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Integrated Safety by Pre-Crash Triggering

Dr. Yngve Haland
Senior Adviser
Autoliv Inc.

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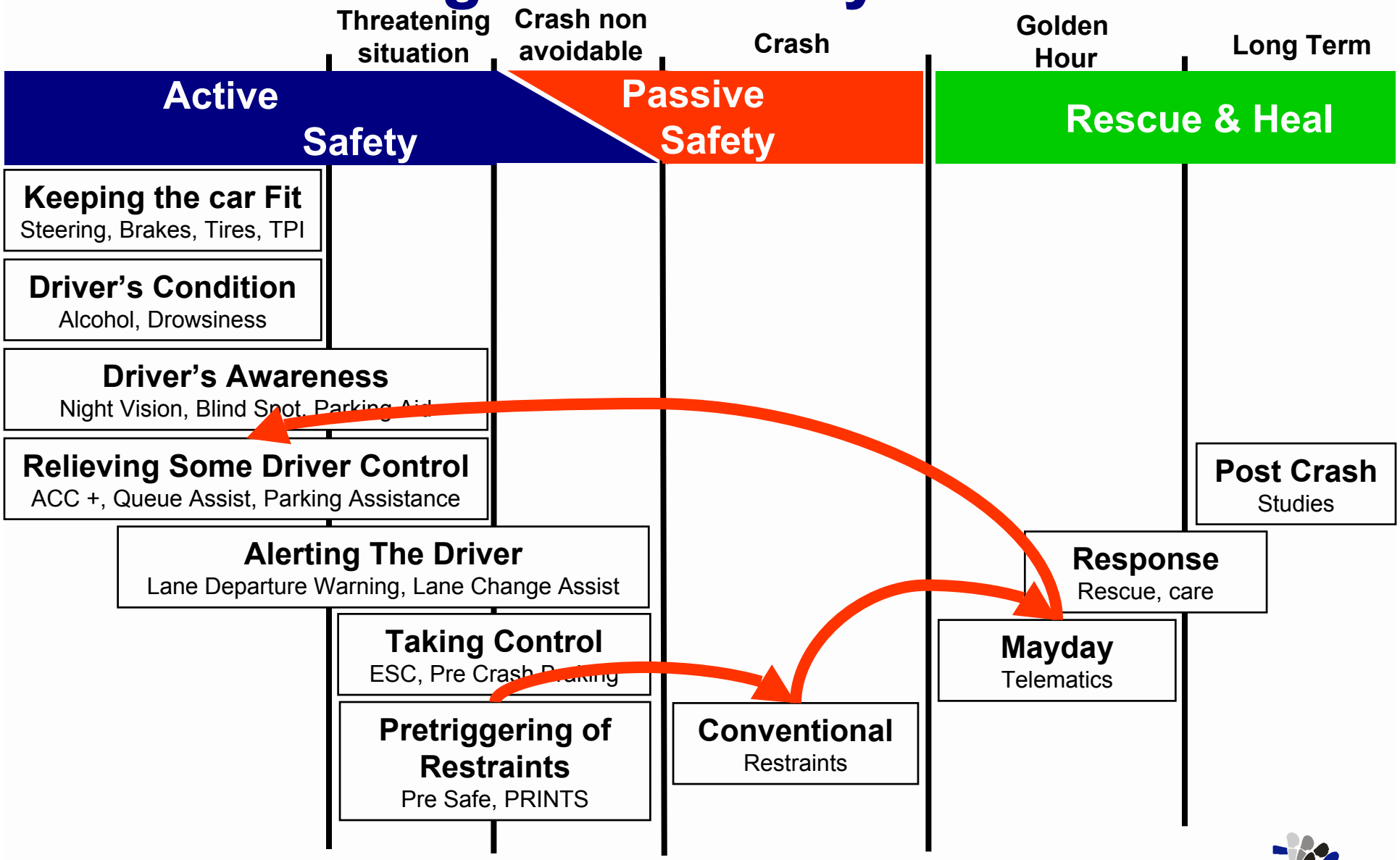
Integrated Safety Chart



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Pre-Crash Triggering
Scope

Triggering Systems prior to the crash allow

- Collision Avoidance
- Collision Severity Mitigation
- Occupant and Pedestrian Protection Enhancement

Not only Reversible Systems like

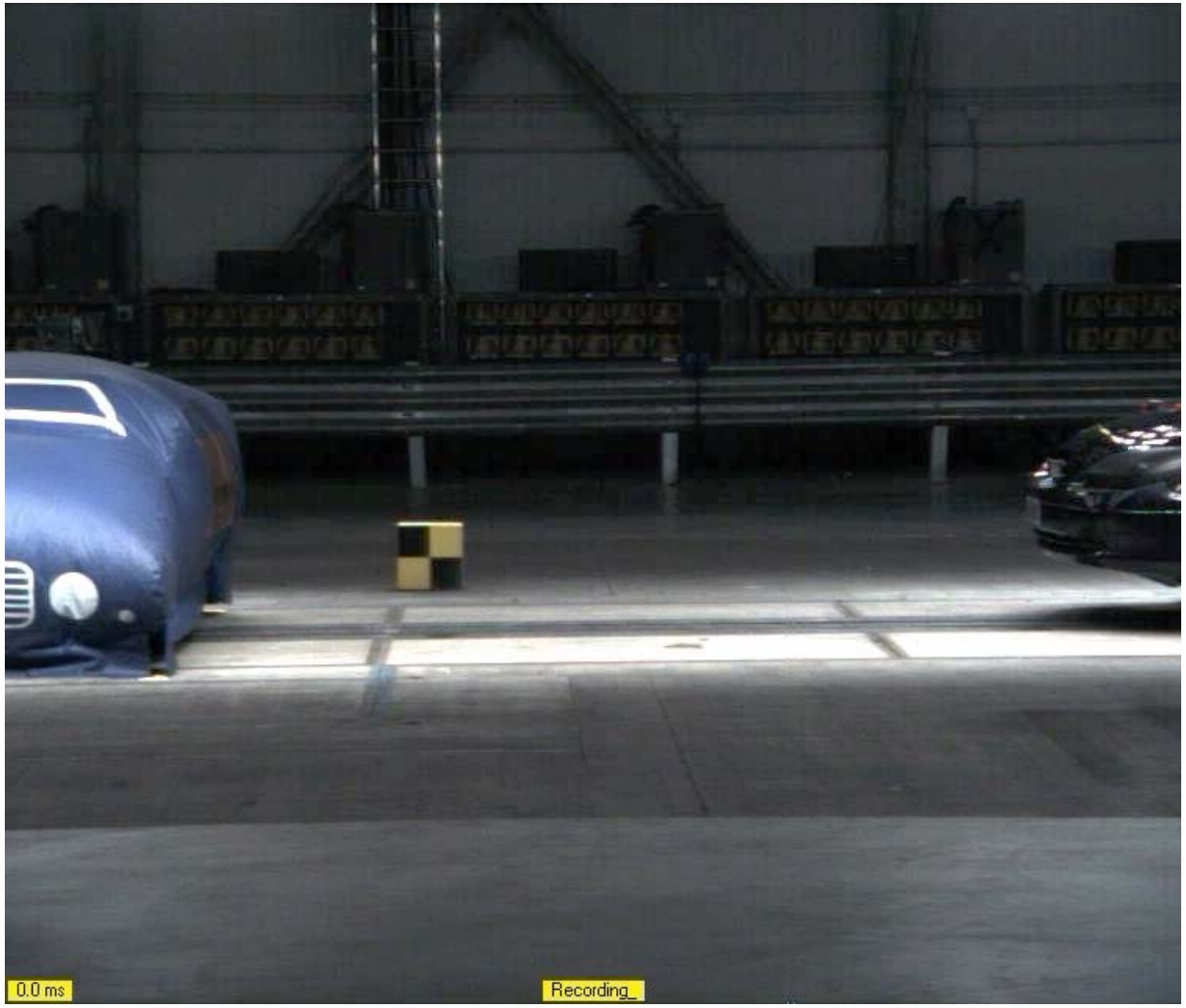
- moderate Automatic Braking (~0.4 g)
- Motorized Pretensioners, Sunroofs, Seat etc

But also Non Reversible Systems like

- hard Automatic Braking (>0.5 g)
- Front & Side Airbags, Hood Lifters etc

Pre-Crash Triggering

example: Active Bumper



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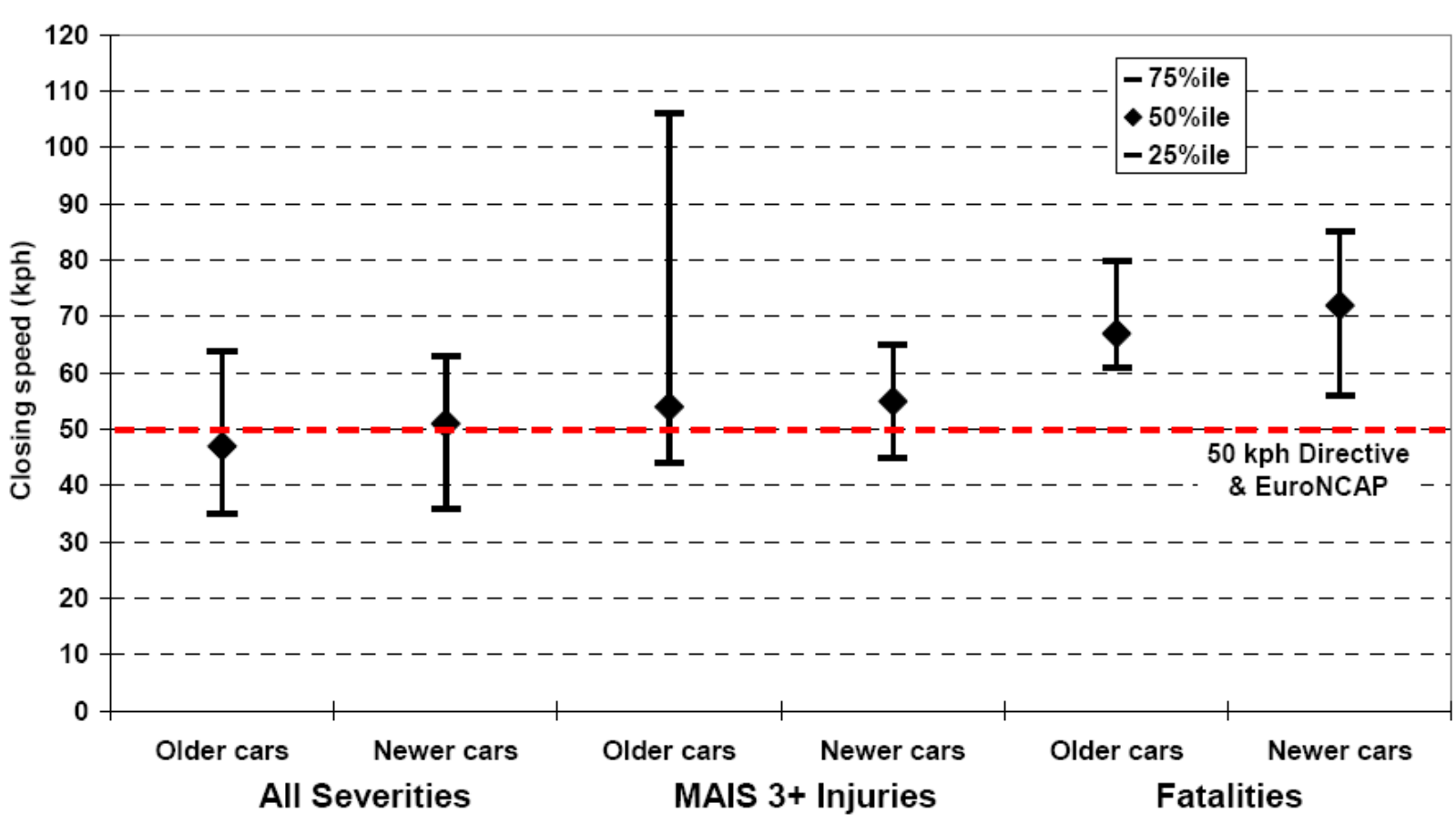
Pre-Crash Triggering

example: Collision Mitigation by Braking

Pre-Crash Triggering of Restraints
Benefits in Side Impacts



SOURCE : Real-world Crash Performance of Recent Model Cars – Next Steps in Injury Prevention
Pete Thomas, Richard Frampton – Vehicle Safety Research Centre, Loughborough University, UK
IRCOBI Conference – Lisbon (Portugal), September 2003

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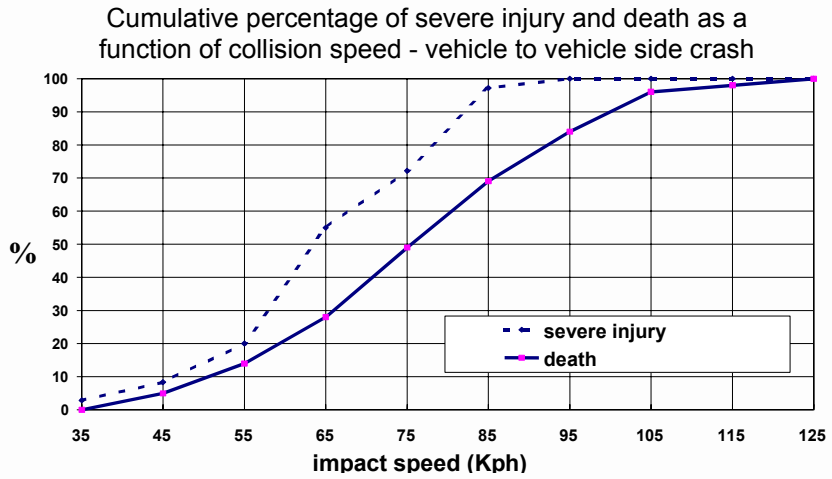
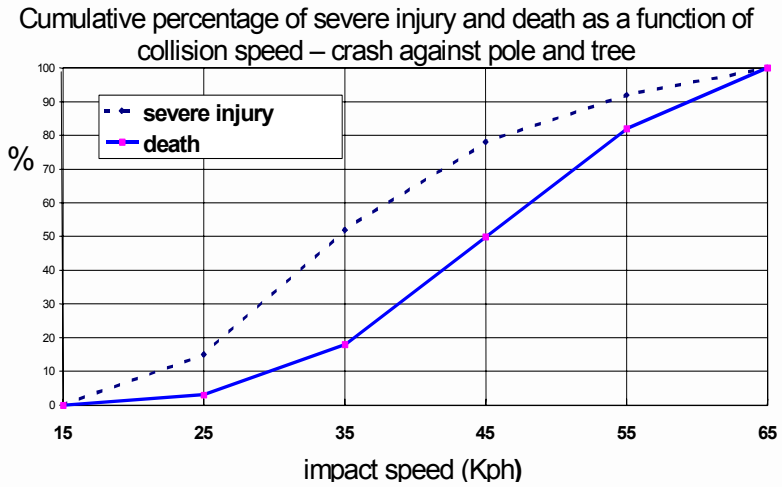
Pre-Crash Triggering of Restraints
Benefits in Side Impacts





Impact speeds in regulatory or rating tests are lower than in real life:

- 90% of fatalities in tree or pole impacts are with impact speeds above 30 Km/h
- 70% of fatalities in car-to-car impacts are with impact speed above 65 Km/h

Protecting occupants at higher impact speeds requires new protection systems that need to be deployed earlier and even prior to the impact

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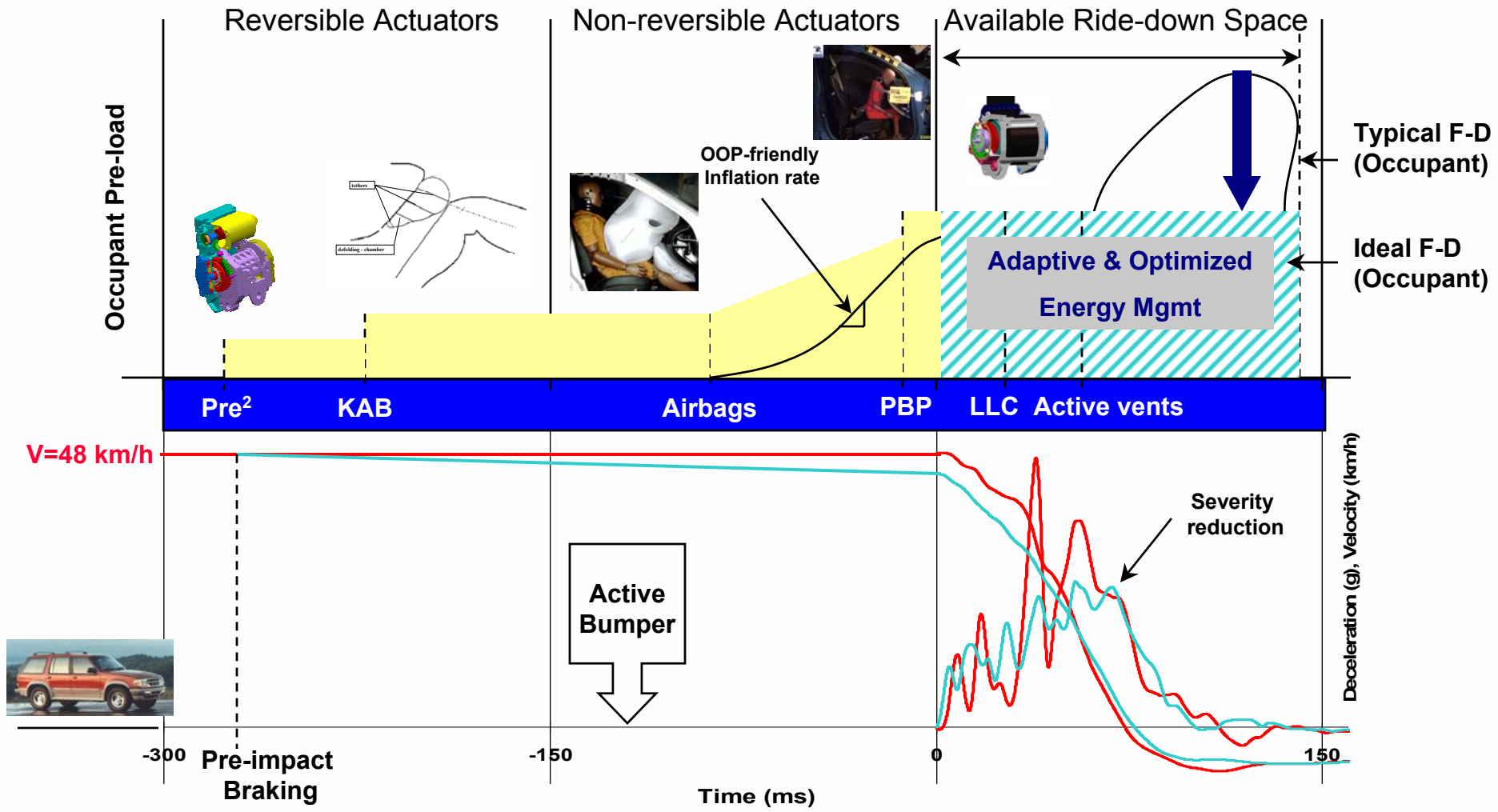
Pre-Crash Triggering of Restraints

Benefits in Frontal Impacts



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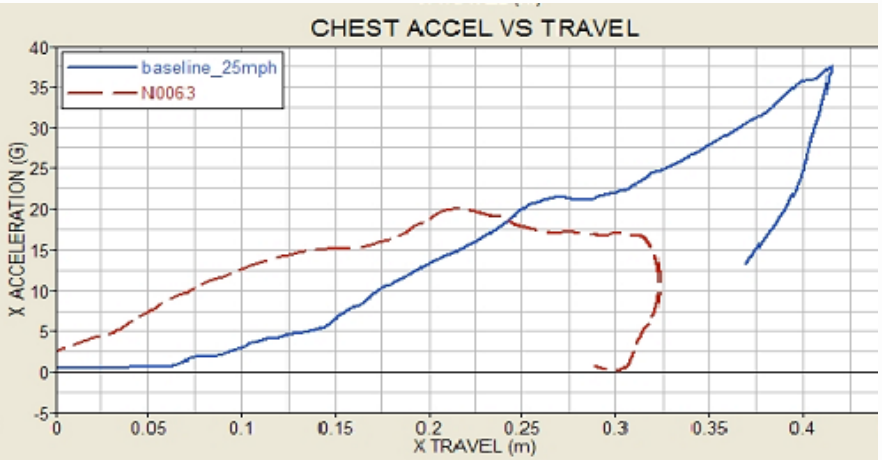
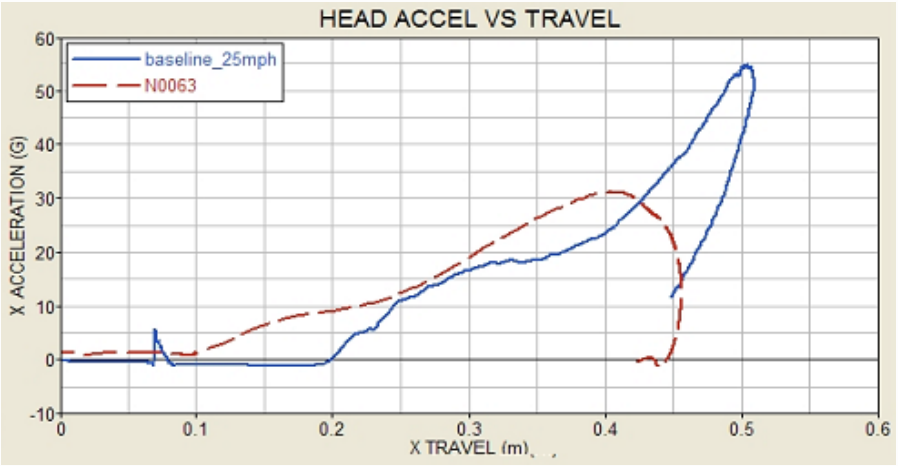
Pre-Crash Triggering of Restraints
Benefits in Frontal Impacts





Pre-Crash Triggering Restraint Systems allow:

- slower deployment
- improved balance between non-aggressiveness and occupant coupling

Leading to

- no deployment-related injuries
- enhanced occupant protection

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Frontal Pre-Crash Triggering

proposed System Objectives (1)

Pre-Crash activation of

- non reversible systems (e.g. airbags)

and/or

- reversible systems with potentially severe impacts on traffic (e.g. > 0.5 g braking)

is evidently dictating the most challenging specifications for the complete systems and for the sensors.

Frontal Pre-Crash Triggering

proposed System Objectives (2)

Sensing System

- Airbag activation decision 80 ms prior to impact for severe frontal impacts (= 2,65 m at 120 km/h)
- Overall reliability as with current sensing systems

Protection System

- Airbags and inflators designed for ~120 ms deployment time
- Optimization for Very Low Risk deployment **and...**
- …maximum possible Occupant-Car coupling

Frontal Pre-Crash Triggering

Sensing System Reliability vs. Performances (1)

Sensing Reliability is measured by

- occurrence of “False Positive” decisions (undesired firing decisions)
- occurrence of “False Negative” decisions (no firing in severe crashes)

Both criteria depend on

- accuracy of impact point prediction
- correct identification of “target” (number of objects, type, size, mass, stiffness)
- processing time

Frontal Pre-Crash Triggering

Sensing System Reliability vs. Performances (2)

Sensing System Comparison - Short Range - Assuming adequate FoV

Sensing Technologies	Resolution and Accuracy Distance	Angle	Separation potential	Classification potential
Required for Pre-Crash	20 cm	1°		
Radar	OK	fair (3°)	fair (Range)	poor
Single camera	poor	fair	fair	good
Stereo Vision	fair	OK	fair (Azimuth)	OK
Scanning Lidar	OK	fair	fair	poor
3D Camera (1)	fair	OK	OK (Range?)	OK

(1) High number of pixel required

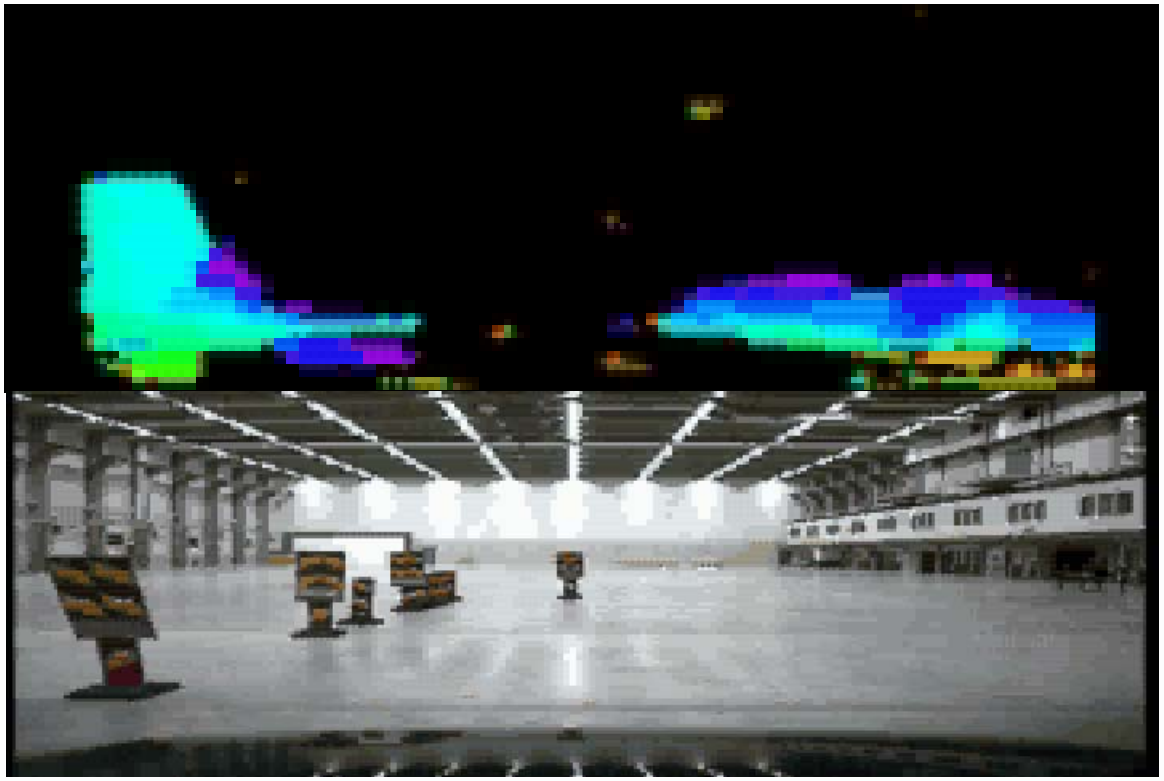
Conclusion: At least two Sensing Technologies must be associated to provide desired performances and thus decision reliability

Frontal Pre-Crash Triggering

Example of Sensing Technologies

Stereo Vision for Pedestrian Sensing

Distance



Separation

Classification

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Example of Sensing Technologies

Radar + Stereo Vision for Pre-Crash

“ Hit ”

“ Near Miss ”

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Sensor Reliability - General

In general terms:

- the slower the actuators, the earlier the activation decision
- the earlier the decision, the lower its reliability (False Positive)
- need for reliability depends on annoyance and consequences of False Positive decisions
- consequences are linked to potential safety impacts of a False Negative decision

Frontal Pre-Crash Triggering

Sensor Reliability - Non Reversible Systems (1)

Current development work

- show that sensor combinations (fusion) can provide good accuracy in predicting the impact position and time (e.g. 20 cm @ -80 ms)

Inherent weaknesses will be

- inability to evaluate mass/stiffness prior to contact
- gray zone (e.g. 20 cm)

Consequences will be

- non desirable activation for impacts against objects with “big” signature but low mass (e.g. bushes)
- “late” firing in crashes with small overlaps

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Sensor Reliability - Non Reversible Systems (2)

Acceptance of weaknesses

- depends on statistical probability and physical consequences
- must make reference to State-of-the-Art systems of which weaknesses are known and accepted

Examples of action

- statistical study about likelihood of impact against “zero mass” objects
- development of backup (alternative) solutions in case of late activation

Frontal Pre-Crash Triggering
Regulatory Considerations

- Pre-Crash activation of Restraint Systems
  - possible in current regulatory and rating tests; no change needed
- Pre-Crash braking
  - all current test procedures specify impact speeds and obstacle types
  - issue # 1: change “impact speed” into “initial speed” and permit automatic intervention resulting in lower impact speed
  - issue # 2: time to automatic braking activation might be dependent on obstacle type

Conclusions

- Effectiveness and feasibility of Pre-Crash activation of Brakes and reversible Restraint Systems are widely recognized
- Pre-Crash activation of non reversible Restraint can provide substantial enhancement of protection performances
- Reliability of Sensor decision is crucial
- Recent developments indicate that Sensor Fusion techniques can provide adequate reliability
- Specific approach of reliability issues is nevertheless needed
- Regulations and Rating Test procedures must be revisited to accommodate Pre-Crash interventions