GTEN 2019 Symposium
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ENVIRONMENTAL CHARACTERIZATION AND IN-SITU TESTING FOR GAS TURBINE INLET FILTER SYSTEM SELECTION

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Camfil Power Systems

Presented at the Gas Turbines Energy Network (GTEN) 2019 Symposium
Banff, Alberta, Canada - October 2019

Agenda

- Why filter
  - Filter –GT performance
- Air filter test standards
- Environmental characterization
  - Site Survey
  - In-situ Testing

Why filter GT inlet air?

- FOD
- Erosion
  - > 5 µm
- Corrosion
  - Salts
- Cooling Passage Plugging
- Fouling
  - <1µm

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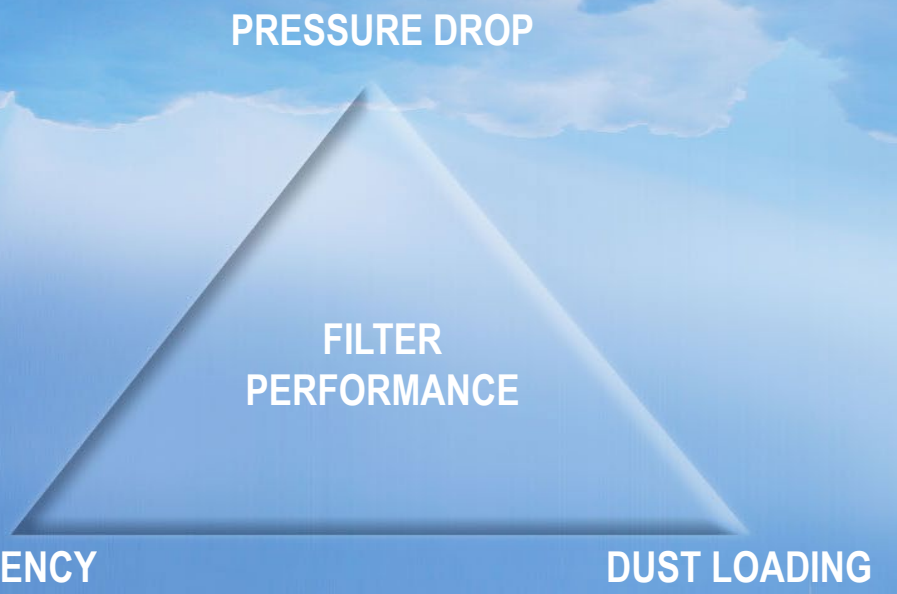
Filter Performance

- Pressure drop
- Dust loading
- Efficiency*
  - Initial, final, minimum, average.
  - Particle count high eff
  - Mass pre-filter low eff



*Filter efficiency typically increases as it loads with dust

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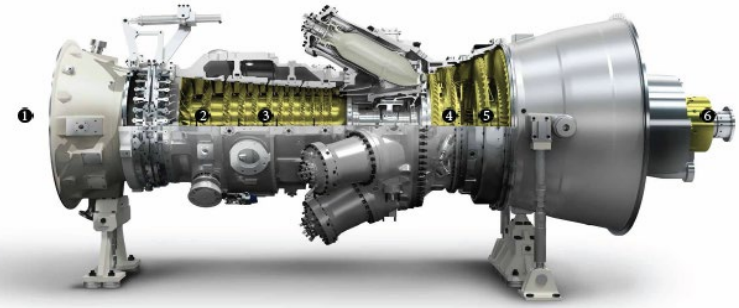
Filter- Turbine Parameters

- Pressure Drop
  - ***Compressor Work***
    - Initial
    - Avg. over life
- Efficiency
  - ***Compressor Fouling***
- Service Life
  - Pressure Drop
  - Age
  - Scheduled Maintenance



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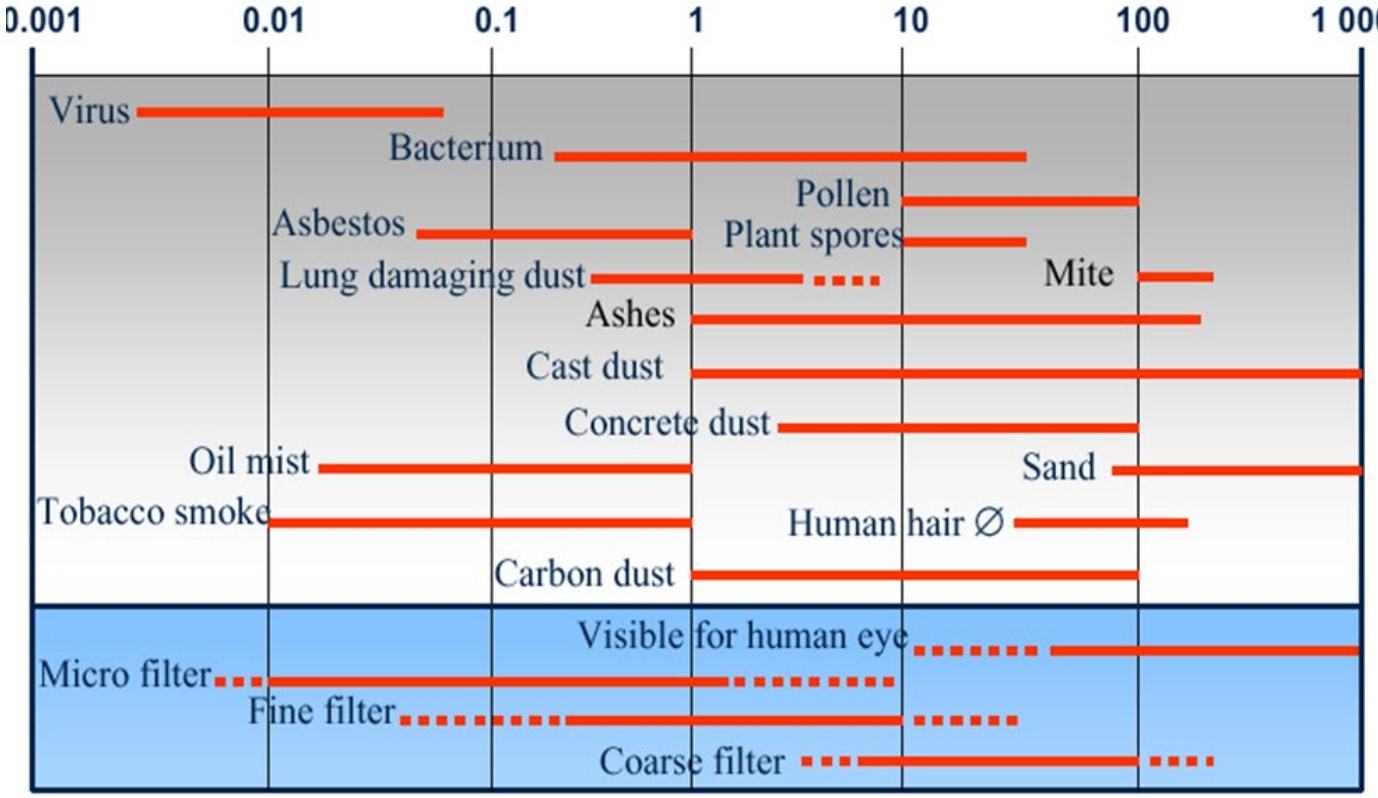
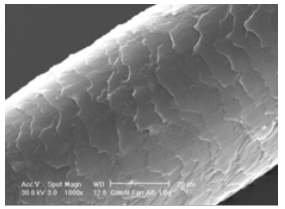
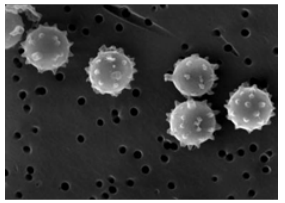
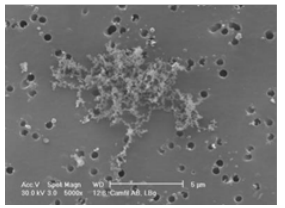
Particles – What's a micron?









Source: ASHRAE Handbook

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Air filter test standards
Efficiency comparison

Test Standard	Efficiency Particle size µm	Electro Discharge	Rating Term	
ISO 16890	1, 2.5 , 10	yes	E_{epm}1, 2.5, 10	
EN 779 (2012)	0.40	yes	G1 – F9	
ASHRAE 52.2	0.3-1.0	Optional	MERV 1-16	
EN 1822	Most Penetrating Particle Size [MPPS] Typ. 0.1 -0.2	Optional	E10 -E12	“High” eff. Filters “HEPA”

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Air filter test standards
Dust holding capacity comparison

Test Standard	Test dust	Final dP*
ISO16890 DHC is Optional	ISO fine	450 Pa
EN 779	ASHRAE	450 Pa
ASHRAE 52.2	ASHRAE	User defined
EN 1822	None	NA

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Understanding GT Environment

- Different environments require specific filter systems/ filter media
- Problem Solving of filter issues
  - Pressure drop
  - Short life
  - Compressor fouling
  - Corrosion
- Air quality - Particles
  - Size distribution
  - Concentration
  - Chemical content

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Filter Recommendation based on Environment

Environment	Contaminants	Filtration	Environment	Contaminants	Filtration
Coastal	Salt	Pre-filter and/or high efficiency	Arctic	Ice	Anti-Icing system, Self cleaning filter
	Cooling Tower Aerosols	Coalescers		Insect	Insect Screens
	Land Based Contaminants	Pre-filter and/or high efficiency		Snow	Weather hood, self cleaning filters
	Water (Rain, Sea Mist)	Vane Separators, coaslescers, weather hood		Summer Dust	Pre-filter and/or high efficiency
	Sand	Pre-filter and/or high efficiency	Tropical	Water (rain)	Weather hood, vane separators, coaslescers
Marine	Salt (wet)	Vane Separators, coaslescers,		Insects	Insect screens
	Salt (dry)	Pre-filter and/or high efficiency		Pollen	Pre-filter and/or high efficiency
	Sand	Pre-filter and/or high efficiency		Salt (near ocean)	Pre-filter and/or high efficiency
	Ice	Anti-Icing: Compressor bleed	Rural Country Side	Water (rain, snow, fog)	Weather hood
	Water (rain, sea mist, waves, wakes)	Vane separators, coaslescers, weather louvers		Agricultural dust	Pre-filter and/or high efficiency, self-cleaning filters
Offshore	Salt	Pre-filter and/or high efficiency		Pollen, ground dust, seeds	Pre-filter and/or high efficiency
	Cooling Tower Aerosols	Coaslescers		Leaves	Trash Screens
	Land Based Contaminants	Pre-filter and/or high efficiency		Ice	Anti-Icing
	Water (Rain, Sea Mist)	Vane Separators, coaslescers, weather hood	Large Cities	Water (rain, snow, fog)	Weather hood
	Sand	Pre-filter and/or high efficiency		Agricultural dust	Pre-filter and/or high efficiency filter, self cleaning filter
	Hydrocarbons, soot, exhaust	High efficiency filter		Pollen, ground dust, seeds	Pre-filter and/or high efficiency filter
	Sand blasting	Pre-filter		Leaves	Trash Screens
Desert	Sand	Self-cleaning filter, Inertial separator		Ice	Anti-Icing
	Pollen, sticky substances	Pre-filters		Soot, pollution, exhaust fumes	High efficiency filter
	Fog or high humidity	Coaslescers and vane axial separators			Sources: GMRC, Camfil

How to measure

- **Observation**
  - What's nearby
    - Freeway
    - Industrial pollution
- **Available data**
  - Initial site permit survey
  - Nearby Gov't monitor
    - Concentration - PM 2.5
- **Used Filter Analysis**
- **On site Sampling**

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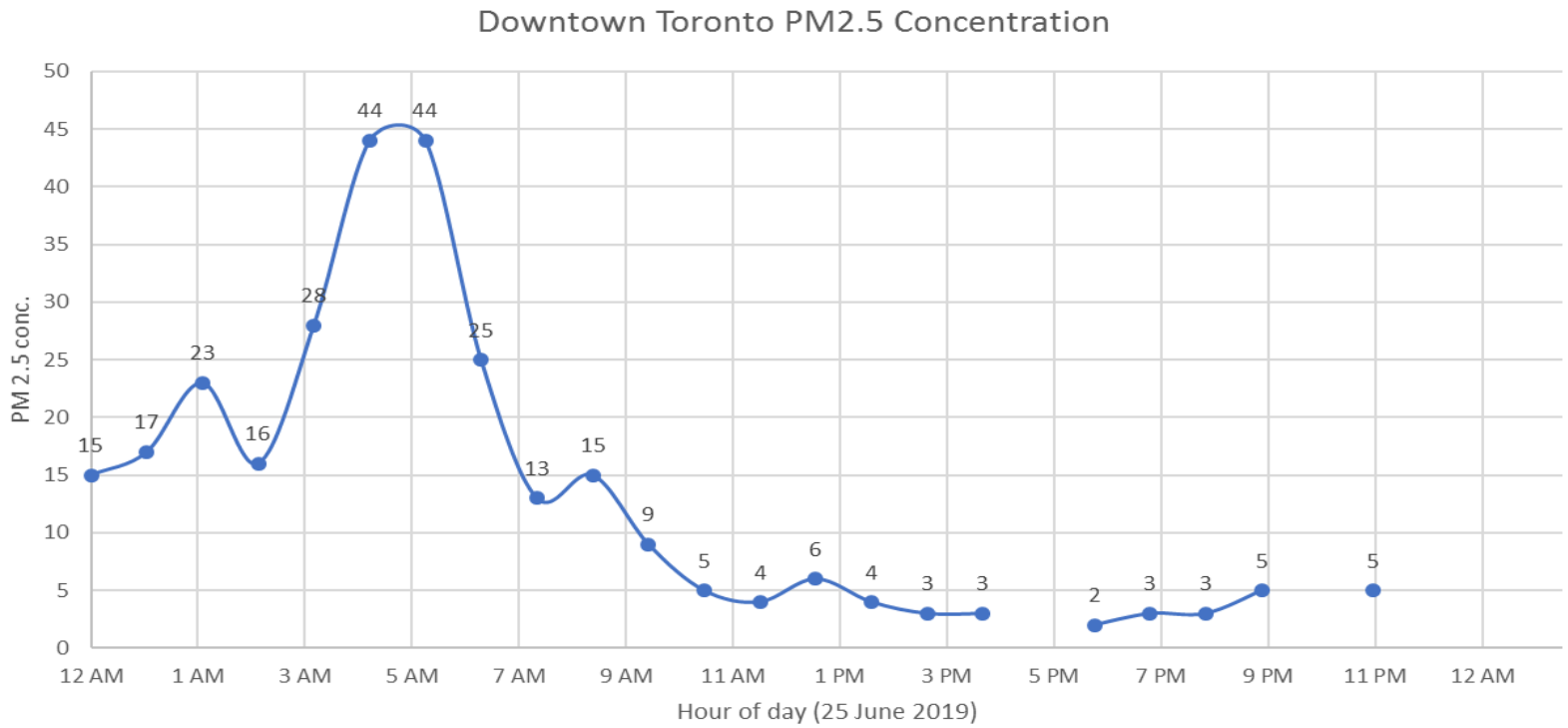
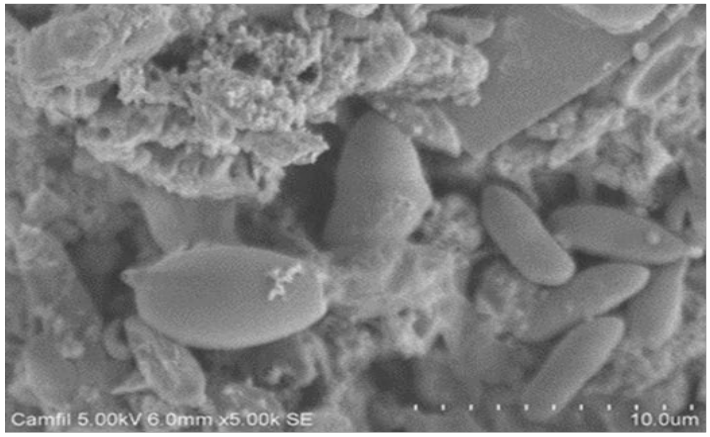
How to measure
Gov't PM data

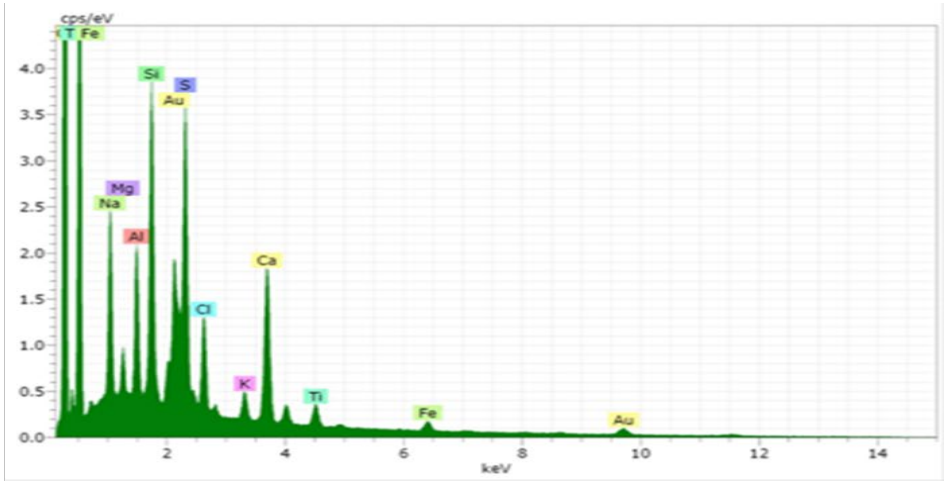


Source: http://www.airqualityontario.com

Returned Filter Analysis

- Pressure drop
- Filter efficiency
- Characterize collected particles over time
  - SEM
  - EDX





Onsite sampling

- Particle counter
  - Number of particles by size
- Mass Concentration (PM 2.5 PM10)
  - µg/m^3
- Cascade Impactor
  - Mass concentration by size
  - Chemistry

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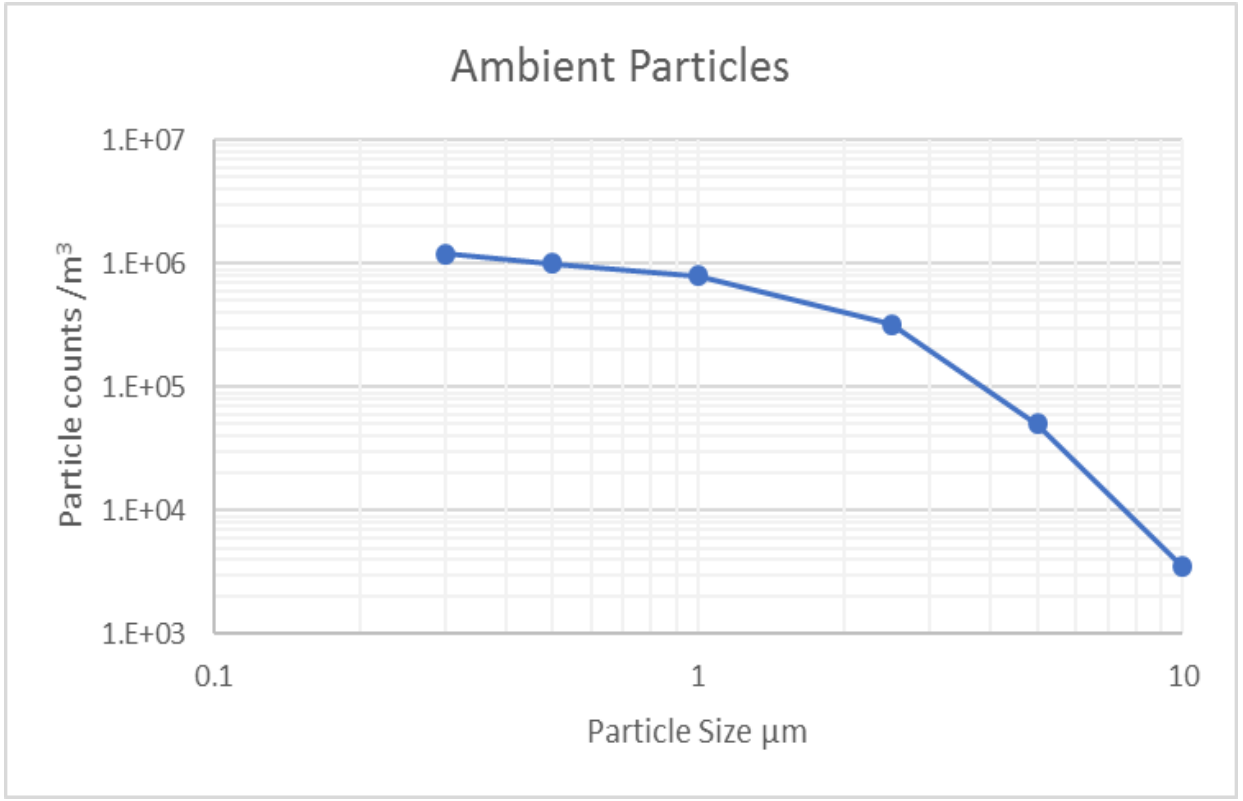
Particle counter



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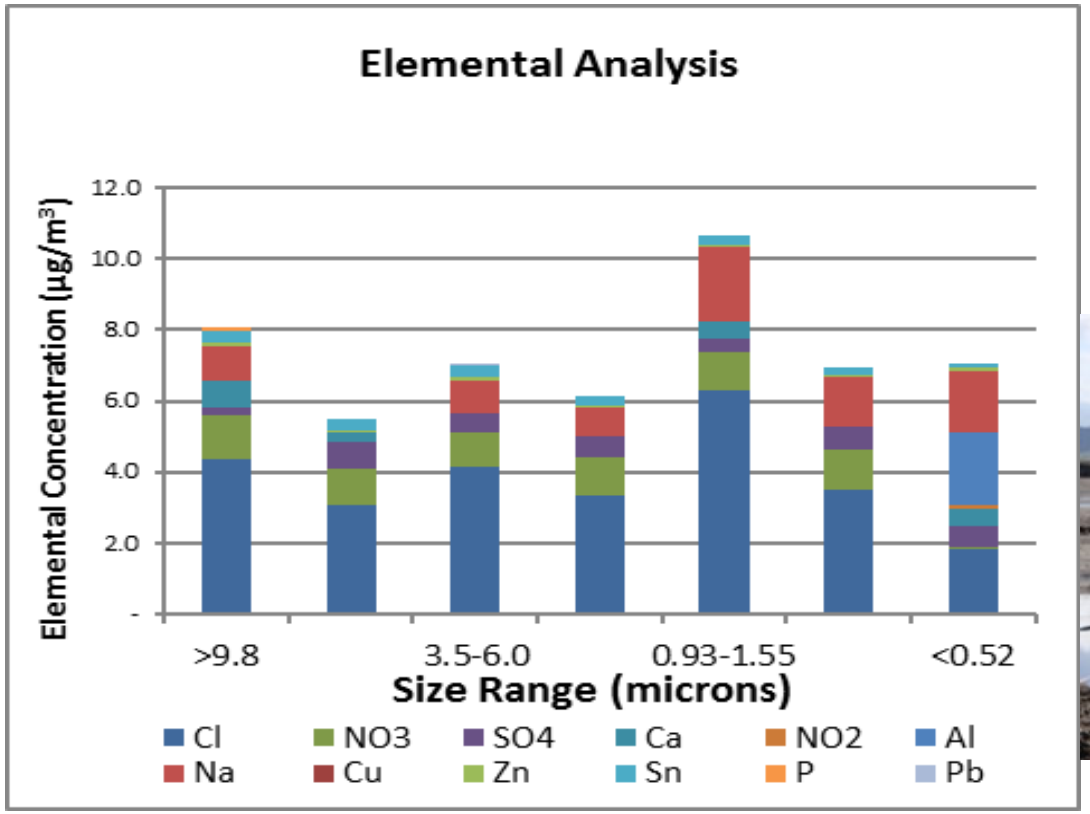
Cascade Impactor



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In-situ Testing -- Mobile test lab

- Real time evaluation of filters
  - dP
  - Efficiency – particle size
  - Environmental conditions
- Allows evaluation in the actual environment
- Typically on site 3-4 months
  - Provides trend analysis

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In-situ Testing -- Mobile test lab

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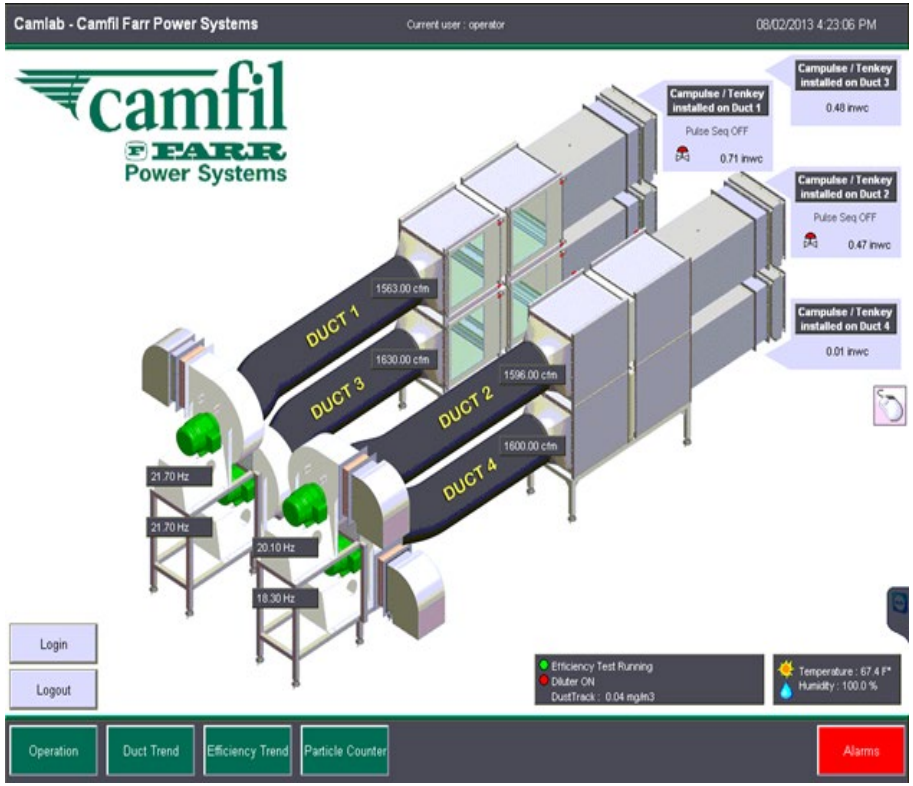

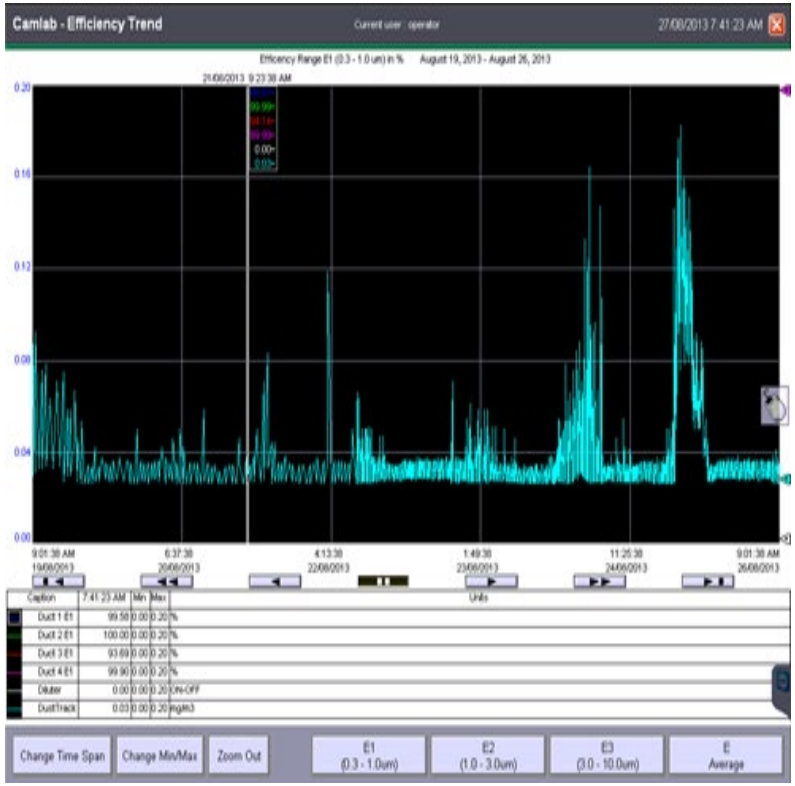

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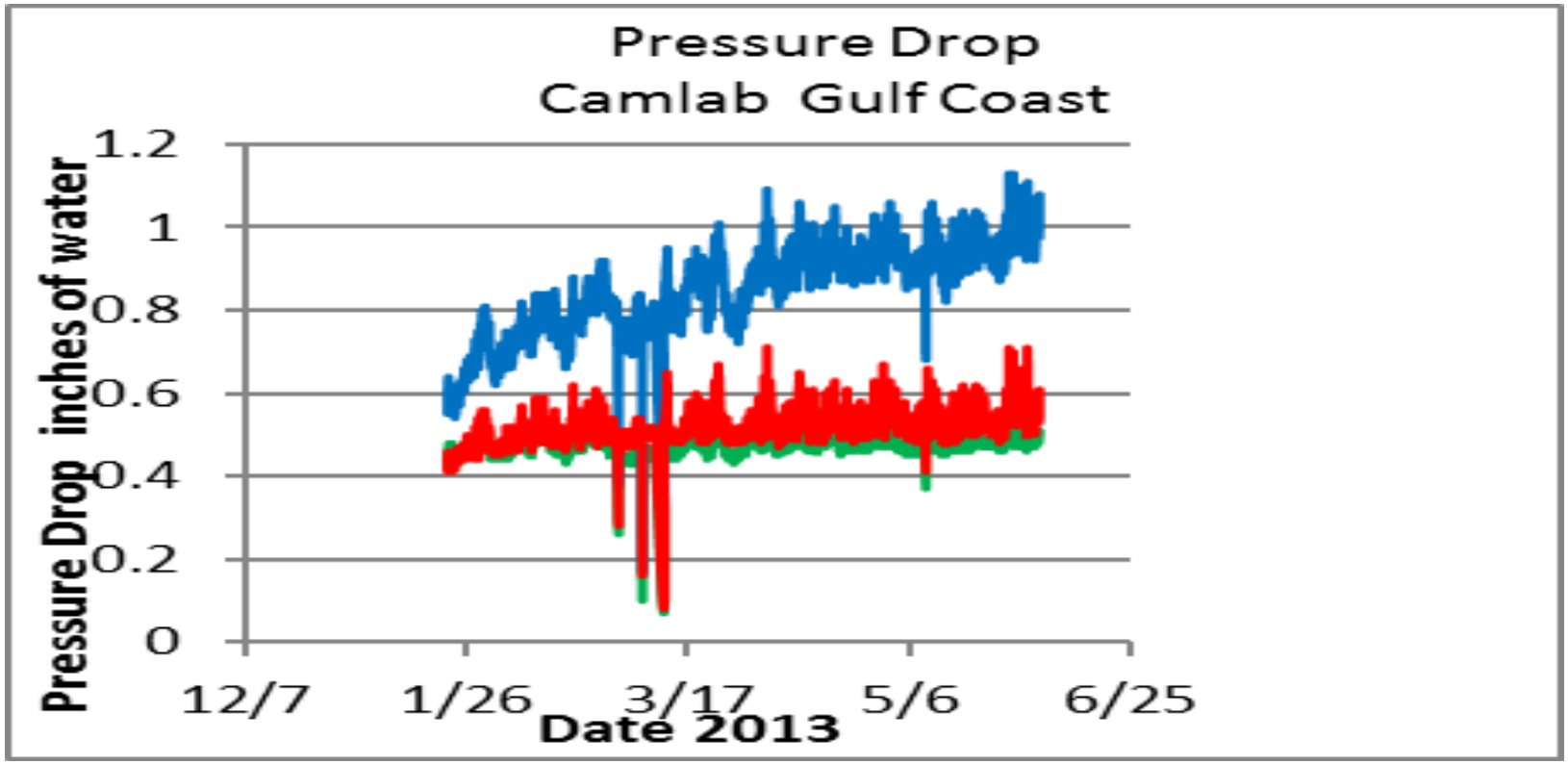

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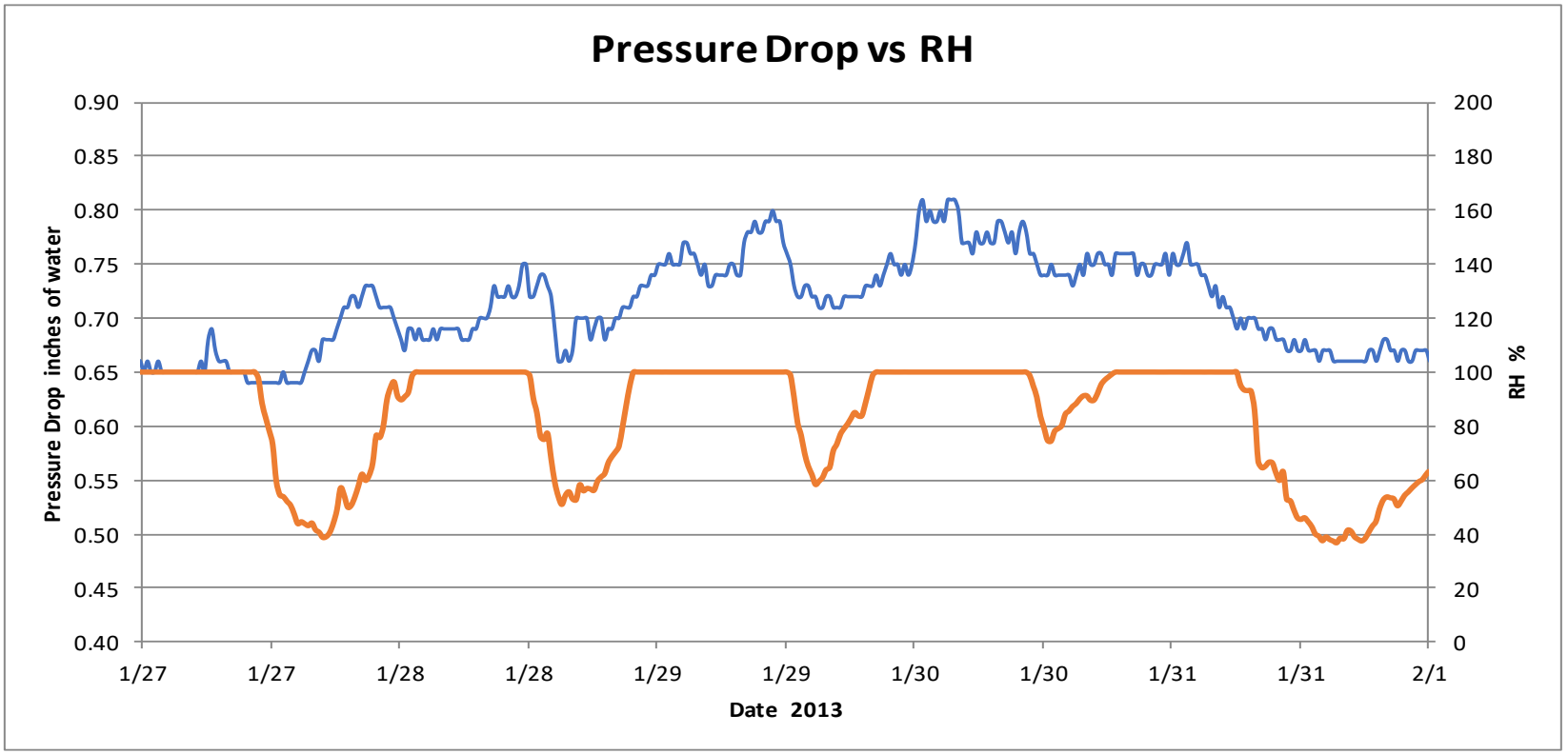
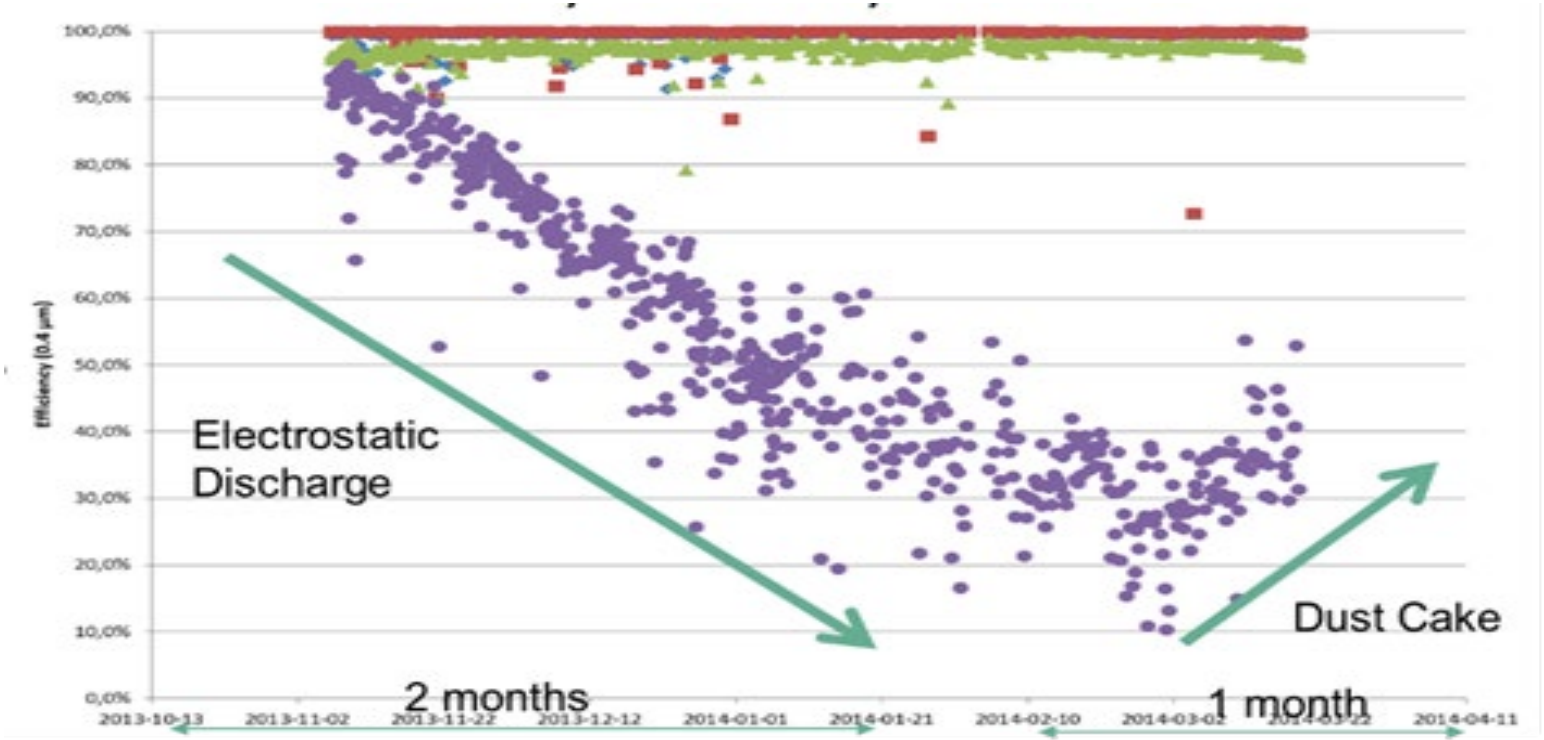


In-situ Testing -- Mobile test lab
Efficiency 0.40 µm



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Benefits of Environmental Characterization & In-situ Filter Testing

- Optimized filter selection w/ data
  - Life cycle cost
- Aid system problem solving
- Several methods available
  - Available data
  - Returned filters
  - Onsite sampling
  - Mobile test lab

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Thank you