Developments in the Management of Exhaust in a Fab

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Drivers for Change

- Energy consumption in a Fab facility is under scrutiny: Exhaust and make-up air fans consume 7% of the total energy
  - Capital cost to add clean room air:$80-$100 per cfm
  - Estimated cost per exhaust ~$9-$10 per cfm
- Many Fabs are exhaust limited today
- Better handling of fab exhaust can lead to improved contamination and EH&S-related issues

SIA Roadmap

Year **Technology Node**	*1999* **180 nm**	*2000*	*2001*	*2002* **130 nm**	*2003*	*2004*	*2005* **100 nm**
ESH	Equipment Design for EH&S						
Energy Consumption: Overall fab equipment kWh/cm^2 (kwh/in^2)	0.5 (3.2) – 0.7 (4.5)						0.4 (2.5) – 0.5 (3.2)
Energy Consumption: Fab FacilitykWh/cm^2 (kwh/in^2)	0.5 (3.2) – 0.7 (4.5)						0.4 (2.5) – 0.5 (3.2)
300 mm production fab equipment energy consumption	X[(1)]				0.5X		

[(1)] X is based on 200 mm tool energy per wafer required

Source: The Semiconductor Industry Association Roadmap with energy reduction metrics for facility and process equipment

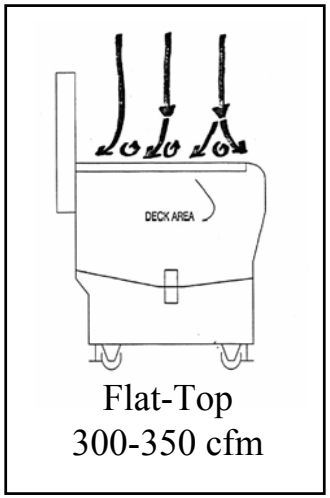
Technologies Presented

1. **Wet bench exhaust reduction:** introduction of the next generation Air Manager System: Reducing air use while improving chemical capture
2. **Recirculating of Ion Implant Exhaust:** A novel approach to reducing the high exhaust requirements in ion implanters: cost savings and safe operation

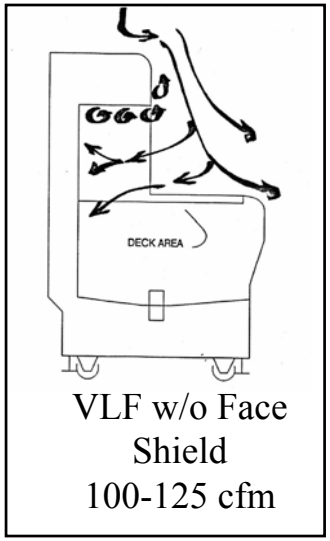
1.- Wet bench Exhaust Reduction:

Wet Bench Evolution:

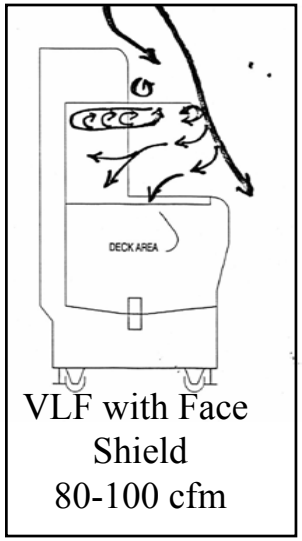
Exhaust Flow Perspective



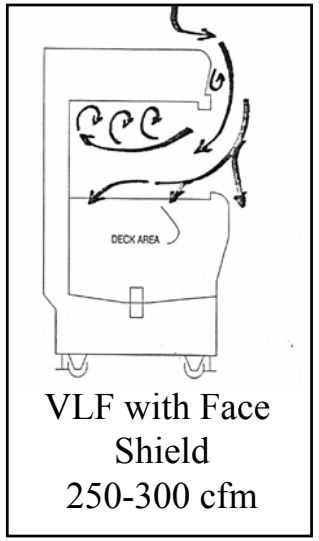
Flat-Top
300-350 cfm



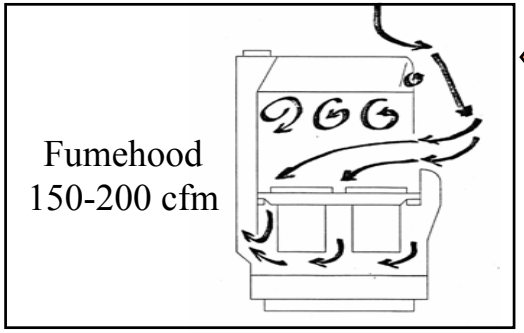
VLF w/o Face Shield
100-125 cfm



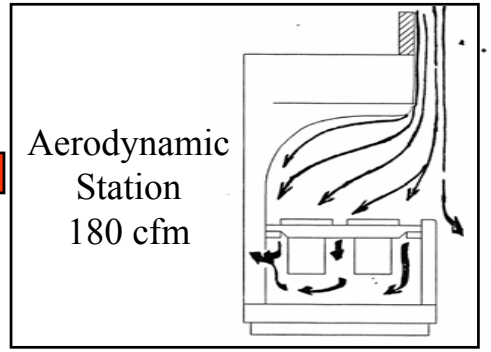
VLF with Face Shield
80-100 cfm



VLF with Face Shield
250-300 cfm



Fumehood
150-200 cfm



Aerodynamic Station
180 cfm

Next Generation AMS

Challenges of State-of-the-Art

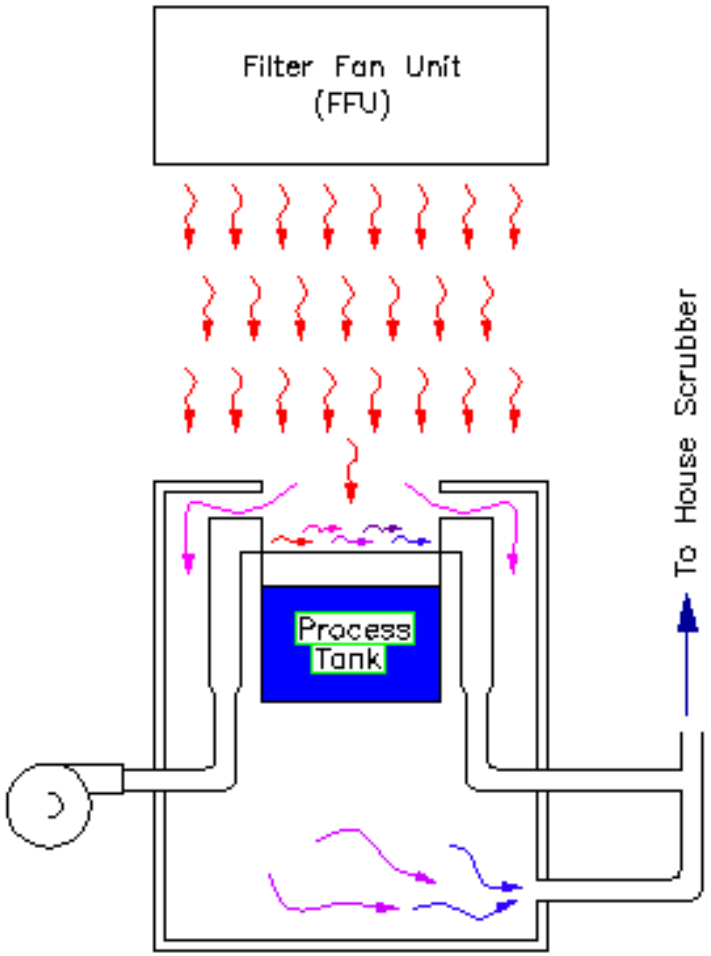
- Modern air management systems use push/pull air flow forces to achieve chemical containment
- Air flow dynamics around wet benches is complexly coupled by any flow variations in its surrounding area
- Even after optimization of air flow balance, air turbulence and fume releases occur upon minor changes in the initial conditions

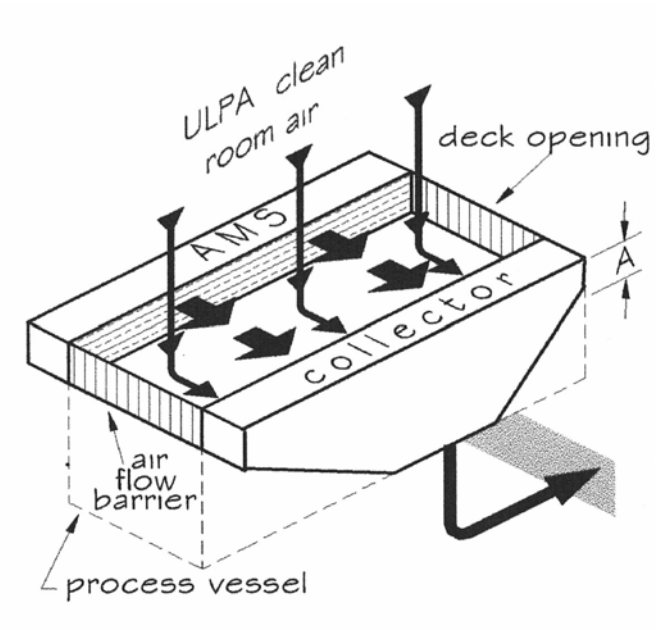
Novel Approach

Air Manager System (AMS): Independent air flow control at deck level decoupled from cleanroom air

- Expected Benefits
  - Reduced Energy Requirements
  - Improved Chemical Fume Containment
  - Enhanced Cost of Ownership
  - Safer Working Environment
  - Extended Equipment Life

AMS Layout/Operation





AMS Development/Optimization

System Variables:

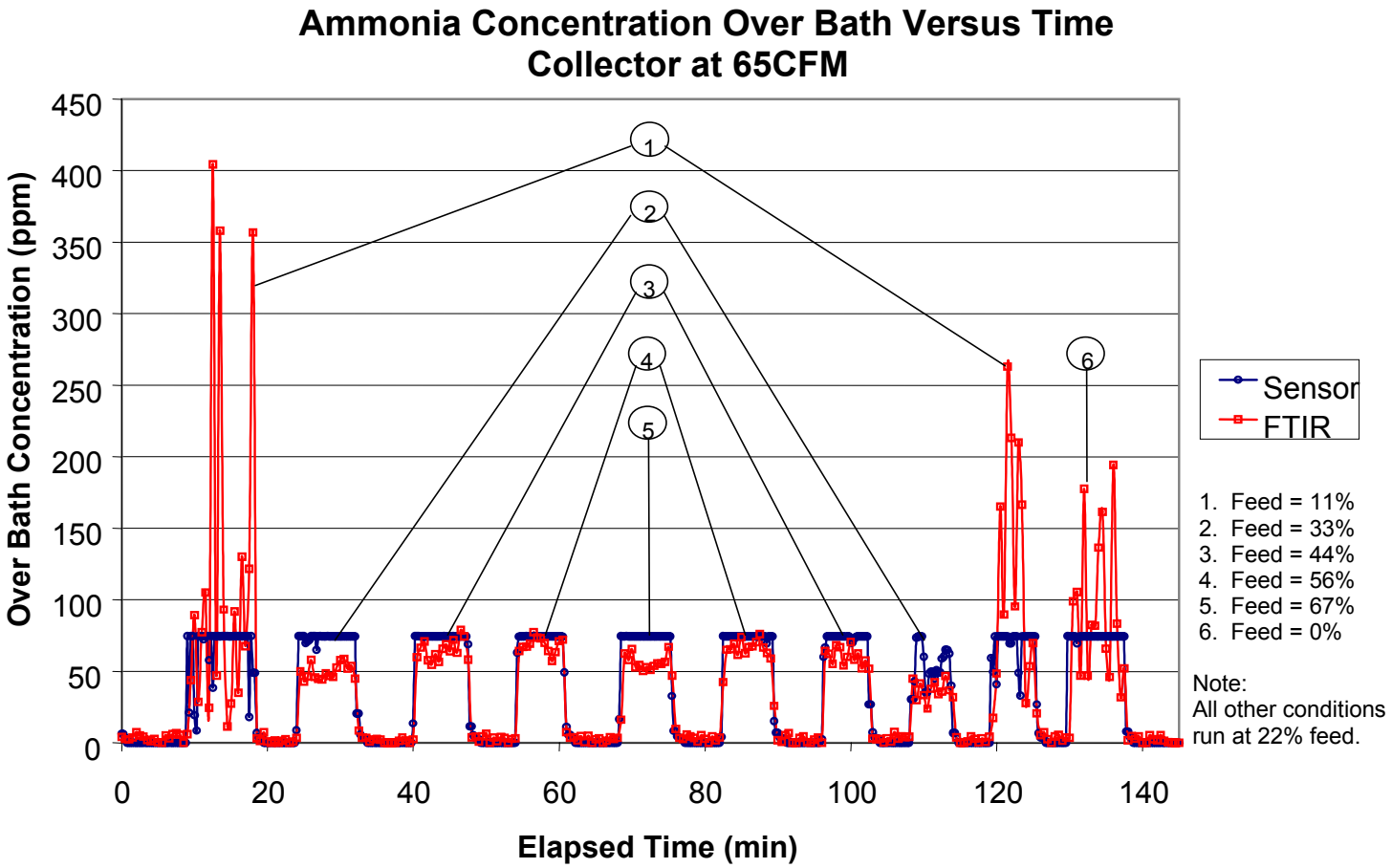
- Filter box feed rate
- Collection rate
- FFU rate
- Filter box type
- Height above bath

System Measurements:

- Over-bath concentration (Point Sensor, FTIR)
- Exhaust concentration (Point Sensor, FTIR)
- Bath temperature (Thermocouple)
- Air velocity (Hot-wire anemometer)

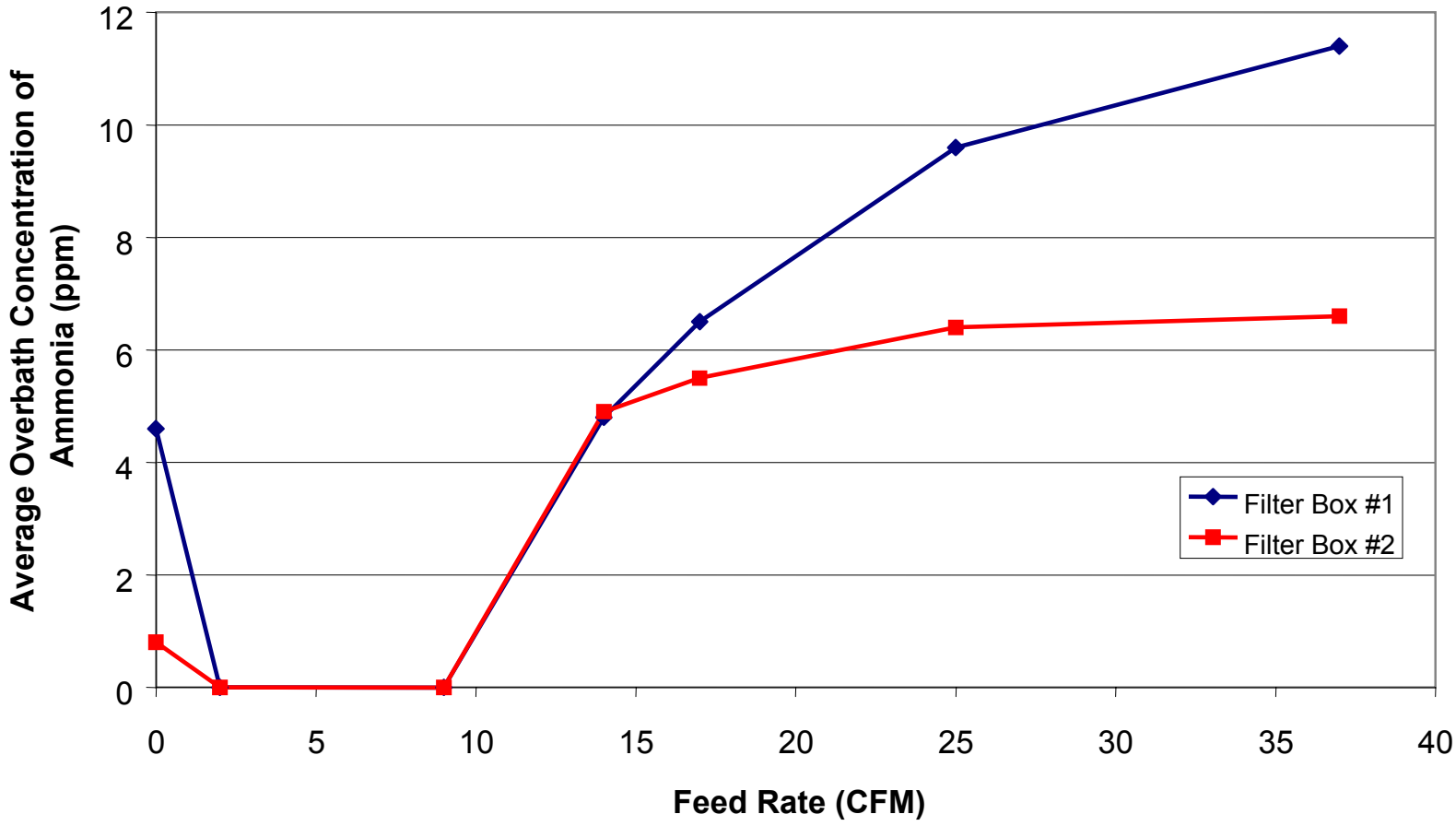
Example Results:

Feed Rate optimization



Repeatability Study

Comparison of Filter Box #1 Versus Filter Box #2
Collector at 65CFM FFU at 113CFM (80 ft/min at face)



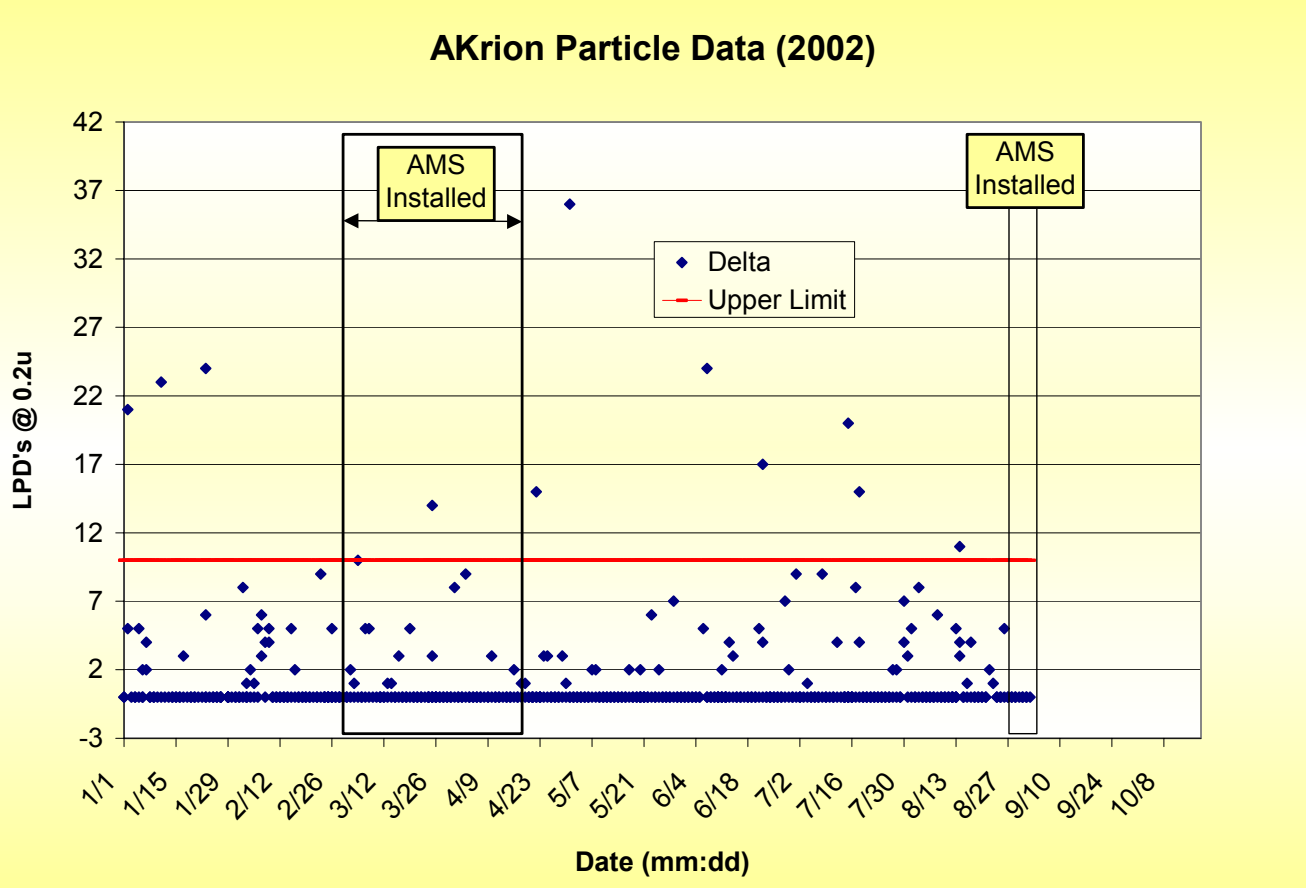
AMS Installation Retrofit

- During recent testing, the AMS was installed into a prototype 300mm wet processing station
- The AMS supplied a blanket of filtered air horizontally across the top of the chemical process vessel to an opposing exhaust collector/receiver
- The AMS partitions the chemical fumes rising from the vessel, captures them and sweeps them into the exhaust collector located in the plenum

Beta Site Results

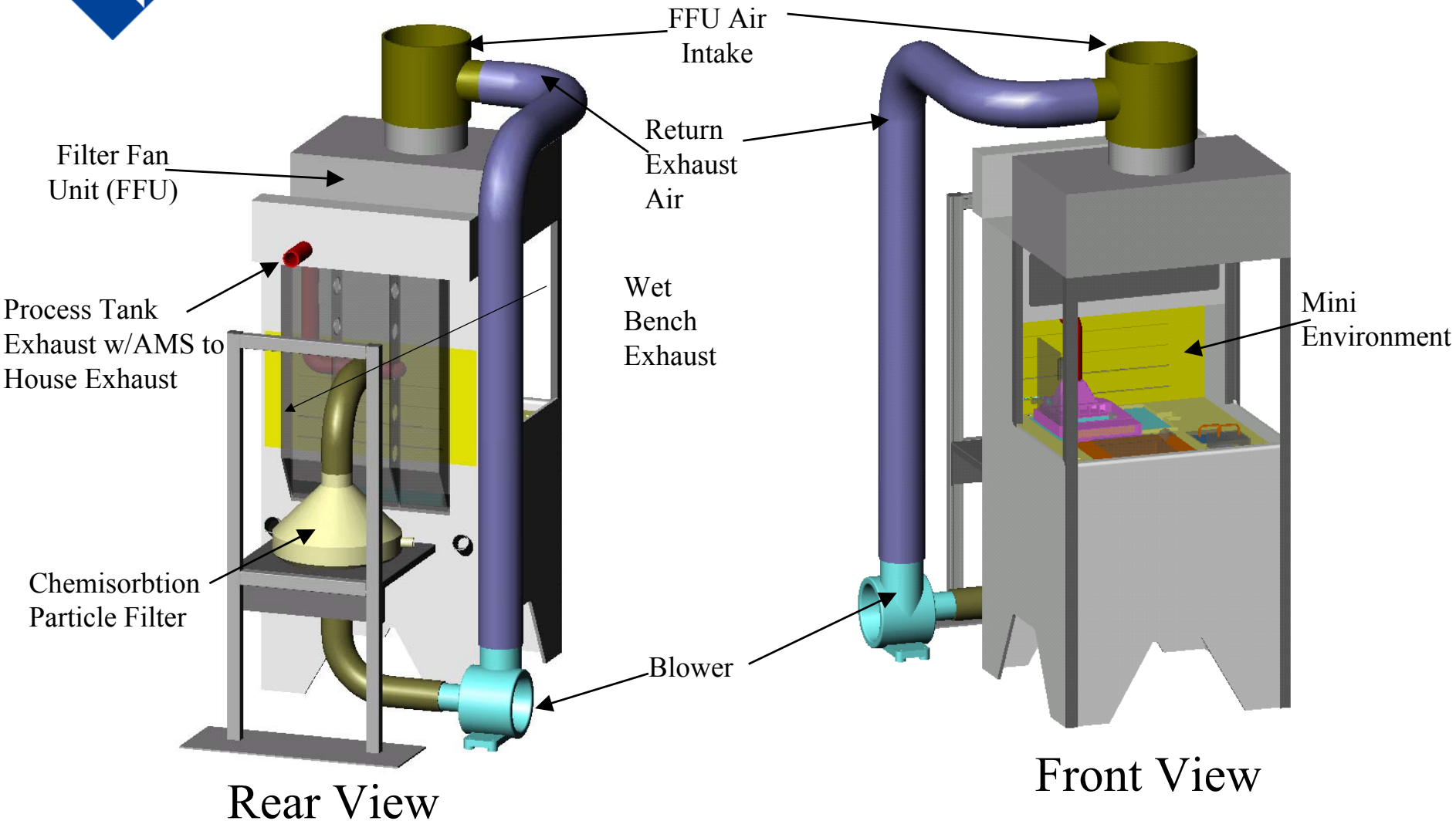
- Point-of-use sensors, located in a grid array above the chemical process vessels were used to optimize the AMS flows
- Complete chemical capture was achieved
- Results of this study supported an overall equipment exhaust reduction of 70%
- Based on this study, a next generation AMS system was designed to improve performance and retrofitability

Beta Site Results: Particle Data

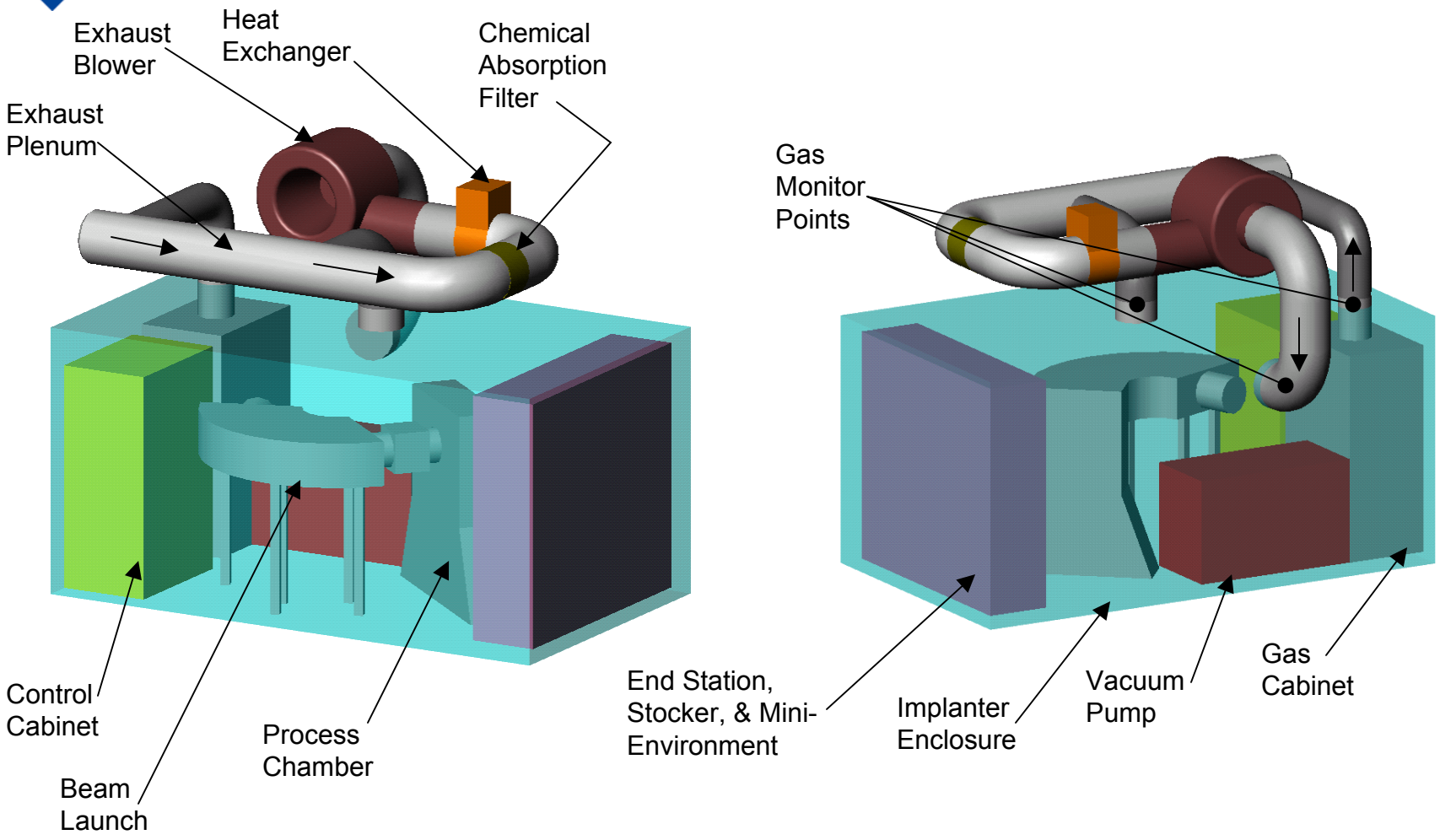


Particle data indicates no process variations while the AMS was operating

Self-Contained Bench Concept



2.- Ion Implant Exhaust Recirculation


Exhaust Blower
Heat Exchanger
Chemical Absorption Filter
Exhaust Plenum
Control Cabinet
Beam Launch
Process Chamber
Gas Monitor Points
End Station, Stocker, & Mini-Environment
Implanter Enclosure
Vacuum Pump
Gas Cabinet