Artificial understeering by means of active steering – an investigation of proper handling test methods

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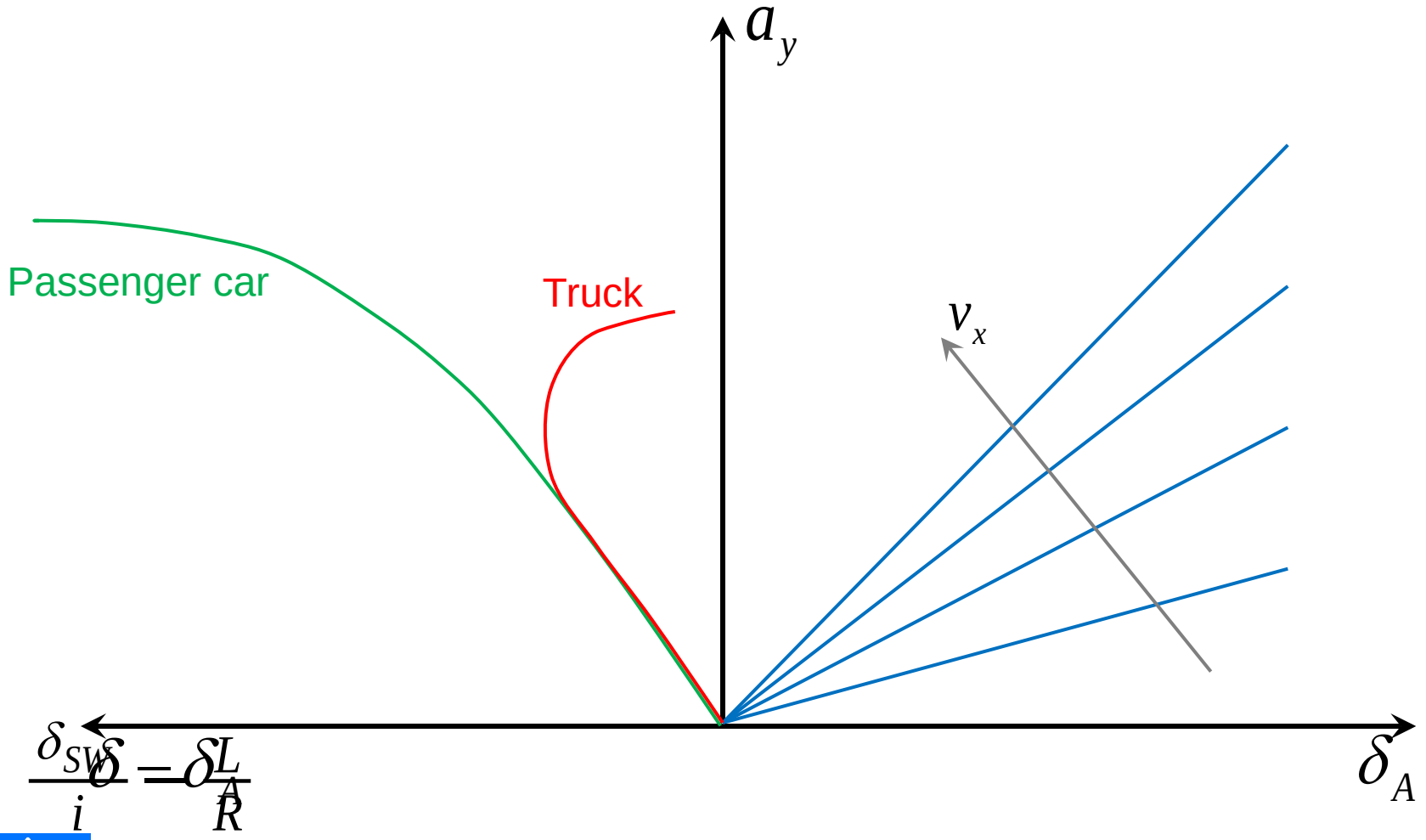
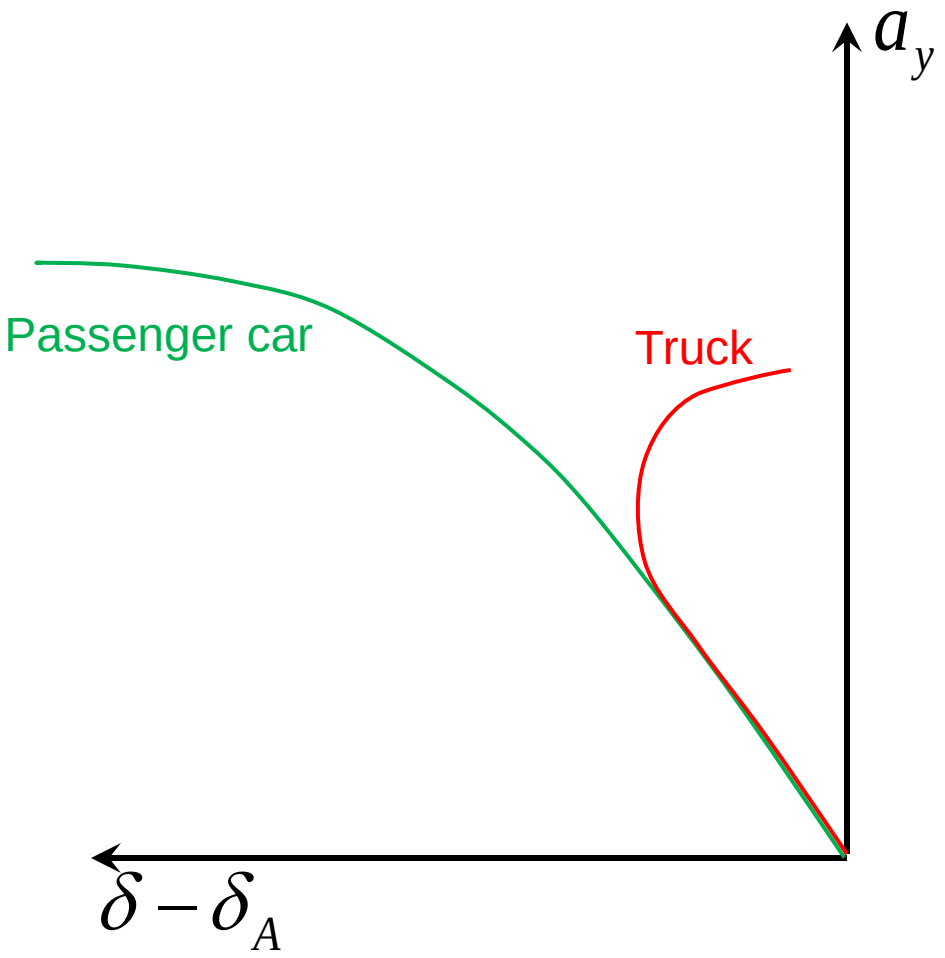
This presentation will be available at www.steeringfeel.org

Truck understeering behaviour



Understeering - definition

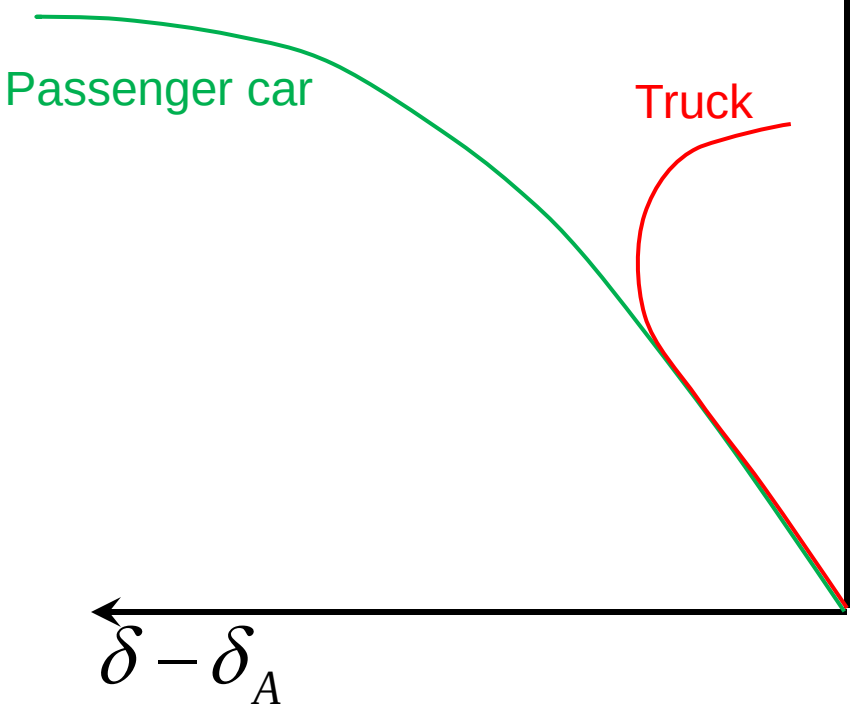


Angle overlay – superposition of steering angle

Harmonic Drive

Planetary Gearbox

Understeering - definition



$$a_{yK_{us}} = \frac{\partial(\delta - \delta_A)}{\partial a_y}$$

$$K_{us} = \frac{\partial(\frac{\delta_{SW}}{i} - \delta_A)}{\partial a_y}$$

$$K_{us} = \frac{\partial(\frac{\delta_{SW}+\delta_{add}}{i} - \delta_A)}{\partial a_y}$$

$$K_{us} = \frac{\partial(\delta + \frac{\delta_{add}}{i} - \delta_A)}{\partial a_y}$$

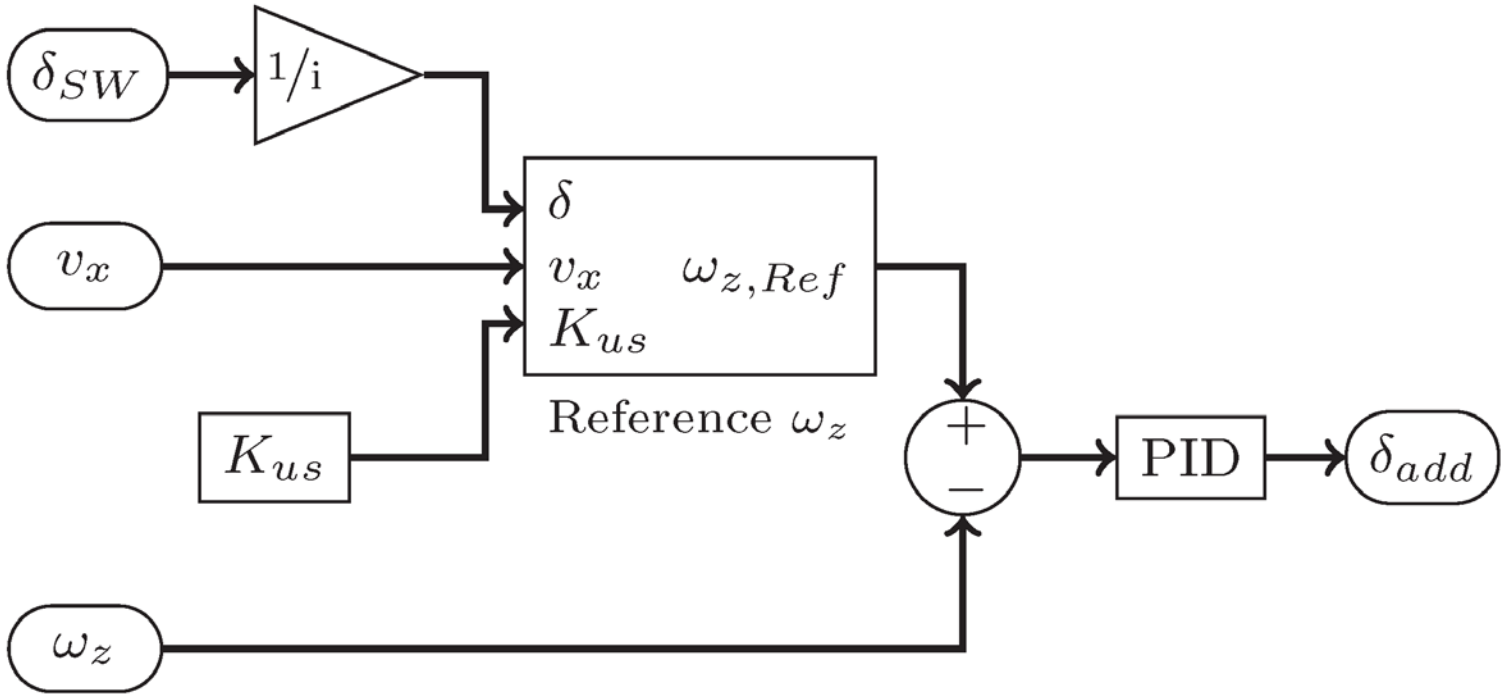
Artificial understeering

Methodology

- **Comparison real and calculated yaw rate**
- **Implementation in functionality**
- **Trimming and testing in a SiL test bed**
- **Standard handling tests according to ISO tests**

Artificial understeering

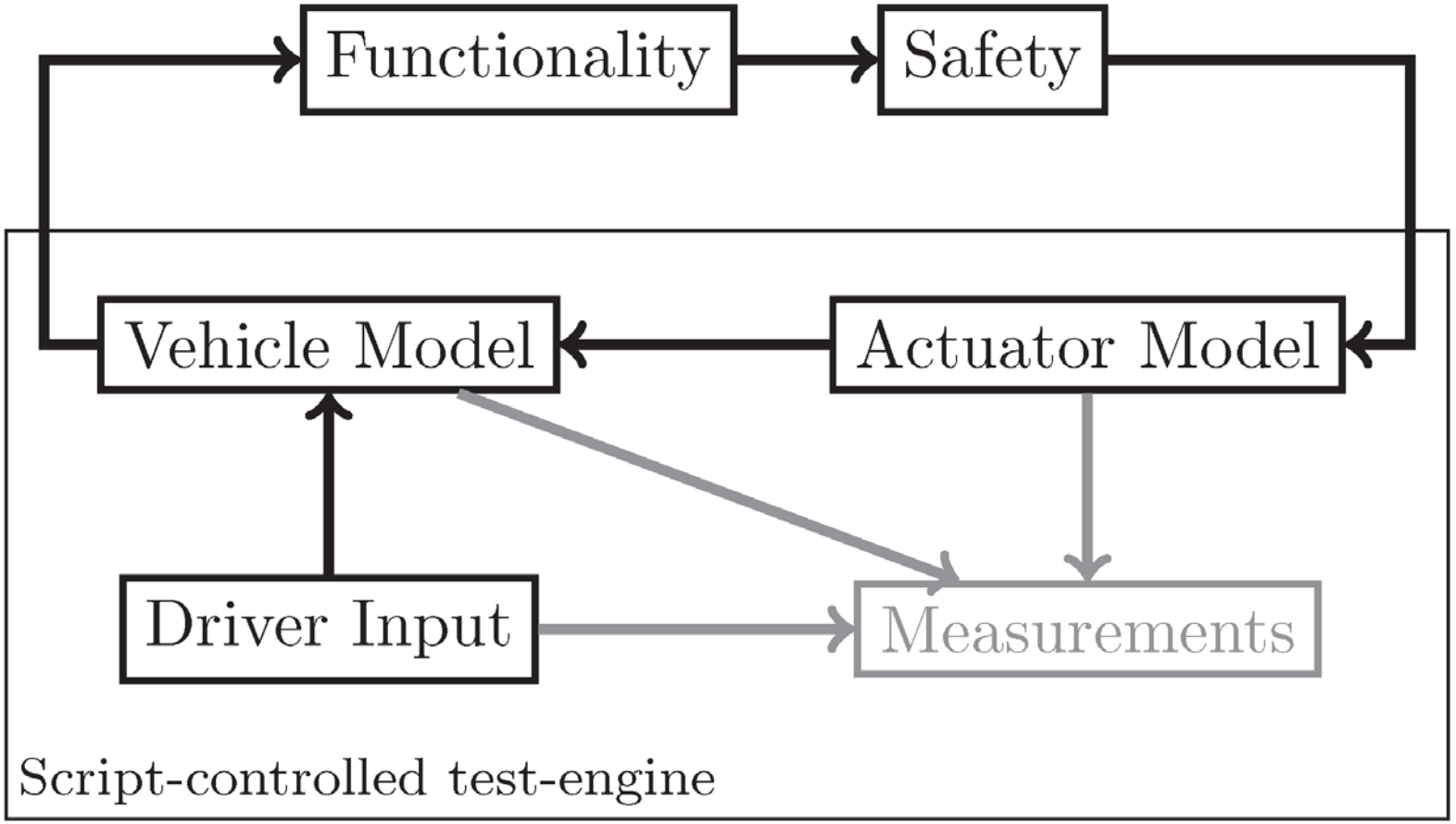
Online-measurement in the vehicle



Angle overlay system

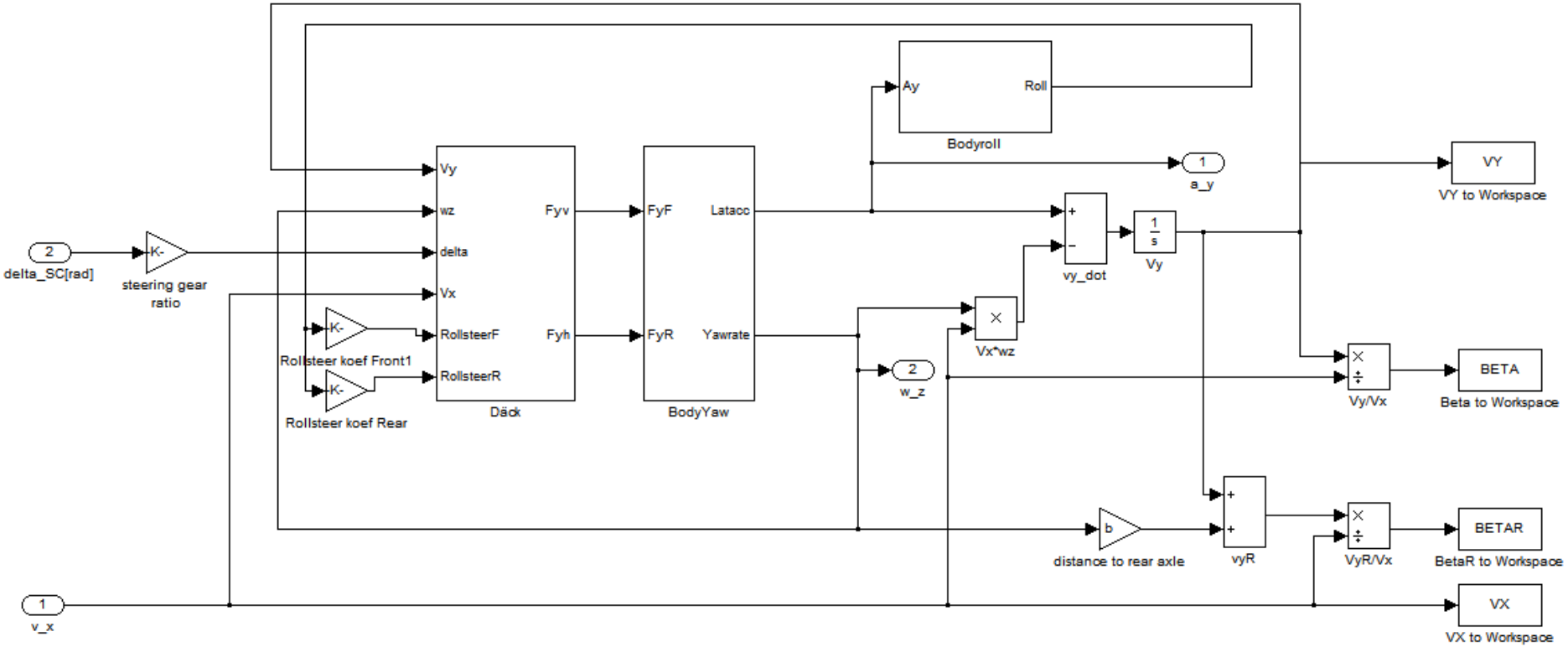
$$\omega_{z,Ref} = \frac{v_x \cdot \delta}{L + K_{us} \cdot v_x^2}$$

Artificial understeering SiL



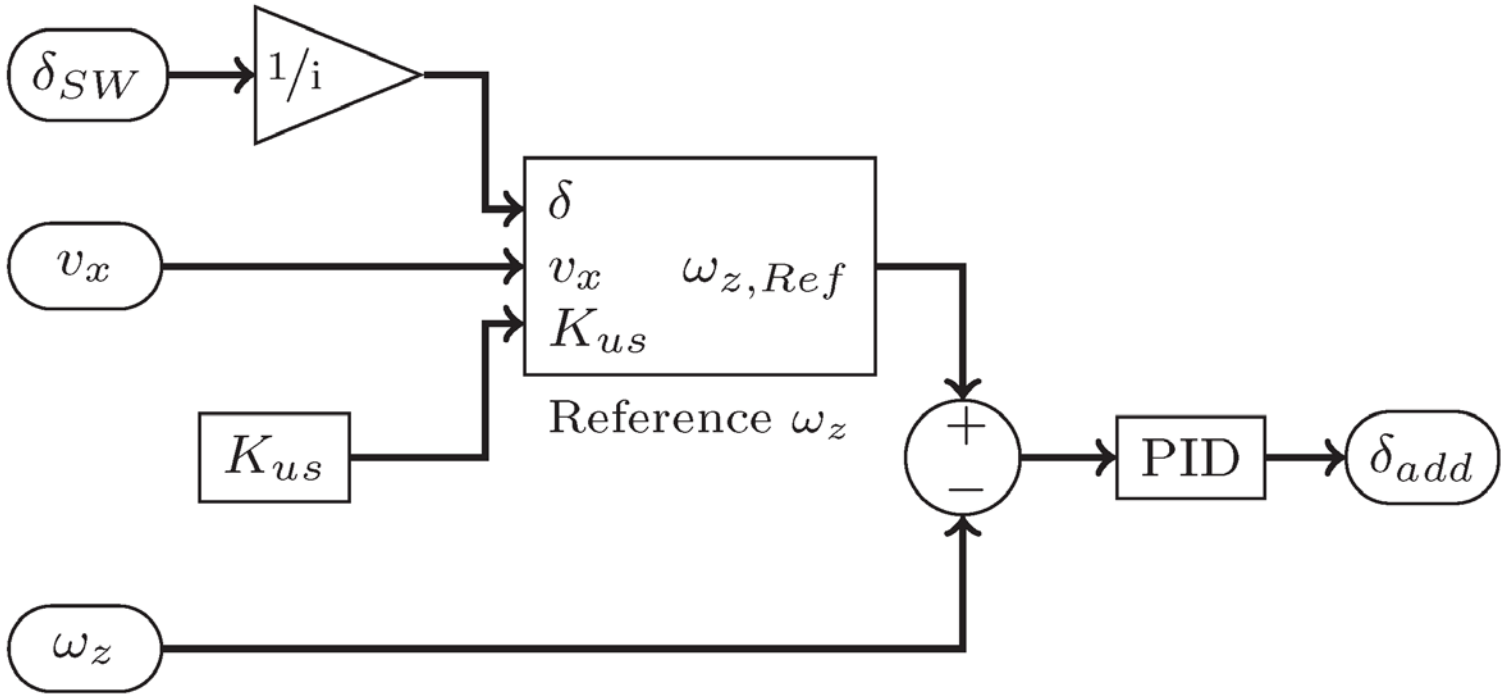
Artificial understeering SiL

Truck model



Artificial understeering

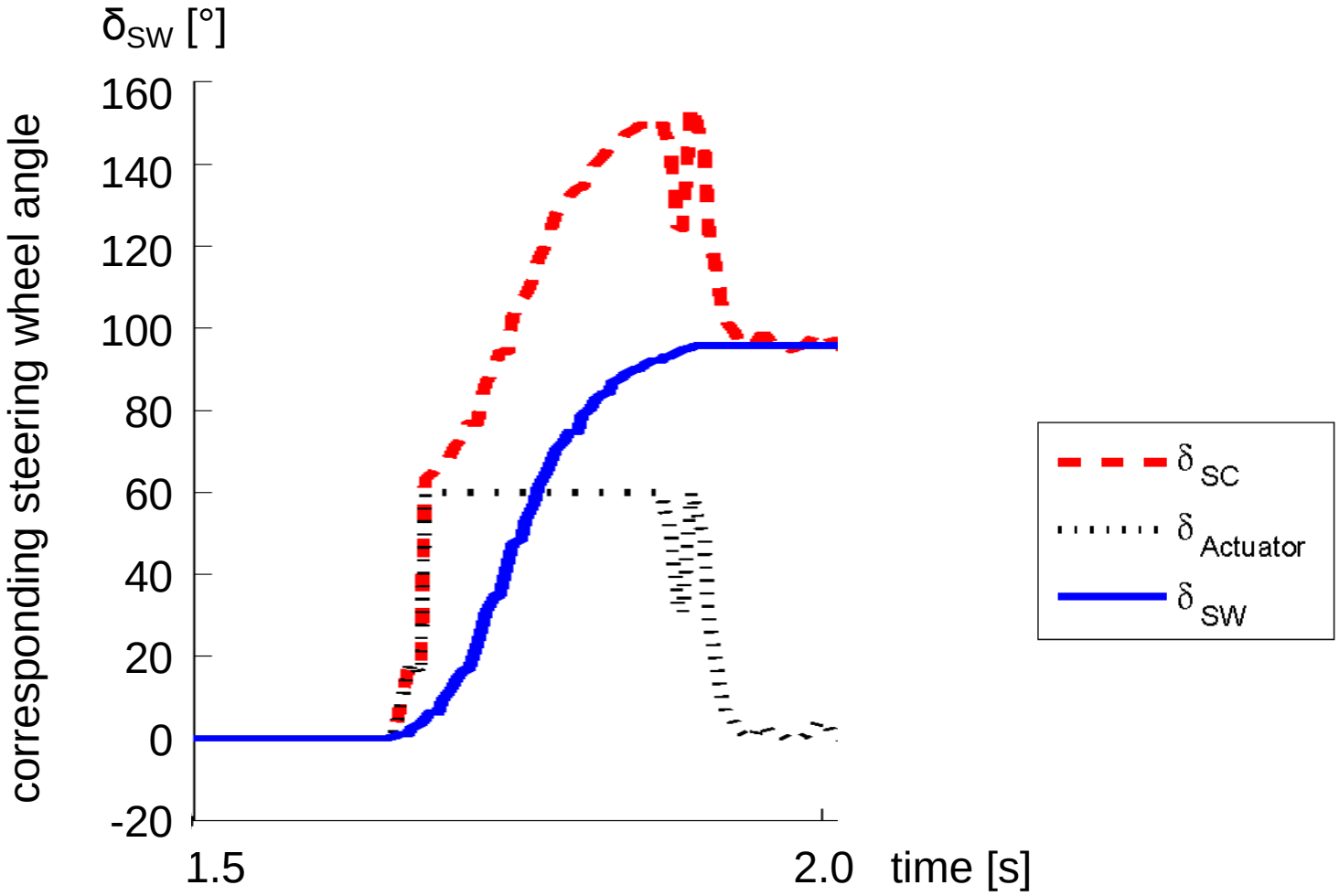
Online-measurement in the vehicle



Angle overlay system

$$\omega_{z,Ref} = \frac{v_x \cdot \delta}{L + K_{us} \cdot v_x^2}$$

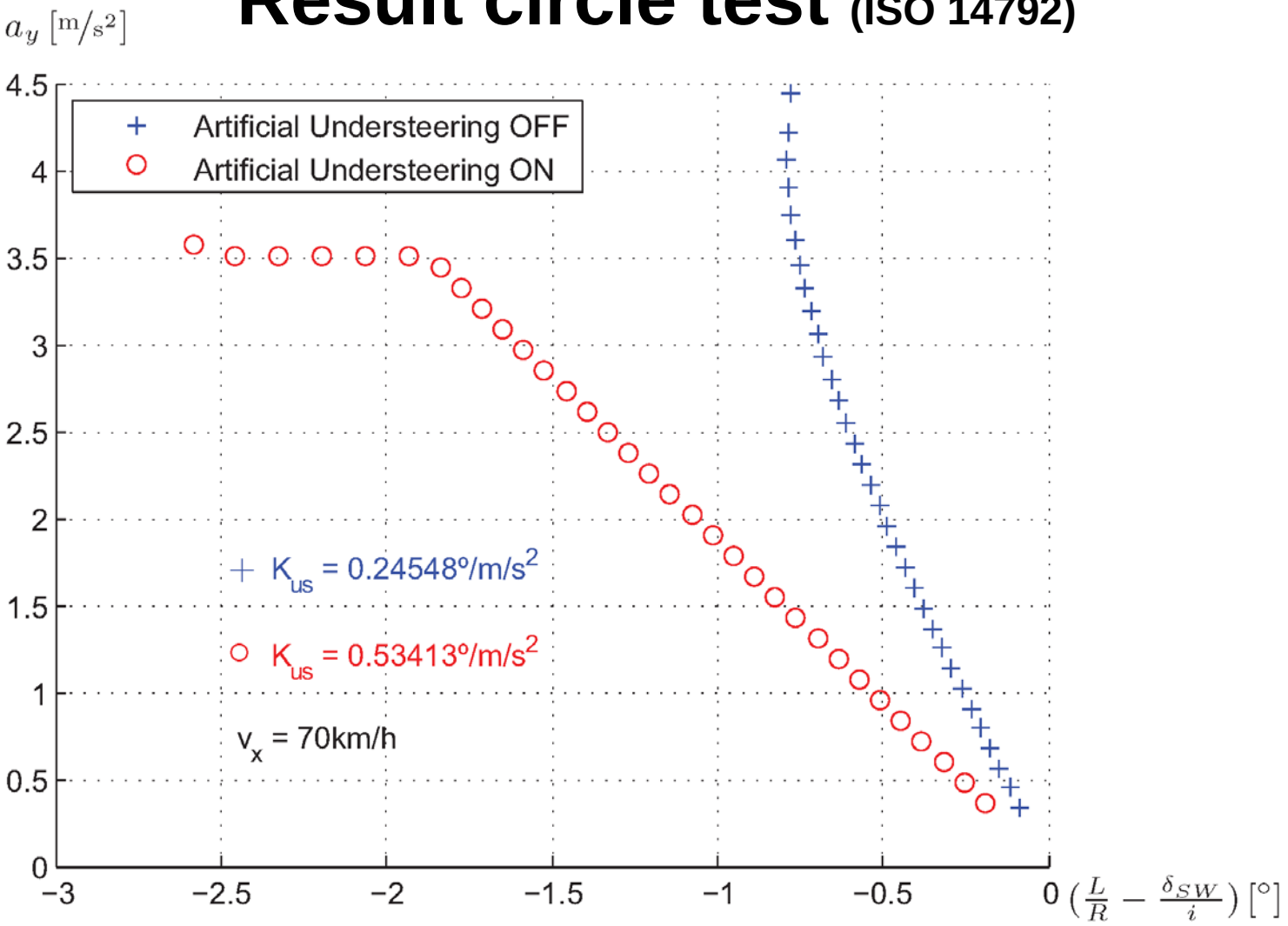
Characterisation Artificial understeering



Circle test (ISO 14792)

- Constant vehicle speed (70km/h)
- Stepwise increase of steering angle
- Stabilisation time 9.5s

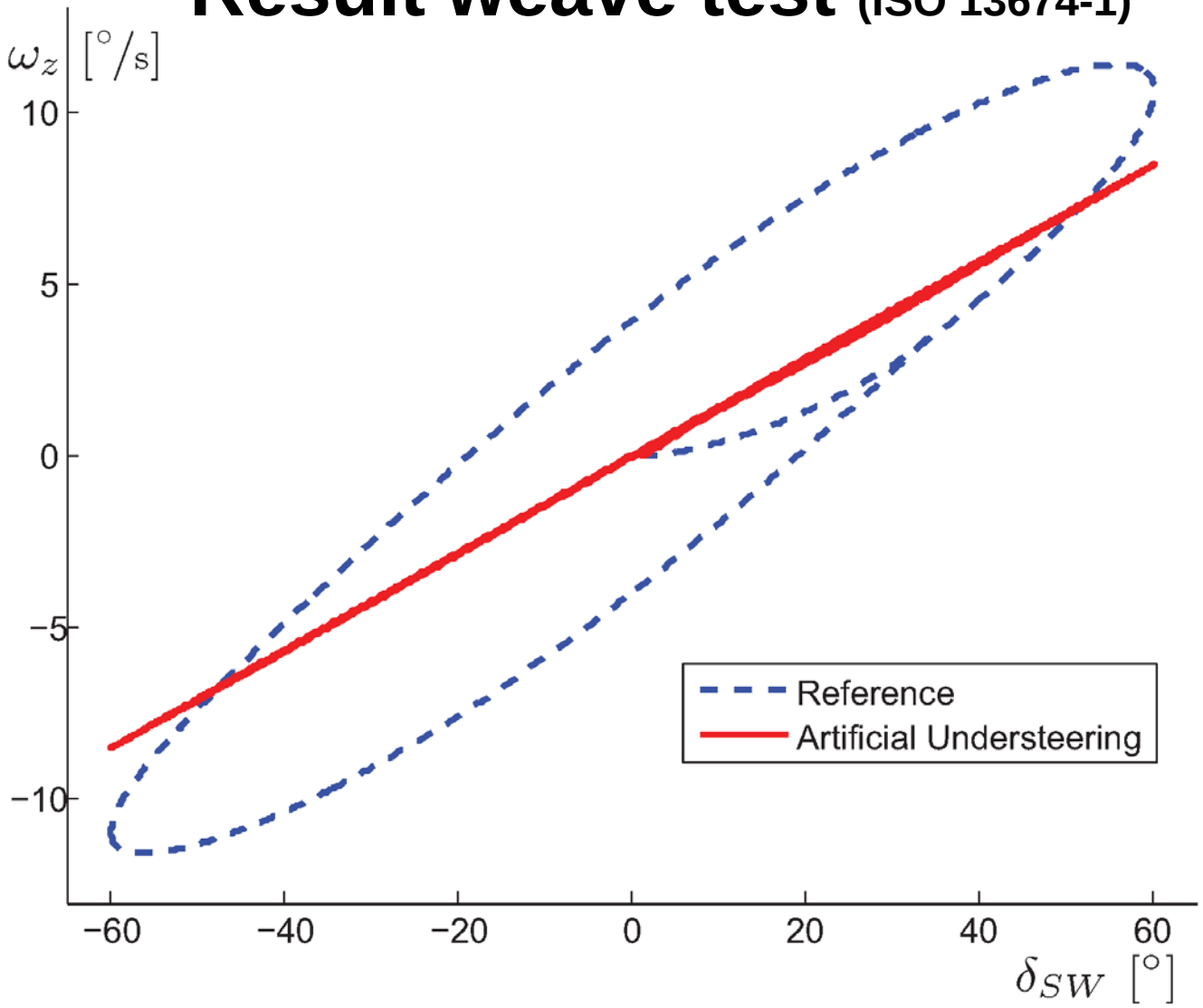
Result circle test (ISO 14792)



Weave test (ISO 13674-1)

- Constant vehicle speed (70km/h)
- Steering wheel sine input at 0.2Hz
- Steering wheel sine amplitude +/-60° resulting in a_y=+/-2$^{m}/_{s\hat{}2}$

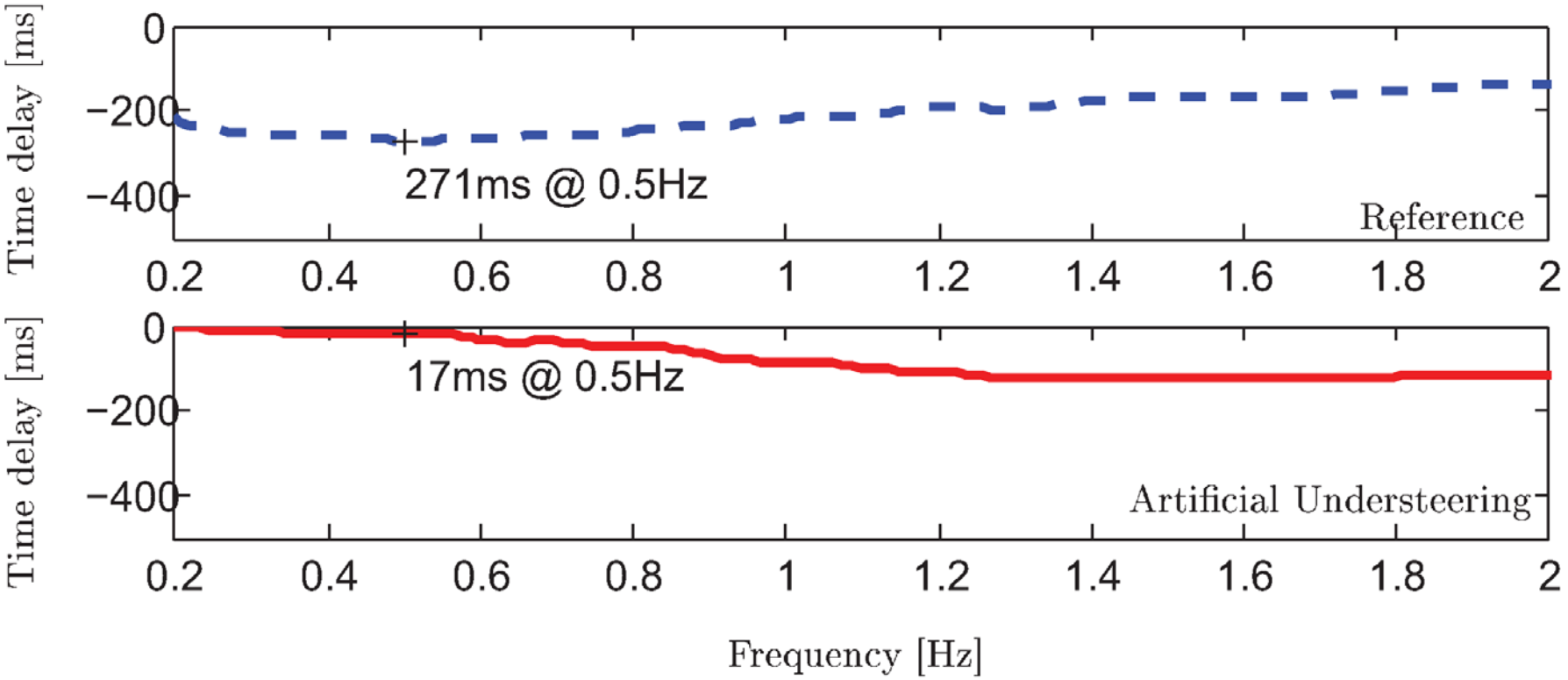
Result weave test (ISO 13674-1)



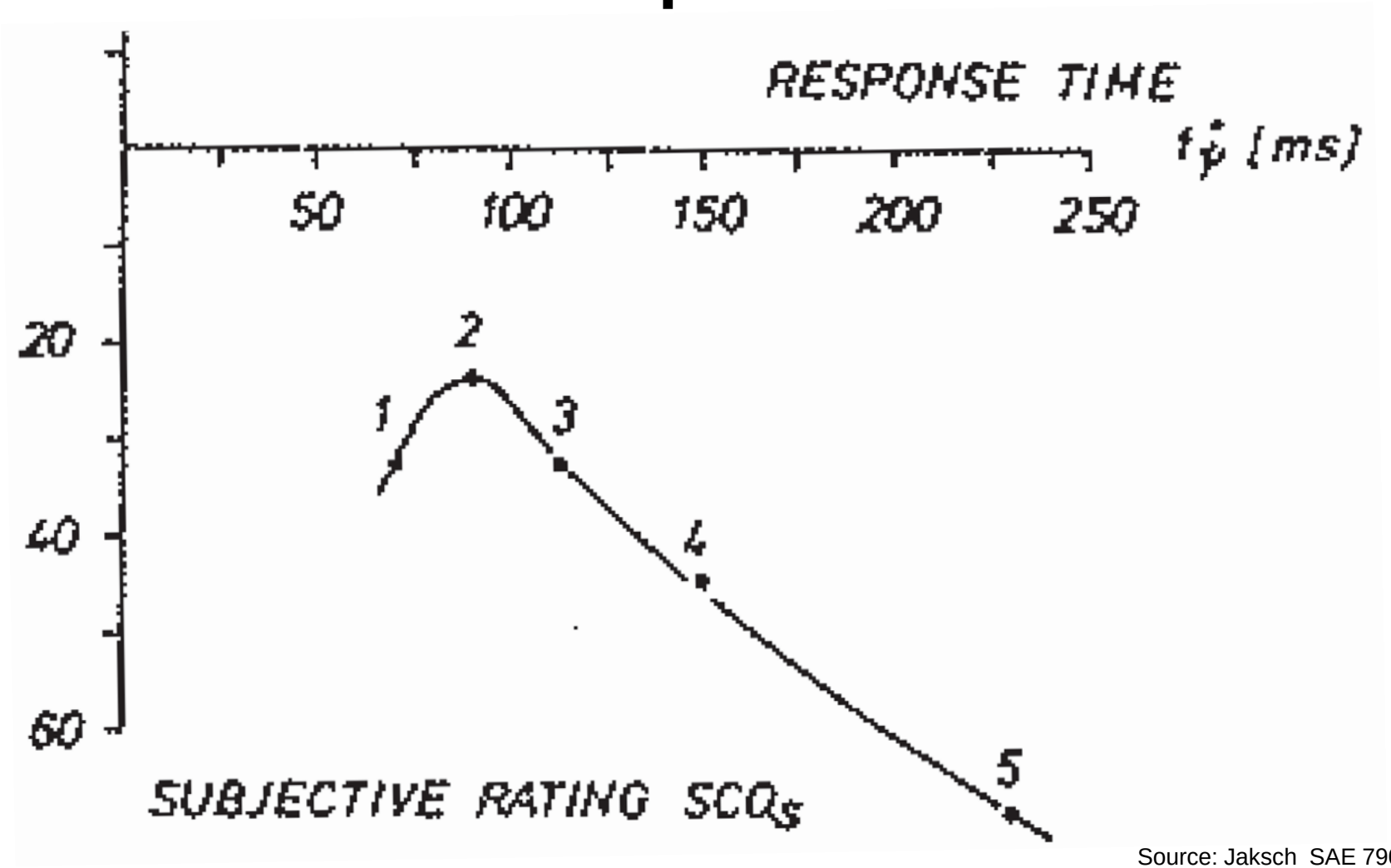
Result random test (ISO/TR 8726)

- Constant vehicle speed (70km/h)
- Steering wheel sine input with increasing frequency
- Steering wheel sine amplitude +/-60°

Result random test (ISO/TR 8726)

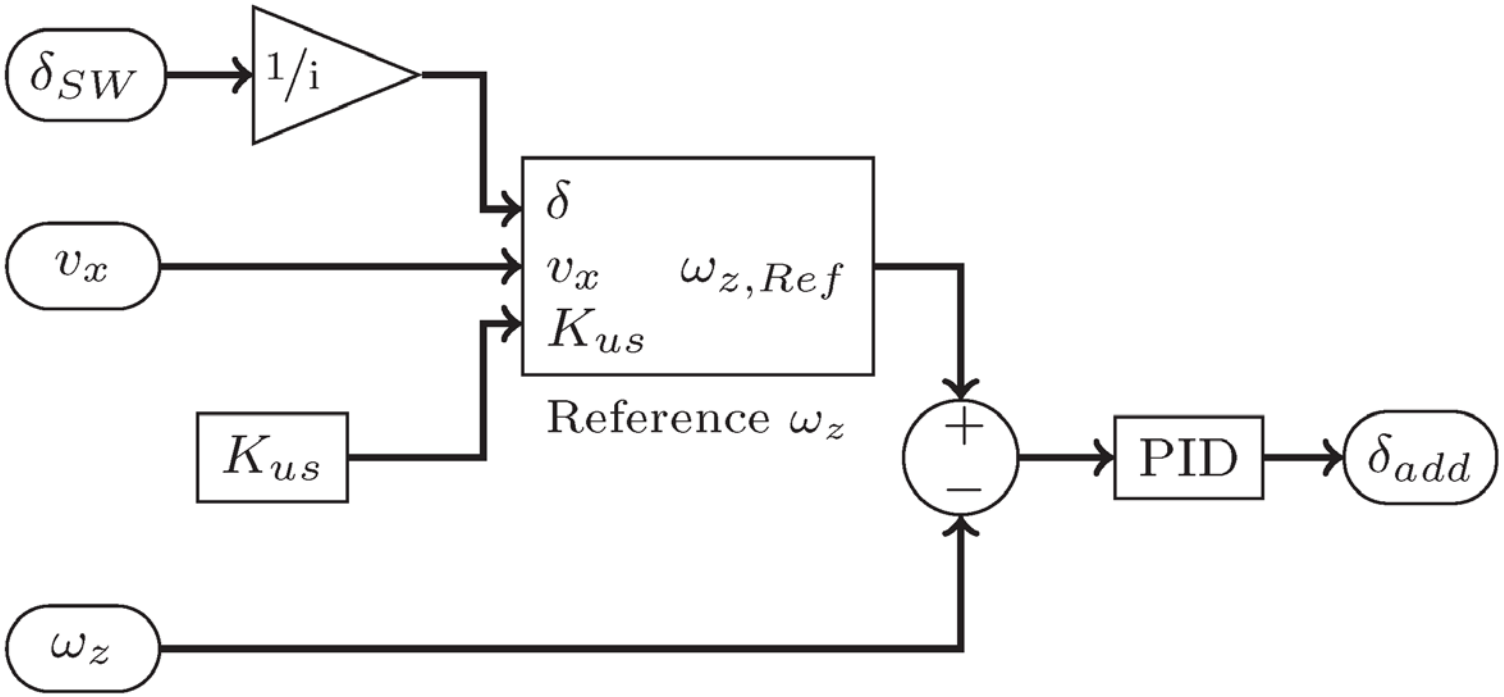


Vehicle response time

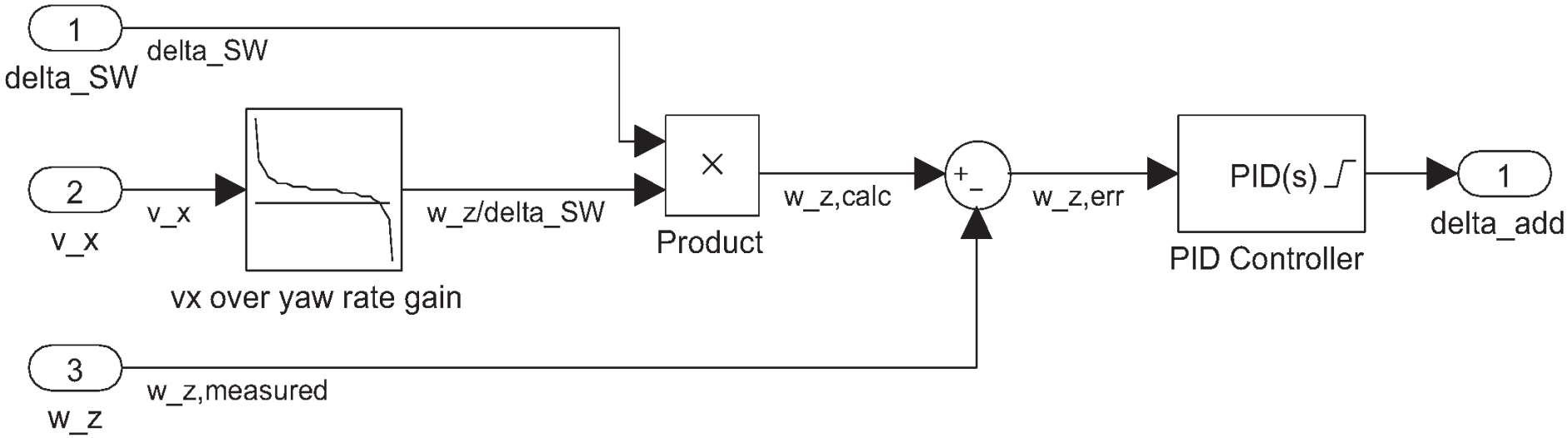


Source: Jaksch SAE 790740

Outlook


δ_{SW}
1/i
v_x
K_{us}
δ
v_x
$\omega_{z,Ref}$
K_{us}
Reference ω_z
+
−
PID
δ_{add}
ω_z

Outlook


1
delta_SW
delta_SW
2
v_x
v_x
vx over yaw rate gain
w_z/delta_SW
Product
w_z,calc
+
−
w_z,err
PID(s)
PID Controller
1
delta_add
3
w_z,measured
w_z

Outlook

- **Implementation and track tests in a prototype vehicle**
- **Refine parameters**
- **Investigation of steering feel and vehicle performance**

Results & Conclusions

- **A functionality for artificial understeering by means of active steering with superposition of steering angle has been presented**
- **The modified vehicle behaviour can be detected in standard handling tests**
- **For characterisation, application and analysis of the functionality there are the usual tools of control theory are to be used**

Thank you for your attention!

Questions?

Thanks to Scania, KTH and FFI

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