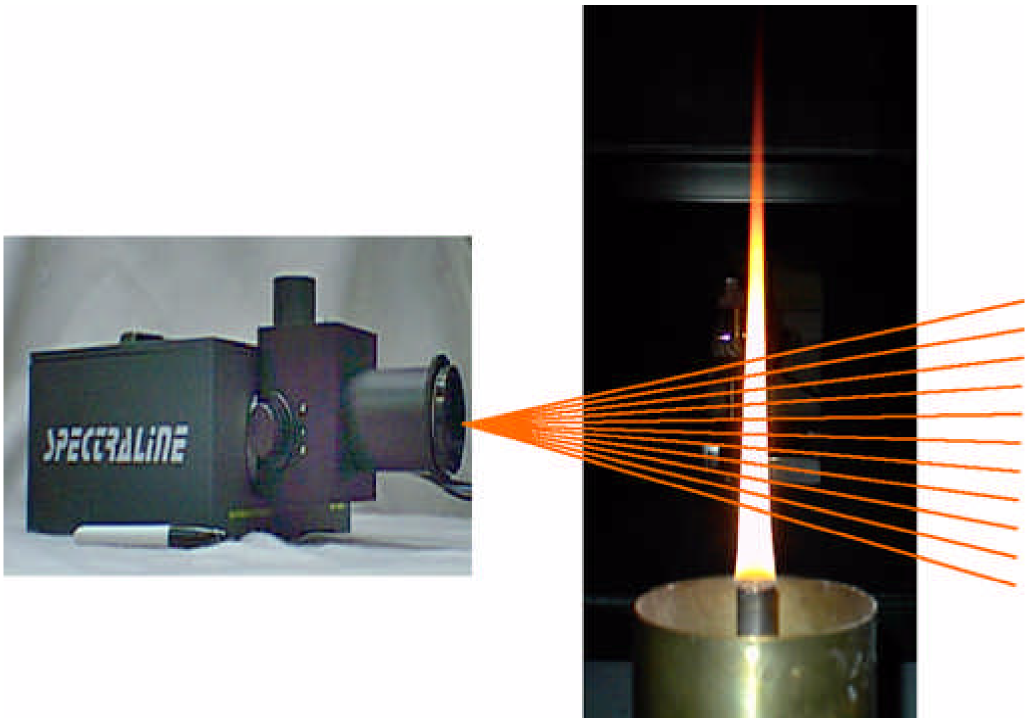
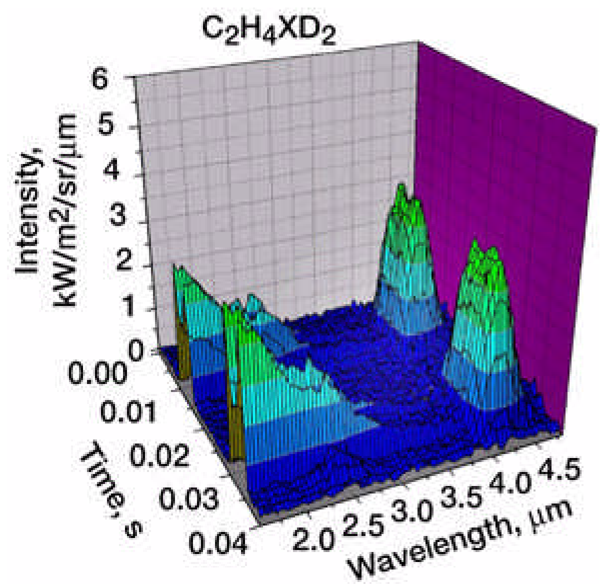
Fan Beam Emission Tomography Demonstrated Successfully in the Reduced-Gravity Environment of Drop Towers



Scanning spectrometer with an ethylene laminar flame with air coflow.

Fires onboard manned spacecraft and launch vehicles are a particularly feared hazard because one cannot jump ship while in orbit 240 nmi above the Earth at 17 000 mph! Understanding the physical properties of fires in free fall and on orbit is, therefore, a very important endeavor for NASA's Human Exploration and Development of Space (HEDS) enterprise. However, detailed information concerning the structure of microgravity fires remained elusive until recently since robustness, limited power, limited volume, and limited mass place severe constraints on diagnostic equipment for use in space and in NASA Glenn Research Center's reduced-gravity facilities. Under NASA Research Associate funding since 2001, En'Urga, Inc. (Dr. Sivathanu, principal investigator, and Dr. Lim, coinvestigator) in collaboration with Glenn (Dr. Feikema, coinvestigator) have successfully demonstrated a new technology for use in microgravity combustion. A midinfrared scanning spectrometer has been developed by En'Urga and tested at Glenn to measure 30 spectra per second at different spatial locations in a flame from 1.8 to 4.8 μm. The spectra clearly show water vapor, soot, and carbon dioxide emissions from the flame. A deconvolution program is being developed to transform the spectra into spatial profiles of soot volume fraction, gas temperature, water vapor concentration, and carbon dioxide concentration. This is a particularly important technological achievement since, for the first time in weightlessness, one instrument can measure simultaneously and nonintrusively many parameters that previously required multiple instruments. This instrument will enable combustion researchers in the microgravity program to obtain detailed information concerning flame and fire phenomenon in reduced gravity. This information will help improve the models and safety of manned spacecraft. Spinoff technologies may be used in areas such as biological diagnostics, food processing industries, automotive industries, and aircraft manufacturing. Jet engine manufacturers also may benefit from the development of flight-weight diagnostic capabilities.



Sample transient microgravity flame spectra collected in Glenn's 2.2-Second Drop Tower. Water vapor peaks near 2.0 mm and carbon dioxide peaks near 4.0 mm.

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