SIMULATION FOR AIRBAG SENSOR CALIBRATION

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2nd **E**uropean **H**yperWorks **T**echnology **C**onference

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AB VOLVO GROUP – Business Area

Volvo Trucks

Renault Trucks

Mack Trucks

Nissan Diesel

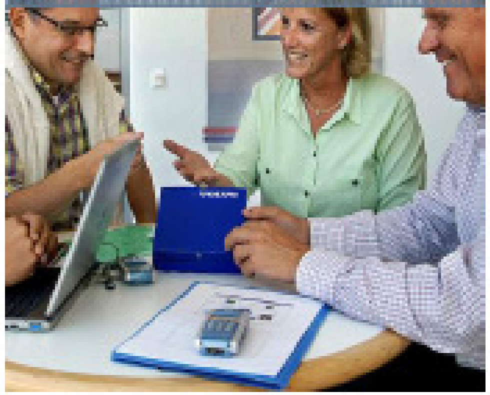
Construction Equipment

Buses

Volvo Penta

Volvo Aero

Financial Services



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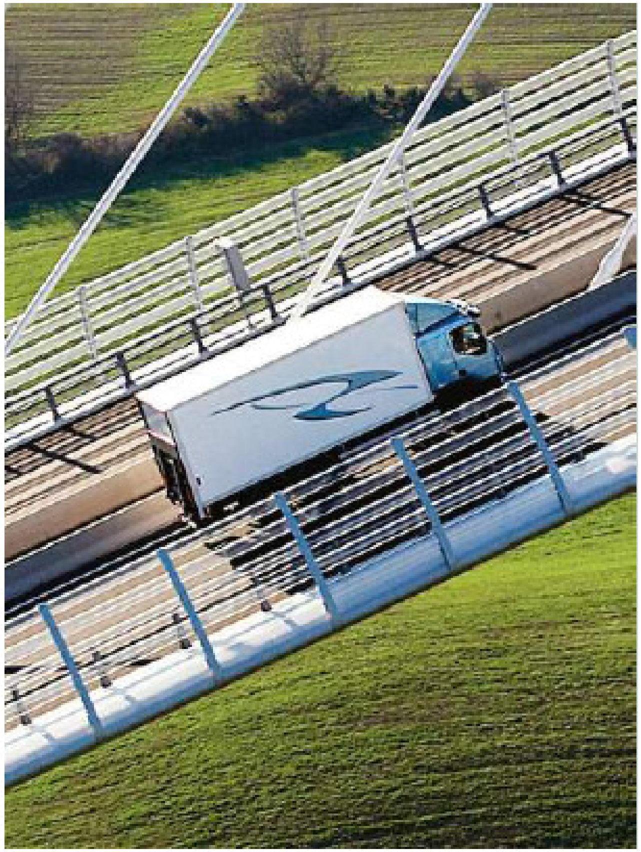
AB VOLVO GROUP – Corporate Values



QUALITY

SAFETY

ENVIRONMENT

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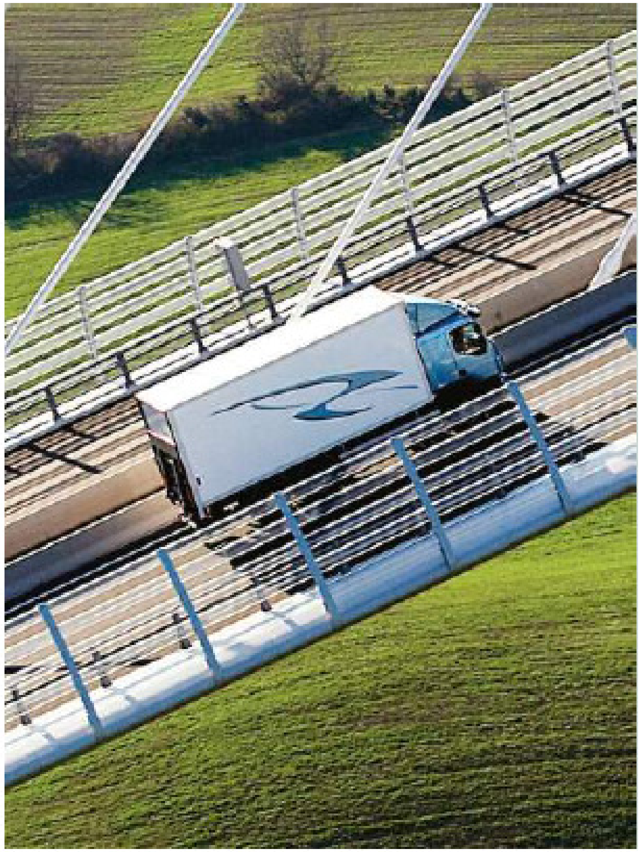
AB VOLVO GROUP – Corporate Values



QUALITY

"Safety is – and must always be – the fundamental principle of our design work-"

SAFETY

Assar Gabrielsson and Gustaf Larson,
founders of Volvo

ENVIRONMENT

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AIRBAG TEST

FM
30 km/h
0° TRAILER BACK

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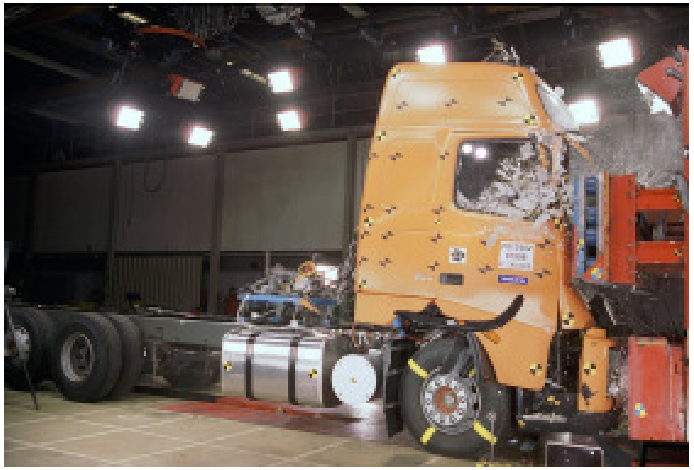
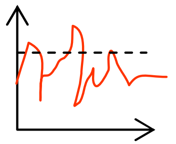
AIRBAG CONTROL



ECU

Electronic **C**ontrol **U**nit

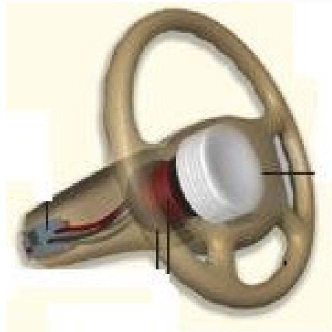
CRASH SITUATION



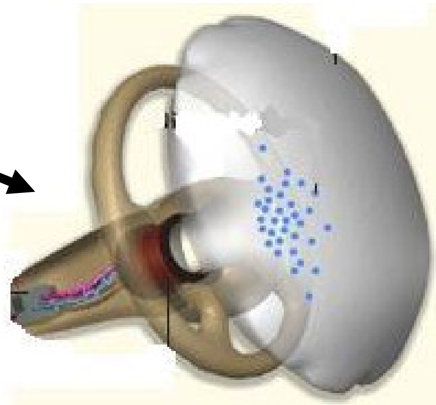
accelerations

ECU

algorithm



NON FIRE



FIRE

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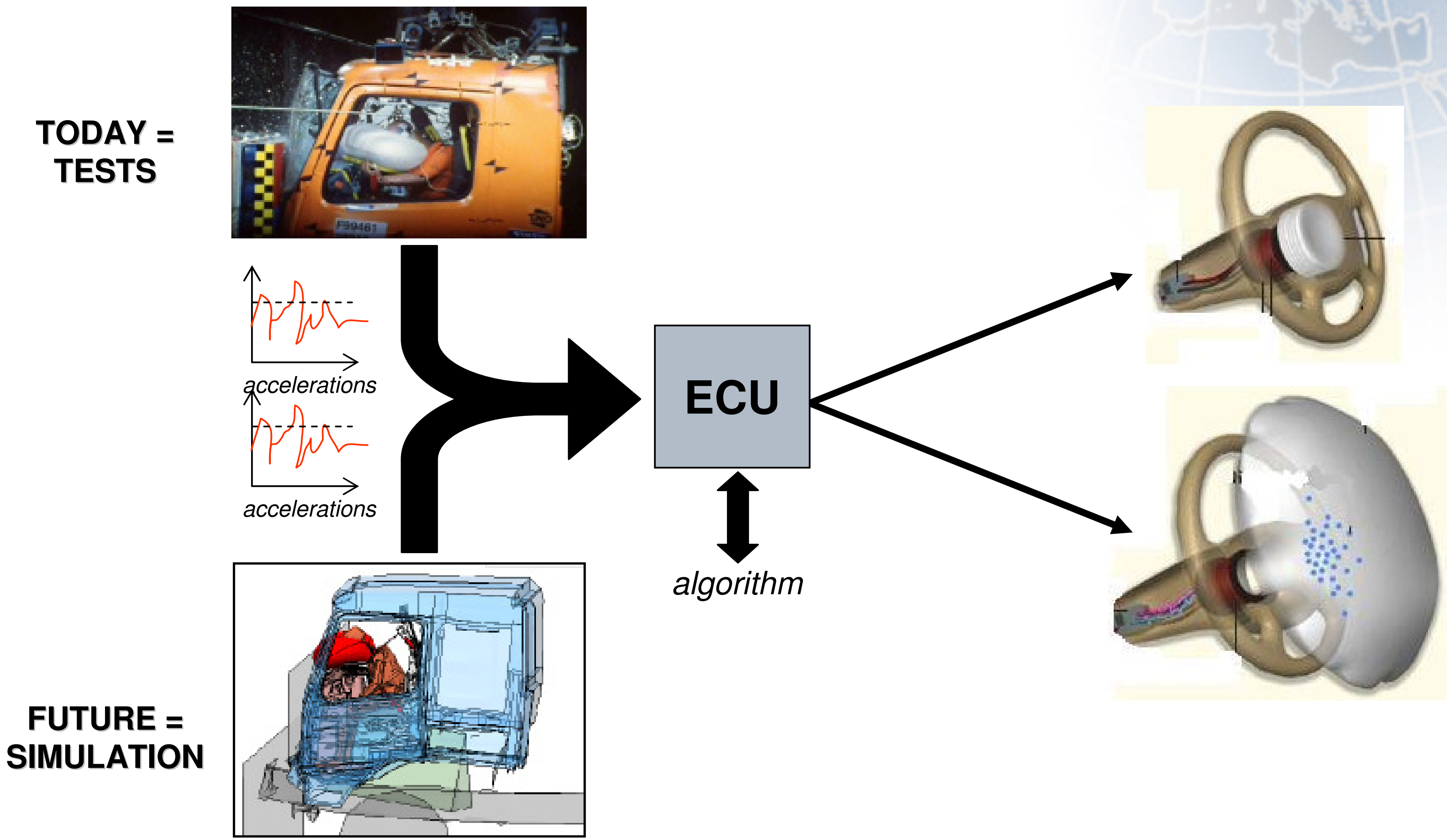
HOW TO CALIBRATE AN AIRBAG ECU ?



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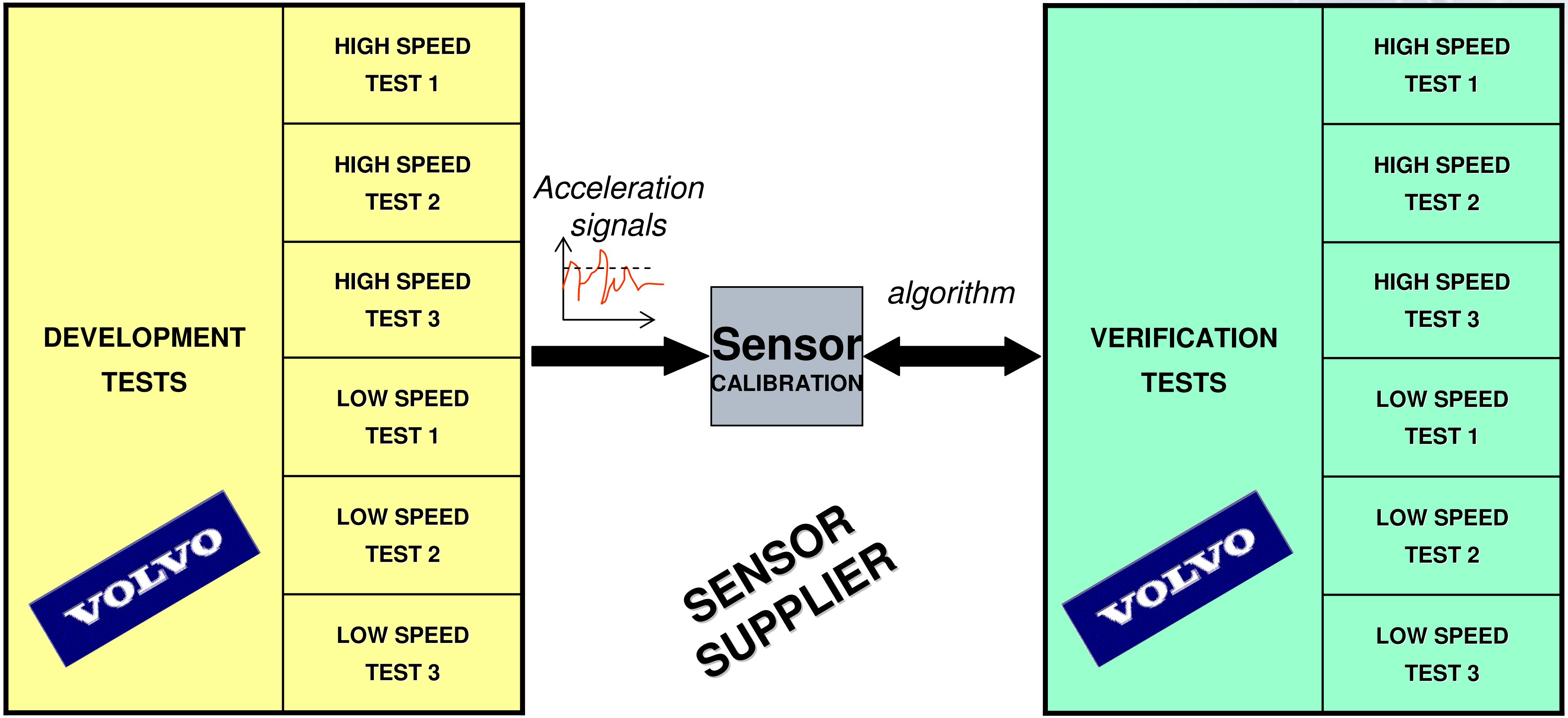
HOW TO CALIBRATE AN AIRBAG ECU ?

An **airbag sensor** has to be ***calibrated*** based on acceleration signals.



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RESEARCH AND DEVELOPMENT PROJECT

A two years **research and development** project has been done to define the **simulation methodology**:

- MESH GUIDELINES: recommendations for the mesh quality, mesh size (mesh class) and element formulation

- TEST SENSOR ACCELERATION: frequency analysis to find the frequency spectrum that needs to be caught

- FILTERING: cut off frequency and sampling rate have been set up to filter numerical noise and catch physical accelerations

- SENSOR MODELING: recommendations to represent the sensors

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PROJECT APPLICATION: FH trucks

A new airbag sensor will be introduced in **FH trucks** and in the mean time, some parts will be modified:

2007-2008: 1st application of airbag sensor calibration with simulation help in the VOLVO Group

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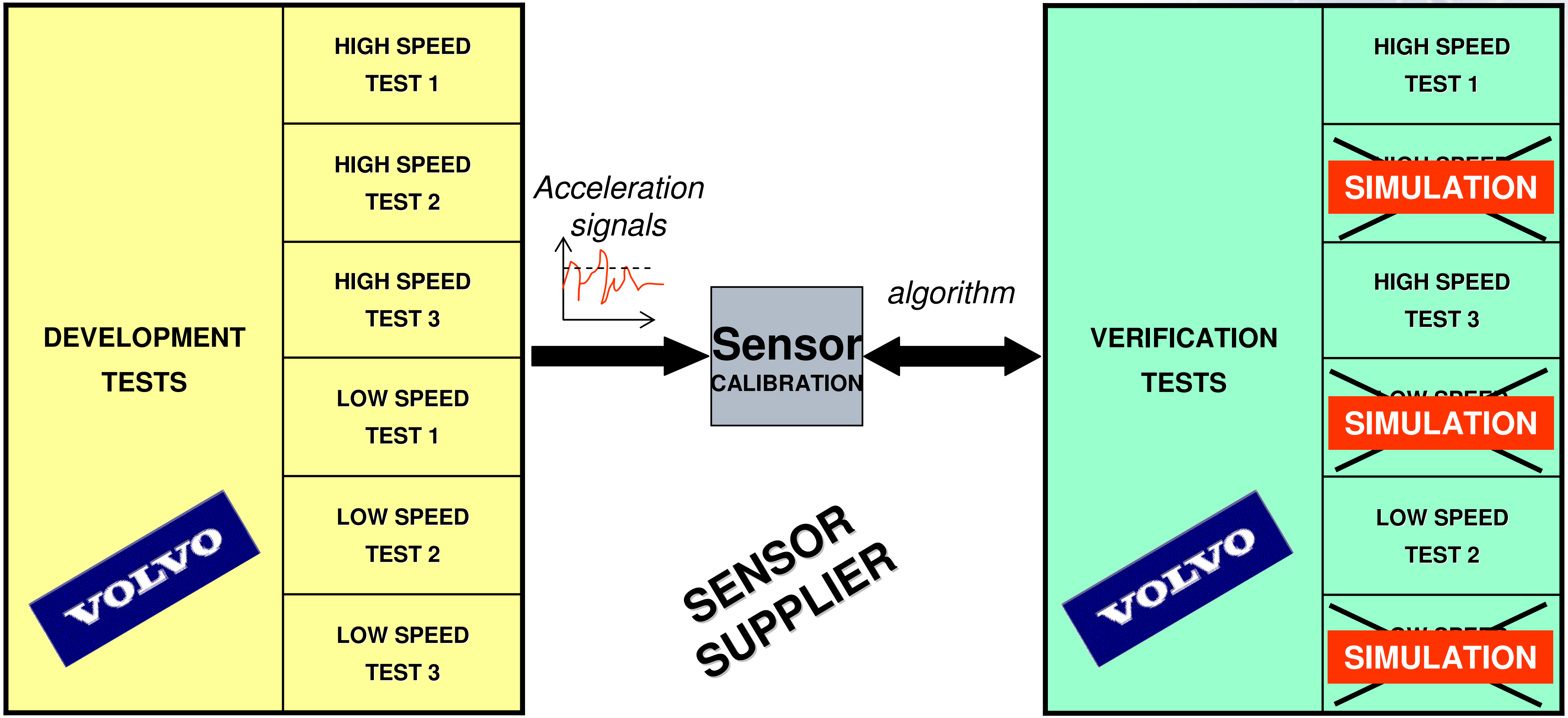
PROJECT APPLICATION: FH trucks

Airbag sensor calibration matrix



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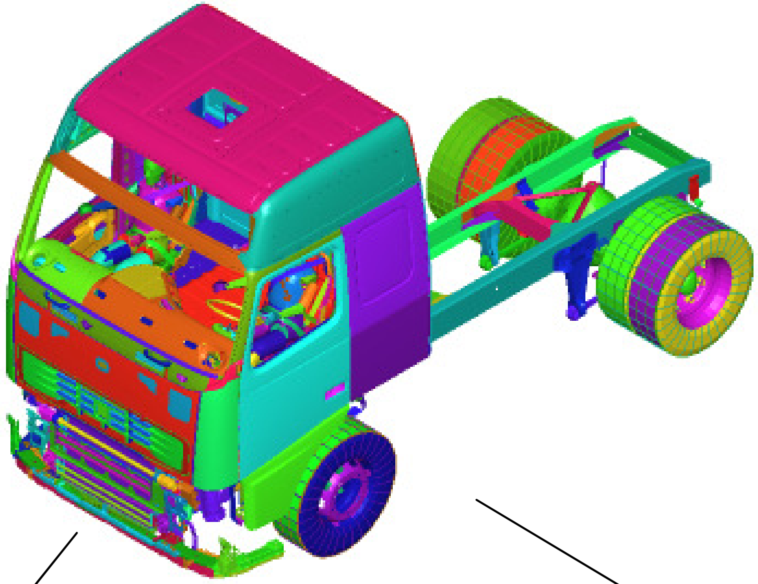
PROJECT APPLICATION: FH trucks

Finite Element model

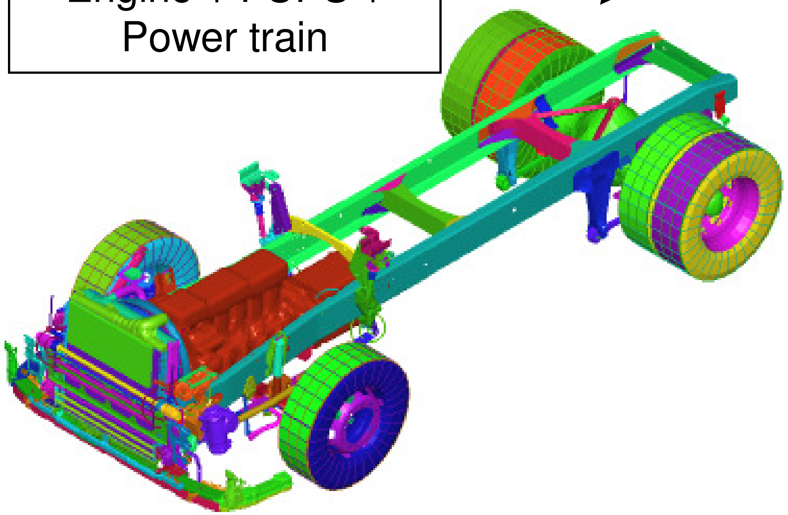
1.5 million elements

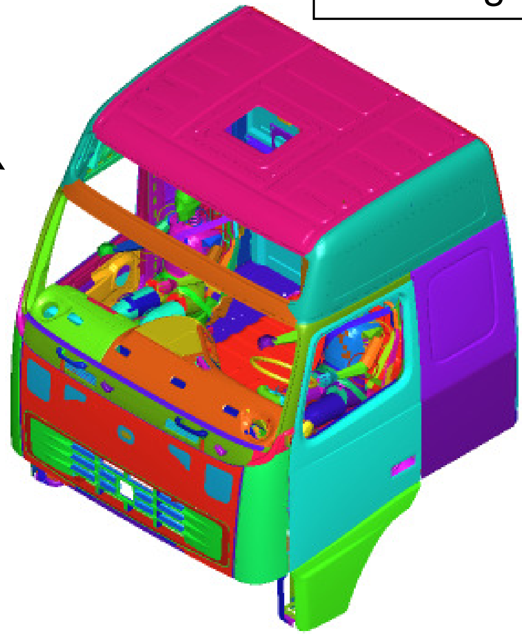
RADIOSS 5.1 solver



Complete BIW + DIW + Dummies + Dashboard + Seats + Steering column + …

Complete chassis + Engine + FUPS + Power train





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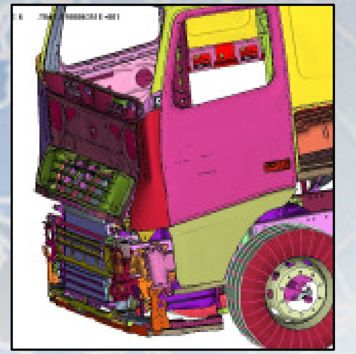
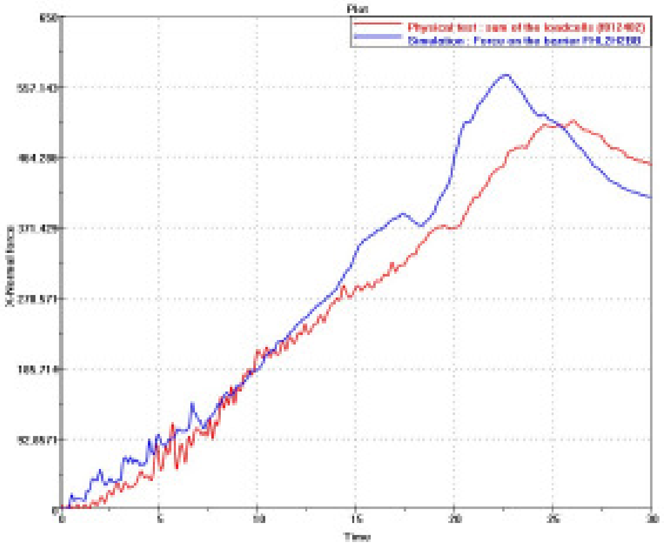
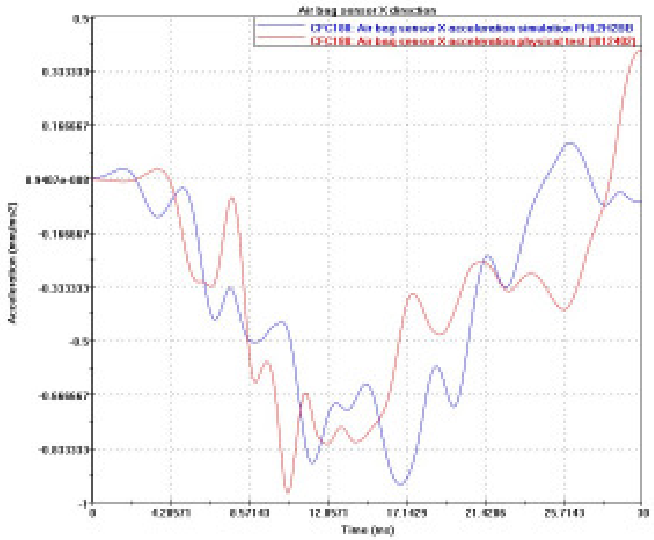
PROJECT APPLICATION: FH trucks



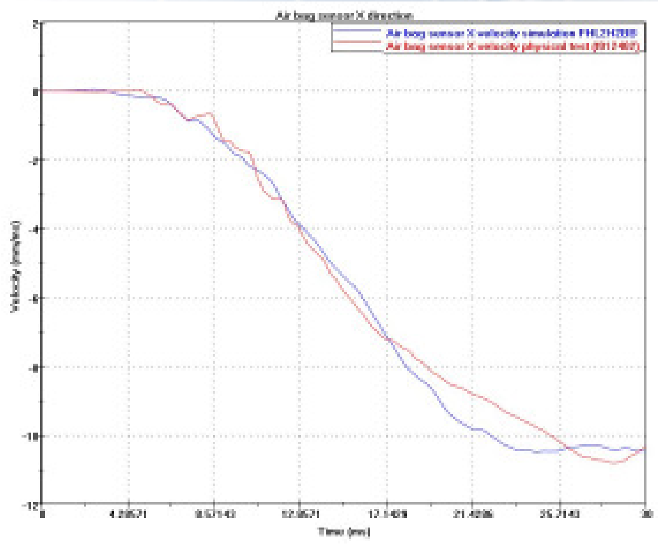
Test versus simulation **correlation**: **Simulation** / **Physical test**



BARRIER FORCE



AIRBAG SENSOR ACCELERATION



AIRBAG SENSOR VELOCITY

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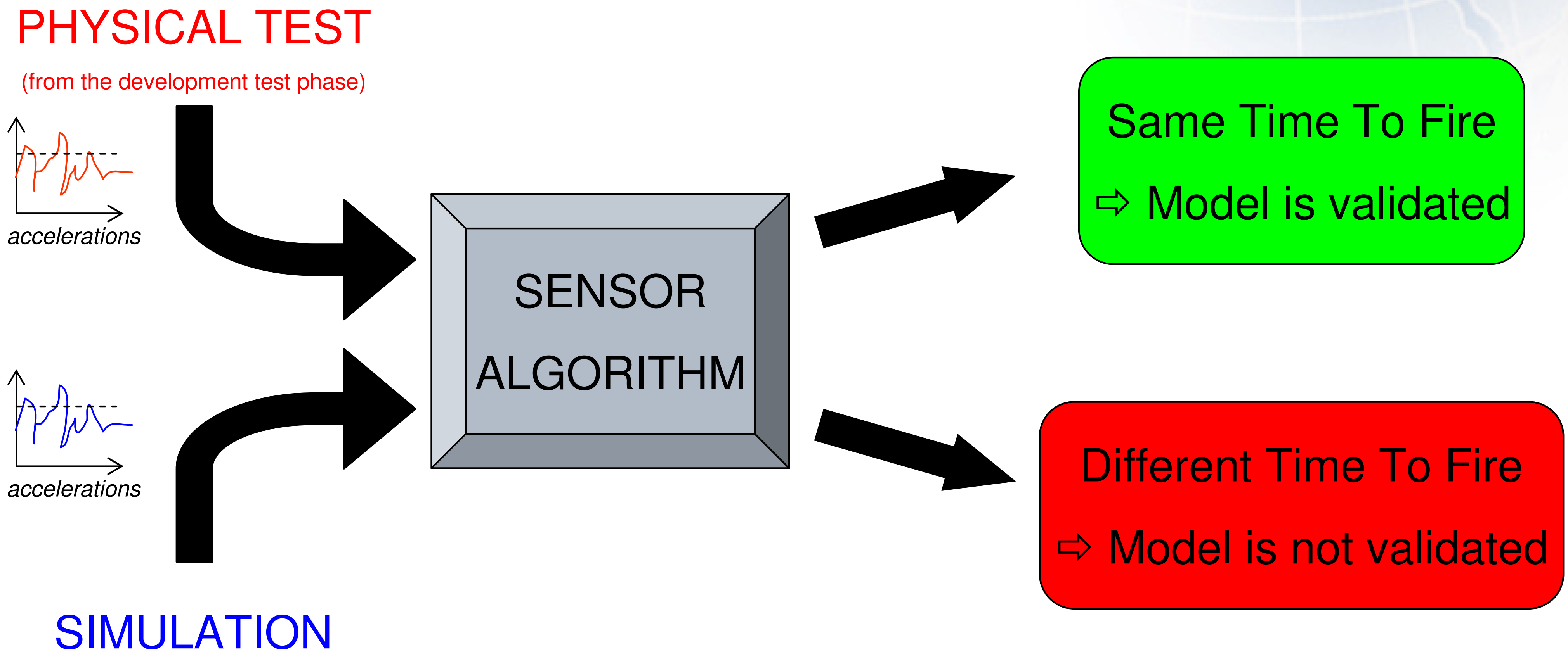
PROJECT APPLICATION: FH trucks

Test versus simulation **correlation**: validation of the model with the airbag sensor supplier



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PROJECT APPLICATION: FH trucks

Sensitivity analysis: done if the model is validated to improve the **robustness** of the algorithm

- influence of new or modified parts
- influence of cab variants
- influence of chassis variants
- influence of truck mass
- influence of test speed
- influence of barrier position (height, angle…)

Influence on the airbag *Time To Fire*
⇨ Algorithm adjustments

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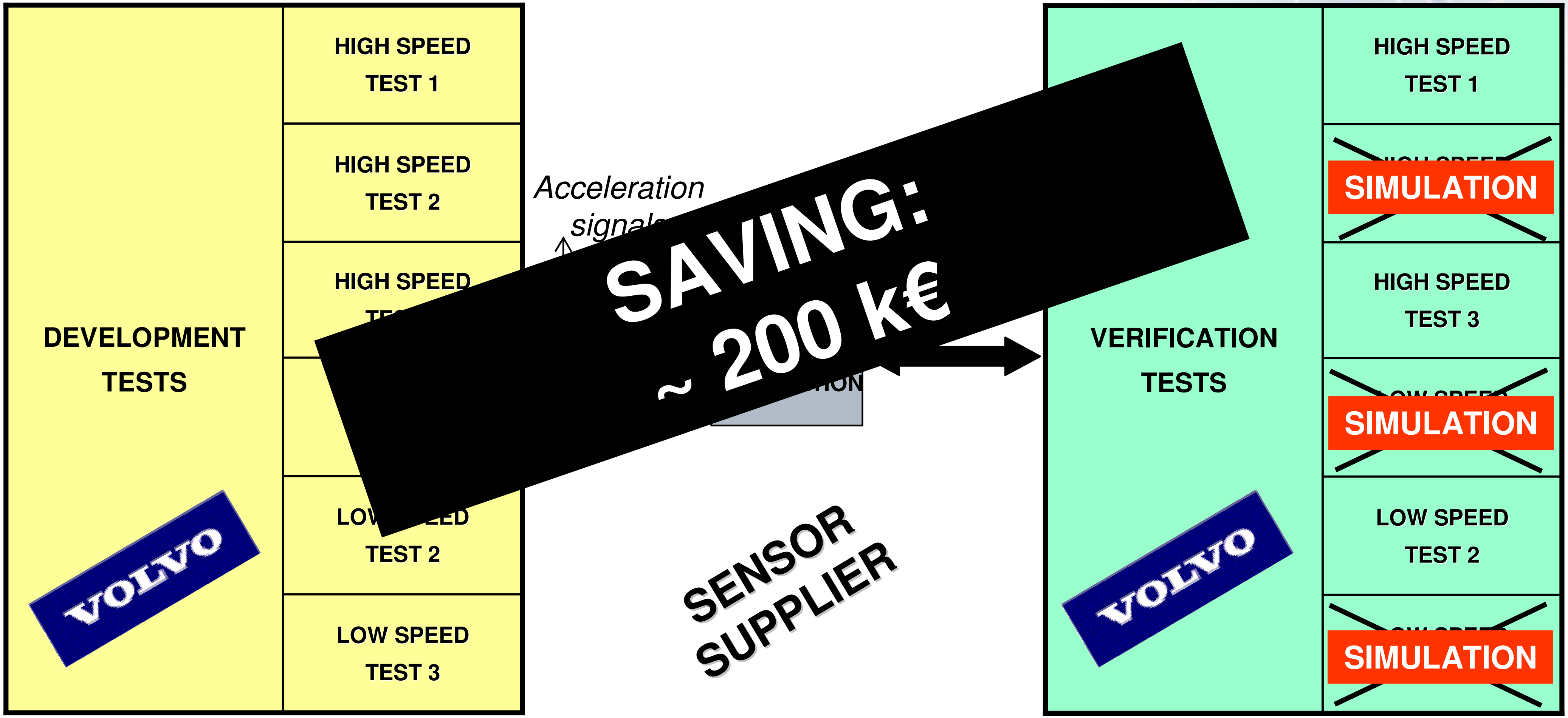
PROJECT APPLICATION: FH trucks

Airbag sensor calibration matrix



CONCLUSIONS: DIFFICULTIES ENCOUNTERED

- Level of details needed in the models (pipes, tanks, brackets…)
- Material characteristics for crash application
- Rupture, tearing (welds, glue, bolts, sheet metal…)
- Model size: 64 bits workstations and software needed
- Model size : CPU time
- Test robustness

CONCLUSIONS: CAE BENEFITS

- Many variants can be simulated (cab size, engine...)
- Details can be seen in simulation and not in test (transparent vehicle)
- The worst case scenario can be found by computation and influence the verification test configuration
- New test conditions can be tested (speed, angle...)
- Simulations will bring higher robustness to the algorithm
- Simulations can show how new introduced parts (eg Front lid in steel instead of plastic) will effect the sensor signal and the algorithm

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THANK YOU FOR YOUR ATTENTION

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BACKUP SLIDE: sampling rate

If we need 10 sampling points per period and if we want to catch accelerations up to 1500 Hz we need a sampling frequency :

$$T_{samp} = \frac{1}{10\nu} = \frac{1}{15/\mathrm{ms}} = 0.06\mathrm{ms}$$

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BACKUP SLIDE: mesh size

- We need 10 elements ($10.l_c$) per wavelength ($c.T = c/\nu$) for the highest frequency and the slowest (plastic) stress wave :

$$l_c \le \frac{c}{10\nu} = \frac{50\text{mm/ms}}{15/\text{ms}} = 3.333\text{mm}$$

- For thicknesses of 2.mm or less this is close to the mesh convergence requirement