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MECONTROL

Boiler Combustion Optimization

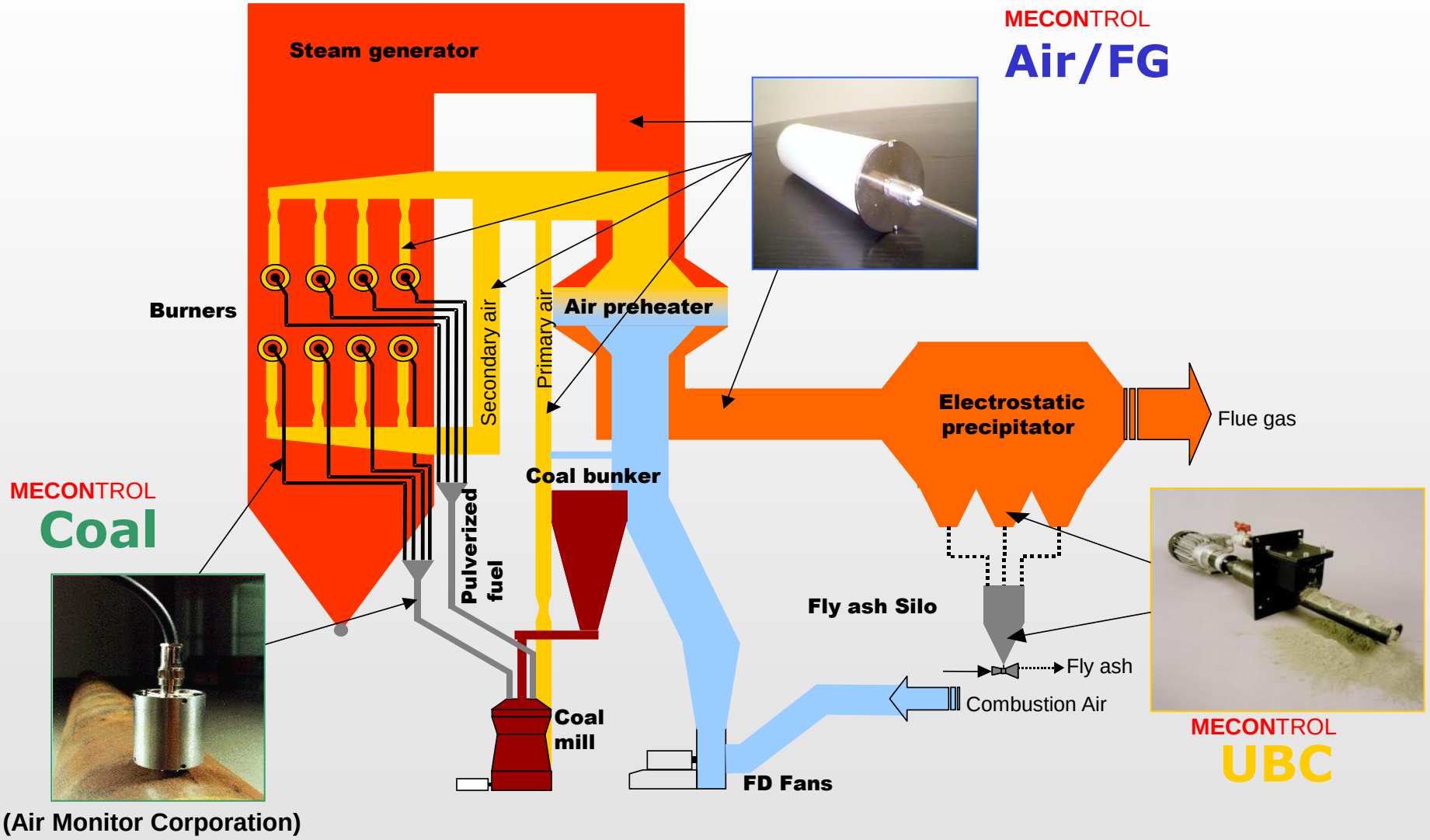
# Advanced Instrumentation for Improved Plant Operation

Presented to:

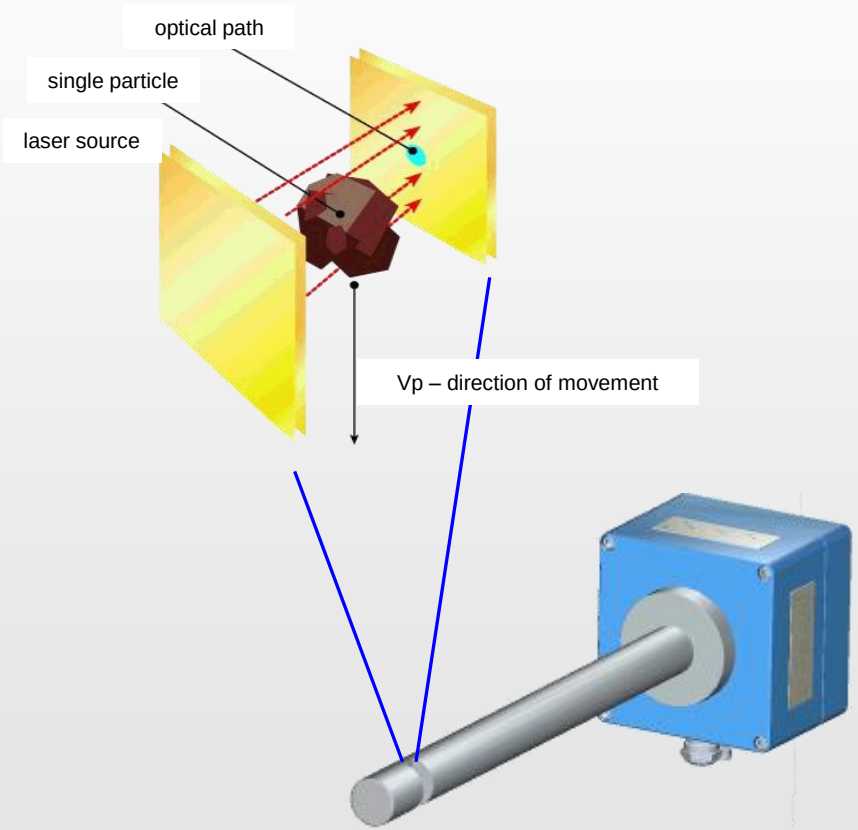
**McIlvaine Webinar**

August 8, 2013

# "New" Instrumentation for Boiler Optimization



# Extended spatial filter MECONTROL PSA




Based on evaluation of the shadows of a laser beam created by moving particles

## Properties:

- Measuring range 30µm to 6mm
- Recording of particle velocity and particle size
- In-situ measurement on PF pipes
- Chord length measurement

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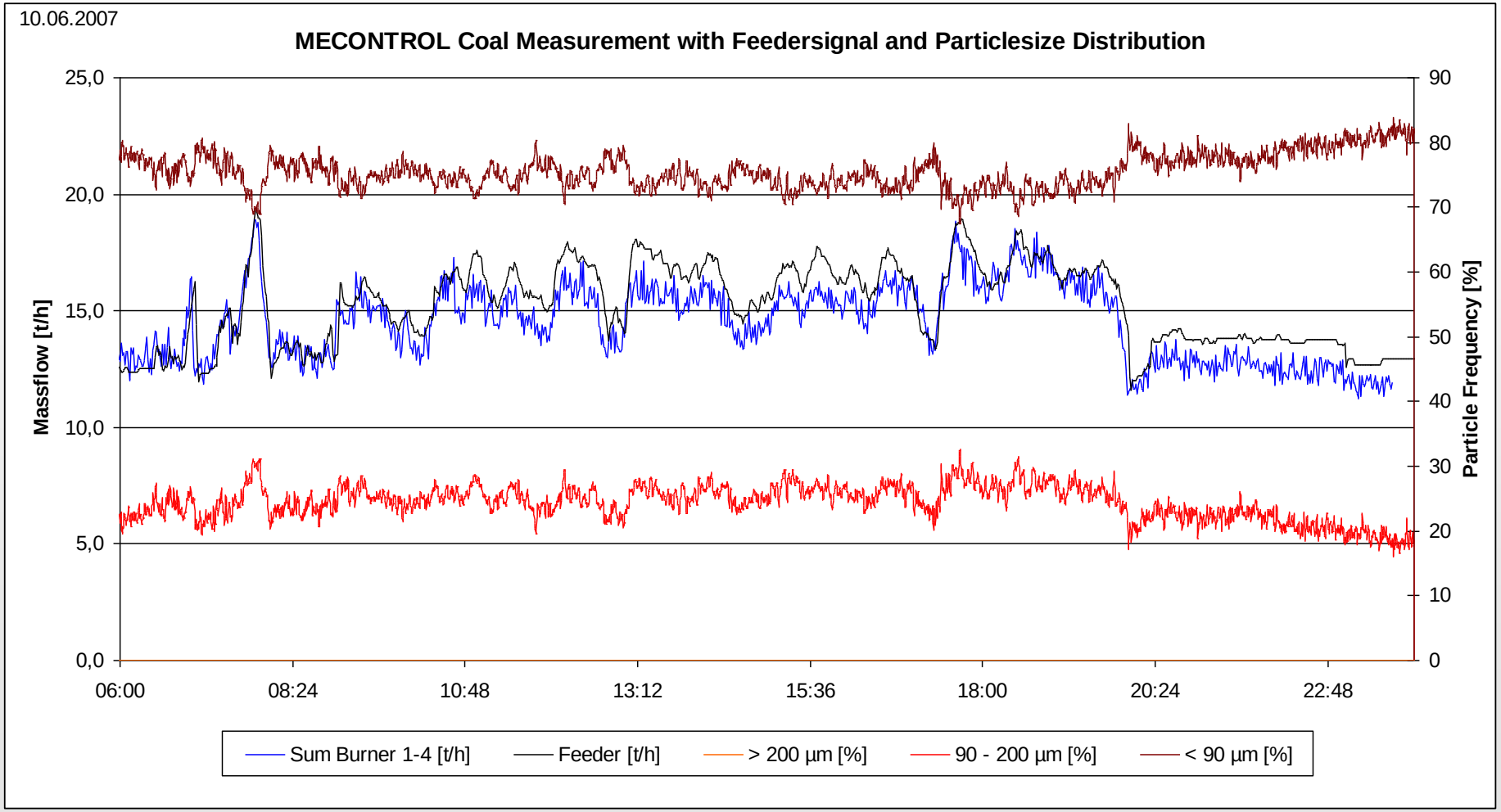
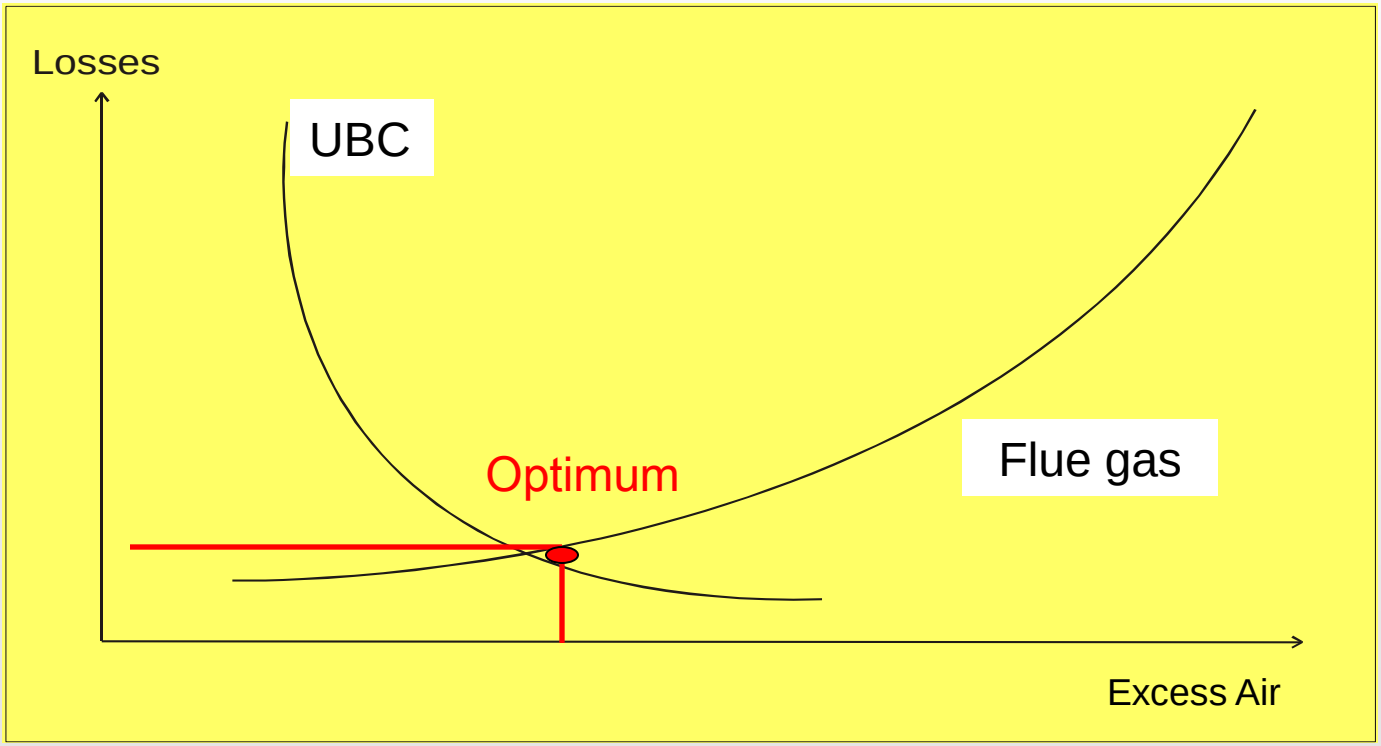
# Particle Size Analysis (PSA)

## Test Data: PS Reuter West, Berlin



# Efficiency Optimization Principle

Minimize energy losses from unburned carbon & flue gas -- function of excess air levels



# Key Functions

- SAMPLING

  Instrument must collect a representative sample

- MEASUREMENT

  Instrument must accurately measure the amount of unburned carbon in the sample

# Sampling Approaches

- Extractive (remove ash from handling system to make measurement)

  Classical approach used for early instrument design

- In-situ (measurement made within ash handling system)

  New approach – providing significantly better reliability

***PROMECON APPROACH***

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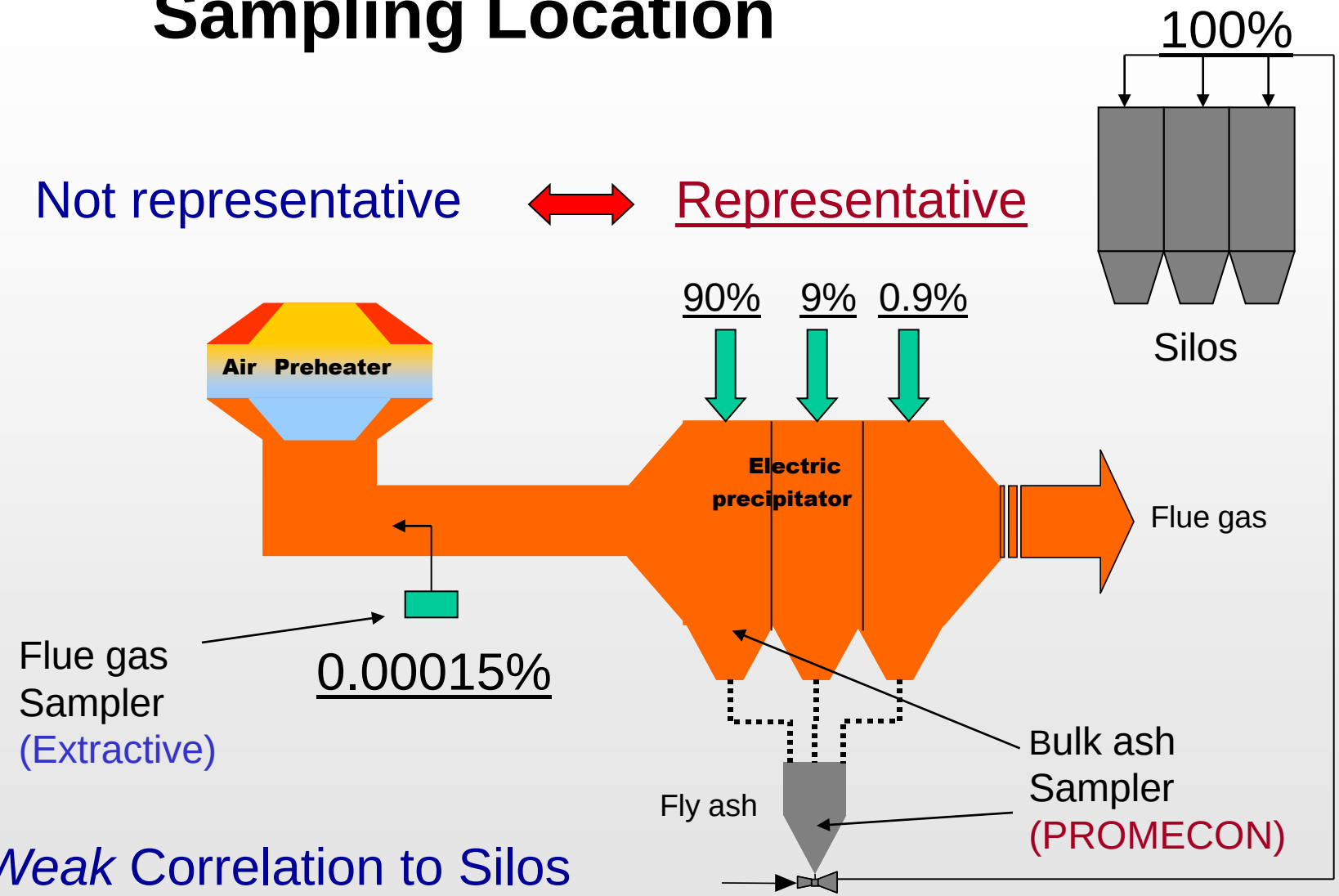
# Sampling Location

Not representative ⟷ Representative




*Weak* Correlation to Silos

*Strong* Correlation to Silos

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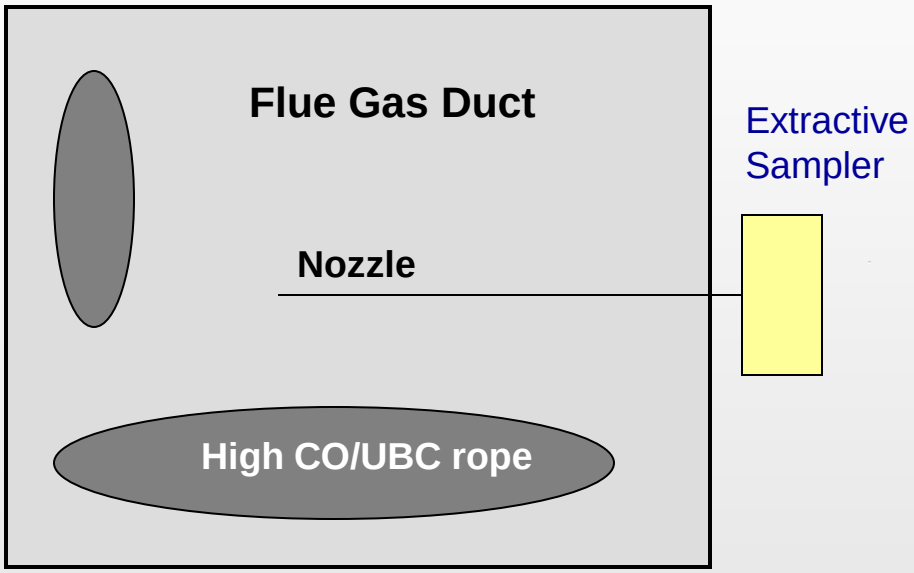
# Sampling of the Ash Flow

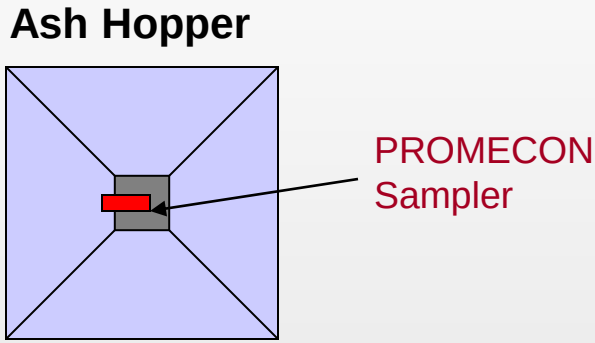
Ash and gas not uniform




Cross sectional coverage: 0.000005%

Fly ash concentration: 5g/m$^3$

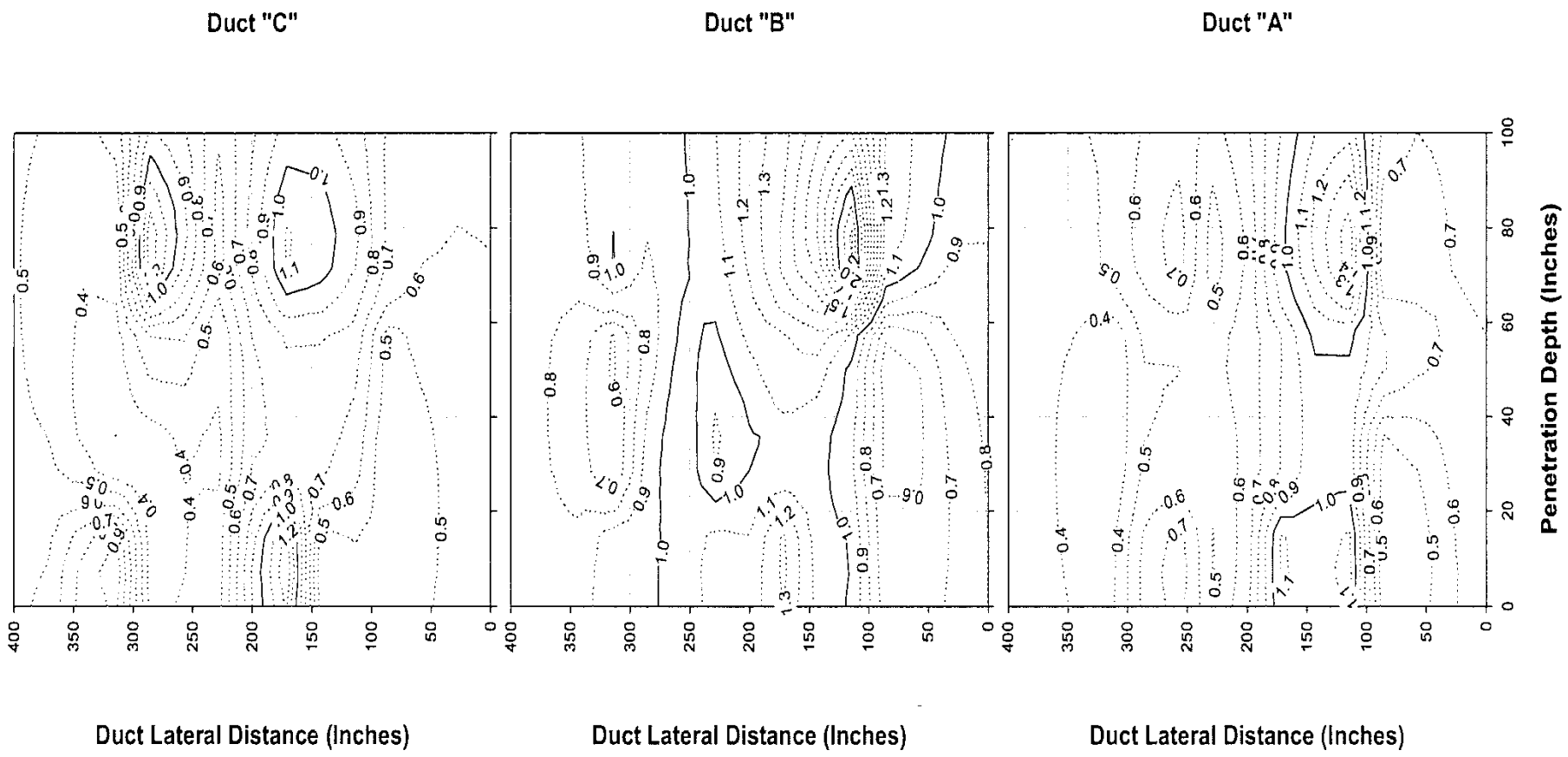
Ash discharged in dense quantities



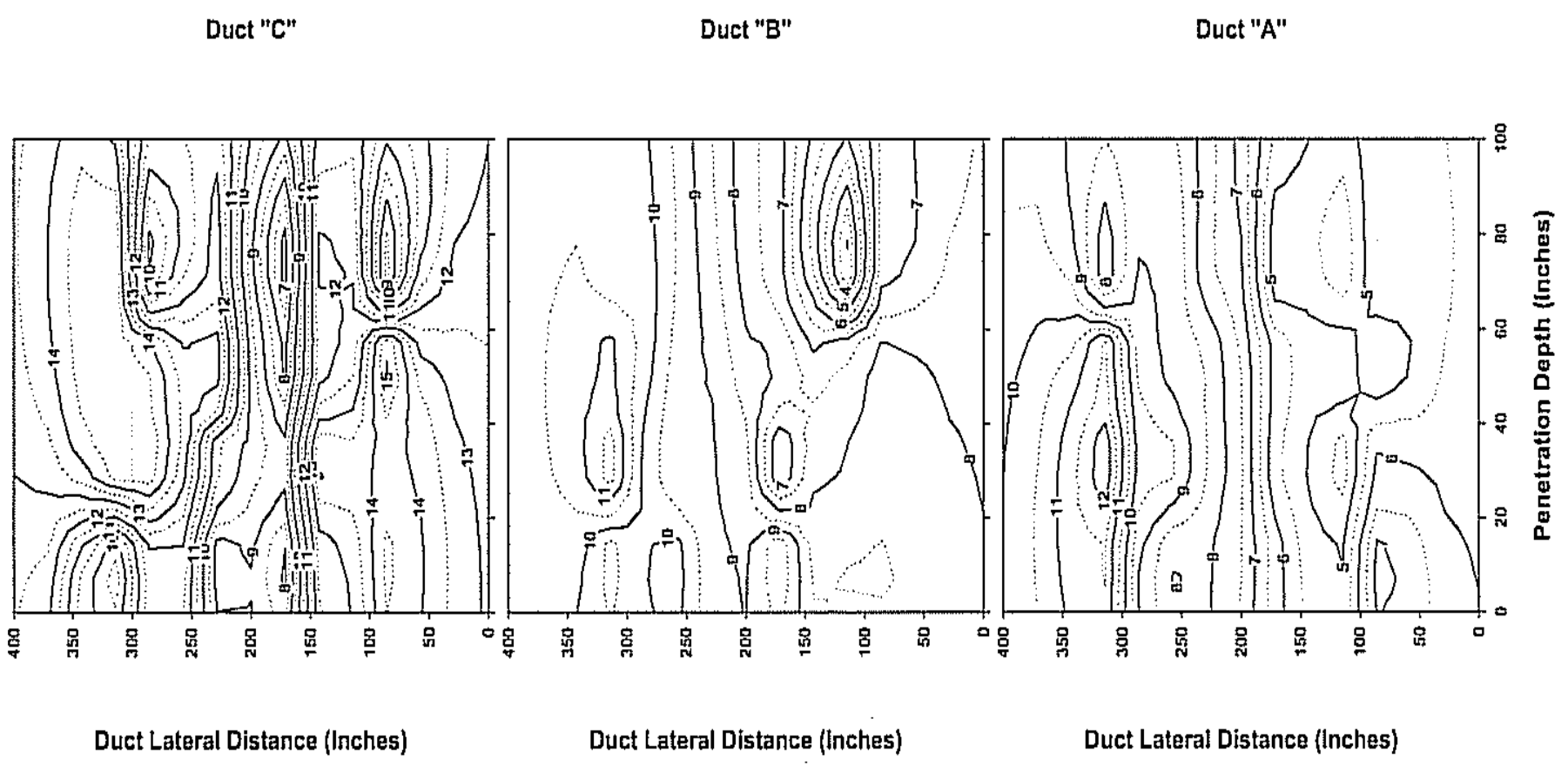

Cross sectional coverage: 2-8%

Fly ash concentration: 200,000 g/m$^3$

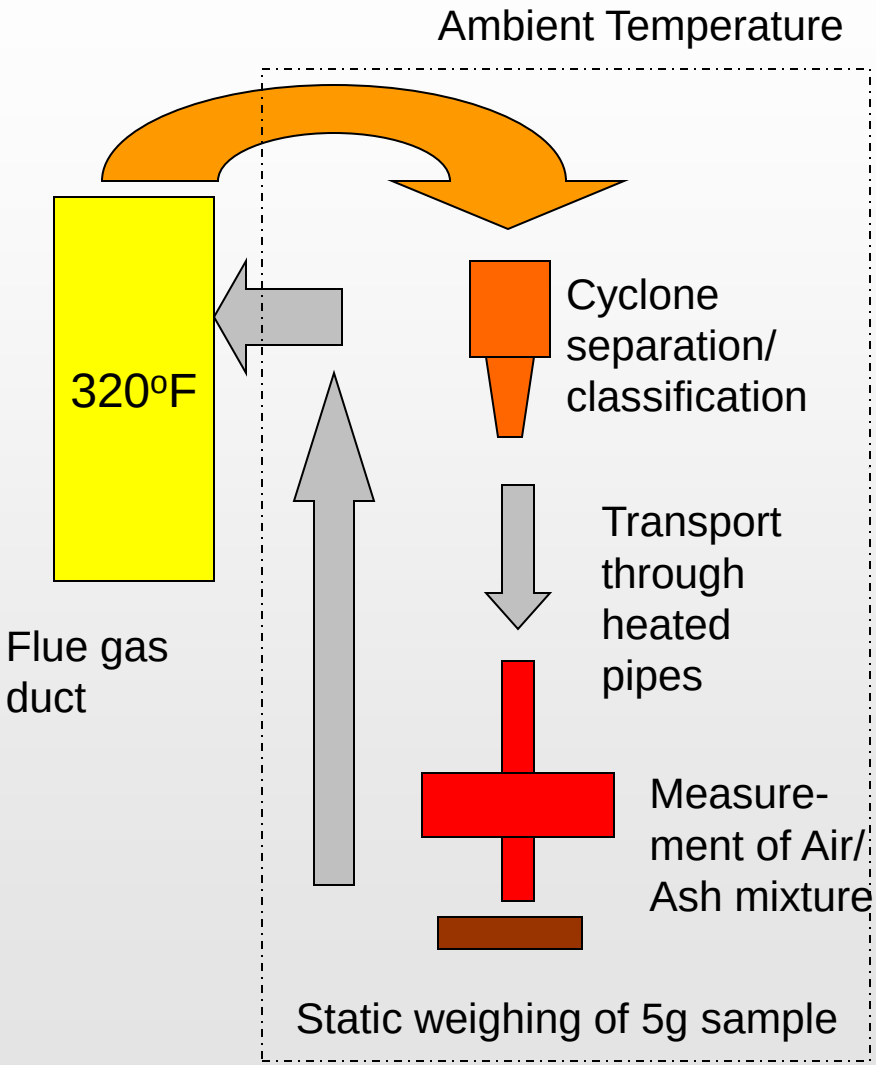
# Typical Fly Ash Loading Distribution



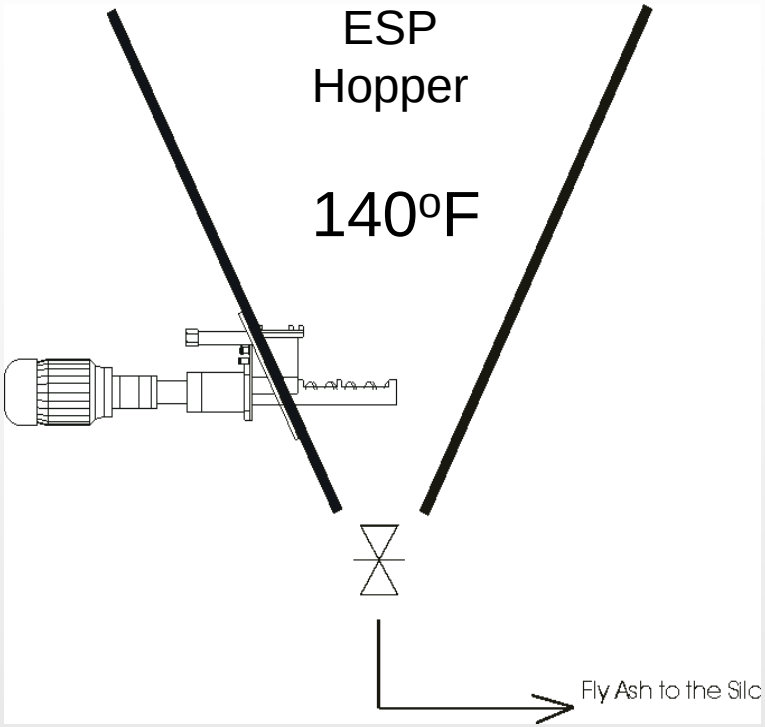
# Typical Fly Ash LOI Distribution



# Extractive Measurement




# PROMECON In-Situ Measurement




Sampling and measurement in the hopper:

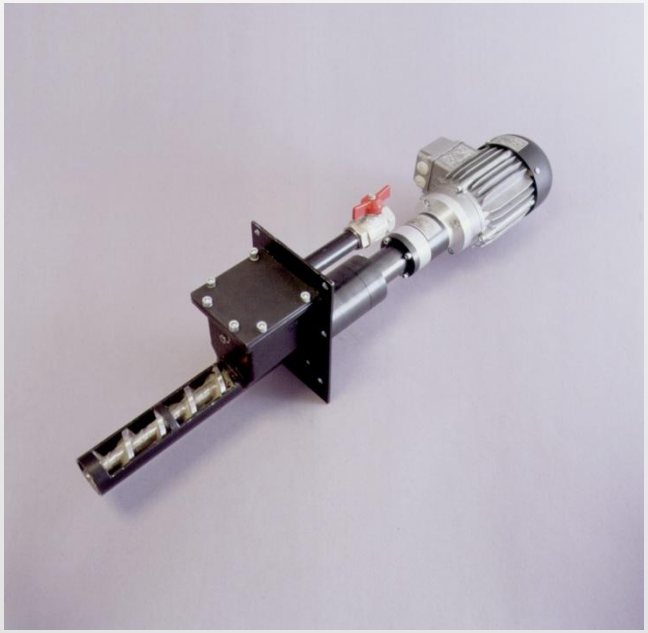
- ✓no extraction
- ✓no cyclone separation
- ✓no static weighing
- ✓no heating elements

# Measurement Approaches

- Microwave
  - Basis: Response to microwave radiation
  - Pros: Simple; Accurate; Infrequent calibration
    Insensitive to fuel type or blend
    Can be performed in-situ
    Multiple sampling points w/ one instrument
  - Cons: Higher initial cost (# sampling points?)

# PROMECON UBC Measurement Principle

Dielectric constant of fly ash is a function of the carbon content. Measuring the shift of frequency (microwave) in a resonator ($\Delta$ f) enables the carbon content to be calculated.



$$UBC = A + B \cdot \Delta f$$

A and B are the calibration coefficients

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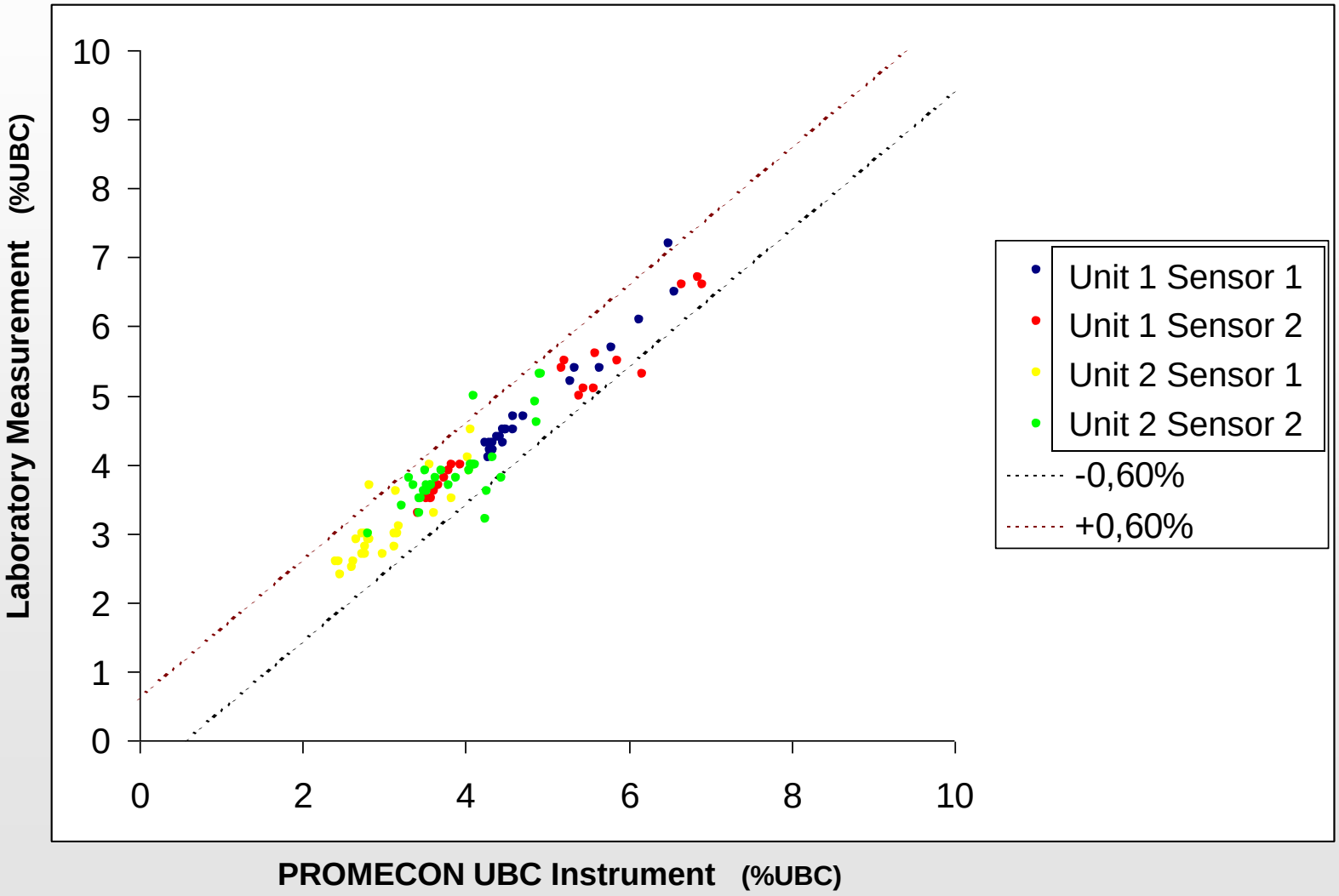
# Typical Measurement Data Accuracy



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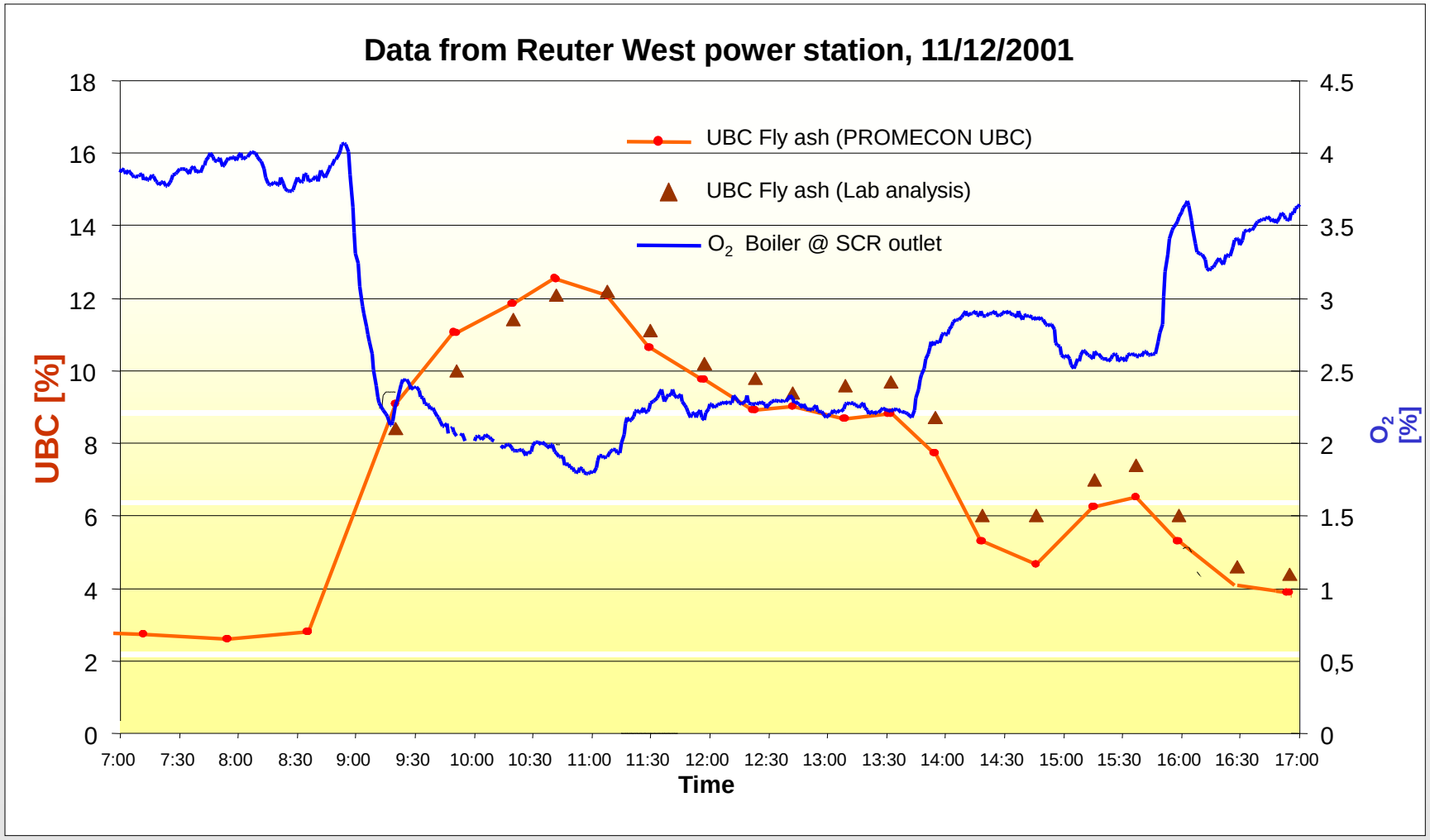
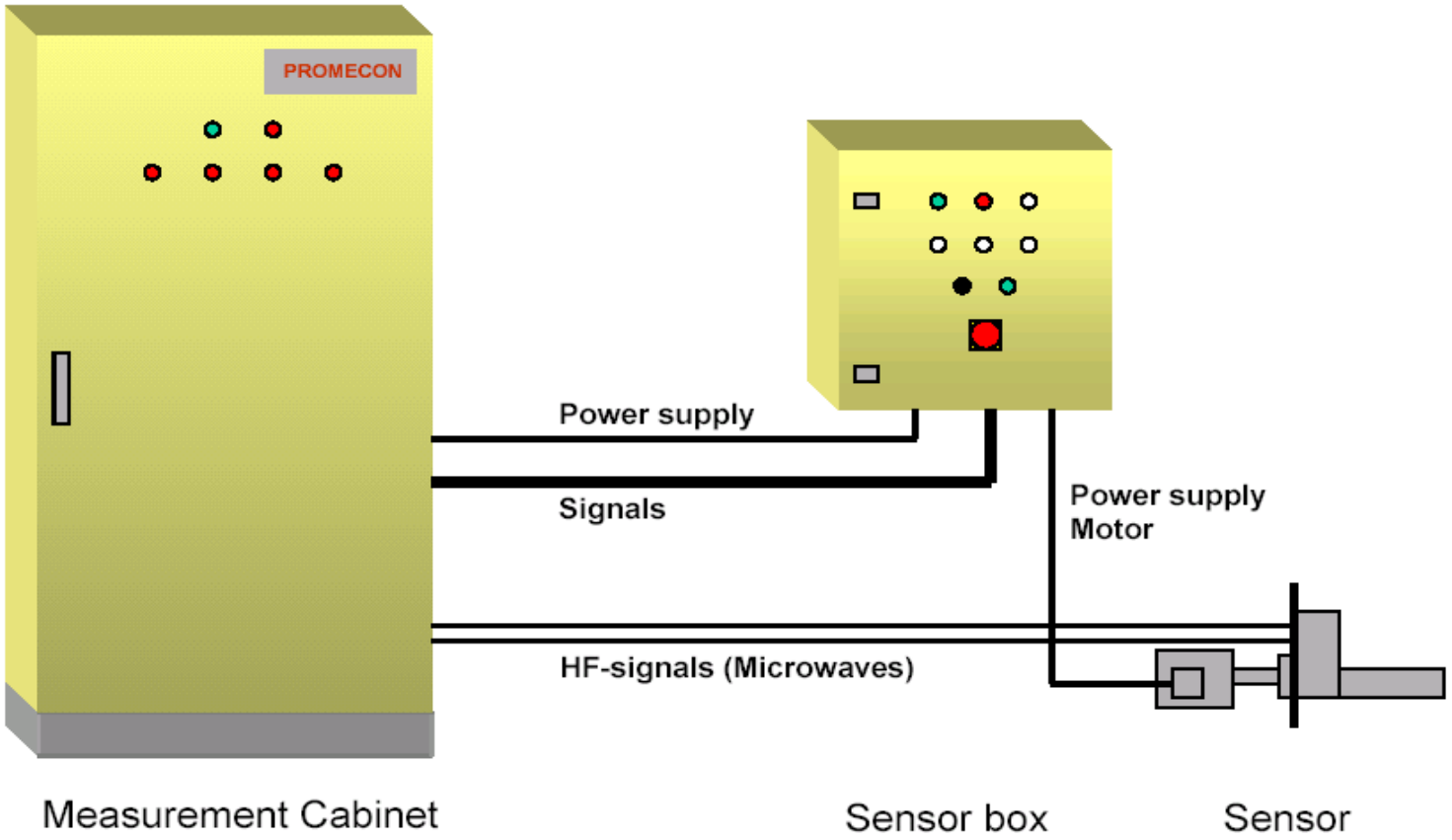
# Boiler/Mill Optimization w/ UBC Monitoring



# MECONTROL UBC Design

we focus on your proces



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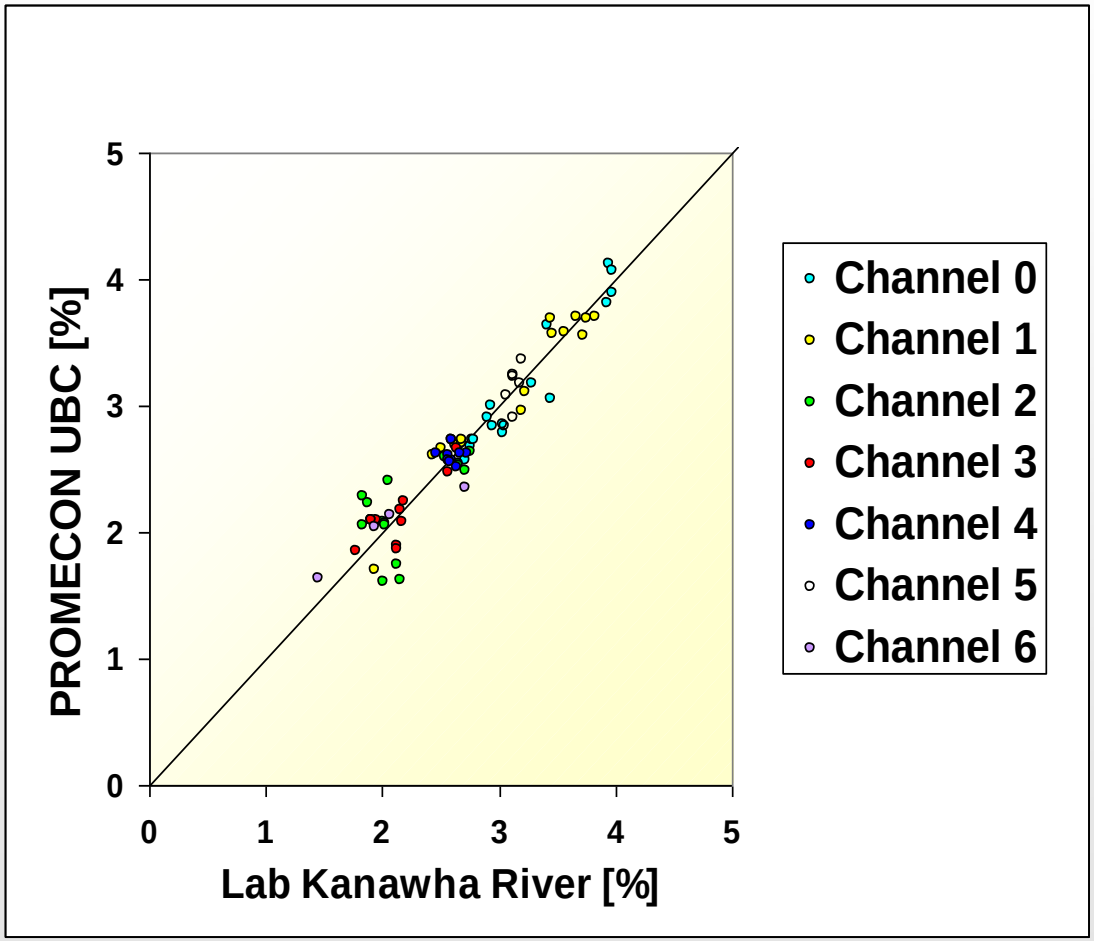
# Kanawha River UBC Data




Standard Deviation
of UBC Measurements

Channel 0: 0.17%
Channel 1: 0.15%
Channel 2: 0.28%
Channel 3: 0.15%
Channel 4: 0.10%
Channel 5: 0.16%
Channel 6: 0.25%

**All Channels = 0.18%**

# Benefits to the Power Plant

- **Accurate measurement of a very key combustion parameter (UBC)**
- Optimization of mill/boiler performance
- Improvement of NOx, CO, $O_2$ and UBC (quantity and consistency)
- Operating cost savings by reduction of primary losses and increased fly ash sales

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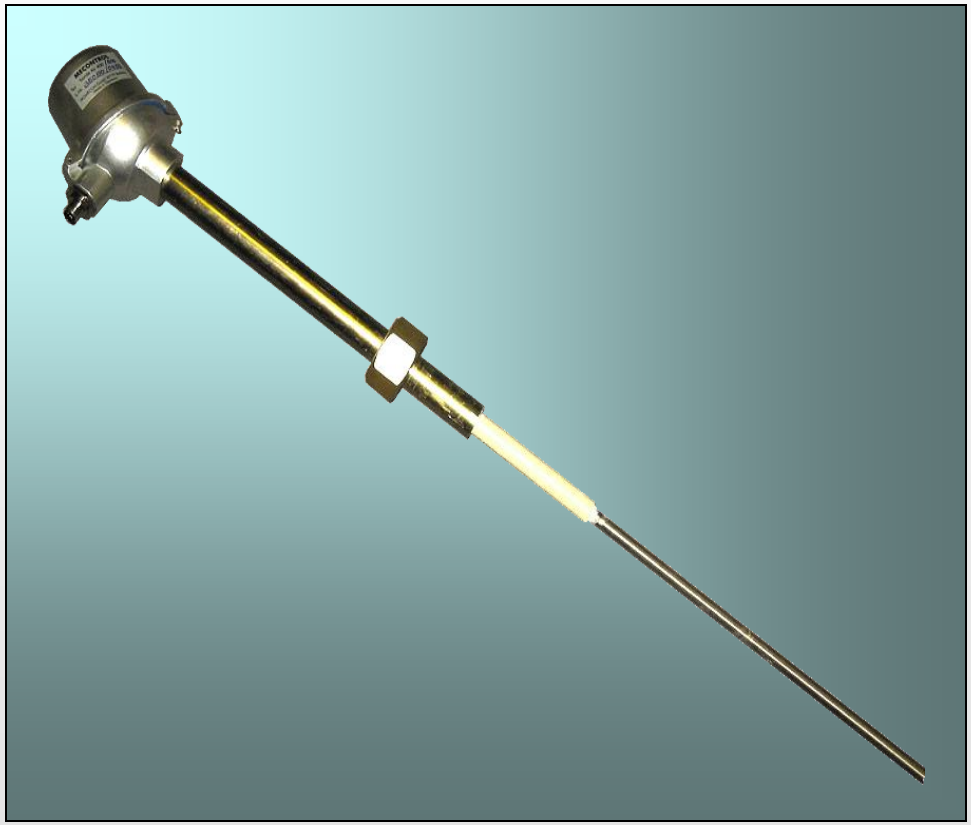
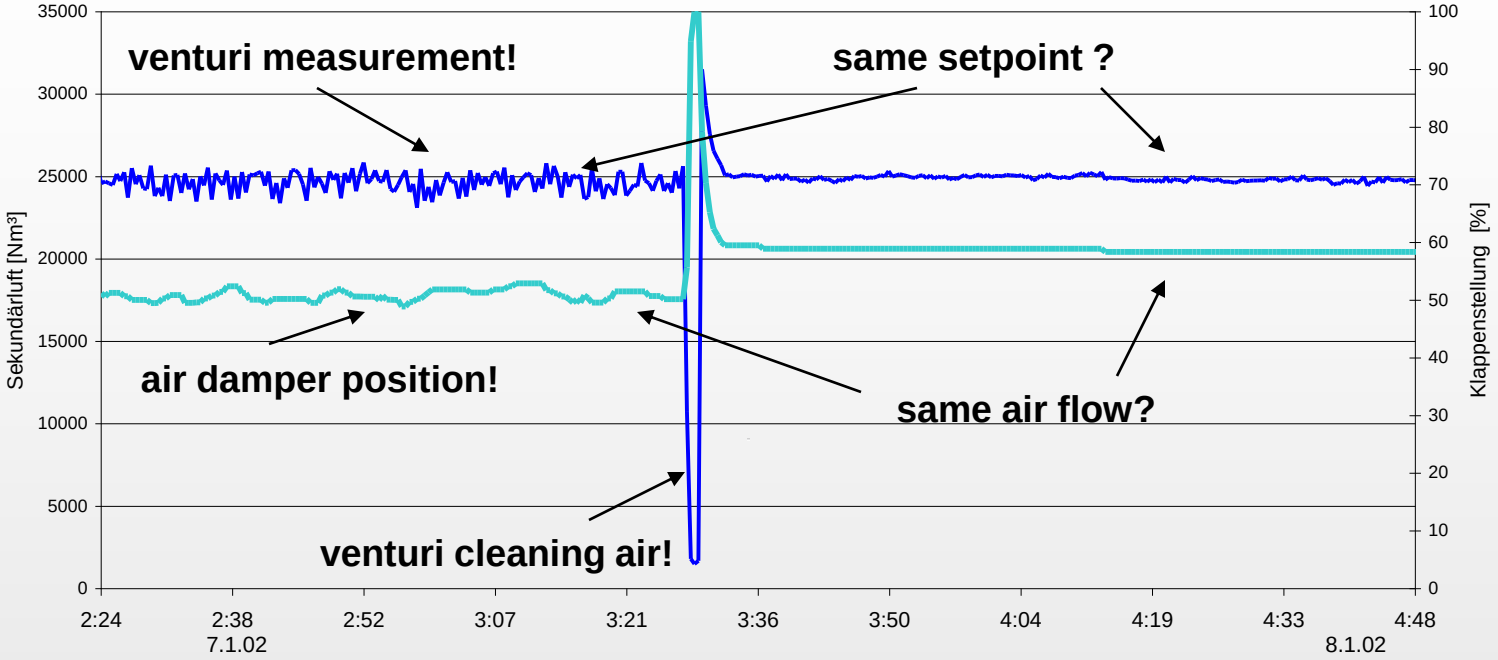
# Boiler Combustion Optimization

## Air/Flue Gas

### Hot Gas Flow Measurement



# How accurate is your air flow measurement?

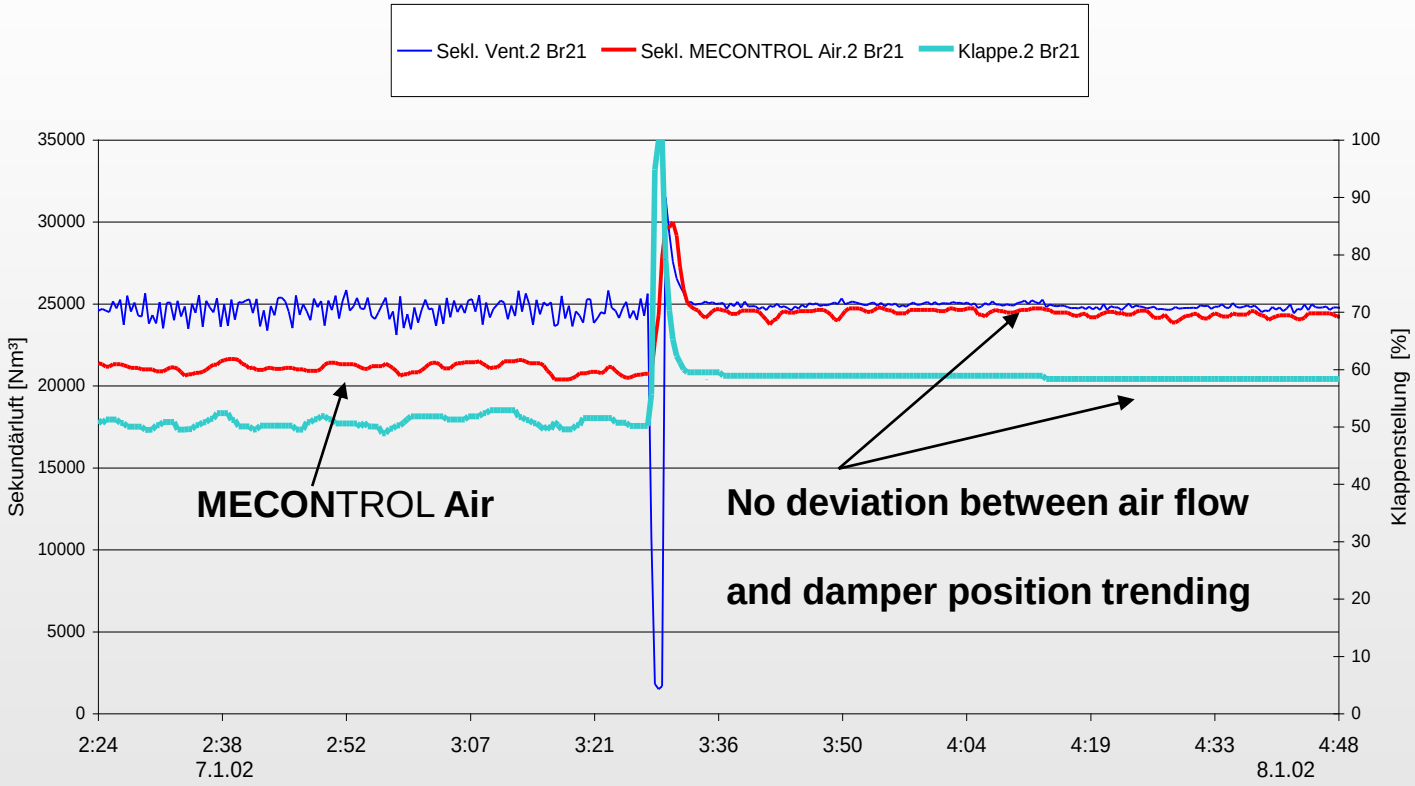



-Venturi measurements usually control dampers to a fixed set point. Therefore the venturi measurement indicates this set point during normal operation. Any deviations of inaccuracies therefore can not be observed from the measurement value itself, because it indicates the desired value. The damper curves usually do not allow the detection of deviations of the venturi measurement. But they often are not plausible(see picture)

-Since the $O_2$ control loop usually corrects the deviations caused by a faulty air flow measurement, the problem can not therefore be detected by a flue gas $O_2$ monitor.

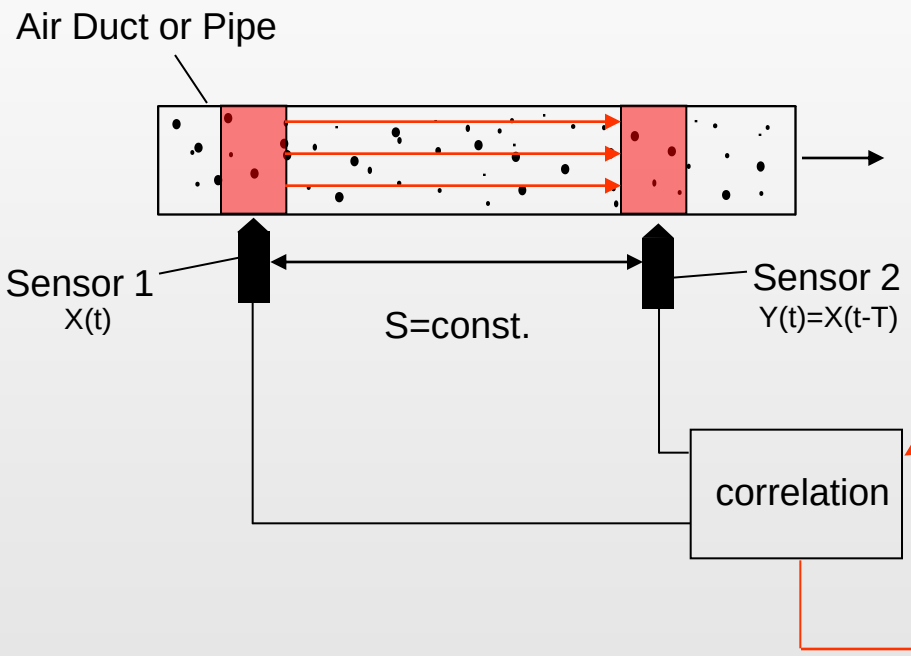
**<u>This problem causes loss in efficiency as well as unnecessary damper wear!!</u>**

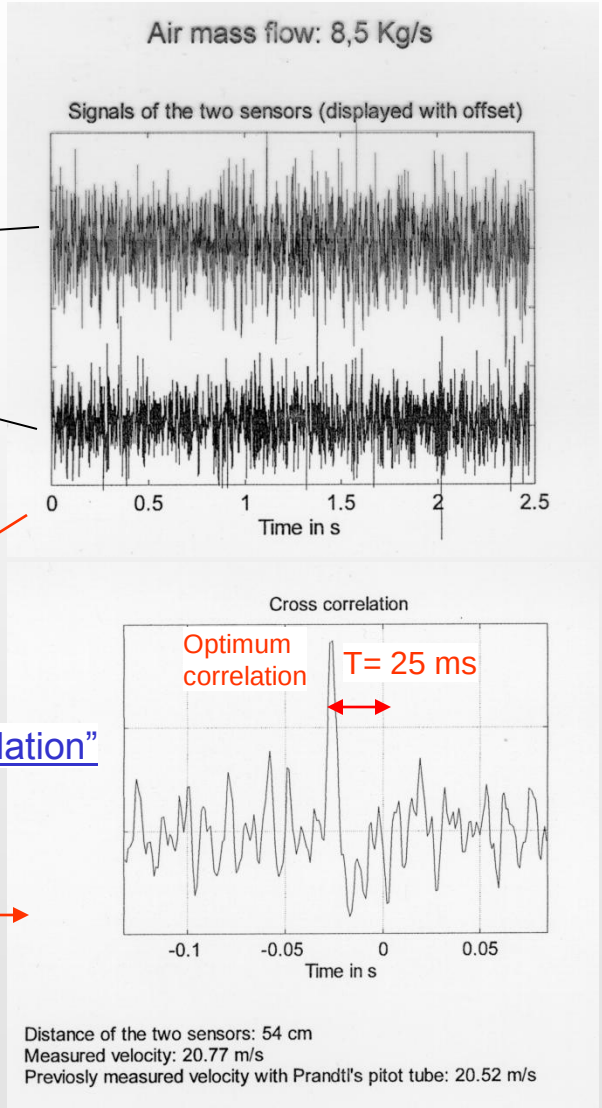
# MECONTROL Air/FG flow measurement




-no measurement drift, reduced damper control error and wear
-accurate air distribution to each burner
-unaffected by dust and dirt in the gas stream
-no pressure drop at the measurement location

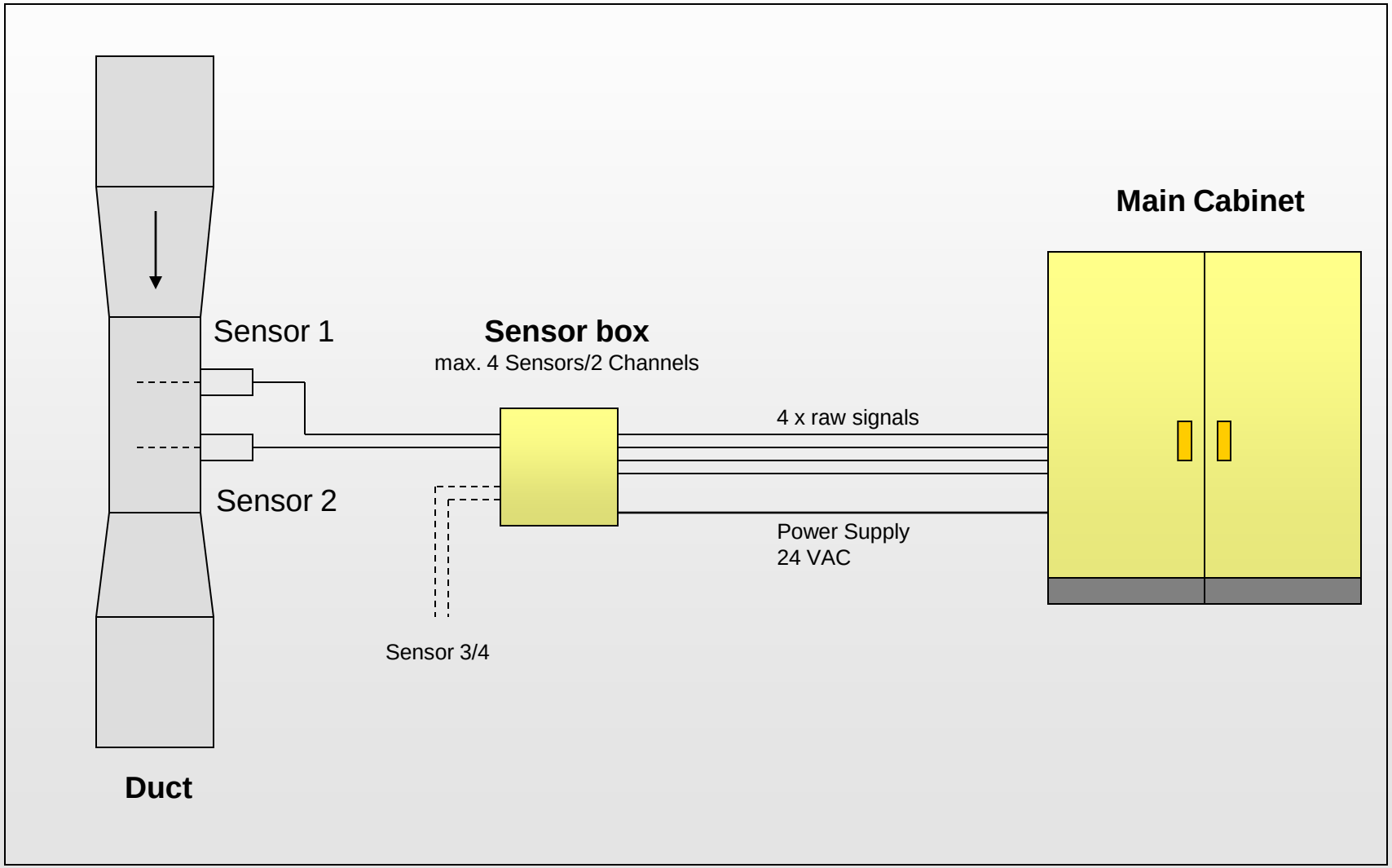
# MECONTROL Air/FG
# Measurement Principle

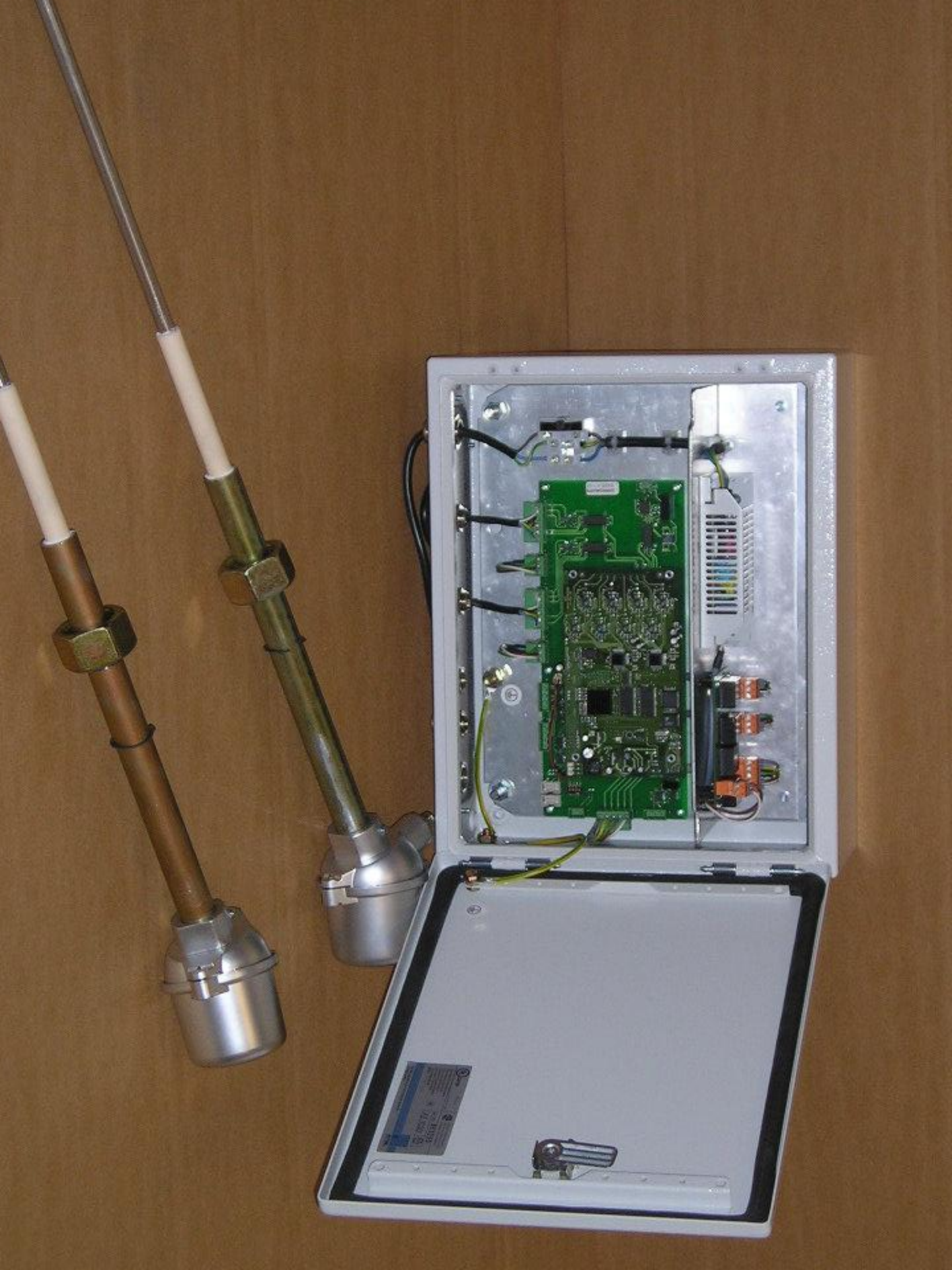


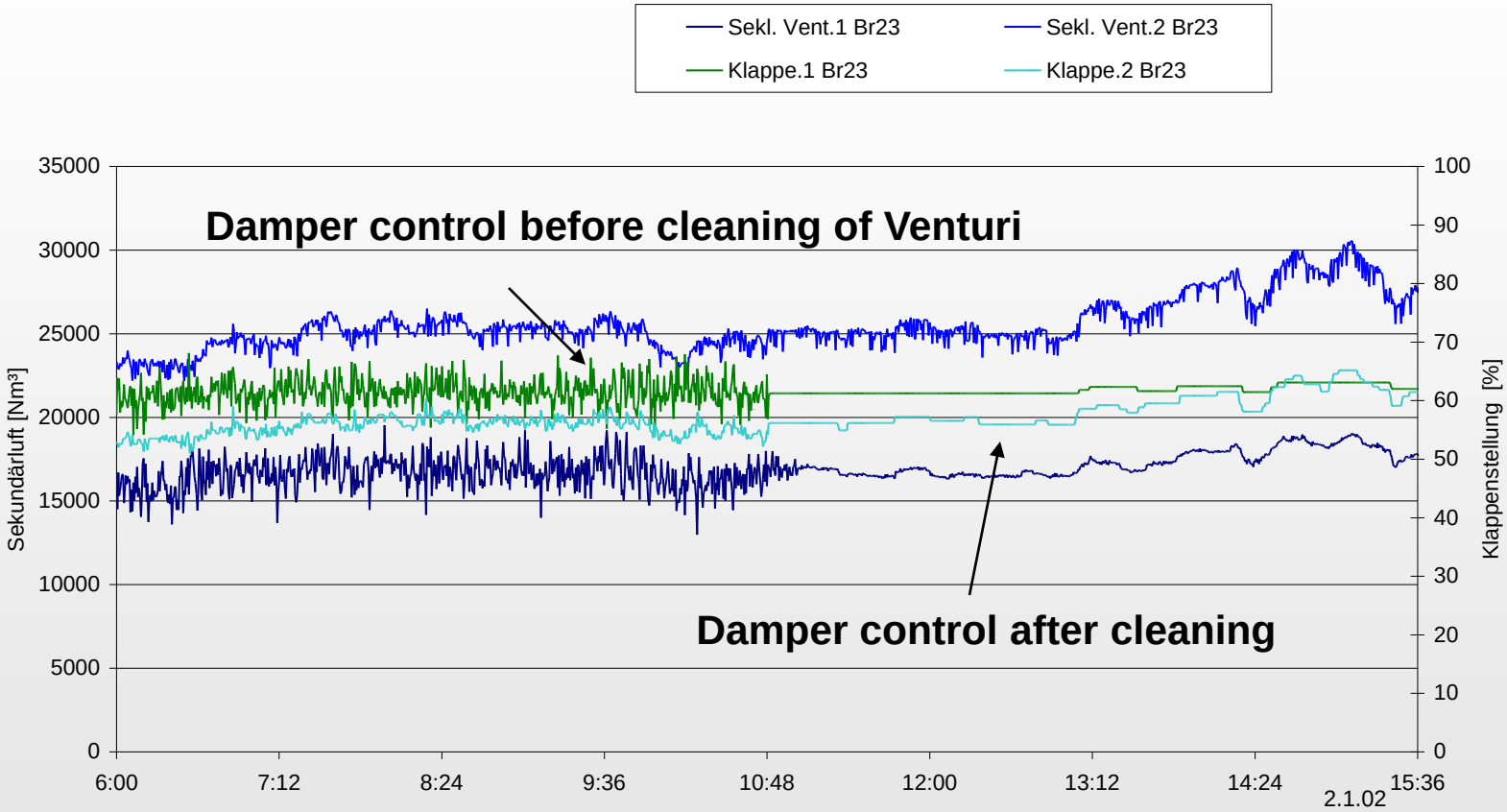

**Example**
S = 2 ft
T = 25 ms → V = 80.0 ft/s (average velocity)

# MECONTROL Air/FG Overview





# How do these problems affect the damper control?




A venturi measurement is highly non-repeatable when exposed to dust contamination in secondary air ducts. This leads to a wrong stoicheometry as well as to increased wear of the damper actuators. The problem does not become appearant on the venturi values themselves or the O2 values at the boiler outlet, but mainly on the dynamic behaviour of the dampers themselves.

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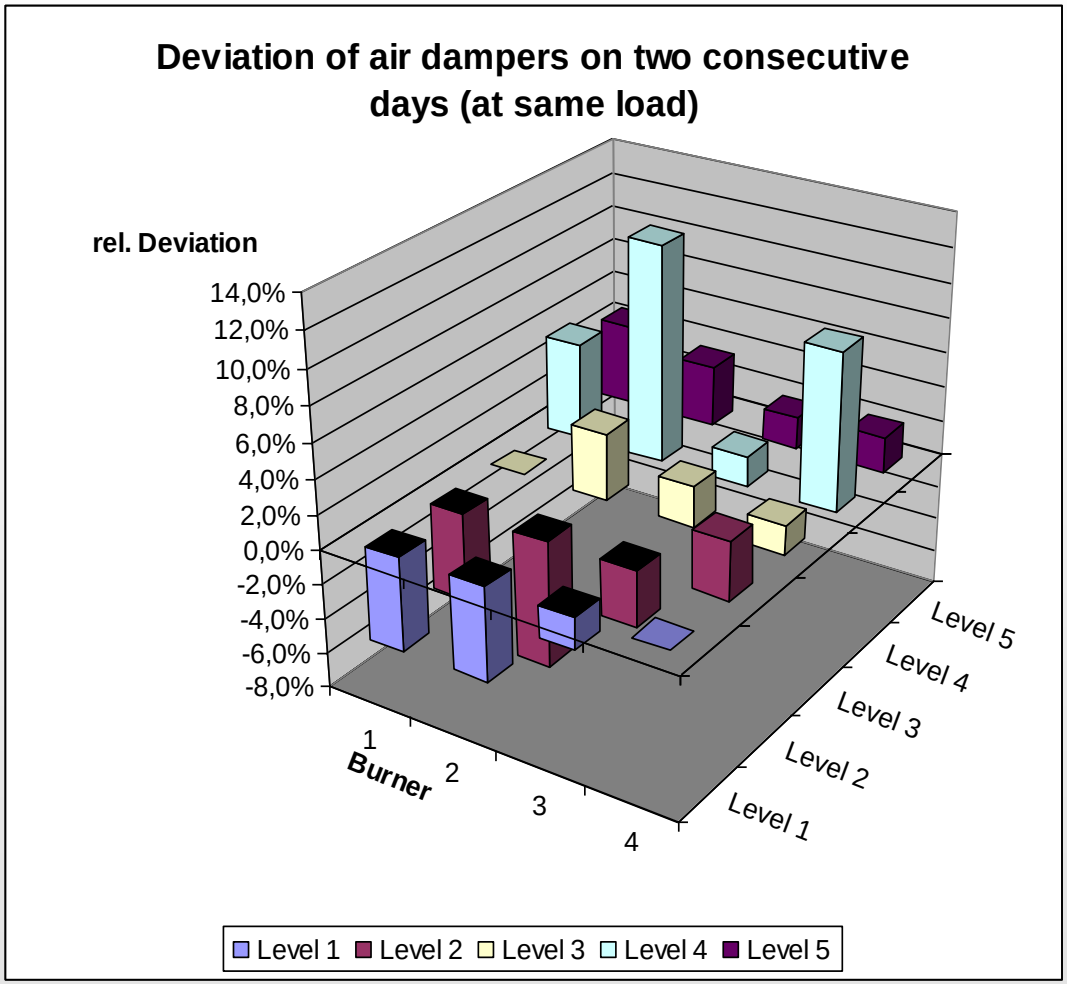
# Case Study: wall-fired boiler

Despite constant O2 values, combustion conditions vary from day to day!




Venturi measurements indicated the same air flow on both days.

However damper position showed large variations. This result is not plausible as the air ducts come off the same main duct which showed the same static pressure on both days.

# Contact Information

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