The main achievements of the CHILD project

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4th International Conference "Protection of children in cars"
December 7 – 8 2006 Munich, Germany

CHILD

Contract G3RD-CT-2002-00791

Duration: (49 months) : September 2002 – September 2006

Funding: Partially funded by the European Commission

Programme : Standard, Measurements & Testing

Partners: 14, from seven European countries

Coordinator: RENAULT S.A - Françoise CASSAN

How was CHILD born?

- 1989 : International Task Force on Child Restraint, initiated by Claude Tarrière from RENAULT – 13 pioneers from all over the world, working on a voluntary basis, without any financial subsidiary.

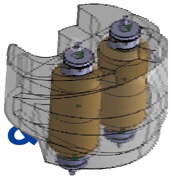
- 1996 : CREST was the successor of the ITFCRS. It was partly funded by the European Commission under the SMMT programme of the 4th PCRD. It opened the way to a better knowledge in the field of children protection.

- 2002 : CHILD takes the advantage of the CREST experience. It is a continuation, but with many new development items that were not in CREST. CHILD is now completed, but there is still a lot to do to improve the safety of children in cars.

ITF-CRS

CHILD organisation

Experimentation & modelling

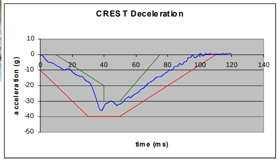


Real world situation study

WP1

WP2

WP3



Consolidation & analysis

Co-ordination & dissemination

WP4

WP 1 Accidentology

Main contributions of WP1

WP1 has made a contribution to the scientific objectives of CHILD through the provision of real-world crash investigations.

These in-depth cases provide a better understanding of the crash events including :

- the injury causes and outcomes for restrained children
- the child restraint systems used
- the child kinematics

CHILD accident database

- Contains 669 accident cases
  - 264 CHILD cases
  - 405 CREST cases
- Effectively and efficiently managed
- Analysis conducted, dissemination through publications.

The results of analysis of the accident data base are presented during this conference in two other CHILD communications :

- "CHILD : Analysis of CHILD data related to frontal impacts", Alan Kirk et al…
- "CHILD : Analysis of CREST and CHILD data related to side impacts", Philippe Lesire et al…

USE and MISUSE

WP1 has also provided a literature review, surveys of use and a testing programme to evaluate misuse.

They have all contributed to the understanding of the effects of misuse on the performance of child restraint systems.

Literature review

- Review of the knowledge of CRS use and misuse in Europe and the rest of the world
- Surveys undertaken in France and Spain
- Report of the situation in Germany, to complement literature report
- All these reports are available on the CHILD website :

www.childincarsafety.com

Spanish & French misuse surveys

Aim of studies:

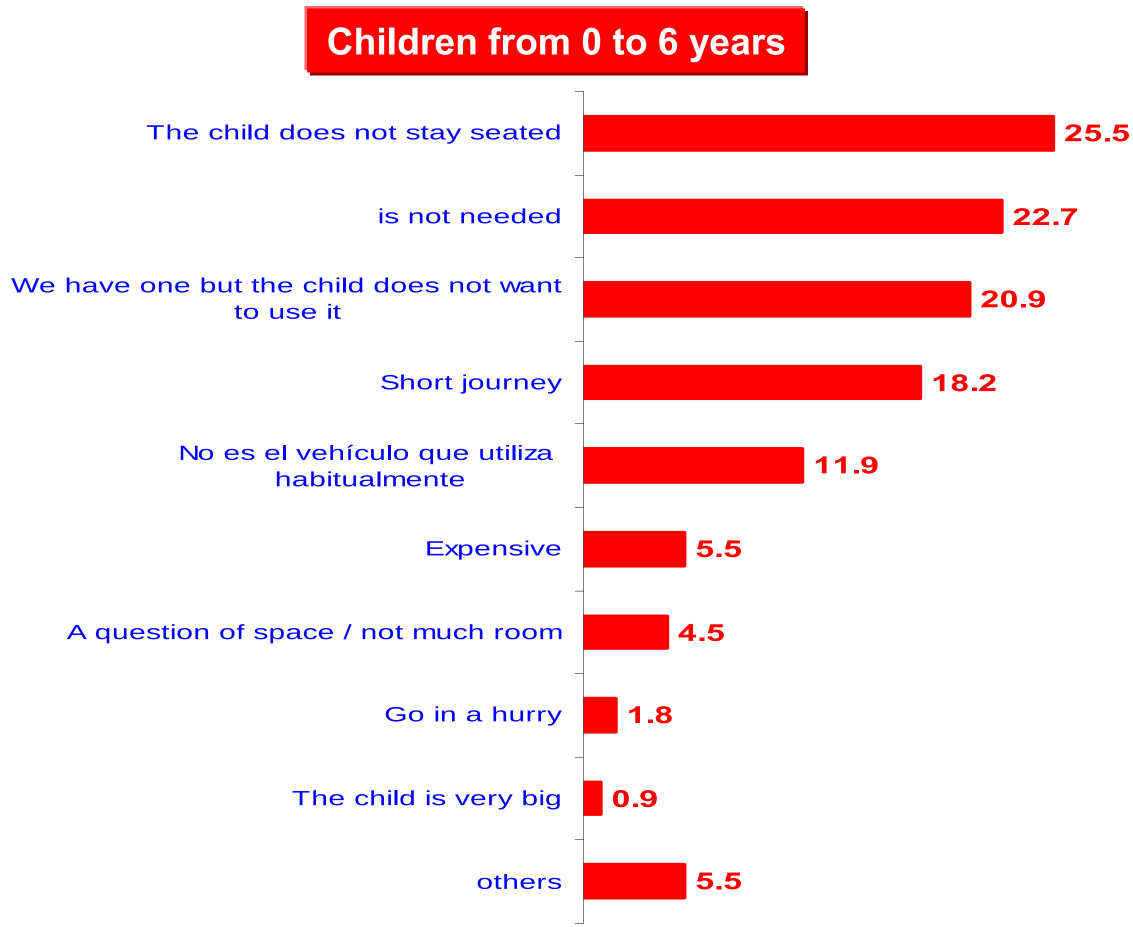
- To determine the level of use & misuse of CRS
- To know the attitudes of parents towards the use & misuse of CRS
- Additionally, to collect information to be used for the development of test procedures and the misuse evaluation programme

MISUSE of a child restraint system is defined as any incorrect fitting of the restraint in the vehicle (e.g. having the seat belt routed incorrectly) or incorrect positioning or restraining of the child within it (e.g. having the harness too loose).

INAPPROPRIATE USE is defined as the child being restrained in the wrong type of restraint for their size, age or weight. Inappropriate use can also include use of a CRS not corresponding to ECE R44.

Attitudes towards the use of CRS

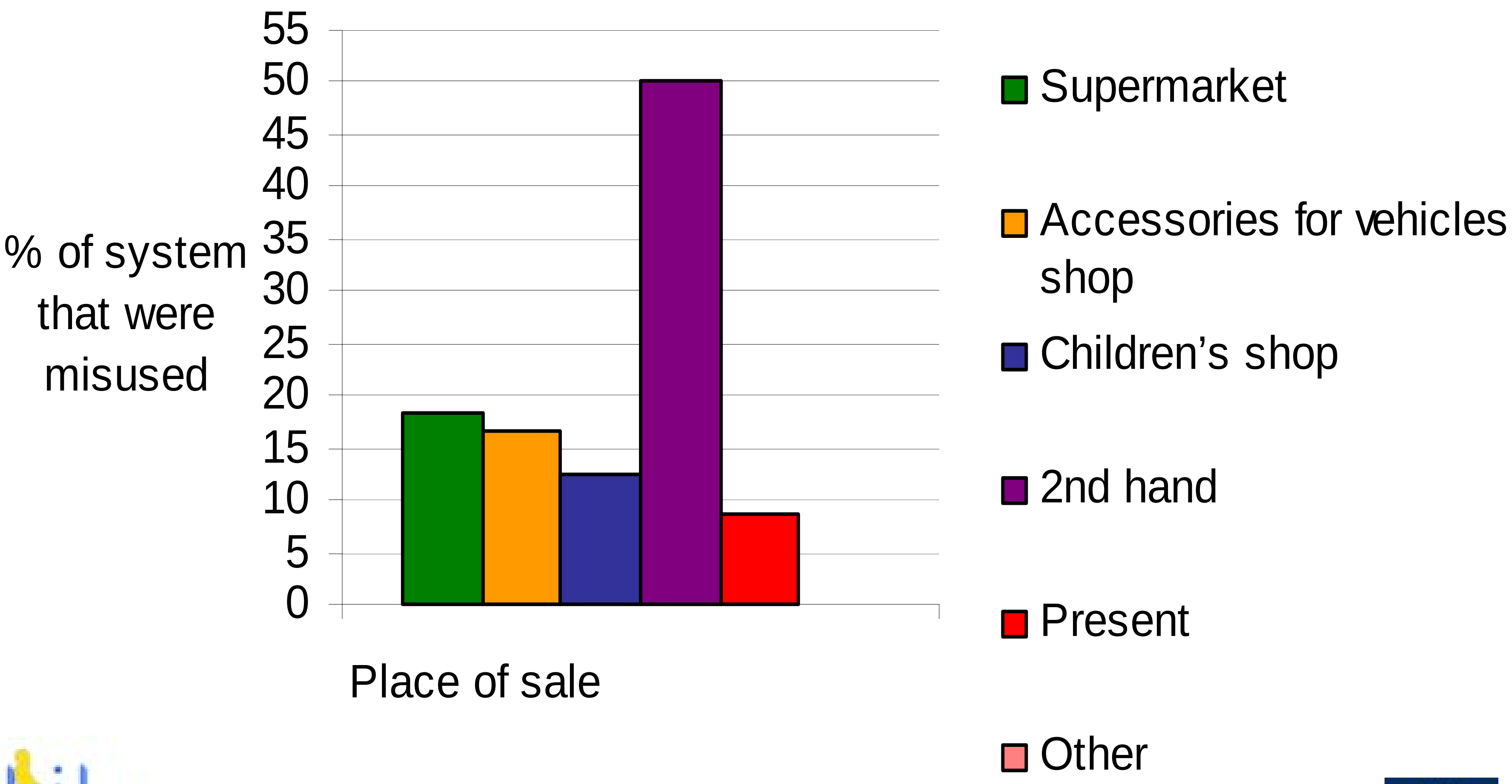
(%) Reasons for not using the CRS



BASE: 110 children that do not use CRS

Purchased place / misuse

Place where the CRS was purchased and misuse (%)



Conclusions

The proportion of children well protected while travelling in cars appears to be extremely low.

As an average value, 73% of children of the surveys were not using their CRS correctly.

A large proportion of CRS shows several misuse at the same time.

- Review did not provide information on the effect of misuse on the performance of CRS,
  - An additional task was agreed partly through the CHILD project, involving non CHILD partners,
  - A comprehensive testing programme to evaluate the effects of misuse was set up.

A presentation will be made tomorrow :

"MISUSE : how can the experience gained in the ad-hoc group of misuse be useful for the comprehension of real life crash consequences", Manuela Cataldi et al

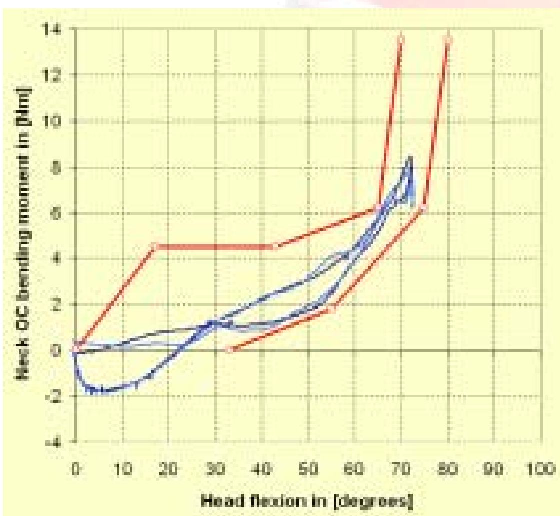
WP2: Experimentation & Modelling

- Dummy and sensor development
- Virtual dummy and human modelling
- Experimental accident reconstructions
- Virtual Accident Reconstructions

Dummy development

TNO developed and validated a new born dummy, the Q0

FTSS improved and updated the whole Q-Dummy family

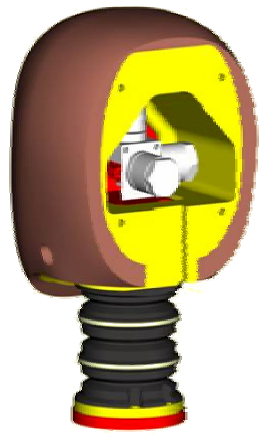


Future of Q0

- **Improved research tool**
  - Protection of babies in cars
  - Shaken baby syndrome (UvA)
- **Use in regulation**
  - EEVC WG12-18:
    proposal of new dummies for ECE-R44
- **Use in consumer programmes**
  - NPACS: Q-dummies for frontal & lateral

Q-dummies Update Program

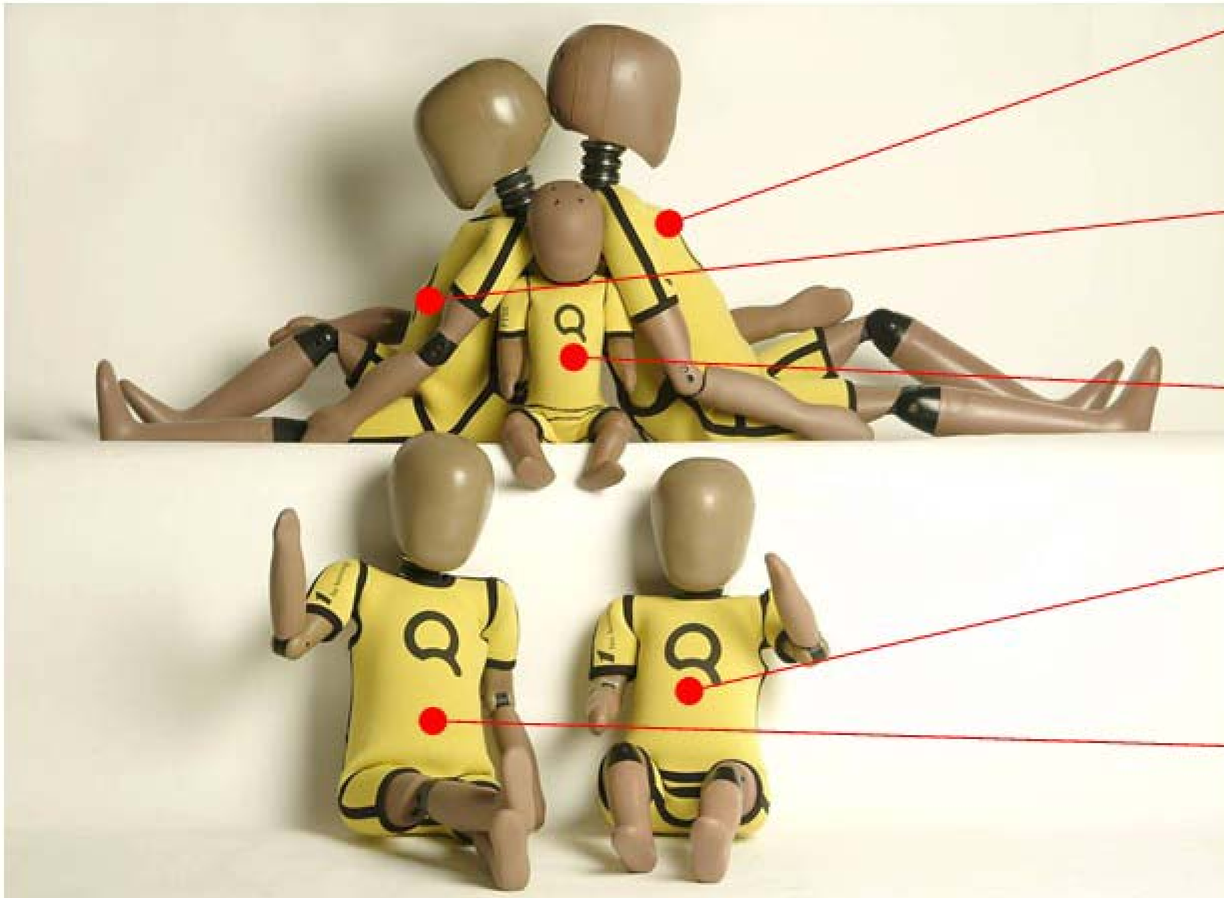
- **Update program started 2003**
- Based on CREST experience
- Improve dummy durability, retain current biofidelity
- Frontal impact evaluations
- Updated dummies evaluated by EEVC WG12 and 18 (introduction in ECE-R44)
- Q1.5 added to cover ECE-R44 mass groups



Improvements made:

- New head and neck
- New durable rubber shoulder
- Infra-red measurement system in chest
- Modified hip cups and elbow joint.
- Q0 dummy developed

Q-family fully equipped …



Q6 23.0 kg

Q3 14.5 kg

Q0 3.4 kg

Q1 9.6 kg

Q1.5 11.0 kg

… to contribute to child safety

Sensors development

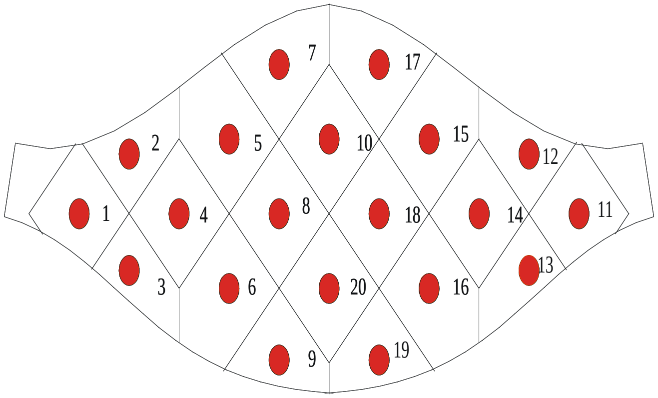
- "Children are not small adults"
- Additional measurements on the dummies necessary
- Although abdominal injuries still occur, currently no possibilities to assess the abdominal loads within the Q-child-dummy family exist
  - 2 different principles were investigated within CHILD

Force sensor

- Every sensor is assigned to a small area on the abdomen's surface

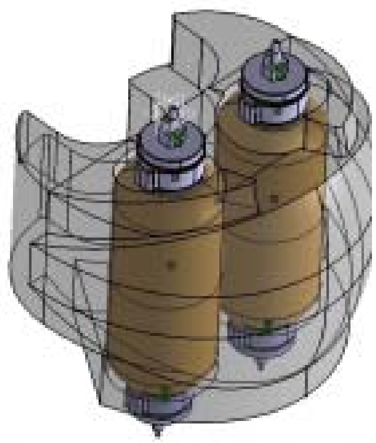
- The prototype works well but further improvements are necessary

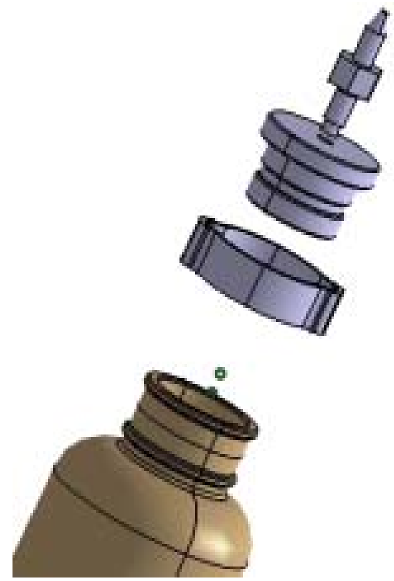
- The effective local force can be calculated by using the measured pressure and the area



Pressure sensor

- Abdominal block with two holes
- Two gel filled bladders replace the normal abdomen
- The pressure inside the abdomen is measured

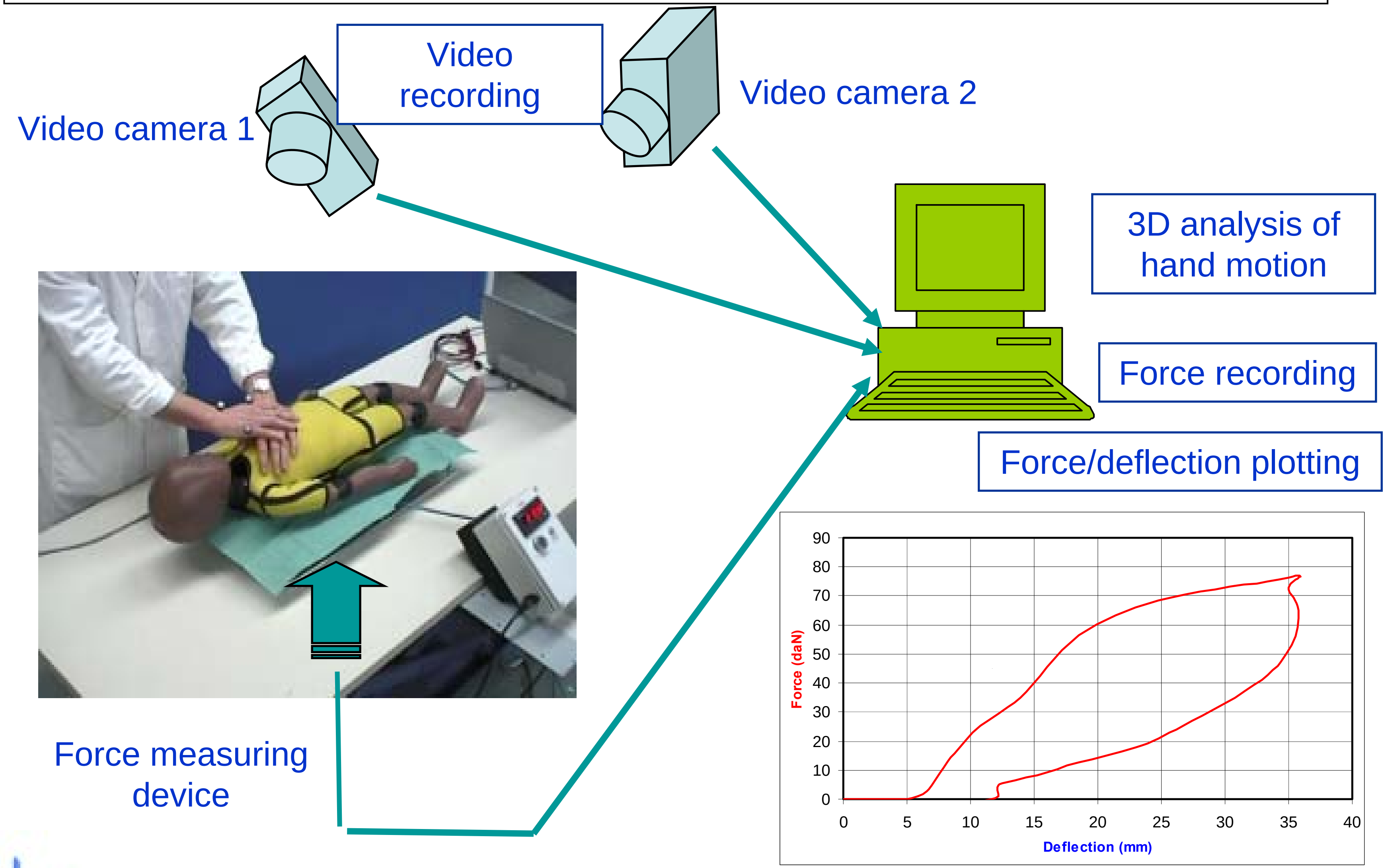




Enhanced method & tools for child thoracic and abdominal compliance assessment by clinical treatment observations

INRETS & Université FOURIER - Grenoble

Displacement & force acquisition



Tracking of hands displacement and 3D reconstruction

Virtual dummy & human modelling

- Numerical simulation improves the development in child safety
- Real dummy measurements of crash/sled tests are used for the validation of virtual dummy models

Proposed approach within CHILD

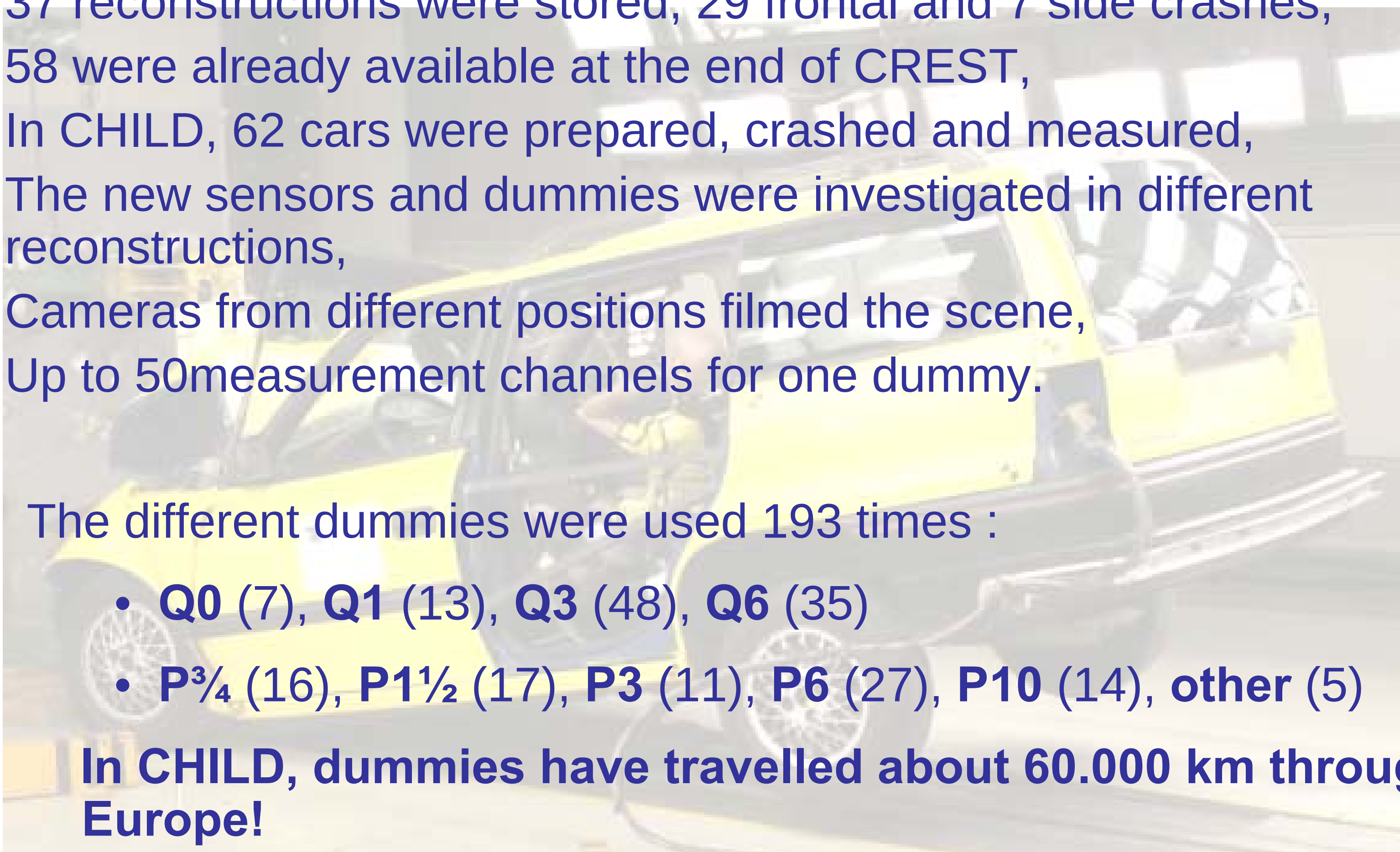
- Development of a detailed child neck model
- Coupling of the detailed neck FE model to a multibody
- model
- Definition of neck loading under accidental conditions
- Extraction of best injury parameter candidate

A presentation will be made this afternoon :

« Child neck finite element model development and validation against expeerimental data », Remy Willinger et al..

Experimental accident reconstructions

Experimental accident reconstructions

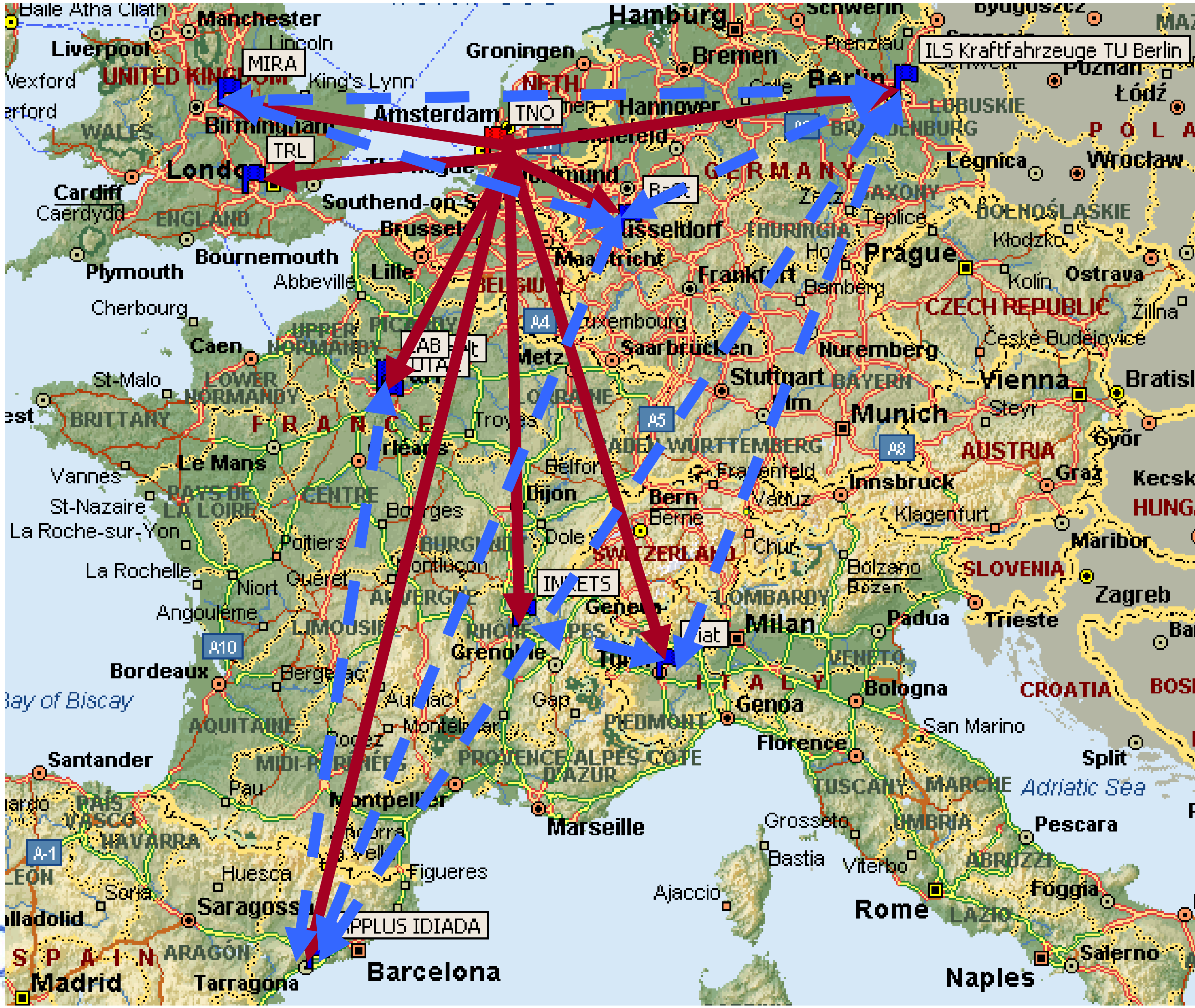


- 37 reconstructions were stored, 29 frontal and 7 side crashes,
- 58 were already available at the end of CREST,
- In CHILD, 62 cars were prepared, crashed and measured,
- The new sensors and dummies were investigated in different reconstructions,
- Cameras from different positions filmed the scene,
- Up to 50measurement channels for one dummy.

The different dummies were used 193 times :

- **Q0** (7), **Q1** (13), **Q3** (48), **Q6** (35)
- **P¾** (16), **P1½** (17), **P3** (11), **P6** (27), **P10** (14), **other** (5)

In CHILD, dummies have travelled about 60.000 km through Europe!


MIRA
TNO
TRL
ILS Kraftfahrzeuge TU Berlin
LAB
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Manchester
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UNITED KINGDOM
Lincoln
King's Lynn
Birmingham
Cardiff
Caerdydd
Plymouth
Bournemouth
Southend-on-S
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Bamberg
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Grenoble
Turin
VENETO
Bay of Biscay
Aurillac
Gap
ITALY
Bologna
Genoa
CROATIA
AQUITAINE
Montélimar
PIEDMONT
San Marino
Rodez
Florence
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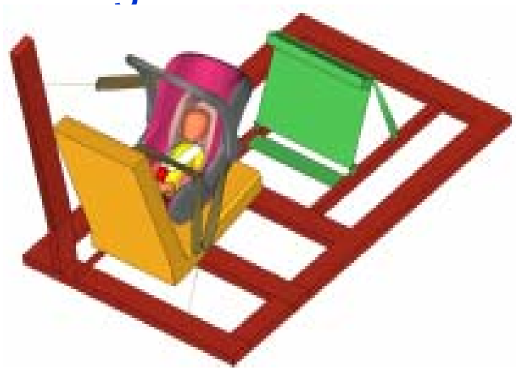
TUSCANY
MARCHE
Adriatic Sea
PAIS VASCO
Pau
Montpellier
Marseille
Grosseto
UMBRIA
Pescara
NAVARRA
Andorra
Bastia
ABRUZZI
Huesca
Figueres
Viterbo
Soria
Ajaccio
Foggia
Saragossa
Rome
LAZIO
Valladolid
ARAGÓN
SPAIN
Madrid
Tarragona
Barcelona
Salerno
Naples
A4
A5
A8
A10
A-1

Virtual accident reconstruction

- A simplified numerical model of a group 0+ CRS was created to validate the Q0 model, by modelling a real CRS

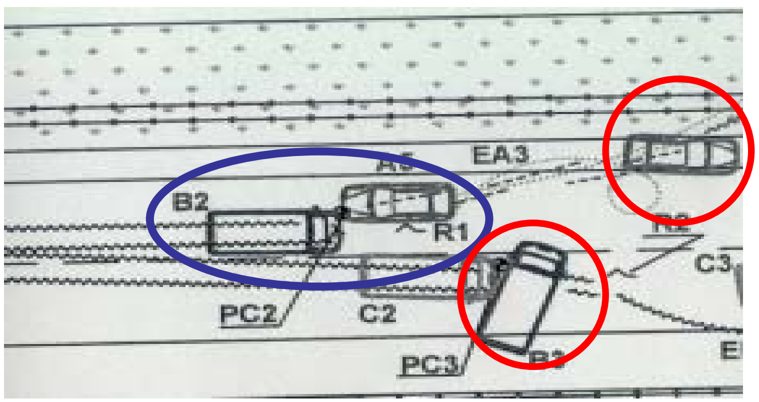
- A series of frontal and lateral sled tests were performed to obtain more data for the validation of the LS-Dyna dummy model within a CRS environment

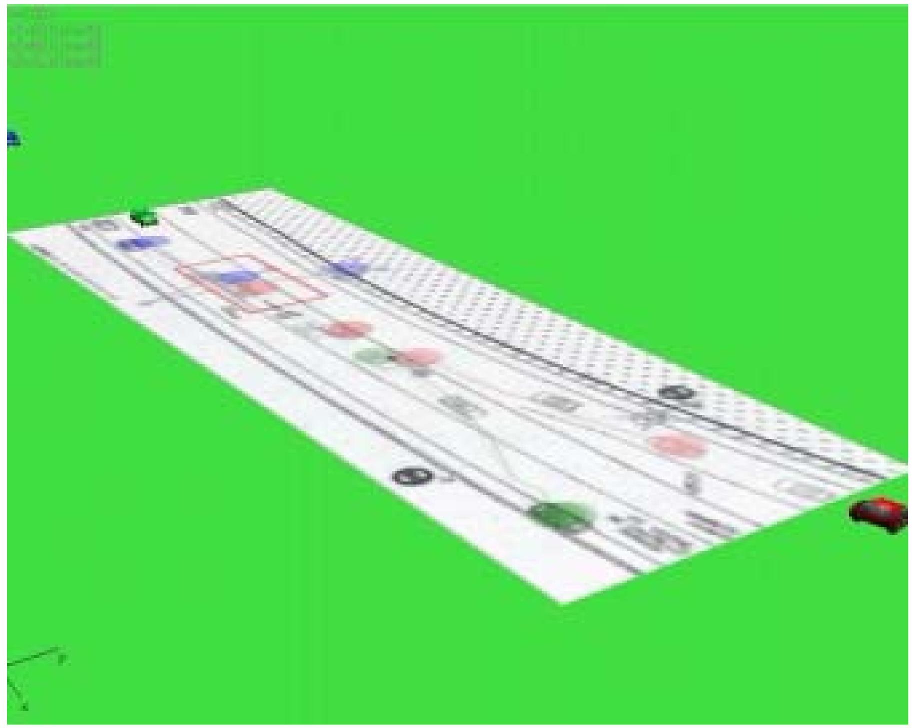
- Frontal and side impact configurations were finally used for the validation



Virtual accident reconstruction

- The use of PC Crash was useful to reconstruct the real world accident.
- As better the knowledge is about the accident, as better will be the reconstruction





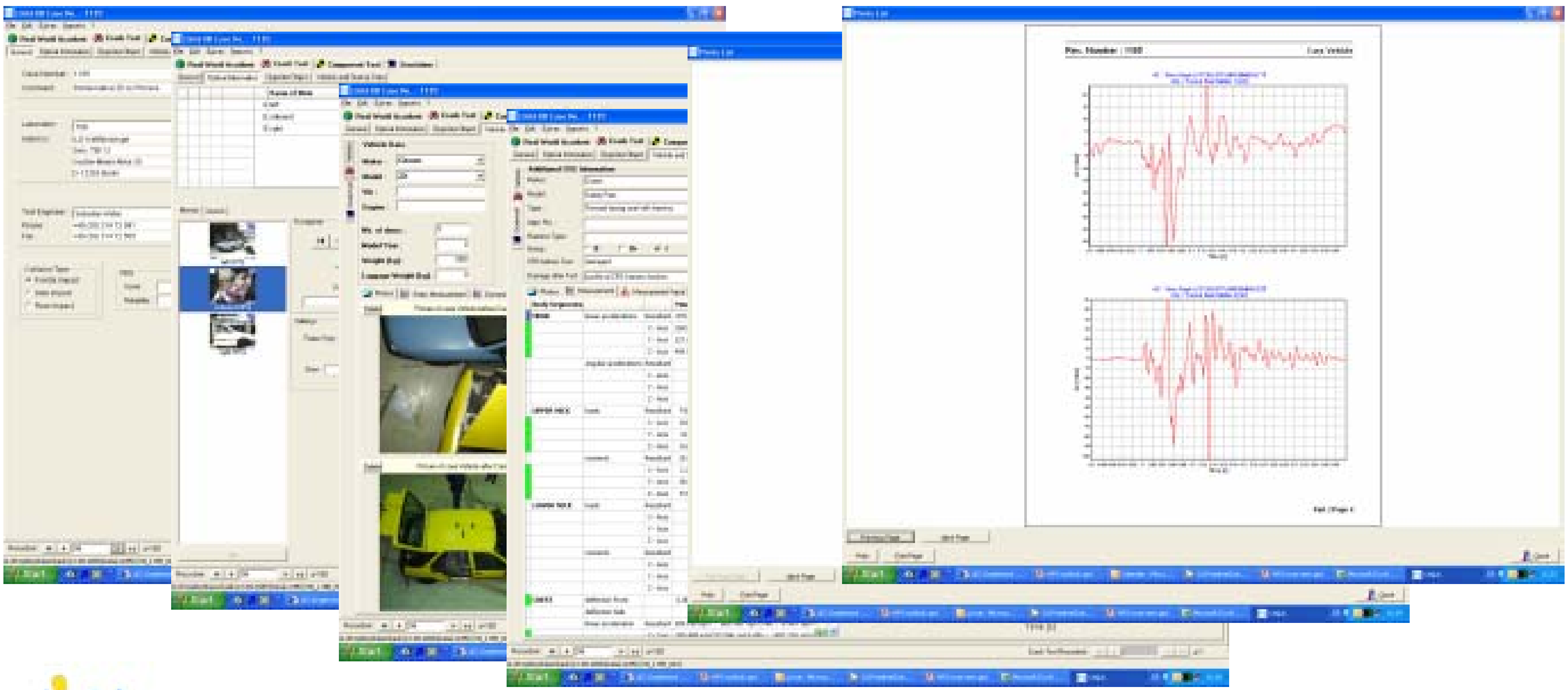
1176	IDIADA ARTPOE	VW PASSAT	57	left side	2	y11	0	seatbelt	0	0	0	0	0	0	no good Q dummy for that age
1177	IDIADA PIS26/04	R. ESPACE N	35	right side	5	y07	1	seatbelt	1	0	0	0	0	0	CONFIGURATION TOO DIFFICULT
1178	IDIADA ART PO	R. 19	65	frontal	3	y03	0	FWD FC G1	0	0	0	0	0	0	high severity - no injury - but old designed car
1179	IDIDADA GI199	O.VECTRA	60	frontal	3	y7	2	seatbelt	2	0	0	0	0	2	no severe interesting injuries and no additional CRS
1179	IDIDADA GI199	O.VECTRA	60	frontal	5	y10	2	seatbelt	0	0	1	0	0	2	no good Q dummy for that age
1180	LAB15267	R. KANGOO		right side	6	m32	1	FWD FC G1	1	0	0	0	0	0	Side impact on engine block - final position of the right side
1181	LAB15260	O. CORSA		side swipe	3	y06	0	booster	0	0	0	0	0	0	difficult to reproduce
1181	LAB15260	O. CORSA		side swipe	5	y03	4	booster	4	0	0	0	0	0	difficult to reproduce - interestin g for validation of nour expertise (expectation of head impact with the pole)
1182	LAB16026	P. 206	65	frontal	2	y08	2	seatbelt	1	0	0	0	2	2	airbag interaction / load limitors - age of child is eight years old - OK if Q- fits withh height and/or weight
1183	LAB15691	C. EVASION	72	frontal	3	y09	2	seatbelt	0	0	1	0	0	2	no good Q dummy for that age
1184	LAB16068	C. XSARA	65	frontal	5	m15	0	FWD FC G1	0	0	0	0	0	0	high severity - Q1 with no injury if needed
1185	LAB15208	C. ZX	37	frontal	5	m09		FWD FC G1	4	0	0	0	0	0	low severity crash with high level of injury - misuse to be reproduced, may be followed by sled testing
1186	LAB15256	S. IBIZA	65	frontal	4	y11	3	seatbelt	0	0	0	0	2	0	no good Q dummy for that age
1187	LAB13847	F. PALIO	65	frontal	3	y05	3	FWD FC G1	0	0	0	4	0	0	opposite vehicle is truck - dificult to reproduce
1187	LAB13847	F. PALIO	65	frontal	5	m26	5	FWD FC G1	5	0	0	0	0	0	opposite vehicle is truck - dificult to reproduce
1188	MUH30000961	A.100	63	frontal	3	y06	1	seatbelt	2	0	0	0	0	2	Opposite vehicle is rear of bus - and roll over - dificult to reproduce
1189	MUH30010275	VW GOLF II	37	frontal	5	y11	2	seatbelt	0	0	0	1	0	2	no good Q dummy for that age
1190	MUHCLENZE051	VW PASSAT	45	left side	3	y06	2	booster	2	0	0	0	0	0	CRS MODEL NOT EXACTLY KNOWN - TO BE CHECKED
1190	MUHCLENZE051	VW PASSAT	45	left side	5	y05	1	booster	0	0	0	0	0	1	NOT INTERESTING FOR THIS CHILD
1191	MUHUPLENGEN	F.FIESTA	55	left side	3	y08	6	booster	6	0	0	0	0	2	INTERESTING BUT DIFFICULT -TRUCK AND DIRECT CRUSH OF TOHE HEAD ON THE FRONT OF THE TRUCK
1192	MUH VOLTLAGI	VW POLO	67	right side	3	m05	1	RWD FC G0+	1	1	0	0	0	0	INTERESTING CASE - Q1 is possible (child is 10kg and 68cm)
1192	MUH VOLTLAGI	VW POLO	67	right side	5	y03	4	FWD FC G1	4	0	0	0	0	0	INTERESTING CASE - SEVERE HEAD INJURY - Q3 is possible (child is 14kg and 100cm)
1193	MUH WISCHHAF	VW GOLF IV	51	frontal	3	m11	1	FWD FC G1	0	0	1	0	0	0	Interesting case because the CRS fixation is different than the ones that we are used to. Severe crash - recent ca
1193	MUH WISCHHAF	VW GOLF IV	51	frontal	6	y03	2	Booster	0	0	0	1	2	0	interesting case because integrated booster in recent car and pelvis injury. Severe crash - Q3 fits in terms of age
1194	CHALMERS040	BMW525		right side	2	m32	0	RWD FC G1	0	0	0	0	0	0	RWD FC G1 CRS in side impact - exact model to be precised - Q3 is OK

WP 3: validation & procedures

Example of accident case in db

Example of reconstruction in db

- Reconstruction database contains all information
- Connection to the accident database possible



RQS

Reconstruction **Q**uality **S**core method

Based on reconstruction experience,
It is difficult to assess the quality of a reconstruction, when compared with accident. Comparison of pictures is not sufficient to guarantee that the test severity was correct. Comparison of static deformations of cars from accident and reconstructions is necessary.

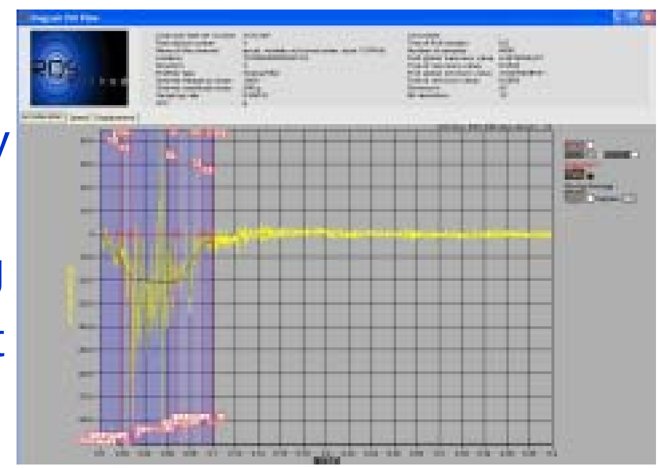
Static measurement

Deceleration curve

Score and its reliability

Shape for sled testing

Adjustment of pulse



Validation of crash data

Test is performed with given configuration.

The validation of crash data is based on :

- static deformations measurements,
- pictures of vehicles,
- deceleration curves,
- pictures of child dummies,
- curves,
- films, on board camera views

Injury criteria

Injury criteria

- Objectives: to propose test procedures using instrumented child dummies and to recommend limits for the injury criteria values

- Difficulty: no child biomechanical injury data available in literature, directly usable for Q-dummies

Need: determine child injury limits

Objectives:

- To identify the physical parameters associated with various child injury mechanisms

- To determine the injury risk curves for the Q-family dummies :
  - In frontal and side impact,
  - For head, neck, thorax and abdomen

Methodology

The reconstructions from CHILD & CREST are validated by the group

↓

Injuries paired with dummy measurements

↓

data scaled to a given age

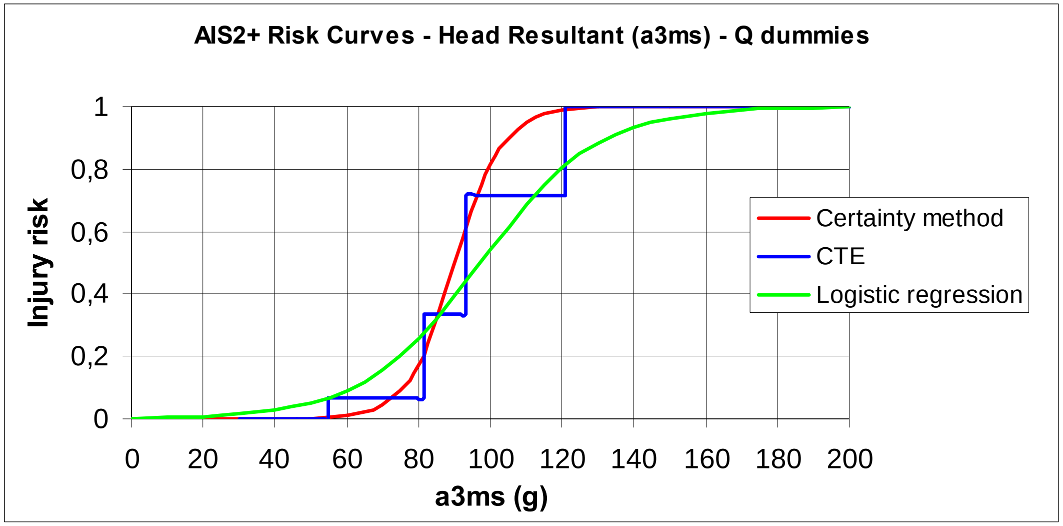
↓

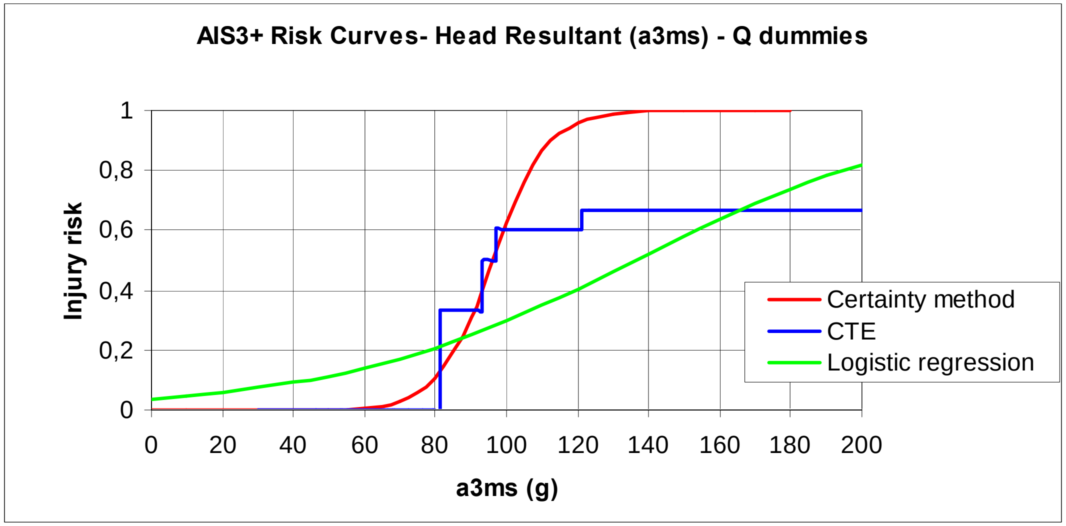
Injury risk curves

Injury risk curves

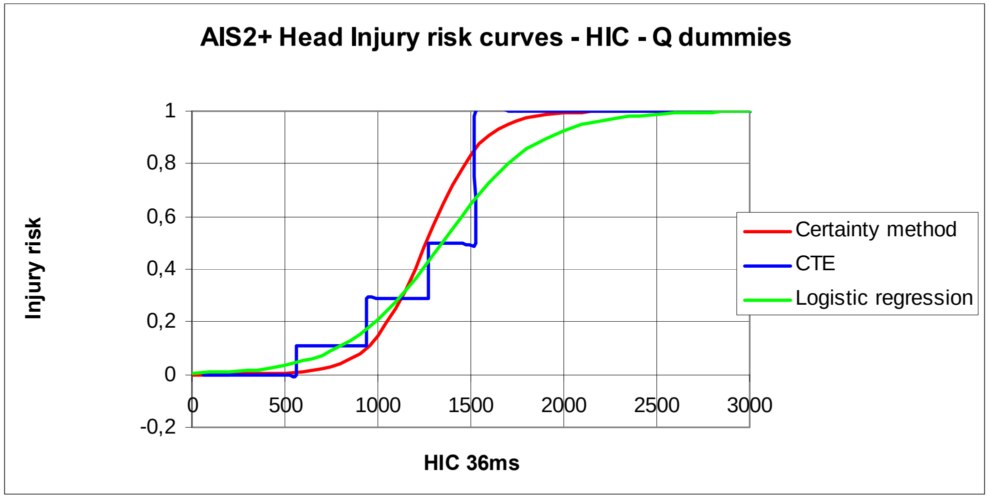
- Three methods used to construct the injury risk curves :
  - Certainty method
  - CTE (Consistant Threshold Estimate)
  - Logistic regression

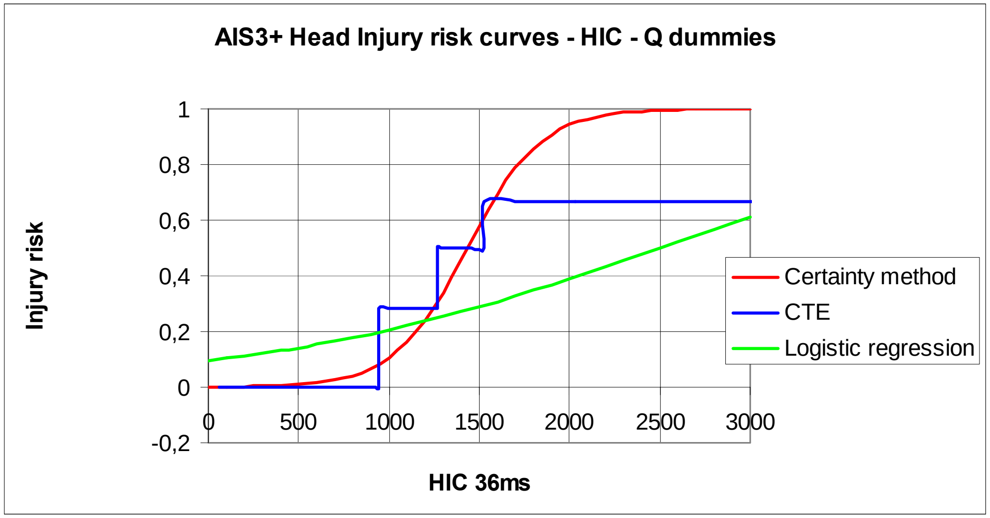
Frontal impact: head injury risk curves





Frontal impact: head injury risk curves





Frontal impact: head injury risk thresholds

ACCELERATION

Injury risk	20%	50%
AIS 2+	81g	90g
AIS 3+	88g	97g

HIC 36ms

Injury risk	20%	50%
AIS 2+	1050	1290
AIS 3+	1150	1460

Side impact: data analysis (head)

- For the side impact the sample size is not large enough to construct injury risk curves

- Acceleration threshold observed between INJURED & NON INJURED

➢

Acc 3ms	0 – 50g	50 – 89g	≥99g
AIS	0	1 - 5	≥5

Conclusions - head

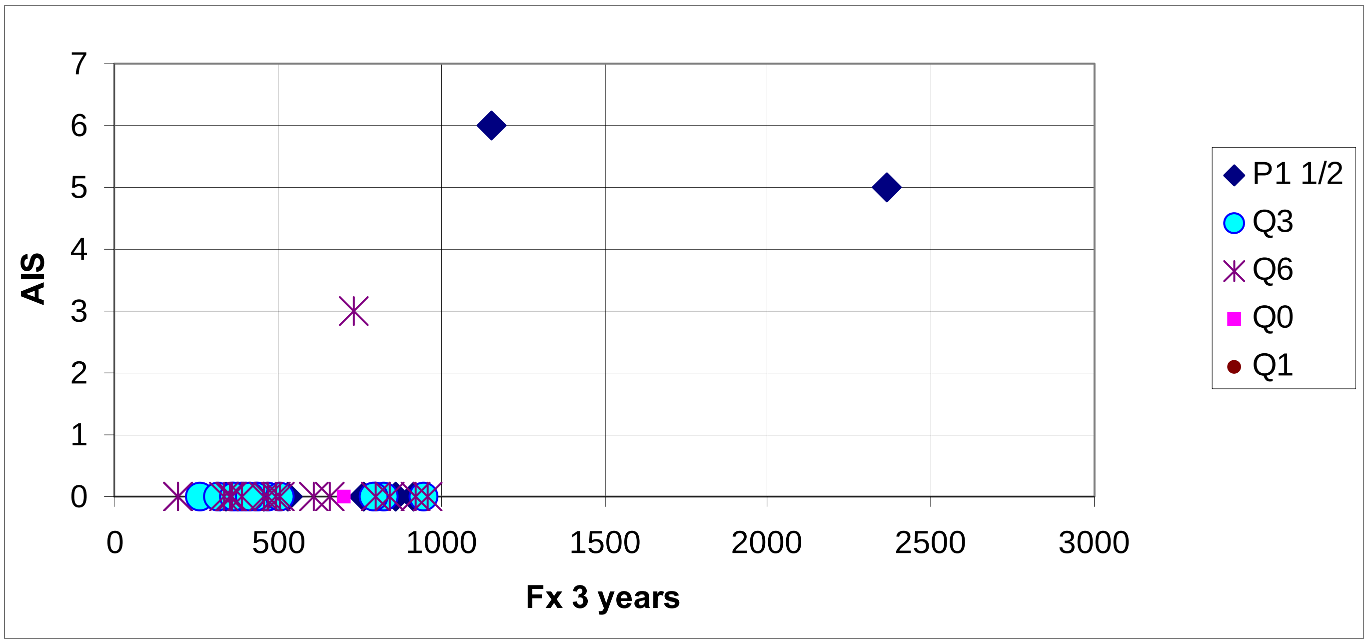
- Relatively large sample size in frontal impact for AIS2+ and AIS3+ but not enough AIS4+ data sample for comparison with US legislation (5% of AIS 4+)

- Sample size in side impact small, nevertheless observation of an acceleration threshold between INJURED & NON INJURED is encouraging the continuation of side impact reconstructions

- Both in frontal and side reconstructions, head impact is the most frequent injury mechanism: to be considered to use the given criteria

Data analysis : neck shearing force Fx

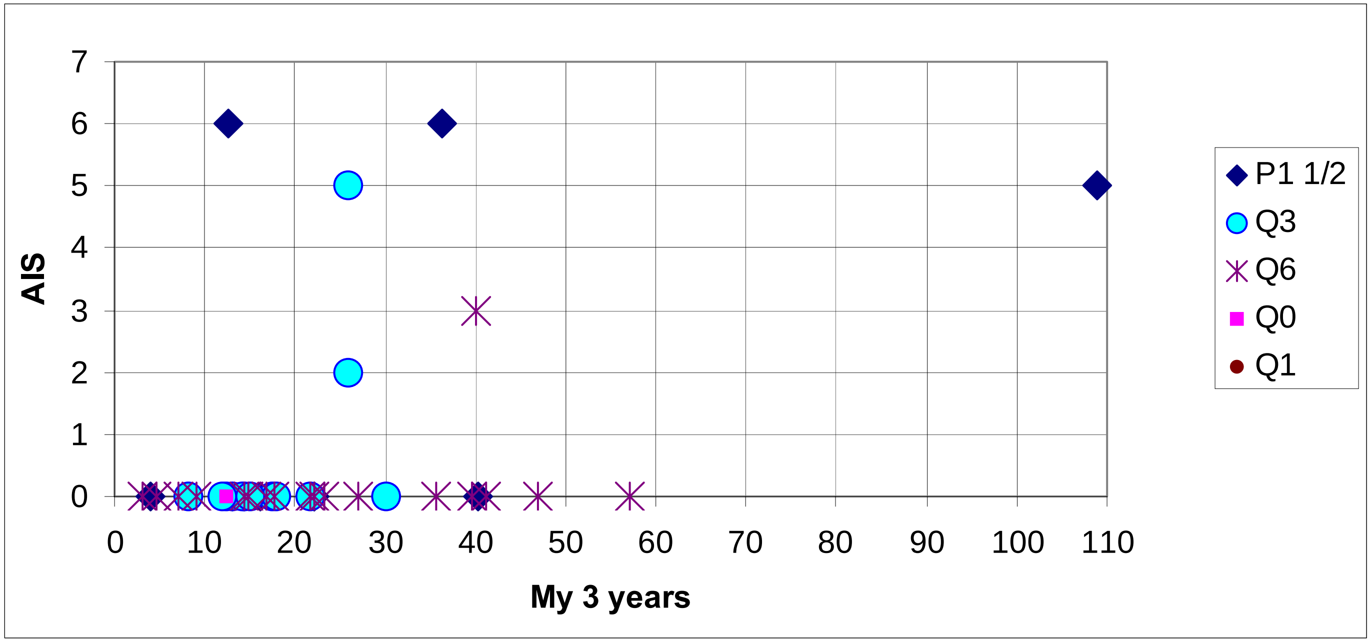
Distribution by dummy age



	Fx
No neck injury	< 730N
AIS 5+	>1000N

Neck flexion moment My

Distribution by dummy age

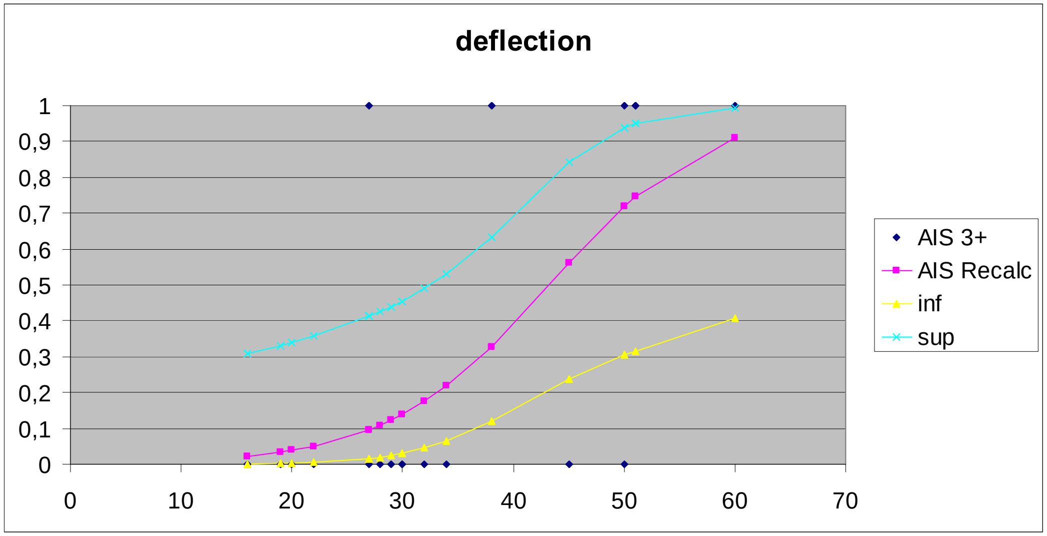


	My
No neck injury	<13Nm
AIS 5+	/

Injury risk curve - chest

AIS 3+ Injury risk curve for the chest;

chest deflection considered for Q6



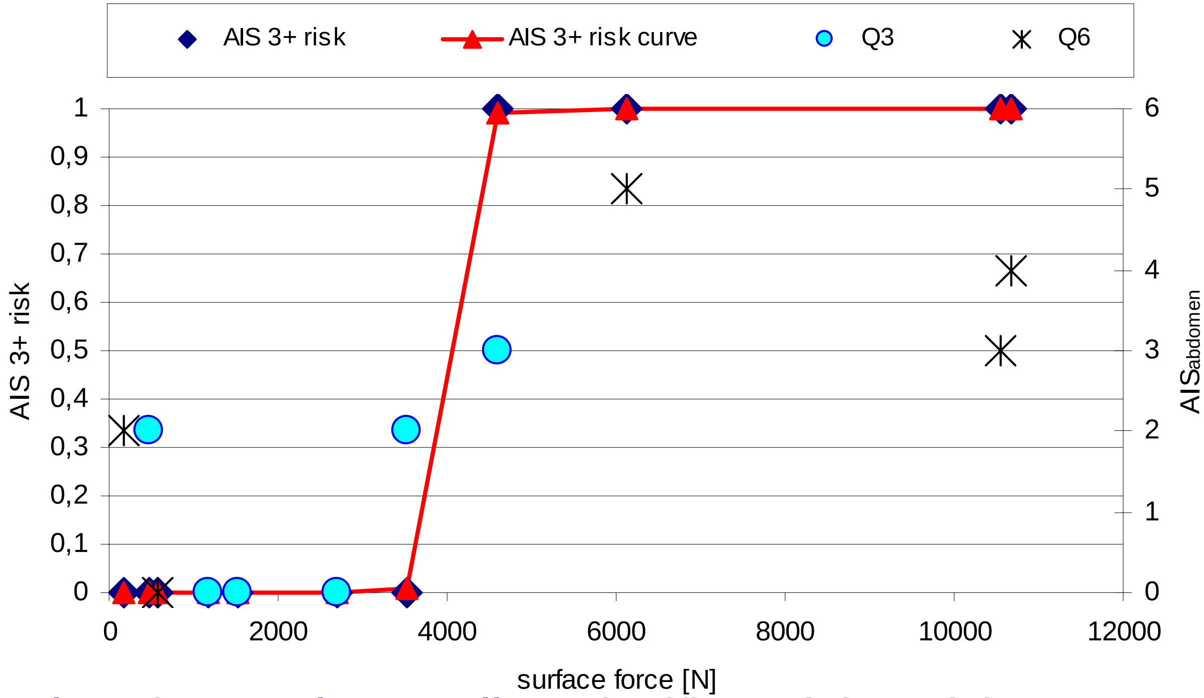
Injury risk	20%	50%
AIS 3+	33mm	42.5mm

- Sample should be improved in terms of number of values
- Specific response of the Q dummies to thoracic strap solicitations have to be thoroughly analyzed and improved using biomechanical data (geometry and stiffness)
- Afterwards V*C should be considered as a more pertinent criterion

Abdominal injury criteria

Injury risk curves were determined, based on :

- APTS data,
- MFS data

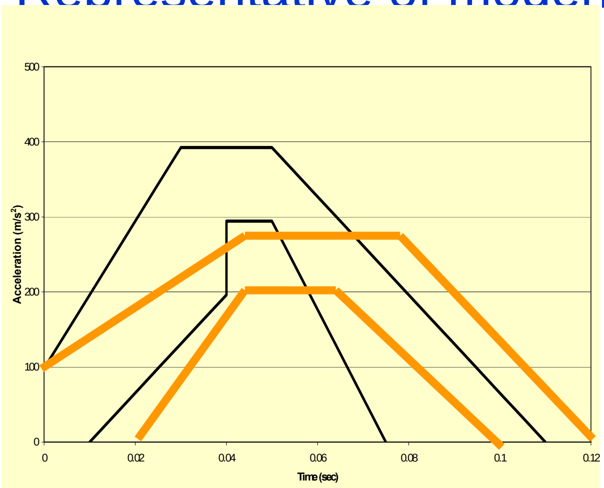


- Number of analyzed cases low to allow significant injury risk curves
- First step to assess abdominal criterion
- Specific response of the Q dummies to thoracic strap solicitations have to be improved using biomechanical data (geometry and stiffness)
- Both sensor systems show considerable potential for the prediction of the abdominal injury risk

Test Procedures

Frontal Impact Test Procedure

- Representative of accidents in the CHILD database, which tends to be severe
- Representative of modern cars



- CHILD
- EEC 44

Needs for further investigations:

- Interaction between children and advanced restraints in the rear
- Monitor average space allowed for head excursion
- Seat back strength in vehicles with seat belts integrated into seat back

Selected Side Test Procedure

With respect to harmonisation it is reasonable to propose a side impact test procedure, which is already in use (Harmonization if possible with ISO and NPACS).

As the CHILD proposal is meant to form as base for legislation and NPACS is a consumer test, there are good reasons to reduce the severity level, compared to NPACS.

Modified NPACS procedure:

- Intrusion velocity reduced by 20 %
  (corresponding to approx. 8 m/s)

Worst -case conditions :Maximum intrusion close to dummy's head

A presentation will be made tomorrow :

"Latest developments in side impact testing for CRS",

Heiko Johannsen et al..

Website & Workshop

www.childincarsafety.com

30 & 31 May 2006, Berlin, Germany

CHILD SUMMARY

The CHILD project had many objectives, all of which were met. However, for some of the objectives new information would enable them to be further validated.

The CHILD project brings together the expertise and technologies from the field of occupant safety with the focus on children.

This work has involved a combination of traditional research methods together with the development of new expertise in areas such as the virtual environment.

For the further improvement of child occupant safety it remains necessary to extend this fundamental research activity. However, new, complimentary and specialised activities are also necessary.

As a consequence, whilst the outcomes of CHILD are directly ready for use, there is a need for future research activities which focus on children, taking the outputs of the CHILD research project as the basis.


Thanks to take care of **us !!**