Flow Visualization Study in the OSU

Comparison of Cold vs. Hot Internal Flow

Presented to: IAMFTWG

By: Robert I Ochs

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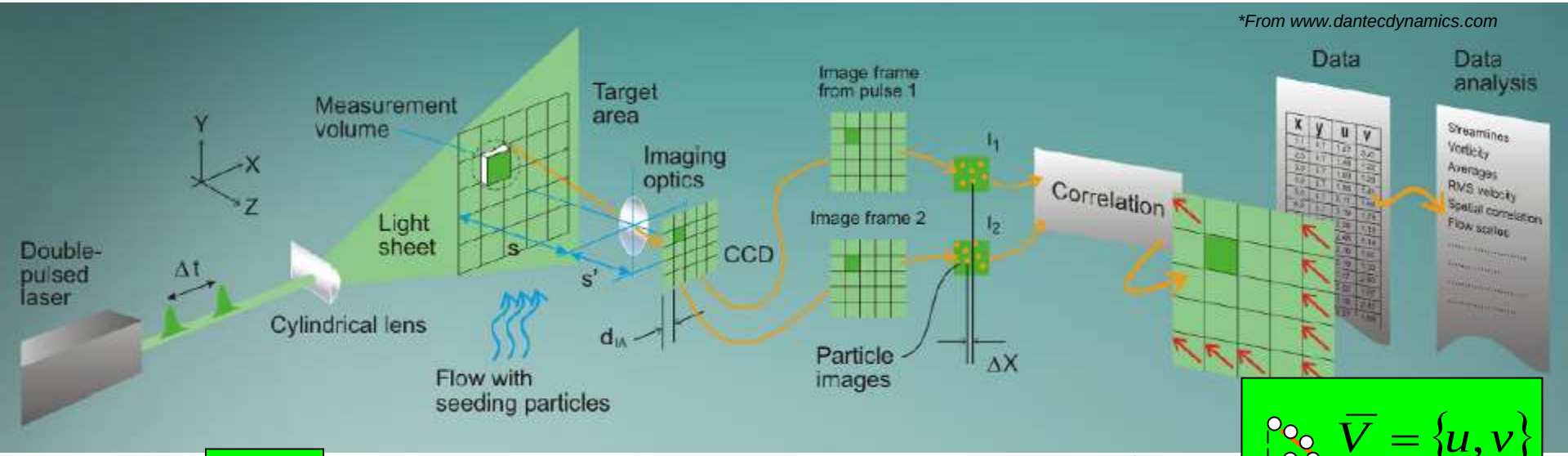
Federal Aviation Administration

Introduction

- FAA’s PIV system was set up around an OSU rate of heat release apparatus
- PIV is a non-intrusive, whole flow field velocity measurement technique

Particle Image Velocimetry



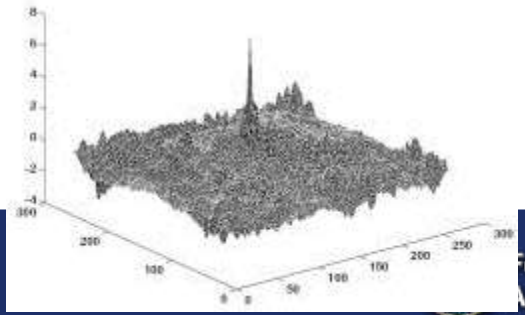
IA_1

Δt

IA_2

Cross-Correlation

Peak Detection



$$v = \frac{\Delta y}{\Delta t}$$

$$\bar{V} = \{u, v\}$$

Δy

Δx

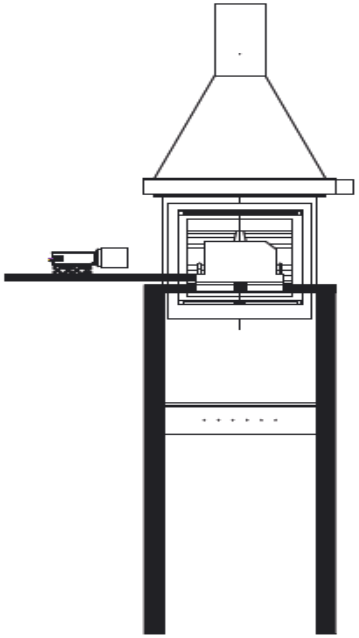
y

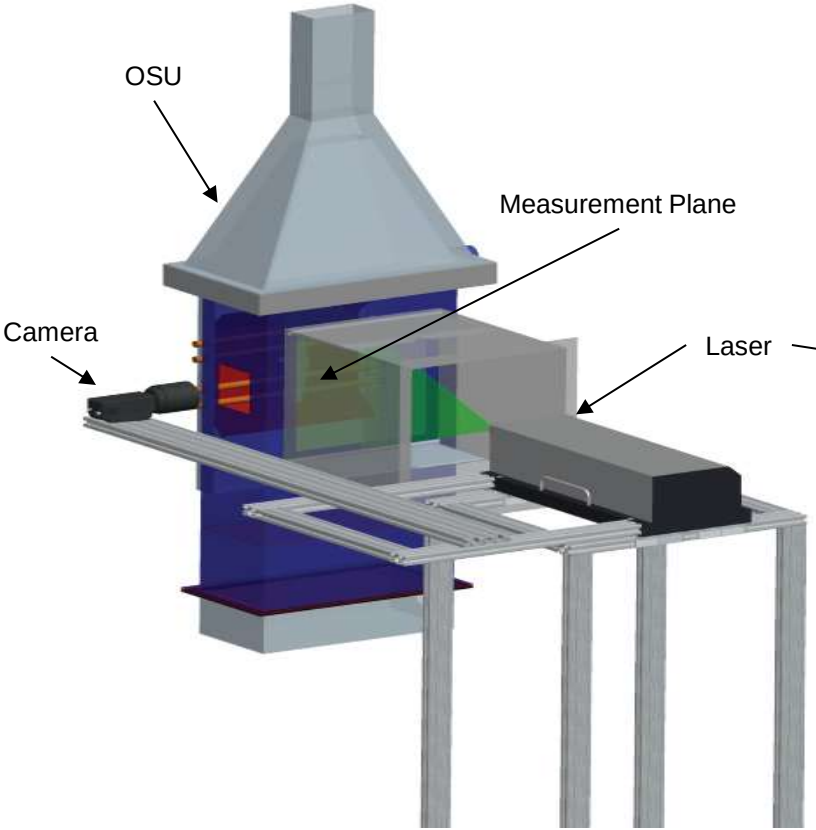
x

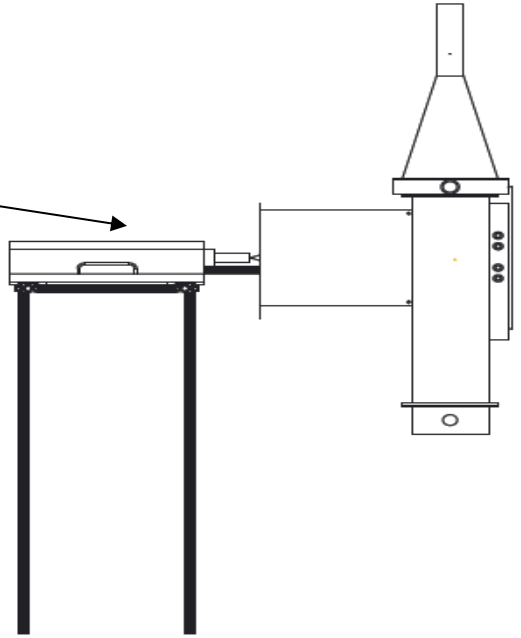
$$u = \frac{\Delta x}{\Delta t}$$

Federal Aviation Administration

Setup

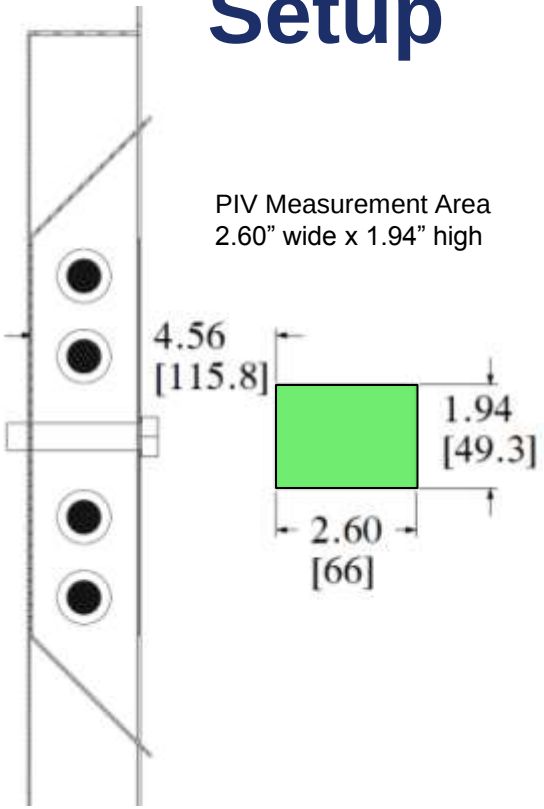


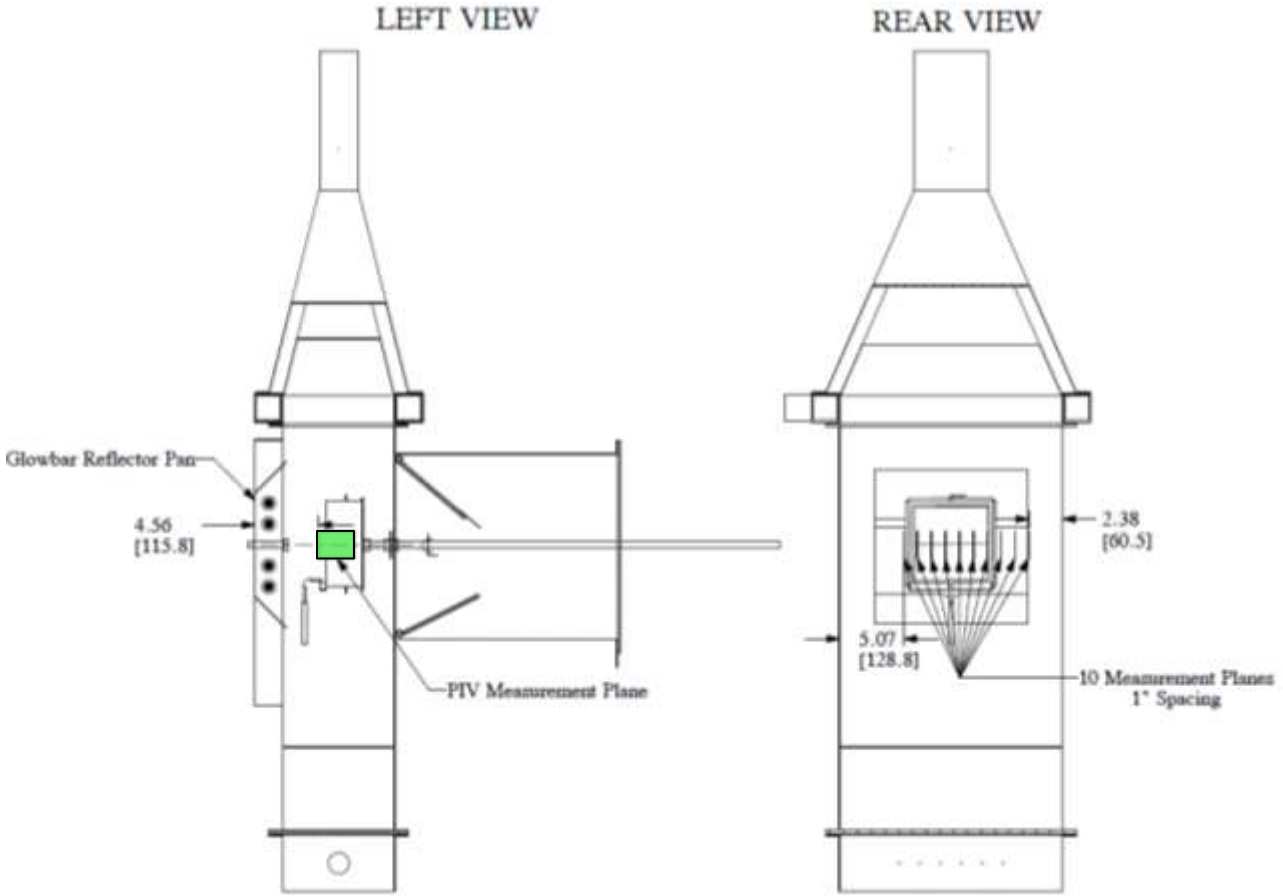


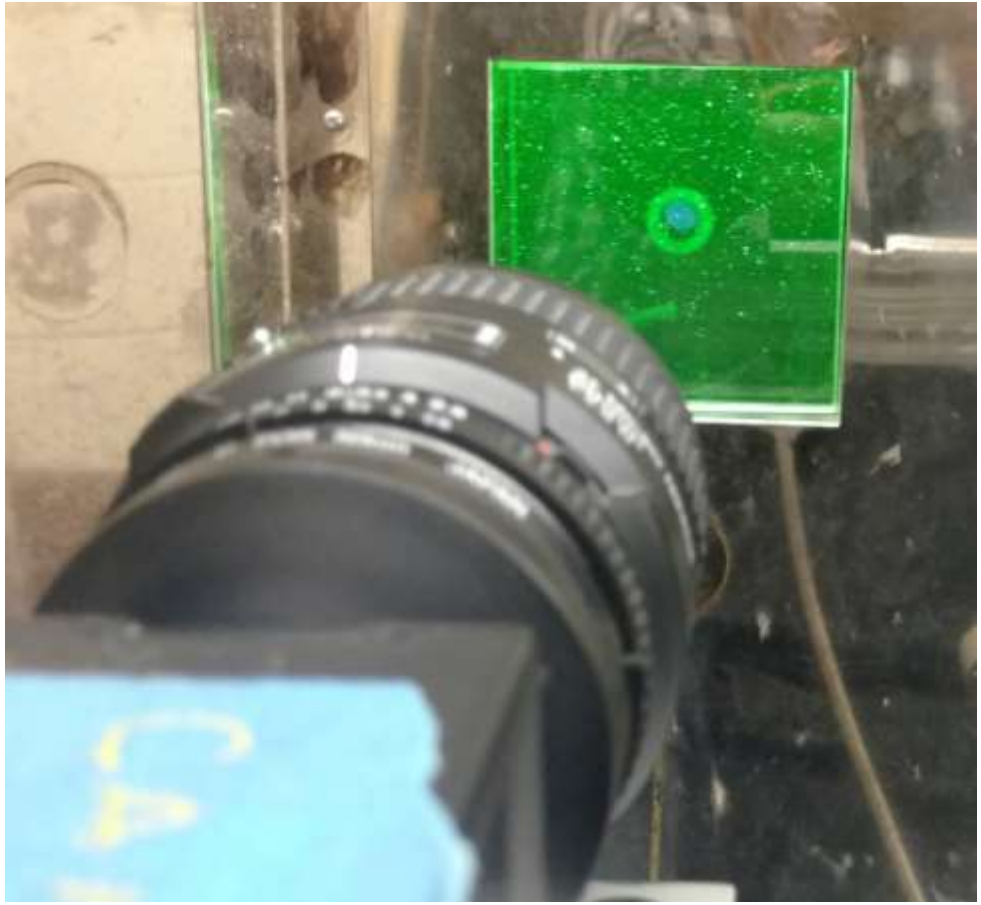


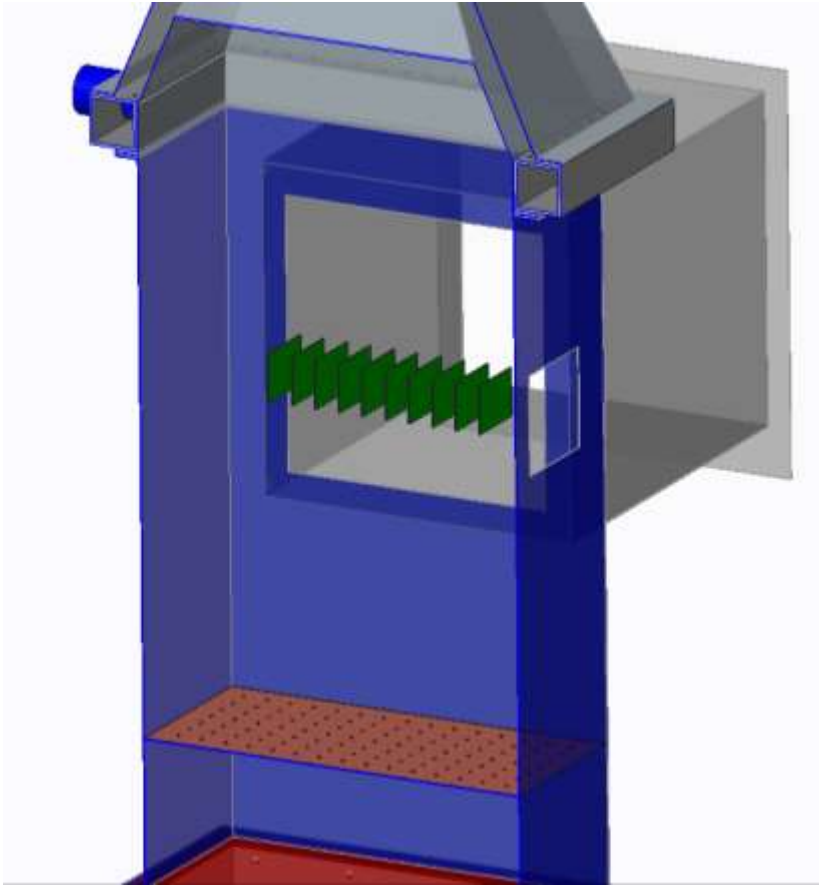
Setup

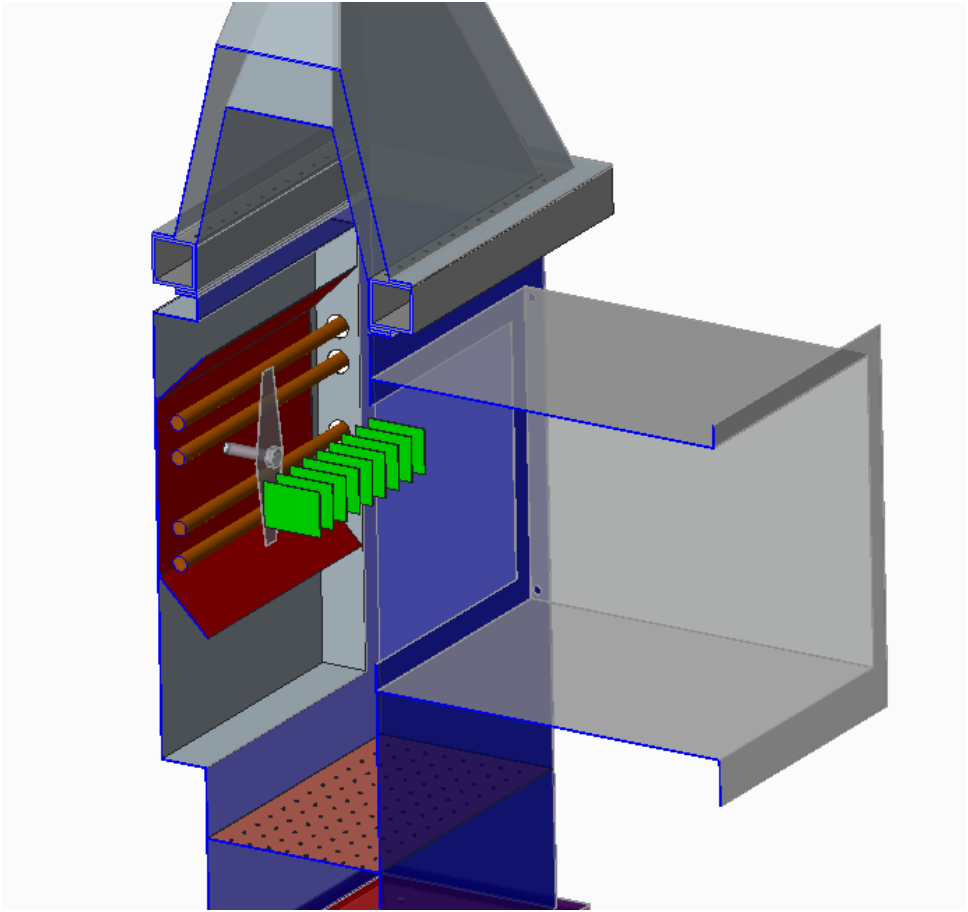
PIV Measurement Area
2.60” wide x 1.94” high

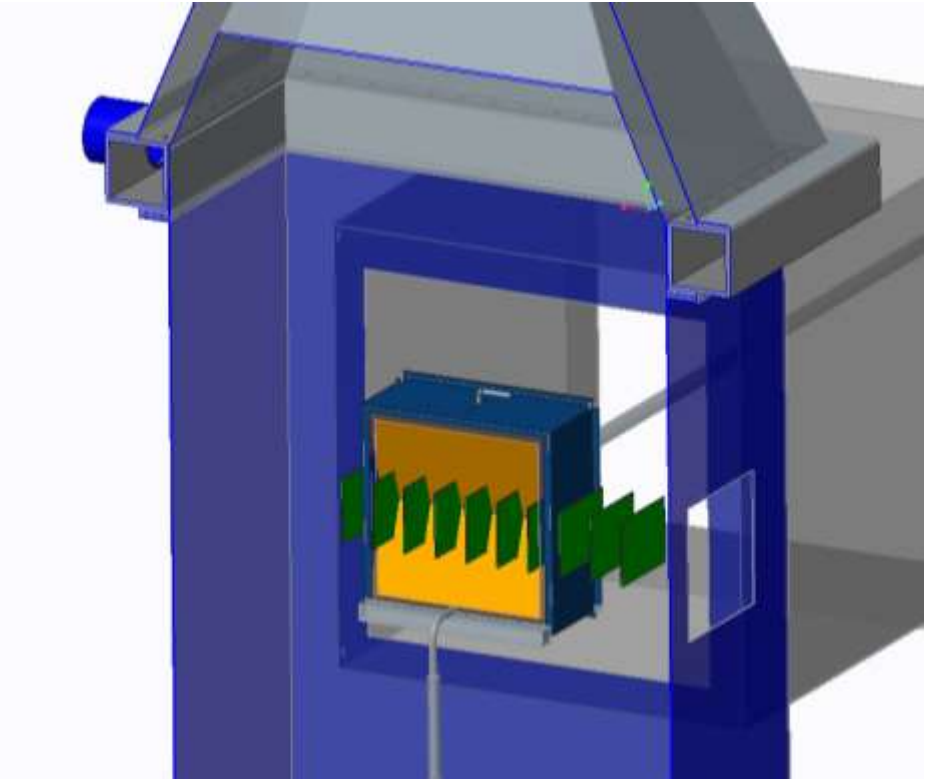


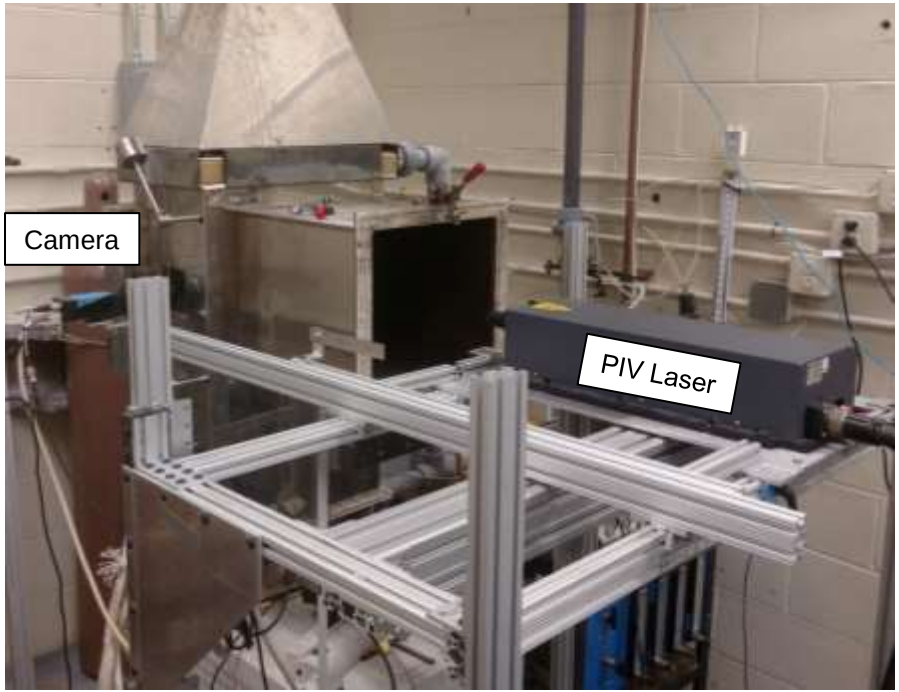


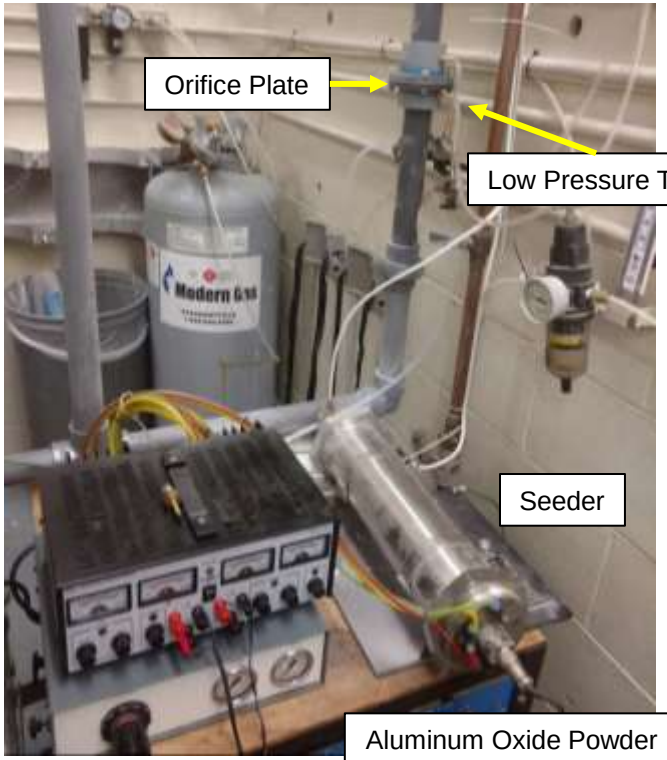









Camera
PIV Laser


Orifice Plate
Low Pressure Tap
Seeder
Aluminum Oxide Powder
500# ≈ 35 micron

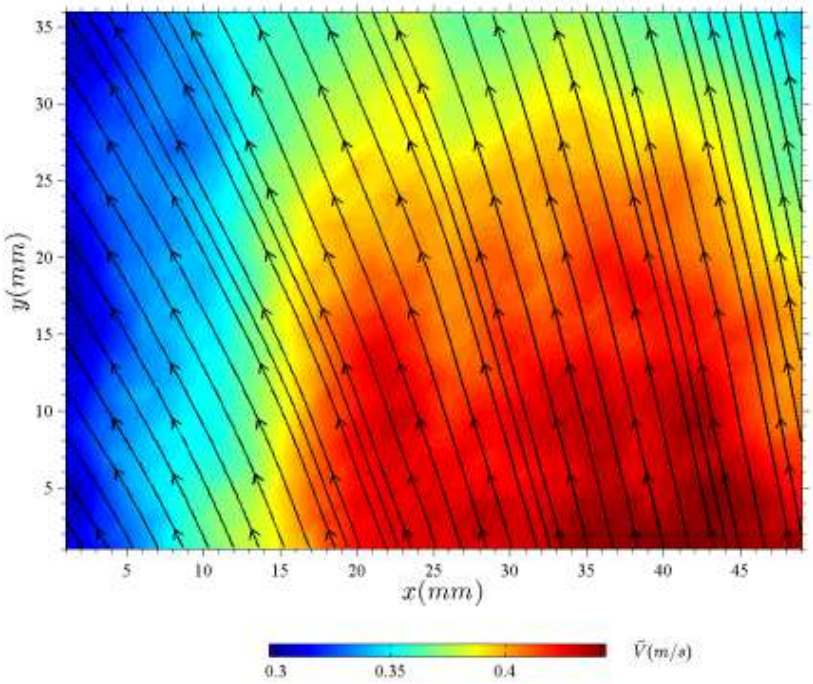
PIV Measurement Details

- Acquisition Settings
  - Time between pulses
    - 300 µs
  - Trigger rate
    - 15 Hz
  - Number of Images
    - 500
  - Time domain
    - 33.3 seconds
- Analysis Settings
  - 64 x 64 Interrogation Area
  - 50% Overlap
  - Peak Validation 1.2 relative to nearest peak
  - Moving Average local neighborhood validation
- Resulting Vector Map
  - 49 x 36 vectors
  - 1764 total vectors per measurement area

Hot OSU Setup

7/8” from left wall

Cold OSU



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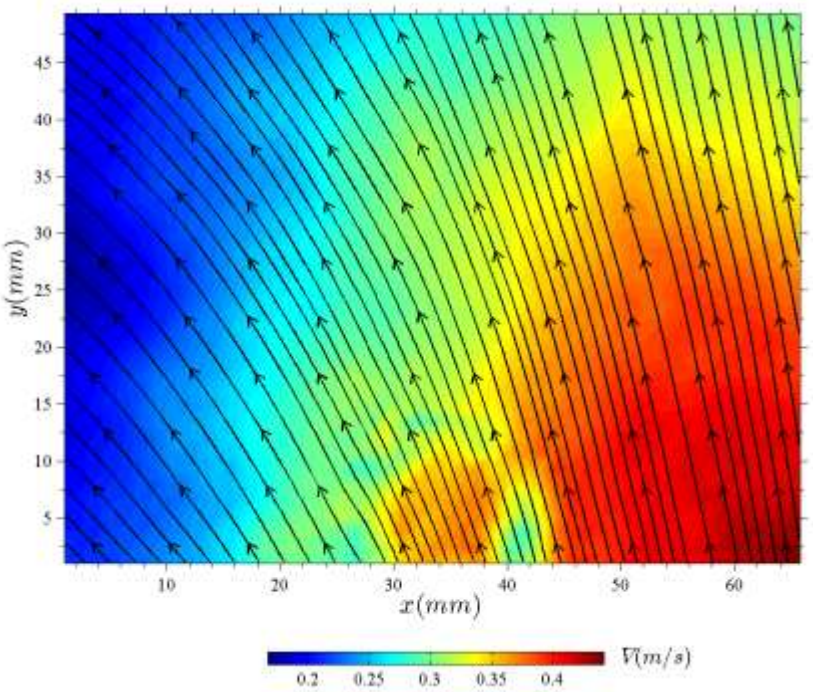
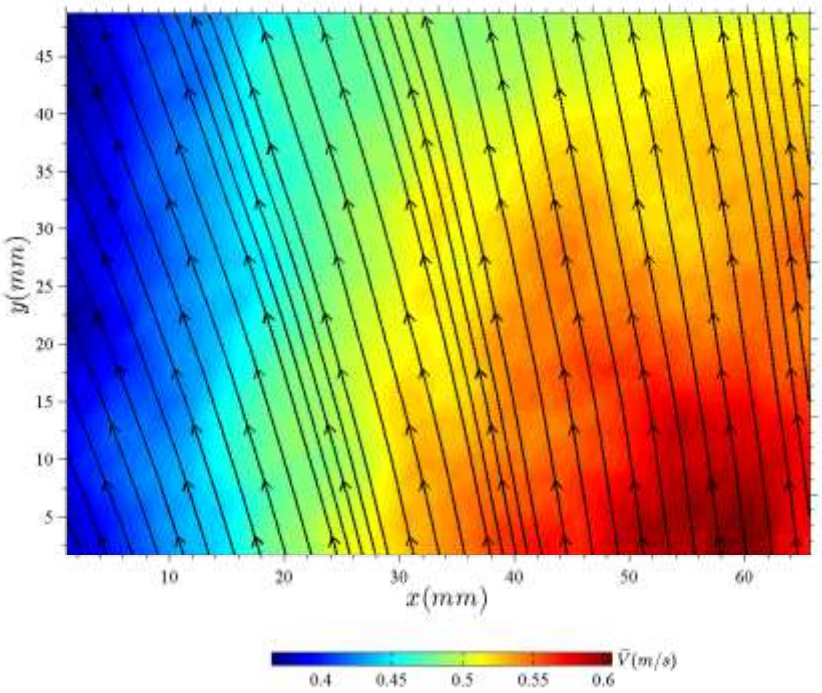
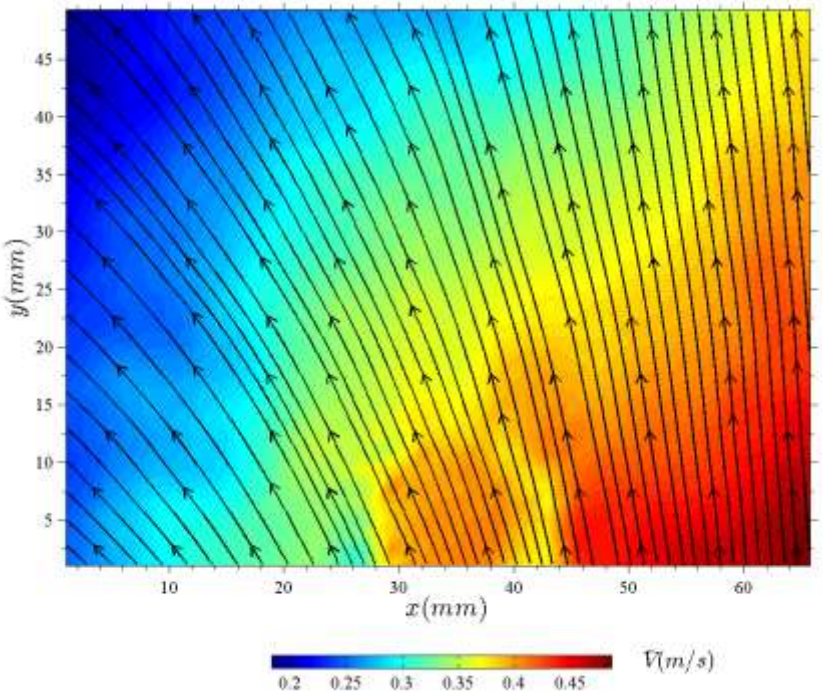


1 7/8” from left wall

Cold OSU

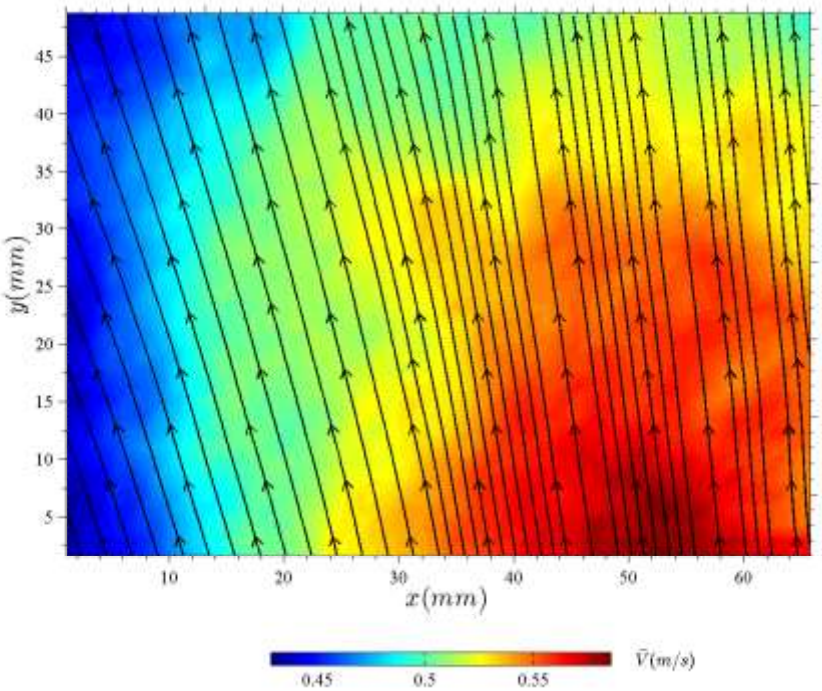


Hot OSU

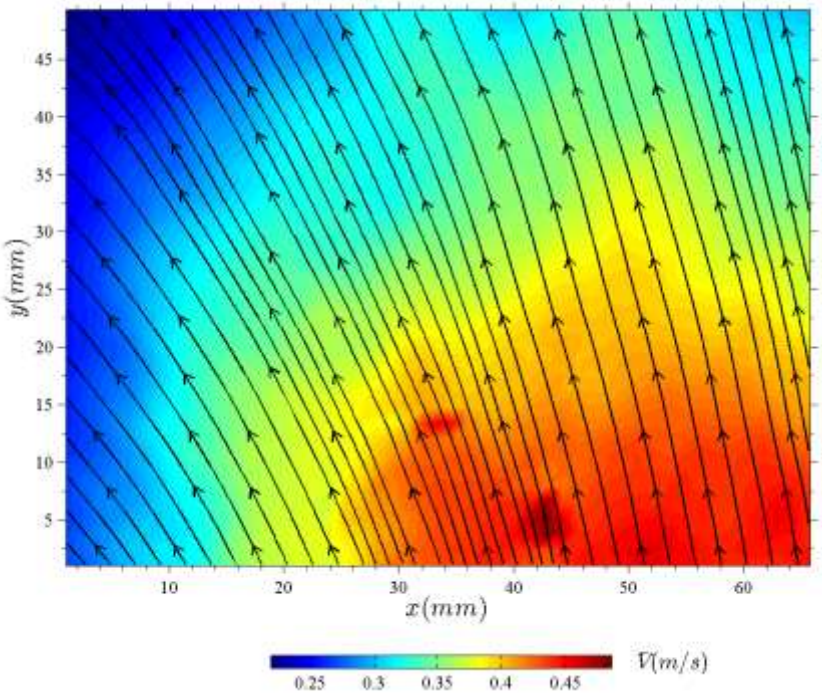


2 7/8” from left wall

Cold OSU

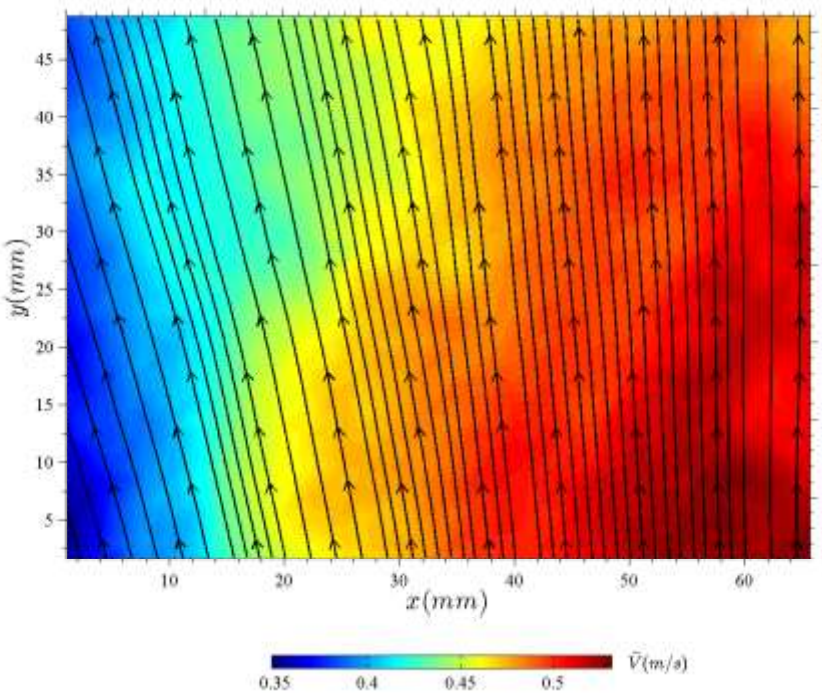


Hot OSU

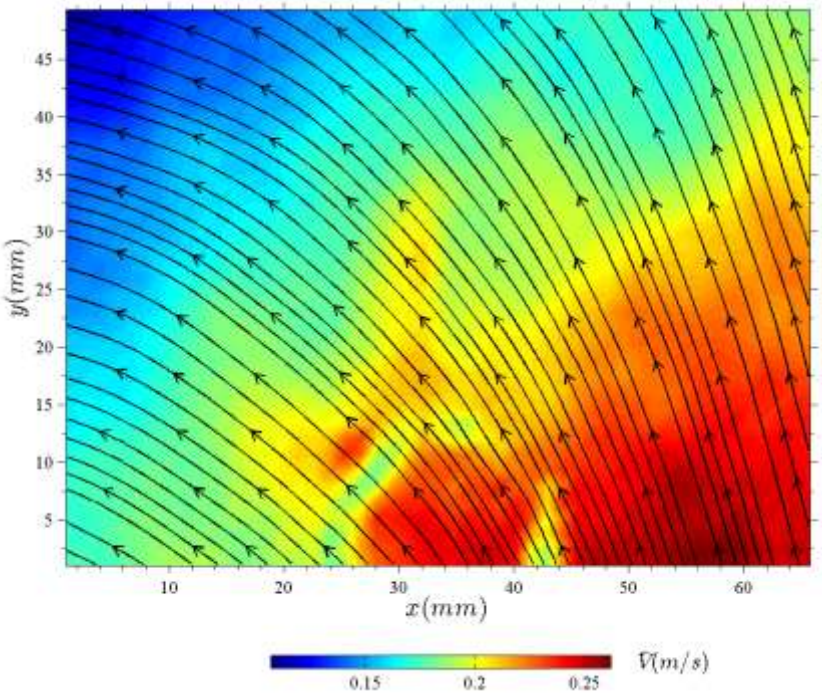


3 7/8” from left wall

Cold OSU

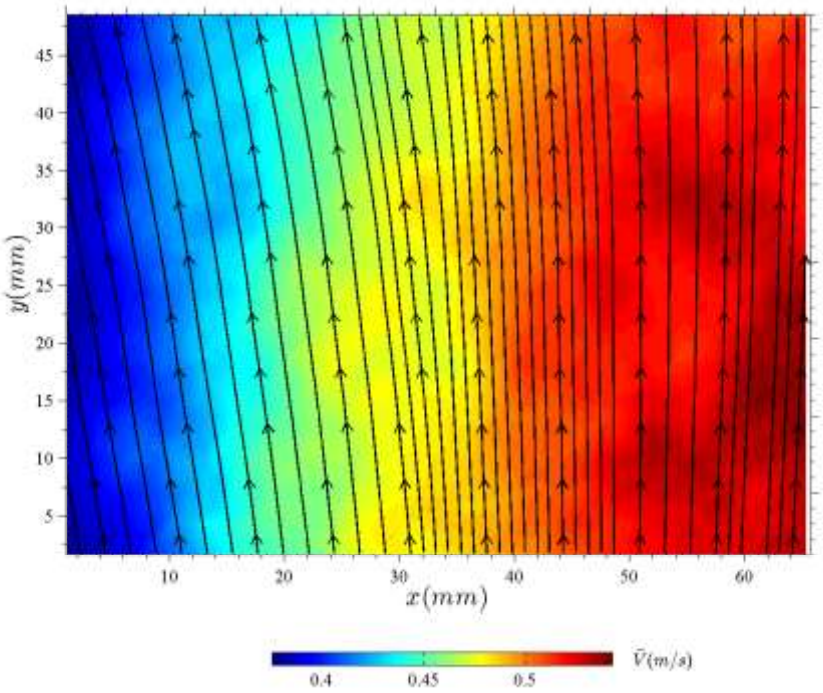


Hot OSU

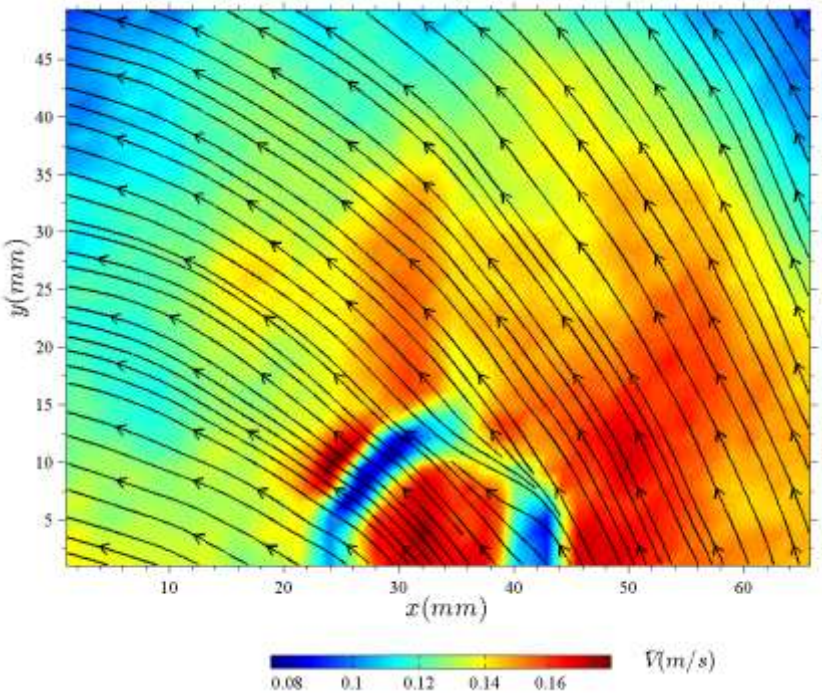


4 7/8” from left wall

Cold OSU

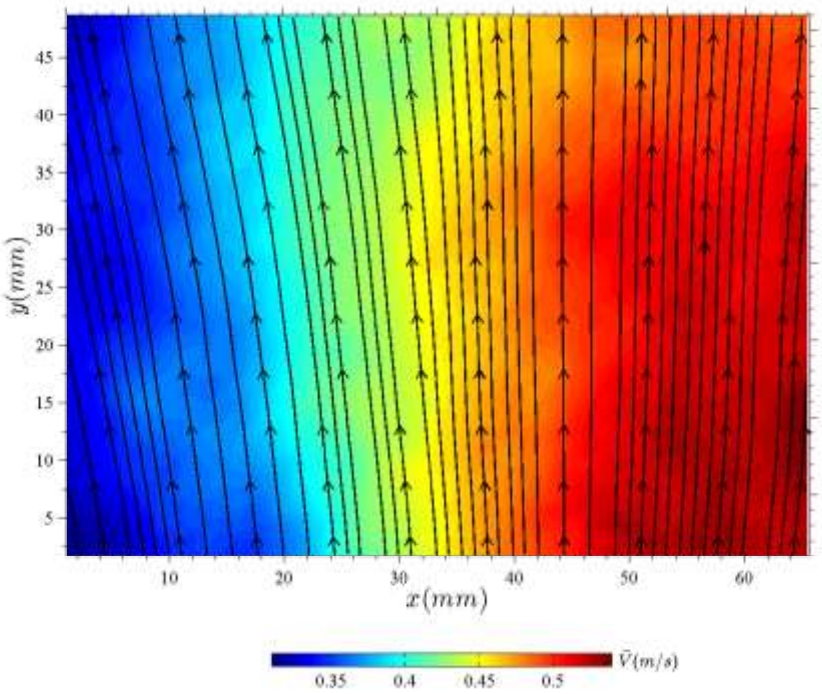


Hot OSU

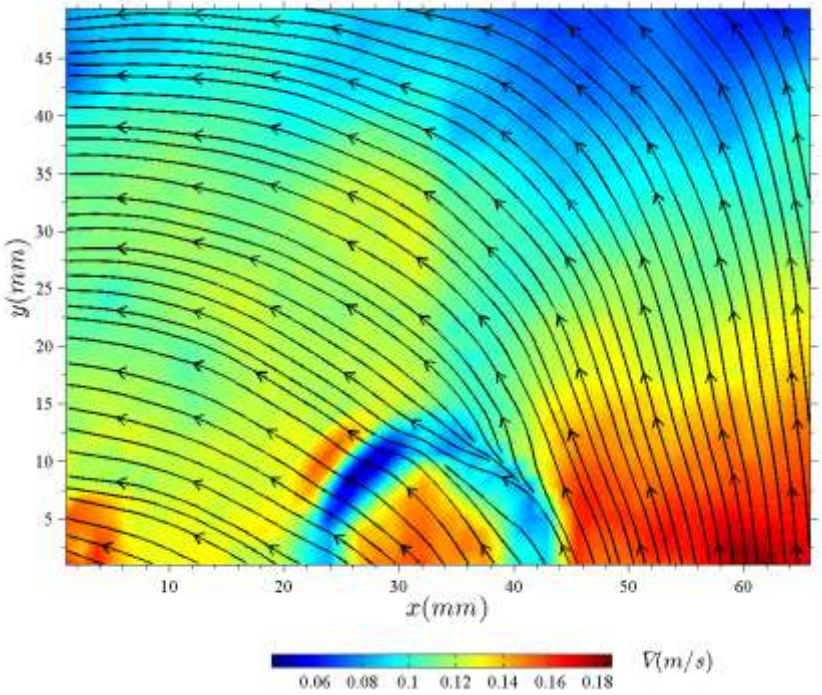


5 7/8” from left wall

Cold OSU

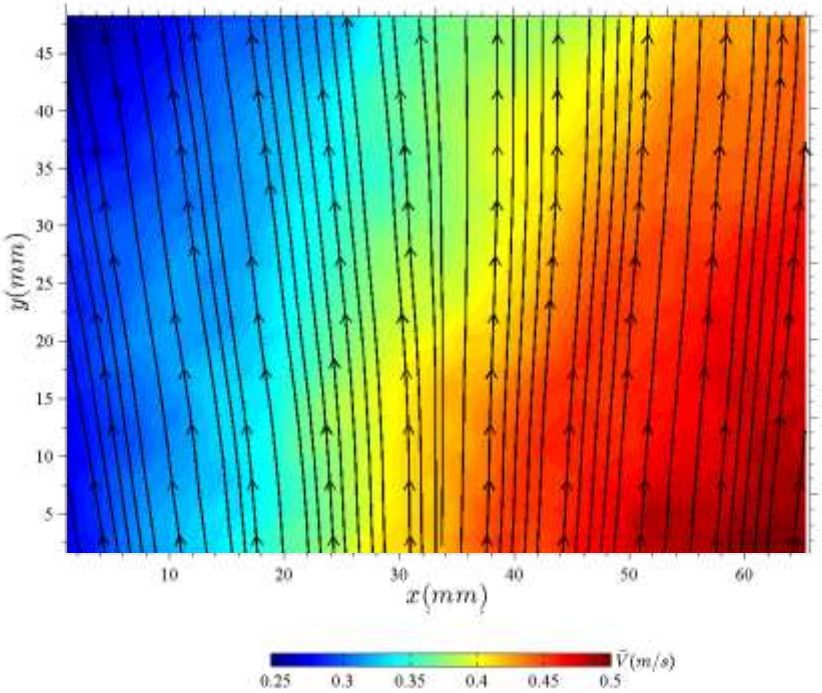


Hot OSU



6 7/8” from left wall

Cold OSU



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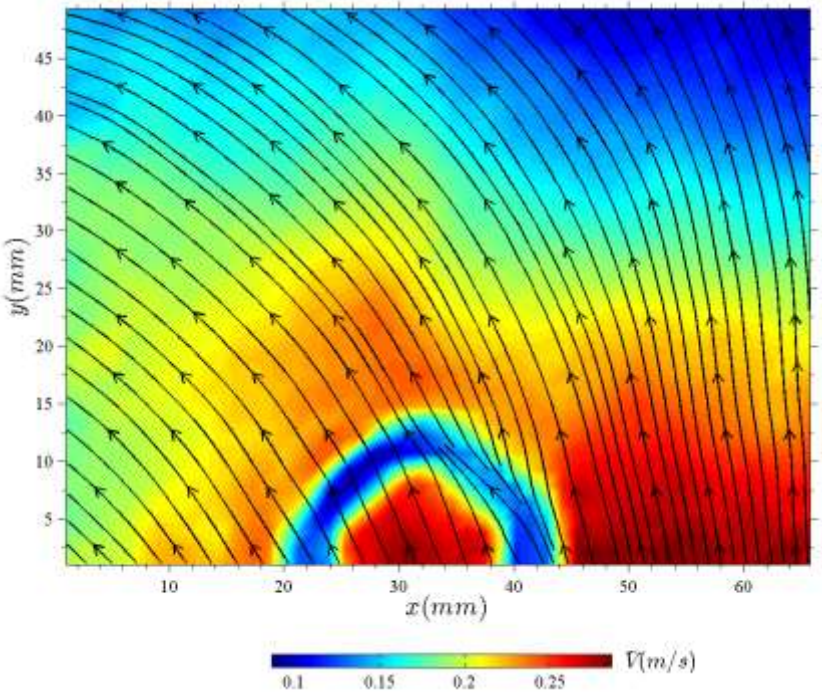
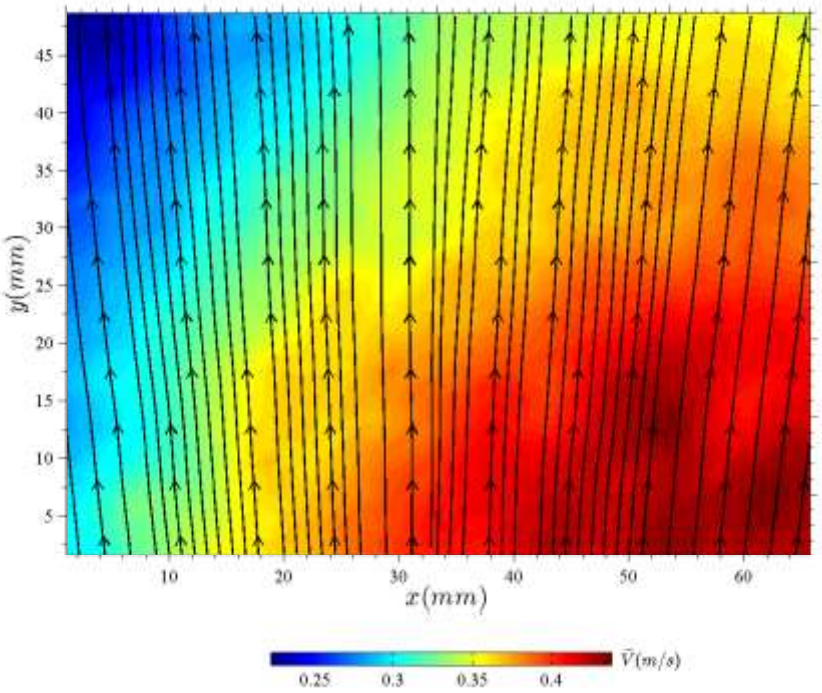


7 7/8” from left wall

Cold OSU



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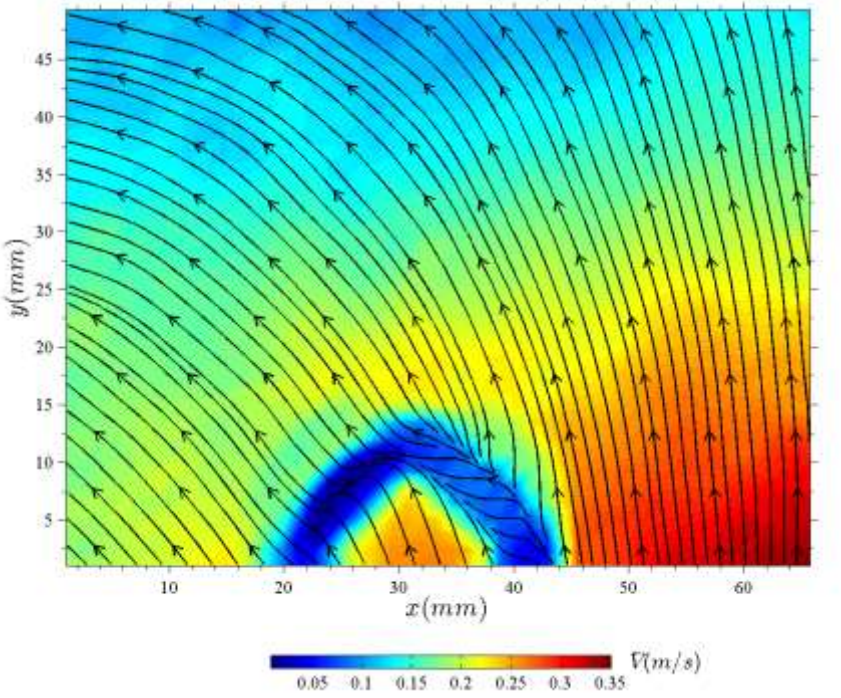
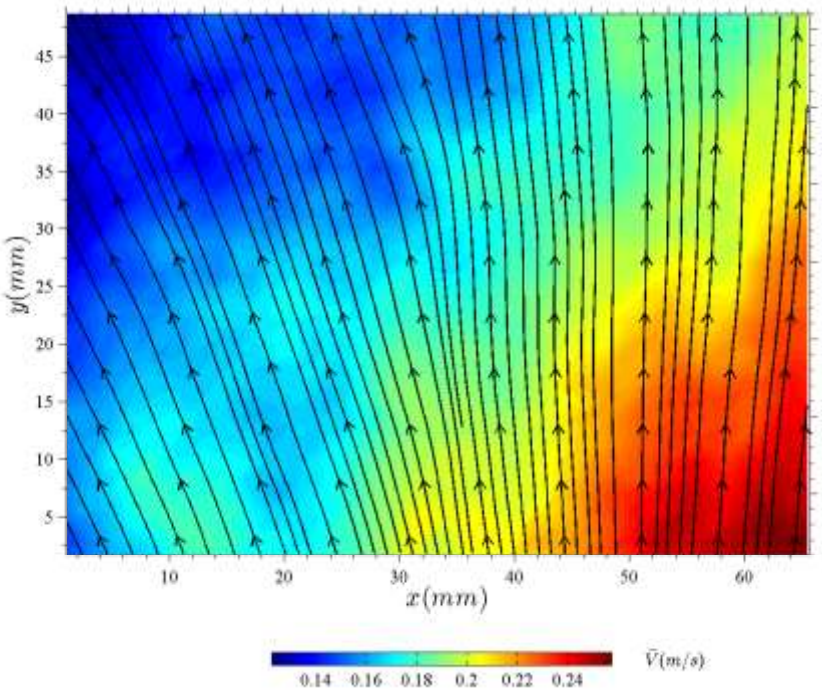


8 7/8” from left wall

Cold OSU



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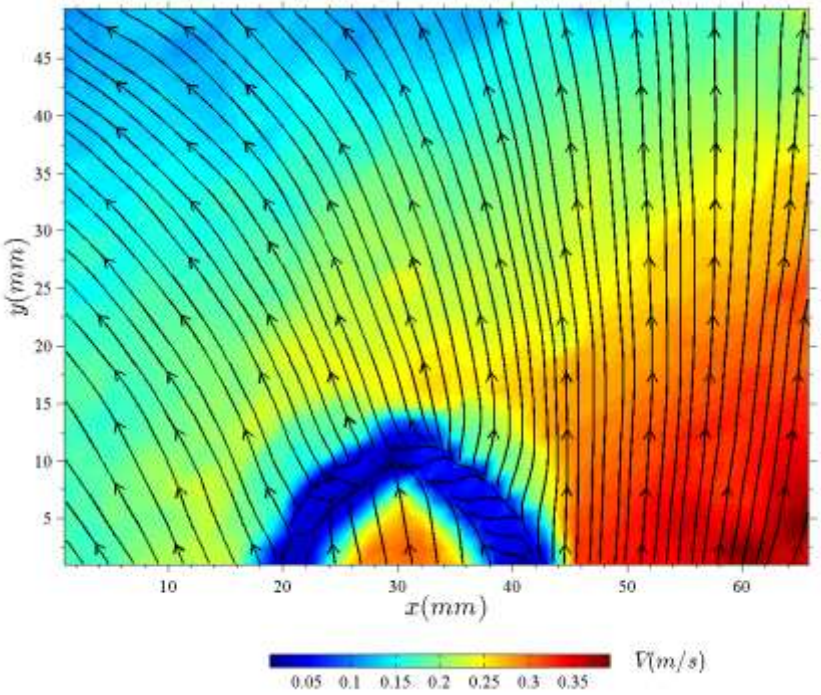
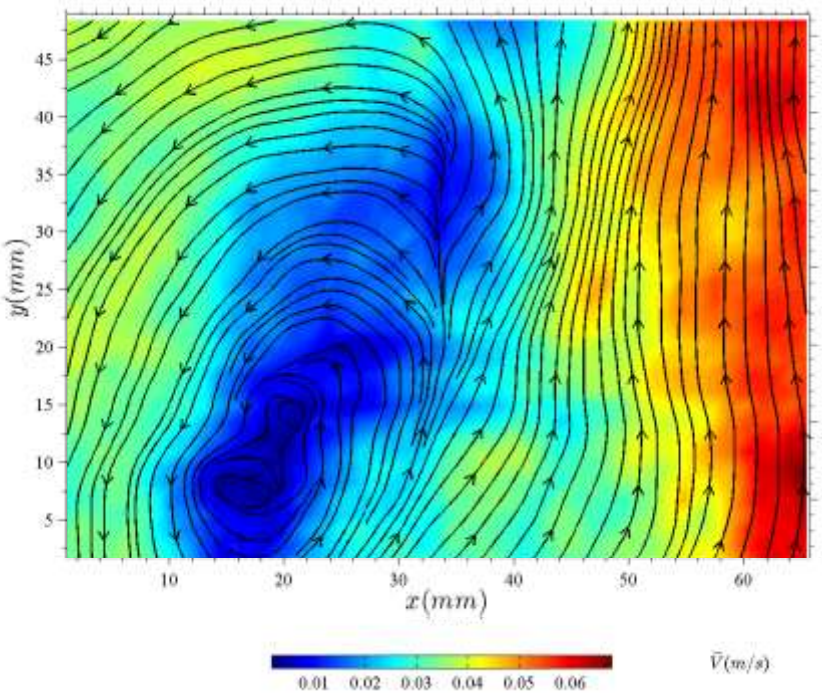


9 7/8” from left wall

Cold OSU



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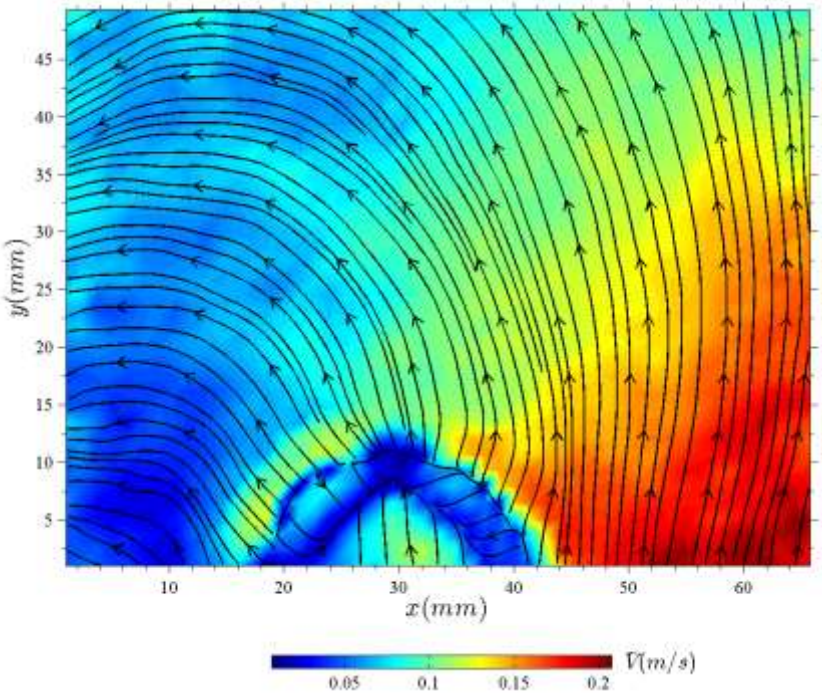
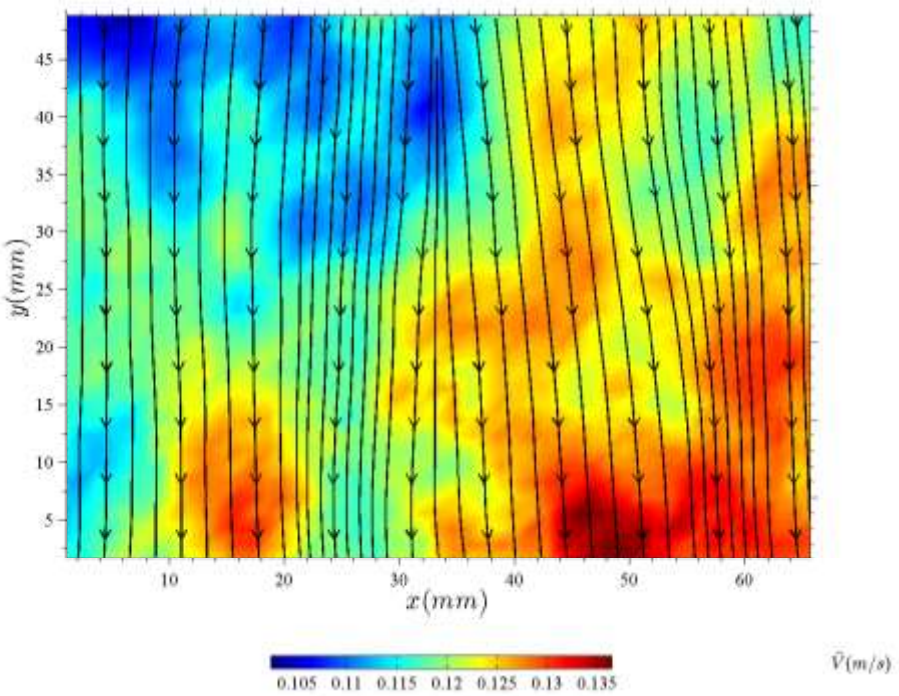


10 7/8” from left wall

Cold OSU

Hot OSU



No Hot OSU data – camera too close to window too hot!

Image Mean #1

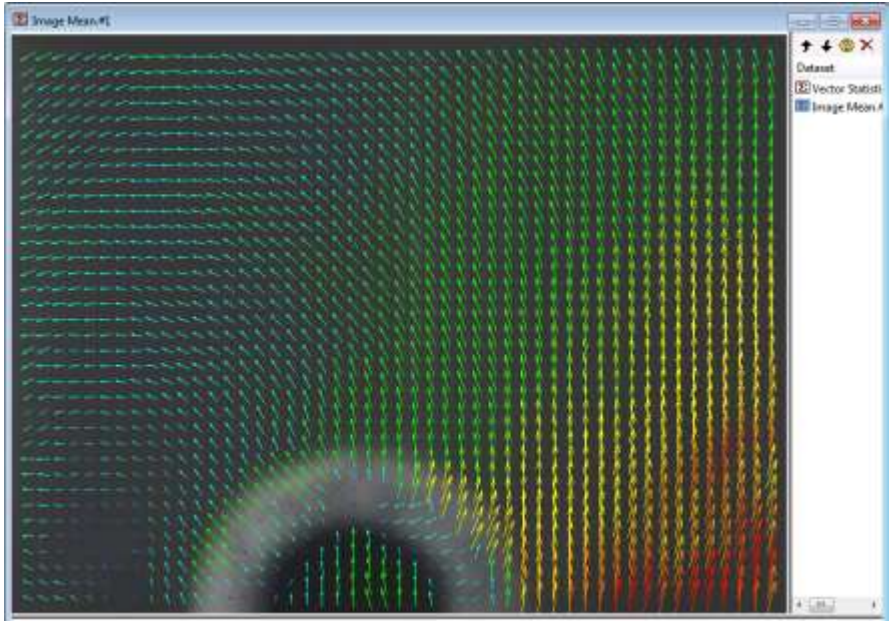
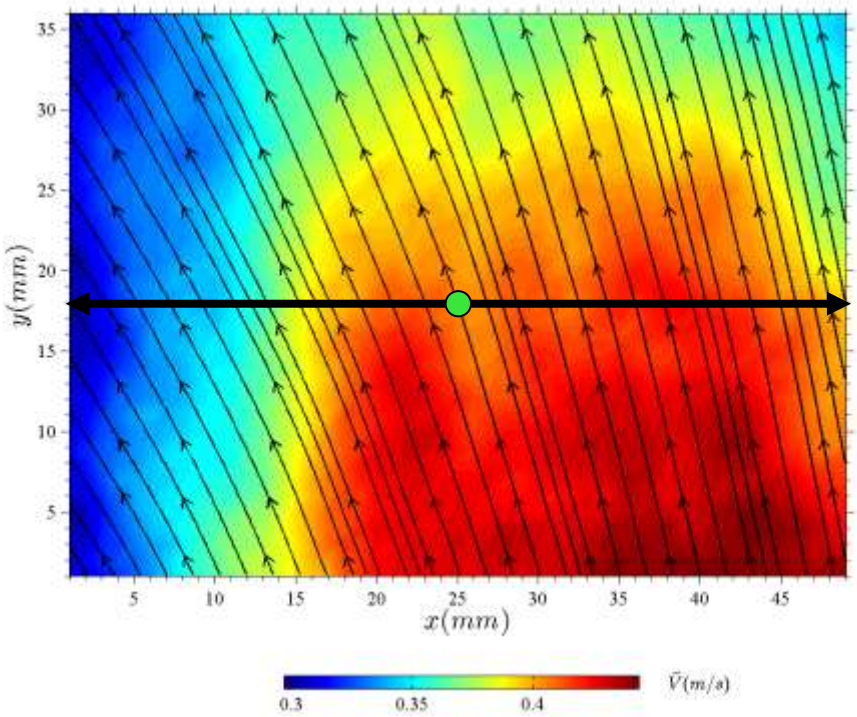
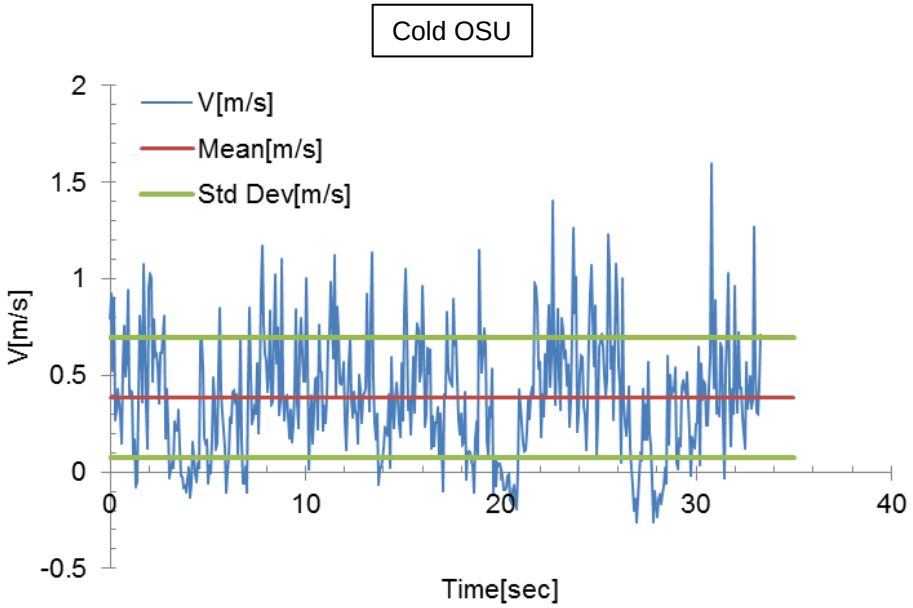


Image Mean #1
Dataset

Turbulence Intensity

7/8” from left wall

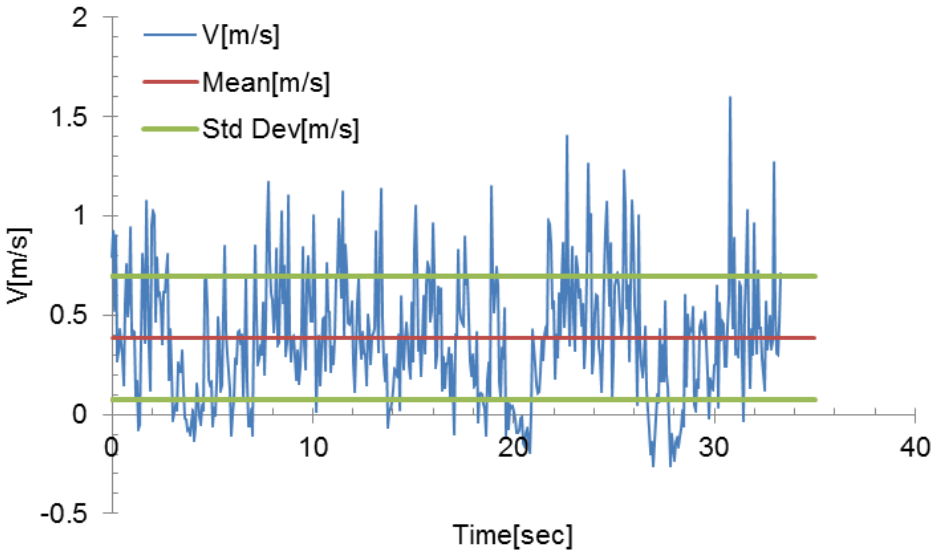




Mean V Velocity = 0.385 m/s
Std Dev = 0.313
%Std Dev = 81%

7/8” from left wall

Cold OSU



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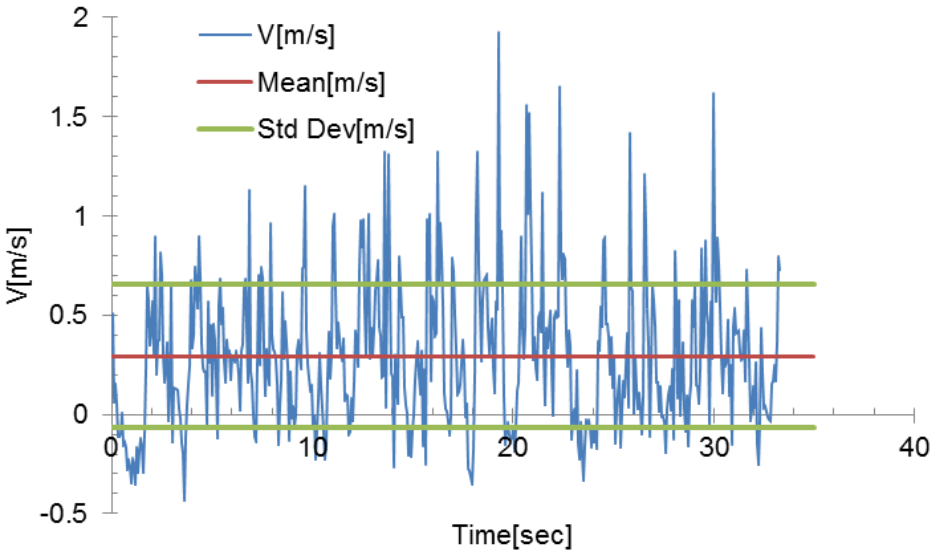

Mean V Velocity = 0.294 m/s
Std Dev = 0.360
%Std Dev = 123%

Plexiglas OSU for Visualization Study

Summary

- PIV measurements were made in the OSU, both hot and cold conditions
- Higher levels of turbulence were found for hot OSU, though measurements could be re-done for more certainty
- Will perform cold flow measurements in clear OSU
- Will take suggestions for other possible measurements
  - At top exhaust plane
  - Near thermopile junctions

Questions or Comments?

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