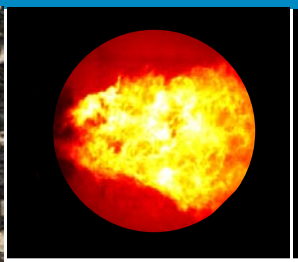
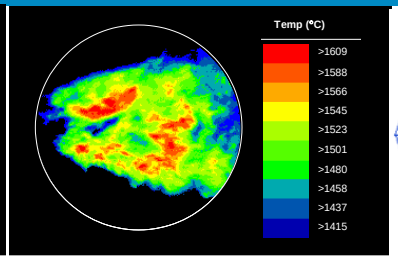
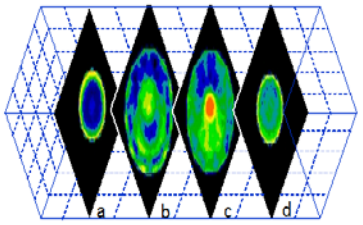
University of Kent

华北电力大学
NORTH CHINA ELECTRIC POWER UNIVERSITY

Advanced Sensors and Monitoring Techniques for the Optimization of Coal and Biomass Fired Power Plants





YAN YONG (闫 勇)

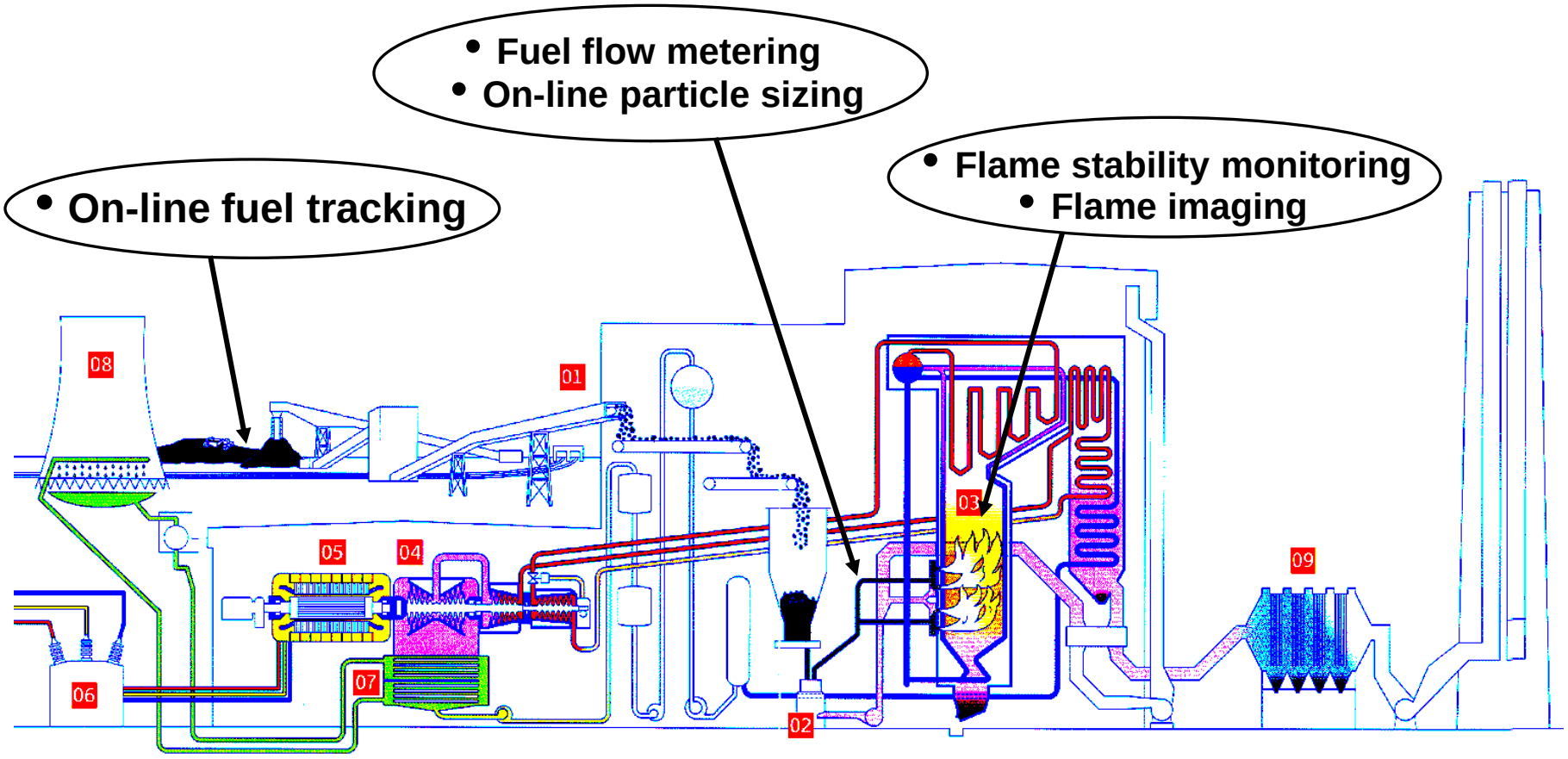
Outline

- Background
- Pulverised fuel flow metering
- On-line particle sizing
- Flame stability monitoring
- On-line fuel tracking
- Flame imaging
- Summary

Background

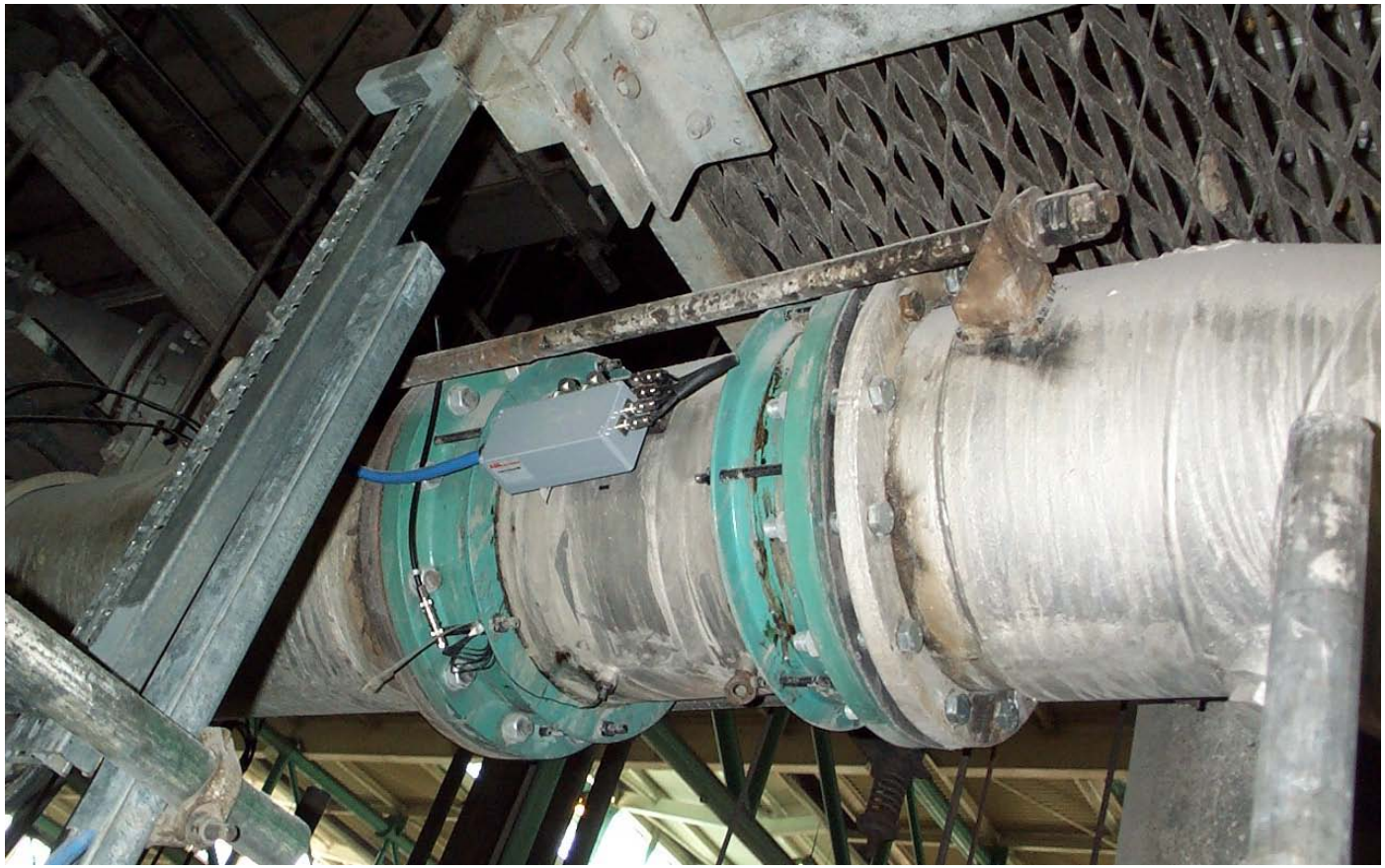
- Power generation organisations are constantly seeking new ways of improving combustion efficiency and profitability.
- Environmental legislations are becoming increasing stringent.
- A diverse range of fuels and fuel blends including biomass are fired at coal fired power plants.
- Many power stations are operated under variable load as per electricity demand.
- Carbon Capture and Storage (CCS) systems are being implemented in many countries.
- New monitoring and measurement techniques have an important part to play in response to these changes.

Monitoring Challenges at Coal and Biomass Fired Power Plants

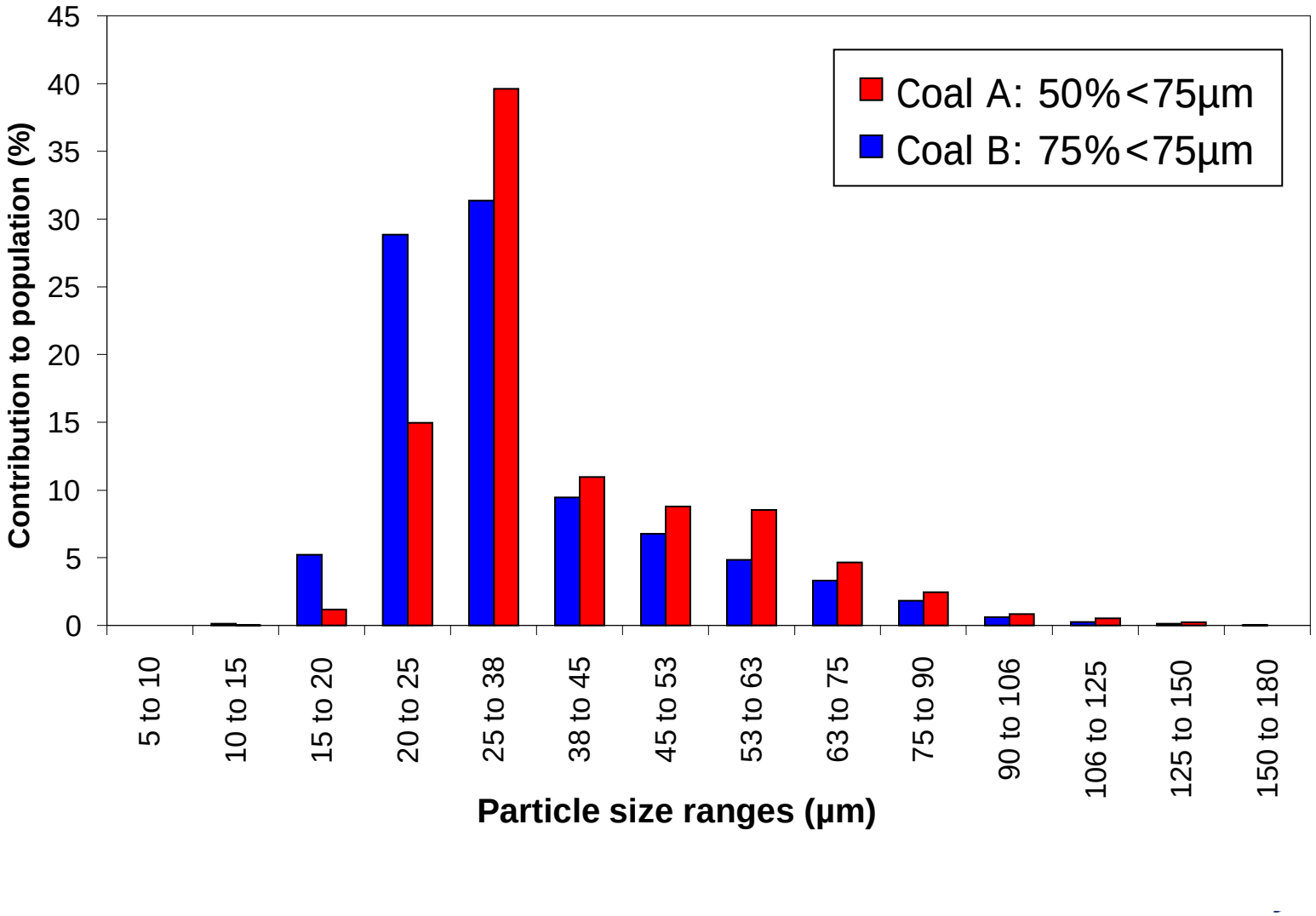


Coal and Biomass Fired Power Plant

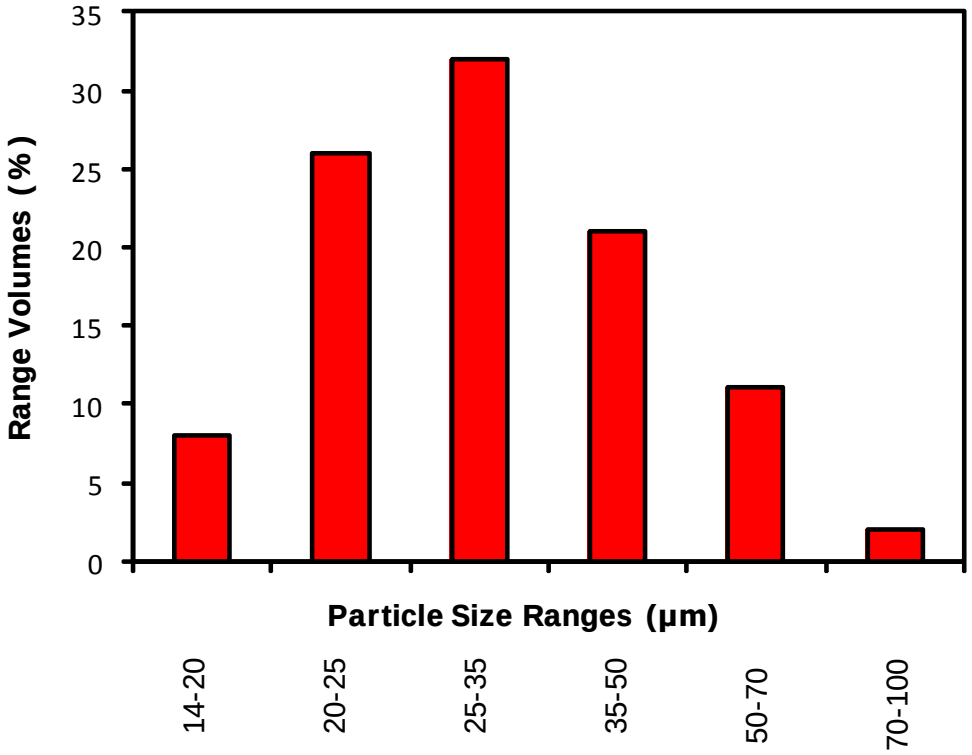
Pulverised Fuel Flow Metering

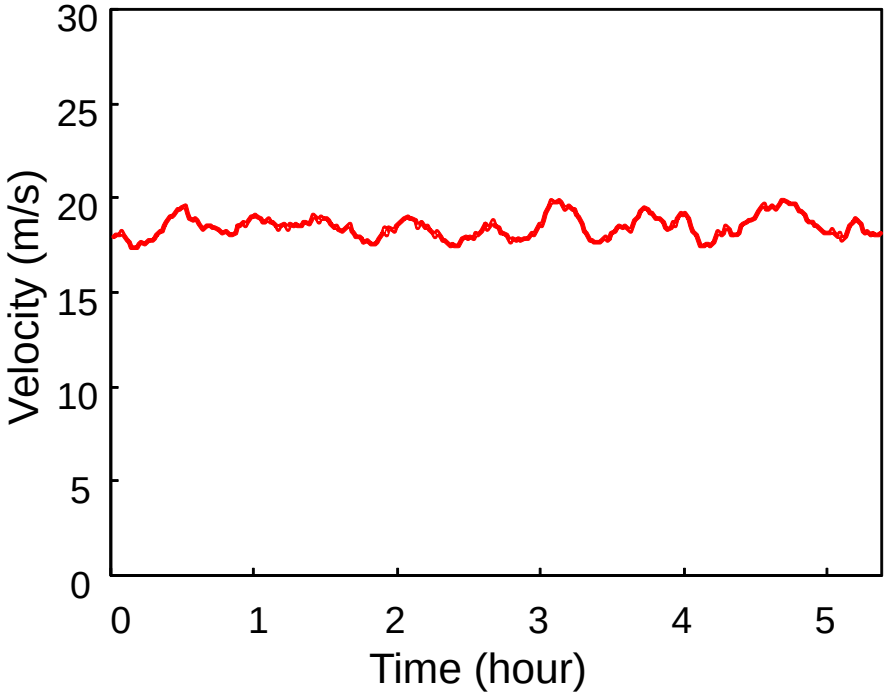


On-Line Particle Sizing

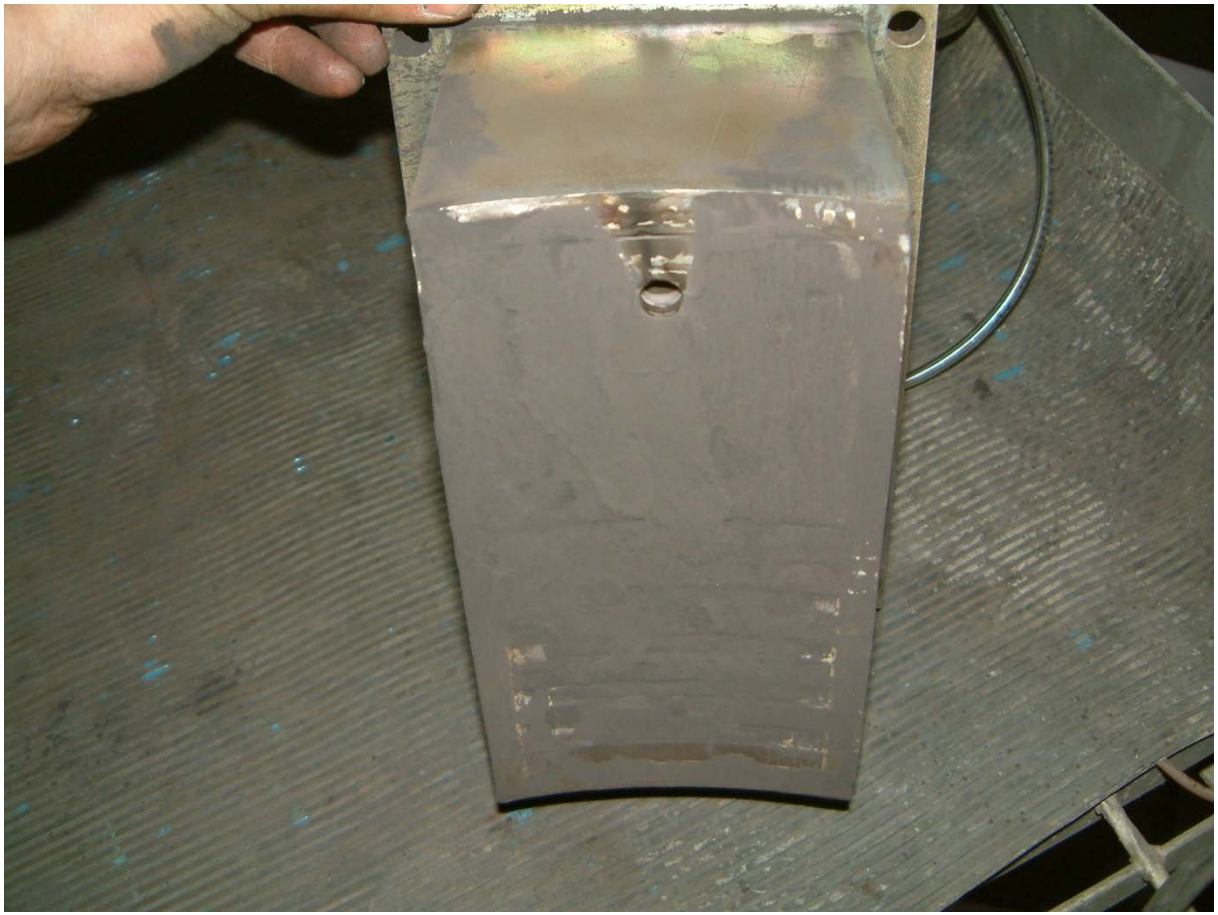


Pulverised Fuel Flow Metering

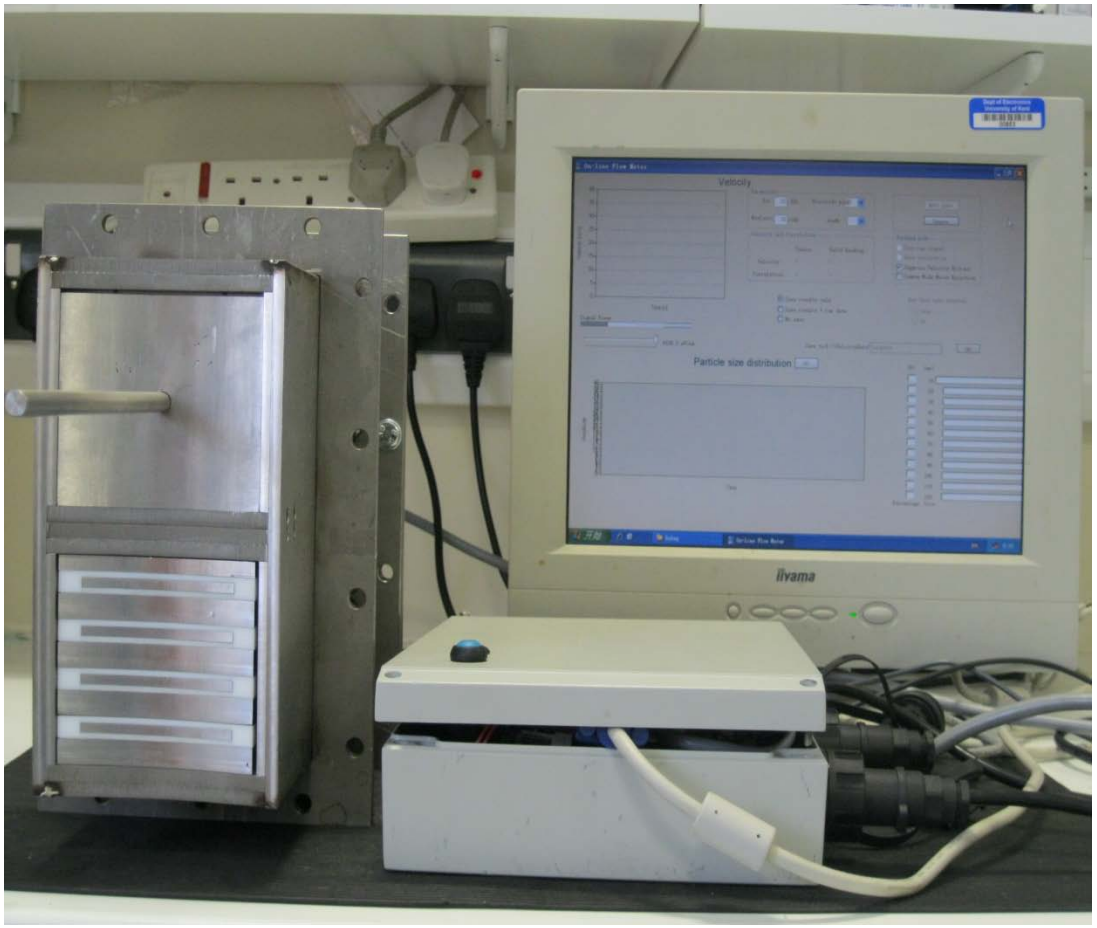




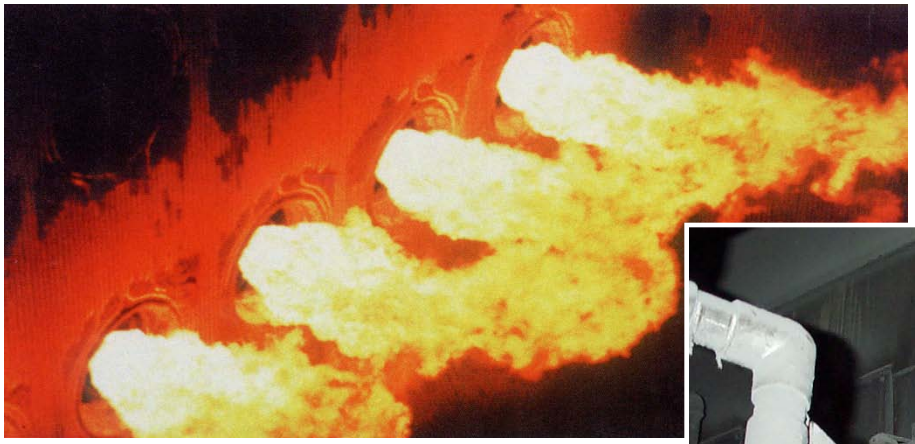
Trials on 350MW Coal-Fired Power Plant

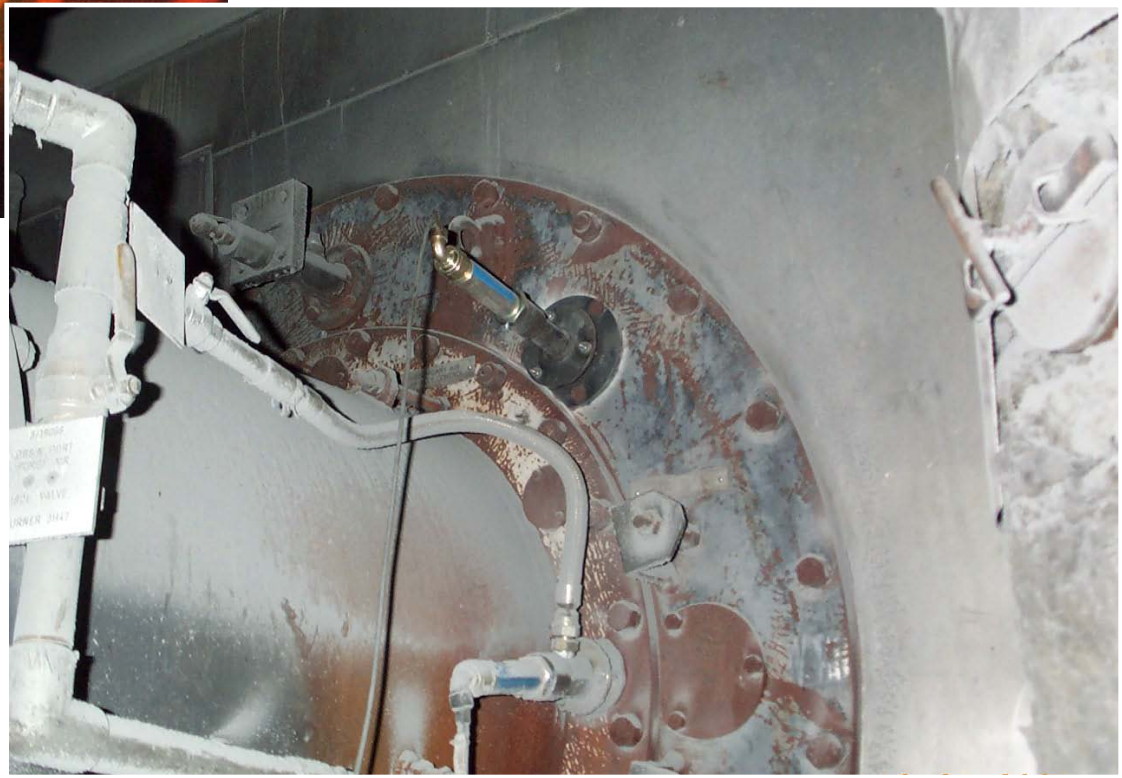


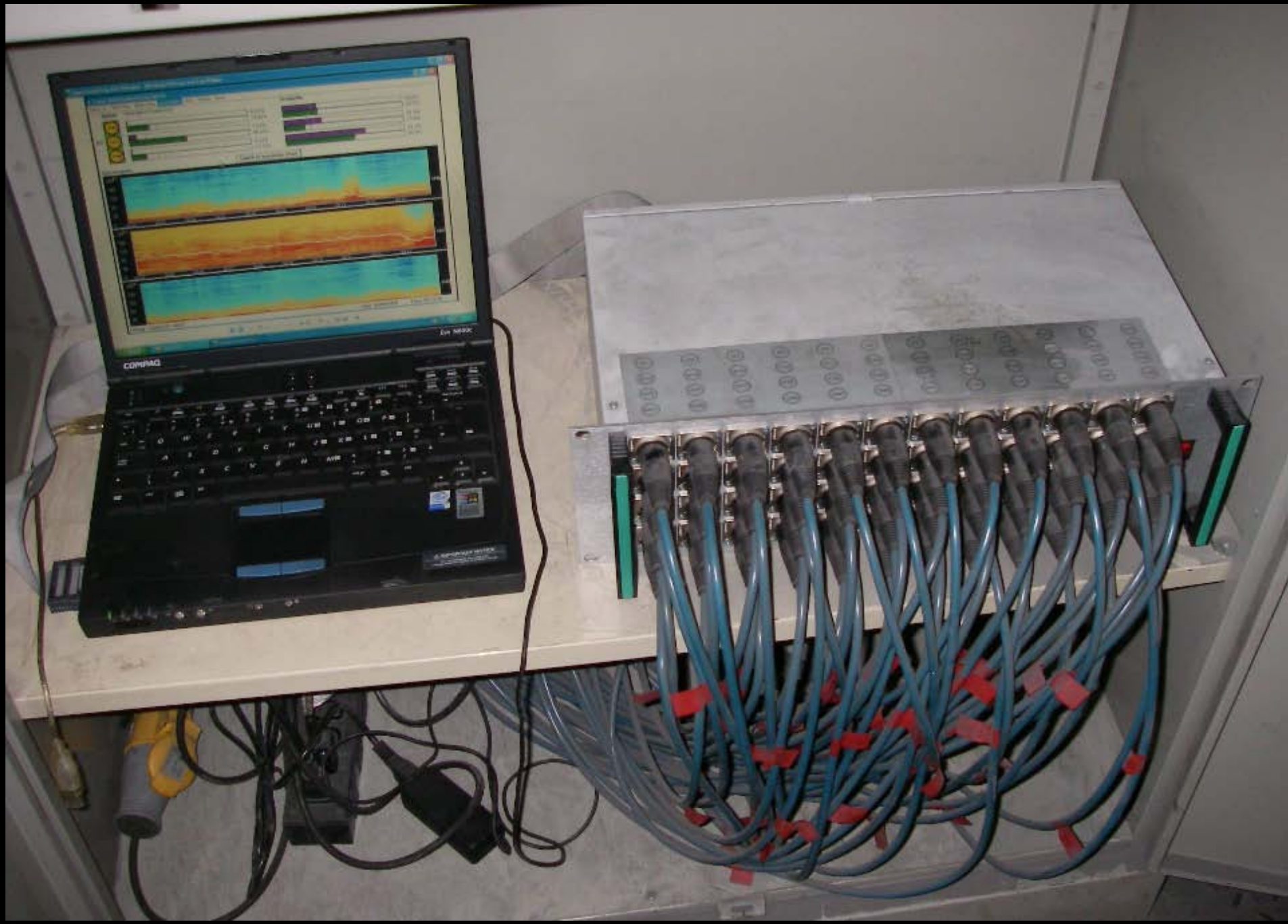
On-Line Particle Sizing



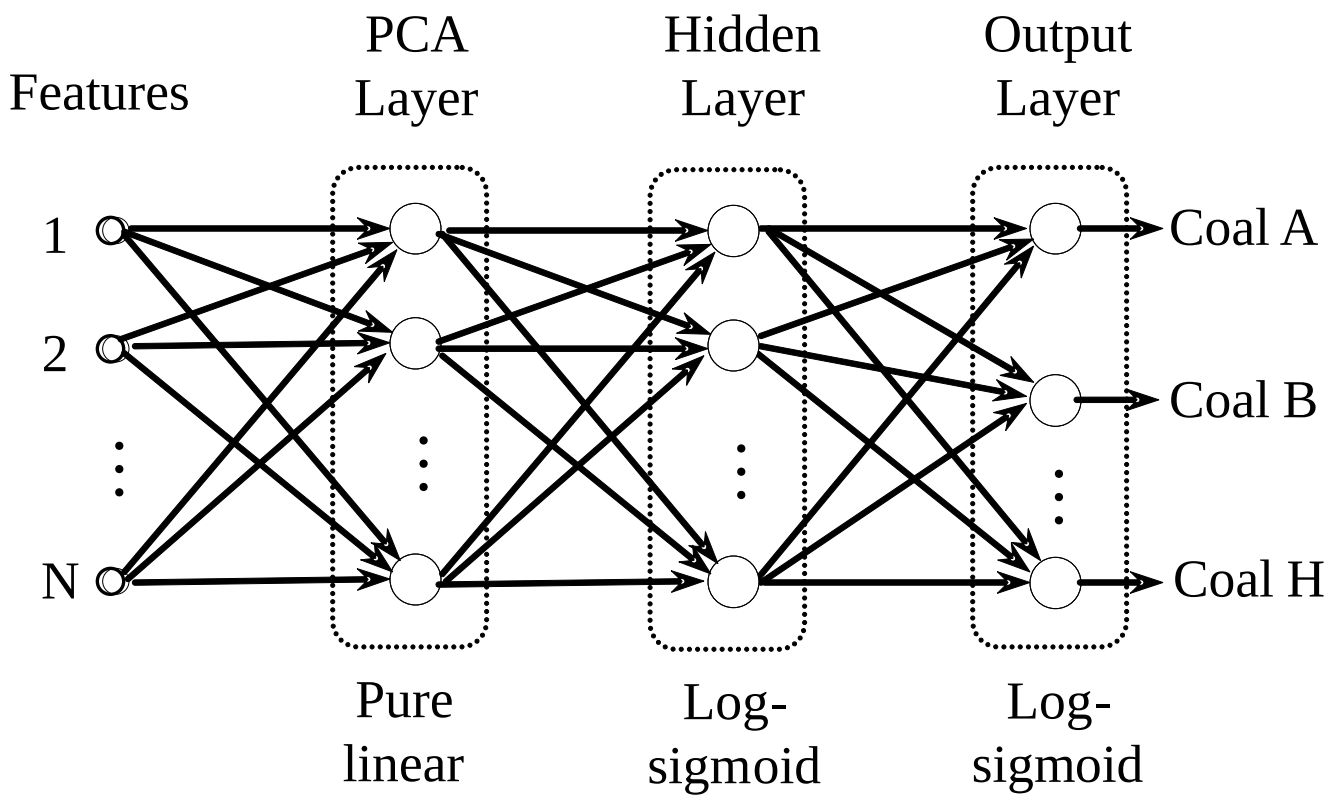
Flame Stability Monitoring



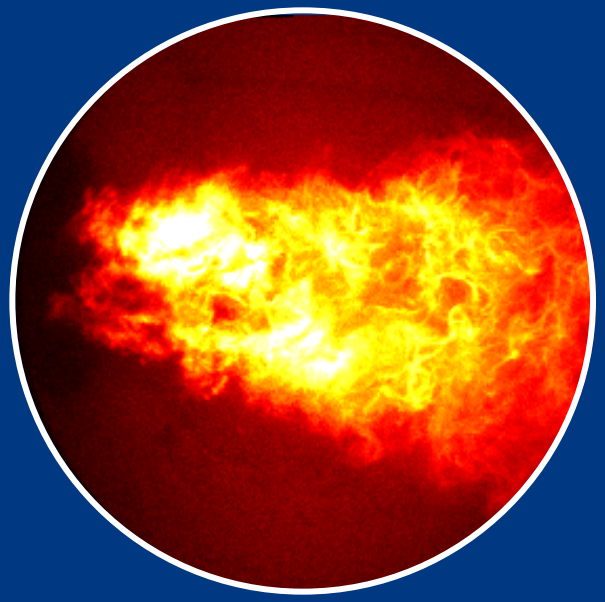



COMPAQ

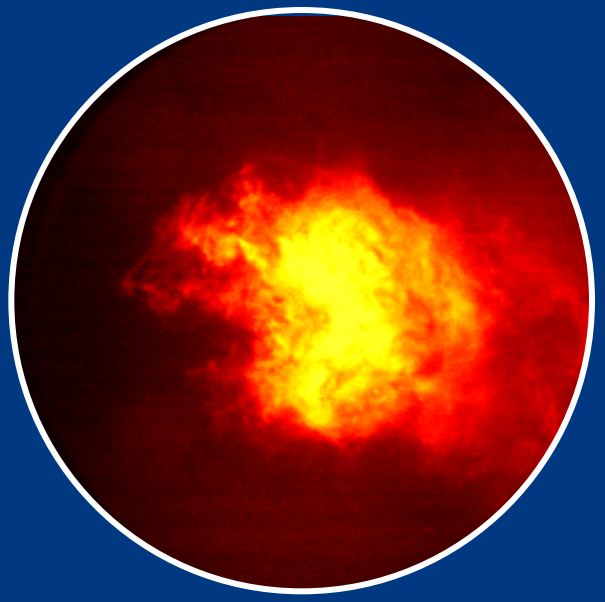
On-Line Fuel Tracking



Flame Imaging

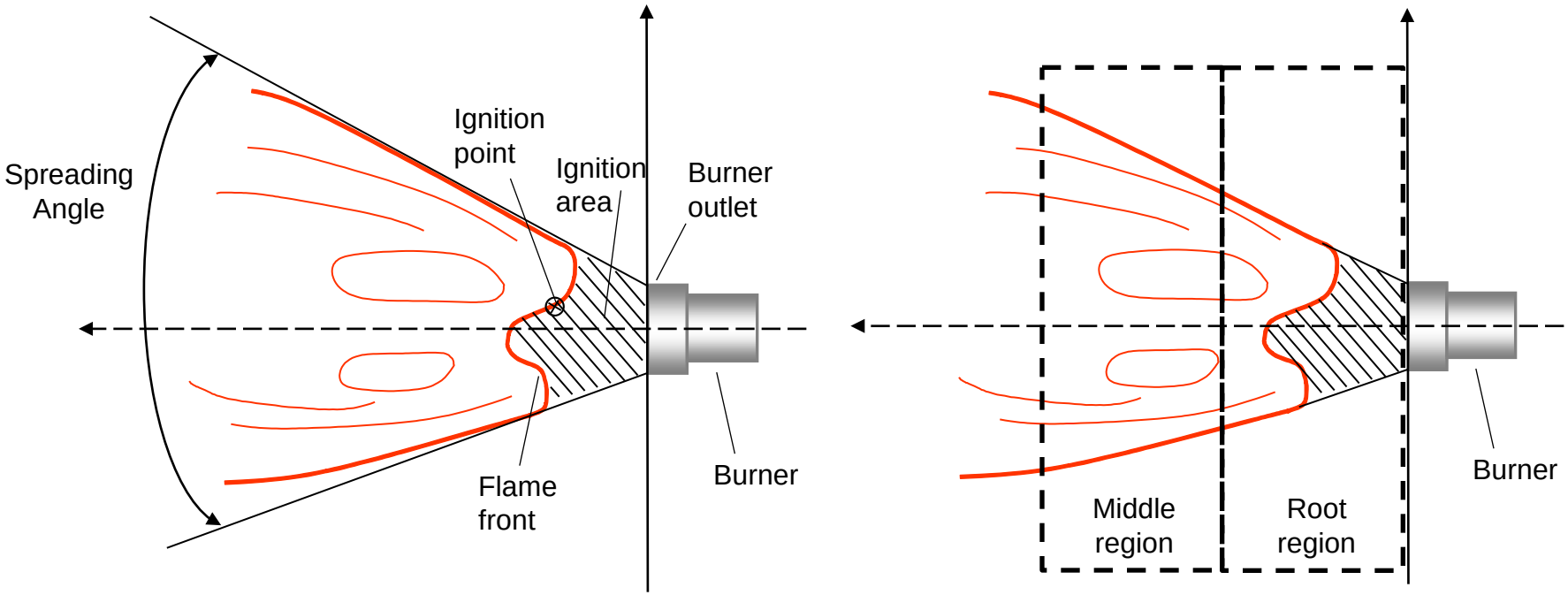


Coal A



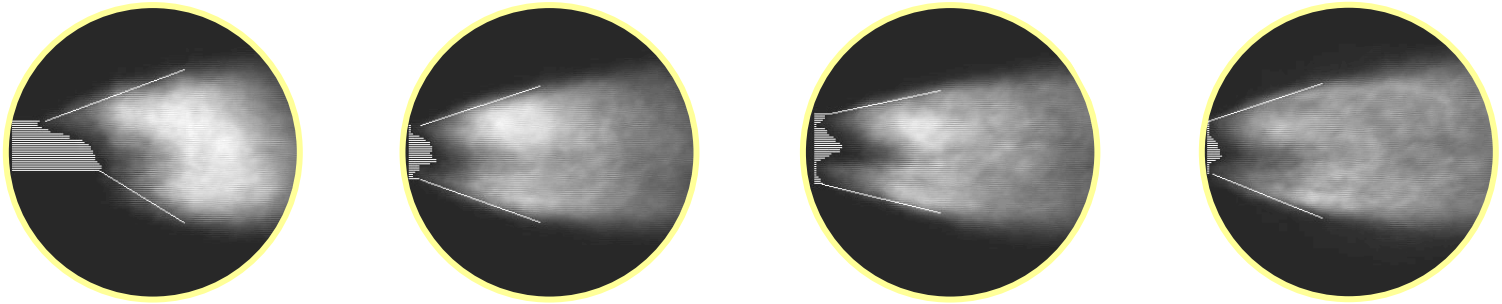
Coal B

Flame Imaging

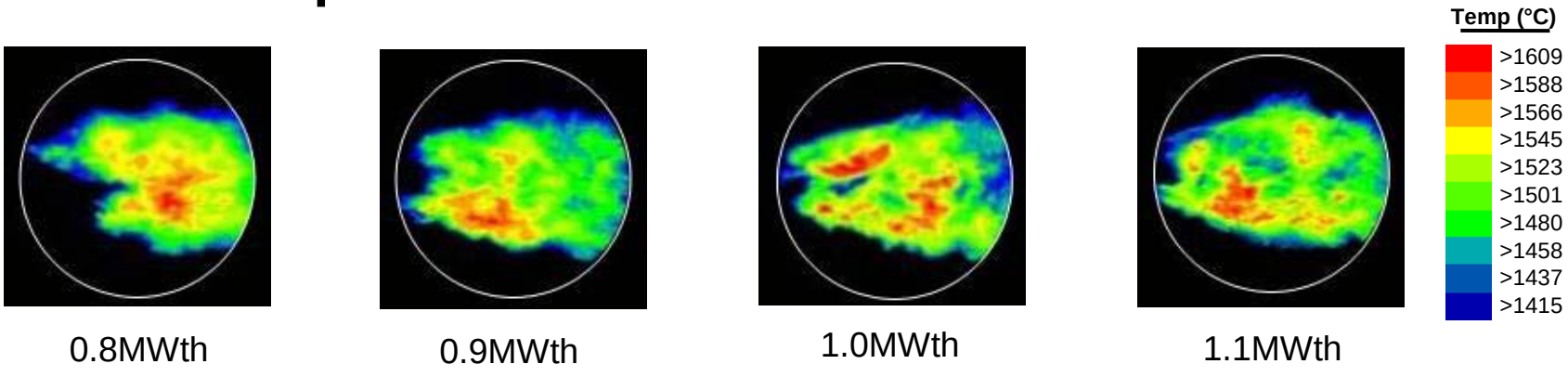


Flame Imaging

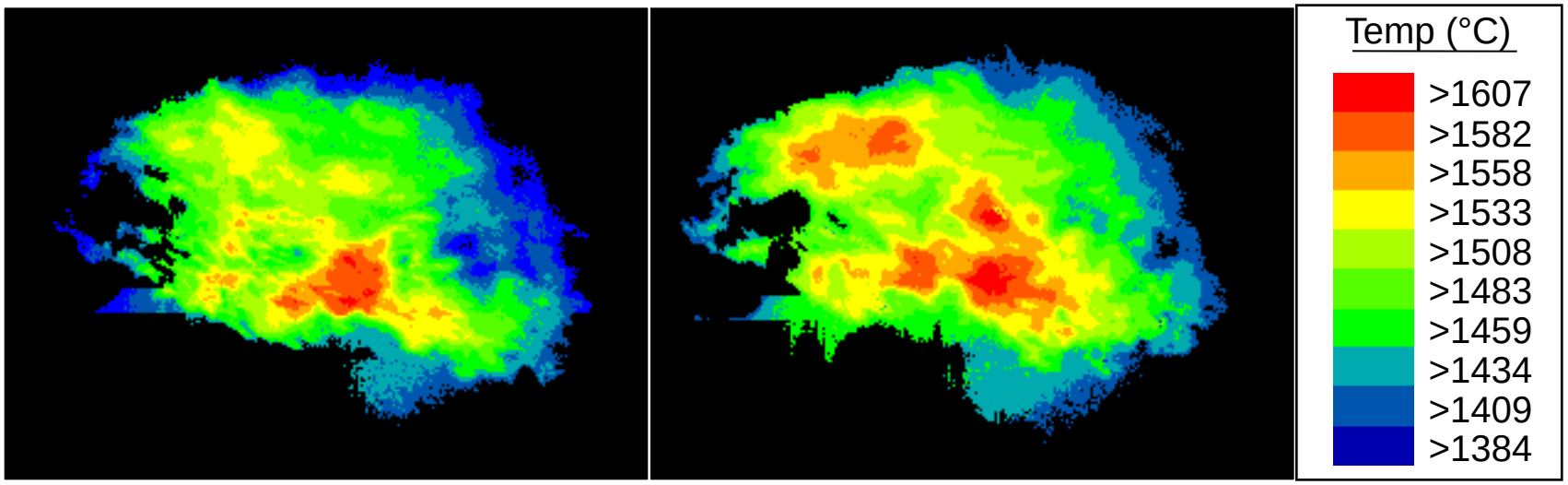
- **Flame ignition profile**



- **Flame temperature distribution**



Flame Imaging

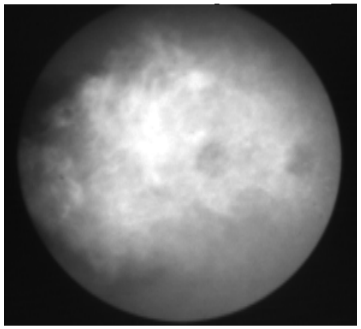


Fine Coal **Coarse Coal**

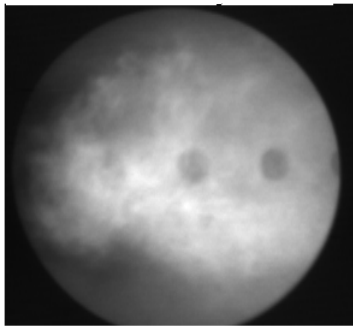
Variable Particle Size (Coal B 62.9kg/h, 3.2% O_2)

Oxyfuel Flames - Russian coal

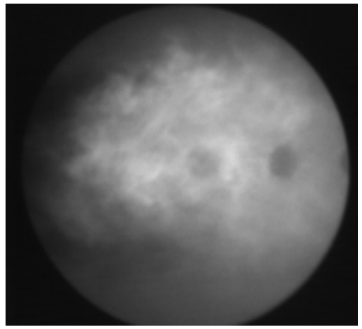
Images for different simulated recycle rates under low O_2 setting



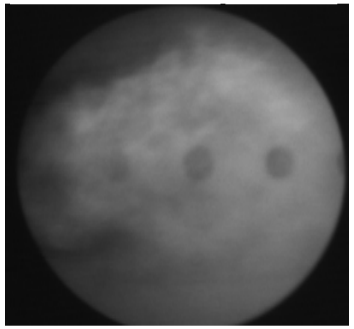
62%rr, Total flow 477.8kg/h
Sec. flow 322kg/h@39.4%O_2
(time: 12:32, 30-10)



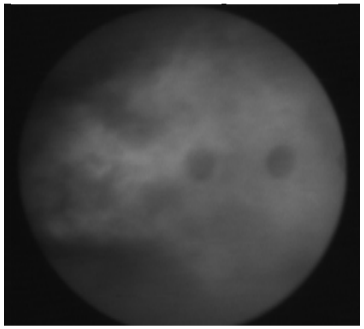
65%rr, Total flow 523.0kg/h
Sec. flow 368kg/h@34.8%O_2
(time: 15:18, 29-10)



68%rr, Total flow 577.7kg/h
Sec. flow 422kg/h@30.5%O_2
(time: 15:05, 29-10)

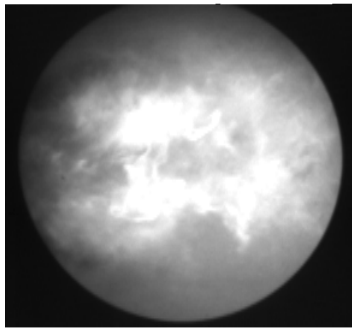


72%rr, Total flow 669.6kg/h
Sec. flow 513kg/h@25.5%O_2
(time: 14:18, 29-10)

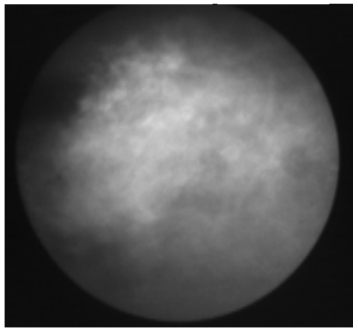


75%rr, Total flow 757.1kg/h
Sec. flow 600kg/h@22.1%O_2
(time: 13:41, 29-10)

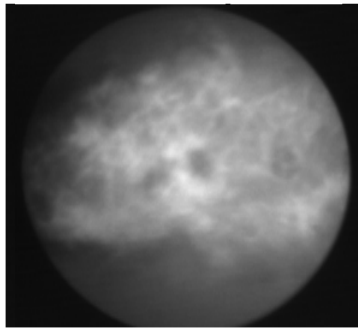
Images for different simulated recycle rates under high O_2 setting



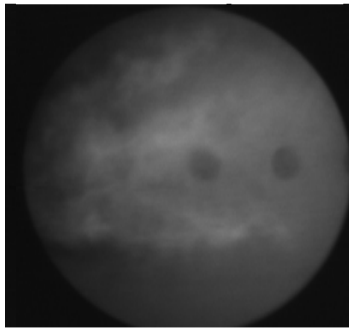
62%rr, Total flow 487.5kg/h
Sec. flow 332kg/h@41.7%O_2
(Time: 12:54, 30-10)



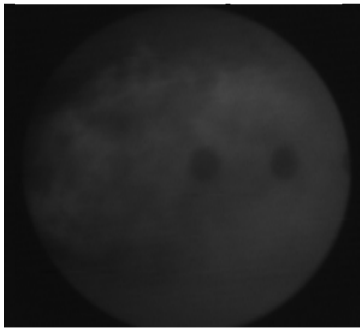
65%rr, Total flow 532.9kg/h
Sec. flow 379kg/h@37.1%O_2
(time: 12:01, 30-10)



68%rr, Total f. 590.5kg/h
Sec. flow 435kg/h@32.9%O_2
(time: 14:48, 29-10)

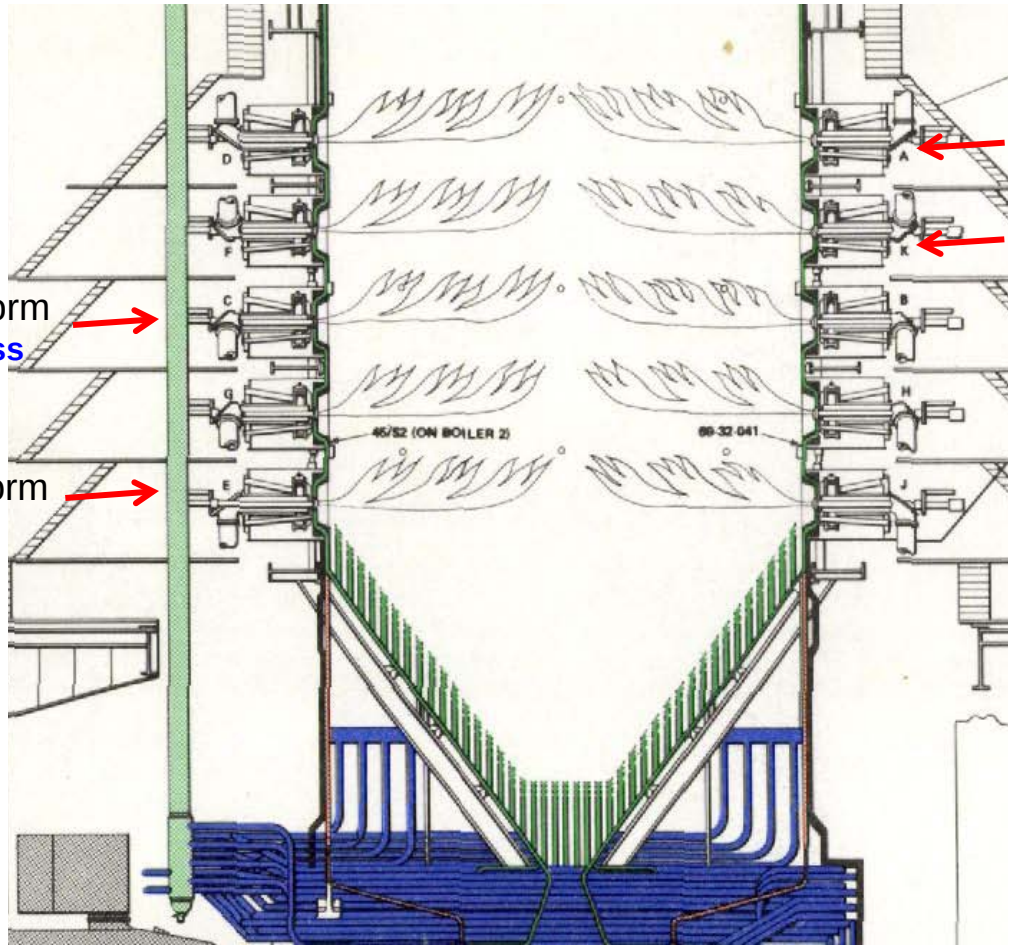


72%rr, Total f. 681.9kg/h
Sec. flow 527kg/h@28.0%O_2
(time: 14:35, 29-10)



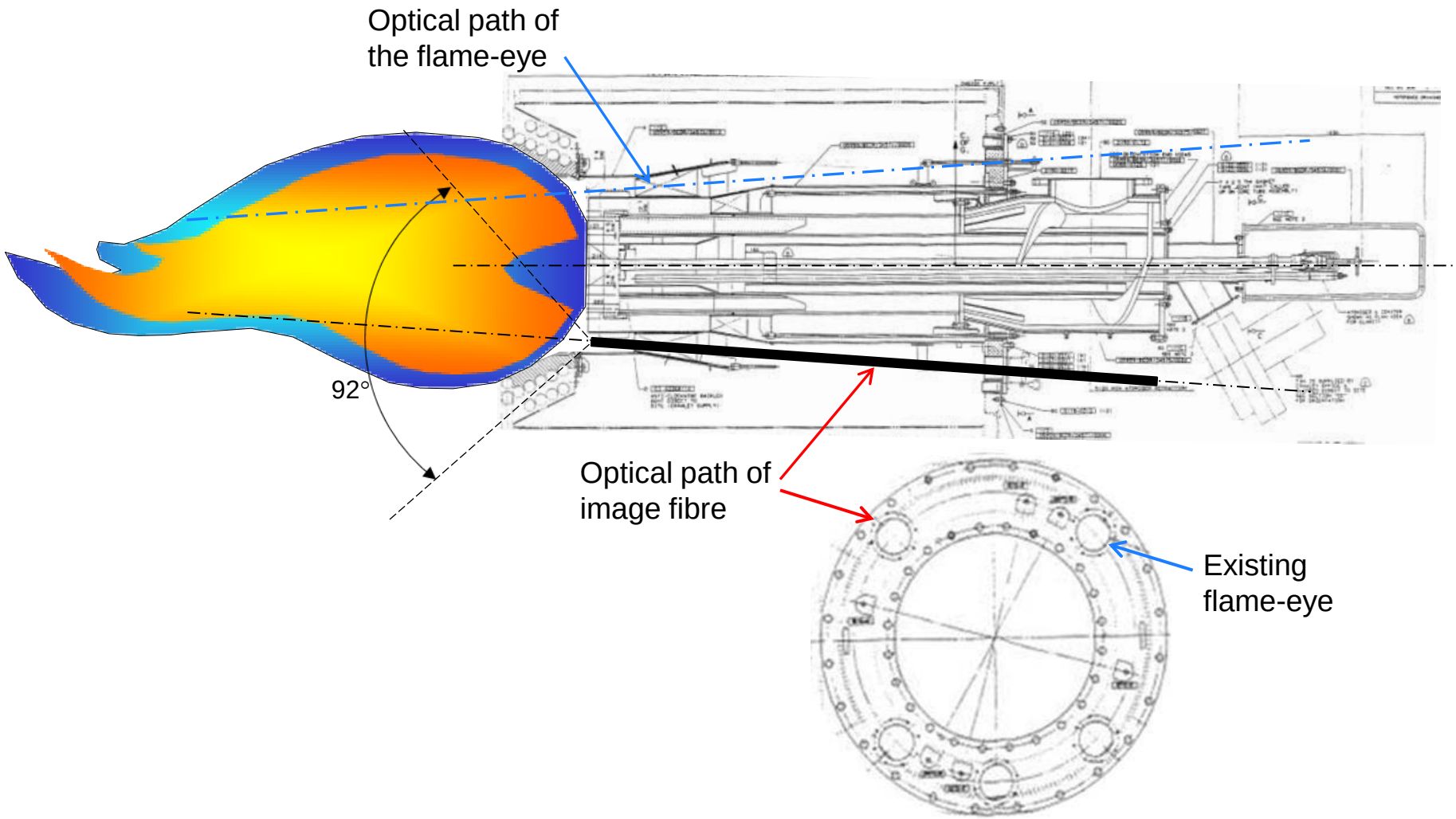
75%rr, Total f. 772.1kg/h
Sec. flow 616kg/h@24.5%O_2
(time: 13:58, 29-10)

Flame Imaging

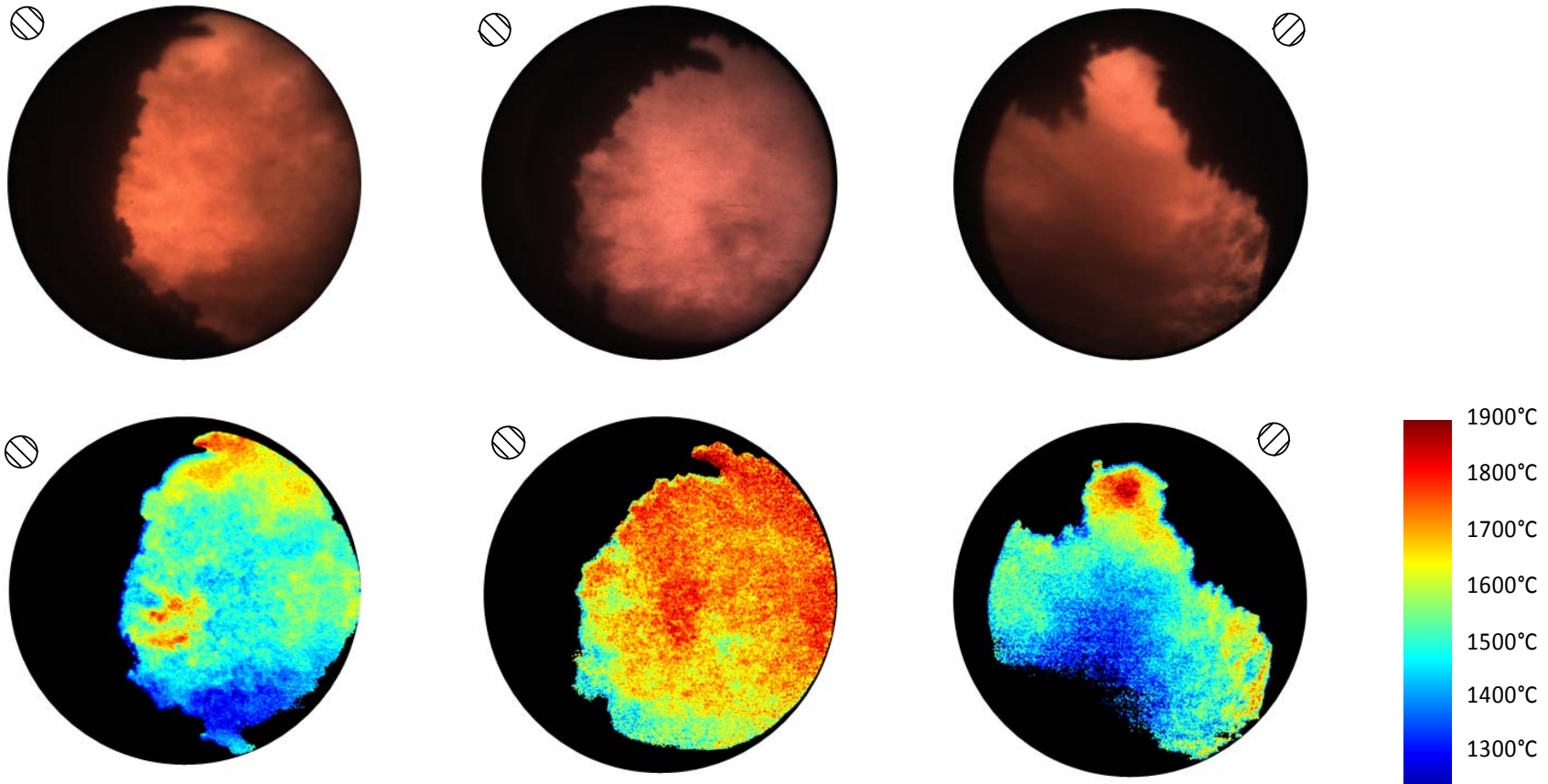


The imaging fibre probe was inserted through the existing sighting tubes of Burners 1A5, 1C2, 1C3 and 1E5.

Flame Imaging

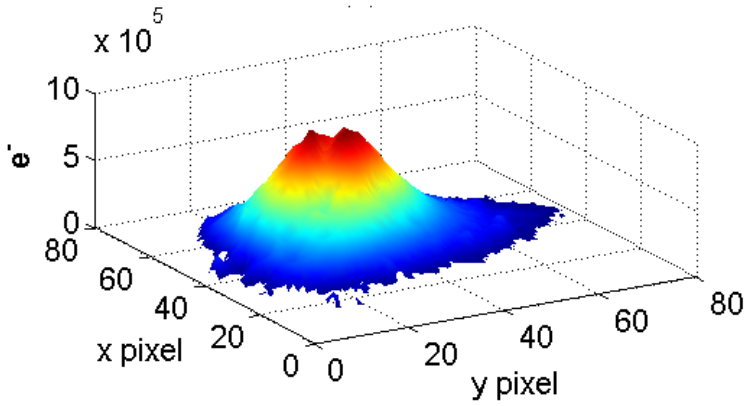


Flame Imaging

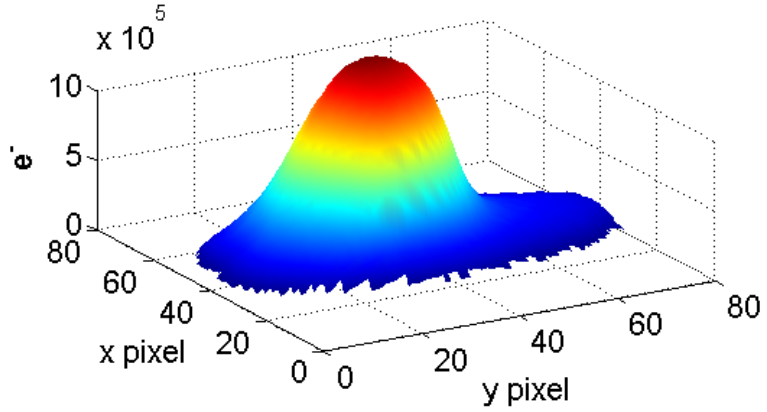


1A5 Biomass-On **1A5 Biomass-Off** **1C2 Biomass-On**

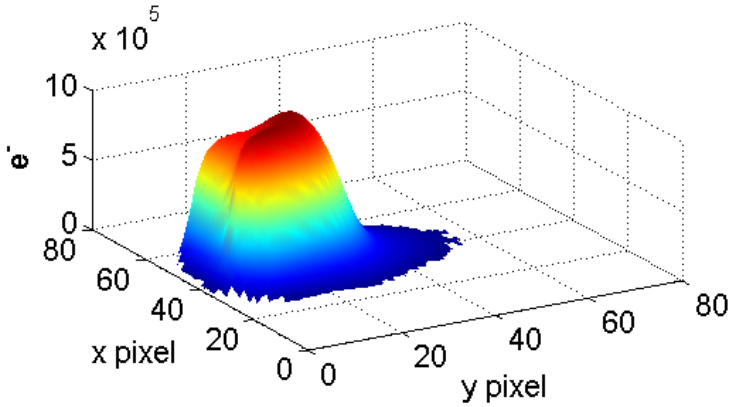
Imaging of Flame Radicals



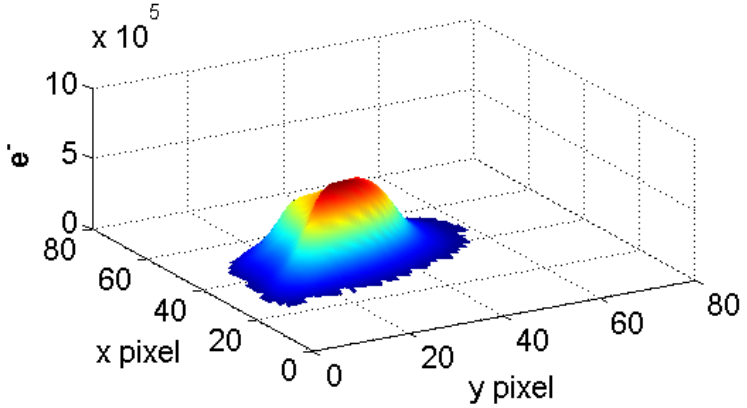
OH*



CN*



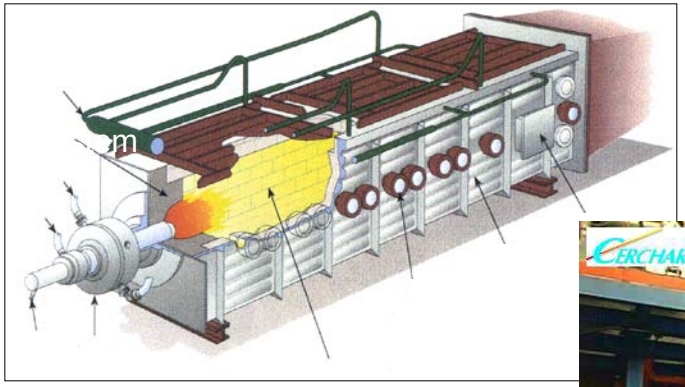
CH*



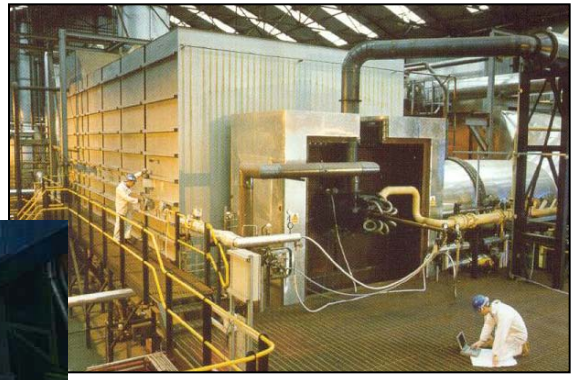
C_2*

Premixed air-propane flame

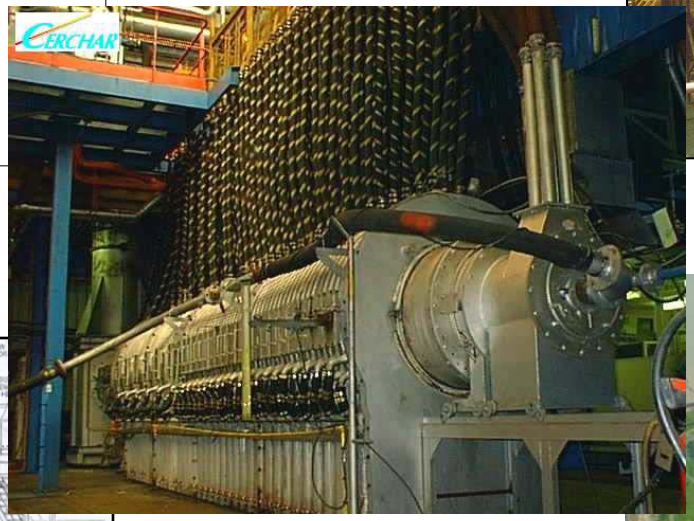
Industrial Trials



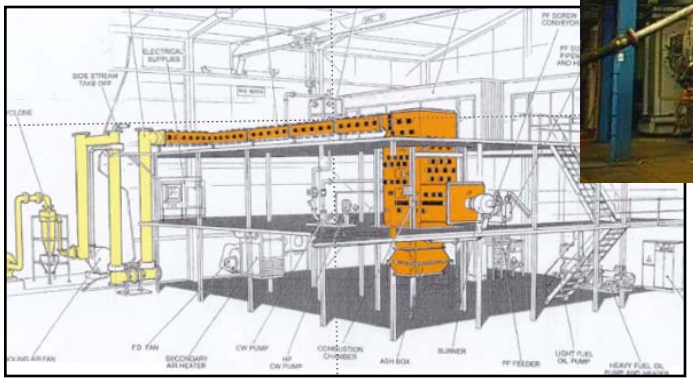
0.5MWth Combustion Test Facility, RWE npower



90 MWth Combustion Test Facility, Doosan Babcock



3MWth Combustion Test Facility, Cerchar (France)



1MWth Combustion Test Facility, E.ON UK

Tilbury Power Station

Summary

- A range of new sensors and instruments are available for the optimization of coal and biomass fired power plants.
- Embedded digital signal and image processing plays an important part.
- Making the sensors and instruments cost-effective, robust and reliable has been a challenge.
- Good progress has been made in 2D and 3D flame imaging.
- Further trials on full-scale power stations are being undertaken to assess the operability and effectiveness of the new sensors and instruments.
- Significant research in biomass/air two-phase and biomass/coal/air three-phase flow is required.