

Background

Problem

- Aerosols are small liquid or solid particles suspended in the air
- Contrails (ice crystals that form on the aerosols emitted from aircraft engines) trap heat in the atmosphere, contributing to global warming
- Boeing researches emissions produced by jet engines using advanced aerosol sensing instruments fitted to test aircraft
- Calibration is currently done externally
 - Extended downtime & high cost

Boeing's Instruments

- Condensation Particle Counter (CPC)
 - Condensing fluid grows aerosol particles
 - 0.007-2 μm
- Cloud & Aerosol Spectrometer (CAS)
 - Scattering detection methods
 - 0.51-50 μm

Our Task

- Design calibration and test system for advanced aerosol sensing instruments
- Produces, mixes, and delivers aerosols to instruments with high accuracy and repeatability

Specs & Requirements

Mixing Chamber

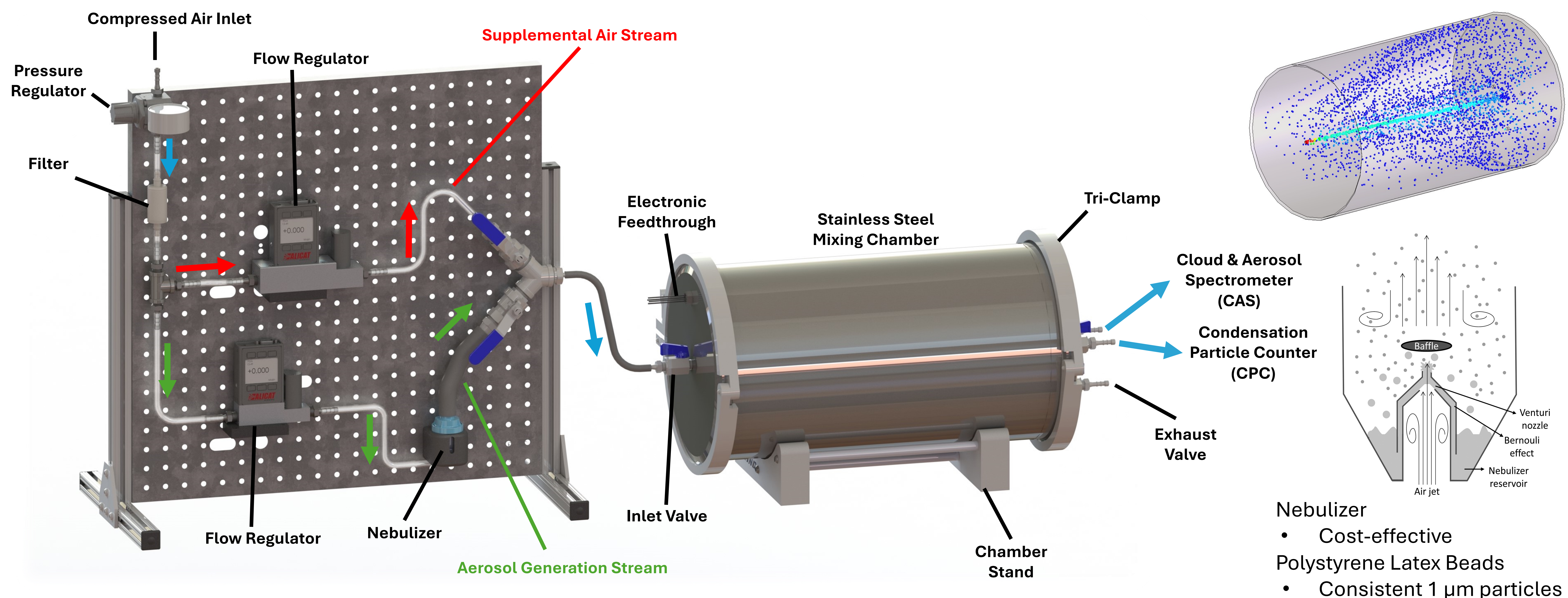
- Particle **concentrations** must be within **15% of the chamber mean** at all points within the chamber
- Weigh less than 100 lb. and fit within a 4' x 4' x 3' space
- Live monitoring (Temperature, Humidity, Pressure)
- No leaks
- Expense constraint arising from the unique nature of components

Aerosol Generation

- Generate particles with 1-micron diameter
- Achieve particle concentrations up to 5,000 particles per cubic centimeter
- Generate aerosols at variable flow rates
- Able to safely purge chamber of aerosols

Thank You: Dominick Heskett, Handix Scientific, Greg Potts, Julie Steinbrenner, Mike Hannigan, Percy Smith, Sam Sankhyam, Shelly Miller, Sean Benjamin, Caroline Frishmon, Andrew Garcia

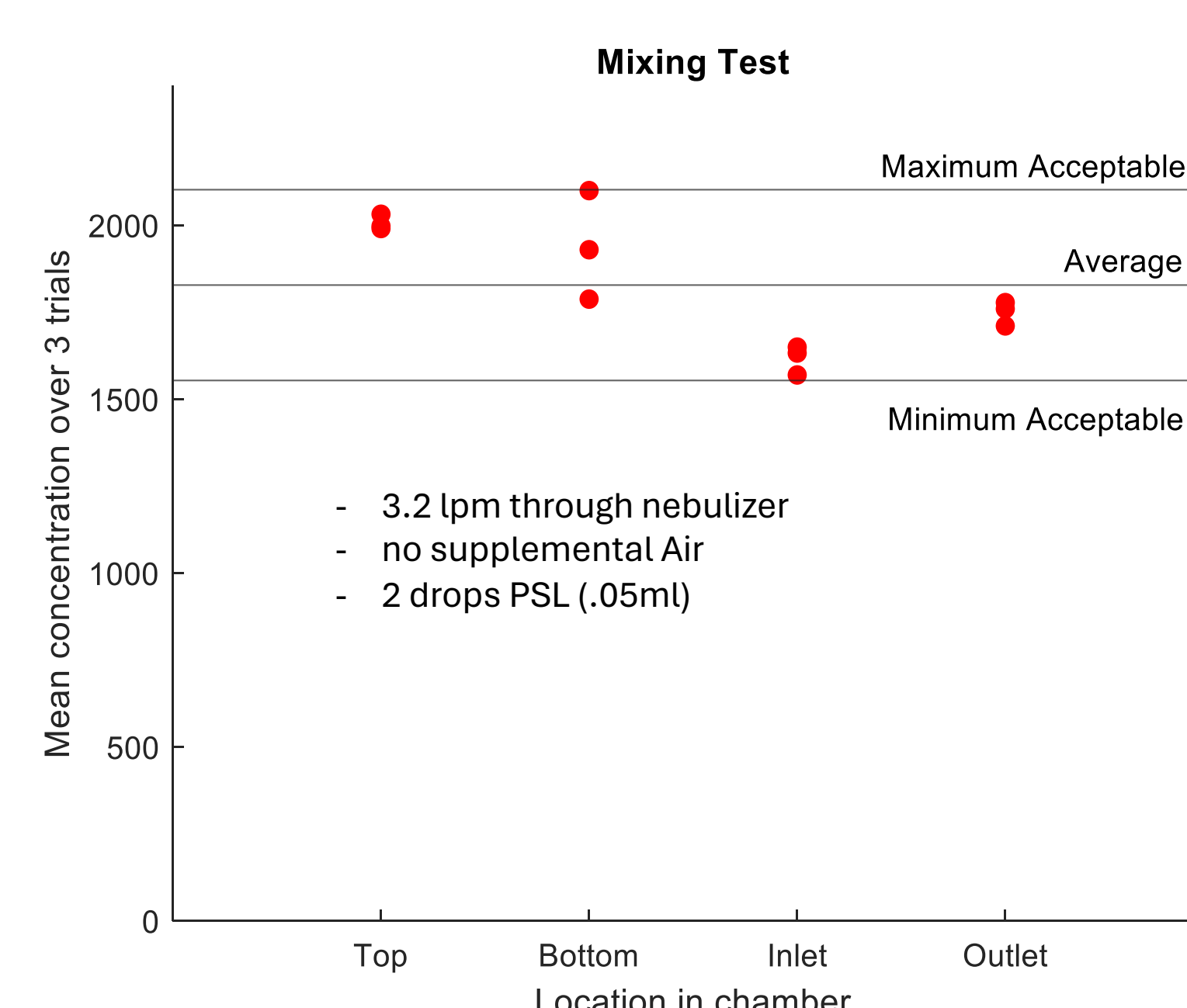
Design



Testing Results

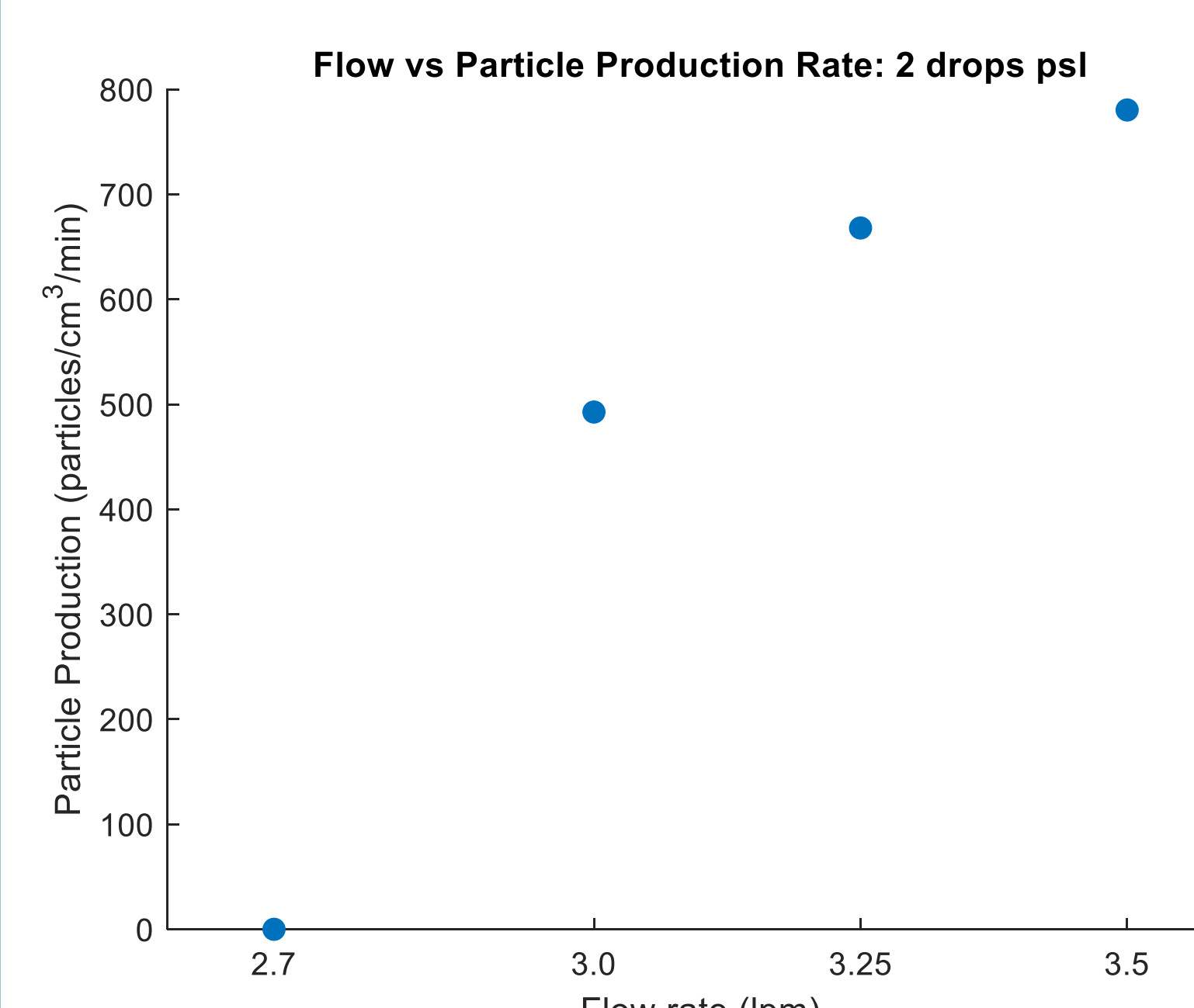
- ✓ **Cleanability Test** – Isopropyl alcohol valid cleaning agent
- ✓ **Leak Test** - No detectable leaks over multiple tests
- ✓ **Filter Test** - Filter effectively reduced particles in intake
- ✓ **Reliability** – Results of previous tests were observed to be similar over multiple dates

Mixing – Aerosols in chamber were evenly distributed

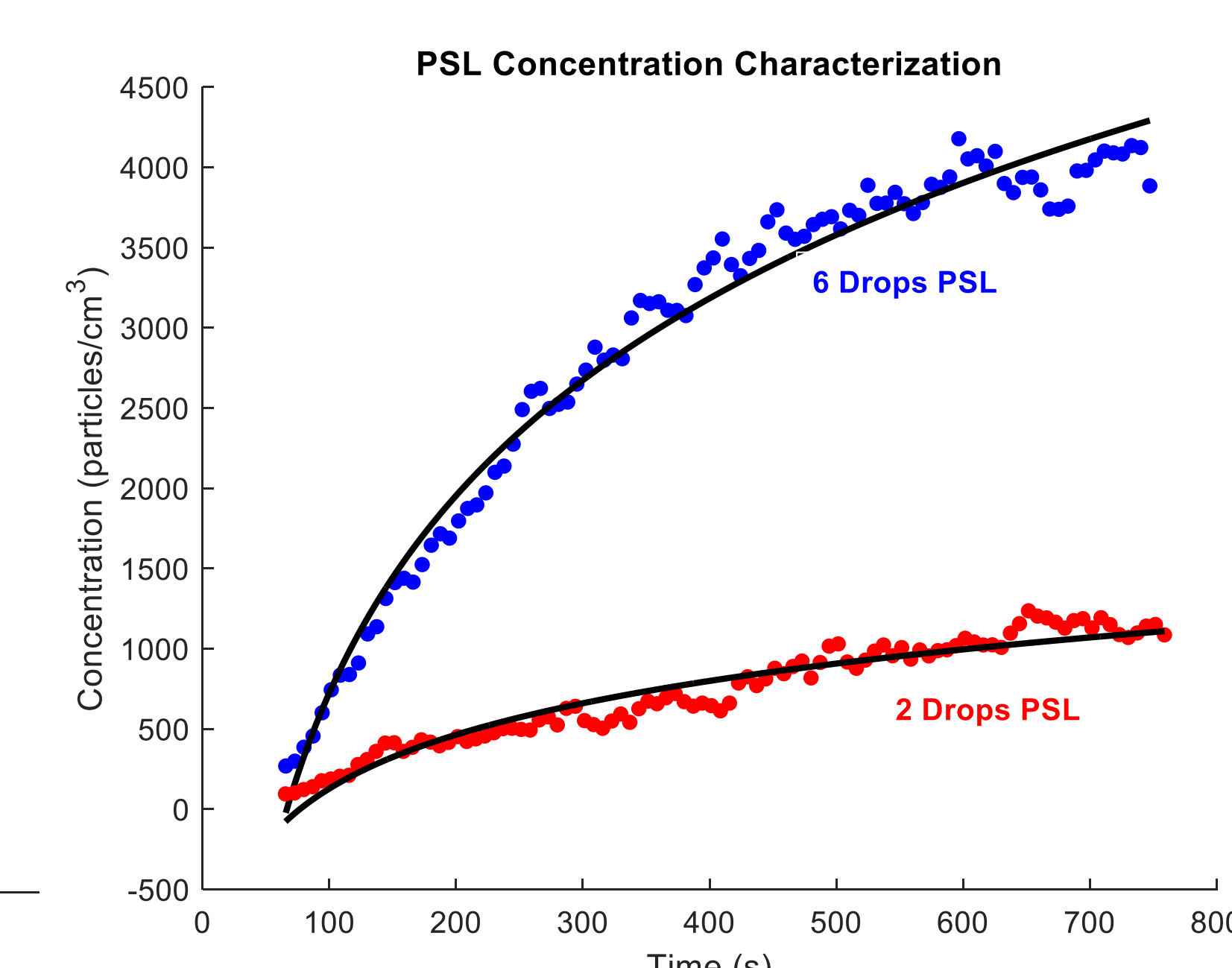


- Concentrations were within spec at all locations within the chamber

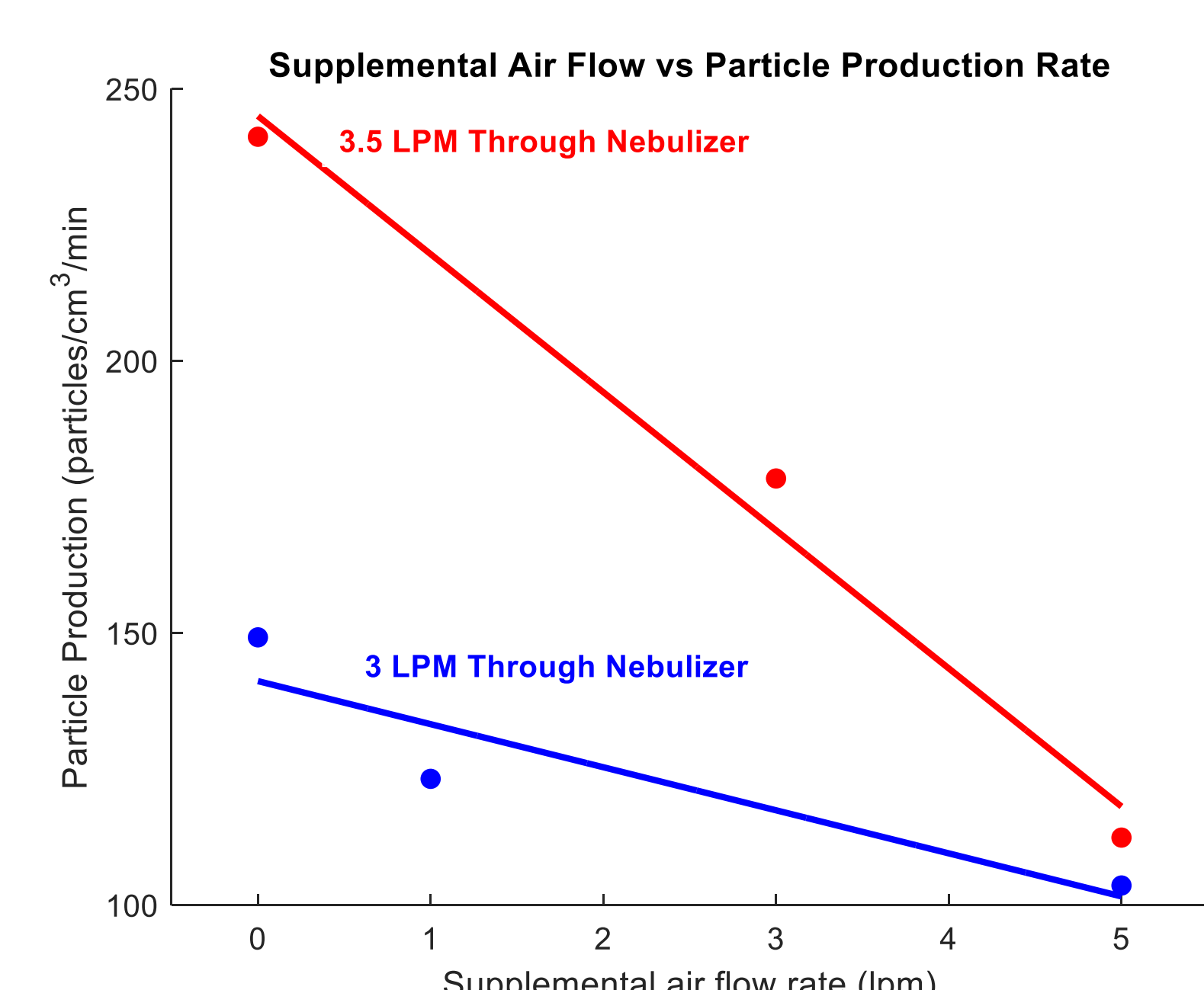
Aerosol Generation Characterization – The aerosol generation system was characterized and documented for future use



- The particle production rate increases logarithmically with increased flow through the nebulizer



- The particle concentration over time in the chamber is also defined by logarithmic curves



- Supplemental air flow dilutes the concentration in the chamber linearly

Impact and Continuing Efforts

- System versatility allows researchers to modify the device for specialized projects (commercial aerosol generator, diffusion dryer, etc.)
- Gives Boeing capabilities to perform in-house calibration, reducing downtime and increasing data collection capabilities
- Increases Boeing's research capabilities to more efficiently mitigate pollutants that impact global warming