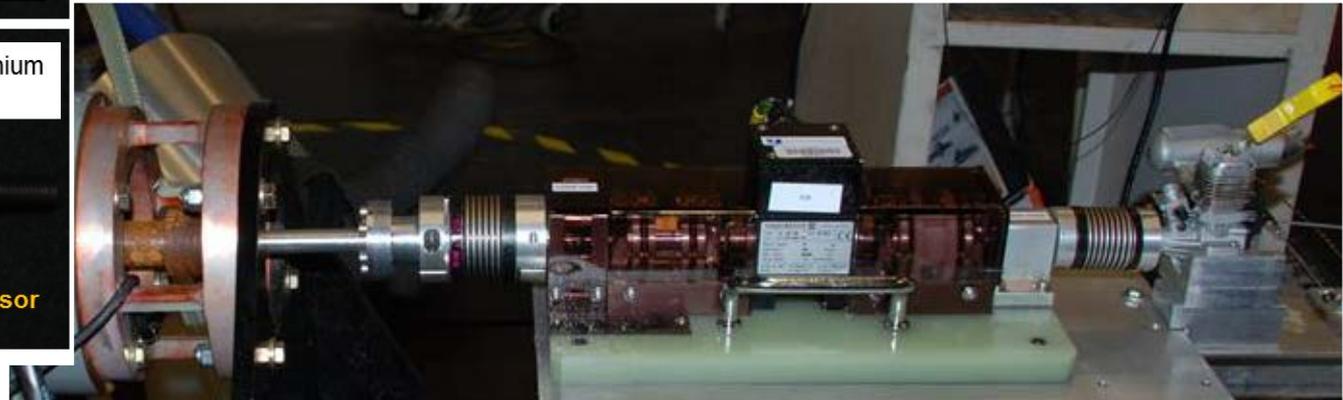
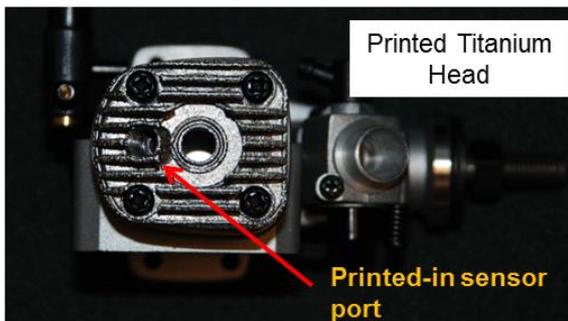
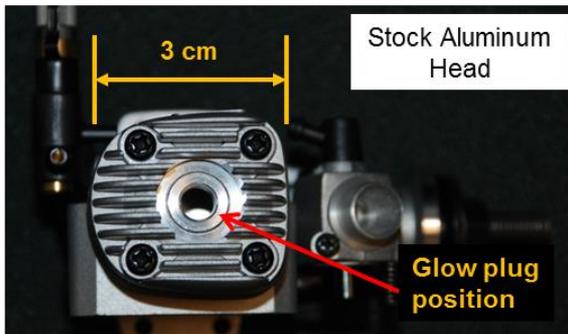
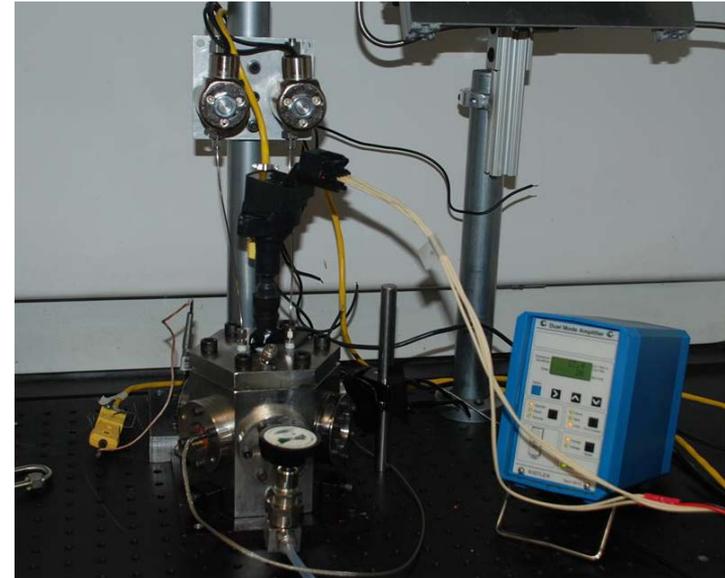


# Approaches Being Considered at ORNL for Improved SI Engine Efficiency and Durability Include:

- Extending stable flame propagation to high dilution levels
- Improved lubricity & durability
- Utilizing additive manufacturing to facilitate prototyping and sensing/instrumentation
- Capabilities include:
  - Small engine motoring dynamometer
    - 10,000 RPM
    - 15kW or less
  - Analytical and Modeling Support



# Pathways to Increasing SI Engine Efficiency Include Extending Dilution and Pressure Limits

- Fundamental advantages of very dilute combustion and high cylinder pressures are related lower heat loss, more favorable gamma {specific heat ratio}.
- Industry believes that engine efficiency can be increased up to 15% by going to higher dilution and boost pressures than currently achievable.
- Limited by range of stable flame propagation!

- Initial flame growth slows due to local thermal quenching. When a critical size is reached, the flame speed increases and the flame propagates through the bulk fuel-air mixture, otherwise it dies.
- Increased dilution and/or cylinder pressure increase quenching.
- Slow flame propagation enables secondary ignition (knocking)

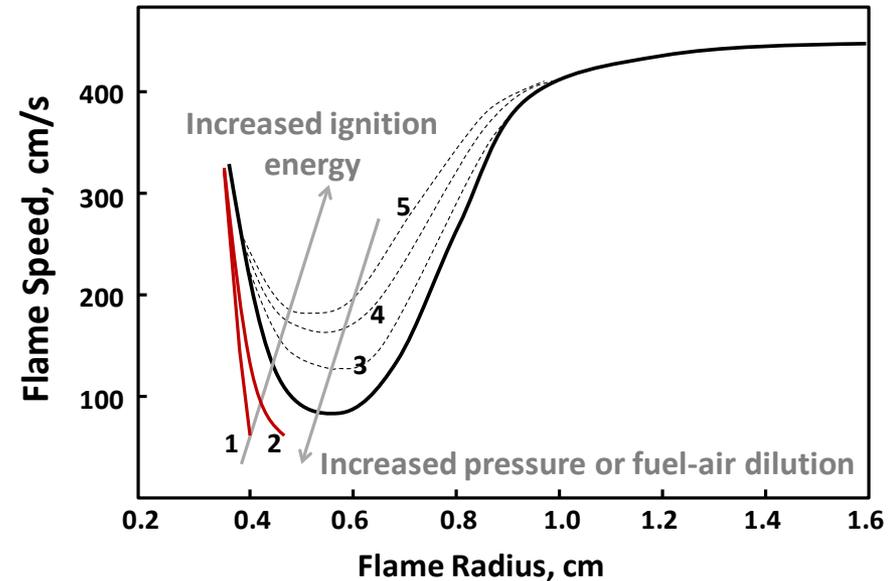
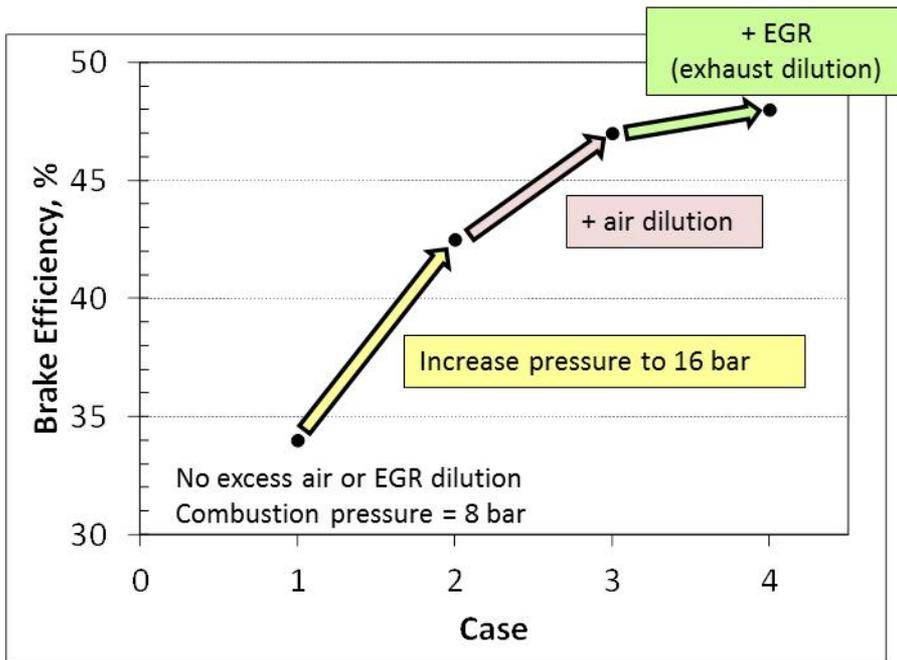
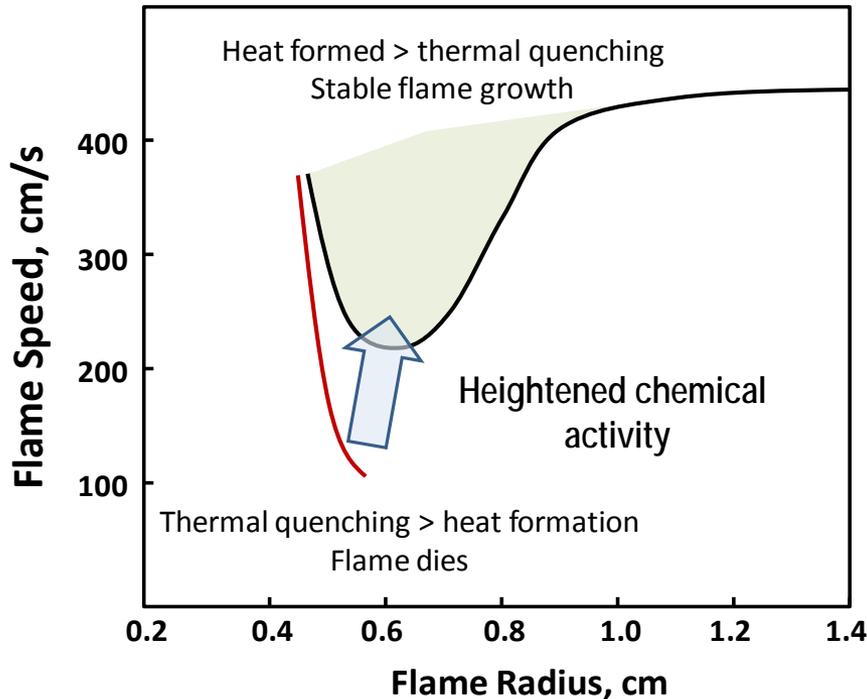
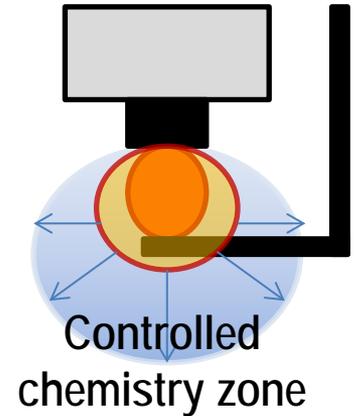


Figure is derived from J. A. Caton, Energy Conversion and Management 58 (2012) 84-93

# Stable Flame Propagation Concept Has Two Industry Partners On-board

- Concept involves raising the ignition energy (flame radius) during the onset of flame kernel growth.
- Approach is to locally affect the fuel/air ratio at the spark plug gap.
- Combination of engine and constant volume combustion experimentation.
- **Primary goal is to reduce operating costs by achieving  $\geq 50\%$  fuel efficiency.**



- Concept is feasible for any engine size including the 1 to 5 kW range.
- Trade-off of different features (efficiency vs slight increase in system cost)
- Meets current level of manufacturing capability
- Engine efficiency decreases with decreasing cylinder volume. However, small displacements also provide opportunities.