LES of Direct-injection Spark-ignition Engine Spray and Flow Variability

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Motored Engine Simulations

Transparent Combustion Chamber (TCC) Engine
- Fully transparent cylinder with an optical piston
- Pancake-type combustion chamber
- Simplified port geometry with large intake/exhaust plenums
- Fully instrumented with pressure transducers at plenum inlet/outlet, in intake/exhaust ports and in the cylinder
- Two computational meshes: full domain & runners-only

- Circular standard deviation shows variability due solely to changes in flow direction, regardless of magnitude
- Shows high RMS primarily due to changes in flow magnitude cycle-to-cycle

Spray Uncertainty Quantification

Sprays also subject to shot-to-shot variations
- Use spray model initial/boundary conditions to incorporate variability and uncertainty
- Many possible parameters; 4 (2 numerical, 2 physical) chosen for initial study

<table>
<thead>
<tr>
<th>Input Variable</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Nominal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>KH Time Constant</td>
<td>10</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>RT Break-up Length</td>
<td>1.0</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Injection Duration (μs)</td>
<td>716</td>
<td>816</td>
<td>766</td>
</tr>
<tr>
<td>Spray Axis Angle (°)</td>
<td>22.5</td>
<td>27.5</td>
<td>25</td>
</tr>
</tbody>
</table>

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