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UNIVERSITY OF CAMBRIDGE

Intelligent Lorries?

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25th April 2012

Intelligent Lorries?

What would we like to improve?

Safety

- Roll-over
- Braking
- Handling and Stability
- Passive safety – vulnerable road users

Environmental Impact

- Fuel consumption / emissions
- Noise

Road Impact

- Vehicle-Road Interaction
- Traffic congestion

Productivity

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CVDC Membership

Tractor units	Volvo Trucks
Tyres	Goodyear
Air springs	Firestone
Brakes	Haldex Brake Products
Hydraulics	Poclain
Steering Systems	Tridec
Trailers	SDC Trailers
Vehicle engineering	MIRA Ltd
Fleet Operation	Denby Transport Ltd
Steel components	Tinsley Bridge Limited
Fast pneumatics	Camcon
Electronics	Mektronika Systems
Simulation Software	SIMPACK

Dampers
Instrumentation
Buses
Rubber components
Trailer axles and suspensions

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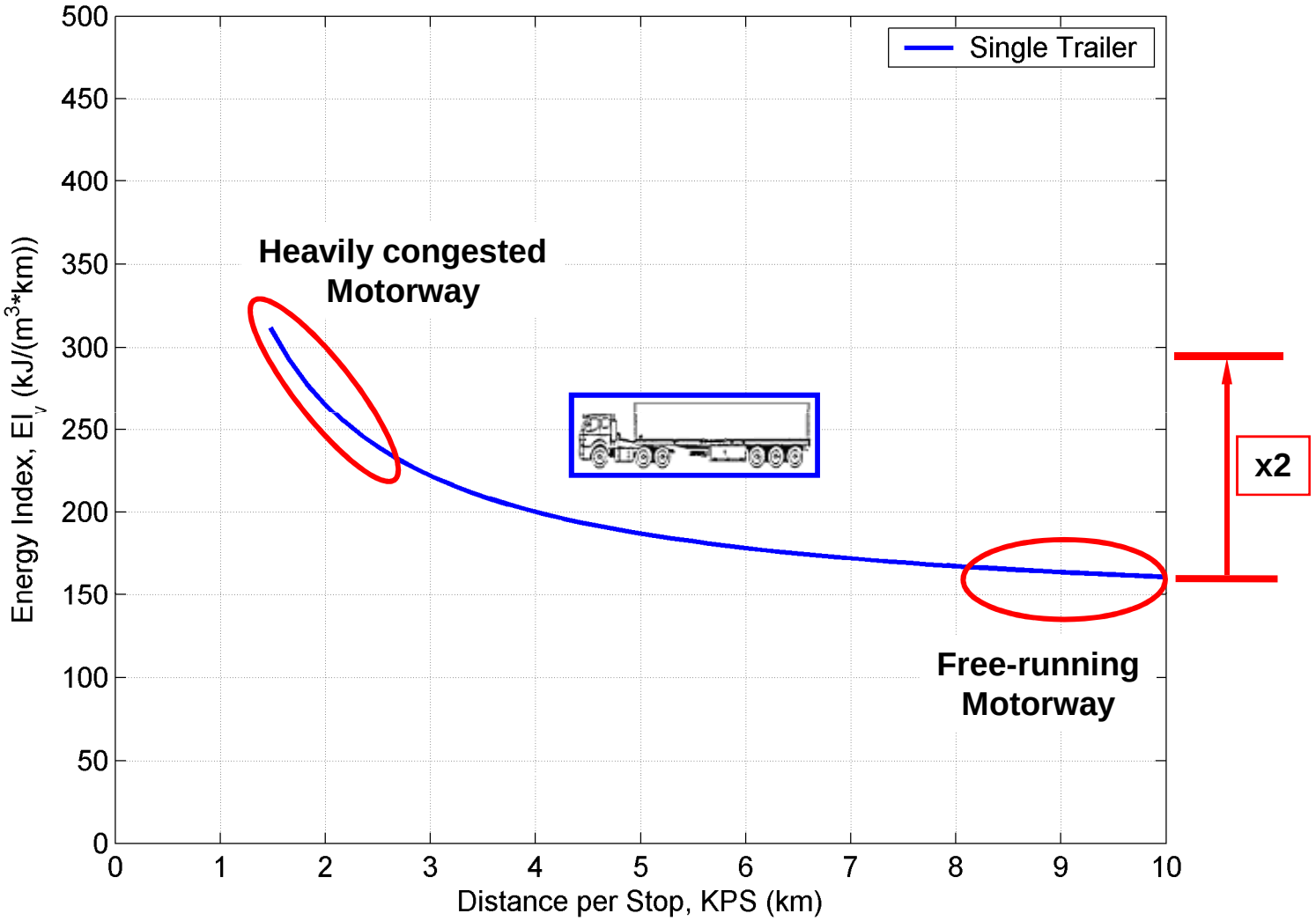
Presentation Overview

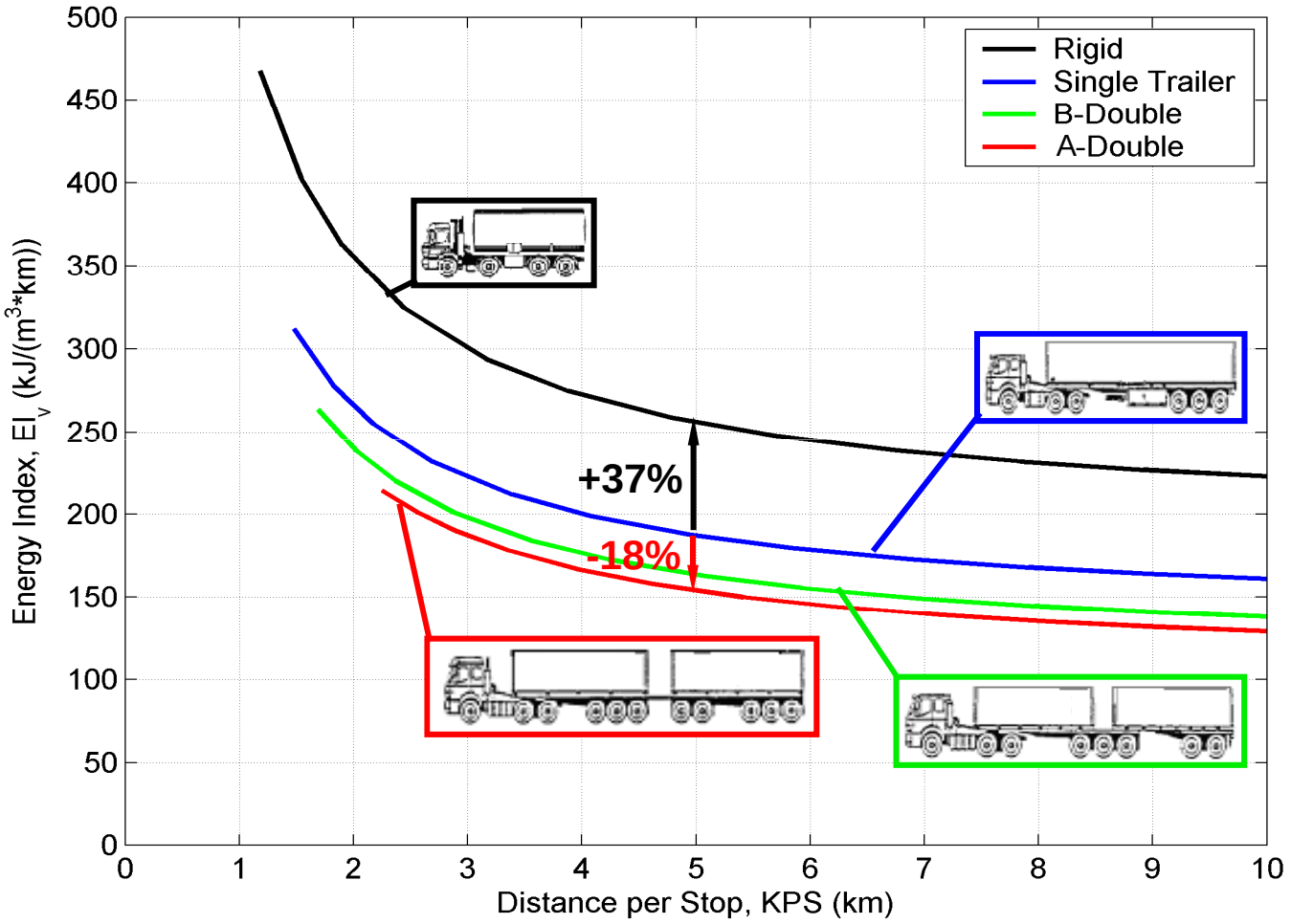
1. Background
2. Active Steering
3. Improved emergency braking
4. Regenerative braking
5. Conclusions

Effect of Congestion, 56mph (max)



- **Congestion has a dominant effect on energy consumption**
- **Night-time curfews: 9pm-7am!**

Effect of Vehicle Configuration, 56mph (max)



Larger trucks use significantly less fuel

- **A-double is 18% more efficient than Tractor/semitrailer**

Energy penalty for trans-shipping onto smaller vehicles

- **Rigid uses 37% more fuel than Tractor/semitrailer**

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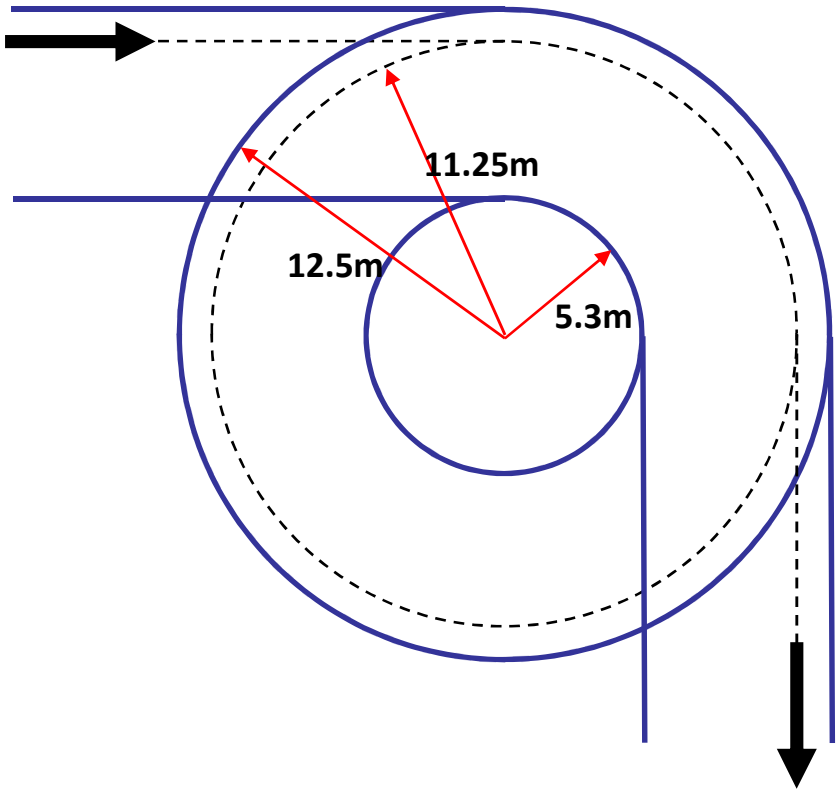
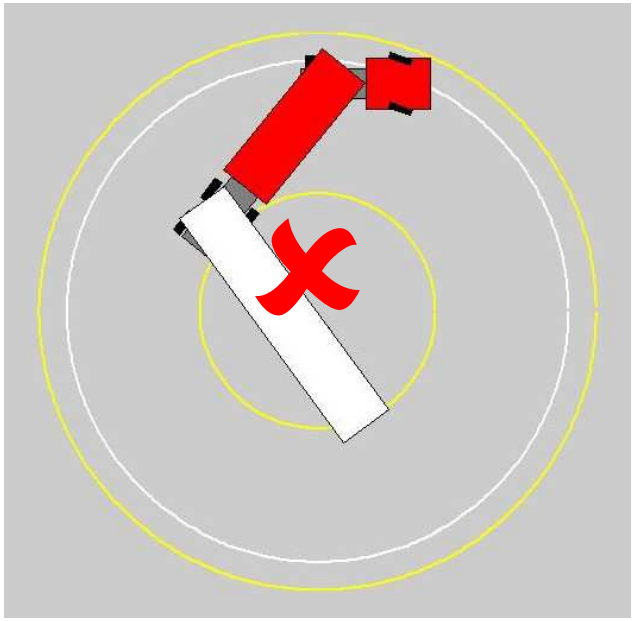
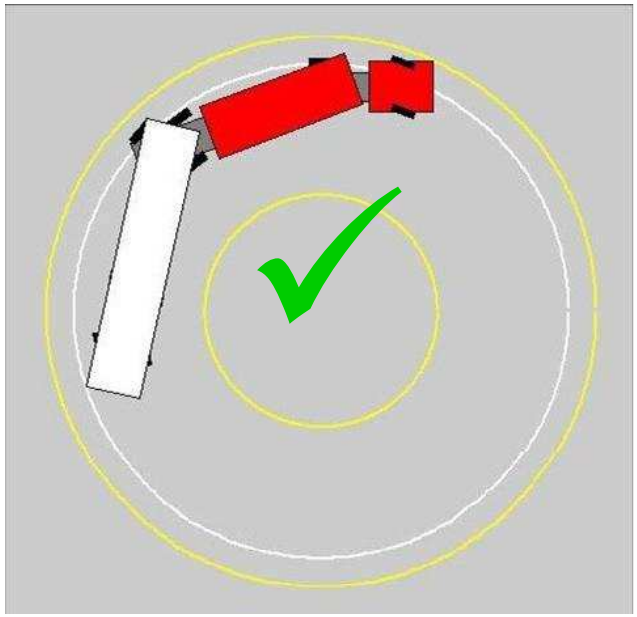
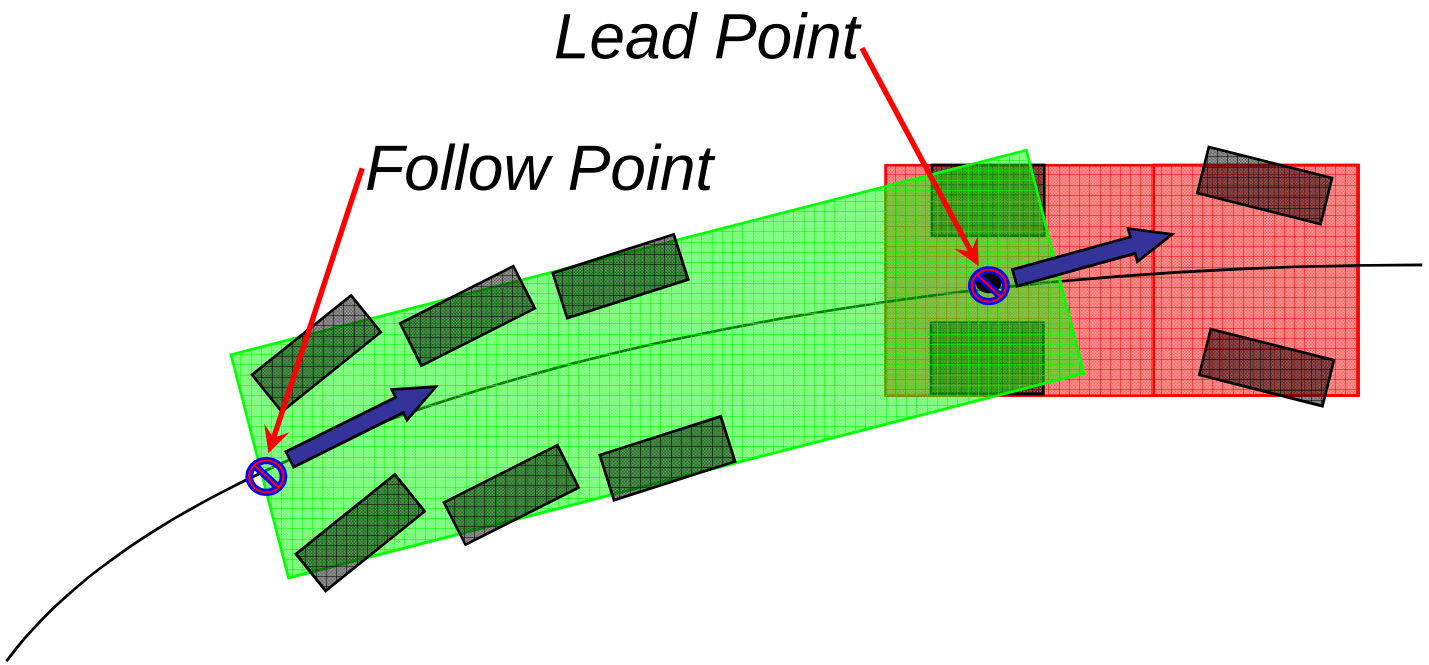
Background: The Need For Steering







Active Steering



Intelligent?

- **Sensors & optimal state estimation**
- **Electro-hydraulic actuators**
- **Advanced computer control strategies**

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Actively-Steered Semitrailer (2002)

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Low Speed Circles - Unsteered

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Low Speed Circles - Steered

Longer Test Vehicles – Active Steering

B-Double

European Modular System (EMS)

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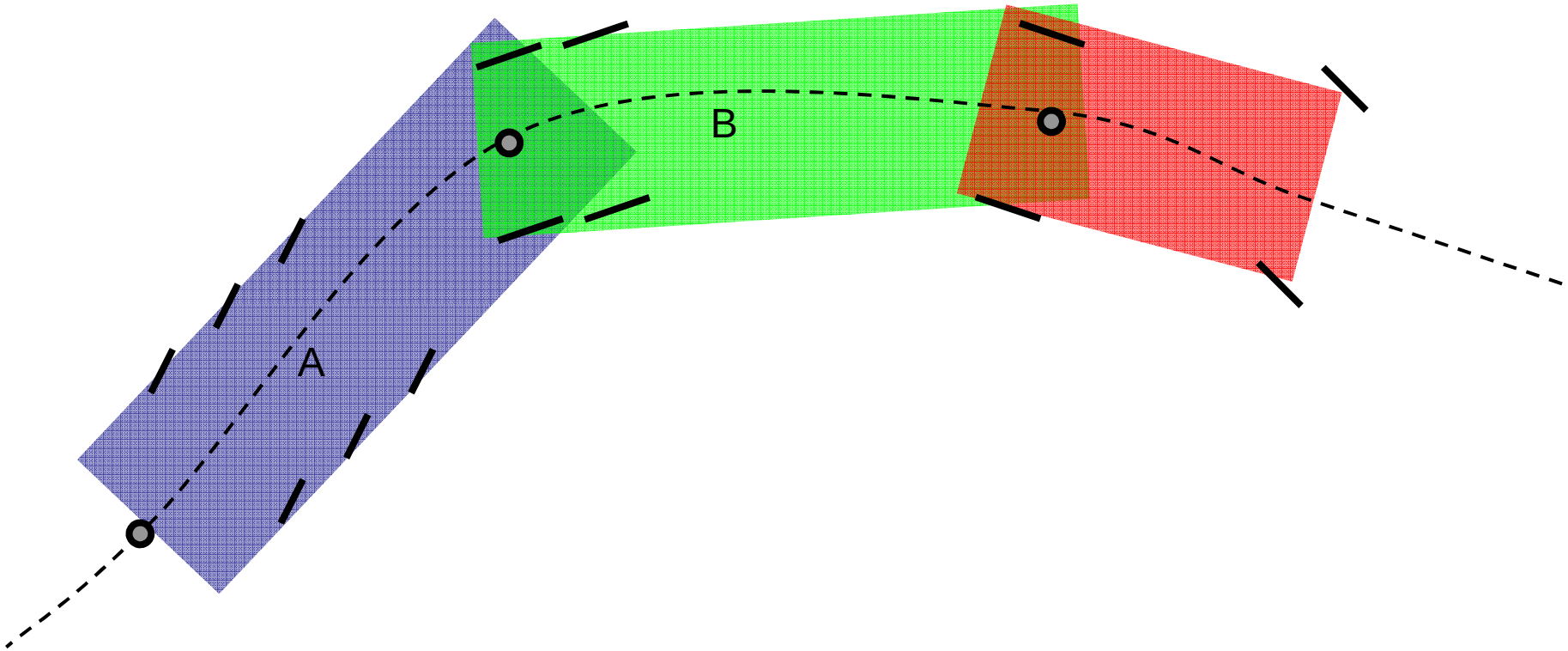
Background: Longer Vehicles

Active Steering (Feed Forward)



Active Steering of B-Double

Rearward Amplification

EMS: High-speed lane change

Do Truck Brakes Matter?

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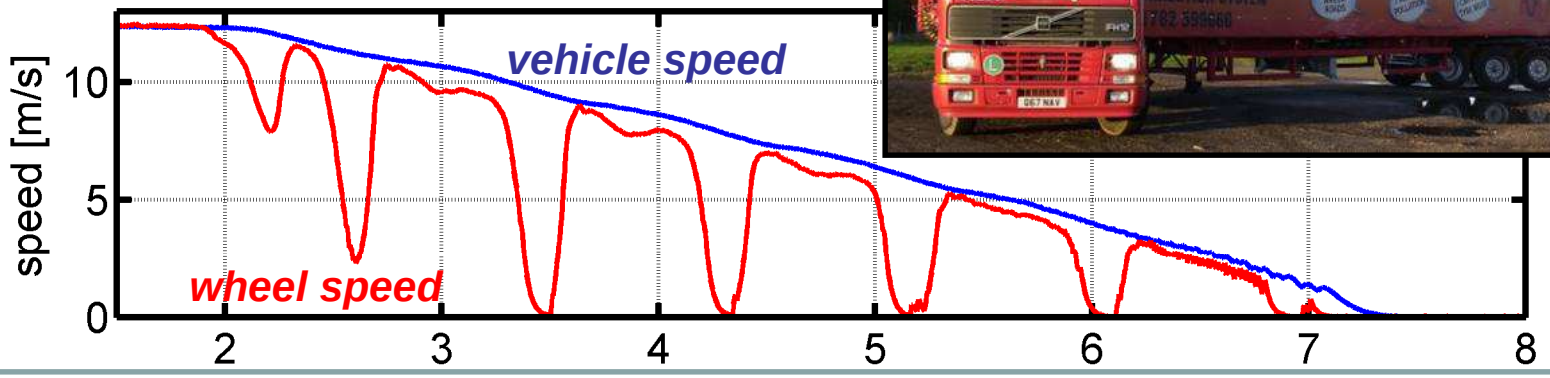
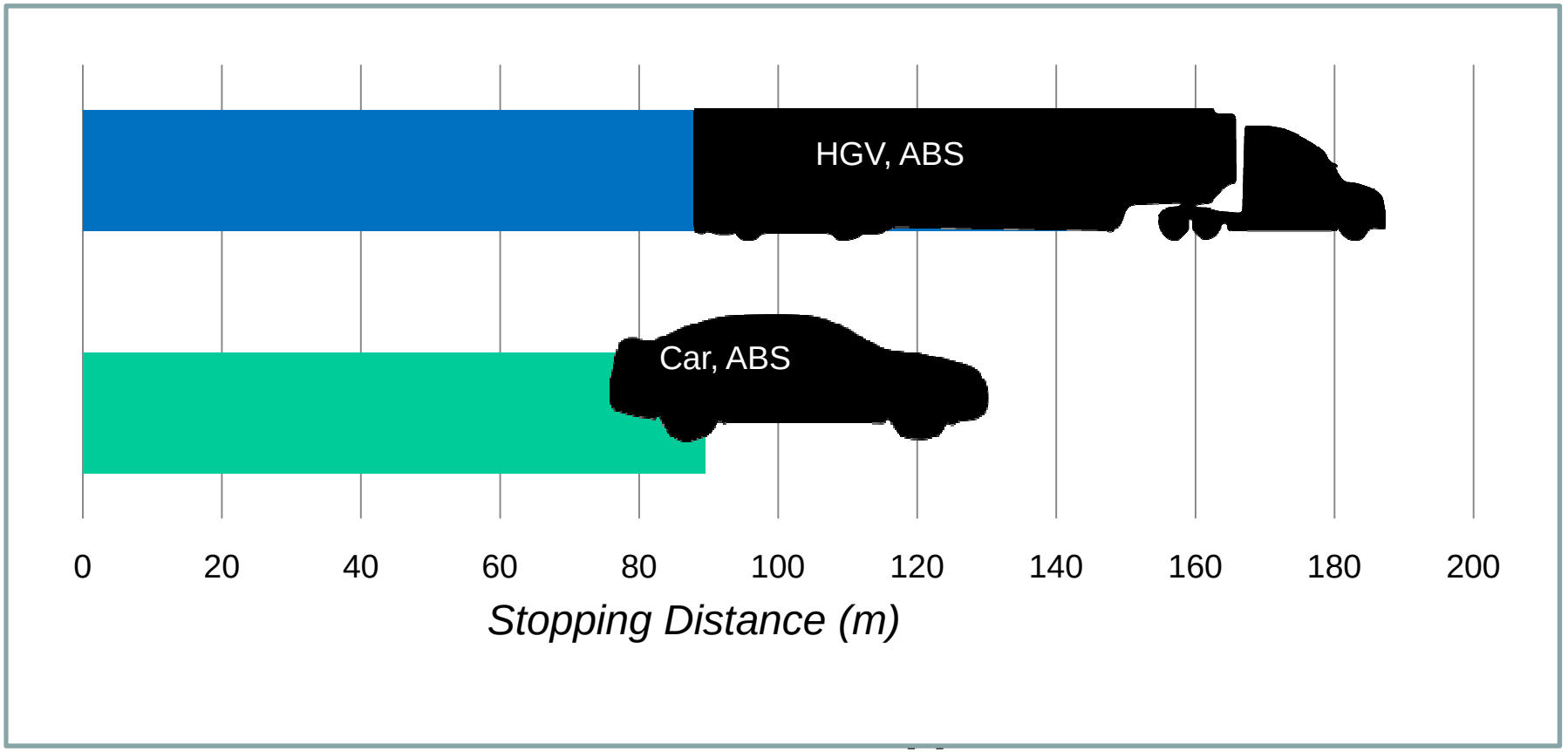
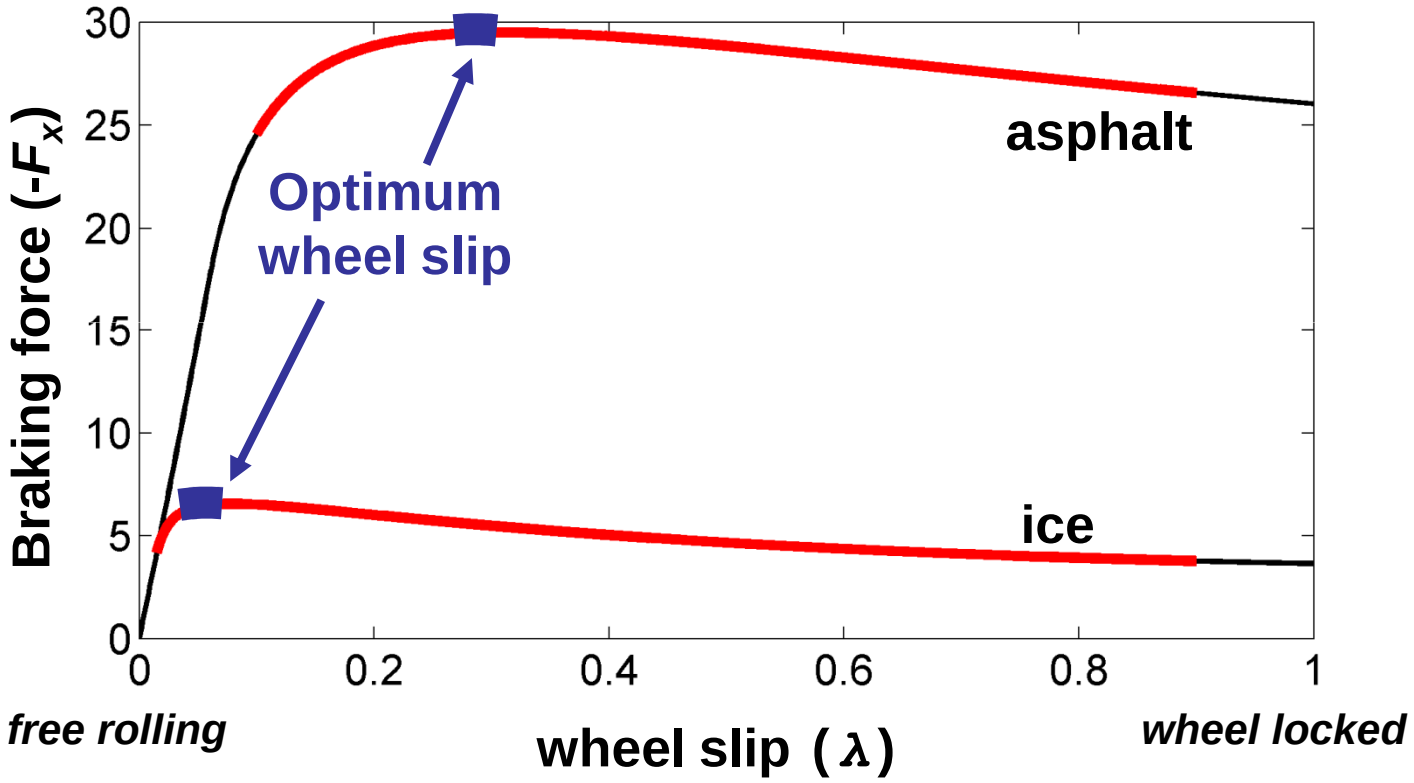
ABS Stop


speed [m/s]
10
5
0
2
3
4
5
6
7
8
vehicle speed
wheel speed


HGV, ABS
Car, ABS
0
20
40
60
80
100
120
140
160
180
200
Stopping Distance (m)

ABS versus Slip Control



Key Features of New ABS System

1. **Sliding-mode slip control**
2. **Accurate, low-cost ‘inertial’ measurement of vehicle speed**
3. **Continuous estimation of optimal slip point**
4. **Completely different form of pneumatic actuation with much faster valves**

Close collaboration between university and industrial partner (Haldex)

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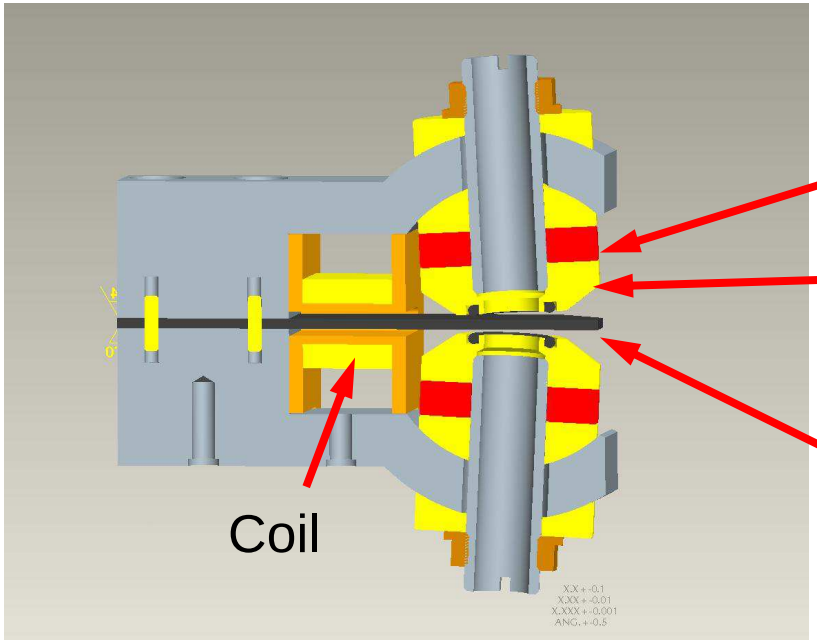
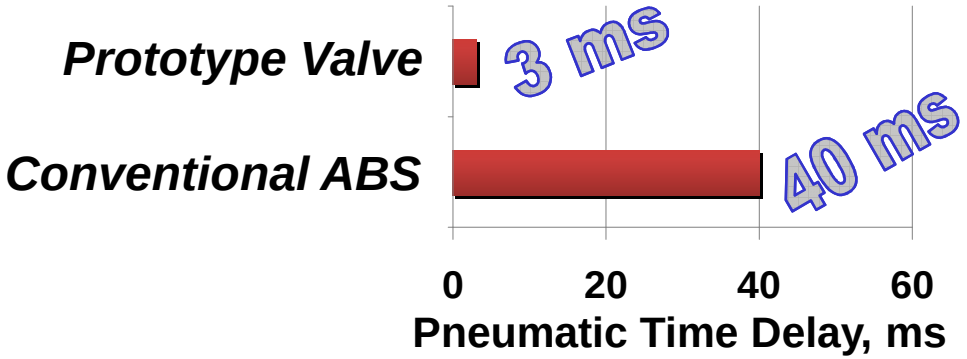
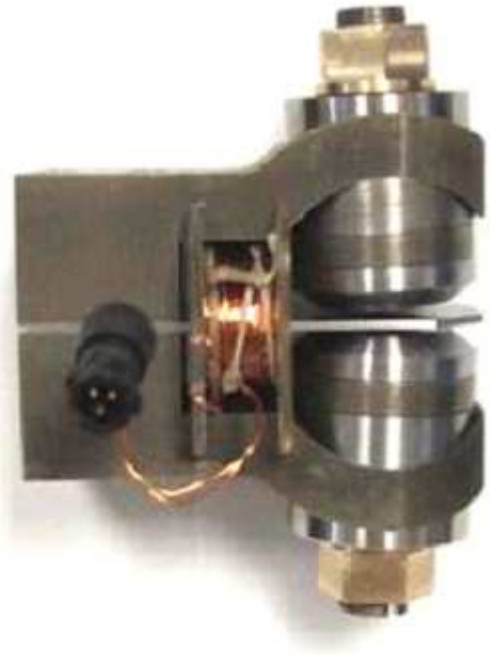
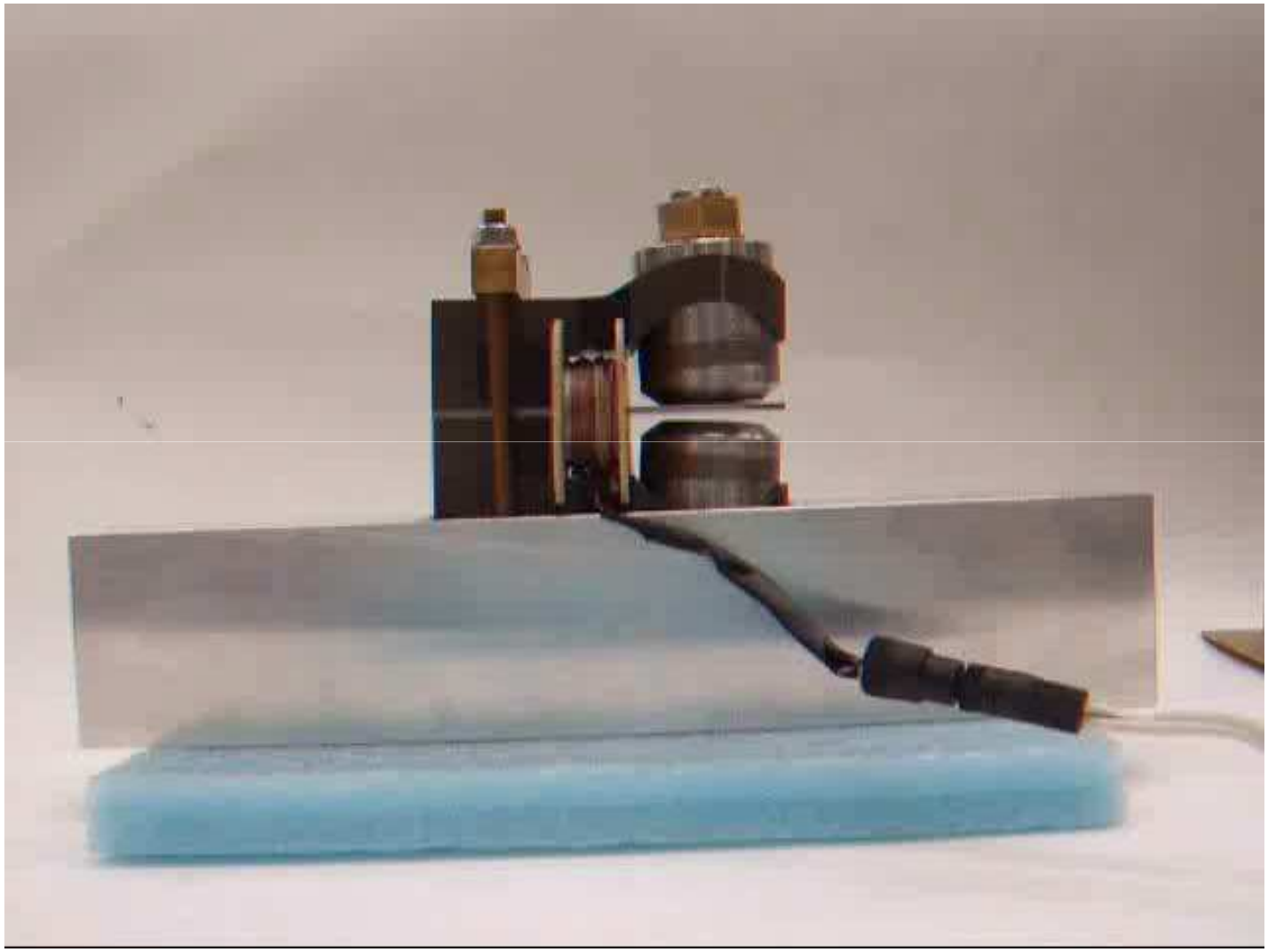
Novel Pneumatic Valve



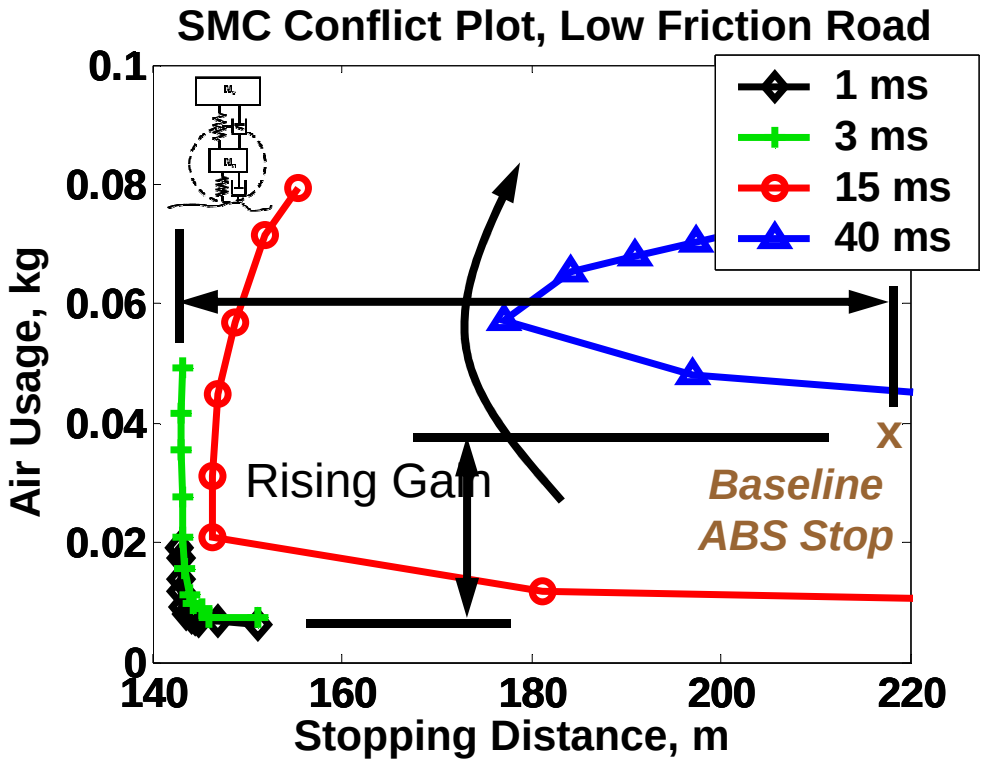




Valve switching

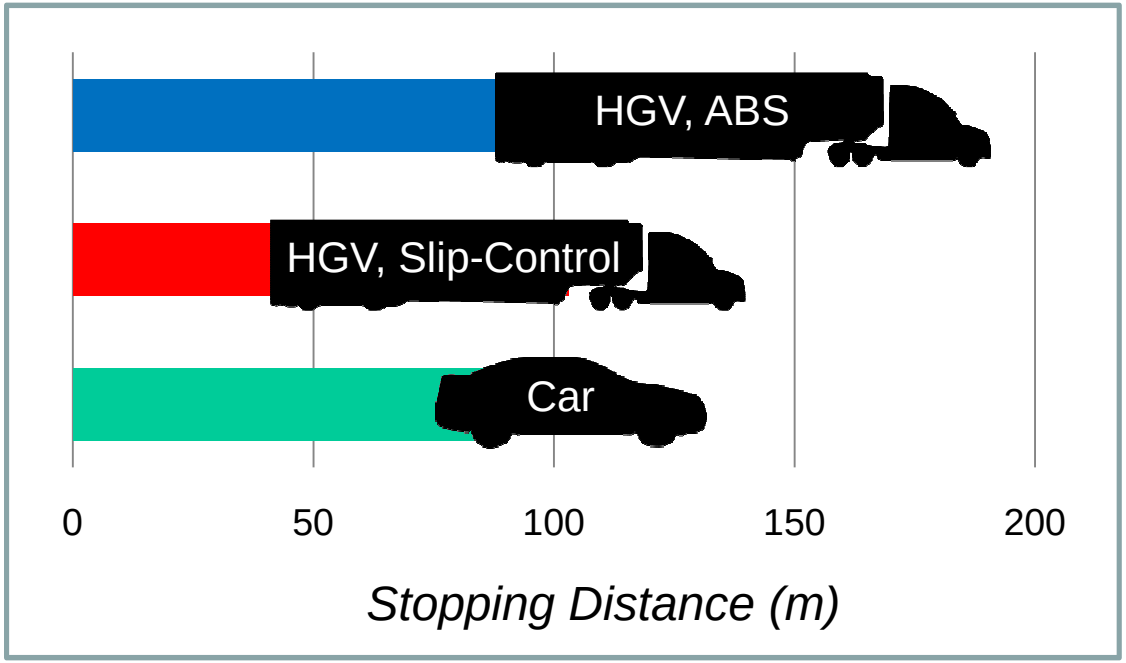


Performance Benefits



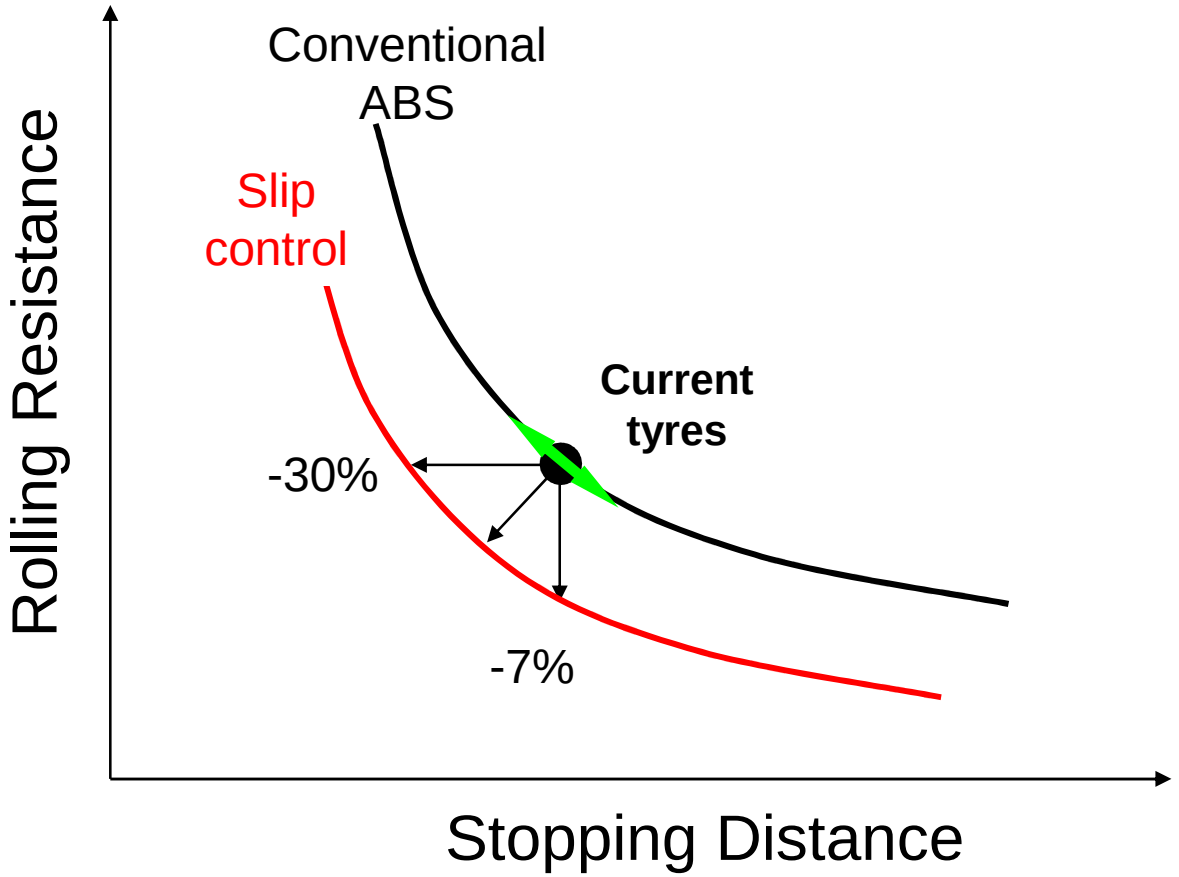
- Stops 30% shorter
- Uses 70% less air

Summary



➔ Full-scale Vehicle testing scheduled for Summer 2012

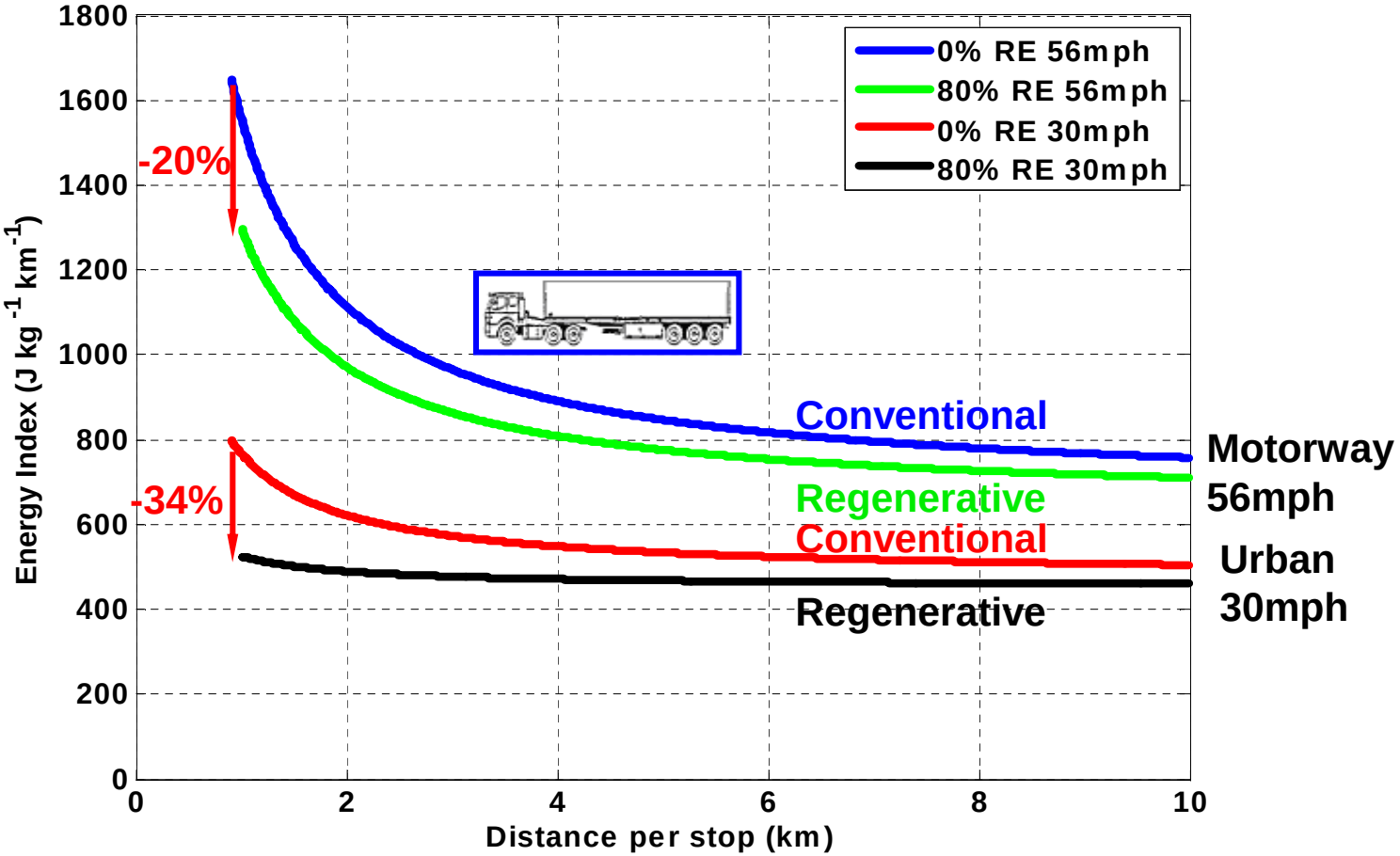
Rolling Resistance vs Friction



Change the design paradigm:

➔Consider the whole system: brakes + tyres

Regenerative Braking



- 25% saving from longer vehicles
- 20% saving using regenerative braking
- Maximise savings by combining the two

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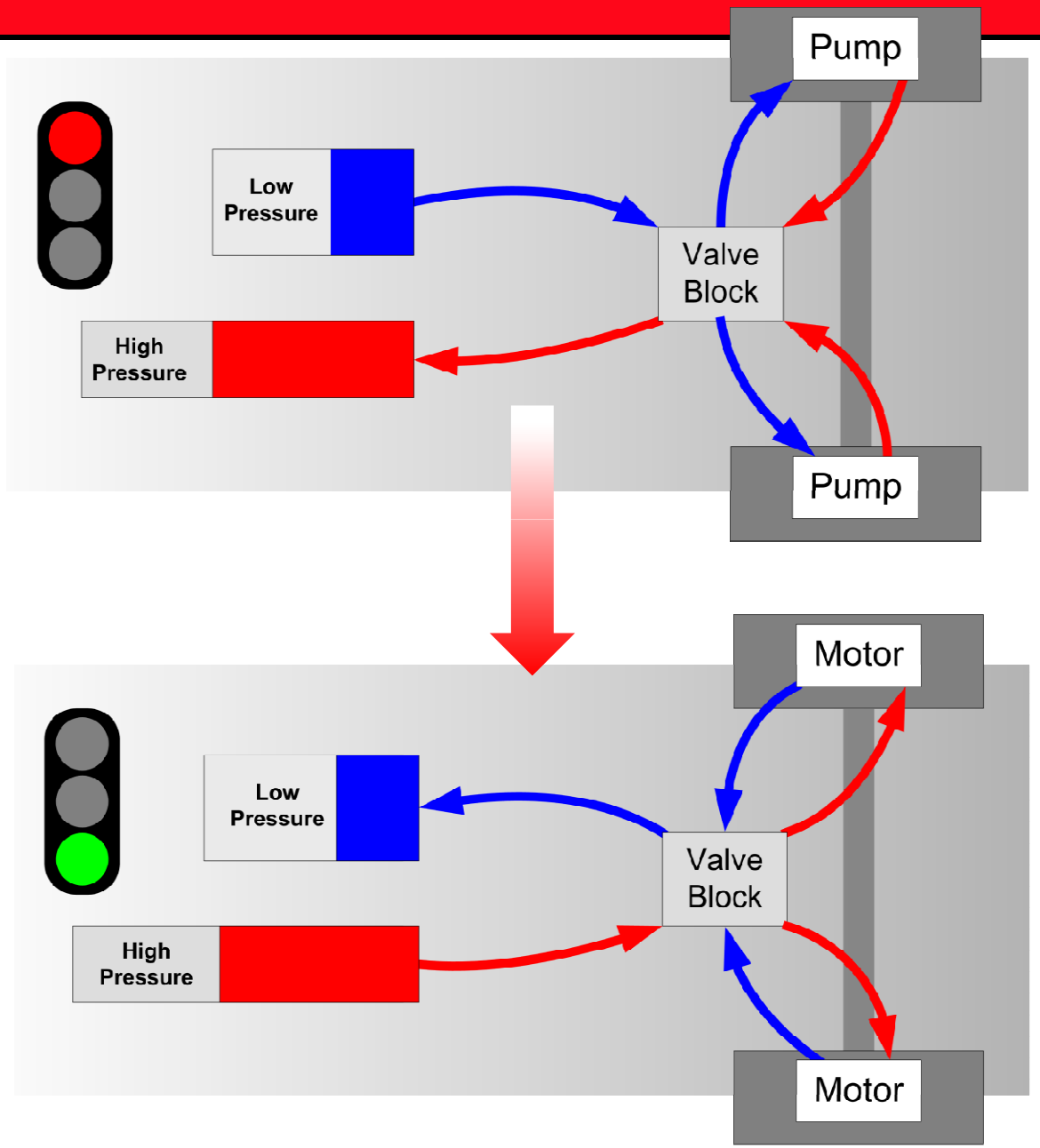
Hydraulic Hybrid Concept



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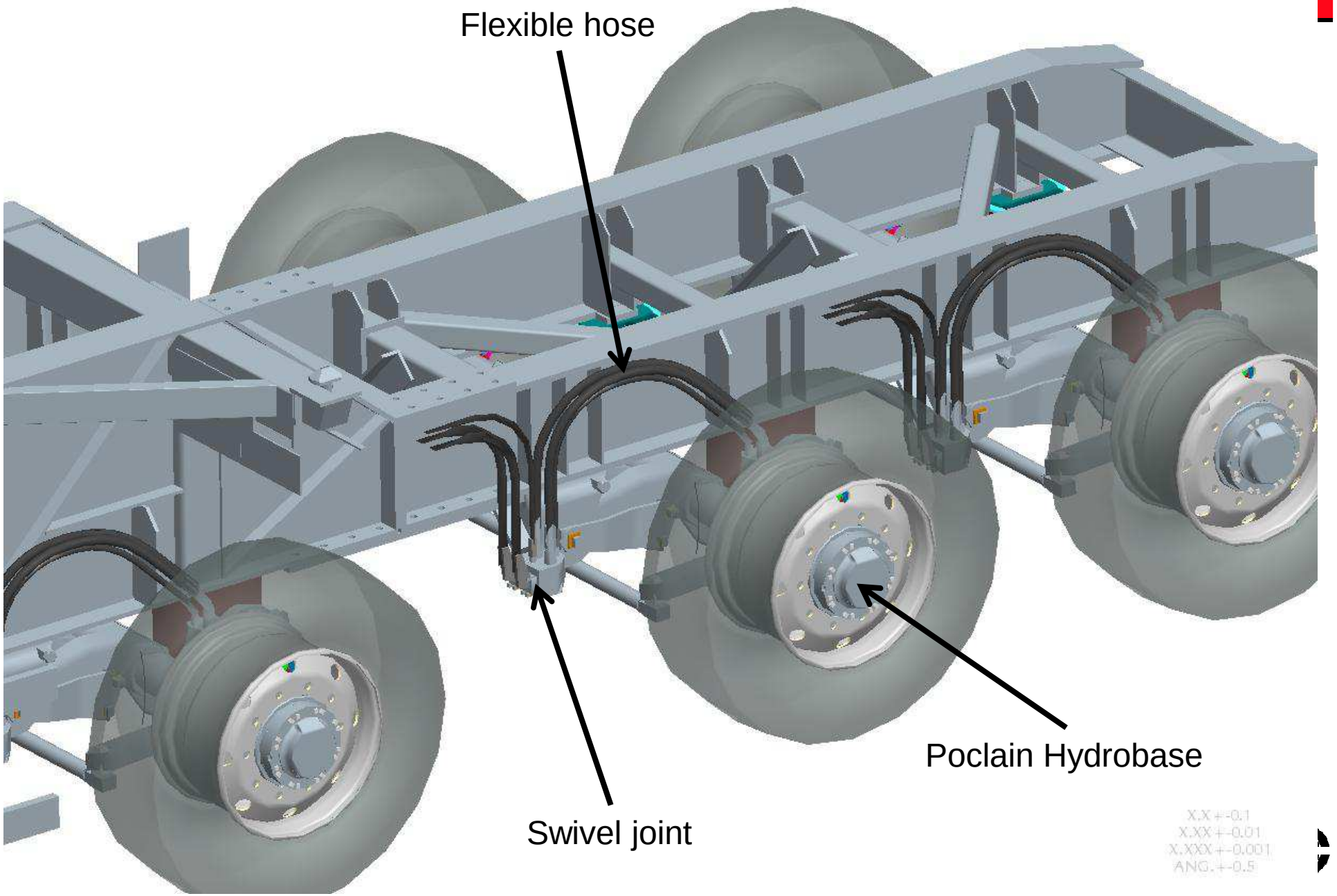
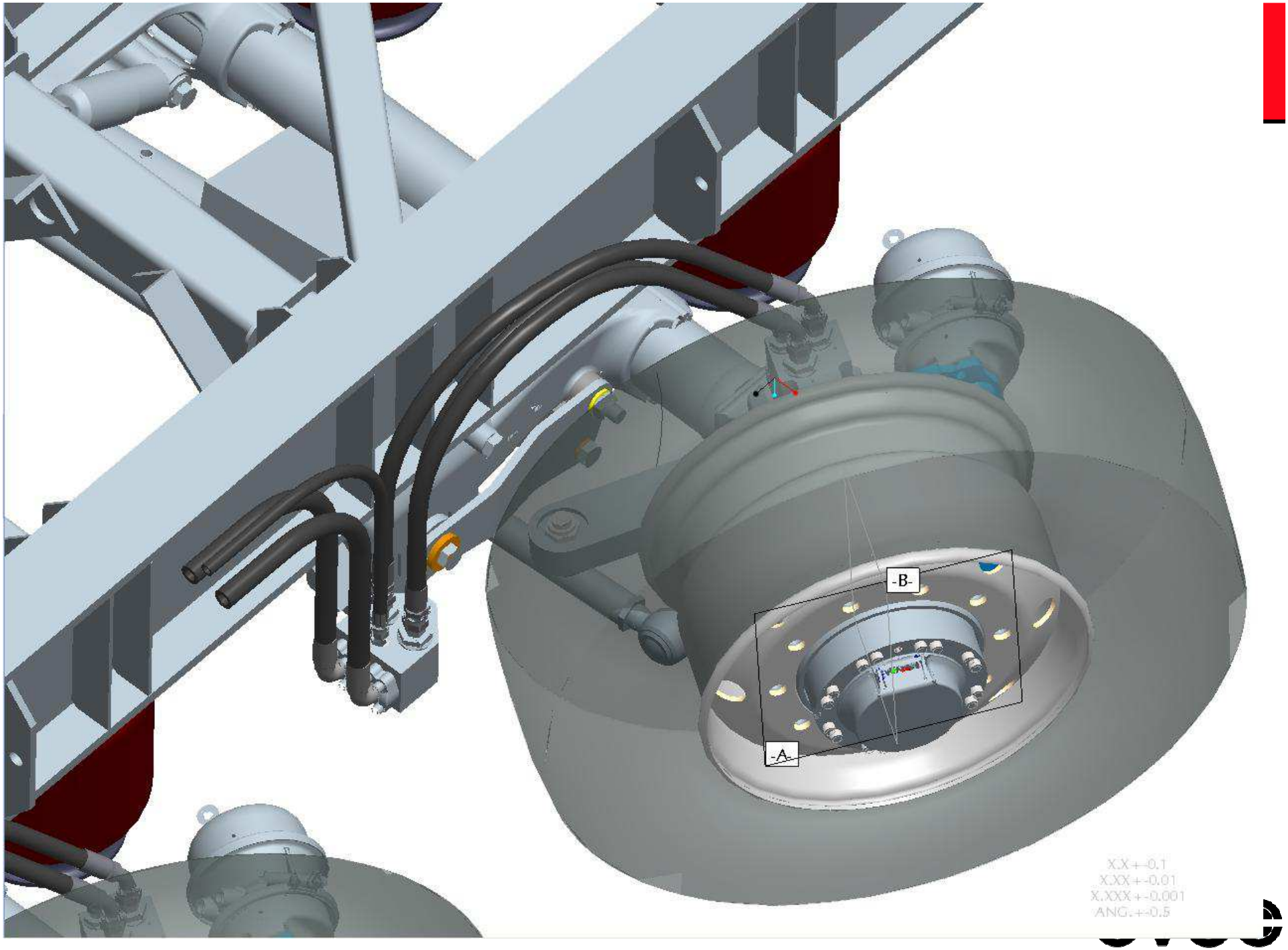

Flexible hose
Swivel joint
Poclain Hydrobase
X.X +-0.1
X.XX +-0.01
X.XXX +-0.001
ANG. +-0.5


-B-
-A-
X.X+-0.1
X.XX+-0.01
X.XXX+-0.001
ANG.+-0.5

Conclusions

1. System thinking:
   - Break-out of normal constraints
   - Bigger pay-off
2. Intelligent?
   - Extensive use of instrumentation, computer control and advanced actuation
3. Benefits of improved vehicles:
   - Substantially lower fuel consumption
   - Reduced traffic congestion
   - Improved safety
   - Improved productivity

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Intelligent Lorries?

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Intelligent Policy?

Facilitate Systemic Change

Long term decisions

Based on strategic technical thinking

Centre for Sustainable Road Freight Transport

1. Collaboration between Cambridge Univ and Herriot Watt Logistics Research Centre
2. An integrated approach to the Engineering and Logistical opportunities to minimize fuel consumption and CO2 emissions
3. Funding - £6m over 5 years:
   - EPSRC
   - A new industrial consortium with heavy input from FTA and fleet operators

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