Aerodynamic Aerosol Concentrators

Shawn Conerly
John S. Haglund
Andrew R. McFarland

Aerosol Technology Laboratory
Texas A&M University/Texas Eng. Exp. Station

Presented at:
Joint Services Scientific Conference on
Chemical and Biological Defense Research
Towson, MD

November 19, 2003

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
19 NOV 2003	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Aerodynamic Aerosol Concentrators	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Aerosol Technology Laboratory Texas A&M University/Texas Eng. Exp. Station**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001851, Proceedings of the 2003 Joint Service Scientific Conference on Chemical & Biological Defense Research, 17-20 November 2003. , The original document contains color images.

14. ABSTRACT

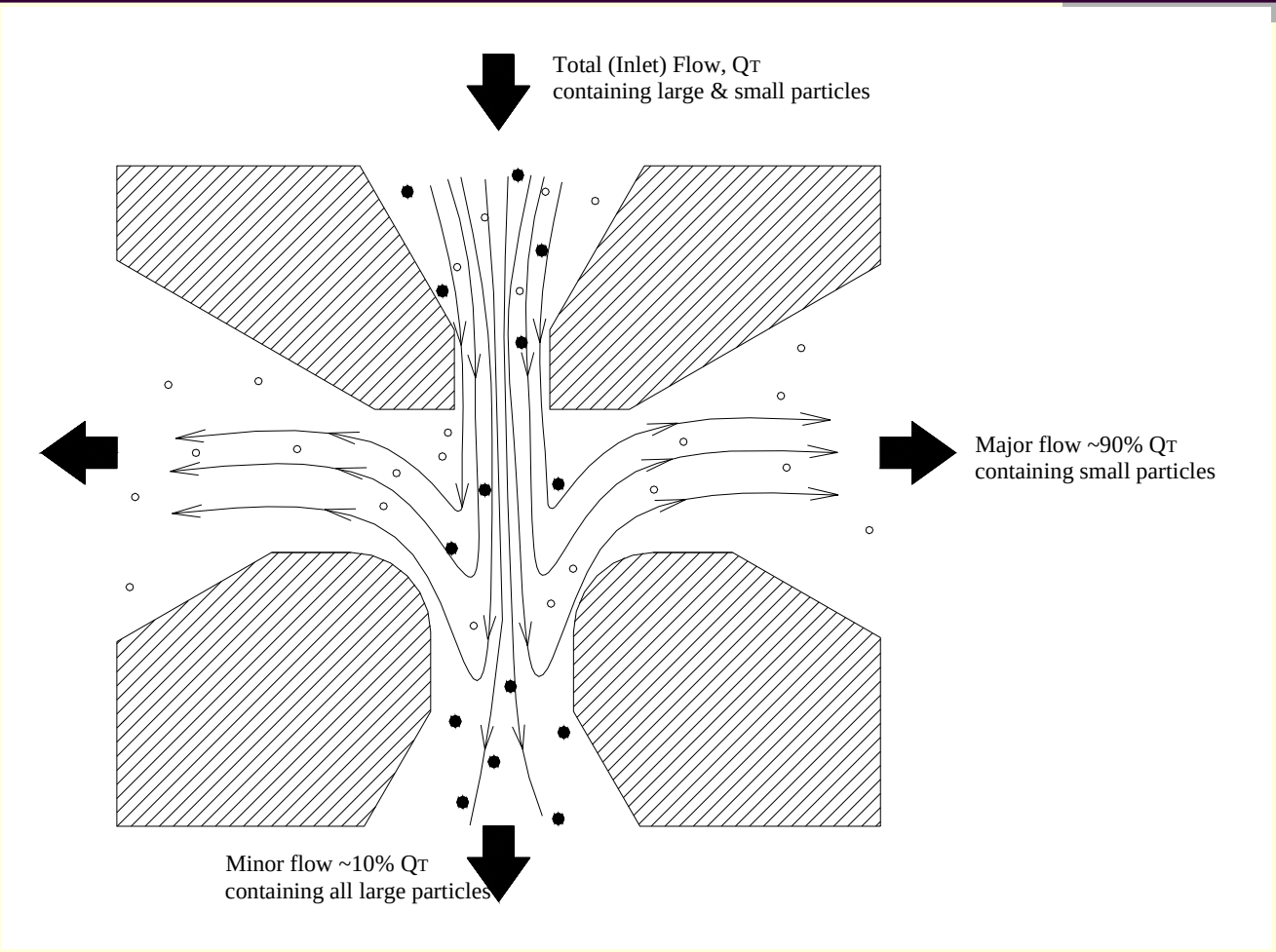
15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**20**	

Overview

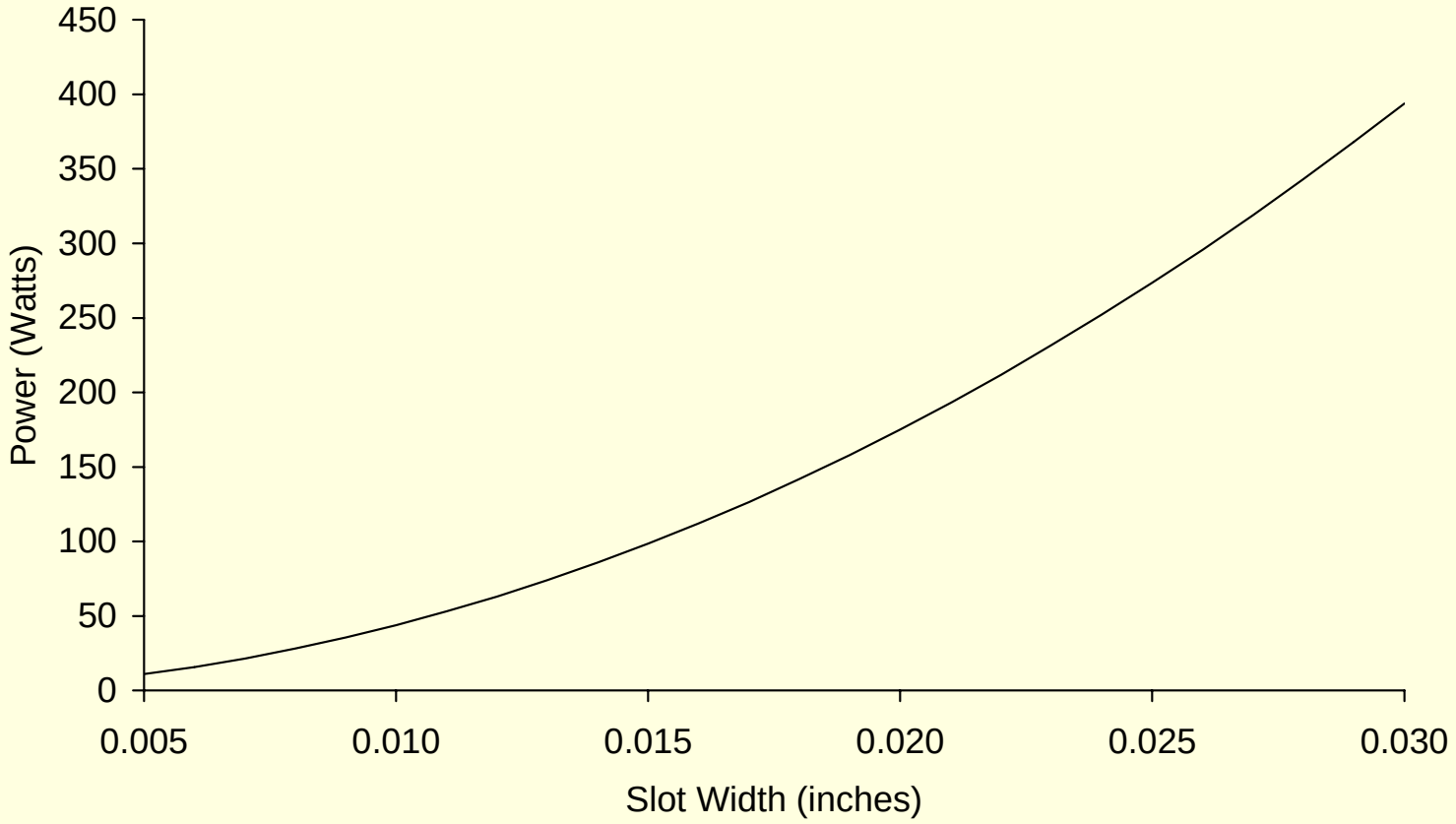
- **Detector Considerations**
  - Response threshold on the order of 10^4 particles.
  - Air handling system is a major power consumer in the detector system.
- **Goal:** Develop High-Throughput, Low-Power Bioaerosol Concentrators.
- **Slot-Nozzle Virtual Impactors**
  - Smaller nozzle dimensions reduce power consumed for fixed cutpoint and flow rate concentrator.
  - Slot nozzles are easier to manufacture for high through-put and resist fouling to a greater degree than round nozzle virtual impactors.
- **Prototype Devices**
  - LSVI and CSVI Units
  - Wall loss mechanisms
    - Misalignment of acceleration and receiver nozzle.
    - Receiver nozzle profile.
    - Acoustic resonance.
  - Experimental Data
- **Research Plans**

Concept of Virtual Impaction



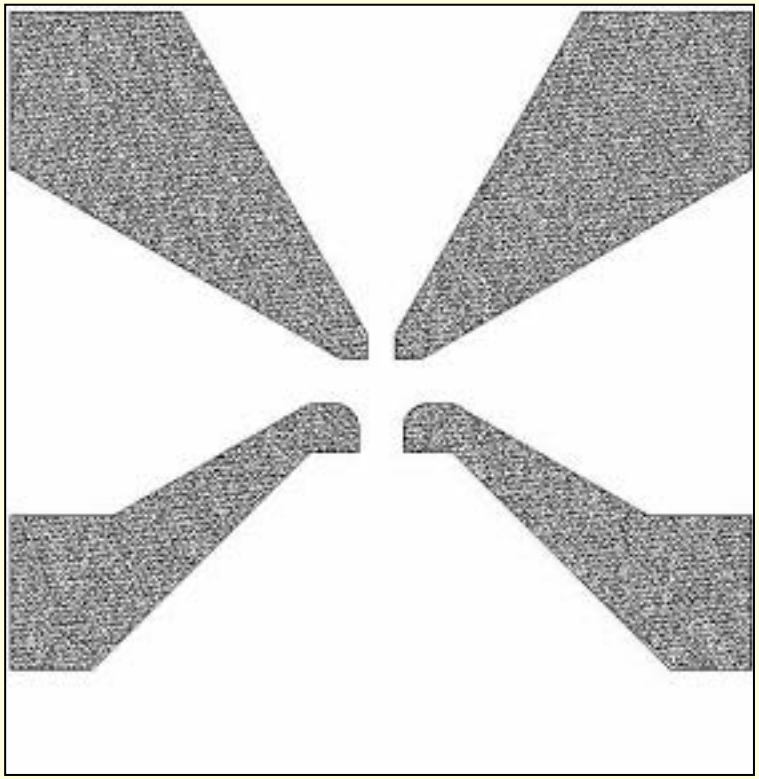
Theoretical Power

(slot nozzle virtual impactor operating at
500 L/min and with 0.8 μm AD cutpoint)



Texas A&M University AEROSOL
TECHNOLOGY LABORATORY

Nozzle Geometry of Current Slot Nozzle Prototypes



Acceleration nozzle width:
305 μm (0.012”)

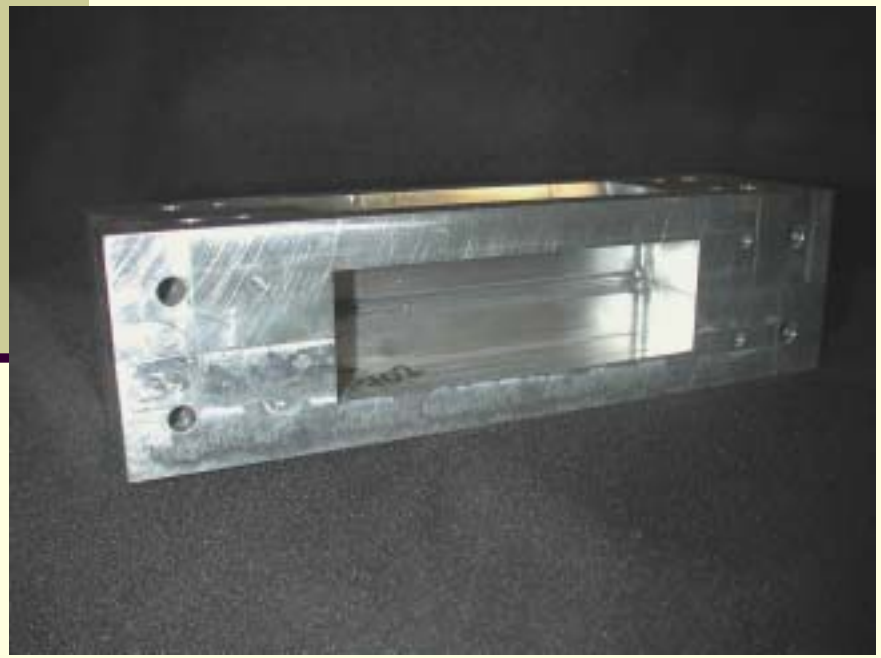
Receiver nozzle width:
457 μm (0.018”)

Slot length:
89 mm (3.500”)

Receiver nozzle taper:
Compound, 508 μm (0.020”) step, 60 degrees, full step

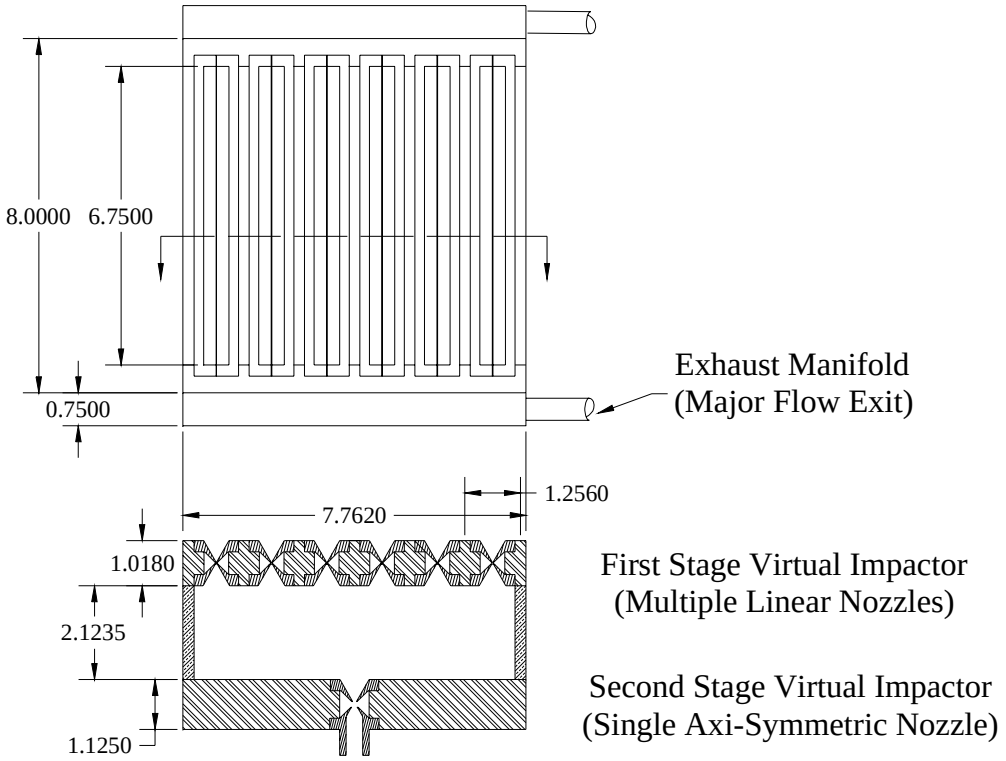
Prototype Slot Nozzle Virtual Impactors

- LSVI Prototype
- CSVI Prototype

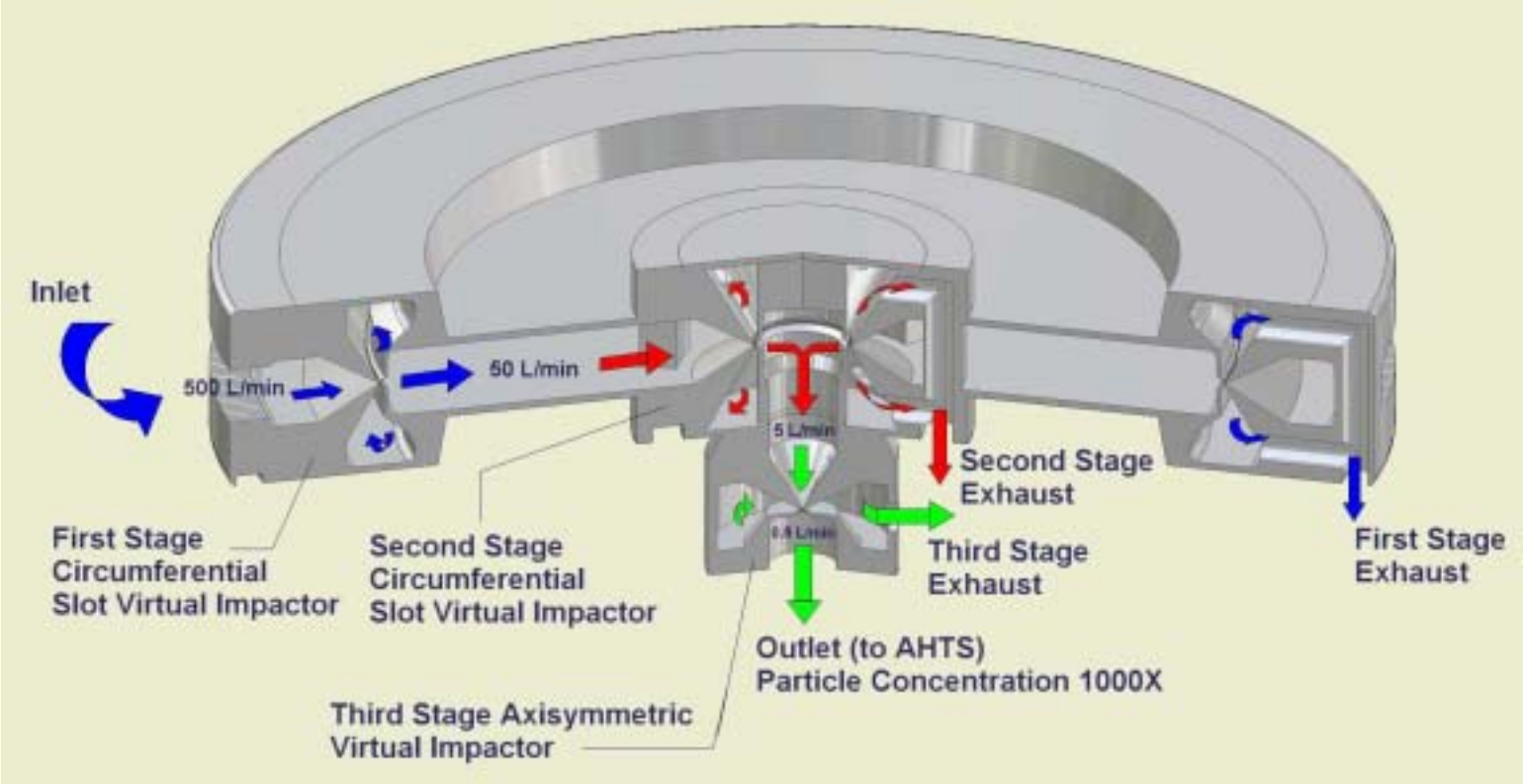


Multi-Stage LSVI Bioaerosol Concentrator

Plan and Cross-Section Views of
2 Stage Virtual Impactor



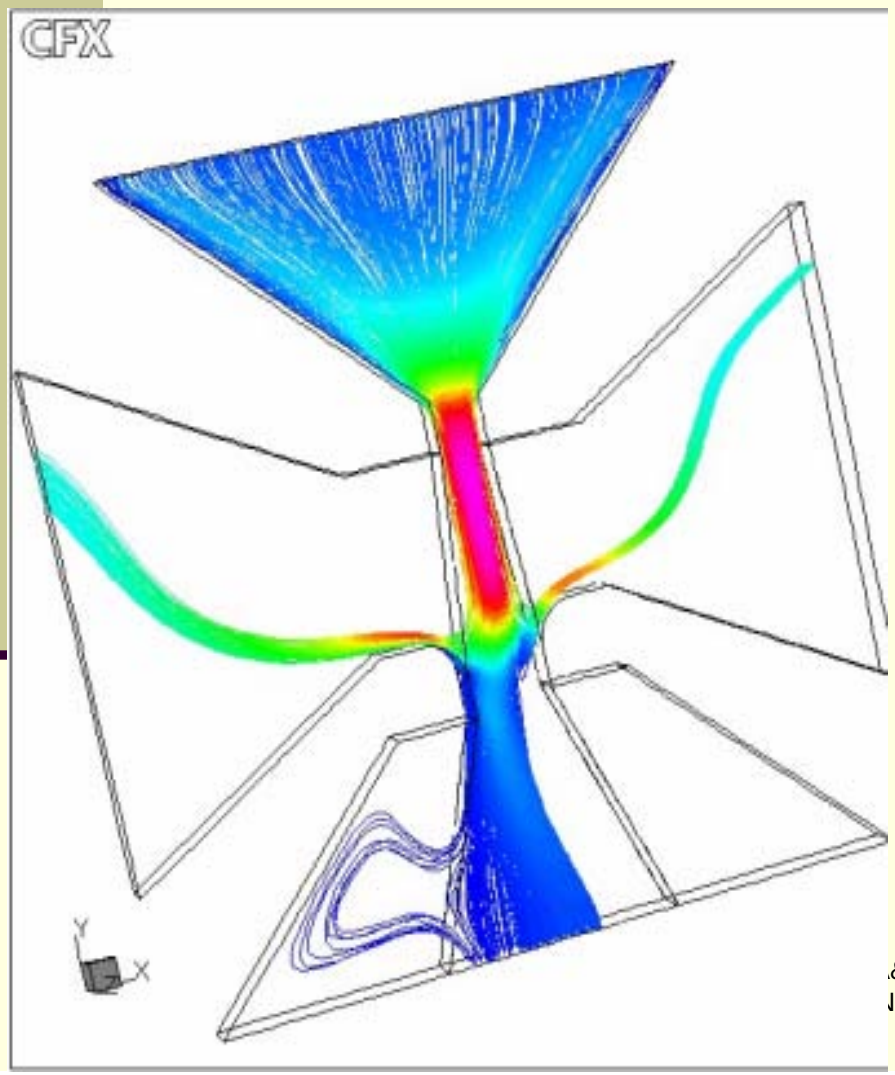
Multi-Stage CSVI Bioaerosol Concentrator

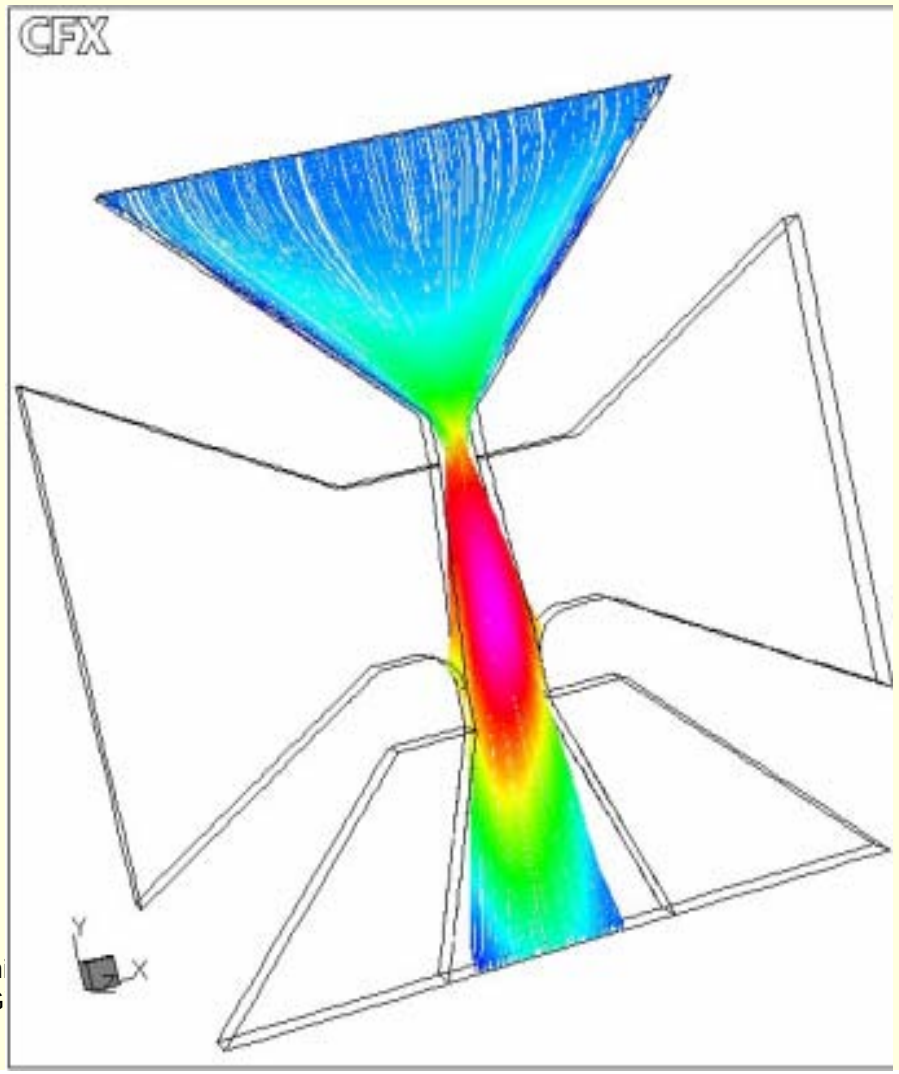


Comparison of Particle Deposition Evident on Receiver Nozzles Without (a) and With (b) Secondary Expansion

(a) (b)

Numerical Prediction of Particle Tracks (1.0 micron and 5.0 micron) with 0.002” Nozzle Misalignment

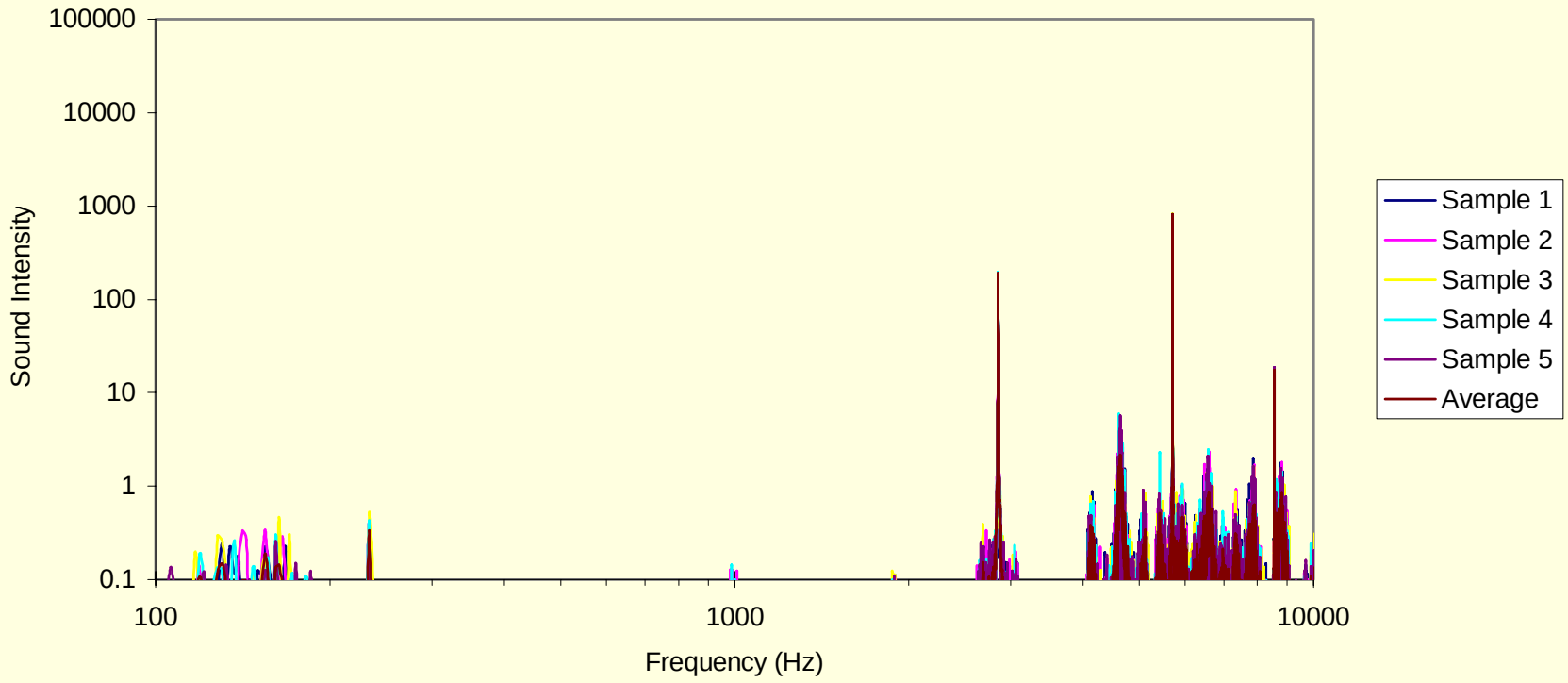




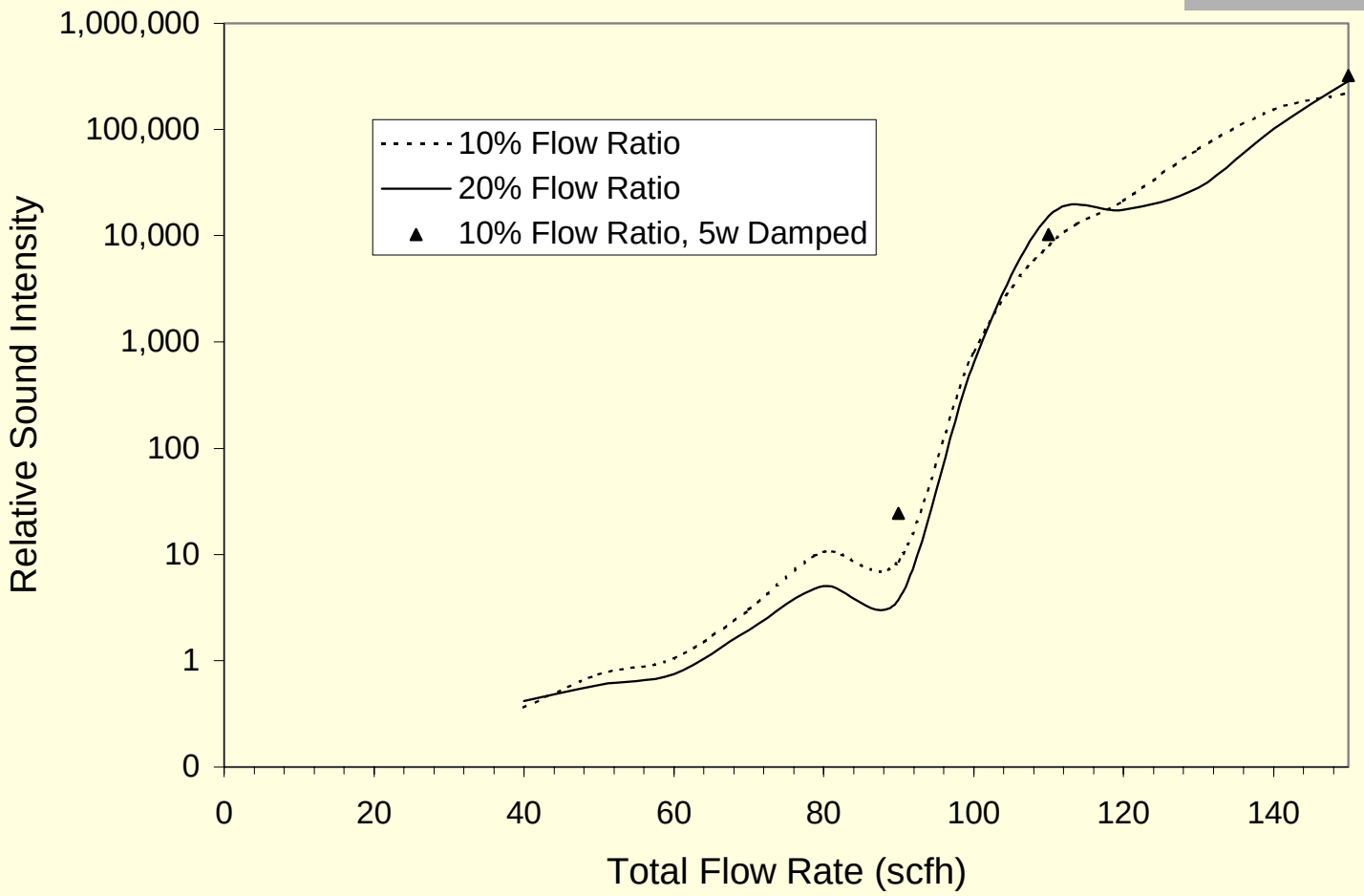
Sound Recordings of LSVI Open to Ambient Environment at Test Flow Rates

- LSVI 42 L/min 
- LSVI 47 L/min 
- LSVI 57 L/min 
- LSVI 66 L/min 

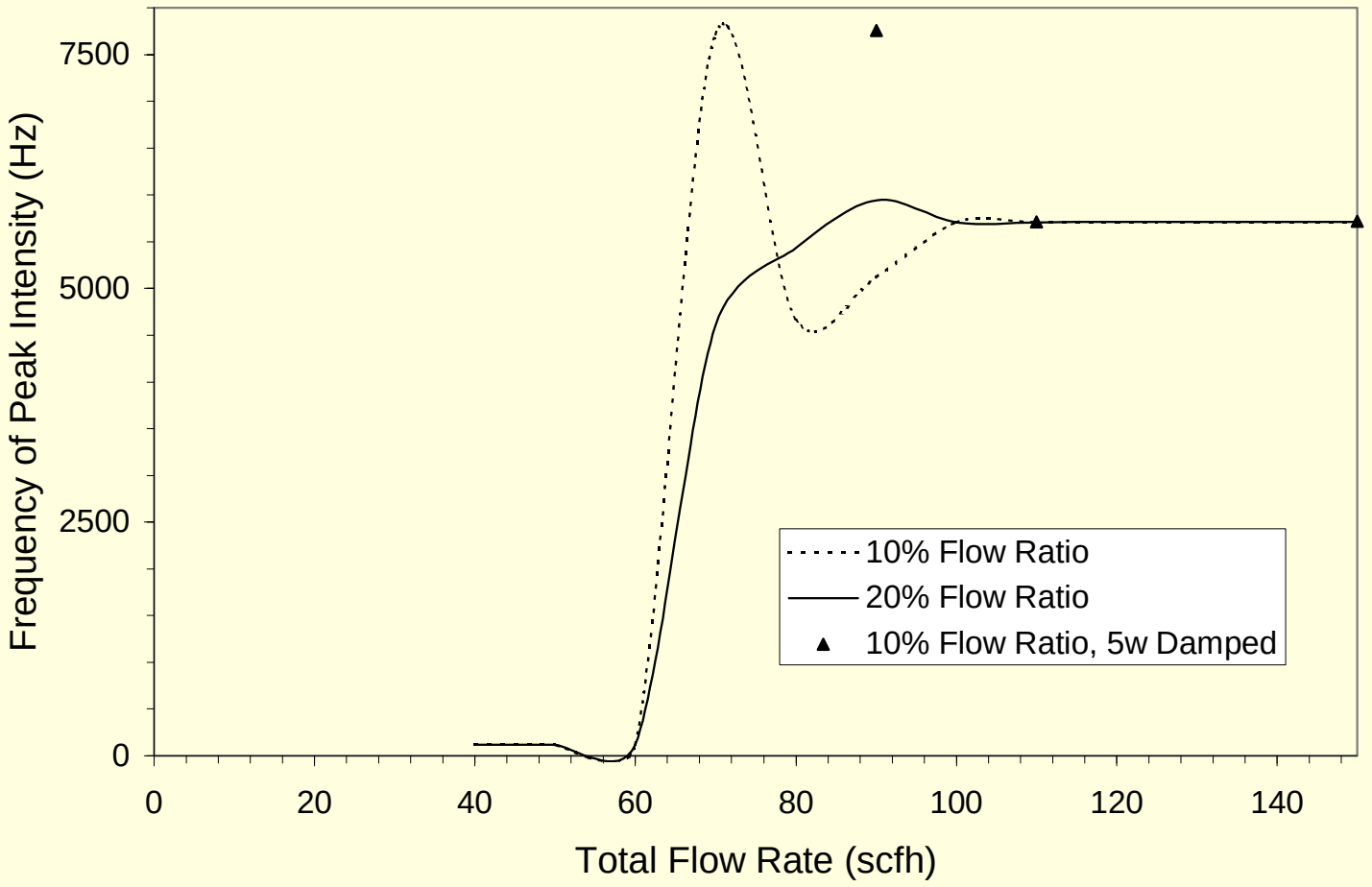
Sound Power Spectrum of LSVI at 47.2 L/min



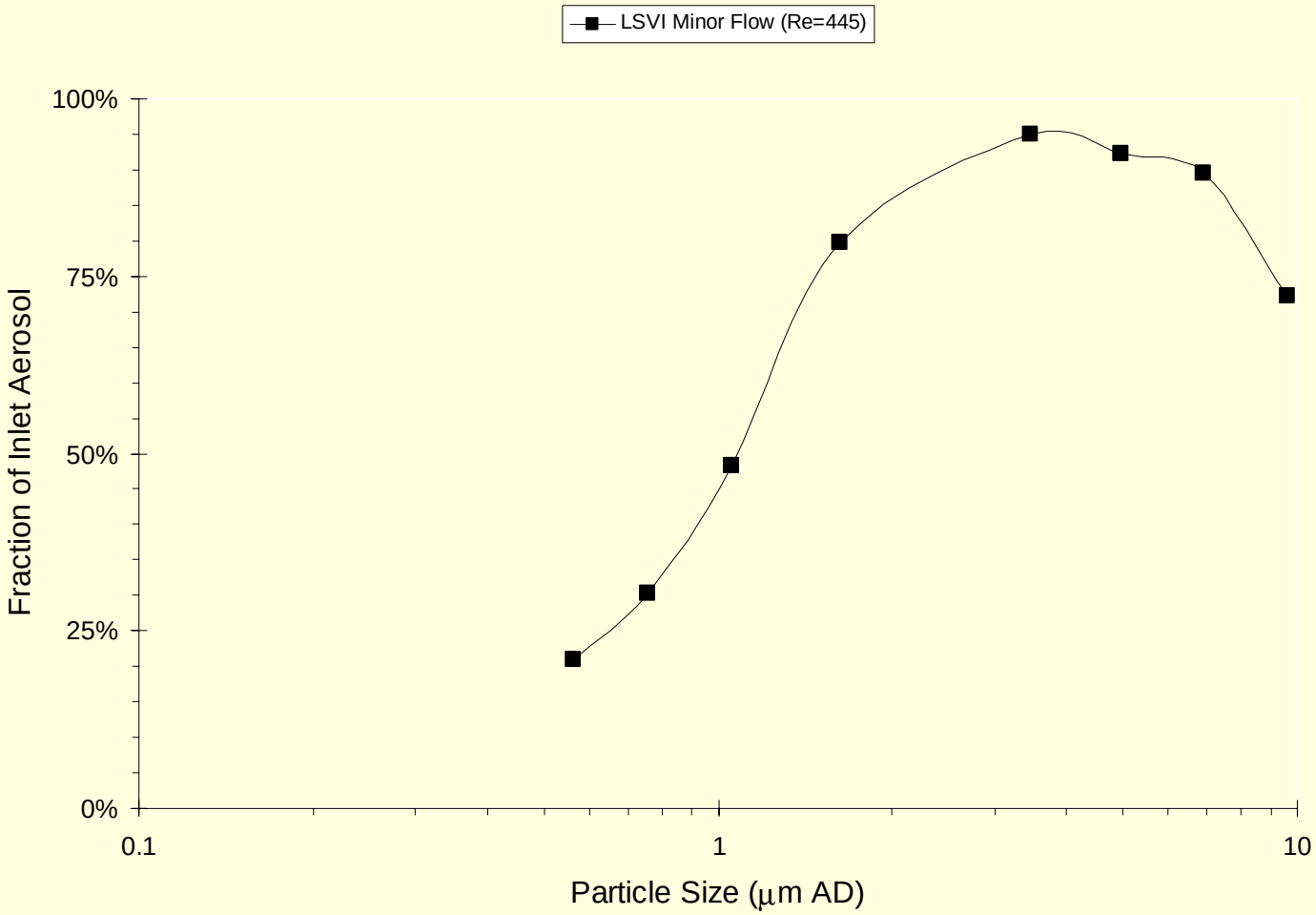
Peak Sound Intensity of LSVI Unit



Frequency of Peak Sound Component

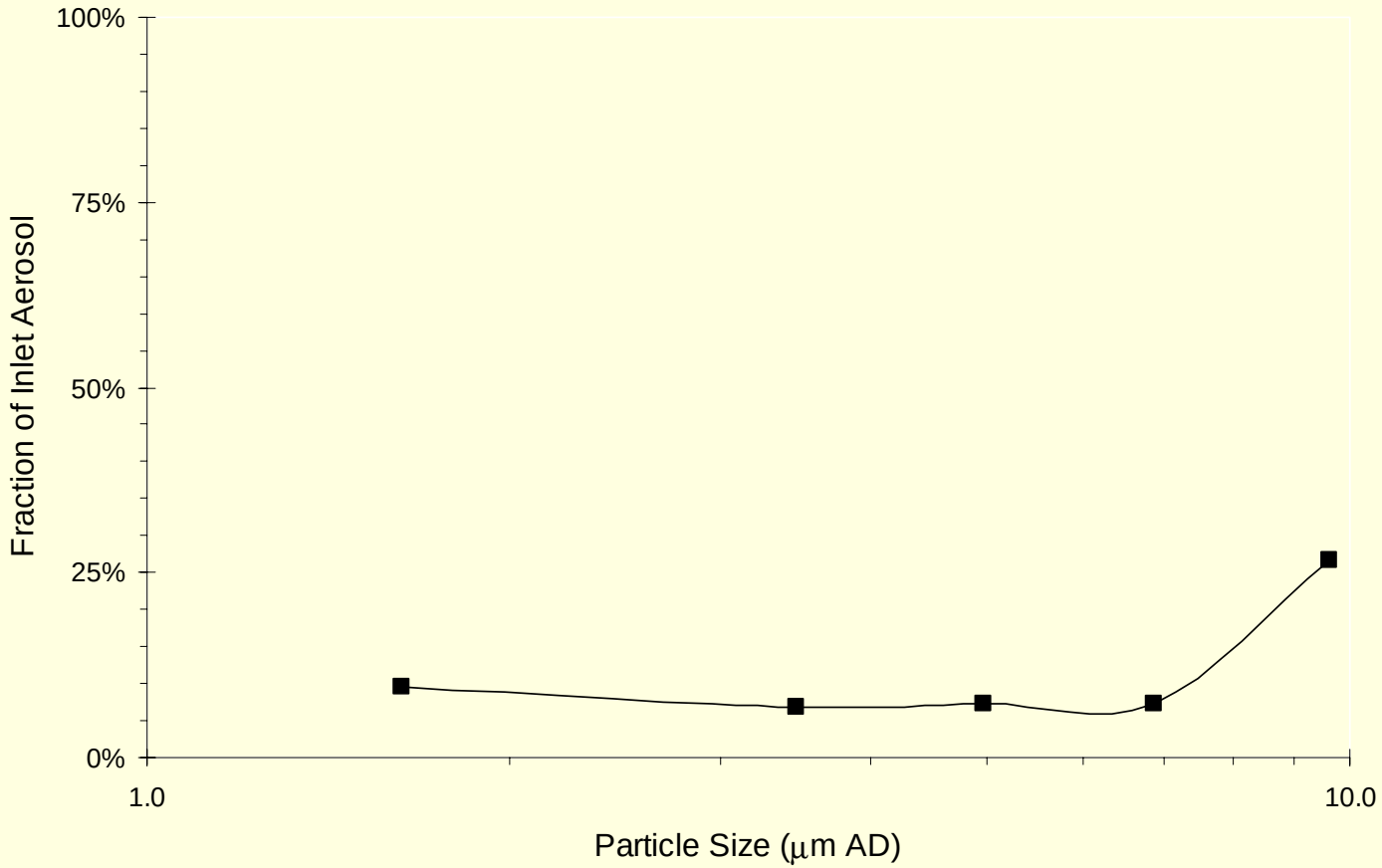


Collection Efficiency of LSVI Minor Flow

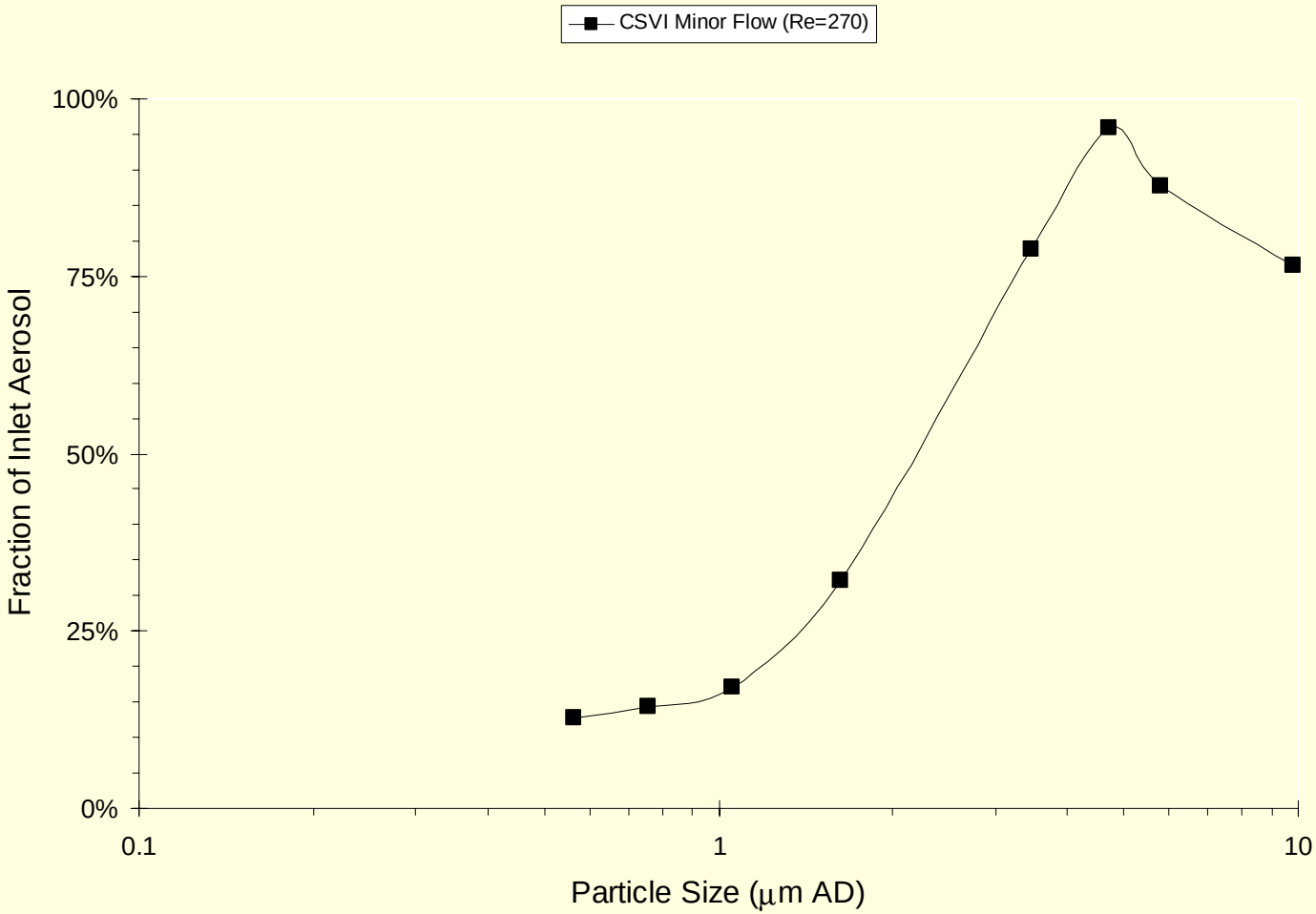


Texas A&M University AEROSOL
TECHNOLOGY LABORATORY

Wall Losses on Critical Zone of LSVI

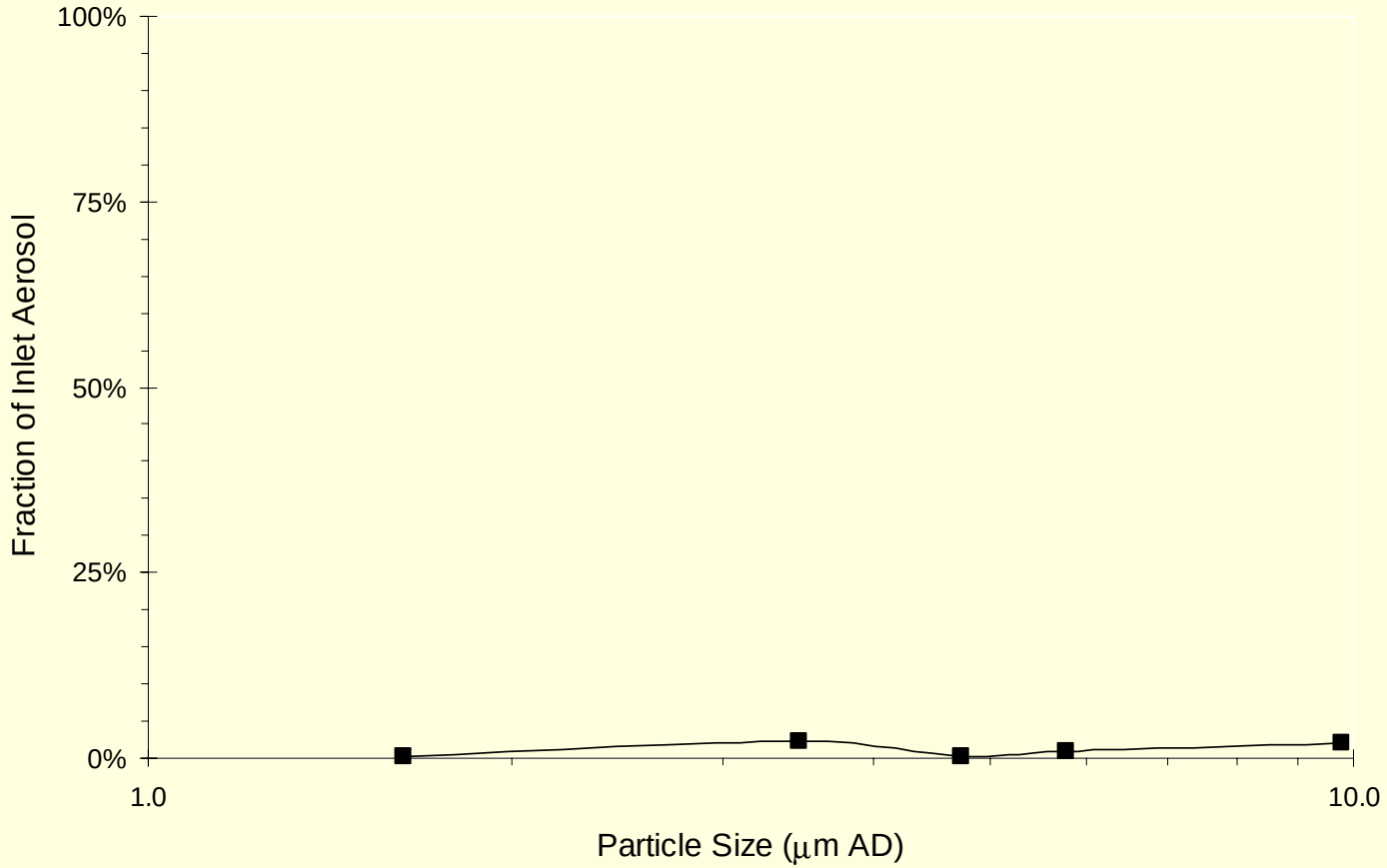


Collection Efficiency of CSVI Minor Flow



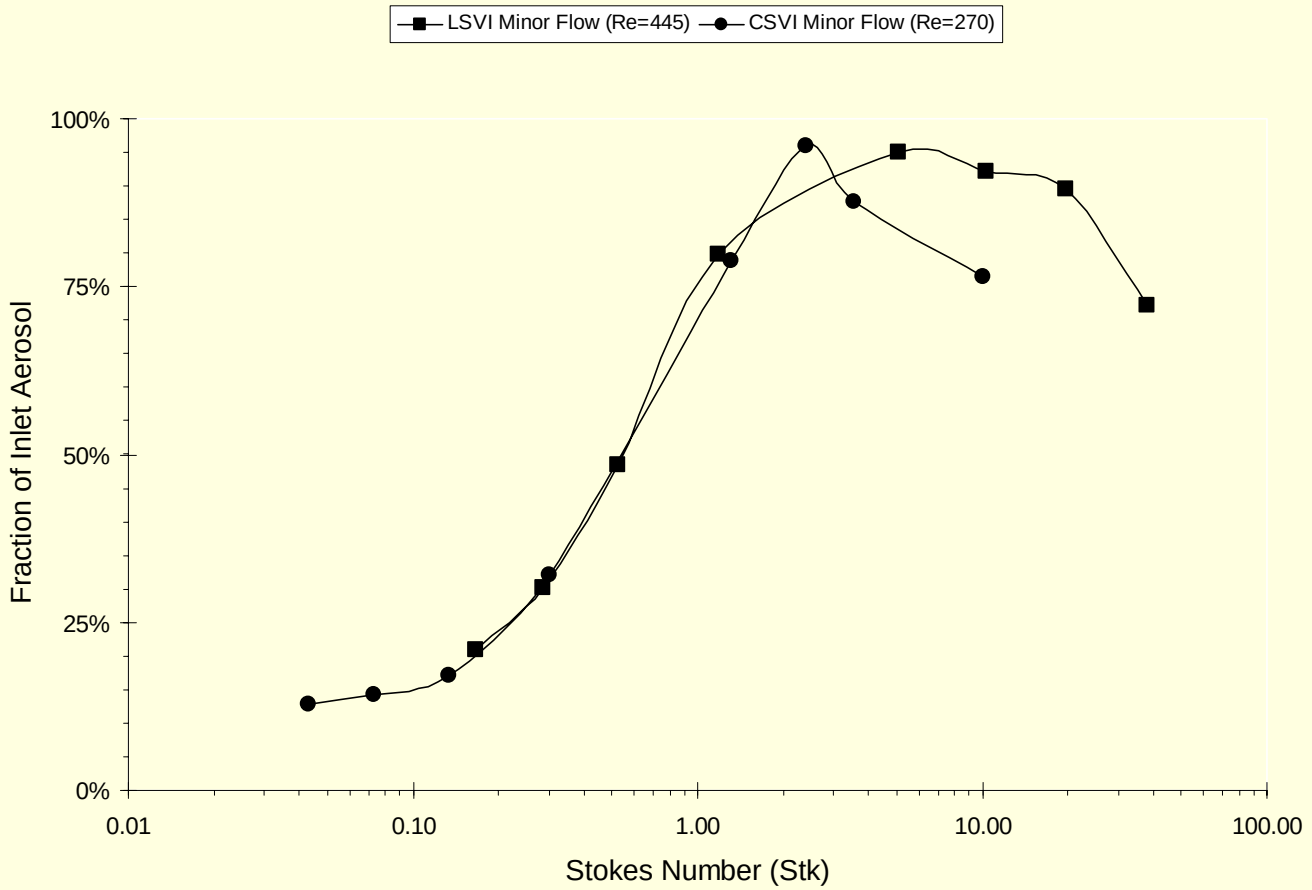
Texas A&M University AEROSOL
TECHNOLOGY LABORATORY

Wall Losses on Critical Zone of CSVI



Texas A&M University AEROSOL
TECHNOLOGY LABORATORY

LSVI and CSVI Minor Flow Collection Efficiency on Stokes Number Basis



Texas A&M University AEROSOL
TECHNOLOGY LABORATORY

Research Plans

- **Construct Single-Stage LSVI Concentrator System**
  - Eight LSVI units operating in parallel for 300 L/min total sampling rate.
  - Design flow control instrumentation.
  - Test with monodisperse aerosols: PSL (non-viable), single-spore BG, monodisperse BG clusters.

- **Identify and Eliminate Acoustic Resonance in LSVI units**
  - Determine resonance source (Helmholtz, standing-wave).
  - Tapered major flow path.
  - Materials maximizing acoustic absorption.

- **Construct new CSVI unit**
  - 0.012” Acceleration Slot Width.
  - Incorporate resonance elimination features.
  - Add additional stages.
  - Test with monodisperse aerosols: PSL (non-viable), single-spore BG, monodisperse BG clusters.