CORRSYS DATRON
Sensorsysteme GmbH
A Kistler Group Company

High resolution slip angle measurement

Corrsys-Datron Sensorsysteme GmbH
A Kistler Group Company

www.Corrsys-Datron.com

Corrsys-Datron Sensorsysteme GmbH

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Sensorsysteme GmbH
A Kistler Group Company

Headquarters:

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35578 Wetzlar
Germany

Since 2009:
A Kistler Group Company

Short Product Overview

CORRSYS DATRON
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- Optical Sensors
- Mechanical Sensors
- Fuel Measurement Sensors
- Equipment
- Data Acquisition
- Software

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Technologie

Optical Sensors for slip angle measurement

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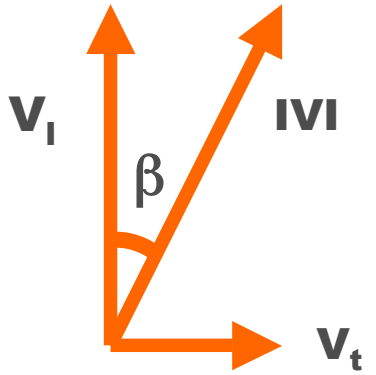
Specifications

- Non-Contact optical sensor
- 2 axis sensor
- High bandwidth of 250 Hz
- Speed range up to 250 kph
- Resolution 2,66 mm
- Accuracy 0,2% FSO



Slip angle specifications

- Improved working principal for slip angle
- High resolution slip angle of 0.01°
- Slip angle accuracy of 0.1°
- Low noise (unfiltered)

S-HR Sensor

Working principal of Correvit® One axis

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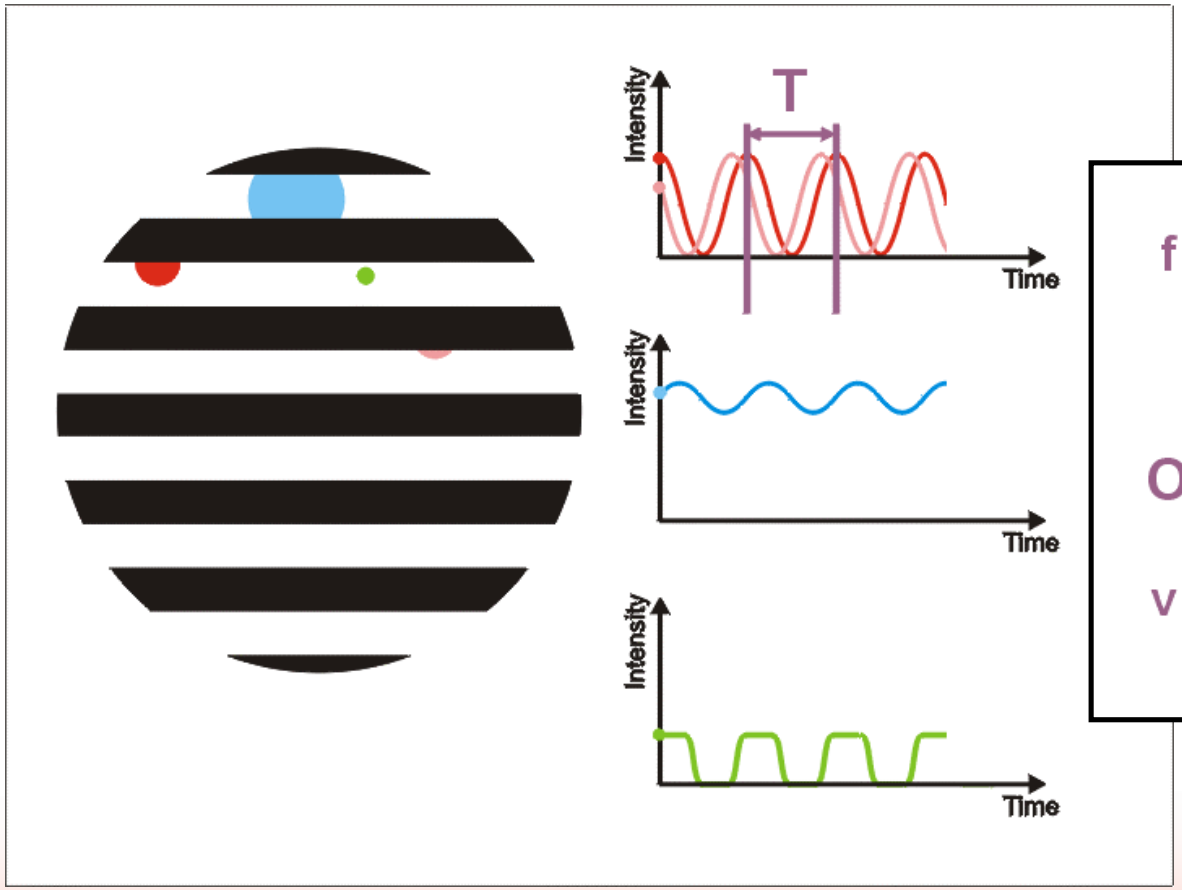

$$f = 1/T$$

$$= \frac{v \cdot M}{g}$$

OR

$$v = \frac{f \cdot g}{M}$$

Working principal of Correvit® Two axis Speed

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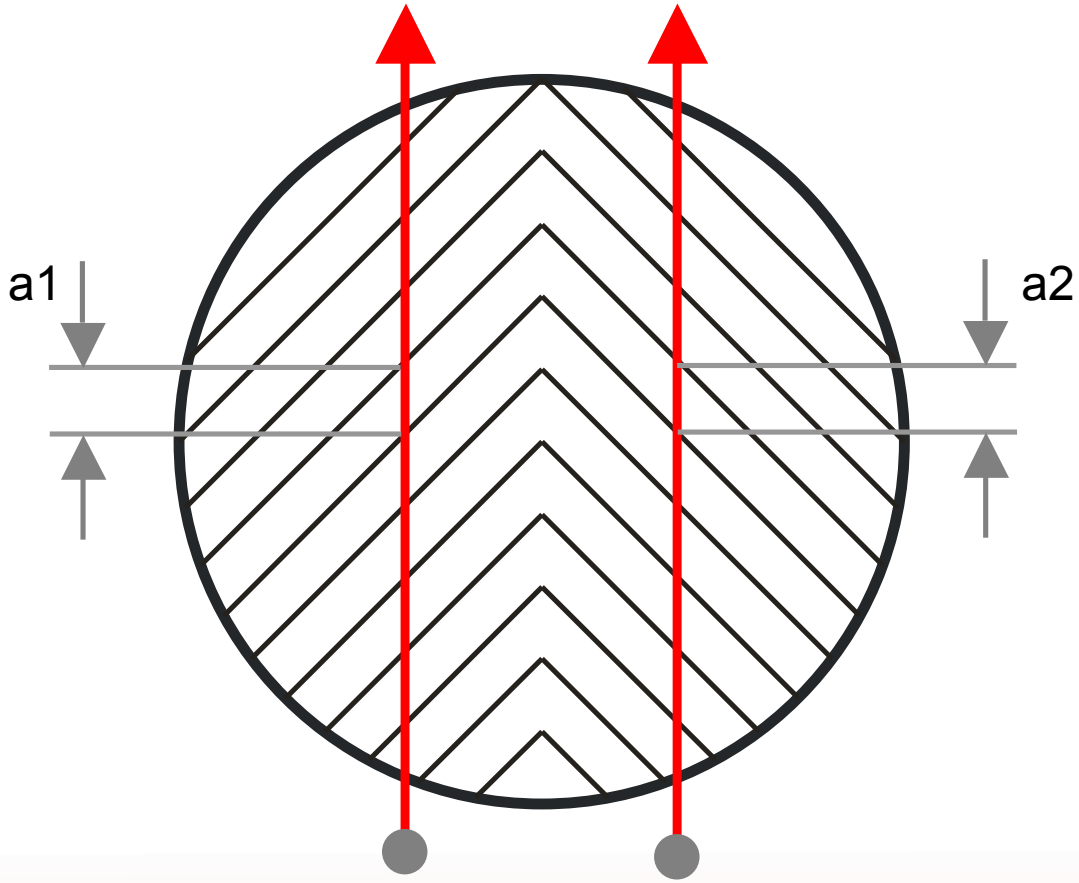

Mathematics:

a1=a2

f1 = f2 => v1=v2

v = (f•g) / M

vabs = sqr (v_1^2+v_2^2)

angle = 45°- atan(f1/f2)

v_L=v_{abs}

v_Q=0

Working principal of Correvit® Two axis Speed

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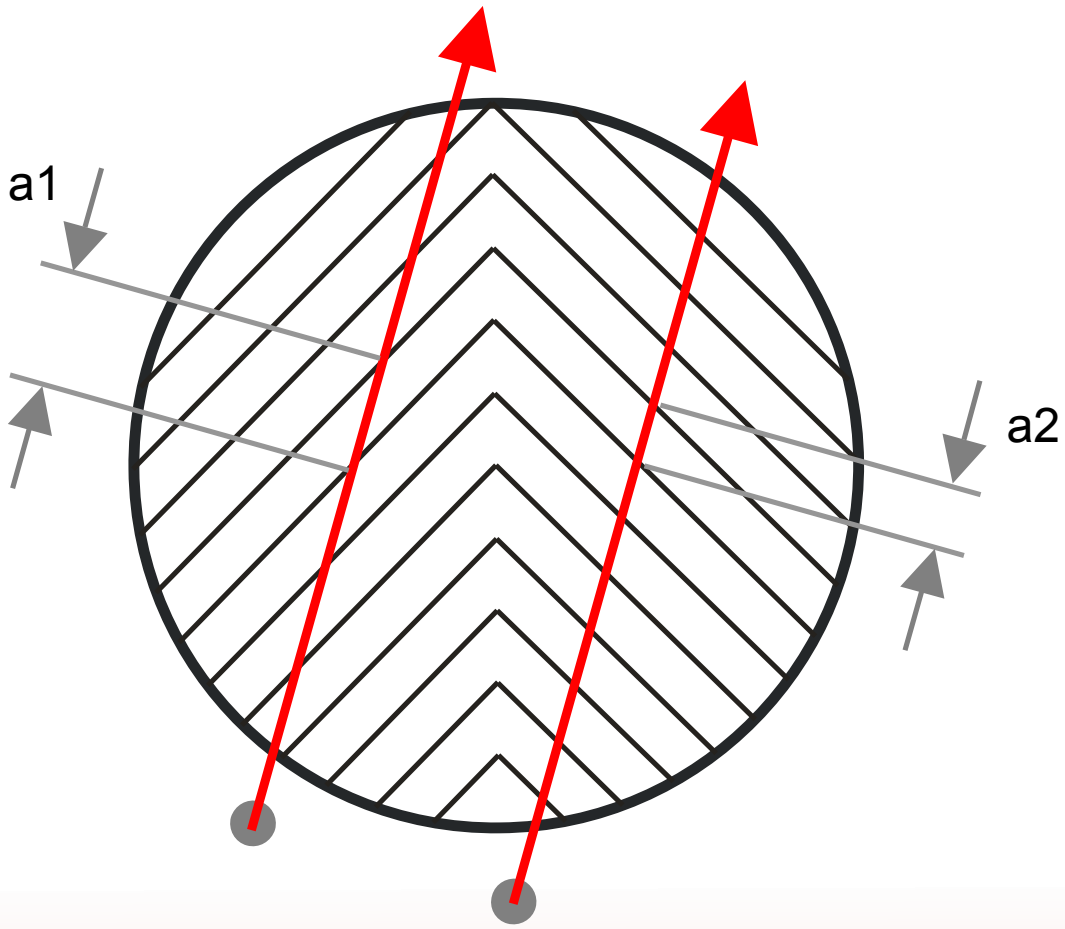

Mathematics:

$a_1 > a_2$

$f_1 < f_2 \Rightarrow v_1 < v_2$

$v = (f \cdot g) / M$

$v_{abs} = \text{sqr}\,(v_1^2 + v_2^2)$

$\text{angle} = 45° - \text{atan}\,(f_1/f_2)$

$v_L = v_{abs} \cdot \cos(\text{angle})$

$v_Q = v_{abs} \cdot \sin(\text{angle})$

Current Status

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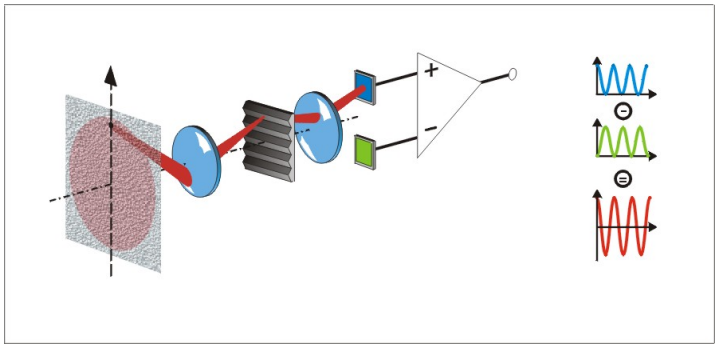
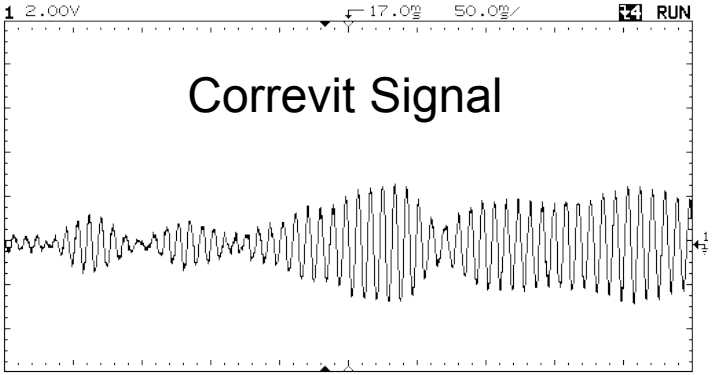
Current sensors:

- Based on Correvit principal
- Distance measuring system
- Speed and angle information is calculated
- Distance resolution 1,5 to 2,5mm





Current Problems:

- Low resolution of slip angle
- Noise on slip angle
- Resolution is speed dependant

Improvement

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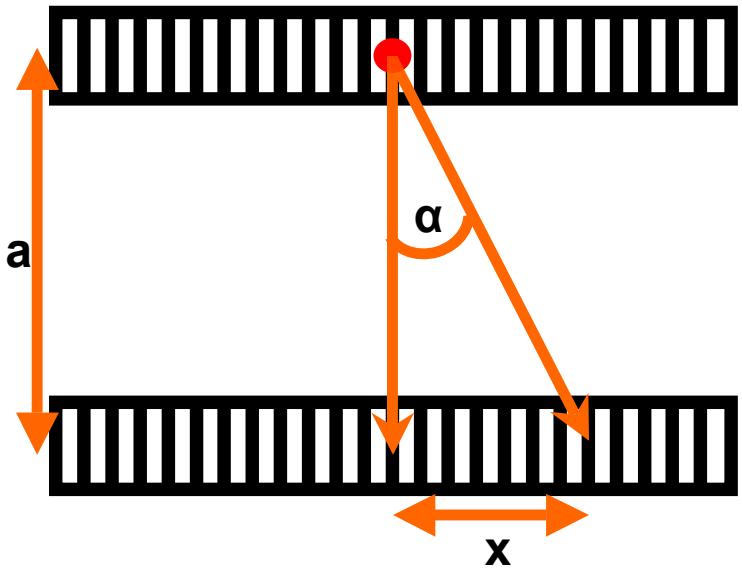
New S-HR sensor

- New, patented optical principal
- CCD lines for high resolution slip angle
- Combined with Correvit principal
- Distance and angle measuring system
- Speed and angle information is calculated
- Distance resolution 1,5 to 2,5mm



Improved values

- Angle resolution: 0,01°
- Angle accuracy: 0,1°

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Signal improvement

Signal improvements

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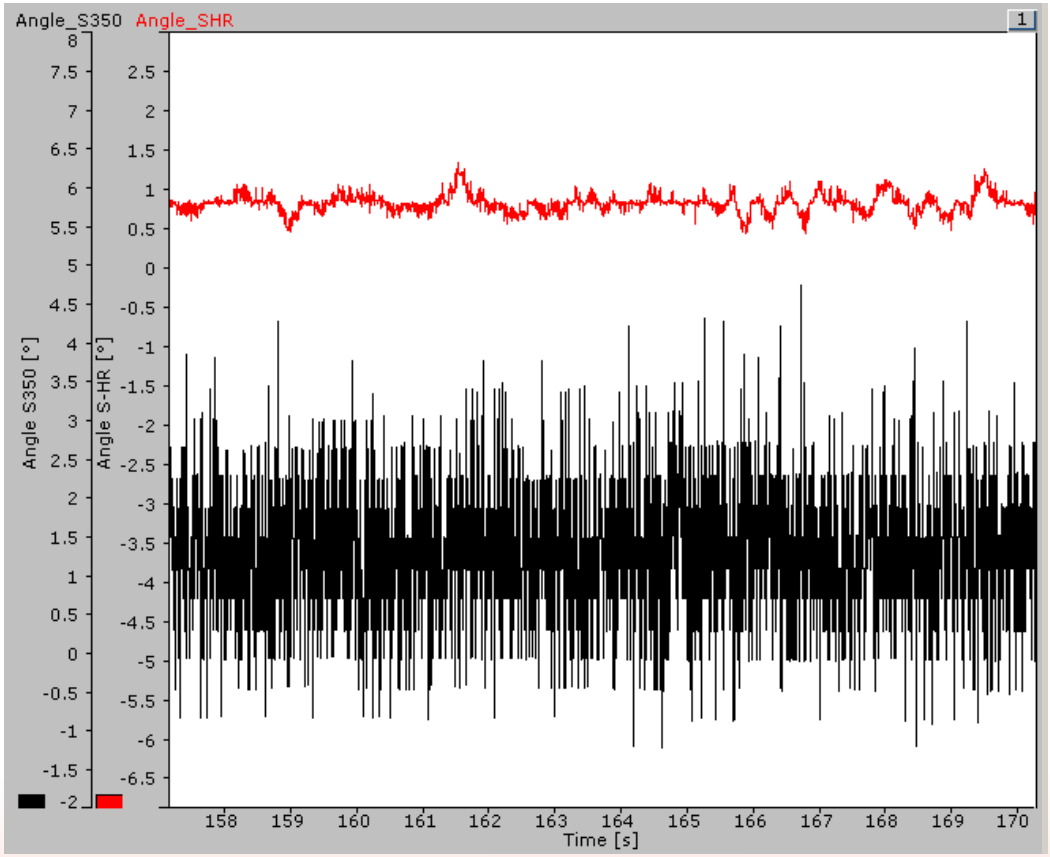
Comparison slip angle

in static condition at car:

- S350
- S-HR

- Performed at constant speed of 80 kph.
- scaling is identical
- sensors are unfiltered



Slip angle versus speed

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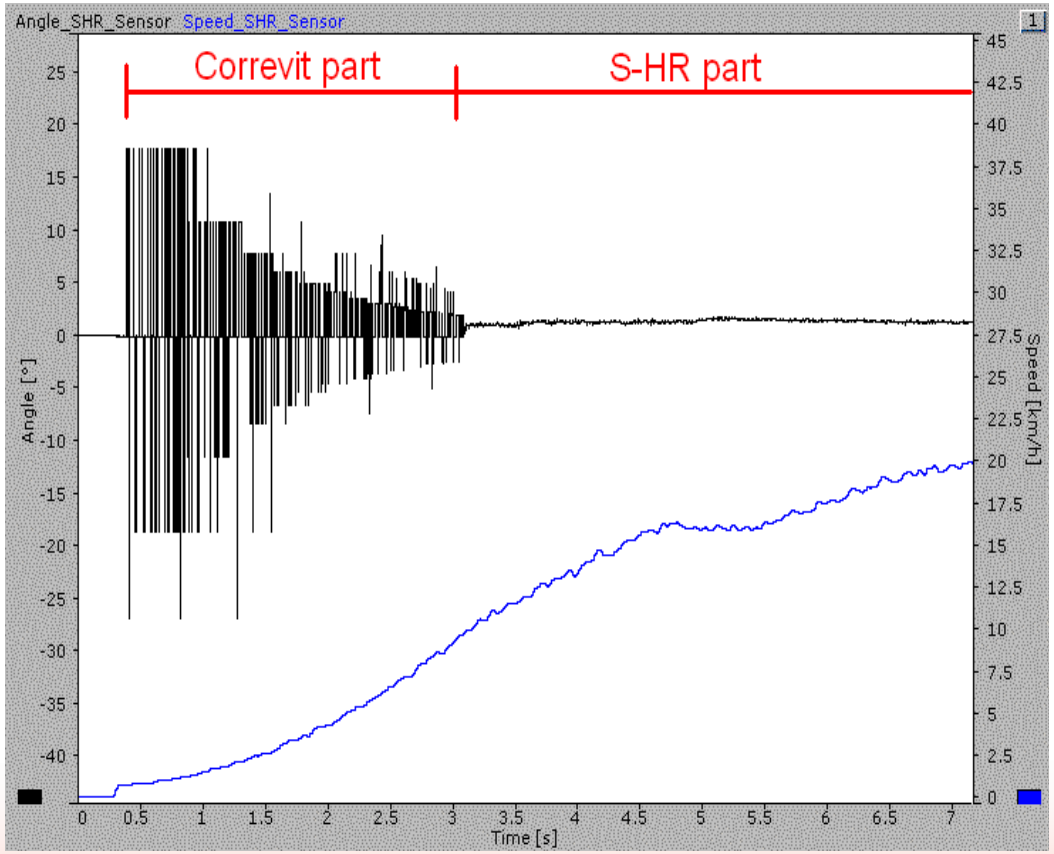
Correvit part

- Low resolution area below 10 kph
- Resolution is dependent on speed

S-HR part

- Low resolution area above 10 kph
- Resolution is not dependent on speed



Customer Test

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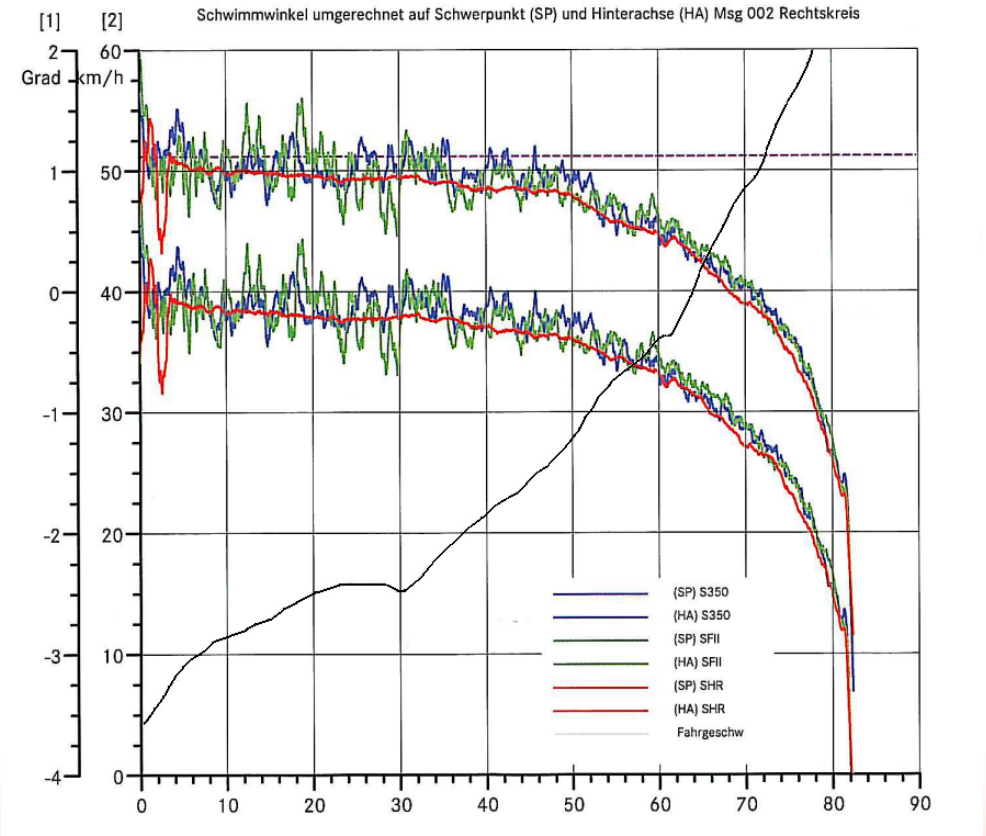
Comparison slip angle steady state circular :

- SFII
- S350
- S-HR

- Performed by a German Customer.
- Sensors are unfiltered



Applications

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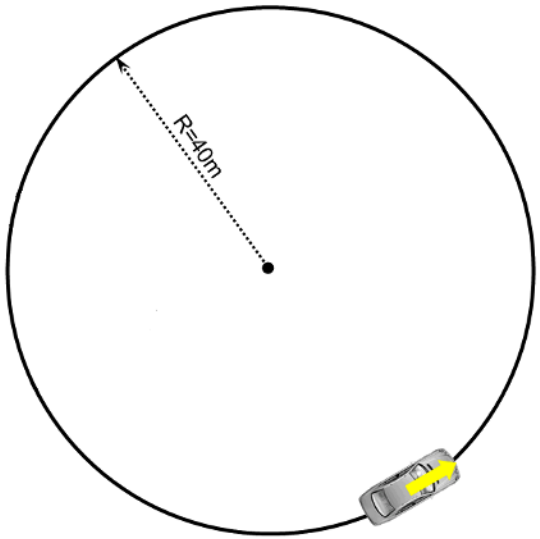
ISO Tests:

- Sine Sweep
- Steady state circular
- Yaw amplification
- Step steer input
- …



Other Applications:

- Tyre development
- ESP development
- Crosswind
- …

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Applications

Slip angle at car

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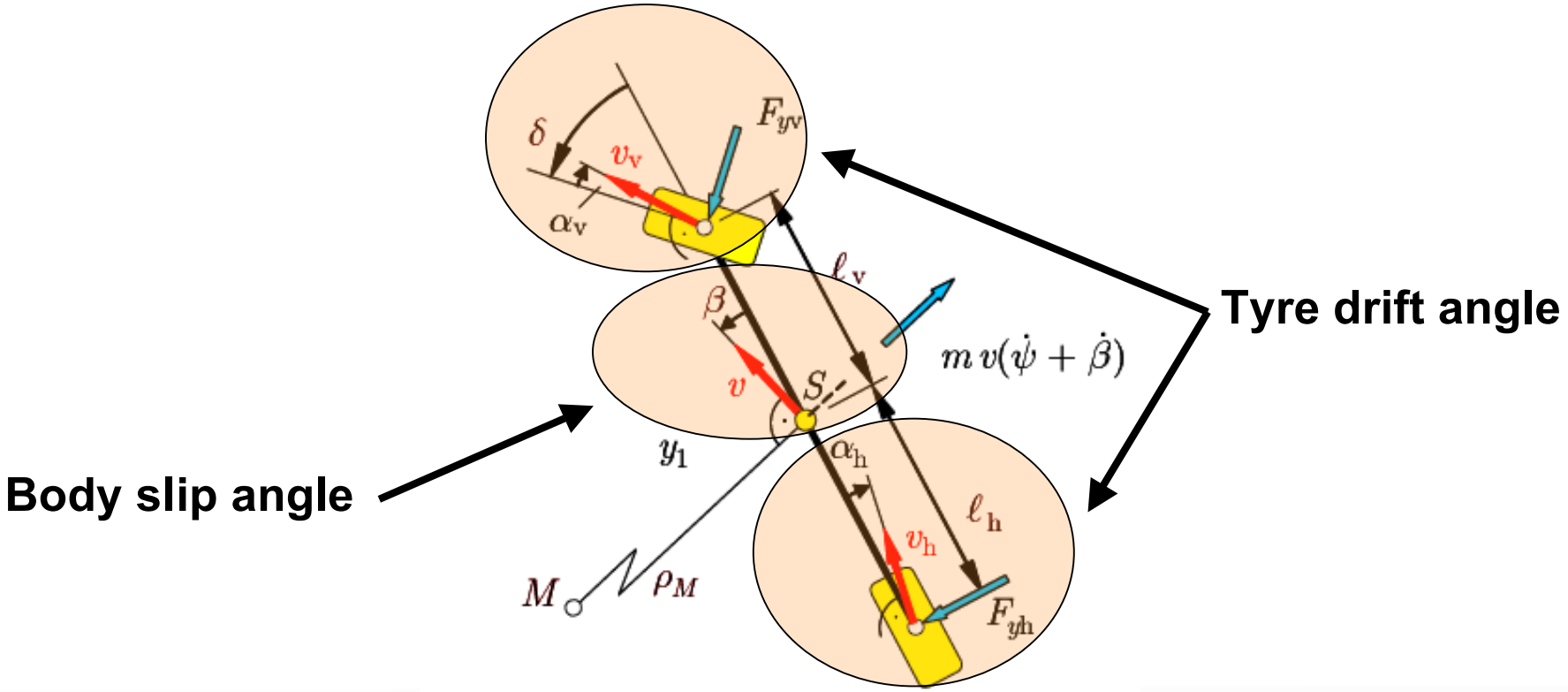

Linear one-track model

Slip angle at car

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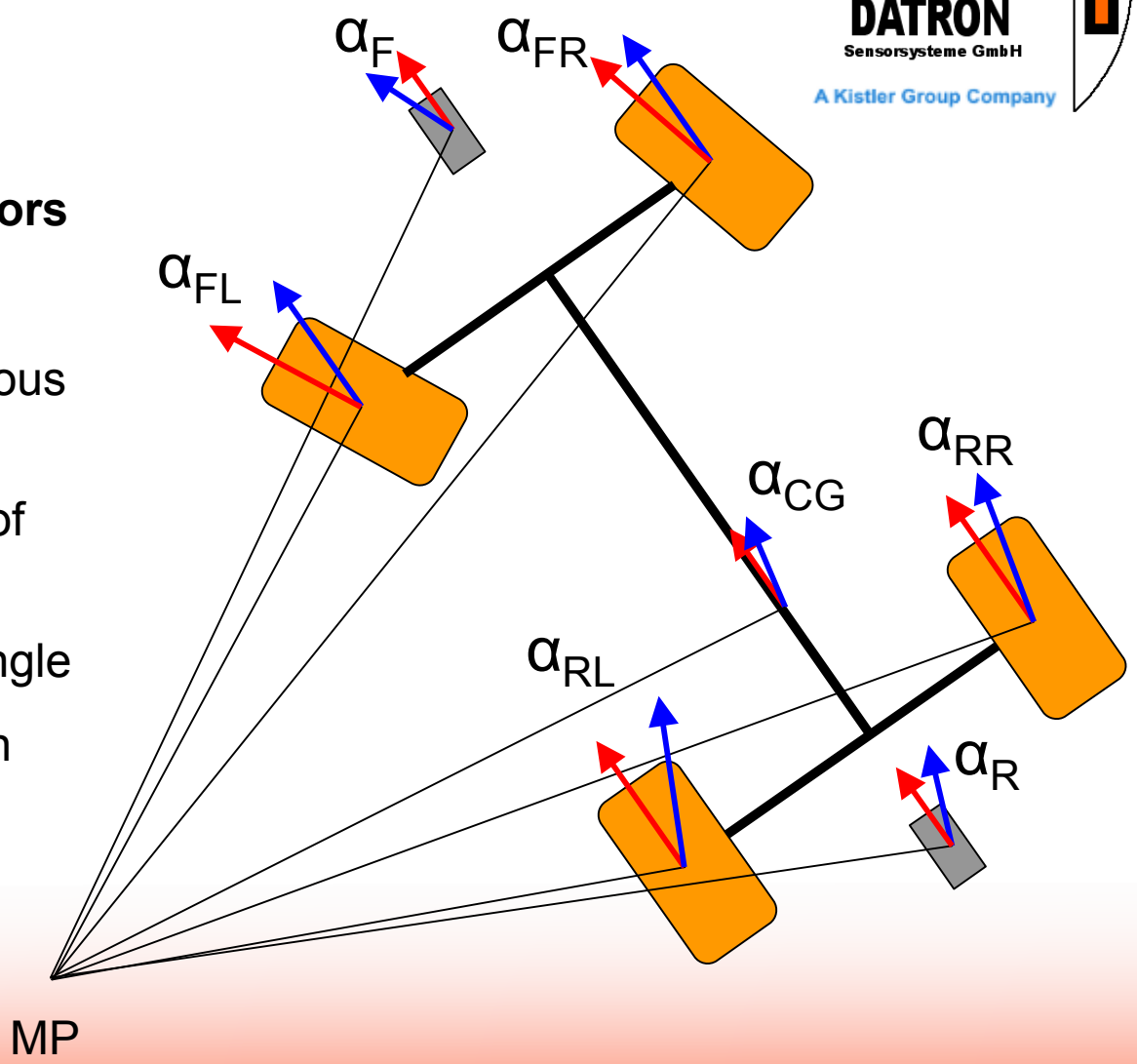
Calculation of tyre drift angle using 2 S-HR sensors

- Calculation of instantaneous center MP
- Calculation of slip angle of CG
- Calculation of tyre drift angle
- at front axle: transmission of steer angle must be added



Self steer behavior

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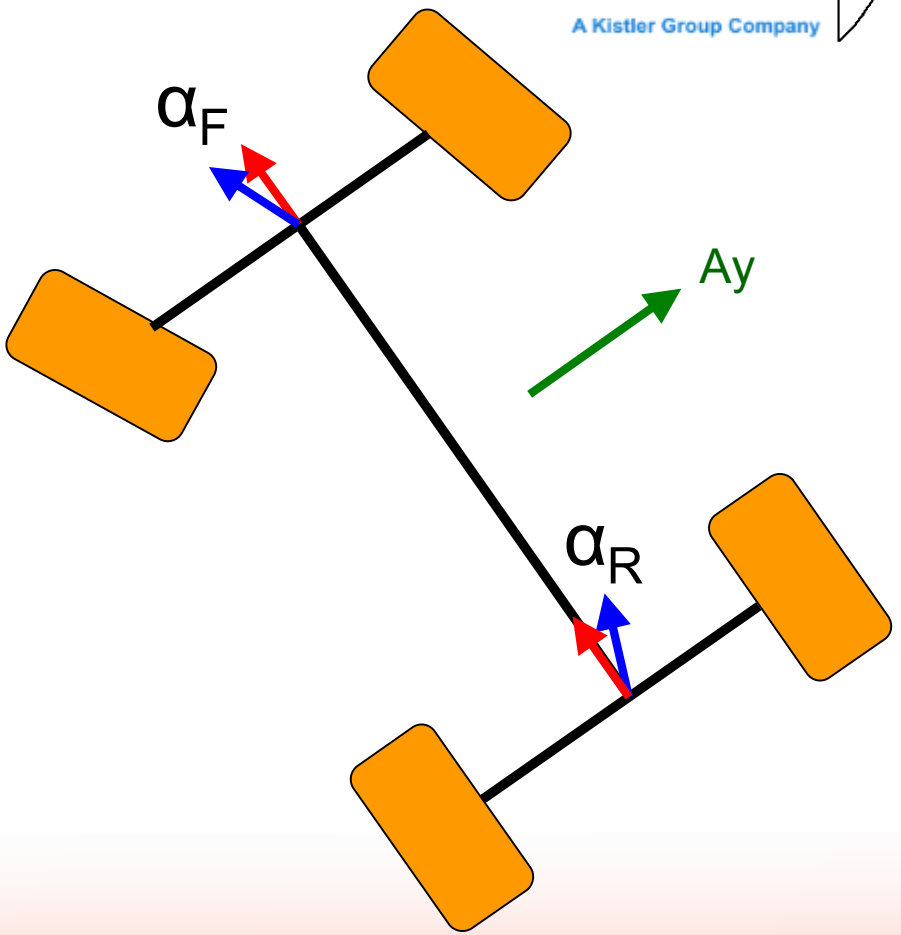
Based on slip angles and lateral acceleration

$$\frac{\ddot{A}\acute{a}_F}{\ddot{A}A_Y} - \frac{\ddot{A}\acute{a}_R}{\ddot{A}A_Y} > 0$$ Understeer

$$\frac{\ddot{A}\acute{a}_F}{\ddot{A}A_Y} - \frac{\ddot{A}\acute{a}_R}{\ddot{A}A_Y} < 0$$ Oversteer

$$\frac{\ddot{A}\acute{a}_F}{\ddot{A}A_Y} - \frac{\ddot{A}\acute{a}_R}{\ddot{A}A_Y} = 0$$ Neutral



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Thank you for your attention