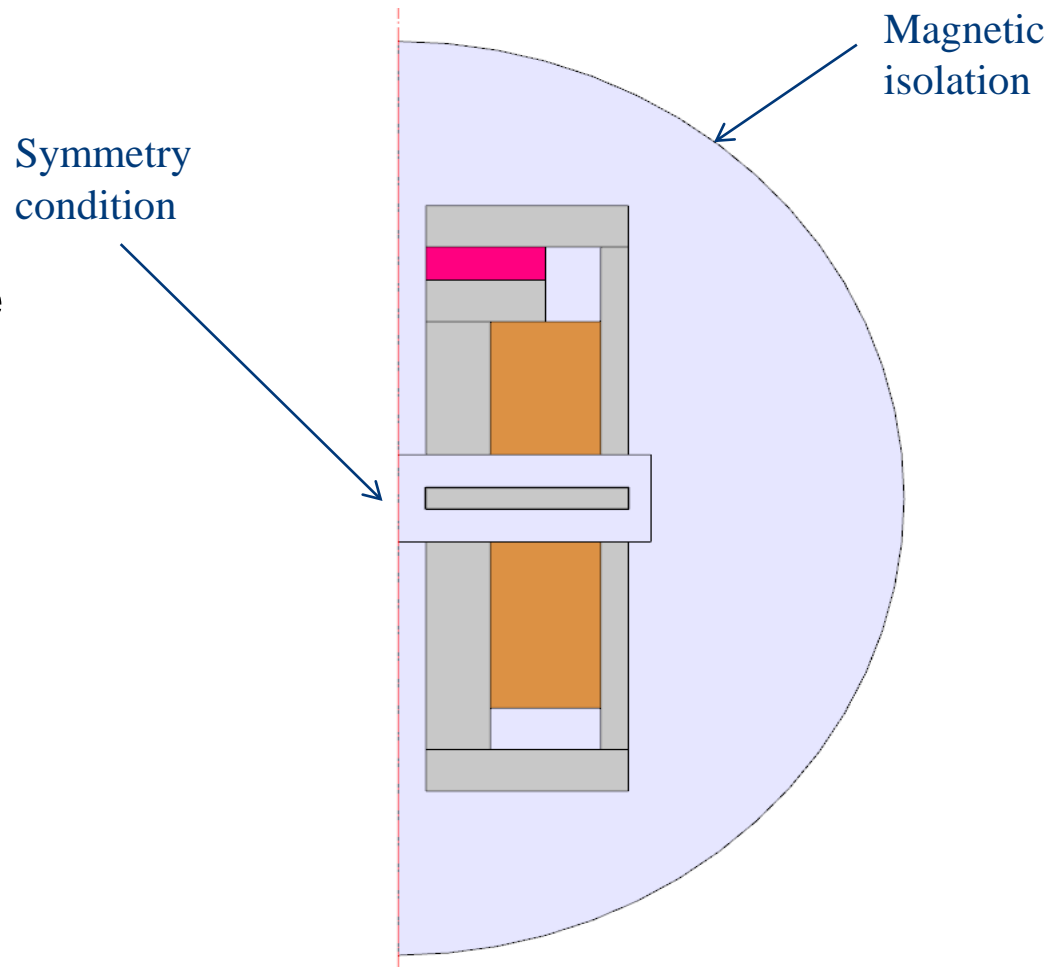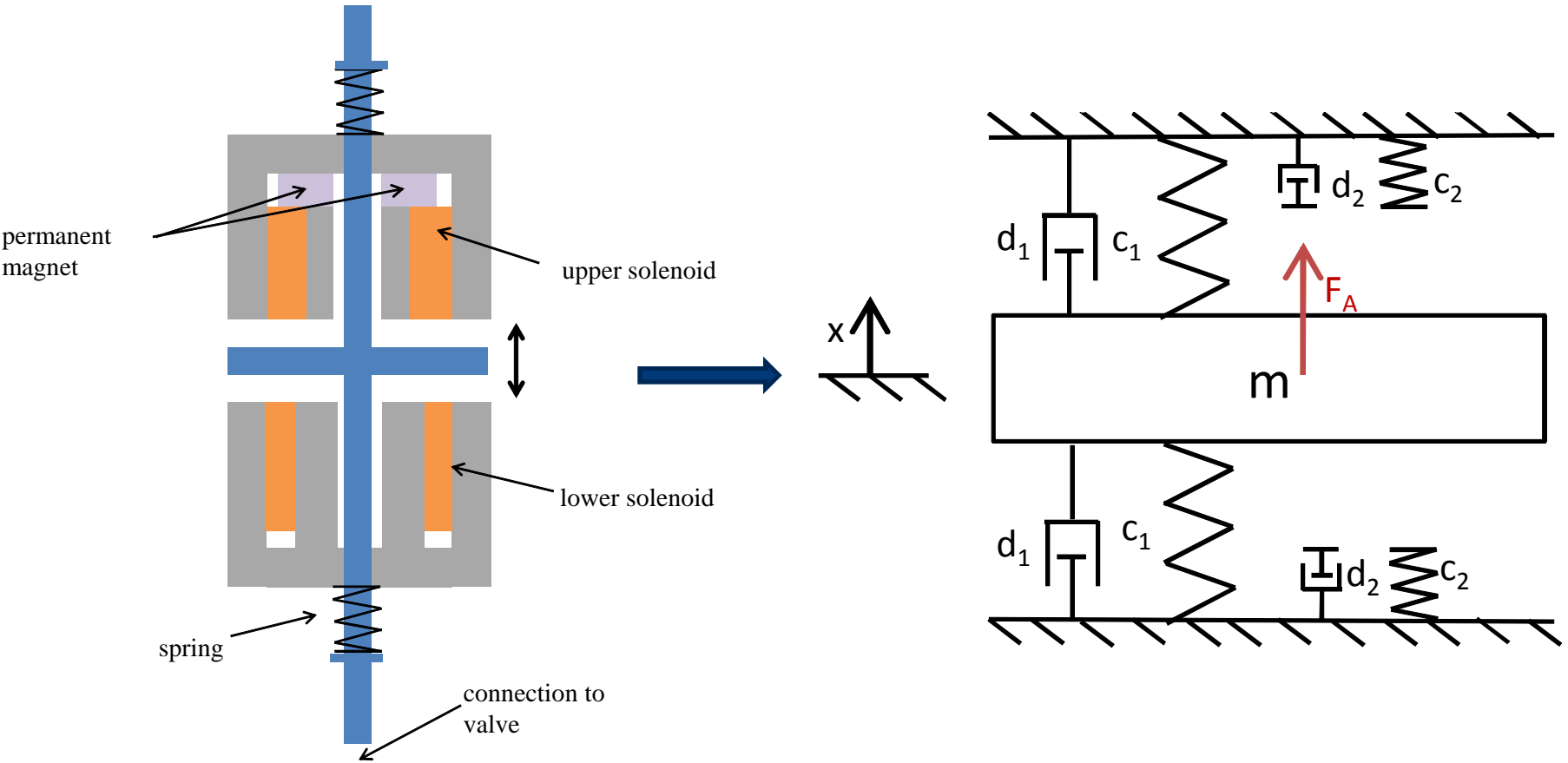 – Amplitude of the remanent flux density to achieve fail-safe behavior

permanent magnet

upper solenoid

lower solenoid

spring

connection to valve

Modeling the concept with COMSOL

Force

Magnetic Field

ODE

Mesh

Moving Mesh

Position
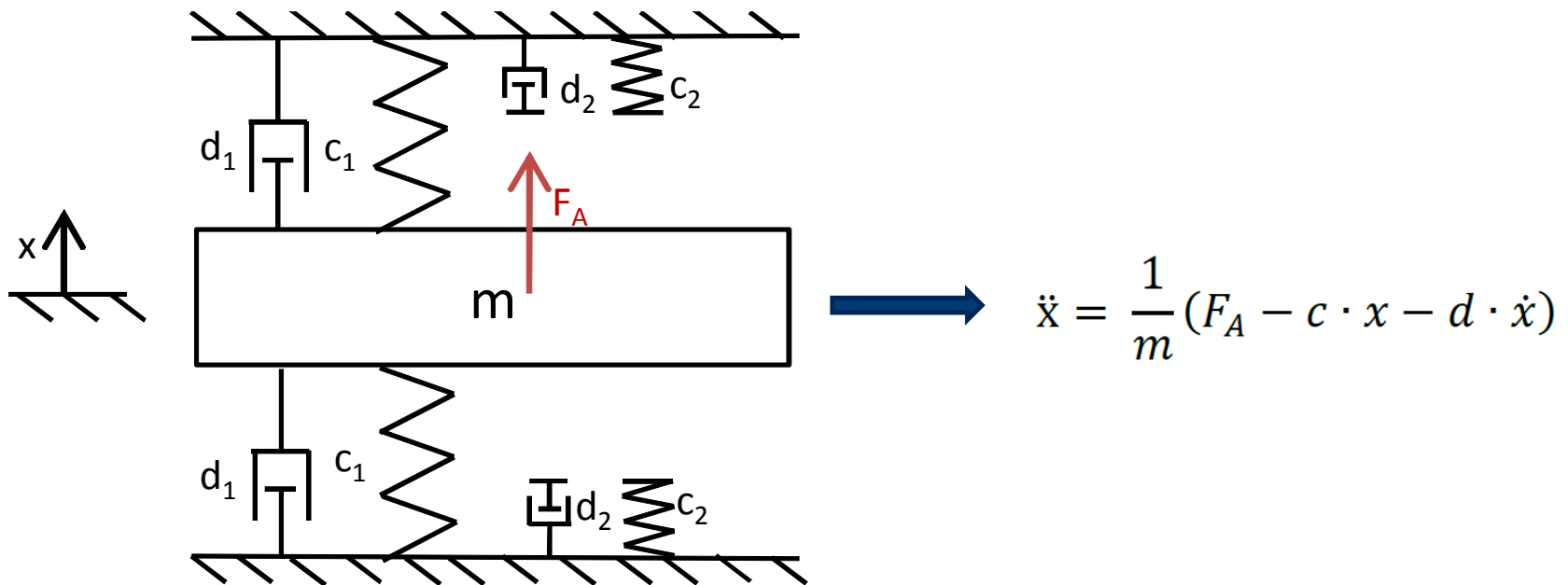
Modeling the concept with COMSOL

- Symmetry condition to reduce the model
- Nonlinear BH-Curve for the iron
- Multiturn-coil
- Permanent magnet
- Force calculation domain for the valve plate

Magnetic isolation

Symmetry condition
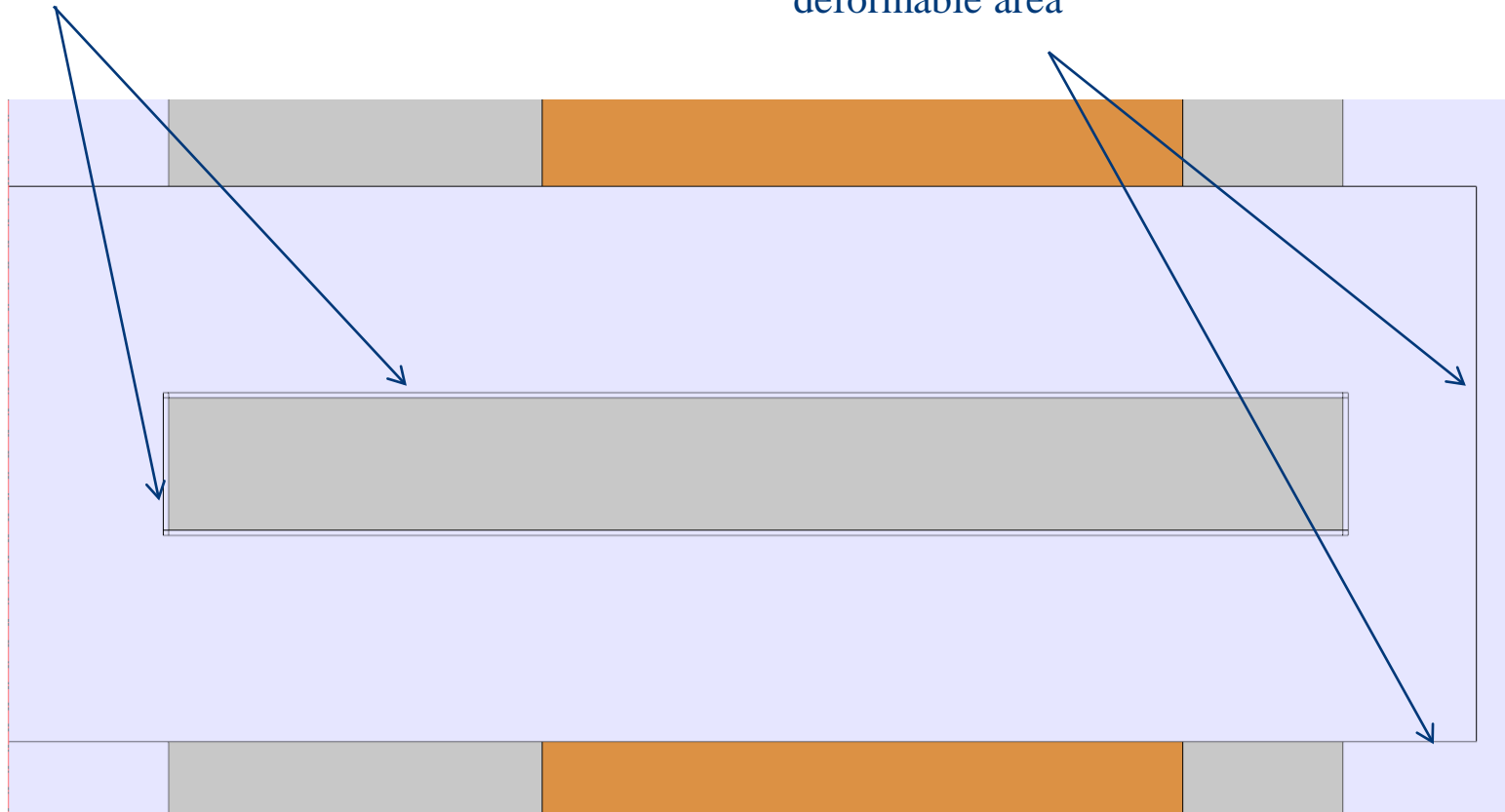
Modeling the concept with COMSOL

permanent
magnet

upper solenoid

lower solenoid

spring

connection to
valve

x

d_2 c_2

d_1 c_1

F_A

m

d_1 c_1

d_2 c_2

Modeling the concept with COMSOL

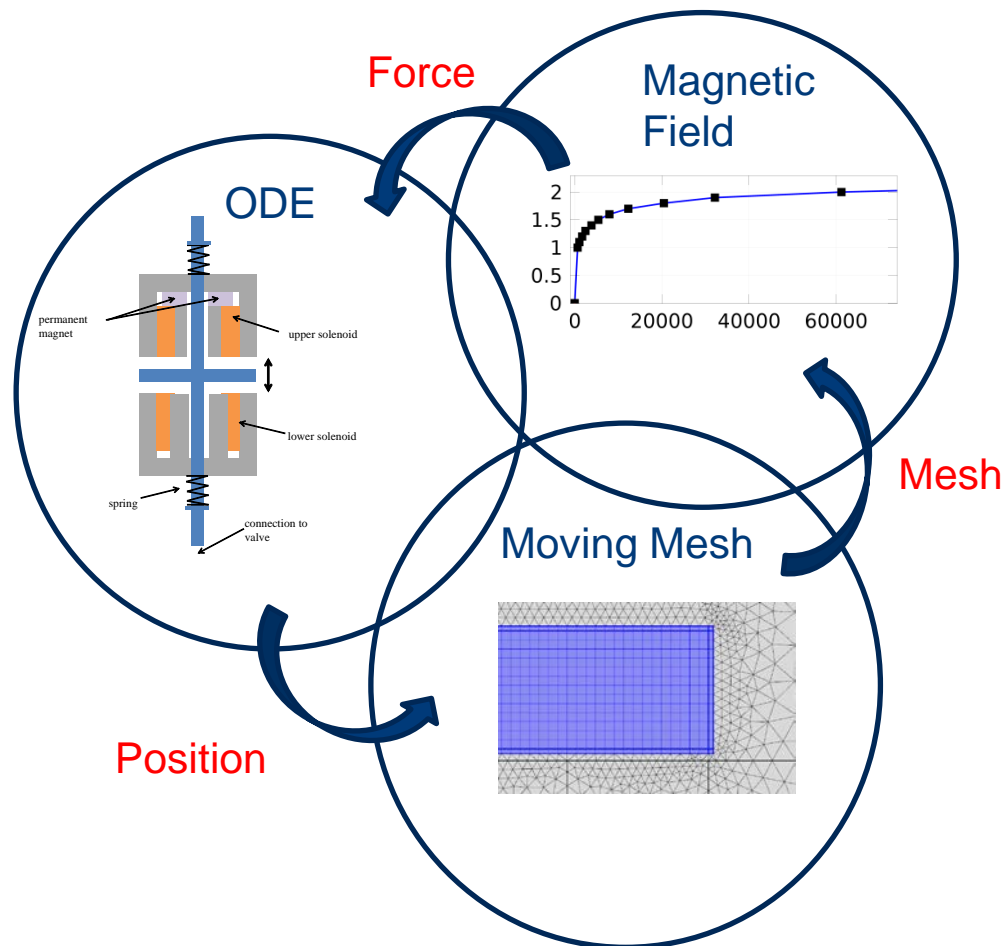$$\ddot{x} = \frac{1}{m}(F_A - c \cdot x - d \cdot \dot{x})$$

Modeling the concept with COMSOL

Surrounding boundaries

Exterior boundaries of the deformable area

Modeling the concept with COMSOL

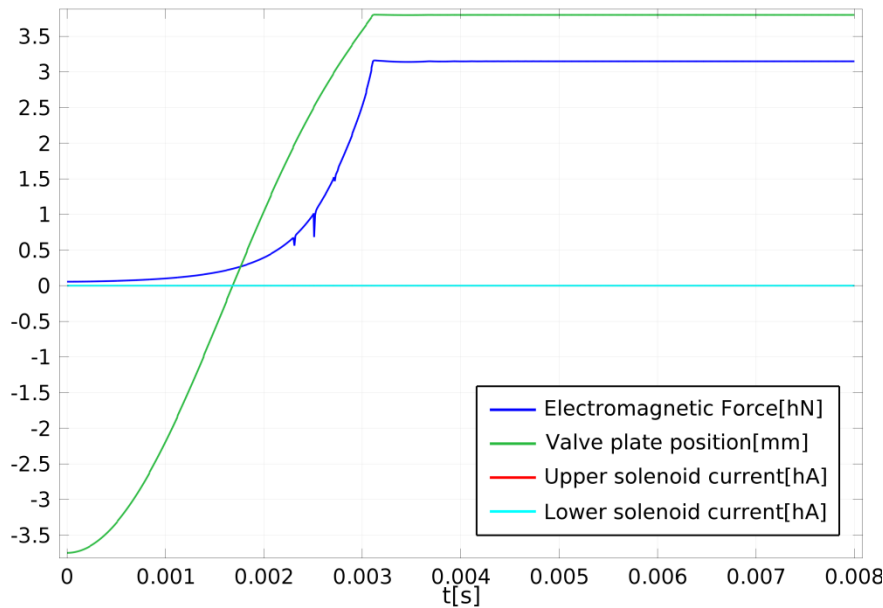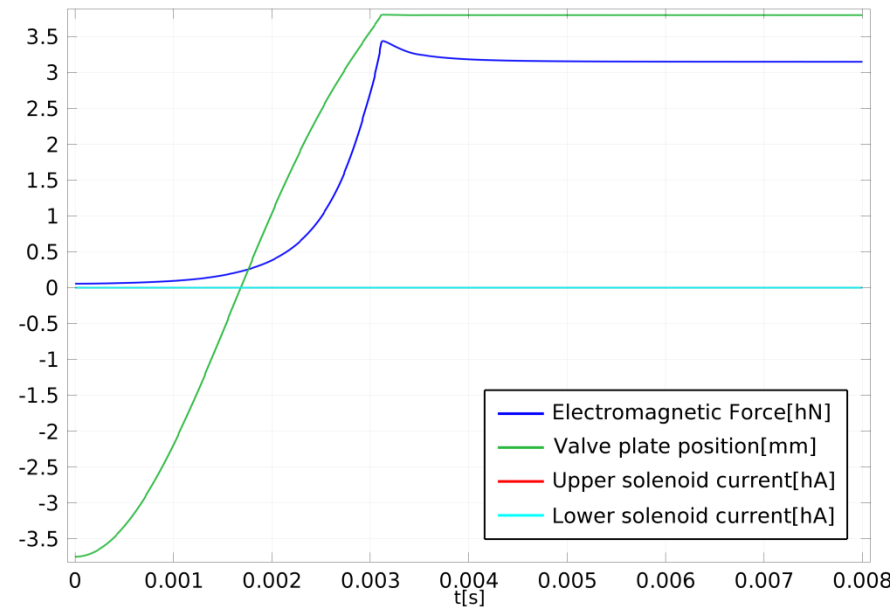# A few results of the transient analysis
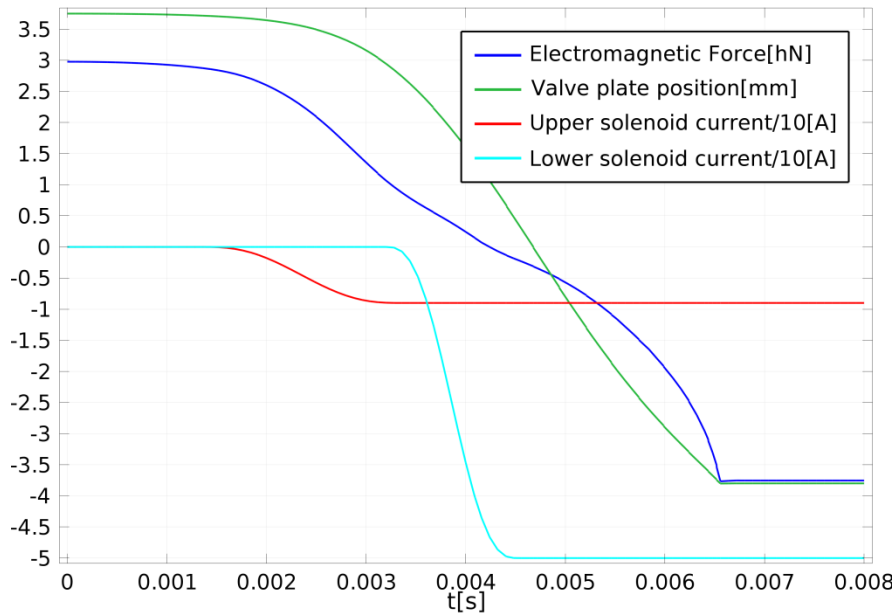
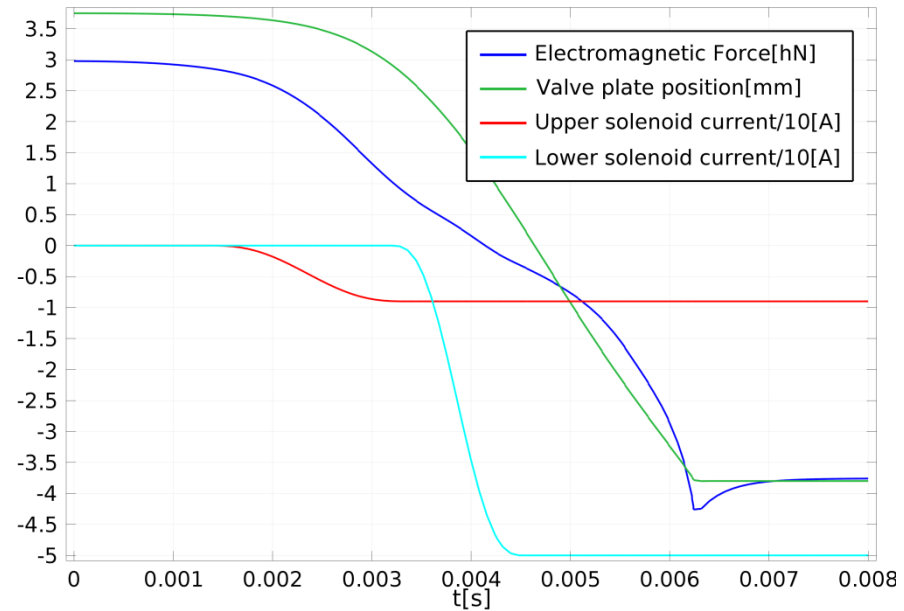● Test the fail-safe behavior

A few results of the transient analysis

- Normal transition mode

Eddy currents deactivated, starting point: upper limit

Eddy currents activated, starting point: upper limit

Thank You