

# Development Status: Quantitative Aerosol Generator (QAG) for PM CEMS Calibration Improvements to Prototype Design

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**Sponsors: EPRI/CES**

# Problem

## PM CEMS Required on More Stacks

- Calibration is difficult & costly
- Calibration requires modification of plant PM emissions/operations to span analytical range of PM CEMS

# Solution

**Extend EPA-approved multi-metals QAG audit  
technology to PM CEMS calibration**

**Use QAG to calibrate PM CEMS at different PM  
concentrations traceable to NIST standards**

**Think: Cal gas equivalent**

**PM sensors: scattered light or beta attenuation**

# Key Points

- **Generates an aerosol of known concentration**
  - MM: high  $\text{pg/m}^3$  to  $\text{mg/m}^3$
  - PM:  $\mu\text{g/m}^3$  to  $\text{mg/m}^3$
- **Linear** over these ranges
- Used for **Independent** QA audit of MM CEMS
- May be useful for PM CEMS calibration & audits
- On and off in **seconds**
- Emission rate **measured** during each test
- Accurate, stable and repeatable
- Traceable to NIST Stds.

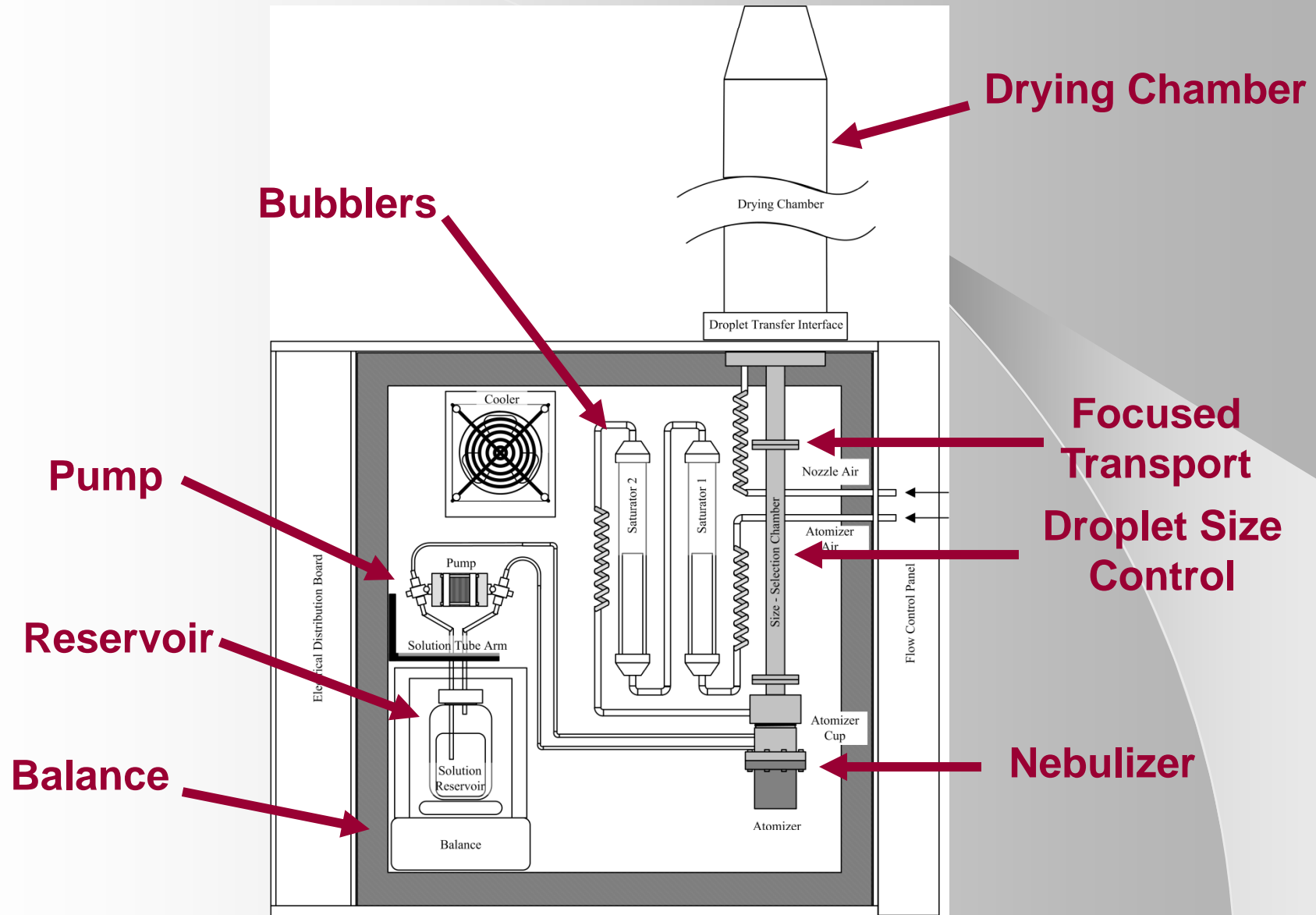
# Note Difference Between Aerosol

**Generation**

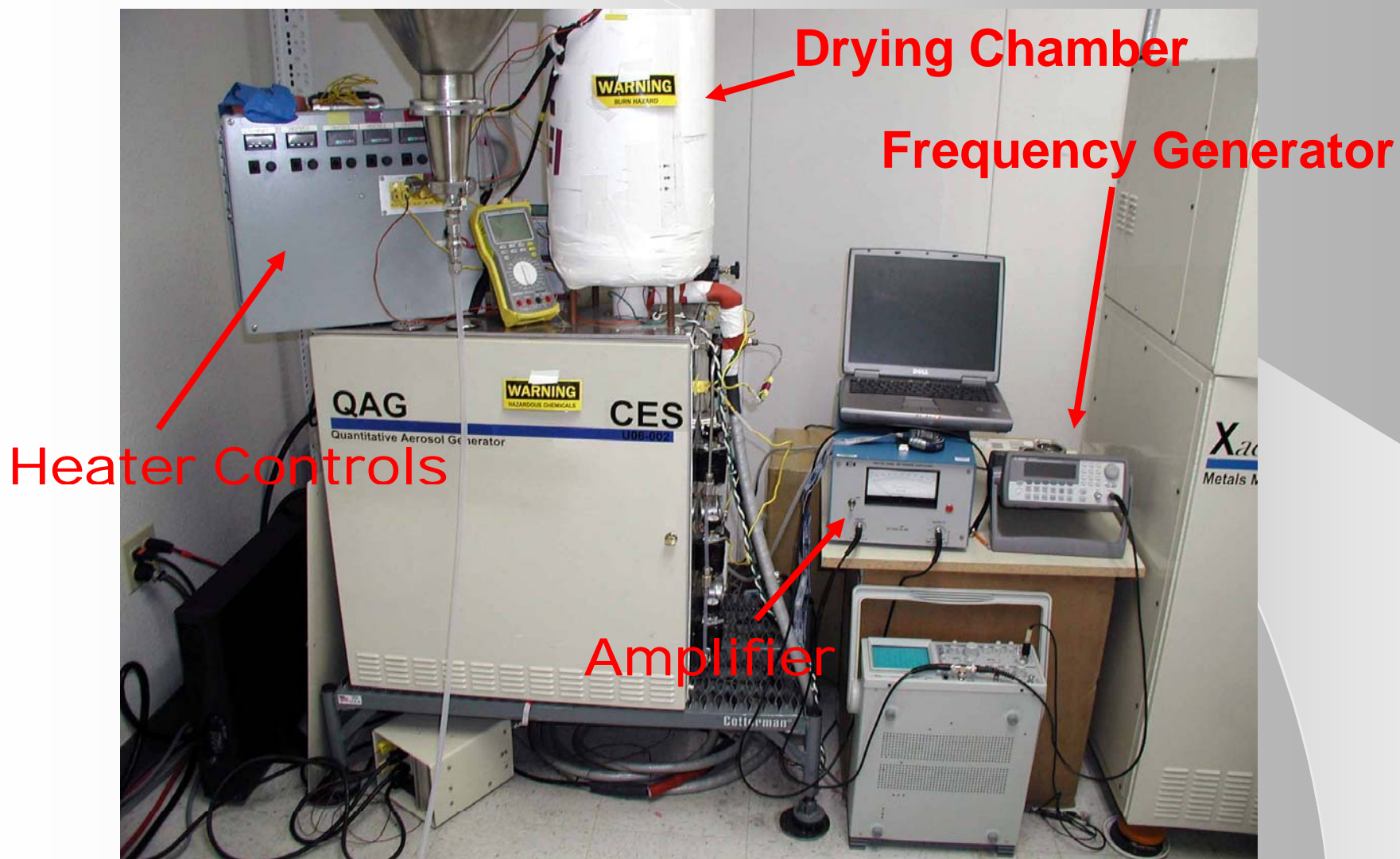
**Transport**

**Utility**

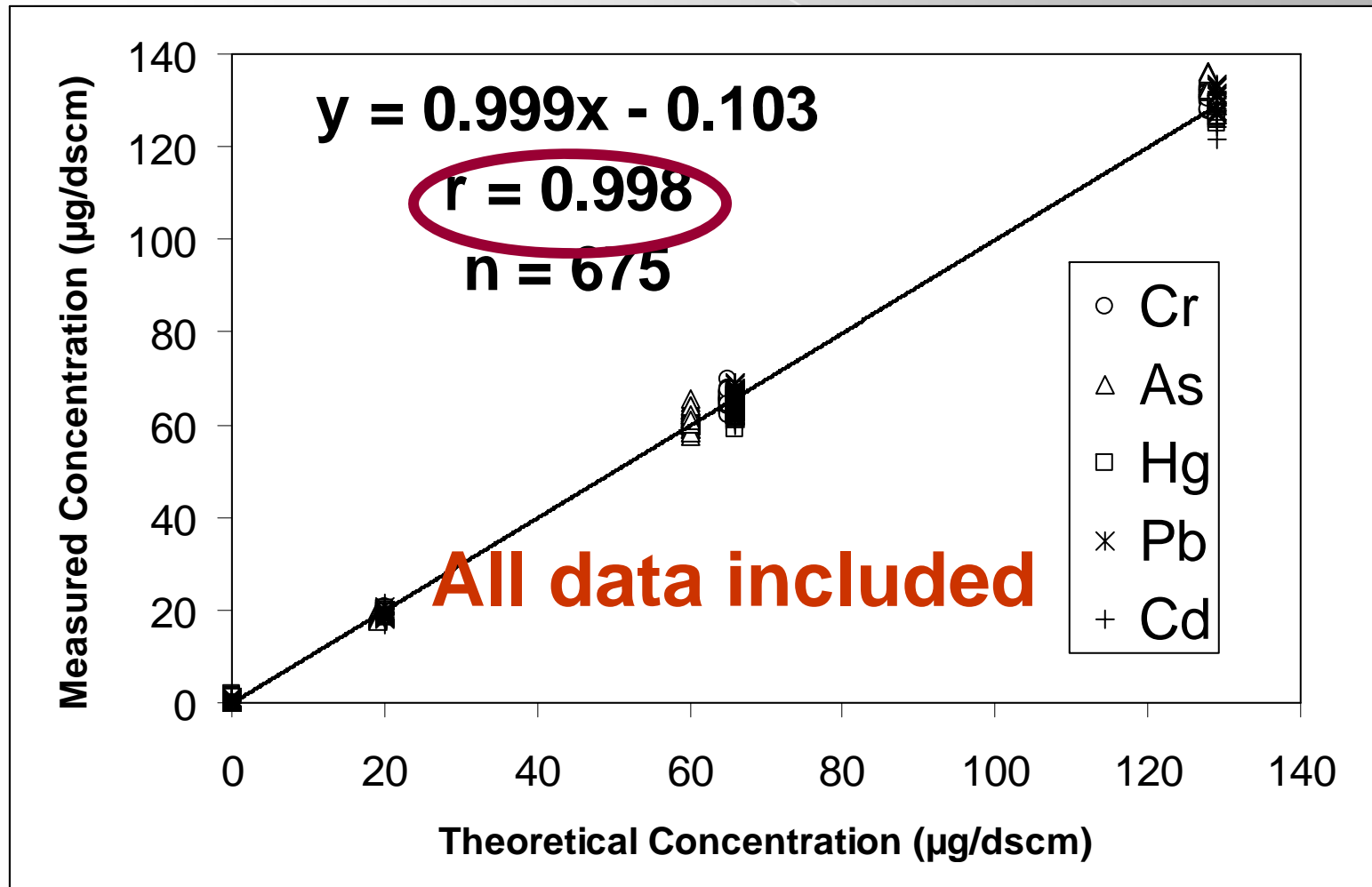
# Quantitative Aerosol Generator (v.02)



# Prototype QAG (v.02)



# QAG Multi Metal (v.02) Linearity Demonstration



# Total Capture Aerosol Concentration Equations

**QAG Predicted**

$$C_{KI}^Q = (RTC) / V$$

Time  
Solution loss rate  
Salt Sol. conc.  
Carrier air volume

**Gravimetric Measurement**

$$C_{KI}^G = (M_a - M_b) / V$$

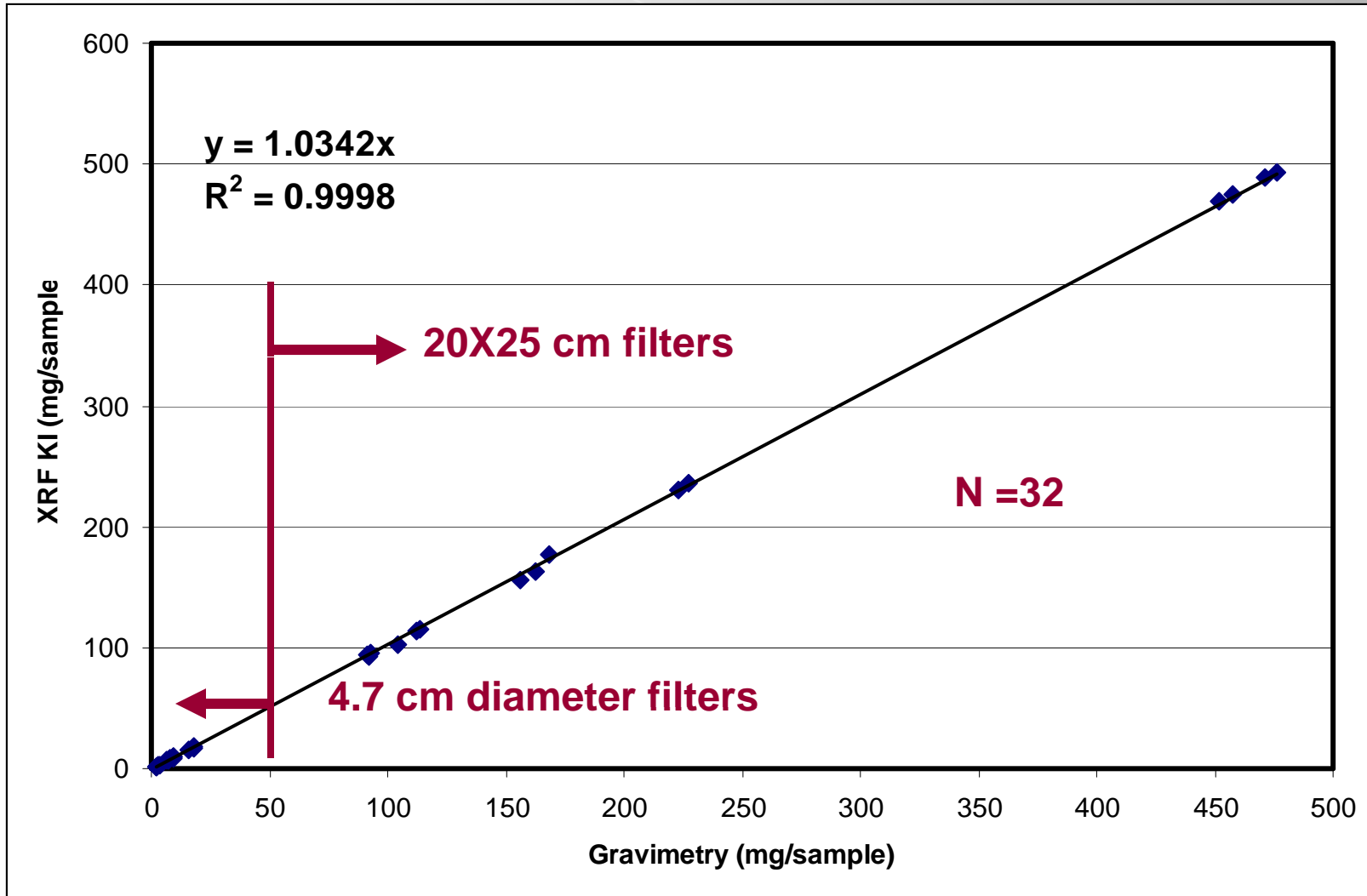
Filter mass – after and before

**XRF KI Measured**

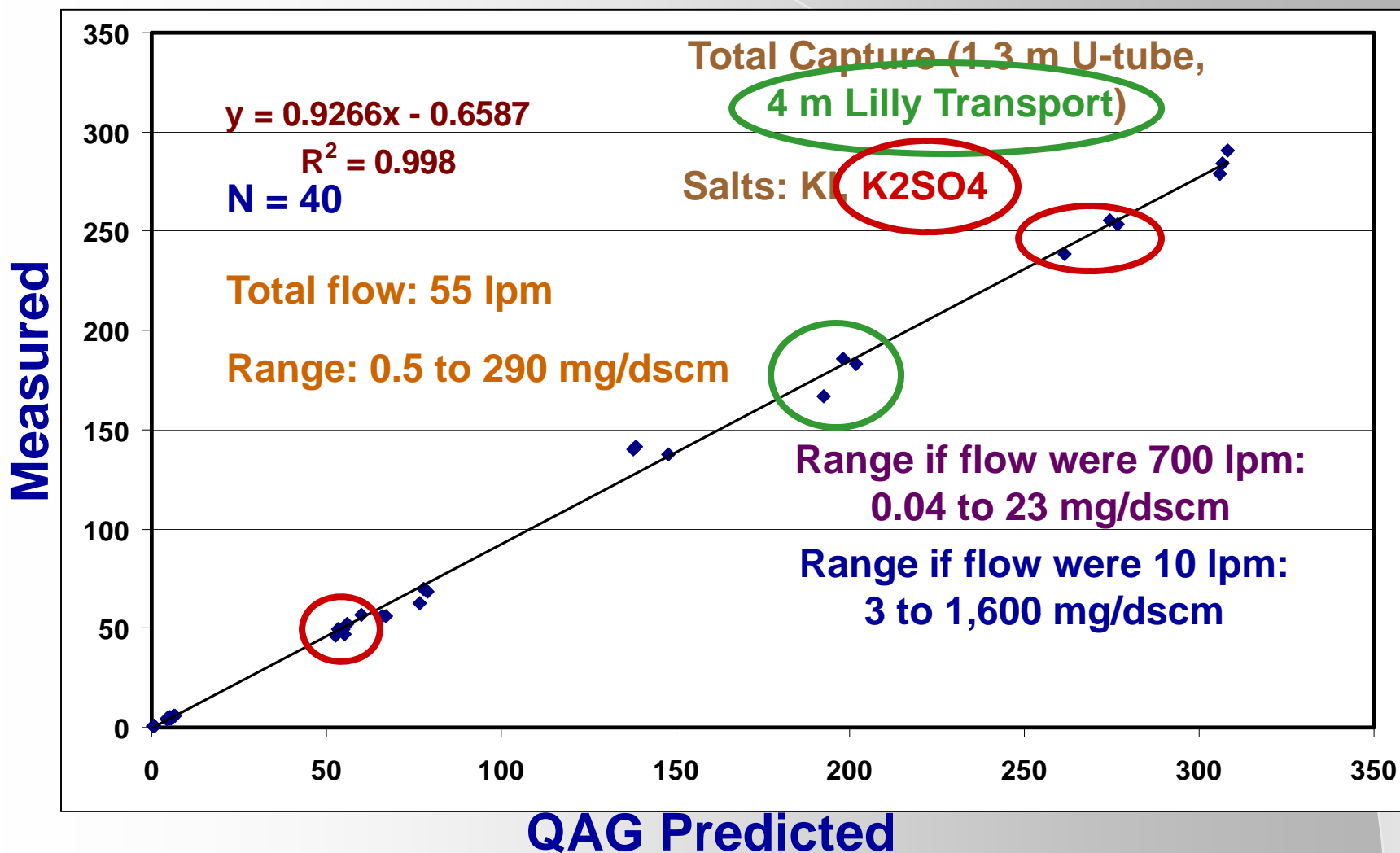
$$C_{KI}^X = (1.31 D_I A_d) / V$$

KI Factor  
Iodine aerial density  
Deposit area

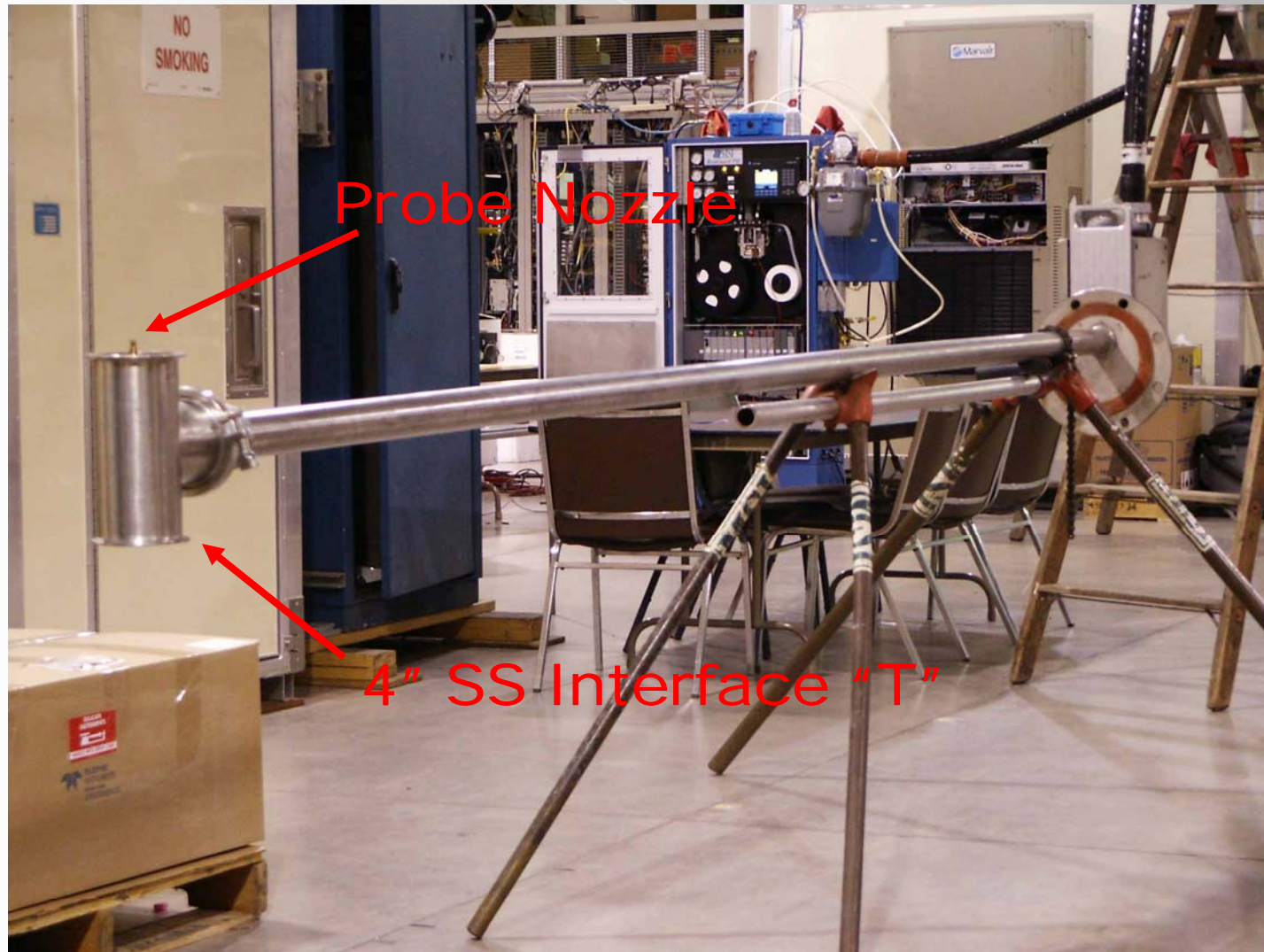
# XRF KI Compared to Gravimetric Mass



# Linearity of QAG (v.02) Aerosol Conc. (mg/dscm)



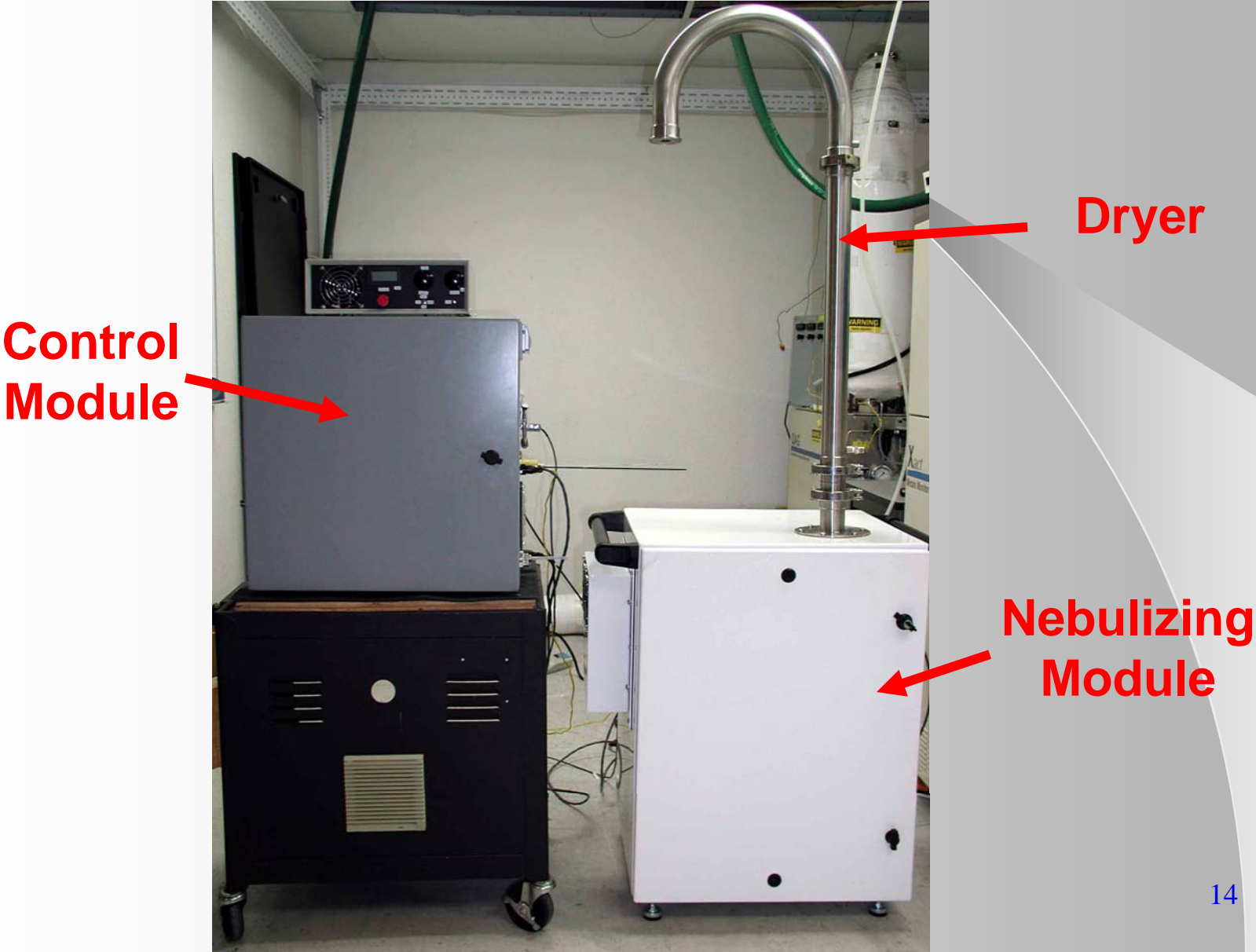
# Preliminary QAG (v.02) Evaluation: Interface with PM CEMS Probe



# Objective

**Modify prototype QAG (v.02) to deliver a more useful, charge neutral aerosol at mg/m<sup>3</sup> concentrations**

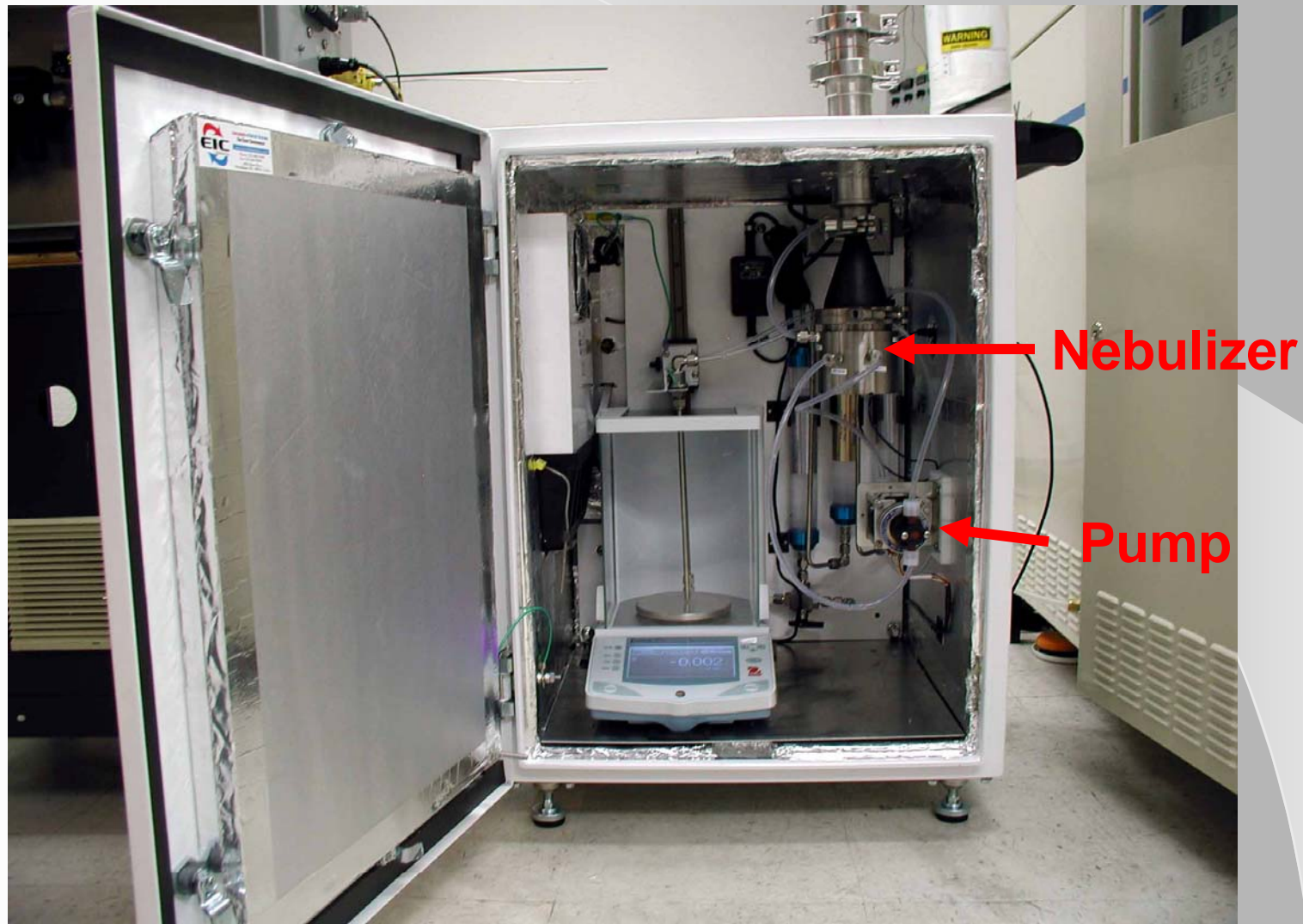
# QAG (v.03) With Control Module



# QAG (v.03) Droplet Production



## QAG (v.03) Nebulization Module

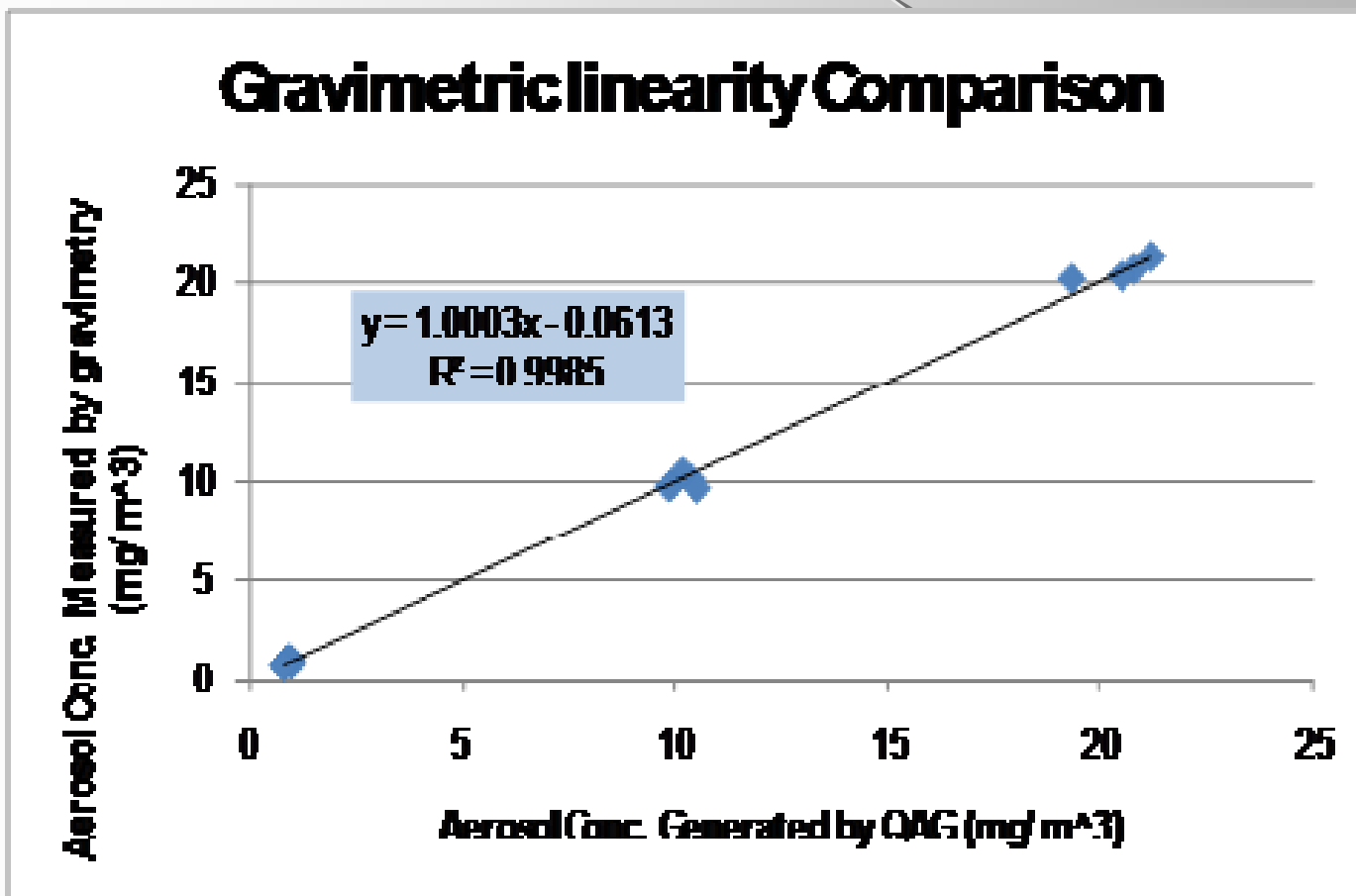


# QAG (v.03) Control Module



# Modified QAG (v.03) Validation

## Total capture tests using KI with gravimetric and XRF determinations



# Target Performance Goals

<u>Target Goal</u>	<u>Actual</u>	<u>Met?</u>
● Traceable to NIST standards	Yes	Yes
● Transport efficiency > 98%	>98%	Yes
– Total capture gravimetry	98.5%	
– Total capture XRF	104%	
– Loss directly	99%	
● Linearity:		
– Slope = 1.00±0.03	1.0003	Yes
– Intercept < 0.1 mg/m <sup>3</sup>	-0.06	Yes
● Accuracy: ± 2% at 10 mg/m <sup>3</sup>	1.6±1.4	Yes
● 8 Hr. Stability/Drift: < 2%	<3%	No
● PM range: 0.1 to 20 mg/m <sup>3</sup>	0.5 to 20	No
● Flow range: 10 to 100 lpm	55 lpm	?
● Repeatability: 10%	3%	Yes
● Mechanical: one field technician.	@Install	Yes

# Other Applications

- **EPA approved for multi-metals CEMS QA audits at HWI**
  - **Dynamic spike audits at 3 concentrations of a multi metal solution including mercury**
- **Potential applications**
  - **Other source categories for MM CEMS**
  - **PM CEMS validation, certification and audits**
  - **Audits of ambient monitors for PM and metals**
  - **Other inorganic and organic species**
  - **Continuous effluent and natural water monitoring**
  - **Thin film aerosol deposit standards**

# Next Steps for PM QAG

- Field Evaluation
- Aerosol Size control?
- EPA Acceptance?
  - Calibration
  - Dynamic spike audits
  - Standards