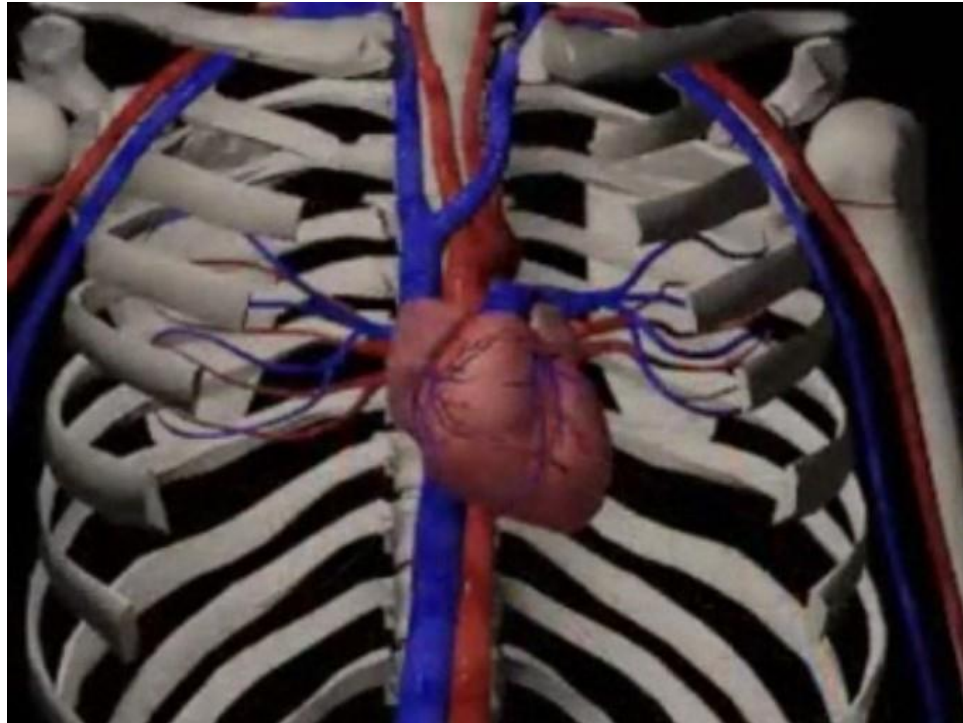


GPU COMPUTING – USING NVIDIA CUDA TO ACCELERATE SIMULATIONS IN BIOMEDICAL ENGINEERING

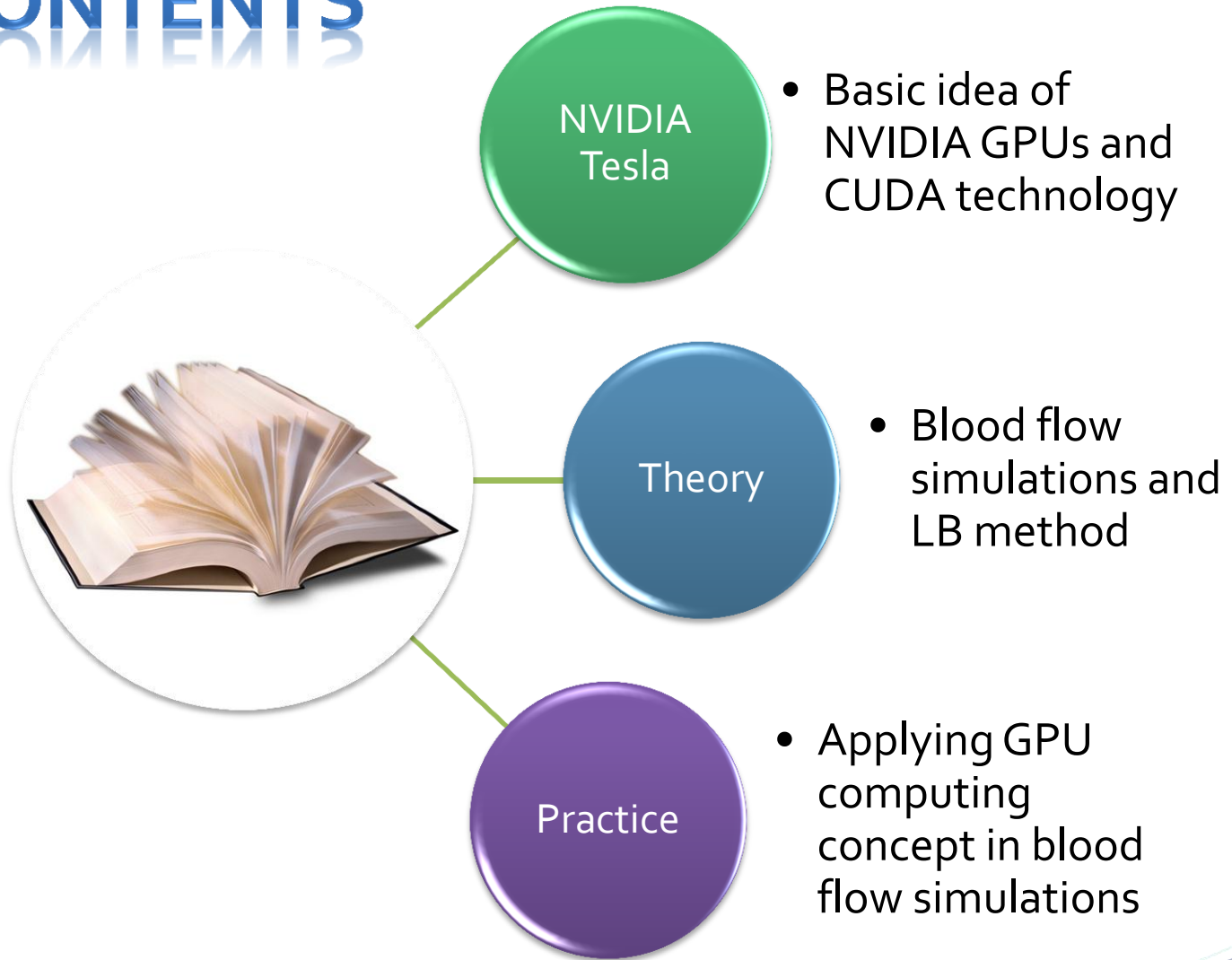
Tijana Đukić

*Research fellow,
Research and Development Center for Bioengineering,
BioIRC
Microsoft Student Partner*

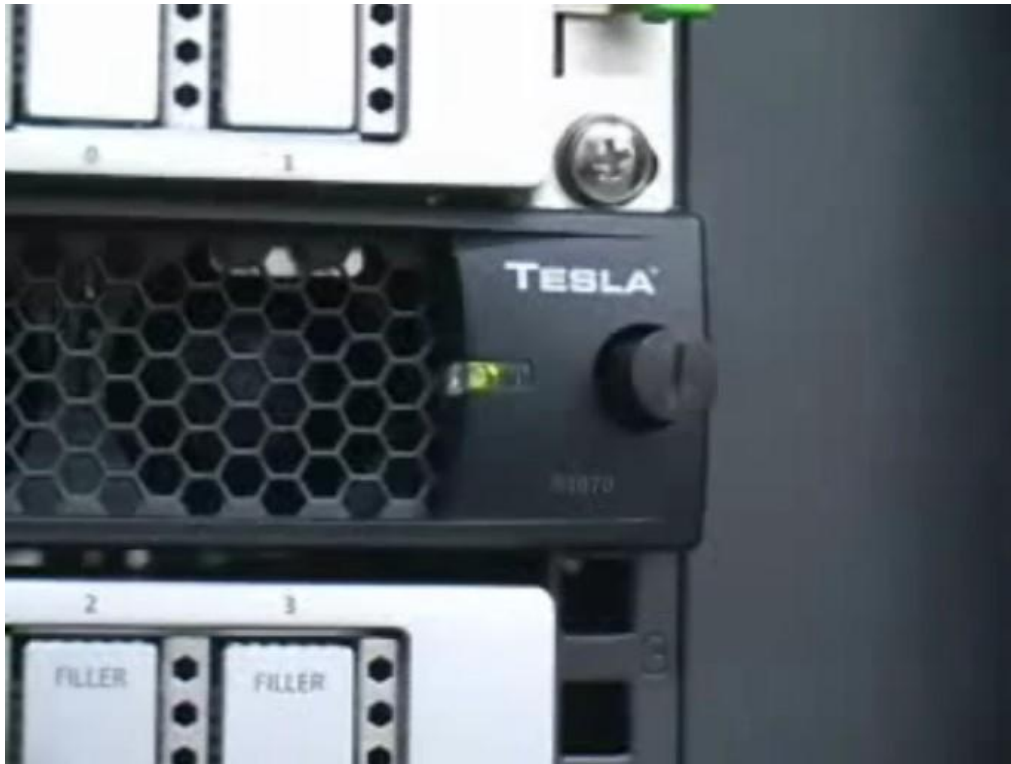
GOAL OF BIOMEDICAL ENGINEERING



CONTENTS



NVIDIA TESLA – GPU DEVICES

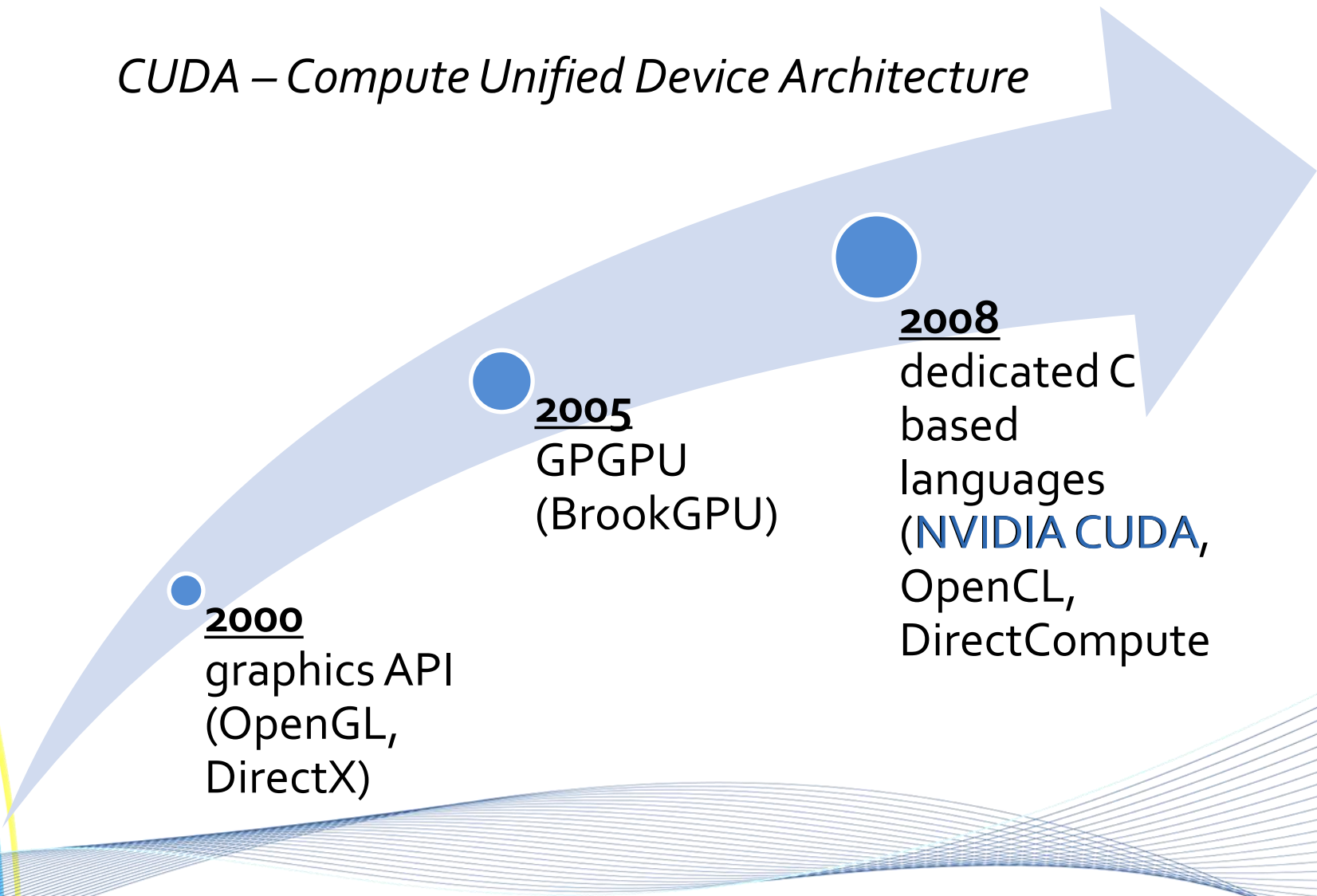


*GPU – Graphics
Processing
Units*



DEVELOPMENT OF GPU COMPUTING

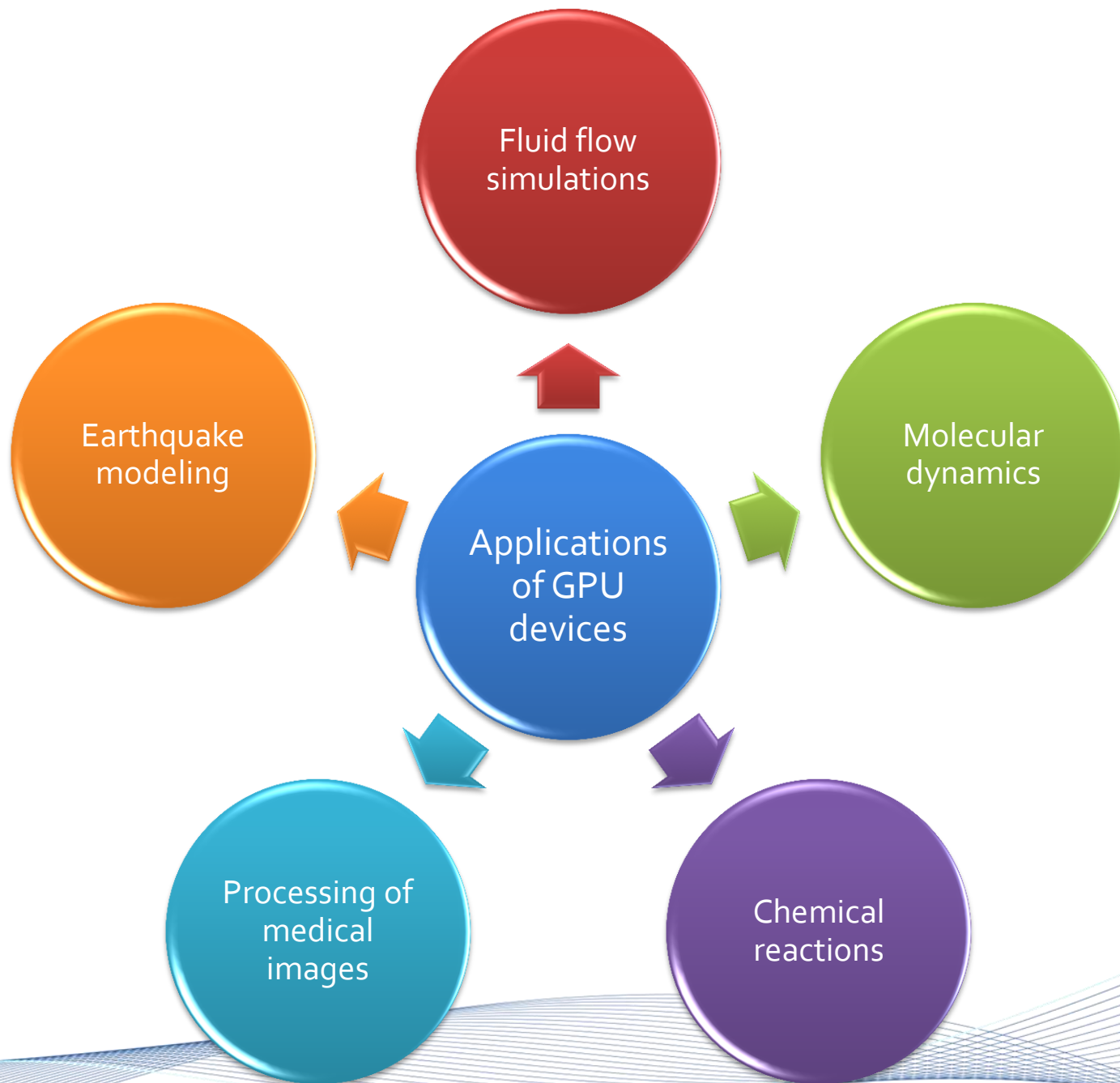
CUDA – Compute Unified Device Architecture



2000
graphics API
(OpenGL,
DirectX)

2005
GPGPU
(BrookGPU)

2008
dedicated C
based
languages
(**NVIDIA CUDA**,
OpenCL,
DirectCompute)



TESLA C1060



ADVANTAGES OF GPU DEVICES

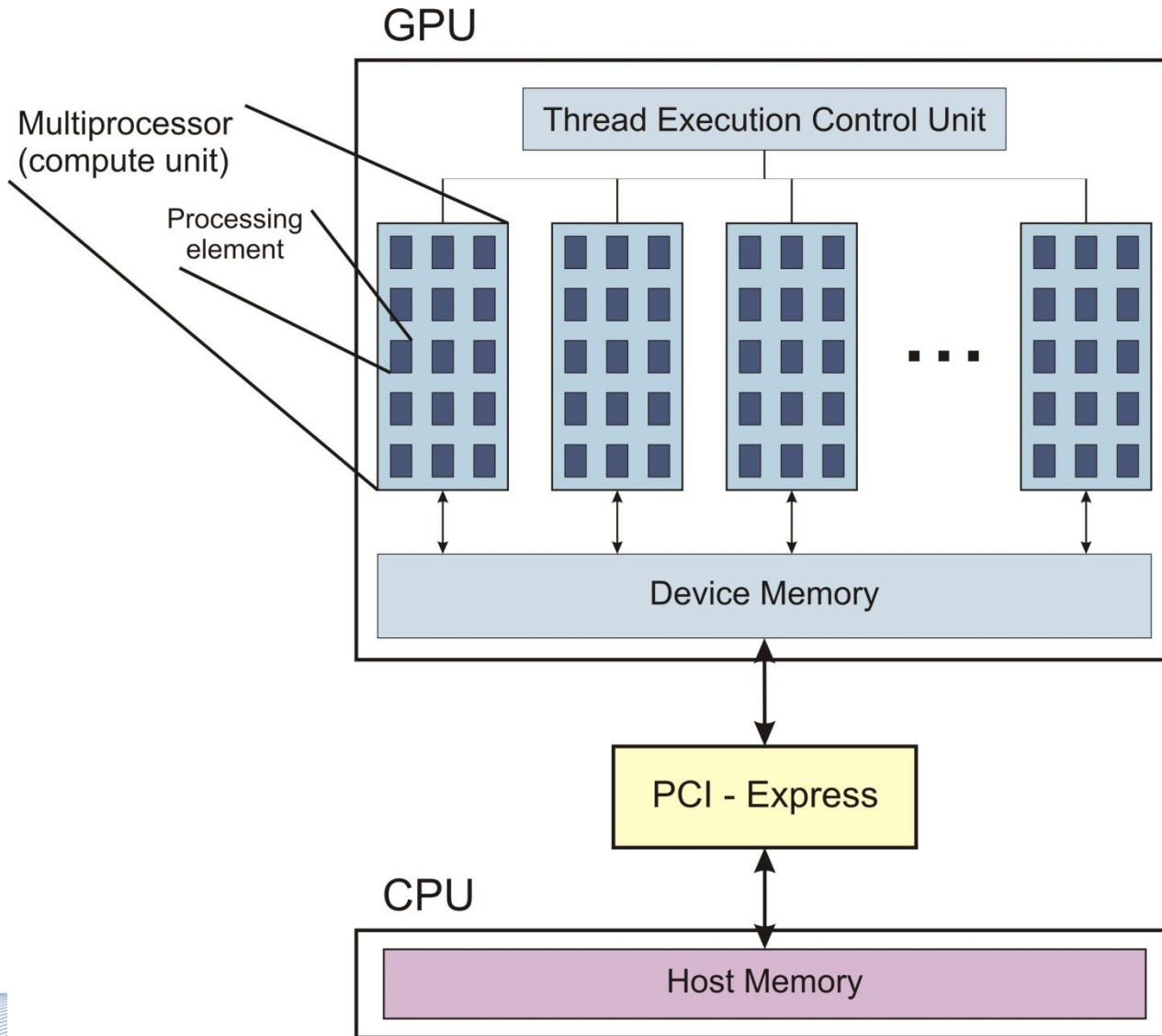
Parallel processing of data - SIMD

Contrast to the sequential approach

Simultaneous programming of CPU and GPU

Minimal changes of existing programs

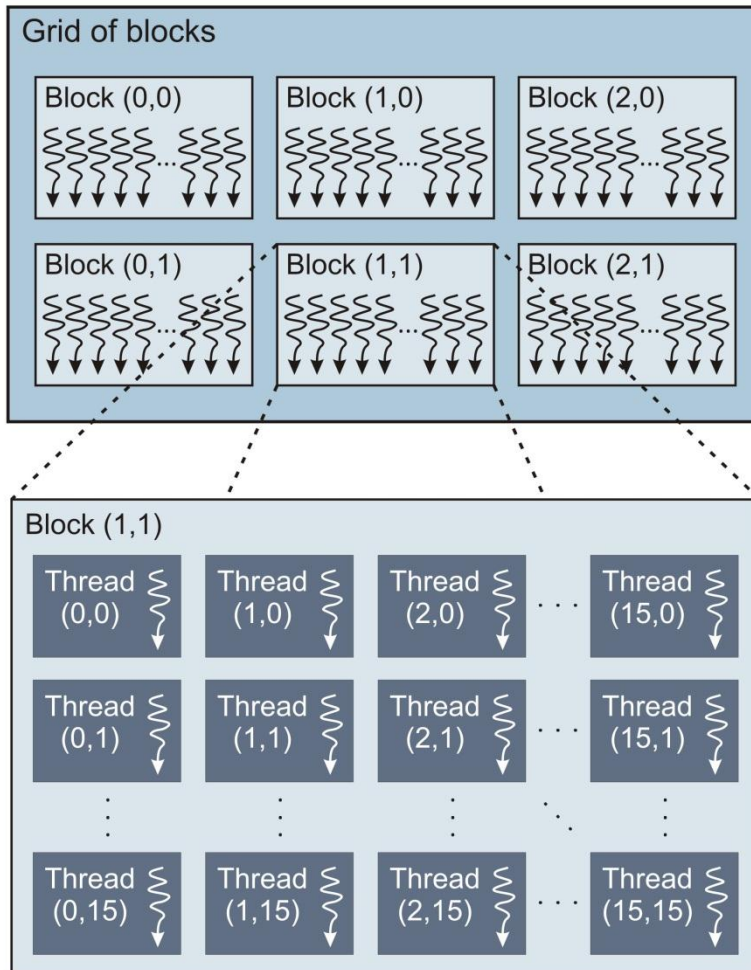
GPU ARCHITECTURE

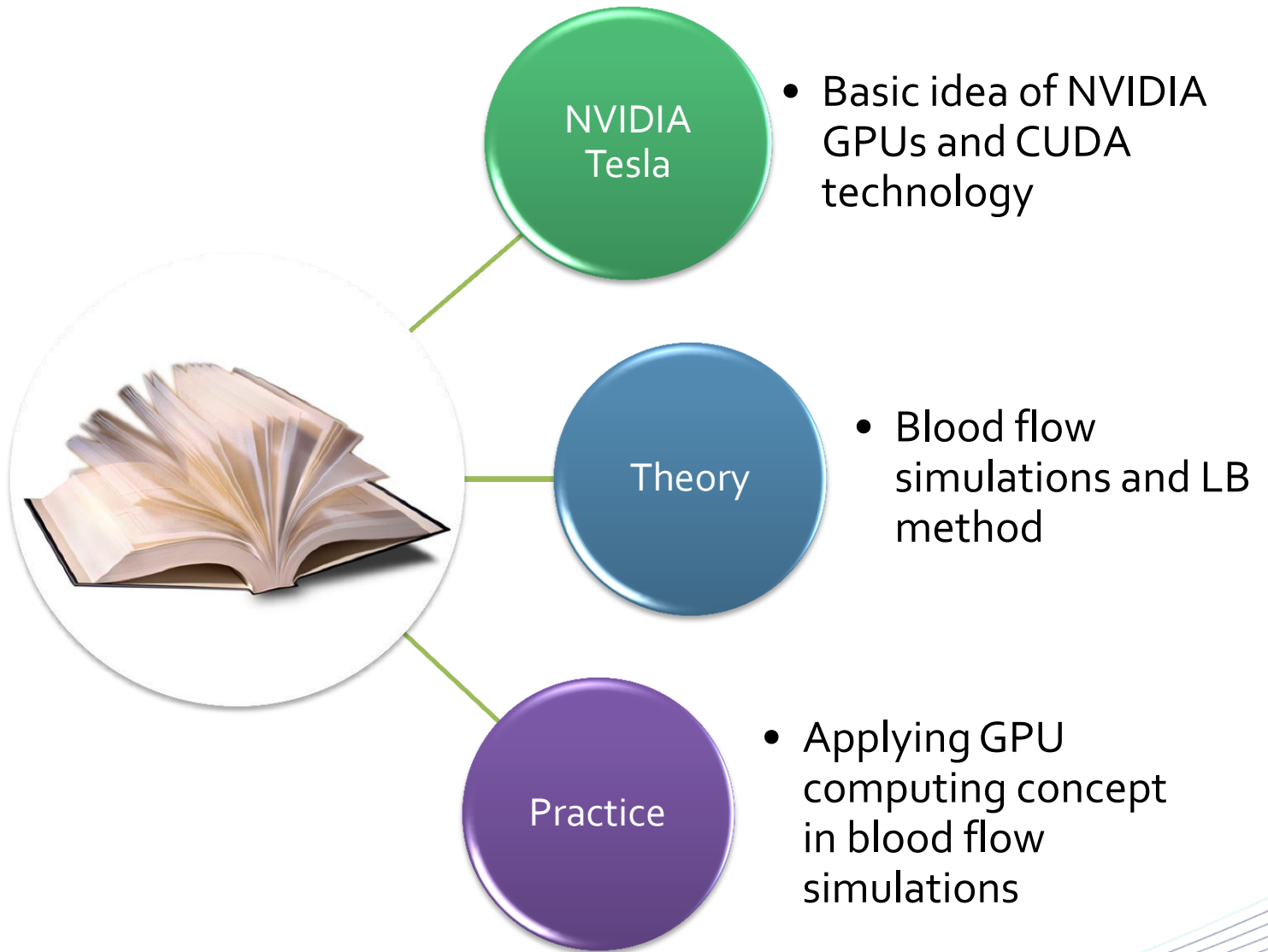


```
dim3 dimBlock(16, 16);  
dim3 dimGrid(2, 3);  
KernelFunction <<< dimGrid, dimBlock >>> (parameters);
```

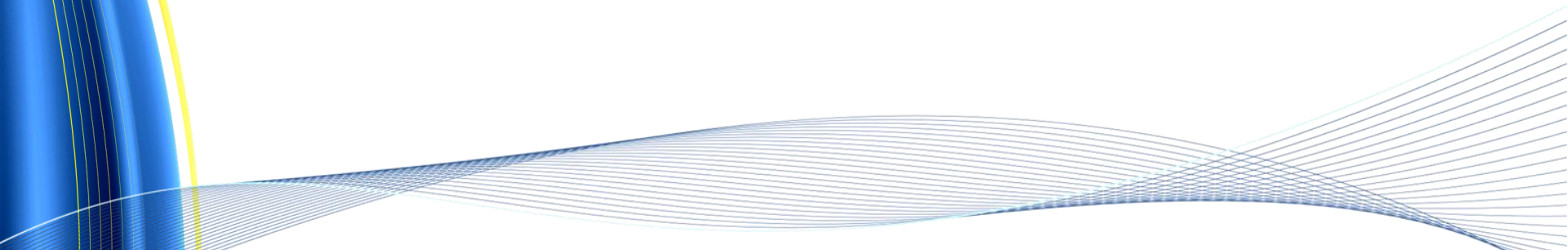


EXECUTION PROCEDURE

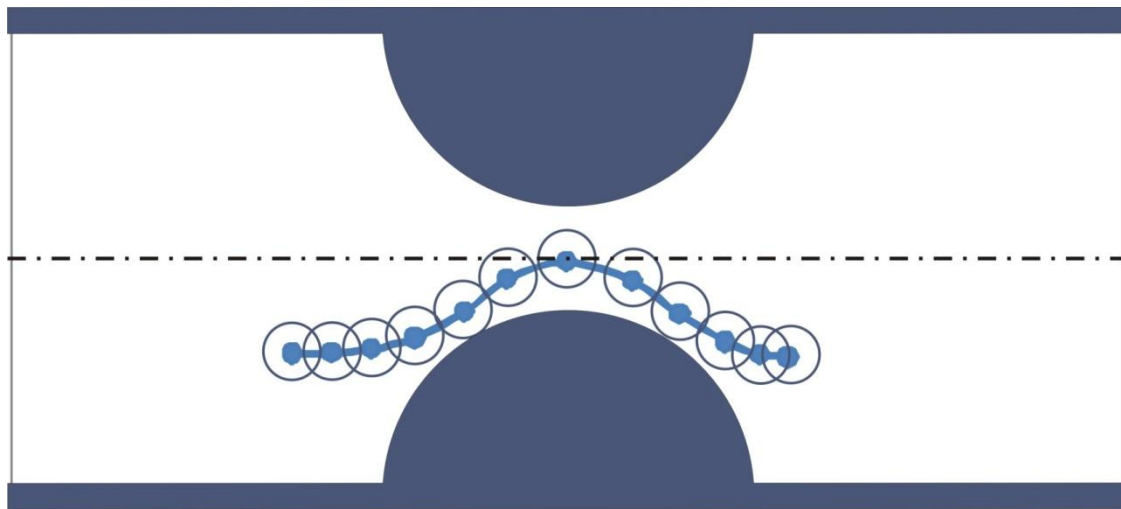
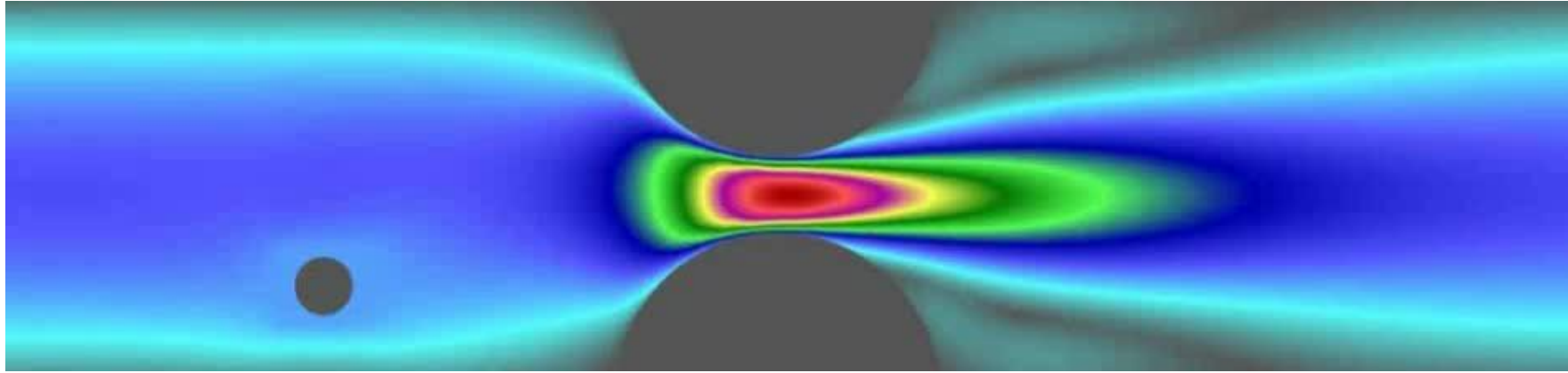




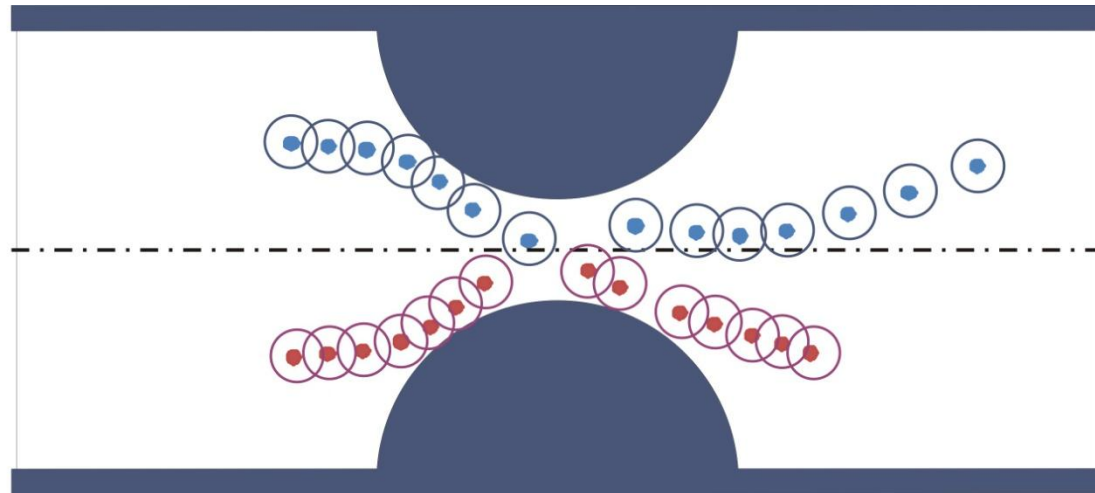
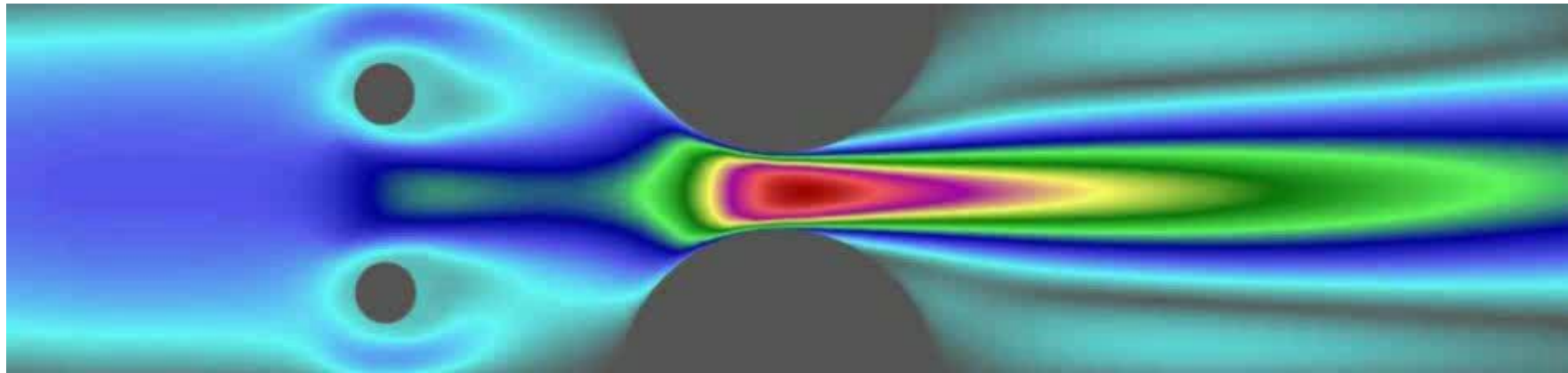
LB METHOD ... BASIC IDEA



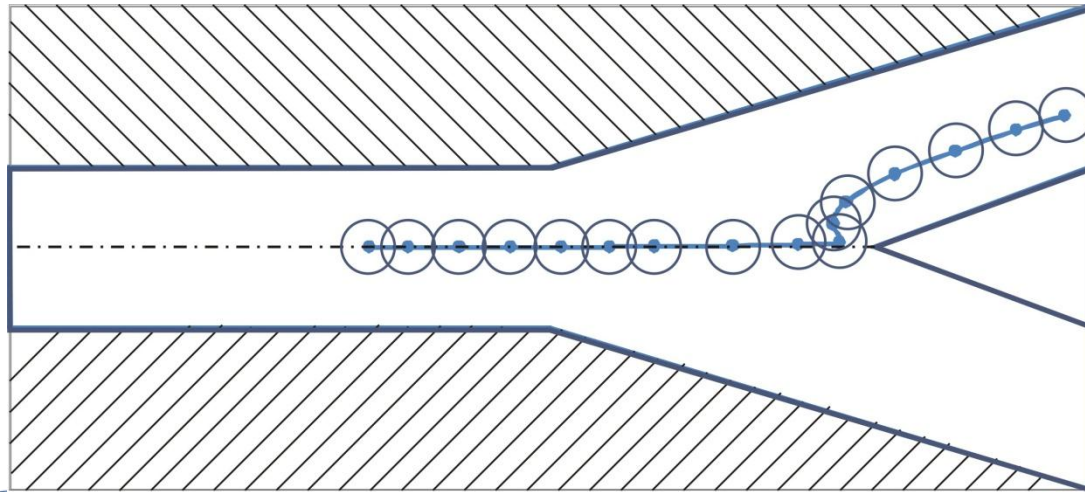
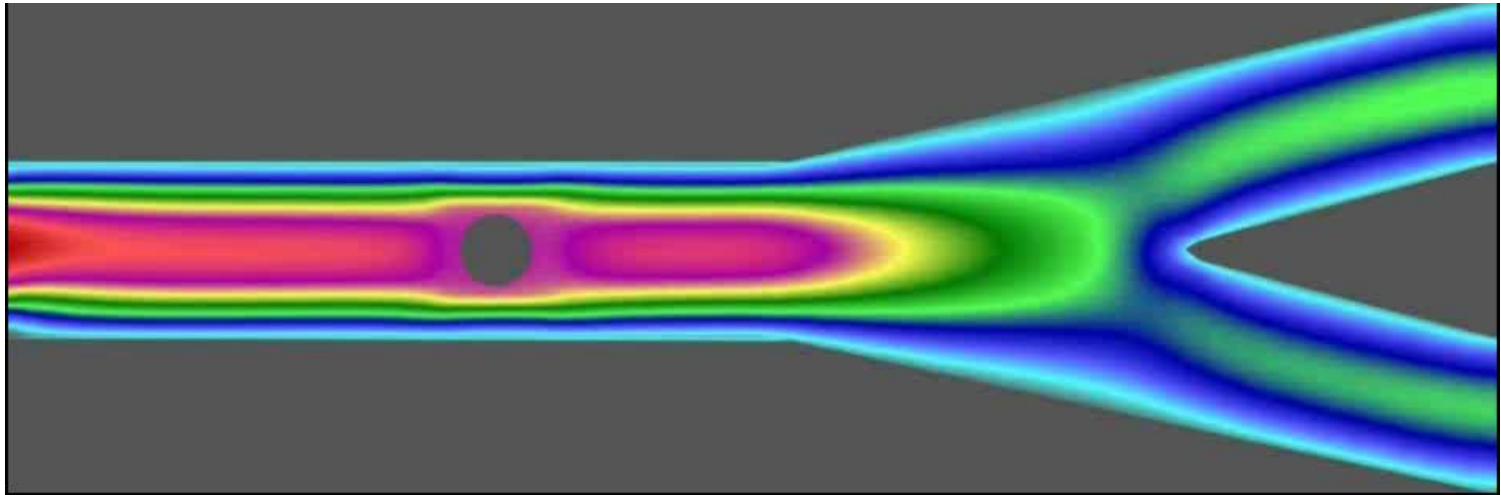
MOVEMENT OF CIRCULAR PARTICLE THROUGH A STENOTIC ARTERY

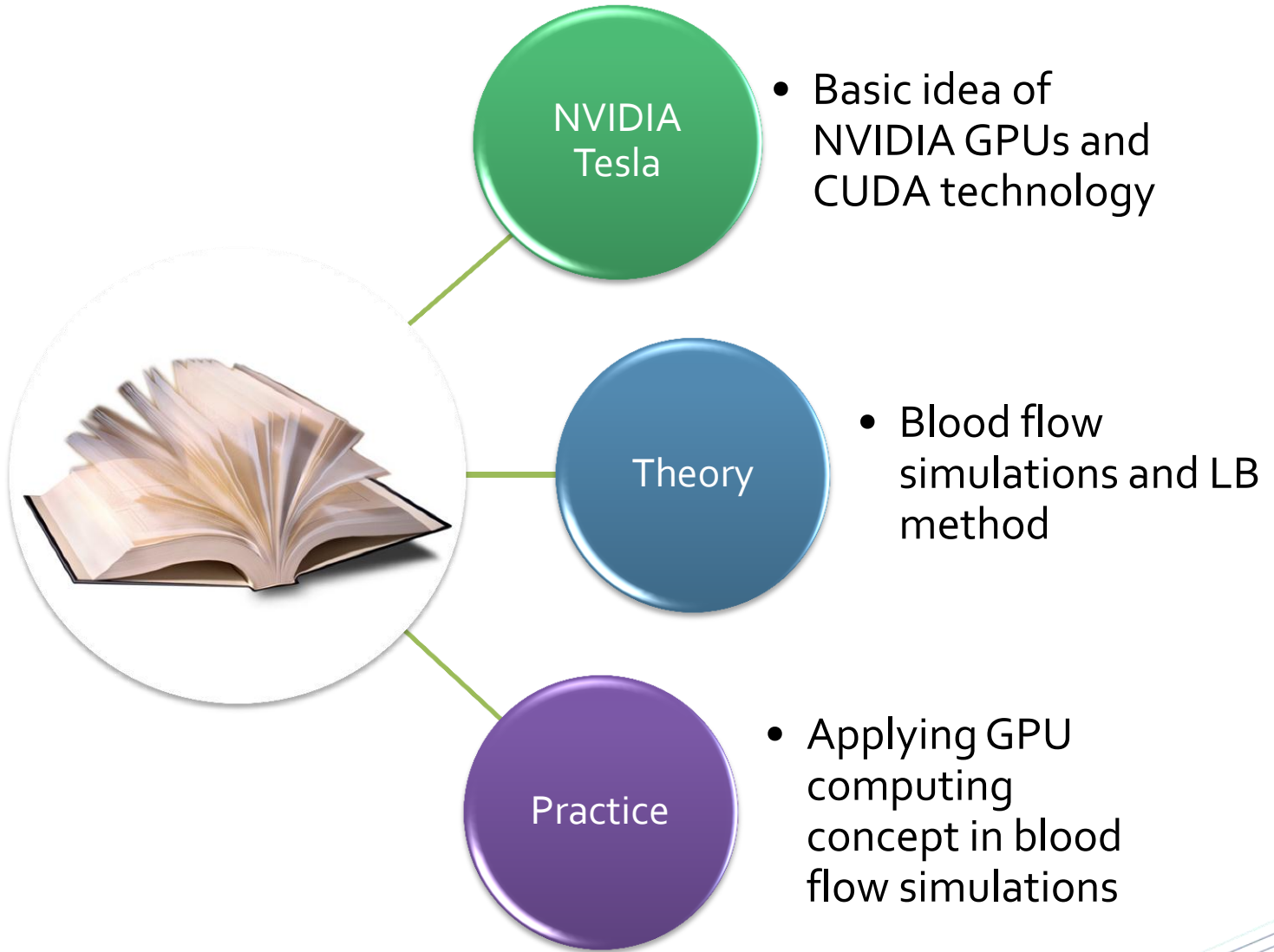


MOVEMENT OF TWO CIRCULAR PARTICLES THROUGH STENOTIC ARTERY

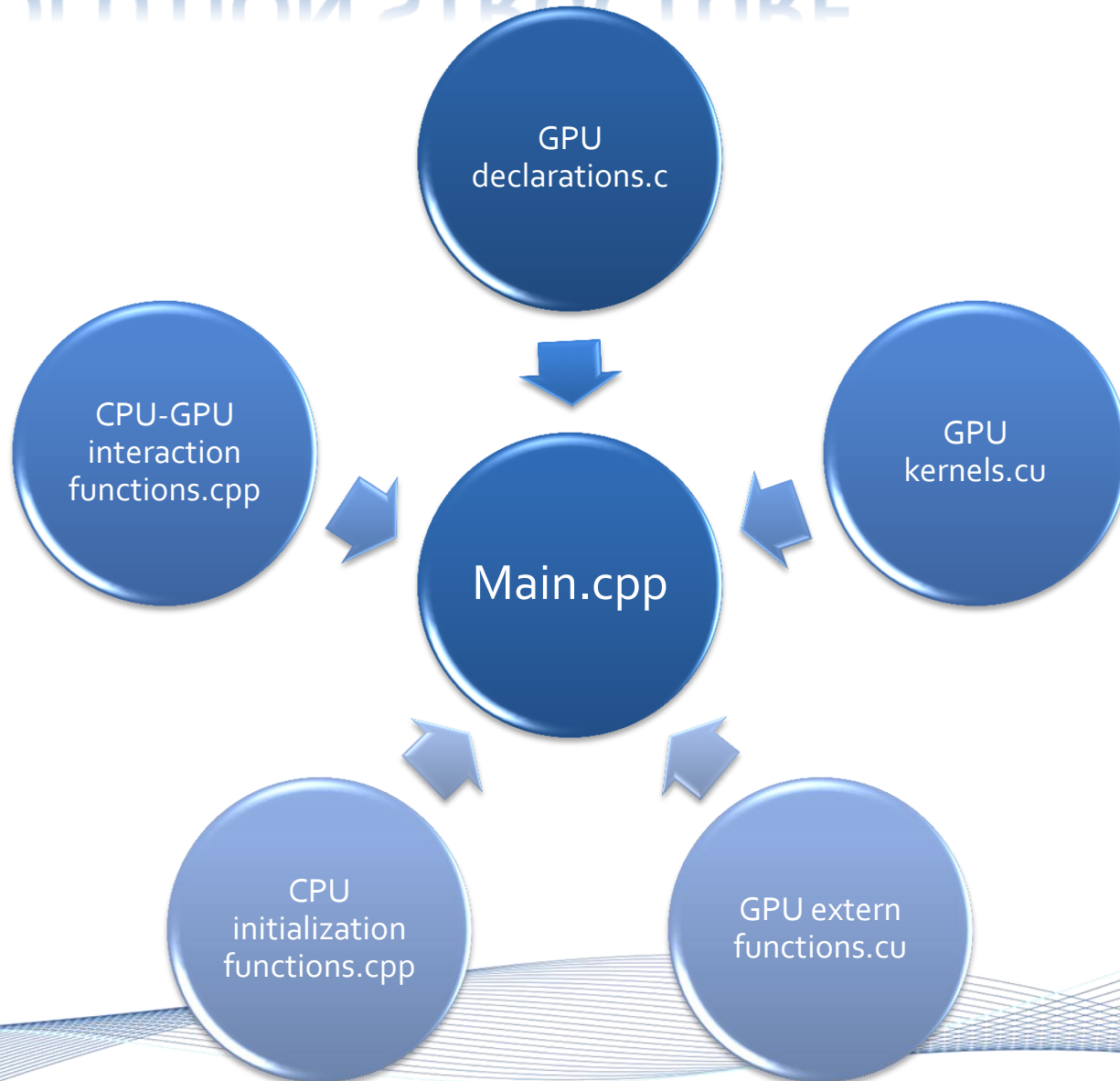


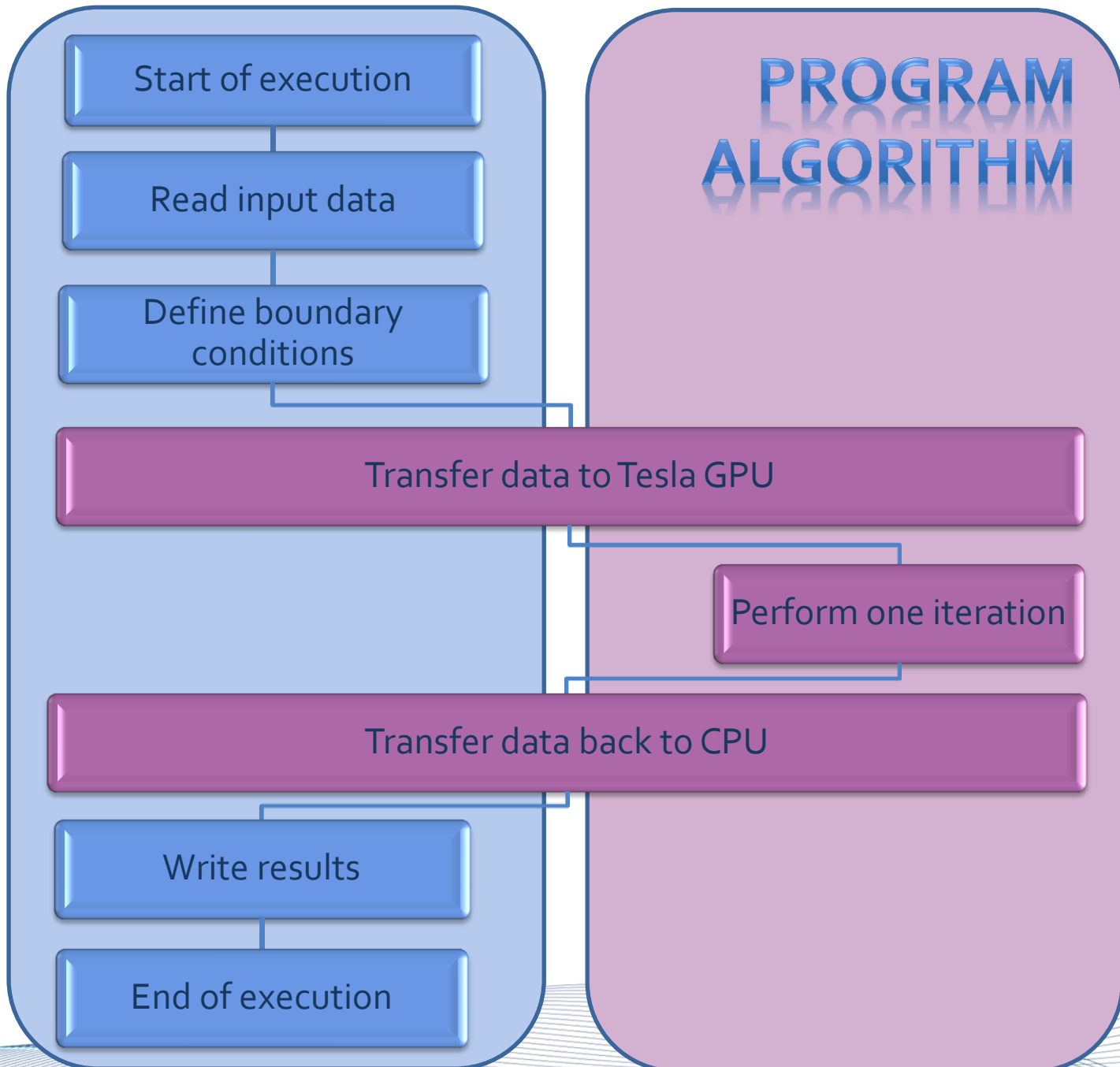
MOVEMENT OF CIRCULAR PARTICLE THROUGH AN ARTERY WITH BIFURCATION





SOLUTION STRUCTURE





Start of execution

Read input data

Define boundary conditions

Transfer data to Tesla GPU

PROGRAM ALGORITHM

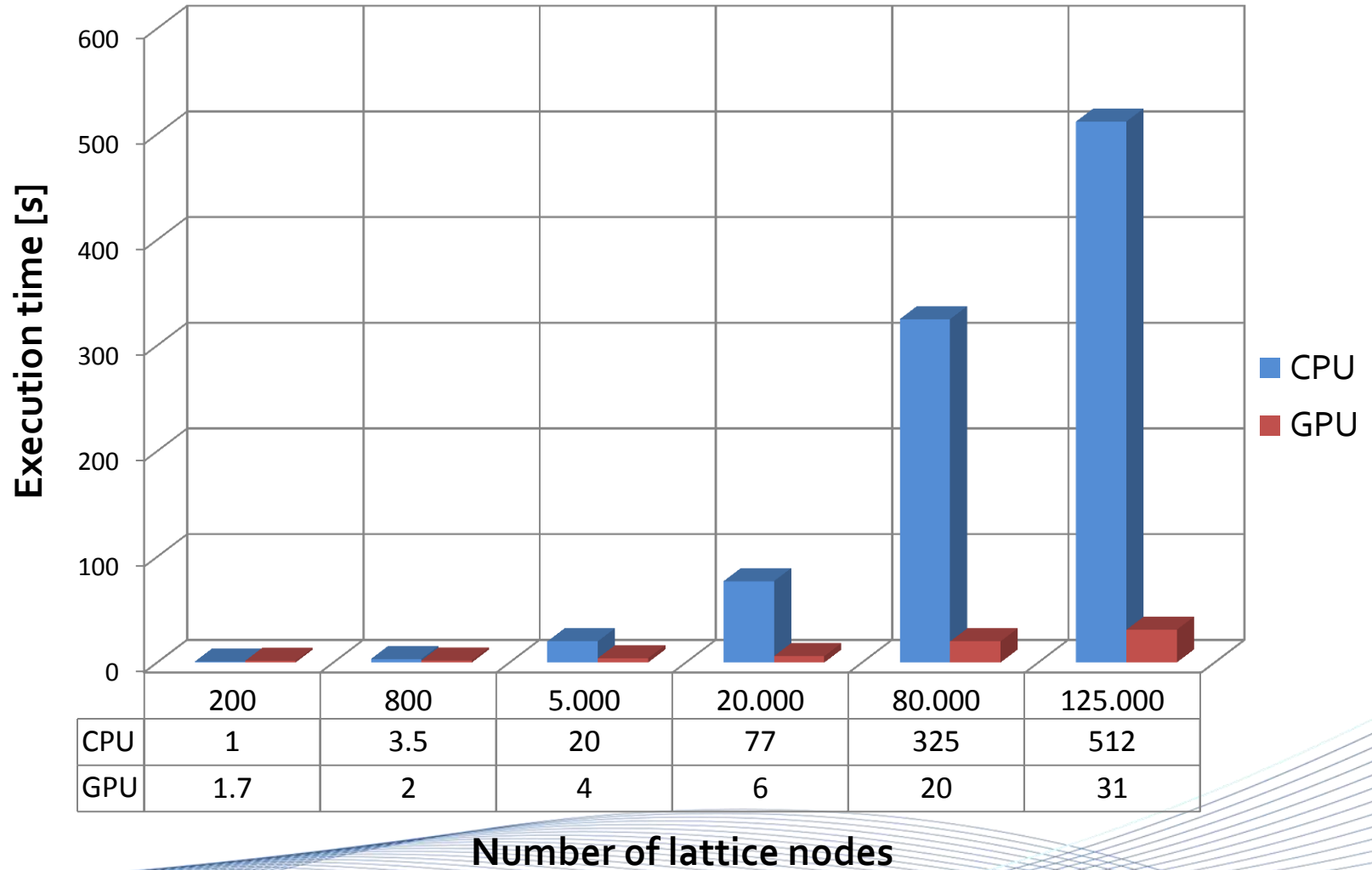
Perform one iteration

Transfer data back to CPU

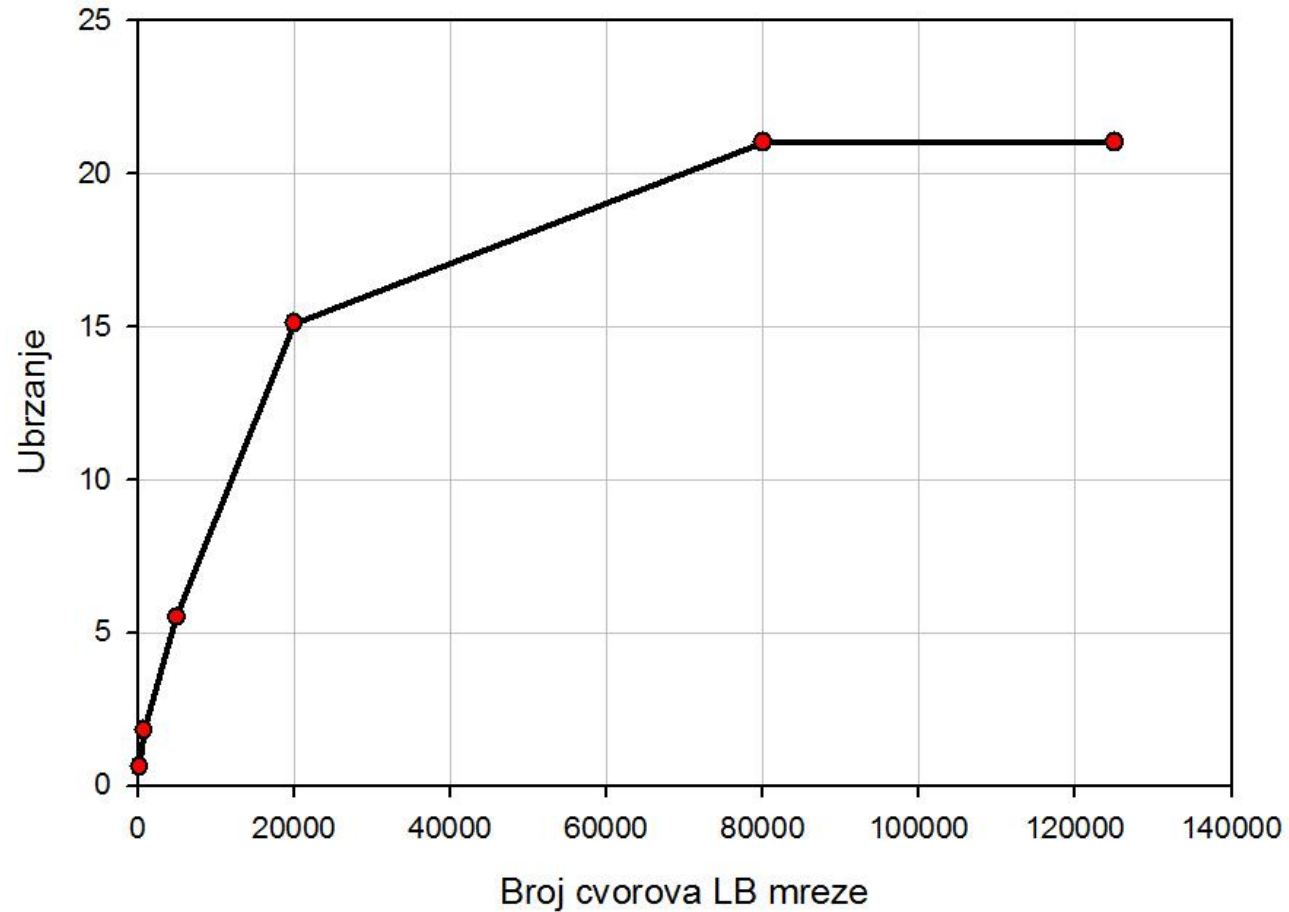
Write results

End of execution

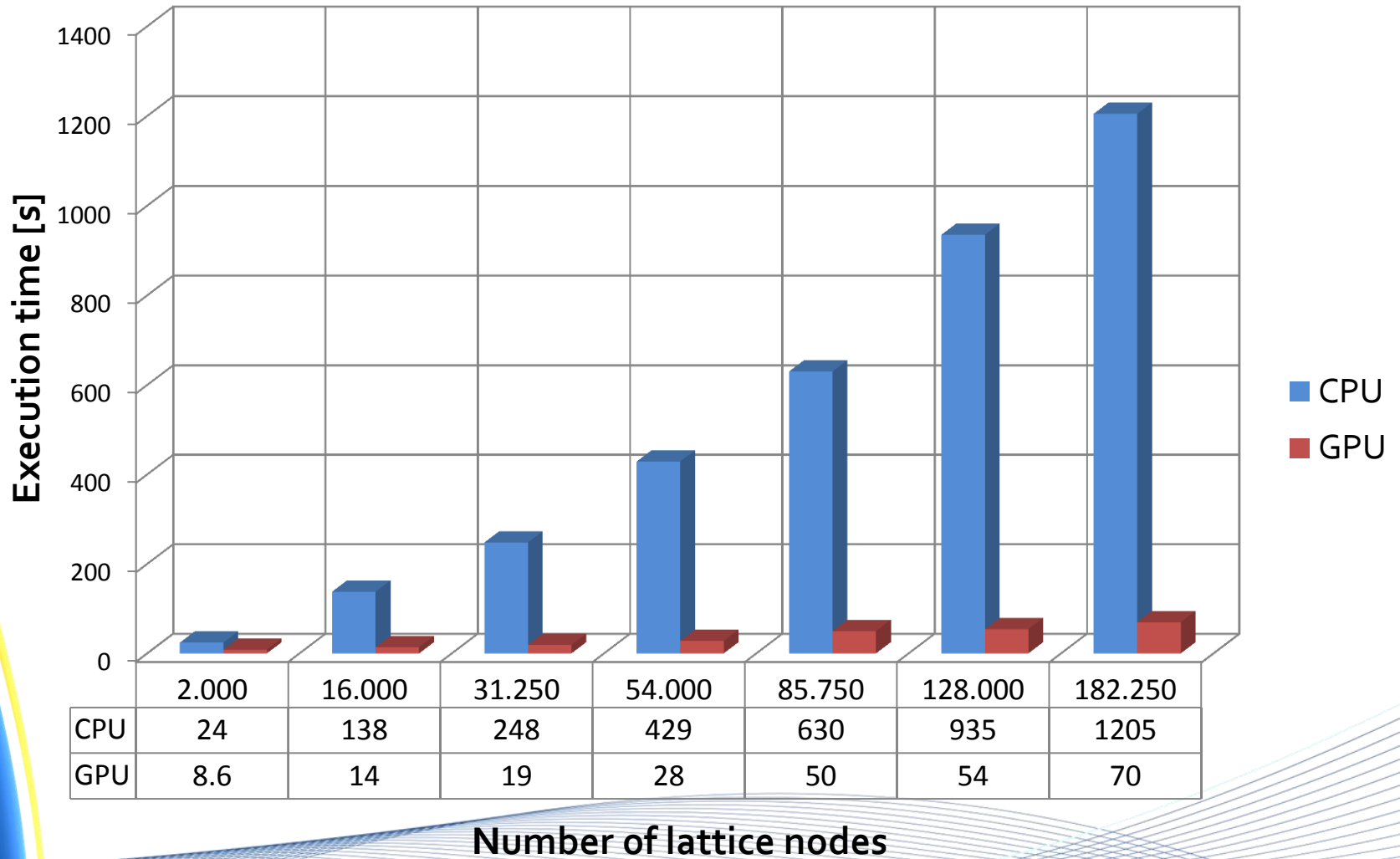
SPEED-UP OF PARALLELIZED LB SOLVER



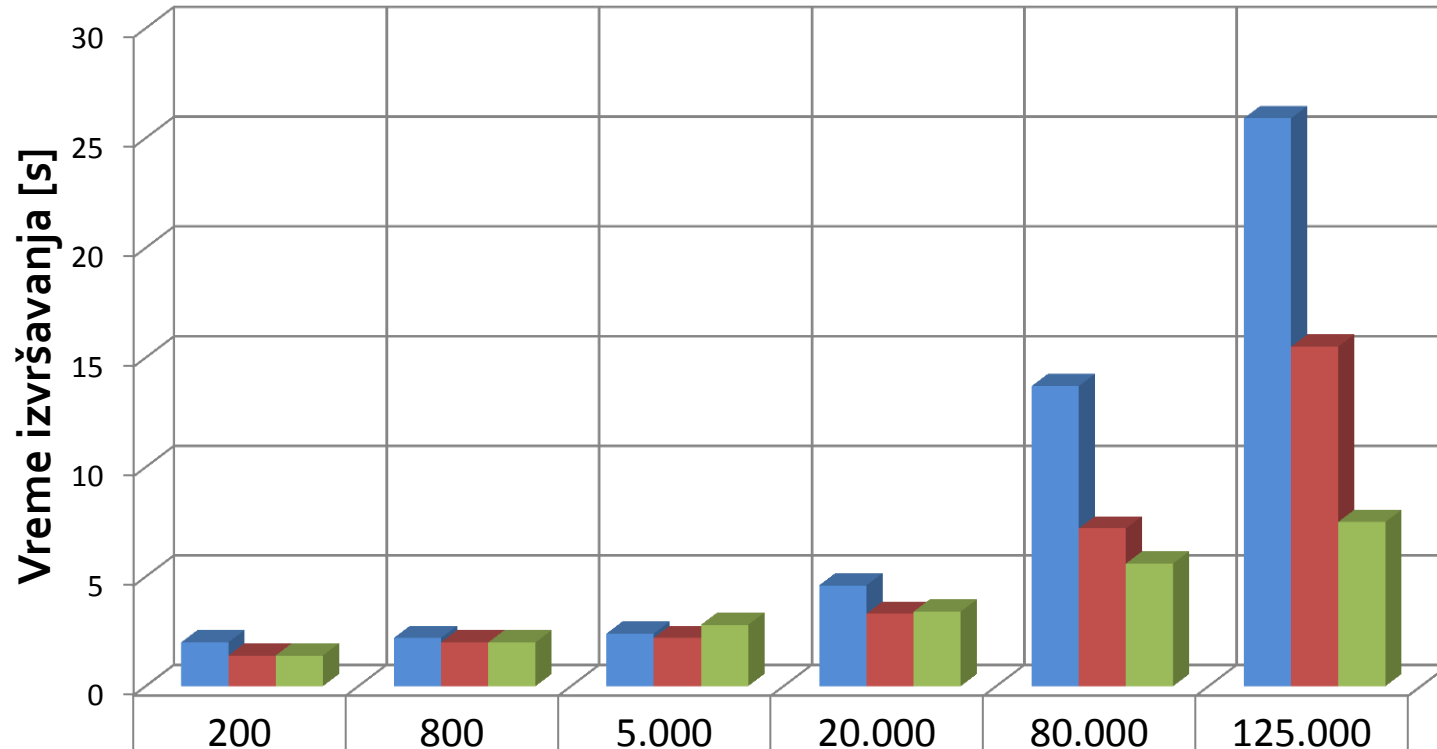
SPEED-UP OF PARALLELIZED LB SOLVER IN 2D



SPEED-UP OF PARALLELIZED LB SOLVER IN 3D



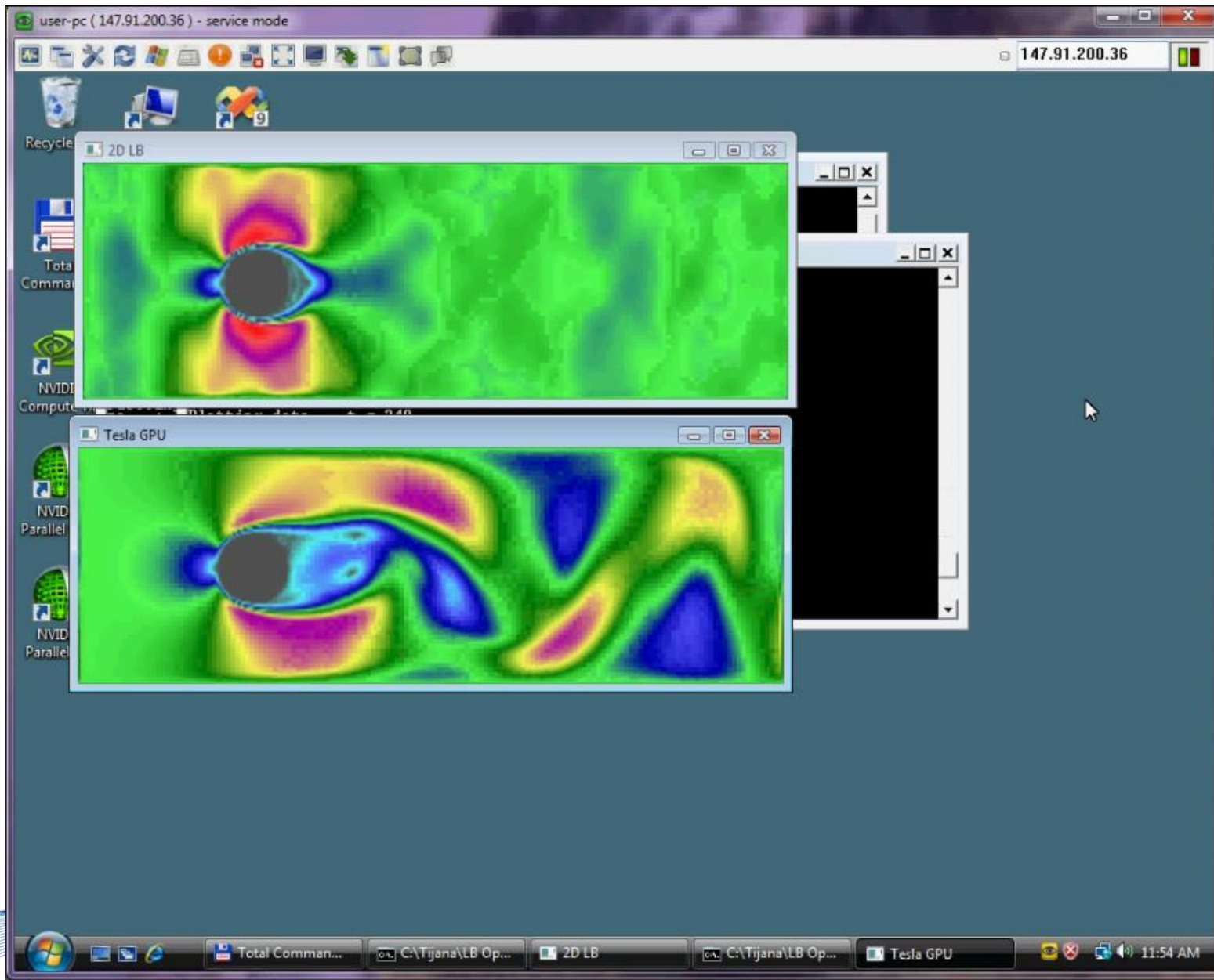
MULTI GPU IMPLEMENTATION



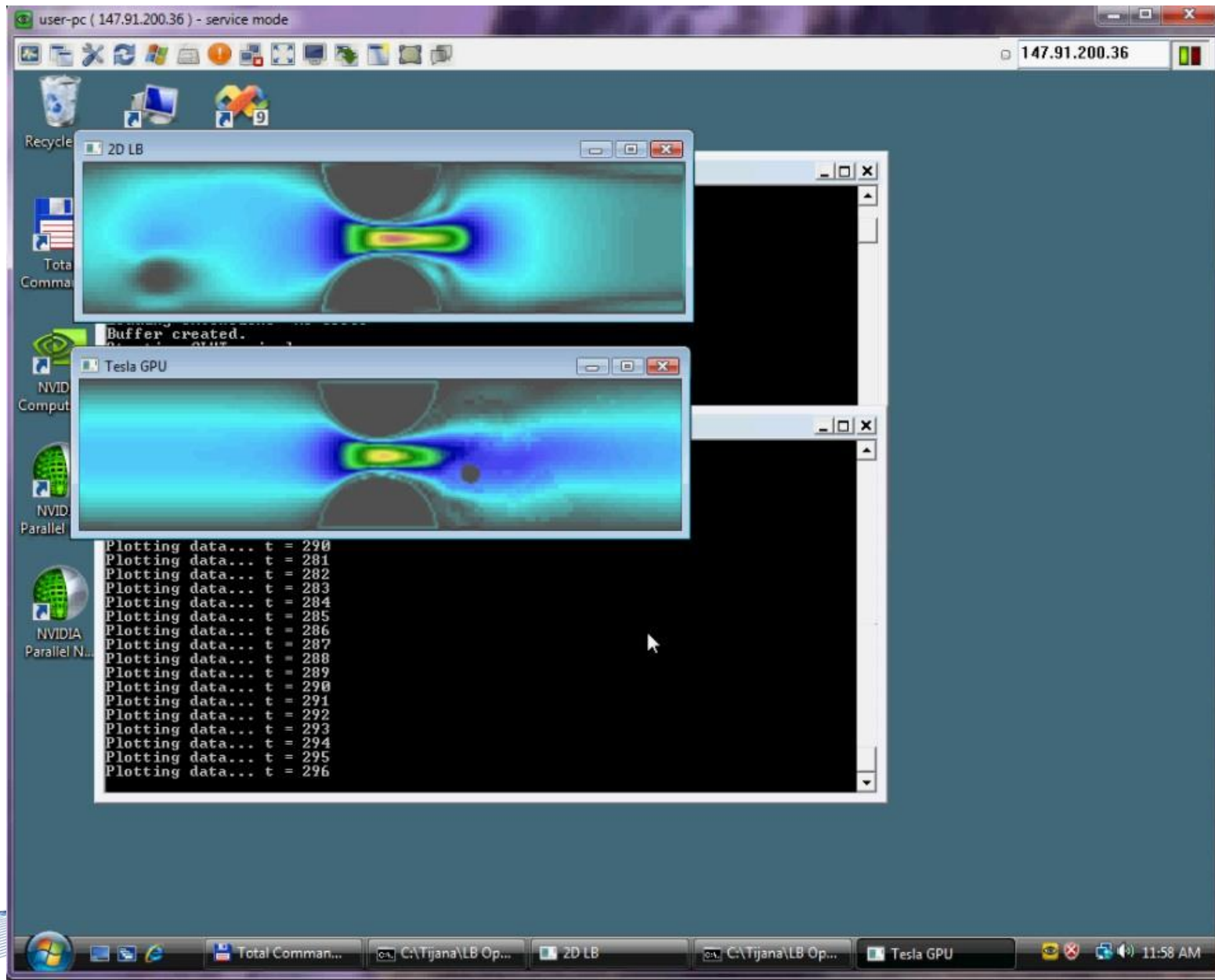
	200	800	5.000	20.000	80.000	125.000
GPU = 1	2	2.2	2.4	4.6	13.7	25.9
GPU = 2	1.4	2	2.2	3.3	7.2	15.5
GPU = 3	1.4	2	2.8	3.4	5.6	7.5

Number of lattice nodes

SPEED-UP DEMONSTRATION



SPEED-UP DEMONSTRATION



GPU COMPUTING – USING NVIDIA CUDA TO ACCELERATE SIMULATIONS IN BIOMEDICAL ENGINEERING

Tijana Đukić

*Research fellow,
Research and Development Center for Bioengineering,
BioIRC
Microsoft Student Partner*