CMP202 ASSESSMENT

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TOPIC

- Interactive Mandelbrot
  - Parallelised using GPU
  - Lab exercise used as a basis
- External Libraries
  - OpenGL (Year 2, Semester 1 base project file)

PURPOSE

- Interactive Mandelbrot via OpenGL
  - Demonstrate good GPU parallelisable algorithm.
- What was the problem?

PARALLEL CONSTRUCTION

- Pipeline pattern
- Single CPU Thread (Host)
- SIMD
- OpenGL calls
- Mutexes?

```
array_view<uint32_t, 2> a(h, w, pImage);
a.discard_data();

try
{
    parallel_for_each(a.extent, [=](index<2> idx) restrict(amp)
    {
```

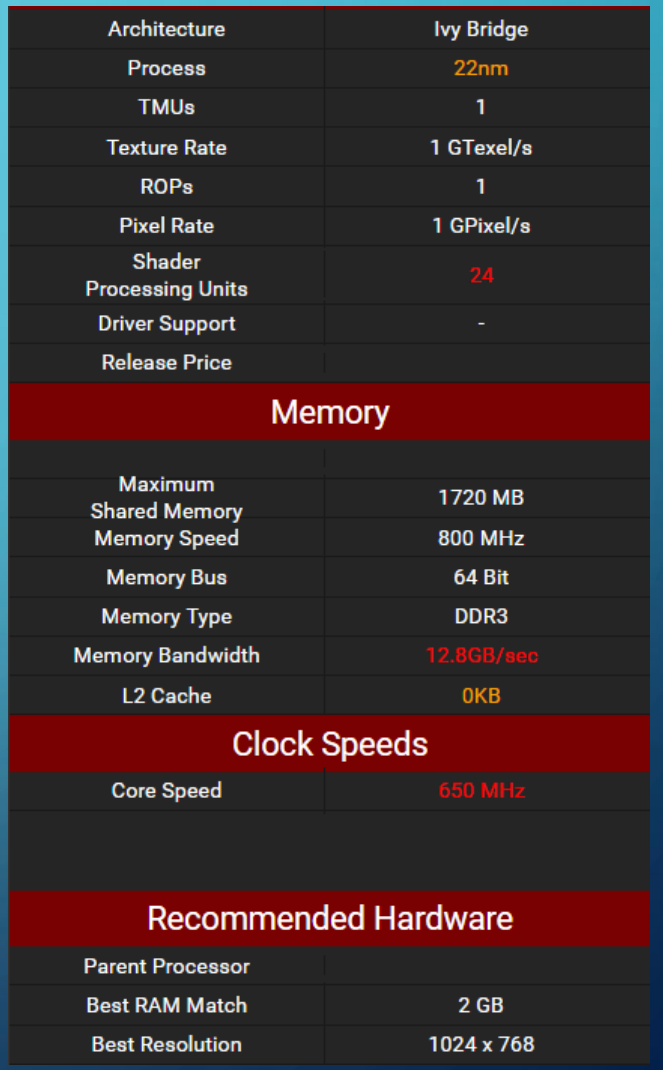
```
extent<2> e(h, w);
array_view<uint32_t, 2> a(e, pImage);
a.discard_data();

try
{
    parallel_for_each(a.extent.tile<TS, TS>(), [=](tiled_index<TS,TS> t_idx) restrict(amp)
    {
```

THREAD UTILISATION

- Single CPU Thread (Host)
- Non-tiled GPU kernel vs Tiled GPU kernel
- Mandelbrot – Data independent
- Multi GPU (future)

SPECIFICATION

- 4506 Lab Computers
  - OS – Windows 7 Professional
  - GPU – Intel® HD Graphics 2500
  - CPU – Intel® Core™ i5-3470S @ 2.90GHz
  - RAM – 4GB

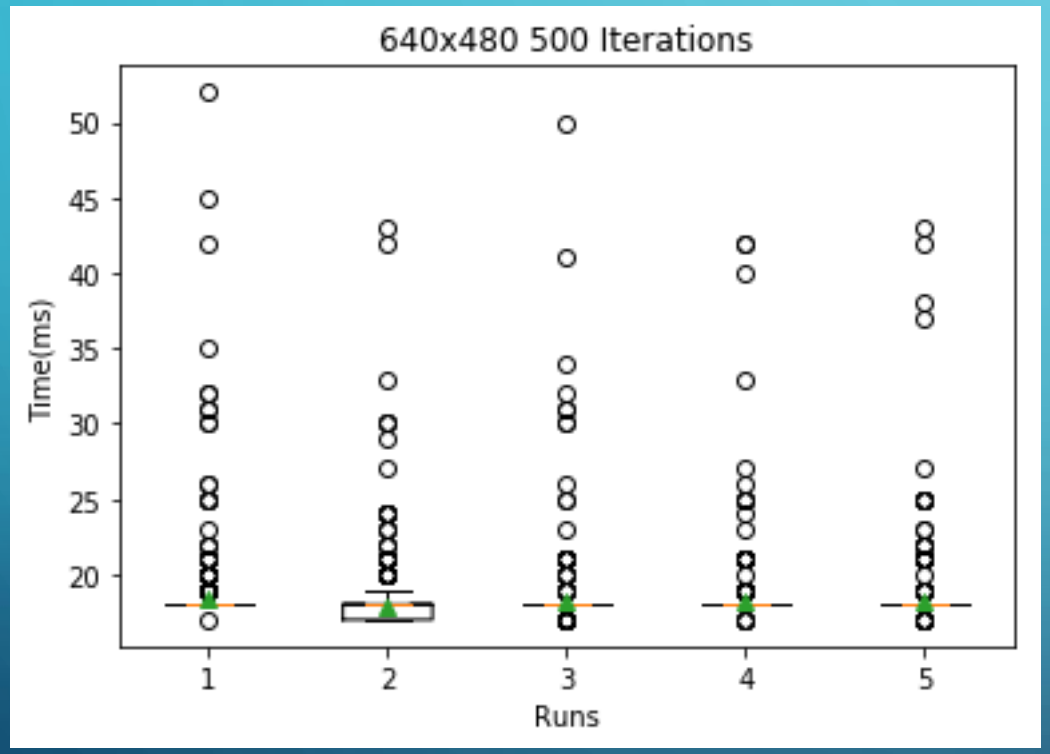


Architecture	Ivy Bridge
Process	22nm
TMUs	1
Texture Rate	1 GTexel/s
ROPs	1
Pixel Rate	1 GPixel/s
Shader Processing Units	24
Driver Support	-
Release Price	
Memory	
Maximum Shared Memory	1720 MB
Memory Speed	800 MHz
Memory Bus	64 Bit
Memory Type	DDR3
Memory Bandwidth	12.8GB/sec
L2 Cache	0KB
Clock Speeds	
Core Speed	650 MHz
Recommended Hardware	
Parent Processor	
Best RAM Match	2 GB
Best Resolution	1024 x 768

RESULTS

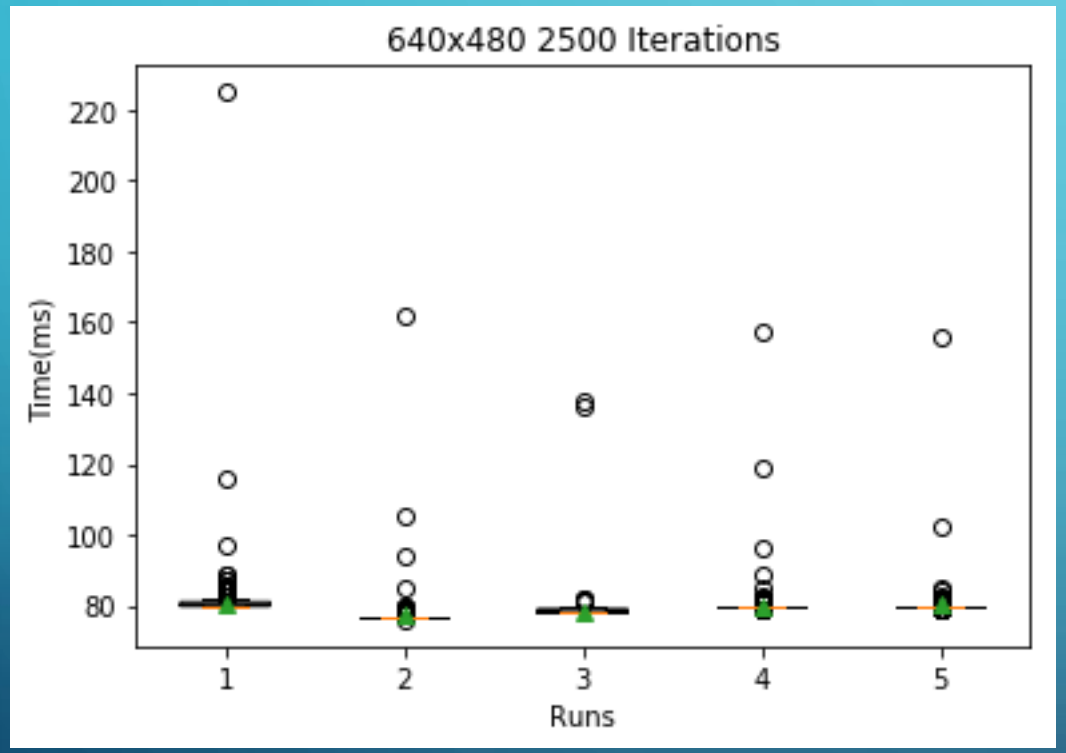
- Time taken to compute Mandelbrot at various levels. (Iterations, Width/Height) (ms)
  - 1000 x (500,2500,5000 Max_Iters) @ 640x480
  - 1000 x (500,2500,5000 Max_Iters) @ 960x768
  - 1000 x (500,2500,5000 Max_Iters) @ 1280x960
  - 1000 x (500,2500,5000 Max_Iters) @ 1920x1280
- Eliminate sources of error

RESULTS – 640X480 – 500 ITERATIONS



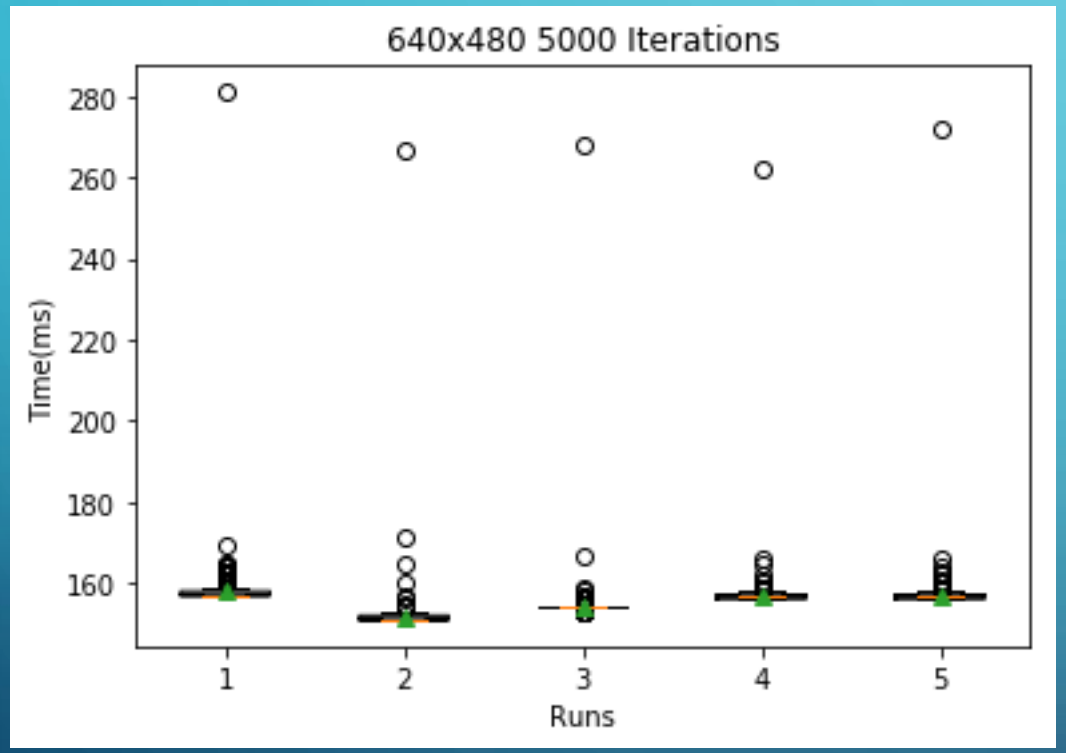
Tile Size	Mean(ms)	Median(ms)
Not tiled	18.4105894106	18.0
4	17.8291708292	18.0
8	18.1508491508	18.0
16	18.2137862138	18.0
32	18.2157842158	18.0

RESULTS – 640X480 – 2500 ITERATIONS



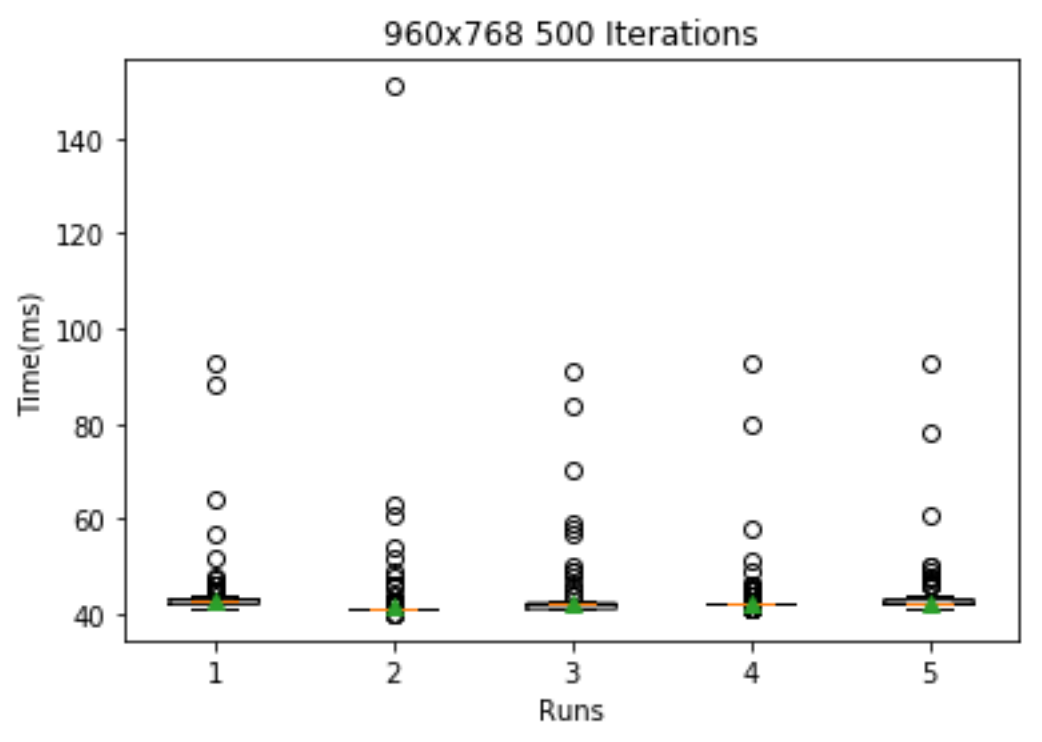
Tile Size	Mean(ms)	Median(ms)
Not tiled	80.6573426573	80.0
4	77.2767232767	77.0
8	78.4095904096	78.0
16	80.0799200799	80.0
32	80.1378621379	80.0

RESULTS – 640X480 – 5000 ITERATIONS



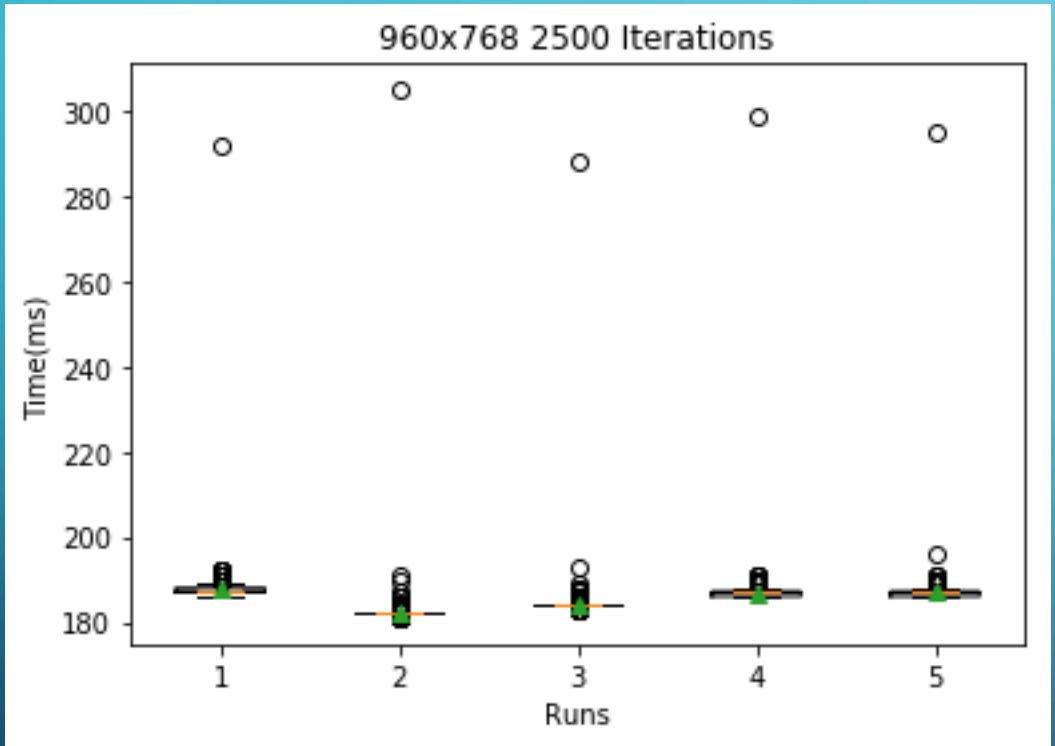
Tile Size	Mean(ms)	Median(ms)
Not tiled	157.963036963	157.0
4	151.51048951	151.0
8	154.268731269	154.0
16	156.754245754	157.0
32	156.92007992	157.0

RESULTS – 960X768 – 500 ITERATIONS



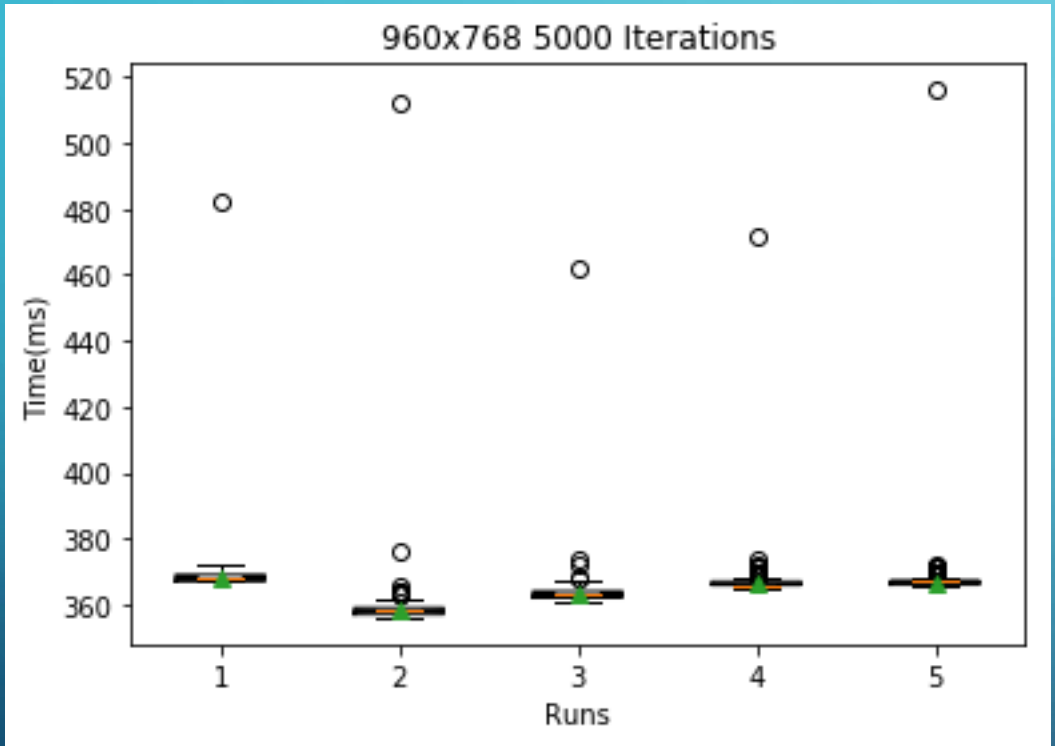
Tile Size	Mean	Median
Not tiled	42.6983016983	43.0
4	41.4445554446	41.0
8	41.9380619381	42.0
16	42.2747252747	42.0
32	42.4185814186	42.0

RESULTS – 960X768 – 2500 ITERATIONS



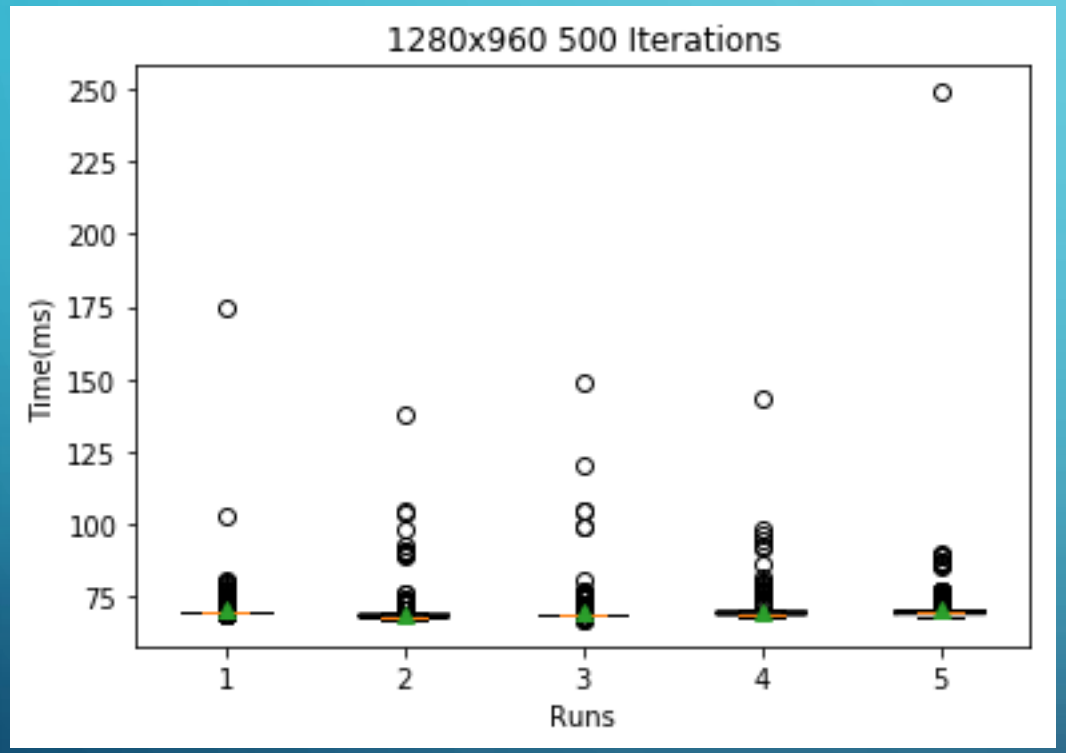
Tile Size	Mean	Median
Not tiled	187.566433566	187.0
4	182.123876124	182.0
8	184.236763237	184.0
16	186.776223776	187.0
32	186.97002997	187.0

RESULTS – 960X768 – 5000 ITERATIONS



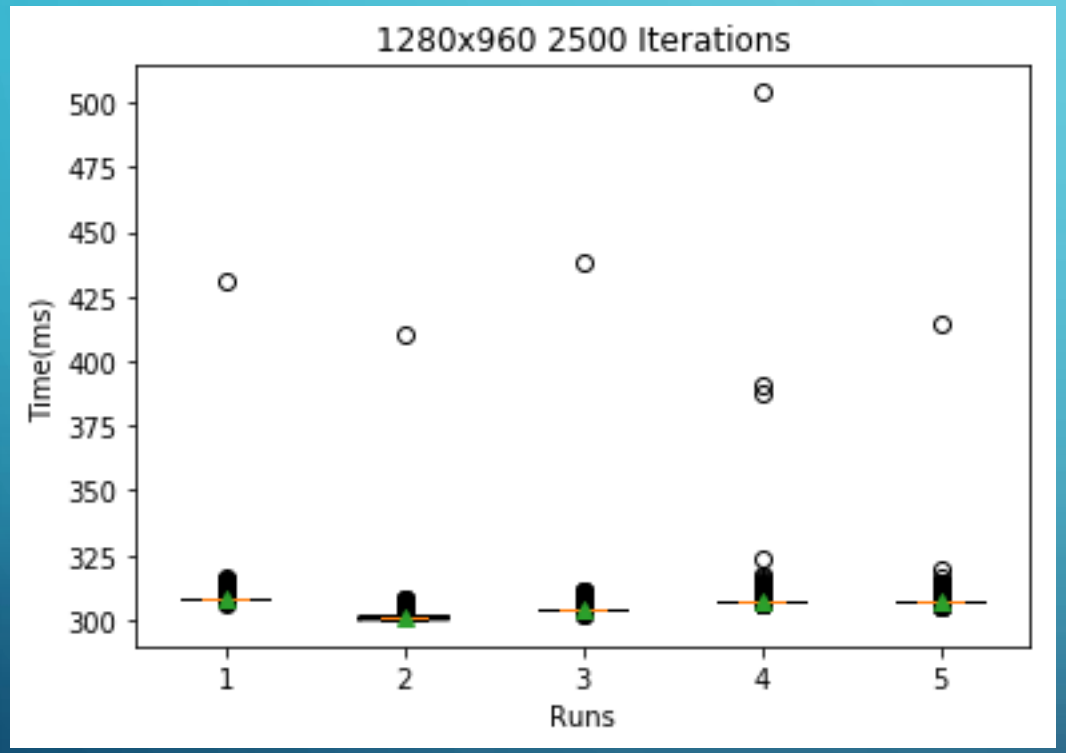
Tile Size	Mean(ms)	Median(ms)
Not tiled	368.331668332	368.0
4	358.282717283	358.0
8	362.982017982	363.0
16	366.833166833	366.0
32	366.839160839	367.0

RESULTS – 1280X960 – 500 ITERATIONS



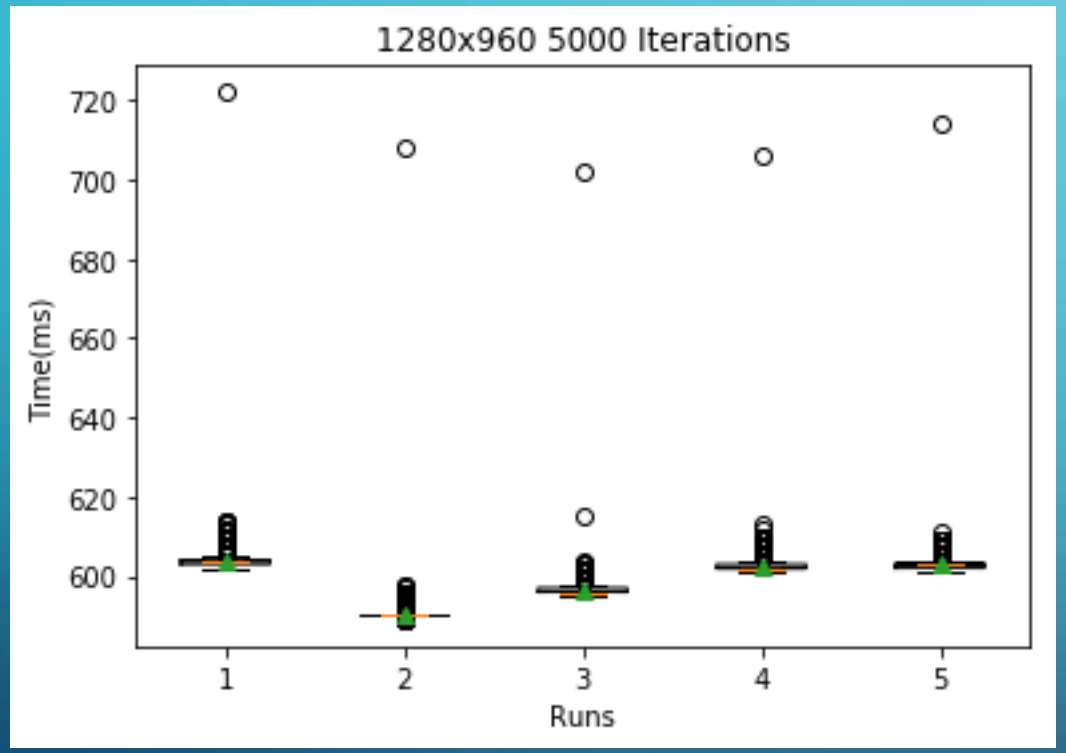
Tile Size	Mean(ms)	Median(ms)
Not tiled	70.2417582418	70.0
4	68.8521478521	68.0
8	69.4185814186	69.0
16	69.8181818182	69.0
32	70.2057942058	70.0

RESULTS – 1280X960 – 2500 ITERATIONS



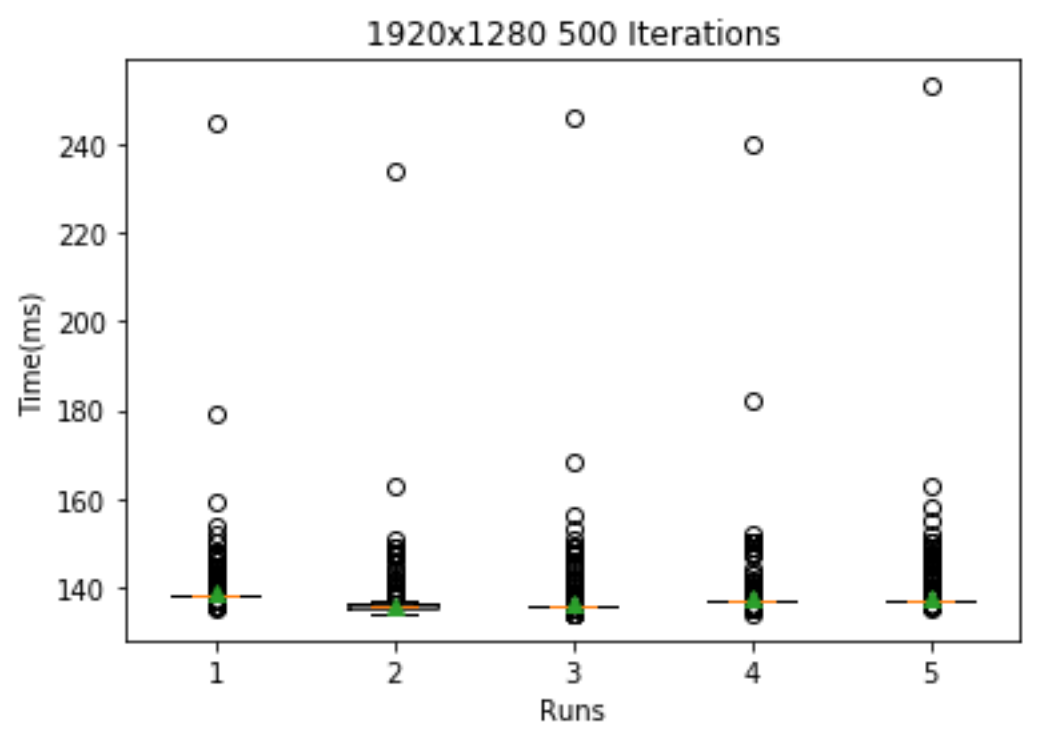
Tile Size	Mean(ms)	Median(ms)
Not tiled	308.418581419	308.0
4	301.057942058	301.0
8	304.186813187	304.0
16	307.411588412	307.0
32	307.253746254	307.0

RESULTS – 1280X960 – 5000 ITERATIONS



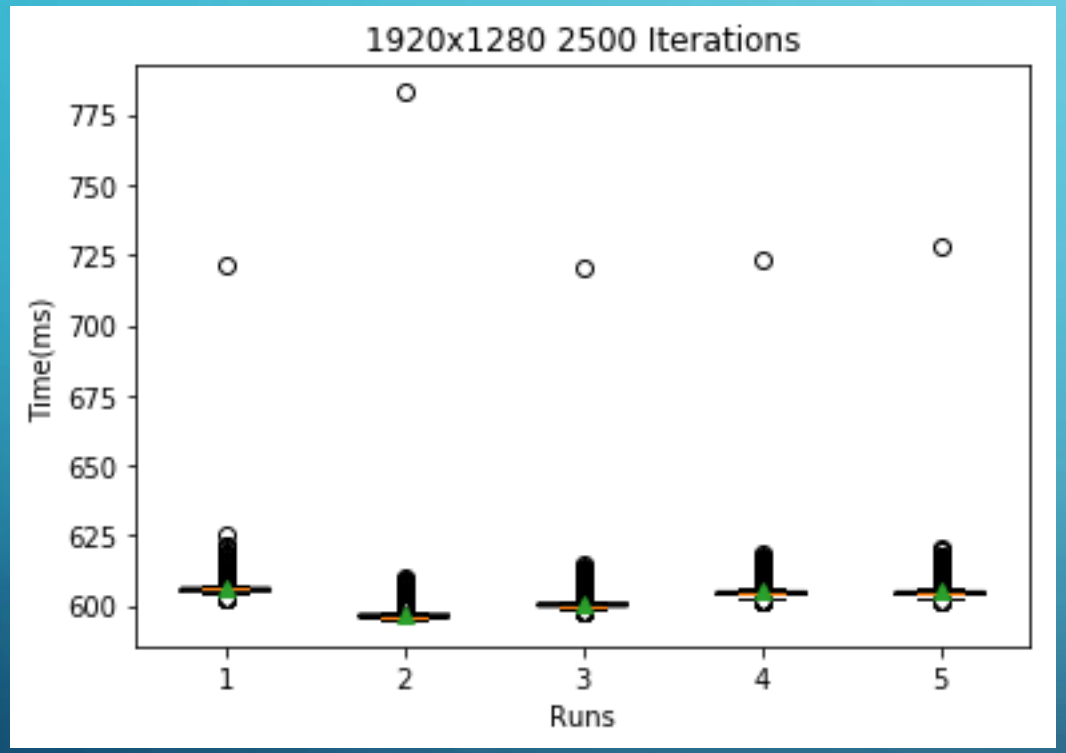
Tile Size	Mean(ms)	Median(ms)
Not tiled	603.978021978	604.0
4	590.294705295	590.0
8	596.665334665	596.0
16	602.69030969	602.0
32	602.886113886	603.0

RESULTS – 1920X1280 – 500 ITERATIONS



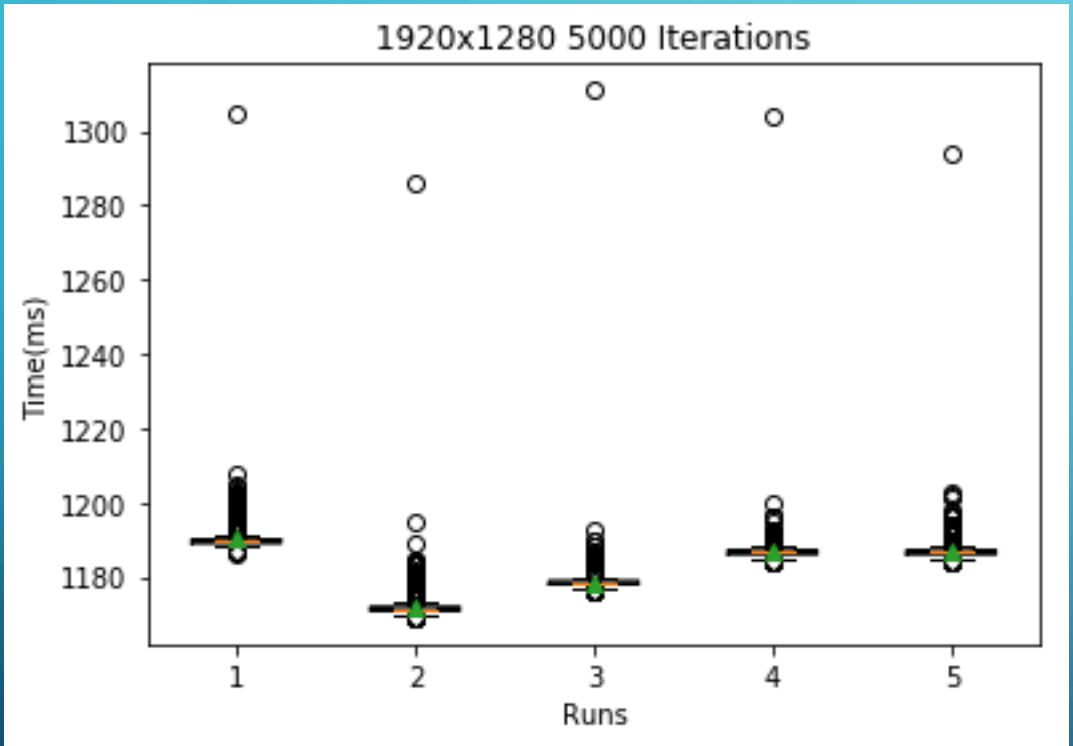
Tile Size	Mean(ms)	Median(ms)
Not tiled	138.552447552	138.0
4	136.03996004	136.0
8	136.529470529	136.0
16	137.585414585	137.0
32	137.517482517	137.0

RESULTS – 1920X1280 – 2500 ITERATIONS



Tile Size	Mean(ms)	Median(ms)
Not tiled	606.14985015	606.0
4	596.944055944	596.0
8	600.948051948	600.0
16	605.020979021	604.0
32	604.929070929	604.0

RESULTS – 1920X1280 – 5000 ITERATIONS



Tile Size	Mean(ms)	Median(ms)
Not tiled	1190.27072927	1190.0
4	1171.91808192	1171.0
8	1178.58941059	1178.0
16	1187.05394605	1187.0
32	1187.07992008	1187.0

EXPLANATION

- Tiled vs Non-Tiled
- Shared Memory
- Implicit Synchronisation
- Key Result: TS 4 Best

CRITICAL EVALUATION

- Tiled vs Non-Tiled
- Multi GPU

TECHNICAL CHOICES

- Array vs Vector
- No tile-static
- No barriers, Mutexes or atomic variables

RESOURCES

- Spyder(numpy, scipy, matplotlib) – Statistics calculations, graphical representations.
- Adam Sampson/Ruth Falconer – Lab project which this submission is based off of.
- Paul Robertson – OpenGL base project

QUESTIONS?