

Met Talk on OIML R 91 Traffic Speed Meters

Moving Metrological Field Test & Metrological Field Test of the Ego Speed Meter

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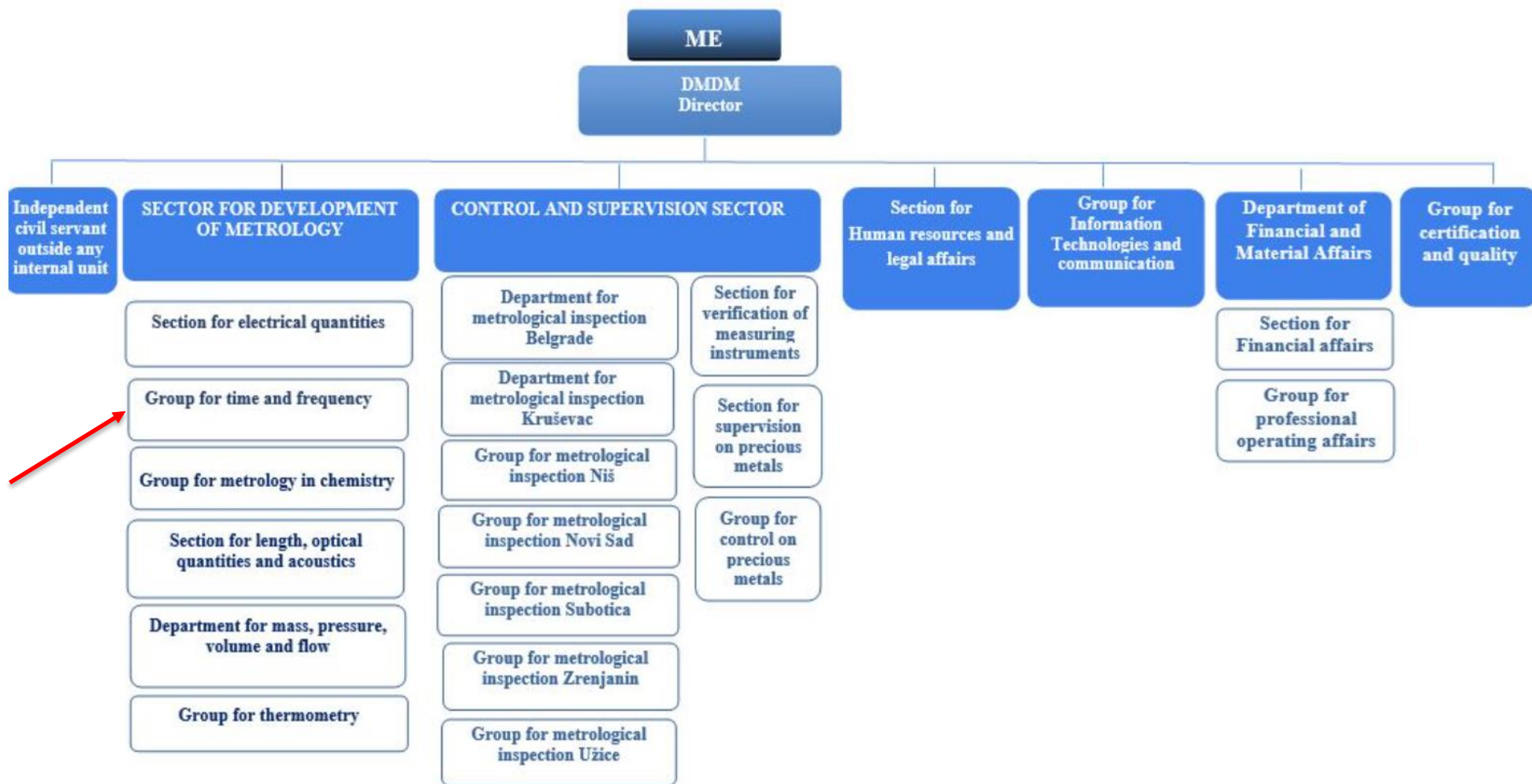
September 9, 2026



Directorate of Measures and Precious Metals (DMDM)

- Serbian National Metrology Institute (NMI) within Ministry of Economy
- Scientific, industrial and legal metrology
- Located in Belgrade and 6 other locations in Serbia
- Established in 1873.
- Signatory of CIPM-MRA and member of CGPM (BIPM), EURAMET, EURACHEM, WELMEC, OIML, IAAO, Hallmarking Convention.
- 163 published CMCs
- Quality system is implemented and followed by our IMS according to: ISO 9001, ISO 14001, OHSAS 18001, ISO/IEC 17025, ISO/IEC 17043.

Serbia joined the Metre Convention as a member state on October 30, 1879.



Group for Time and Frequency

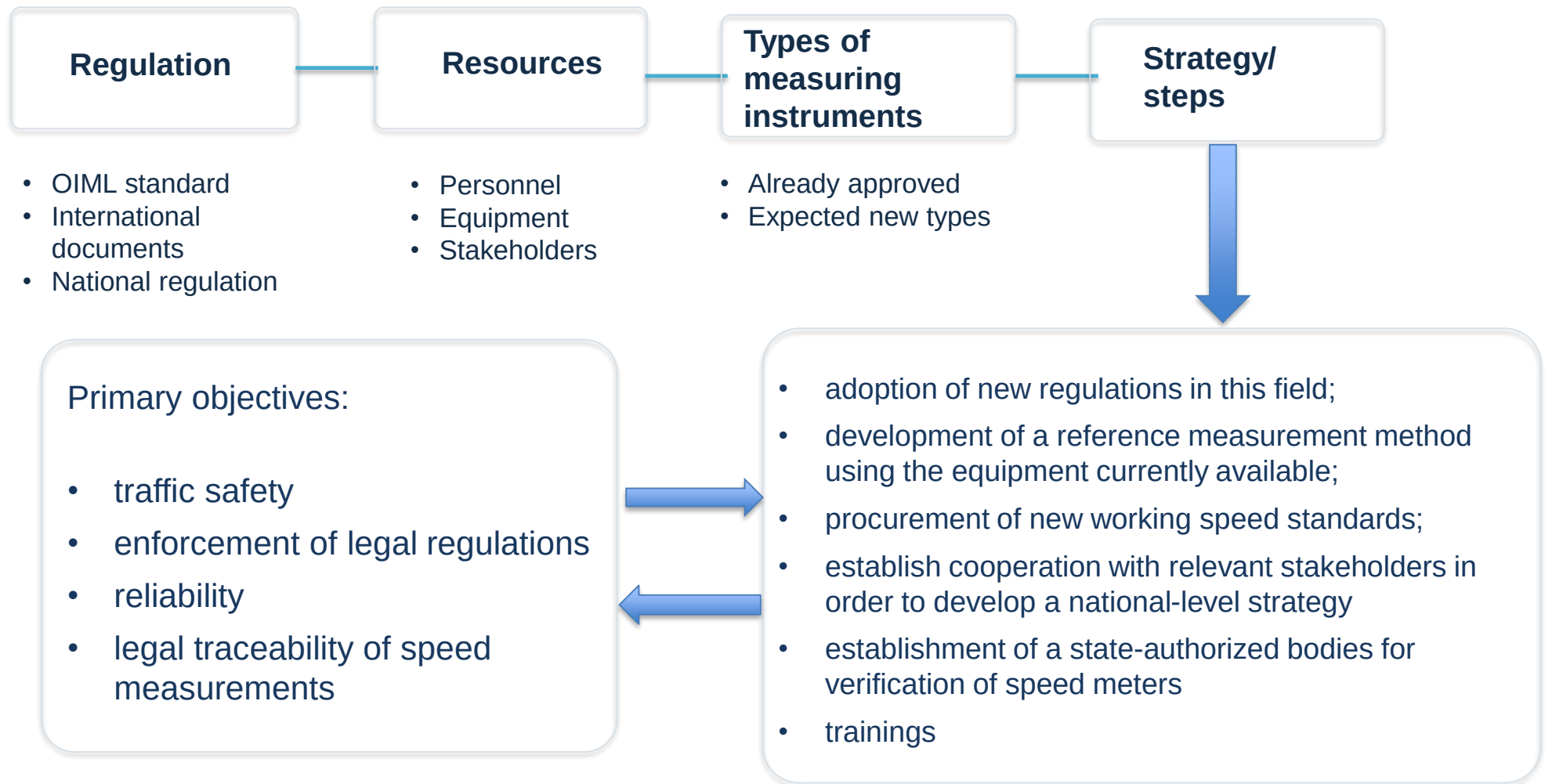
Legislative framework

- The Law on Metrology ("Official Gazette of RS", no. 15/2016)
- The Law on time ("Official Gazette of SCG", no. 20/2006)
- **The Regulation on speedmeters ("Official Gazette of RS", no. 26/23)**
- DMDM performs activities pertaining to the drafting of regulations governing metrology
new regulation on speedmeters

Responsibilities

- Operation and maintenance of the national TF standard
- Generation of the local UTC(DMDM) scale
- Time transfer using GNSS
- Dissemination of legal time
- Calibration of TF standards
- **Metrological activities for the purpose of type approval of speed meters in road traffic**
- Provision of highly precise frequency signals for other labs (Optical Frequency Comb, Josephson-Standard)
- drafting of regulations governing metrology

Legal metrology - speed meters - input consideration/ analysis



Moving speed meters requirements: national regulation / OIML R91:2025

Moving speed meter is speed meter installed on a vehicle, which is moving during the measurements.
Ego speed meter is instrument measuring the speed of the vehicle in which the moving speed meter is installed.

Rulebook on speed meters,
("Official Gazette of RS" no 26/23).

MPE for moving measurements

- a. ± 5 km/h at speeds up to and including 100 km/h, and
- b. ± 5 % at speeds above 100 km/h.

Evidence file: the ego speed shall be displayed and stored in the evidence file

OIML R91-1:2025

MPE for moving measurements

Class A

- a. ± 3 km/h at speeds up to and including 100 km/h, and
- b. ± 3 % at speeds above 100 km/h.

Class B

- a. ± 7 km/h at speeds up to and including 100 km/h, and
- b. ± 7 % at speeds above 100 km/h.

The OIML certificate shall indicate the class of the instrument.

MPE for the ego speed meter:

- a. ± 1 km/h at ego speeds up to and including 100 km/h, and
- b. ± 1 % at ego speeds above 100 km/h.

Evidence file: the ego speed shall be displayed and stored in the evidence file with a resolution of **at least 0.1 km/h**.

The ego speed with a resolution of at least 0.01 km/h shall be part of the output data of the test interface of moving speed meters.

Moving metrological field test: national regulation/ OIML R91:2025

OIML R91-2:2025

7.7.1 Moving metrological field test

Moving speed meters shall be tested on the road under real traffic conditions. Installation of the EUT shall be done on a test vehicle according to the user manual. As a reference an ego speed meter installed on a second vehicle shall be used (called reference vehicle hereafter). The expanded measurement uncertainty ($k = 2$) of the reference speed meter shall not exceed 1 km/h at speeds up to and including 100 km/h and 1 % of the speed value at speeds above 100 km/h. The EUT shall perform at least 200 valid measurements of the reference vehicle under various traffic conditions. A lower number of measurements is justified if the EUT only allows measurements in a few well-defined traffic conditions and scenarios.

7.7.2 Metrological field test of the ego speed meter

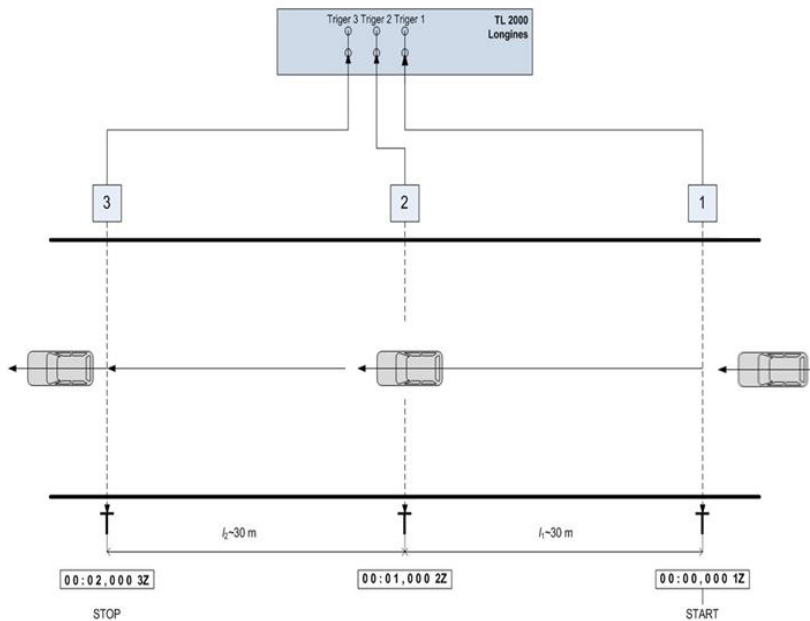
The metrological performance of the ego speed meter of the EUT shall be tested on the road. Installation of the EUT shall be done on a test vehicle according to the user manual. A suitable reference for the speed of the test vehicle shall be used. The expanded measurement uncertainty ($k = 2$) of the reference shall not exceed 0.2 km/h at speeds up to and including 100 km/h and 0.2 % of the speed value at speeds above 100 km/h.

Rulebook on speed meters, ("Official Gazette of RS" no 26/23)

Moving speed meters shall be tested on a suitable test track or road on which speeds within the prescribed minimum range of 30 km/h to 150 km/h can be safely attained. If the measuring range of the measuring instrument exceeds the minimum prescribed range, the range of test speeds may be extended only within the limits of the performance characteristics of the test vehicle and the safety conditions of the road on which the instrument is installed.

For measuring instruments operating in automatic mode, a total of at least 500 valid measurements shall be performed. For manual measurements (manual operating mode), a total of at least 50 valid measurements shall be performed.

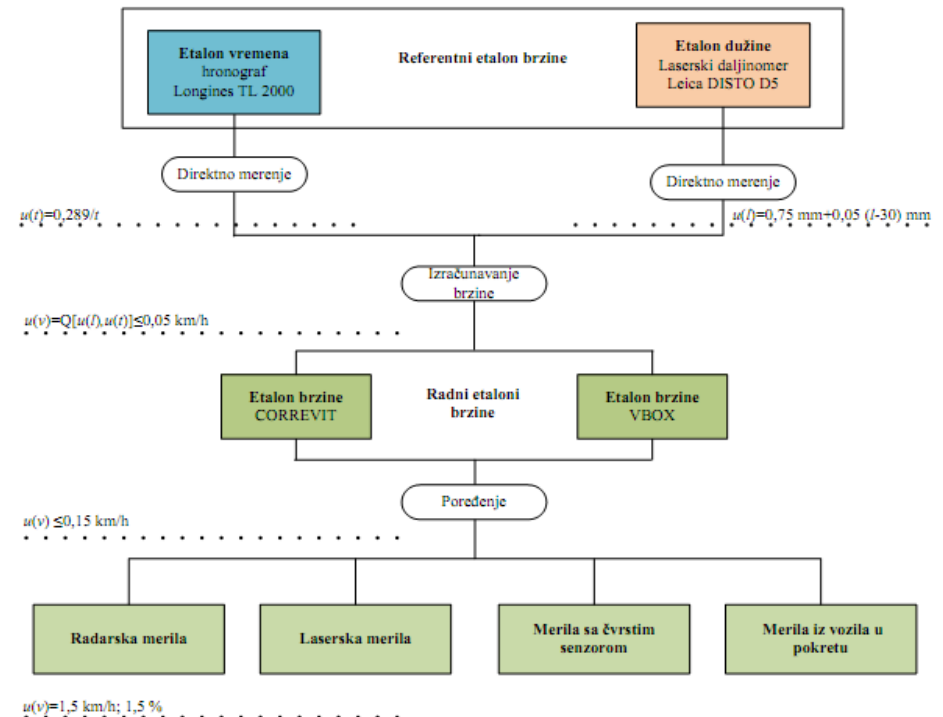
Reference method and a traceability chain for speed measurements



Measurement system:

light barriers + laser distance meter

The speed is determined based on the transit time between three detection points located at fixed distances.



A traceability chain - national level

Metrological traceability was established through the verification of the reference method, as well as the calibration of both reference and working standards

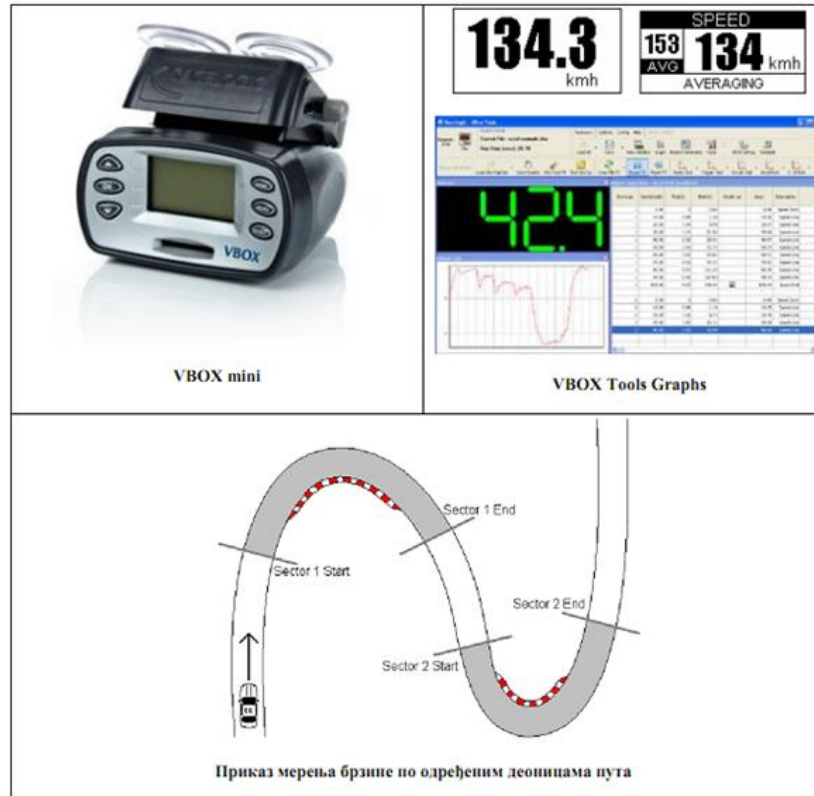
Equipment – speed measuring reference and working standards



Longines measuring system
„light barriers“



Leica DISTO
laser distance meter



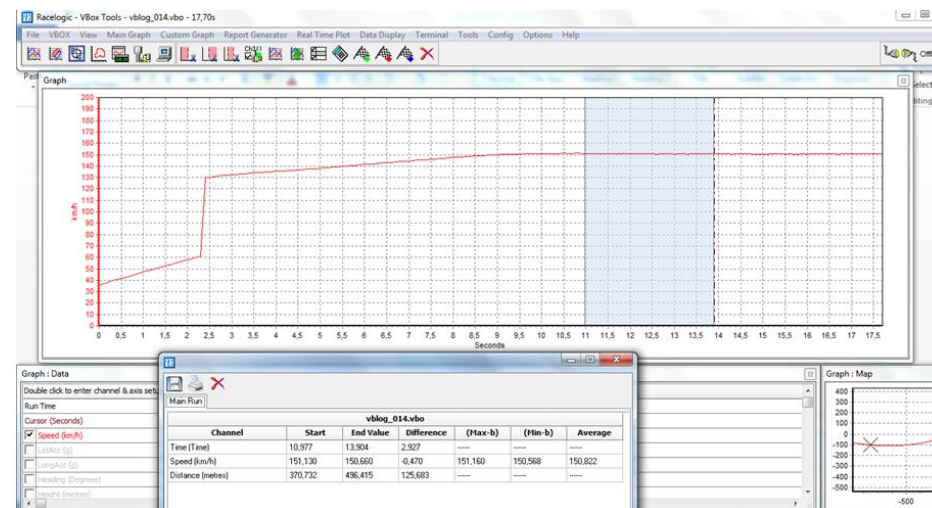
Racelogic VBOX measuring system
GPS data logger



Corrsys-Datron Correvit
surface picture under the
CCD sensor

Requirements for reference equipment

- must be traceable to the SI system of units (calibrated in accredited laboratories or NMIs in accordance with adequate calibration plans)
- the measurement uncertainty of the equipment must be less than 1/3 of the MPE of the tested measuring speed device
- the reference speed meter shall preferably perform automatic measurements
- the equipment must be verified to determine that it is suitable for the required speed measurements



KISTLER

Description

Common Test

Information

File	Test_002.adf
File Size	0.1695 MB
Measuring Time	25.06.2025, 08:32:53
Measurement Duration	14.469 s
Start Trigger	
Stop Trigger	
Sampling Rate	500 Hz

Metadata

End Values

Vel_Avg	39.354 km/h
Vel_Start	38.351 km/h
Vel_Stop	39.400 km/h
Vel_Min	38.349 km/h
Vel_Max	39.659 km/h

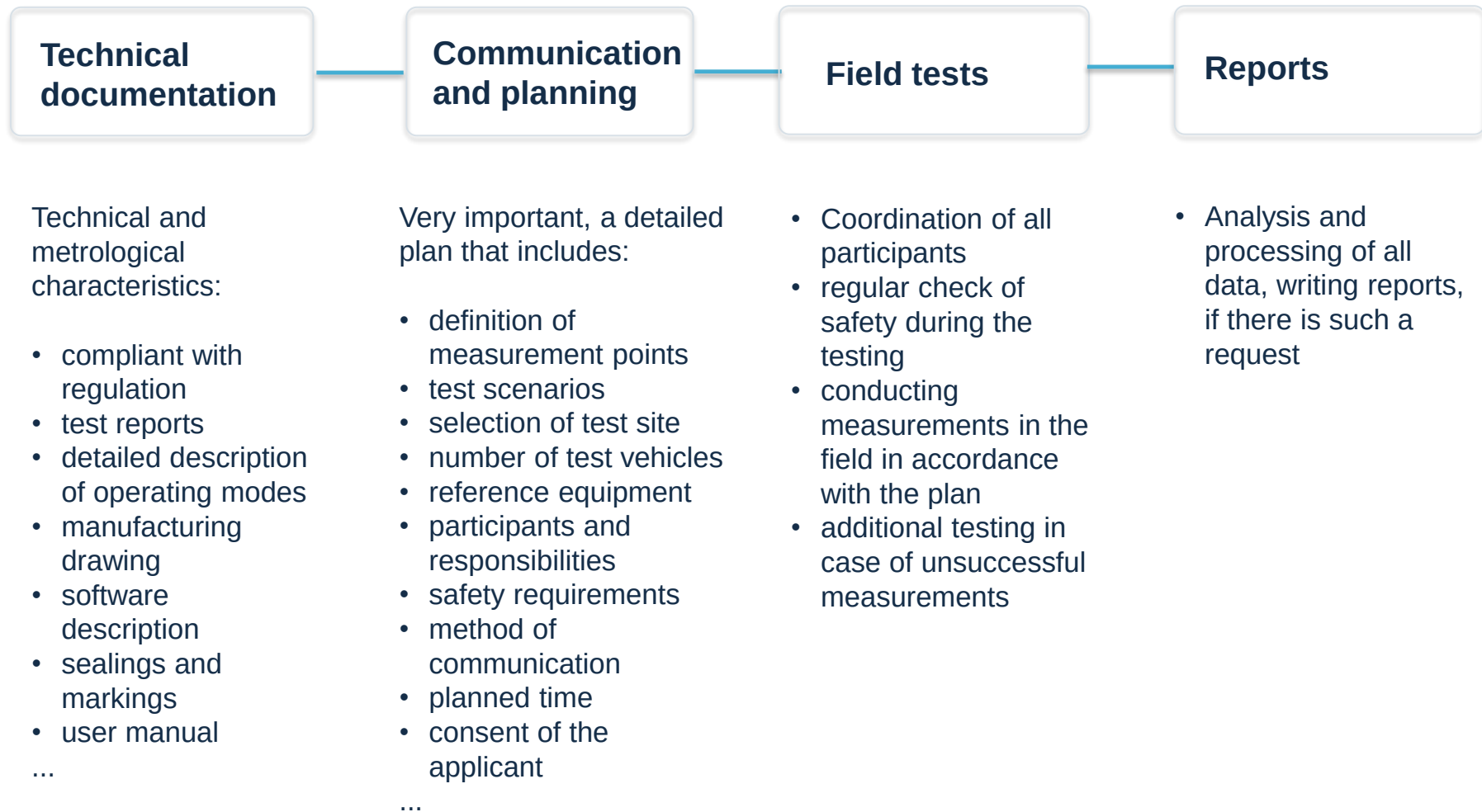
Reference equipment - verification during field tests

Multiple verifications of 4 working standards have been carried out, by comparison with the reference speed standard, and between themselves, during simultaneous measurements in the field.



All results were processed, and the measurement uncertainty was calculated, confirming the suitability of the equipment for speed-measurement testing. In addition, all reference standards are calibrated within the prescribed intervals, followed by an appropriate analysis of the calibration results.

Field tests process



Field tests process – challenges

incomplete technical documentation

insufficient time for planning

the speed meter is not prepared for field measurements

lack of technical knowledge about the operation of the device

misunderstanding of legal requirements

software modifications

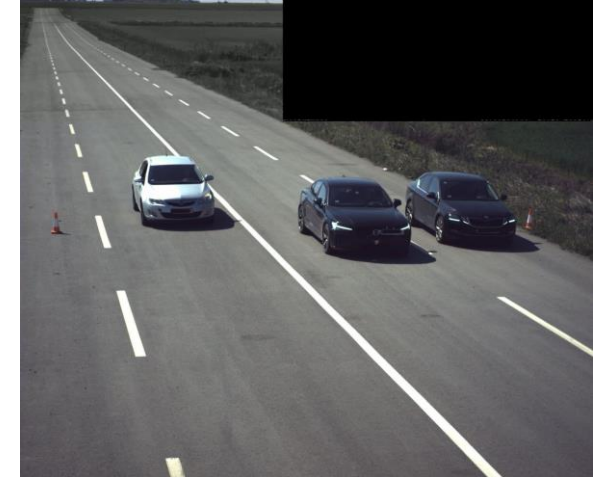
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Consequences

- Repeated or additional testings
- Costs multiplication
- Extended time of examination
- Refusal of type approval application

Field tests planning – test site



Different types of test tracks, depending on the number of measurements, maximum required speed, availability, contracts, costs, number of lanes etc. The length of the test tracks used is from 1.2 km to 7 km. Typical scope of measurements - from 30 km/h to 200 km/h.

Field tests planning – challenges



Unconditional test track - poor maintenance

Expired contracts

Temporarily unavailable or out of service

Currently - applicant's responsibility

Uncalibrated equipment
Insufficient personnel

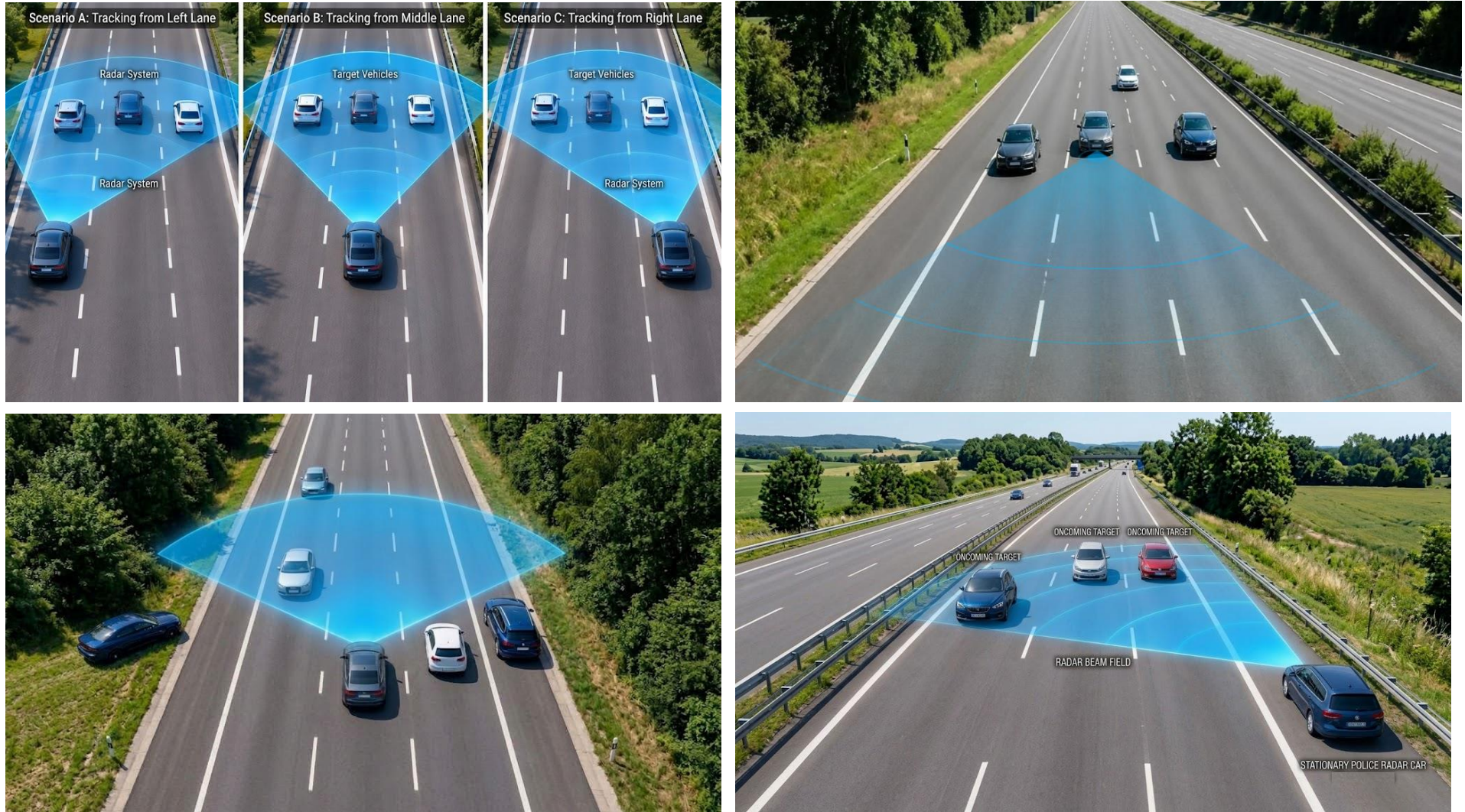


Close cooperation with Traffic police directorate,
verification bodies, producers, accredited laboratories

Work in different weather conditions – day, night, fog, rain



Field tests planning – scenario(s)



Number and type of scenarios - as much as possible. **The scenario has to be indicated in the report**

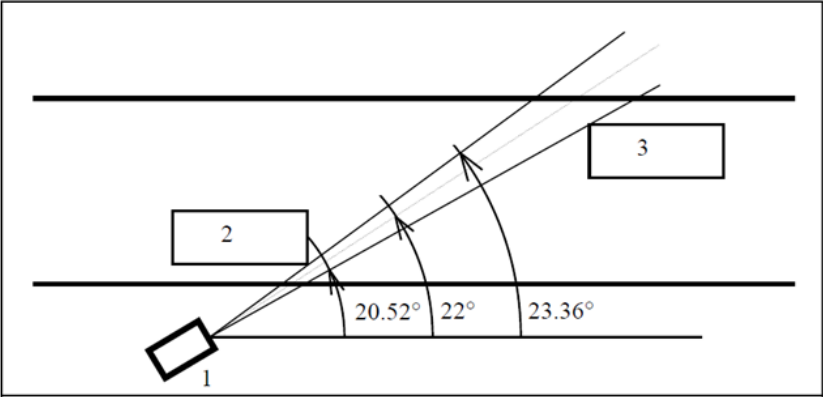
Different types of moving speed meters – DMDM experience

Technology/ measurement principle	Radar frequency	Functionalities	Placement of radar unit
A revolution counter of a wheel of the patrol vehicle	/	pursuing speed meter not in use any more not in compliance with the regulation after 2013.	/
Radar	34.0 GHz or 34.3 GHz	moving speed meter, stationary and moving mode	front bumper mask
Radar	33.4 GHz to 36.0 GHz	moving speed meter, stationary and moving mode	inside the patrol vehicle
Radar	76 GHz or 77 GHz $\pm$ 250 MHz	moving speed meter, stationary and moving mode; fixed above/ beside the road; mobile speedmeter	inside the patrol vehicle
Radar	76 GHz to 77 GHz	moving speed meter, stationary and moving mode;	front bumper mask



Challenges

Measurement principle	Observation
Radar 34.0 GHz	Results highly dependent on the positioning angle of the radar unit and camera. Difficulties in euipment handling by the operator during measurements.



Different angle for arrival and departure during radar measurement

Measurement principle	Observation
A revolution counter of a wheel of the patrol vehicle	Pursuing speed meter Maintaining a constant distance from the vehicle throughout the measurement, especially during its initial and final stages, can be challenging for operator.



Field tests – scope and method

The scope of field tests depends:

- On the required number of measurements,
- On the range of speeds to be achieved,
- Whether functional speed measurements only are required, or the full set of measurements must be carried out,
- On the number of vehicles and standards available, and other relevant factors.
- Where a full set of measurements is required because the client has not provided test reports for speed measurement, a total of 500 measurements shall be performed, ideally test track plus real traffic condition.

Method:

- One reference standard is installed in the test vehicle in order to measure the ego speed of the vehicle under test,
- Second reference standard is installed in another vehicle, whose speed will be measured by the instrument under test.
- In this way, the two reference standards enable the simultaneous measurements of the both vehicle's ego speed as well as the speed measured by the speed meter under test.
- Ideally, for the larger scope of measurements, 3-4 vehicles and reference standards would be available in order to reduce the measurement time.

Functional and safety checks before the measurements begin:

- The EUT's serial number, software version, instrument configuration, and any other data required for the subsequent analysis of the measurement results are recorded.
- Synchronization of reference standards and EUT.
- The necessary calibration of both the reference standard and the device under test is carried out, where required by the user manual.
- Communication is established, generally by means of a conference call involving all participants.
- The procedures for ensuring safe operating conditions are checked.
- Measurements are carried out in accordance with the test plan.

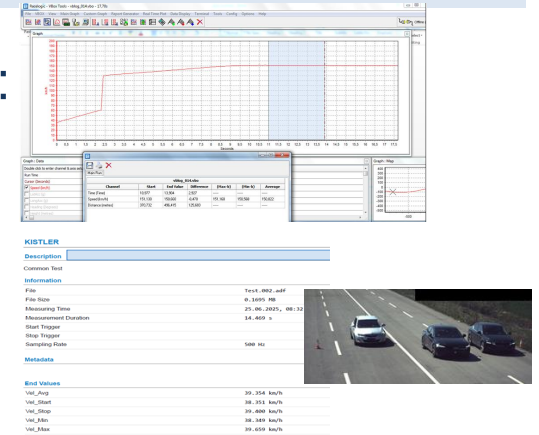
Field tests – measurements

Two approaches can be applied during measurements:

1. Measurement-by-measurement verification

Results and evidence files checked after each measurement.

Next measurement initiated only after successful verification that all relevant data have been successfully recorded and the measurement is considered valid.



2. Post-processing

Data stored in the reference standard(s) and tested speed meter. Subsequent processing and analysis of recorded data.

Large datasets requiring cross-checking against recorded offences.

The large volume of raw data creates a potential risk of errors during result processing.

The use of dedicated data-processing software helps to minimize this risk.



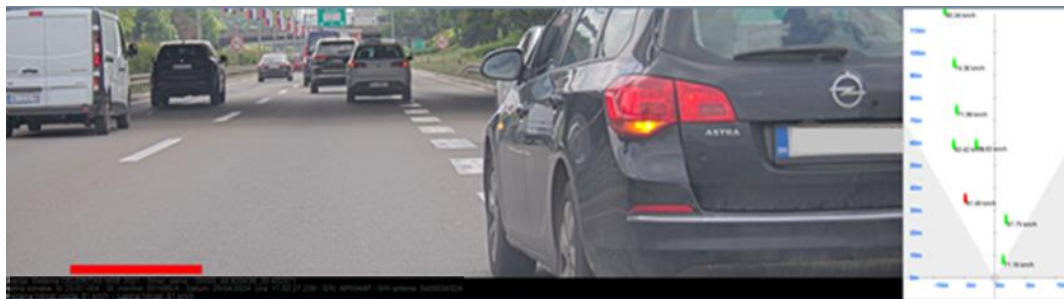
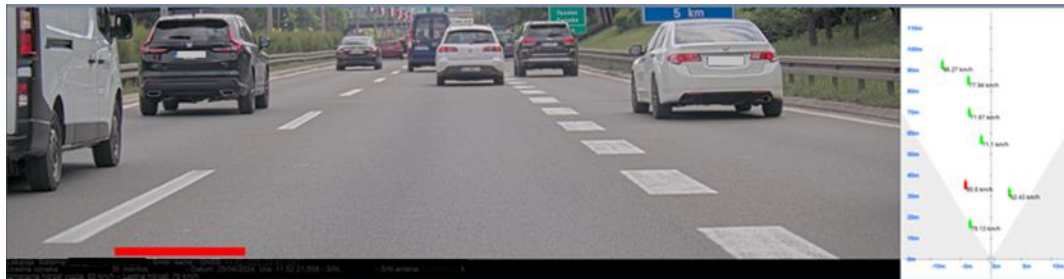
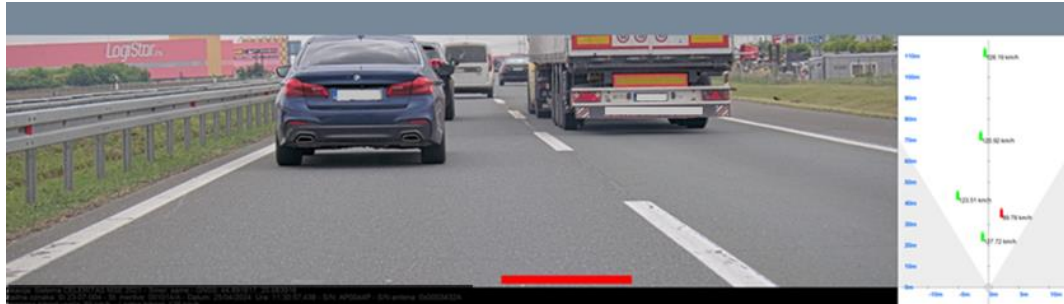
**Our experience:
using both
approaches**

The screenshot shows a spreadsheet with data for two vehicles: BMW and SKODA. The data is organized into columns for 'File', 'Name', 'Speed', 'Time', 'Distance', 'Track', 'File No.', 'File Size', 'Measurement Time', 'Measurement Duration', 'Start Trigger', 'Stop Trigger', and 'Sampling Rate'. The BMW data is in the top section, and the SKODA data is in the bottom section. The spreadsheet also includes a 'Comments' column and a 'Track Offset (metres)' column.

Field tests EUT 1 - radar 77 GHz – evidence files

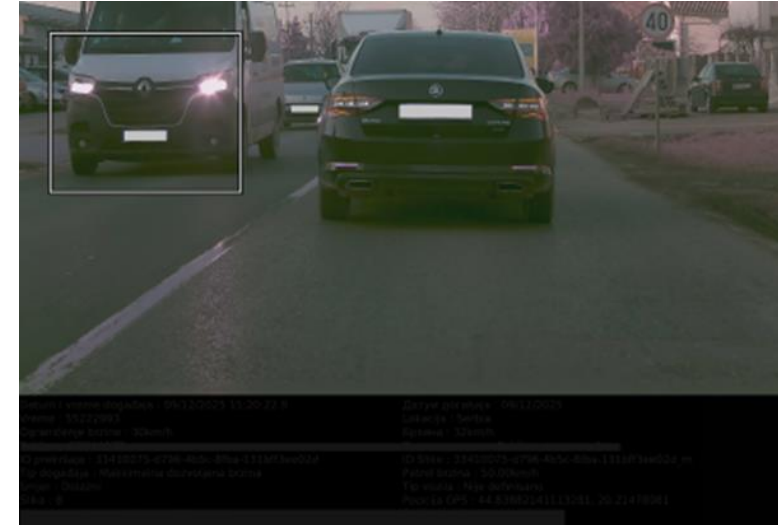
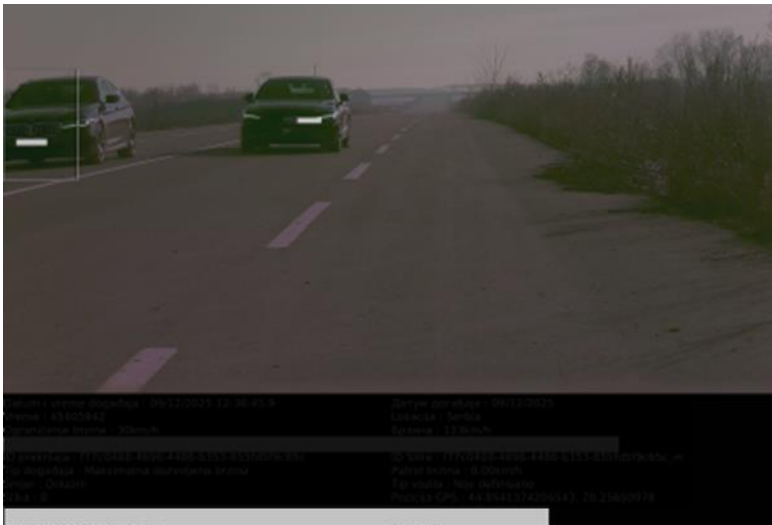
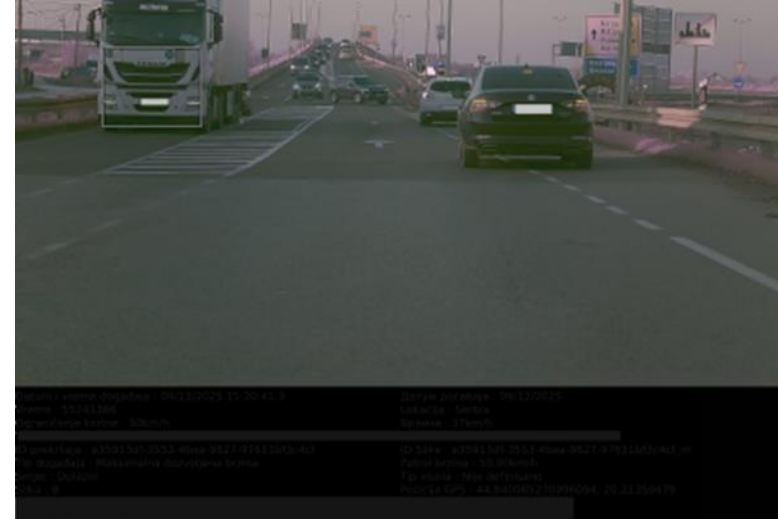
National regulation/ OIML R 91-1:2025 7.3

The evidence files consist of a video recording, a metadata file, and multiple photographs documenting the recorded offence, including all information required under the applicable regulation.



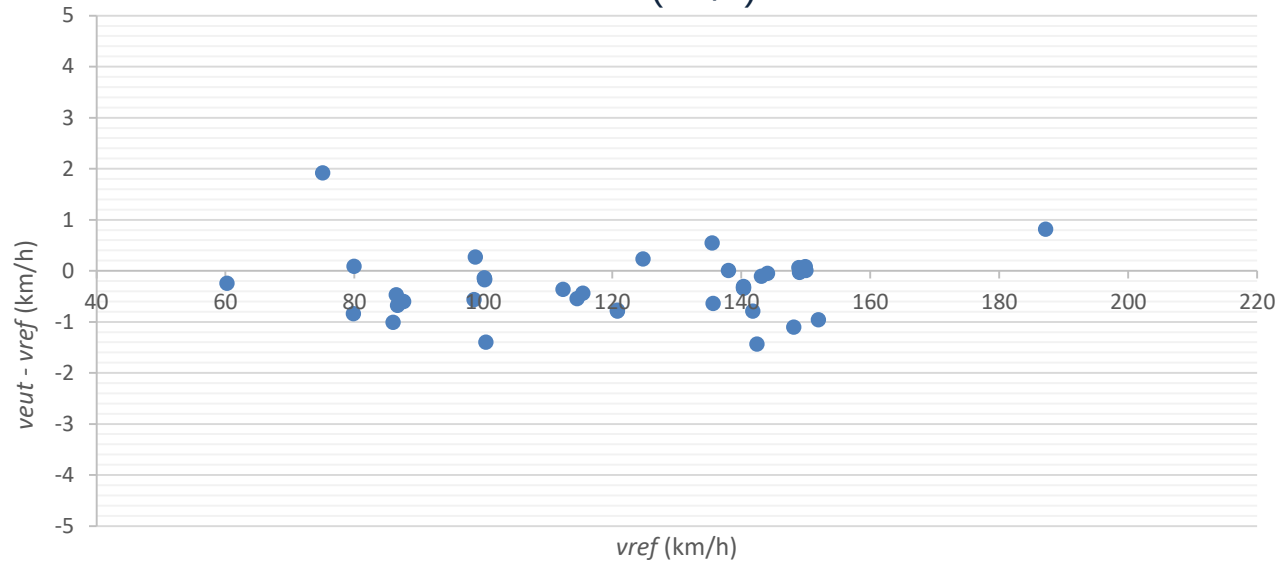
Field tests EUT 2 - radar 77 GHz – evidence files

The evidence files consist of a video recording, a metadata file, and multiple photographs documenting the recorded offence, including all information required under the applicable regulation.



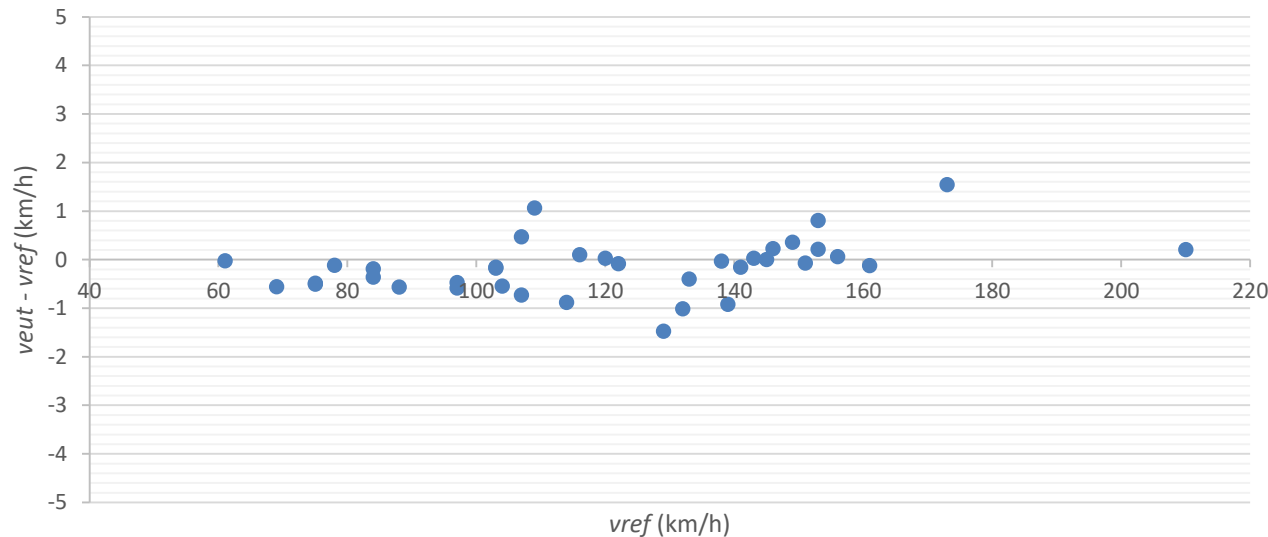
Observations EUT 1 – radar 77 GHz - one series of measurements

EUT-REF
(km/h)



Moving field test

- Real traffic - highway
- Braking
- Acceleration
- Instantaneous speed

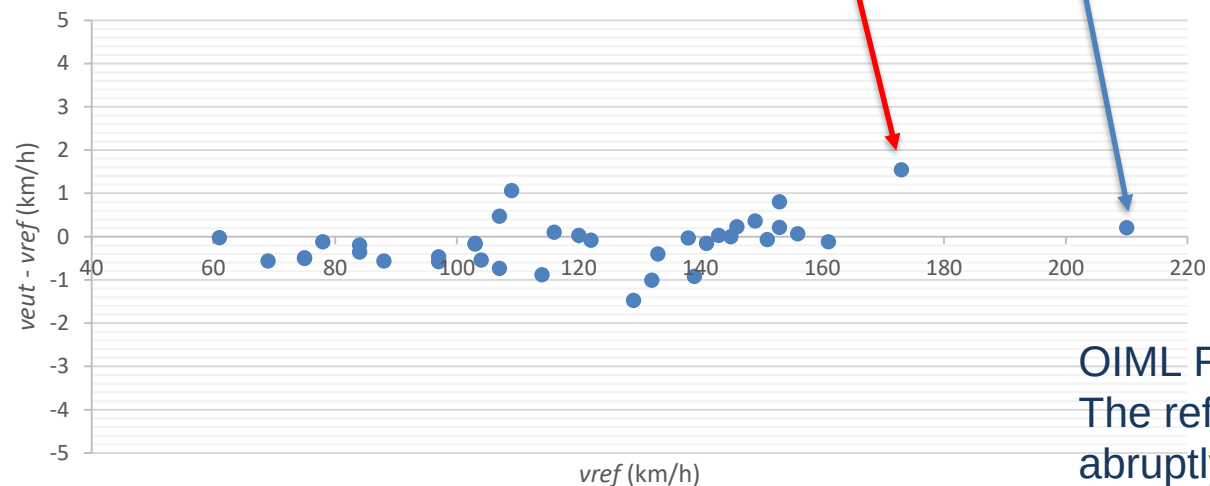
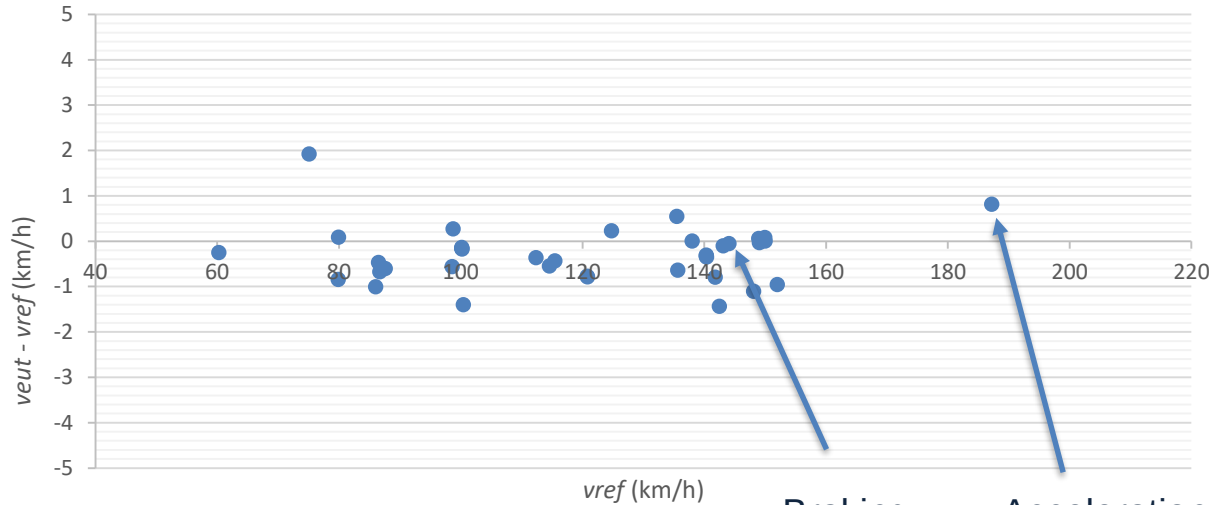


Field test of the ego speed meter

- Real traffic - highway
- Braking
- Acceleration
- Instantaneous speed

Observations EUT 1 – radar 77 GHz - additional checking

EUT-REF
(km/h)

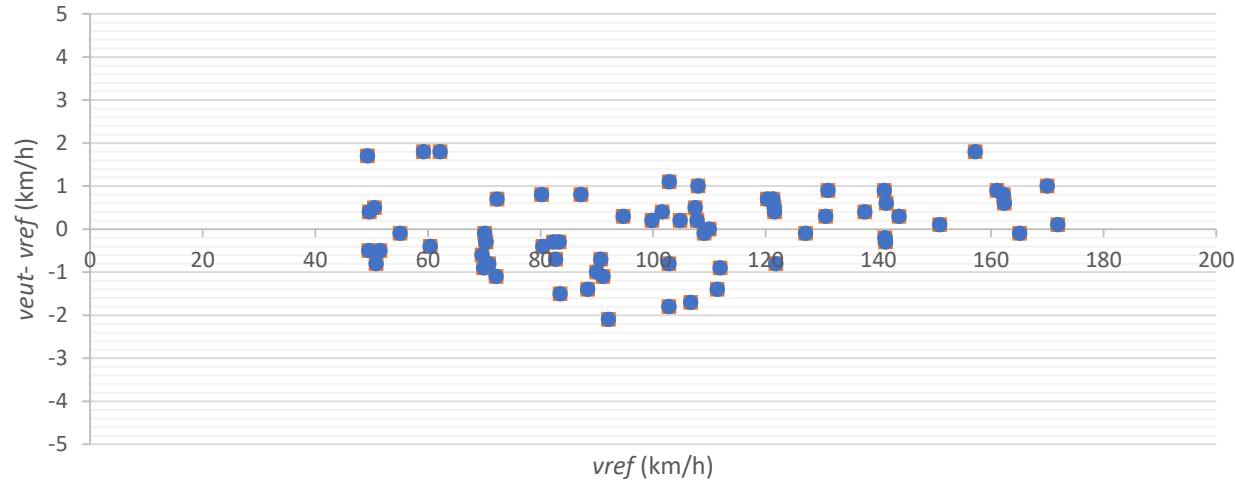


OIML R 91-2:2025 7.7.1

The reference vehicle shall generally not brake abruptly or accelerate strongly during the measurements.

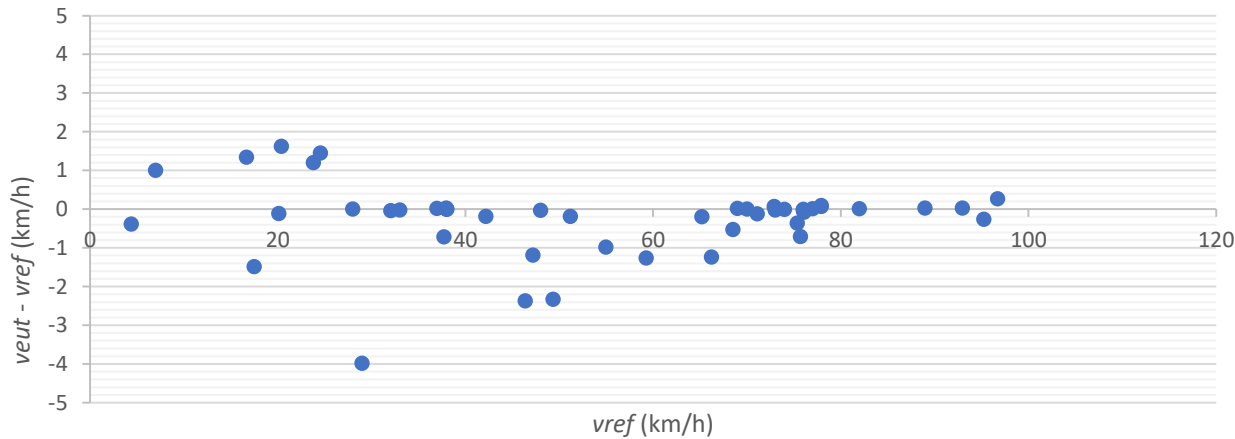
Observations EUT 2 – radar 77 GHz

EUT-REF
(km/h)



Moving field test

- Test track

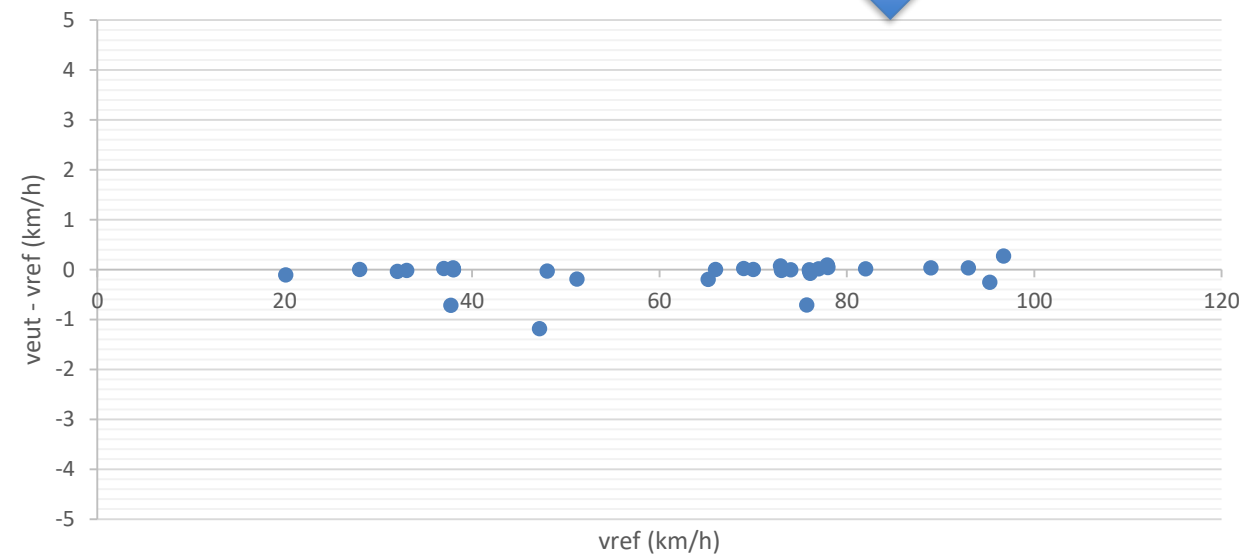
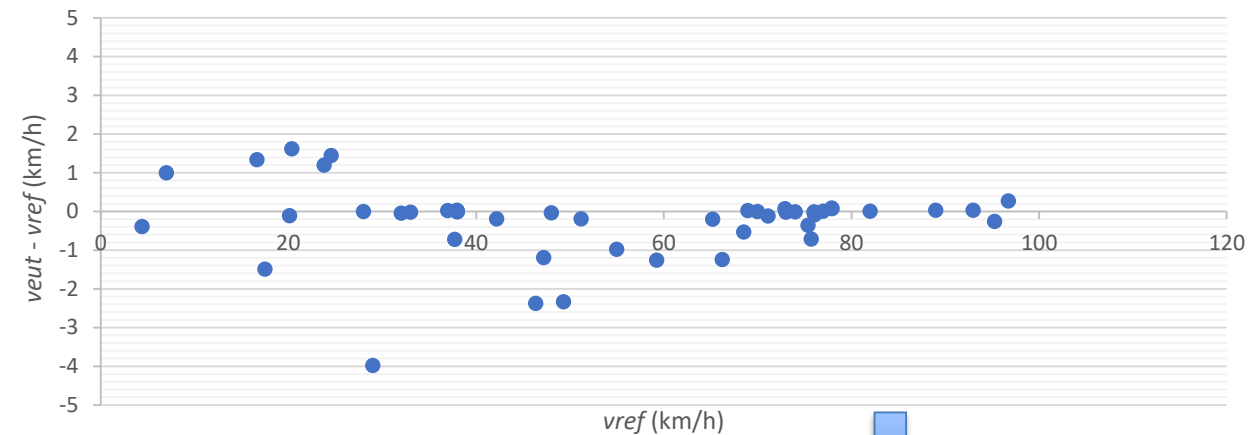


Field test of the ego speed meter

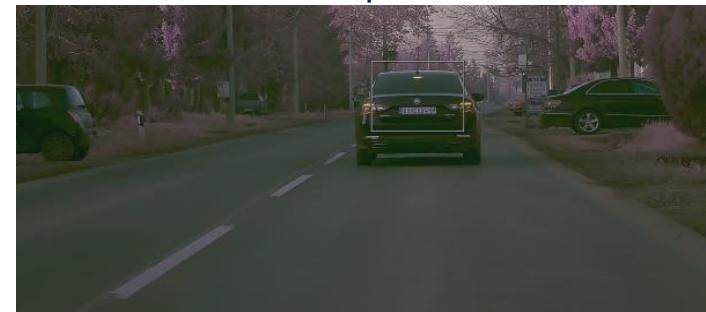
- Side roads + highway
- Braking
- Acceleration
- Instantaneous speed

Observations EUT 2 – radar 77 GHz – additional checking

EUT-REF
(km/h)



Bumps

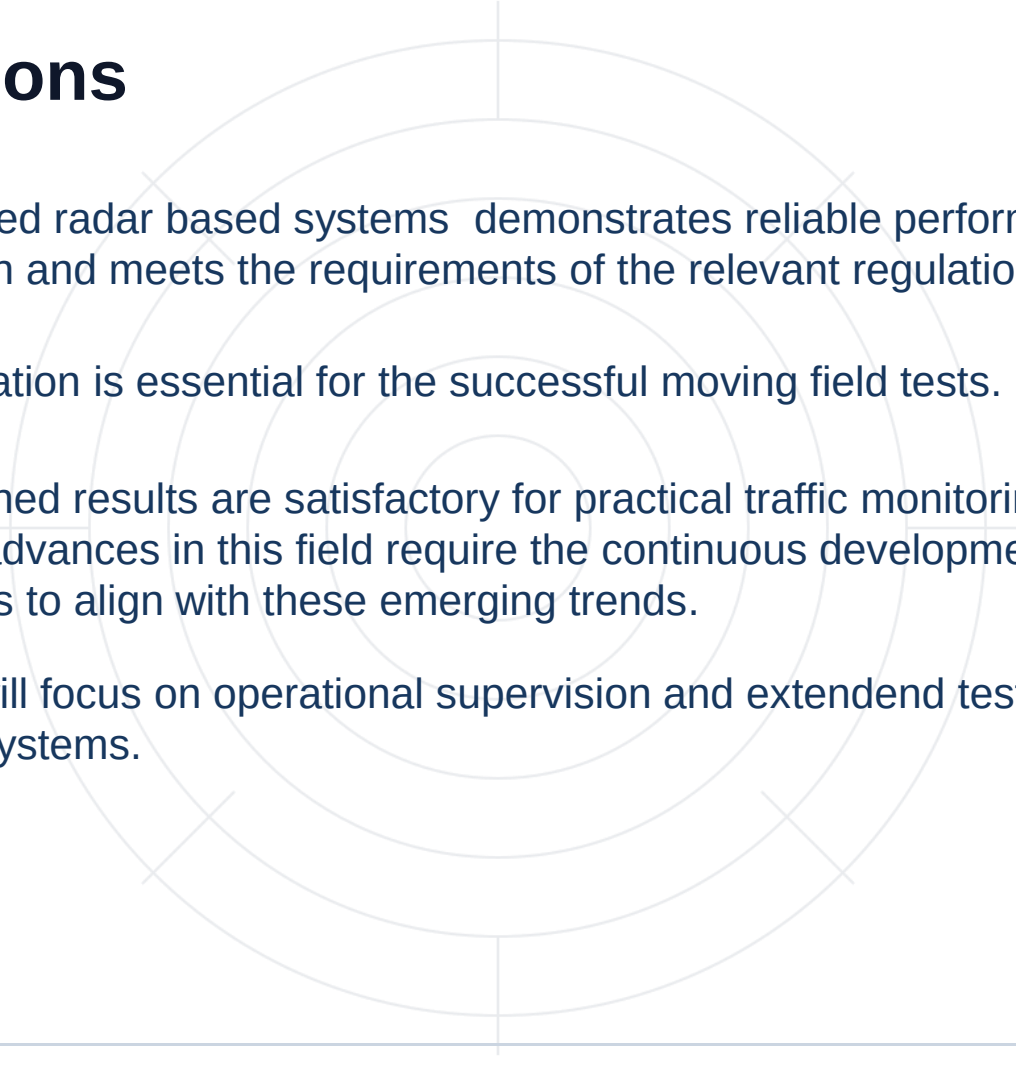


Braking



Curves

Conclusions

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- 1 The all evaluated radar based systems demonstrates reliable performance in moving mode operation and meets the requirements of the relevant regulation.
 - 2 Proper preparation is essential for the successful moving field tests.
 - 3 Although obtained results are satisfactory for practical traffic monitoring, the rapid technological advances in this field require the continuous development of our methods and procedures to align with these emerging trends.
 - 4 Further work will focus on operational supervision and extendend testings of new FMCW radar systems.
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Thank you

for your attention

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