

# MF-Swift:

A tire model for handling, ride comfort, durability and control applications

*EHTC 2010*

**TNO | Knowledge for business**

**Delft-Tyre**



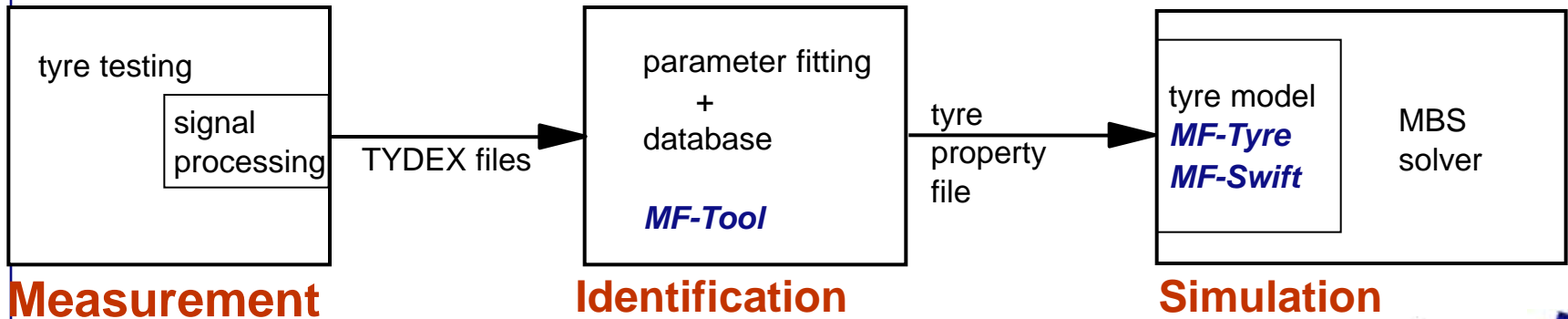
**tass**  
beyond safe



# Contents

- TNO Delft-Tyre toolchain
- MF-Swift:
  - Intended range of application
  - Concept
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  - Application example
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# TNO Delft-Tyre toolchain

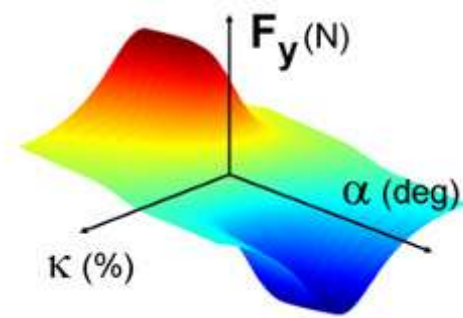


**Measurement**

**Identification**

**Simulation**

# MF-Swift



TNO is the original developer of MF-Tyre:

- Empirical model based on Pacejka's Magic Formula
- Single point tyre to road contact
- Used for vehicle handling:
  - Step steer, slalom, sine steer, j-turn
  - Smooth road surfaces
- Applicable for both passenger car as well as motorcycle tyres

MF-Swift is an extension of MF-Tyre with:

- An advanced road contact/enveloping model
- Representation of tyre dynamics

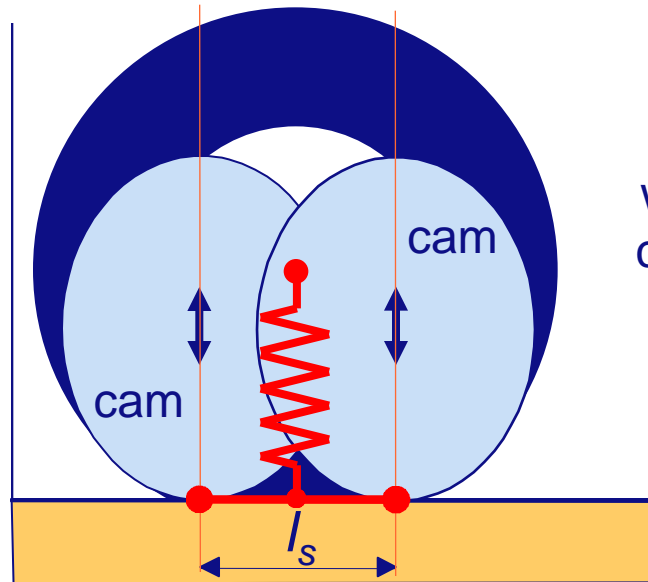
# MF-Swift

Intended range of application

- Vehicle behaviour on uneven roads:
  - ride comfort analyses
  - durability load calculations (fatigue spectra and load cases)
- Simulations in which control systems are involved that can excite tyre dynamics, e.g. ABS, ESP, etc.
- Analysis of drive line vibrations
- Analysis of shimmy vibrations; these vibrations typically have a frequency in the range of 10-25 Hz.

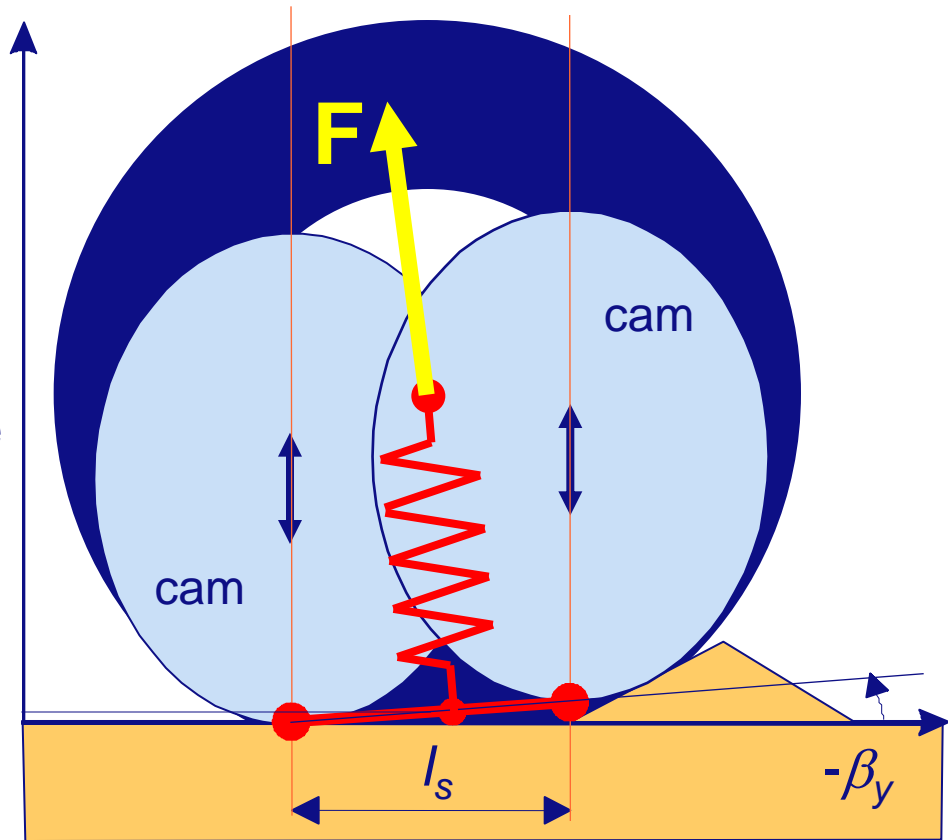
# MF-Swift

Advanced road contact model



wheel centre

$W$

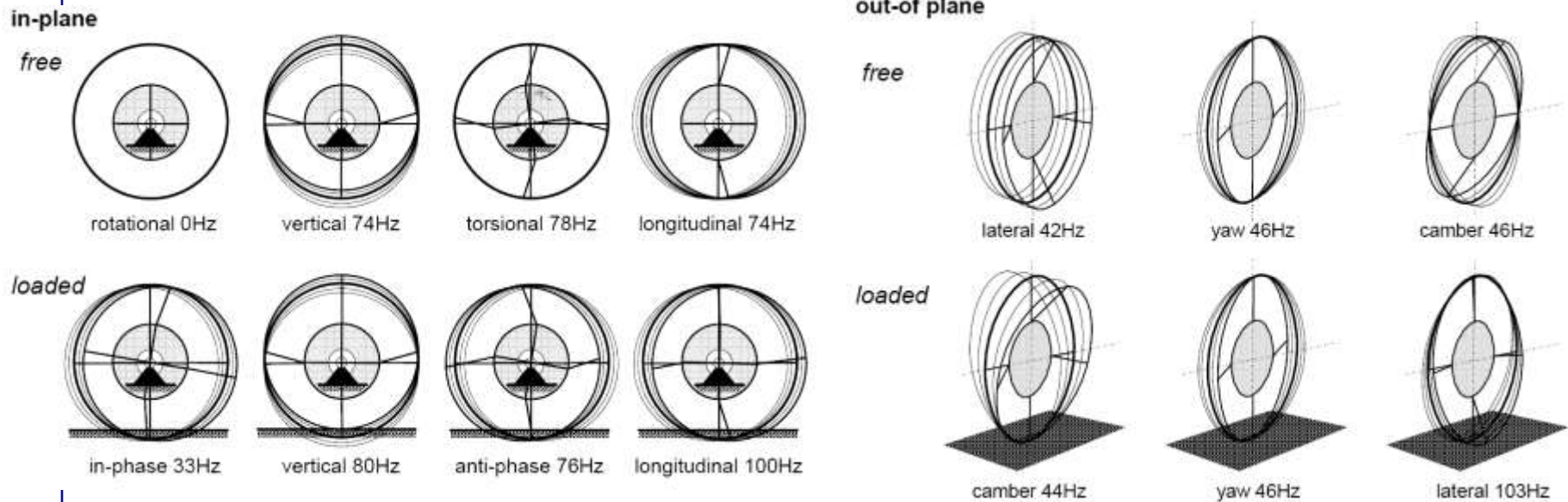


- Elliptical cams represent tyre contour
- Enveloping model output is effective road surface with:
  - 2D: height, forward slope, road curvature
  - 3D: road banking/camber

# MF-Swift

## Tyre dynamics

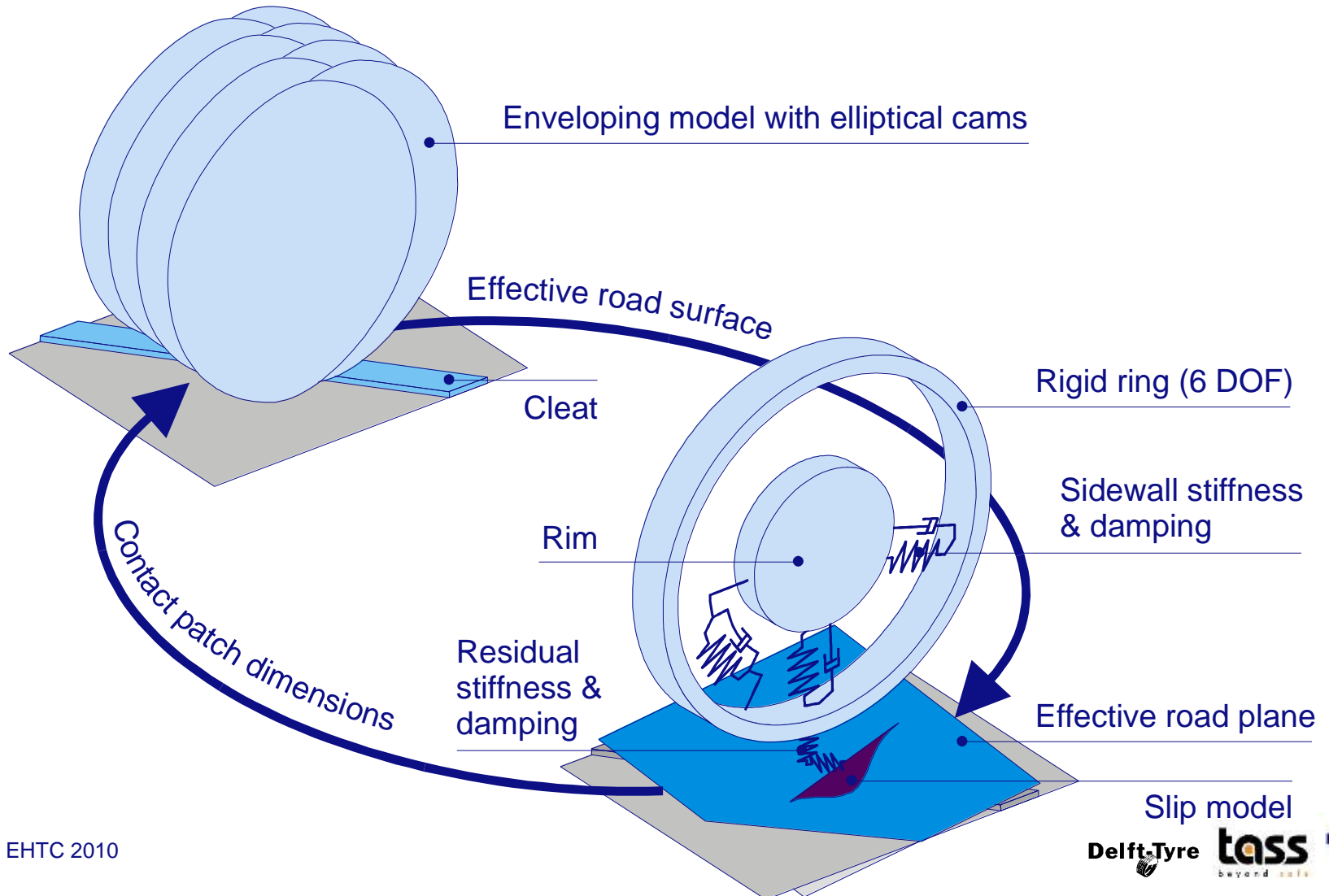
- Primary/first eigenmodes of the a passenger car tyre:



- below 60 to 100 Hz tread band may still be considered as a rigid body, e.g.:
  - truck tyre < 60 Hz
  - passenger car tyre < 100 Hz

# MF-Swift

Tyre dynamics



# Unique advantages MF-Tyre/MF-Swift

- MF-Tyre has unique features and is available free of charge in the major simulation packages
- MF-Swift is an extension of MF-Tyre:
  - One tyre model for all applications
  - Little extra measurements required
  - Older MF-Tyre datasets can be 'upgraded' to MF-Swift
- MF-Swift only has 6 degrees of freedom → computationally efficient
- MF-Tool provides stand alone (independent) parameter fitting possibilities

# MF-Tyre/MF-Swift availability

Under construction:

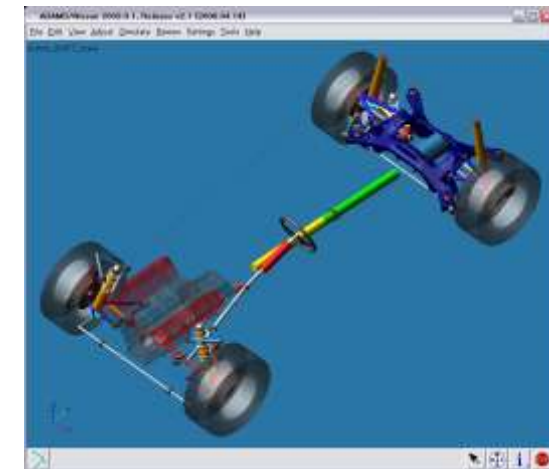
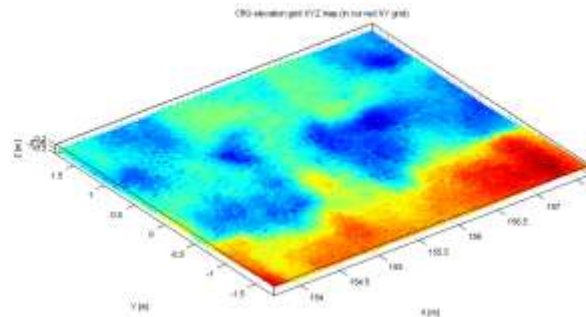


Available:



## MF-Swift application example

Durability load calculation at Nissan, Japan



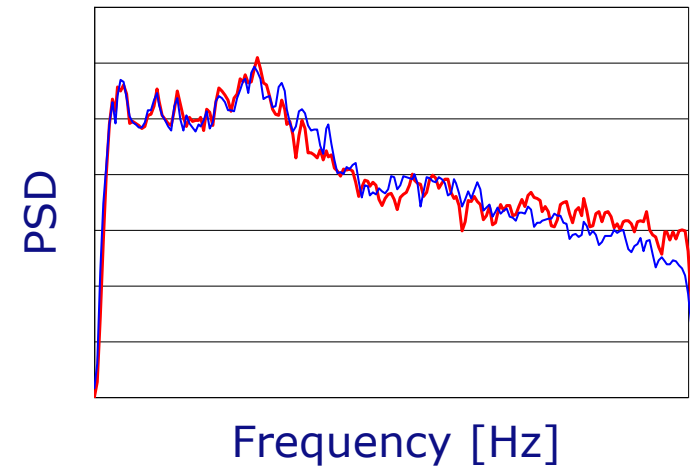
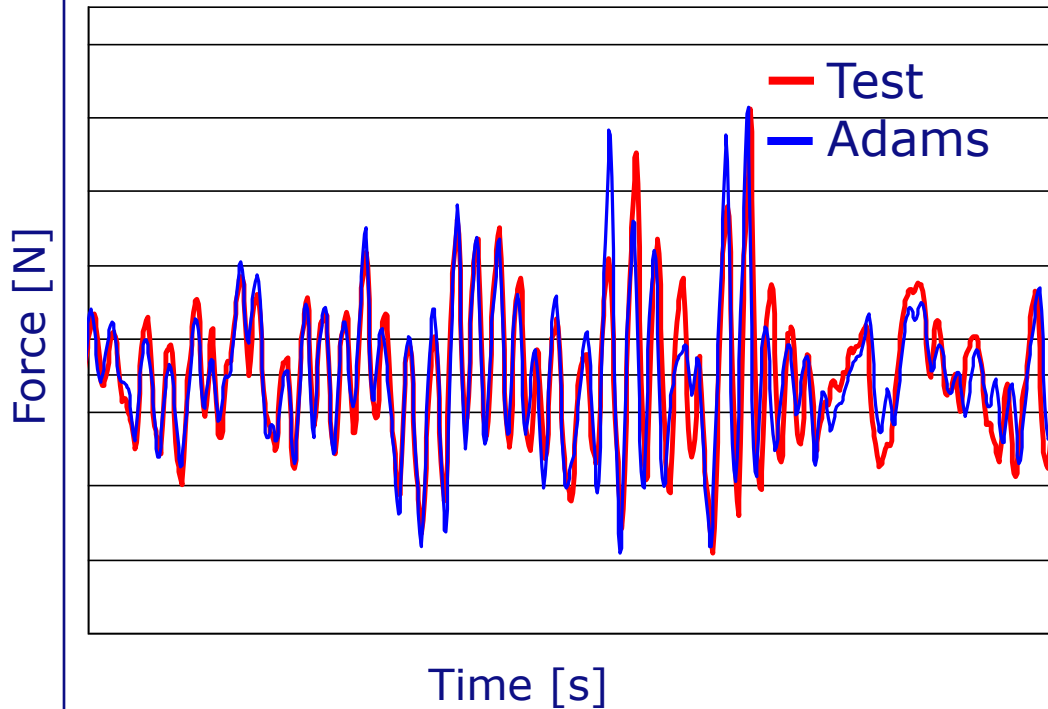
- durability road
- digitised 4x4 mm grid
- 9.7 GB

- OpenCRG file
- 4x4 mm grid size
- binary, 273 MB

- Adams model
- flexible bodies
- MF-Swift 6.1.2

## MF-Swift application example

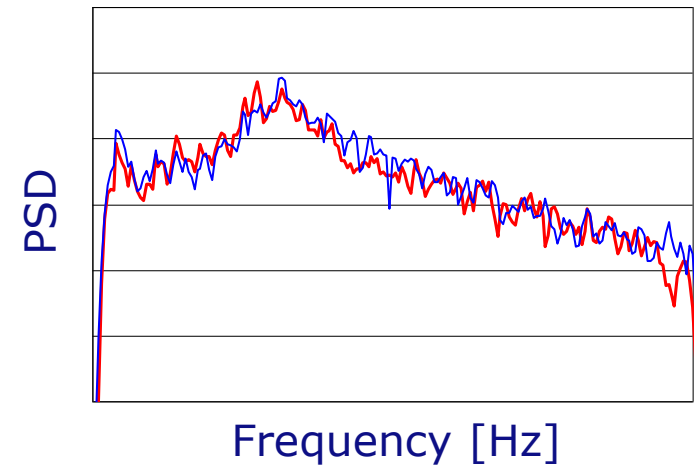
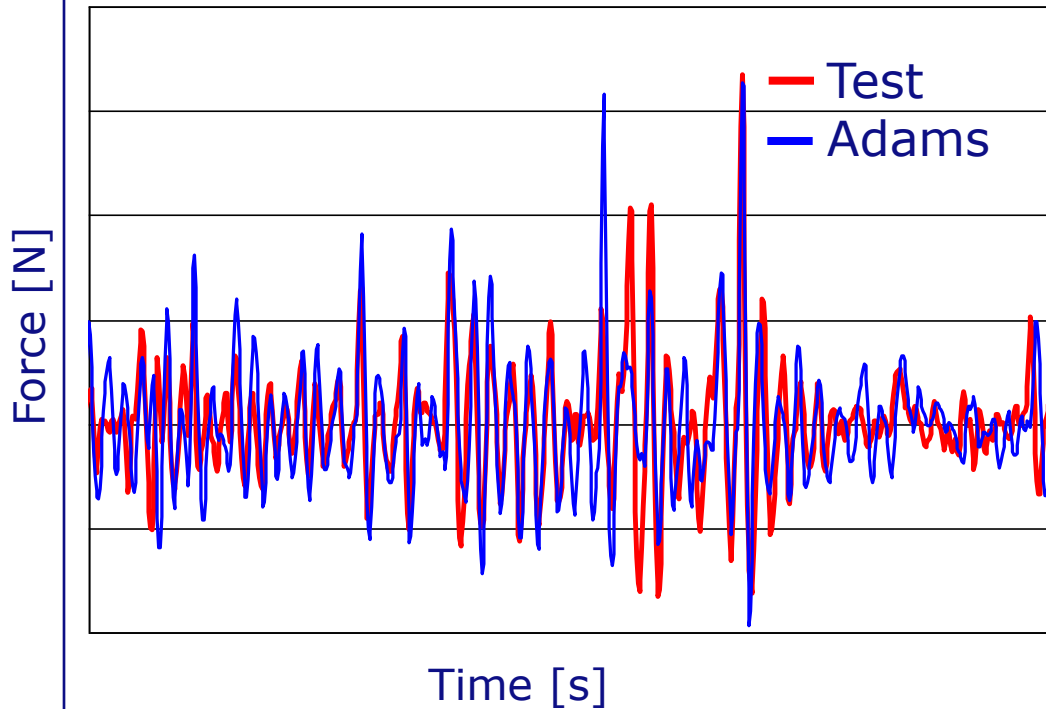
**Example: uneven road simulation**  
**Comparison vertical force on vehicle body**



## MF-Swift application example

Example: uneven road simulation

Comparison longitudinal force on vehicle body



# Concluding remarks

- With Delft-Tyre TNO has developed an integral toolchain for all tyre modelling needs
- The MF-Tyre/MF-Swift tyre model can be applied for all vehicle dynamic simulations, ranging from handling to durability
- The MF-Tyre/MF-Swift concept is fast, accurate and requires little measurements
- The MF-Tyre/MF-Swift models will be available soon in the Altair program suite