



# Validation Method : Virtual Testing

## IWG AEBS - UTAC

➤ Virtual testing activities already in progress

➤ Discussions on going for validation methods

➤ Automated Driving applications

➤ Next steps

➤ Virtual testing activities already in progress

➤ Discussions on going for validation methods

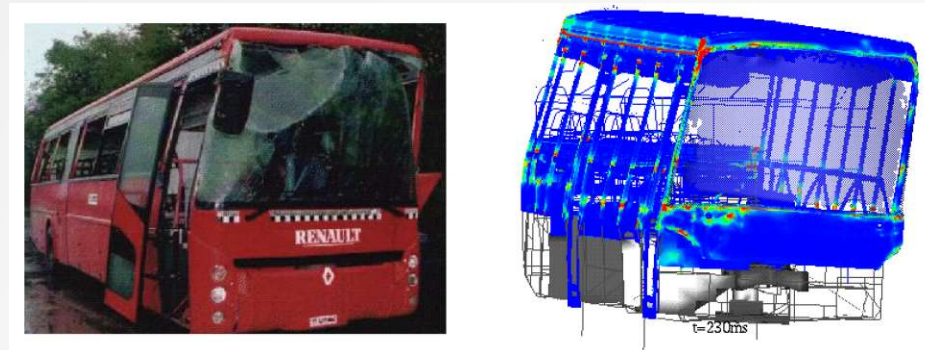
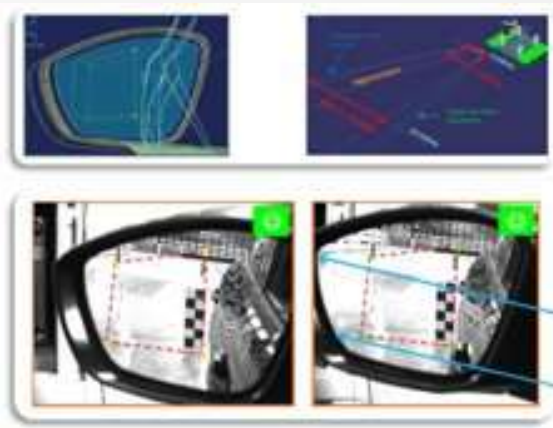
➤ Automated Driving applications

➤ Next steps

# Virtual testing activities already in progress

Virtual testing already in use for alternative testing solutions according to regulations or to European approval framework for motor vehicles

- ▶ 2007/46 annex XVI or 2018/858 annex VIII defining the specific conditions required from virtual testing methods and regulatory acts for which virtual testing methods may be used by a manufacturer or a technical service
  - UNECE n° 46 on indirect vision
  - UNECE n° 125 on forward field of vision
  - UNECE n° 21 on interior fittings
  - UNECE n° 66 on strength of superstructure of large passenger vehicles



# Virtual testing activities already in progress

|  |  |   |
|--|--|---|
|  | <b>VIRTUAL TESTING METHOD VALIDATION PROTOCOL</b>  | 1/19  |
| FI.UTA.000.004.EN                                | Revision 01  |   |
| Instruction applicable on the following site(s): | <input checked="" type="checkbox"/> Montigny       | <input checked="" type="checkbox"/> Montefontaine |
| Classification level:                            | <input checked="" type="checkbox"/> Not classified | <input type="checkbox"/> Internal                 |
|  | <input type="checkbox"/> Confidential              | <input type="checkbox"/> BNA                      |
|  |  | <input type="checkbox"/> Secret                   |



**Validation protocol for a virtual testing method according to Framework Directive 2007/46/EC, Annex XVI and UNECE regulatory procedures**



|            | WRITTEN BY       | CHECKED BY   | APPROVED BY             |
|------------|------------------|--------------|-------------------------|
| Date:      | 10/04/2019       |              |                         |
| Signature: |                  |              |                         |
| Name:      | Fabrice HERVELEU | Julie SCARPA | Béatrice LOPEZ DE RODAS |

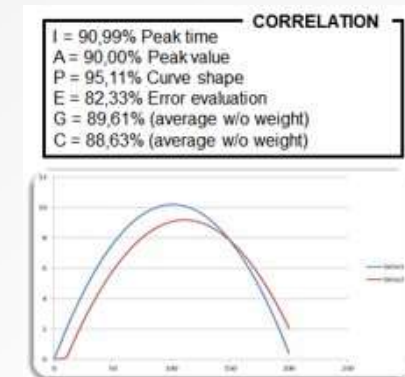
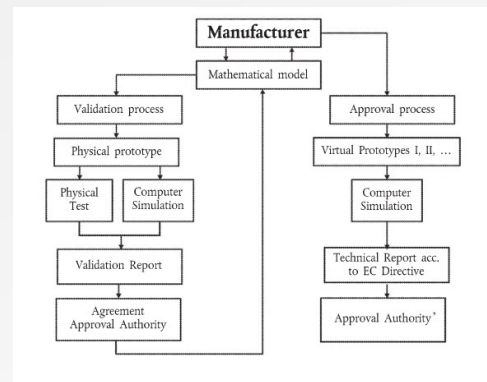
*This instruction is applicable upon receipt and no later than two weeks after the date of approval.*



Users should refer to the paper version as the one in force

Virtual testing already in use for alternative testing solutions according to regulations or to European approval framework for motor vehicles

- UTAC protocol defined for virtual testing application : validation methodology of virtual testing method focusing on objective evaluation of a correlation level.
- Objective evaluation based on different evaluations between physical and numerical results under a validity area depending on the application :
  - Kinematics
  - Scalar Values
  - Curves using IAPE method (peak time, peak value, curve shape, error evaluation)



➤ Virtual testing activities already in progress

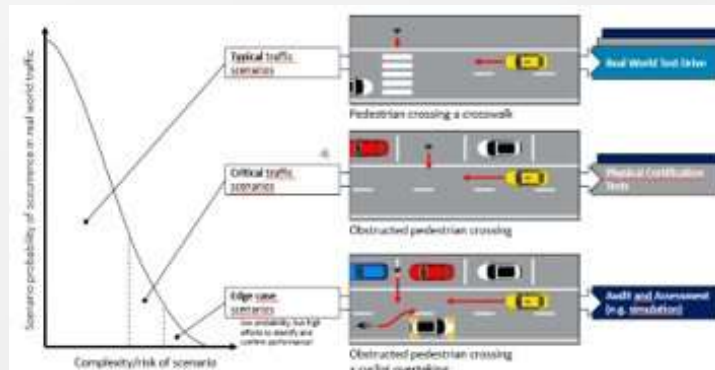
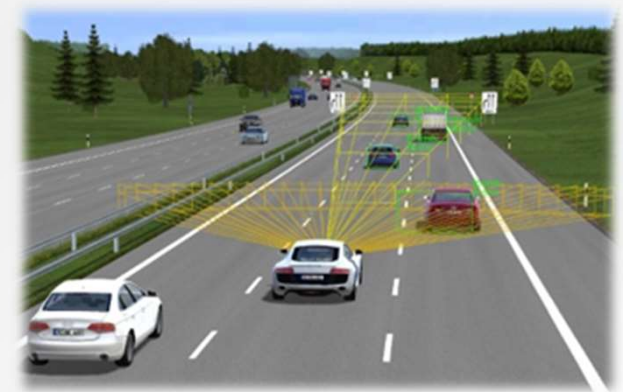
➤ Discussions on going for validation methods

➤ Automated Driving applications

➤ Next steps

## Dedicated Informal Working Group of GRVA for validation methods (VMAD)

- Virtual testing considered as part of the audit/assessment of vehicles with automated mode
  - Safety principles evaluation & validation
  - Critical situations to be evaluated
  - High number of situations to be covered



## Dedicated Informal Working Group of GRVA for validation methods (VMAD)

- New regulation on Automated Lane Keeping Systems (ALKS) annex 4 (functional and operational safety) § 4.2. :
  - Simulation tool and mathematical models for verification of the safety concept may be used in accordance with 1958 Agreement, in particular for scenarios that are difficult on a test track or in real driving conditions.
  - Manufacturers shall demonstrate the scope of the simulation tool, its validity for the scenario concerned as well as the validation performed for the simulation tool chain (correlation of the outcome with physical tests).
  
- Similar approach and application for larger AD functions implementation.





➤ Virtual testing activities already in progress

➤ Discussions on going for validation methods

➤ **Automated Driving applications**

➤ Next steps



- 100% numérique
- Utilisation de modèles



- Essai composants
- Environnement émulé

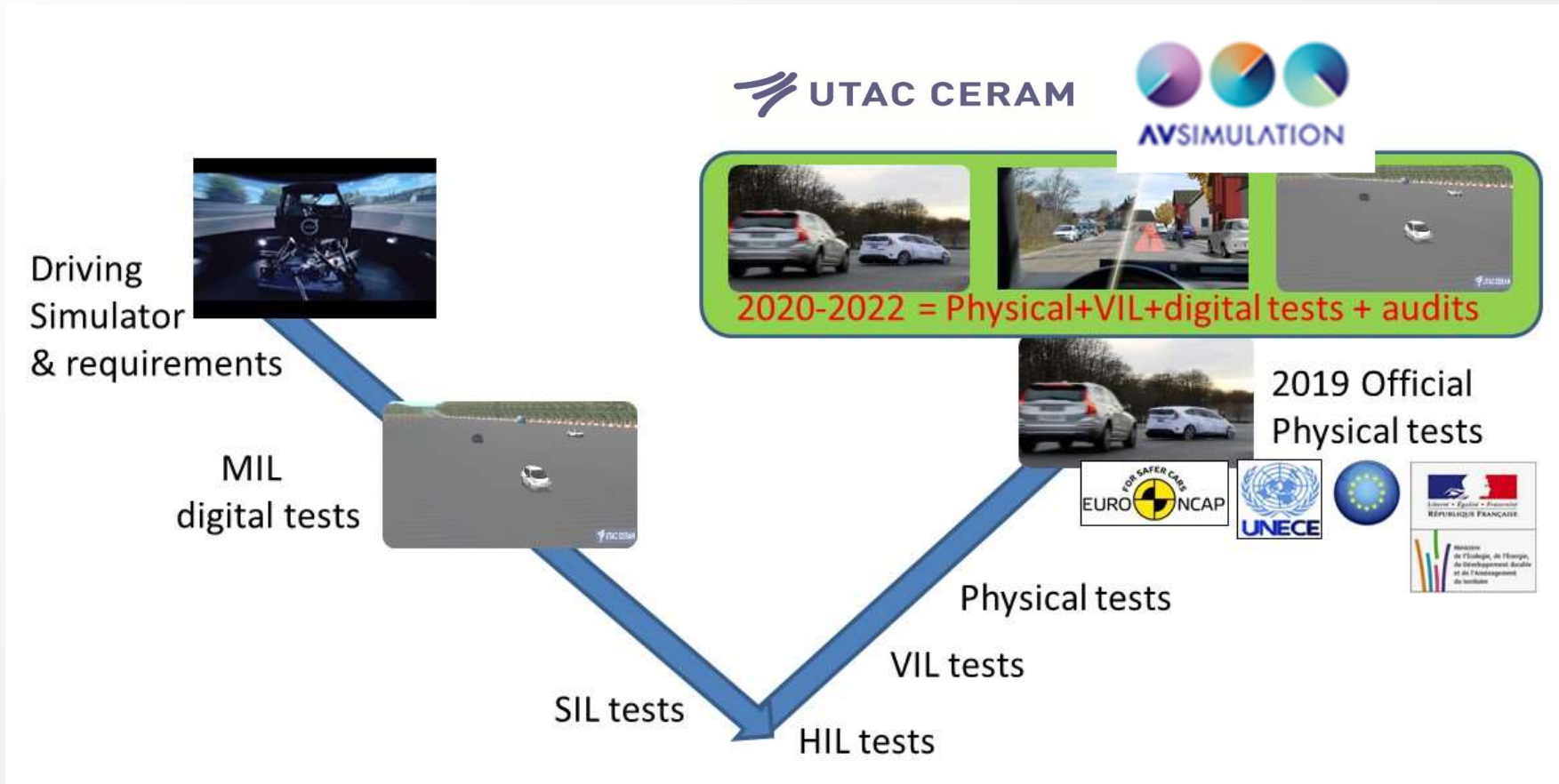


- Essai sur véhicule complet
- Environnement émulé indoor/outdoor



- Essai sur véhicule complet
- Environnement réel (piste/route ouverte)

- UTAC involved in Working Group Euro NCAP Virtual testing
- UTAC involved in WMAD traffic scenarios
- Member of P.E.A.R.S initiative: Prospective safety performance assessment of pre-crash technology by virtual simulation
  - ISO assessment method of active safety simulation

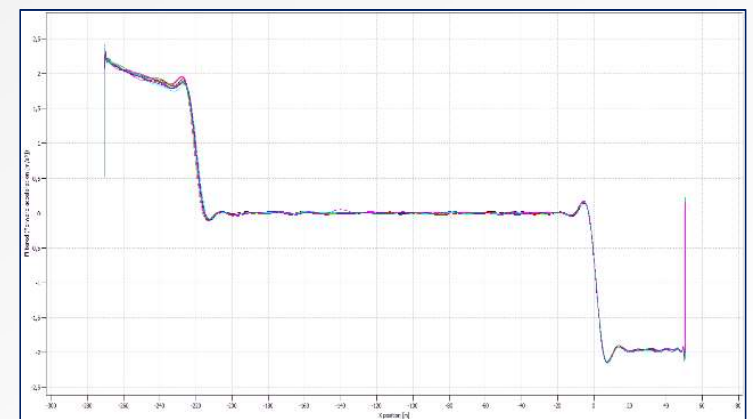
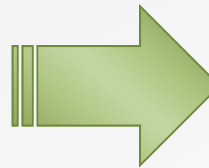
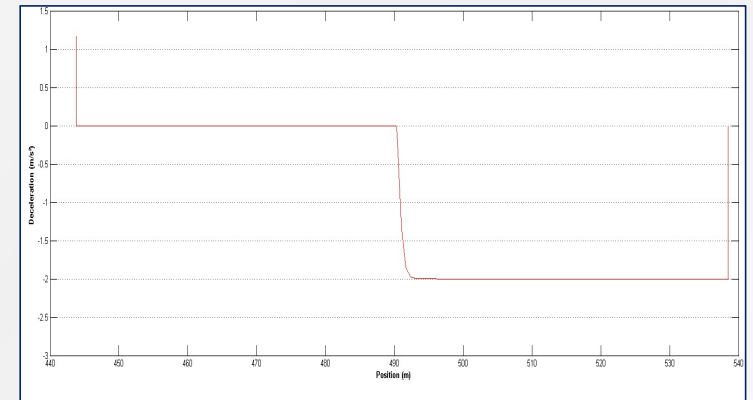
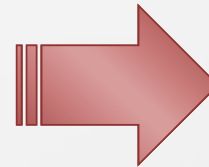
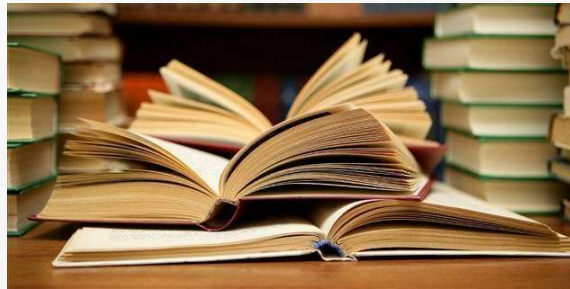


A good input mean a good correlation rate



# Injecting real test data into scenarios...

Test Protocol  
spécifications



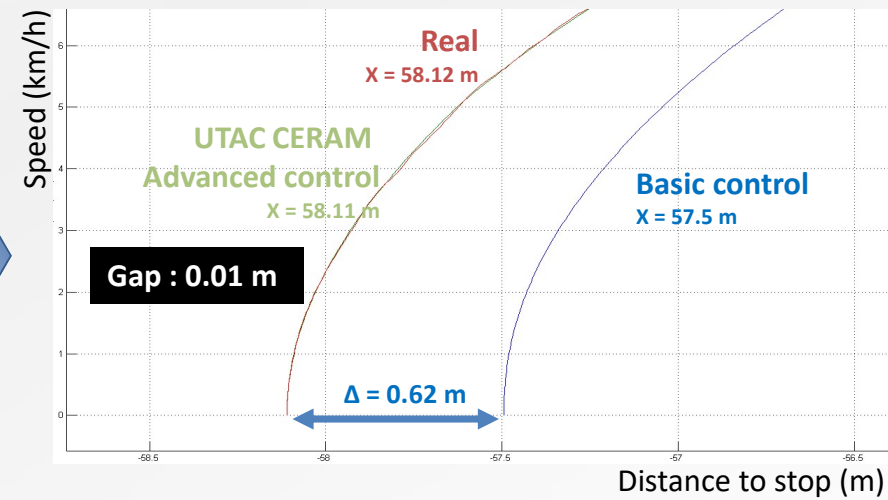
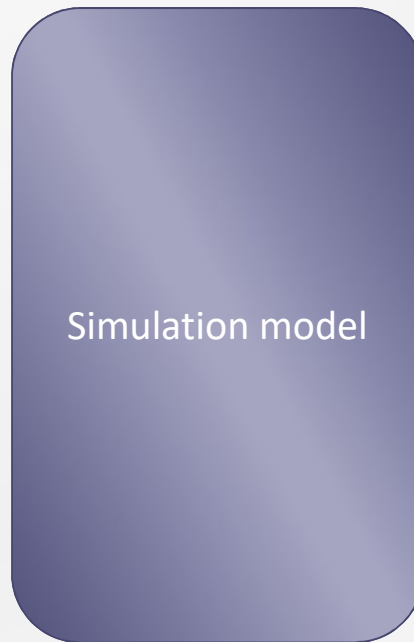
... provides results very close to reality

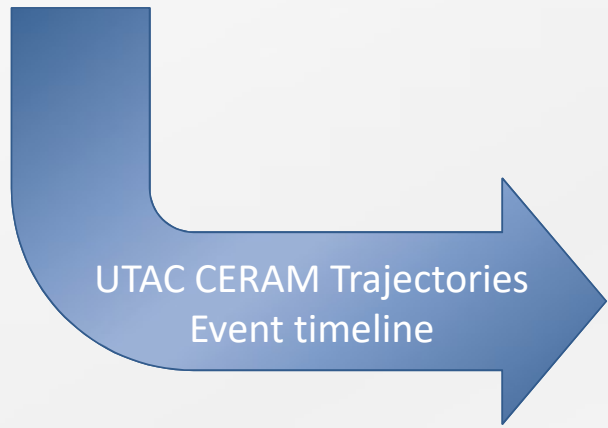
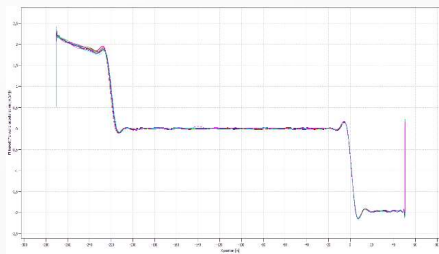


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# Example of correlation : Pedestrian turning scenario

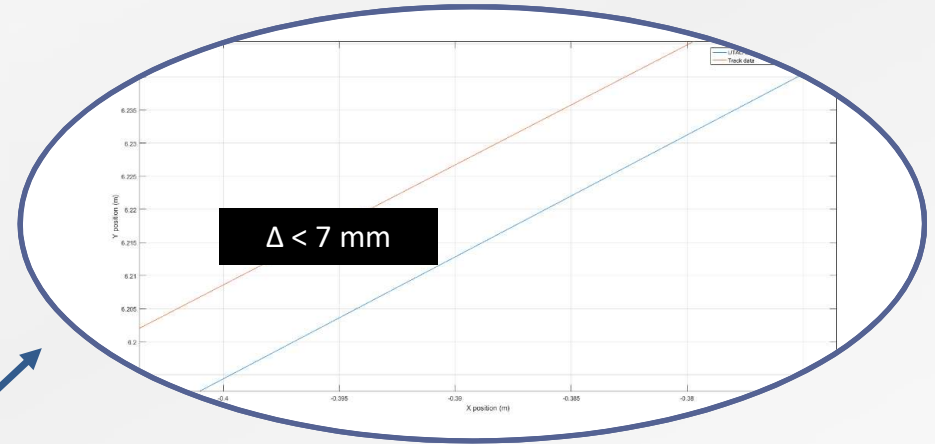
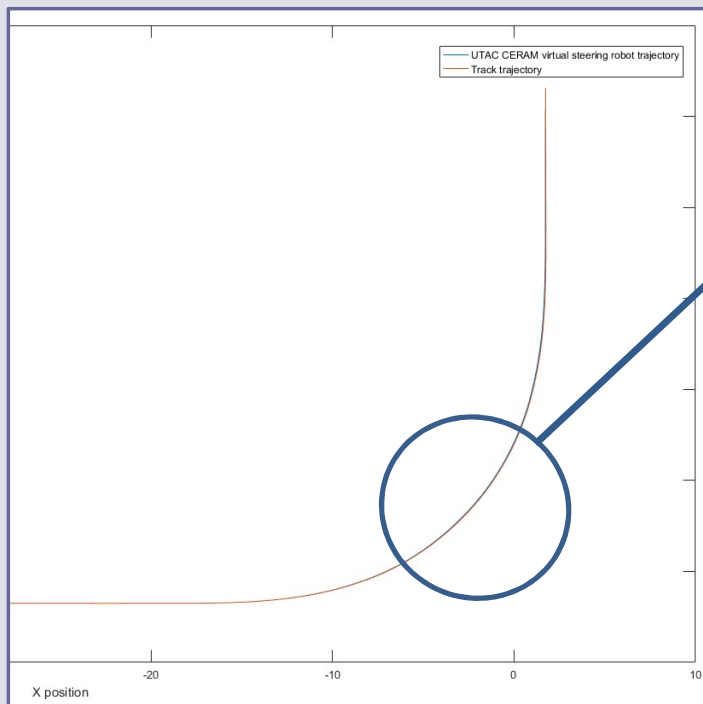




# Example of correlation : Pedestrian turning scenario

UTAC CERAM driving robot model control Vehicle Under Test

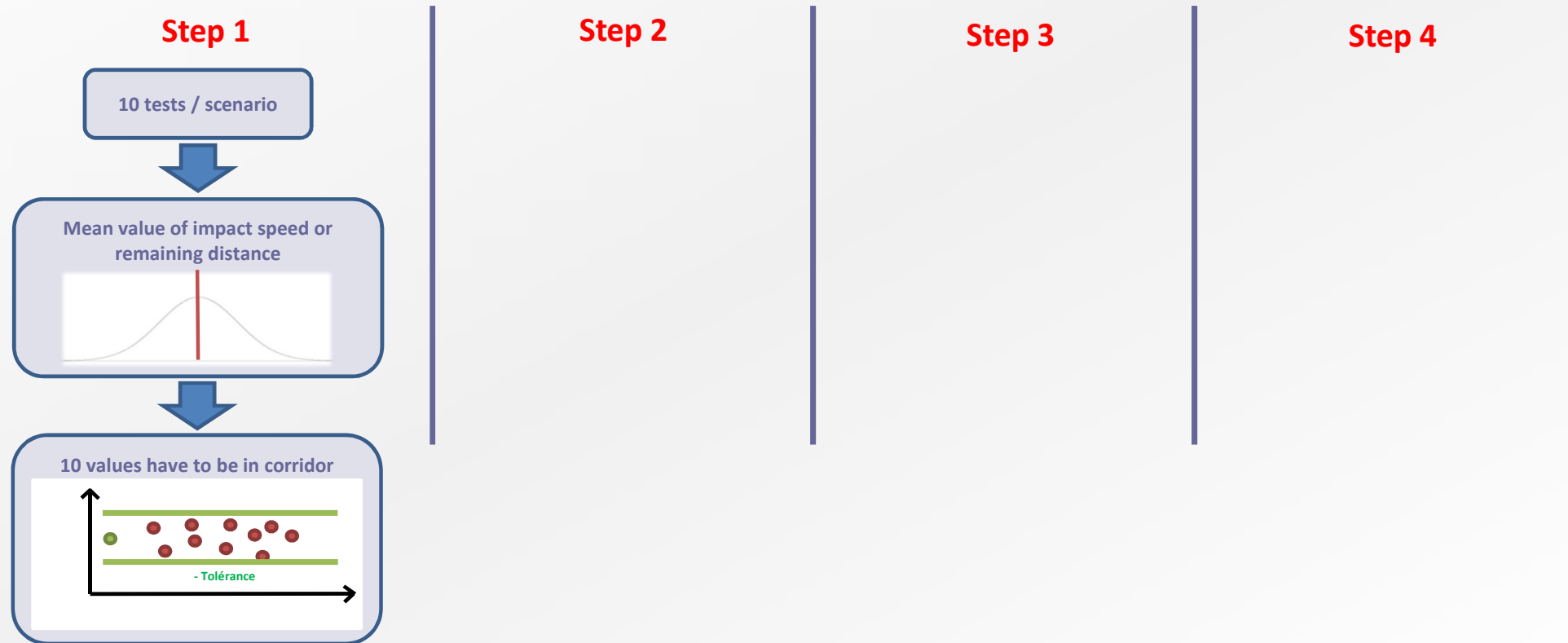
Ego vehicle pedestrian turning scenario trajectory



- **Trajectory definition in test protocols**
  - Design to be use by robot control software on track
- **Difficult to design without real input**
- **Theoretical scenarios haven't real trajectories**
  - UTAC CERAM have real trajectories

# 4 Steps methodology

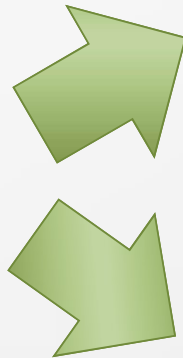
- Methodology use availability: is the vehicle reproducible ?
- Find physical mean value to compare
- Output correlation rate of each variables
- Output final correlation rate: process **validated** or **not validated**



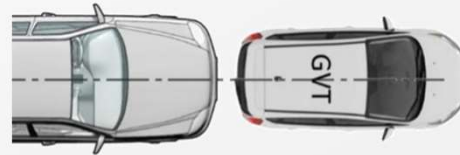
# Necessity to check if physical is reproducible

UTAC CERAM have tested 2 vehicles, with different scenarios

same vehicle  
2 different scenarios



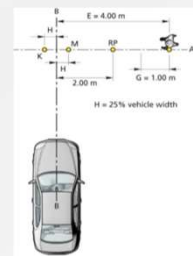
Car-to-Car Rear Stationary (CCRs)  
100% overlap



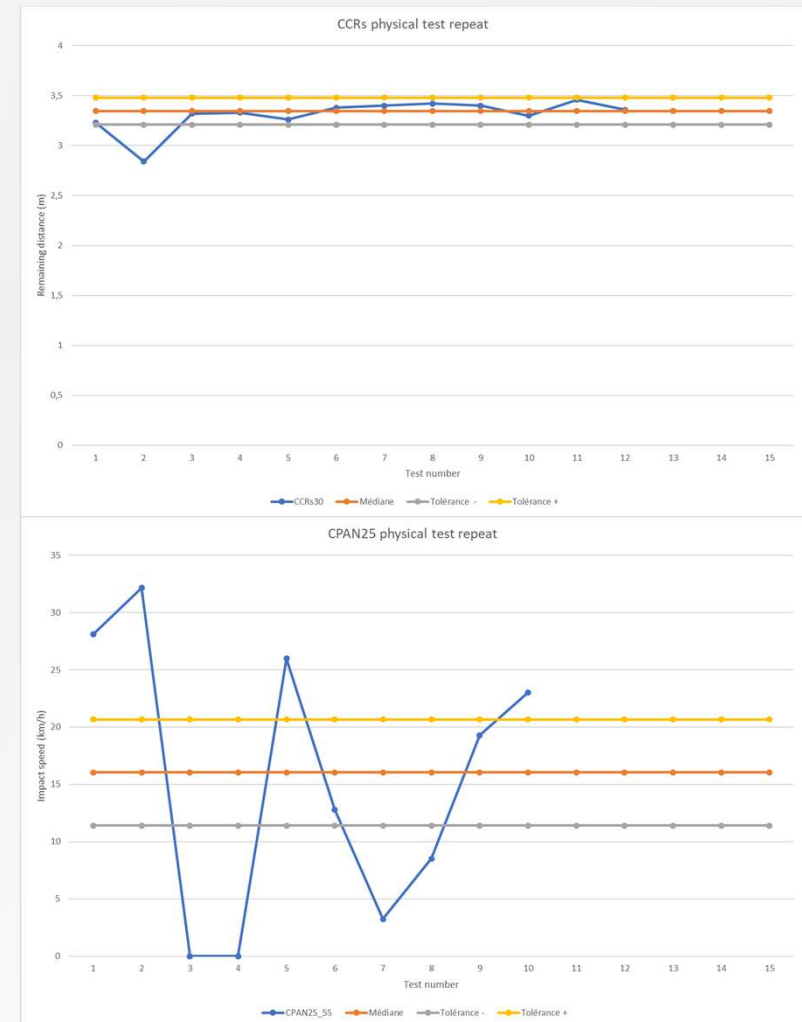
Test vehicle speed: 30 kph  
Target vehicle speed: 0 kph



Car-to-Pedestrian Nearside Adult 25% (CPAN25)

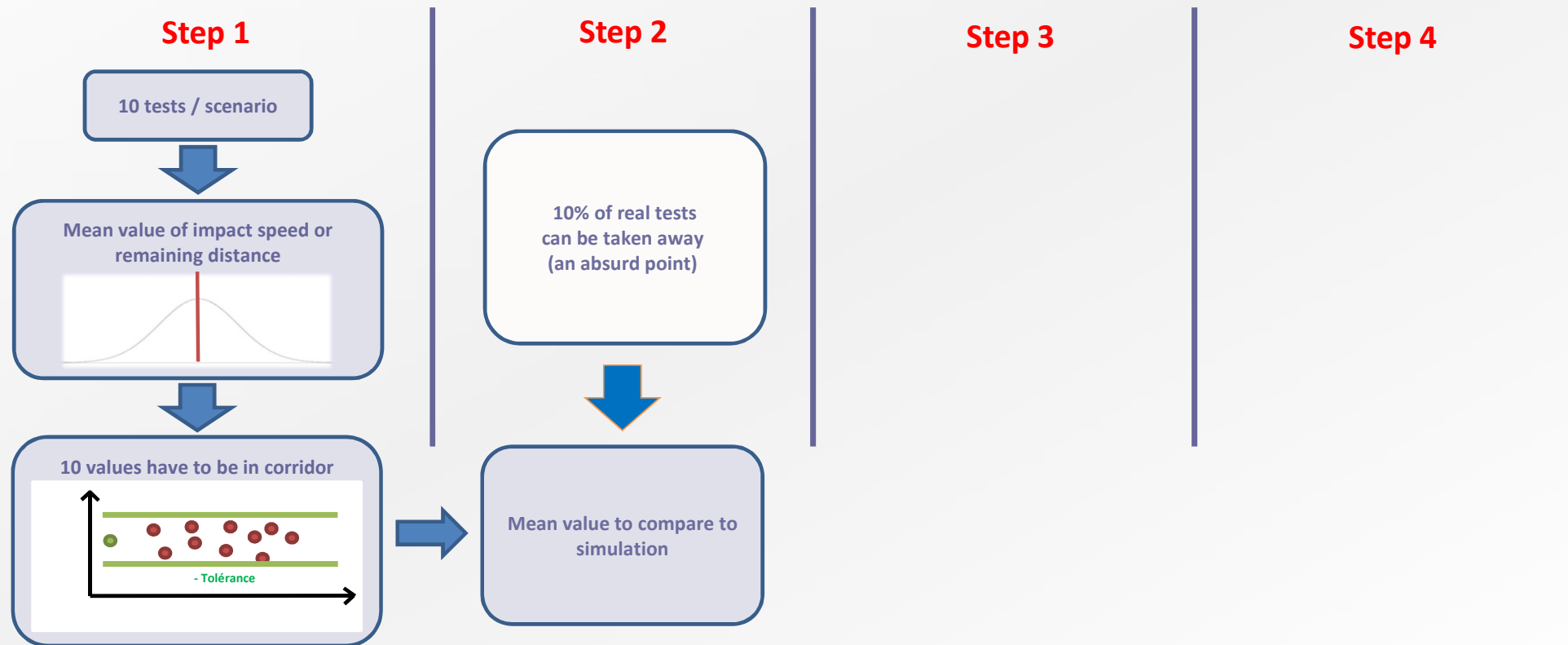


Test vehicle speed: 55 kph



# 4 Steps methodology

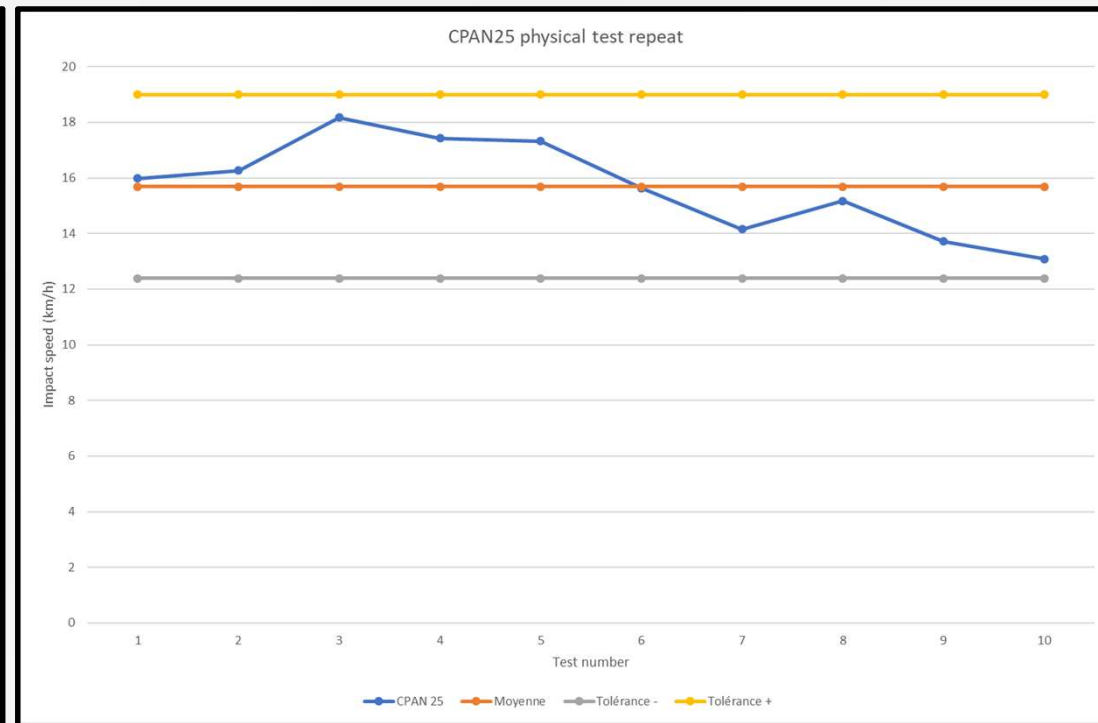
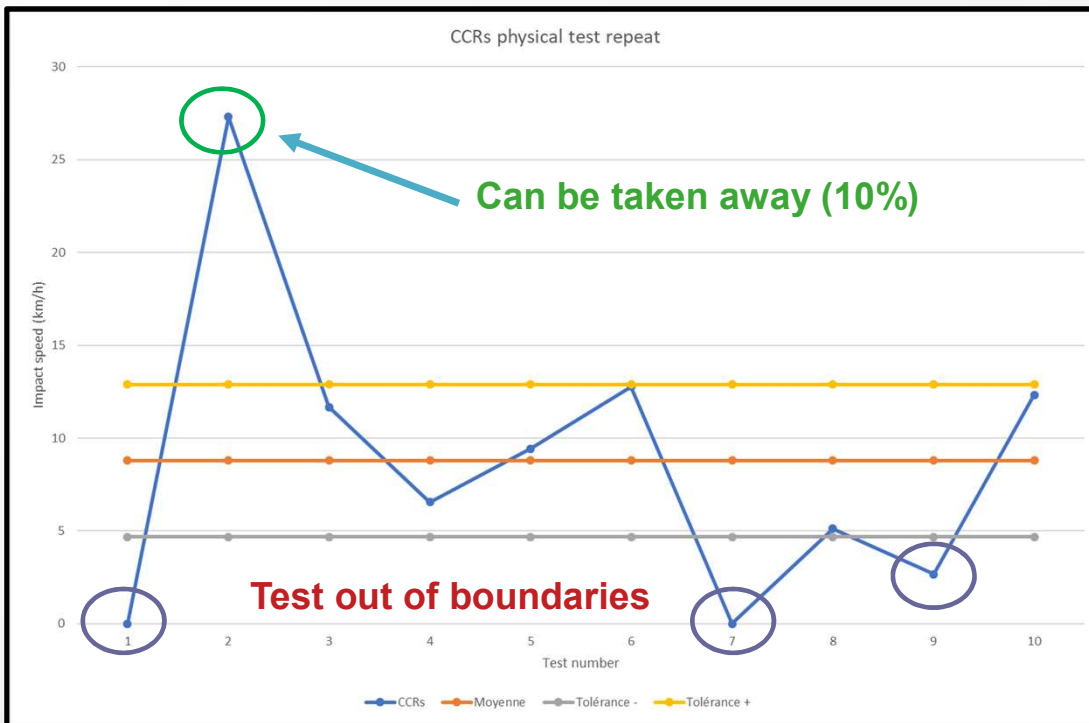
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# Virtual validation can be applied in a validity domain

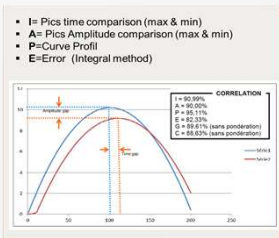
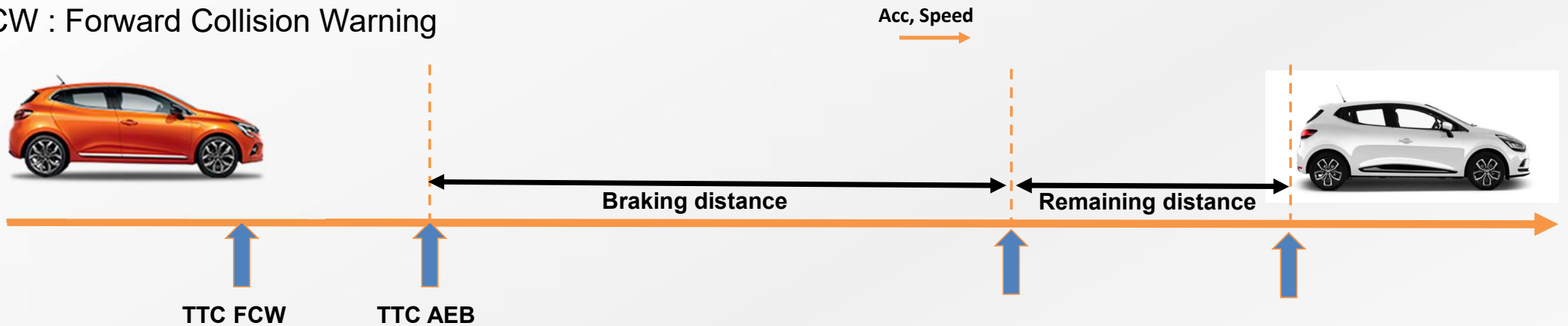
UTAC CERAM step 1 apply → Vehicle tested in UTAC CERAM: 10 tests repeated each scenario

- Car to car validity domain: **NOK**
- Pedestrian validity domain: **Ok → Full methodology can be apply**



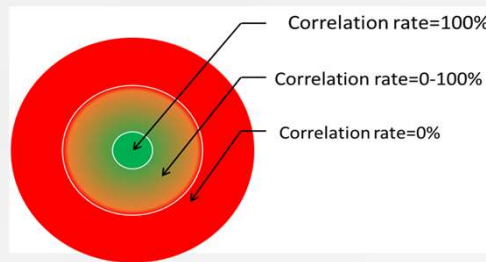
# The UTAC numerical procedure applied on AEB

TTC : Time to collision  
 FCW : Forward Collision Warning



## IAPE Method

- Vehicle Speed
- Acceleration
- TTC AEB
- TTC FCW



## Double thresholds method

- Remaning distance
- Impact Speed

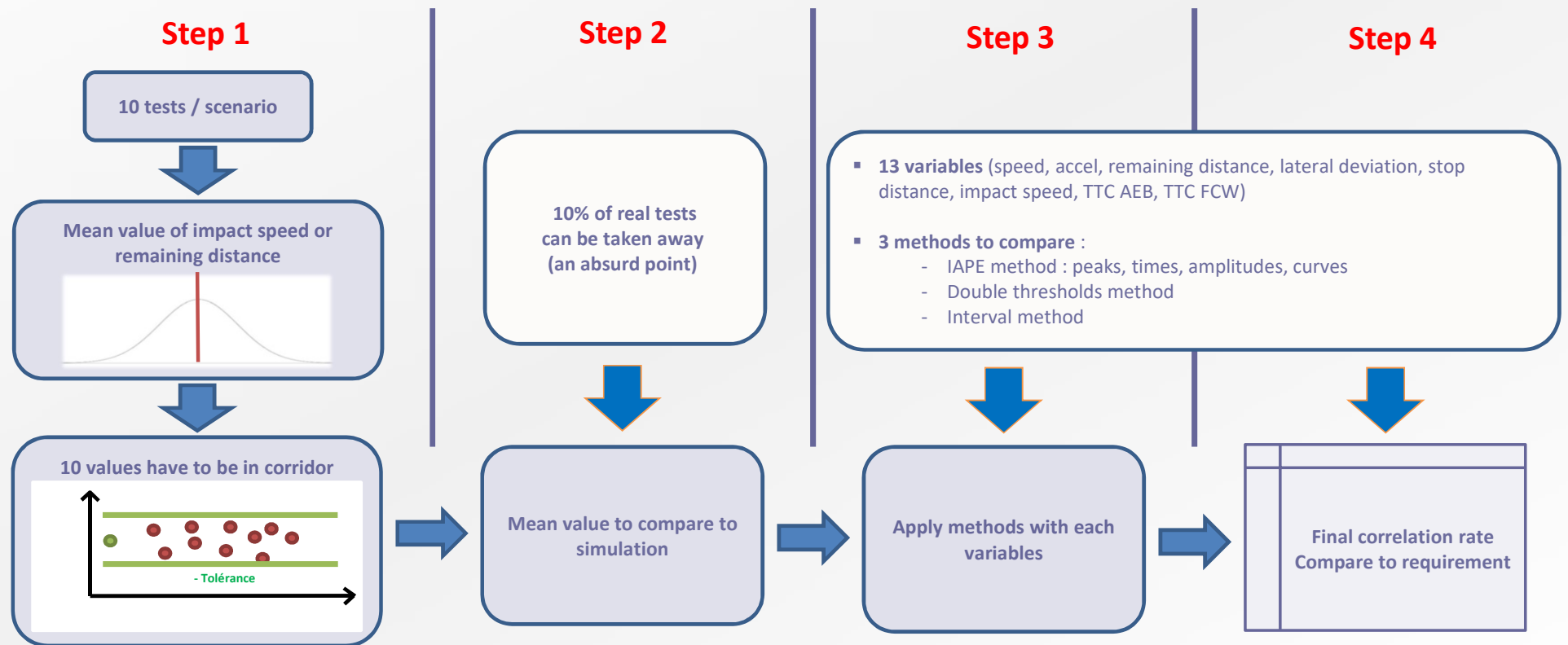
If  $A < X < B \rightarrow 100 \%$   
 Else  $\rightarrow 0 \%$

## Interval Method

- Lateral distance
- Relative distance

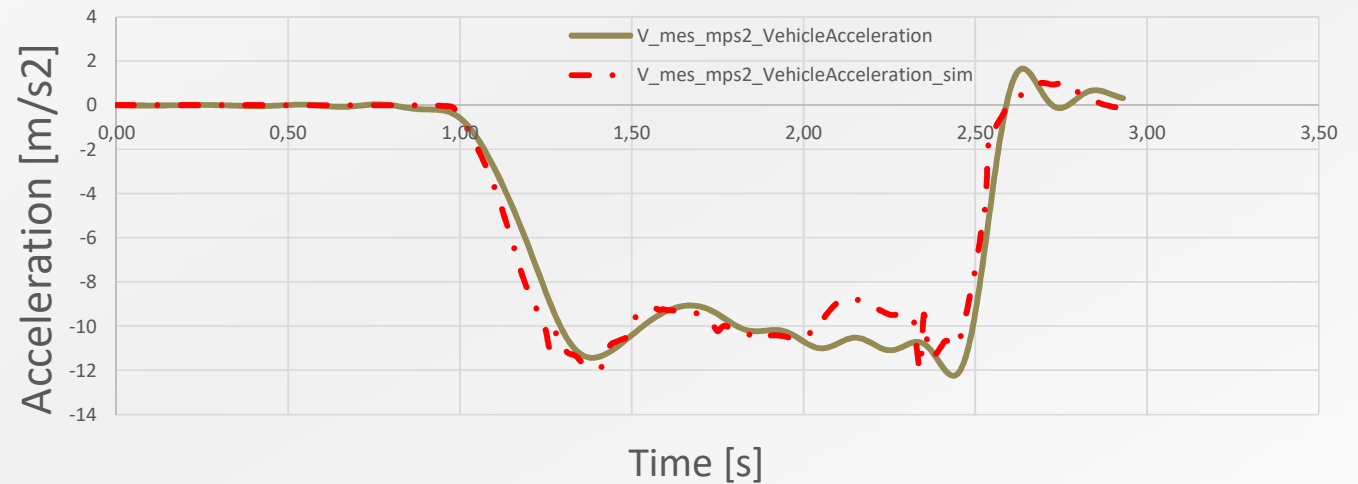
# 4 Steps methodology

- Methodology use availability: is the vehicle reproducible ?
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# IAPE example

- Curve to curve comparison shows good correlation
- IAPE method to quantify correlation rate



|             | I      | A      | P      | E      | G      | C      | Correlation Rate |
|-------------|--------|--------|--------|--------|--------|--------|------------------|
| Ponderation | 1      | 1      | 1      | 1      |        |        |                  |
| Critere     | 95,93% | 97,45% | 99,57% | 86,22% | 94,79% | 92,70% | 94%              |



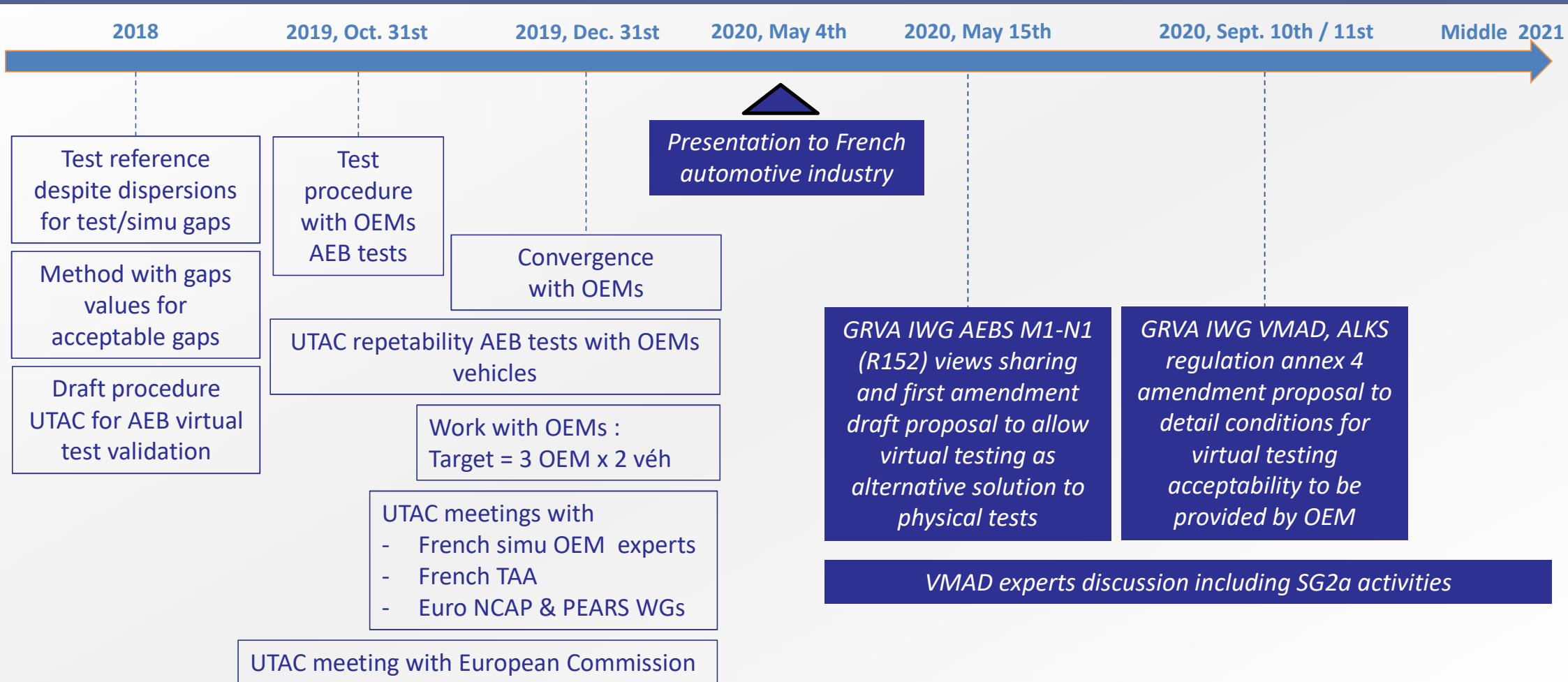
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# Action Plan : AEBS & ALKS virtual test validation & type approval



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## FR proposal for presentation to GRVA IWGs VMAD

- Virtual test validation method presentation (based on the current slides)
  - Information sharing, experts discussions and contracting parties feedbacks
  - Proposal for next steps to introduce such approach as virtual testing alternative for AEBS M1-N1 with longitudinal application only
  - Proposal for next steps to detail such approach for virtual testing in ALKS audit/assessment annex with longitudinal application only

