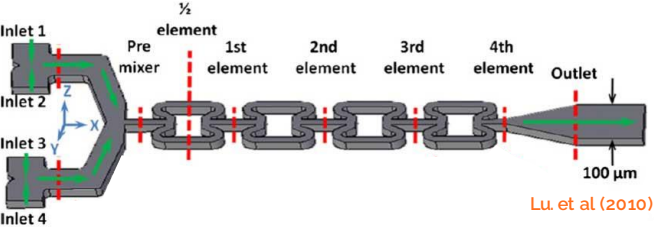
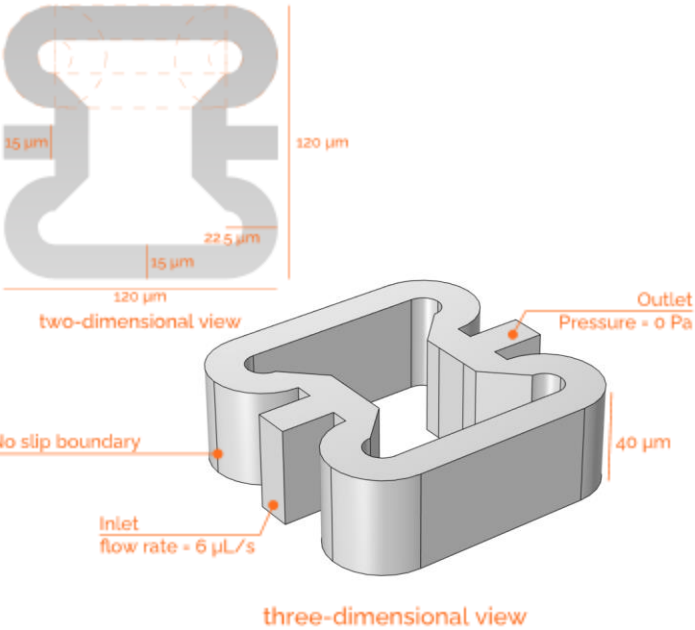


CRYO-EM AND MICROFLUIDICS INTEGRATION

- Time-resolved cryo-EM is used to determine the structure of transient intermediates during reactions with biological macromolecules.
- Temporal snapshots are obtained by quickly mixing and quenching two reactants, then observing the result in a TEM.
- Microfluidics are ideal for this application because they exhibit:
 - Low sample consumption
 - Predictable flow
 - Easy integration with other fluidic components (e.g. sprayer nozzles)
- Low turbulence in small channels poses a design challenge to minimize the mixing time, which is a limiting factor in the temporal resolution of the device.
- GOAL: CREATE A WORKING SIMULATION FOR FUTURE IMPROVEMENTS



BUTTERFLY-SHAPED MIXING ELEMENT

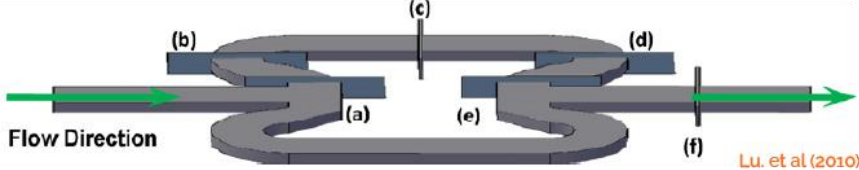
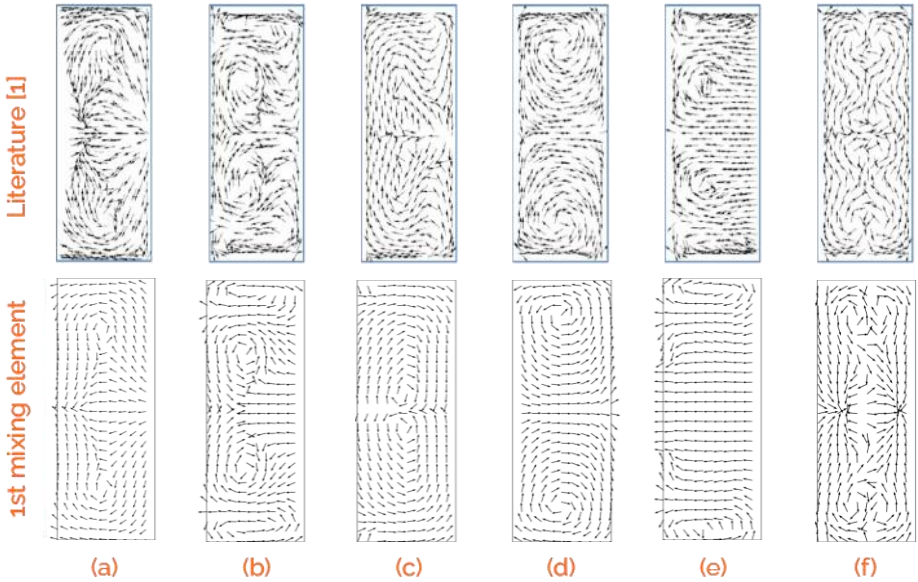


Cryo-Electron Microscopy Microfluidic Mixers
A COMSOL SIMULATION

Reynaldi Wijaya, Pasadena City College
Nathan Harper, California Institute of Technology



VELOCITY VECTOR PLOTS

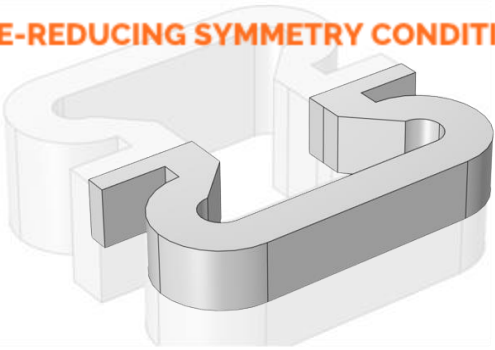


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[2] Lu, Z., Shaikh, T. R., Barnard, D., Meng, X., Mohamed, H., Yassin, A., Mannello, C. A., Agrawal, R. K., Lu, T.-M., & Wagenknecht, T. (2009). Monolithic microfluidic mixing-spraying devices for time-resolved cryo-electron microscopy. In *Journal of Structural Biology* (Vol. 168, Issue 3, pp. 388-395). Elsevier BV

SIZE-REDUCING SYMMETRY CONDITION



MESH REFINEMENT STUDY - VORTICITY CONVERGENCE



SIMULATION PARAMETER

Maximum mesh size	0.6 µm
Dynamic viscosity	1 mPa.s
Fluid density	1000 kg/m³
Reynold's number	285

FUTURE IMPROVEMENTS & DIRECTIONS

- Simulate the whole mixer to fully replicate the device
- Run concentration-based study to visualize the mixing of the reactants
- Optimize the geometry to minimize reactants mixing time