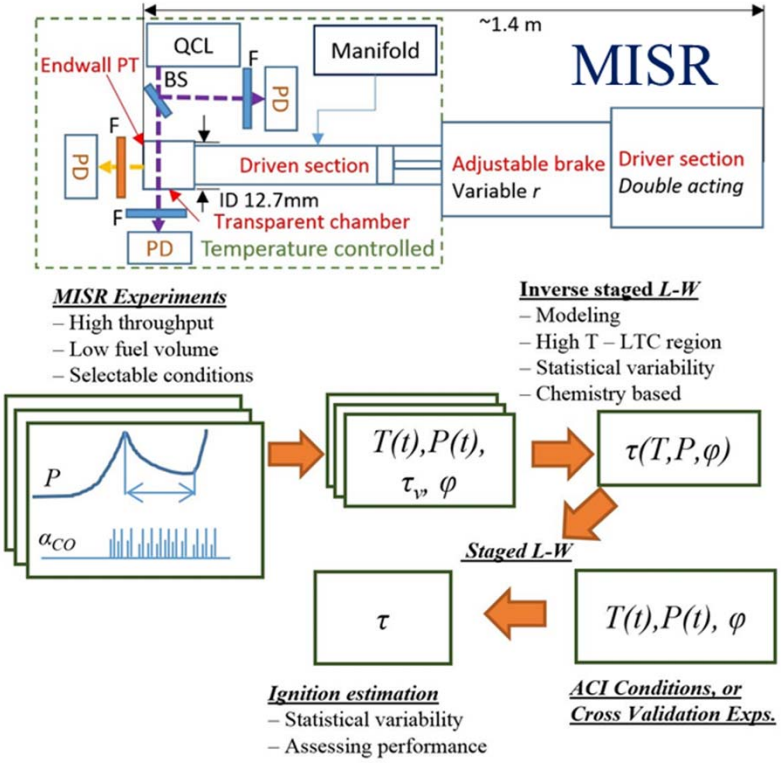
MISR: Miniature Ignition Screening Rapid Compression Machine for Kinetic Measurements of Novel Fuels

Goals

- To provide a small volume tester for high throughput fuel and fuel blend ignition screening.
- To provide experimental data and analysis tools for kinetic mechanism development, especially for ignition properties.
- To provide an alternative analysis method for fuel property screening and cross-validation, especially relevant to ACI conditions.

Approach

A combined experimental/modelling effort will build and use a novel miniature rapid compression machine suitable for high-throughput screening of ignition delay times: the Miniature Ignition Screening RCM (MISR). This device will be used for characterizing properties from very small volumes of low volatility fuels <20µL per exp. (T>600K, P<100 bar, various ϕ, various diluents). The MISR will operate with high repetition rate (up to 1 Hz), high repeatability, and can quickly map out a wide range of temperature and pressure conditions.
The modelling effort will provide kinetic insights from extracting the temperature, pressure, and concentration specific constant-condition ignition delay times (i.e. a multiparameter chemistry based map) from the MISR data with newly developed algorithms using an inverse- staged-Livengood-Wu integral technique (i-L-W). That complex ignition delay map can be convolved with the state history in other devices to predict ignition characteristics, especially for ACI conditions.



Potential Impact on Co-Optima Goals

Ignition performance is a key target within Co-Optima's central fuel hypothesis. The MISR will achieve high-throughput, accurate, small fuel quantity ignition characterization for use with fuels and blends of interest. The i-L-W analysis and modeling further contribute to kinetic modeling of these systems and contributes to data validation across different experimental facilities within Co Optima. Our approaches contribute to the search for a general fuel property relevant to ignition in ACI engines (kinetically controlled ignition). It is expected that the data and models based on staged i-L-W will be able to simulate fuel ignition characteristics in ACI conditions. More useful and predictive fuel properties permit engine designers to exploit higher vehicle engine efficiency configurations.

Team Members

Ci-PI: Patrick Lynch (University of Illinois, Chicago)
Co-PI: Peng Zhao (Oakland University)