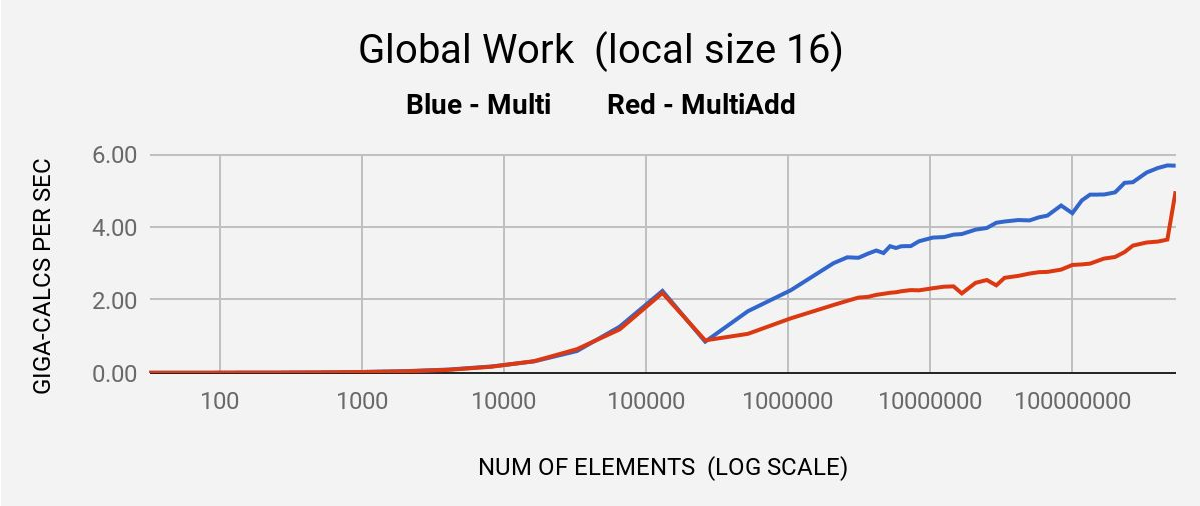
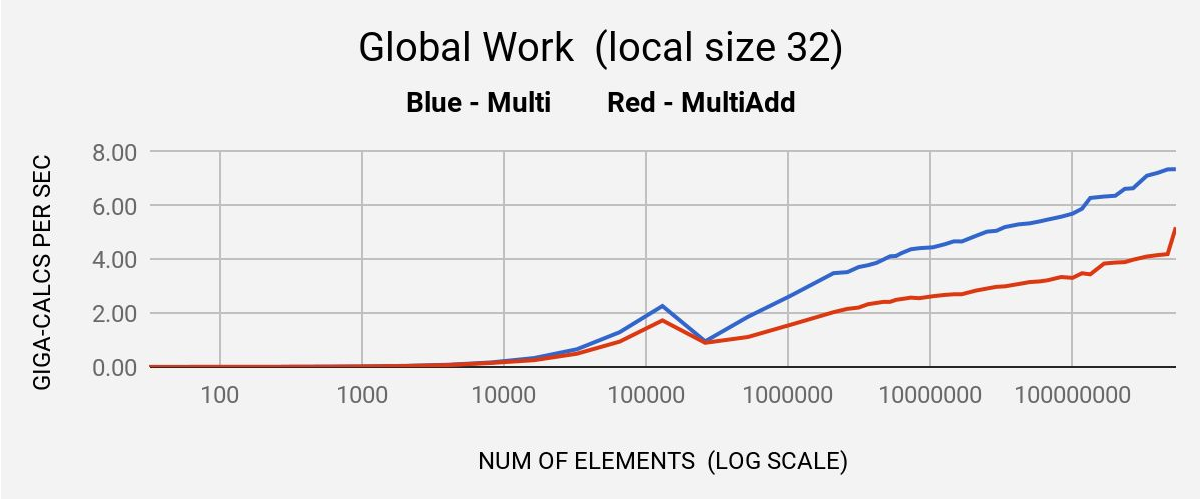
1. Personal computer
   - Intel i7-7700K @ 4.20GHz (4 cores, 8 threads)
   - NVIDIA 1080ti @ 1.57GHz (3584 CUDA cores)

2. Tables attached to end.





3. Global Work - As the number of elements to calculate increments, processing speed generally trends upward. The only hitch is a drop between 131072 & 2097152 number of elements (for tasks of 262144, 524288, & 1048576 elements). This trend holds true for both Multiplication and Multiplication+Addition work structures.

Local Work - At first, both structures benefit from a growing local work size (and declining global work size), only to plateau once a certain local yield is met. For Multiply, this plateau begins at local work size of 64 items, while Multiply +Add experiences a similar plateau but earlier, starting at local work size of 16 items.

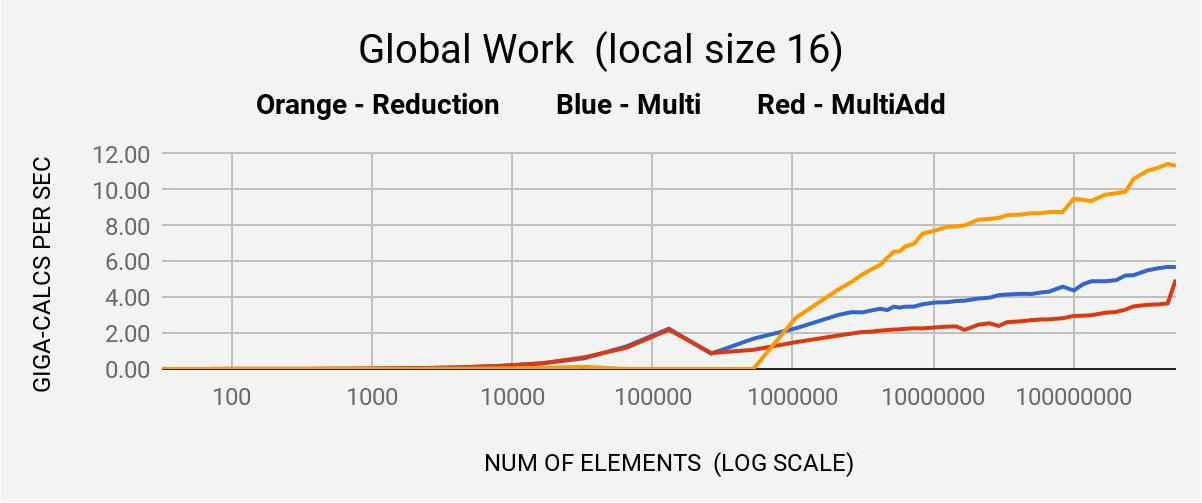
4. Global Work - What initially stands out for me is the benefit doubling local work benefits performance for both Mult and Mult+Add structures. The second feature that stands out is the consistent *drop-off* in performance after the number of elements surpasses 131072. Relieved to know this isn't an aberration, a cursory device querying report reveals that 131072 matches the 1-dimensional "maximum texture dimension size" for this video card's architecture. Far from a coding error, what I'm seeing is the overwhelming of the maximum number of IDs upon which work can be performed by my video card before a queue of future work must be stored over in host memory (PC's RAM).

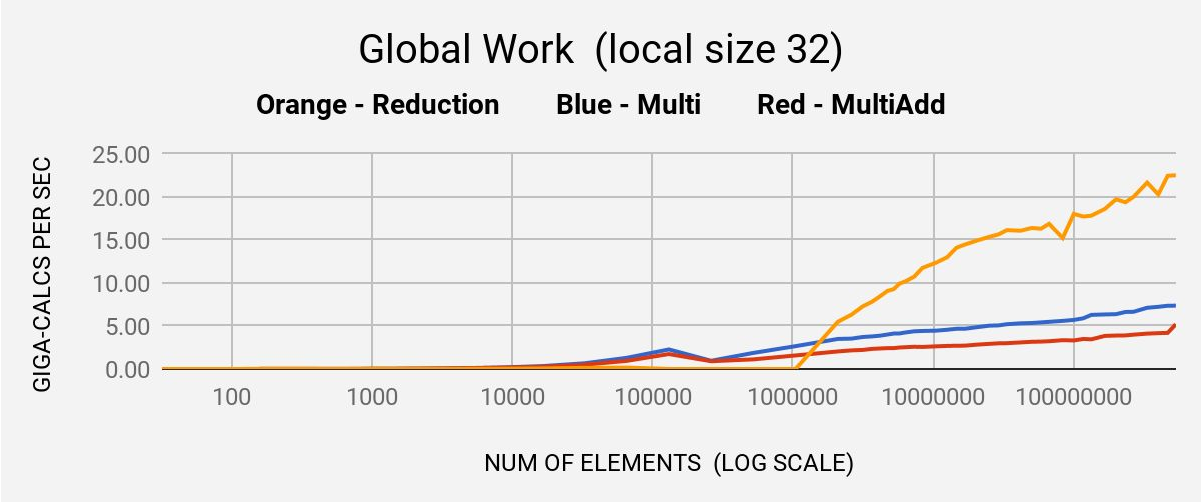
Local Work - I believe this reflects more upon the algorithmic structures of the multiplication and addition, and the minimum number of calls work groups must make back to global memory notwithstanding any attempt to offload overhead by shifting work into work groups' local cache. That is, at 64 items per local group, our multiplication operation must make a minimum number of global calls that limits any further optimization provided by increasing local memory size, while, at 16 items, we observe the effect of including an array addition operation that differentiates Mult+Add from Mult. By including this addition instruction, multiplicative data from work done by work groups must now interact with data yielded by other work groups, therefore, reading/writing their data results back to global memory in order to retrieve the globally-stored data sets for array addition.

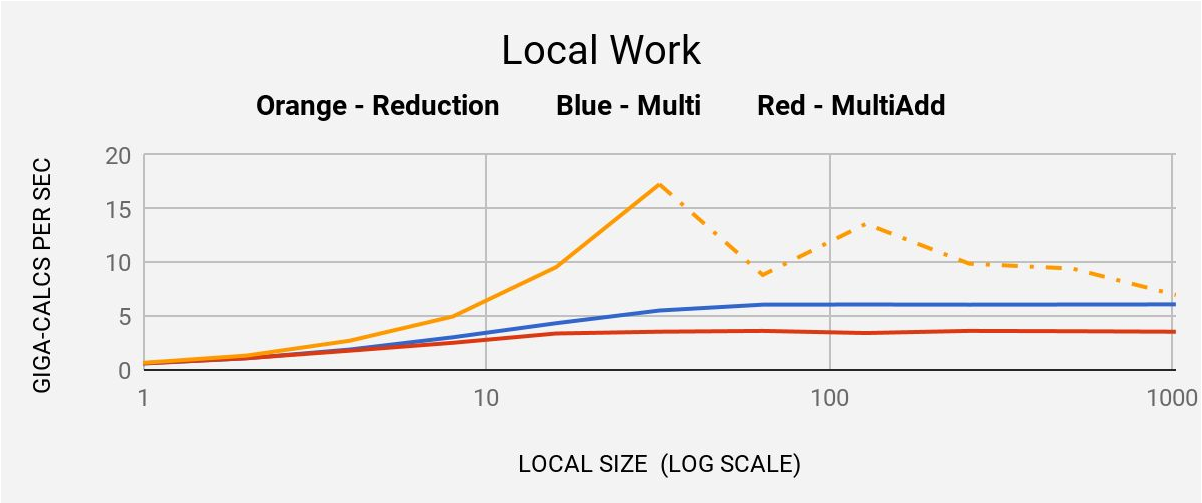
5. Taking the slope difference from the final entry, 7.36 over 5.20 yields a performance difference of 141% for Mult over Mult+Add.

6. That maximizing one's local resources (memory space for one's work groups) and, directly related, limiting the overhead work reading/writing/retrieving (up-the-work-chain) is *paramount* to optimizing GPU parallel computing.

1. Reads from same tables (attached to the end).







2. Global - What I observe is a sudden acceleration in performance: for Local Size 16 items, starting at 1048576 elements, and where Local Size 32 items, at 2097152 elements (or 2x1048576).

Local - Performance acceleration aside, what the reader will notice on-graph is a separated line delineation between 32 and 64 items. This is intended to reflect that from 64 items to 1024 items of designated local memory, Reduction's performance is presented with a caveat for an unrecognized error thrown at clWaitForEvents (*i.e.,* I tested for every event listed in the OpenCL standard and none returned).

3. Global - Performance benefits from the retention of all product summing within the work groups (warps) rather than shifting back to global pointers with sum values. That is, according to the code, all global memory stored array data passes downstream into the work group's private elements where calculation work completes, then is passed into the groups' shared local memory, from where a binary-summation of the multiplicative results can occur, and the sum result passed back upstream. (An immediate benefit from this is sum data can be reused by all the work-items in a work-group.) I believe Reduction's acceleration in performance at 2097152 items where Local Size is 32 and 1048576 elements where Local Size is 16 reflects the most efficient memory occupancy of my GPU's work-groups. This is supported by my GPU's maximum constant memory size of 65536 bytes, which is the same result of 1048576/16 or 2097152/32.

Local - Where Multiply experienced incrementally better performance until 64 items and Mult+Add benefitted through 16 items, Reduction continues to benefit through 32 items and may have continued its inclination were it not for work-syncing errors (which, once again, I was not able to identify an error-code-specific cause, but my guess is its relation to global memory not guaranteed to remain consistent between work groups).

4. That how one algorithmically instructs local memory and global memory interaction matters *even more than* maximizing local work group's efficiency, *i.e.,* the amount of cost associated with global memory calls carries significantly greater weight than making the most of work groups' local memory space.

GLOBAL WORK (LOCAL SIZE 16)

Num Elements	GigaCalcs/Sec	Type	Local Size	Num Work Groups
32	0.00	Mult	16	1
64	0.00	Mult	16	2
128	0.00	Mult	16	4
256	0.00	Mult	16	8
512	0.01	Mult	16	16
1024	0.02	Mult	16	32
2048	0.05	Mult	16	64
4096	0.09	Mult	16	128
8192	0.17	Mult	16	256
16384	0.31	Mult	16	512
32768	0.60	Mult	16	1024
65536	1.27	Mult	16	2048
131072	2.25	Mult	16	4096
262144	0.85	Mult	16	8192
524288	1.69	Mult	16	16384
1048576	2.27	Mult	16	32768
2097152	3.01	Mult	16	65536
2621440	3.17	Mult	16	81920
3145728	3.16	Mult	16	98304
3670016	3.27	Mult	16	114688
4194304	3.36	Mult	16	131072
4718592	3.29	Mult	16	147456
5242880	3.48	Mult	16	163840
5767168	3.43	Mult	16	180224
6291456	3.47	Mult	16	196608
7340032	3.48	Mult	16	229376
8388608	3.61	Mult	16	262144
10485760	3.71	Mult	16	327680
12582912	3.73	Mult	16	393216
14680064	3.79	Mult	16	458752
16777216	3.81	Mult	16	524288
20971520	3.93	Mult	16	655360
25165824	3.98	Mult	16	786432
29360128	4.12	Mult	16	917504
33554432	4.15	Mult	16	1048576
41943010	4.19	Mult	16	1310720
50331648	4.18	Mult	16	1572864
58720256	4.27	Mult	16	1835008
67108864	4.31	Mult	16	2097152

83886080	4.59	Mult	16	2621440
100663296	4.38	Mult	16	3145728
117440512	4.73	Mult	16	3670016
134217728	4.89	Mult	16	4194304
167772160	4.89	Mult	16	5242880
201326592	4.95	Mult	16	6291456
234881024	5.22	Mult	16	7340032
268435456	5.23	Mult	16	8388608
335544320	5.50	Mult	16	10485760
402653184	5.62	Mult	16	12582912
469762048	5.69	Mult	16	14680064
536870912	5.69	Mult	16	16777216
32	0.00	MultAdd	16	1
64	0.00	MultAdd	16	2
128	0.00	MultAdd	16	4
256	0.01	MultAdd	16	8
512	0.01	MultAdd	16	16
1024	0.02	MultAdd	16	32
2048	0.04	MultAdd	16	64
4096	0.08	MultAdd	16	128
8192	0.17	MultAdd	16	256
16384	0.32	MultAdd	16	512
32768	0.65	MultAdd	16	1024
65536	1.19	MultAdd	16	2048
131072	2.19	MultAdd	16	4096
262144	0.89	MultAdd	16	8192
524288	1.07	MultAdd	16	16384
1048576	1.49	MultAdd	16	32768
2097152	1.86	MultAdd	16	65536
2621440	1.98	MultAdd	16	81920
3145728	2.06	MultAdd	16	98304
3670016	2.08	MultAdd	16	114688
4194304	2.14	MultAdd	16	131072
4718592	2.17	MultAdd	16	147456
5242880	2.20	MultAdd	16	163840
5767168	2.21	MultAdd	16	180224
6291456	2.24	MultAdd	16	196608
7340032	2.27	MultAdd	16	229376
8388608	2.26	MultAdd	16	262144
10485760	2.32	MultAdd	16	327680
12582912	2.36	MultAdd	16	393216
14680064	2.37	MultAdd	16	458752
16777216	2.18	MultAdd	16	524288

20971520	2.47	MultAdd	16	655360
25165824	2.55	MultAdd	16	786432
29360128	2.40	MultAdd	16	917504
33554432	2.61	MultAdd	16	1048576
41943010	2.66	MultAdd	16	1310720
50331648	2.72	MultAdd	16	1572864
58720256	2.76	MultAdd	16	1835008
67108864	2.77	MultAdd	16	2097152
83886080	2.83	MultAdd	16	2621440
100663296	2.96	MultAdd	16	3145728
117440512	2.98	MultAdd	16	3670016
134217728	3.00	MultAdd	16	4194304
167772160	3.13	MultAdd	16	5242880
201326592	3.18	MultAdd	16	6291456
234881024	3.32	MultAdd	16	7340032
268435456	3.49	MultAdd	16	8388608
335544320	3.58	MultAdd	16	10485760
402653184	3.60	MultAdd	16	12582912
469762048	3.66	MultAdd	16	14680064
536870912	4.98	MultAdd	16	16777216
32	0.00	Reduct	16	1
64	0.00	Reduct	16	2
128	0.00	Reduct	16	4
256	0.01	Reduct	16	8
512	0.00	Reduct	16	16
1024	0.00	Reduct	16	32
2048	0.01	Reduct	16	64
4096	0.02	Reduct	16	128
8192	0.03	Reduct	16	256
16384	0.06	Reduct	16	512
32768	0.12	Reduct	16	1024
65536	0.00	Reduct	16	2048
131072	0.00	Reduct	16	4096
262144	0.00	Reduct	16	8192
524288	0.00	Reduct	16	16384
1048576	2.85	Reduct	16	32768
2097152	4.42	Reduct	16	65536
2621440	4.85	Reduct	16	81920
3145728	5.28	Reduct	16	98304
3670016	5.58	Reduct	16	114688
4194304	5.80	Reduct	16	131072
4718592	6.21	Reduct	16	147456
5242880	6.54	Reduct	16	163840

5767168	6.56	Reduct	16	180224
6291456	6.82	Reduct	16	196608
7340032	7.00	Reduct	16	229376
8388608	7.54	Reduct	16	262144
10485760	7.74	Reduct	16	327680
12582912	7.92	Reduct	16	393216
14680064	7.97	Reduct	16	458752
16777216	8.01	Reduct	16	524288
20971520	8.33	Reduct	16	655360
25165824	8.37	Reduct	16	786432
29360128	8.42	Reduct	16	917504
33554432	8.58	Reduct	16	1048576
41943010	8.61	Reduct	16	1310720
50331648	8.69	Reduct	16	1572864
58720256	8.69	Reduct	16	1835008
67108864	8.75	Reduct	16	2097152
83886080	8.76	Reduct	16	2621440
100663296	9.50	Reduct	16	3145728
117440512	9.43	Reduct	16	3670016
134217728	9.37	Reduct	16	4194304
167772160	9.72	Reduct	16	5242880
201326592	9.80	Reduct	16	6291456
234881024	9.89	Reduct	16	7340032
268435456	10.60	Reduct	16	8388608
335544320	11.05	Reduct	16	10485760
402653184	11.23	Reduct	16	12582912
469762048	11.44	Reduct	16	14680064
536870912	11.33	Reduct	16	16777216

GLOBAL WORK (LOCAL SIZE 32)

Num Elements	GigaCalcs/Sec	Type	Local Size	Num Work Groups
32	0.00	Mult	32	1
64	0.00	Mult	32	2
128	0.00	Mult	32	4
256	0.01	Mult	32	8
512	0.01	Mult	32	16
1024	0.02	Mult	32	32
2048	0.04	Mult	32	64
4096	0.08	Mult	32	128
8192	0.17	Mult	32	256
16384	0.33	Mult	32	512
32768	0.66	Mult	32	1024
65536	1.29	Mult	32	2048
131072	2.27	Mult	32	4096
262144	0.95	Mult	32	8192
524288	1.87	Mult	32	16384
1048576	2.65	Mult	32	32768
2097152	3.49	Mult	32	65536
2621440	3.53	Mult	32	81920
3145728	3.72	Mult	32	98304
3670016	3.79	Mult	32	114688
4194304	3.87	Mult	32	131072
4718592	4.00	Mult	32	147456
5242880	4.12	Mult	32	163840
5767168	4.13	Mult	32	180224
6291456	4.23	Mult	32	196608
7340032	4.38	Mult	32	229376
8388608	4.42	Mult	32	262144
10485760	4.45	Mult	32	327680
12582912	4.56	Mult	32	393216
14680064	4.67	Mult	32	458752
16777216	4.67	Mult	32	524288
20971520	4.87	Mult	32	655360
25165824	5.03	Mult	32	786432
29360128	5.07	Mult	32	917504
33554432	5.20	Mult	32	1048576
41943040	5.30	Mult	32	1310720
50331648	5.34	Mult	32	1572864
58720256	5.41	Mult	32	1835008
67108864	5.48	Mult	32	2097152

83886080	5.59	Mult	32	2621440
100663296	5.70	Mult	32	3145728
117440512	5.89	Mult	32	3670016
134217728	6.29	Mult	32	4194304
167772160	6.34	Mult	32	5242880
201326592	6.37	Mult	32	6291456
234881024	6.63	Mult	32	7340032
268435456	6.65	Mult	32	8388608
335544320	7.11	Mult	32	10485760
402653184	7.23	Mult	32	12582912
469762048	7.35	Mult	32	14680064
536870912	7.36	Mult	32	16777216
32	0.00	MultAdd	32	1
64	0.00	MultAdd	32	2
128	0.00	MultAdd	32	4
256	0.01	MultAdd	32	8
512	0.01	MultAdd	32	16
1024	0.02	MultAdd	32	32
2048	0.04	MultAdd	32	64
4096	0.07	MultAdd	32	128
8192	0.15	MultAdd	32	256
16384	0.25	MultAdd	32	512
32768	0.49	MultAdd	32	1024
65536	0.94	MultAdd	32	2048
131072	1.73	MultAdd	32	4096
262144	0.90	MultAdd	32	8192
524288	1.12	MultAdd	32	16384
1048576	1.57	MultAdd	32	32768
2097152	2.04	MultAdd	32	65536
2621440	2.16	MultAdd	32	81920
3145728	2.21	MultAdd	32	98304
3670016	2.34	MultAdd	32	114688
4194304	2.38	MultAdd	32	131072
4718592	2.42	MultAdd	32	147456
5242880	2.42	MultAdd	32	163840
5767168	2.50	MultAdd	32	180224
6291456	2.53	MultAdd	32	196608
7340032	2.58	MultAdd	32	229376
8388608	2.56	MultAdd	32	262144
10485760	2.63	MultAdd	32	327680
12582912	2.68	MultAdd	32	393216
14680064	2.70	MultAdd	32	458752
16777216	2.71	MultAdd	32	524288

20971520	2.84	MultAdd	32	655360
25165824	2.92	MultAdd	32	786432
29360128	2.98	MultAdd	32	917504
33554432	3.00	MultAdd	32	1048576
41943040	3.08	MultAdd	32	1310720
50331648	3.16	MultAdd	32	1572864
58720256	3.18	MultAdd	32	1835008
67108864	3.22	MultAdd	32	2097152
83886080	3.35	MultAdd	32	2621440
100663296	3.31	MultAdd	32	3145728
117440512	3.49	MultAdd	32	3670016
134217728	3.45	MultAdd	32	4194304
167772160	3.85	MultAdd	32	5242880
201326592	3.88	MultAdd	32	6291456
234881024	3.90	MultAdd	32	7340032
268435456	3.99	MultAdd	32	8388608
335544320	4.11	MultAdd	32	10485760
402653184	4.16	MultAdd	32	12582912
469762048	4.20	MultAdd	32	14680064
536870912	5.20	MultAdd	32	16777216
32	0.00	Reduct	32	1
64	0.00	Reduct	32	2
128	0.00	Reduct	32	4
256	0.01	Reduct	32	8
512	0.00	Reduct	32	16
1024	0.00	Reduct	32	32
2048	0.01	Reduct	32	64
4096	0.01	Reduct	32	128
8192	0.03	Reduct	32	256
16384	0.06	Reduct	32	512
32768	0.13	Reduct	32	1024
65536	0.16	Reduct	32	2048
131072	0.00	Reduct	32	4096
262144	0.00	Reduct	32	8192
524288	0.00	Reduct	32	16384
1048576	0.00	Reduct	32	32768
2097152	5.49	Reduct	32	65536
2621440	6.32	Reduct	32	81920
3145728	7.27	Reduct	32	98304
3670016	7.81	Reduct	32	114688
4194304	8.45	Reduct	32	131072
4718592	9.07	Reduct	32	147456
5242880	9.28	Reduct	32	163840

5767168	9.93	Reduct	32	180224
6291456	10.15	Reduct	32	196608
7340032	10.73	Reduct	32	229376
8388608	11.74	Reduct	32	262144
10485760	12.35	Reduct	32	327680
12582912	12.99	Reduct	32	393216
14680064	14.09	Reduct	32	458752
16777216	14.46	Reduct	32	524288
20971520	14.97	Reduct	32	655360
25165824	15.36	Reduct	32	786432
29360128	15.65	Reduct	32	917504
33554432	16.14	Reduct	32	1048576
41943040	16.07	Reduct	32	1310720
50331648	16.38	Reduct	32	1572864
58720256	16.31	Reduct	32	1835008
67108864	16.87	Reduct	32	2097152
83886080	15.22	Reduct	32	2621440
100663296	18.03	Reduct	32	3145728
117440512	17.72	Reduct	32	3670016
134217728	17.82	Reduct	32	4194304
167772160	18.61	Reduct	32	5242880
201326592	19.72	Reduct	32	6291456
234881024	19.38	Reduct	32	7340032
268435456	20.01	Reduct	32	8388608
335544320	21.66	Reduct	32	10485760
402653184	20.29	Reduct	32	12582912
469762048	22.46	Reduct	32	14680064
536870912	22.52	Reduct	32	16777216

LOCAL WORK

Local Size	Num Work Groups	GigaCalcs/Sec	Type
1	67108864	0.596	Mult
2	33554432	1.083	Mult
4	16777216	1.897	Mult
8	8388608	3.038	Mult
16	4194304	4.346	Mult
32	2097152	5.527	Mult
64	1048576	6.072	Mult
128	524288	6.086	Mult
256	262144	6.07	Mult
512	131072	6.084	Mult
1024	65536	6.097	Mult
1	67108864	0.622	MultAdd
2	33554432	1.089	MultAdd
4	16777216	1.792	MultAdd
8	8388608	2.525	MultAdd
16	4194304	3.391	MultAdd
32	2097152	3.557	MultAdd
64	1048576	3.631	MultAdd
128	524288	3.433	MultAdd
256	262144	3.632	MultAdd
512	131072	3.601	MultAdd
1024	65536	3.555	MultAdd
1	67108864	0.663	Reduct
2	33554432	1.334	Reduct
4	16777216	2.716	Reduct
8	8388608	4.971	Reduct
16	4194304	9.563	Reduct
32	2097152	17.27	Reduct
64	1048576	8.835	Reduct
128	524288	13.593	Reduct
256	262144	9.883	Reduct
512	131072	9.426	Reduct
1024	65536	6.977	Reduct