# Multi-GPU computing of moving boundary flow using lattice Boltzmann method

## Akira Hatakeyama

Graduate School of Engineering, The University of Tokyo

## Takashi Shimokawabe

Information Technology Center, The University of Tokyo

### Background

Moving boundary flow is one of important problems of Computational fluid dynamics (CFD).

#### Communication between GPUs or compute nodes decrease parallel efficiency.

We present implementations and GPU assignment to increase parallel efficiency of immersed boundary – lattice Boltzmann method (IB-LBM), the numerical method of moving boundary flow, and show the results of the performance improvement.

#### Lattice Boltzmann method (LBM) 2.

Time evolution equation about velocity distribution function.

D3Q27 model

 $e_{26}$ 

#### Implementations 6.

#### 6.1. naïve

**G** communication

1 row

• 3 rows communication.

#### 6.2. communication reduction

- •1 row communication for *f*.
- Communication of only 9 direction of 27 for f.
- •Not communicating body force more than  $3\Delta x$  from boundary.

#### f communication





Only velocity distribution function of direction to analysis domain is used.





YZ allocation – same node comm in y, over node comm in z.

ZY allocation – same node comm in z, over node comm in y.

For example, computational domain is divided into 2 in y direction and 8 in z. (Y-2 Z-8 split)





#### 8. Conclusion

In this poster, we present implementations and the way to assign a GPU to each subdomain in 2-dim split and evaluate performance of IB-LBM. Comm. Reduction implementation improves performance, and overlap more. Proper GPU assignment results high performance also.

HPC ASIA 2022