华北电力大学 NORTH CHINA ELECTRIC POWER UNIVERSITY

University of Kent | School of Engineering and Digital Arts

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Investigations into the Blockage of Pulverised Fuel Pipes on Coal-Fired Boilers Using an Electrostatic Sensor System

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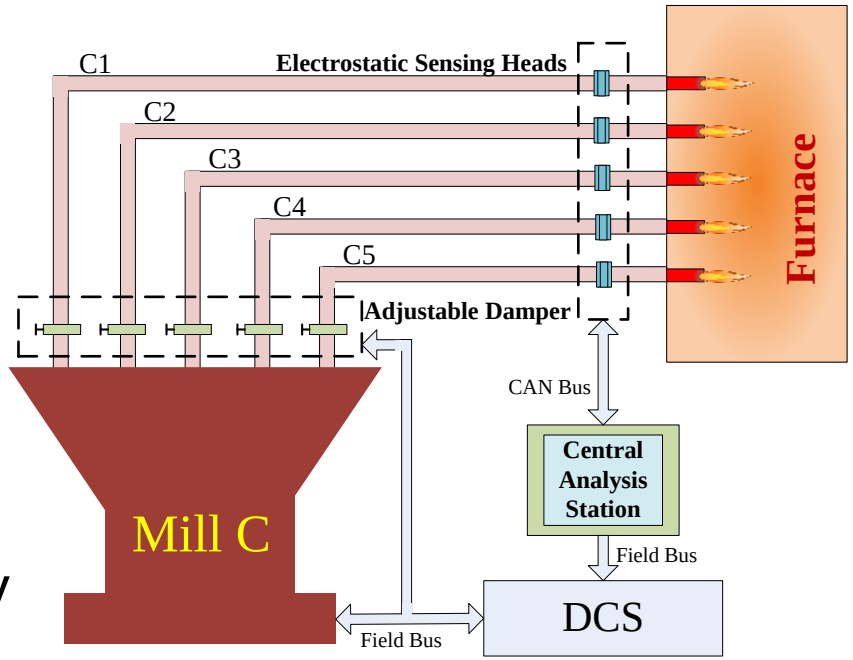
Outline

- Background
- Electrostatic Sensor System
- Monitoring Data and Discussion
- Conclusion

Background

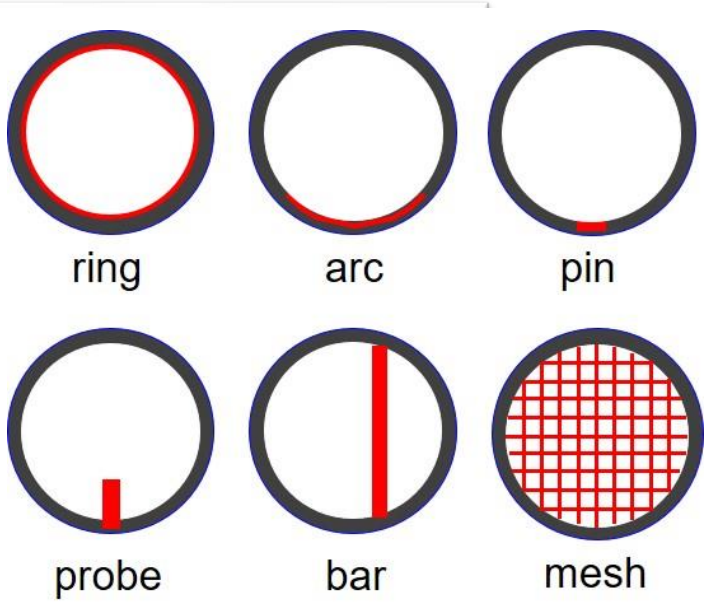
- **Hazards of pulverised fuel (PF) pipe blockage**
  - Uneven fuel distribution between burners may cause severe deviation of temperature distribution in a furnace
  - Damage of boiler and serious safety accidents

- **How to prevent PF pipes from blockage?**
  - To convey PF with an excessively high velocity
  - To configure the operation parameters of a milling system with optimal values
  - To monitor the dynamic parameters of PF flow and make adjustments accordingly



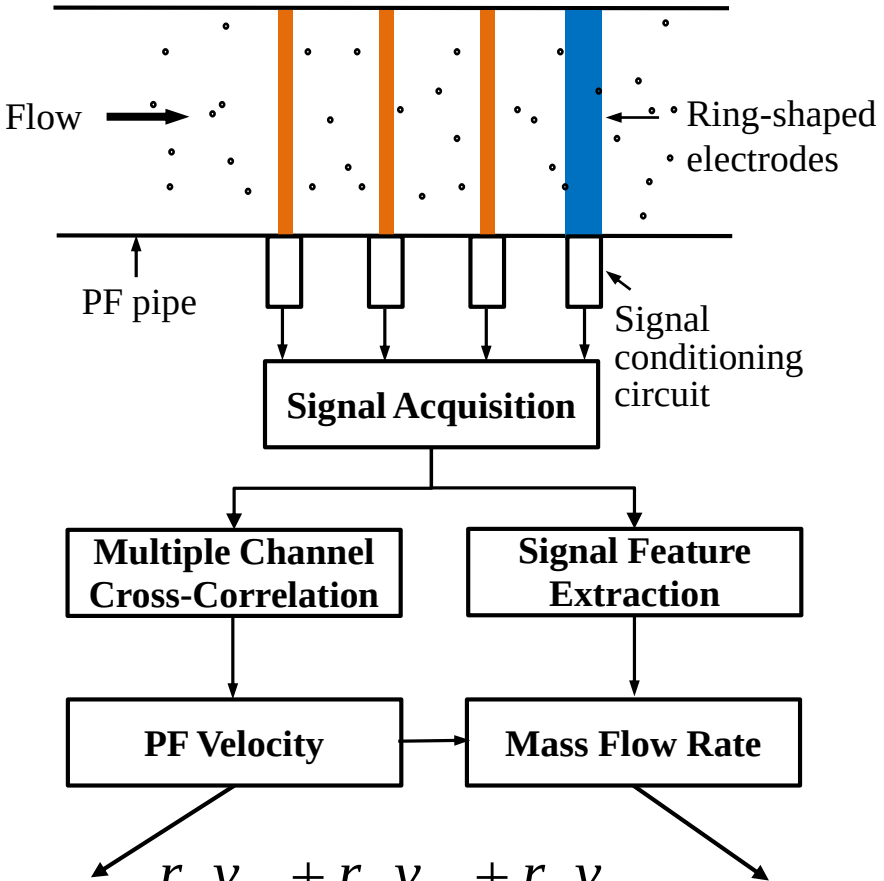
Background

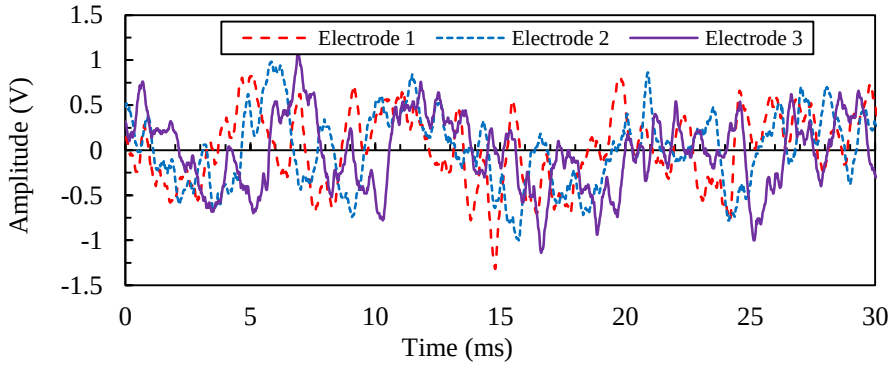
- ***Challenges*** **of PF flow measurement**
  - Complex dynamic characteristics of PF
  - Variation of boiler operation parameters
  - Harsh power plant environment
- ***Available*** **measurement methods**
  - Isokinetic sampling
  - Acoustic emission
  - Optical/Laser
  - Digital imaging
  - Radiometric

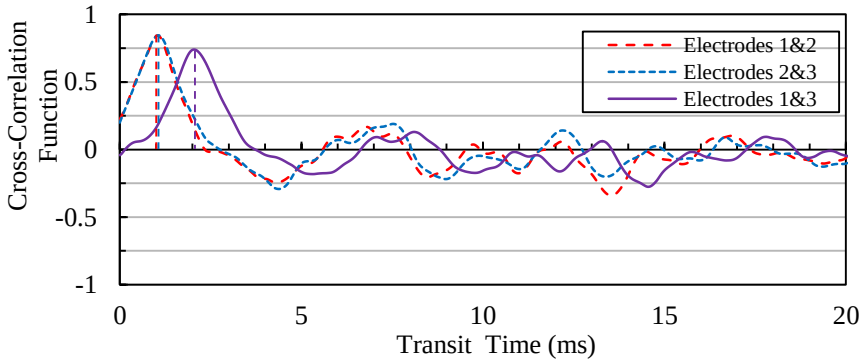


✓ **Electrostatic Techniques**

- **Measurement Principle**







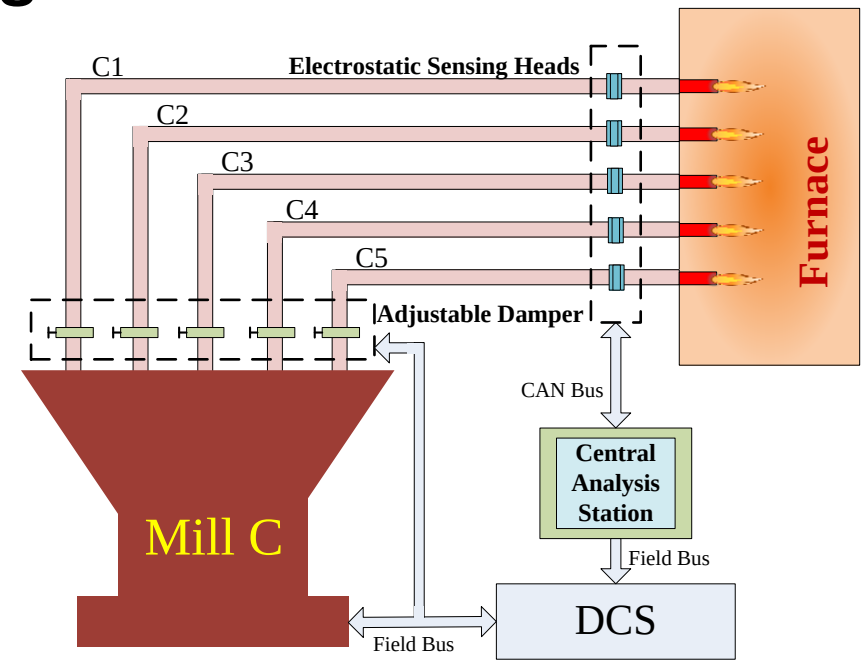
$$v_c = \frac{r_{12}v_{12} + r_{23}v_{23} + r_{13}v_{13}}{r_{12} + r_{23} + r_{13}}$$

$$q_{m,s} = A_p \rho_s v_c \beta_s = a v_c^b A_{rms}$$

Electrostatic Sensor System

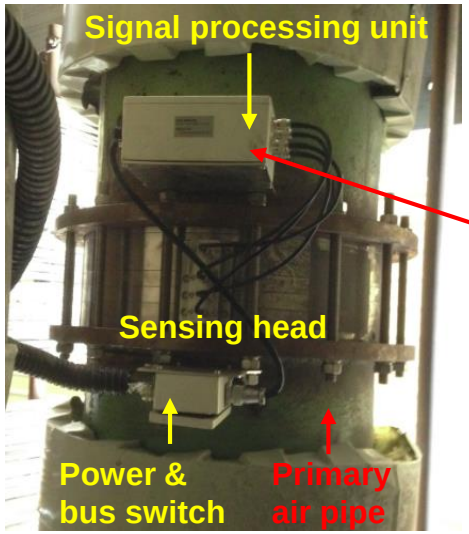
- **PF ratio between fuel pipes**

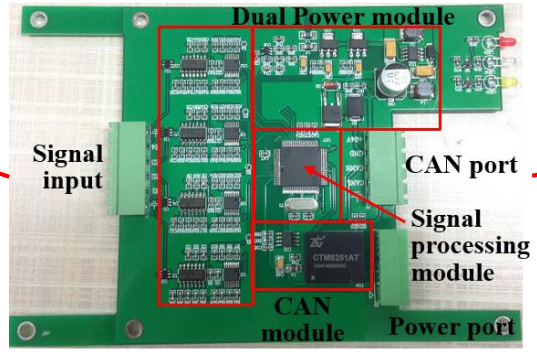
$$Ratio_{Ci} = \frac{q_{m,s,Ci}}{\sum_{k=1}^{n} q_{m,s,Ck}}$$

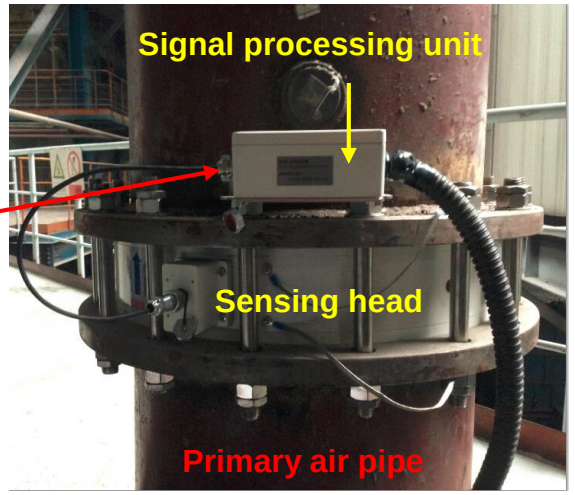


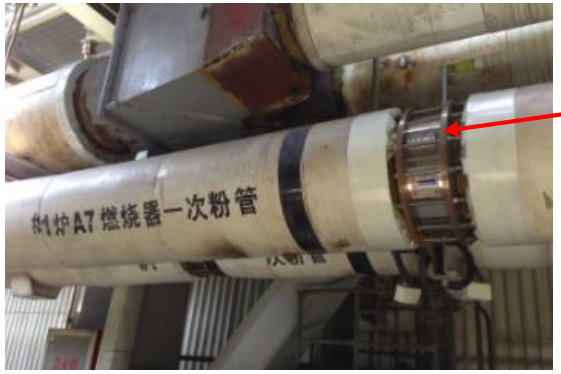
- **Features the electrostatic sensor system**
  - ✓ Ring-shaped electrostatic sensor array flushed with inner pipe wall
  - ✓ Optimised multiple correlation velocimetry update PF velocity every 0.5 seconds
  - ✓ On-line fuel distribution ratio monitoring between fuel pipes
  - ✓ Embedded electronic system and fast, reliable fieldbus communication
  - ✓ Essentially robust performance and minimum maintenances, etc.…

System Installation







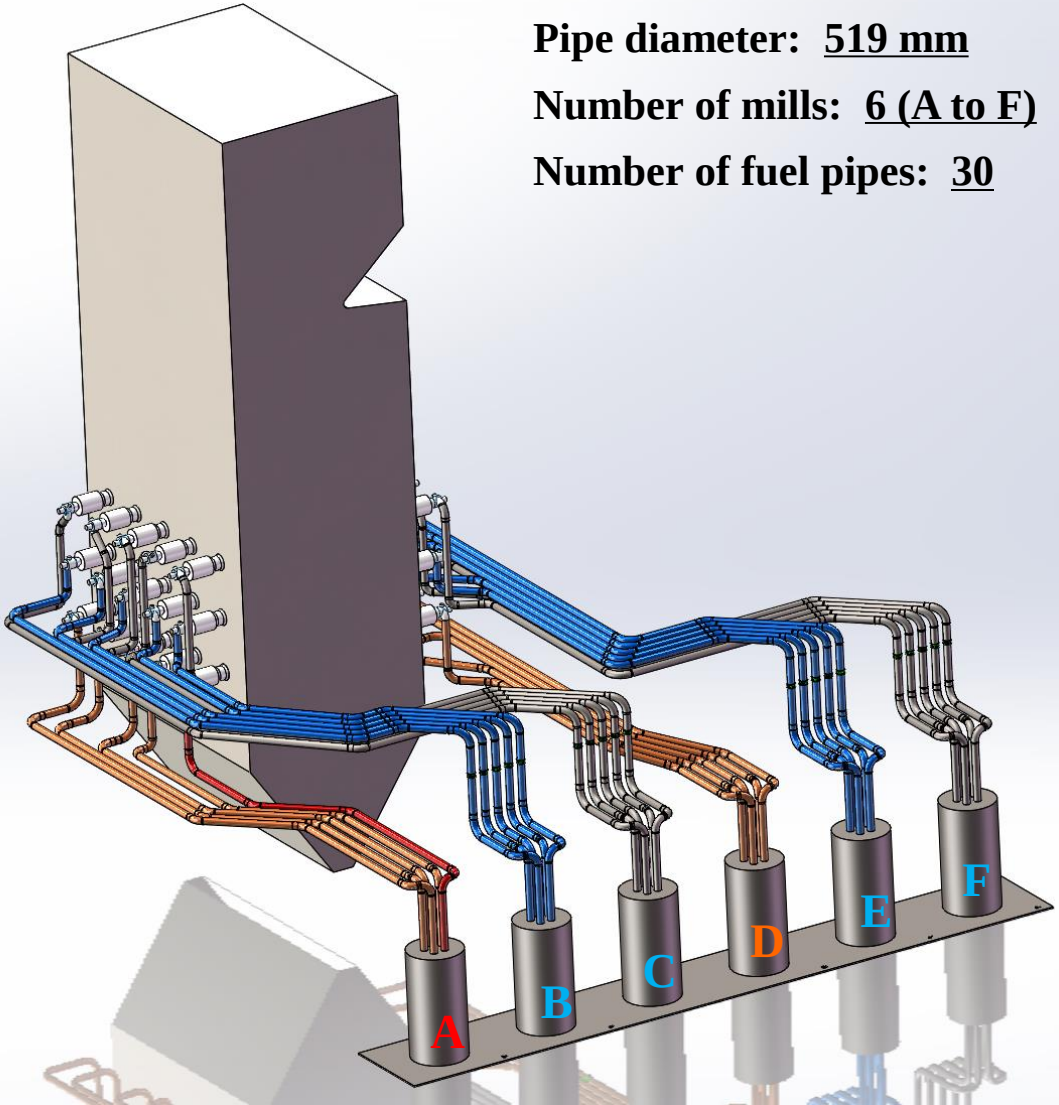


Luyang,
1000 MW opposed wall firing boiler
State Power Investment Co.

Bengbu
600 MW opposed wall firing boiler
China Guodian Co.

Monitoring Data and Discussion

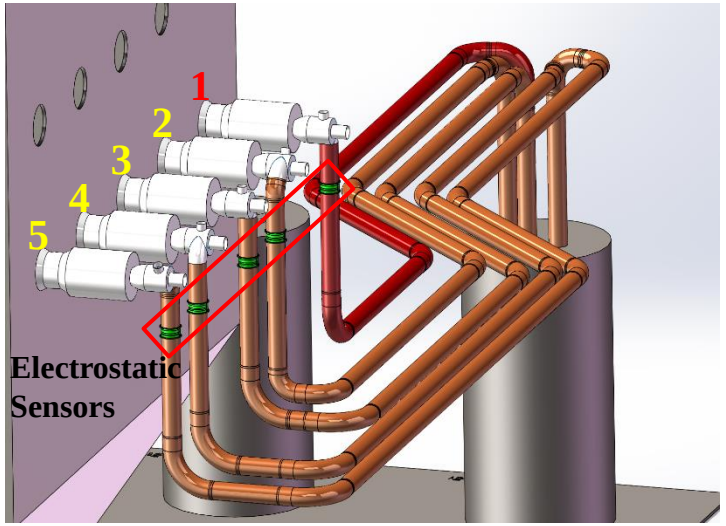
- **PF pipe layout of a 600 MW boiler at Bengbu Power Plant**

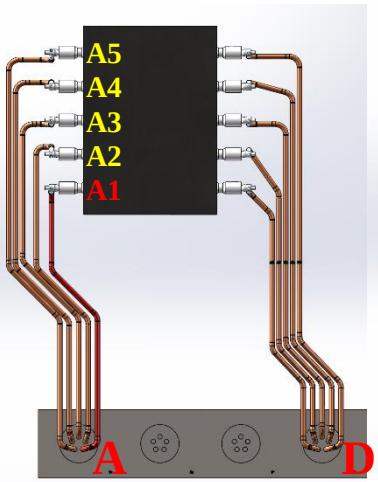


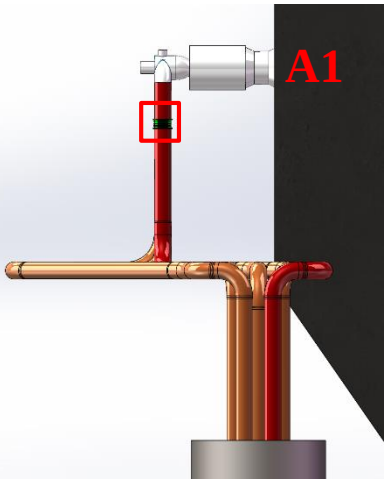
Pipe diameter: 519 mm

Number of mills: 6 (A to F)

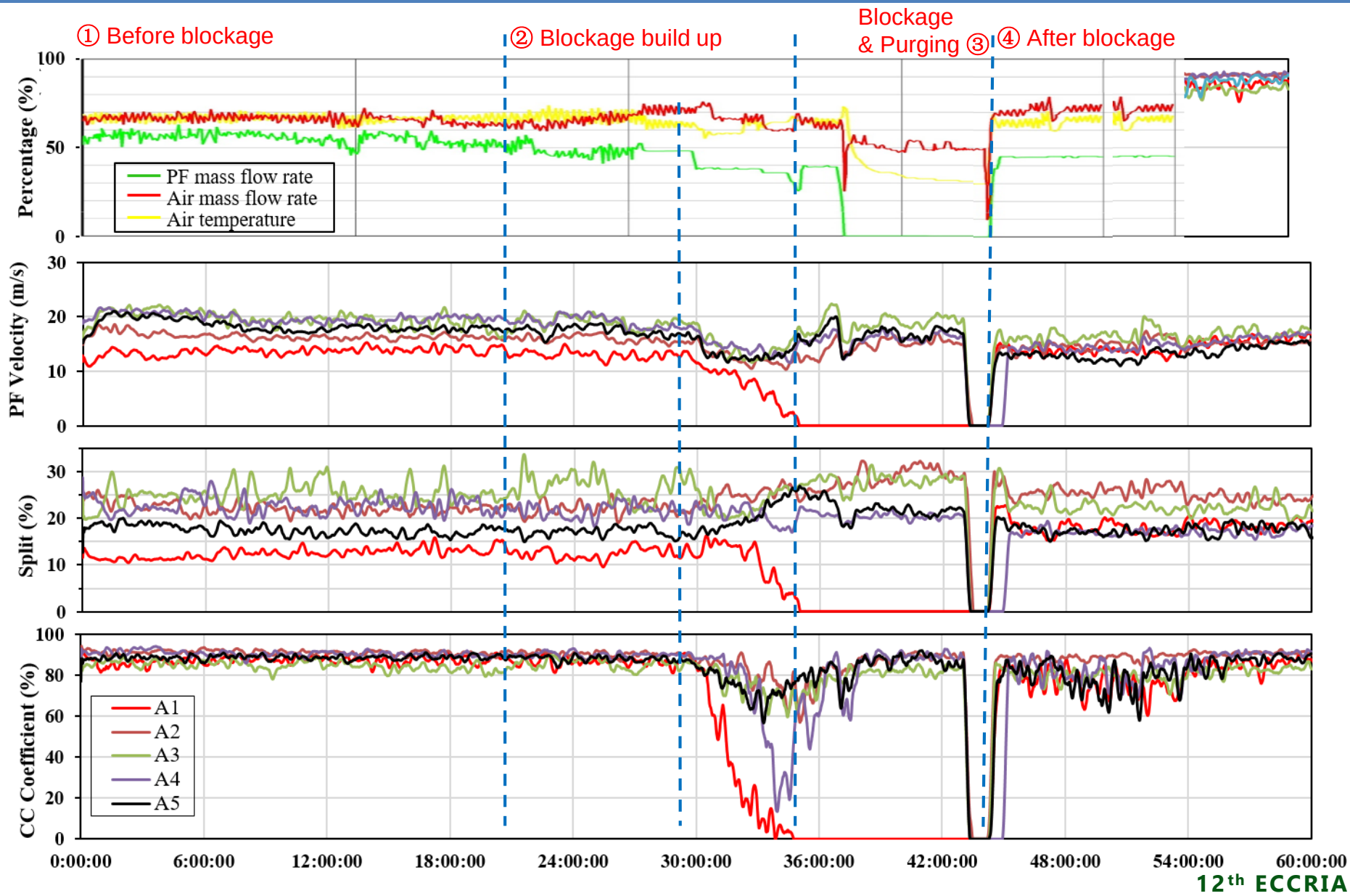
Number of fuel pipes: 30





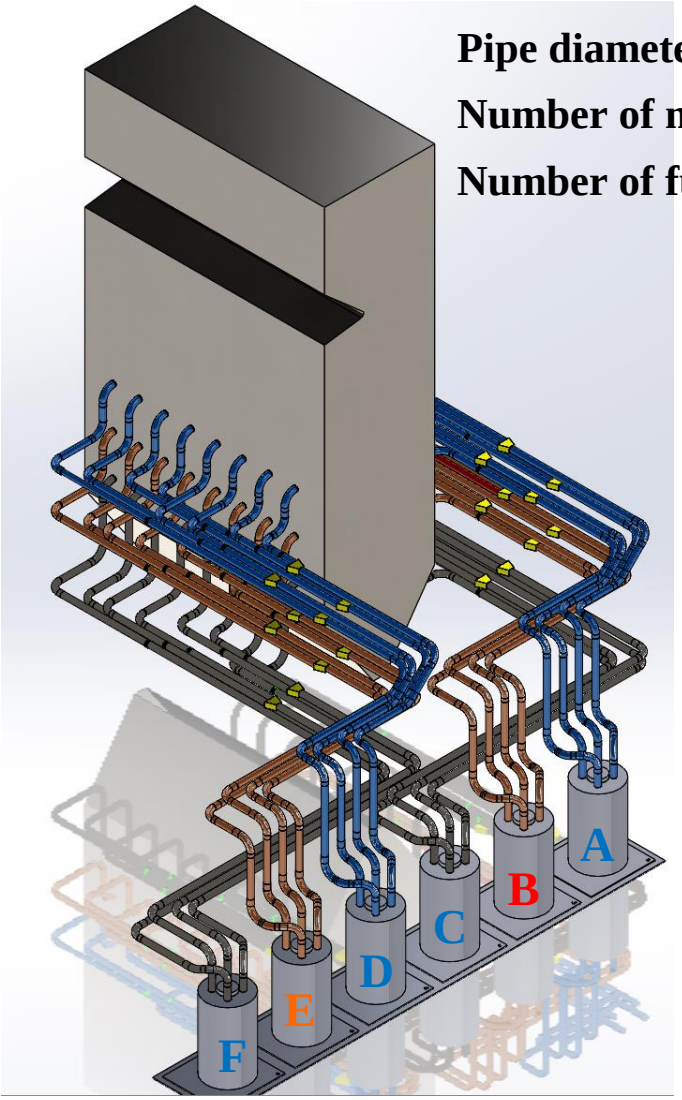


Monitoring Data at Bengbu Power Plant



Monitoring Data and Discussion

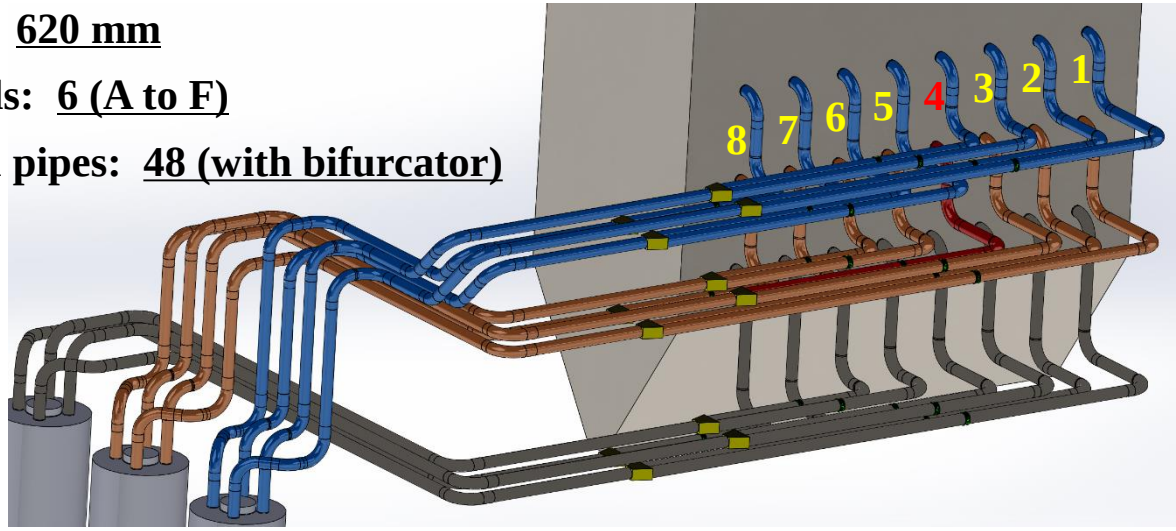
- **PF pipe layout of a 1000 MW boiler at Luyang Power Plant**

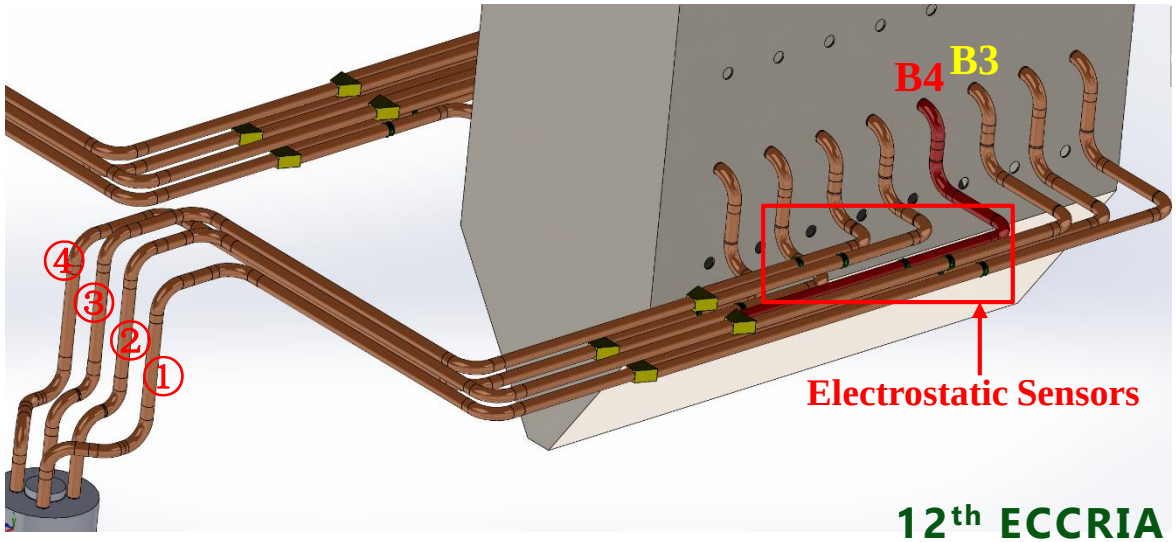


Pipe diameter: 620 mm

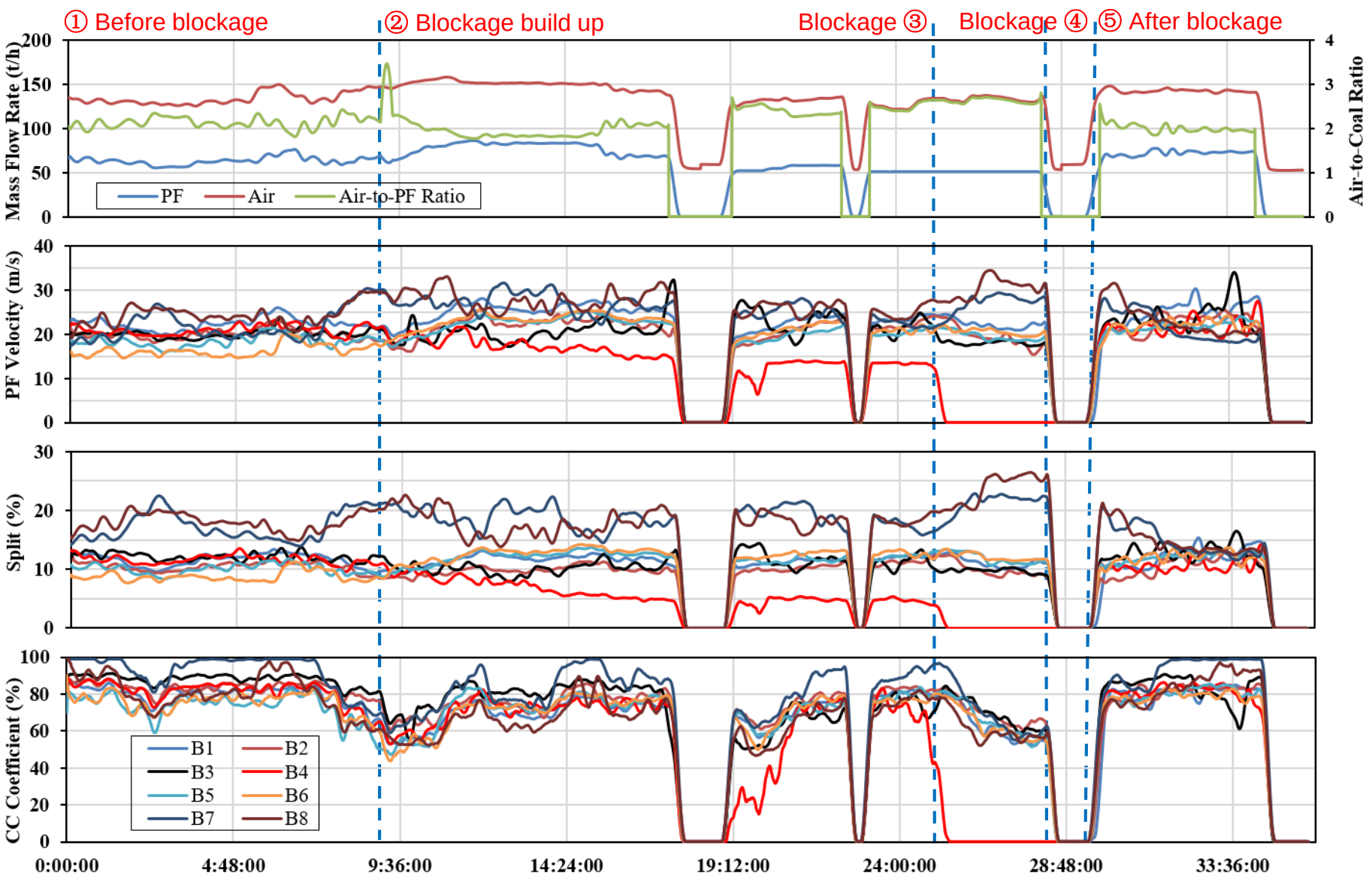
Number of mills: 6 (A to F)

Number of fuel pipes: 48 (with bifurcator)





Monitoring Data at Luyang Power Plant



Conclusion

- ✓ On-line monitoring of PF flow in pipes is capable of predicting pipe blockage in an early stage.
- ✓ A reasonable PF velocity is crucial to prevent pipe blockage.
- ✓ Multiple bends connections with very short spacings should be avoid.
- ✓ The distribution of PF between fuel pipes and particle size have little effect on particle deposition.
- ✓ Continuous monitoring of PF flow is a better way to prevent fuel pipes from blockage as the blockage may be caused by various reasons.

Thanks for your attention!

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