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Linux 4.19 I/O Scheduler Performance

Linux I/O scheduler benchmarks for a future article on Phoronix.com.

Automated Executive Summary

Deadline had the most wins, coming in first place for 31% of the tests.

Based on the geometric mean of all complete results, the fastest (Deadline) was 1.238x the speed of the slowest (MQ Deadline). BFQ was 0.971x the speed of Deadline, CFQ was 0.972x the speed of BFQ, Kyber was 0.916x the speed of CFQ, Noop was 0.983x the speed of Kyber, MQ None was 0.964x the speed of Noop, BFQ low_latency was 0.996x the speed of MQ None, MQ Deadline was 0.99x the speed of BFQ low_latency.

The results with the greatest spread from best to worst included:

Flexible IO Tester (Type: Random Read - IO Engine: Linux AIO - Buffered: No - Direct: Yes - Block Size: 2MB - Disk Target: Default Test Directory) at 2.146x
FS-Mark (Test: 4000 Files, 32 Sub Dirs, 1MB Size) at 1.559x
Flexible IO Tester (Type: Sequential Read - IO Engine: Linux AIO - Buffered: No - Direct: Yes - Block Size: 2MB - Disk Target: Default Test Directory) at 1.516x
Flexible IO Tester (Type: Sequential Write - IO Engine: Linux AIO - Buffered: No - Direct: Yes - Block Size: 2MB - Disk Target: Default Test Directory) at 1.318x
Flexible IO Tester (Type: Sequential Read - IO Engine: Linux AIO - Buffered: No - Direct: Yes - Block Size: 4KB - Disk

Target: Default Test Directory) at 1.306x
Flexible IO Tester (Type: Sequential Read - IO Engine: Linux AIO - Buffered: No - Direct: Yes - Block Size: 4KB - Disk Target: Default Test Directory) at 1.305x
Flexible IO Tester (Type: Random Read - IO Engine: Linux AIO - Buffered: No - Direct: Yes - Block Size: 4KB - Disk Target: Default Test Directory) at 1.166x
Flexible IO Tester (Type: Random Read - IO Engine: Linux AIO - Buffered: No - Direct: Yes - Block Size: 4KB - Disk Target: Default Test Directory) at 1.159x
BlogBench (Test: Read) at 1.141x
Flexible IO Tester (Type: Random Write - IO Engine: Linux AIO - Buffered: No - Direct: Yes - Block Size: 4KB - Disk Target: Default Test Directory) at 1.123x.

Test Systems:

CFQ

Processor: 2 x AMD EPYC 7601 32-Core (64 Cores / 128 Threads), Motherboard: Dell 02MJ3T (1.2.5 BIOS), Chipset: AMD Family 17h, Memory: 16 x 32 GB DDR4-2400MT/s 36ASF4G72PZ-2G6D2, Disk: 120GB SSDSCKJB120G7R + 20 x 500GB Samsung SSD 860, Graphics: Matrox G200eW3, Monitor: VE228, Network: Broadcom BCM57416 NetXtreme-E Dual-Media 10G RDMA

OS: Ubuntu 18.10, Kernel: 4.19.0-041900-generic (x86_64), Compiler: GCC 8.2.0 + Clang 7.0.0-3 + LLVM 7.0.0, File-System: ext4, Screen Resolution: 1600x1200

Compiler Notes: --build=x86_64-linux-gnu --disable-vtable-verify --disable-werror --enable-checking=release --enable-clocale=gnu --enable-default-pie --enable-gnu-unique-object --enable-languages=c,ada,c++,go,brig,d,fortran,objc,obj-c++ --enable-libmpx --enable-libstdcxx-debug --enable-libstdcxx-time=yes --enable-multiarch --enable-multilib --enable-nls --enable-objc-gc=auto --enable-offload-targets=nvptx-none --enable-plugin --enable-shared --enable-threads=posix --host=x86_64-linux-gnu --program-prefix=x86_64-linux-gnu- --target=x86_64-linux-gnu --with-abi=m64 --with-arch-32=i686 --with-default-libstdcxx-abi=new --with-gcc-major-version-only --with-multilib-list=m32,m64,mx32 --with-target-system-zlib --with-tune=generic --without-cuda-driver -v
Disk Notes: CFQ / relatime,rw
Python Notes: Python 2.7.15+ + Python 3.6.7
Security Notes: __user pointer sanitization + Full AMD retpoline IBPB + SSB disabled via prctl and seccomp

Deadline

Processor: 2 x AMD EPYC 7601 32-Core (64 Cores / 128 Threads), Motherboard: Dell 02MJ3T (1.2.5 BIOS), Chipset: AMD Family 17h, Memory: 16 x 32 GB DDR4-2400MT/s 36ASF4G72PZ-2G6D2, Disk: 20 x 500GB Samsung SSD 860 + 120GB SSDSCKJB120G7R, Graphics: Matrox G200eW3, Monitor: VE228, Network: Broadcom BCM57416 NetXtreme-E Dual-Media 10G RDMA

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Disk Notes: DEADLINE / relatime,rw
Python Notes: Python 2.7.15+ + Python 3.6.7
Security Notes: __user pointer sanitization + Full AMD retpoline IBPB + SSB disabled via prctl and seccomp

Linux 4.19 I/O Scheduler Performance

Noop

MQ None

BFQ low_latency

BFQ

Kyber

MQ Deadline

Processor: 2 x AMD EPYC 7601 32-Core (64 Cores / 128 Threads), Motherboard: Dell 02MJ3T (1.2.5 BIOS), Chipset: AMD Family 17h, Memory: 16 x 32 GB DDR4-2400MT/s 36ASF4G72PZ-2G6D2, Disk: 120GB SSDSCKJB120G7R + 20 x 500GB Samsung SSD 860, Graphics: Matrox G200eW3, Monitor: VE228, Network: Broadcom BCM57416 NetXtreme-E Dual-Media 10G RDMA

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Disk Notes: MQ-DEADLINE / relatime,rw
Python Notes: Python 2.7.15+ + Python 3.6.7
Security Notes: __user pointer sanitization + Full AMD retpoline IBPB + SSB disabled via prctl and seccomp

	CFQ	Deadline	Noop	MQ None	BFQ low_latenc	BFQ	Kyber	MQ Deadline
PostgreSQL pgbench - Buffer Test - Normal Load - Read Write	3656	**5074**	2554	**2089**	3406	4837	2303	2453
Normalized	72.05%	100%	50.34%	41.17%	67.13%	95.33%	45.39%	48.34%
Standard Deviation	32.4%	1.5%	20.9%	11.4%	19.7%	1.1%	42.8%	11.6%
PostgreSQL pgbench - Buffer Test - Normal Load - Read Only (TPS)	519438	**552470**	533709	533463	519792	545719	**497899**	506397
Normalized	94.02%	100%	96.6%	96.56%	94.09%	98.78%	90.12%	91.66%
Standard Deviation	8.2%	1.8%	1.6%	0.4%	4.6%	3.2%	10.2%	10.1%
BlogBench - Read (Final Score)	748396	736143	**705847**	795075	785541	**805148**	780536	783446
Normalized	92.95%	91.43%	87.67%	98.75%	97.56%	100%	96.94%	97.3%
Standard Deviation	2.8%	3.4%	6.2%	1.2%	1.7%	1.4%	0.8%	3.4%
FS-Mark - 5.F.1.S.4.T (Files/s)	181	173	178	140	131	181	**183**	**123**
Normalized	98.91%	94.54%	97.27%	76.5%	71.58%	98.91%	100%	67.21%
Standard Deviation	10.9%	0.1%	0.6%	17.3%	17.7%	9.9%	0.3%	25.3%

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Timed GCC Compilation - Time To	806	803	**807**	800	804	800	804	**796**
Normalized	98.76%	99.13%	98.64%	99.5%	99%	99.5%	99%	100%
SQLite - T.S.I (sec)	**33.17**	34.20	77.10	68.29	75.05	57.32	69.11	**77.52**
Normalized	100%	96.99%	43.02%	48.57%	44.2%	57.87%	48%	42.79%
Standard Deviation	0.2%	0.1%	39%	43.7%	35.6%	1.9%	42.2%	39.1%
Compile Bench - Compile (MB/s)	**1554**	1576	1568	1571	**1591**	1575	1577	1577
Normalized	97.67%	99.06%	98.55%	98.74%	100%	98.99%	99.12%	99.12%
Standard Deviation	5.8%	2%	0.4%	1.1%	2.5%	3%	1.1%	1%
Timed Linux Kernel Compilation - Time To Compile (sec)	26.38	**26.37**	26.48	**26.50**	26.49	26.43	26.42	26.44
Normalized	99.96%	100%	99.58%	99.51%	99.55%	99.77%	99.81%	99.74%
Standard Deviation	3.4%	4.2%	3.9%	3.7%	3.9%	3.6%	3.4%	3.8%
FS-Mark - 4.F.3.S.D.1.S (Files/s)	86.70	84.47	81.80	**57.20**	66.93	83.83	**89.17**	67.38
Normalized	97.23%	94.73%	91.73%	64.15%	75.06%	94.01%	100%	75.56%
Standard Deviation	0.1%	0.2%	3.2%	3%	9.1%	0.1%	0.1%	9.2%
Flexible IO Tester - Rand Write - Linux AIO - No - Yes - 2MB (MB/s)	391	**403**	310	280	**223**	379	311	243
Normalized	97.02%	100%	76.92%	69.48%	55.33%	94.04%	77.17%	60.3%
Standard Deviation	1.8%	3.2%	0.9%	9%	20.1%	1.7%		17.8%
Flexible IO Tester - Rand Write - Linux AIO - No - Yes - 4KB (IOPS)	**60767**	60600	60633	58067	**54280**	60333	60533	57733
Normalized	100%	99.73%	99.78%	95.56%	89.32%	99.29%	99.61%	95.01%
Standard Deviation	0.8%		0.9%	0.8%	3.7%	0.8%	0.3%	3.3%
Flexible IO Tester - Rand Write - Linux AIO - No - Yes - 4KB (MB/s)	237	237	**238**	227	**212**	236	236	226
Normalized	99.58%	99.58%	100%	95.38%	89.08%	99.16%	99.16%	94.96%
Standard Deviation	0.9%			0.9%	3.6%	0.6%		3.3%
FS-Mark - 1.F.1.S (Files/s)	**174**	173	91.30	64.43	61.33	168.23	91.68	**59.23**
Normalized	100%	99.43%	52.47%	37.03%	35.25%	96.68%	52.69%	34.04%
Standard Deviation	0.1%	0.2%	23.8%	11.5%	13%	0.5%	8.1%	14.1%
Flexible IO Tester - Seq Write - Linux AIO - No - Yes - 2MB (MB/s)	405	**410**	318	**311**	312	386	312	313
Normalized	98.78%	100%	77.56%	75.85%	76.1%	94.15%	76.1%	76.34%
Standard Deviation	1.6%	0.3%	0.2%	0.2%	0.4%	3.2%	0.5%	1%
Flexible IO Tester - Seq Read - Linux AIO - No - Yes - 2MB (MB/s)	**382**	**382**	253	**252**	**252**	381	253	**252**
Normalized	100%	100%	66.23%	65.97%	65.97%	99.74%	66.23%	65.97%
Flexible IO Tester - Rand Read - Linux AIO - No - Yes - 2MB (MB/s)	**253**	542	542	**543**	**543**	542	**543**	**543**
Normalized	46.59%	99.82%	99.82%	100%	100%	99.82%	100%	100%
Standard Deviation	0.2%						0.1%	

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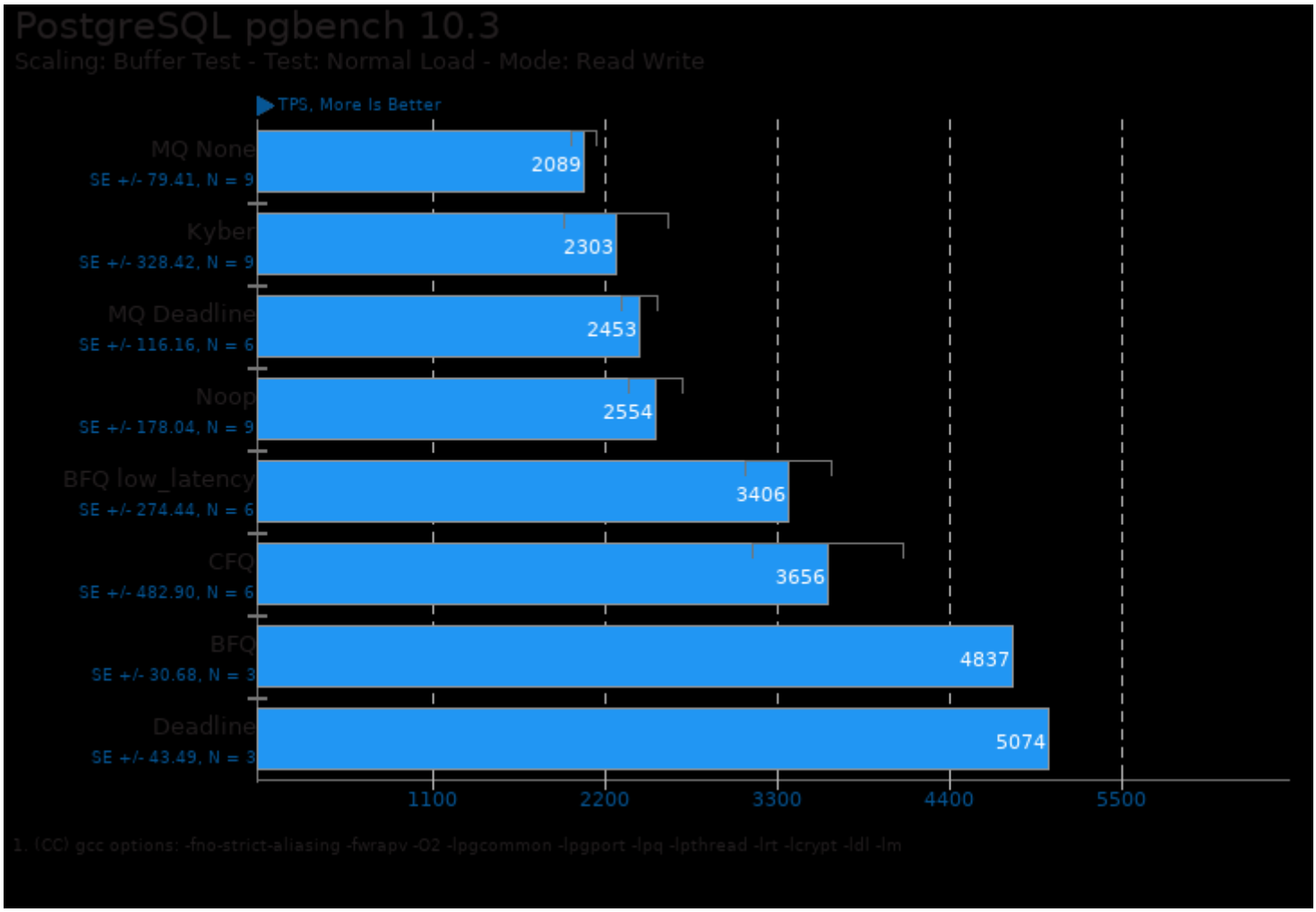
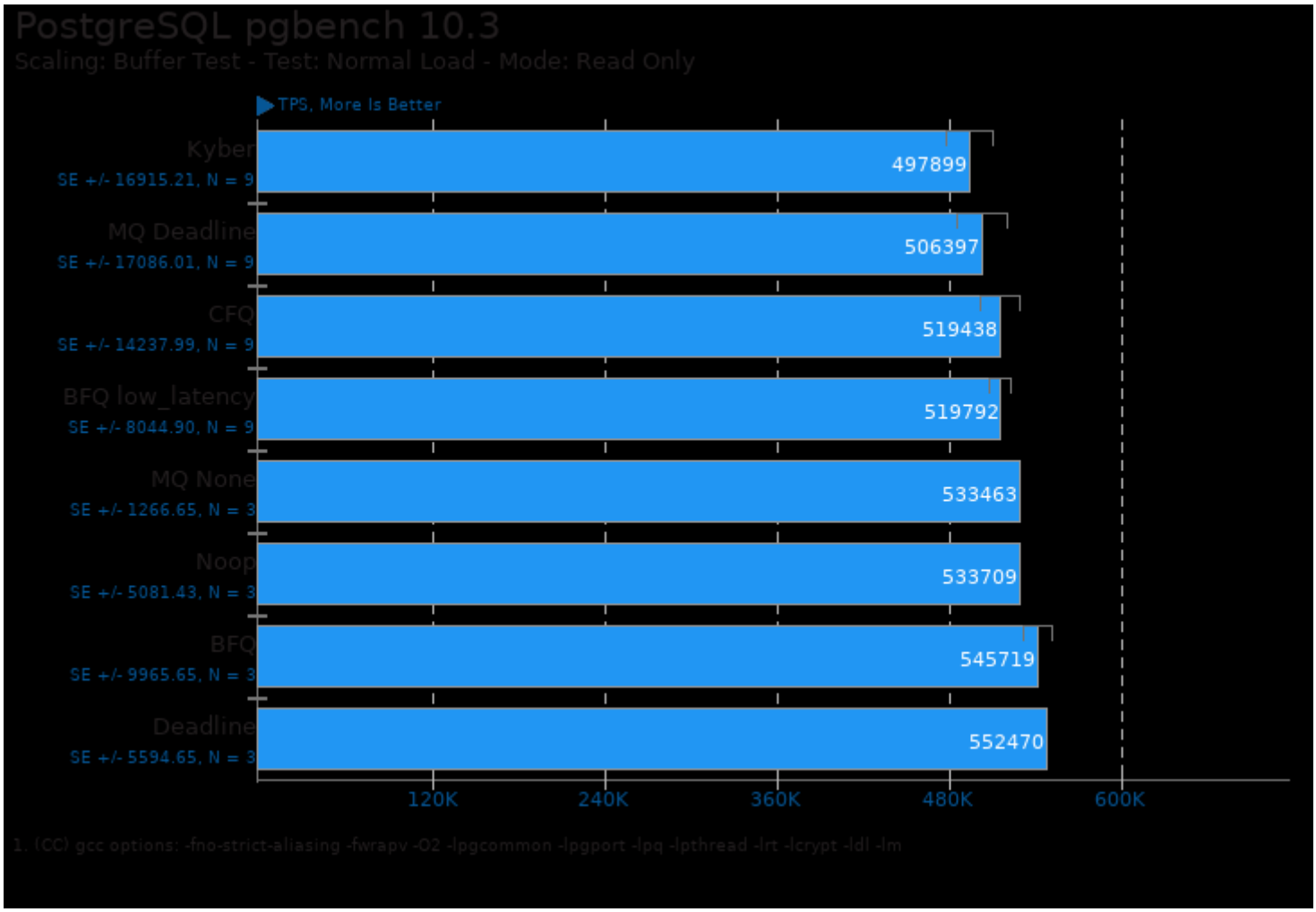
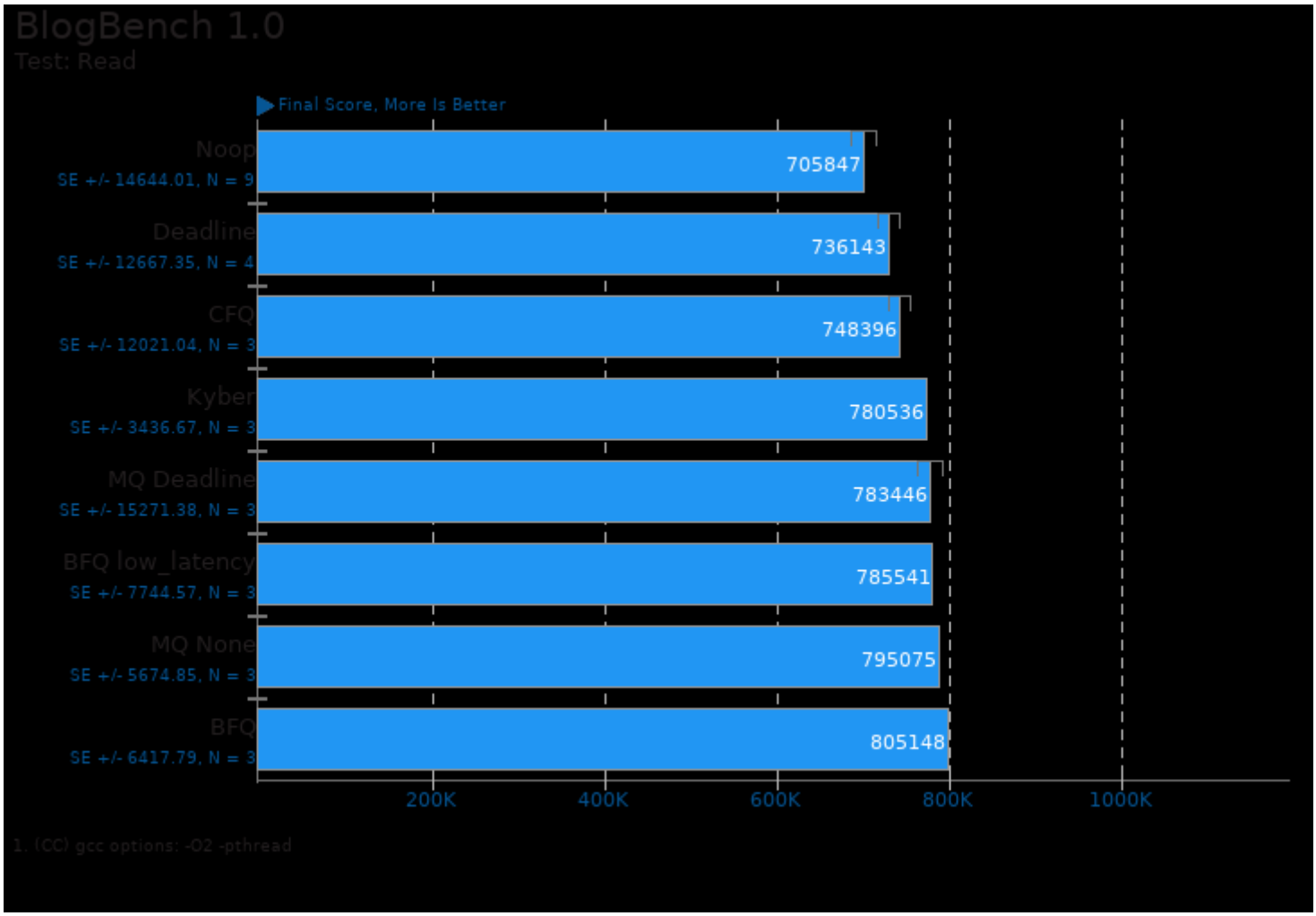
Flexible IO Tester - Seq Write - Linux AIO - No - Yes - 4KB (IOPS)	80167	**80567**	79100	79167	79300	80233	**78567**	78767
Normalized	99.5%	100%	98.18%	98.26%	98.43%	99.59%	97.52%	97.77%
Standard Deviation	1.3%	0.9%		0.3%	0.5%	1.4%	0.7%	0.8%
Flexible IO Tester - Seq Write - Linux AIO - No - Yes - 4KB (MB/s)	313	**315**	309	309	310	313	308	**307**
Normalized	99.37%	100%	98.1%	98.1%	98.41%	99.37%	97.78%	97.46%
Standard Deviation	1.2%	1%		0.4%		1.4%	0.4%	0.8%
Flexible IO Tester - Seq Read - Linux AIO - No - Yes - 4KB (IOPS)	82567	82833	64800	**64600**	64633	**84300**	64700	**64600**
Normalized	97.94%	98.26%	76.87%	76.63%	76.67%	100%	76.75%	76.63%
Standard Deviation	0.3%	0.5%			0.1%	1.3%		
Flexible IO Tester - Seq Read - Linux AIO - No - Yes - 4KB (MB/s)	322	324	253	**252**	253	**329**	253	**252**
Normalized	97.87%	98.48%	76.9%	76.6%	76.9%	100%	76.9%	76.6%
Standard Deviation		0.5%				1.2%		
Flexible IO Tester - Rand Read - Linux AIO - No - Yes - 4KB (IOPS)	72667	**80200**	69500	69133	69500	**68767**	70467	69700
Normalized	90.61%	100%	86.66%	86.2%	86.66%	85.74%	87.86%	86.91%
Standard Deviation	0.1%			0.1%		1%	0.1%	0.2%
Flexible IO Tester - Rand Read - Linux AIO - No - Yes - 4KB (MB/s)	284	**313**	271	**270**	272	**270**	275	272
Normalized	90.73%	100%	86.58%	86.26%	86.9%	86.26%	87.86%	86.9%
Standard Deviation					0.2%	0.2%		
FS-Mark - 1.F.1.S.N.S.F (Files/s)	**1890**	1896	1897	**1920**	1918	1896	1909	1893
Normalized	98.44%	98.75%	98.8%	100%	99.9%	98.75%	99.43%	98.59%
Standard Deviation	0.4%	0.4%	0.5%	0.9%	1.2%	0.8%	0.8%	0.5%
Compile Bench - Read Compiled Tree (MB/s)	**881**	938	968	**972**	960	969	949	955
Normalized	90.64%	96.5%	99.59%	100%	98.77%	99.69%	97.63%	98.25%
Standard Deviation	17.4%	3%	0.1%	0.1%	1.9%	2.4%	6.1%	1.8%
Compile Bench - Initial Create (MB/s)	**370**	388	391	**396**	394	387	390	389
Normalized	93.43%	97.98%	98.74%	100%	99.49%	97.73%	98.48%	98.23%
Standard Deviation	6.6%	2.3%	0.2%	1%	1.3%	2.1%	1.5%	2%
BlogBench - Write (Final Score)	23547	22817	**21485**	27320	22512	24163	**27492**	26342
Normalized	85.65%	83%	78.15%	99.37%	81.89%	87.89%	100%	95.82%
Standard Deviation	11.7%	13.1%	12.4%	2.4%	22.6%	17.1%	1.7%	7.5%

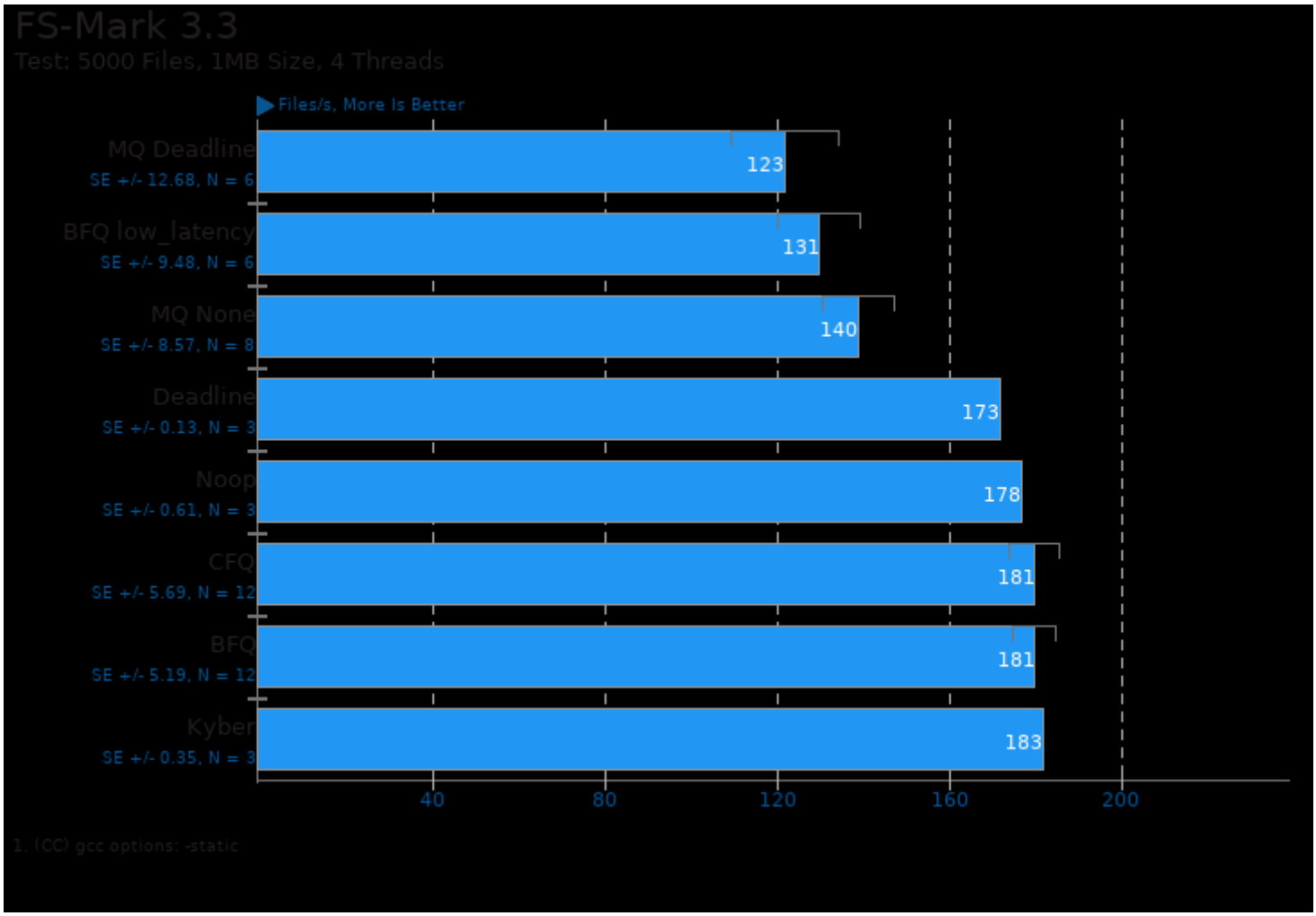

PostgreSQL pgbench 10.3
Scaling: Buffer Test - Test: Normal Load - Mode: Read Write
TPS, More Is Better
MQ None
SE +/- 79.41, N = 9
2089
Kyber
SE +/- 328.42, N = 9
2303
MQ Deadline
SE +/- 116.16, N = 6
2453
Noop
SE +/- 178.04, N = 9
2554
BFQ low_latency
SE +/- 274.44, N = 6
3406
CFQ
SE +/- 482.90, N = 6
3656
BFQ
SE +/- 30.68, N = 3
4837
Deadline
SE +/- 43.49, N = 3
5074
1100
2200
3300
4400
5500
1. (CC) gcc options: -fno-strict-aliasing -fwrapv -O2 -lpgcommon -lpgport -lpq -lpthread -lrt -lcrypt -ldl -lm

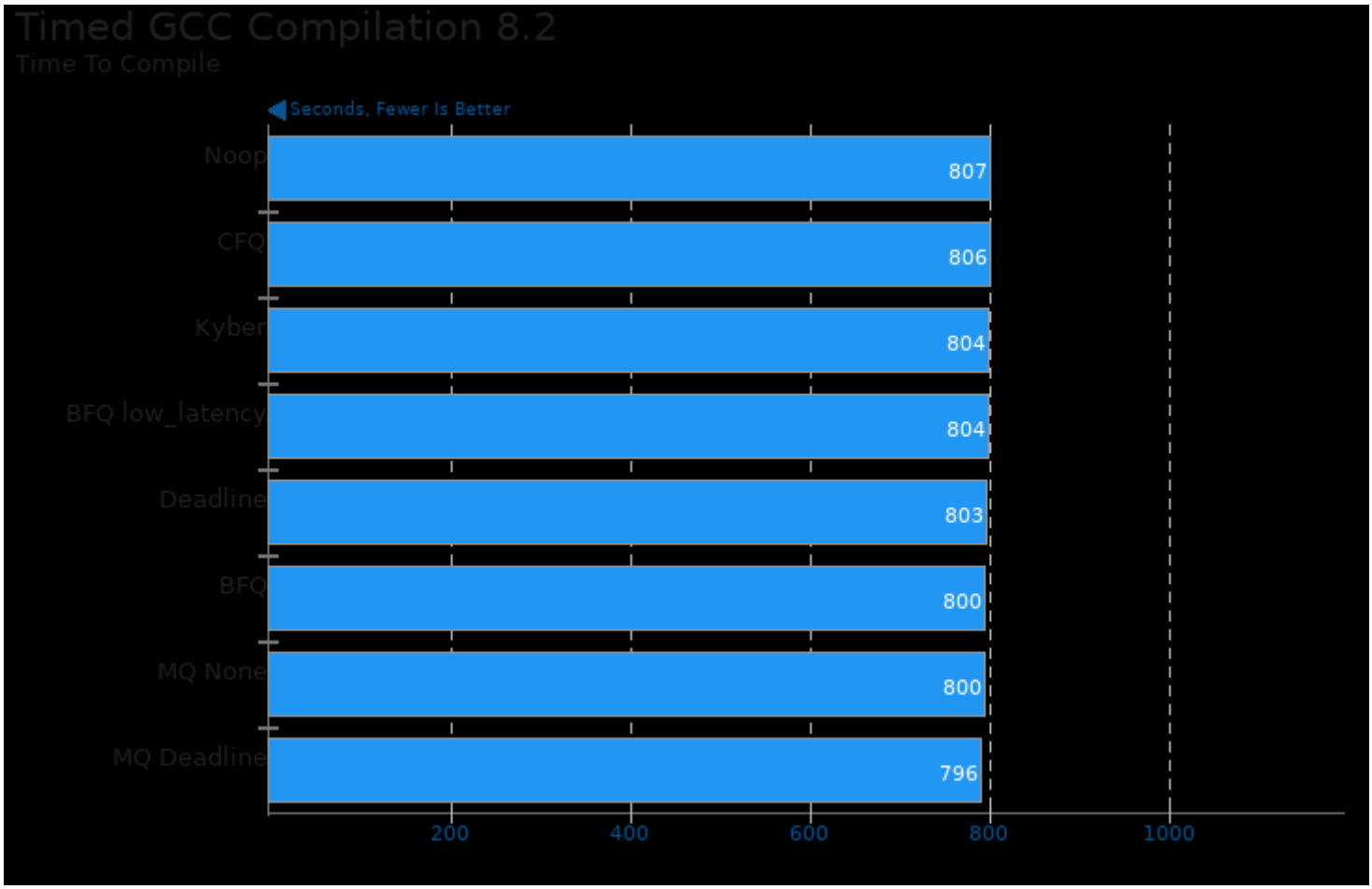

PostgreSQL pgbench 10.3
Scaling: Buffer Test - Test: Normal Load - Mode: Read Only
TPS, More Is Better
Kyber
SE +/- 16915.21, N = 9
497899
MQ Deadline
SE +/- 17086.01, N = 9
506397
CFQ
SE +/- 14237.99, N = 9
519438
BFQ low_latency
SE +/- 8044.90, N = 9
519792
MQ None
SE +/- 1266.65, N = 3
533463
Noop
SE +/- 5081.43, N = 3
533709
BFQ
SE +/- 9965.65, N = 3
545719
Deadline
SE +/- 5594.65, N = 3
552470
120K
240K
360K
480K
600K
1. (CC) gcc options: -fno-strict-aliasing -fwrapv -O2 -lpgcommon -lpgport -lpq -lpthread -lrt -lcrypt -ldl -lm

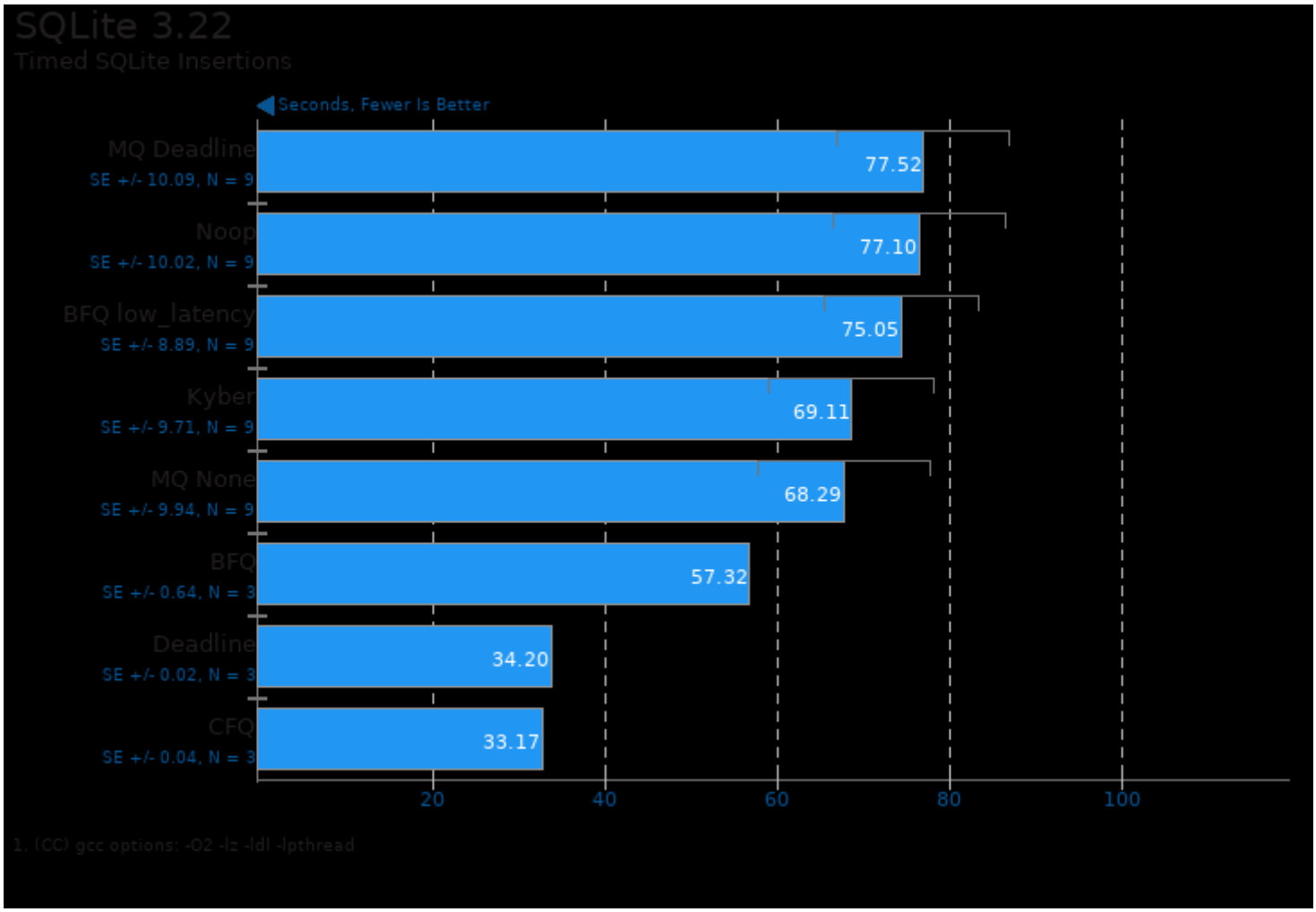
Linux 4.19 I/O Scheduler Performance



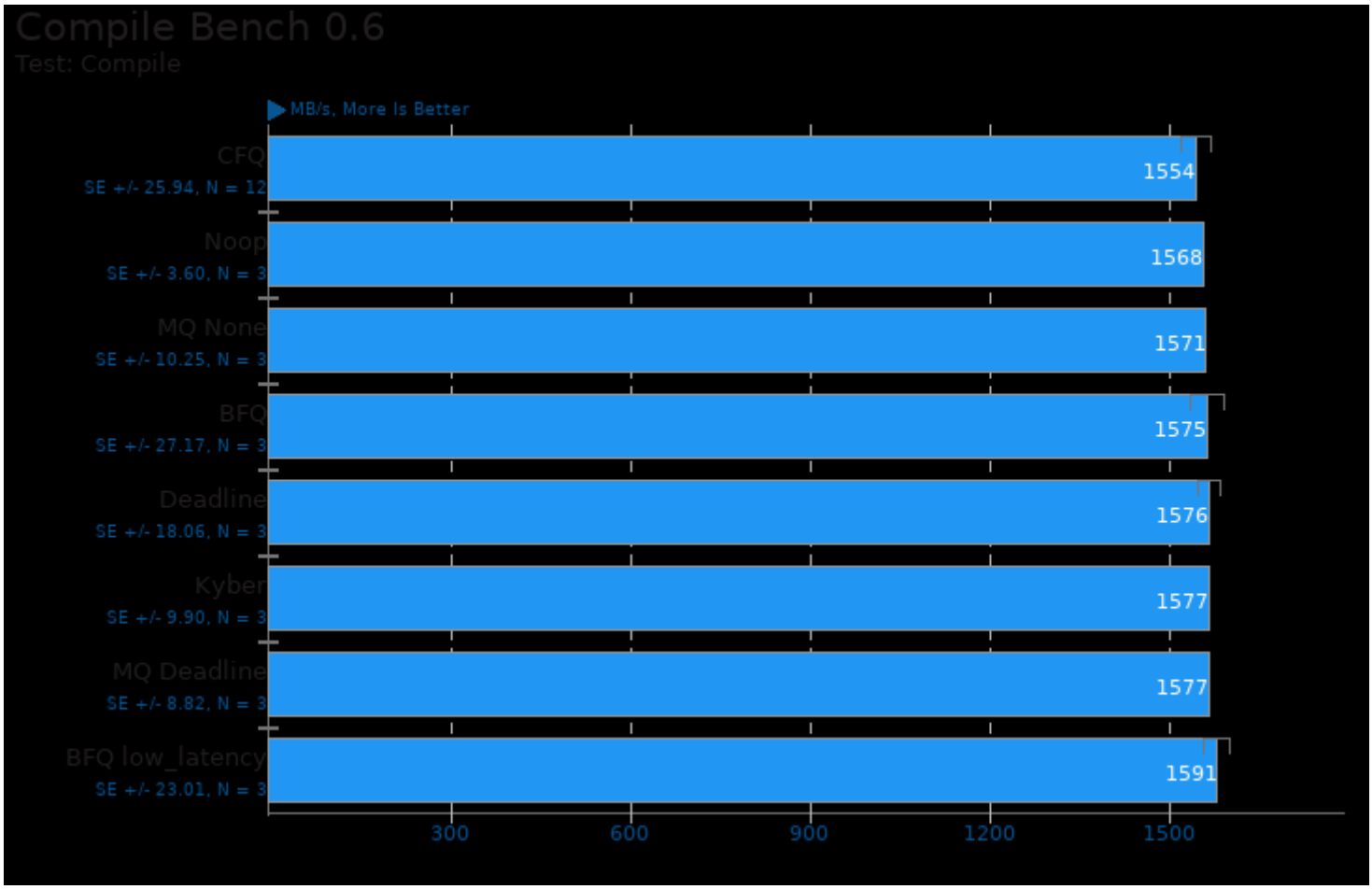
Linux 4.19 I/O Scheduler Performance




Timed GCC Compilation 8.2
Time To Compile
Seconds, Fewer Is Better
Noop
807
CFQ
806
Kyber
804
BFQ low_latency
804
Deadline
803
BFQ
800
MQ None
800
MQ Deadline
796
200
400
600
800
1000


SQLite 3.22
Timed SQLite Insertions
Seconds, Fewer Is Better
MQ Deadline
SE +/- 10.09, N = 9
77.52
Noop
SE +/- 10.02, N = 9
77.10
BFQ low_latency
SE +/- 8.89, N = 9
75.05
Kyber
SE +/- 9.71, N = 9
69.11
MQ None
SE +/- 9.94, N = 9
68.29
BFQ
SE +/- 0.64, N = 3
57.32
Deadline
SE +/- 0.02, N = 3
34.20
CFQ
SE +/- 0.04, N = 3
33.17
20
40
60
80
100
1. (CC) gcc options: -O2 -lz -ldl -lpthread

Linux 4.19 I/O Scheduler Performance



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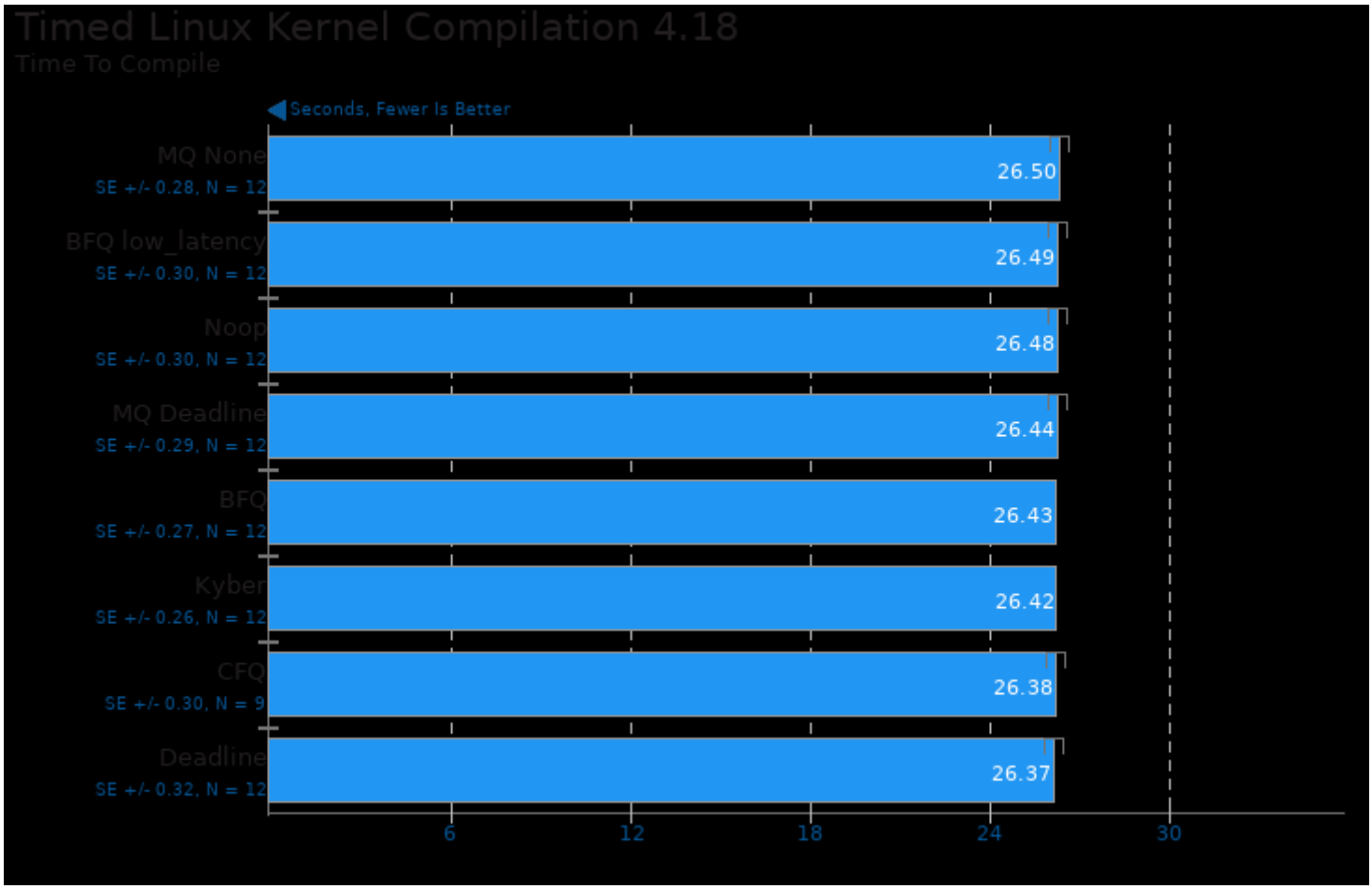

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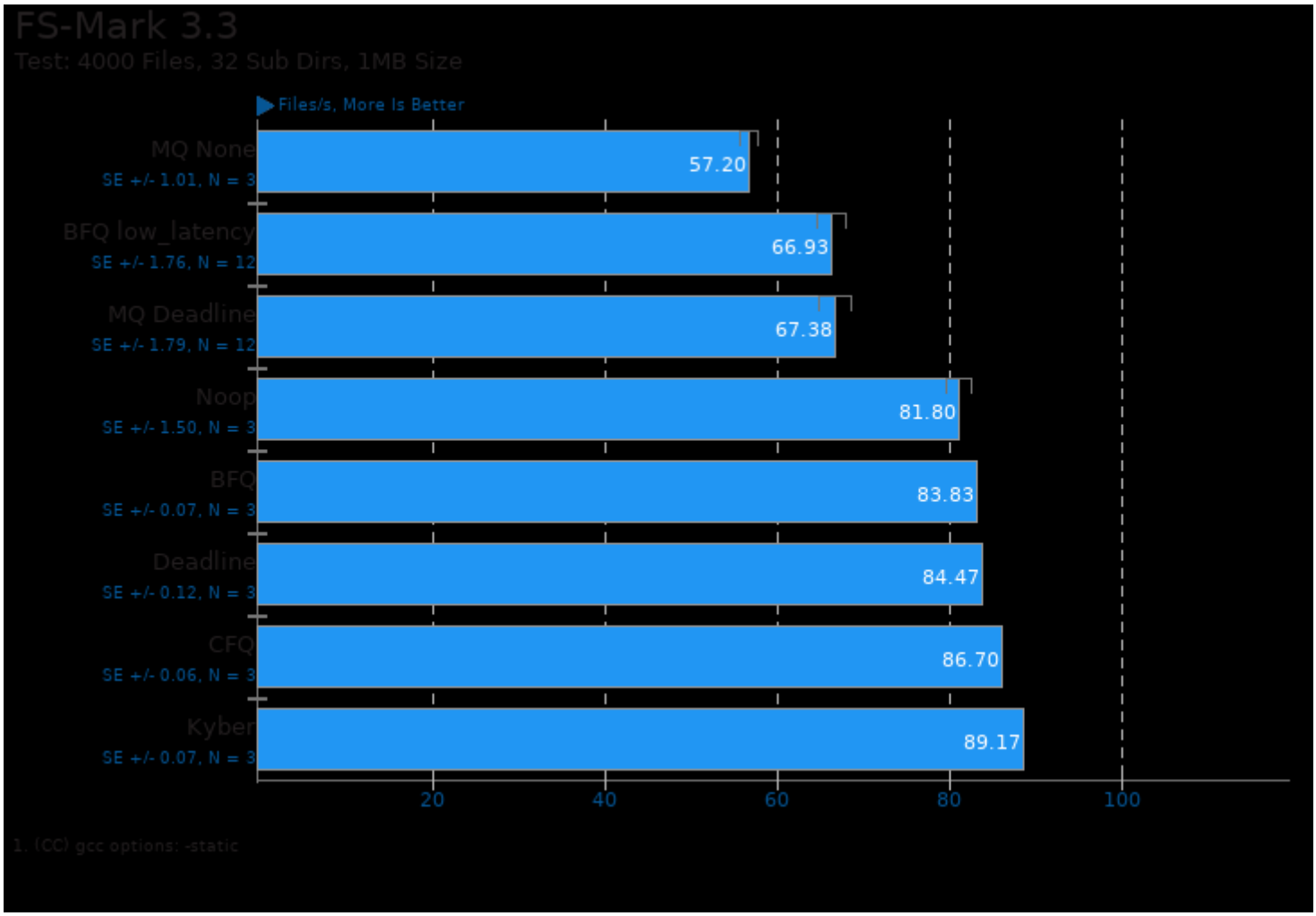

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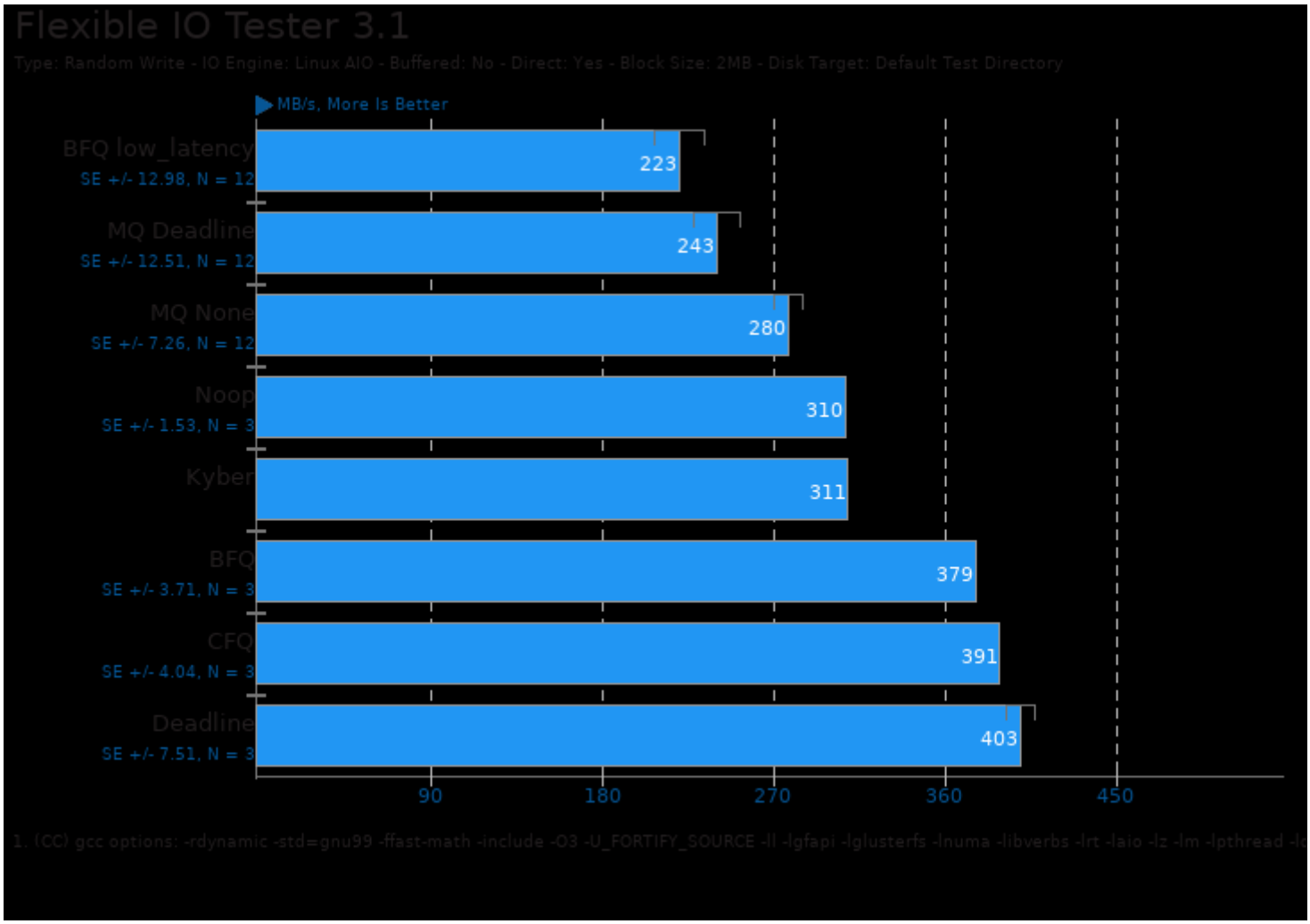

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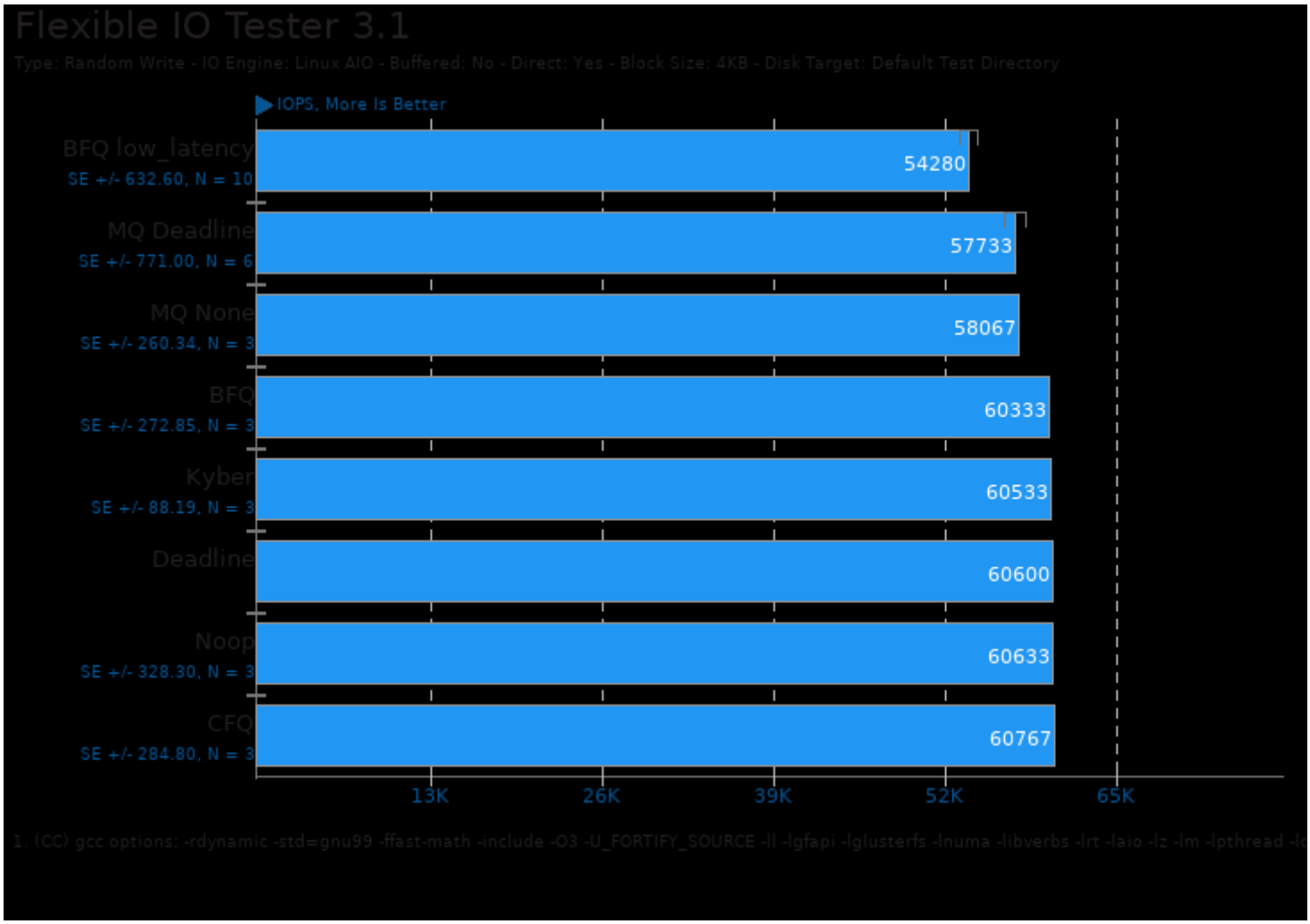

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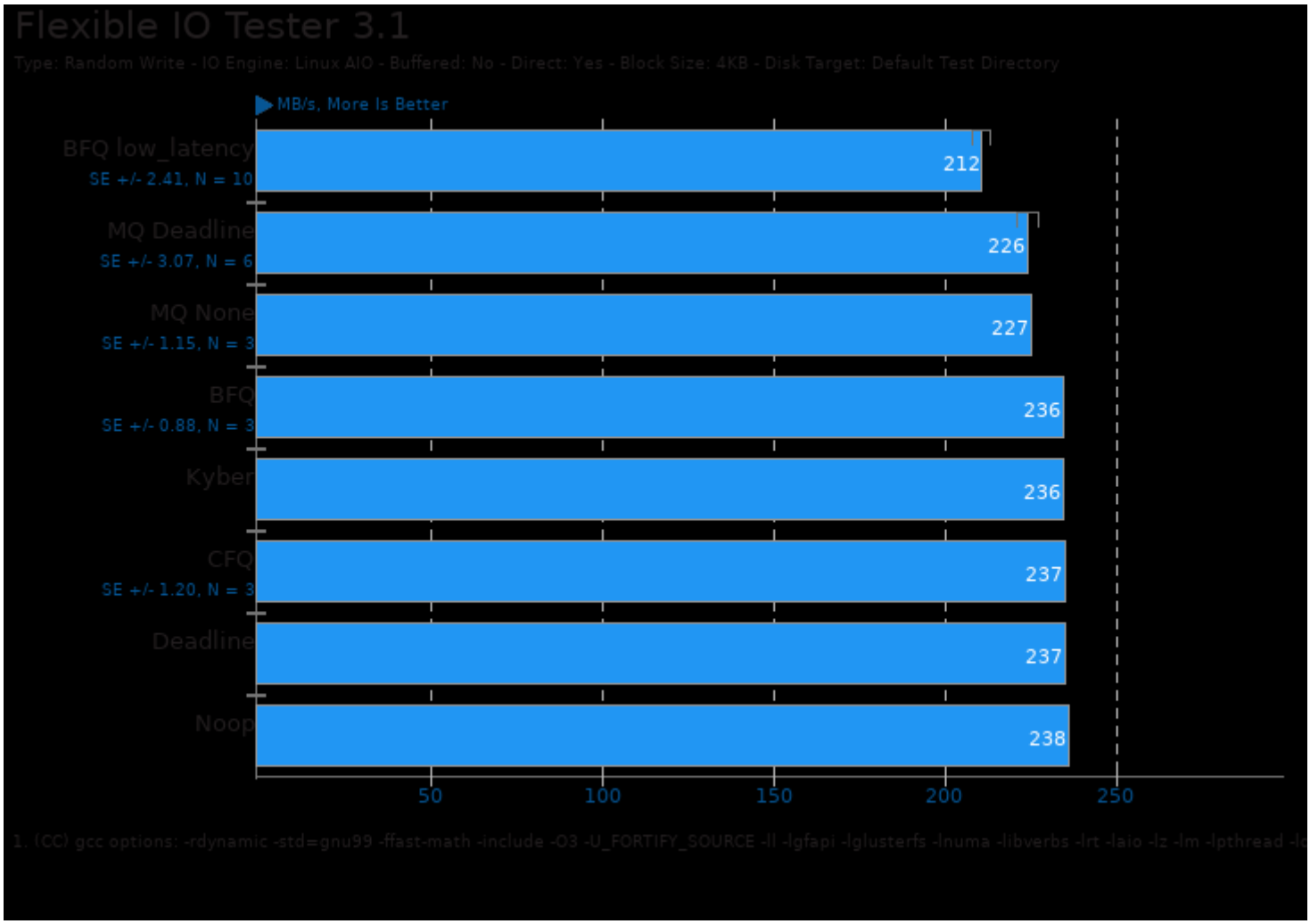
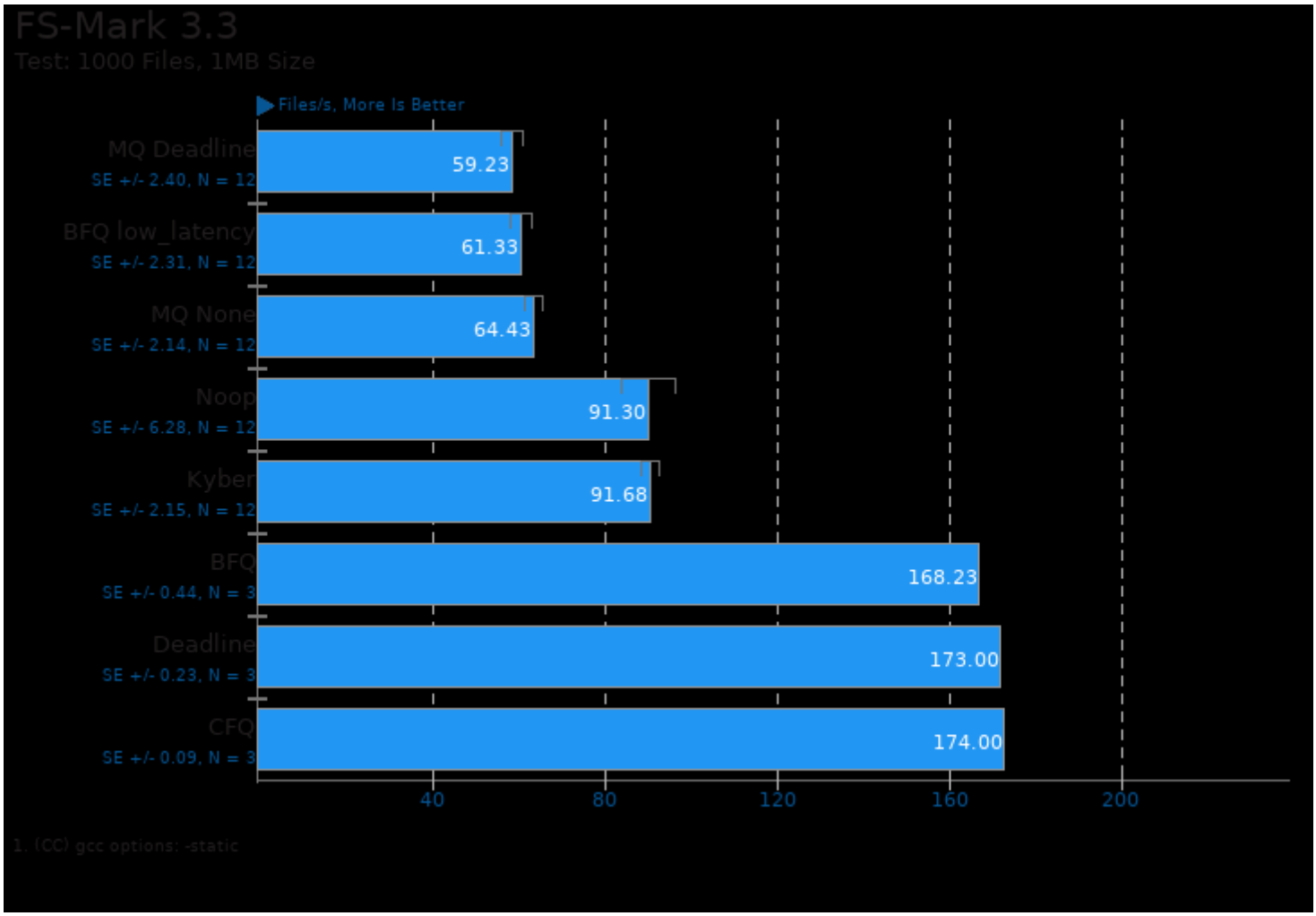
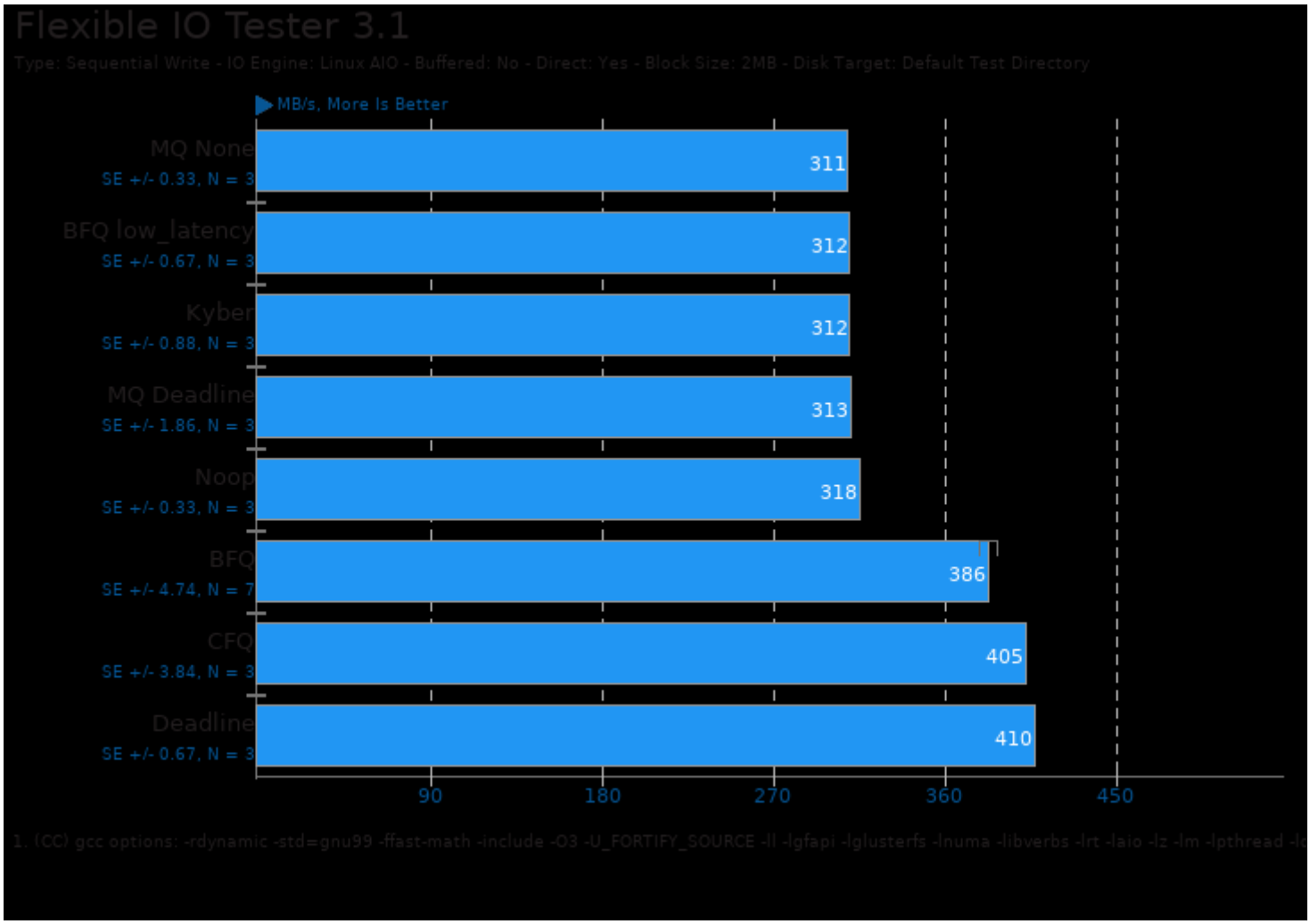


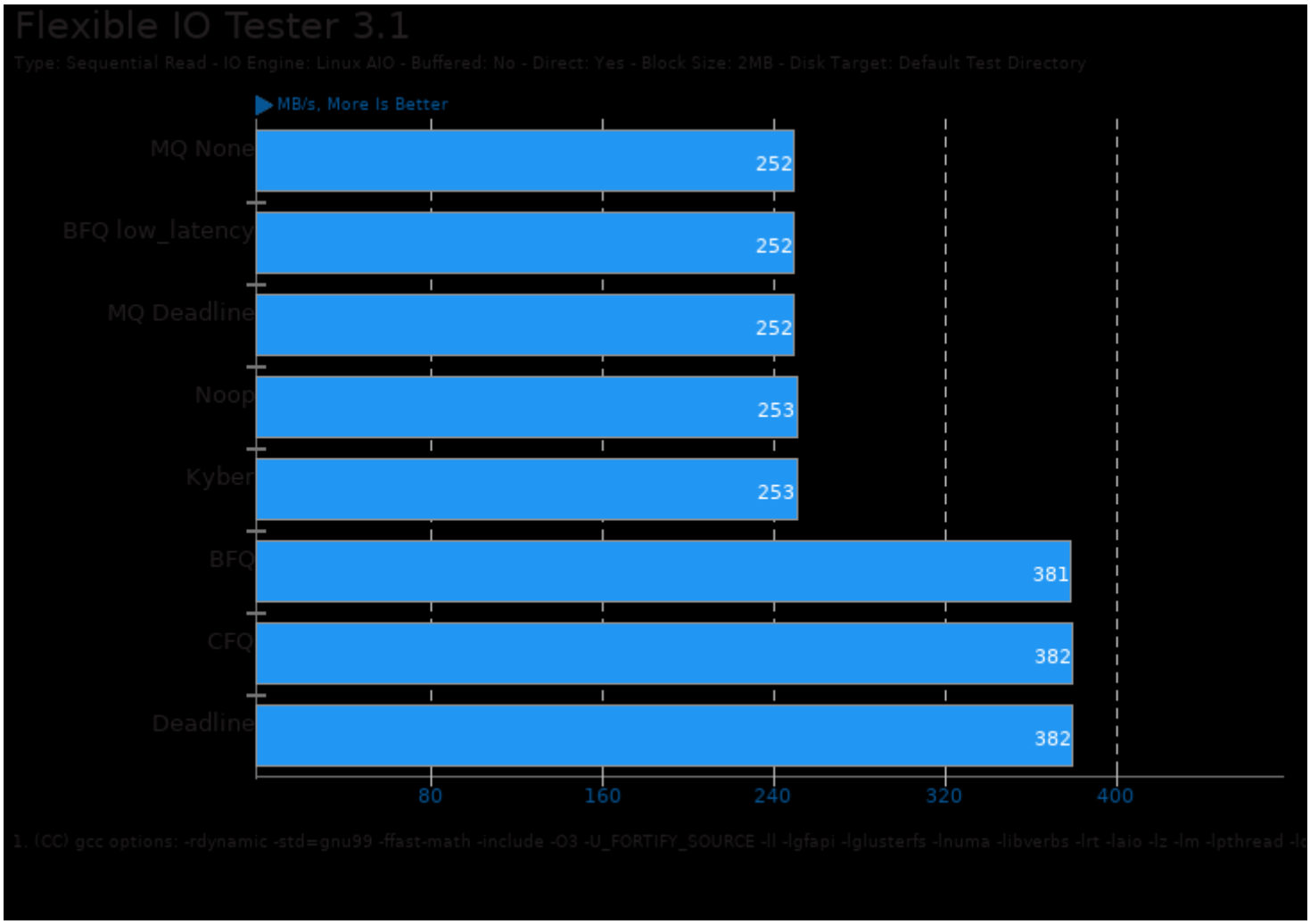
Linux 4.19 I/O Scheduler Performance



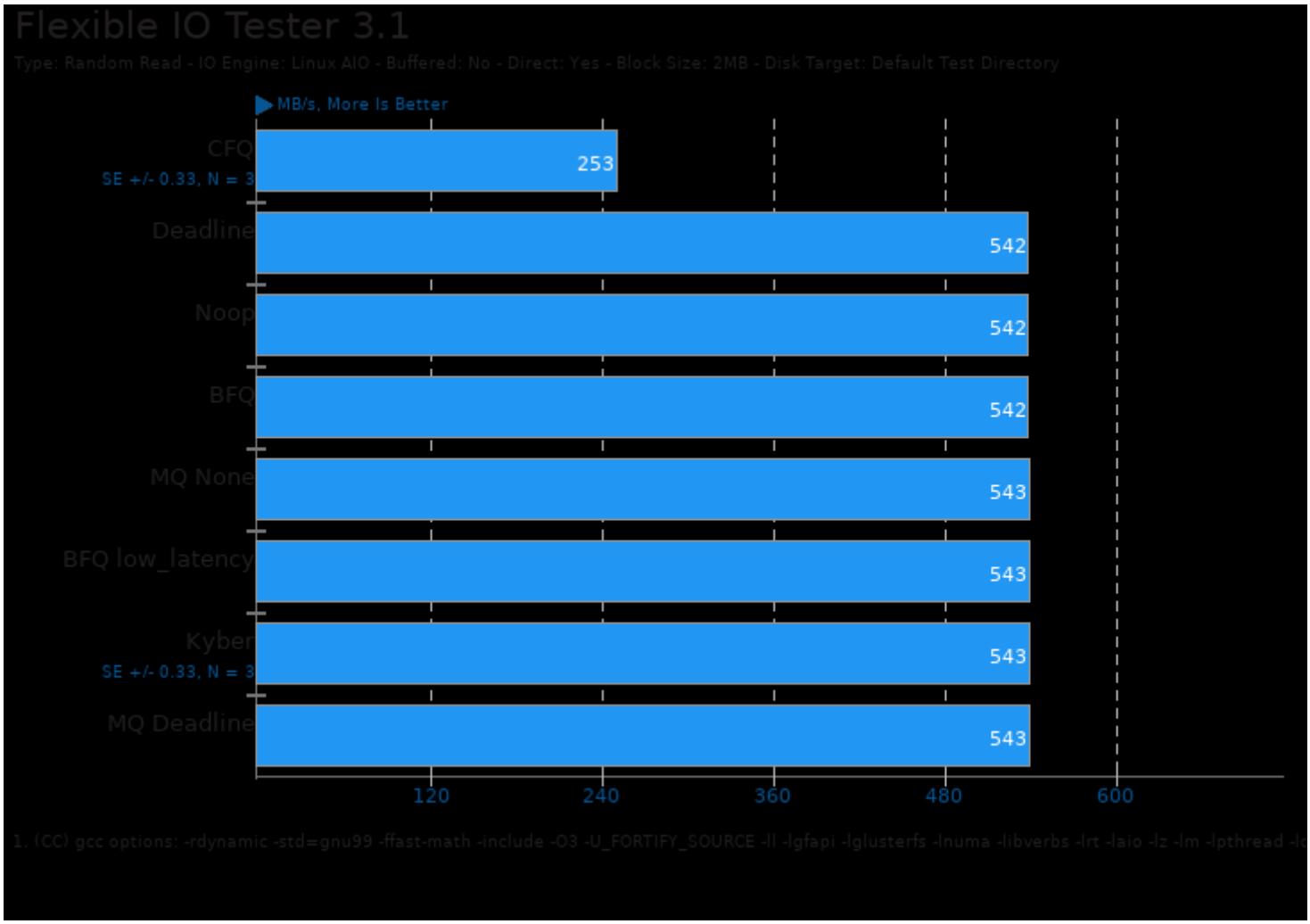
Linux 4.19 I/O Scheduler Performance



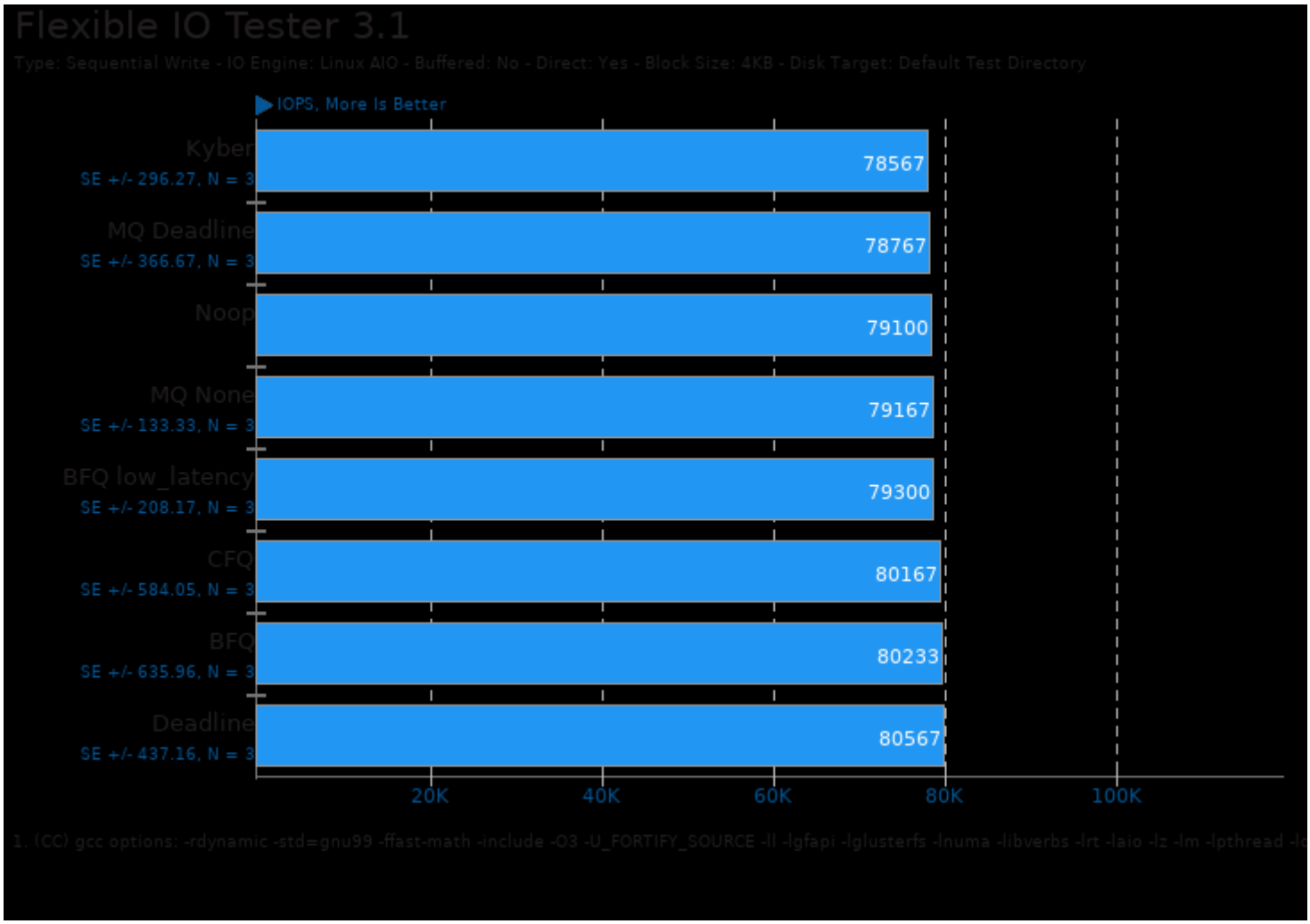
Linux 4.19 I/O Scheduler Performance



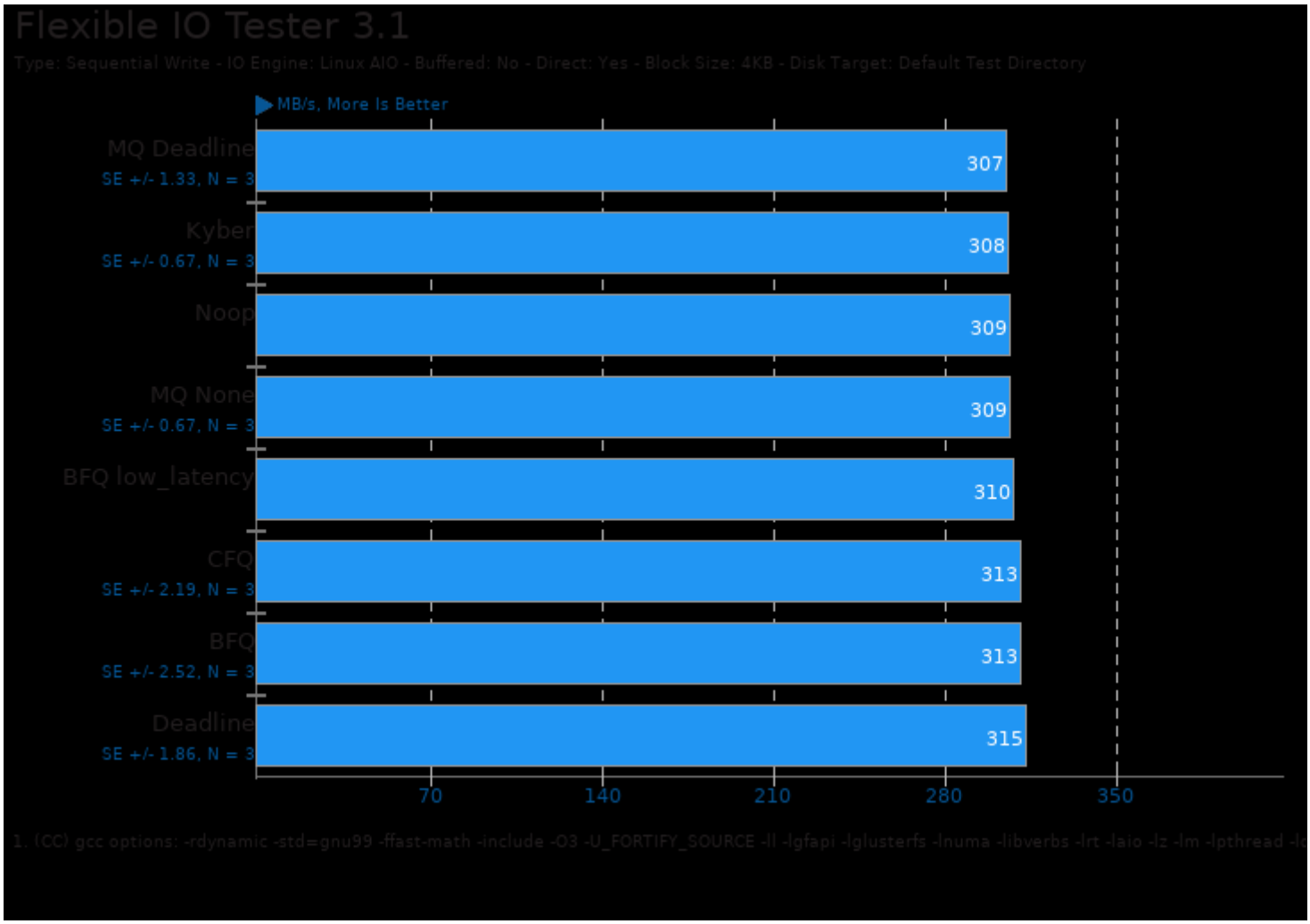
Linux 4.19 I/O Scheduler Performance



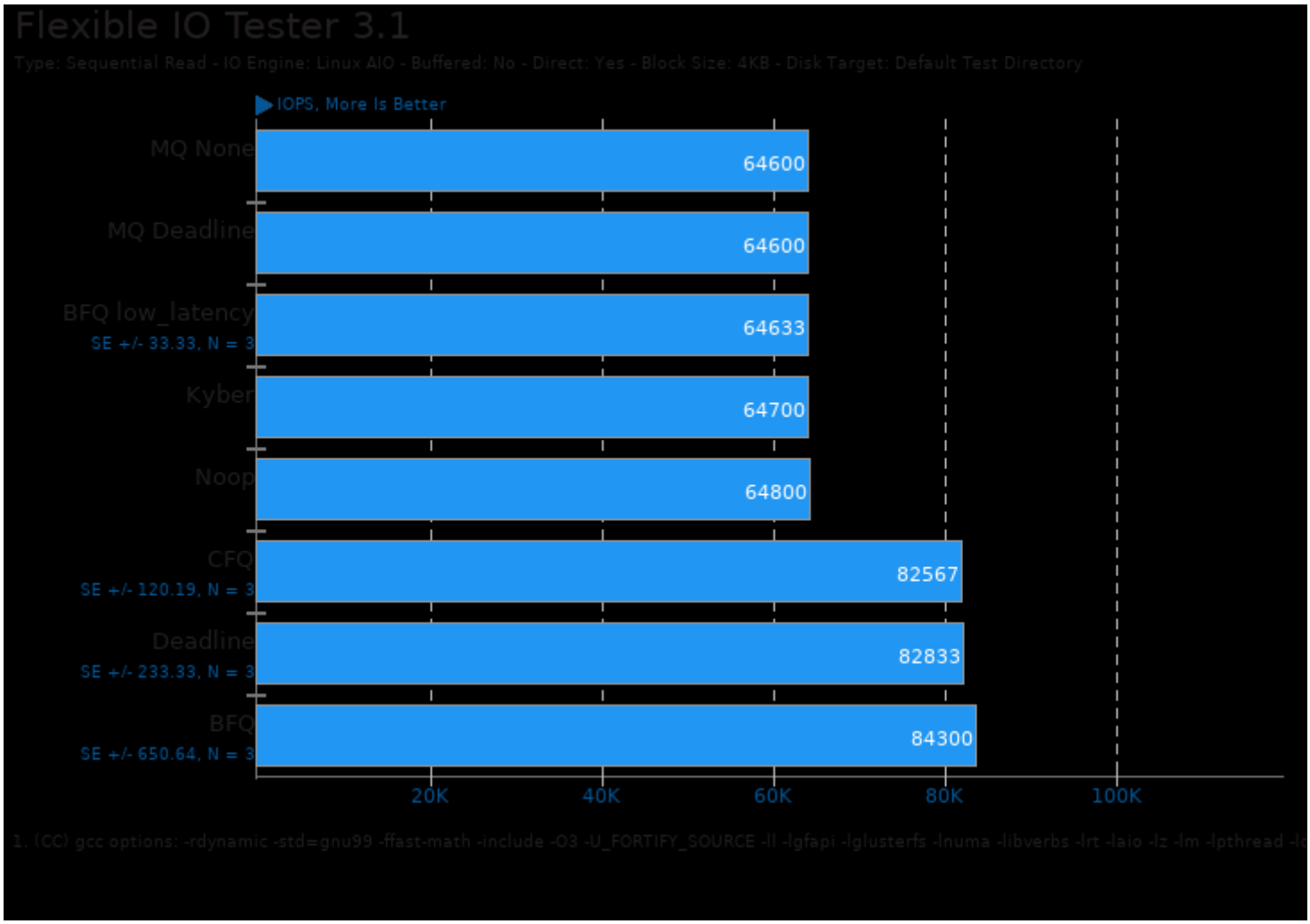
Linux 4.19 I/O Scheduler Performance



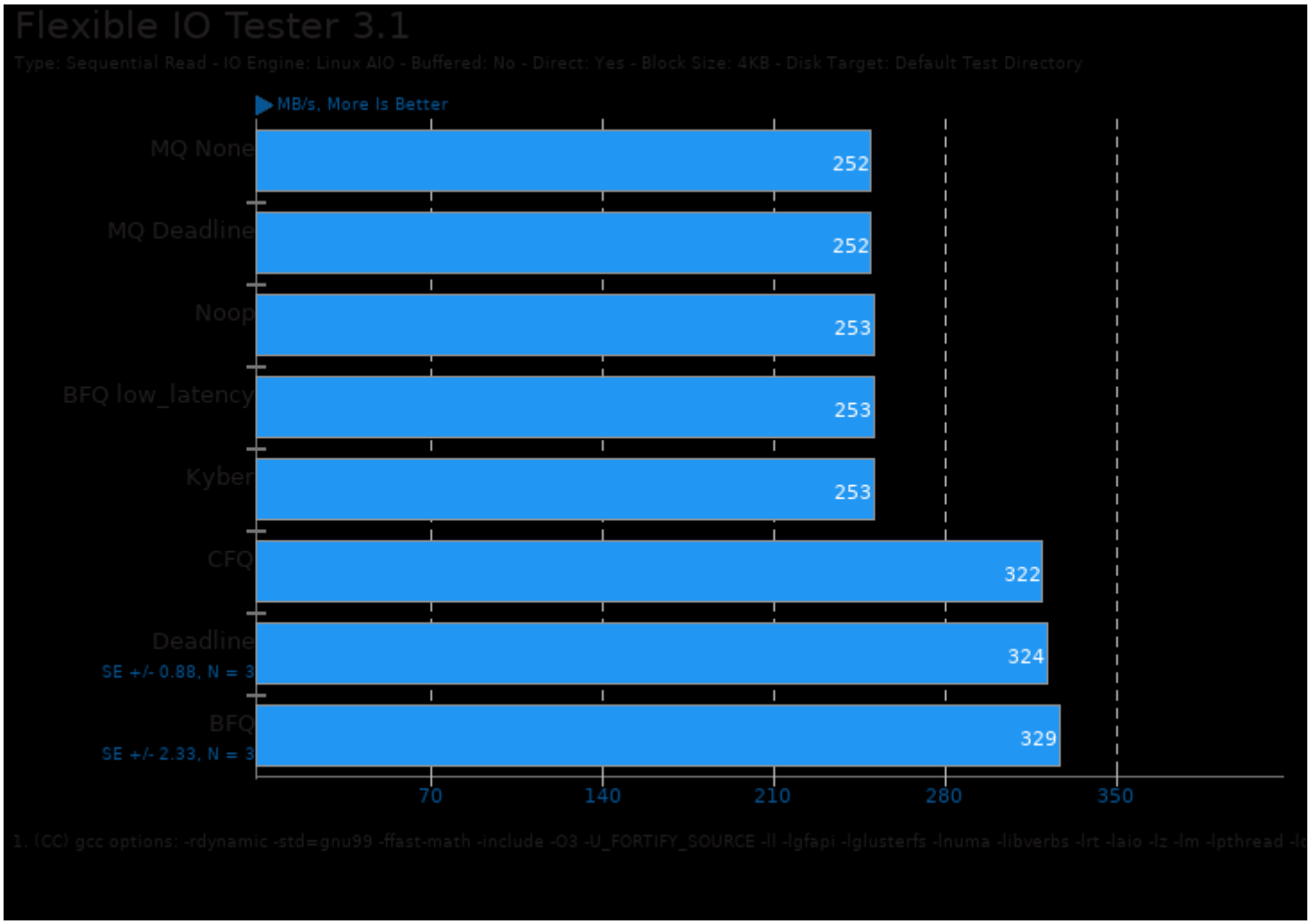
Linux 4.19 I/O Scheduler Performance



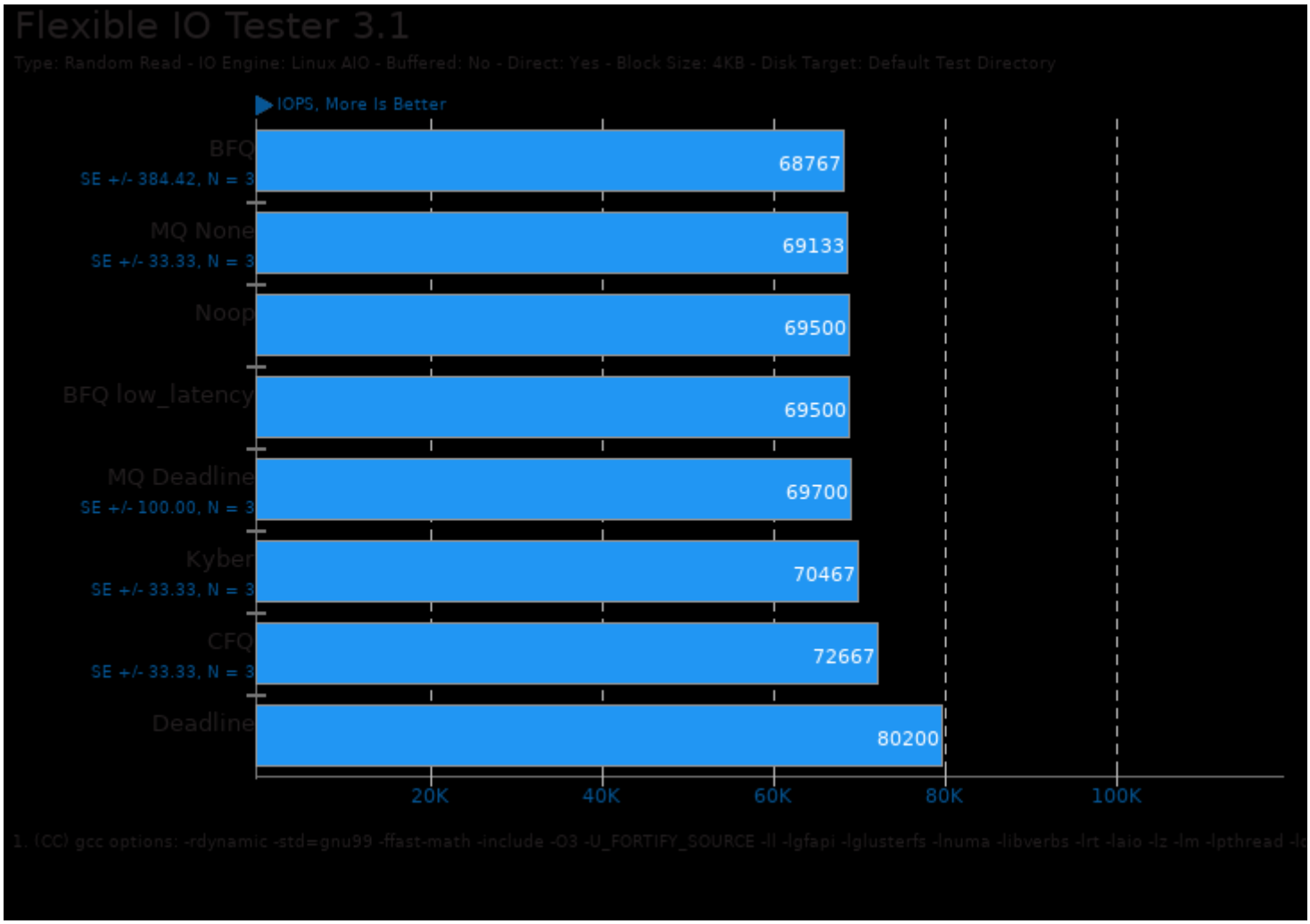
Linux 4.19 I/O Scheduler Performance



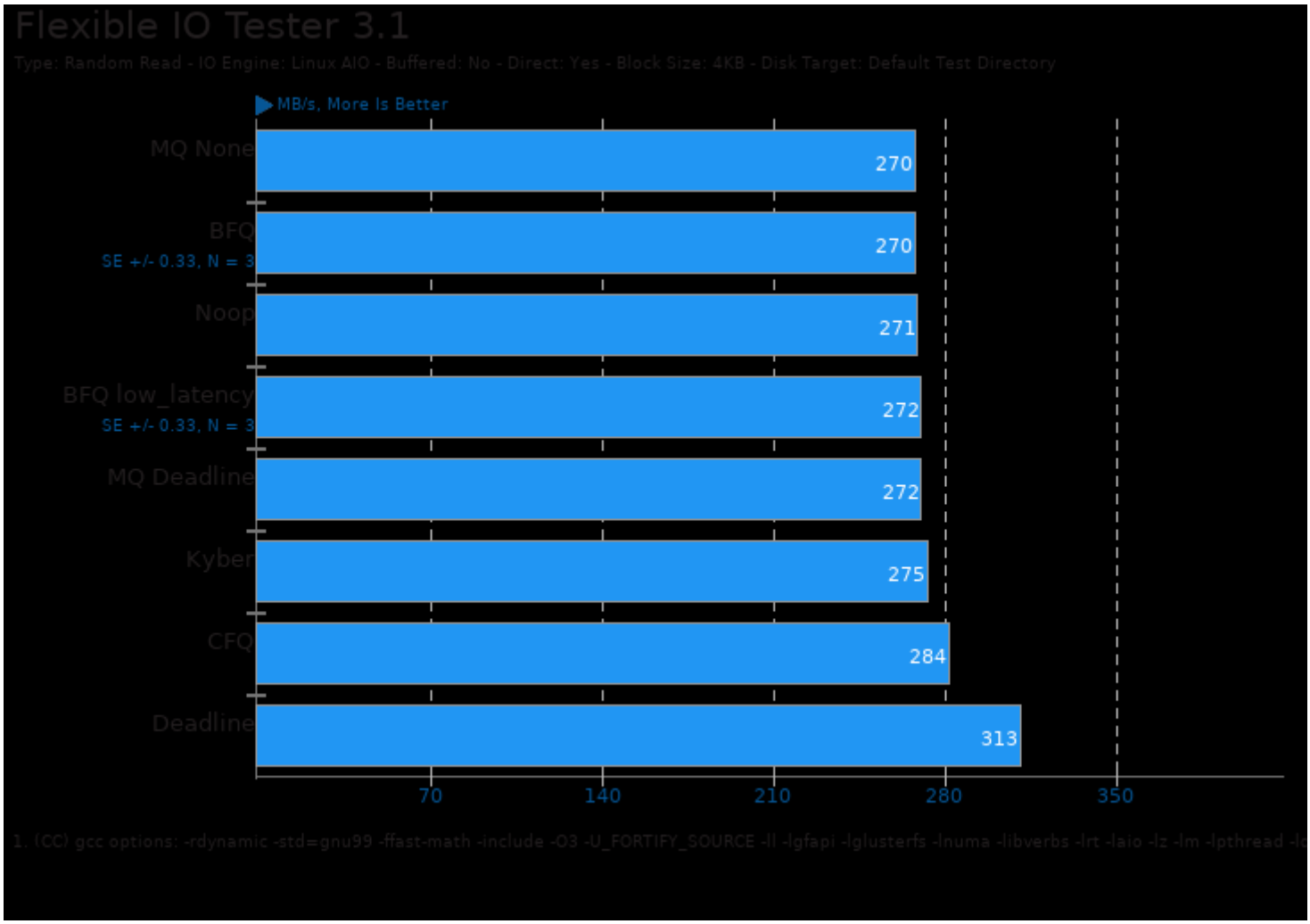
Linux 4.19 I/O Scheduler Performance

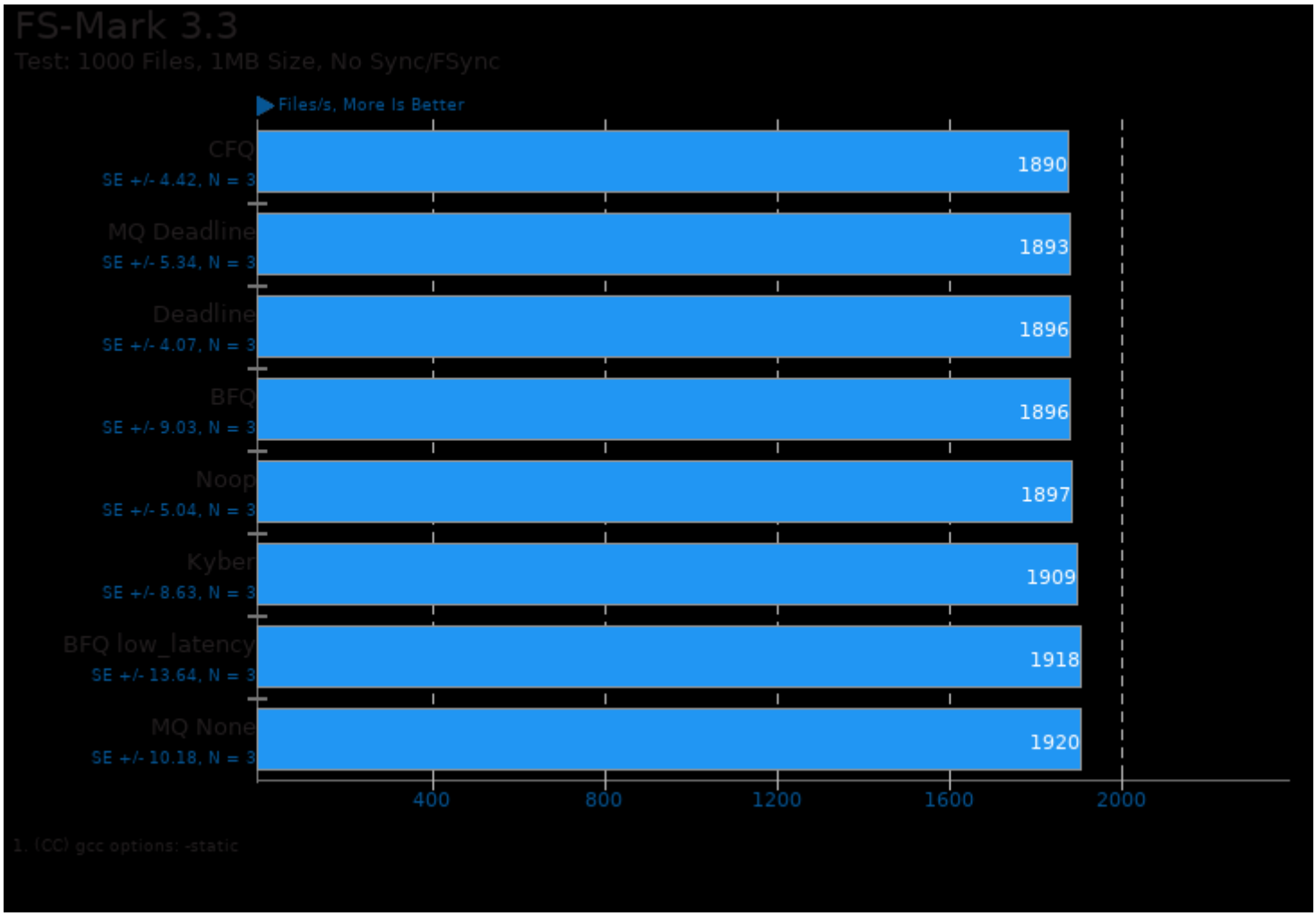


Linux 4.19 I/O Scheduler Performance

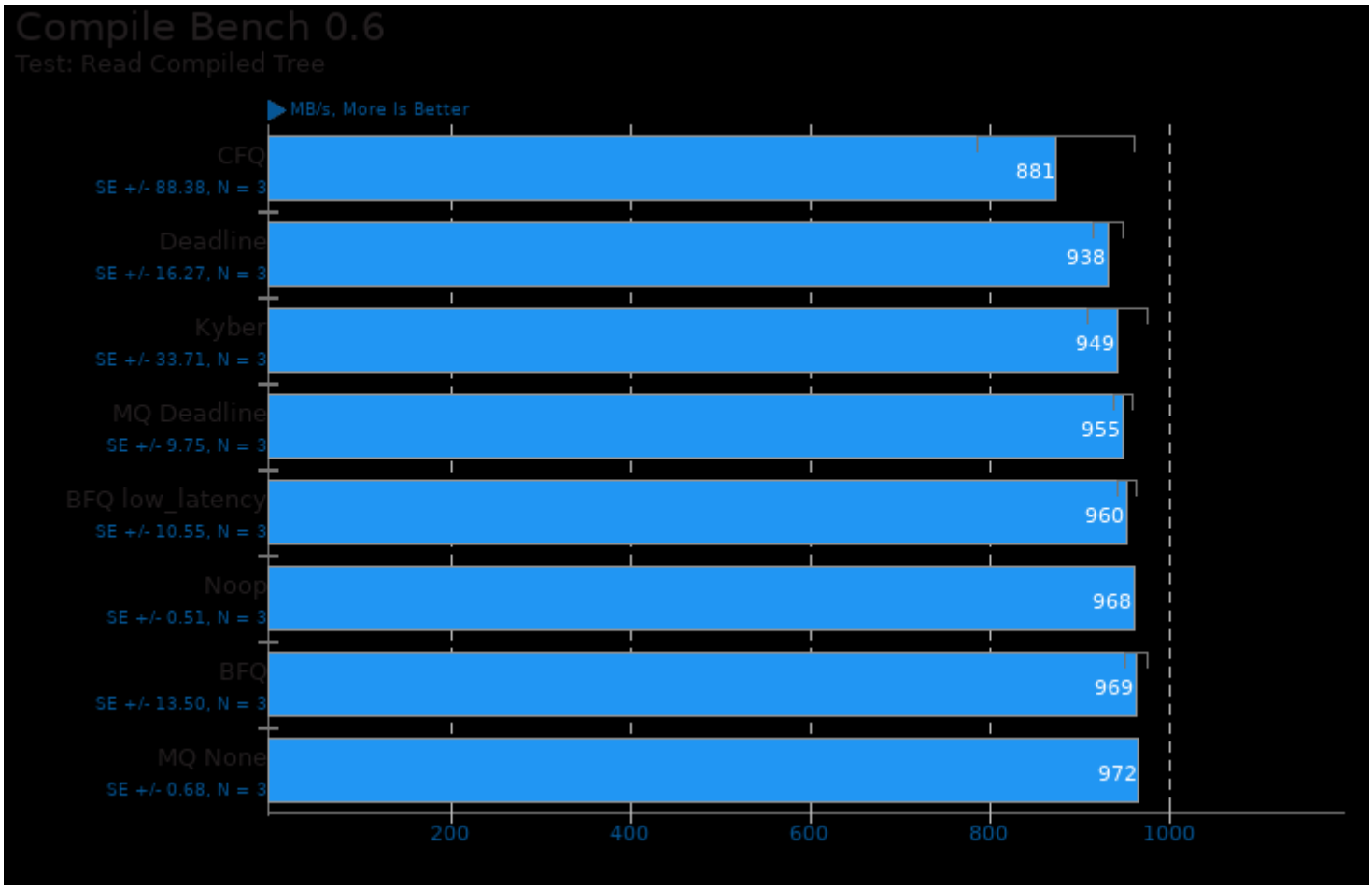


Linux 4.19 I/O Scheduler Performance

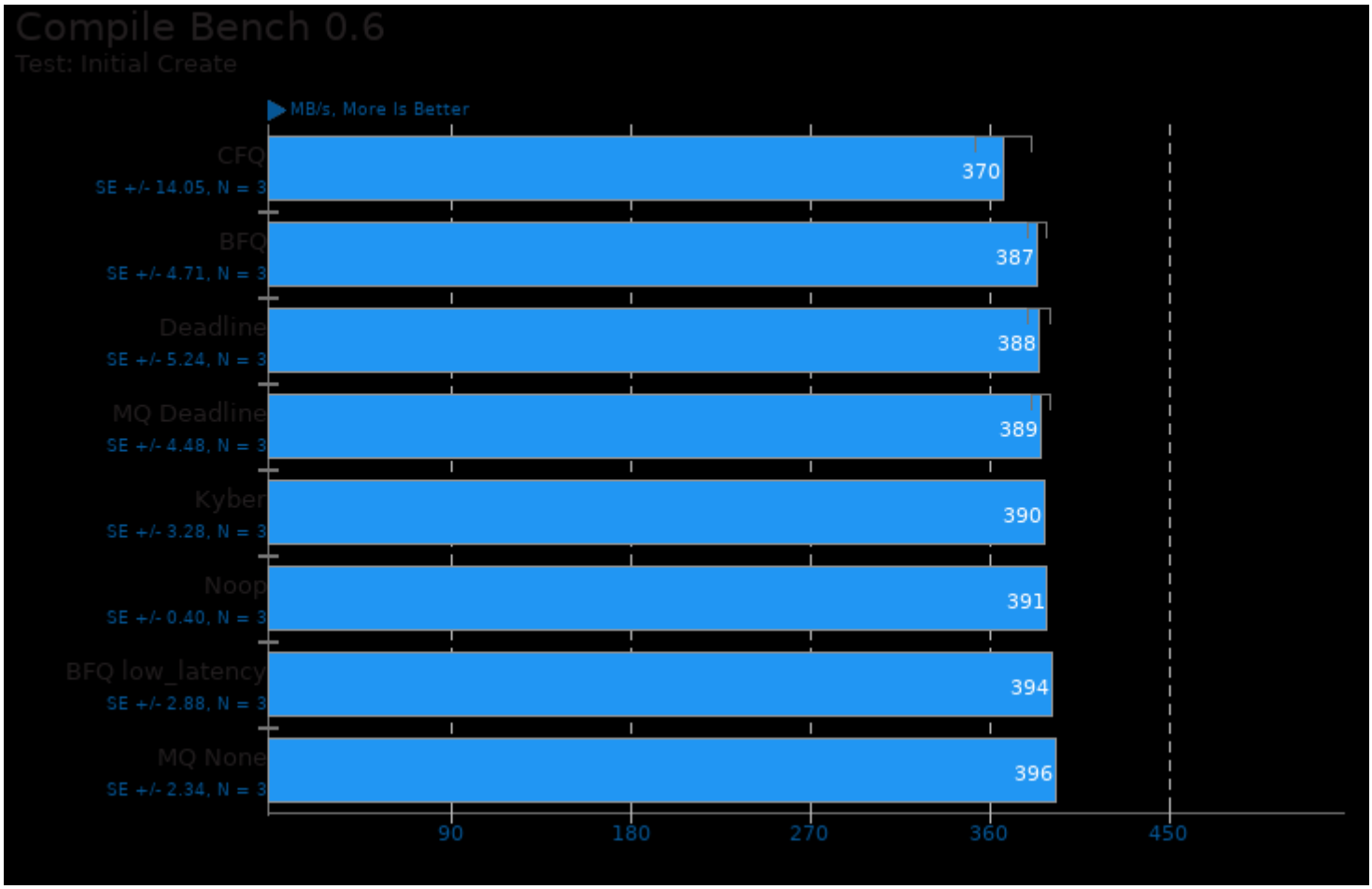



FS-Mark 3.3
Test: 1000 Files, 1MB Size, No Sync/FSync
Files/s, More Is Better
CFQ
SE +/- 4.42, N = 3
1890
MQ Deadline
SE +/- 5.34, N = 3
1893
Deadline
SE +/- 4.07, N = 3
1896
BFQ
SE +/- 9.03, N = 3
1896
Noop
SE +/- 5.04, N = 3
1897
Kyber
SE +/- 8.63, N = 3
1909
BFQ low_latency
SE +/- 13.64, N = 3
1918
MQ None
SE +/- 10.18, N = 3
1920
400
800
1200
1600
2000
1. (CC) gcc options: -static

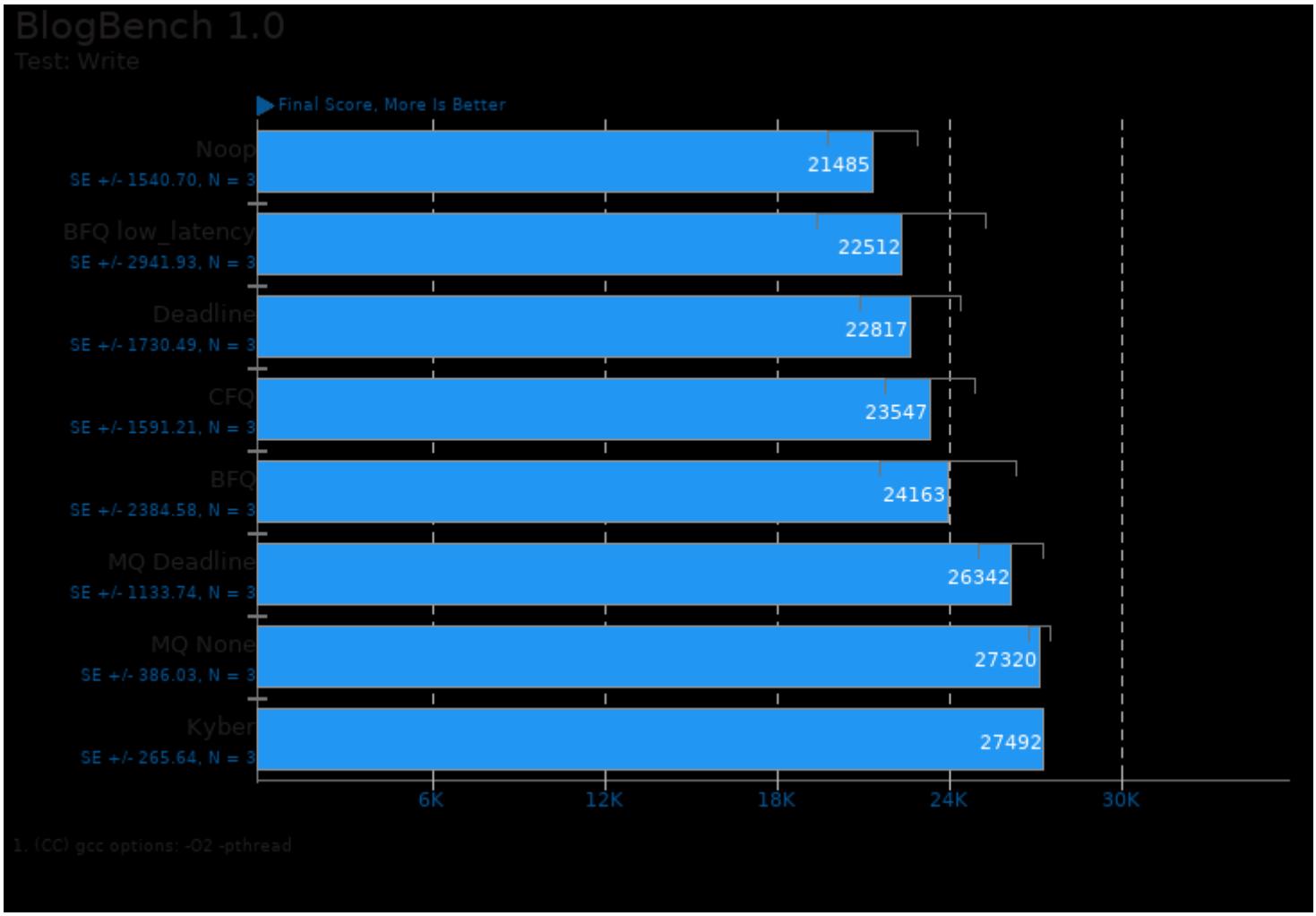
Linux 4.19 I/O Scheduler Performance



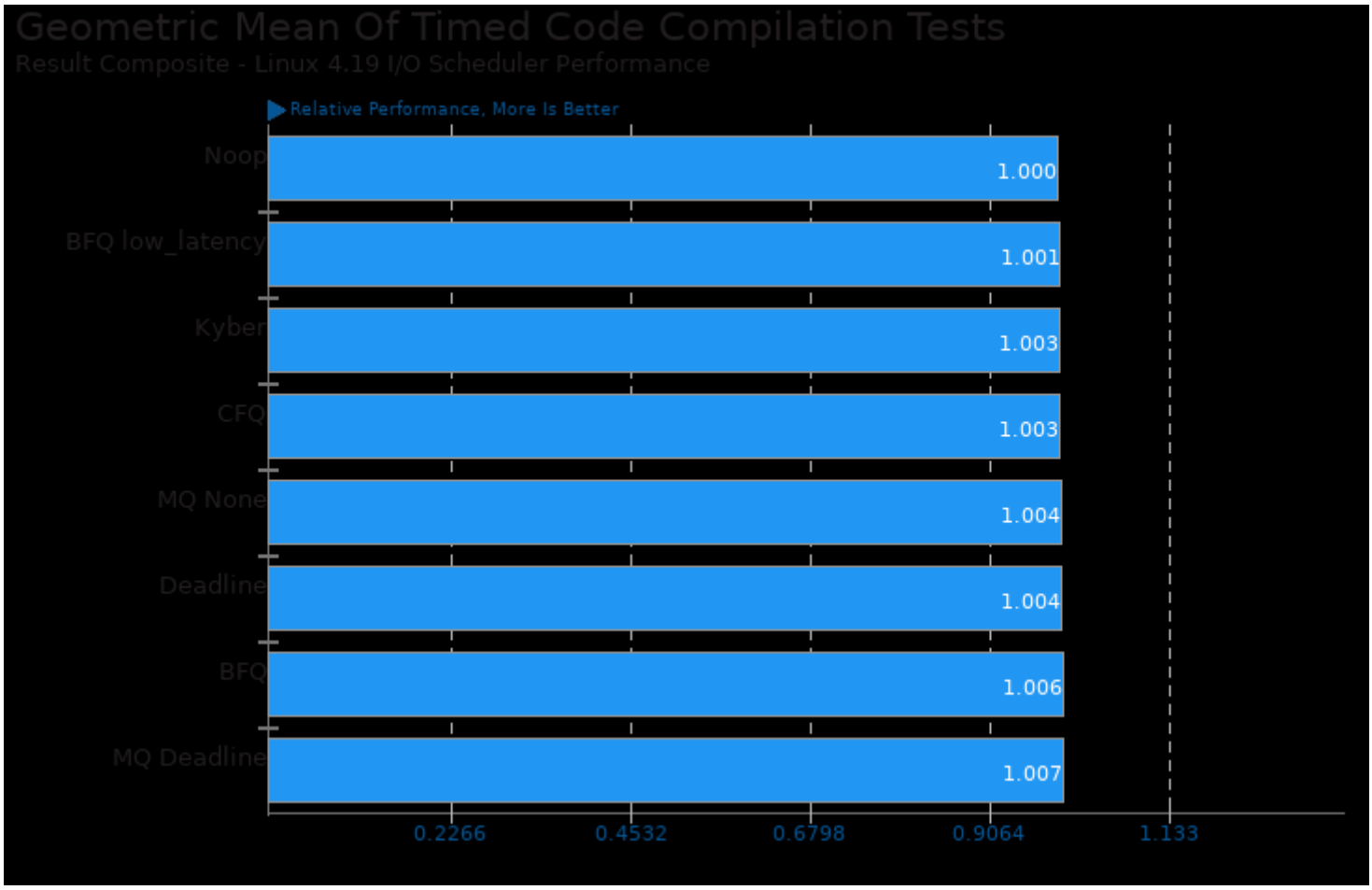
Linux 4.19 I/O Scheduler Performance



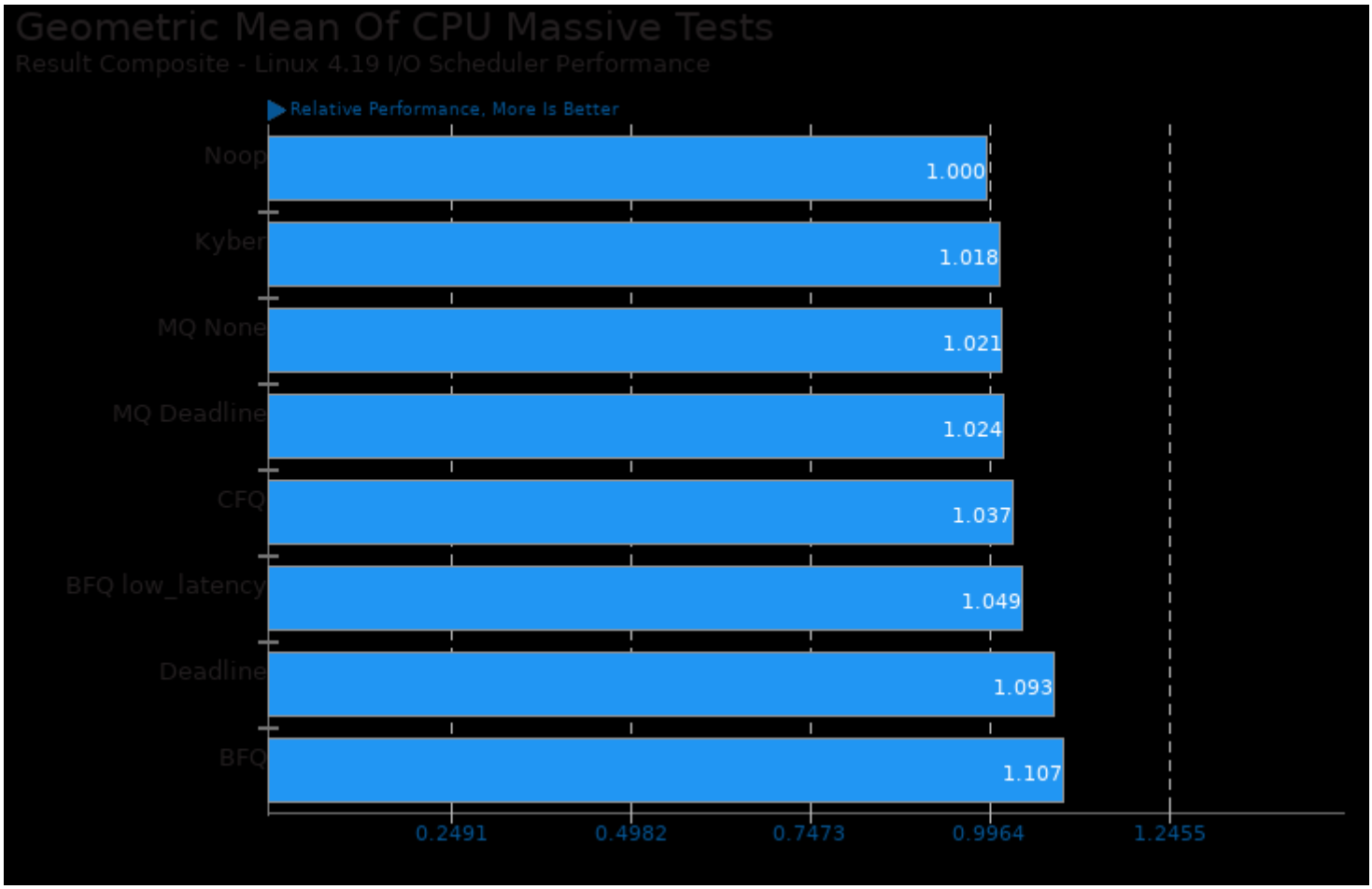
Linux 4.19 I/O Scheduler Performance



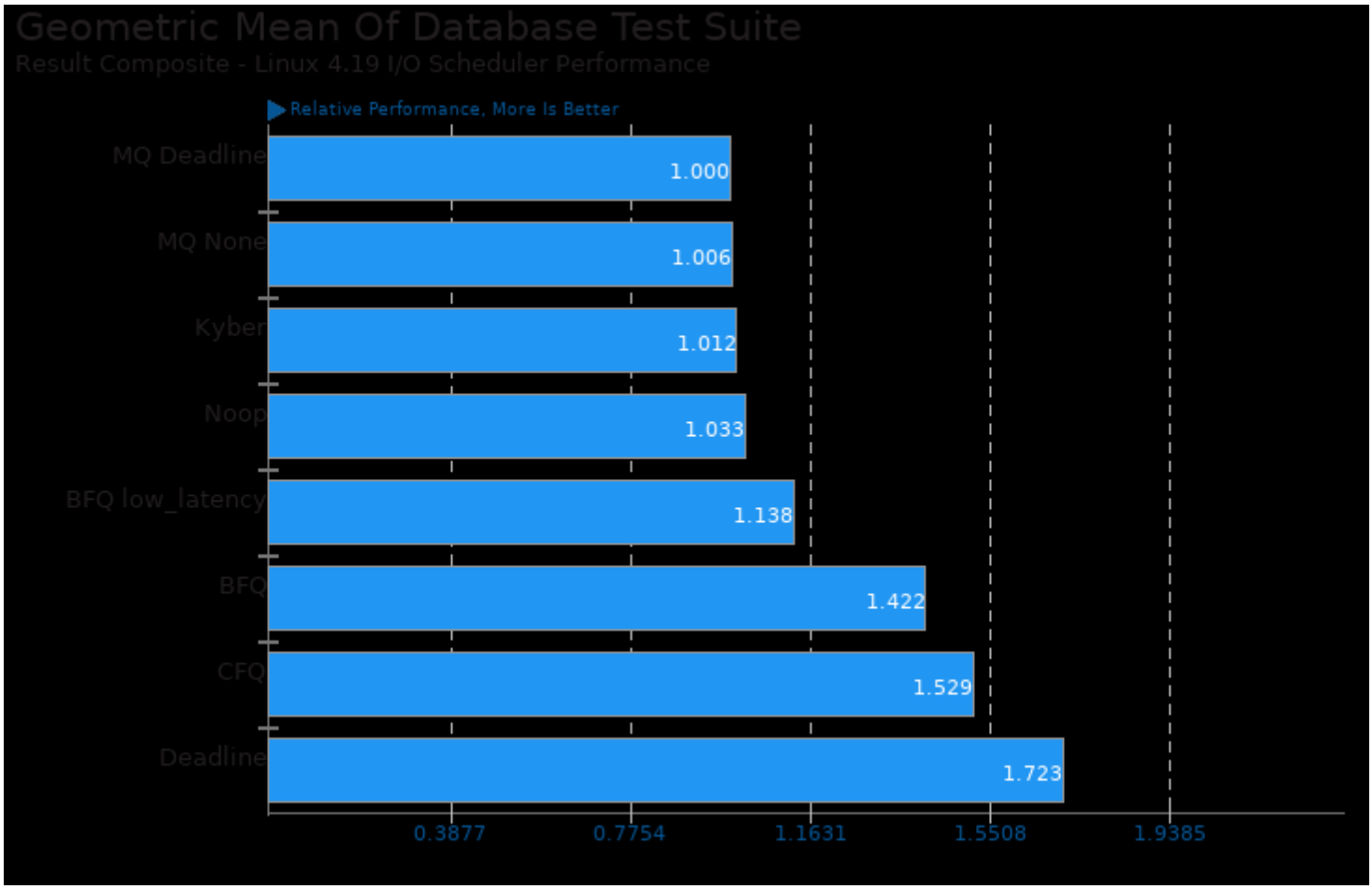
These geometric means are based upon test groupings / test suites for this result file.



Geometric mean based upon tests: pts/build-linux-kernel and pts/build-gcc

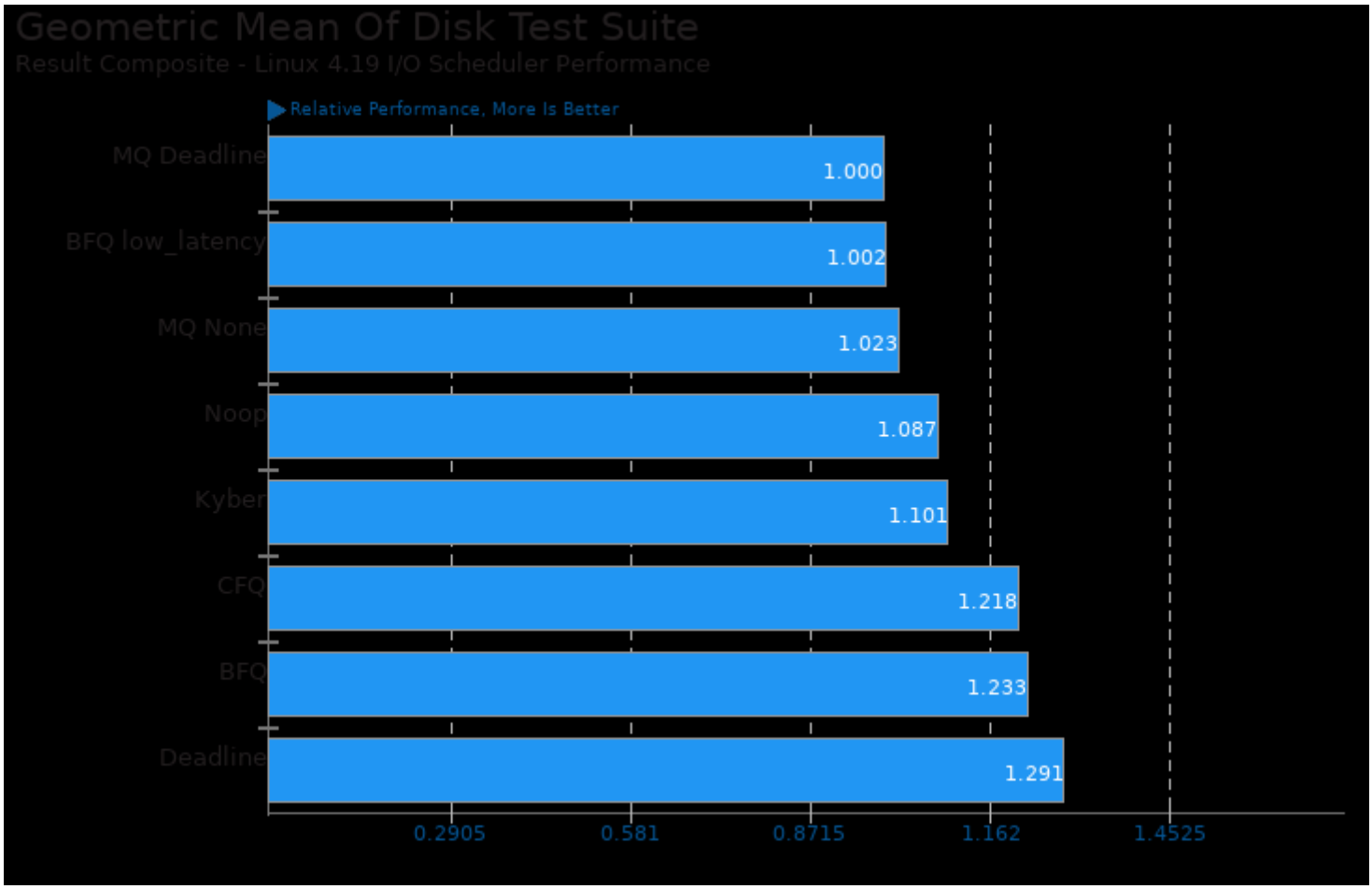


Geometric mean based upon tests: pts/blogbench, pts/build-gcc, pts/build-linux-kernel, pts/compilebench and pts/pgbench



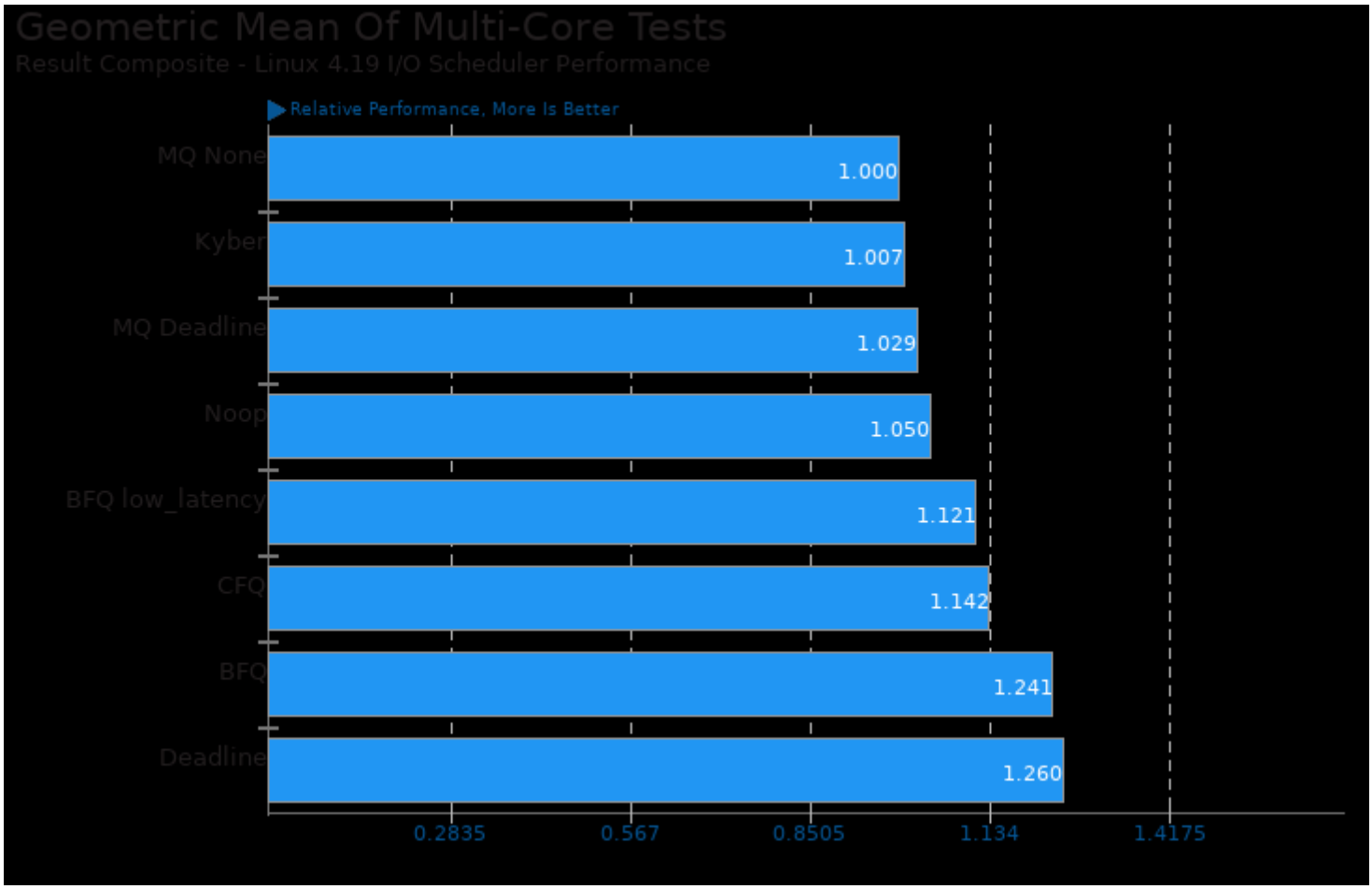
Geometric mean based upon tests: pts/sqlite and pts/pgbench

Linux 4.19 I/O Scheduler Performance



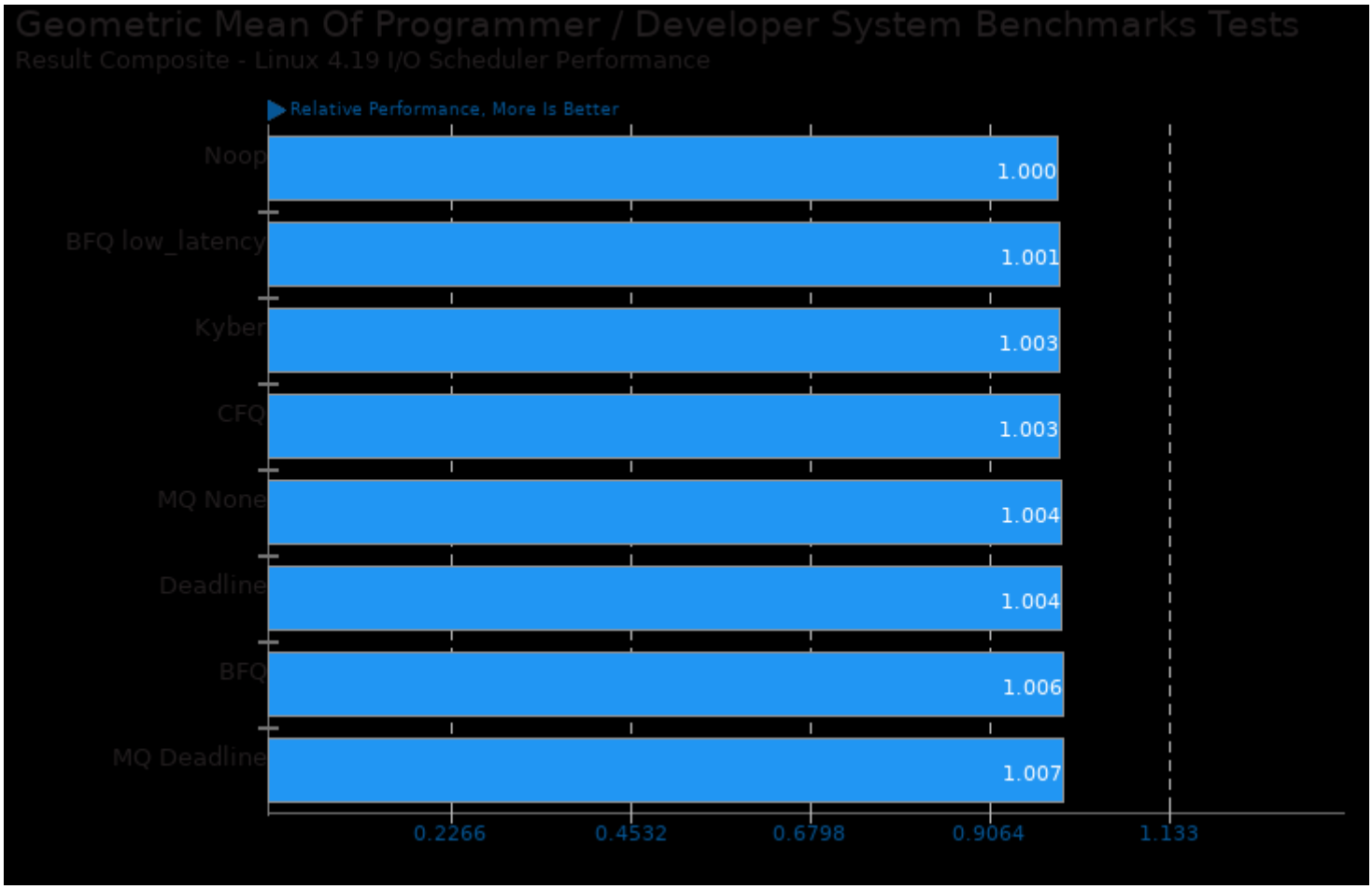
Geometric mean based upon tests: pts/sqlite, pts/fs-mark, pts/compilebench and pts/fio

Linux 4.19 I/O Scheduler Performance



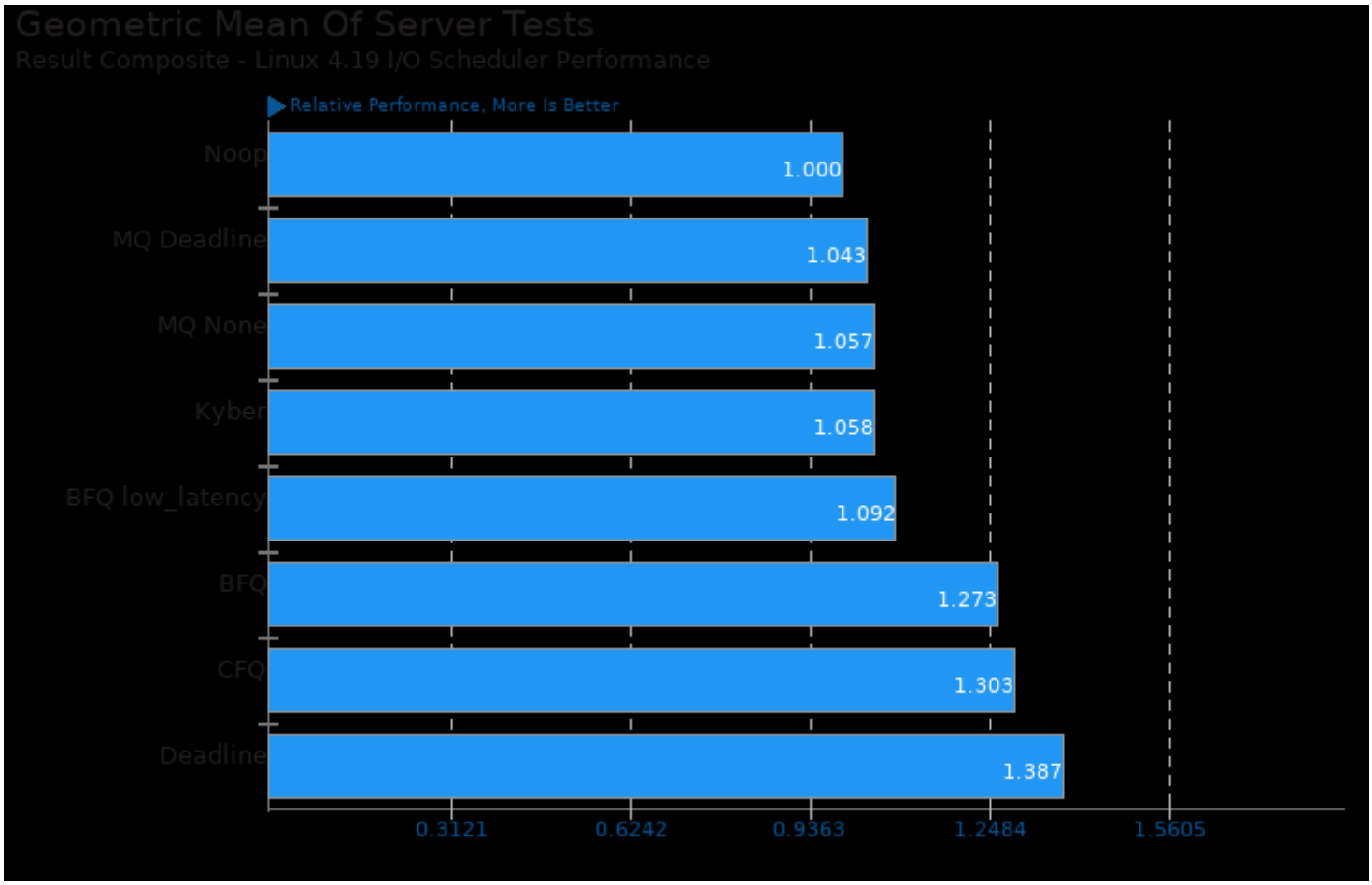
Geometric mean based upon tests: pts/build-linux-kernel, pts/build-gcc and pts/pgbench

Linux 4.19 I/O Scheduler Performance



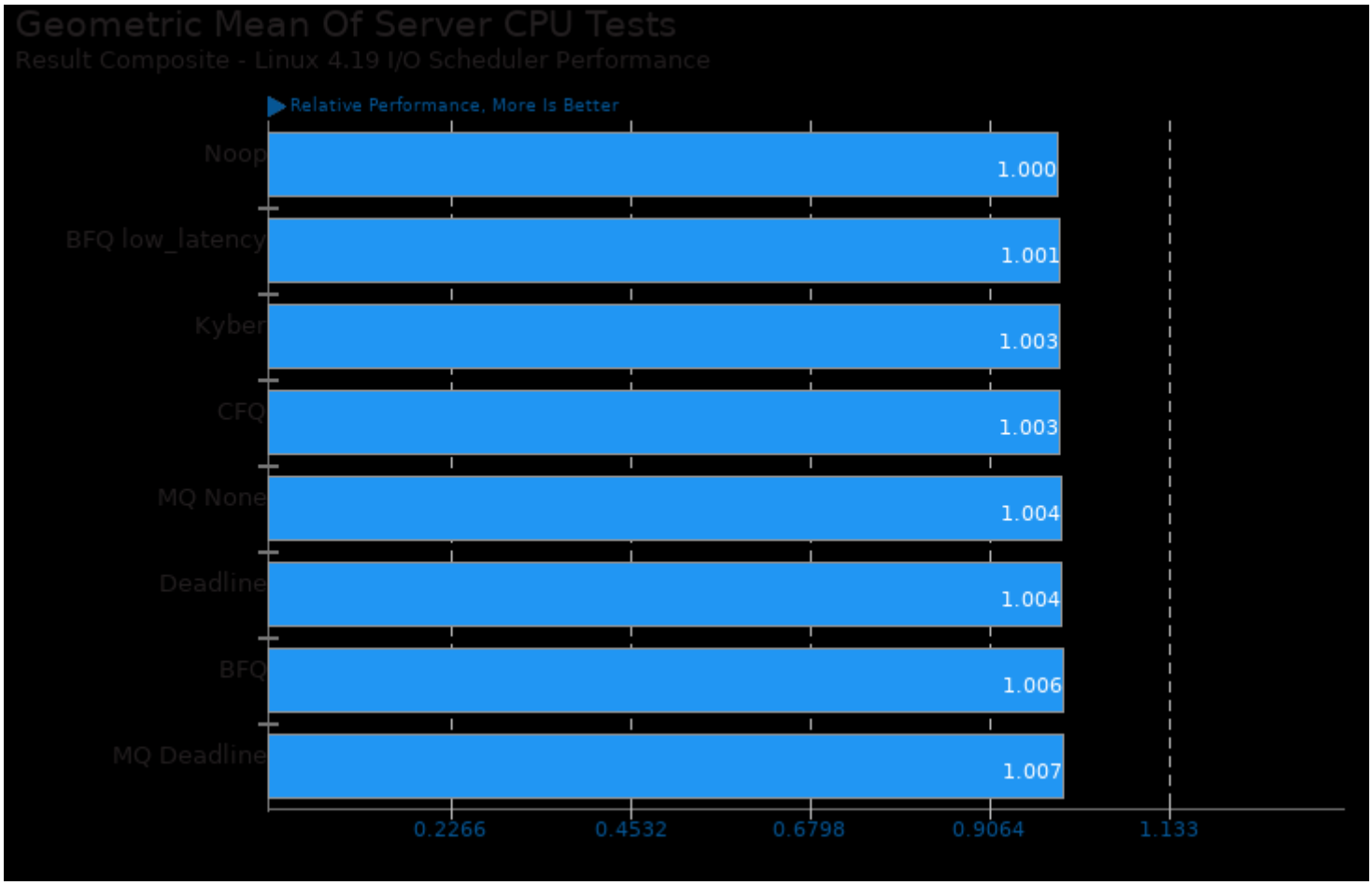
Geometric mean based upon tests: pts/build-linux-kernel and pts/build-gcc

Linux 4.19 I/O Scheduler Performance



Geometric mean based upon tests: pts/blogbench, pts/pgbench and pts/sqlite

Linux 4.19 I/O Scheduler Performance



Geometric mean based upon tests: pts/build-gcc and pts/build-linux-kernel

This file was automatically generated via the Phoronix Test Suite benchmarking software on Sunday, 1 December 2024 13:07.