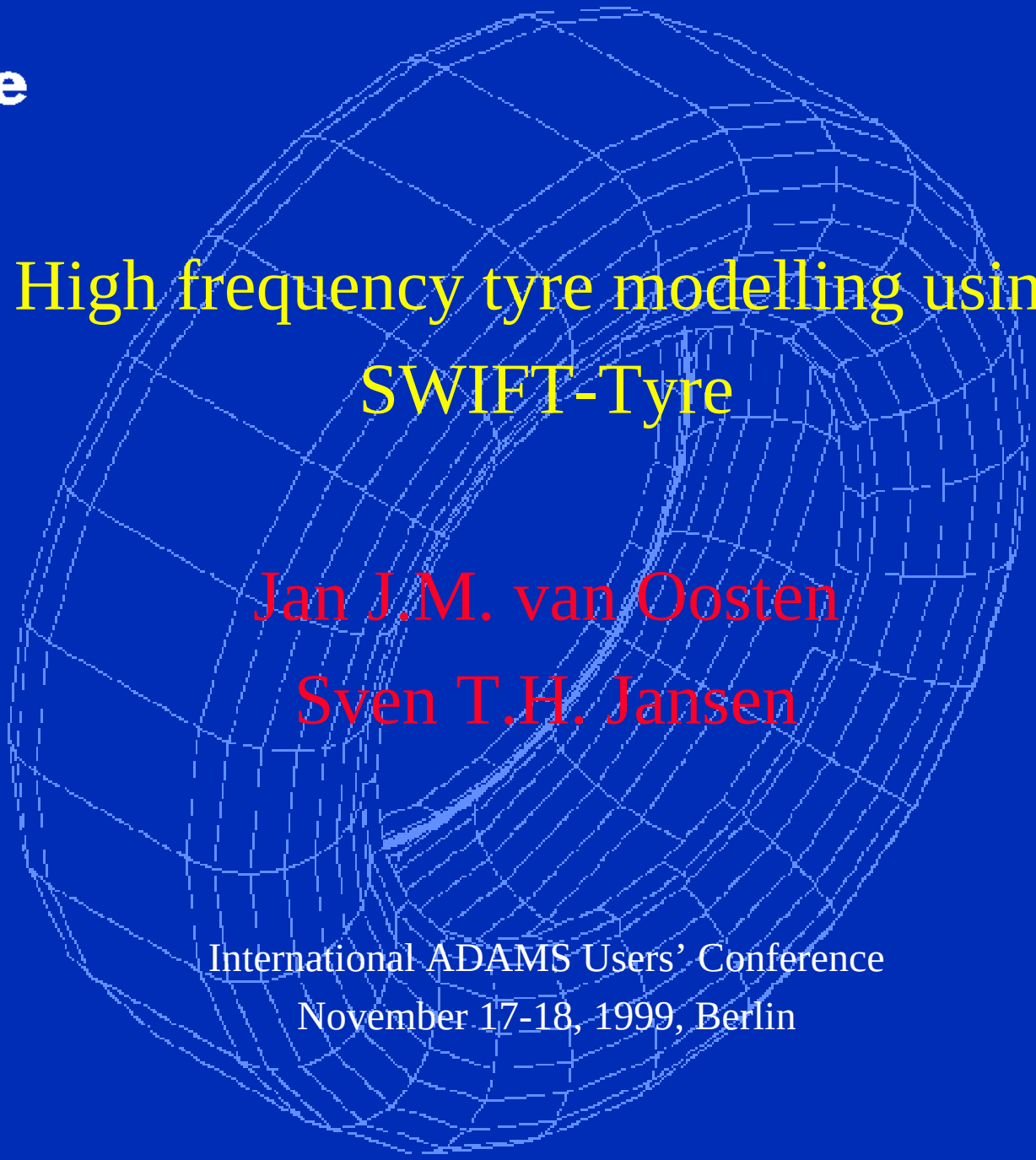
Delft-Tyre



# High frequency tyre modelling using SWIFT-Tyre

Jan J.M. van Oosten

Sven T.H. Jansen

International ADAMS Users' Conference

November 17-18, 1999, Berlin

TNO

Delft-Tyre

# Content

- Current DELFT-TYRE modelling
- SWIFT-Tyre
  - the objectives
  - the model
  - experiments
  - validation
- SWIFT modelling in ADAMS
- Availability

TNO

Delft-Tyre

# DELFT-TYRE

## current tools

Magic Formula tyre modelling for vehicle handling studies up to 8 Hz:

- MF-Tyre in ADAMS/Tire & ADAMS/Car
- MF-MCTyre (motorcycle tyres)
- MF-Tool, MF-Fit
- MF-MCTool, MF-MCFit

TNO

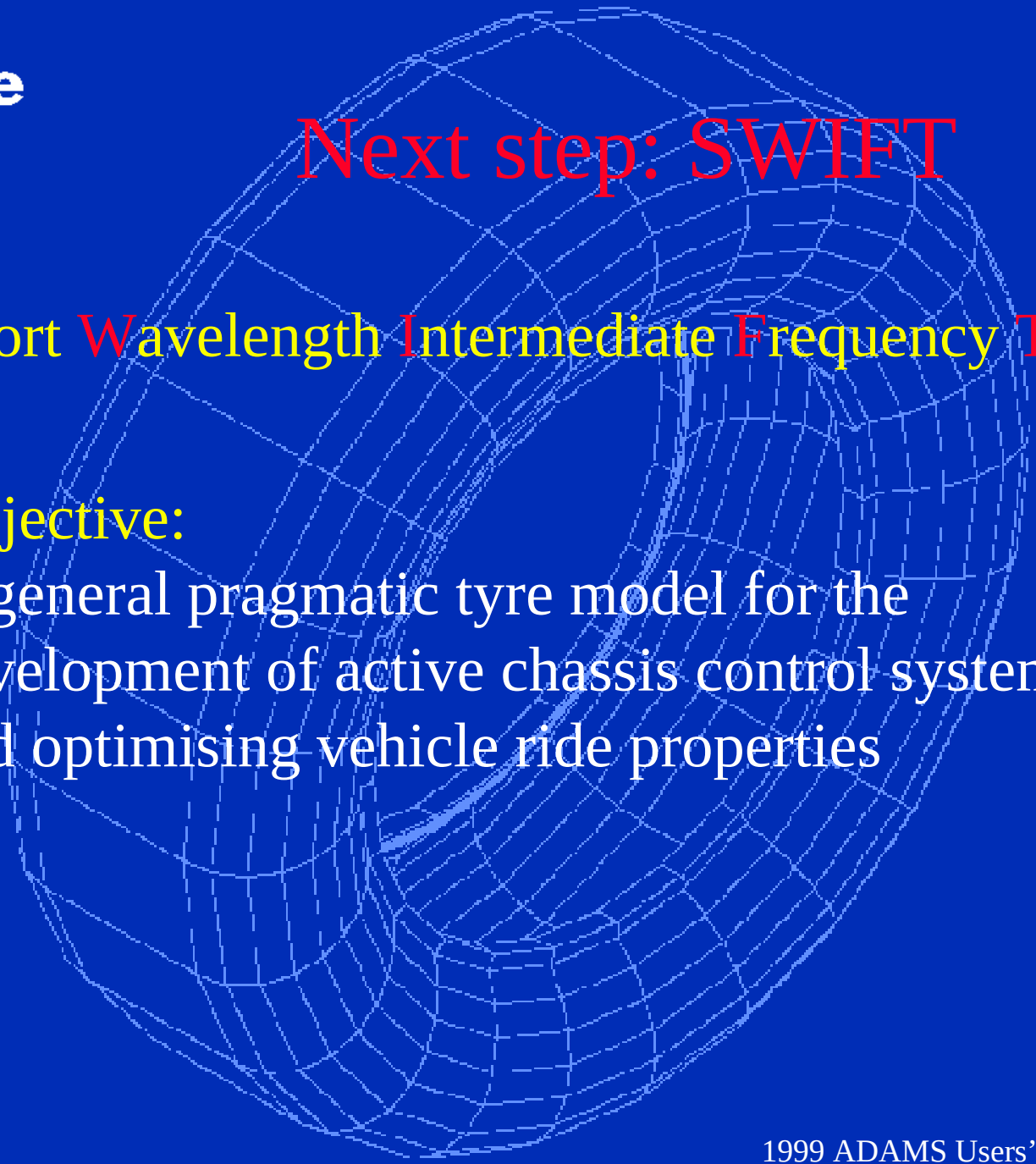
Delft-Tyre

# Next step: SWIFT

Short Wavelength Intermediate Frequency Tyre

Objective:

A general pragmatic tyre model for the development of active chassis control systems and optimising vehicle ride properties

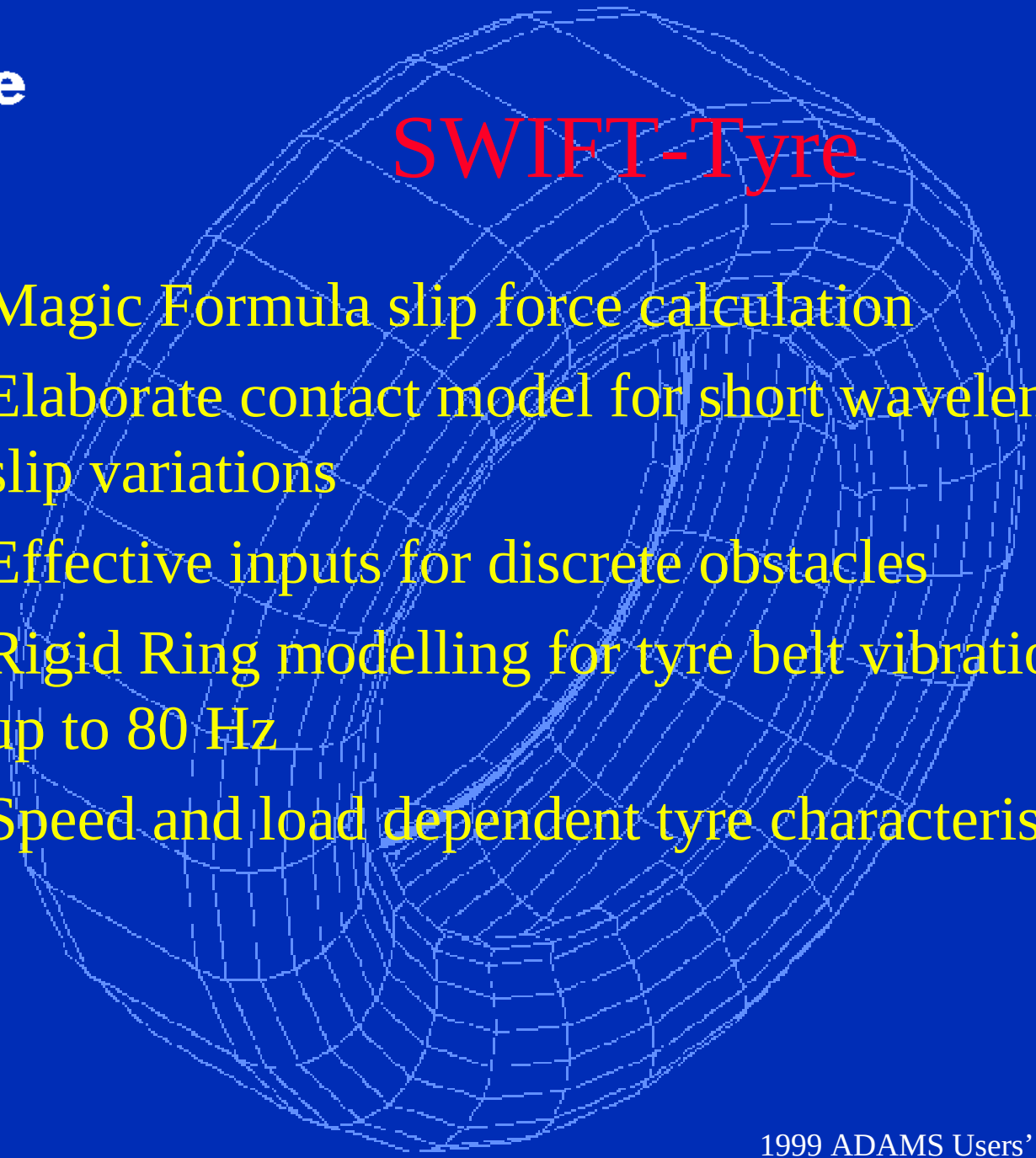


TNO

Delft-Tyre

# SWIFT-Tyre

- Magic Formula slip force calculation
- Elaborate contact model for short wavelength slip variations
- Effective inputs for discrete obstacles
- Rigid Ring modelling for tyre belt vibrations up to 80 Hz
- Speed and load dependent tyre characteristics



TNO

Delft-Tyre

# SWIFT-Tyre
## applications

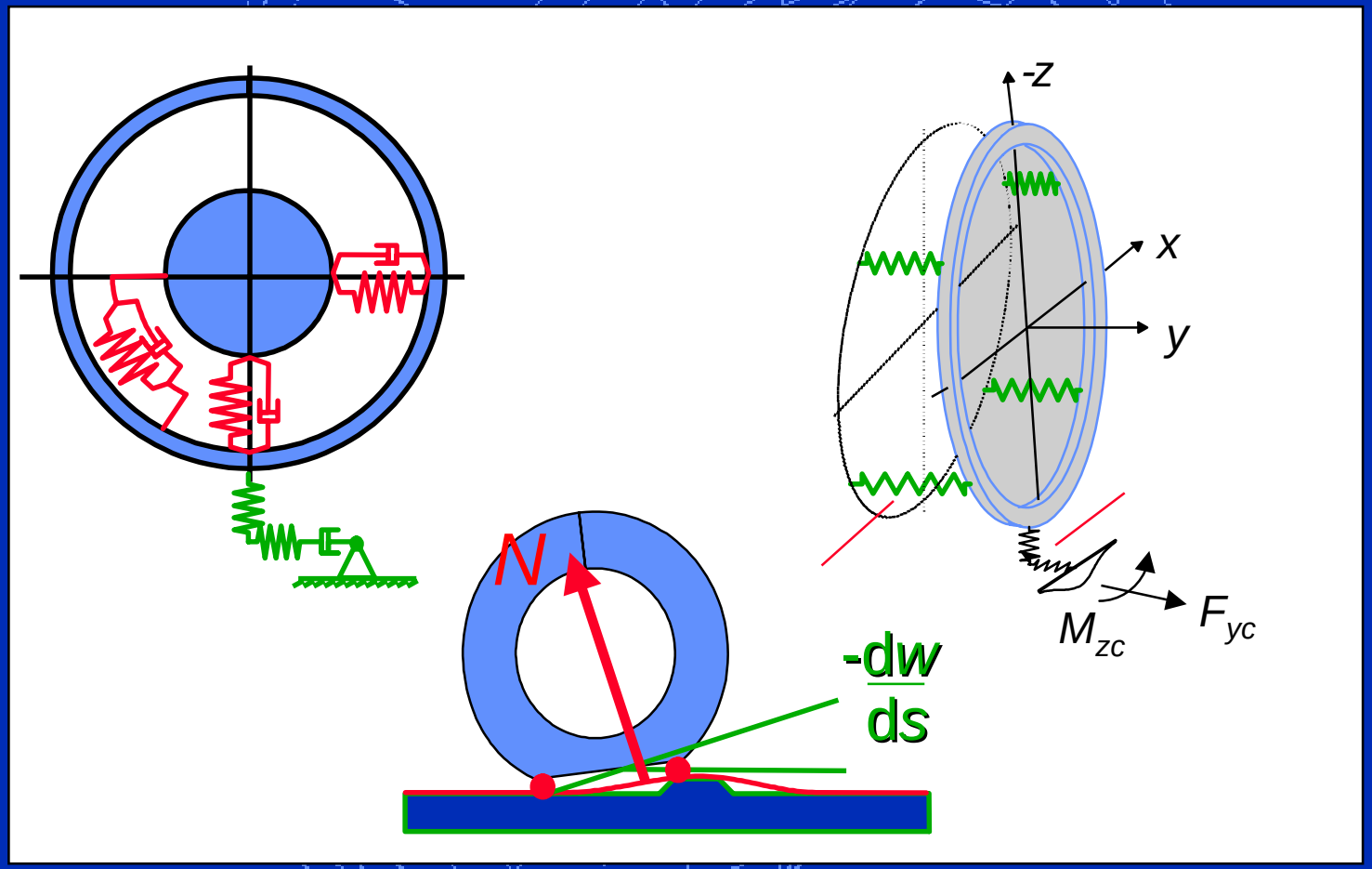
- Ride comfort & vibrations
- Dynamic braking/driving (ABS/TCS)
- Vehicle Dynamic Control (VDC/ESP)
- Vehicle suspension and steering system design:
  combined dynamic braking, cornering and ride
- 4 post rig ride testing
- ...

TNO

Delft-Tyre

# SWIFT-Tyre

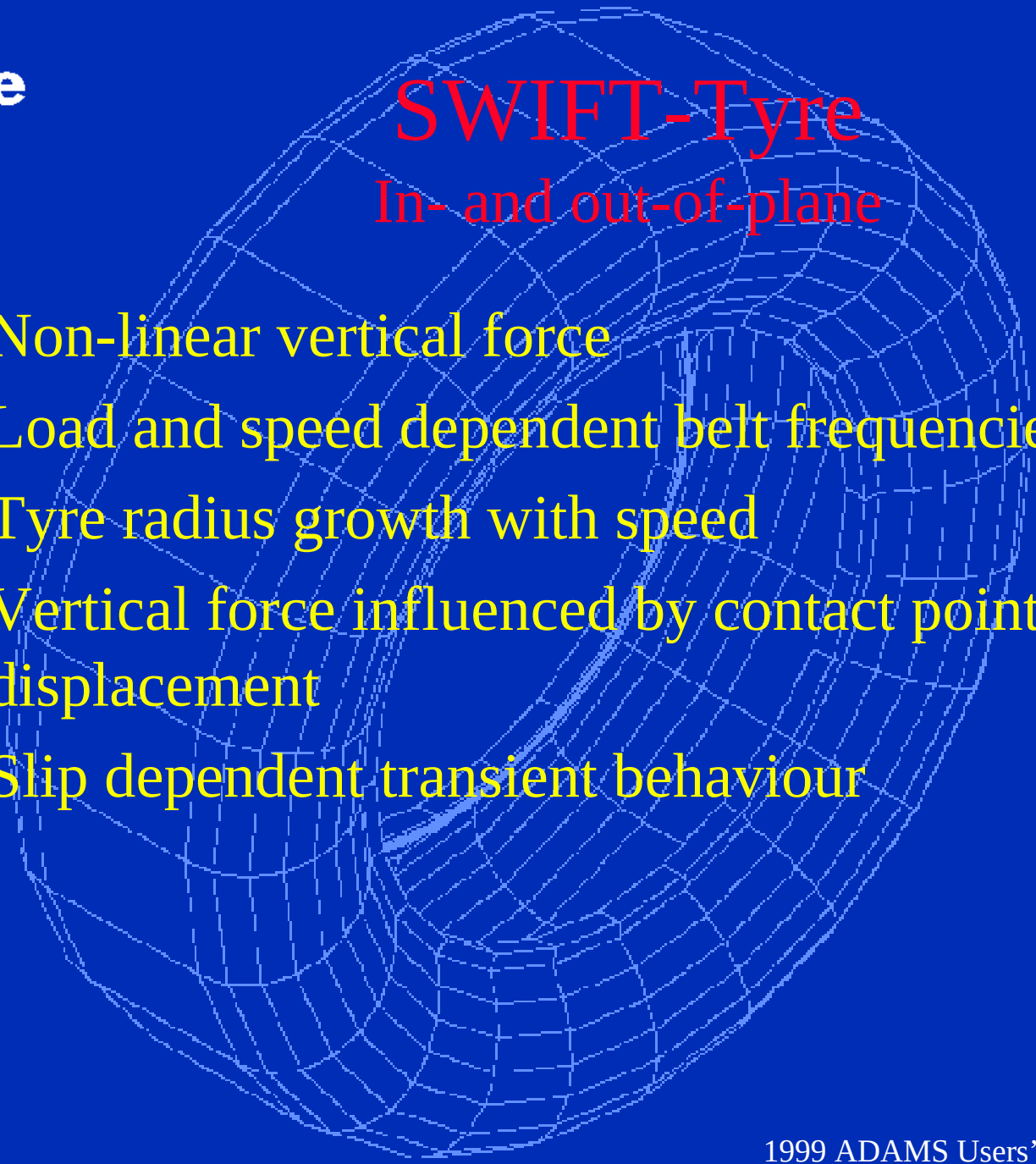
## Model description



Delft-Tyre

# SWIFT-Tyre

## In- and out-of-plane

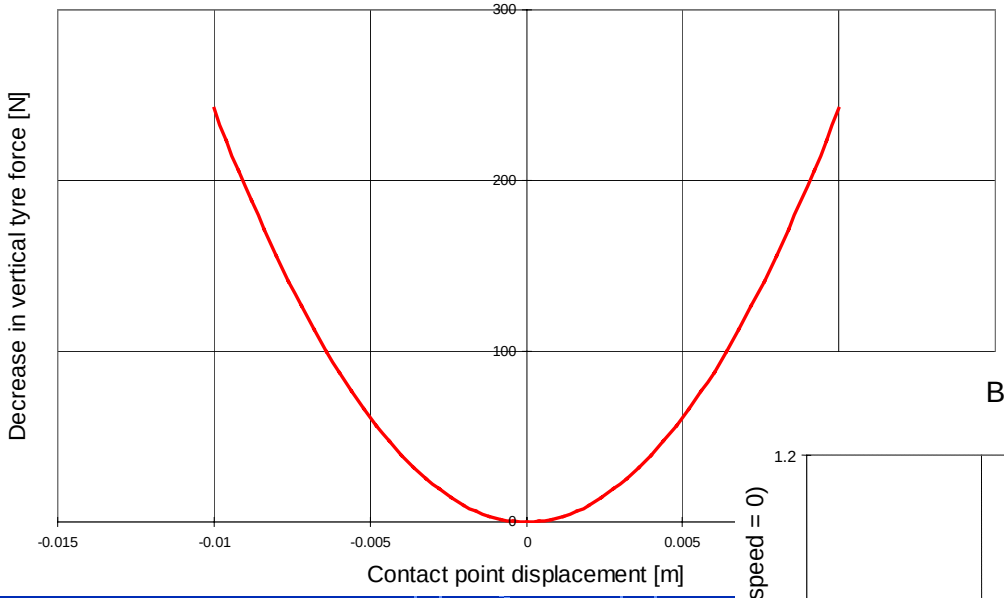


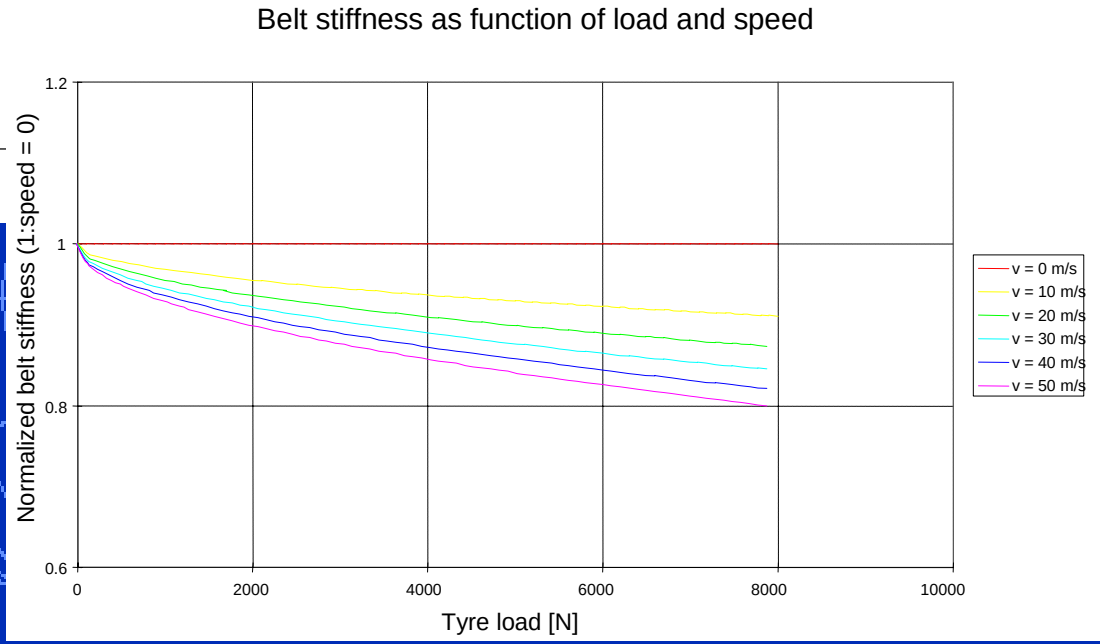
- Non-linear vertical force
- Load and speed dependent belt frequencies
- Tyre radius growth with speed
- Vertical force influenced by contact point displacement
- Slip dependent transient behaviour

TNO

# In- and out-of-plane

## contact point & belt stiffness



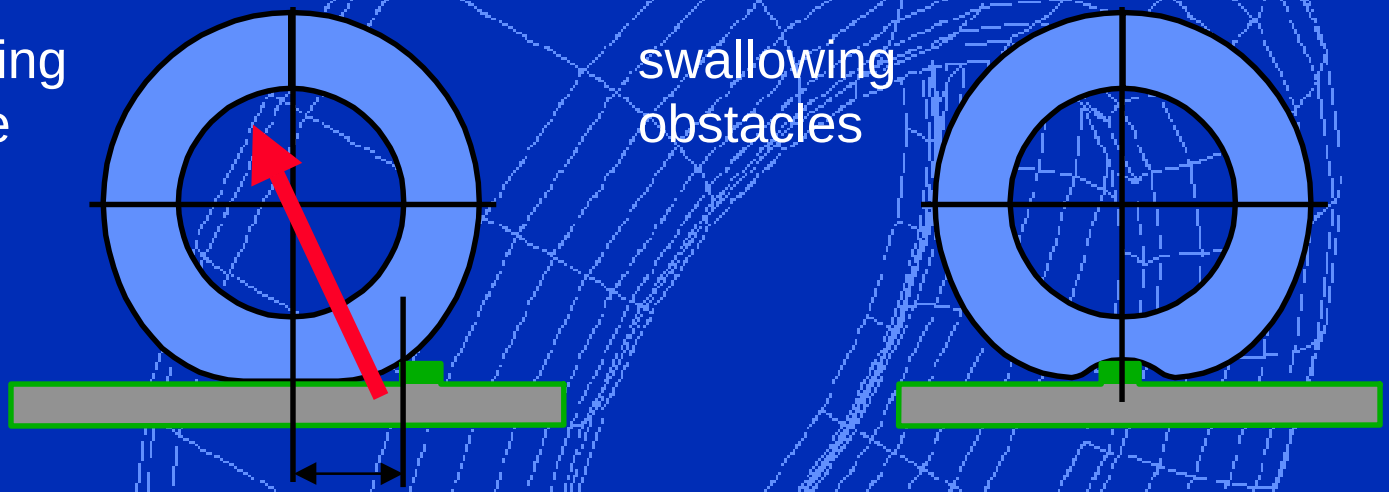
Delft-Tyre

# SWIFT-Tyre

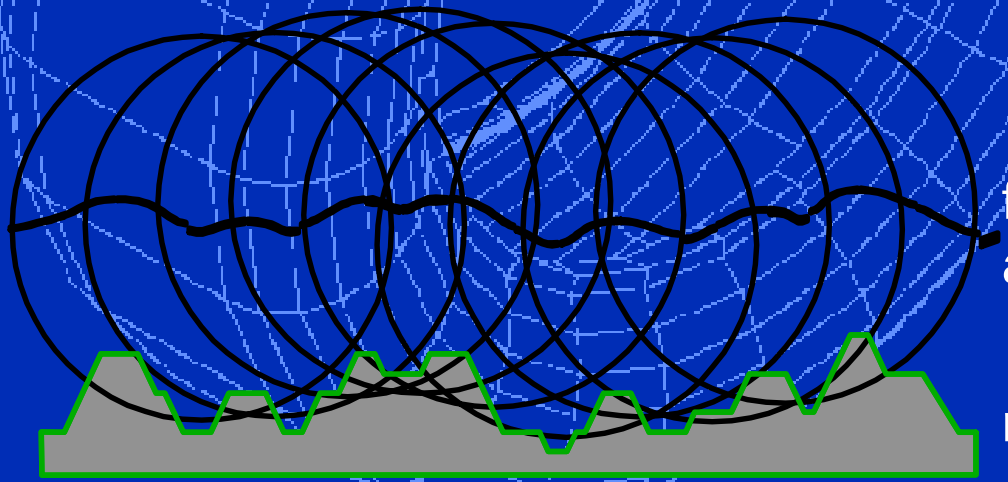
## Short obstacles (enveloping)

lengthening response

swallowing obstacles



filtering unevenesses

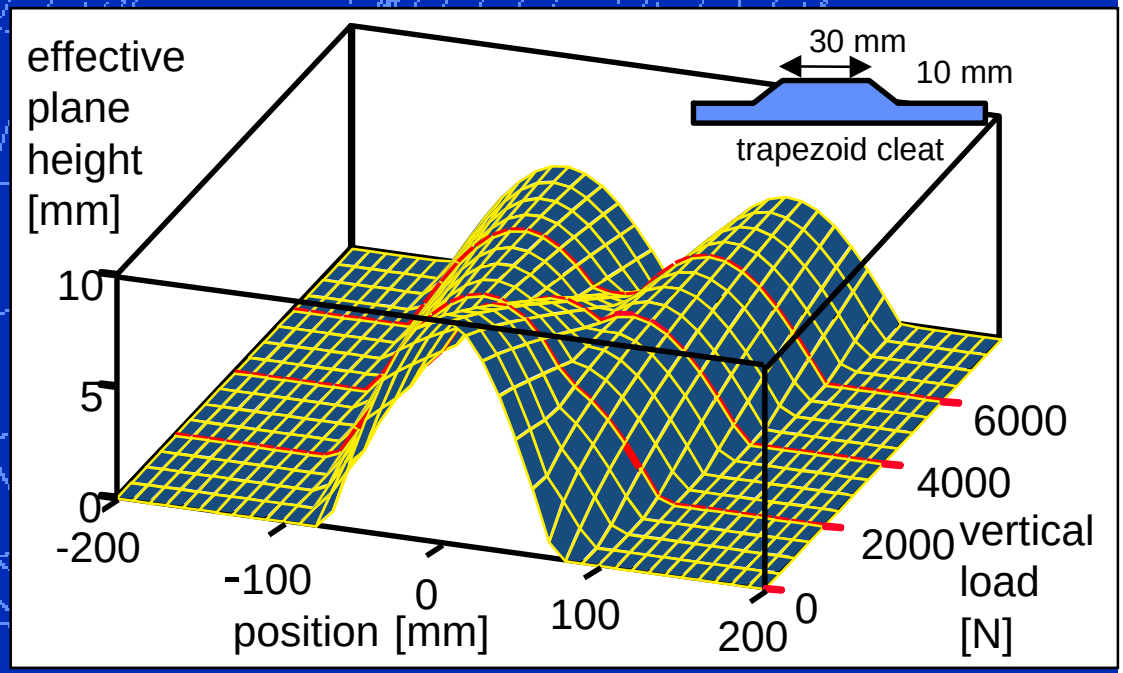



TNO

# Short obstacles

## Effective inputs

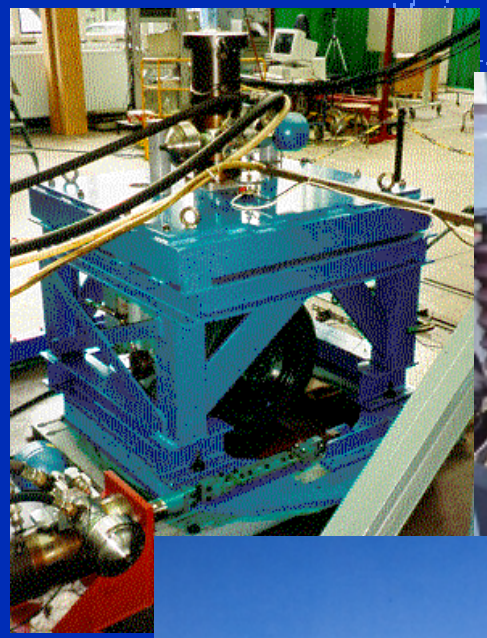
- Road profile is transferred to effective inputs
  - Effective plane height
  - Effective plane angle
- Vertical and longitudinal tyre forces
- Rolling radius variations

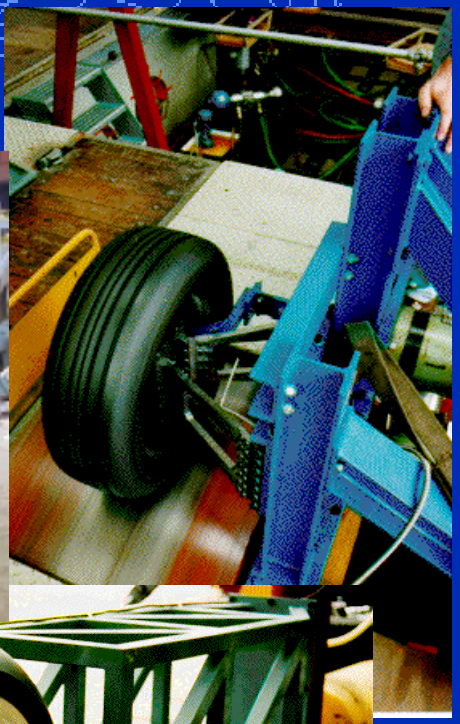


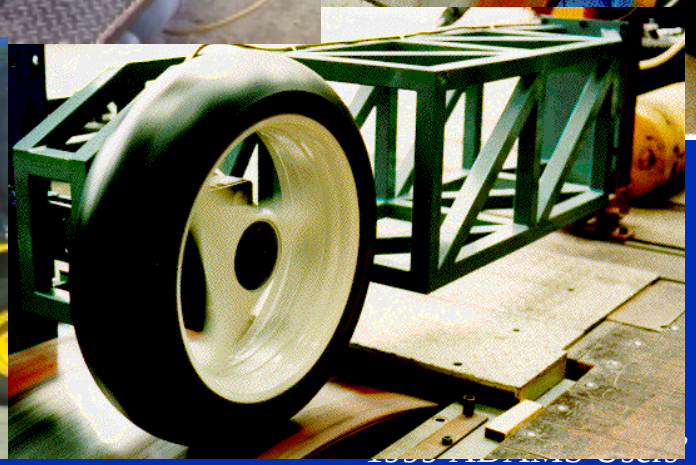
Delft-Tyre

# SWIFT-Tyre

## Experiments & Validation







Delft-Tyre

# F&M testing
## for SWIFT parameters

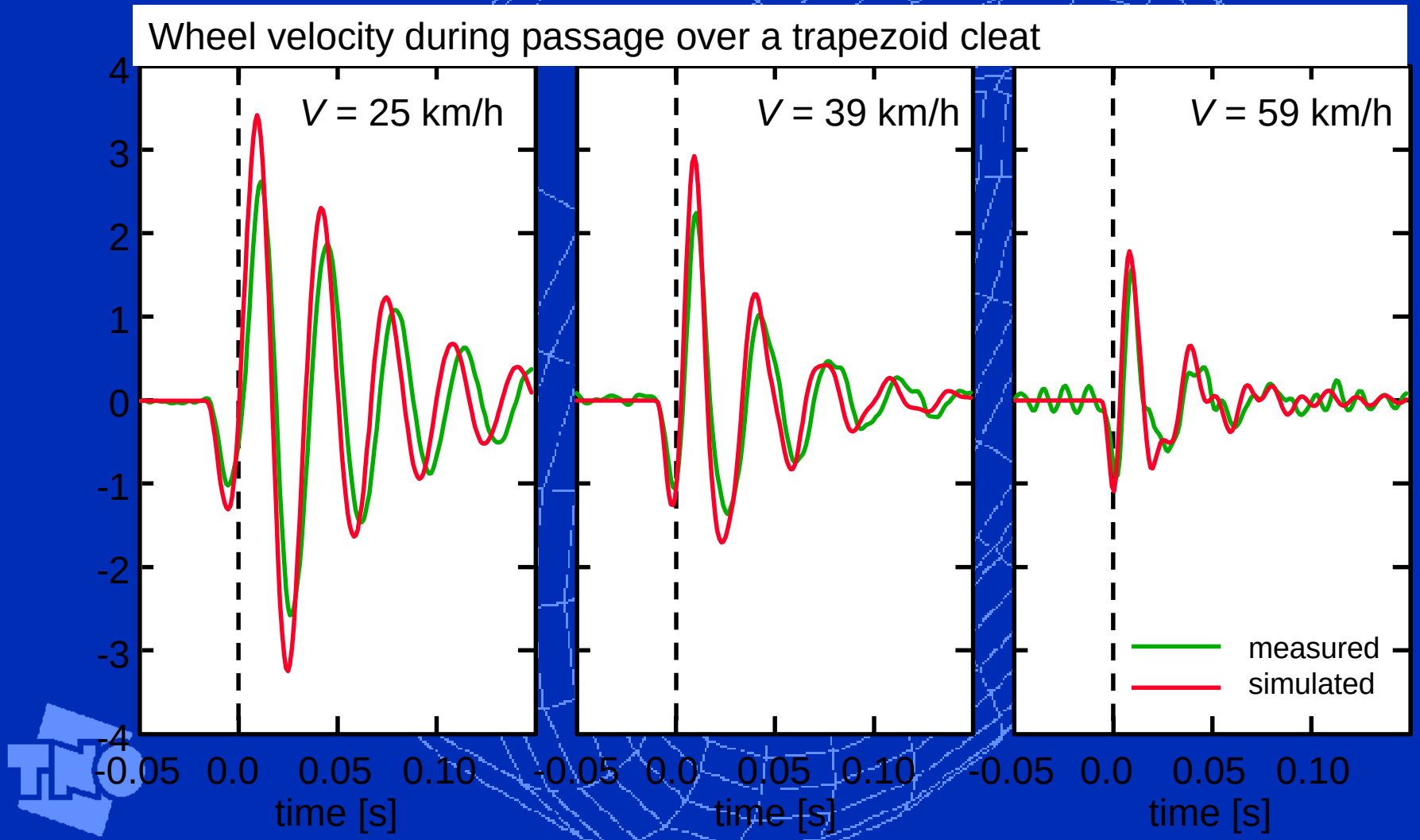
- Dynamic tyre testing for SWIFT parameters (at different loads and speeds)
  - dynamic braking
  - cleat testing
  - dynamic cornering
  - effective input tests
- Model analysis approach
  - Identified frequencies not representative for tyre behaviour under driving conditions
  - Not suitable to assess speed and load effects

TNO

Delft-Tyre

# Validation

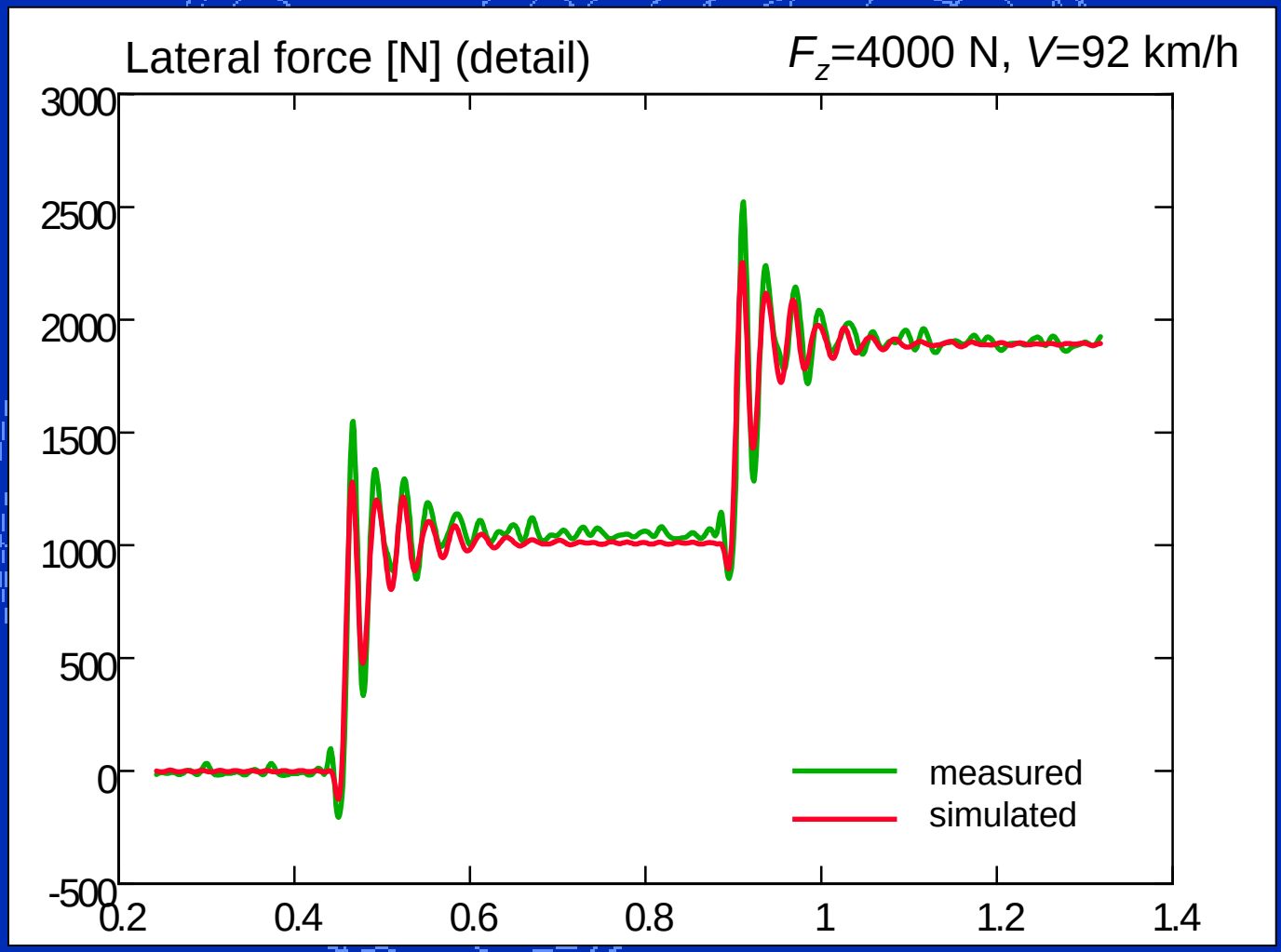
## Long. force when rolling over cleat



Delft-Tyre

# Validation

## Lateral force due to slip angle step

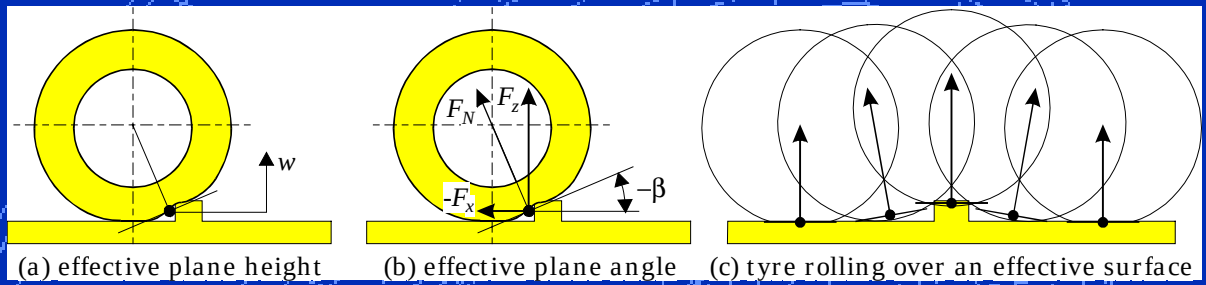



TNO

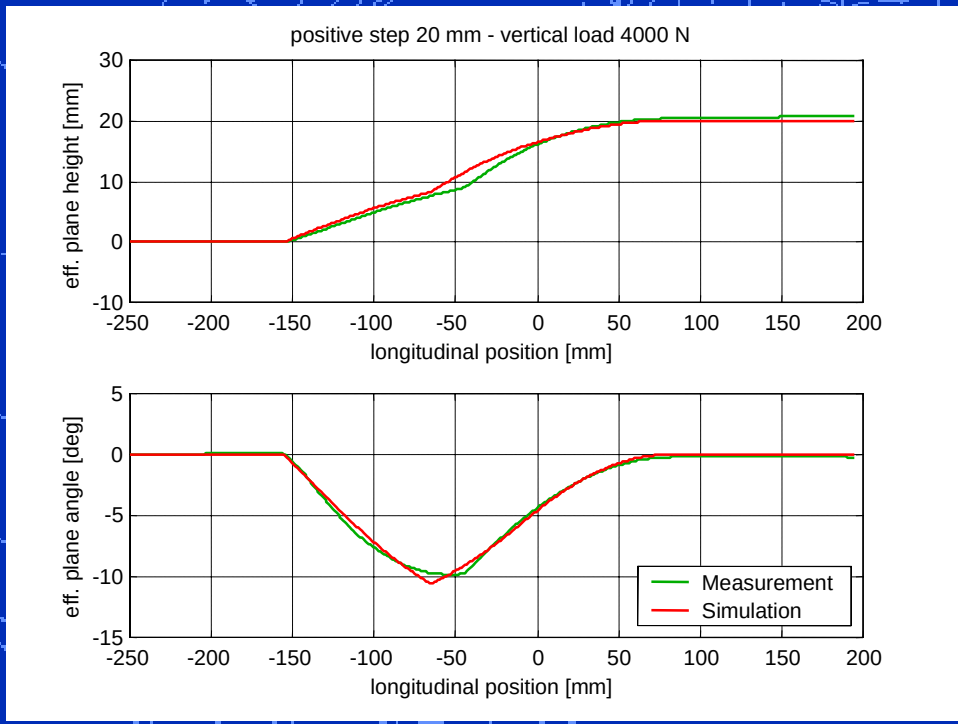
Delft-Tyre

# Validation

## Enveloping



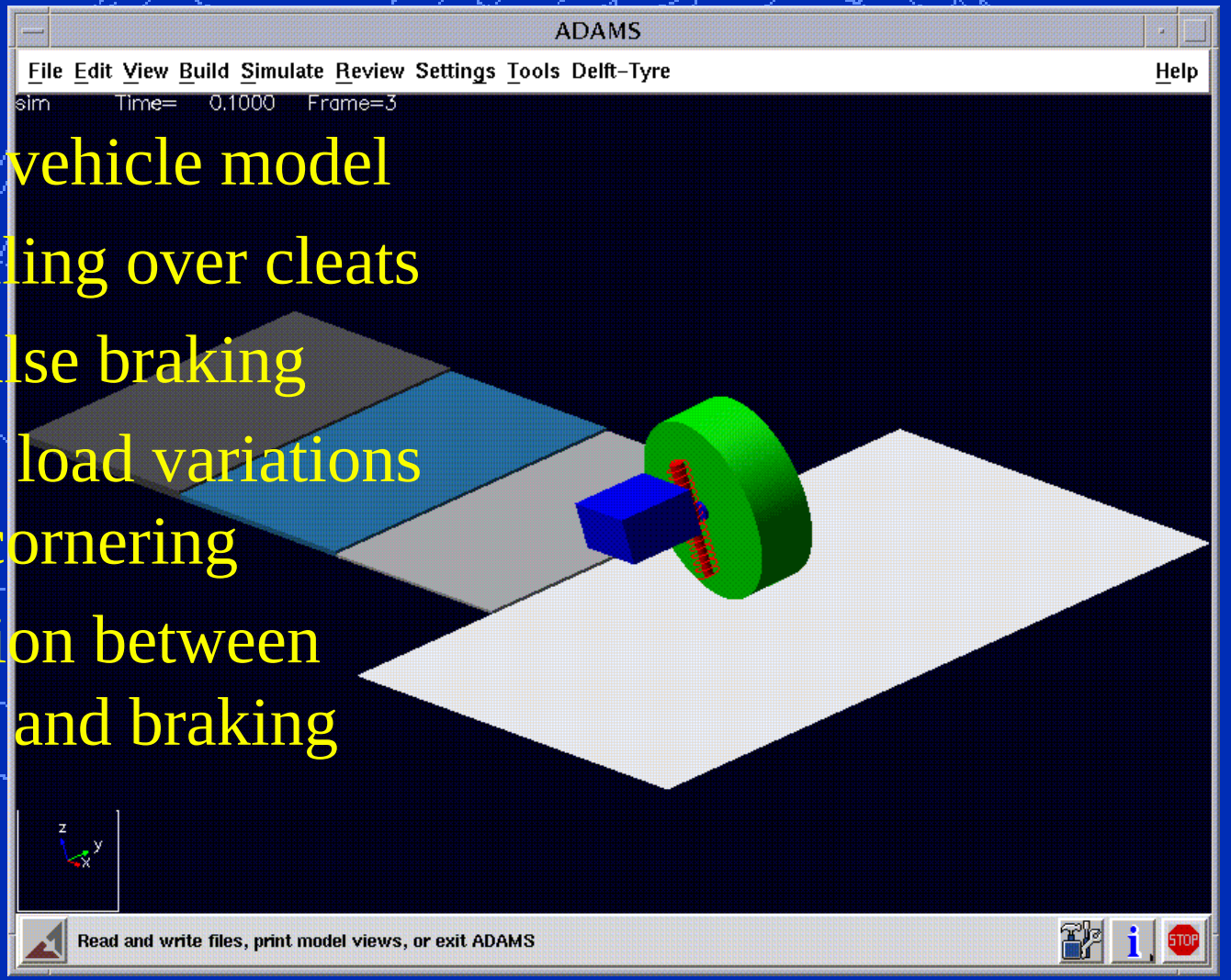

(a) effective plane height (b) effective plane angle (c) tyre rolling over an effective surface



# SWIFT in ADAMS

## example

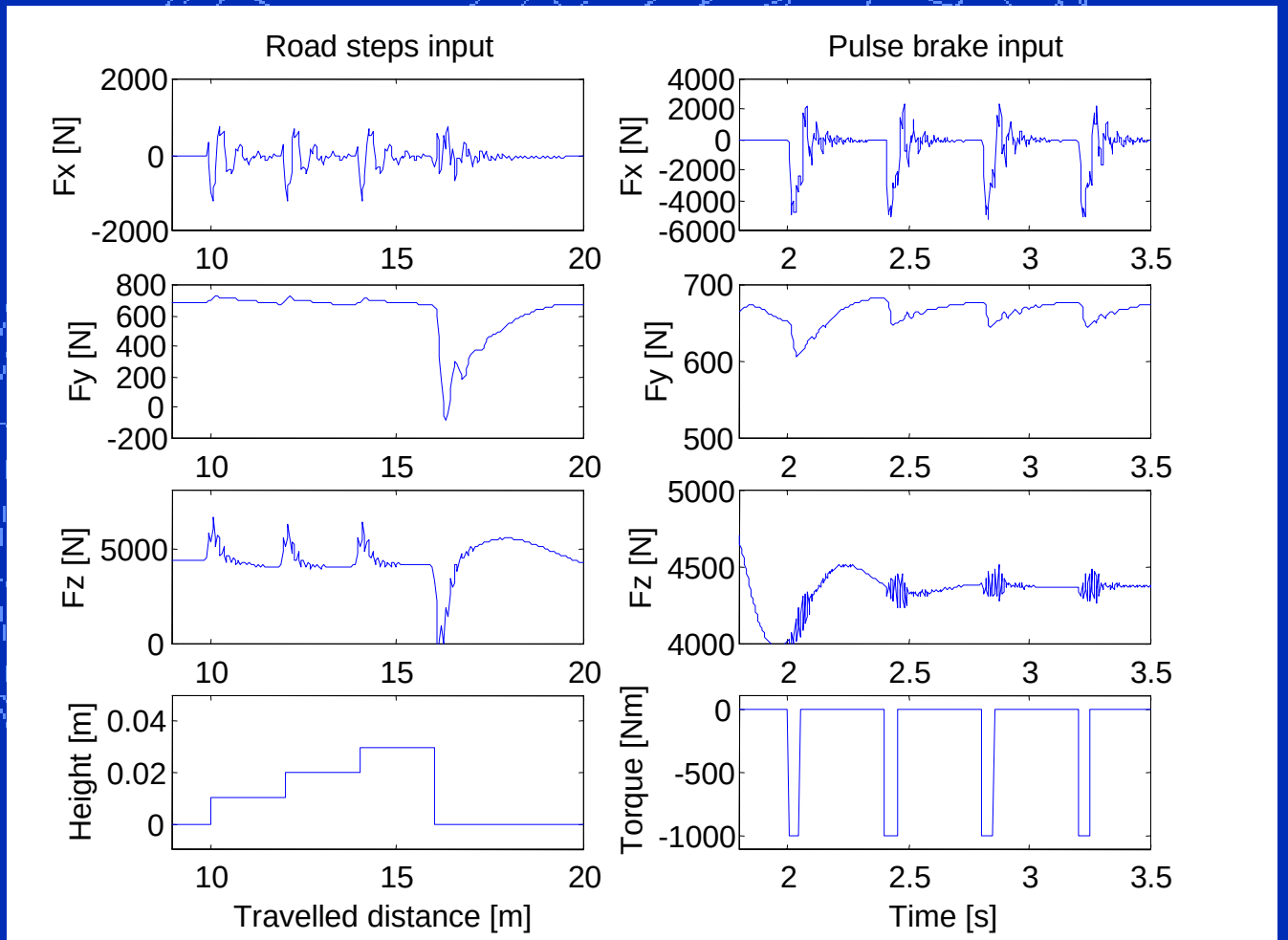
- Quarter vehicle model
- Tyre rolling over cleats
- ABS-pulse braking
- Vertical load variations during cornering
- Interaction between steering and braking forces



Delft-Tyre

# SWIFT in ADAMS

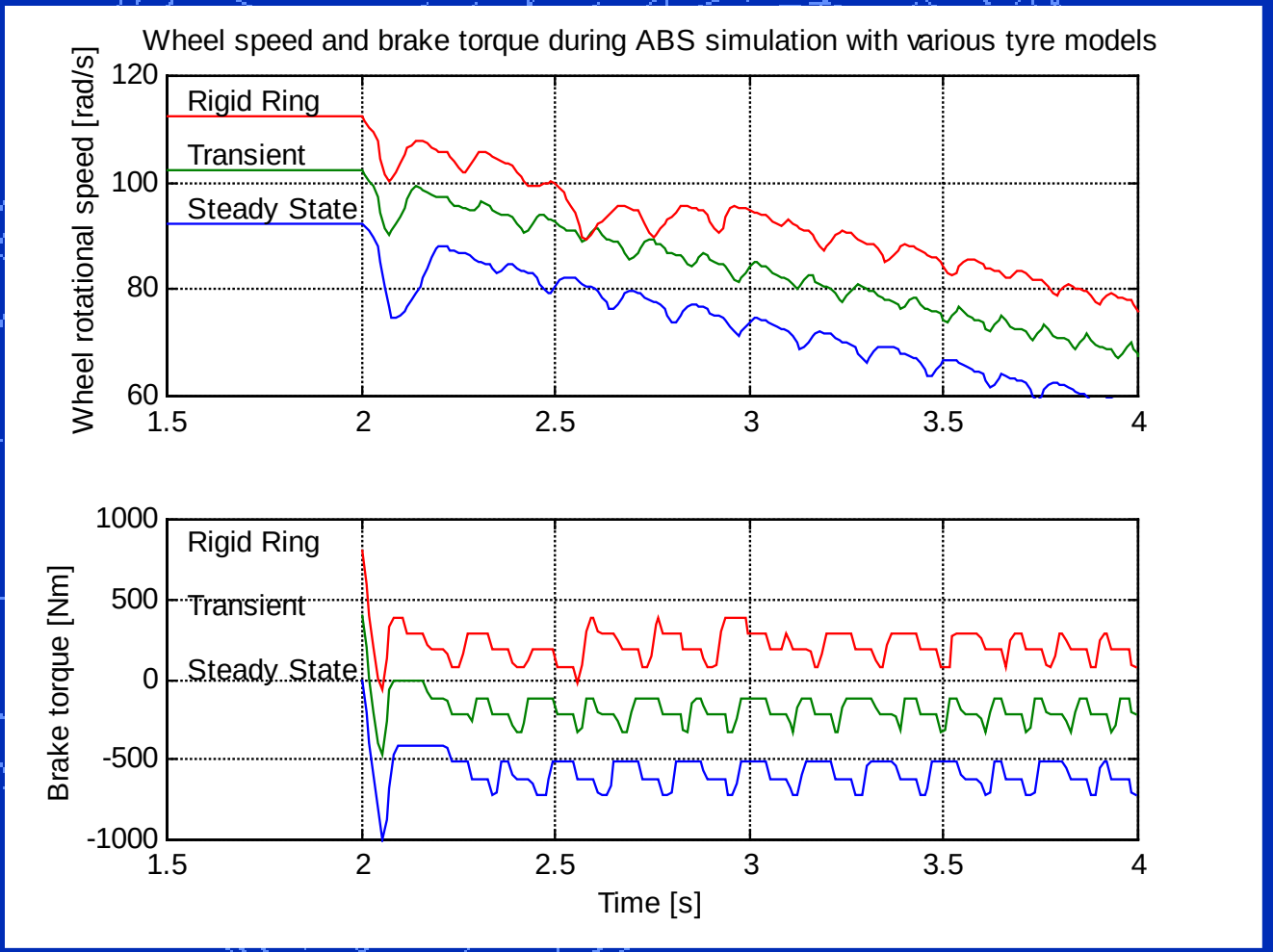
## example



Delft-Tyre

# ABS simulation

## comparison of tyre models




TNO

Delft-Tyre

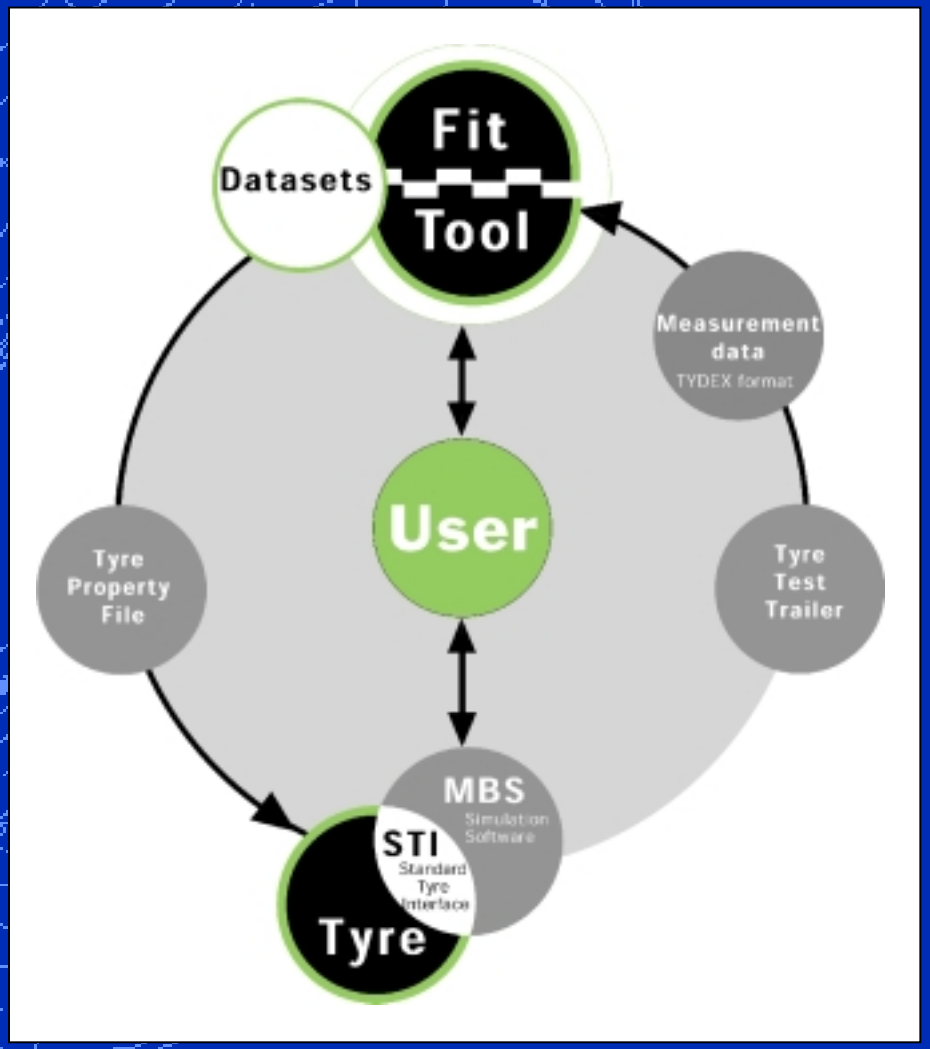
# Availability

Now:

- SWIFT-Tyre
- SWIFT-Datasets

First half 2000:

- SWIFT-Tool
- SWIFT-Fit




TNO