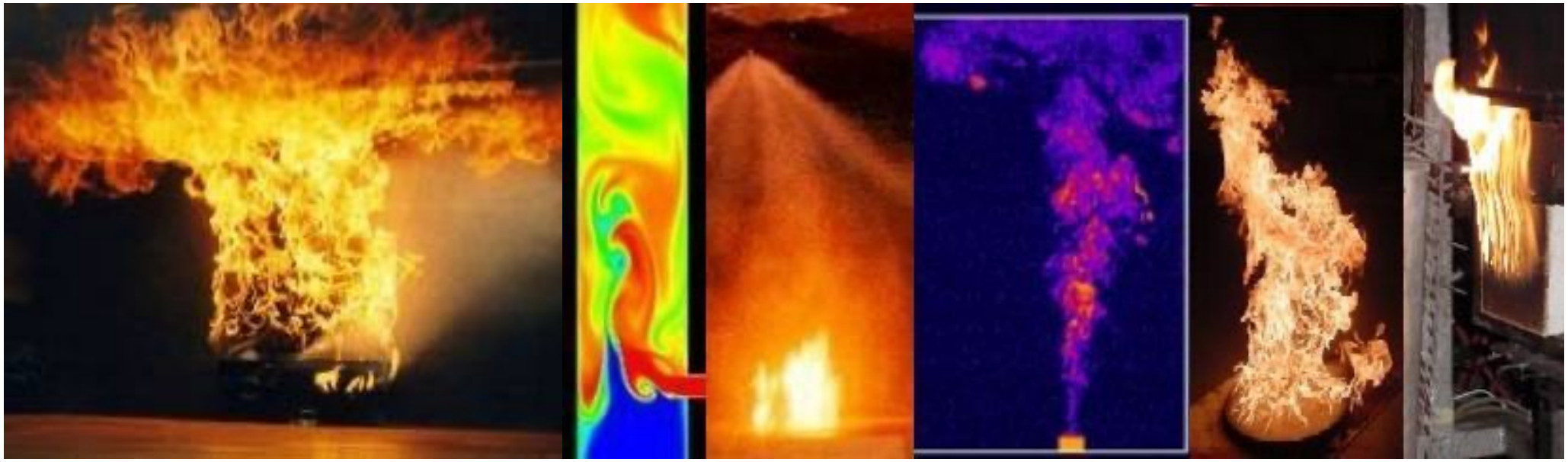


Research Overview

Department of Fire Protection Engineering
University of Maryland
College Park, MD 20742, USA

http://www.fpe.umd.edu

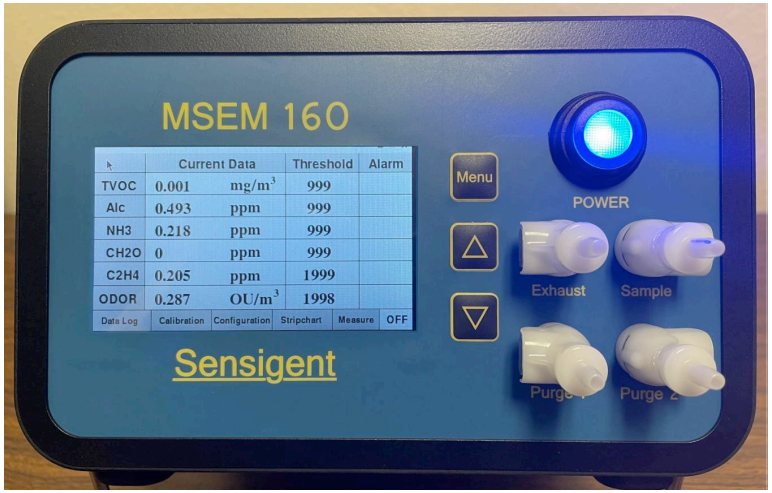
November 2022

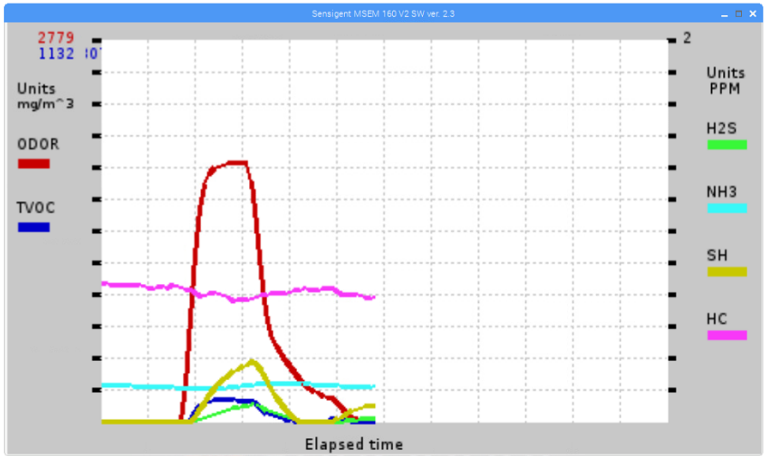
Full-Time Faculty

Faculty	Research Areas
K.E. Isman	fire suppression systems
J.A. Milke	suppression, detection, egress
S. Ni	structures, fire forensics, mass timber
F. Raffan-Montoya	toxicity, wildfire monitoring/forecasting
S.I. Stoliarov	pyrolysis, flammability, flame spread/growth
P.B. Sunderland	firebrands, soot, microgravity, cool flames
A. Trouvé	turbulent combustion, fire/wildfire modeling

Nuisance Alarms on Commercial Aircraft

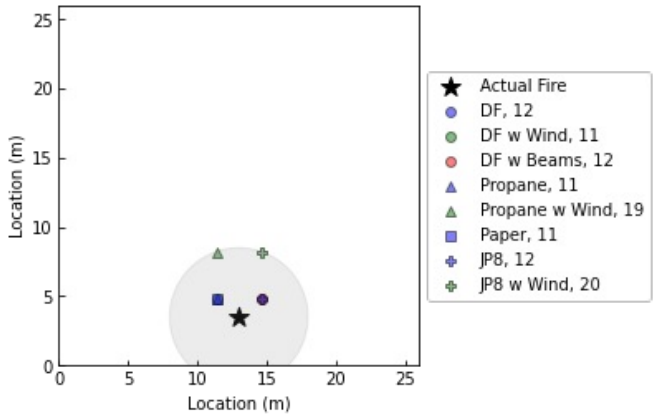
- *Faculty*: J.A. Milke
- *Students:* S. Anthrathodiyil
- *Sponsor:* FAA
- *Title*: "Detection of Signatures from Internal Contaminant Sources"
- *Sponsor*: FAA
- *Objective*: use an electronic nose to detect signatures/significant markers (e.g., certain classes of particulates and/or chemical species) from onboard equipment failures and identify signatures/markers that could potentially adversely affect other airplane systems or sensors due to masking a measurement or triggering a false warning.



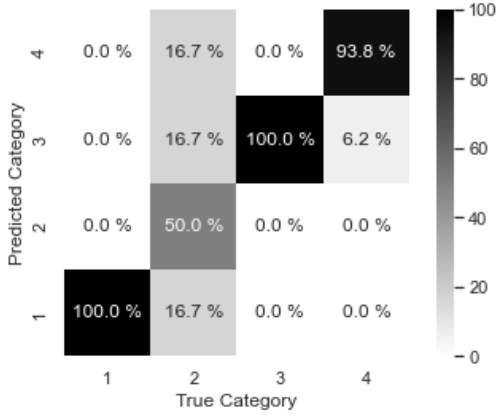


Fire Detection and Artificial Intelligence

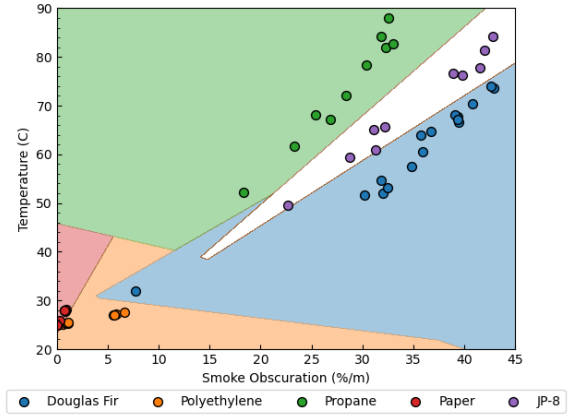
- *Faculty*: J.A. Milke and A. Trouvé
- *Students:* A. Davis
- *Title*: "Feasibility Analysis of Coupling FDS Modeling with Machine Learning for Situational Awareness in Aircraft Hangars"
- *Sponsor*: Battelle
- *Objective*: To provide information for incident commanders to understand the current environment and enable effective action. Real-time data can be collected from distributed fire and environmental sensors located in the affected space to identify the location and size of the fire and composition of the burning fuel.



Correctly identified 45 out of 56 fire locations within a 5 m radius



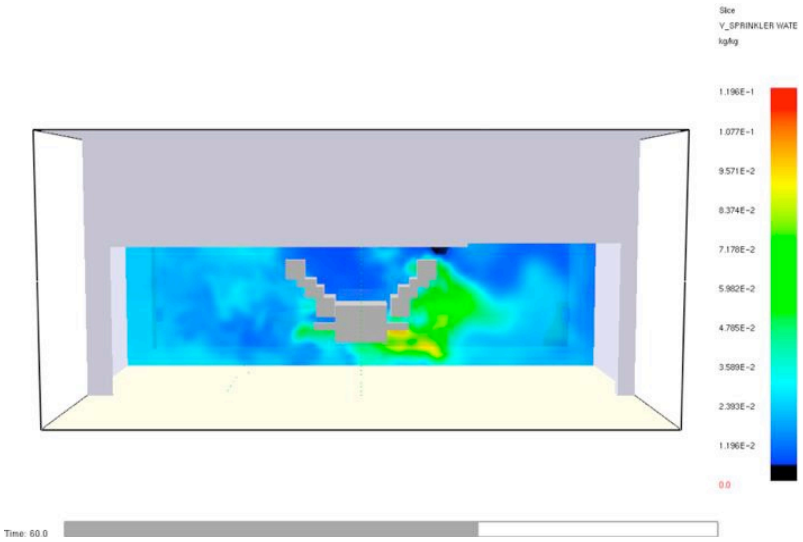
Correctly identified 85% of categories
Cat. 1: 0-250 kW, Cat. 2: 251-500 kW
Cat. 3: 501-1000 kW, Cat. 4: > 1000 kW

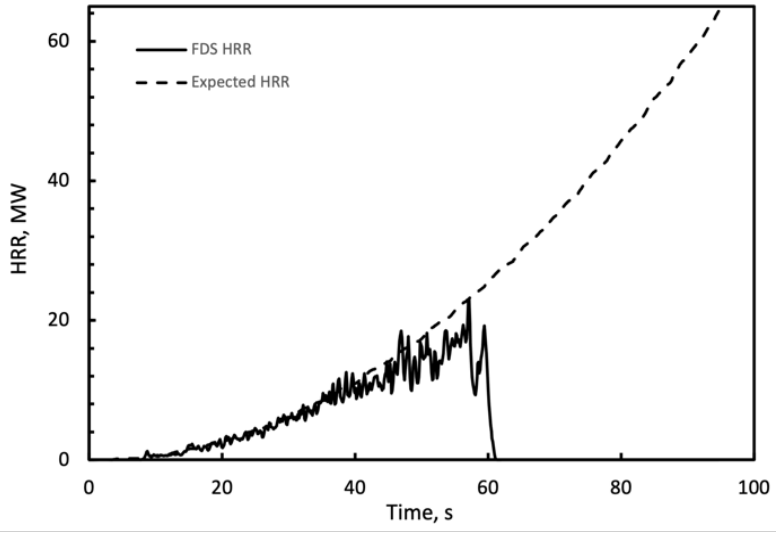


Correctly identified 91% of fuel composition (JP-8 vs other)

Water-Based Fire Suppression Systems

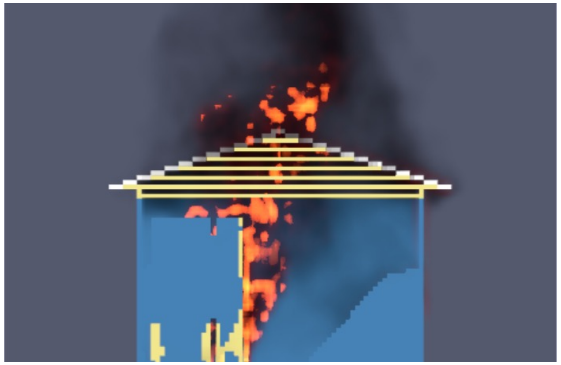
- *Faculty*: J.A. Milke and A. Trouvé
- *Students:* K. Steranka, K. Lee, S. Bradock, Y. Kim
- *Title*: Fire Suppression Alternatives for Protection of Aircraft Hangars
- *Sponsor*: Battelle
- *Objective*: To identify feasible design alternatives with water mist or sprinklers in lieu of foam to provide protection for aircraft hangars. The analysis is conducted via FDS simulations of liquid fuel spill fires.





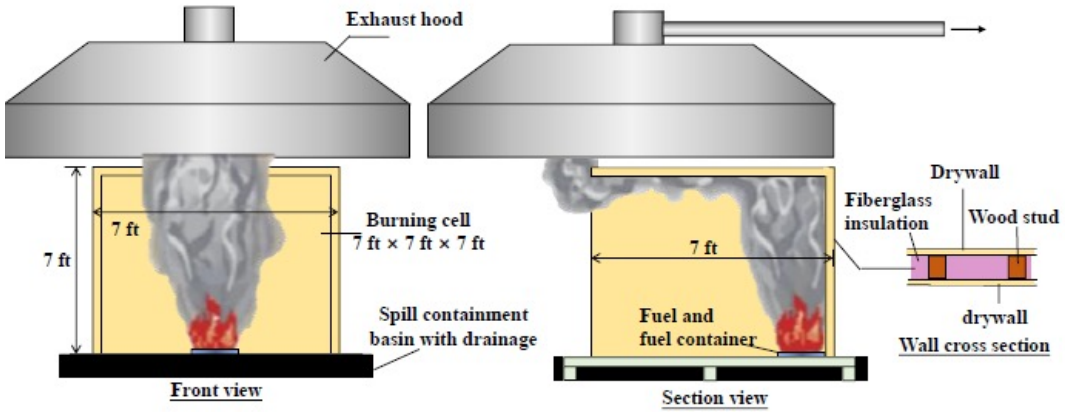
Fire Risk in Low-Income Communities

- *Faculty*: J.A. Milke
- *Students:* G. Tan, 14 Sophomores in FPE, 6 high school interns
- *Title*: Fire Safety Challenges in Refugee Camps and Informal Settlements
- *Sponsor*: None
- *Objective*: To identify causes of disproportionate fire losses in vulnerable populations in refugee camps and informal settlements. Assist with identifying solutions to the significant fire safety challenges posed in these communities.

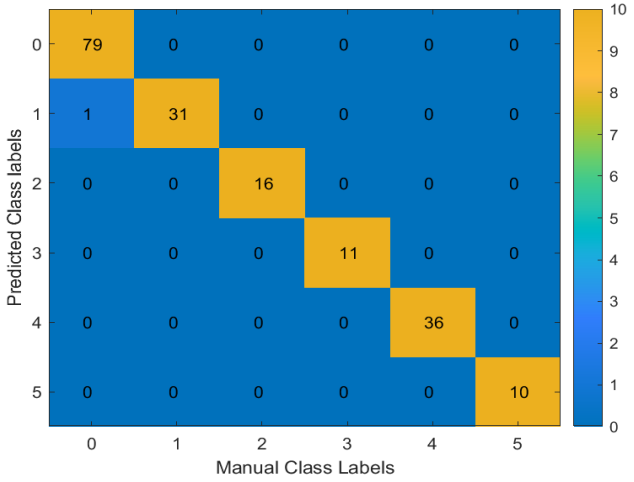


Fire Pattern Analysis

- *FPE Faculty*: S. Ni and S. Stoliarov
- *Ph.D. Students:* TBA
- *Collaborators*: P. Tang
- *Title*: Flame Design: Investigating the Impact of Architectural Finishes on Fire Patterns in Support of Developing Data-driven Tools for Pattern Analysis
- *Sponsor*: NIJ
- *Objectives*: Study the effects of architectural finishes on fire patterns, and use the resulting test data in combination with other data to develop data-driven tools for automatic and quantitative fire-pattern analysis.



Burn cells used in this project to investigate the impact of architectural finishes on fire patterns

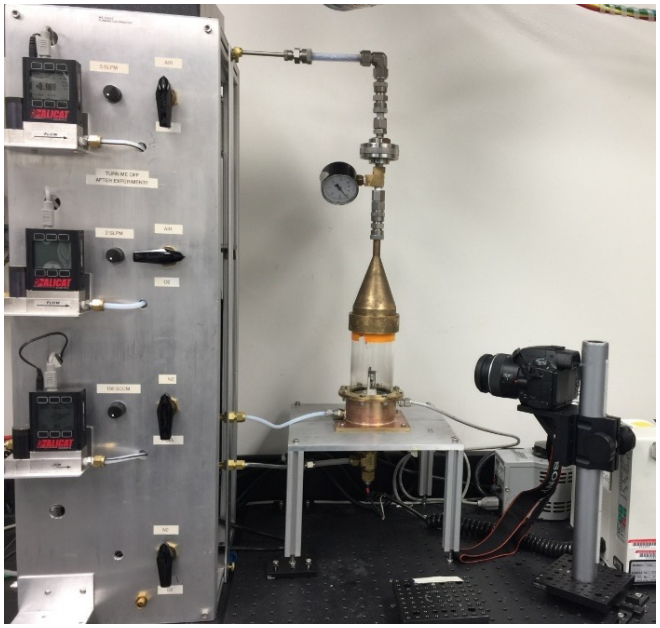


Manual vs. algorithm classification of degree of fire damage (DOFD) to gypsum boards

Material Flammability

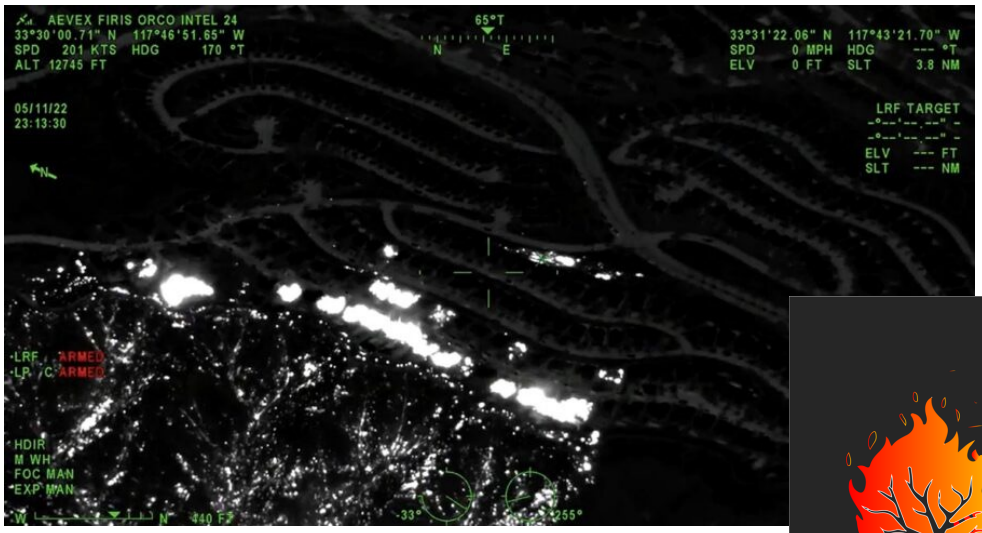
Milligram-scale Flame Calorimetry

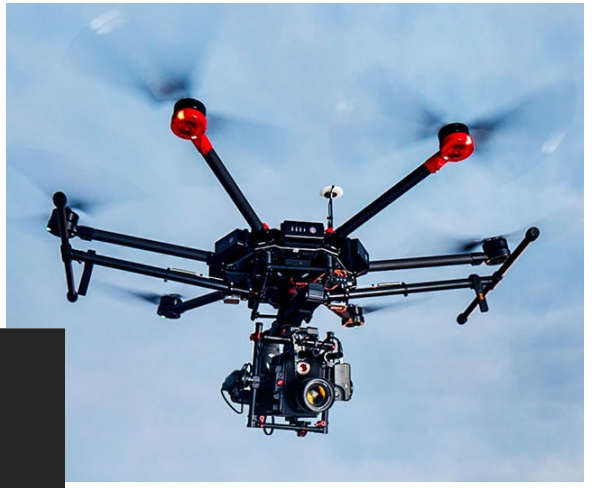
- *Faculty*: F. Raffan-Montoya
- *Title*: Development of a methodology for the evaluation of fire retardancy of fabrics using the Milligram-scale Flame Calorimeter
- *Sponsor:* U.S. Army DEVCOM Soldier Center
- Collaborators: R. Nagarajan (Umass-Lowell), A.B. Morgan (University of Dayton Research Institute)
- *Objectives*: Characterize flammability parameters and thermal response of fabrics using milligram-sized samples and compare data to bench scale tests (vertical flame spread, mannequin test)



Wildfire Monitoring and Characterization

- *Faculty*: F. Raffan-Montoya, A. Trouvé
- *Title*: High-Resolution Observations of Wildfires and Wildland-Urban-Interface Fires Through State-of-the-Art UAVs and Fire Imaging Technologies
- *Sponsor:* TBD
- *Objectives*: Characterize ember fluxes with camera system onboard UAV. Autonomously monitor wildfire location, perimeter, size.

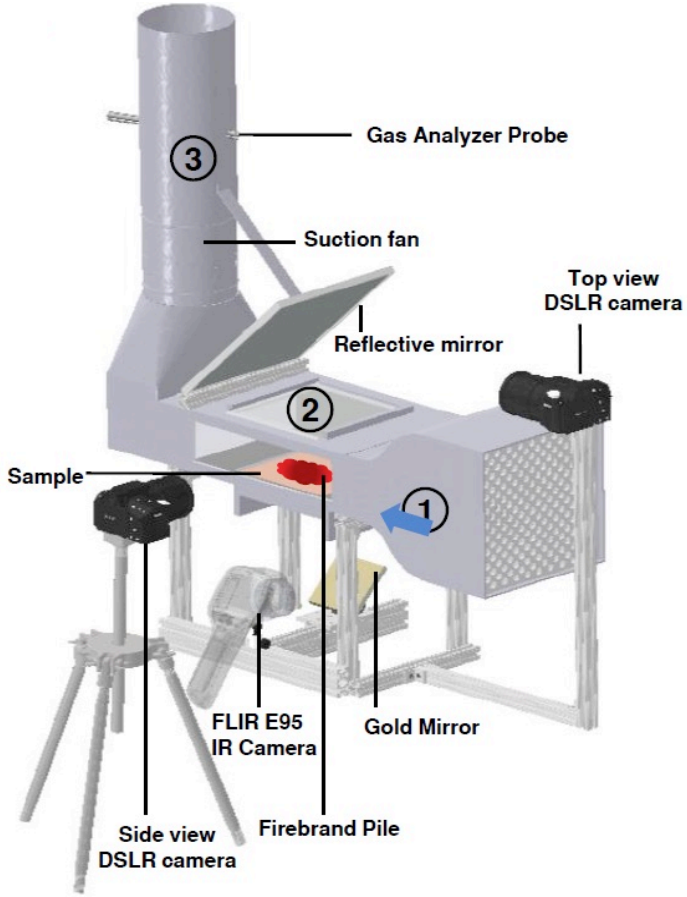


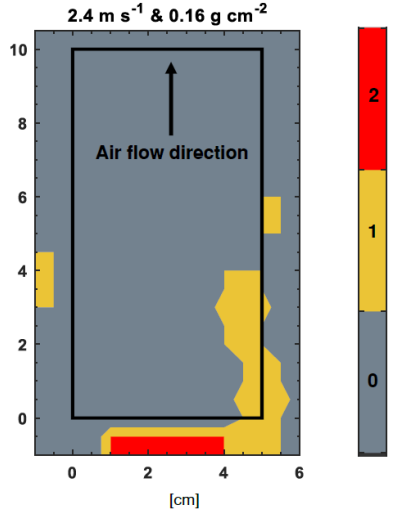


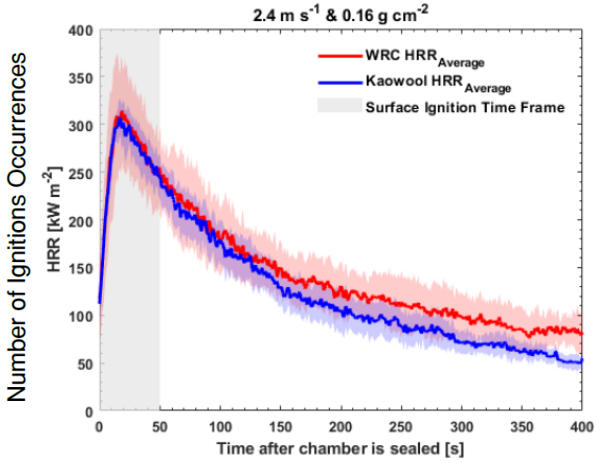
Wildland Fires

Ignition of Building Materials by Firebrands

- *Faculty:* S. Stoliarov and P. Sunderland, in collaboration with A. Filkov, M. Gollner
- *Students:* J. De Beer (Ph.D.), S. Lee (Ph.D.), A. Lauterbach (M.S.)
- *Sponsor:* NIST and UL FSRI
- *Objective:* To determine the mechanism of ignition of representative building materials by firebrands and develop a model for this ignition process



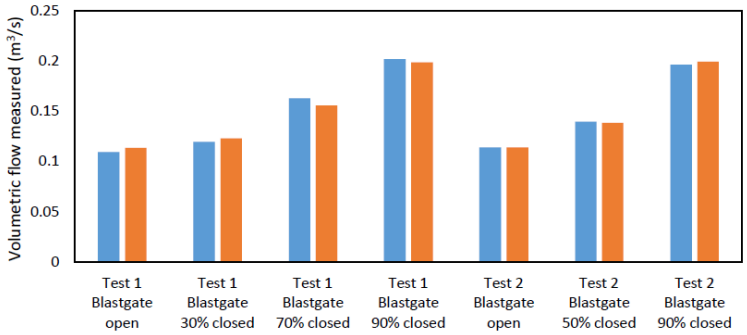


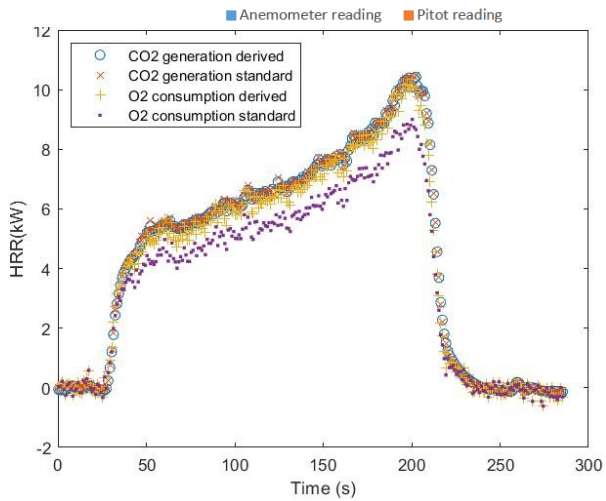


Fire Toxicity

Characterization of Fire Effluent Composition

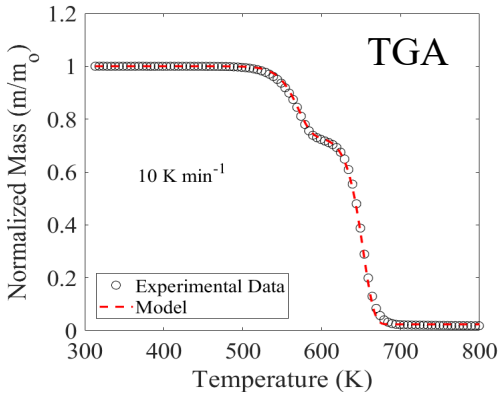
- *Faculty:* S. Stoliarov and F. Raffan-Montoya
- *Students:* F. Beygi (Ph.D.), S. Roy (M.S.)
- *Sponsor:* FAA and FM Global
- *Objective:* To develop an advanced version of the Fire Propagation Apparatus that enables controlled equivalence ratio fire experiments including time resolved measurements of O_2, CO, CO_2, soot, HCN, HCl, HBr, and total hydrocarbons

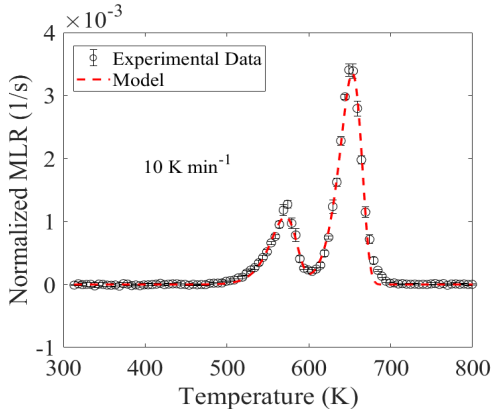




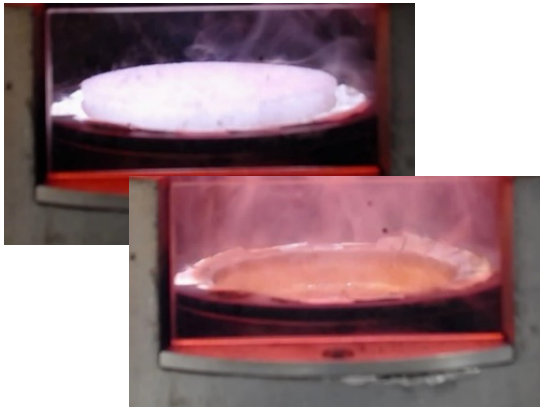
Development of Pyrolysis Model for Flexible PU Foam

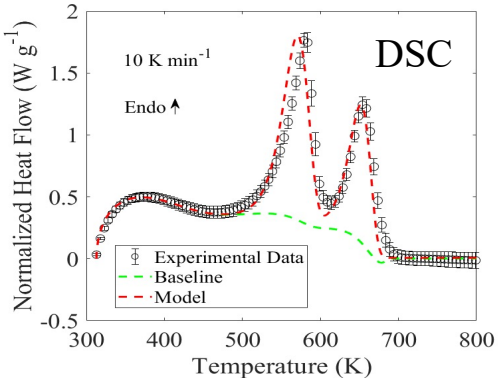
- *Faculty:* S. Stoliarov
- *Students:* W. Saar (M.S.)
- *Sponsor:* NIST
- *Objective:* To measure properties that govern gaseous fuel production by standard flexible polyurethane foam used in upholstered furniture and develop a complete pyrolysis model for this material

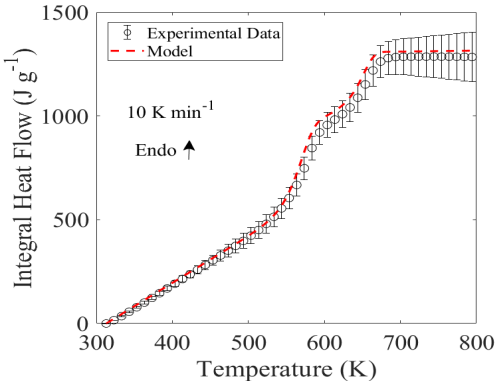


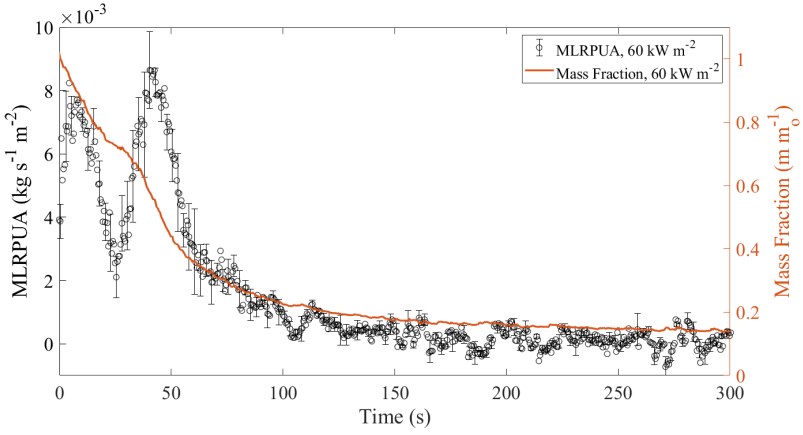


Controlled Atmosphere Pyrolysis Apparatus II at 60 kW m^{-2}



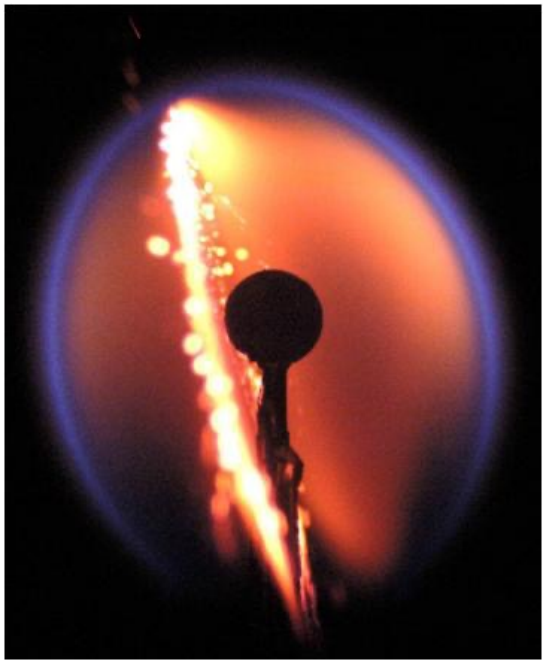


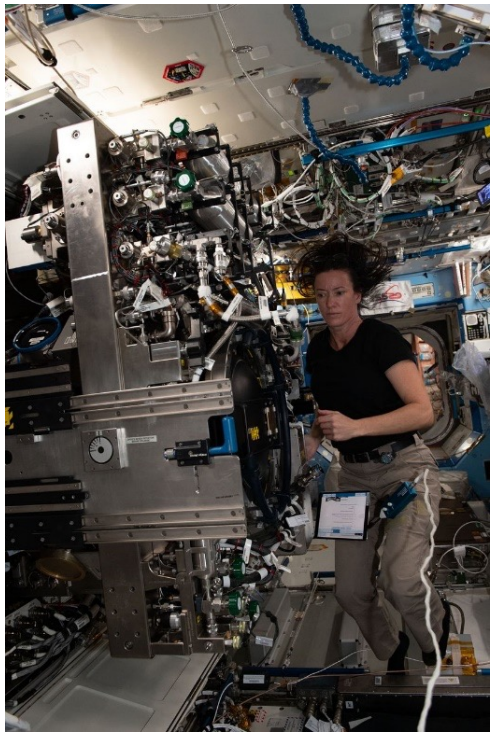


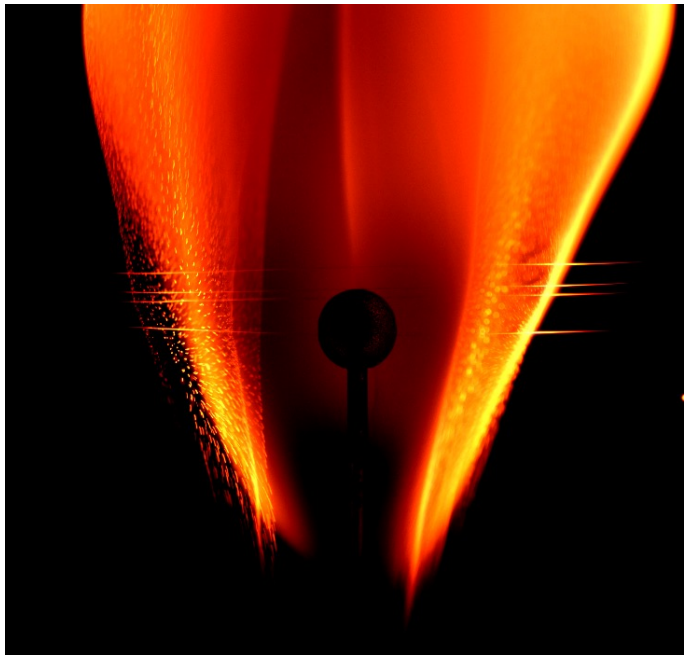


Flame Design

- *FPE Faculty*: P.B. Sunderland
- *Ph.D. Students:* K. Waddell, Z. Wang
- *Collaborators*: R.L. Axelbaum, D.L. Urban
- *Title*: Flame Design: A Novel Approach to Clean Efficient Diffusion Flames
- *Sponsor*: NASA Glenn
- *Objectives*: Study microgravity spherical flames aboard the ISS to identify the effects of radiation on soot, combustion chemistry, and extinction.

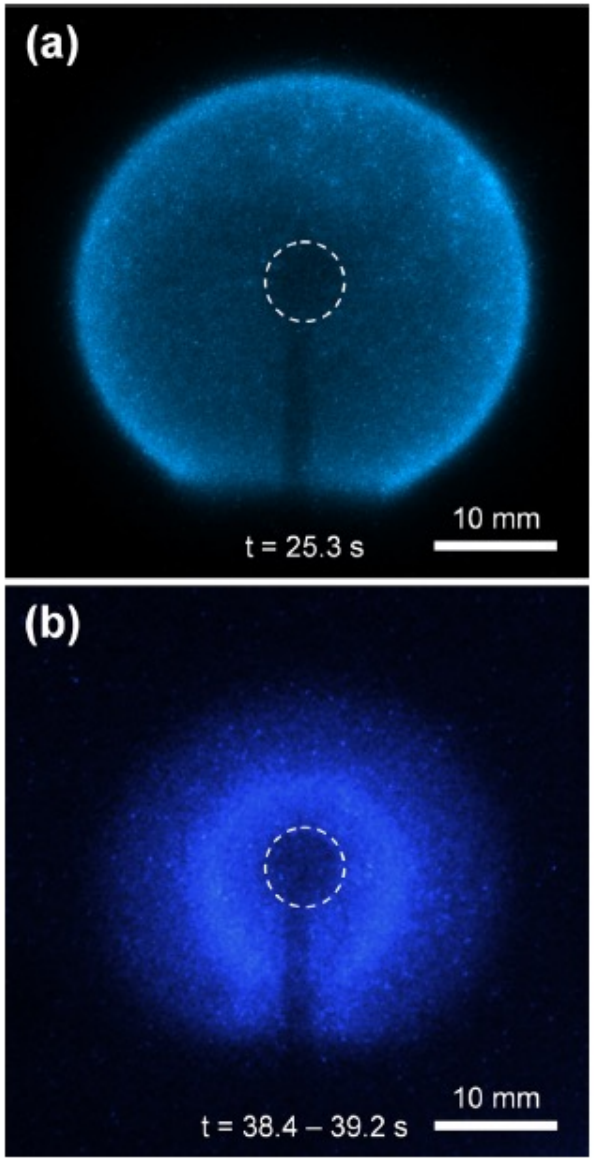






Spherical Cool Diffusion Flames

- *FPE Faculty*: P.B. Sunderland
- *Ph.D. Student:* K. Waddell
- *M.S. Student:* M. Kim
- *Collaborators*: R.L. Axelbaum, F.A. Williams
- *Title:* Spherical Cool Diffusion Flames Burning Gaseous Fuels
- *Sponsor*: NSF, with CASIS, and NASA
- *Objectives*: Observe cool diffusion flames in microgravity aboard the ISS using porous spherical burners.

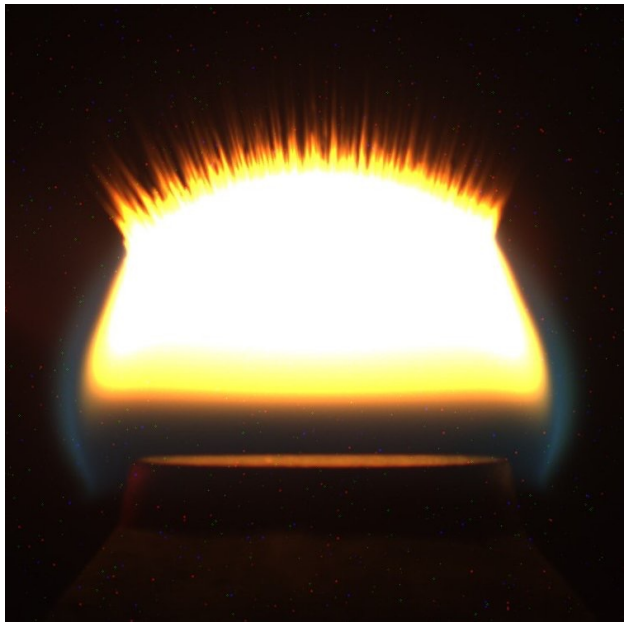


Images of (a) a hot flame and (b) a cool diffusion flame on the International Space Station.

Microgravity Fire Dynamics

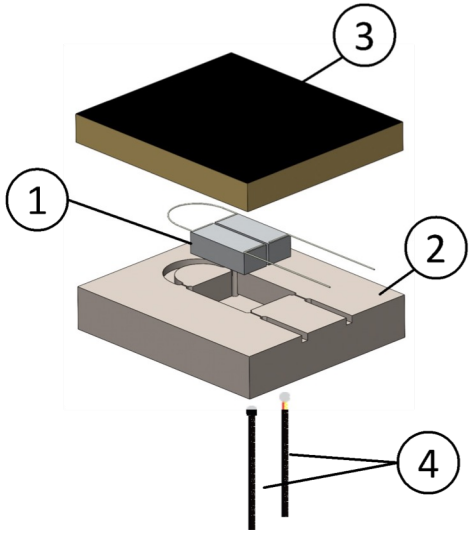
Burning Rate Emulator

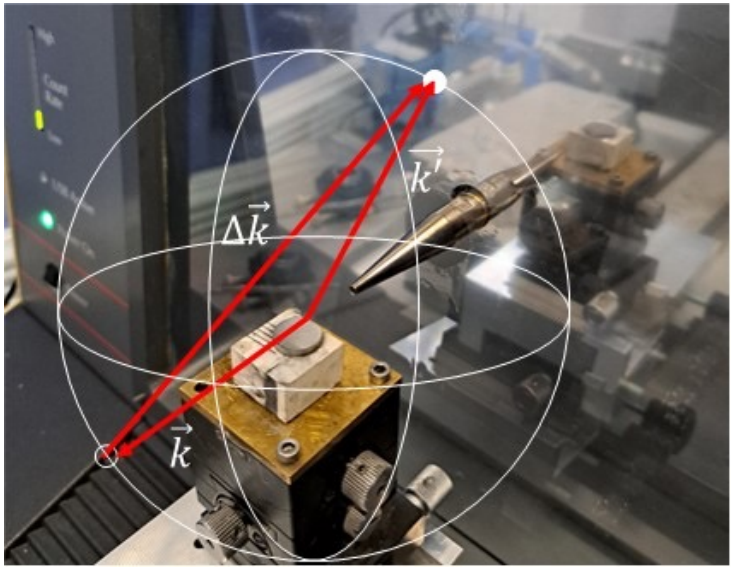
- *FPE Faculty:* J.G. Quintiere, P.B. Sunderland, H.R. Baum
- *Ph.D. Students*: P. Dehghani, A. Markan
- *M.S. Students*: E. Auth, M. Bustamante, H. Kim, R. Venzon, A. Wright
- *Collaborator*: J. deRis
- *Title*: Experimental Investigation of Emulated Burning Rate at Various Gravity Levels
- *Sponsor*: NASA Glenn
- *Objectives*: Use gases to emulate condensed fuel fires in microgravity aboard the international space station.

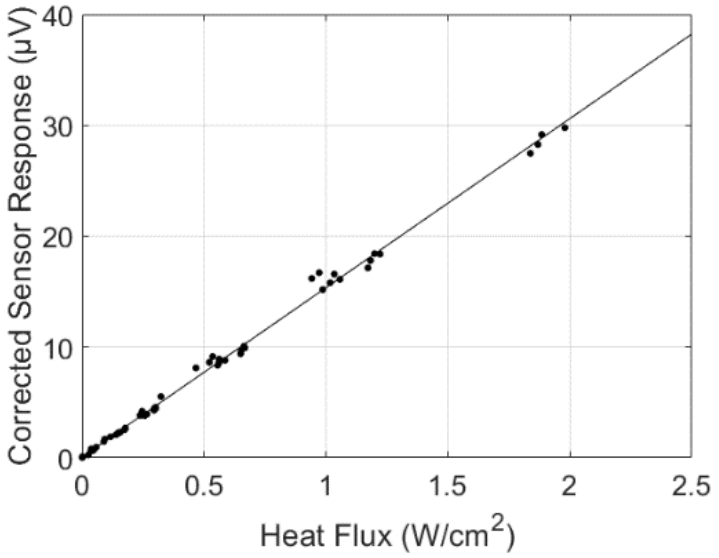


High Temperature Heat Flux Gages

- *FPE Faculty*: P.B. Sunderland
- *MSE Faculty:* O. Rabin
- *Ph.D. Student:* K. McAfee
- *Title:* Robust Heat-Flux Sensors for Coal-Fired Boiler Extreme Environments
- *Sponsor*: DOE – NETL
- *Objectives*: Develop novel heat flux gages that exploit the transverse Seebeck effect in rhodium single-crystal pellets.

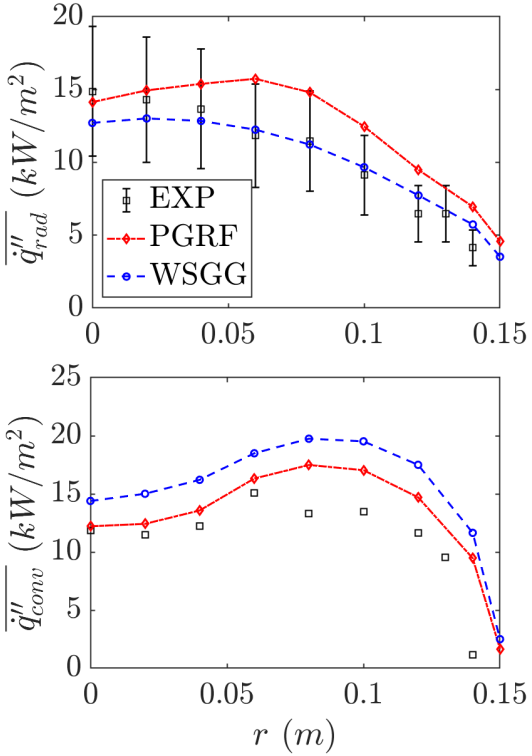






The MaCFP Working Group

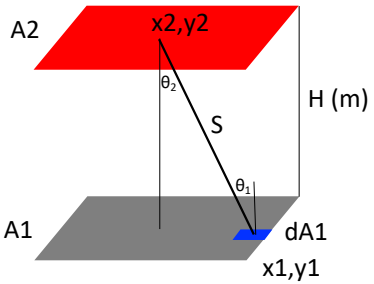
- *Faculty*: A. Trouvé – *PhD student*: M. Ahmed
- *Title*: "Towards a Collaborative Research Infrastructure for Fundamental Studies of Turbulent Fire Phenomena"
- *Sponsor*: NSF
- *Collaborators*: the IAFSS Working Group on Measurement and Computation of Fire Phenomena (the MaCFP Working Group, http://www.iafss.org/macfp)
- *Objective*: Build a collaborative framework (through a series of workshops) around the topic of the experimental validation of computer-based fire models.



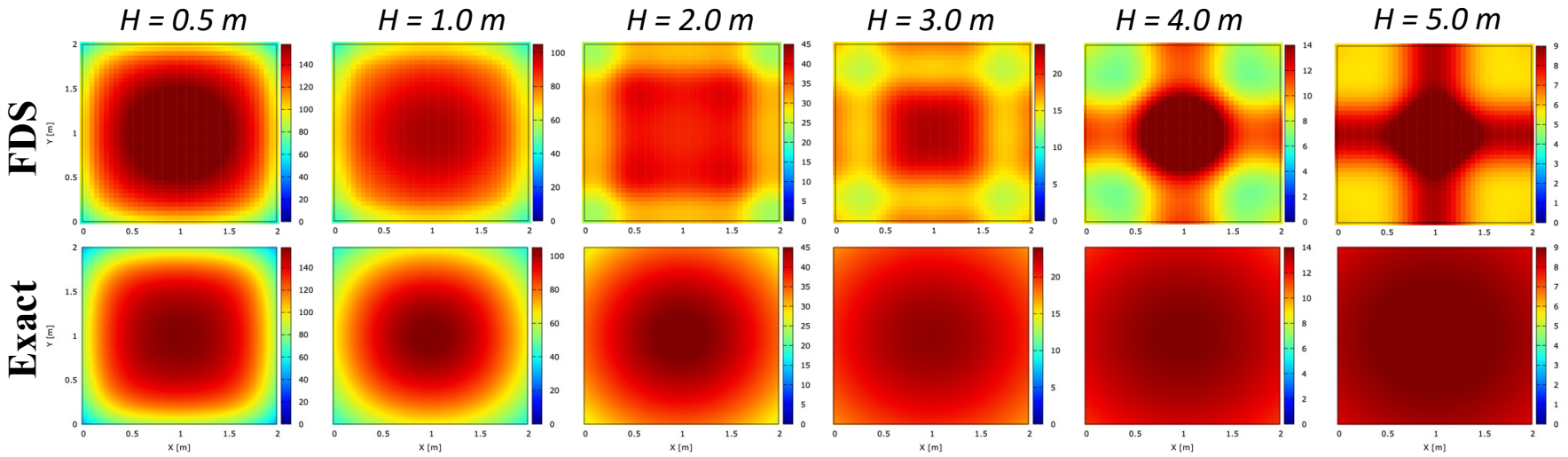
High-resolution FireFOAM simulation of a methanol pool flame

Compartment Fire Dynamics

- *Faculty*: A. Trouvé – *Postdoctoral researcher*: Y.J. Kim
- *Title*: "Numerical Modeling of Compartment Effects in Benchmark Compartment Fire Configurations"
- *Sponsor*: UL
- *Collaborators*: G. Maragkos, B. Merci (Ghent Univ.), T. Ngo (Univ. Melbourne)
- *Objective*: Evaluate the performance of the Fire Dynamics Simulator (FDS) in simulations of compartment fires



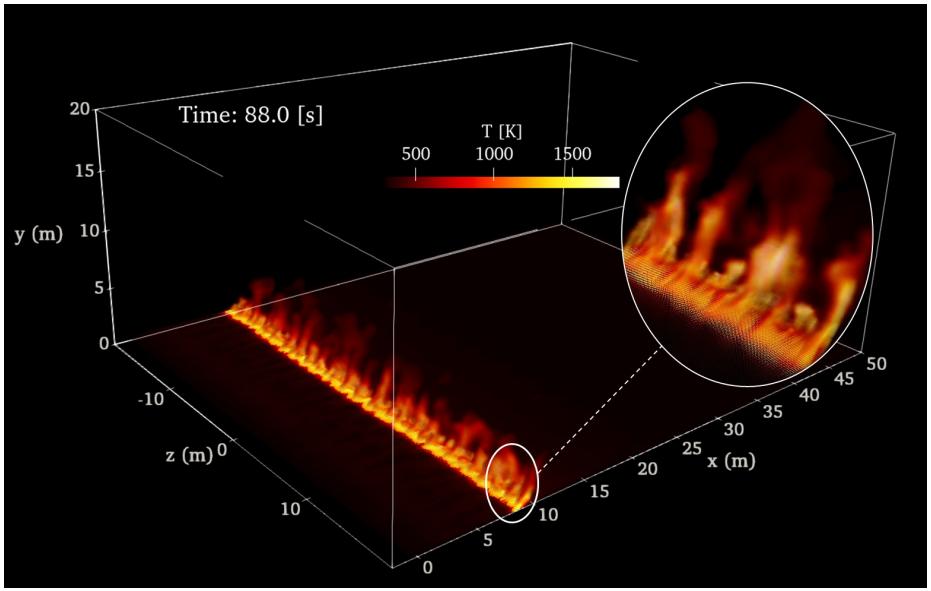
Test of FDS accuracy in simulations of the radiation load on a planar surface located at different separation distances *H* from a source



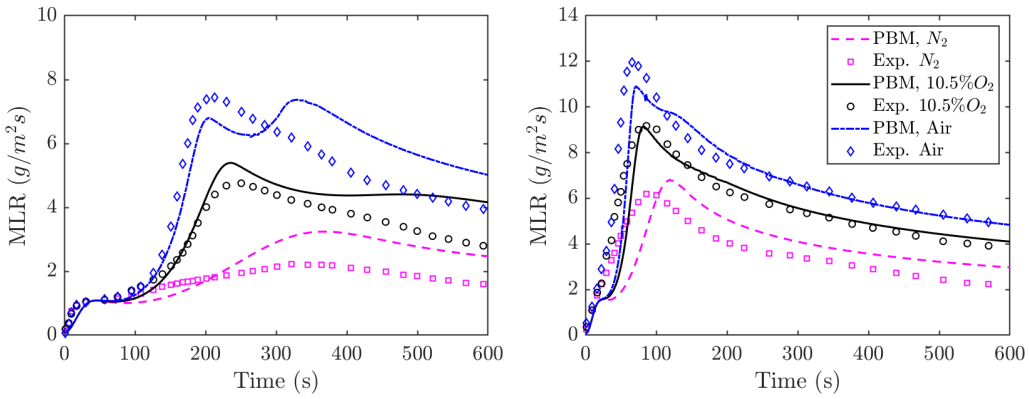
Flame-Scale Modeling of Wildland Fire Spread

- *Faculty*: A. Trouvé – *PhD student*: M. Ahmed
- *Title:* "Large Eddy Simulation of Flame Spread in Wildland Fires"
- *Sponsor*: USDA Forest Service
- *Collaborators*: M. Finney, J. Forthofer (US Forest Service)
- *Objective*: Develop a state-of-the-art computational modeling capability that simulates wildland fire behavior at vegetation and flame scales. Perform detailed numerical simulations of wildland fire behavior with a high-resolution description of flame spread, heat release and fuel consumption.

OpenFOAM simulation of flame spread across a biomass vegetation bed treated as a population of distributed particles



Simulations of drying, pyrolysis and char oxidation for a single particle representing biomass vegetation



Regional-Scale Modeling of Wildland/WUI Fire Spread

- *Faculty*: A. Trouvé – *PhD student*: Y. Qin
- *Title:* "PREEVENTS Track 2: Fire Spread at the Wildland-Urban Interface (WUI) Modeling and Data Assimilation for Prediction and Risk assessment (WUI MAPR)"
- *Sponsor*: NSF
- *Collaborators*: E. Ellicott, K. Ide (UMD), M. Gollner (UCB), C. Lautenberger (Reax Engineering)
- *Objective*: Extend modeling capabilities of current wildland fire spread models to the cases of WUI fire spread and wildland/WUI fire spread due to firebrands (Solver: ELMFIRE, developed by Reax Engineering Inc.)