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Vp2 AP JRC Ispra

26 June-3 July 2015

12th WLTP
by C. Astorga

participants:

AVL
HORIBA
IONICON
LumaSense
Synspec
JRC

Experimental campaign: VELA lab Ispra

September 2015

Vehicle specifications

Features	FFV
Combustion type	Spark Ignition
Year of registration	2012
EU emission standard	Euro 5
After-treatment	TWC*
Fuel system	Direct Injection
Engine power (kW)	132
Engine displacement (cm ³)	1596
Odometer (km)	20010

*TWC (Three Way Catalyst)

Figure 1. WLTC speed profile

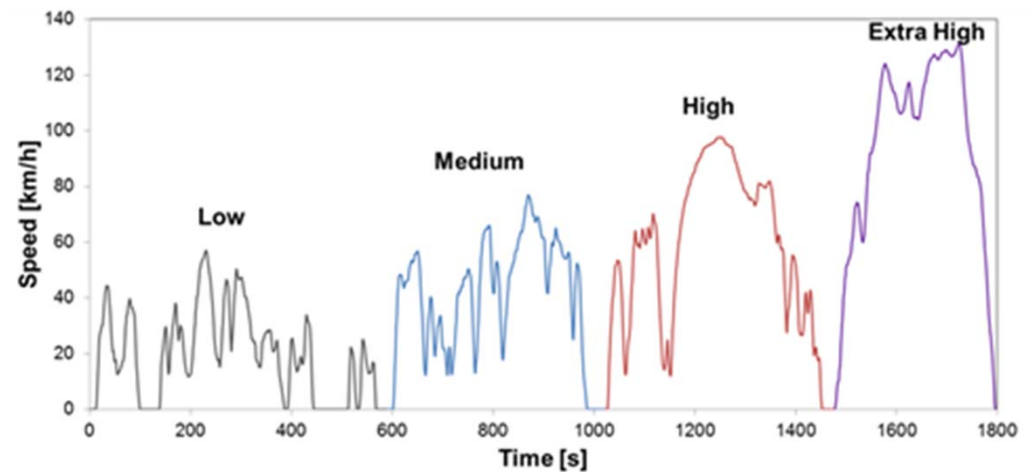


Table 2. Fuel specifications.

¹Research Octane Number; ²Motor Octane Number; ³Dry Vapor Pressure Equivalent

Parameter	Method	Unit	E85
RON ¹	ISO 5164	Index	107.3
MON ²	ISO 5163	Index	90.7
Density at 15 °C	EN ISO 3675-98	kg m ⁻³	782.3
DVPE ³ at 100 F	EN ISO 13016	mbar	464
Ethanol	EN ISO 13132	% v/v	84.1
Water	ASTM E 1064	% v/v	0.1
Sulphur (S)	EN ISO 20846	mg kg ⁻¹	<3.0
Carbon (C)	GC/calculated	mass %	57.0
Hydrogen (H)	GC/calculated	mass %	13.3
Oxygen (O)	GC/calculated	mass %	29.7

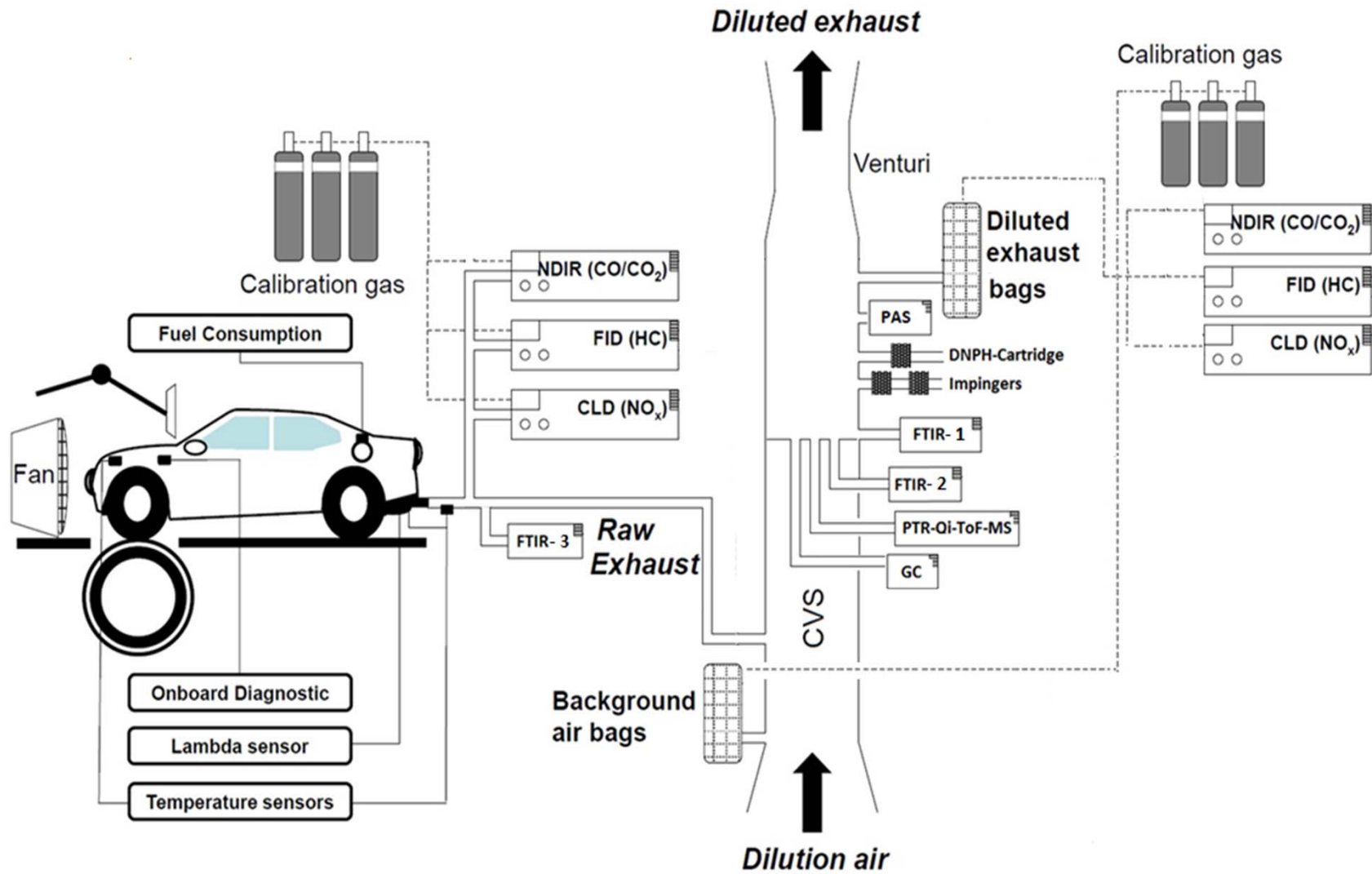


Table 4. Regulated emissions (mg/km); (*g/km).
Errors refer to the standard deviation of the three performed tests.

	THC	NMHC	CO	NO_x	CO₂*
Phase 1	172±17	127±11	588±154	52±3	258.2±0.9
Phase 2	4±1	2.1±0.4	117±82	14±2	186.9±0.4
Phase 3	1.8±0.5	1.0±0.2	110±35	9±1	170.3±0.3
Phase 4	18±1	7.8±0.6	931±226	23±0.6	210±1
WLTC	10.5±0.8	20±1	466±36	20.8±0.6	199.5±0.5



		Analysis				
	Technique	Sampling flow (l/min)	Frequency and Response	Sampling Temp (°C)	Cell/chamber Temp (°C)	Additional Pollutant measured
AVL SESAM i60 FT SII	FTIR-1	8	5 Hz	50	50	EtOH, HCHO & CH ₃ CHO
HORIBA MEXA-FT	FTIR-2	5	1 Hz	r.t.	53	EtOH, HCHO & CH ₃ CHO
IONICON	PTR-Qi-ToF-MS	0.067	1 Hz	80	80	EtOH, HCHO & CH ₃ CHO
LumaSense	PAS	0.2	≤ 60 s*	r.t.	~ 40°C	EtOH
Synspec	GC	1.1**	5 min	r.t.	-	EtOH & CH ₃ CHO
JRC MKS	FTIR-3	10	5 Hz	190	190	EtOH, HCHO & CH ₃ CHO
CARB Method 1001	Impinger/ GC-FID	4	Off-line	50	-	EtOH
CARB Method 1004	Cartridge/ HPLC-UV	1	Off-line	50	-	HCHO & CH ₃ CHO

*PAS measured from a bag once the test was finished; ** 5.5 l sampled every 5 minutes.

Table 5. Formaldehyde (HCHO), acetaldehyde (CH₃CHO) and ethanol (EtOH) emission factors (mg/km) over the WLTC

	Sampling*	EtOH	CH ₃ CHO	HCHO
FTIR-1	CVS	17±4	5.4±0.4	1.1±0.1
FTIR-2	CVS	16±2	5.2±0.3	0.8±0.2
PTR-Qi-ToF-MS	CVS	17±3	5.4±0.2	1.0±0.1
PAS¹	CVS	16±1	-	-
GC²	CVS	14±2	5±1 ^o	-
FTIR-3	TP	17±2	5.3±0.6	1.1±0.1
Cartridges + HPLC-UV (CARB 1004)	CVS	-	4.6±0.3 [□]	1.2±0.1
Impingers + GC-FID (CARB 1001)	CVS	16±2	-	-
Assigned value (mg/km)		16.2	5.2	1.0
Repeatability (%)		14	12	13
Reproducibility (%)		14	12	19

The errors refer to the standard deviation of the three repetitions.

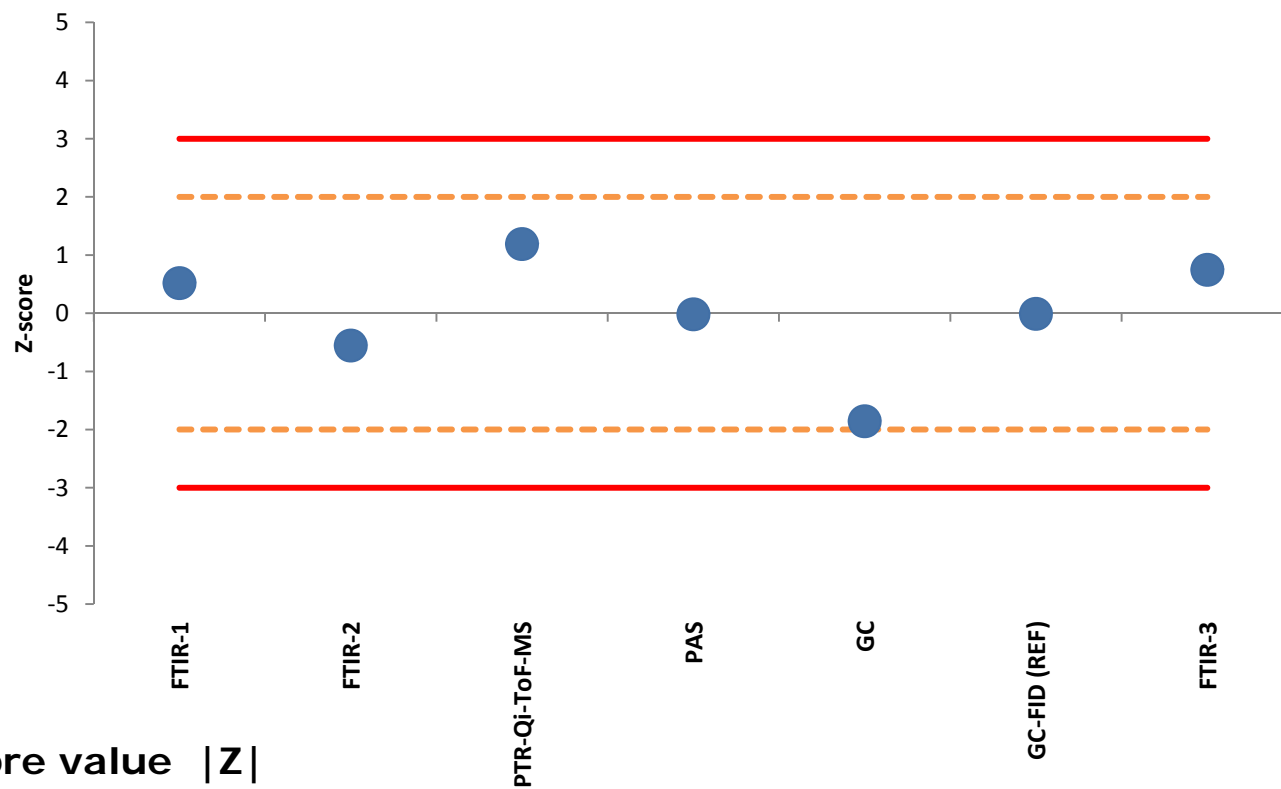
*Sampling points: CVS dilution tunnel; TP tailpipe; ¹ photoacoustic spectroscopy; ² double GC system. Statistical analysis: ^o variance straggler (Cochran's test with 5% critical value), [□] average straggler (Grubbs' test with 5% critical value).



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PERFORMANCE INDICATOR – Z-SCORE

Ethanol (n = 7)



Evaluation of
performance

Z-score value |Z|

Satisfactory	≤ 2
Questionable	> 2 but ≤ 3
Unsatisfactory	> 3

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Figure 8 a. Z-scores obtained for the instruments capable of monitoring acetaldehyde

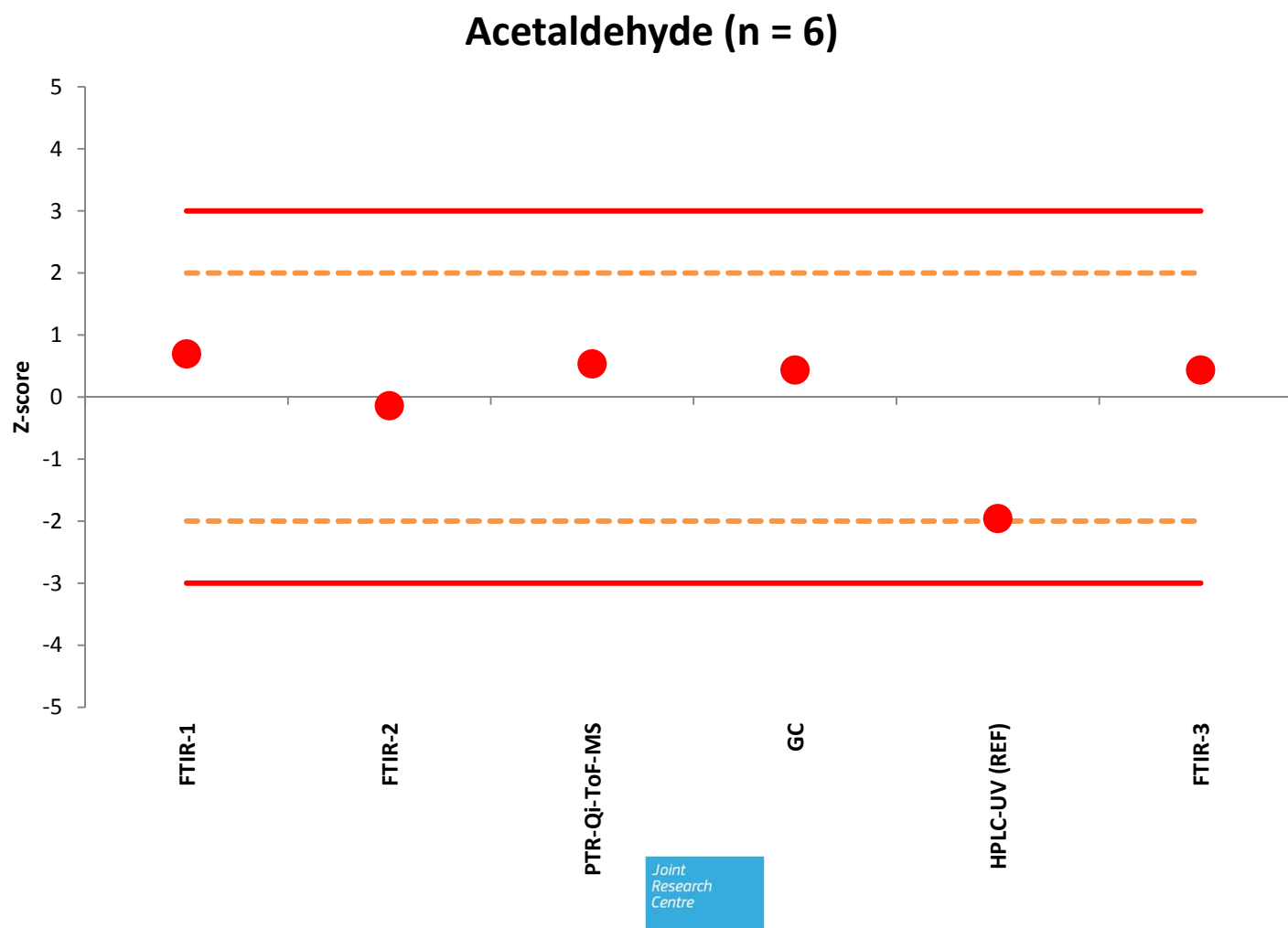
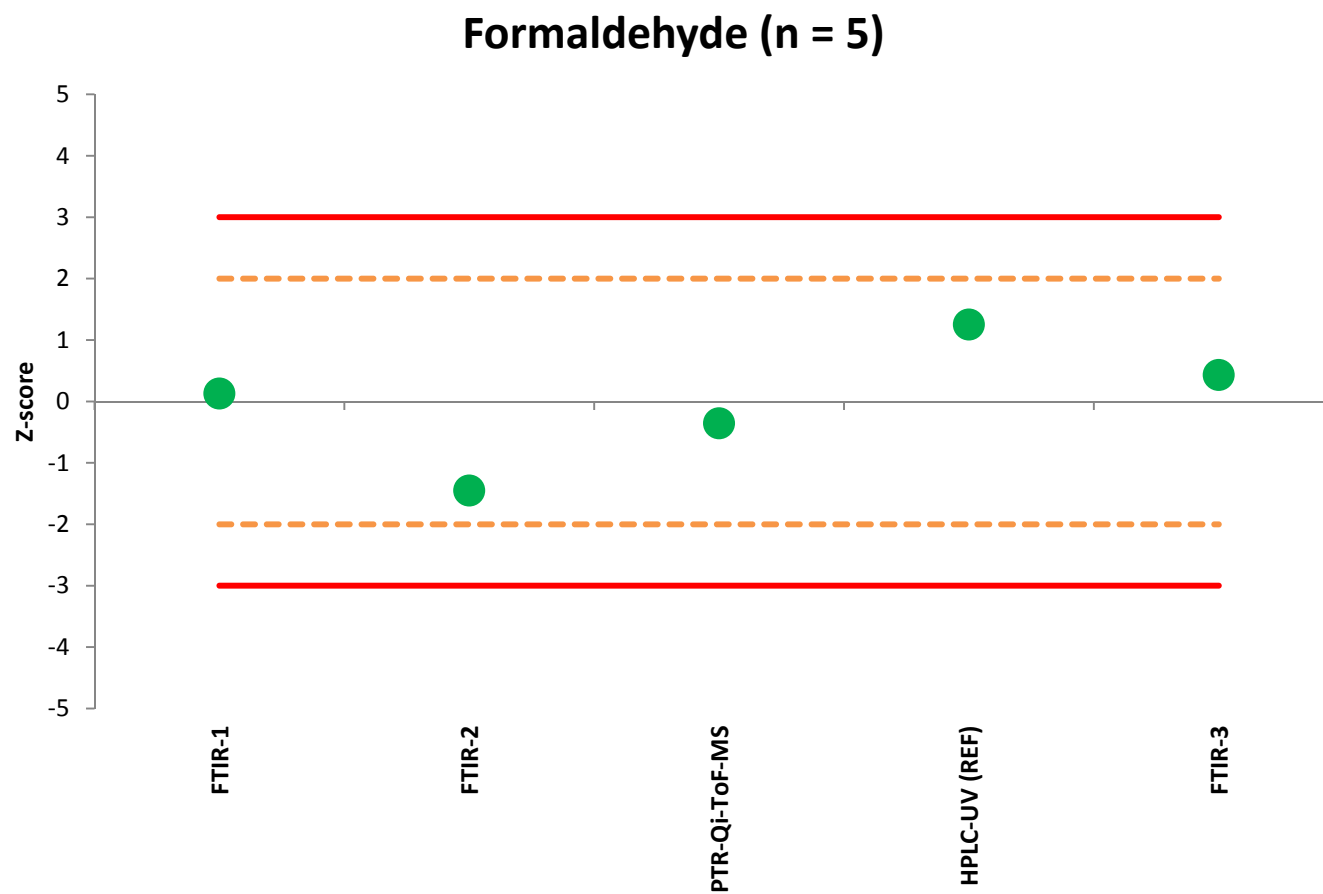


Figure 8 b. Z-scores obtained for the instruments capable of monitoring formaldehyde



Conclusions

During the exercise there were found in-situ analytical instrumentation capable of measuring the three additional pollutants (EtOH, HCHO and CH₃CHO) from the diluted exhaust (sampled at the CVS) with good accuracy, sensitivity and reproducibility.

All instruments presented a very good accuracy when measurements. Hence, the intercomparison of all analytical instrumentation measuring at the CVS was very satisfactory.



**This presentation will be extended
and presented during the next
12th WLTP meeting.**

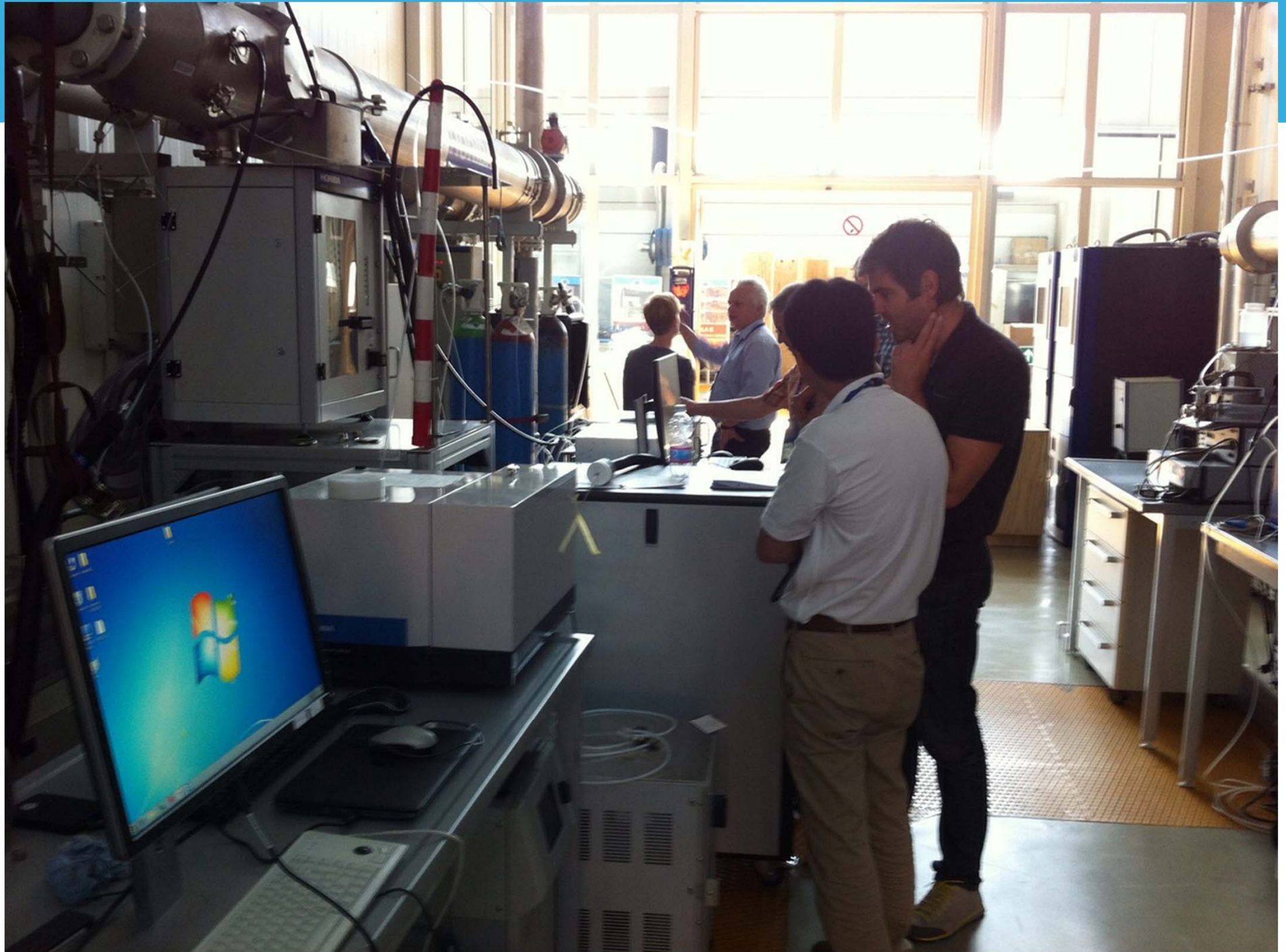
**All data are taken from the Report*
prepared by JRC staff after the
validation phase.**

Dr Suarez Bertoa

Dr Clairotte

Dr Astorga

*** Contributions from all participants
in the Validation phase in Ispra
have been collected for the
elaboration of the report**



PERFORMANCE INDICATOR – Z-SCORE

1st Stage

- **No outlier detection**

Cochran test for variance outliers and Grubbs test for average outliers will be checked in the 2nd Stage (ref. ISO 5725-2, 7.3.3-7.3.4)

- **Assigned/reference value = consensus value**

Average of all technics used in the inter-comparison exercise (including the conventional technic)

- **Z-score** = $\frac{X_{inst.} - X_{cons.}}{s}$

where $X_{inst.} - X_{cons.}$ is the difference between the mean of the technic and the consensus value, and s is the standard deviation associated to the consensus value (ref. ISO 17083, B.3.1.3)

Evaluation of performance	Z-score value Z
Satisfactory	≤ 2
Questionable	> 2 but ≤ 3
Unsatisfactory	> 3