



NASA Microgravity Combustion: ISS Results and Future Plans

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ISS Combustion Science > 5 years ago

Droplet Combustion

- MDCA – FLEX (Flame Extinction Experiment)

Non-premixed Gaseous Flames

- SPICE (Smoke Points In Coflow Experiment)
- SLICE (Structure & Liftoff In Combustion Experiment)

Smoke Detection

- DAFT (Dust Aerosol Measurements Feasibility Test)
- SAME (Smoke Aerosol Measurement Experiment)

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Droplet Combustion

- MDCA - Cool Flames
- MDCA – FLEX-2, FLEX-ICEGA, FLEX-2J (Chemical kinetics and transport)
- Group Combustion Experiment – JAXA

Solid Fuel / Flammability

- MSG – BASS / BASS-2 Solid Material Flammability

Saffire (Spacecraft Fire Safety Demonstration Project)

ISS Combustion Science - Future Plans

Gaseous non-premixed Flames - ACME (CIR Insert)

Address critical issues in flame structure supporting terrestrial, energy efficiency and pollution

Solid Fuel / Flammability

– SoFIE (CIR) insert

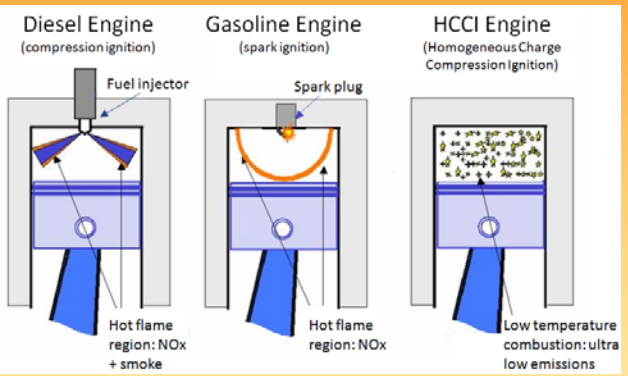
Address critical issues in material flammability in low gravity

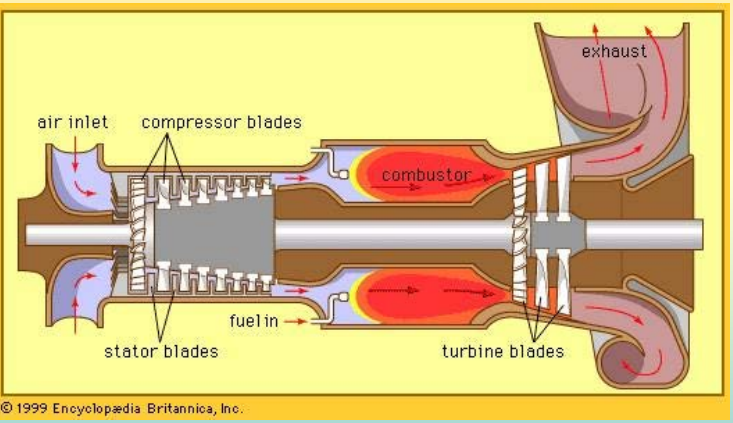
– MSG – Windμ (solid material flammability)

Saffire (Spacecraft Fire Safety Demonstration Project)

Increased size of fire and vehicle impact

Droplets, Sprays and Aerosols *Applications*



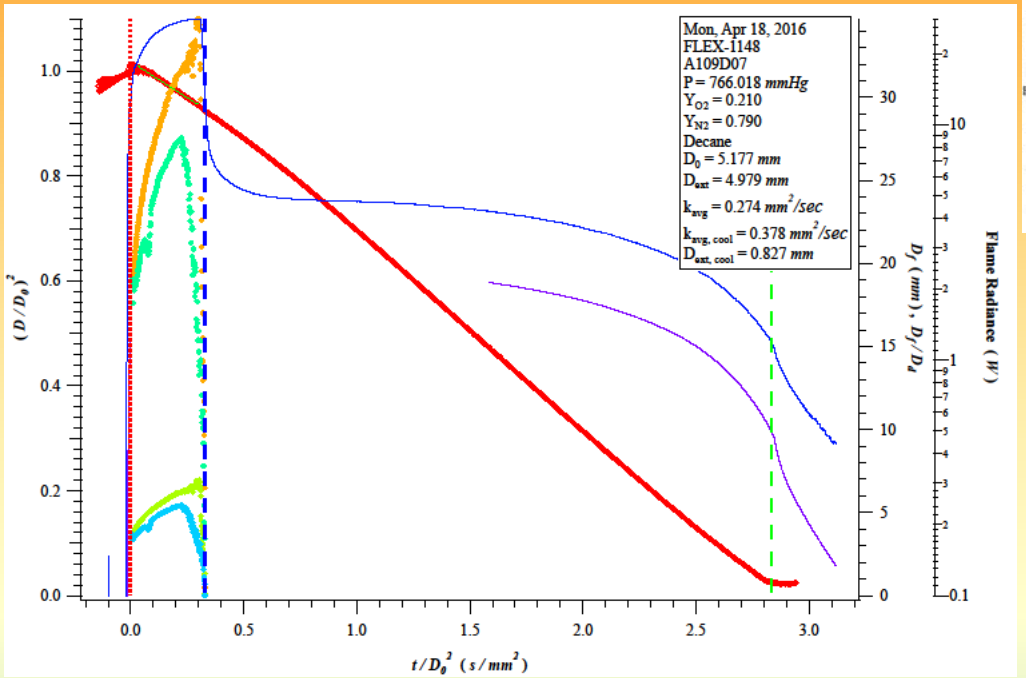


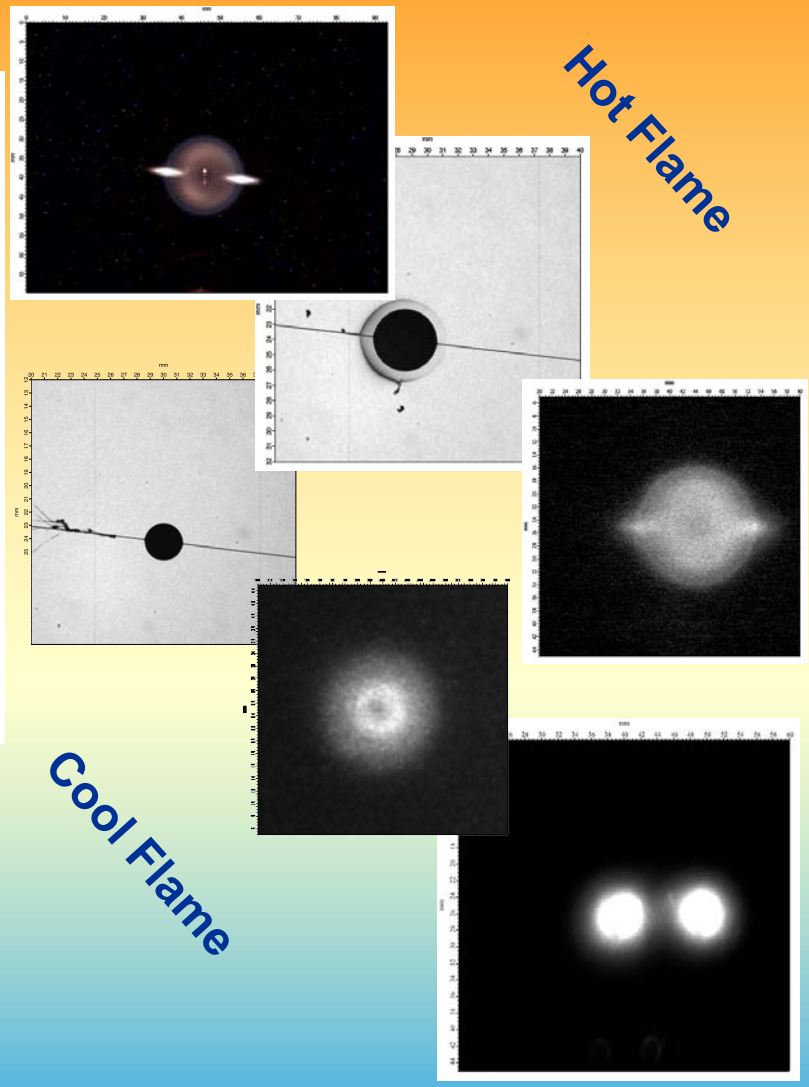
In engines: **timing is everything**
Low-gravity gives the opportunity to evaluate the chemical kinetics and transport needed to control the interactions between these processes and the bulk flow in engines
e.g.:
Knock versus non-ignition (diesel)
Delayed ignition (followed by explosion)
Stable engine versus flame out

Microgravity Cool Flames results provide a novel means to test these low-temperature kinetics in an actual flame system.

These results, although initially controversial, have sparked new interest in microgravity research and in stabilizing cool flames in the laboratory environment

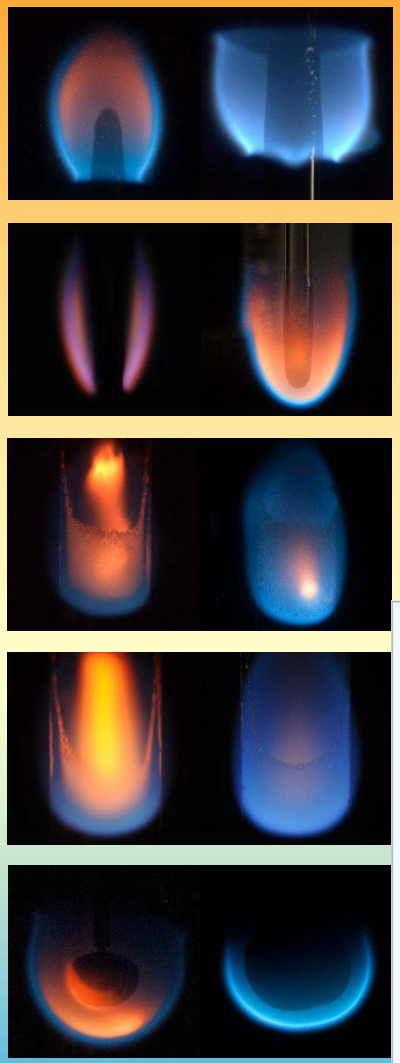
MDCA- FLEX-2 Results





Droplet and flame history

Solid Results: BASS



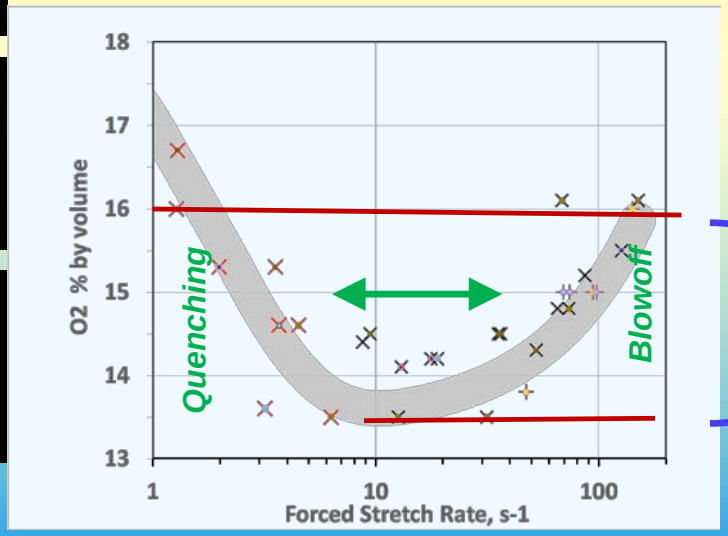
Repurposed existing gas-jet hardware to provide our biggest database to-date of low-gravity materials flammability

55 Publications to date

Demonstrated existence of the “U-Shaped” flammability curve and a negative margin of safety for 3 materials:

- PMMA Rods
- “Sibal” cotton-fiberglass fabric
- Cellulose (paper)

This demonstrates the need for further examination of material flammability in reduced gravity

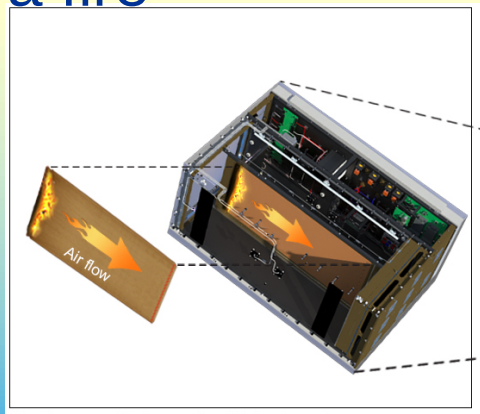


- 2.4% Margin of Safety

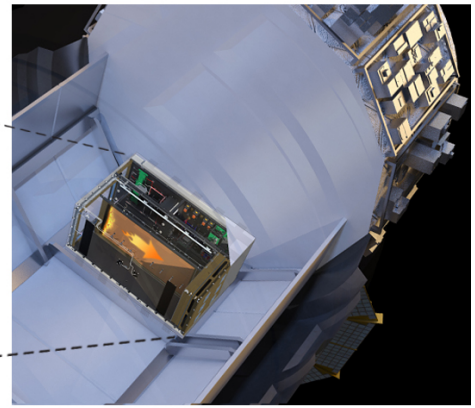
Spacecraft Fire Safety Demonstration Project

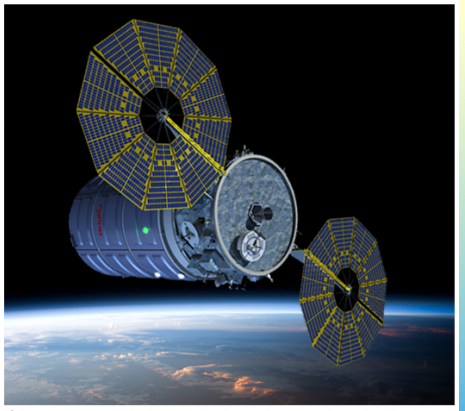
Large Scale Fire testing

- Saffire I-III:
  - Material Flammability Testing
- Saffire IV-VI
  - Material Flammability Testing
  - Fire Detection
  - Post Fire Cleanup
  - Greater Impact on Vehicle –Understand risk from a fire

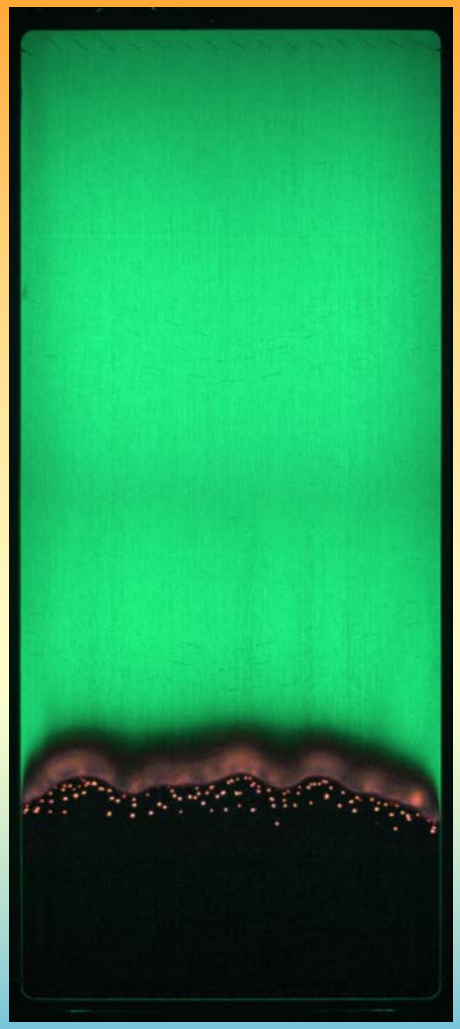


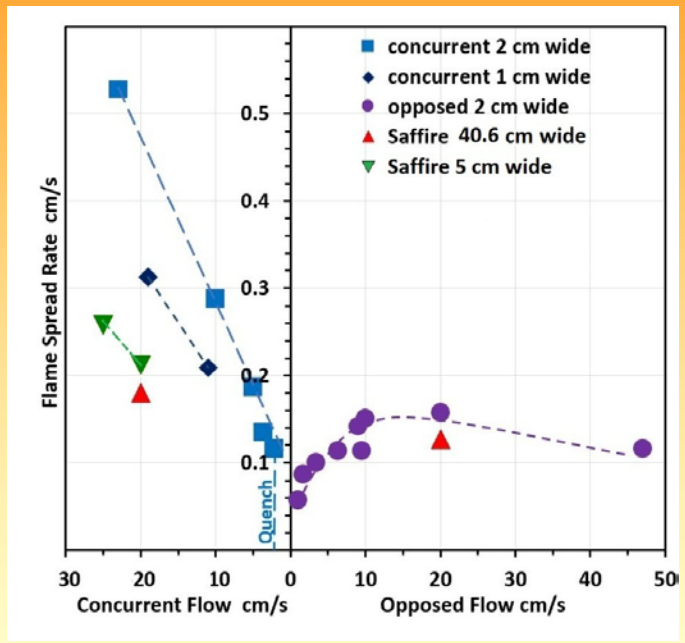
Test sample inserted into hardware.


Hardware installed on Cygnus vehicle.


Cygnus vehicle with hardware installed.

Material Flammability-Saffire





- Flame reaches a limiting length
- Concurrent spread substantially slower than expected – attributed to the larger duct
- Impact of fire on vehicle was limited, need to test with bigger fires

Key Research Needs

Based on input from:

- A 2014 workshop that considered a wide range of combustion topics
- Spacecraft Safety Stakeholders

1. High Pressure Combustion (~ 100 Atm.)
2. Droplet Vaporization and Spray Behavior in the Transcritical Regime (~ 100 Atm.)
3. Low Temperature Chemistry
4. Spacecraft Fire Safety (fire growth, detection, suppression)
5. Supporting ground-based testing and modeling