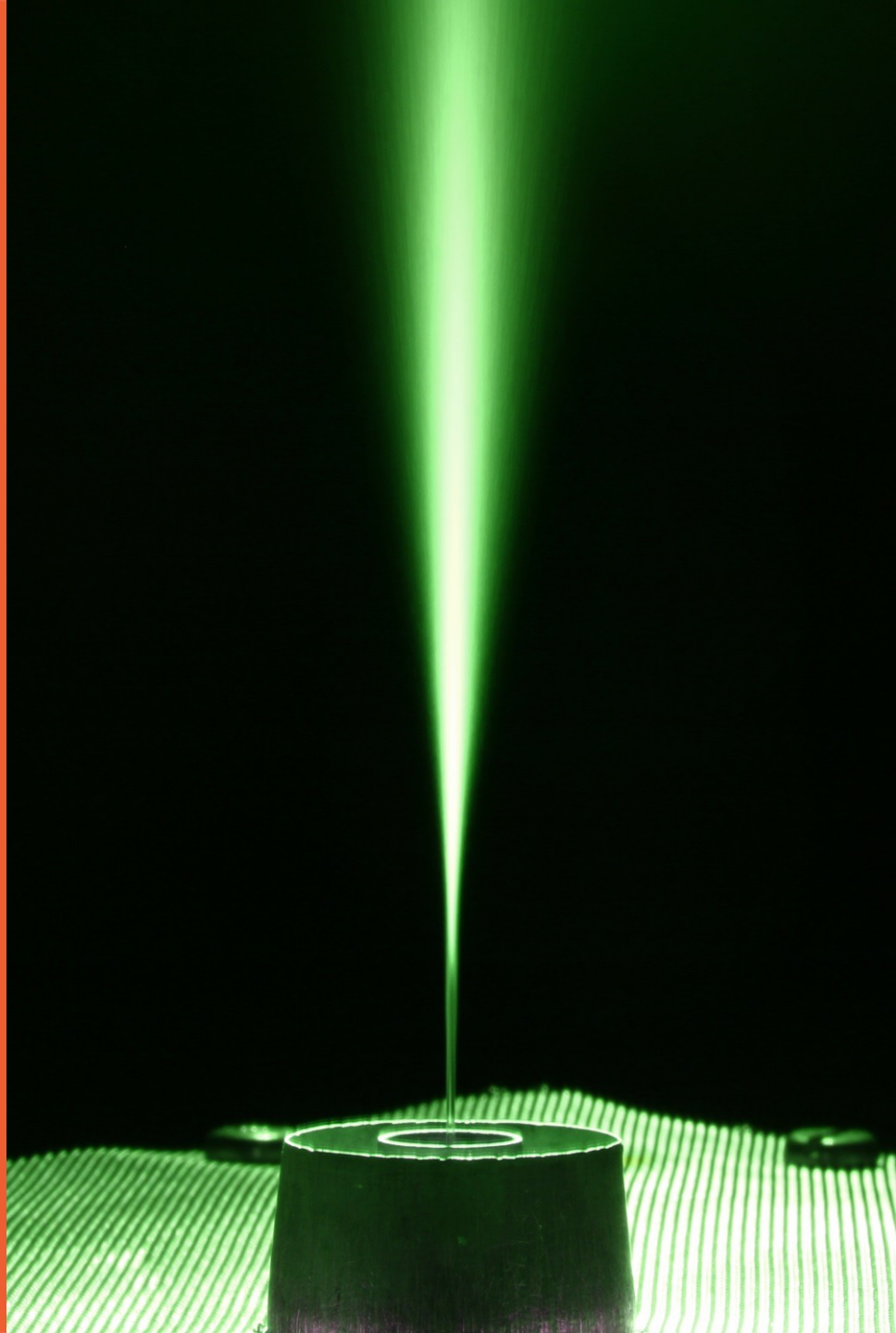
Experiments in Multiphase and Multiphysics flows

Dr. Agisilaos Kourmatzis

Senior Lecturer

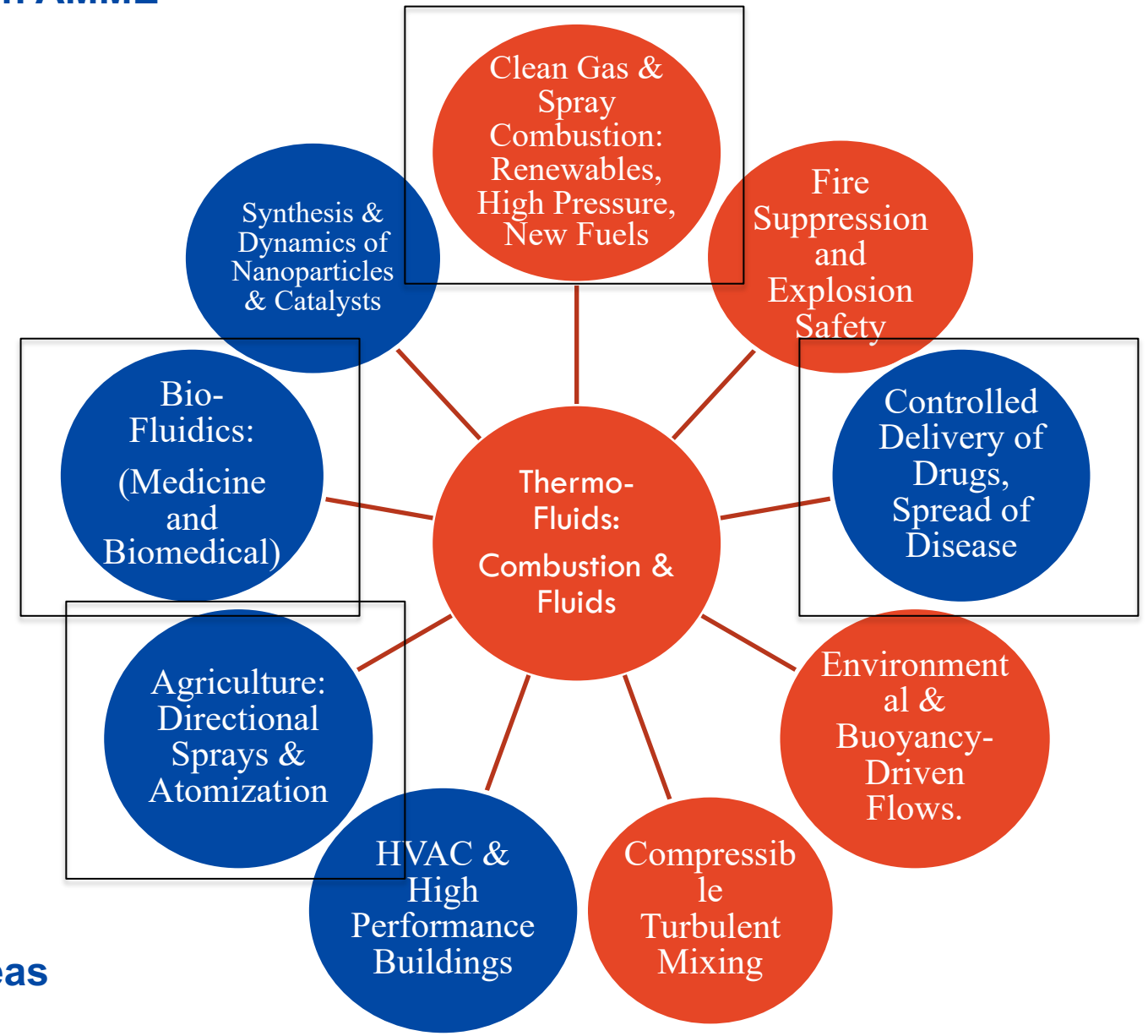
School of Aerospace, Mechanical and Mechatronic Engineering

THE UNIVERSITY OF SYDNEY



Thermo-fluids in AMME

Armfield
Cleary
Dunn
Kirkpatrick
Kourmatzis
Masri
Thornber
Verstraete
Williamson



New and evolving areas are in Blue

Outline

- **Broad overview of active research**
  - **Fundamentals**
  - **Applications**
  - **Technique development/new measurements**

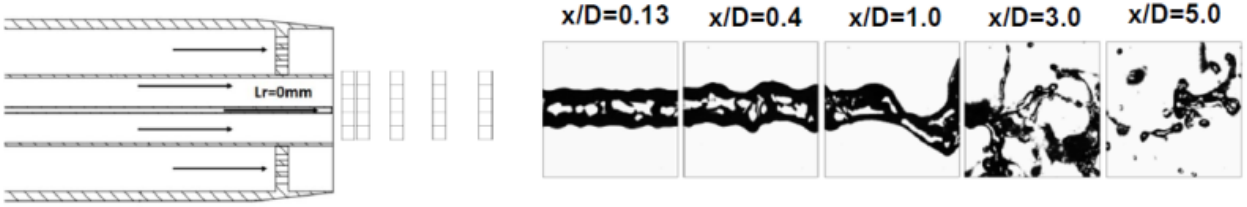
- Some typical “raw data”

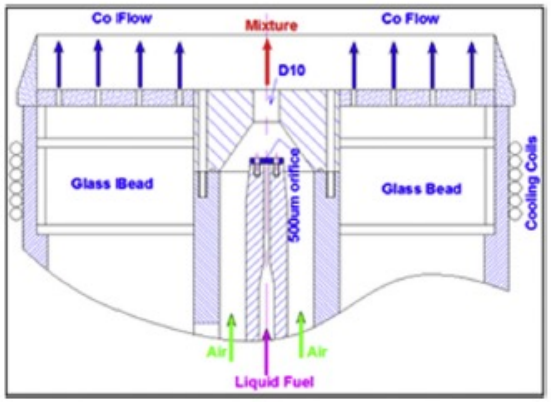
- Some “processed results”

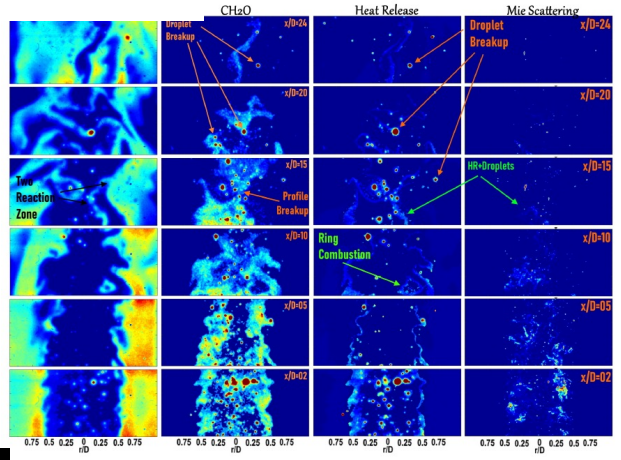
- Where are we going with all of this and what are some of the outstanding issues?

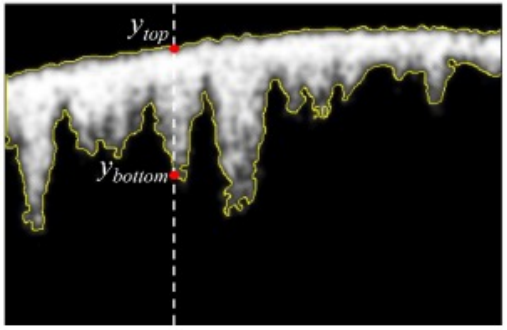
Fundamentals

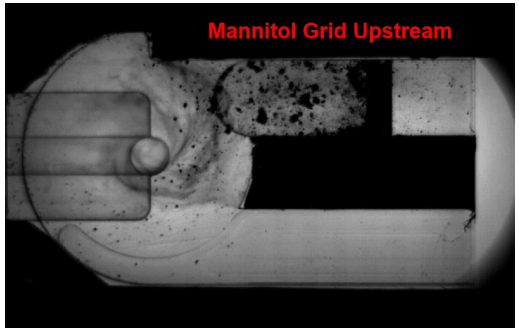
- **Focus Area 1: Fundamentals-** Droplet and spray formation (turbulent spray focus), powder de-agglomeration and dispersion, droplet and particle-turbulence interaction, turbulent reacting two-phase flows, deposition in turbulent flows

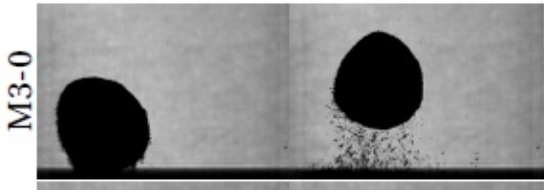






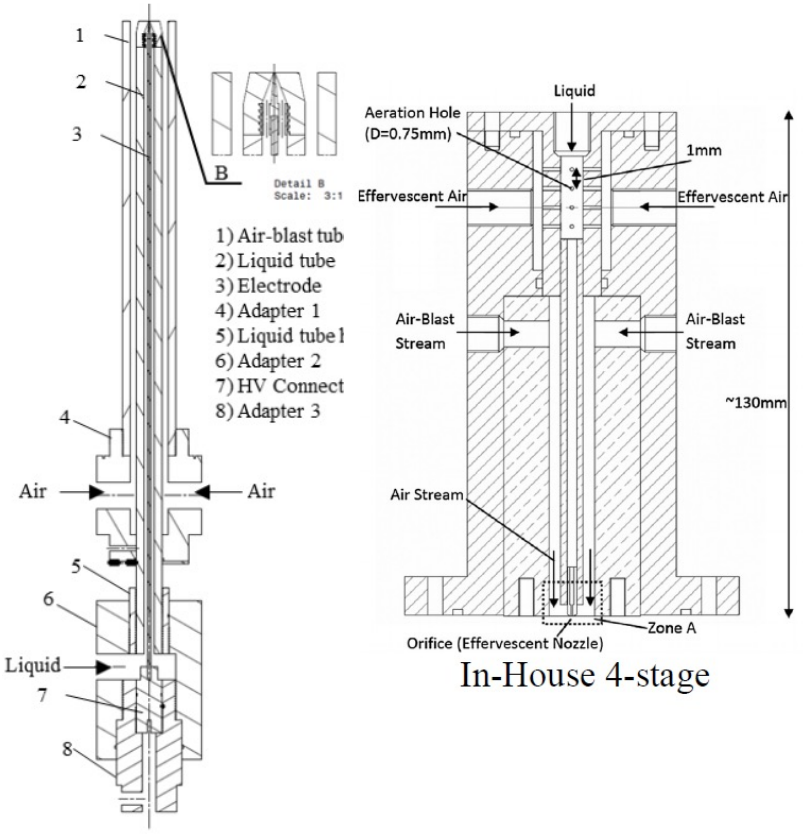


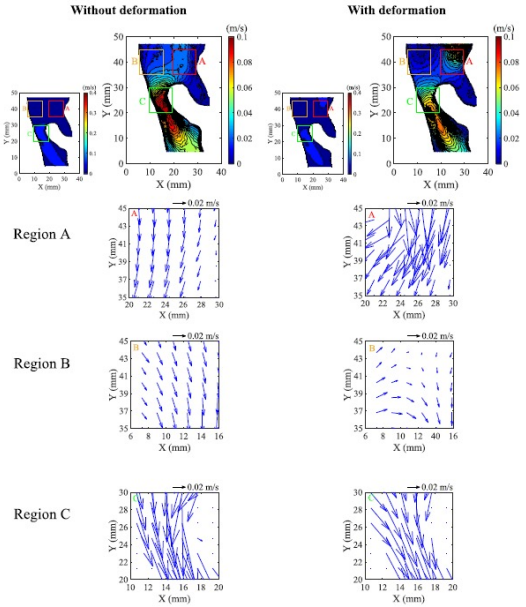


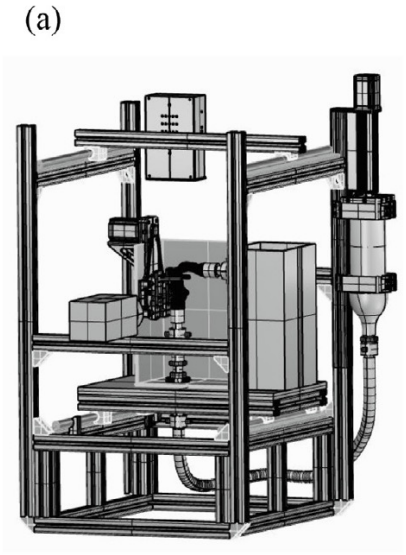


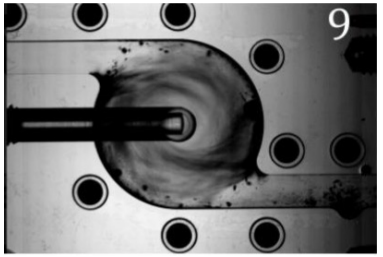
Applications

- **Focus Area 2: Specific Applications-** Nozzle design, Inhaler Devices Design, Human Specific Upper Airway Flows







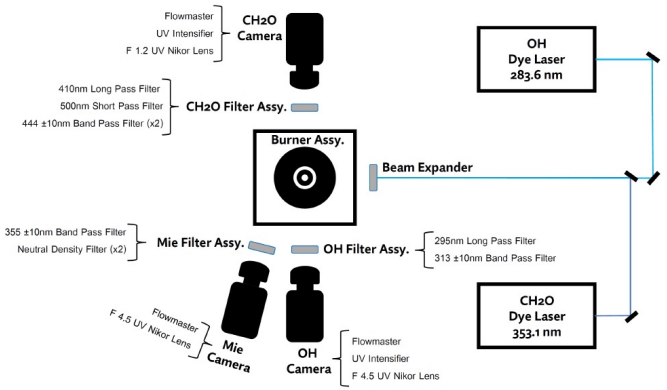


Current partners: Proveris Scientific Corporation, Singmed, US-FDA, Mitsubishi Heavy Industries, GBR foundation

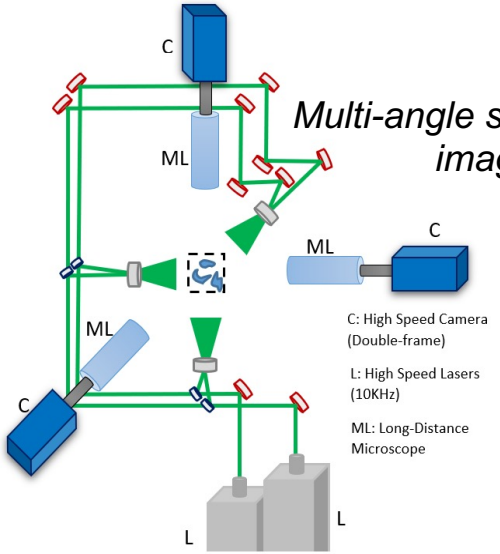
Technique Development

- **Focus Area 3 (measurement methods):** *fragment characterization at high spatial+temporal resolution, liquid volume fraction joint with local turbulence measurements*, deposition measurement, *species measurement in turbulent combustion*

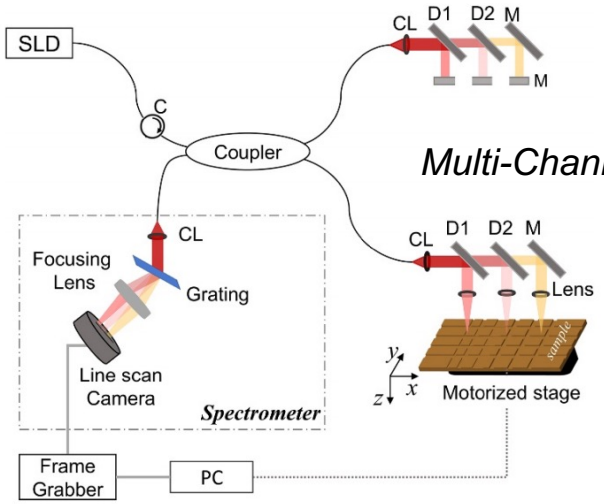
Multi-species LIF + Mie

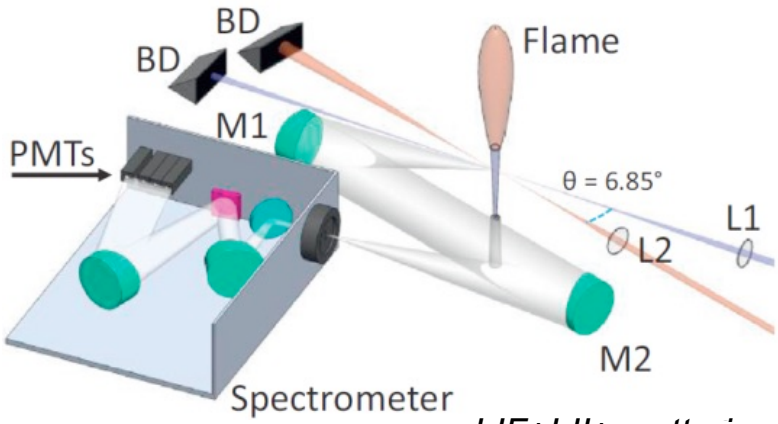


Multi-angle shadowgraph imaging



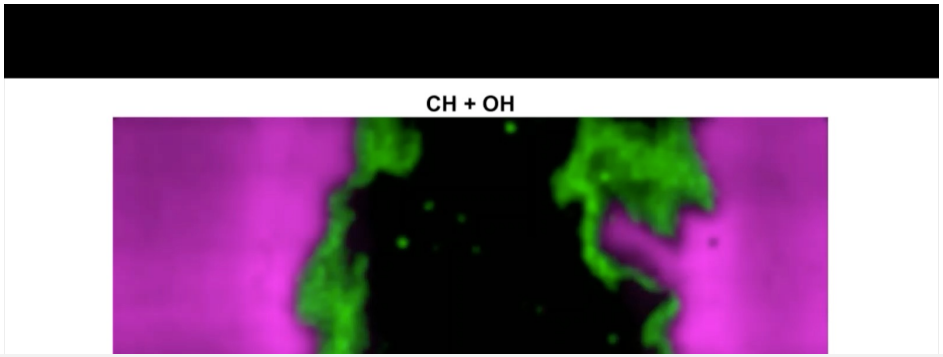
Multi-Channel SD-OCT

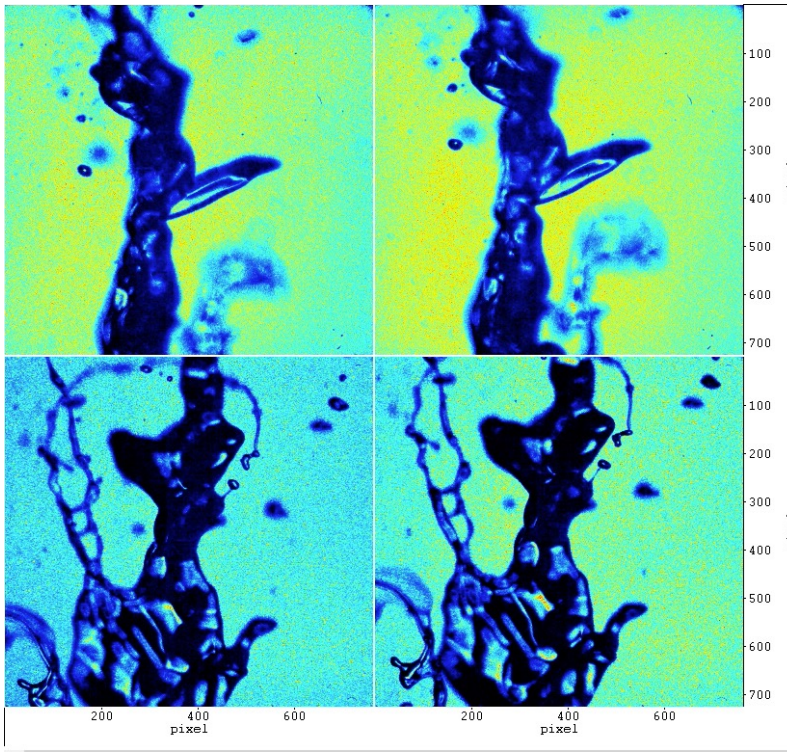




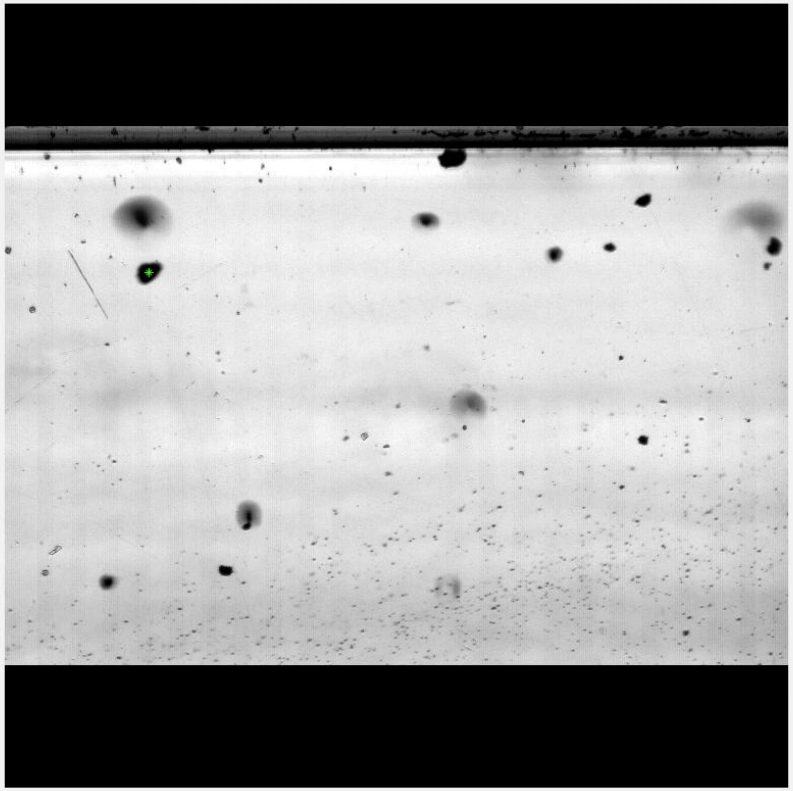
LIF+LII+scattering

Some of the "raw data" we get (usually images but not always…)

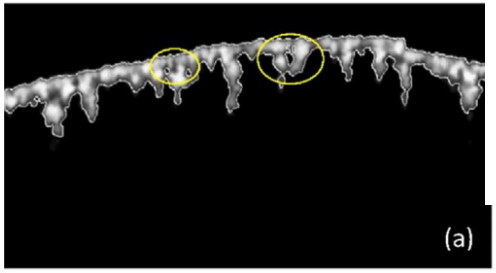


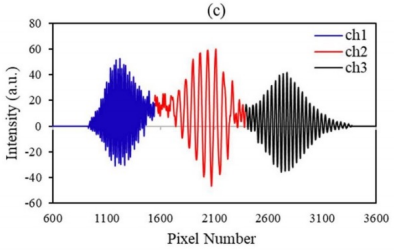


DAPTV Shadowgraph



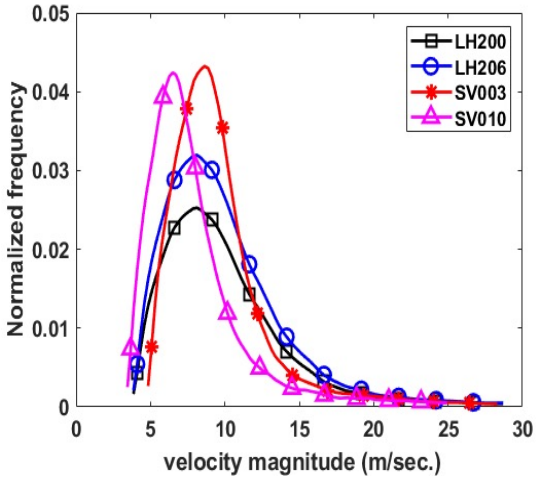
DPI particle collisions





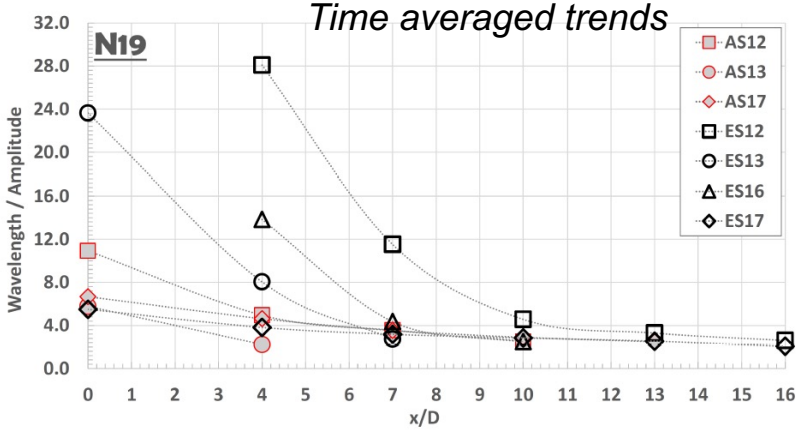
Spectral Domain OCT

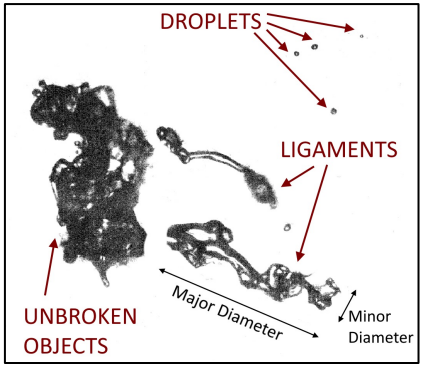
Some Processed Results-things we look for/things we do



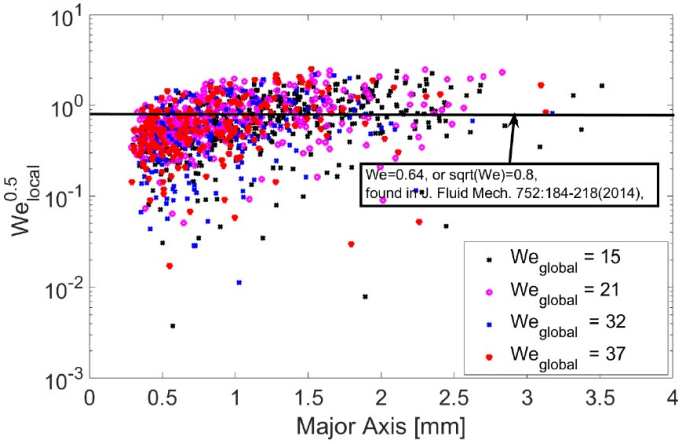
Probability Density Functions of Velocity (might be conditioned or not)

Time averaged trends

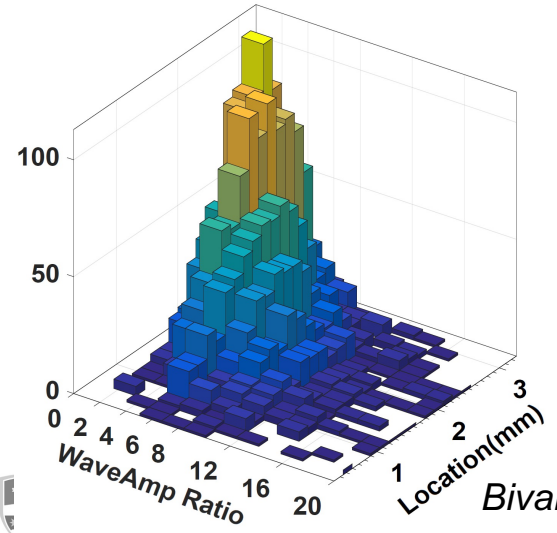




Morphological Classification (e.g. based on automated ellipse fitting or something else)



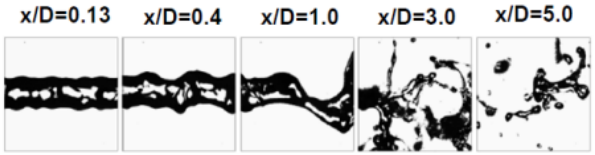
Scatter plots showing distribution of some key underlying parameter



Bivariate distributions

Some example outstanding questions/issues

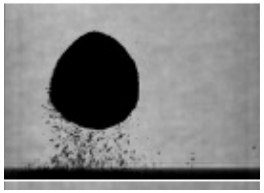
In droplet flows:



Can we "hybridize" (use multiple "modes" to atomize a liquid) such that injectors can be made more tuneable?

Role of data science: We have millions and millions of images archived. How can we be smarter in using them to better predict key behaviours in the near-nozzle region?

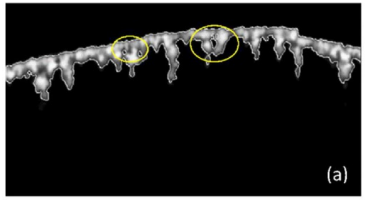
Drug agglomerate flows:



Miniscule changes in the constituent particle size of an agglomerate completely alter the macroscopic fragmentation behaviour.

Role of data science: Fragmentation is CRITICAL to treatment efficacy. Current models (DEM) are not great as they are very expensive and also require a lot of tuning. We have never tried "non physics based" predictions in this area and our experiments are among a small handful.

Deposition: Near-wall inhomogeneity means non-uniform absorption



The people who do all the work

Dr. Gajendra Singh (Postdoc 2020-current)
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Dr. Liam McGurk (Postdoc 2021-current)
Dr. Khalid Elserfy (PhD Graduate, Macquarie U)
Dr. Taye Mekonnen (PhD Graduate, Macquarie U)
Tushar Ahmed (PhD candidate)
Othman Jaber (PhD candidate)
Athiya Azeem (PhD candidate)
Zhaoqi Ma (PhD candidate)

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