

Concepts for Optimizing Indoor Tire Abrasion Tests on Sandpaper

Günter Leister, tire.wheel.mobility solutions

S. Parthibhan, MRF

Eric Pranesh De Reuben, MRF

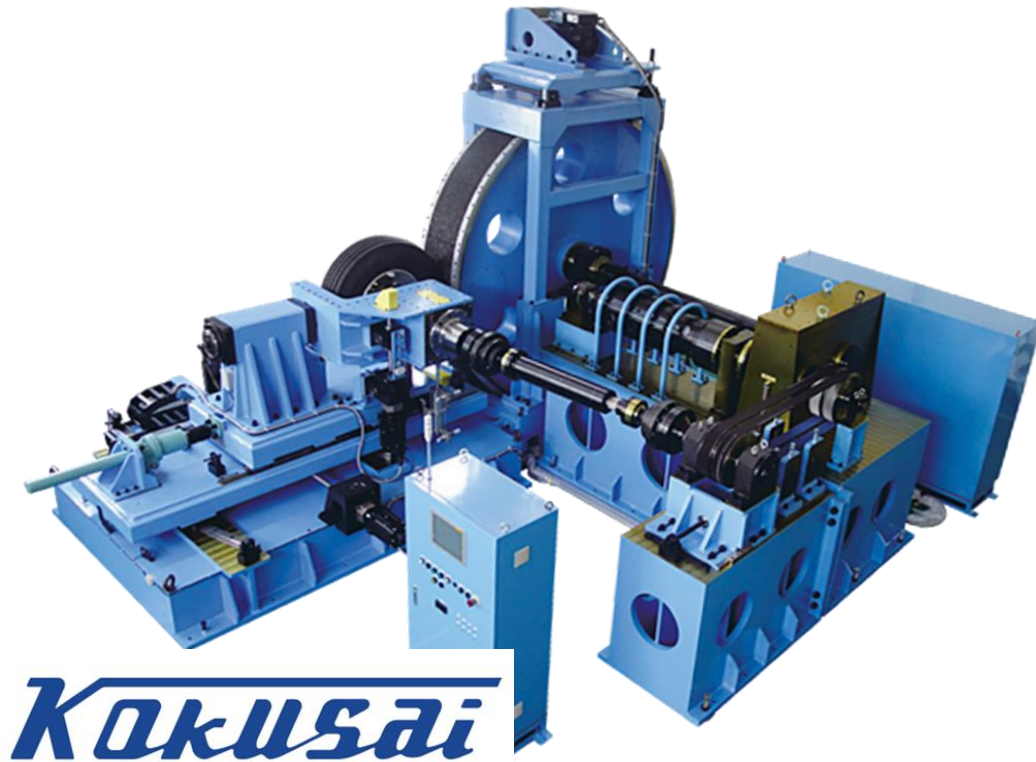
Markus Winter, Kokusai



Kokusai



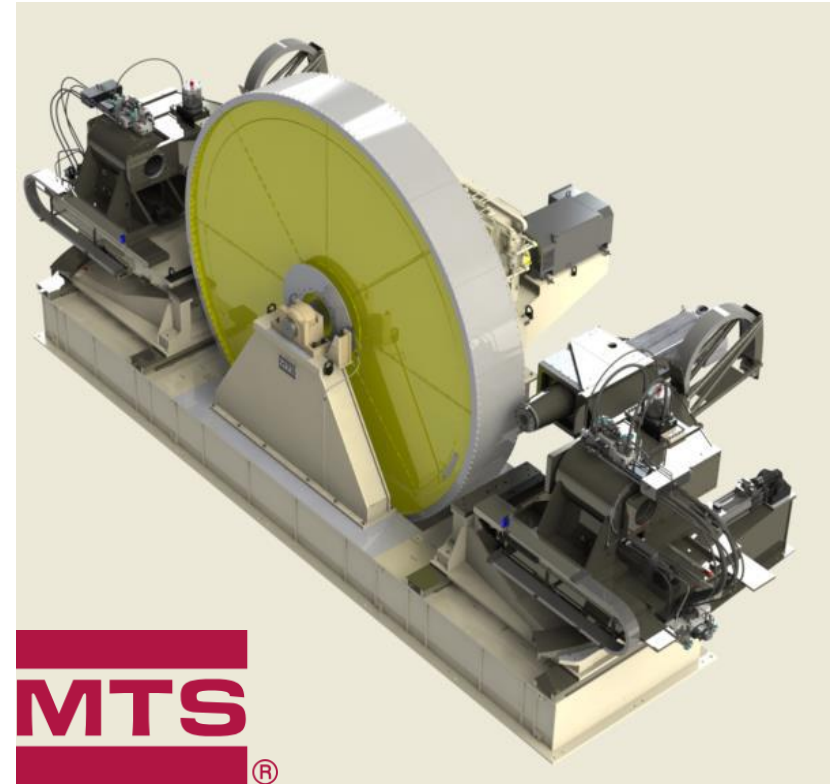
Tread Wear Tester used for this investigation



Kokusai, Japan

Drum Diameter: 3m /18 Segments

Fx control by speed difference tire/drum
& Torque on Demand



MTS@MRF, India

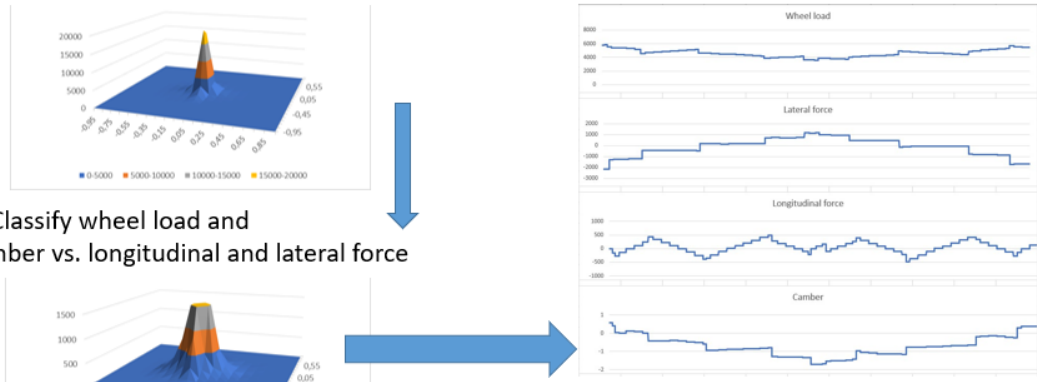
5m /22 Segments

tire speed

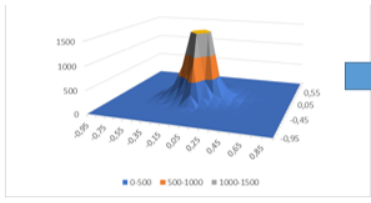
Kokusai presented in May 2022 independent from ETRTO/JASIC a approach based on the same theorie, but including wheel load transfer and including the camber influence

Generating the KOKUSAI drive file: How to reduce testing time:

- I) Divide into speed ranges:
- Due to vehicle kinematics, the camber angle behaviour depends on velocity
 - At higher speeds, aerodynamic downforce influences the wheel load
 - Vehicles with level control, the camber is also influenced



II) Classify wheel load and camber vs. longitudinal and lateral force



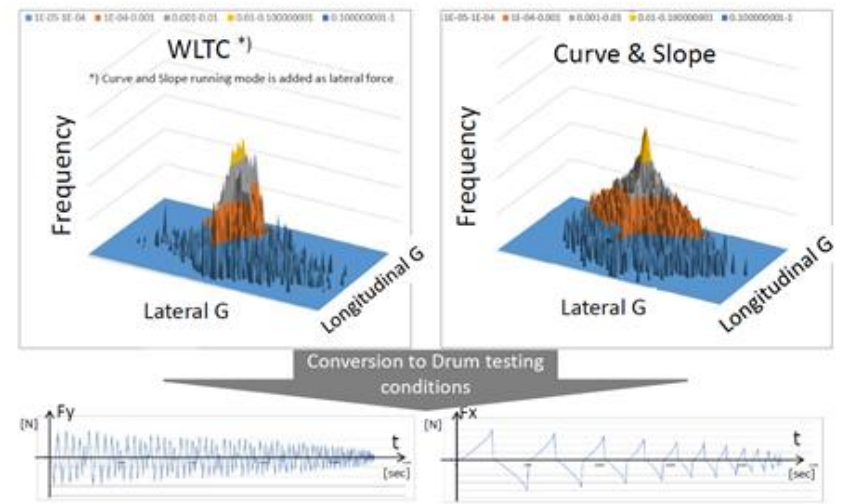
IV) Generation of an artificial driving maneuver. „Energy Efficient State Space Drive File Generator“

III) Constrain distance travelled for classes having nearly no contribution to tire wear

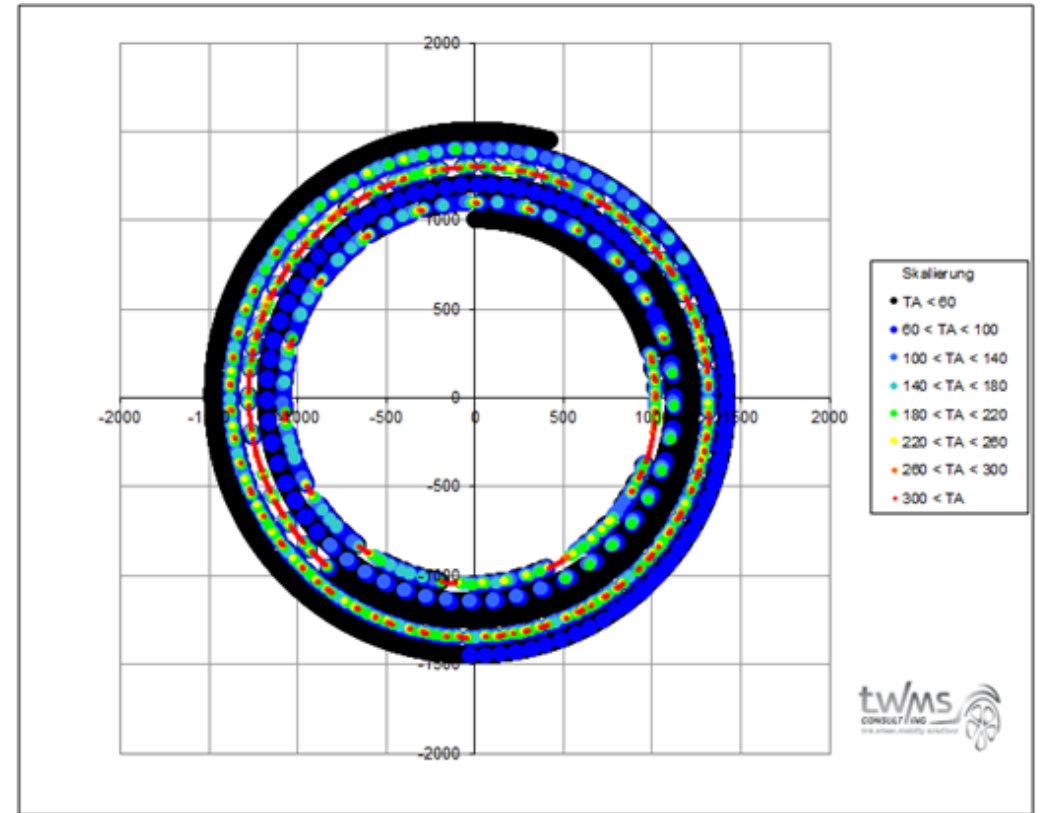
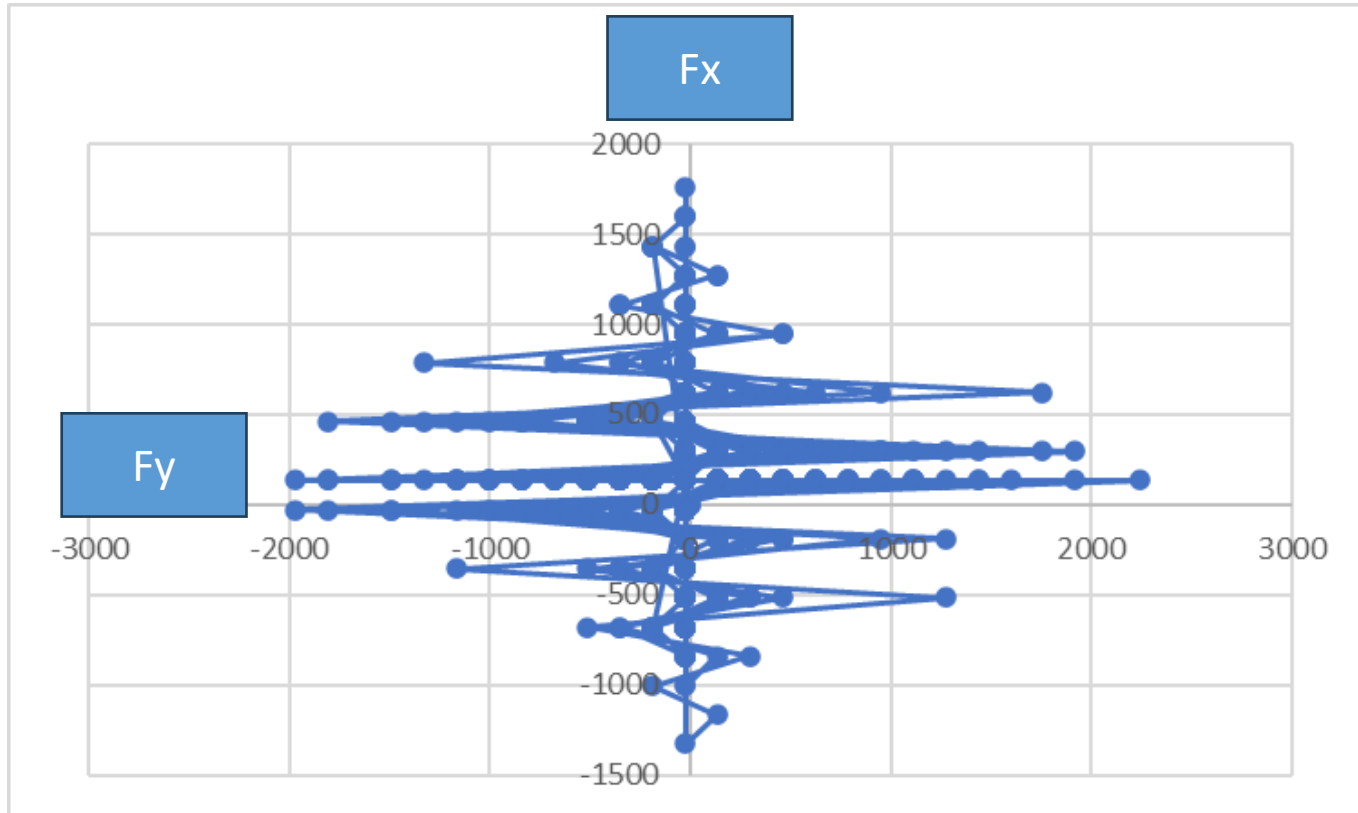
Note: The method was developed for the substitution of classic wear tests, not for wear on racetracks !



Development for driving mode: Lateral / Longitudinal force frequency distribution of WLTC and Curve & Slope



Visualization of the Original TFTA procedure (360 deg = 50 km) longitudinal force change slow, lateral force change fast

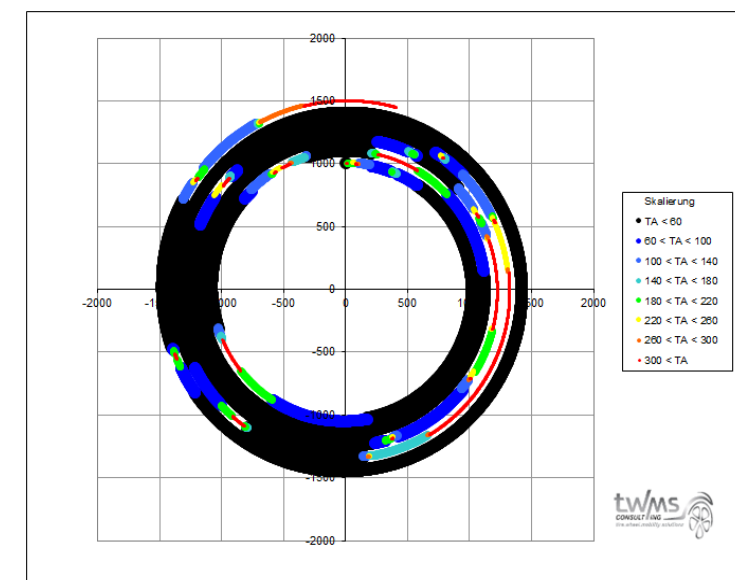
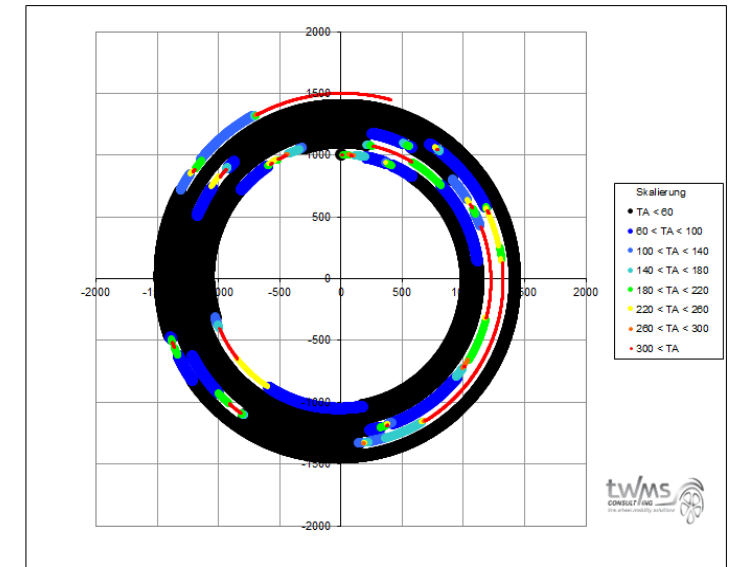
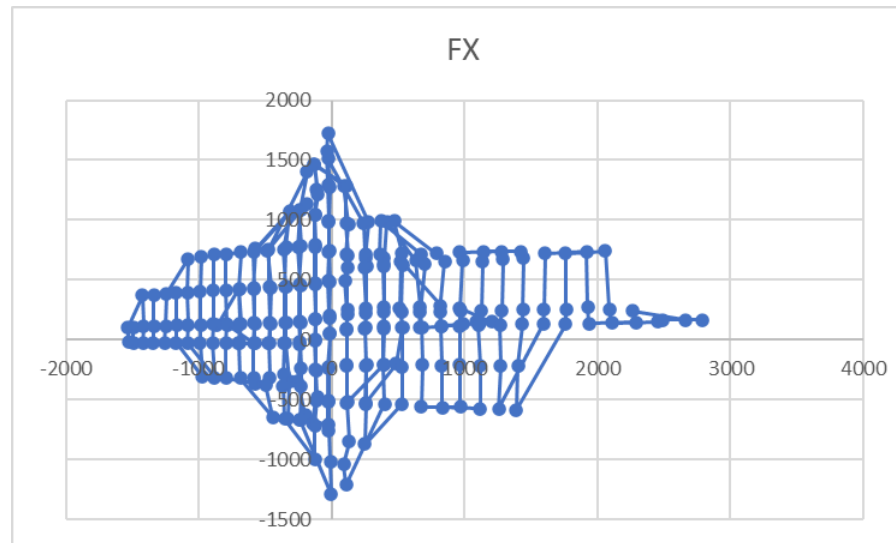
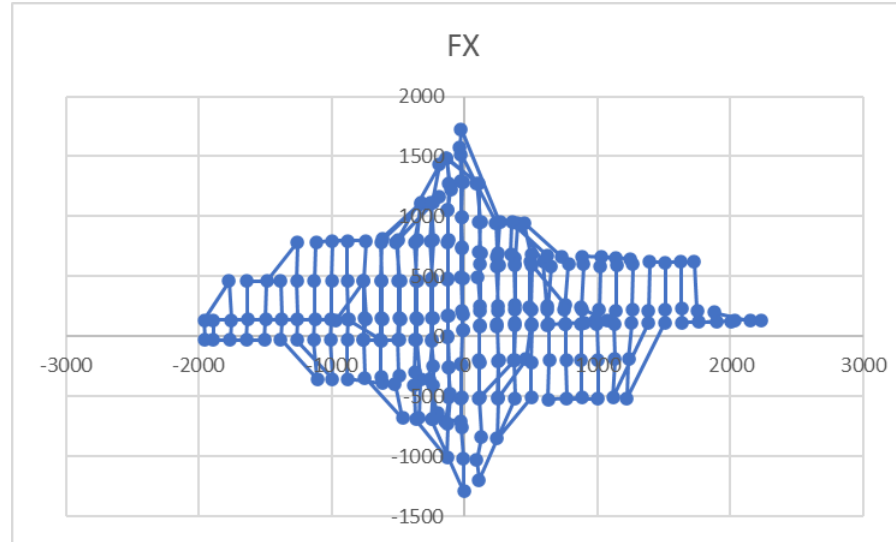


F:\Dropbox\TWMS\rezepte\rezepte\files\jstms\jstms_circle.xdm\trsch.wor

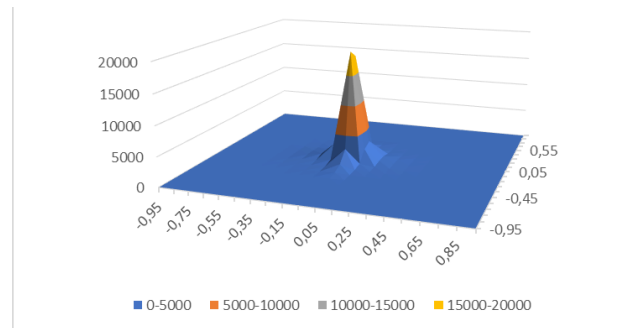
Modification:

I) resorting according the Kokusai Method
(lateral force change slow,
longitudinal force change fast)

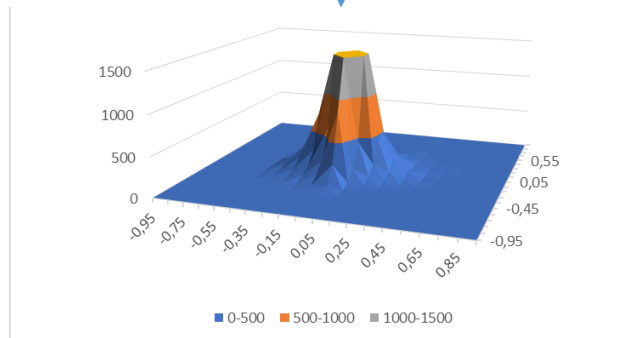
II) Introducing Wheel
load transfer & camber
using a very simple
vehicle model



How to optimize testing time: eliminate states with only few wear by limitation of maximum driving distance per cluster

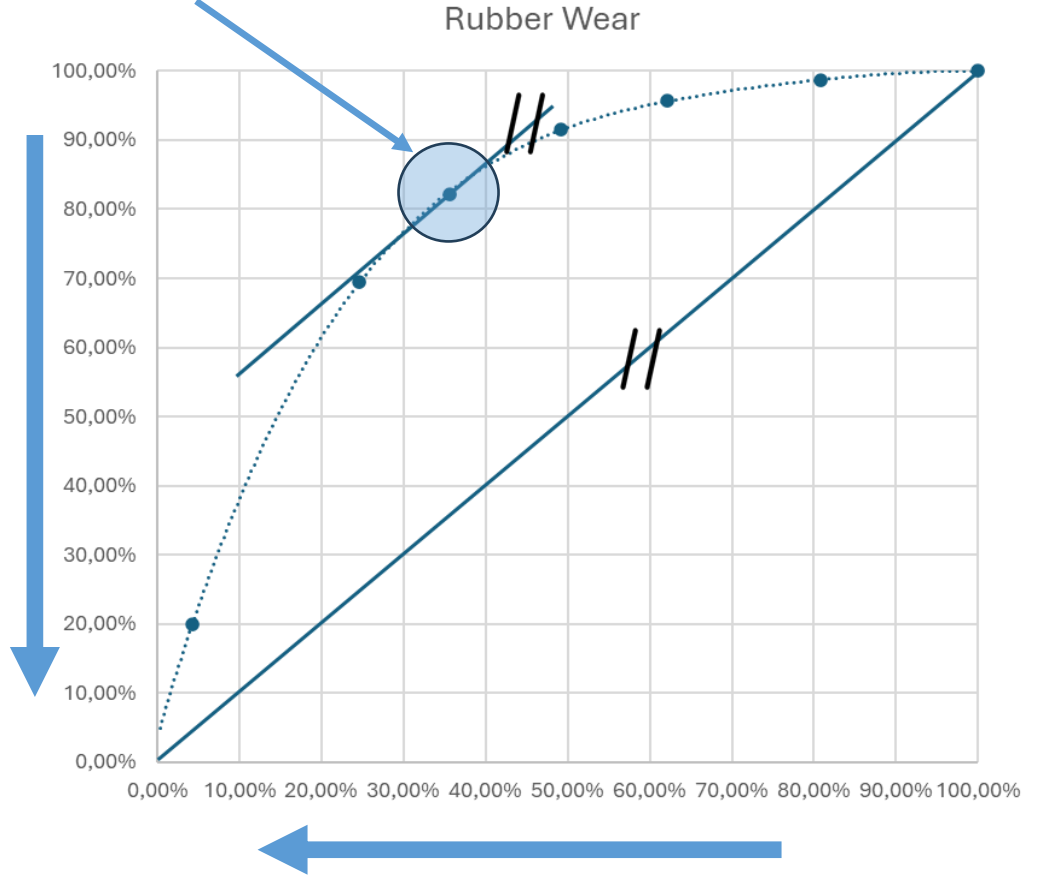


Reduction of mileage



Wear acceleration factor: 0,42

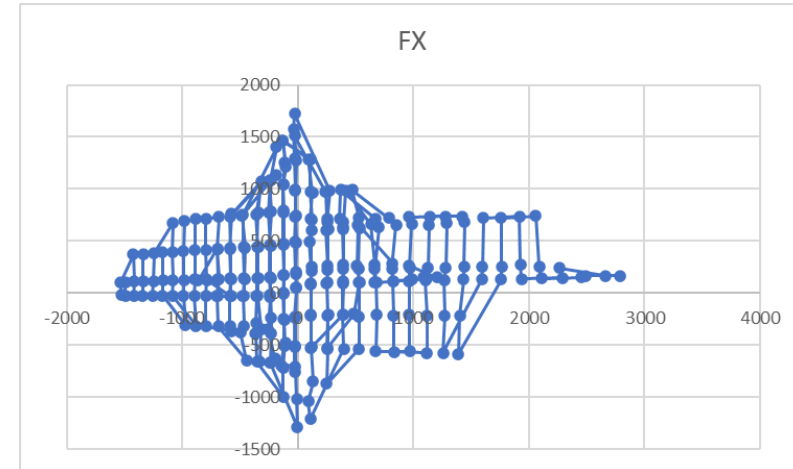
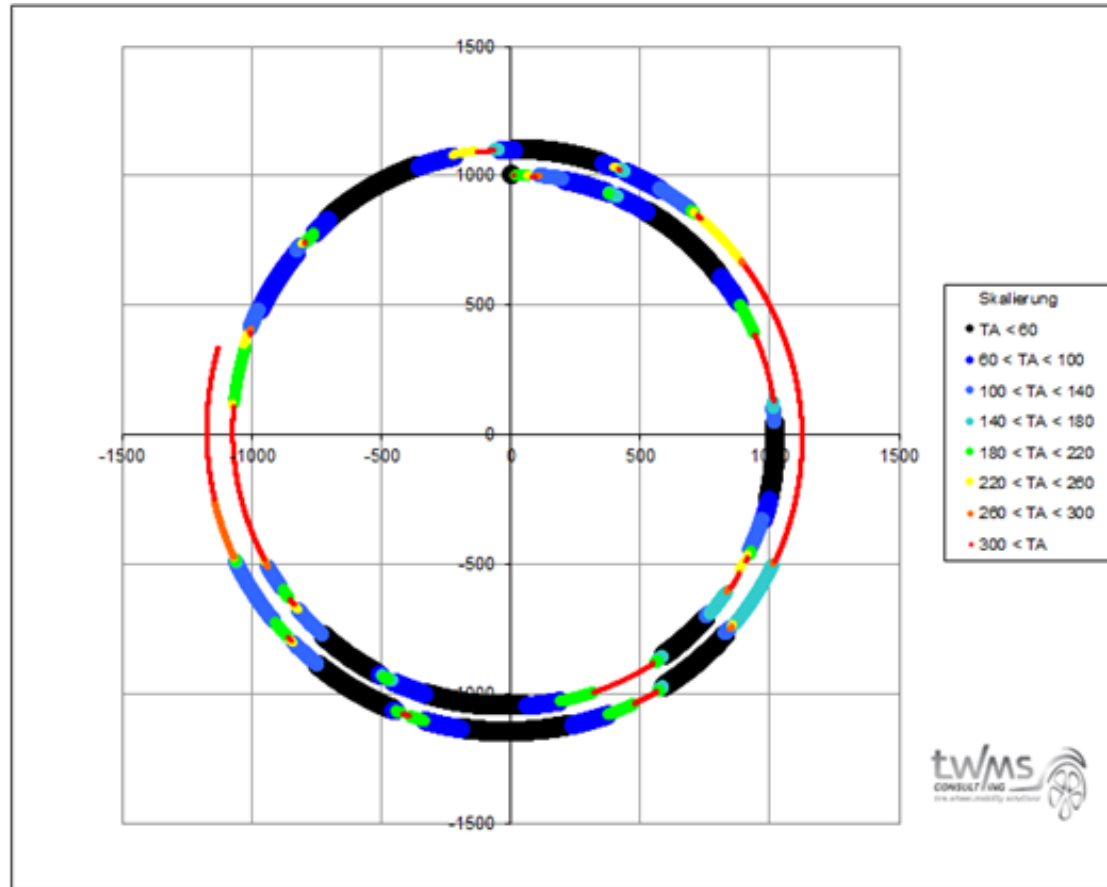
Reduction of friction energy



Reduction of mileage

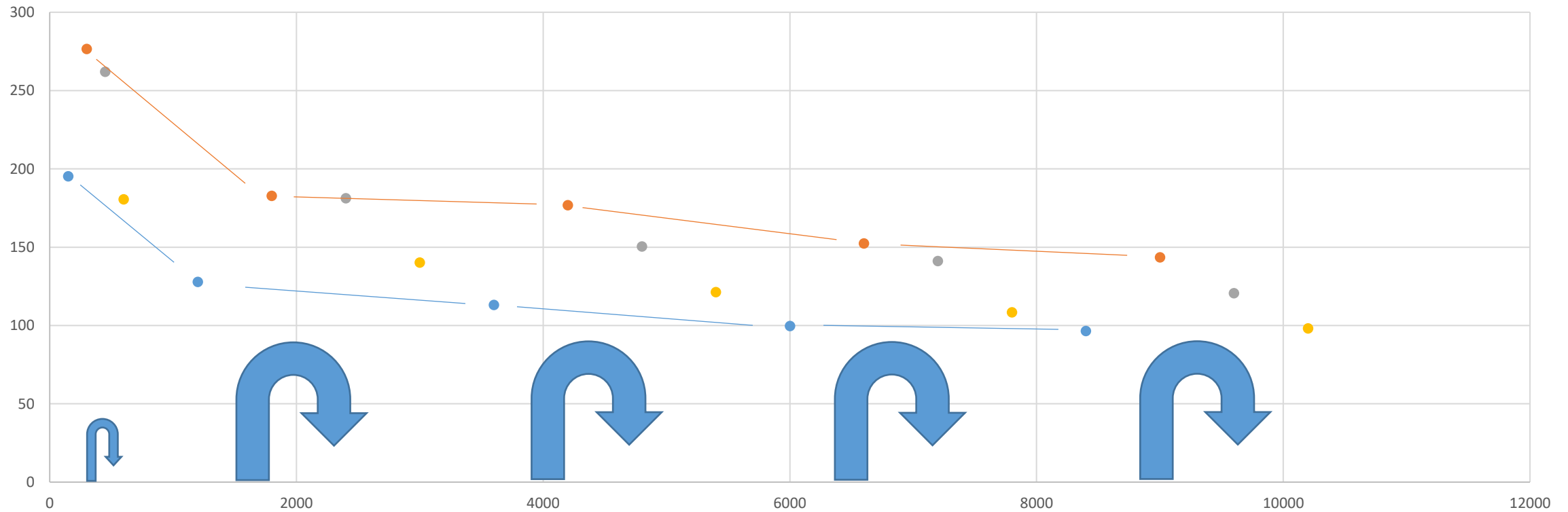


35 % of mileage reduction by 18 % loss of friction energy including camber and wheel load transfer which leads to an acceleration factor of 42%.

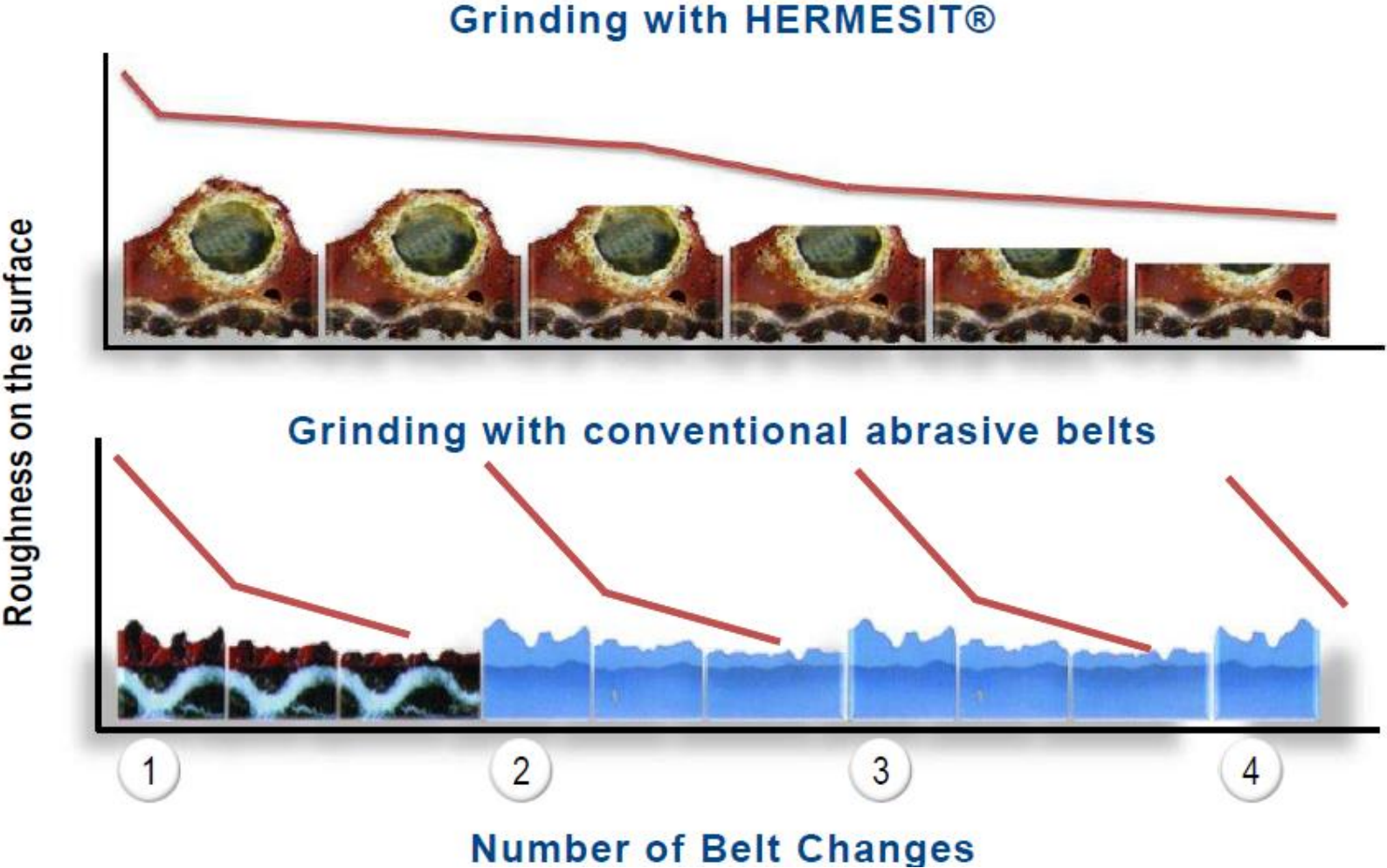


F:\Dropbox\TWMS\werkzeuge\final\jstms\jstms_circle_camber_sport mit cz 1000.slm\truck wear

Test on Kokusai TWT: Decreasing rubber loss on 4 tires measured alternately on new sandpaper (rolling-in + 4 cycles)



Learning from the grinding industry: Same behaviour



Drum Surface: Why sandpaper ?

- Easy to replace
- Easy to standardize

but

- Different abrasion mechanism compared to asphalt

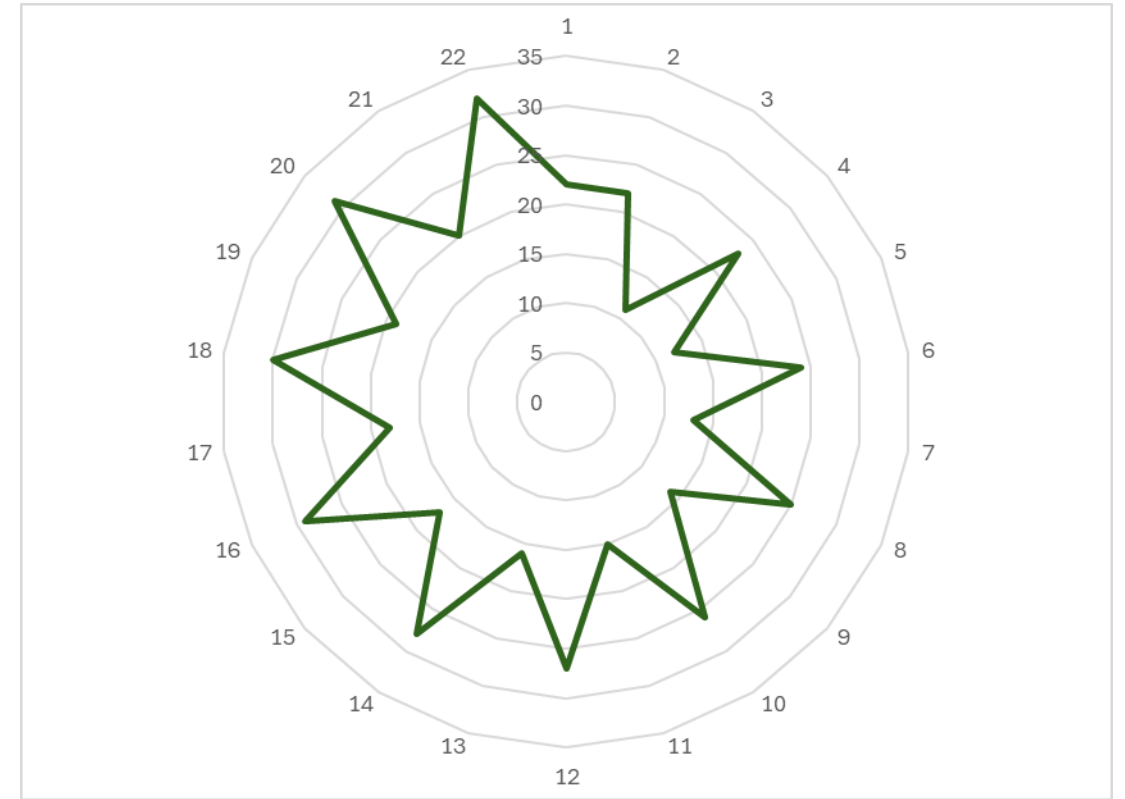
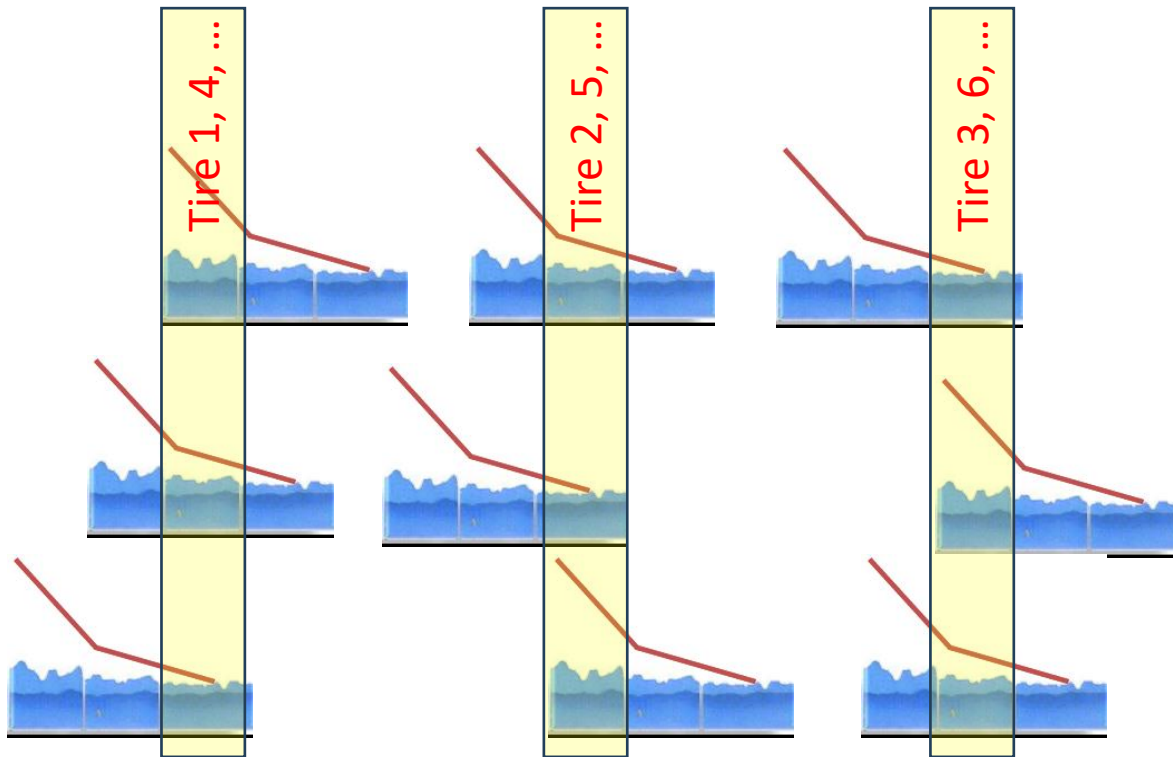


- TFTA: 80 Grid, average grain diameter: 200 μm
- Here used: 341D / 348DX from 3M™, grit sizes P120 with an average grain diameter of 120 μm

Generating constant drum wear properties for every tire

Renew after each tire measurement the sandpaper of one segment

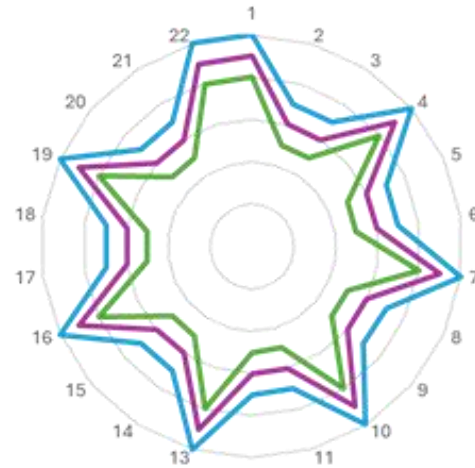
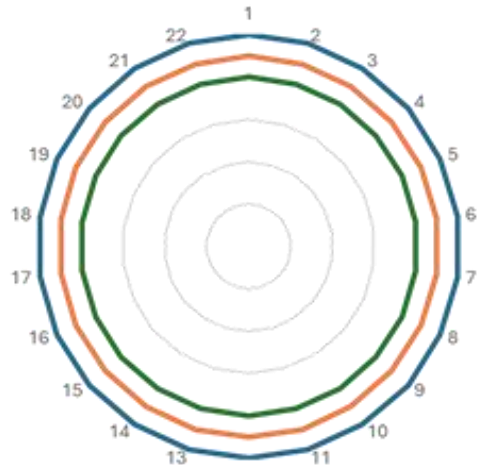
⇒ Every tire will have the same (averaged) drum surface condition



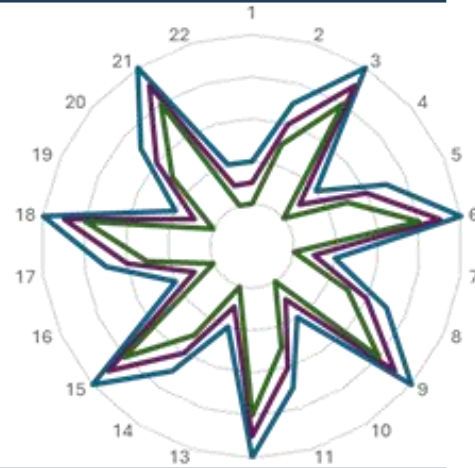
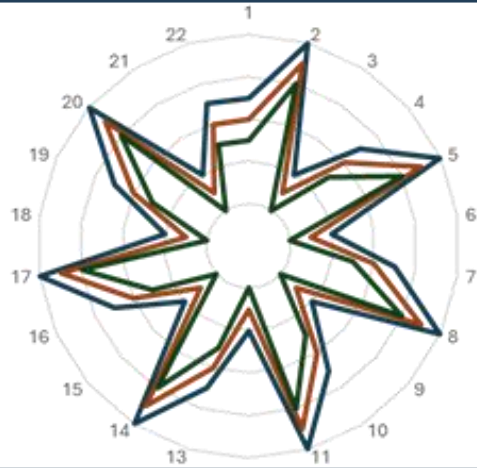
Wear state of a 22 segment drum

Validating Exchange of segments:

Wear pattern replacing 1/3 of the covering at a time 0, 6.000, 12.000,18.000 km



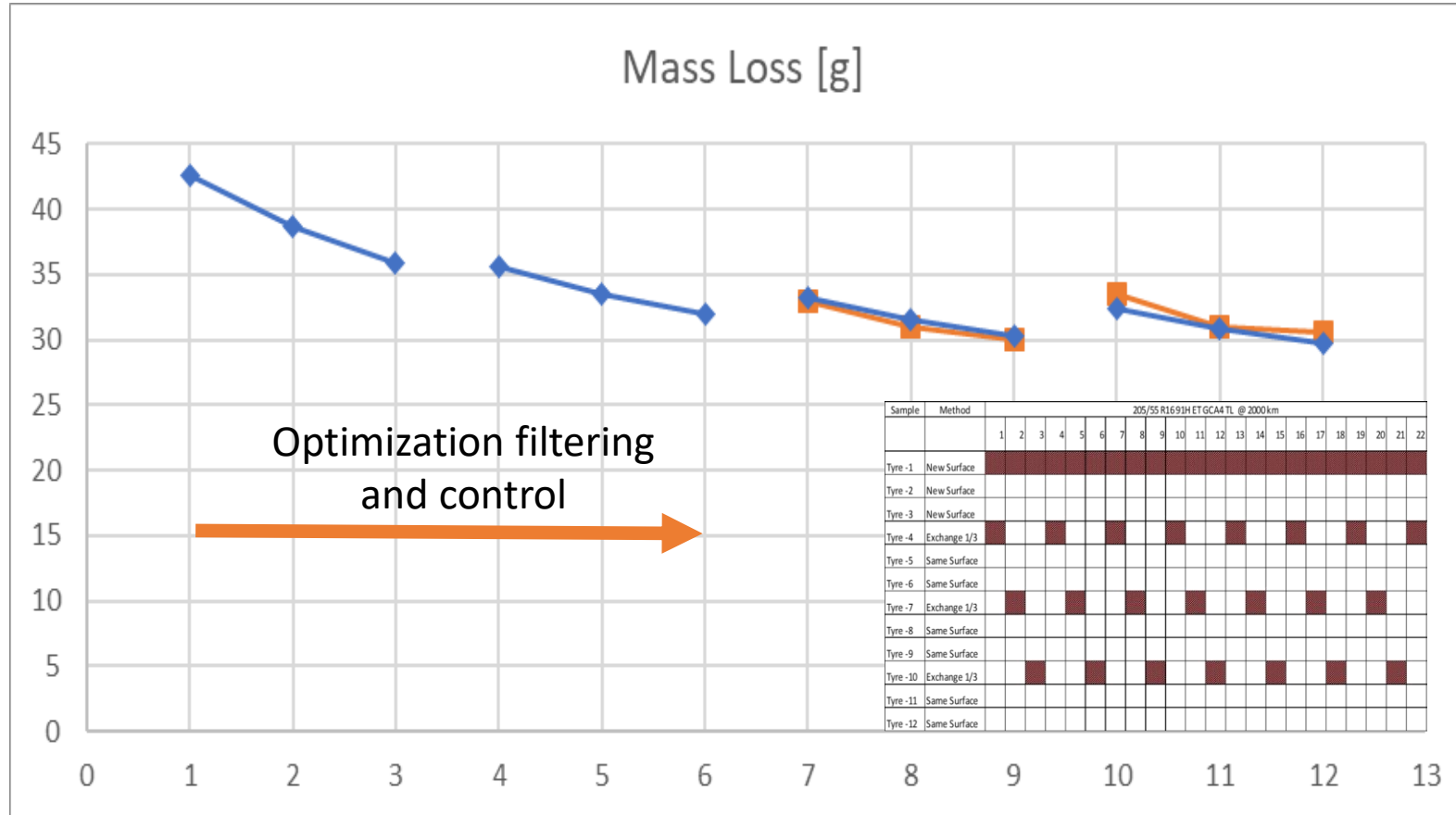
Tire 1, 2, 3 4, 5, 6,



Tire 7, 8, 9 10, 11, 12

Sample	Method	205/55 R1691H ET GCA4 TL @ 2000 km																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Tyre -1	New Surface	[Shaded]																					
Tyre -2	New Surface	[Blank]																					
Tyre -3	New Surface	[Blank]																					
Tyre -4	Exchange 1/3	[Shaded]			[Shaded]				[Shaded]				[Shaded]				[Shaded]				[Shaded]		
Tyre -5	Same Surface	[Blank]																					
Tyre -6	Same Surface	[Blank]																					
Tyre -7	Exchange 1/3		[Shaded]			[Shaded]			[Shaded]			[Shaded]			[Shaded]			[Shaded]			[Shaded]		
Tyre -8	Same Surface	[Blank]																					
Tyre -9	Same Surface	[Blank]																					
Tyre -10	Exchange 1/3		[Shaded]			[Shaded]			[Shaded]			[Shaded]			[Shaded]			[Shaded]			[Shaded]		
Tyre -11	Same Surface	[Blank]																					
Tyre -12	Same Surface	[Blank]																					

Results tire 7 – 12 (red) vs. Simulation expectation on the basis of a Kokusai Wear test (blue)
 mass loss / 2000 km / 550 kg on 120 grid Sandpaper 3M (33 g = 30 g / 1000 km / t)



Initial – 0 km



Final – 2000 km

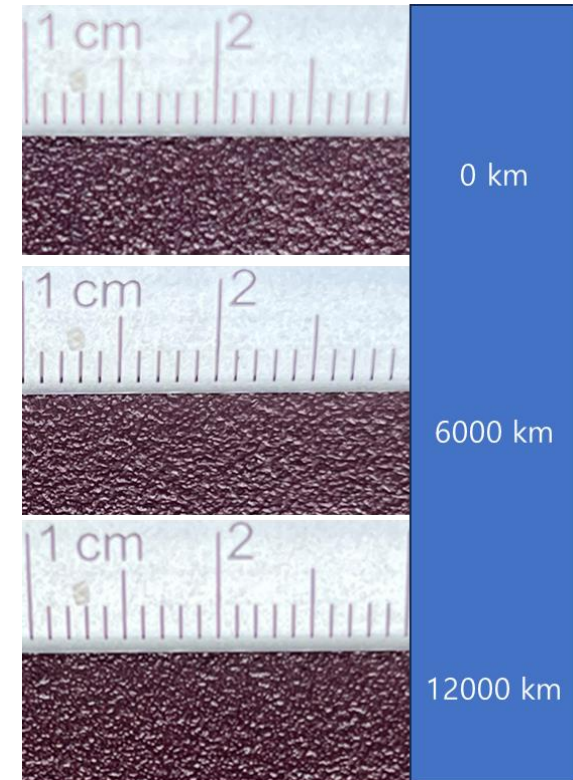


How to evaluate the sandpaper quality (wear state)

It was not possible to measure, to feel or to see any the differences in dependance of the wear state 0, 6Tkm and 12Tkm

=> If the sandpaper is worn down differences can be found

Only a „OK“ on „not OK“ test is possible.



Outdoor



TFTA Outdoor method

4 car convoy

8 Tkm

(8 Tkm in the convoy)

100 h (Weather ?)

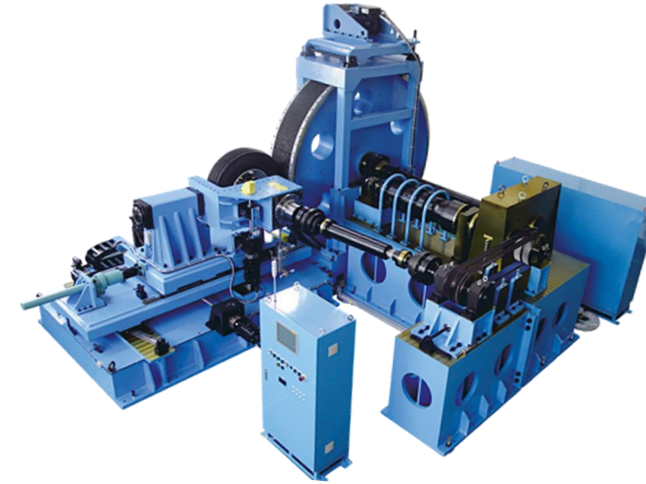
Rental 4 cars

4 driver

Fuel for 32 Tkm

12,2 T€/Tire

Indoor test



TFTA Indoor method

2 position tester

3x5 Tkm

3x5 Tkm

188 h

Machine costs

1 Operator

Electrical power **15-20 kW**

10,1 T€/tire

=> Kokusai method (2 pos.)

2 position tester

3x2,1 Tkm

max. 1x2,1 Tkm

52 h

2,8 T€/tire

- 3 sets of tires
- Reference
- Duration (1 tire)
- Hardware Costs
- Personal costs
- Energy costs
- **Overall Costs (est.)**

Summary on Basis of the TFTA- Indoor Method

Method Extension:

- Camber and wheel load transfer improves wear figure
- Elimination of low wear conditions reduces cost and time
- Changing a segment after each measurement reduces reference tires
- Changing the order of longitudinal slip variation (fast) and slip angle variation (slow) reduces relaxation time

Wear tester:

- The control and filtering of wheel load, lateral force and longitudinal force is very sensitive to handling and can have an immense influence on the wear result. Both should be included in the regulation.
- The rate of change of wheel load, lateral force and longitudinal force must be specified in (KN/second).

Acknowledgments

Kokusai

