



RESEARCH ON PERFORMANCE OF STACK ULTRASONIC FLOWMETERS

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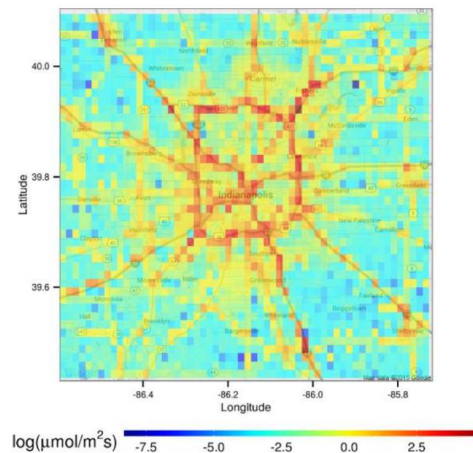
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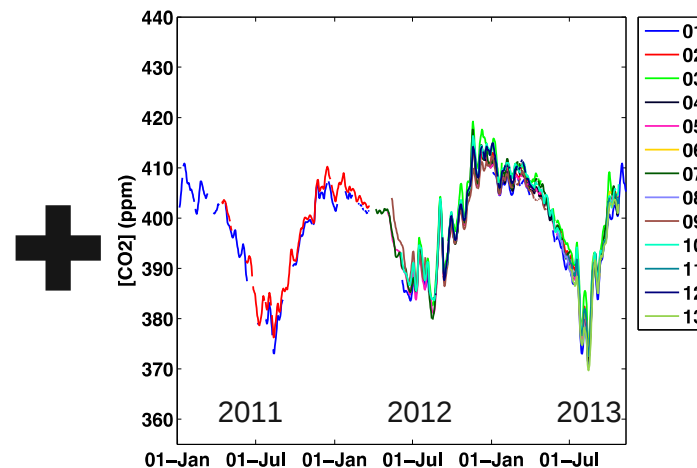
Greenhouse Gas Emission City Observation

Emission Inventory + Tower Observation → Modified Emission Inventory

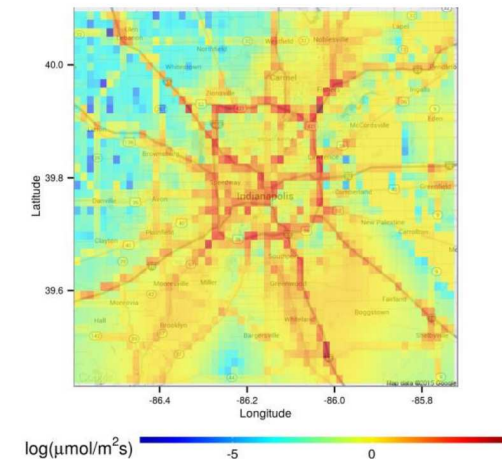
Inversion Model



(a) 先验碳排放通量数据 (Hestia)



=



(b) 后验的碳排放通量修正结果

Through monitoring the concentration of pollutants and greenhouse gases in urban atmosphere, combined with inversion calculation, the existing inventory data can be revised to obtain more accurate inventory data.

Greenhouse Gas Emission City Observation

□ Emission inventory is used as initial value for inverse model

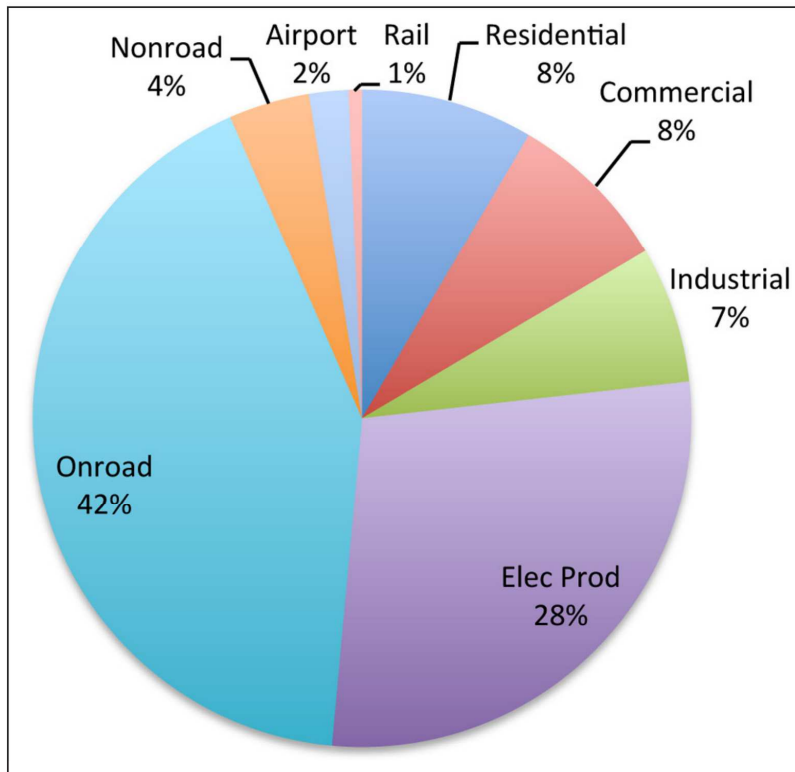
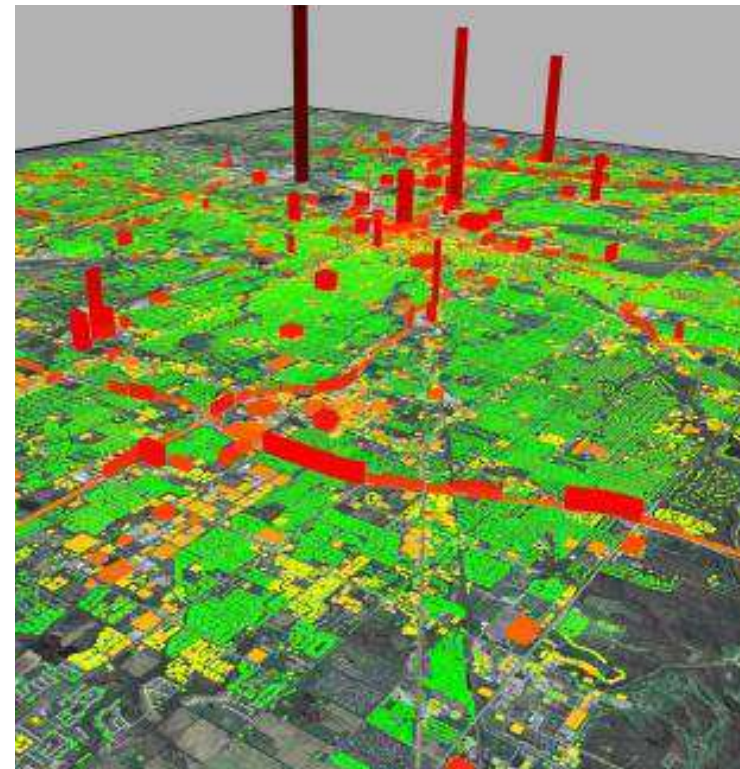


Figure 2: Hestia FFCO₂ emissions for Marion County, Indiana. Proportion of the total 2011 Hestia version 3.0 FFCO₂ emissions for Marion County, Indiana from each of the eight sectors. DOI: <https://doi.org/10.1525/elementa.137.f2>

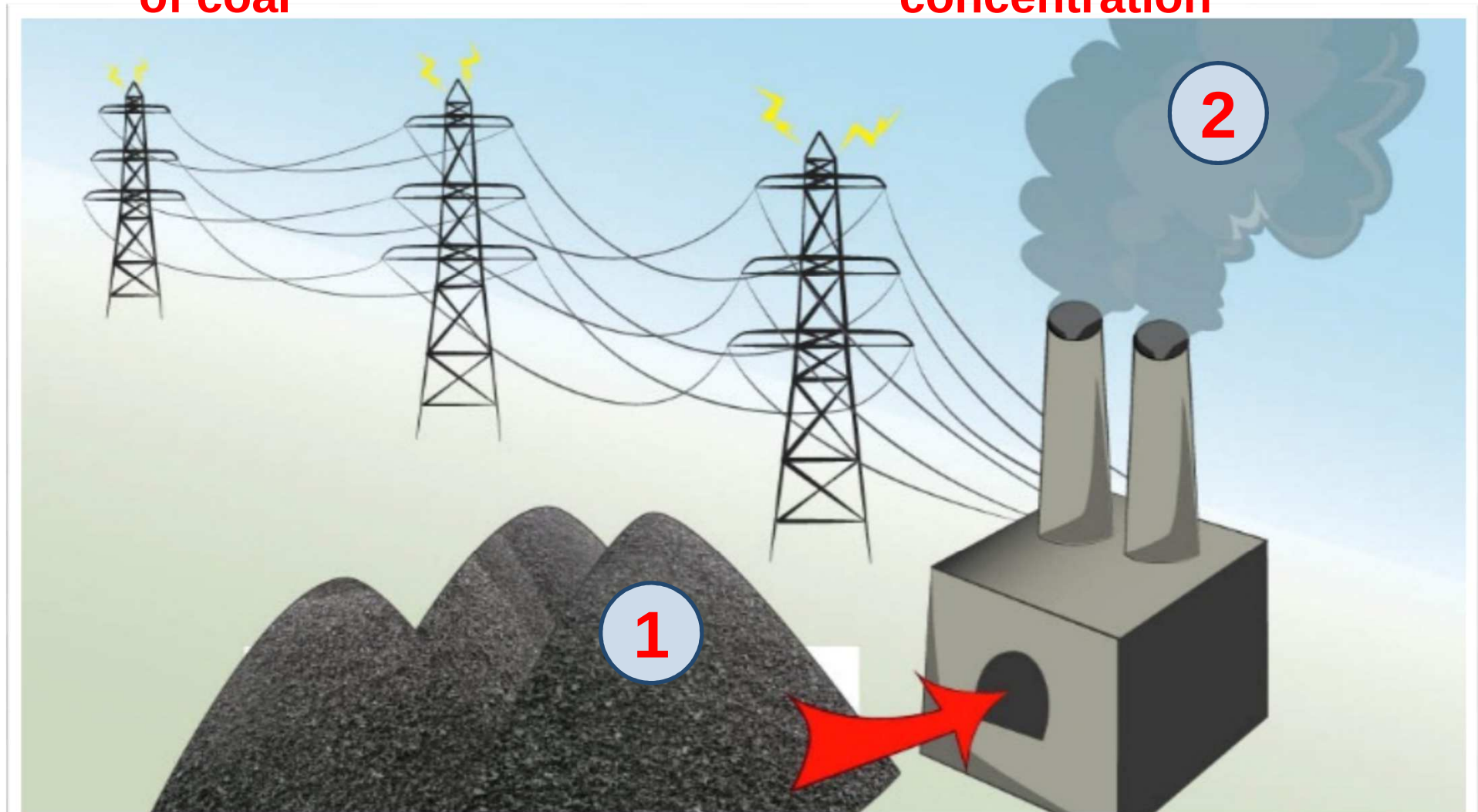


Cited from Kevin R. Gurney etc. "Reconciling the differences between a bottom-up and inverse-estimated FFCO₂ emissions estimate in a large US urban area" and "Quantification of Fossil Fuel CO₂ Emissions on the Building/Street Scale for a Large U.S. City"

High Time Resolution Emission Measurement

1 *Fuel:*
Amount & quality
of coal

2 *Emissions:*
Flow and CO₂
concentration



Stack CEMs Data Uncertainty

□ Concentration

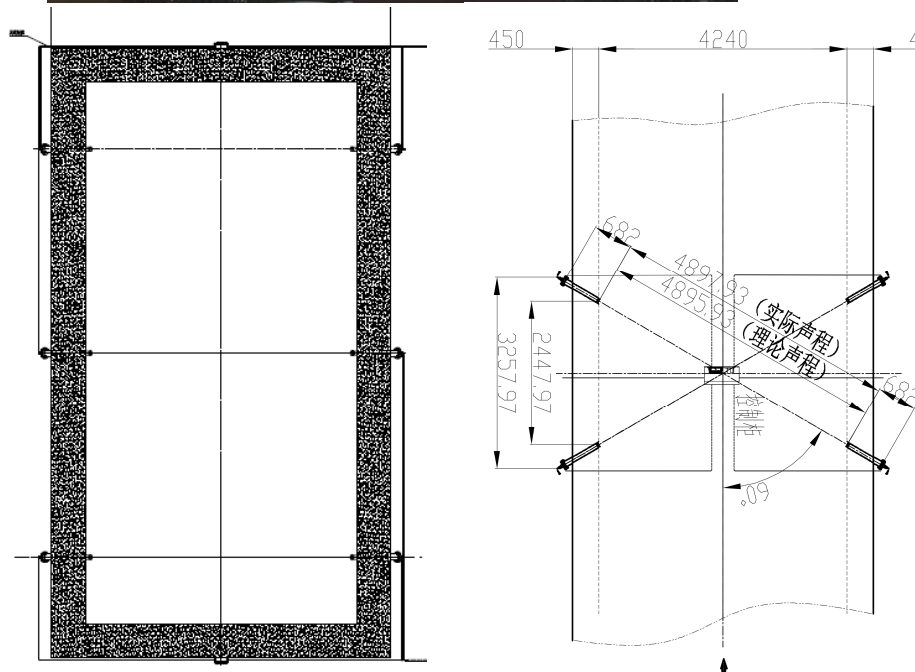
- Standard gas calibration
- Portable calibrated instrument comparison
- Uncertainty: 1%~5%

□ Flowrate

- S type pitot tube (EPA method 2) calibration
- 3D pitot tube using nulling method (EPA method 2f) calibration
- Uncertainty: 5%~50%

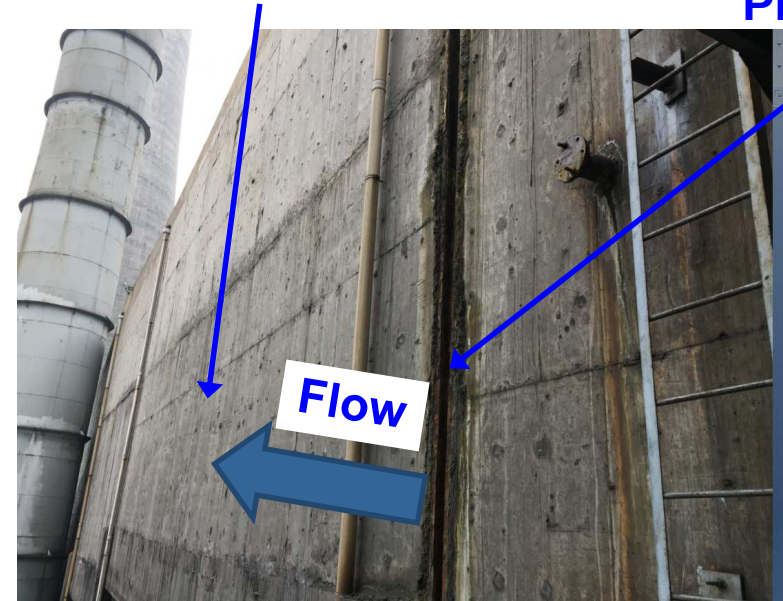
USM Installation

□ 6 path USM(OWIRS) installed in Coal-fired power plant



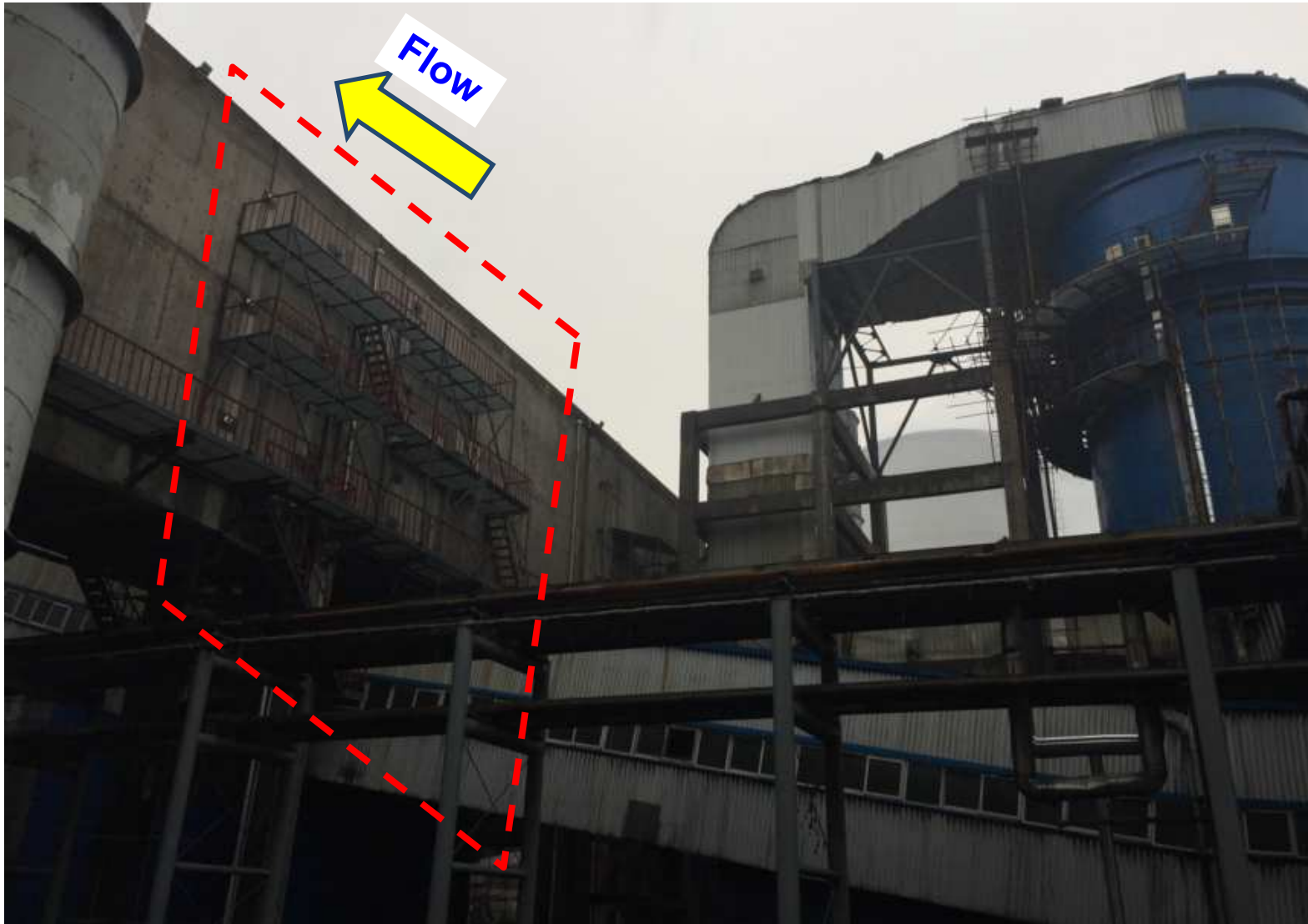
Install 6-Path
Ultrasonic Flowmeter

Pitot Tube
Test
Platform



USM Installation

□ Test location

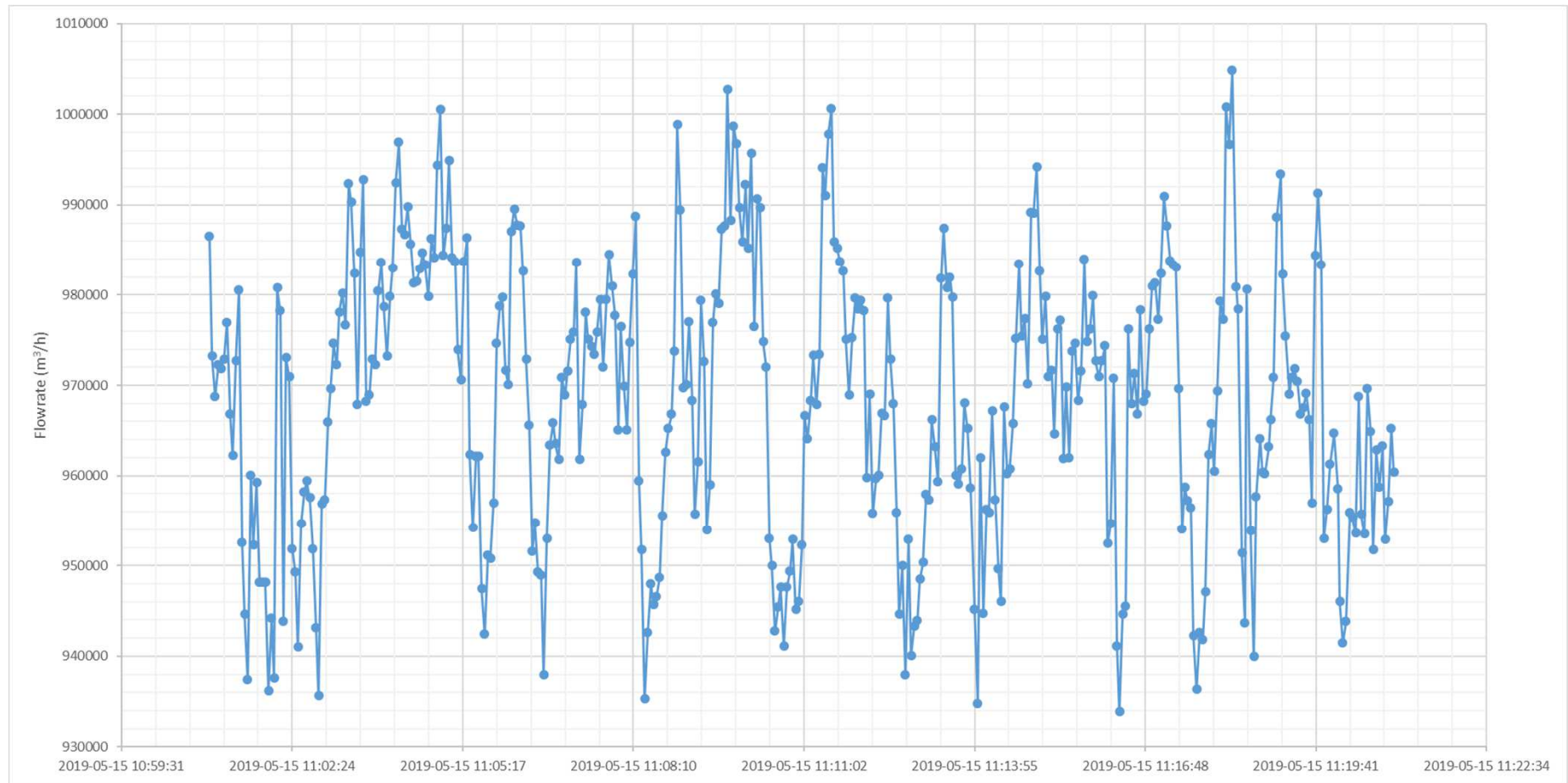


USM Installation

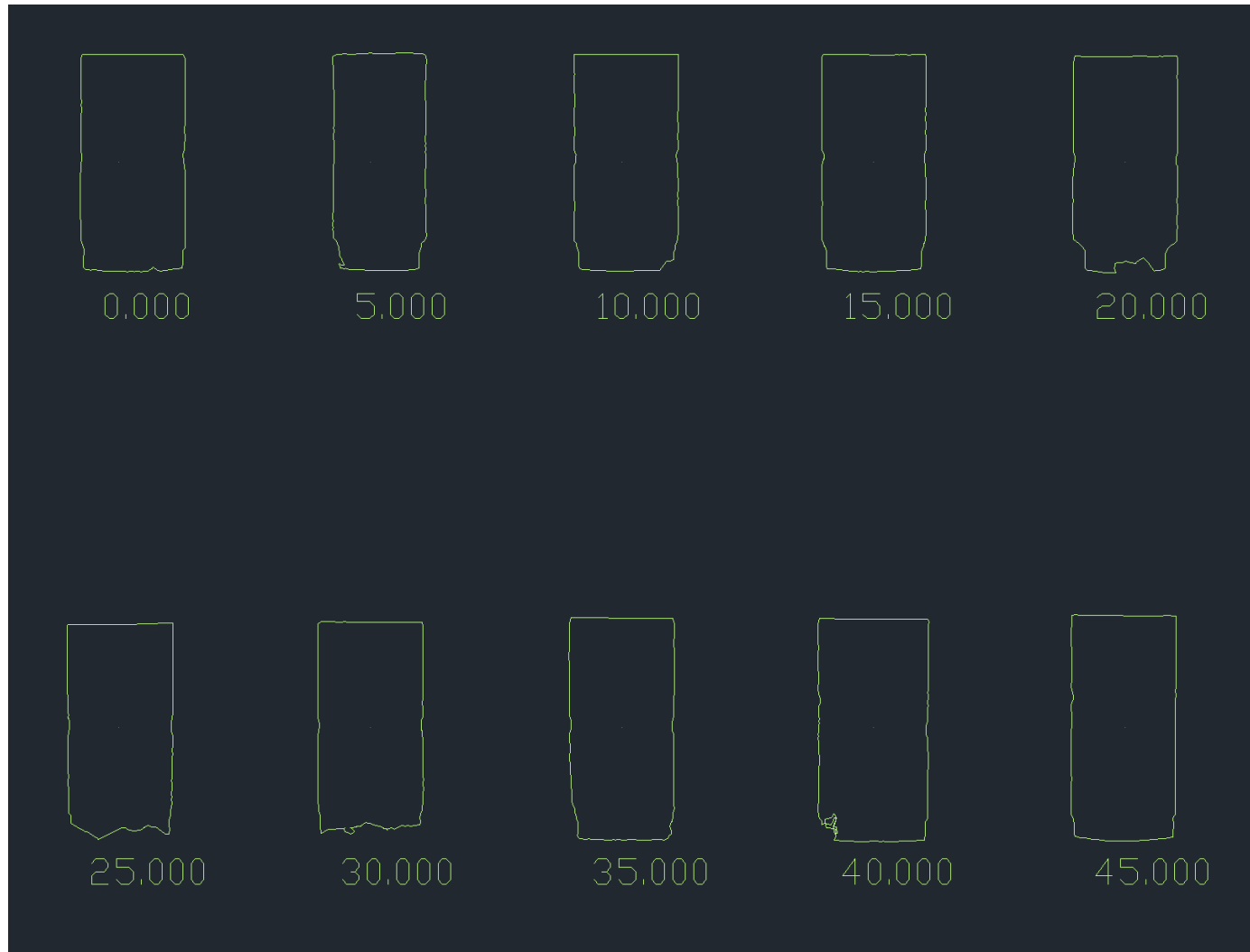


USM Measurement

□ USM reading



Cross Section Area of Duct

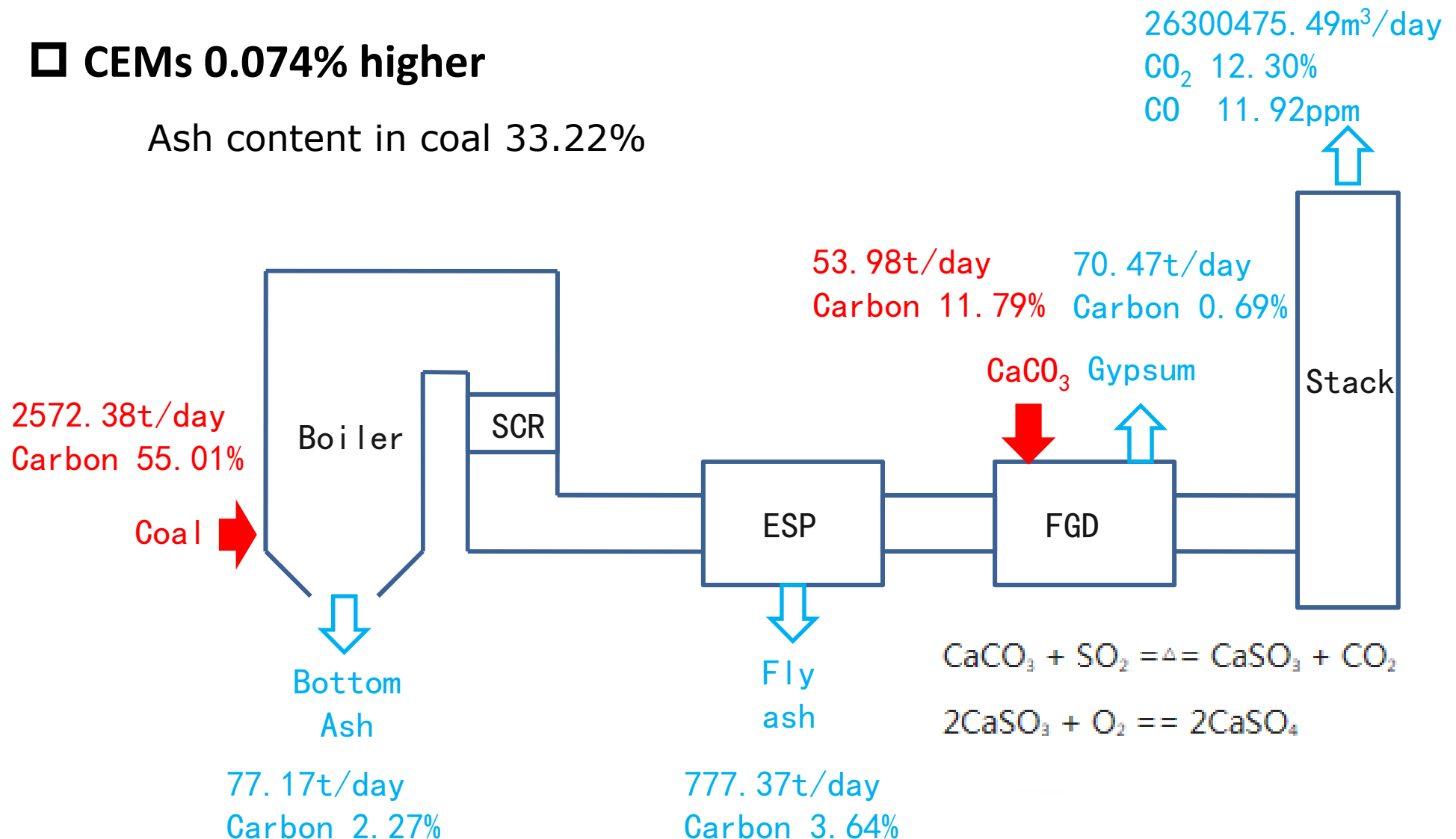


Carbon Balance of the Power Plant

❑ Fuel based: 1390549.063kg/day; CEMs: 1391577.979kg/day

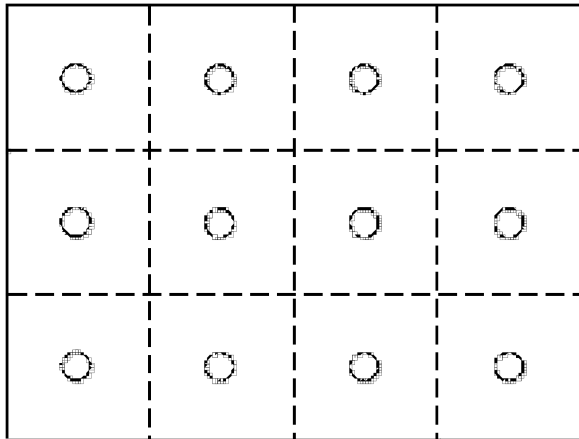
❑ CEMs 0.074% higher

Ash content in coal 33.22%



USM Calibration by Pitot Tube

□ US EPA Method 1



□ S type pitot tube calibration

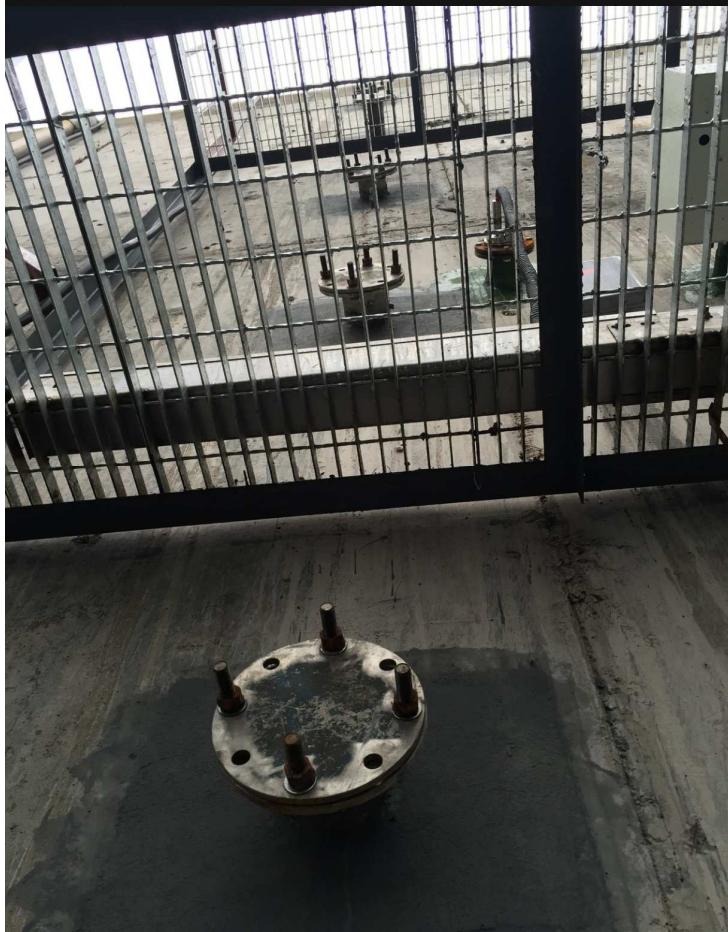
(3min/point)

□ 3D pitot tube calibration

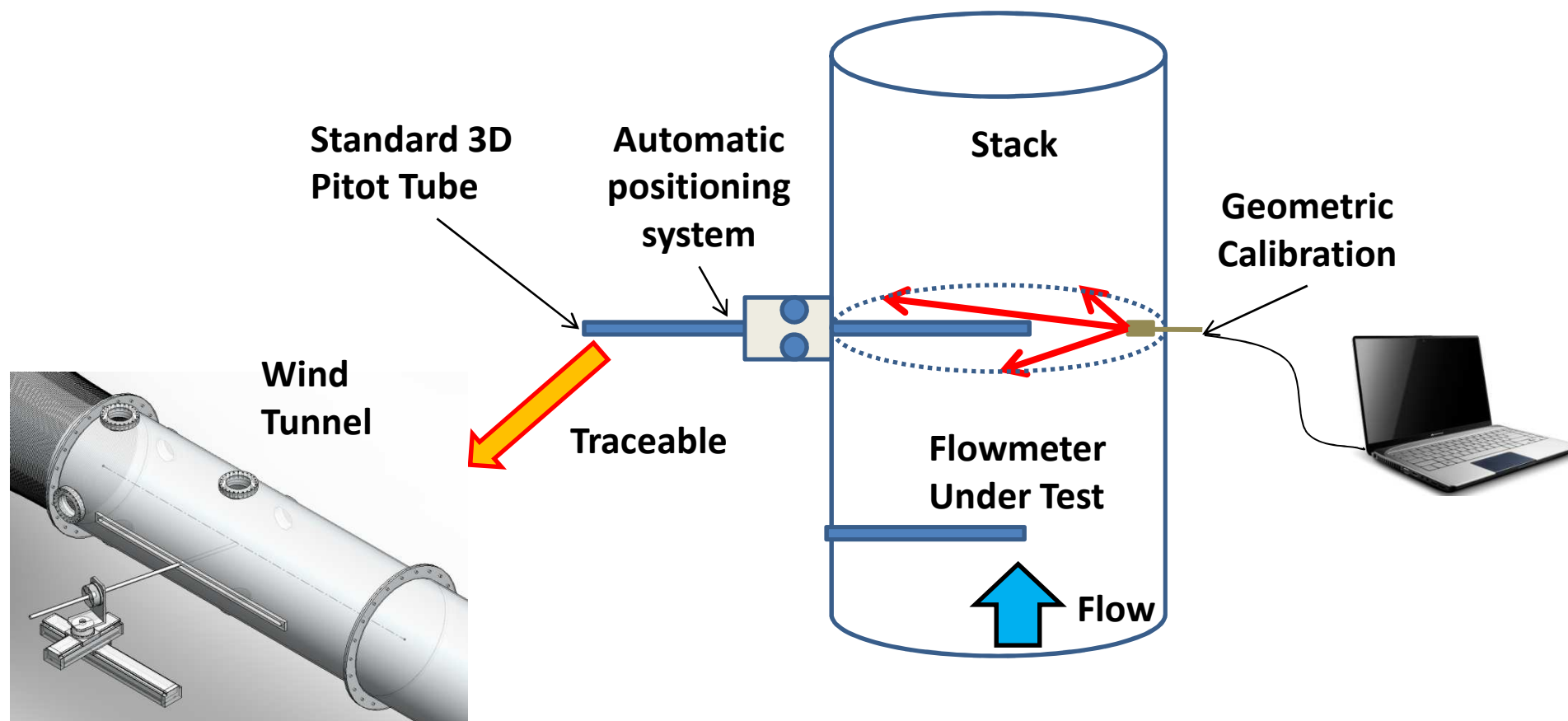
(3min/point)



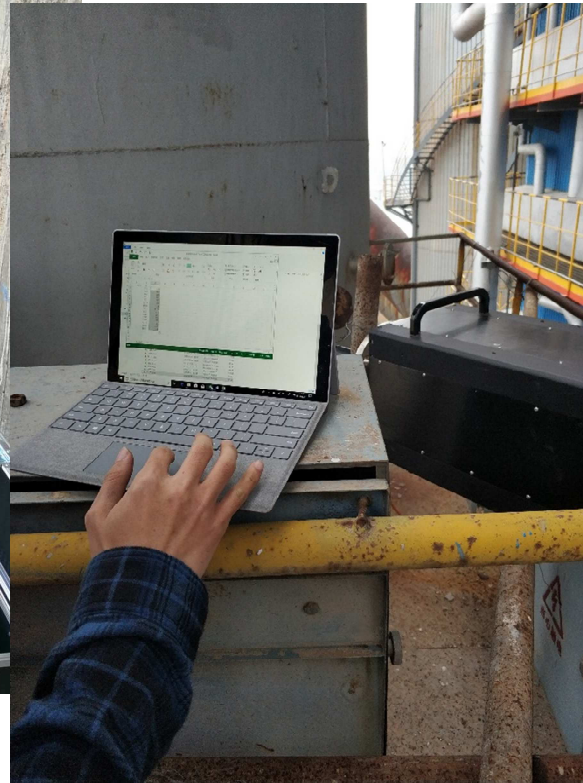
USM Calibration by Pitot Tube



Field Calibration System



Field Calibration System



USM Calibration by Pitot Tube

□ S type pitot tube

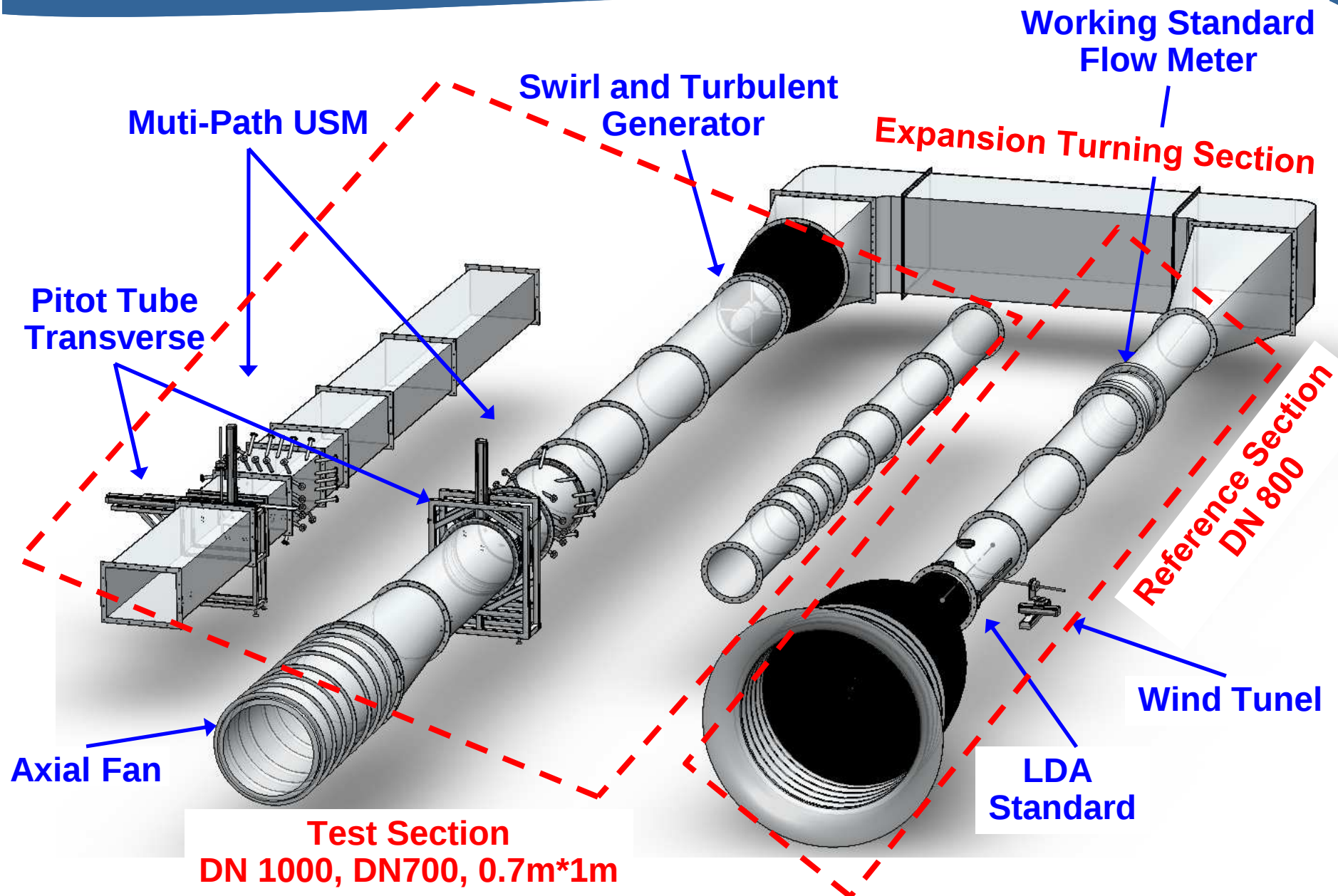
	Test 1	Test 2
S type pitot tube	1222656.3m ³ /h	1614091.2 m ³ /h
USM	837262.3m ³ /h	1067952.3m ³ /h
Difference	46.0%	51.1%

USM Calibration by Pitot Tube

□ Non-nulling prism 3D pitot tube

	Test 1	Test 2
S type pitot tube	986182.1 m ³ /h	1027034.2 m ³ /h
USM	1042290.8 m ³ /h	1094118.9m ³ /h
Difference	-5.4%	6.1%

Smoke Stack Simulator of NIM



Smoke Stack Simulator of NIM



Conclusion

- ❑ Muti-path stack USM is very accurate;
- ❑ 3D pitot tube have huge improvement compare to S probe;
- ❑ More research work need to be done to further improve the uncertainty of stack flowrate measurement.

Thank you for your attention

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