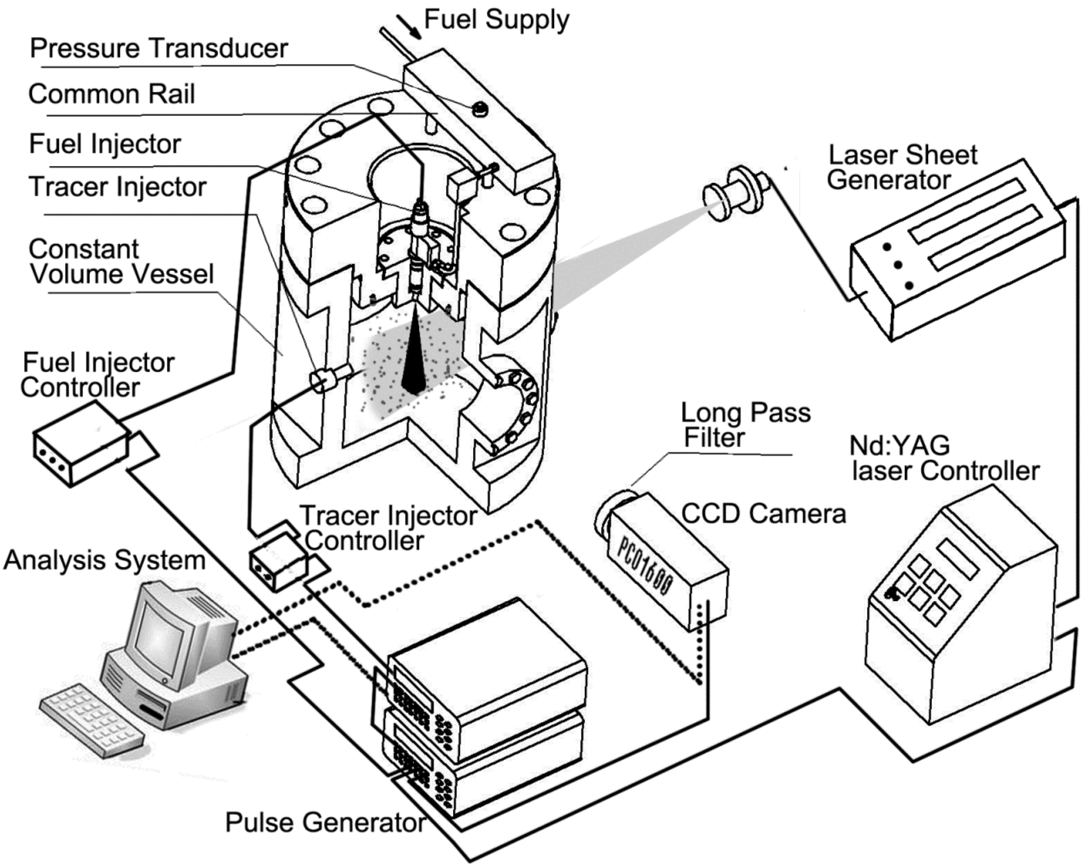


Fig.1 Schematics of Experimental Setup

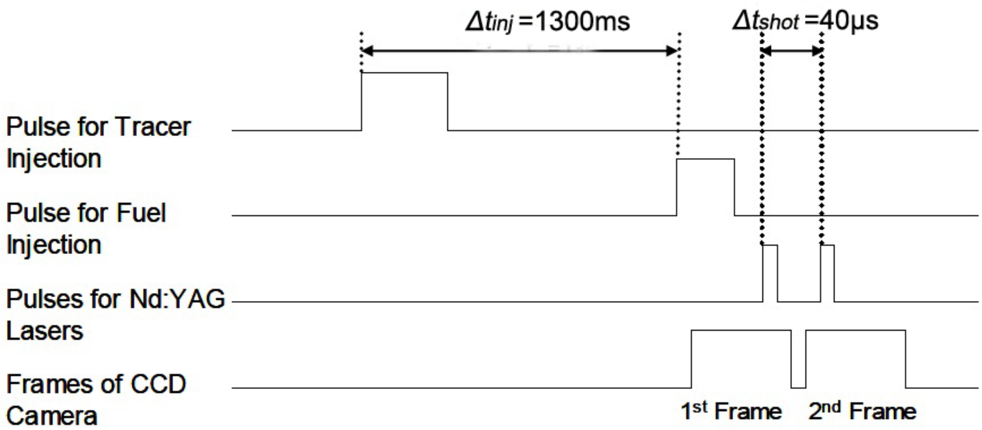


Fig.2 Time Chart of LIF-PIV Experiment

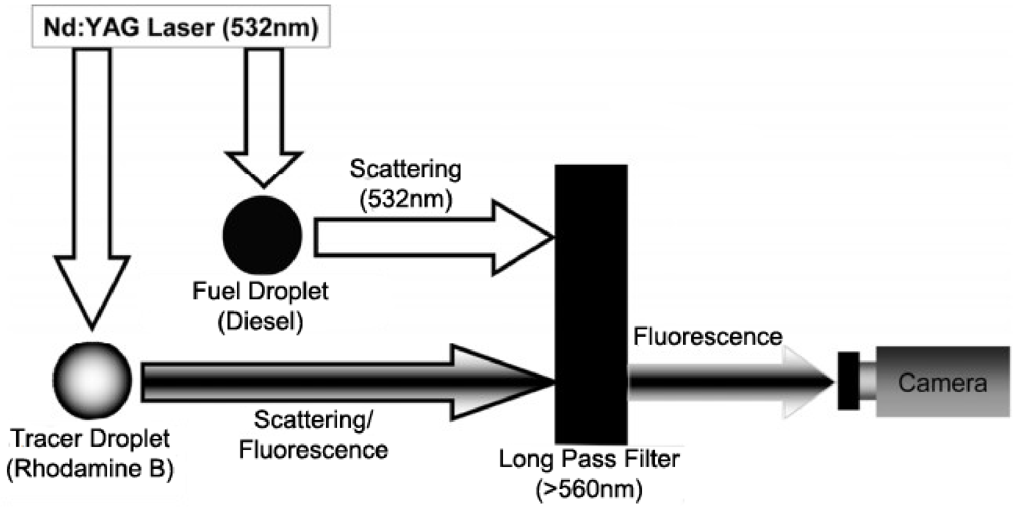


Fig.3 Principle of Image Capturing of Tracer Droplet with Long Pass Filter

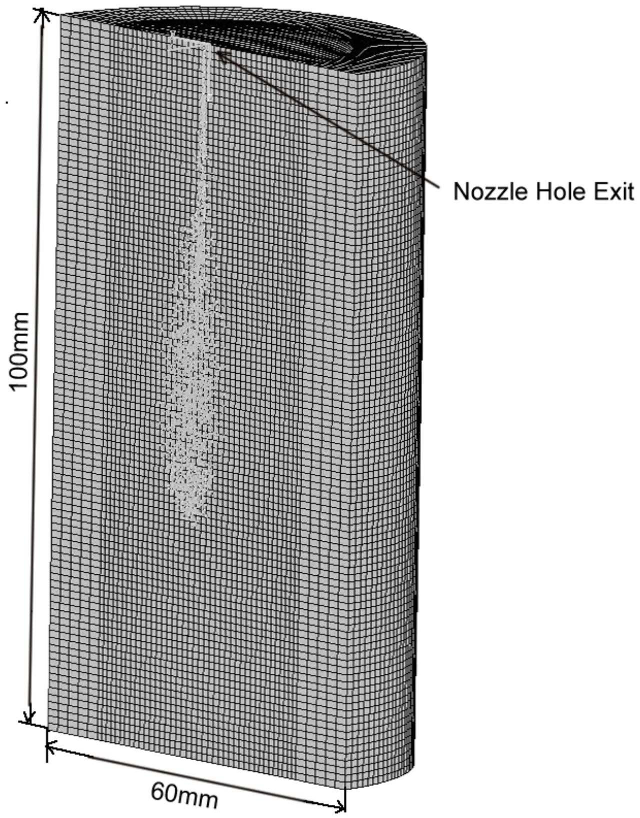


Fig.4 Computational Mesh

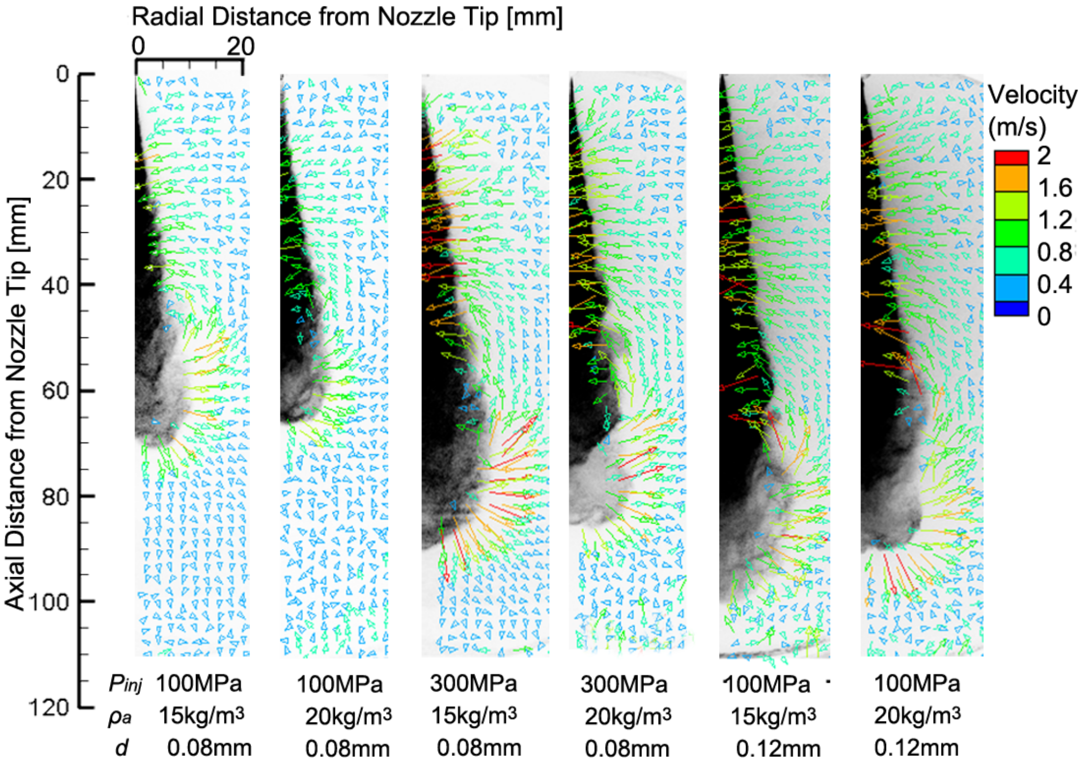


Fig.5 Spatial Distribution of Velocity Vectors of Ambient Gas Motion around Spray Periphery (2.2ms after Start of Injection)

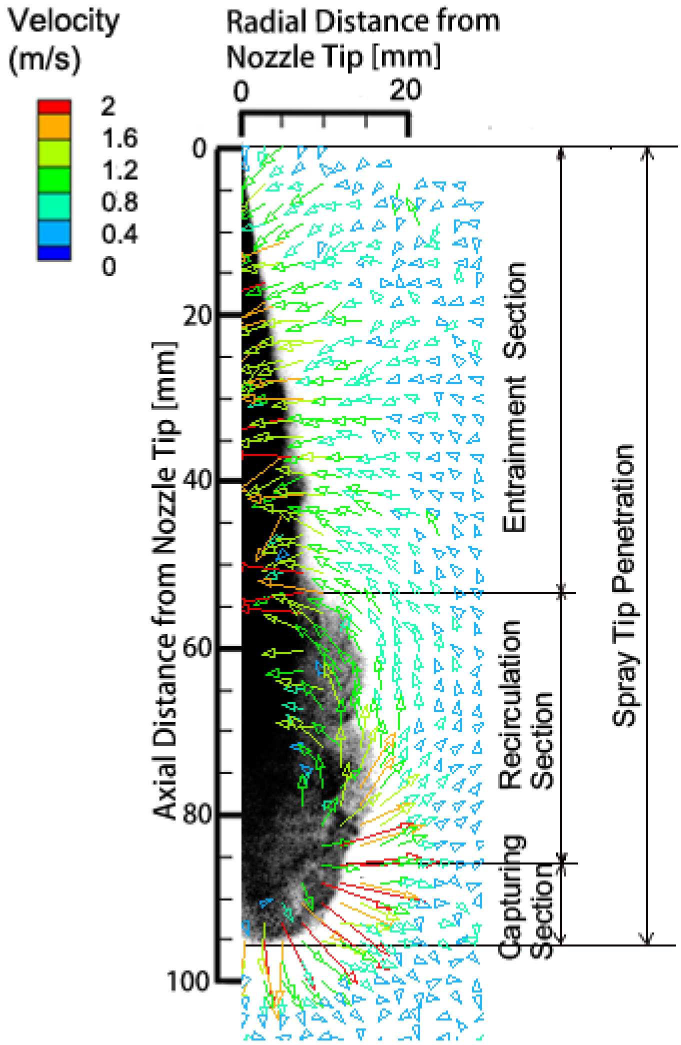


Fig.6 Description of Three Sections around Spray Periphery with Different Ambient Gas Motion Features (P_{inj}=300MPa, ρ_a=11kg/m^3, d=0.08mm, t=2.2ms ASOI)

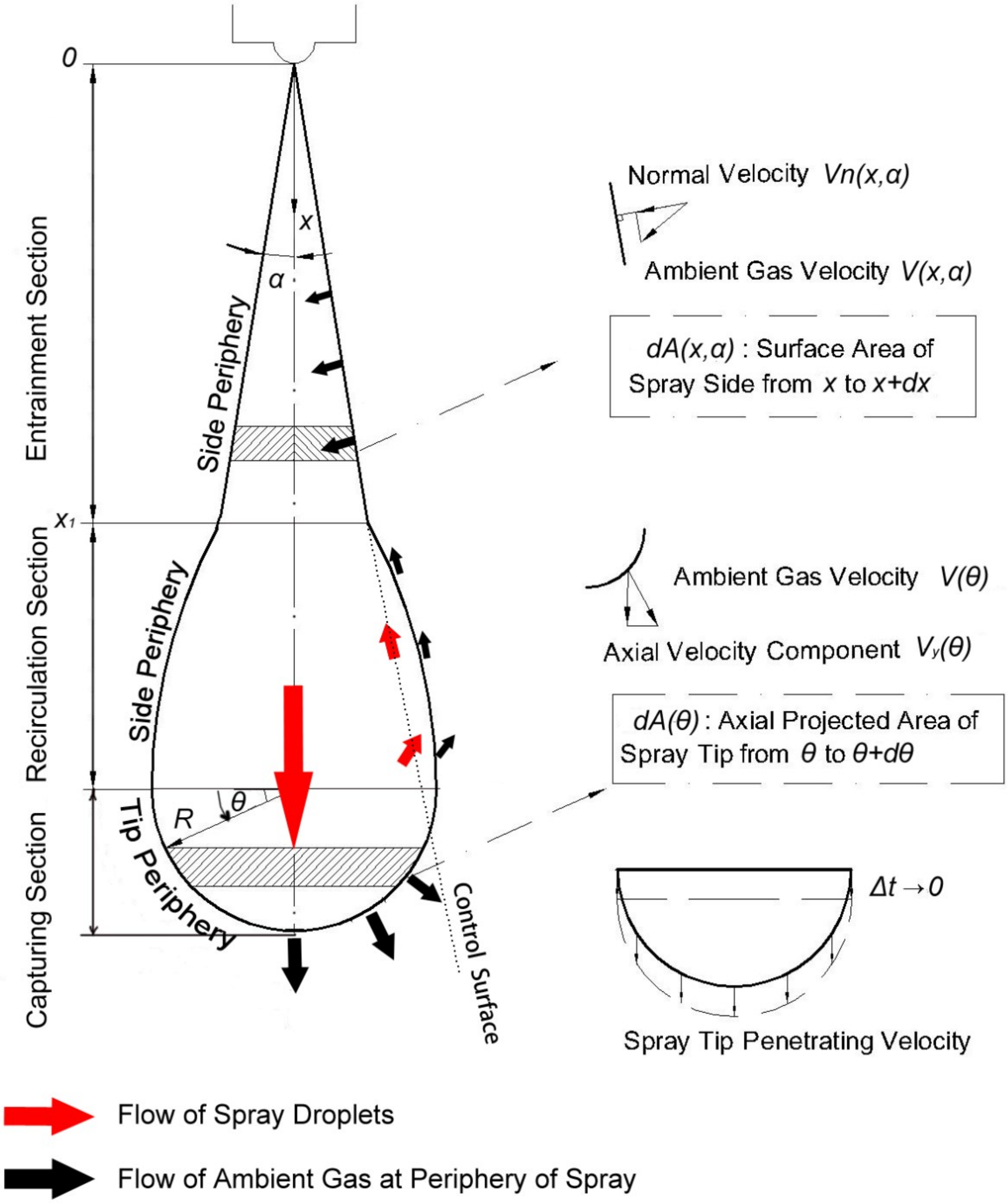


Fig.7 Definition of Velocity Components, Sections around Spray Periphery

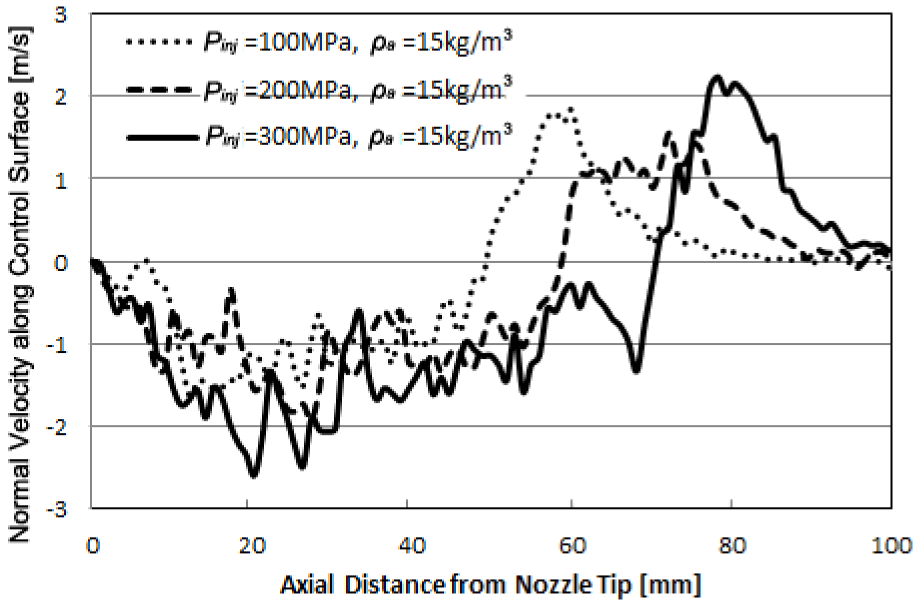
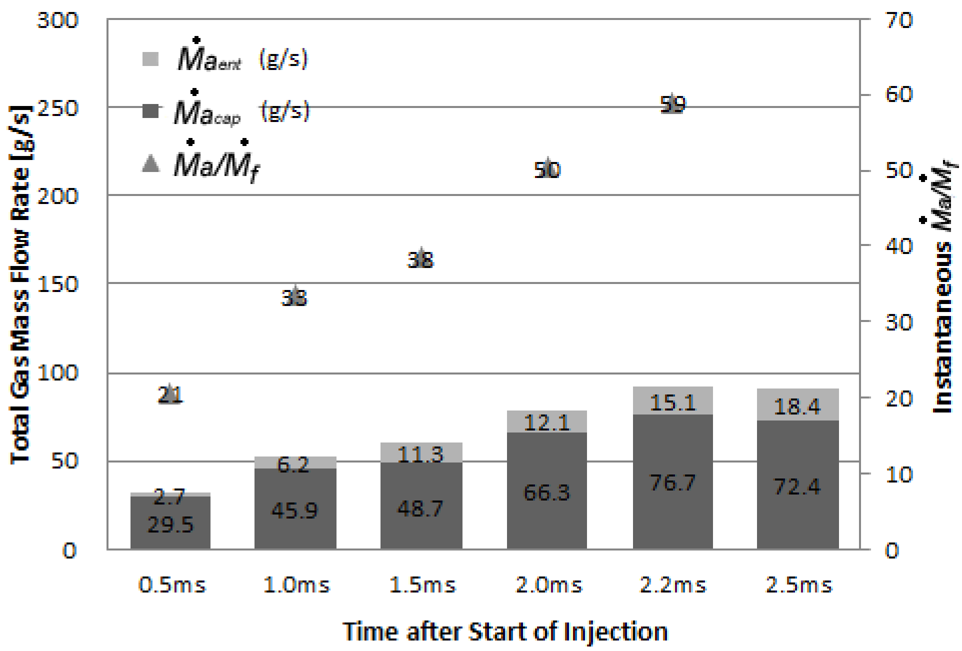
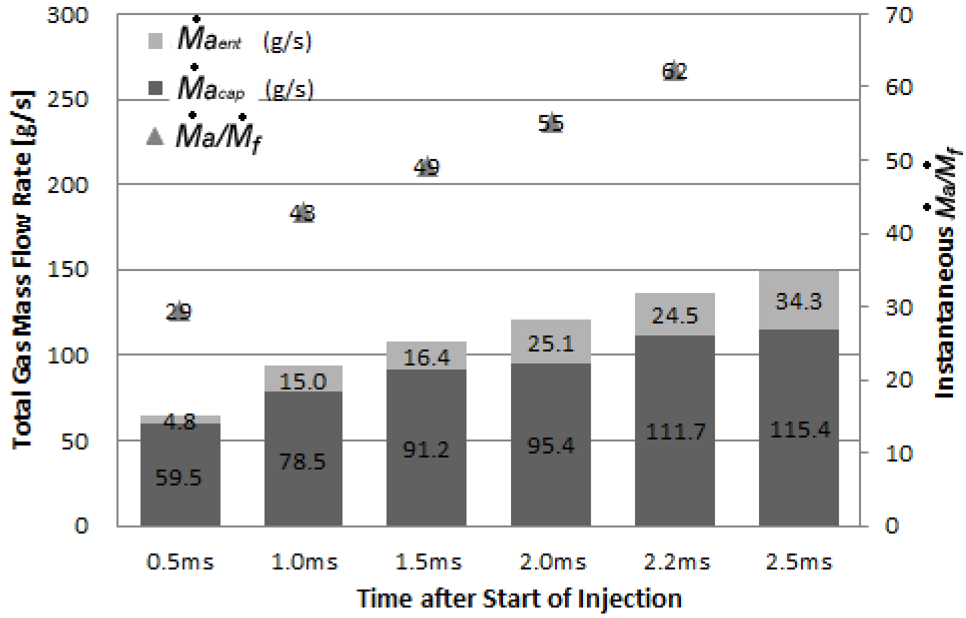


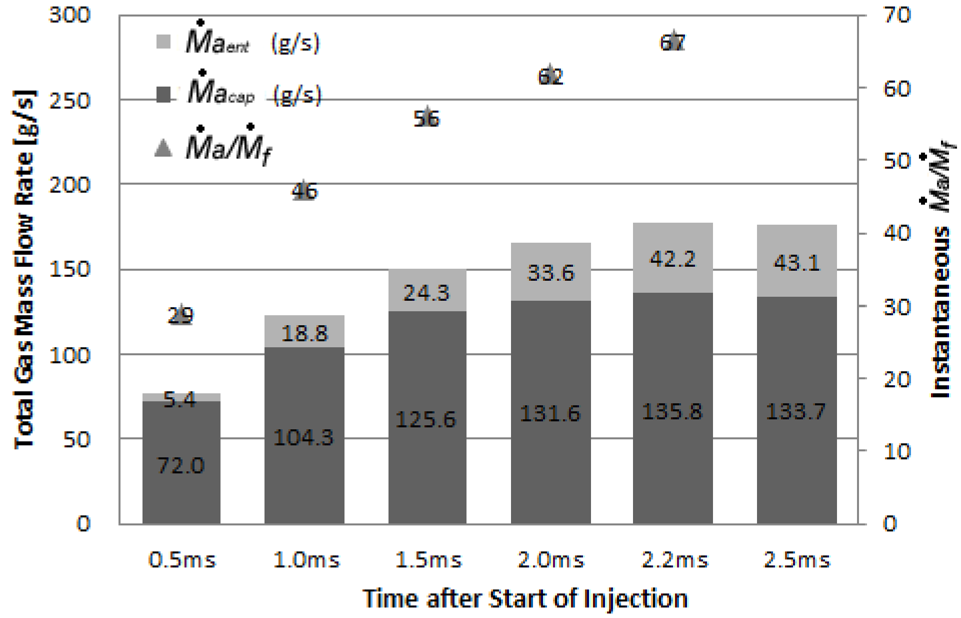
Fig.8 Spatial Distribution of Normal Velocity along Control Surface
(ρ_a=15kg/m^3, d=0.08mm, 2.2ms ASOI)



(a) P_{inj}=100MPa

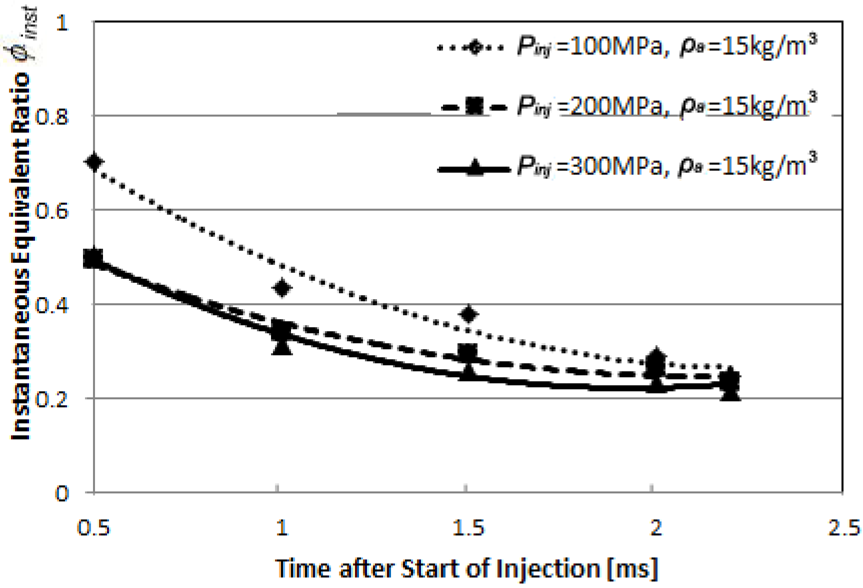


(b) P_{inj}=200MPa

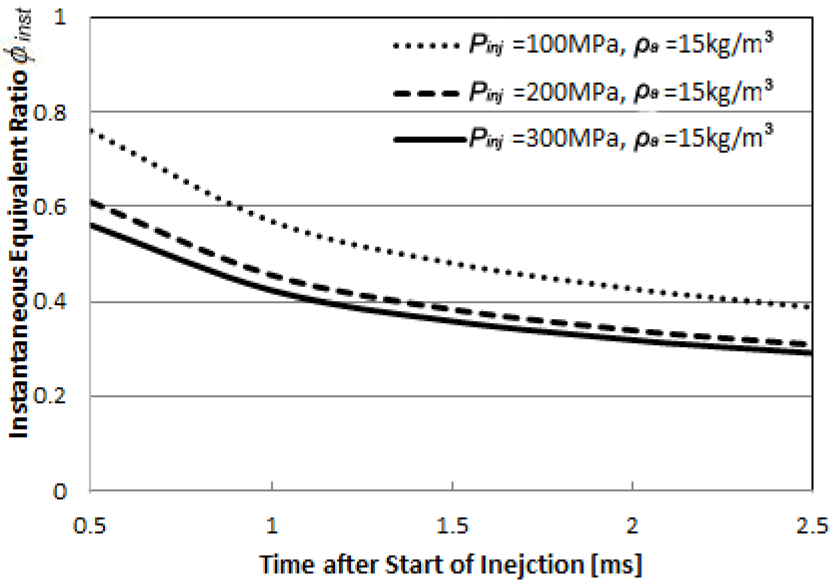


(c) P_{inj}=300MPa

Fig.9 Temporal Variation of Total Ambient Gas Mass Flow Rate and Instantaneous $\dot{M}a / \dot{M}_f$ (ρ_a=15kg/m^3, d=0.08mm)

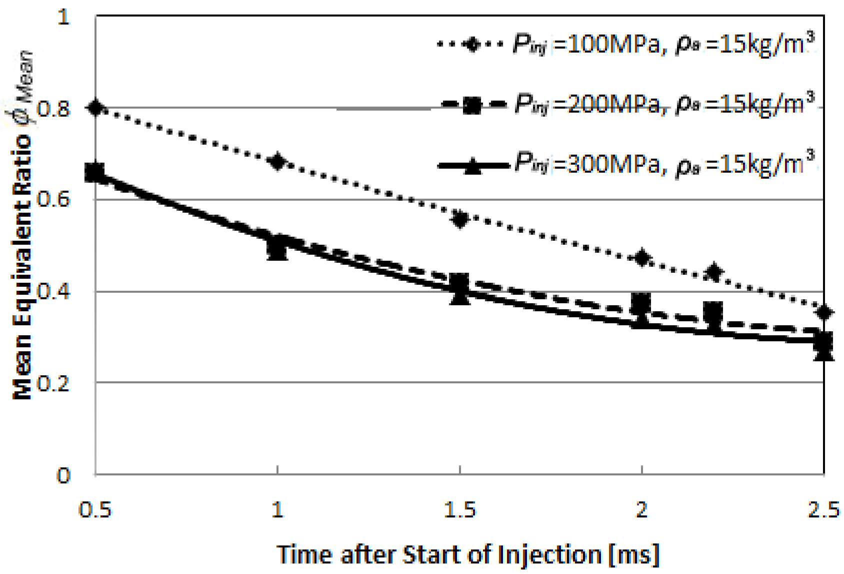


(a) Instantaneous Equivalence Ratio Calculated from Instantaneous Ambient Gas-Fuel Mass Flow Rate by LIF-PIV Result

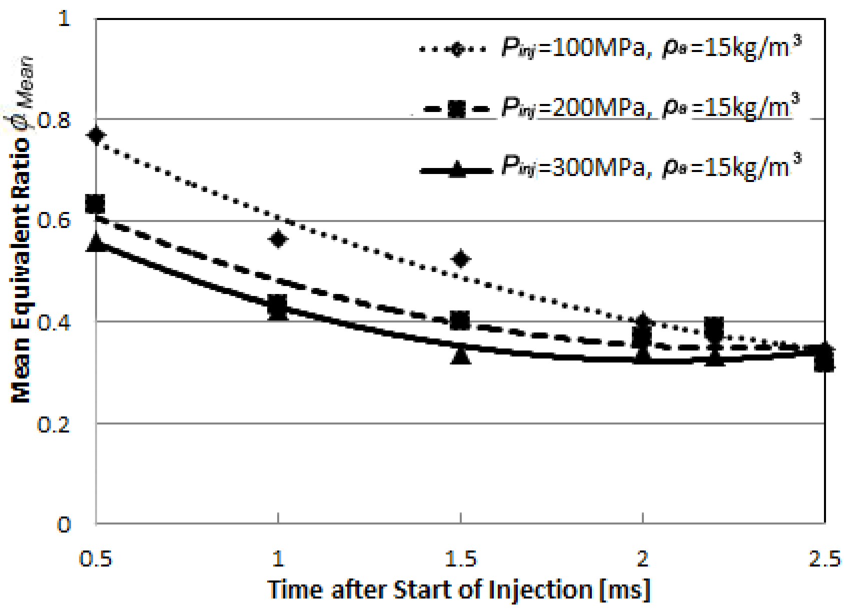


(b) Instantaneous Equivalence Ratio Calculated from Predictive Model

Fig.10 Comparison of Instantaneous Equivalence Ratio as Function of Time (ρ_a=15kg/m^3, d=0.08mm)



(a) Mean Equivalence Ratio Calculated from Temporal Integration of Instantaneous Ambient Gas-Fuel Mass Flow Rate by LIF-PIV Result



(b) Mean Equivalence Ratio Calculated from Spray Volume

Fig.11 Comparison of Mean Equivalence Ratio as Function of Time

(ρ_a=15kg/m^3, d=0.08mm)

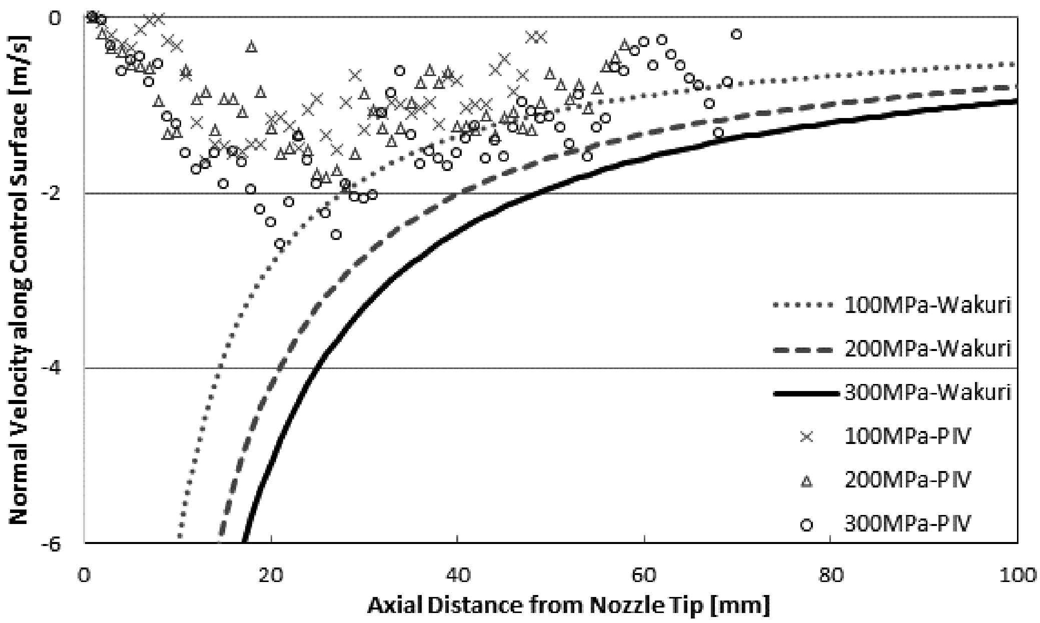


Fig.12 Comparison of Spatial Distribution of Normal Velocity along Control Surface (ρ_a=15kg/m^3, d=0.08mm, 2.2ms ASOI)

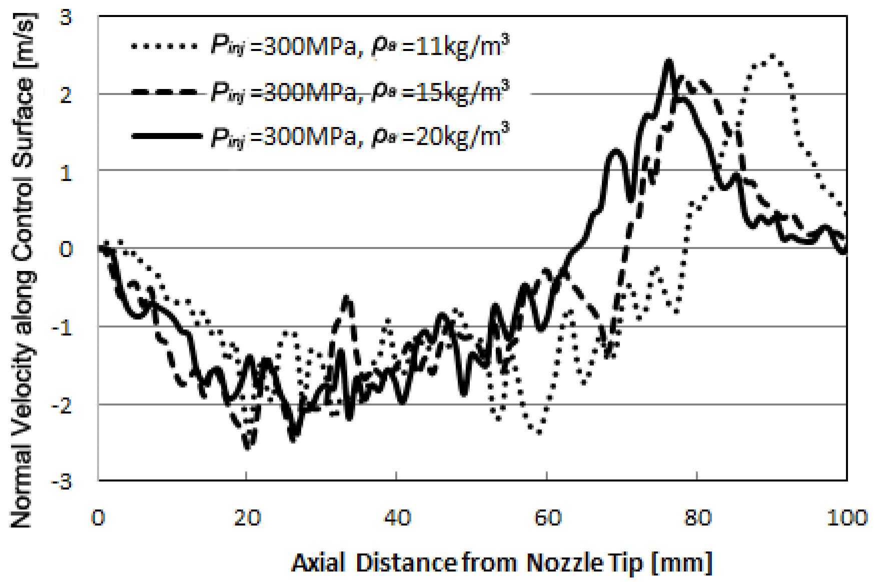


Fig.13 Spatial Distribution of Normal Velocity along Control Surface (P_{inj}=300MPa, d=0.08mm, 2.2ms ASOI)

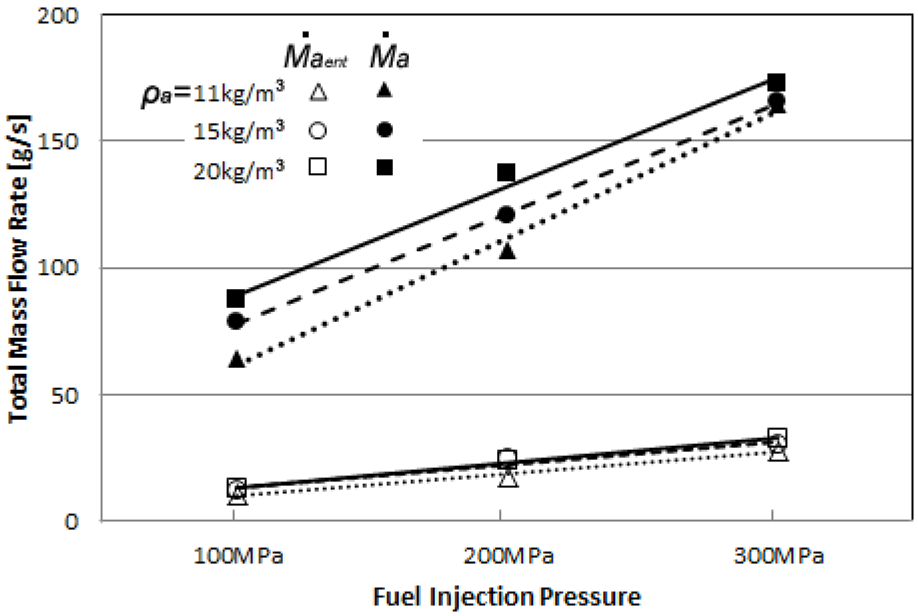


Fig.14 Total Mass Flow Rate along Side Periphery and Whole Spray Periphery
(d=0.08mm, 2.2ms ASOI)

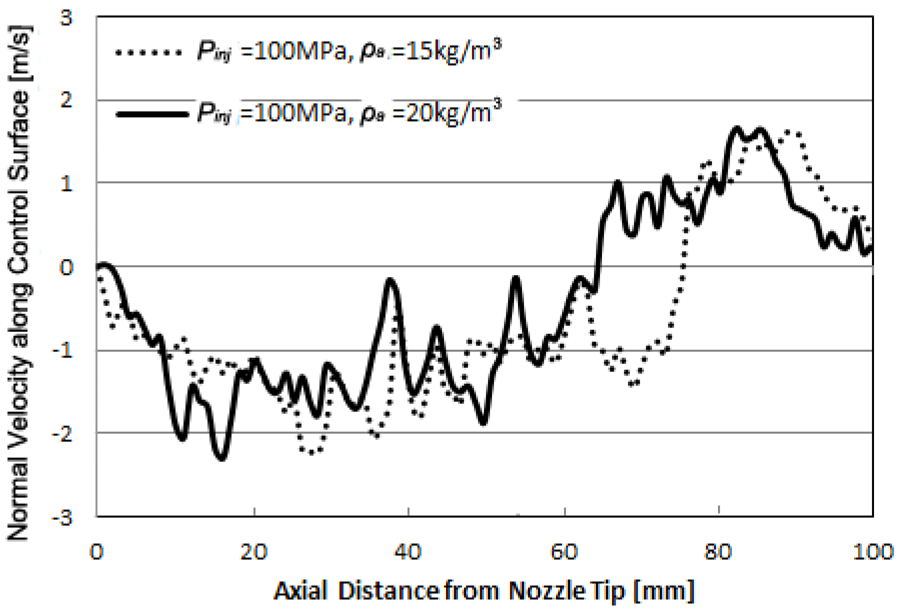
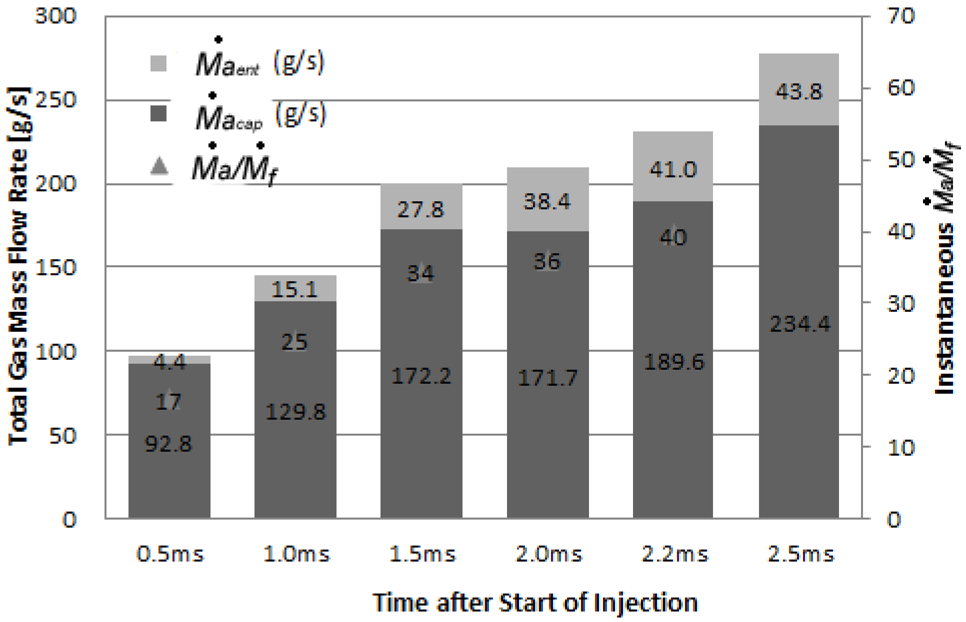
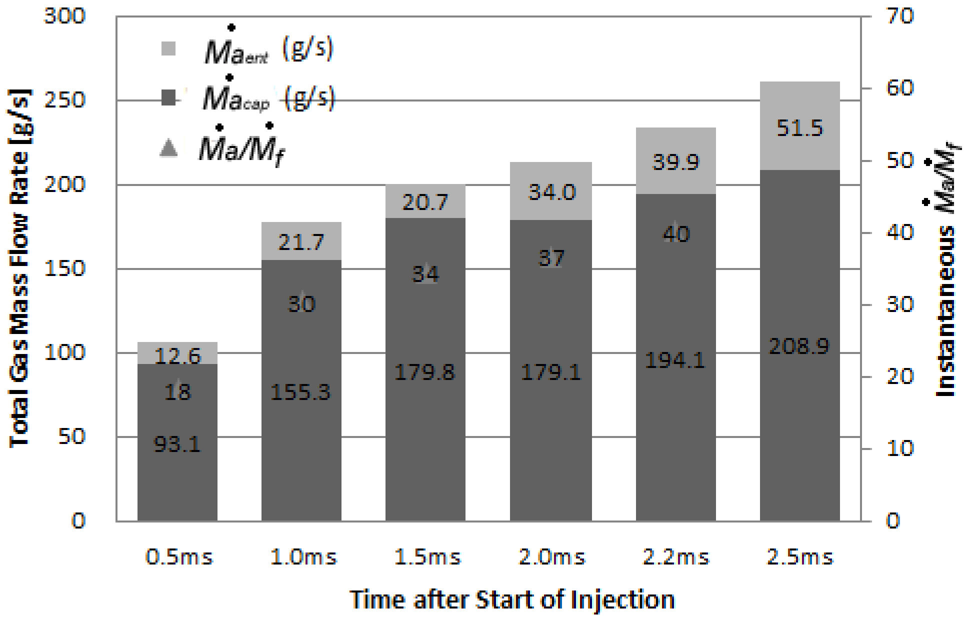


Fig.15 Spatial Distribution of Normal Velocity along Control Surface
(P_{inj}=100MPa, d=0.12mm, 2.2ms ASOI)



(a) ρ_a=15kg/m^3



(b) ρ_a=20kg/m^3

Fig.16 Temporal Variation of Total Ambient Gas Mass Flow Rate and Instantaneous $\dot{M}a / \dot{M}_f$

(P_{inj}=100MPa, d=0.12mm)

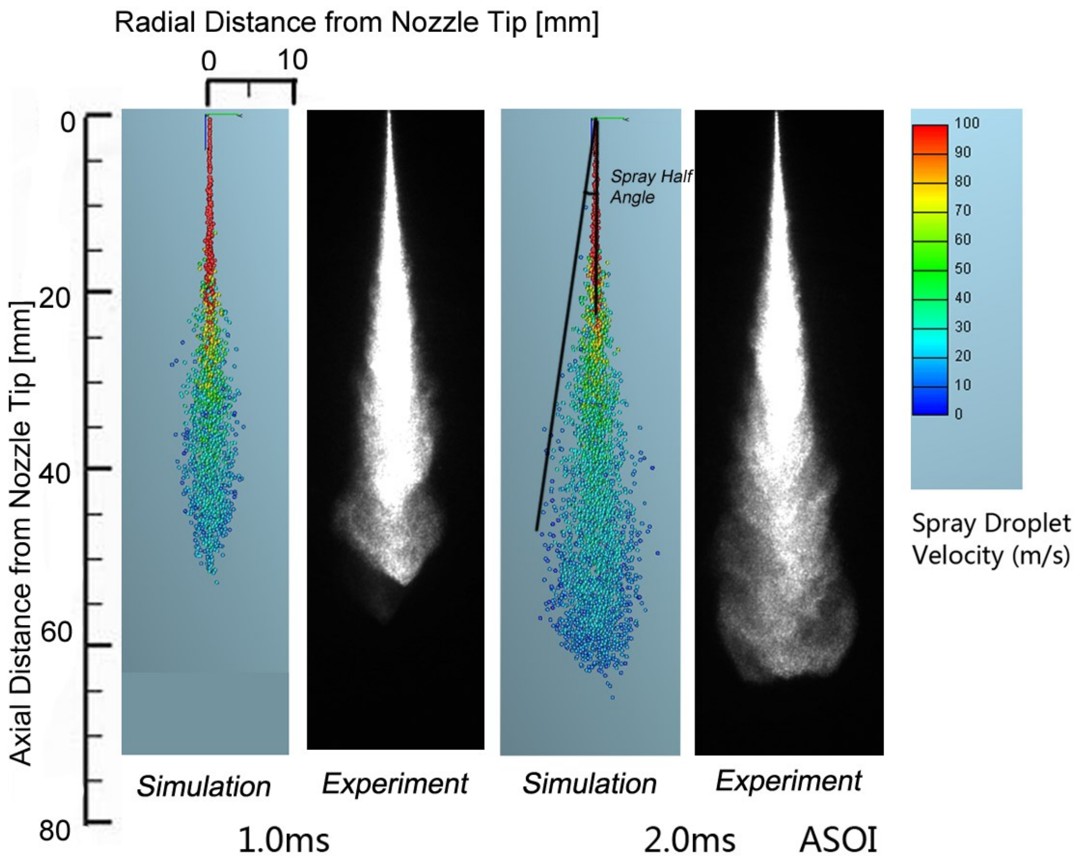


Fig. 17 Comparison of Spray Images from Experiment and Simulation
(P_{inj}=100MPa, ρ_a=15kg/m^3, d=0.08mm)

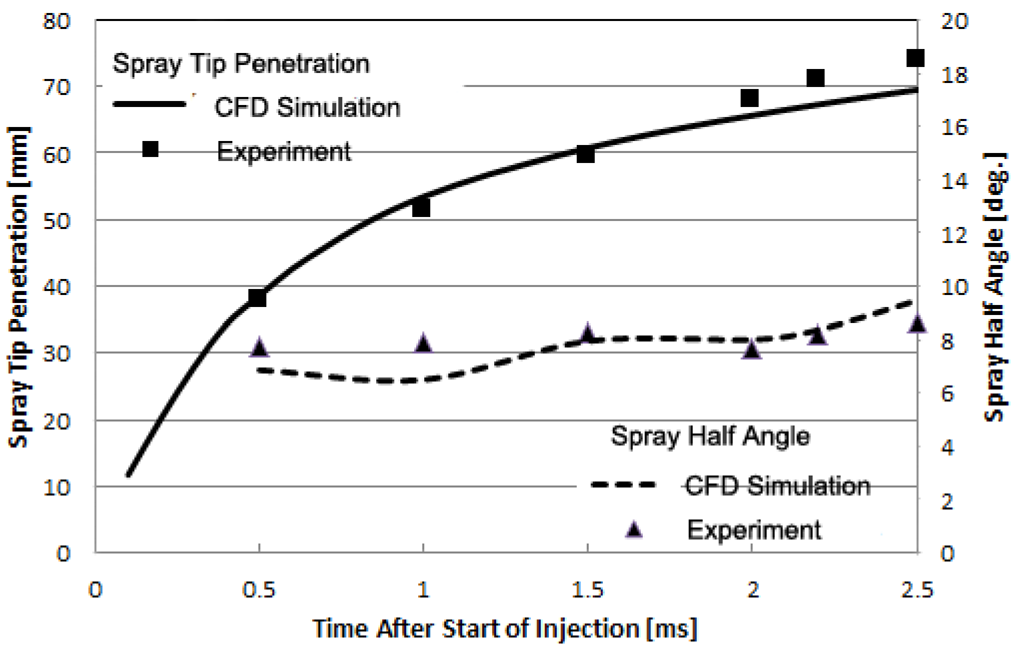


Fig.18 Comparison of Spray Penetration and Spray Half Angle with Experiment Result
(P_{inj}=100MPa, ρ_a=15kg/m^3, d=0.08mm)

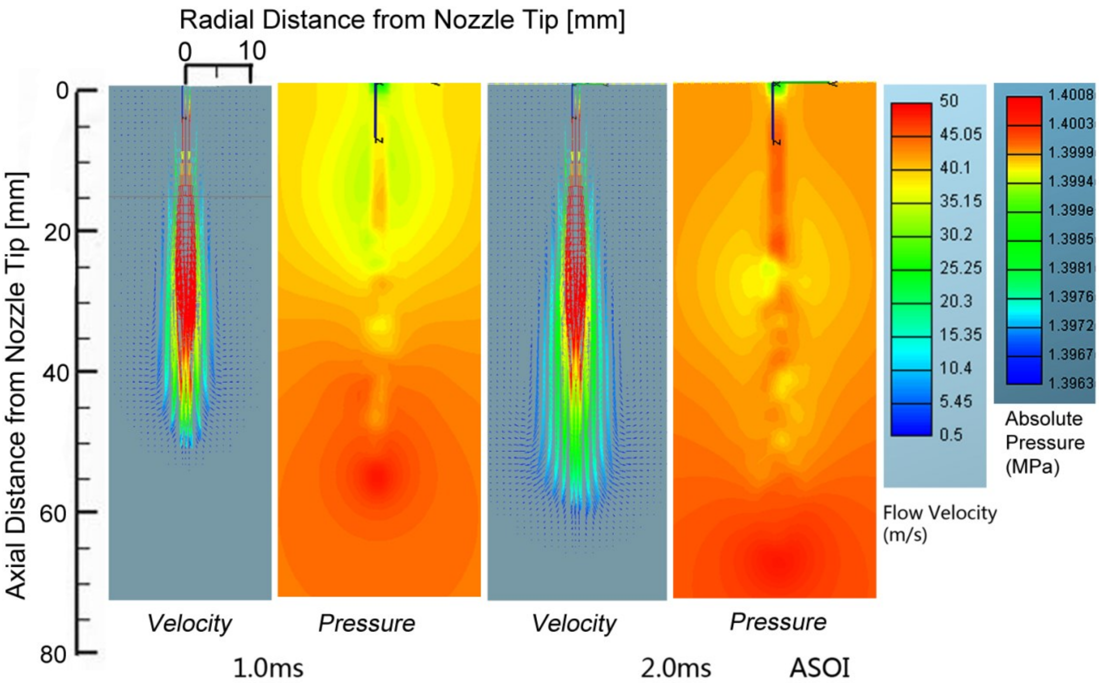


Fig. 19 Simulation Result of Spatial Distribution of Gas Flow Velocity
(P_{inj}=100MPa, ρ_a=15kg/m^3, d=0.08mm)

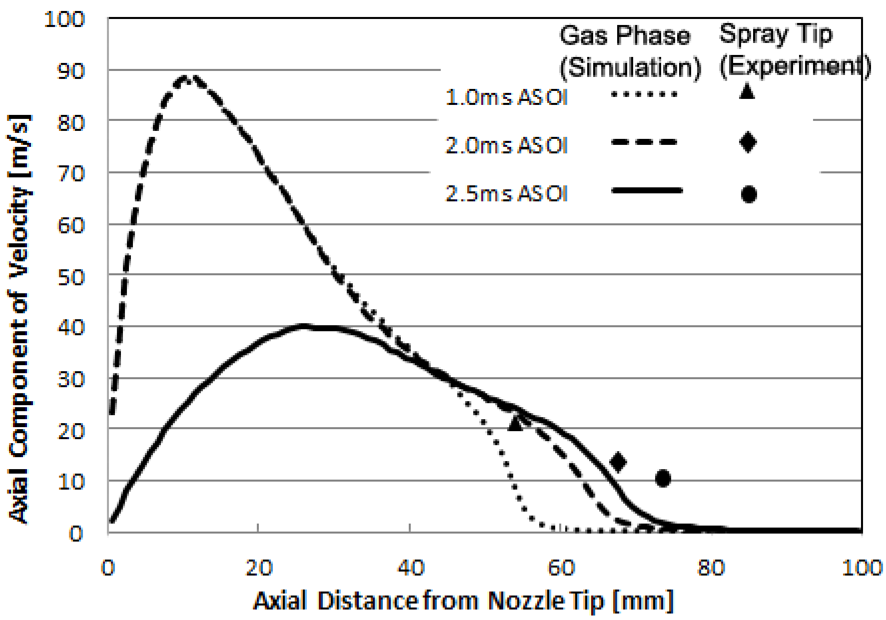


Fig. 20 Comparison of Axial Velocity of Ambient Gas and Spray Tip Penetrating Velocity
(P_{inj}=100MPa, ρ_a=15kg/m^3, d=0.08mm)

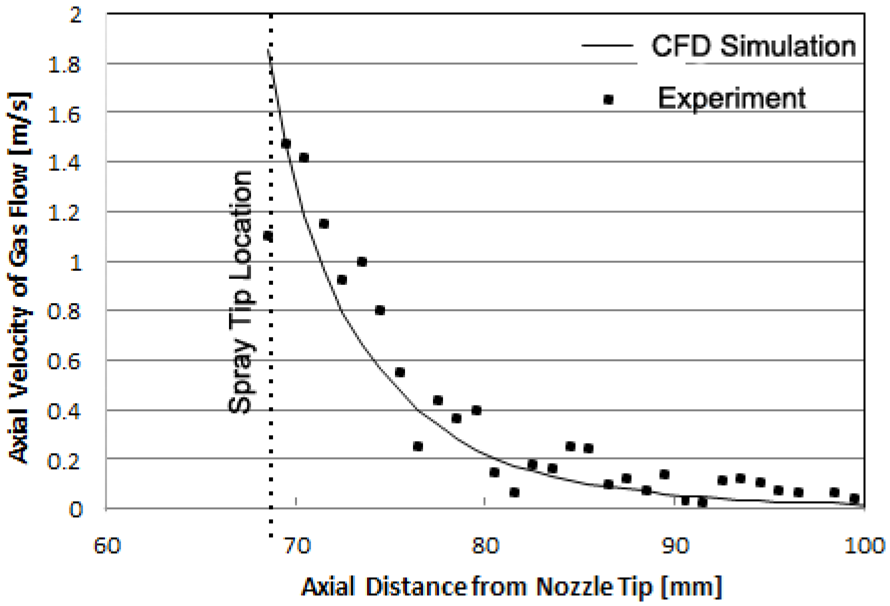


Fig.21 Comparison of Gas Flow Velocity along Nozzle Axis between CFD and LIF-PIV Results
(P_{inj}=100MPa, ρ_a=15kg/m^3, d=0.08mm, 2.0ms ASOI)

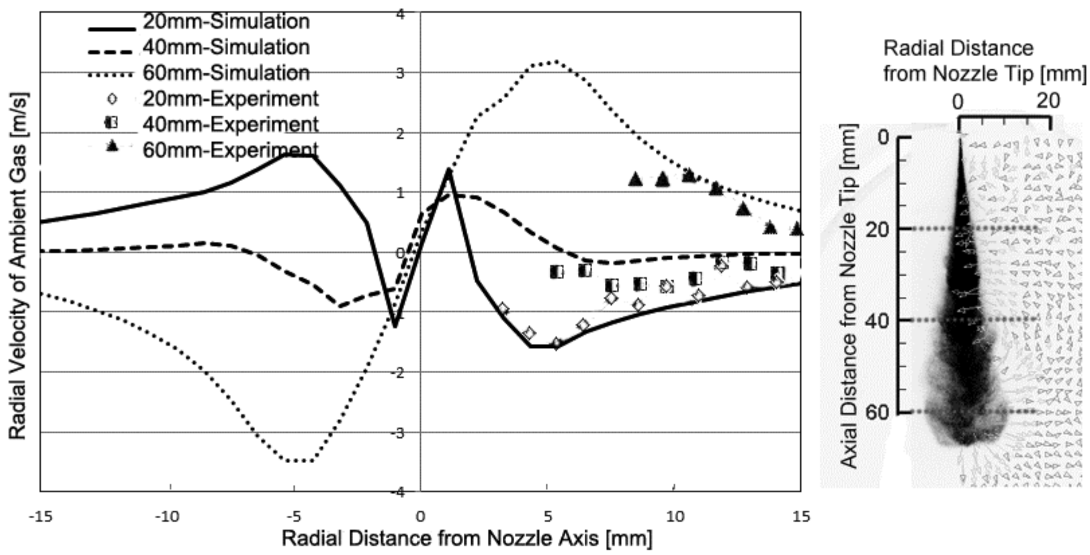


Fig.22 Radial Velocity of Gas Flow along Cross Sections with Different Distance from Nozzle Tip
(P_{inj}=100MPa, ρ_a=15kg/m^3, d=0.08mm, 2.0ms ASOI)

Table 1 Experiment Conditions

Nozzle Type	Single Hole Nozzle
Hole Diameter (mm)	0.08; 0.12
Injection System	Common Rail System
Injection Pressure (MPa)	100; 200; 300
Injection Duration (ms)	2.2
Fuel Type	Diesel JIS #2
Density (g/cm^3,300K)	0.82~0.86
Kinematic Viscosity (cSt, 300K)	1.3~4.1
Surface Tension (N/m, 300K)	0.025
Ambient Gas	Nitrogen
Density/Temperature/Pressure (kg/m^3; K; MPa)	11/300/1.1 15/300/1.4 20/300/1.8
Measurement Timing	0.5, 1.0, 1.5, 2.0, 2.2, 2.5ms ASOI

Table 2 Calculation models

Turbulent Model	k-ε Model
Nozzle Flow Simulation	Diesel Nozzle Flow (L/D=15; R/D=0.03)
Particle Interaction Model	O'Rourke
Primary Break-up Model	Core Injection
Secondary Break-up Model	WAVE