PSI-02-09

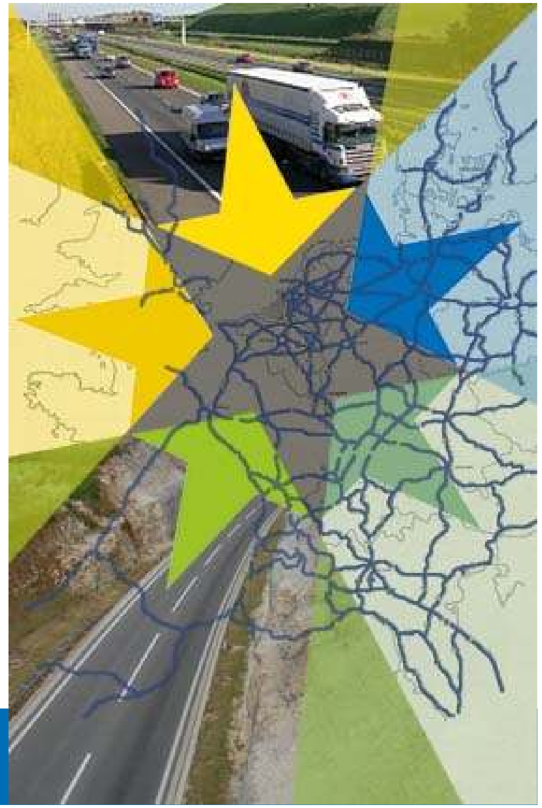
APROSYS

Car to pole side impact activities

Ton Versmissen

TNO

The Netherlands



Content

- APROSYS project
- Side impact activities
- Car to pole side impact
  - Full scale test
  - Numerical simulations
  - Main conclusions

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APROSYS / Main goal

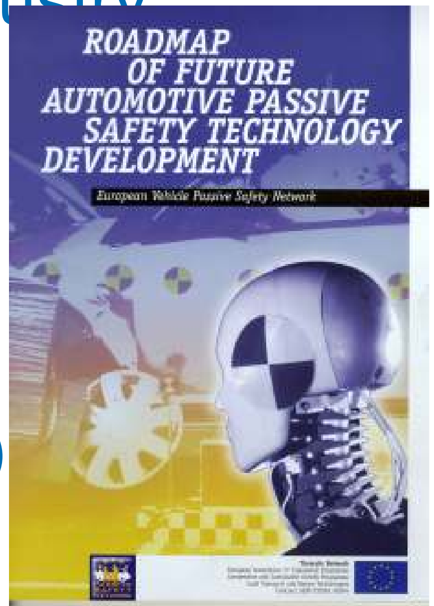
To improve passive safety

for all European road users

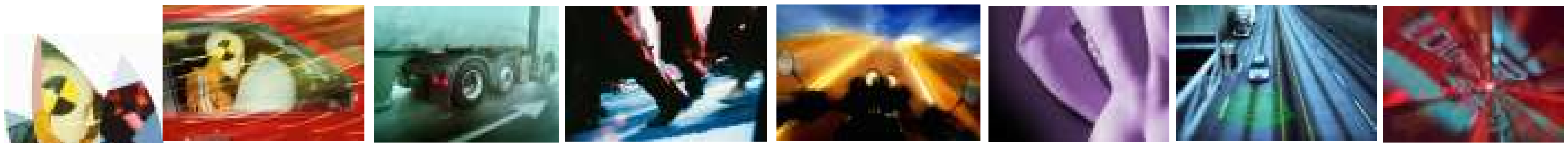
in all relevant accident types and accident severities

APROSYS Motivation

- Need to reduce European road casualty problem
- EUCAR Masterplan 2000: “Safety in road traffic stays a top priority for the automotive industry”
- White Paper for Transport:
  “50% reduction in number of fatalities
  in next decade”
- Roadmap of Future Automotive Passive Safety Technology Development (APSN)

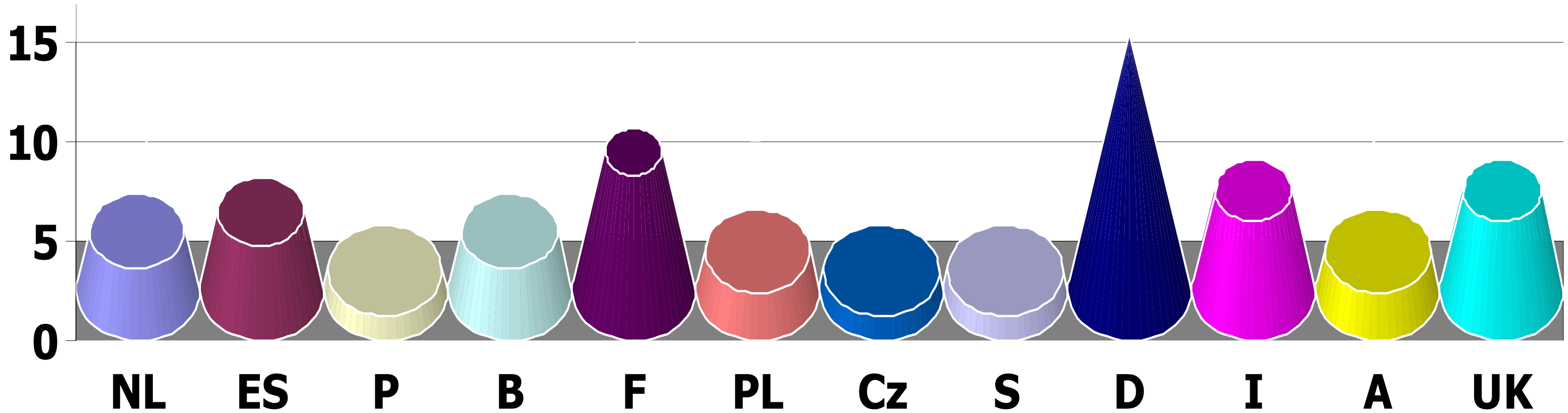


Project name:	Advanced Protection Systems - APROSYS
Coordinator:	TNO
Consortium:	48 partners (OEM, Suppliers, RTDs, Universities)
Core group members & sub project leaders:	Daimler, Renault, FIAT, Continental, TNO, CIDAUT, TRL, TUG, INRETS, Altair, Volkswagen, CIC
Starting Date:	01 April 2004
Ending Date:	30 March 2009
Budget Total / Funding:	30 MEURO / 18 MEURO



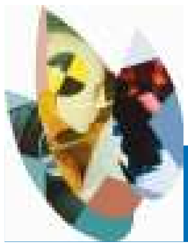
Project “Statistics” (at start)

- 47 APROSYS consortium partners
  - 7 car manufacturers (DC, Regienov, PSA, FIAT, VW, Skoda, Toyota-Europe), 11 suppliers (Siemens, Faurecia, etc.), 13 universities and 14 research institutes
- 12 EU countries



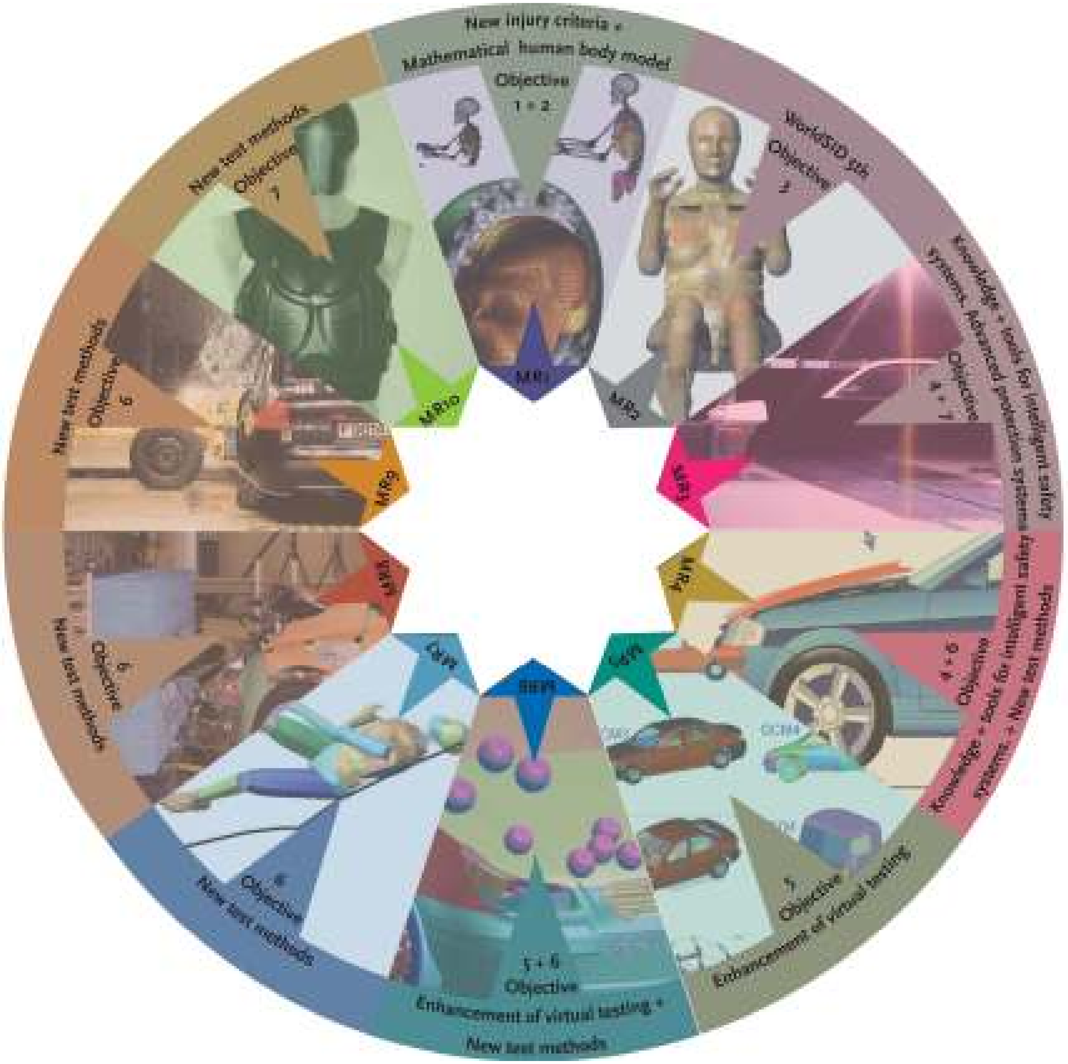
General project objectives

1. New injury criteria and injury tolerances
2. New mathematical models of the human body
3. New world-wide harmonized crash dummy
4. New knowledge and tools for intelligent safety systems
5. Enhancement of virtual testing technology
6. New test methods (for advanced safety systems)
7. Advanced protection systems



APROSYS

TNO innovation for life



MR 1:
New human body mathematical models

MR 2:
WorldSID 5th percentile female dummy for side impact

MR 3:
Side impact protection system for car occupants

MR 4:
Generic assessment methodology for advanced safety systems

MR 5:
Generic car mathematical models

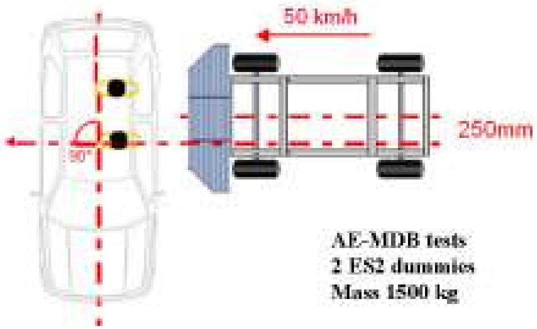
MR 6:
Virtual testing methodology

MR 7:
Test methods for vulnerable road users

MR 8:
Full width frontal test for Europe

MR 9:
New side impact test methods

MR 10:
New protection systems for vulnerable road users



Main Result 9:
Advanced side impact test method

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Side impact / Background

- In Europe ~10.000 car occupant fatalities in side impact crashes annually
- At 2005 ESV conference a 4 part draft test procedure was published by IHRA
  - Car to car test / AE-MDB
  - Car to narrow objects (car to pole)
  - Free motion headform tests
  - Side Out Of Position
- Further development of proposed procedures and evaluation of applicability for Europe

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Side impact / Activities

Multi vehicle lateral crashes
- AE-MDB development
    - Car to car / AE-MDB tests
    - LCW calibration tests
- AE-MBD / IIHS barrier comparison
- ES2/WorldSID 50th/WorldSID 5th
- Supporting simulation activities

Car to narrow object crashes
- Oblique / perpendicular impacts
- Euro NCAP <> NPRM 214
- Full scale tests / numerical studies
- Velocity / angle / impact location / pole
- Effect of ESC (literature review)

Head protection
- Update of EEVC WG13 protocol
- FMH tests and feasibility checks
- Definition of impact angle
- Selection of impact locations
- Reproducibility

Side Out of position
- Based on IHRA / TWG proposal
- Focus on European situation
- Hybrid-III 3yo, 6yo, SIDIIs
- Additional tests with CRS

Side impact / Main Findings

Multi vehicle lateral crashes

- Updated test protocol
  - V3 improvement of V2
  - V3.9 representative for c2c
  - More severe as ECE R95
- ES-2 / WordSID50th/WorldSID 5th
  - Test information available
  - Waiting for injury criteria

Car to narrow object crashes

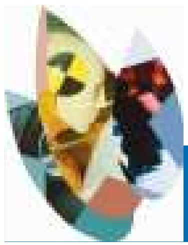
- Euro NCAP & NPRM 214 possible
- Preference for perpendicular test
  - Dummy>> oblique loading
- Oblique possible for harmonization
- ESC: significant effect on number

Head protection

- Updated protocol / flowchart
- Good reproducibility
- Evaluation workshop scheduled

Side Out of position

- No need in Europe (yet ?!?)
- Sub-set TWG scenario's feasible in EU
- Change to type approval regulation
- Booster seats included



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  - Numerical simulations
  - Main results
  - Conclusions

Car to pole tests / Introduction

- Full scale tests
  - Feasibility / practicality NPRM 214 car to pole
  - ES-2 / WorldSID 50th
  - Impact location variation
- Simulation study
  - Test parameter variations

Car to pole tests / Test program

Subaru

Subaru Legacy	Test S1	Test S2	Test S3	Test S4
• angle/speed	75° / 32 km/h	90° / 32 km/h	*75° / 32 km/h*	*90° / 29 km/h*
• impact location	NPRM-214	Euro NCAP	*NPRM-214*	*Euro NCAP*
• dummy	WorldSID 50%	WorldSID 50%	*ES-2*	*ES-2*
• project	APROSYS	APROSYS	-	-
Toyota Avensis	**Test T1**	**Test T2**	**Test T3**	**Test T4**
• angle/speed	75° / 32 km/h	75° / 32 km/h	75° / 32 km/h	*90° / 29 km/h*
• impact location	NPRM-214	NPRM 214	Euro NCAP	*Euro NCAP*
• dummy	ES-2	ES-2	ES-2	*ES-2*
• project	APROSYS	APROSYS/DOTARS	APROSYS	*Euro NCAP*

APROSYS

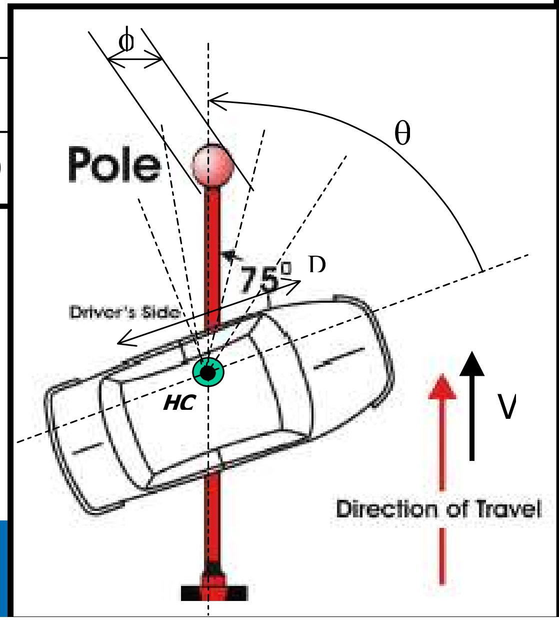
Pole diameter	**254 ± 6 mm**	
Pole height	**Bottom no more than 102 mm above the lowest point of the tires.** **Top extended above the highest point of the vehicle**	
Test velocity	**APROSYS / NPRM-214** **Euro NCAP / FMVSS-201**	**32 ± 0.5 km/h** **29 ± 0.5**
Angle of impact	**APROSYS / NPRM-214** **Euro NCAP / FMVSS-201**	**75 ± 3 °** **90 ± 3 °**
Impact location	**APROSYS / NPRM-214**	**On a reference line on the vehicle were the vehicle side wall intersects with a vertical plane passing the head COG of the seated driver dummy at an angle of 75° from the vehicle's X-axis.**
	Euro NCAP / FMVSS-201	**On a reference line on the striking side of the vehicle where a transverse vertical plane passes through the COG of the head of the seated dummy.**
Impact location accuracy	**± 20 mm**	**all tests**
Vehicle preparation	**According to the Euro NCAP Pole protocol V4.1 April 2004**	
Seat and dummy position	**WorldSID**	**According to UMTRI protocol:** **•ATD_postioning_procedure.PDF** **•ATD_positioning_templateV4.xls**
	Euro NCAP / FMVSS-201	**According to Euro NCAP side impact protocol V4.1**

Full scale test set-up (NPRM 214)

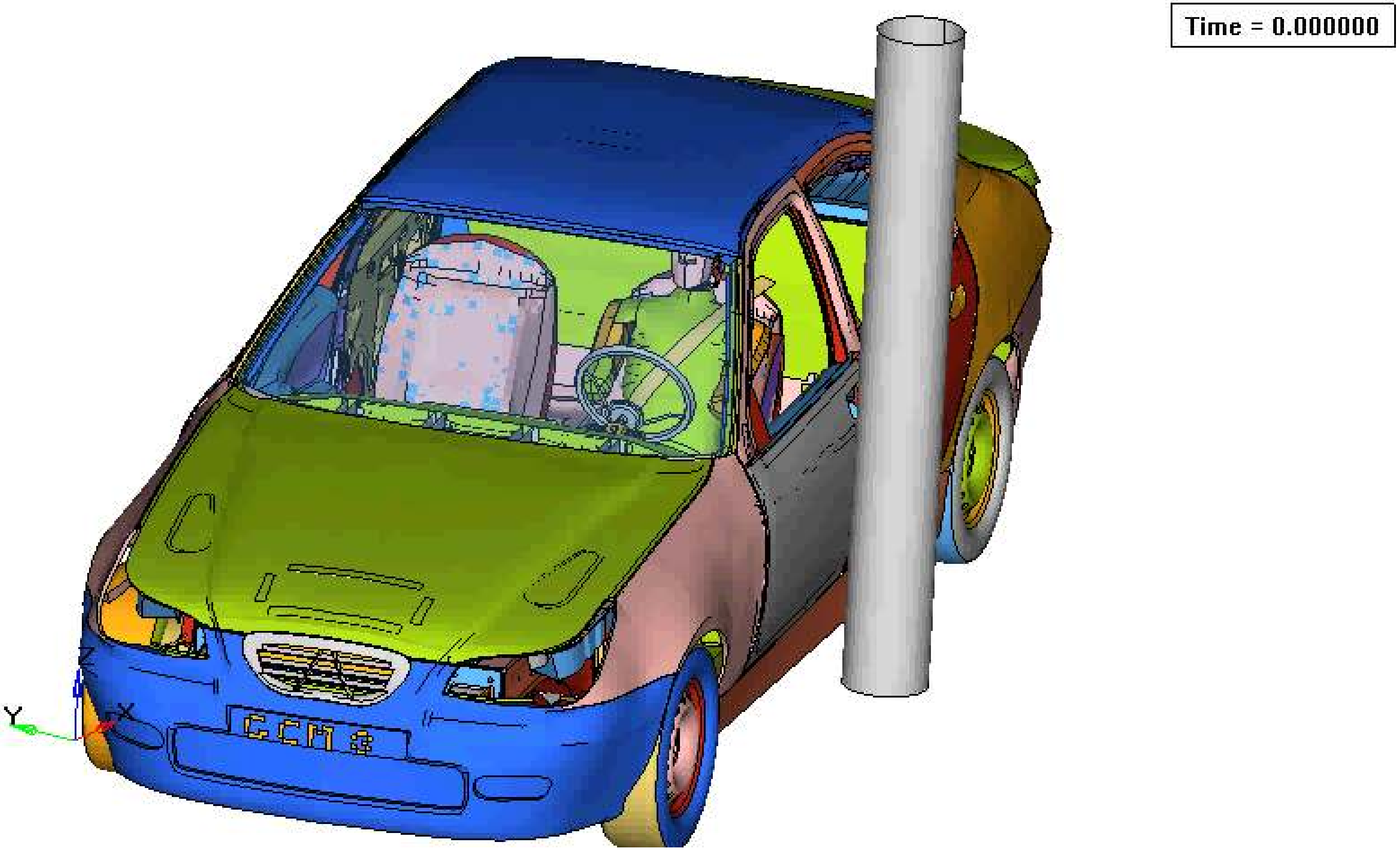
Full scale tests / Example (NPRM 214)

Car to pole / Simulation program

Parameter	
Vehicle model	'Generic' model of a 4-doors passenger car (GCM3)
Impact angles θ [°]	90 (FMVSS-201) / 82.5 / 75 (NPRM-214)
Test velocities V [km/h]	29 (FMVSS-201) / 32 (NPRM-214) / 36
Impact point	-100, 0 and 100 mm shifted from specified, along vehicle for-aft axis
Pole diameters Φ [mm]	254 (NPRM-214) / 350 (ISO)
Dummy	ES-2 model (EEVC specification)



Car to pole / Simulation example



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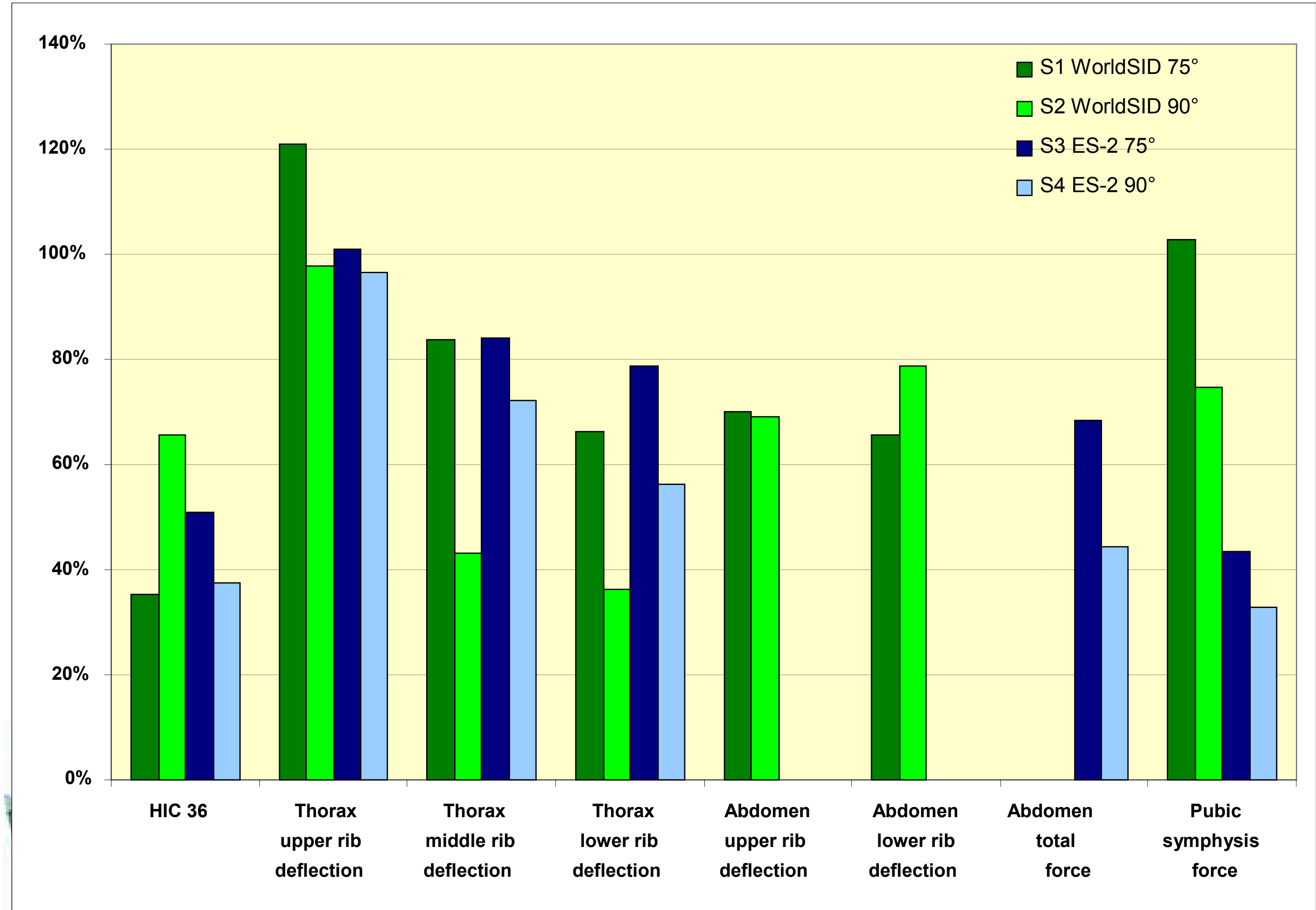
Full scale test / results

Subaru Legacy	Test S1	Test S2	Test S3	Test S4
Test ID	045106JI	O3QQ	PB31RZP	EA82RZP
Laboratory	IDIADA	TRL	Subaru	Subaru
Dummy	WorldSID	WorldSID	ES-2	ES-2
Test mass	1725 kg	1730 kg	1789 kg	1681 kg
Test angle	75°	90°	75	90°
Test velocity	31.8 km/h	31.7 km/h	31.5 km/h	29.0 km/h
Impact accuracy	4 mm fore	8 mm aft	2 mm/*	6 mm/*
Toyota Avensis	**Test T1**	**Test T2**	**Test T3**	**Test T4**
Test ID	F044703	F051701	14497	04NQ
Laboratory	TNO	TNO	Fiat	TRL
Dummy	ES-2	ES-2	ES-2	ES-2
Test mass	1500 kg	1505 kg	1501 kg	1506 kg
Test angle	75°	75°	75°	90°
Test velocity	32.4 km/h	31.9 km/h	32.5 km/h	29 km/h
Impact accuracy	4 mm fore	7 mm fore	7 mm fore	14 mm aft

Full scale test / results



Subaru

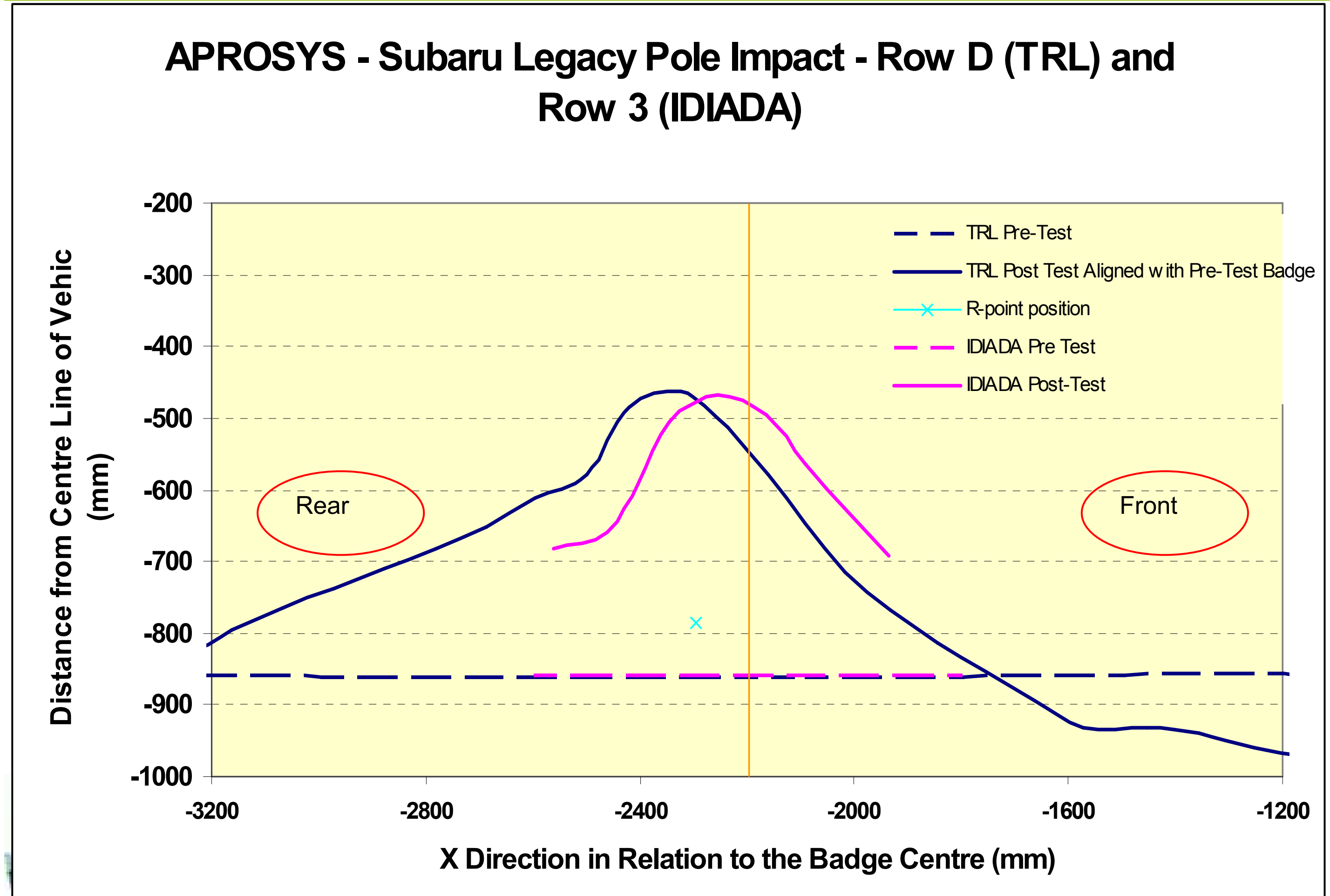
S4

lower speed

Airbag:

Difference in airbag trigger time observed

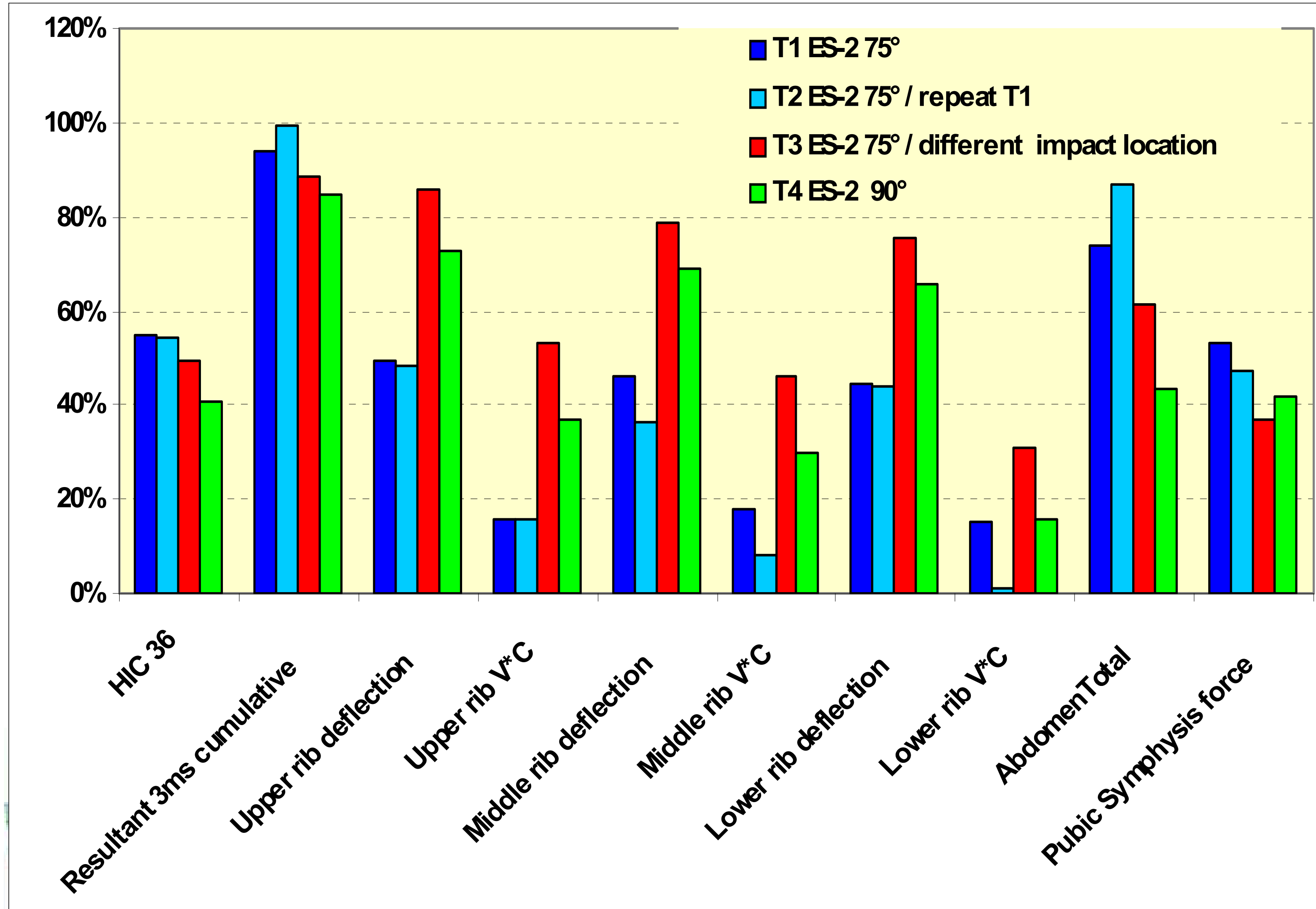
Full scale test / results



Subaru

- Similar maximum deformations
- Small longitudinal shift

Full scale test / results



Toyota

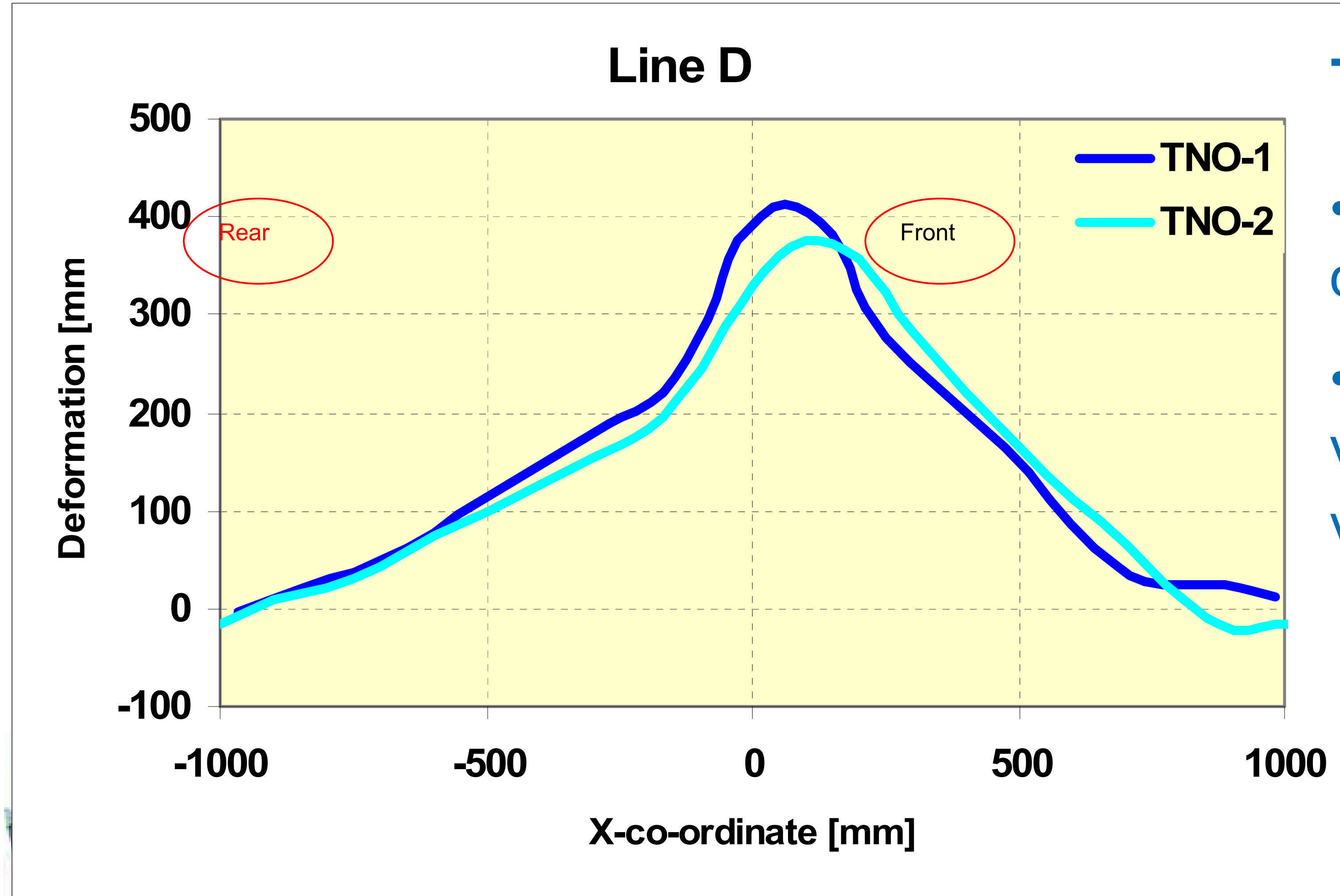
T1 – T2

Repeatability

Airbag:

No significant differences in trigger timing

Full scale test / results



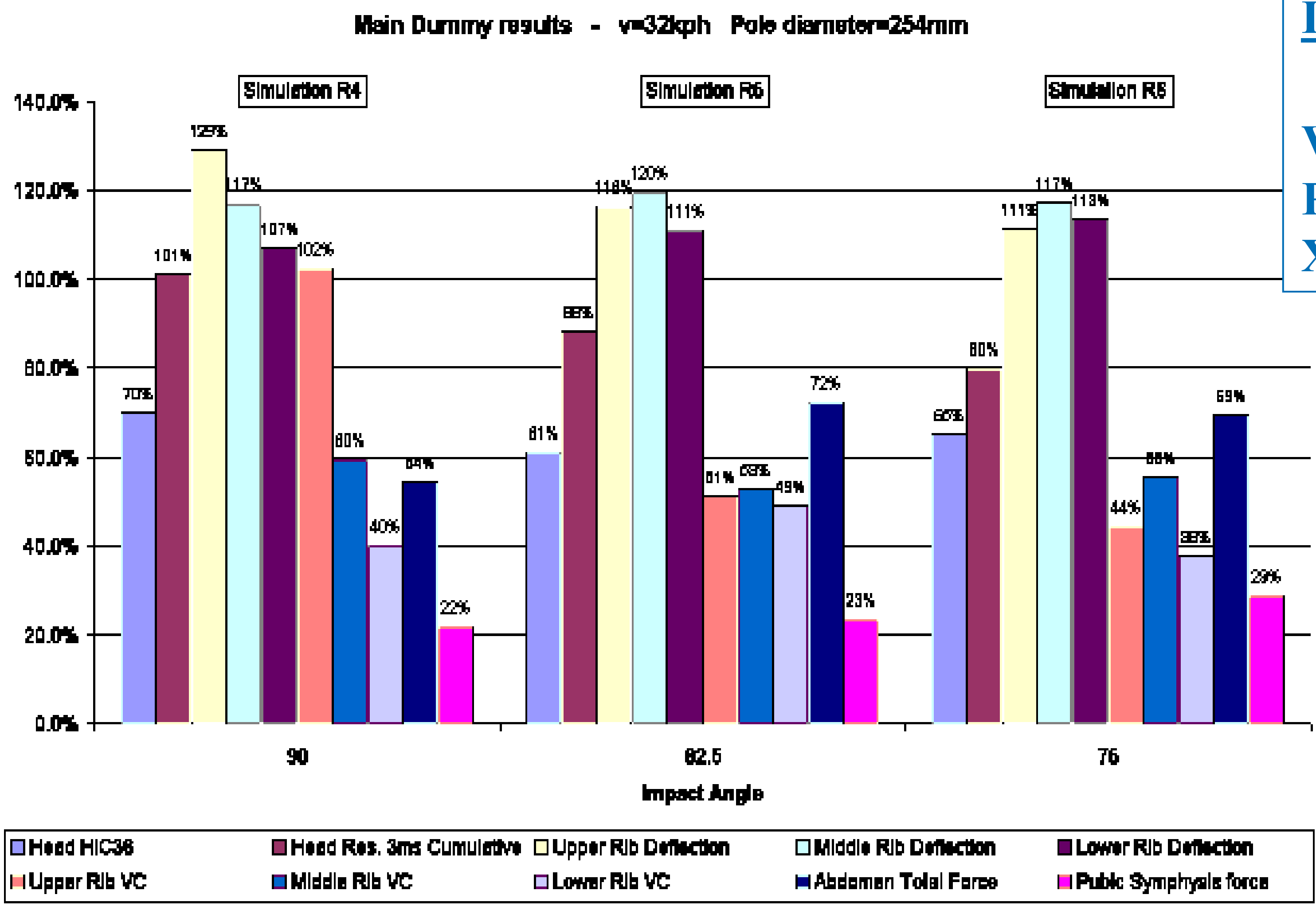
Toyota

- Small difference
- Test & vehicle variations

Full scale test / Summary of results

- General
  - No practical problems to carry out tests
- Dummies
  - Subaru results difficult to compare by variation in airbag timing
  - Repeatability of ES-2 tests is good
  - Changing impact location increased rib deflection values
  - NPRM-214 results in lower injury rib values and higher values for the other body regions
- Deformations
  - Toyota NPRM-214 tests quit similar
  - Maximum deformations of Subaru NPRM-214 and perpendicular test were about equal

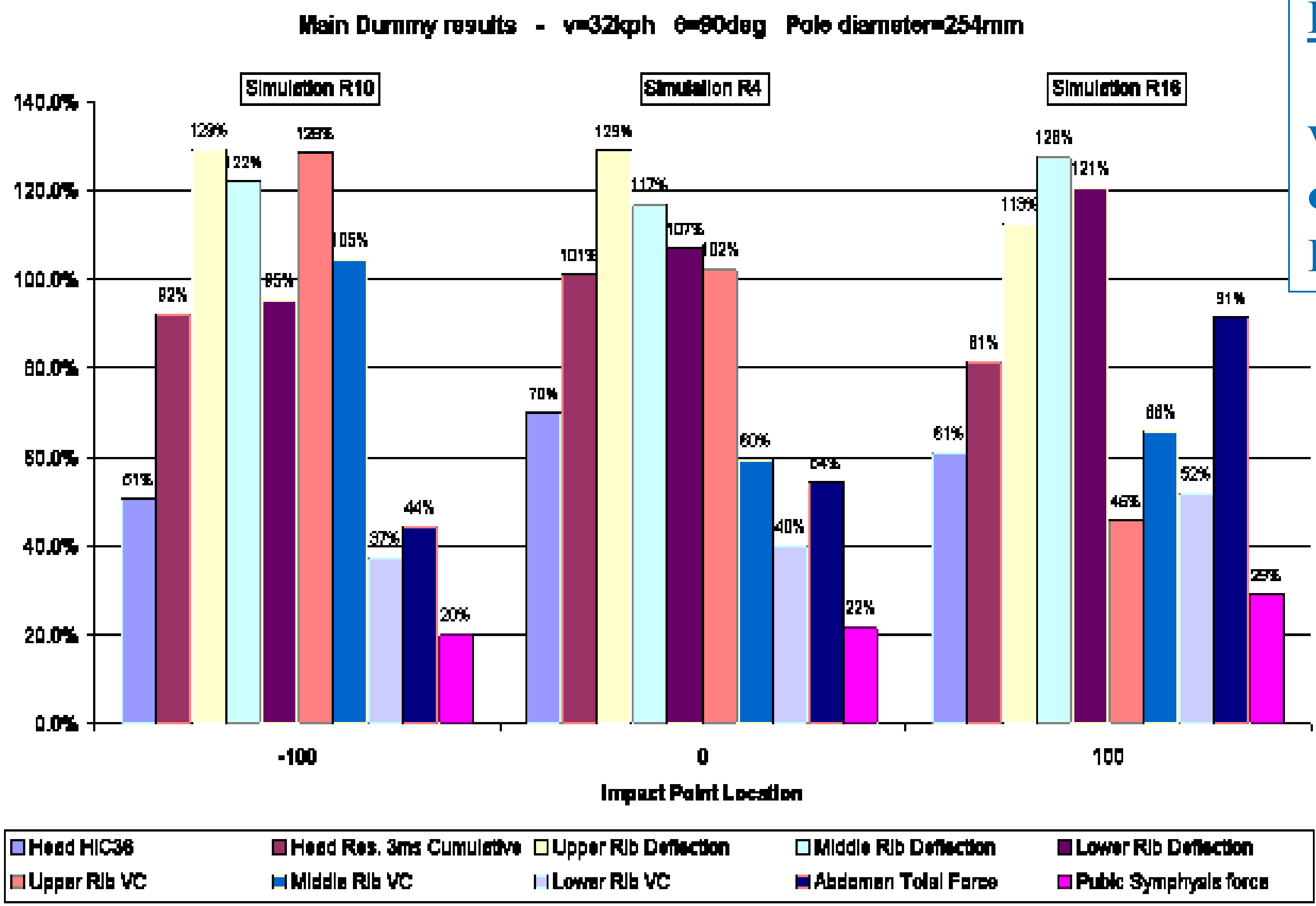
Car to pole tests / Simulation results



Impact angle

V 32 kph
Pole 254 mm
X 0 mm

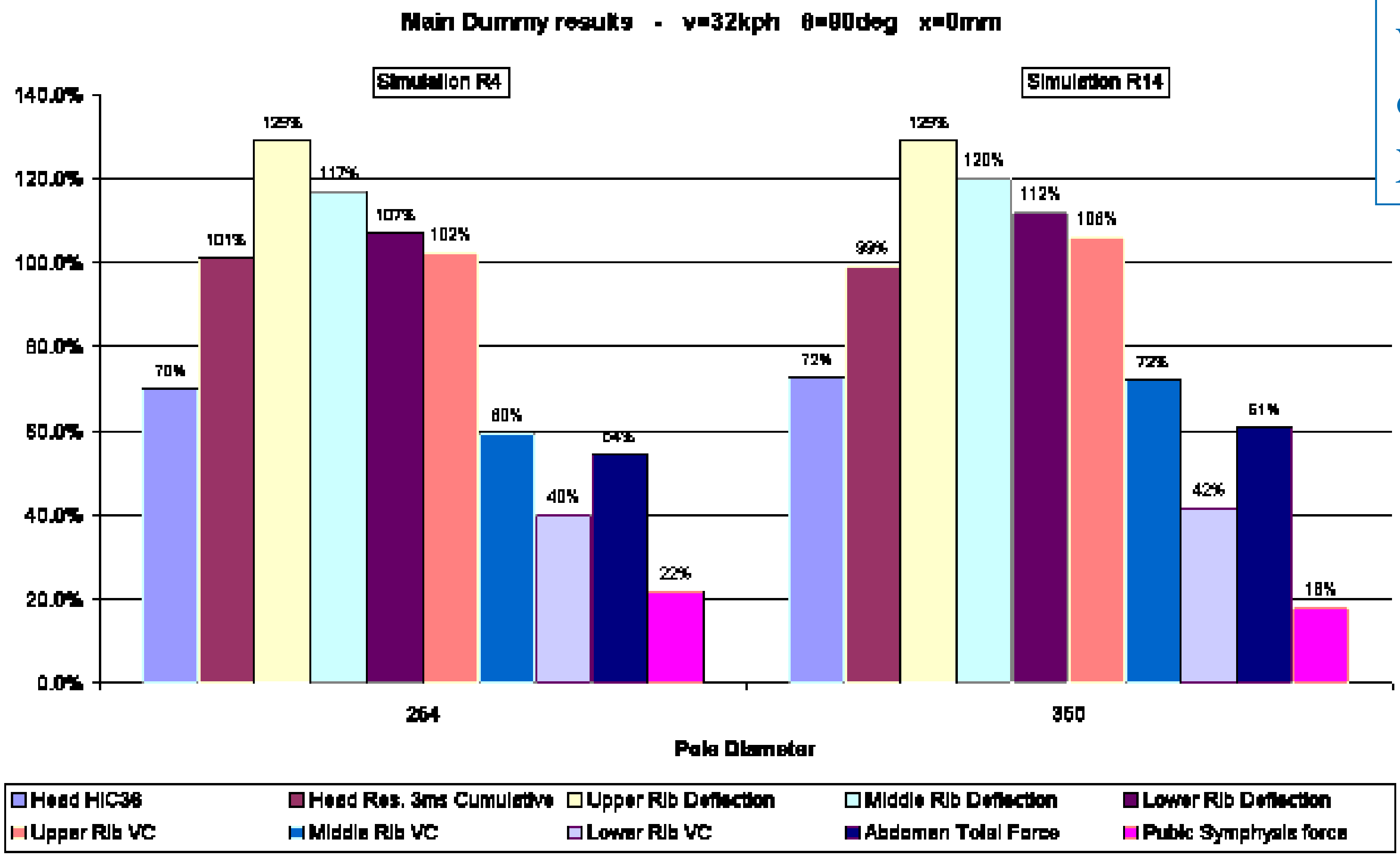
Car to pole tests / Simulation results



Impact Location

V 32 kph
Φ 90º
Pole 254 mm

Car to pole tests / Simulation results



Pole diameter

V 32 kph
Φ 90º
X 0 mm

Simulations / Summary of results

- Dummy injuries increase with higher impact velocity
- The 75° oblique test configuration results in higher dummy injury criteria values, for the abdomen and pelvis regions, compared to the perpendicular case
- The dummy injury values for the 75° oblique test configuration are approximately equivalent to those for a perpendicular test with the impact location contact point on the car shifted 100 mm forward.
- Pole diameter has only a minor effect on test results
- The study shows that a change in the airbag firing time from 16 msec to 40 - 50 ms can result in large changes in the dummy injury criteria of the order of those seen by changing the test configuration parameters.

Final conclusions

- Repeatability oblique tests
  - Toyota tests showed good repeatability
- Oblique vs perpendicular and impact location
  - Oblique needs test equipment modifications
  - ES2 and WorldSID more accurate in perpendicular loading
  - Impact location more important than impact angle
  - Perpendicular test to be preferable for Europe
  - However oblique test acceptable for international harmonisation
- Impact speed / Pole diameter
  - No need to alter the proposed speed of 32 km/h
  - No needs to change the current diameter of 254 mm
- WorldSID vs ES2
  - No significant problems with one of the dummies
  - Design changes needed for oblique loading (WorldSID ongoing)

More information

- Contact
  - Ton Versmissen / ton.versmissen@tno.nl
- Download
  - APROSYS deliverable D1.1.2A
  - www.aprosys.com/

Acknowledgments

- WP1.1 partners
  - BAST
  - Cellbond
  - CRF
  - FIAT
  - IDIADA
  - INSIA UPM
  - TK-P
  - TNO
  - Toyota
  - TRL
  - TUG
  - VW

- European Commission DG-TREN
- Test vehicles
  - Subaru
- Test and simulation results
  - Subaru
- Support / additional tests
  - DOTARS, Australian
  - RDW, the Netherlands