

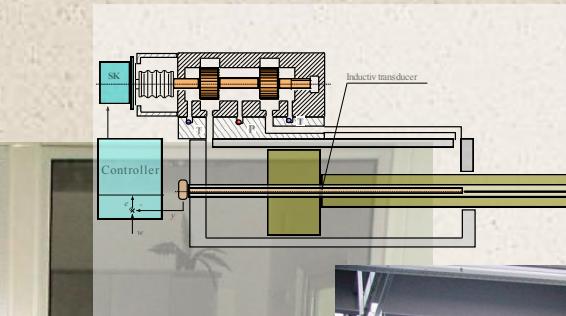
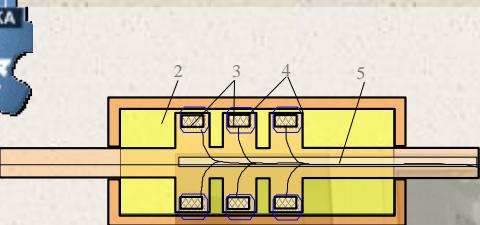


# Investigations area

- ❖ **Design and investigation of electrohydraulic devices**
  - ❖ Theroretical analysis and modelling
  - ❖ New valves and other elements development
  - ❖ New control methods used for valve and drives
  - ❖ Special design and applications (low velocity)
- ❖ **MR Fluids applications**
  - ❖ Dampers and brakes
  - ❖ Shock absorbers
- ❖ **Automation of hydraulic devices (PLC,  $\mu$ C)**
  - ❖ PID, state, adaptive and other advanced control methods
  - ❖ Artificial intelligence in control
  - ❖ PLC, PC controllers
  - ❖ Microcontrollers



# HYDRAULICS LABORATORY

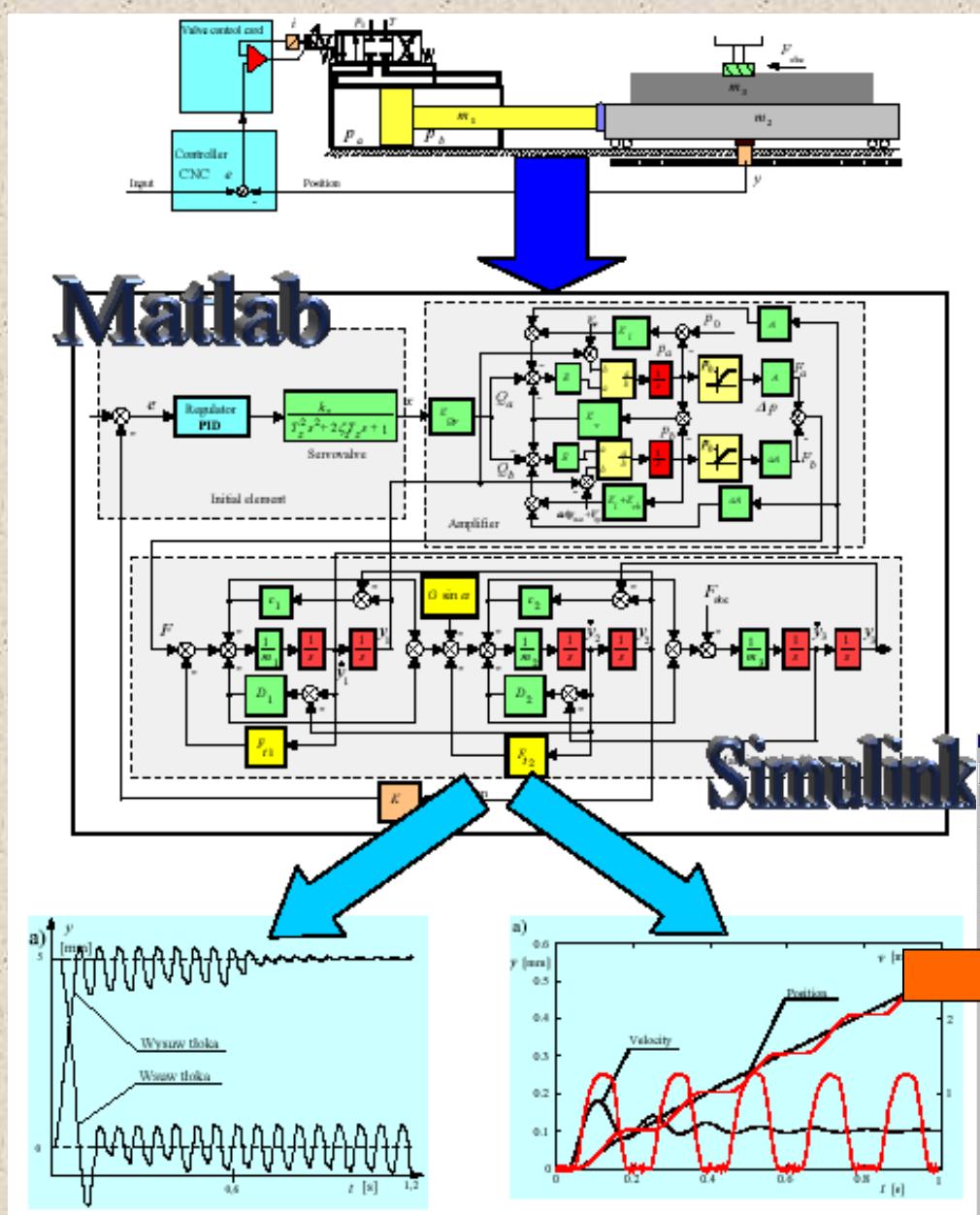


# HYDRAULICS LABORATORY

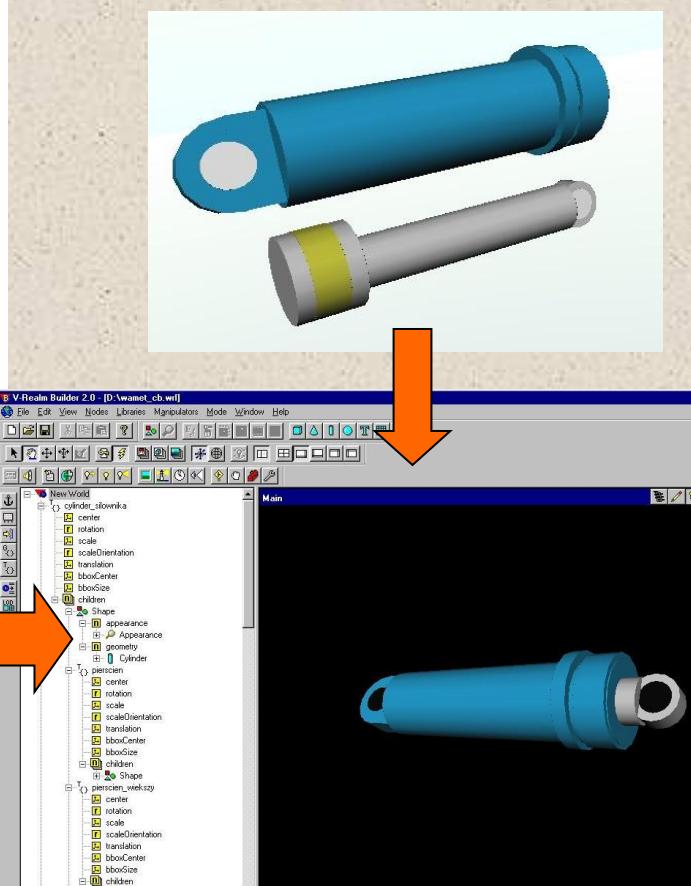
## Equipped with:

- ❖ Hydraulic supply unit:  $P = 37 \text{ kW}$ ,  $Q = 100 \text{ dm}^3/\text{min}$  i  $p_0 = 40 \text{ MPa}$ ,
- ❖ filtration 6  $\mu\text{m}$ ,
- ❖ Hydraulic supply unit:  $P = 5 \text{ kW}$ ,  $Q = 10 \text{ dm}^3/\text{min}$  i  $p_0 = 20 \text{ MPa}$ , filtration 5  $\mu\text{m}$
- ❖ Different electrohydraulic servo drives with servovalves and proportional valves: Boschrexroth, Moog, Vickers, PZL-Hydral, Ponar-Wadowice with electronic control cards and units,
- ❖ PLC, PC computers for control and data collecting,
- ❖ Different sensors (position, pressure, flow, force, moment) and measure systems (DMC plus Hottinger Baldwin),

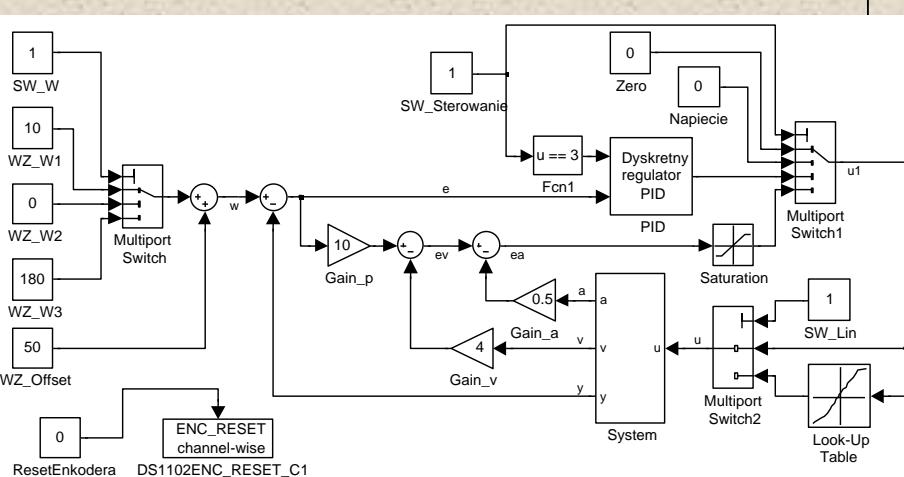
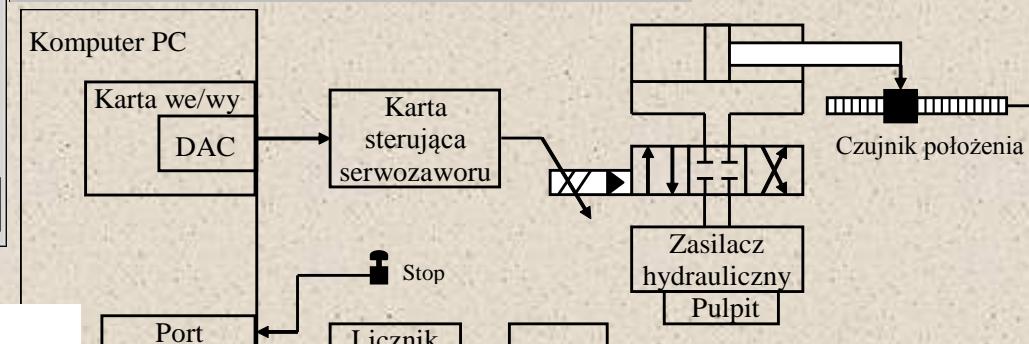
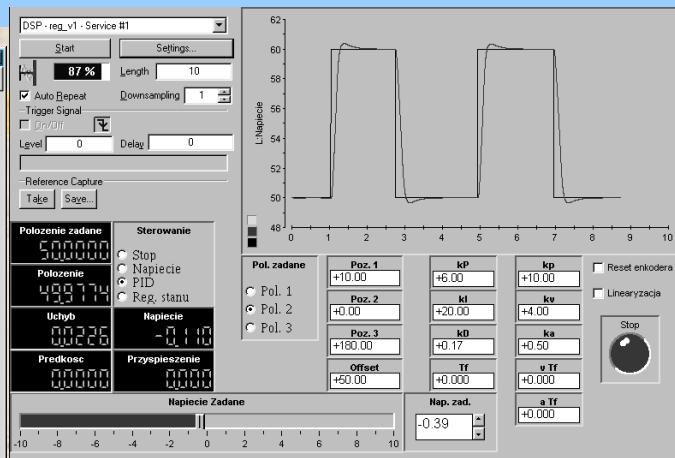
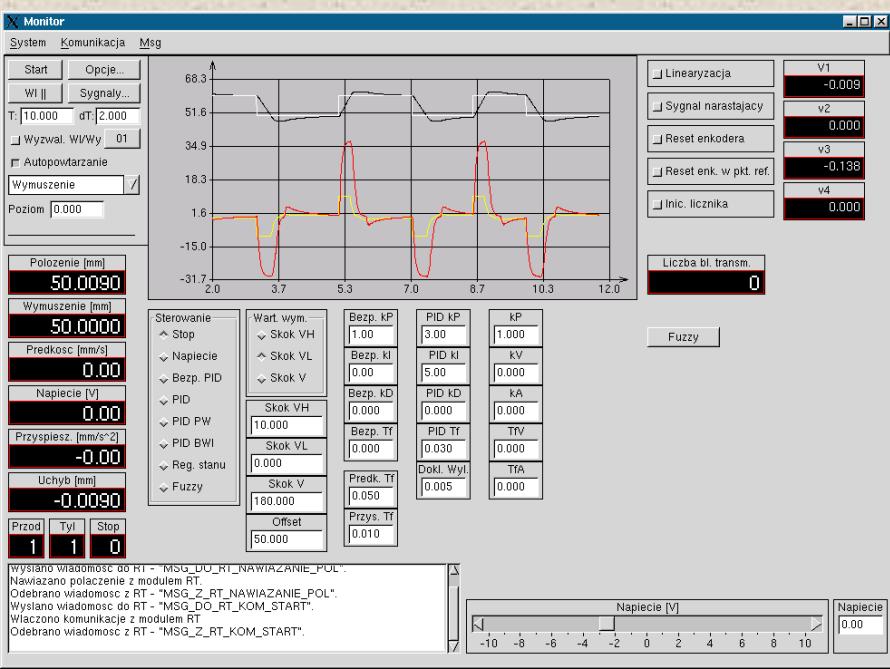
# MODELLING with MATLAB-SIMULINK



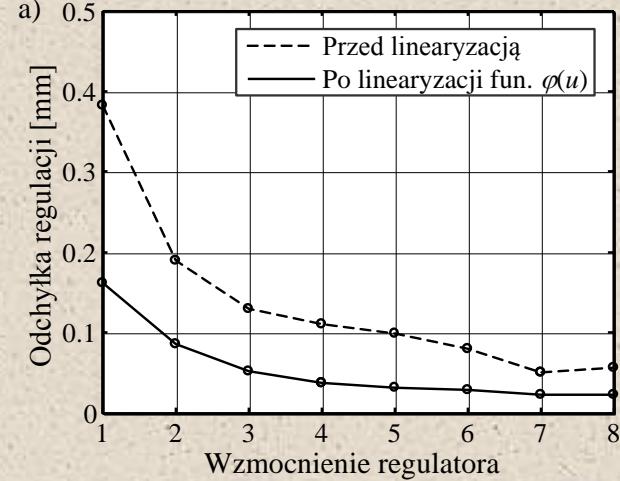
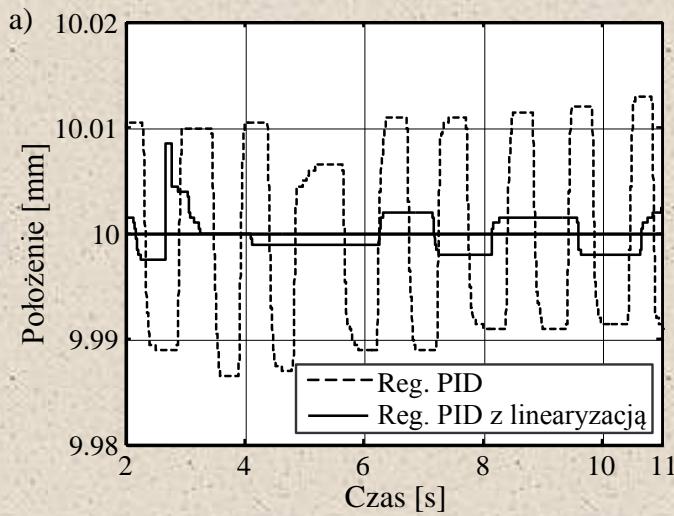
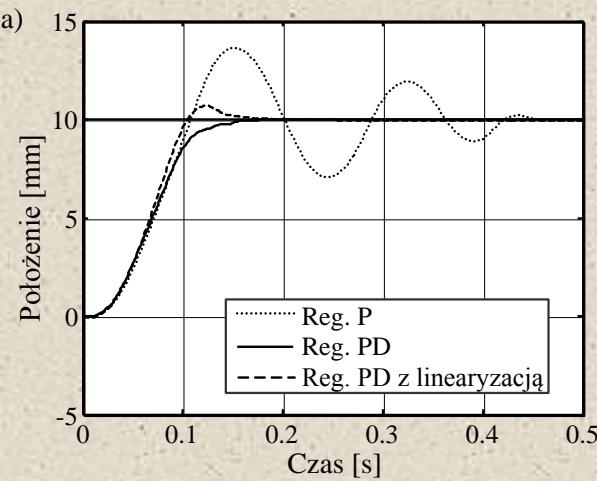
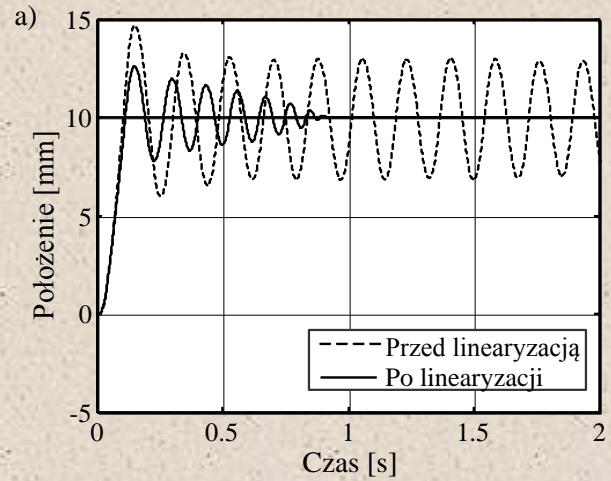
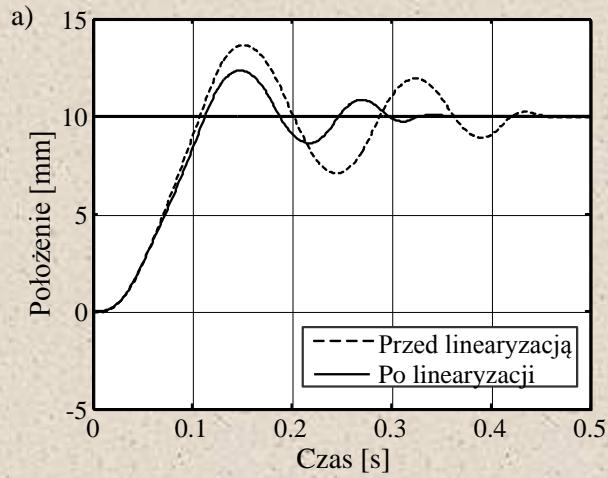
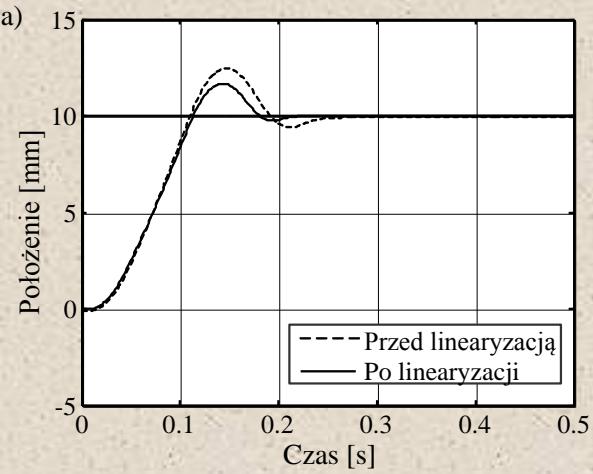
Virtual reality in investigations of electrohydraulic devices



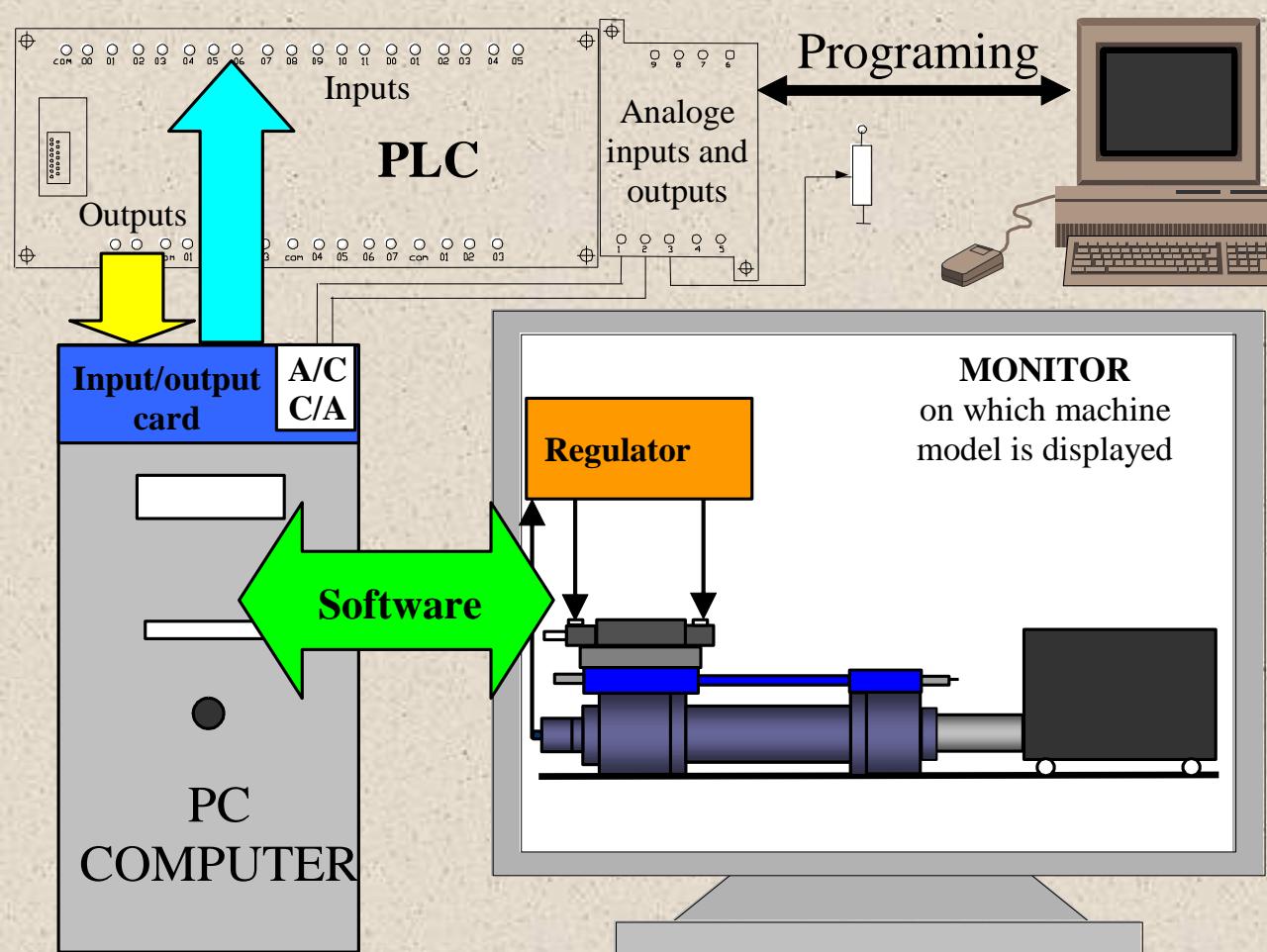
# Advanced software tools for control



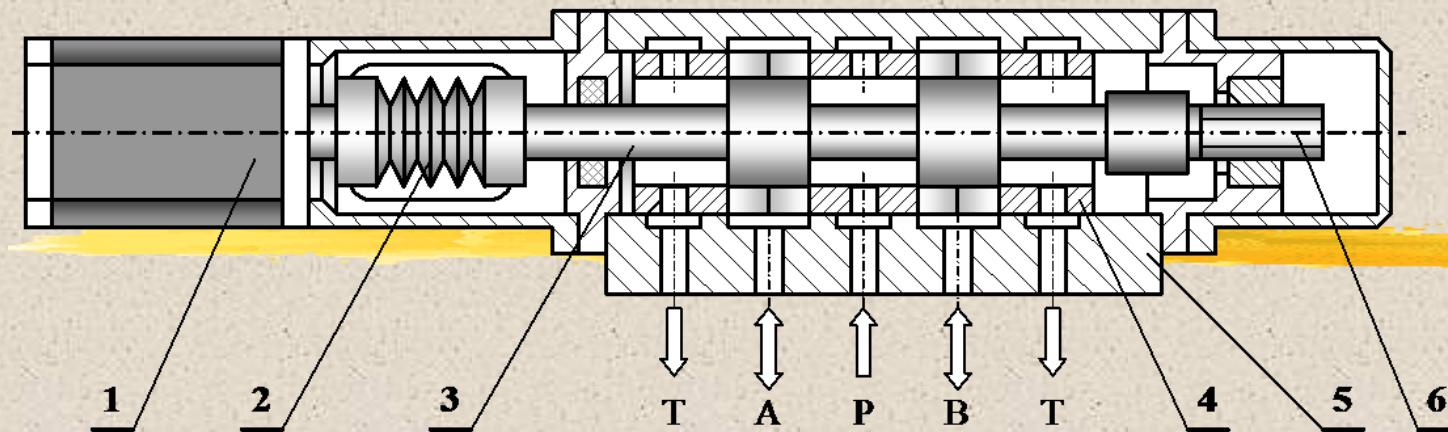
# Characteristics linearization



# Hardware in the Loop (HIL)

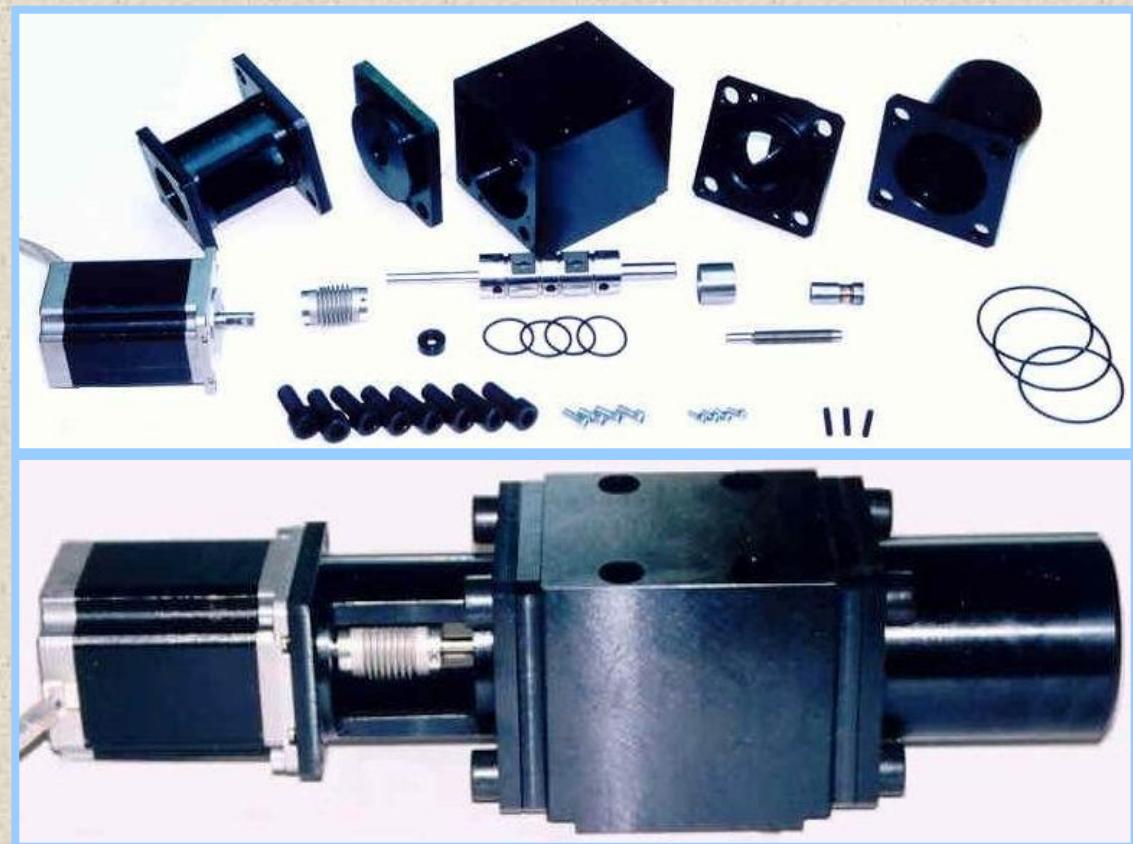


**The real controller  
controls the  
simulation model  
of electrohydraulic  
drive**

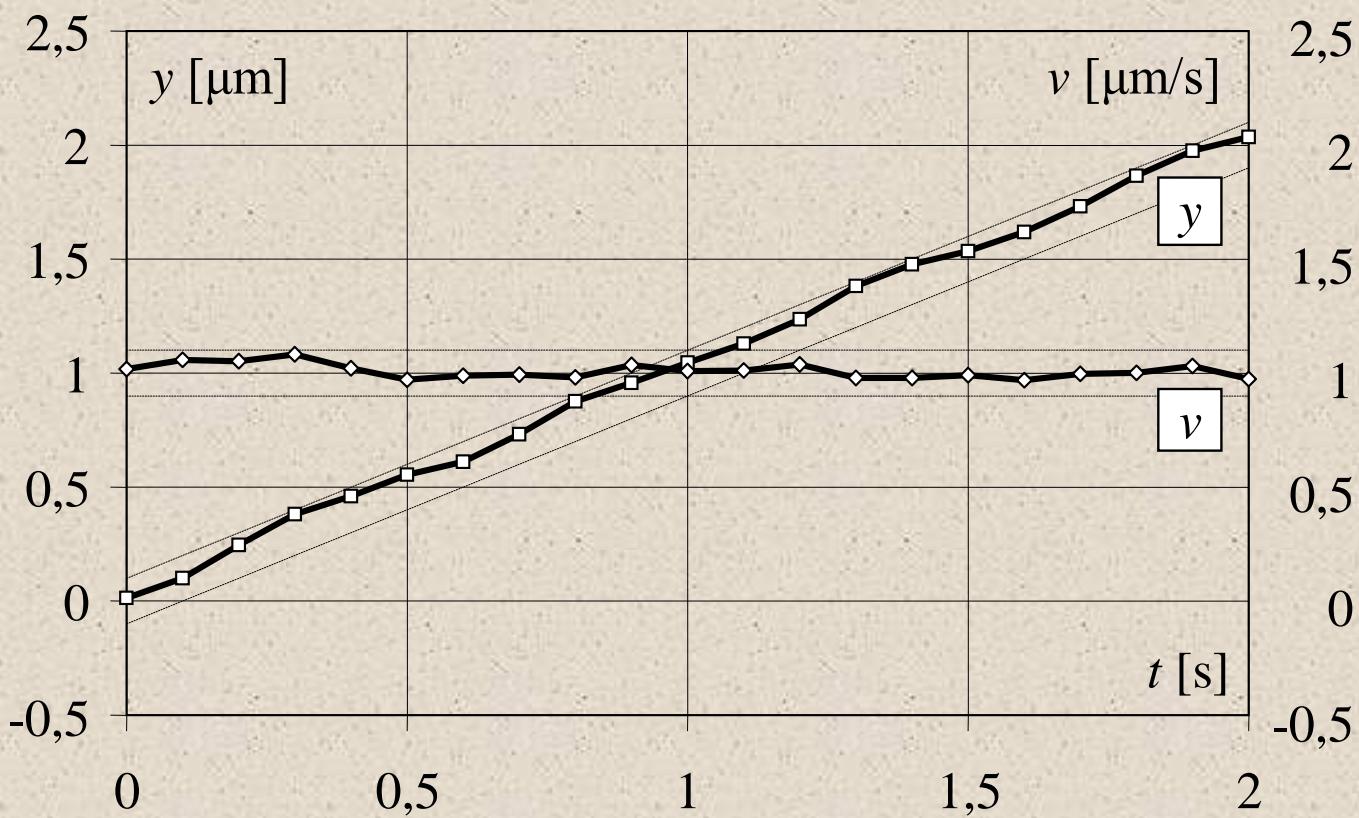


# The valve controlled by stepping motor

- 1 - stepping motor,**
- 2 - bellows clutch,**
- 3 - spool,**
- 4 - clutch,**
- 5 - nut,**
- 6 - screw.**

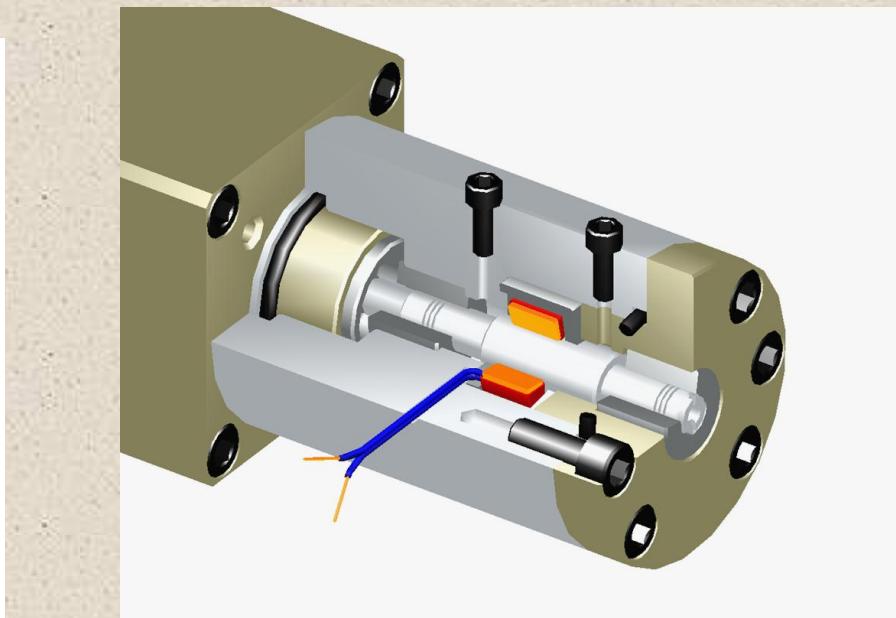
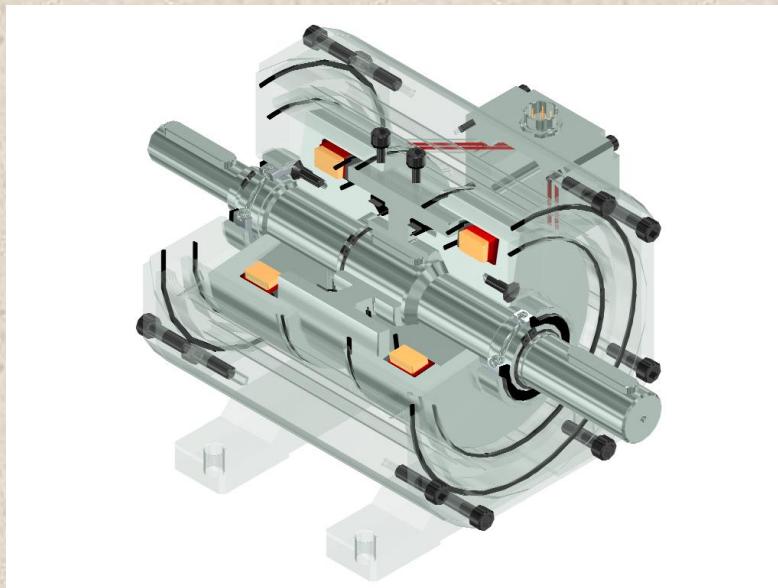
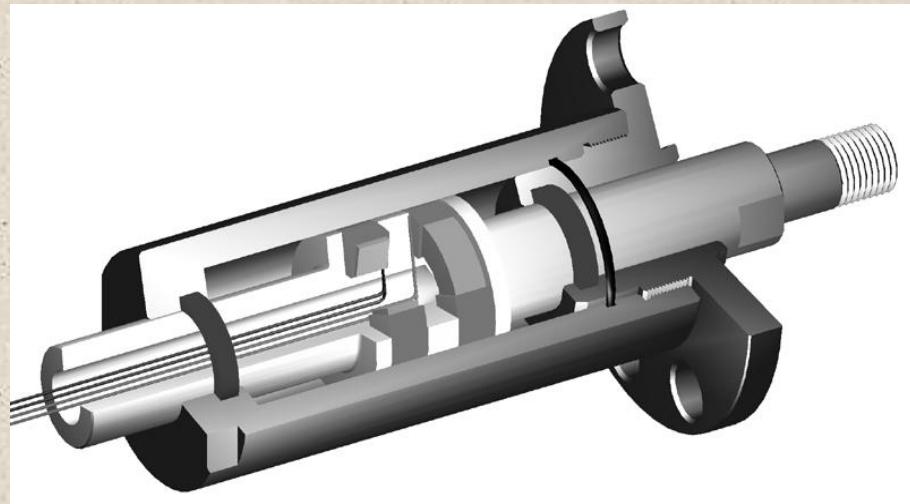
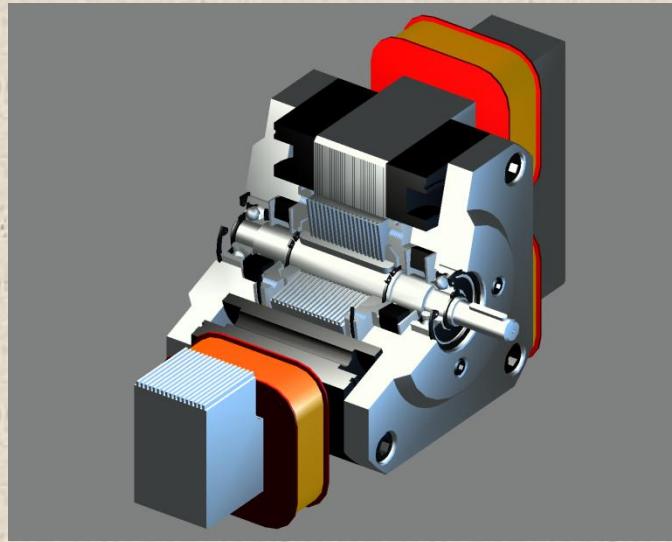


# Cylinder velocities at triangular gap shape of hydraulic control valve (pressure 8 MPa)



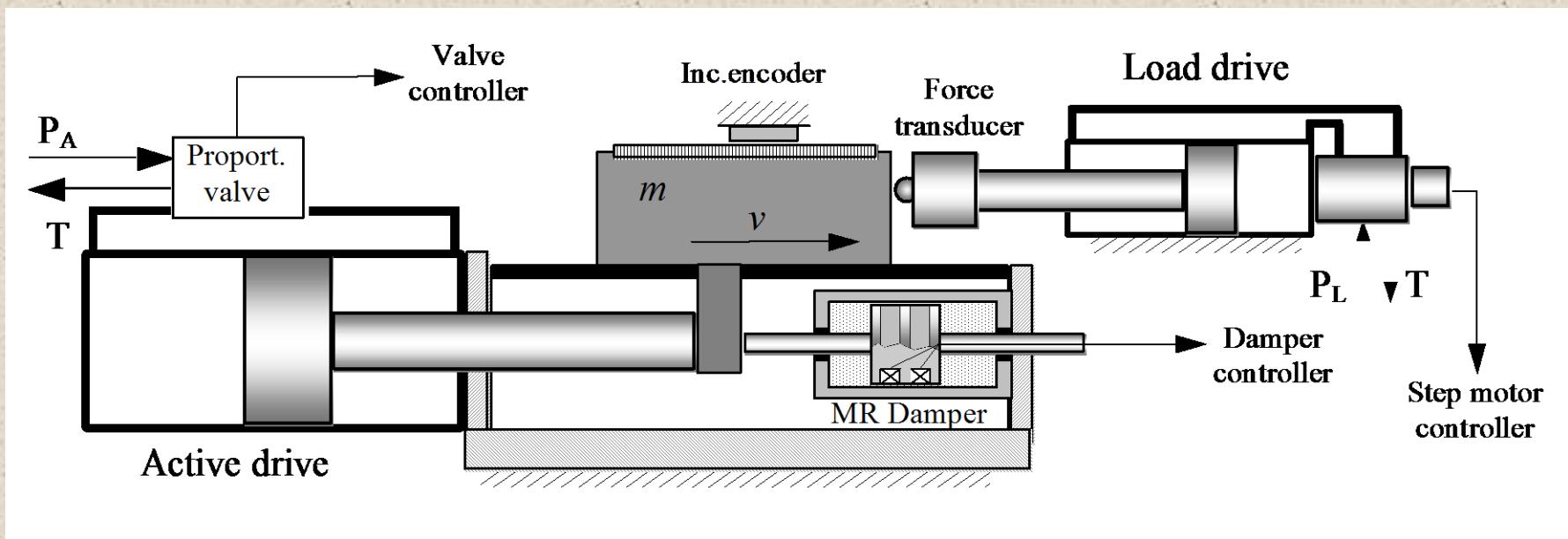
The drive is able to move with constant velocity: 1 um/sec.

# MADE AT PUT MRF DAMPERS



# The usage of MRF damper to reduce velocity peak

- Minimising velocity changes under variable load conditions
- Rapid load drops creates velocity jumps with value few times bigger than assumed constant velocity
- MRF damper inserted to the drive chain system can limit velocity jumps.
- Such damper can fast react on rapid load disappearing like breaking device and gradually equalize motion to desired level.

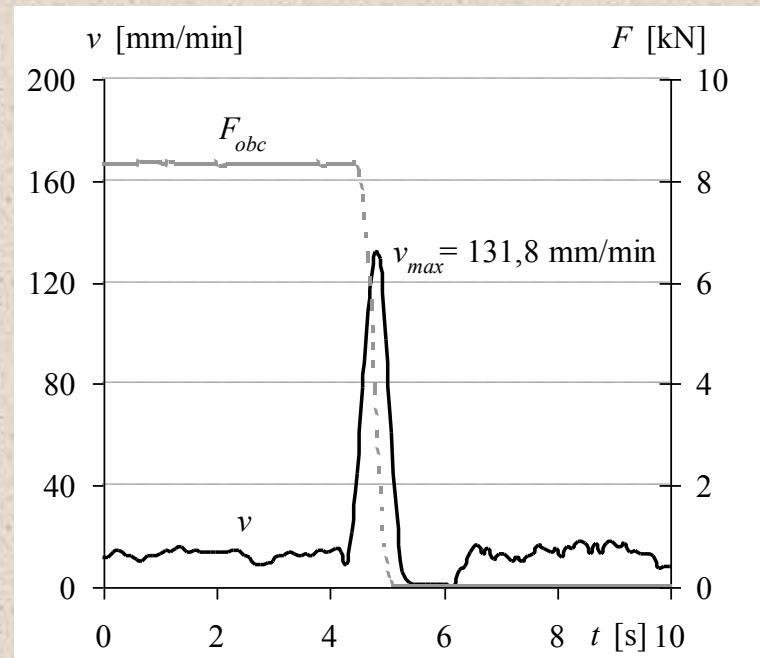
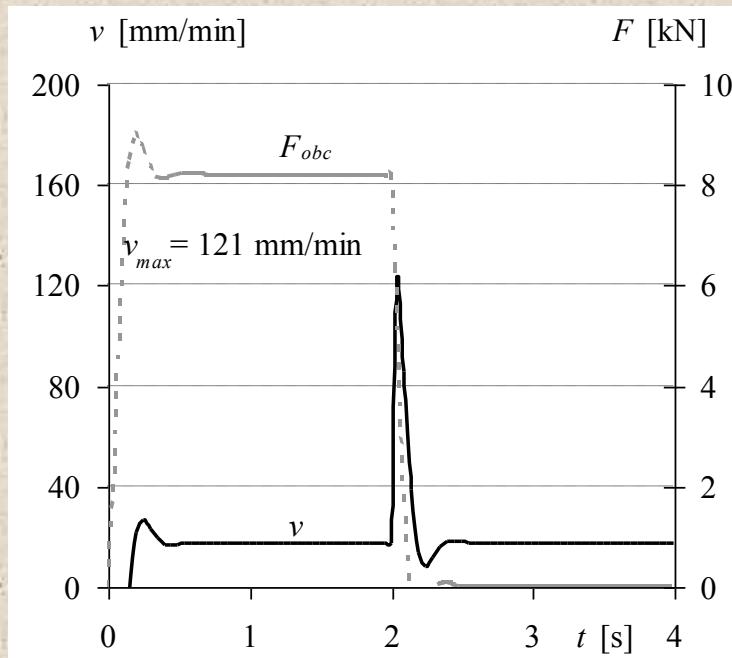


# Comparison of simulation and experimental results, case without damper

Velocity perturbations appeared after 8 kN rapid load drops,  
velocity 20 mm/min

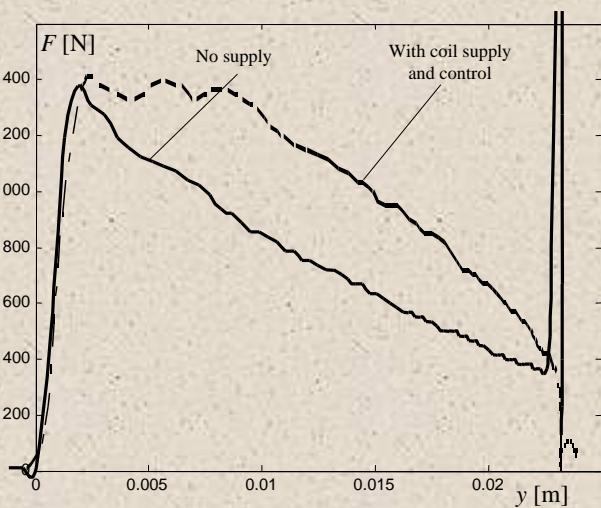
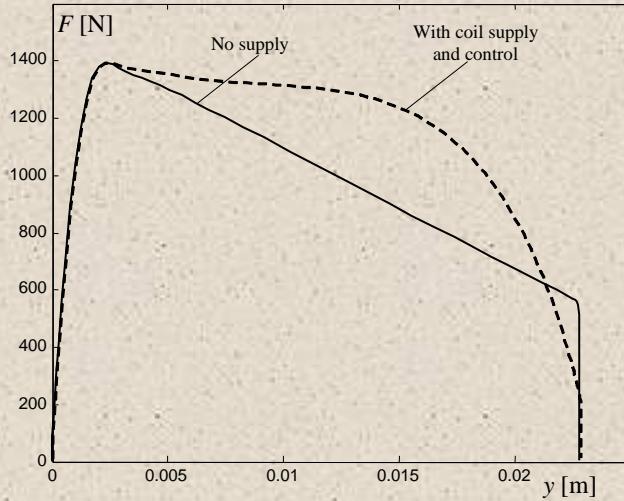
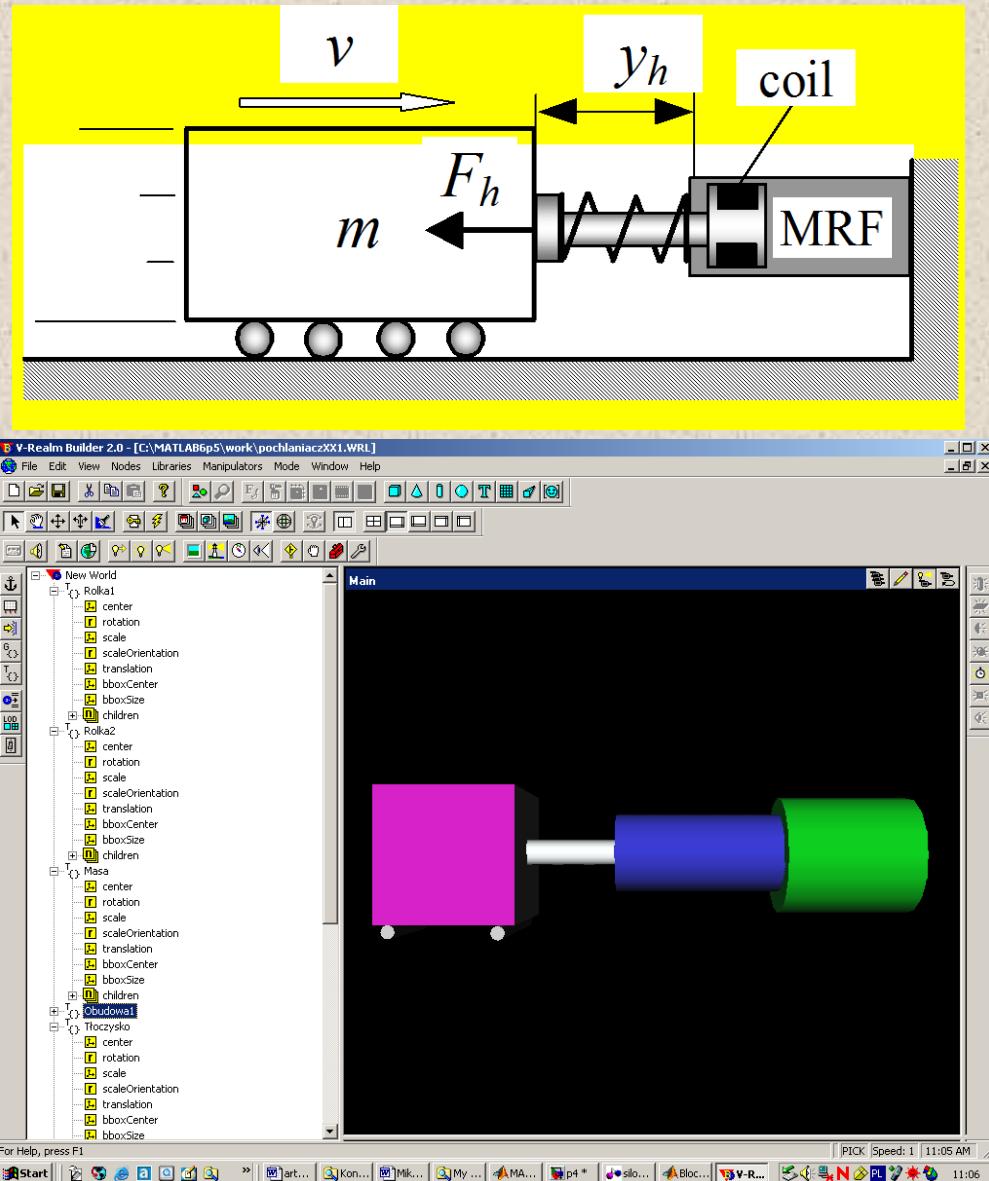
**simulation**

**experiment**



simulation:  $v_{max} = 121,0 \text{ mm/min}$ ,  $\delta_{vd} = 5,4 \%$   
experiment:  $v_{max} = 131,8 \text{ mm/min}$ ,  $\delta_{vd} = 7,2 \%$

# MRF shock absorbers



MR damper is used for controllable stopping of a mass