



Dynamische Erprobung einer Karosserie am Virtuellen Prüfstand

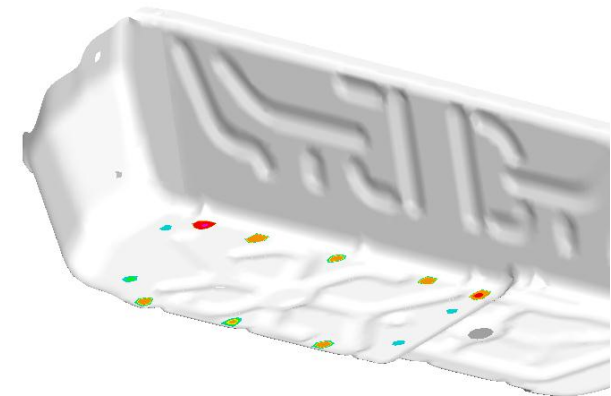
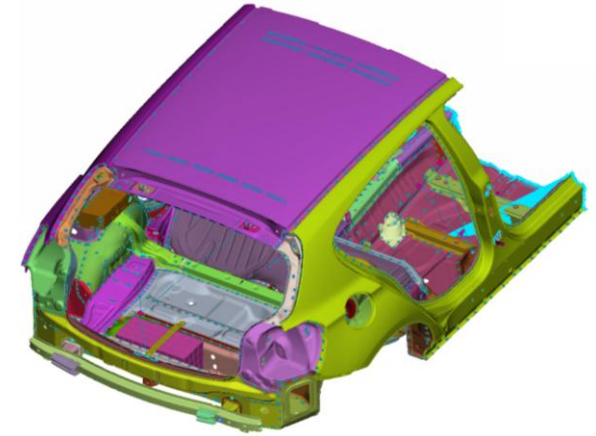
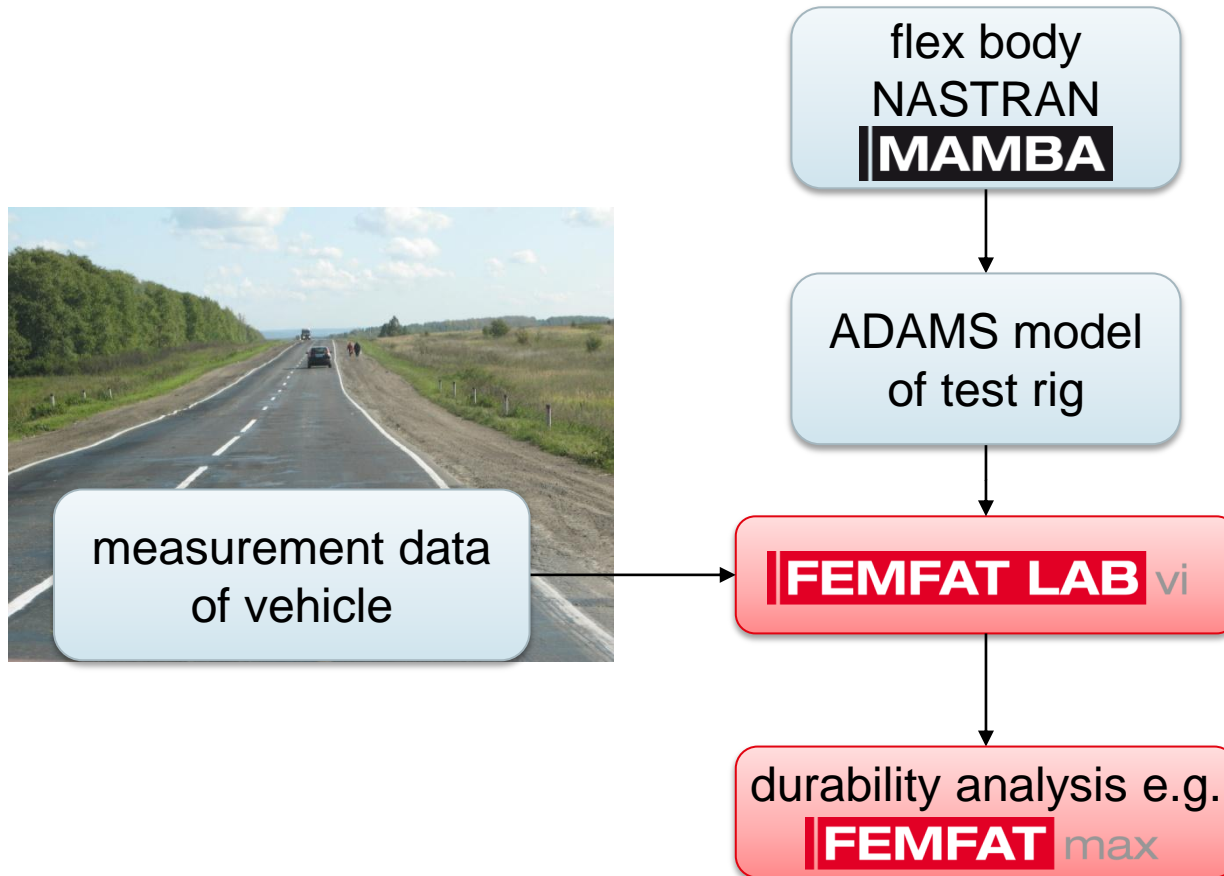
MSC Usermeeting 2013

Dr. Oliver Grieshofer

MAGNA Powertrain – Engineering
Center Steyr

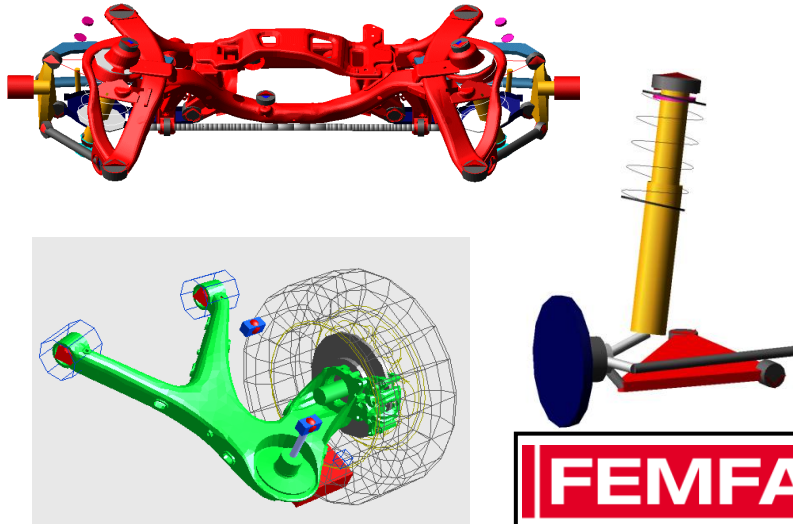
- Vehicle components are dynamically loaded during usage
- Deformation of components leads to modified contact situation and stresses
- Fatigue assessment
 - Virtual test rig in early development phase
 - Reproduction of load situation on test track
- Goal: reliable method for fatigue calculation of dynamically loaded flexible structures with contacts

- Workflow of virtual test rig
- Virtual iteration of measured loads
- NASTRAN and ADAMS modeling of test rig
- Durability analysis of spot welded body structures
- Example: Durability of battery carrier

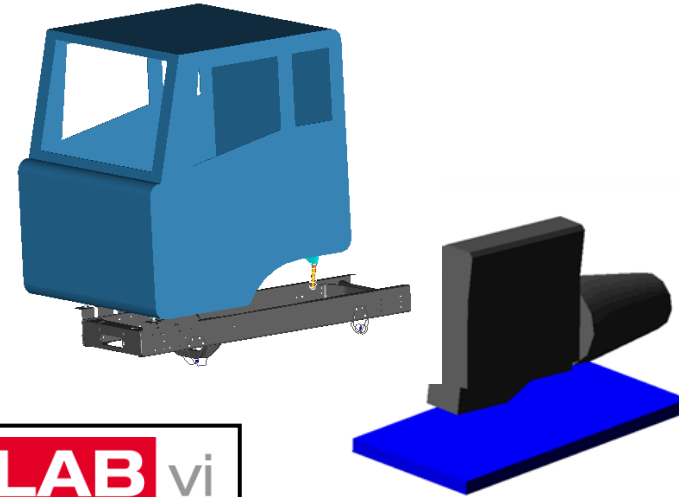


Virtual Iteration of Loads Using FEMFAT Lab

Axles



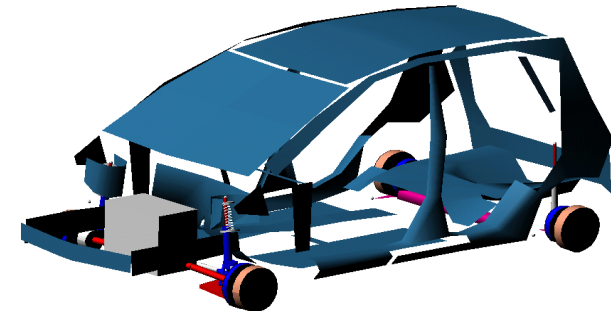
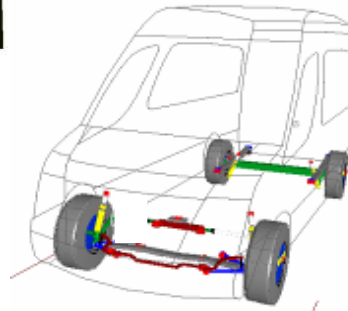
Attachment parts

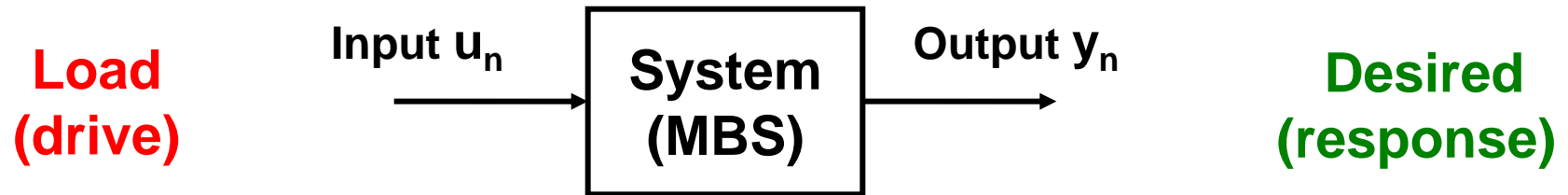


FEMFAT LAB vi
LOAD DATA ANALYSIS

Applications

Fullvehicles





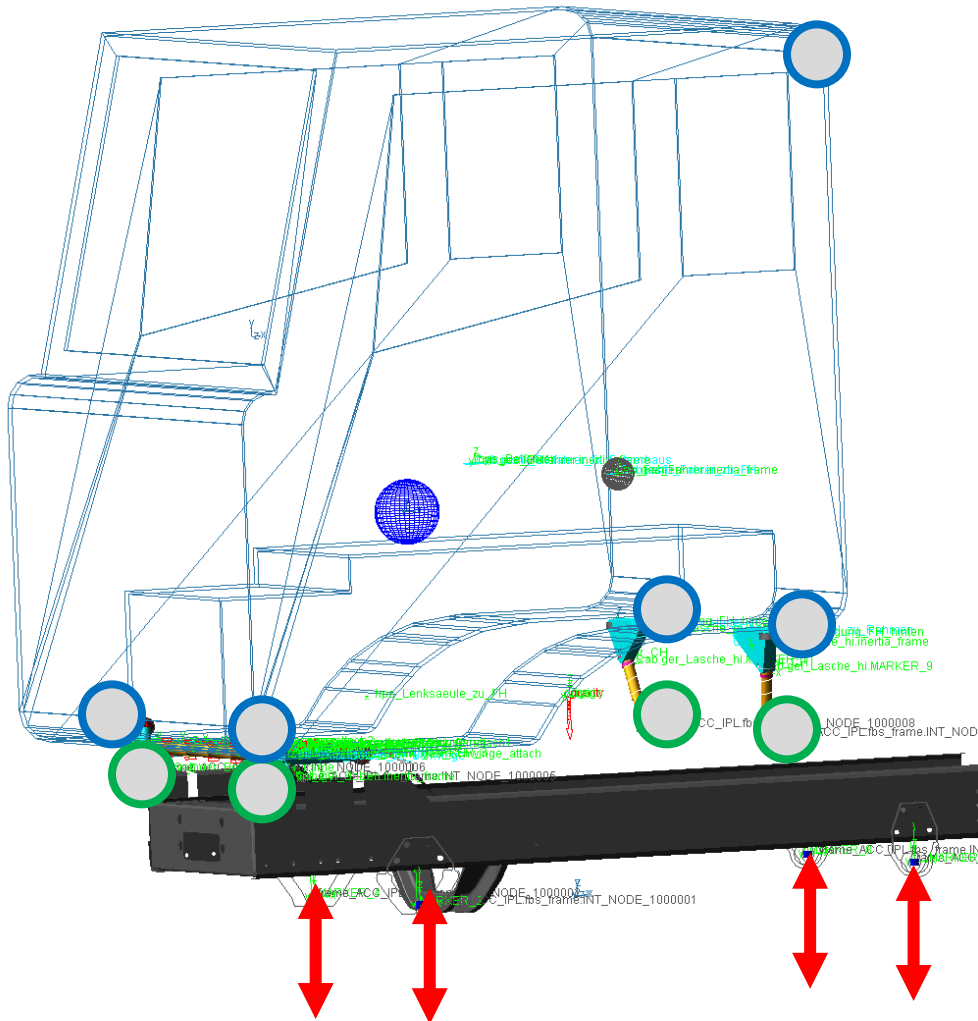
Inverse non-linear problem: *find loads for given responses*

Drive

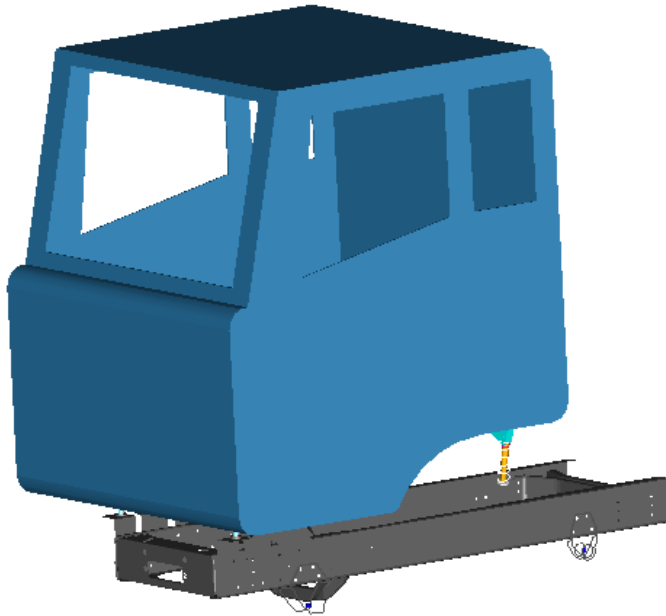
- Forces (external)
- Displacements (absolute)

Response

- Accelerations
- Strains
- Displacements (relative)
- Forces (internal)

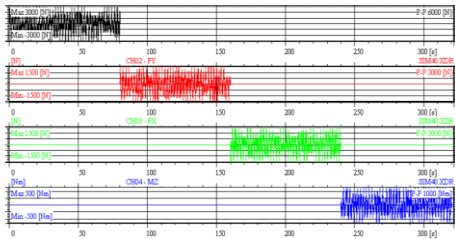


- Measurements from test track
 - Accelerations at frame
 - Accelerations at cabin
- Load
 - Vertical displacement at the frame at 4 positions
- Desired
 - Vertical acceleration at frame
- Model check
 - Vertical accelerations at cabin bottom
 - Acceleration at cabin roof (3-axial)

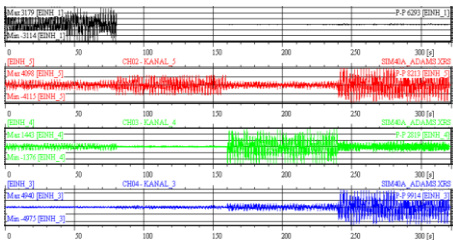


- Components for durability analysis
 - Rigid body -> evaluation of interface loads
 - Flex body -> direct use of flex body modes in durability analysis
- Loads defined in subsystem, splines prepared by VI
 - GFORCE on body
 - MOTION (joint, point or general)
- Simulated response for measurement comparison
 - REQUEST: displacement, acceleration, force,...
 - Scaling to fit unit of measurement channel

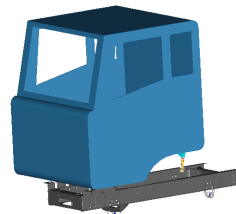
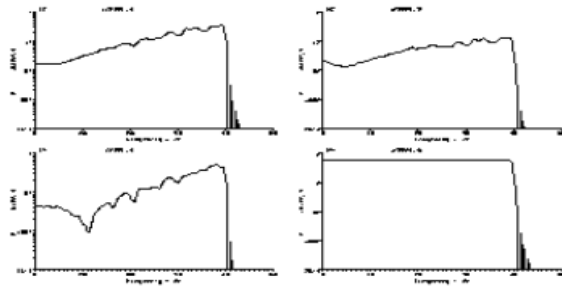
1. Pink noise



2. Response of noise



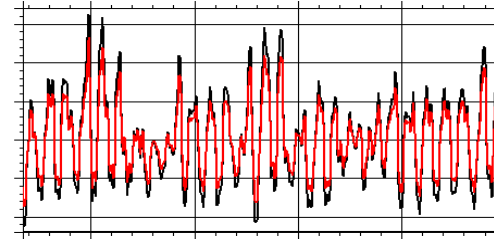
3. Transfer functions



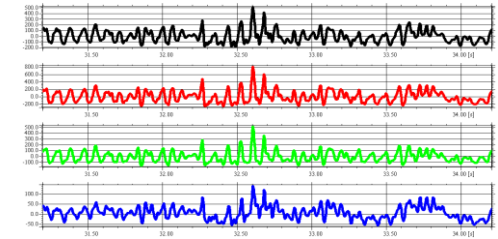
$$F = \frac{y_{Noise}}{u_{Noise}}$$

$$u_0 = F^{-1} y_{Desired}$$

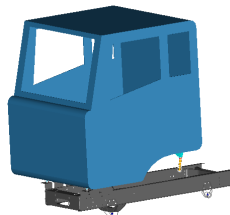
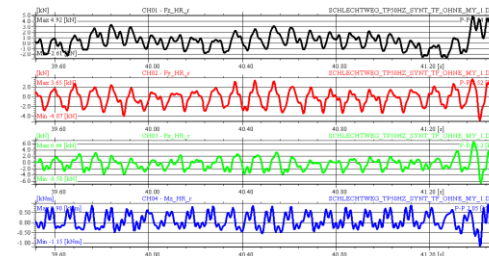
6. Response = desired



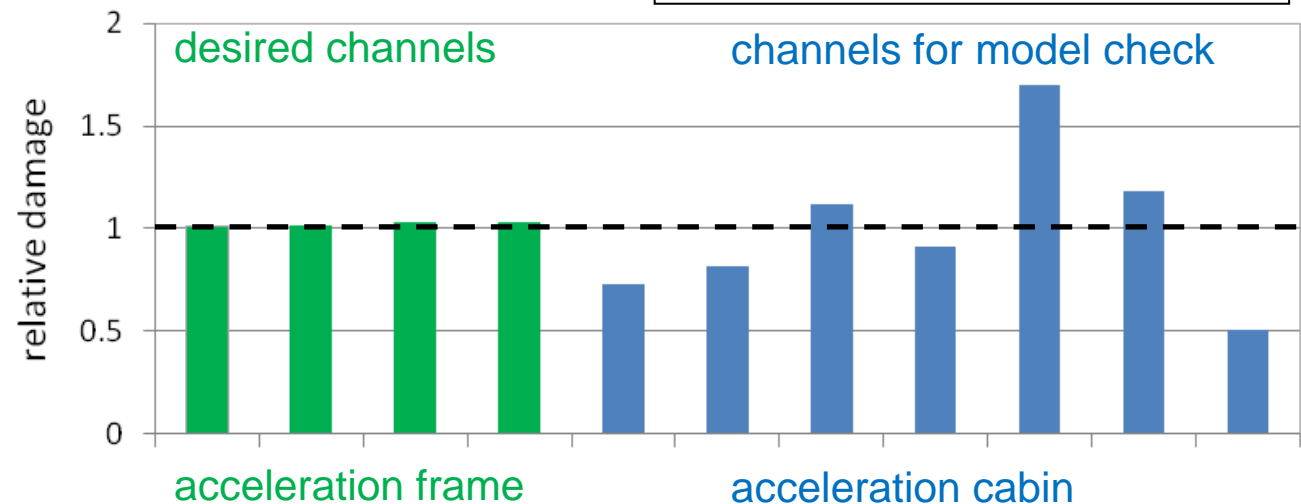
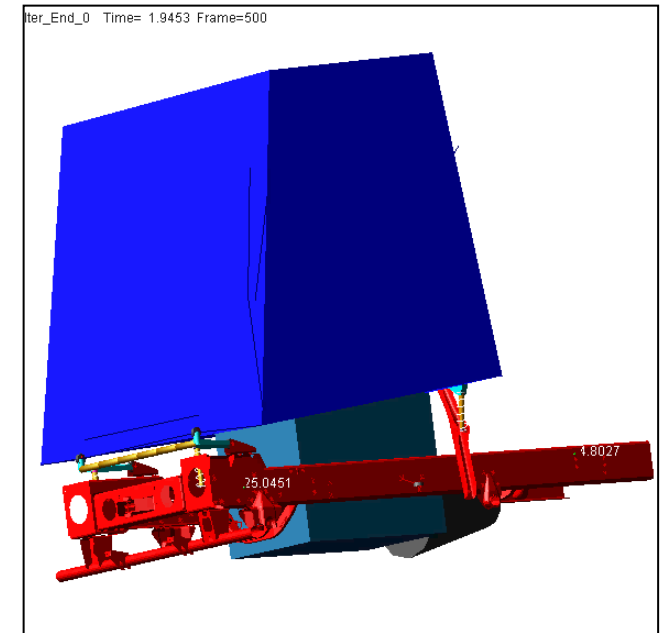
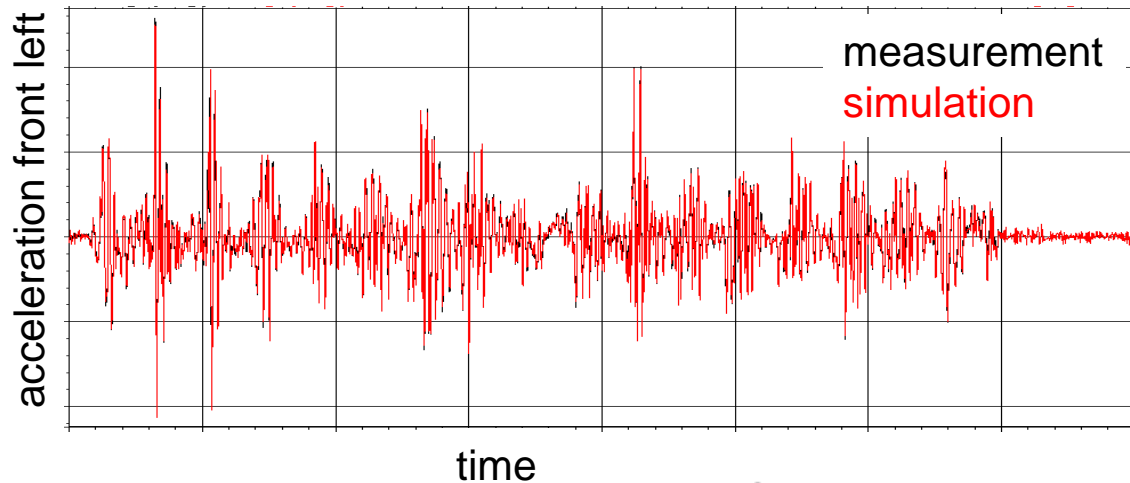
5. Response



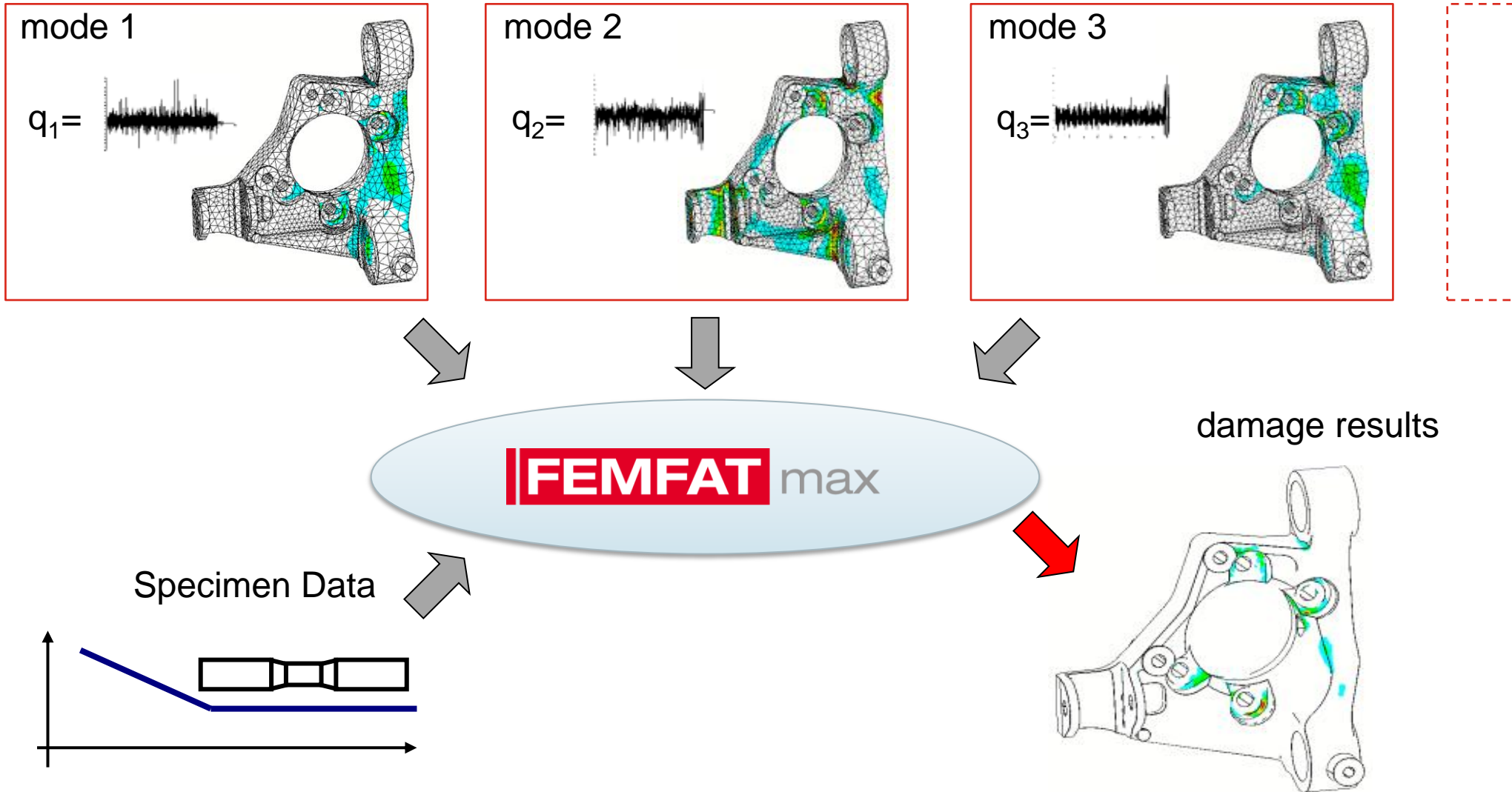
4. Drive signal



Result of virtual iteration after 11 iterations (rough road)

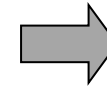
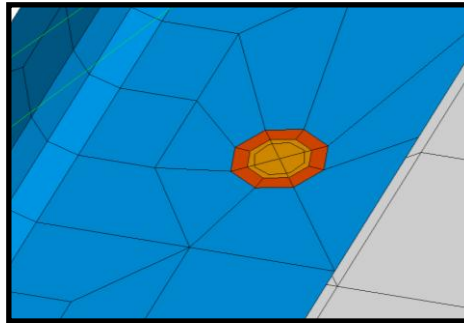
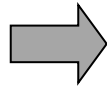
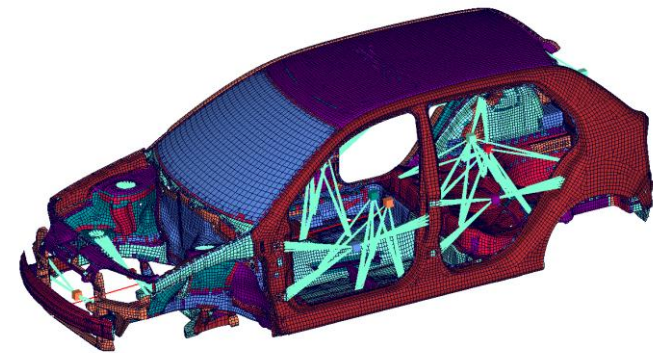


Durability Analysis – Flex Body Modes



Durability Analysis – Spot Weld

automated spot remeshing

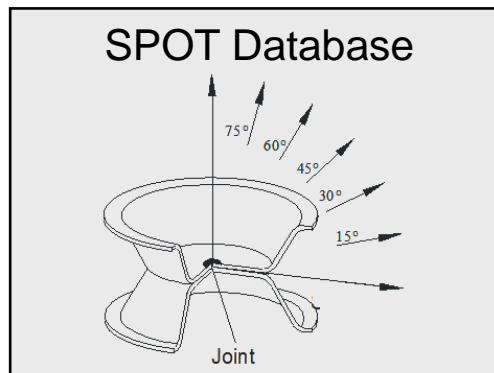
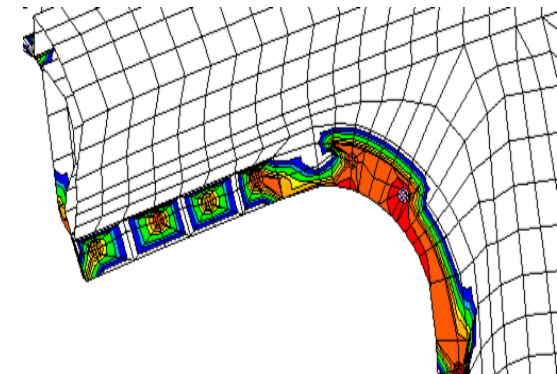


NASTRAN and
ADAMS



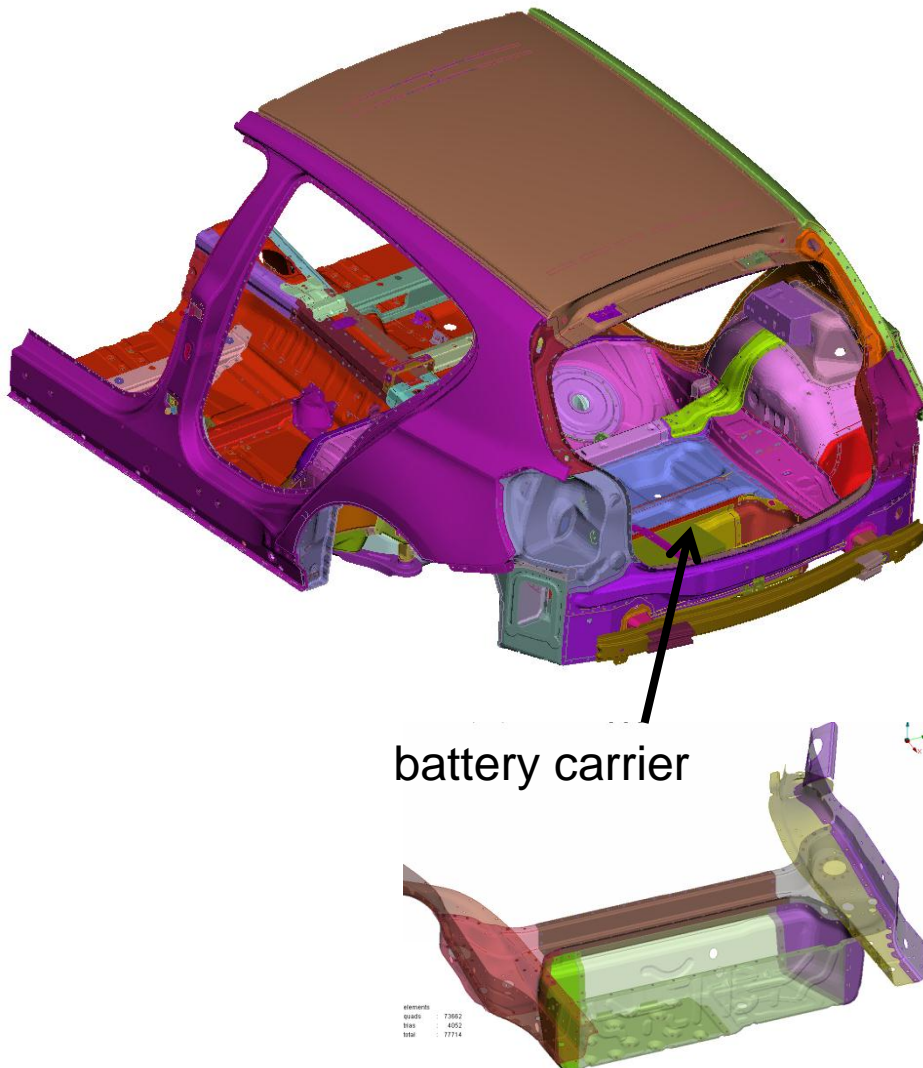
FEMFAT spot

damage results



Example

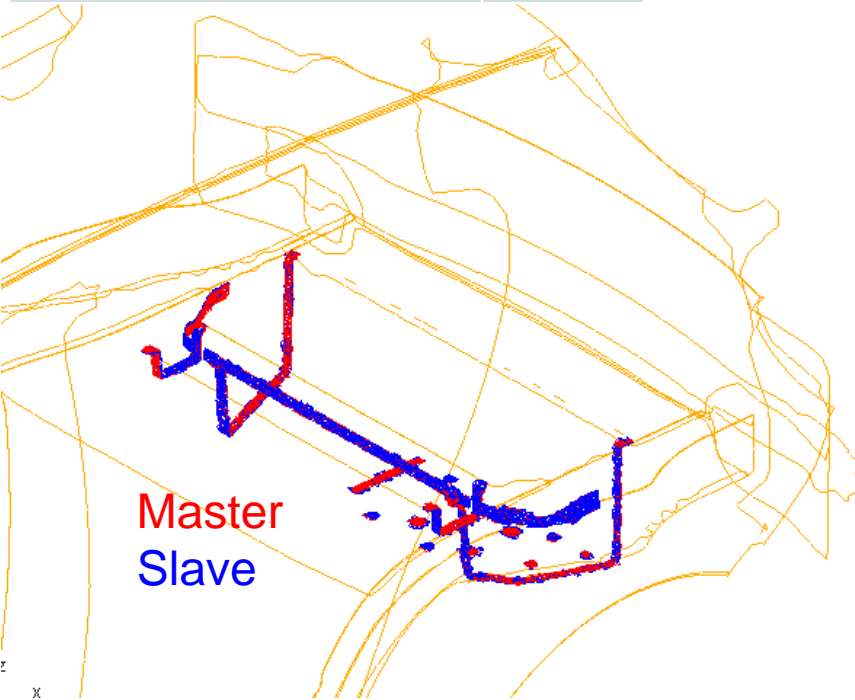
Virtual Test Rig – Durability of Battery Carrier



- Modeling
 - linear NASTRAN Model
 - Contact preprocessing with MAMBA
- Analyses
 - Loads from virtual iteration or pre-defined
 - Full dynamic MSC Adams analysis with contacts
 - Boundary conditions analogous to NASTRAN model
- Result
 - Damage of the spots in the area of the battery carrier
 - Damage of base material

Number of Modes

Constraint Modes	6
Normal Modes	110
Contact modes (JIM)	150



Preprocessing of flexible structure

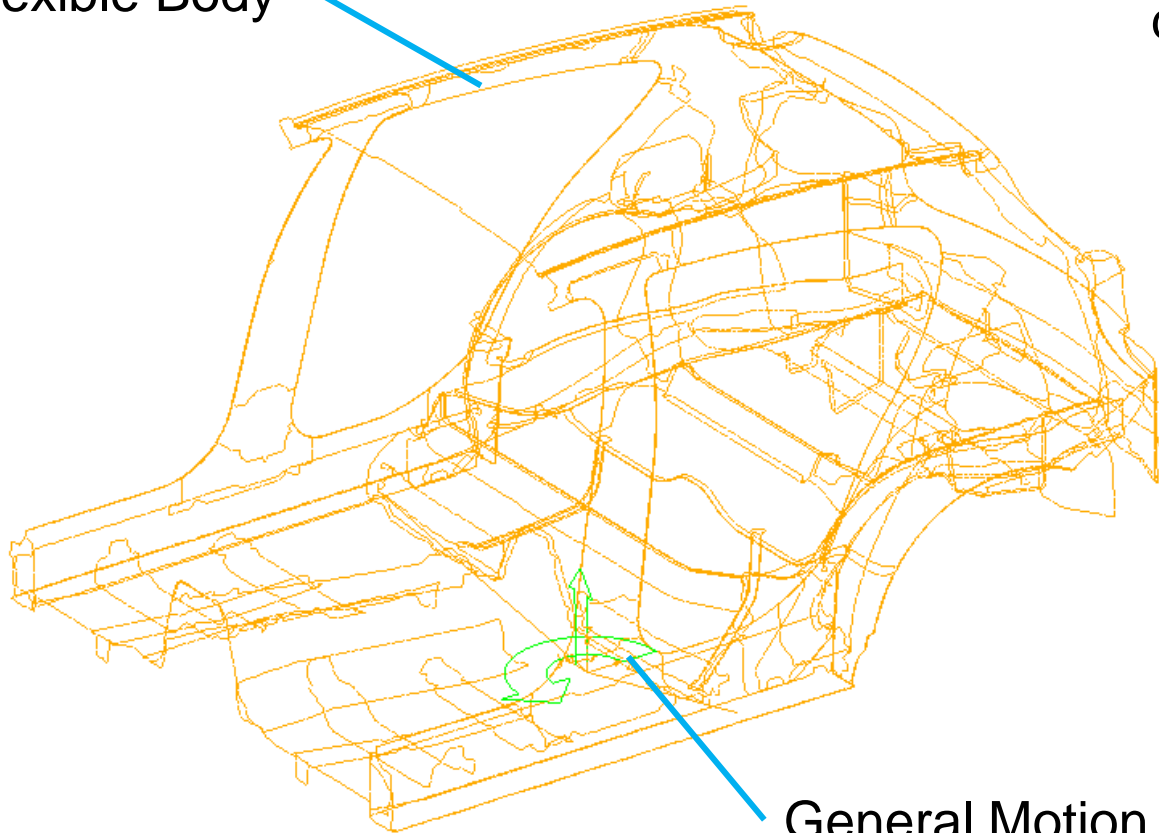
- Definition of PIDs for contact algorithm
 - Self-contact within PID
 - Contact between different PIDs
- Automated definition of contact zones with MAMBA preprocessor
- Clearance tolerance for finding contacts
- Export of contact as ADAMS shell file for visualization

Virtual Test Rig – Durability of Battery Carrier

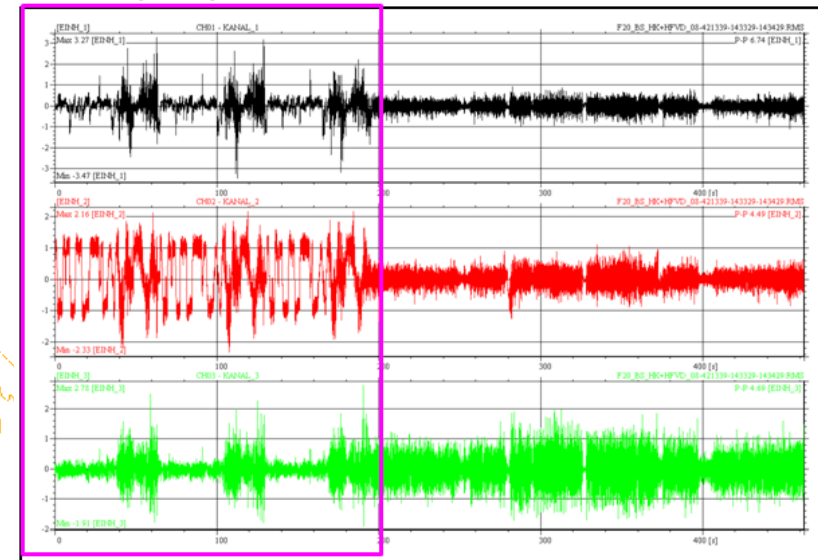
load history

damaging interval

Flexible Body



General Motion

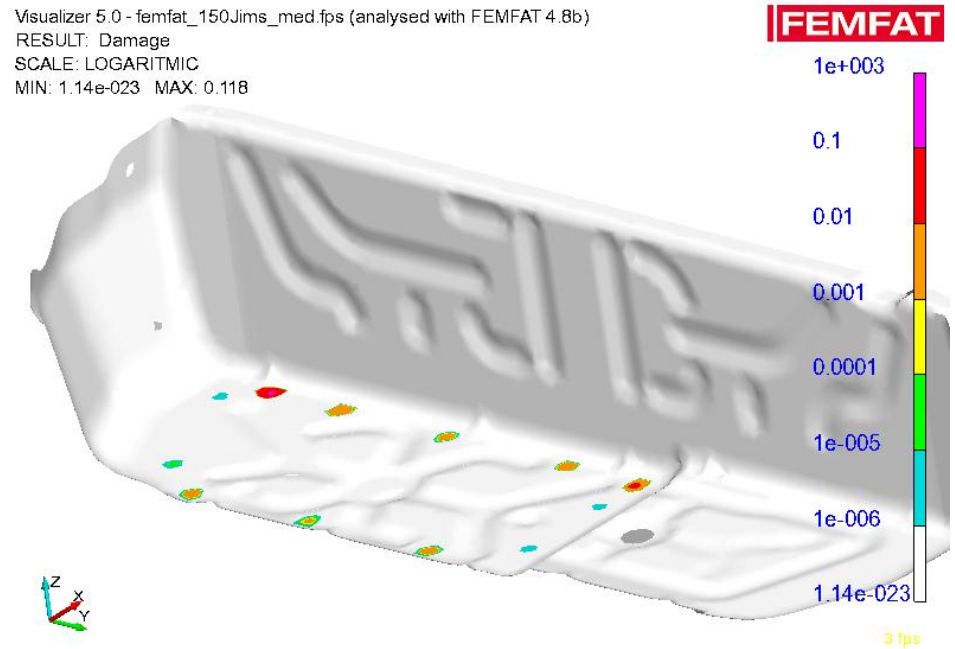


Virtual Test Rig – Durability of Battery Carrier

test rig - fracture at spots



simulation – comparable damage at spots



- Process applicable for wide range of vehicle components
- Investigation of virtual prototypes or test rig concepts
- Model for part of the vehicle to reproduce local dynamics
- ADAMS model verification and trimming by additional checking signals
- Nonlinear contact behavior of flexible structure considered
- Absolute fatigue life prediction possible
- NASTRAN and ADAMS are fully compatible with MAMBA and FEMFAT



The future is ours to make.