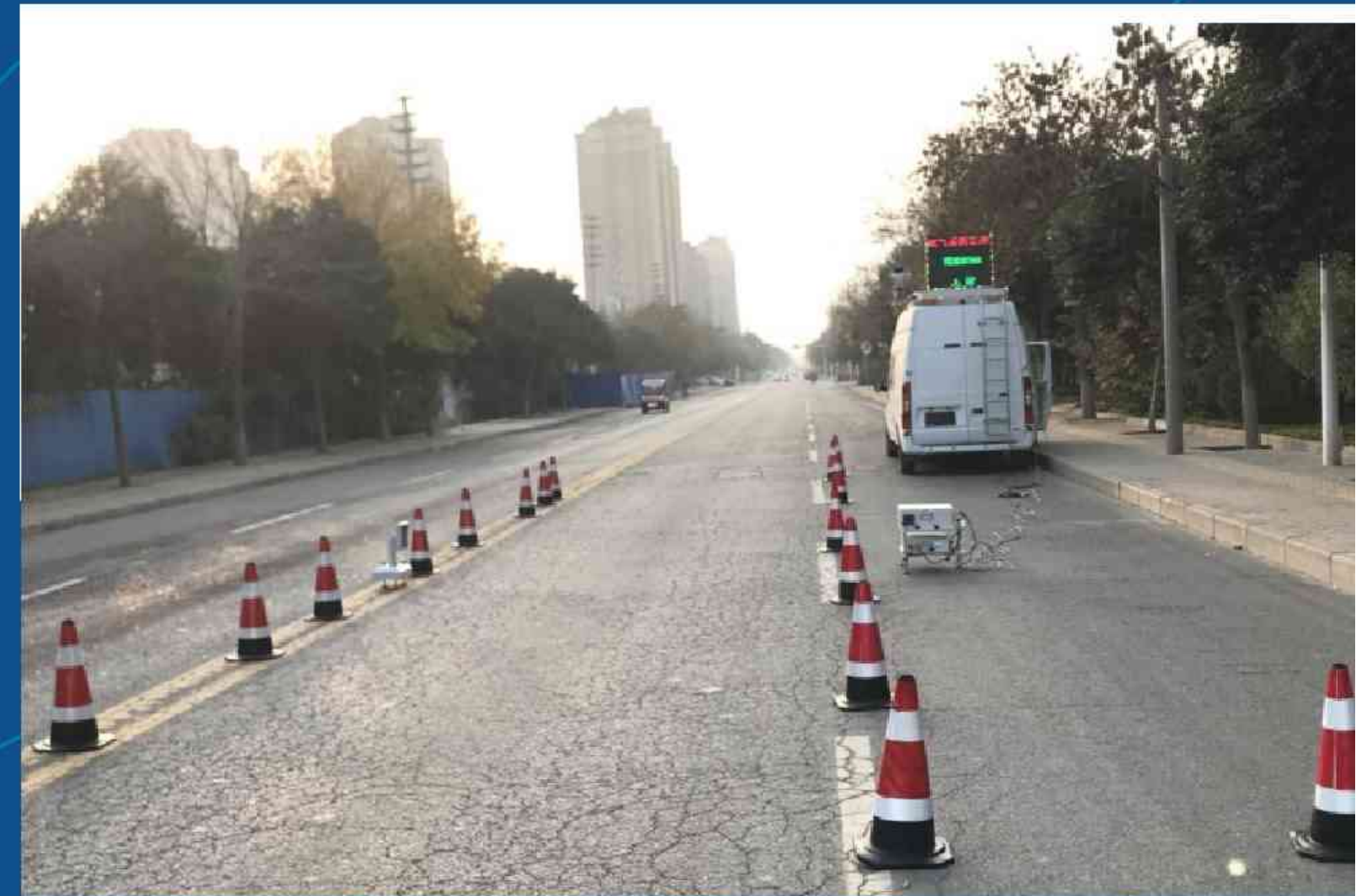




**浙江多普勒环保科技有限公司**  
ZHEJIANG DOPLER ECO-TECHNOLOGIES CO., LIMITED

**Clean The Air  
Better Our Life**



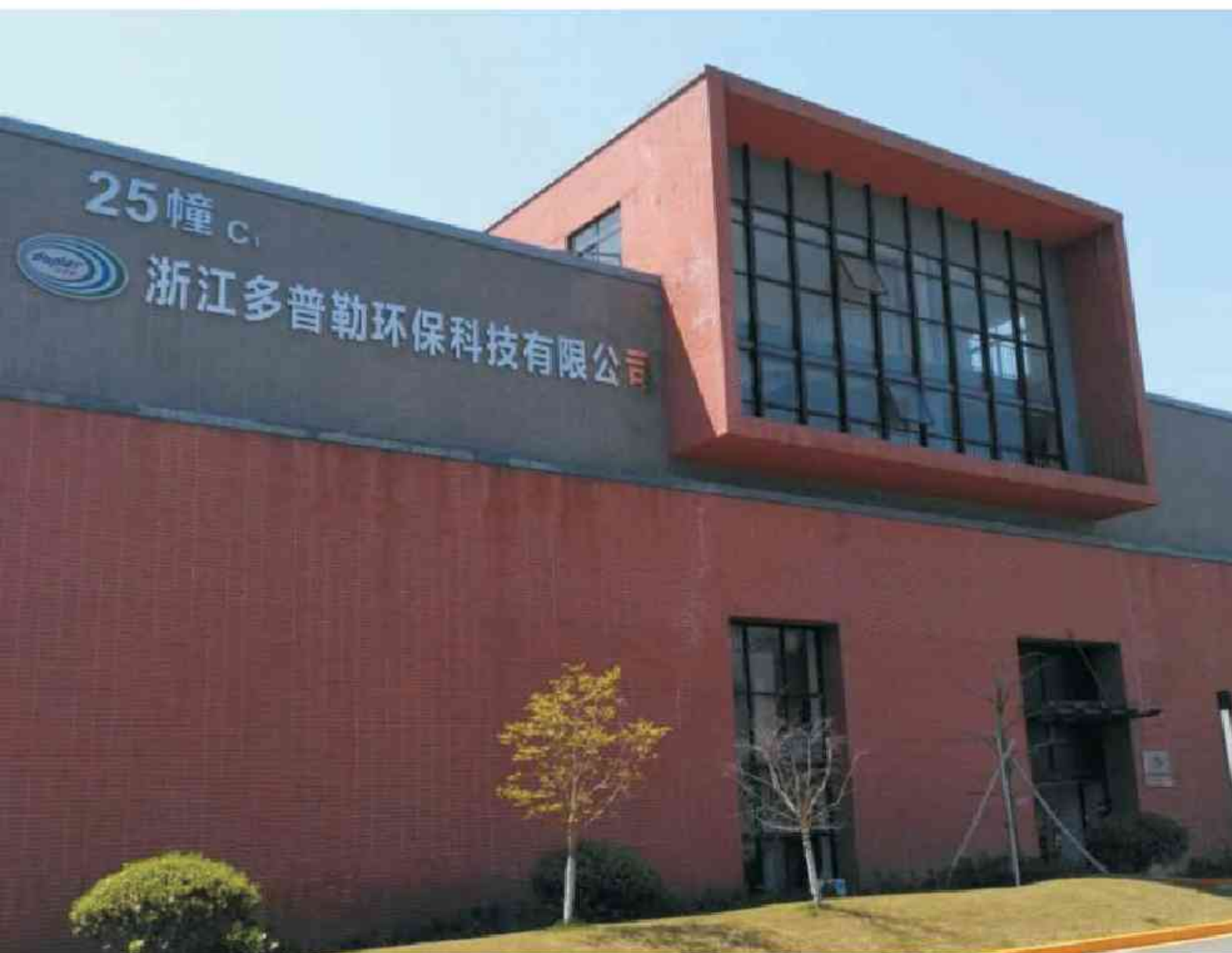
**All Laser Based Remote Sensing Device for Vehicle  
Exhaust Measurement -- DPL8000**

Zhejiang Company  
Address: C1, Building 25, Mold Industrial Park, Binhai New Area, Southern Ningbo, Ningbo City, Zhejiang Province  
Phone: +86-574-59952529

Beijing Company  
Address: Rm. 2206, Tower C, Golden Changan Plaza, 82 East Fourth Ring Middle Road, Chaoyang District, Beijing  
Phone: +86-10-52080114  
Website: <http://www.dopler.com.cn>



**浙江多普勒环保科技有限公司**  
ZHEJIANG DOPLER ECO-TECHNOLOGIES CO., LIMITED



## Enterprise Profile

Dopler Eco-Technologies Co.Limited is a high-tech enterprises which is engaged in atmospheric environment monitoring field and provides state-of-art products, services and integrated solutions for atmospheric environmental monitoring and vehicle exhausts. We provide the vehicle exhaust remote sensing device (RSD), vehicle exhaust portable emission measurement system (PEMS), aerosol particles measurement instruments and air filtration test stands. We have wide and close connections with high-tech talents and atmospheric environmental experts. We always takes "clean the air, better our life" as our target and responsibility. Our team have nearly 15 years experiences of atmospheric environmental instrumentations, sales and services.

## Vehicle Exhaust Testing Team

From 2011 on, our vehicle exhaust testing team has been focusing on "real exhaust emission on road" and starting the use of PEMS and RSD in China. Now, we are the biggest PEMS supplier/service provider and one of the biggest RSD supplier/service provider in China. For RSD, we have near 12 years using experiences and 6 years developing experiences. Nearly 100 sets of our own developed unit have been set up to provide testing service for different local Chinese EPB. Our team have about 90 hard-working and professional employees to service our customers and distributors.



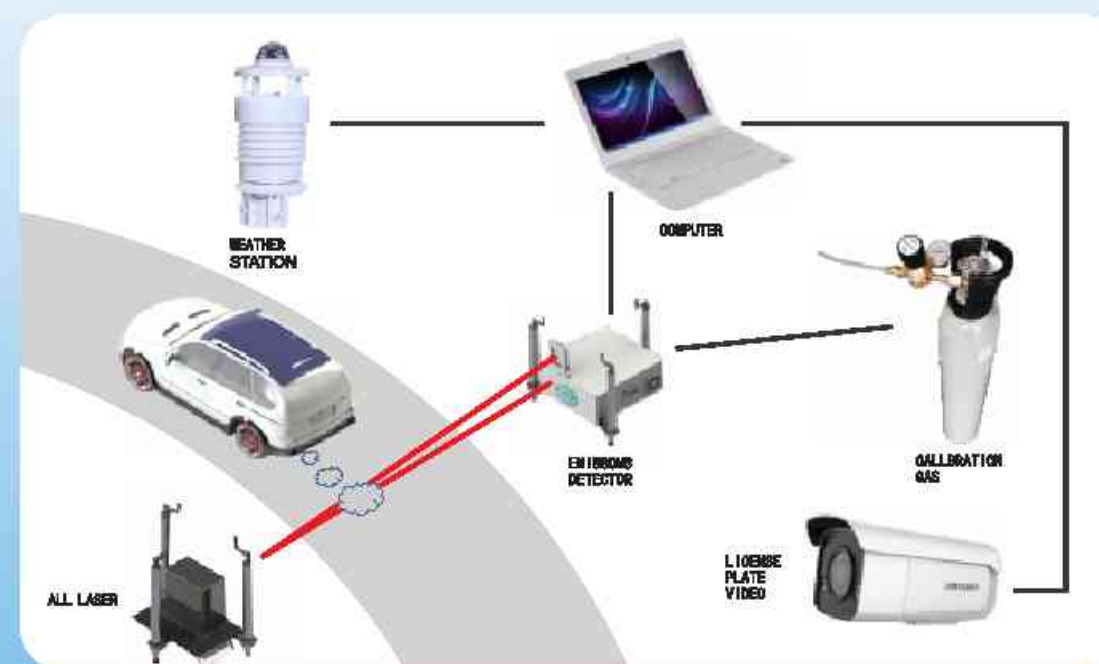
## overview

More and more vehicle manufacturers have been found to "cheat" in the very specific conditions of laboratory emission test programs, as opposed to designing effective control of emissions during real-world driving. Consequently, many cars emit pollutants such as nitrogen oxides (NOx) at rates significantly higher than nominal regulatory limits when driven in real-world conditions. These excess emissions have exacerbated urban air quality problems and have been linked a lot of premature deaths each year.

Since the 1980s, remote sensing (RS) technique of vehicle exhaust emissions have been applied in the USA, Europe and Asian. Different with laboratory testing methods, the RS technique measures exhaust emissions by absorption spectroscopy without interference with the vehicle, its driver, or the driving. The concentrations of CO<sub>2</sub>, CO, HC, NO<sub>x</sub> and PM in the exhaust plume can be obtained in only 1~2 seconds, which makes it possible to test thousands of cars in one day. The large sample sizes with RS mean it is well-suited for fleet screening, high-emitting identification and effectiveness evaluation of emission-control programs. In addition, RS technique can be used to detect individual tampering and encourage proper maintenance of vehicle emission control systems.

## principle

The system is fixed beside the road and the detecting light beam looks the road from the light source consist of five lasers which are collimated into one beams. The beam is reflected back the detectors and the concentrations of the pollutants are measured based on TDLAS technique and time-sharing scanning method. A camera is used to capture the photo of the passing vehicle to the vehicle license plate number. The speed and acceleration of the vehicle are accurately measured by a speed measuring device using the principle based on multi-point beam-cut measurement or radar multi-point measurement, which is used to estimate the operational condition of engine. A weather station is used to measure the environmental parameters around the testing site. A computer nearby is used to control the system and data processing.





## 1 Source Emitting and Detecting Module (SDM)

For each channel, a wavelength optimized laser is chosen including one QCL for NO channel at near 5263nm. A built-in sealed gas cell is fixed to lock the emitting wavelength of lasers to ensure the measurement precision.. All the lasers are optimized to scan at rate from 7kHz~13kHz. Three different detector are used to cover all the laser wavelength from 520nm to 5263nm and the original TDLAS signals are averaged 17~23 times to get one data point. A built-in open calibration gas cell is used to do the calibration. Two visible laser beam (green and red) are used to help do the system collimation during system fixing and automatic signal gain technique are used to facilitate the operation.

### Source Emitting and Detecting Module (horizontal stationary setup)

Source emitting unit and detecting unit are designed to be separated and the detecting beam could goes through the exhaust plume twice. The distance between to top and the bottom of the beam can be adjusted and the total height of the beam can also be adjusted very easily to satisfy different tail type. The promised optical length of the system (from the source to the reflection unit) is 14 meters. It can also be used as mobile type.



SDM for horizontal stationary setup  
\*Source (top), Detector (bottom)

### Source Emitting and Detecting Module (mobile setup)

Source emitting unit and detecting unit are designed to be together. The small plate is used to do the second reflection of the detection beam. The optical beam could pass through the exhaust plume four time. The promised optical length of the system is 8 meters.



SDM for mobile setup

## Reflection Module (RM)

The collimated laser beam at the source emitting window is about 0.5cm in diameter. After reflecting back to the detector window, the beam spot is about 20~30cm in diameter at 10 meters optical length. The large beam spot is advantageous to the light regulation and the anti vibration performance of the system is very good. The light beam adjustment can be completed within 5 minutes with the help of the auxiliary mirror even under the condition of strong external light. All the reflectors are design to be very cheap or to be protected very well.

For horizontal stationary setup, an aluminum plate, which is a pure physical structure and with no additional power supply, is used to reflect the combined laser beam back to the detector window. All these aluminum plates are designed and manufactured to provide good reflectivity, a certain diffuse reflection performance, long term use and easy maintenance and low cost at the meantime.



Aluminum Reflector  
(horizontal stationary setup)



Mirror Reflector  
(for mobile setup)



Second Aluminum Reflector  
(for mobile setup)

For mobile setup, a mirror with surface coating (gold, aluminum or silver) and a second aluminum plate are used to reflected the laser beam. The materials used in the second aluminum reflector is the same with that used in the horizontal stationary aluminum reflector. The coated mirror is fixed in a thick metal box with fine height adjusters which protects the mirror from damaged when setting up on road temporarily.

## 3 SDM platform



The platform is designed for horizontal stationary or mobile setup of the SDM. It provide fine adjustment for SDM beam height and height between the source unit and detector unit, which helps to cover more vehicle types with different height of tail pipes.



#### 4 Video License Plate Recognition Unit

HD video license plate recognition unit mainly includes HD camera, lens, supplementary light, license plate recognition software, transmission system, central application system, etc., through the analysis of captured pictures to identify the license plate.

Note: software development needed for foreign license plate

#### 5 Speed/Acceleration Detection Unit

The speed/acceleration detection unit measures speed and acceleration using either a photo-cut speed measuring pole or a multi-point radar.

#### 6 Micro Meteorological Monitoring Station

The micro meteorological monitoring station adopts fully digital high-precision sensor, including ultrasonic wind speed sensor, wind direction sensor, high-precision digital temperature sensor, humidity sensor, pressure sensor. The lightweight and compact structure and the high-strength structure design enable the meteorological station to work stably for a long time in harsh weather environments, providing accurate environmental parameters for remote sensing measurements.

#### 7 System Control and Data Validation Analysis Software

The system control software integrates multiple functions such as calibration, test, data processing and data statistics.

All the original data will be reserved for each test, and it can be viewed in real time on the software interface (limited to the latest 100 items). Further analysis can be carried out by means of the data validity analysis software, including linear fitting degree, maximum plume increment, background value change and other factors that are very critical to judge the validity of measurements.

Note: Data validity analysis software is an offline analysis software.



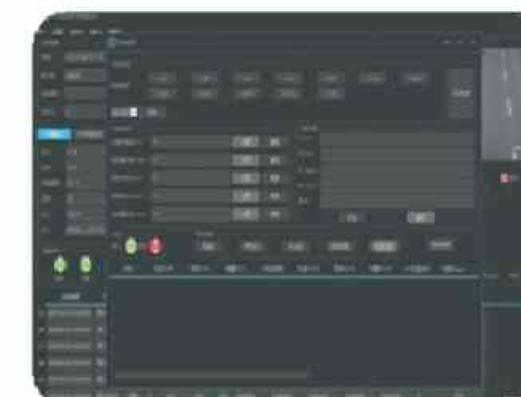
Software operation interface



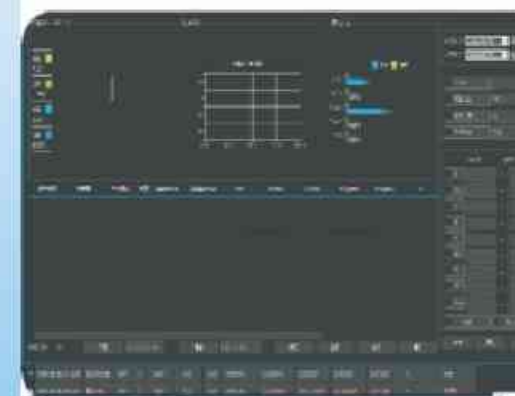
View interface for raw data of measurement process



Manual calibration interface



automatic calibration interface



Statistics interface



Data validity analysis software interface



## 8 Vehicle Exhaust Measurement and Data Analysis Services

Based on our DPL8000 system, we can provide vehicle exhaust remote sensing monitoring and analysis service based on the original diffuse data, including the further analysis of subsequent data. On the premise of obtaining the annual vehicle exhaust inspection data, the analysis process and service includes:

1. Collect the gaseous pollutant concentration and smoke intensity collected by mobile and stationary remote sensing monitoring equipment on the road, and identify the corresponding vehicle license plate number.
2. Eliminate invalid emission data and data of non-conforming test quality.
3. The remote sensing recognition information of vehicle license plate is matched with vehicle information database (vehicle registration information database and vehicle insurance mark database, etc.), in order to get vehicle model year, inspection period information, vehicle manufacturers, vehicle type, vehicle quality and other information.
4. The collected large sample remote sensing monitoring data are tested to screen effective data that could be used for subsequent statistical analysis.
5. Statistics are made on the overall distribution of emission concentration and smoke intensity obtained by remote sensing device, and the results were compared with those of other cities in China and abroad to evaluate the overall emission level of urban motor vehicles.
6. According to vehicle first registration year, vehicle age and emission standard, the distribution interval of emission concentration and smoke degree of gas pollutants are calculated, and the statistical results are compared with those of other cities in China and abroad.
7. The multi-year remote sensing monitoring data are compared, and the statistical results of this year's remote sensing monitoring data are compared with the historical statistical results according to the classification of the first registration year, vehicle age and emission standards, so as to analyze the multi-year changes of vehicle emission level.
8. Gaseous pollutant concentration is respectively transformed of emissions into emission factor (in unit of mg/L) based on the fuel consumption rate and based on the mileage (unit for g/km, commonly used in emission model), respectively according to the vehicle first registration, vehicle age and emissions standards, statistics distribution range of gas pollutants are obtained.
9. Through analysis and comparison of remote sensing data samples grouped by vehicle manufacturers, vehicle type, vehicle age and remote sensing monitoring sites, the vehicle sample group with significantly higher overall emission level or with a larger proportion of high-emission vehicles were selected.

## 9 Smoke Video Capture System

Benefitting from the development of low cost HD camera, image processing chip, high speed network transmission and AI technologies, smoke video capture system is now used in China to find the most dirty diesels which are emitting black smoke automatically on road without too much human interference. It is also recommended by the Chinese government (HJ845-2017).

The principle of smoke video capture system is as following: one HD camera capture the 10 seconds video image of the vehicle at the back when it passing; then a deep learning algorithm-based analysis software installed in a local GPU-based workstation near this camera is used to identify whether there is any dubious smoky characters in the video. Then the dubious smoky video is transferred through internet network to a remote computing server where quick and deep analysis of the smoke characters are done using a more complicated AI based algorithm. Then the captured smoky vehicle video and its plate, which is captured by the other local camera are transferred to the user interface. By comparison with an virtual ringerman chart, the degree of the smoke can be divided in order to provide criterion for manual audit.



By full consideration of environmental light (the direction and intensity of sunshine, the street light and the light of back vehicles, etc.), the rain and small dust, now our smoke video capture system is able to find 80% smoky diesels at 85% correction ratio at daytime. By the accumulation of smoky vehicles and algorithm upgrading, the performance is becoming better.



## Features and Advantages

1. All gaseous TDLAS based measurement which provides higher precision than NDIR and NDUV, especially for NO;
2. With five lasers for five channel and time-sharing scanning method at 7~1kHz scanning rate, provide 17~23 times internal average and 235Hz plume data output;
3. Small light dot emitting and half-diffuse reflection design with optical alignment time within 5 minutes;
4. Built-in reusable and sealed wavelength lock gas cell design which promises stable performance of the lasers;
5. Built-in open calibration gas cell design which is convenient for daily use;
6. Detecting beam multi-pass exhaust plume (two times or four times) which provide improved plume capture rate;
7. Factory calibration plots stored in control software which can be done easily at a field maintenance laboratory after long-time usage;
8. At least twice longer optical length than NDIR and NDUV based system;
9. Provide original plume data, which is used to calculate the exhaust emission concentration during each measurement;
10. Provide data validity analysis software is an offline analysis software which is used to do further analysis for each measurement;
11. Provide smoke factor, which is useful for estimating the PM concentration of the exhaust;
12. Laser lifetime up to 50,000 hours except for the green laser with lifetime of 20,000 hours, much longer than the expensive UV lamp whose life is only 4000 hours.

## Technical Specifications

Static measurement error (absolute or relative error, whichever is suitable)			Dynamic measurement error (absolute or relative error, whichever is suitable)		
pollutant	absolute error	relative error	pollutant	absolute error	relative error
CO	$\pm 0.15 \times 10^{-2}$	$\pm 5\%$	CO	$\pm 0.25 \times 10^{-2}$	$\pm 10\%$
CO <sub>2</sub>	$\pm 0.15 \times 10^{-2}$	$\pm 5\%$	CO <sub>2</sub>	$\pm 0.25 \times 10^{-2}$	$\pm 10\%$
HC	$\pm 150 \times 10^{-6}$	$\pm 5\%$	HC	$\pm 250 \times 10^{-6}$	$\pm 10\%$
NO	$\pm 100 \times 10^{-6}$	$\pm 5\%$	NO	$\pm 150 \times 10^{-6}$	$\pm 10\%$
Opacity	$\pm 2\%$	$\pm 5\%$			
Smoke Factor	$\pm 0.2$	$\pm 15\%$			

\*Static measurements are done in the inner gas cell with 10 cm optical length using gas concentrations recommended by Chinese government (HJ845-2017).

\*CO, CO<sub>2</sub>, HC, NO, opacity measurement repeatability is not greater than  $\pm 3\%$

\*The unit of absolute error is volume concentration. \*Dynamic measurements is done under condition of CO<sub>2</sub> plume larger than 20%\*cm using a gas-puff electric vehicle at 30 km/h.

\*CO, CO<sub>2</sub>, HC, NO measurement repeatability is not greater than  $\pm 5\%$

### Speed/acceleration

Speed range: 10~100 km/h  
Corresponding time:  $\leq 0.5$  s  
Speed Accuracy:  
 $\pm 3.0$  km/h (50~100 km/h),  
 $\pm 1$  km/h (10~50 km/h),  
Acceleration accuracy: 0.18 m/s<sup>2</sup>

### Electrical characteristics

Response time: < 1.5s  
power consumption: 180W  
Power supply: DC48V  
Warming time: less than 5 mins

### Environment requirements

Temperature: -10~45℃  
Relative humidity:  $\leq 85\%$  RH  
Wind Speed:  $\leq 5$  m/s  
Atmospheric Pressure: 70kPa ~ 101.4 kPa  
Others: no rain or snow, no obvious raise dust

### Size and weight

SDM (horizontal stationary type with platform):  
64cm\*61cm\*58cm (L\*W\*H), 37kg  
SDM (mobile type):  
50cm\*51cm\*45cm (L\*W\*H), 22kg  
Mirror Reflector:  
41cm\*57cm\*56cm (L\*W\*H), 16kg



Horizontal stationary equipment installation case



mobile equipment installation case

### Partial Reference list

No	Customer	item	No	Customer	item
01	Kunshan environmental protection bureau	horizontal type*2	16	Changzhou bureau of ecological environment lianning district branch	horizontal type*1
02	Xiangtan environmental protection bureau	horizontal type*3	17	Changzhou bureau of ecological environment by district branch	horizontal type*1
03	Qingfeng county environmental protection bureau	horizontal type*1	18	Changzhou bureau of ecological environment wujin district branch	horizontal type*1
04	Jincheng city environmental protection bureau	horizontal type*2	19	Ningbo bureau of ecological environment ninghai branch	horizontal type*7
05	Hancheng environmental protection bureau	horizontal type*1	20	Wuxi bureau of ecological environment	horizontal type*2
06	Sanmenxia shannzhou environmental protection bureau	horizontal type*1	21	Changshu environmental protection bureau	horizontal type*3
07	Linzhou environmental protection bureau	horizontal type*1	22	Shanwei environmental protection bureau	Mobile type*1
08	Bengbu environmental protection bureau	horizontal type*2	23	Shanwei environmental protection bureau	Mobile type*1
09	Cixian environmental protection bureau	horizontal type*1	24	Linzhou environmental protection bureau	Mobile type*1
10	Zhengzhou east environmental protection bureau	horizontal type*1	25	Qingfeng county environmental protection bureau	Mobile type*1
11	Xueshan county environmental protection bureau	horizontal type*1	26	Sanmenxia shannzhou environmental protection bureau	Mobile type*1
12	Guangdong hongsheng technology co. LTD	horizontal type*1	27	Xueshan county environmental protection bureau	Mobile type*1
13	Lingbao city environmental protection bureau	horizontal type*1	28	Lingbao city environmental protection bureau	Mobile type*1
14	Dalian environmental protection bureau	horizontal type*1	29	Dalian environmental protection bureau	Mobile type*1
15	Changzhou bureau of ecological environment jintan district branch	horizontal type*2	30	Changzhou environmental protection bureau	Mobile type*1