The MATERHORN Fog Aerosol Sampling System (FASS)

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Outline

- The FASS Concept

  Basis of Concept; Proof of Design and Testing

- The MATERHORN FASS

  UAV Design; CAD/CAM; Sensors; Circuit; Calibrations; Modeling

- Tower FASS

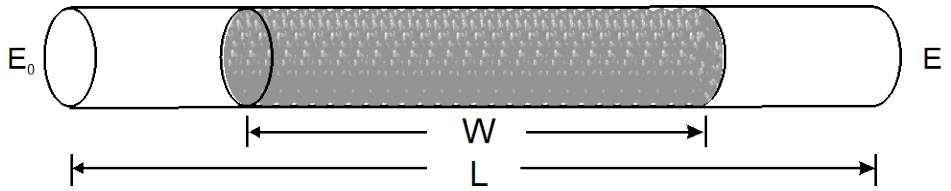
Reference Report: The MATERHORN Fog Aerosol Sampling System, PF Dunn, May 2013

Fog Characteristics

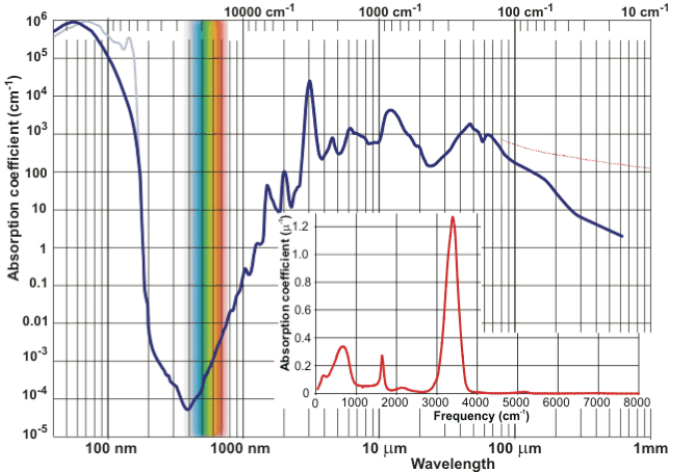
- Fog: ~1 μm to 100 μm diameter condensed water droplets
- Many types (ground, advection, …)
- Reported measured fog concentrations range from ~10 #/cm^3 to ~10^4 #/cm^3
- Reported fog droplet diameters from ~0.5 μm to 50 μm
- Diameter distribution mostly lognormal

Concept Basis

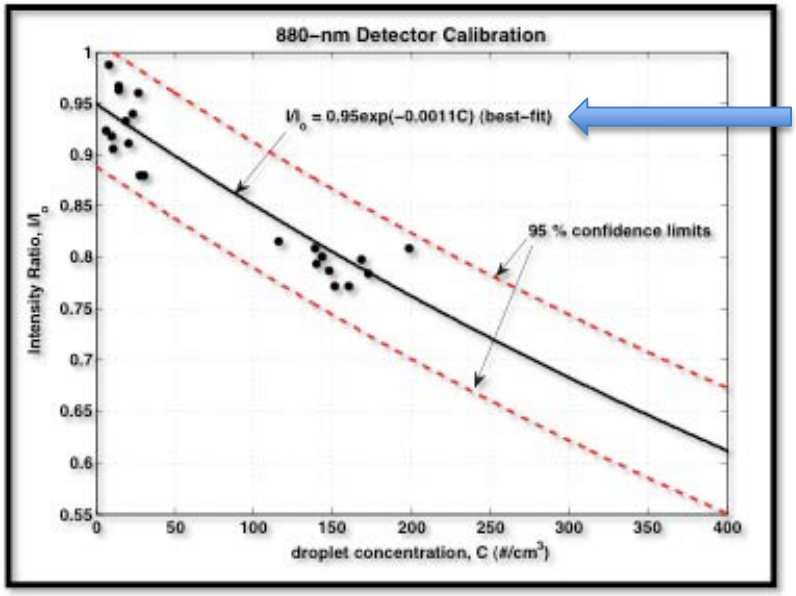
- IR light attenuation & the Lambert-Beer law



(σ: extinction coefficient)

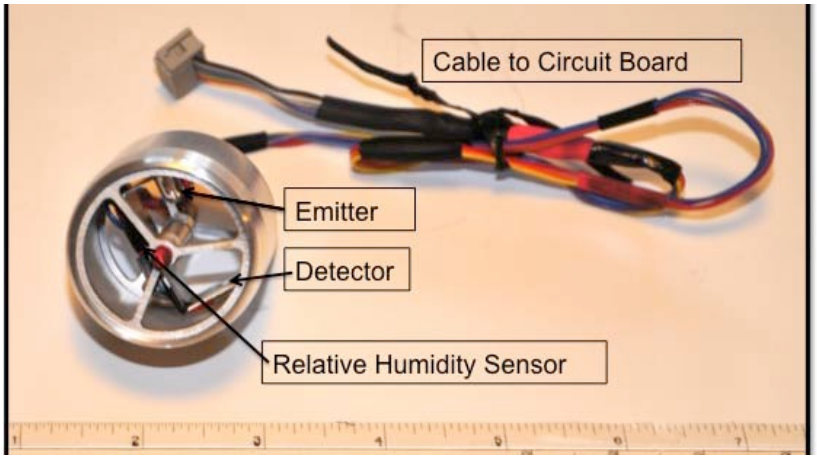


sufficient IR absorption at 880 nm for FASS design

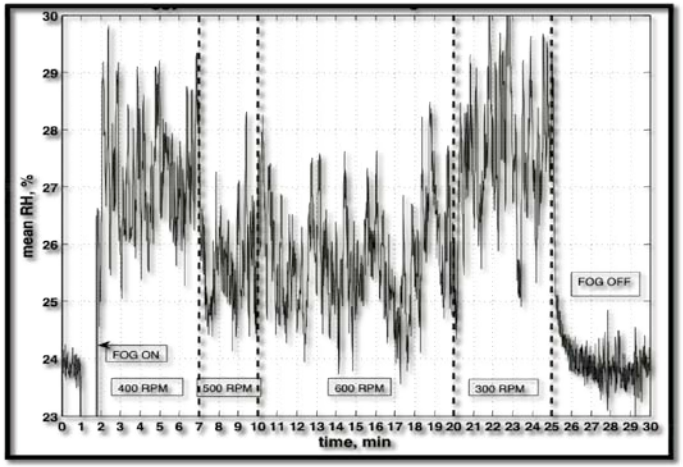


C_{fog}

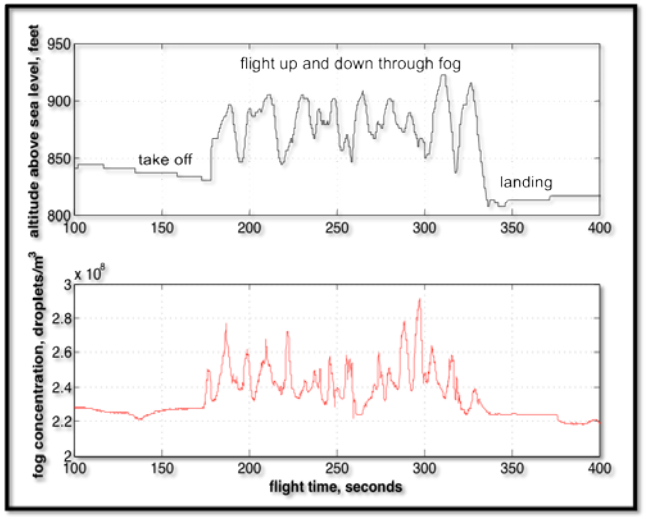
Proof of Design and Testing



Wind Tunnel Tests

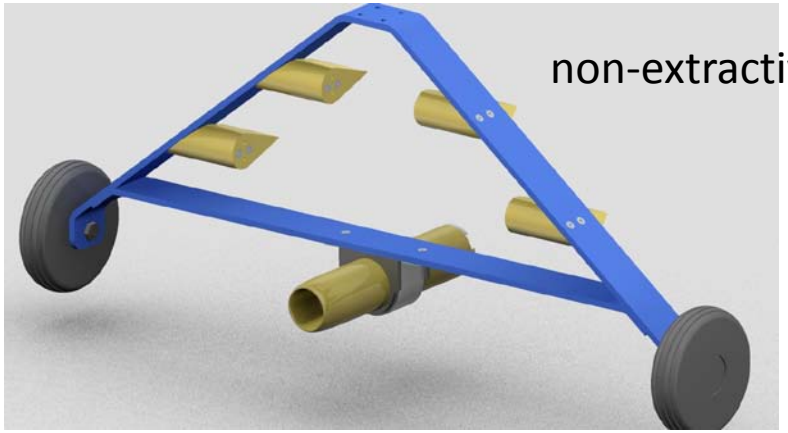


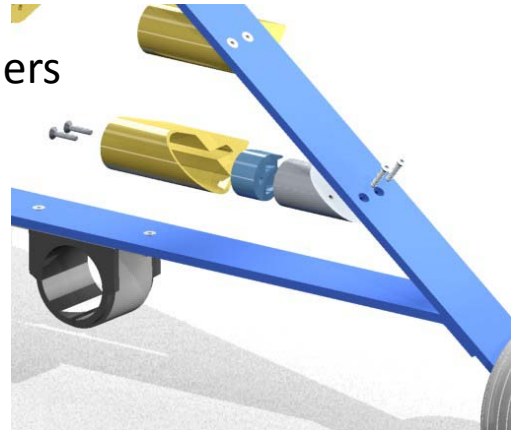
Flight Tests



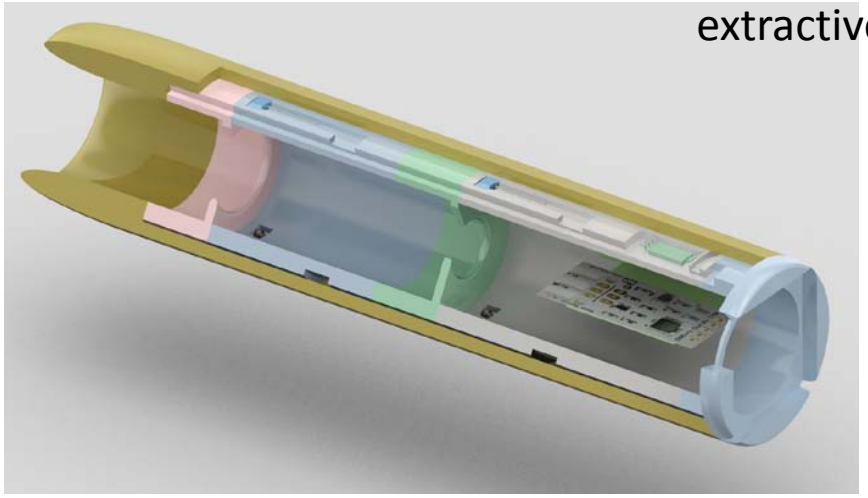
UAV Design and Its CAD/CAM

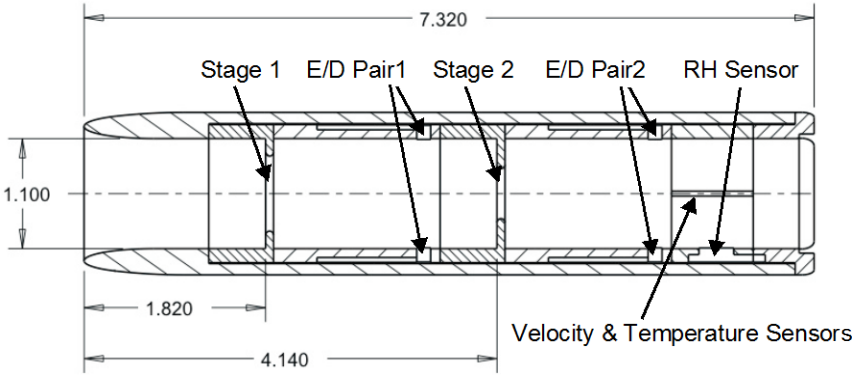
non-extractive samplers





extractive sampler



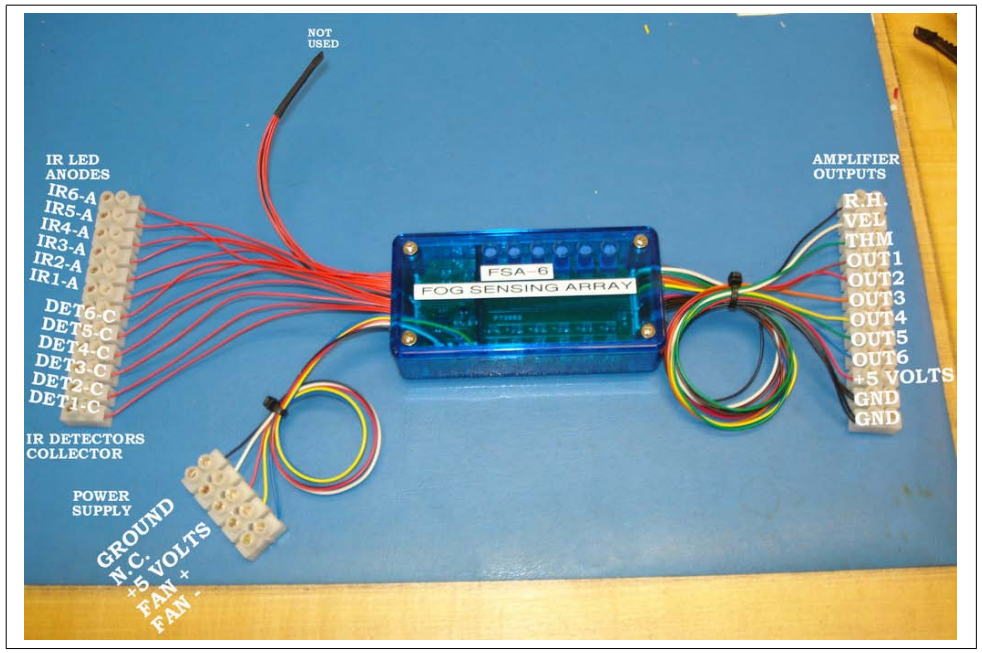


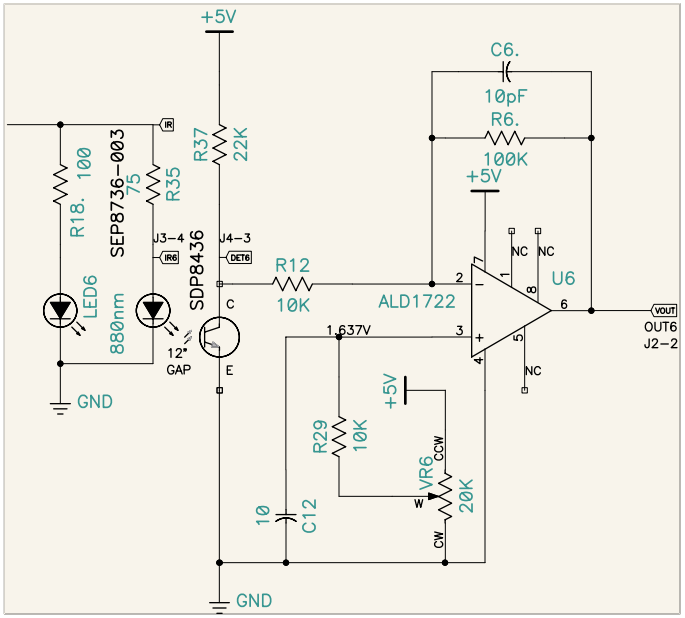
Sensors

- Non-Extractive Sampler:
  - 4 E/D pairs >> 4 duplicated measures of C_{total}
- Extractive Sampler:
  - 2 E/D pairs >> diameter-partitioned C >> diameter distribution function using sampler stage transmission efficiencies and C_{total}
  - Sampler Internal Velocity, Temperature
  - Air % Relative Humidity

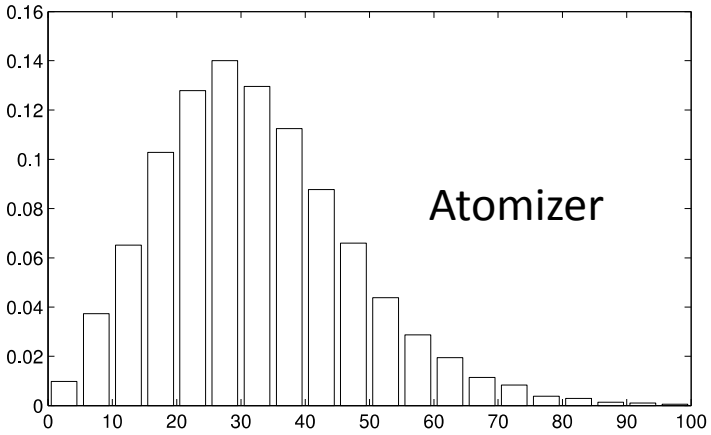
FASS Circuit

- 5 V dc supply; 0 V to 5 V dc sensor outputs; <50 mA current required
- 60 Hz, 10 % duty-cycle driven emitters

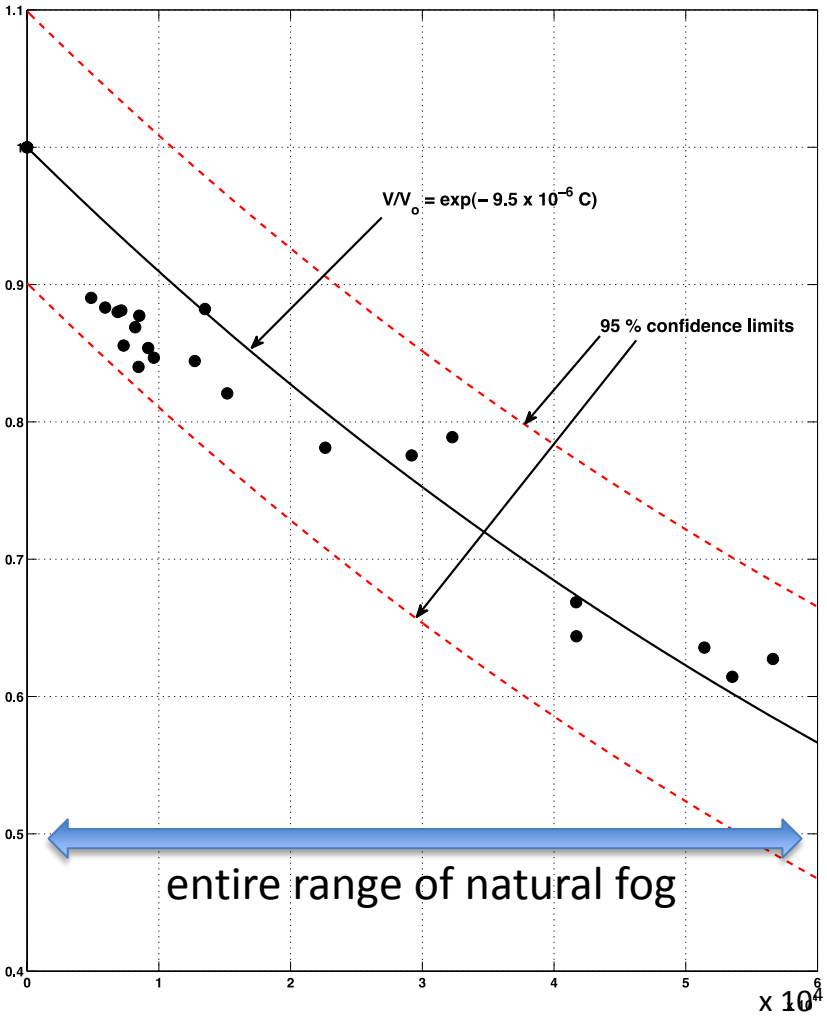




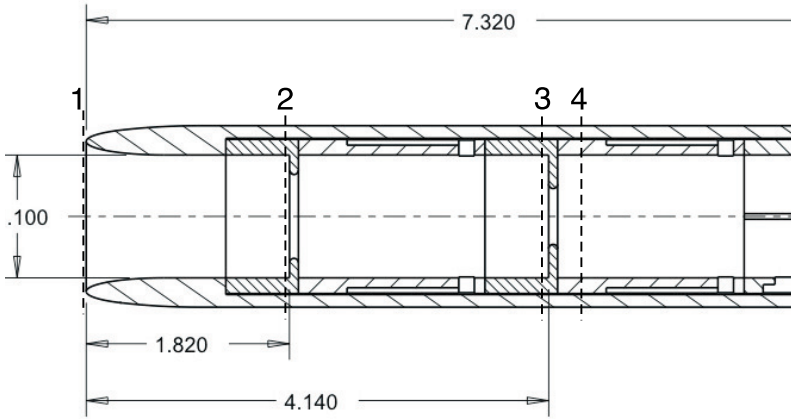
Laboratory Calibrations

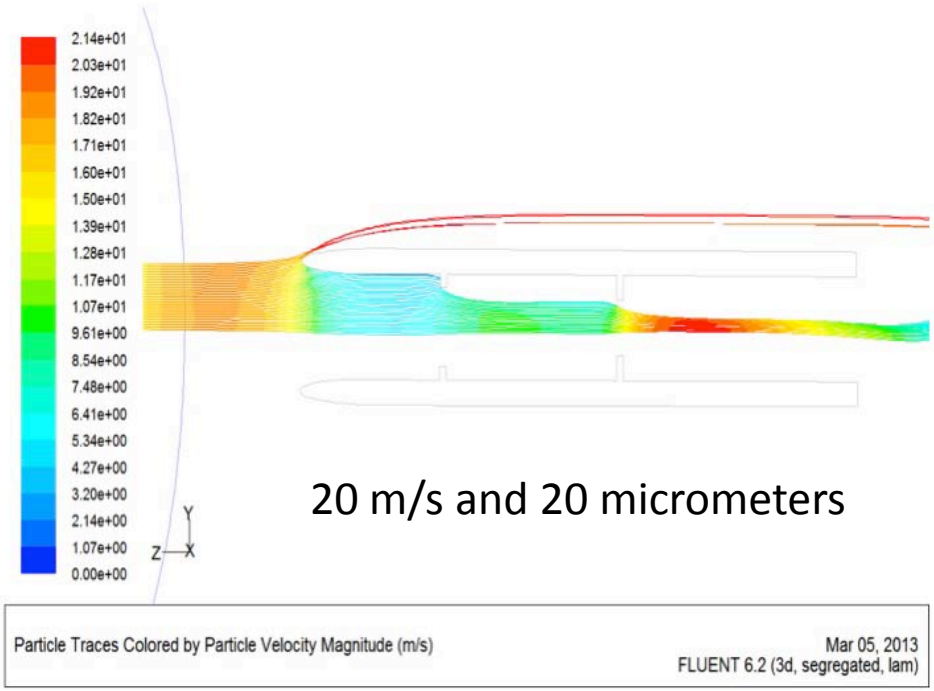


Ultrasonic Humidifier

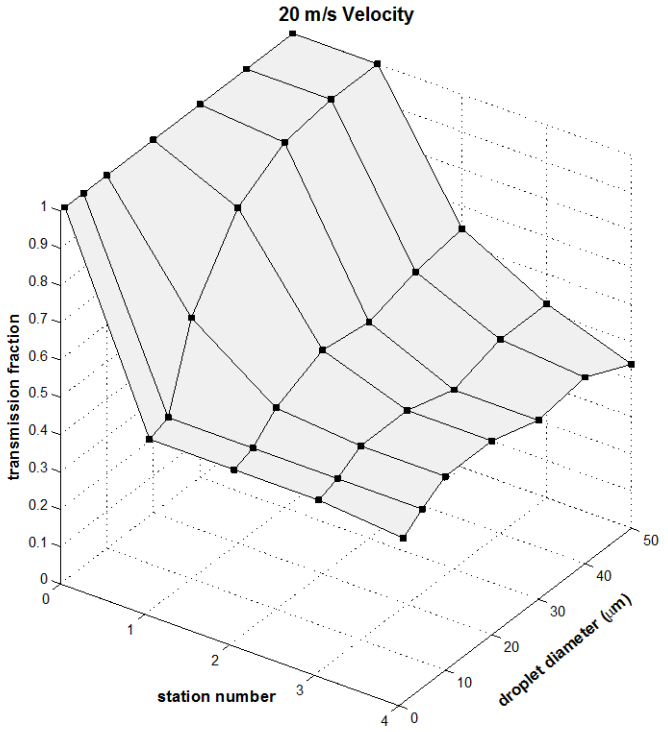


FLUENT Simulations



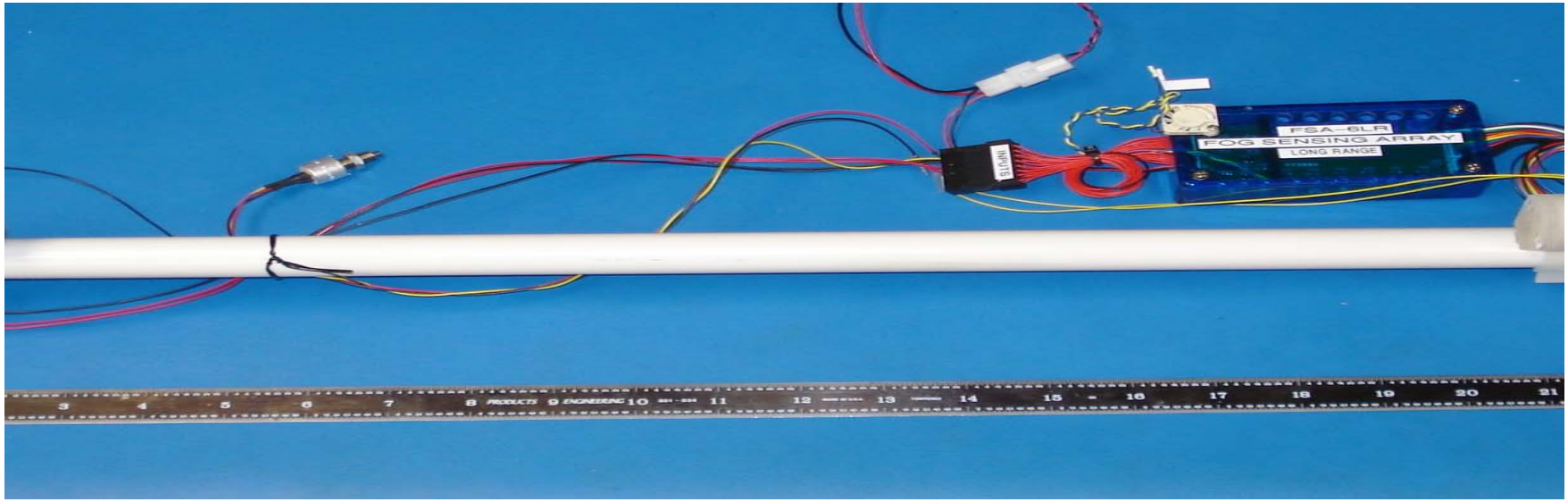


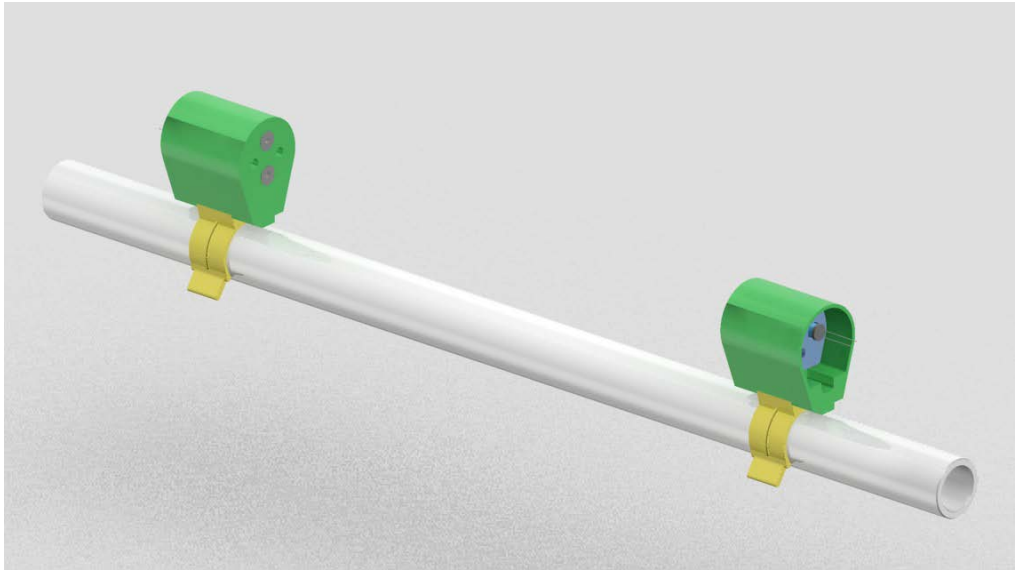
20 m/s and 20 micrometers



droplet transmission efficiencies

Tower FASS





Conclusions

- The MATERHORN FASS is ready for deployment.

Bring on the fog!

Measurement Scheme

$$E_d / E_{d_{nofog}} = \frac{V_{out} - k_4}{V_{out_{nofog}} - k_4}$$

c

Increasing blockage