Analysis Report

mysgemm(int, int, int, float const *, float const *, float*)

Duration	7.31177 ms (7,311,771 ns)
Grid Size	[64,64,1]
Block Size	[16,16,1]
Registers/Thread	30
Shared Memory/Block	2 KiB
Shared Memory Requested	96 KiB
Shared Memory Executed	96 KiB
Shared Memory Bank Size	4 B

[0] Tesla M60

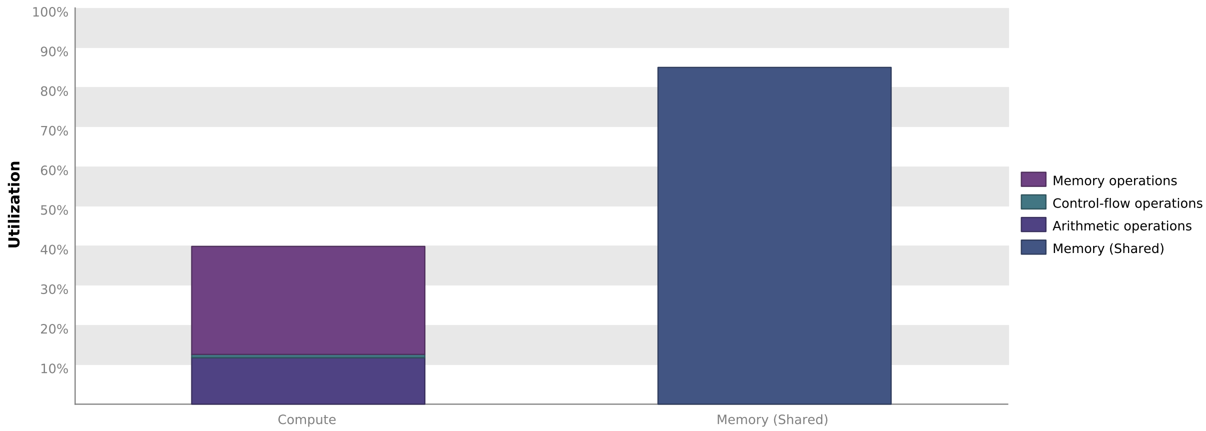
GPU UUID	GPU-7dd05407-dba7-a874-62fe-55ac2820076c
Compute Capability	5.2
Max. Threads per Block	1024
Max. Threads per Multiprocessor	2048
Max. Shared Memory per Block	48 KiB
Max. Shared Memory per Multiprocessor	96 KiB
Max. Registers per Block	65536
Max. Registers per Multiprocessor	65536
Max. Grid Dimensions	[2147483647, 65535, 65535]
Max. Block Dimensions	[1024, 1024, 64]
Max. Warps per Multiprocessor	64
Max. Blocks per Multiprocessor	32
Single Precision FLOP/s	4.823 TeraFLOP/s
Double Precision FLOP/s	150.72 GigaFLOP/s
Number of Multiprocessors	16
Multiprocessor Clock Rate	1.177 GHz
Concurrent Kernel	true
Max IPC	6
Threads per Warp	32
Global Memory Bandwidth	160.32 GB/s
Global Memory Size	7.939 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 "mysgemm" is most likely limited by memory bandwidth. You should first examine the information in the "Memory Bandwidth" section to determine how it is limiting performance.

1.1. Kernel Performance Is Bound By Memory Bandwidth

For device "Tesla M60" the kernel's compute utilization is significantly lower than its memory utilization. These utilization levels indicate that the performance of the kernel is most likely being limited by the memory system. For this kernel the limiting factor in the memory system is the bandwidth of the Shared memory.



2. 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 shared memory.

2.1. GPU Utilization Is Limited By Memory Bandwidth

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. The results show that the kernel's performance is potentially limited by the bandwidth available from one or more of the memories on the device.

Optimization: Try the following optimizations for the memory with high bandwidth utilization.
Shared Memory - If possible use 64-bit accesses to shared memory and 8-byte bank mode to achieved 2x throughput.
L2 Cache - Align and block kernel data to maximize L2 cache efficiency.
Unified Cache - Reallocate texture data to shared or global memory. Resolve alignment and access pattern issues for global loads and stores.
Device Memory - Resolve alignment and access pattern issues for global loads and stores.
System Memory (via PCIe) - Make sure performance critical data is placed in device or shared memory.

Transactions	Bandwidth	Utilization	
Shared Memory			
Shared Loads	49545216	1,666.742 GB/s	
Shared Stores	4128768	138.895 GB/s	
Shared Total	53673984	1,805.637 GB/s	Idle Low Medium High Max
L2 Cache			
Reads	16000071	134.564 GB/s	
Writes	187006	1.573 GB/s	
Total	16187077	136.137 GB/s	Idle Low Medium High Max
Unified Cache			
Local Loads	0	0 B/s	
Local Stores	0	0 B/s	
Global Loads	32000000	134.563 GB/s	
Global Stores	187000	1.573 GB/s	
Texture Reads	16128000	135.64 GB/s	
Unified Total	48315000	271.776 GB/s	Idle Low Medium High Max
Device Memory			
Reads	7132832	59.989 GB/s	
Writes	156755	1.318 GB/s	
Total	7289587	61.307 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	42.051 kB/s	Idle Low Medium High Max

3. 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.

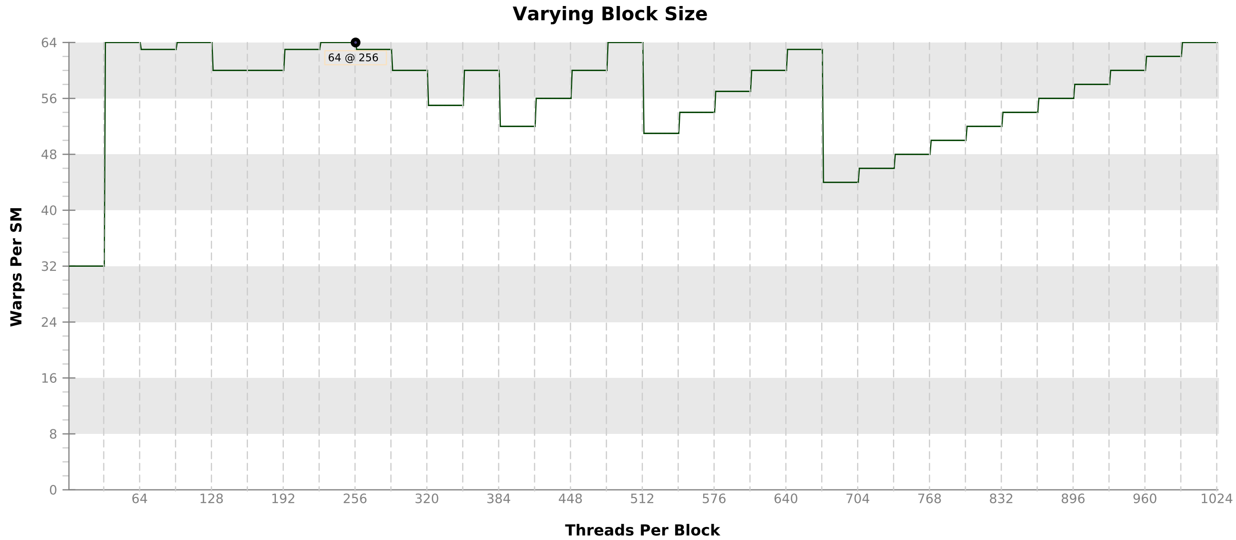
3.1. Occupancy Is Not Limiting Kernel Performance

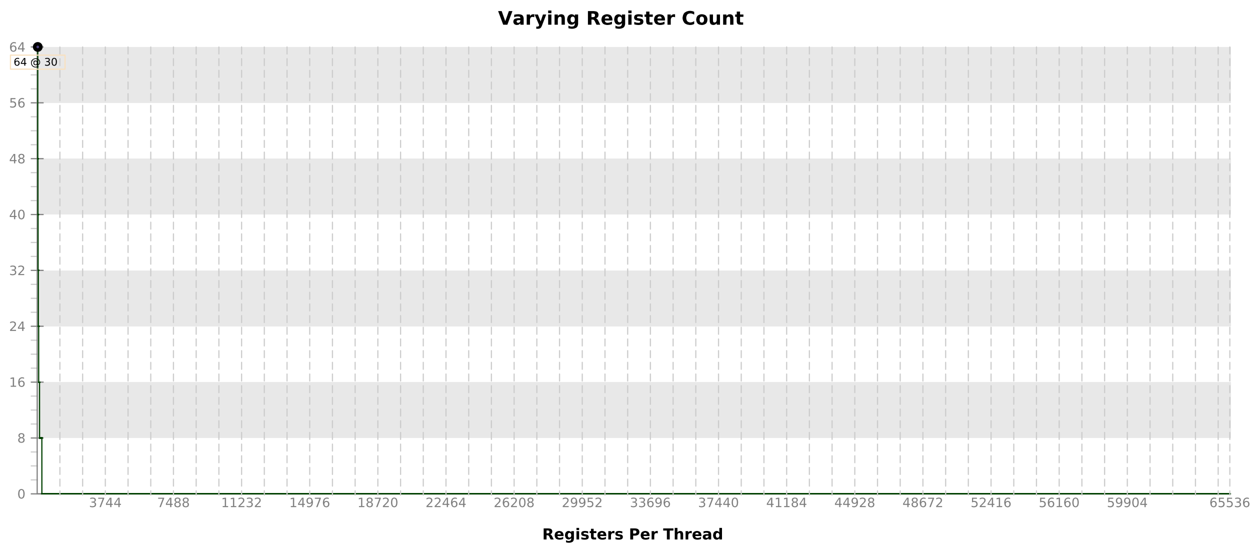
The kernel's block size, register usage, and shared memory usage allow it to fully utilize all warps on the GPU.

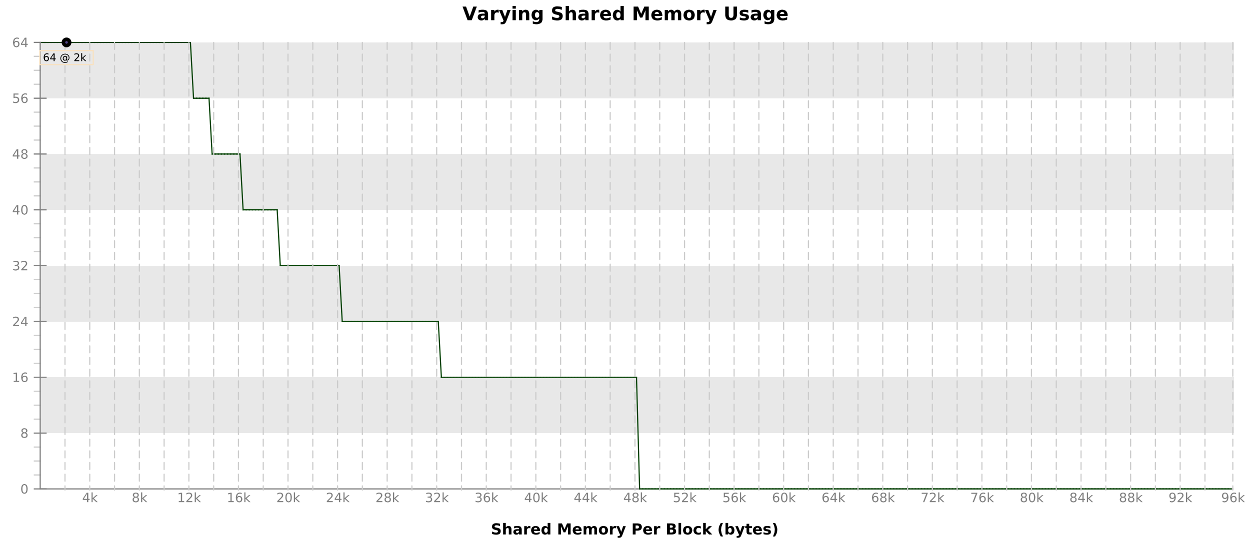
Variable	Achieved	Theoretical	Device Limit	Grid Size: [64,64,1] (4096 blocks) Block Size: [16,16,1
Occupancy Per SM				
Active Blocks		8	32	0 4 8 12 16 20 24 28 32
Active Warps	63.4	64	64	0 9 18 27 36 45 54 63 64
Active Threads		2048	2048	0 512 1024 1536 2048
Occupancy	99.1%	100%	100%	0% 25% 50% 75% 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		30	65536	0 16384 32768 49152 65536
Registers/Block		8192	65536	0 16k 32k 48k 64k
Block Limit		8	32	0 4 8 12 16 20 24 28 32
Shared Memory				
Shared Memory/Block		2048	98304	0 32k 64k 96k
Block Limit		48	32	0 4 8 12 16 20 24 28 32

3.2. Occupancy Charts

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

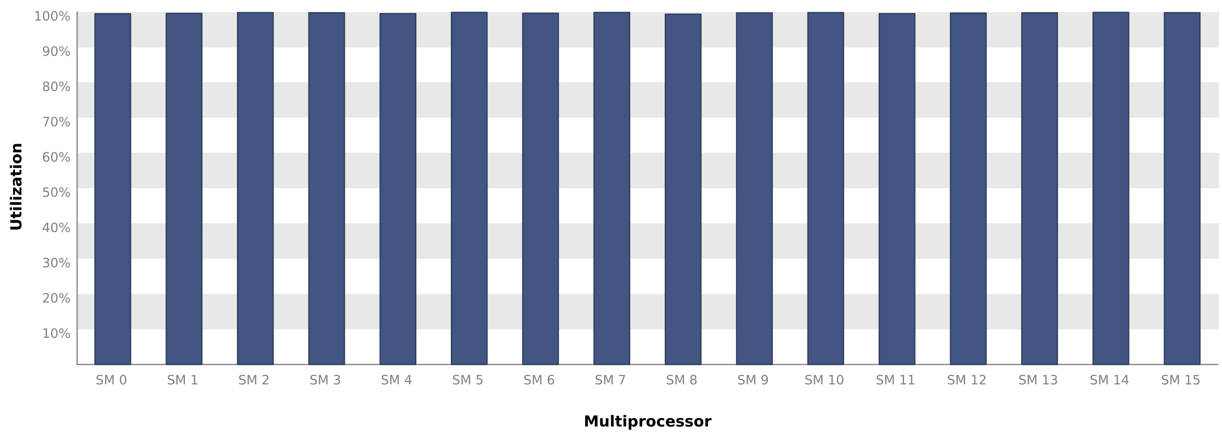

Varying Block Size
Warps Per SM
Threads Per Block
64 @ 256
0
8
16
24
32
40
48
56
64
64
128
192
256
320
384
448
512
576
640
704
768
832
896
960
1024


Varying Register Count
Registers Per Thread
64 @ 30
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



3.3. 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.



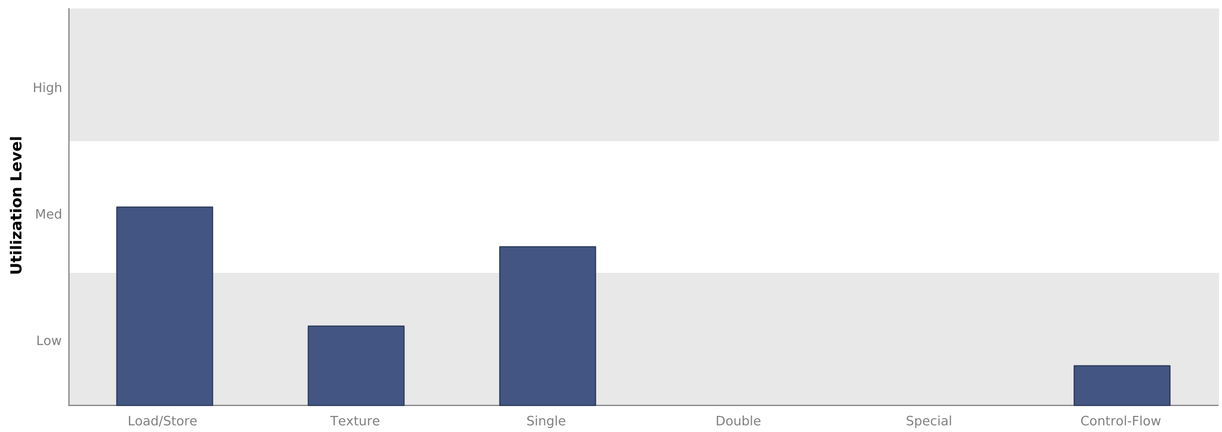
4. Compute Resources

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

4.1. Function Unit Utilization

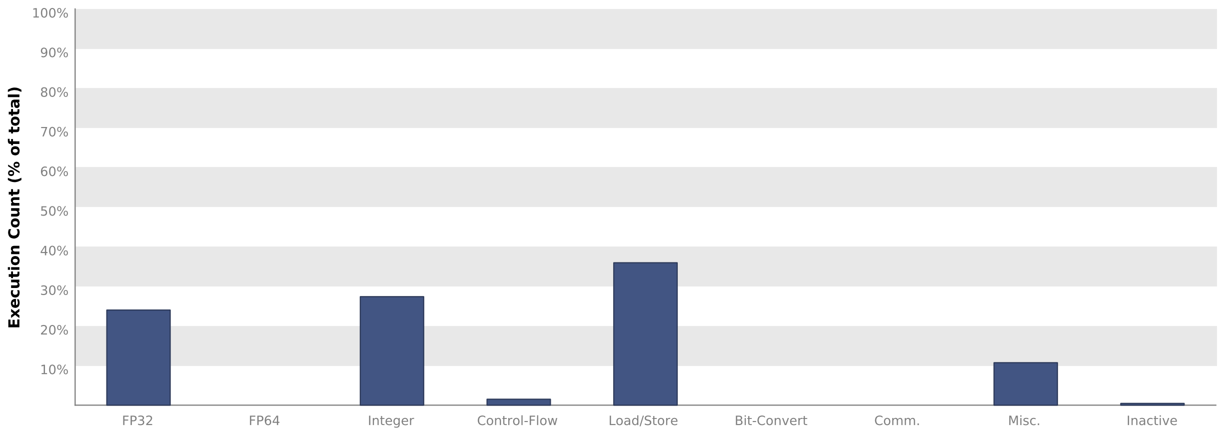
Different types of instructions are executed on different function units within each SM. Performance can be limited if a function unit is over-used by the instructions executed by the kernel. The following results show that the kernel's performance is not limited by overuse of any function unit.

Load/Store - Load and store instructions for shared and constant memory.
Texture - Load and store instructions for local, global, and texture memory.
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.



4.2. 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.



4.3. 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.