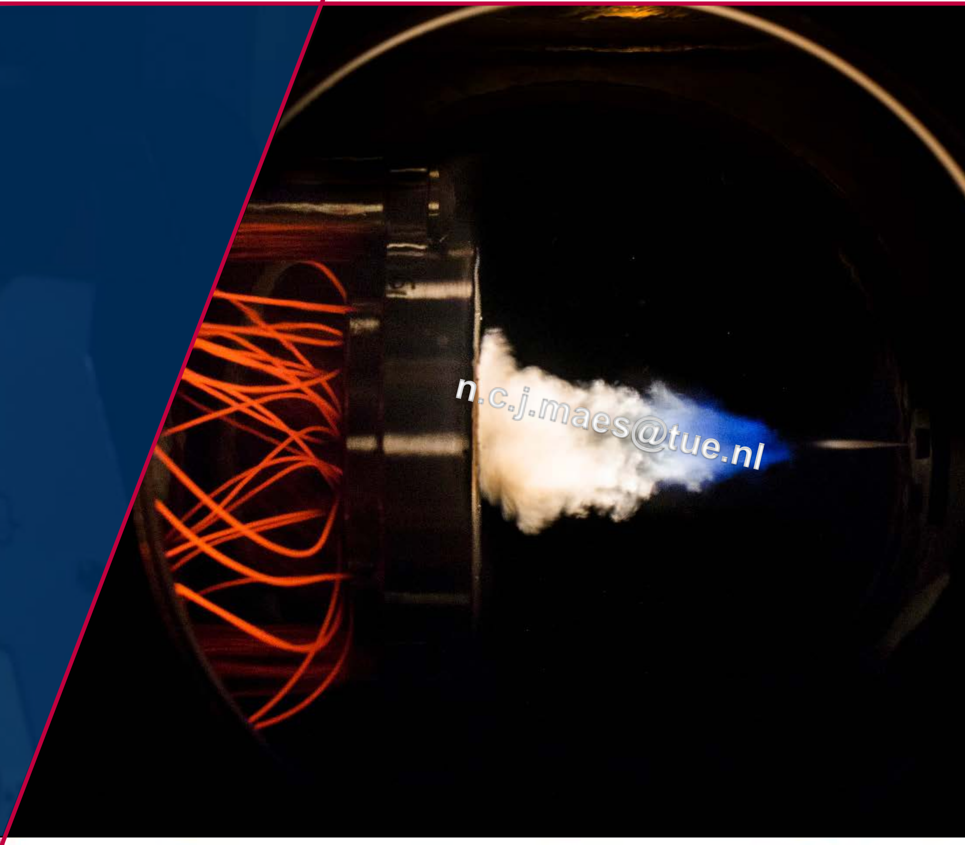
Comparison of Spray C & D reacting experimental data

IFP – SNL – CAT – TU/e

Noud Maes*, Scott A. Skeen, Michele Bardi, Russell P. Fitzgerald, Louis-Marie Malbec, Gilles Bruneaux, Lyle M. Pickett, Koji Yasutomi, Kenth Svensson, Glen Martin, …

n.c.j.maes@tue.nl



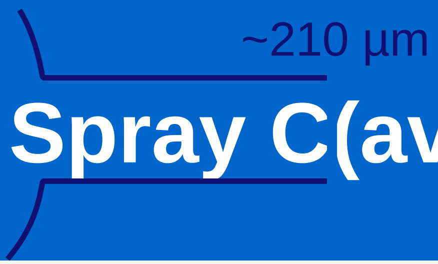
Technische Universiteit Eindhoven University of Technology

Where innovation starts

Content

- Recap: experimental comparison of heavy-duty sprays in the ECN
  - Spray C(avitating) & Spray D
- Combustion indicators
- Analyzing soot for large-orifice injectors
- An alternative soot analysis
- Why we can’t say that Spray C produces more soot than Spray D

Heavy-duty in the ECN → Spray C(avitating) & Spray D



- **Several publications by CMT and SNL;**
  - **Payri 2016 (Fuel), Payri 2016 & Gimeno 2016 (Energy conversion and management), Pastor 2018 (SAE), Westlye 2016 (SAE), Daly 2018 (SAE), (+ geometries! Matusik 2018 (IJER))**
- **Whats new? → Characterization & comparison with T-variations at IFP, SNL & CAT**
  - **Spray & liquid pen., combustion indicators (pressure & OH*), and soot!**

Table 1: Fuel injection equipment details and soot extinction system features for experiments performed at IFP, Sandia and Caterpillar. Double values, when presented, represent independent entries for Spray C and Spray D.

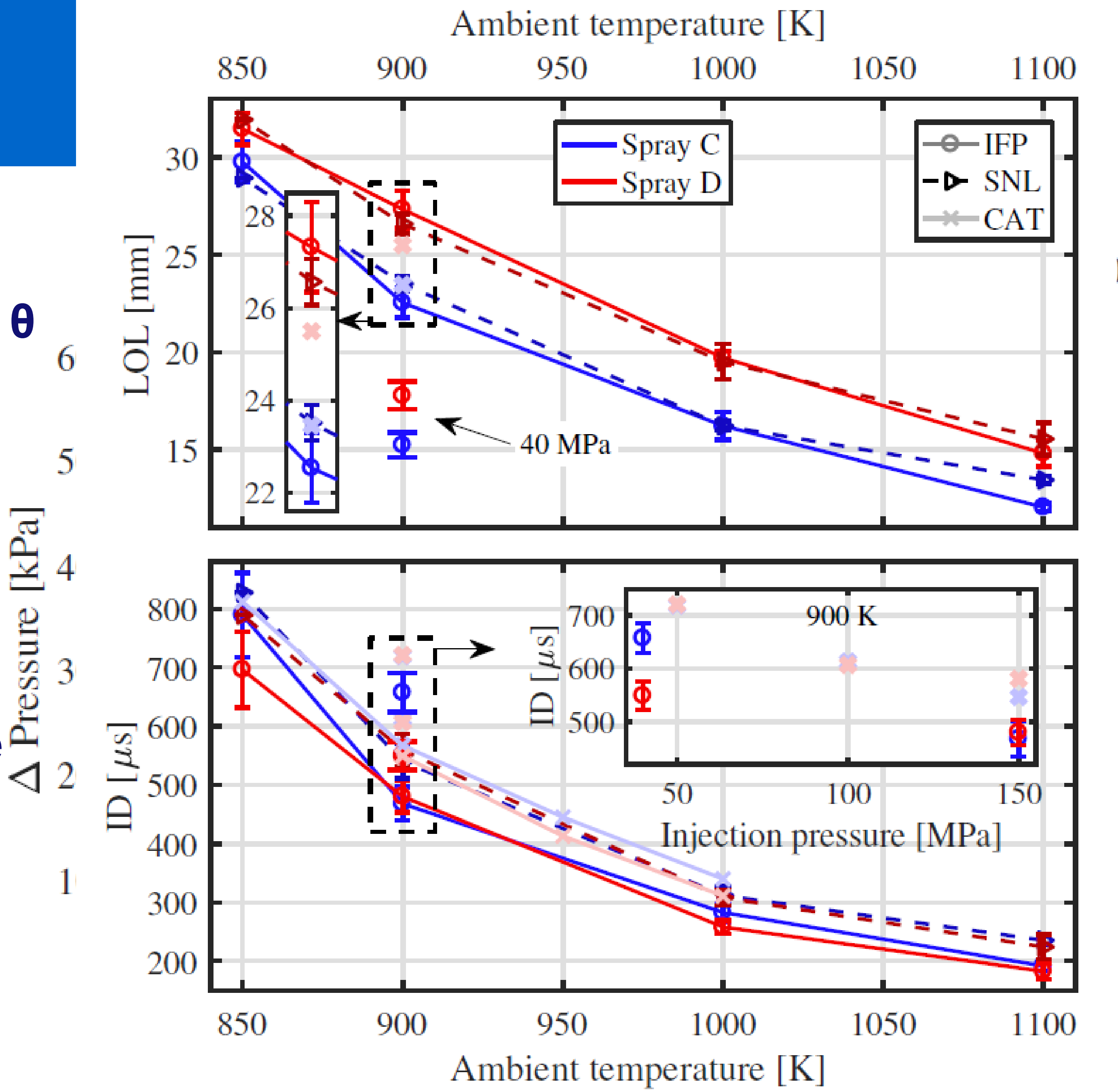
	Sandia	Caterpillar	IFP
Injectors	C037 & D134	C037 & D134	C003 & D135
Injector driver	Genotec	Labview driven	EFS IPoD
Mass flow [g/s][a]	10.10 & 11.95	10.10 & 11.95	10.26 & 11.49
Orifice diameter [μm][a]	208 & 191	208 & 191	212 & 190
Hydraulic delay [μs][b]	361 & 380	400	440
Light source [nm]	850 - LED	623 - LED	810 - Laser
Extinction coefficient k_e [-]	5.0	7.2	5.5
Filtering [nm]	OD2.3, 850±5	OD1.8, 623±5	OD2, 810±2
Camera	Phantom V2512	Phantom V2512	Photron SA-Z
Maximum FOV [mm]	70	73	67

[a] Values from Payri et al. [36].
[b] Values do not vary between injectors for identical injector driver and driver settings according to Payri et al. [36].

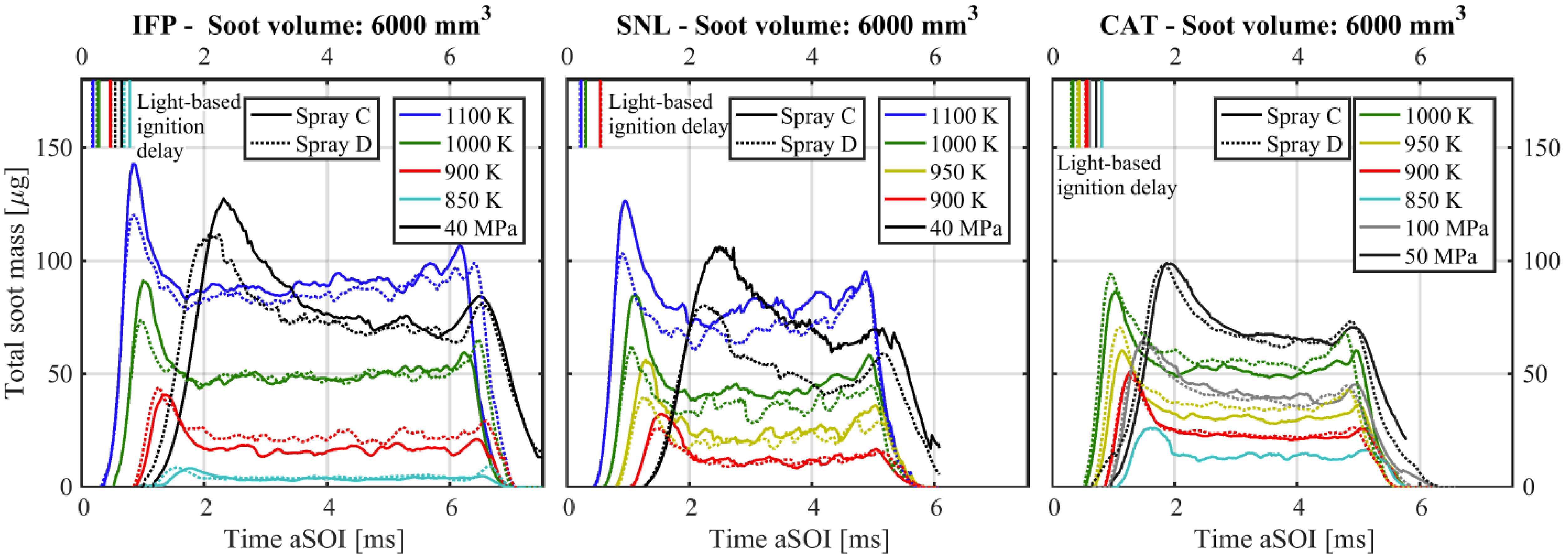
For reference!

Combustion indicators

- **LOL; decent agreement**
  - **~3 mm shorter due to increased θ**
- **Ignition delay shorter at IFP**
  - **More sensitive optical system?**
- **Pressure-based ID:**
  - **Really similar, if anything;**
  - **SNL slightly shorter than IFP!**
  - **Note evap. cooling resemblance**

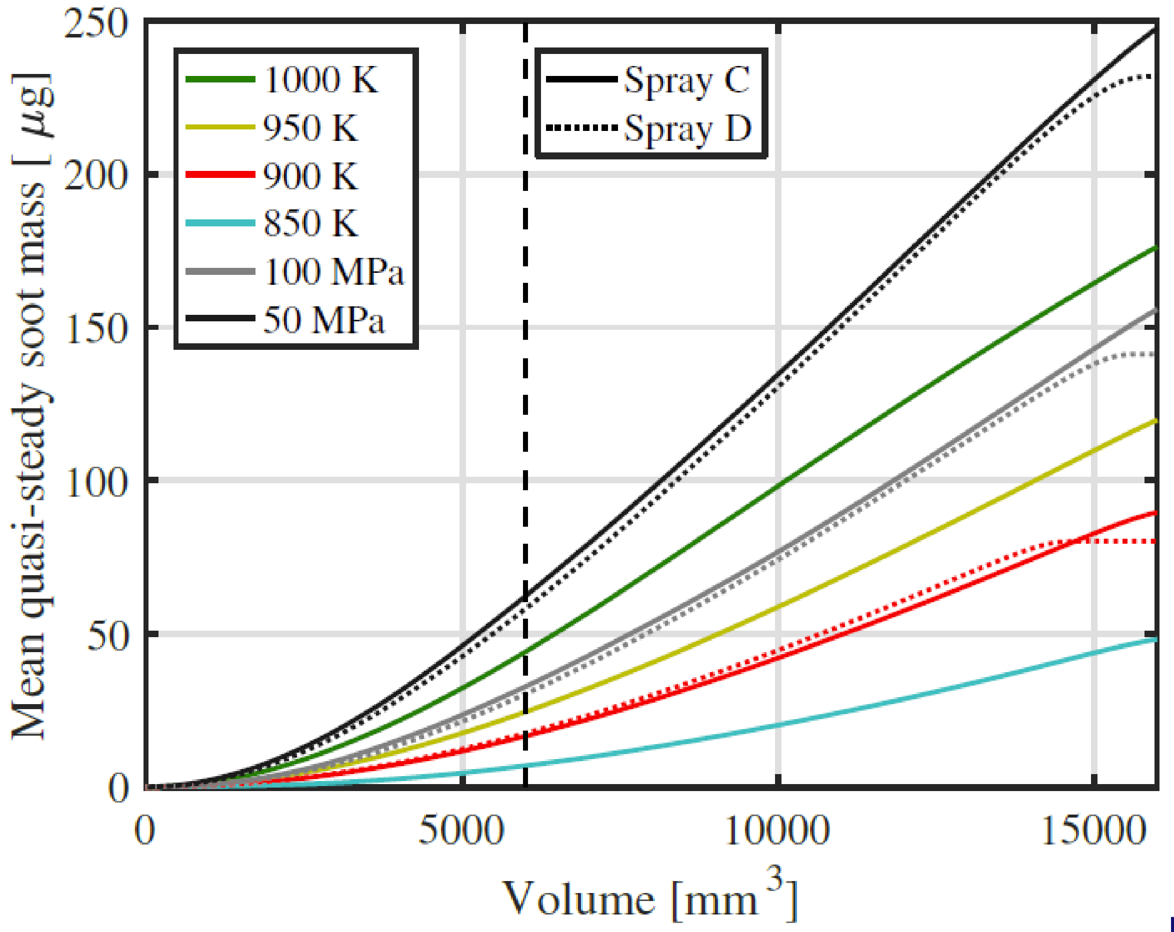


Analyzing soot for large-orifice injectors



Analyzing soot for large-orifice injectors

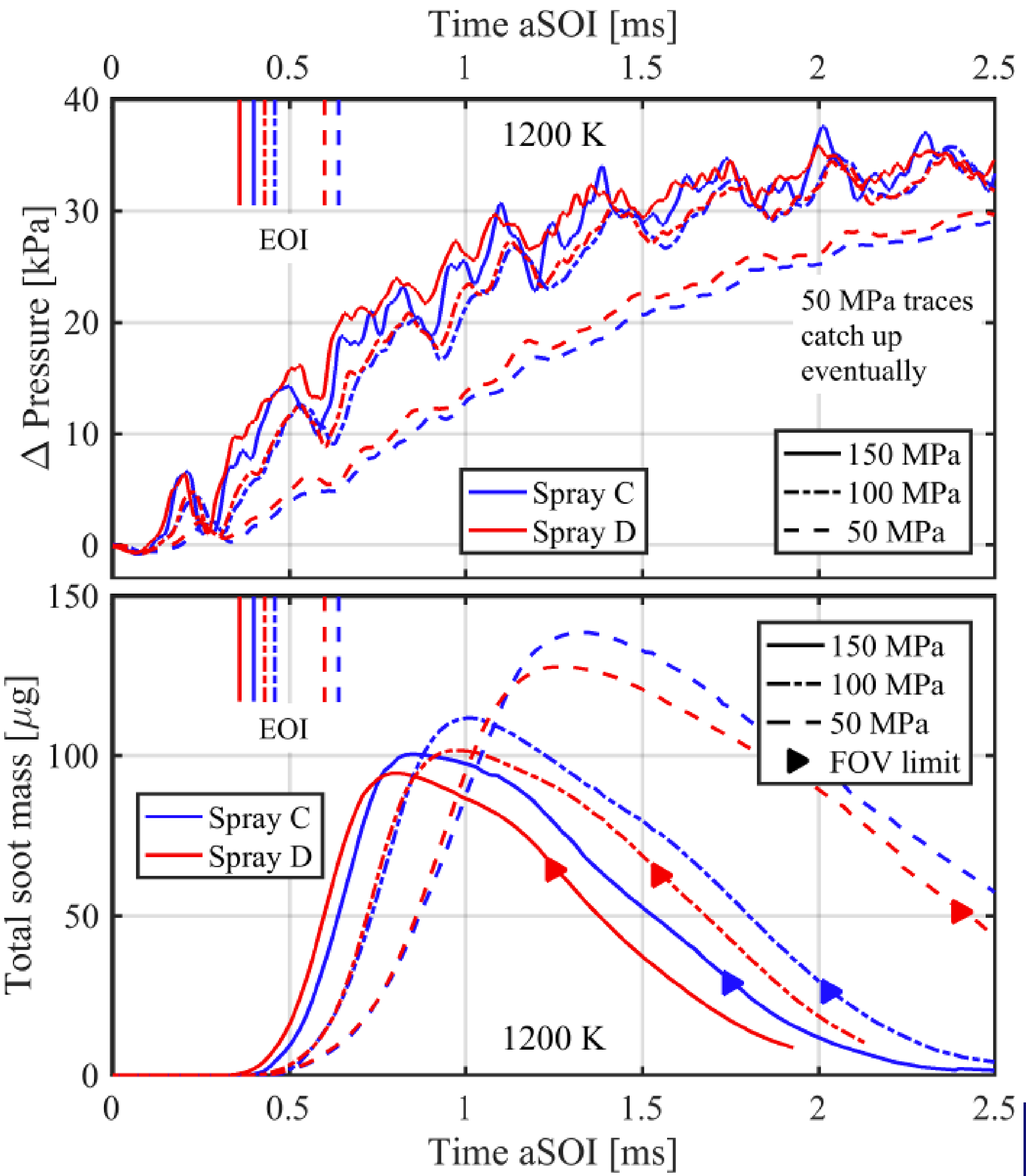
- **In the paper, more details on how soot depends on volume**
- **(Thanks to large CAT windows!)**
- **→ easy to extrapolate data over a relatively large range**



An alternative soot analysis

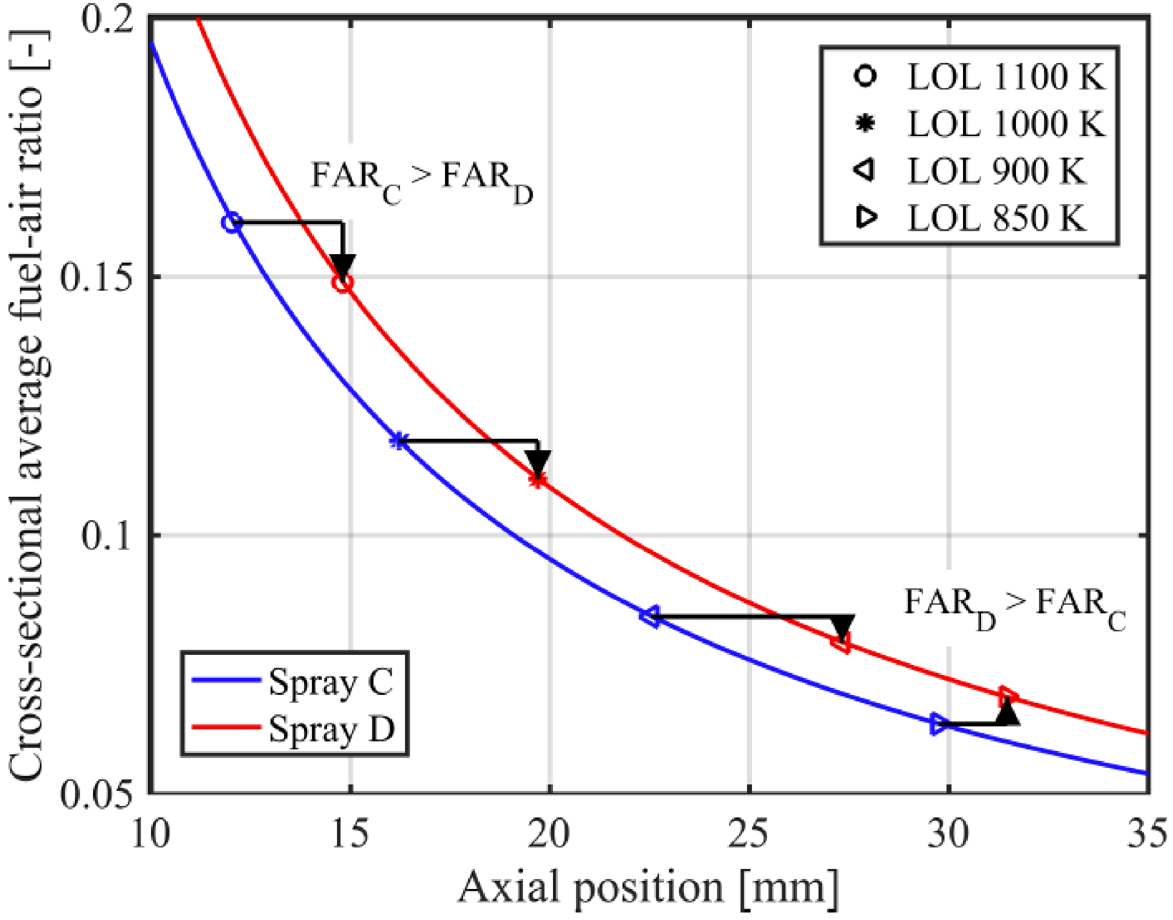
- **SNL short injections**
  - **1200-K ambient, 50-100-150 MPa inj.**
  - **Fuel mass matched by Δp!**

- **Spray C produces more soot**
  - **Low injection pressure;**
    - **Later onset, slow burn-out**
    - **Higher peak-soot**



So Spray C produces more soot?

- **Spray D starts to produce more soot at lower temperatures…**
- **Lift-off region of Spray D is fuel rich compared to Spray C at 850 K!**
- **Improved mixing for Spray C is only advantageous at low reactivity!**



Questions? – n.c.j.maes@tue.nl