National Aeronautics and
Space Administration

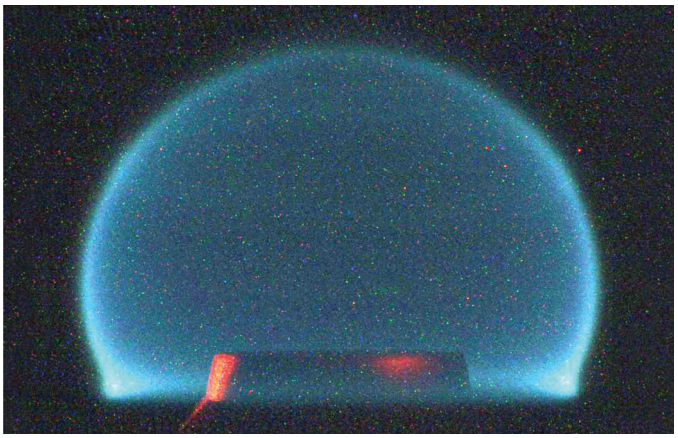
NASA GLENN RESEARCH CENTER

Advanced Combustion via Microgravity Experiments (ACME)

PURPOSE: ACME is focused on advanced combustion technology via fundamental microgravity research. The primary goal is to improve efficiency and reduce pollutant emission in practical terrestrial combustion. A secondary objective is fire prevention, especially for spacecraft.

German astronaut Alex Gerst exchanging the nitrogen mass flow controller on the ACME chamber insert within the CIR facility.

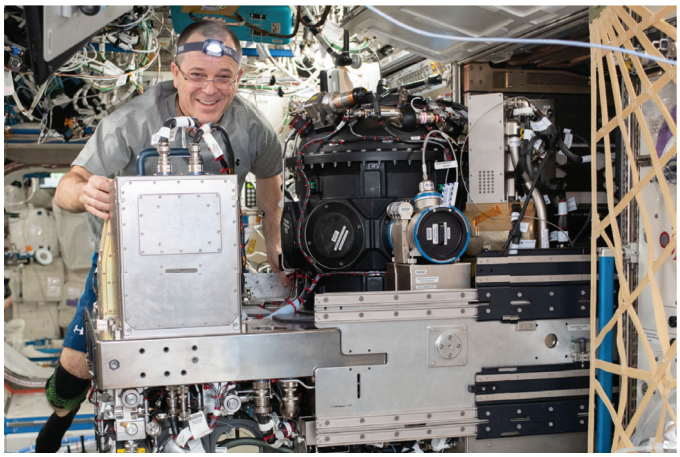
RESEARCH: ACME includes six independent experiments investigating laminar, nonpremixed flames of gaseous fuels. The experiments are being conducted with a single set of modular hardware in the Combustion Integrated Rack (CIR) on the International Space Station (ISS). While the ISS astronauts set up the experimental hardware, the ACME tests are remotely commanded from NASA's Glenn ISS Payload Operations Center.



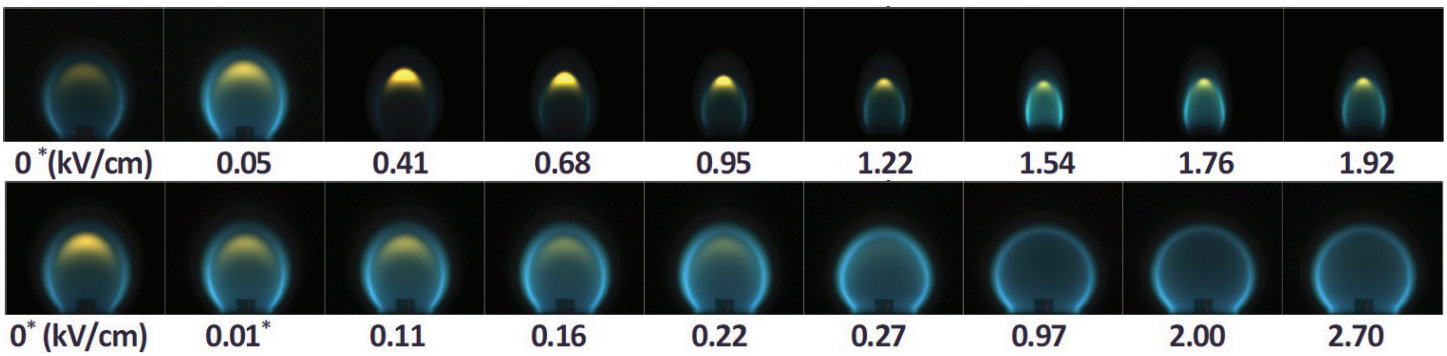
Example flame from the Burning Rate Emulator (BRE) experiment led by Prof. Jim Quintiere (University of Maryland).

U.S. astronaut Joe Acaba and Russian cosmonaut Alexander Misurkin exchanging the CIR oxidizer bottle.

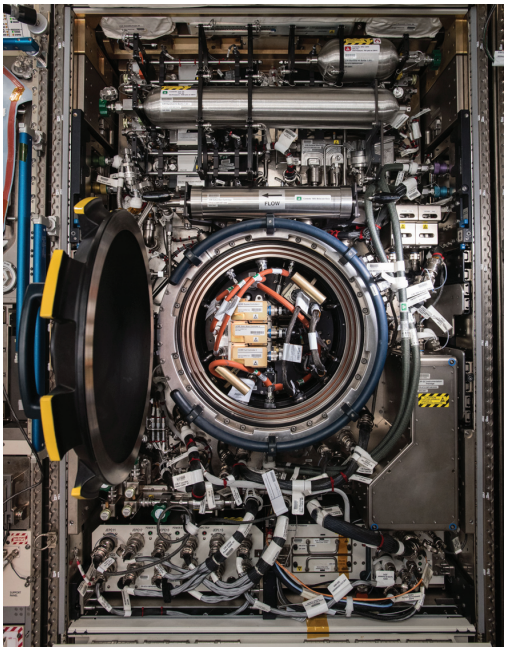
STATUS: ACME was setup by the ISS crew in Sept.-Oct. 2017 where thus far sixteen astronauts from Canada, Germany, Italy, Japan, Russia, and the United States have supported the research. Since November 2017, over 550 flames have been ignited for the Coflow Laminar Diffusion Flame (CLD Flame), Electric-Field Effects on Laminar Diffusion Flames (E-FIELD Flames), and Burning Rate Emulator (BRE) experiments. They are respectively led by Profs. Marshall Long (Yale University), Derek Dunn-Rankin (University of California, Irvine), and Jim Quintiere (University of Maryland). Russian collaborators on those experiments are with the Far Eastern Federal University and Peter the Great St. Petersburg Polytechnic University.

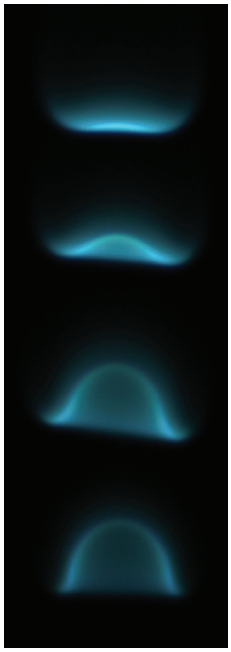


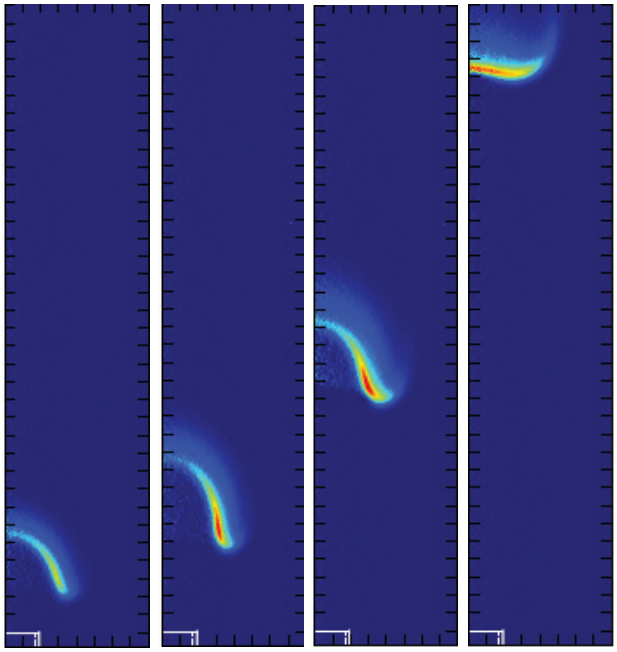
U.S. astronaut Ricky Arnold carrying out CIR maintenance tasks during CLD Flame experiment operations.



Diffusion flames with a weak air coflow as a function of the electric field strength, where an open copper mesh above the flame is negatively and positively charged in the top and bottom rows, respectively. Flames naturally include ions which can be affected by a powerful electric or magnetic field. In ACME's E-FIELD Flames experiment, the copper mesh is energized up to 10,000 volts. This technology could be used to stabilize fuel-lean flames under conditions which are less polluting.







ACME chamber insert within the CIR facility (above left) and two examples (above middle and right) of lifted flames that are detached from CLD Flame's coflow burner, as a function of the fuel and air velocities. The false color in the image to the right indicates the CH* concentration as function of the radius and height above the burner. CH* is an excited species and emits blue light as it drops to a lower energy level in a process known as chemiluminescence. It is the primary source of the blue that is the natural color of hydrocarbon flames (neglecting the broadband thermal radiation from the soot).

Canadian astronaut David Saint-Jacques preparing the ACME chamber insert for the BRE experiment.

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