STANFORD UNIVERSITY

ASCENT 25: NJFCP – Area #1
Chemical Kinetics Combustion Experiments

Motivation and Objectives

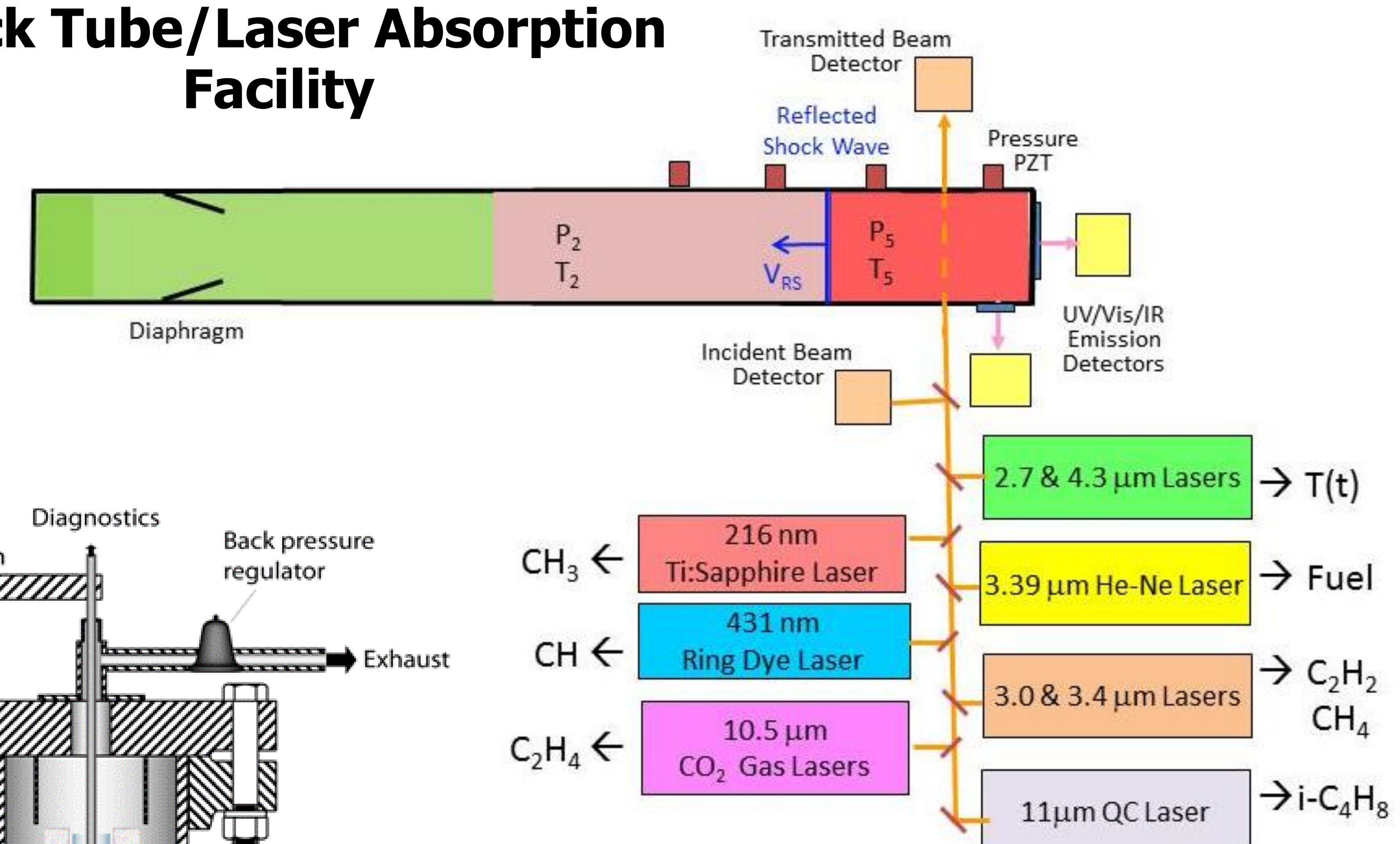
Experiments provide an extensive fundamental kinetics database for selected jet fuels. These data are used as critical input for Area #2 that seeks to develop a new hybrid and detailed kinetics model for jet fuels (HyChem).

These experiments continue to reveal the sensitivity of combustion properties to variations in fuel composition for ultimate use in simplifying the alternative fuel certification process.

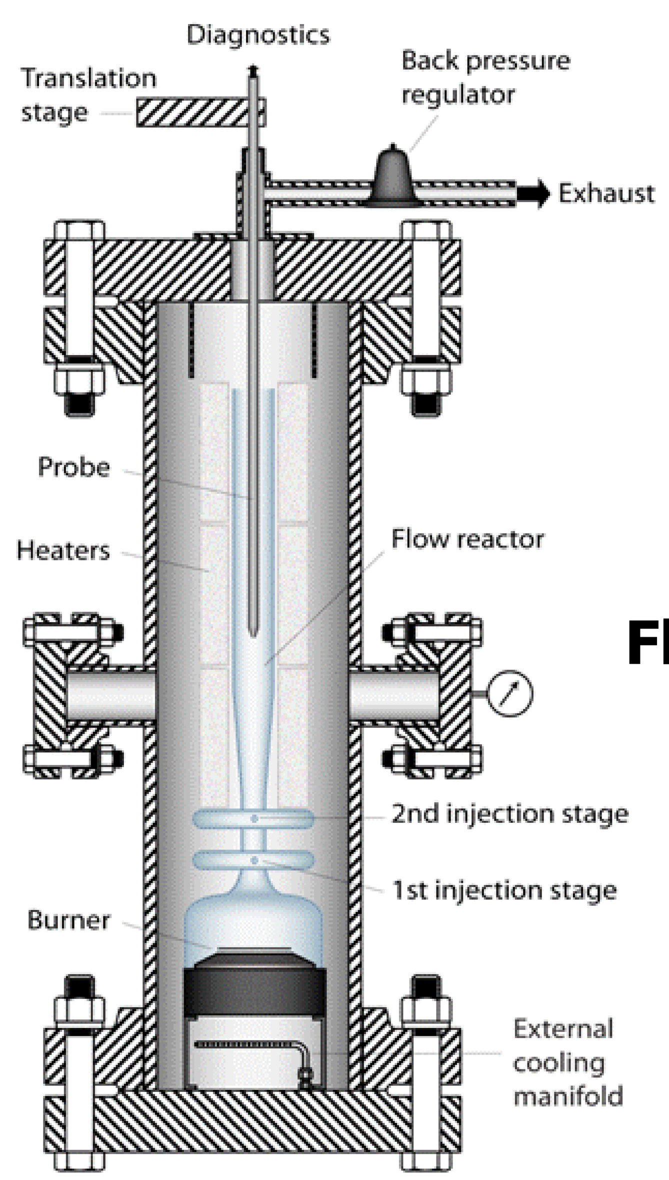
The data provided will also ensure that the combustion models developed in Area #4 to simulate the extinction and ignition processes controlling lean blowout, cold ignition and high altitude relight, are chemically accurate.

Methods and Materials

Shock Tube/Laser Absorption Facility

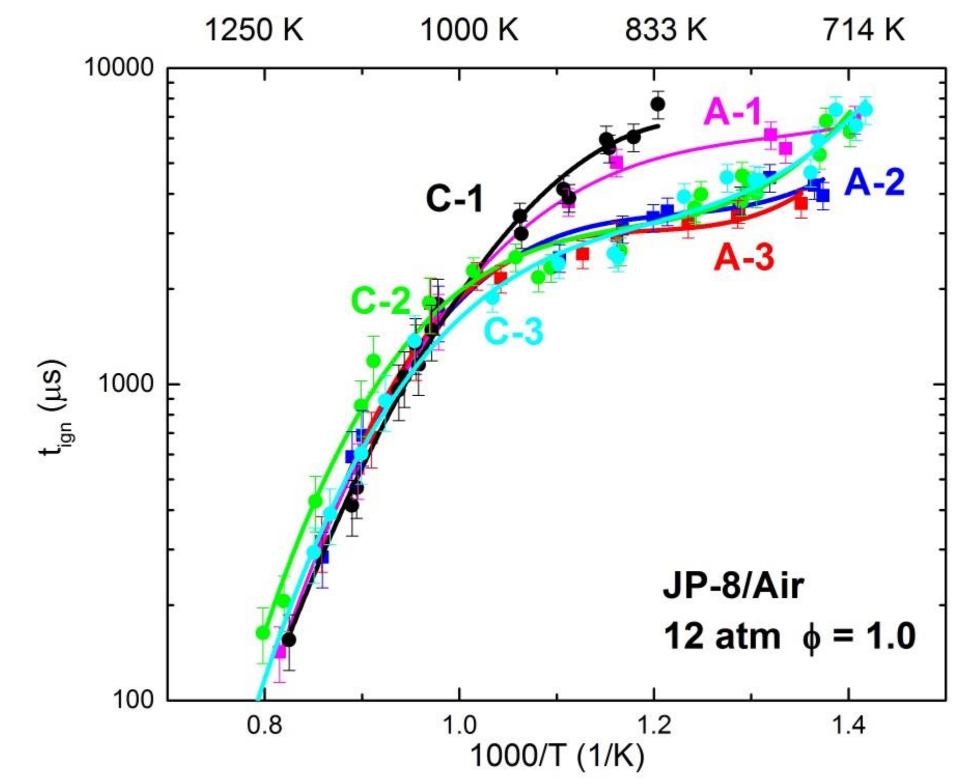


Flow Reactor/GC Facility

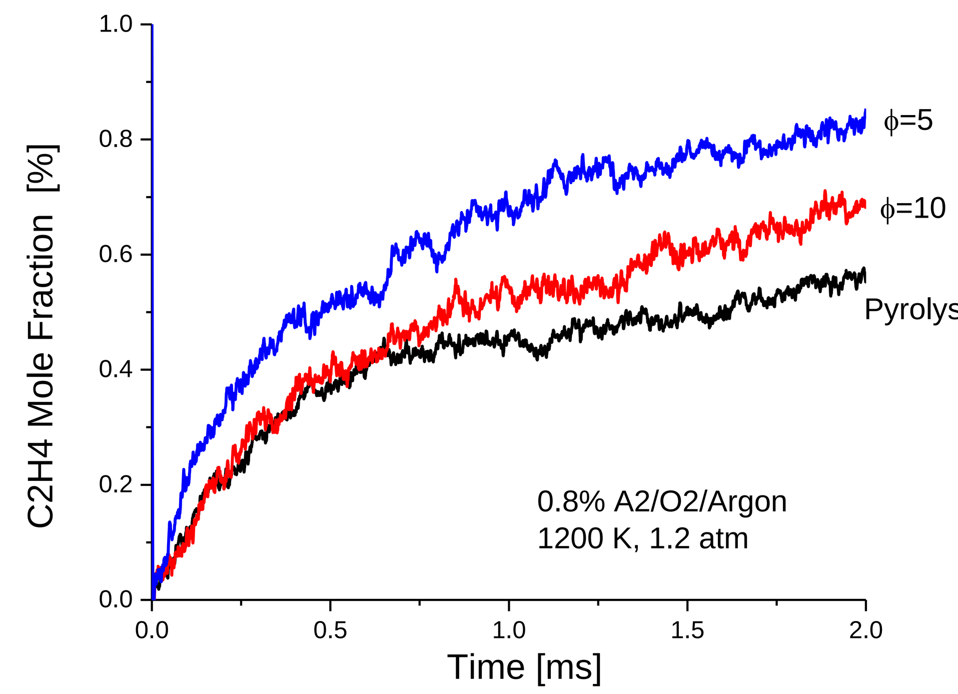


Summary: Representative Data

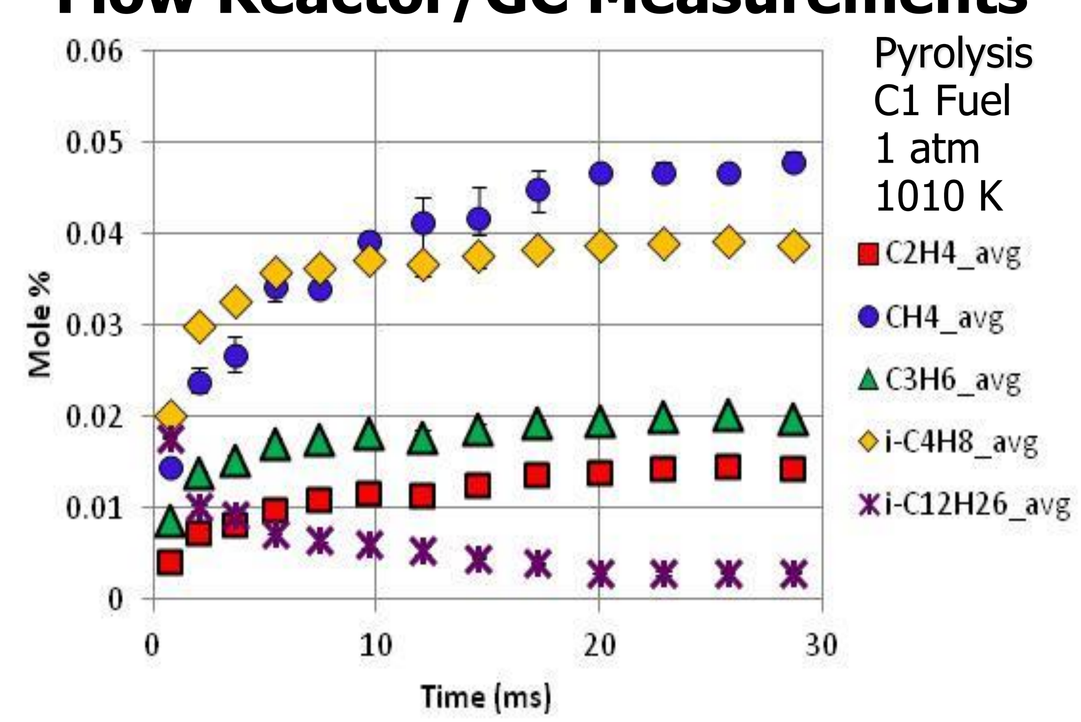
Ignition Delay Time Measurements



Partial Oxidation Speciation Measurements



Flow Reactor/GC Measurements



Results and Discussion

Using shock tube/laser absorption methods we acquired fuel, ethylene, and methane time-histories for all 9 FAA fuels during pyrolysis. In flow reactor experiments this set of species was extended using gas chromatography measurements These pyrolysis product yield data are directly applicable to the development of the HyChem model by Prof. Hai Wang in Area #2.

In addition, we extensively examined the ignition delay times of 9 different fuels over a wide range of temperatures (700-1200 K) in an effort to provide the FAA with sufficient information to allow down-selection to a smaller test set.

Conclusions and Next Steps

Advances in the HyChem model development indicate several important issues that should be addressed.

The first is the development of a protocol for specification of sub-model kinetic parameters. The HyChem model currently requires 6 constraining relationships based on pyrolysis experiments. Can these be derived from an independent fuel analysis or are shock tube and flow reactor experiments required?

The second is the need to establish temperature and pressure boundaries for the validity of the HyChem modeling approach.

The third issue that may become important is the possible need to extend the HyChem model to the NTC (negative temperature coefficient) regime. The unique oxygen-addition chemistry in this low temperature regime can become important at higher pressures, but also at longer residence times.

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