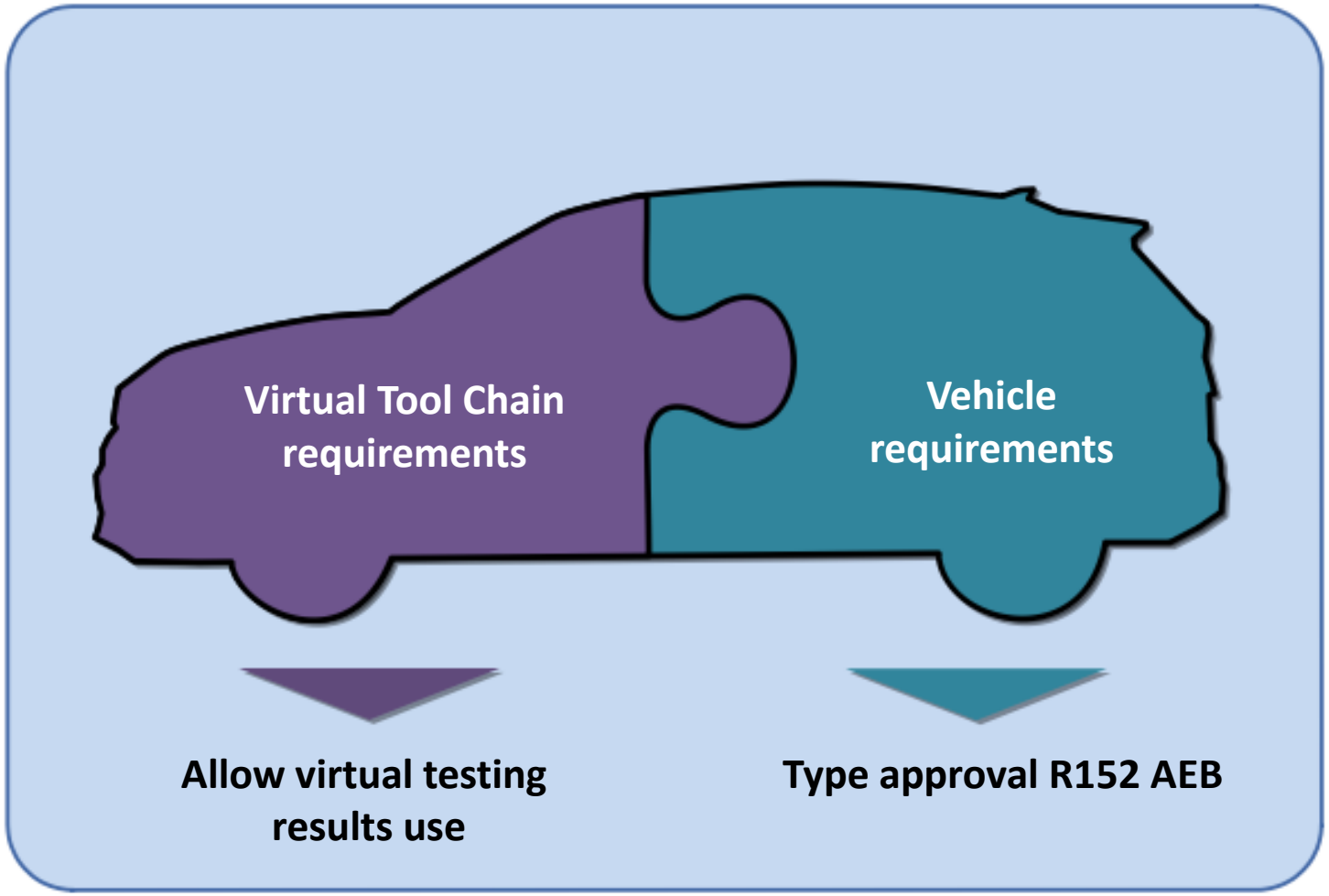
UTAC CERAM virtual testing method
Use case application

REQUIRED PHYSICAL TESTING R152 (AEBS M1N1)
UTAC CERAM PROPOSITION

UTAC CERAM

UC	Target	Test Case	Overlap	Speed	Weight config	R152 AEB M1N1 test	Repeatability test	Correlation test	Physical test not replaced by virtual
CtC	Car	CCRs	100%	20 kph	MMAC	✓ x2			Random physical test to validate vs virtual in the validity domain (30%)
					VODM	✓ x2			
				42 kph	MMAC	✓ x2			
					VODM	✓ x2			
				60 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
		CCRm	100%	30 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
				60 kph	MMAC	✓ x2			
					VODM	✓ x2			
VRU	Bicycle	CBNA	50%	20 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
				30 kph	MMAC	✓ x2			
					VODM	✓ x2			
				60 kph	MMAC	✓ x2			
					VODM	✓ x2			
	Pedestrian	CPNC	50%	20 kph	MMAC	✓ x2			
					VODM	✓ x2			
				30 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
				60 kph	MMAC	✓ x2			
					VODM	✓ x2			

VIRTUAL TOOLCHAIN ASSESSMENT BEFORE VIRTUAL VEHICLE ASSESSMENT FOR TYPE APPROVAL



METHOD OVERVIEW
WE WILL ACHIEVE GREEN LINE

Homologation

X+Y vehicles type

Physical homologation

Physical validation
44(11x2x2) tests

Without virtual testing way

Qualitative audit of proposed methodology

+

Y vehicles type

X vehicles type

Repeatability tests
40(4x10)

- 1 CCRS 60kph MMAC
- 1 CCRm 30kph MMAC
- 1 C2P 30kph MMAC
- 1 C2B 20 kph MMAC

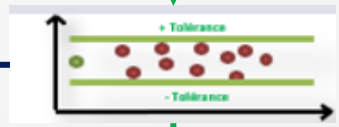
AEB M1N1 UN152:
- CCRS 20/42/60
- CCRm 30/60
- CBNA50 20/30/60
- CPNC50 20/30/60

Homologation OK

Virtual validation

+ 30% Physical tests:

Dispersion Thresholds



KO

OK

11 variables (SUT+Target)
3 Metrics: IAPE, Double th, interval

Analyze of correlation results

Correlation Rate X veh

>90%

OK

KO

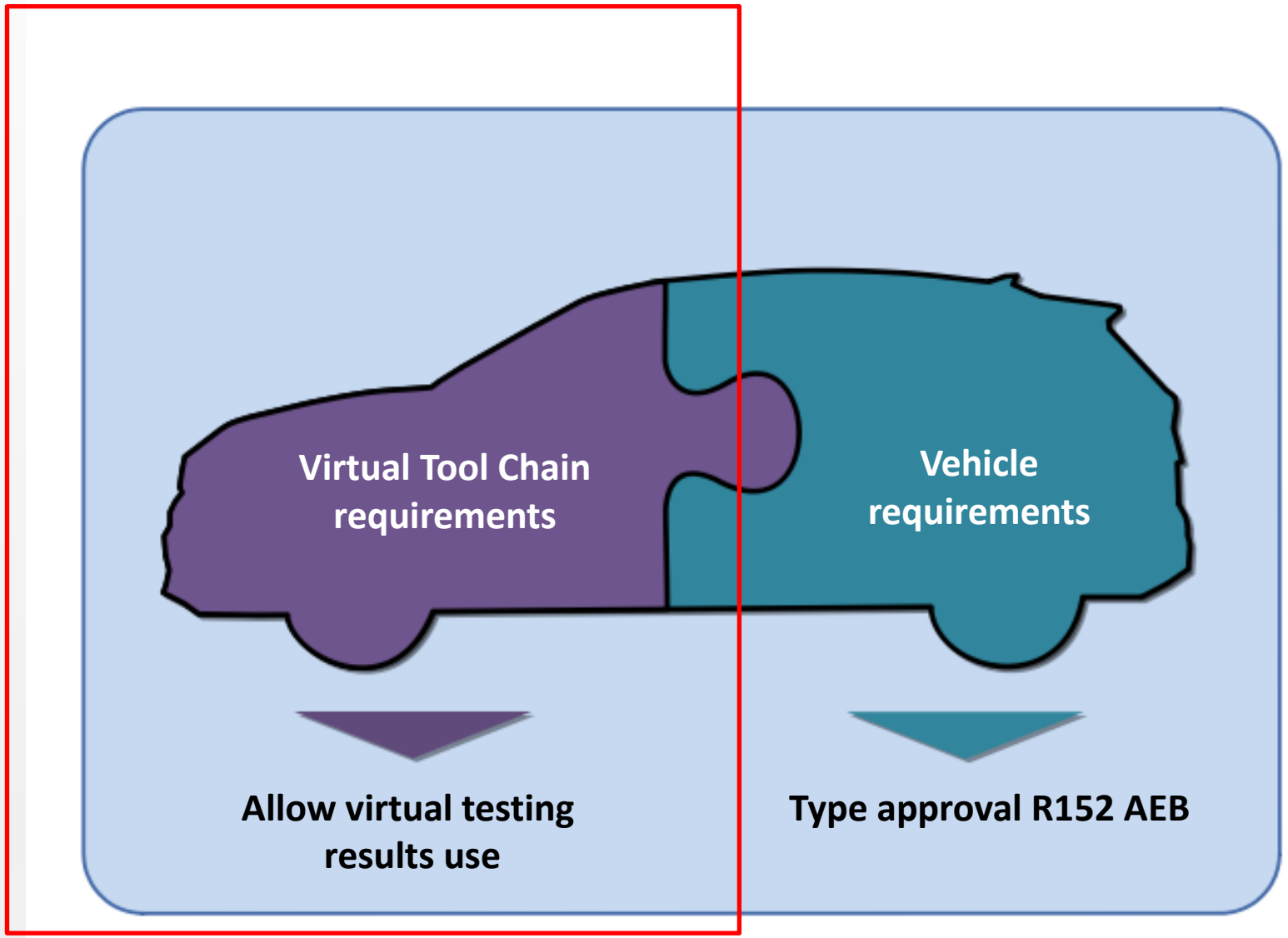
+

Simulation Certified for homologation

Under finalization

virtual testing way

VIRTUAL TOOLCHAIN ASSESSMENT BEFORE VIRTUAL VEHICLE ASSESSMENT FOR TYPE APPROVAL



VEHICLES OEM WANTS TO PRESENT TO R152 AEB

Vehicle 1 « City »

- Standard version

Other version

- Convertible

Vehicle 2 « Compact »

- Standard version

Other version

- Convertible
- Station wagon
- 2 doors
- SUV

Vehicle 3 « Executive »

- Standard version

Other version

- Convertible
- Station wagon
- Off road station wagon

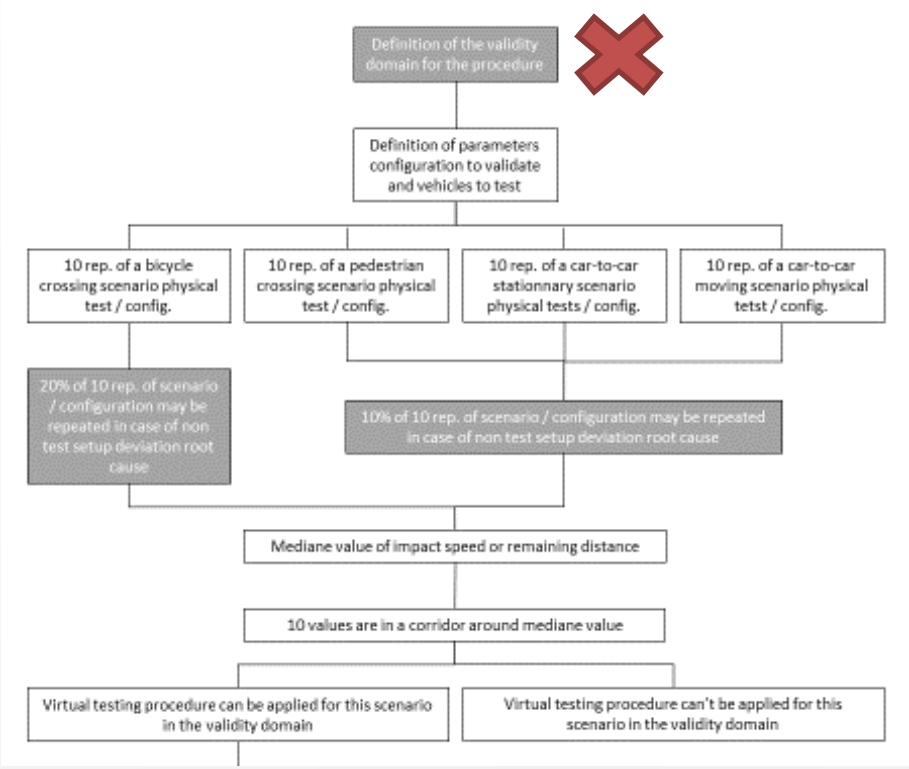
Vehicle 4 « Van »

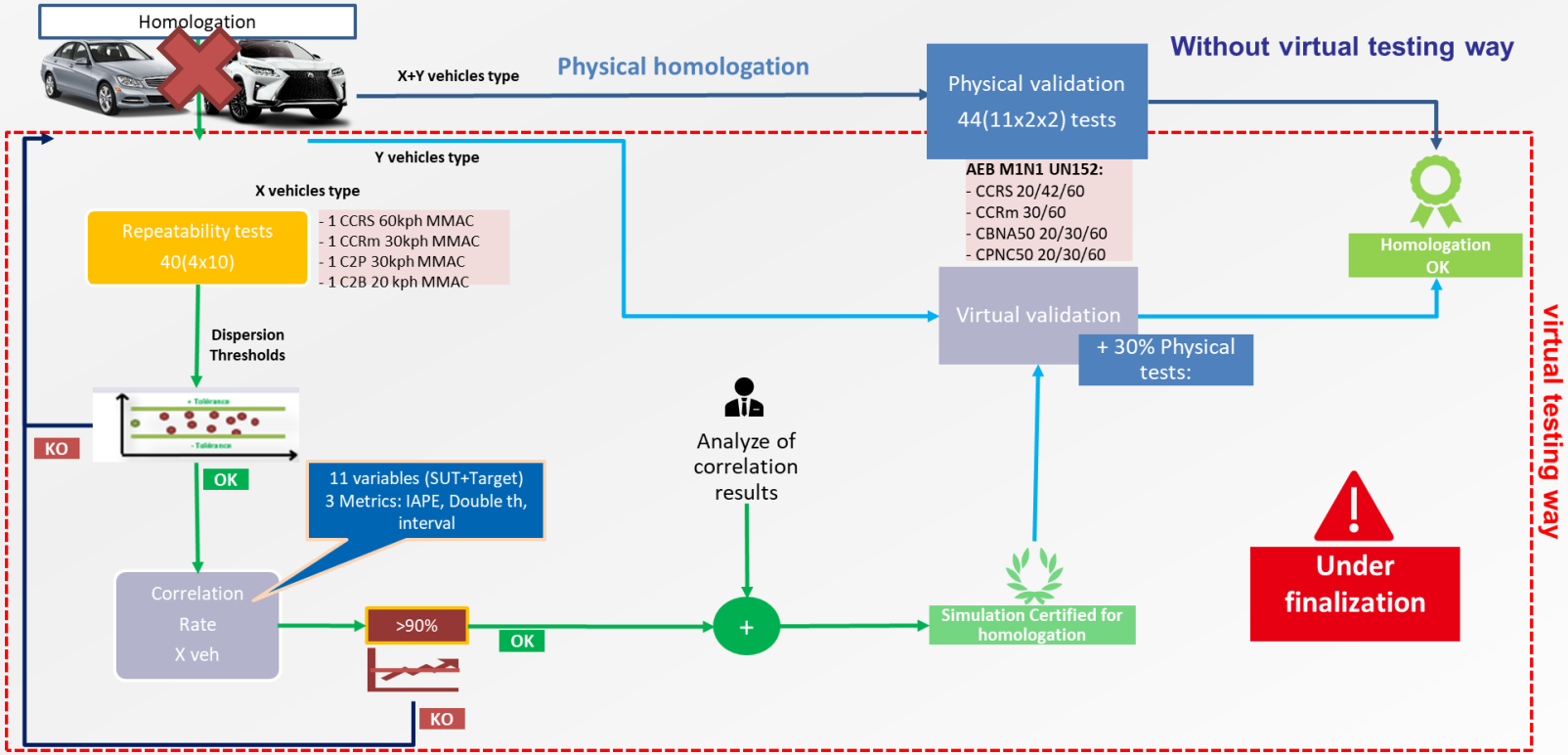
- Standard version

Other version

- Long body

METHOD DIAGRAM





OEM VALIDITY DOMAIN REQUEST

- OEM define following validity domain with authority for simulation:
  - Models can handle **900 kg** to **2500 kg**
  - Models can handle all configuration: **can cover vehicle 1 to 3**
  - Models can be use within **Pedestrian** and **Car to car scenarios**
  - Models can be use within speed range: **20 km/h to 50 km/h**

R152 AEB tests requested to be covered by using The virtual method in the validity domain defined (Yellow color)

Vehicle	Version	Mass (kg) VODM	Mass (kg) MMAC	CCRs 100%						CCRm 100%				CBNA 50%						CPNC 50%					
				20		42		60		30		60		20		30		60		20		30		60	
				MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM
Vehicle 1 "City"	Standard	1100	1600																						
	Convertible	1250	1750																						
Vehicle 2 "Compact"	Standard	1200	1800																						
	Convertible	1300	1900																						
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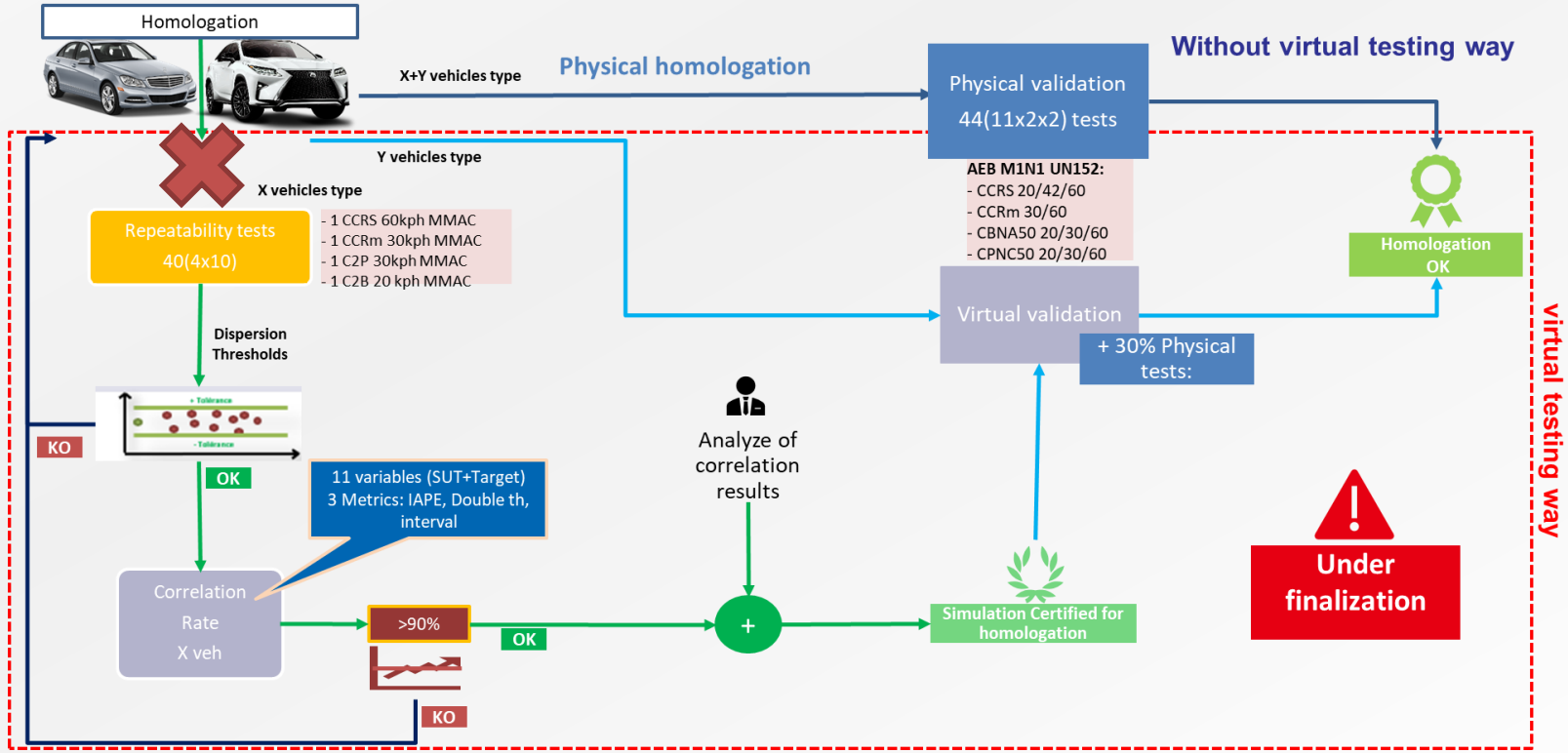
	Two doors	1150	1600																						
	SUV	1450	2200																						
Vehicle 3 "Executive"	Standard	1800	2400																						
	Convertible	1950	2200																						
	Station wagon	2100	2600																						
	OffRoad station wagon	2200	2600																						
Vehicle 4 "Van"	Standard	1600	3000																						
	Long body	1800	3500																						

METHOD DIAGRAM



DEFINE VEHICLES AND SCENARIOS TO TEST FOR REPEATABILITY

UTAC CERAM

- Laboratory choose to test vehicle 1 and vehicle 3 to cover the requested validity domain
  - **CCRs scenario 42 kmh MMAC** will be repeated 10 times
  - **CCRm scenario 30 kmh MMAC** will be repeated 10 times
  - **CPNC scenario 30 kmh MMAC** will be repeated 10 times

R152 AEB tests to repeat 10 times
(Green color)

Vehicle	Version	Mass (kg) VODM	Mass (kg) MMAC	CCRs						CCRm				CBNA						CPNC					
				100%						100%				50%						50%					
				20		42		60		30		60		20		30		60		20		30		60	
				MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM
Vehicle 1 "City"	Standard	1100	1600																						
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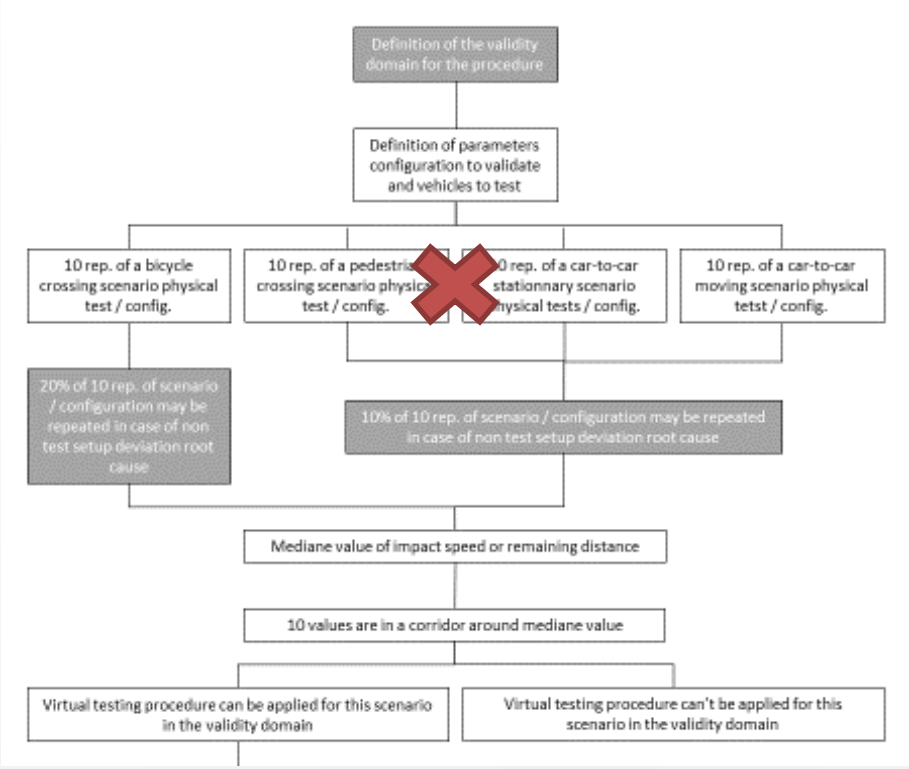
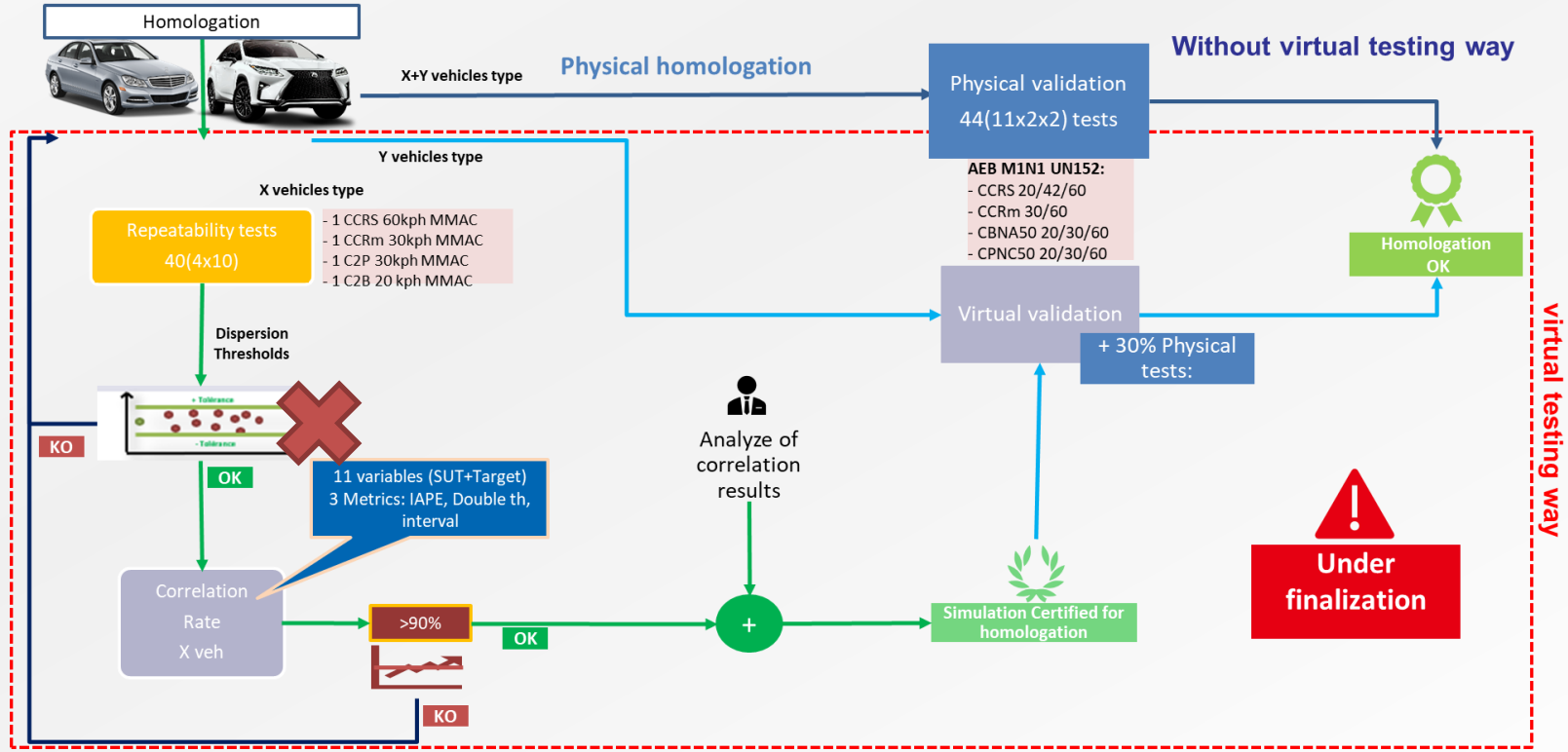
METHOD DIAGRAM





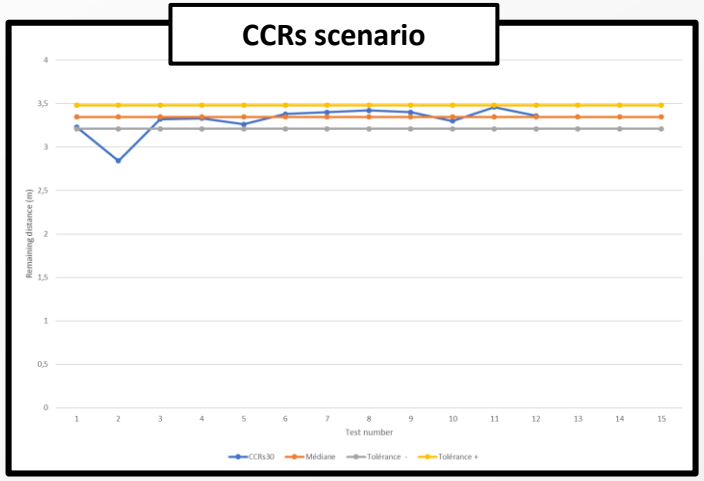
REPEATABILITY PHYSICAL TESTS RESULTS (ONE VARIABLE USE FOR EXAMPLE)
ONLY VEHICLE 1 & 3 IN CCRS WILL CONTINUE THE METHOD

UTAC CERAM

Vehicle 1

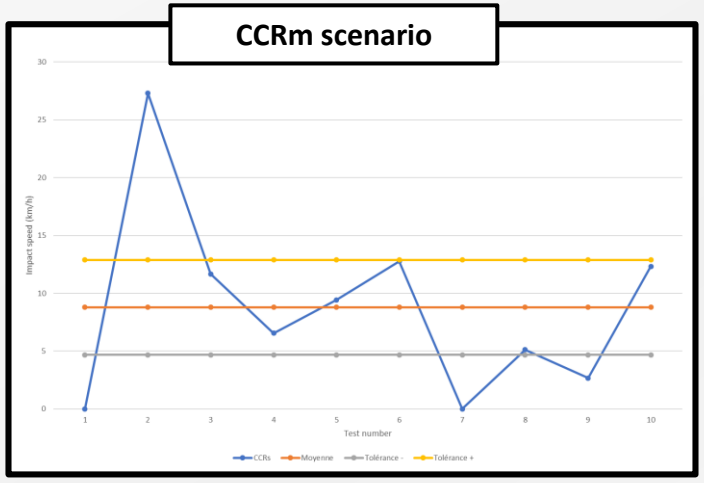
PASS

CCRs scenario



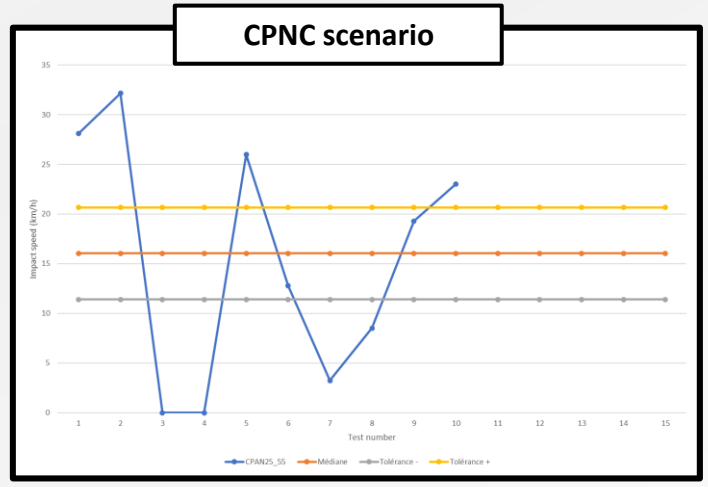
FAIL

CCRm scenario



FAIL

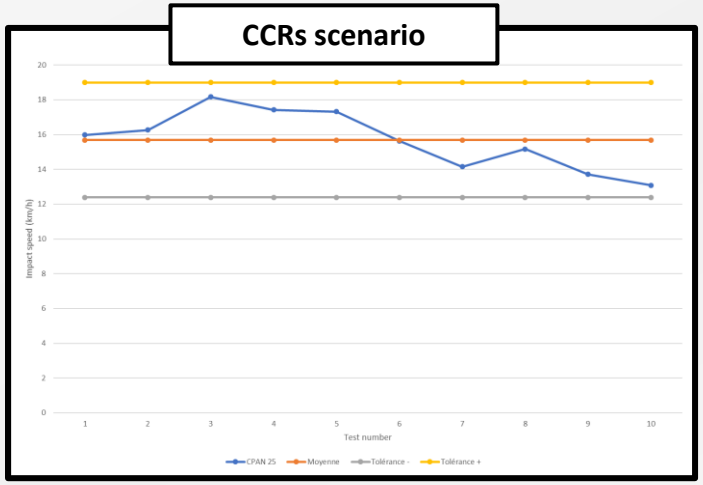
CPNC scenario



Vehicle 3

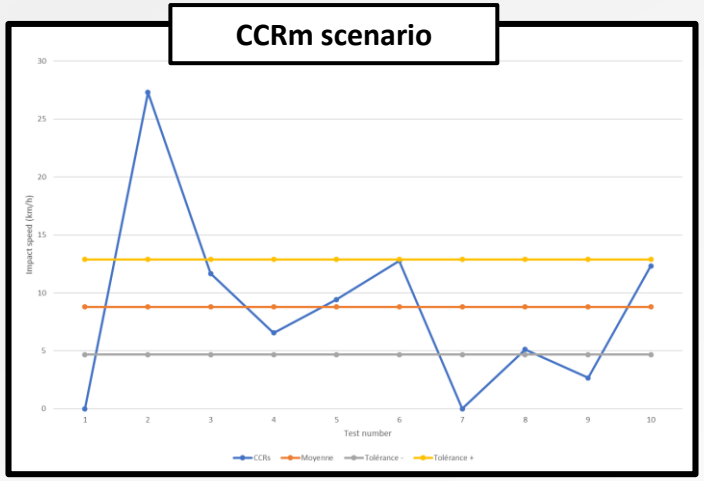
PASS

CCRs scenario



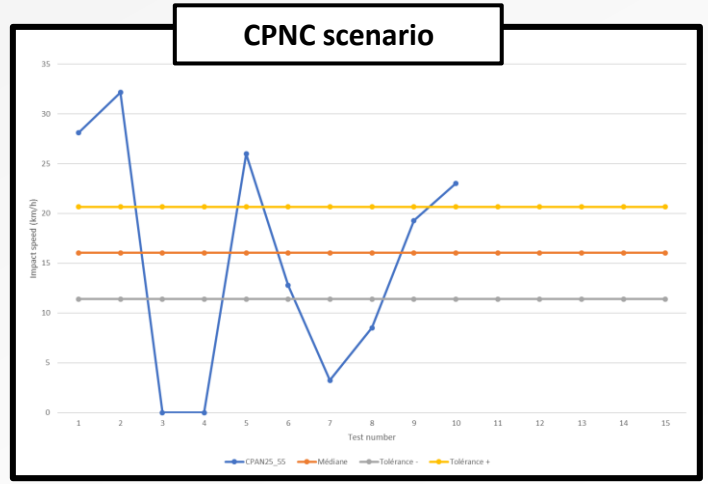
FAIL

CCRm scenario

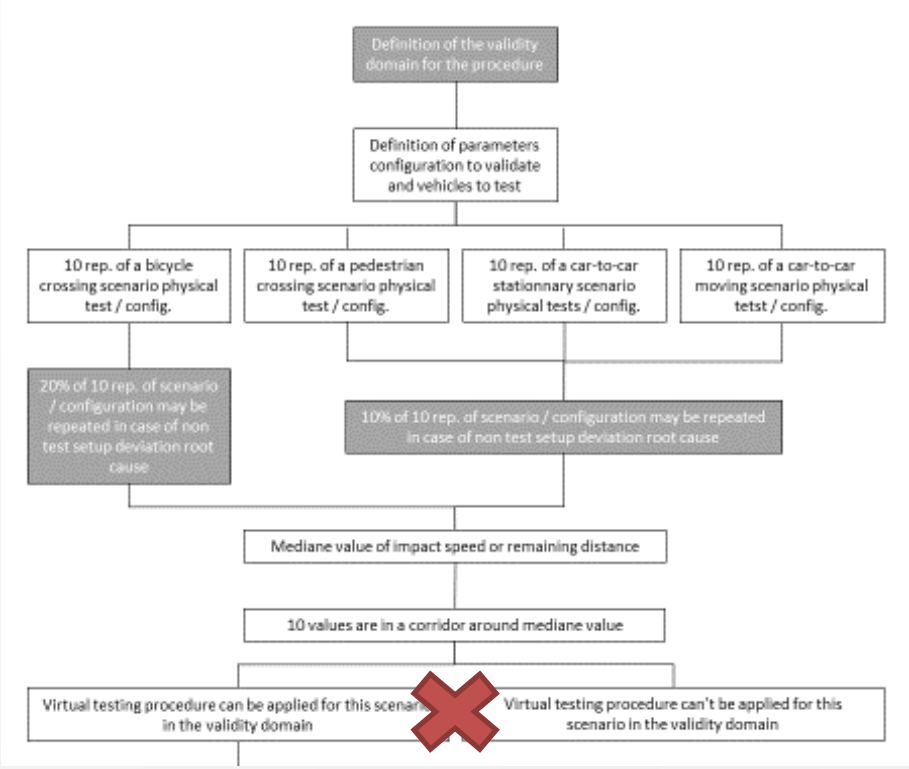


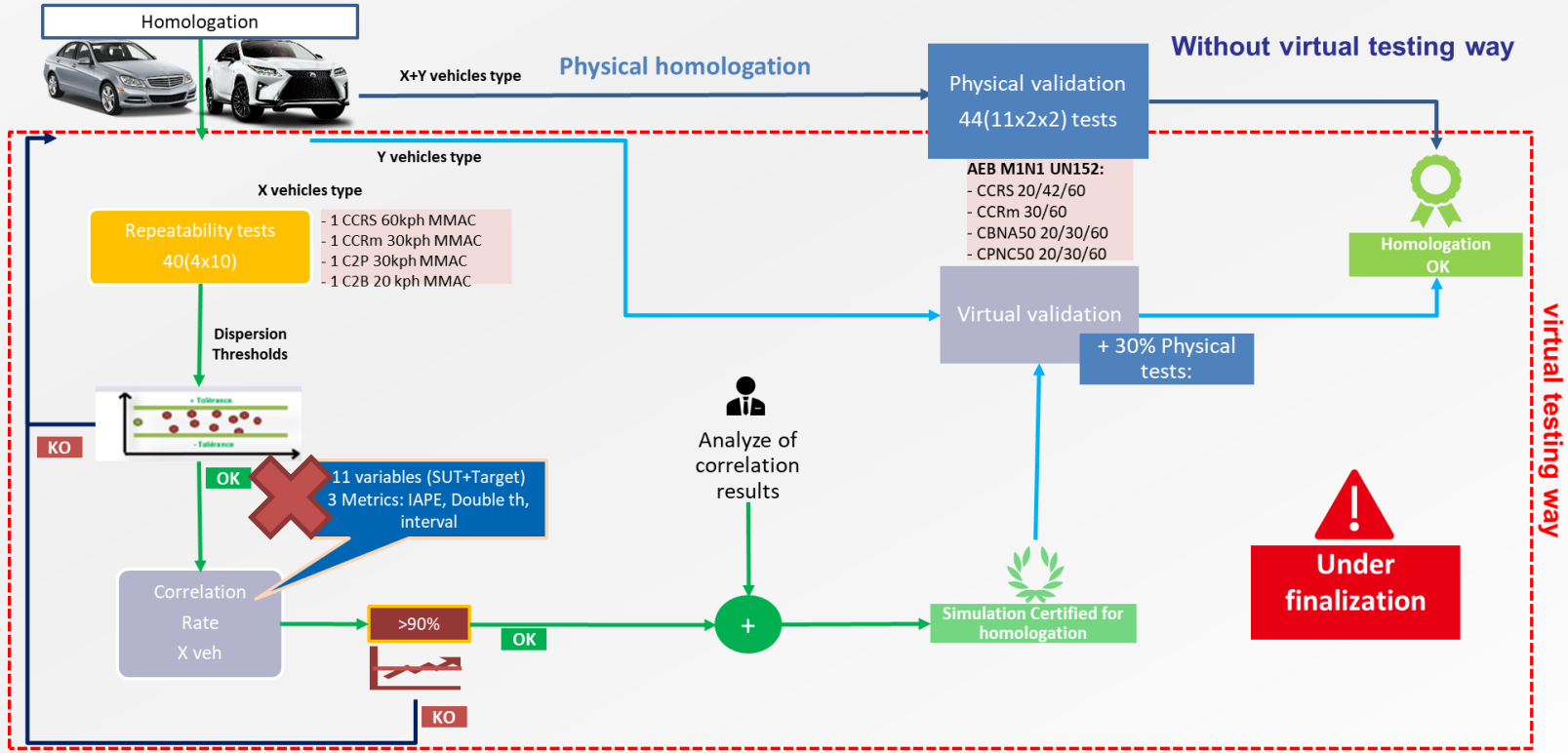
FAIL

CPNC scenario



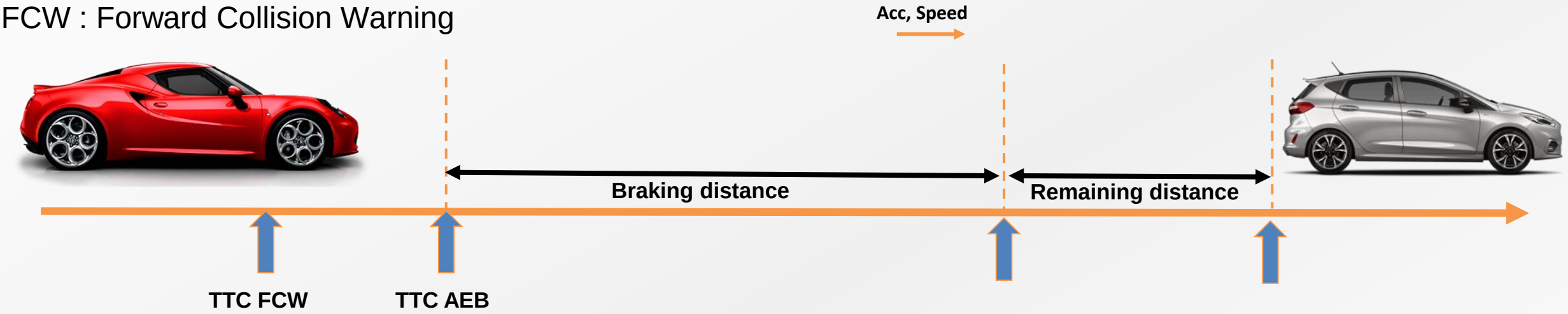
METHOD DIAGRAM

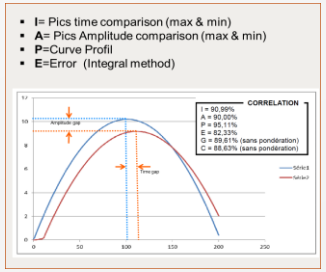




VARIABLES WE ARE ASSESSING

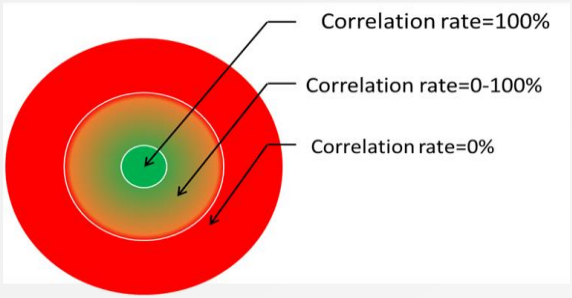
TTC : Time to collision
FCW : Forward Collision Warning





IAPE Method

- Vehicle Speed
- Acceleration



Double thresholds method

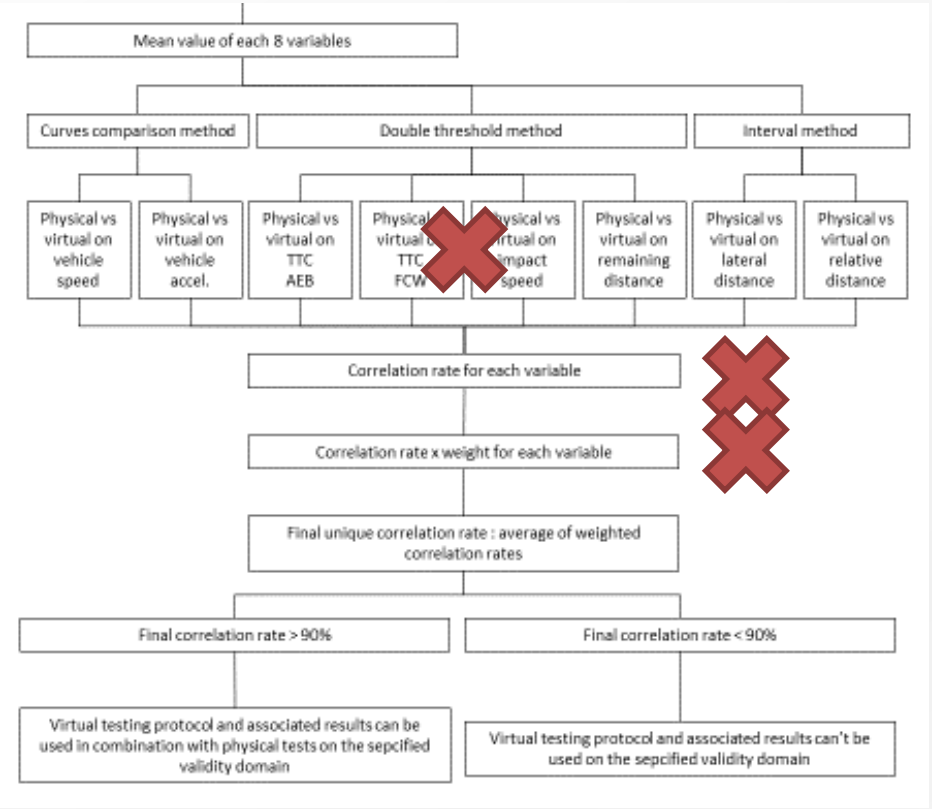
- Remaning distance
- Impact Speed
- TTC AEB
- TTC FCW

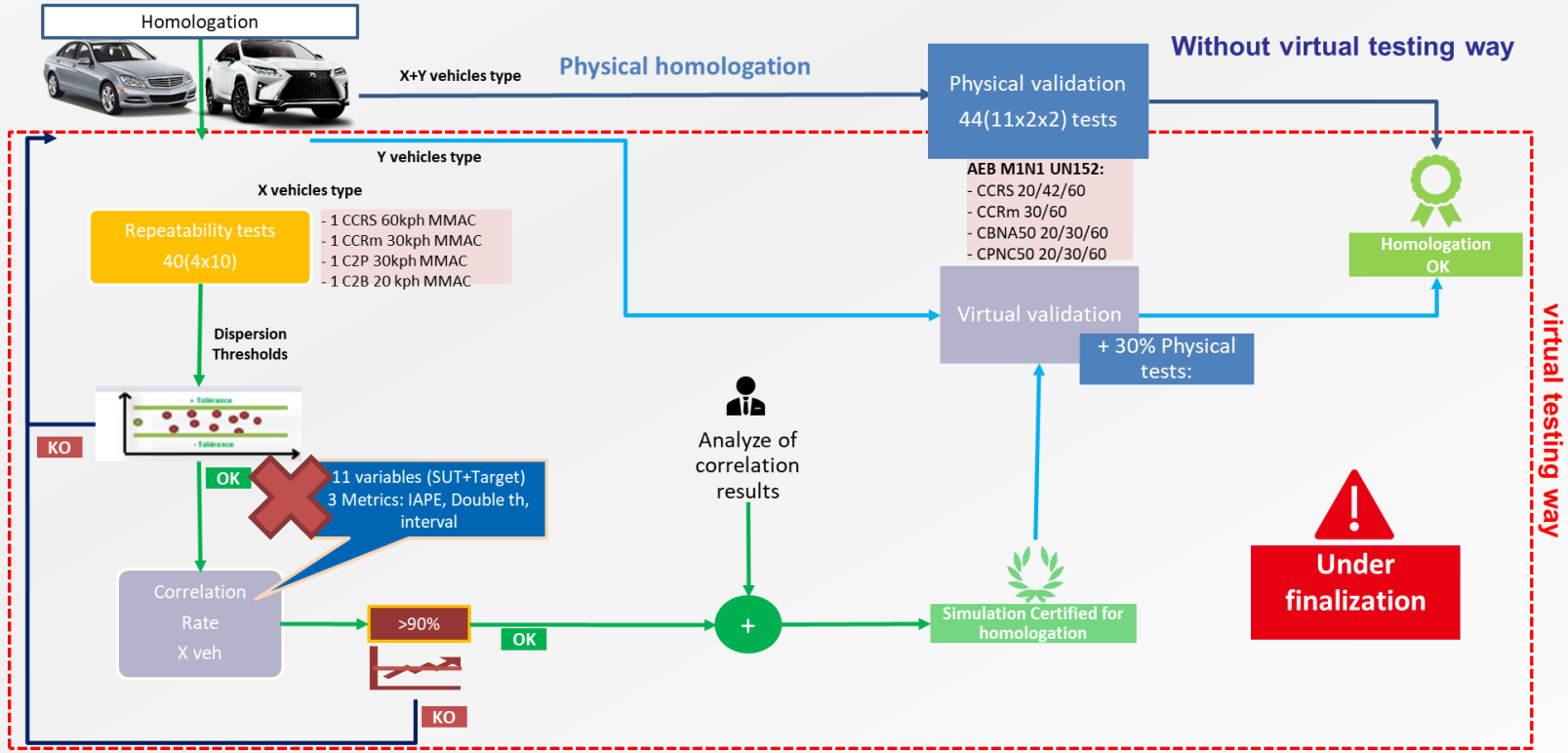
If A < X < B → 100 %
Else → 0 %

Interval Method

- Lateral distance
- Relative distance

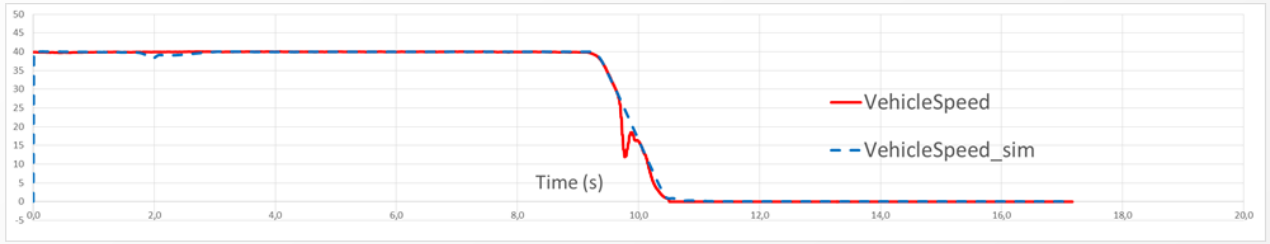
METHOD DIAGRAM



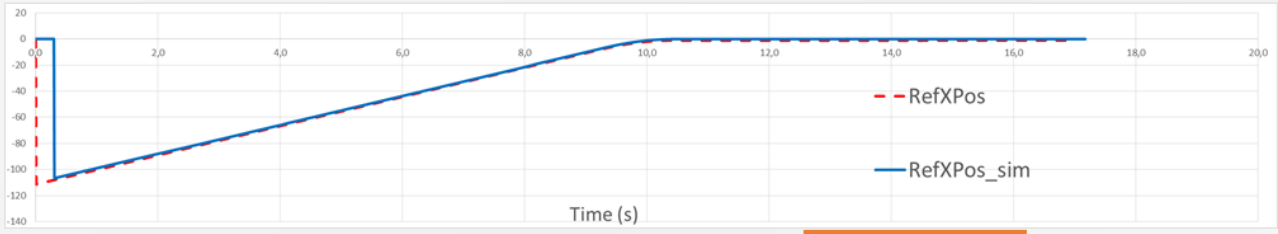


IAPE RESULTS FROM OEM GIVE RESULTS FOR ALL CONFIGURATIONS

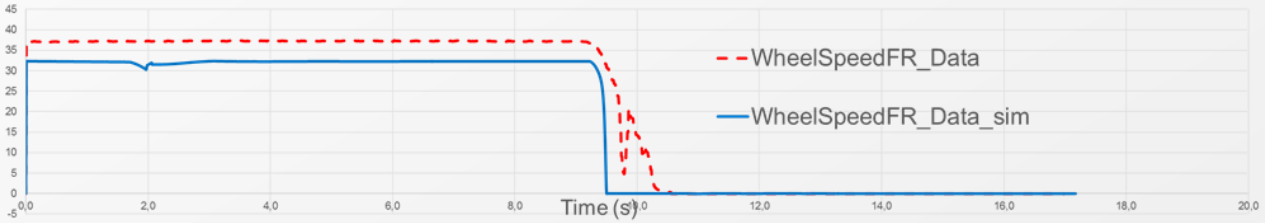
UTAC CERAM



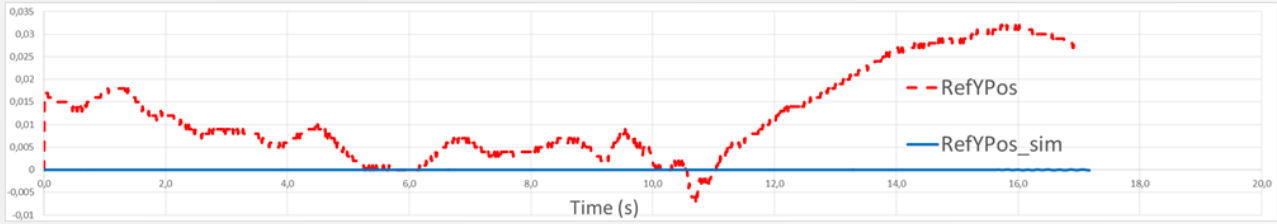
	I	A	P	E	G	C	Taux de corrélation
Ponderation	0	1	1	1			
Critere	67%	100%	100%	79%	93%	88%	90%



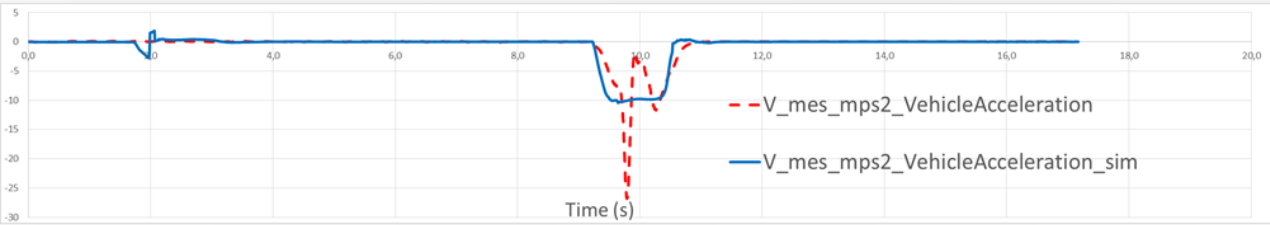
	I	A	P	E	G	C	Taux de corrélation
Ponderation	0	1	1	1			
Critere	11%	96%	96%	74%	89%	85%	87%



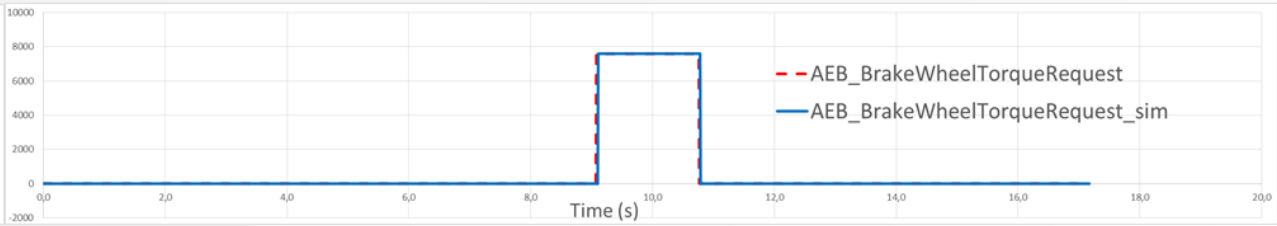
	I	A	P	E	G	C	Taux de corrélation
Ponderation	0	1	1	1			
Critere	76%	87%	100%	73%	86%	82%	84%



	I	A	P	E	G	C	Taux de corrélation
Ponderation	0	0	1	1			
Critere	90,39%	0,29%	97,50%	58,10%	77,80%	70,32%	74%

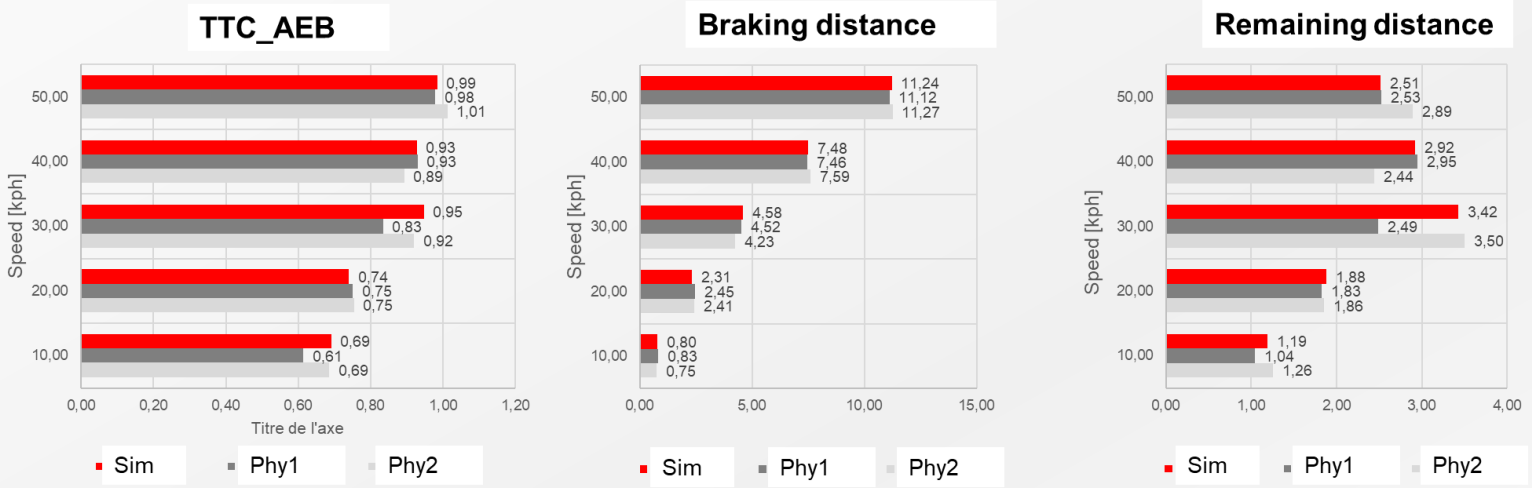


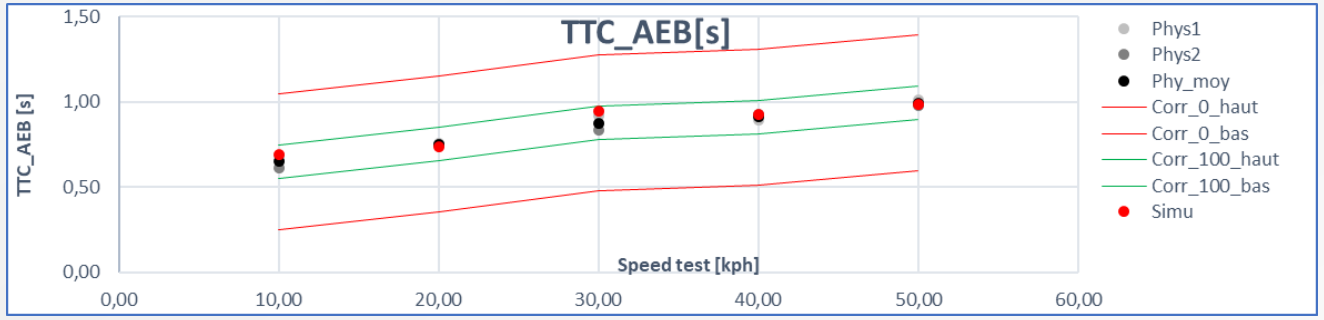
	I	A	P	E	G	C	Taux de corrélation
Ponderation	0	1	1	1			
Critere	98,57%	38,77%	99,65%	87,89%	75,44%	63,97%	70%



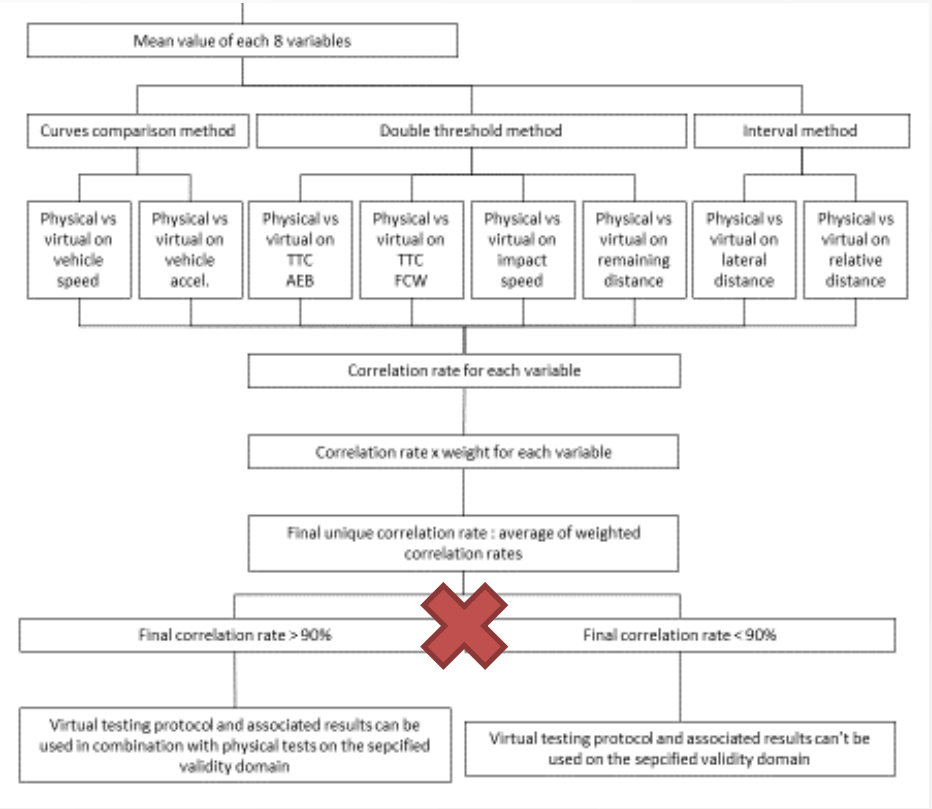
	I	A	P	E	G	C	Taux de corrélation
Ponderation	1	1	1	1			
Critere	100%	100%	100%	100%	100%	100%	100%

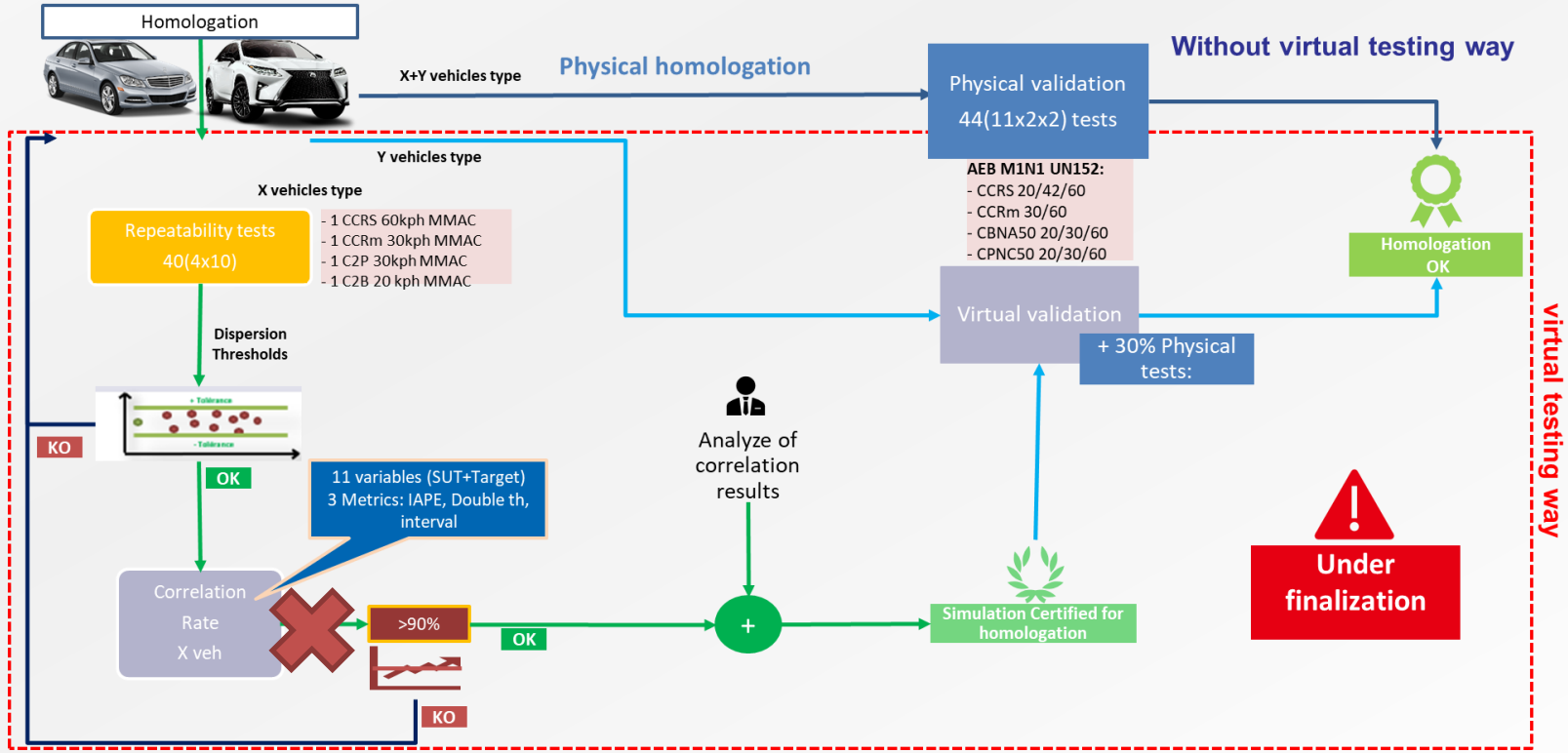
DOUBLE THRESHOLD RESULTS FROM OEM GIVE RESULTS FOR ALL CONFIGURATIONS





METHOD DIAGRAM



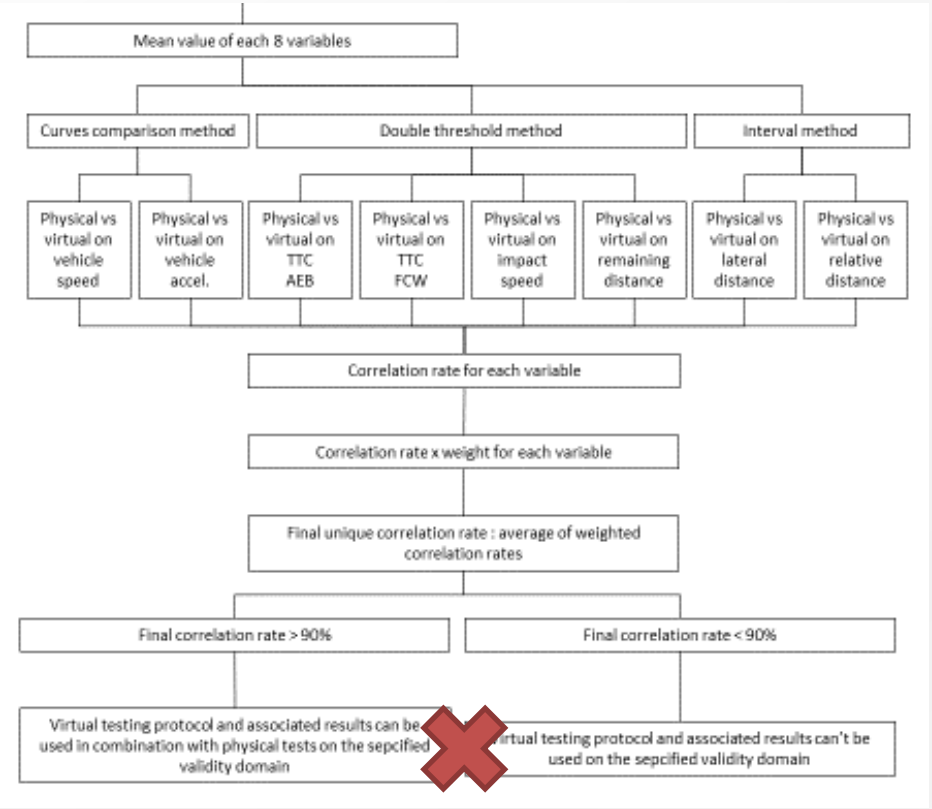


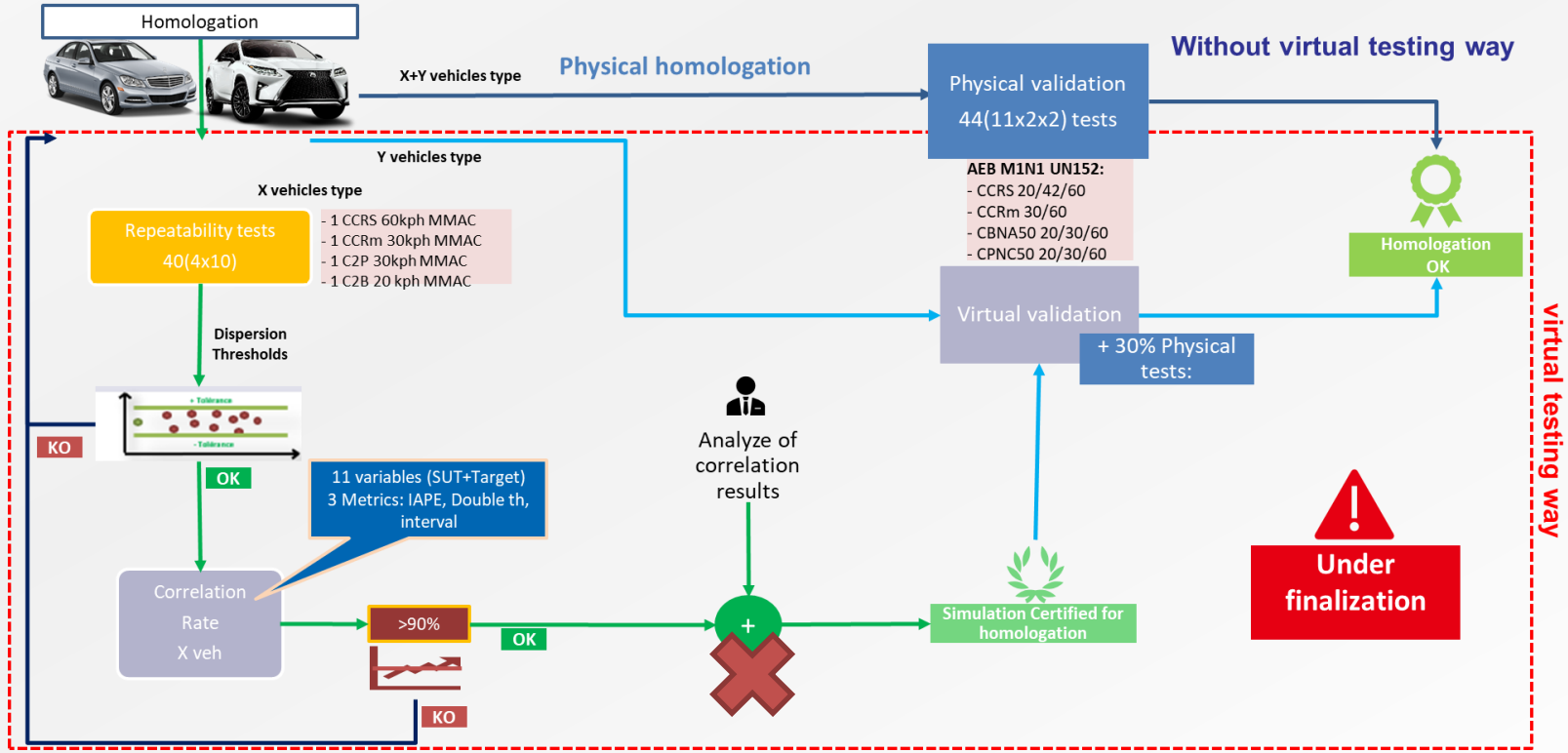
FINAL CORRELATION RATE
GIVE RESULTS FOR ALL CONFIGURATIONS

Variable	Methode	Coeff	Correlation 10kph	Correlation 20kph	Correlation 30kph	Correlation 40kph	Correlation 50kph	
Speed (VUT)	IAPE	0,50	90,00	94,00	92,00	93,00	92,00	
Acceleration		1,00	93,00	93,00	94,00	96,00	93,00	
Lateral deviation	Interval	1,00	100,00	100,00	100,00	100,00	100,00	
Relative distance		1,00	NA	NA	NA	NA	NA	
TTC AEB	Double seuil	1,00	100,00	100,00	100,00	100,00	100,00	
TTC FCW		1,00	NA	NA	NA	NA	NA	
Impact speed		1,00	NA	NA	NA	NA	NA	
Remaining distance		1,00	63,97	79,97	0,00	0,00	0,30	**Global Correlation rate [%]**
	Correlation rate		**89**	**93**	**99**	**97**	**75**	**91**

- Vehicle 1 & 3 pass with CCRs scenario the method

METHOD DIAGRAM





ANALYZING RESULTS BY LABORATORY

UTAC CERAM

- After analyzing results, OEM can present virtual results in the range:
  - Models can handle **900 kg** to **2500 kg** **OK**
  - Models can handle all configuration: **can cover vehicle 1 to 3** **OK**
  - Models can be use within **Pedestrian** and **Car to car scenarios** **Only Car to car stationary scenario**
  - Models can be use within speed range: **20 km/h to 50 km/h** **OK**
- All white range shall be physically tested only
- Virtual toolchain validated for X years with
  - Simulation software(s) used
  - ADAS architecture

Vehicle	Version	Mass (kg) VODM	Mass (kg) MMAC	CCRs 100% 20 MMAC	CCRs 100% 20 VODM	CCRs 100% 42 MMAC	CCRs 100% 42 VODM	CCRs 100% 60 MMAC	CCRs 100% 60 VODM	CCRm 100% 30 MMAC	CCRm 100% 30 VODM	CCRm 100% 60 MMAC	CCRm 100% 60 VODM	CBNA 50% 20 MMAC	CBNA 50% 20 VODM	CBNA 50% 30 MMAC	CBNA 50% 30 VODM	CBNA 50% 60 MMAC	CBNA 50% 60 VODM	CPNC 50% 20 MMAC	CPNC 50% 20 VODM	CPNC 50% 30 MMAC	CPNC 50% 30 VODM	CPNC 50% 60 MMAC	CPNC 50% 60 VODM
Vehicle 1 "City"	Standard	1100	1600																						
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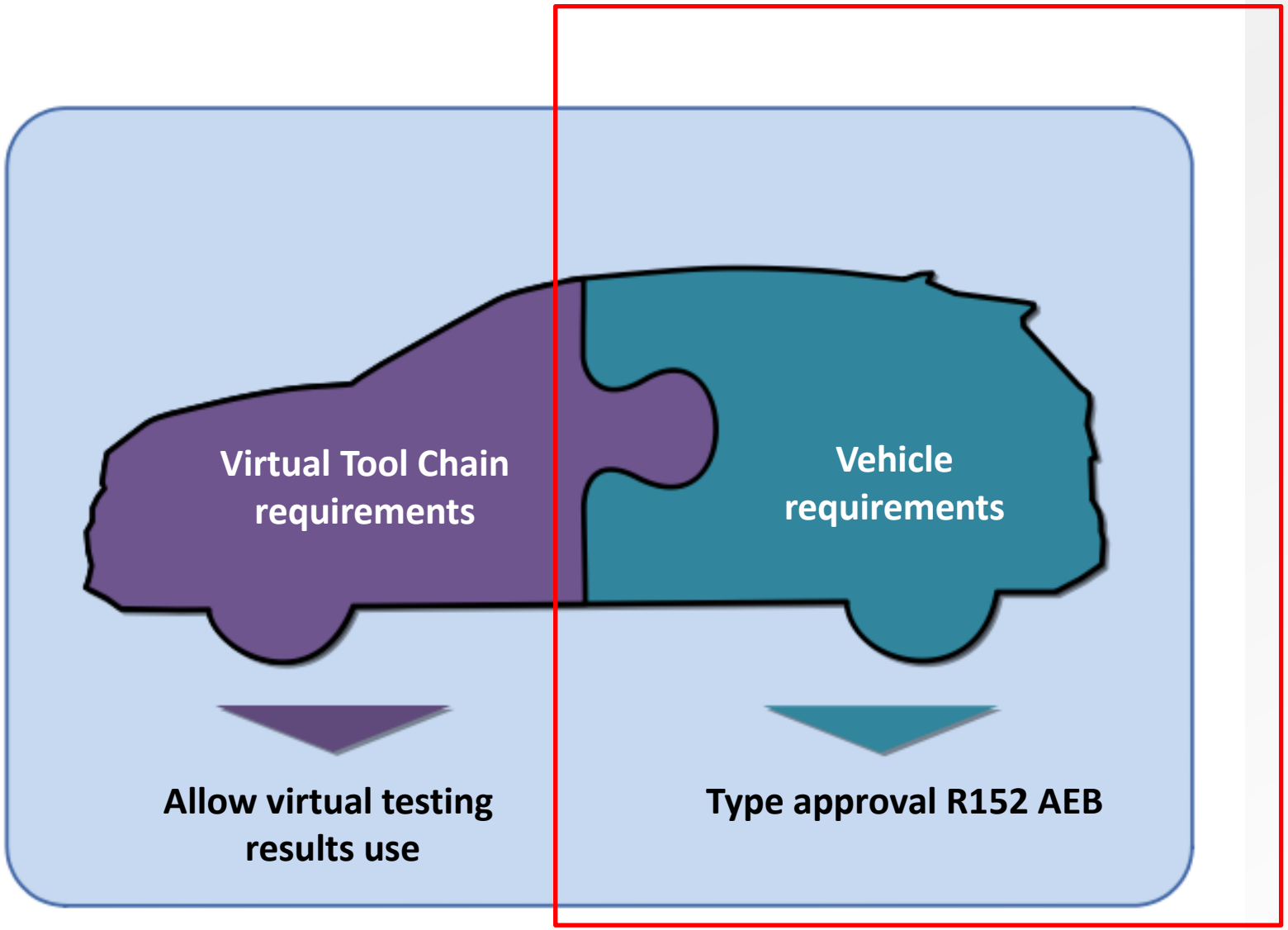
Vehicle 3 "Executive"	Standard	1800	2400																						
	Convertible	1950	2200																						
	Station wagon	2100	2600																						
	OffRoad station wagon	2200	2600																						
Vehicle 4 "Van"	Standard	1600	3000																						
	Long body	1800	3500																						

VIRTUAL TOOLCHAIN ASSESSMENT BEFORE VIRTUAL VEHICLE ASSESSMENT FOR TYPE APPROVAL



METHOD OVERVIEW
WE WILL ACHIEVE DARK BLUE LINE

Homologation

X+Y vehicles type

Physical homologation

Physical validation
44(11x2x2) tests

Without virtual testing way

Qualitative audit of proposed methodology

+

Y vehicles type

X vehicles type

Repeatability tests
40(4x10)

- 1 CCRS 60kph MMAC
- 1 CCRm 30kph MMAC
- 1 C2P 30kph MMAC
- 1 C2B 20 kph MMAC

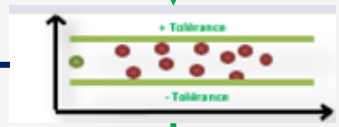
AEB M1N1 UN152:
- CCRS 20/42/60
- CCRm 30/60
- CBNA50 20/30/60
- CPNC50 20/30/60

Homologation OK

Virtual validation

+ 30% Physical tests:

Dispersion Thresholds



KO

OK

11 variables (SUT+Target)
3 Metrics: IAPE, Double th, interval

Analyze of correlation results

Correlation Rate X veh

>90%

OK

KO

+

Simulation Certified for homologation

Under finalization

virtual testing way

REQUIRED PHYSICAL TESTING R152 (AEBS M1N1) RESULTS
R152 AEB M1N1 TEST COLUMN

UC	Target	Test Case	Overlap	Speed	Weight config	R152 AEB M1N1 test	Repeatability test	Correlation test	Physical test not replaced by virtual
CtC	Car	CCRs	100%	20 kph	MMAC	✓ x2			Random physical test to validate vs virtual in the validity domain (30%)
					VODM	✓ x2			
				42 kph	MMAC	✓ x2			
					VODM	✓ x2			
				60 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
		CCRm	100%	30 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
				60 kph	MMAC	✓ x2			
					VODM	✓ x2			
VRU	Bicycle	CBNA	50%	20 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
				30 kph	MMAC	✓ x2			
					VODM	✓ x2			
				60 kph	MMAC	✓ x2			
					VODM	✓ x2			
	Pedestrian	CPNC	50%	20 kph	MMAC	✓ x2			
					VODM	✓ x2			
				30 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
				60 kph	MMAC	✓ x2			
					VODM	✓ x2			

OEM MUST SHOW PHYSICAL TEST RESULTS IN ORANGE RANGE

Vehicle	Version	Mass (kg) VODM	Mass (kg) MMAC	CCRs 100% 20 MMAC	CCRs 100% 20 VODM	CCRs 100% 42 MMAC	CCRs 100% 42 VODM	CCRs 100% 60 MMAC	CCRs 100% 60 VODM	CCRm 100% 30 MMAC	CCRm 100% 30 VODM	CCRm 100% 60 MMAC	CCRm 100% 60 VODM	CBNA 50% 20 MMAC	CBNA 50% 20 VODM	CBNA 50% 30 MMAC	CBNA 50% 30 VODM	CBNA 50% 60 MMAC	CBNA 50% 60 VODM	CPNC 50% 20 MMAC	CPNC 50% 20 VODM	CPNC 50% 30 MMAC	CPNC 50% 30 VODM	CPNC 50% 60 MMAC	CPNC 50% 60 VODM
Vehicle 1 "City"	Standard	1100	1600																						
	Convertible	1250	1750																						
Vehicle 2 "Compact"	Standard	1200	1800																						
	Convertible	1300	1900																						
	Station wagon	1500	2100																						
	Two doors	1150	1600																						
	SUV	1450	2200																						
Vehicle 3 "Executive"	Standard	1800	2400																						
	Convertible	1950	2200																						
	Station wagon	2100	2600																						
	OffRoad station wagon	2200	2600																						
Vehicle 4 "Van"	Standard	1600	3000																						
	Long body	1800	3500																						

- Tests in orange range will be assess according to R152 AEB M1N1 protocol criterion

METHOD OVERVIEW
WE WILL ACHIEVE LIGHT BLUE LINE

Homologation

X+Y vehicles type

Physical homologation

Physical validation
44(11x2x2) tests

Without virtual testing way

Qualitative audit of proposed methodology

+

Y vehicles type

X vehicles type

Repeatability tests
40(4x10)

- 1 CCRS 60kph MMAC
- 1 CCRm 30kph MMAC
- 1 C2P 30kph MMAC
- 1 C2B 20 kph MMAC

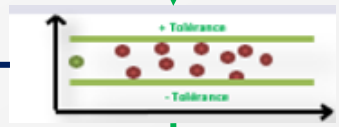
AEB M1N1 UN152:
- CCRS 20/42/60
- CCRm 30/60
- CBNA50 20/30/60
- CPNC50 20/30/60

Homologation OK

Virtual validation

+ 30% Physical tests:

Dispersion Thresholds



KO

OK

11 variables (SUT+Target)
3 Metrics: IAPE, Double th, interval

Analyze of correlation results

Correlation Rate X veh

>90%

OK

KO

+

Simulation Certified for homologation

Under finalization

virtual testing way

REQUIRED PHYSICAL TESTING R152 (AEBS M1N1) RESULTS
PHYSICAL TEST NOT REPLACED BY VIRTUAL COLUMN

UTAC CERAM

UC	Target	Test Case	Overlap	Speed	Weight config	R152 AEB M1N1 test	Repeatability test	Correlation test	Physical test not replaced by virtual
CtC	Car	CCRs	100%	20 kph	MMAC	✓ x2			✗
					VODM	✓ x2			
				42 kph	MMAC	✓ x2			
					VODM	✓ x2			
				60 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
		CCRm	100%	30 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
				60 kph	MMAC	✓ x2			
					VODM	✓ x2			
VRU	Bicycle	CBNA	50%	20 kph	MMAC	✓ x2	✓ x10	✓	Random physical test to validate vs virtual in the validity domain (30%)
					VODM	✓ x2			
				30 kph	MMAC	✓ x2			
					VODM	✓ x2			
				60 kph	MMAC	✓ x2			
					VODM	✓ x2			
	Pedestrian	CPNC	50%	20 kph	MMAC	✓ x2			
					VODM	✓ x2			
				30 kph	MMAC	✓ x2	✓ x10	✓	
					VODM	✓ x2			
				60 kph	MMAC	✓ x2			
					VODM	✓ x2			

LABORATORY WILL CHOOSE 30% OF TESTS WITHIN VALIDITY DOMAIN OUTPUT BY THE METHOD

UTAC CERAM

Before methodology check → **After methodology check**

Vehicle	Version	Mass (kg) VODM	Mass (kg) MMAC	CCRs 100%						CCRm 100%				CBNA 50%						CPNC 50%					
				20		42		60		30		60		20		30		60		20		30		60	
				MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM
Vehicle 1 "City"	Standard	1100	1600																						
	Convertible	1250	1750																						
Vehicle 2 "Compact"	Standard	1200	1800																						
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Vehicle 4 "Van"	Standard	1600	3000																						
	Long body	1800	3500																						

Vehicle	Version	Mass (kg) VODM	Mass (kg) MMAC	CCRs 100%						CCRm 100%				CBNA 50%						CPNC 50%					
				20		42		60		30		60		20		30		60		20		30		60	
				MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM	MMAC	VODM
Vehicle 1 "City"	Standard	1100	1600																						
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	Station wagon	2100	2600																						
	OffRoad station wagon	2200	2600																						
Vehicle 4 "Van"	Standard	1600	3000																						
	Long body	1800	3500																						

LABORATORY WILL CHOOSE 30% OF TESTS WITHIN EXAMPLE

- Laboratory can choose 30 % of test to check virtually and physically within the range
  - 20 kmh to 50 km/h
  - Car to car stationary 100%
- 36 tests in the range: 30 % of 36 tests, we can choose 11 random test to check
  - They can be out of this table

- Laboratory have chosen, he will ask OEM to prove that vehicle 3 in following scenarios is accurate with simulation results:
  - CCRs convertible MMAC 25 km/h
  - CCRs convertible MMAC 30 km/h
  - CCRs convertible VODM 50 km/h
  - ….
  - …

- Tests in blue range will be assess according to R152 AEB M1N1 protocol criterion

Vehicle	Version	Mass (kg) VODM	Mass (kg) MMAC	CCRs 100% 20 MMAC	CCRs 100% 20 VODM	CCRs 100% 42 MMAC	CCRs 100% 42 VODM	CCRs 100% 60 MMAC	CCRs 100% 60 VODM	CCRm 100% 30 MMAC	CCRm 100% 30 VODM	CCRm 100% 60 MMAC	CCRm 100% 60 VODM	CBNA 50% 20 MMAC	CBNA 50% 20 VODM	CBNA 50% 30 MMAC	CBNA 50% 30 VODM	CBNA 50% 60 MMAC	CBNA 50% 60 VODM	CPNC 50% 20 MMAC	CPNC 50% 20 VODM	CPNC 50% 30 MMAC	CPNC 50% 30 VODM	CPNC 50% 60 MMAC	CPNC 50% 60 VODM
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Vehicle 4 "Van"	Standard	1600	3000																						
	Long body	1800	3500																						

HOMOLOGATION OK OR NOK

Homologation

X+Y vehicles type

Physical homologation

Physical validation
44(11x2x2) tests

Without virtual testing way

Qualitative audit of proposed methodology

+

Y vehicles type

X vehicles type

Repeatability tests
40(4x10)

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AEB M1N1 UN152:
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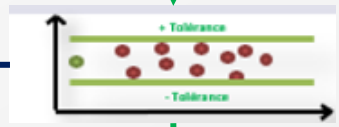
Homologation OK

Virtual validation

+ 30% Physical tests:

Dispersion Thresholds



KO

OK

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3 Metrics: IAPE, Double th, interval

Analyze of correlation results

Correlation Rate X veh

>90%

OK

KO

+

Simulation Certified for homologation

Under finalization

virtual testing way