MSE | MASTER OF SCIENCE IN ENGINEERING

Hes·so
Haute Ecole Spécialisée de Suisse occidentale
Fachhochschule Westschweiz
University of Applied Sciences and Arts Western Switzerland

Master Thesis

Atlas Tracking Optimization on GPU

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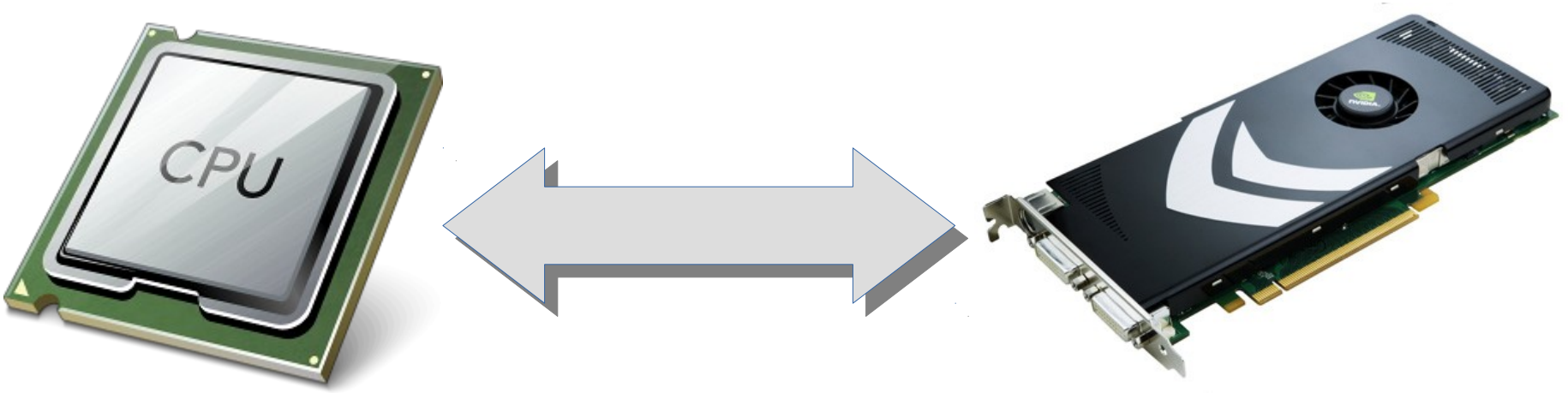
BERKELEY LAB

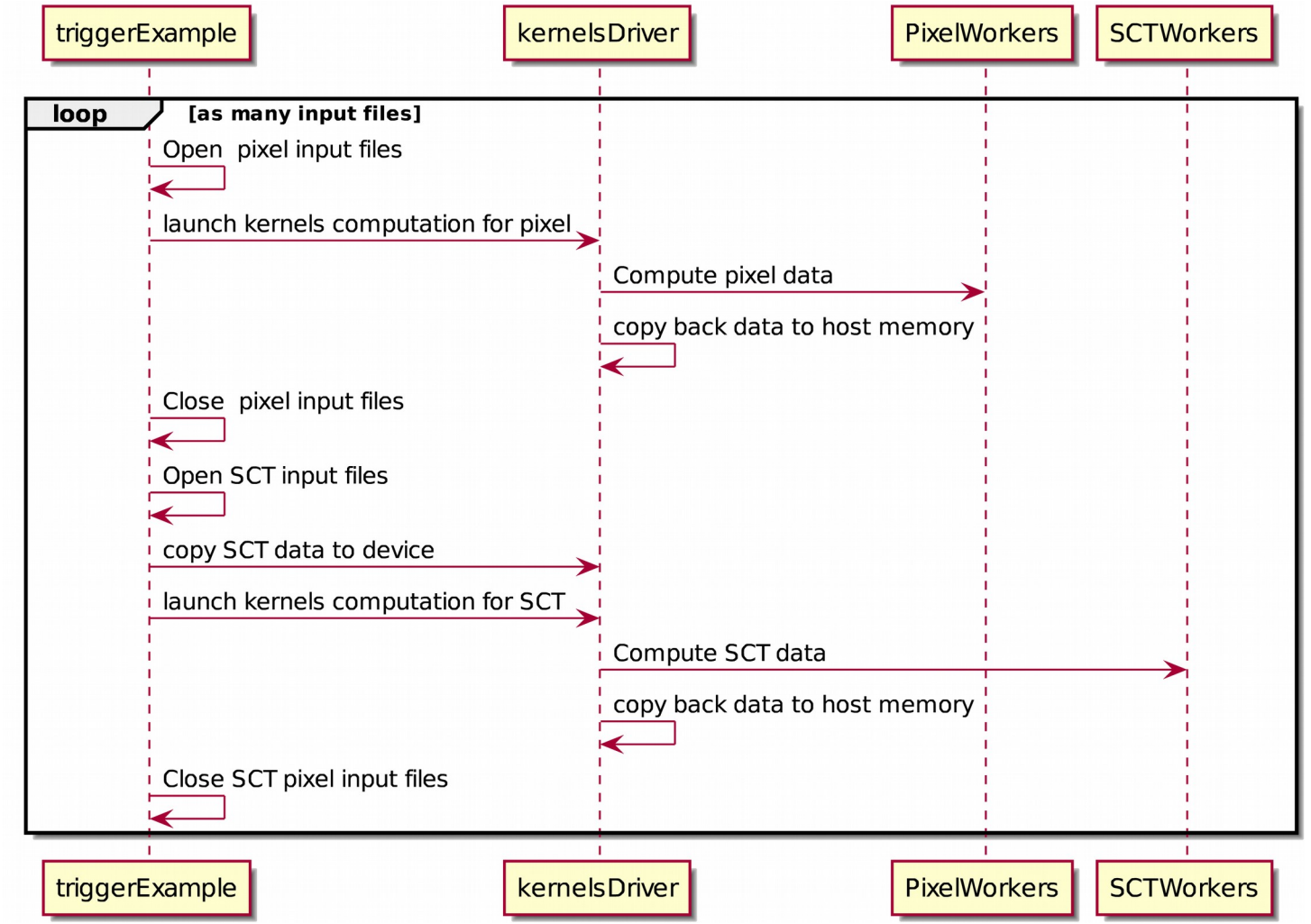
Target



Code we started from

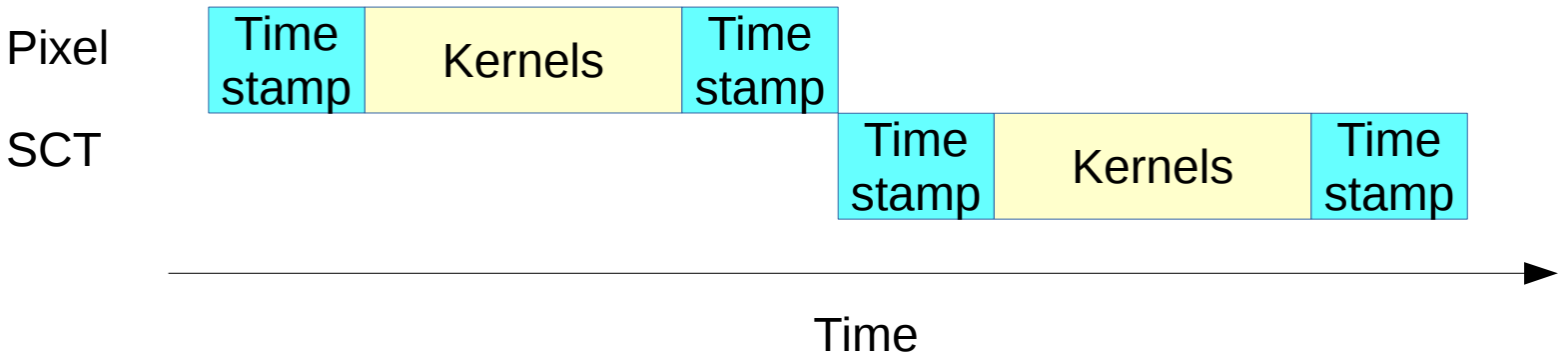
- Demonstrator of ATLAS trigger on GPUs
- Basic host side
  - Take data
  - Send and compute data on GPU
  - Sleep waiting the response

Code we started from

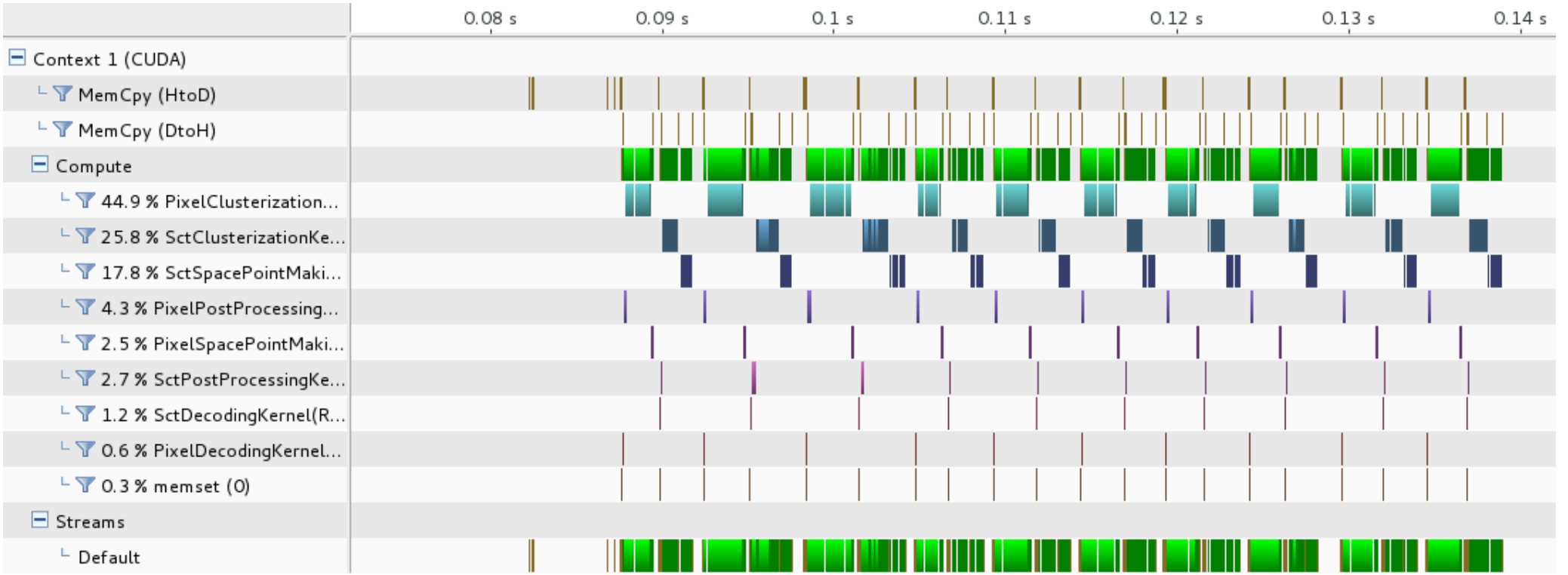


Overlapping pixels and SCT

- The pixel and SCT processing are done in sequence
- Same event, but sequential processing...

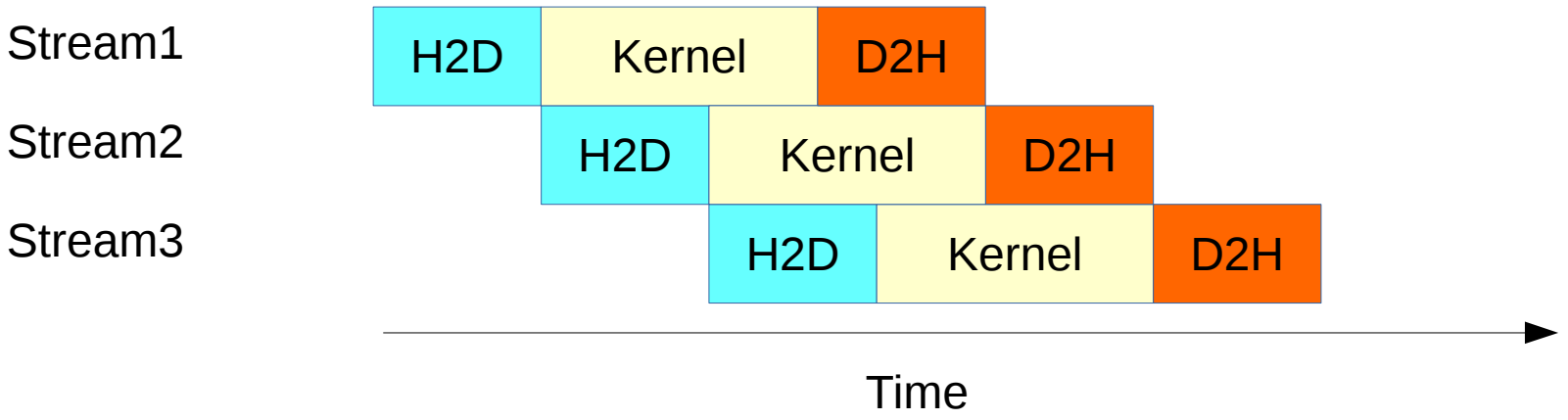


Overlapping pixels and SCT



CUDA Streams

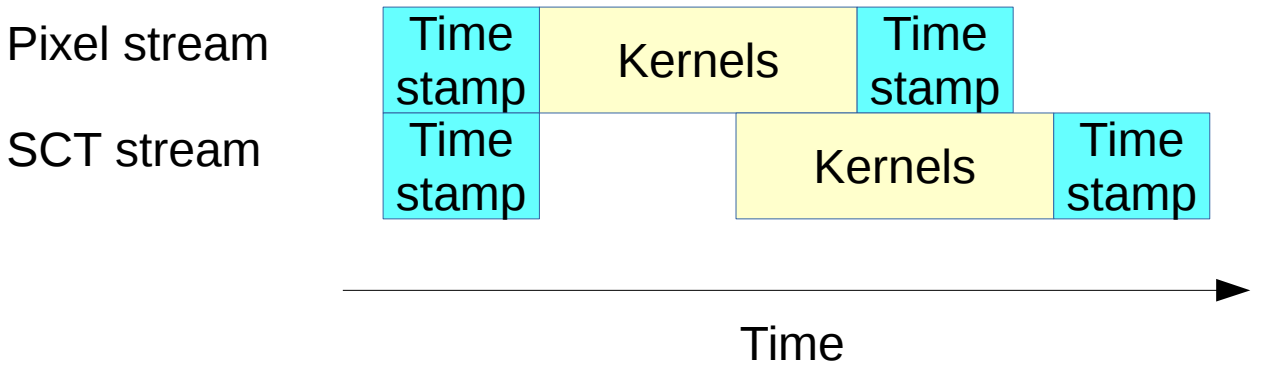
- A stream is a queue of execution
- Non-default streams can be executed in parallel



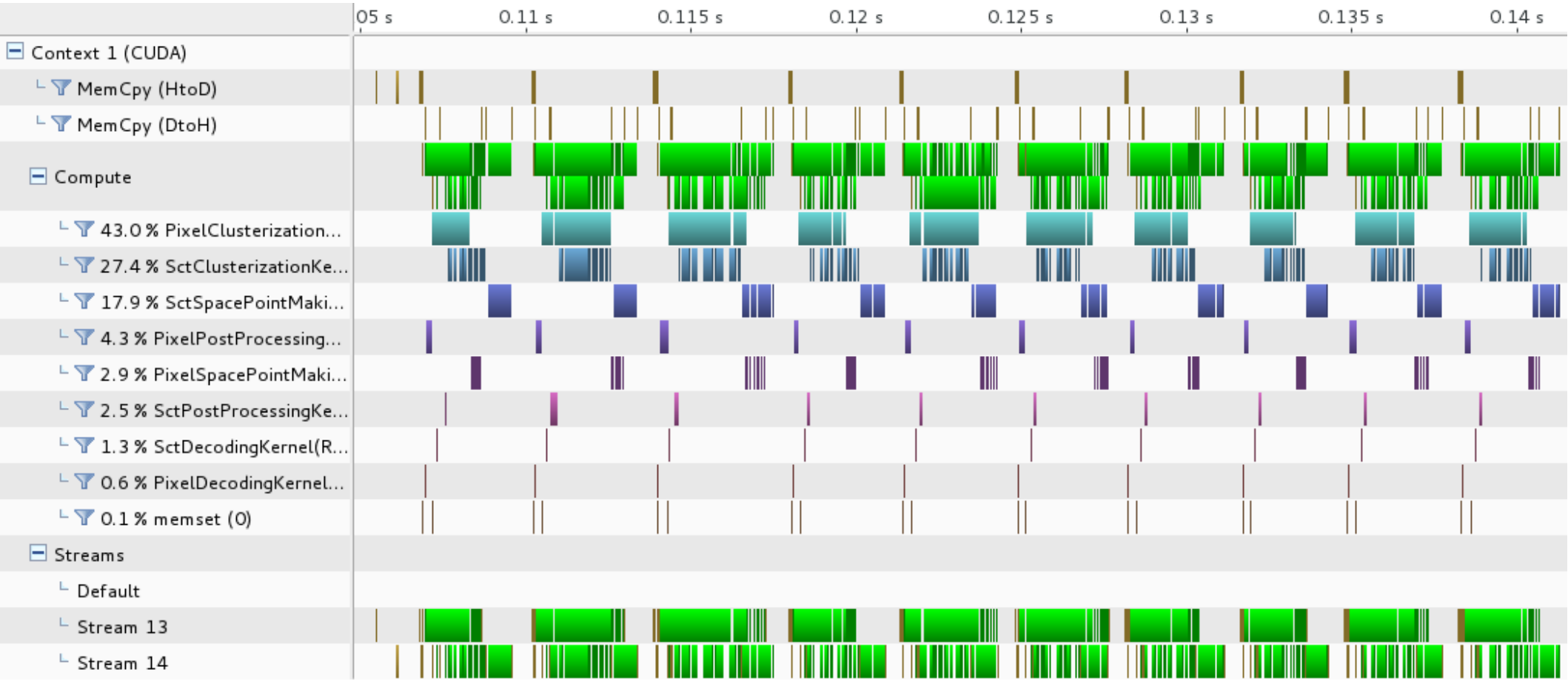
H2D = Host to device transfer
D2H = Device to host transfer

Overlapping pixels and SCT

- Use CUDA Streams
- Start the processing of SCT before pixels end



Overlapping pixels and SCT



Overlapping pixels and SCT

- For 2000 events, without overlapping
  - Avg Pixel: 2.03 ms
  - Avg SCT: 1.95 ms
  - Total avg: 3.98 ms
- For 2000 events, overlapping
  - Avg Pixel: 2.3 ms
  - Avg SCT: 2.5 ms

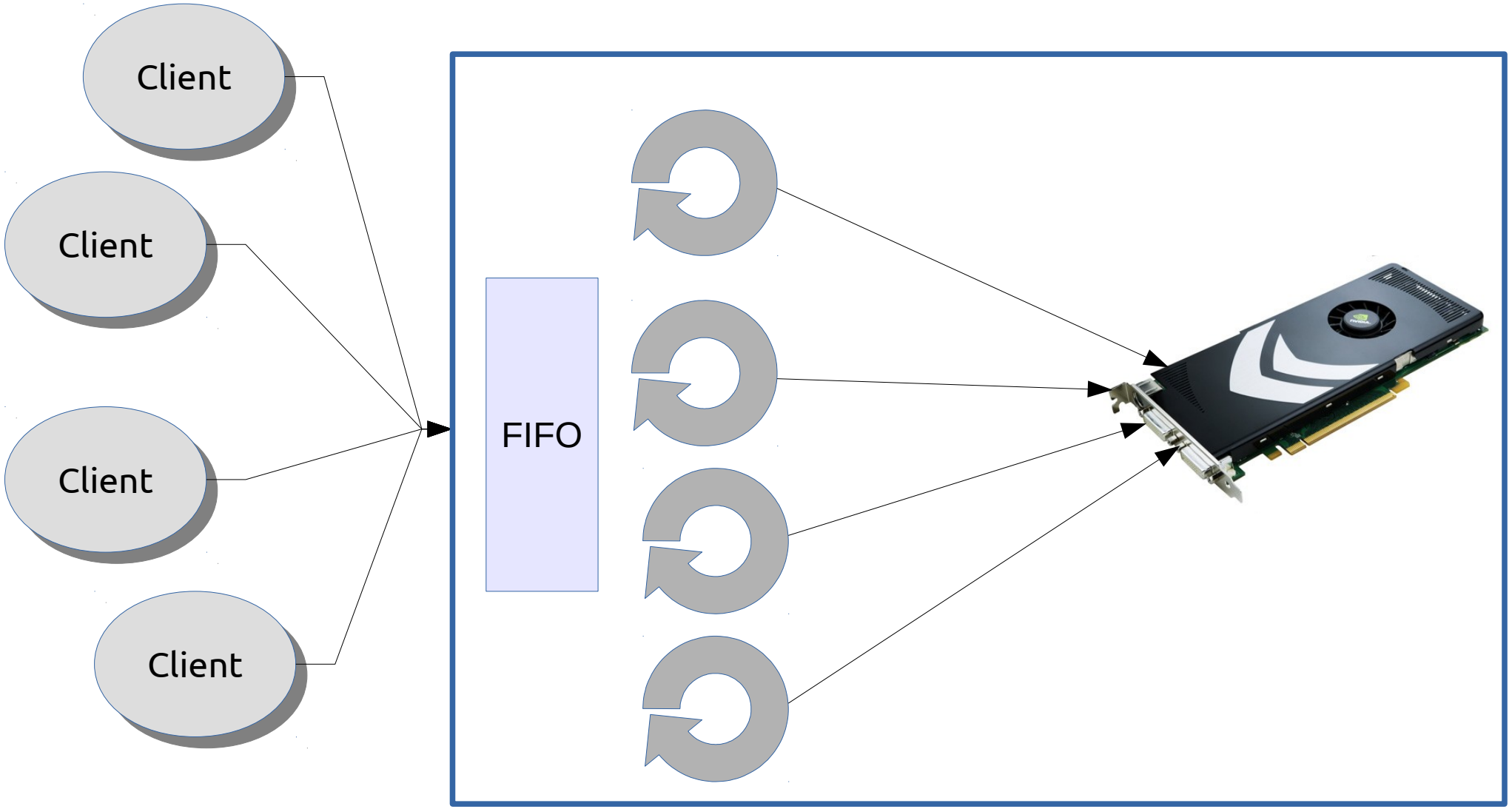
Overlapping pixels and SCT

- Total execution
  - Without overlapping: 8.65 s
  - With overlapping: 6.53 s

Multi-thread server side

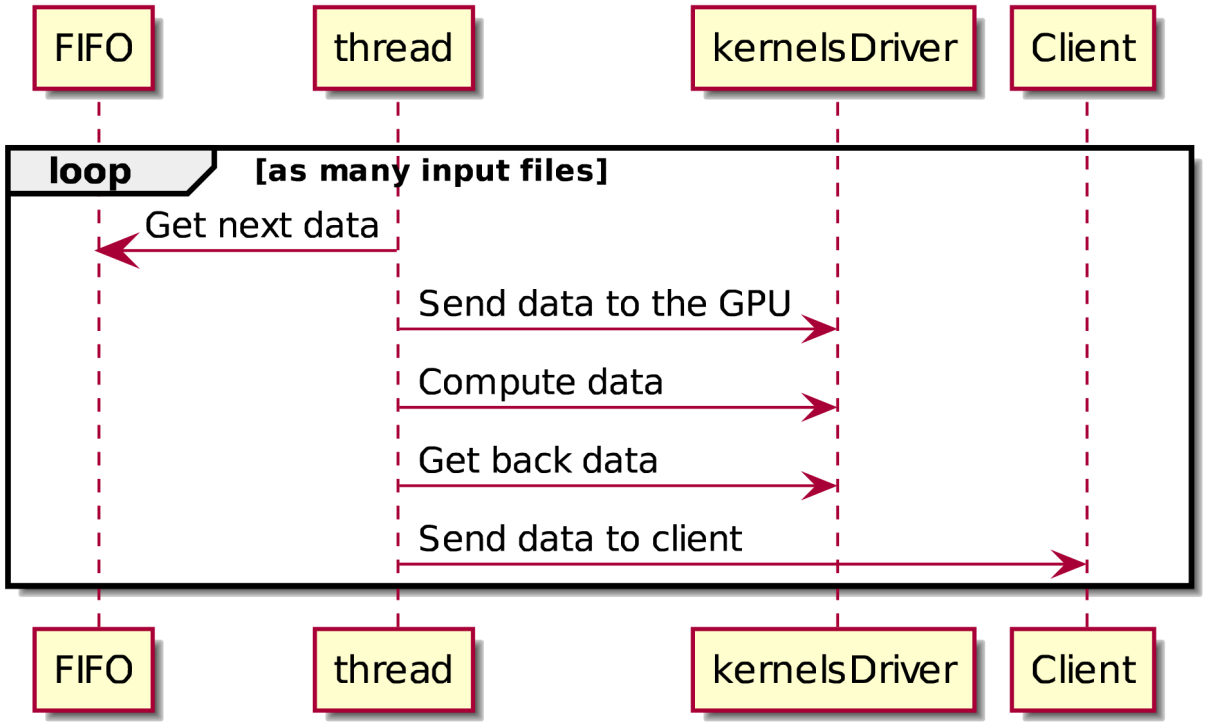
- Huge amount of “small” data
  - They do not fulfill the GPU
- Parallelize the “event” level processing with streams

Multi-thread server side

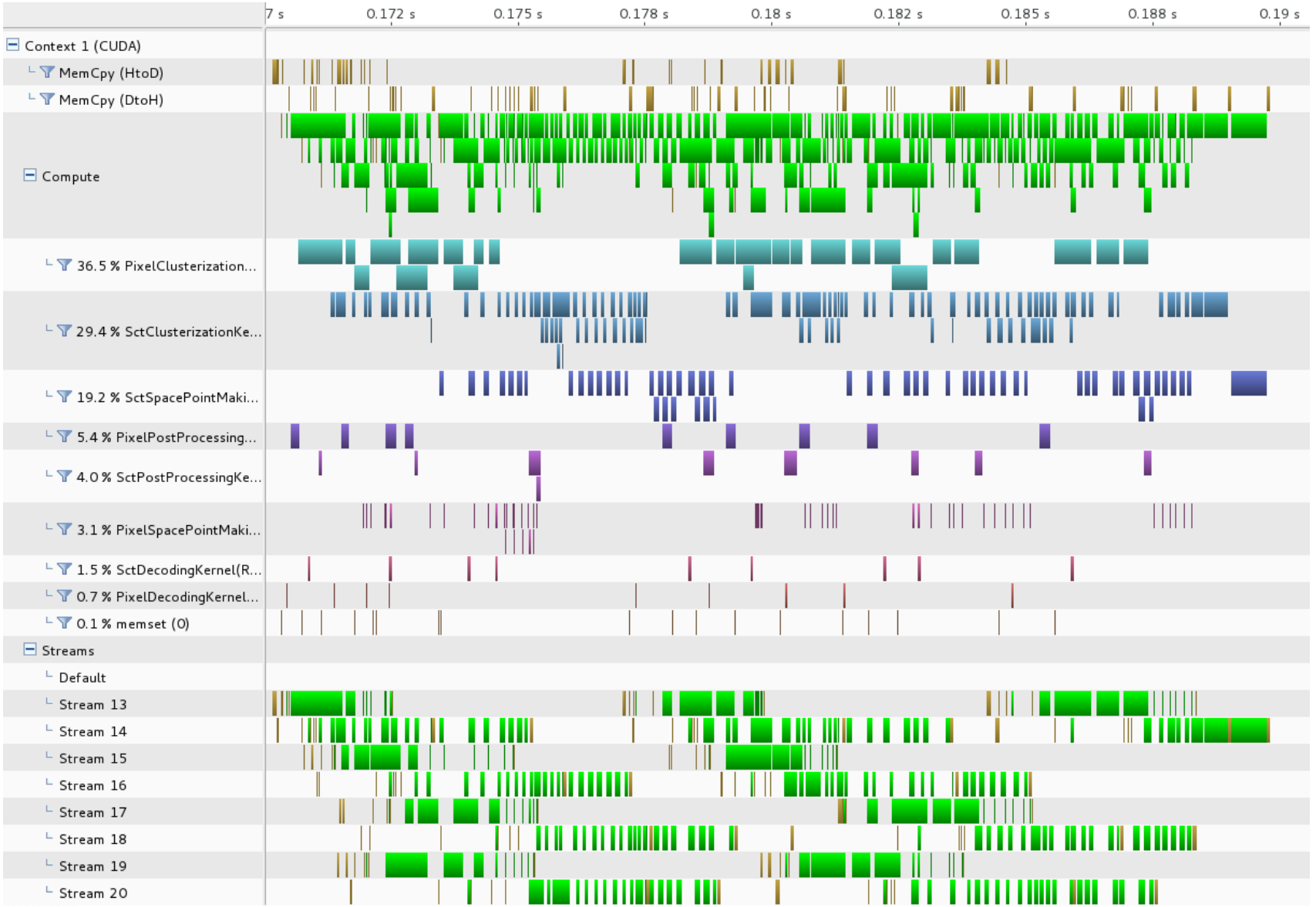


Multi-thread server side

- Life of a thread



Multi-thread server side



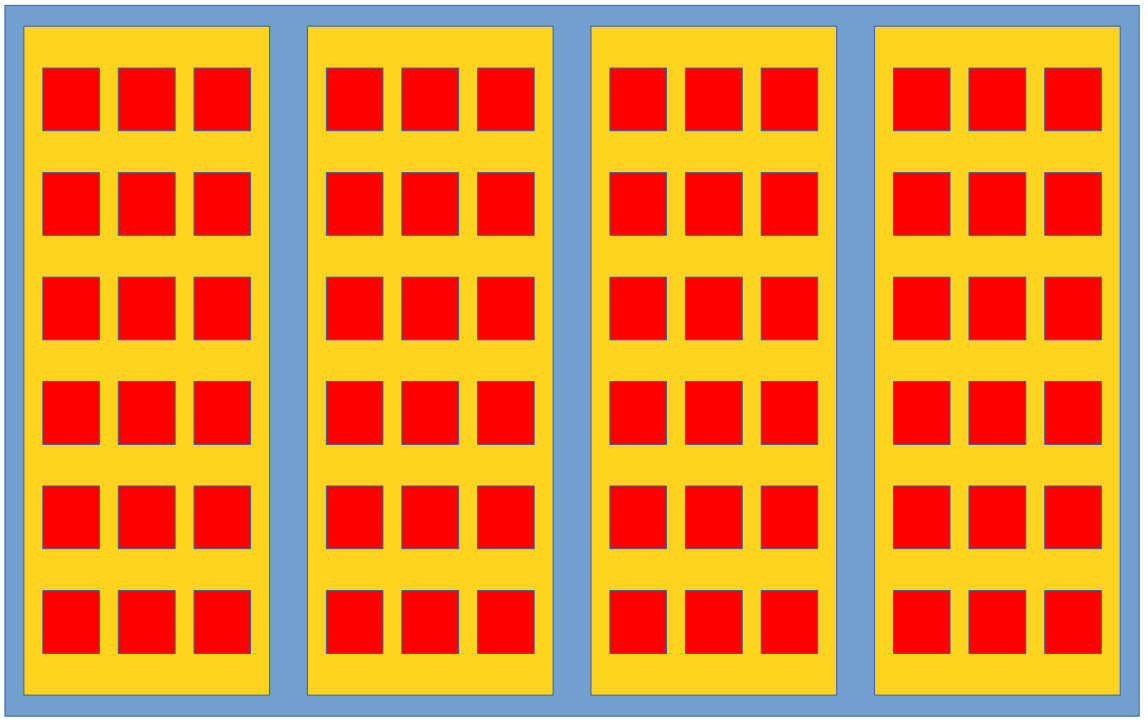
Multi-thread server side

- Executions time
  - Without overlapping: 8.65 s
  - With overlapping: 6.53 s
  - Multi-threading server side: 4.7 s

CUDA Occupancy

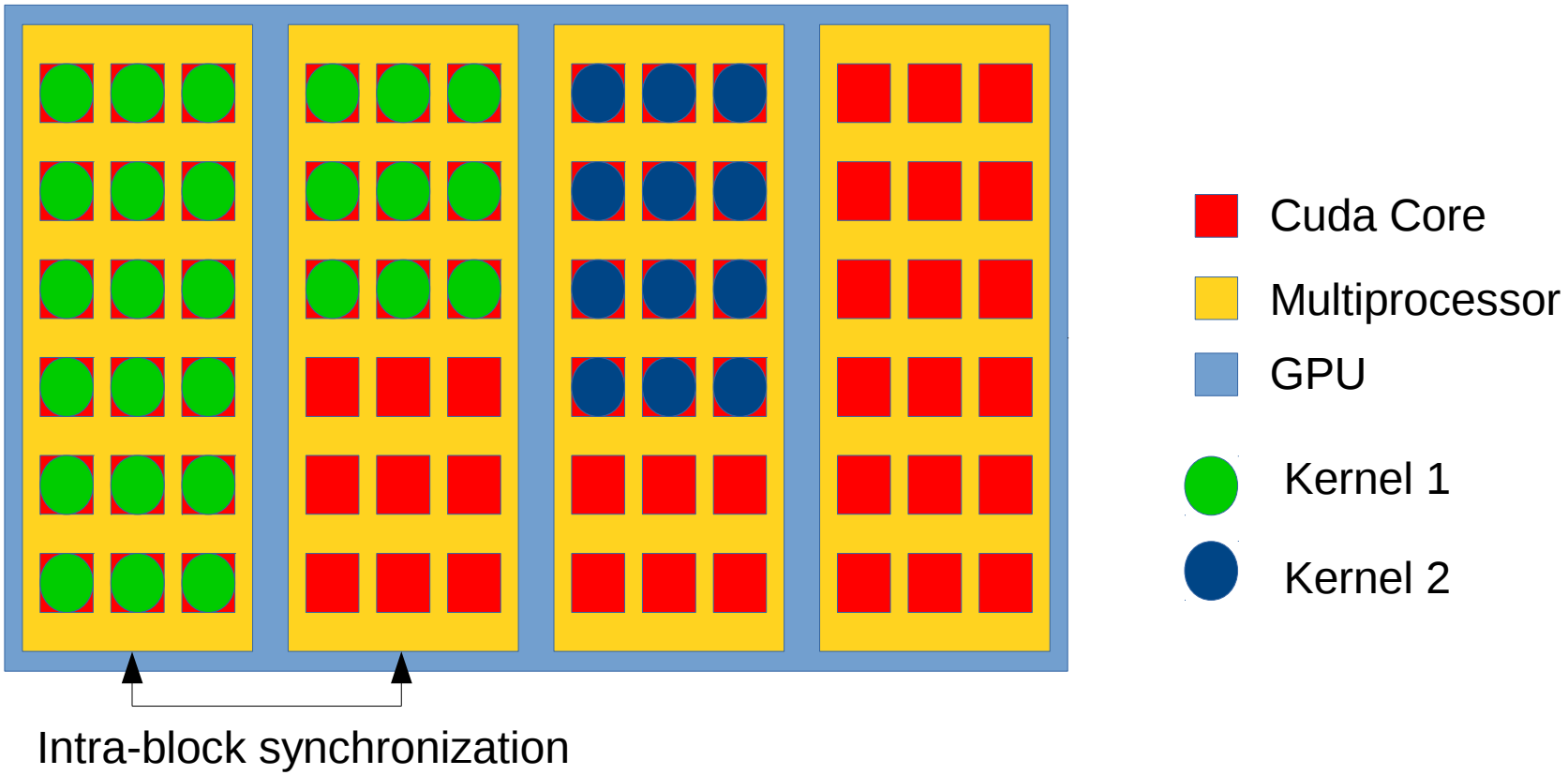
- A good setup of Grid/Block size in card can be significant
- CUDA offers an API to maximize the occupancy of the kernels

CUDA Occupancy



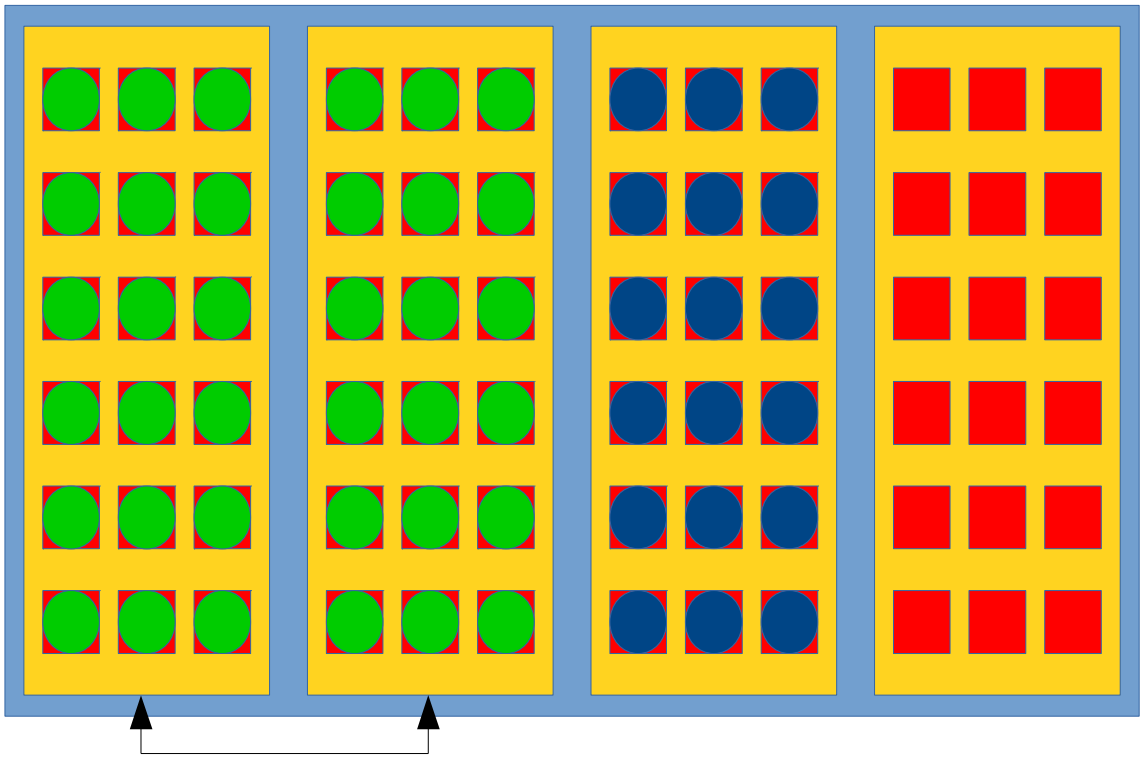
CUDA Occupancy

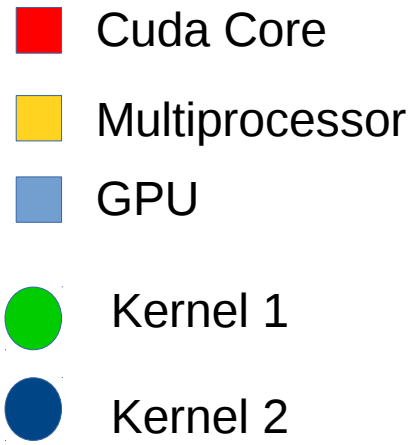
- Bad block size Setup



CUDA Occupancy

- Better block Setup





CUDA Occupancy

- Maximize the occupancy kills global performances
- Runs results for 2000 events
  - Big Blocks size: 10.88 s
  - Original configuration: 4.7 s
  - Small blocks size: 4.4 s

CUDA Occupancy

- Maximize the occupancy kills global performances
- Runs results for 2000 events
  - Big blocks size: 3 kernels in parallel (Max 5)
  - Small blocks size: 4 kernels in parallel (Max 7)

Conclusion

- Important points when using a GPU
  - Port of an algorithm to the GPU
  - Communicate with the GPU
  - Host side design

- Keep the GPU busy
- Big occupancy does not allow the GPU to schedule its tasks efficiently