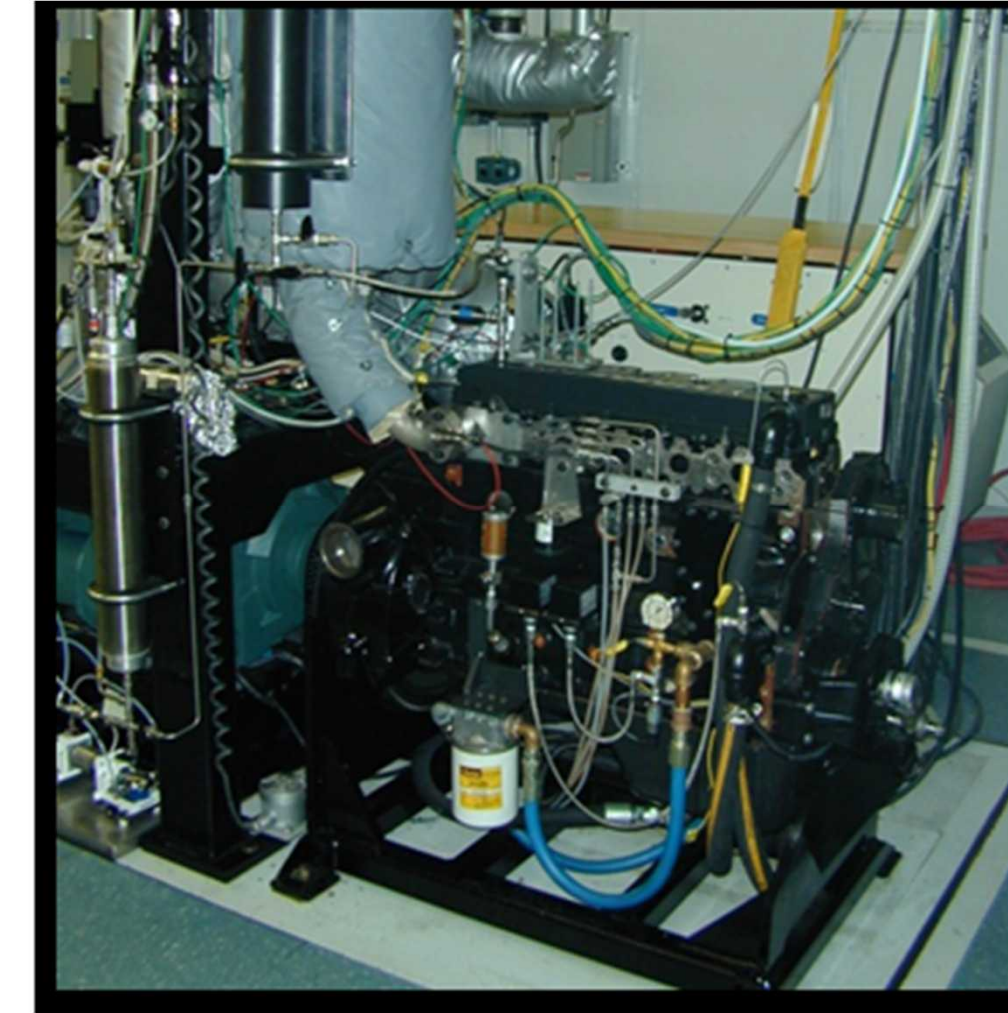
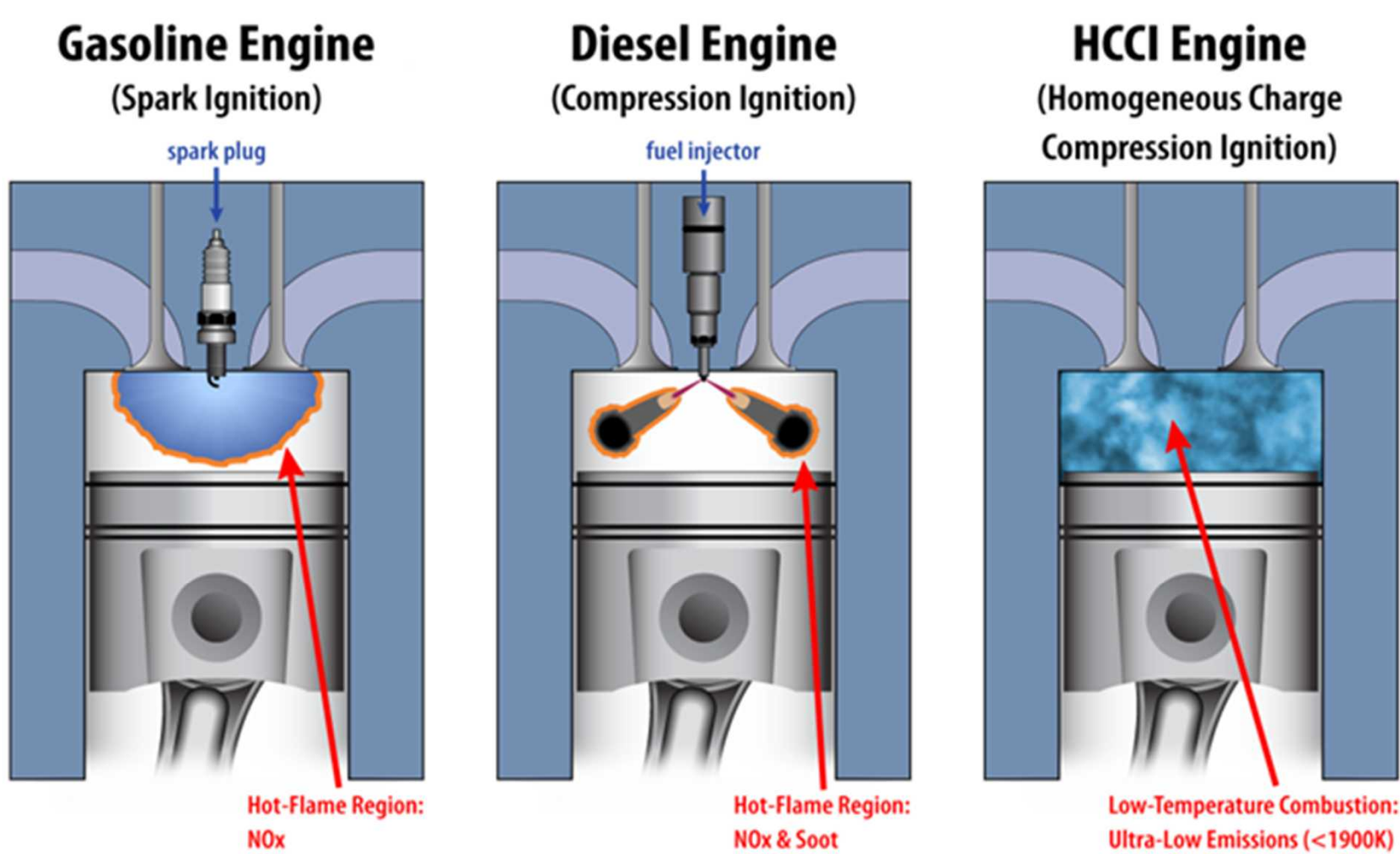


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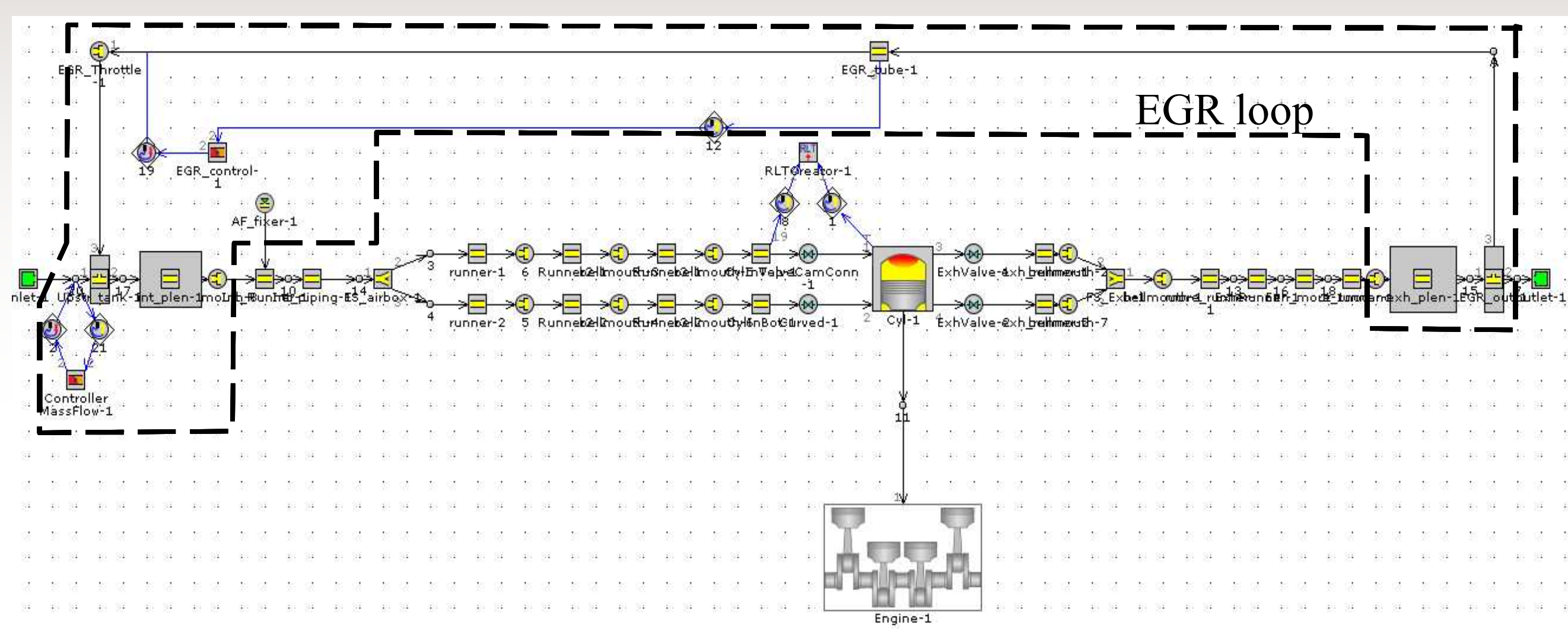


Simulating a Research Engine

Trevor Jackson, Texas A&M University B.S. Mechanical Engineering, est. May 15. John Dec, 08300, Engine Combustion 30 July 2014.

Abstract

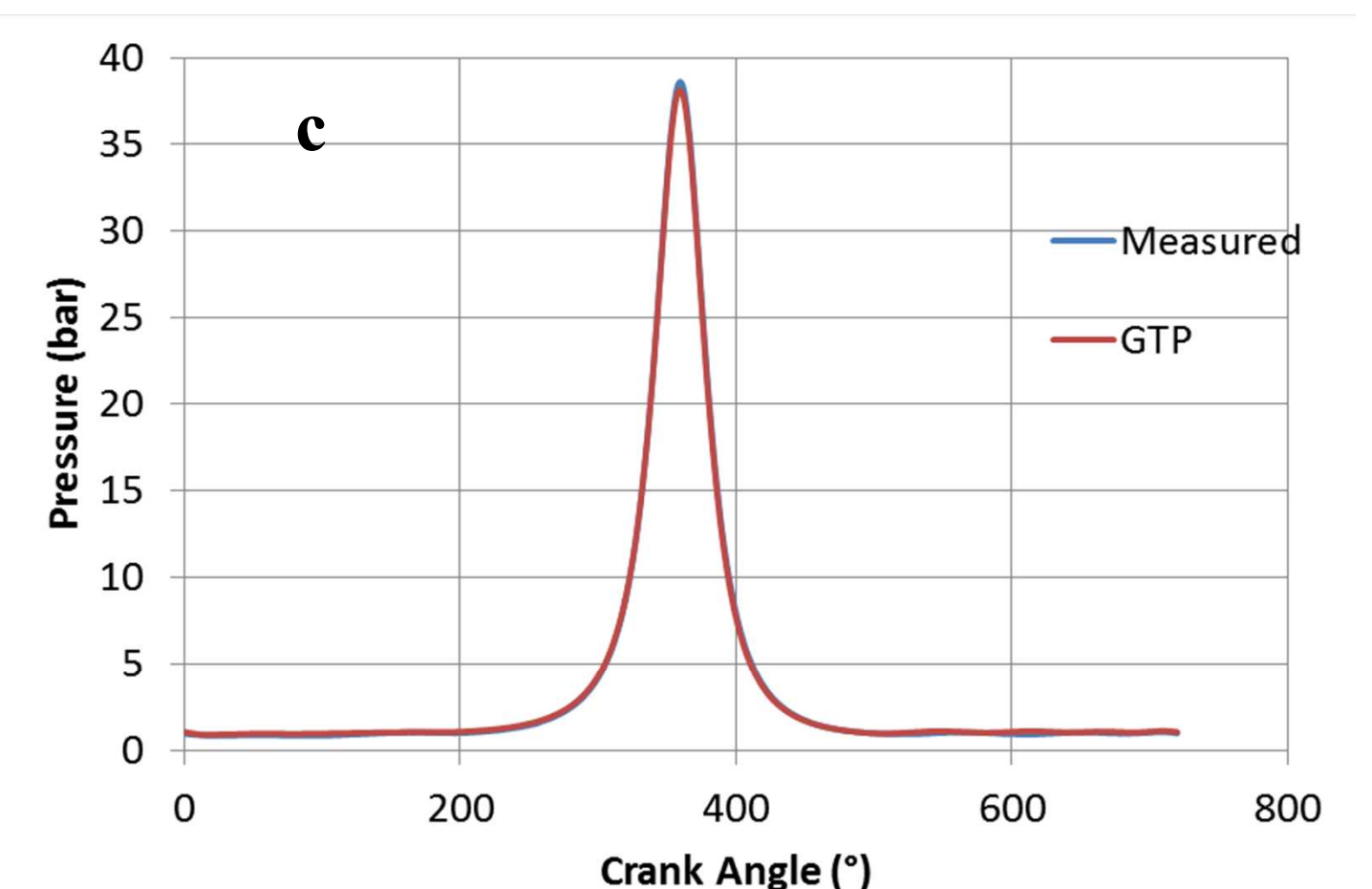
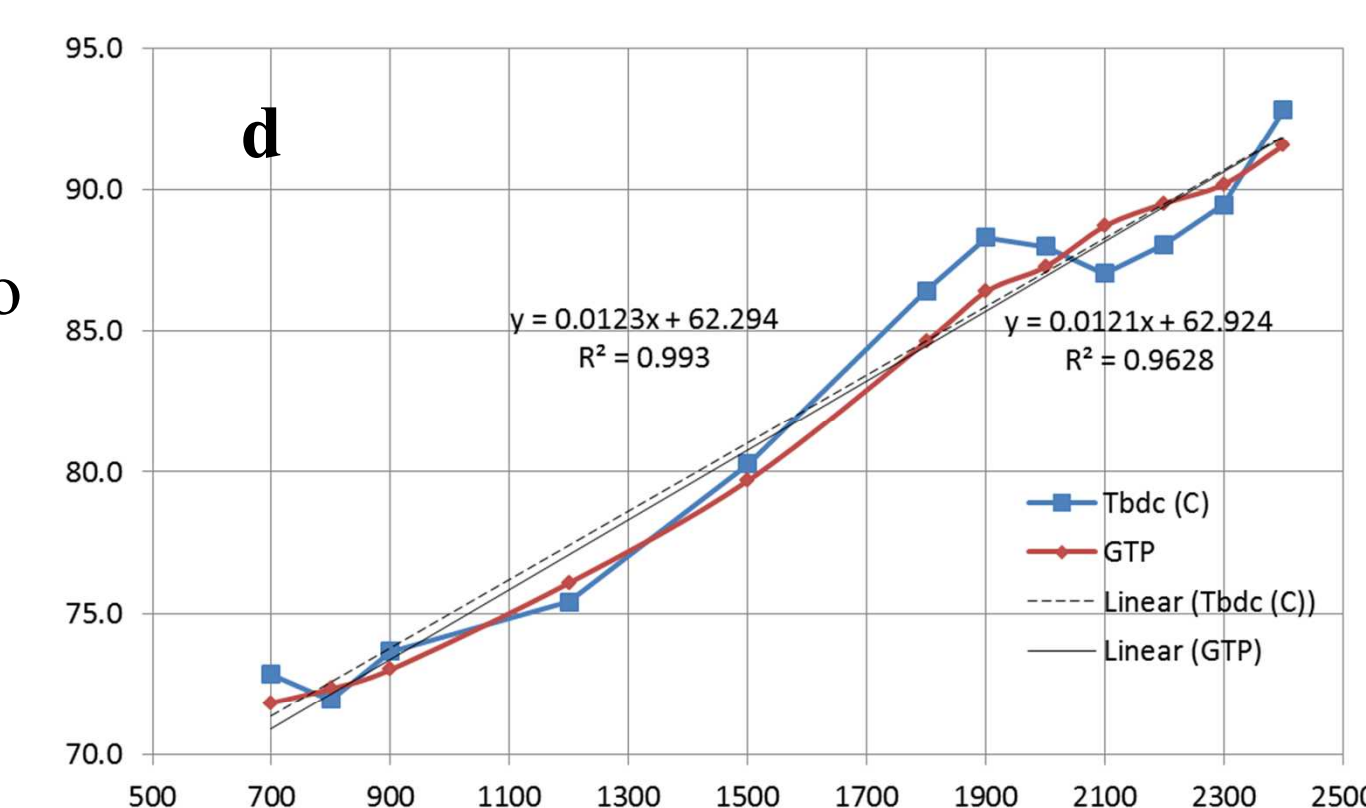
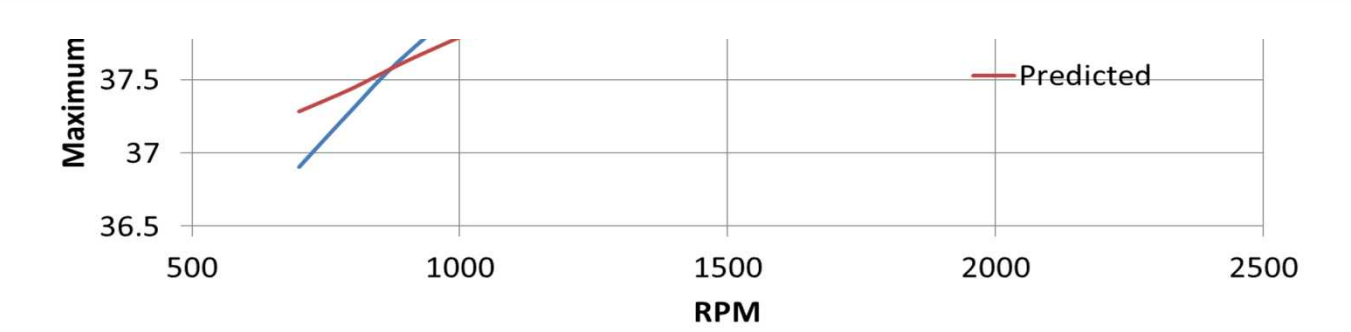
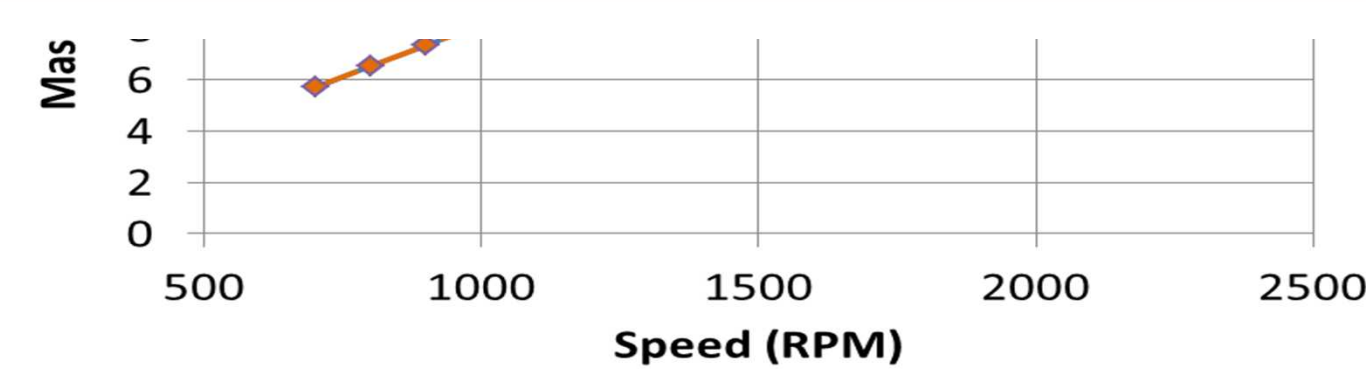
To develop an accurate method for assessing and predicting high efficiency Low Temperature Gasoline Combustion (LTGC) engine performance, a model was created via GTPower software. Experimental data from motored (unfueled) operation was used to calibrate the basic physical model before fired (fueled) data from sweeps over various parameters was used to calibrate the model's combustion aspects. This model significantly reduces analysis time, and provides information not previously available.



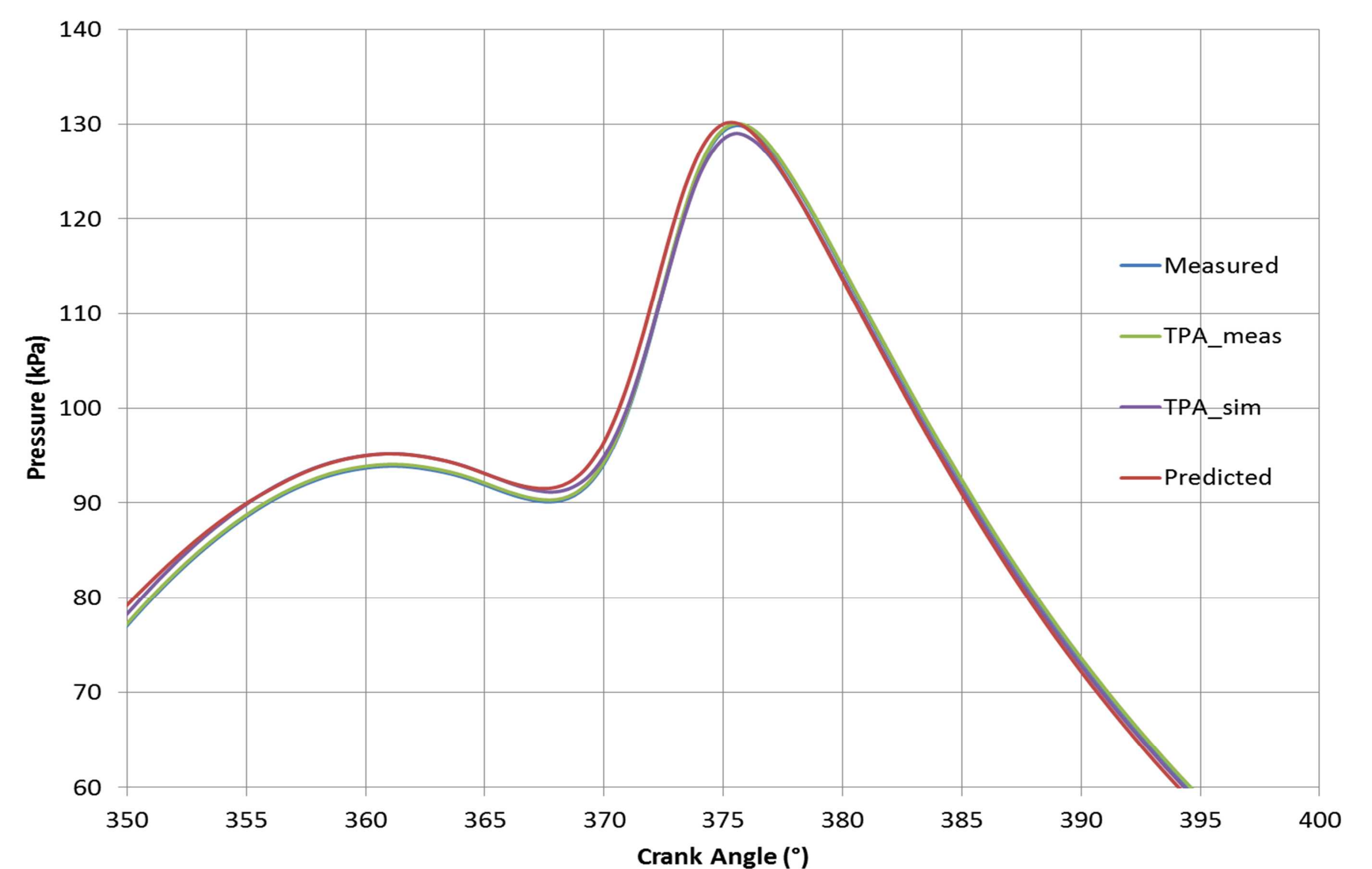
Final engine model (after EGR loop added)

Introduction

- Diesel and Spark-Ignition (SI) engines are relatively well understood by the industry.
- SI engines have relatively low efficiency, produce pollutants which can be cheaply removed via 3-way catalyst
- Diesel engines offer higher efficiency but treatment of pollutants is expensive
- LTGC engines are even more efficient than diesel and require no treatment for soot, NO_x
 - LTGC is not yet well understood, so research efforts are underway
- Models that accurately predict quantities which are difficult to measure can significantly enhance experimental studies and save considerable time and expense

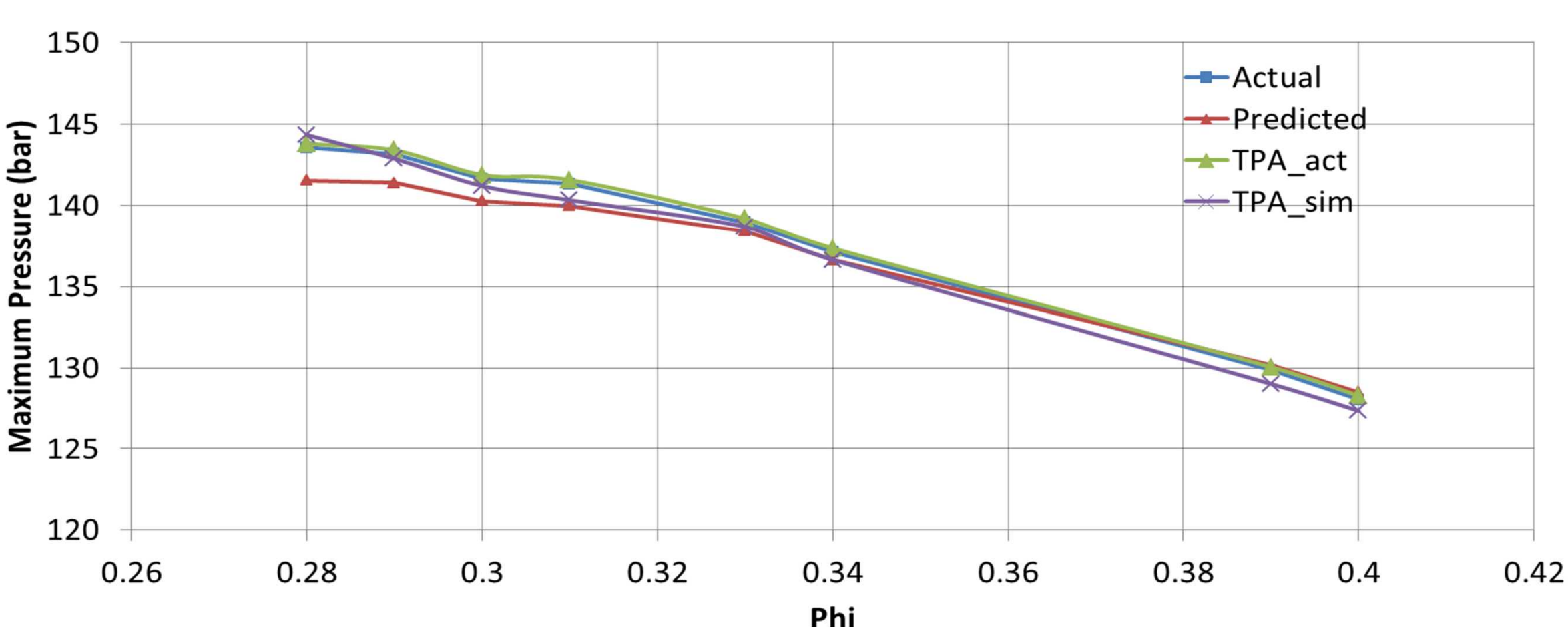


Model vs. experimental: (a) Average mass flow as function of speed (b) Peak pressure as a function of speed (c) BDC Temperature as a function of speed (d) Pressure as a function of crank angle at 1200 RPM



Methods & Results

- To calibrate the model under the motored condition, the air flow rate was first matched to measured data to ensure all flow restrictions and valve events were properly simulated.
- Next, the BDC Temperature was approximately matched to values predicted by older analysis, ensuring the accuracy of the heat transfer and cylinder flow models.
- Pressure traces were matched over a range of speeds to ensure correct model operation during the compression and expansion strokes.
- After verifying the model's accuracy at a variety of intake pressures and temperatures, model calibration for fired (fueled) conditions began.
- Because an exhaust gas recycling (EGR) loop is used experimentally to control combustion, this capability was added to the model. A fuel injector was also needed.
- Three-Pressure Analysis (TPA) allows modeling of combustion via experimental data, outputting a burn rate profile given profiles of intake, in-cylinder, and exhaust pressures.
- TPA data then models combustion in the LTGC engine to within 2% accuracy.
- Examples of data that can easily be determined from the model include: amount of residual gases, in-cylinder gas temperatures, heat transfer losses, and exhaust heat energy losses.



Fired Operation

Left: peak pressure versus equivalence ratio (ϕ)
Right: pressure trace at $\phi = .34$