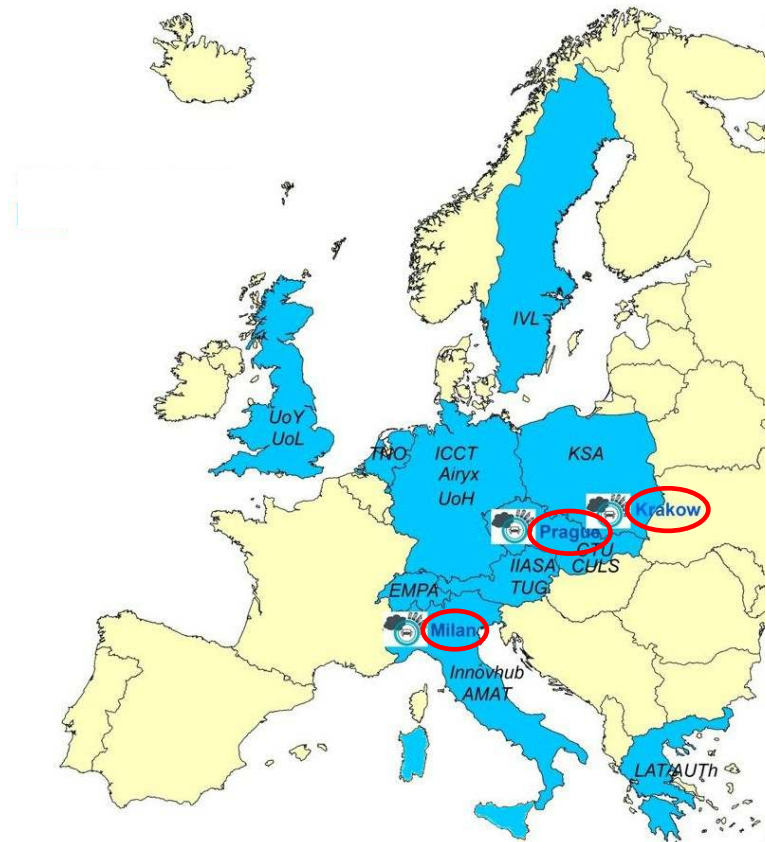


# CARES – City Air Remote Emission Sensing



*Åke Sjödin*  
*Swedish Environmental Research Institute*

# CARES – a H2020 InCo flagship project bringing together worldwide RES/RDE expertise



Commercial remote sensing service providers:



# CARES overall objectives

“... reduce the hurdles for applications of **remote emission sensing (RES)** to make it a **widespread** means of both **monitoring and enforcement of vehicle emissions**.”



# CARES challenges

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## Develop and demonstrate remote emission sensing hard- and software to:

- Improve the accuracy of measurements of **particulate matter**;
- Improve the detection of **high-emitting vehicles**;
- **Lower costs** of remote emission sensing measurements;
- **Facilitate use by unskilled personnel** to achieve a broader deployment potential;
- **Support local air quality plans**;
- Establish a proper **data infrastructure** built around **vehicle registration databases, traffic management** measures and **air quality monitoring** systems.



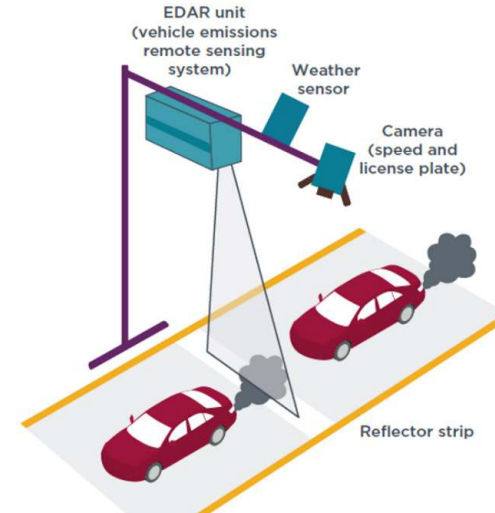
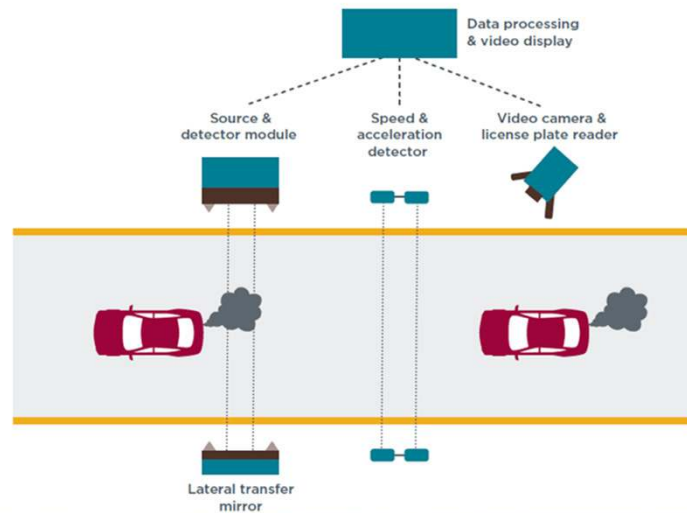


# CARES elements

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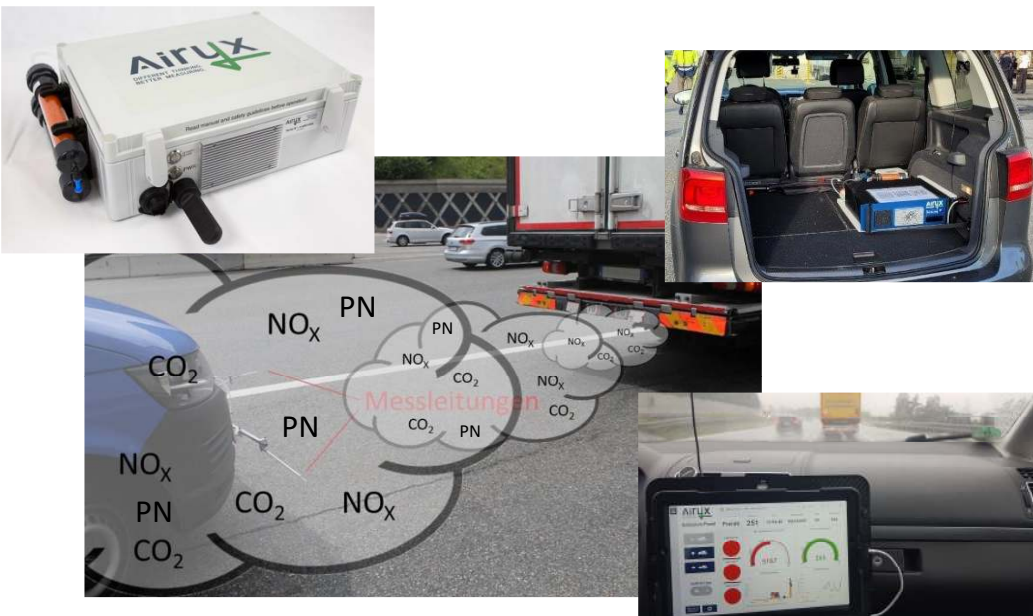
- Hardware development
- Database and software development
- Demonstrations in three polluted cities
- Provision of user toolboxes and RES guidance

# Conventional/commercial RES

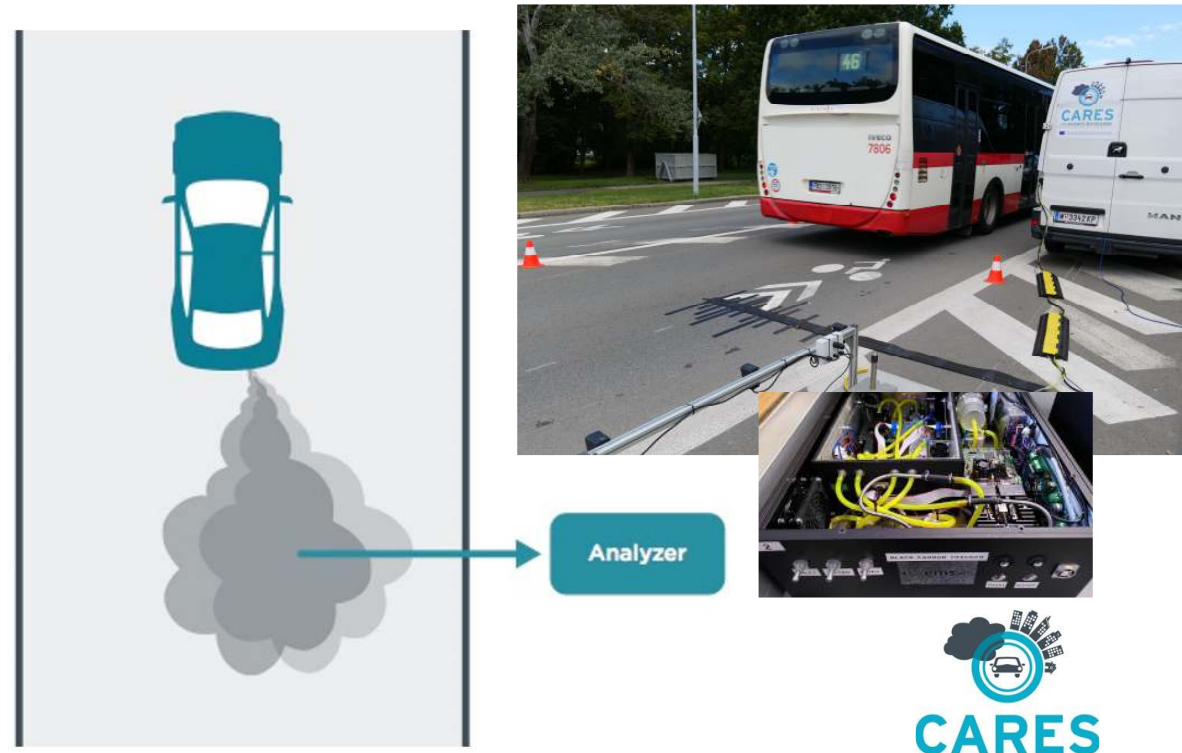


# CARES is further developing RES techniques

## Plume chasing – NO<sub>x</sub> and PN



## Point sampling – PN, BC and NO<sub>x</sub>





# Characterization and validation experiments

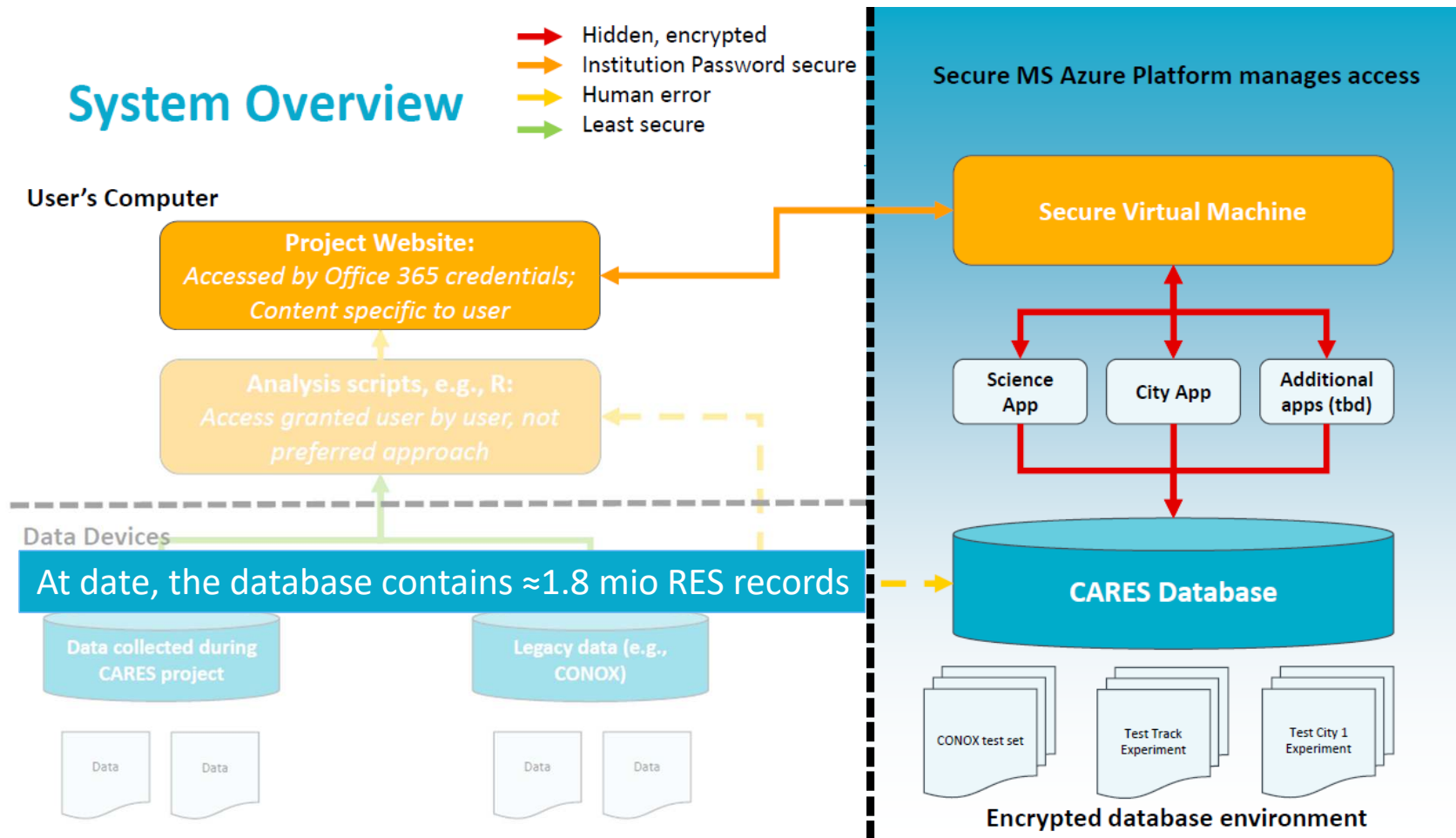
- Emission characterization and technology validation experiments at a test track





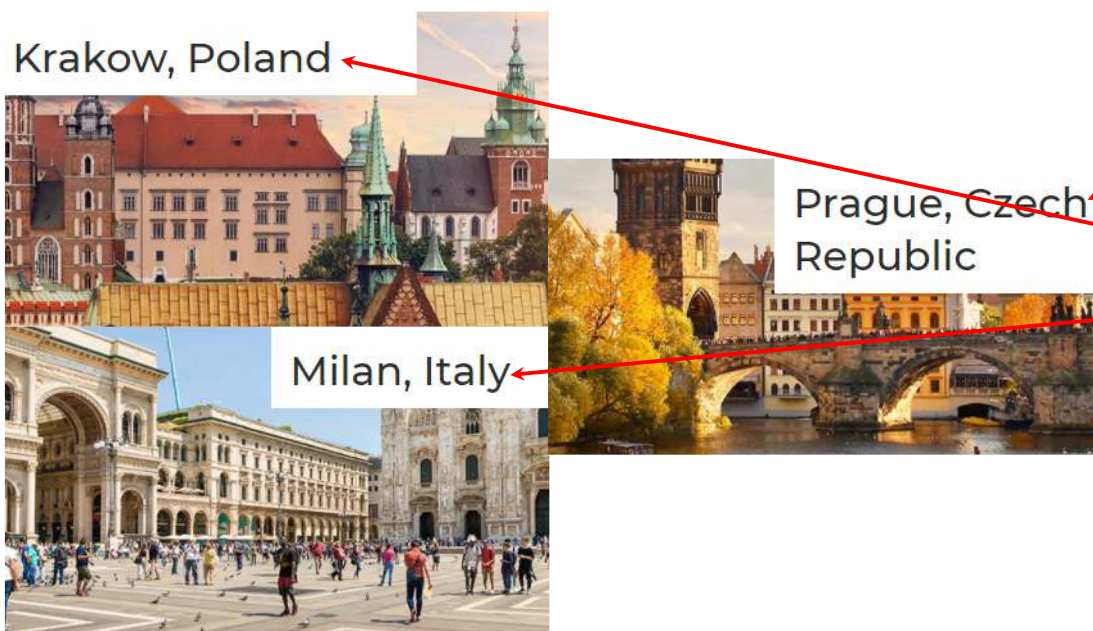
# CARES database platform

## System Overview



# City demonstration measurements

- Demonstrations of RES applications in three polluted cities:



## RES applications:

- 1) Identification of **high-emitting vehicles**
- 2) Generation of real-world **emission factors**
- 3) Steering **new policies**
- 4) Track **policy effectiveness**
- 5) Track **technology effectiveness**
- 6) Screen fleets for **market surveillance**
- 7) Monitoring **single fleets**
- 8) Understand **impact** of driving conditions
- 9) Inform **purchasing decisions**

# Milan measurement campaign

## via Madre Cabrini

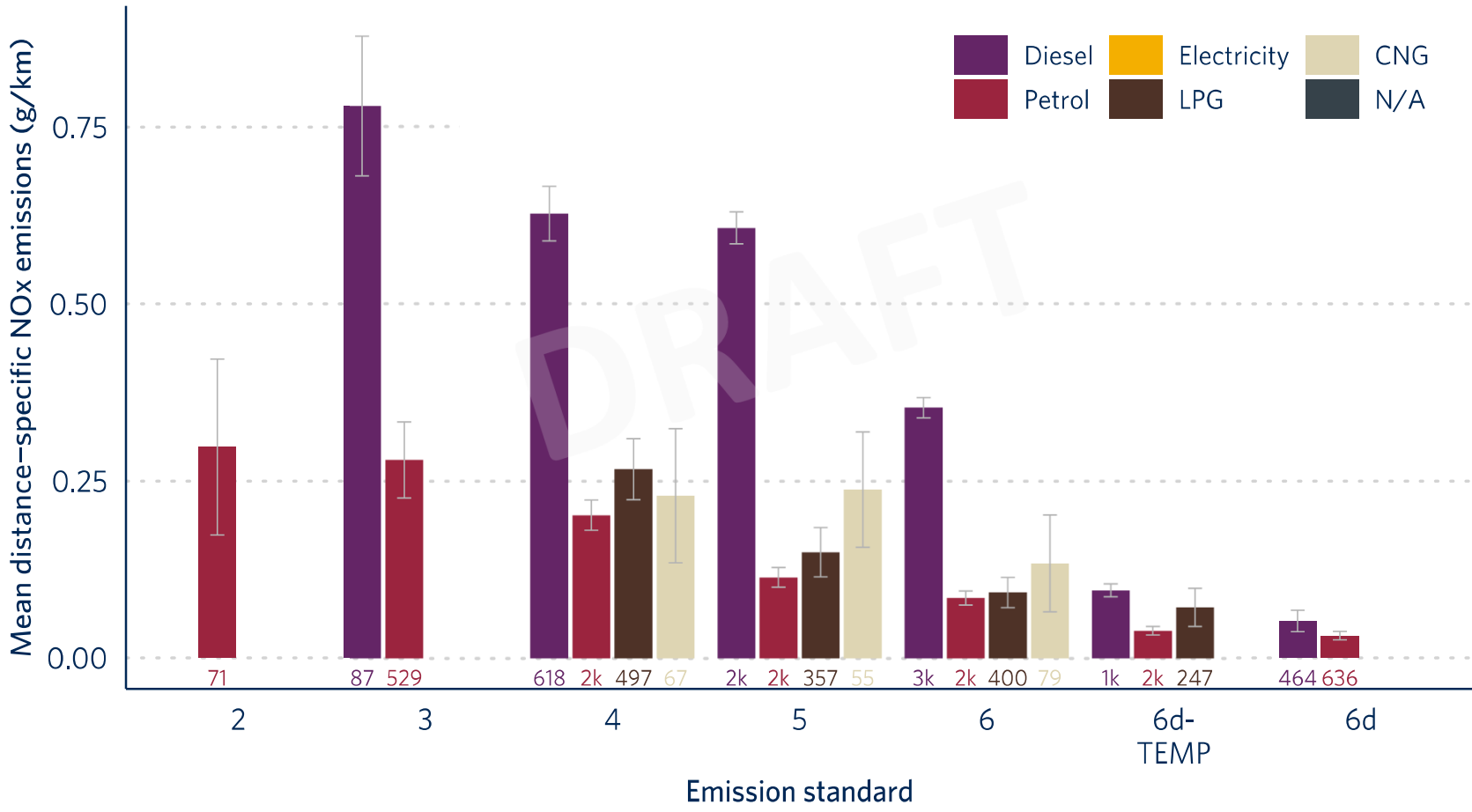
- Inside and outside Milan Low Emission Zone
- HEAT EDAR remote sensing – CO, NO, NO<sub>2</sub>, HC, PM, CO<sub>2</sub>
- Point sampling RES - PN, BC, NO<sub>x</sub>, CO<sub>2</sub>
- SIFT-MS measurements - speciated VOC, CO<sub>2</sub>
- Air quality monitoring station:
  - NO, NO<sub>2</sub>
  - CO, CO<sub>2</sub>
  - THC, NMHC, CH<sub>4</sub>
  - PM<sub>10</sub>, PM<sub>2.5</sub>, PM<sub>x</sub>, PN, BC
  - O<sub>3</sub>
  - Resuspension particles – EC, OC, metals
- PEMS measurements

## via Cilea

## via Bazzoni



# Preliminary res

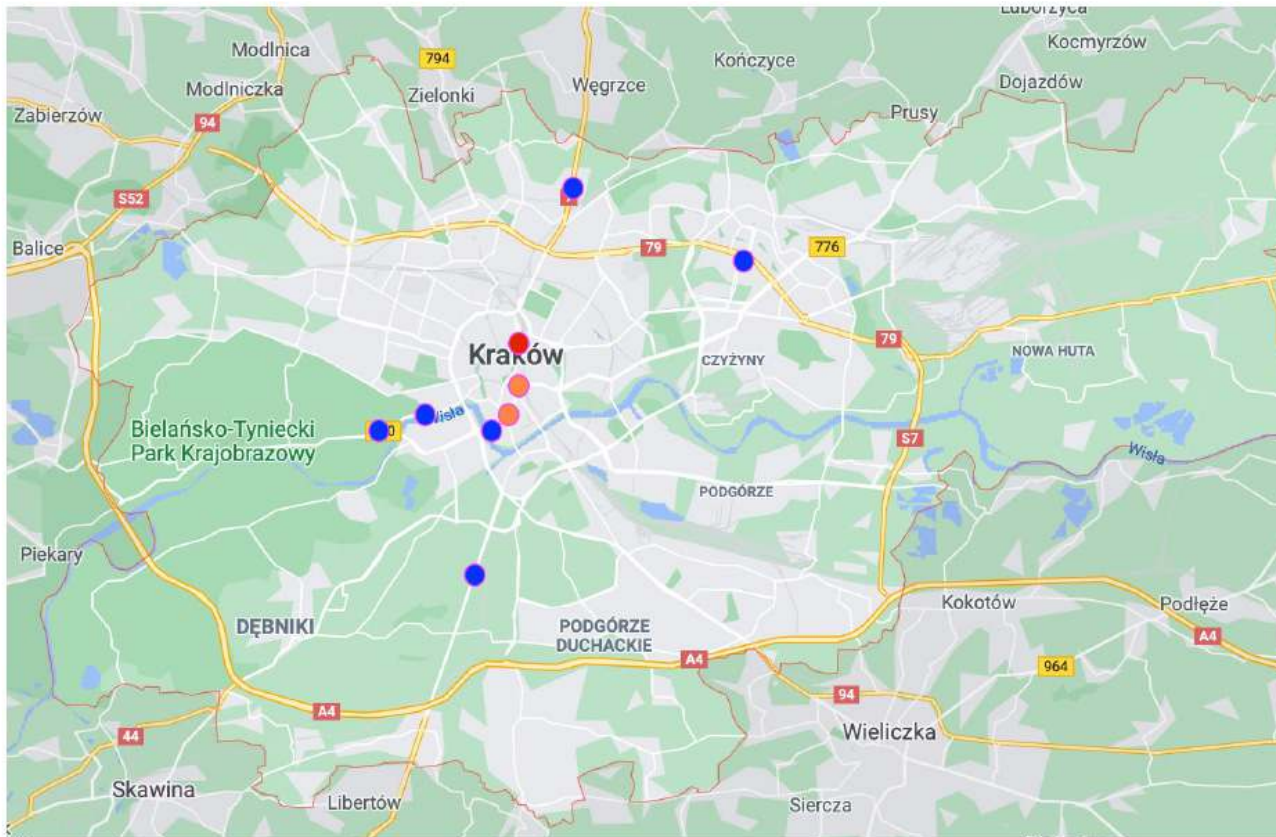


# Krakow measurement campaign





# Krakow measurement campaign



- Nine different measurement sites
- Opus RSD remote sensing (blue)
- Point sampling RES - PN, BC, NO<sub>x</sub> (orange)
- Collocation (red)



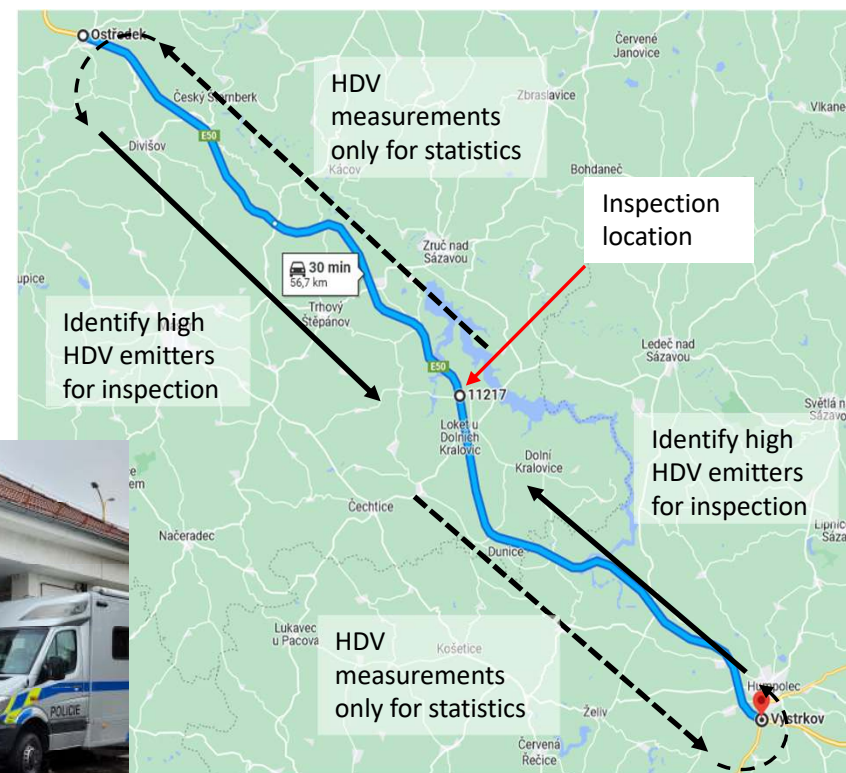


# Prague measurement campaign





# Prague – detection of HDV high-emitters

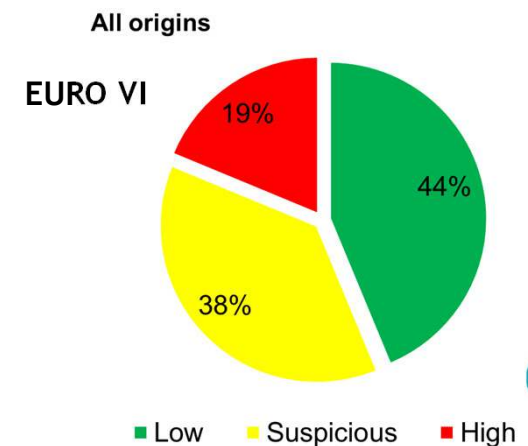
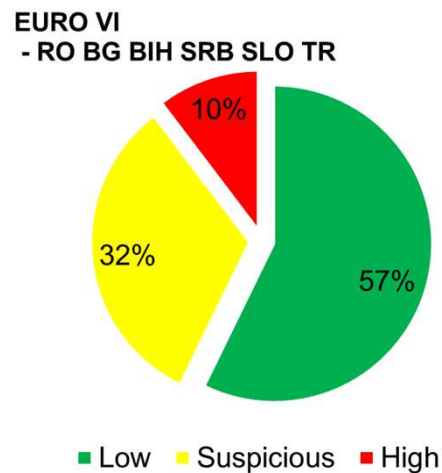
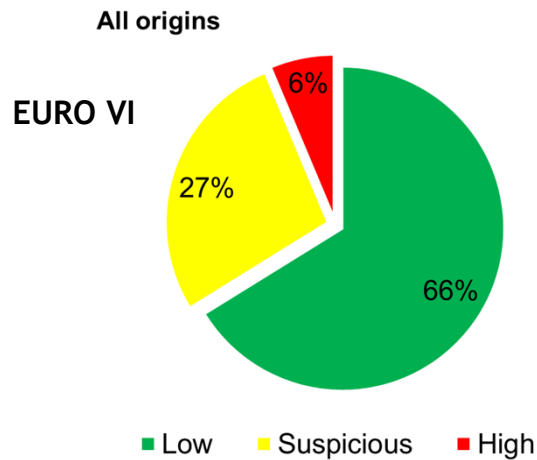
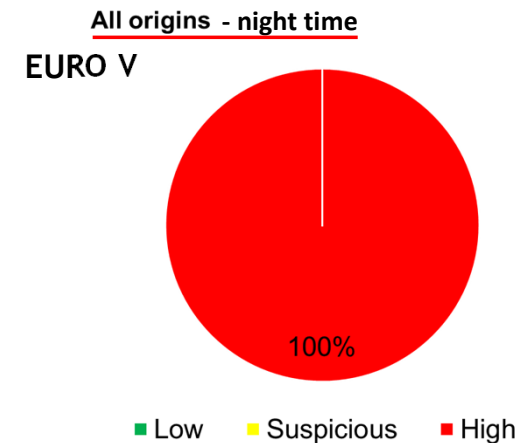
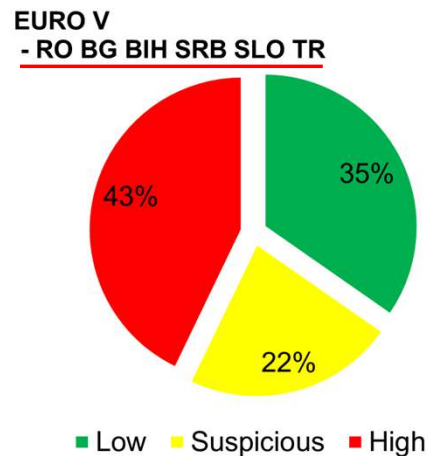
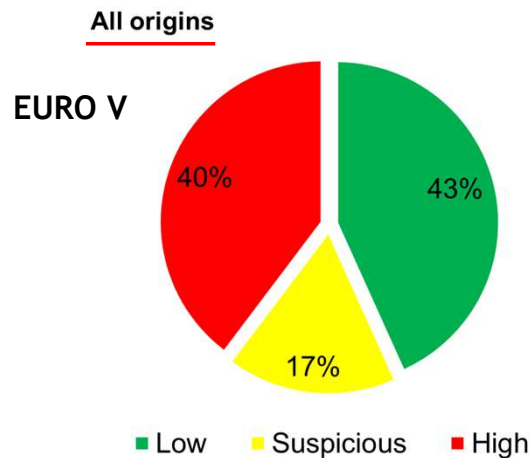


# Plume chase and vehicle pull-over



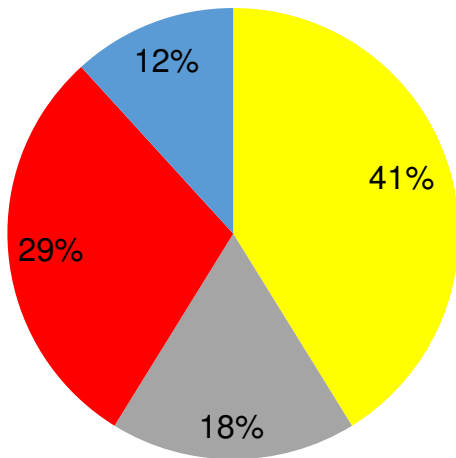


# Results from plume chase measurements



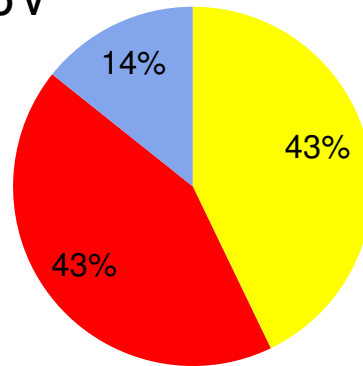
# Results from vehicle inspections

All inspected vehicles

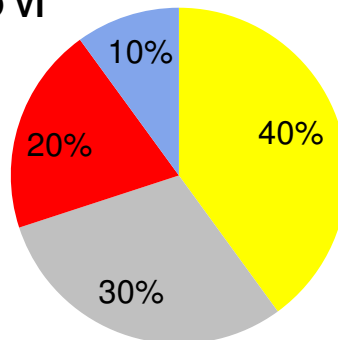


- No Error
- Defect / Error
- Software issues
- Manipulated
- Cold SCR

EURO V



EURO VI



# Achievements of the objectives (so far)

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- ✓ Improved the accuracy of measurements of **particulate matter**;
- ✓ Improved the detection of **high-emitting vehicles**;
- ✓ **Lowered costs** of remote emission sensing measurements;
- ✓ **Facilitated use by unskilled personnel** to achieve a broader deployment potential;
- Support local air quality plans;
- Establish a proper **data infrastructure** built around **vehicle registration databases**, **traffic management** measures and **air quality monitoring** systems.





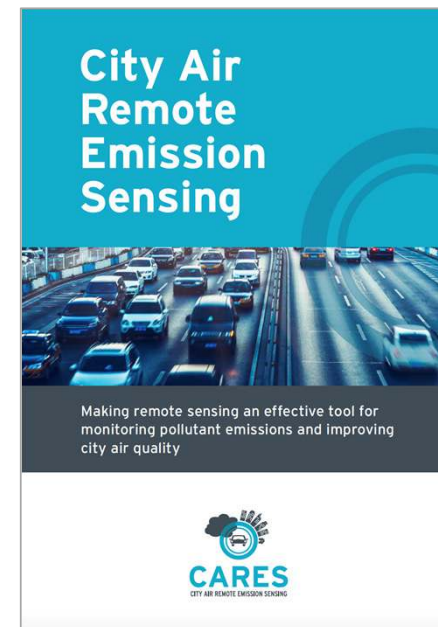
# Acknowledgements

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- Hager Environmental & Atmospheric Technologies (Milan)
- Opus Remote Sensing Europe (test track, Krakow, Prague)
- ACEM and Yamaha, the Netherlands (motorcycles to test track)
- JRC Ispra (PEMS measurements Milan)
- Bohemian Police and Vehicle Inspection Group (Prague)
- TÜV Nord (arranging Prague police inspections)
- Martin Kristensen, NO<sub>x</sub> Consulting (Prague HDV inspections)

# For further information

- Check the website: <https://cares-project.eu>
- Download the project brochure →
- E-mail contact: [ake.sjodin@ivl.se](mailto:ake.sjodin@ivl.se)
- Follow us on social media:
  -  [https://twitter.com/cares\\_project](https://twitter.com/cares_project)
  -  <https://www.linkedin.com/company/city-air-remote-emission-sensing-cares/>



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# Thank you for your attention! Questions?

