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# Online Coal Analyzers in the US Utility Industry

Richard Woodward  
Thermo Fisher Scientific

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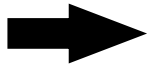
EPRI Webcast  
7 October 2008

# Presentation Outline

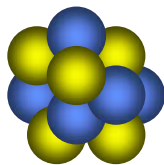
- PGNAA principle of operation
- Background
- Common utility applications
- PGNAA Analyzers
  - Two different models
  - Choosing between them
- Getting the most value from the analyzer
  - Software packages

# Prompt Gamma Neutron Activation Analysis (PGNAA)

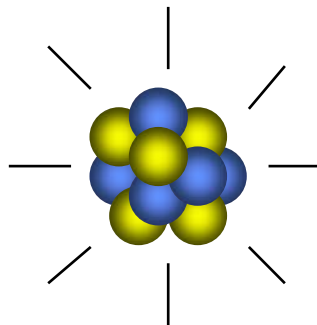
Thermal  
Neutron



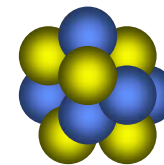
Nucleus



Excited  
Nucleus



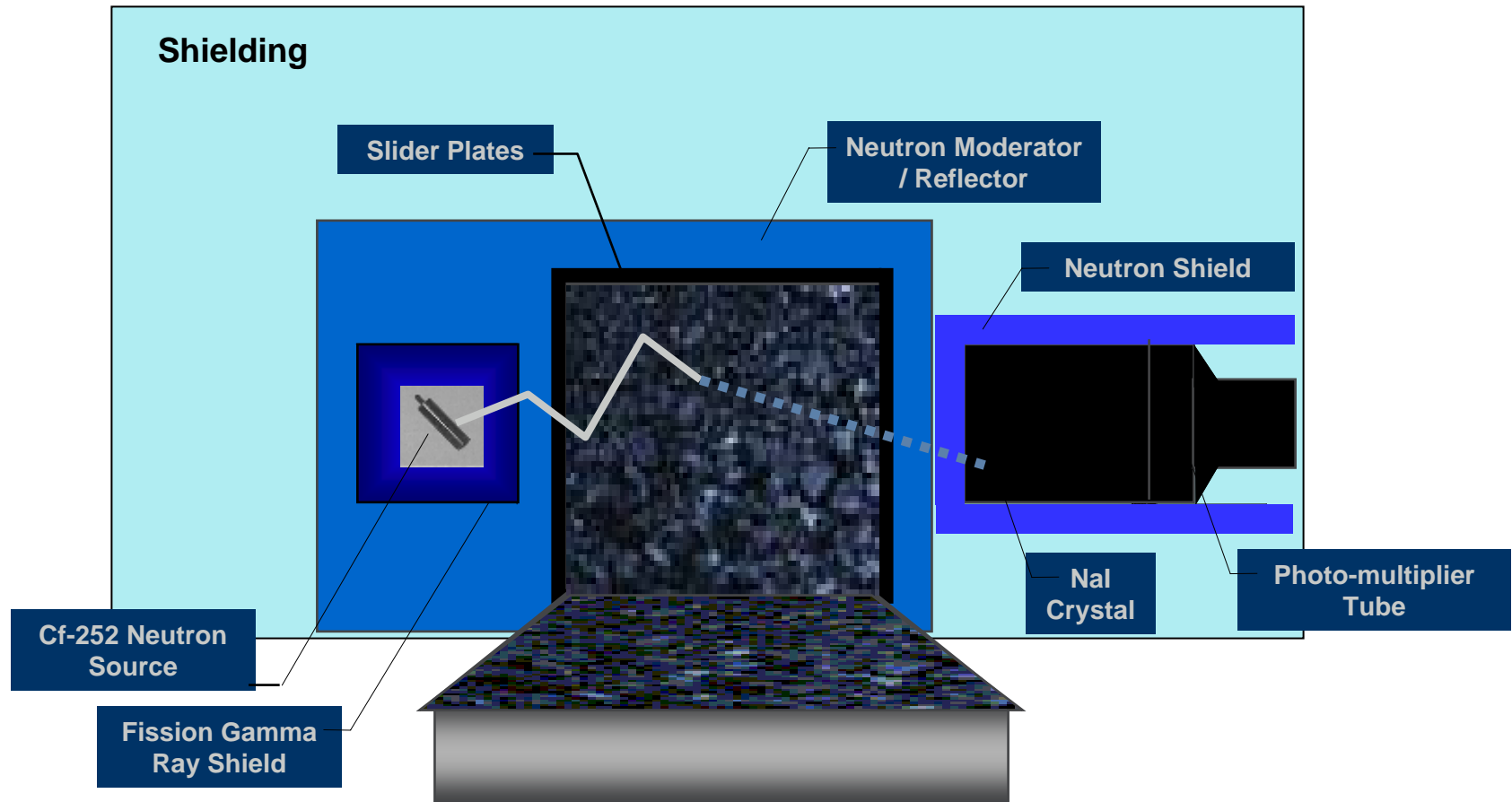
Stable  
Nucleus



Gamma  
Ray



# Principle of Operation: Thermo Scientific CQM



# Advantages of (PGNAA) Prompt Gamma Neutron Activation Analysis

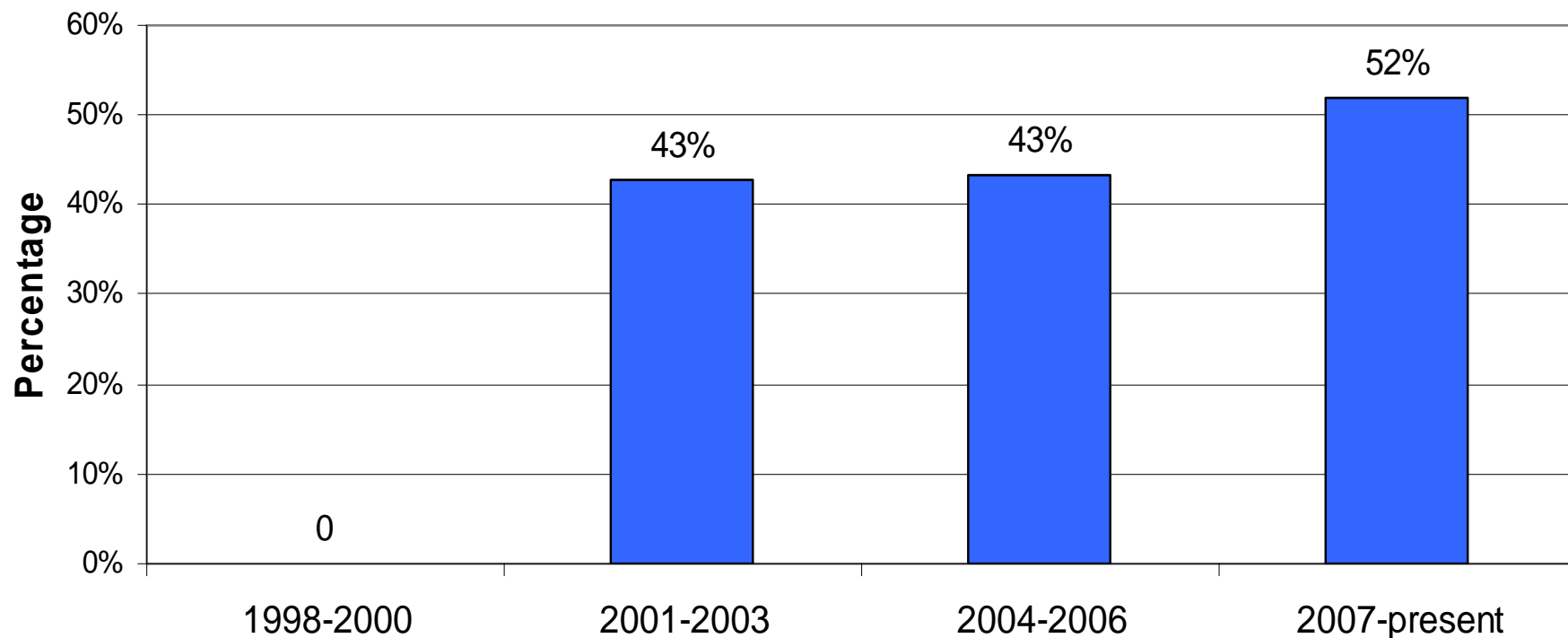
- Lowest cost of neutrons
- Lowest radiation while in operation
- Most uniform sensitivity to entire coal cross-section, leading to superior accuracy
- When coal source is known, has best algorithm for calorific value determination
- Best reliability—no chance of failure of ionization source
- Most mature online analysis technology
  - Thermo Fisher alone has sold more than 600 analyzers in the past 25 years
  - Large installed base permits service staff location close to customer

# Background on elemental coal analyzers

- Online elemental coal analyzers have been in use for 25 years
  - EPRI was an early sponsor
- Analyzers measure
  - sulfur
  - ash
  - moisture
  - caloric value
  - all major ash constituents
- Analyzer use in power plant applications growing

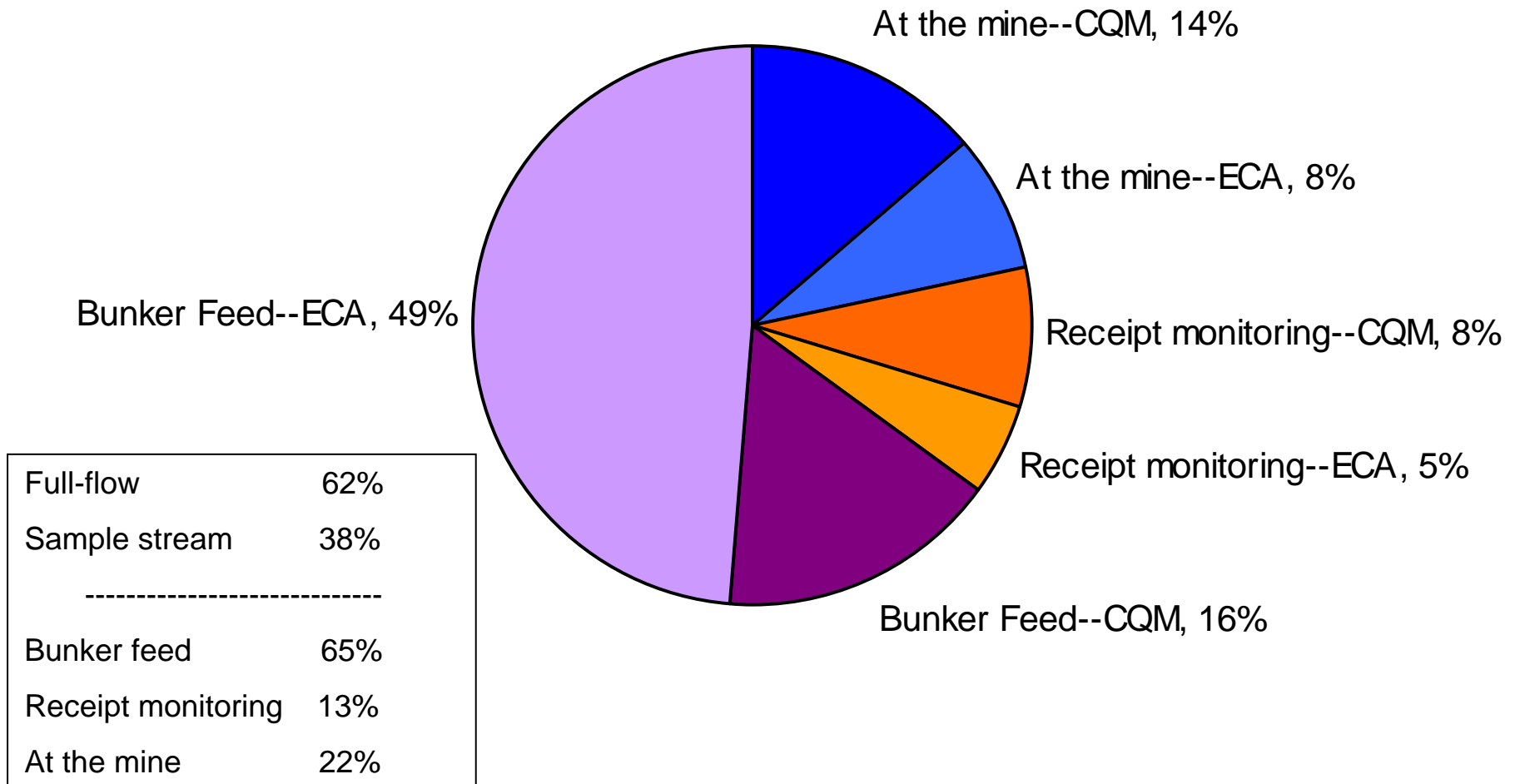
# Utilities are becoming a more significant part of the analyzer user population

## % of Thermo Scientific Coal Analyzers Sales going to Utilities



# Most utility analyzers are belt analyzers and are found on bunker feed

## Mix of Thermo Scientific Coal Analyzers sold to Utilities since 2000





# Bunker Feed Application

- Accounts for 65% of all Thermo Scientific utility installations since 2000
- Process goals include
  - Boiler optimization
  - Emissions compliance
  - Ensuring proper sorting between scrubbed and unscrubbed units
- When there are parallel bunker feed conveyors the solution can be
  - Two full-flow analyzers
  - One sample-stream analyzer, fed by two primary samplers



# Receipt monitoring application



Luoyang Longyu power plant in China

- Use an auger sampler to sample each incoming truck
  - Sample increment sent through sample stream analyzer to determine if truck is on spec
  - Plant saved \$375K in six months

Constellation Energy's C. P. Crane plant in Maryland

- Installed full-flow analyzer
  - Monitors all incoming rail shipments as conveyed to yard stockpile
  - Operator Console located in coal yard office



# Two Types of PGNAA Elemental Analyzers

## ■ Sample stream

- Typically flow rates of 2-10 tph
- Primary save stream or secondary rejects
- Most accurate analyzer in industry
- Constant analysis geometry

## ■ Full flow

- Most effective on belt sizes between 30 and 60 inches
- Accuracy best when flow variations are minimal



Thermo Scientific (formerly Gamma-Metrics) CQM



Thermo Scientific ECA

# Choosing between sample stream analyzer (CQM) and full flow analyzer (ECA)

Any one of the following conditions could tip the scales in favor of a sample stream analyzer

- Stringent accuracy requirements
- Highly variable belt loading
  - Top sizes greater than 4 inches
- Conveyor belt conditions
  - Steel corded belts
  - Belt sizes of 72 inches and greater
- Installation conditions
  - Two parallel belt conveyors, which might be able to share—in a multiplexed manner—a single sample stream analyzer
  - Existing sampling system with which a sample stream analyzer can be easily integrated

# Choosing between sample stream analyzer (CQM) and full flow analyzer (ECA)

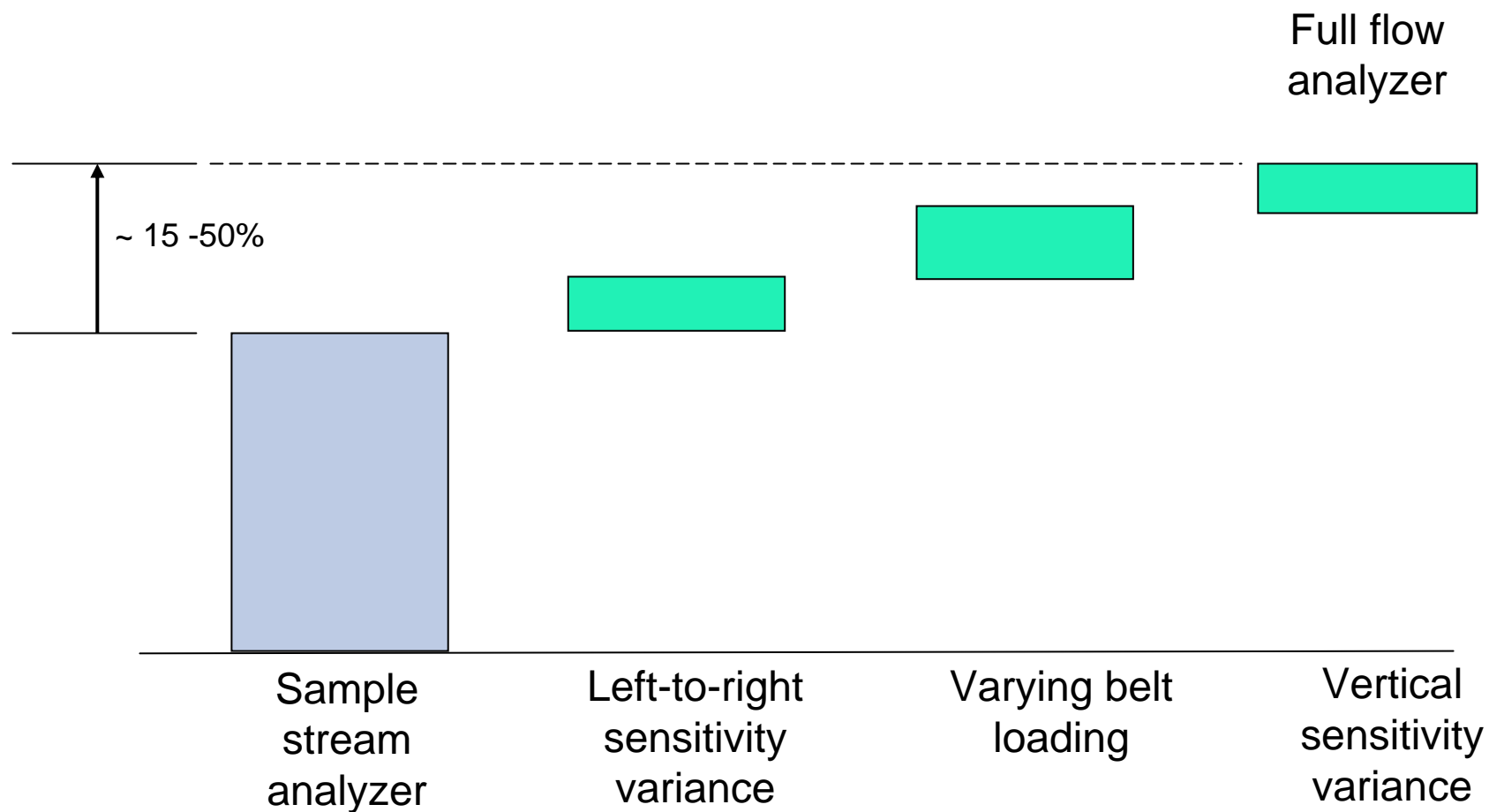
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If none of these are issues, a full flow analyzer should be sufficient

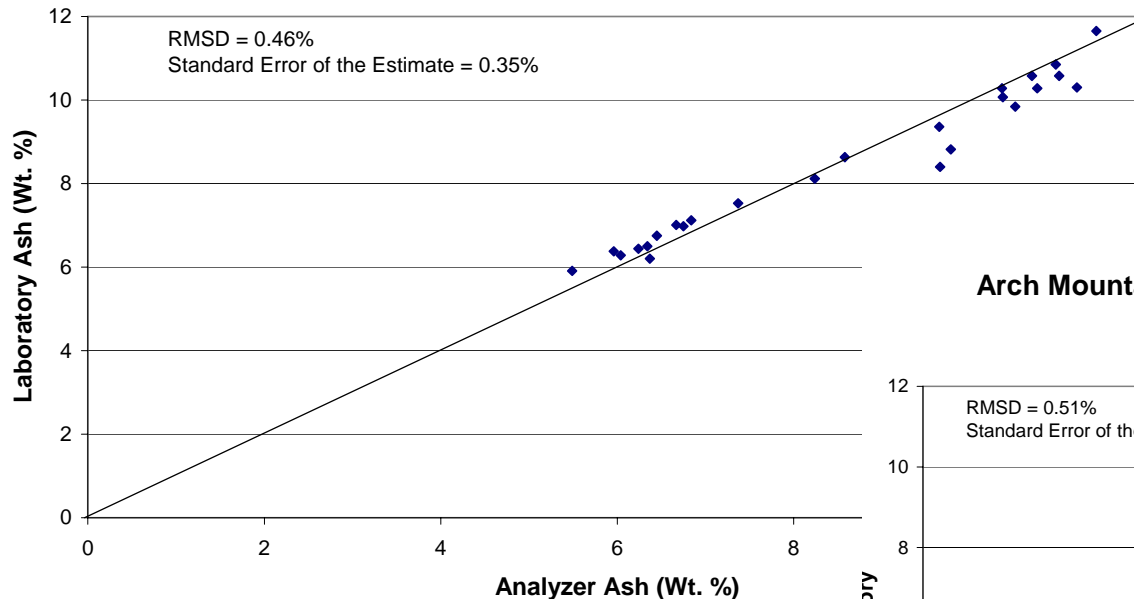


# Full Stream Analyzer Accuracy Compared with Sample Stream Analyzer Accuracy

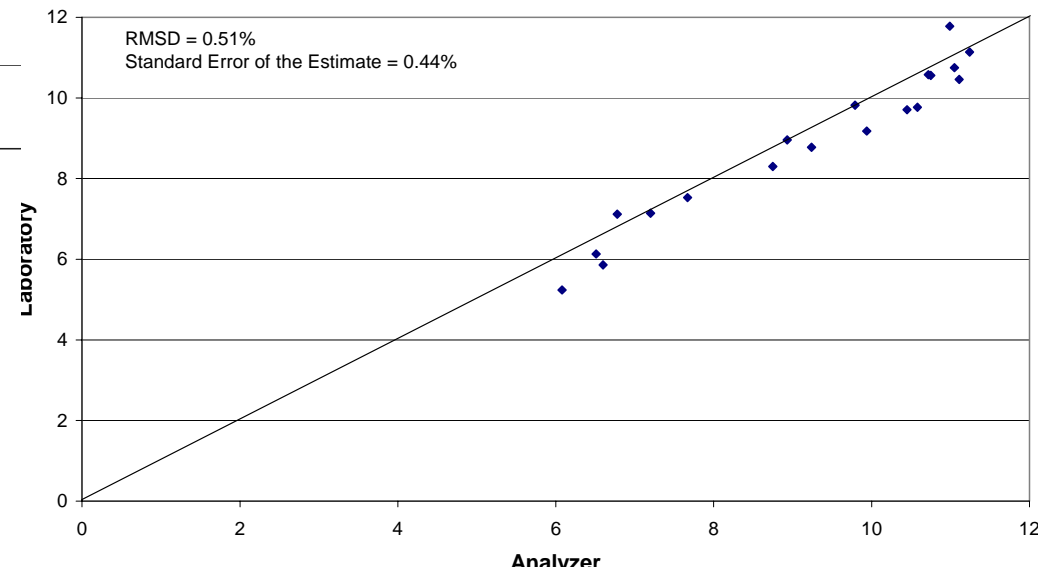


# Accuracy comparison: sample stream vs. full flow

Arch Mountain Laurel CQM: Lab vs. Analyzer Ash  
Comparison  
August 2007



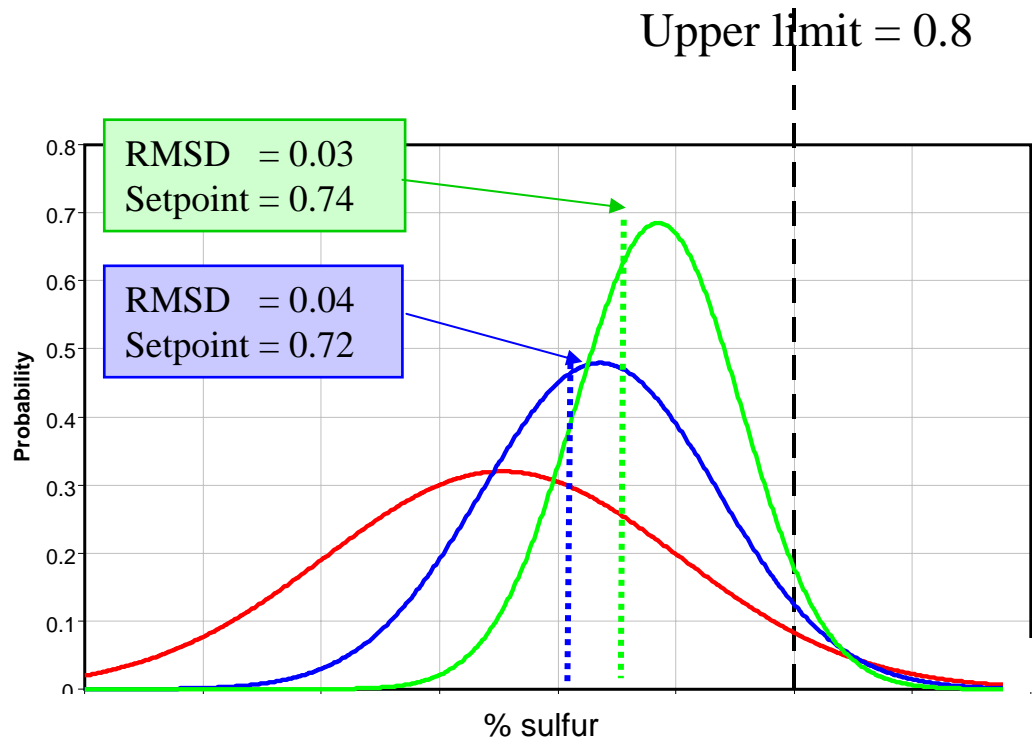
Arch Mountain Laurel ECA: Lab vs. Analyzer Comparison  
August 2007



**When flow is consistent and belt is fully loaded, the accuracy difference is slight; *in this example***

- *20% worse Standard Error of the Estimate*

# The critical importance of analyzer and reference system accuracy



Seemingly modest differences in accuracy can lead to huge profit differences

- Assume
  - 5 mtpy clean coal burned
  - \$10/ton cost differential
    - 0.6% sulfur
    - 1.8% sulfur
- **Annual savings associated with 0.03% RMSD rather than 0.04% = \$833,000**

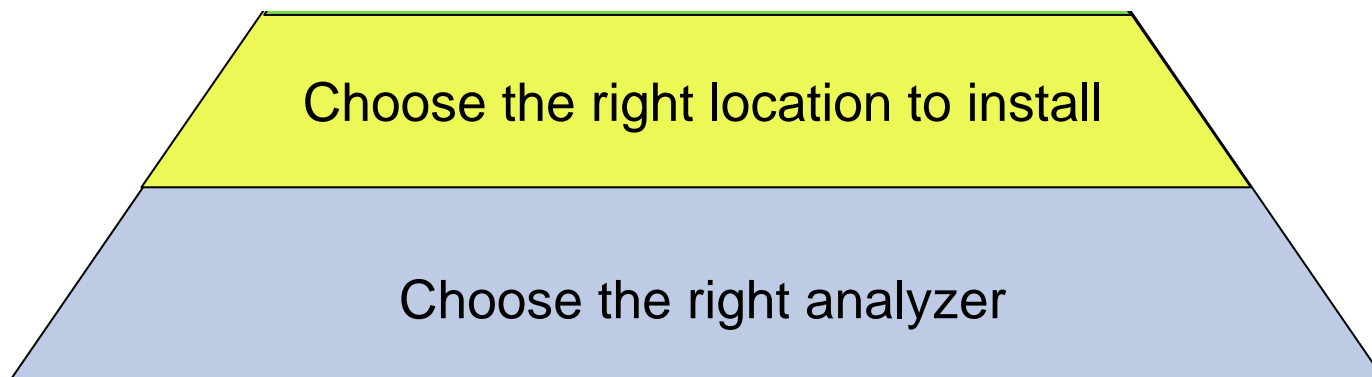


# The analyzer value pyramid

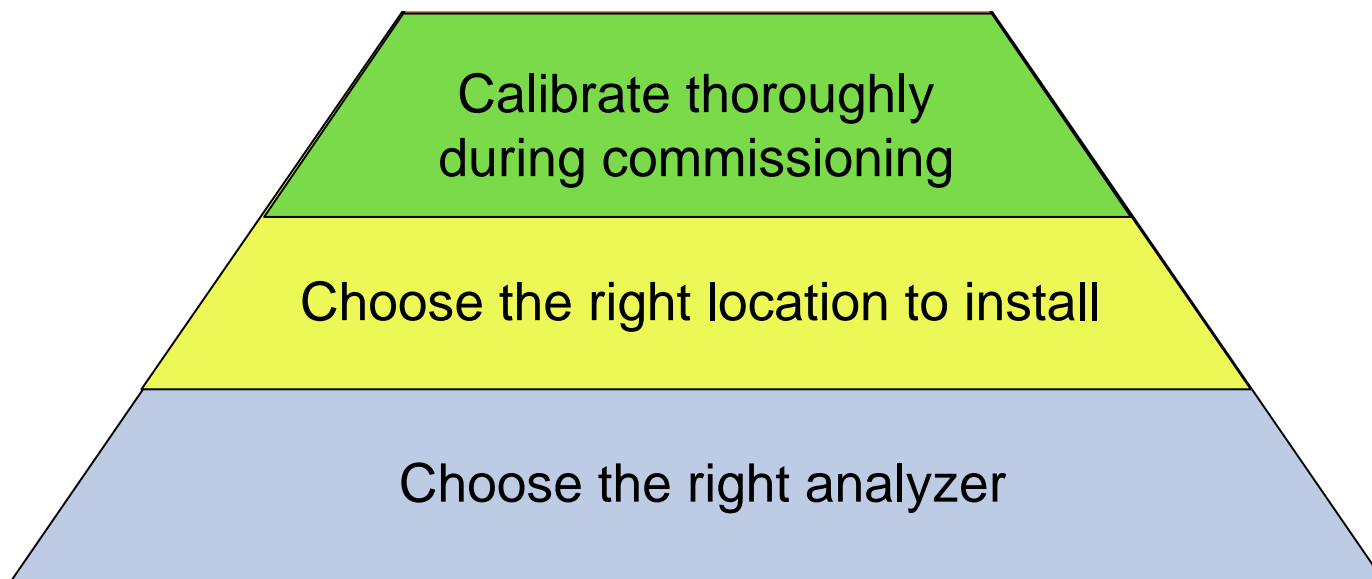


Choose the right analyzer

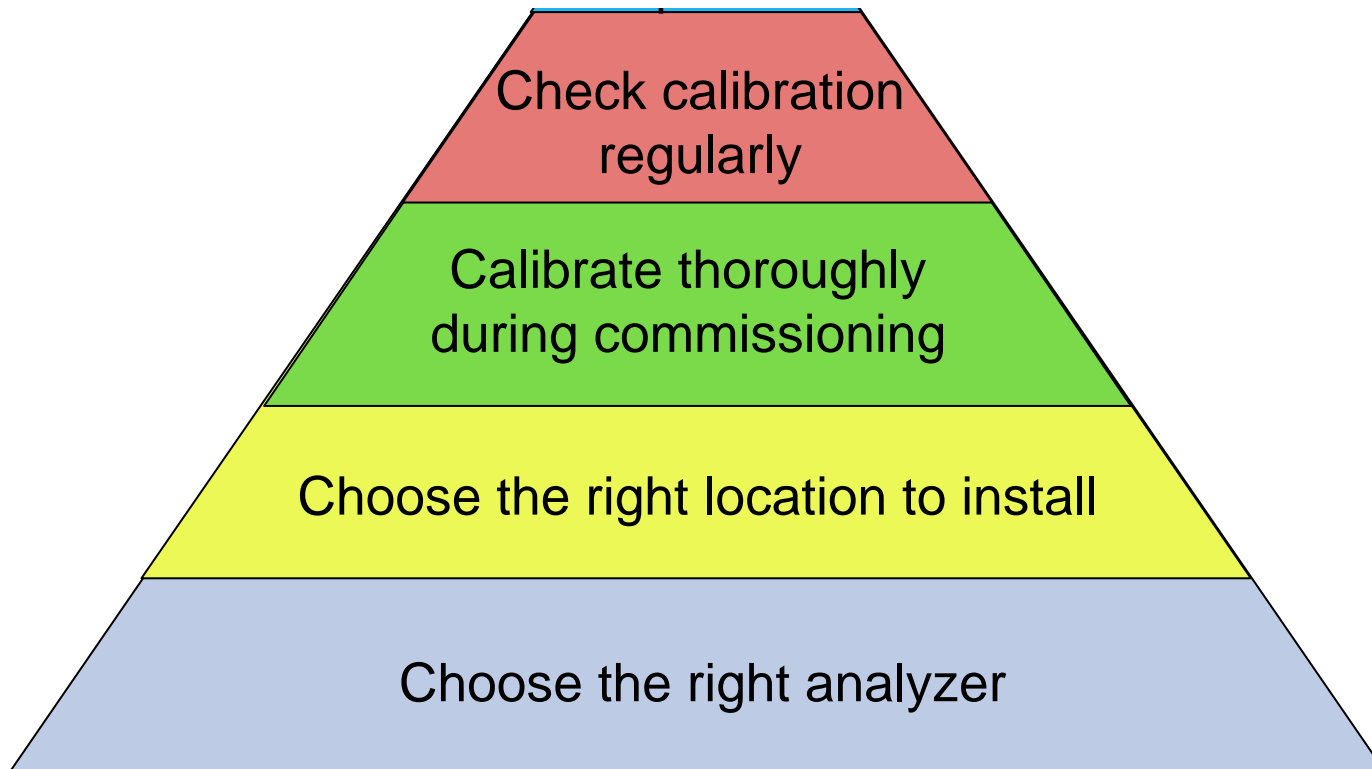
# The analyzer value pyramid



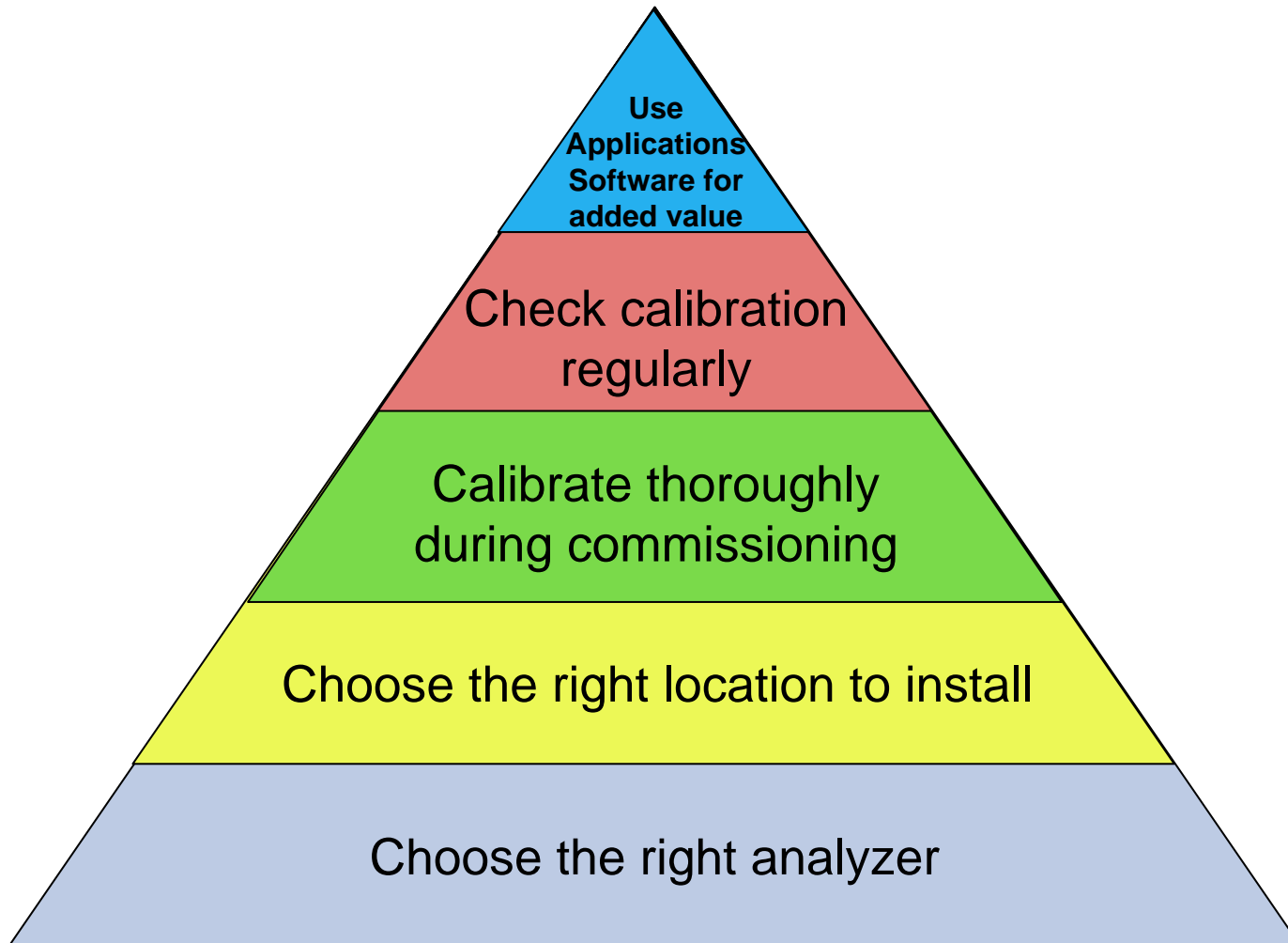
# The analyzer value pyramid



# The analyzer value pyramid



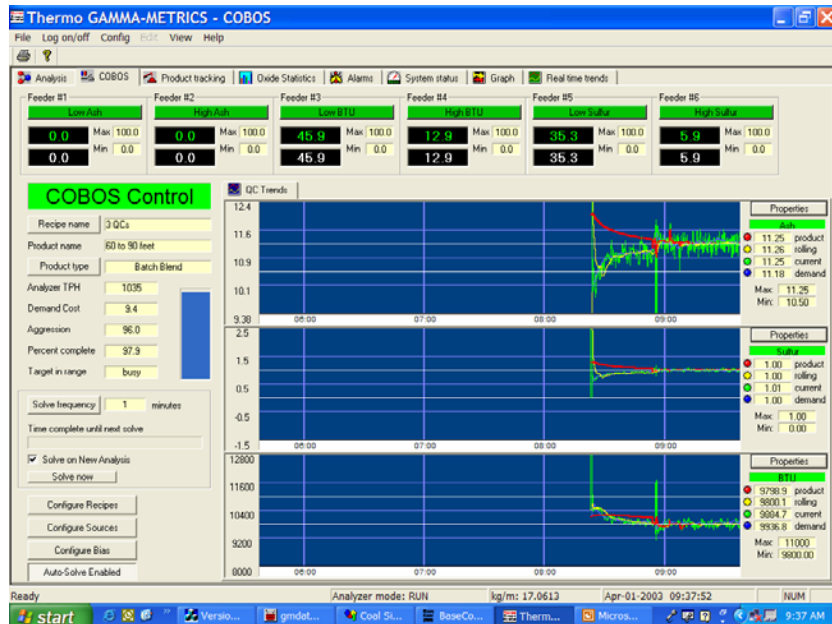
# The analyzer value pyramid



# Utility Applications Software

- COBOS Automated Blending from Thermo Scientific
- Coal yard Quality and Silo Tracking from the Engineering Consulting Group
- Boiler optimization and profit maximization from Black & Veatch

# COBOS from Thermo Fisher



- Up to six sources
- Up to three control parameters
- Cost minimization algorithm subject to achieving min's & max's on control variables
- Batch or continuous, with adjustable recovery rate from deviations
- Feeder constraints
- Adjusts for varying delays from feeders
- Auto adjustment in analyzer assumptions (e.g., MAF Btu) based upon feed proportions

# ECG's AccuTrack Objectives

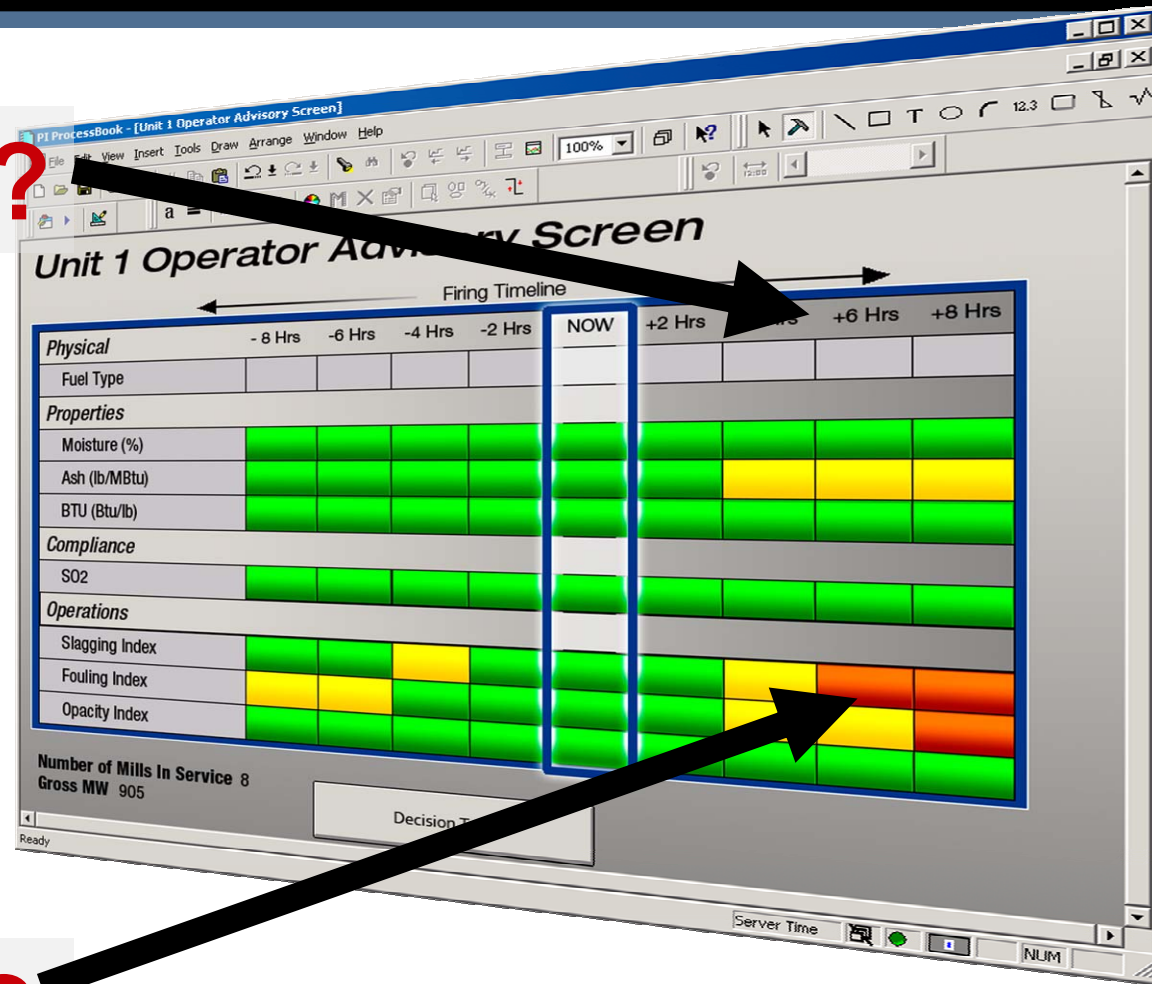
## ■ Fuel Tracking Objectives:

- Track incoming coal tons and fuel spec from Mine to Yard to Bunker to Burner
- Forecast Blending to meet Operational and Economic Objectives
- Track Chemistry to Avoid Boiler Upsets while Maintaining Consistent Emissions
- Provide Operators with Early Warning Advisory Information



# AccuTrack Operator Advisory Screen

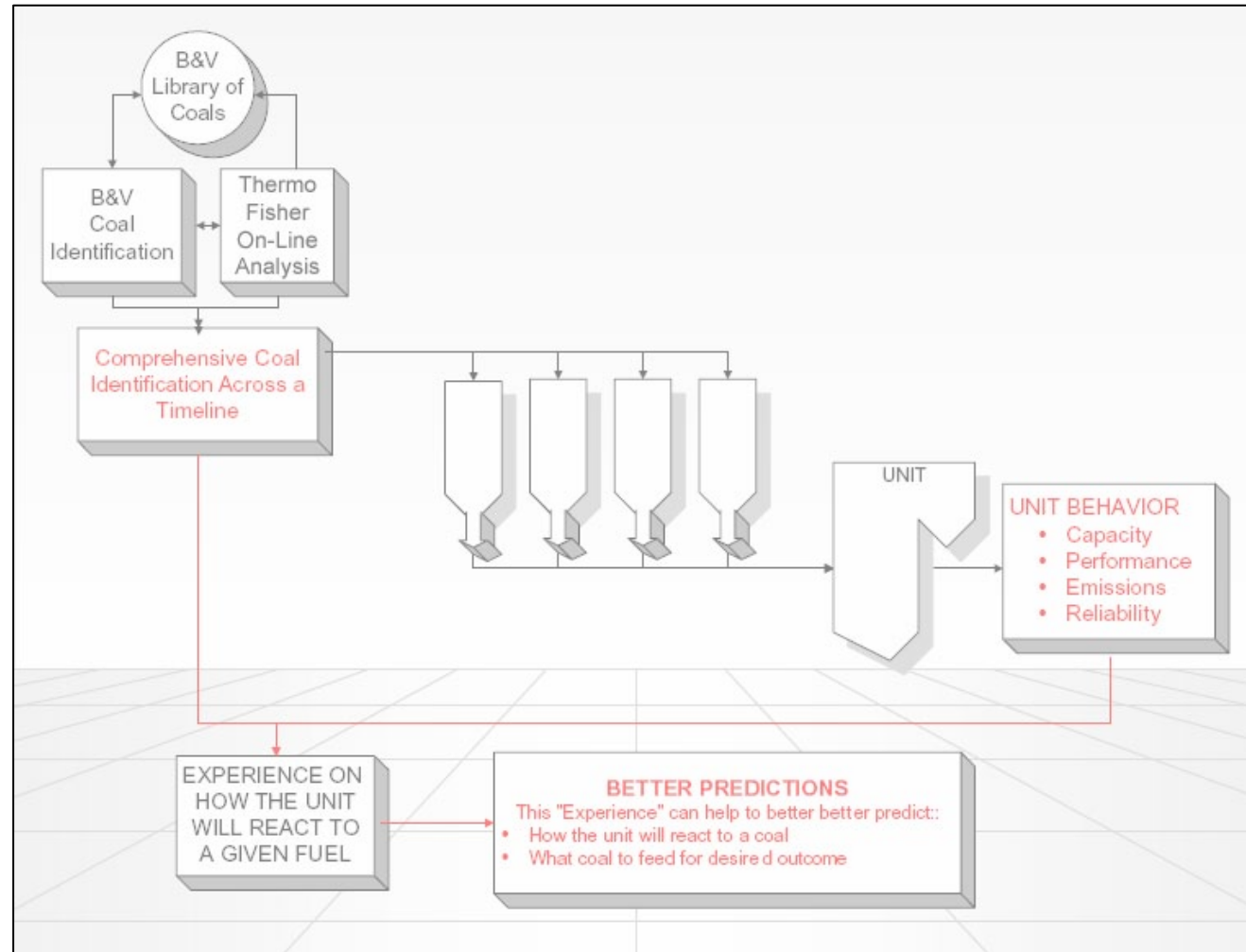
When?



What?

# Black & Veatch: Predicting Performance Based on Coal Quality

- Holistic view
- Takes market conditions into account
- Overall goal is profit maximization
- Model is dynamic, learning from actual effects of different coal qualities



# Questions and Comments