

DAIMLER

Driveline Investigations at Mercedes Benz

Daimler AG

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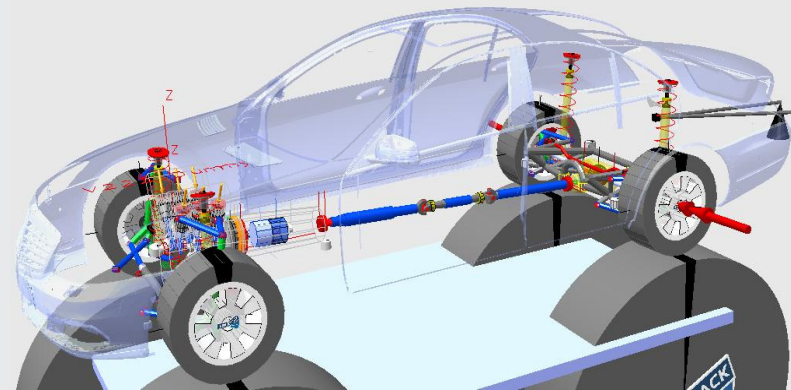
SIMPACK AG 

Jan Zeman



Driveline Investigations at Mercedes Benz

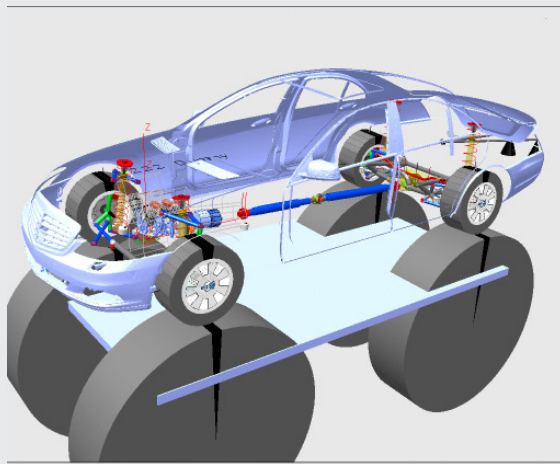
- the problem
- the appropriate SIMPACK model
- measurement and simulation result
- the excitation and the chain of effects
- driveline optimization and sensitivity



Driveline design for extra long upper class vehicles

Driveline booming vs. beating

two- parted prop shaft

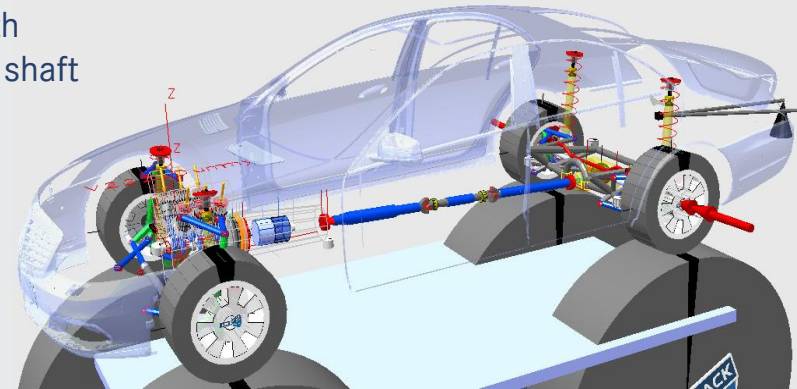


High speed driveline booming
due to prop shaft bending modes

no booming with
three- parted prop shaft



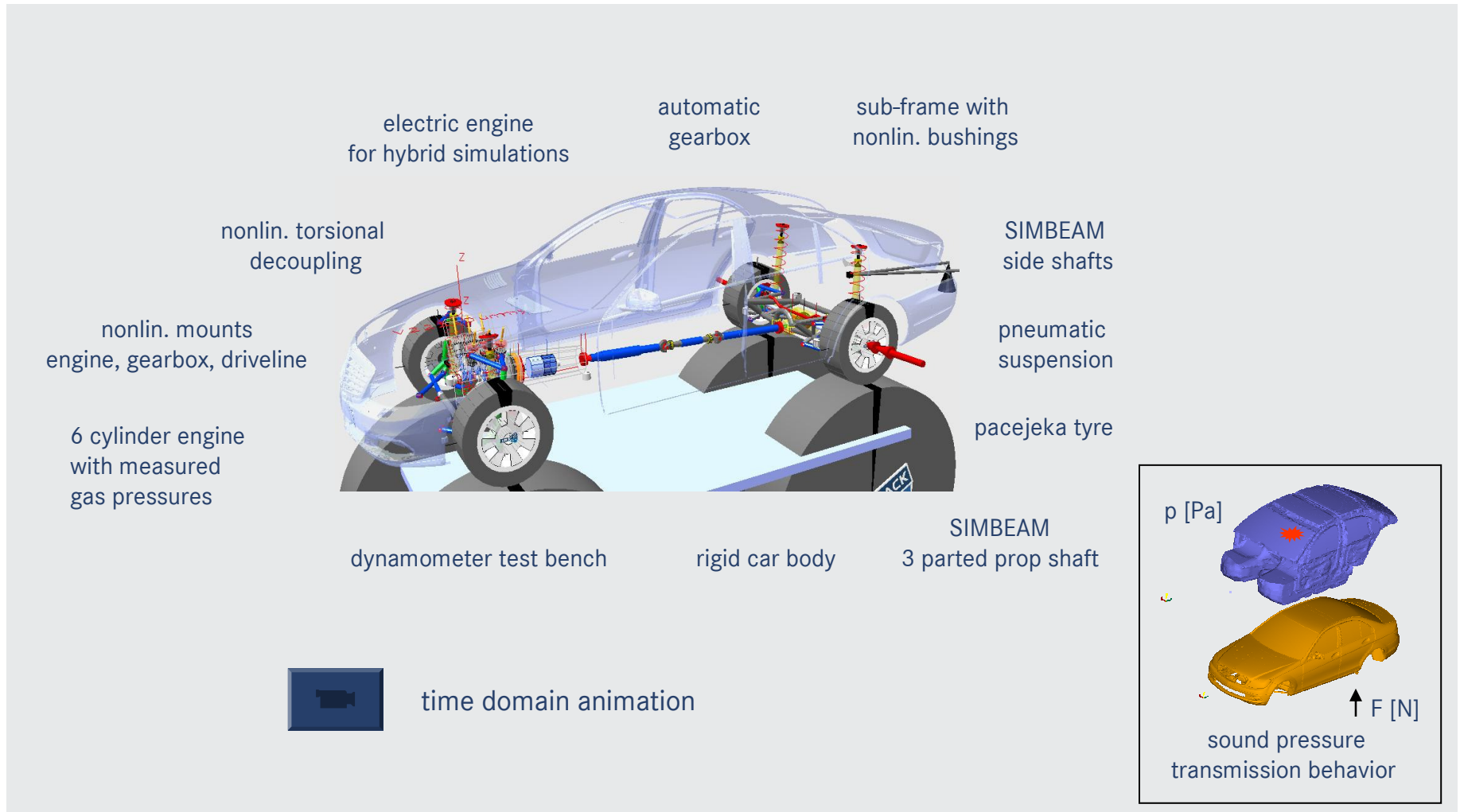
three- parted prop shaft



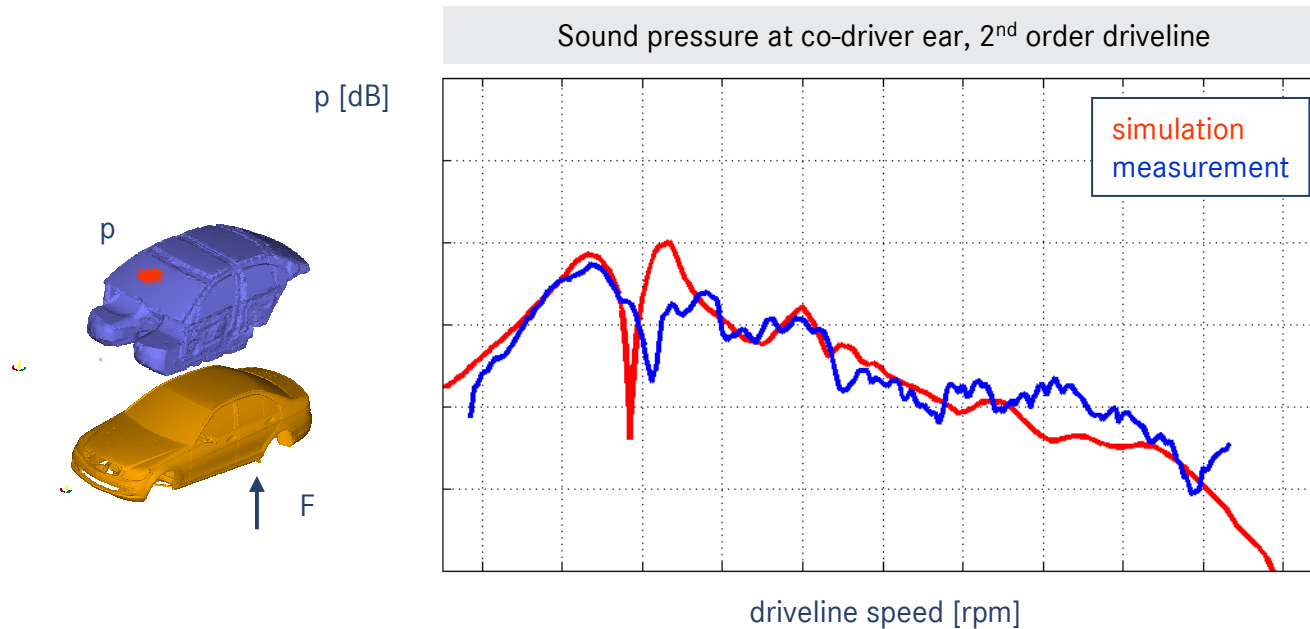
Low speed driveline beating
due to rigid body prop shaft modes



Basic setup for driveline simulations

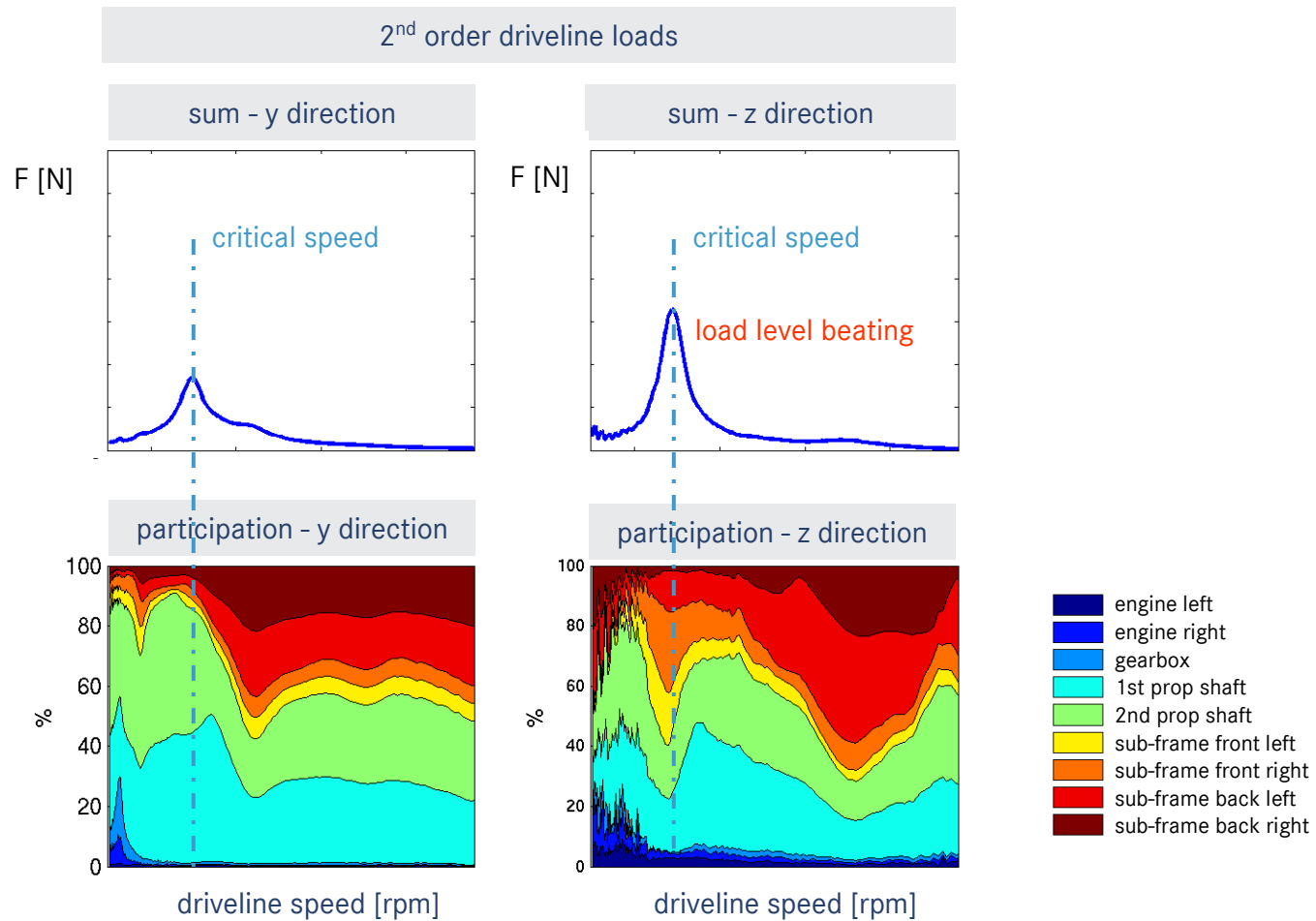


Beating of three-parted prop shaft measurement vs. simulation



Good correlation between simulation and measurement.

Investigation of driveline load levels

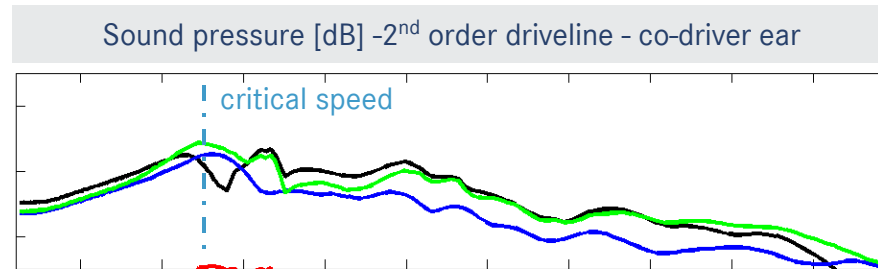


At critical speed the load levels of the prop shaft and sub-frame mounts are increased.

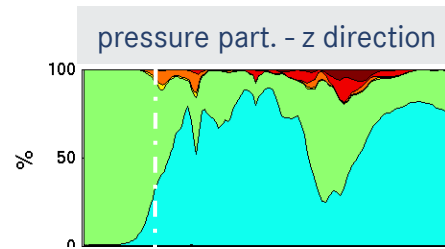
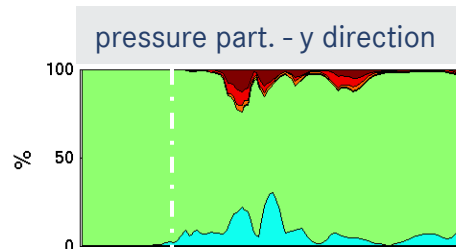
Investigation of sound pressure level

sound pres. (sum)

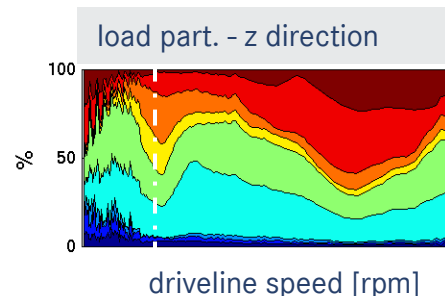
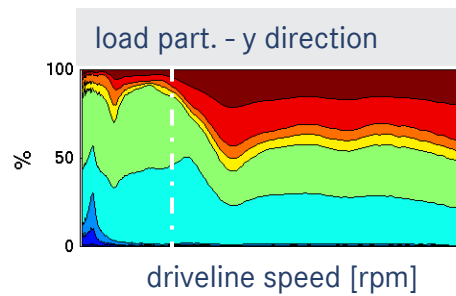
sound pres. only due to loads in
y direction
z direction



eigenmode 1



eigenmode 2

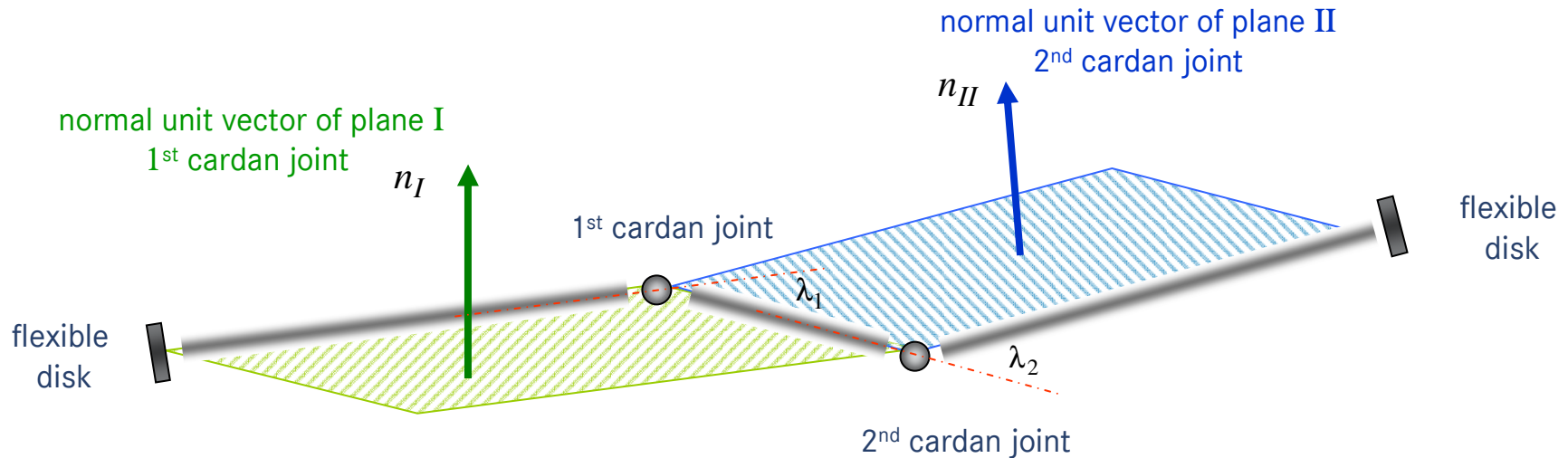


- engine left
- engine right
- gearbox
- 1st prop shaft
- 2nd prop shaft
- sub-frame front left
- sub-frame front right
- sub-frame back left
- sub-frame back right

The sound pressure level of driveline beating is dominated by the load level at the prop shaft mounts.

Homo-kinematic condition of three parted prop shaft

Nonlinear optimization problem



Find optimal positions of the cardan joints for the following conditions:

plane of cardan joints parallel

$$n_I \parallel n_{II}$$

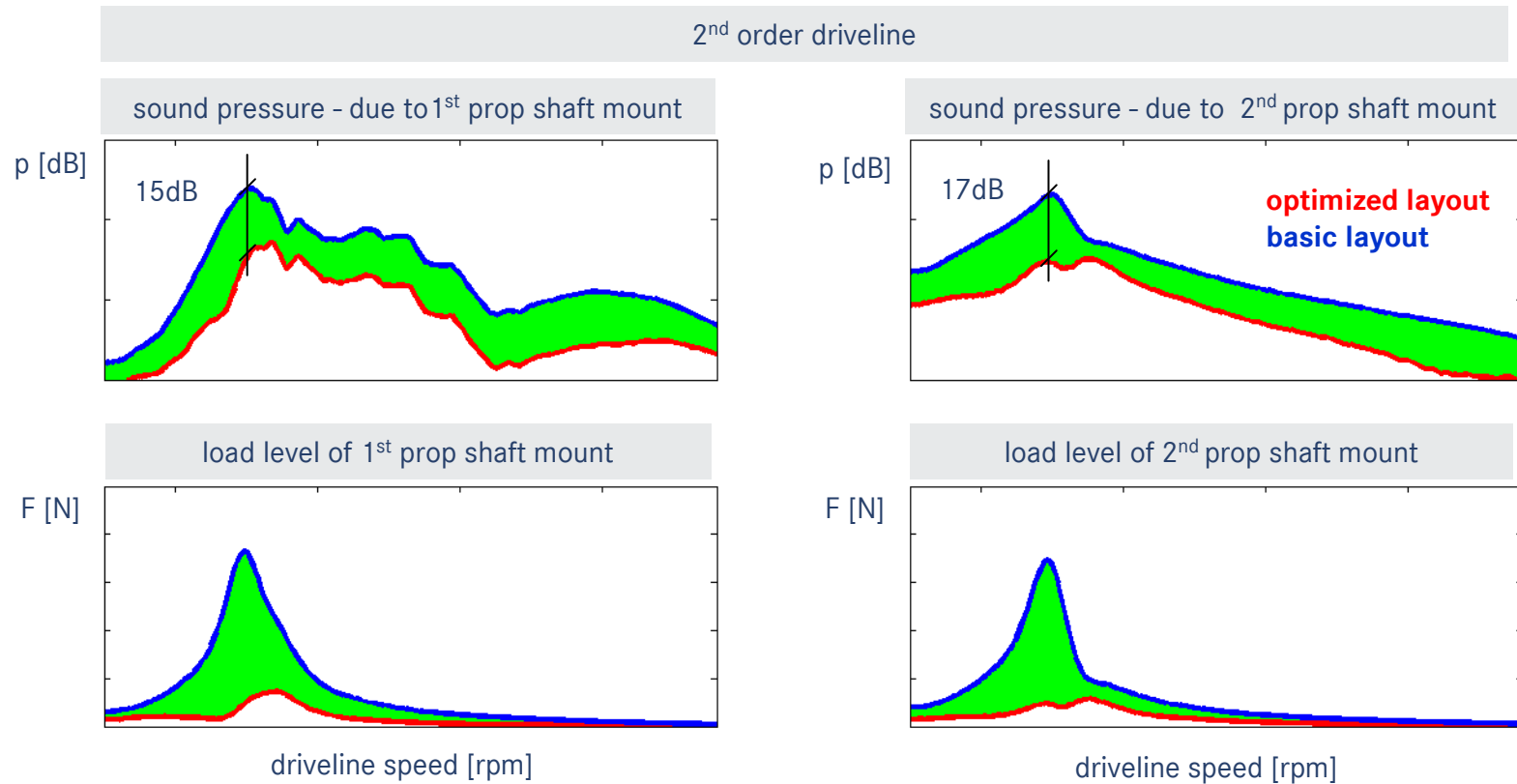
kink angle identical

$$\lambda_1 = \lambda_2$$

kink angle minimal

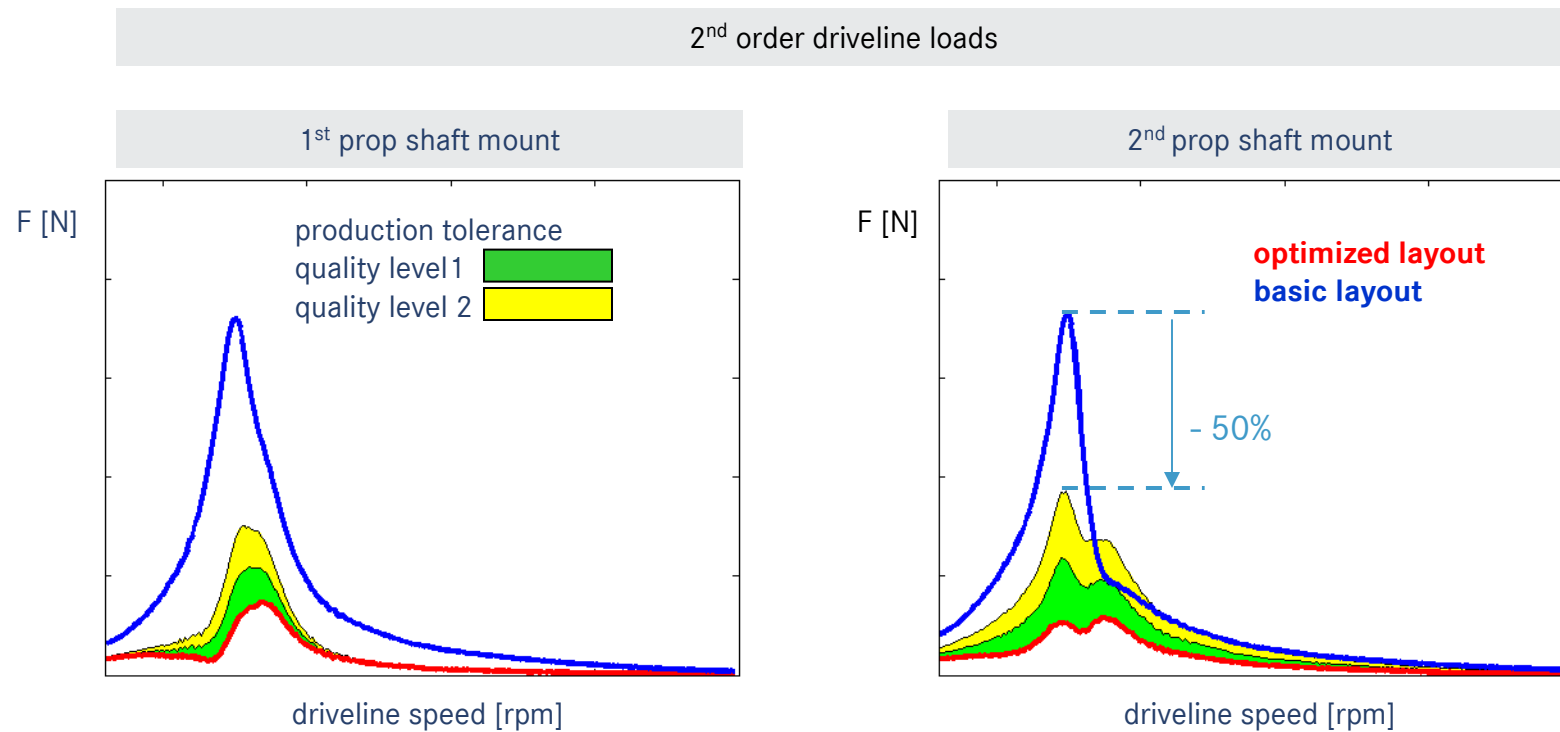
$$\min(\lambda_1, \lambda_2)$$

Optimized driveline layout



The optimized driveline layout shows a reduction of 15 - 17 dB in the relevant chain of effects.

Sensitivity of optimized driveline layout



For a optimized driveline layout and the quality production level 2
a load reduction of the prop shaft mounts remains by 50% ⇒ stable layout.

Conclusion

The excitation and chain of effects of driveline beating is explicitly illustrated and well understood.

Optimized driveline layout is generated by solving the nonlinear homokinematic conditions.

The sensitivity of an optimized driveline layouts is shown.