Informal document No. **GRSP-45-15**
(45th GRSP, 25-29 May 2009
agenda item 16(a))

ANSWERS ABOUT ISSUES ON R94 AMENDMENT

French Experts

May 2009

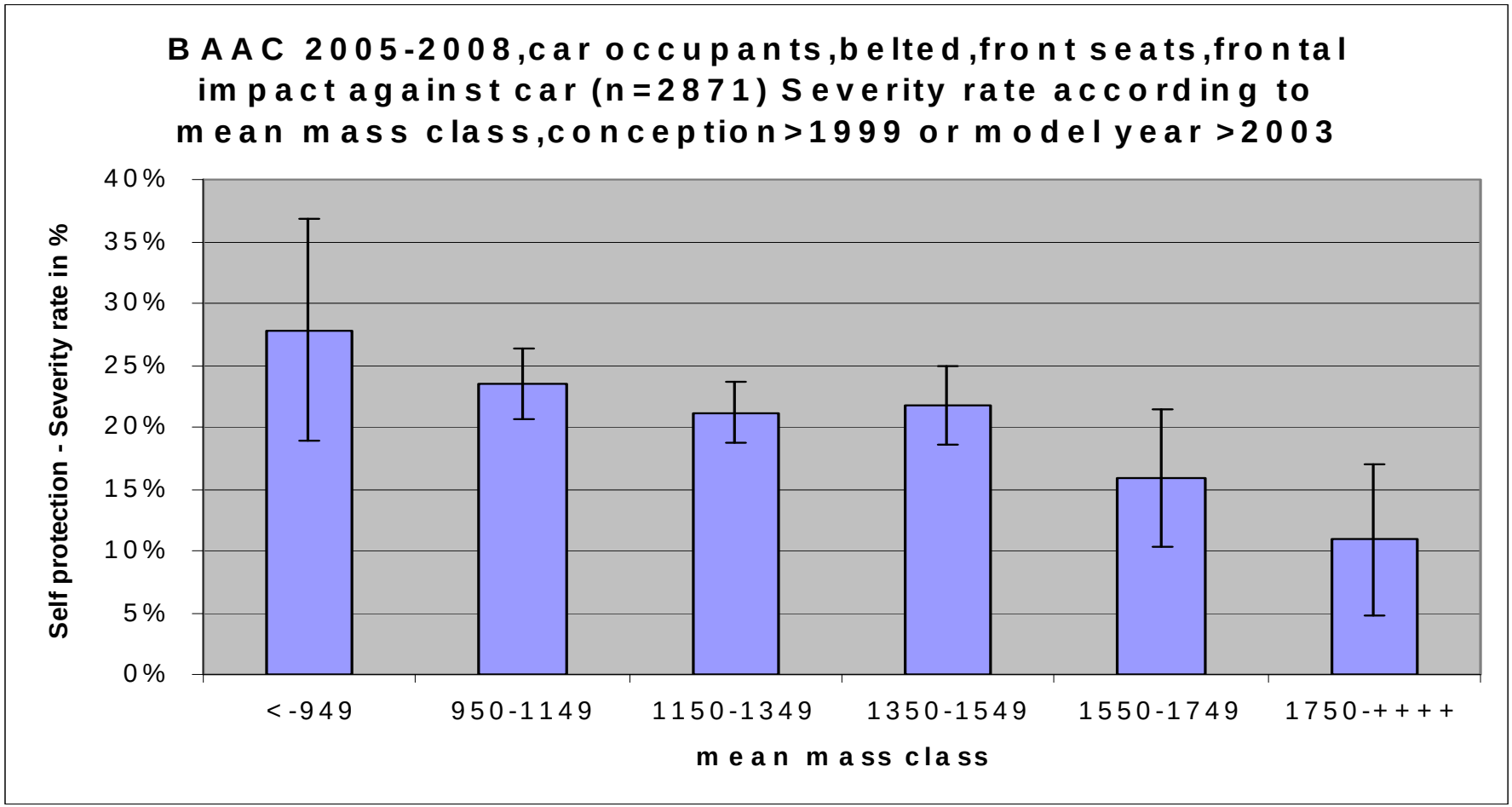
Agenda

- Accident analysis
- Harmonization of Frontal impact
- Test severity of R94 amendement
- Assessment of occupant restraint system with PDB test
- Testing with the current PDB design
- Passive Safety Benefit
- Design of future vehicle

Issue 1:
ACCIDENT ANALYSIS

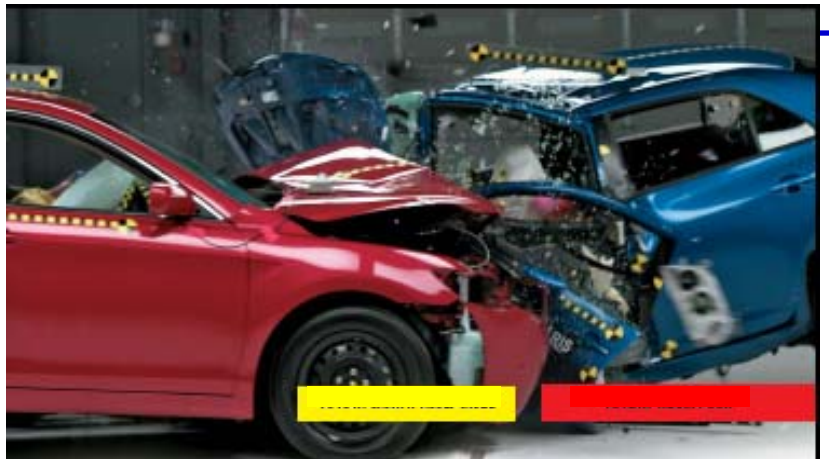
Is an accident analysis needed to update information on changing vehicle fleet?

PROBLEM IDENTIFICATION



➢ SEVERITY RATE IS MASS DEPENDENT FOR R94 CAR DESIGN

PROBLEM IDENTIFICATION



➢self protection level differences were also observed in crash tests

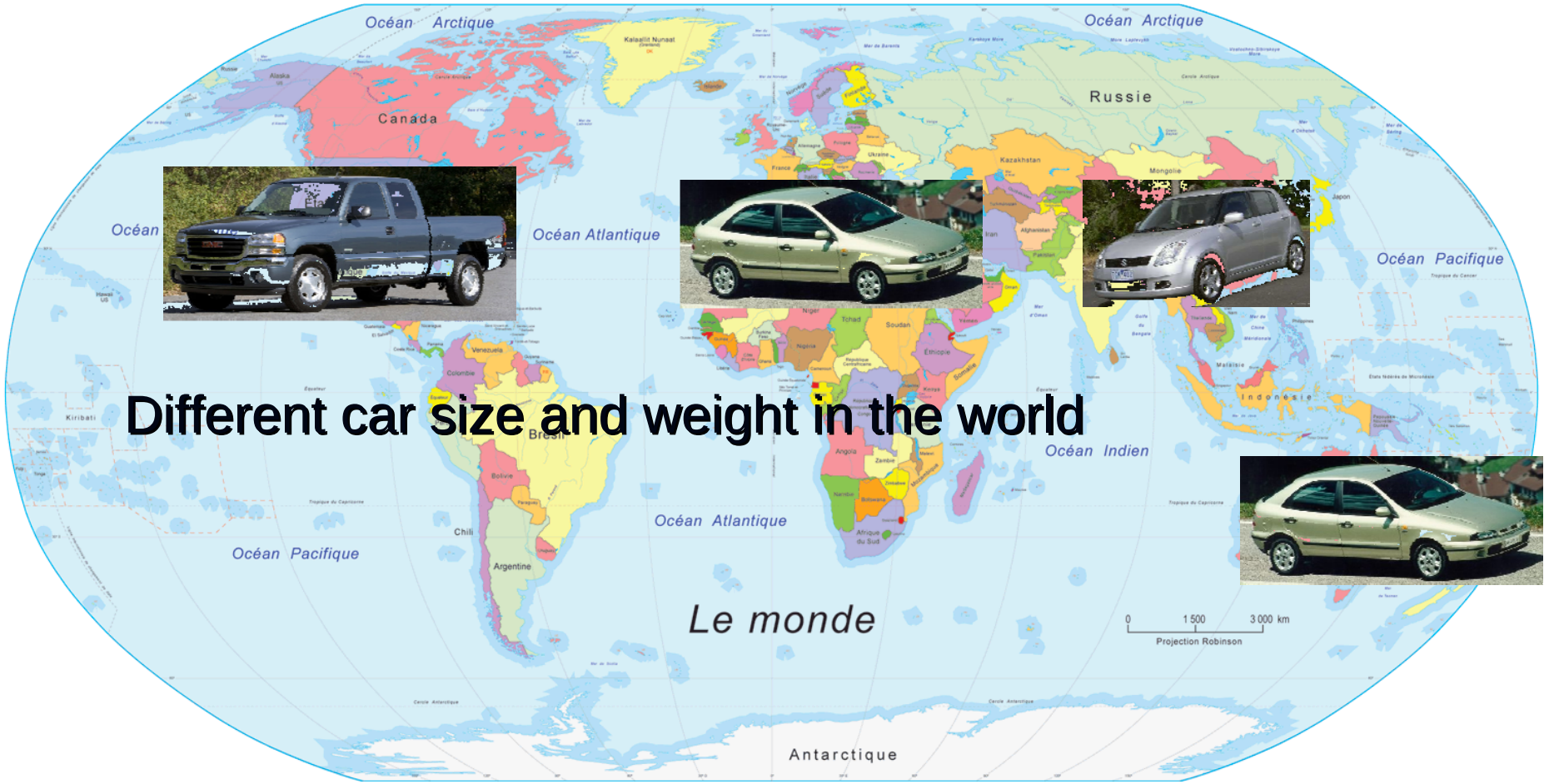
CONCLUSION OF ISSUE 1

- Different front end force and compartment force design lead to incompatible energy distribution in car to car configuration
- Problem still exists for “R94 fleet” generation
- Problem was confirmed by different worldwide organizations, different working groups and countries.

Issue 2:

Harmonisation of frontal impact procedure

HARMONISATION



Different car size and weight in the world

⇨ Current obstacle is not adapted for harmonization

CONCLUSION OF ISSUE 2

- Different fleet, size vehicle and mass around the world
- Obstacle has problems with bottoming out and weak stiffness can not be adapted for worldwide harmonization
- PDB shows that it is convenient and adapted for light cars to heavy vehicles

Issue 5:

Validate that PDB Test guarantees a minimum EES test severity for all vehicles

PDB GUARANTEE MINIMUM EES

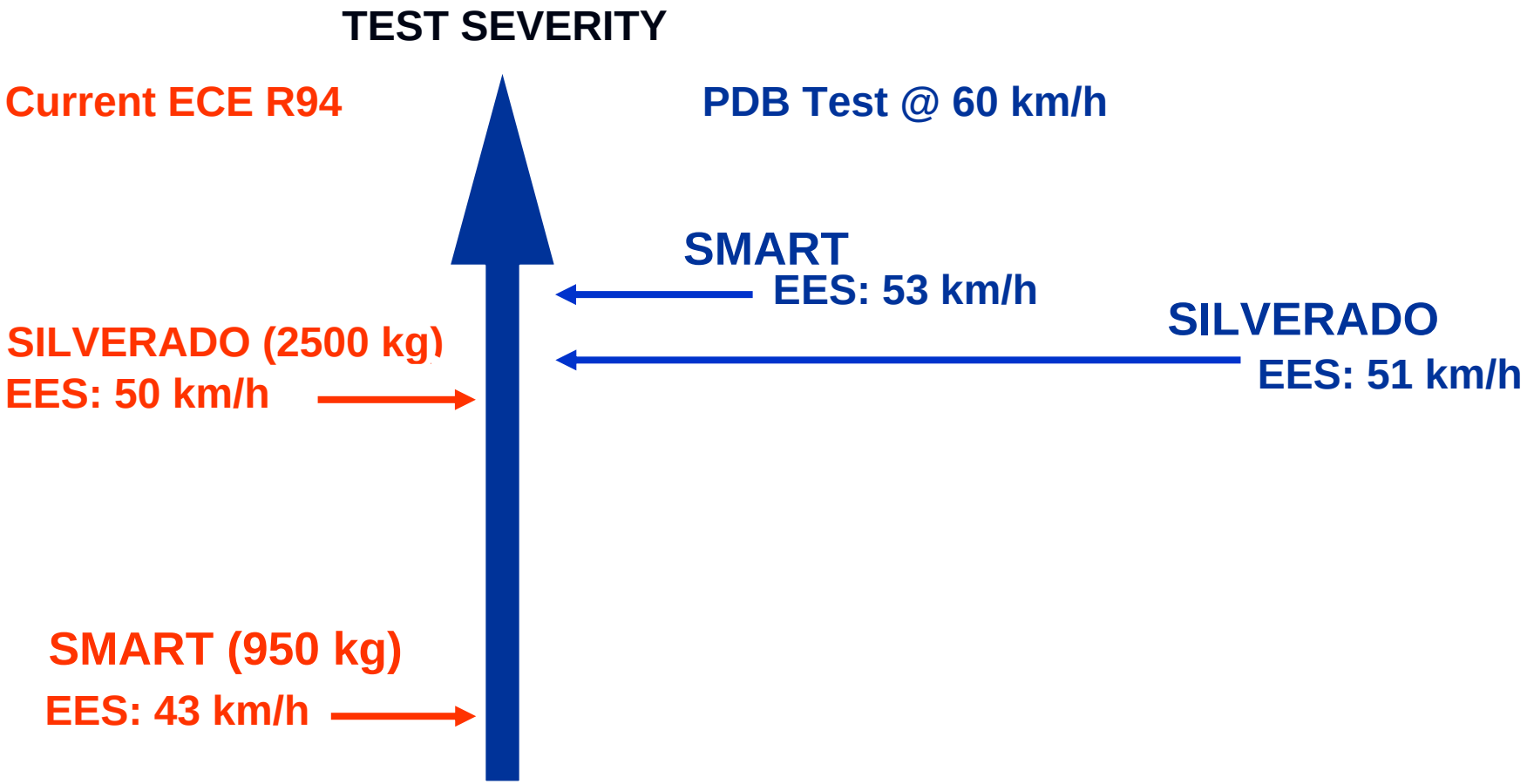
(VC-Compat test)

⇨ The Smart, known for its high stiffness factor doesn't put so much energy in the barrier.

PDB GUARANTEE MINIMUM EES

⇨ Large pick up known for its high front end stiffness doesn't put so much energy in the barrier

PDB GUARANTEE MINIMUM EES



- Self protection of the light car elevated (+ 20%)
- Self protection of the heavy vehicle is quite constant

CONCLUSION OF ISSUE 2

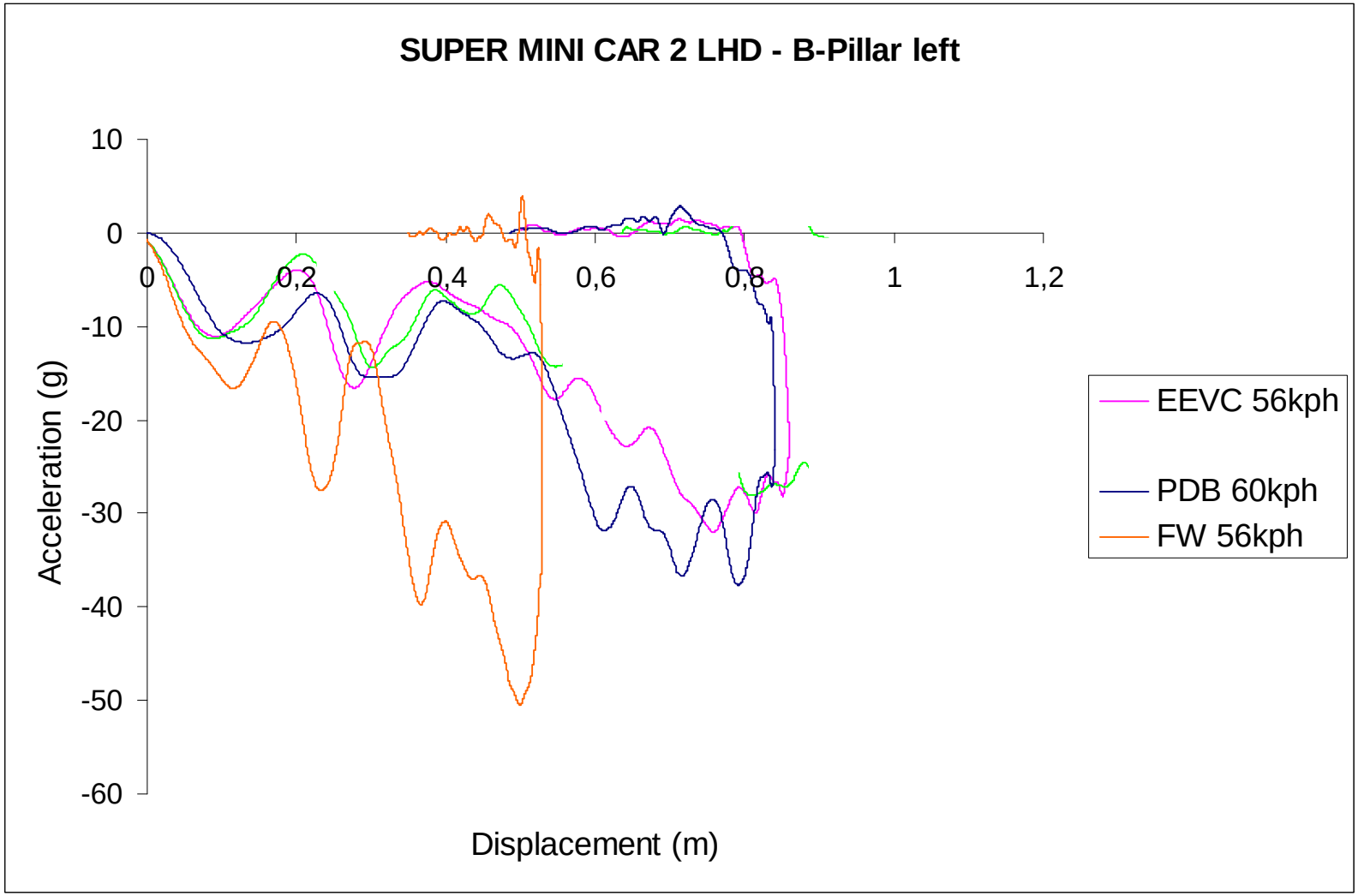
- Self protection level of a stiff light car is increased according to the combination of speed and deformable element stiffness.
- Self protection level of the stiff heavy car is not affected
- By design, PDB is able to guarantee a minimum self protection level (associated to reasonable and common design rules used by car makers).

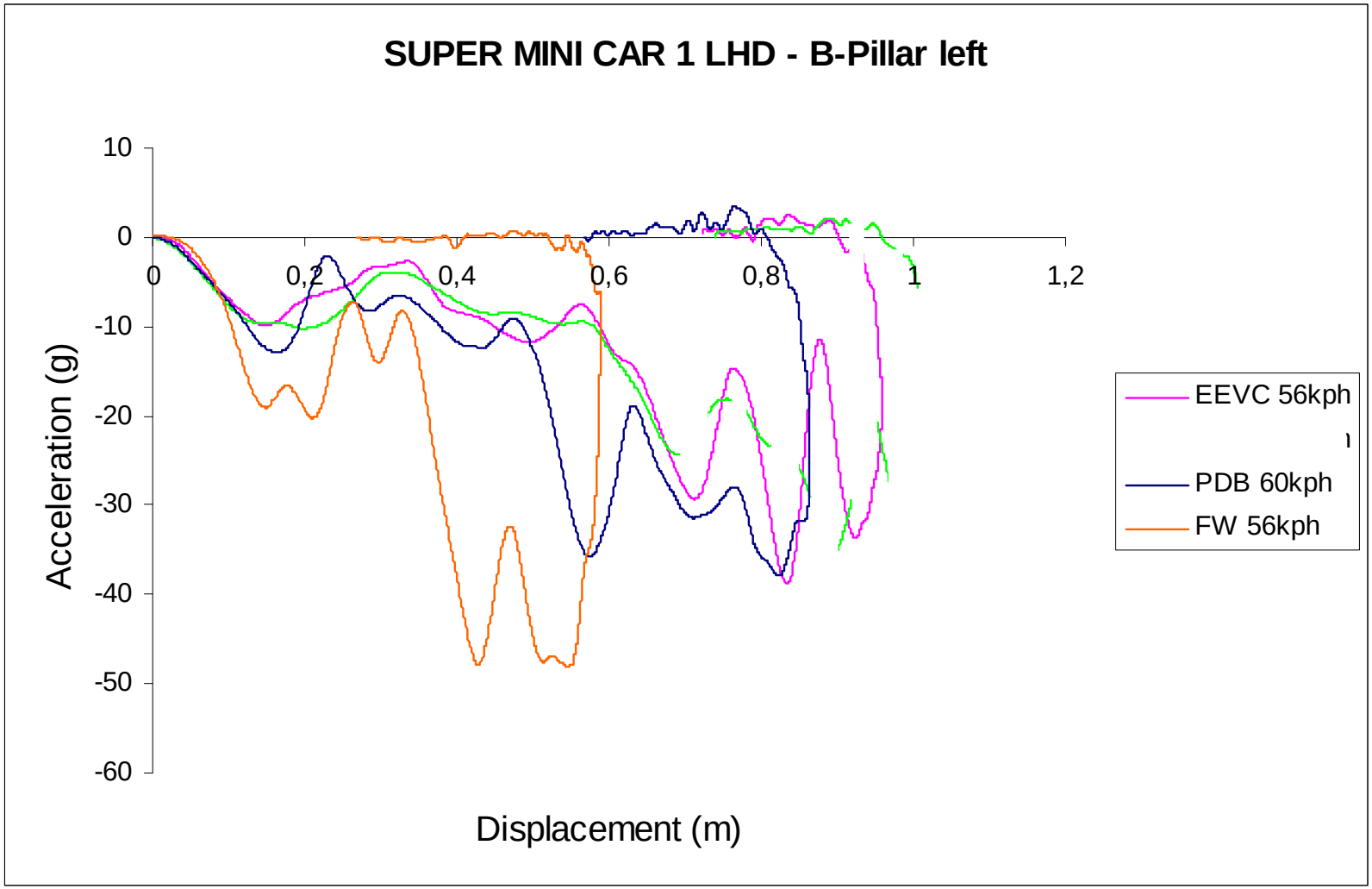
Issue 7:

Validate that PDB provides the required test requirements for interior restraints

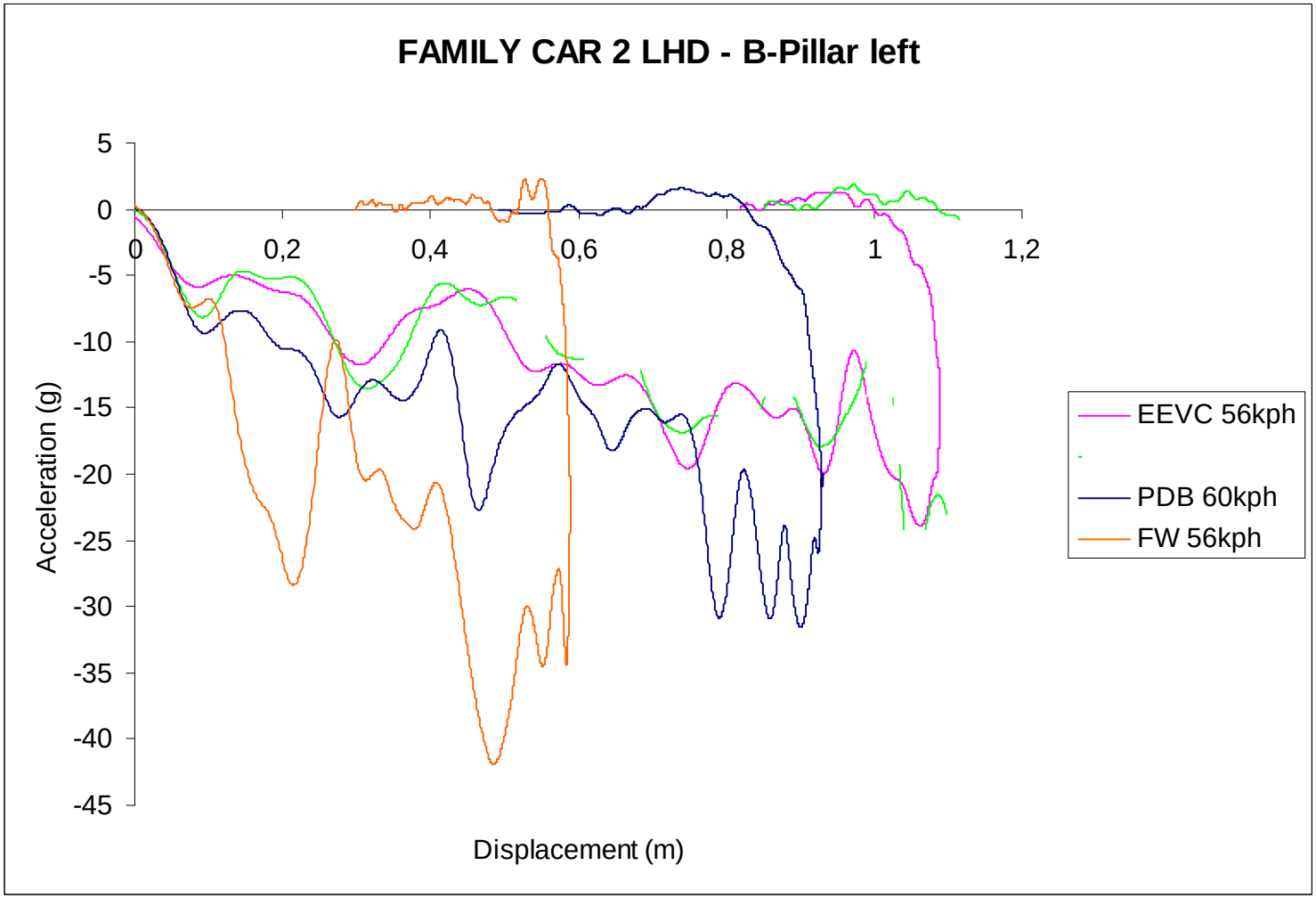
Issue 4:

Assessment of occupant restraint system with PDB Test

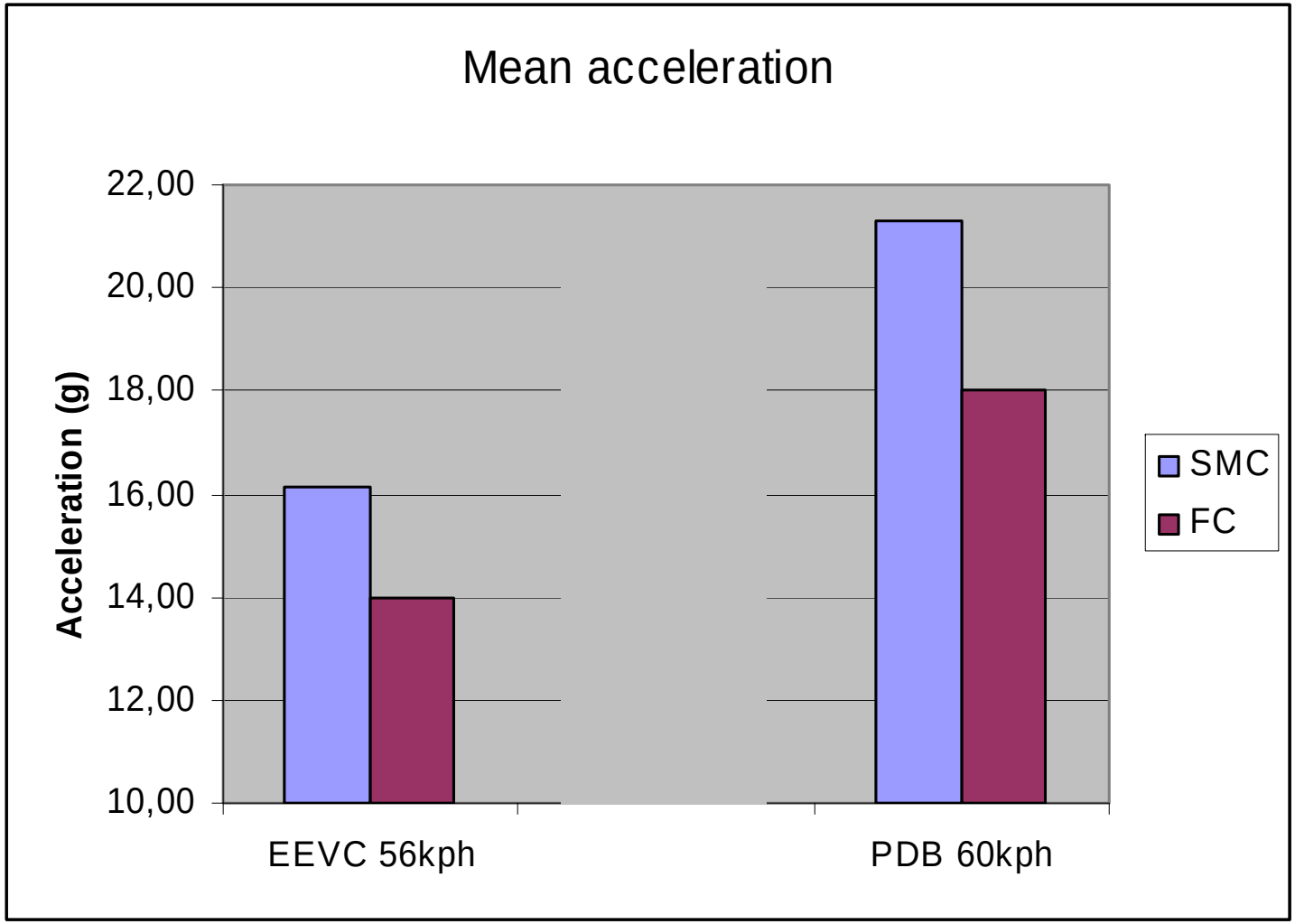

SUPER MINI CAR 2 LHD - B-Pillar left
10
0
-10
-20
-30
-40
-50
-60
0
0,2
0,4
0,6
0,8
1
1,2
Acceleration (g)
Displacement (m)
EEVC 56kph
PDB 60kph
FW 56kph


SUPER MINI CAR 1 LHD - B-Pillar left
10
0
-10
-20
-30
-40
-50
-60
0
0,2
0,4
0,6
0,8
1
1,2
Acceleration (g)
Displacement (m)
EEVC 56kph
PDB 60kph
FW 56kph

2- SELF PROTECTION: VEHICLE SEVERITY



2- SELF PROTECTION: VEHICLE SEVERITY



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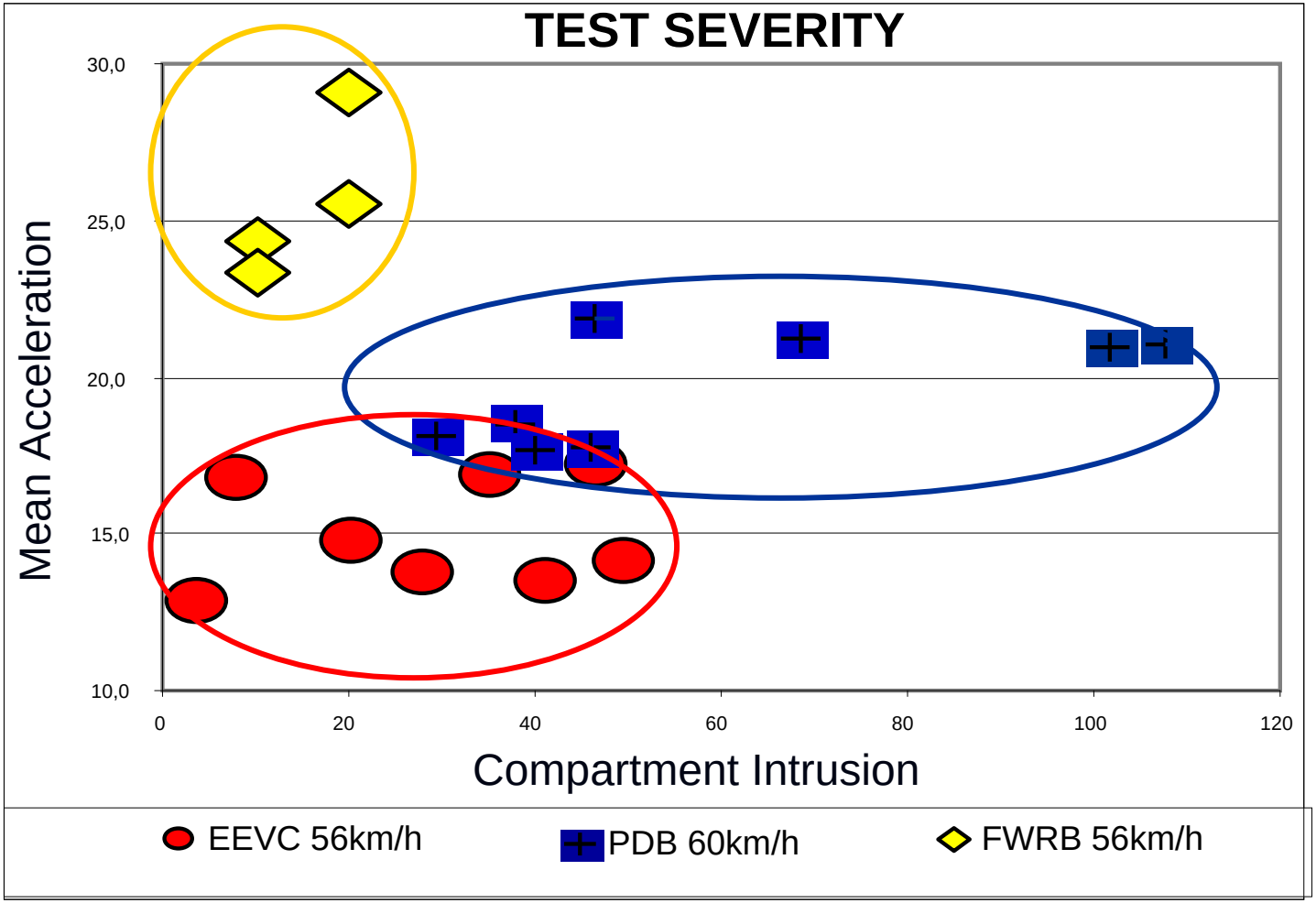
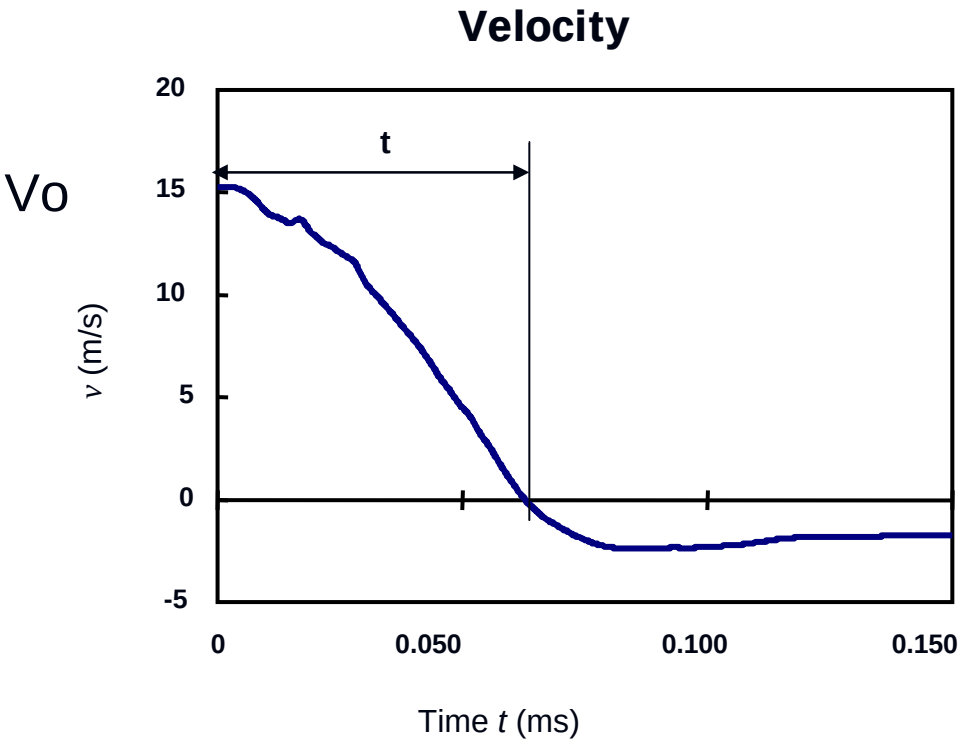


⇨PDB test combines acceleration and intrusion

MEAN ACCELERATION DEFINITION



Mean acceleration = Vo / t

t = pi / w

w= f (K / M)

K ↗ **=> w** ↗ => t ↘

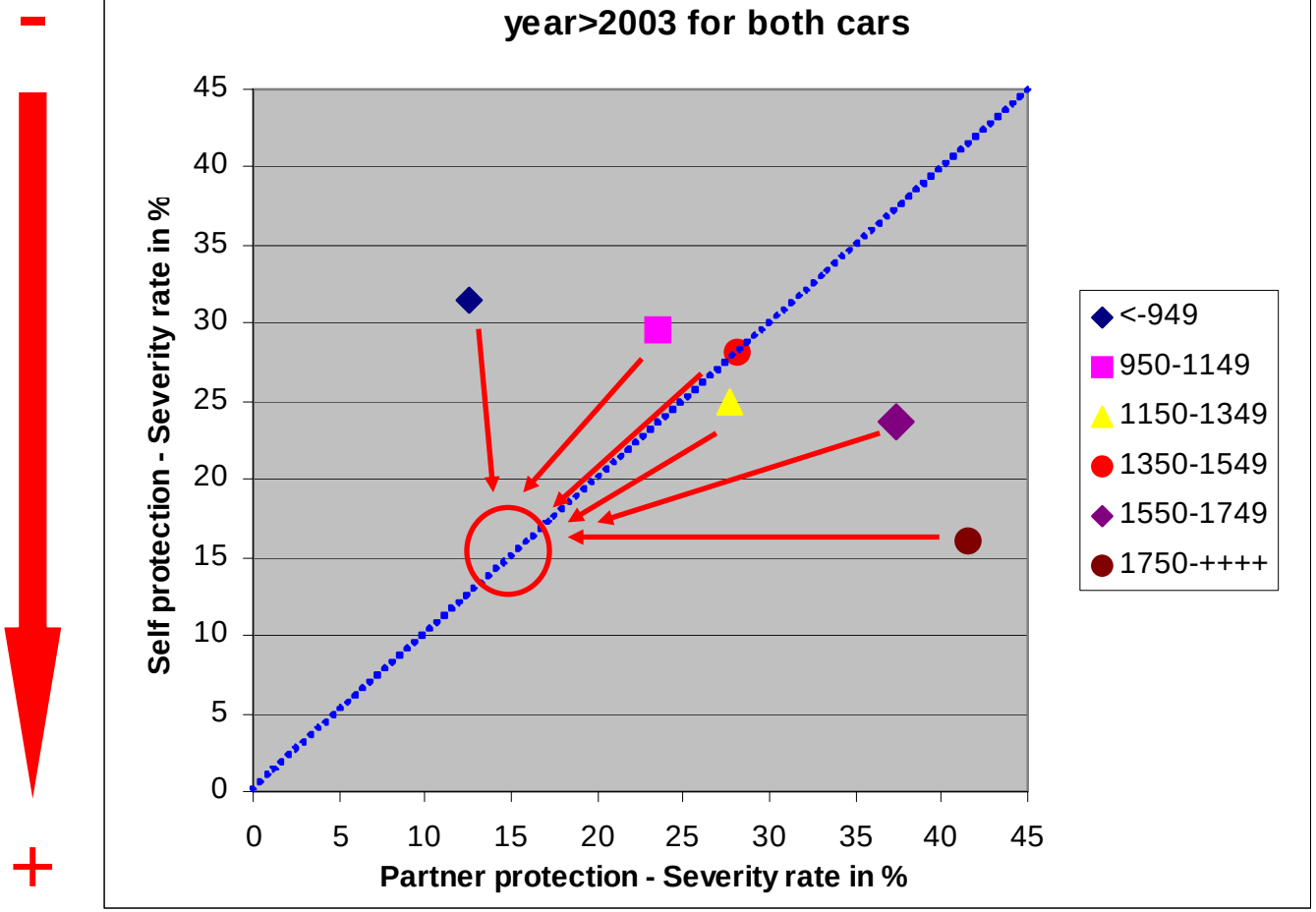
➪ According to physics, higher stiffness leads to higher acceleration

CONCLUSION OF ISSUE 2

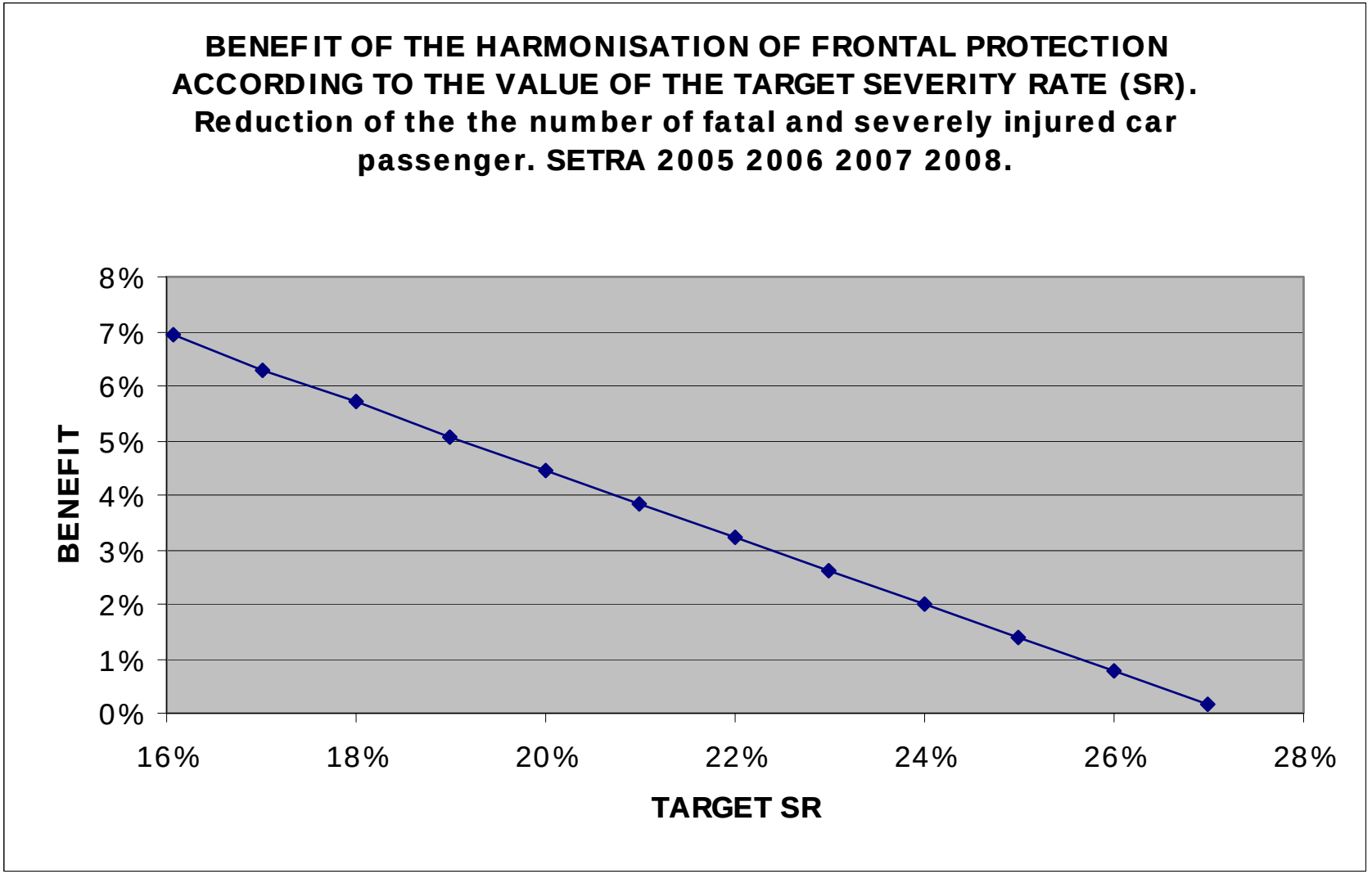
- Combination of higher test speed and higher obstacle stiffness lead to higher acceleration severity for occupants
- PDB test combines in one test the two causes responsible for road injuries in the real world
- Confirmed by laws of physics and tests performed

Issue 6:
BENEFITS

WHAT R94 AMENDEMENT COULD DO?



TARGET TO BE DEFINE

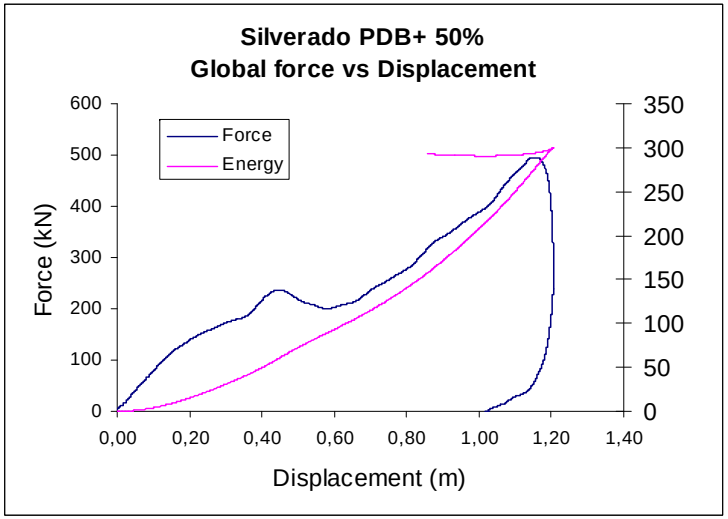


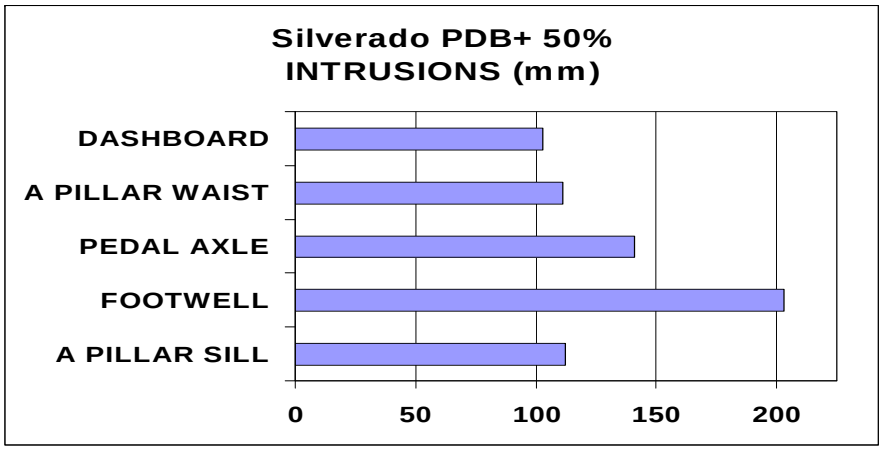
CONCLUSION OF ISSUE 2

- In 2007, benefits should have reached 7 % of fatalities and severely injured that represent 1700 persons by year

Issue 7:
Design of future vehicles / Misuse of the PDB

Examples

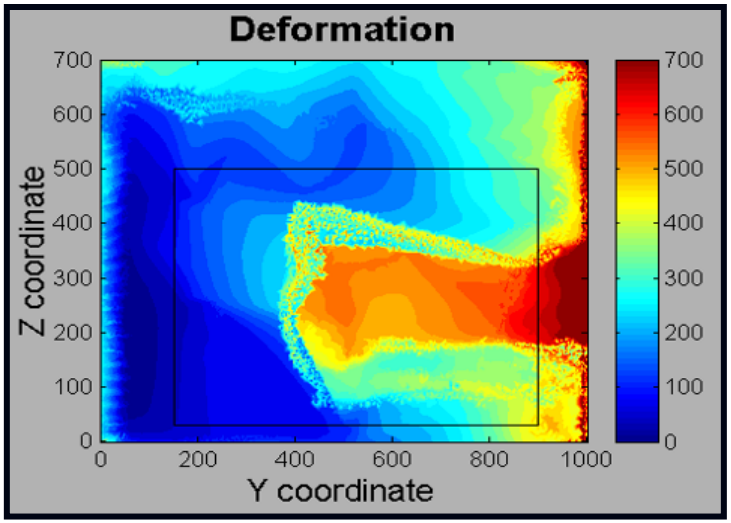




⇨ **Weak compartment is detected**

⇨ **Possibility to detect weak compartment even if car is design with stiff front end**

Examples



⇨ **Stiff front end is also detected**

Examples

- Chevrolet Silverado 2293 Kg

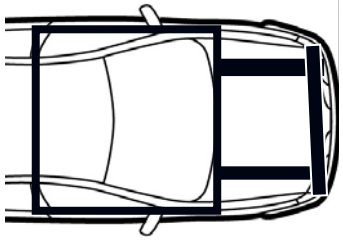
- Ford Escape 1791 Kg

- Ford F250 3291 kg

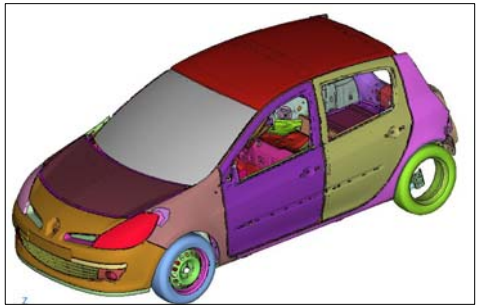
- Saturn Outlook 1916 Kg

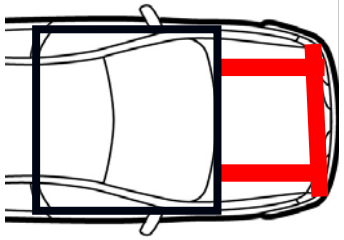
⇨ Different front designs were investigated

MISUSE OF PDB: LIGHT CAR



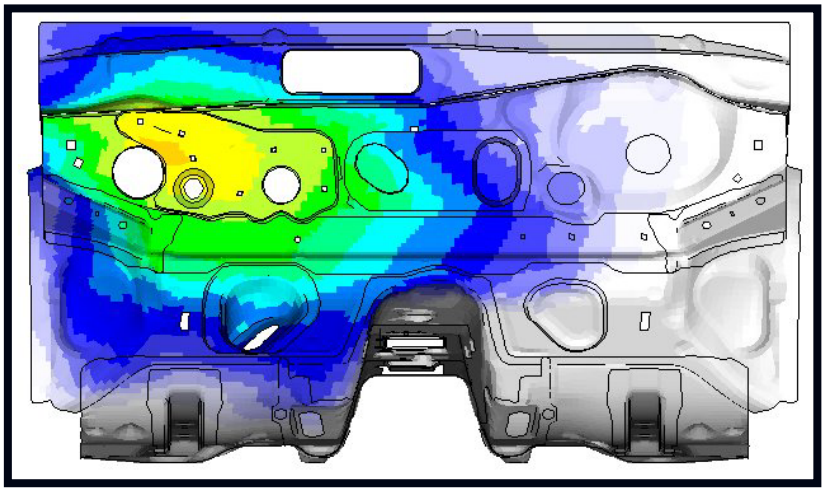
Standard

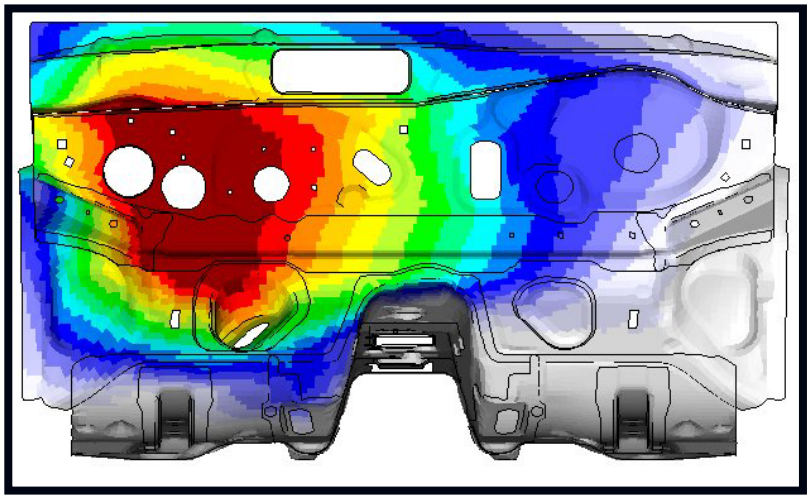




Reinforced

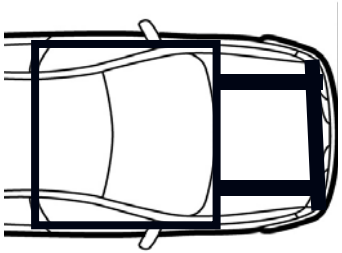
+ 12 kg



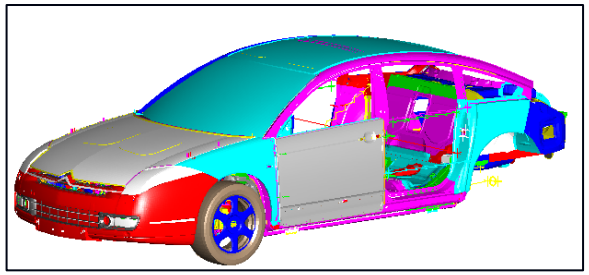


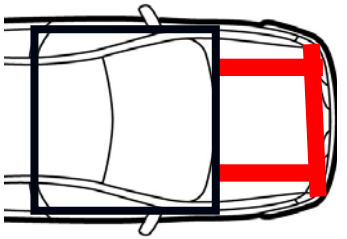
⇨ Front unit reinforcements lead to higher intrusions in the compartment

MISUSE OF PDB: LARGE CAR



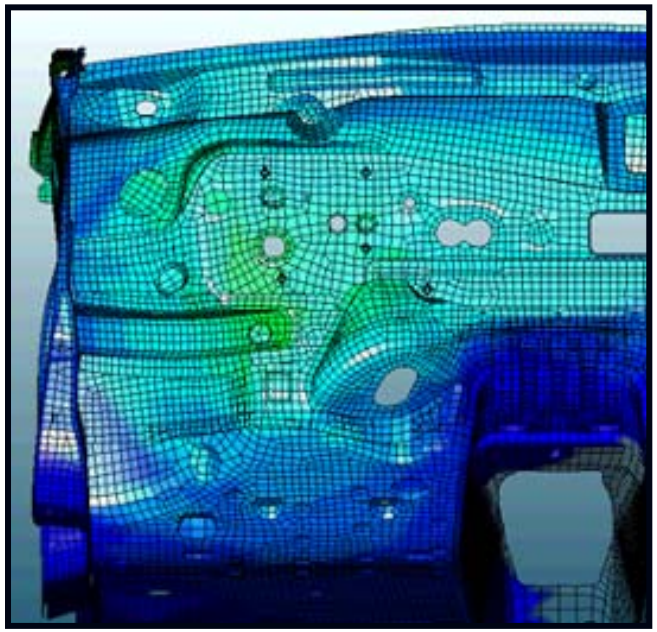
Standard

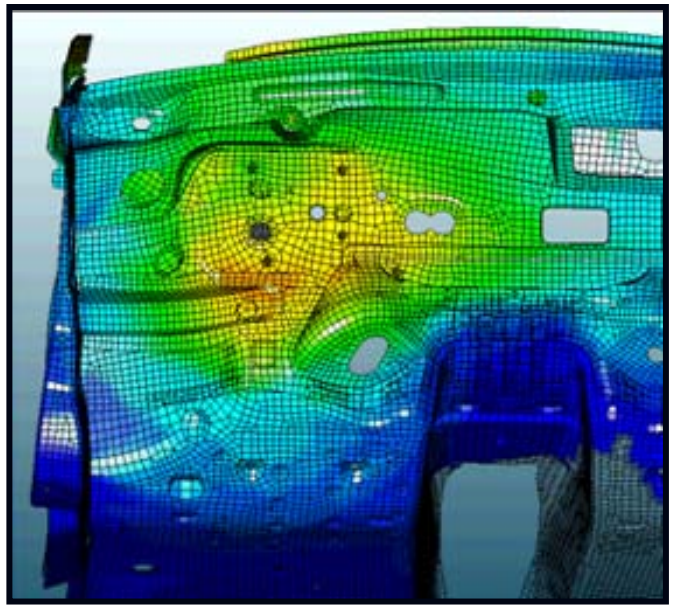




+16 kg

Reinforced





⇨ Front unit reinforcement leads to higher intrusions in the compartment

CONCLUSION OF ISSUE 7

- Tests performed did not confirm the possibility to over deform the barrier, confirmed by simulations
- Possibility to detect weak compartment even if vehicle is designed with stiff front end
- Misuse of the PDB is not yet shown

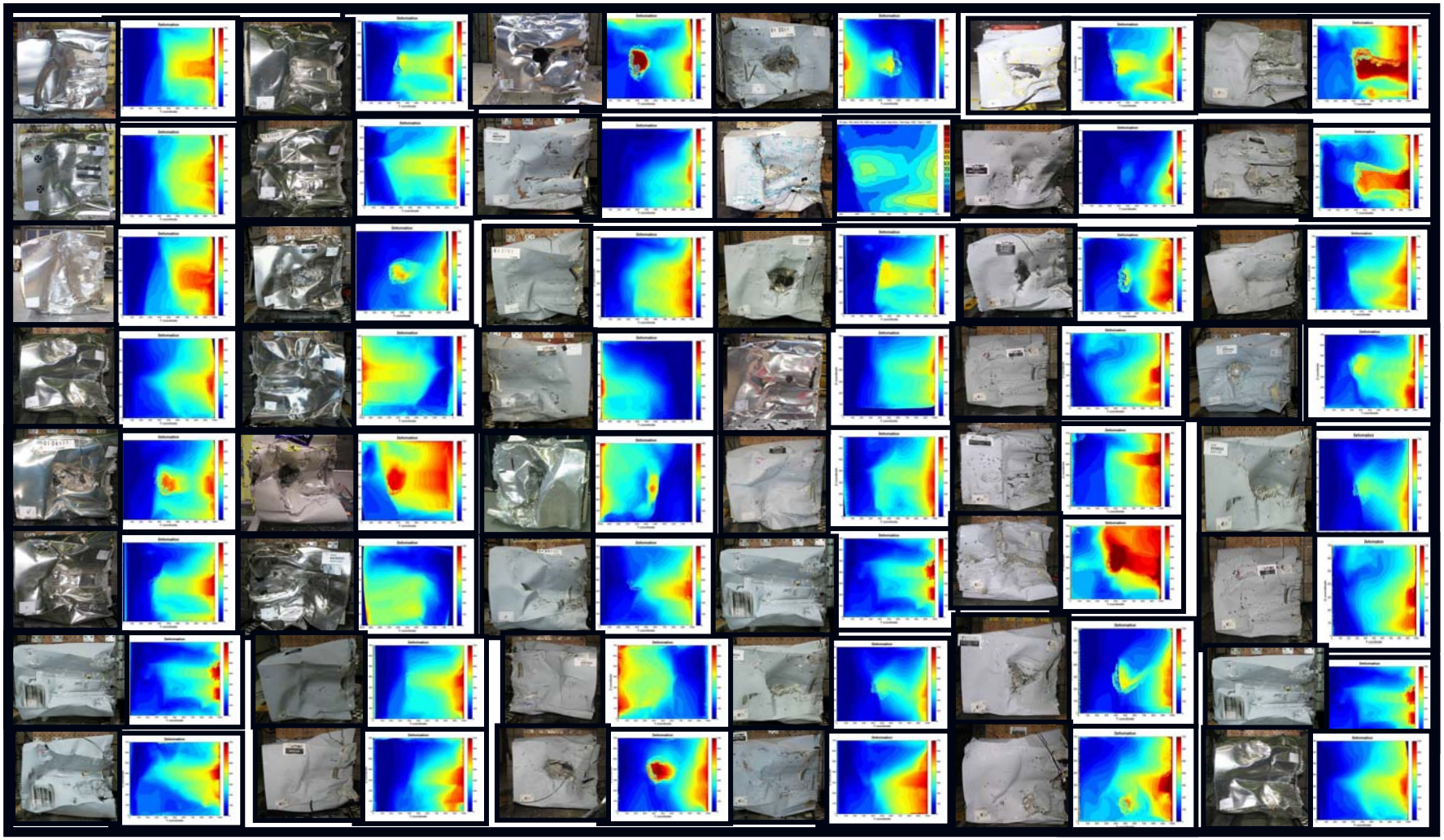
Issue 8:

Insufficient testing has been performed to validate the proposed barrier specification

ACCIDENT ANALYSIS

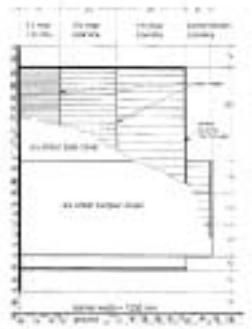
CAR TO CAR TEST INVESTIGATIONS

PDB TESTS

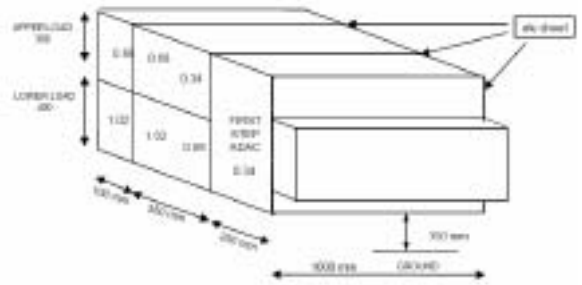


⇨ More than 80 tests have been performed since 2003

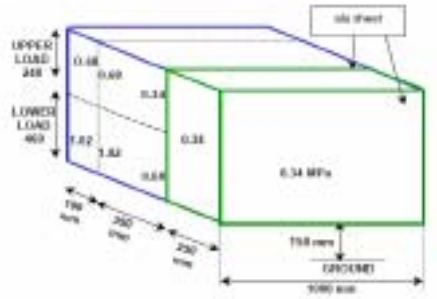
INSUFICIENT TESTING: DIFFERENT BARRIER



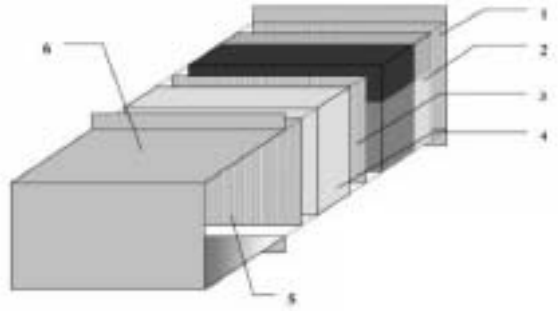
1996: ADAC Barrier
40% overlap



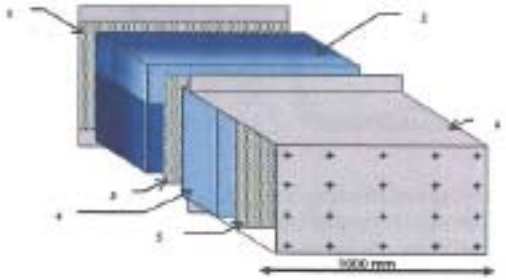
2000: PDB
750 mm overlap



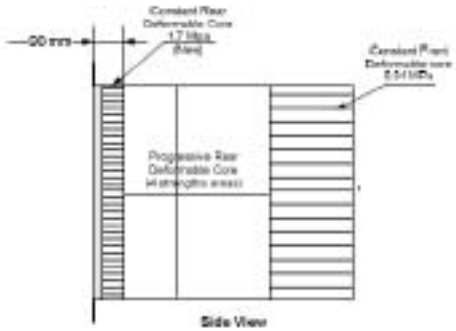
2002: PDB v6
750 mm overlap



2003: PDB v7
50% overlap



2006: PDB v8
50% overlap



2006: PDB +
50% or 100% overlap

⇨ Since 2003, tests performed are comparable

INSUFICIENT TESTING: MAIN BARRIER CHANGES

CONCLUSION OF ISSUE 8

- Concept of the PDB is not new, it has existed since 1996 (derived from the German ADAC barrier)
- 80 R94 amendment tests comparable and available performed by countries, laboratories, car makers and international working groups
- Eclectic cars / vehicles representing the “World fleet”

GENERAL CONCLUSIONS

- There is still a car to car problem with current R94
- R94 amendment doesn’t affect self protection level
- Misuse of the R94 amendment never observed
- Numerous tests are available and comparable for 6 years, performed with different vehicles from different continents
- R94 amendment has a high potential for future frontal test harmonization