FIMCAR
frontal impact and compatibility assessment research

SEVENTH FRAMEWORK PROGRAMME

EU-Project FIMCAR
WP 3: Development of Full Width Test

Thorsten Adolph

Mervyn Edwards

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Background / Input from Accident Analyses

- Structural interaction (under/overriding, low overlap, fork effect)
  - First priority and will be addressed with the criteria
    - Height, width and strength of cross beam to address structural interaction → forces in row F3, F4 (Proposal from Japan or modification)
- Acceleration loading
  - Will be addressed in general with the full width test. But a more appropriate dummy is needed! (Output from THORAX / COVER)
- Range of frontal force levels needs to be checked in combination with compartment strength
  - Proposal to control frontal forces (VTI proposal)
- Compartment strength should not be reduced compared to state of the art
  - Can not be addressed with full width test

Objectives

- Develop metrics for full width test Deformable Barrier (FWDB) and Rigid Barrier (FWRB)
  - new / revised metric to control alignment of main frontal structures
  - New / revised proposal to control frontal force levels, in particular aggressiveness vehicles
  - Validate metrics (Repeatability, robustness, etc.)
- Develop load cell wall specification

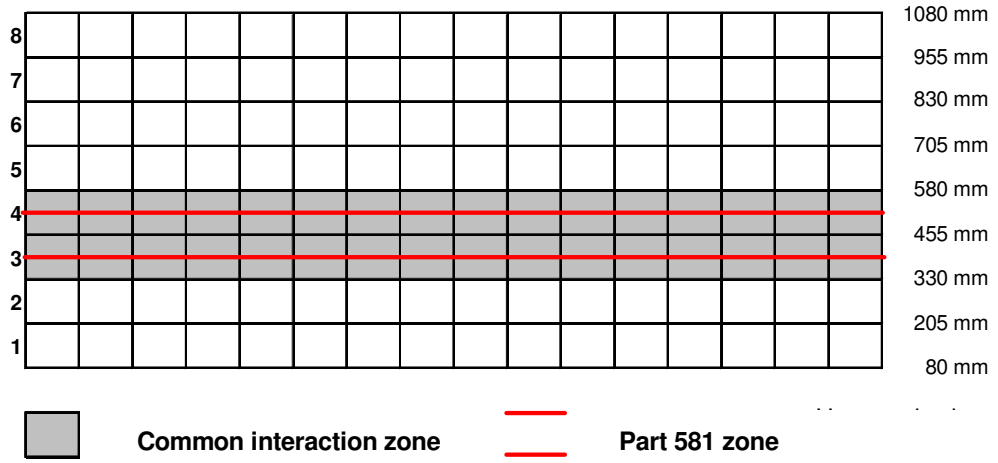
- Decision in July 2011 (M 3.2)

FWRB vs FWDB

- FWRB
  - Effectively already de-facto worldwide standard test
- FWDB
  - More representative of real world accident especially in initial stage of impact
  - Engine dump loading attenuated, so easier to make assessment of vehicle structural loading
  - Can assess SEAS structures, so no need for supplementary ORB test
  - Possibly can assess horizontal structures (bumper beams)

Review of current and past proposals

- Alignment of main frontal structures (PEAS and SEAS)
  - AHOF (400)
  - Structural Interaction (SI) from UK
    - Minimum load in rows 3 and 4 (up to time of 40 ms)
  - Recent proposals from Japan
    - Control of loads in rows 3 and 4 (up to time when total LCW load = 200kN)
- Frontal force levels
  - Kw400
    - Energy based initial stiffness



FWDB test

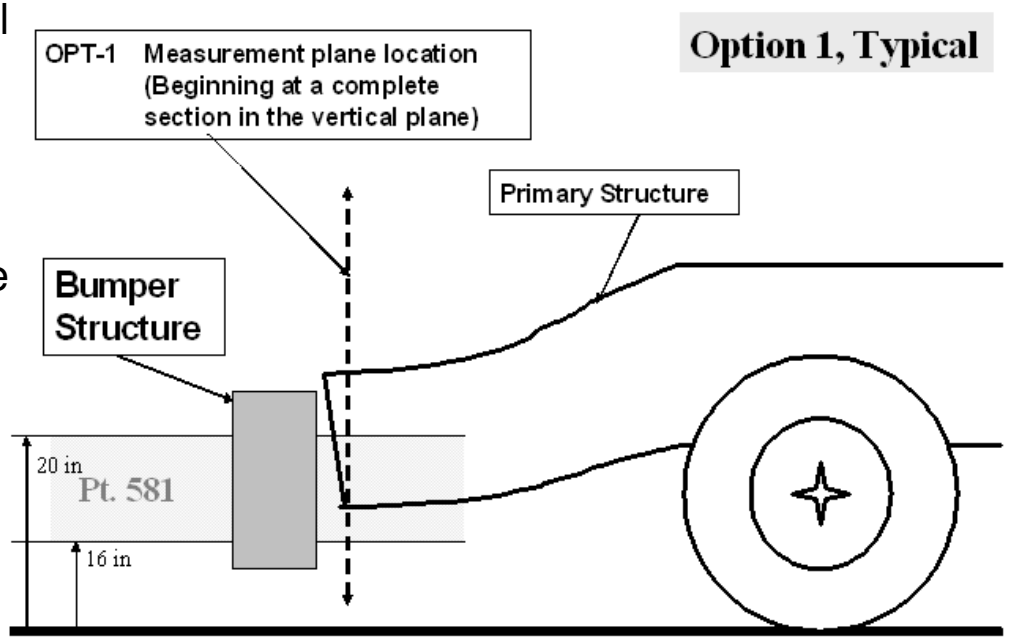
Development of metric to control alignment of frontal structures for FWDB test

- FWDB data collation:
  - **17 test** from VC-Compat, Aprosys, ACEA, BASt, DfT with load cell wall data and structural geometry data
  - Some tests with different height of LCW, thus adaption was necessary

Geometric assessment of structural alignment

- Assessment based on US voluntary commitment

Option 1: The light truck's primary frontal energy absorbing structure shall overlap at least 50 percent of the Part 581 zone AND at least 50 percent of the light truck's primary frontal energy-absorbing structure shall overlap the Part 581 zone
Option 2: If a light truck does not meet the criteria of Option 1, there must be a secondary energy absorbing structure, connected to the primary structure, whose lower edge shall be no higher than the bottom of the Part 581 bumper zone. This secondary structure shall withstand a load of at least 100 kN.



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Comparison of lower rail height and bumper crossbeam (adjusted)

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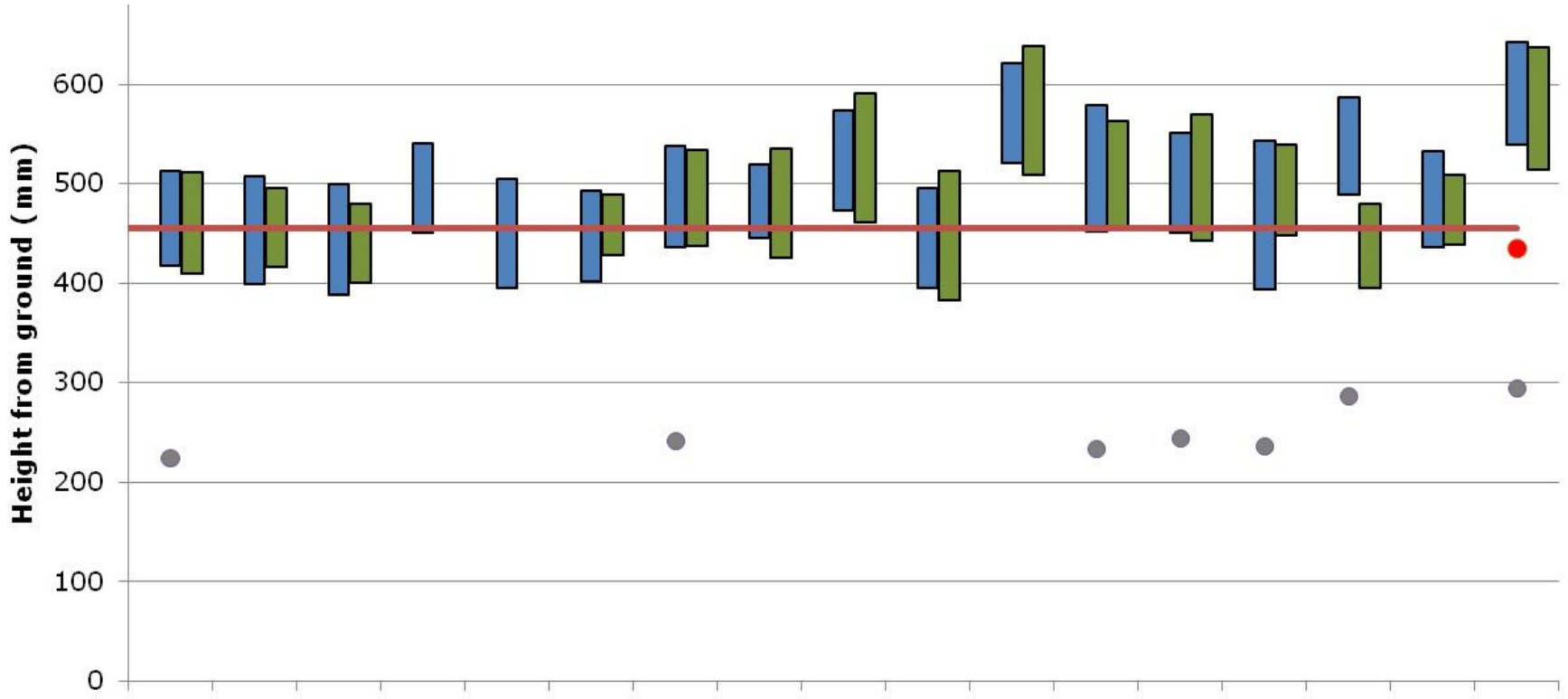
PEAS	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	×	×	✓	✓	×	✓	×
PEAS / SEAS	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	×	×	✓	✓	✓	✓	?



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FWDB – Metrics investigated

- PEAS alignment type metric
  - Consider initial part of impact – up to time at which LCW total load = 200 kN
    - Row maximums in Row 3 & Row 4
      1. F3 + F4 > [100 kN] & F3 > [40 kN] & F4 > [40 kN]
      2. F3 + F4 > [100 kN] & [0.2]< F4/(F4+F3) < [0.8]
  - Why up to LCW total load = 200 kN?
    - Minimises effect of engine dump
- PEAS / SEAS alignment type metric
  - Consider first part of impact – up to time of 40 ms
    - Row maximums in Row 3 & Row 4
      - Minimum load requirement of [100 kN]
  - Why up to time of 40 ms
    - Minimises effect of engine dump but still allows detection of Secondary Energy Absorbing Structures (SEAS)

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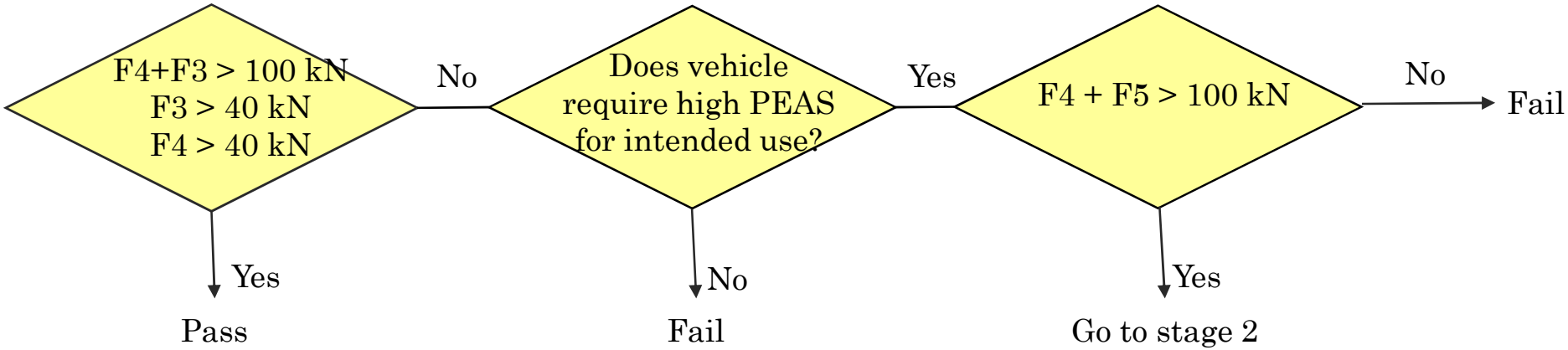
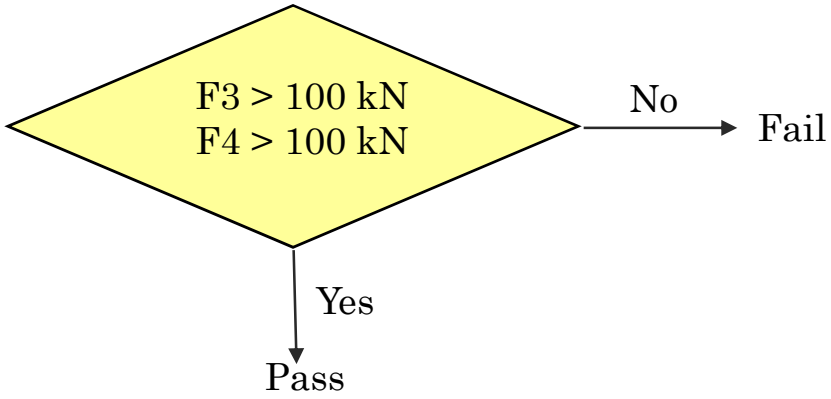
Metric initial proposal (1)

Stage 1 (PEAS alignment) Up to LCW total force = 200 kN

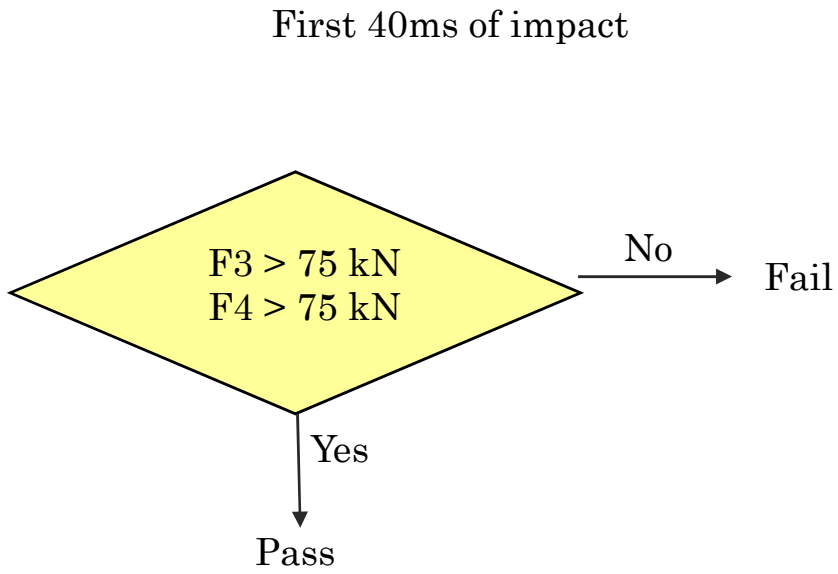


Stage 2 (SEAS assessment) First 40ms of impact



Metric initial proposal (2)

Force in common interaction zone (PEAS / SEAS)



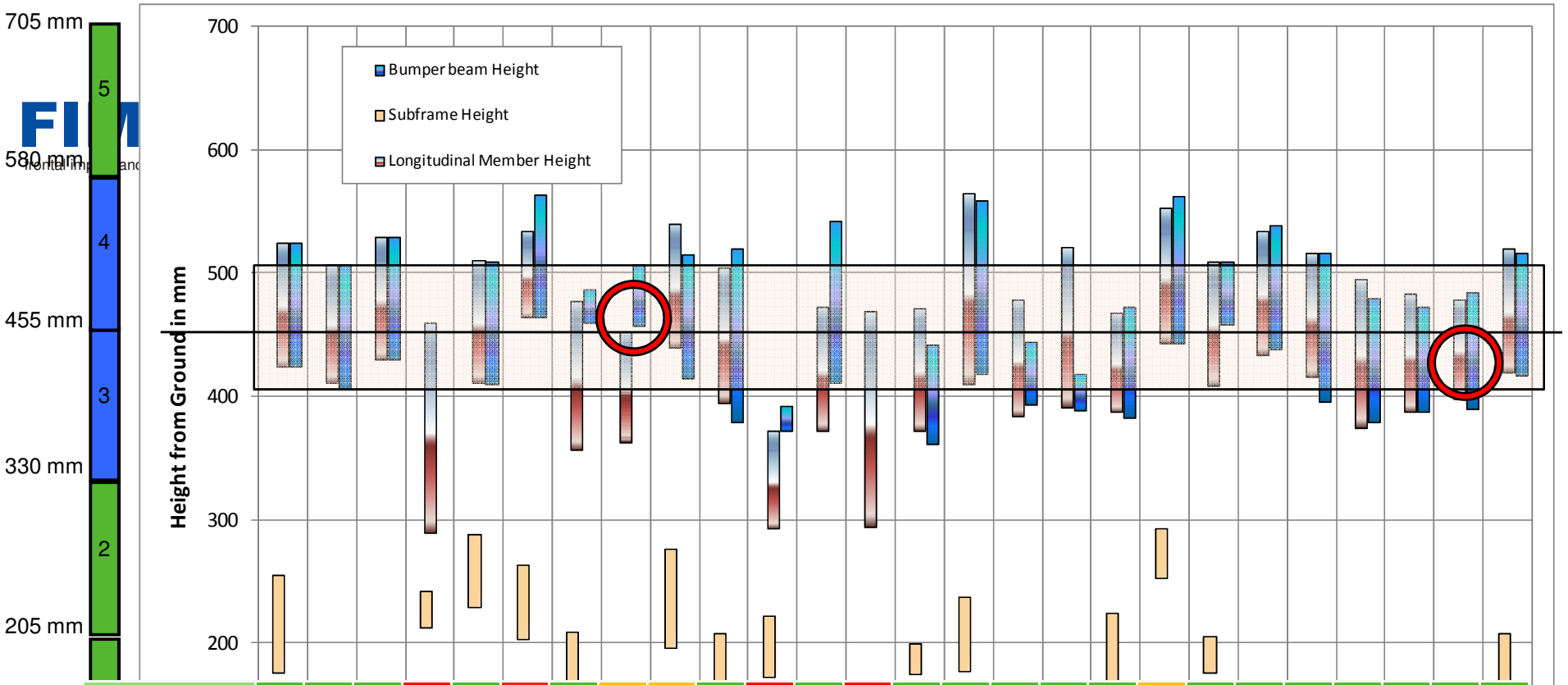
FWRB test

Development of metric to control alignment of frontal structures for FWRB test

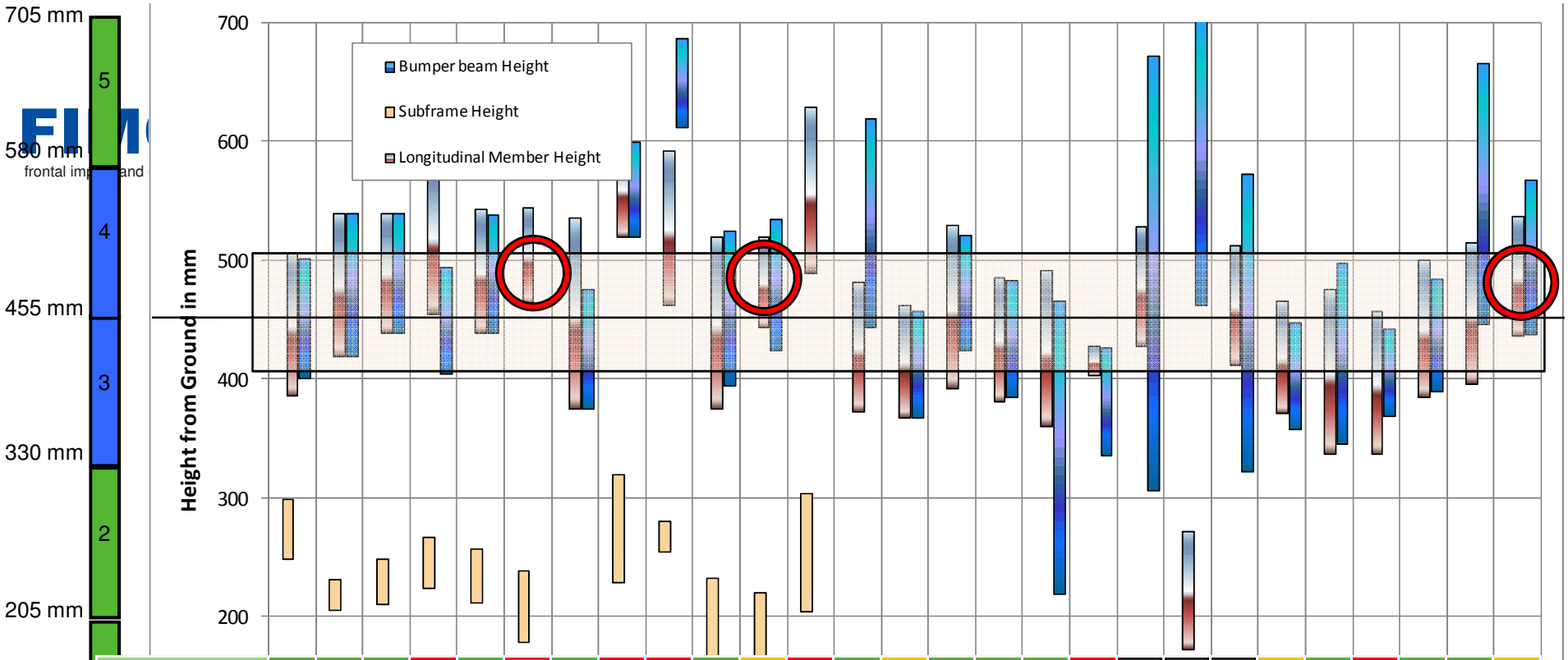
- FWRB data collation
  - JNCAP
    - 35 vehicles from 2006 & 2007 with structural data
  - NHTSA
    - 15 vehicles with structural data (some with different LCW ground clearance)
  - APROSYS EC 6th framework project
    - 3 vehicles with structural data

Metrics investigated

- PEAS alignment type metric as proposed by Japan
  - Consider initial part of impact – up to time at which LCW total load = 200 kN
    - Row maximums in Row 3 & Row 4
    1. F3 + F4 > [100 kN] & F3 > [40 kN] & F4 > [40 kN]
    2. F3 + F4 > [100 kN] & [0.2] < F4/(F4+F3) < [0.8]
  - Why up to LCW total load = 200 kN?
    - Minimises effect of engine dump
- Average Height of Force (AHOF400)



	Subjective Assessme	**1**	**1**	**1**	**3**	**1**	**3**	**1**	**2**	**2**	**1**	**3**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
1.M	F3+F4 > 100	167	147	155	87	149	167	138	155	153	176	73	157	86			148	126	143	97	130	151	168	160	149	152	155
	F4/F3+F4(,2-,8)	0,54	0,51	0,77	0,31	0,57	0,93	0,30	0,38	0,71	0,52	0,25	0,31	0,25			0,59	0,47	0,31	0,70	0,52	0,65	0,64	0,46	0,37	0,24	0,47
		√	√	?	√	√	√	√	?	√	√	√	√	√			√	√	√	?	√	√	√	√	√	?	√
2.M	F3+F4 > 100	167	147	155	87	149	167	138	155	153	176	73	157	86			148	126	143	97	130	151	168	160	149	152	155
	F3>40 (200)	77	72	36	61	63	11	97	95	45	85	54	109	65			60	67	99	29	62	52	61	86	94	115	82
	F4>40 (200)	90	75	119	27	86	156	41	59	108	91	19	49	22			88	59	44	68	67	99	107	74	55	36	72
		√	√	!	√	√	√	?	?	√	√	√	√	√			√	√	√	?	√	√	√	√	√	!	√
	AHOF 400	425	457	517	423	449	527	363	440	465	441	509	414	435			436	455	445	464	457	489	474	465	466	434	458

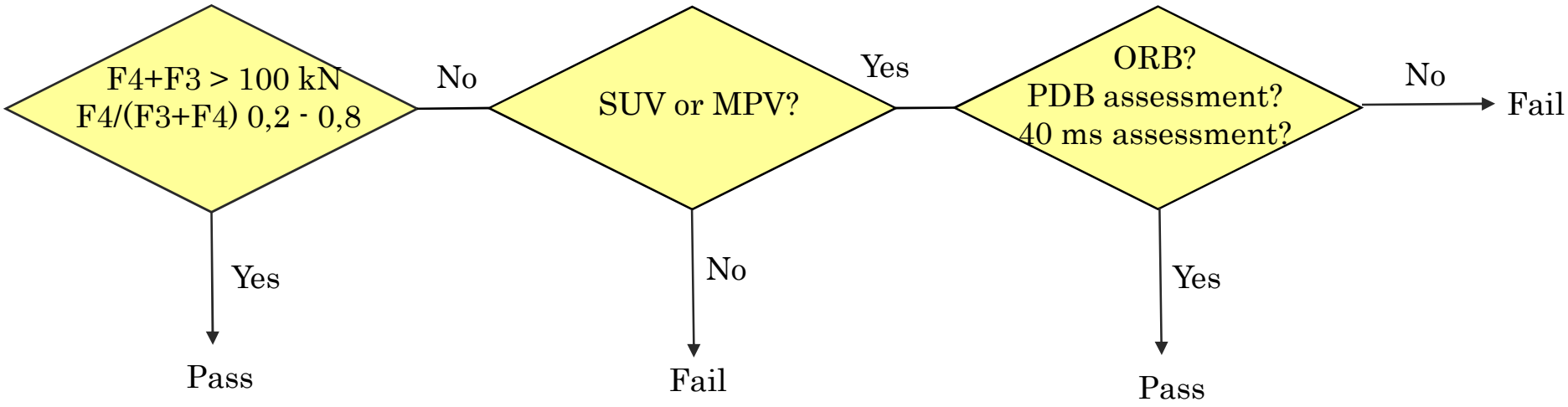


	Subjective Assessme	1	1	1	3	1	3	1	3	3	1	2	3	1	2	1	1	1	3	1	3	1	2	1	3	1	1	2
1.M	F3+F4>100	156	130	132	133	138	154	151	95	145	177	134	167	166	175	163	160	131	161	139	142	157	170	159	169	166	140	167
	F4/(F3+F4)	0,48	0,61	0,65	0,80	0,59	0,73	0,43	0,95	0,97	0,49	0,91	0,93	0,69	0,37	0,45	0,46	0,56	0,05	0,33	0,44	0,24	0,27	0,37	0,09	0,42	0,74	0,98
		√	√	√	√	√	!	√	√	√	√	!	√	√	?	√	√	√	√				√	√	√	√	?	!
2.M	F3+F4>100	156	130	132	133	138	154	151	95	145	177	134	167	166	175	163	160	131	161	139	142	157	170	159	169	166	140	167
	F3>40 (200)	81	51	46	26	57	41	86	5	5	90	12	11	52	110	90	86	58	153	93	80	119	125	100	154	95	37	4
	F4>40 (200)	75	79	86	107	81	113	64	91	141	87	123	156	114	65	73	73	73	8	46	62	37	45	59	15	70	103	163
		√	√	√	√	√	!	√	√	√	√	!	√	√	?	√	√	√	√				√	√	√	√	!	!
	AHOF 400	464	497	475	546	475	519	506	557	551	482	515	499	512	398	466	462	447	436	489	479	460	472	453	426	479	525	547

Metric initial proposal

Proposal FWRB

Up to LCW total force = 200 kN



Definition of a SUV or a MPV

EU Project IMPROVER

Table 4.1 Final definition of SUVs and MPVs

	Requirements	SUV	MPV
Geometrical requirements	Approach angle	> 25 °	-
	Departure angle	> 20 °	-
	Ramp angle	> 20 °	-
	Front and rear axle ground clearance	> 180 mm	-
	Ground clearance between axles	> 200 mm	-
	Height	> 1600 mm	> 1600 mm
AND	AND		
Add-On's	Vehicle class (in accordance with reg. 70/156/EWG)	M1-class-vehicle	M1-class-vehicle
		-	Not being an SUV

Framework Directive Off-Road vehicle definition

- Off road vehicles (symbol G)
- 4.1 Vehicles in category N1 with a maximum mass not exceeding two tonnes and vehicles in category M1 are considered to be off-road vehicles if they have:
  - at least one front axle and at least one rear axle designed to be driven simultaneously including vehicles where the drive to one axle can be disengaged,
  - at least one differential locking mechanism or at least one mechanism having a similar effect and if they can climb a 30 % gradient calculated for a solo vehicle.
- In addition, they must satisfy at least five of the following six requirements:
  - the approach angle must be at least 25 degrees,
  - the departure angle must be at least 20 degrees,
  - the ramp angle must be at least 20 degrees,
  - the ground clearance under the front axle must be at least 180 mm,
  - the ground clearance under the rear axle must be at least 180 mm,
  - the ground clearance between the axles must be at least 200 mm.

Way forward

- Address issues
  - Can FW test distinguish car designs with longitudinals and cross beam on different heights?
  - Can a ‘car’ and ‘SUV’ be defined for regulatory purposes?
- Finalize metric(s)
  - FWRB or FWDB test?
    - Control of PEAS and SEAS alignment separately or together?
    - FWRB will probably need supplementary ORB test for SEAS
- Validate metric(s)
  - Repeatability, robustness, etc.
- Test severity / test velocity?
  → WP 6, WP 1 [impact speed: 48 – 56 km/h]

Bundesanstalt für Straßenwesen

Research Associate
Dr. Thorsten Adolph

Passive Fahrzeugsicherheit,
Biomechanik

Brüderstraße 53
D-51427 Bergisch Gladbach

Telefon +49 (0)2204 43 626
Telefax +49 (0)2204 43 687
adolph@bast.de

Do You Have Any Questions?