Collision of two bodies

Main Tasks:

- include googletest, spdlog
- add CI pipeline
- new way of calculating forces
- performance measurement
- reading files with cuboids and creating the particles accordingly
- the actual simulation

Lennard-Jones-Potential using some λ :-)

- calculateF() takes function parameter for force calculations between two Particles
- possible to dynamically switch between the two force calculations
- “curried” Function for Lennard-Jones-Potential

```
forceLennJonesPotentialFunction(double sigma, double epsilon)
```

$$-\frac{24\cdot\epsilon}{(||x_i - x_j||_2)^2}\left(\left(\frac{\sigma}{||x_i - x_j||_2}\right)^6 - 2\left(\frac{\sigma}{||x_i - x_j||_2}\right)^{12}\right)(x_i - x_j)$$

```
forceSimpleGravitational()
```

$$\frac{m_i \cdot m_j}{(\|x_i - x_j\|)^3}(x_j - x_i)$$

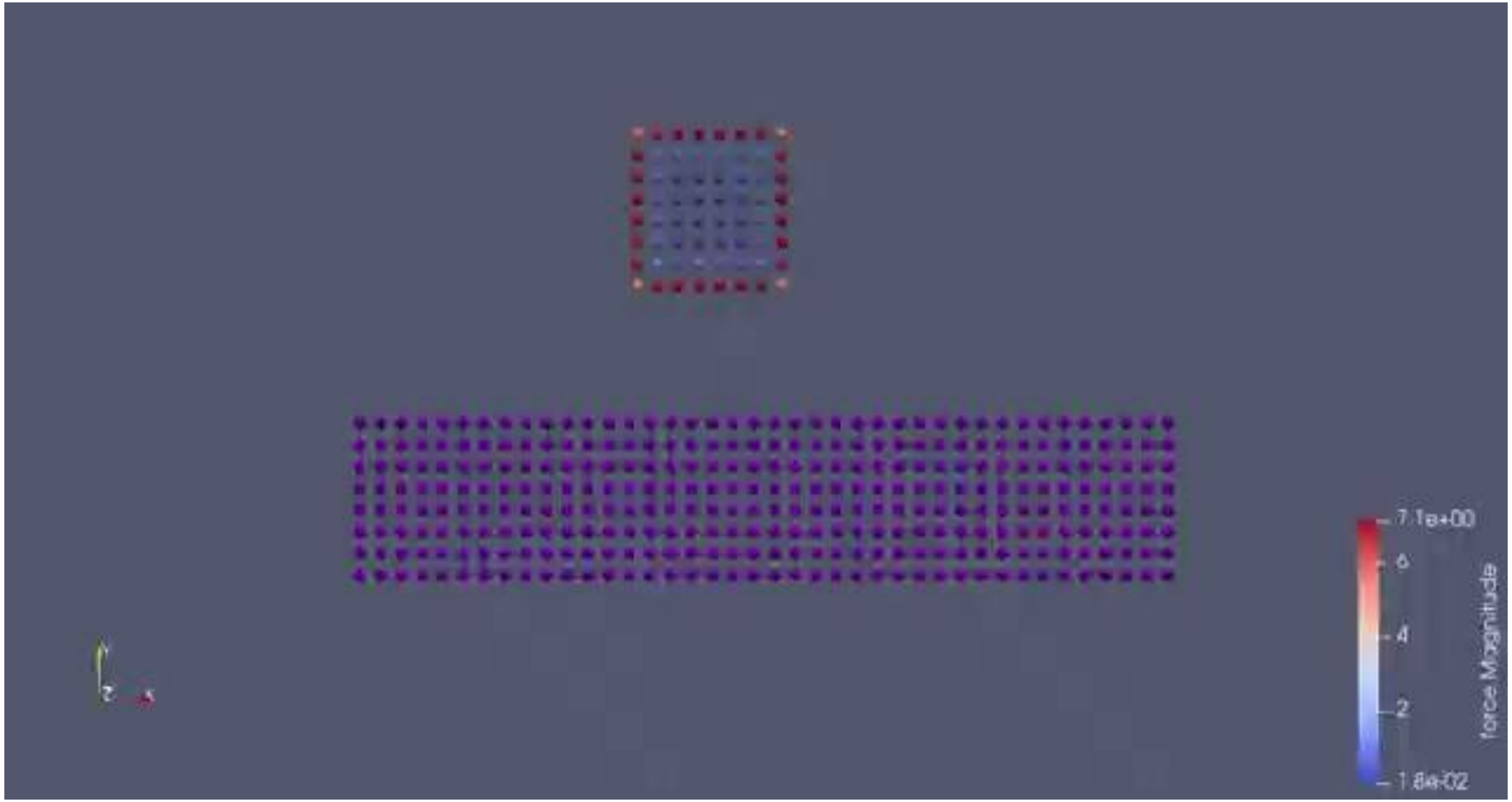
Performance

Parameters:

- `std::chrono::high_resolution_clock` used for time measurement
- Measurements in Linux environment on AMD Ryzen 7 5700U
- Compiled with gcc and flag -O2 for runtime measurement
- Memory access measured with cachegrind (program compiled with -O1)

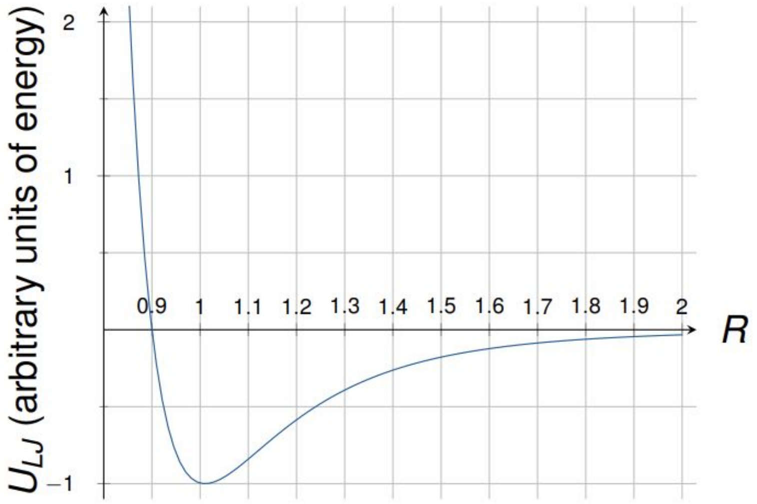
	nested loop	Newtons third law
runtime	~ 122 sec	~ 114 sec
memory access	~ 5,86 bil. data accesses	~ 3,27 bil. data accesses
cache miss rate	0.1 %	0.1 %

Simulation

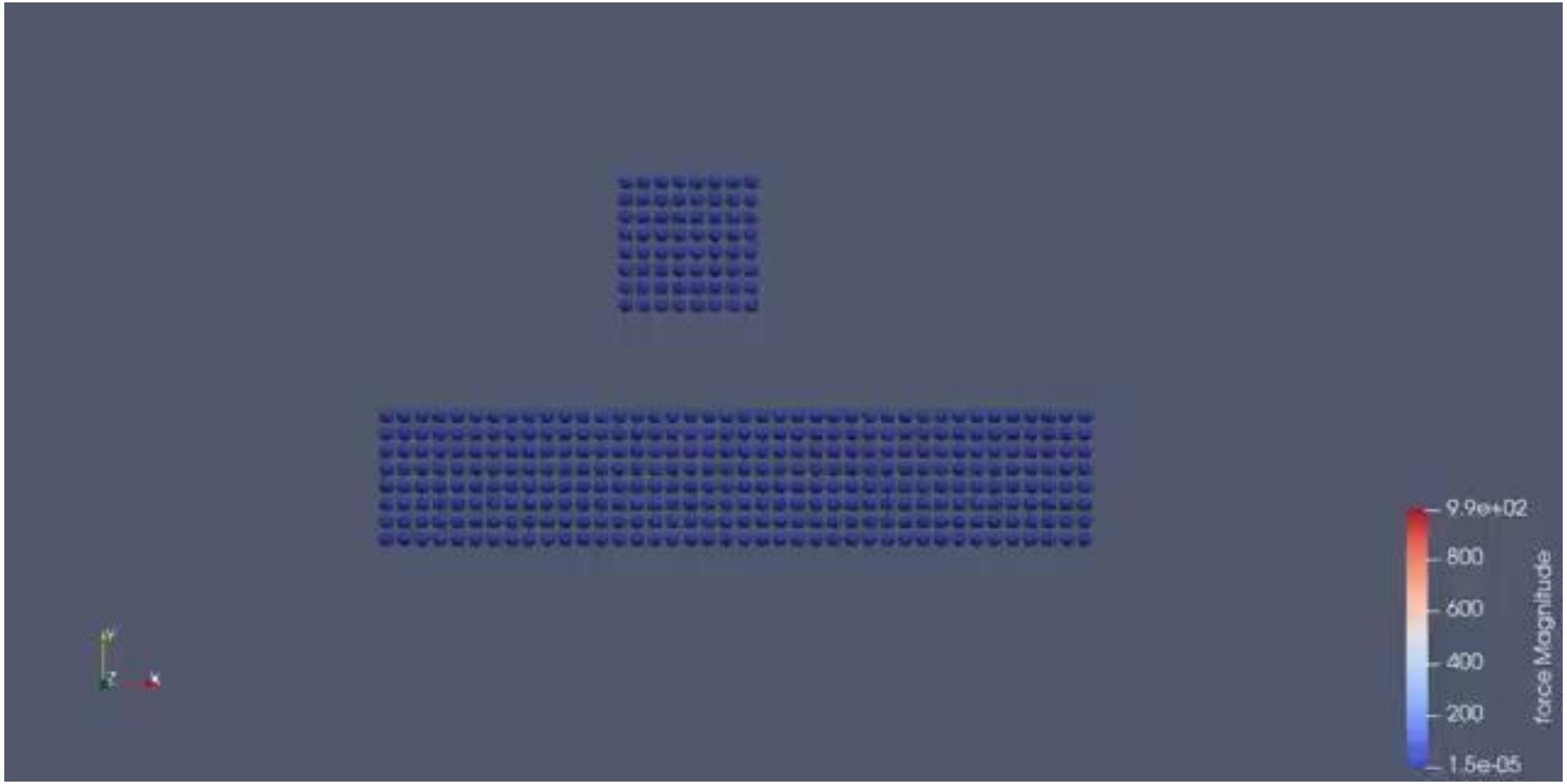


Observations

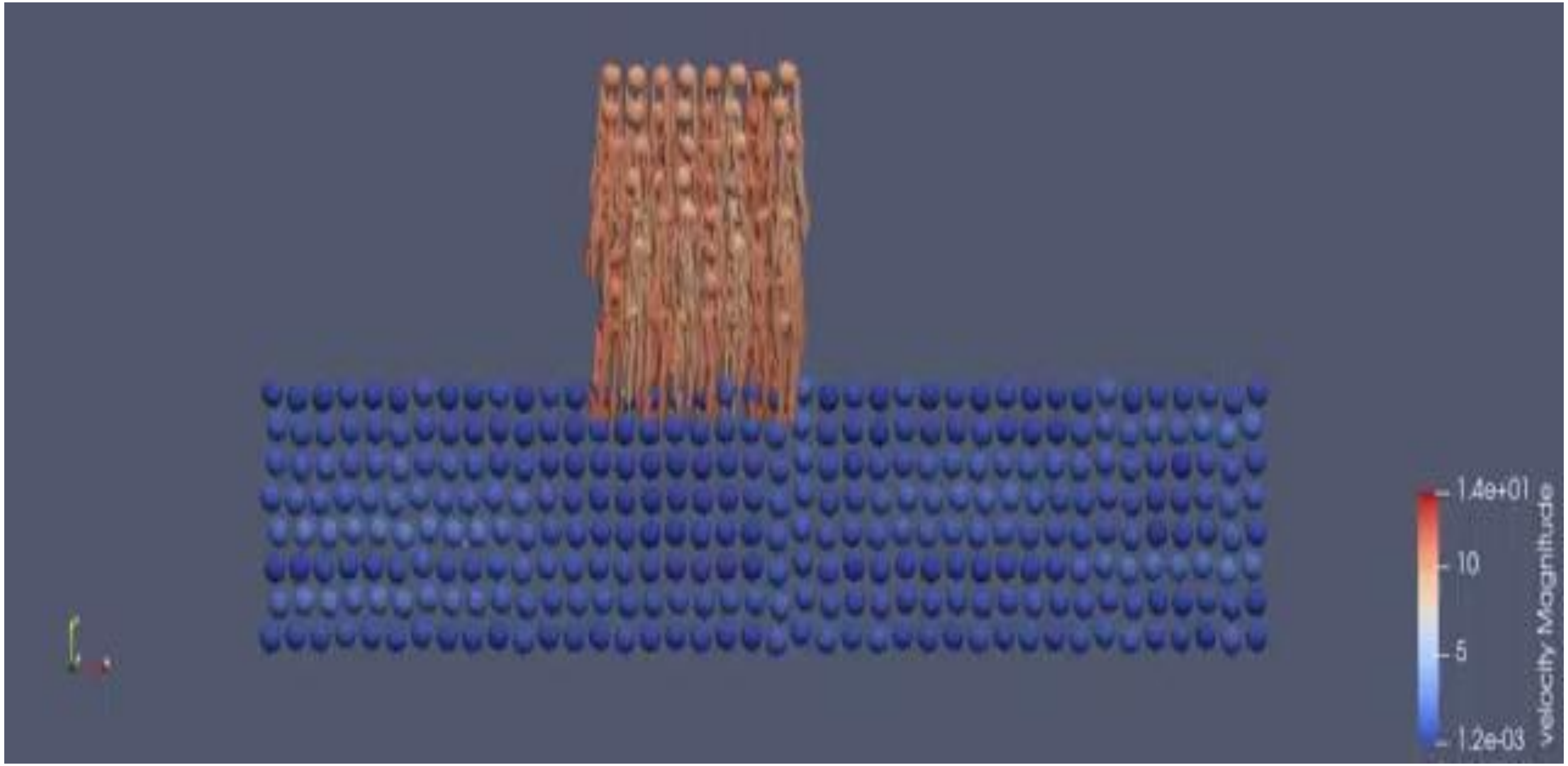
- particles push each other during collision
- force of isolated particles oscillates



Simulation



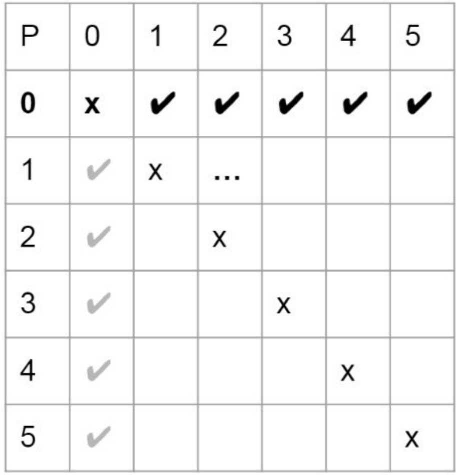
Simulation



Calculating

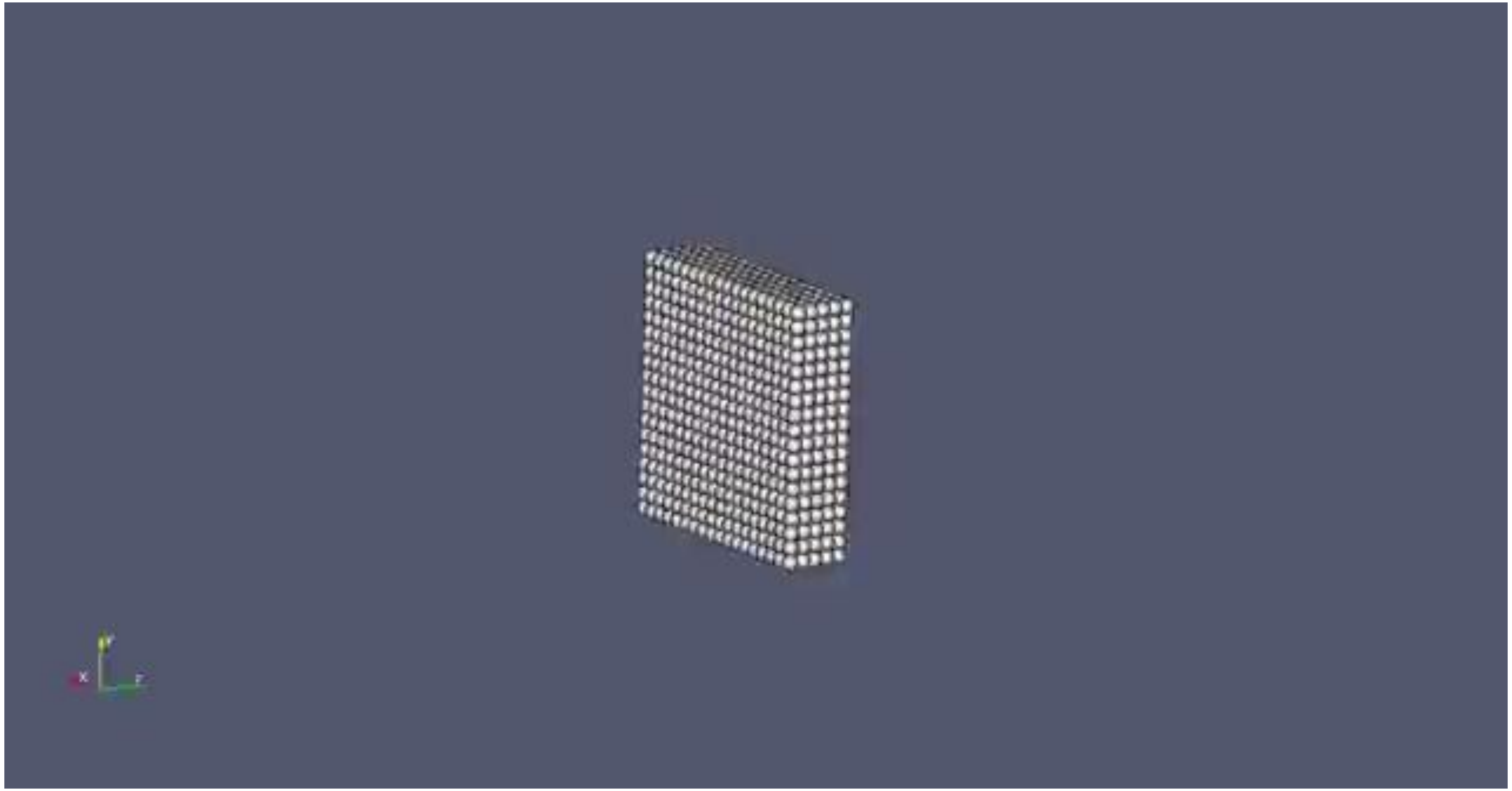
- implemented pairwise iteration
- only half needed through Newton’s third law

- amount of calculations increases non-linear
- 20x40x4 -> 5.1 mio, 20x35x4 -> 3.9 mio



P	0	1	2	3	4	5
0	**x**	✔	✔	✔	✔	✔
1	✔	x	...			
2	✔		x			
3	✔			x		
4	✔				x	
5	✔					x

Smashing stuff



Smashing stuff