# Hybrid Eulerian-Lagrangian Methods for Fluid Simulation

## Group 4

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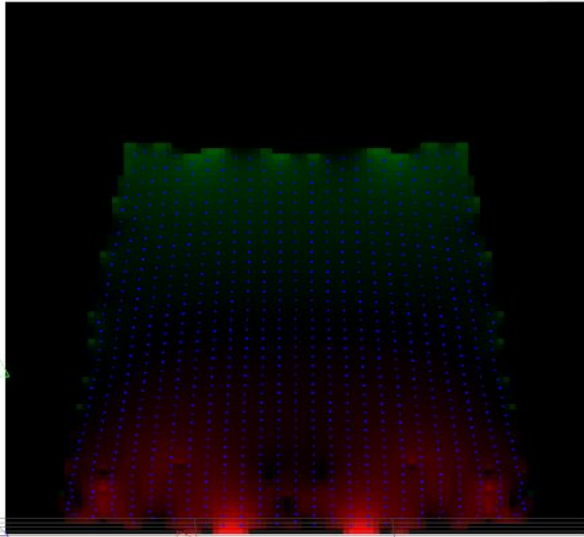
# Simulation Targets

- Minimal:
  - A hybrid Eulerian-Lagrangian fluid simulation system
  - Particle-in-Cell (PIC),  Fluid implicit particles (FLIP)

- Desired:
  - Affine PIC

- Bonus:
  - MLS-MPM
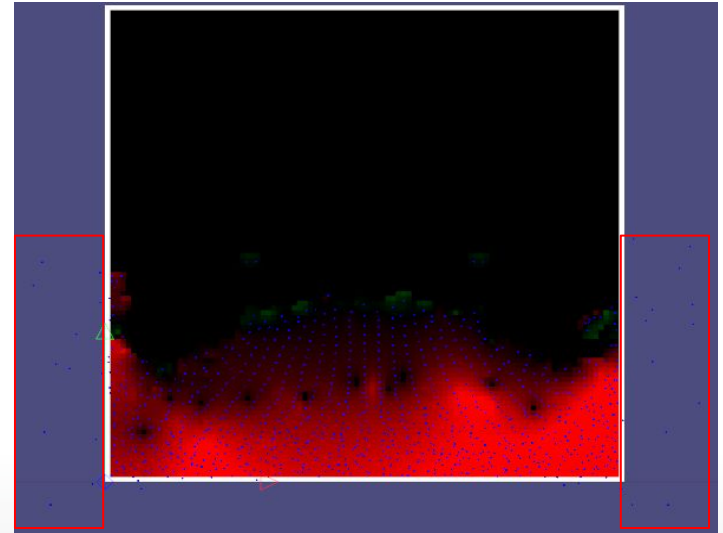  - Extend the simulation to 3D

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# Since Milestone

- Fix existing bugs

  - Velocity extrapolation
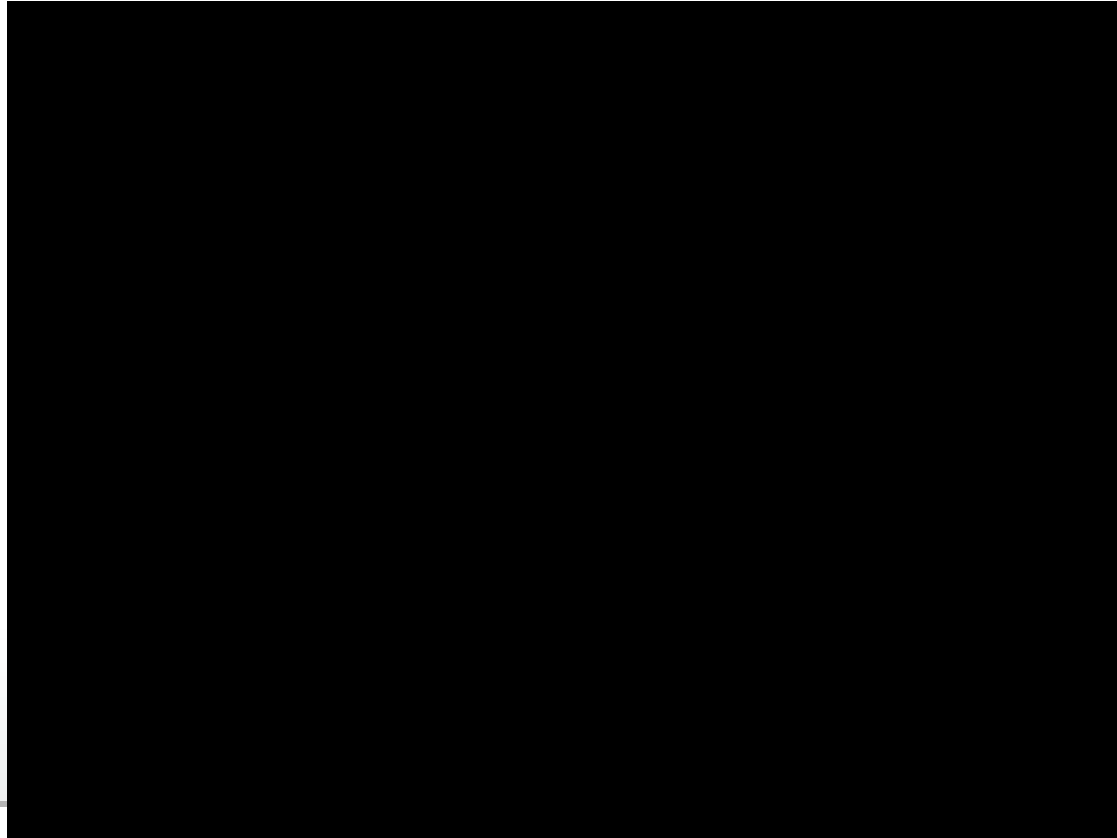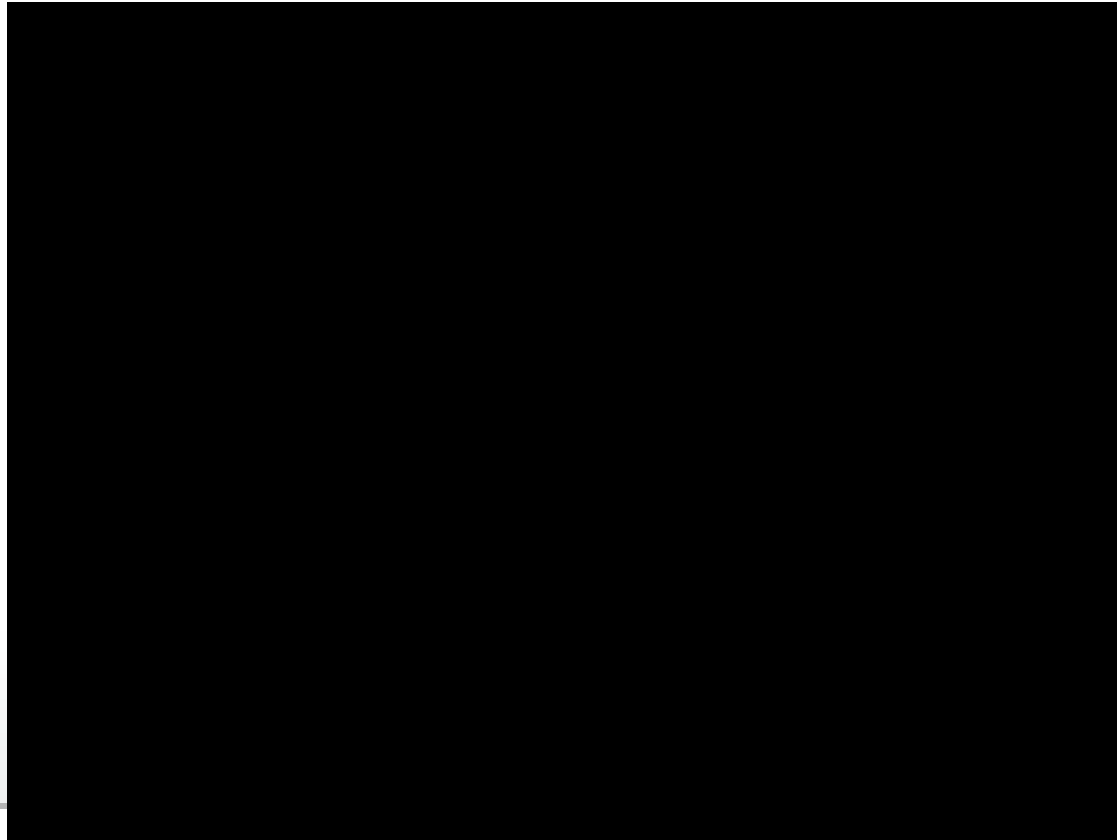
  - New boundary conditions

# Since Milestone

- Implement new features
  - Affine PIC ✔
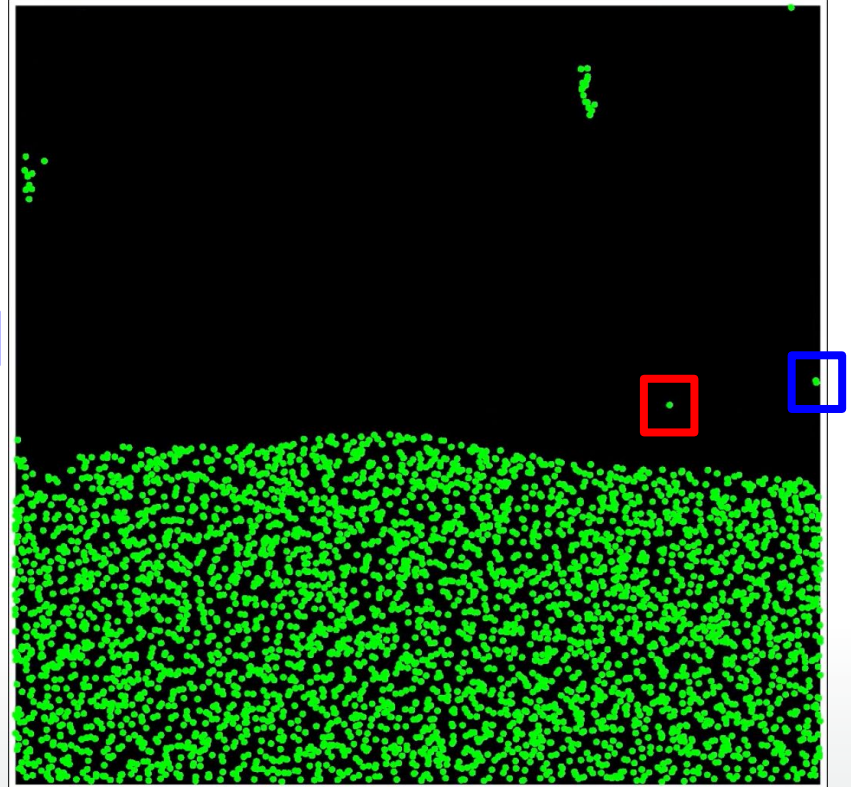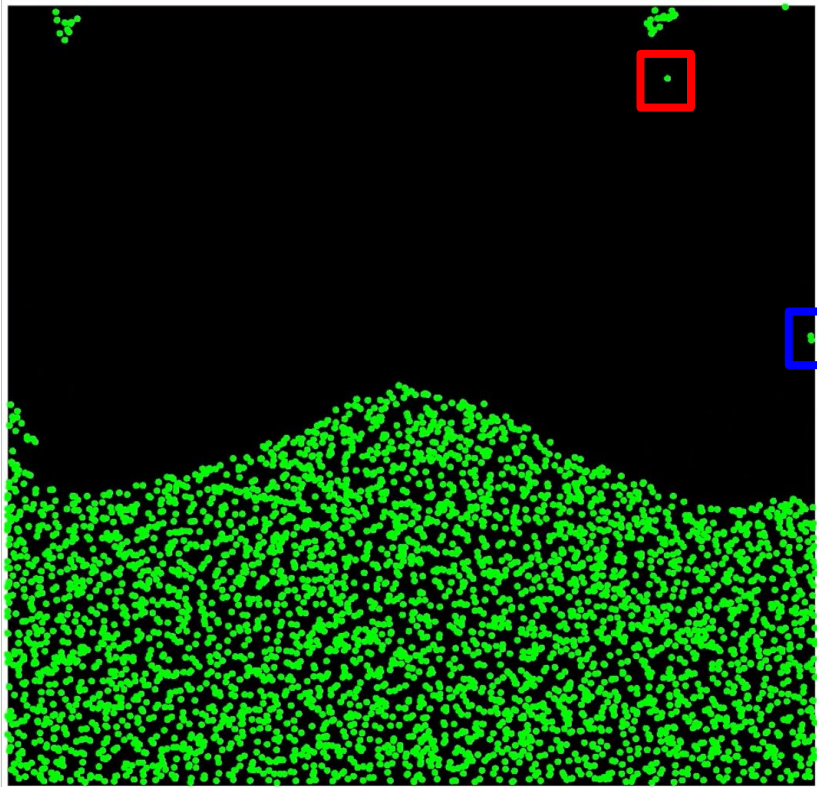  - Extend the whole pipeline to 3D ✔
  - MLS-MPM ✘

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# 2D Dam Break

# Angular Momentum Preservation

# Problem of Sticky Particles

# Effective Grid
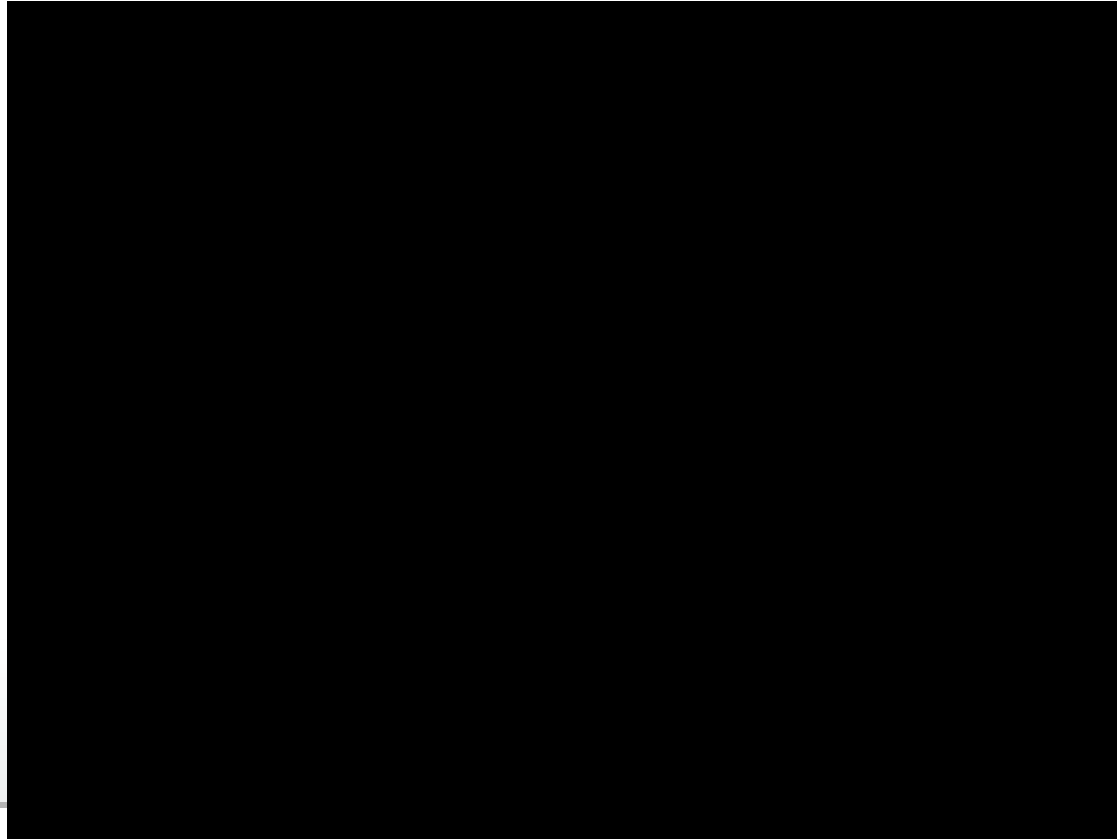
# Simulation in 3D
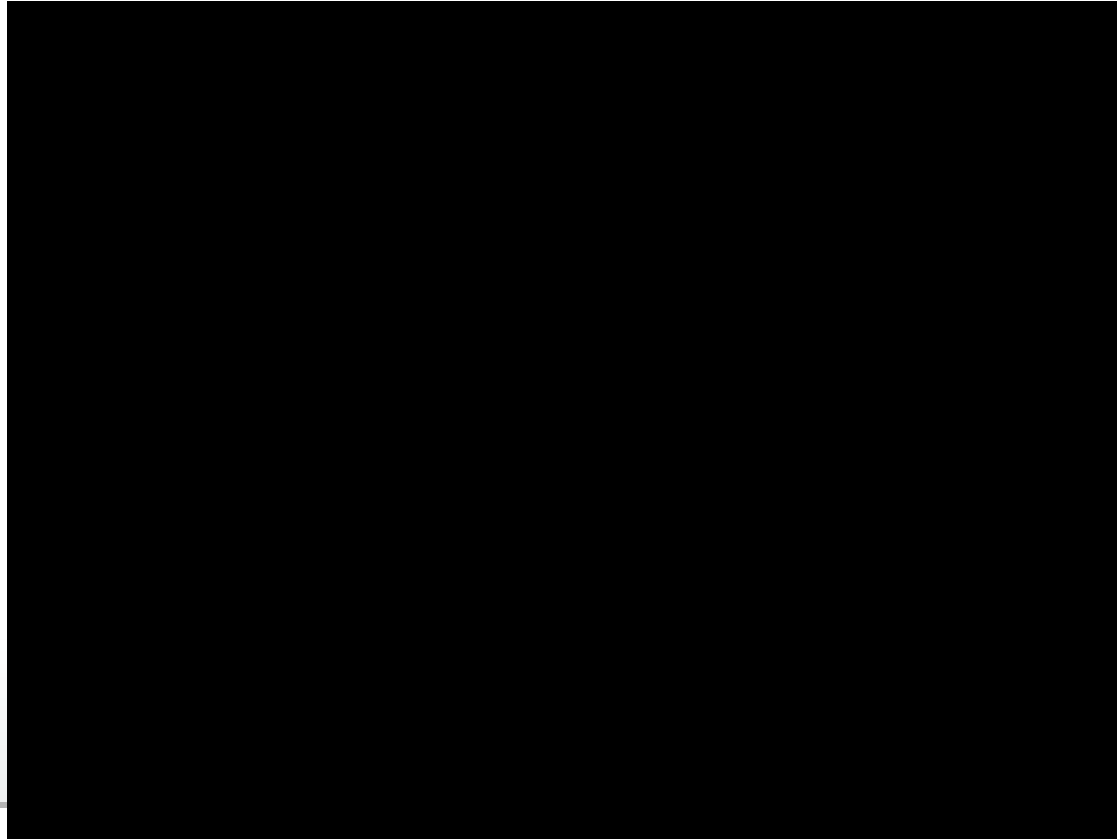
# Summary

| | PIC | FLIP | APIC |
|---|---|---|---|
| Incompressibility | - | + | - |
| Linear Momentum | - - | + | + |
| Angular Momentum | - - | + | + + |
| Stability | + + | + | - |
| Efficiency | + | + | - |

# Improvements

- Speedup
  - 97% of time is used in solving the pressure for incompressibility: use the MICCG(0) solver instead
- Strange phenomena in simulation
  - One particle falling from high can lead to a huge splash
  - Particles stick to boundary
  - APIC is too dissipative and too noisy
  - Empty vortices in FLIP/APIC

# References

- [Bridson & Muller-Fischer's SIGGRAPH Course Notes for Fluid Simulation](#)

- [Bridson's Book: Fluid Simulation for Computer Graphics](#)

- [Yuanming Hu's Course on Hybrid Eulerian-Lagrangian Methods](#)

- [Jiang's Affine PIC paper](#)

- [Niall's Tutorial on MLS-MPM Fluid Simulation](#)

# Thank You