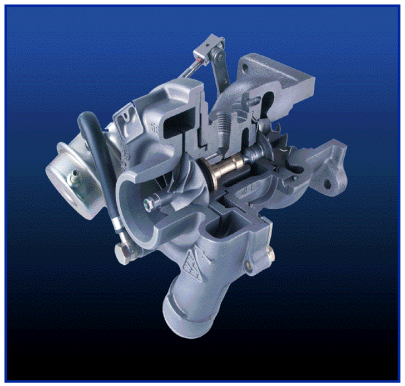
Thomas Buchholz
BorgWarner Cooling Systems

Verification of road tests on the chassis dynamometer and by using KULI

BorgWarner Operations

Morse TEC/Chain and



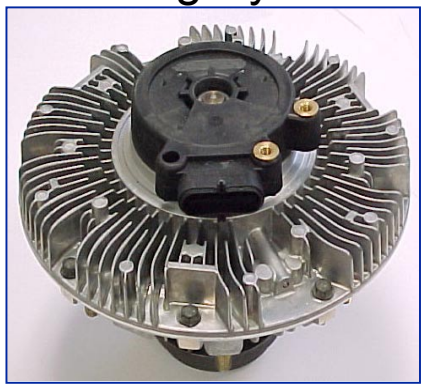
Turbo Systems

TorqTransfer Systems

Air/Fluid Systems

Transmission Systems

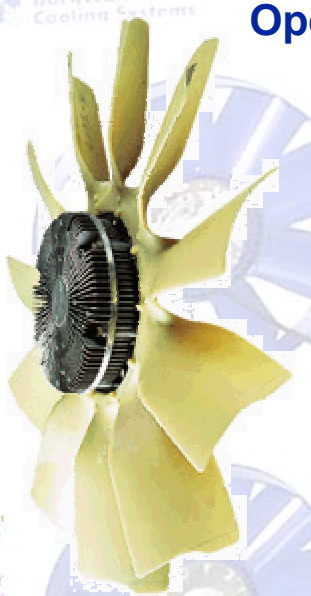
Cooling Systems



Verification of road tests on the chassis dynamometer and by simulation using KULI

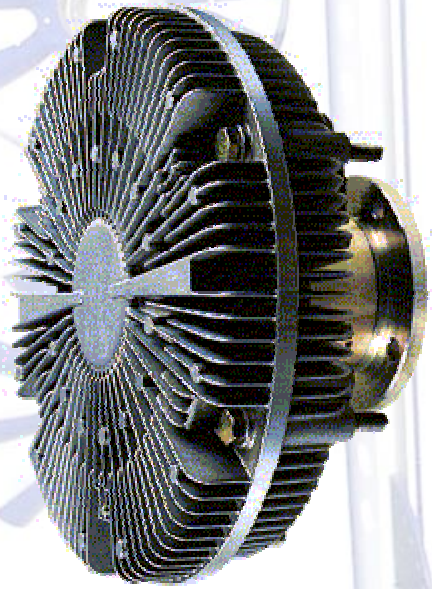
BorgWarner Cooling Systems

Products:



Open Fans

Ring Fans



Electrically controlled
Viscous Fan Drives

Bimetal controlled
Viscous Fan Drives

Verification of road tests on the chassis dynamometer and by simulation using KULI

BorgWarner Cooling Systems

Location Germany

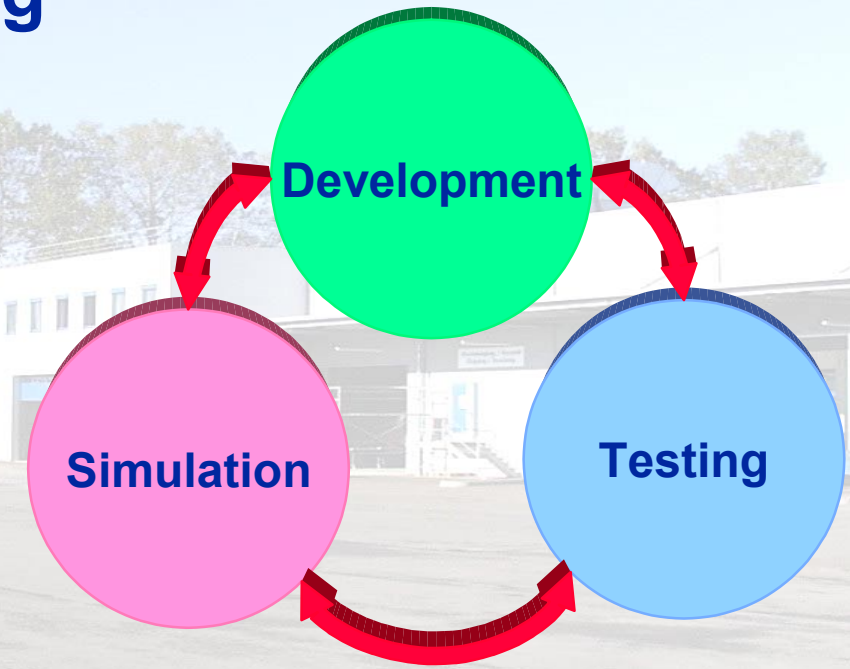
Verification of road tests on the chassis dynamometer and by simulation using KULI

BorgWarner Cooling Systems

- Development of mechatronic components
- Development of control software and strategies
- Development of cooling systems

System Engineering

- BorgWarner Software Tools
- Simulink
- KULI
- CFD Tools

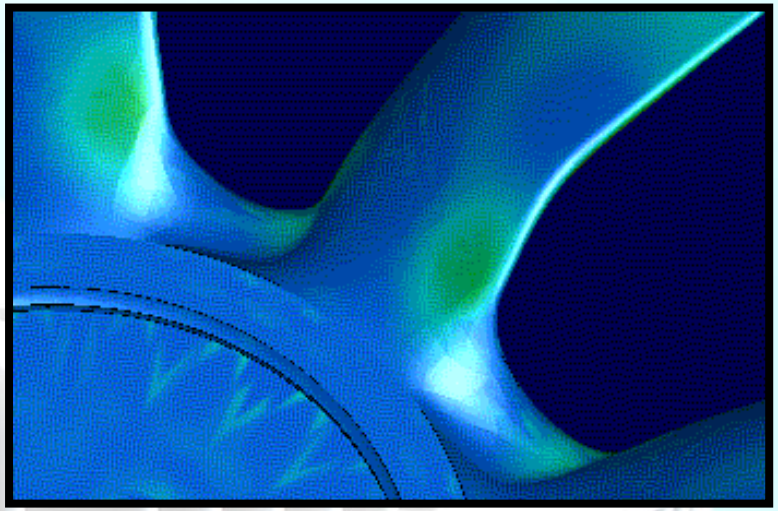


- Road / Field Invehicle Tests
- Tests in Chassis Dynamometer
- Tests in Component Test Benches (Fullambient Tester)

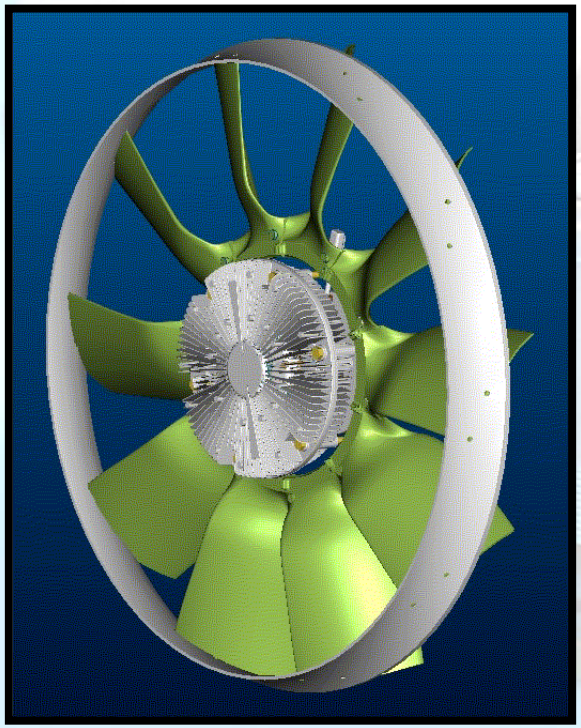
Verification of road tests on the chassis dynamometer and by simulation using KULI

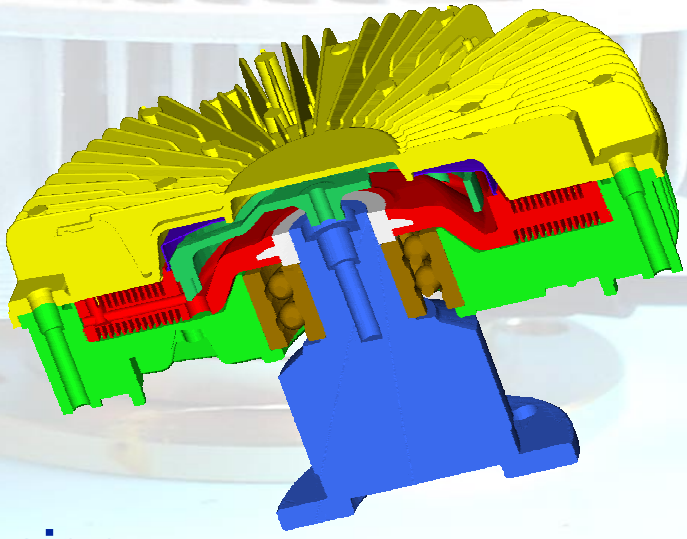
BorgWarner Cooling Systems

Development

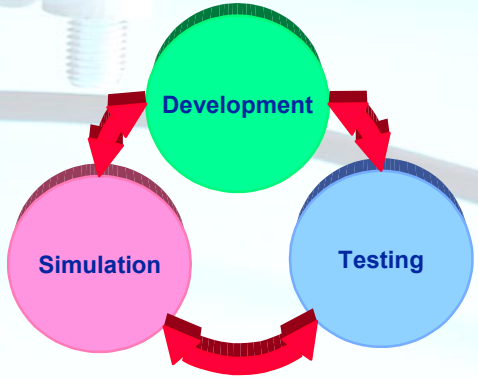


FEA





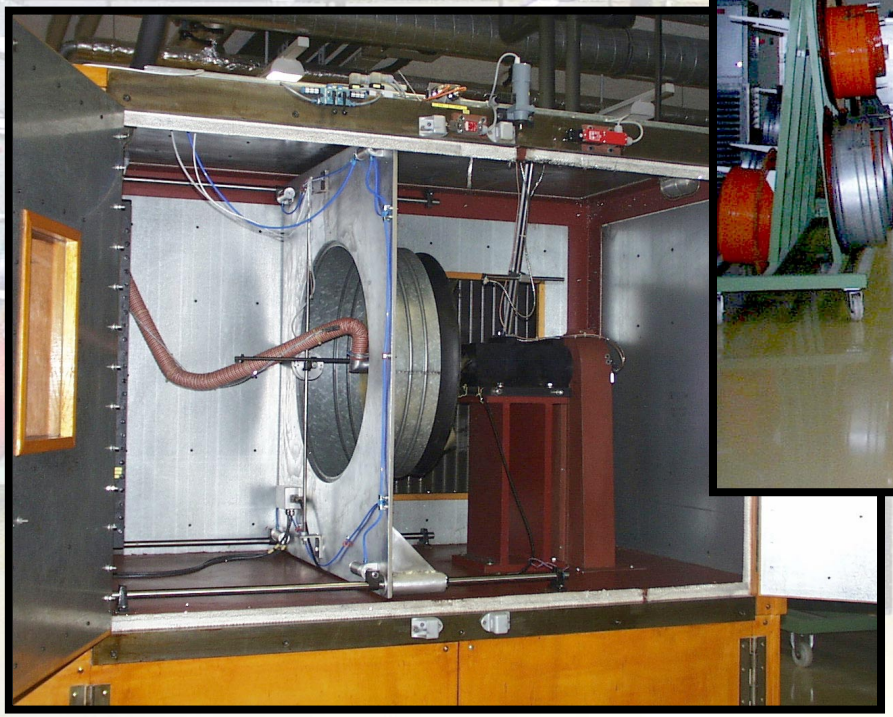
CAD Design

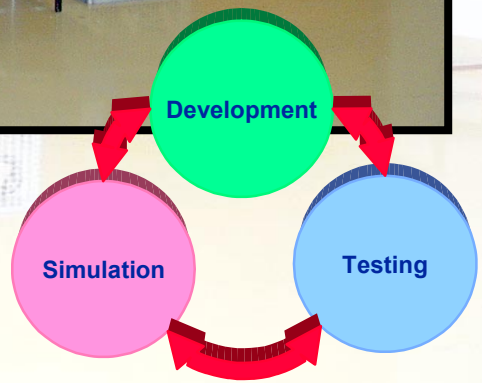


Verification of road tests on the chassis dynamometer and by simulation using KULI

BorgWarner Cooling Systems

Component testing

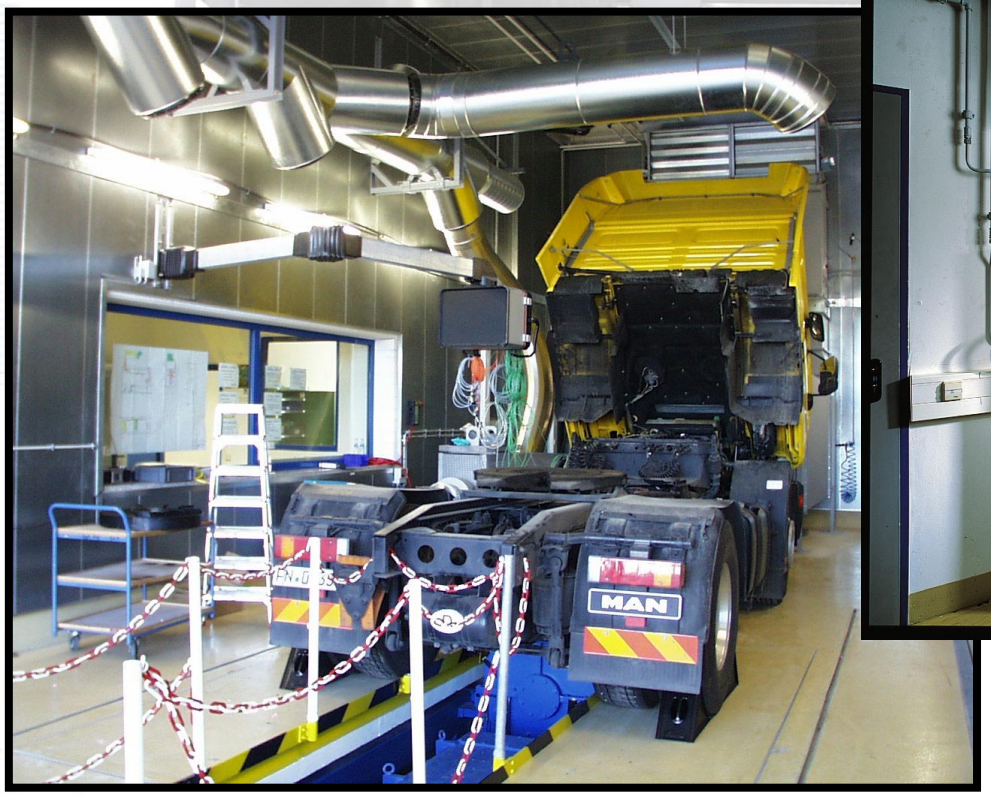


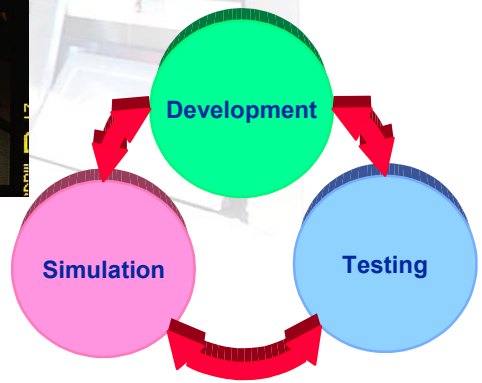


Verification of road tests on the chassis dynamometer and by simulation using KULI

BorgWarner Cooling Systems

Vehicle testing

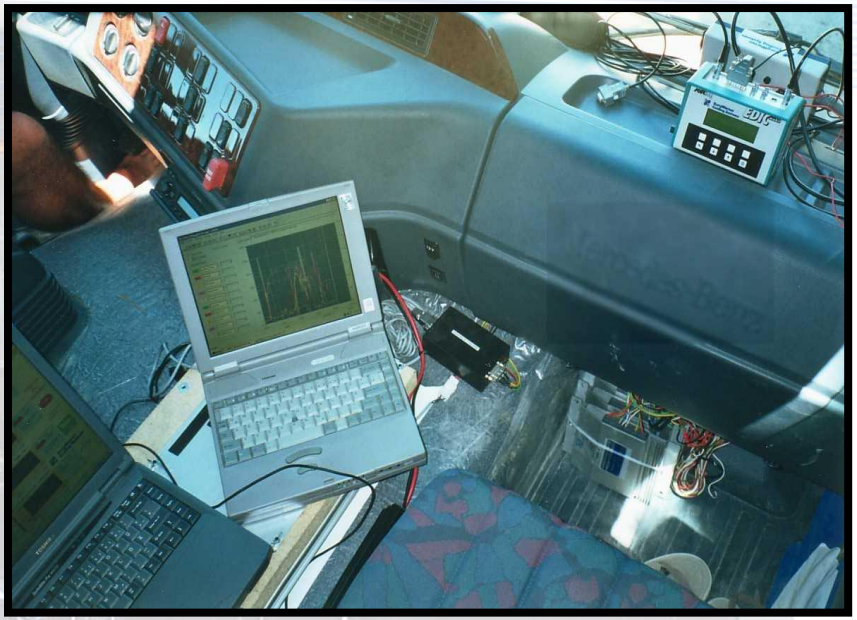


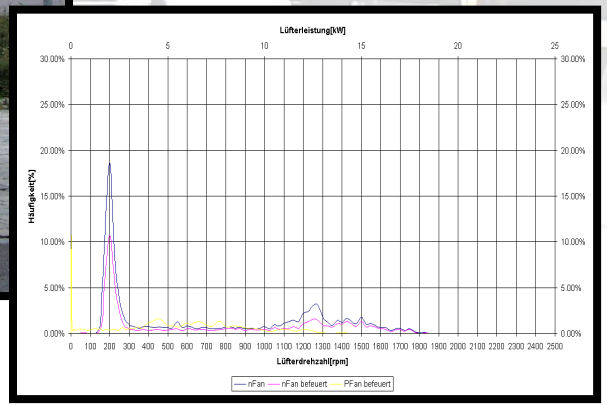


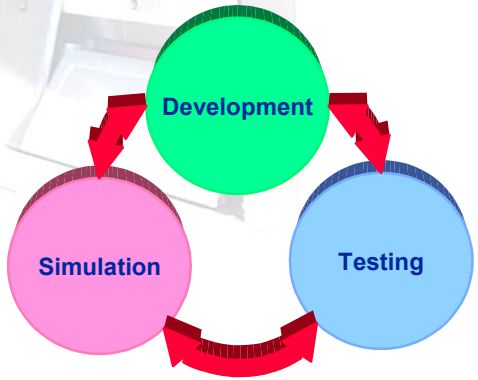
Verification of road tests on the chassis dynamometer and by simulation using KULI

BorgWarner Cooling Systems

Vehicle testing



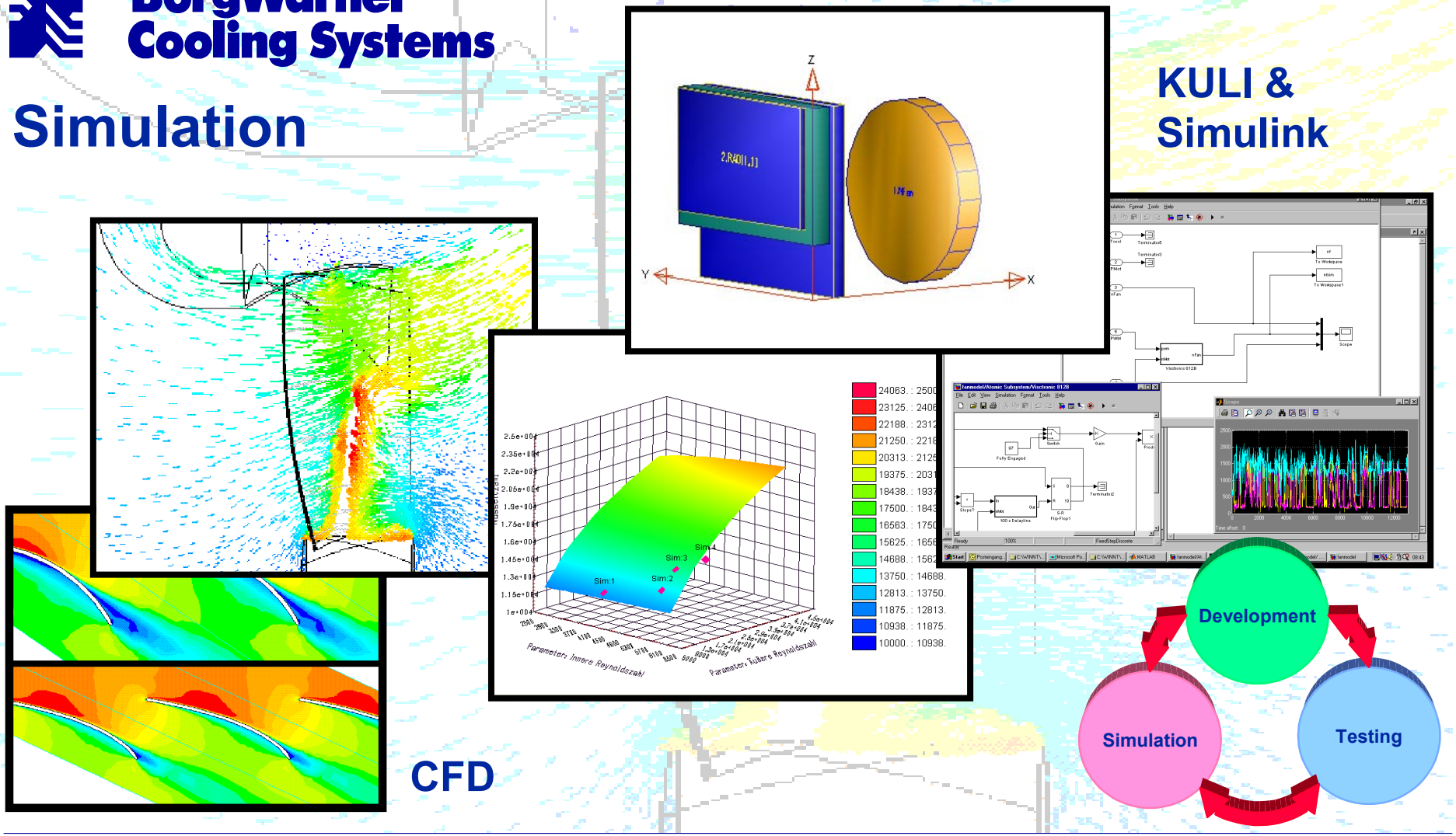




Verification of road tests on the chassis dynamometer and by simulation using KULI

BorgWarner Cooling Systems

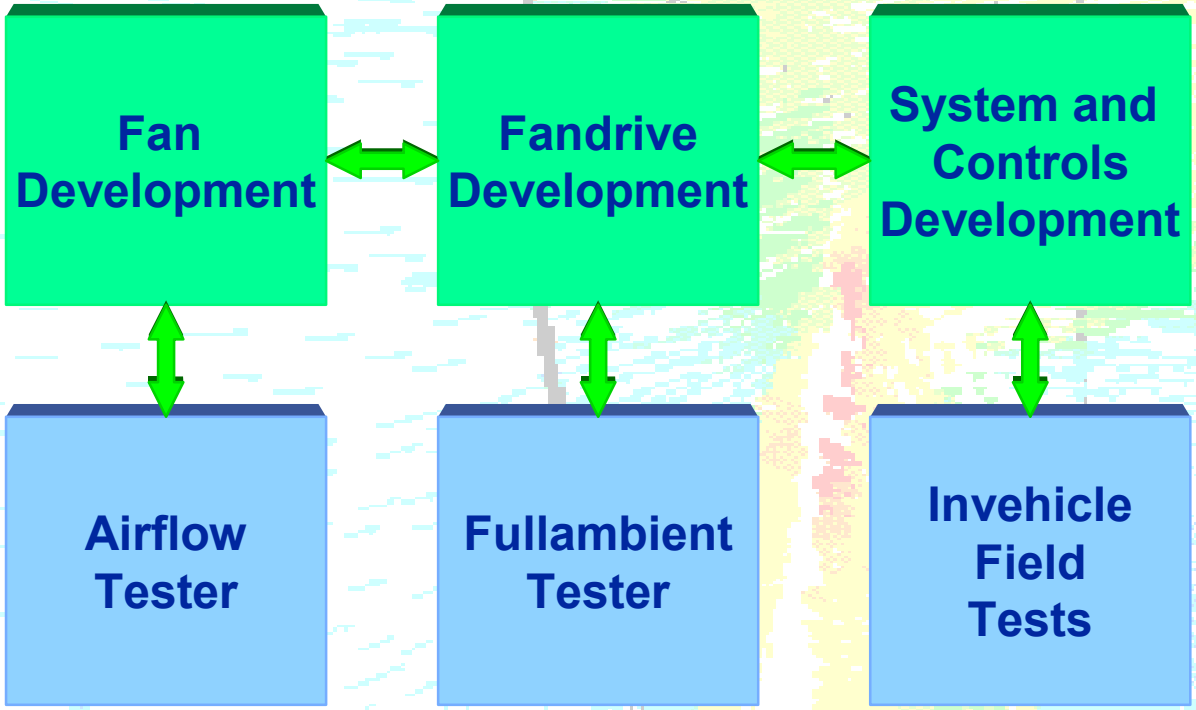
Simulation



KULI & Simulink

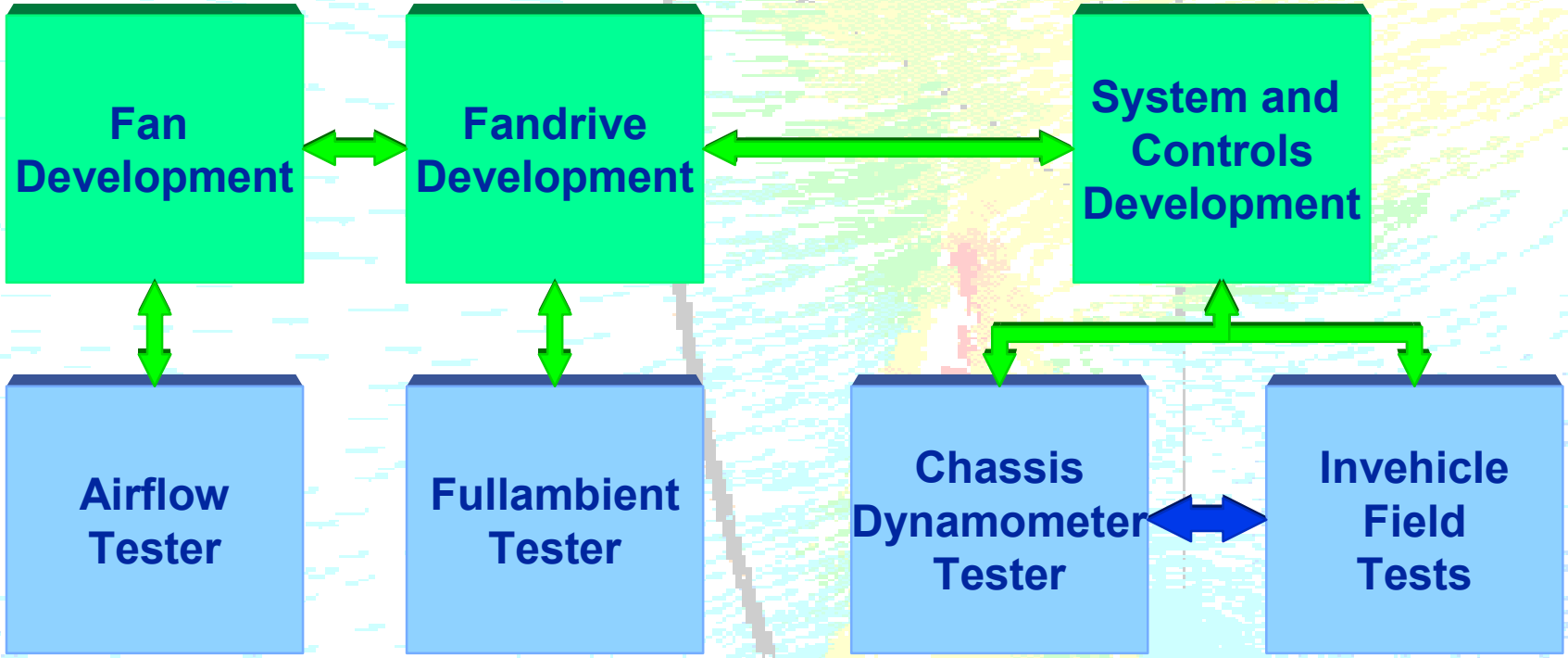
CFD

Traditional development process



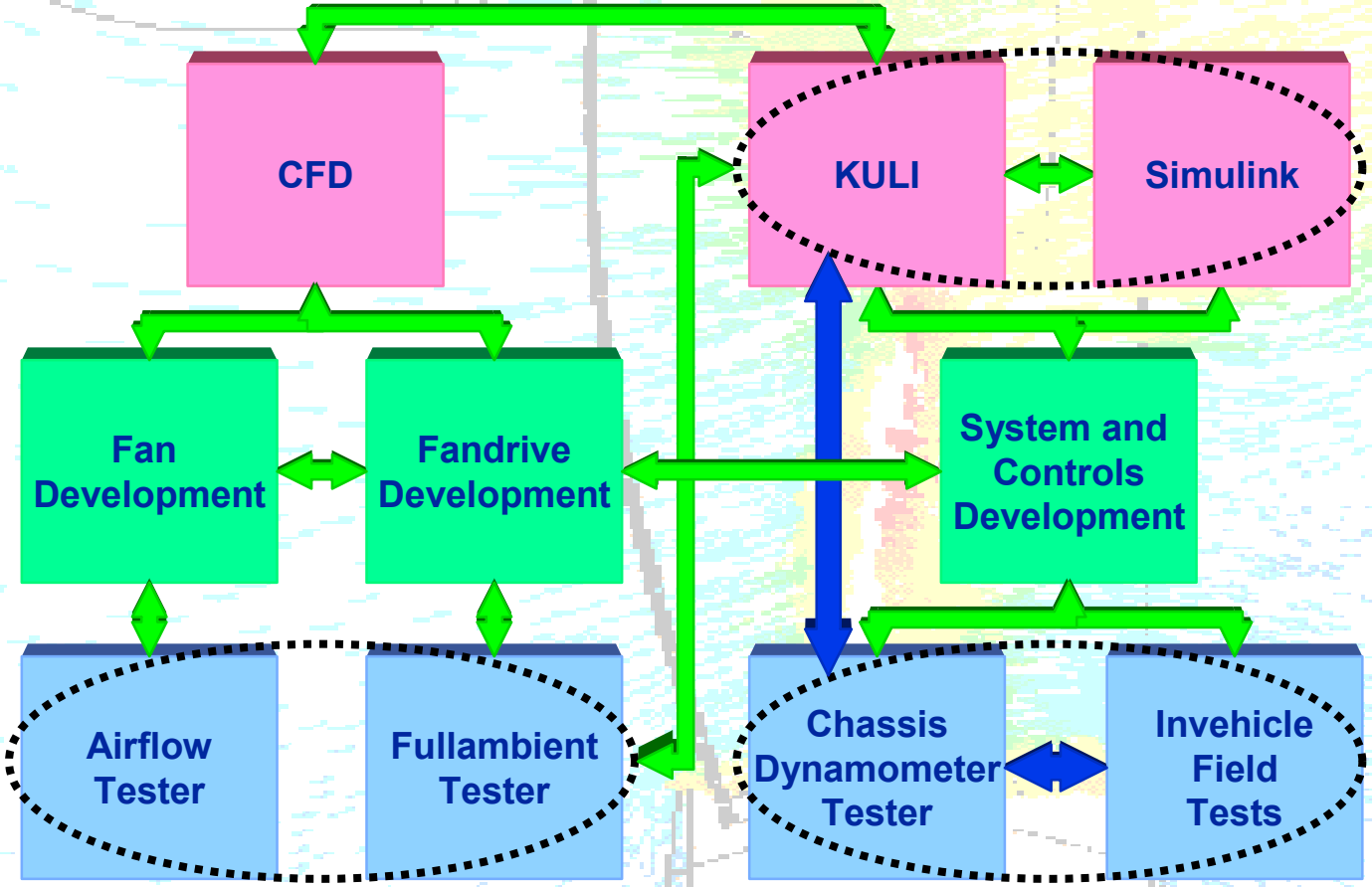
Verification of road tests on the chassis dynamometer and by simulation using KULI

Development process using new testing facilities

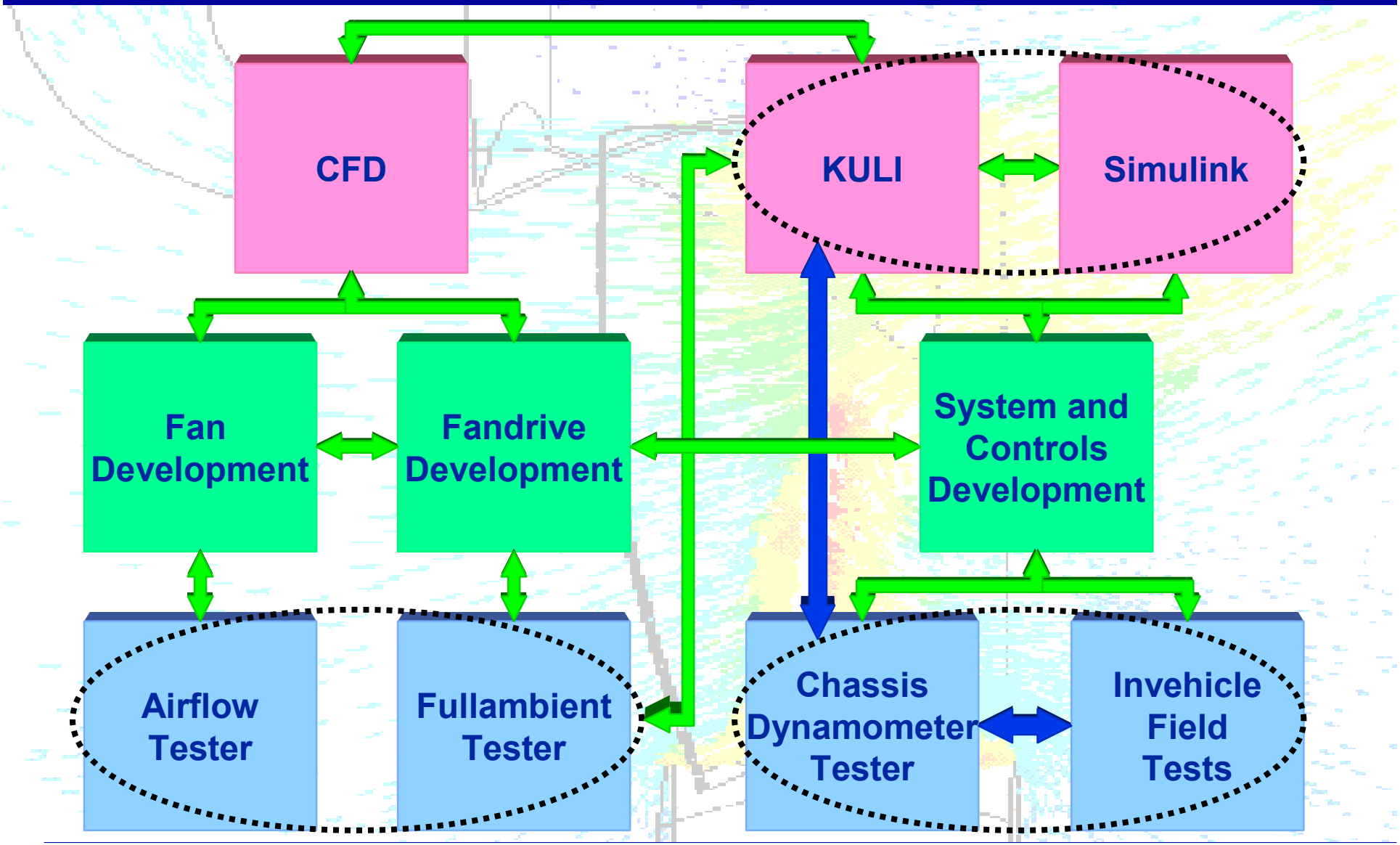


Verification of road tests on the chassis dynamometer and by simulation using KULI

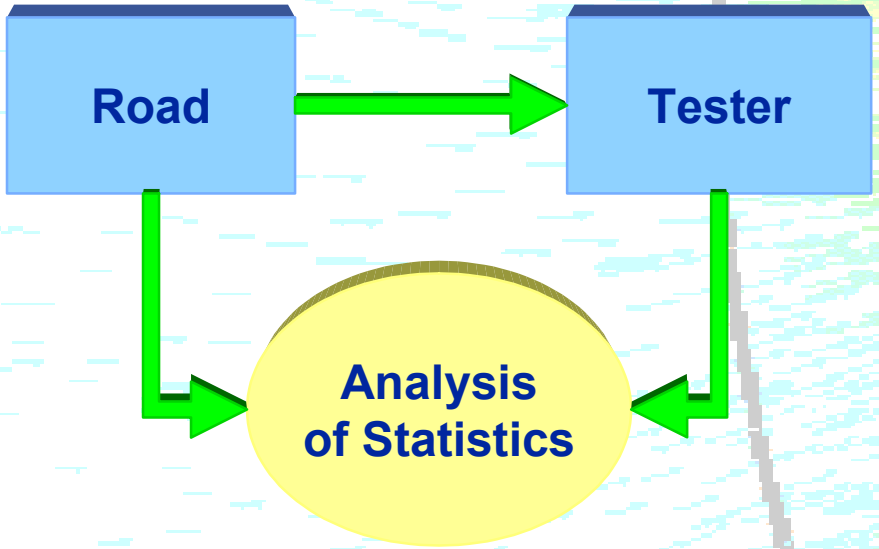
Development process using new simulation tools



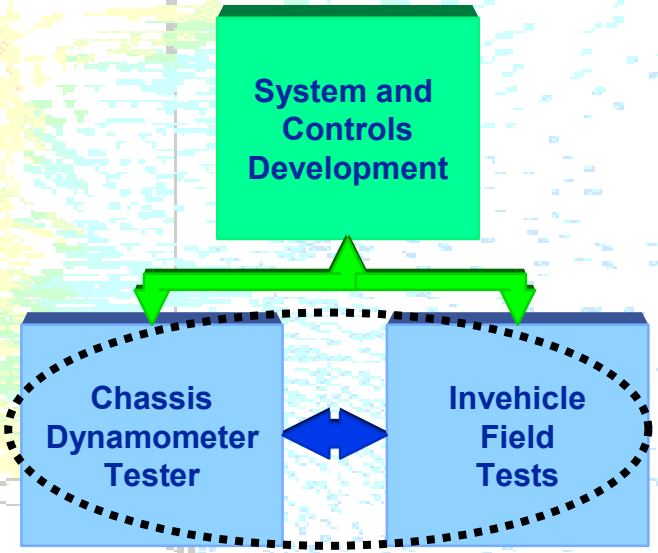
Verification of road tests on the chassis dynamometer and by simulation using KULI



Verification of road tests on the chassis dynamometer

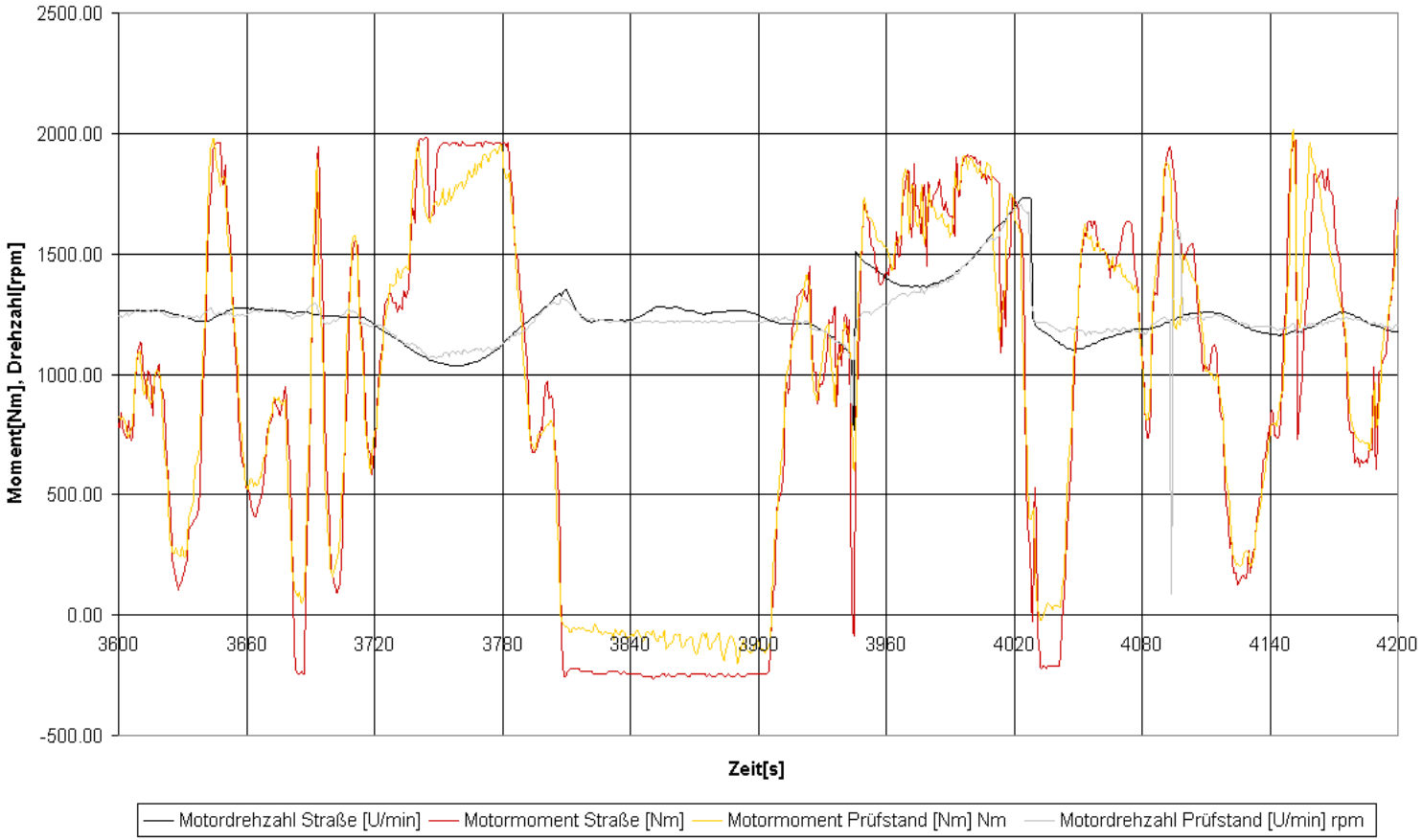


- Analysis of engine power statistics
- Analysis of temperature statistics
- Analysis of fan speed statistics



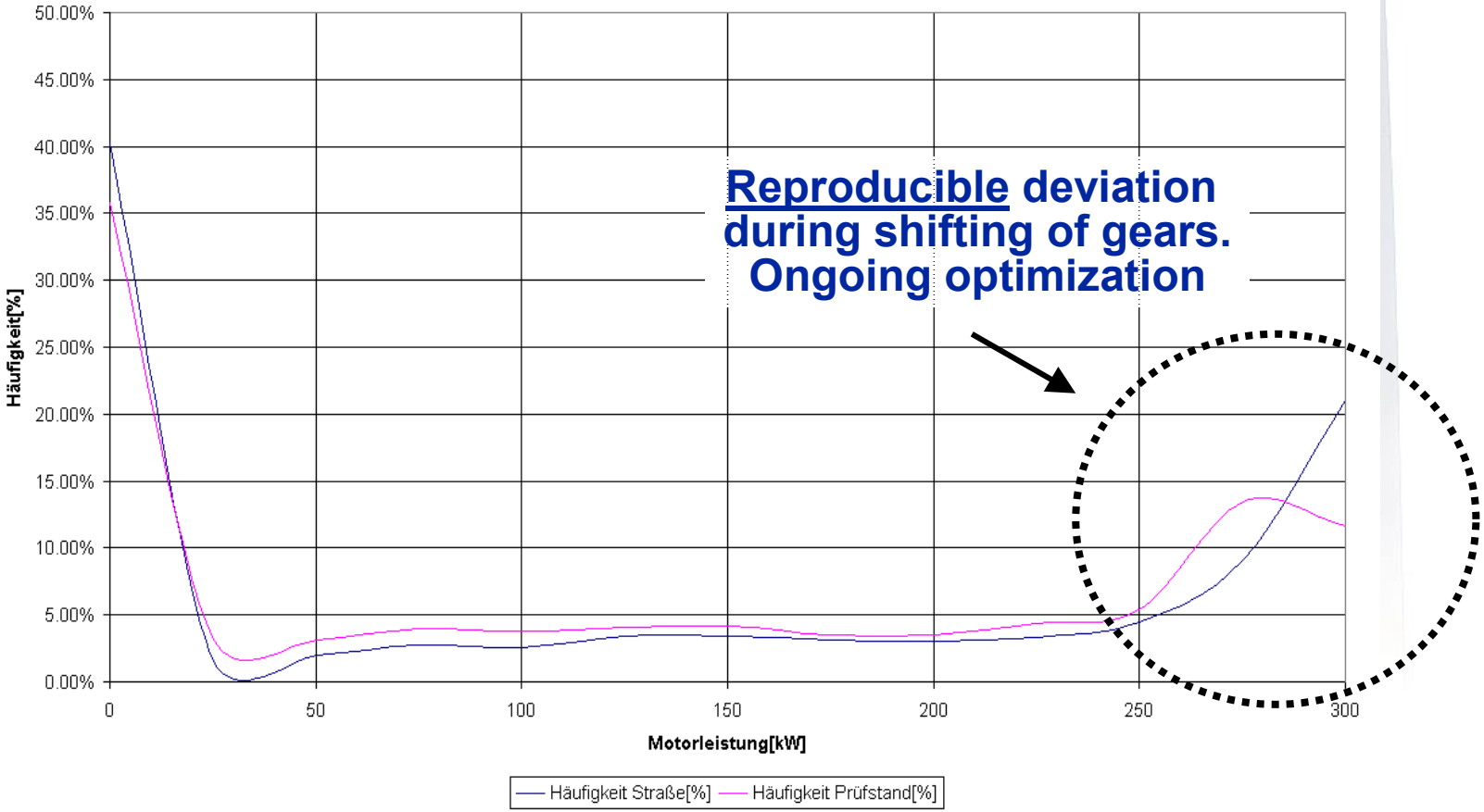
Verification of road tests on the chassis dynamometer and by simulation using KULI

Time based analysis

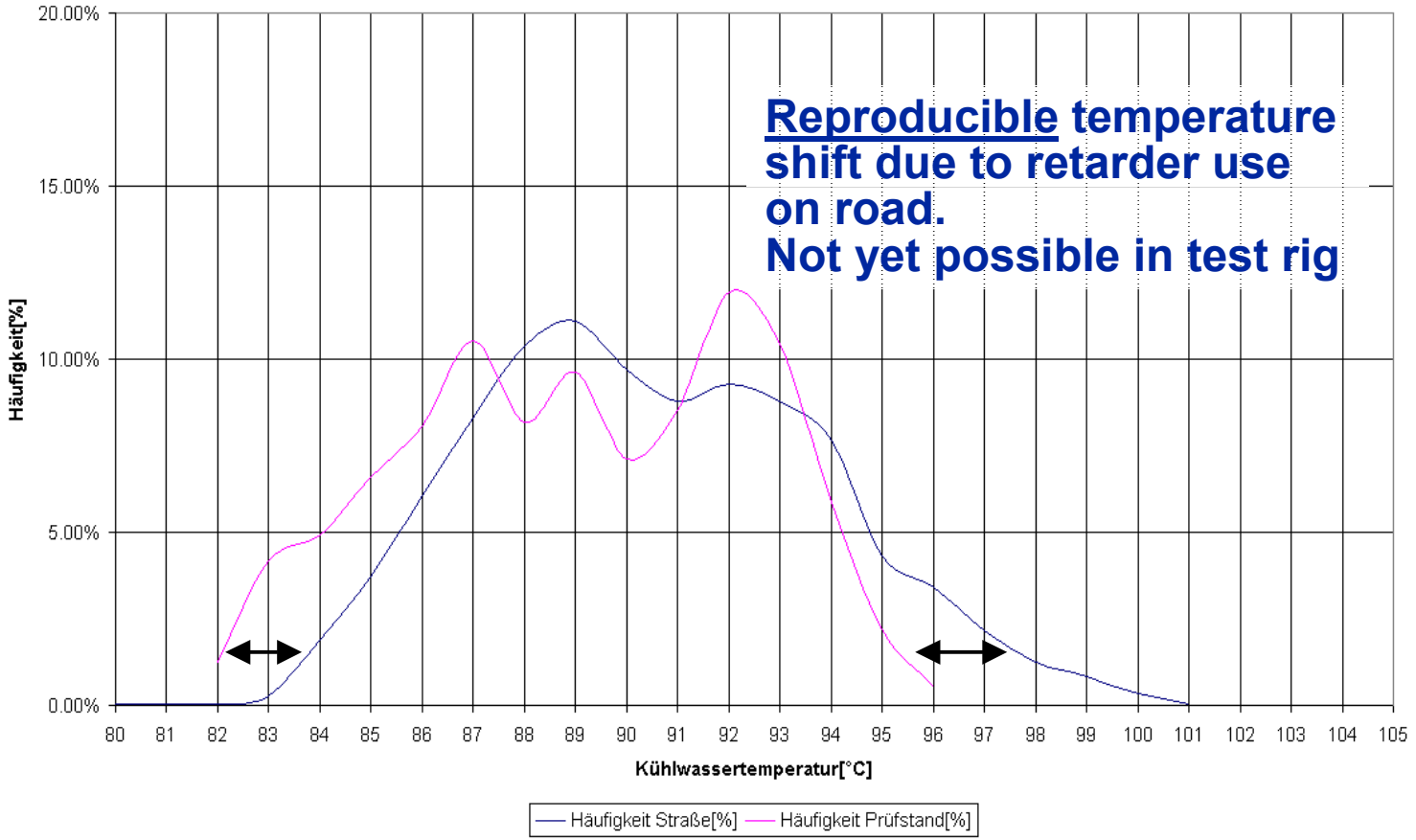


Verification of road tests on the chassis dynamometer and by simulation using KULI

Analysis of engine power statistics

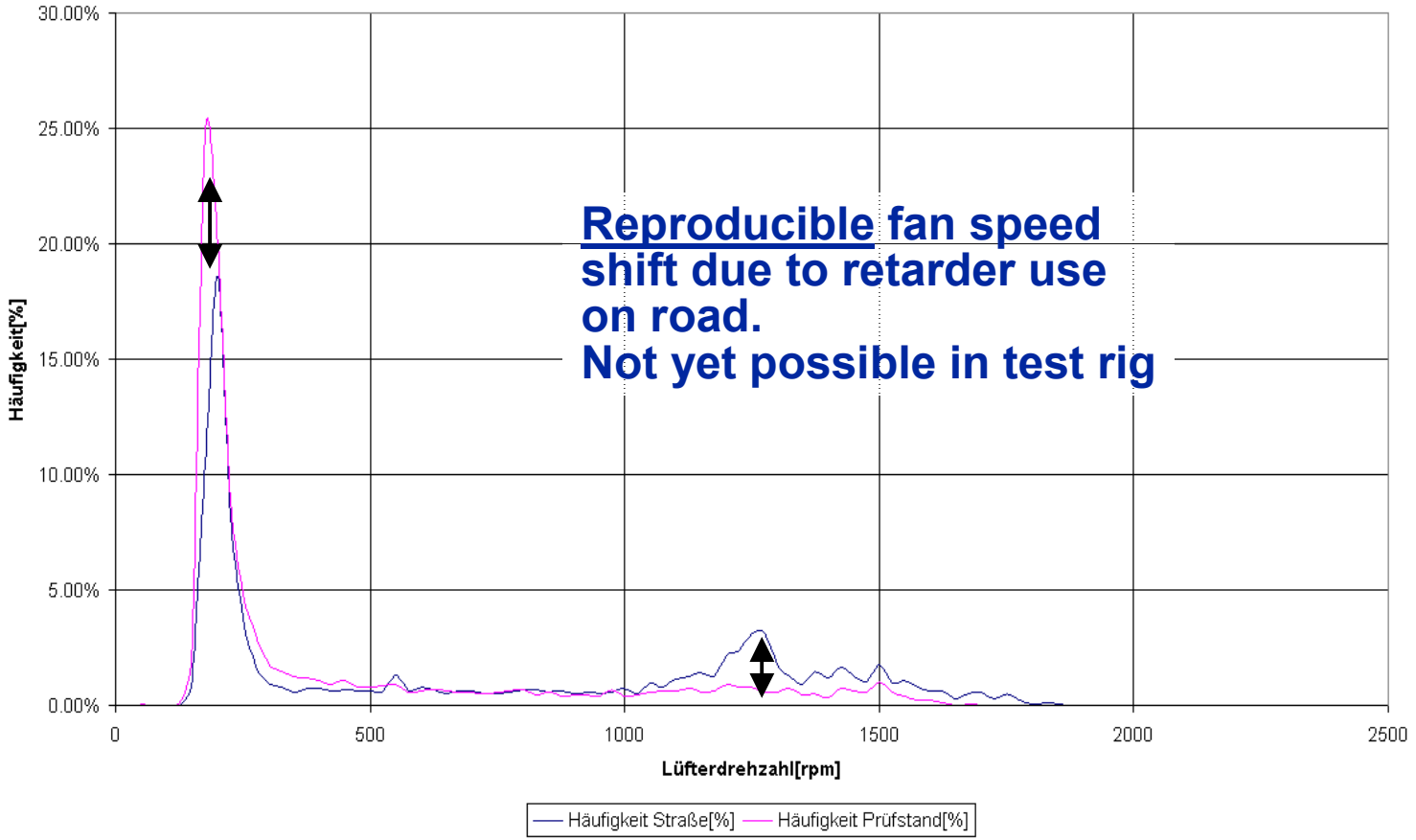


Analysis of temperature statistics



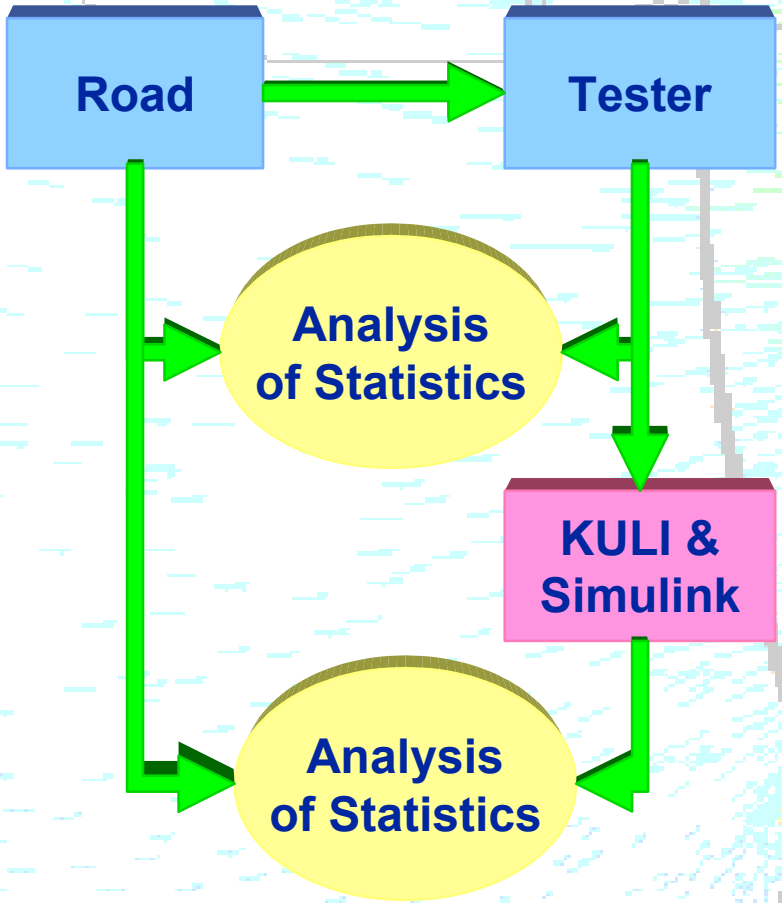
Reproducible temperature shift due to retarder use on road.
Not yet possible in test rig

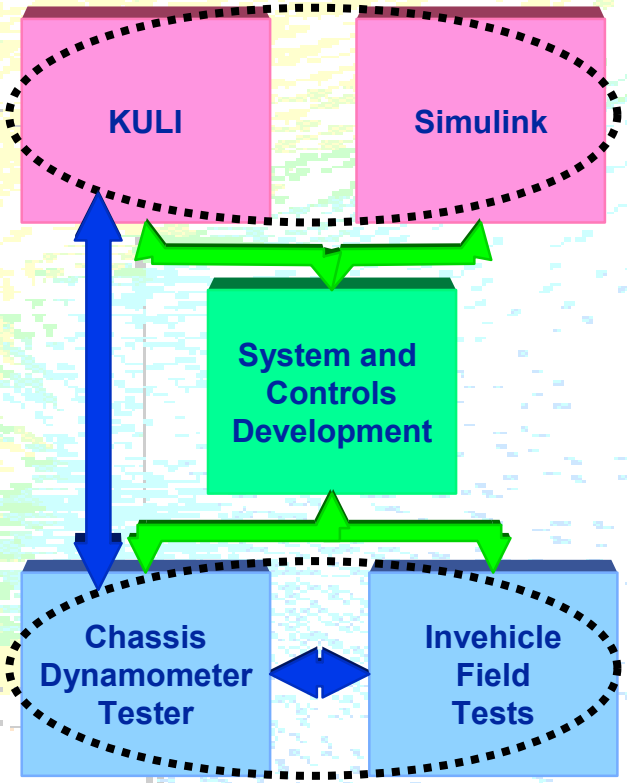
Analysis of fan speed statistics



Reproducible fan speed shift due to retarder use on road.
Not yet possible in test rig

Verification of road tests by using KULI & Simulink

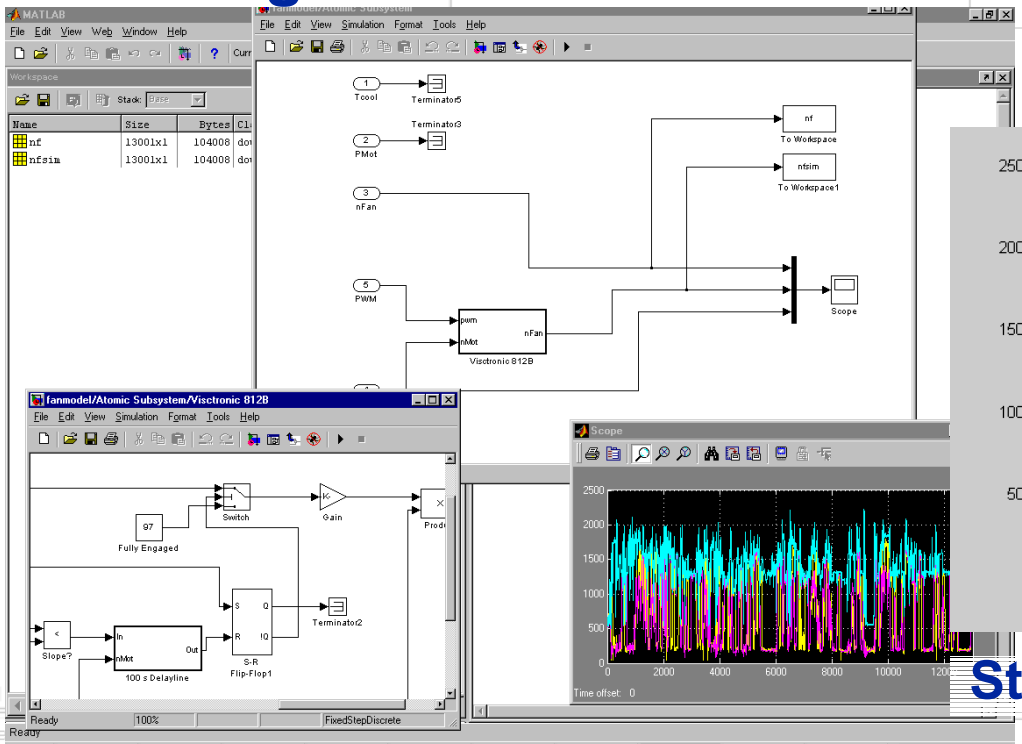


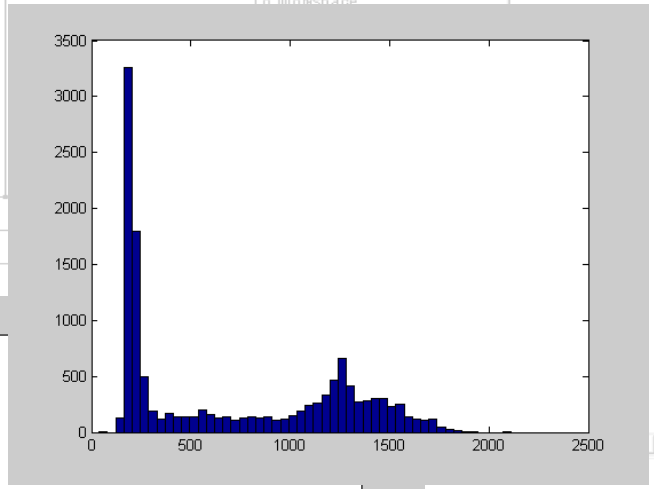


Verification of road tests on the chassis dynamometer and by simulation using KULI

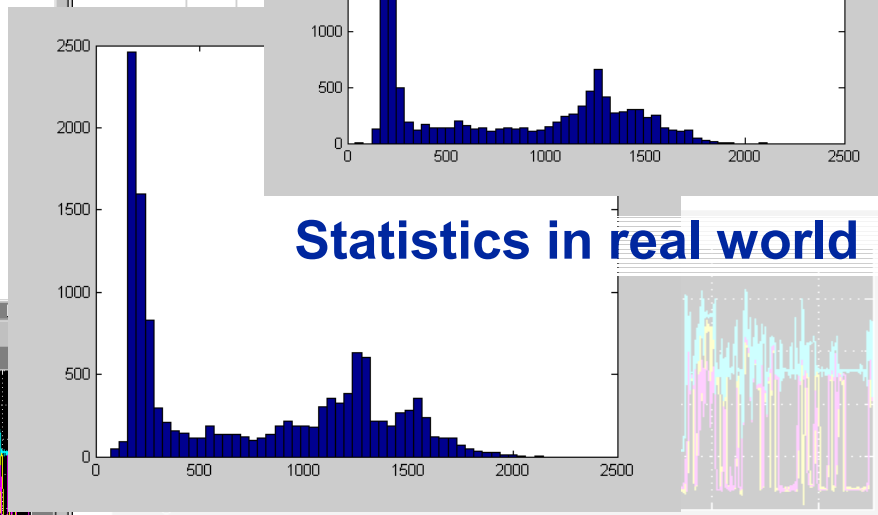
Component and Controls Simulation in Simulink

Clutch Model in Simulink using real world data





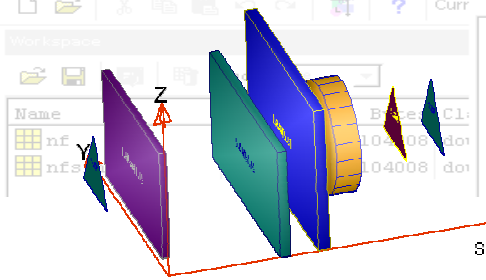
Statistics in real world



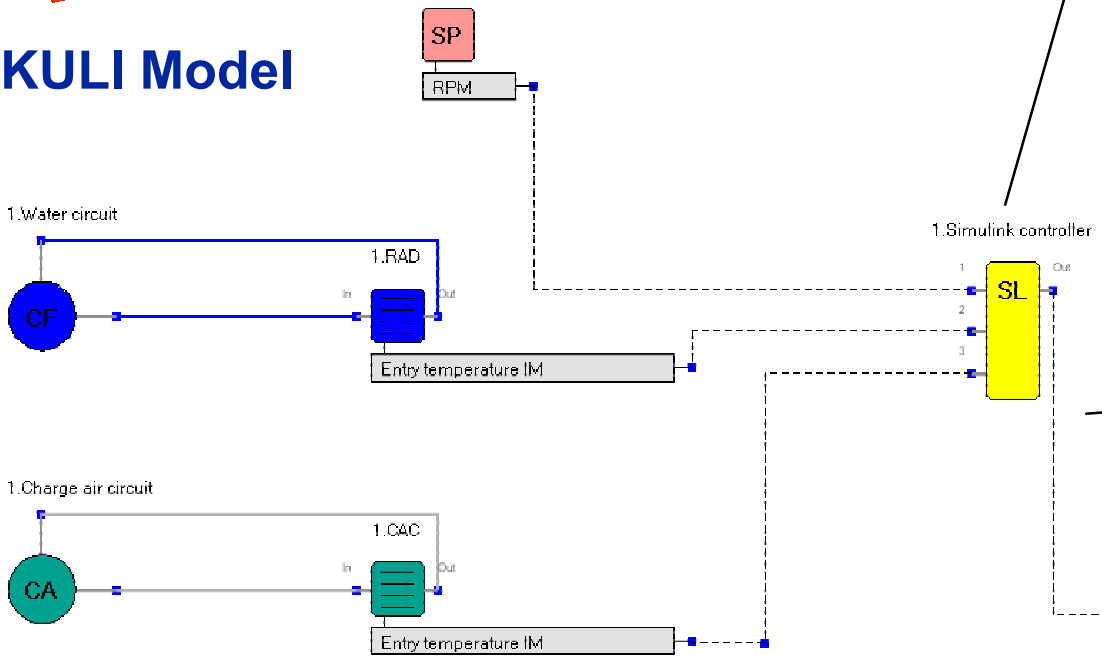
Statistics in Simulation

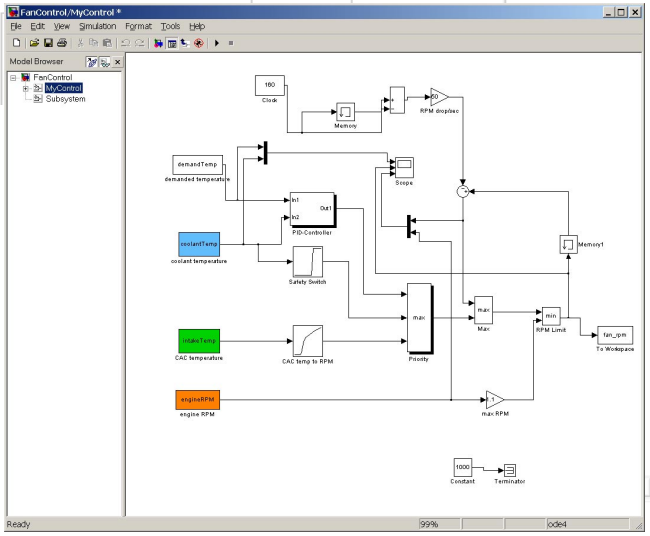
Verification of road tests on the chassis dynamometer and by simulation using KULI

Embedding Simulink Models into KULI

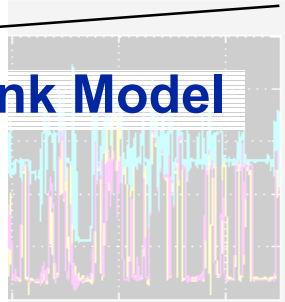


KULI Model





Simulink Model



Definition of Sensors

Verification of road tests on the chassis dynamometer and by simulation using KULI

Status:

- Technical base for invehicle data acquisition
- Chassis dynamometer ready for road data
- First vehicle model in KULI
- Transfer of controls and components into Simulink ongoing
- First test data (simple step tests) in KULI

Next Steps:

- Improve test procedures
- Correlation between tester and KULI for simple profiles (step test, ramp test)
- Improve simulation models for road data
- Correlation between tester and KULI

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BorgWarner Cooling Systems

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