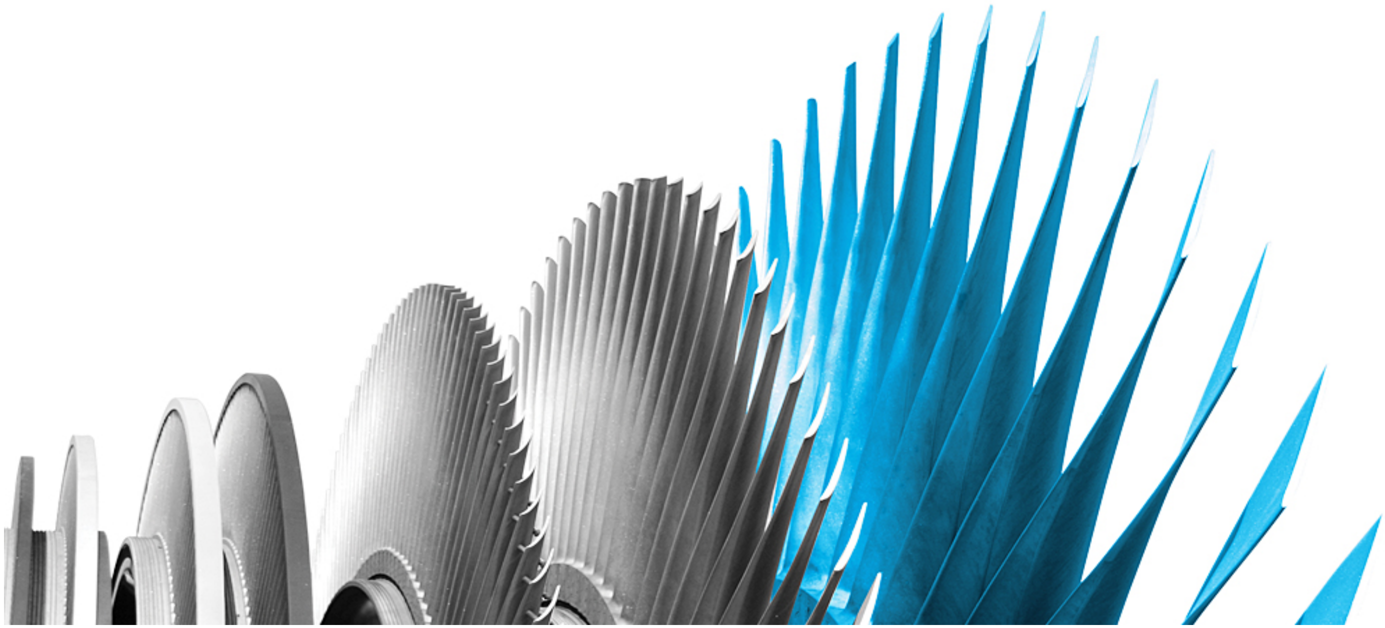
Volcanic ash impingement



PROVIDA

Cranfield University

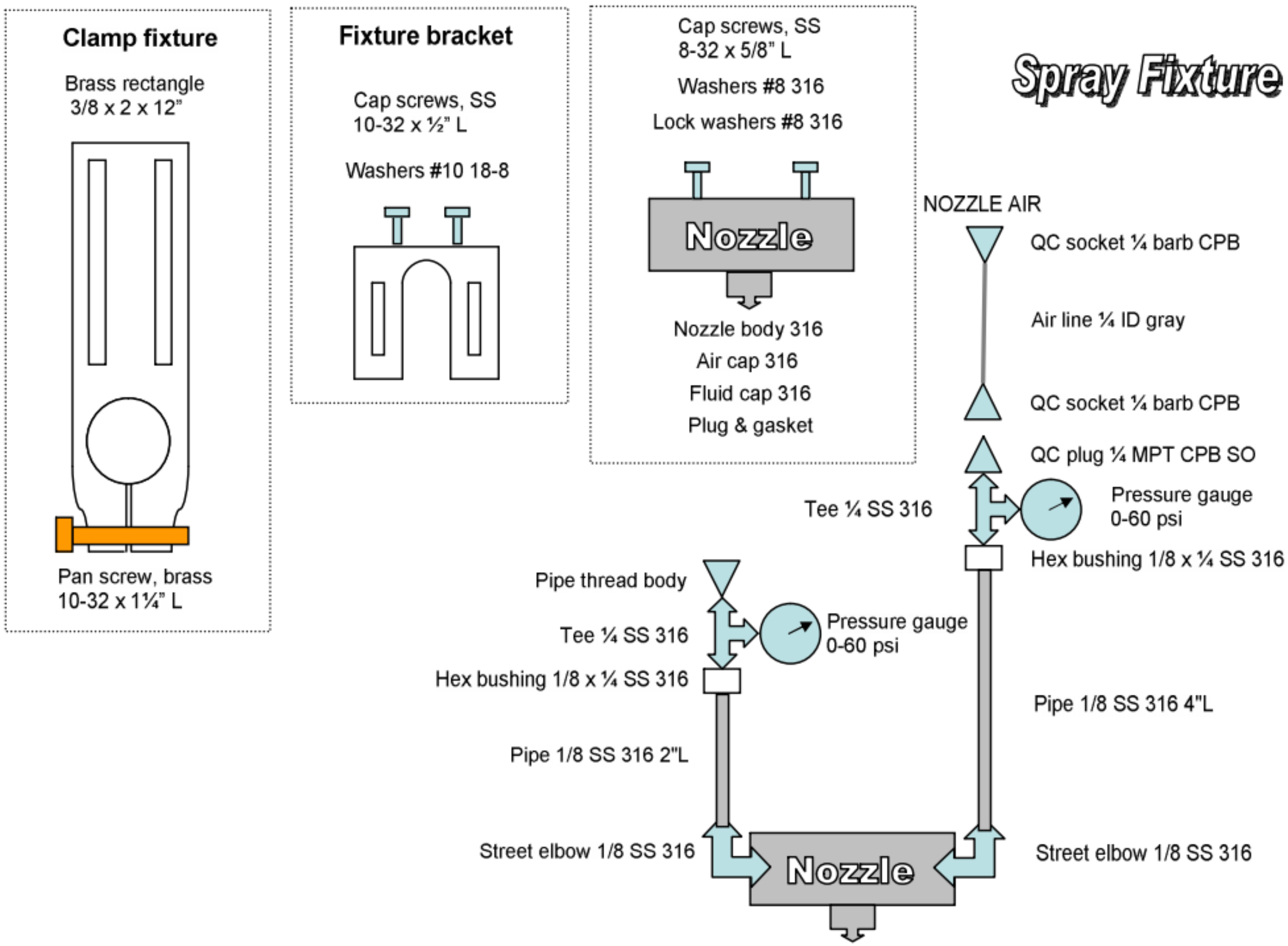
Prof. Sai Gu, Zihang Zhu

14/DEC/2015

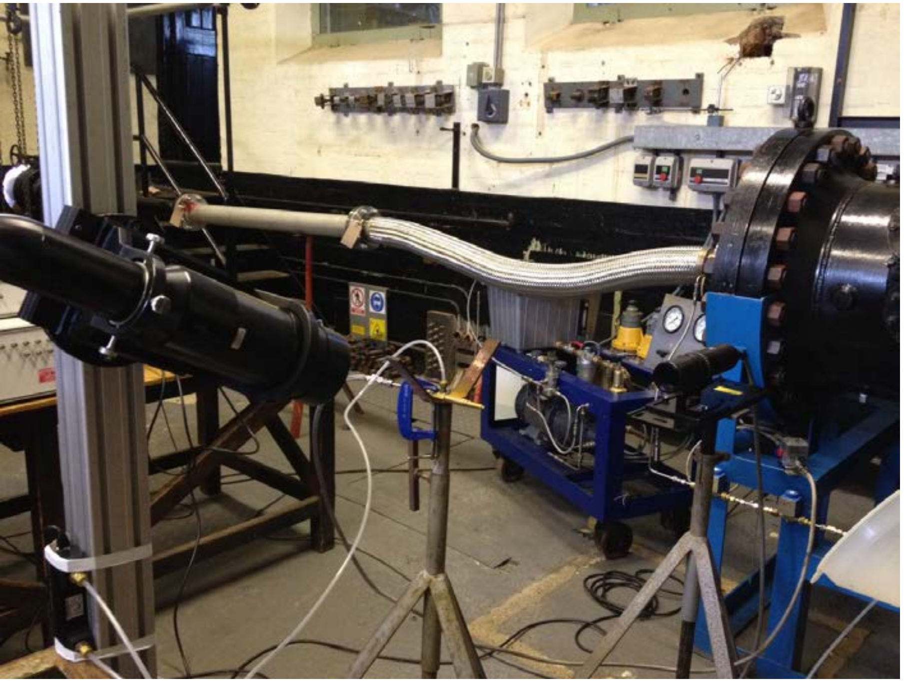
Content

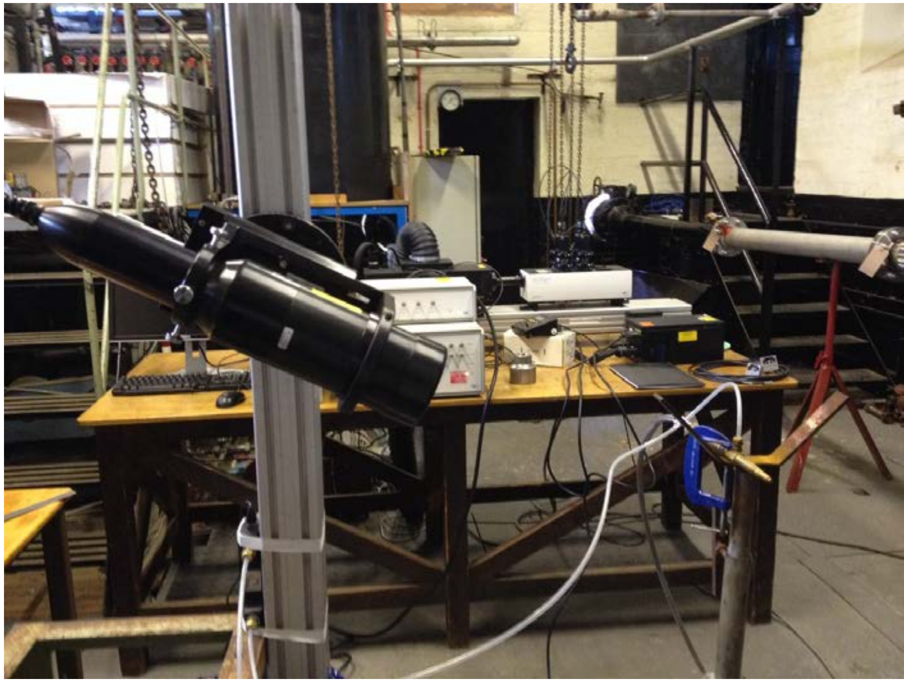
- SPPS atomizer experiment test
- SPPS atomizer simulation
- MD model of Particle impact

ARCI Atomizer test for SPPS



Experiment set-up for atomizer



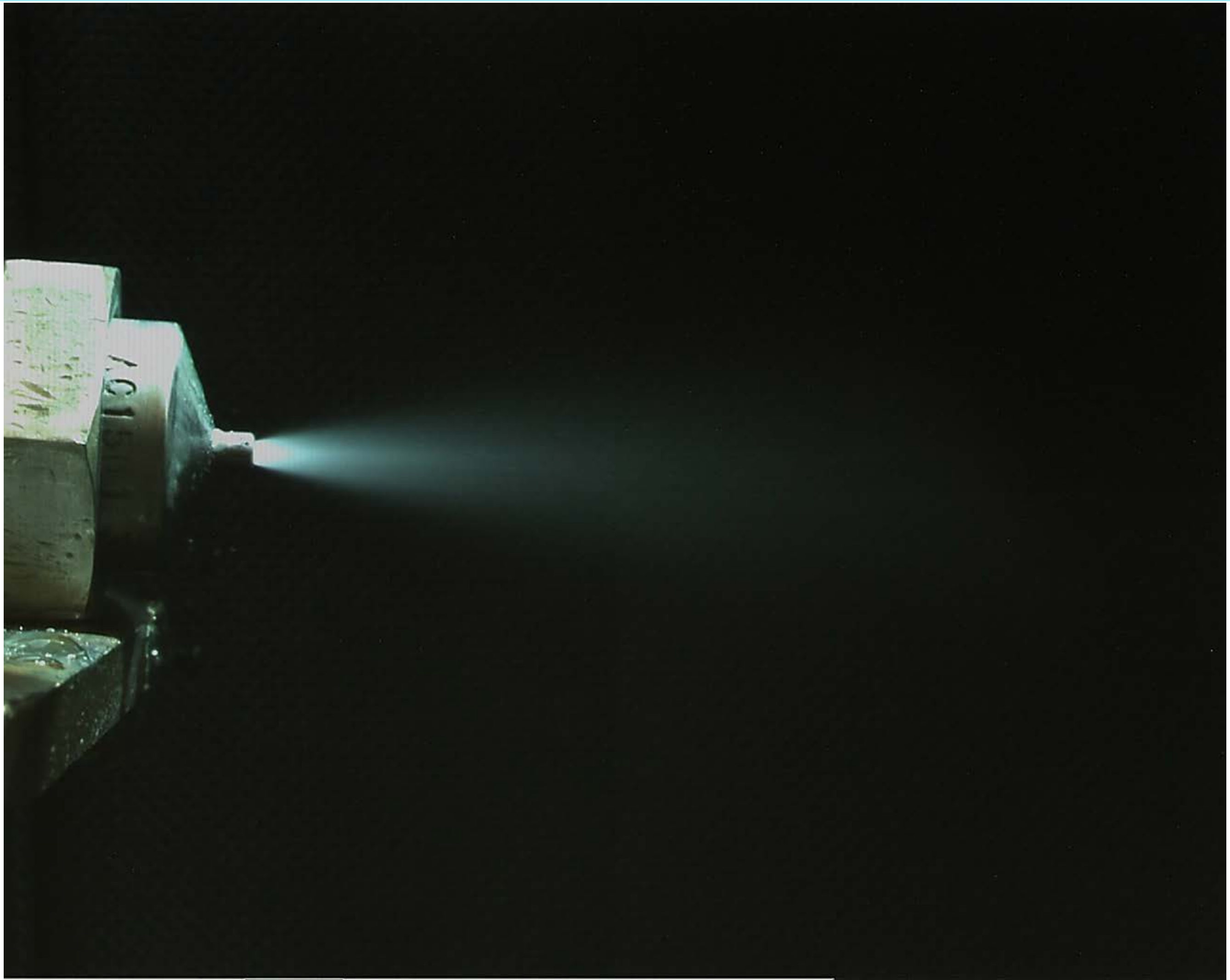


Test cases

- Test atomizer spray condition
  - 20 ml/min @ pressure 40 psi for water
  - Pressure @ 20 psi for Nitrogen gas
  - Room temperature

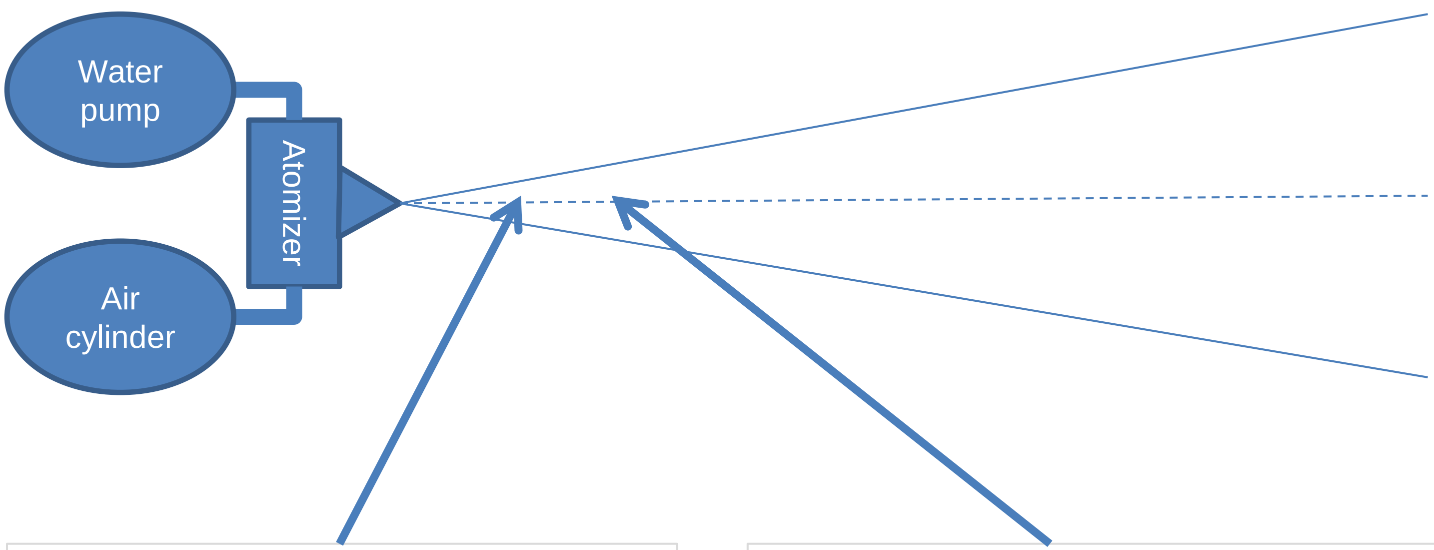
- Measurement
  - Utilizing the *Phase Doppler Particle Analyzer* (PDPA-LDV) system to measure the droplet particle diameter distribution from a distance to the outlet of the atomizer
  - Velocity, diameter were measured at 0.5 cm, 2 cm, 3 cm, 4cm, 6 cm, 9 cm, 15 cm from the atomizer
  - Every test cases were repeated 3 times

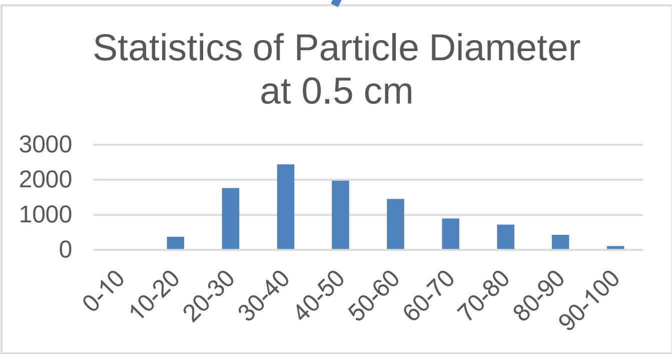
Atomizer Spray (high speed Cam)



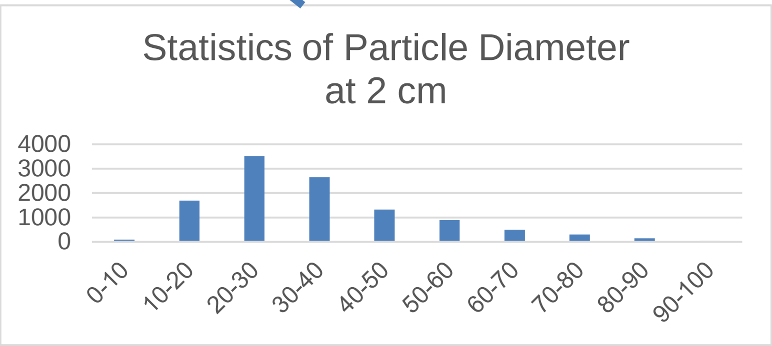
Particles Diameter Distribution

Cranfield UNIVERSITY



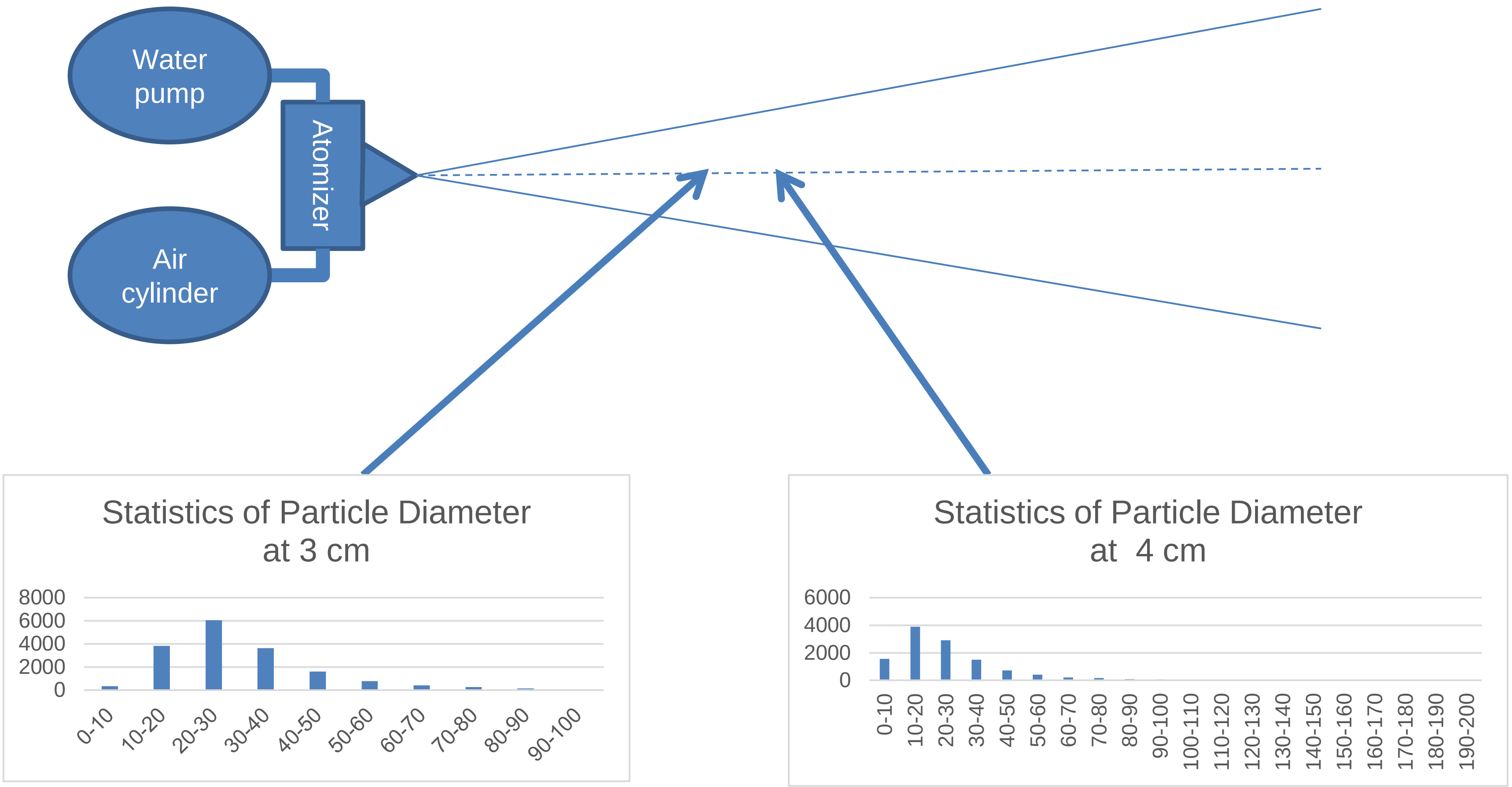


Mean: 45.567 µm



Mean: 34.679 µm

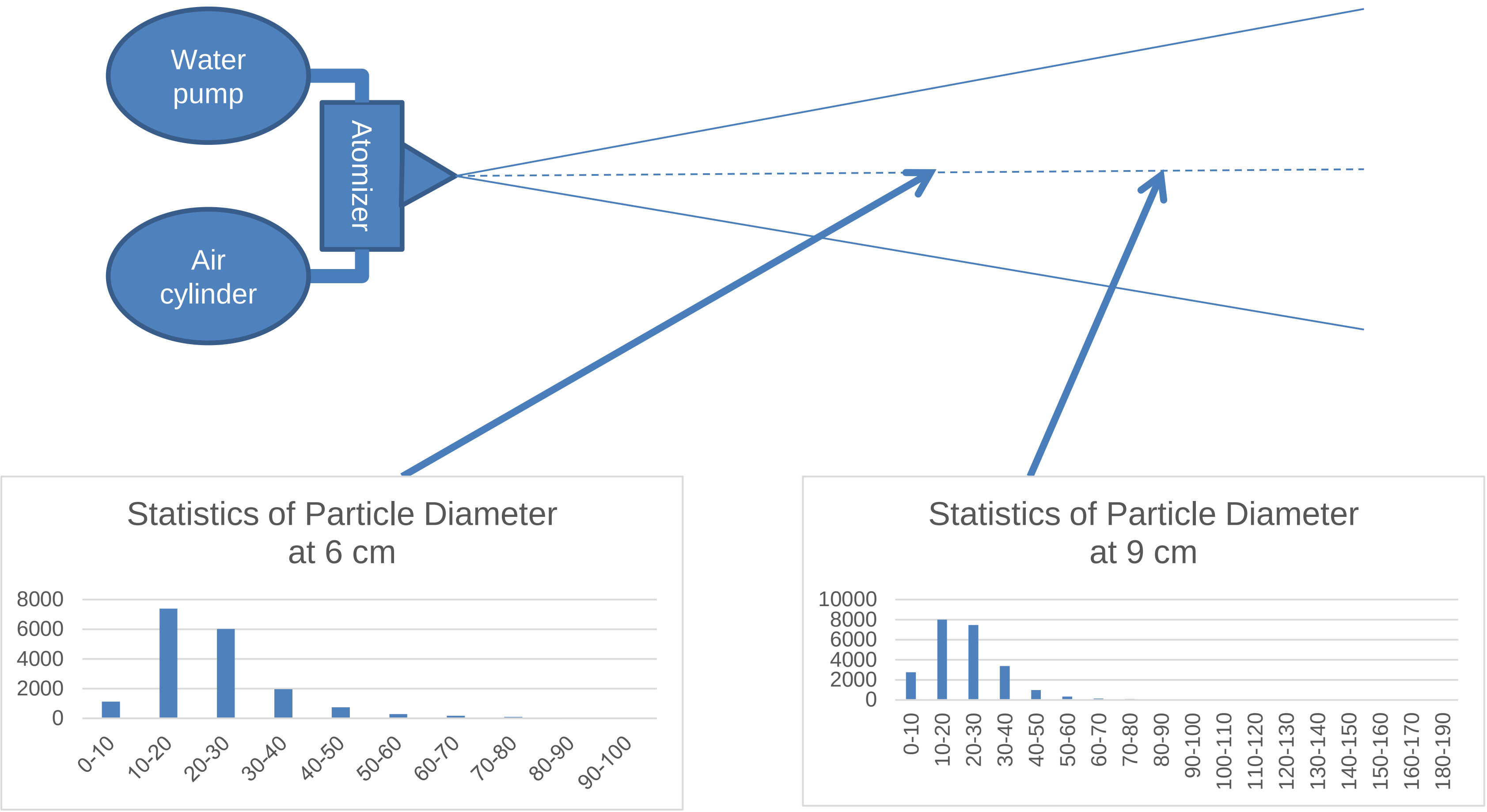
Particles Diameter Distribution



Mean: 30.116 µm

Mean: 25.781 µm

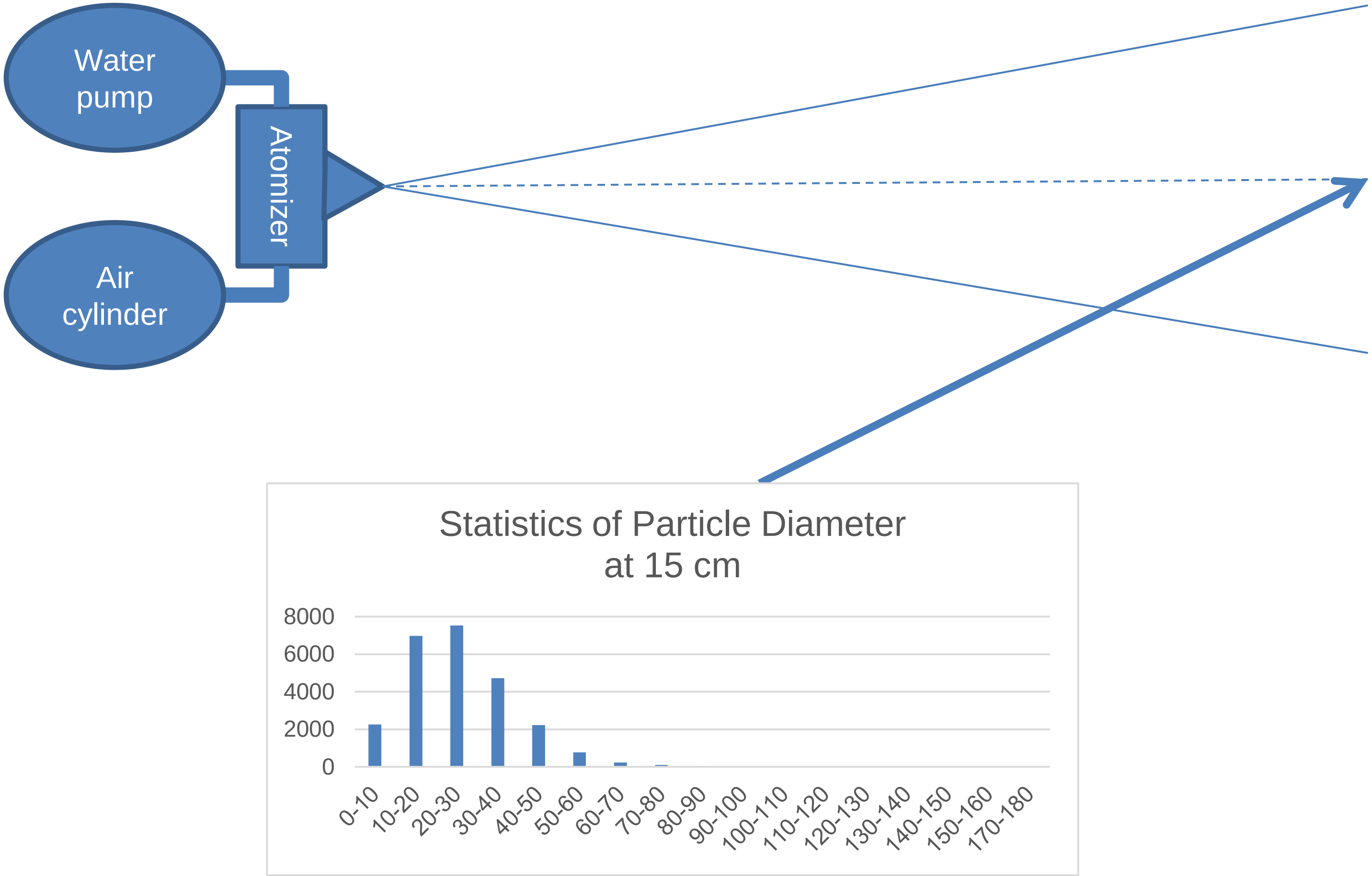
Particles Diameter Distribution



Mean: 22.814 μm

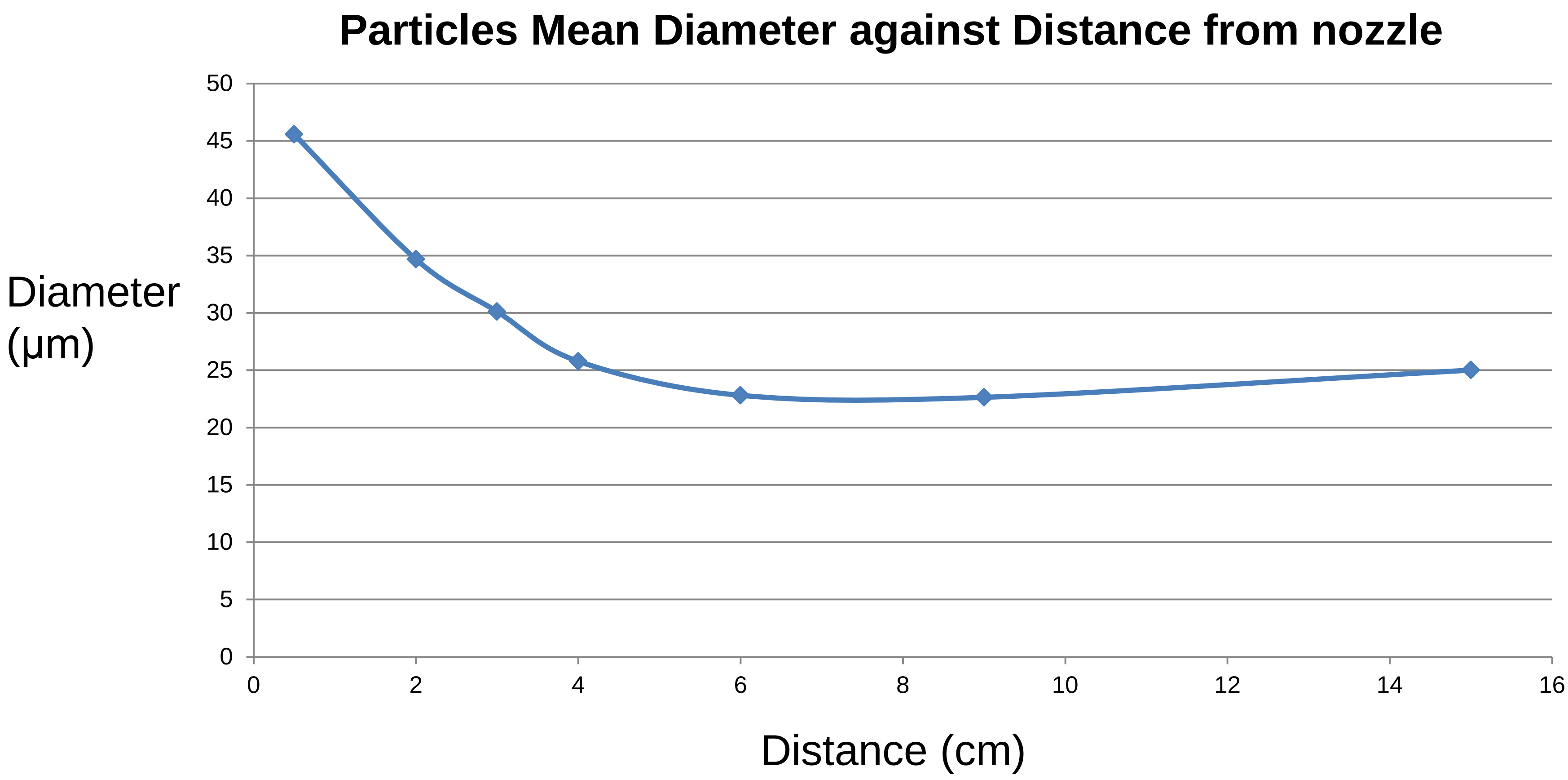
Mean: 22.623 μm

Particles Diameter Distribution

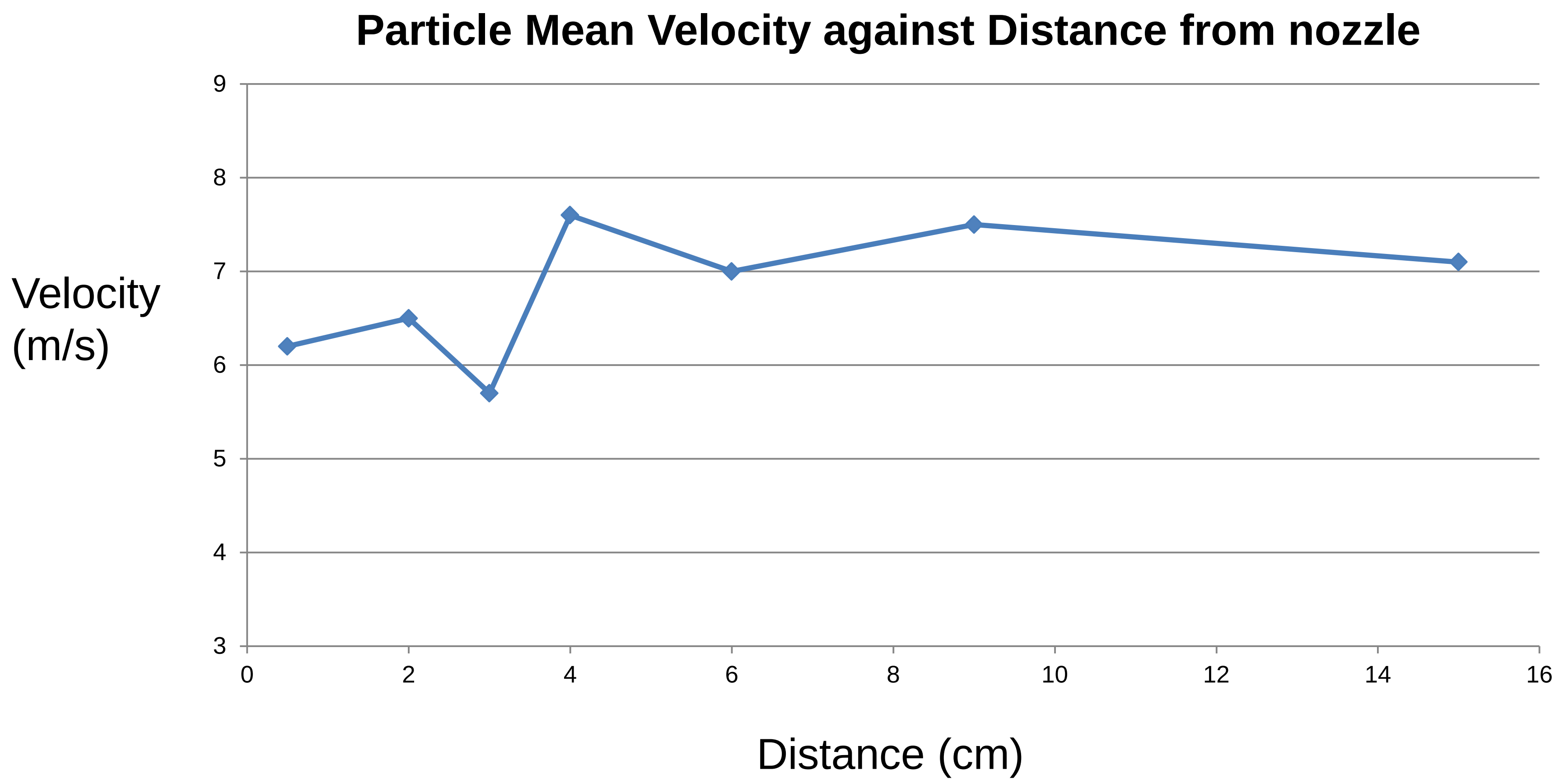


Mean: 24.163 μm

Particles Mean Diameter against Distance



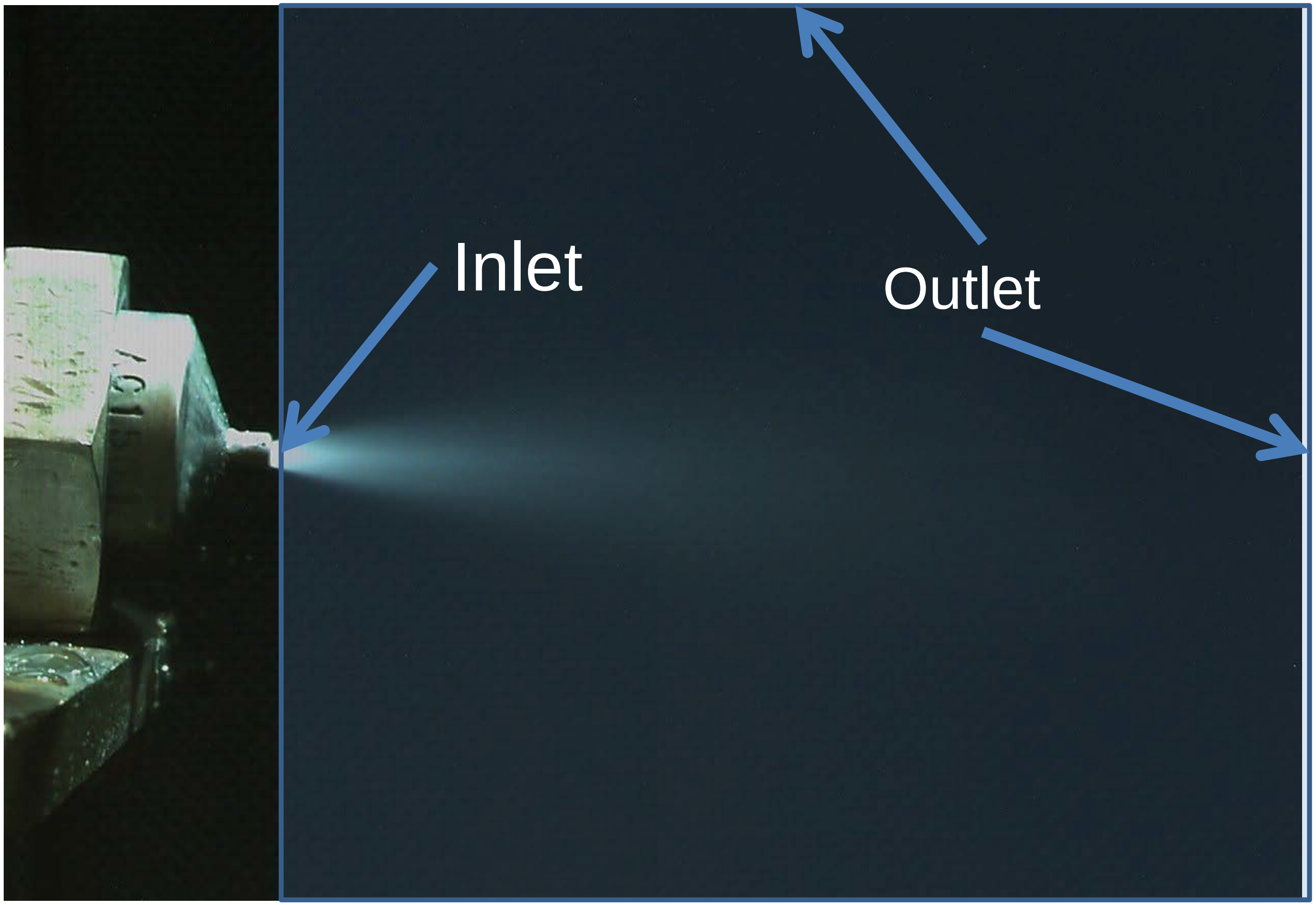
Cranfield UNIVERSITY



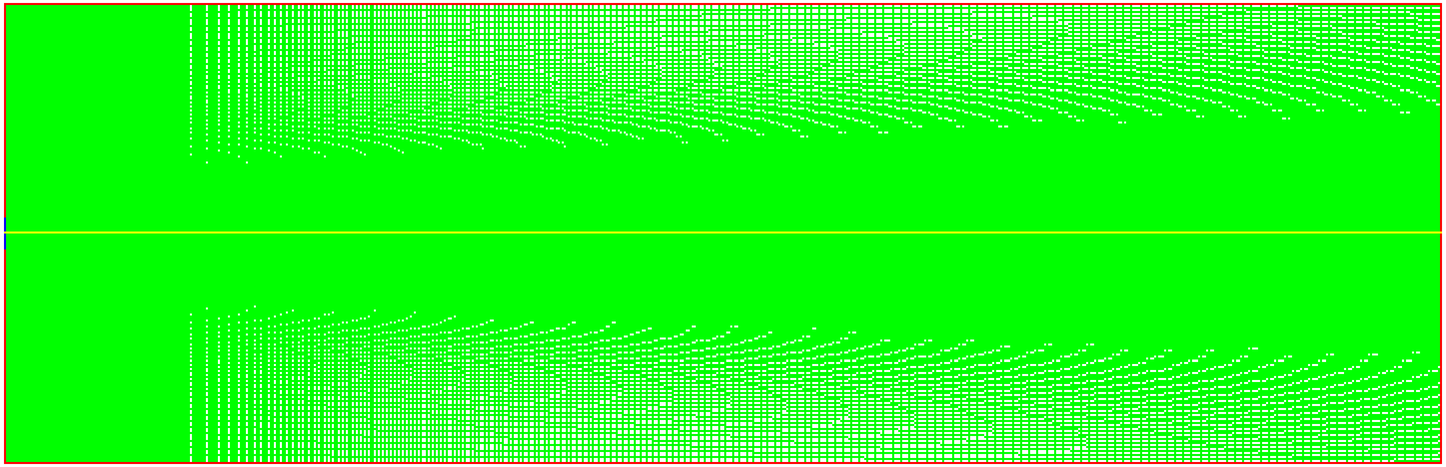
Numerical model of SPPS atomizer

- 1. Structure and mesh
- 2. Model
- 3. Results

Schematic Drawing



Mesh Drawing for the computed area

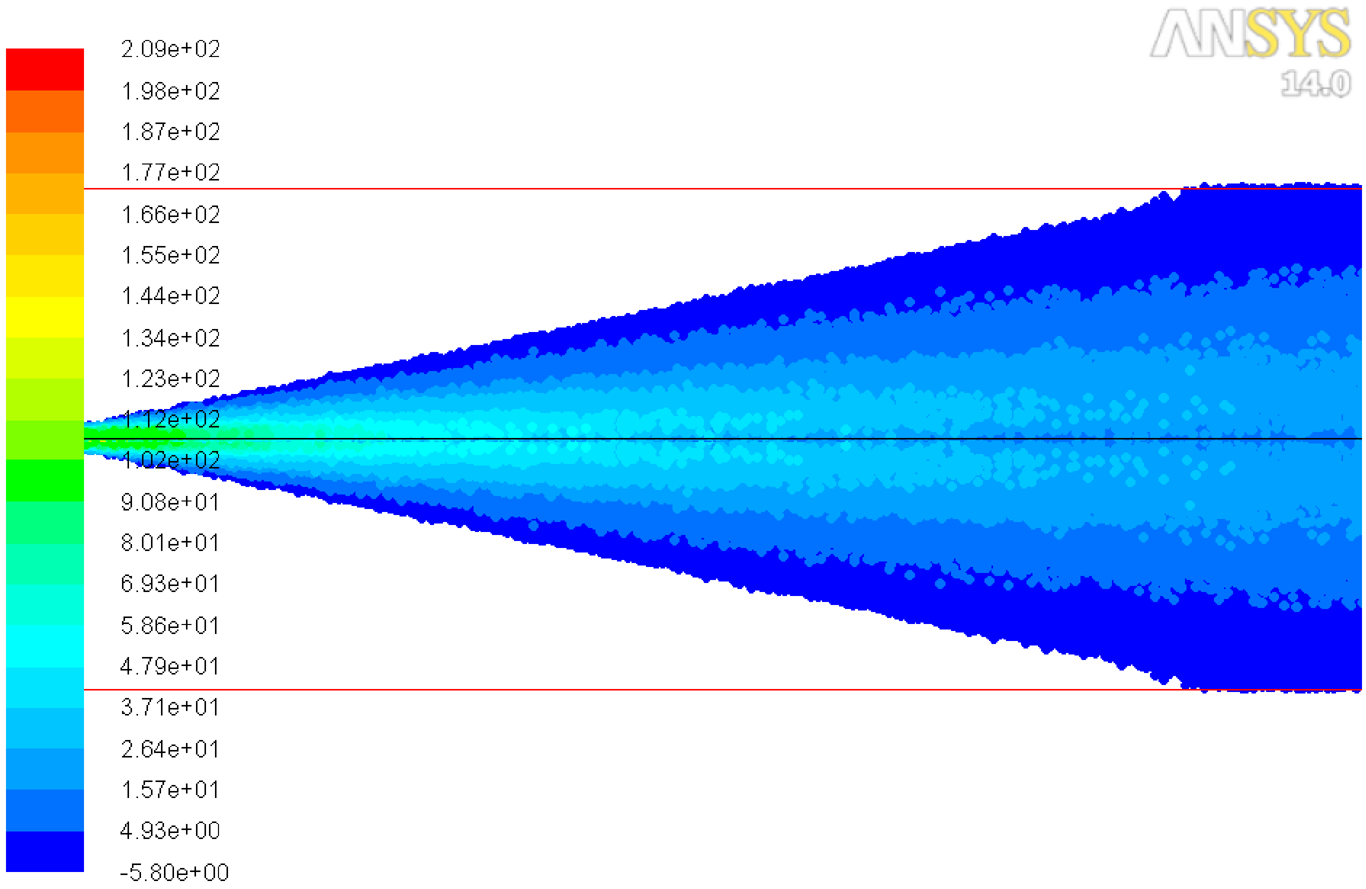


Prime breakup of droplets

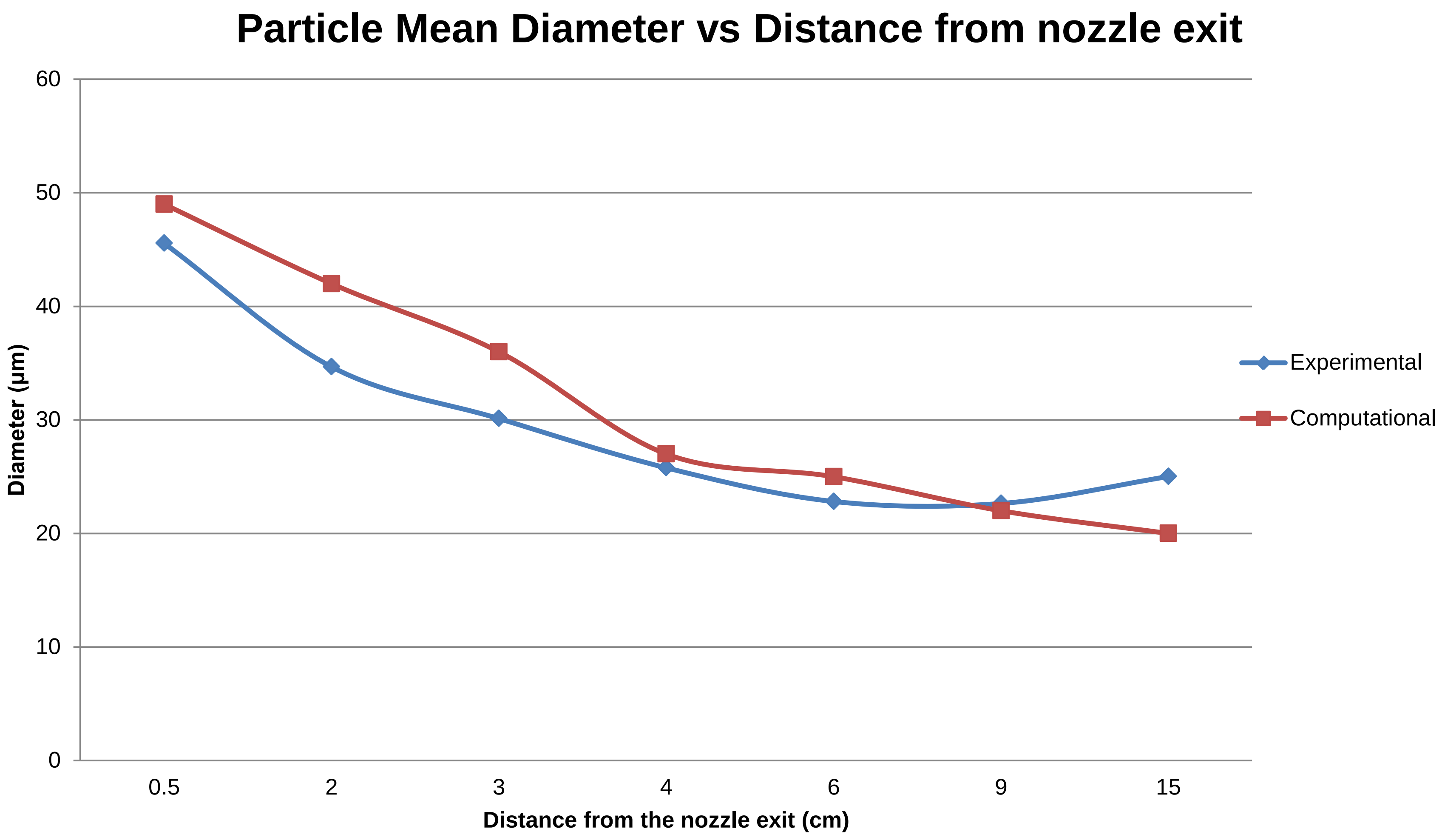
- The Linear instability Sheet Atomization (LISA) model is applied for capturing the primary breakup of ligament set. The motion of liquid in the injector creates an air core surrounded by the liquid film. The thickness of this film is related to the mass flow rate, nozzle exit diameter , liquid density and axial velocity of liquid film by following formula:

$$\dot{m}_{eff} = \pi \rho_l u t (D_{inj} - t)$$

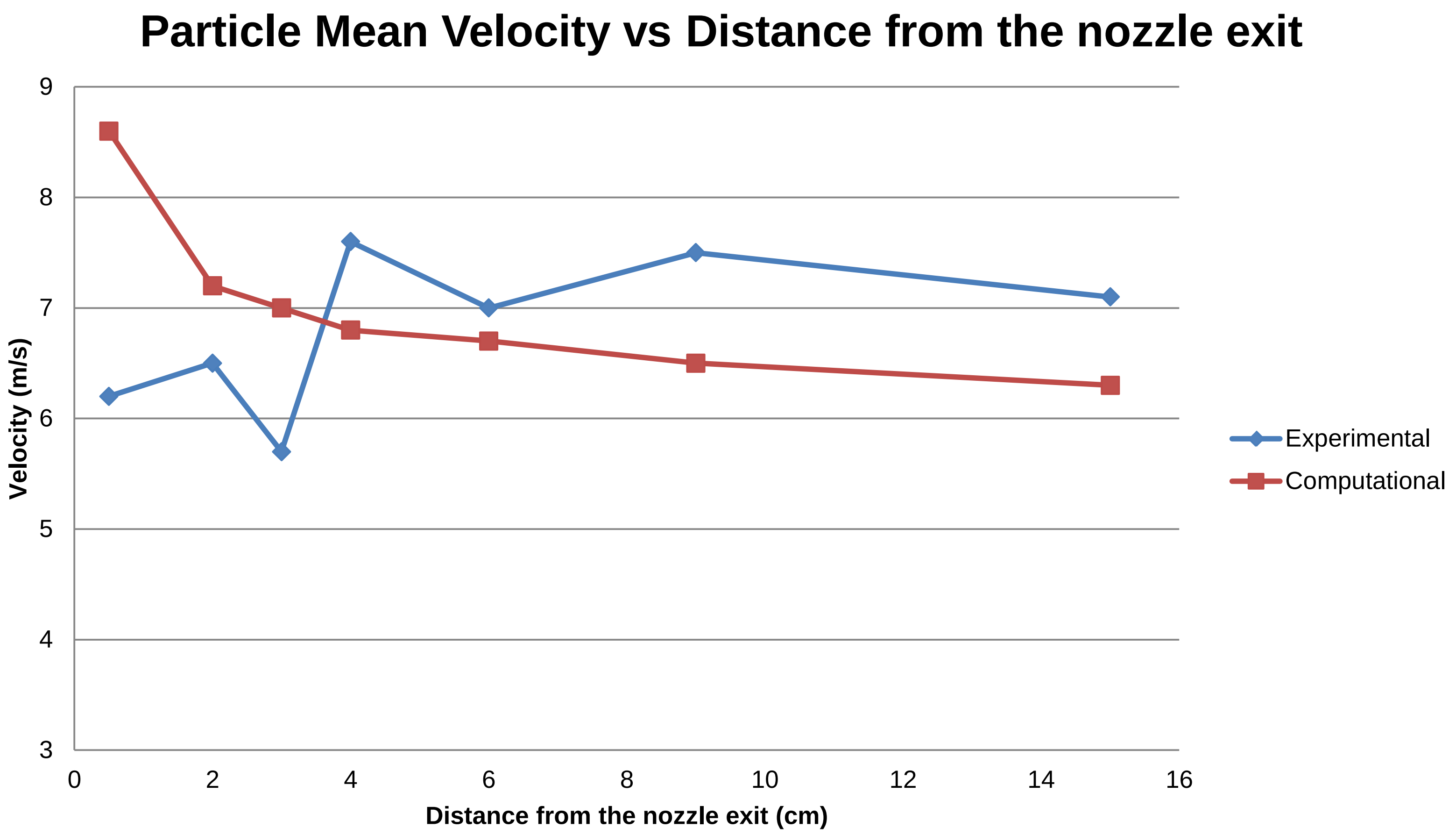
Utilizing DPM model (Transient)



Particles Mean Diameter against Distance



Particle Mean Velocity against Distance



Molecular Dynamic Model

The potential for Fe-Ni-Cr Alloy was used to simulate the substrate*

**G. Bonny et al., Modell. Simul. Mater Sci. Eng. 21 (2013) 085004.*

A transferable potential model (called CMAS 94 potential) applicable to both crystals and melts in the CMAS system*

**Matsui M (1994) A transferable interatomic potential model for crystals and melts in the system CaO-MgO-A1203-SiO 2. Mineral Mag 58 A:571-572*

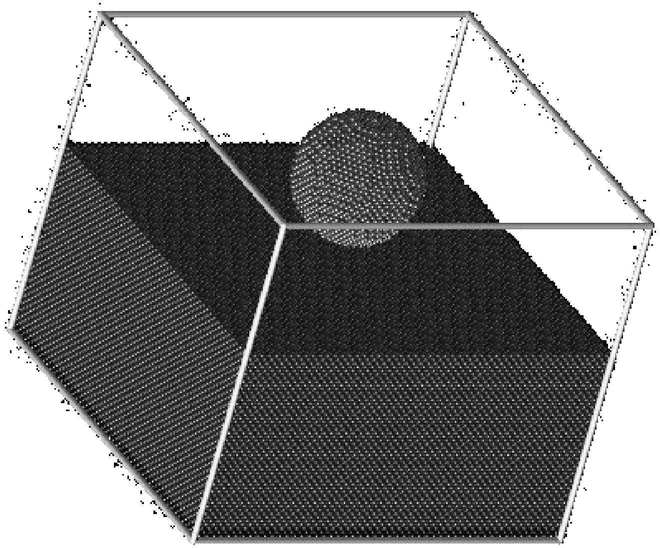
Particles was preheated to 1000K and substrate was preheated to 600K

Velocity of 80 m/s was initialized for particles

MD particle impact case

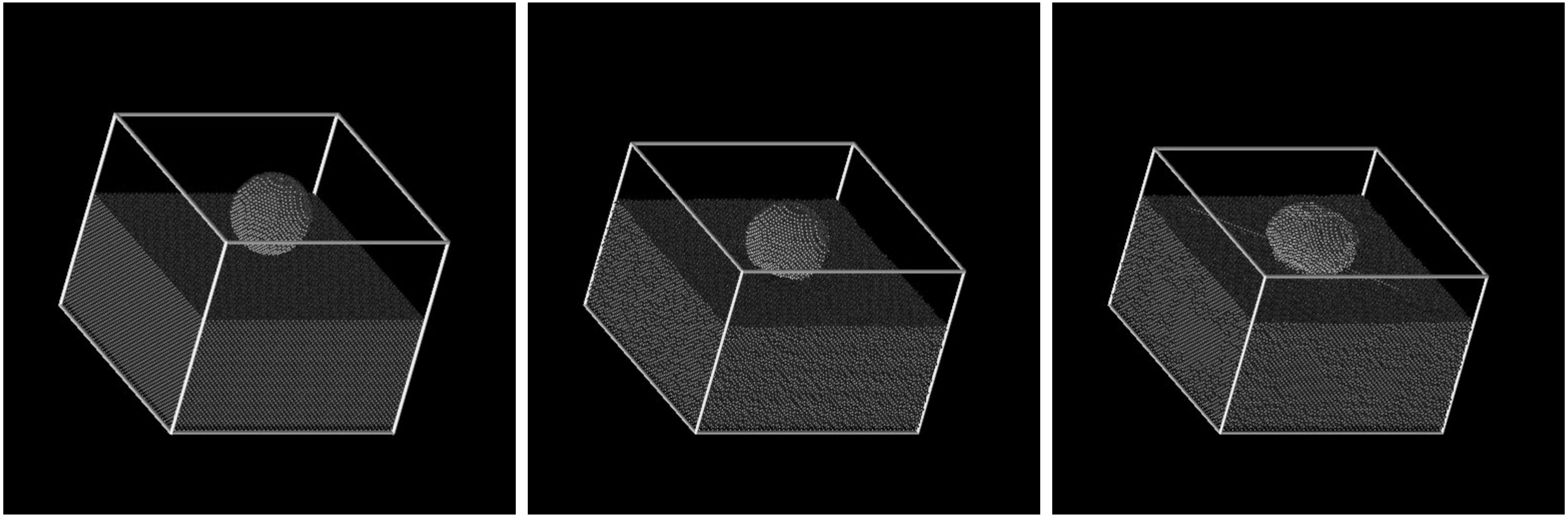
Energy parameters of the CMAS 94 potential, used for simulation

	$q/\|e\|$	$A/Å$	$B/Å$	$C/[Å^3 (kJ/mol)^{1/2}]$
Mg	0.945	0.8940	0.040	29.05
Ca	0.945	1.1720	0.040	45.00
Al	1.4175	0.7852	0.034	36.82
Si	1.890	0.7204	0.023	49.30
O	−0.945	1.8215	0.138	90.61



Initialized MD impact case

MD particle impact case



Thank you