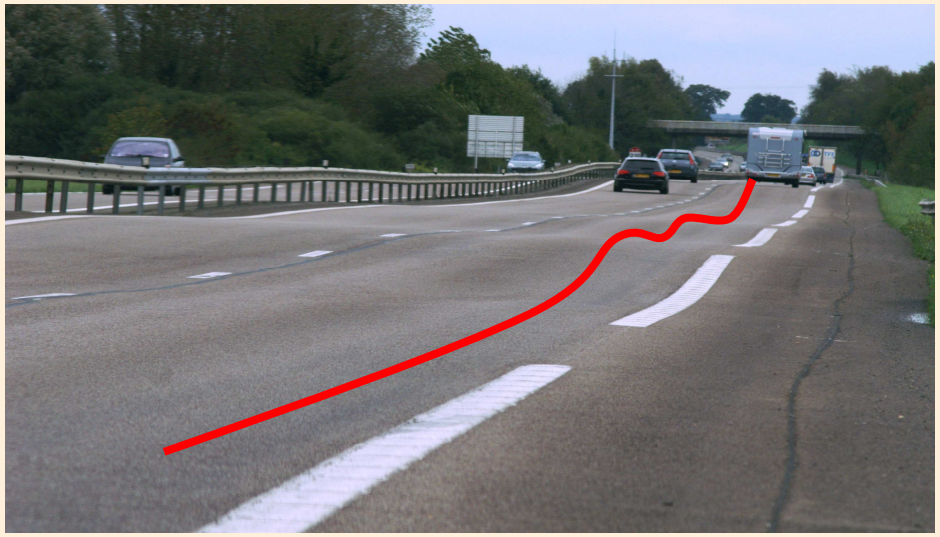
WORLD ROAD ASSOCIATION MONDIALE DE LA ROUTE
Norfolk, Virginia / September 19-22, 2012
7th symposium on pavement surface characteristics
SURF 2012

INFORMATIONS RELATING TO THE MEASUREMENT OF THE LONGITUDINAL EVENNESS IN FRANCE



Authors

Jean-Marc Martin

Fabien Menant

Philippe LEPERT

IFSTTAR Nantes

Presented by

Philippe LEPERT

IFSTTAR Nantes

Outline of the presentation

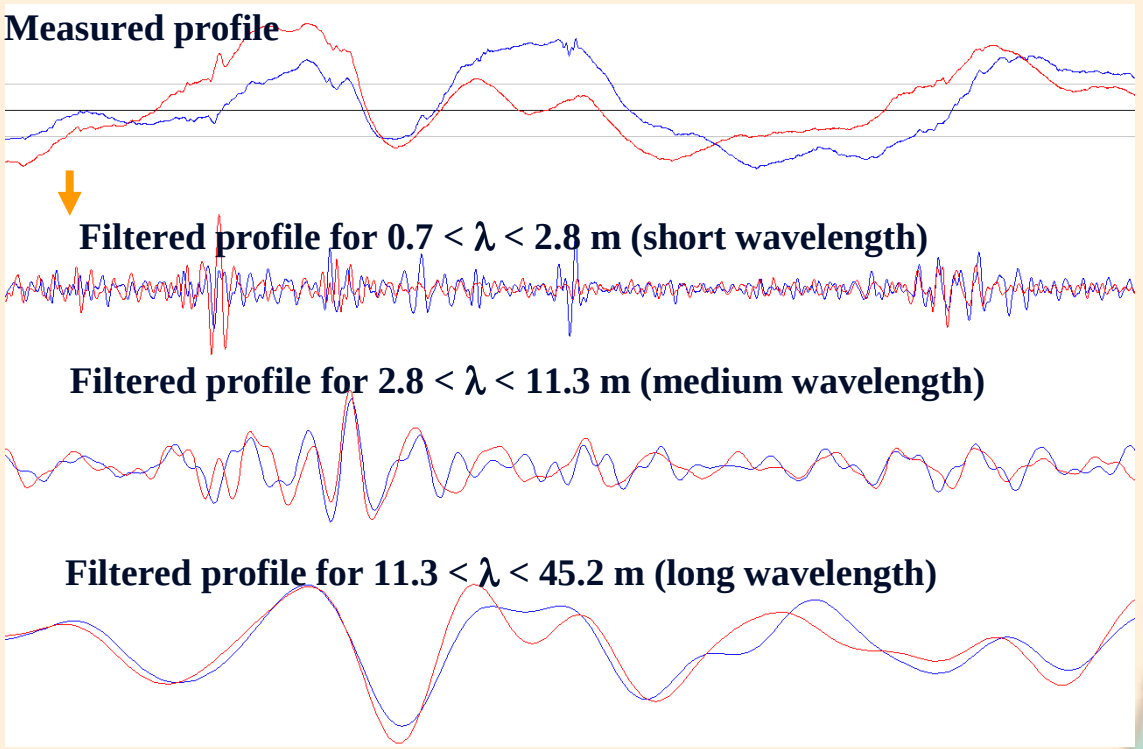
- **French practices on longitudinal evenness**
- **The new available tools:**
  - **A new measurement device**
  - **A new measurement test method**
  - **An enhanced software**
- **Current researches:**
  - **Evaluation of the French secondary roads using low-cost sensors (« Uni Box »)**
  - **Measurement of the driver comfort using sensors included in smart phones**

French practices until 2008

- APL system : this device is mainly used for the reception of the wearing course

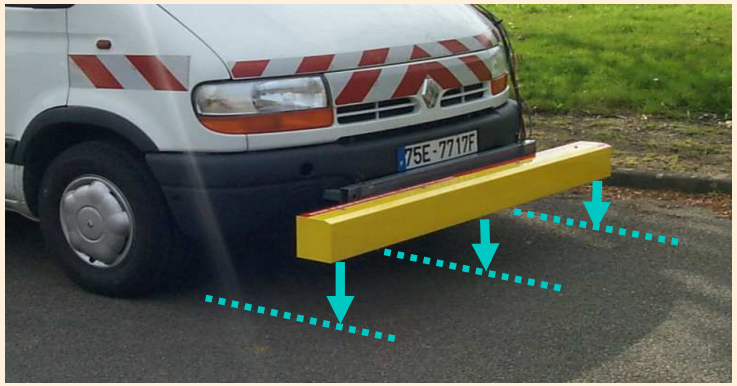
Notes NBO	Intervalle des énergies EBO (borne droite inclue, borne gauche exclue)		
	Petites ondes EPO_{25} (en cm^3)	Moyennes ondes EMO_{100} (en cm^3)	Grandes ondes EGO_{200} (en cm^3)
10	0 à 1,1	0 à 39	0 à 1 267
9,5	1,1 à 1,4	39 à 49	1 267 à 1 585
9	1,4 à 1,7	49 à 62	1 585 à 1 983
8,5	1,7 à 2,2	62 à 77	1 983 à 2 481
8	2,2 à 2,7	77 à 97	2 481 à 3 103
7,5	2,7 à 3,4	97 à 121	3 103 à 3 882
7	3,4 à 4,2	121 à 151	3 882 à 4 857
6,5	4,2 à 5,3	151 à 189	4 857 à 6 076
6	5,3 à 6,6	189 à 236	6 076 à 7 601
5,5	6,6 à 8,2	236 à 296	7 601 à 9 509
5	8,2 à 10,3	296 à 370	9 509 à 11 896
4,5	10,3 à 12,9	370 à 463	11 896 à 14 882
4	12,9 à 16,1	463 à 579	14 882 à 18 618
3,5	16,1 à 20,2	579 à 725	18 618 à 23 292
3	20,2 à 25,3	725 à 906	23 292 à 29 139
2,5	25,3 à 31,6	906 à 1134	29 139 à 36 453
2	31,6 à 39,5	1 134 à 1 419	36 453 à 45 604
1,5	39,5 à 49,5	1 419 à 1 775	45 604 à 57 051
1	49,5 à 61,9	1 775 à 2 220	57 051 à 71 372
0,5	61,9 à 77,4	2 220 à 2 778	71 372 à 89 288
0	> 77,4	> 2 778	> 89 288

Calculation of the energy in profiles and conversion into a score



The new measurement system

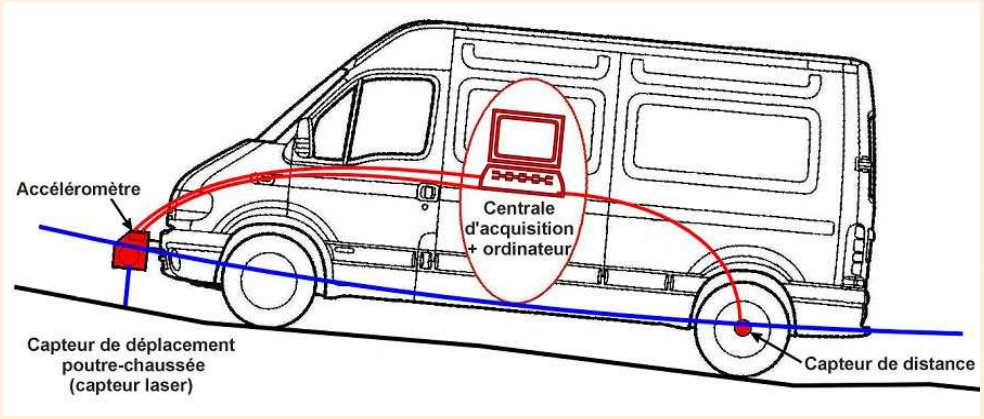
- **Longitudinal MuLtiProfilometer (MLPL*)**
  - **Measurement principle**



=> 3 kinds of sensors are combined

- 2 or 3 laser (D) : distance between the vehicle and the road surface
- 1 accelerometer (A) : vertical acceleration
- 1 gyroscope (P) : roll measurement (correction)

$$Z_x = D_x + \iint_x A_x^{\,2} dx$$ **corrected by Px**



* Based on a Greenwood™ device, adapted to French context.

The new measurement system

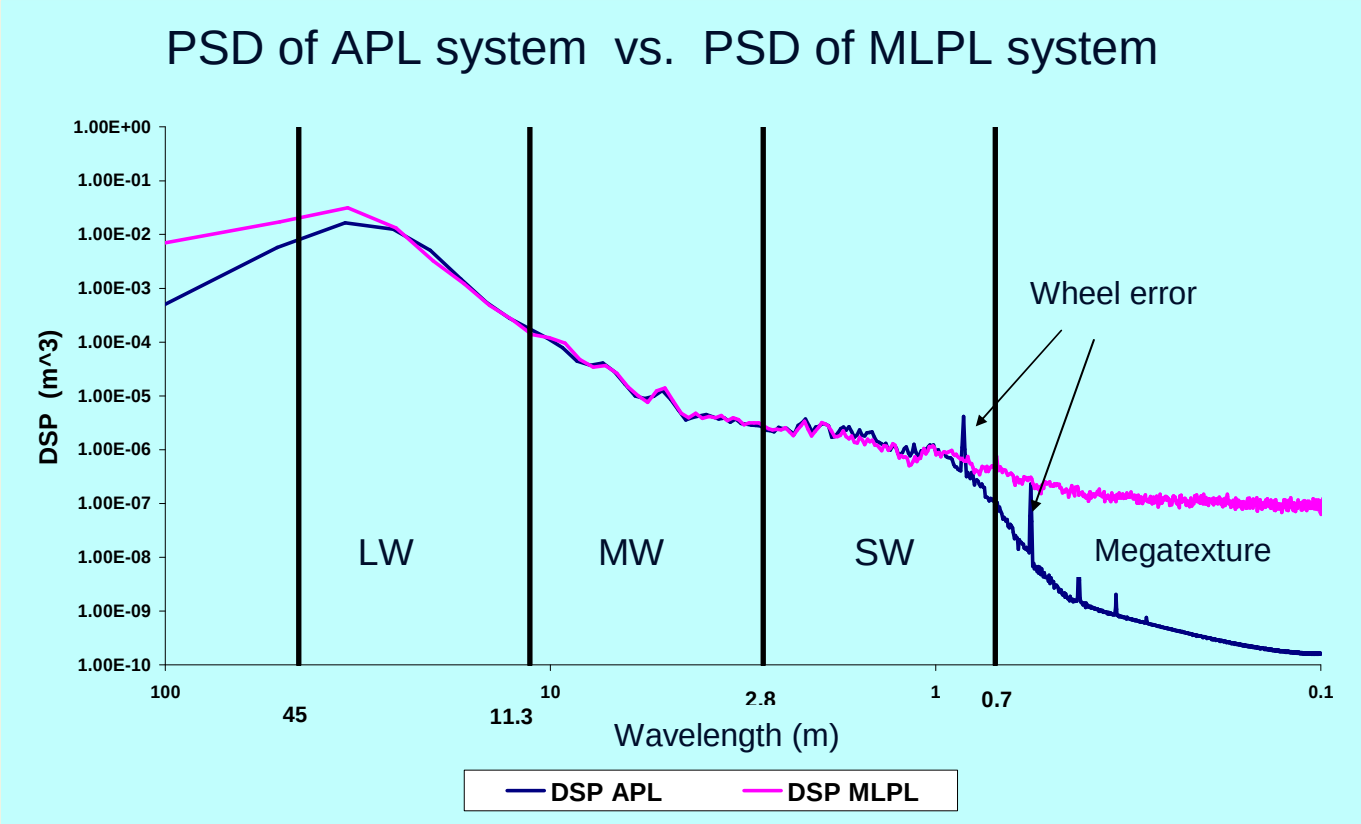
Performance of the MLPL in comparison with the APL

Vibration bench test

- Checking the transfer function between MLPL & APL using a bench vibration
- Identical response in the range $0.7 < \lambda < 50$ m
- MLPL system works independently of the velocity (unlike APL system)
- Works on all types of wearing course
- Also able to measure the megatexture ($\lambda<0.7$m) and the very long wavelengths ($\lambda>50$ m)

The new measurement system

- **Validation of the MLPL system (analysis of the PSD)**



The new method

- **A new method describing longitudinal evenness measurement procedures**
  - **Aim : Defining the measurement conditions and the data processing**
  - **Description**
    - **1 general volume**
    - **5 specific volumes addressing applications in different fields**

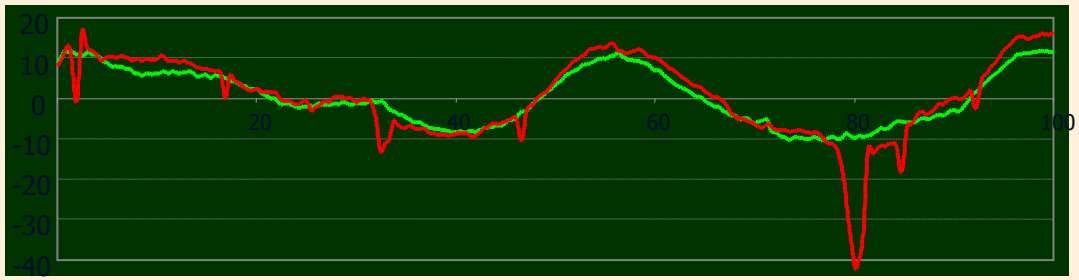
The new method

- **Volume 1** : Control of road wearing courses conformity
- **Volume 2** : Pavement condition evaluation on main roads
- **Volume 3** : Definition of reshaping specifications
- **Volume 4** : Control of airfield wearing courses conformity
- **Volume 5** : Assessment, diagnosis, decision-making

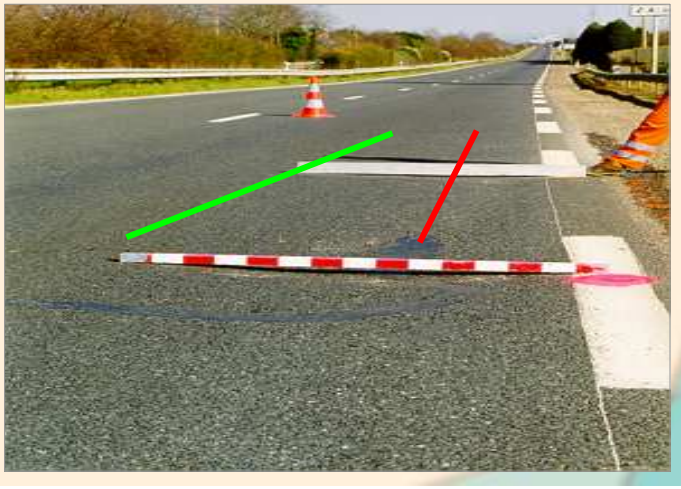
- **Appendix** : Description of the device and its verification

The new method

- **Volume 2 : Pavement condition evaluation on main roadways**
  - **Observations**
    - Surface or fatigue deterioration (cracking, depression...) often result in distresses specific to the wheel paths
    - This distresses impact the short wavelength indicator (SW and megatexture) but only in the wheel paths
    - A new indicator, based on the difference of SW between the wheel paths and the middle of the lane, has been set up to identify the presence of these structural problems

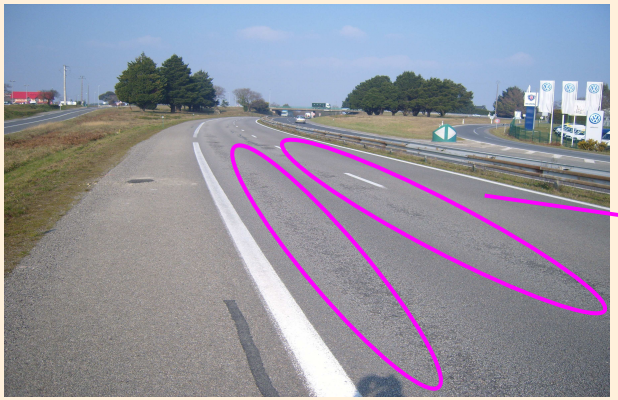


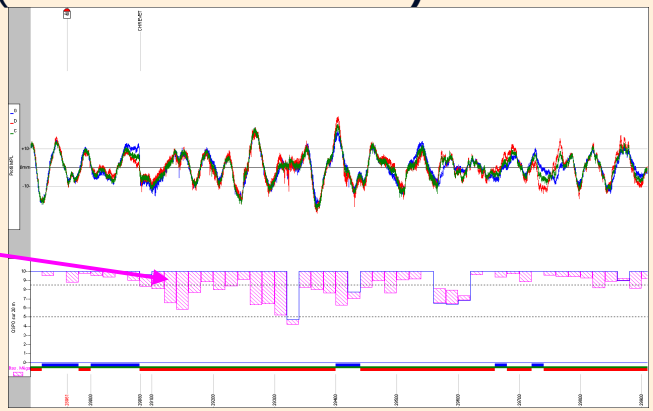
Succession of depressions with depth between 1 and 3 cm

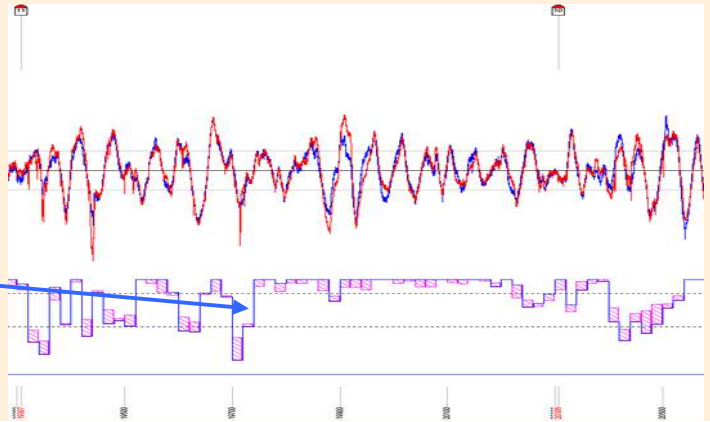


The new method

- **Volume 2 : Pavement condition evaluation on main roadways**
  - Illustrations of quality indicators (surface and structure**)**





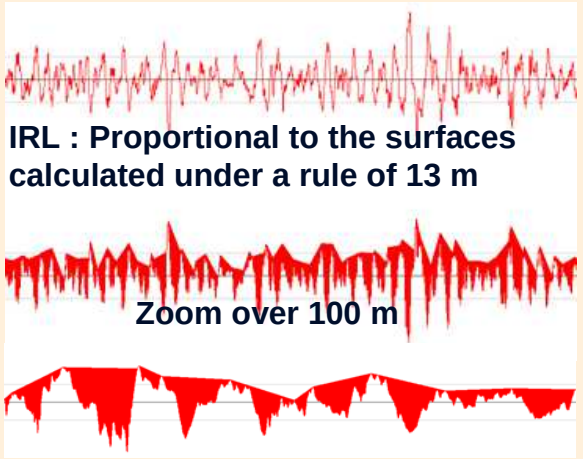


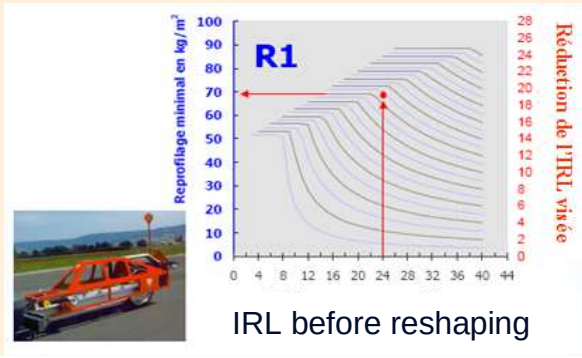
Surface defects

Structure defects

The new method

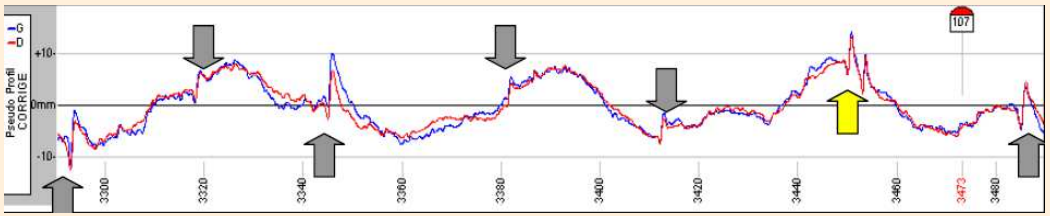
- **Volume 3 : Definition of reshaping specifications**
  - Estimating the reshaping of a minor road with the IRL indicator

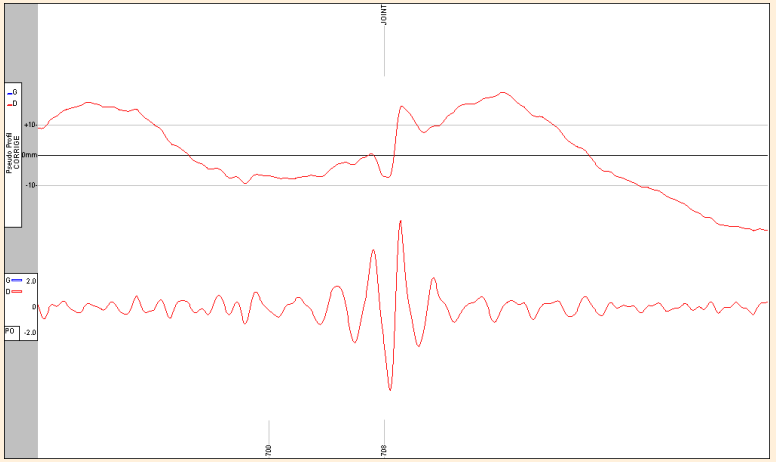




The new method

- **Volume 5 : Assessment, diagnosis, decision-making**
  - Goal : Creating new tools in order to detect individual defects which are difficultly detectable with the usual scoring system
  - Very localized defects during overlaying (joint return or stop finisher)

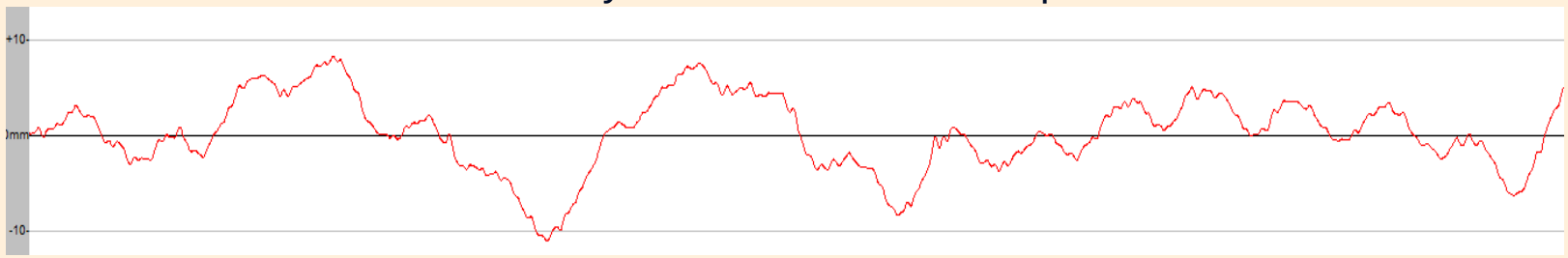




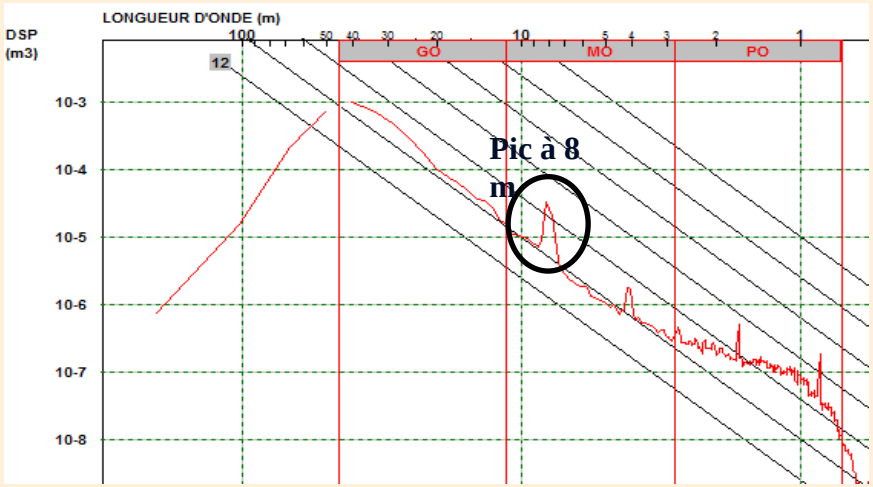
The new method

- Periodic defects due to the inappropriate adjustment of the finisher

Defects are not easily detectable on the raw profile…



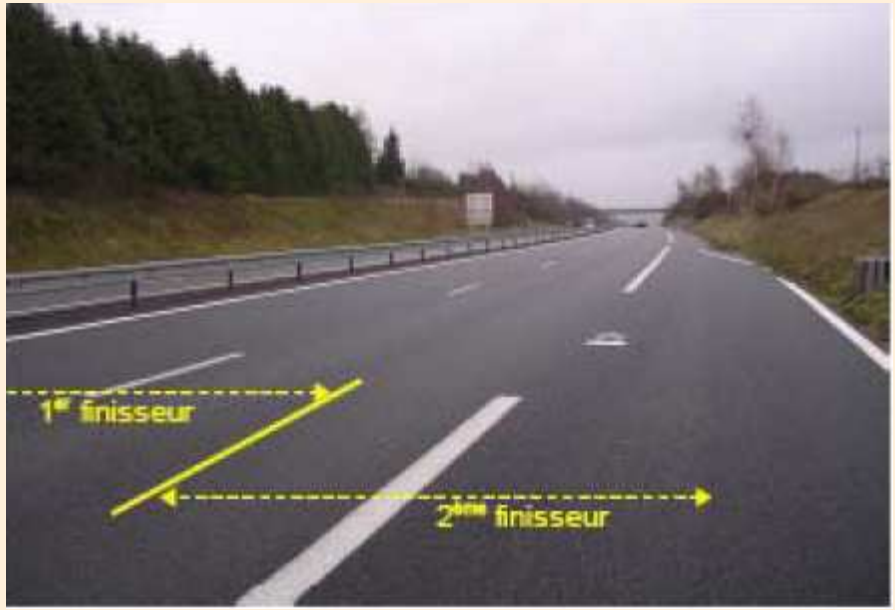
…but they are clearly visible on the PSD (peak)

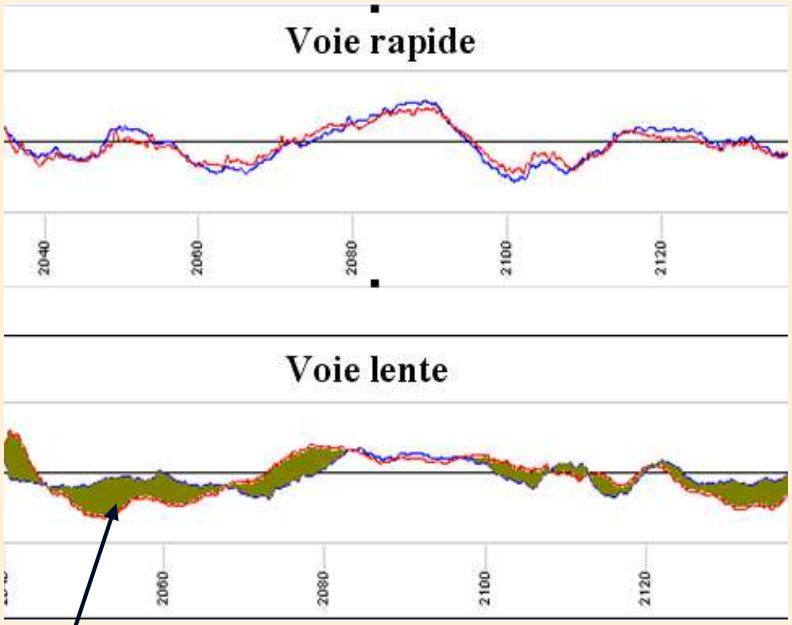


Video

The new method

- Generation of roll due to the spreading by two finishers on the same (central) lane → phase difference on signals between the left and the right profile

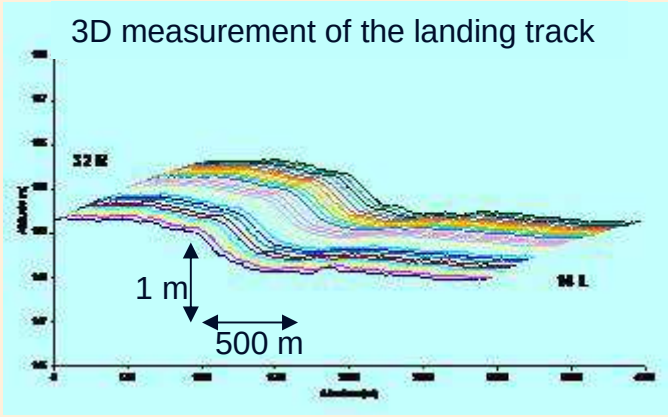


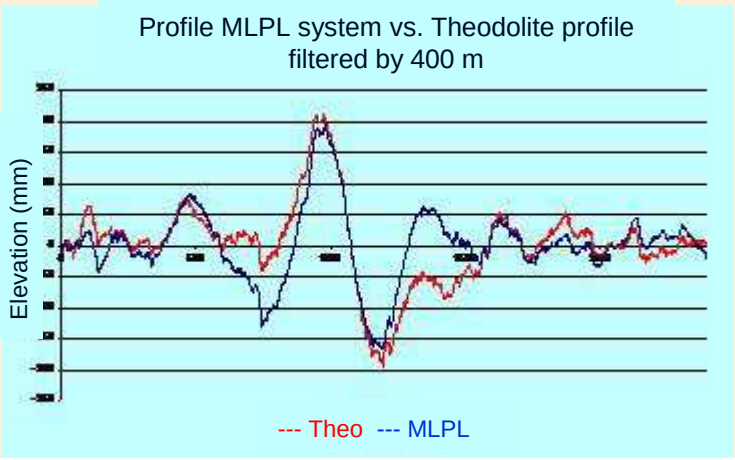


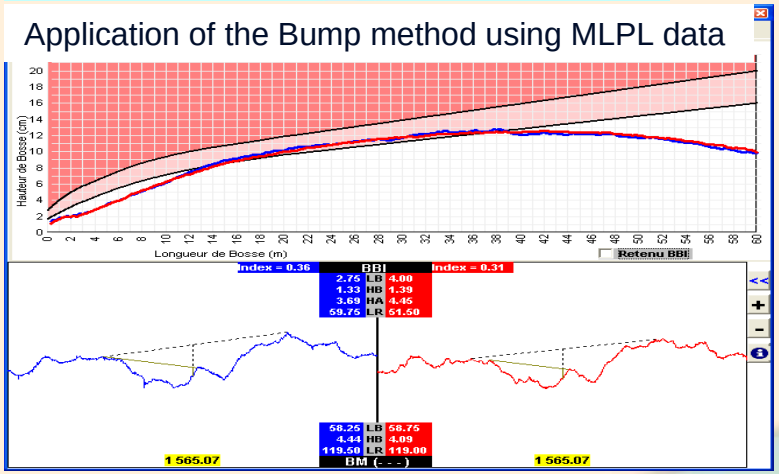
Phase shift

The new method

- Airfield pavement : measurement of the very long wavelengths (λ>50m) using the MLPL system



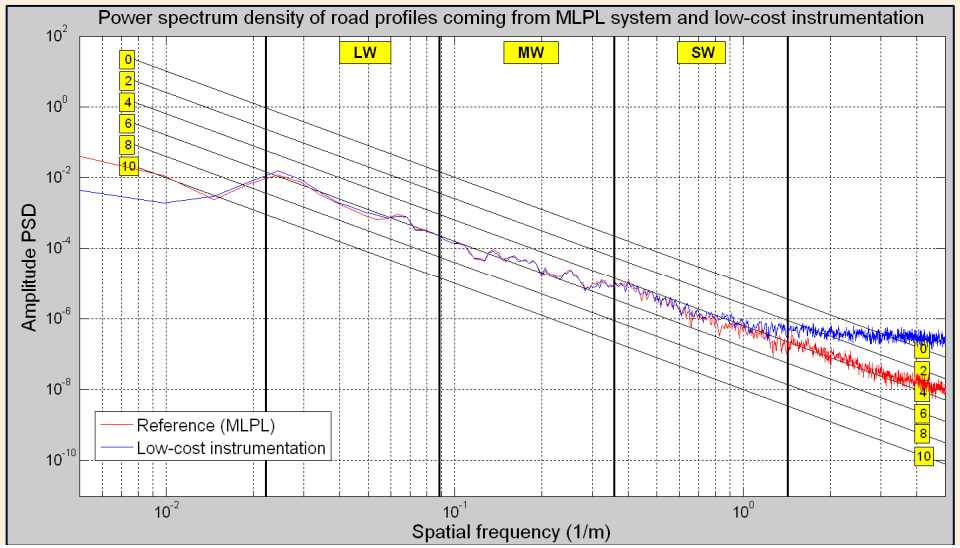


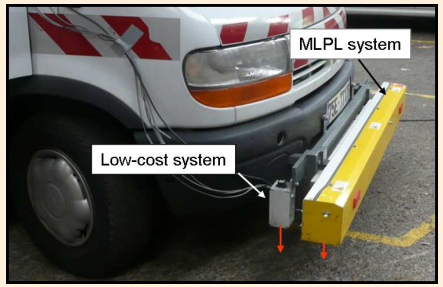


Current researches

- Finding a new pavement monitoring strategy for secondary roads : Data collection and processing by a fleet of vehicles, equipped with low-cost instrumentation, that run all across the road network (e.g. patrol vehicles)

- Development of a compact system composed with low-cost sensors and based on the same principle than the MLPL system.

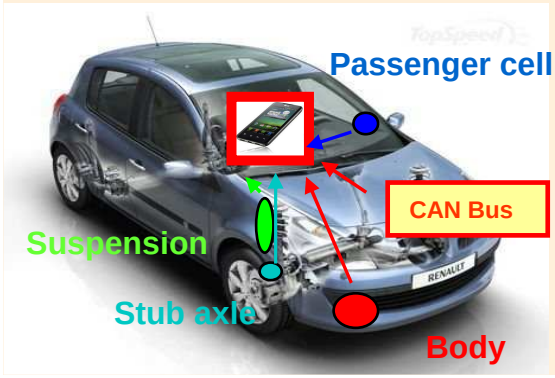


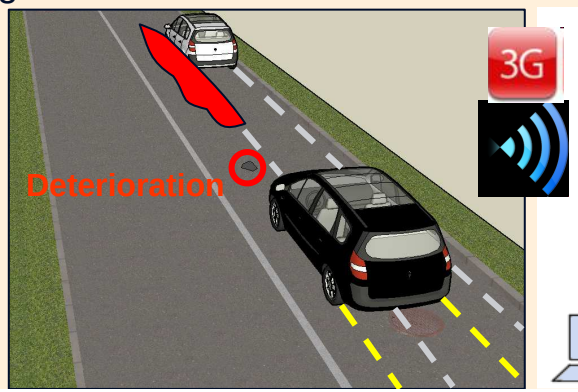


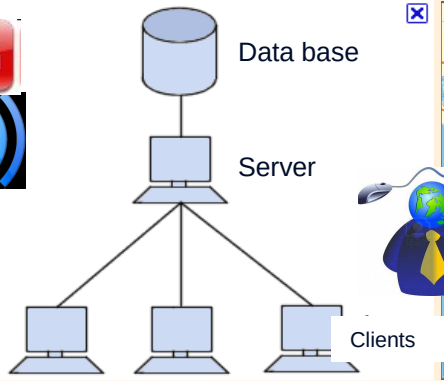
The metrological performance of the low-cost instrumentation is relevant in view of the operating spatial frequencies (according to road experiments).

Current researches

- "Smartphone project" : Realization of a demonstrator for the measurement of the users comfort using smartphone sensors
  - Selection of road sections on which the comfort and the geometry are precisely known
  - Equipment of a fleet of vehicles with smartphones
  - Recording of geospatial data using:
    - Accelerometer + gyroscope + GPS data coming from smartphone sensors
    - Eventually, other vehicle sensors via Bluetooth (CAN bus, low-cost sensor)
  - Inboard preprocessing delivers indicators for each vehicle
  - 3G indicators transmission toward a roadside server
  - Fusion of multi-vehicles data to increase the accuracy
  - Looking up & displaying data







Thanks for your attention

IFSTTAR

Département « Infrastructure et Mobilité »

UR « Analyse et Gestion des Infrastructures de Transport »

philippe.lepert@ifsttar.fr
jean-marc.martin@ifsttar.fr
fabien.menant@ifsttar.fr

www.ifsttar.fr