EUtech Scientific Engineering

Effective emissions reduction & plant optimization

Intelligent & cost-efficient determination of key process parameters in thermal plants

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Effective emissions reduction & plant optimization

Content

- Energy transition & power generation in India
- Combustion challenges
- Key process parameter: Furnace exit gas temperature (FEGT)
- Best practices & application results
- Summary and outlook

Energy transition & power generation in India

Energy transition & power generation in India

Current status

- Electricity demand is expected to increase by a factor 2 by 2042[1]
- Existing plants are designed for base-load and well-known fuels
- Almost no online and reliable information of fuel, air flows, particle size distribution and FEGT available

Challenges

- Integration of Renewable Energy with Conventional sources
- Dynamic, flexible and new minimal operation requirements for fossil fuels base-load plants
- Compliance of emission limits (NO_x & CO), improvement of plant efficiency and plant reliability
- Retrofitting and/or upgrading existing boilers to take advantage of past investments

1) NITI Aayog

Combustion challenges

Main combustion parameter

Air-Fuel Equivalence ratio (Lambda)

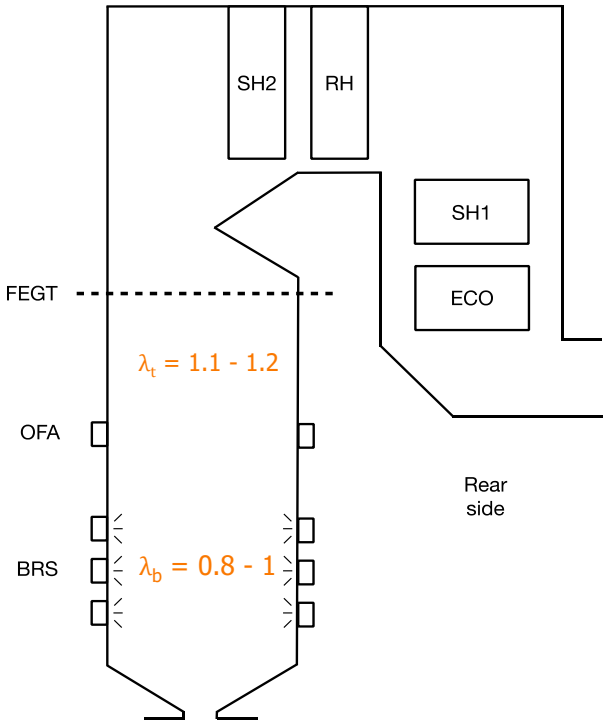
Total air = burner air + OFA air

- λ_{burner} app. 0.8 – 1 depending on fuel and burner/boiler design
- λ_{total} app. 1.1 – 1.2 depending on fuel and boiler design

Air excess = $\lambda - 1$

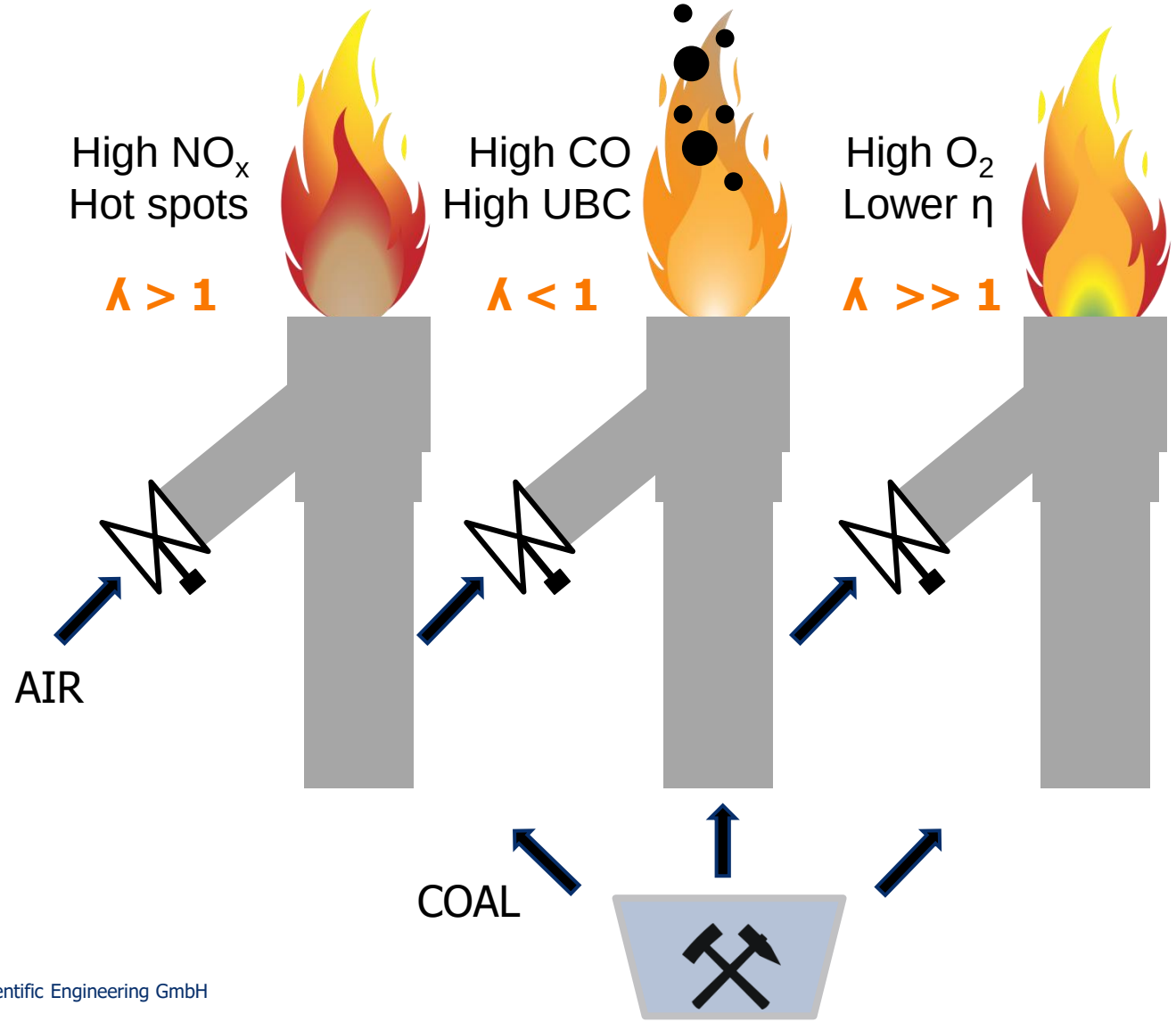
O_2 excess at boiler exit = 1% to 3% (depending on fuel)

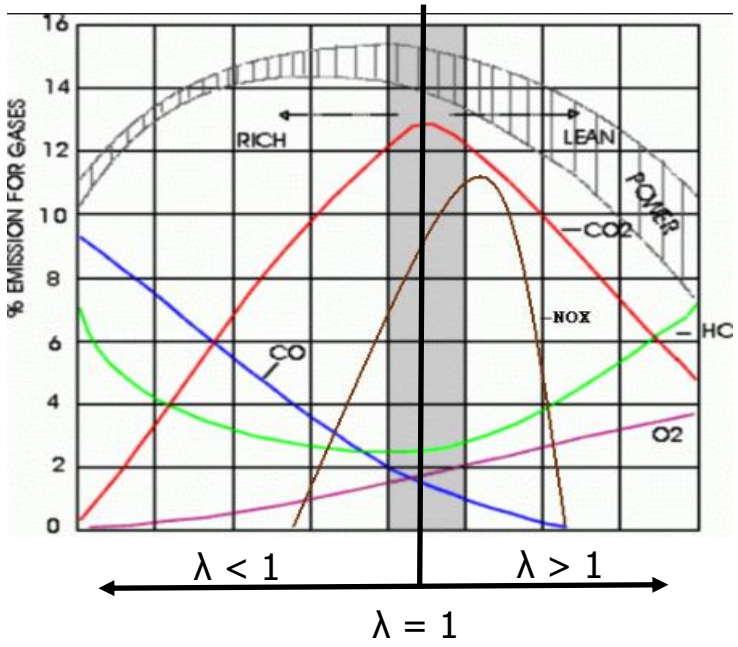
- O_2 measured before air preheater
- O_2 at stack higher due to leakage of air preheater



Main combustion parameter

Impact of Air-Fuel Ratio on efficiency and emissions





Challenge - Optimal adjustment of air and fuel

Situation

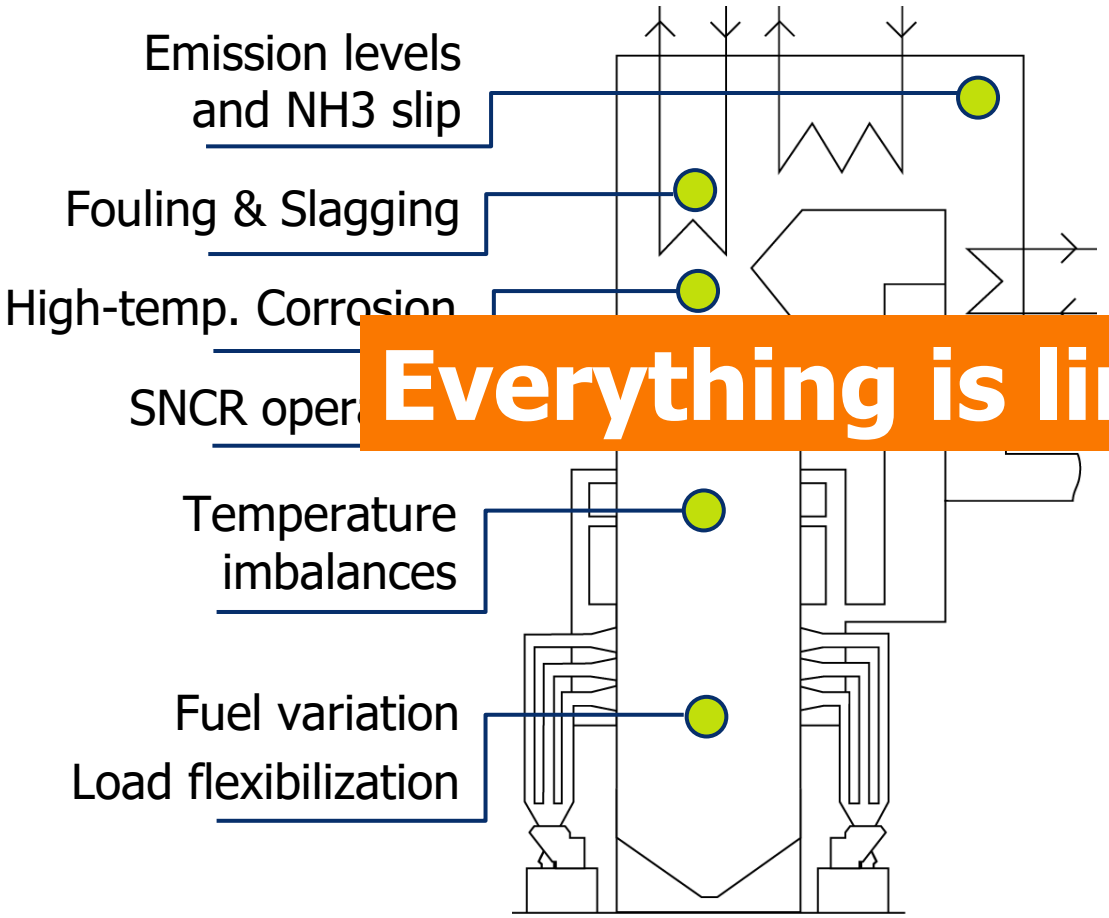
- Four to eight mills (= burner levels)
- Each mill with three to eight burner lines and each mill serves one level

- Each pipes shows different lengths (pressure drops to be corrected – only once)
- Coal flow is hardly balanced, AFR is hardly equal

- Additionally, particle size distribution has to be adjusted to burner level

Combustion challenges

Temperature is a key parameter



Everything is linked with temperature

Demand

- Cost-effective determination of important process variables (online root cause analysis)
- Online measurement and diagnostic

Measures

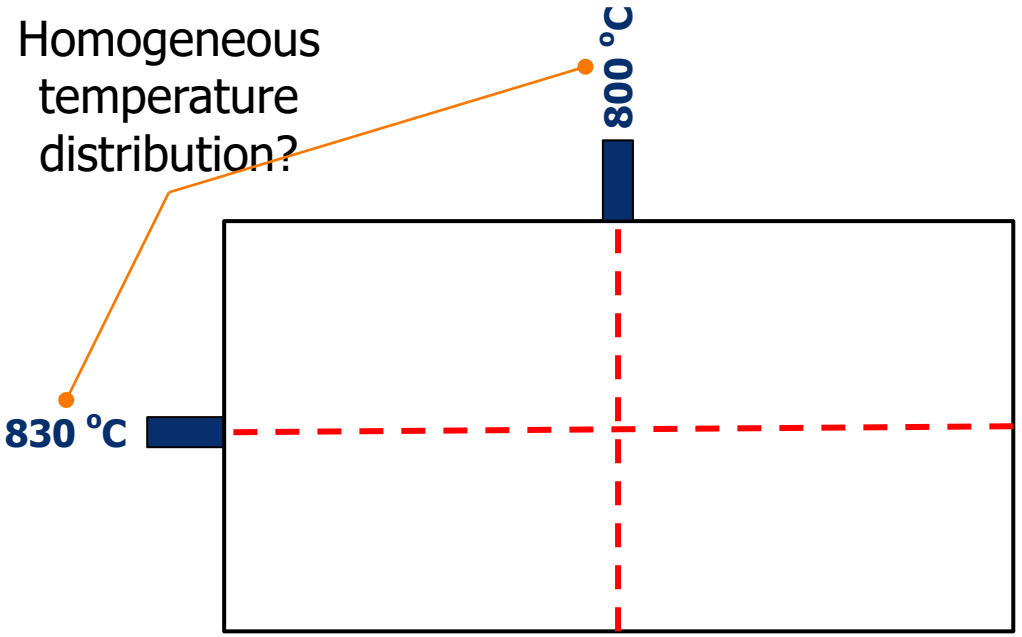
- Effective primary measures
- Enabling secondary measures

Furnace exit gas temperature (FEGT)

EUflame

Application - Benefits

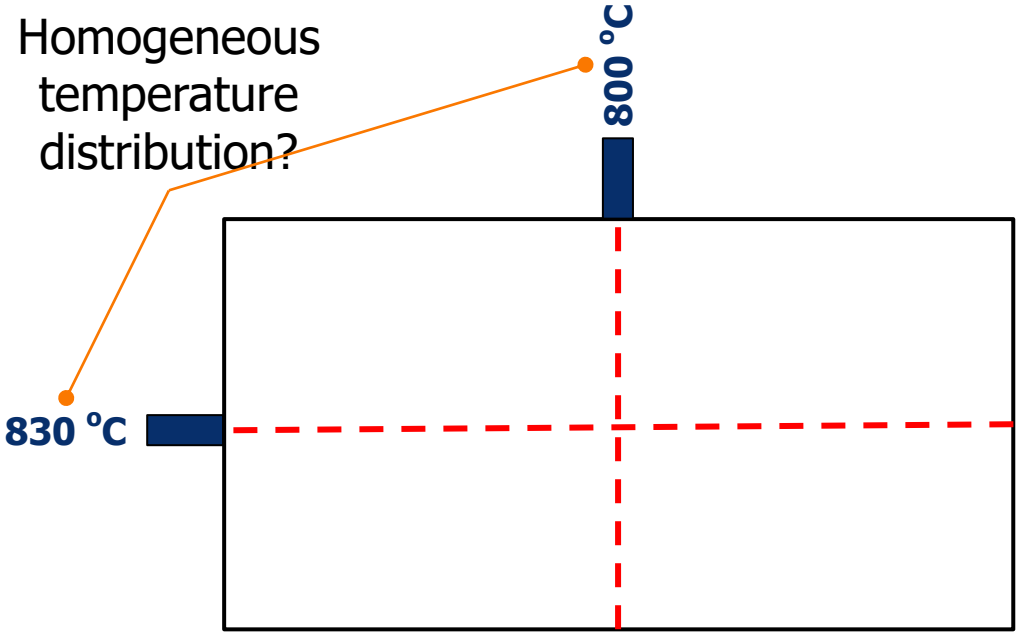
Line measurement vs. 2D temperature mapping



Furnace cross section EUflame Sensor Direction of view – measuring path

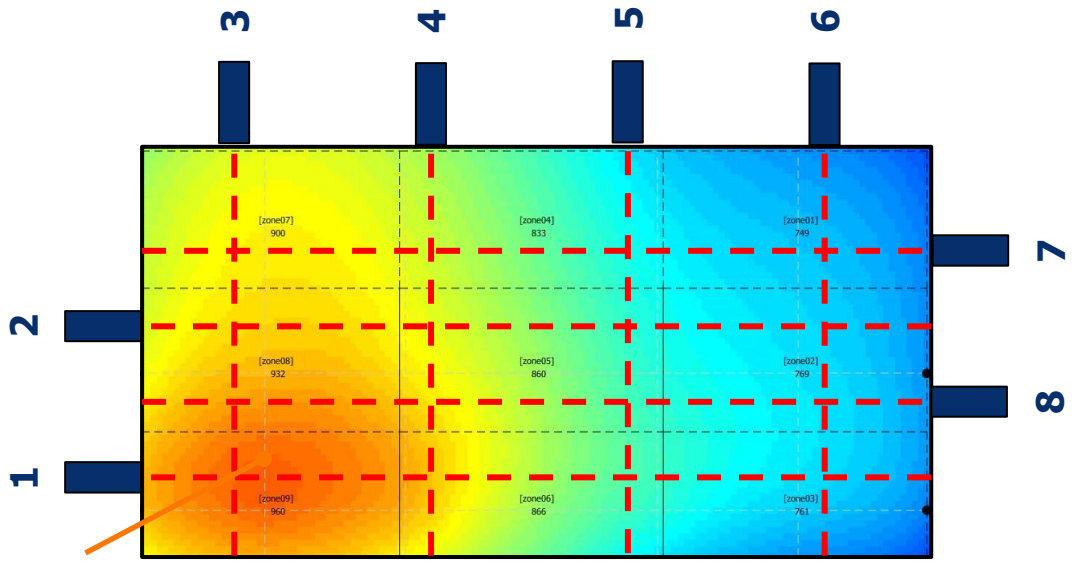
Application - Benefits

Line measurement vs. 2D temperature mapping



Limited, misleading temperature information!

vs.



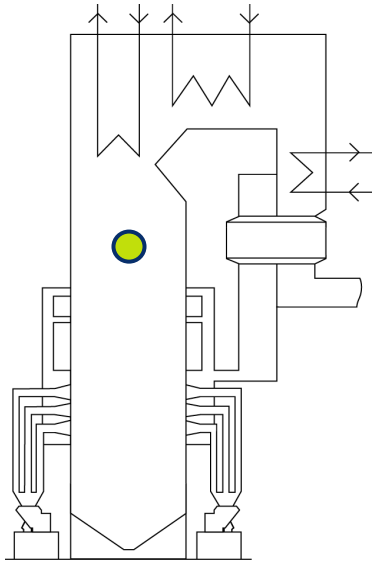
2D Temperature information
No blind spot!

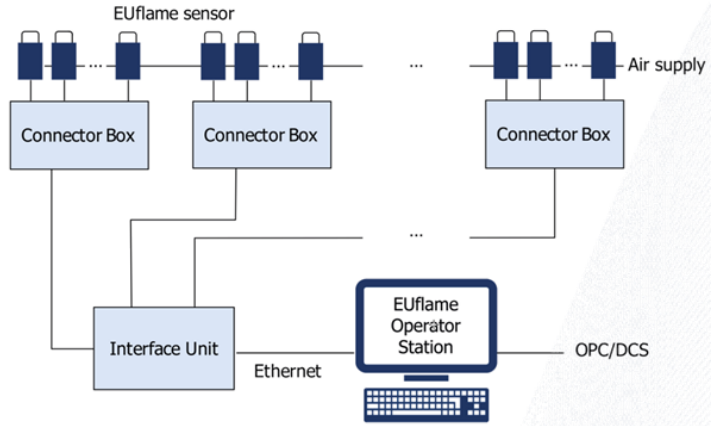
Furnace cross section EUflame Sensor Direction of view – measuring path

EUflame

Flame temperature and burnout

- Online flame temperature and burnout measurement (2D/3D)
- Sensor based on optical measuring technique
- Single-point and 2D/3D-measurements
- Stationary or mobile system available
- Essential for effective combustion optimization and DeNO$_x$ (e.g. SNCR) operation

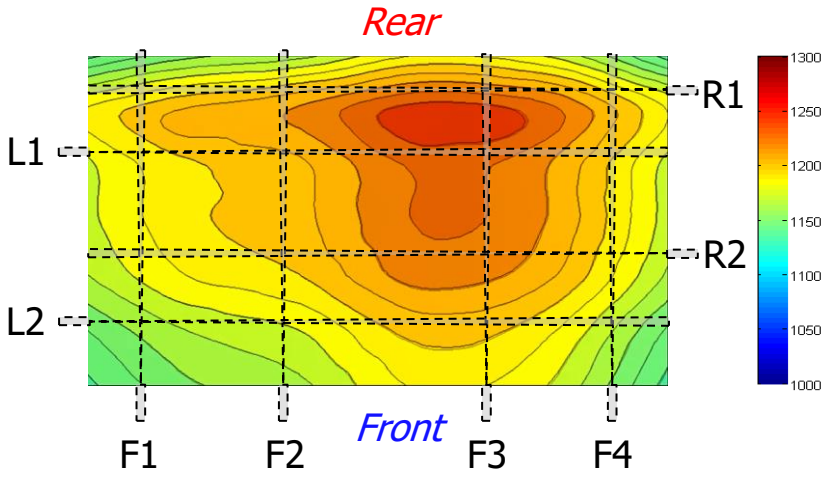


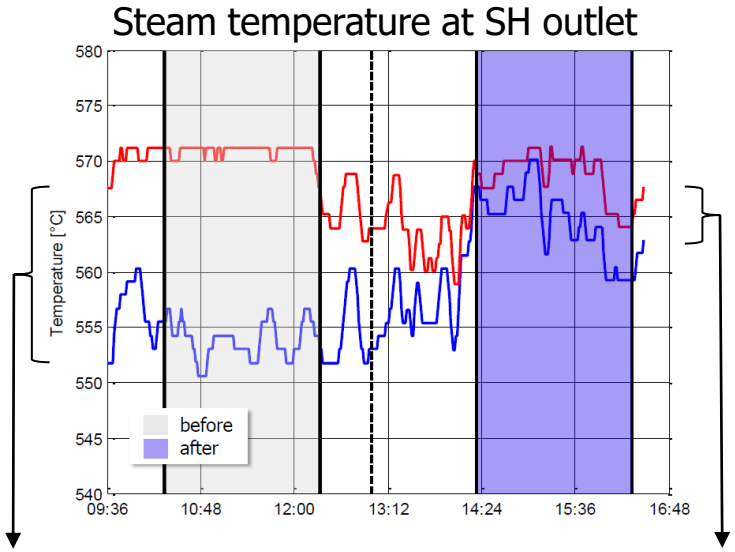


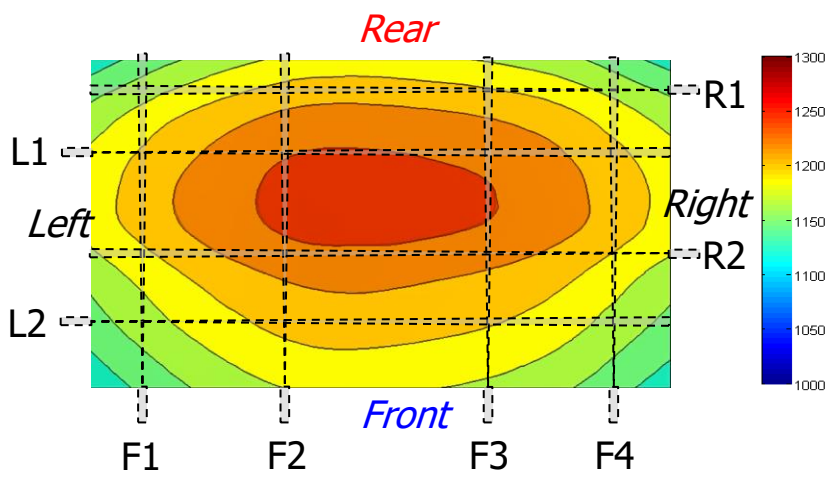
Best practices & application results

Application - Fossil/biomass fired power plants

Flame positioning and homogenization







Δt **before** optimization of the flame position

Δt **after** optimization of the flame position

Achievements

- Higher combustion efficiency and higher flexibility
- Active FEGT control / homogenization and emissions improvement (CO, LoI, NOx, particulates)
- Identify and optimize optimal location for injecting NO reducing agents in SNCR
- Reduce spray-water injection requirements
- Less thermal stress

Application - Coal-fired TPP (660 MW), Thailand

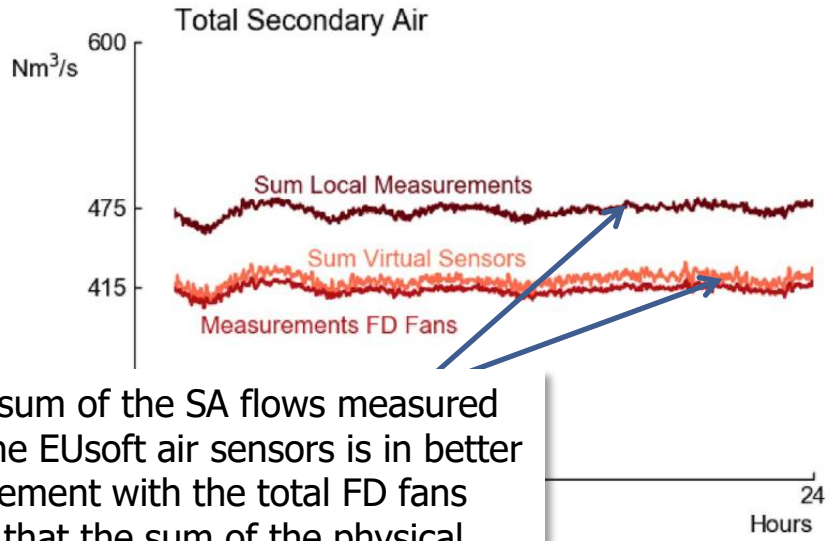
Combustion process improvement

- Challenge
  - Imbalance right-left (O_2, NO_x, FEGT) based on existing measurements
  - Suboptimal operation of $DeNO_x$ system (SCR)

- Solution
  - Measurement of air distribution (EUsoft air)
  - Measurement of fuel distribution (EUcoalflow)
  - Measurement of Particle Size Distribution (EUcoalsizer)

- Results
  - Air-Fuel Ratio balancing and staging (key-driver of combustion)
  - Balanced O_2 and FEGT distribution
  - Improved operation of $DeNO_x$ system

Wall-fired boiler, Thailand (2017)

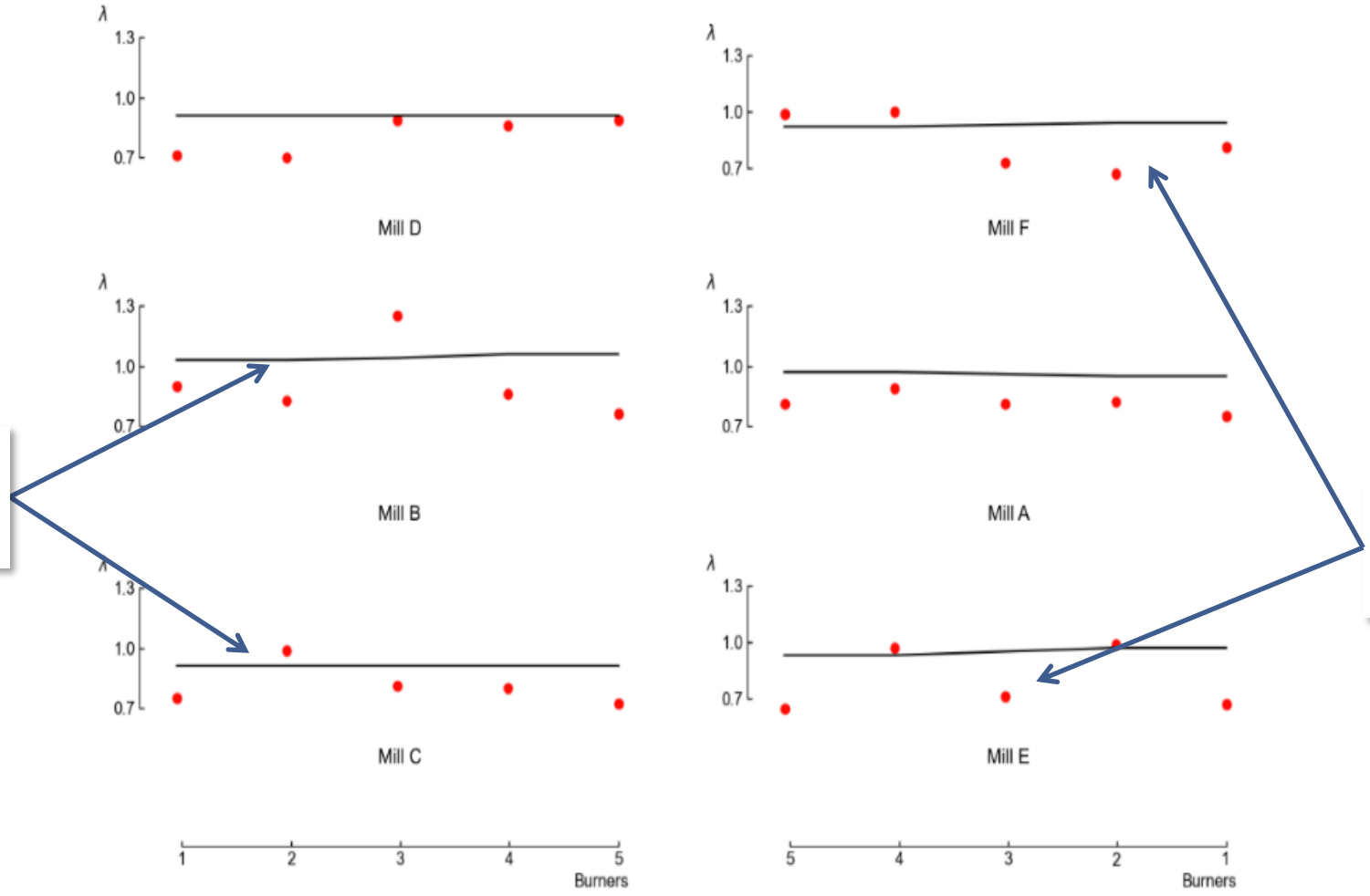


The sum of the SA flows measured by the EUsoft air sensors is in better agreement with the total FD fans flow that the sum of the physical measurement

Application - Coal-fired TPP (660 MW), Thailand

Combustion process improvement

- Air-Fuel equivalent Ratio (Lambda) per burner



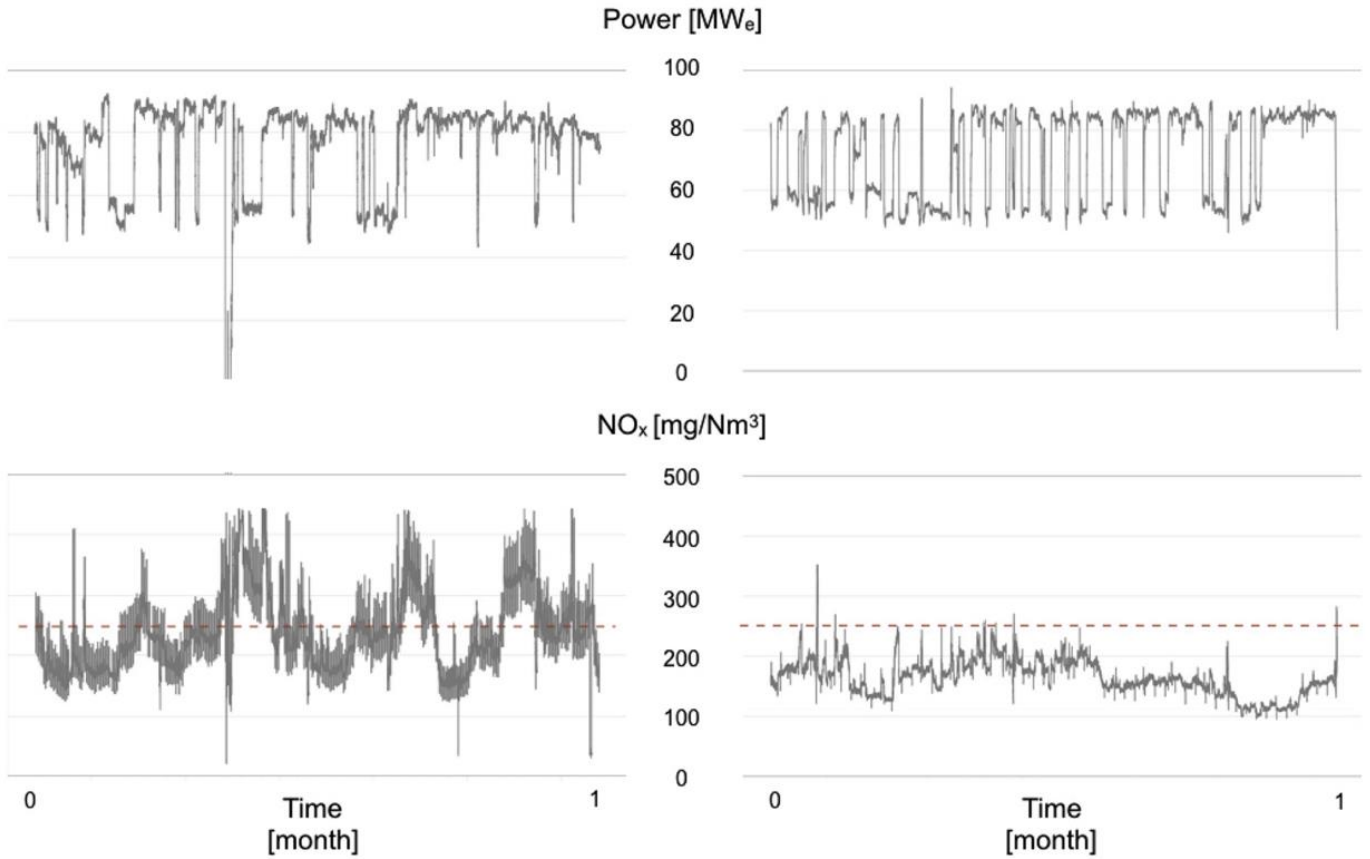
Black lines:
Expectation based on standard measurements

Red dots:
Results of advanced measurements

Application - Biomass TPP (80 MW), Belgium

NO_x Emission Reduction

- Challenge
  - Increase of load variations
  - Unstable NO_x emissions, due to the global air control
- Solution
  - Online measurement of air-fuel-ratio
  - Control the air flow distribution per burner
- Results
  - Optimization of fuel and air flows
  - Balancing of temperature distribution
  - Lower and stable NO_x emissions

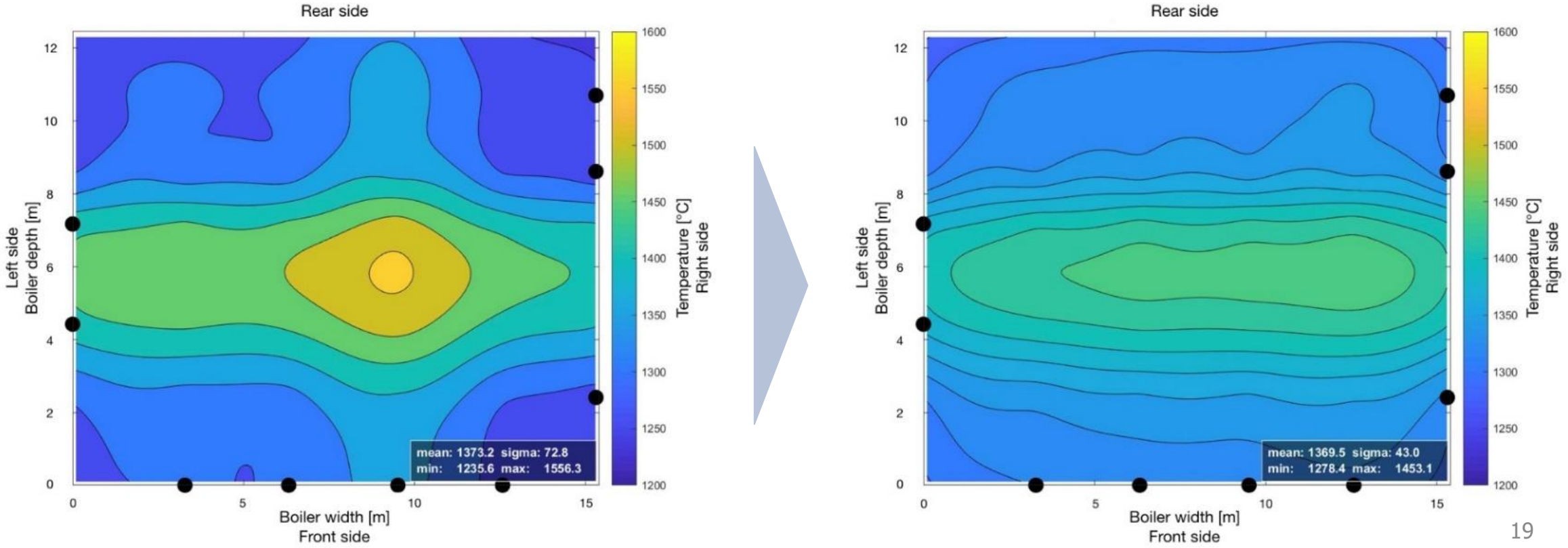


before **after**

Application - Large Scale Boiler Optimization - 1.500 MW_{th} boiler

Improving Furnace Exit Temperature Distribution

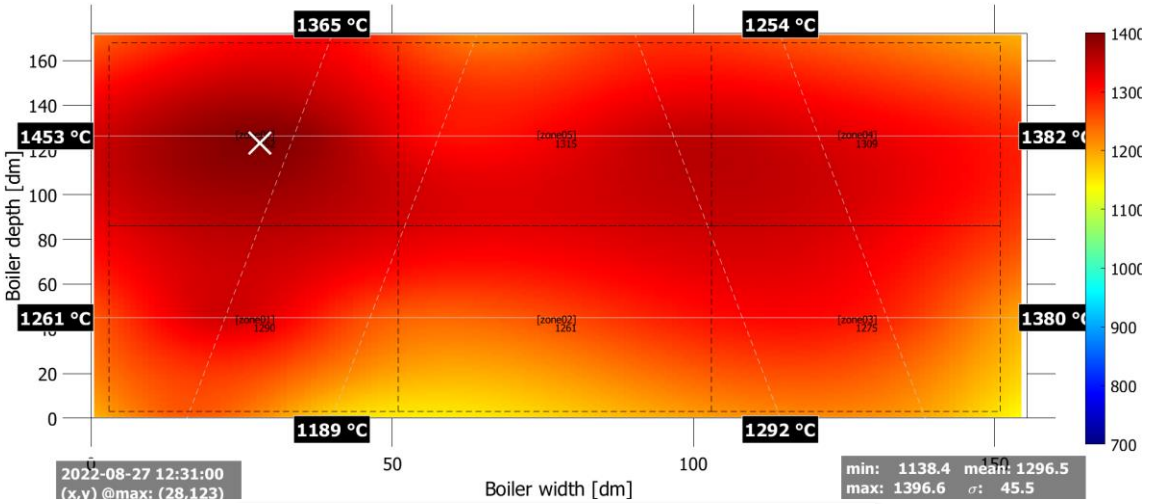
- Boiler leakages issues, hot spots
- Lower heat flow at the level of the furnace exit
  - Increase lambda at level of the burners from ~0.8 to ~0.9
- While respecting emission limits (NO_x and CO)



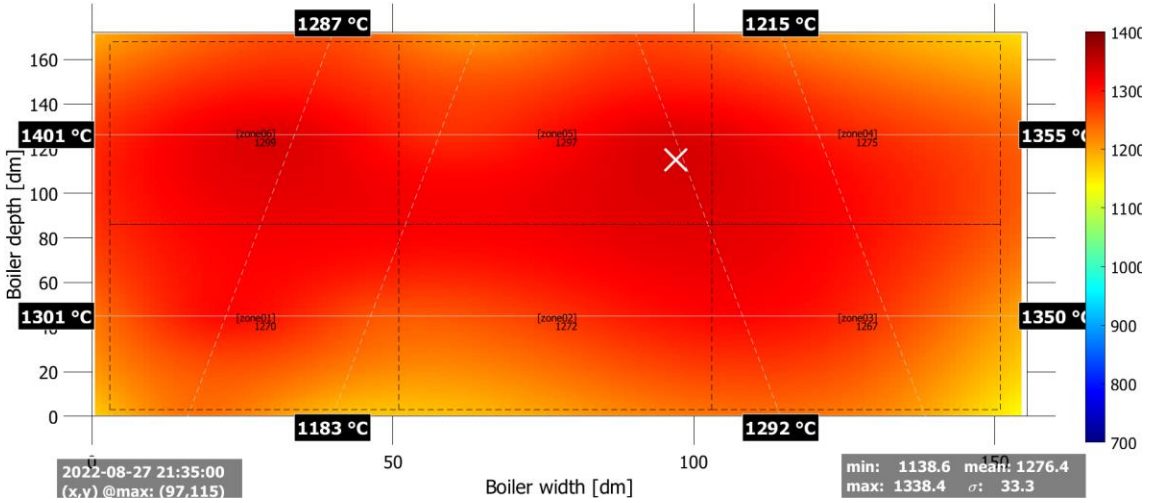
Application - Wall-fired TPP (660 MW), Turkey

Combustion operation improvement

- Challenge
  - High slagging & fouling
  - High O_2 excess oxygen level, especially under low-load conditions
- Solution
  - Online measurement of air-fuel-ratio per burner
  - Online FEGT measurement & distribution
- Results
  - Homogeneous FEGT temperature distribution under adapted operation conditions
  - Balanced O_2 values over furnace width
  - Reduced overall O_2 excess level, especially at lower boiler loads



Before optimisation AFR per burner



After optimisation AFR per burner

Summary and outlook

Summary and outlook

- Successful upgrading of large utility boilers with intelligent determination of key combustion parameters

- Optical pyrometers, virtual sensors, microwave sensors & laser probes used to monitor and adjust
  - Furnace Exit Gas Temperature (FEGT)
  - Air and fuel distributions (AFR)
  - Particle Size Distribution (PSD)

- In all cases, information that was not previously available to the operators have been brought to light and allowed for corrective actions leading to
  - Improved and more flexible combustion process
  - Savings in emissions production

- An accurate, online monitoring of these parameters is becoming necessary to address the fuel- and load-flexibility challenges that thermal assets will have to face in India

Thank you!
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