Analysis Report

void fft2d_r2c_32x32<float, bool=1>(float2*, float const *, int, int, int, int, int, int, int, int, int)

Duration	207.295 µs
Grid Size	[2,128,1]
Block Size	[512,1,1]
Registers/Thread	64
Shared Memory/Block	35.062 KiB
Shared Memory Requested	96 KiB
Shared Memory Executed	96 KiB
Shared Memory Bank Size	4 B

[0] GeForce GTX 1080

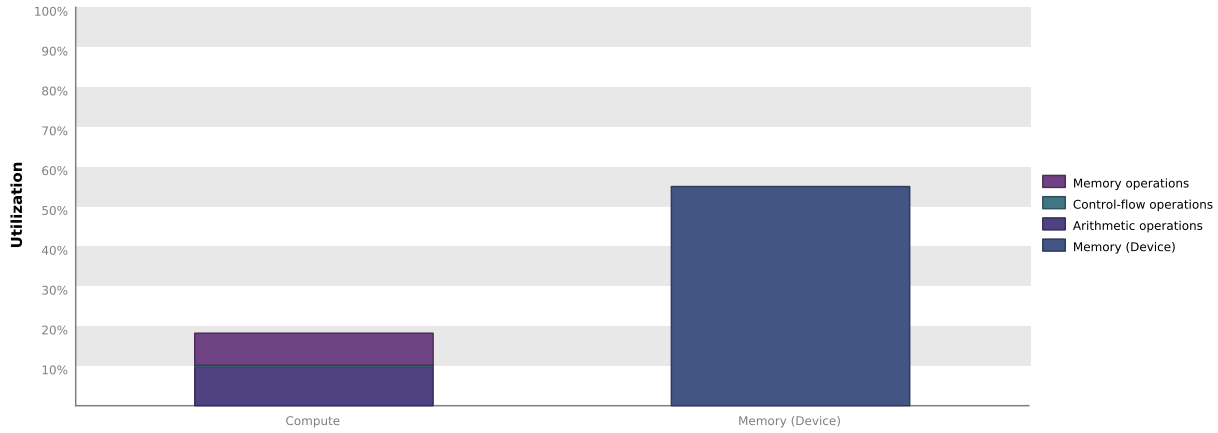
GPU UUID	GPU-edd19385-a5f1-ce46-e1d9-61408827cccc
Compute Capability	6.1
Max. Threads per Block	1024
Max. Threads per Multiprocessor	2048
Max. Shared Memory per Block	48 KiB
Max. Shared Memory per Multiprocessor	96 KiB
Max. Registers per Block	65536
Max. Registers per Multiprocessor	65536
Max. Grid Dimensions	[2147483647, 65535, 65535]
Max. Block Dimensions	[1024, 1024, 64]
Max. Warps per Multiprocessor	64
Max. Blocks per Multiprocessor	32
Half Precision FLOP/s	72.9 GigaFLOP/s
Single Precision FLOP/s	9.331 TeraFLOP/s
Double Precision FLOP/s	291.6 GigaFLOP/s
Number of Multiprocessors	20
Multiprocessor Clock Rate	1.823 GHz
Concurrent Kernel	true
Max IPC	6
Threads per Warp	32
Global Memory Bandwidth	320.32 GB/s
Global Memory Size	7.923 GiB
Constant Memory Size	64 KiB
L2 Cache Size	2 MiB
Memcpy Engines	2
PCIe Generation	3
PCIe Link Rate	8 Gbit/s
PCIe Link Width	16

1. Compute, Bandwidth, or Latency Bound

The first step in analyzing an individual kernel is to determine if the performance of the kernel is bounded by computation, memory bandwidth, or instruction/memory latency. The results below indicate that the performance of kernel "void fft2d_r2c_32x32<float,..." is most likely limited by instruction and memory latency. You should first examine the information in the "Instruction And Memory Latency" section to determine how it is limiting performance.

1.1. Kernel Performance Is Bound By Instruction And Memory Latency

This kernel exhibits low compute throughput and memory bandwidth utilization relative to the peak performance of "GeForce GTX 1080". These utilization levels indicate that the performance of the kernel is most likely limited by the latency of arithmetic or memory operations. Achieved compute throughput and/or memory bandwidth below 60% of peak typically indicates latency issues.



2. Instruction and Memory Latency

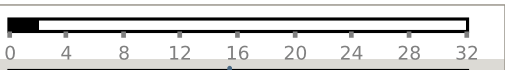
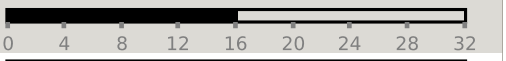
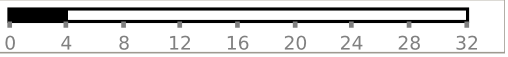
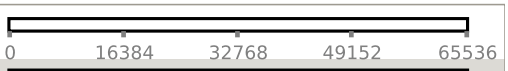
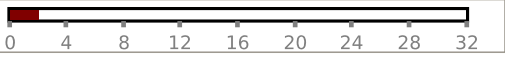
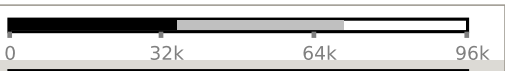
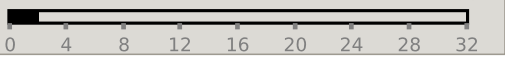
Instruction and memory latency limit the performance of a kernel when the GPU does not have enough work to keep busy. The performance of latency-limited kernels can often be improved by increasing occupancy. Occupancy is a measure of how many warps the kernel has active on the GPU, relative to the maximum number of warps supported by the GPU. Theoretical occupancy provides an upper bound while achieved occupancy indicates the kernel's actual occupancy. The results below indicate that occupancy can be improved by reducing the number of registers used by the kernel.

2.1. GPU Utilization May Be Limited By Register Usage

Theoretical occupancy is less than 100% but is large enough that increasing occupancy may not improve performance. You can attempt the following optimization to increase the number of warps on each SM but it may not lead to increased performance.

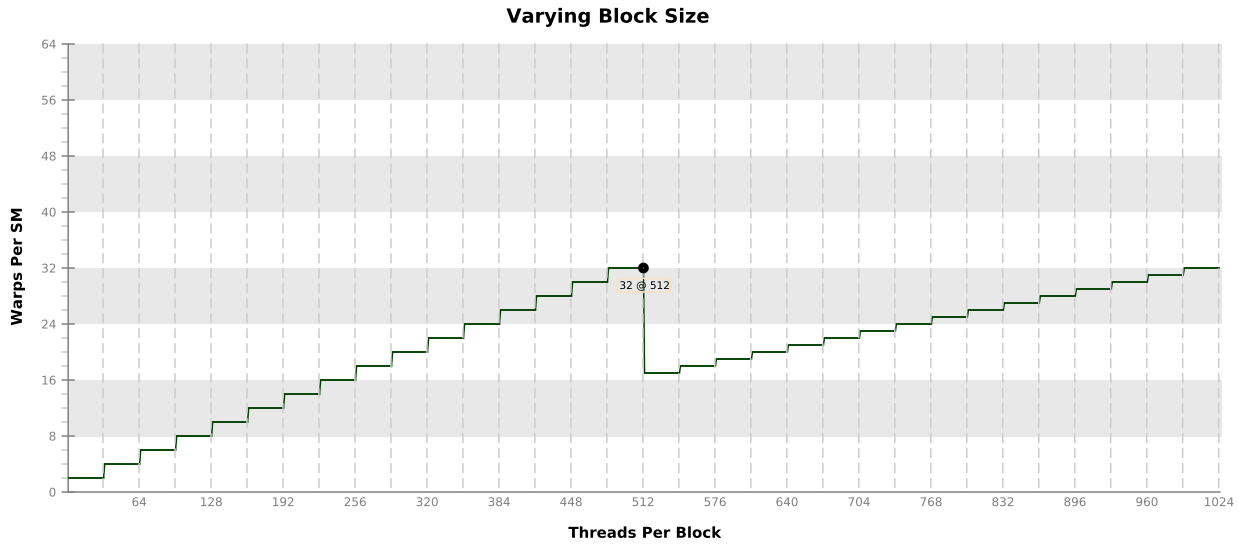
The kernel uses 64 registers for each thread (32768 registers for each block). This register usage is likely preventing the kernel from fully utilizing the GPU. Device "GeForce GTX 1080" provides up to 65536 registers for each block. Because the kernel uses 32768 registers for each block each SM is limited to simultaneously executing 2 blocks (32 warps). Chart "Varying Register Count" below shows how changing register usage will change the number of blocks that can execute on each SM.

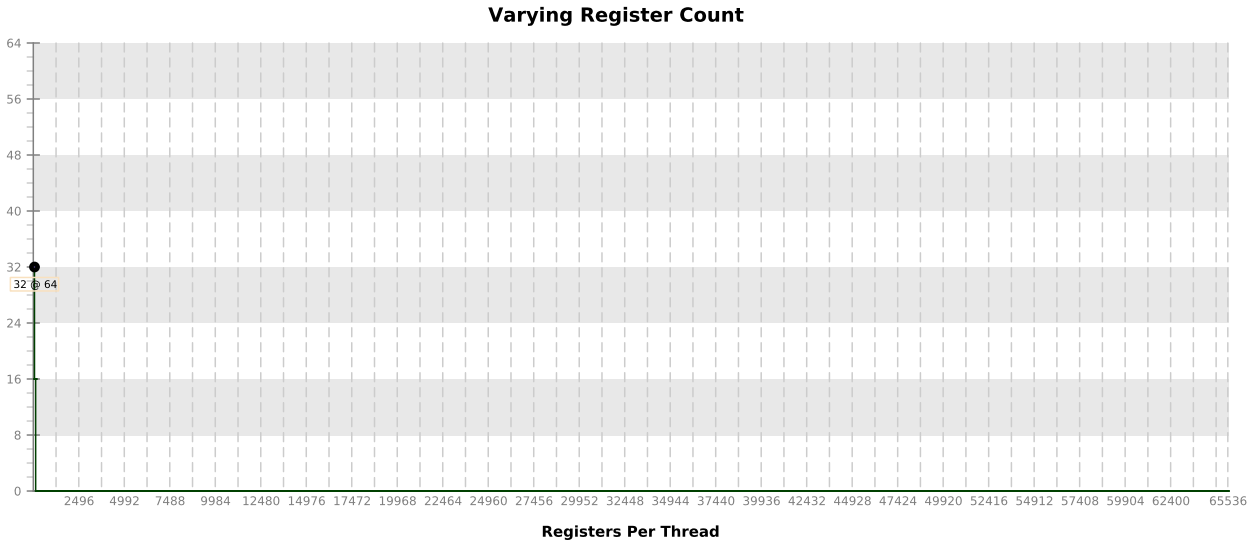
Optimization: Use the -maxrregcount flag or the __launch_bounds__ qualifier to decrease the number of registers used by each thread. This will increase the number of blocks that can execute on each SM. On devices with Compute Capability 5.2 turning global cache off can increase the occupancy limited by register usage.

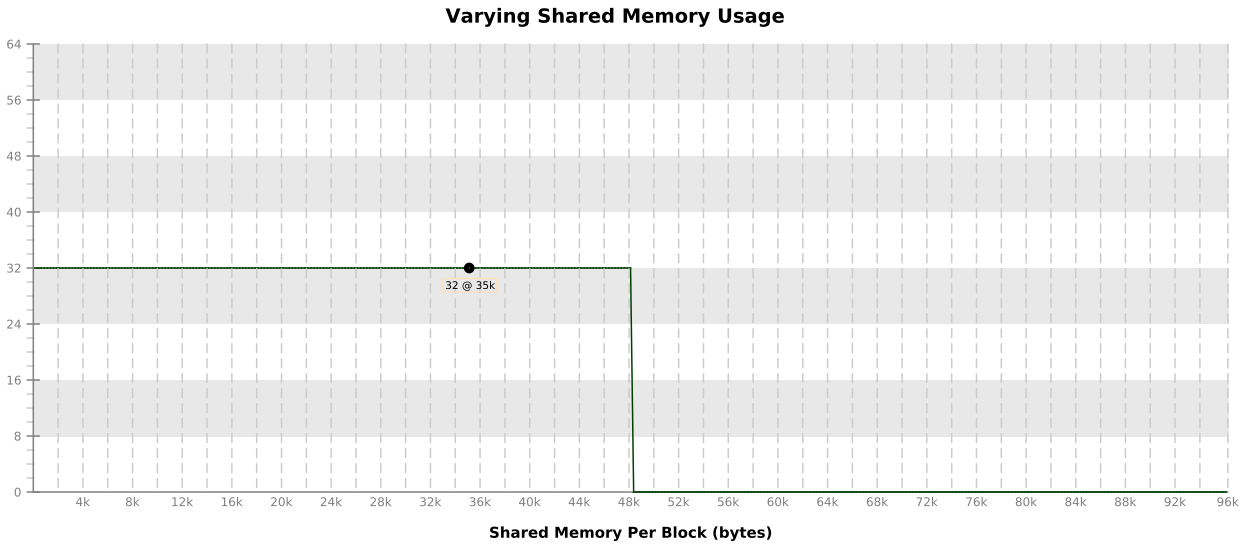
Variable	Achieved	Theoretical	Device Limit	Grid Size: [2,128,1] (256 blocks) Block Size: [512,1,1]
Occupancy Per SM				
Active Blocks		2	32	
Active Warps	30.44	32	64	
Active Threads		1024	2048	
Occupancy	47.6%	50%	100%	
Warps				
Threads/Block		512	1024	
Warps/Block		16	32	
Block Limit		4	32	
Registers				
Registers/Thread		64	65536	
Registers/Block		32768	65536	
Block Limit		2	32	
Shared Memory				
Shared Memory/Block		35904	98304	
Block Limit		2	32	

2.2. Occupancy Charts

The following charts show how varying different components of the kernel will impact theoretical occupancy.


Varying Block Size
Warps Per SM
Threads Per Block
32 @ 512
0
8
16
24
32
40
48
56
64
64
128
192
256
320
384
448
512
576
640
704
768
832
896
960
1024


Varying Register Count
Registers Per Thread
32 @ 64
0
8
16
24
32
40
48
56
64
2496
4992
7488
9984
12480
14976
17472
19968
22464
24960
27456
29952
32448
34944
37440
39936
42432
44928
47424
49920
52416
54912
57408
59904
62400
65536


Varying Shared Memory Usage
64
56
48
40
32
24
16
8
0
32 @ 35k
4k
8k
12k
16k
20k
24k
28k
32k
36k
40k
44k
48k
52k
56k
60k
64k
68k
72k
76k
80k
84k
88k
92k
96k
Shared Memory Per Block (bytes)

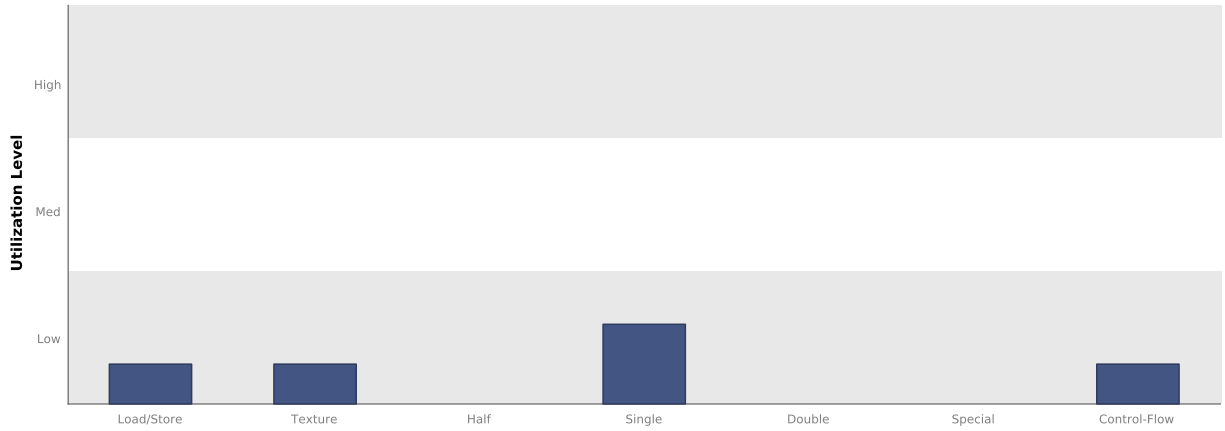
3. Compute Resources

GPU compute resources limit the performance of a kernel when those resources are insufficient or poorly utilized.

3.1. Function Unit Utilization

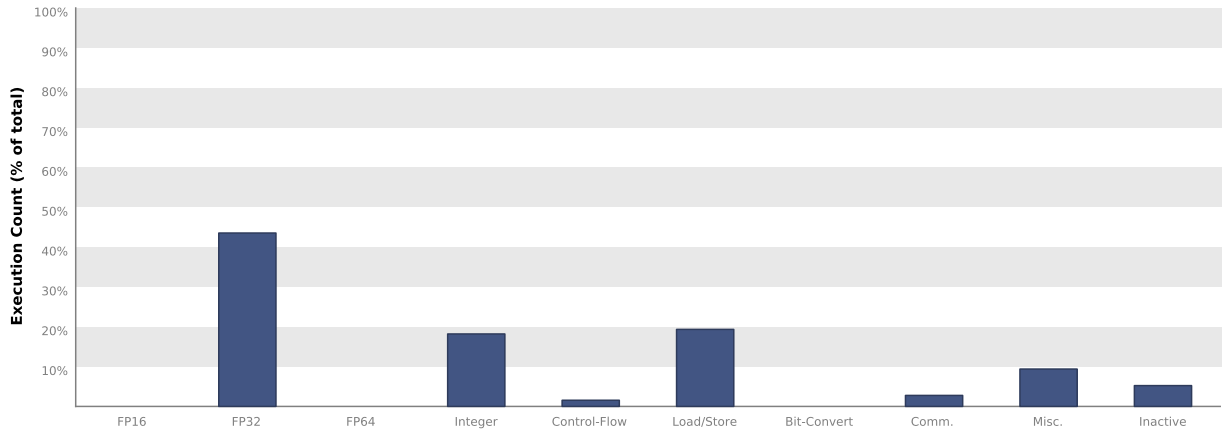
Different types of instructions are executed on different function units within each SM. Performance can be limited if a function unit is over-used by the instructions executed by the kernel. The following results show that the kernel's performance is not limited by overuse of any function unit.

Load/Store - Load and store instructions for shared and constant memory.
Texture - Load and store instructions for local, global, and texture memory.
Half - Half-precision floating-point arithmetic instructions.
Single - Single-precision integer and floating-point arithmetic instructions.
Double - Double-precision floating-point arithmetic instructions.
Special - Special arithmetic instructions such as sin, cos, popc, etc.
Control-Flow - Direct and indirect branches, jumps, and calls.



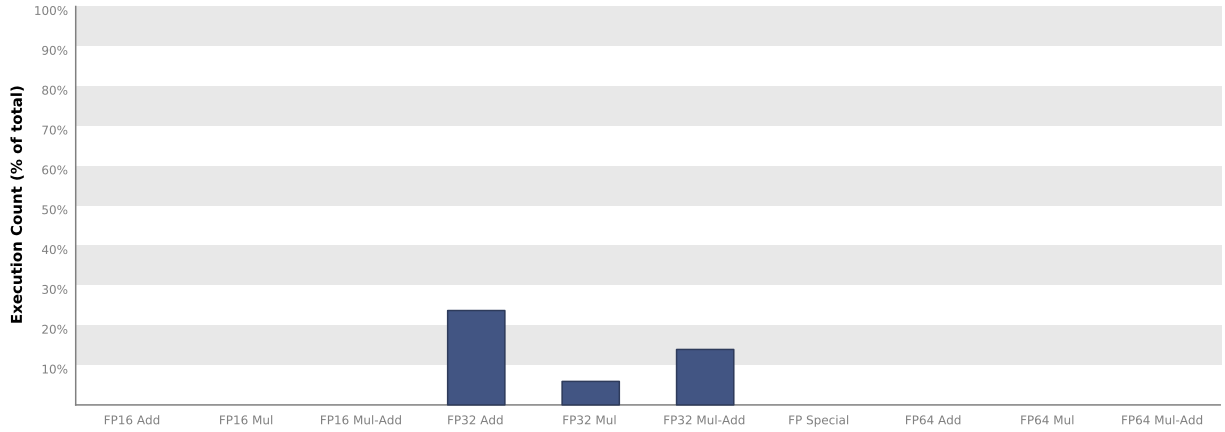
3.2. Instruction Execution Counts

The following chart shows the mix of instructions executed by the kernel. The instructions are grouped into classes and for each class the chart shows the percentage of thread execution cycles that were devoted to executing instructions in that class. The "Inactive" result shows the thread executions that did not execute any instruction because the thread was predicated or inactive due to divergence.



3.3. Floating-Point Operation Counts

The following chart shows the mix of floating-point operations executed by the kernel. The operations are grouped into classes and for each class the chart shows the percentage of thread execution cycles that were devoted to executing operations in that class. The results do not sum to 100% because non-floating-point operations executed by the kernel are not shown in this chart.



4. Memory Bandwidth

Memory bandwidth limits the performance of a kernel when one or more memories in the GPU cannot provide data at the rate requested by the kernel. The results below indicate that the kernel is limited by the bandwidth available to the device memory.

4.1. Global Memory Alignment and Access Pattern

Memory bandwidth is used most efficiently when each global memory load and store has proper alignment and access pattern.

Optimization: Each entry below points to a global load or store within the kernel with an inefficient alignment or access pattern. For each load or store improve the alignment and access pattern of the memory access.

4.2. Memory Bandwidth And Utilization

The following table shows the memory bandwidth used by this kernel for the various types of memory on the device. The table also shows the utilization of each memory type relative to the maximum throughput supported by the memory.

Transactions	Bandwidth	Utilization	
Shared Memory			
Shared Loads	540672	343.681 GB/s	
Shared Stores	401408	255.157 GB/s	
Shared Total	942080	598.838 GB/s	Idle Low Medium High Max
L2 Cache			
Reads	1353072	215.022 GB/s	
Writes	557069	88.526 GB/s	
Total	1910141	303.548 GB/s	Idle Low Medium High Max
Unified Cache			
Local Loads	0	0 B/s	
Local Stores	0	0 B/s	
Global Loads	3211264	510.314 GB/s	
Global Stores	557056	88.524 GB/s	
Texture Reads	458752	72.902 GB/s	
Unified Total	4227072	671.74 GB/s	Idle Low Medium High Max
Device Memory			
Reads	471822	74.979 GB/s	
Writes	553618	87.978 GB/s	
Total	1025440	162.957 GB/s	Idle Low Medium High Max
System Memory			
[PCIe configuration: Gen3 x16, 8 Gbit/s]			
Reads	0	0 B/s	Idle Low Medium High Max
Writes	5	794.569 kB/s	Idle Low Medium High Max