

2020 KY Professional Engineers in Mining Seminar

# Reduced-Scale Modeling of Machine Mounted Scrubber

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# Outline

- Introduction
- Scale Model Setup
- PIV Testing Results
- Conclusions

# Introduction

# Types of Modeling

- Full Scale
- Reduced Scale
- Computational



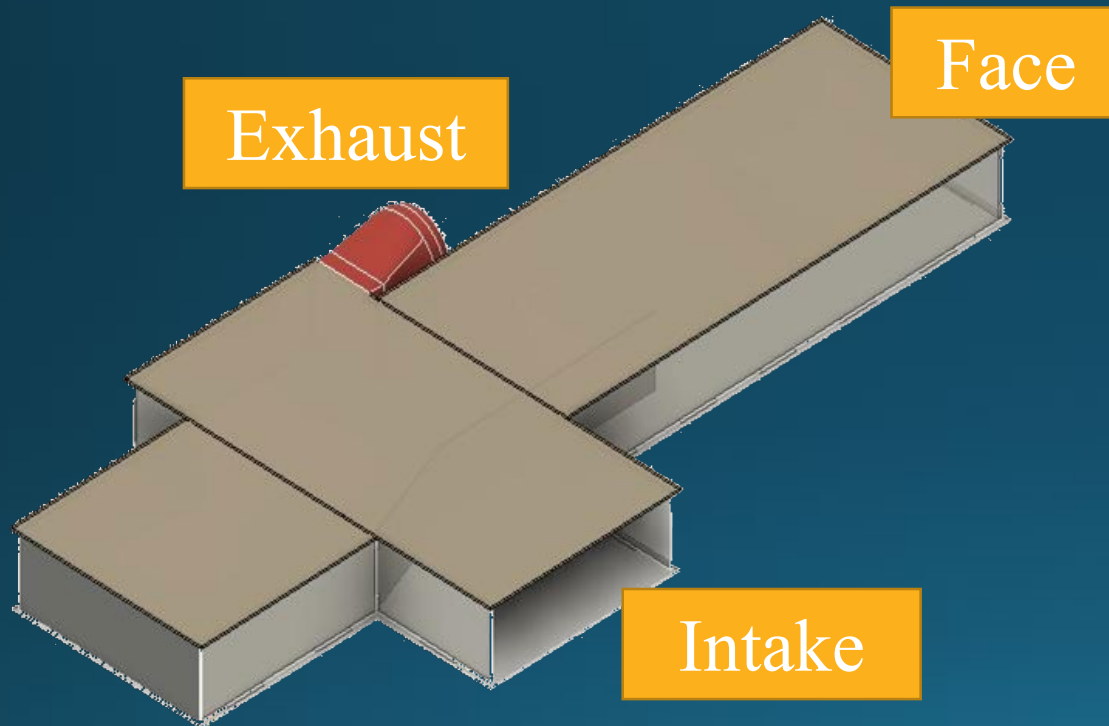
# Full-Scale Model: Dust Gallery

- A full-scale mine entry was constructed based on field measurements from Eastern KY mine.
- Entry is 20' wide, 7' high.
- Located within a large underground limestone quarry.



# Scale-Model Testing Setup

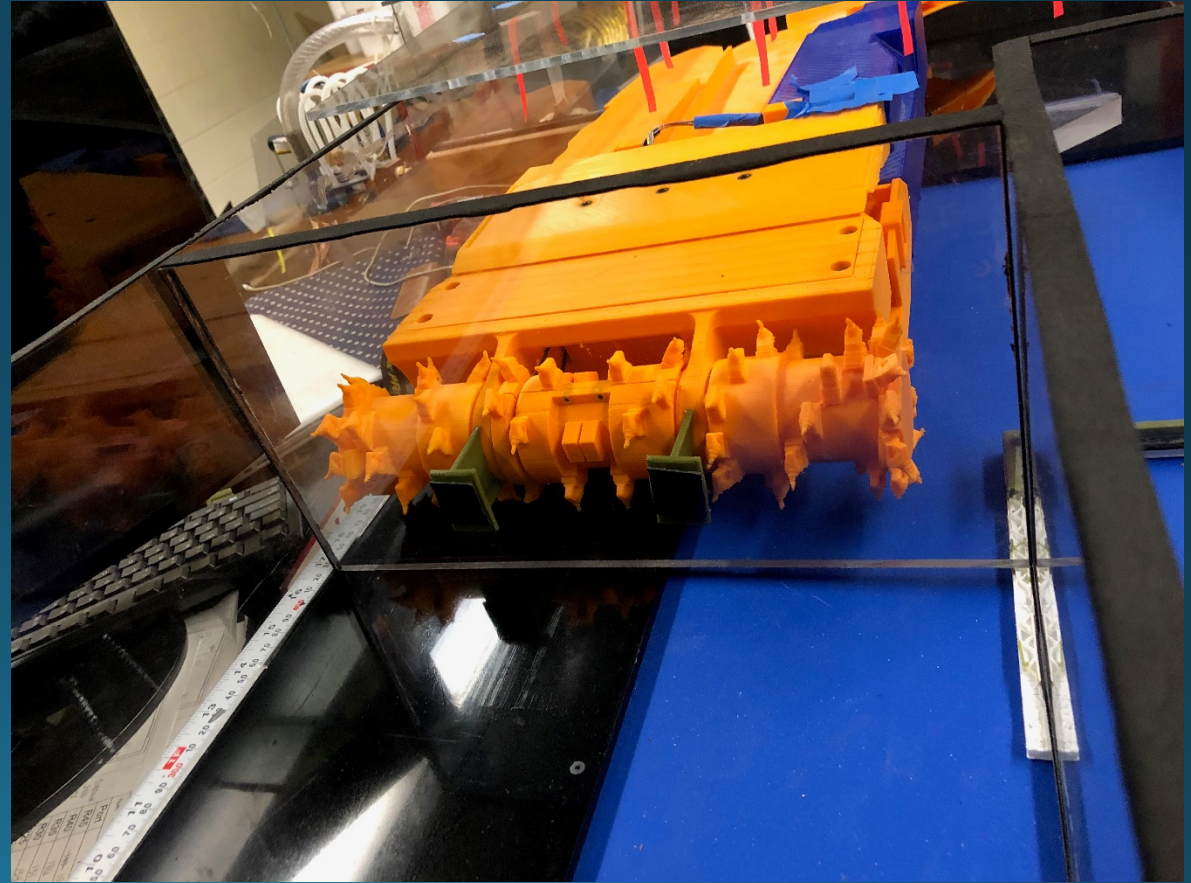
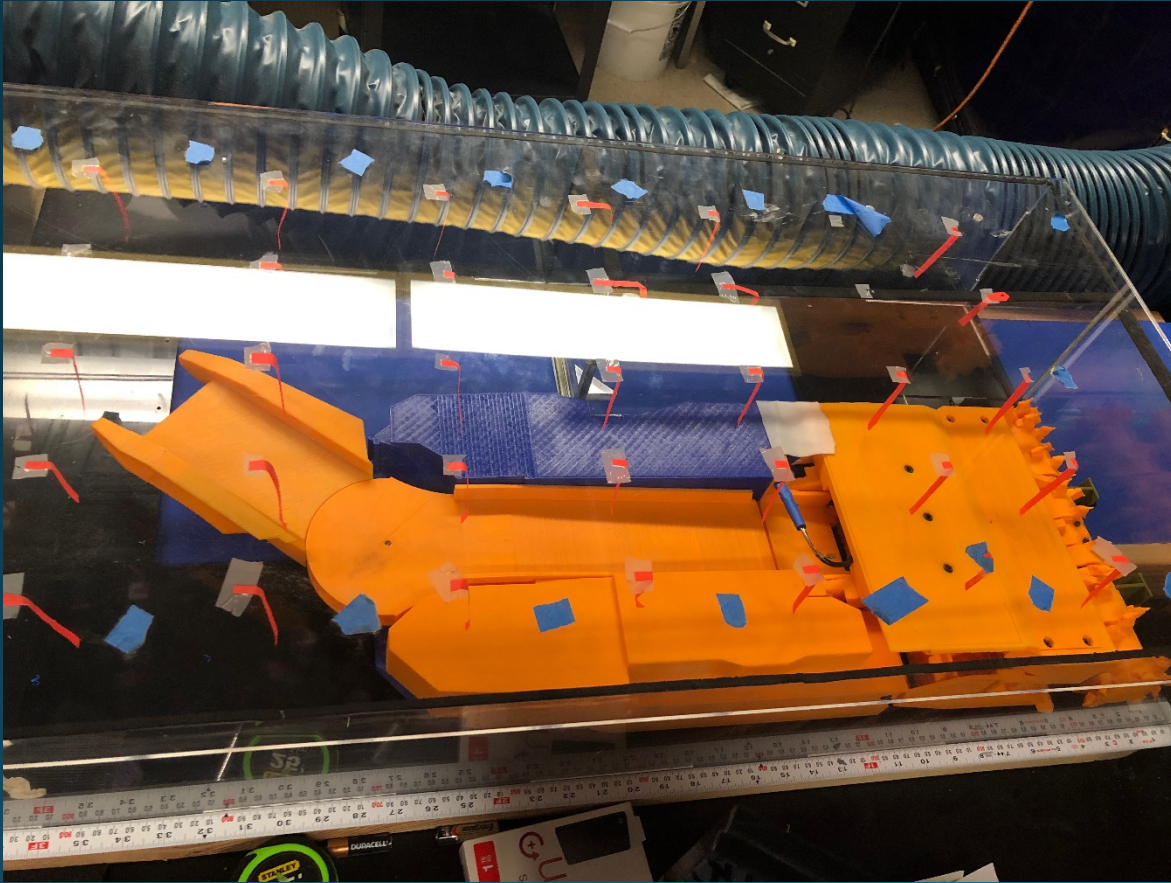
# Reduced Physical-Scaled Model of Dust Gallery



- Designed as a 1:12 Scaled model of the Dust Gallery
- Curtain length and offset is adjustable
- Ribs and Top are made of clear materials for high light transmissivity.



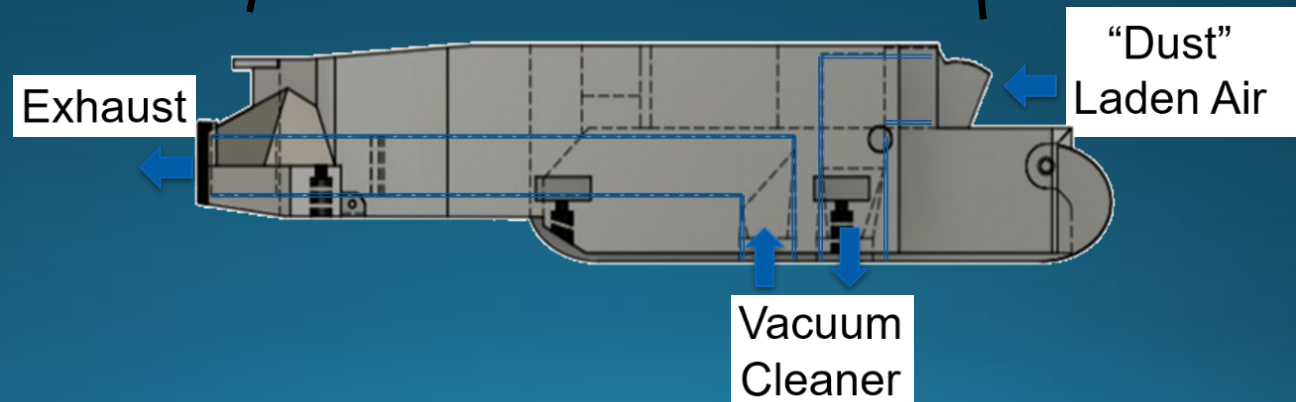
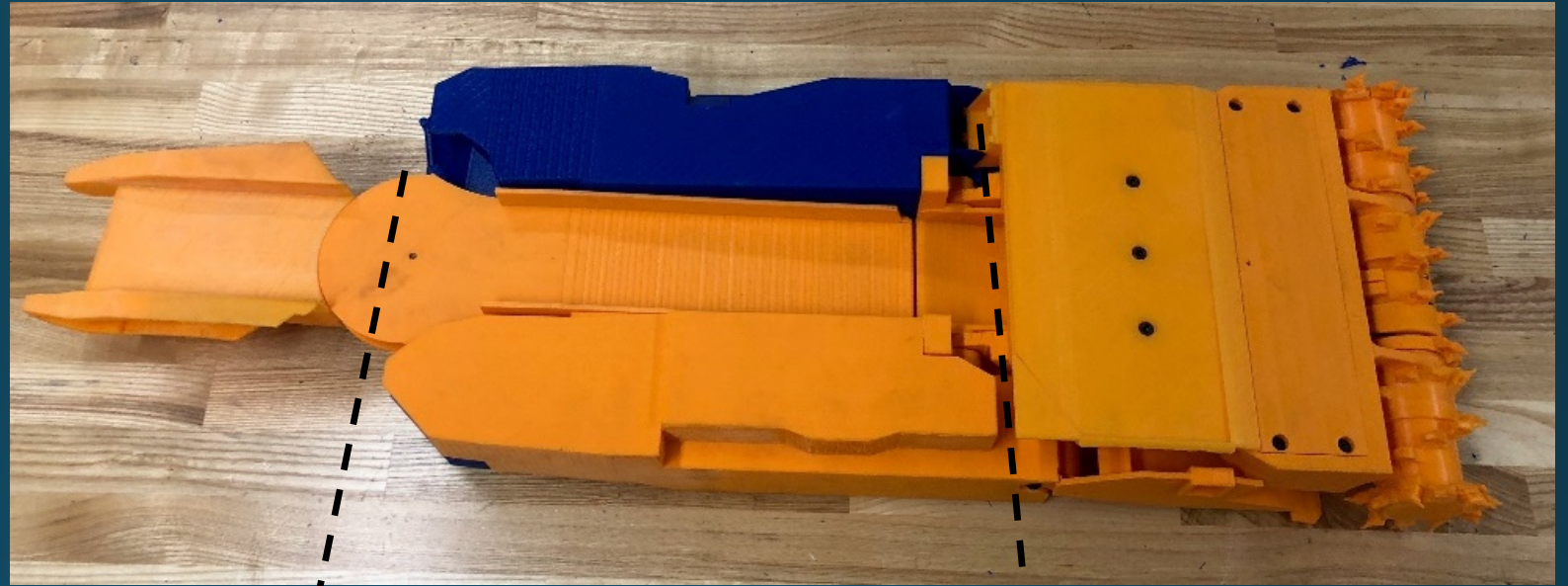
# 3D Printed Miner attached to Movable Floor & Faux Face



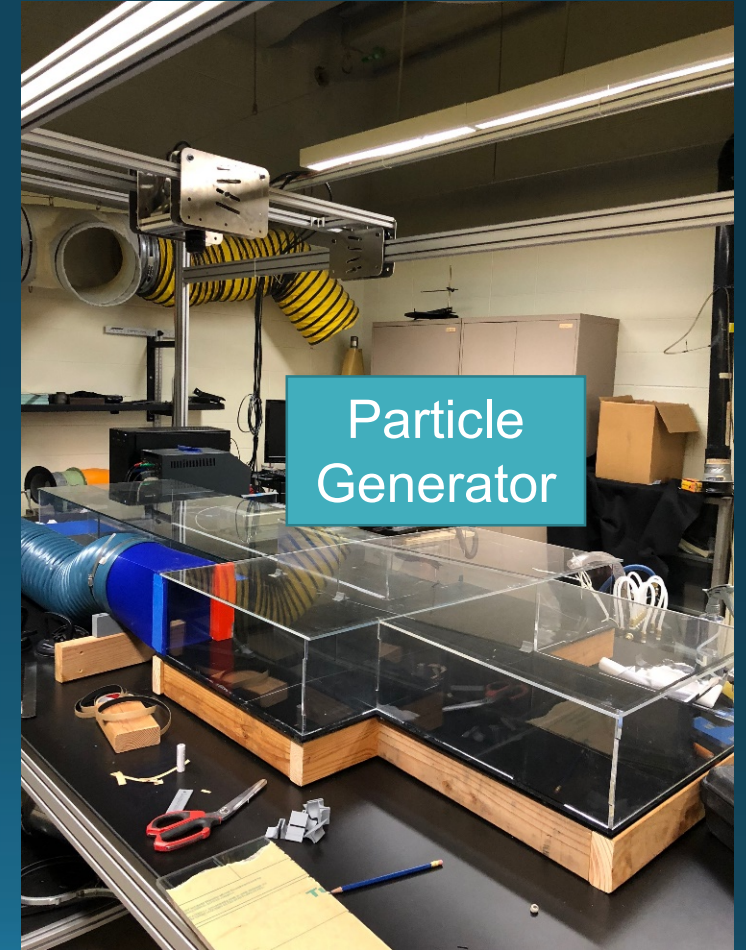
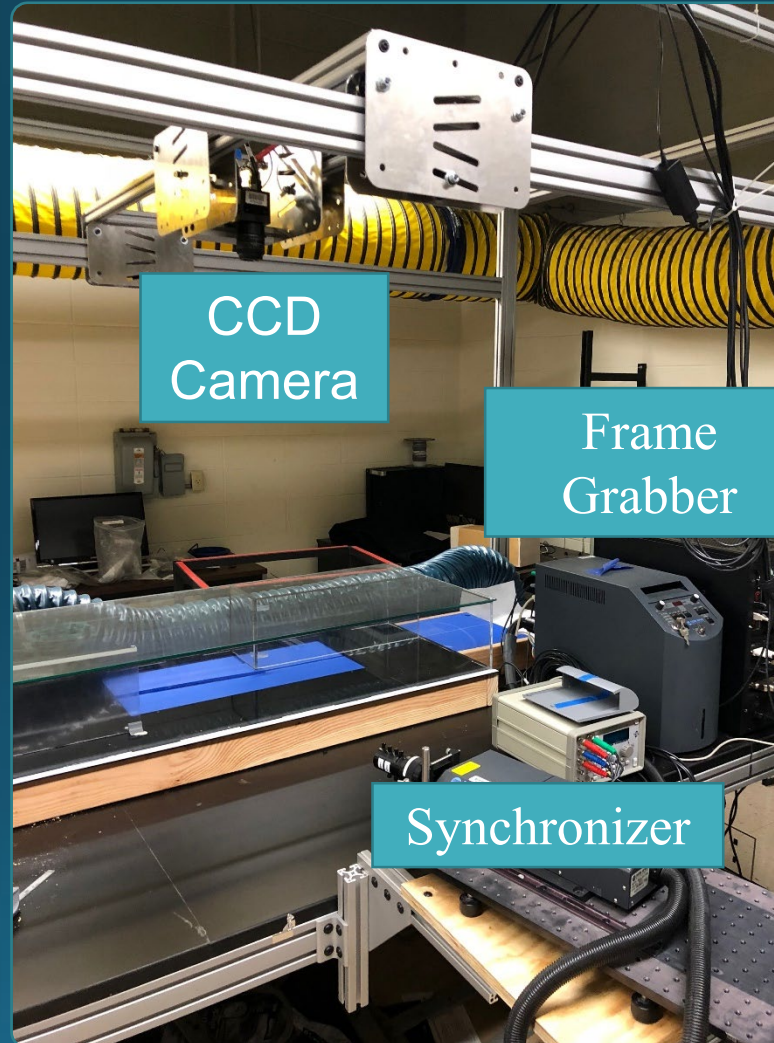
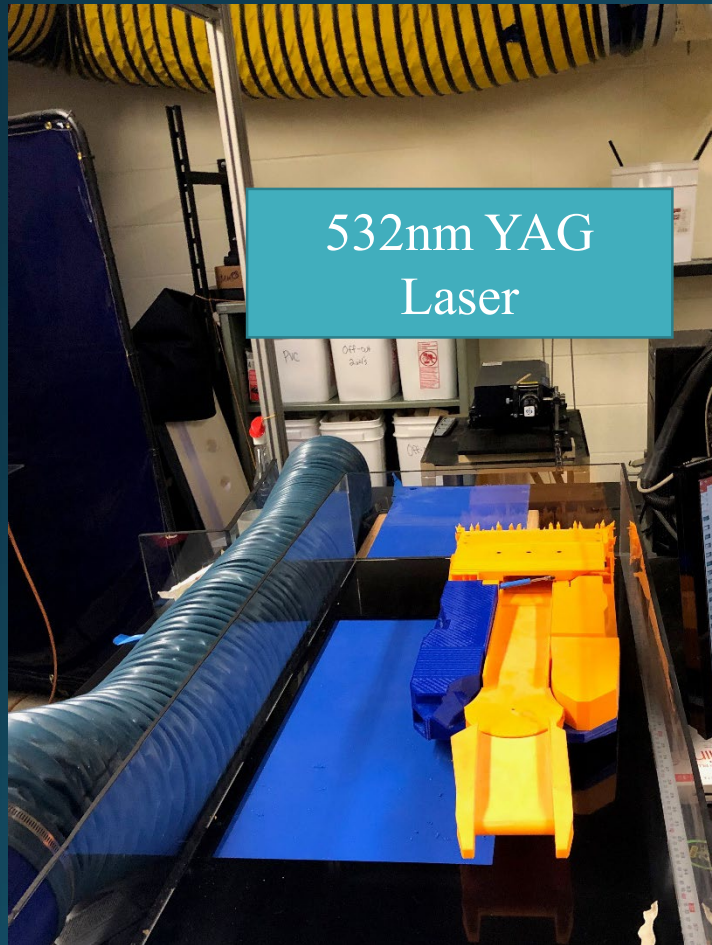
# 3D printed scrubber Module

A vacuum cleaner, with motor controller, removes and filters air from the model

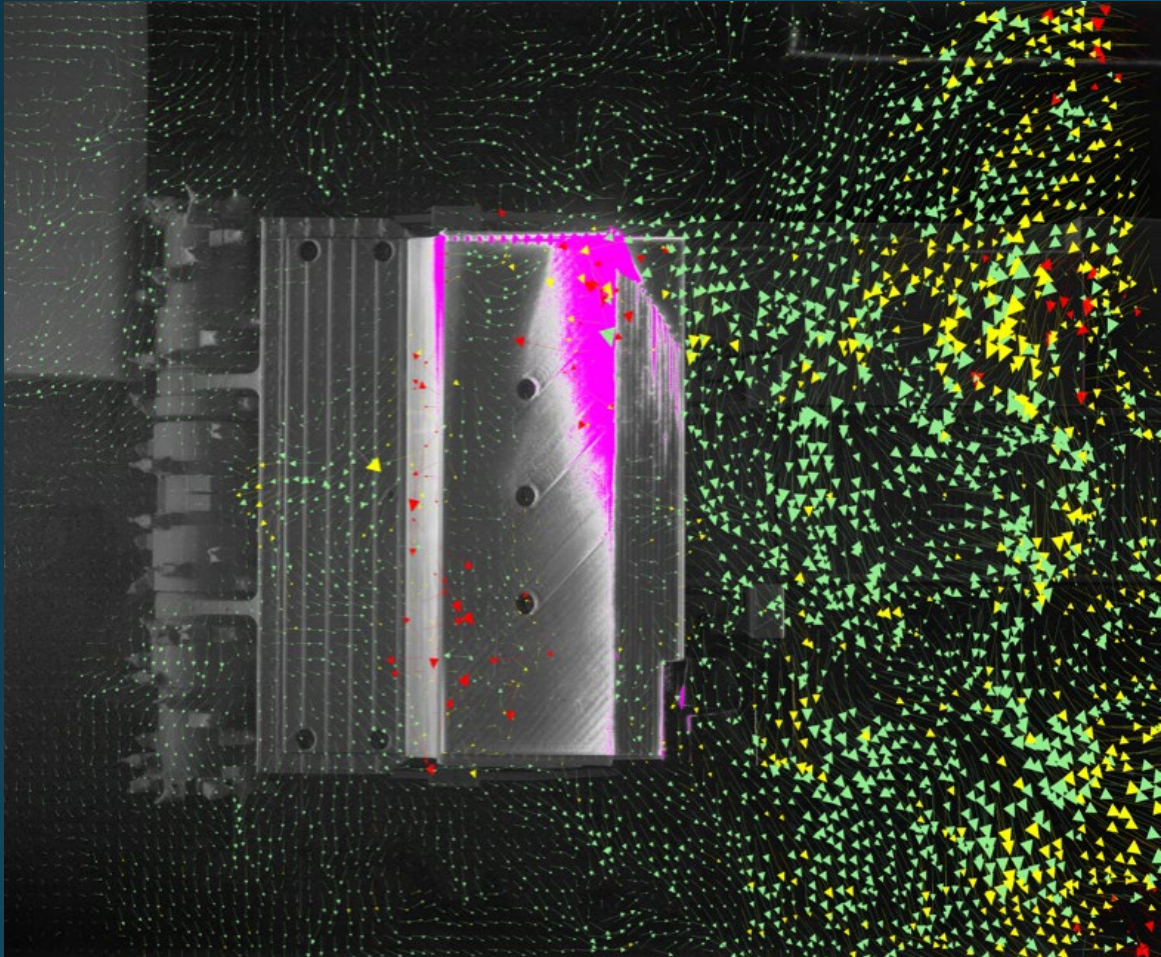
A blower vac, with motor controller, pushes clean air back into the model



# Experimentation and Particle Image Velocimetry



# Vector Generation



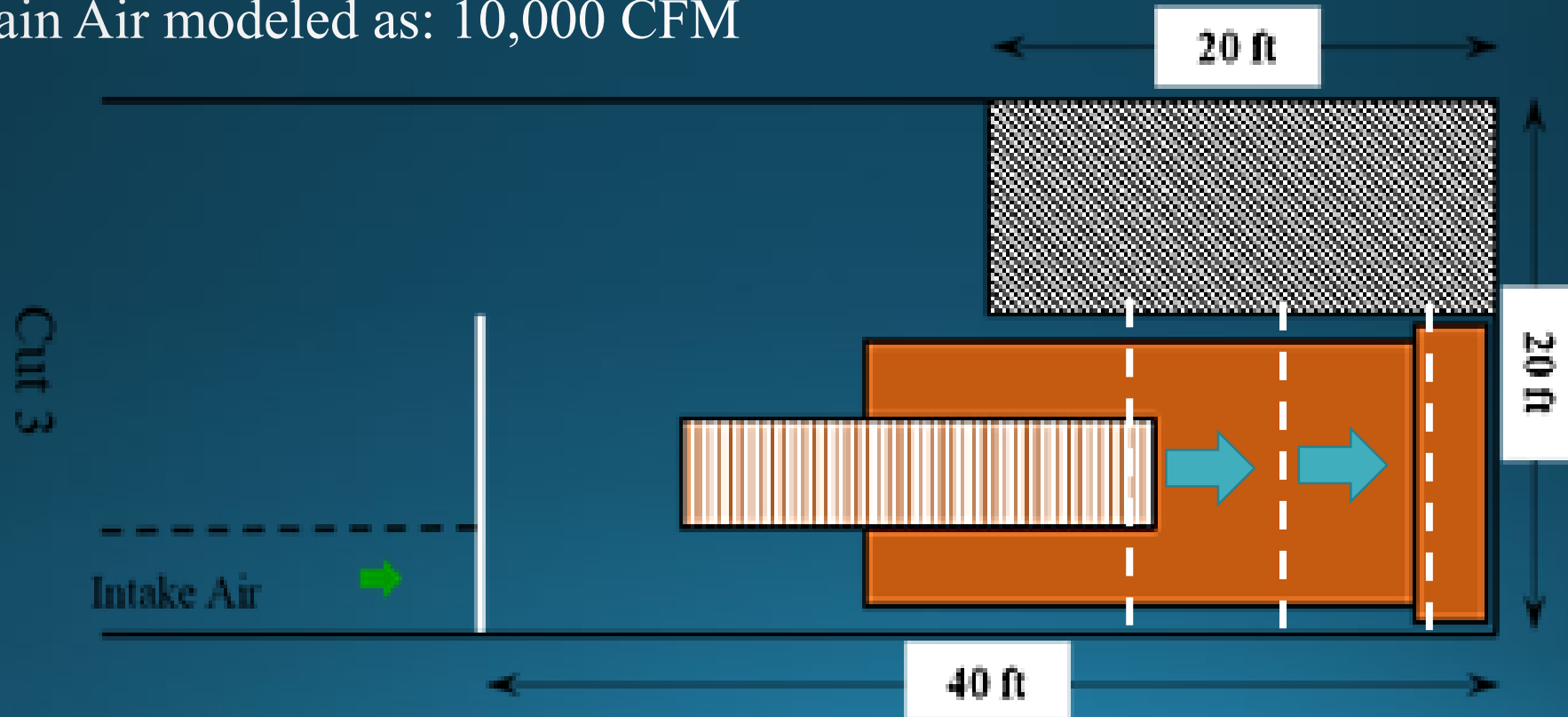
- Particles are tracked across 2 frames to develop vectors
- Time step between frames dependent on flow velocity
- 100 or more image pairs depending on vector quality

# PIV Testing & Results

# Scale and Velocity

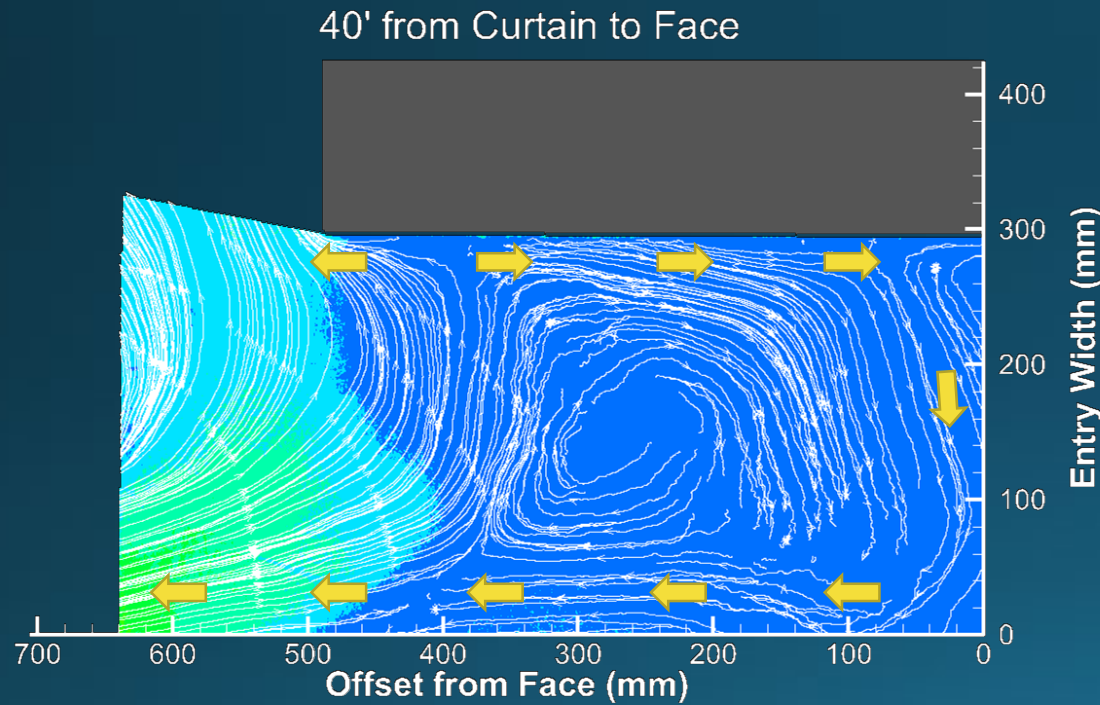
Model was scaled to match these full-scale condition:

- Curtain offset of 4'
- Extended cut; curtain setback of 40'
- Curtain Air modeled as: 10,000 CFM

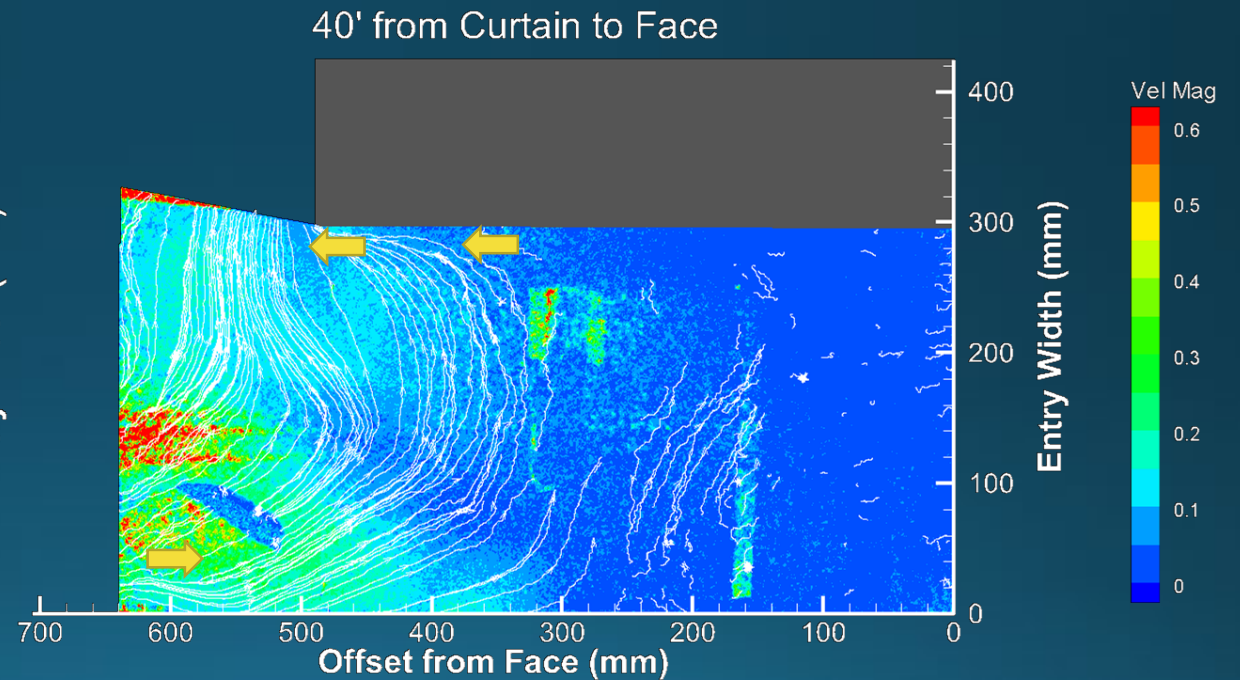


# Influence of the Continuous Miner on Air Patterns

Without Miner

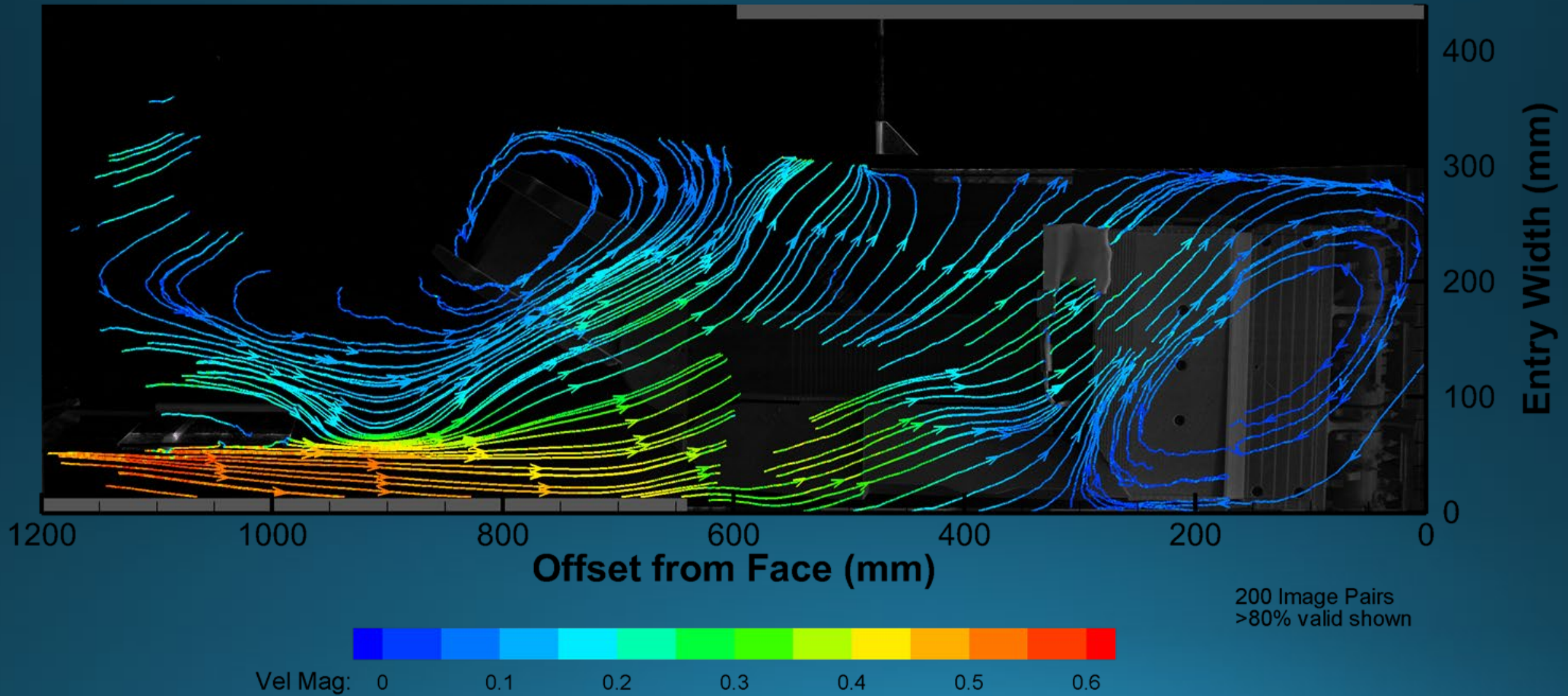


With Miner



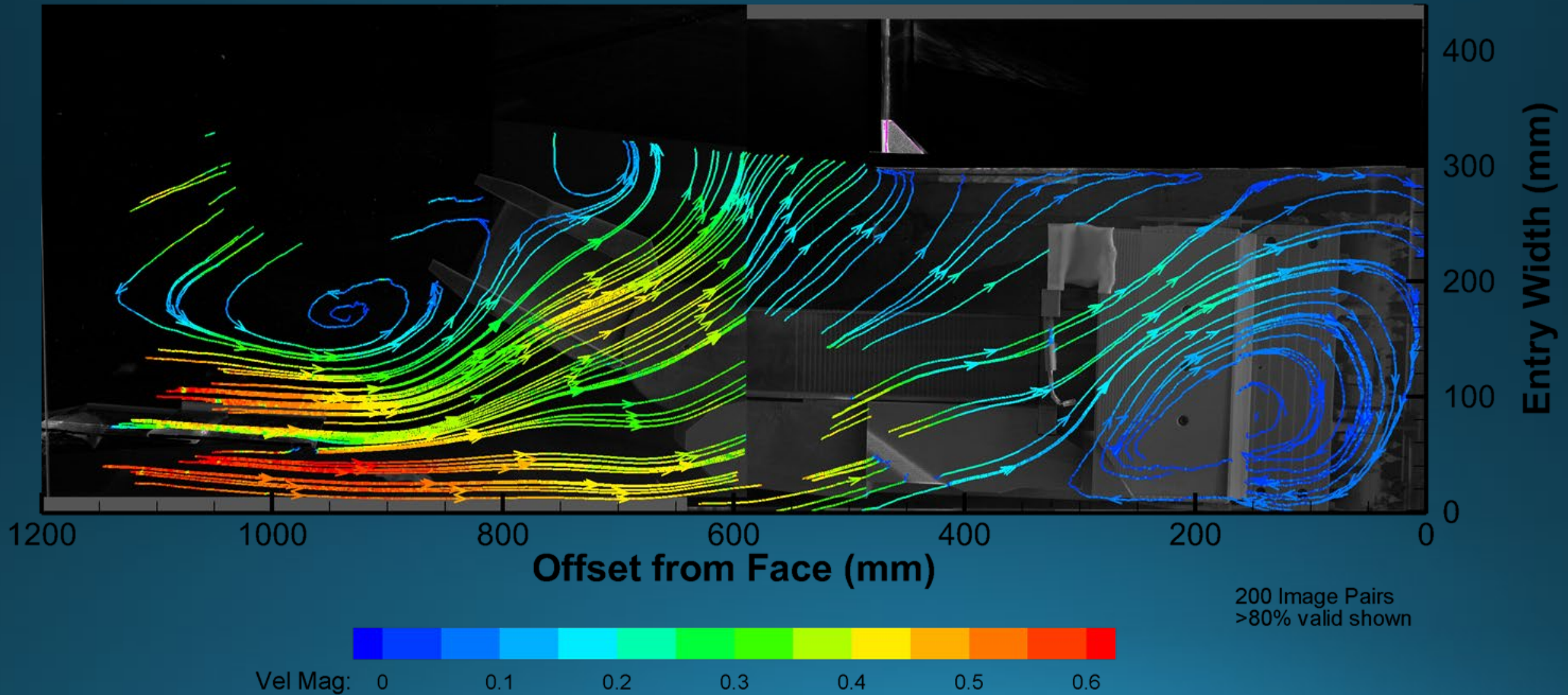
← Full-Scale Testing

Scrubber Target = 85% Intake Air

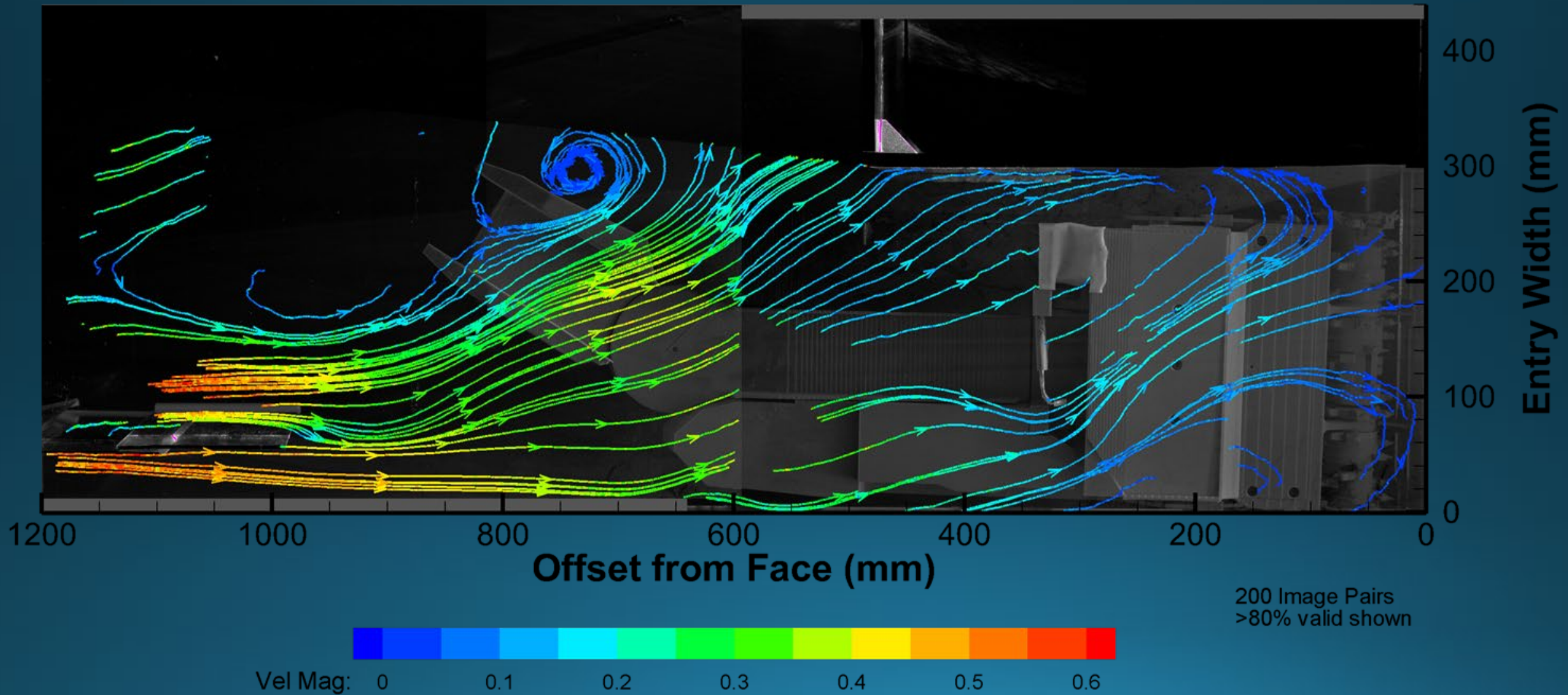




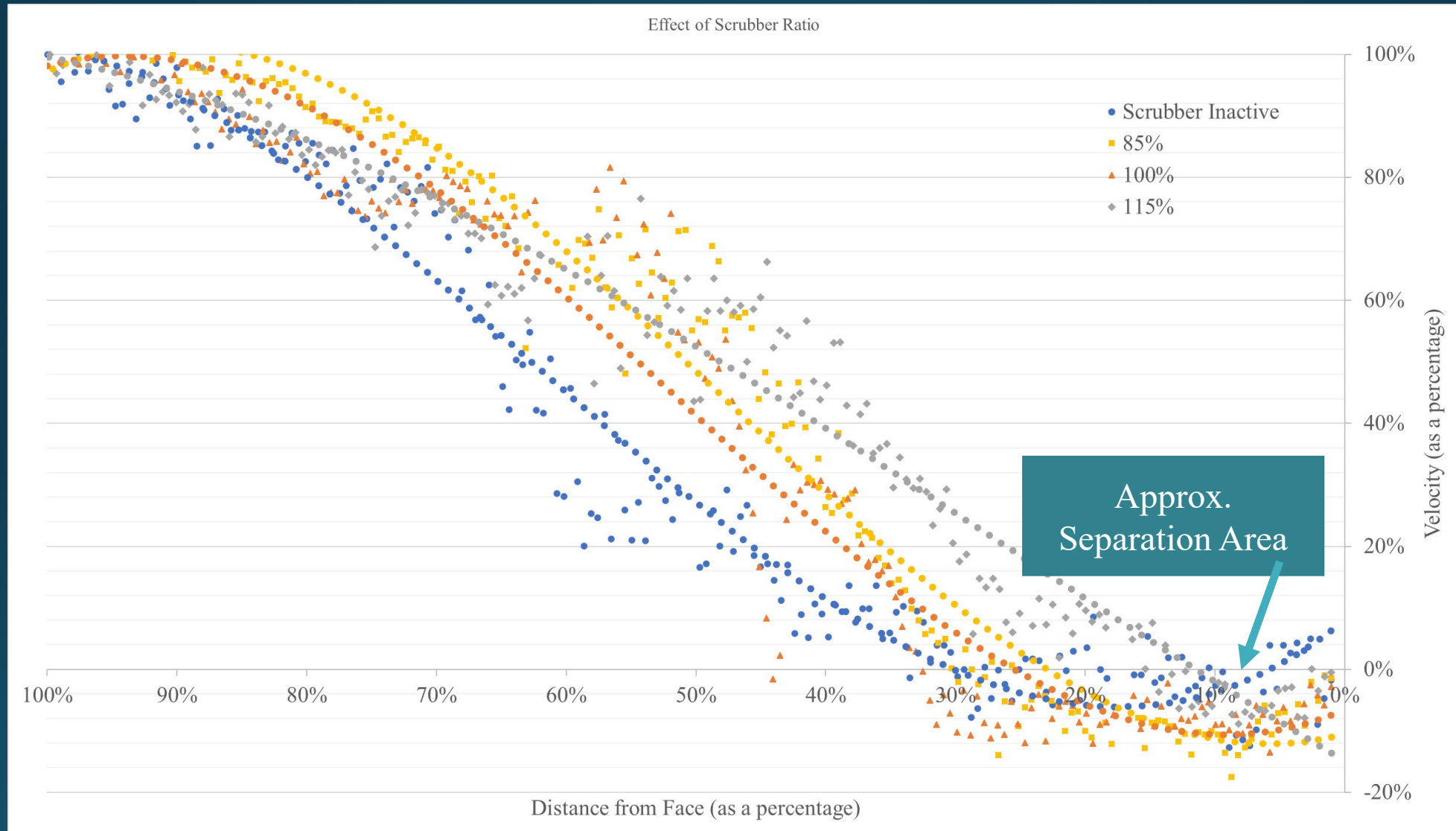
# Scrubber Target = 100% Intake Air

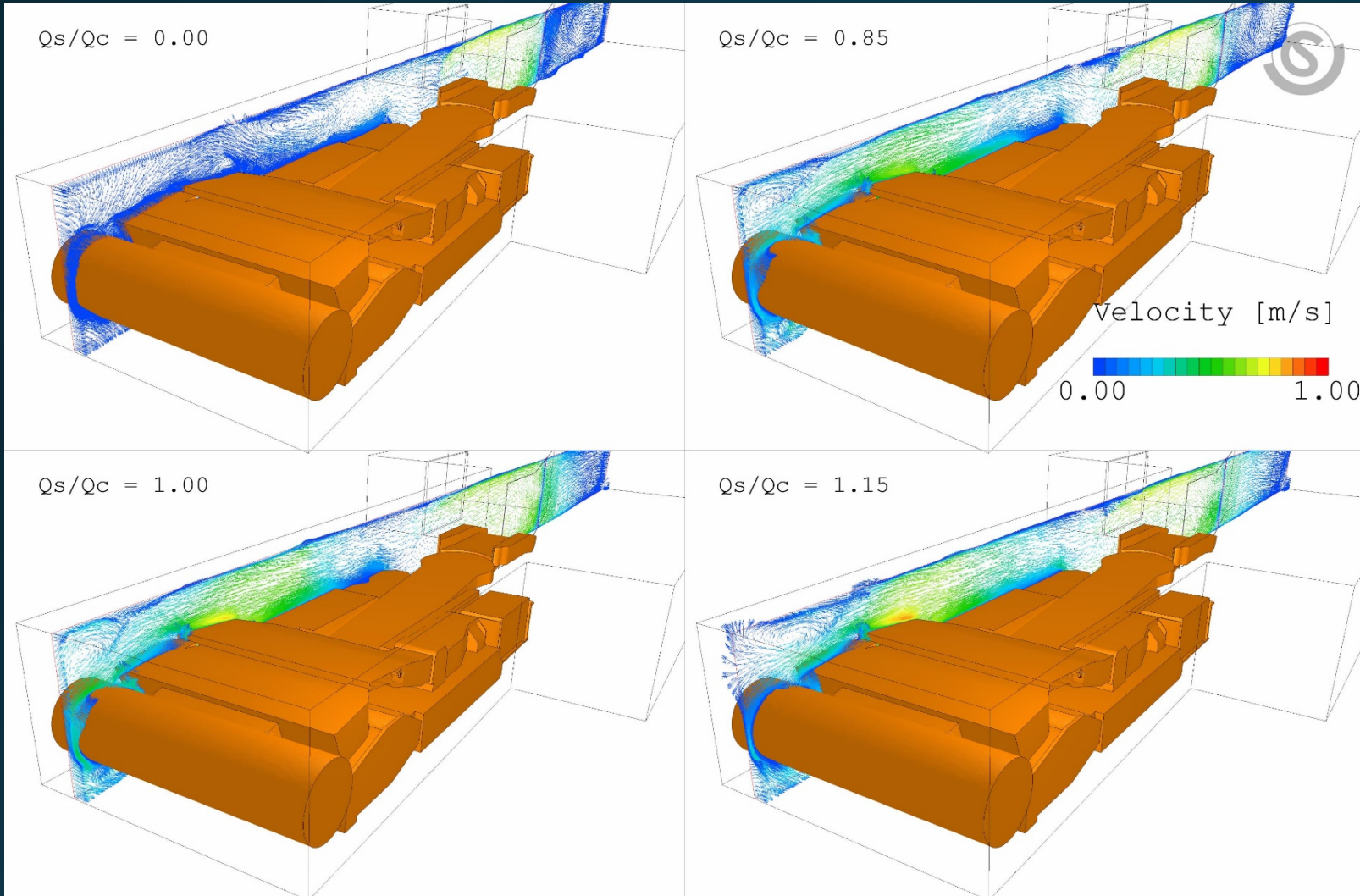


Scrubber Target = 115% Intake Air



# Quantitative Results





Similar phenomena is seen in the full-scale tests as well in CFD models (shown right).

# Conclusions

Reduced-Scale Modeling is an effective form of modeling complex systems:

- Manageable scale
- Decreased experimental and computational time
- Reduction of safety and health hazards
- Increased data resolution

Tests show that increasing the scrubber airflow too high pulls more of the incoming air into the scrubber, reducing the effectiveness of the fresh air and scrubber

THANK YOU!!!!!!

