Early Fire Detection System for Partial and Low Gravity Environments

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Overview

We present preliminary results on the development of a fire detection system for partial and low gravity environments. A significant challenge is the design of a system with a low false alarm rate. The detection system therefore has to discriminate between combustion particles, cabin, and lunar dust.

Aerosol properties are measured and cross referenced to the target detectors at the Gases and Aerosols from Smoldering Polymers (GASP) Laboratory located at the NASA Glenn Research Center. A computational fluid dynamics plume model is also employed to determine the smoke transport properties of the targeted habitats.

Preliminary Results

Synergy Pro (SGY) is a heat-resistant fabric material with a variety of applications. To understand the mixed smoke and lunar dust signals, a lunar highlands regolith (LHS) simulant was used.

For the materials studied, the ionization detector produces the earliest detectable signal. Trace gases are important, but are not considered an early signal. Based on the reference particle size measurements, the smoldering aerosols are likely volatile organic compounds or monomers emitted from the material. They key challenge is smoke and real lunar dust have overlapping particle sizes that set off the detector.

A key need is a low-cost sensor to discriminate between small pre-pyrolysis particles and lunar dust. Work on signal analysis and signal discrimination is on-going

Fire Scenario Modeling

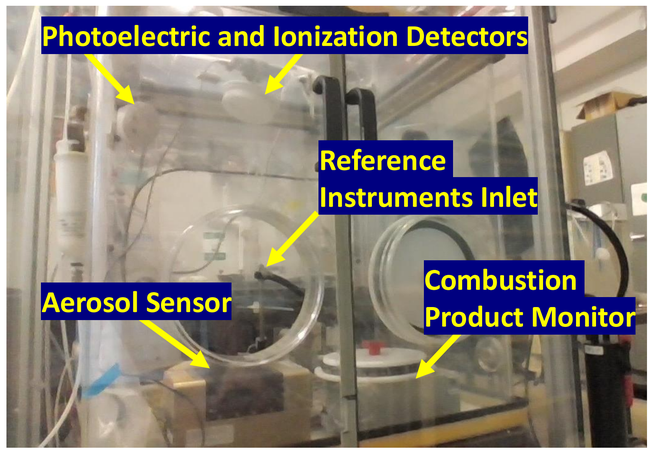
Fire scenarios are being developed considering the most probable fires in a lunar habit. Partial gravity provides unique challenges due to decreased buoyant flow and reduced particle settling velocities. The model considers the effect of the Environmental Control and Life Support System (ECLSS) on the flow fields and how the smoke plume concentration changes with time.

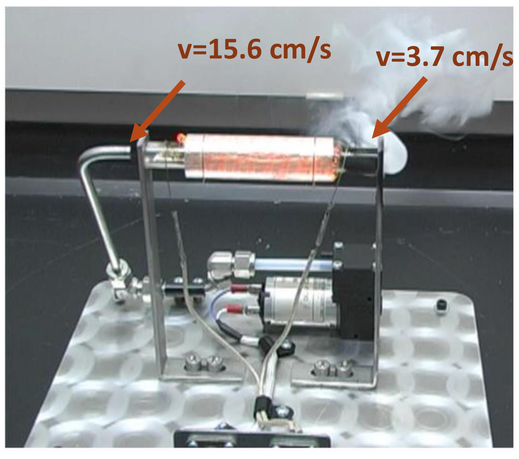
References

[1] Marit Meyer, PhD Dissertation

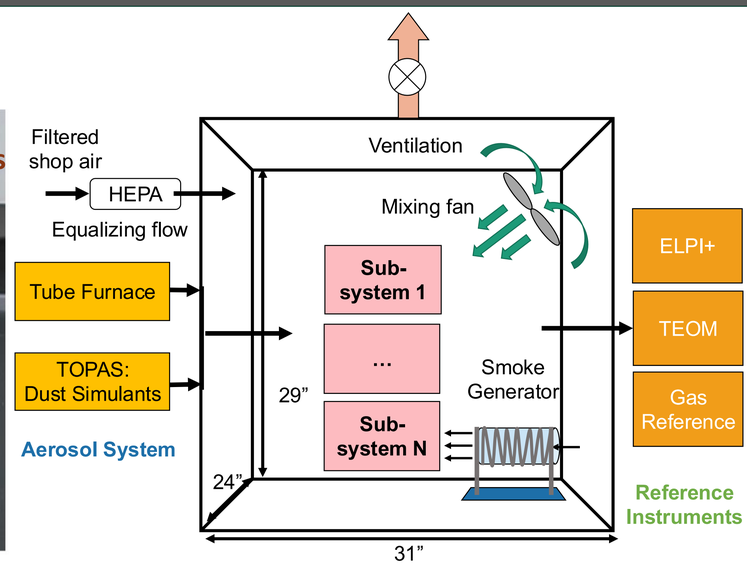
[2] Park et al, Journal of Aerospace Engineering 21 (2008) 266-271

GASP Chamber

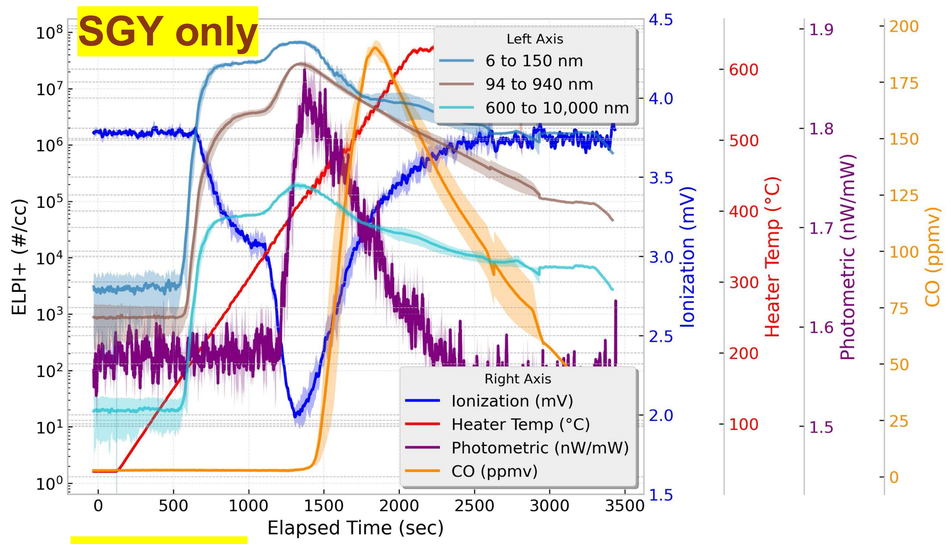


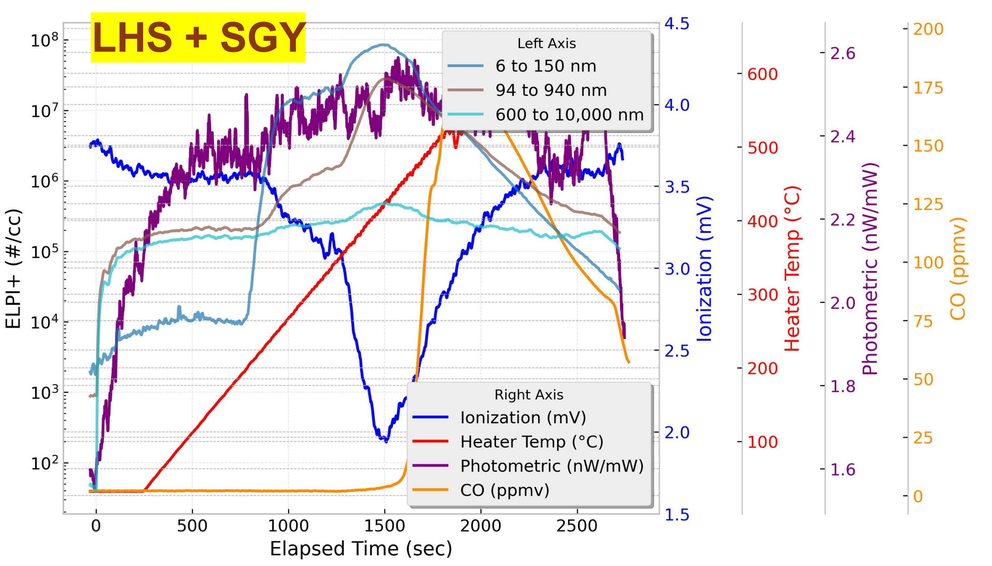


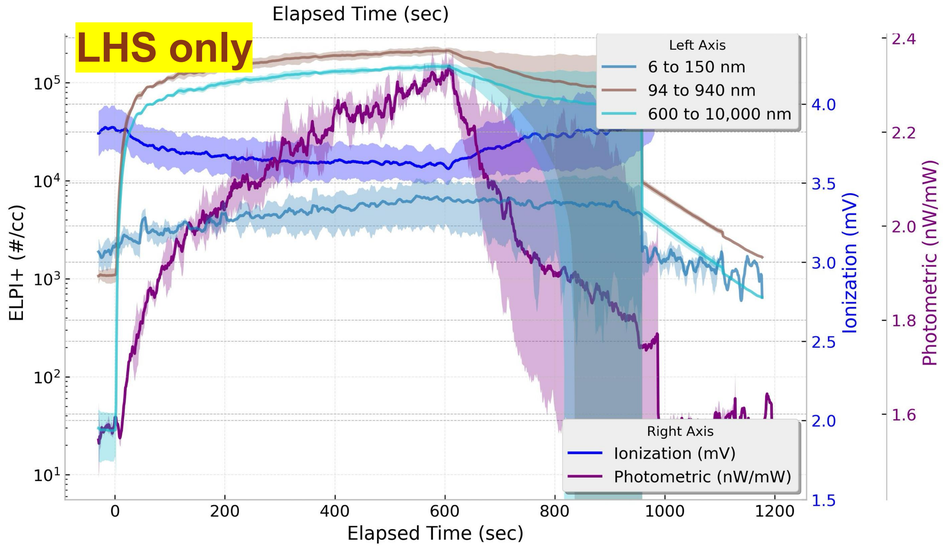
GASP Schematic

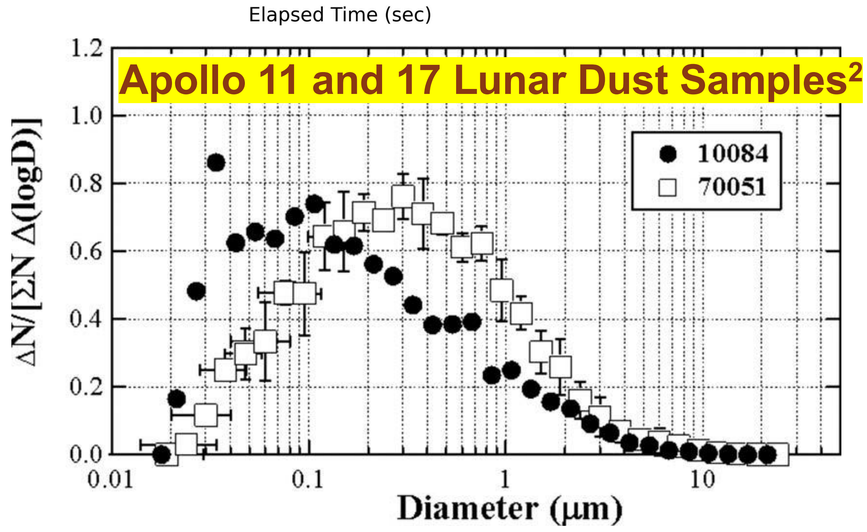


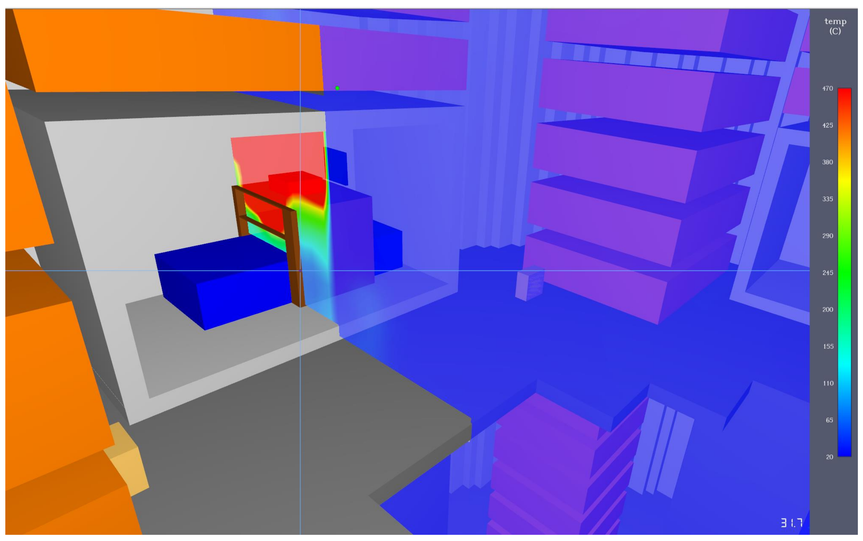
White Sands Smoke Generator[1]

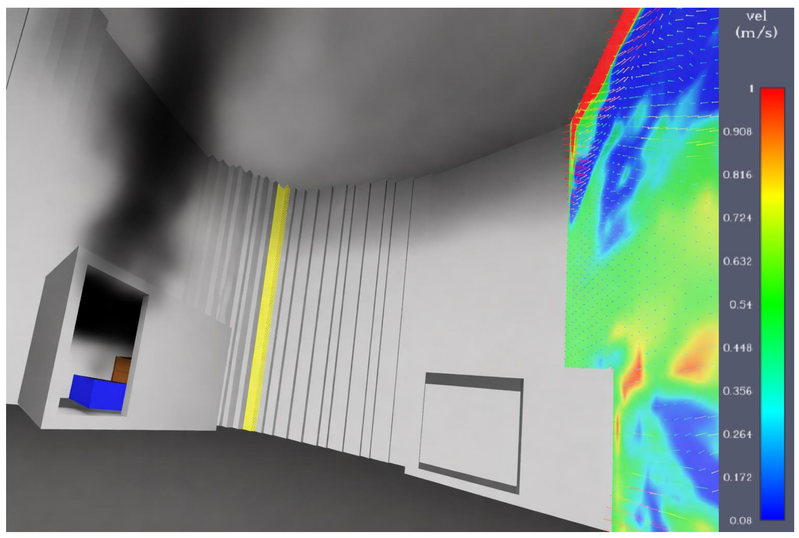












Laptop Fire Smoke Plume Simulation in a Lunar Habitat using NIST FDS

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