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A Brief Introduction to Ducted Fuel Injection

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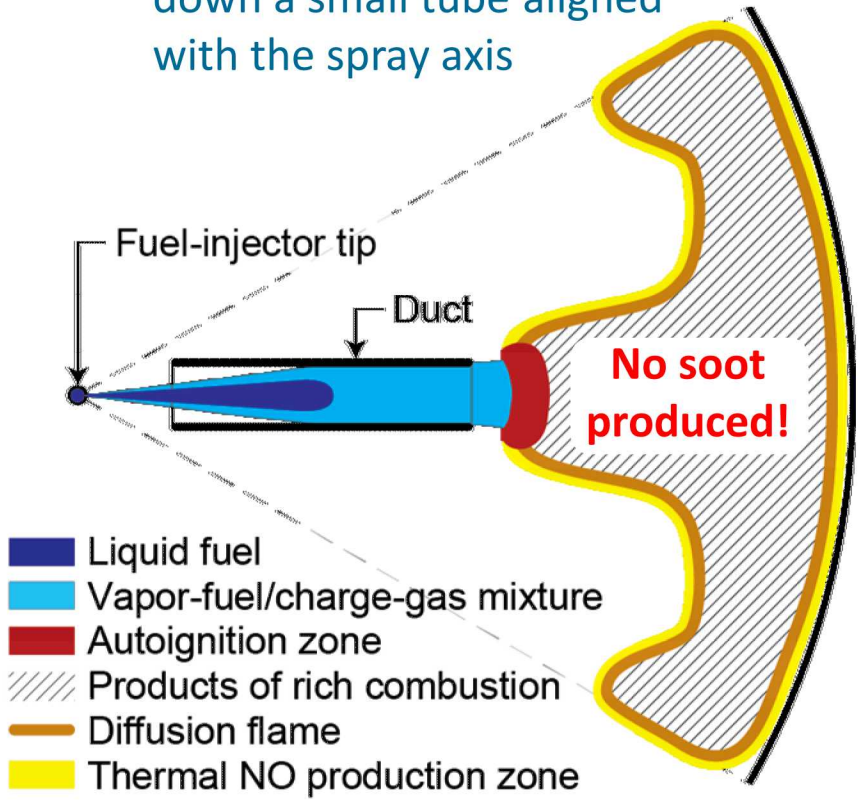
Ducted fuel injection (DFI) can enable mixing-controlled CI combustion that doesn't form soot

Basic idea: inject the fuel spray down a small tube aligned with the spray axis

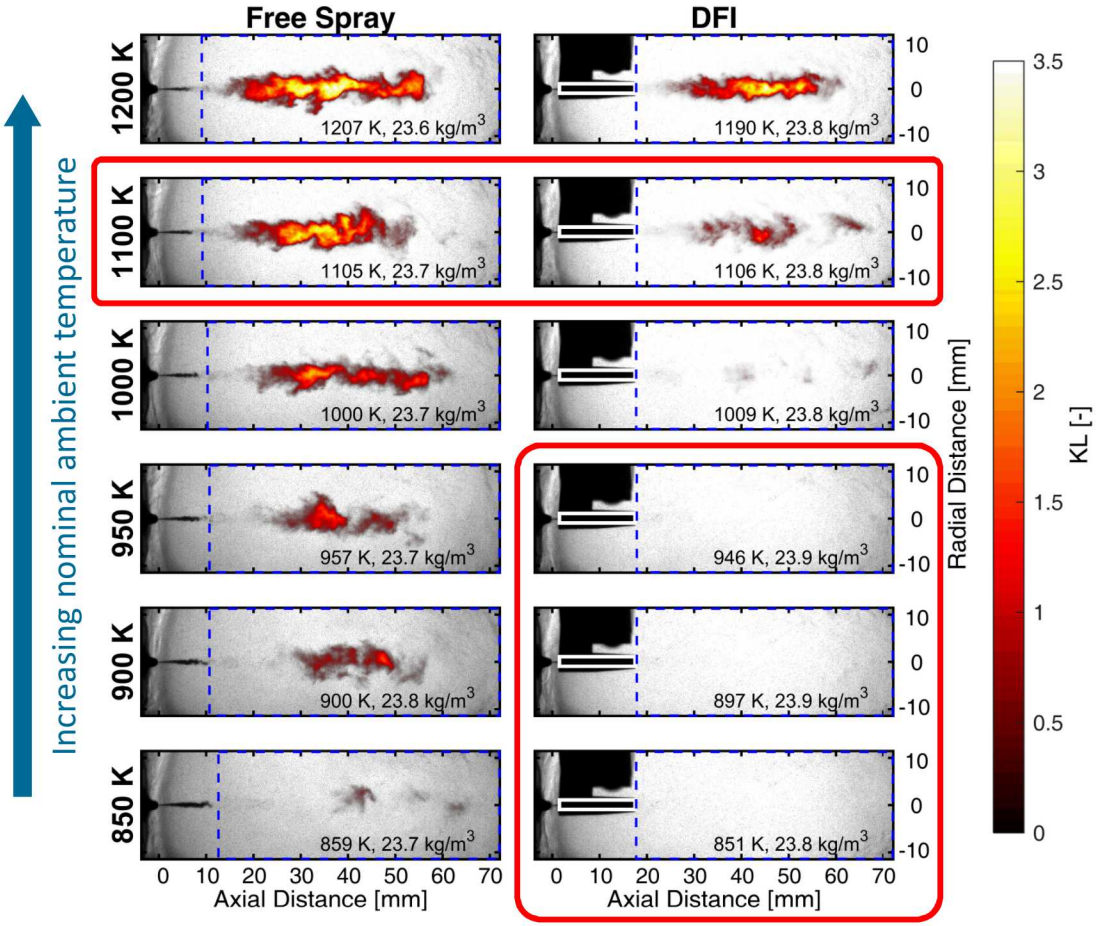
- **DFI enhances mixing before autoignition**
  - If $\phi < 2$, soot formation is prevented
- **Simple, mechanical approach**
  - Motivated by Bunsen burner concept
  - Modifies mixture, T, & velocity fields
- **Effective at eliminating soot over a range of conditions**
- **Tolerant to dilution for NO_x control**
- **Should be fuel-flexible (like CDC)**
  - Fuel oxygenation is likely to enlarge the viable non-sooting operating range



Mueller et al., doi:10.1016/j.apenergy.2017.07.001

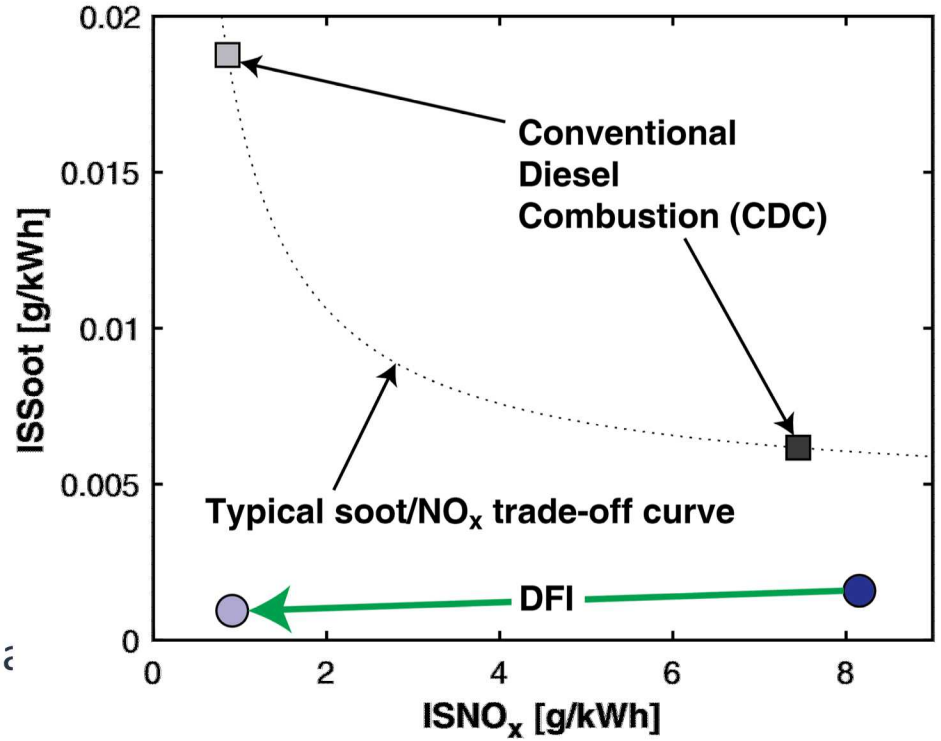
DFI curtails or eliminates soot production.

- **Initial experiments conducted in constant-volume combustion vessel**
  - n-dodecane fuel
- **Soot levels are clearly lower with DFI**
  - No soot for $T \leq 950$ K
  - Substantial attenuation for $T > 950$ K
- **That's great, but can DFI work in an engine?**



Engine results: DFI with dilution can break the long-standing diesel soot/NO_x trade-off.

- **Conducted experiments with & without DFI**
  - 2 × 0.110 mm injector tip
  - No. 2 S15 diesel certification fuel
  - 21 mol% & 16 mol% oxygen
  - Ducts with 2 mm ID, 12 mm long
- **DFI with dilution lowers soot & NO_x emissions simultaneously**
  - Unclear where the dilution benefit will end
  - Changes in other emissions & therma efficiency are small



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