King Abdullah University of Science and Technology

KAUST

Preparation for ECN spray D/A and spray G study

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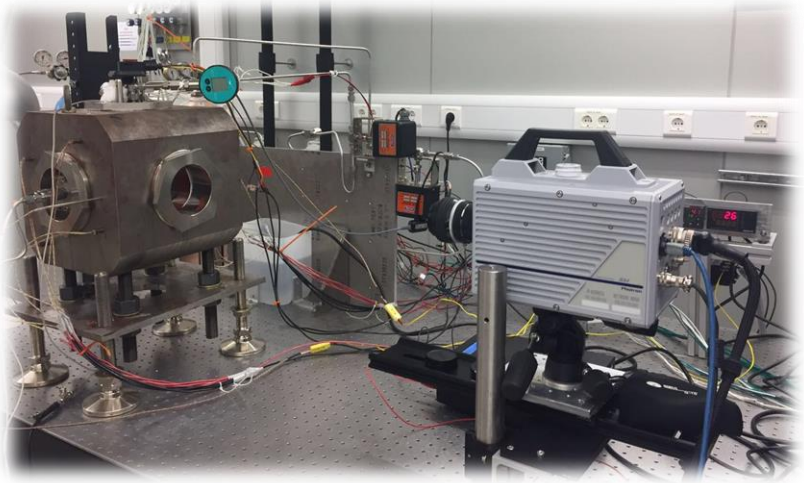
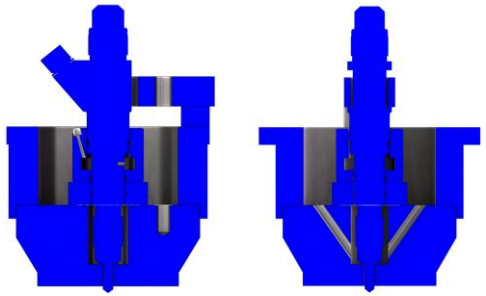
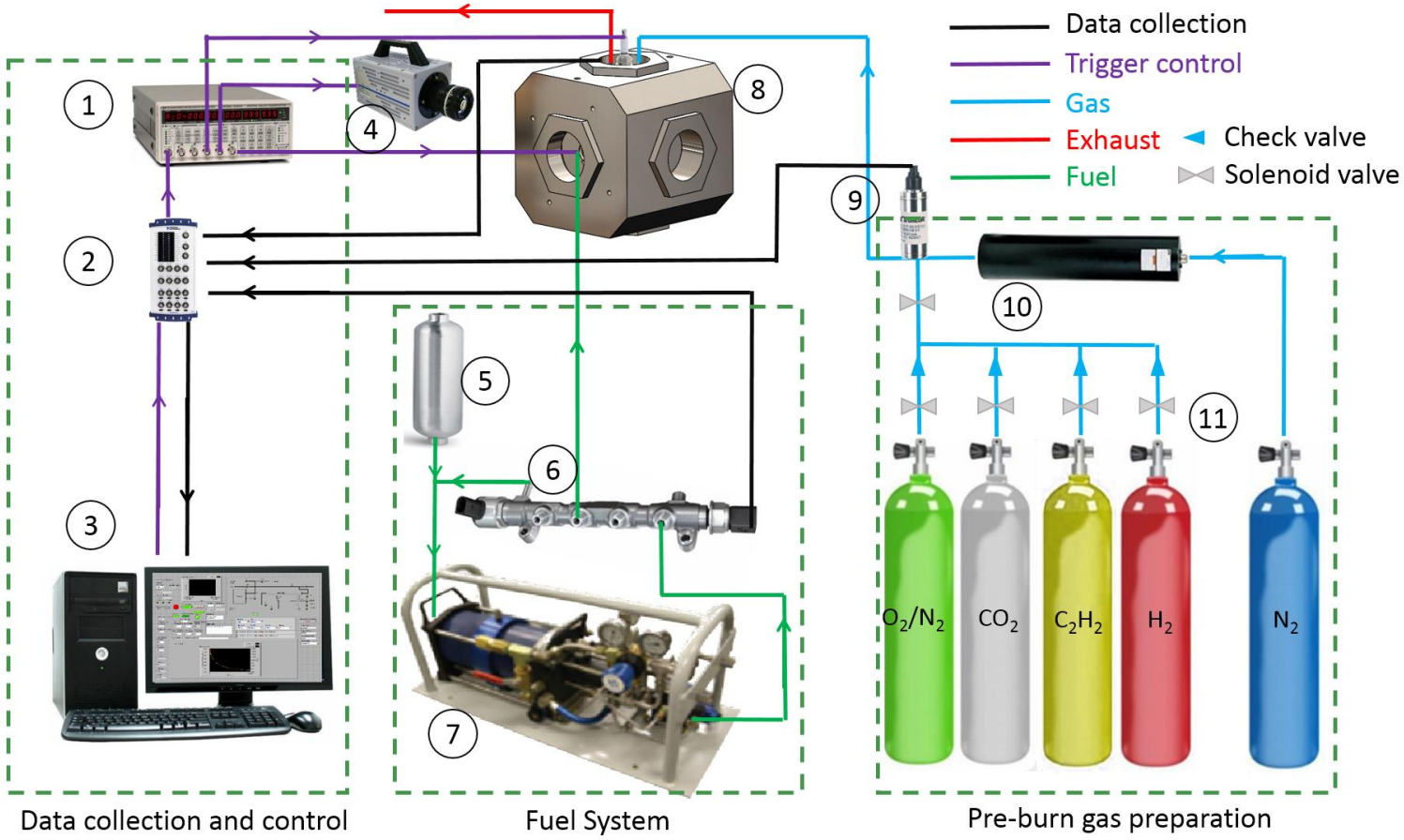
Control of spray conditions

- Injector activation: NI DIDS2003 driver;
- Injection pressure: Air driven liquid pump which can work from 100 bar to 4000 bar; Motor driven common rail system which can work up to 1800 bar; Kistler 4067E3000 pressure sensor for measuring static and dynamic injection pressure (3000 bar).
- Fuel temperature: Cooling jacket with heat exchanger
- Ambient gas components: H_2, C_2H_2, O_2, N_2 or H_2, C_2H_2, O_2, N_2, CO_2
- Ambient gas pressure: Kistler 6041B pressure sensor
- Ambient gas temperature: 75 micron R type bare wire thermocouple
- Rate of injection: Bosch method (being built) and Momentum flux method

Fuel temperature & Gas filling



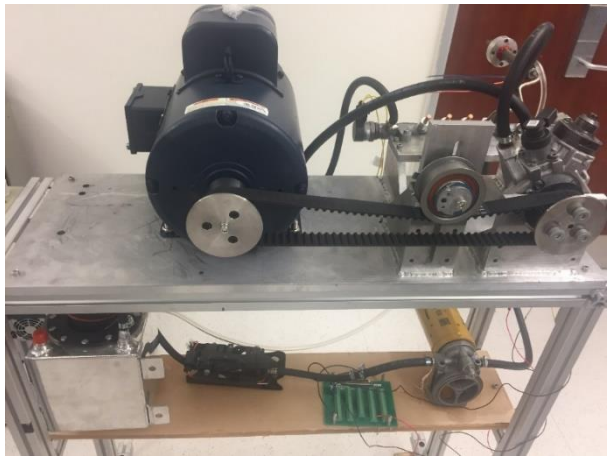


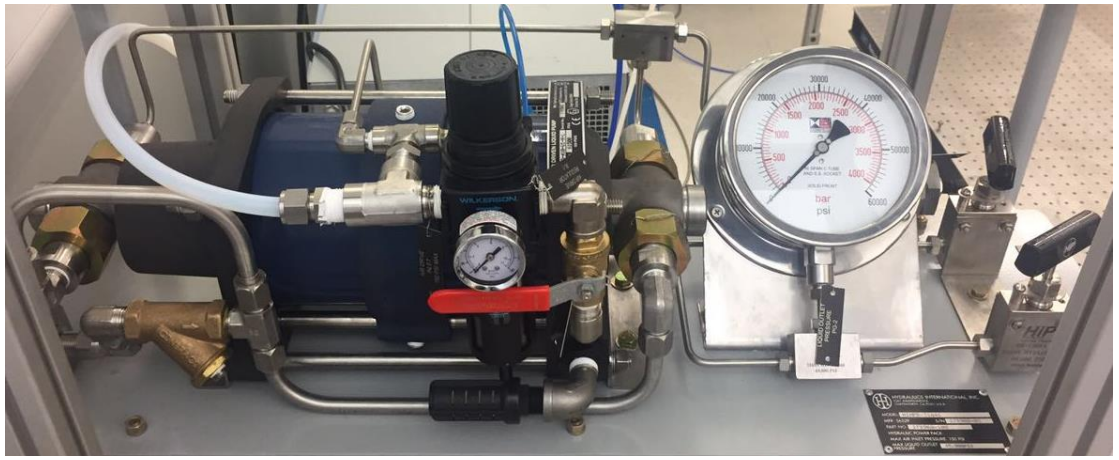


Gas components	H2	C2H2	O2	N2	CO2
%	3	5	14	14	64

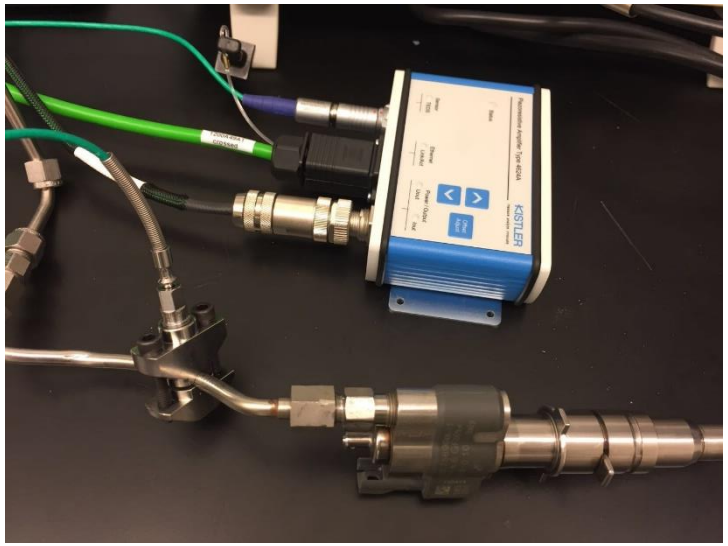
Injection pressure

- Common rail system and Air driven liquid pump





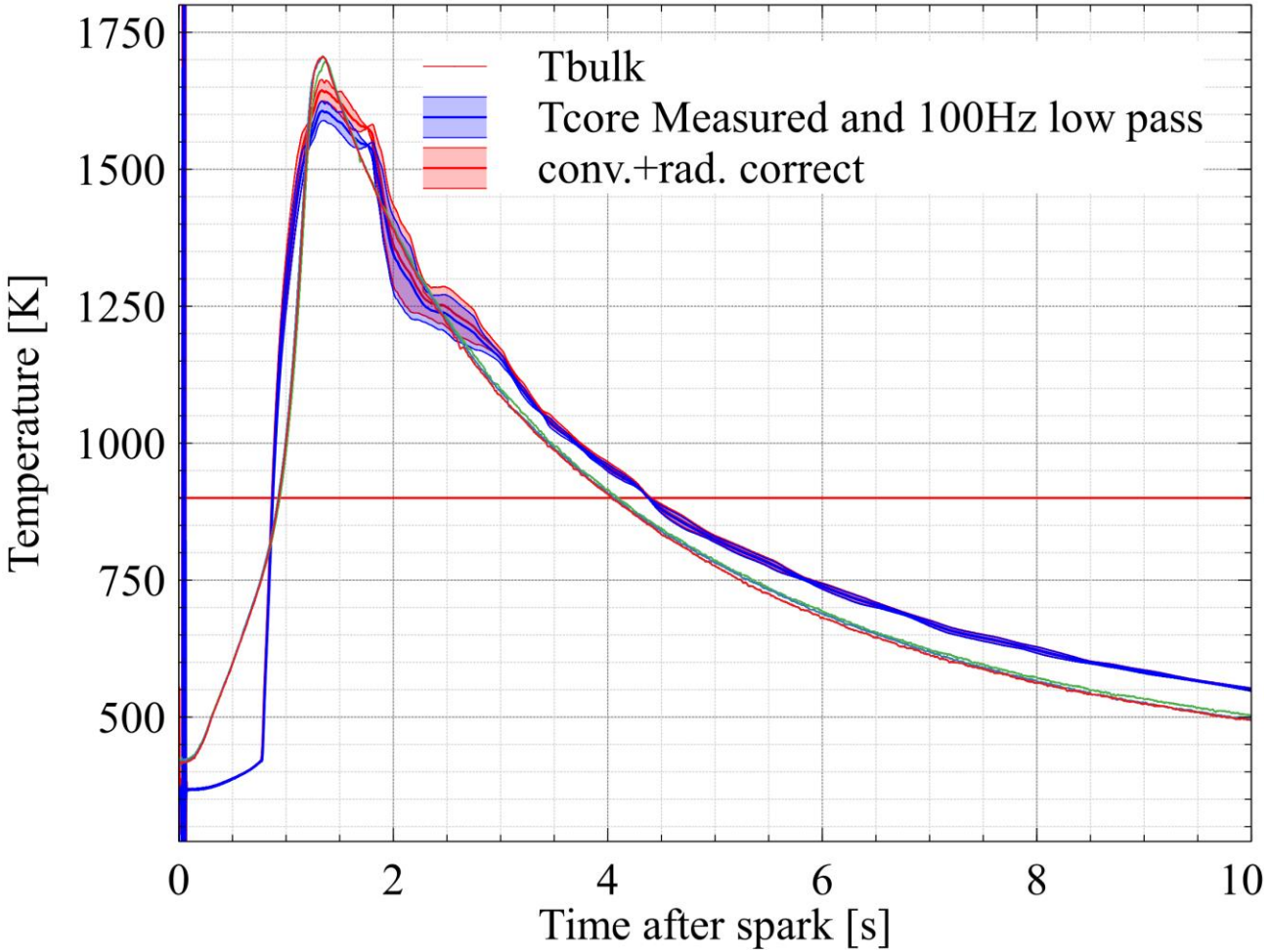
- Injection pressure sensor



Spray D/A

Spray D/A Pre-burn T measurement

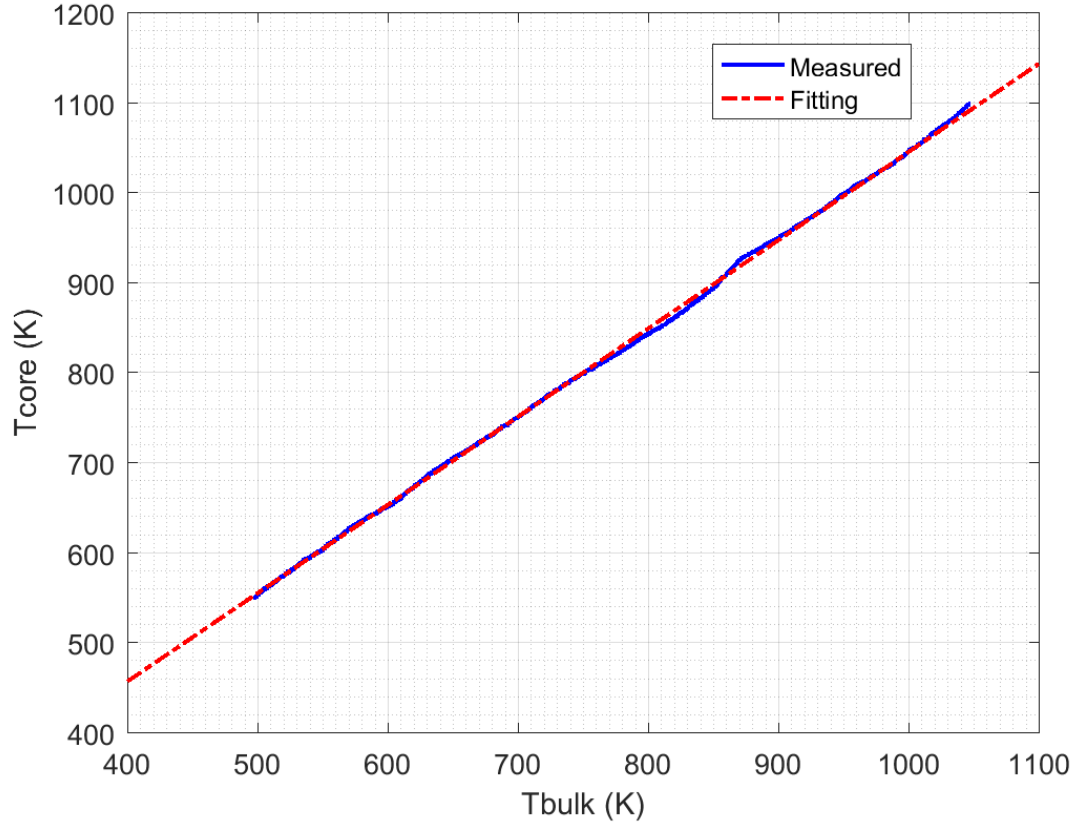
Gas components	H2	C2H2	O2	N2	CO2
%	3	5	14	14	64

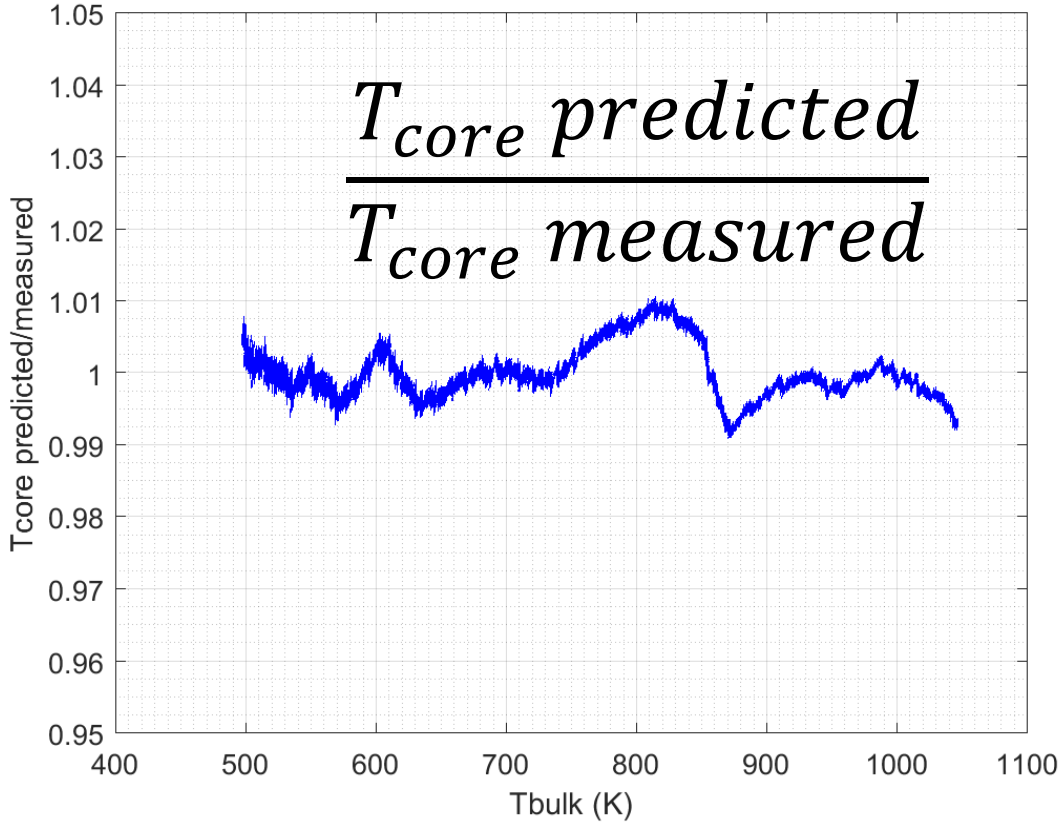


75 micron R type thermocouple
Measured position: axial 60 mm from nozzle
X = 60 mm; Y = 0 mm; Z = 0 mm

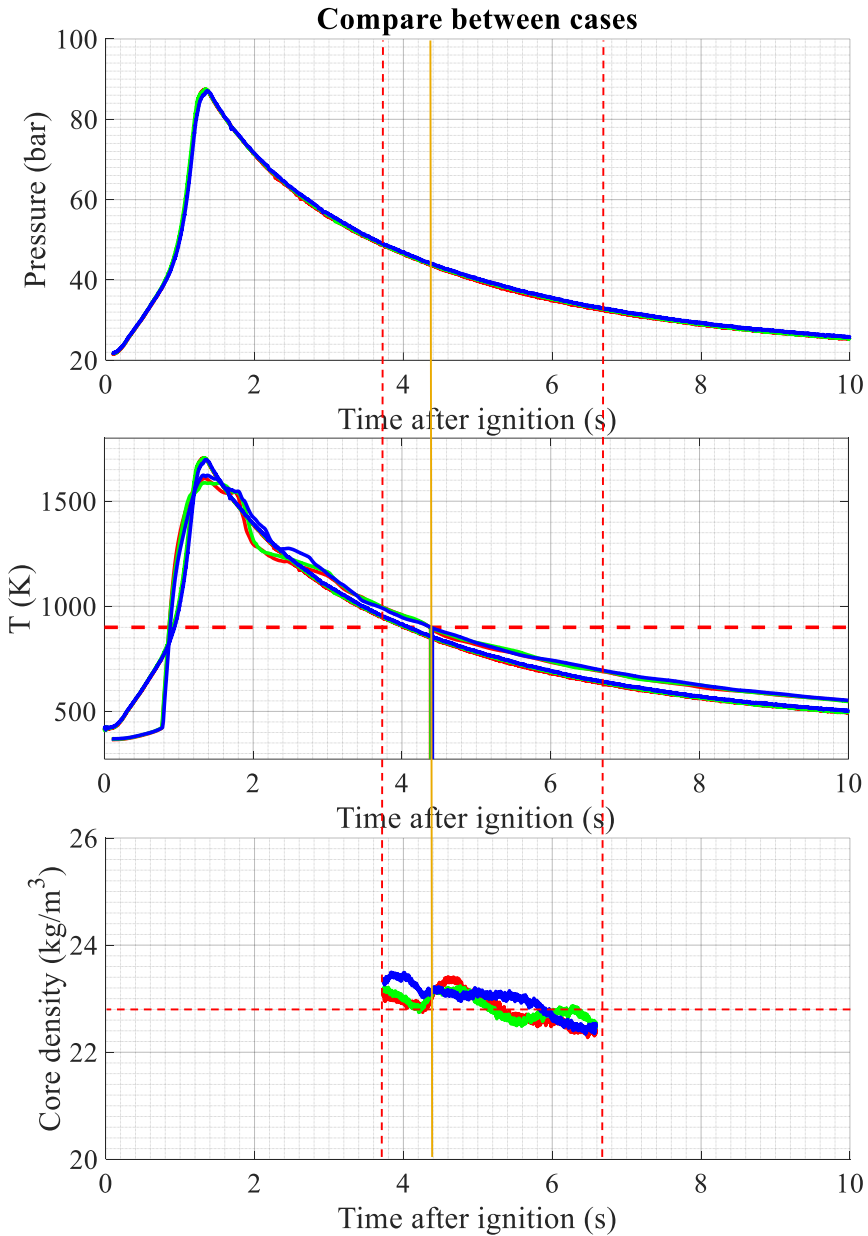
0% O_2 combustion products
24.37 kg/m^3 Bulk density
22.8 kg/m^3 Core density
900K Core temperature

Spray D/A Prediction of core T from bulk T





Spray D/A Core density



ECN spray A : O_2 left =0%

Core density =22.8 kg/m3 ; Core temperature=900K;

← Bulk density set at 24.37 kg/m3

900 K

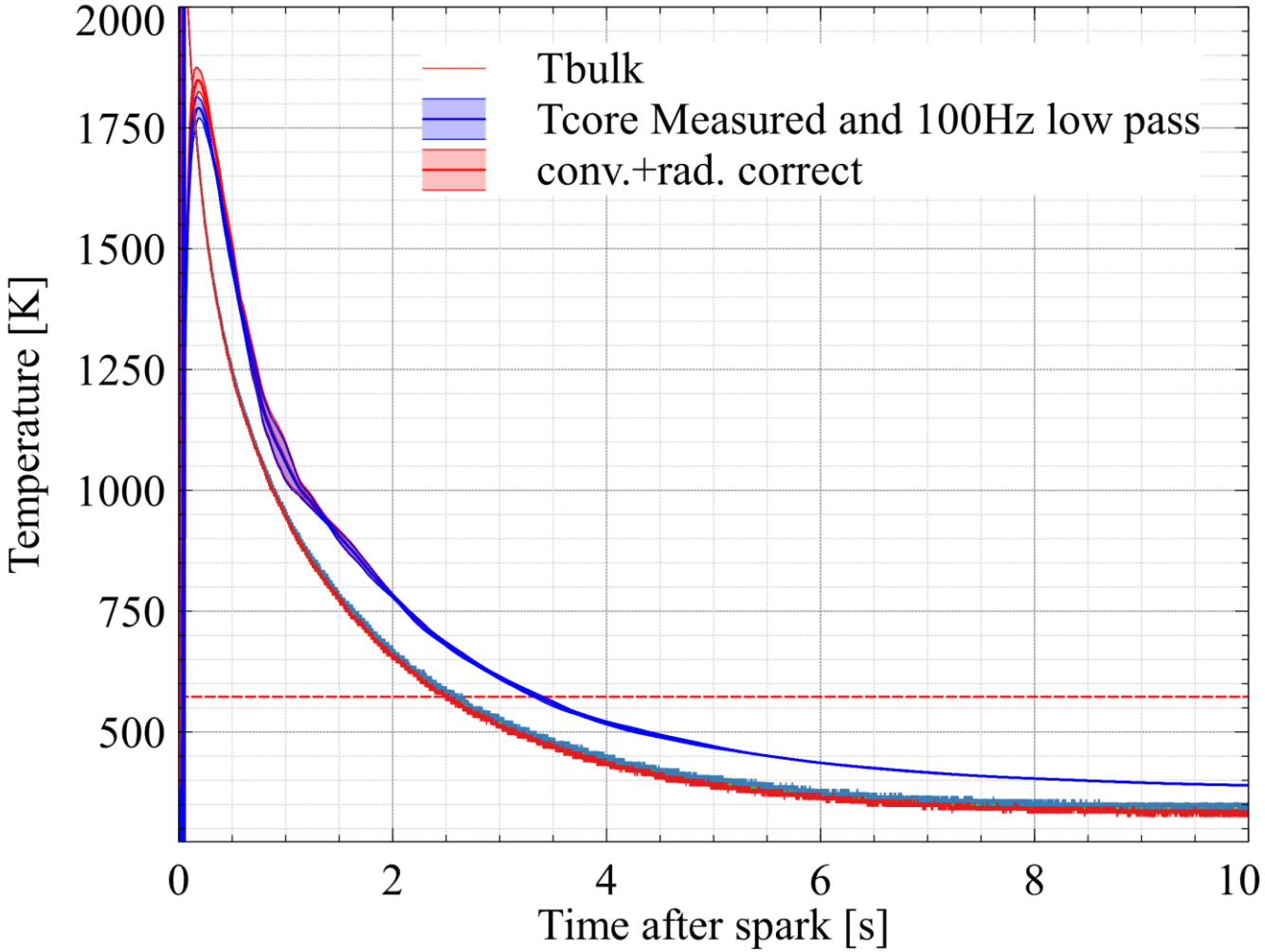
22.8 kg/m3 →

Mean core density= 22.8 kg/m3,
averaged on: from Tcore 1000 K to 700 K

Spray G

Spray G Pre-burn T measurement

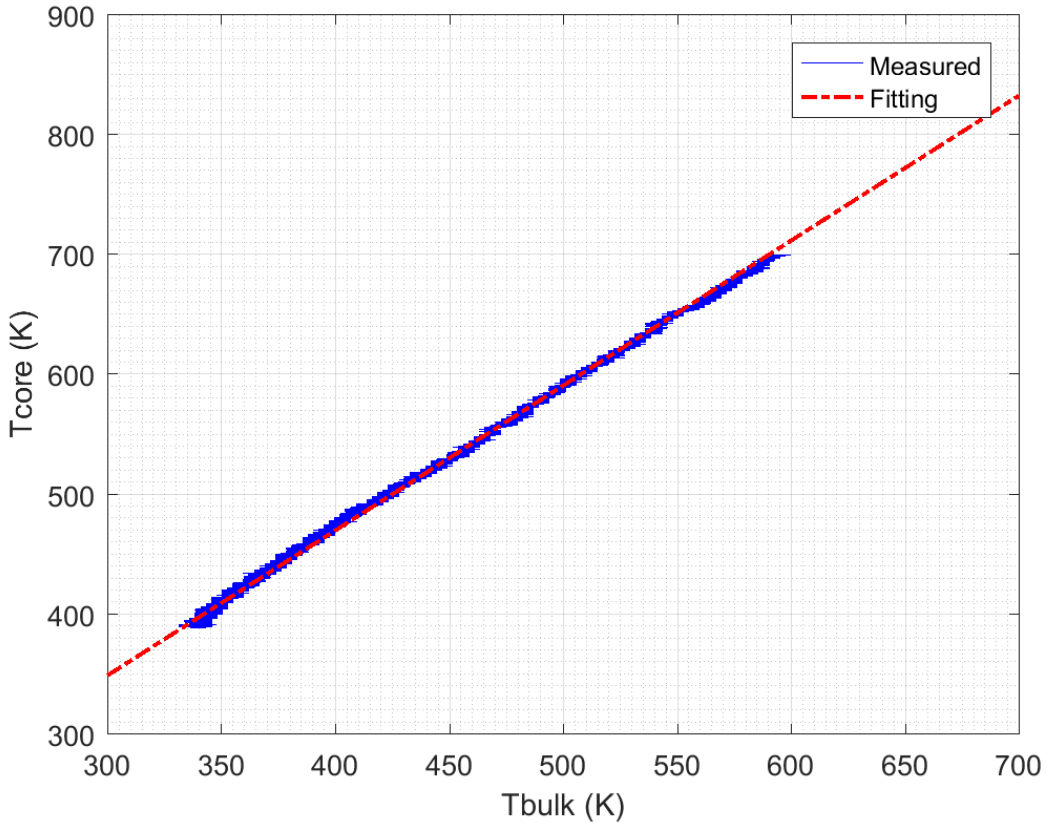
Gas components	H2	C2H2	O2	N2
%	3	5	14	78

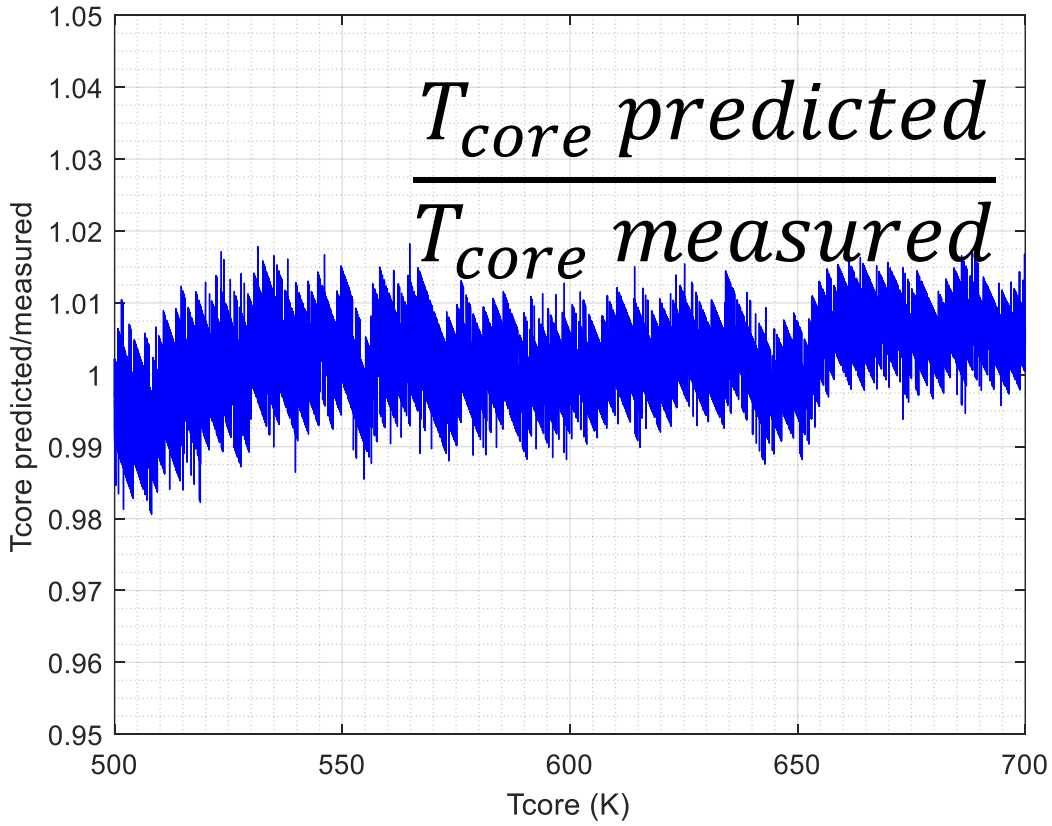


75 micron R type thermocouple
Measured position: axial 60 mm from nozzle
X = 60 mm; Y = 0 mm; Z = 0 mm

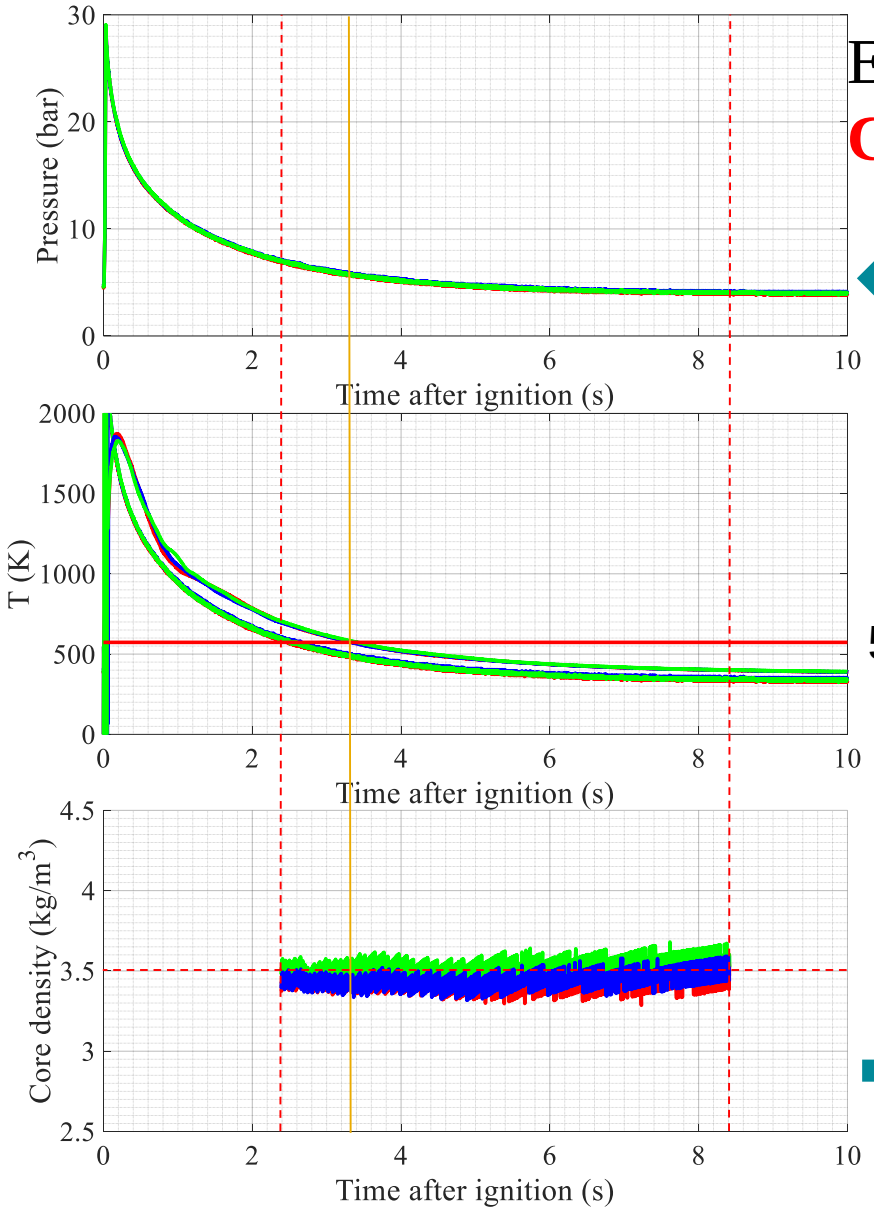
0% O_2 combustion products
4.07 kg/m^3 Bulk density
3.5 kg/m^3 Core density
573 K Core temperature

Spray G Prediction of core T from bulk T





Spray G Core density



ECN spray A : O_2 left =0%

Core density =3.5 kg/m3 ; Core temperature=573K;

Bulk density set at 4.07 kg/m3

573 K

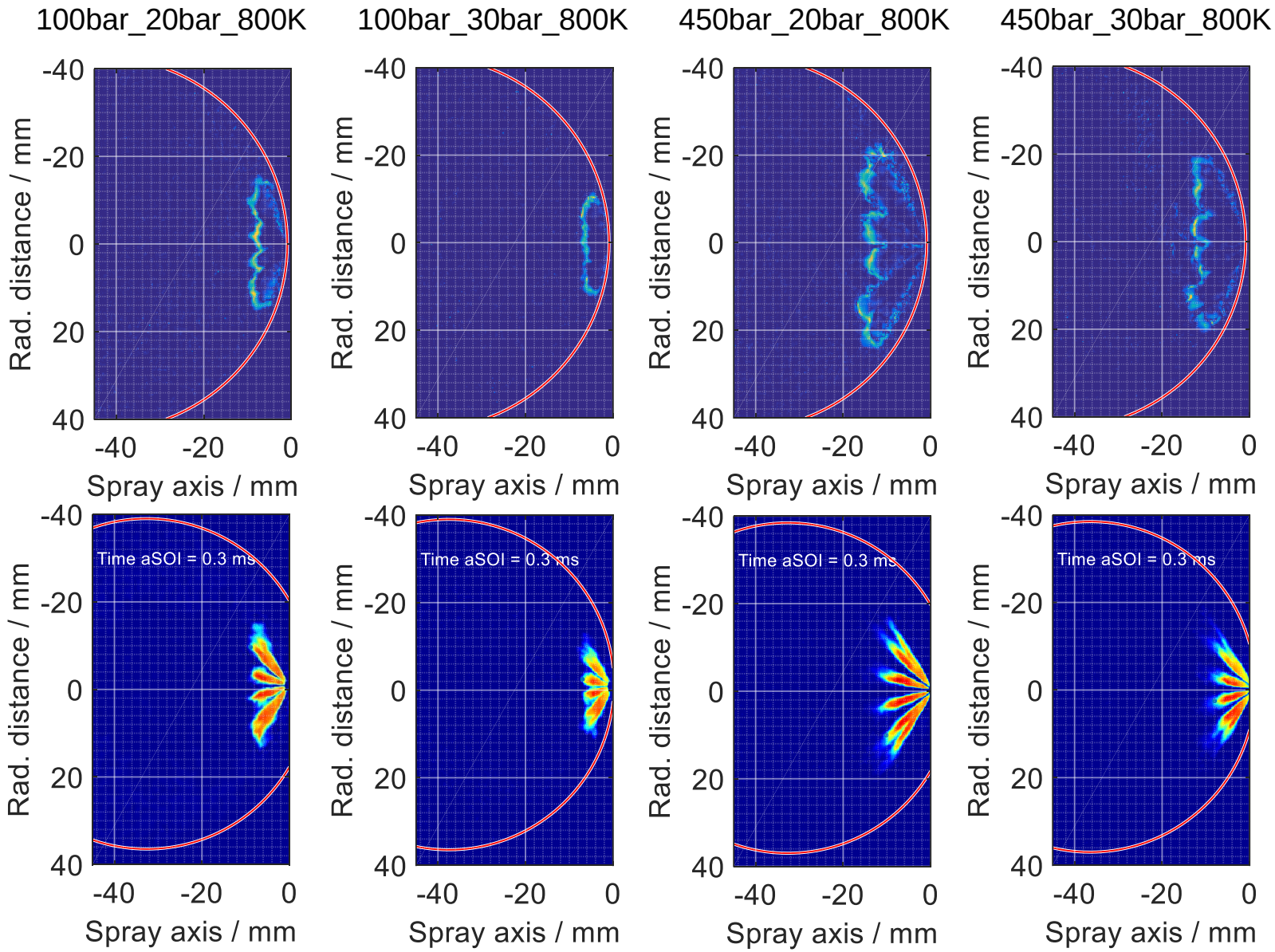
3.5 kg/m3

Mean core density= 3.46 kg/m3,
averaged on: from Tcore 700 K to 400 K

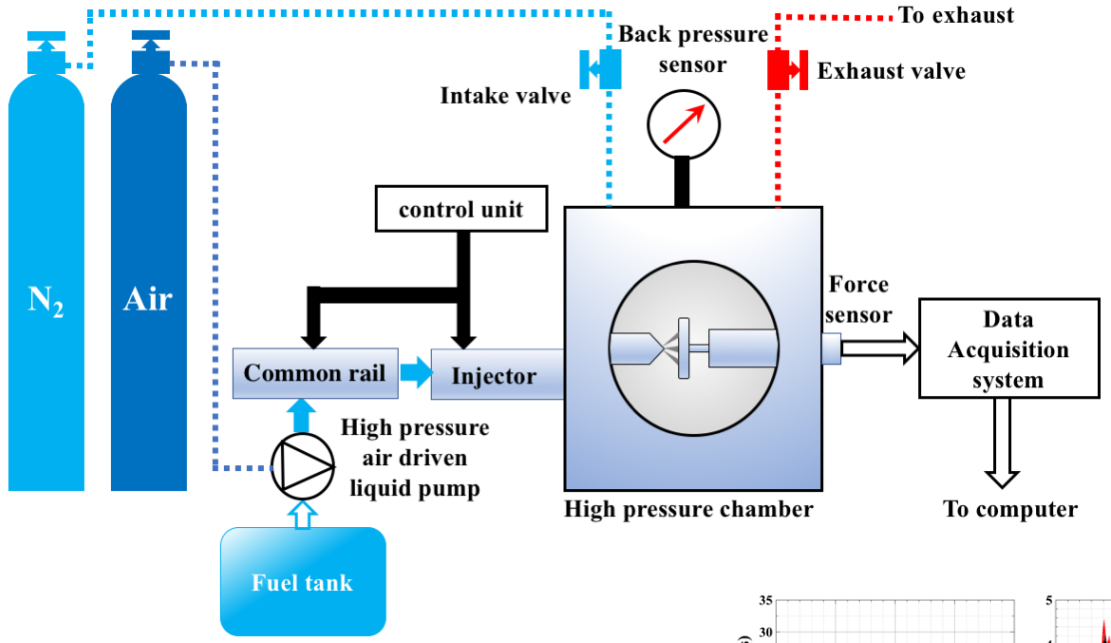
Shadowgraph & DBI (example)

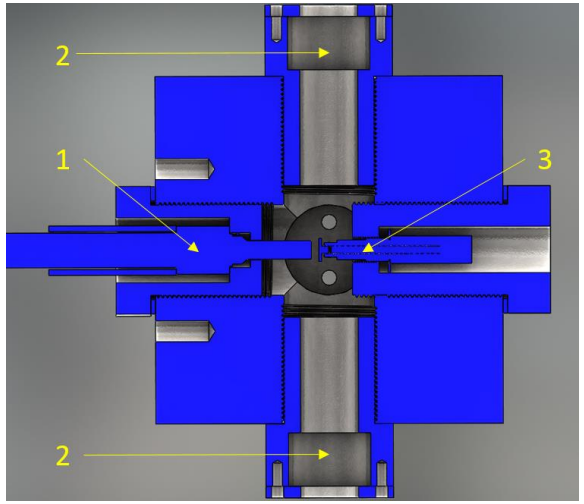
Shadowgraph

DBI

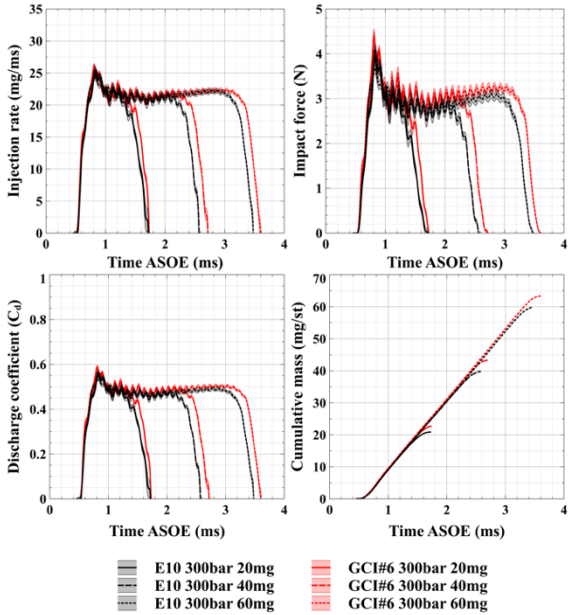


Rate of injection





Bottom view (cross section) of ROI chamber (1. Injector; 2. Optical window; 3. Force sensor)



ROI, impact force, Discharge coefficient and Cumulative mass for 20, 40 and 60mg injected mass for E10 and GCI6 fuels

Facilities in KAUST_CCRC for spray study

- Constant volume combustion chamber
- ROI measurement: Momentum flux method and Bosch method
- Droplet size and velocity: Artium PDI system, Malvern particle size analyzer
- Flow field: Lavision 10 kHz PIV; Lavision image doubler
- Reaction: High speed OH-PLIF
- High speed camera: Photron SA4 and Photron SA-X2
- Leica microscopic imaging lens
- Princeton PIMAX ICCD

Borrow spray D/A & G injector for:

Spray D:

- Penetration length and spray angle measurement using DBI & Shadowgraph
- ROI measurement using momentum flux method and Bosch method

Spray G3, G7

Thank You !