EFFECT OF WATER MIST SYSTEM ON CONTROLLED FIRE

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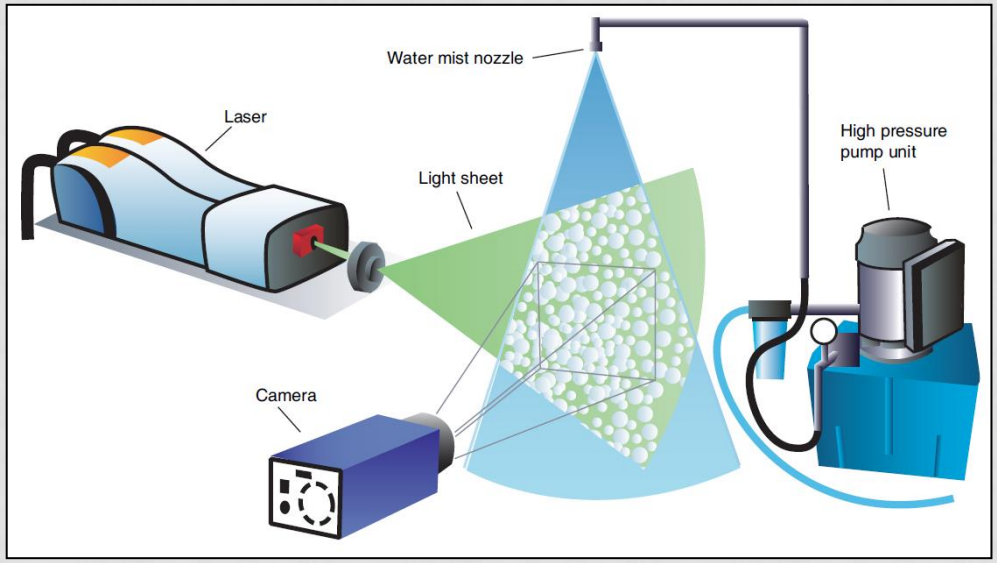
OBJECTIVE

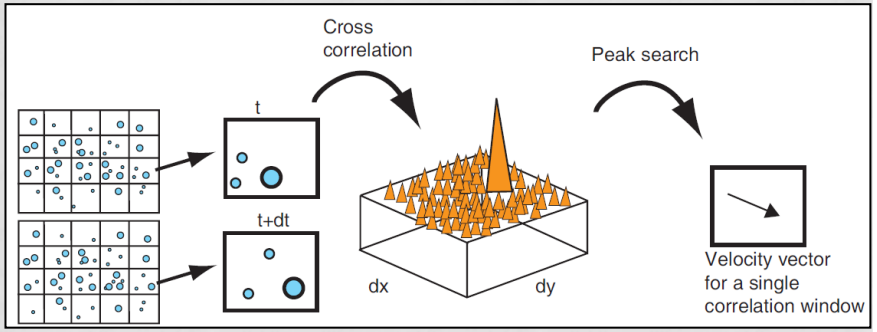
- Replicate **water mist system in FDS** accurately
- Achieve **best distribution (uniform) of water vapour** in enclosure
- **Measure water concentration** at representative spot in enclosure
- **Investigate effect of water mist on flame** (HRR reduction/ extinguishment)

REFERENCES TO PAST WORK

Particle Image Velocimetry (PIV)

- Pattern recognition technique
  - Laser illuminates a thin sheet in spray and takes two images within short intervals
  - Movement of droplets by comparing pixel intensity of the two frames

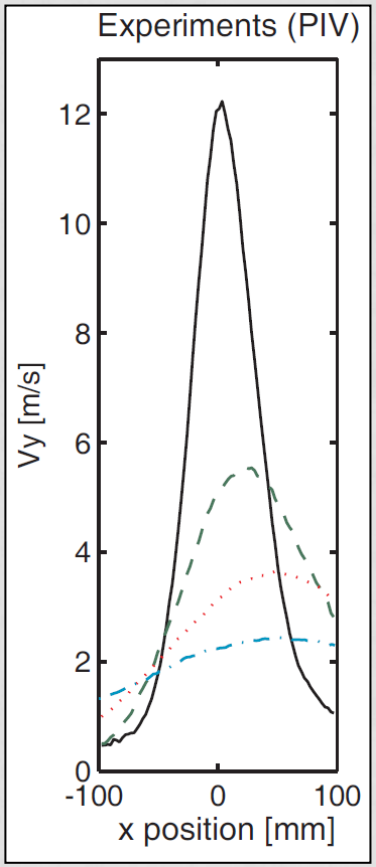




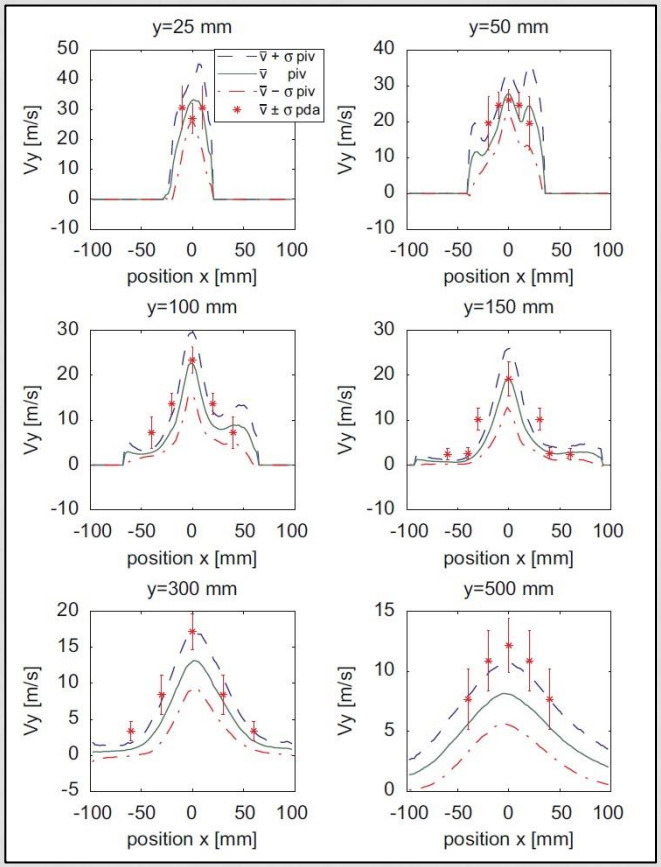
Images from:

"Experimental measurements of water mist systems and implications for modeling in CFD" ***Bjarne Paulsen Husted (2007)***

REFERENCES TO PAST WORK (PIV RESULTS – VELOCITY MEASUREMENTS)



(i)



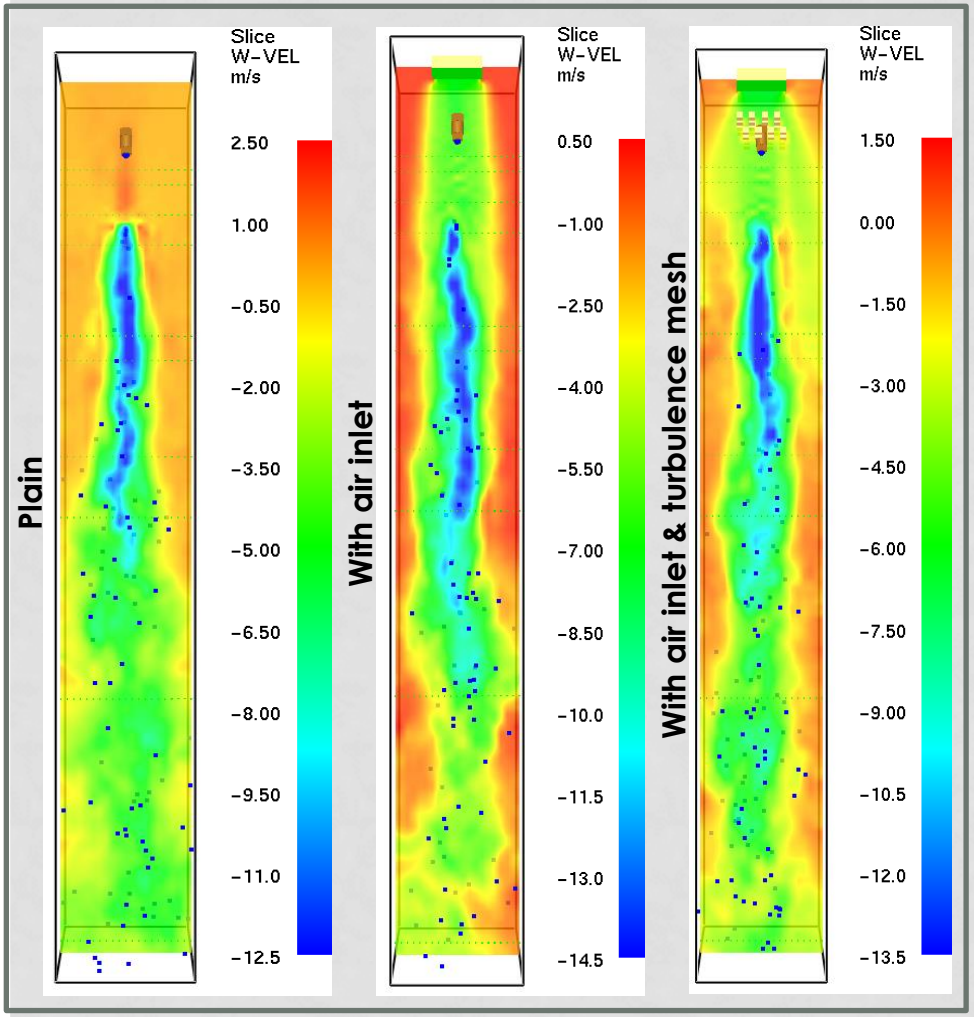
(ii)

Distance from nozzle (mm)
25
50
100
150
300
340
500
600
900
1300

i) "Experimental measurements of water mist systems and implications for modeling in CFD"
Bjarne Paulsen Husted (2007)

ii) "Comparison of PIV and PDA droplet velocity measurement techniques on two high pressure water mist nozzles"
Bjarne Paulsen Husted, Per Petersson, Ivar Lund, Göran Holmstedt

W-VELOCITY (VERTICAL)



Investigating past attempt to improve accuracy of water mist simulation (method replicated)

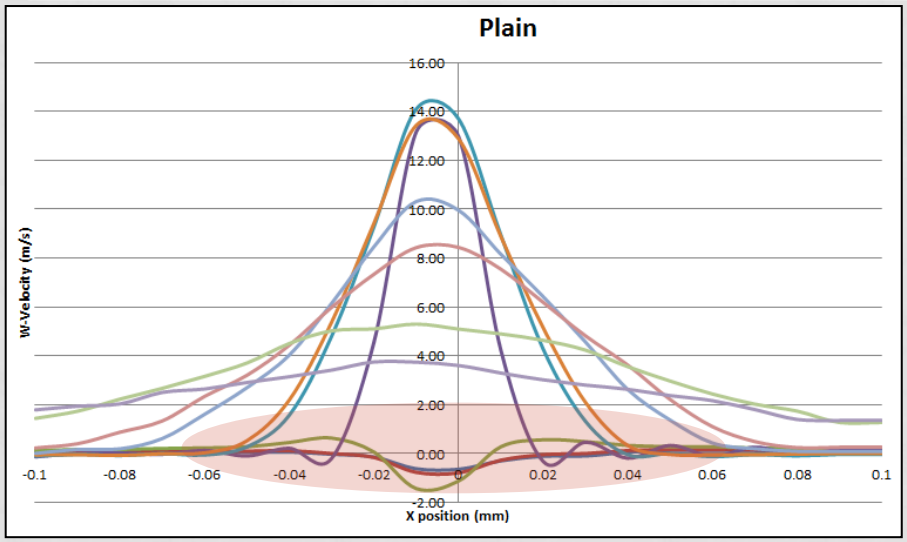
Previously had challenges validating velocity profiles

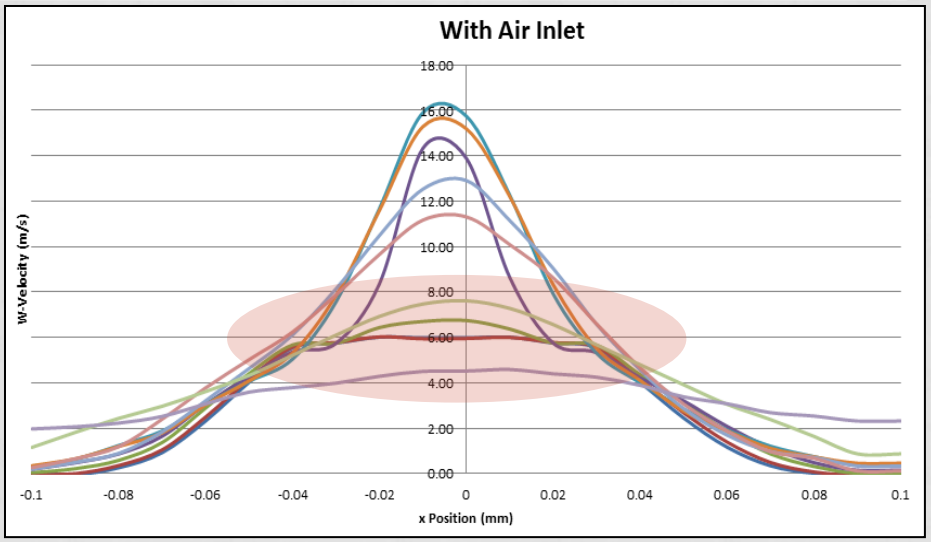
1. Plain

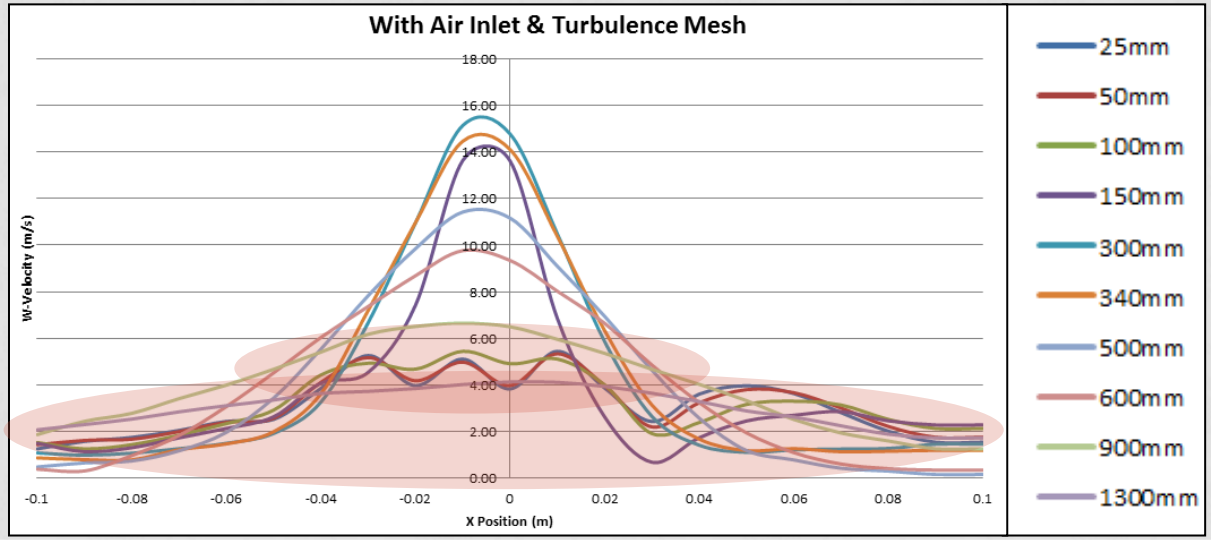
1. With Air Inlet
   - 80 x 80mm
   - $0.045 m^3/s$

2. With Air Inlet & Turbulence Mesh
   - two obstruction layers (1cm blocks)
   - 80 x 80mm each

W-VELOCITY (VERTICAL)

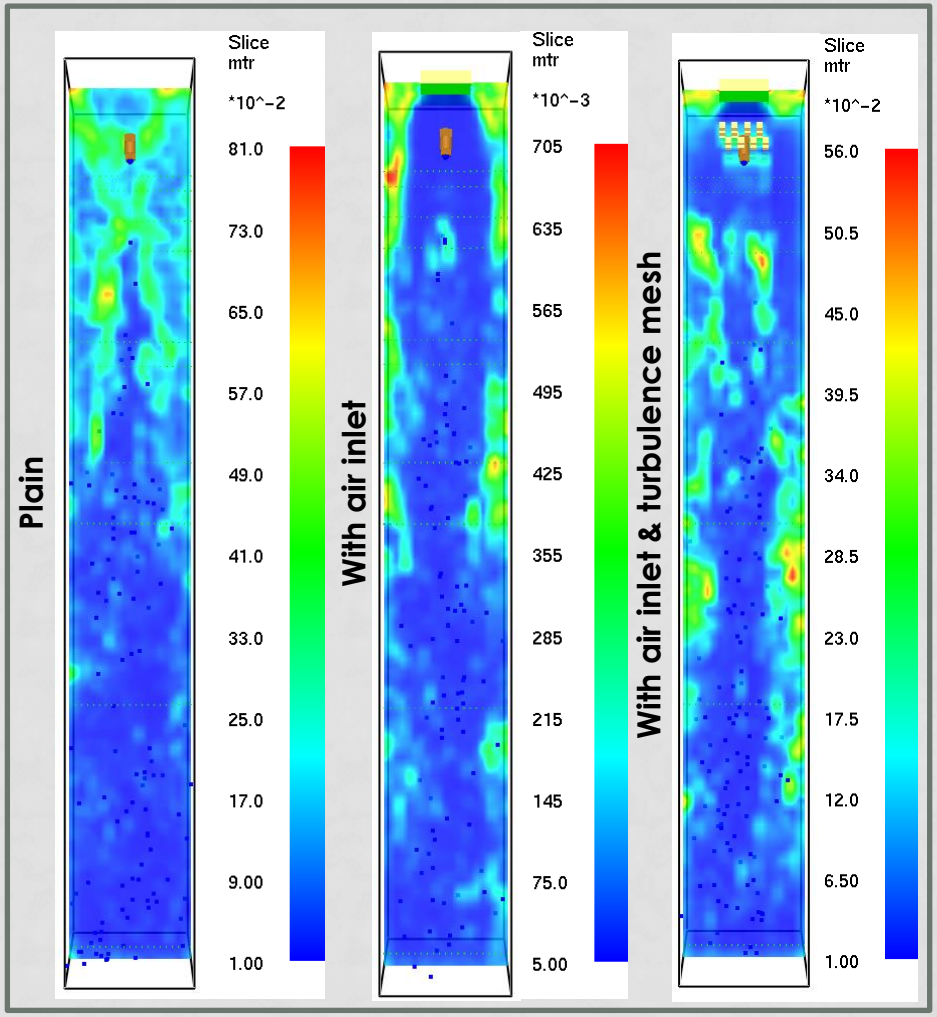






Momentum lost

TURBULENCE RESOLUTION



Investigating degree of turbulence captured in simulation (LES)

Measure of Turbulence Resolution, MTR

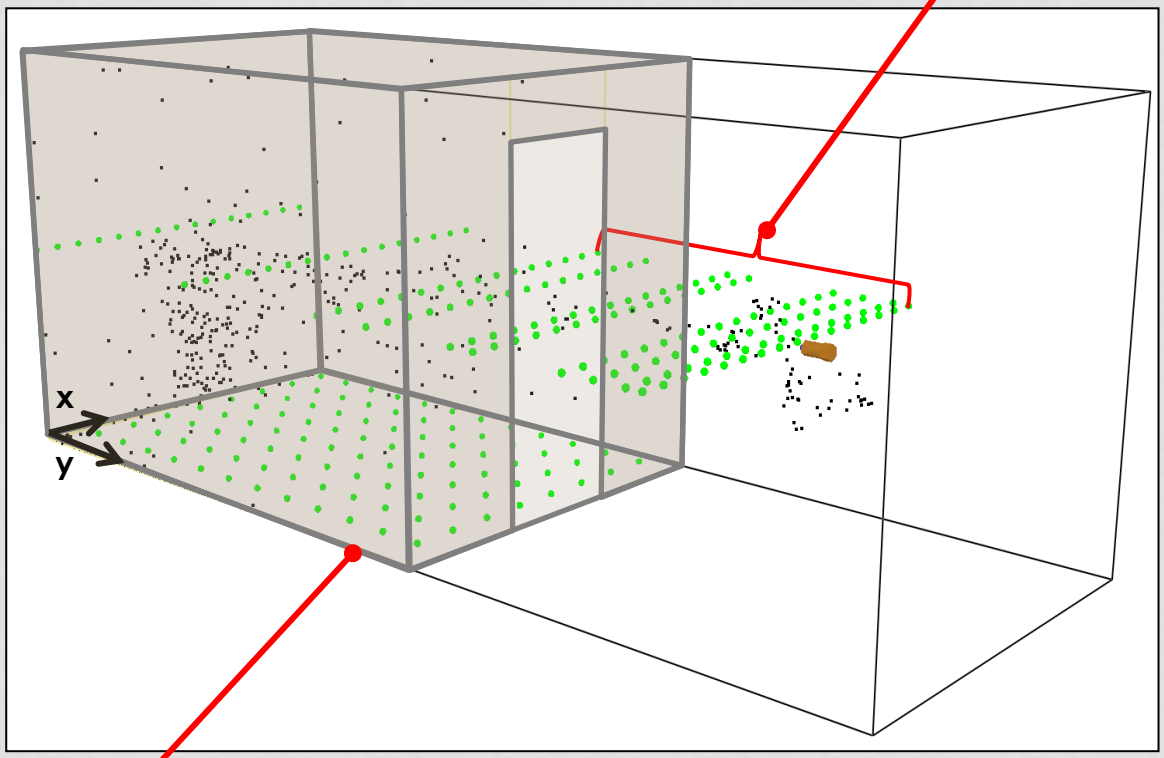
$$MTR = \frac{k_{subgrid}}{k_{LES}+k_{subgrid}}$$

- Ideally should be 0
  - Turbulence fully resolved by LES (DNS)
- LES to resolve 80% of total turbulence

SIMULATION

Nozzle distance from opening

- 20 cm
- 30 cm
- 40 cm
- 50 cm
- 60 cm

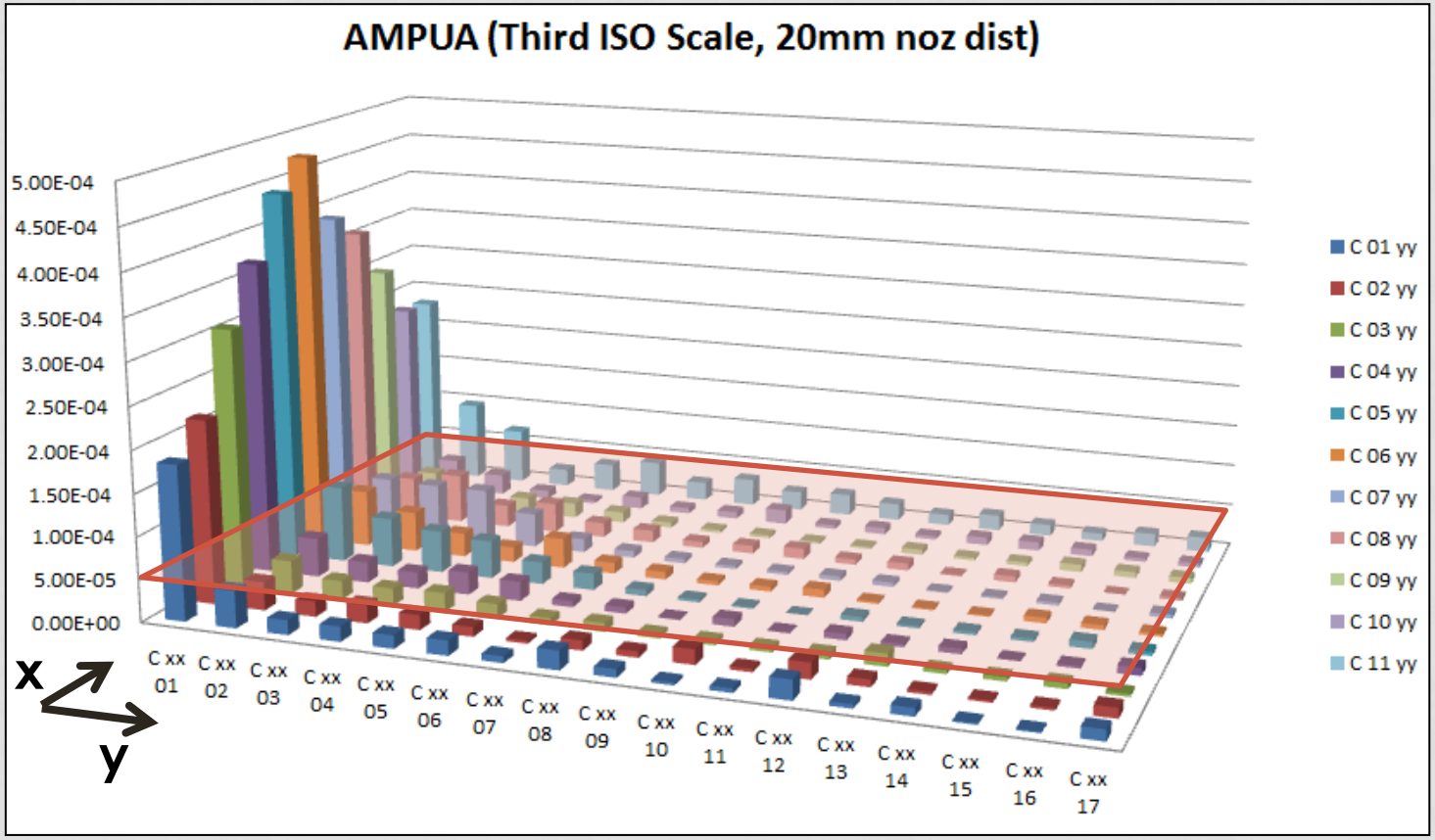


ISO Fire Cell Scale

- Quarter (0,8 x 1.2 x 0.8m)
- Third (0.6 x 0.9 x 0.6m)

SIMULATION

Regions of acceptable magnitude (threshold value of $5x10^{-5}$)

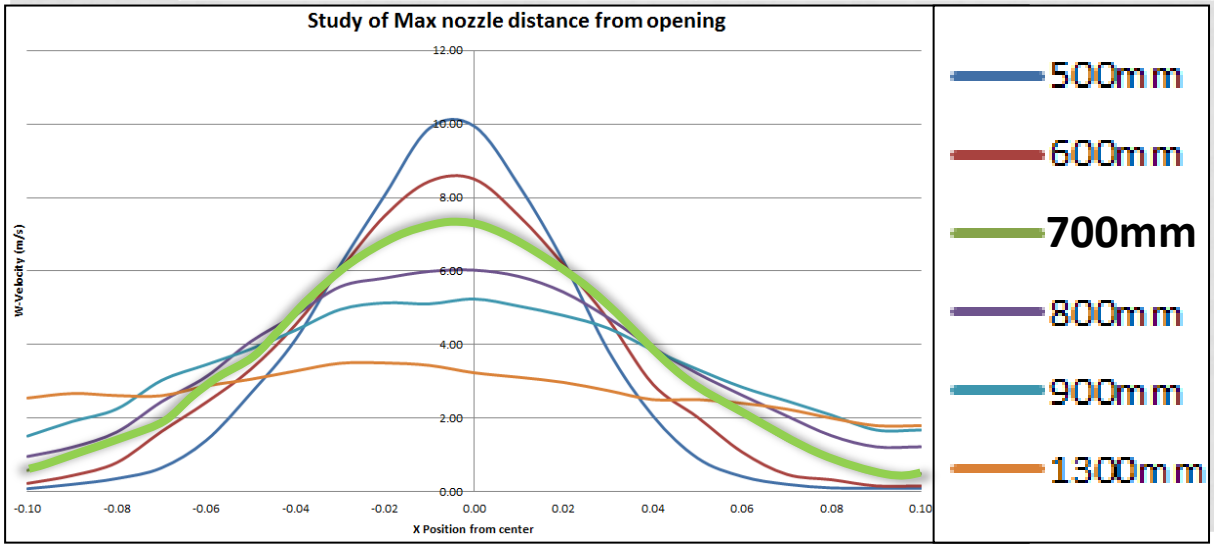


- Accumulated Mass Per Unit Area (AMPUA)
- 21 device measurements exceed
- Total of 187

Overall: 11%

SIMULATION

Nozzle distance from opening (cm)	ISO Fire cell scale	
	Quarter	Third
20	8%	11%
30	14%	16%
40	24%	18%
50	31%	24%
60	38%	28%



Max distance limited by

- Physical setup (hood & extreme nozzle position)

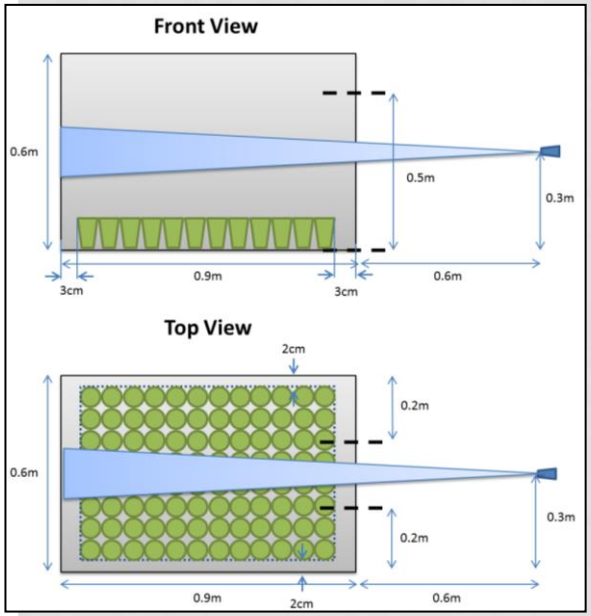
  ≈100cm

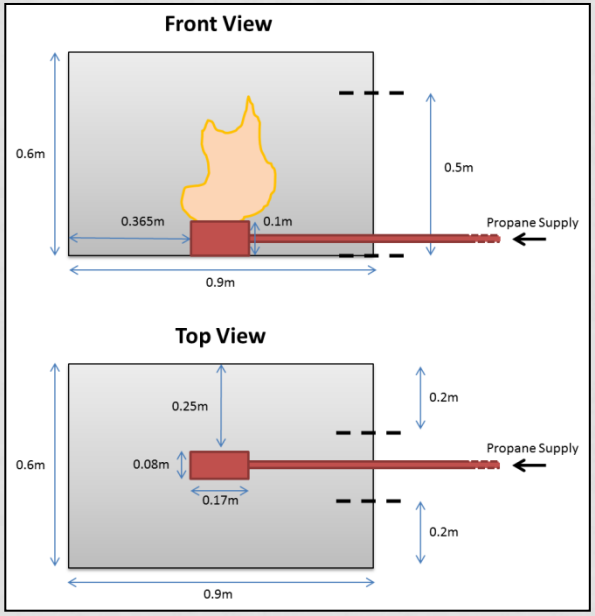
- "Opening width" vs "Spray width"

  ≈60cm

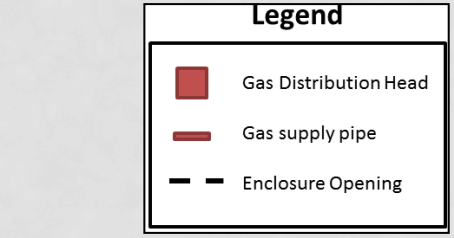
EXPERIMENT

WATER

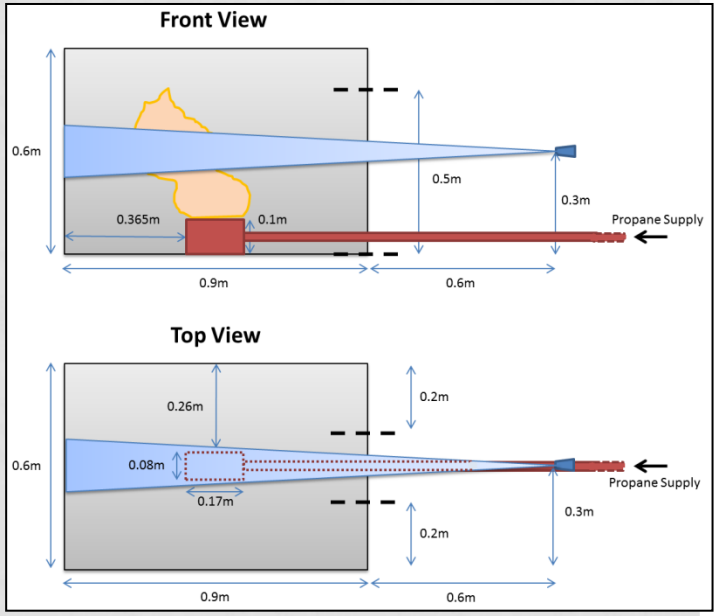


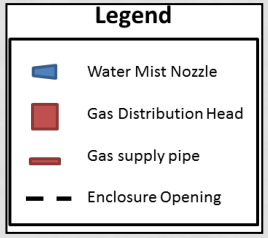


FIRE



COMBINATION





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