



# Cmake Primer



# What is CMake?

- Cross-platform, open-source build system
- Family of tools for building, testing, and packaging software
- CMake is used to control the software compilation process using platform and compiler independent configuration files
- CMake generates native makefiles or solution files
- First implemented in 2000
- Current release: 3.6.3
- Website: <https://cmake.org/>



# Using CMake

- Command line:

`cmake [<options>] (<path-to-source> | <path-to-existing-build>)`  
configures a build system for the specified cmake project dir

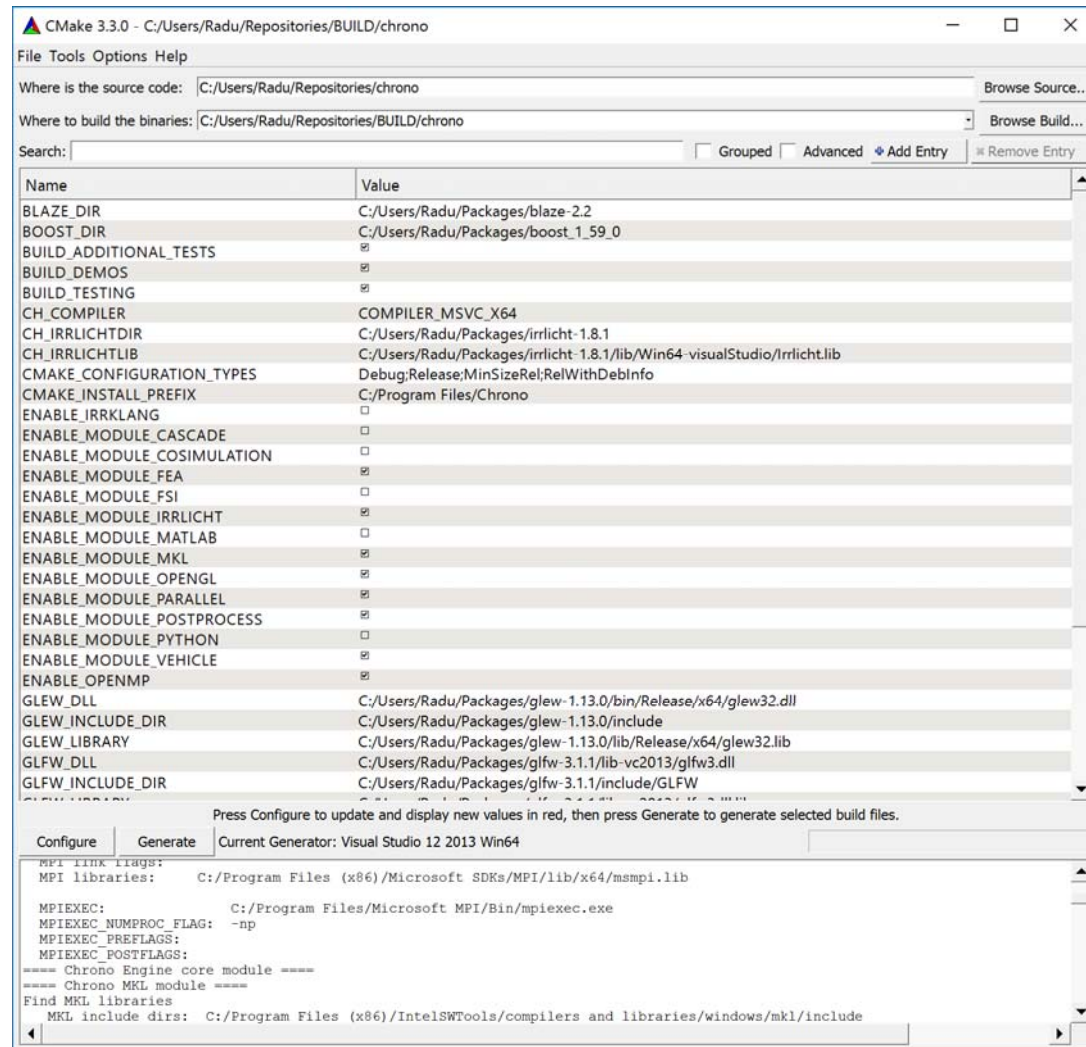
`cmake [(-D<var>=<value>)...] -P <cmake-script-file>`  
executes a cmake script file

`cmake --build <dir> [<options>] [-- <build-tool-options>...]`  
executes the build process through a generic interface

`cmake -E <command> [<options>...]`  
gives you cross platform commands

# Using CMake

- cmake-gui



# Using CMake

- ccmake



```
serban@euler33:~/Repositories/BUILD/chrono
Page 1 of 1
BLAZE_DIR /usr/local/include
BUILD_ADDITIONAL_TESTS ON
BUILD_DEMOS ON
BUILD_TESTING ON
CH_COMPILER COMPILER_GCC_X64
CMAKE_BUILD_TYPE Release
CMAKE_INSTALL_PREFIX /usr/local
ENABLE_MODULE_CASCADE OFF
ENABLE_MODULE_COSIMULATION OFF
ENABLE_MODULE_FEA ON
ENABLE_MODULE_FSI OFF
ENABLE_MODULE_IRRLICHT OFF
ENABLE_MODULE_MATLAB OFF
ENABLE_MODULE_MKL ON
ENABLE_MODULE_OPENGL ON
ENABLE_MODULE_PARALLEL ON
ENABLE_MODULE_POSTPROCESS OFF
ENABLE_MODULE_PYTHON OFF
ENABLE_MODULE_VEHICLE ON
ENABLE_OPENMP ON
GLEW_INCLUDE_DIR /usr/local/include
GLEW_LIBRARY /usr/lib64/libGLEW.so
GLFW_INCLUDE_DIR /usr/local/include/GLFW
GLFW_LIBRARY /usr/local/lib/libglfw.so
GLM_INCLUDE_DIR /usr/local/include
IOMP5_LIBRARY /usr/local/intel/2016/compilers_and_libraries_2016.2.181/linux/compiler/lib/intel64
MATH_LIBRARY /usr/local/intel/2016/compilers_and_libraries_2016.2.181/linux/compiler/lib/intel64
MPI_EXTRA_LIBRARY /usr/local/openmpi/1.10.0/lib/libmpi.so
MPI_LIBRARY /usr/local/openmpi/1.10.0/lib/libmpi_cxx.so
PTHREAD_LIBRARY /usr/lib64/libpthread.so
USE_PARALLEL_CUDA OFF
USE_PARALLEL_DOUBLE ON
USE_PARALLEL_SIMD ON

BLAZE_DIR: Path to a file.
Press [enter] to edit option
Press [c] to configure
Press [h] for help Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)
CMake Version 2.8.11
```

# The CMake build process

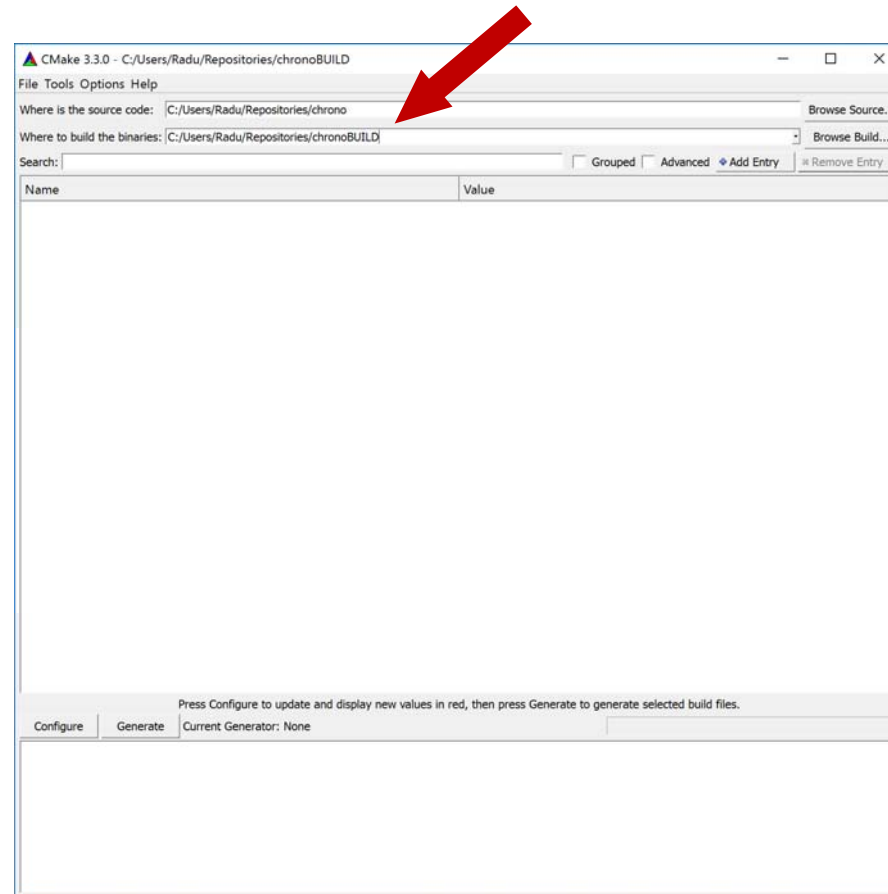
- Consists of two stages:
  1. Create standard (platform-specific) build files from the configuration files
  2. Use the platform native build tools for the actual building
- Creating the build files
  - always prefer out-of-source builds
  - if using cmake-gui, **select the generator** (for Chrono, make sure to use 64-bit)
  - [iterate] set options → **configure**
  - **generate**



# Chrono CMake configuration

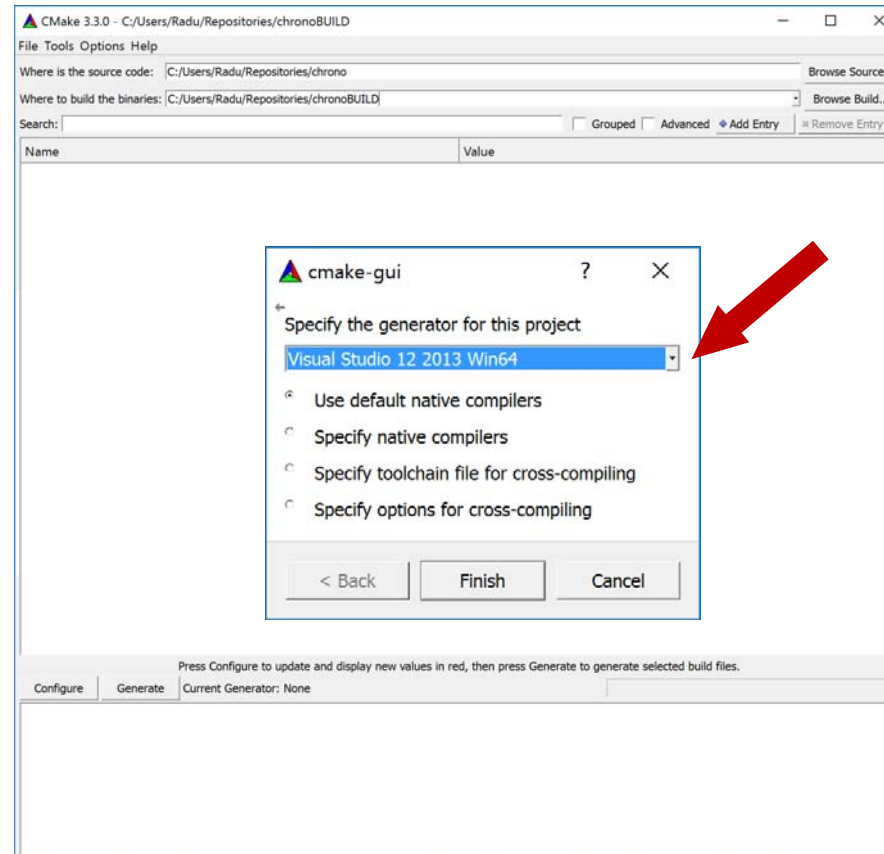
Using cmake-gui on Windows

# Specify source and build locations

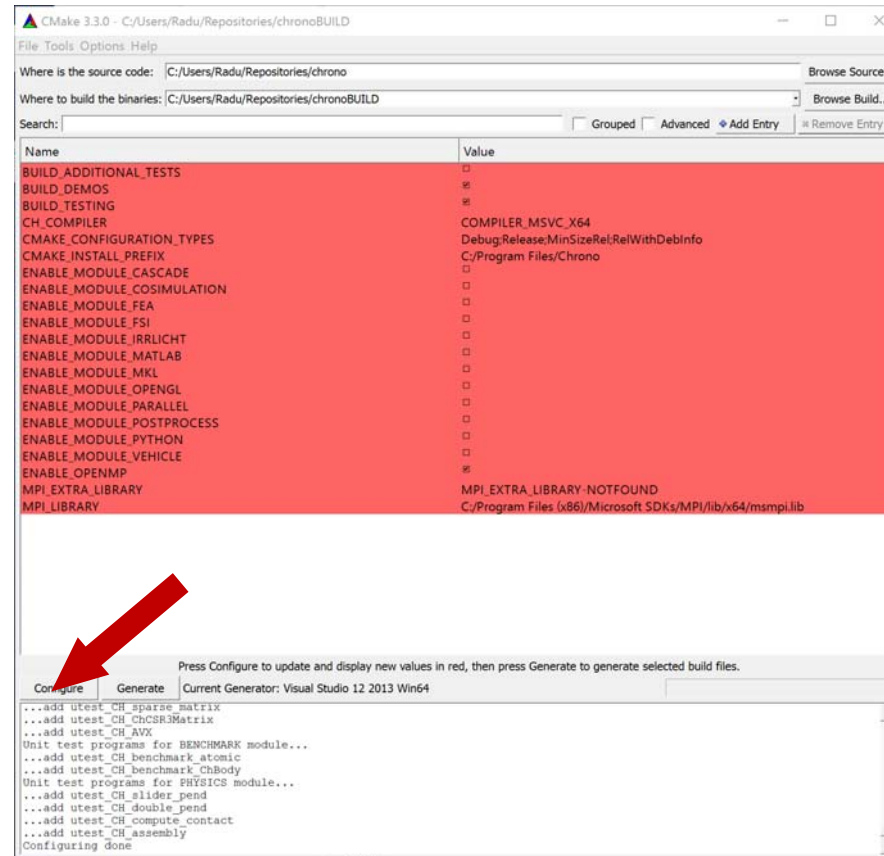




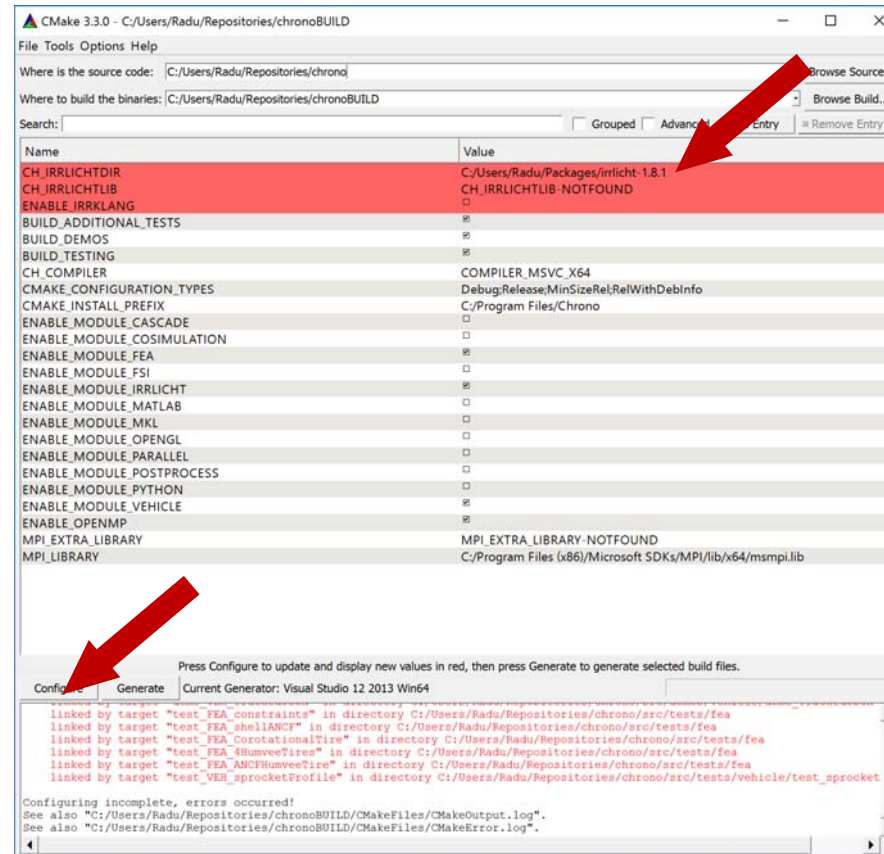
# Select generator



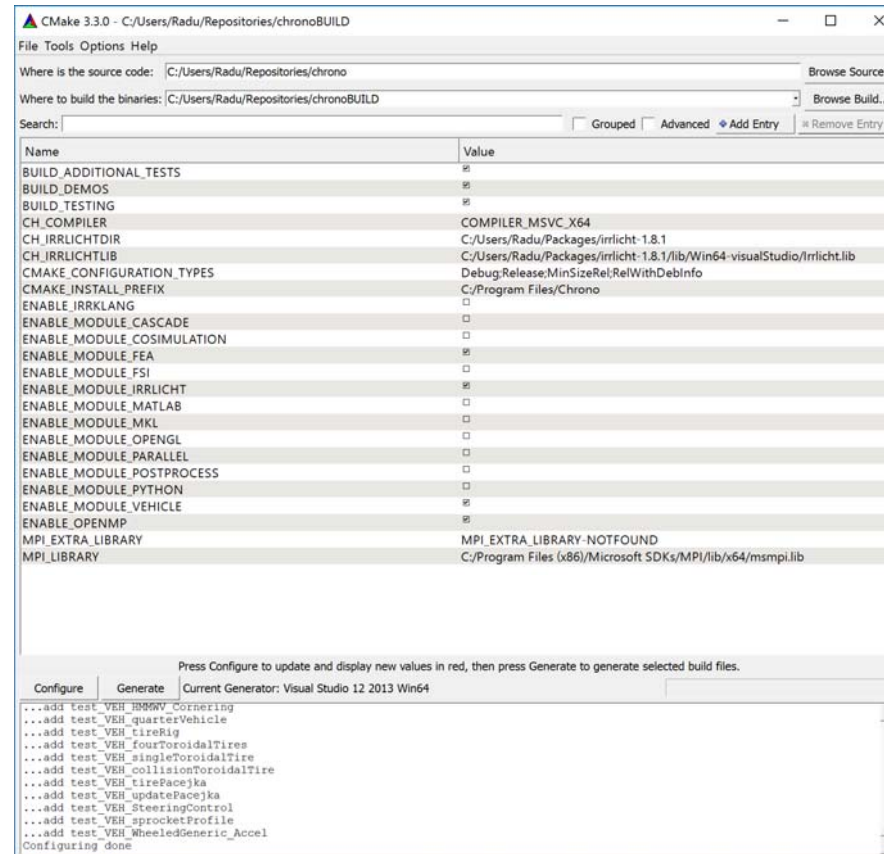
# Set configuration options



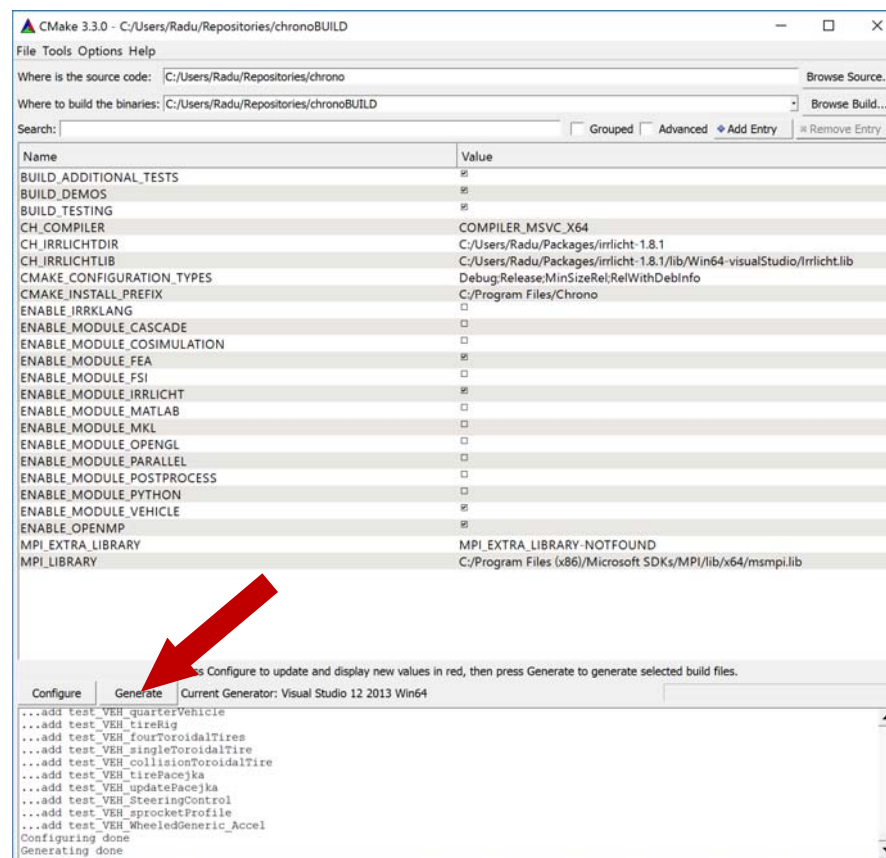
# Set new configuration options



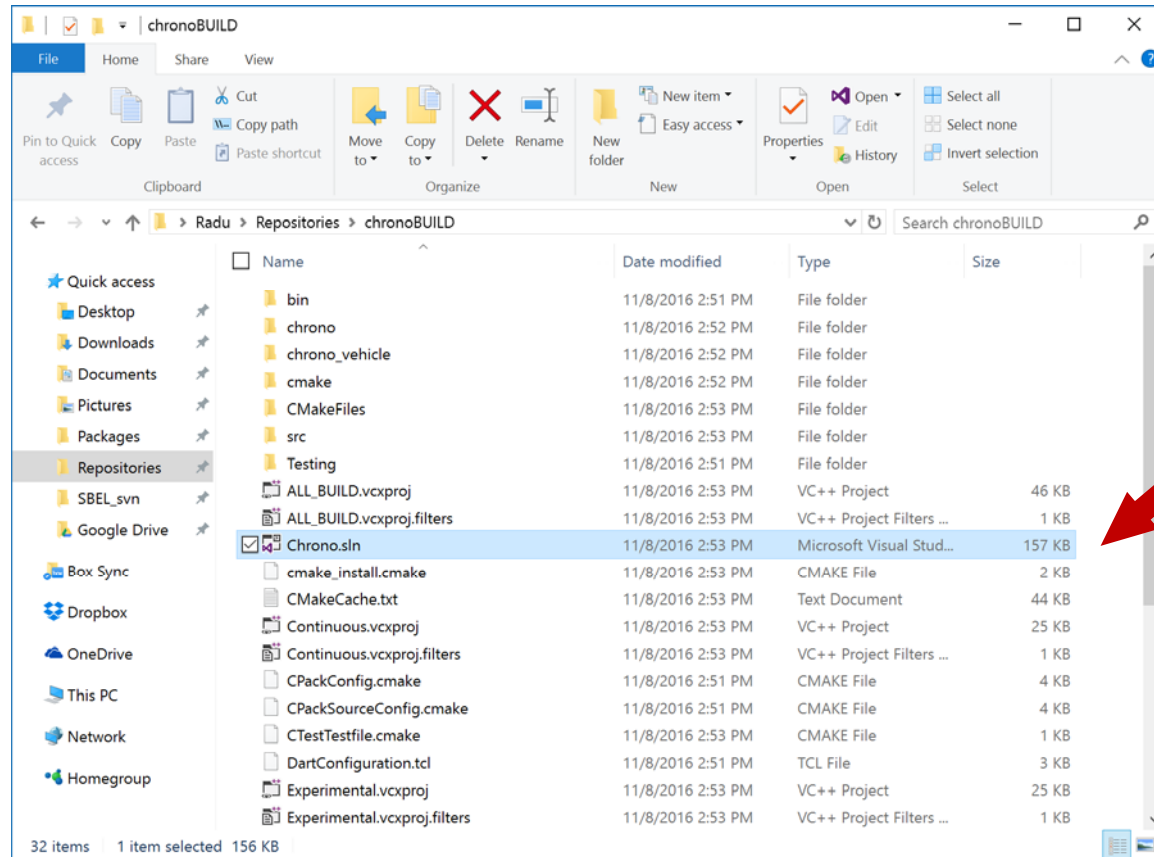
# Iterate until all dependencies are resolved



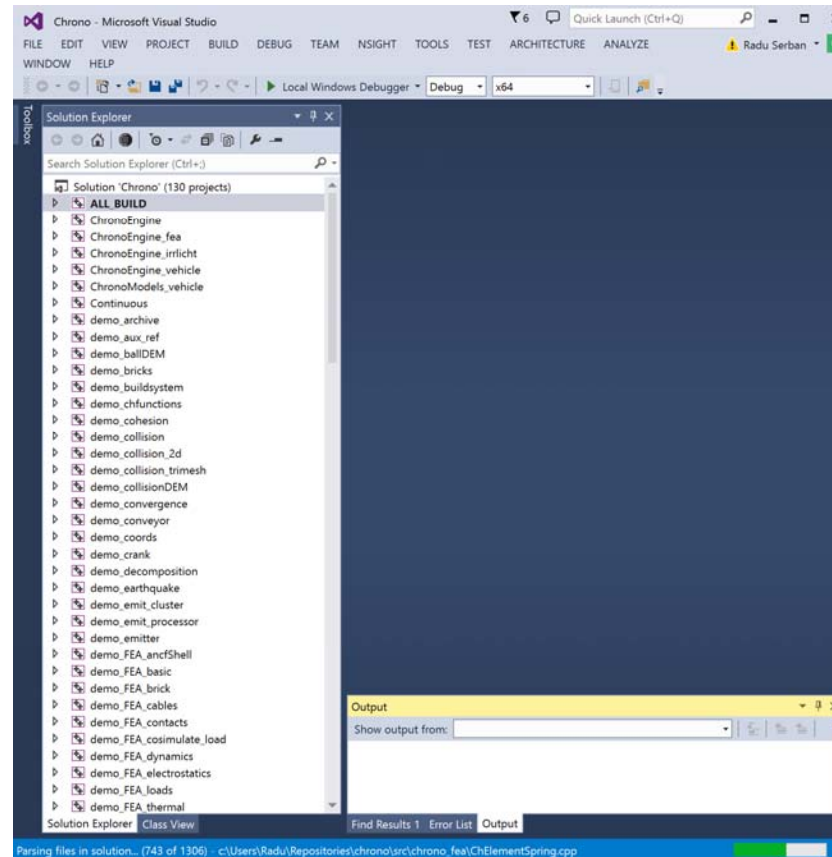
# Generate native build files (VS solution file)



# Generated solution file



# Build project





# Chrono CMake configuration

Using cmake on Linux



# Prepare out-of-source build



```
serban@euler33:~/Repositories/chronoBUILD
[serban@euler33 ~/Repositories/chrono]$ pwd
/srv/home/serban/Repositories/chrono
[serban@euler33 ~/Repositories/chrono]$ cd ..
[serban@euler33 ~/Repositories]$ mkdir chronoBUILD
[serban@euler33 ~/Repositories]$ cd chronoBUILD
[serban@euler33 ~/Repositories/chronoBUILD]$ cmake ../chrono
```

# Initial configuration



```
serban@euler33:~/Repositories/chronoBUILD
Page 0 of 1
EMPTY CACHE

EMPTY CACHE
Press [enter] to edit option
Press [c] to configure
Press [h] for help          Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)
CMake Version 2.8.11
```

# Default settings



```
serban@euler33:~/Repositories/chronoBUILD
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BUILD_ADDITIONAL_TESTS  OFF
BUILD_DEMOS              ON
BUILD_TESTING            ON
CH_COMPILER              *COMPILER_GCC_X64
CMAKE_BUILD_TYPE         *
CMAKE_INSTALL_PREFIX     */usr/local
ENABLE_MODULE_CASCADE    OFF
ENABLE_MODULE_COSIMULATION OFF
ENABLE_MODULE_FEA        OFF
ENABLE_MODULE_FSI        OFF
ENABLE_MODULE_IRRLICHT   OFF
ENABLE_MODULE_MATLAB     OFF
ENABLE_MODULE_MKL        OFF
ENABLE_MODULE_OPENGL     OFF
ENABLE_MODULE_PARALLEL   OFF
ENABLE_MODULE_POSTPROCESS OFF
ENABLE_MODULE_PYTHON     OFF
ENABLE_MODULE_VEHICLE    OFF
ENABLE_OPENMP            ON
MPI_EXTRA_LIBRARY        */usr/local/openmpi/1.10.0/lib/libmpi.so
MPI_LIBRARY              */usr/local/openmpi/1.10.0/lib/libmpi_cxx.so

BUILD ADDITIONAL TESTS: Build additional test programs
Press [enter] to edit option
Press [c] to configure
Press [h] for help          Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)

CMake Version 2.8.11
```

# Set options



```
serban@euler33:~/Repositories/chronoBUILD
BUILD_ADDITIONAL_TESTS  ON
BUILD_DEMOS              ON
BUILD_TESTING            ON
CH_COMPILER              64
CMAKE_BUILD_TYPE         Release
CMAKE_INSTALL_PREFIX     /usr/local
ENABLE_MODULE_CASCADE    OFF
ENABLE_MODULE_COSIMULATION OFF
ENABLE_MODULE_FEA        ON
ENABLE_MODULE_FSI        OFF
ENABLE_MODULE_IRRLICHT   ON
ENABLE_MODULE_MATLAB     OFF
ENABLE_MODULE_MKL        OFF
ENABLE_MODULE_OPENGL     OFF
ENABLE_MODULE_PARALLEL   OFF
ENABLE_MODULE_POSTPROCESS OFF
ENABLE_MODULE_PYTHON     OFF
ENABLE_MODULE_VEHICLE    ON
ENABLE_OPENMP            ON
MPI_EXTRA_LIBRARY        /usr/local/openmpi/1.10.0/lib/libmpi.so
MPI_LIBRARY              /usr/local/openmpi/1.10.0/lib/libmpi_cxx.so

ENABLE_MODULE_VEHICLE: Enable the Chrono Vehicle module
Press [enter] to edit option
Press [c] to configure
Press [h] for help      Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)
CMake Version 2.8.11
```

# Iterate



```
serban@euler33:~/Repositories/chronoBUILD
Page 1 of 1

BUILD_ADDITIONAL_TESTS ON
BUILD_DEMOS ON
BUILD_TESTING ON
CH_COMPILER COMPILER_GCC_X64
CH_IRRLICHTDIR /usr/local/irrlicht/1.8.3
CH_IRRLICHTLIB /usr/local/irrlicht/1.8.3/lib/libIrrlicht.so
CMAKE_BUILD_TYPE Release
CMAKE_INSTALL_PREFIX /usr/local
ENABLE_IRRKLING OFF
ENABLE_MODULE_CASCADE OFF
ENABLE_MODULE_COSIMULATION OFF
ENABLE_MODULE_FEA ON
ENABLE_MODULE_FSI OFF
ENABLE_MODULE_IRRLICHT ON
ENABLE_MODULE_MATLAB OFF
ENABLE_MODULE_MKL OFF
ENABLE_MODULE_OPENGL OFF
ENABLE_MODULE_PARALLEL OFF
ENABLE_MODULE_POSTPROCESS OFF
ENABLE_MODULE_PYTHON OFF
ENABLE_MODULE_VEHICLE ON
ENABLE_OPENMP ON
MPI_EXTRA_LIBRARY /usr/local/openmpi/1.10.0/lib/libmpi.so
MPI_LIBRARY /usr/local/openmpi/1.10.0/lib/libmpi_cxx.so

CH_IRRLICHTLIB: Path to a library.
Press [enter] to edit option
Press [c] to configure
Press [h] for help Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)

CH_IRRLICHTLIB: Path to a library.
Press [enter] to edit option
Press [c] to configure
Press [h] for help Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)

CMake Version 2.8.11
```

# Generate native build files (Unix makefiles)

```

serban@euler33:~/Repositories/chronoBUILD
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BUILD_ADDITIONAL_TESTS  ON
BUILD_DEMOS              ON
BUILD_TESTING            ON
CH_COMPILER              COMPILER GCC_X64
CH_IRRLICHTDIR           /usr/local/irrlicht/1.8.3
CH_IRRLICHTLIB           /usr/local/irrlicht/1.8.3/lib/libIrrlicht.so
CMAKE_BUILD_TYPE         Release
CMAKE_INSTALL_PREFIX     /usr/local
ENABLE_IRRKLING           OFF
ENABLE_MODULE_CASCADE    OFF
ENABLE_MODULE_COSIMULATION OFF
ENABLE_MODULE_FEA        ON
ENABLE_MODULE_FSI        OFF
ENABLE_MODULE_IRRLICHT   ON
ENABLE_MODULE_MATLAB     OFF
ENABLE_MODULE_MKL        OFF
ENABLE_MODULE_OPENGL     OFF
ENABLE_MODULE_PARALLEL   OFF
ENABLE_MODULE_POSTPROCESS OFF
ENABLE_MODULE_PYTHON     OFF
ENABLE_MODULE_VEHICLE    ON
ENABLE_OPENMP            ON
MPI_EXTRA_LIBRARY        /usr/local/openmpi/1.10.0/lib/libmpi.so
MPI_LIBRARY              /usr/local/openmpi/1.10.0/lib/libmpi_cxx.so

BUILD_ADDITIONAL_TESTS: Build additional test programs
Press [enter] to edit option
Press [c] to configure      Press [g] to generate and exit
Press [h] for help          Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)

BUILD_ADDITIONAL_TESTS: Build additional test programs
Press [enter] to edit option
Press [c] to configure      Press [g] to generate and exit
Press [h] for help          Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)
CMake Version 2.8.11

```

BUILD\_ADDITIONAL\_TESTS: Build additional test programs  
 Press [enter] to edit option  
 Press [c] to configure      Press [g] to generate and exit  
 Press [h] for help          Press [q] to quit without generating  
 Press [t] to toggle advanced mode (Currently Off)

# Generated makefile



```
serban@euler33:~/Repositories/chronoBUILD
[serban@euler33 ~/Repositories/chrono]$ pwd
/srv/home/serban/Repositories/chrono
[serban@euler33 ~/Repositories/chrono]$ cd ..
[serban@euler33 ~/Repositories]$ mkdir chronoBUILD
[serban@euler33 ~/Repositories]$ cd chronoBUILD
[serban@euler33 ~/Repositories/chronoBUILD]$ cmake ../chrono

[serban@euler33 ~/Repositories/chronoBUILD]$ ls
bin/          cmake/          cmake_install.cmake  CPackSourceConfig.cmake  data/          serban/
chrono/       CMakeCache.txt compile_commands.json CTestTestfile.cmake     lib64/         src/
chrono_vehicle/ CMakeFiles/    CPackConfig.cmake    DartConfiguration.tcl    Makefile
```

# Build project



% make

```
serban@euler33:~/Repositories/chronoBUILD
[ 4%] [ 4%] [ 4%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChForce.cpp.o
[ 4%] [ 4%] [ 4%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChBodyAuxRef.cpp.o
[ 4%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChBody.cpp.o
[ 4%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkForce.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkMask.cpp.o
[ 5%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkDistance.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLink.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkMasked.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkLock.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkBase.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkMarkers.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkBrake.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkBushing.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkGear.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkLinActuator.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkEngine.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkPulley.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkSpringCB.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkScrew.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkSpring.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkPneumaticActuator.cpp.o
[ 5%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkWheel.cpp.o
[ 5%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkClearance.cpp.o
[ 5%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkPointSpline.cpp.o
[ 6%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkTrajectory.cpp.o
[ 6%] [ 6%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkMate.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkRackpinion.cpp.o
[ 6%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkRevolute.cpp.o
[ 6%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkRevoluteSpherical.cpp.o
[ 6%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkRevoluteTranslational.cpp.o
[ 6%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChLinkUniversal.cpp.o
[ 7%] [ 7%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChGlobal.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChSystem.cpp.o
[ 7%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChEvents.cpp.o
[ 7%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChSolveMain.cpp.o
[ 7%] [ 7%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChControls.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChProbe.cpp.o
[ 7%] [ 8%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChController.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChIterative.cpp.o
[ 8%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChRef.cpp.o
[ 8%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChGenericConstraint.cpp.o
[ 8%] [ 8%] Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChParticlesClones.cpp.o
Building CXX object src/chrono/CMakeFiles/ChronoEngine.dir/physics/ChPhysicsItem.cpp.o
```