



# SPEC® CPU2017 Integer Rate Result

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## IBM Corporation

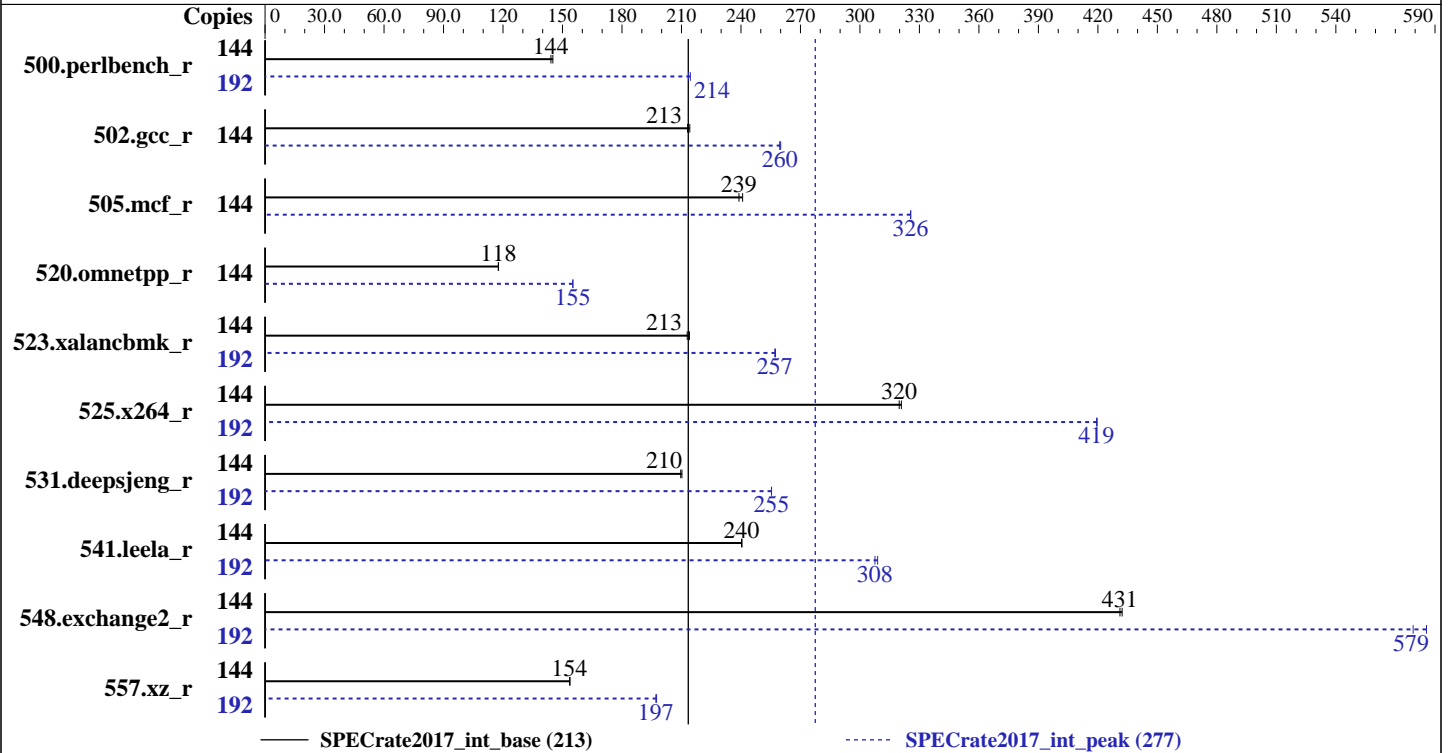
SPECrate2017\_int\_base = 213

IBM Power S924 (3.4 - 3.9 GHz, 24 core, SLES)

SPECrate2017\_int\_peak = 277

CPU2017 License: 11  
Test Sponsor: IBM Corporation  
Tested by: IBM Corporation

Test Date: Mar-2018  
Hardware Availability: Mar-2018  
Software Availability: Apr-2018



### Hardware

CPU Name: POWER9  
Max MHz.: 3900  
Nominal: 3400  
Enabled: 24 cores, 2 chips, 8 threads/core  
Orderable: 1, 2 Chips  
Cache L1: 64 KB I + 64 KB D on chip per core  
L2: 512 KB I+D on chip per core  
L3: 120 MB I+D on chip per chip shared NUCA / 12 cores  
Other: None  
Memory: 256 GB (16 x 16 GB 1Rx4 PC4-2666V-R)  
Storage: 2 x 1.8 TB 10K RPM 4K SAS HDD  
Other: None

### Software

OS: SUSE Linux Enterprise Server 12 SP3  
4.4.114-94.11-default  
Compiler: C/C++: Version 16.1.0 of IBM XL C/C++ for Linux;  
Fortran: Version 16.1.0 of IBM XL Fortran for Linux  
Parallel: No  
Firmware: Version VL910\_061 Released Feb-2018  
File System: xfs  
System State: Run level 3 (multi-user)  
Base Pointers: 64-bit  
Peak Pointers: 64-bit  
Other: Post-Link Optimization (fdprpro) for Linux on POWER, version 5.6.4.0;  
Advance Toolchain 11.0-0



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## Results Table

| Benchmark       | Base   |                    |                   |                    |                   |         |       | Peak   |                    |                   |                    |                   |         |       |
|-----------------|--------|--------------------|-------------------|--------------------|-------------------|---------|-------|--------|--------------------|-------------------|--------------------|-------------------|---------|-------|
|                 | Copies | Seconds            | Ratio             | Seconds            | Ratio             | Seconds | Ratio | Copies | Seconds            | Ratio             | Seconds            | Ratio             | Seconds | Ratio |
| 500.perlbench_r | 144    | <b><u>1590</u></b> | <b><u>144</u></b> | 1579               | 145               |         |       | 192    | <b><u>1431</u></b> | <b><u>214</u></b> | 1425               | 214               |         |       |
| 502.gcc_r       | 144    | <b><u>957</u></b>  | <b><u>213</u></b> | 952                | 214               |         |       | 144    | <b><u>786</u></b>  | <b><u>260</u></b> | 784                | 260               |         |       |
| 505.mcf_r       | 144    | <b><u>974</u></b>  | <b><u>239</u></b> | 966                | 241               |         |       | 144    | 715                | 326               | <b><u>715</u></b>  | <b><u>326</u></b> |         |       |
| 520.omnetpp_r   | 144    | 1606               | 118               | <b><u>1606</u></b> | <b><u>118</u></b> |         |       | 144    | <b><u>1217</u></b> | <b><u>155</u></b> | 1217               | 155               |         |       |
| 523.xalanbmk_r  | 144    | <b><u>714</u></b>  | <b><u>213</u></b> | 711                | 214               |         |       | 192    | 788                | 257               | <b><u>789</u></b>  | <b><u>257</u></b> |         |       |
| 525.x264_r      | 144    | <b><u>788</u></b>  | <b><u>320</u></b> | 786                | 321               |         |       | 192    | <b><u>802</u></b>  | <b><u>419</u></b> | 801                | 420               |         |       |
| 531.deepsjeng_r | 144    | <b><u>787</u></b>  | <b><u>210</u></b> | 785                | 210               |         |       | 192    | <b><u>862</u></b>  | <b><u>255</u></b> | 861                | 255               |         |       |
| 541.leela_r     | 144    | <b><u>992</u></b>  | <b><u>240</u></b> | 991                | 241               |         |       | 192    | 1029               | 309               | <b><u>1034</u></b> | <b><u>308</u></b> |         |       |
| 548.exchange2_r | 144    | <b><u>875</u></b>  | <b><u>431</u></b> | 873                | 432               |         |       | 192    | 859                | 586               | <b><u>869</u></b>  | <b><u>579</u></b> |         |       |
| 557.xz_r        | 144    | <b><u>1013</u></b> | <b><u>154</u></b> | 1011               | 154               |         |       | 192    | <b><u>1052</u></b> | <b><u>197</u></b> | 1050               | 197               |         |       |

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Results appear in the order in which they were run. Bold underlined text indicates a median measurement.

## Peak Tuning Notes

The FDPR post compiler binary optimizer was used

500.perlbench fdpr options: -O3 -noasd

502.gcc fdpr options: -RC -nop -bp -bf -A 2 -ihf 20 -isf 12

505.mcf fdpr options: -O4 -RC -nop -bf -tlo -pto -rt 0 -kr -hr -RD -las

520.omnetpp fdpr options: -O4 -A 2 -rcl 2 -sls -dir -vrox

523.xalan fdpr options: -O3

525.x264 fdpr options: -O3 -RC -nop -bf -tlo -pto -rt 0 -kr -hr -RD -las -vrox -lux -l -lu 9 -isf 12 -si -ihf 20 -sidf 50 -bp

531.deepsjeng fdpr options: -O3 -noasd

541.leela fdpr options: -RC -nop -bp -bf -hr

557.xz fdpr options: -O4

## Submit Notes

The config file option 'submit' was used to assign benchmark copies to specific kernel thread using the "numactl" command (see flags file for details).

## Operating System Notes

Stack size is set to unlimited

```
ulimit -s unlimited
```

Number of huge pages allocated are 11520

```
echo 11520 > /proc/sys/vm/nr_hugepages
```

drop cache is used before invoking runcpu command

```
sync; echo 3 > /proc/sys/vm/drop_caches
```



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## General Notes

Environment variables set by runcpu before the start of the run:

```
HUGETLB_MORECORE = "yes"
HUGETLB_VERBOSE = "0"
LD_LIBRARY_PATH = "$LD_LIBRARY_PATH:/opt/FDPR"
LD_PRELOAD = "/opt/at11.0/lib64/libhugetlbf.so"
MALLOC_MMAP_MAX_ = "0"
TCMALLOC_MEMFS_MALLOC_PATH = "/dev/hugepages/"
XLFRTEOPTS = "intrinths=1"
XLSMPOPTS = "spins=0:yields=0:schedule=STATIC:stack=8000000"
```

Yes: The test sponsor attests, as of date of publication, that CVE-2017-5754 (Meltdown) is mitigated in the system as tested and documented.

Yes: The test sponsor attests, as of date of publication, that CVE-2017-5753 (Spectre variant 1) is mitigated in the system as tested and documented.

Yes: The test sponsor attests, as of date of publication, that CVE-2017-5715 (Spectre variant 2) is mitigated in the system as tested and documented.

Post-Link Optimizer (fdprpro): sources available at <https://developer.ibm.com/linuxonpower/sdk-packages/AdvanceToolchain11.0-0>: sources available at <https://ibm.biz/AdvanceToolchain>

For release, the compiler version numbers were updated to 16.1.0 (from 13.1.7) for the C/C++ compiler and 16.1.0 (from 15.1.7) for the Fortran compiler.

## Platform Notes

Firmware configuration:  
Idle Power Saver mode is disabled

```
Sysinfo program /spec/CPU2017/v1.0.2/bin/sysinfo
Rev: r5797 of 2017-06-14 96c45e4568ad54c135fd618bcc091c0f
running on linux-0at1 Thu Mar 8 19:06:43 2018
```

SUT (System Under Test) info as seen by some common utilities.

For more information on this section, see  
<https://www.spec.org/cpu2017/Docs/config.html#sysinfo>

From /proc/cpuinfo

```
'clock : ' reported by /proc/cpuinfo may not be reliable. Use with caution.
cpu : POWER9 (architected), altivec supported
clock : 2750.000000MHz
machine : CHRP IBM,9009-42A
model : IBM,9009-42A
platform : pSeries
revision : 2.2 (pvr 004e 0202)
```

Number of cores, from 'ppc64\_cpu --cores-present' : 24

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### Platform Notes (Continued)

WARNING regarding the output of 'lscfg': this utility reports resources for the system, not the current partition. Therefore, for a partition that has a subset of the full system resources:

- (1) The tester may need to adjust the sysinfo-supplied 'hw\_ncores'.
- (2) The tester may need to adjust the sysinfo-supplied 'hw\_nchips'.

Processors, from lscfg -vp

```
^^^Note: sum of ways = 0, differs from 'ppc64_cpu --cores-present'
192 "processors"
```

From numactl --hardware WARNING: a numactl 'node' might or might not correspond to a physical chip.

```
available: 2 nodes (0-1)
node 0 cpus: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27
28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56
57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85
86 87 88 89 90 91 92 93 94 95
node 0 size: 126493 MB
node 0 free: 33434 MB
node 1 cpus: 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114
115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136
137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158
159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180
181 182 183 184 185 186 187 188 189 190 191
node 1 size: 124023 MB
node 1 free: 31569 MB
node distances:
node 0 1
0: 10 40
1: 40 10
```

From /proc/meminfo

```
MemTotal: 256529344 kB
HugePages_Total: 11520
Hugepagesize: 16384 kB
```

/usr/bin/lsb\_release -d

SUSE Linux Enterprise Server 12 SP3

From /etc/\*release\* /etc/\*version\*

SuSE-release:

```
SUSE Linux Enterprise Server 12 (ppc64le)
VERSION = 12
PATCHLEVEL = 3
```

```
# This file is deprecated and will be removed in a future service pack or release.
# Please check /etc/os-release for details about this release.
```

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### Platform Notes (Continued)

```
os-release:
  NAME="SLES"
  VERSION="12-SP3"
  VERSION_ID="12.3"
  PRETTY_NAME="SUSE Linux Enterprise Server 12 SP3"
  ID="sles"
  ANSI_COLOR="0;32"
  CPE_NAME="cpe:/o:suse:sles:12:sp3"
```

```
uname -a:
Linux linux-0at1 4.4.114-94.11-default #1 SMP Thu Feb 1 19:28:26 UTC 2018 (4309ff9)
ppc64le ppc64le ppc64le GNU/Linux
```

```
run-level 3 Mar 8 15:59
```

```
SPEC is set to: /spec/CPU2017/v1.0.2
Filesystem      Type  Size  Used Avail Use% Mounted on
/dev/mapper/spec-spec1v xfs   1.6T  1.2T  432G  74% /spec
```

(End of data from sysinfo program)  
Sysinfo output is not correct for the disk information. Two disks, each of 1.8 TB capacity each were used. After the volumes were created, the available capacity reported for each disk was 1.6 TB. One disk is used for the operating system, compilers, libraries and Advance Toolchain, and another disk is used for the SPEC tree.

### Compiler Version Notes

```
=====
CC 500.perlbench_r(base) 502.gcc_r(base) 505.mcf_r(base) 525.x264_r(base)
557.xz_r(base)
-----
```

```
IBM XL C/C++ for Linux, V13.1.7 (Beta 2)
Version: 13.01.0007.0000
Driver Version: 13.1.7(C/C++) Level: 180226 ID: _znni8Ra7Eeid4OHRoHeItA
C/C++ Front End Version: 13.1.7(C/C++) Level: 180226 ID:
_7h4RcReEEeid4OHRoHeItA
High-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180227
ID: _q9W8QRvXEeiwhLbSB1AWWhQ
Low-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180226
ID: _mRjxcBdjEeid4OHRoHeItA
-----
```

```
=====
CXXC 520.omnetpp_r(base) 523.xalancbmk_r(base) 531.deepsjeng_r(base)
541.leela_r(base)
-----
```

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Version: 13.01.0007.0000  
Driver Version: 13.1.7(C/C++) Level: 180226 ID: \_znni8Ra7Eeid4OHRoHeItA  
C/C++ Front End Version: 13.1.7(C/C++) Level: 180226 ID:  
\_7h4RcReEEeid4OHRoHeItA  
High-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180227  
ID: \_q9W8QRvXEeiwhLbSBlAWWhQ  
Low-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180226  
ID: \_mRjxcBdjEeid4OHRoHeItA

=====  
CC 500.perlbench\_r(peak) 502.gcc\_r(peak) 505.mcf\_r(peak) 525.x264\_r(peak)  
557.xz\_r(peak)  
=====

IBM XL C/C++ for Linux, V13.1.7 (Beta 2)  
Version: 13.01.0007.0000  
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High-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180227  
ID: \_q9W8QRvXEeiwhLbSBlAWWhQ  
Low-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180226  
ID: \_mRjxcBdjEeid4OHRoHeItA

=====  
CXXC 520.omnetpp\_r(peak) 523.xalancbmk\_r(peak) 531.deepsjeng\_r(peak)  
541.leela\_r(peak)  
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High-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180227  
ID: \_q9W8QRvXEeiwhLbSBlAWWhQ  
Low-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180226  
ID: \_mRjxcBdjEeid4OHRoHeItA

=====  
FC 548.exchange2\_r(base)  
=====

IBM XL Fortran for Linux, V15.1.7 (Beta 2)  
Version: 15.01.0007.0000  
Driver Version: 15.1.7(Fortran) Level: 180226 ID: \_znni8Ra7Eeid4OHRoHeItA

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## Compiler Version Notes (Continued)

Fortran Front End and Run Time Version: 15.1.7(Fortran) Level: 180226 ID:   
\_t6CIRqxEeiwhLbSBlAWHQ  
Fortran Transformer Version: 15.1.7(Fortran) Level: 180226 ID:   
\_J6BFYRi8Eeid4OHRoHeItA  
High-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180227  
ID: \_q9W8QRvXEeiwhLbSBlAWHQ  
Low-Level Optimizer Version: 13.1.7(C/C++) and 15.1.7(Fortran) Level: 180226  
ID: \_mRjxcBdjEeid4OHRoHeItA

=====  
FC 548.exchange2\_r(peak)  
-----

IBM XL Fortran for Linux, V15.1.7 (Beta 2)  
Version: 15.01.0007.0000  
Driver Version: 15.1.7(Fortran) Level: 180226 ID: \_znni8Ra7Eeid4OHRoHeItA  
Fortran Front End and Run Time Version: 15.1.7(Fortran) Level: 180226 ID:   
\_t6CIRqxEeiwhLbSBlAWHQ  
Fortran Transformer Version: 15.1.7(Fortran) Level: 180226 ID:   
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ID: \_q9W8QRvXEeiwhLbSBlAWHQ  
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ID: \_mRjxcBdjEeid4OHRoHeItA  
-----

## Base Compiler Invocation

C benchmarks:  
/opt/ibm/xlC/13.1.7/bin/xlc\_at -qlanglvl=extc99

C++ benchmarks:  
/opt/ibm/xlC/13.1.7/bin/xlc\_at

Fortran benchmarks:  
/opt/ibm/xlf/15.1.7/bin/xlf95\_at

## Base Portability Flags

500.perlbench\_r: -DSPEC\_LP64 -DSPEC\_LINUX\_PPC\_LE  
502.gcc\_r: -DSPEC\_LP64  
505.mcf\_r: -DSPEC\_LP64  
520.omnetpp\_r: -DSPEC\_LP64

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## Base Portability Flags (Continued)

523.xalancbmk\_r: -DSPEC\_LP64 -DSPEC\_LINUX  
525.x264\_r: -DSPEC\_LP64  
531.deepsjeng\_r: -DSPEC\_LP64  
541.leela\_r: -DSPEC\_LP64  
548.exchange2\_r: -DSPEC\_LP64  
557.xz\_r: -DSPEC\_LP64

## Base Optimization Flags

C benchmarks:

-lhugetlbfs -qipa=noobject -qalias=noansi -O5 -qarch=pwr9  
-qtune=pwr9

C++ benchmarks:

-lhugetlbfs -qipa=noobject -O4 -qarch=pwr9 -qtune=pwr9 -ltcmalloc

Fortran benchmarks:

-lhugetlbfs -qipa=noobject -O4 -qarch=pwr9 -qtune=pwr9  
-qprefetch=dscr=1

## Base Other Flags

C benchmarks:

-qsuppress=1500-036 -qsuppress=1500-029

C++ benchmarks:

-qsuppress=1500-036 -qsuppress=1500-029

Fortran benchmarks:

-qsuppress=1500-036 -qsuppress=1500-029

## Peak Compiler Invocation

C benchmarks:

/opt/ibm/xlC/13.1.7/bin/xlC\_at -qlanglvl=extc99

C++ benchmarks:

/opt/ibm/xlC/13.1.7/bin/xlC\_at

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## Peak Compiler Invocation (Continued)

Fortran benchmarks:

/opt/ibm/xlf/15.1.7/bin/xlf95\_at

## Peak Portability Flags

Same as Base Portability Flags

## Peak Optimization Flags

C benchmarks:

```
500.perlbench_r: -w1,-q -lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O3
-qarch=pwr9 -qtune=pwr9 -qinline=level=10
-qprefetch=dscr=1 -qipa=noobject:partition=large
-qalias=noansi -qstrict=nans -qfdpr
```

```
502.gcc_r: -w1,-q -lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O3
-qarch=pwr9 -qtune=pwr9 -ltdmalloc -w1,-z,muldefs
-qipa=noobject -qalias=noansi -qfdpr
```

```
505.mcf_r: -w1,-q -lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O5
-qarch=pwr9 -qtune=pwr9 -qdatasmall -qprefetch=dscr=4
-ltdmalloc -qipa=noobject -qfdpr
```

```
525.x264_r: -w1,-q -lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O5
-qarch=pwr9 -qtune=pwr9 -qnounroll -qrestrict
-qprefetch=dscr=7 -ltdmalloc -qipa=noobject -qfdpr
```

```
557.xz_r: -w1,-q -lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O5
-qarch=pwr9 -qtune=pwr9 -qpagesize=16M -qprefetch=dscr=7
-ltdmalloc -qipa=noobject -qfdpr
```

C++ benchmarks:

```
520.omnetpp_r: -w1,-q -lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O5
-qarch=pwr9 -qtune=pwr9 -qlibansi -qprefetch=dscr=1
-ltdmalloc -qipa=noobject -qfdpr
```

```
523.xalancbmk_r: -w1,-q -lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O5
-qarch=pwr9 -qtune=pwr9 -qpagesize=16M -qprefetch=dscr=7
-ltdmalloc -qipa=noobject -qfdpr
```

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## Peak Optimization Flags (Continued)

```
531.deepsjeng_r: -w1, -q -lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O2
-qarch=pwr9 -qtune=pwr9 -qipa -qrestrict
-qprefetch=dscr=1 -qipa=noobject -qfdpr
```

```
541.leela_r: -w1, -q -lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O5
-qarch=pwr9 -qtune=pwr9 -qenum=small -funroll-all-loops
-qinline=level=10 -qprefetch=dscr=6 -qipa=noobject -qfdpr
```

Fortran benchmarks:

```
-lhugetlbfs -qpdf1(pass 1) -qpdf2(pass 2) -O3 -qarch=pwr9
-qtune=pwr9:smt4 -qhot -qsimd=noauto -qsmallstack -qprefetch=dscr=1
-ltcmalloc -qipa=noobject
```

## Peak Other Flags

C benchmarks:

```
-qsuppress=1500-036 -qsuppress=1500-029
```

C++ benchmarks:

```
-qsuppress=1500-036 -qsuppress=1500-029
```

Fortran benchmarks:

```
-qsuppress=1500-036 -qsuppress=1500-029 -qsuppress=cmpmsg
```

The flags files that were used to format this result can be browsed at

[http://www.spec.org/cpu2017/flags/IBM\\_Linux\\_9009\\_S.html](http://www.spec.org/cpu2017/flags/IBM_Linux_9009_S.html)

[http://www.spec.org/cpu2017/flags/IBM\\_XL\\_Linux\\_1317\\_flags.html](http://www.spec.org/cpu2017/flags/IBM_XL_Linux_1317_flags.html)

You can also download the XML flags sources by saving the following links:

[http://www.spec.org/cpu2017/flags/IBM\\_Linux\\_9009\\_S.xml](http://www.spec.org/cpu2017/flags/IBM_Linux_9009_S.xml)

[http://www.spec.org/cpu2017/flags/IBM\\_XL\\_Linux\\_1317\\_flags.xml](http://www.spec.org/cpu2017/flags/IBM_XL_Linux_1317_flags.xml)

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