中仪股份
EASY-SIGHT

Pipeline High Accuracy Detection Technology

Panoramic Quantitative Robot

Wuhan Easy Sight Technology Co.,Ltd.

Catalog

1 The significance of research on high accuracy detection technology


EASY SIGHT
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X01

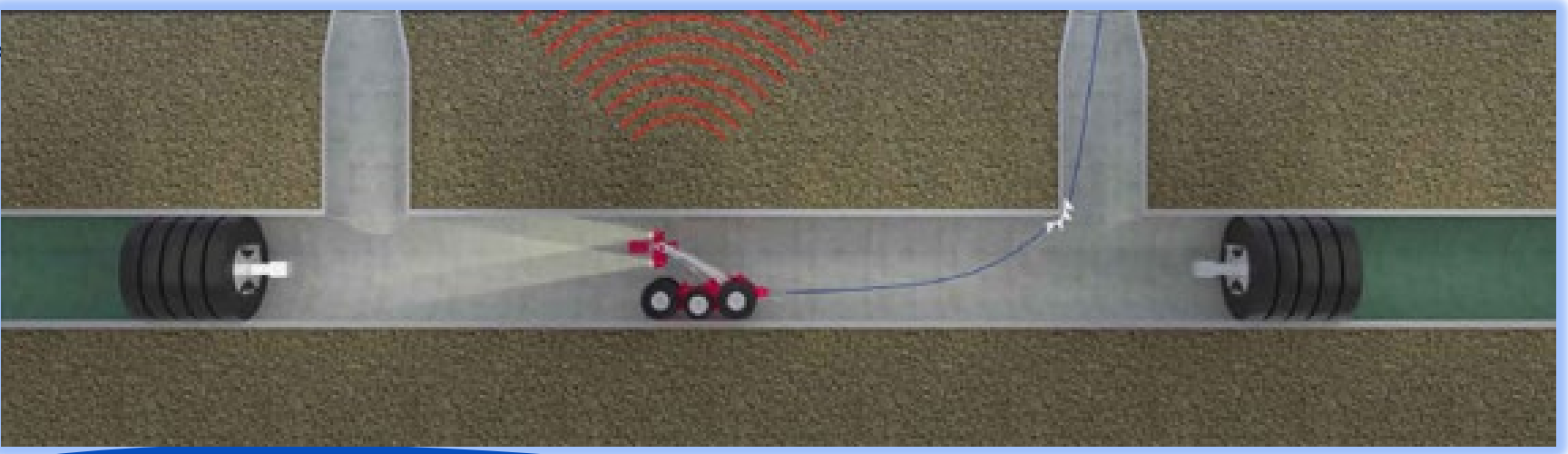
The main disadvantages of current CCTV inspection

The most common inspection tool at present is the CCTV inspection system, which has the following main disadvantages:

◉Complex operation process: During the inspection process, the camera head cannot be adjusted to find defects; when defects are found, it is necessary to stop and observe the defects carefully.

◉Low interpretation efficiency: The staff in the office repeatedly watch the inspection video to interpret the defects. If the defects are missed when recording the video, it will be impossible to interpret.

◉Defect interpretation based on experience: The size, length, area, etc. of the defect cannot be accurately quantified, and the pipeline assessment score obtained is inaccurate.



Pipeline trenchless repair project

Repair Design

- Technical specification for trenchless repair and renewal of urban drainage pipelines CJJ/T 210-2014
- Technical specification for in-situ curing repair of water supply and drainage pipelines T/CECS 559-2018

5.2.2内衬管壁厚设计：

1内衬管与原有管道联合承受外部地下水静液压力及真空压力时，壁厚可按下列公式计算：

$$t=\frac{D_0}{\left[\frac{2KE_LC}{(P_W+P_V)N(1-\mu^2)}\right]^{\frac{1}{3}}+1} \qquad (5.2.2\text{-}1)$$

$$C=\left[\frac{\left(1-\frac{q}{100}\right)}{\left(1+\frac{q}{100}\right)^2}\right]^3 \qquad (5.2.2\text{-}2)$$

$$q=100\times\frac{(D_E-D_{min})}{D_E}\text{或}\quad q=100\times\frac{(D_{max}-D_E)}{D_E} \qquad (5.2.2\text{-}3)$$

式中：Pw——管底位置地下水压力（MPa），$Pw=0.00981H_w$；

P_V——真空压力（Mpa）（根据工程实际取值，不应小于0.05MPa）；

C——椭圆度折减因子；

N——管道截面环向稳定性抗力系数（取值不应小于2.0）；

Pipeline trenchless repair project

The liner size is too small: the liner does not fit the pipe to be repaired

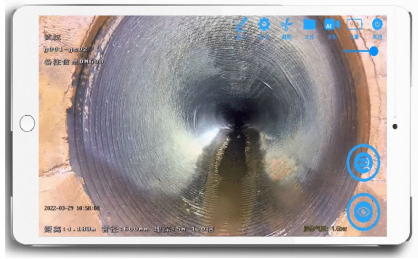
At a project site, the ordered liner size is DN415, and the actual pipe diameter is DN440. After the curing is completed, the liner does not fit the pipe to be repaired at all.

The liner size is too large: the liner expands and forms radial extrusion

At a project site, the ordered liner size is DN300, and the actual pipe diameter is DN270. After curing, there are a lot of circumferential wrinkles inside the pipeline liner.

2 Introduction of millimeter-level measurement robot

The Evolution of High Accuracy Measurement Robots

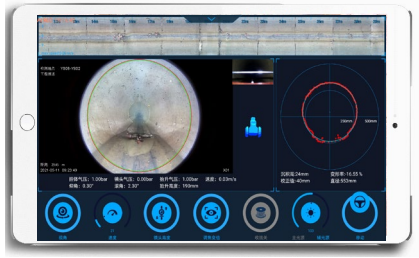


2016

The first one to realize digital high-definition pipeline inspection

2020

Launched laser quantitative detection technology with centimeter-level accuracy



2021

Upgraded to panoramic lidar quantitative detection, comprehensive collection of high-definition video, chromatogram, lidar profile map, and comprehensive analysis

2023

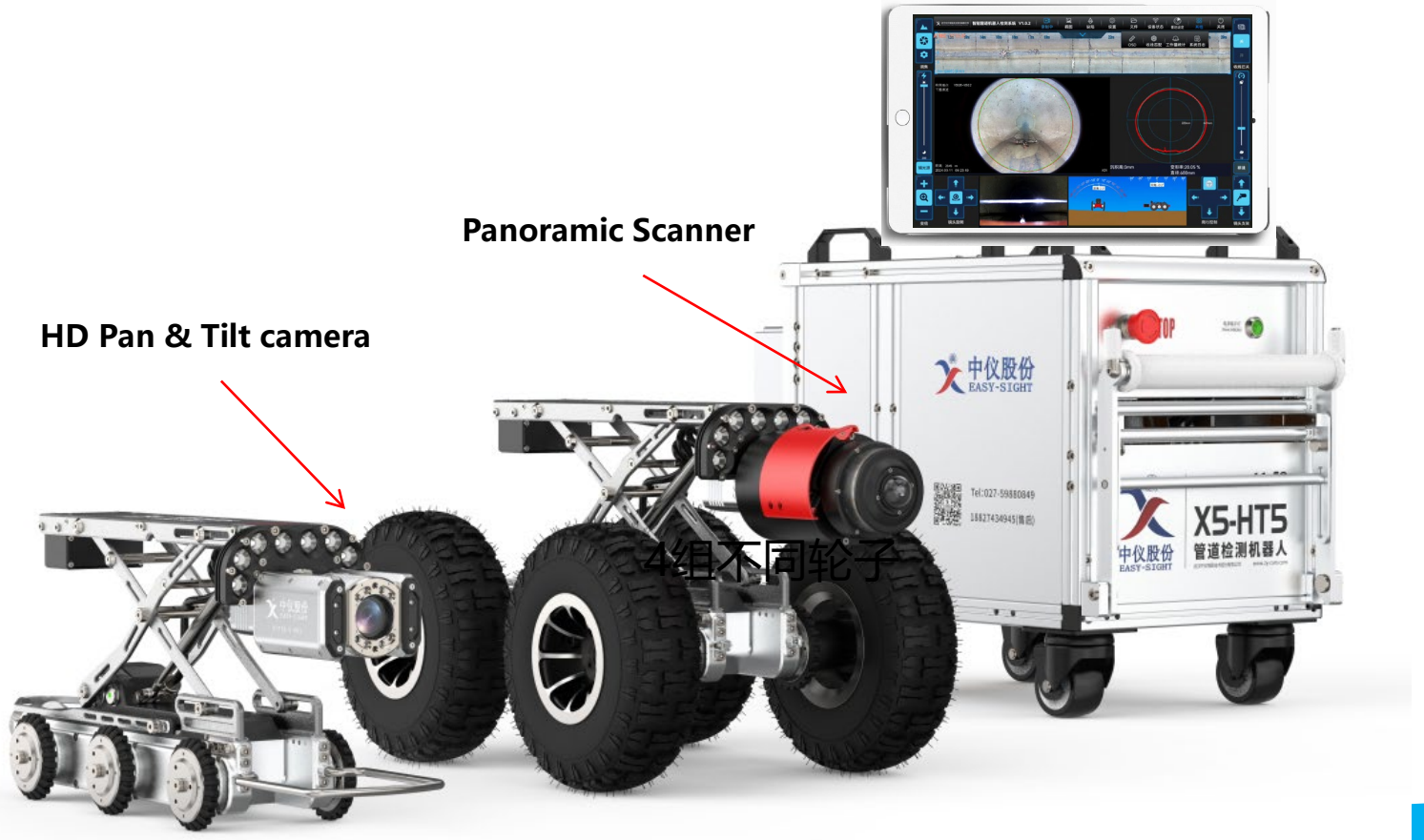
Panoramic lidar inspection technology is fully upgraded to achieve millimeter-level high-precision measurement

X5-HT5 Pipeline Inspection Robot

Inspection Robot

It can perform millimeter-level high-precision measurements of pipeline parameters such as pipe diameter, deformation, deposition, and defect size, providing accurate data support for maintenance and repair operations. It is suitable for engineering measurement tasks that require extremely high accuracy and reliability.

- Millimeter-level measurement accuracy
- 500m long distance detection
- 190mm height gap X-type electric lift
- Driving speed increased by 1.5 times
- Quantitative detection speed increased by 2 times



X5-HT5 Pipeline Inspection Robot

Technical Features

Panoramic display: **present the whole view of the pipeline in one picture**

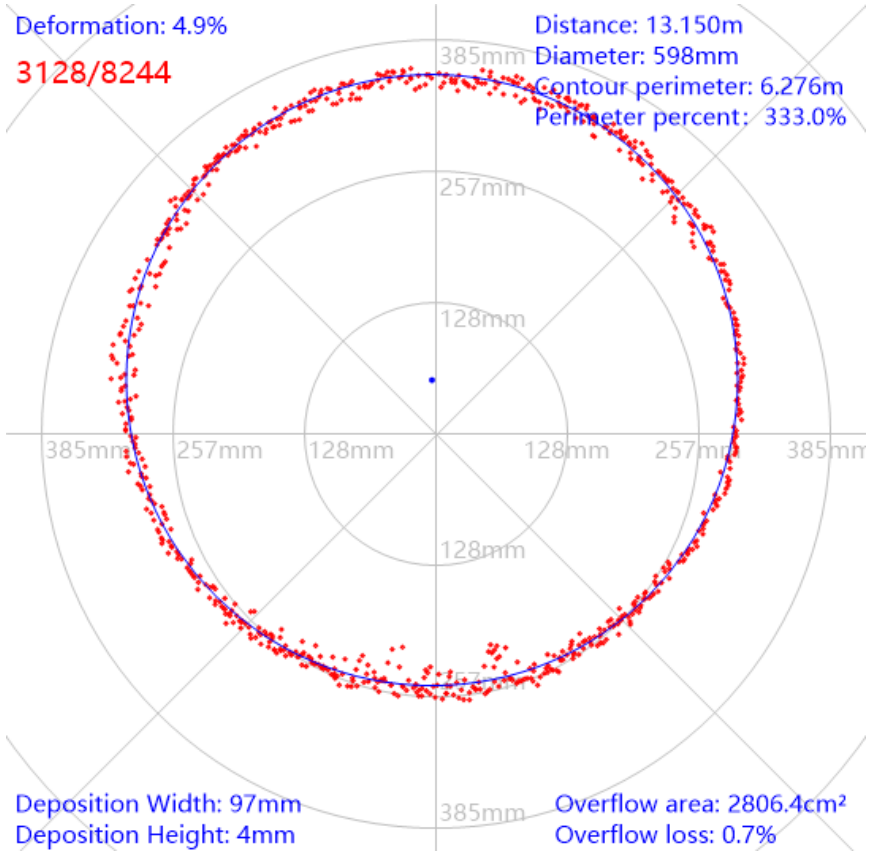
Lidar quantification: **Defects can be accurately quantified**

How to use:

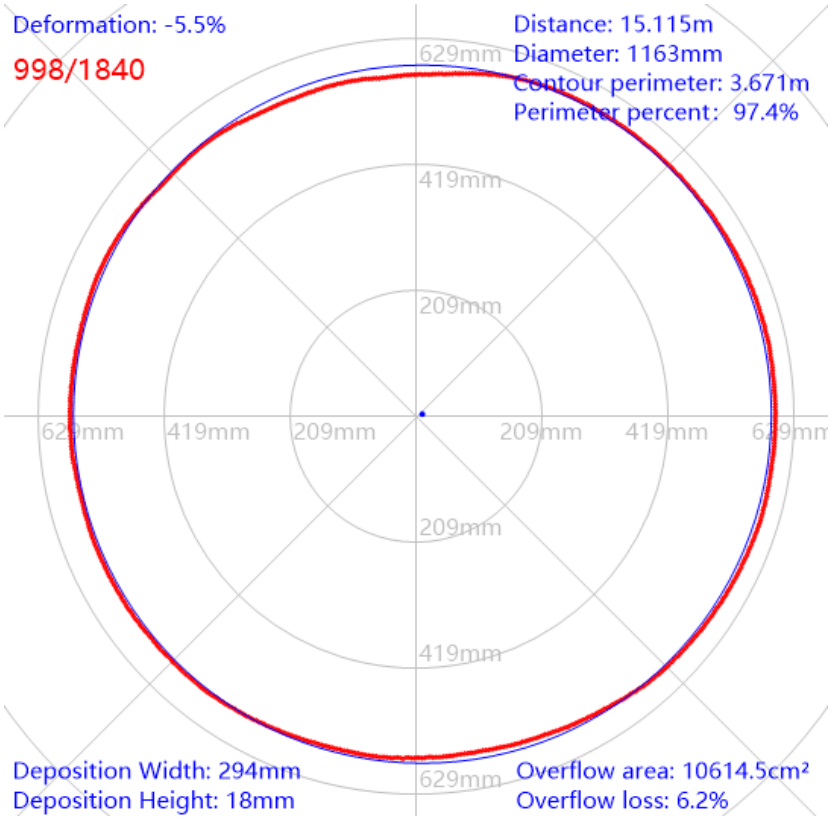
When inspecting, just set the inspection parameters, and the crawler will crawl automatically without stopping, observing defects, or rotating the lens; after the inspection is completed, data is generated and analyzed immediately; When interpreting, interpret and analyze on the pipeline panorama and chromatogram; when clicking on a defect, it will automatically associate with the corresponding video frame and lidar contour data for precise quantification.

Easy synchronization of indoor and outdoor work

High accuracy lidar



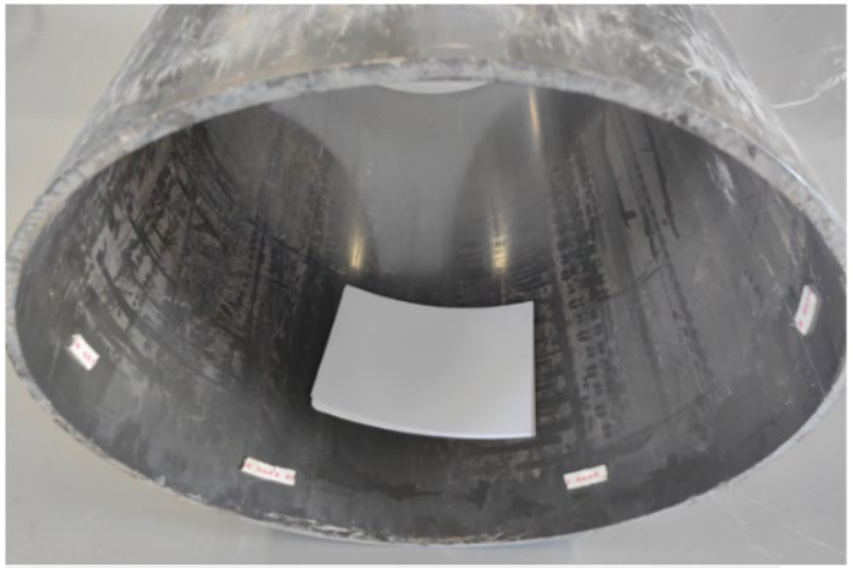
Regular lidar（centimeter grade）



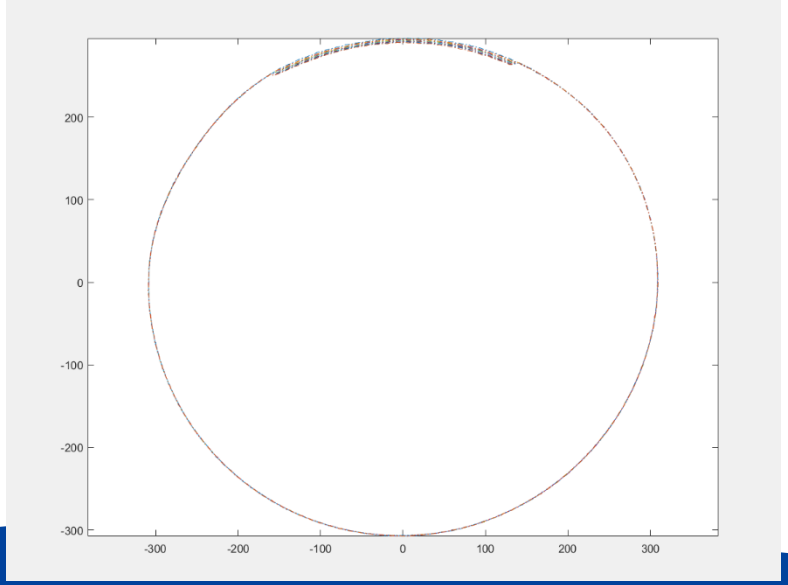
High accuracy lidar（millmeter grade）

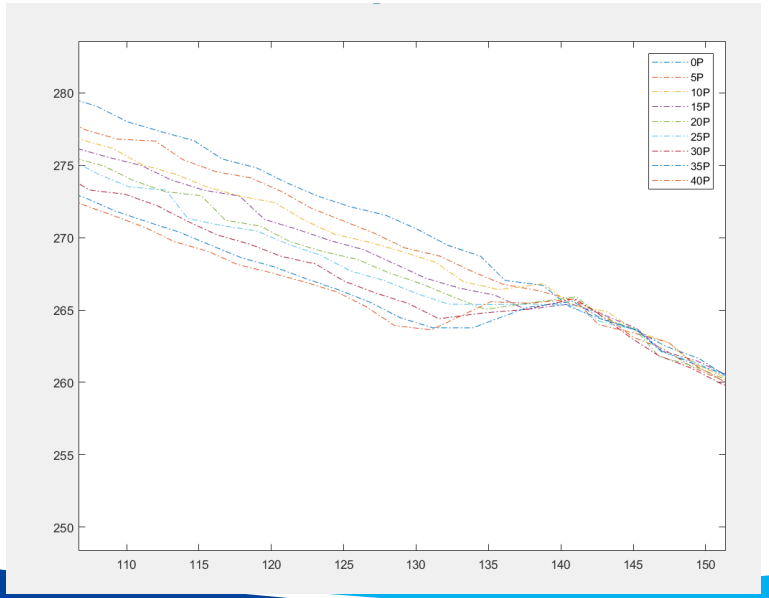
The high accuracy lidar collects 800 points per frame, eliminating stray points and making the contours smoother.

Verification and comparison



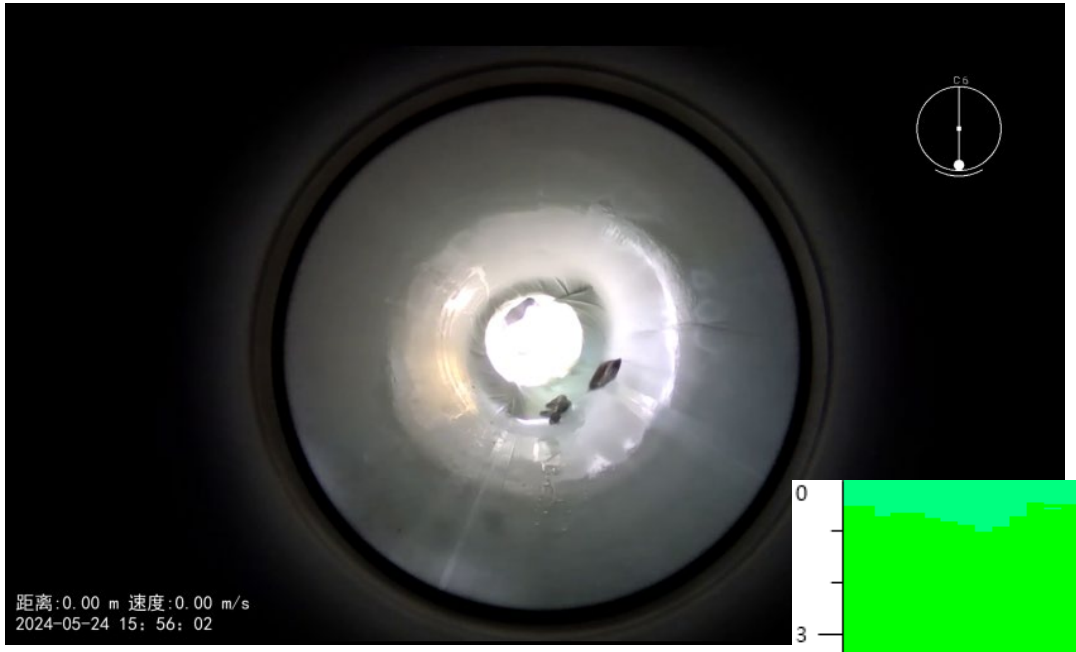
Place the lidar inside the pipe for scanning. Place 5, 10, 15, 20, 25, 30, 35, and 40 A4 papers at the bottom. Measured by caliper, the thickness of 40 papers is 4mm, so the resolution of every 5 papers is 0.5mm.

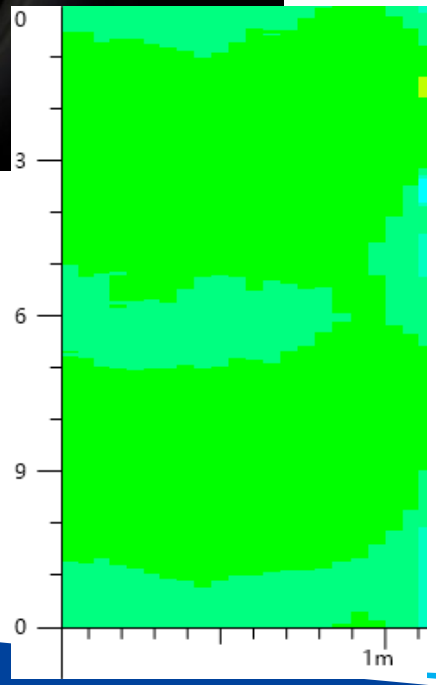




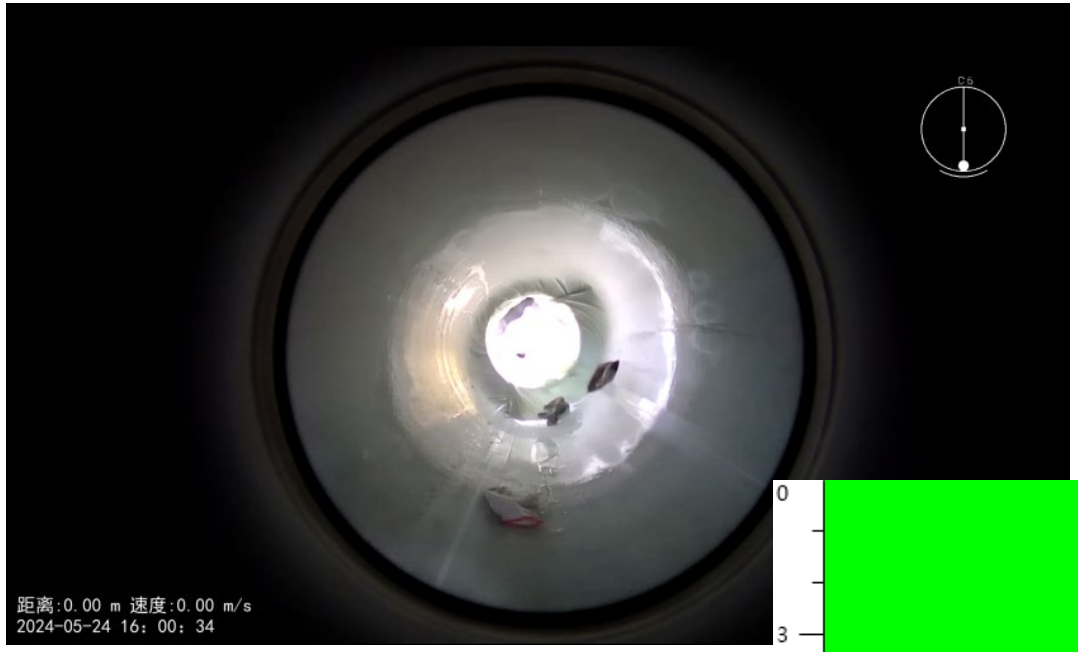
Through data statistics, it was found that there were clear dividing lines between different paper layers, and the display resolution was higher than 0.5mm.

Verification and comparison

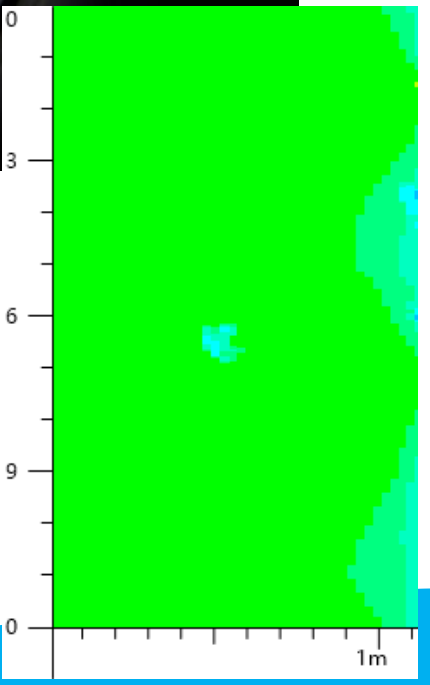




Hong Kong Verification:
Light-cured repair material for DN600 pipe diameter

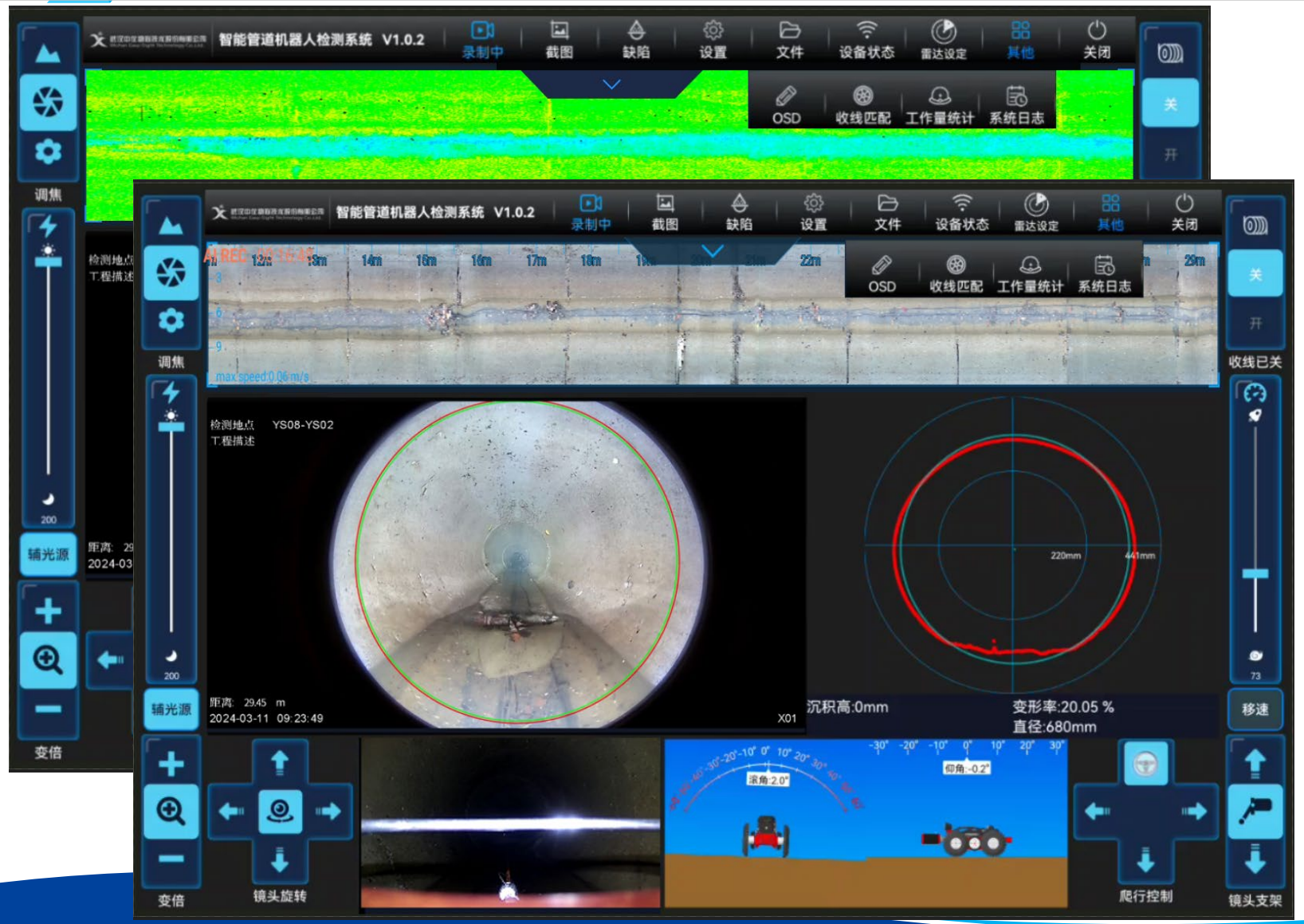


Chromatogram when three people are stepping on it



Chromatogram when no one is stepping on it and one glove is placed

Data Collection



One test, get multiple data:

- ◉HD video
- ◉Lidar Profile
- ◉Panorama
- ◉Chromatogram
- ◉Posture data
- ◉No post-processing required

Data Collection

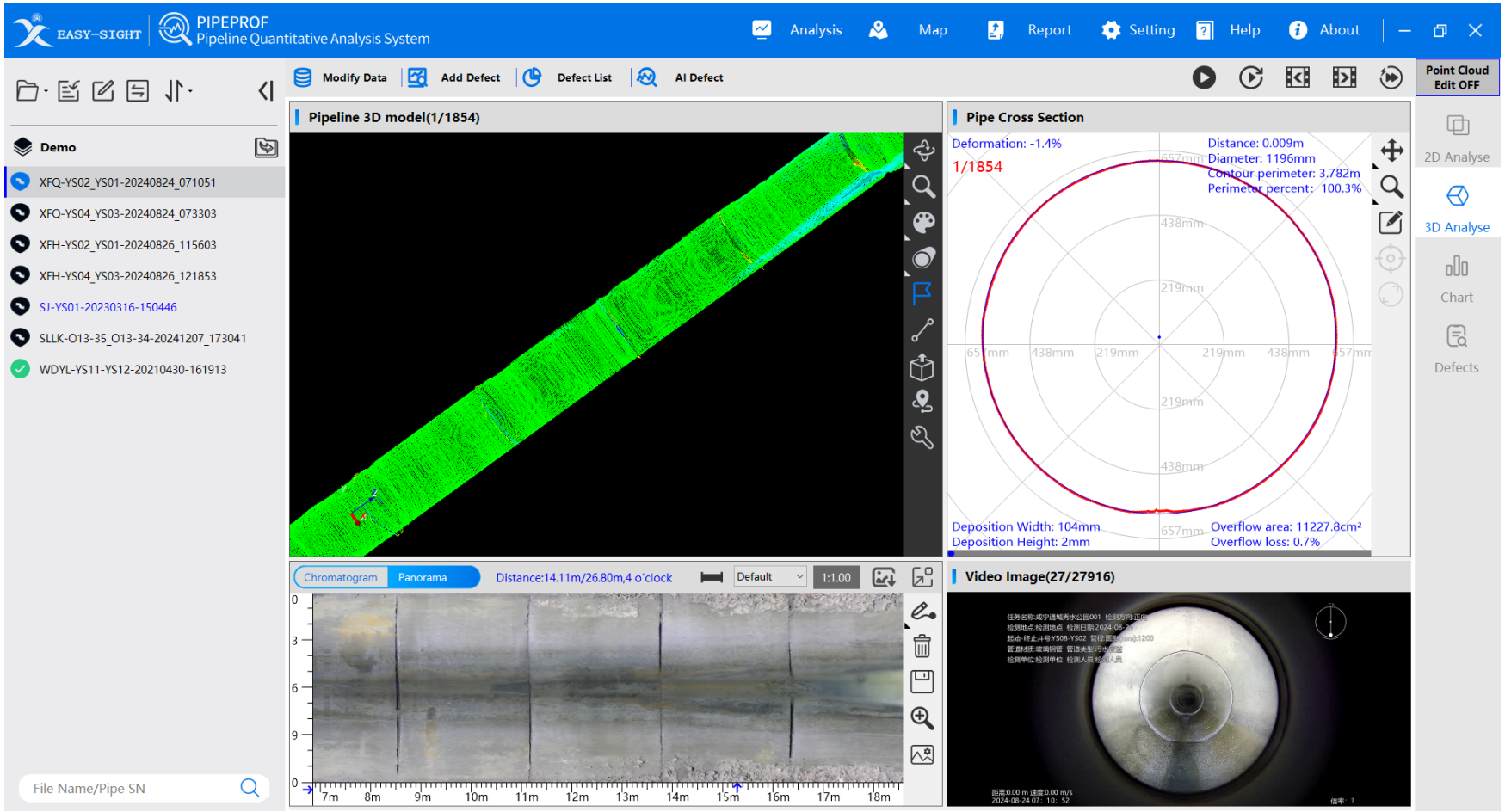
Video display

Inspection process: complete the whole process in one time, no need for operator monitoring:

- ◉Non-stop
- ◉No rotation
- ◉No Look Around
- ◉No zoom and focus
- ◉No need to stop for observation

3 Inspection data analysis and output display

High accuracy lidar



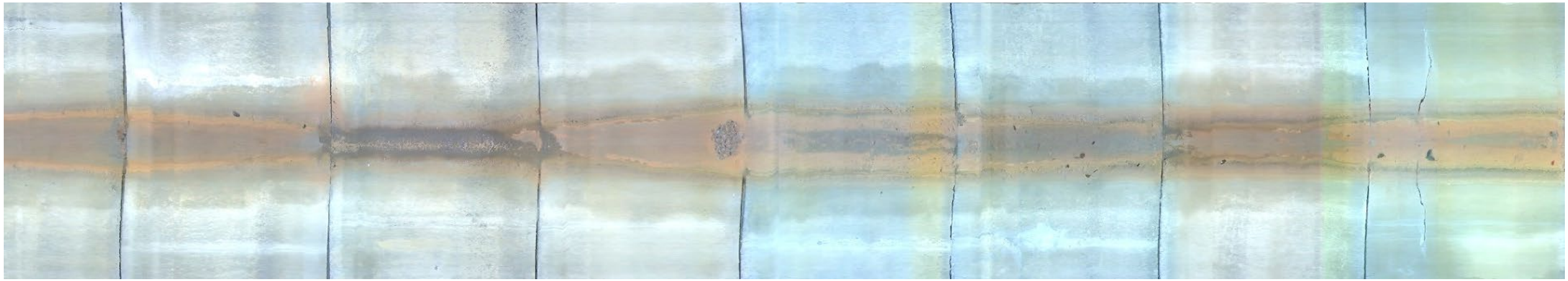
Synchronous analysis of lidar, panoramic, video, IMU and other data.

◉Lidar profile, chromatogram, panorama, video linkage analysis

◉Automatic calculation of defect size

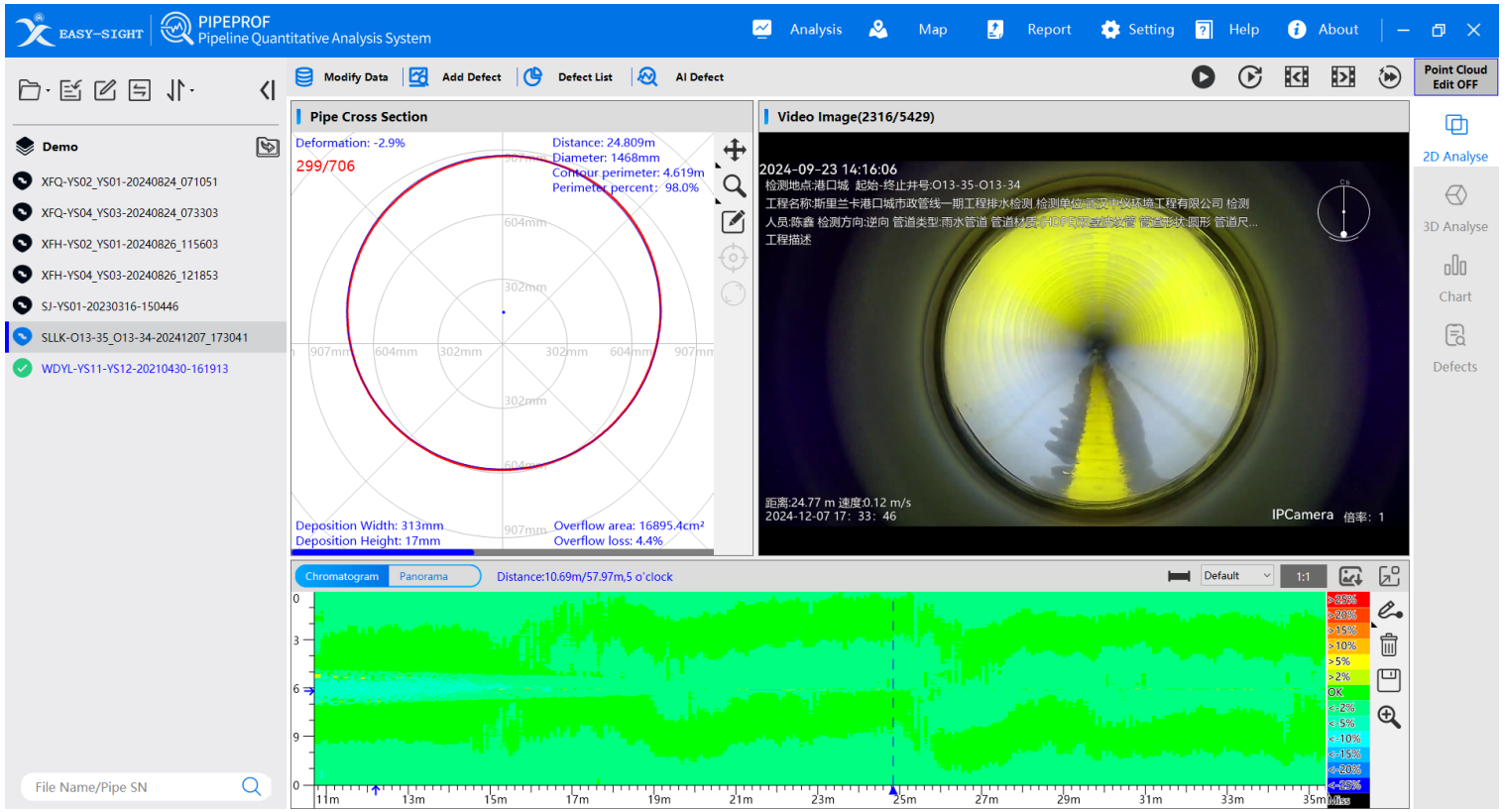
◉Intuitive and simple interpretation

Panoramic expansion of pipeline



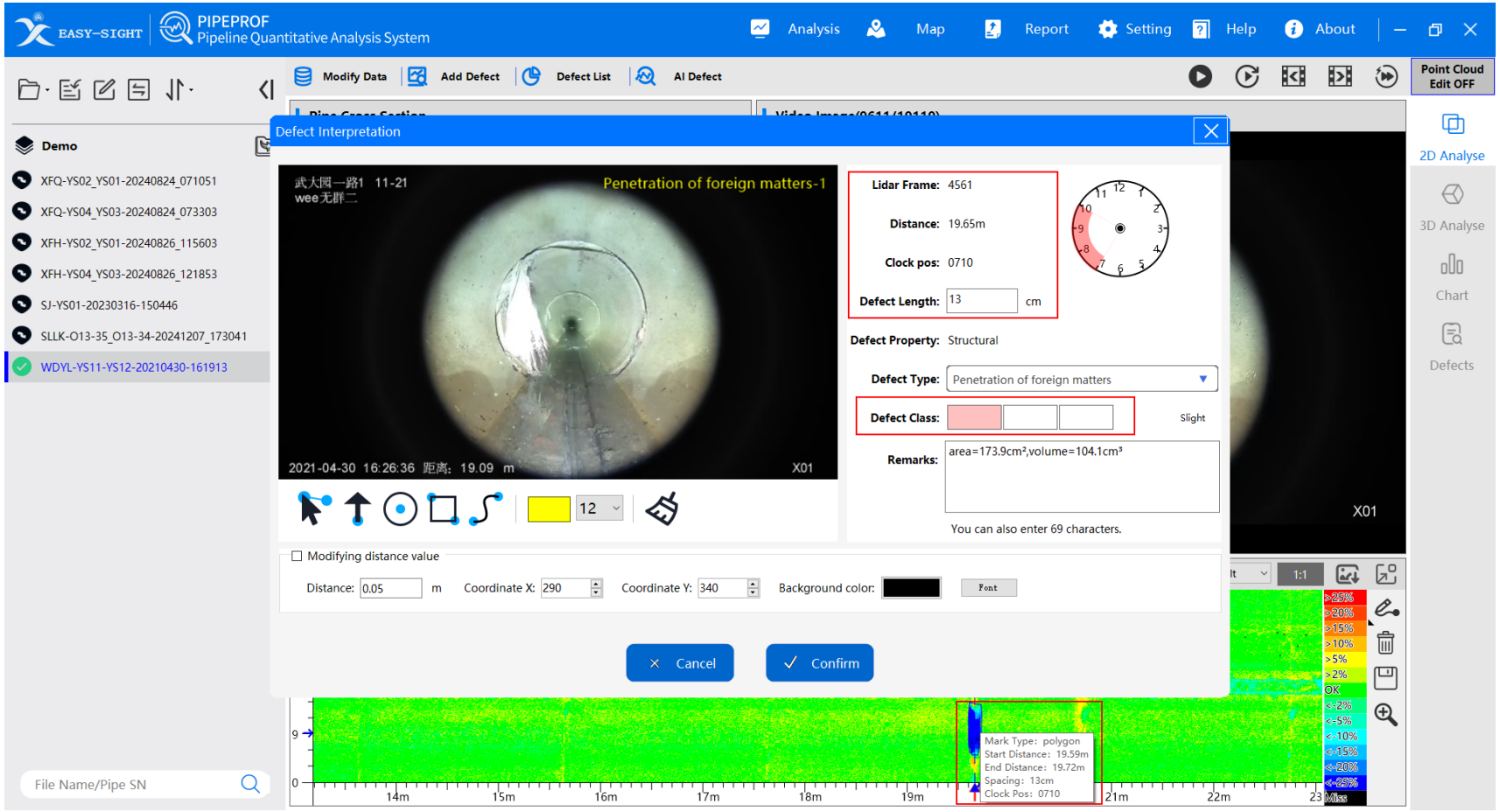
The above picture is a panoramic view of the inside of the pipeline obtained using panoramic quantitative detection technology, which is equivalent to cutting the pipeline open and then laying it flat. From the above picture, you can clearly see the deposits on the bottom of the pipe, cracks on the pipe wall, etc.

Intelligent defect analysis



◉Through the conditions set by the user, the defects are automatically judged according to the chromatogram expansion diagram, panoramic diagram, etc., and the automatic identification of various defects is supported.

Defect interpretation

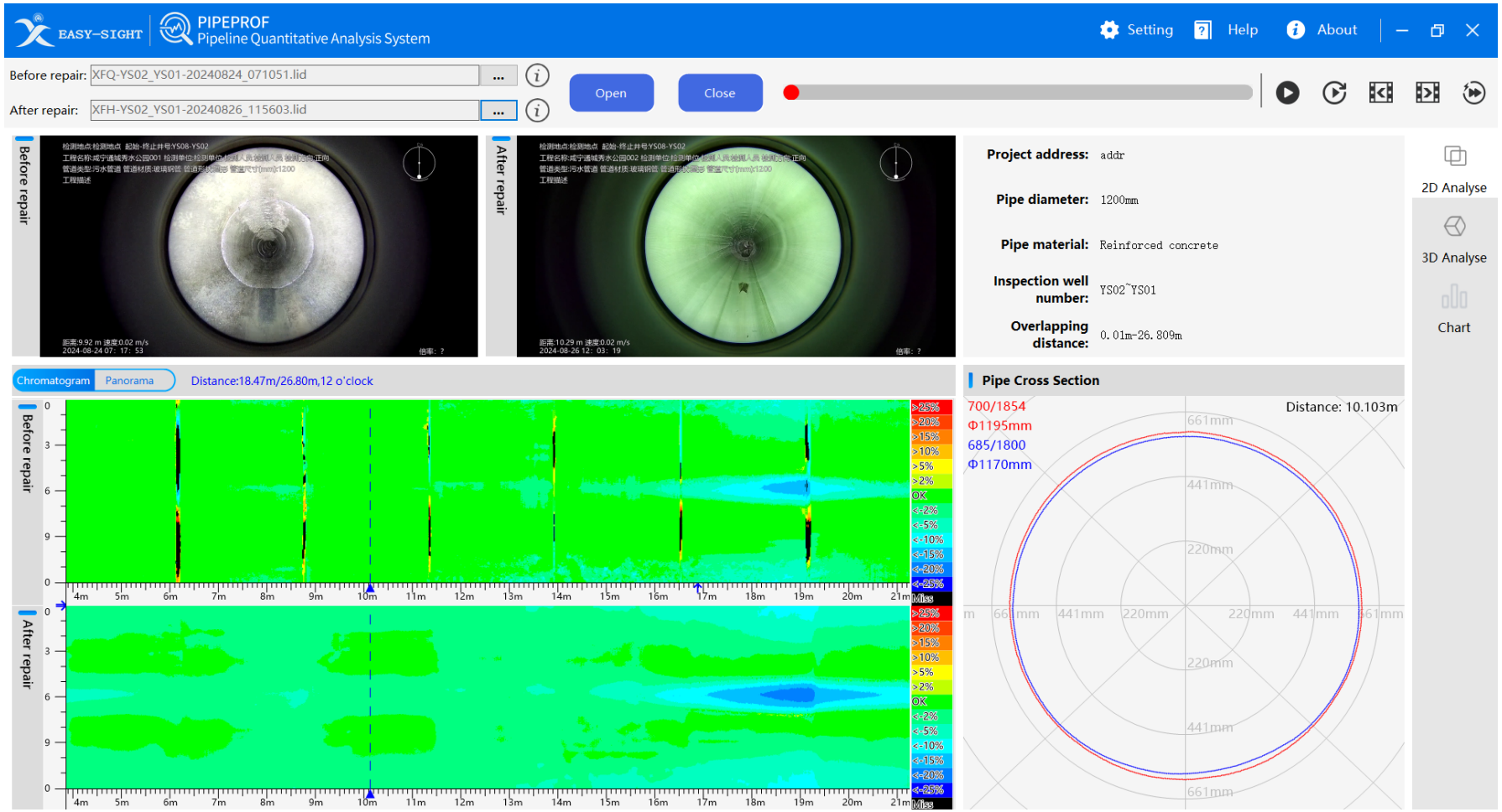


◉Automatic quantification (area, volume, size)

◉Automatic positioning (distance interval, time of day and time of day)

Comparative analysis before and after repair

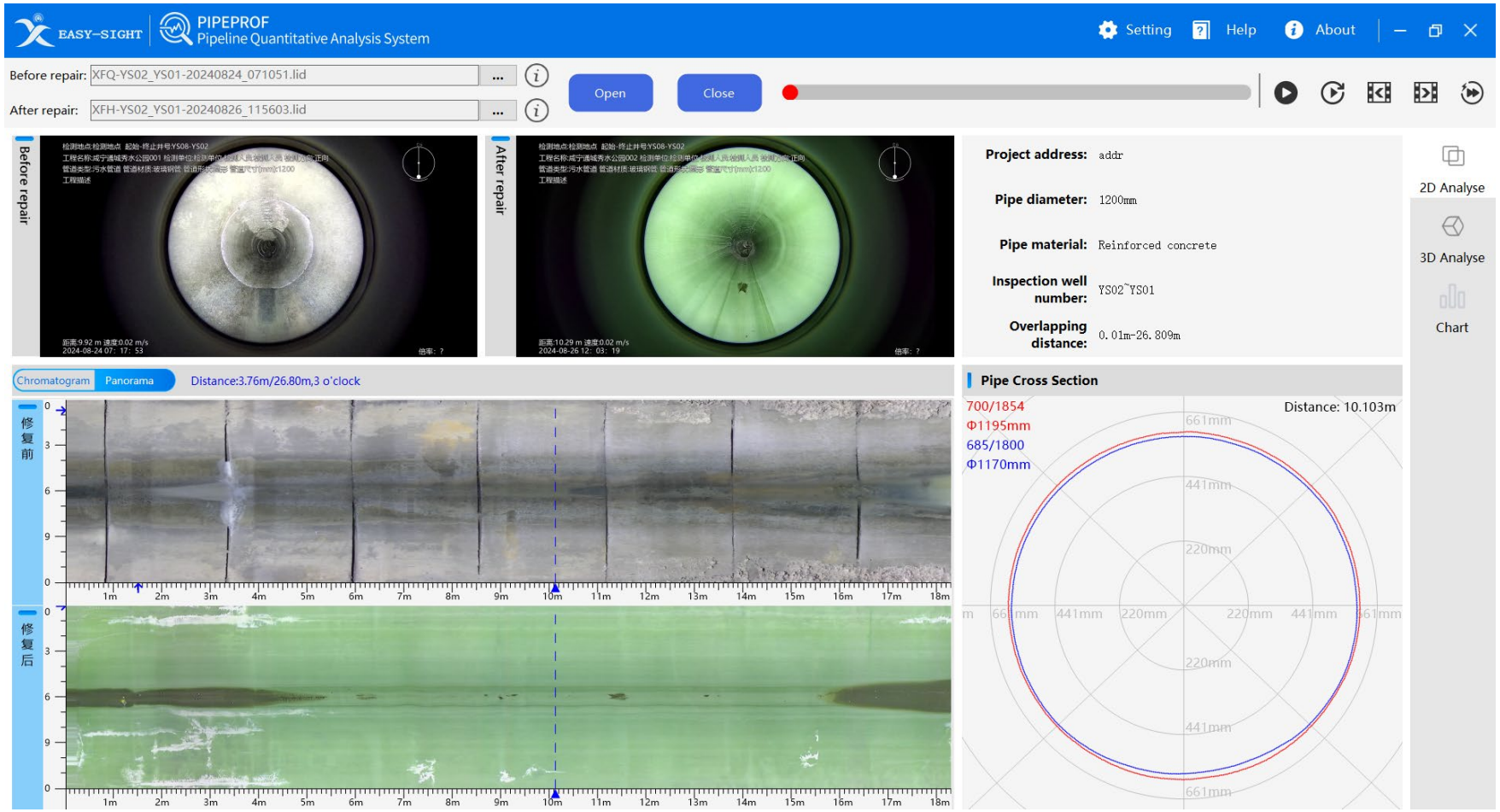
Data Analysis



2D analysis

It can quickly view the video images before and after the pipeline repair, the pipeline chromatogram expansion diagram, the pipeline panoramic expansion diagram, and the comparison diagram of the lidar cross-section profile. It can accurately measure the thickness of the repair material.

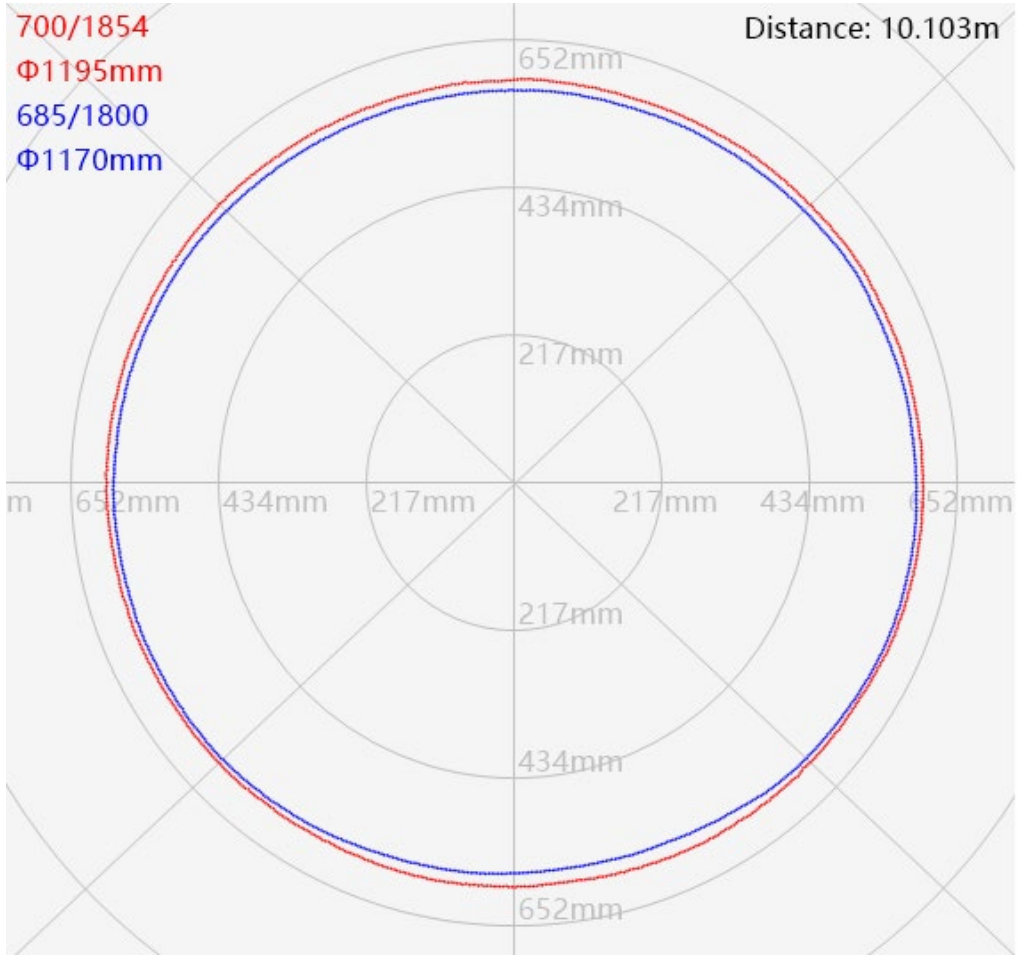
Comparative analysis before and after repair



➢ 2D analysis

It can quickly view the video images before and after the pipeline repair, the pipeline chromatogram expansion diagram, the pipeline panoramic expansion diagram, and the comparison diagram of the laser cross-section profile. It can accurately measure the thickness of the repair material.

Comparative analysis before and after repair



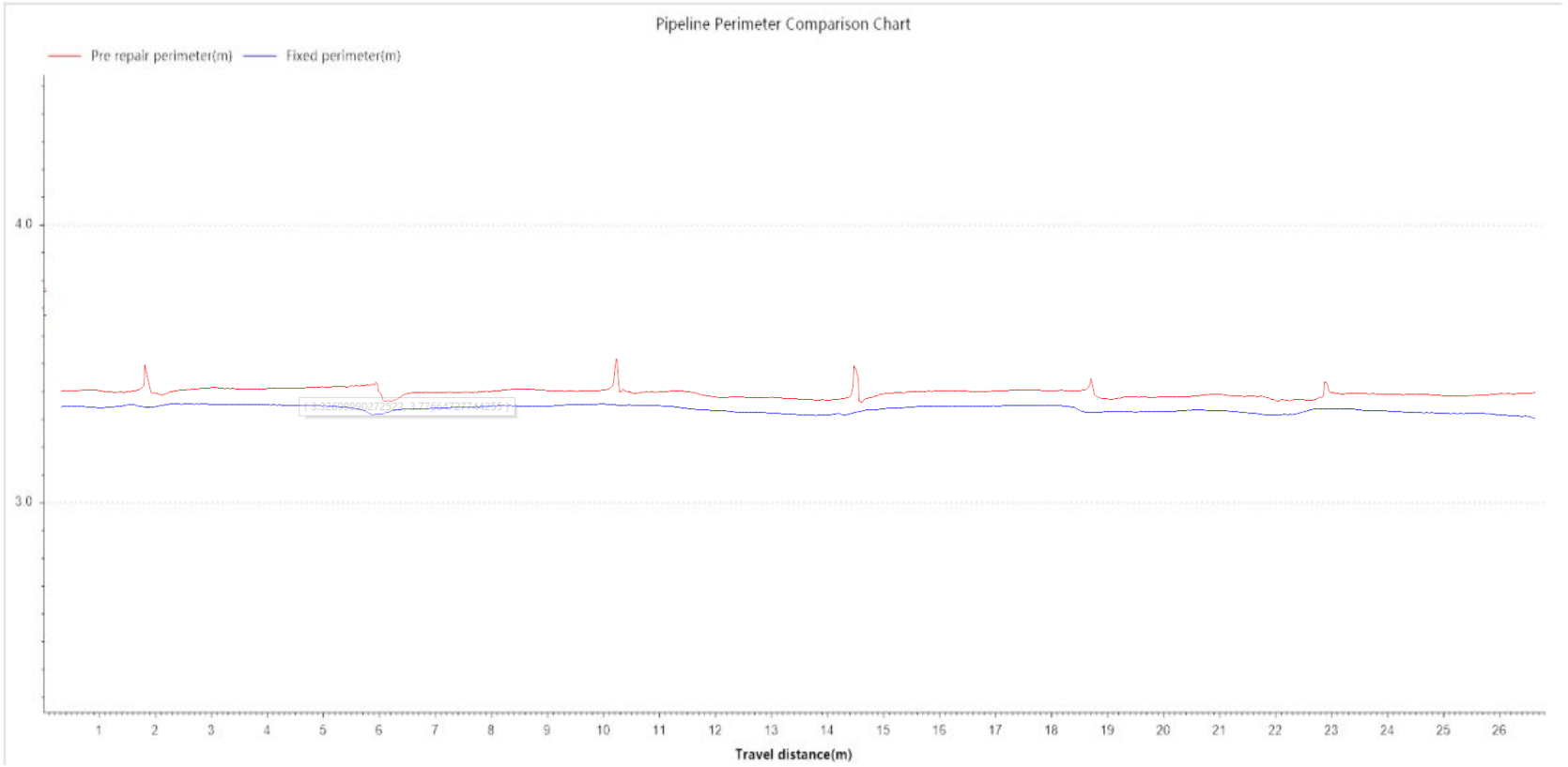
- **2D analysis - single frame profile comparison**

The red part is the point cloud of the pipeline contour before repair, and the blue part is the point cloud of the pipeline contour after repair.
The distance difference at any clock position can be measured to calculate the wall thickness.

Each frame contour (one frame corresponds to one distance point) can be analyzed.

Comparative analysis before and after repair

Data Analysis



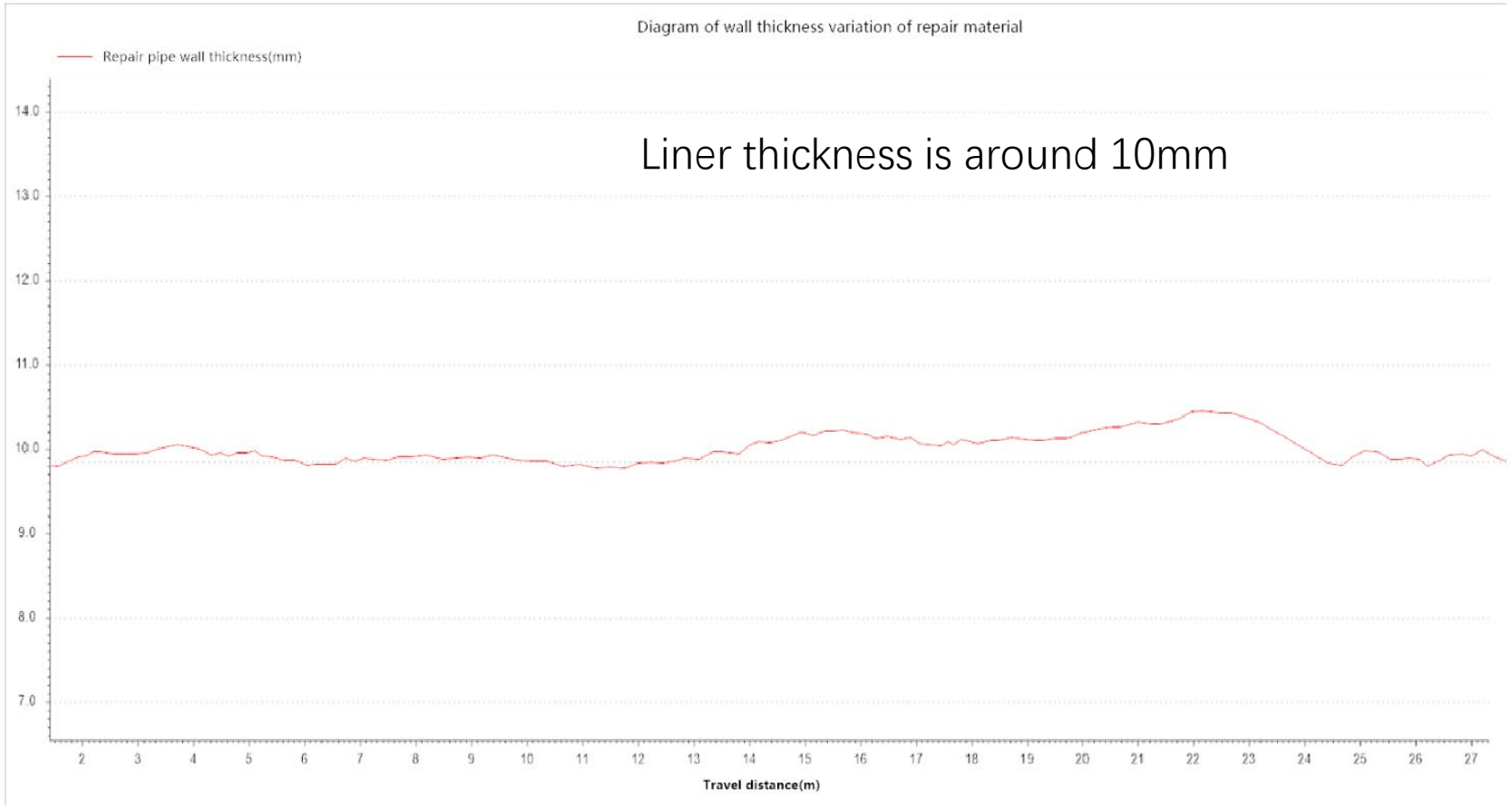
- **Chart Analysis**

Comparative analysis is performed from multiple aspects, including the pipeline contour circumference diagram before and after repair, pipeline wall thickness change diagram, pipeline contour expansion comparison diagram, etc.

The value interval can be set arbitrarily.

Comparative analysis before and after repair

Data Analysis



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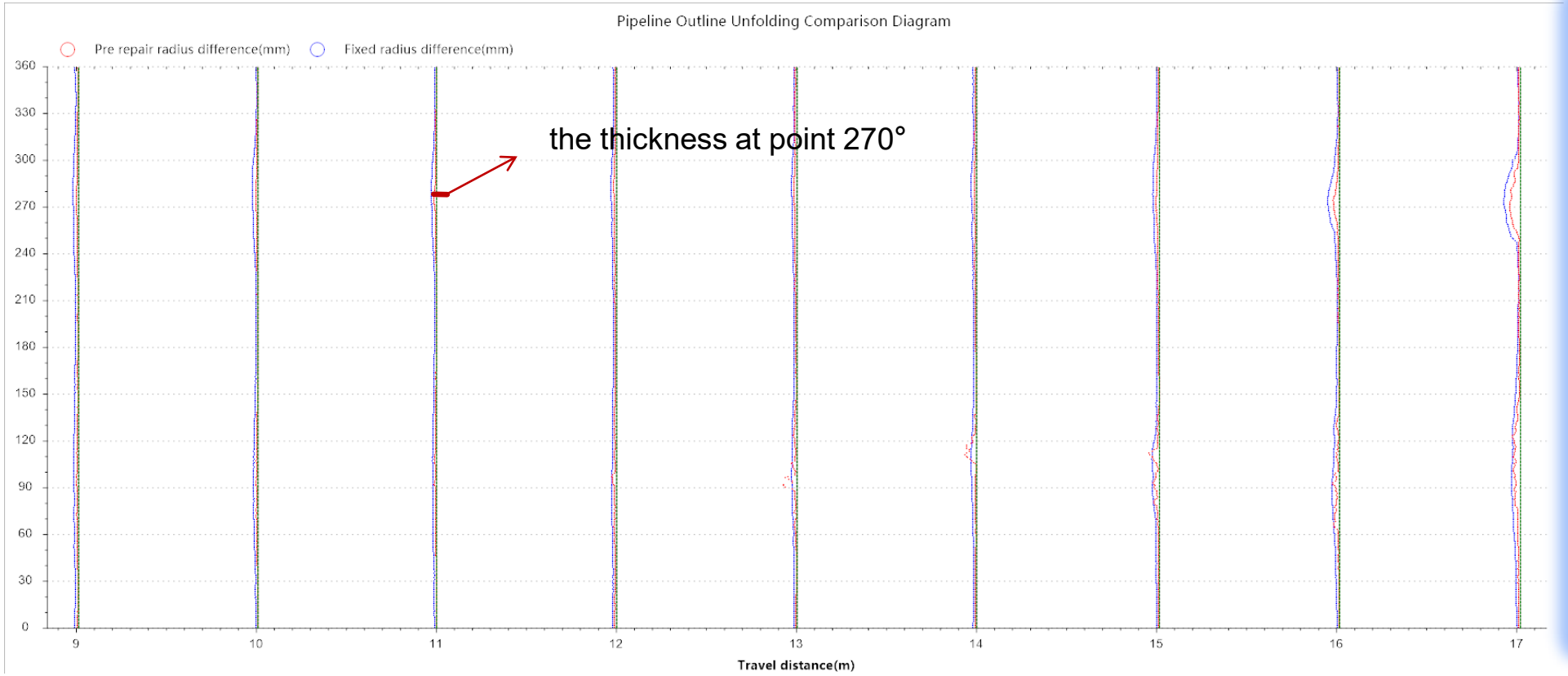
Comparative analysis before and after repair

Data Analysis

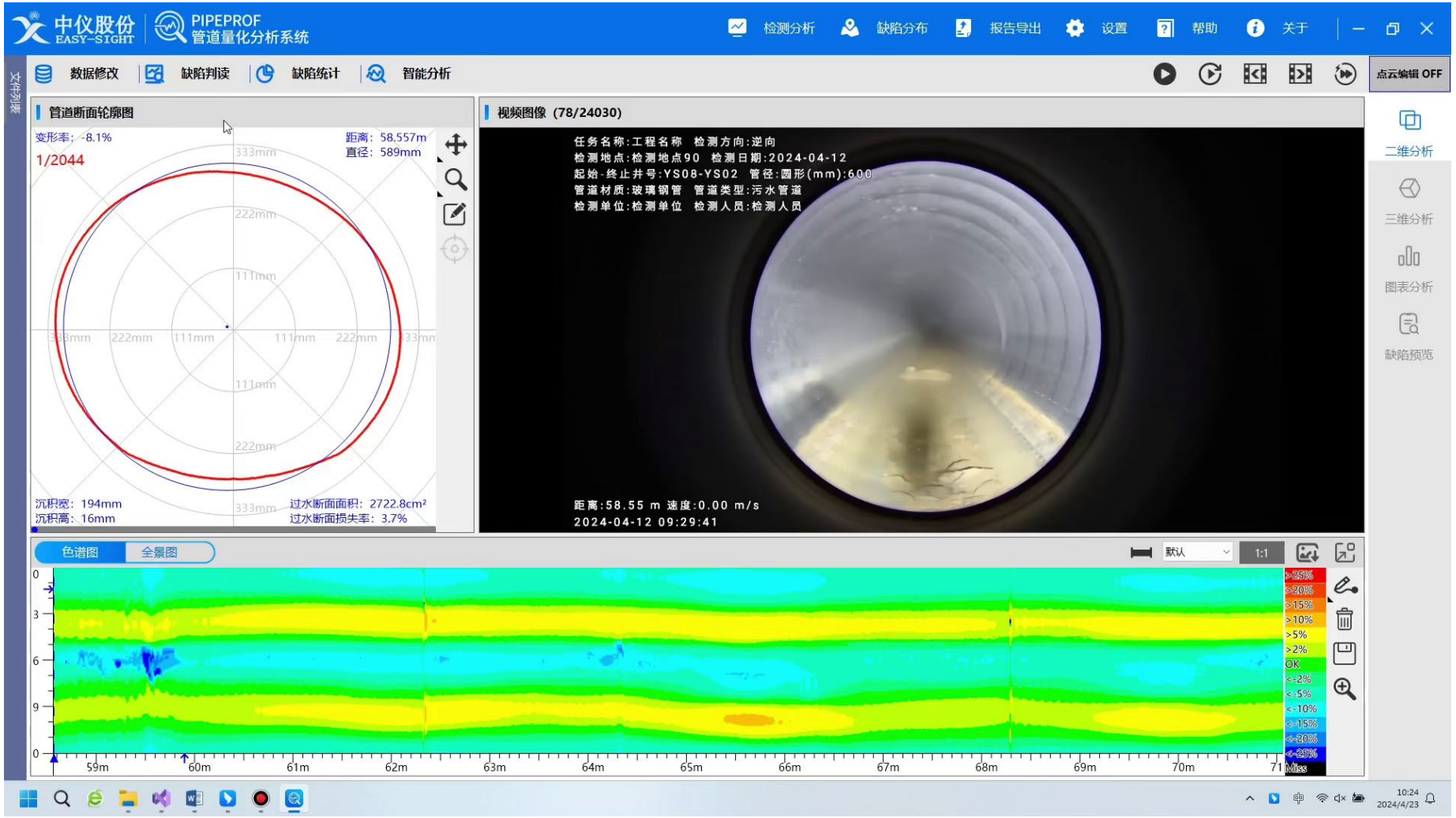


➢ **Chart Analysis**

Comparative analysis is performed from multiple aspects, including the pipeline contour circumference diagram before and after repair, pipeline wall thickness change diagram, pipeline contour expansion comparison diagram, etc.
The value interval can be set arbitrarily.

3D Model

Result output



video display

◉Support 3D point cloud and real scene map display

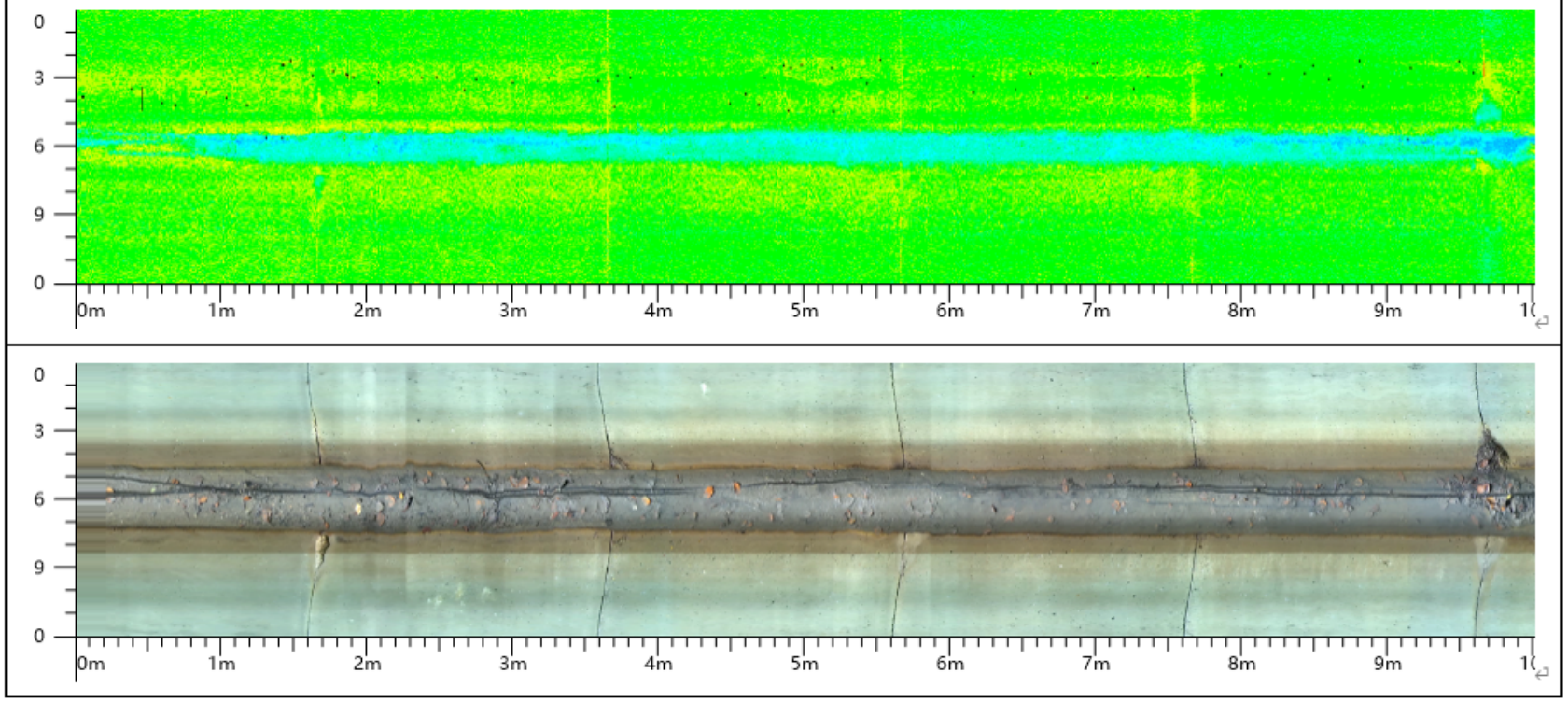
◉3D models can be exported as OBJ format

Pipeline expansion diagram

Result putput

▪ 2.4 Pipeline Expanded View

Pipeline Segment No.	YS11~YS12	Pipe Size	600mm	Length of Pipeline Segment	2m	Testing Length	37.40m
Pipeline Type	Rainwater	Pipeline Material	Reinforced concrete	Burying Depth	3m	Tested at	WD

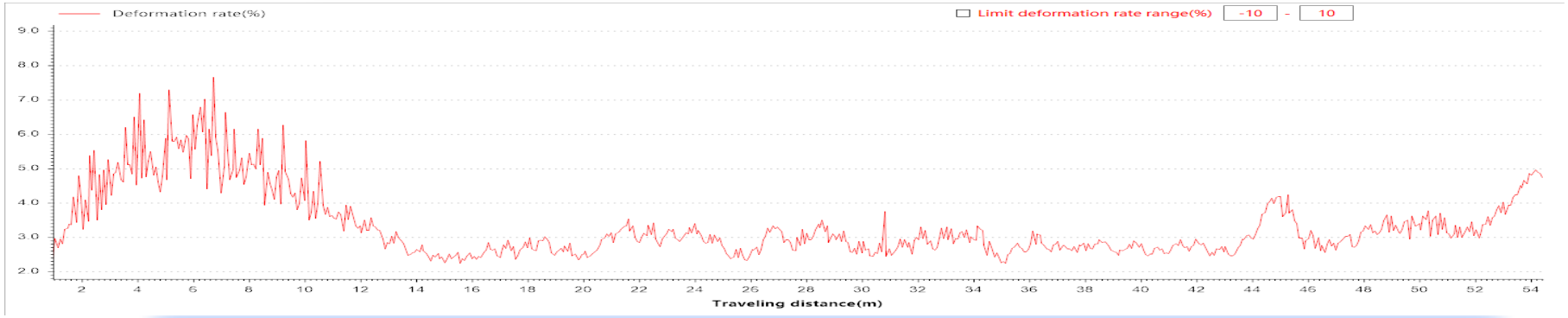


Pipeline expansion diagram, intuitively showing the internal situation of the pipeline, blue indicates slight sediment

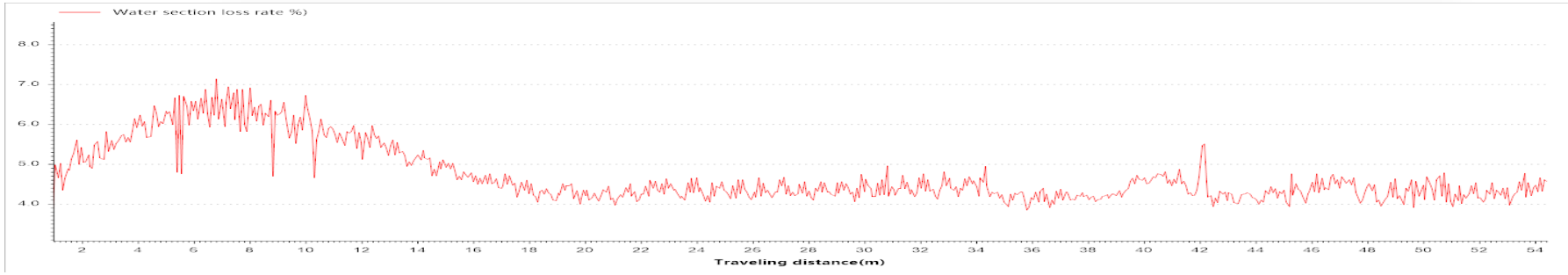
Chart Analysis

Result output

Pipeline deformation rate distribution diagram



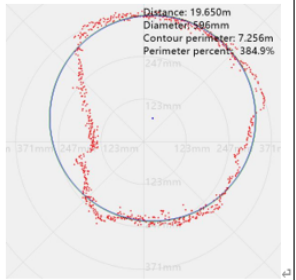
Drainage pipe water section loss rate diagram

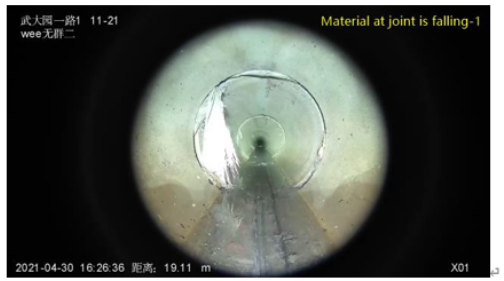


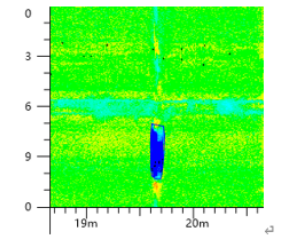
Comprehensive presentation of defects

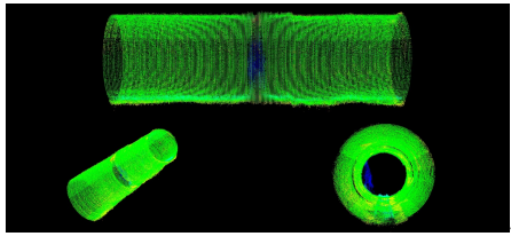
Result output

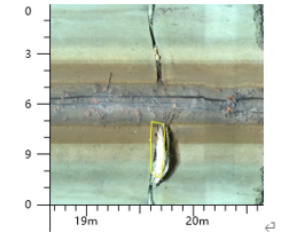
Defect No.	1/2	Defect name	Material at joint is falling	Defect Grade	1	Defect Score	1
Defect Nature	Structural Defect	Vertical Distance	19.65m	Defect Length	13.6cm	Circumferential Position	0711
Sedimentation Width	30.8cm	Sedimentation Height	4.3cm	Deformation Rate	3.9%	Section Loss	10.8%
Defect Description							

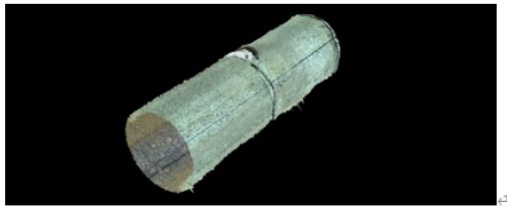




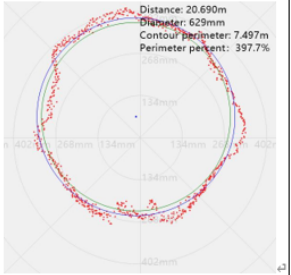


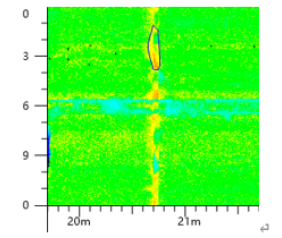


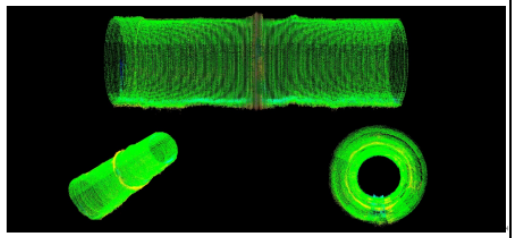


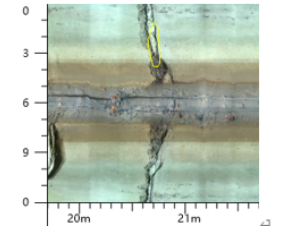


Defect No.	2/2	Defect name	Disjunction	Defect Grade	2	Defect Score	3
Defect Nature	Structural Defect	Vertical Distance	20.69m	Defect Length	11.0cm	Circumferential Position	0104
Sedimentation Width	17.2cm	Sedimentation Height	1.2cm	Deformation Rate	8.7%	Section Loss	-9.1%
Defect Description							









showing defects from multiple angles

4 Application Cases

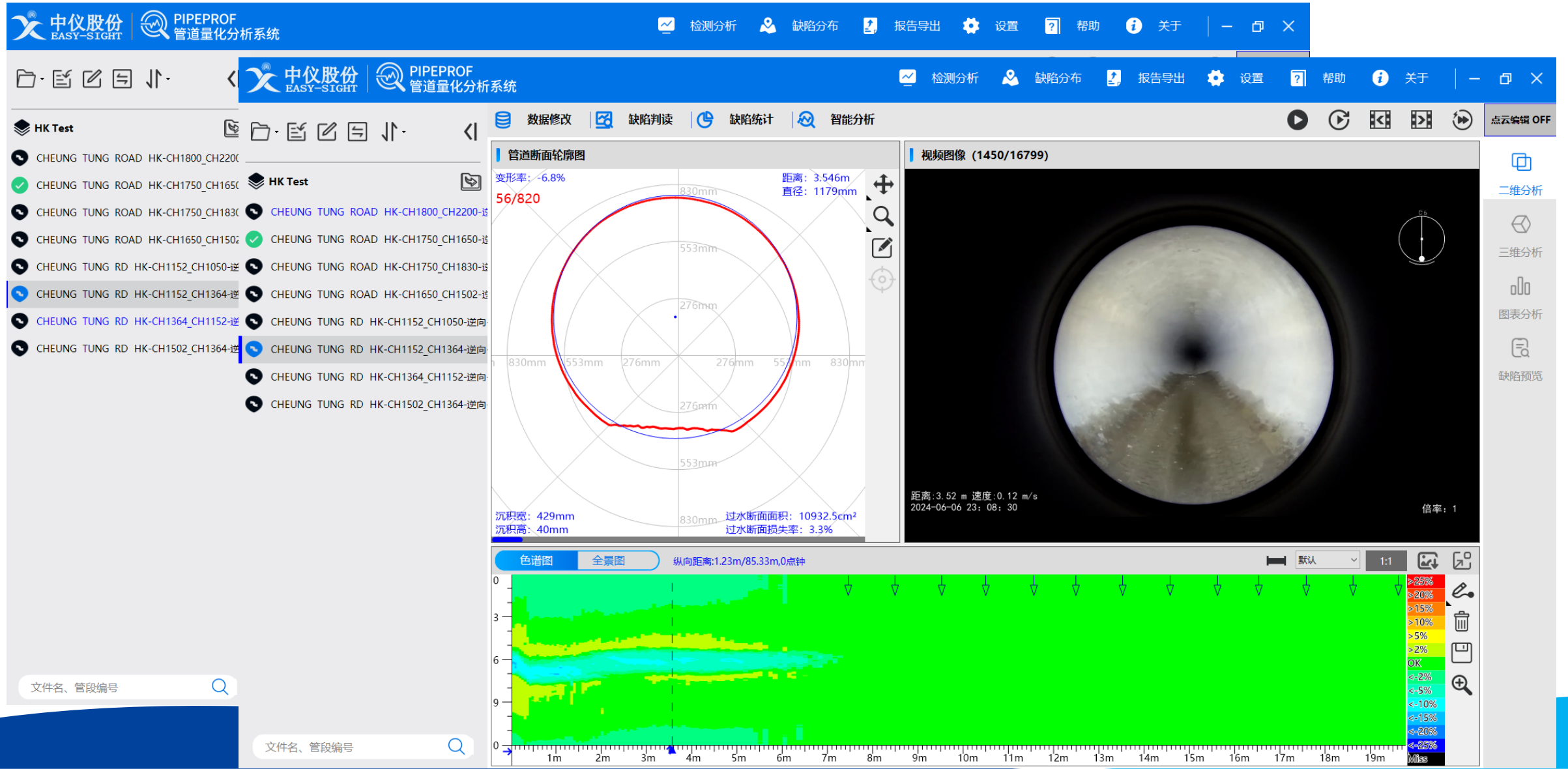
Application cases

Hongkong

The Drainage Services Department of Hong Kong needs to repair a pressurized sewage pipe with a length of about 6KM and a pipe diameter of DN1200. Customized liner is difficult!!

Application cases

Hongkong



Ellipticity analysis

Result output

After desilting is completed, the ovality analysis of the different pipe sections can be performed.

EASY-SIGHT

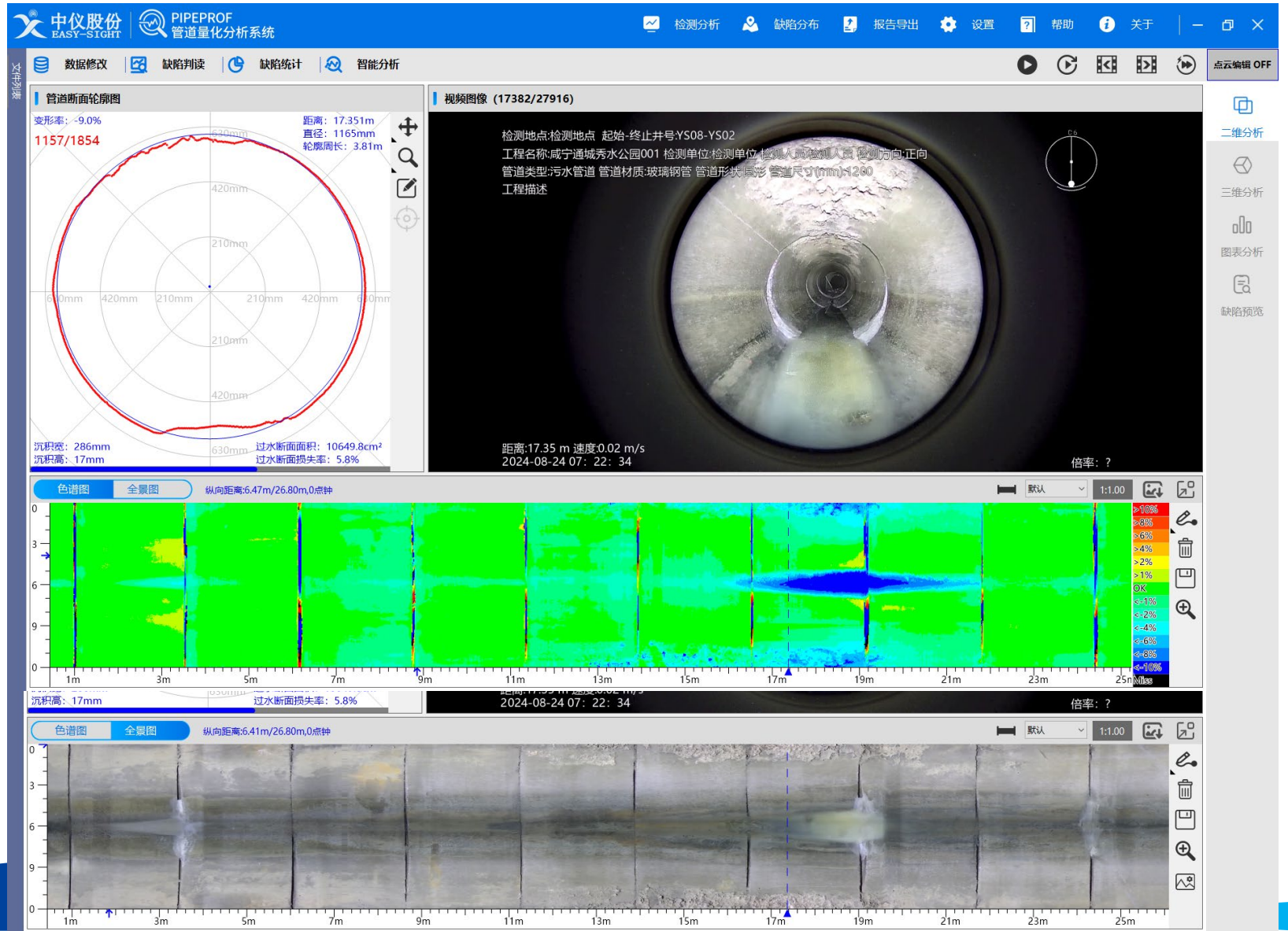
Ovality Data Sheet

Date	06-06-24				
Location	CHEUNG TUNG RD HK	Start Manhole	CH1364	Ovality Average	1.096%
Crew members	FORWIN WANG				
Total length	79.51	End Manhole	CH1226	Maximum overall ovality	1.880%

Distance(m)		Disc Diameter (DD)	1.200	Ovality % - ASTM F1216/ASTM F1741 % Ovality = 100 x (max Dia - ave Dia)/ ave Dia or % Ovality = 100 x (ave Dia - min Dia) / ave Dia		
		Minimum Diameter (m)	1.179			
		Maximum Diameter (m)	1.223			
		Ovality % = 2 x {(Dmax - Dmin) /(Dmax+Dmin)} x 100		Max ovality	2.16 %	
				Average	0.61 %	
				Minimum	0.17 %	
		Maximum Diameter	Minimum Diameter	Ovality	Max vs Ave (%)	Min vs Ave (%)	Max Overall(%)
1.59	Pipe normal	1.216	1.193	1.880%	0.74	1.13	1.13
1.60	Pipe normal	1.214	1.193	1.742%	0.85	0.89	0.89
3.50	Pipe normal	1.210	1.194	1.291%	0.61	0.68	0.68
4.54	Pipe normal	1.198	1.191	0.574%	0.26	0.32	0.32
5.49	Pipe normal	1.200	1.195	0.427%	0.18	0.25	0.25
6.49	Pipe normal	1.203	1.189	1.168%	0.40	0.76	0.76
7.54	Pipe normal	1.208	1.191	1.429%	0.55	0.87	0.87
8.54	Pipe normal	1.202	1.196	0.515%	0.22	0.30	0.30
9.52	Pipe normal	1.202	1.198	0.308%	0.17	0.14	0.17
11.56	Pipe normal	1.201	1.191	0.823%	0.39	0.43	0.43
12.53	Pipe normal	1.201	1.192	0.812%	0.38	0.43	0.43
13.53	Pipe normal	1.203	1.190	1.108%	0.47	0.63	0.63
14.57	Pipe normal	1.206	1.191	1.244%	0.54	0.70	0.70
15.60	Pipe normal	1.207	1.197	0.807%	0.47	0.34	0.47
16.62	Pipe normal	1.199	1.188	0.882%	0.31	0.57	0.57
17.60	Pipe normal	1.202	1.191	0.964%	0.55	0.42	0.55
18.65	Pipe normal	1.205	1.190	1.181%	0.52	0.66	0.66
19.64	Pipe normal	1.203	1.193	0.847%	0.38	0.46	0.46
20.64	Pipe normal	1.205	1.193	0.961%	0.36	0.60	0.60
21.65	Pipe normal	1.207	1.198	0.779%	0.44	0.34	0.44
22.64	Pipe normal	1.203	1.195	0.612%	0.31	0.30	0.31
23.65	Pipe normal	1.205	1.192	1.108%	0.53	0.58	0.58
24.66	Pipe normal	1.206	1.192	1.212%	0.57	0.64	0.64

Application cases

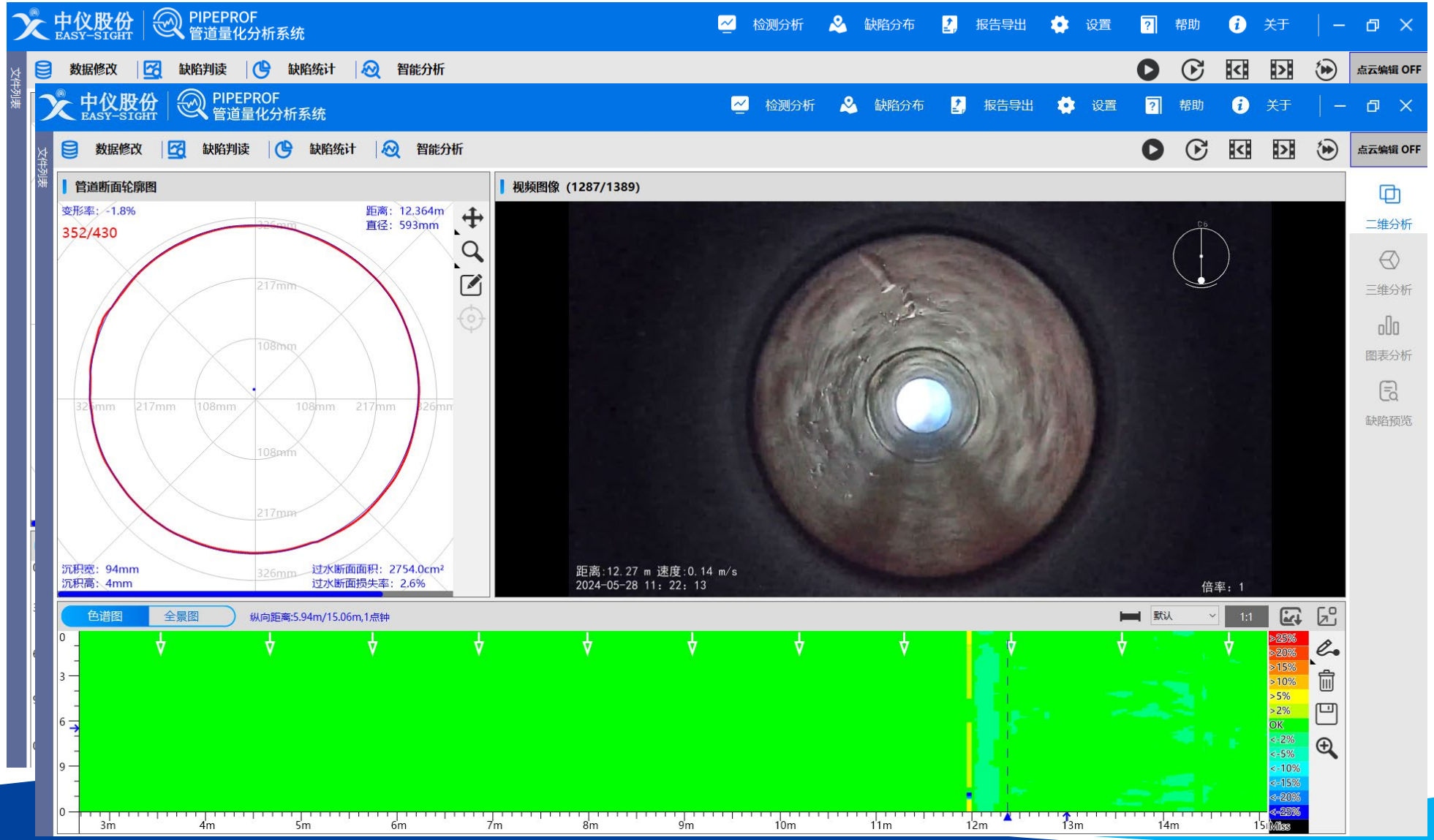
Xianning



In one park, the pipe diameter is DN1200 and the inspection length is 38m. The pipeline has obvious disconnection, undulation, scaling and other problems.

Application cases

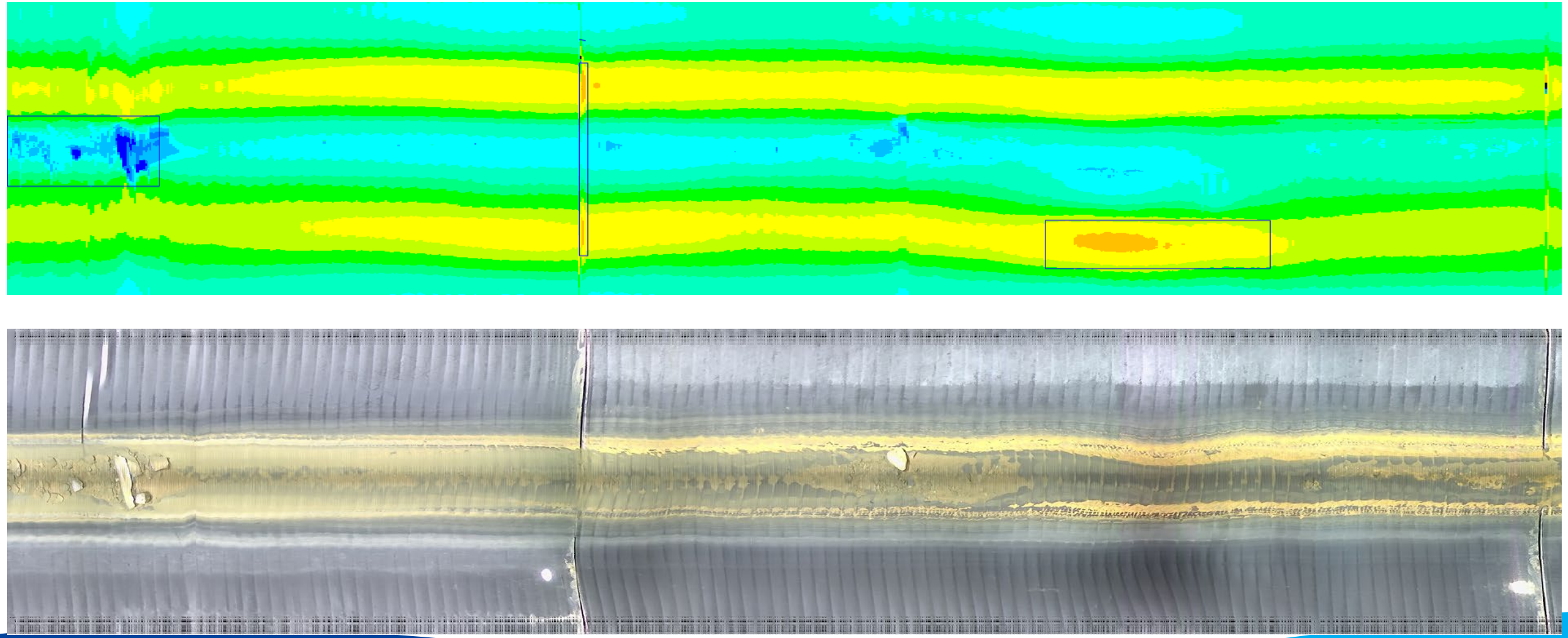
Xi’an



Lay a DN600 water supply pipeline, measure the change in the inner diameter of the pipeline, deformation rate, and other cleaning measures after laying. At 12m is the valve connection pipe, where you can see obvious scratches on the connection pipe and some distortion.。

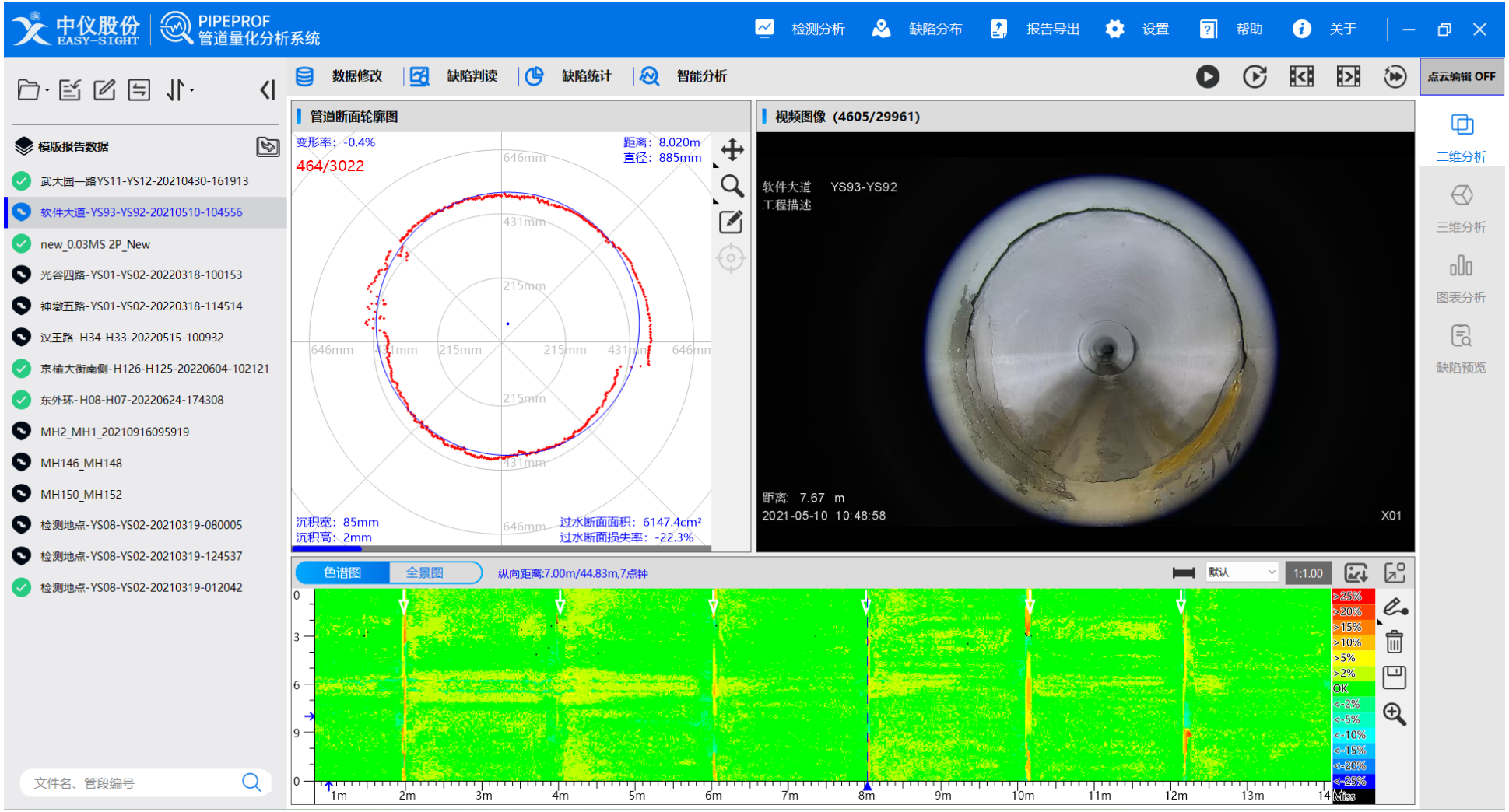
Application cases

Wuhan



Application cases

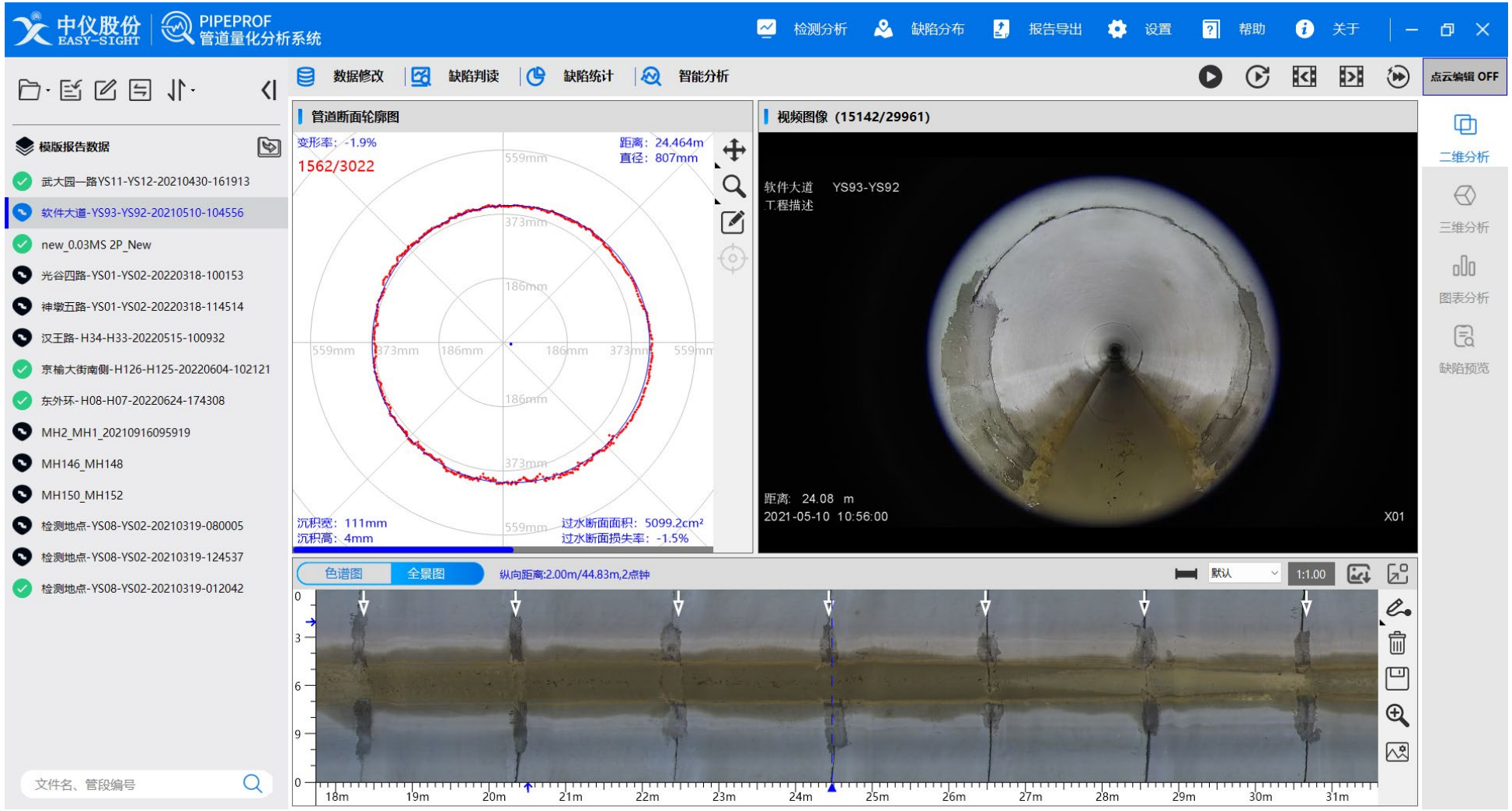
Fuzhou



Inspection of DN800 pipeline, length 45 meters.
From the chromatogram, it can be seen that the interior of the pipeline is generally good, but the interface has more serious problems, such as leakage at 8 meters.

Application cases

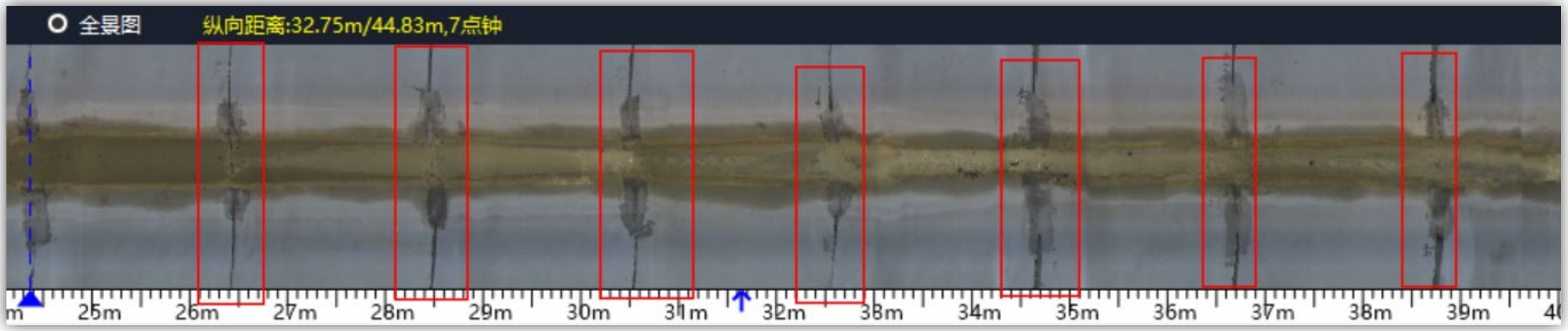
Fuzhou



At 24 meters, the same problem, the interface fell off, and we can see that it has been repaired

Application cases

Fuzhou



Through the panoramic view, we can clearly see that this problem exists at almost every joint of the pipeline, and all have been repaired. Each pipe section is in good health. This is something that cannot be directly observed using current CCTV.

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