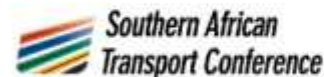


# 3<sup>rd</sup> Regional Seminar on Weigh-In-Motion

OPTIMISING ROAD FREIGHT TRANSPORT USING WIM DATA

— Pretoria, South Africa, July 6–8, 2022 —



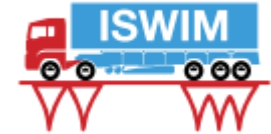
## WIM for Direct Enforcement in France (CSA surcharges)

**David Bétaille**, Directeur de recherche, Université Gustave Eiffel

**Bernard Jacob**, Vice-présidence recherche, Université Gustave Eiffel

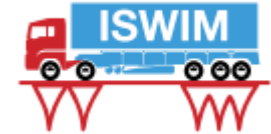
**Victor Dolcemascolo**, Chargé de mission transports de marchandises  
et logistique – Agence de l'Innovation pour les Transports (AIT)

**Technical Session 1 – Wednesday 6 July 2022**



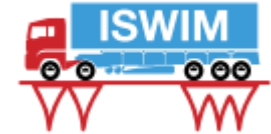
# Motivations for Weigh Enforcement

- Fair competition between freight carriers and between road and other long distance freight transport modes
- Road safety, in particular for vans : trajectory control, instability, severity of accidents...
- Road structure durability : fatigue, rutting, risk of damage or, ultimately, collapse (Annone, Mirepoix !)
- Limitation of static controls : in France on marginal percentage of freight traffic is controlled (50000/an), mobilizing important means (engineering people, police, weighing areas), difficulties for interceptions in traffic flow and time lost in controlling non overweighed trucks



# Stakeholders

- France : [ecologie.gouv.fr/DGITM](http://ecologie.gouv.fr/DGITM), « Home Office », justice...
- Research, development and expertise : Université Gustave Eiffel and Cerema
- Metrological authority and certification : Service de la métrologie légale ([economie.gouv.fr/DGE](http://economie.gouv.fr/DGE)) and Laboratoire National de Métrologie et d'Essais (LNE)
- Weighing systems vendors
- *+ international links : ISWIM, SPW (Wallonie), BAST (Allemagne)...*



# Specifications

1. Tolerances possibly similar as those of static weighing today (so that small overweights would not be possible)
2. Reliability and subsequent acceptability of enforcement : no false positive, which guarantees enforcement of only actual overweights
3. Efficacy : minimising non detections (of overweights) whilst no false positive.

DavidB1

2 & 3  $\Rightarrow$  Algorithms for sorting outliers (invalid or doubtful)...  
 $\rightarrow$  Balance to optimize...

## Diapositive 4

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**DavidB1**

PNAN-14-021; 22/06/2022

# Tests in Laboratory

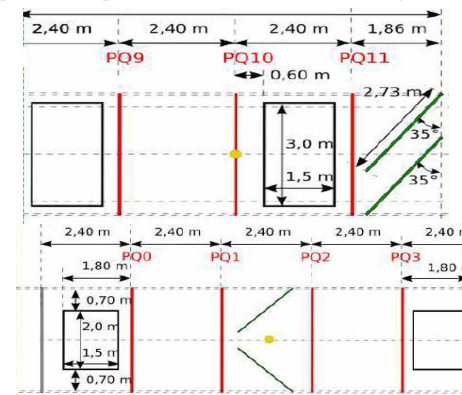
- Tests of different weighing sensors (piezo-ceramic and quartz) in laboratory and on the fatigue test bench (UGE, Nantes)



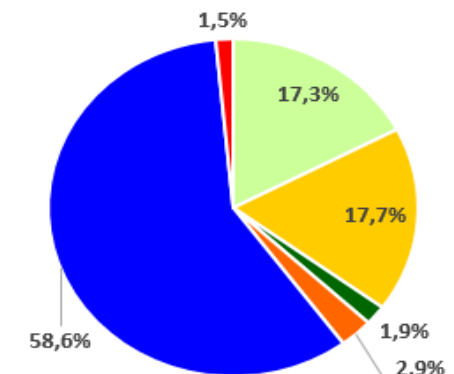
- Qualification of piezo-quartz sensor from Kistler (repeatability, stability, durability)

# Tests on Highway

- SANEF, A4, Saint-Avold, operated by Cerema (East, Metz), class 2
- Three vendors (*Fareco*, Kapsch and Sterela), among which the last two (qualified) use piezo-quartz sensors
- Tests from 2015 to 2019, 1 253 trucks and 332 vans from the traffic & reference static weighing of this sampling



- vans
- 2-axles
- 3-axles
- 4-axles
- 5-axles
- 6+ axles



## Kapsch : 3 lines of sensors

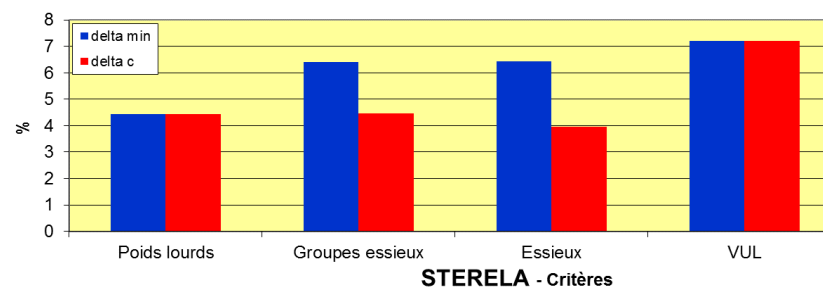
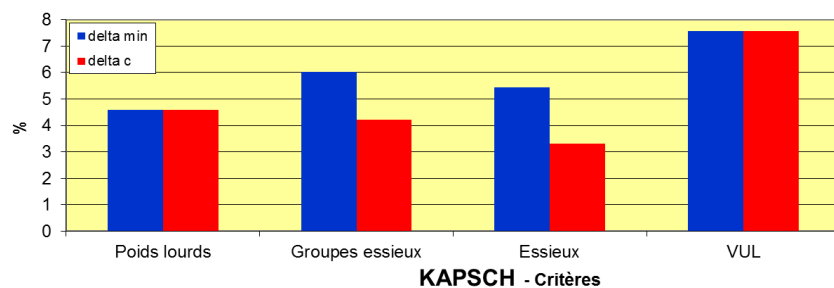
- 19 days working
- 559 trucks validated over 561 (99,6%)
- 1098 axles validated over 1103 (99,5%)
- 553 axle groups validated over 555 (99,6%)
- 182 vans validated over 186 (97,8%)

## Sterela : 4 lines of sensors

- 36 days working
- 1042 trucks validated over 1253 (83,2%)
- 2035 axles validated over 2450 (83%)
- 1045 axle groups validated over 1260 (82,9%)
- 307 vans validated over 332 (92,5%)

# Results vs COST323

KAPSCH	Nombre	Moy. (%)	Ec. type(%)	$\pi_o$	Classe	$\delta$	$\delta_{min}$	$\pi$
Poids total PL	559	1.68	1.96	91.7	A(5)	5	4.6	94.6
Groupes ess.	553	2.42	2.45	91.7	A(5)	7	6.0	96.7
Essieux	1098	0.83	2.87	92.1	A(5)	8	5.4	99.1
VUL	182	1.18	3.99	90.5	B(10)	10	7.6	97.5
STERELA	Nombre	Moy. (%)	Ec. type(%)	$\pi_o$	Classe	$\delta$	$\delta_{min}$	$\pi$
Poids total PL	1042	1.42	2.02	92.1	A(5)	5	4.4	95.5
Groupes ess.	1045	2.35	2.73	92.1	A(5)	7	6.4	95.4
Essieux	2035	0.37	3.51	92.4	A(5)	8	6.4	97.4
VUL	307	3.22	2.70	91.2	B(10)	10	7.6	98.4



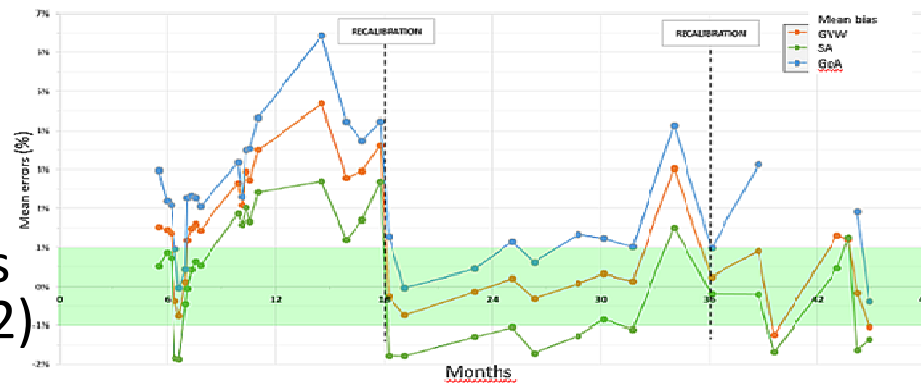


# Results vs OIML R-134

- 100% measurements under tolerances (max. error permitted)
- Target classes : trucks 5 - 10, vans 10 - 15 for gross weigh

OIML	KAPSCH								STERELA							
	Poids total		Groupe d'essieux		Essieu isolé		VUL		Poids total		Groupe d'essieux		Essieu isolé		VUL	
effectif	559		553		1098		182		1042		1045		2035		307	
class 5	20	3,6%	5	0,9%	17	1,6%	42	23,1%	36	3,5%	27	2,6%	50	2,5%	74	24,1%
class 10	0		0		2 0,2%		1 0,6%		0		2 0,2%		4 0,2%		9 2,9%	

- Trucks : class 10 100% gross weigh  
class 5 96,5%
- VUL : class 10 99,4-97,1%
- classes 5-10 for resp. trucks & vans are possible on a class 1 site (here 2) and with regular calibration



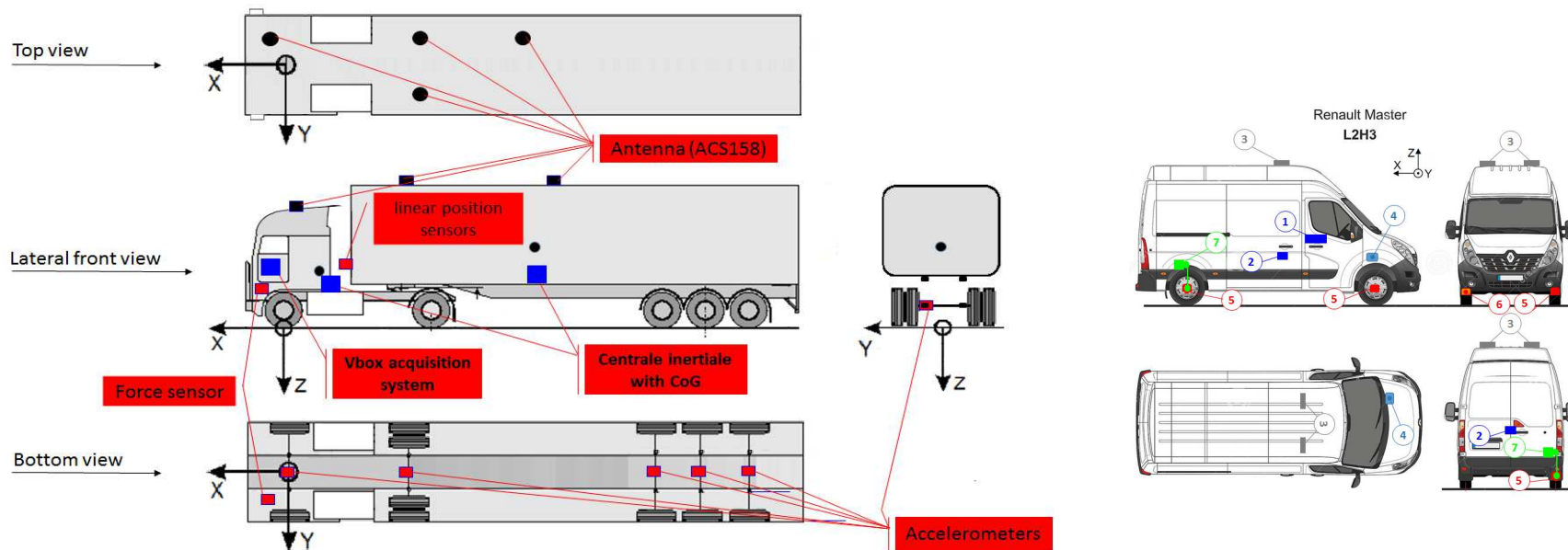
# Qualification of a Certification Testsite

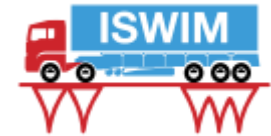
- Closed testsite for type approval : Transpolis
- Security in any condition
- Possibility of passages with overweighs at different speeds
- Short loop → reduced rotation, CO2 emission low
- Verification of the testsite quality : maximum variations of impact forces at each axle along the testsite / half-tolerance



# Methodology

- Estimation of impact forces by accelerometers embedded in a truck (T2S3) and a van (Cerema Lyon Centre-East) and comparison to tolerances
- Comparison of measured accelerations in Transpolis and along the A4 highway in Saint-Avoid





# Results in Transpolis

- Urban boulevard in Transpolis and A4 right lane
- Passages at different speeds (trucks, vans) : 50 à 120 km/h
- Combination of masses (manufacturers) and measured accelerations → estimation of a dynamic impact factor (DIF) = instantaneous load / static load (%)

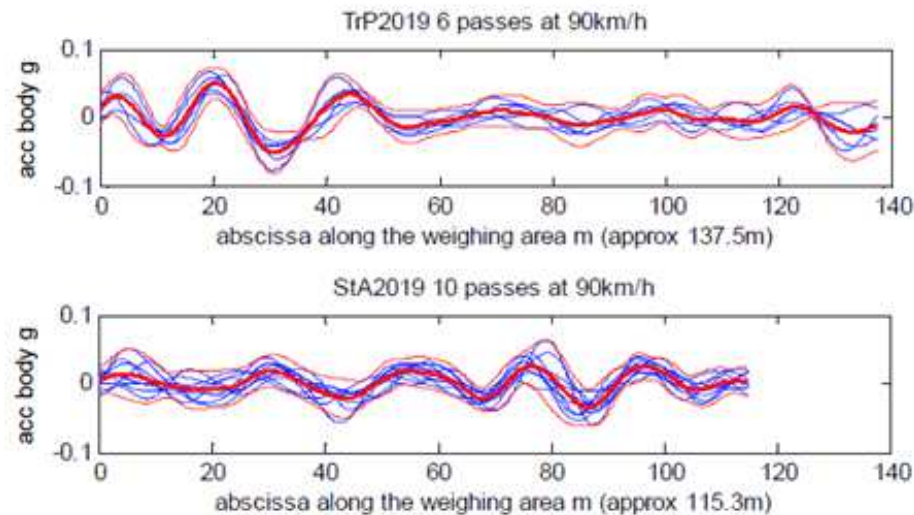
Facteur d'impact dynamique (sur poids total, tous essieux sommés)	T2S3 (5 essieux)	VUL (2 essieux)
Vitesse 50 km/h	/	1.3%
Vitesse 65 km/h	1.9%	3.9%
Vitesse 85 km/h	2.7%	5.1%
Vitesse 110 km/h	/	6.7%
Vitesse 120 km/h	/	8.2%

**TRANSPOLIS**

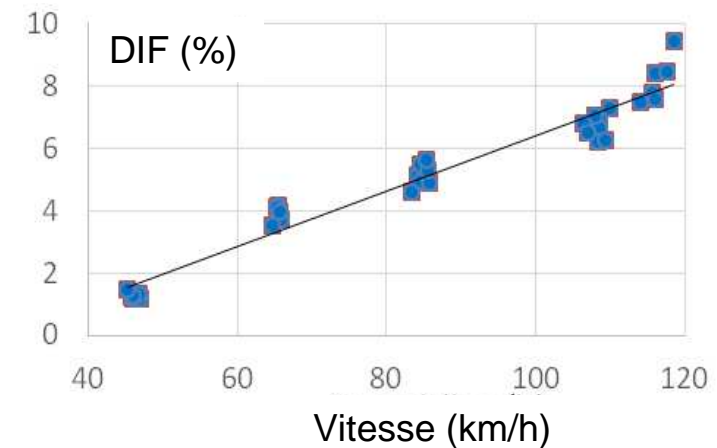
⇒ DIF admissibles for classes 5 (trucks) and 10 (vans) below 85 km/h and class 15 (vans) at 120 km/h

# Comparison Transpolis/A4

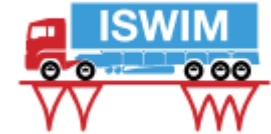
- Measured accelerations at 90 km/h on board a T2S3 similar in Transpolis and Saint-Avold (A4)
- Transpolis is representative of a usual highway pavement



Accelerations T2S3 Transpolis/A4



Dynamic Impact Factor for the van



# Conclusions and perspectives

- 5 axles trucks : class 10 OIML almost reached along the 3-4 years of experiment, very few measurements out of tolerances ( $< 0,2\%$ ). Less than 3,5% of trucks out of tolerances for class 5
- Vans : class 10 almost reached Kapsch (99,4%) and Sterela (97,1%)
- Expected improvements : testsites in class 1 (against class 2 for A4 highway in Saint-Avold), regular recalibration ( $< 6$  months), and better sorting algorithms
- Certification procedure under development by UGE and currently under examination by DGITM/Cerema, for a final validation by legal authorities
- Preparation of the complete homologation of the enforcement procedure (between different ministries...)
- Certification of systems by their vendors
- *SPW in Wallonia approved Sterela system for direct enforcement under real traffic in 2022...*



# Thanks for your attention !

## Contacts :

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- Bernard Jacob, scientific advisor, [bernard.jacob@univ-eiffel.fr](mailto:bernard.jacob@univ-eiffel.fr)

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