

Causes and Implications of Large Particle Penetration during PM₁₀ Sampling

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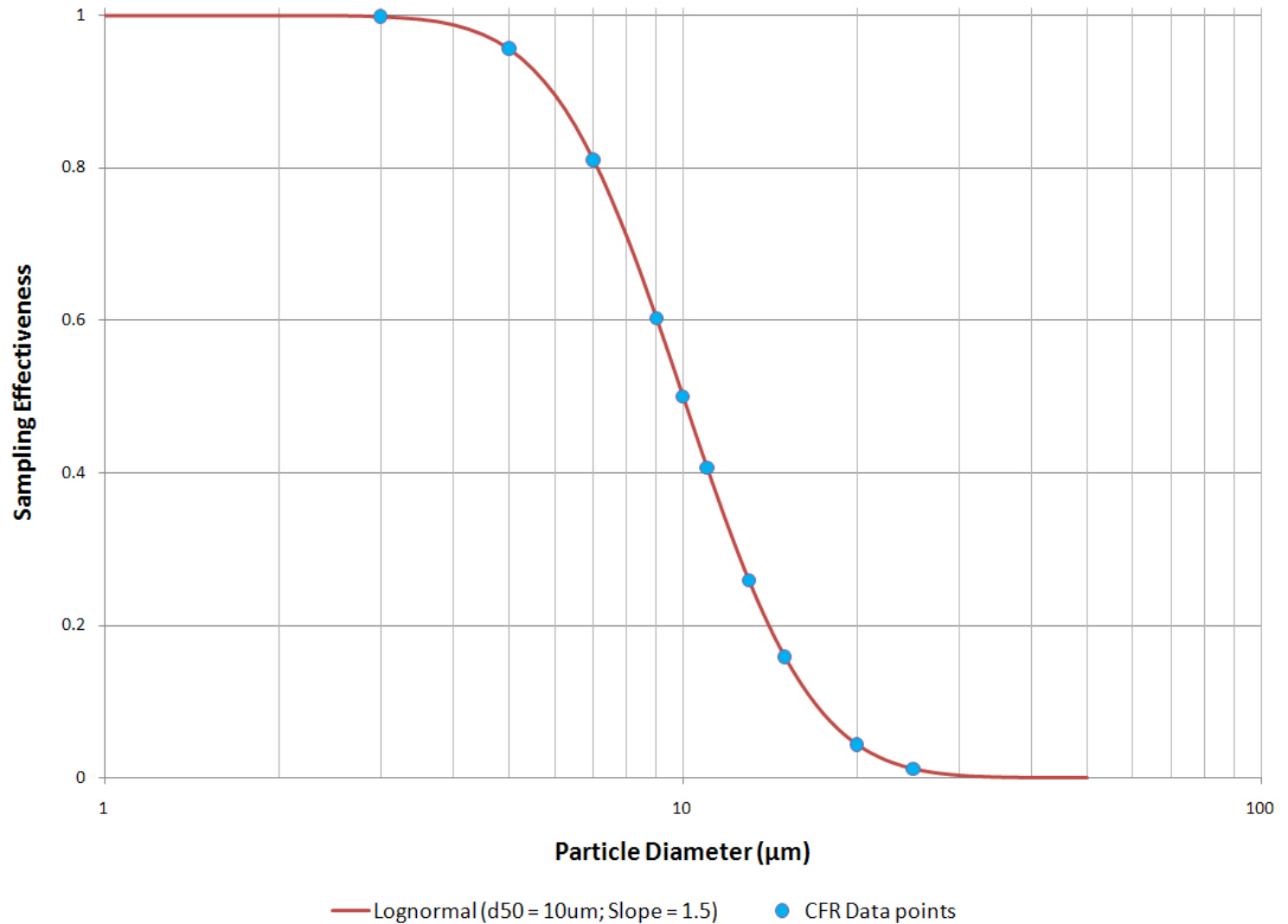
December 2013



FRM PM10 Samplers

- Performance metrics specified in 40 CFR 53 Subpart D
 - Wind Tunnel Testing

FRM PM10 Samplers

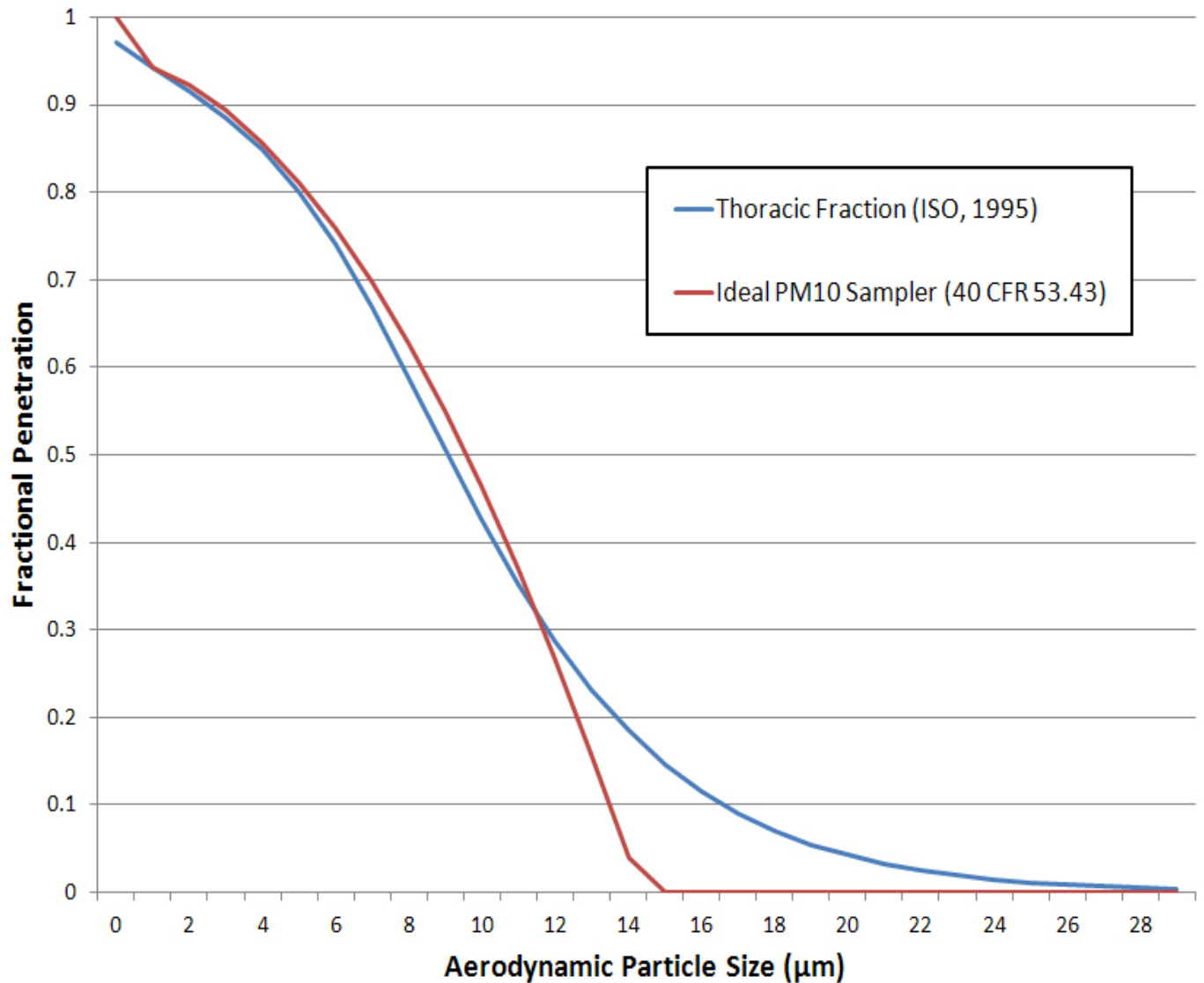




FRM PM10 Samplers

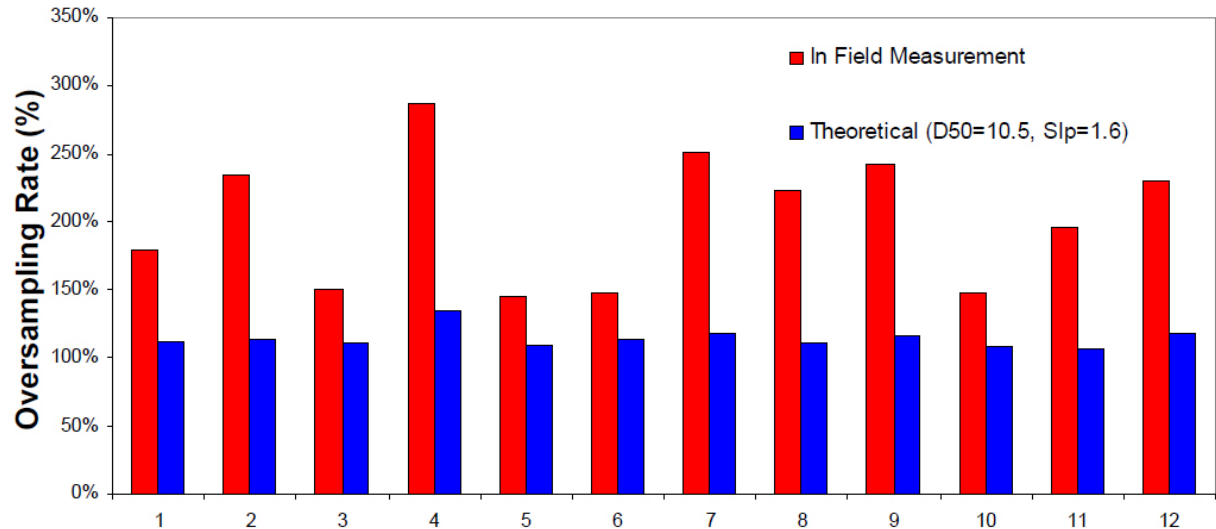
- Performance metrics specified in 40 CFR 53 Subpart D
 - Wind Tunnel Testing
 - Sampler Cutpoint
 - Estimation of Mass Collected from a standard aerosol relative to an “ideal” sampler

FRM PM10 Samplers



FRM PM10 Samplers

- Performance metrics specified in 40 CFR 53 Subpart D
- Speculations of “oversampling”

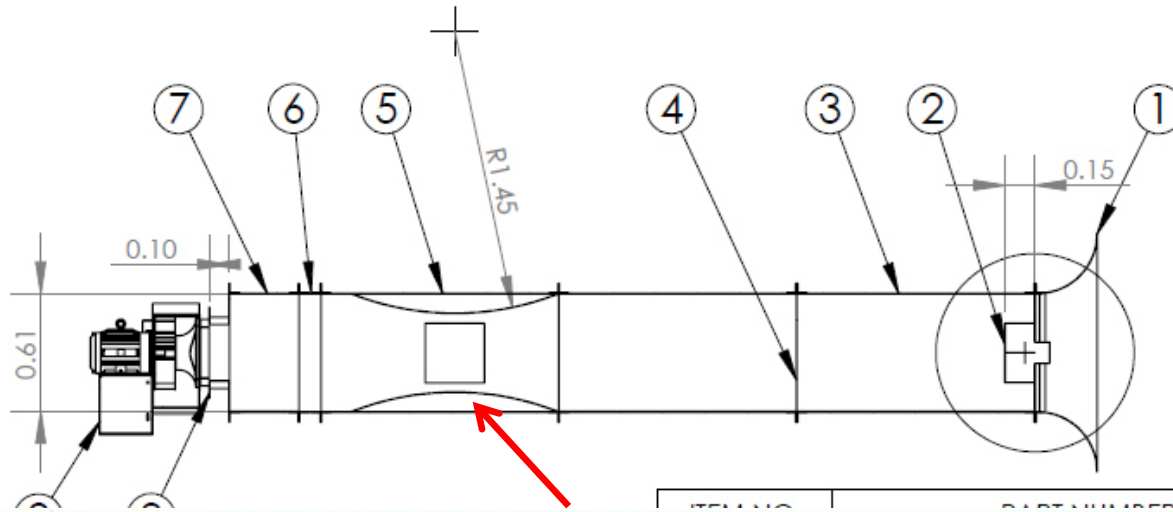




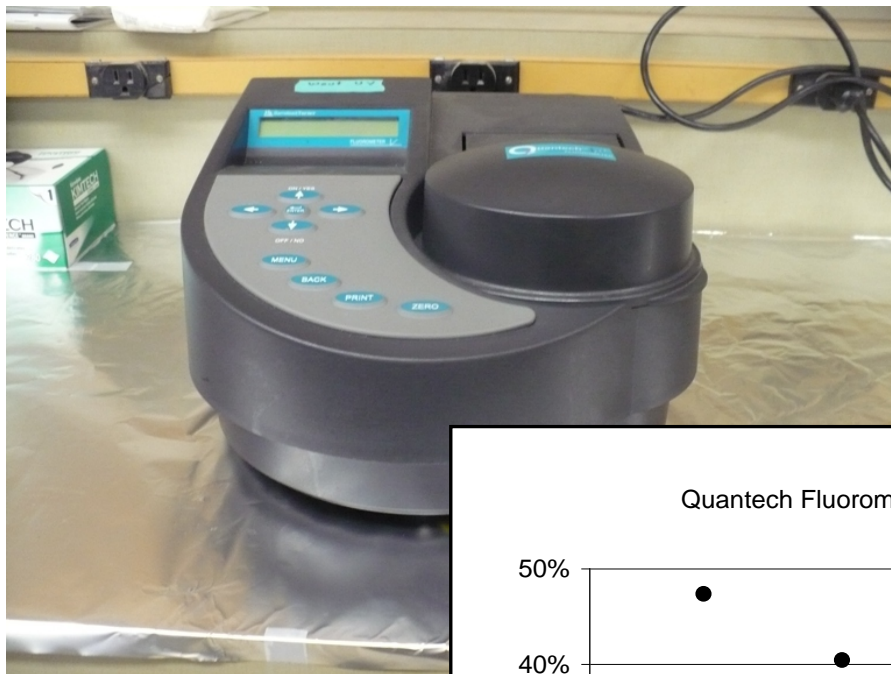
Study Objective

Characterize the performance of a FRM PM10 size-selective inlet using analysis methods designed to minimize the uncertainty in measured sampling effectiveness values for large particles.

Methods

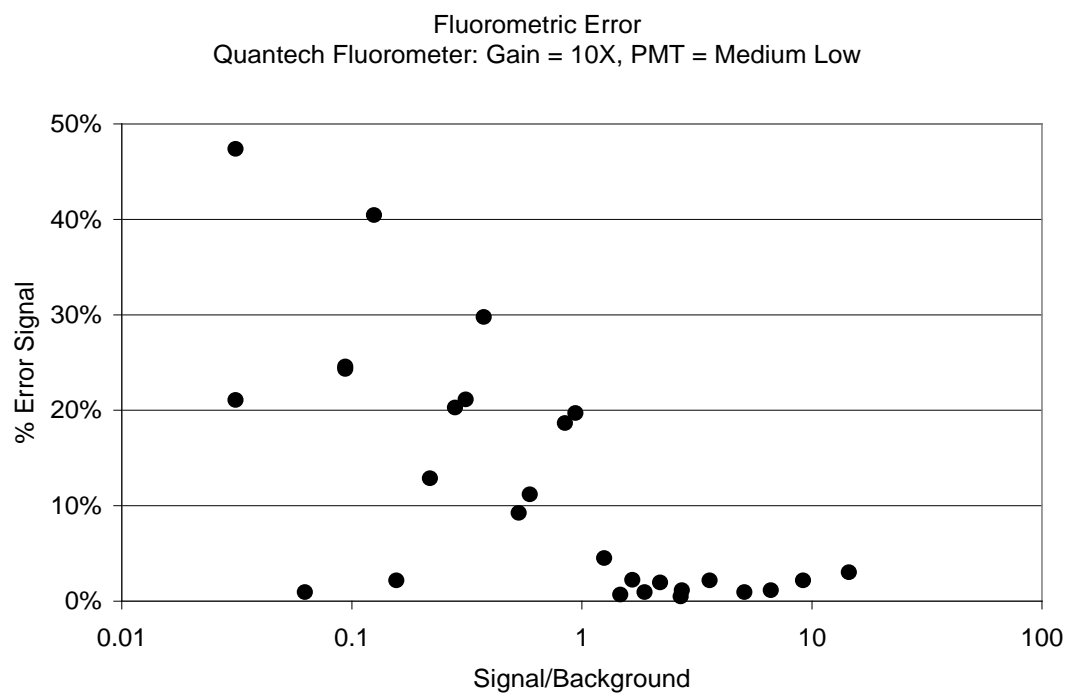


Methods



QAQC for low signal differed from previous studies

C_{in}

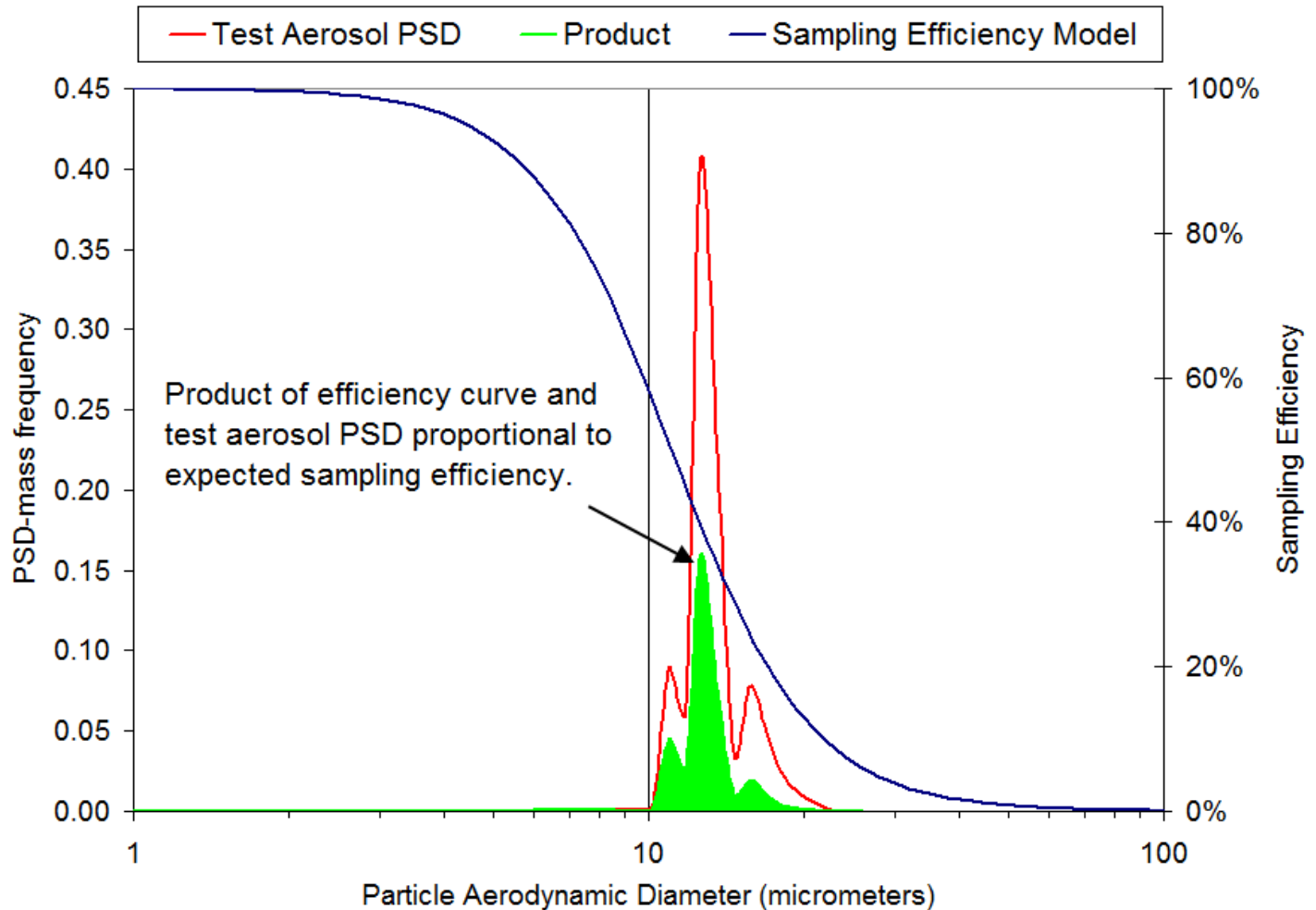


Multiplet/Satellite Correction

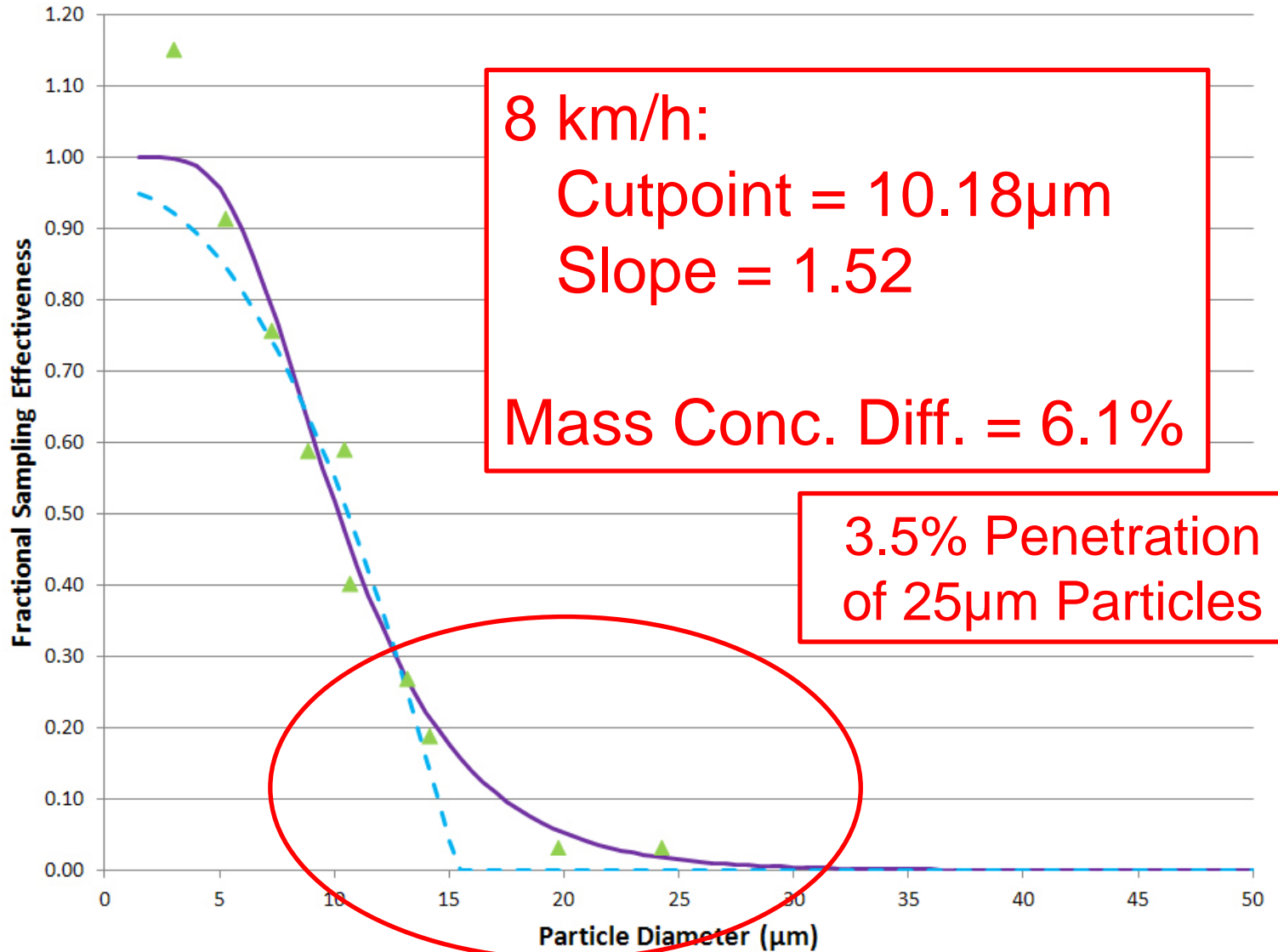
- Subpart D
 - Microscopically count doublets and triplets
 - Ignores satellites
 - Limited sample size
- TAMU Method
 - Use APS to quantify distribution
 - Correct for particle stretching



Multiplet/Satellite Correction



Results



Results

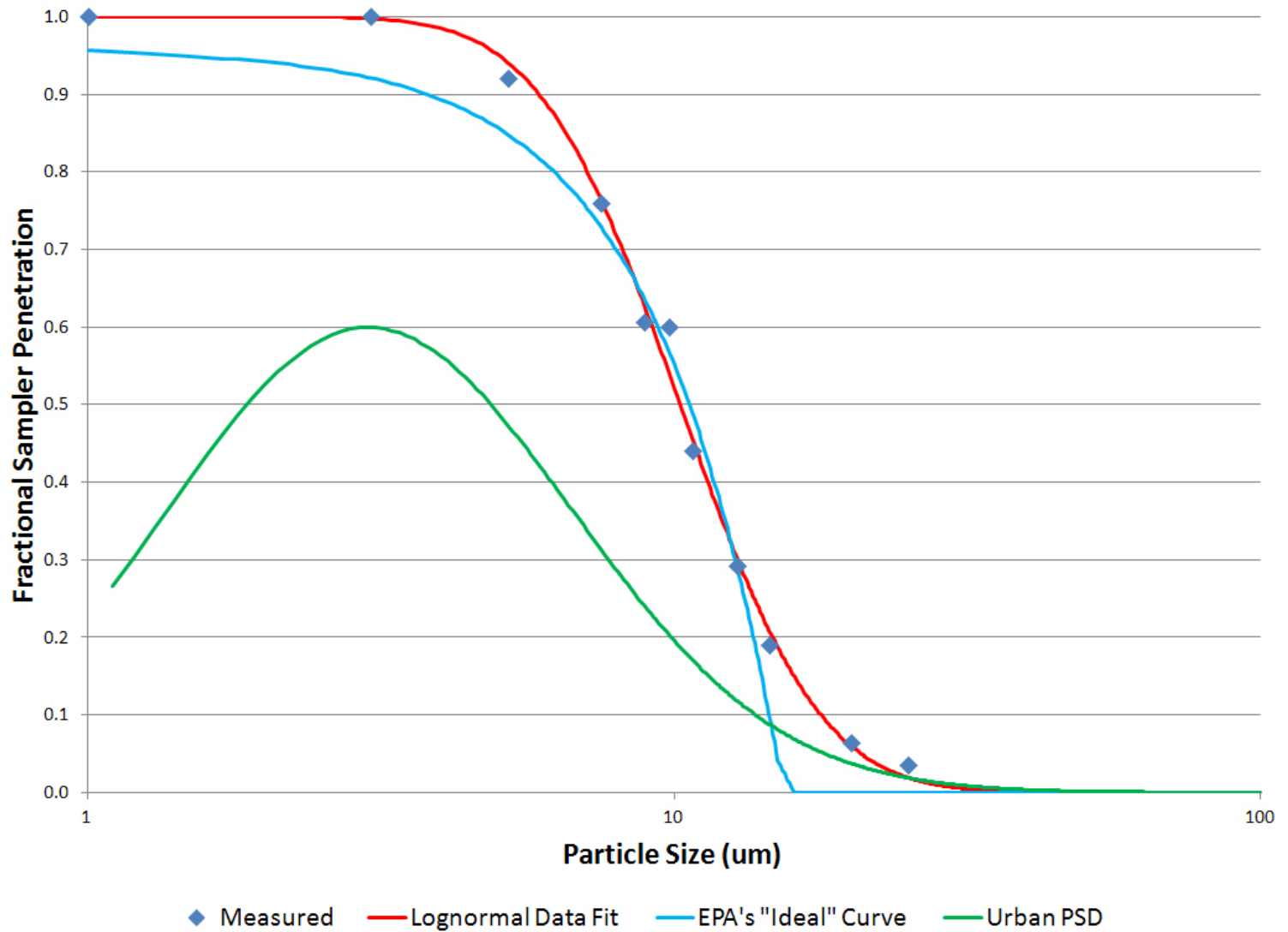
Large Particle Penetration

Wind Speed	20 μ m Particle	25 μ m Particle
FRM “Ideal” Sampler	0%	0%
2 kph	0.5 \pm 0.3%	0.01 \pm 0.01%*
8 kph	3.4 \pm 2.8%	3.5 \pm 0.8%
24 kph	5.4 \pm 3.3%	4.0 \pm 1.2%§

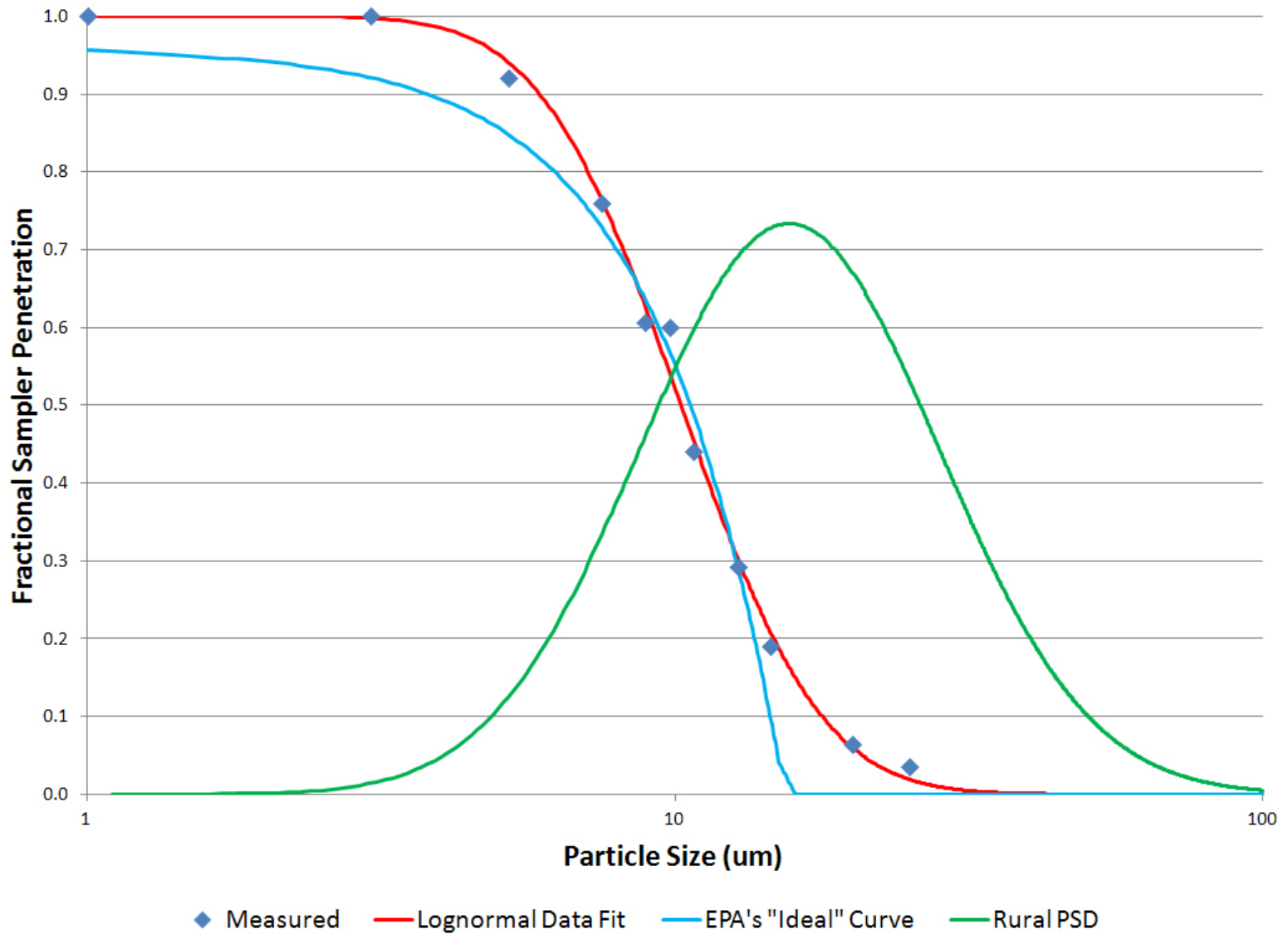
*Not statistically different than “zero”

§ Preliminary data

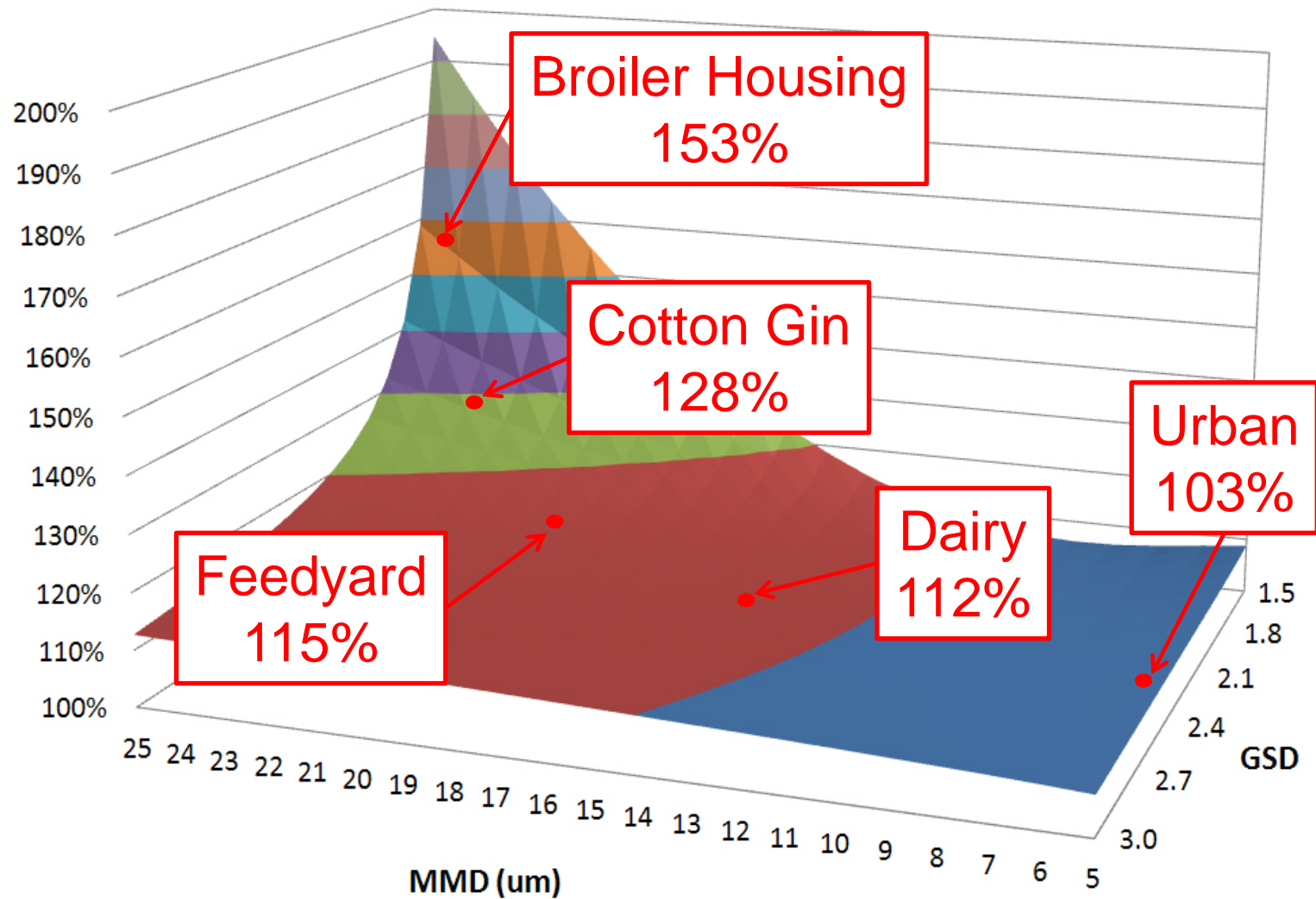
Implications



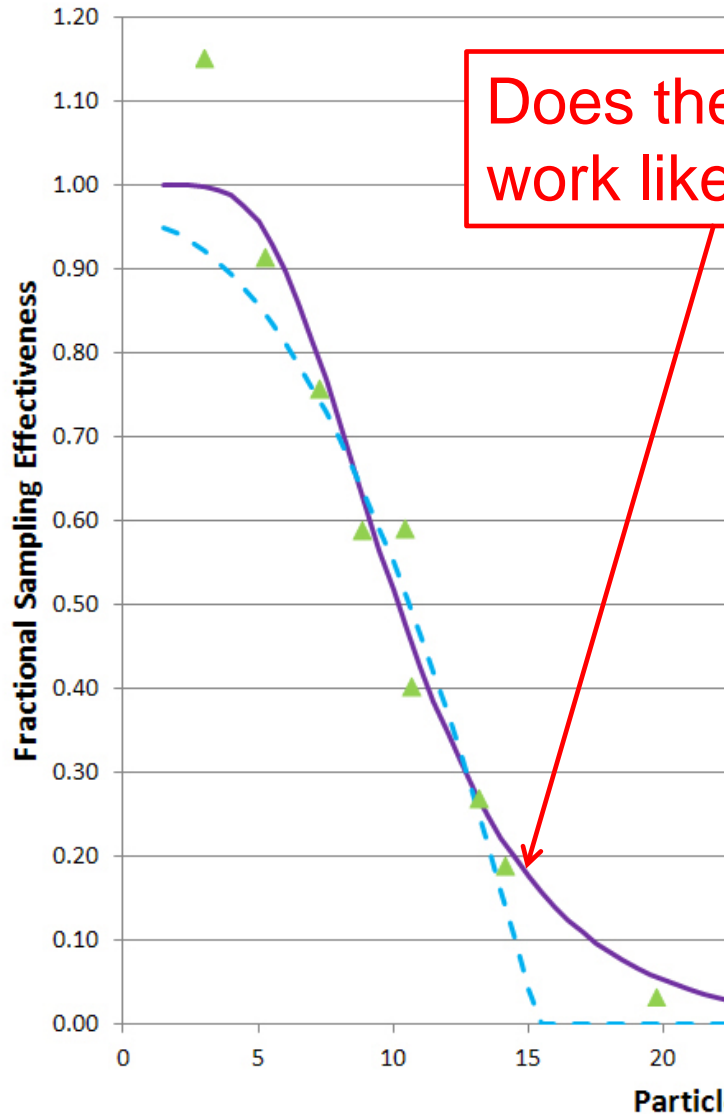
Implications



Measured Performance / "Ideal"



Implications/Questions

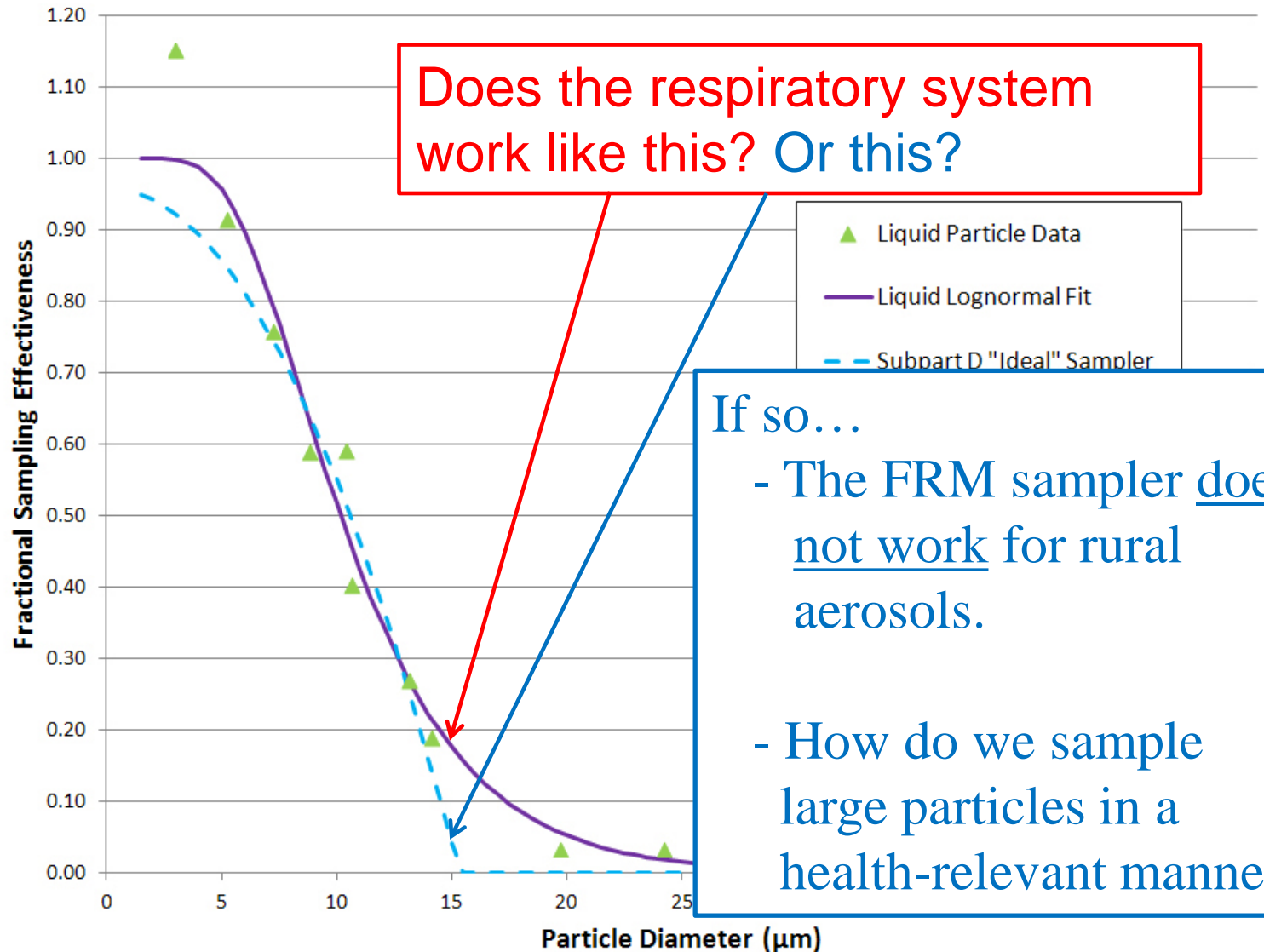


Does the respiratory system work like this?

If so...

- Maybe the FRM sampler is okay for rural aerosols.
- What are the chemical or physical features of ag aerosols?
- At what point does penetration approach “zero”?

Implications/Questions



Respiratory Modeling

Large Particle Penetration (Sampler)

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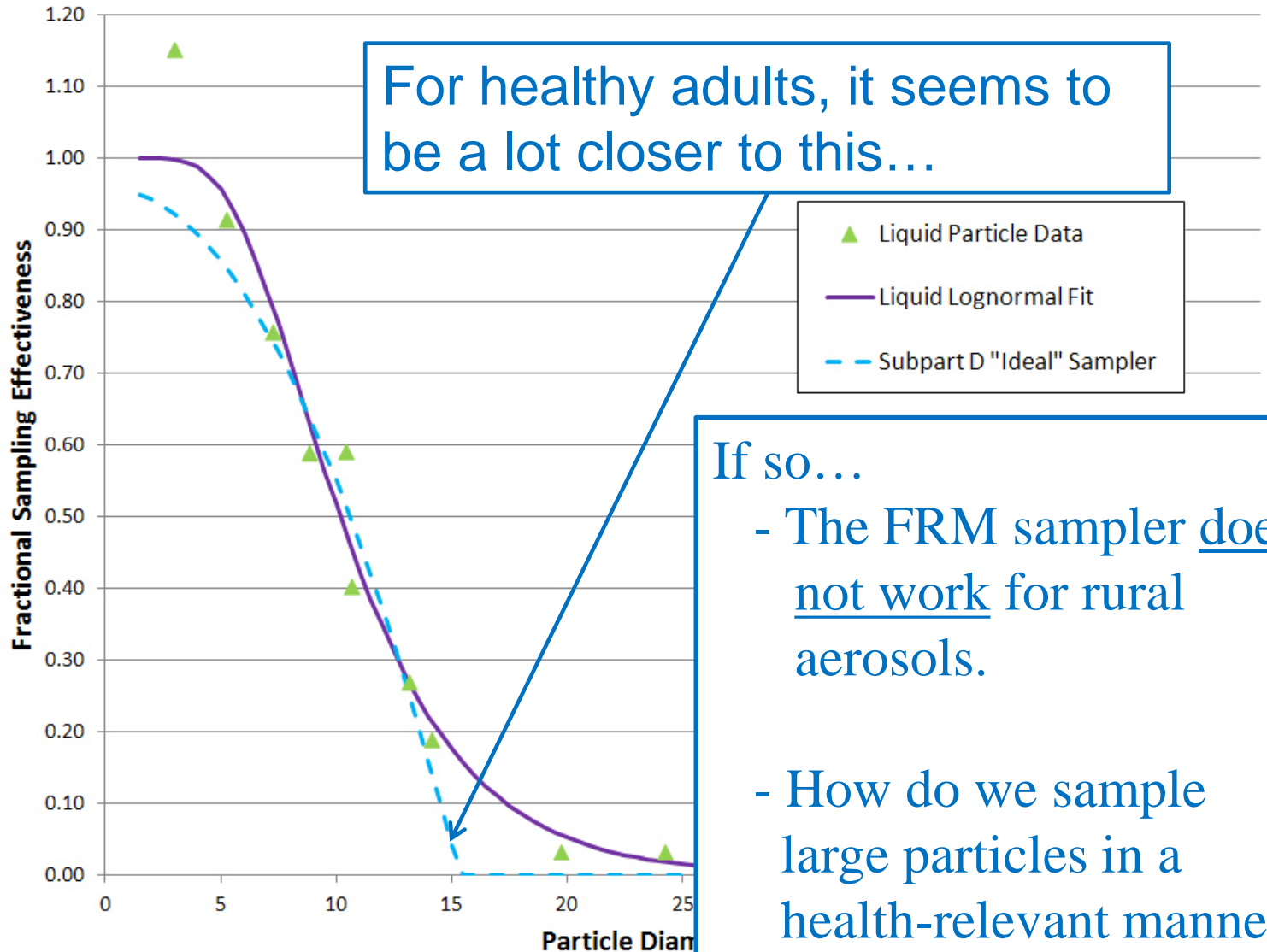
§ Preliminary data

Respiratory Deposition Model[#] Simulation

Fraction	16 μ m	20 μ m	25 μ m
Extra thoracic	99%	99.6%	99.9%
Tracheobronchial	0.962%	0.367%	0.132%
Pulmonary	0.0057%	0.0002%	0.000003%

[#] Multiple-Path Particle Dosimetry Model; Applied Research Associates, Inc.

Implications





Possible Path Forward

- Review new data with Dr. Vanderpool
- Is a Subpart D test similar to Subpart F testing more appropriate?
- What is leading to the penetration of large particles? What can be done about it?



Thanks...

- Cotton Foundation
- Texas AgriLife Air Quality Initiative
- Bob Vanderpool/EPA
- RTI for technical discussions
 - Seung-Hyun Cho
 - Christie Sayes
 - Quentin Malloy