

# Airborne Measurements of Dust, Endotoxin and Contaminant Gases in Swine Production

Peter C. Raynor<sup>1</sup>, Darby Murphy<sup>2</sup>, Shannon Engelman<sup>1</sup>,  
Gurumurthy Ramachandran<sup>1</sup>, Jeff B. Bender<sup>2</sup>,  
Bruce H. Alexander<sup>1</sup>

<sup>1</sup>University of Minnesota, School of Public Health

<sup>2</sup>University of Minnesota, College of Veterinary Medicine

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# Respiratory Health Concerns for Swine Workers

- Airborne exposures
  - Ammonia
  - Hydrogen sulfide
  - Dust
  - Endotoxin
- Asthma/reactive airway disease
  - Induction
  - Exacerbation
- Chronic obstructive pulmonary disease
- Susceptibility to infectious diseases



# UMASH Goal

Determine how changing  
production practices and facilities  
relate to worker health and safety

# Production Systems

## Gestation Stalls



## Gestation Pens



# Objectives

Characterize exposure concentrations in gestation housing

- Compare production systems: pens vs. stalls
- Look for seasonal differences in Minnesota
- Compare sow "moving" days vs. "non-moving" days
- Observe tasks to see effects on concentrations

# Swine Facility at SROC

Gestation Stalls

Gestation Pens

Farrowing

Finishing



# When did we sample?

One time each month for a year:

- Simultaneous 8-hour area samples in gestation room w/ stalls & gestation room w/ pens on "moving" days
- Simultaneous 8-hour area samples in gestation room w/ stalls & gestation room w/ pens on "non-moving" days
- Simultaneous 8-hour area samples in finishing room w/ dry feed & finishing room w/ wet feed
- Concentration mapping of main building three times in one day



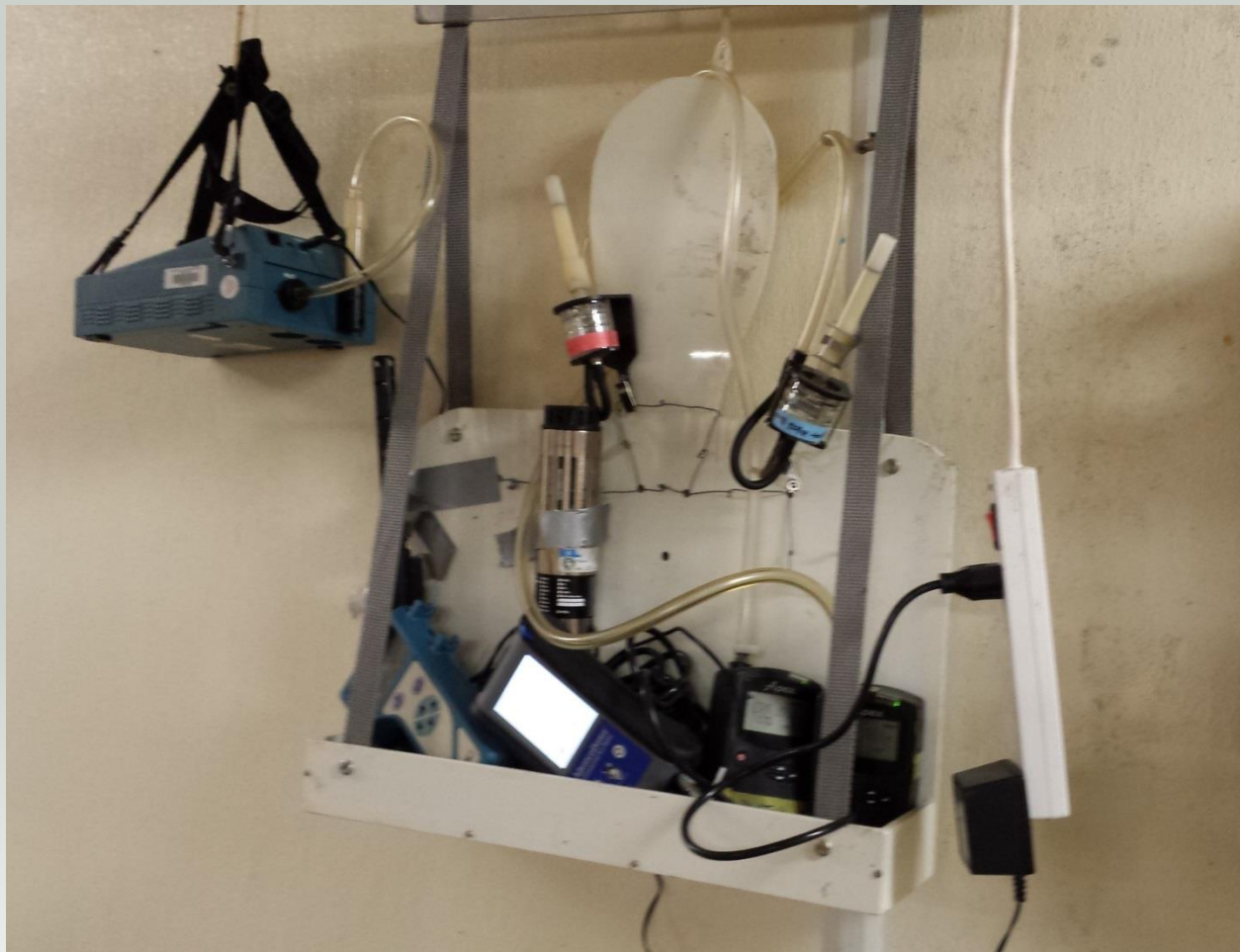
# For what did we sample?

- Ammonia (Gray Wolf, DirectSense Electrochemical Gas Sensors)
- Hydrogen sulfide (Gray Wolf, DirectSense Electrochemical Gas Sensors)
- Respirable dust (37 mm PVC filters; gravimetric analysis)
- Respirable endotoxin (37 mm polycarbonate filters; LAL kinetic chromogenic analysis)
- Carbon dioxide (TSI, Q-Trak Models 8552/7575)
- Temperature (TSI, Q-Trak Models 8552/7575)

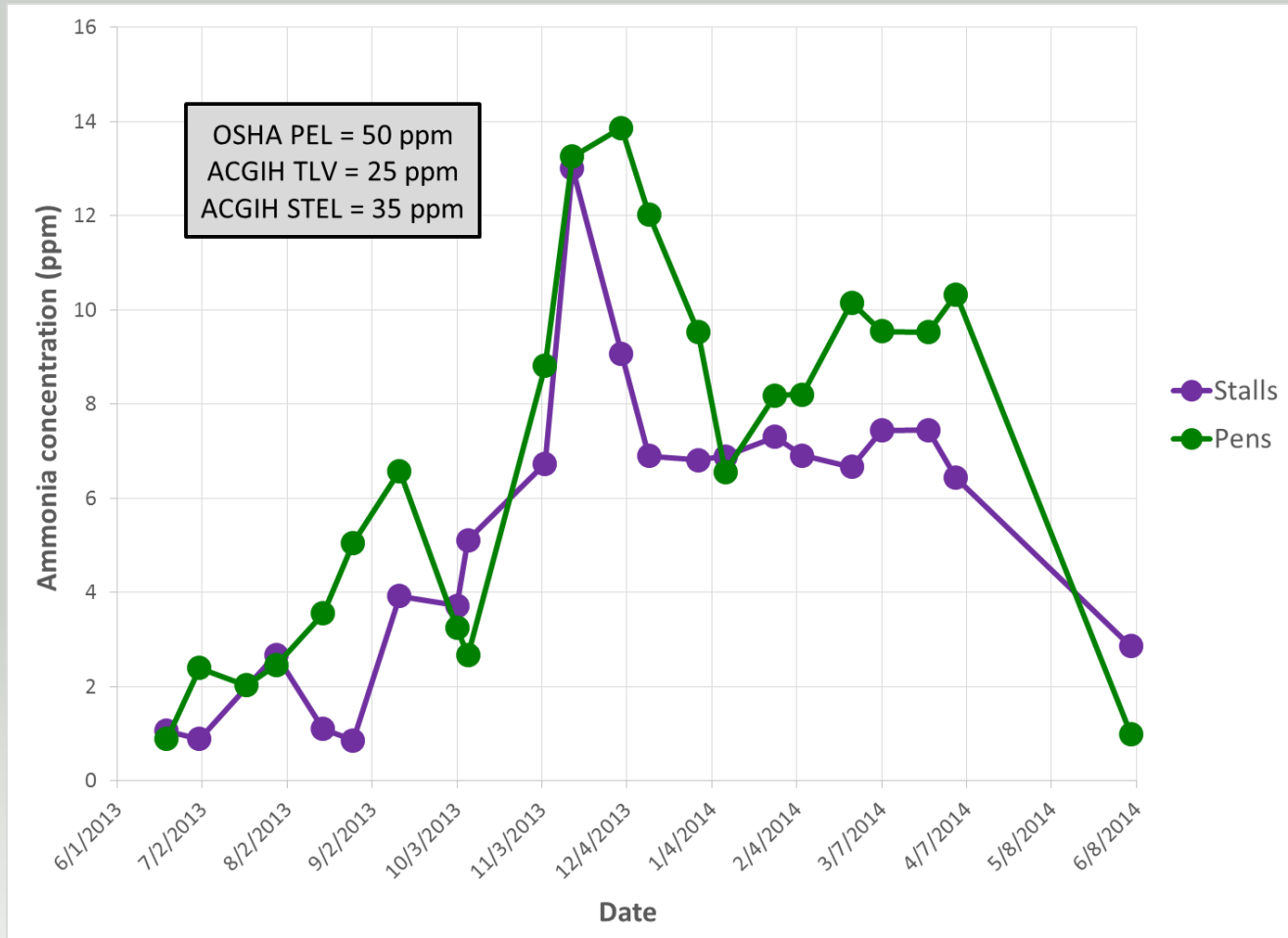




# Samplers

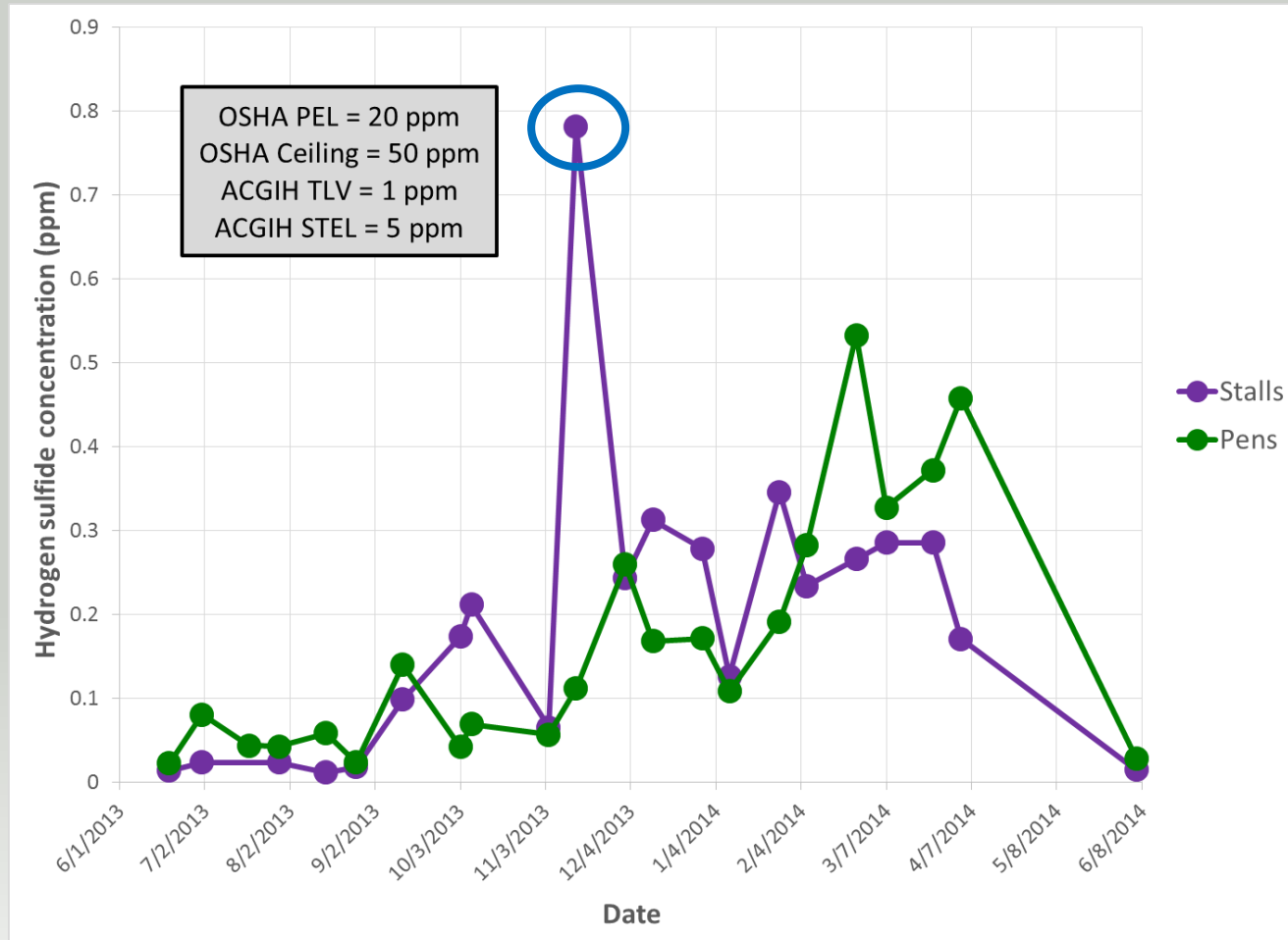


# Pens vs. Stalls: Ammonia



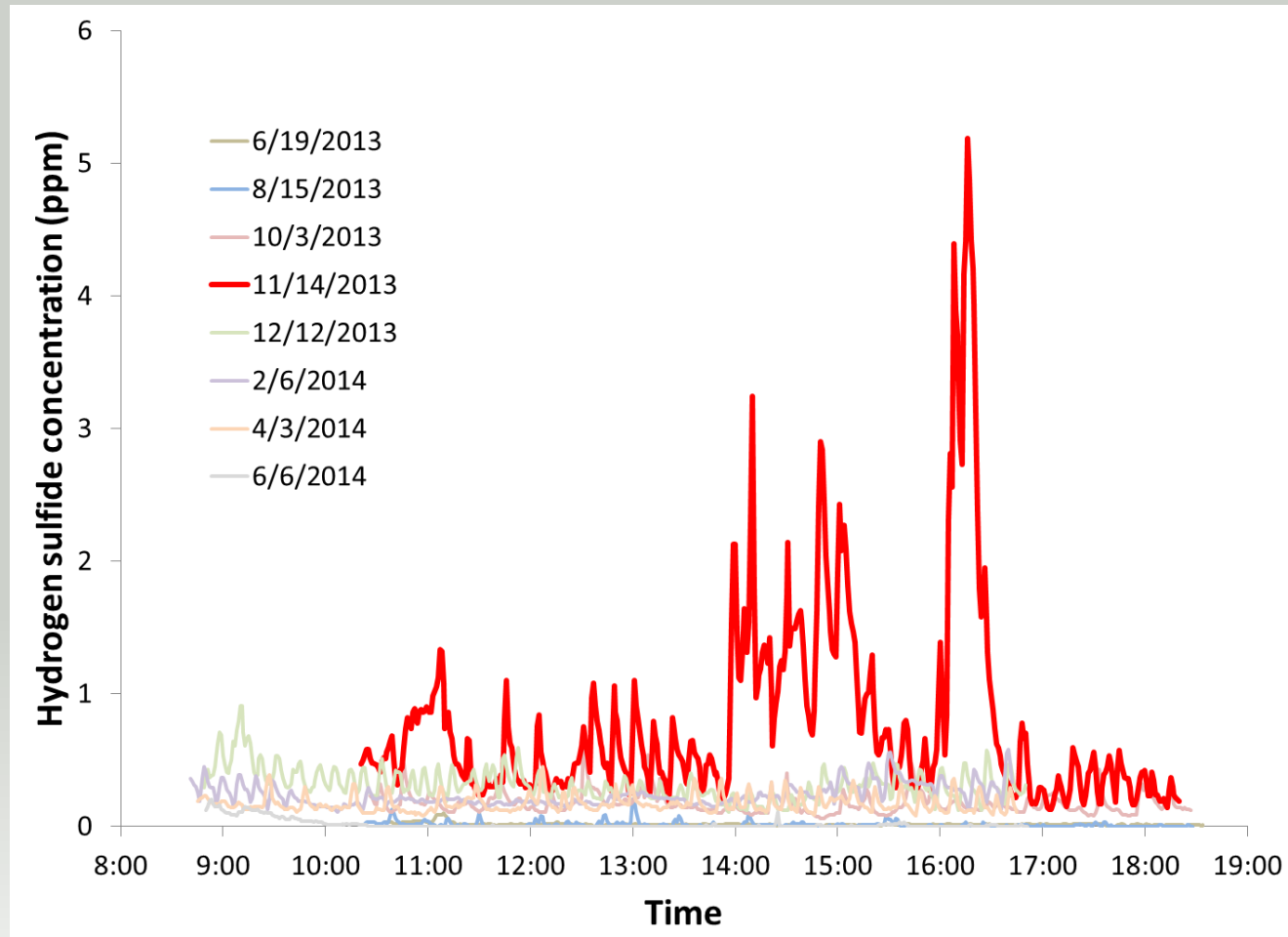
Modeling of High-Moisture Dairy Cows in Stalls

# Pens vs. Stalls: Hydrogen Sulfide

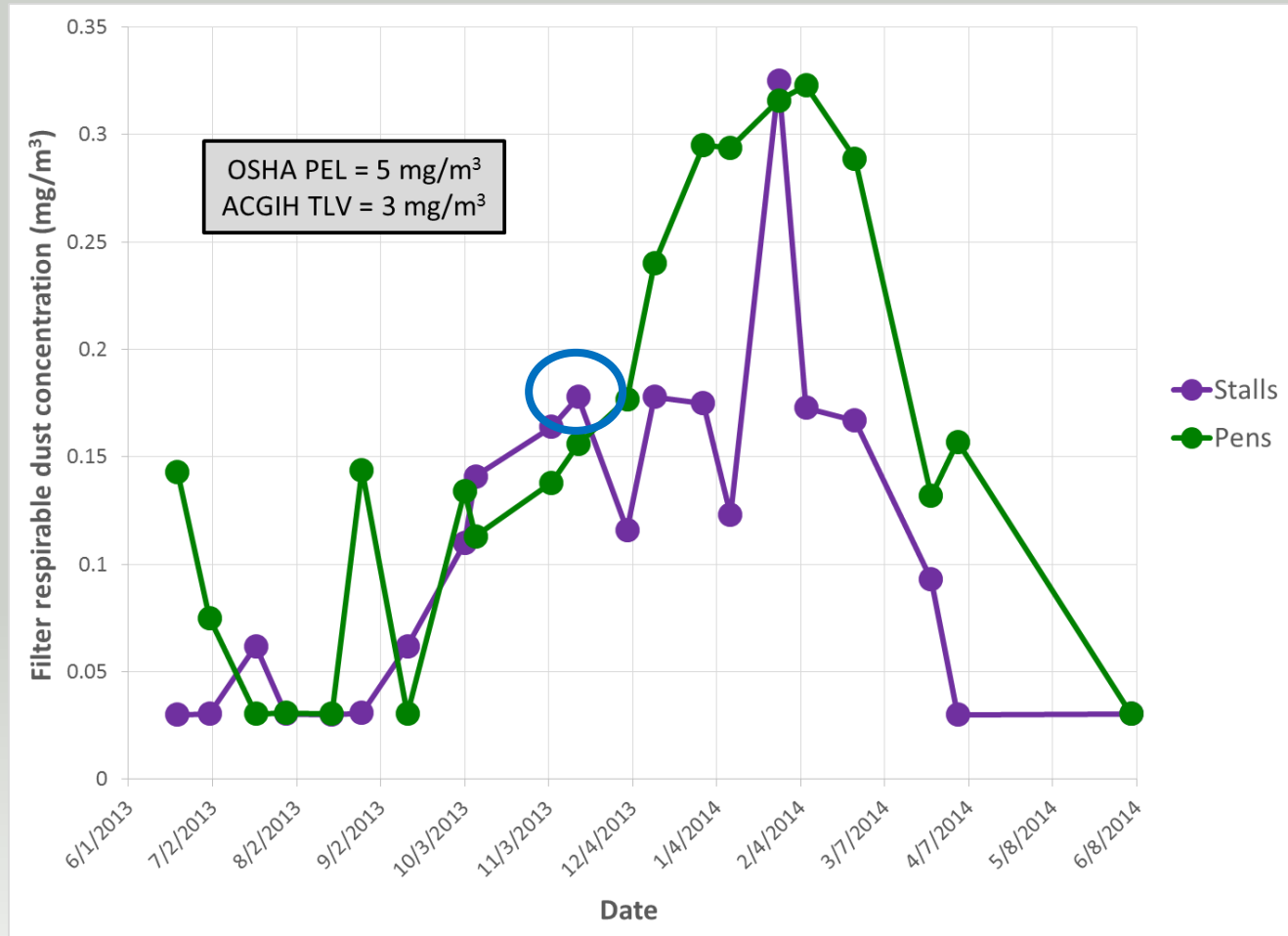


Pens 5% higher on average;  $p = 0.81$

# Hydrogen Sulfide (Stalls; Non-Moving)

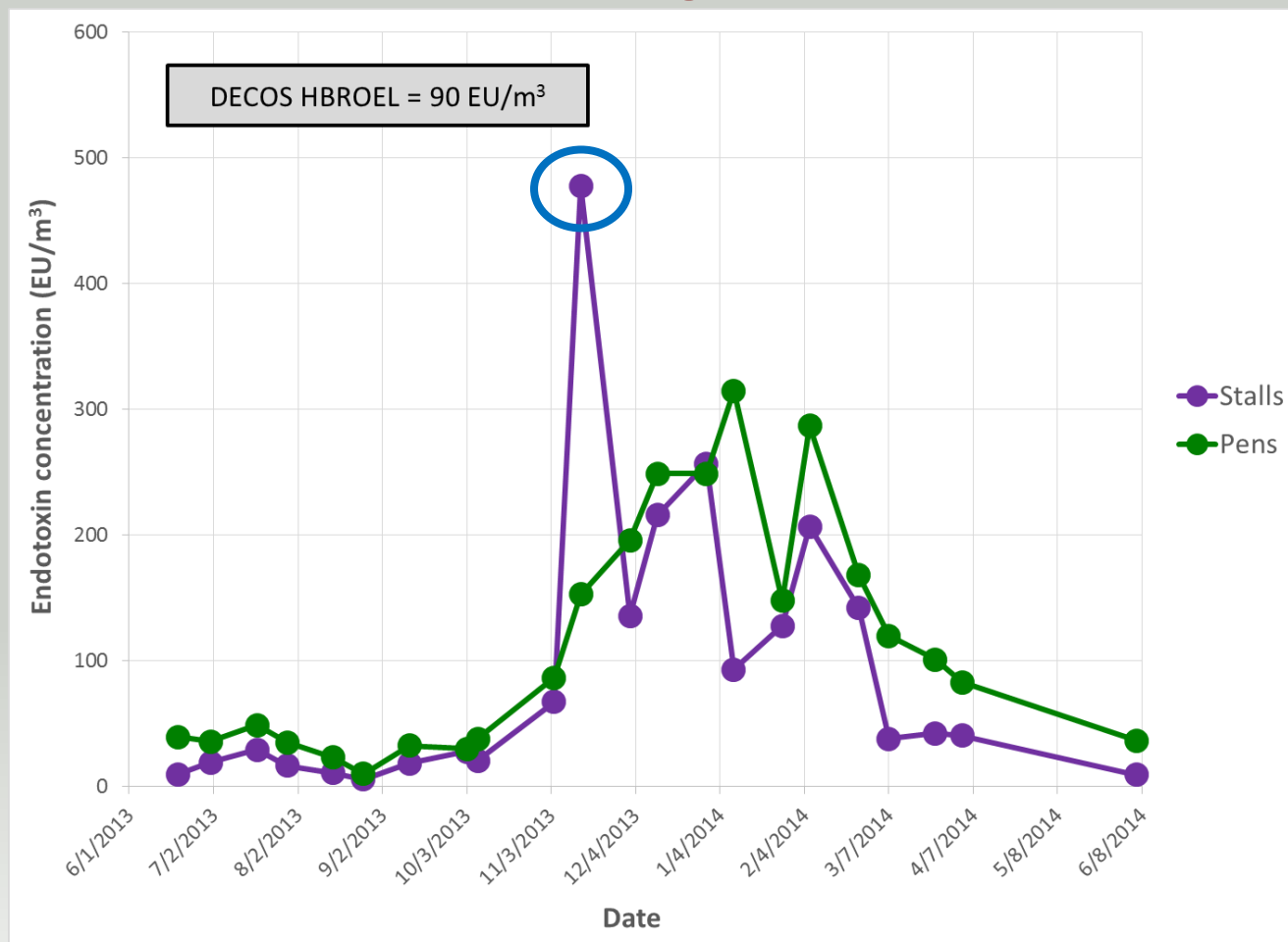


# Pens vs. Stalls: Respirable Dust



Pens 43% higher on average;  $p = 0.023$

# Pens vs. Stalls: Respirable Endotoxin



Pens 67% higher on average;  $p = 0.00027$

# Combined Exposures

- Inhalation of ammonia, hydrogen sulfide, and endotoxin have similar effects on respiratory system
- A way to combine the concentrations:

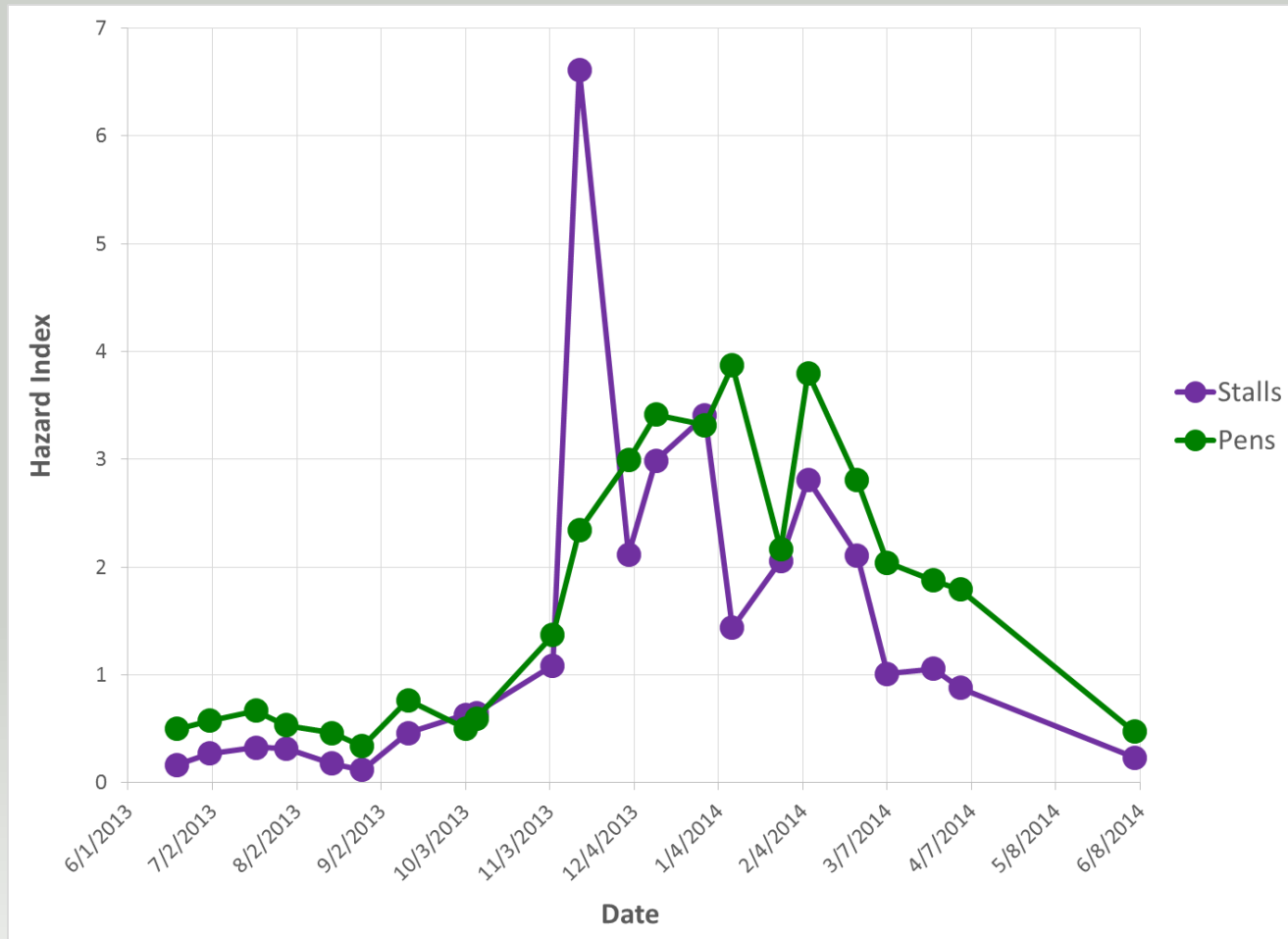
$$\text{Hazard Index} = \frac{\text{Avg NH}_3 \text{ Conc}}{8\text{-hr NH}_3 \text{ TLV}} + \frac{\text{Avg H}_2\text{S Conc}}{8\text{-hr H}_2\text{S TLV}} + \frac{\text{Endotoxin Conc}}{\text{DECOS HBROEL}}$$

$$\text{Hazard Index} = \frac{\text{Avg NH}_3 \text{ Conc}}{25 \text{ ppm}} + \frac{\text{Avg H}_2\text{S Conc}}{1 \text{ ppm}} + \frac{\text{Endotoxin Conc}}{90 \text{ EU/m}^3}$$

- If Hazard Index > 1, concern warranted

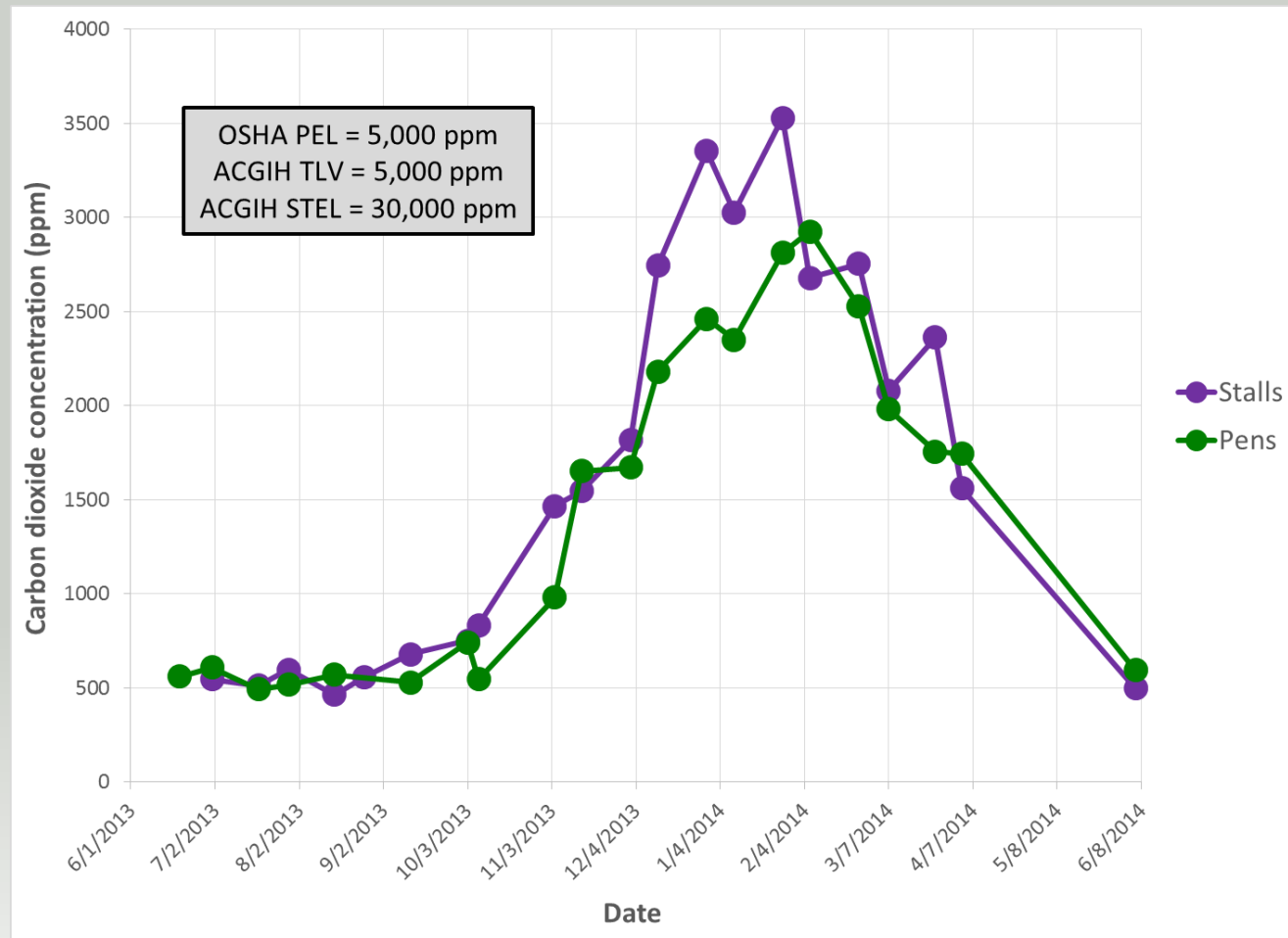


# Pens vs. Stalls: Hazard Index

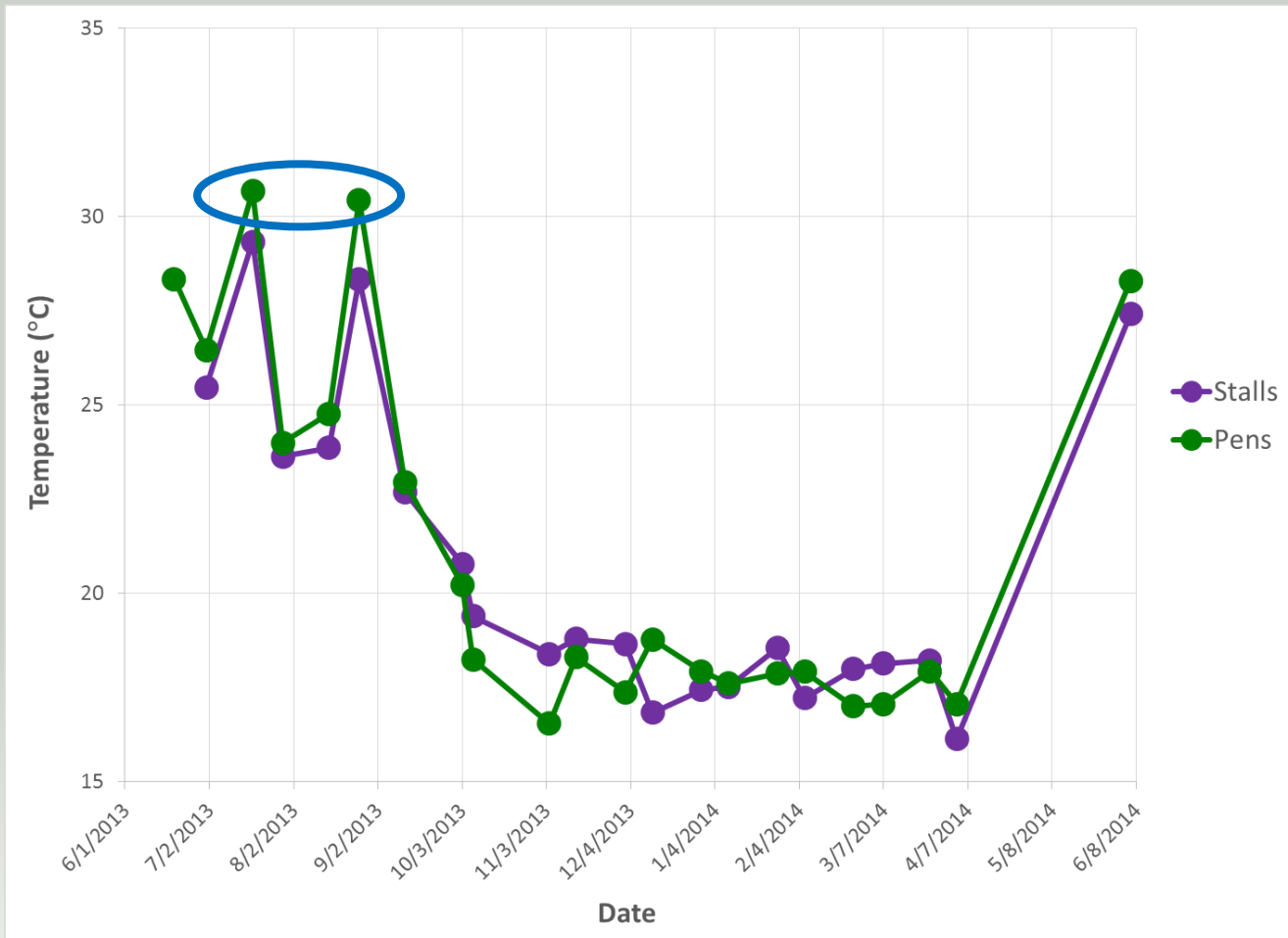




# Pens vs. Stalls: Carbon Dioxide



# Pens vs. Stalls: Temperature



# Summary

- Season dominates most of the other factors due to ventilation
- Concentrations in pens higher, on average, with varying significance
- No significant difference between moving/non-moving days
- Endotoxin levels are high in winter; other agents below OELs
- Effects of combined exposures worth further consideration
- One site in Minnesota: how generalizable?
- Further characterization of exposures during power washing is warranted
- Heat stress is a concern for workers as well as pigs
- Could these air pollutants affect swine growth or productivity?



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