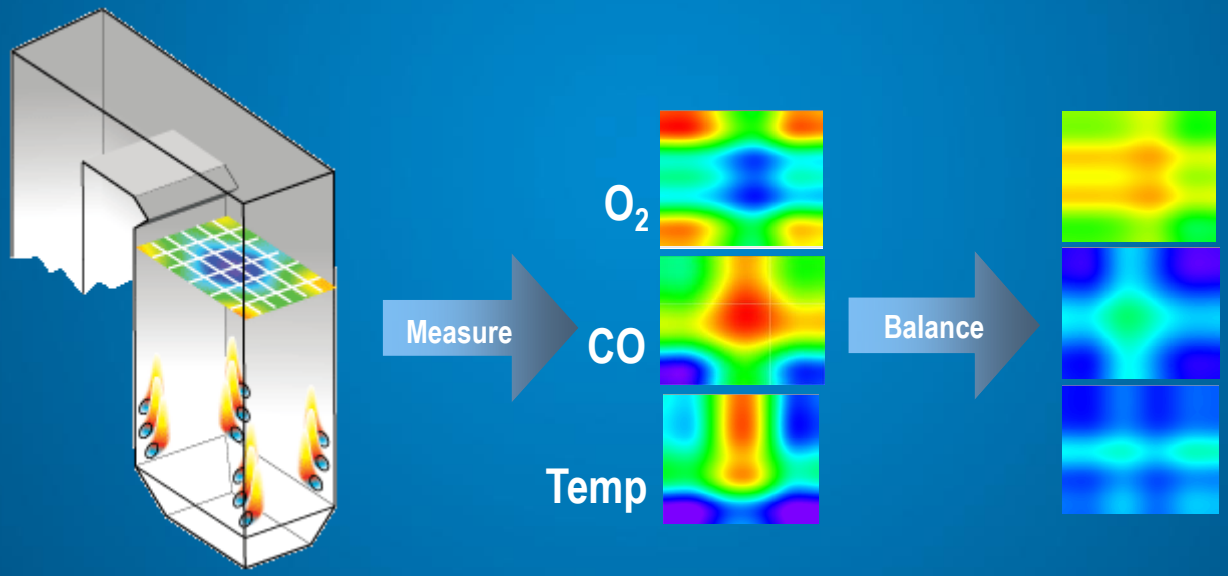
ZoloBOSS:
Laser-based Sensor for Real-time Combustion Optimization

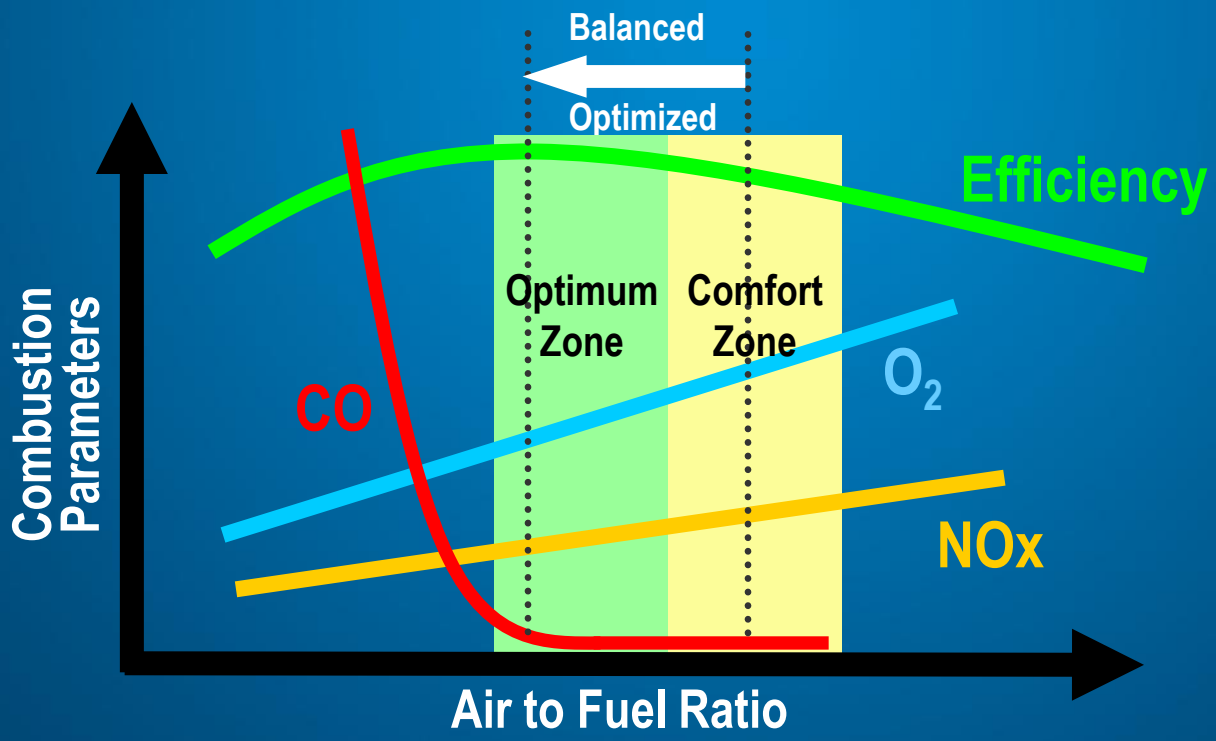


Better Measurements, Better Results

ZOLO TECHNOLOGIES

Balanced Combustion ➔ Optimized Combustion

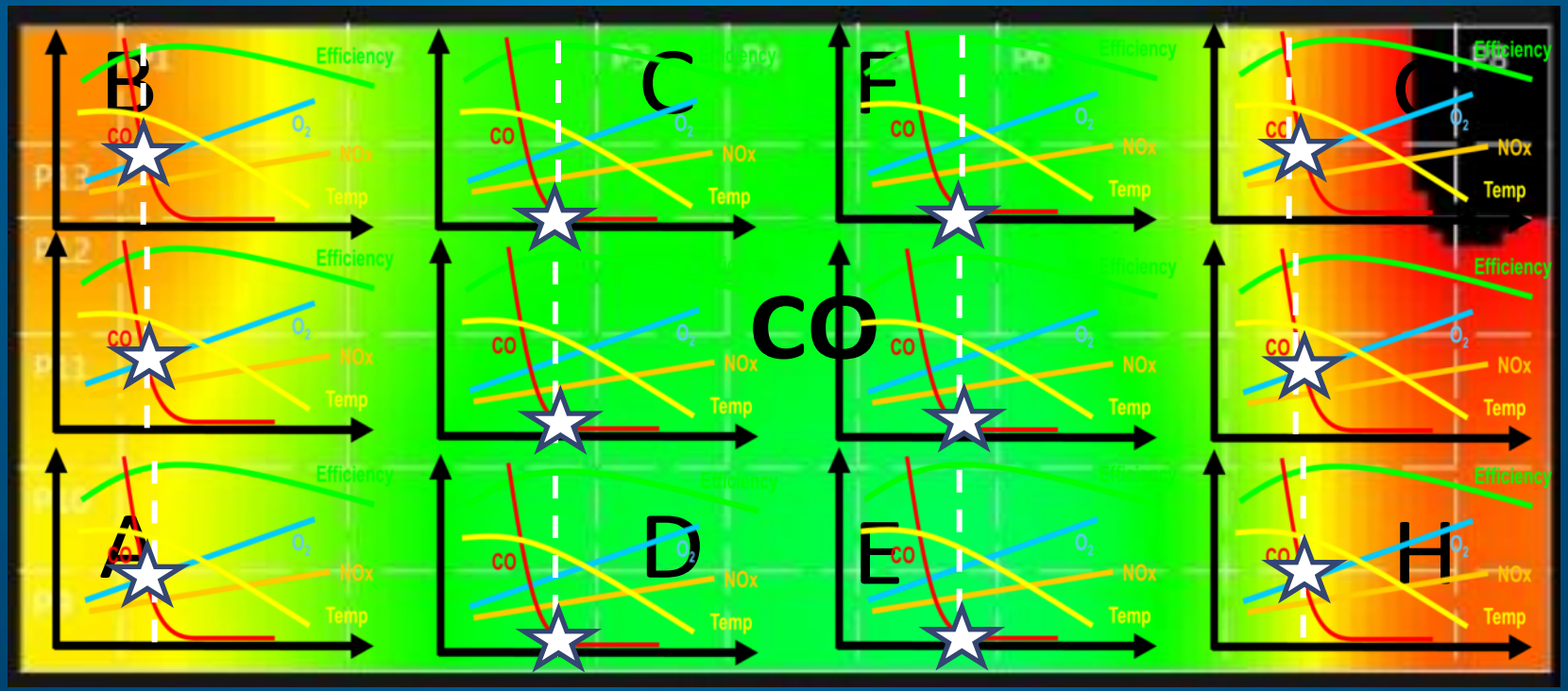
- Balanced combustion (Temp, O_2 & CO) is better combustion
- Balanced combustion permits safe operation at lower excess O_2
- Lower excess O_2 ➔ increases efficiency (heat rate)
- Lower excess O_2 ➔ lowers NOx rates
- Subject to constraints on CO and slagging



ZOLO TECHNOLOGIES

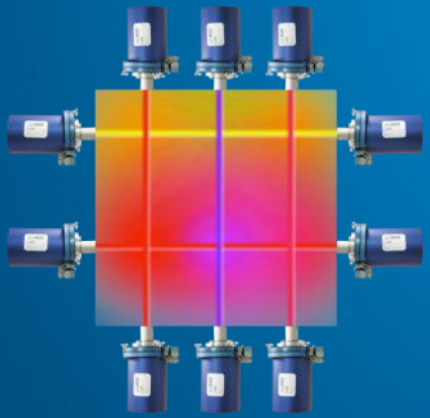
Balancing: The Problem is Local

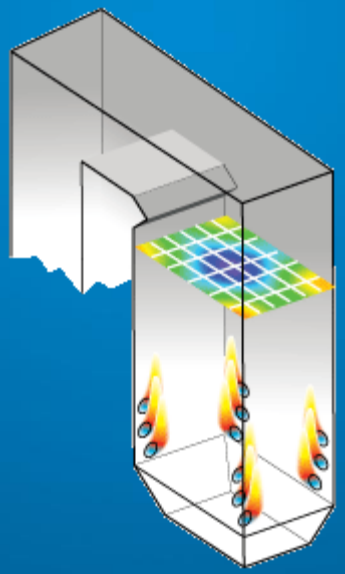
- Natural process variations will lead to local imbalances in furnace
  - "The right amount of ingredients don't equal a good cake"
  - Proper air/fuel at burner is important but may not mean optimized combustion
- 80/20 rule:
  - 80% of emission/slag, 20% of furnace
  - CO Increases exponentially, Slag/fouling hot spots, NOx with high O2
- Problem gets worse as excess O_2 is reduced



The Solution: The Zolo*BOSS* System

- Uses laser light absorption to measure Temp, O_2, CO & H_2O
- Paths measure average concentration across furnace
- Real-time measurement directly in the furnace
- Multiple paths generate two-dimensional images or profiles
- Output used to balance and optimize combustion





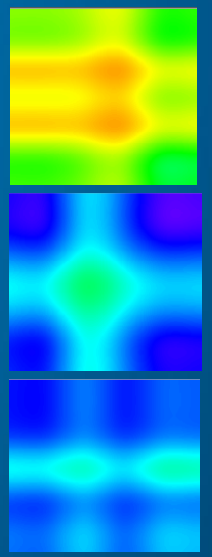
Balanced Combustion

Optimized Combustion

O_2

CO

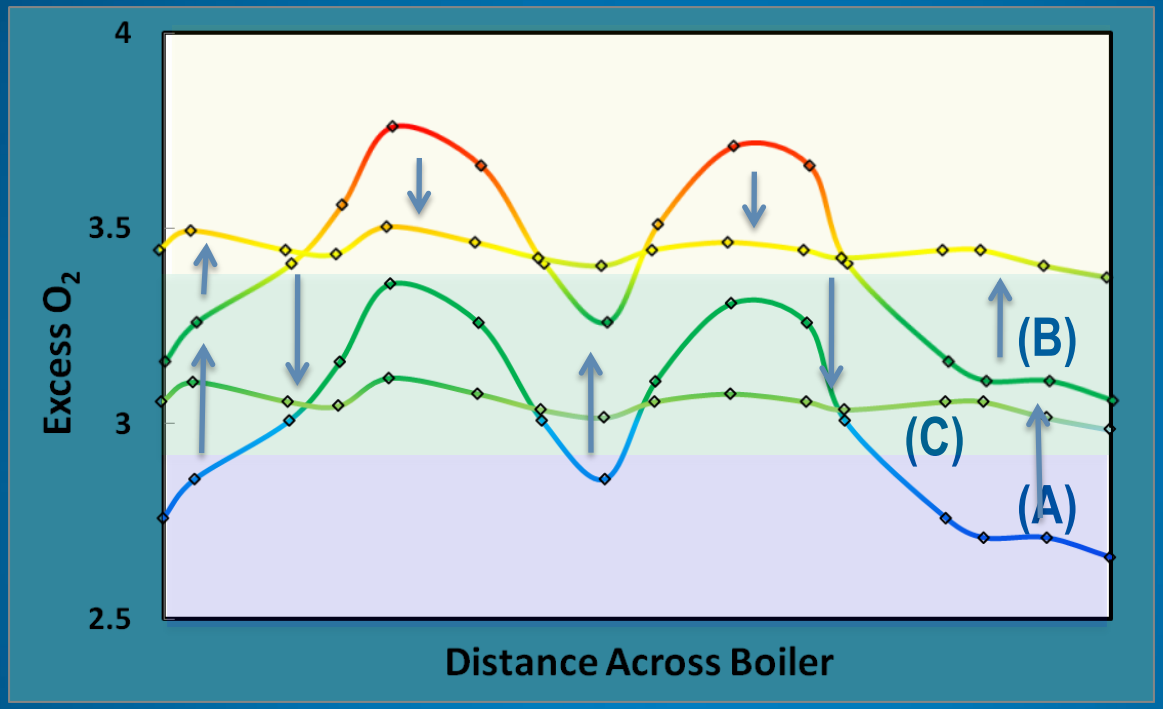
Temp



Better Measurement, Better Results

ZOLO TECHNOLOGIES

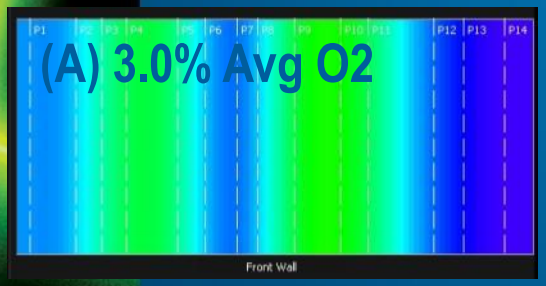
Balancing: Optimization Concept



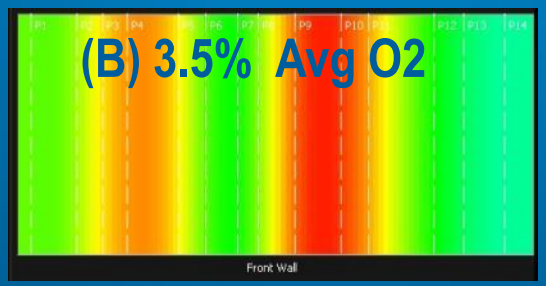
Comfort Zone

Optimal

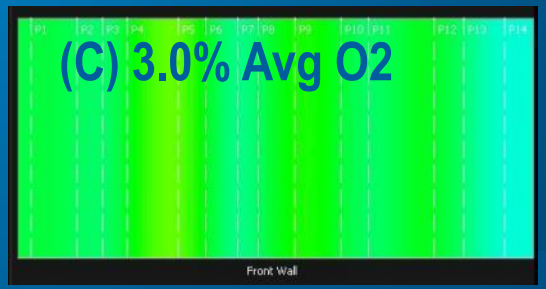
Slag Potential



Pro : Efficiency, NOx
Con : Slag, CO

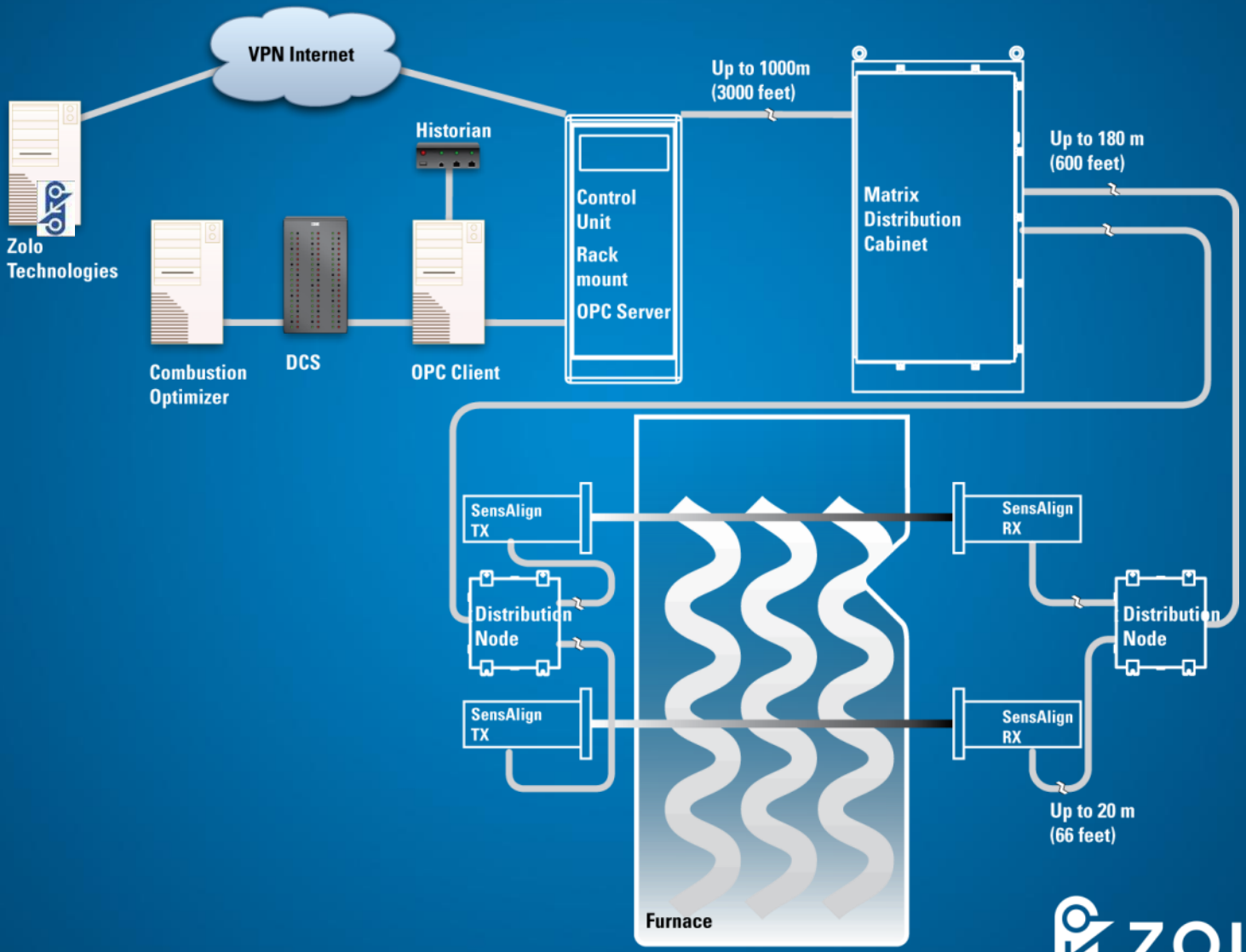


Pro: Slag, CO
Con: Efficiency, NOx



Pro: Efficiency, Slag, NOx, CO
Con : Effort to Balance

Typical Zolo*BOSS* Layout



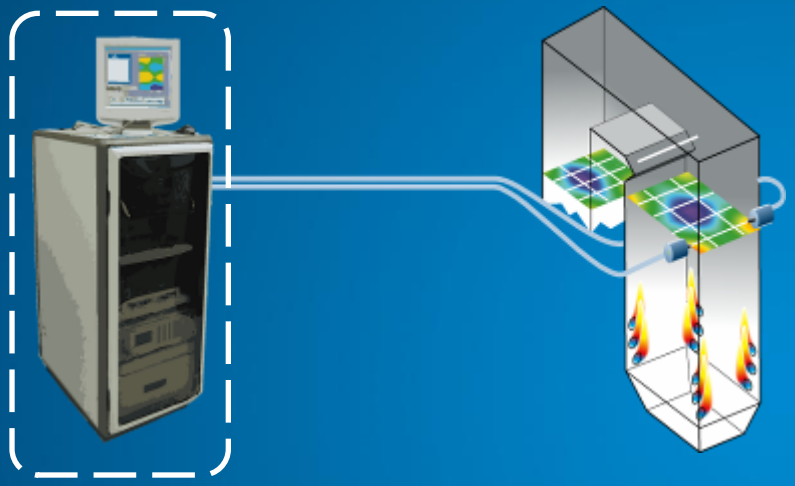
ZOLO TECHNOLOGIES

Key Features of Zolo*BOSS*

- Real-time, in-situ measurements:
  - Temperature, H_20, CO and O_2
  - Path average measurement for each path
- Spatial profiles and furnace balancing information
- Designed for Ultra-harsh Environments
  - Non-intrusive (nothing installed within furnace, nothing to plug)
  - Fiber coupled – key electronics are located in protected area
  - Auto-alignment keeps lasers aligned
  - Port rodder system to keep openings clear of slag
  - No cooling of heads required
- No field calibration required
- Low maintenance:
  - Periodic window cleaning is required
  - Work can be performed while boiler is operating

ZOLO TECHNOLOGIES

Typical Zolo*BOSS* Layout



- 15 path modular system
- Configuration based on Plant needs
- Plant supplies:
  - Membrane wall penetrations
    - Short outage & low cost
  - Conduits for fiber & ethernet
  - 120V Power @ <3KW
  - Instrument air @ ~90psig (6.2 bar)

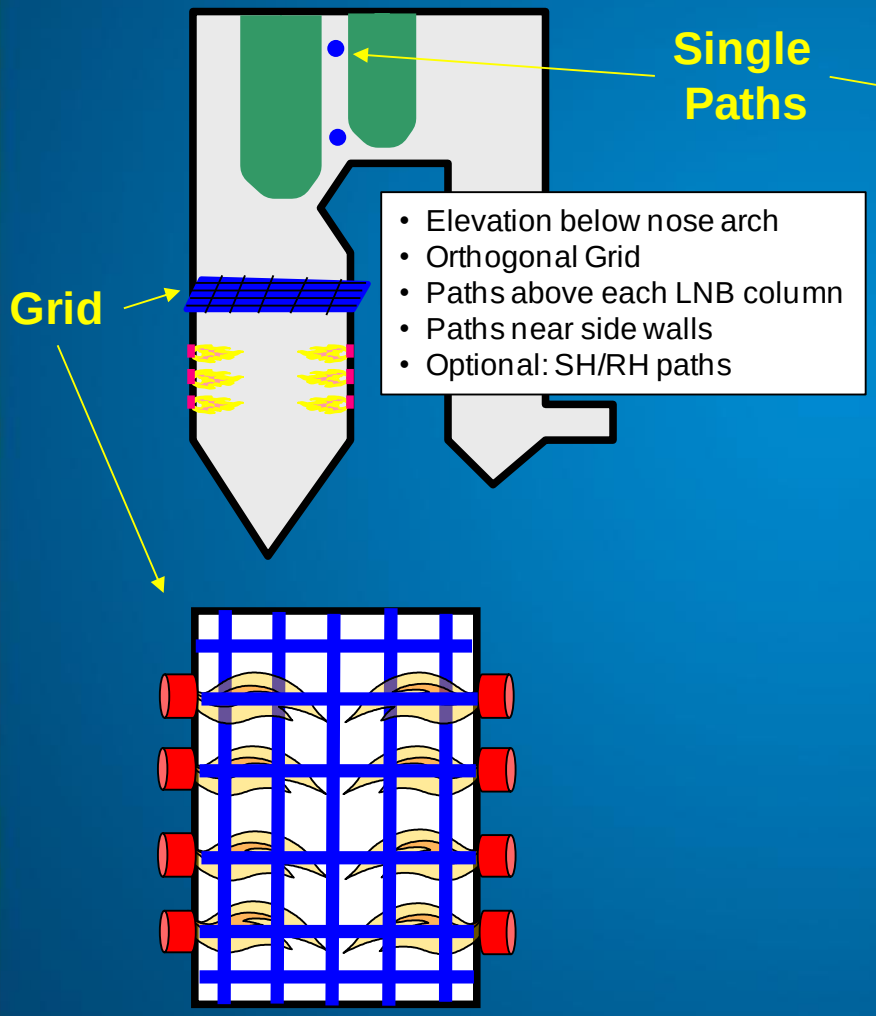
Slotted Opening in Membrane

Port Rodder

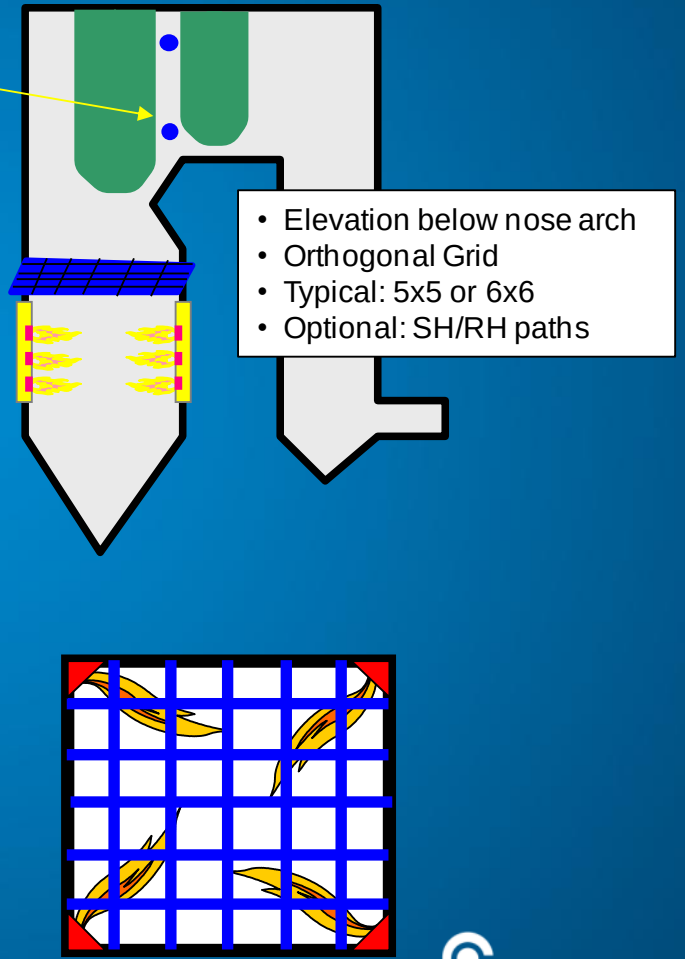
SensAlign™ Head

Typical Zolo*BOSS* Layouts

Wall-fired



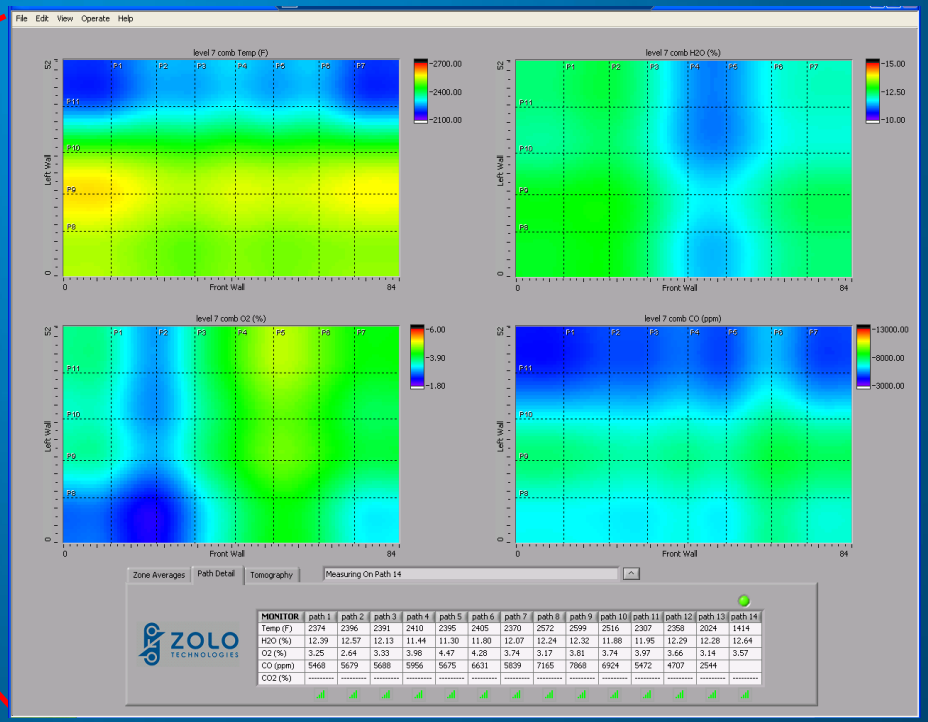
T-fired



ZOLO TECHNOLOGIES

The Zolo*BOSS* Interface

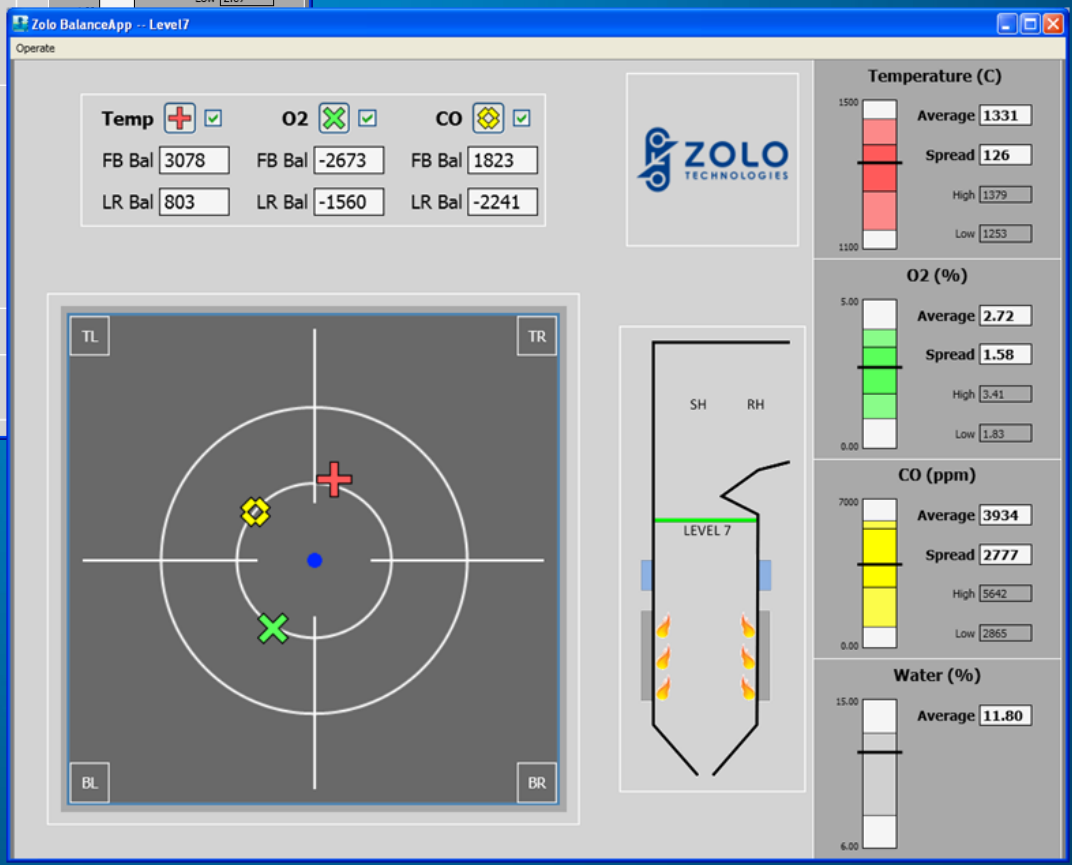
- Zolo*BOSS* data transmitted to historian via OPC or Modbus
- Interfaces available to operators & engineers
  - Tomography for each elevation and constituent
  - Trending data available for specific paths and constituents
  - BalanceApp targeted for operators
- Can integrate with Control System and/or Combustion Optimizer



Operator BalanceApp Interface

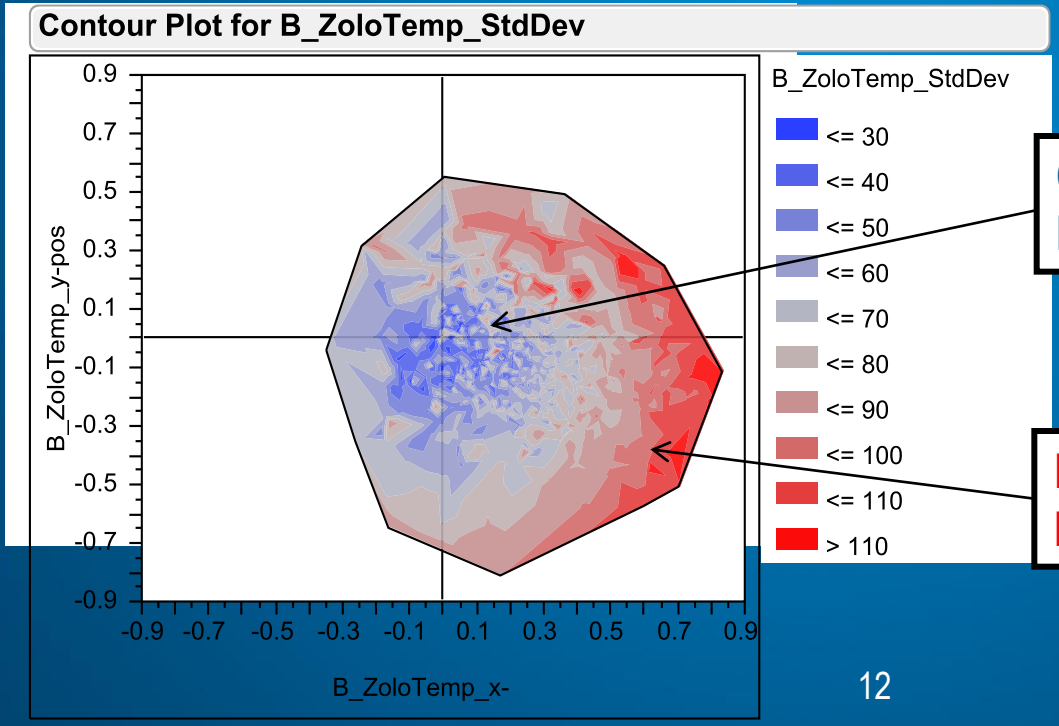
Wall-Fired

T-Fired



Center Combustion: Why?

- Centered Combustion = Balanced combustion
- Goal = Centered Combustion (fireball)
  - Fireball center is a compass to direct combustion manipulations

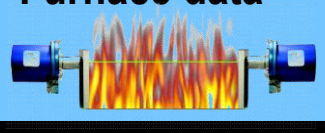


Closer to center
Lower StDev, More balanced

Further away from center
Higher StDev, Less balanced

Summary: Combustion Optimization

Measure
- Plant data
- Furnace data



• Develop Relationships

Correlate
- Parametric Tests
- Model-based
- Rules-based
- Neural-net based

• Manual Balancing
• Operator control
• Combustion Optimizer

Results:
•Improve Heat Rate
•Lower Emissions: NOx & CO_2
•Minimize Slag
•Increase Fuel Flexibility

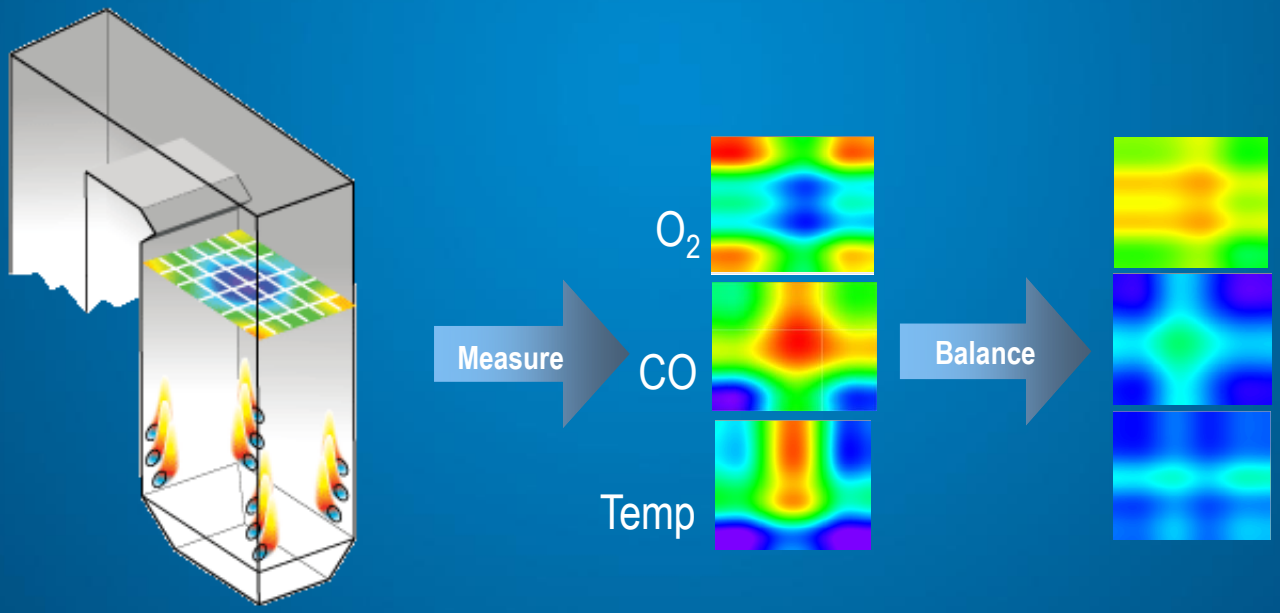
Center/Balance
- Balance/Center Temperature
- Balance O_2
- Balance CO

• Operator control
• Combustion Optimizer

Optimize
- Manipulate Air/Fuel bias
- Reduce Excess O_2

Questions?

- Please visit our website at www.zolotech.com
- Thank you for your time and your interest!



Better Measurements, Better Results

Sensor Comparison

	Zolo*BOSS*	Extractive Sensors
Measurement Location	• Direct in-furnace measurements (<3000F) • Better correlation with combustion settings • Combustion not complete; measurements more sensitive to small operational changes • Measures in-situ – no impact of air leakage	• Back-pass: (<1500F) • Subject to additional mixing and dilution • Combustion complete; not sensitive to small changes in operational settings • Impacted by air-in leakage in penthouse
Constituents	• Simultaneous Temp, H_2O, O_2 & CO	• O_2/CO only • Optional temperature but not useful
Path Average versus Point Measurement	• Measures larger portion of furnace cross-section along entire path of laser • Captures impact of local "pockets" of T/CO/O_2	• Data collected at specific "points" only • No localized areas of CO/O_2 in between "points" • Large number of "points" not economic
Slag Control	• Maintain FEGT below ash fusion temps • Monitor Temp/CO/O_2 in SH/RH • Integrate FEGT into intelligent soot blowing	• No temperature info in furnace
Water wall Corrosion	• Paths located near side walls can monitor for corrosive environments: low O_2 + high CO.	• No relevant data to monitor for corrosion
Impact on NOx reduction	• Identify local areas of high O_2 & temperature	• Not useful for localized NOx
Maintenance	• Nothing installed inside harsh furnace • Maintenance during boiler operation • No calibration required	• Extraction grid installed inside convective pass • Maintenance requires unit shut down • Prone to failure at high (1500F) temps • Aspirator nozzles frequently plug • Regular calibration required for good accuracy