



# **Tendences of the content of nitrogen oxide and dioxide in the car interior air and the environment when operating on city highways during the “summer-autumn” season**

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# Investigation purpose

**This work is a continuation of work to determine the content of NO and NO<sub>2</sub> in the air of car interiors with different types of powertrains at "summer-autumn" season in road conditions with heavy traffic flow.**

**1-st Part : The results of tests performed in the "spring" season were reported in May 2023 (VIAQ-27-07);**

**2-nd Part: The results of tests performed in the "summer-autumn" season are reported here.**

# Investigation description

The tests were carried out on public roads in Moscow and Moscow region in the “summer- autumn” season – June- September 2023.

Driving cycle: start from 38 km of Dmitrovskoe highway (in Moscow region and Moscow). The total length of the driving cycle is 75 km.

The driving cycle consisted of two segments:

55% - urban cycle, speed less than 60 km/h

45% - high-speed cycle - speed from 60 to 100 km/h.

# Test objects



- 1. Lada Granta - petrol
- 2. Nissan Pathfinder - diesel
- 3. Volkswagen Tiguan - diesel
- 4. Hyundai Ioniq - electric
- 5. Sampling line for outer air

# Test equipment



Two gas analyzers R-310 with chemiluminescent detector for measuring NO and NO2  
Location in the cabin of tested car



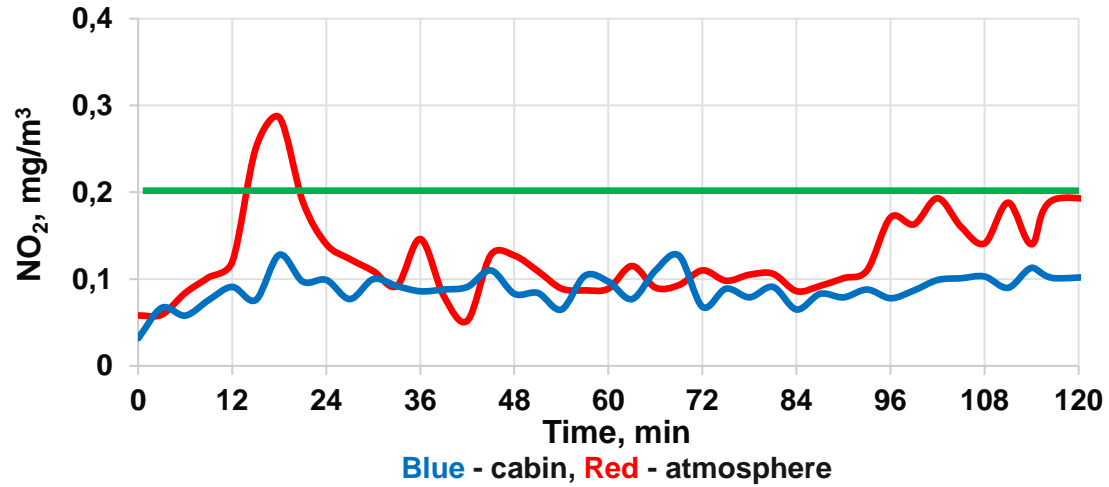
Vbox 3i Racelogic LTD for measuring distance, time, speed

# Test conditions

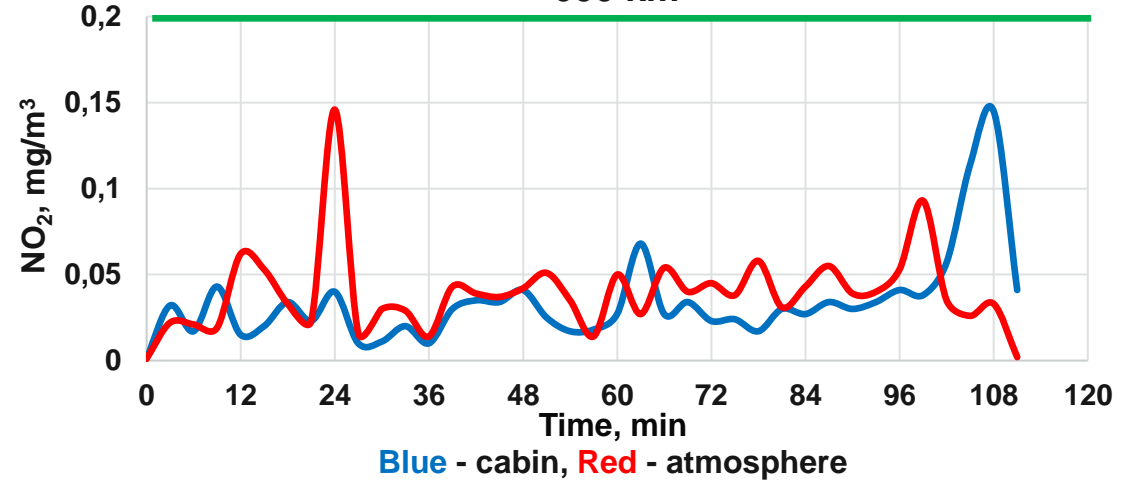
- 1 On each test car, 2 consecutive races were carried out, the second one was carried out next day.
- 2 Operating mode of ventilation, climate control, air conditioning systems:
  - forced ventilation is on, internal recirculation is off; automatic climate control system on, interior temperature was set at  $22\pm 1$  °C;
  - air conditioning system on, fan speed control on.
- 3 After driving tests in urban conditions, comparative tests were carried out on the roads of the Test Center (NICIAMT) in a clean atmosphere and absence of other vehicles. The driving route was as close as possible to the selected route in terms of the ratio of sections of the route to urban and high-speed traffic.

# Test results and discussion

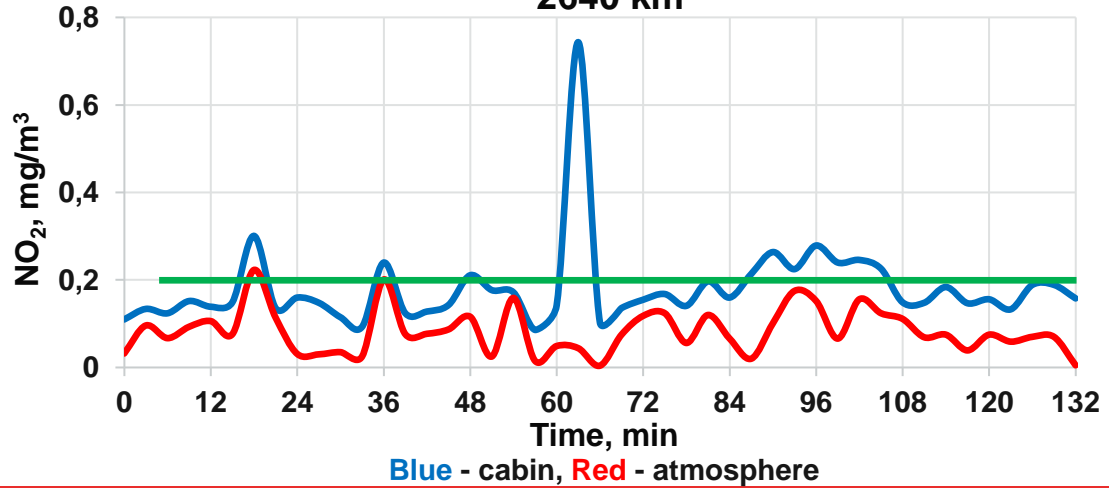
Lada Granta - petrol NO<sub>2</sub> dust and carbon filter



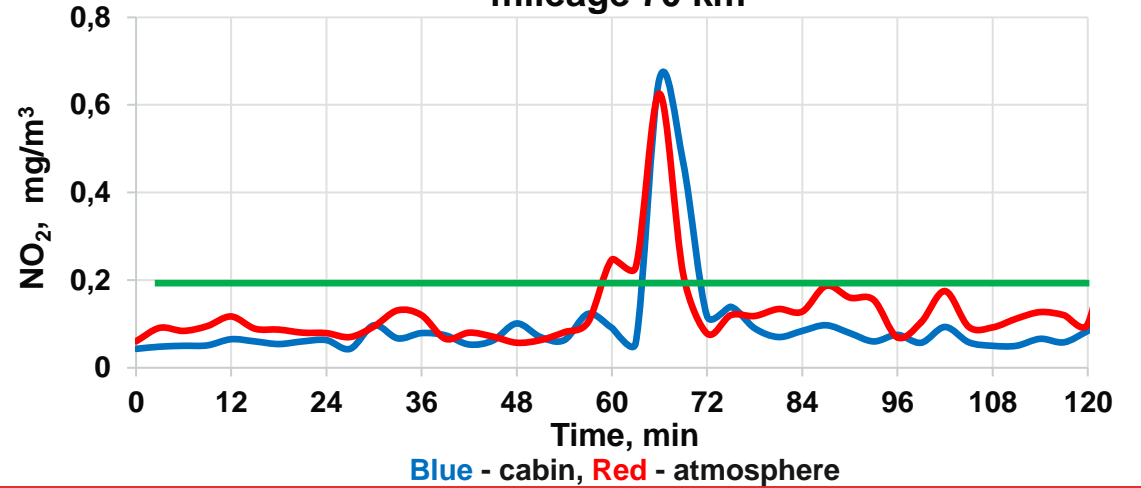
Lada Granta – petrol NO<sub>2</sub> carbon filter mileage 600 km



Lada Granta – petrol NO<sub>2</sub> carbon filter mileage 2640 km



Lada Granta – petrol NO<sub>2</sub> new carbon filter mileage 70 km

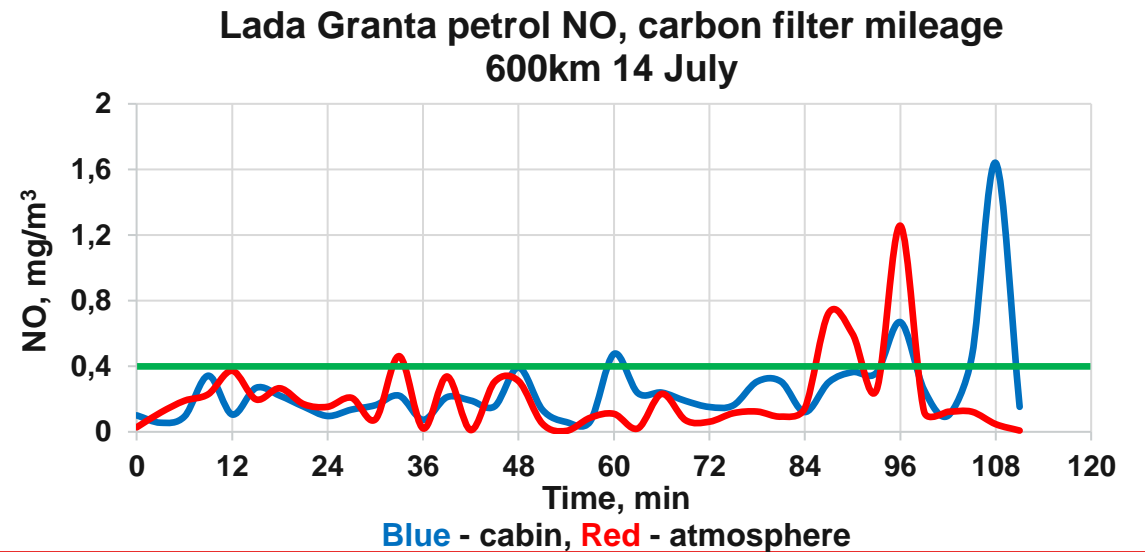
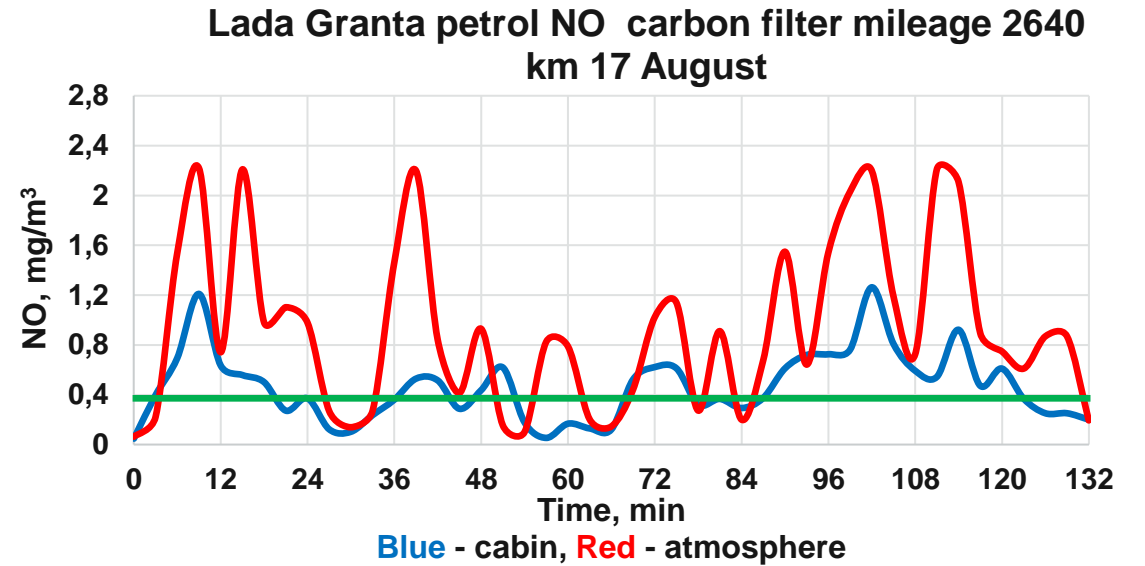


# Test results and discussion



## Carbon filter for Lada Granta

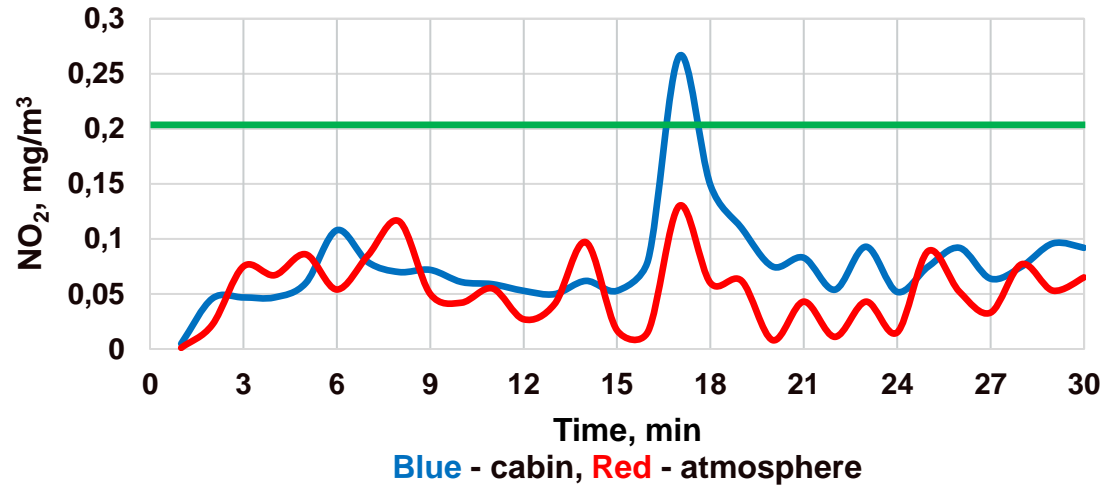
The carbon filter does not retain NO molecules, so an increased amount of it accumulates in the car cabin - above  $0.4 \text{ mg/m}^3$



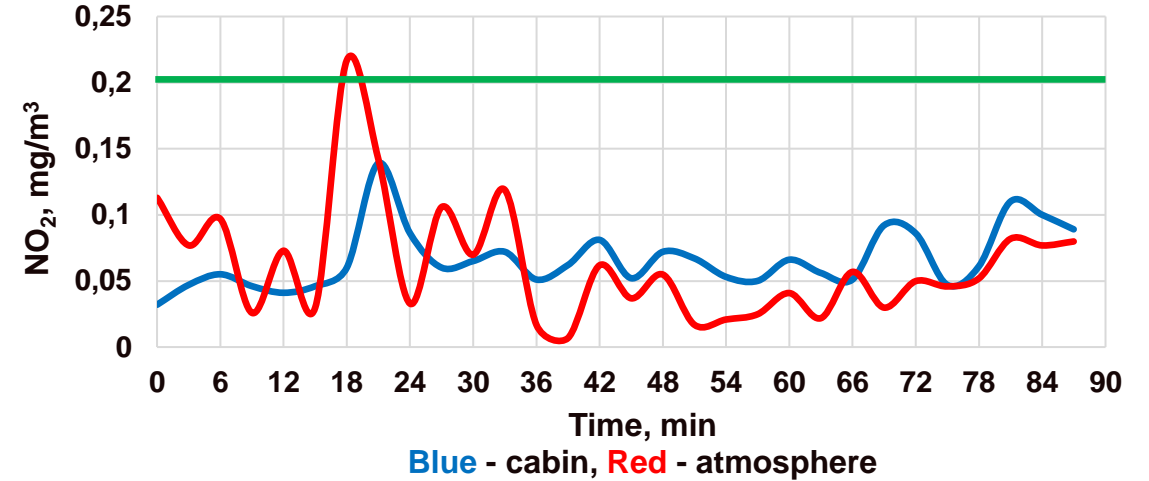


# Test results and discussion

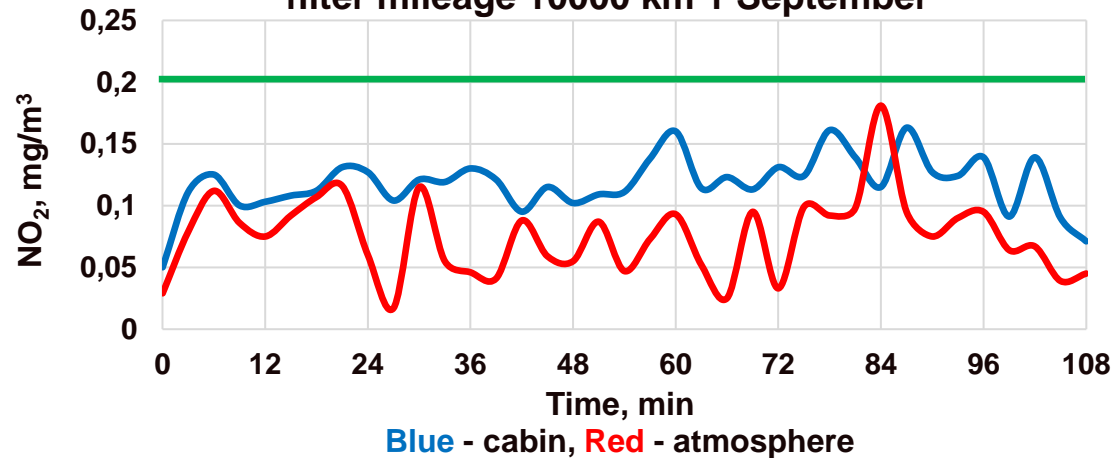
Electric car Hyundai Ioniq NO<sub>2</sub> standard carbon filter 1 June



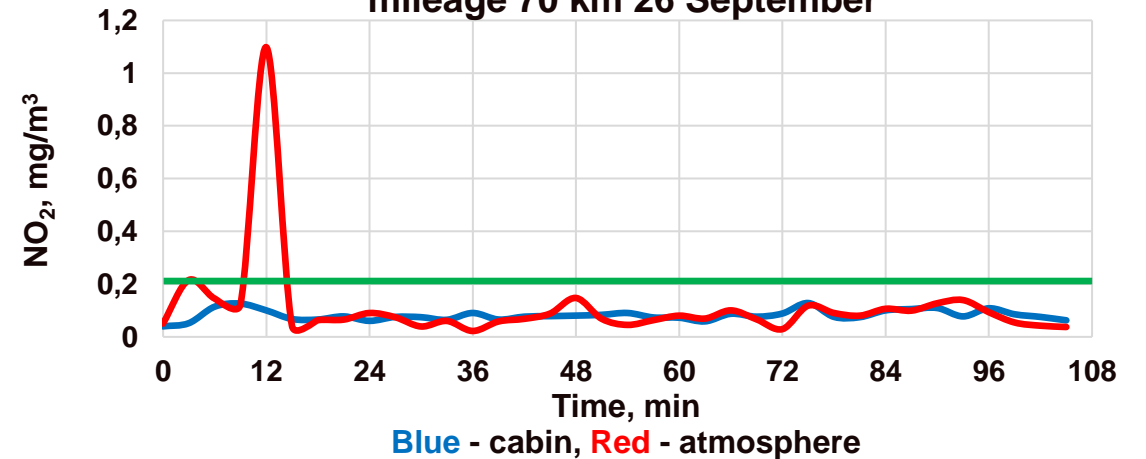
Electric car Hyundai Ioniq NO<sub>2</sub> standard carbon filter 8 June



Electric car Hyundai Ioniq NO<sub>2</sub> standard carbon filter mileage 10000 km 1 September

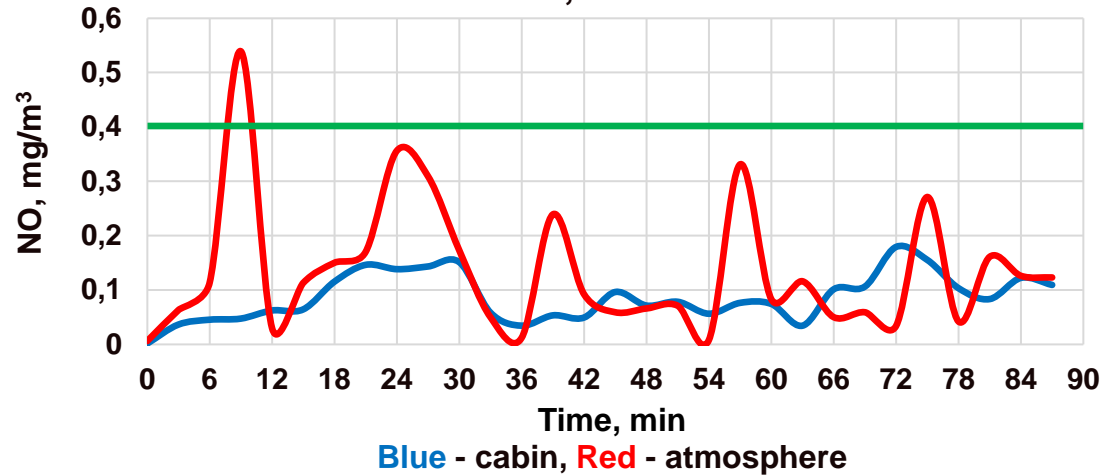


Electric car Hyundai Ioniq, NO<sub>2</sub> new carbon filter mileage 70 km 26 September

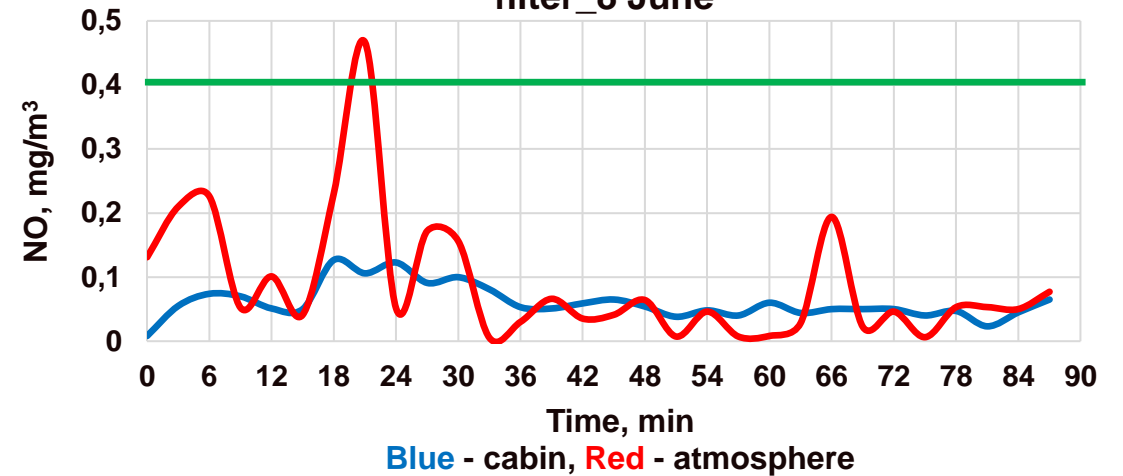


# Test results and discussion

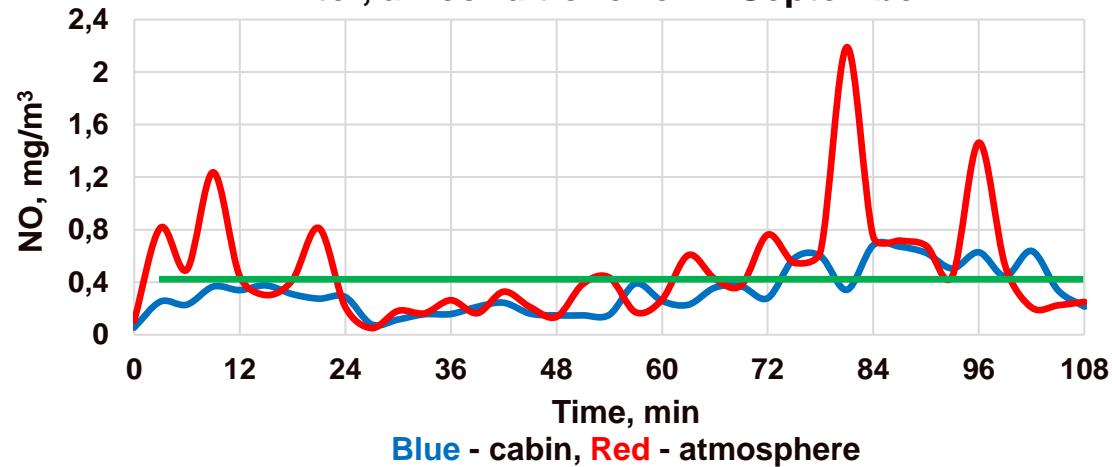
Electric car Hyundai Ioniq NO standard carbon filter, 1 June



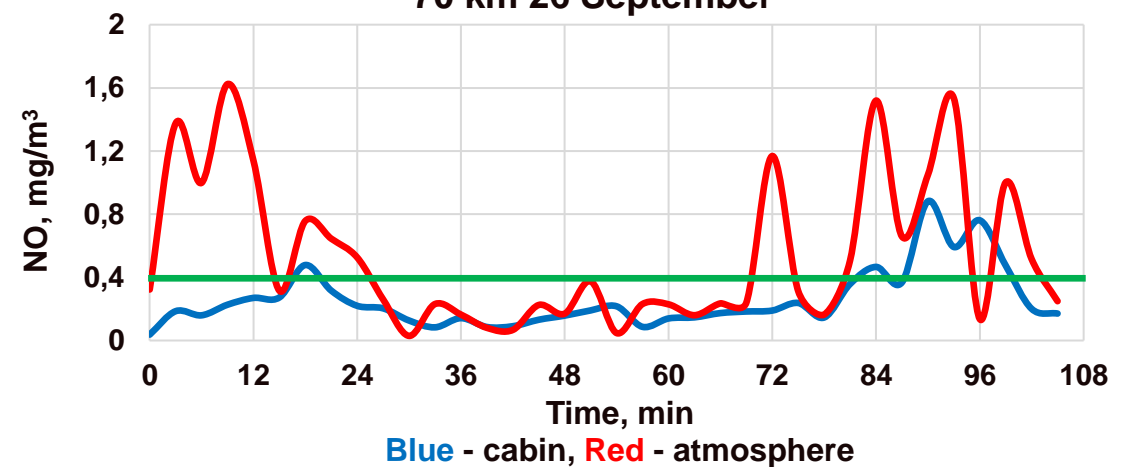
Electric car Hyundai Ioniq NO standard carbon filter\_8 June



Electric car Hyundai Ioniq NO standard carbon filter, air conditioner on 1 September



Electric car Hyundai Ioniq NO new carbon filter, 70 km 26 September



# Test results and discussion

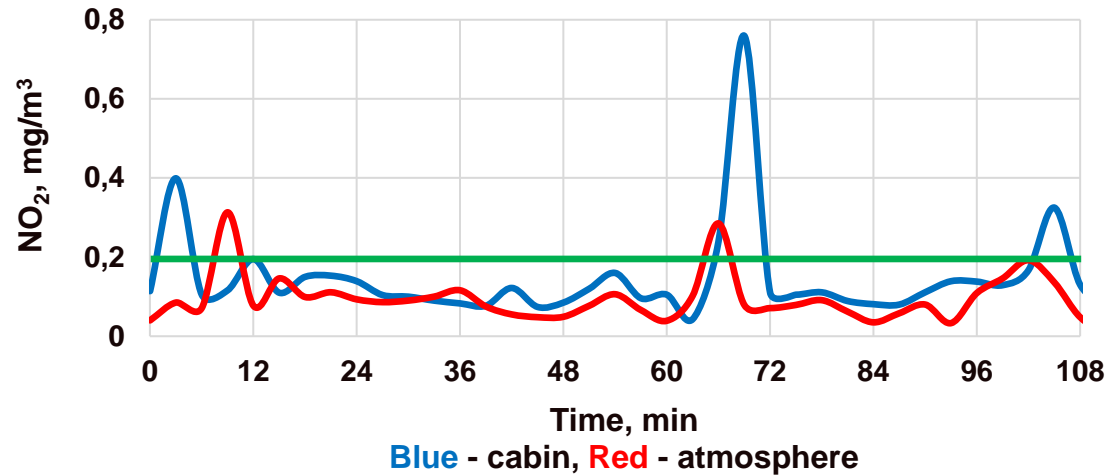


**New carbon filter for HYUNDAI IONIQ car**

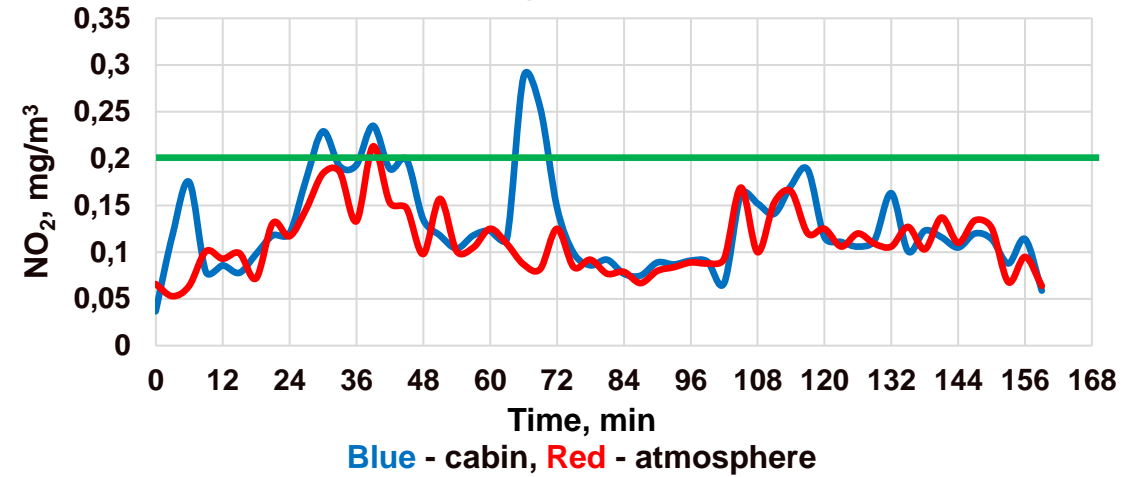
- 1. The average values of NO<sub>2</sub> in the cabin of electric car were in the range of 0.5-1 of limit value.**
- 2. The concentration of NO<sub>2</sub> in the cabin of electric car was always higher than in the atmosphere.**
- 3. The average values of NO in the cabin of electric car were in the range of 0.2-2 of limit value.**
- 4. The content of NO in the cabin of electric car was lower than in the atmosphere, where its concentration was up to 5 times more than limit value.**

# Test results and discussion

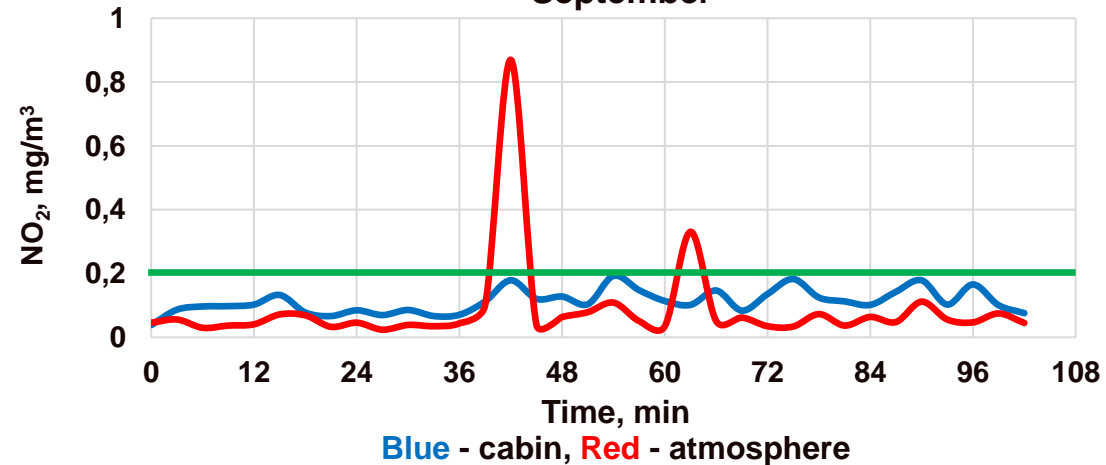
### Nissan Pathfinder diesel NO<sub>2</sub> dust filter 26 July



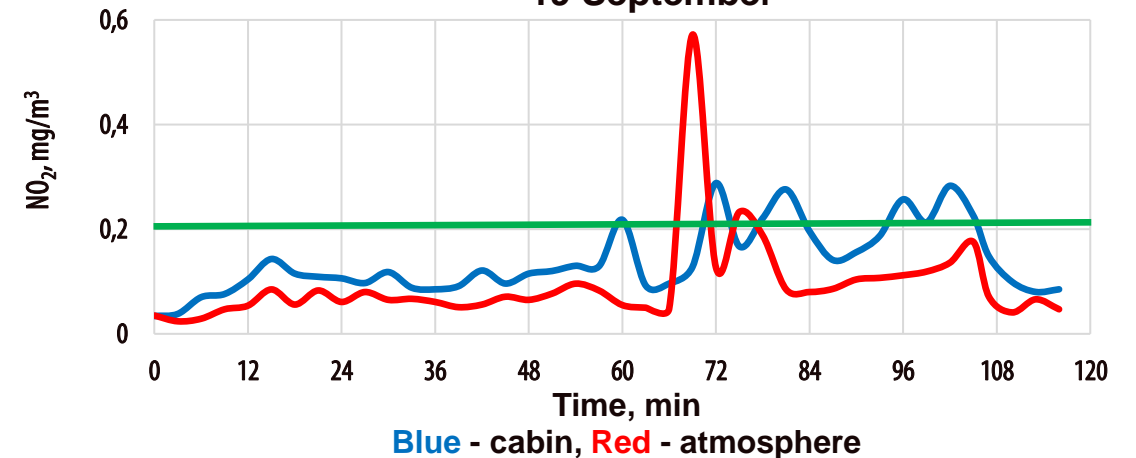
### Nissan Pathfinder diesel NO<sub>2</sub> new carbon filter mileage 80 km 26 July



### Volkswagen Tiguan diesel NO<sub>2</sub> air conditioner on, 18 September

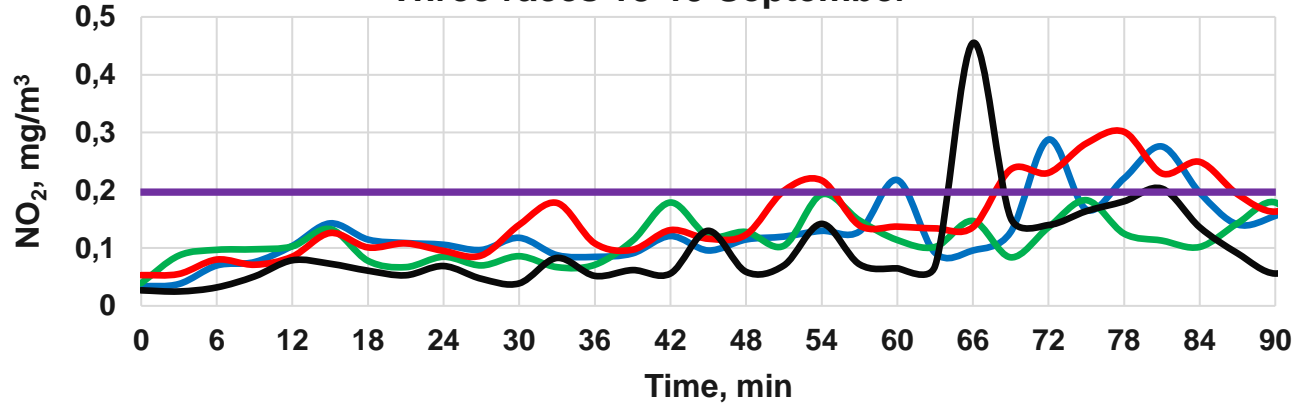


### Volkswagen Tiguan diesel NO<sub>2</sub> air conditioner off, 19 September



# Test results and discussion

Volkswagen Tiguan diesel NO<sub>2</sub>  
Three races 18-19 September

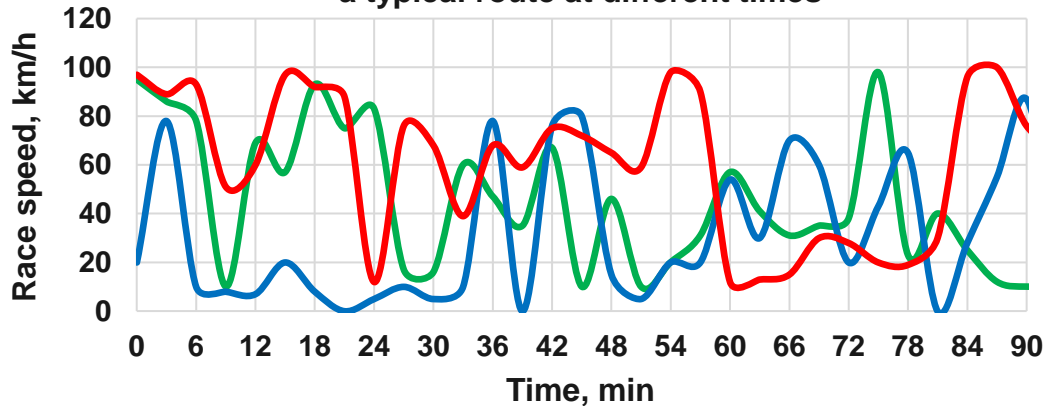


**Red** - cabin air conditioner off-19 Sept, **Blue**-cabin air conditioner on-19 Sept,  
**Green** - cabin air conditioner on-18 Sept, **Black**- atmosphere 19 Sept



Standard carbon filter for Volkswagen Tiguan  
after 10000 km

Changes in the speed limit structure when performing  
a typical route at different times



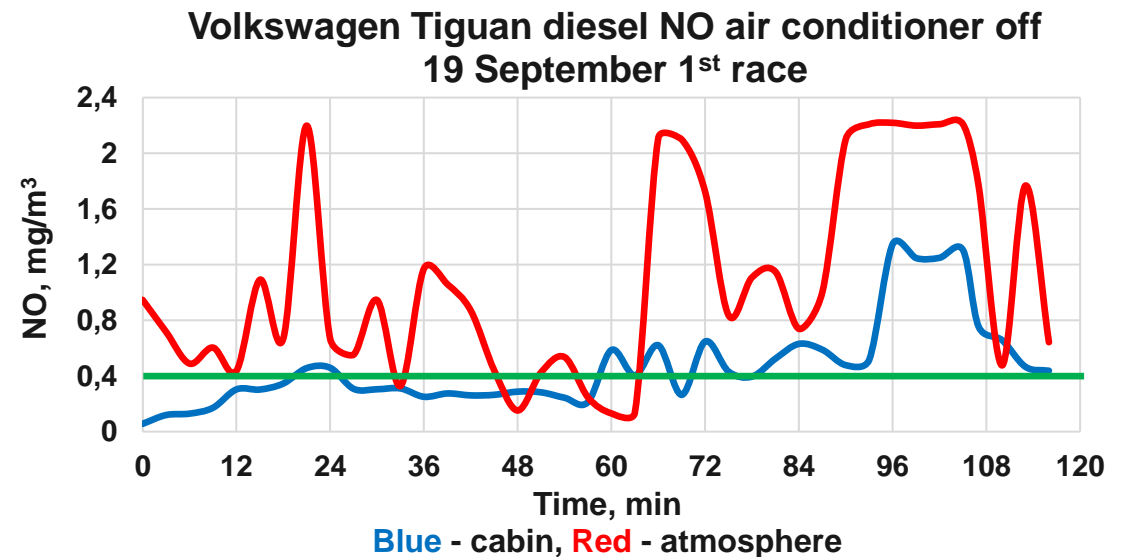
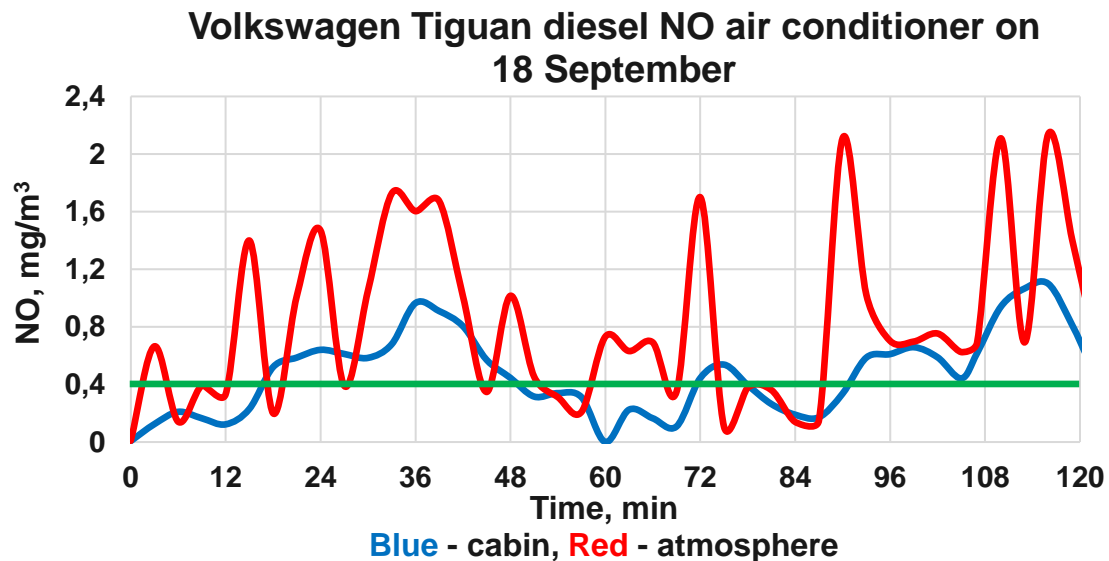
**Red** – 19 September-2, **Green** – 19 September-1, **Blue** – 18 September

The features of the speed depending on the intensity of traffic flows at different times.

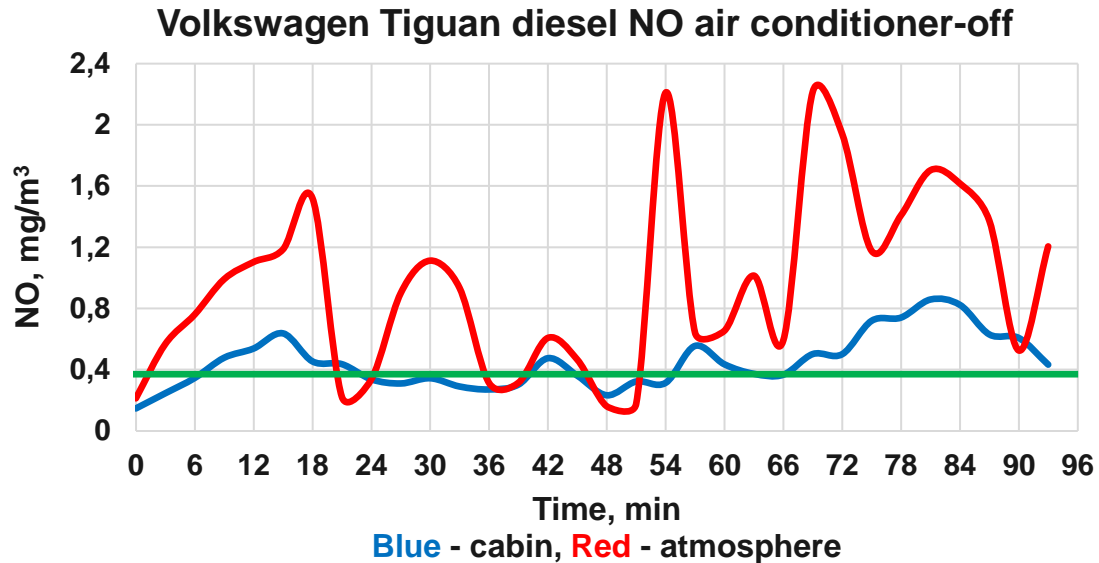
In each test the ratio of the “urban” and “high-speed” modes changes, but in general, the ratio is: at least 55% - “urban” mode with speeds up to 60 km/h and “high-speed” mode – with speeds higher than 100 km/h - 45%.

# Test results and discussion

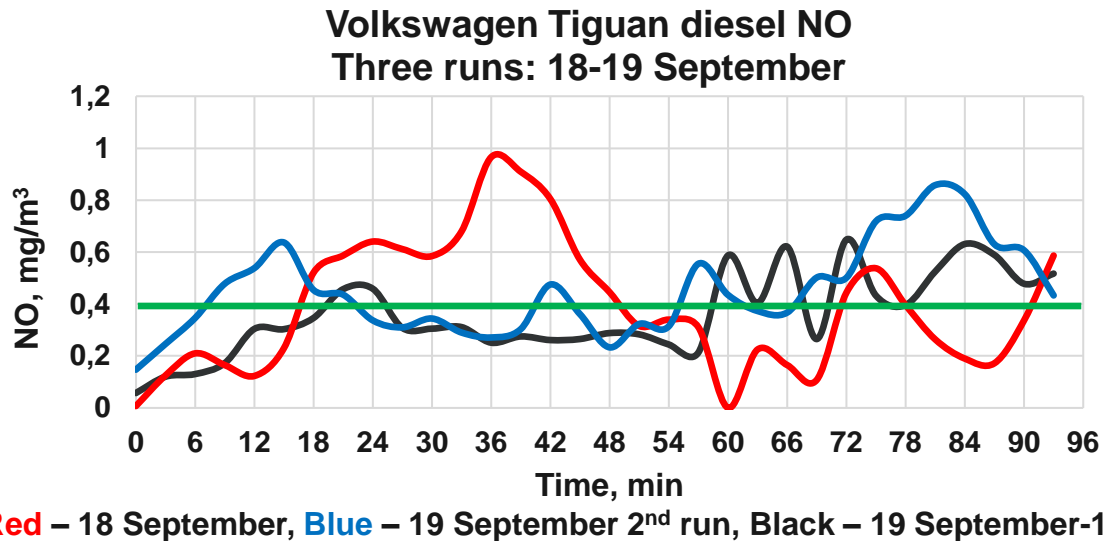
**NO<sub>2</sub>** concentrations in the car cabin with diesel engine have been **always** exceeded their concentrations in the environment. The level of **NO<sub>2</sub>** at the cabin air was **0.5-1.2** of limit value with both the air conditioner ON and OFF.



# Test results and discussion



When testing a car with a diesel engine, a significant content of NO was recorded in the environment in all three runs - 0.8-5.0 Limit value – 0,2 – 2,0 mg/m<sup>3</sup>



NO concentrations measured in three runs in the car cabin with a diesel engine were in the range from 0.5 to 2 of Limit value - 0,2-0,8 mg/m<sup>3</sup>

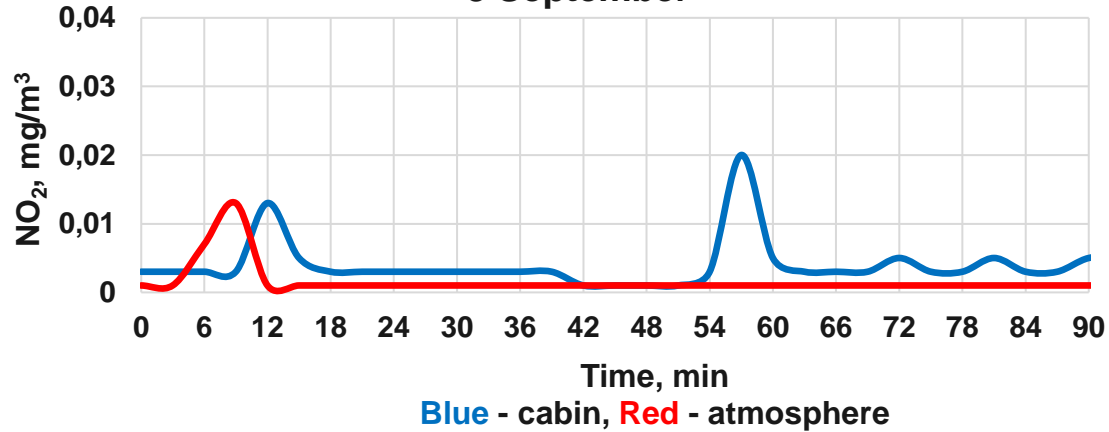
Red – 18 September, Blue – 19 September 2<sup>nd</sup> run, Black – 19 September-1<sup>st</sup> run



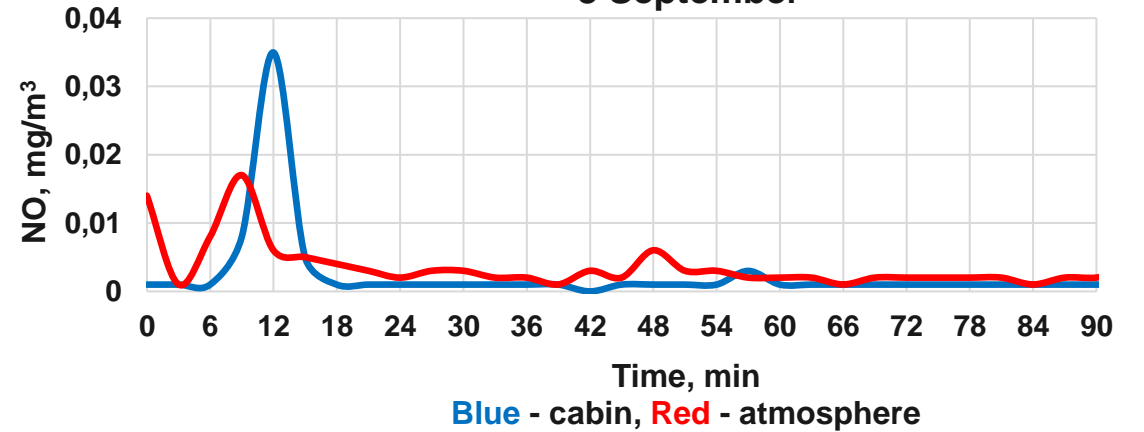
# Test results and discussion

## NICIAMT test roads

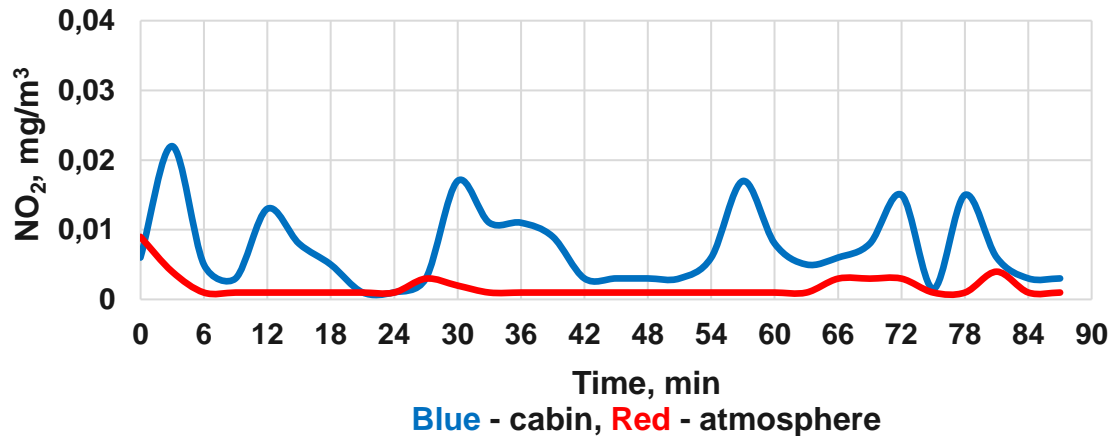
Lada Granta petrol NO<sub>2</sub> carbon filter 850 km  
8 September



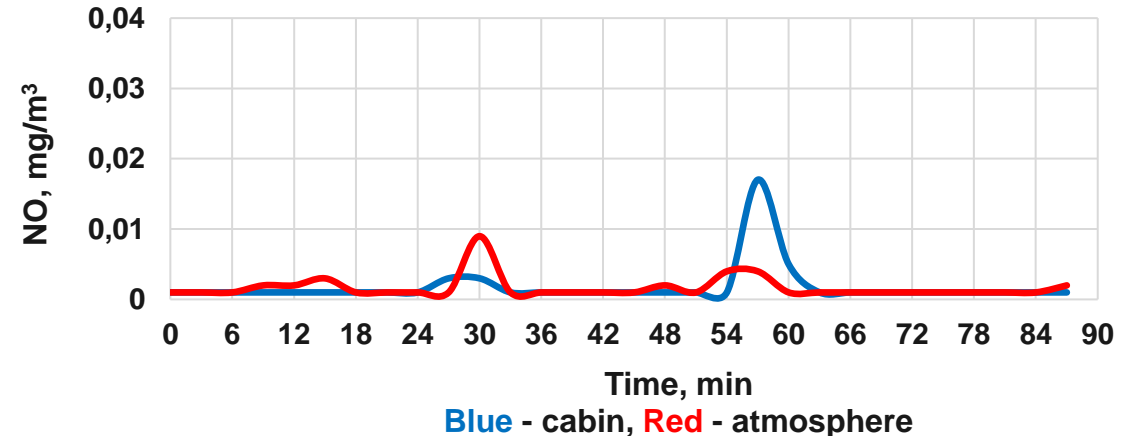
Lada Granta petrol, NO, carbon filter 850 km,  
8 September



HYUNDAI IONIQ NO<sub>2</sub> 2 June 23



HYUNDAI IONIQ NO 2 June 23



# Conclusions

- 1. Three cars with petrol, electric and diesel were tested according to a developed, approved driving cycle under heavy traffic conditions in season “summer-autumn”.**
- 2. Test results have not depended on the seasons.**
- 3. Significant amounts of NO and NO<sub>2</sub>, were detected in cabin air at the level of 0.5 -2.0 of limit value.**
- 4. The concentrations of NO and NO<sub>2</sub> measured in the cabin air of the test vehicles in a clean atmosphere were practically equal to zero.**
- 5. “Green” electric car, safe for the environment, is not safe for passengers and driver, since the content of pollutants (NO<sub>2</sub> and NO) in the car cabins was the same as at the car cabins with other types of engines (petrol, diesel): 0.5 -2.0 of limit value and sometimes was higher than in the outside air.**
- 6. It is necessary to include NO together with NO<sub>2</sub> to the list of test substances because the mechanism of their influence on the human body is different and cumulative effect of both oxides is possible inside the cabin:**
  - NO - affects the hematopoietic system;**
  - NO<sub>2</sub> - affects the respiratory system.**

**-NAMI-**

**Thank you  
for your attention**

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