International Meeting on Air Pollution in Asia – Inventories, Monitoring and Mitigation

February 1-3rd 2023, Hanoi, Vietnam

CONTINUOUS MONITORING TECHNOLOGY FOR PM2.5 AND ELEMENTS IN AMBIENT AIR

Author: MSc. Nguyen Van Dan, HORIBA VIETNAM

Email: Nguyen.van-dan@horiba.com

2023/02/01

HORIBA Process & Environmental

CONTENT

- PM2.5 and Why we develop this technology by HORIBA PX-375?
- Continuous Monitoring Technology for PM 2.5 and elements in ambient air
- Case studies

PM2.5 AND WHY WE DEVELOP THIS TECHNOLOGY BY HORIBA PX-375 ?

What is PM2.5

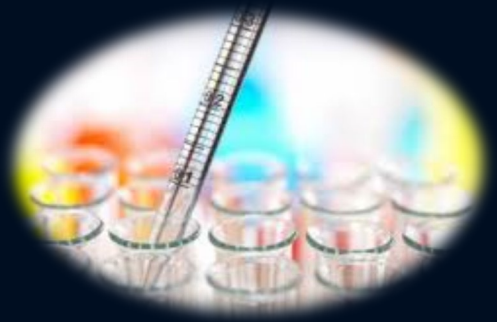
Total PM2,5 means total amount of suspended particulate matters of which the aerodynamic diameter is ≤ 2,5 um (QCVN 05: 2013/BTNMT).

The aerodynamic diameter is: The diameter of a sphere like a dust particle with a density of 1 g/cm3 having the same falling speed as a dust particle gravity at quiet air conditions under temperature conditions, Normal humidity and air pressure. (TCVN 6753 : 2000 or ISO 7708 : 1995)

PM 2.5 can go deep into the breath, circulatory system and brain... Therefore, more research is needed on the composition of dust with elements such as elements. Pb, S, Ti, Cr, Mn, Ni, Cu, Zn, Al, Si, K, Ca, V, Fe, As… serving human health impact research, environmental study and other applications…is necessary and important.

Conventional Analysis Method for PM composition

Sampling



Pre-treatment

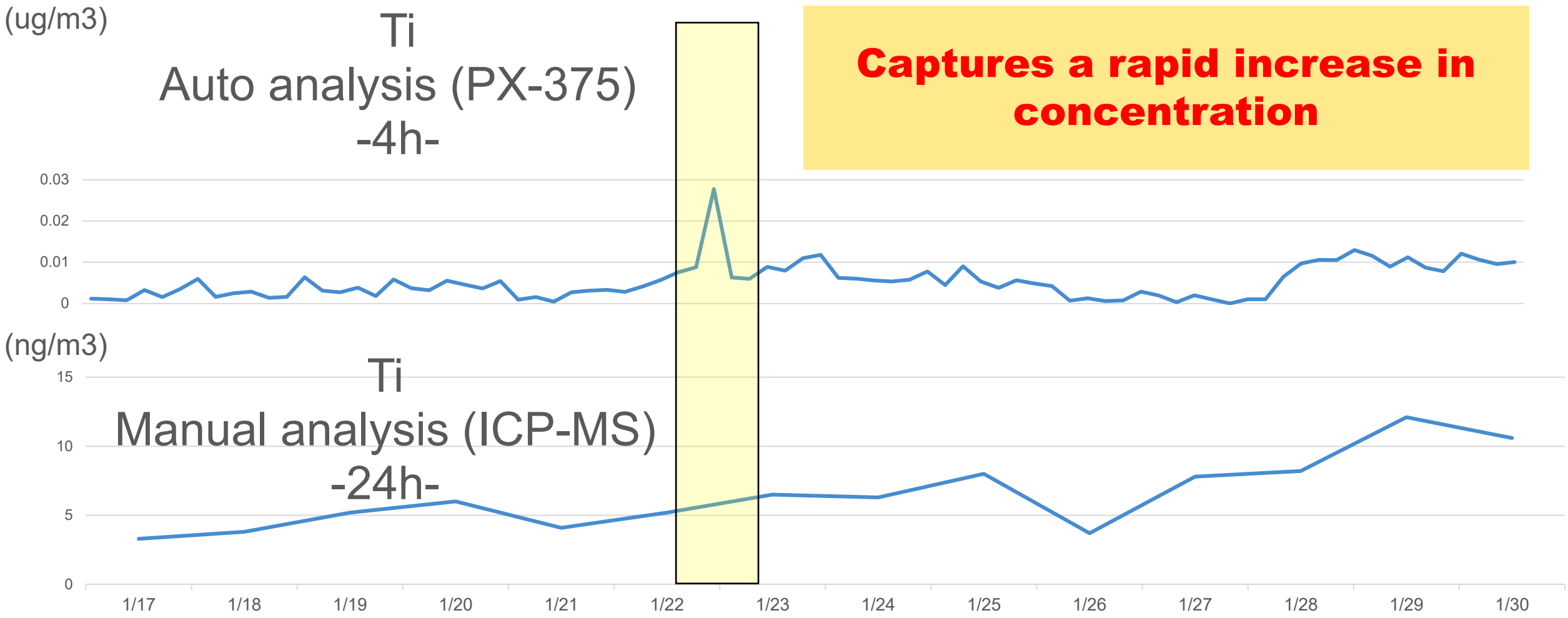
Analysis and results

- Expert analysis is expensive
- Long time from sampling to result acquisition
- Difficult to grasp trends with high frequency

Benefits of PX-375 comparing with conventional method

	ICP/AAS	PX-375	What specifically can we do?
Time resolution	24 hours	**30 minutes (Shortest)**	Analysis of pollution by time of day Capture a short-term rapid increase in concentration
Pre-treatment	Need (professional)	**None Auto**	Easy to install Reduction of man-hours required for analysis
No. of data	Less	**Many**	Improved analysis accuracy of modelling… etc.
Promptness	~2 weeks	**Near real time**	**Smooth verification** **Immediate measures, breaking news alarm**

MoE Japan, data comparison of auto and manual



Captures a rapid increase in concentration

□ Reference□ Ministry of the Environment□

CONTINUOUS MONITORING TECHNOLOGY FOR PM2.5 AND ELEMENTS IN AMBIENT AIR BY HORIBA PX-375

Ambient Multi-Elemental Monitor PX-375

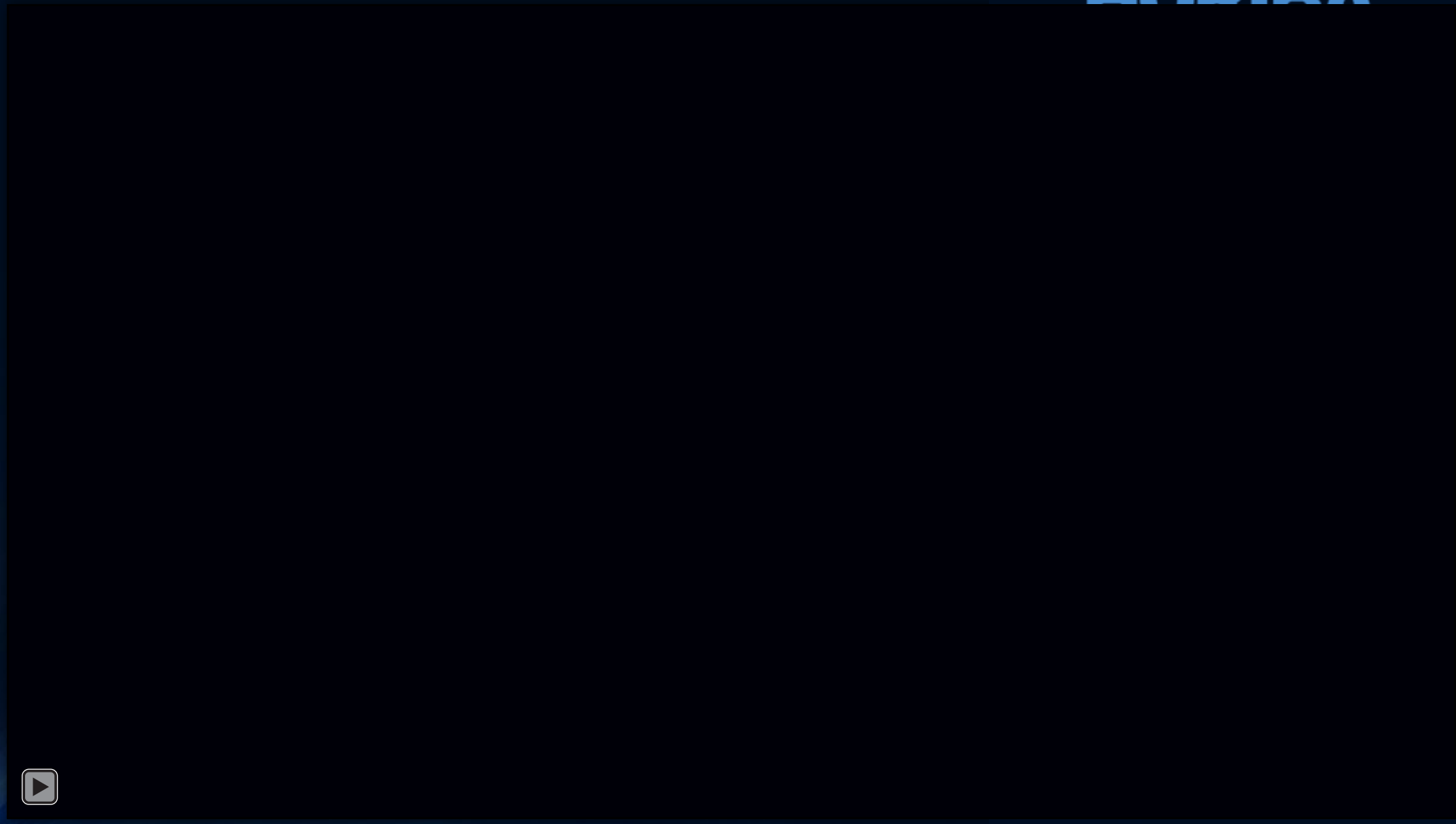
PX-375 features

- Sampling,

  PM mass concentration (β-ray attenuation),

  metal concentration (XRF) all in ONE!
- Automatic near-real time analysis

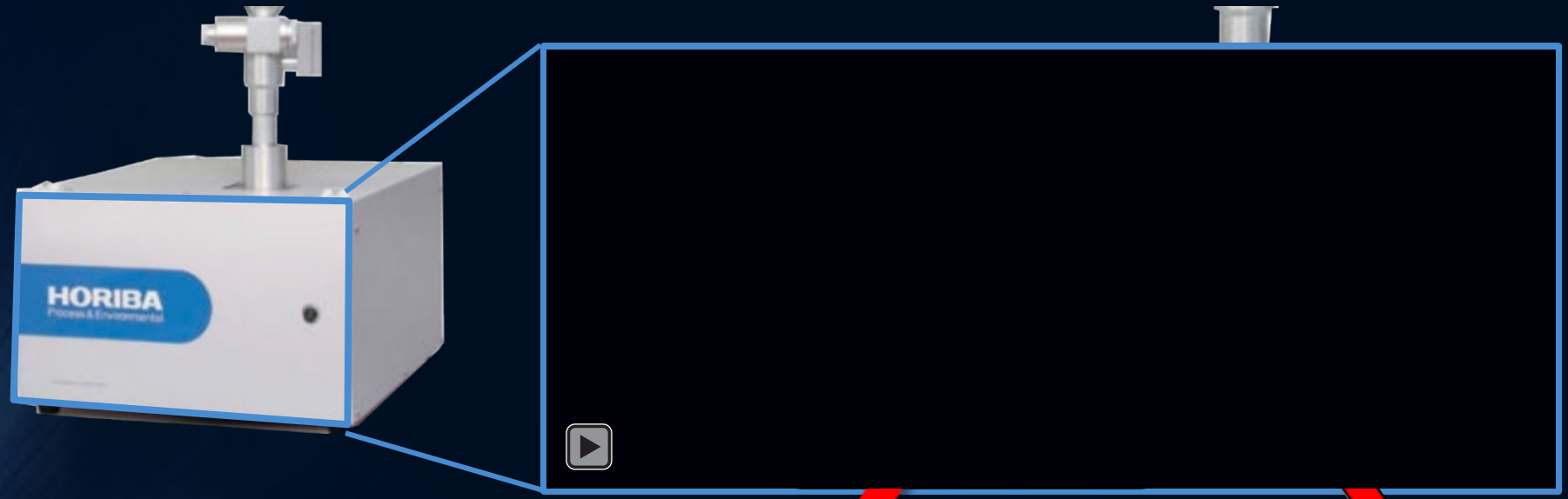
  (Shortest 30 minutes)
- Continuous monitoring and visualizing time trend



Auto analysis of particulate matter mass and metal

HORIBA

Analysis image



Element analyzer

X-ray fluorescence

Recommended by US EPA Method IO 3.3

Mass analyzer

B-ray attenuation

VSCC™ US EPA reference method

CASE STUDIES

Case study of national wide scale pollution source analysis

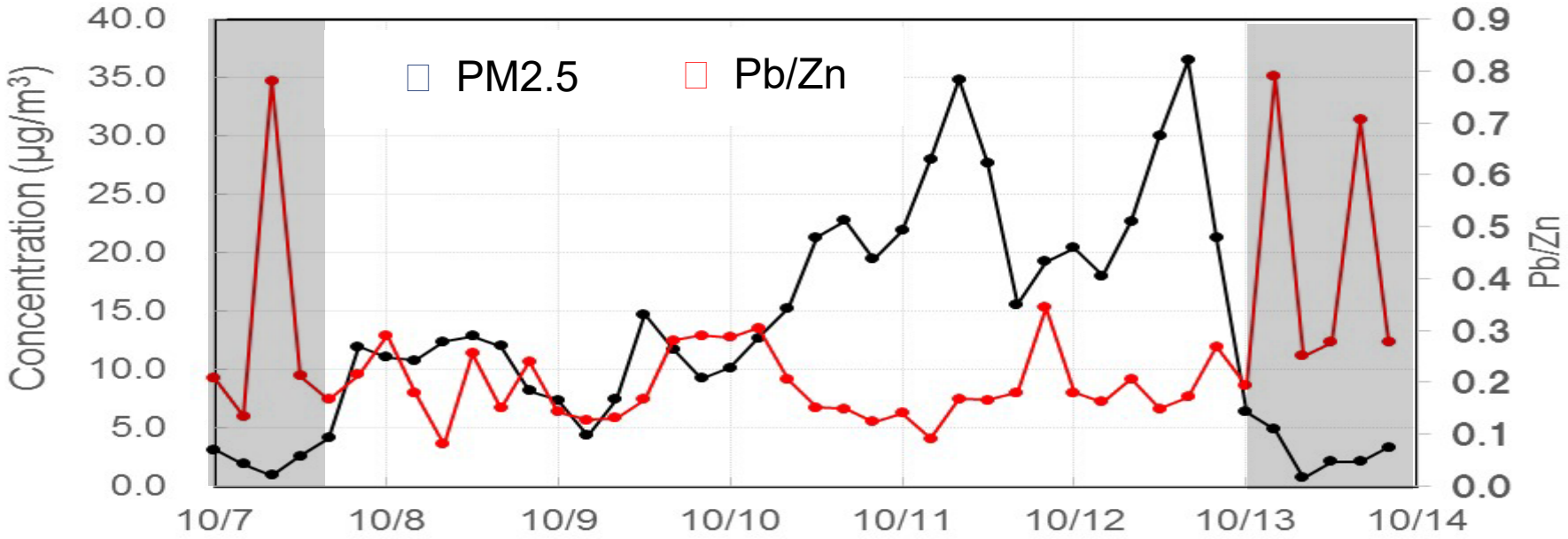
Simultaneous observation of particle metal and Oxidative Ratio (OR)

Analysis of PM2.5 high-concentration events

PM2.5 high conc. event analysis
From PM metal composition and Oxidative Ratio (OR)

Focus on Pb/Zn

Capture element ratio changes with high time resolution!

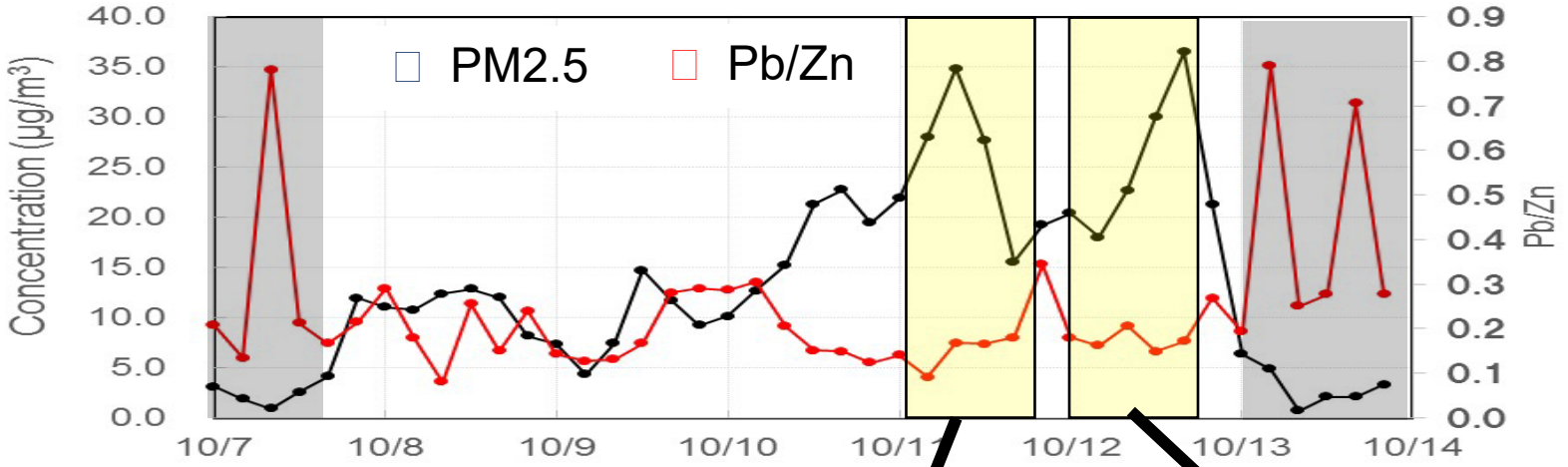


- **PM2.5 mass concentration increase and the influence from continental does not always match.**
  (When Pb / Zn> 0.44, it is said that the continental influence is large)
- **Regional pollution time is clear!**

Reference Naoki Kaneyasu. Estimation of PM2.5 Emission Sources in the Tokyo Metropolitan Area by Simultaneous Measurements of Particle Elements and Oxidative Ratio in Air.

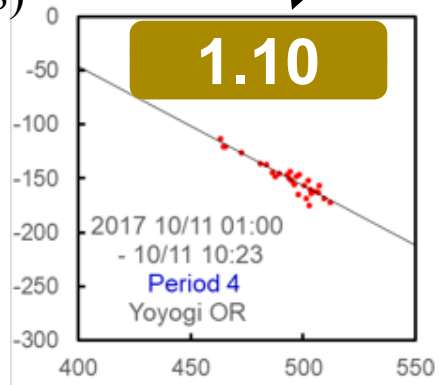
PM2.5 high conc. event analysis
From PM metal composition and Oxidative Ratio (OR)

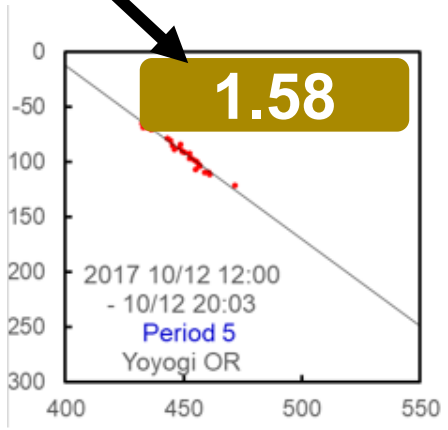
Focus on OR



Profile indicator(Keeling, 1988)

Oxidative Ratio(OR)*	$-\Delta O_2/\Delta CO_2$
LNG	1.95
LPG	1.44
Coal	1.17





Coal

LPG

- **Coal-derived time zone and petroleum-derived time zone are revealed!**

Reference Naoki Kaneyasu. Estimation of PM2.5 Emission Sources in the Tokyo Metropolitan Area by Simultaneous Measurements of Particle Elements and Oxidative Ratio in Air.

Case study of regional pollution analysis

Case study

Analysis by metal composition

Analysis by elemental ratio

Countermeasure

HORIBA

Analysis by metal composition

Analysis by metal composition

HORIBA

Two potential pollution sources

Oil combustion facility

Copper smelter

Reference PIXTA

Analysis by metal composition

HORIBA

Install PX-375 and start sampling

Oil combustion facility

Copper smelter

Reference PIXTA

Analysis by metal composition

HORIBA

Analysis starts!

Oil combustion facility

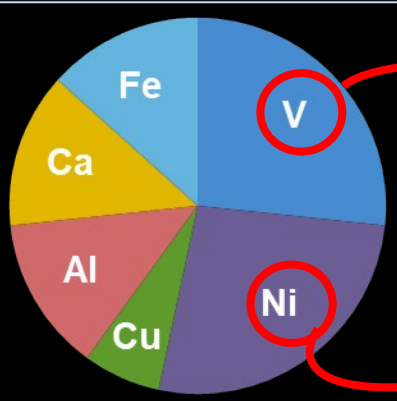
Copper smelter

Reference PIXTA

Analysis by metal composition

HORIBA

21 Jan. PM 12
Metal composition



Metal composition (%)

Metals	V	Ni	Cu
Oil combustion	□	□	
Copper smelter			□

Possibly oil combustion facility

Facility A is most probably the pollution source!

Oil combustion facility

Copper smelter

Reference□ PIXTA

Analysis by elemental ratio

Element ratio in regional pollution analysis

Elemental ratio = element A/ element B

Useful in case like…

- There are multiple combustion equipment of the same type on the company's premises
- There is the same type of combustion equipment around your factory

Analysis by elemental ratio

HORIBA

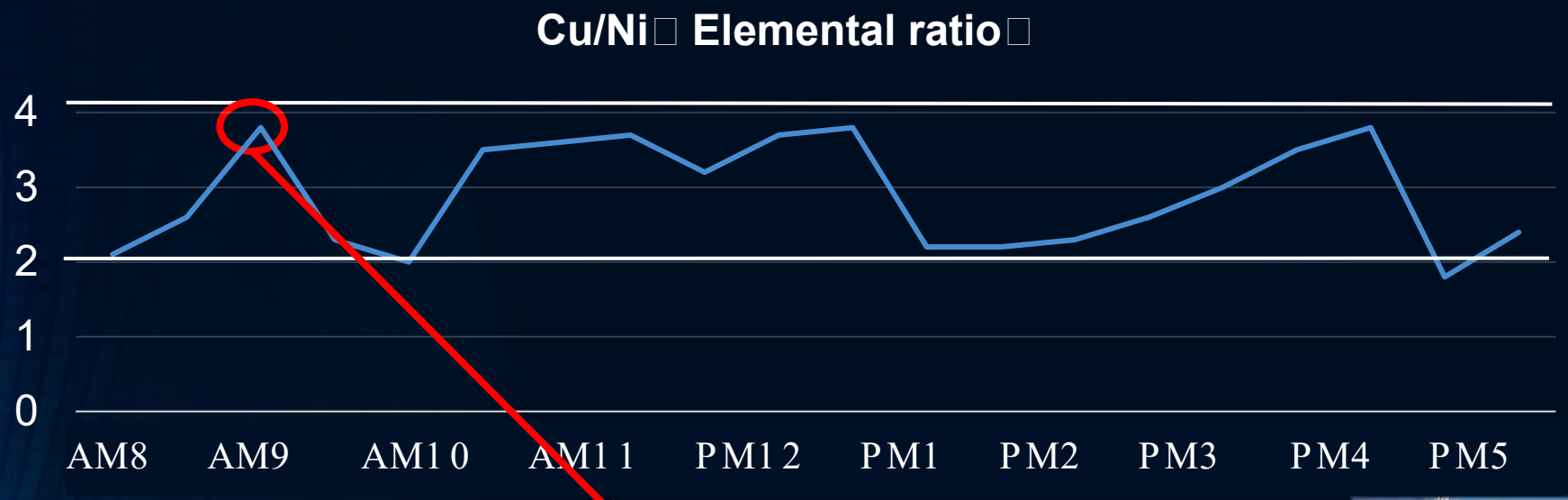
- Identify elemental ratio for each pollution source in advance
- In this case study, 4 for Facility A, and 2 for Facility B

Copper smelter

Copper smelter

Reference PIXTA

Analysis by elemental ratio



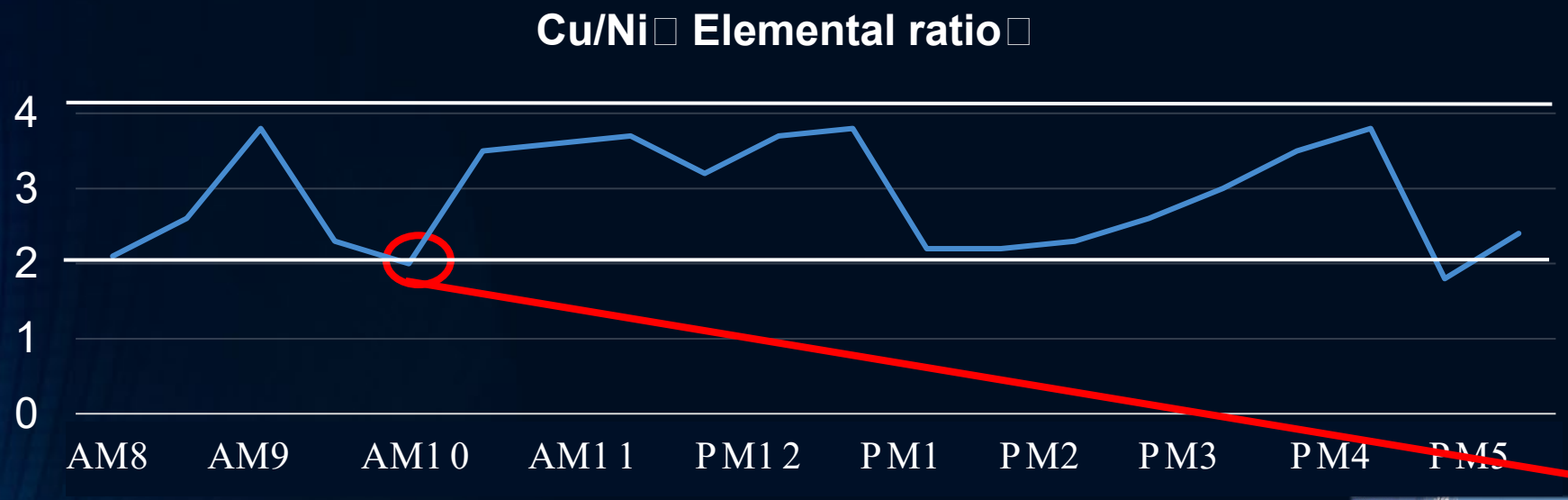
AM 9

Copper smelter

Copper smelter

Reference PIXTA

Analysis by elemental ratio



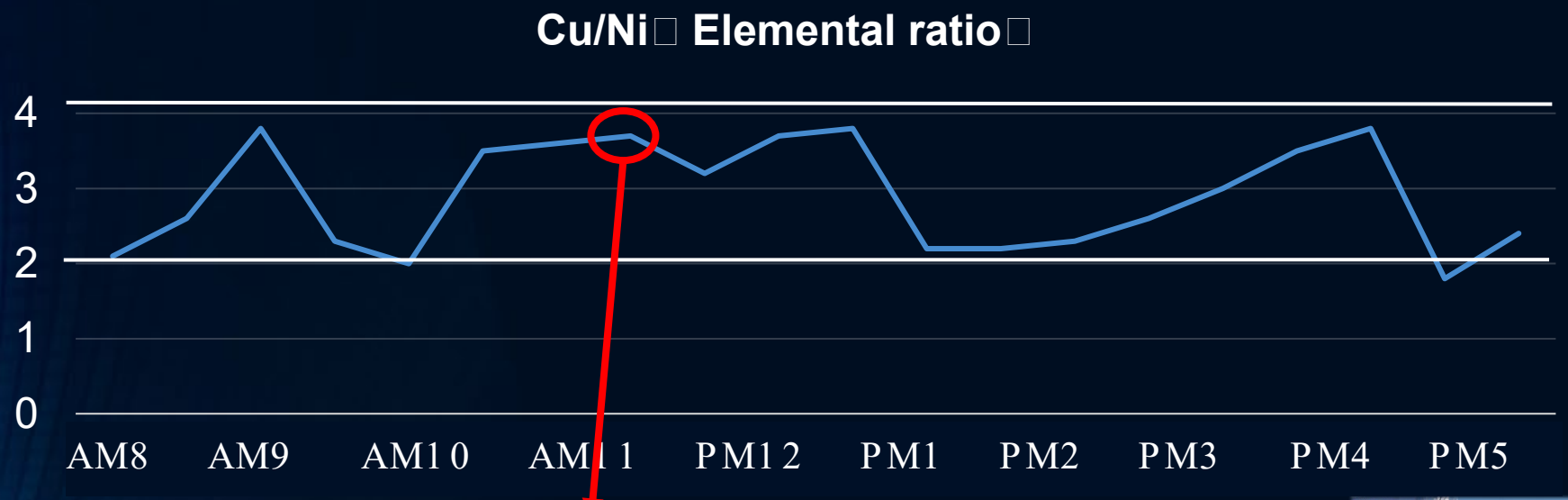
AM 10

Copper smelter

Copper smelter

Reference PIXTA

Analysis by elemental ratio



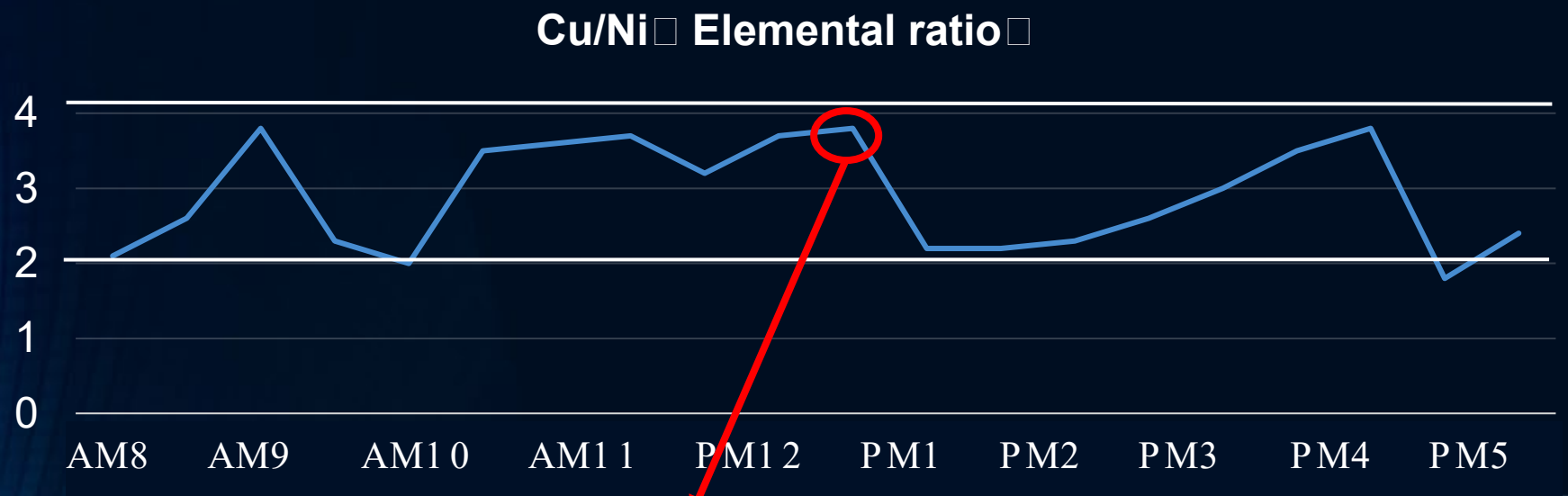
AM 11

Copper smelter

Copper smelter

Reference PIXTA

Analysis by elemental ratio



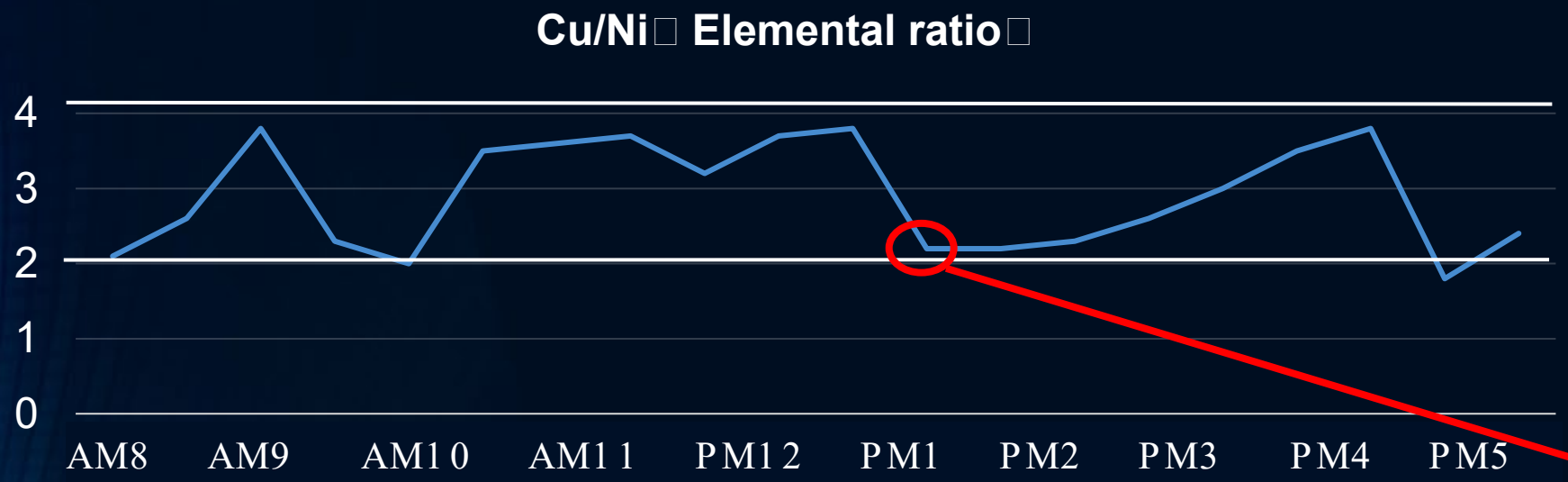
PM 12

Copper smelter

Copper smelter

Reference PIXTA

Analysis by elemental ratio



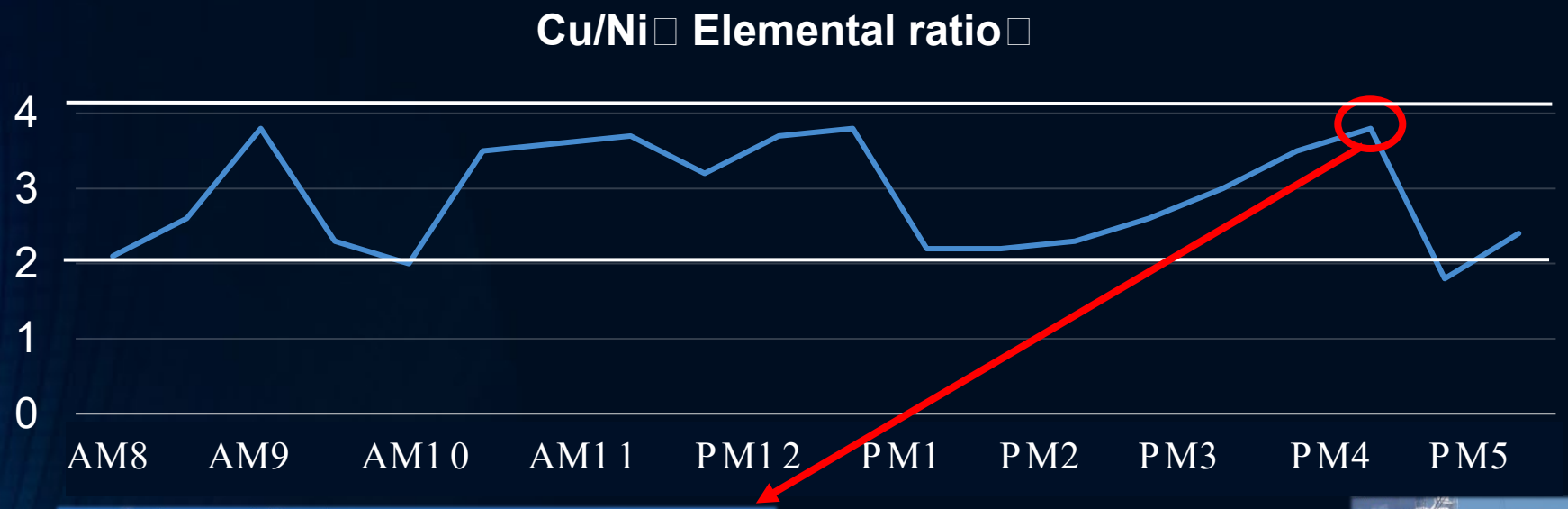
PM 1

Copper smelter

Copper smelter

Reference PIXTA

Analysis by elemental ratio



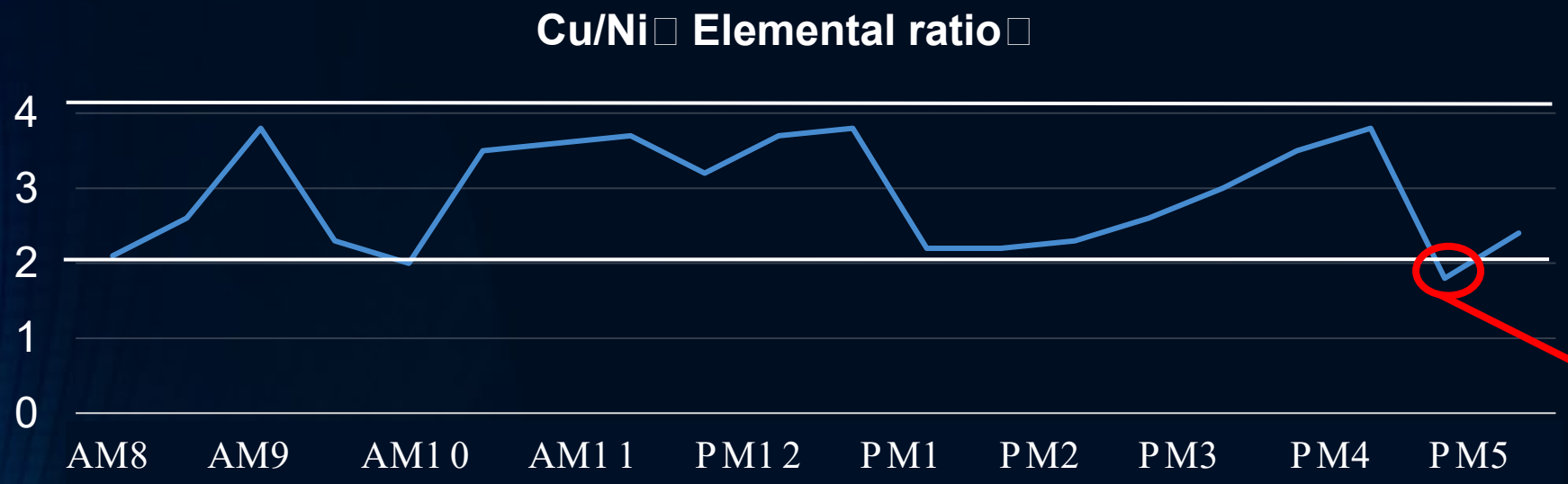
PM 4

Copper smelter

Copper smelter

Reference PIXTA

Analysis by elemental ratio



PM 5

Copper smelter

Copper smelter

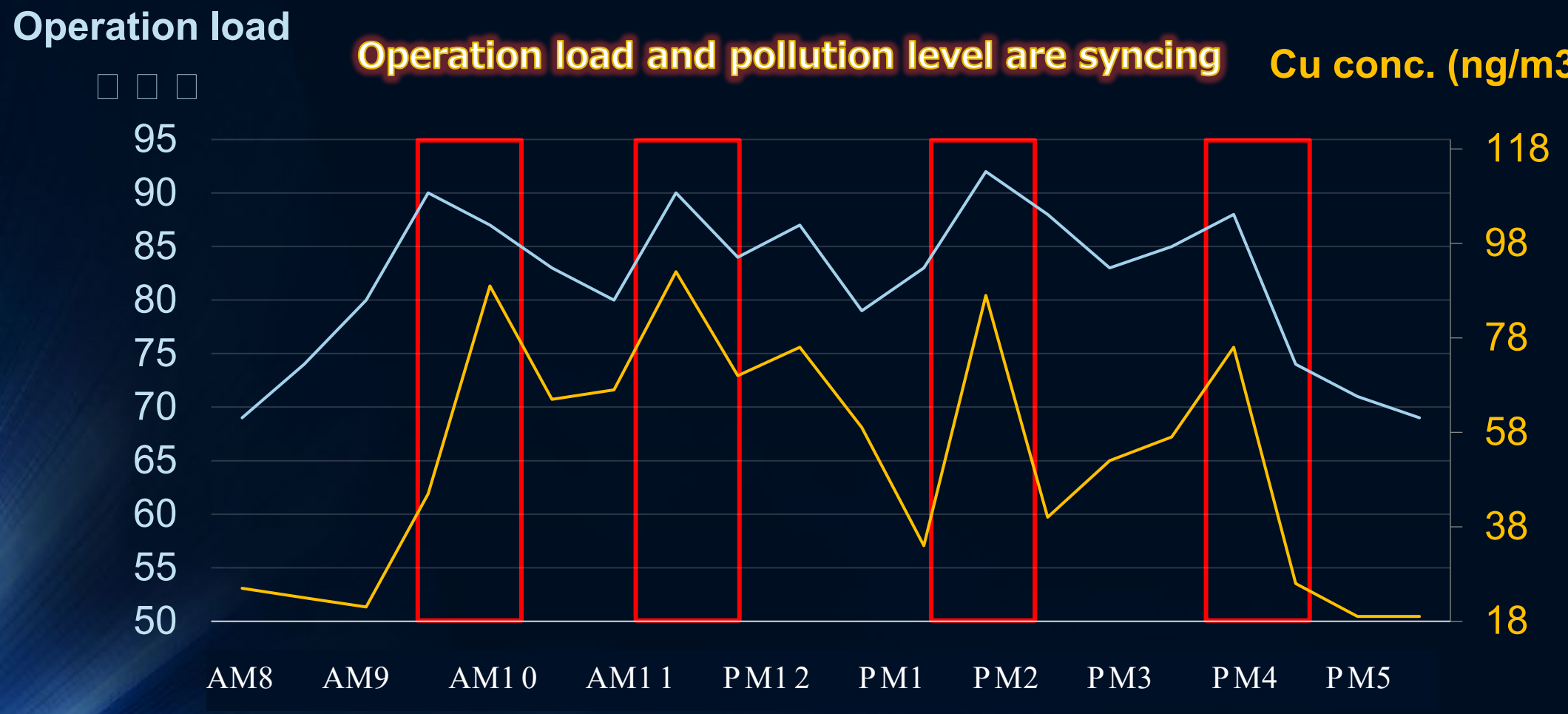
Reference PIXTA

HORIBA

Countermeasure

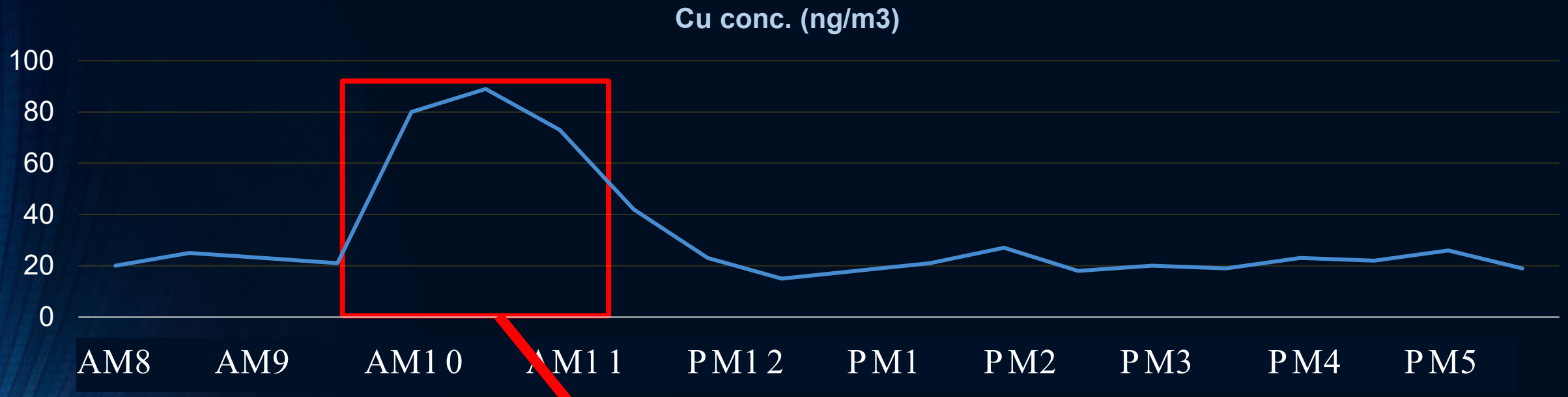
Countermeasure

Potential pollution source facility operation load



Countermeasure

Check site work from daily report



Time	Work
8:30-9:30	□ □ □ □
9:30-11:30	● ● ● ●
Break	
12:30-15:00	□ □ □ □
15:00-17:00	□ □ □ □

Countermeasure

HORIBA

1. Review site work
2. Review emission route
   (Install fan, hood etc...)
3. Review process control
4. Investment in treatment system

HORIBA

Particulate matter multi metal monitor PX-375

Auto analysis of particulate matter mass and metal

Data management system

Remotely! Supports a wide range of analysis!

Supported by the data analysis,

Specific countermeasures
Smooth decision making

HORIBA

PX-375 supports Pollution Source Analysis

CONCLUSION

- Pollution Source Apportionment Analysis and countermeasure.
- Continuous Monitoring of PM 2.5 and the elements in the ambient air for cross-border pollution, forest fire, Volcano, biomass burning emission….
- Continuous Monitoring of PM and the elements in the ambient air for integration in national ambient monitoring station networks.

Omoshiro-okashiku

Joy and Fun

Terima kasih

Gracias 谢谢

Σας ευχαριστώ πάρα πολύ

Danke

Tack ska du ha

Grazie

THANK YOU

ขอบคุณครับ

Obrigado

Большое спасибо

ありがとうございました

Cảm ơn

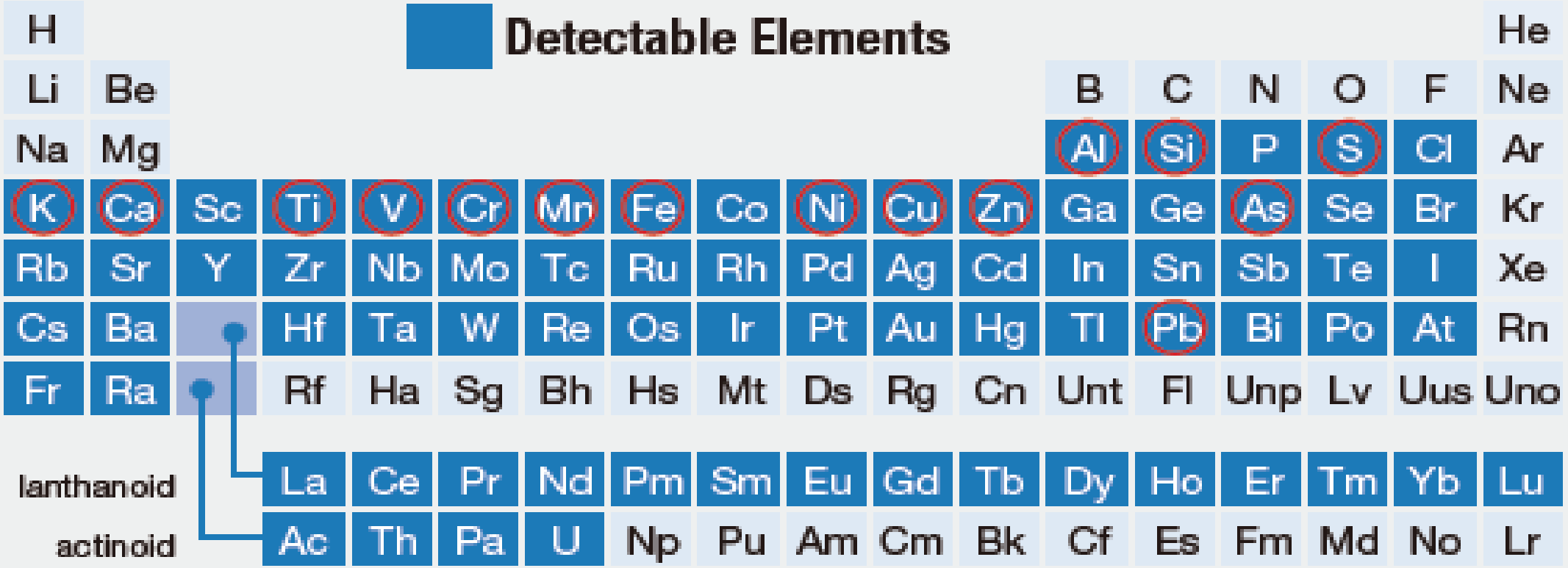
Merci

감사합니다

Dziękuję

HORIBA

Detectable Elements (Table 2)



* ○—Standard parameters, calibrated by standard calibration materials.
* For measurement of element concentration calibration by standard calibration materials is needed.
* Please contact separately about elements, marked as non-detectable.

HORIBA

Lowest Detection Limit (Example) (2σ) (ng/m³) (Table 1)

Element	Analysis time (sec.)		
	100	1000	10000
Ti	26.5	8.4	2.6
Cr	4.5	1.4	0.4
Mn	5.8	1.8	0.6
Cu	5.7	1.8	0.6
Zn	3.0	1.0	0.3
Se	3.4	1.1	0.3
Ag	15.8	5.0	1.6
Cd	35.9	11.3	3.6
Sn	38.4	12.2	3.8
Hg	7.7	2.4	0.8
Pb	5.3	1.7	0.5

HORIBA

Each pollution source has its own metal composition characteristics.

The source can be estimated by analyzing the metal composition!

Metals	Na	Al	Si	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Sb
Sea salt	□															
Soil		□			□	□	□									
Road		□			□	□	□				□					
Vehicle																
Brake							□				□			□		□
Tire															□	
Steel					□		□		□	□	□		□	□	□	
Oil combustion								□					□			
Incineration	□			□					□					□		□
Biomass/ Wild fire				□												