

# **Fuel Design Approach for Low Emission in Engine Systems**

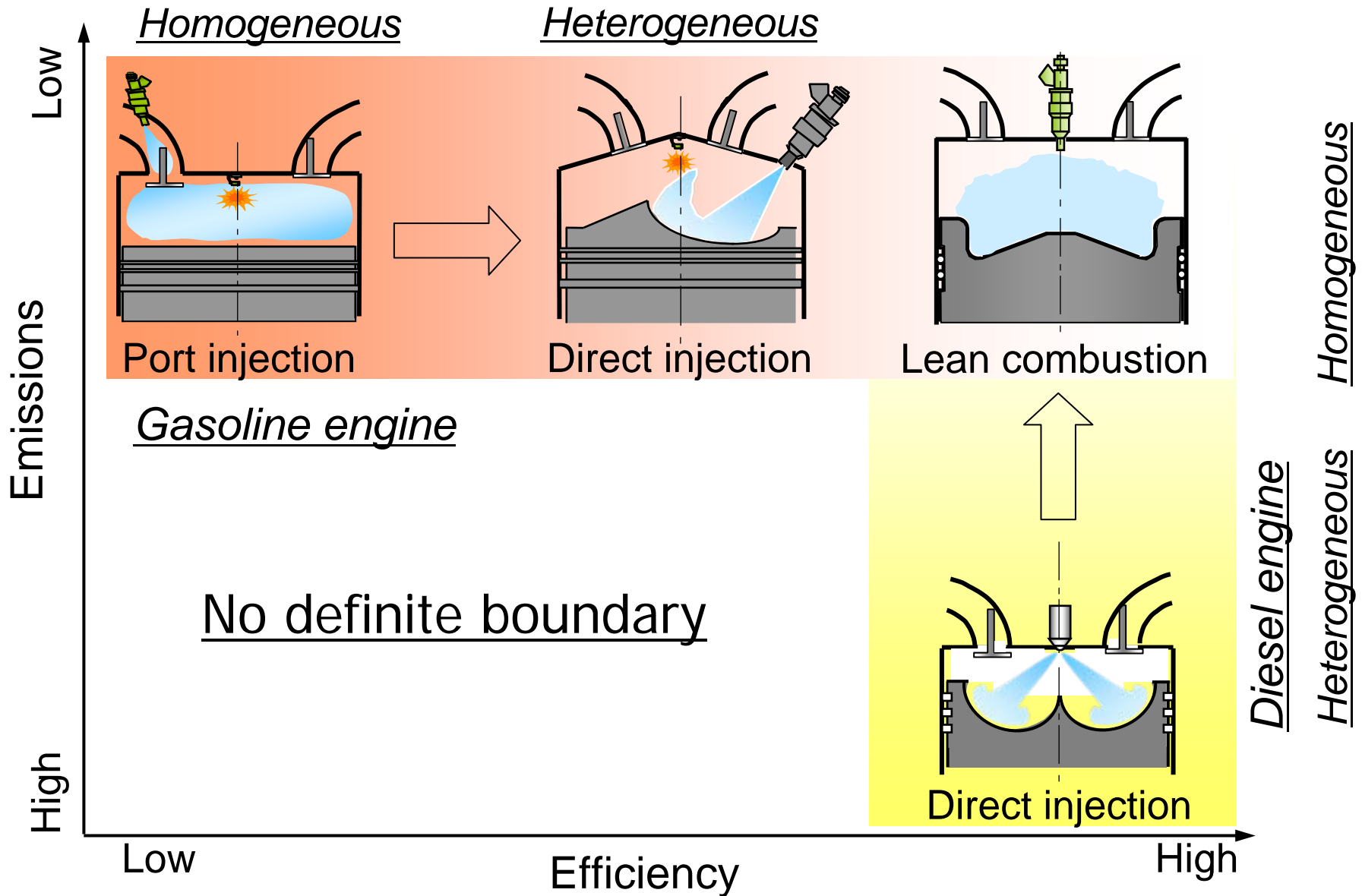
## **- Application of Flash Boiling Spray into HCCI -**

H. Gen Fujimoto, Y. Wada, J. Senda

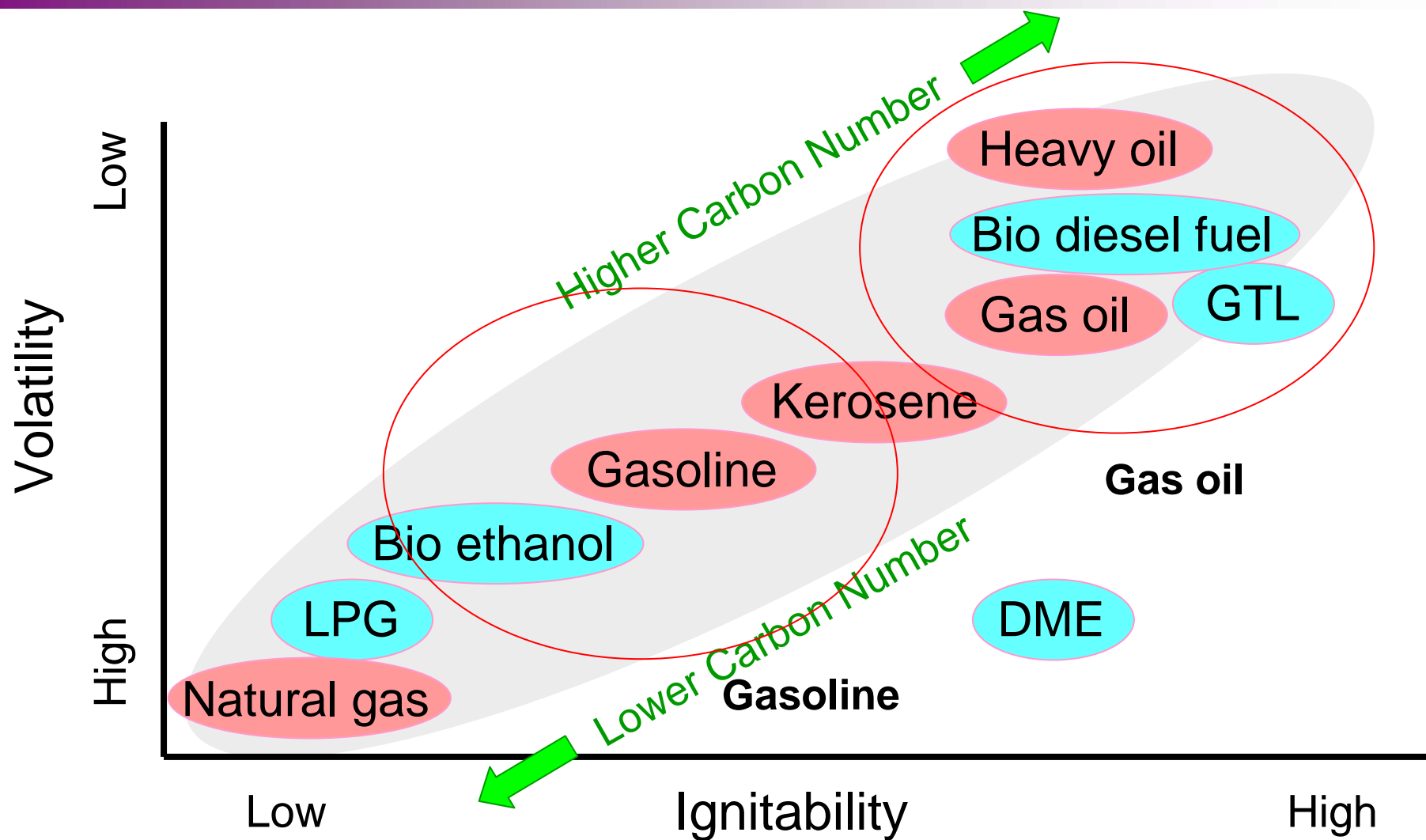
Department of Mechanical Engineering, Doshisha University

IEA TLM Meeting in Heidelberg (13-16 Aug. 06)

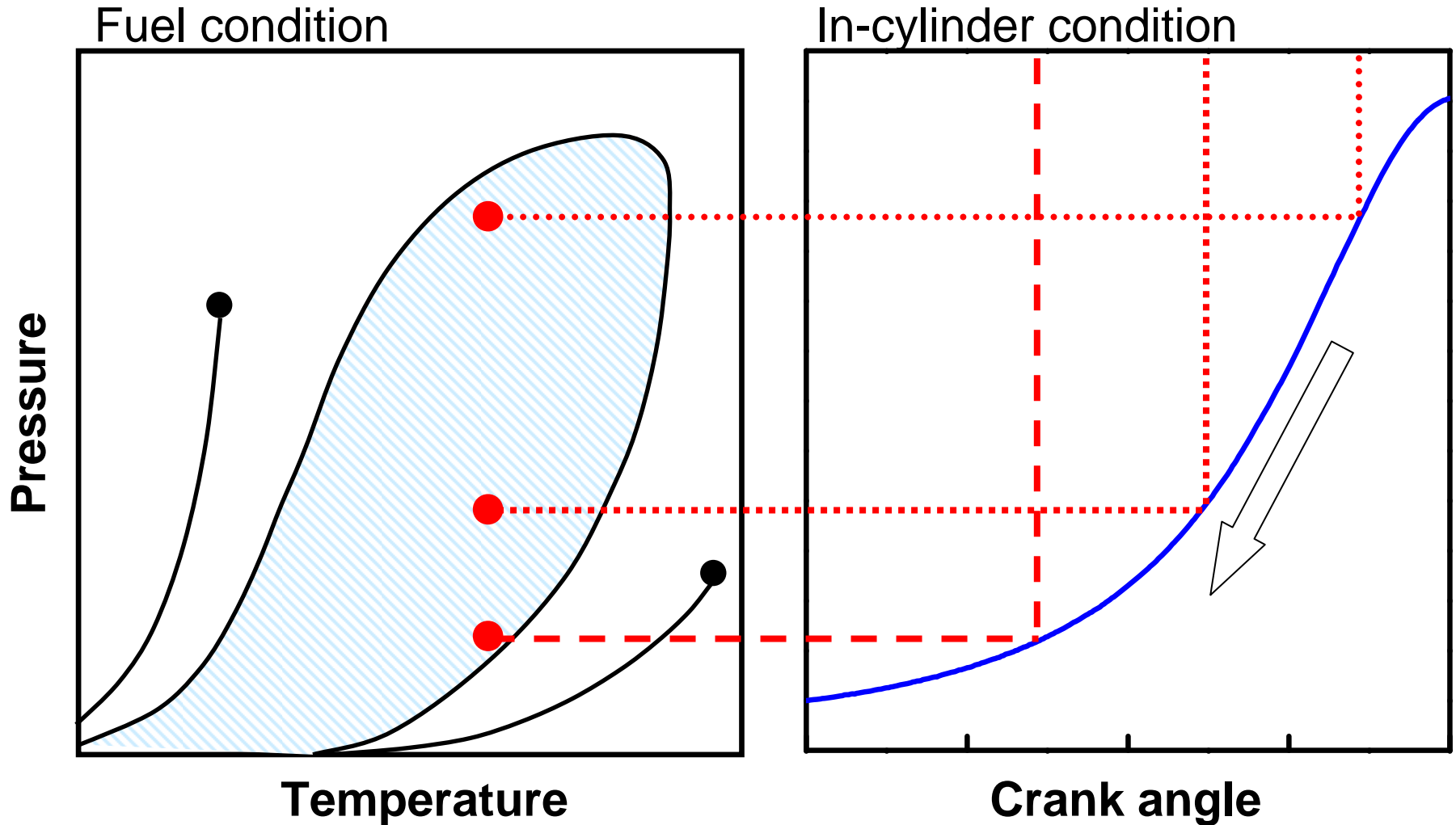
# Introduction



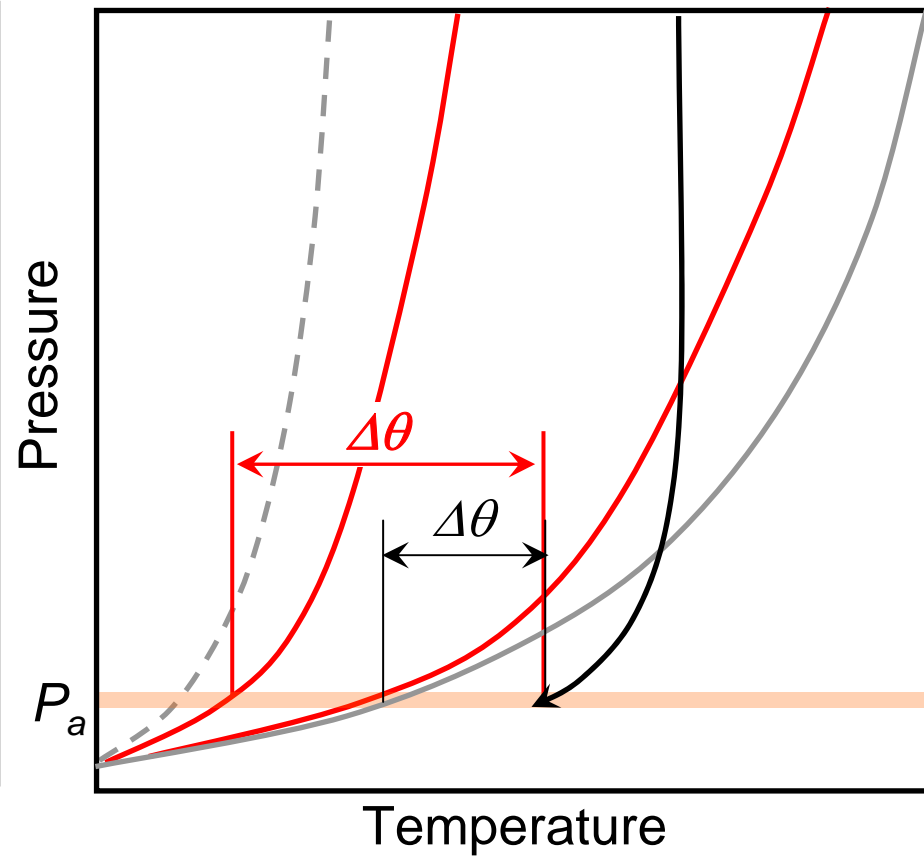
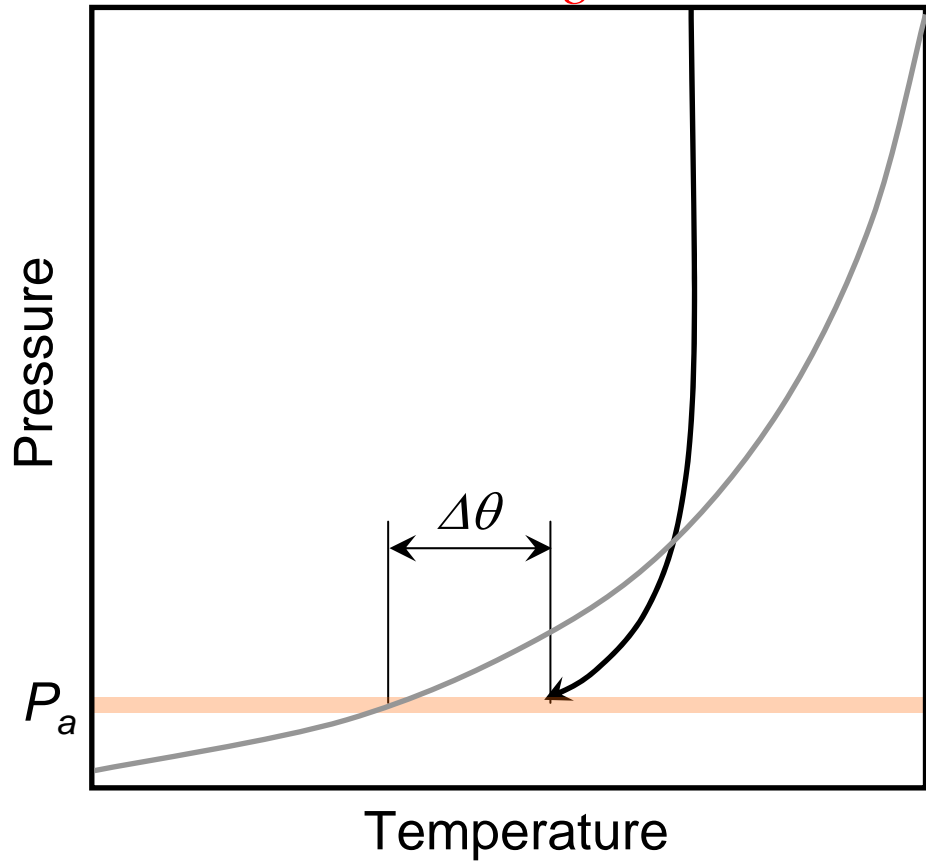
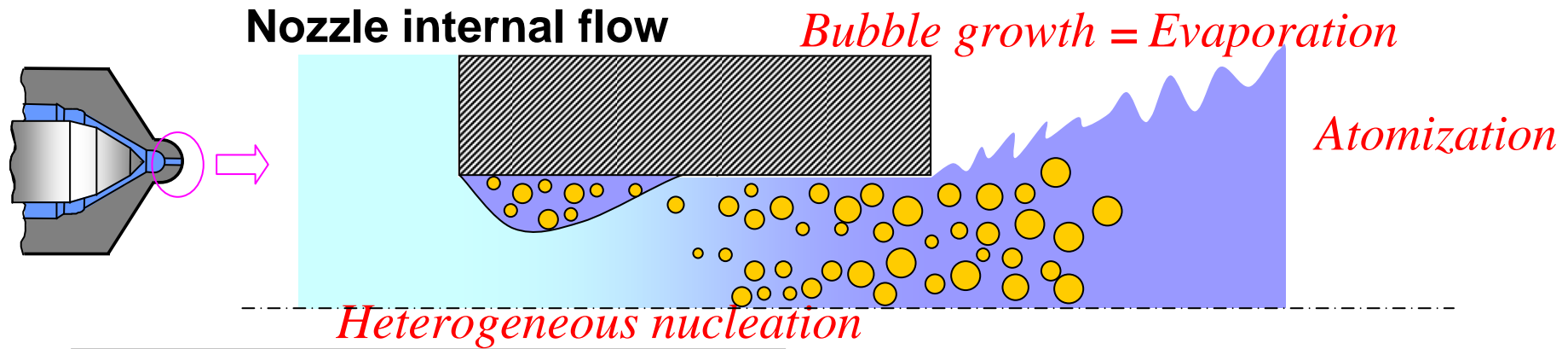
# Physical and Chemical Characteristics of Conventional and Alternative Fuels



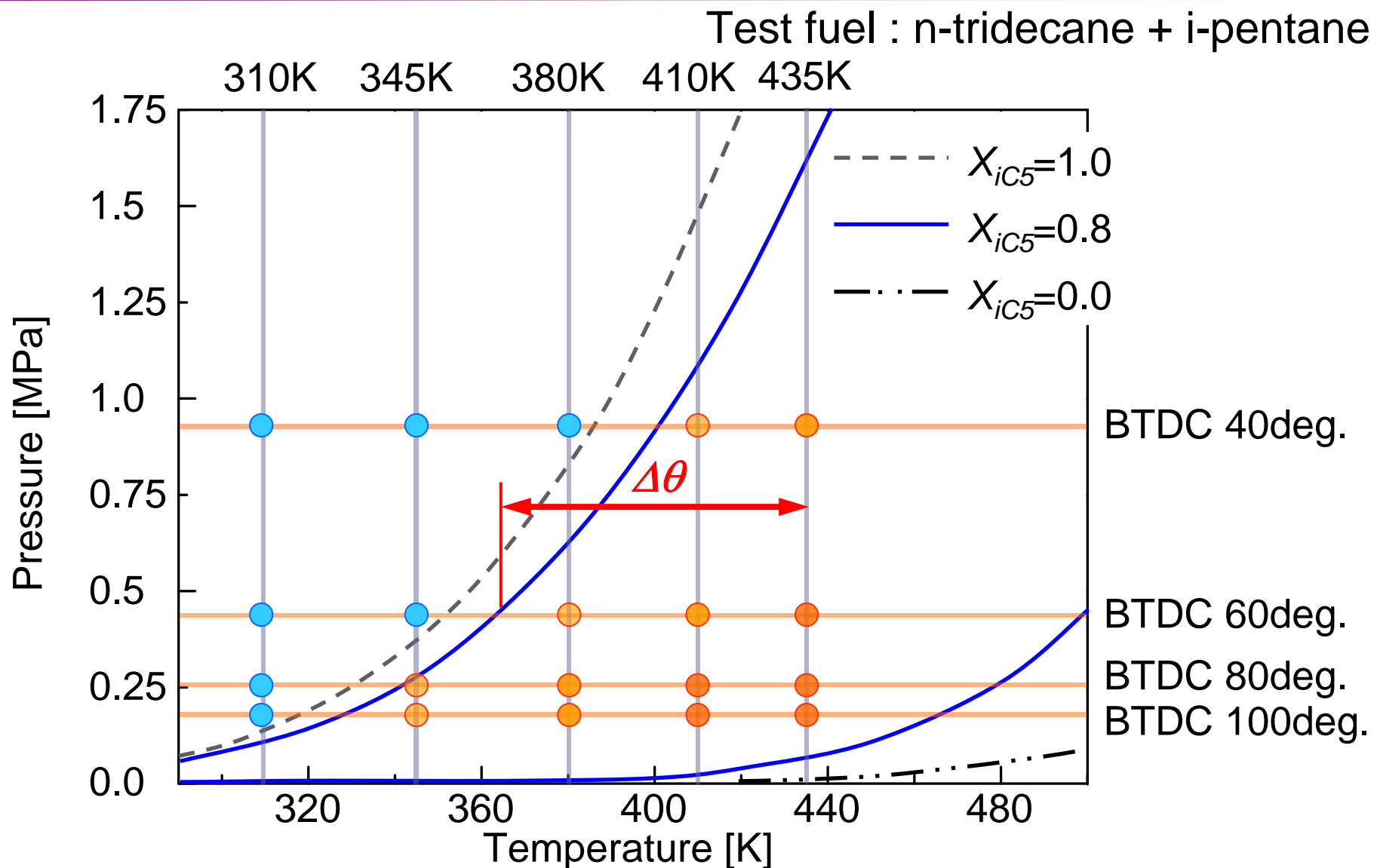
# Comparison between Fuel and In-Cylinder Condition



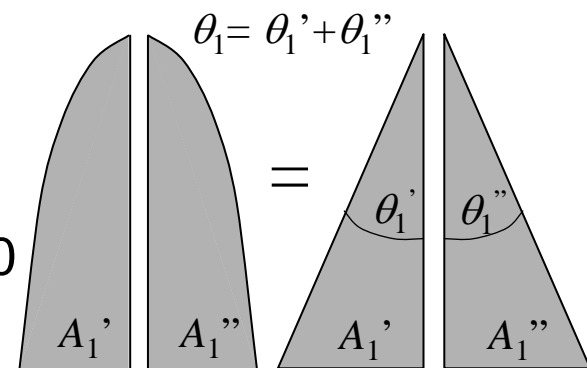
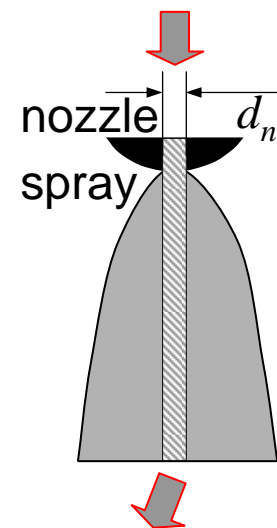
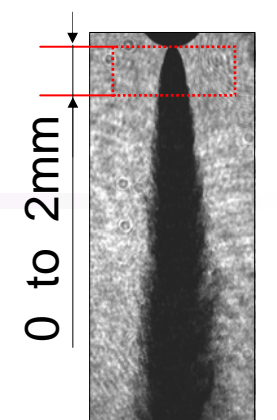
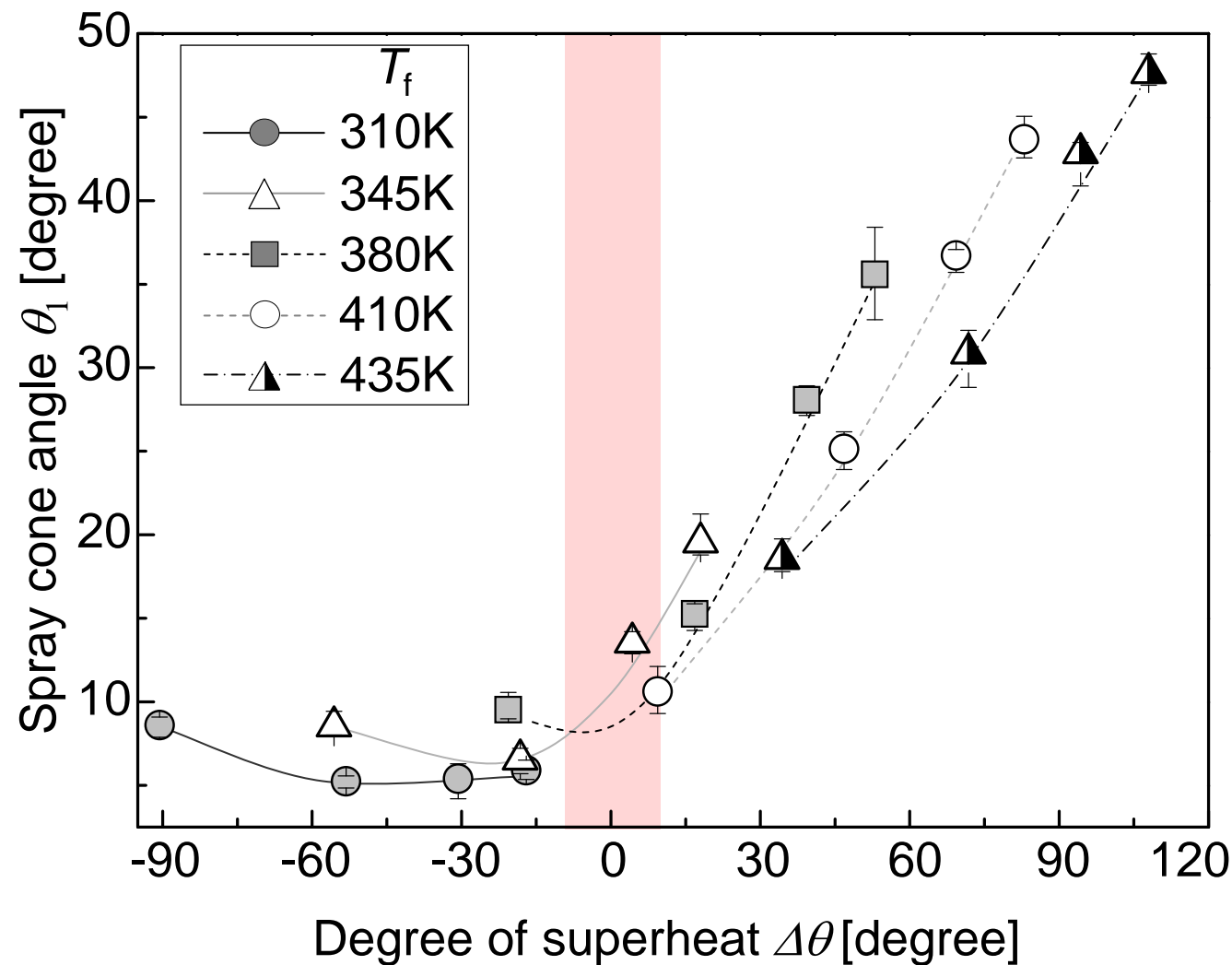
# Flash Boiling



# Experimental Conditions Plotted on Pressure-Temperature Diagram

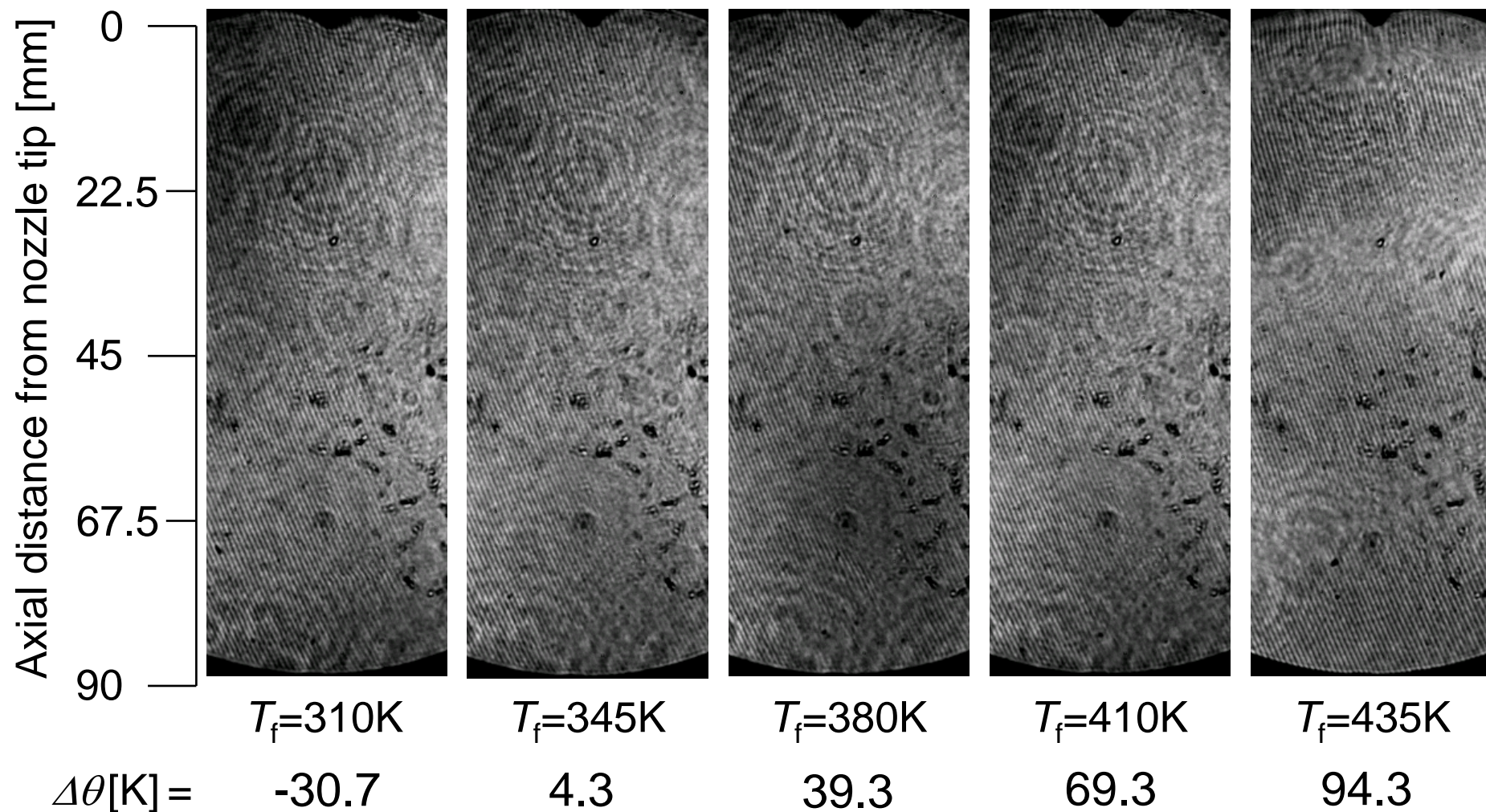


# Spray Cone Angle as a Function of Degree of Superheat





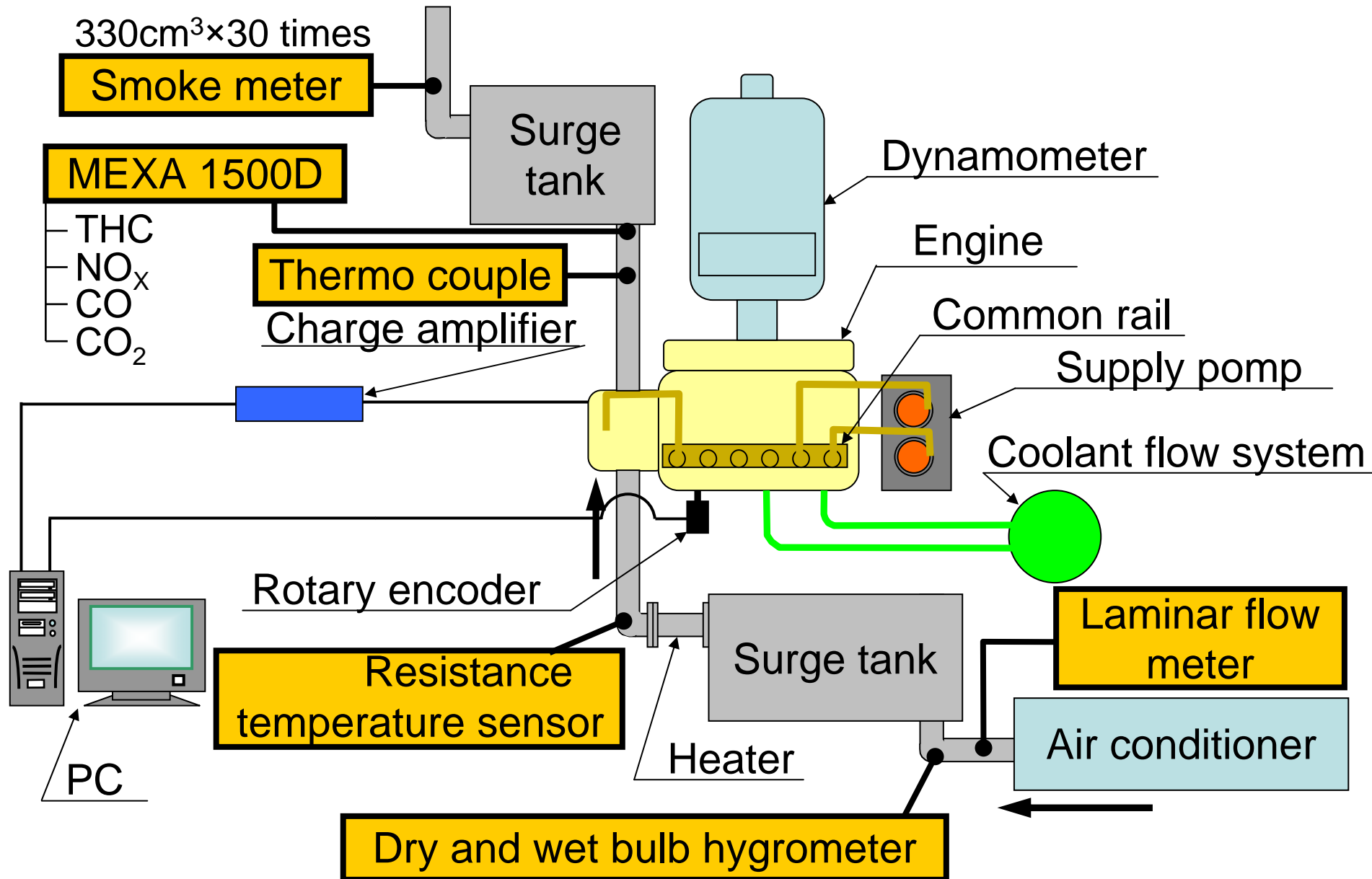
# Spray Images for each Initial Fuel Temp. (Simulated Crank Angle = BTDC80deg.)







# Schematic Diagram of Test Engine

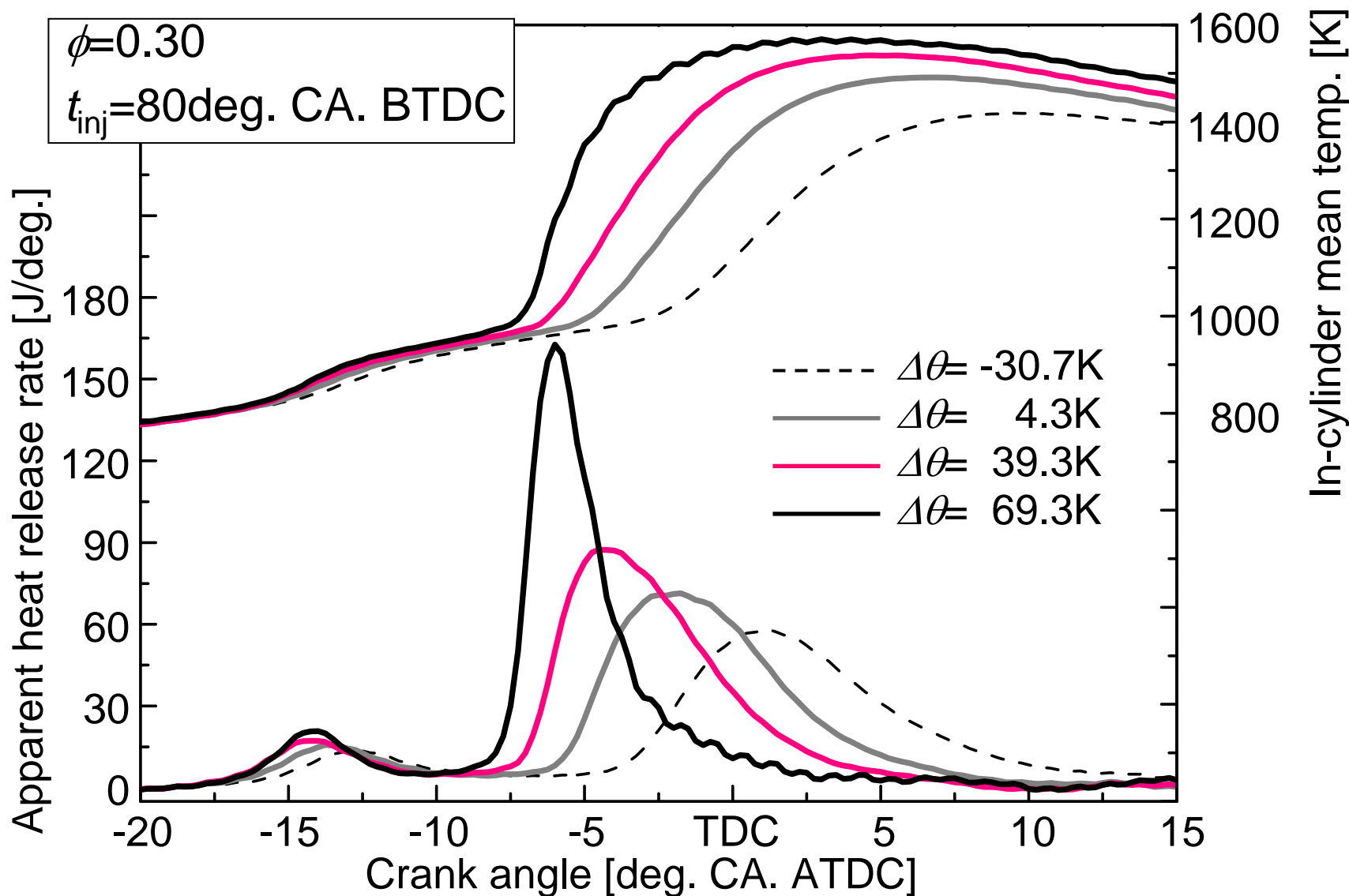




# Specifications of Test Engine

Specification	Natural Aspirated, single cylinder, water cooled, 4 stroke cycle, 2 valves
Bore×Stroke [mm]	$\phi$ 110×106
Compression ratio [-]	<b>13.0 : 1</b>
Combustion chamber	Dish
Engine speed [rpm]	1200
Intake temp. [K] / humidity [%]	303 / 35
Water temp. [K] / Oil temp. [K]	353 / 342
Fuel injection system	Common-rail
Injection pressure [MPa]	50.0
Injection timing [deg. CA. BTDC]	100, 90, 80, 70, 60, 50, 40
Nozzle configuration	$dn=0.2\times 4$ ( Spray Angle 60deg. )
Fuel	i-pentane/n-tridecane mixture (mole fraction of i-pentane =0.8)
Initial fuel temperature [K]	310, 345, 380, 410
Equivalent ratio [-]	0.20, 0.23, 0.27, 0.30

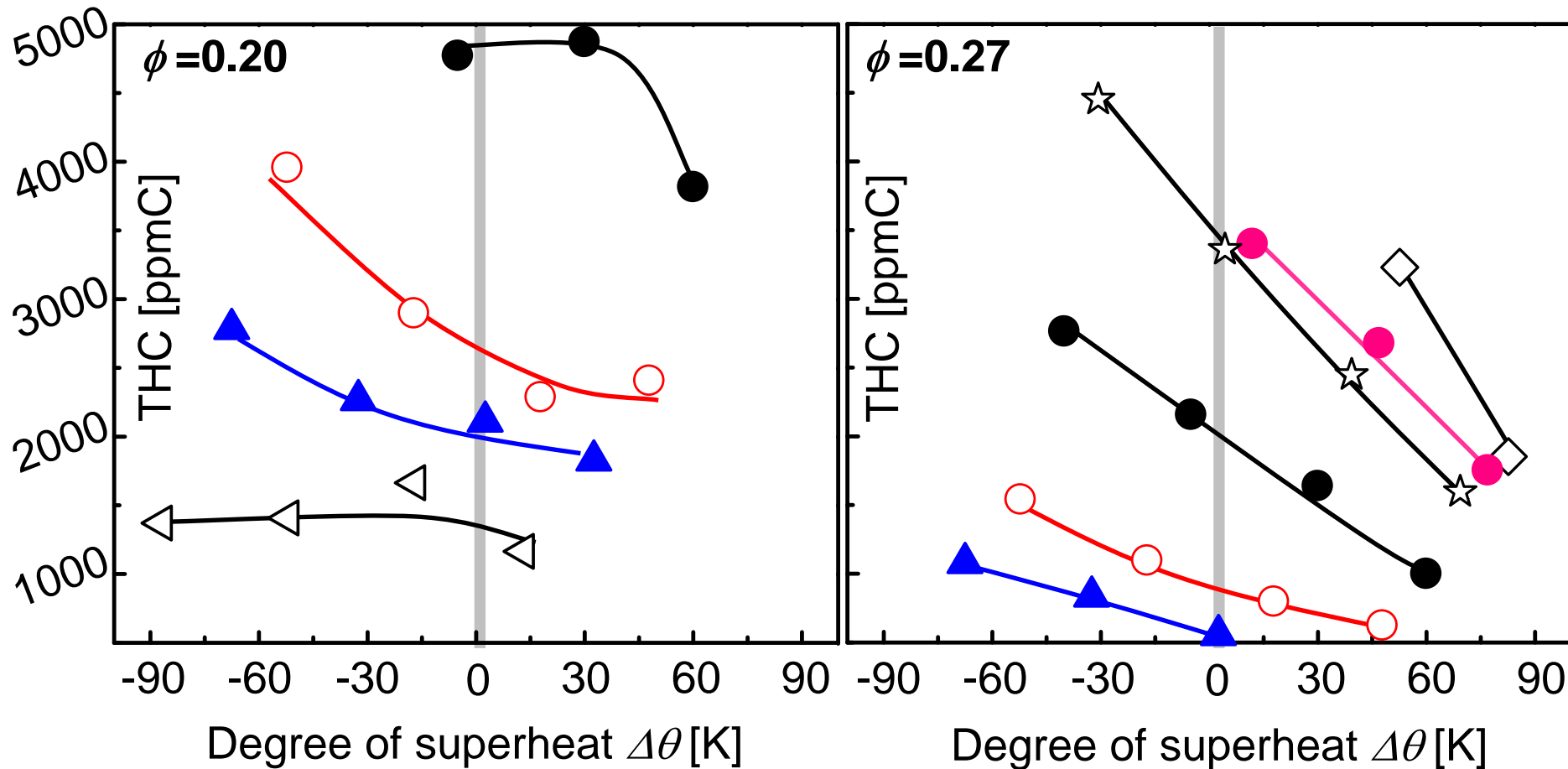
# Histories of Apparent Heat Release Rate and In-Cylinder Mean Temperature



# THC Emission as a Function of $\Delta\theta$

Start of injection —

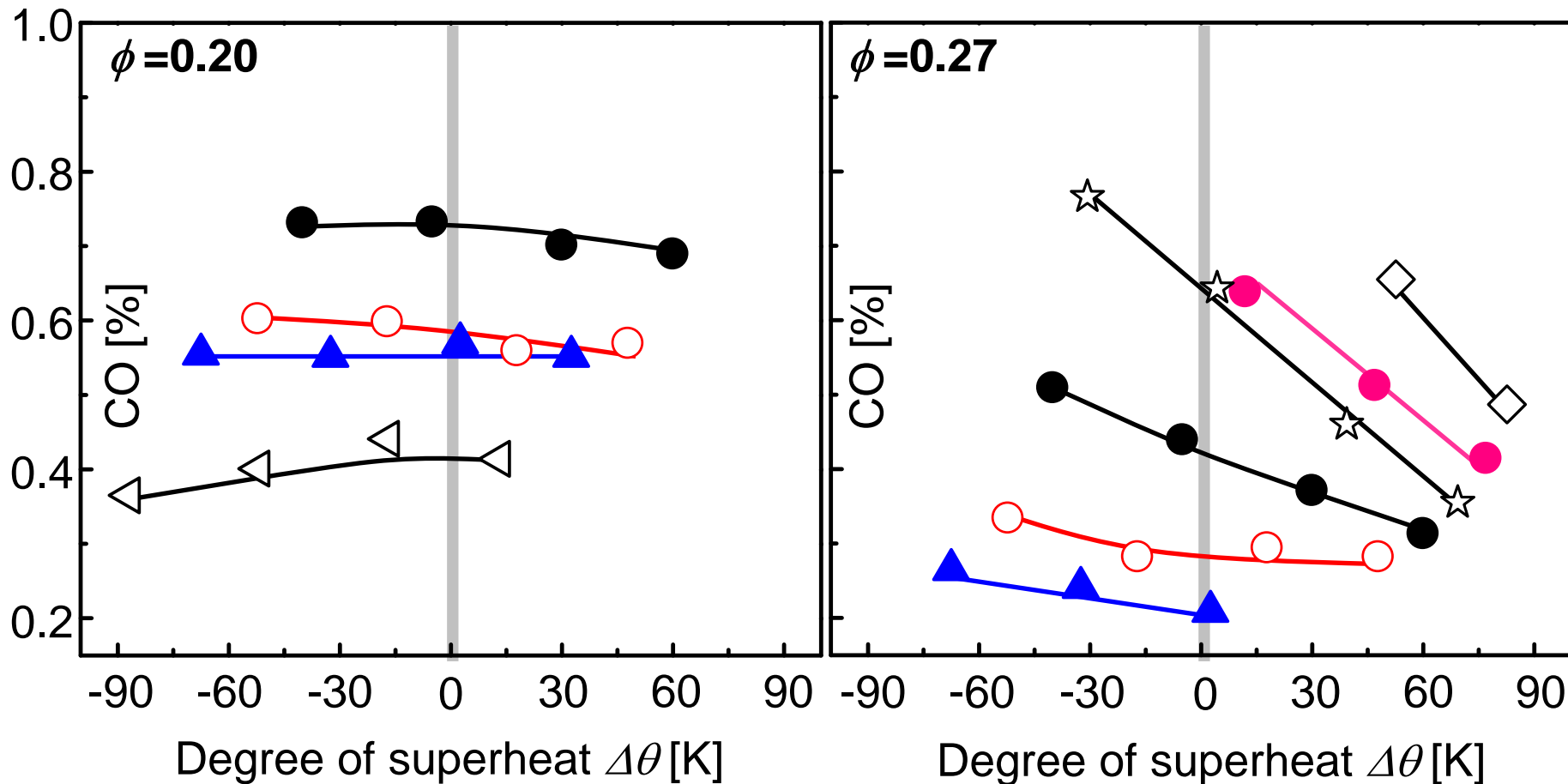
- |                   |                   |                    |
|-------------------|-------------------|--------------------|
| ◁ 40deg. CA. BTDC | ○ 60deg. CA. BTDC | ☆ 80deg. CA. BTDC  |
| ▲ 50deg. CA. BTDC | ● 70deg. CA. BTDC | ● 90deg. CA. BTDC  |
|                   |                   | ◇ 100deg. CA. BTDC |



# CO Emission as a Function of $\Delta\theta$

*Start of injection* —

- |                                  |                           |                             |
|----------------------------------|---------------------------|-----------------------------|
| $\triangleleft$ 40deg. CA. BTDC  | $\circ$ 60deg. CA. BTDC   | $\star$ 80deg. CA. BTDC     |
| $\blacktriangle$ 50deg. CA. BTDC | $\bullet$ 70deg. CA. BTDC | $\bullet$ 90deg. CA. BTDC   |
|                                  |                           | $\diamond$ 100deg. CA. BTDC |





# $\text{NO}_x$ vs. Comb. Efficiency

