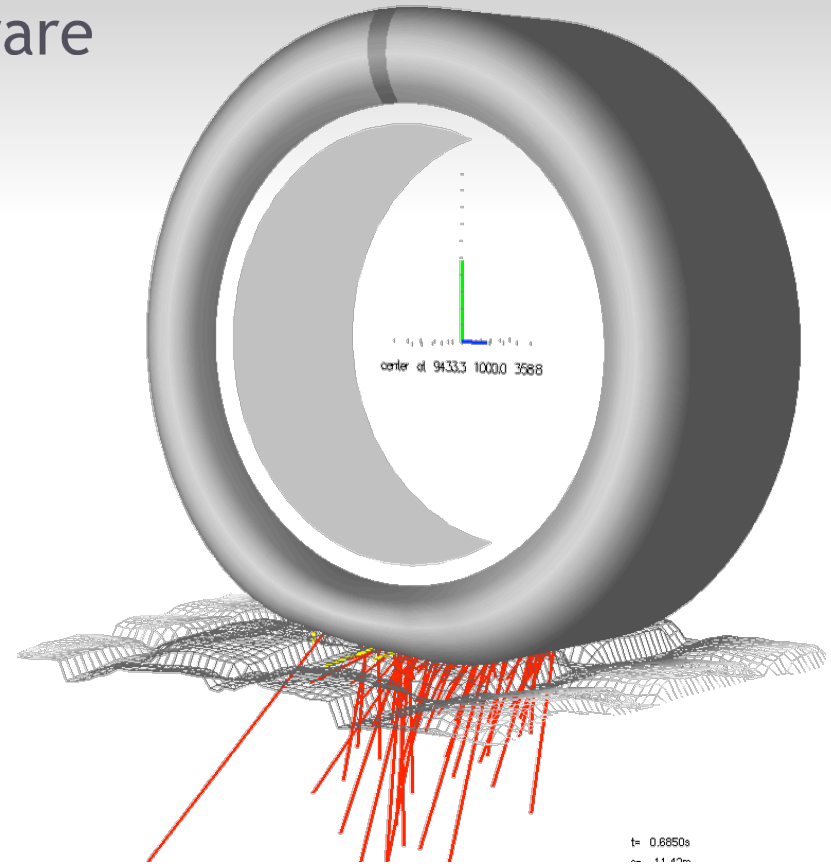
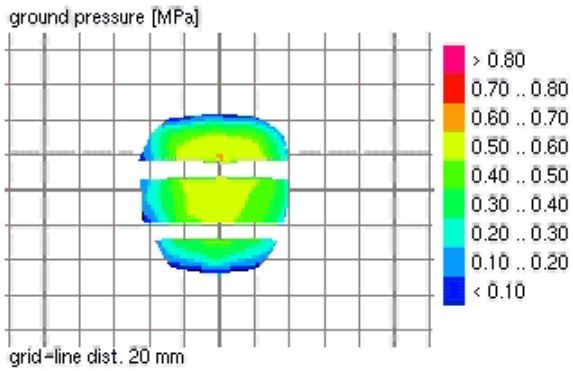
cosin
scientific software

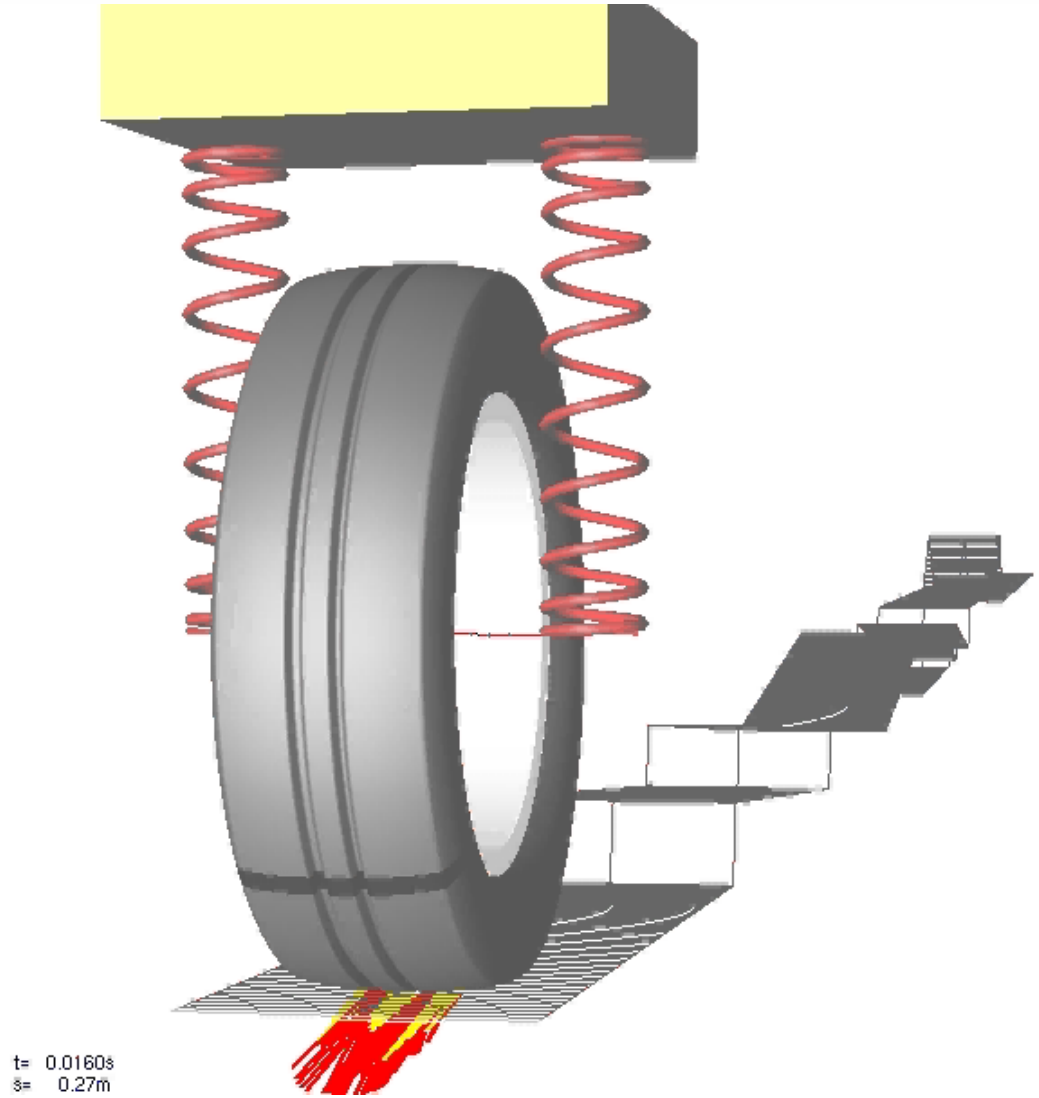


FTire: a Physically Based Tire Model for Handling, Ride, and Durability
Part 5: Applications and Results

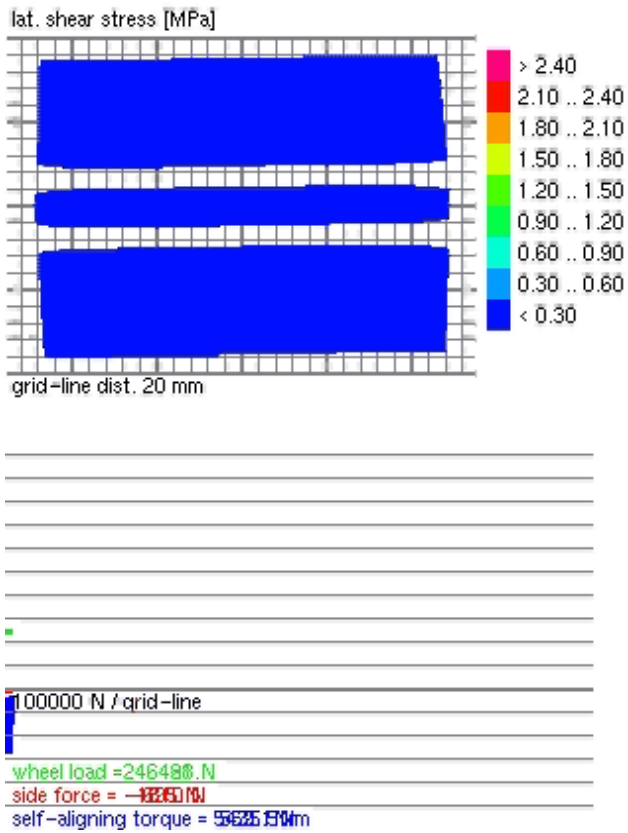
Michael Gipser
Esslingen University of Applied Sciences
& cosin scientific software

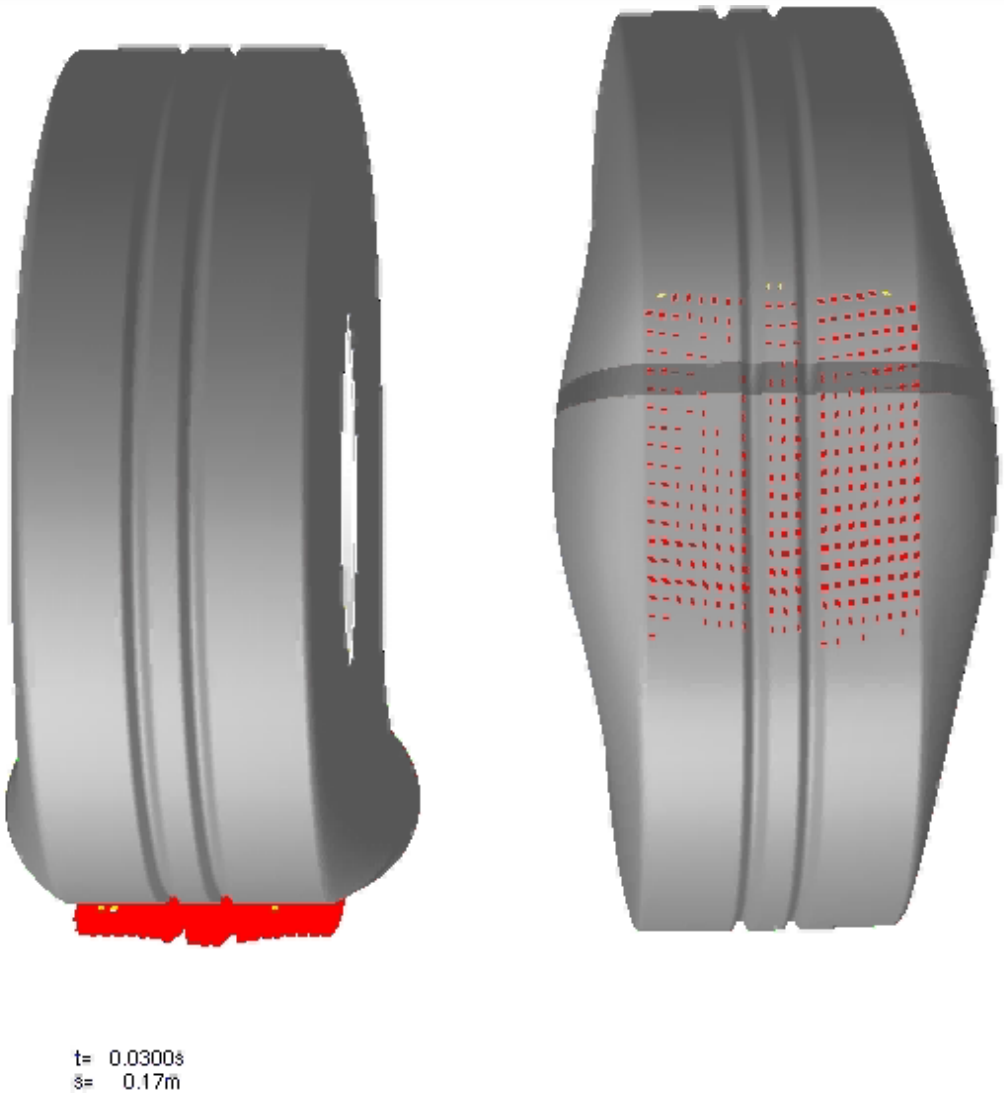
60 Km/h
300 Kg sprung mass
3 deg side-slip angle



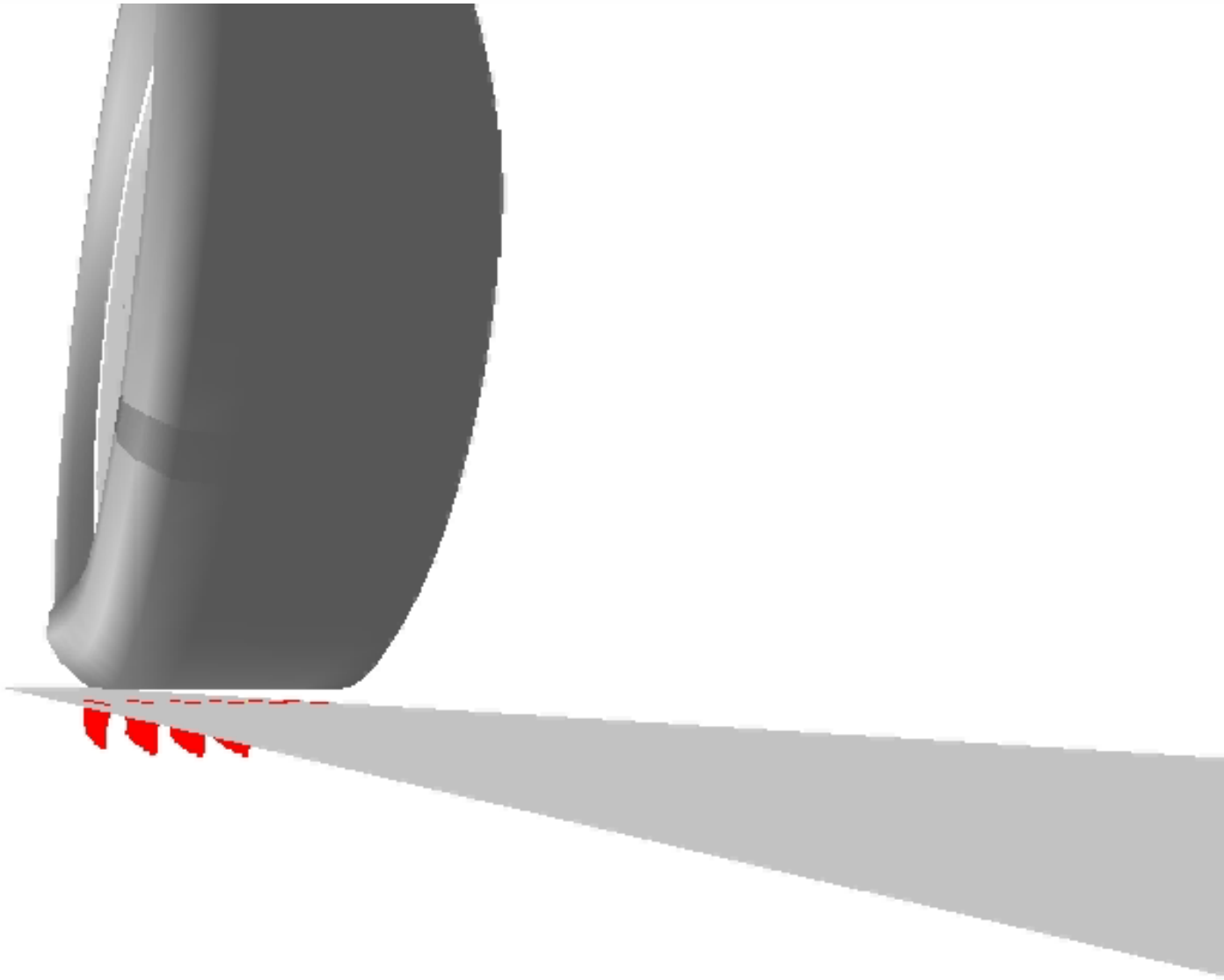


aircraft tire
250 KN
± 15 deg

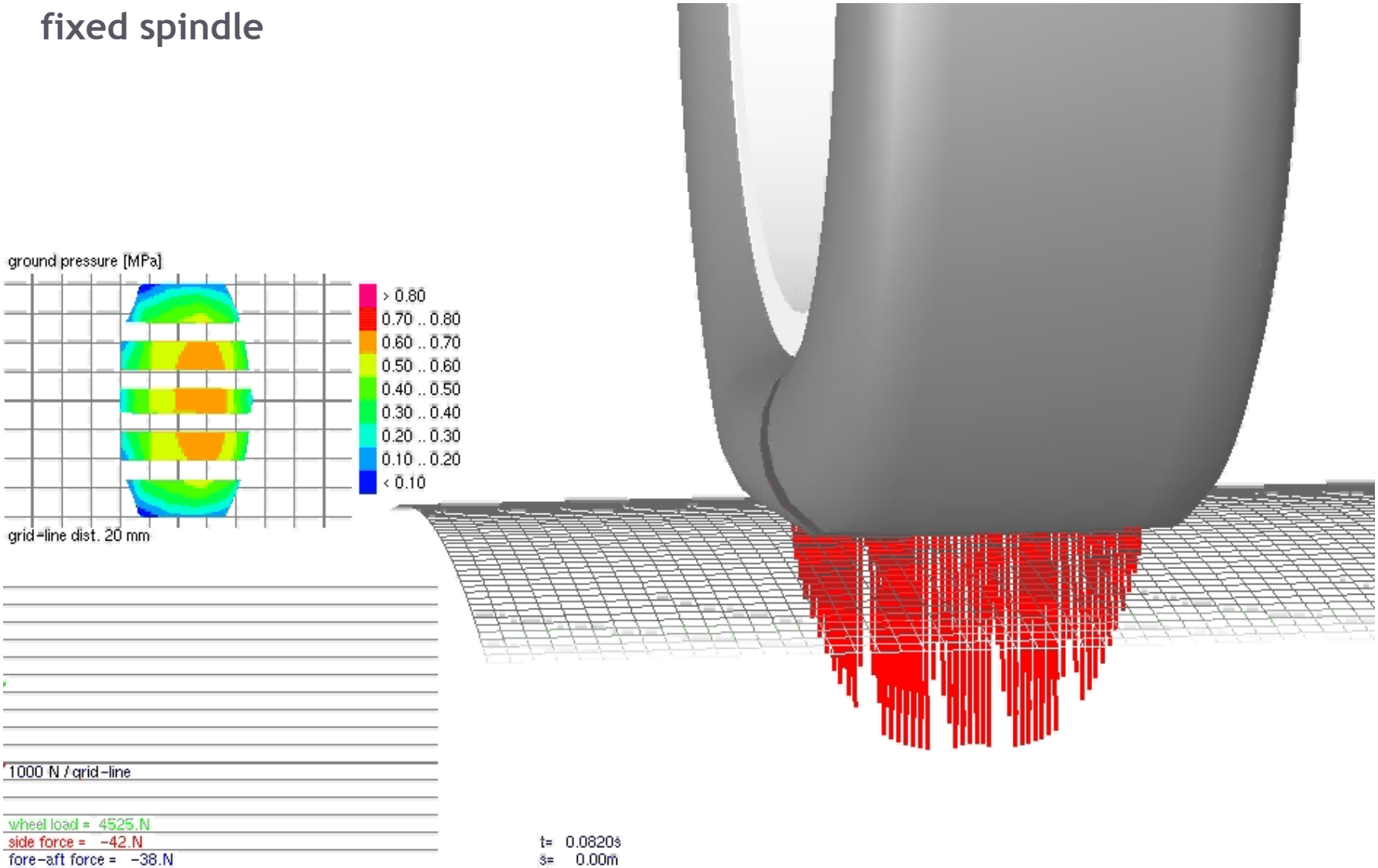




FTire
Harmonic Road Excitation

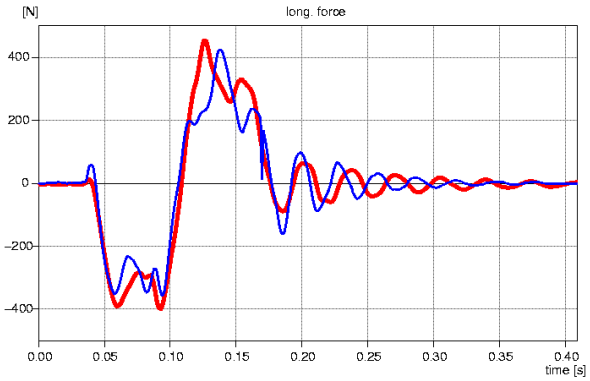


fixed spindle

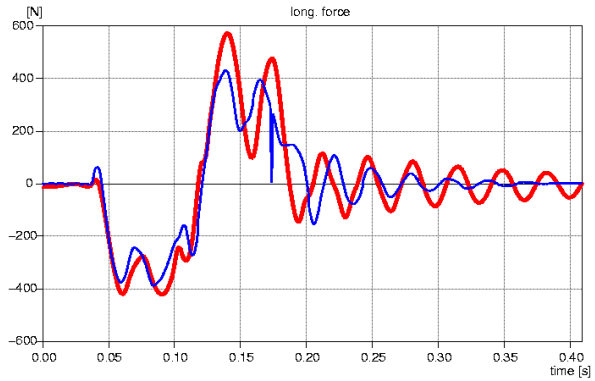


transversal cleat at low, medium, and high wheel load. v = 5 Km/h

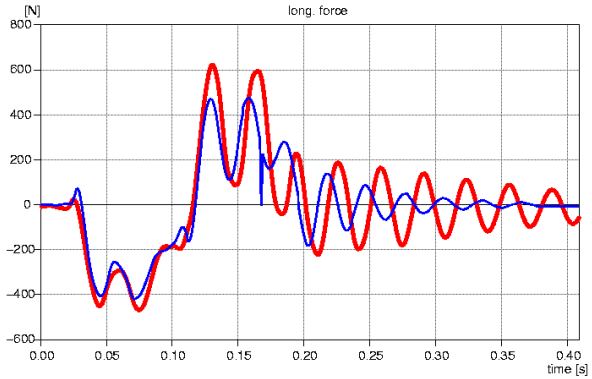
measurement vs. ***FTire*** simulation. First row: F_x, second row: F_z



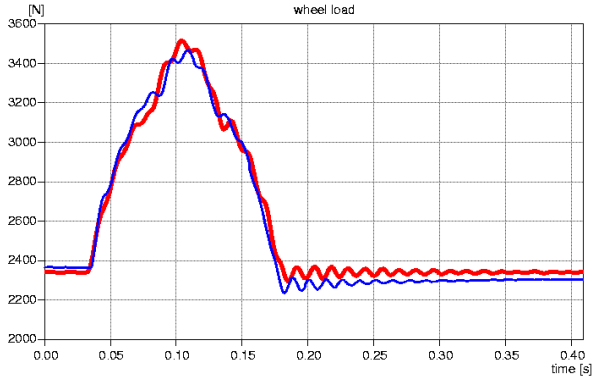
2.3 KN

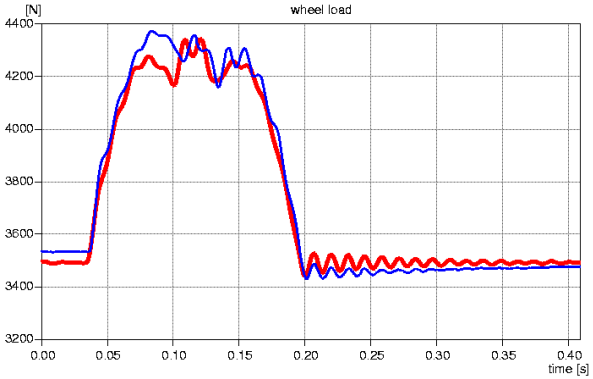


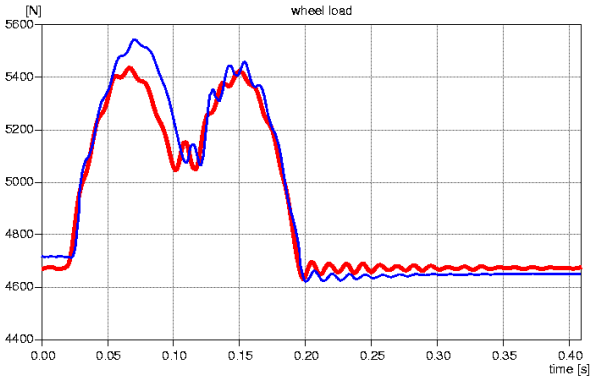
3.5 KN



4.7 KN



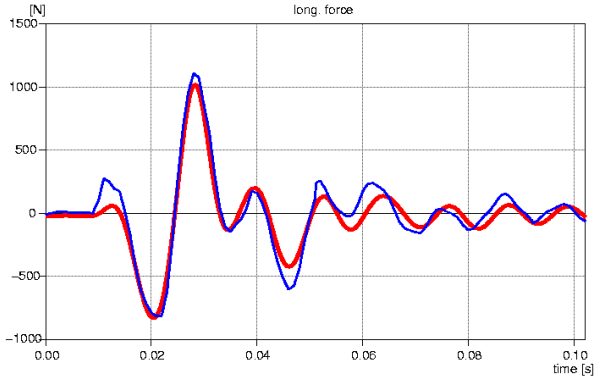




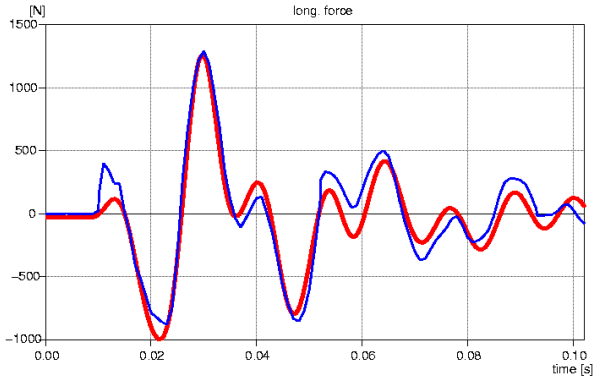
all simulations use exactly the same parameters!

transversal cleat at low, medium, and high wheel load. v = 40 Km/h

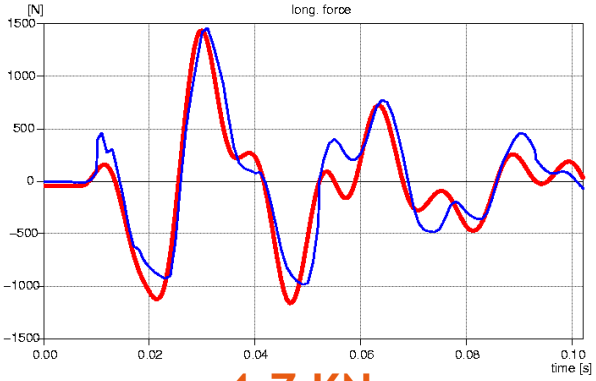
measurement vs. ***FTire*** simulation. First row: F_x, second row: F_z



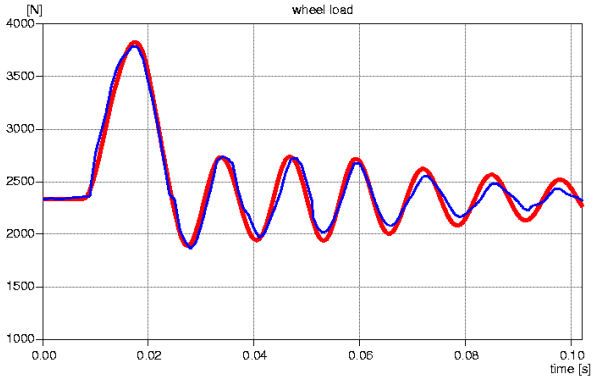
2.3 KN

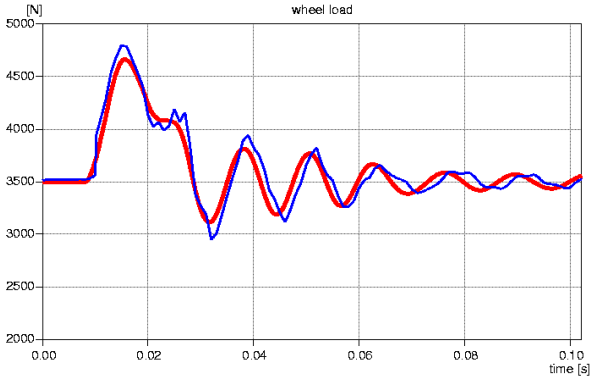


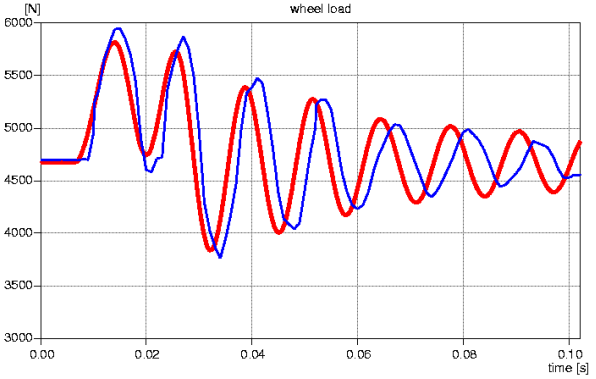
3.5 KN



4.7 KN



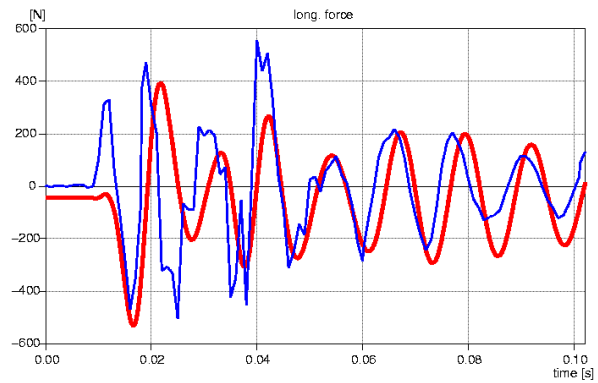




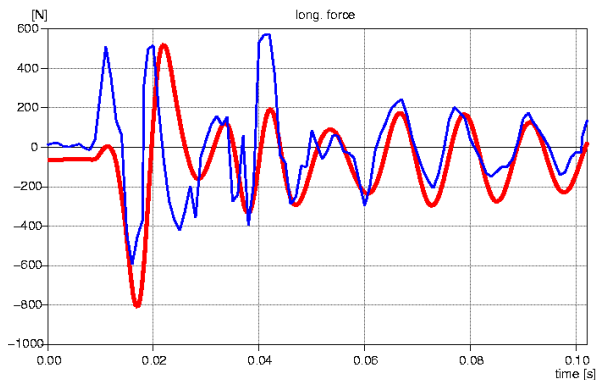
all simulations use exactly the same parameters!

transversal cleat at low, medium, and high wheel load. v = 80 Km/h

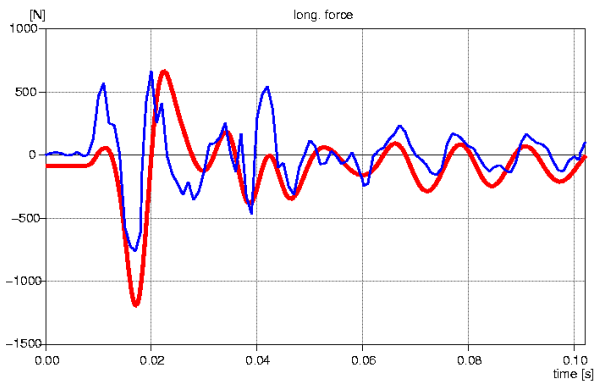
measurement vs. ***FTire*** simulation. First row: F_x, second row: F_z



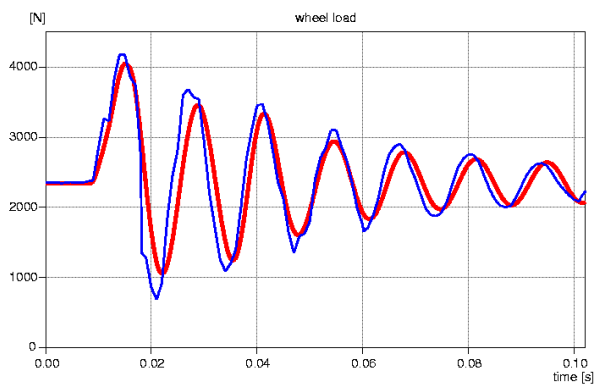
2.3 KN

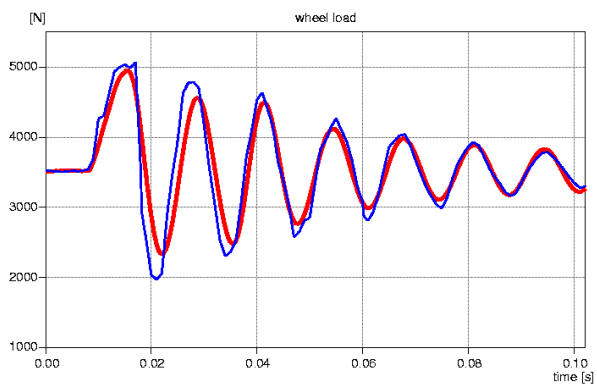


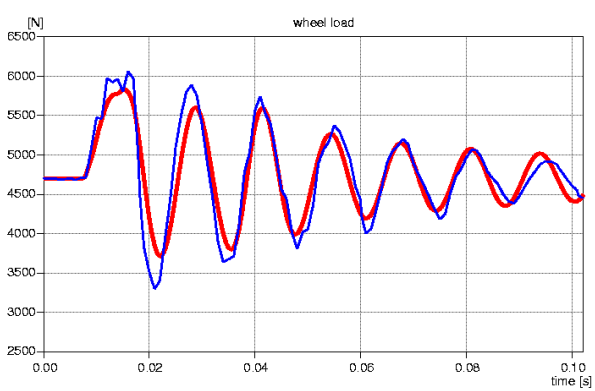
3.5 KN



4.7 KN

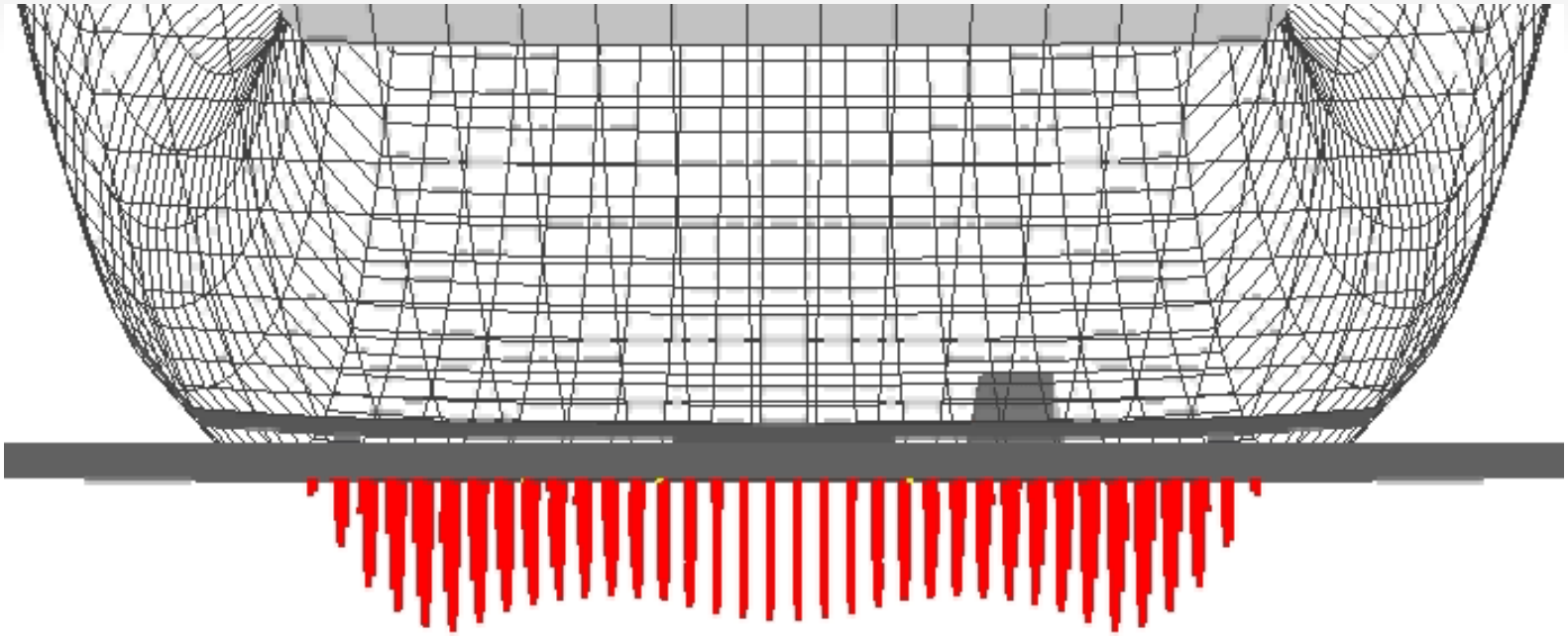


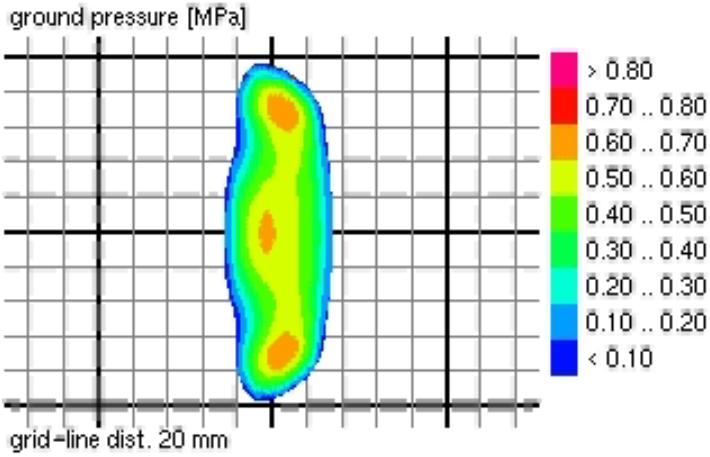




all simulations use exactly the same parameters!

FTire
Enveloping a Stone



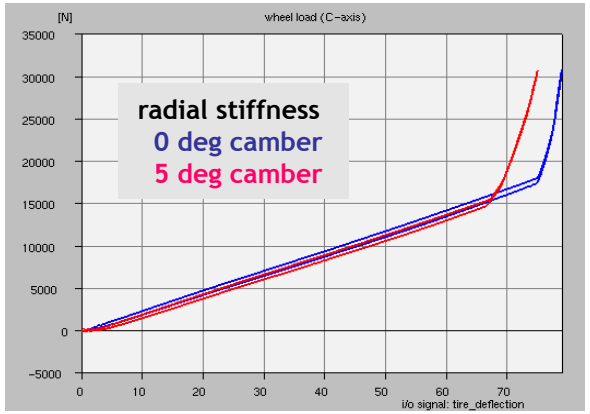


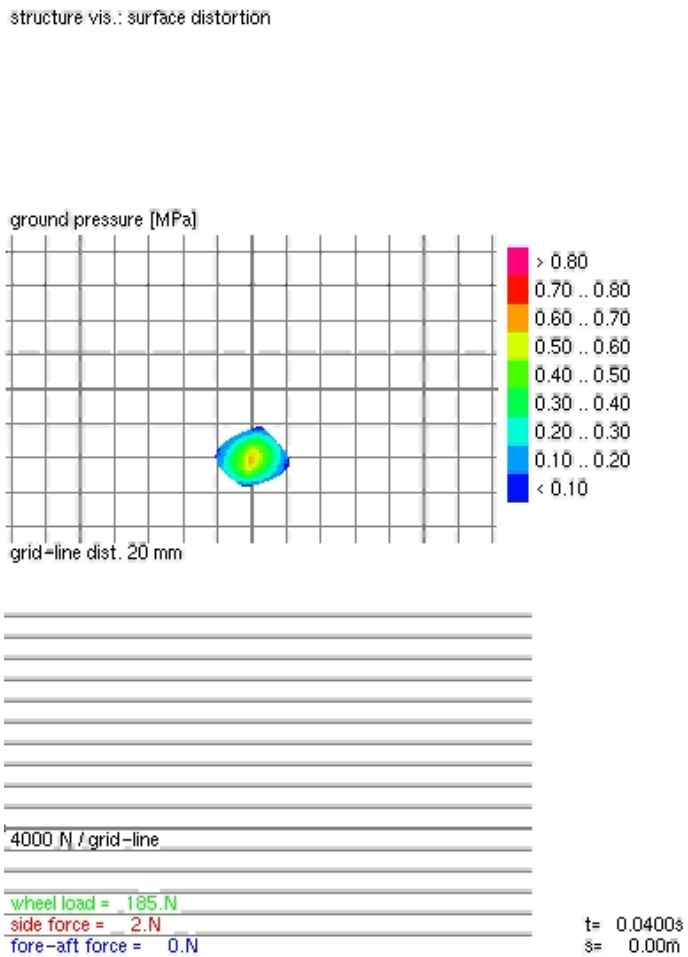
2.6 KN
30x30x30 mm
60 Km/h

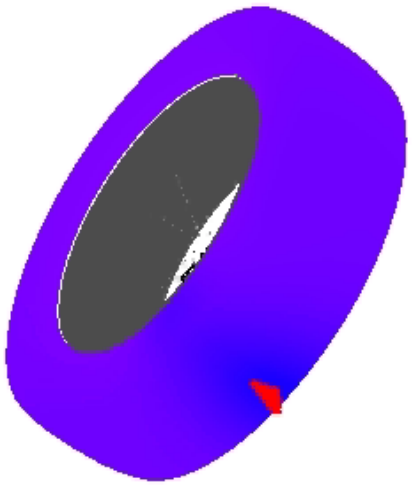
t= 0.0056s
s= 0.09m

100 mm deflection, right rim flange contacts belt

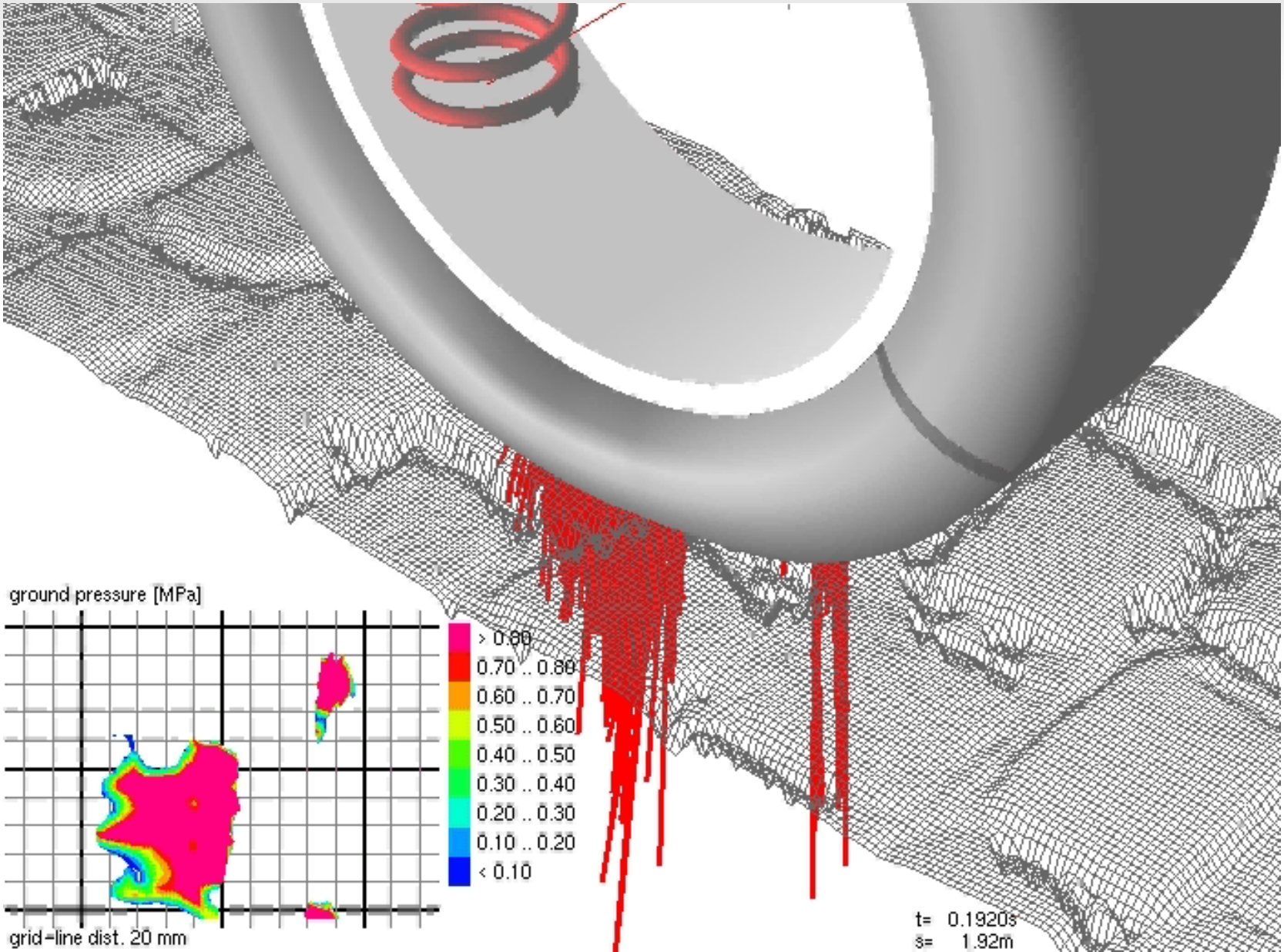
6 deg camber angle



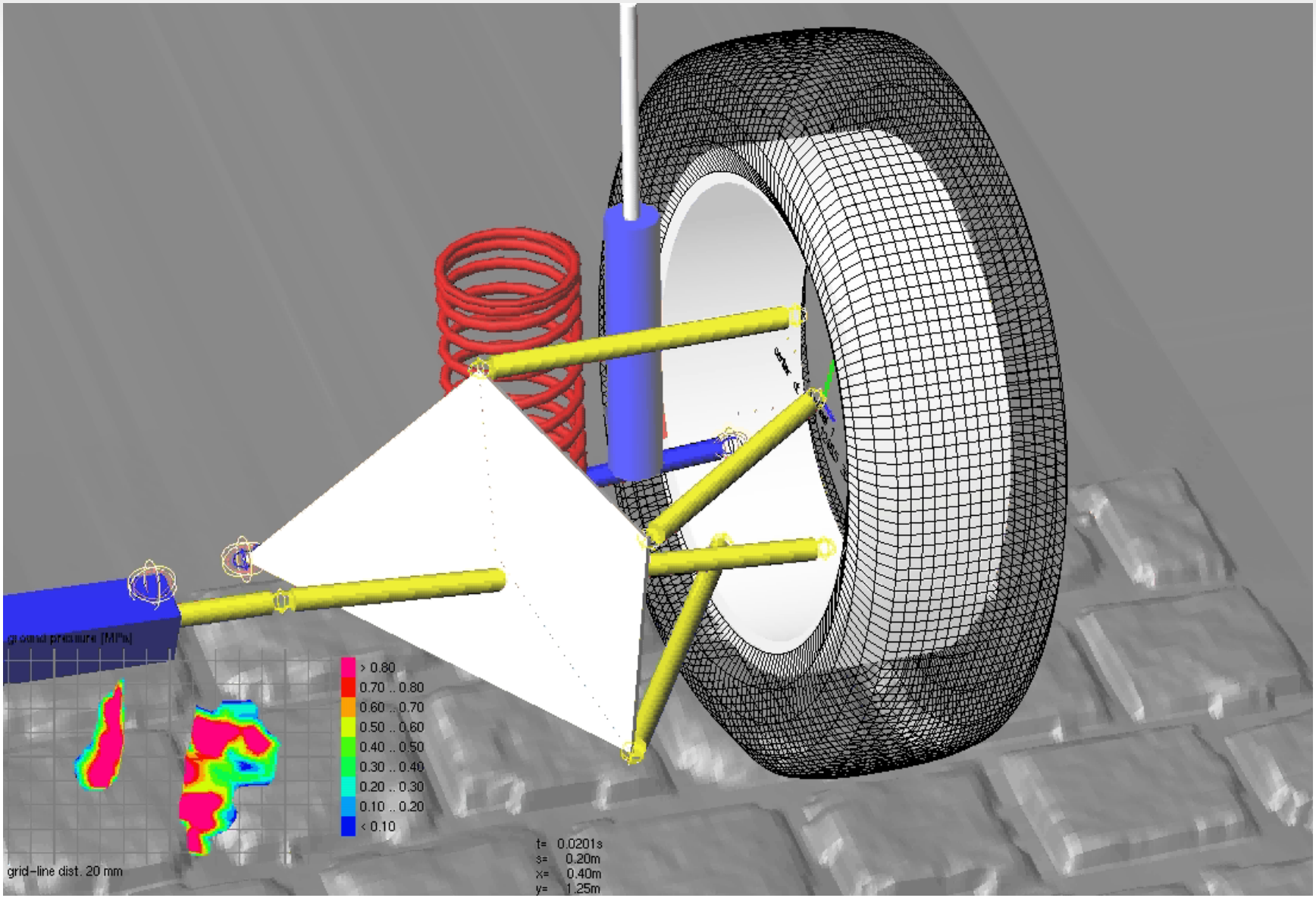




FTire
Quarter Car on Belgian Block, 20 Km/h

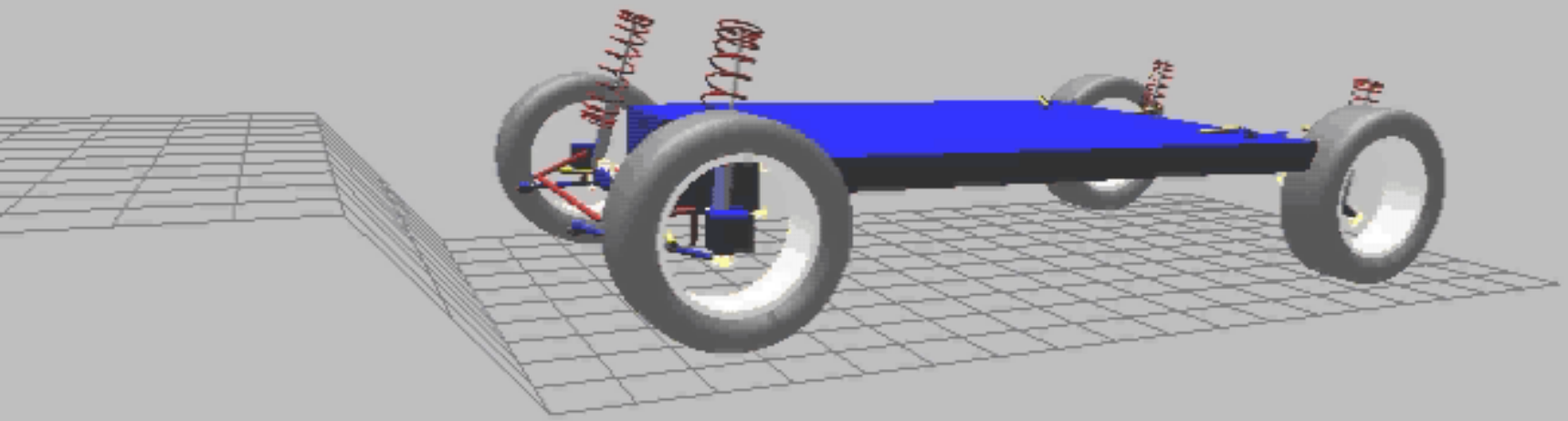


FTire
Integrated Suspension Model

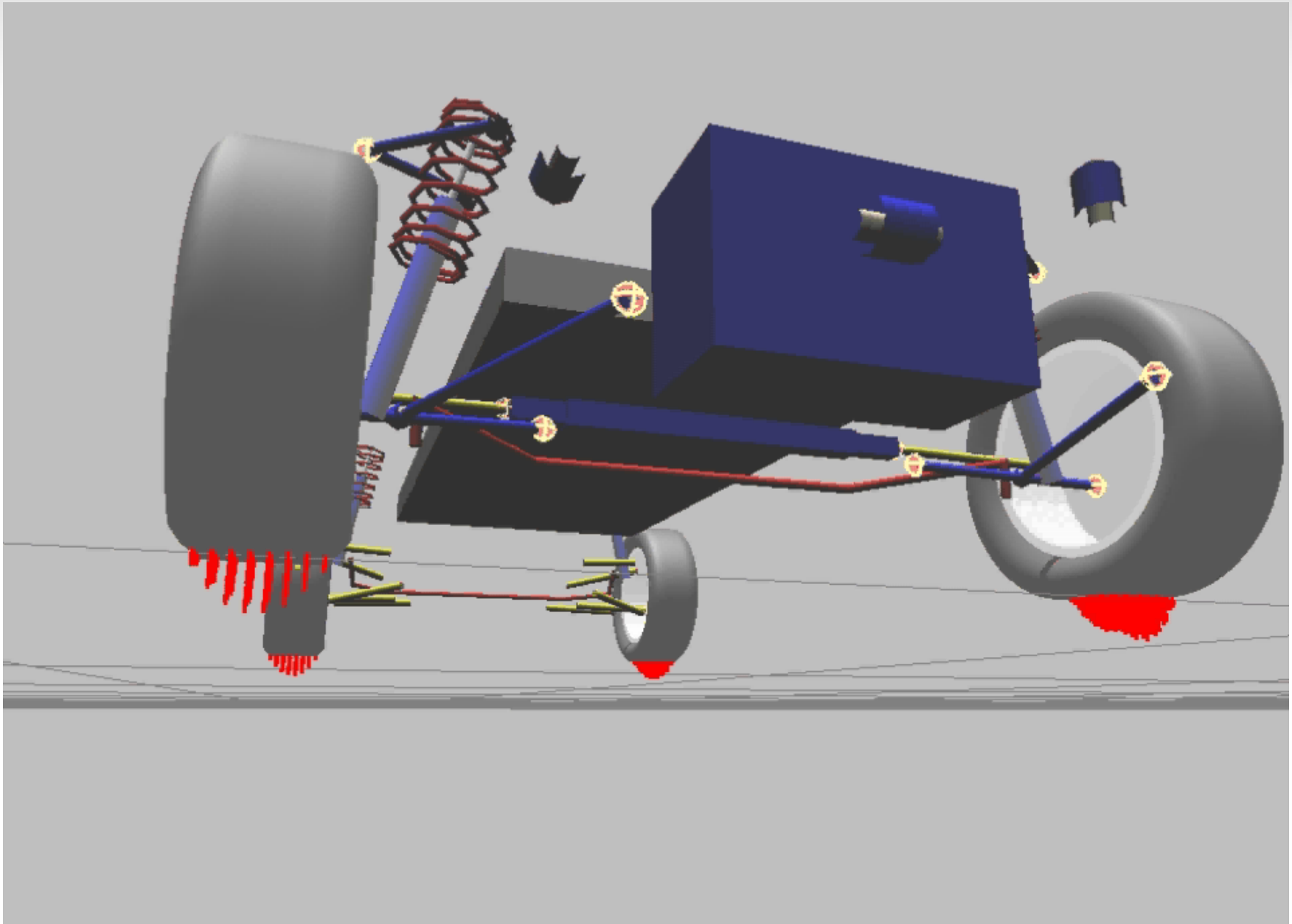


FTire

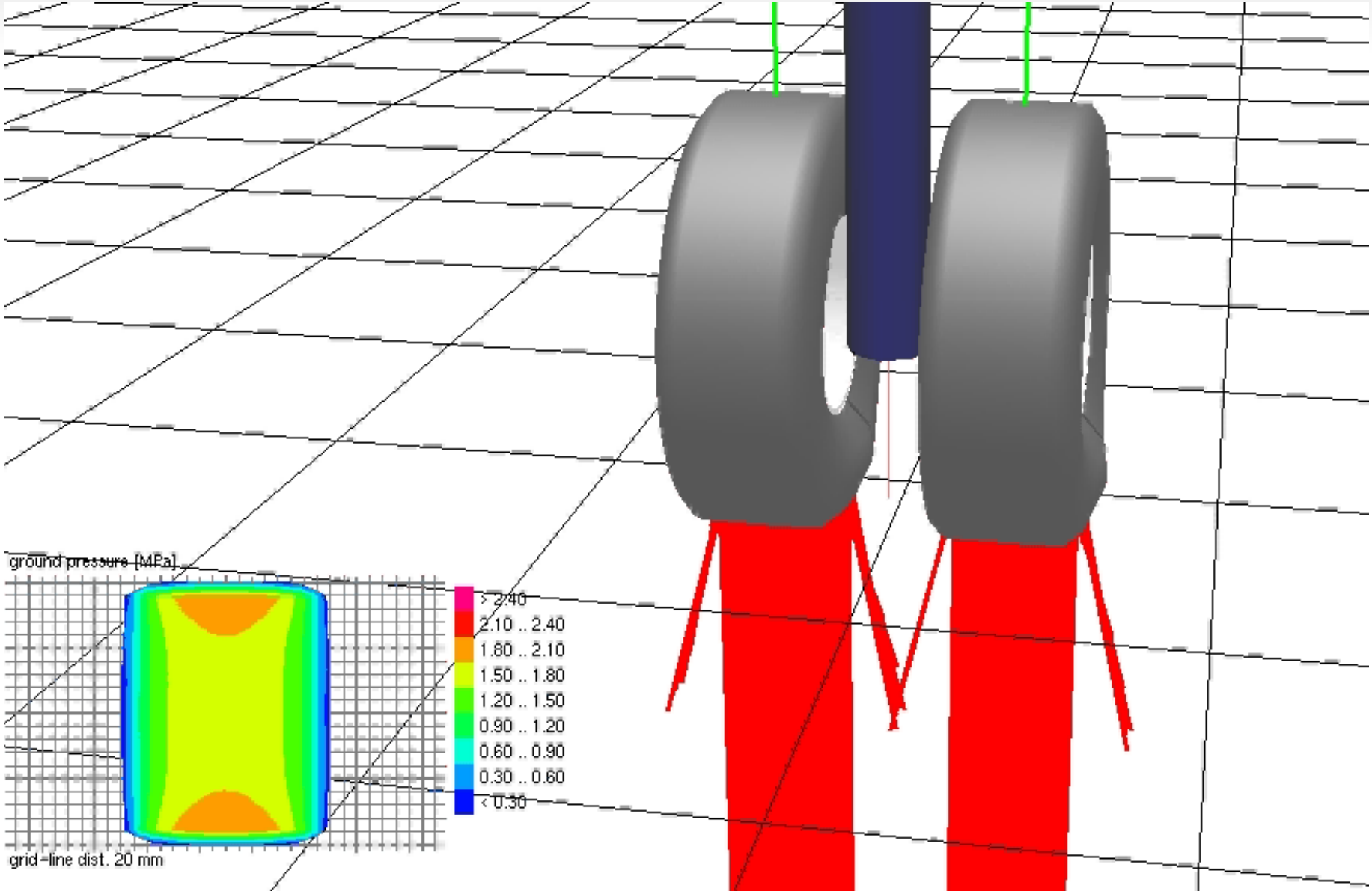
FTire and *cosin/mbs* (1)



FTire
FTire and *cosin/mbs* (2)



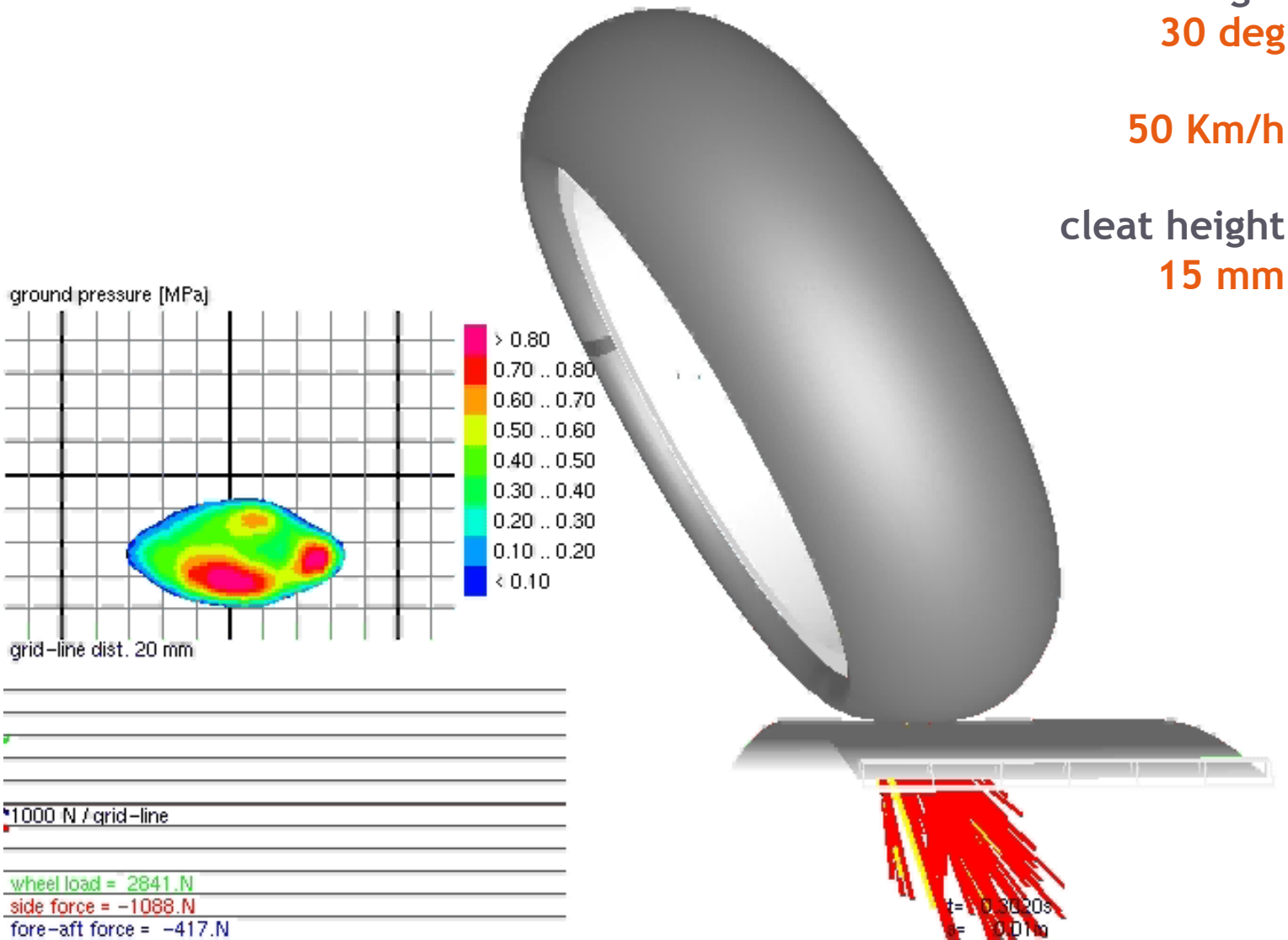
FTire for Aircrafts: Wheel Shimmy

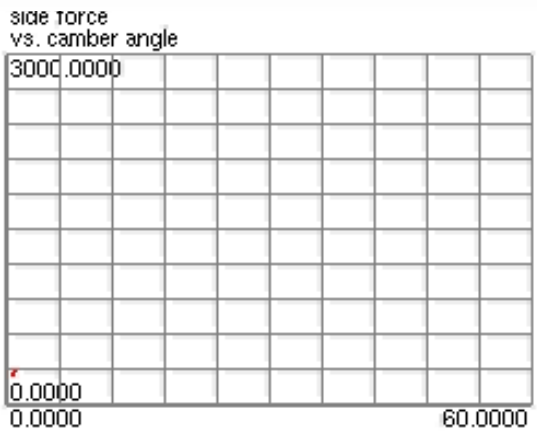


camber angle
30 deg

50 Km/h

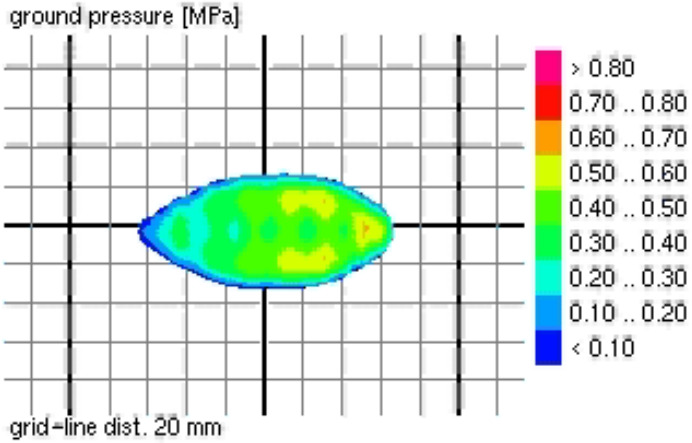
cleat height
15 mm

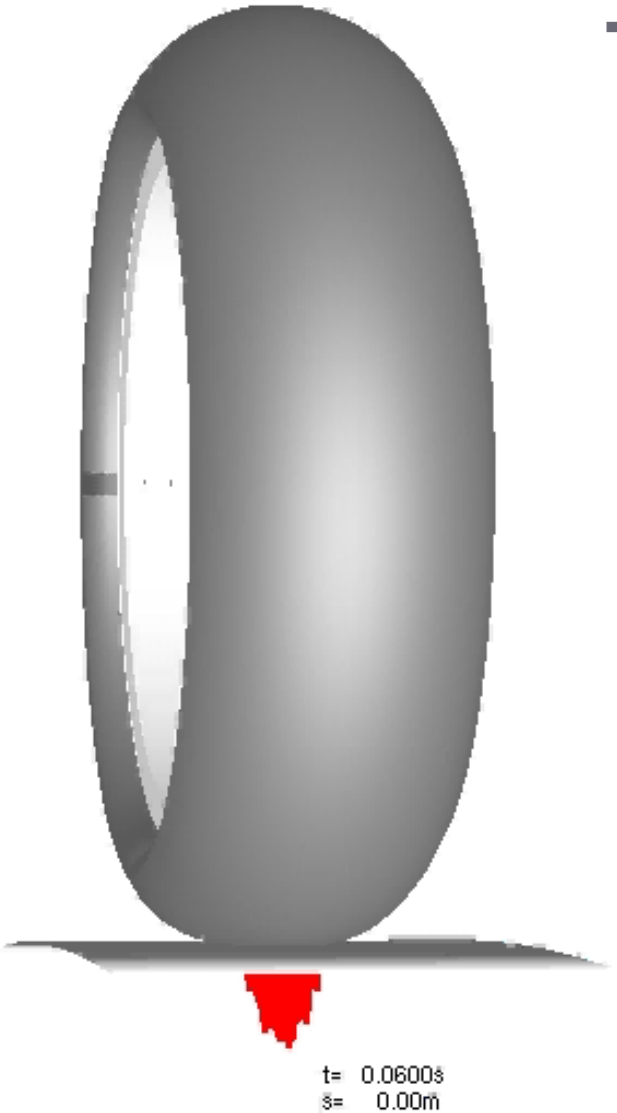




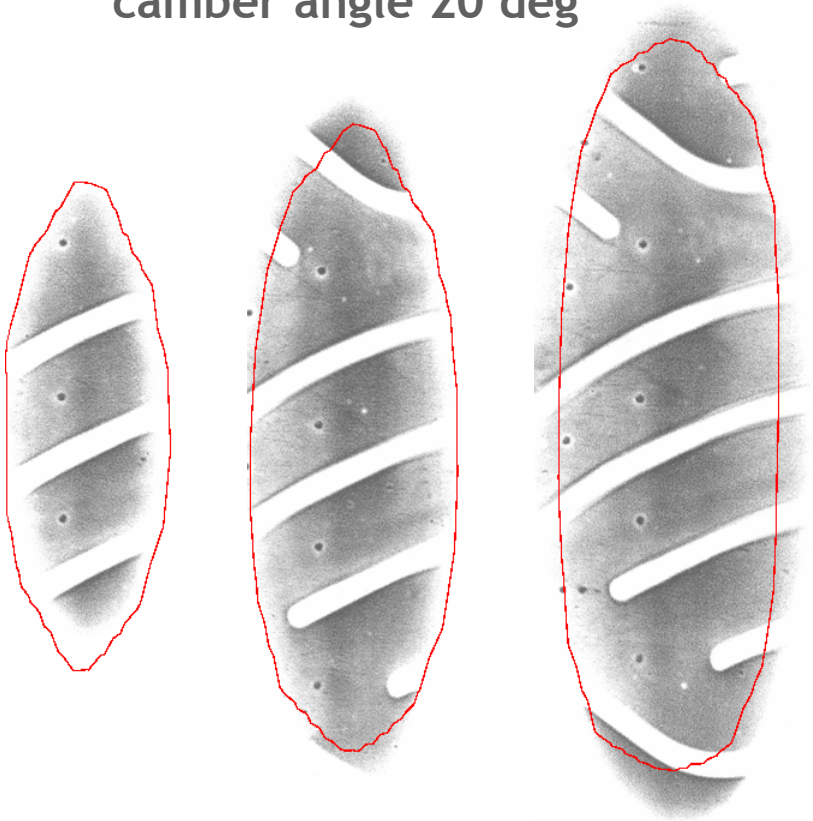
camber angle
➔ 60 deg

30 Km/h

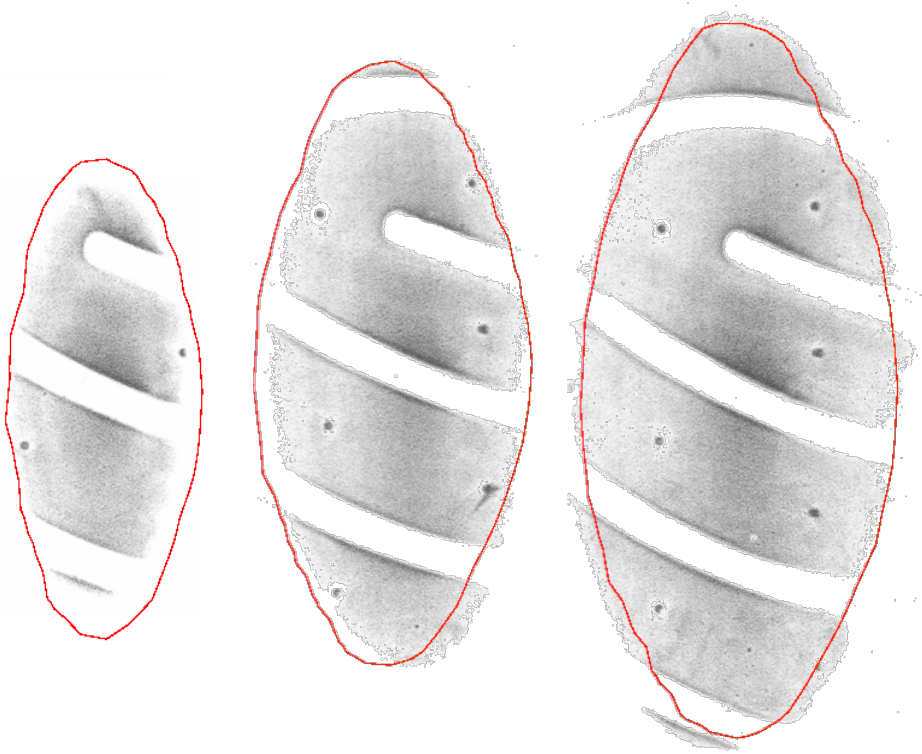




front tire 120/70 ZR 17
at 1000 / 2000 / 3000 N
camber angle 20 deg



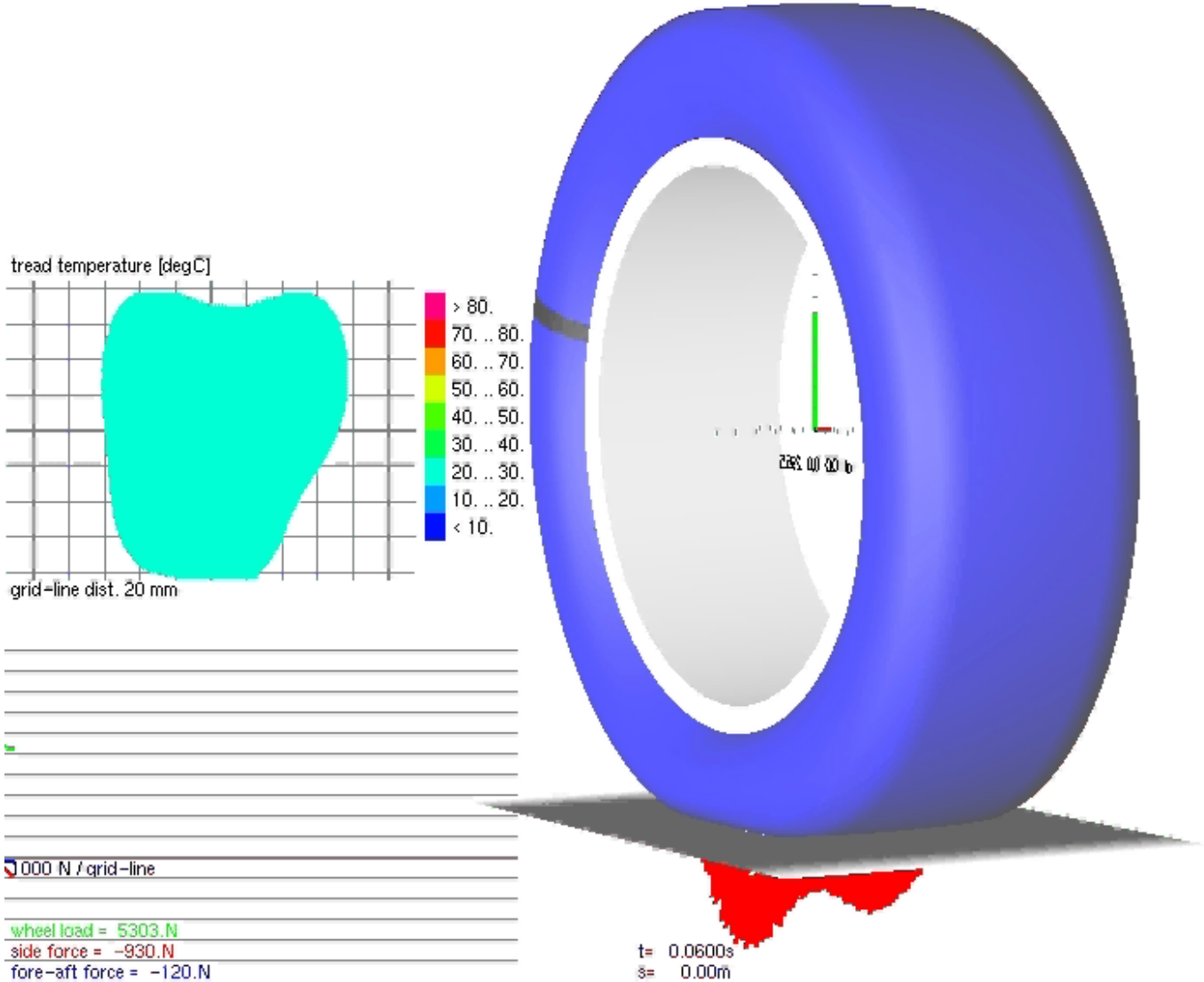
rear tire 180/55 ZR 17
at 1000 / 2000 / 3000 N
camber angle 20 deg



cosin
scientific software

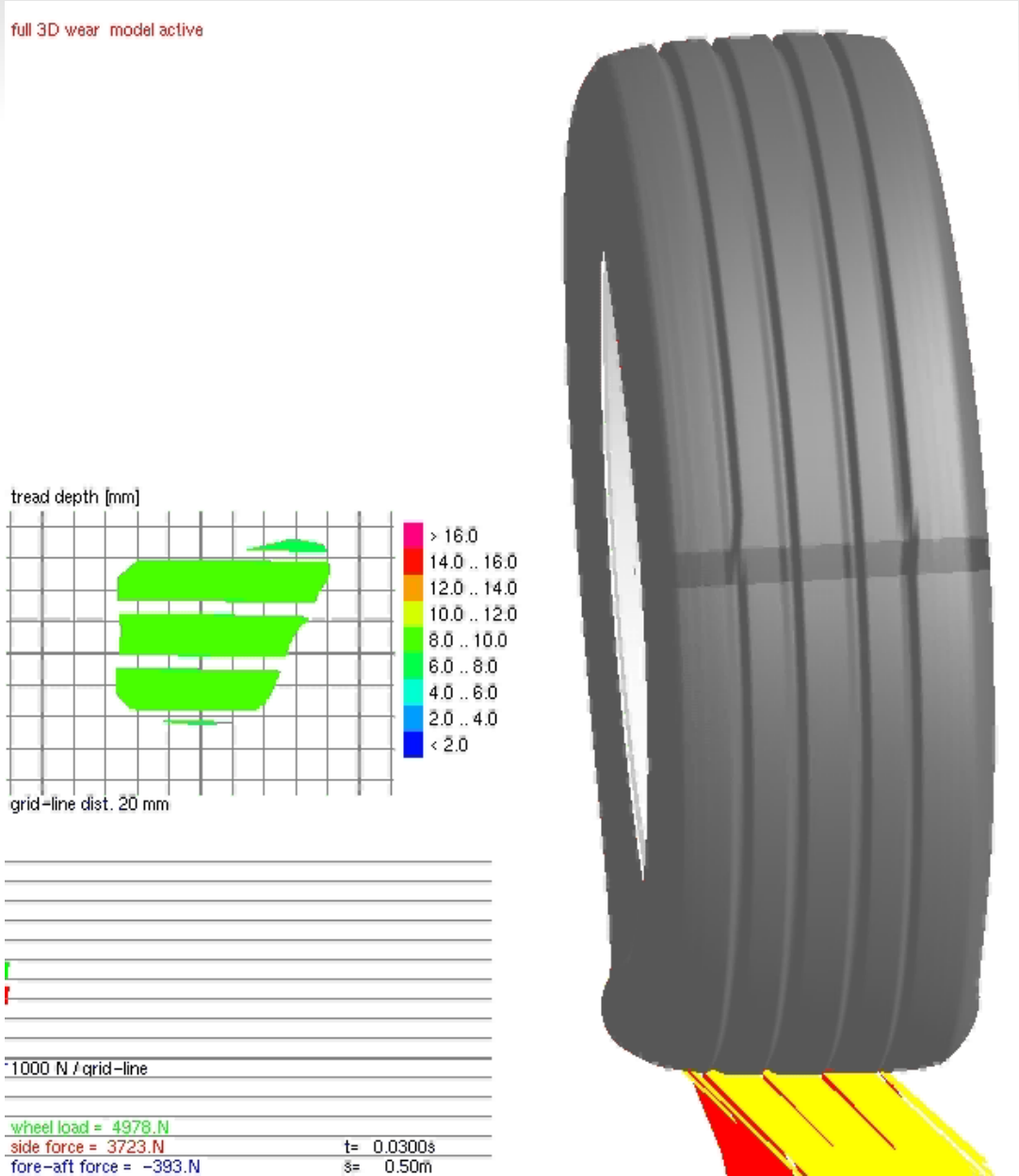
FTire

Temperature Development During Side-Slip Sweep



side-slip angle
±10 deg
camber angle
2 deg

FTire
Tread Wear During Cornering (1)



side-slip angle
-5 deg

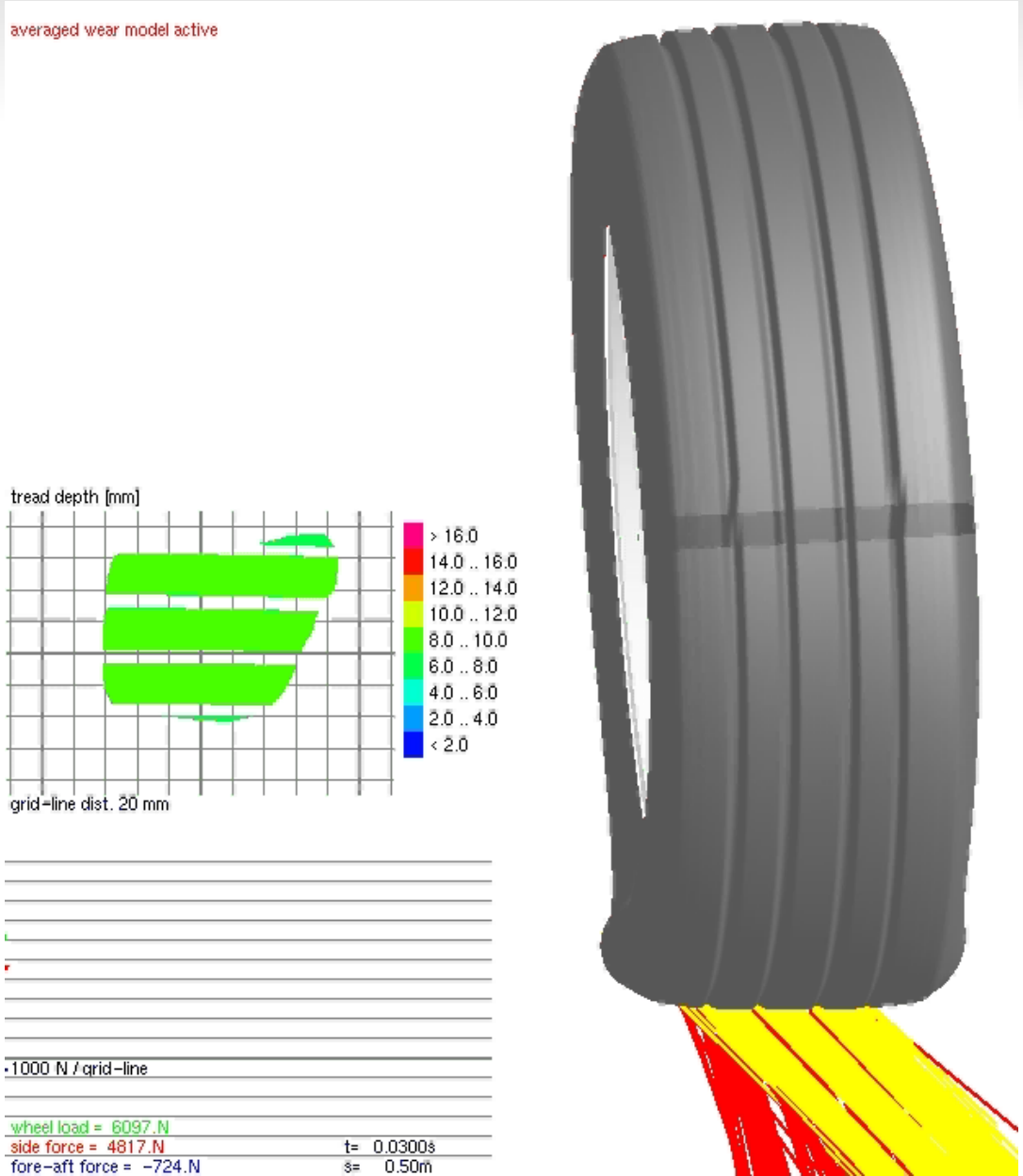
camber angle
4 deg

60 Km/h

6 KN

distributed
wear model

FTire
Tread Wear During Cornering (2)



side-slip angle
-5 deg

camber angle
4 deg

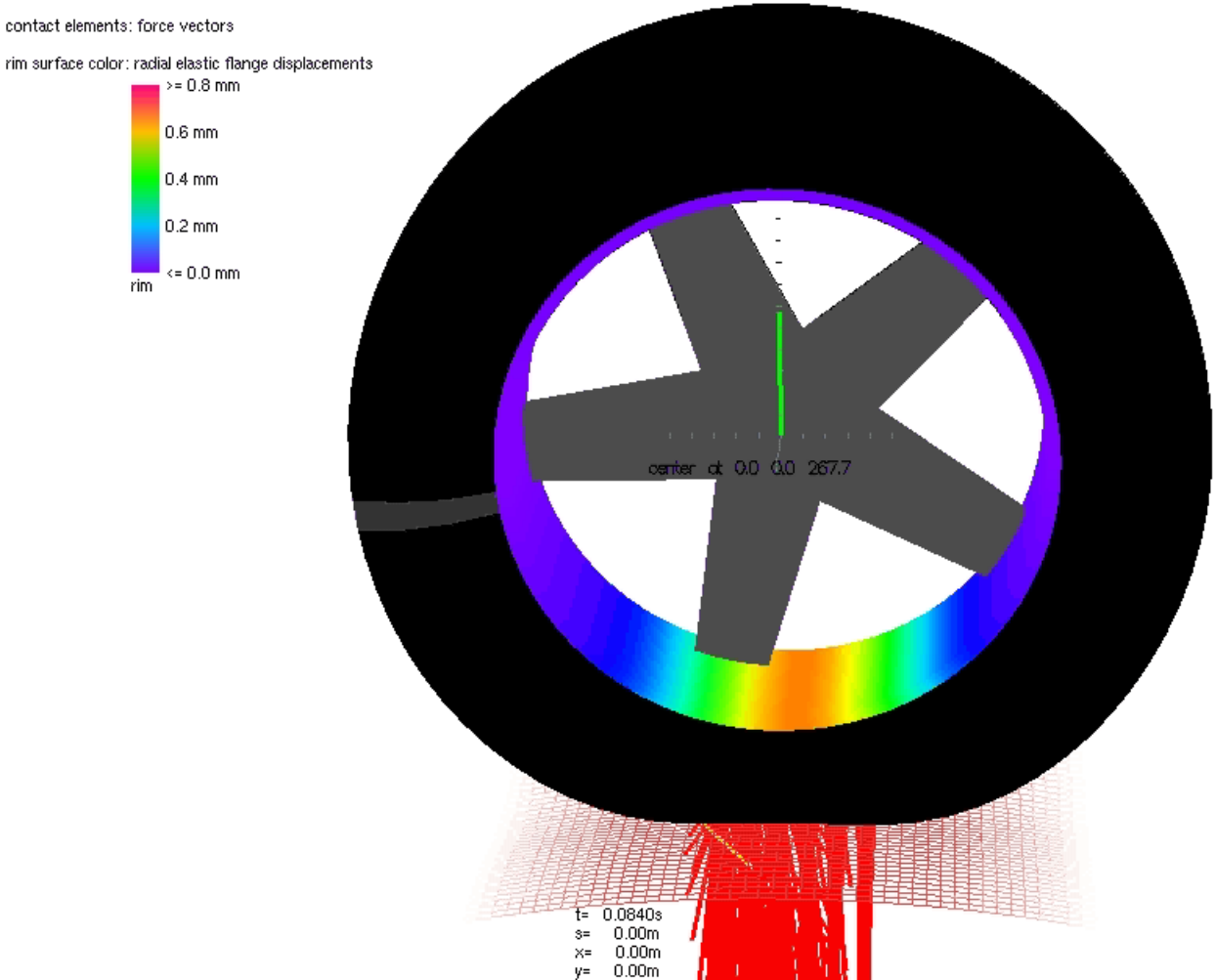
60 Km/h

6 KN

averaged
wear model

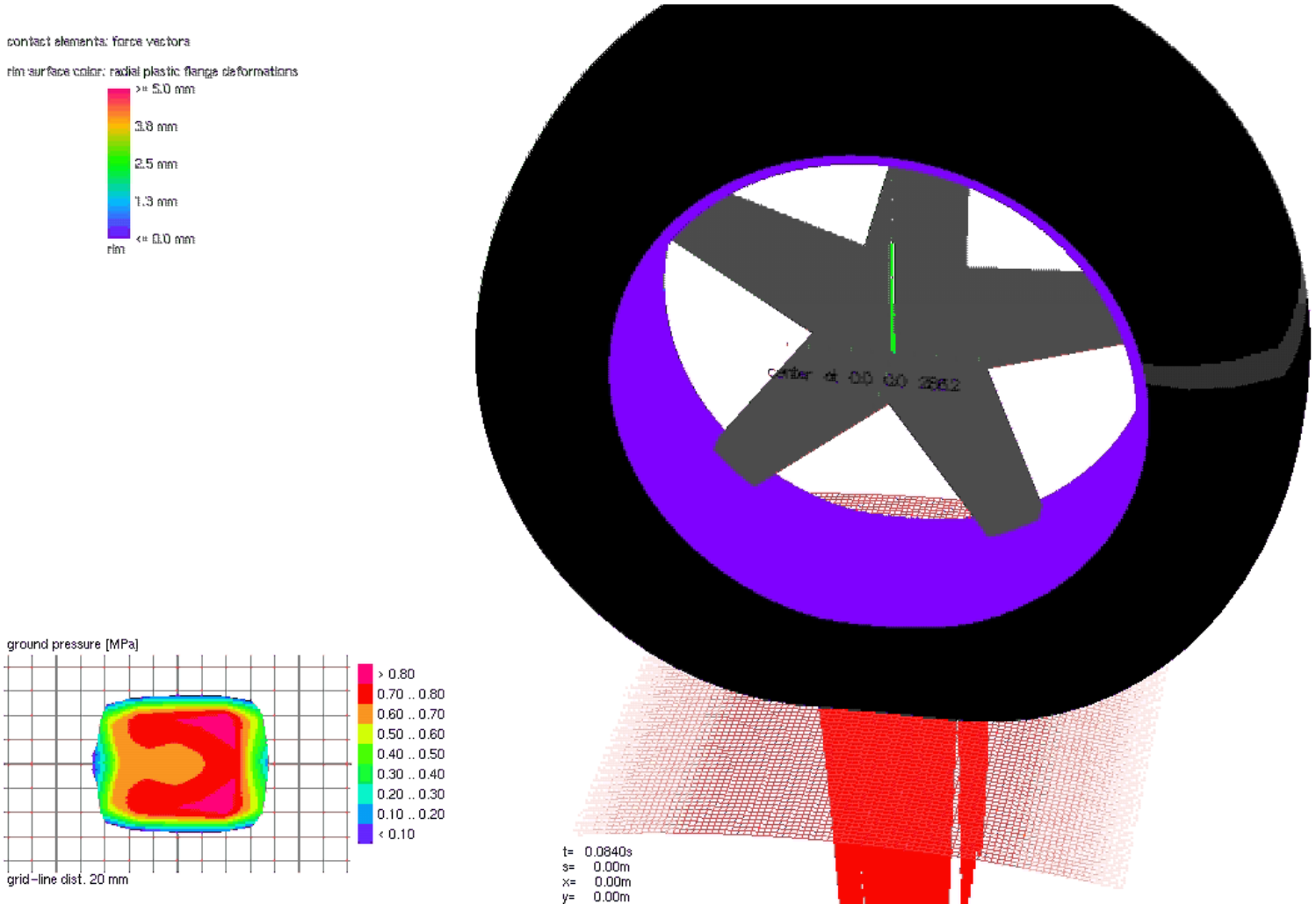
Internal Rim Model: Elastic Deformation

➜ cyclic deformation variation, caused by spokes



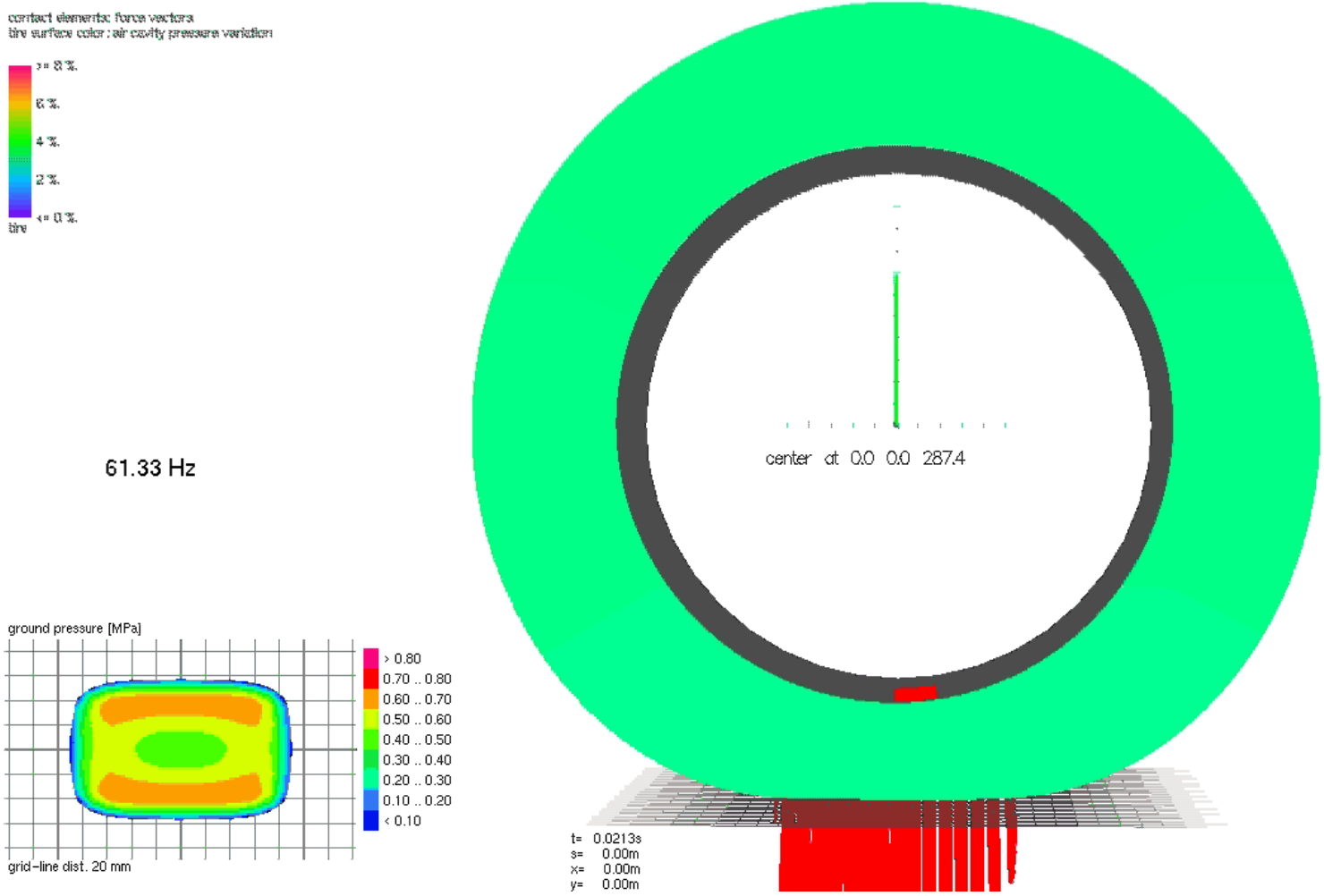
Internal Rim Model: Plastic (Permanent) Deformation

➜ **permanent** deformation, caused by extremely high cleats



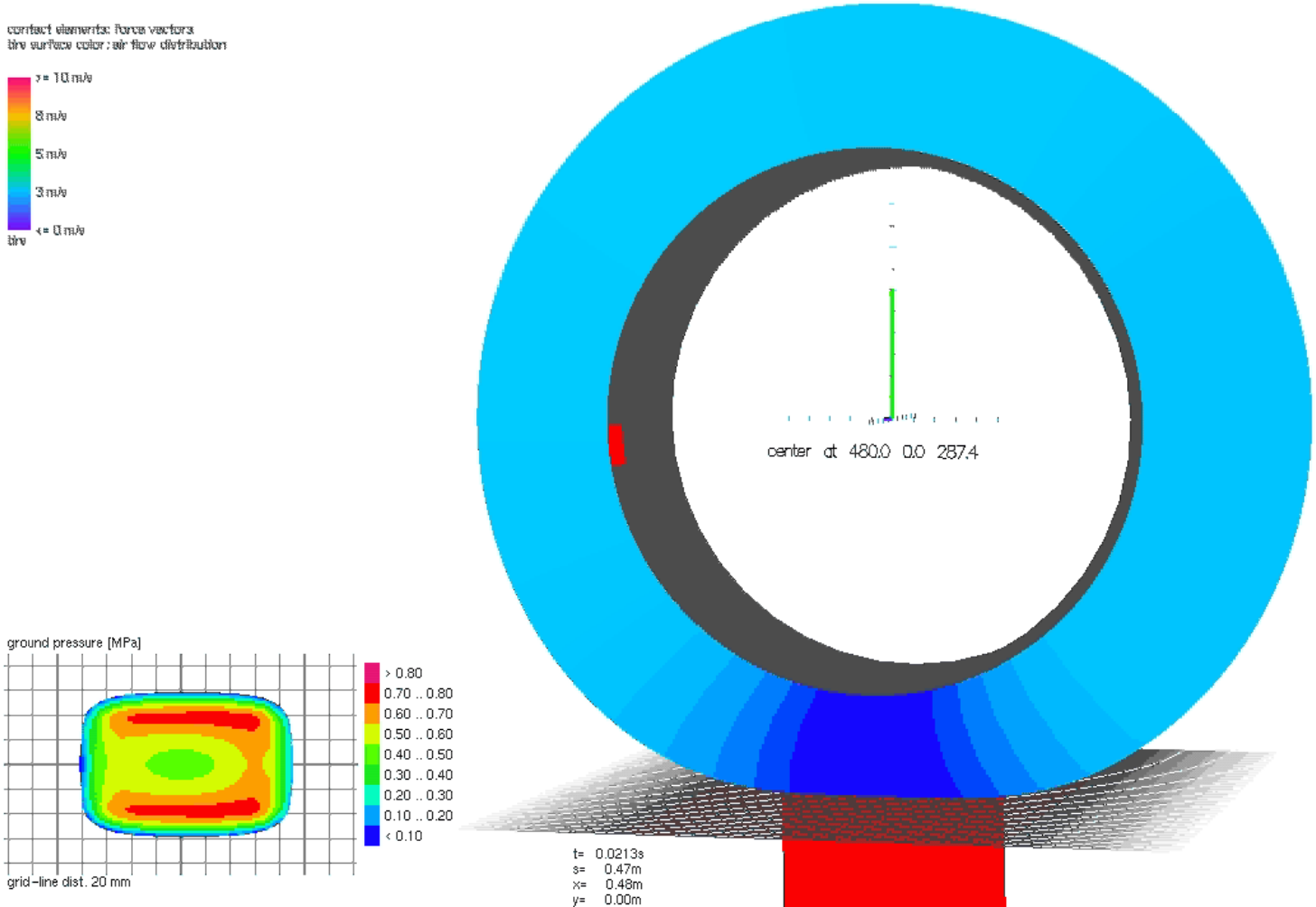
Air Cavity Vibration Model: Resonance caused by Vertical Excitation

➜ swept harmonic excitation 50 ➔ 300 Hz; internal pressure variation

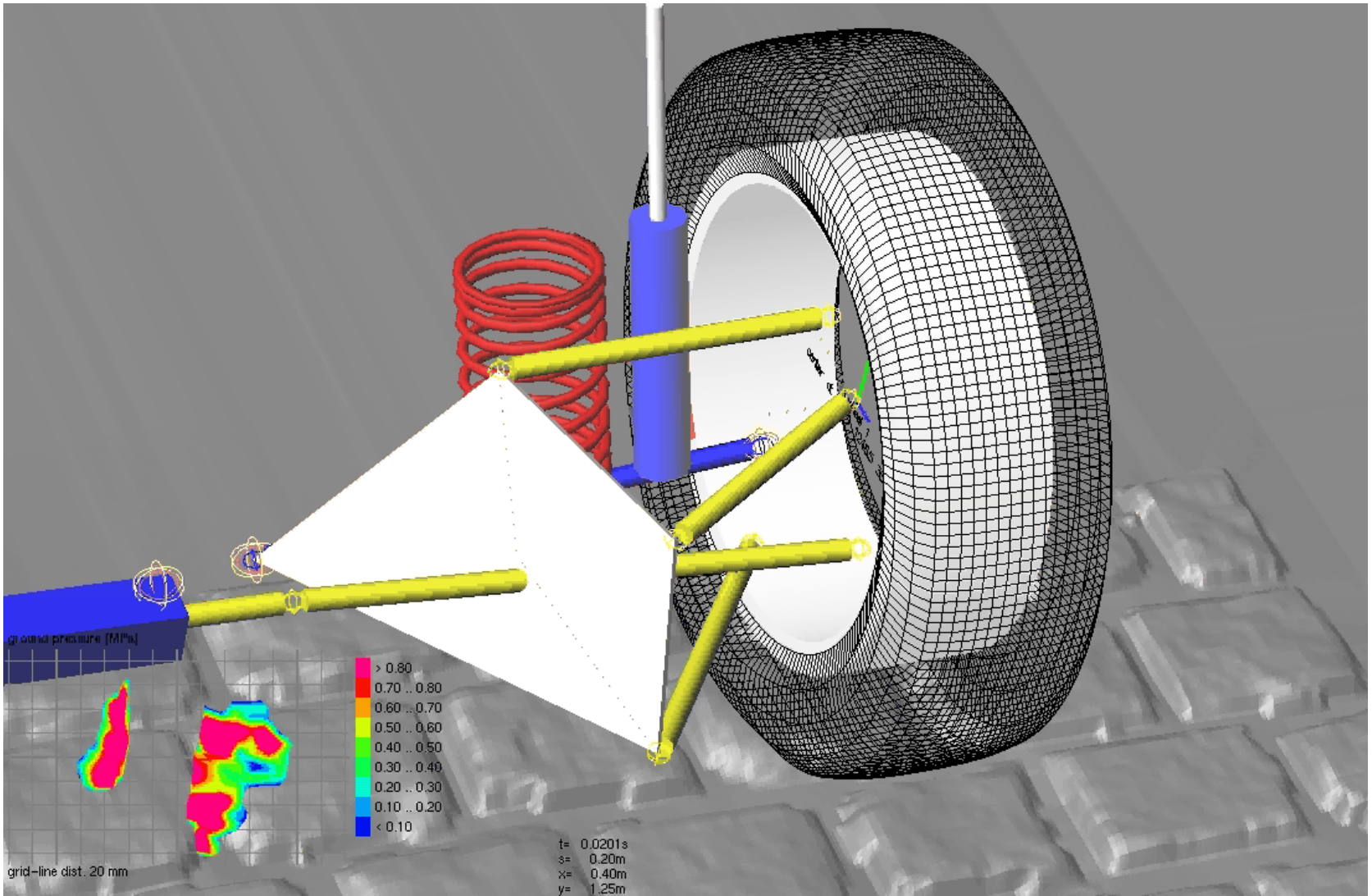


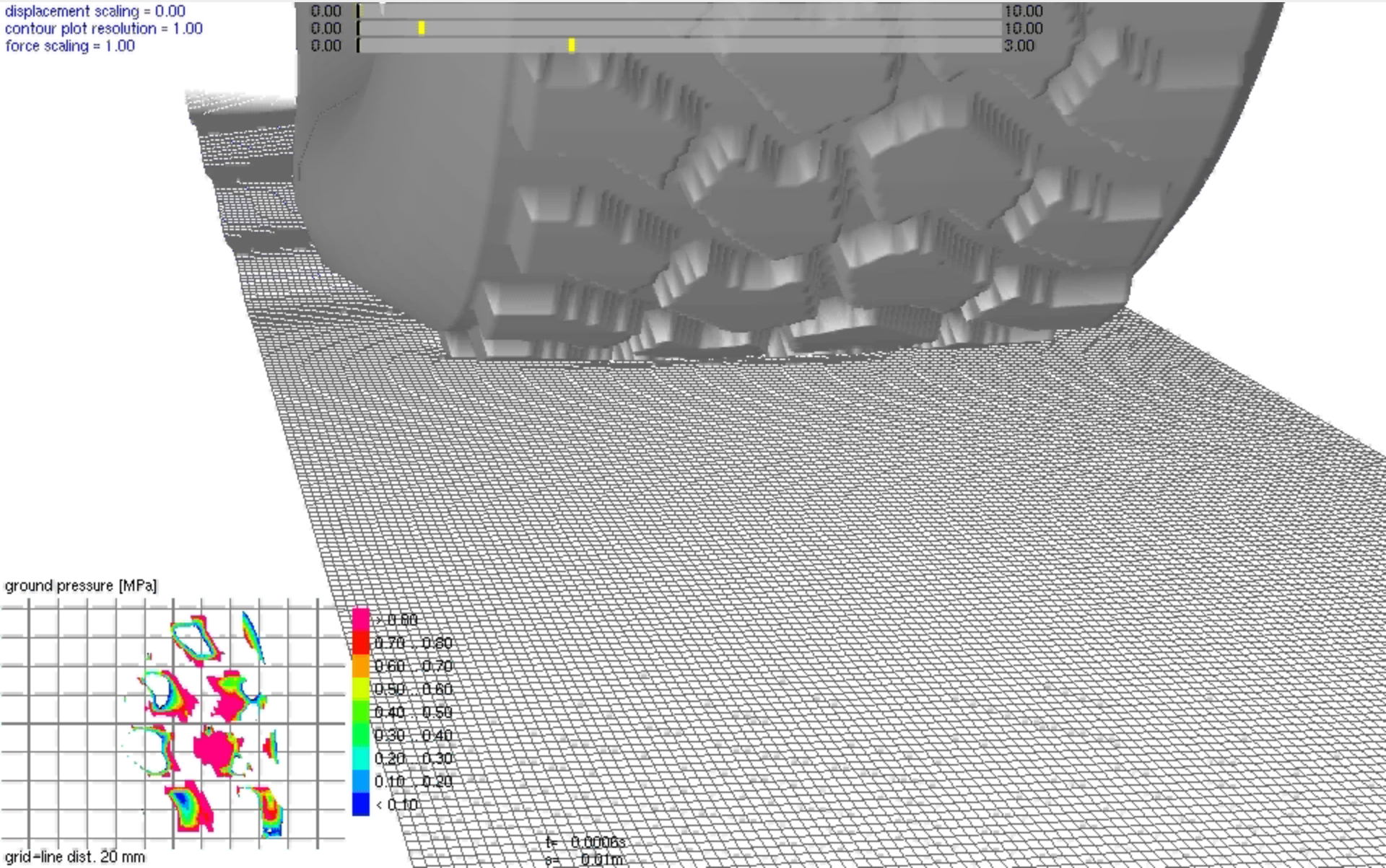
Air Cavity Vibration Model: Resonance caused by Road Waves

➜ road wave length 20 ➔ 8 cm; v = 80 km/h; internal air flow



Integrated Suspension Models: *FTire* + Multi-Link + Belgian Block

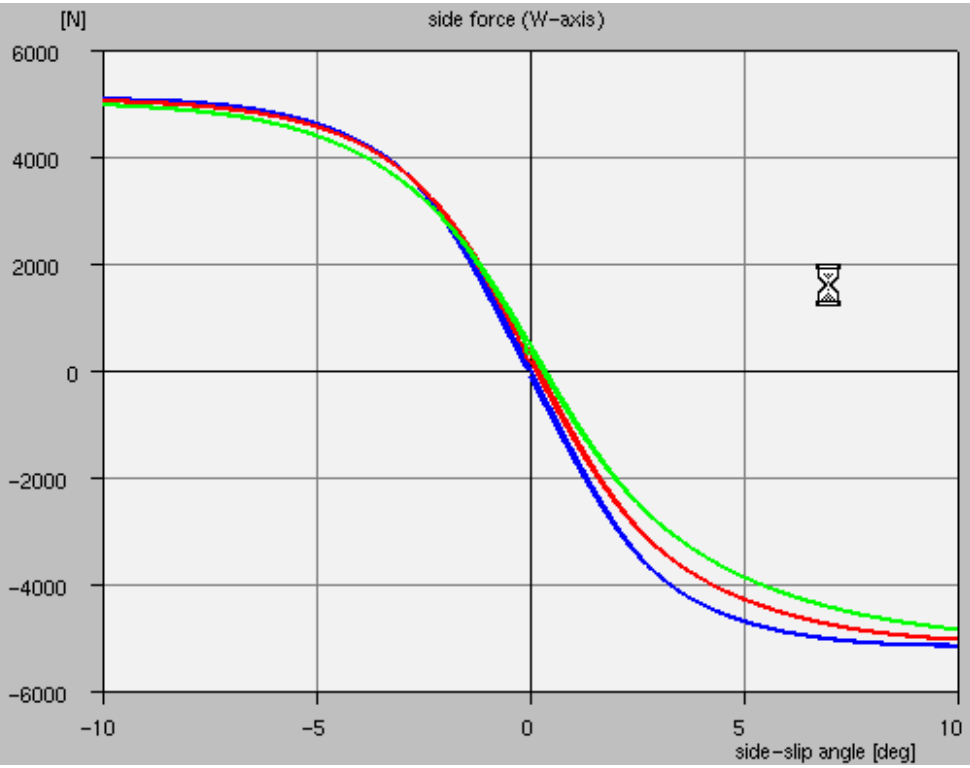


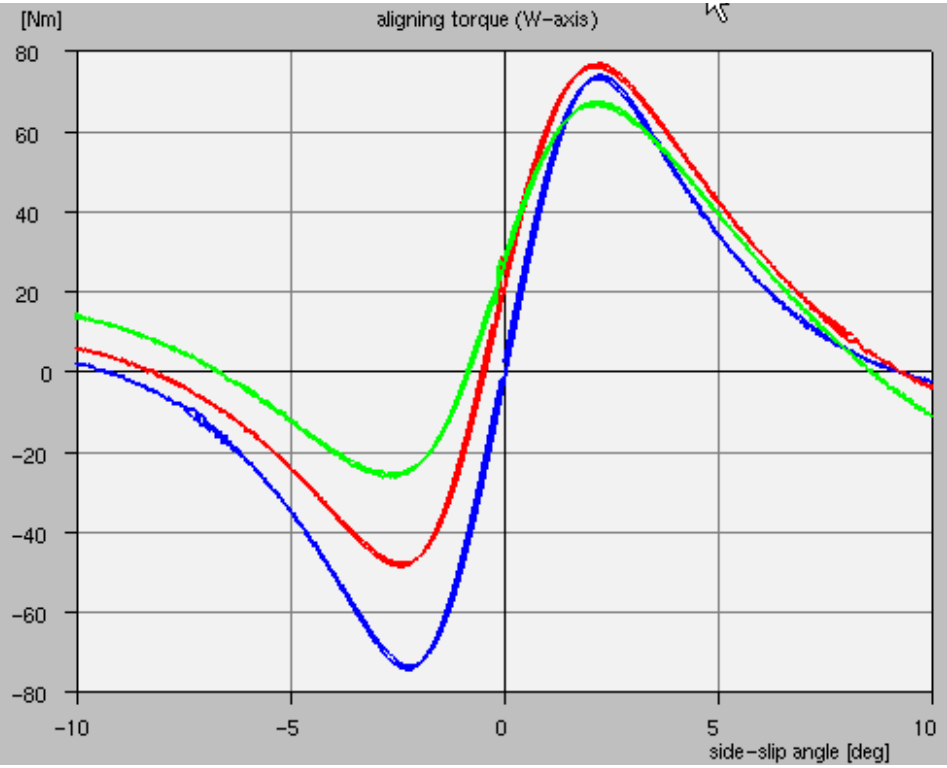

displacement scaling = 0.00
contour plot resolution = 1.00
force scaling = 1.00
0.00
10.00
0.00
10.00
0.00
3.00
ground pressure [MPa]
> 0.80
0.70 .. 0.80
0.60 .. 0.70
0.50 .. 0.60
0.40 .. 0.50
0.30 .. 0.40
0.20 .. 0.30
0.10 .. 0.20
< 0.10
grid-line dist. 20 mm
t= 0.0006s
s= 0.01m

Side-slip sweep, varying camber angle

205/55R16 91V rim 6.5J 2.7 bar

0 deg 3 deg 6 deg

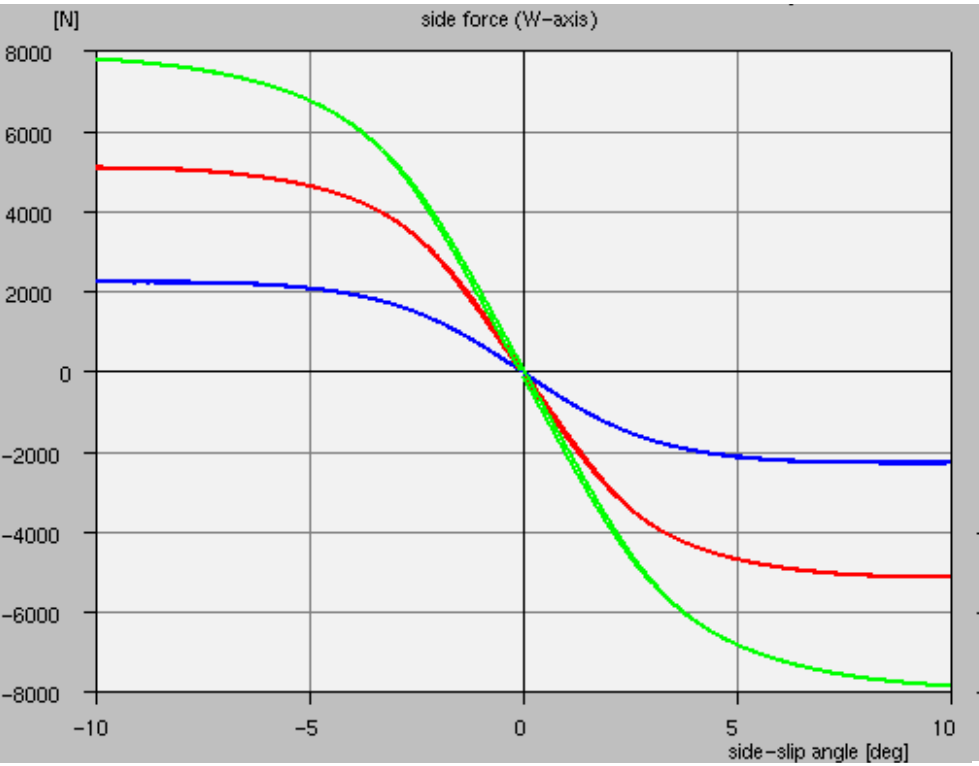


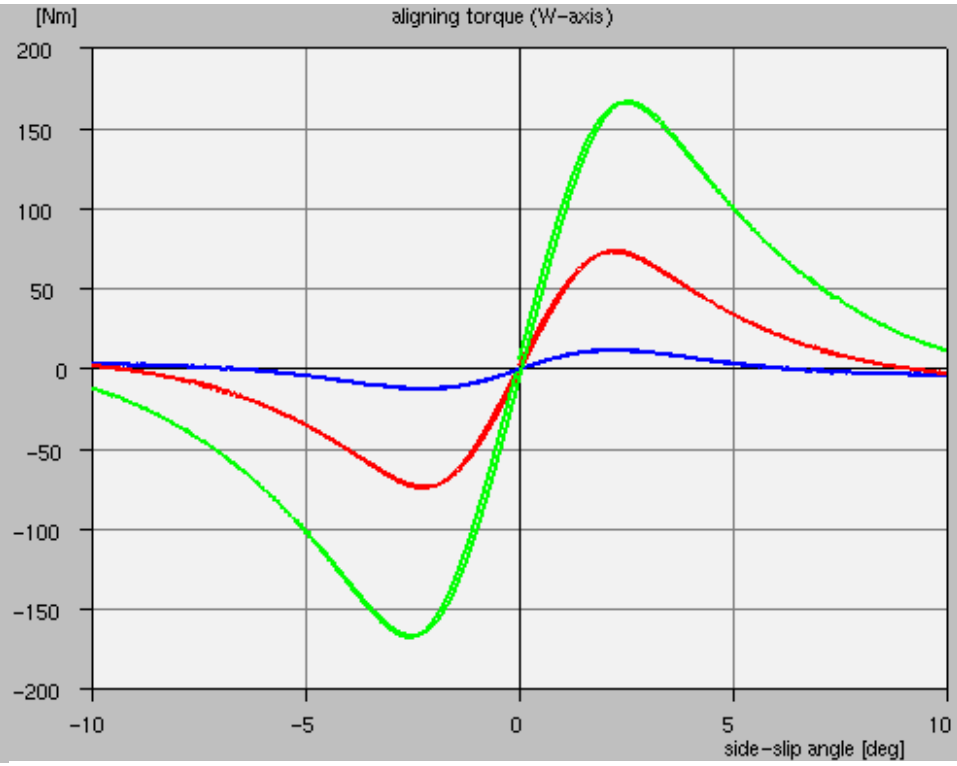


Side-slip sweep, varying wheel load

205/55R16 91V rim 6.5J 2.7 bar

2 kN 5 kN 8 kN

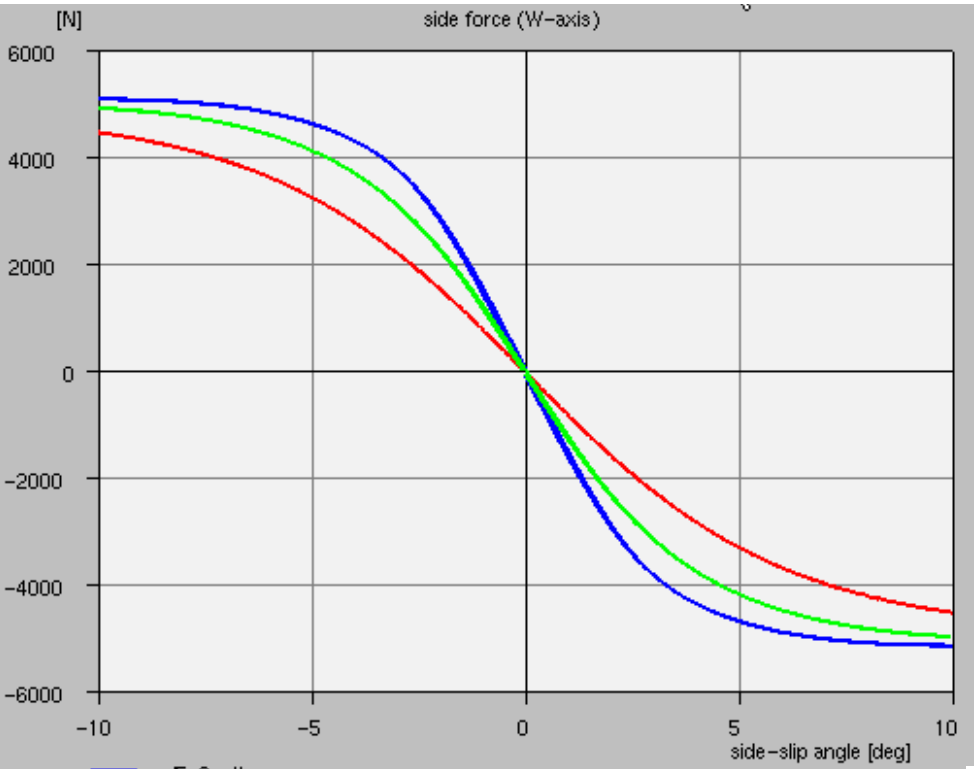


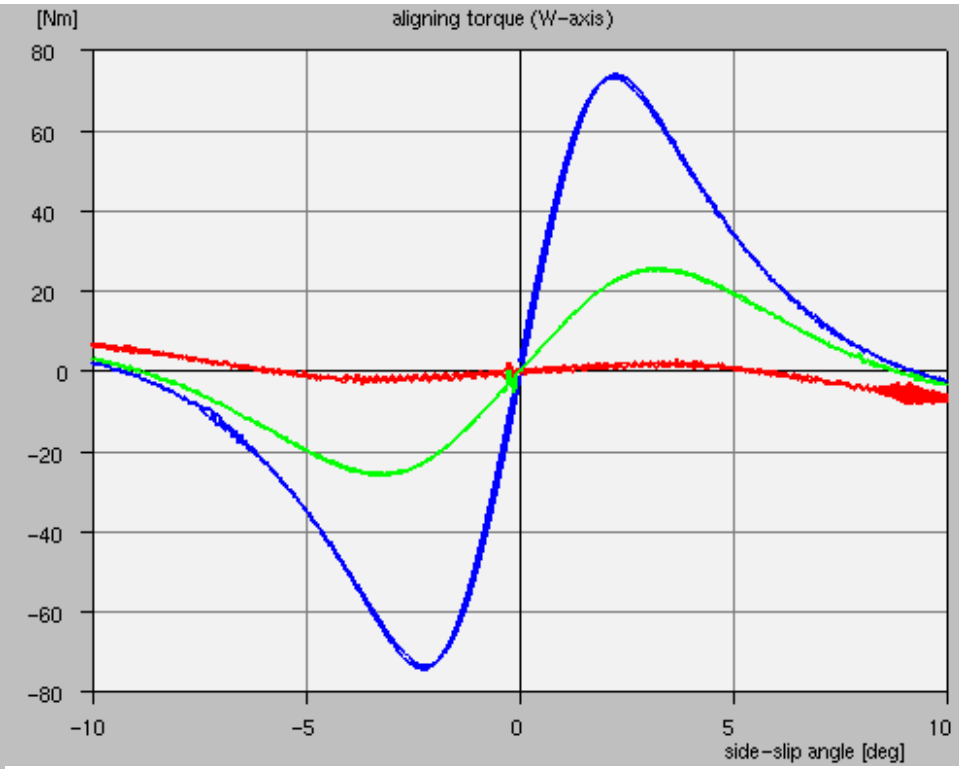


Side-slip sweep, varying longitudinal slip

205/55R16 91V rim 6.5J 2.7 bar

0 % 5 % 10 %

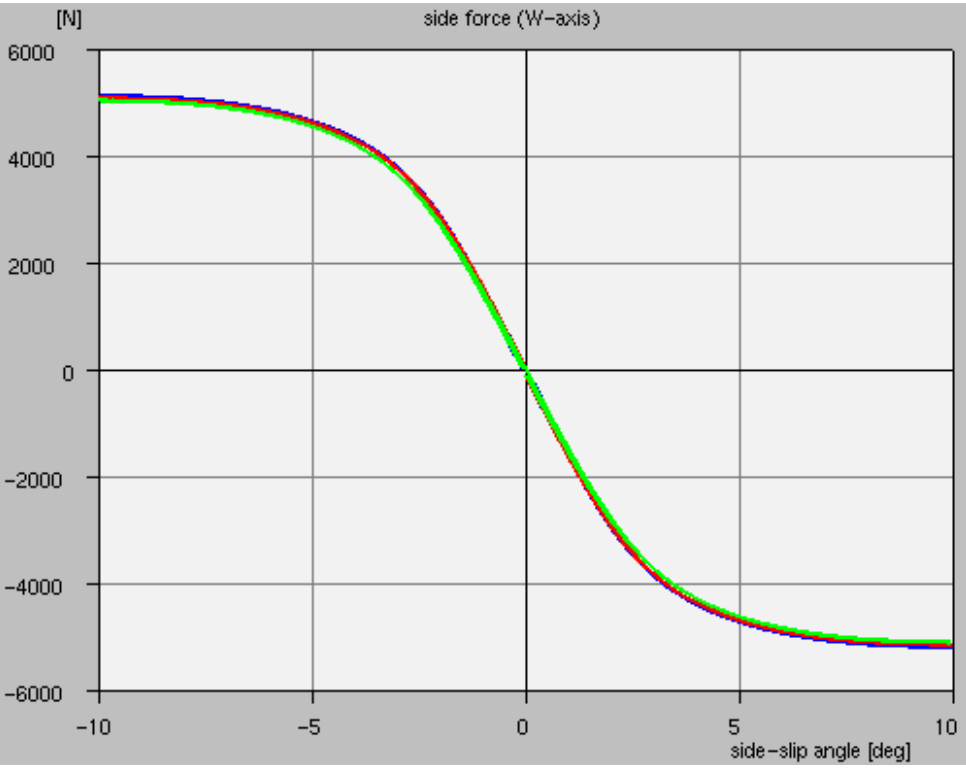


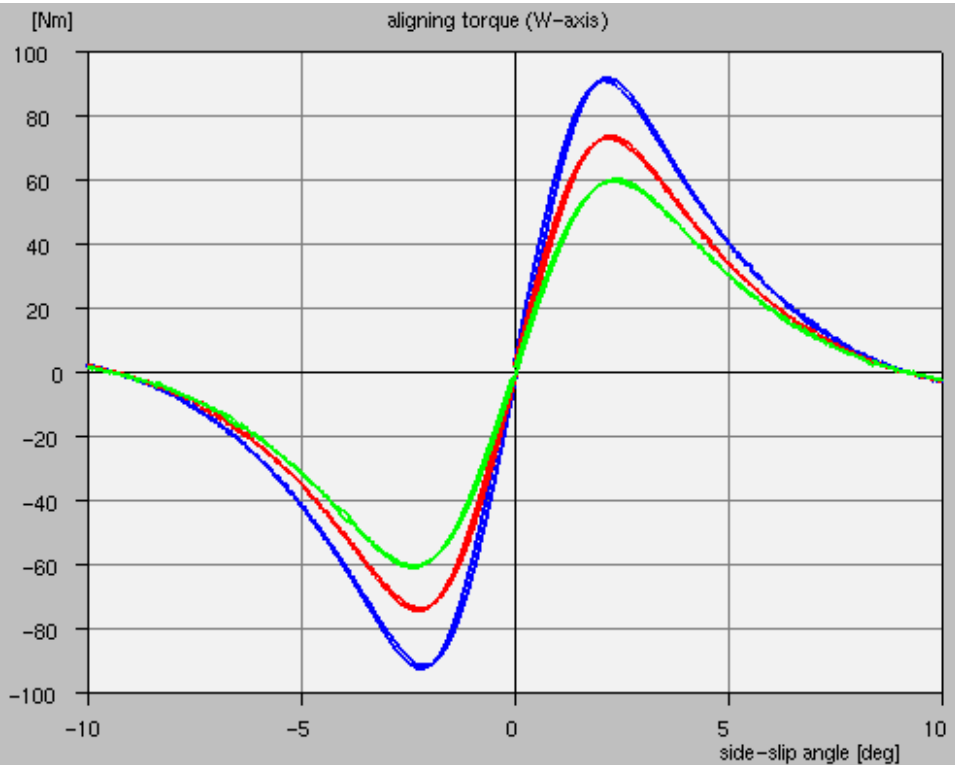


Side-slip sweep, varying inflation pressure

205/55R16 91V rim 6.5J 2.7 bar (nominal)

2.2 bar 2.7 bar 3.2 bar

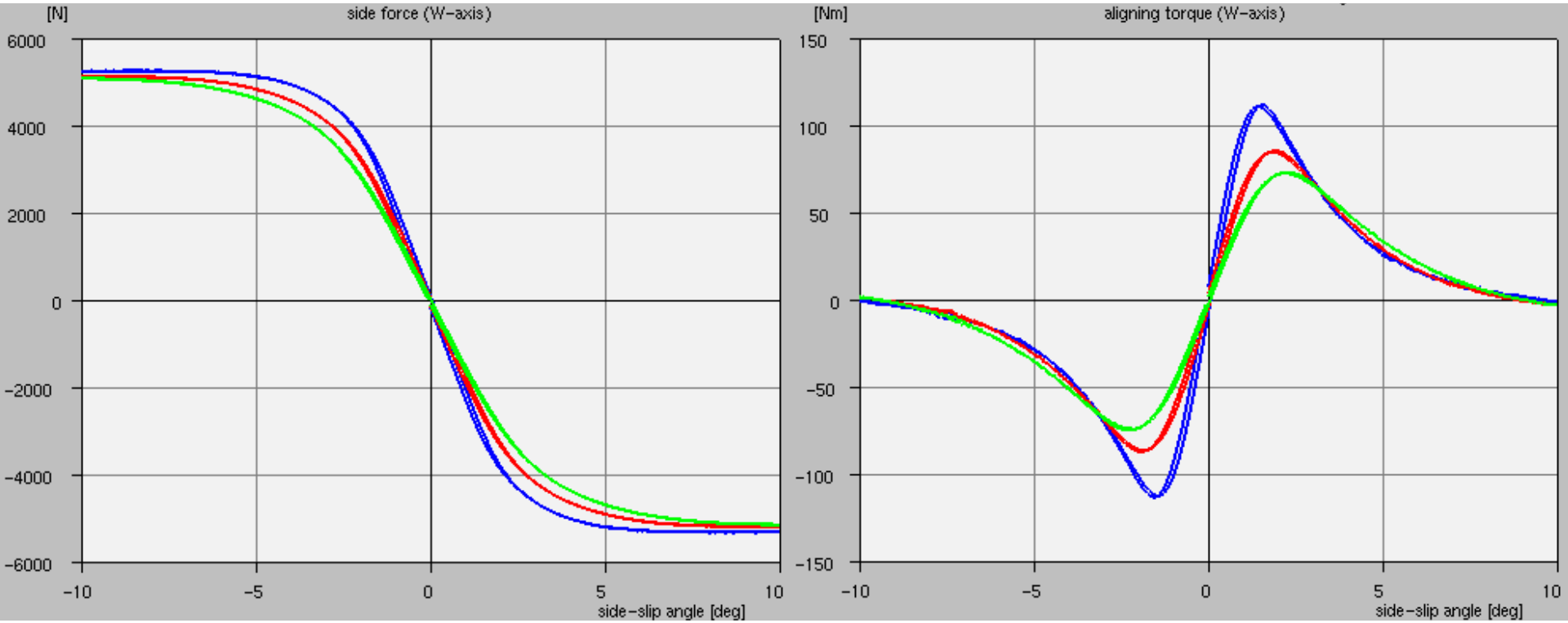




Side-slip sweep, varying tread depth

205/55R16 91V rim 6.5J 2.7 bar

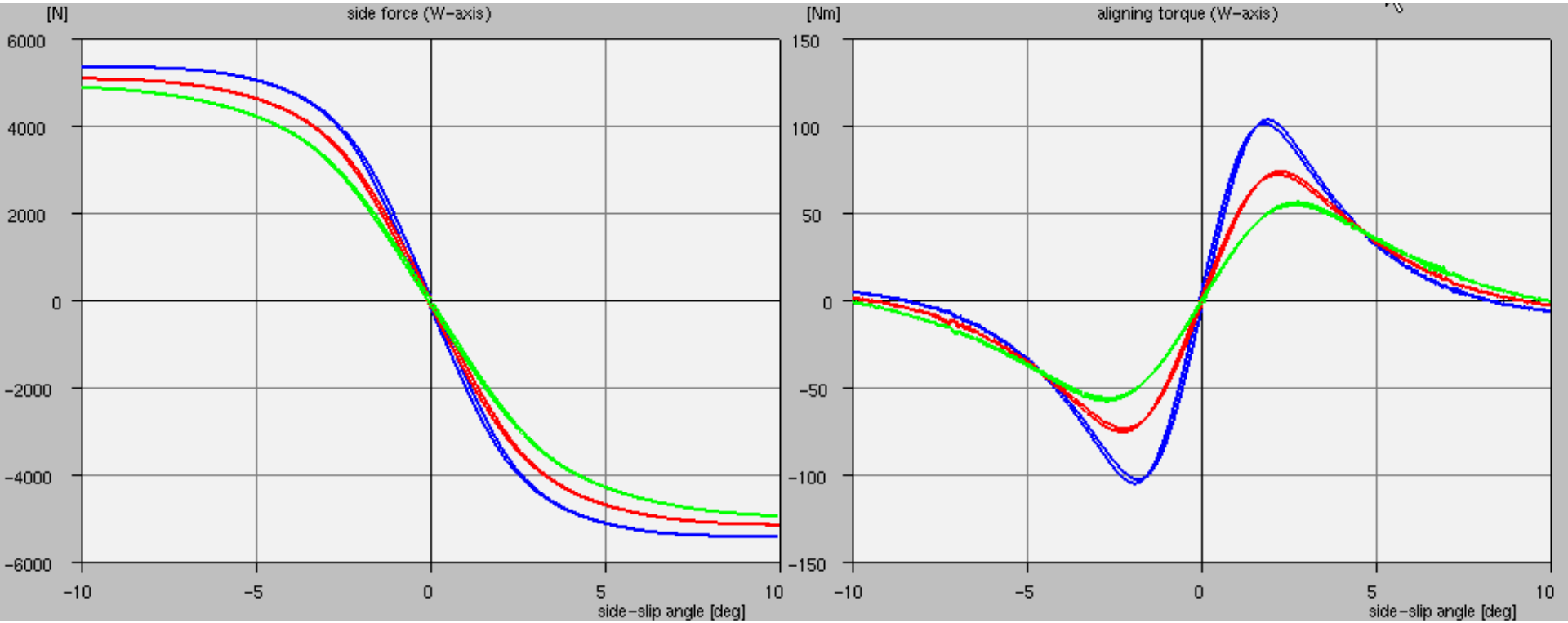
2 mm 5 mm 8 mm

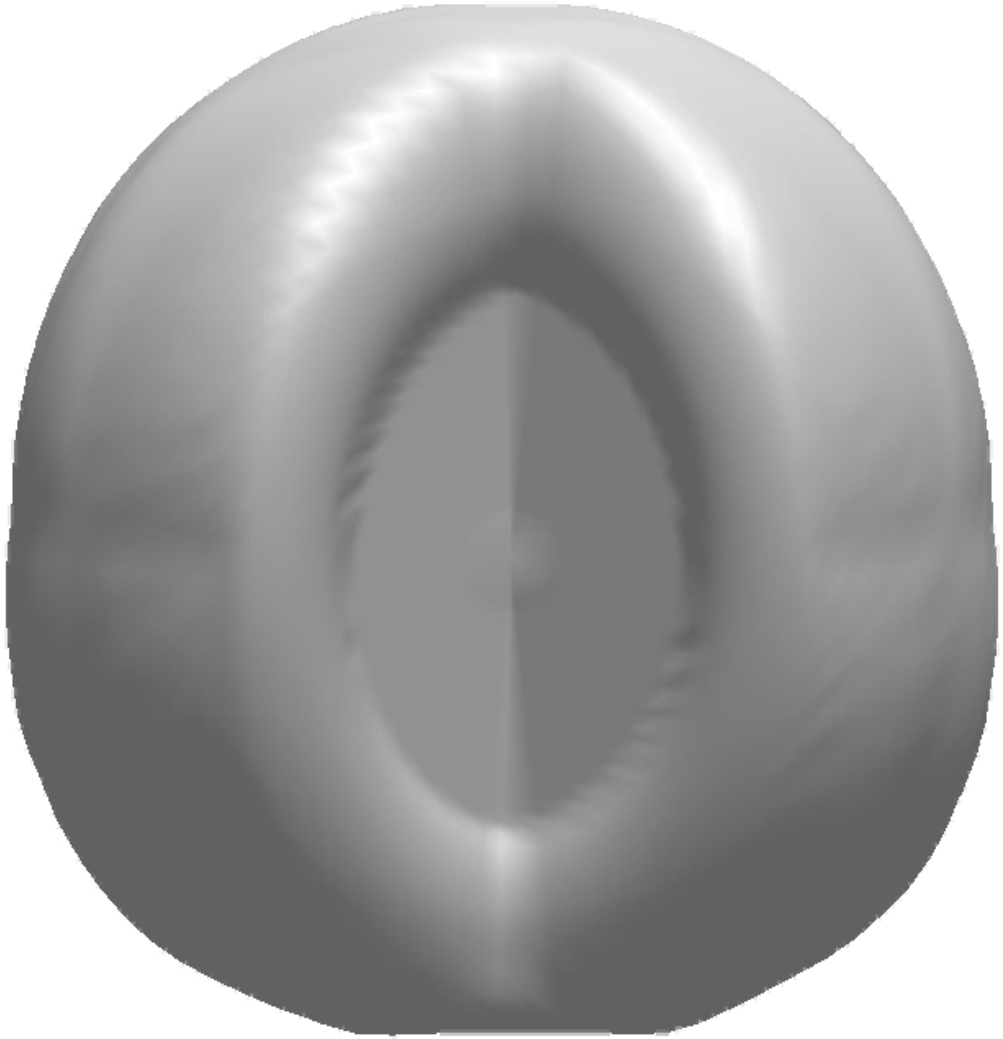


Side-slip sweep, varying drum diameter

205/55R16 91V rim 6.5J 2.7 bar

2 m inner drum flat belt 2 m outer drum





wheel travel
±50 mm

toe angle
±45 deg

P. Lugner, M. Plöchl: *Tire Model Performance Test (TMPT)*

International Journal of Vehicle System Dynamics (Supplement), 45, Taylor & Francis, 2007

The book includes presentations of all participating tire models and MBS programs as well as contributions from the tire manufacturers and appliers. Numerical results of the TMPT are presented and discussed.

..thank you for your attention!

Q & A

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