

Development of TRW's Active Roll Control

16th European Mechanical Dynamics Users' Conference
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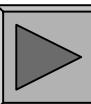
TRW Automotive – Chassis Systems
Global R&D Center Steering & Suspension
TRW Fahrwerksysteme Düsseldorf, Germany

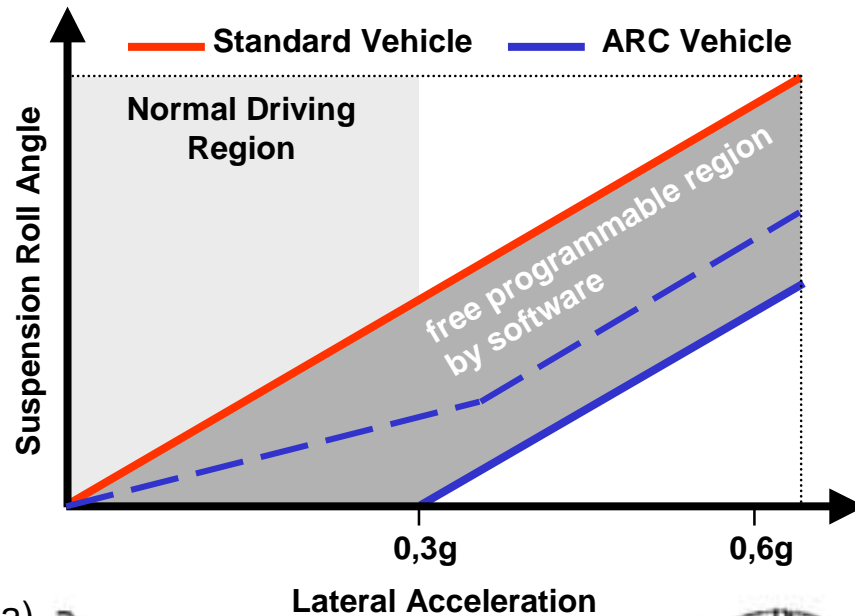
Overview

- **Active Roll Control (ARC)**
- **Modelling**
- **Simulation Results**
- **Summary**

What is **Active Roll Control** ?

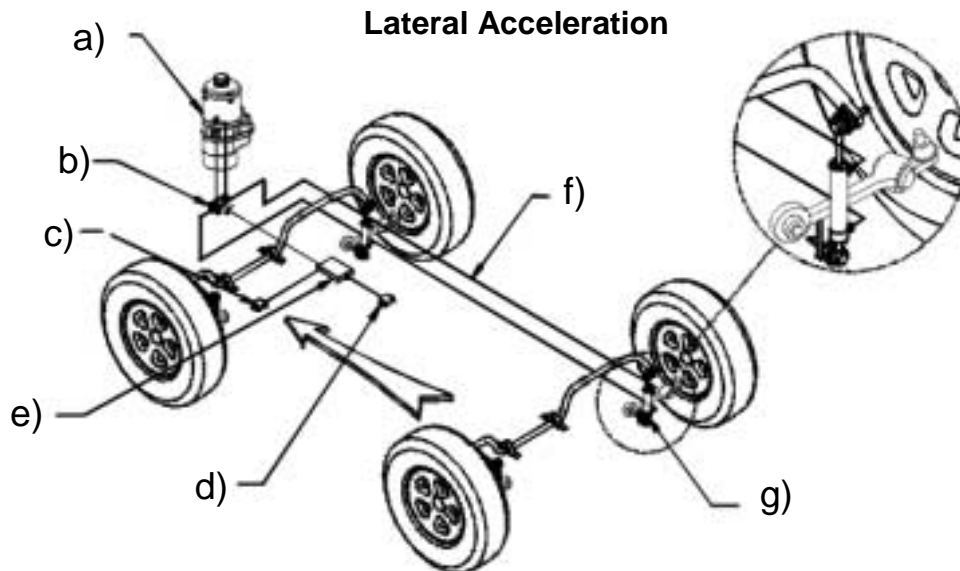
TRW's Active Roll Control (ARC)
is a new active
suspension system to improve
vehicle roll behaviour and ride comfort





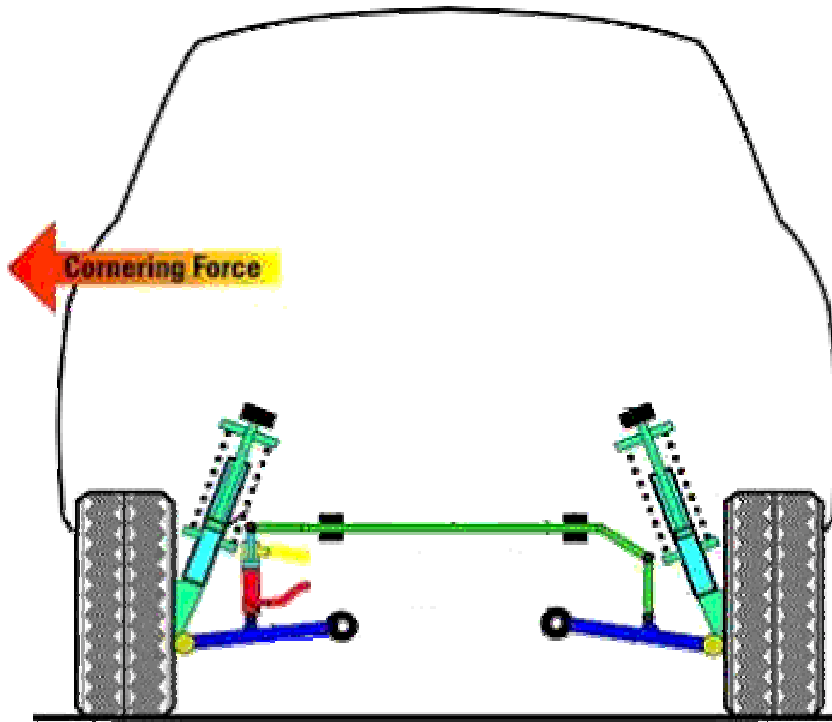
Benefits

- Roll Angle Control
- Ride and Handling Improvement
- Improve Subjective Agility

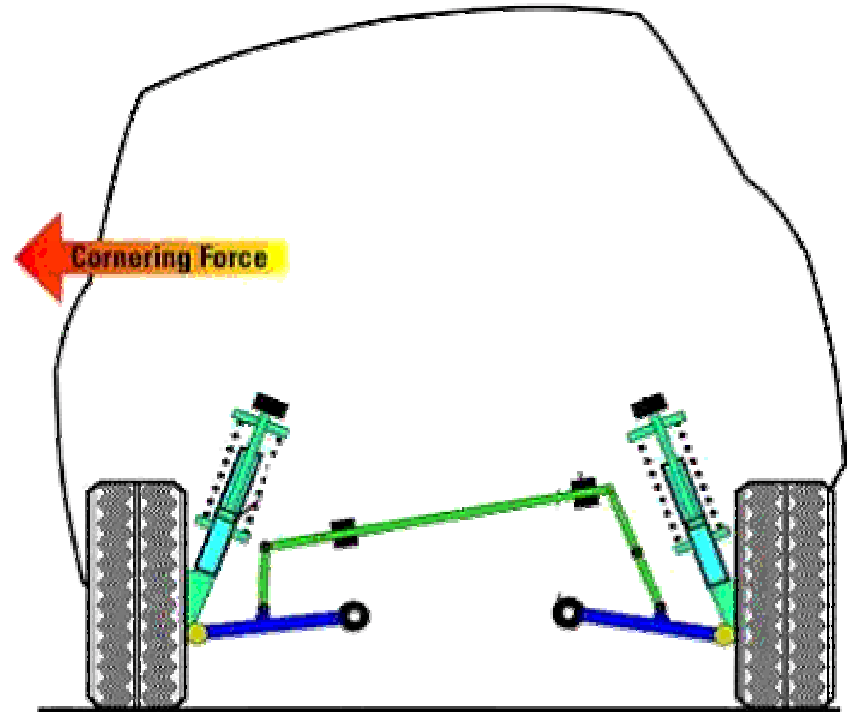


ARC system components

- a) Motor Pump Assembly
- b) Valve Block
- c) Steering Angle Sensor
- d) Lateral Accelerometer
- e) Control Unit
- f) Hydraulic Lines
- g) Linear Actuators



**Cornering Roll with ARC -
Actuator deflects stabilizer bar.
Body roll angle is minimised.**

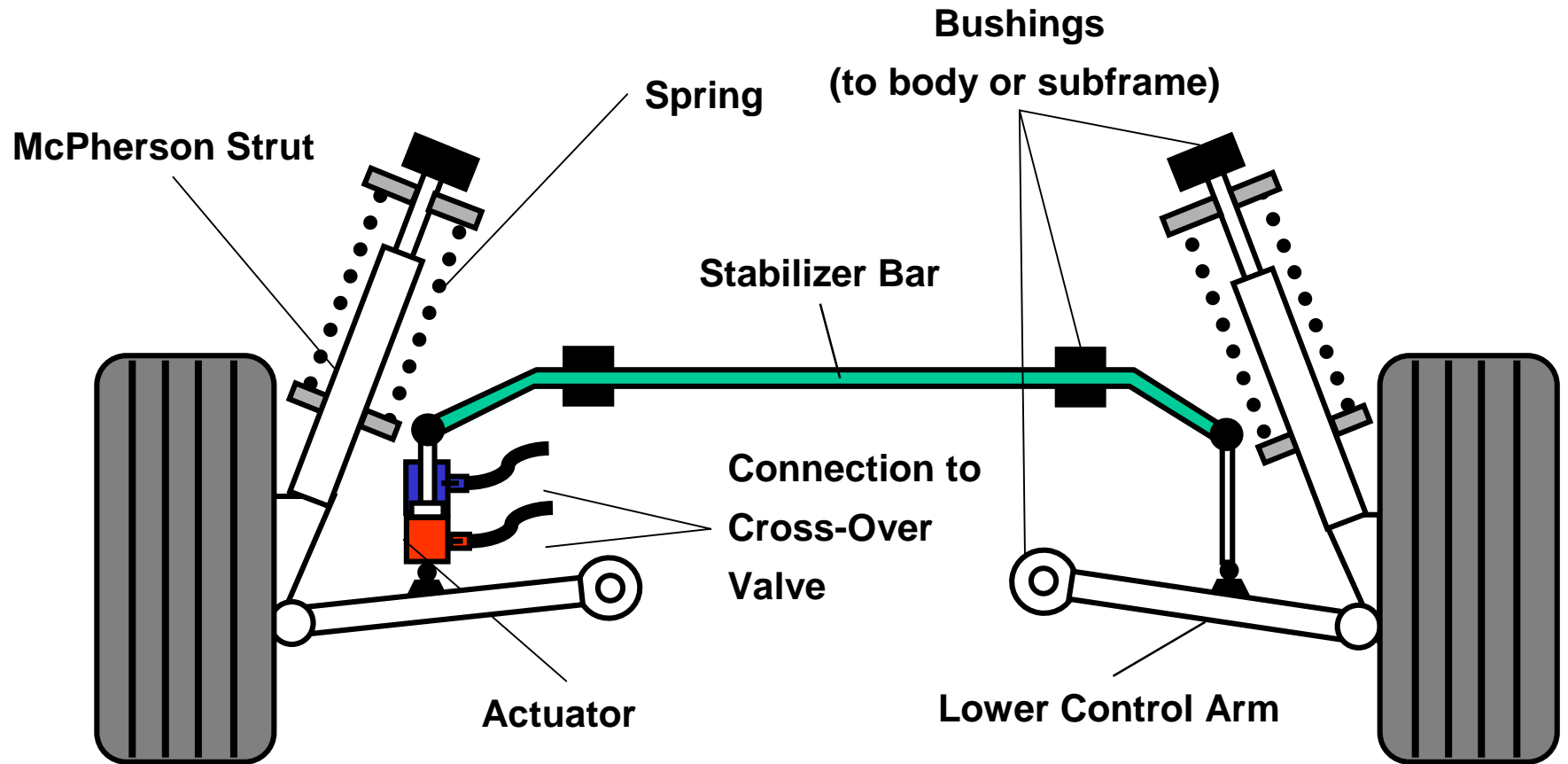


**Cornering Roll without ARC -
Stabilizer bar deflects due to
body roll motion.**

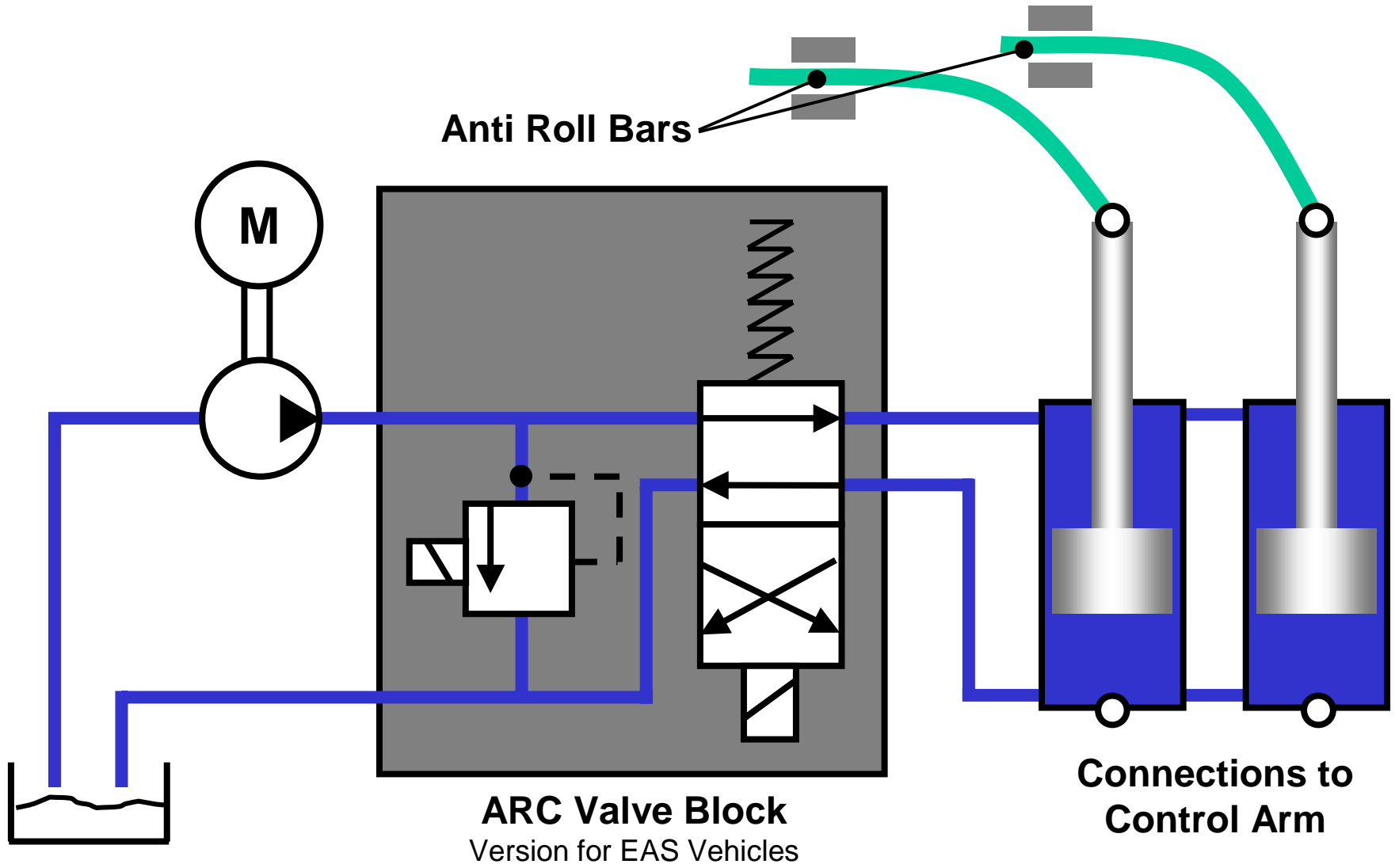
Active Roll Control Suspension Design Principle

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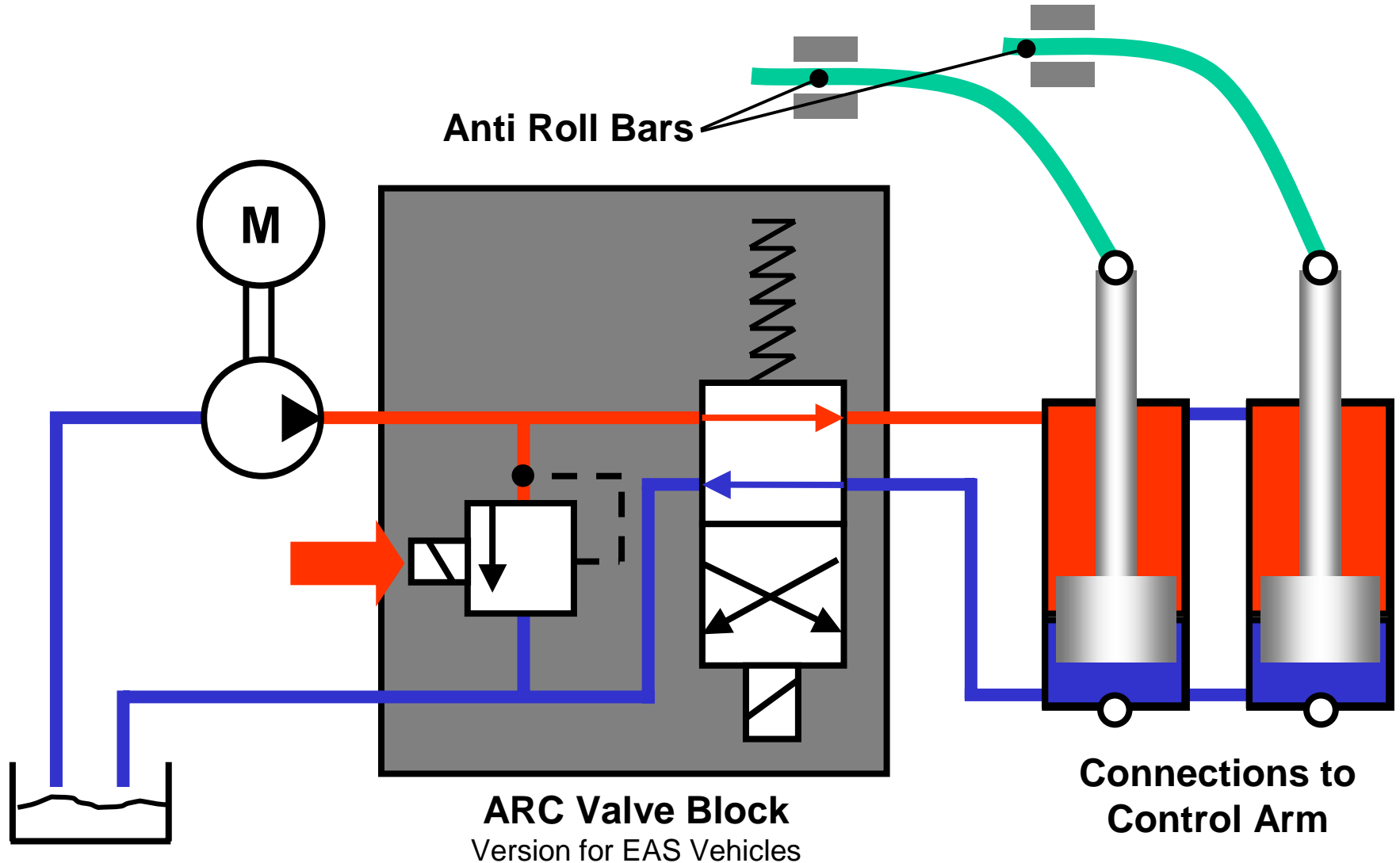
Active Roll Control System Function (Straight Ahead Conditions)



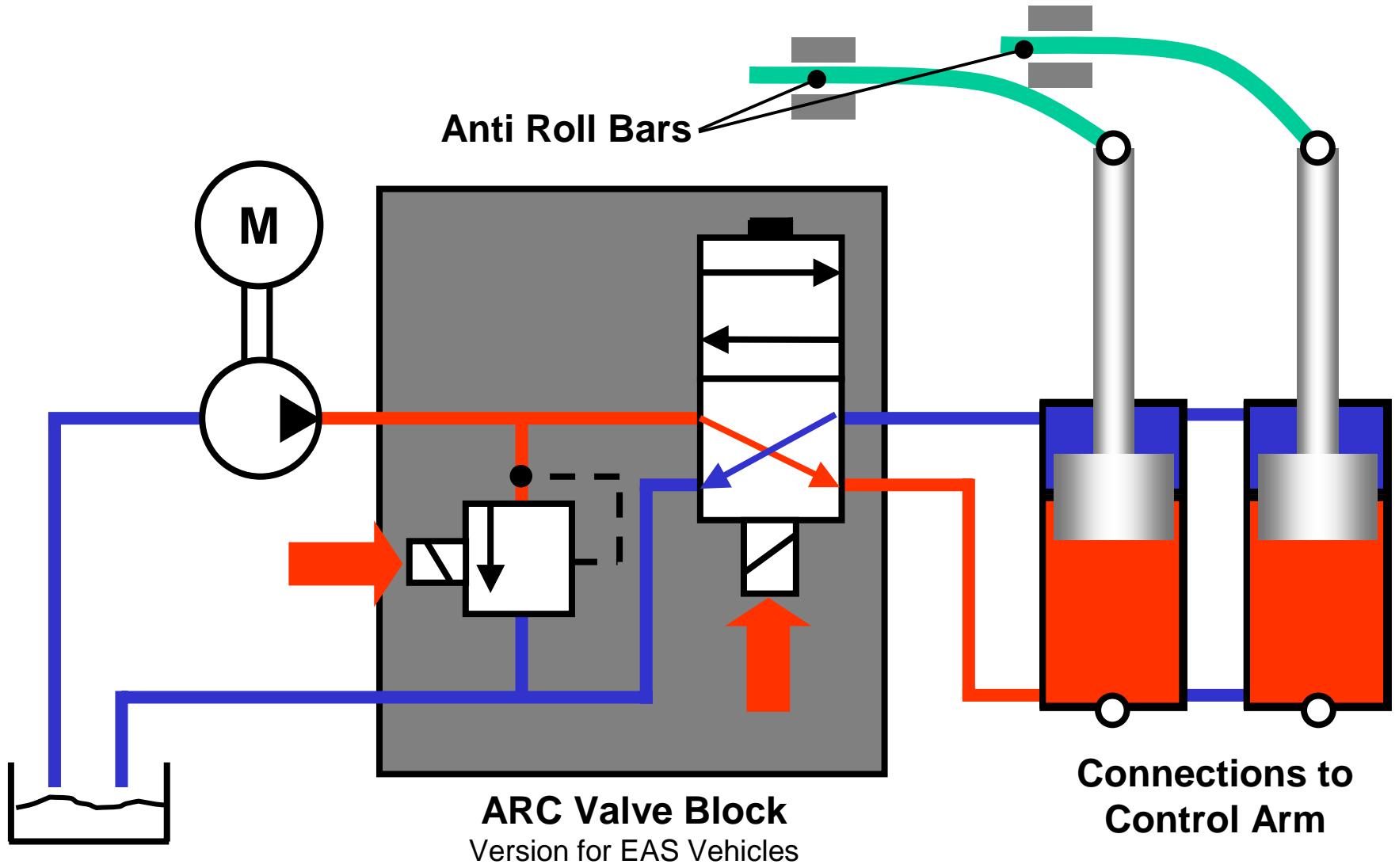
Active Roll Control System Function (Cornering)

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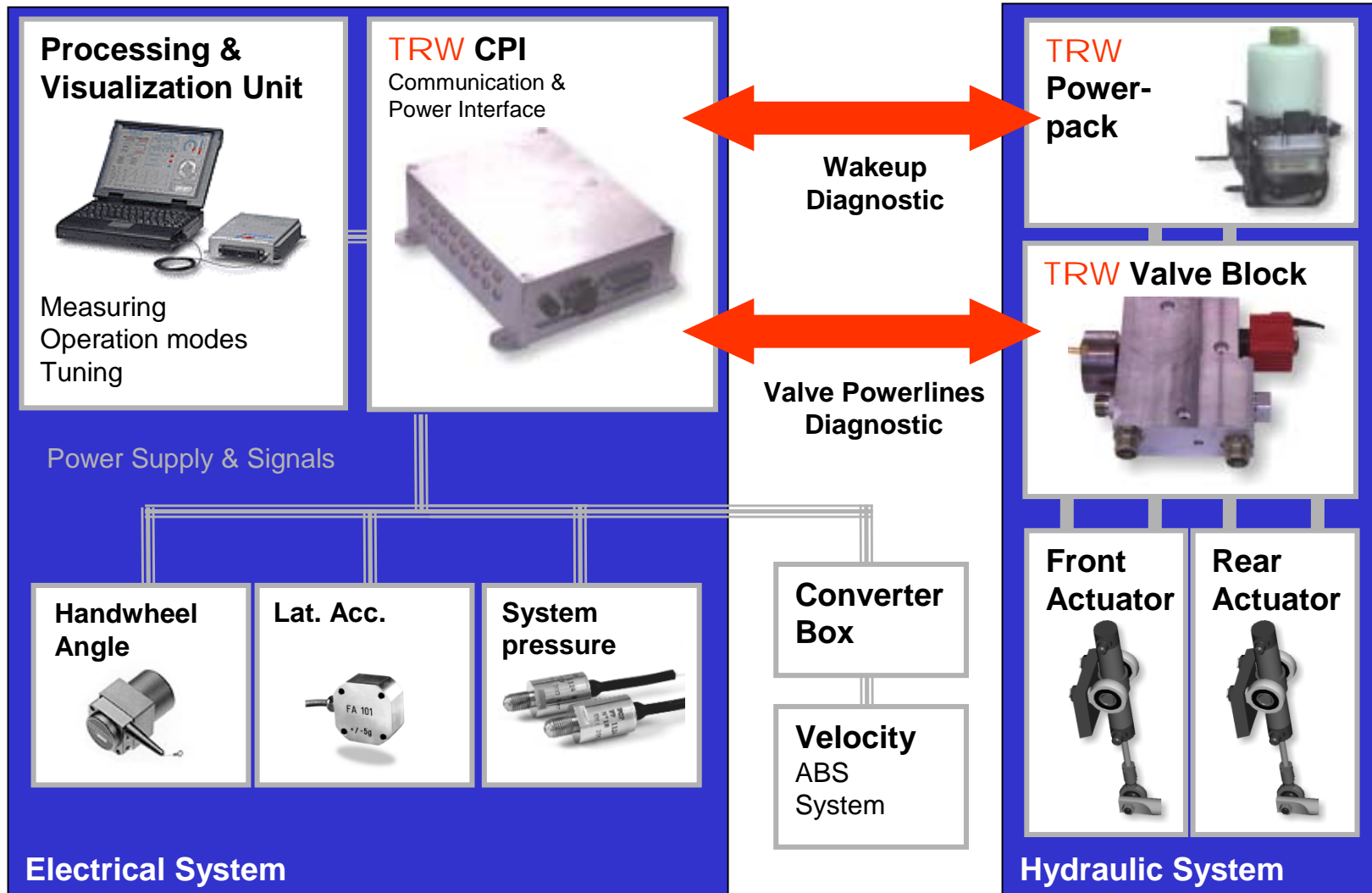
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Active Roll Control System Function (Changing Direction)

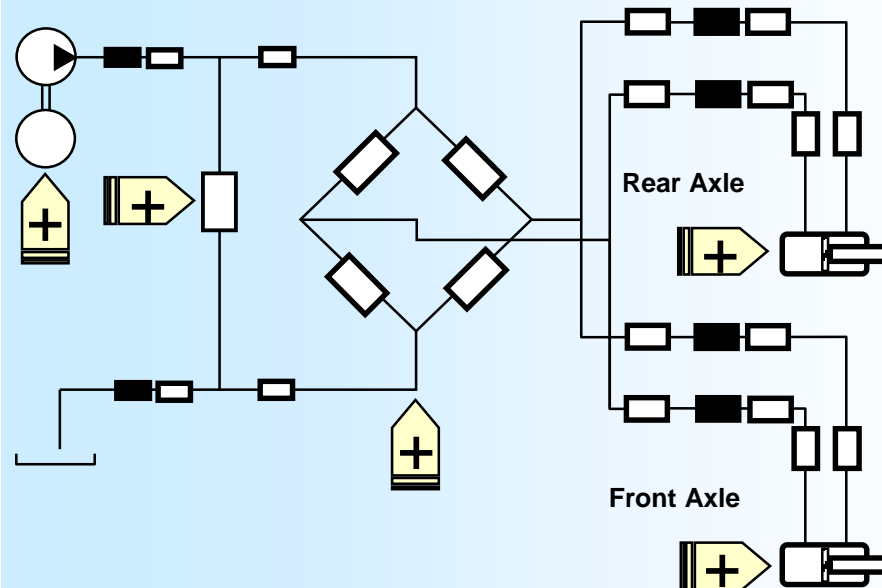


Active Roll Control Physical Structure



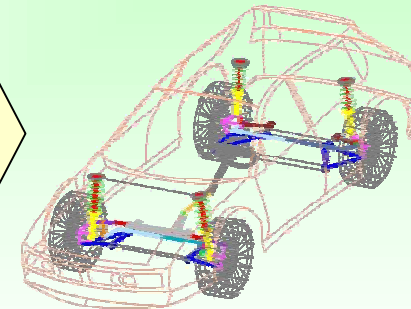
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Mechanical System:

- ADAMS View model or
- ADAMS Car full vehicle model
- Cylinder and bracket model



Coupling:

- Piston force (pressure)
- Piston position
- Piston velocity (fluid flow)

Coupling:

- Vehicle velocity
- Lateral acceleration
- Steering angle

Hydraulic System:

- Differential equation system.
- Feed- and return line divided into time constant, capacitive and inductive elements.
- Valve is a system of adjustable orifices with time lag characteristic.
- Pump modelled as variable flow source.

Diff.-Eqn-System:

$$p_1 = f(Q_1, Q_2, RCL, t)$$

$$p_2 = f(Q_2, Q_3, RCL, t)$$

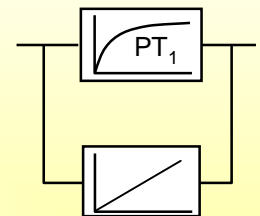
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Coupling:

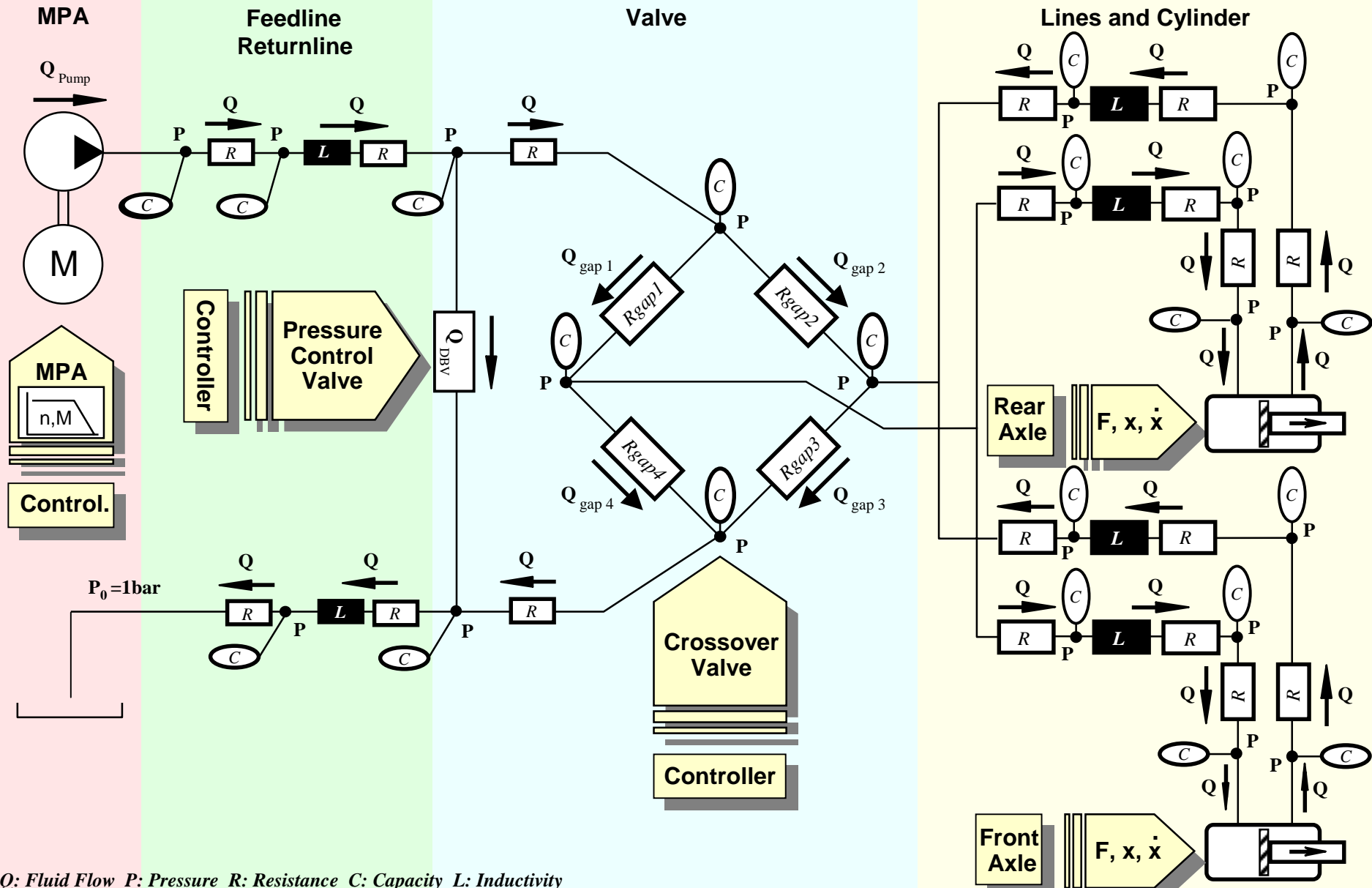
- Switches crossover valve
- Drives pressure control valve
- Controls MPA

Control System:

- Using ADAMS control tools or
- Detailed controller in Matlab/Simulink



Modelling Hydraulic System

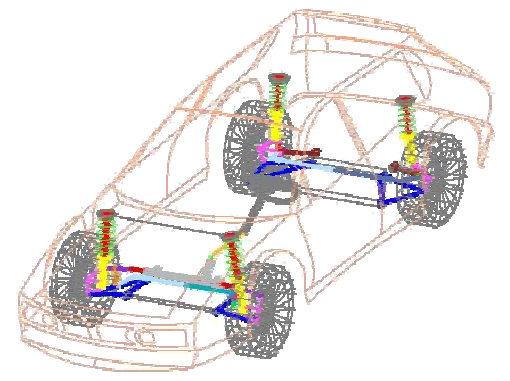
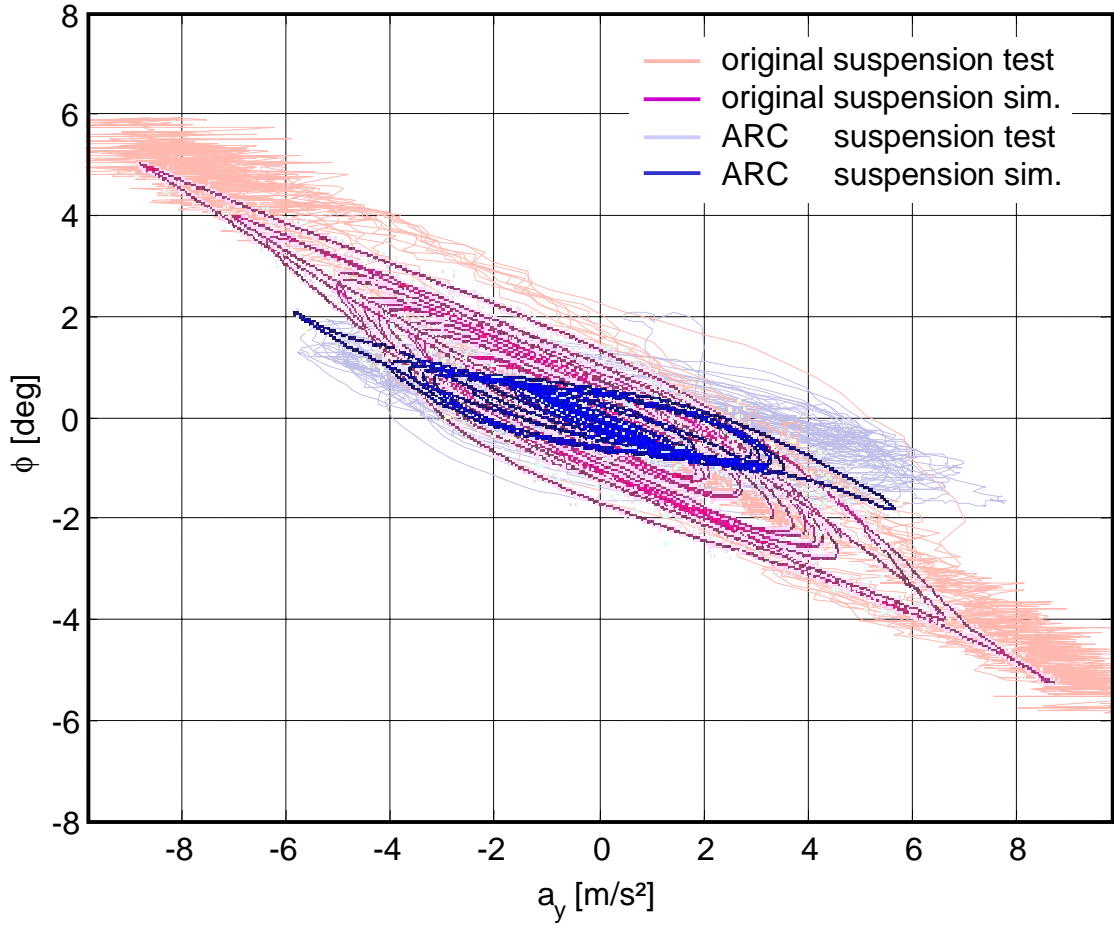


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ARC roll characteristic

roll angle vs. lateral acceleration

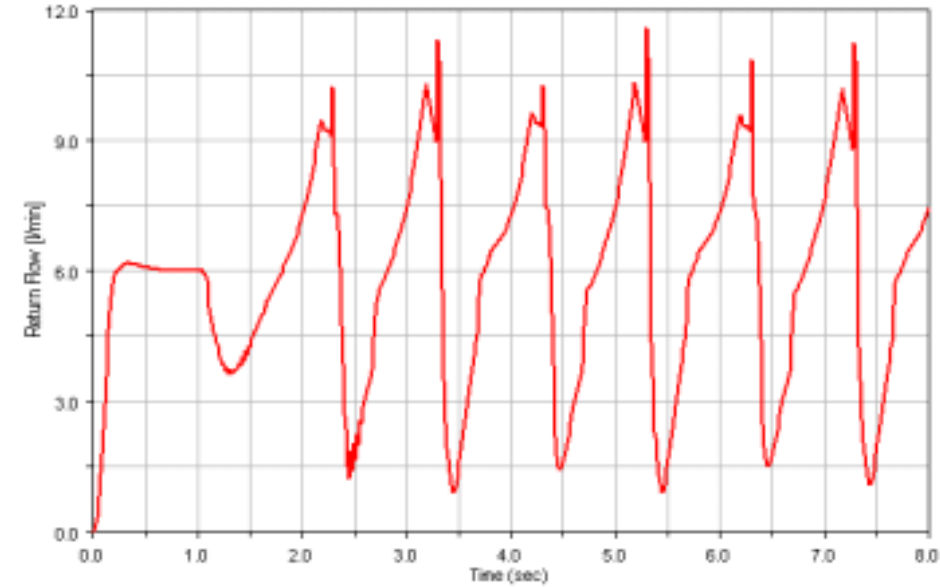
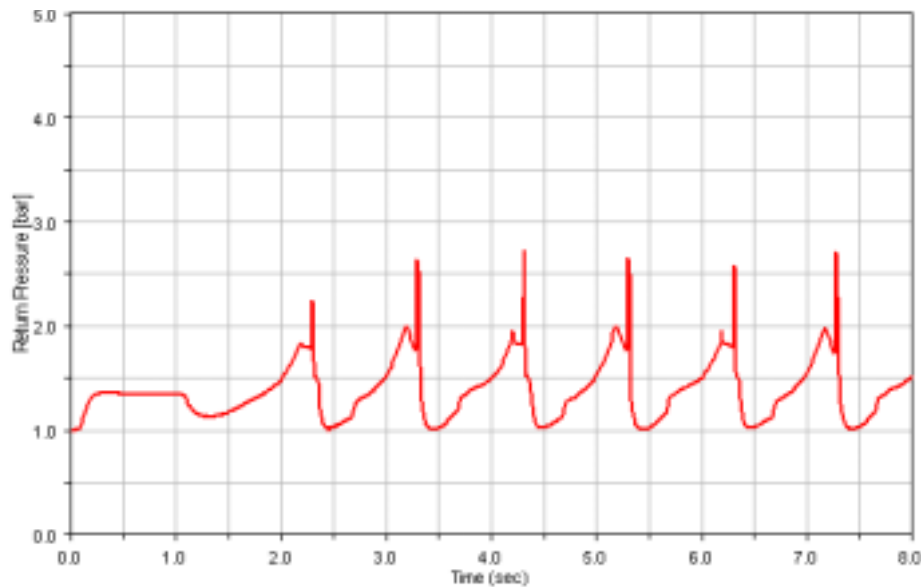
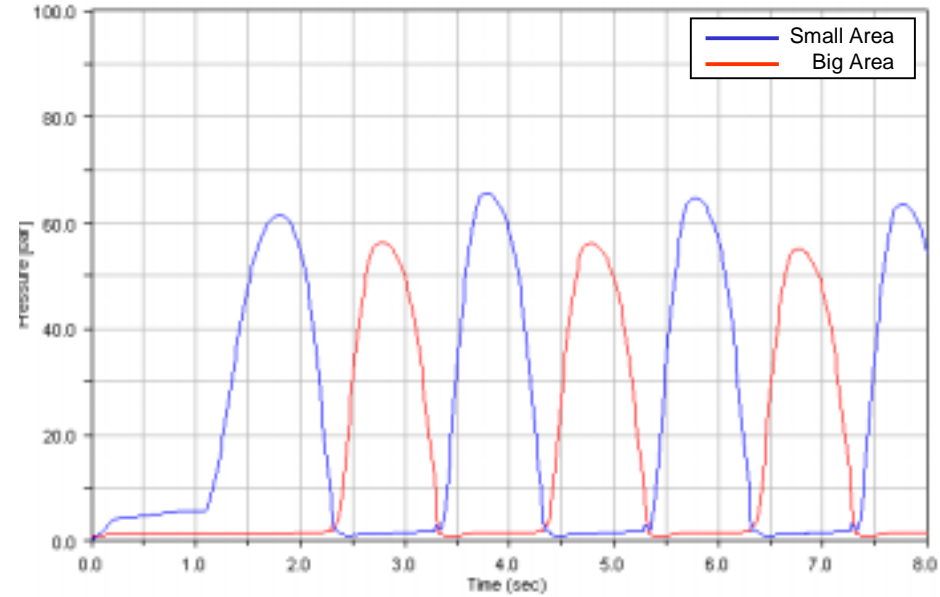
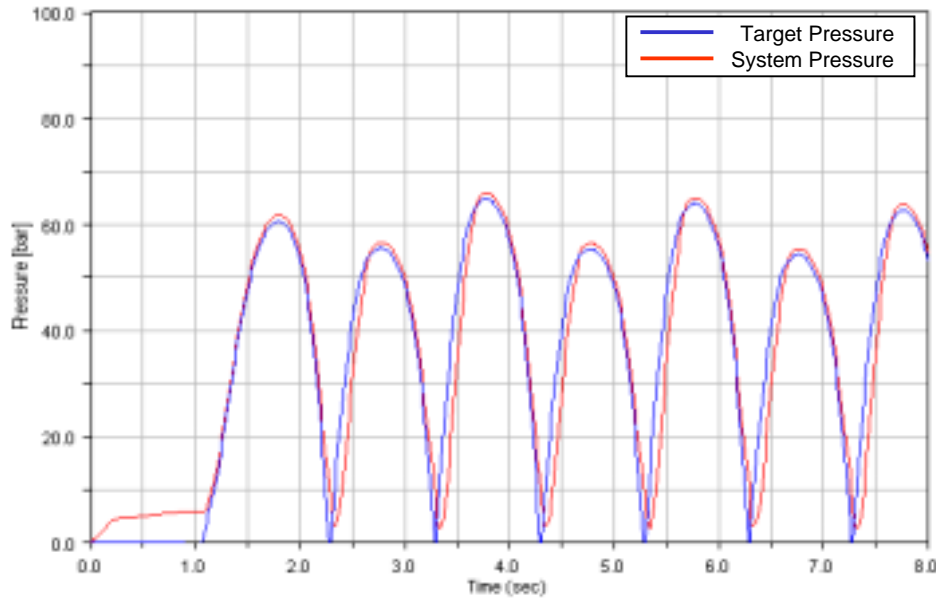


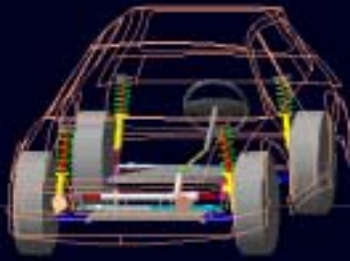
Simulation Results

Sinusoidal Steer 30 deg at 100 km/h

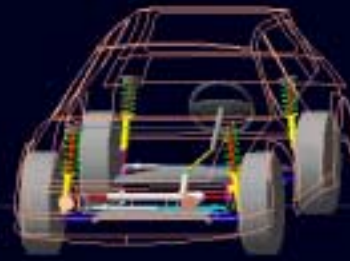
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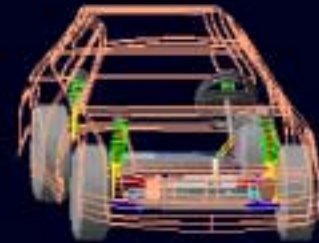




Without ARC 

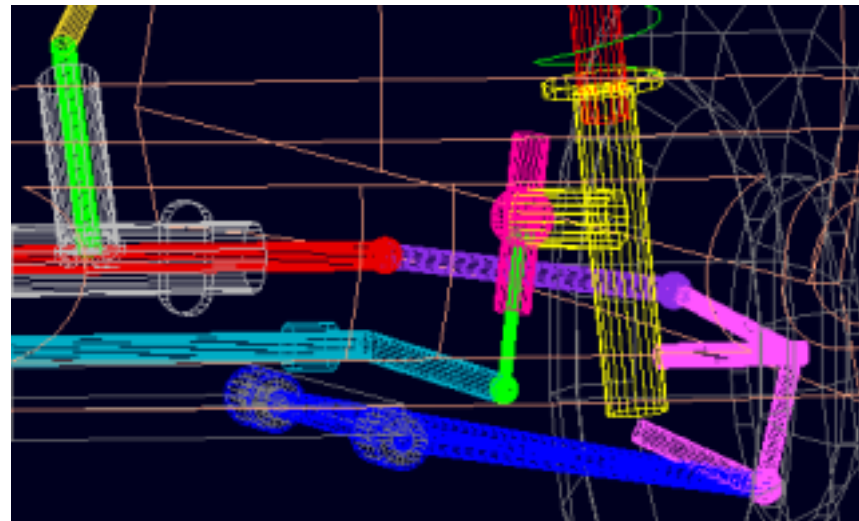


With ARC 



Overlay 

Working Actuator 



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- **TRW's Active Roll Control (ARC) is a new active suspension system to improve the vehicle roll behaviour and ride comfort. The system uses hydraulic actuators which replace the conventional stabilizer links to minimize the vehicle roll angle while cornering.**
- **An ADAMS vehicle simulation was used to reduce the development time and to optimize the system behaviour.**
- **This coupled simulation of mechanical, hydraulic and control systems is based on our experience with the analysis of electro-hydraulic power steering gears.**
- **The control algorithms were developed using Matlab/Simulink and later coupled to the vehicle simulation in a simplified version.**
- **Sufficient correlation between test and analysis was found, integration into ADAMS/Car still ongoing.**

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