**Motivation:**
Investigating the use of natural gas and derivative fuels in advanced combustion strategies is important in developing future engine systems capable of utilizing alternative fuel sources which can be both domestically and renewably produced.

Natural gas is naturally abundant as a low-carbon alternative to conventional liquid fuels, and can also be renewably derived through anaerobic digestion. With a mature supply infrastructure, natural gas is piped directly into many homes. Finally, due to its high resistance to autoignition, natural gas is an ideal fuel for high load and high efficiency applications.

**Experimental Setup:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Engine</td>
<td>Caterpillar SCOTIE</td>
</tr>
<tr>
<td>Bore x Stroke</td>
<td>137.2 mm x 165.1 mm</td>
</tr>
<tr>
<td>Connecting Rod Length</td>
<td>261.62 mm</td>
</tr>
<tr>
<td>Compression Ratio</td>
<td>14.91:1</td>
</tr>
<tr>
<td>Intake Valve Opening/Closing</td>
<td>353°/143° aTDC</td>
</tr>
<tr>
<td>Exhaust Valve Opening/Closing</td>
<td>130°/355° aTDC</td>
</tr>
<tr>
<td>Swirl Ratio</td>
<td>0.7</td>
</tr>
<tr>
<td>Piston Bowl Type</td>
<td>RCCI / CDC</td>
</tr>
<tr>
<td>DI Holes Number</td>
<td>7</td>
</tr>
<tr>
<td>DI Holes Diameter</td>
<td>141 µm</td>
</tr>
<tr>
<td>DI Included Spray Angle</td>
<td>140°</td>
</tr>
</tbody>
</table>

**Projections:**

Comparison of DPI1 and RCCI2 in a Heavy-Duty Engine:

- **Experimental Conditions:**
  - Engine Speed: 1300 rpm
  - IMEP: 6 bar nominal
  - Total Fuel Energy: 3500 J/cycle
  - Methane Energy %: 85%
  - F76 Energy %: 15%
  - Equivalence Ratio Φ: 0.5 to 0.72
  - Intake Pressure: 1.0 to 0.75 bar
  - Intake Temperature: 40°C
  - DI Injection Pressure: 1000 bar
  - EGR Rate: 0%
  - DI (Reactive) Fuel: Methane
  - DPI (Less-Reactive) Fuel: F76
  - DI Injection Timings: Vary to Fix CA50 @ 6° aTDC

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**Funding Sponsors:**
Direct-Injection Engine Research Consortium

Walker et al., ASME 2015 Internal Combustion Engine Division Fall Technical Conference, No. ICEF2015-1128

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**References:**
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- 2010 U.S. EPA HD Limit
- Aucott & Melillo, 2013
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  - Walker et al., ASME 2015 Internal Combustion Engine Division Fall Technical Conference, No. ICEF2015-1128
  - Management of Natural Gas and Derivative Fuels for Advanced Dual-Fuel Combustion Strategies

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