

## CP2K 7.1.0 (gnu)

## Webpage

<https://www.cp2k.org/>

## Version

7.1.0

## Build Environment

- OpenMPI 4.0.2 (GCC 7.3 version)
- GCC 7.3.1 (devtoolset-7)
- cmake 3.16.3

## Files Required

- cp2k-7.1.0.tar.gz
- dbcsr-2.0.1.tar.gz
- tc\_install\_cp2k\_toolchain.sh.diff

```
--- install_cp2k_toolchain.sh.org 2020-01-31 17:07:19.000000000 +0900
+++ install_cp2k_toolchain.sh 2020-01-31 17:07:30.000000000 +0900
@@ -942,8 +942,8 @@
  ./scripts/install_superlu.sh
  ./scripts/install_pexsi.sh
  ./scripts/install_quip.sh
- ./scripts/install_plumed.sh
  ./scripts/install_gsl.sh
+ ./scripts/install_plumed.sh
  ./scripts/install_spglib.sh
  ./scripts/install_hdf5.sh
  ./scripts/install_libvdwxc.sh
```

- tc\_install\_sirius.sh.diff

```
--- install_sirius.sh.org 2020-02-25 14:50:50.000000000 +0900
+++ install_sirius.sh 2020-02-25 14:48:01.000000000 +0900
@@ -131,8 +131,8 @@
  -DSpFFT_DIR="${SPFFT_ROOT}/lib/cmake/SpFFT" \
  -DCMAKE_CXXFLAGS_RELEASE="${SIRIUS_OPT}" \
  -DCMAKE_CXX_FLAGS_RELWITHDEBINFO="${SIRIUS_DBG}" \
- -DCMAKE_CXX_COMPILER=mpic++ \
- -DCMAKE_C_COMPILER=mpicc \
+ -DCMAKE_CXX_COMPILER=${MPICXX} \
+ -DCMAKE_C_COMPILER=${MPICC} \
  ${COMPILE_OPTIONS} .. > compile.log 2>&1
  make -j $NPROCS -C src >> compile.log 2>&1

@@ -155,8 +155,8 @@
  -DCMAKE_CXX_FLAGS_RELWITHDEBINFO="${SIRIUS_DBG}" \
  -DUSE_CUDA=ON \
  -DGPU_MODEL=P100 \
- -DCMAKE_CXX_COMPILER=mpic++ \
- -DCMAKE_C_COMPILER=mpicc ${COMPILE_OPTIONS} .. >> compile.log 2>&1
+ -DCMAKE_CXX_COMPILER=${MPICXX} \
+ -DCMAKE_C_COMPILER=${MPICC} ${COMPILE_OPTIONS} .. >> compile.log 2>&1
  make -j $NPROCS -C src >> compile.log 2>&1
  install -d ${pkg_install_dir}/lib/cuda
  install -d ${pkg_install_dir}/include/cuda
```

- tc\_install\_plumed\_noext.sh.diff

```

--- install_plumed.sh.org    2020-02-19 13:43:07.000000000 +0900
+++ install_plumed.sh    2020-02-19 13:42:49.000000000 +0900
@@ -40,7 +40,7 @@

    echo "Installing from scratch into ${pkg_install_dir}"
    cd plumed-${plumed_ver}
-   ./configure CXX="${MPICXX}" --prefix=${pkg_install_dir} --libdir="${pkg_install_dir}/lib" > configure.log 2>&1
+   ./configure CXX="${MPICXX}" --prefix=${pkg_install_dir} --libdir="${pkg_install_dir}/lib" CXXFLAGS="-I${GSLROOT}/include" LIBS="-L${GSLROOT}/lib" --enable-external-lapack=no --enable-external-blas=no > configure.log 2>&1
    make -j $NPROCS > make.log 2>&1
    make install > install.log 2>&1
    write_checksums "${install_lock_file}" "${SCRIPT_DIR}/${basename ${SCRIPT_NAME}}"
@@ -63,7 +63,7 @@
esac

if [ "$with_plumed" != "_DONTUSE_" ]; then
- PLUMED_LIBS='-lplumed -ldl -lstdc++ -lz -ldl'
+ PLUMED_LIBS='-lplumedKernel -lplumed -ldl -lstdc++ -lz -ldl'
    if [ "$with_plumed" != "_SYSTEM_" ]; then
        cat <<EOF > "${BUILDDIR}/setup_plumed"
        prepend_path LD_LIBRARY_PATH "$pkg_install_dir/lib"

```

## Build Procedure

```

#!/bin/sh

INSTDIR=/local/apl/lx/cp2k710-gnu

VERSION=7.1.0
DBCSR_VERSION=2.0.1

SOURCE_ROOT=/home/users/${USER}/Software/CP2K/${VERSION}

TARBALL=${SOURCE_ROOT}/cp2k-${VERSION}.tar.gz
TARBALL_DBCSR=${SOURCE_ROOT}/dbscr-${DBCSR_VERSION}.tar.gz

TC_PATCH0=${SOURCE_ROOT}/tc_install_cp2k_toolchain.sh.diff
TC_PATCH5=${SOURCE_ROOT}/tc_install_sirius.sh.diff
TC_PATCH9=${SOURCE_ROOT}/tc_install_plumed_noext.sh.diff

PARALLEL=12

#-----
umask 0022
export LANG=C
export LC_ALL=C

module purge
module load scl/devtoolset-7
module load mpi/openmpi/4.0.2/gnu7.3
module load cmake/3.16.3

cd $INSTDIR
if [ -d cp2k-${VERSION} ]; then
    mv cp2k-${VERSION} cp2k-erase
    rm -rf cp2k-erase &
fi
tar xzf ${TARBALL}
sleep 5
mv cp2k-${VERSION}/* .
sleep 5
rm -f cp2k-${VERSION}/.dockerignore
rmdir cp2k-${VERSION}

cd ${INSTDIR}/tools/toolchain

```

```

patch < ${TC_PATCH0}

cd scripts
patch < ${TC_PATCH5}
patch < ${TC_PATCH9}
cd ../

export MPICC=mpicc
export MPICXX=mpicxx
export MPIFC=mpif90

./install_cp2k_toolchain.sh --math-mode=openblas \
    --mpi-mode=openmpi \
    --with-cmake=system \
    --with-mpich=no \
    --with-libxc=install \
    --with-libint=install \
    --with-fftw=install \
    --with-openblas=install \
    --with-scalapack=install \
    --with-reflapack=no \
    --with-mkl=no \
    --with-libxsmm=install \
    --with-elpa=install \
    --with-ptscotch=install \
    --with-pexsi=install \
    --with-parmetis=install \
    --with-superlu=install \
    --with-quip=install \
    --with-plumed=install \
    --with-gsl=install \
    --with-libvdwxc=install \
    --with-spglib=install \
    --with-hdf5=install \
    --with-sfft=install \
    -j ${PARALLEL}

cp install/arch/local.psmf ../arch/rccs.psmf

cd ${INSTDIR}/exts
rmdir dbcscr
tar xzf ${TARBALL_DBCSR}
mv dbcscr-${DBCSCR_VERSION} dbcscr
cd ../
make -j ${PARALLEL} ARCH=rccs VERSION=psmf

```

## Tests

Test script below was executed on ccfep.

```

#!/bin/sh

export LC_ALL=C
export LANG=""

# gcc8
module purge
module load scl/devtoolset-7
module load mpi/openmpi/4.0.2/gnu7.3
module load cmake/3.16.3
#CP2K=/home/users/qf7/Software/CP2K/7.1.0/cp2k-7.1.0-gcc7-openmpi4-openblas
CP2K=/local/apl/ix/cp2k710-gnu

CP2K_ARCH=rccs
CP2K_VER=psmf

```

TIMEOUT=120

PARALLEL=16

ulimit -s unlimited

cd \${CP2K}/regtesting/\${CP2K\_ARCH}/\${CP2K\_VER}

rm -rf LAST-\${CP2K\_ARCH}-\${CP2K\_VER}

# serial test

../../../../tools/regtesting/do\_regtest \

-nobuild \

-nosvn \

-arch \${CP2K\_ARCH} \

-version \${CP2K\_VER} \

-mpiranks 1 \

-ompthreads 1 \

-jobmaxtime \${TIMEOUT} \

-cp2kdir ../../../../ \

-maxtasks \${PARALLEL} >& regtest\_mpi1\_omp1.log

rm -rf LAST-\${CP2K\_ARCH}-\${CP2K\_VER}

# omp test

../../../../tools/regtesting/do\_regtest \

-nobuild \

-nosvn \

-arch \${CP2K\_ARCH} \

-version \${CP2K\_VER} \

-mpiranks 1 \

-ompthreads 2 \

-jobmaxtime \${TIMEOUT} \

-cp2kdir ../../../../ \

-maxtasks \${PARALLEL} >& regtest\_mpi1\_omp2.log

rm -rf LAST-\${CP2K\_ARCH}-\${CP2K\_VER}

# mpi test

../../../../tools/regtesting/do\_regtest \

-nobuild \

-nosvn \

-arch \${CP2K\_ARCH} \

-version \${CP2K\_VER} \

-mpiranks 2 \

-ompthreads 1 \

-jobmaxtime \${TIMEOUT} \

-cp2kdir ../../../../ \

-maxtasks \${PARALLEL} >& regtest\_mpi2\_omp1.log

rm -rf LAST-\${CP2K\_ARCH}-\${CP2K\_VER}

# mpi/openmp test

../../../../tools/regtesting/do\_regtest \

-nobuild \

-nosvn \

-arch \${CP2K\_ARCH} \

-version \${CP2K\_VER} \

-mpiranks 2 \

-ompthreads 2 \

-jobmaxtime \${TIMEOUT} \

-cp2kdir ../../../../ \

-maxtasks \${PARALLEL} >& regtest\_mpi2\_omp2.log

rm -rf LAST-\${CP2K\_ARCH}-\${CP2K\_VER}

# yet another mpi test

../../../../tools/regtesting/do\_regtest \

-nobuild \

-nosvn \

-arch \${CP2K\_ARCH} \

-version \${CP2K\_VER} \

```

-mpiranks 8 \
-ompthreads 1 \
-jobmaxtime ${TIMEOUT} \
-cp2kdir ../../ \
-maxtasks ${PARALLEL} >& regtest_mpi8_omp1.log
rm -rf LAST-${CP2K_ARCH}-${CP2K_VER}

# yet another mpi/openmp test
../../tools/regtesting/do_regtest \
-nobuild \
-nosvn \
-arch ${CP2K_ARCH} \
-version ${CP2K_VER} \
-mpiranks 8 \
-ompthreads 2 \
-jobmaxtime ${TIMEOUT} \
-cp2kdir ../../ \
-maxtasks ${PARALLEL} >& regtest_mpi8_omp2.log
rm -rf LAST-${CP2K_ARCH}-${CP2K_VER}

```

### ■ Result: MPI1 - OMP1

```

----- Summary -----
Number of FAILED tests 1
Number of WRONG tests 0
Number of CORRECT tests 3217
Number of NEW tests 3
Total number of tests 3221

```

- QS/regtest-also-2/ion-pair.inp: RUNTIME FAIL

### ■ Result: MPI1 - OMP2

```

----- Summary -----
Number of FAILED tests 1
Number of WRONG tests 1
Number of CORRECT tests 3216
Number of NEW tests 3
Total number of tests 3221

```

- QS/regtest-also-2/ion-pair.inp: RUNTIME FAIL
- SE/regtest/h2o\_gks\_e.inp: WRONG

### ■ Result: MPI2 - OMP1

```

----- Summary -----
Number of FAILED tests 0
Number of WRONG tests 0
Number of CORRECT tests 3278
Number of NEW tests 8
Total number of tests 3286

```

### ■ Result: MPI2 - OMP2

```

----- Summary -----
Number of FAILED tests 0
Number of WRONG tests 0
Number of CORRECT tests 3278
Number of NEW tests 8
Total number of tests 3286

```

### ■ Result: MPI8 - OMP1

```

----- Summary -----
Number of FAILED tests 0
Number of WRONG tests 9
Number of CORRECT tests 3228

```

Number of NEW tests 6  
Total number of tests 3243

- QS/regtest-mp2-lr/H2O-mp2-gpw-lr.inp: WRONG
- xTB/regtest-2/HF-field-gopt.inp: WRONG
- QS/regtest-mp2-grad/H2O\_grad\_mme.inp: WRONG
- QS/regtest-gpw-4/H2O-debug-5.inp: WRONG
- QS/regtest-gpw-4/H2O-debug-6.inp: WRONG
- QS/regtest-mp2-4/H2O\_NO\_HFX.inp: WRONG
- QS/regtest-rma-3D/H2O-32-dftb-ls-2\_mult.inp: WRONG
- QS/regtest-rma-3D/H2O-32-dftb-ls-2.inp: WRONG
- QS/regtest-mp2-2/H2O-02.inp: WRONG

## Result: MPI8 - OMP2

----- Summary -----  
Number of FAILED tests 0  
Number of WRONG tests 9  
Number of CORRECT tests 3228  
Number of NEW tests 6  
Total number of tests 3243

- QS/regtest-mp2-lr/H2O-mp2-gpw-lr.inp: WRONG
- xTB/regtest-2/HF-field-gopt.inp: WRONG
- QS/regtest-mp2-grad/H2O\_grad\_mme.inp: WRONG
- QS/regtest-gpw-4/H2O-debug-5.inp: WRONG
- QS/regtest-gpw-4/H2O-debug-6.inp: WRONG
- QS/regtest-mp2-4/H2O\_NO\_HFX.inp: WRONG
- QS/regtest-rma-3D/H2O-32-dftb-ls-2\_mult.inp: WRONG
- QS/regtest-rma-3D/H2O-32-dftb-ls-2.inp: WRONG
- QS/regtest-mp2-2/H2O-02.inp: WRONG

## Benchmark

H2O-64.inp was employed for benchmark as in 6.1.0. (output of `grep "CP2K " *.log` is used)  
Ran 21 times, and average of last 20 runs is listed below.

	# of cores				
jobtype	(# of nodes)	MPI	OMP	GPU	elapsed(sec)
core	18 (1)	18	1	-	72.685
small	40 (1)	40	1	-	51.424
small	80 (2)	80	1	-	36.697
small	160 (4)	32	5	-	27.455

## Notes

- GPU versions were skipped for this version; they are not so useful in RCCS for now.
  - SIRIUS GPU version might be efficient if correctly built with MAGMA etc. But skipped this time.
- We couldn't get performance improvement from libgrid (slower than the vanilla one).
  - pyratemp 0.3.2 was used when building libgrid.a. But this version of pyratemp cannot handle \*.template files in xyz\_to\_vab correctly.
  - Applying `sed -i -e "s/\$!/g" -e "s/^\<!/g" -e "s/>!/g"` to \*.template files can solve the issue, although the libgrid.a didn't bring any performance improvement...
    - (Use `sed -i -e "s/\$!/g" -e "s/^\<!/g" -e "s/>!/g"` in the script; above one is valid only when manual execution on terminal.)
- libsmm is simply ignored as in the case of 6.1.0.
- Released version of dbcsr was used in this build. Using master branch of dbcsr is not a good way to build reliable binary.
- At least for GCC build, OpenBlas is better than MKL in terms of performance.
- GCC + Intel MPI failed on building cp2k. MPI module is concerned with this error, but we cannot identify the cause of this error. It might come from the wrong include path setting.
- Couldn't build correctly with OpenMPI 3.1.0. It turned out to be a known issue.
  - <https://github.com/cp2k/dbcsr/issues/141>

- Explicit legacy MPI1 support is required when built with OpenMPI 4.x. (Requested by scalapack (or mkl).)
- gcc8 build is not good as gcc7 one in terms of performance and reliability.