Analysis Report

gpu3_kernel(int, int, int, double*, double*, double*, int)

Duration	50.60773 ms (50,607,729 ns)
Grid Size	[64,128,1]
Block Size	[16,16,1]
Registers/Thread	24
Shared Memory/Block	0 B
Shared Memory Requested	96 KiB
Shared Memory Executed	96 KiB
Shared Memory Bank Size	4 B

[0] Tesla V100-PCIE-16GB

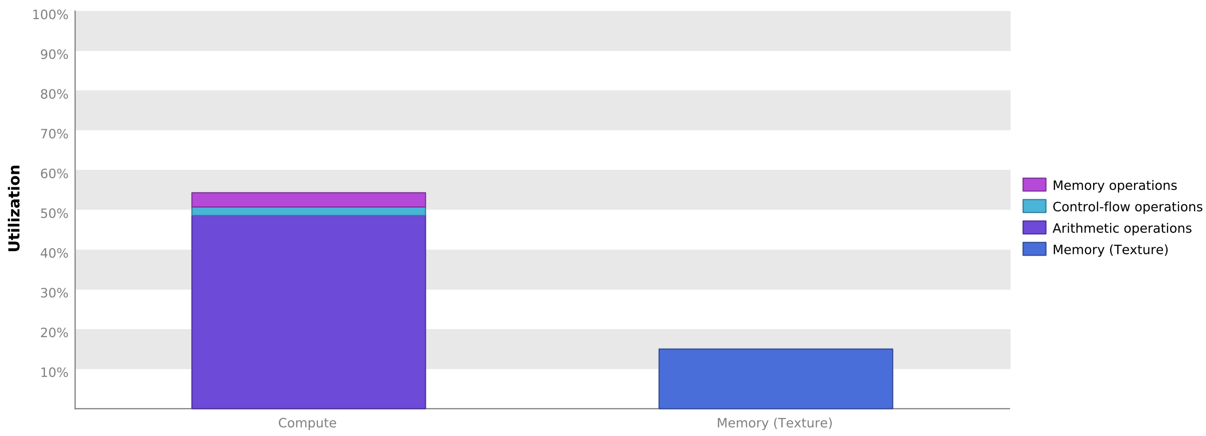
GPU UUID	GPU-fe492529-48c2-9a7f-92d9-a7ace94a08d9
Compute Capability	7.0
Max. Threads per Block	1024
Max. Threads per Multiprocessor	2048
Max. Shared Memory per Block	48 KiB
Max. Shared Memory per Multiprocessor	96 KiB
Max. Registers per Block	65536
Max. Registers per Multiprocessor	65536
Max. Grid Dimensions	[2147483647, 65535, 65535]
Max. Block Dimensions	[1024, 1024, 64]
Max. Warps per Multiprocessor	64
Max. Blocks per Multiprocessor	32
Half Precision FLOP/s	28.262 TeraFLOP/s
Single Precision FLOP/s	14.131 TeraFLOP/s
Double Precision FLOP/s	7.066 TeraFLOP/s
Number of Multiprocessors	80
Multiprocessor Clock Rate	1.38 GHz
Concurrent Kernel	true
Max IPC	4
Threads per Warp	32
Global Memory Bandwidth	898.048 GB/s
Global Memory Size	15.774 GiB
Constant Memory Size	64 KiB
L2 Cache Size	6 MiB
Memcpy Engines	7
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 "gpu3_kernel" 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 "Tesla V100-PCIE-16GB". 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.

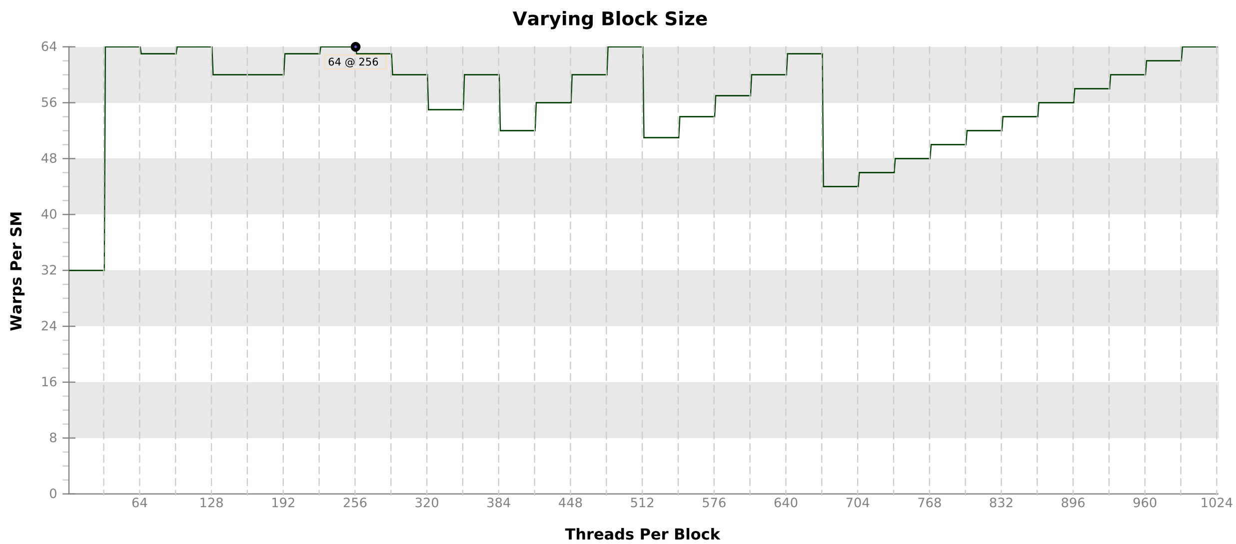
2.1. Occupancy Is Not Limiting Kernel Performance

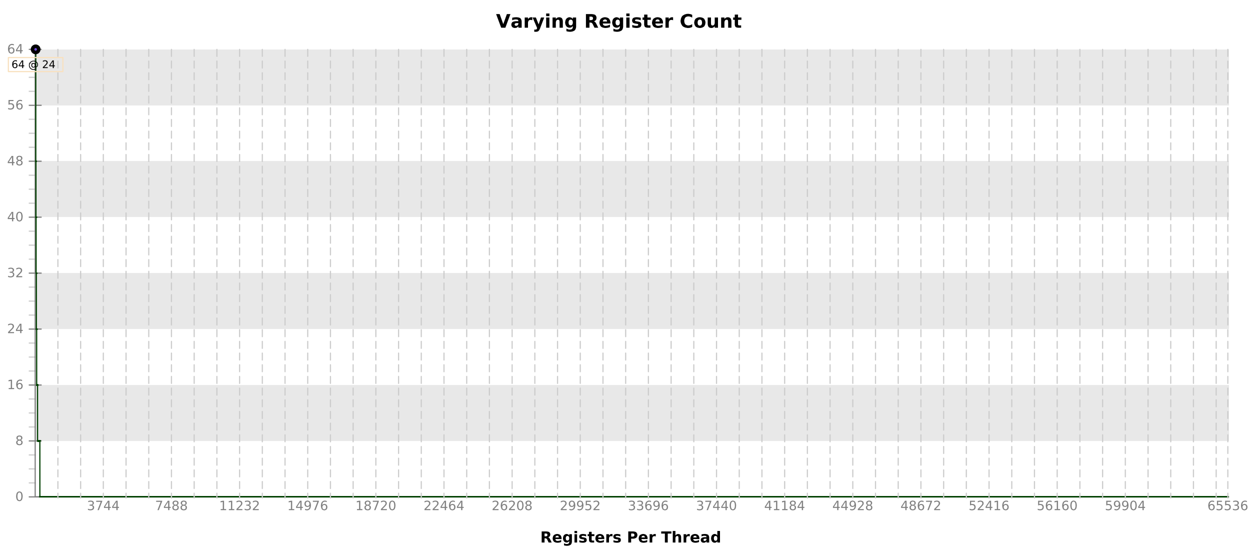
The kernel's block size, register usage, and shared memory usage allow it to fully utilize all warps on the GPU.

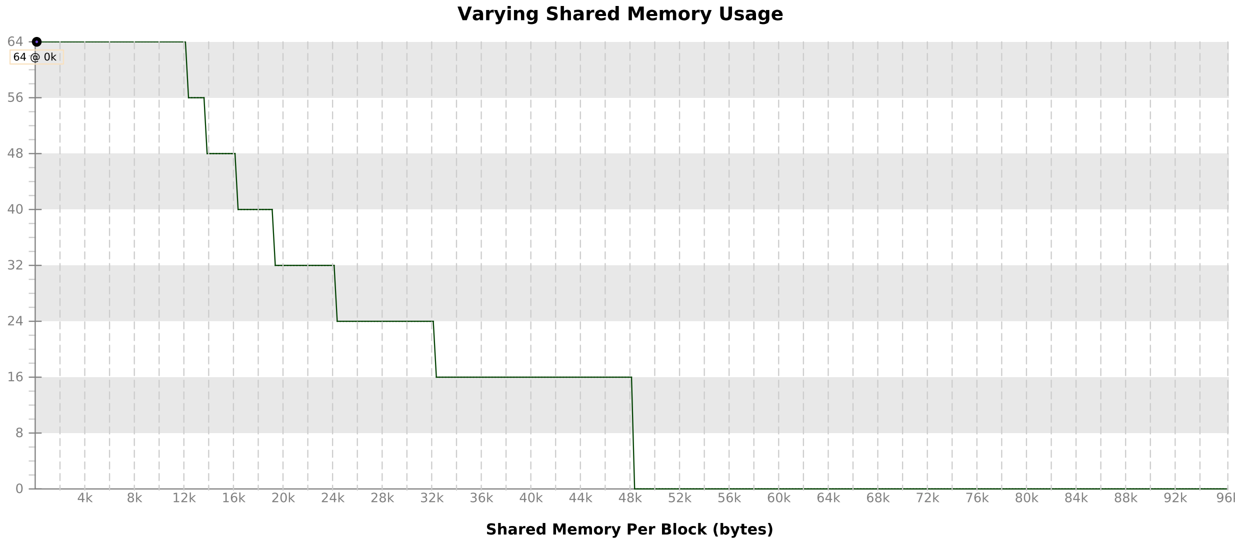
Variable	Achieved	Theoretical	Device Limit	Grid Size: [64,128,1] (8192 blocks) Block Size: [16,16,
Occupancy Per SM				
Active Blocks		8	32	0 4 8 12 16 20 24 28 32
Active Warps	60.06	64	64	0 9 18 27 36 45 54 6364
Active Threads		2048	2048	0 512 1024 1536 2048
Occupancy	93.8%	100%	100%	0% 25% 50% 75% 100%
Warps				
Threads/Block		256	1024	0 256 512 768 1024
Warps/Block		8	32	0 4 8 12 16 20 24 28 32
Block Limit		8	32	0 4 8 12 16 20 24 28 32
Registers				
Registers/Thread		24	65536	0 16384 32768 49152 65536
Registers/Block		6144	65536	0 16k 32k 48k 64k
Block Limit		10	32	0 4 8 12 16 20 24 28 32
Shared Memory				
Shared Memory/Block		0	98304	0 32k 64k 96k
Block Limit		0	32	0 4 8 12 16 20 24 28 32

2.2. Occupancy Charts

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

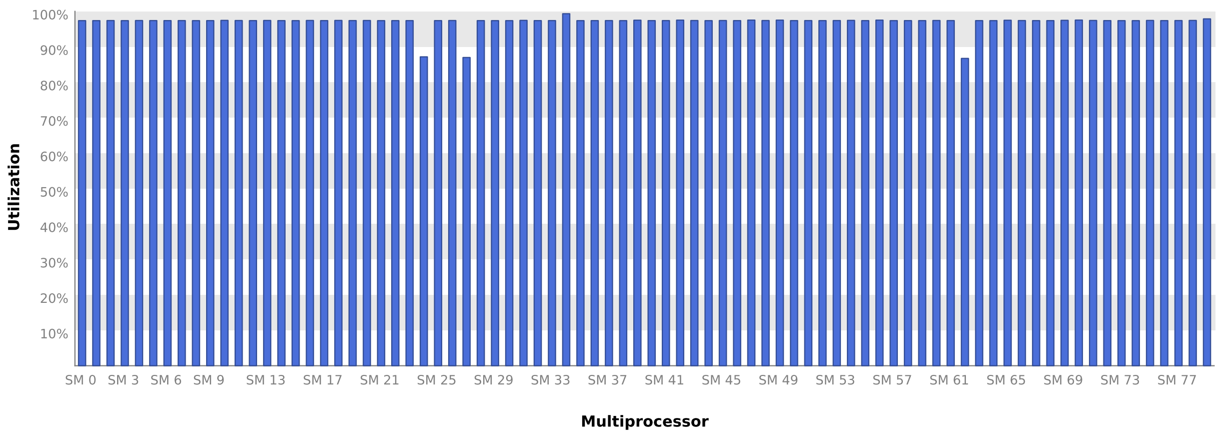

Varying Block Size
Warps Per SM
Threads Per Block
64 @ 256
0
8
16
24
32
40
48
56
64
64
128
192
256
320
384
448
512
576
640
704
768
832
896
960
1024


Varying Register Count
Registers Per Thread
64 @ 24
0
8
16
24
32
40
48
56
64
3744
7488
11232
14976
18720
22464
26208
29952
33696
37440
41184
44928
48672
52416
56160
59904
65536



2.3. Multiprocessor Utilization

The kernel's blocks are distributed across the GPU's multiprocessors for execution. Depending on the number of blocks and the execution duration of each block some multiprocessors may be more highly utilized than others during execution of the kernel. The following chart shows the utilization of each multiprocessor during execution of the kernel.



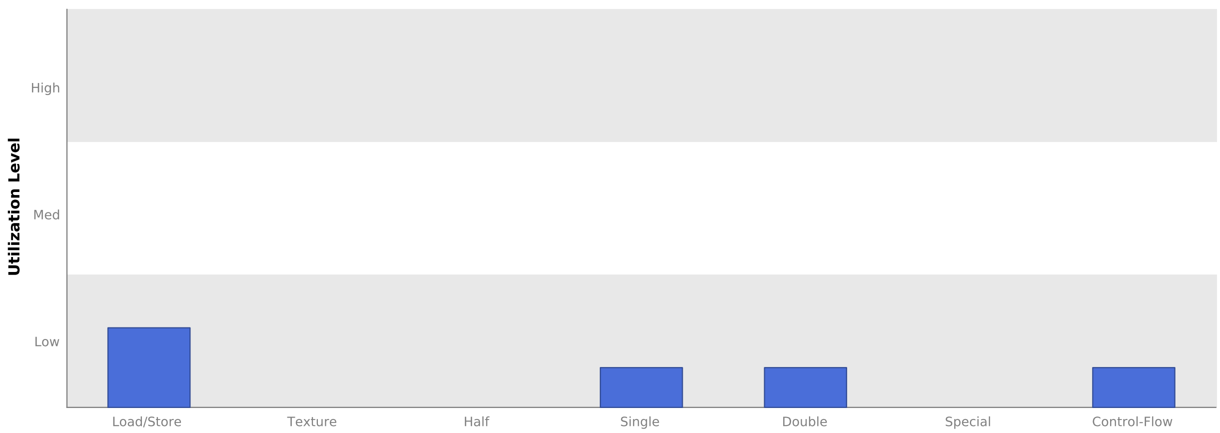
3. Compute Resources

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

3.1. Function Unit Utilization

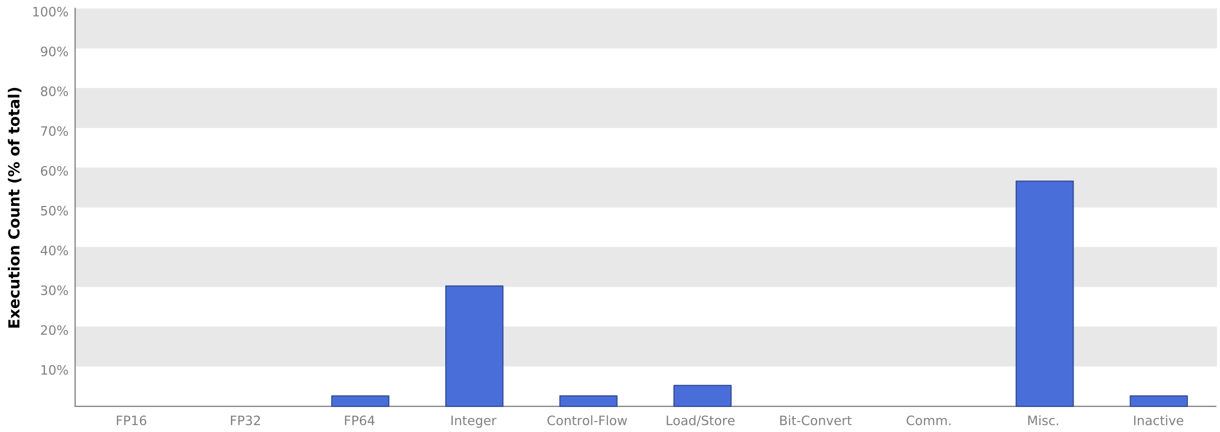
Different types of instructions are executed on different function units within each SM. Performance can be limited if a function unit is over-used by the instructions executed by the kernel. The following results show that the kernel's performance is not limited by overuse of any function unit.

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.



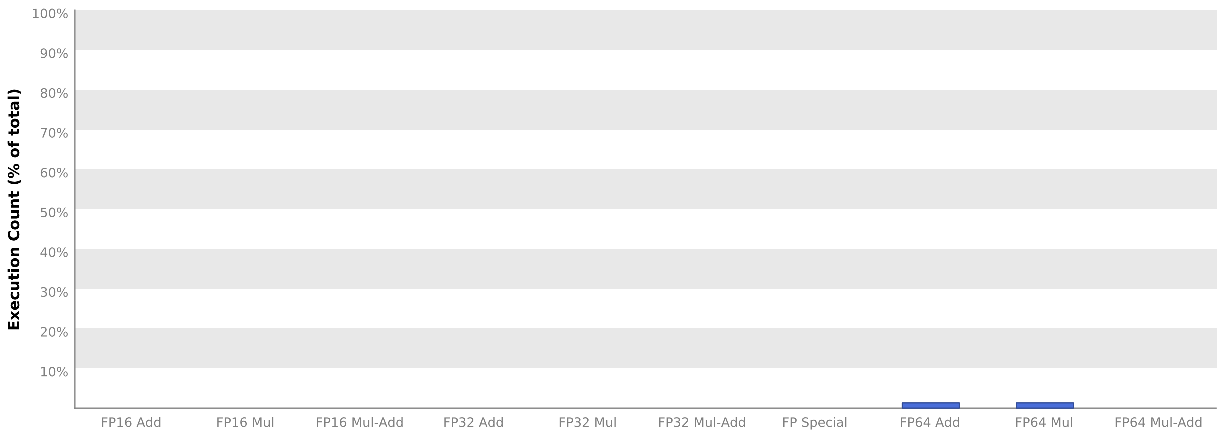
3.2. Instruction Execution Counts

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.

4.1. 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	0	0 B/s	
Shared Stores	0	0 B/s	
Shared Total	0	0 B/s	Idle Low Medium High Max
L2 Cache			
Reads	119512777	86.664 GB/s	
Writes	1076484843	780.61 GB/s	
Total	1195997620	867.274 GB/s	Idle Low Medium High Max
Unified Cache			
Local Loads	0	0 B/s	
Local Stores	1433600	1.04 GB/s	
Global Loads	1879695895	1,363.056 GB/s	
Global Stores	1074940032	779.49 GB/s	
Texture Reads	805437440	2,336.243 GB/s	
Unified Total	3761506967	4,479.829 GB/s	Idle Low Medium High Max
Device Memory			
Reads	8633294	6.26 GB/s	
Writes	8269756	5.997 GB/s	
Total	16903050	12.257 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	10245	7.429 MB/s	Idle Low Medium High Max