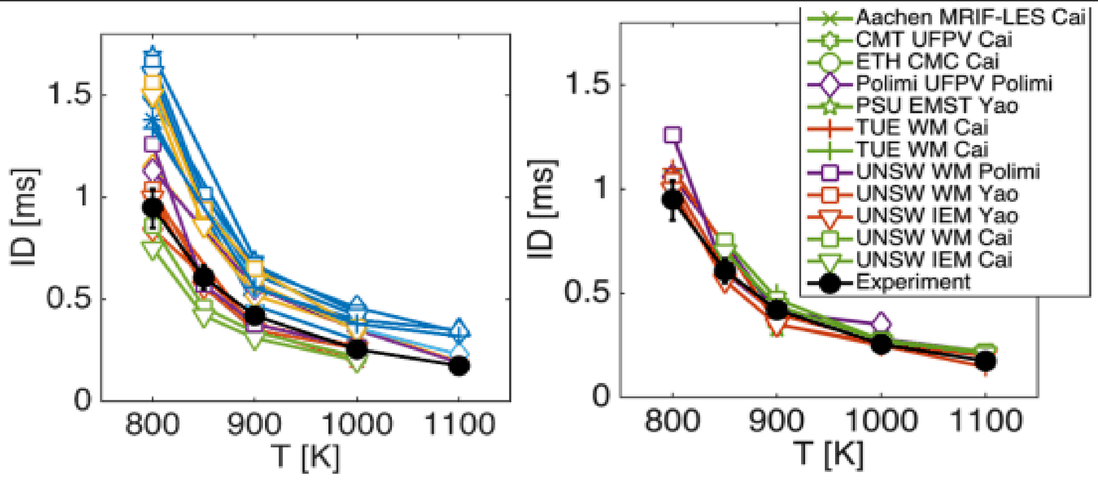
SAND2018-7765C

Sandia National Laboratories

Design of Thermocouple Probes for Temperature Field Measurements in Combustion Engines

Motivation

- Simulations aren't perfectly predictive
- Experimental results exhibit different behavior between different ECN facilities



Ignition delays between different ECN

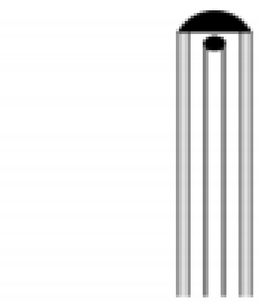
Project Introduction

- Other ECN facilities use temperature measurement techniques with challenges such as O2 quenching or requiring calibration expensive

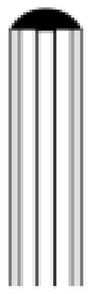
Method	Temperature range Min / Max(°C)	Response / transient capability	Accuracy	Commercially available / relative cost
Rayleigh scattering	20 / 2500	Very fast / no	1%	No / very high
Raman scattering	20 / 2227	Very fast / no	7%	No / very high
CARS (Coherent Anti-Stokes Raman Scattering)	20 / 2000	Fast / NA	5%	Yes / very high
LIF (Laser Induced Fluorescence)	0 / 2700	Very fast / no	10%	No / very high
Thermographic phosphors	-250 / 2000	Very fast / yes	0,1%-5%	Yes / high

Temperature measurement techniques

- Consists of 2 connected wires of different metal with a voltage between them proportional to temperature



UNGROUNDED JUNCTION



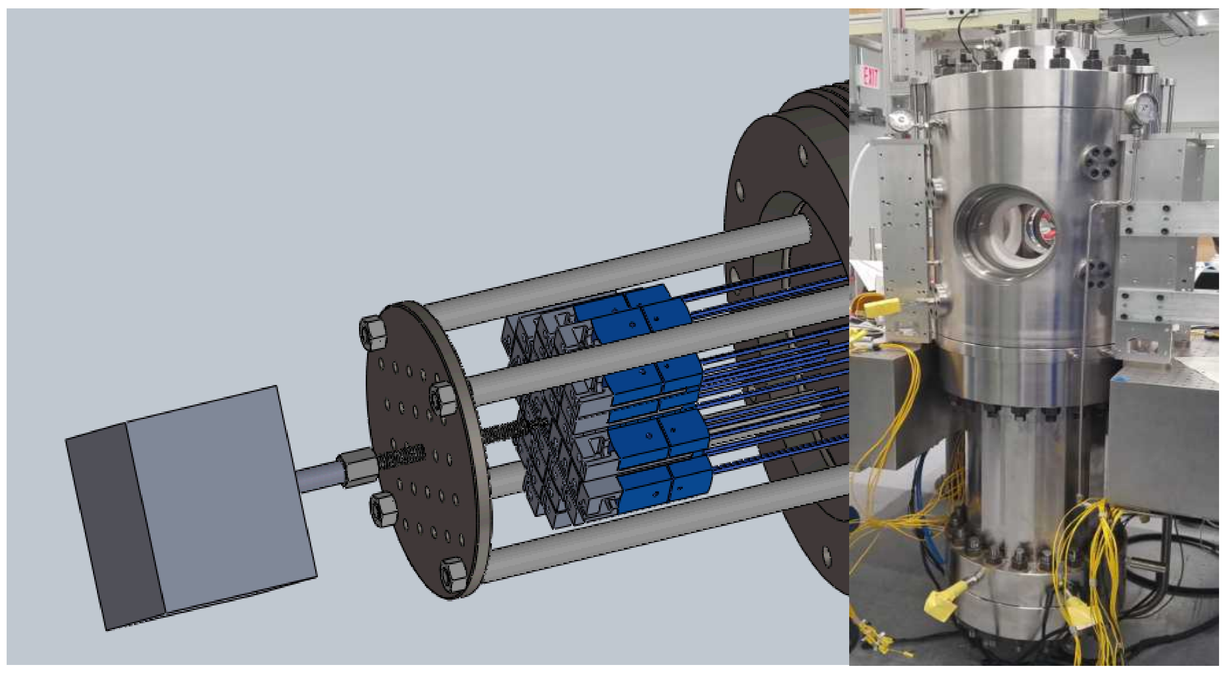
GROUNDED JUNCTION

- Low-cost with fast response

Invasive method	Temperature range Min / Max(°C)	Response / transient capability	Accuracy	Commercially available / relative cost
Thermocouple	-270 / 2300	Very fast / yes	±0.5-±2°C	Yes / very low

Design Why

- Automating thermocouple insertion enables user to not have to stand in front of vessel while pressurized
- More accurate temperature measurements through numerical positioning (as compared to eyeballing)
- Finds positions of interest more easily



Methods

- Used stepper motor and threaded rod to automate thermocouple movement
- Raspberry Pi & python script to control movement
- Rotating the threaded rod using motor allows for linear translation of the thermocouple
- Only one needs to be automated; used to find positions of interest while vessel is pressurized
  - Other thermocouples can then be moved as needed for taking measurements

References

- Experimental Temperature/Velocity Control and Implications for CFD.
- Meijer, Maarten, et al. "Engine Combustion Network (Ecn): Characterization And Comparison Of Boundary Conditions For Different Combustion Vessels." Atomization and Sprays, vol. 22, no. 9, 2012, pp. 777–806., doi:10.1615/atomizspr.2012006083.

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