

# What's Happening... ...at Penn State

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Director, Indoor Environment Center

# Indoor Environment Center Mission

- Provide indoor environments that are...
  - Healthier
  - Safer
  - More comfortable...with minimal resource use and environmental impact

*IEQ, use of energy and other resources, environmental impact are coupled*

# People

- Penn State
  - Bill Bahnfleth, Director
  - Jim Freihaut, Aerosol Laboratories
  - Paul Kremer, Lab Supervisor
  - John Cimbala (MNE), CFD Modeling
  - Chobi Debroy (Vet. Sci.), Microbiology
  - Rick Mistrick, Lighting
  - Kevin Houser (1/08), Lighting
  - 9 graduate students
- Collaborators
  - Iowa Energy Center
  - Drexel University
  - NIST
  - Vandemusser Design

# Research Areas

- Bioaerosol characterization
- Bioaerosol control technology
- Effective HVAC system design
- Design for control of risk from airborne agents
- Advanced lighting systems

# Bioaerosol Characterization

- Resuspension from room & HVAC system surfaces
- Production of standardized allergen particles
- Protocols for handling and determining viability of test bioaerosols

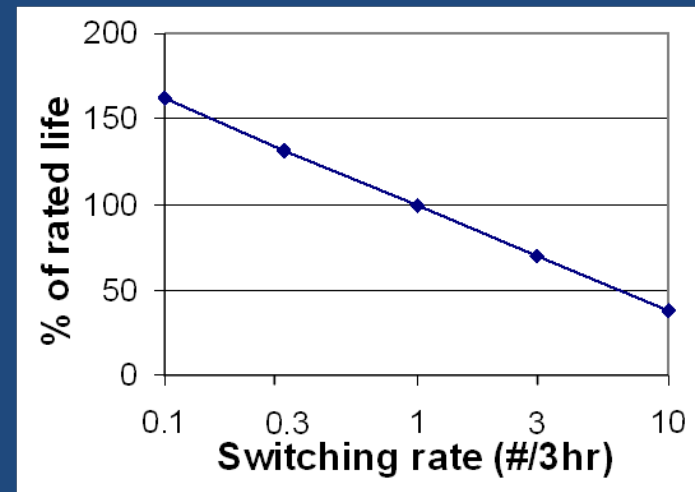
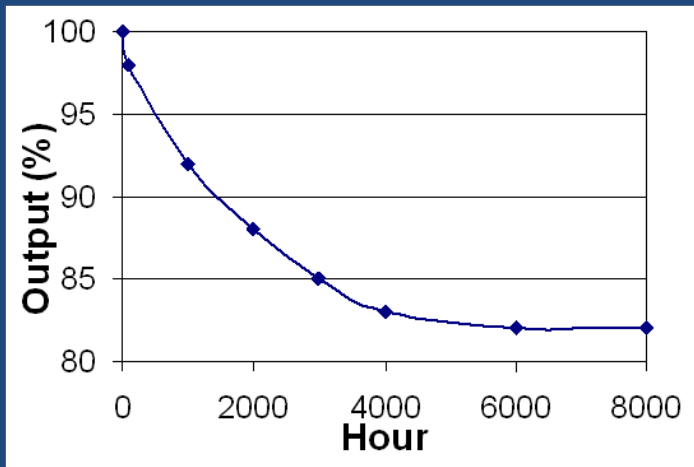
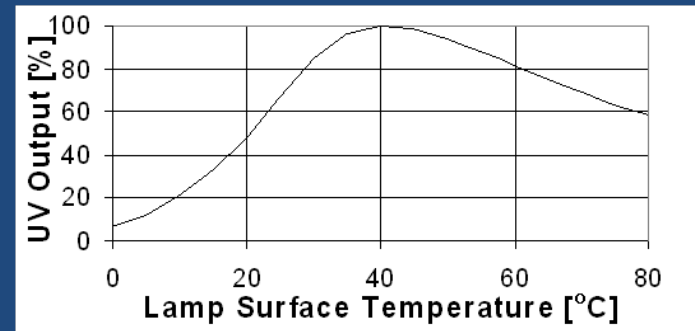
*Research question—how do we accurately describe and predict indoor aerosol exposures?*

# Bioaerosol Control Technology

- Ultraviolet germicidal irradiation (UVGI)
- Particulate filtration
- New laboratory
  - Modified ASHRAE 52.2-based test loop
  - Microbiological testing
  - UVC Lamp testing facilities
    - Aging (depreciation): lamp type, cycling rate, current
    - Ambient response: wind chill effect from air velocity and temperature

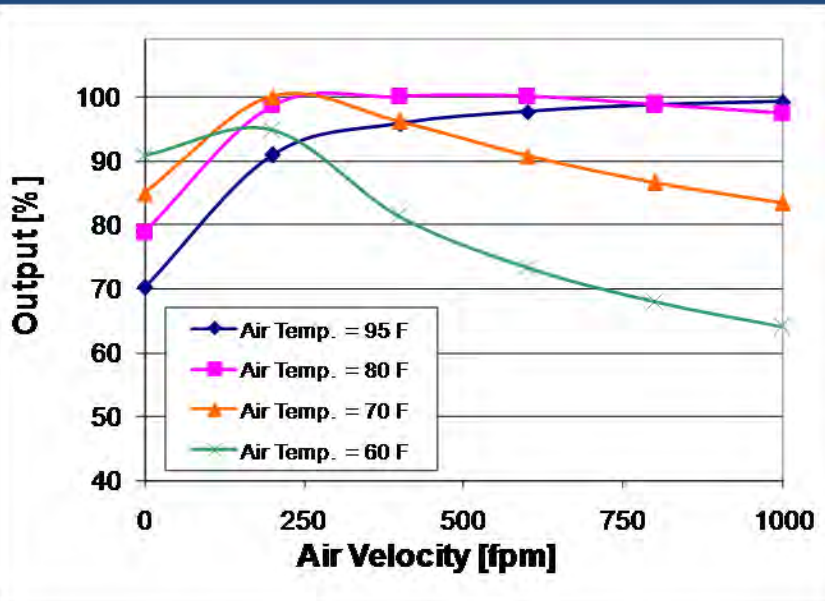
# UVGI Principles

$$\frac{N}{N_0} = e^{-kIt}$$

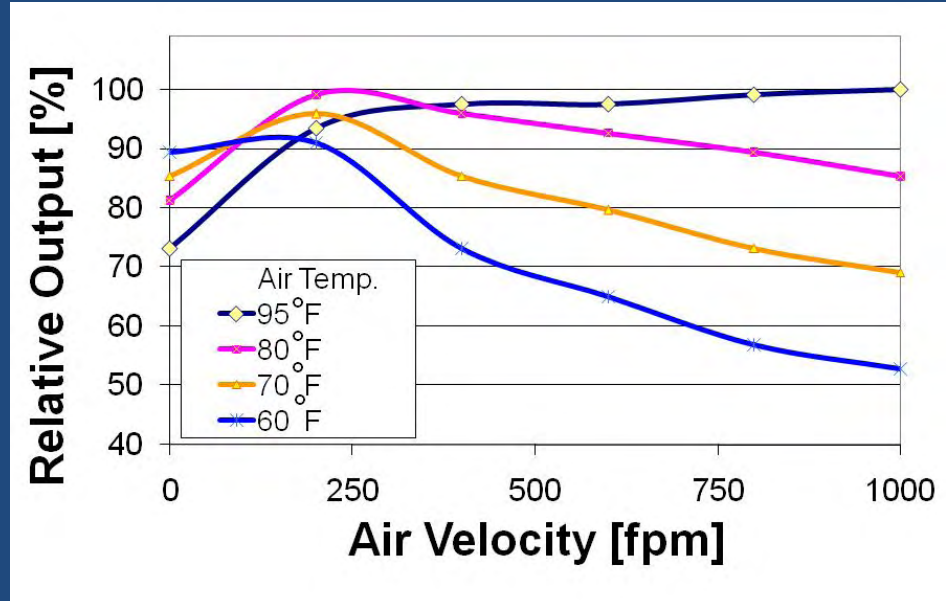


# UVC Lamp Modeling

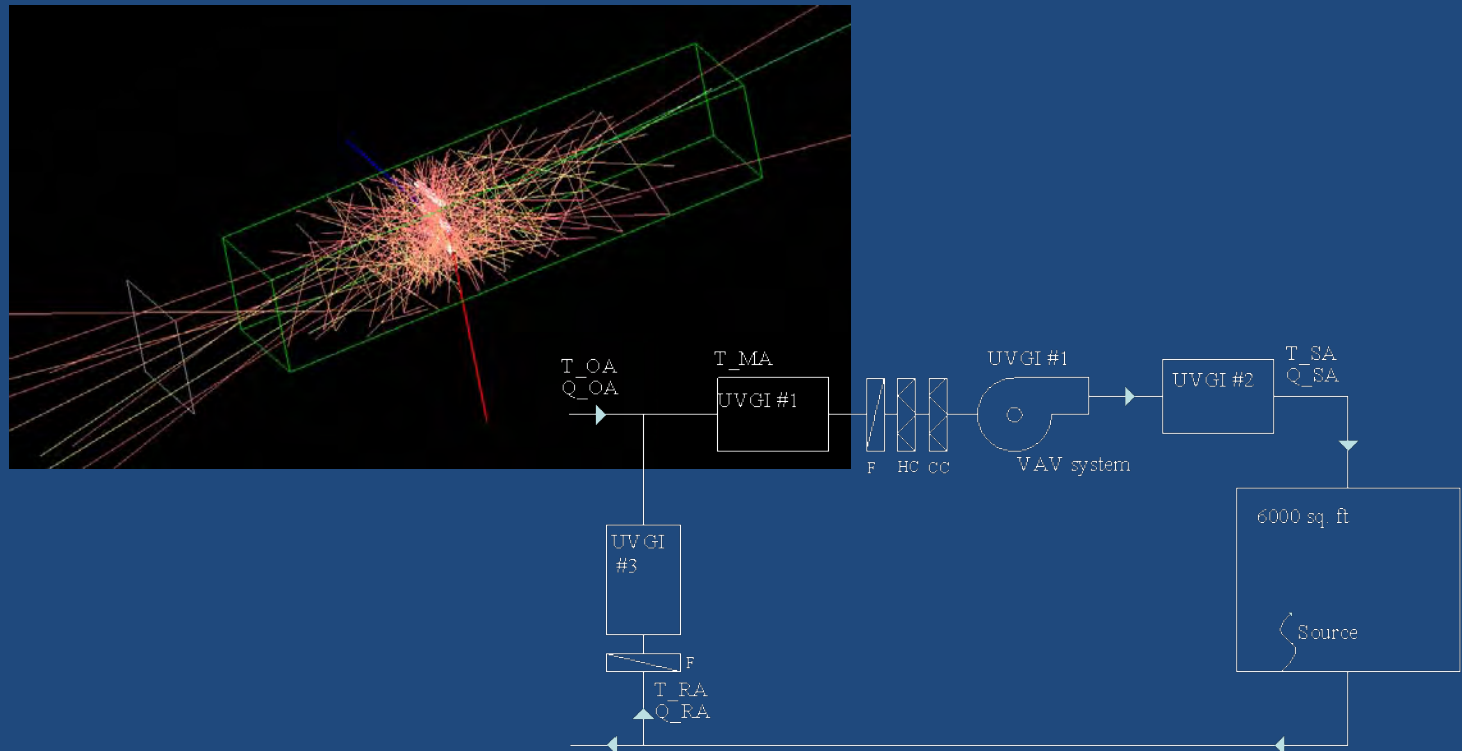
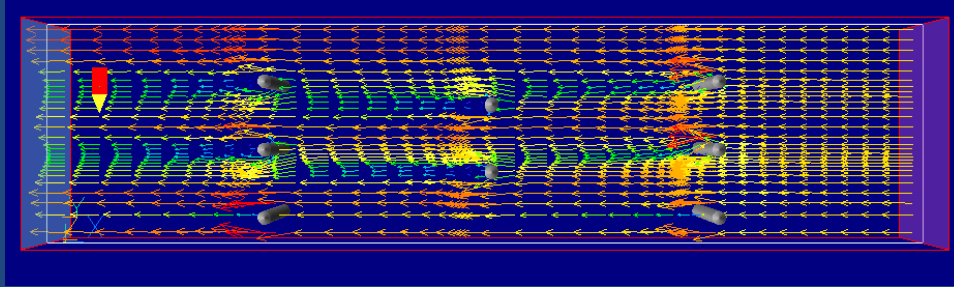
## Typical Simulated Lamp Output



## Typical Manufacturer Data



# UVGI Device and System Modeling



# Modified 52.2 UVGI Rig



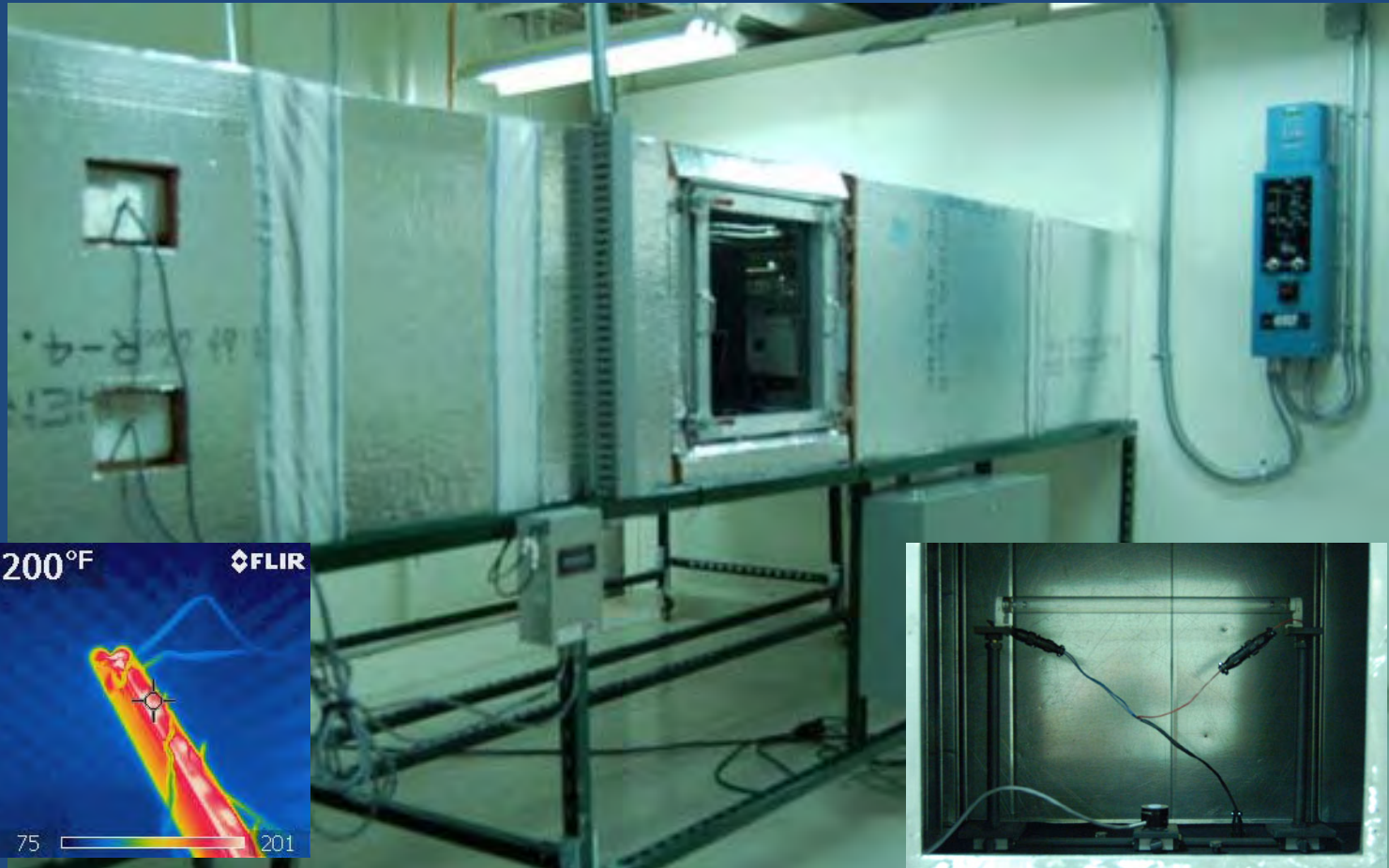
# 52.2 UVGI Rig UV Section



# Aging Facility Lamp Racks



# Short Term Lamp Test Facility



# Bioaerosol Control Technology

- Research objectives
  - Standard protocols for device rating
  - Modeling capability for design
    - Lamp
    - Device
    - System
  - Life-cycle evaluation compared to filtration and ventilation

# HVAC Design

- Currently studying impact of return system type on air quality, comfort, energy use, security
- Collaboration with Iowa Energy Center
- Laboratory measurements at ERS
- Field measurements at PSU
- Air/contaminant flow and energy modeling

# Risk Management

- Rapid air flow modeling software and associated model calibration procedure
- Evaluation of performance metrics
- Exposure modeling for microbial risk assessment procedure
- Scoping study for security measure evaluation protocols

# Risk Management

- Research needs
  - How to do cost-benefit on events that, on average, never occur
  - Accounting for other impacts of security measures (energy, air quality...)
  - Analysis, selection and design methods

# Lighting Research

- The impact of fabric shades on daylighting and building energy performance
- Performance analysis and proper commissioning protocol for multi-zone daylight-responsive photosensor control systems
- Assisting with optical modeling for ultraviolet germicidal irradiation research
- CANDLE (Create an Alliance to Nurture Design in Lighting Education) – Lighting Education Research (Houser).
- Lighting spectrum impacts related to LED and fluorescent lighting

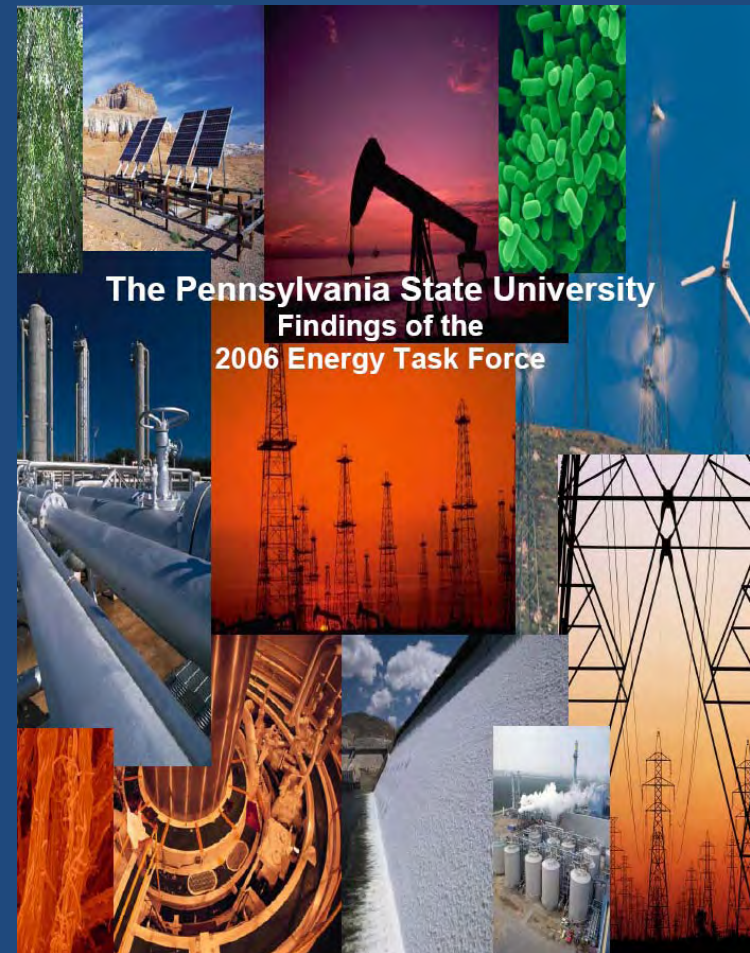
# Solar Decathlon

Photovoltaic systems, battery storage and DC lighting systems will be studied once the house returns to Penn State's campus.



# Penn State Energy Task Force

- Major university-level initiative
- 24 new faculty lines
- Emphasis heavily biased towards supply
- Penn State Institutes of the Environment becomes Penn State Institutes of *Energy* and the Environment



# ETF Immediate Emphasis Areas

- Clean coal, ultra clean fuels, carbon sequestration, and *in situ coal* extraction/conversion
- Materials and nanotechnology for energy efficiency
- Genetically modified plants and microorganisms, sustainable biomass production systems, enzymatic conversion, and production of biofuels, bioenergy, and biomaterials
- H<sub>2</sub> production, storage and transportation, and usage (fuel cells)
- Social acceptance of nuclear power, nuclear power generation, the nuclear fuel cycle, and proliferation resistant nuclear power plants
- Direct conversion of light to work with molecular transducers

*Efficiency--later*