Performance auto-tuning of a fluid simulation on heterogeneous devices

Presentation 3

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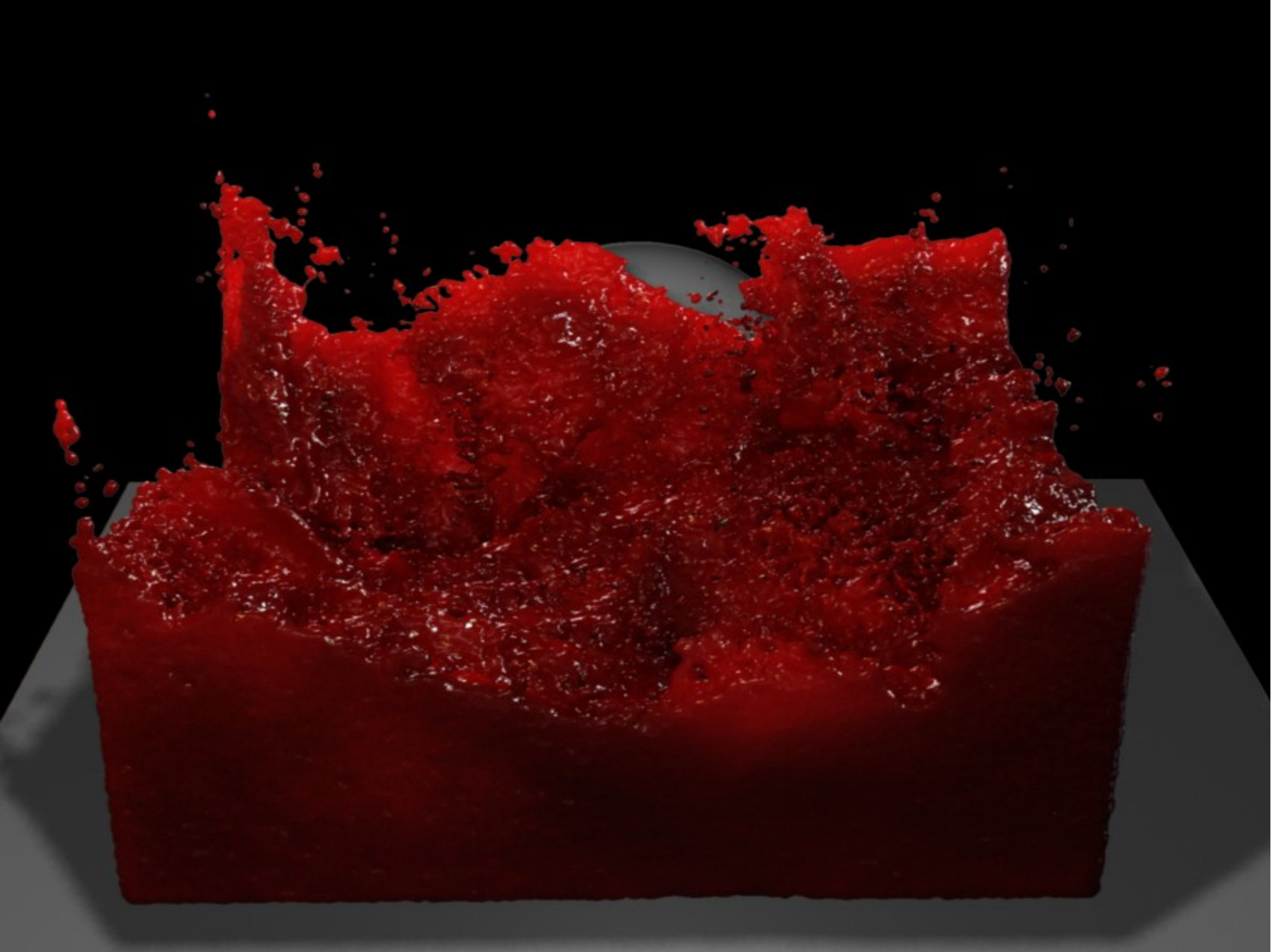
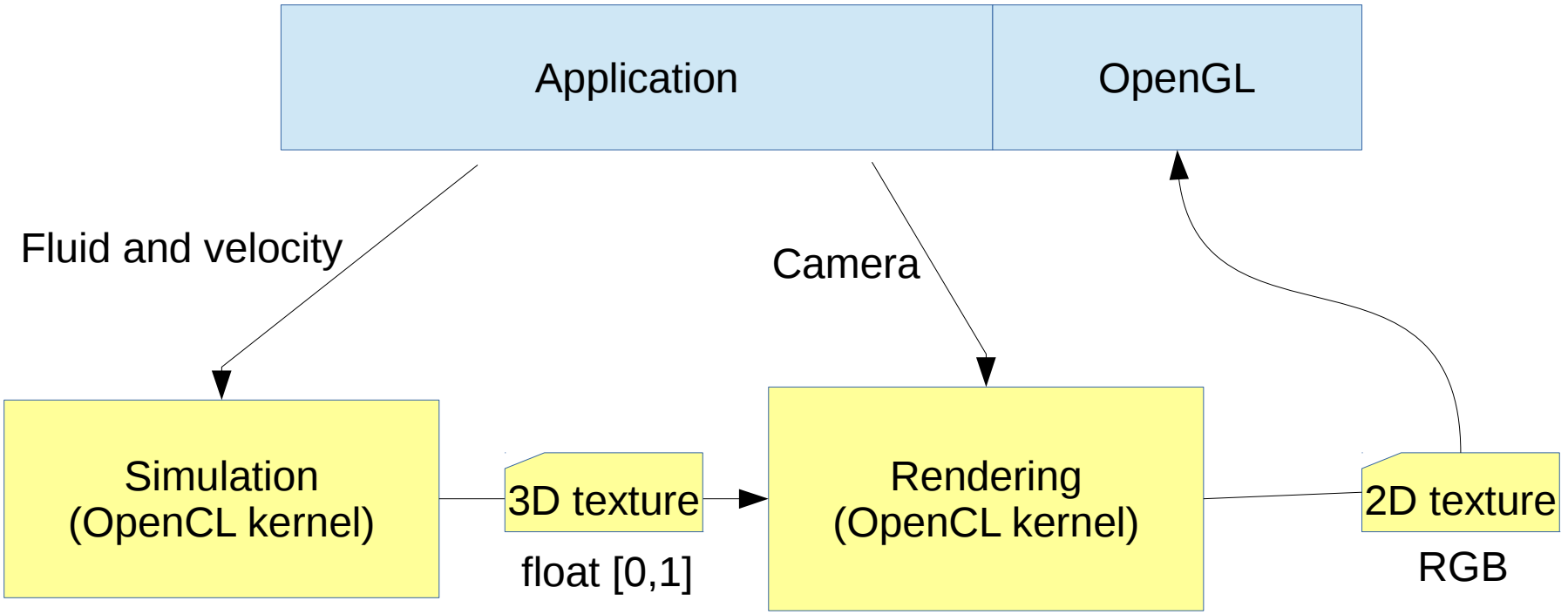
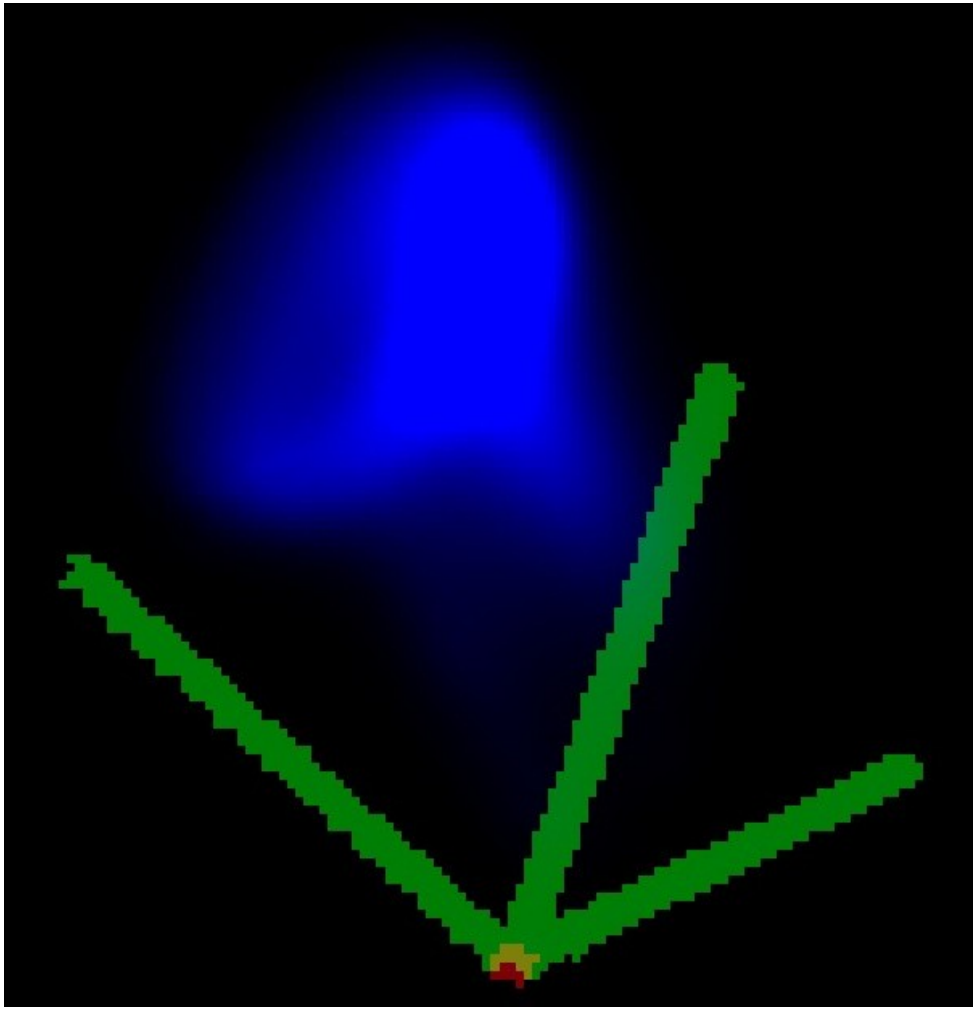


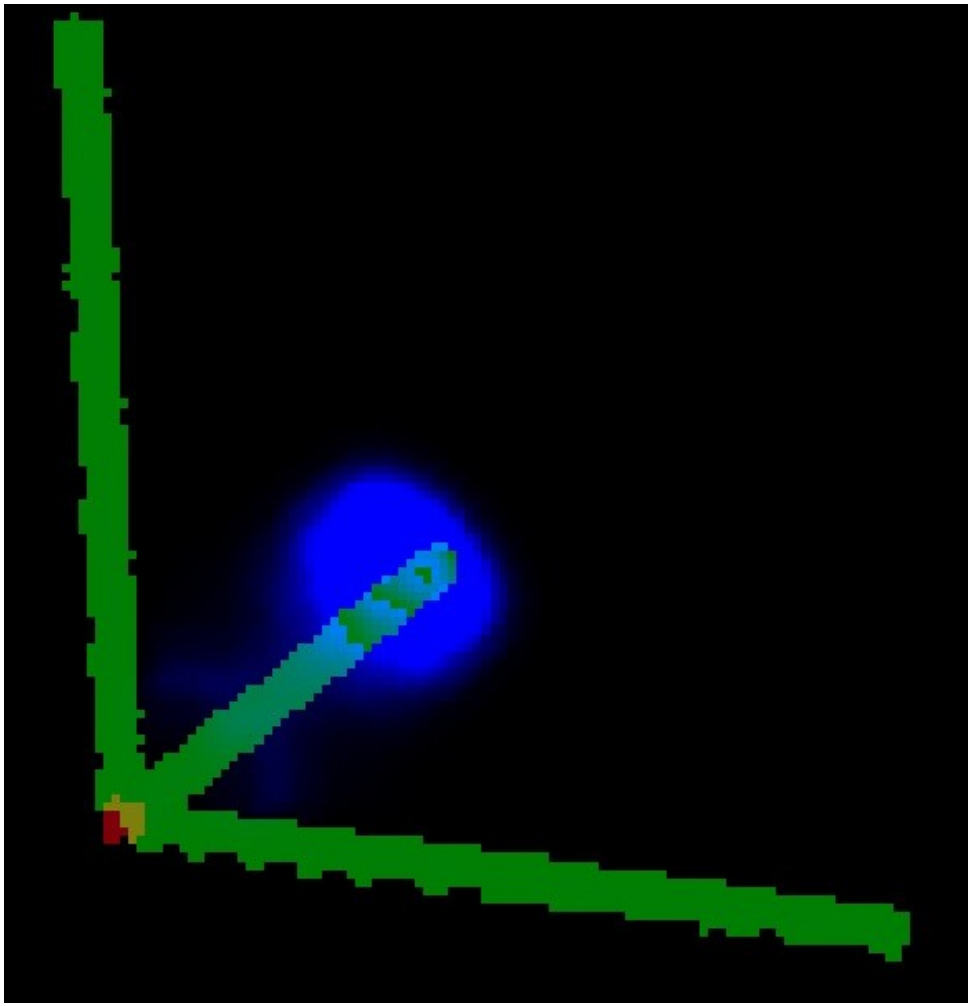
December progress



December progress

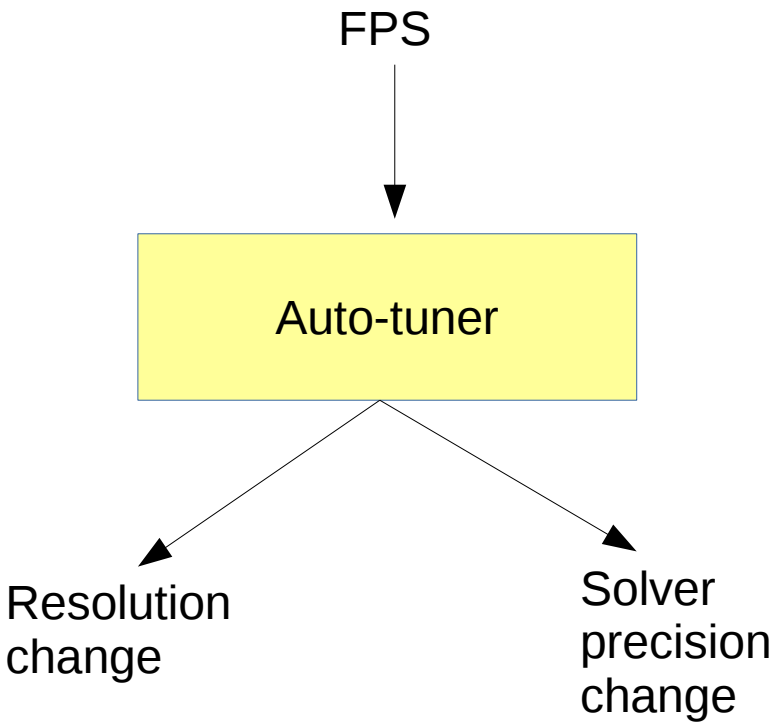
- Rendering





Current progress

- Simulation parallelised fully
- Functional auto-tuning of parameters



Parallelisation

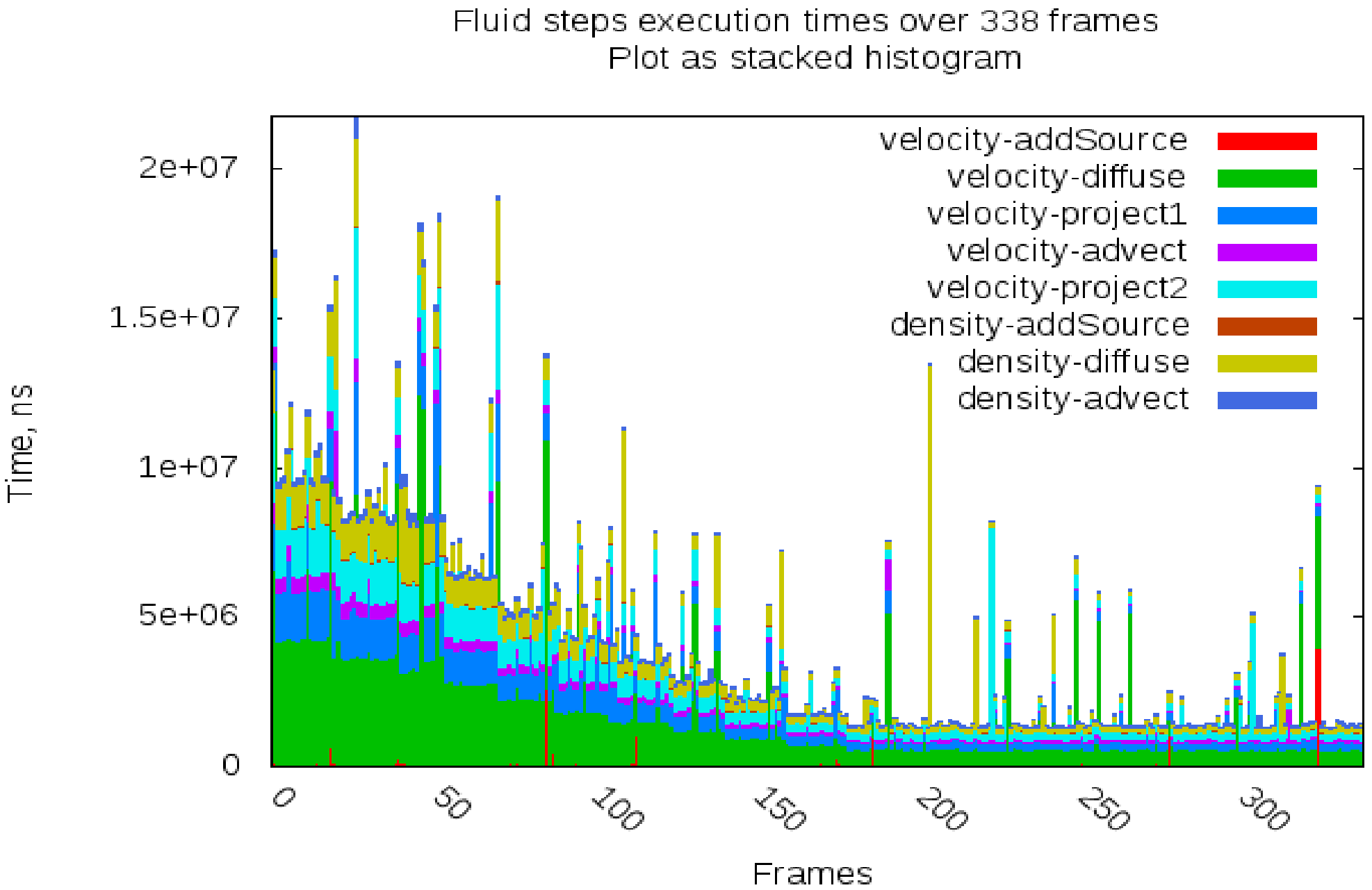
- Each simulation step → OpenCL kernel(s)
-

kernel	runtime	used in
addSource	$O(n^3)$	density, velocity step
diffuse	$O(Sn^3)$	density, velocity step
advect	$O(n^3)$	density, velocity step
project1	$O(n^3)$	velocity step
project2	$O(Sn^3)$	velocity step
project3	$O(n^3)$	velocity step
setBound	$O(n^2)$	advect, diffuse, project operations

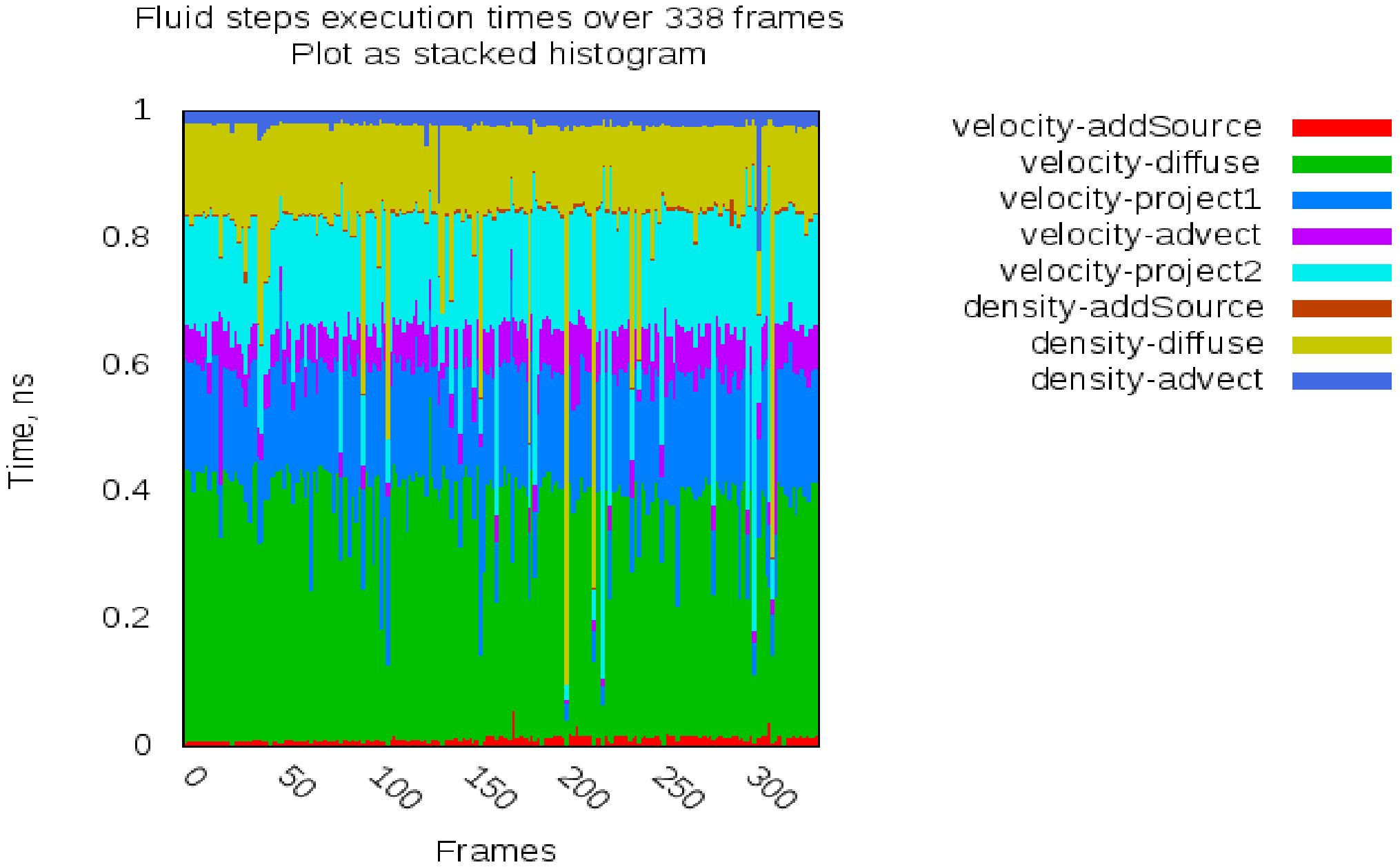
Parameter changing

- Resolution
  - 3D-resize the simulation space
  - Separate kernel
  - Fast enough not to notice
- Precision of the linear equation solvers
  - Affects diffuse and projection steps
  - Changes number of iterations

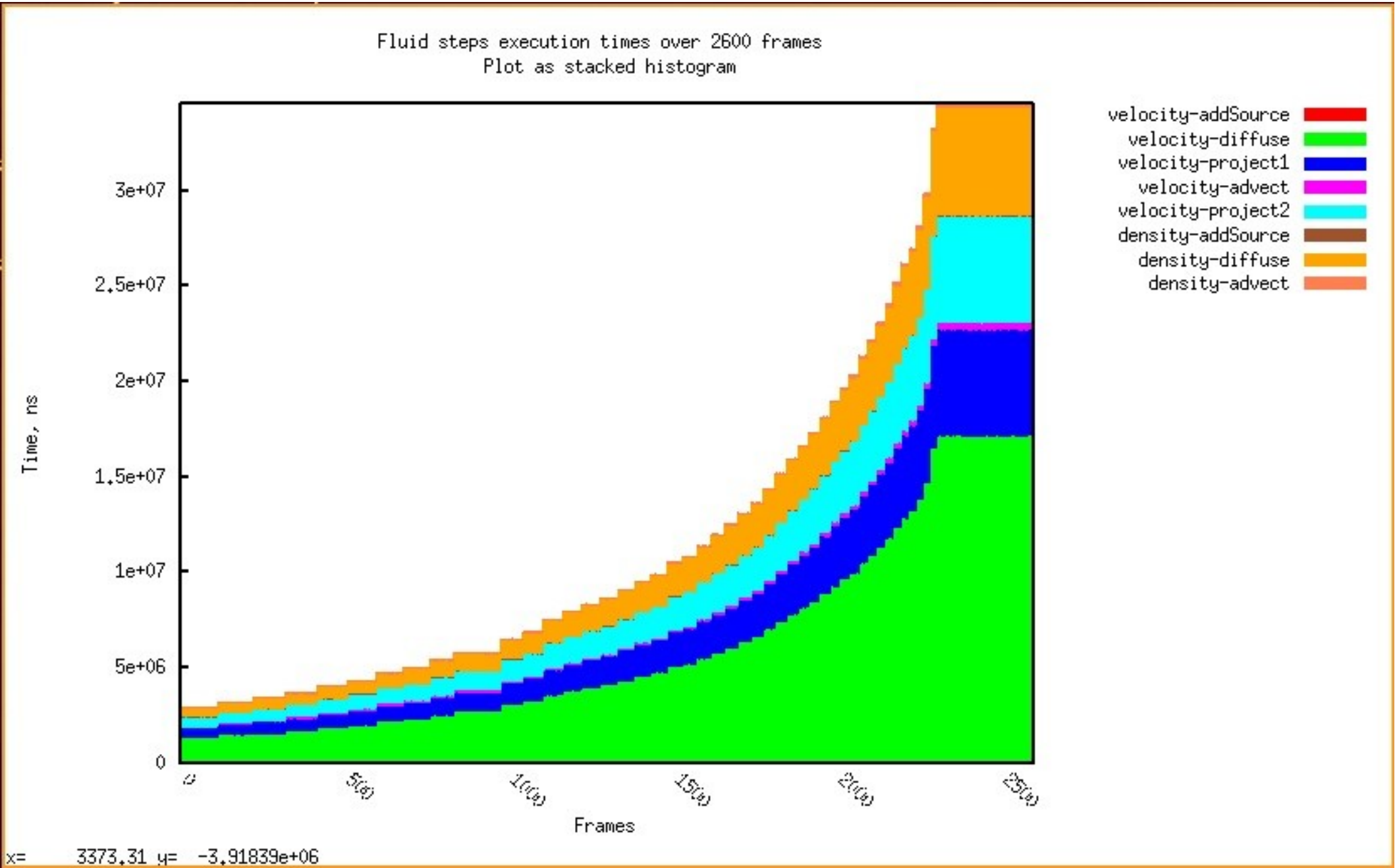
Test run - CPU


Fluid steps execution times over 338 frames
Plot as stacked histogram
velocity-addSource
velocity-diffuse
velocity-project1
velocity-advect
velocity-project2
density-addSource
density-diffuse
density-advect
2e+07
1.5e+07
1e+07
5e+06
0
Time, ns
0
50
100
150
200
250
300
Frames

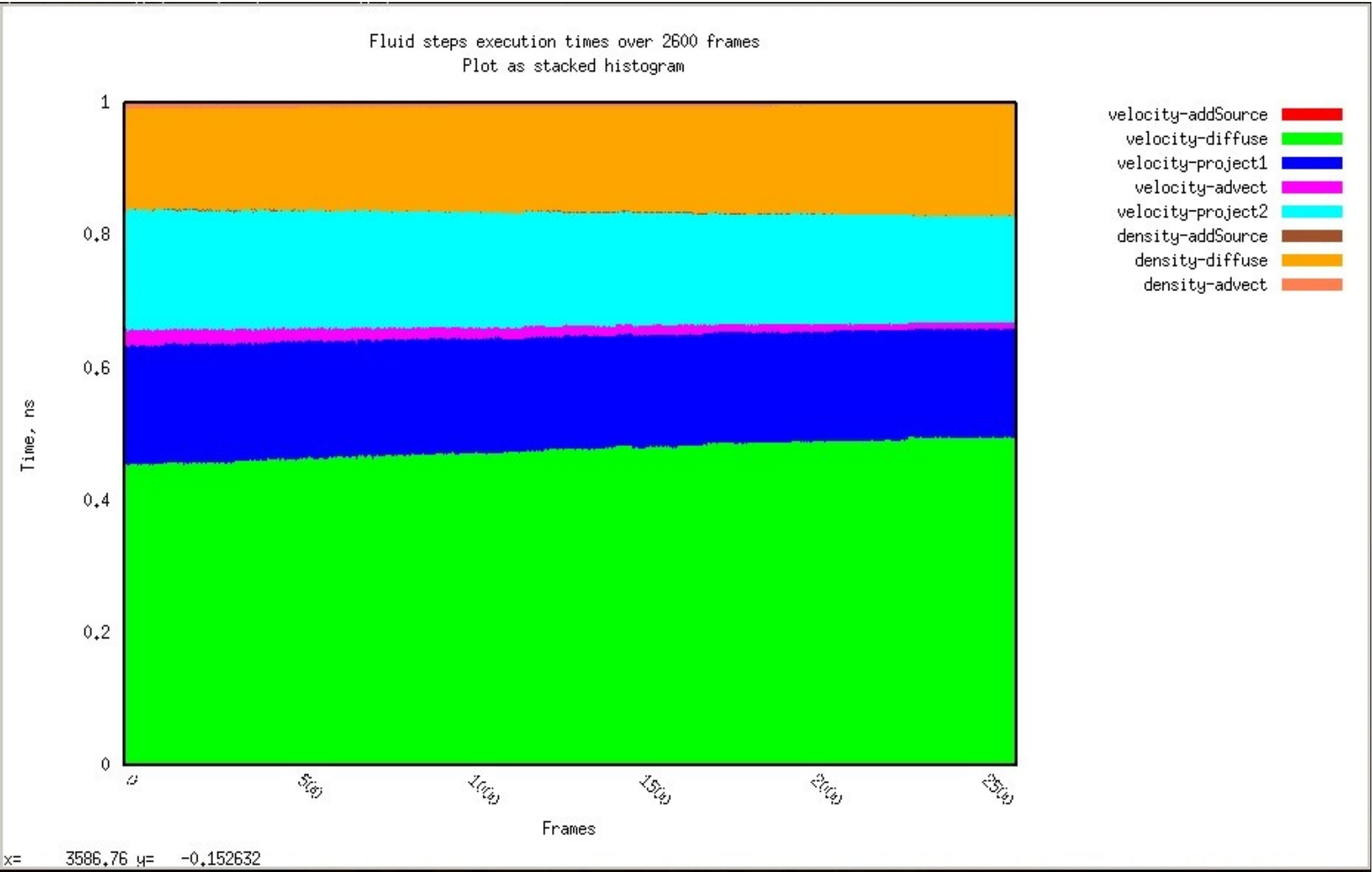
Test run - CPU


Fluid steps execution times over 338 frames
Plot as stacked histogram
Time, ns
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
Frames
velocity-addSource
velocity-diffuse
velocity-project1
velocity-advect
velocity-project2
density-addSource
density-diffuse
density-advect

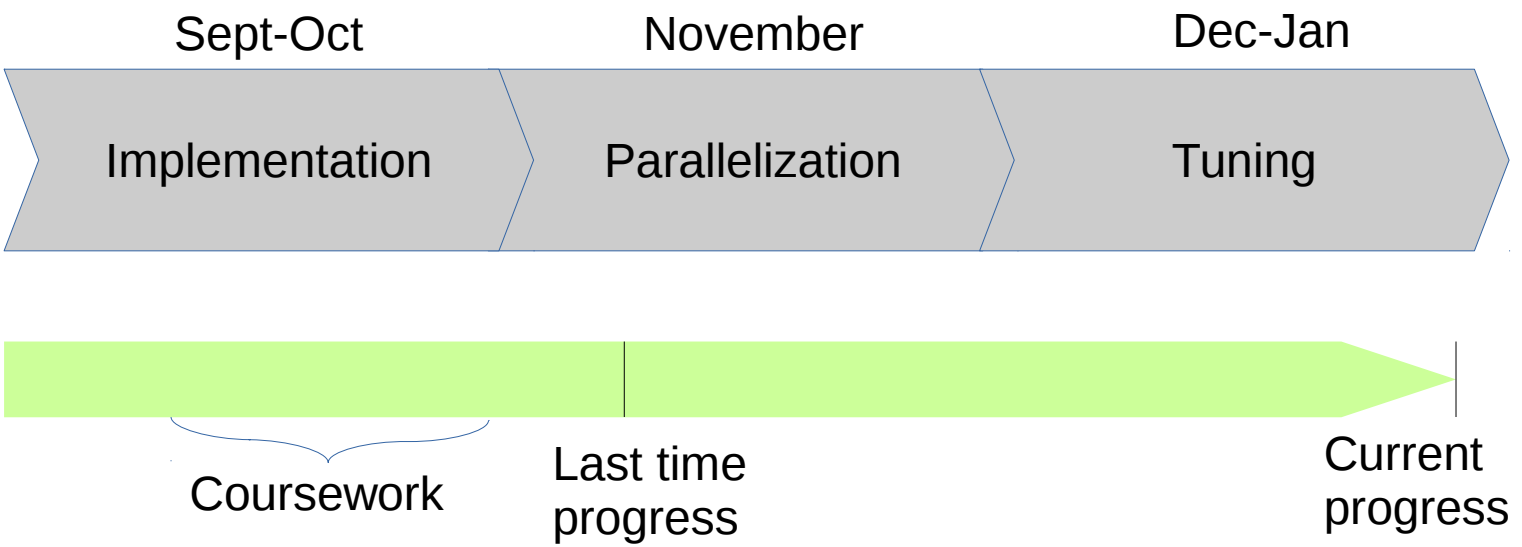
Test run - GPU


Fluid steps execution times over 2600 frames
Plot as stacked histogram
velocity-addSource
velocity-diffuse
velocity-project1
velocity-advect
velocity-project2
density-addSource
density-diffuse
density-advect
3e+07
2.5e+07
2e+07
1.5e+07
1e+07
5e+06
0
Time, ns
0
5(6)
10(4)
15(4)
20(4)
25(4)
Frames
x= 3373.31 y= -3.91839e+06

Test run - GPU


Fluid steps execution times over 2600 frames
Plot as stacked histogram
Time, ns
1
0.8
0.6
0.4
0.2
0
0
5(a)
1(a)
15(a)
2(a)
25(a)
Frames
velocity-addSource
velocity-diffuse
velocity-project1
velocity-advect
velocity-project2
density-addSource
density-diffuse
density-advect
x= 3586.76 y= -0.152632

Roadmap


Sept-Oct
November
Dec-Jan
Implementation
Parallelization
Tuning
Coursework
Last time progress
Current progress

Things to do

- Parallel optimizations
  - Local reductions
  - Coalesced memory access
- Useful output (fire)
- Better parameter tuning - explore the impact on FPS of each parameter, devise the optimum configuration)