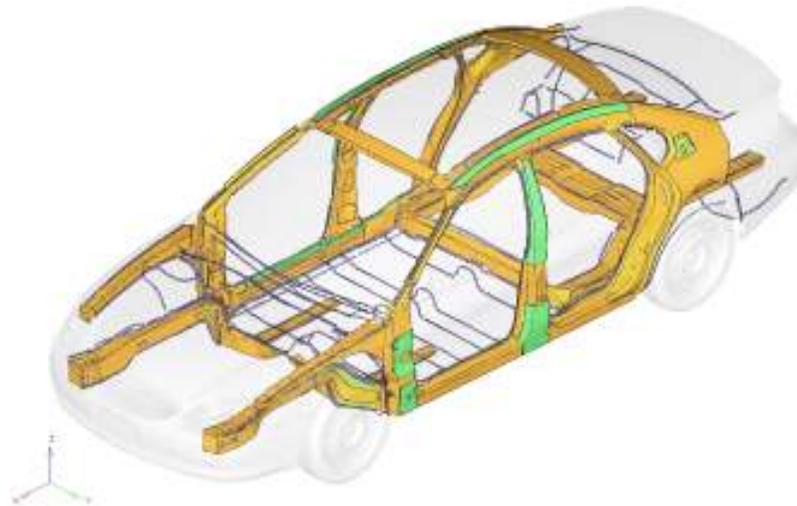


POTENTIALS OF POLYMERIC BASED BODY STRUCTURE MATERIALS IN FULL CAR CRASH

POTENTIALE POLYMERBASIERTER KAROSSERIEWERKSTOFFE IM
VOLLFAHRZEUG-CRASH



Alexander Droste, Onkareshwar Bijjargi; Deep Wang; Bob Qi

LS-DYNA Update Forum 2009, 12. November 2009, Filderstadt, Germany

Agenda:

- Motivation and introduction
- Body Structure Solutions material overview
- Scope and demonstrator selection
- Solution setups and modular model build
- IHS side impact example
- Summary and outlook

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Motivation and Introduction

Vehicles of the “next generation” [Mobility, Energy, Regulations, Markets]:

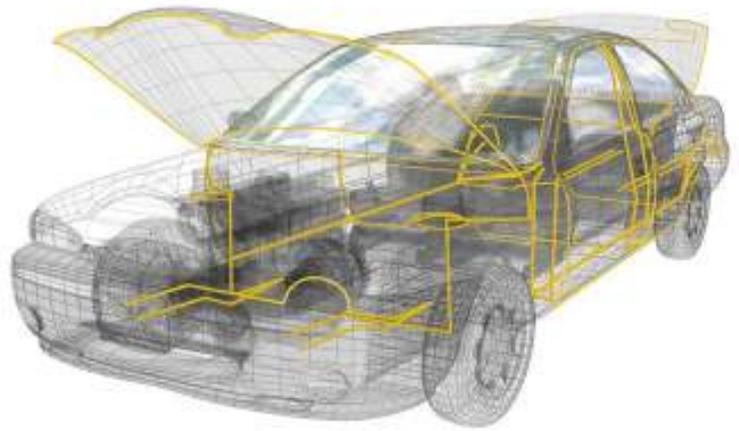
- New **package concepts** and vehicle architectures
- Module driven vehicle development
- Exploitation of further **lightweight potentials** by **advanced materials**
- Implementation of **multi-material concepts**
- Enabling **simulation of advanced materials** and **joining techniques**
- Ensuring active and **passive vehicle safety**
- Investigation of advanced urban mobility concepts
- Complete redesign of automotive production, esp. for smaller volumes

(Source: Prof. S. Gies, Trends and concepts – vehicles of the next Generation, Aachener Body Engineering Days 2009, 22nd September 2009, Aachen, Germany)

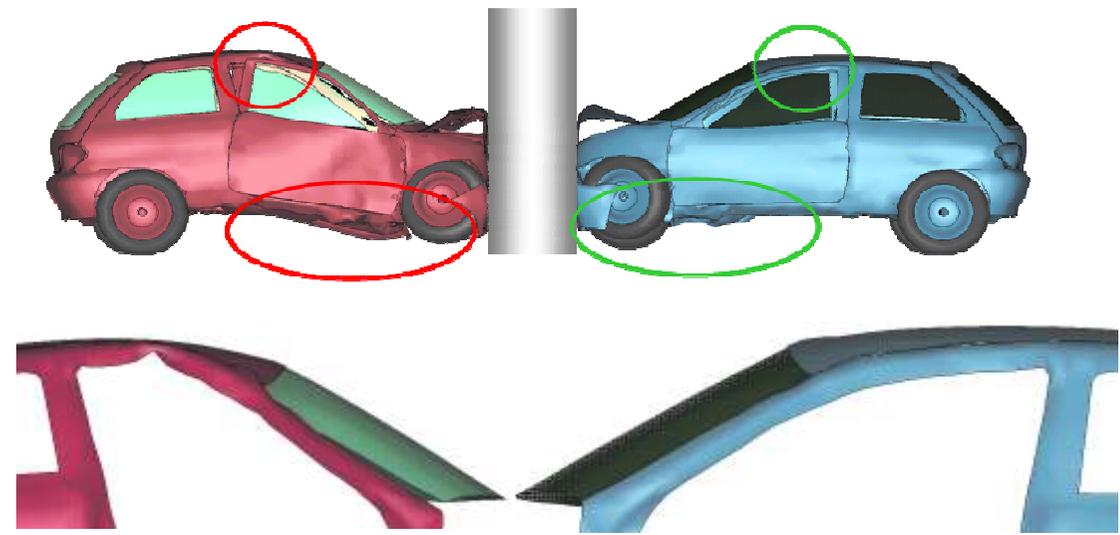
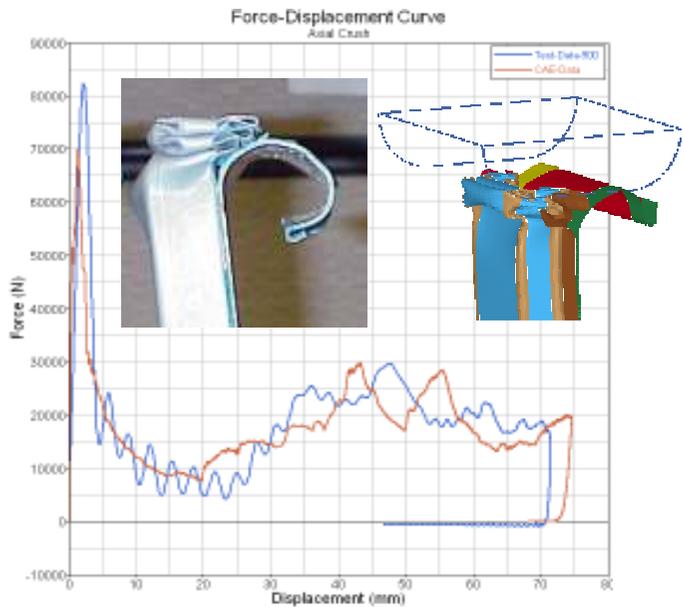
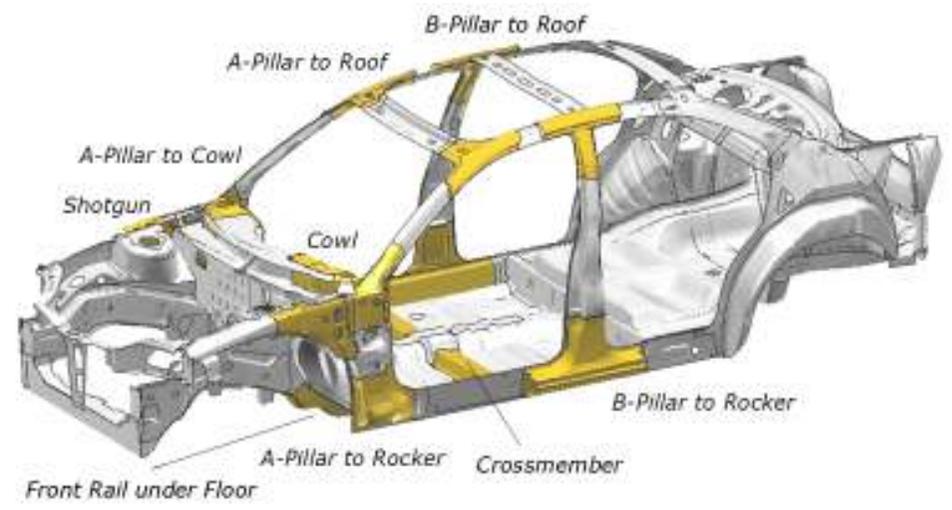
Related Polymeric based Application and Solution Development:

- In general the **basic idea** of such “next generation” application or solution developments is **independent** of a specific vehicle
- To explain the advantages and to evaluate the potentials of these polymeric materials, a **full vehicle demonstrator** is used

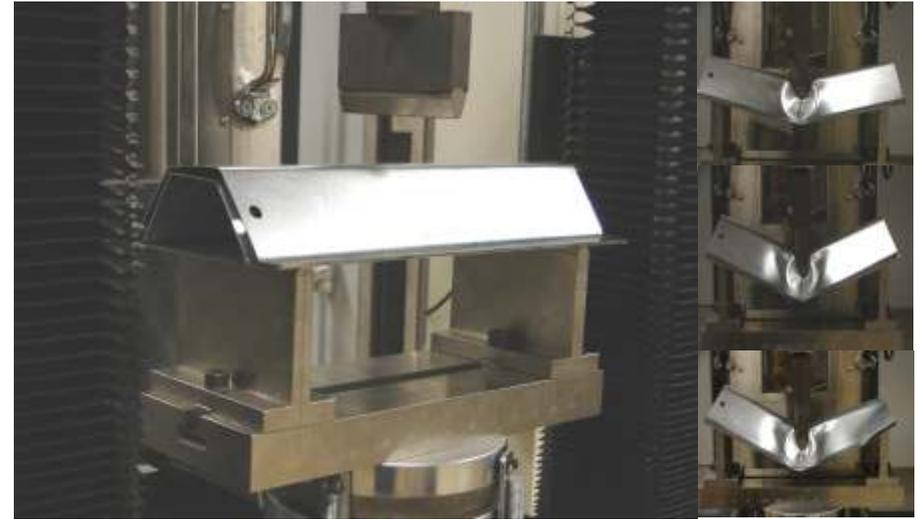
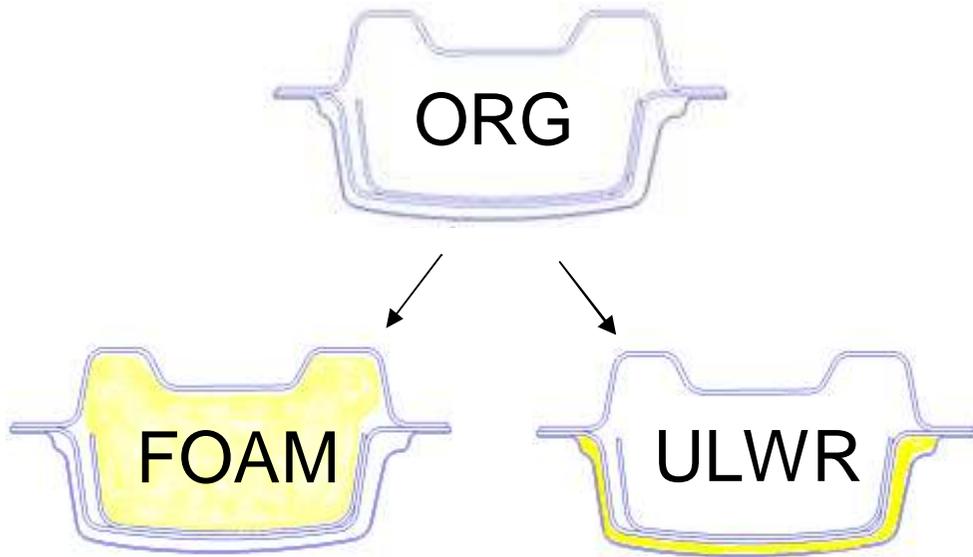
BETAMATE™ Structural Adhesives



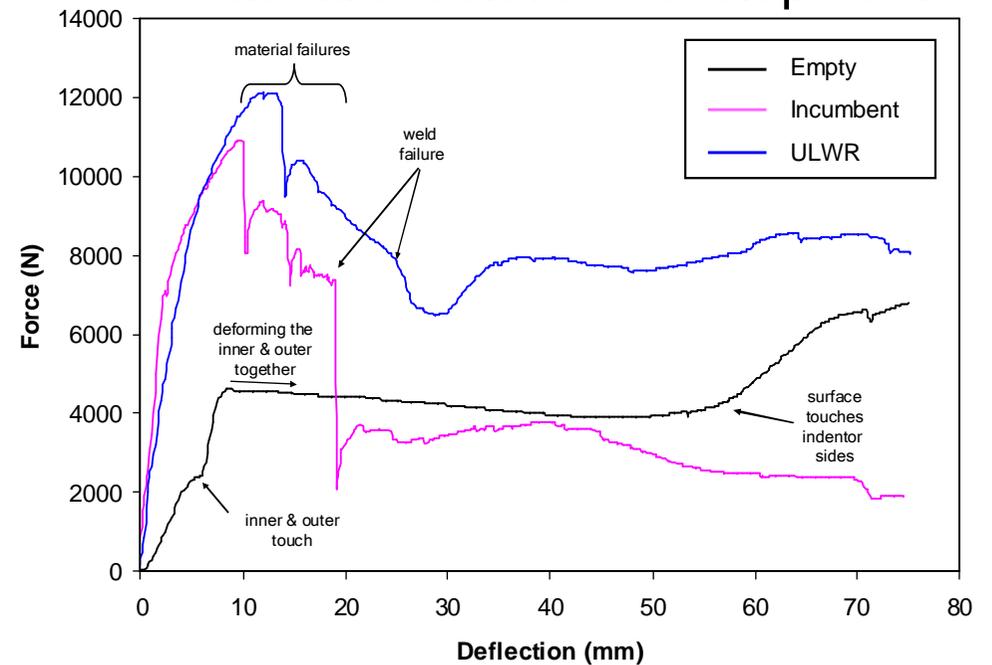
BETAFOAM™ Acoustical and Structural Cavity-Filling Foam



BETAMATE™ Ultra Light Weight Reinforcement



Material & Solution development

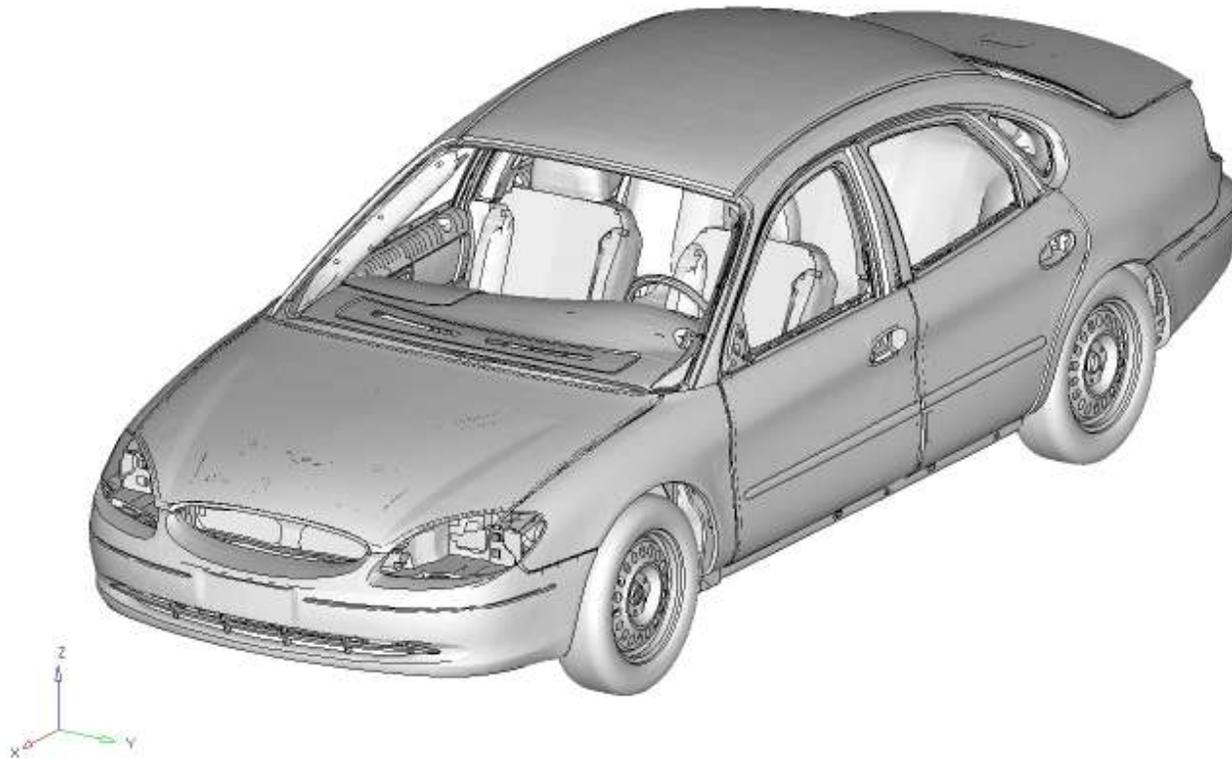


SCOPE: Analyze and optimize DOW Body Structure Solutions in a full vehicle environment by using a Demonstrator Car

Why selecting the Ford Taurus 2001 vehicle?

- Mass production mid class sedan vehicle
- 3rd model review with cleanup and refinement (2008)
- Public available from NCAC – National Crash Analysis Center

<http://www.ncac.gwu.edu/vml/models.html>

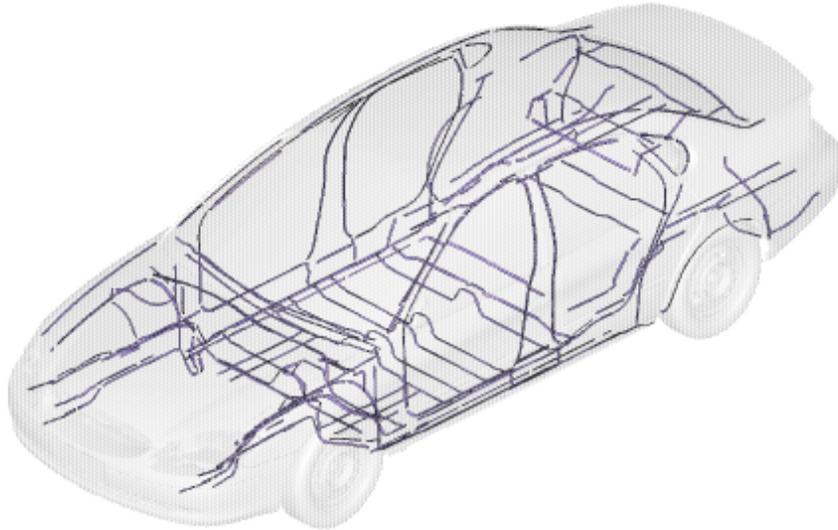


Some CAE facts:

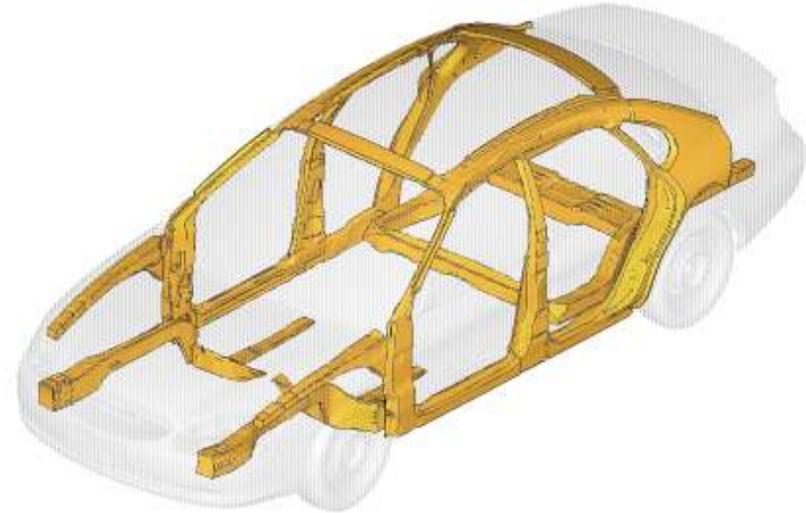
- 1 064 611 elements
- 936 259 nodes
- 795 components

Crash Durable Adhesive Setup:

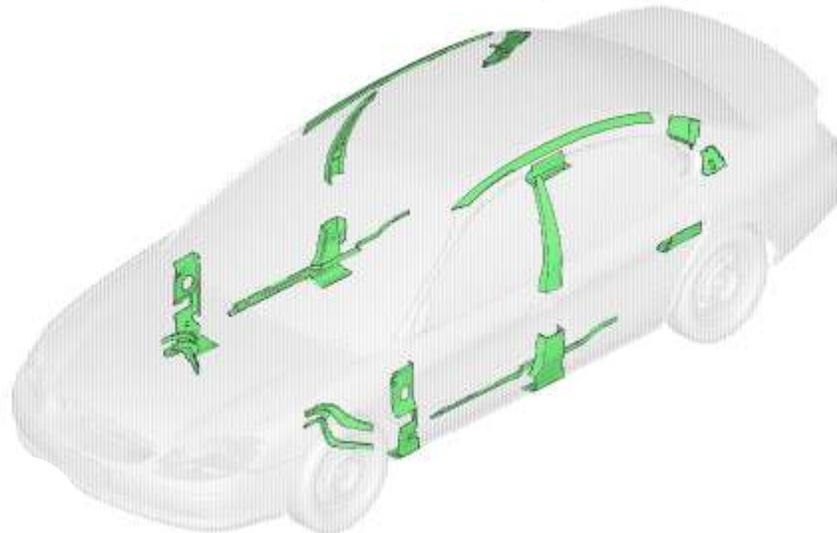
BETAMATE™ 1496 all length ~100 m

**Structural BEATFOAM Setup:**

BETAFOAM™ 89100/124 all cavity 82.9 kg

**Ultra Light Weight Reinforcement Setup:**

BETAMATE™ ULWR all gap/edge 4.2 kg



Modular approach LS-DYNA

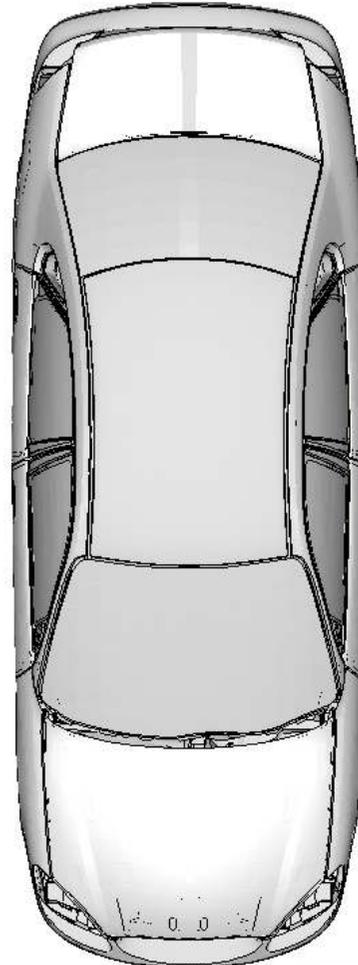
Vehicle Model
Ford Taurus 2001
by NCAC

Master and Control file

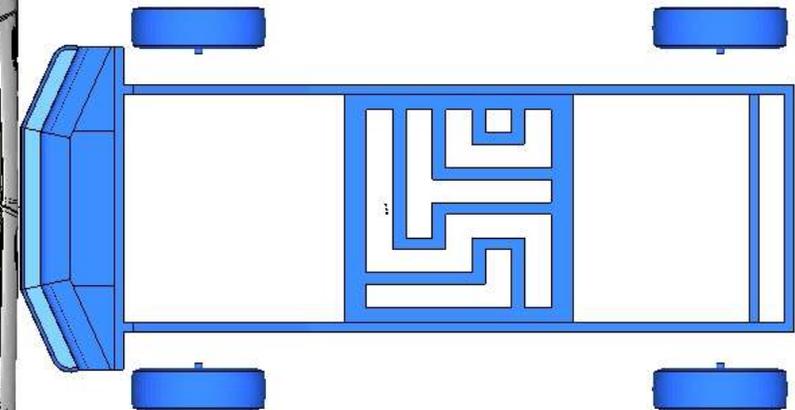
```
Master odb.k - WordPad
File Edit View Insert Format Help
[Icons]
[Master File of ODB simulation]
*KEYWORD
*CONTROL_TERMINATION
$$ EBDTIN EBDCTC DTMIN ENDING ENIMAS
0.14
*CONTROL_TIMESTEP
$$ DTIME TSSFAC ISDO TSLINT DTMS LCTM ERODE MSIST
0.0 0.0 01.0000E-06-1.000E-06
0.0 0
*CONTROL_SHELL
$$ NSPARM ESORT IRSDX ISTUPD THEORY SMC NITER PROJ
0.0 1
1.0 0 0 1
0 0
*CONTROL_HOURLASS
$$ ISQ QS
1 0.1
*CONTROL_SOLID
```

Loadcase, Contact and Output

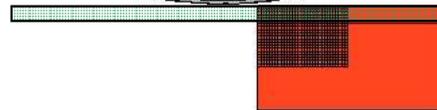
```
Contact_load_nodehistory.k - WordPad
File Edit View Insert Format Help
[Icons]
*KEYWORD
*CONTACT_SINGLE_SURFACE_ID
$MSNAME GROUPS $$$$$$Barrier_Vehicle
$MNCOLOR GROUPS $$$$$$ 1
$$$$$$ 1
$$$$$$ 2
0.2 0.1
1
2 1
*SET_PART_LIST
$MSSET
$MSNAME SETS $$$$$$Barr_Vehicle
$$$$$$
$$$$$$ 6000001 6000002 6000003 6000004 2000012 2000013 2000014
2000015 2000016 2000017 2000018 2000021 2000022 2000024 2000025
2000027 2000028 2000029 2000035 2000036 2000038 2000042
```



Insurance Institute for Highway
Safety (IIHS) side impact Barrier
by LSTC



Rigid Barrier by NCAC
(Baseline)

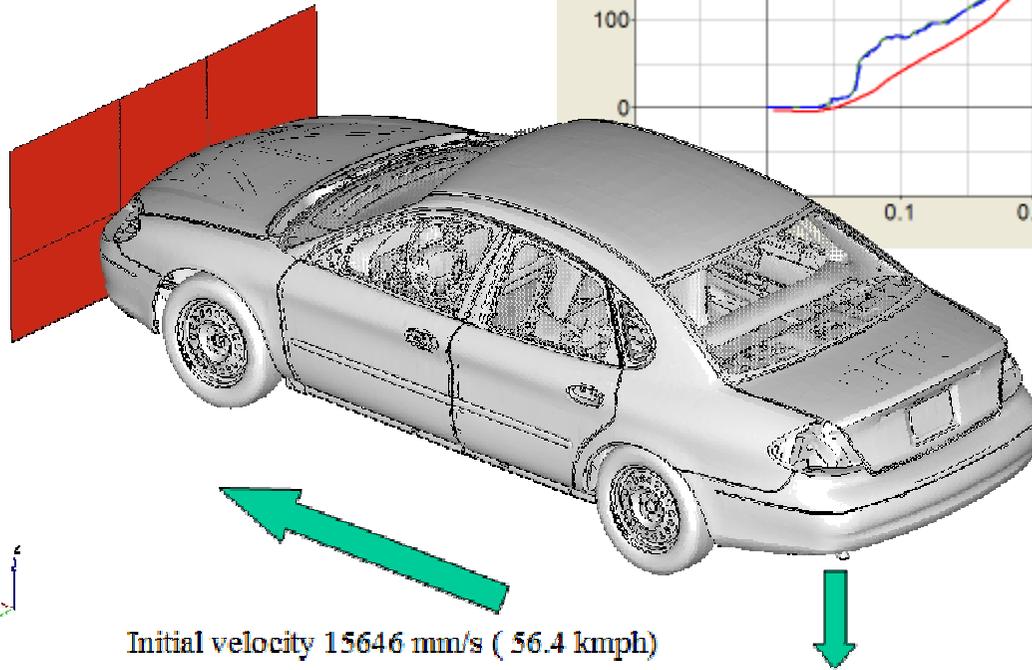
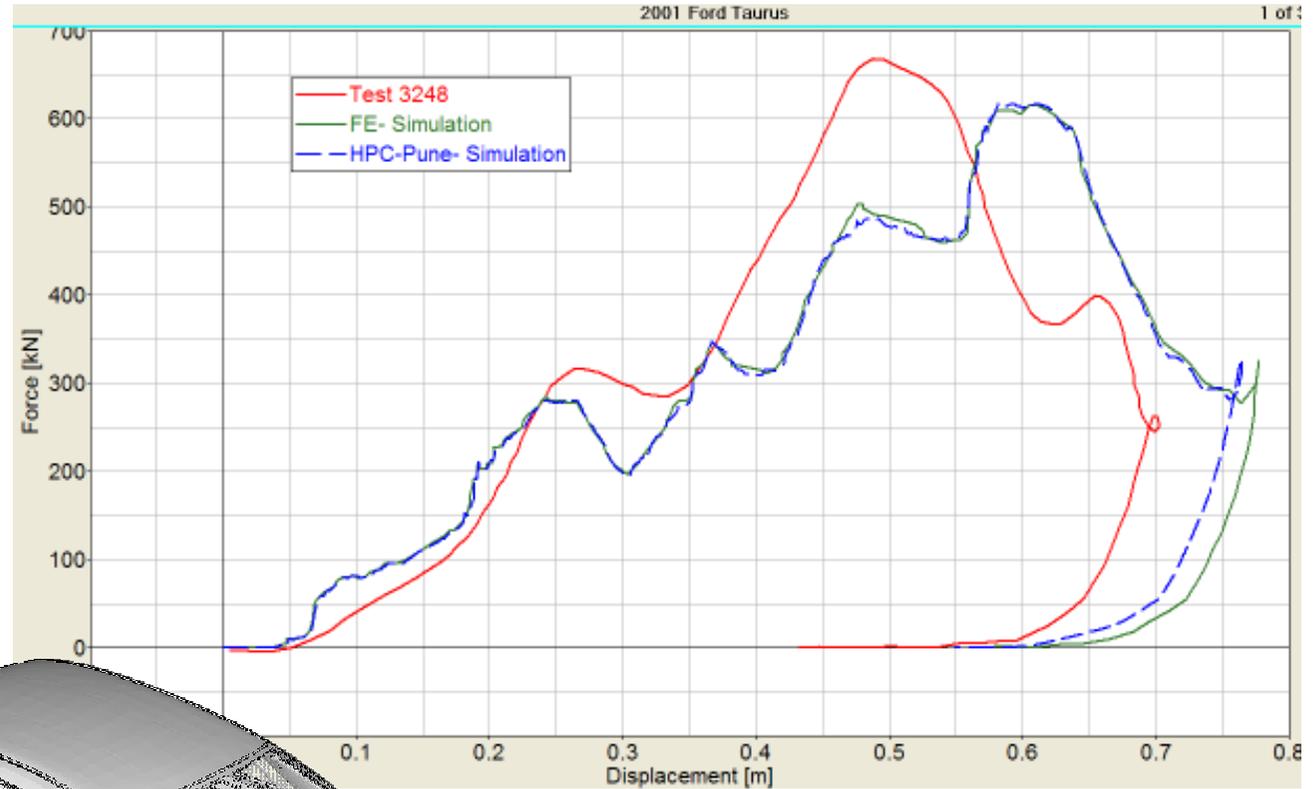


Frontal Offset Deformable Barrier
(ODB) by LSTC



Baseline Verification

Baseline Original: NCAC
LS-DYNA
 Version: mpp971s R2
 Revision: 7600.1224
 Platform: SGI Altix Workstation IA64
 OS level: Linux 2.4(64 bit)
 Precision: Single precision (I4R4)
 Total CPU time: ~ 14 hrs (for 150 ms)
 Number of processors: 12



Initial velocity 15646 mm/s (56.4 kmph)

Gravity load 9810 mm/s²
 (Entire vehicle)

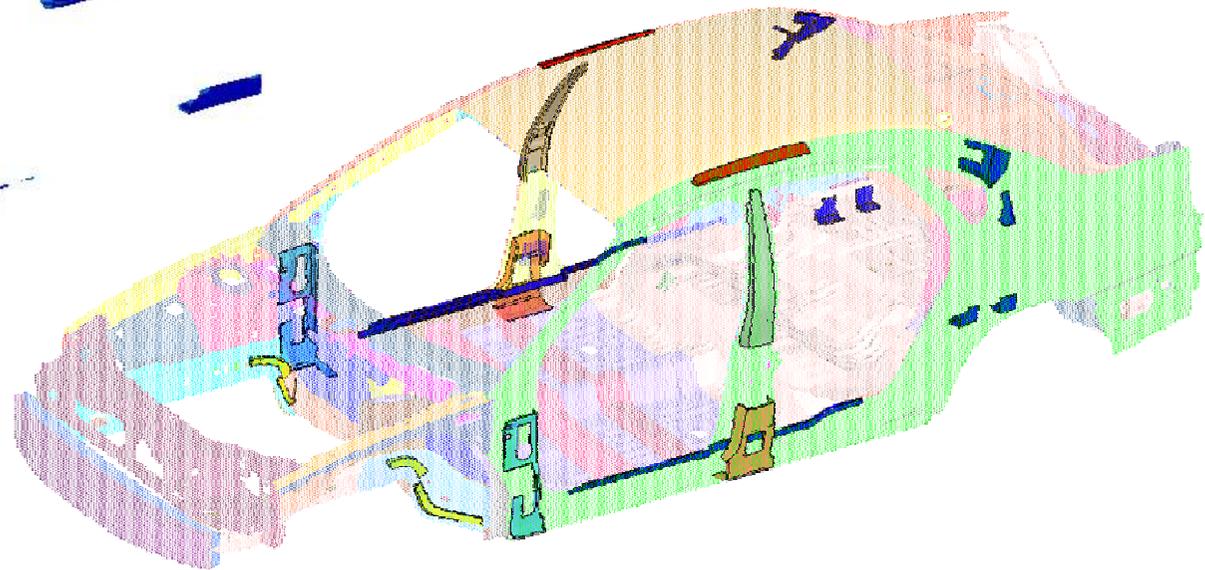
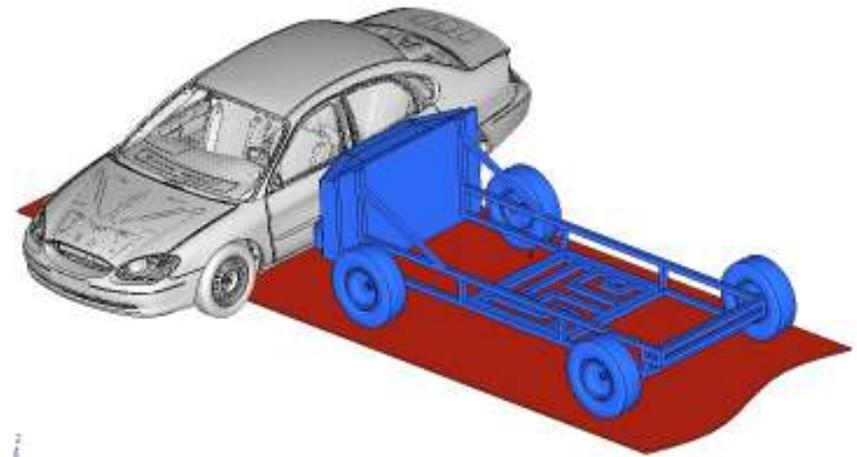
Baseline HM exported: DOW
LS-DYNA
 Version: mpp971s R2
 Revision: 7600.1224
 Platform: HPC - Pune, Linux Workstation Intel-Xeon64
 OS level: RH EL 4 upd 3 (MPICH 1.2.6)
 Precision: Single precision (I4R4)
 Total CPU time: ~ 11 hrs
 Number of processors: 16

Example: ULWR IIHS Side Impact Optimization for weight reduction potential

Contour Plot
Stress(vonMises, Max)
Global System
Advanced Average

2.414E+01
2.146E+01
1.876E+01
1.610E+01
1.341E+01
1.073E+01
8.048E+00
5.365E+00
2.683E+00
3.810E-05

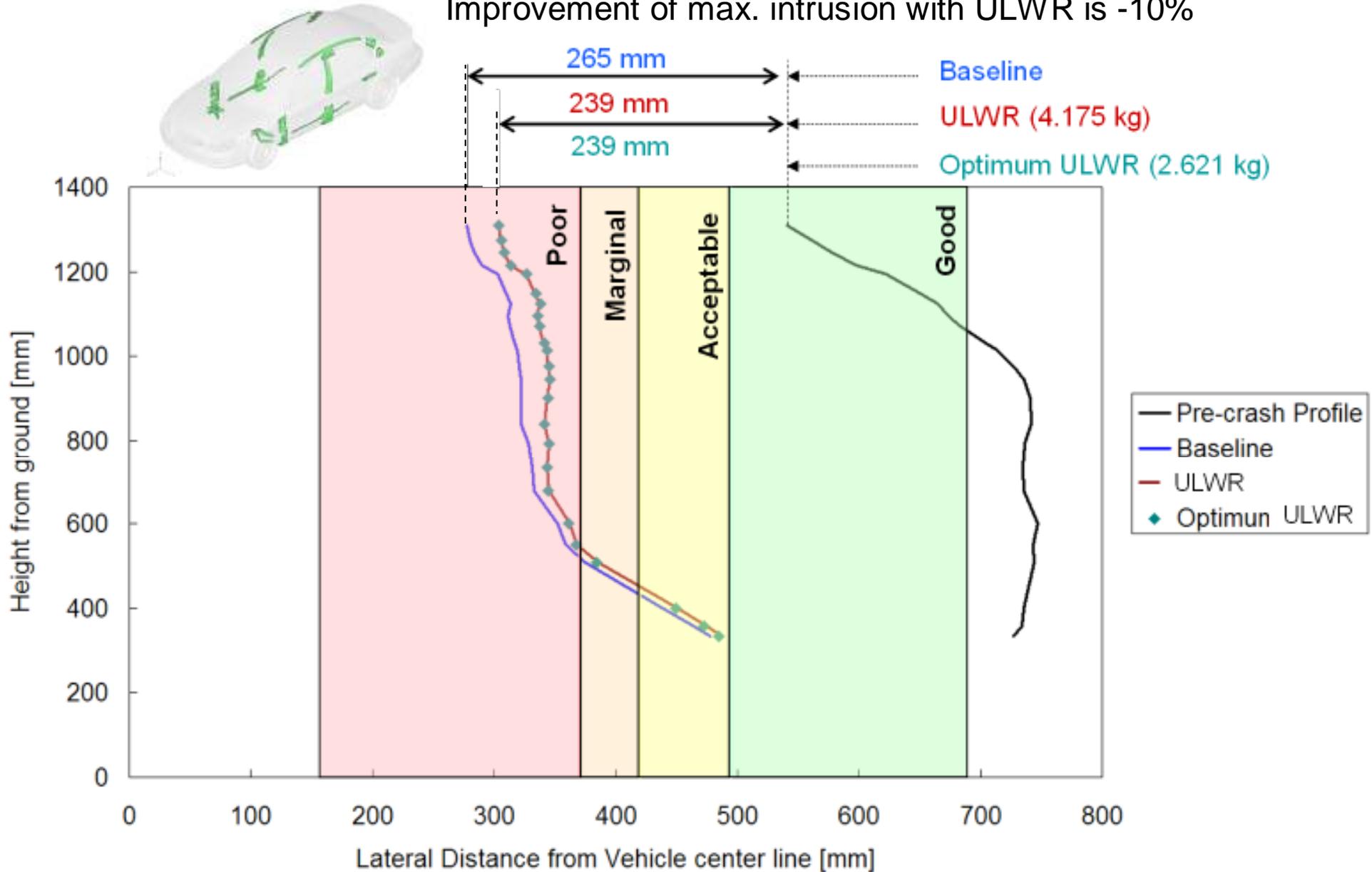
■ No result
Max = 2.414E+01
Node 2175291
Min = 3.810E-05
Node 2336948



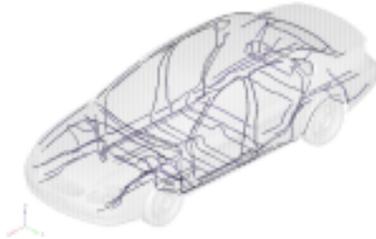
**Total Weight: 2.621 kg
(37% weight saved)**

B-Pillar Intrusion (ULWR)

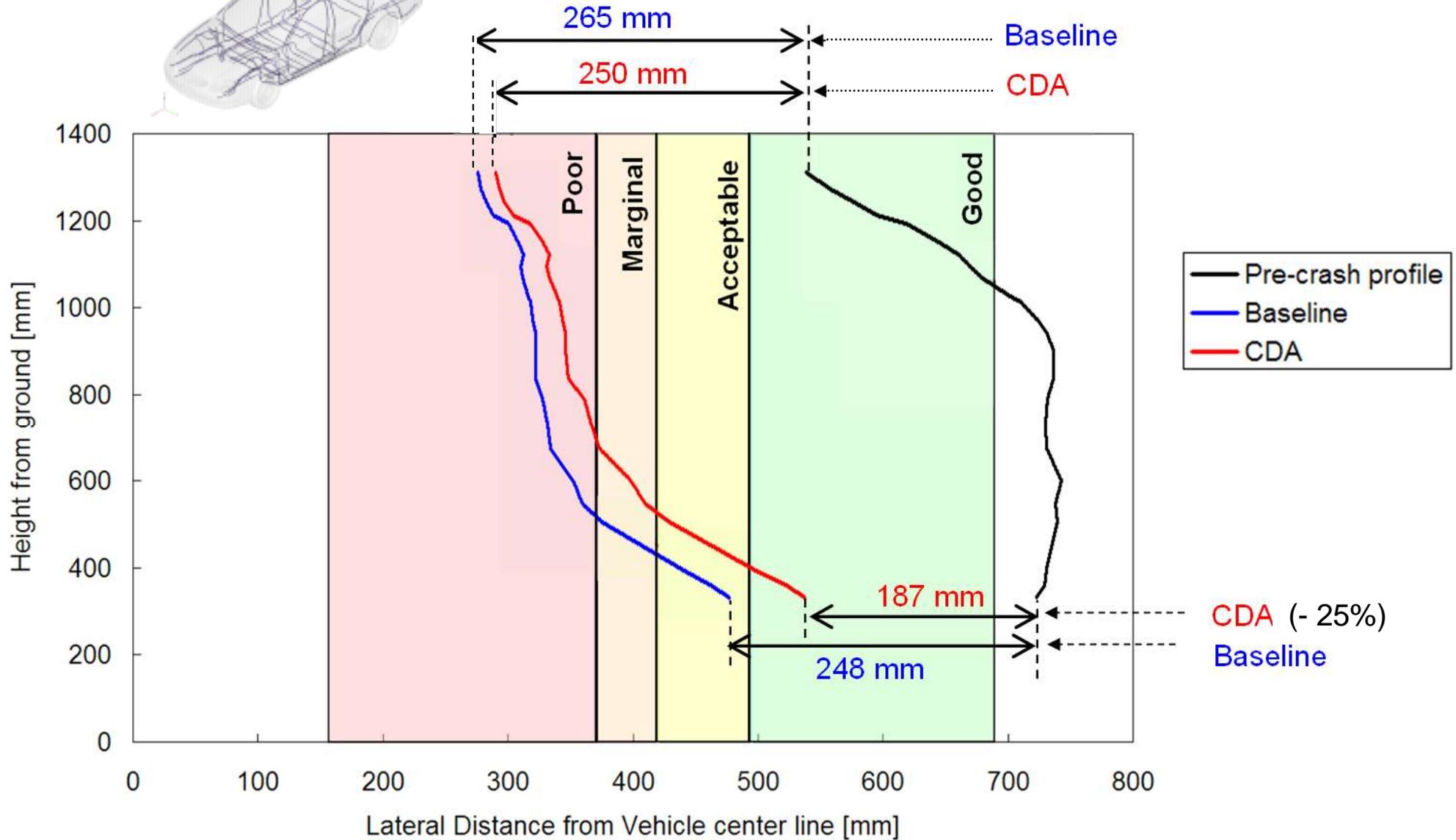
Improvement of max. intrusion with ULWR is -10%



B-Pillar Intrusion (CDA)

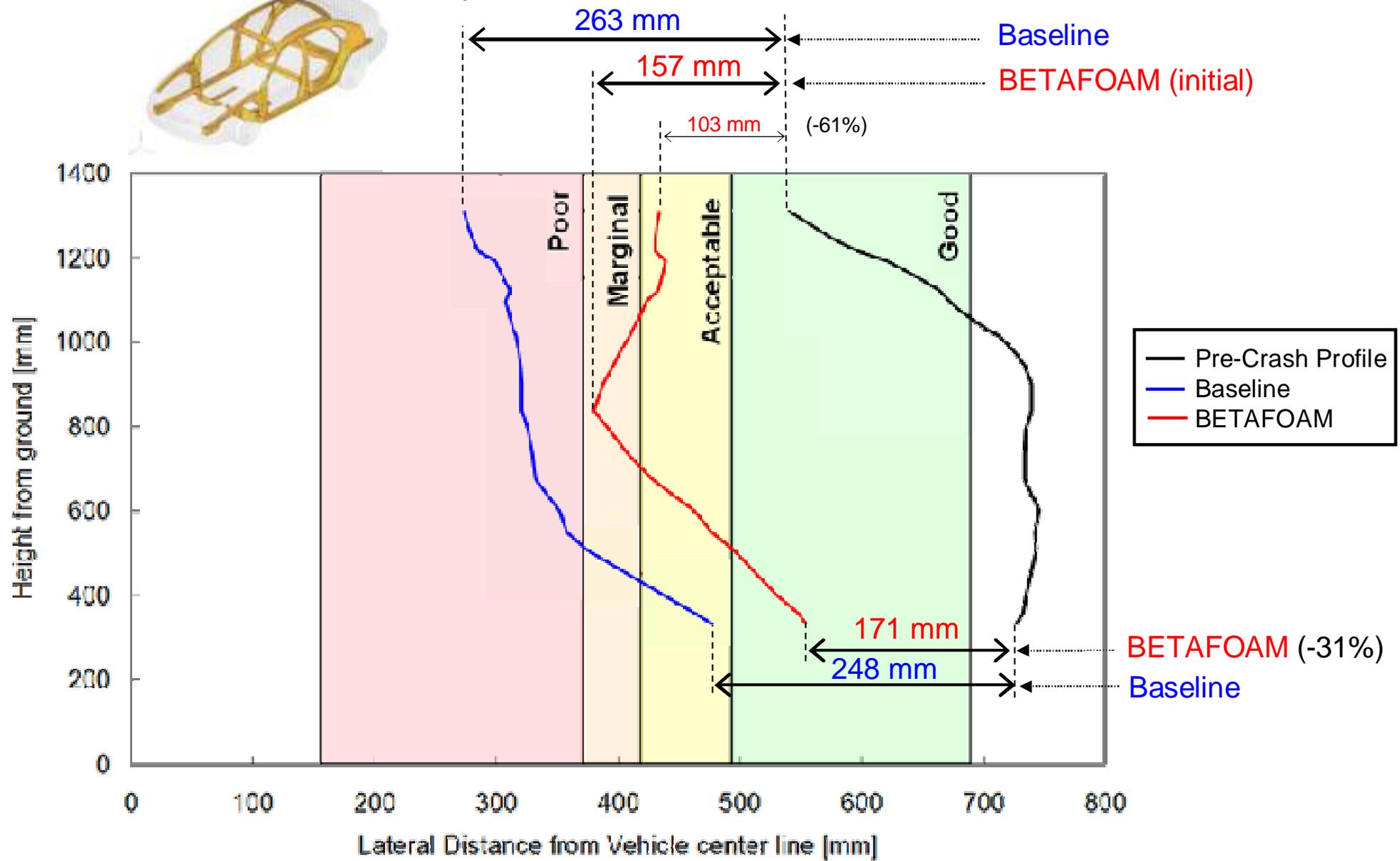


Improvement of max. intrusion with CDA is - 6%



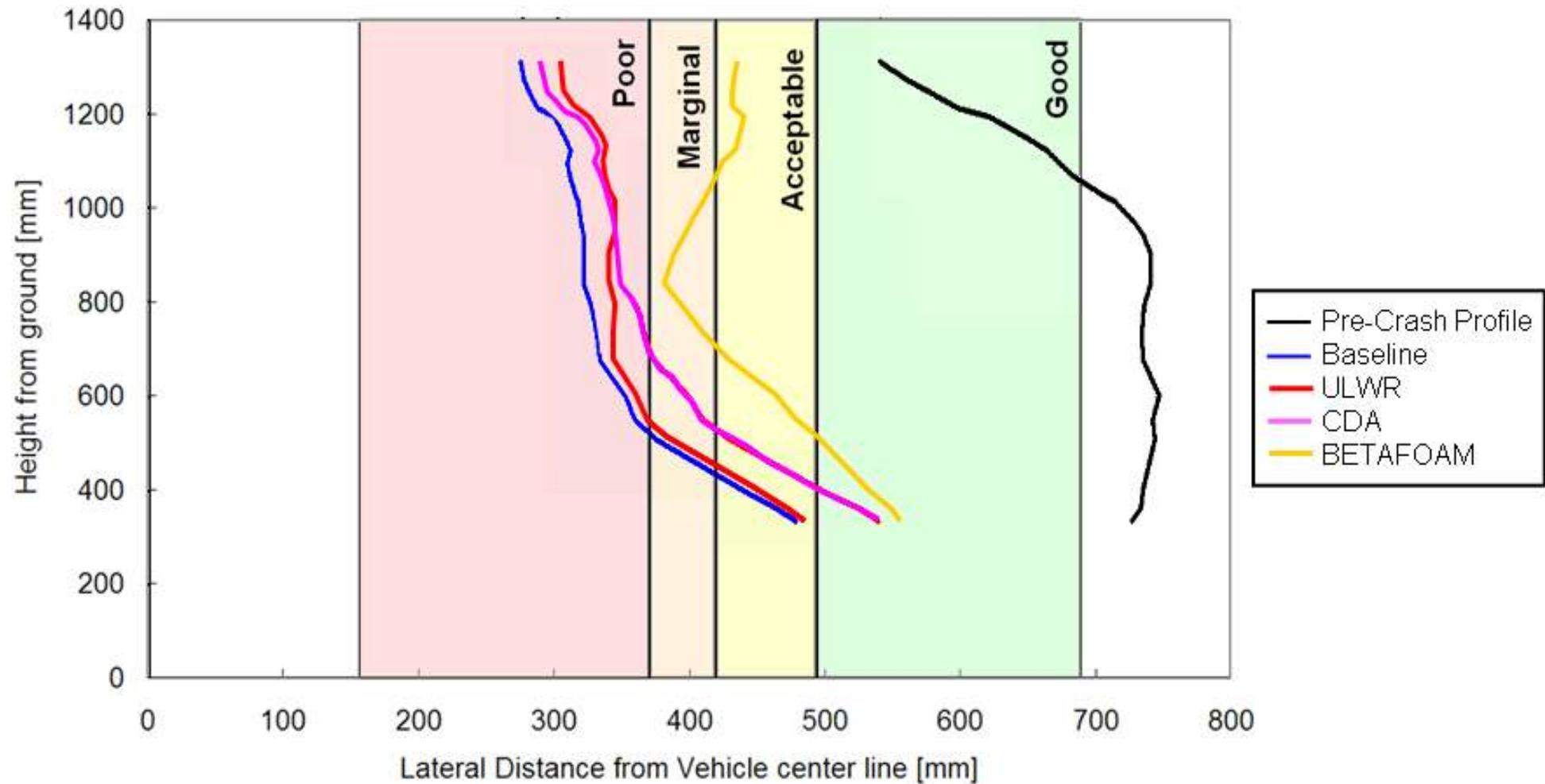
B-Pillar Intrusion (BETAFOAM)

Improvement of max. intrusion with BETAFOAM is -40%



B-Pillar Intrusion (comparing)

reducing max. intrusion: **ULWR** (10%), **CDA** (6%), **BETAFOAM** (40%)



Further optimization of all solutions is ongoing

Summary and Outlook:

- A full vehicle demonstrator (Ford Taurus model year 2001 by the NCAC) is used to examine and optimize the development capabilities of automotive materials and solutions
 - The full vehicle model demonstrates qualitative benefits of new material and solution based developments
 - Limitations can be seen on the quantitative potential as the vehicle model is from 2001 and not represents latest state-of-the-art design
 - Optimization objectives depend on design strategies and performance targets including weight and costs. The demonstrator approach enables to study and present related methods
-
- Additional load cases like rear and roof crash as well as the pole impact should be added
 - Further optimization strategies should be discussed in cooperation with OEMs and Tiers

Plotting Your Course –

Application Development and Engineering

Design conceptualization,
material selection, fabrication
methodology validation

On-site support at customer
facilities ensures our products
meet or exceed design and
engineering requirements

