

CFD Lab: Final Project

3D Navier Stokes Code for Arbitrary Geometries

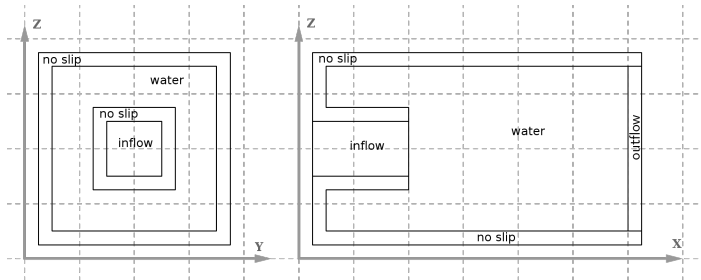
Norbert Schmidbartl, Wei Ni, Zhibin Cheng, Eva Breznik

Technische Universität München
Fakultät für Informatik

July 17, 2015

Project Topic

- 3D Navier Stokes for arbitrary geometries
- possible extension: Free surface flows



Project Topic

3D Navier Stokes for arbitrary geometries

- truly arbitrary scenarios, any of the following b.c. can be employed in any domain cell:
 - no slip
 - free slip
 - inflow
 - outflow
 - moving wall
- \Rightarrow the obstacles inside the domain have arbitrary boundaries

Implementation

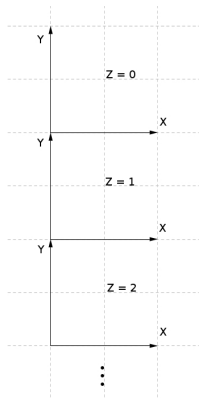
3D Navier Stokes for arbitrary geometries

- Special numbering of cells when generating input pgm files,
- geometries represented by a grayscale image with 7 levels of brightness.

Cell type	Number code
water	0
air	1
no-slip	2
free-slip	3
inflow	4
outflow	5
moving wall	6

Implementation

Input: Lid Driven Cavity example



2	2	2	2
2	2	2	2
2	2	2	2
2	2	2	2
2	2	2	2
2	0	0	2
2	0	0	2
2	2	2	2
2	2	2	2
2	0	0	2
2	0	0	2
2	2	2	2
6	6	6	6
6	6	6	6
6	6	6	6
6	6	6	6



Implementation

Extending the flag field

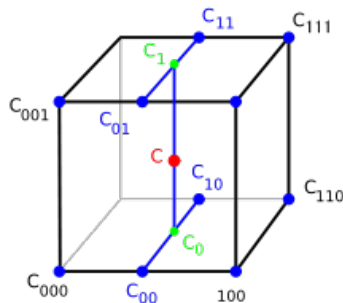
- 4bits for center cell
- 2bits for every neighbour
- altogether 16 bits

center	east	west	north	south	bottom	top
4bits	2bits	2bits	2bits	2bits	2bits	2bits

Implementation

Particle Tracking

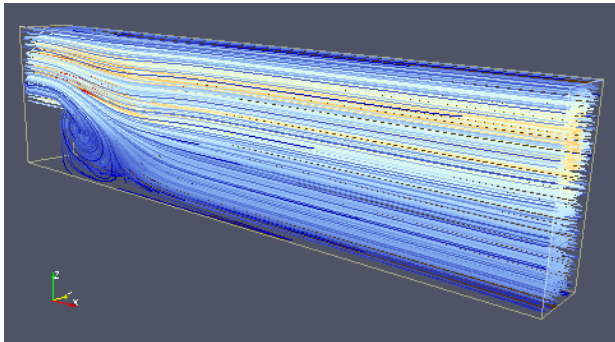
- implemented adding and advancing of particles
- surface boundary conditions still under development
- multiple particle sets possible



Results

Flow over step

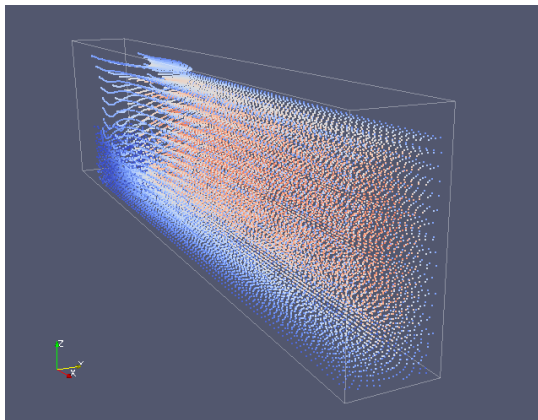
- Streamlines



Results

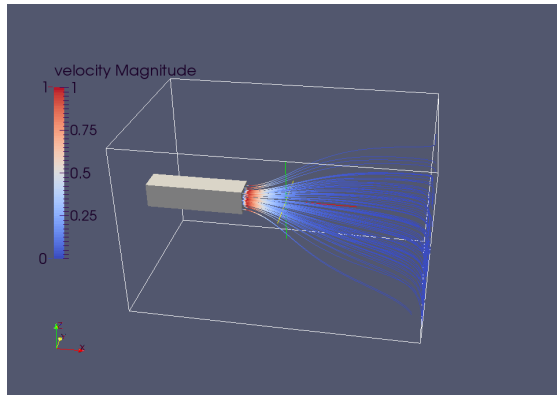
Flow over step

- Particle paths



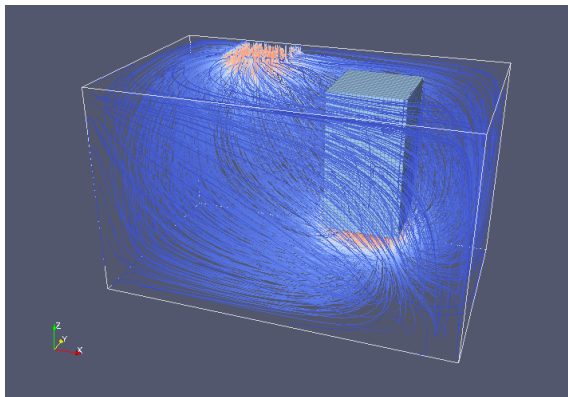
Results

Inflow through a pipe



Results

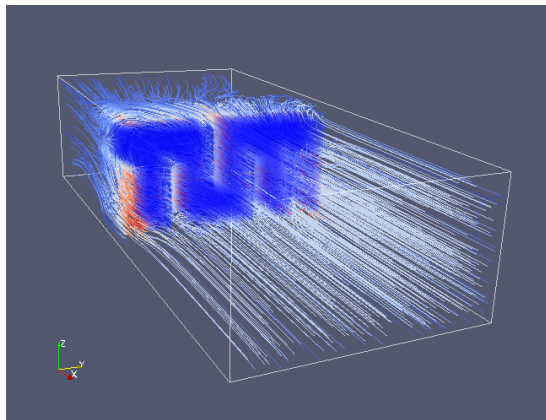
- Inflow through part of wall
- Outflow through pipe



Results

Flow across TUM :)

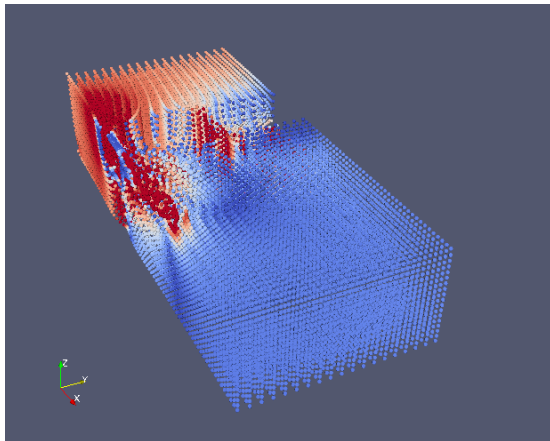
- Streamlines



Results

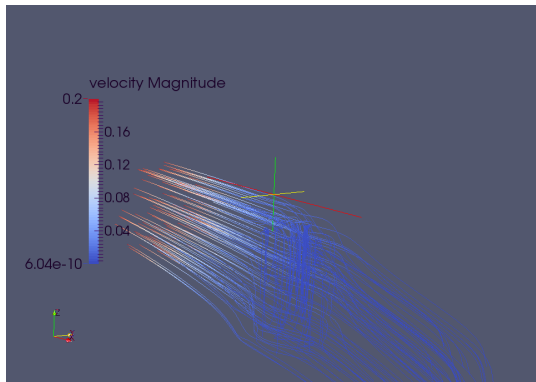
Flow across TUM :)

- Particle paths



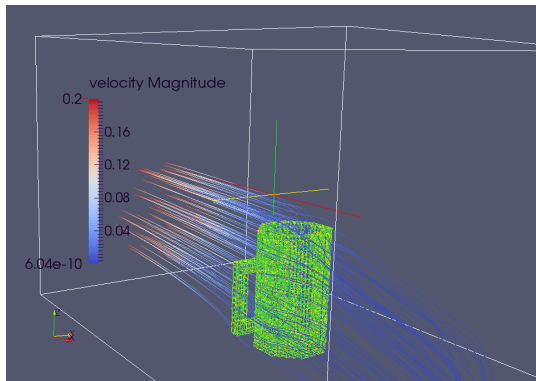
Results

A 'Bavarian' example: Later Today...



Results

A 'Bavarian' example: Later Today...



Conclusion and Further Development

- Finish Free Surface flow
- add Thermal flow
- Parallelization