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Automation of Coherent anti-Stokes Raman Spectroscopy (CARS) Probe Delay Scan Measurements

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U.S. DEPARTMENT OF ENERGY
National Nuclear Security Administration

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Presentation Outline

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- Introduction
- Overview of CARS
- Probe Delay Scanning
- Automation and its Benefits
- Future Work
- Questions

Role of Optical Diagnostics in Combustion Research

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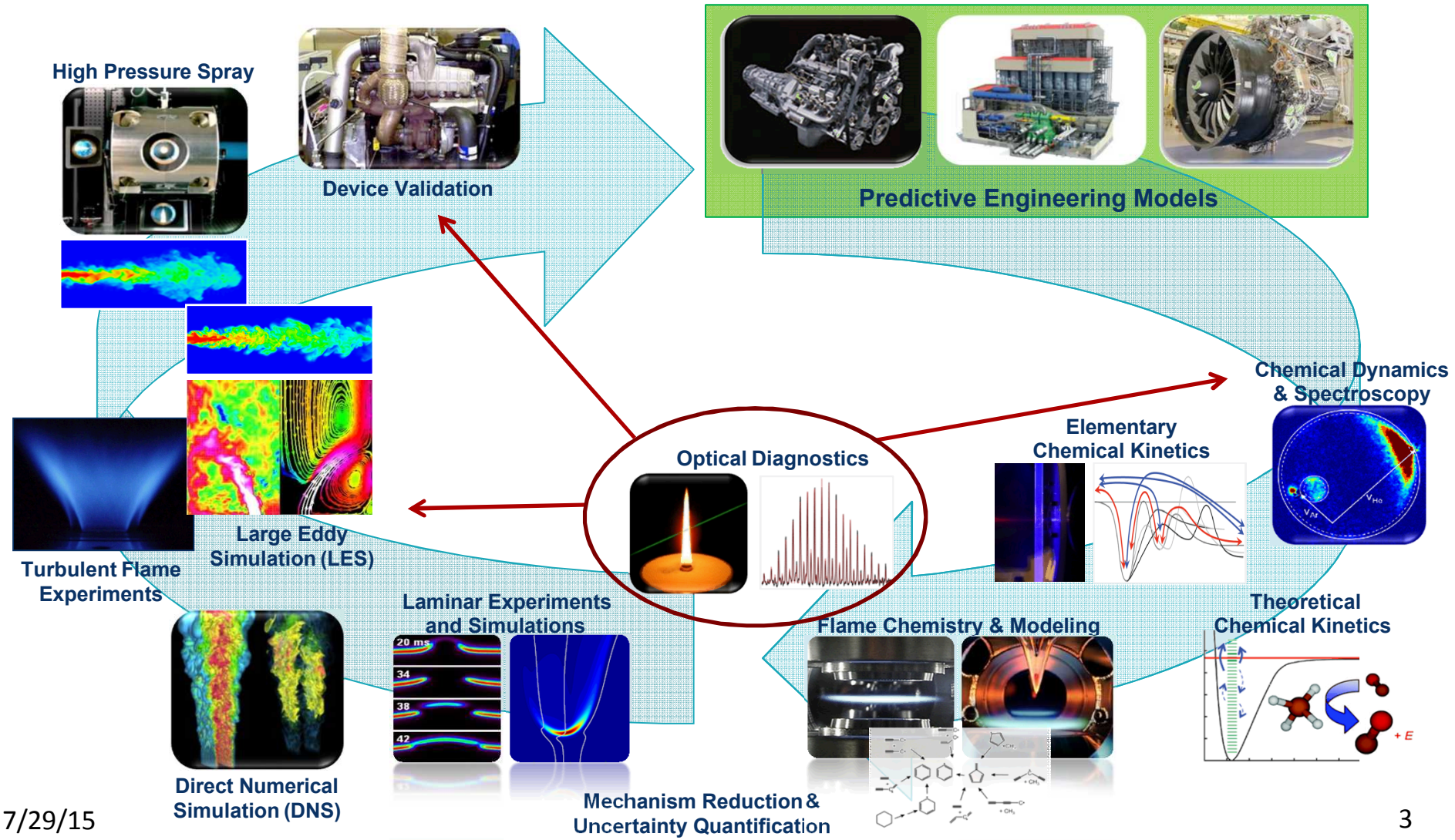
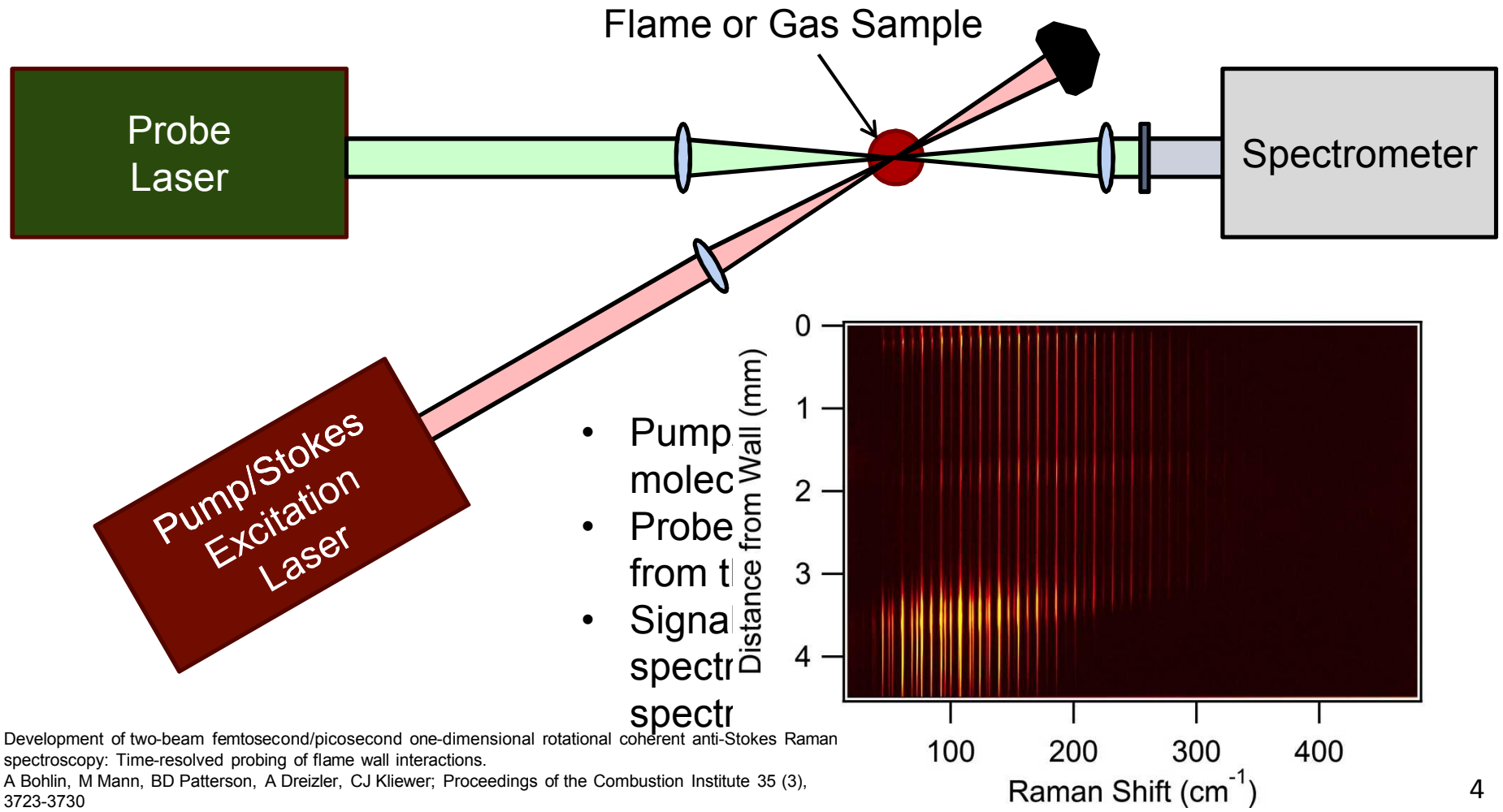


Overview of CARS



- Pump
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- Probe
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- Signa
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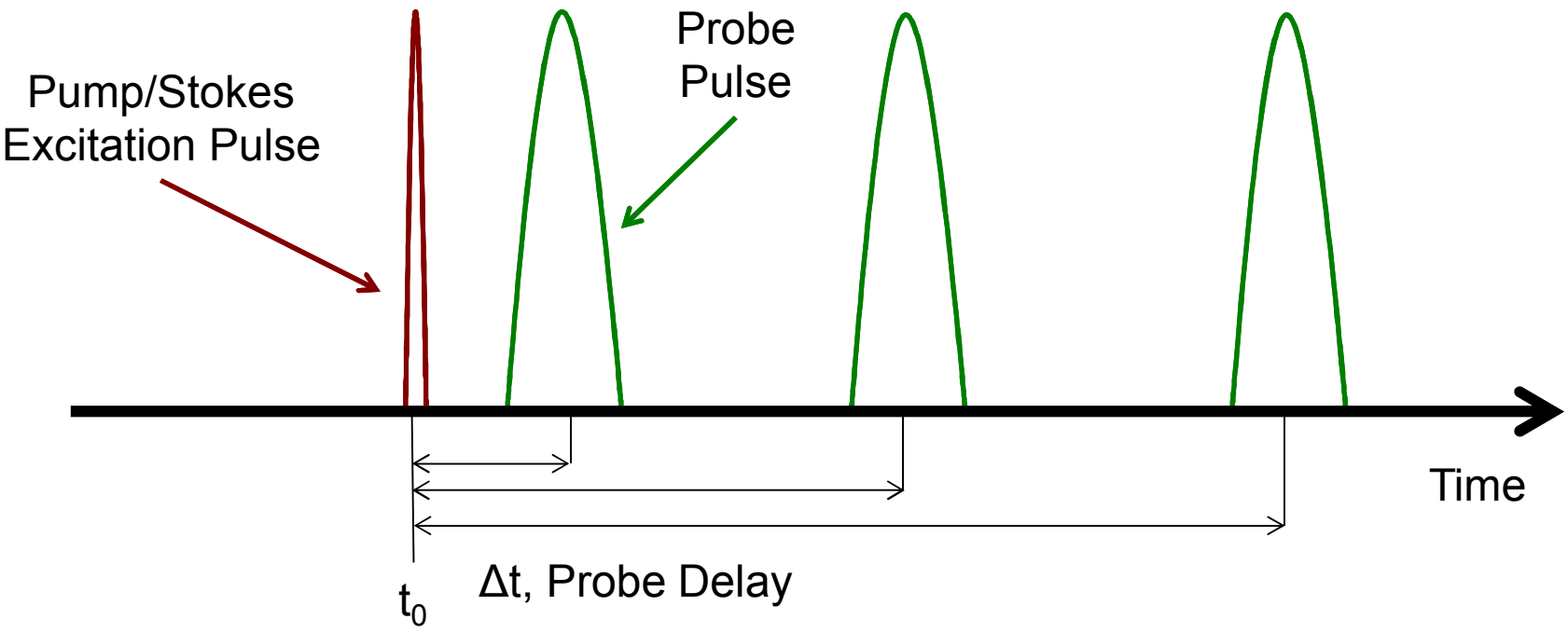
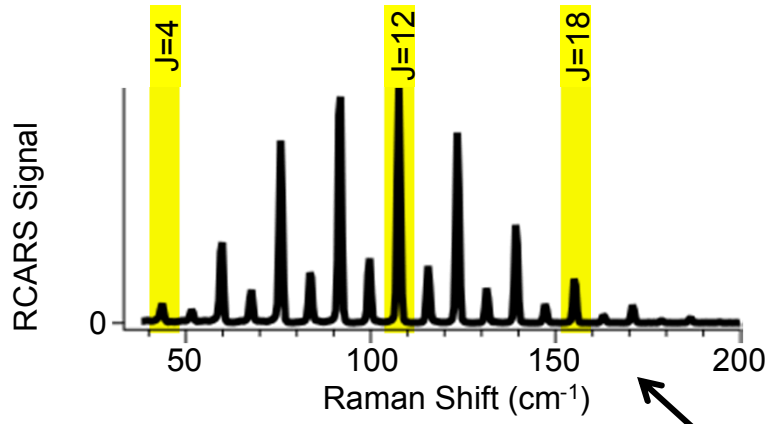
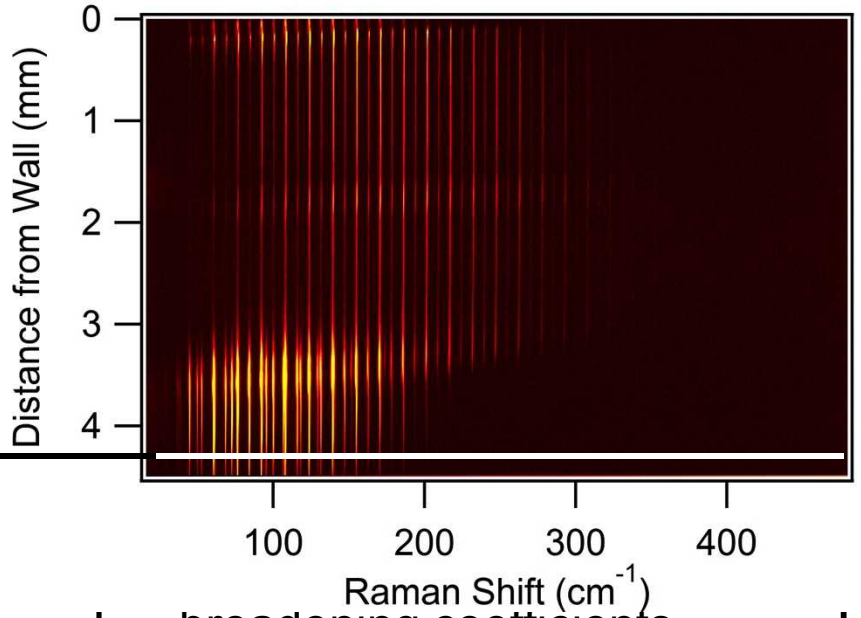
Development of two-beam femtosecond/picosecond one-dimensional rotational coherent anti-Stokes Raman spectroscopy: Time-resolved probing of flame wall interactions.
A Bohlin, M Mann, BD Patterson, A Dreizler, CJ Kliewer; Proceedings of the Combustion Institute 35 (3), 3723-3730

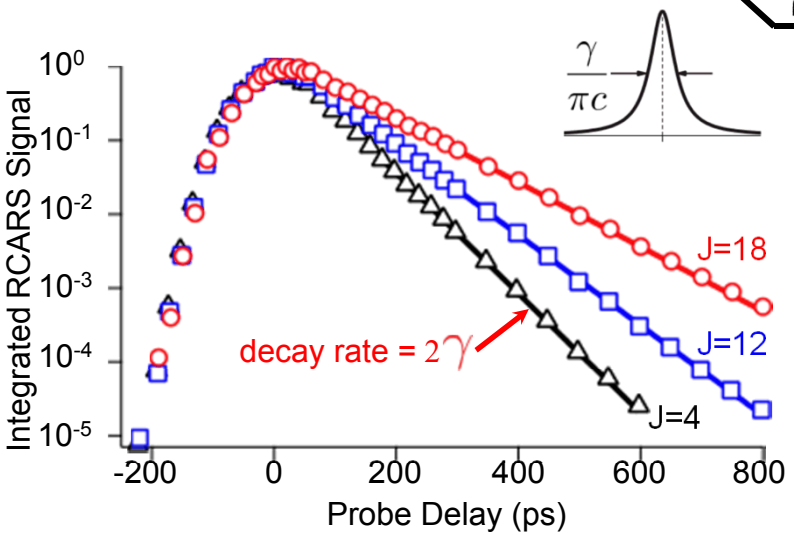
Probe Delay


Pump/Stokes
Excitation Pulse
Probe
Pulse
Time
t_0
Δt, Probe Delay

Probe Delay Scans





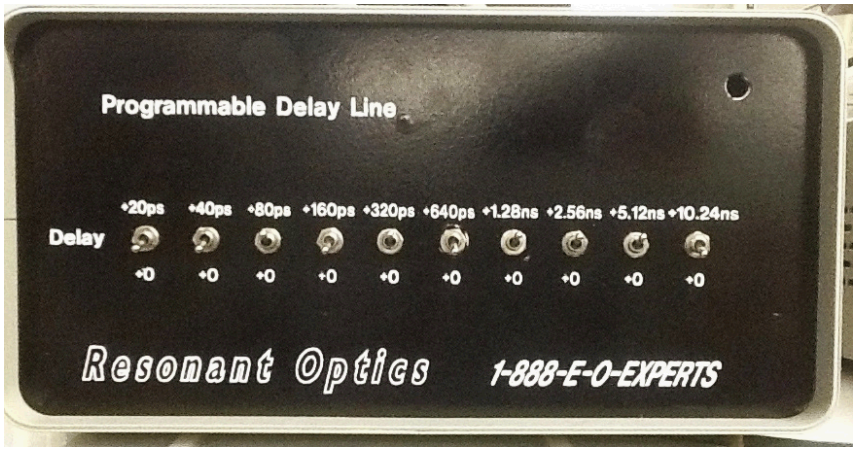


- broadening coefficients
- Simultaneously measure each transition

Automation of the Delay Scan

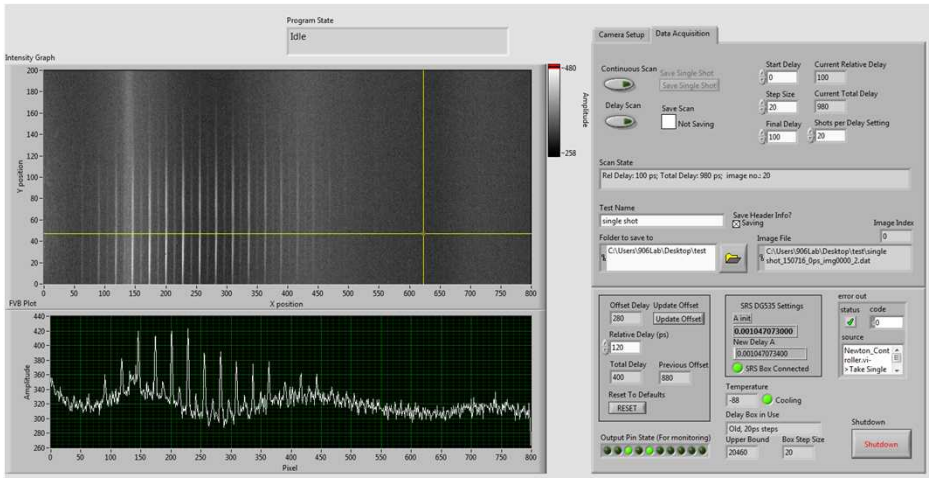
Before Automation

- Manually set delay using toggle switch box
- Record and save a single delay scan
- Update delay setting and repeat



After Automation

- Set scan parameters
- Begin the scan and wait for completion



Benefits of Delay Scan Automation

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- Researcher is free to tend to other work while experiment runs
- Reduces chance of operator error when setting delays
- Enables efficient measurements at multiple settings
  - On average, reduces experiment time by 50%

Saves time and effort

Future Work

- Add other sensor inputs to automatically save relevant information
  - Thermocouples
  - Joule Meters
  - Beam Profile Data
- Incorporate automatic data analysis into scan to reduce post-processing

Acknowledgements

- Christopher Kliewer
- Brian Patterson
- Alexis Bohlin
- DOE WDTS SULI program

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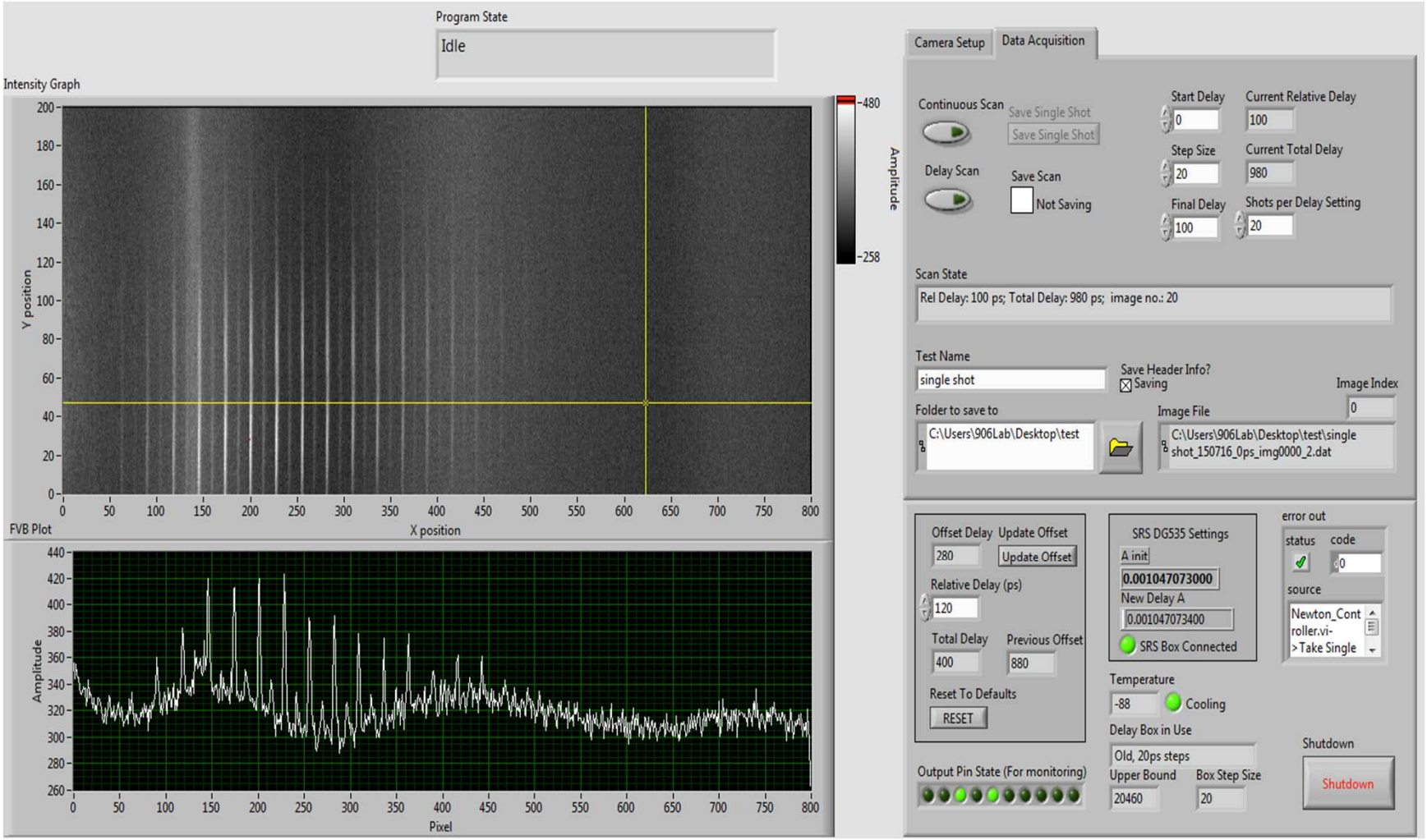
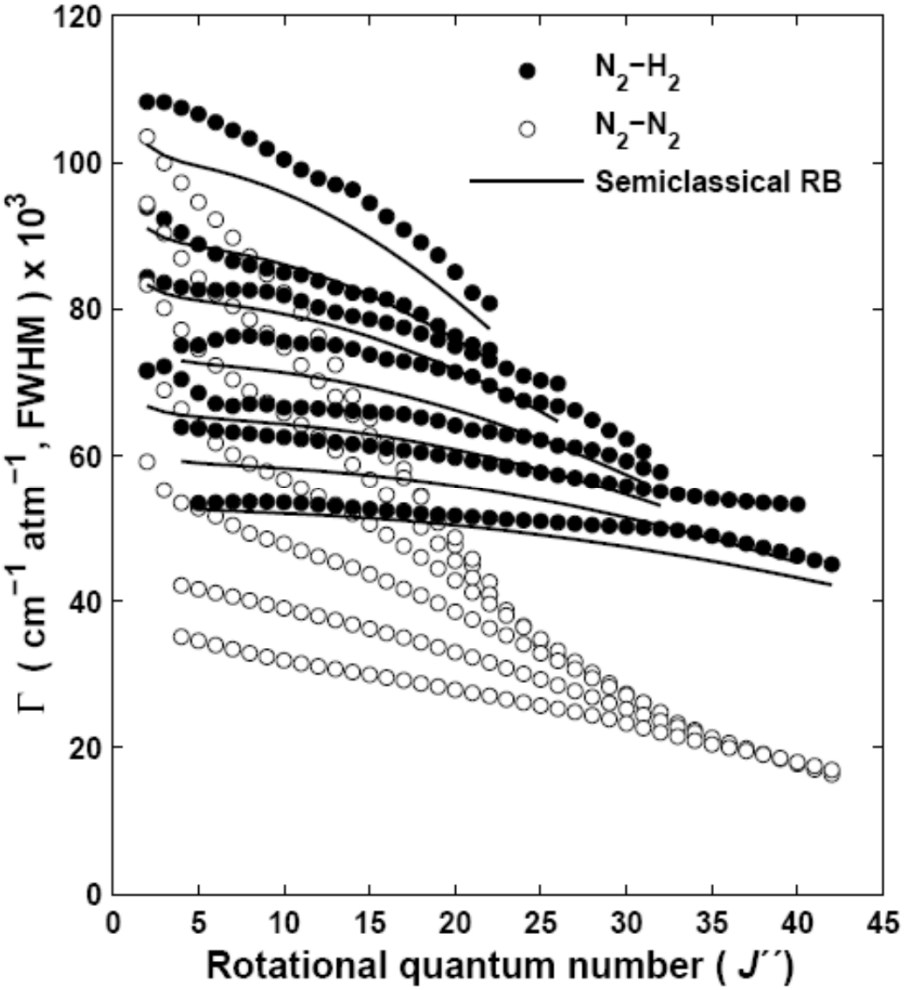
Questions

Program User Interface

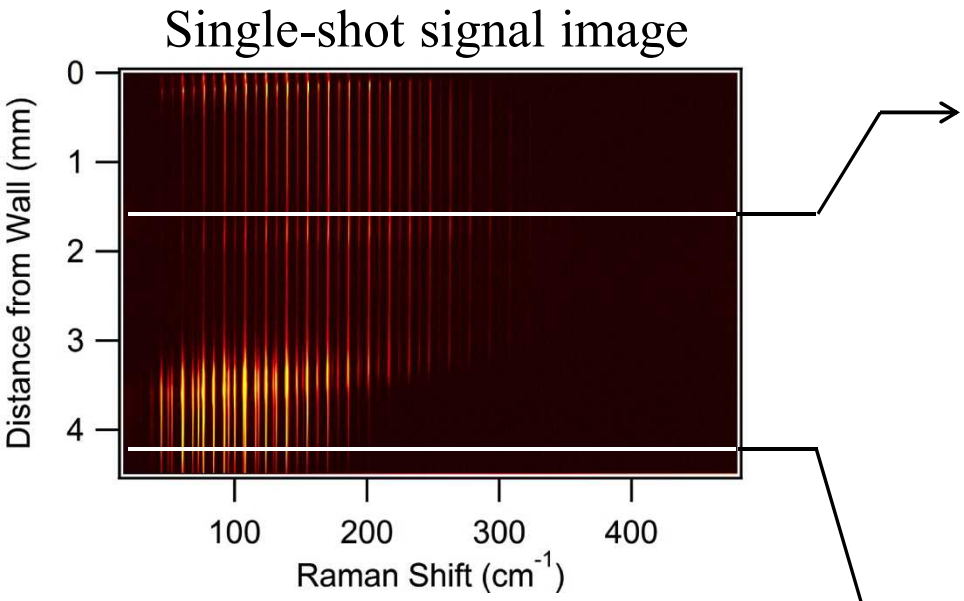


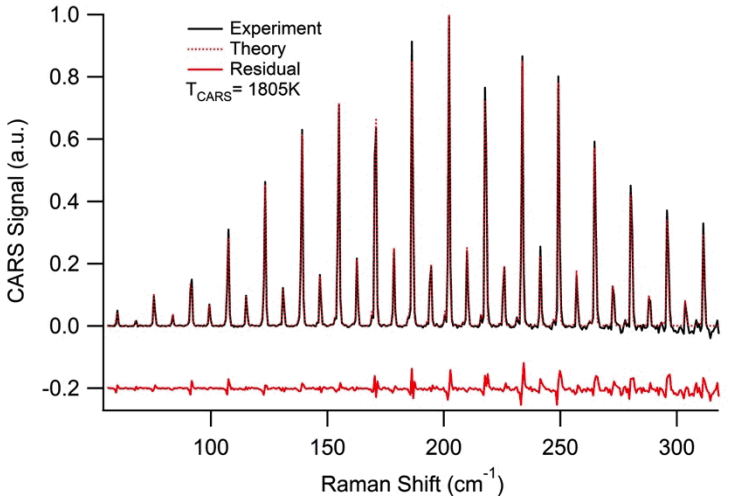
Composition and Temperature Dependence of Broadening Coefficients

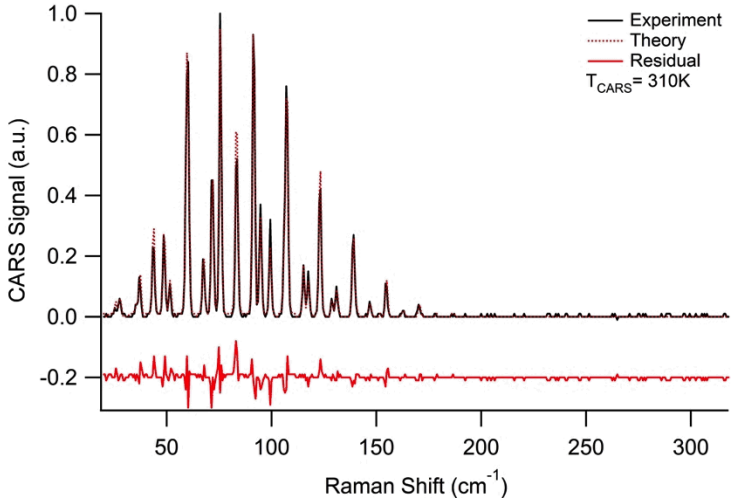
- Broadening related to collisional effects
  - Composition
  - Temperature
- Different for each mixture and condition measured



Single-laser-shot 1D-CARS measurements







- Spatially resolved spectra in measurement region
- Spectra provide temperature and composition information

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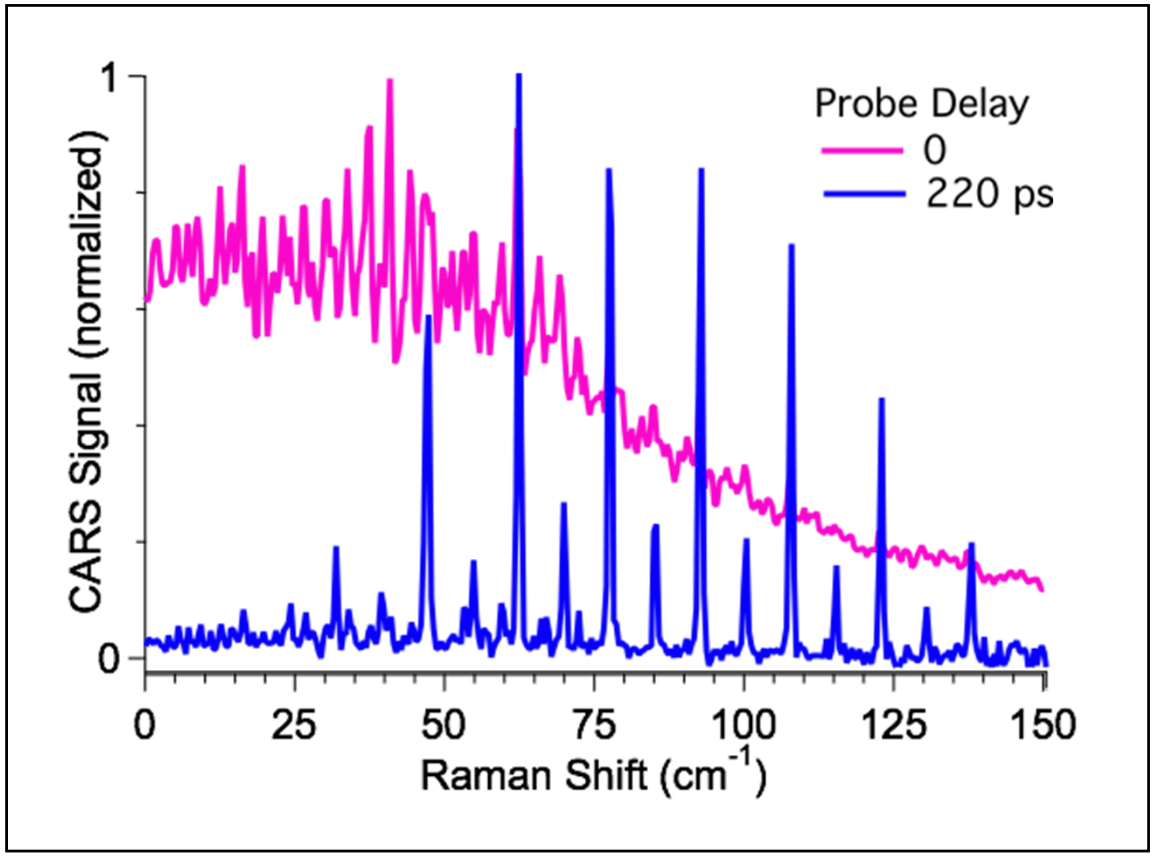
Effects of Delaying Probe Beam

15% N_2 in C_2H_4 at 300 K, 1 bar



Delaying probe beam enables significant reduction in noise

C_2H_4 fuel-rich flow