



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

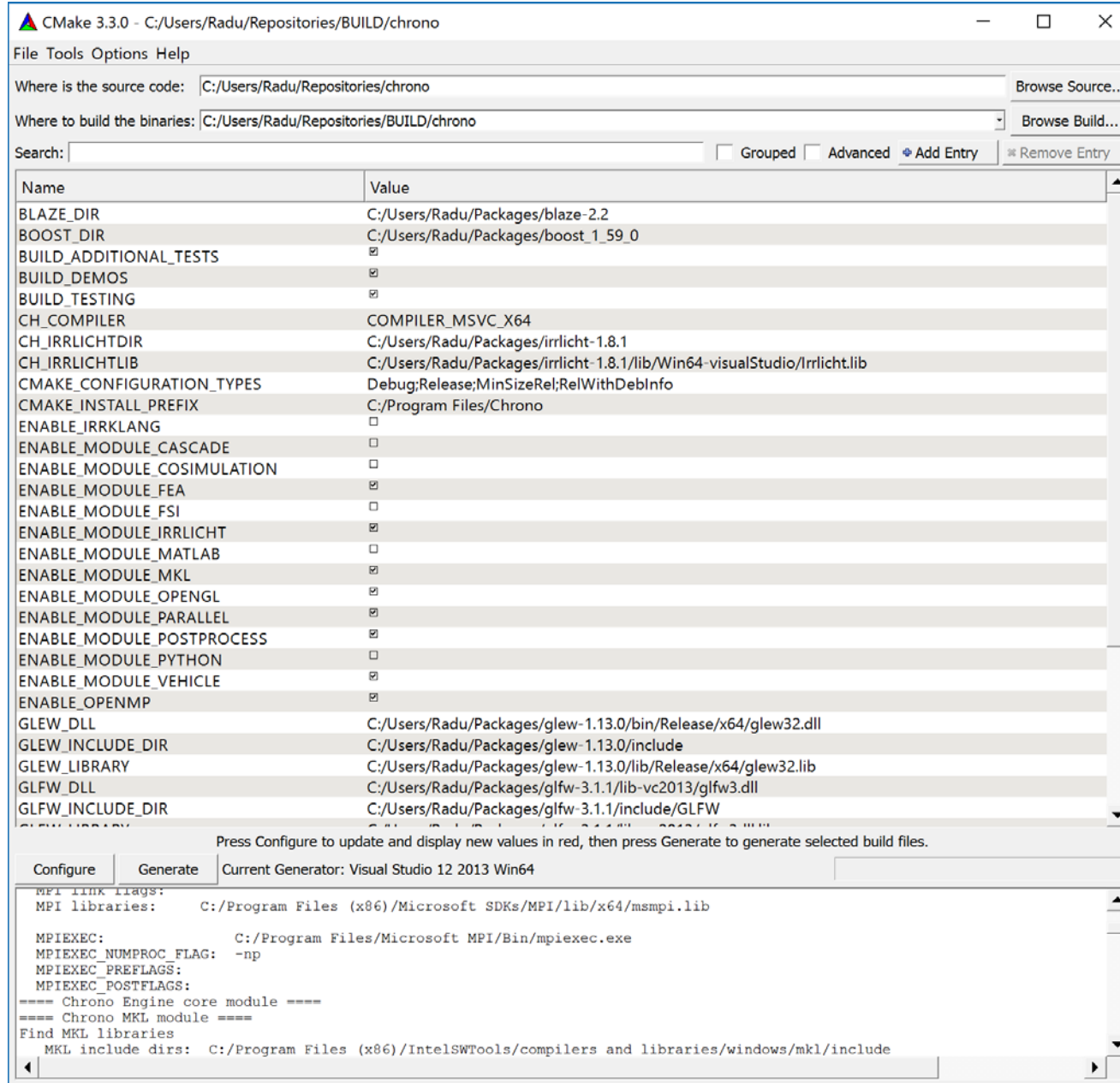
`cmake [(-D<var>=<value>)...] -P <cmake-script-file>`
executes a cmake script file

`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



CMake 3.3.0 - C:/Users/Radu/Repositories/BUILD/chrono

File Tools Options Help

Where is the source code: C:/Users/Radu/Repositories/chrono Browse Source...

Where to build the binaries: C:/Users/Radu/Repositories/BUILD/chrono Browse Build...

Search: Grouped Advanced Add Entry Remove Entry

Name	Value
BLAZE_DIR	C:/Users/Radu/Packages/blaze-2.2
BOOST_DIR	C:/Users/Radu/Packages/boost_1_59_0
BUILD_ADDITIONAL_TESTS	<input checked="" type="checkbox"/>
BUILD_DEMOS	<input checked="" type="checkbox"/>
BUILD_TESTING	<input checked="" type="checkbox"/>
CH_COMPILER	COMPILER_MSVC_X64
CH_IRRLICHTDIR	C:/Users/Radu/Packages/irrlicht-1.8.1
CH_IRRLICHTLIB	C:/Users/Radu/Packages/irrlicht-1.8.1/lib/Win64-visualStudio/Irrlicht.lib
CMAKE_CONFIGURATION_TYPES	Debug;Release;MinSizeRel;RelWithDebInfo
CMAKE_INSTALL_PREFIX	C:/Program Files/Chrono
ENABLE_IRRKLING	<input type="checkbox"/>
ENABLE_MODULE_CASCADE	<input type="checkbox"/>
ENABLE_MODULE_COSIMULATION	<input type="checkbox"/>
ENABLE_MODULE_FEA	<input checked="" type="checkbox"/>
ENABLE_MODULE_FSI	<input type="checkbox"/>
ENABLE_MODULE_IRRLICHT	<input checked="" type="checkbox"/>
ENABLE_MODULE_MATLAB	<input type="checkbox"/>
ENABLE_MODULE_MKL	<input checked="" type="checkbox"/>
ENABLE_MODULE_OPENGL	<input checked="" type="checkbox"/>
ENABLE_MODULE_PARALLEL	<input checked="" type="checkbox"/>
ENABLE_MODULE_POSTPROCESS	<input checked="" type="checkbox"/>
ENABLE_MODULE_PYTHON	<input type="checkbox"/>
ENABLE_MODULE_VEHICLE	<input checked="" type="checkbox"/>
ENABLE_OPENMP	<input checked="" type="checkbox"/>
GLEW_DLL	C:/Users/Radu/Packages/glew-1.13.0/bin/Release/x64/glew32.dll
GLEW_INCLUDE_DIR	C:/Users/Radu/Packages/glew-1.13.0/include
GLEW_LIBRARY	C:/Users/Radu/Packages/glew-1.13.0/lib/Release/x64/glew32.lib
GLFW_DLL	C:/Users/Radu/Packages/glfw-3.1.1/lib-vc2013/glfw3.dll
GLFW_INCLUDE_DIR	C:/Users/Radu/Packages/glfw-3.1.1/include/GLFW

Press Configure to update and display new values in red, then press Generate to generate selected build files.

Current Generator: Visual Studio 12 2013 Win64

```
MPI link flags:
MPI libraries: C:/Program Files (x86)/Microsoft SDKs/MPI/lib/x64/msmpi.lib

MPIEXEC: C:/Program Files/Microsoft MPI/Bin/mpiexec.exe
MPIEXEC_NUMPROC_FLAG: -np
MPIEXEC_PREFLAGS:
MPIEXEC_POSTFLAGS:
==== Chrono Engine core module ====
==== Chrono MKL module ====
Find MKL libraries
MKL include dirs: C:/Program Files (x86)/IntelSWTools/compilers and libraries/windows/mkl/include
```

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
```

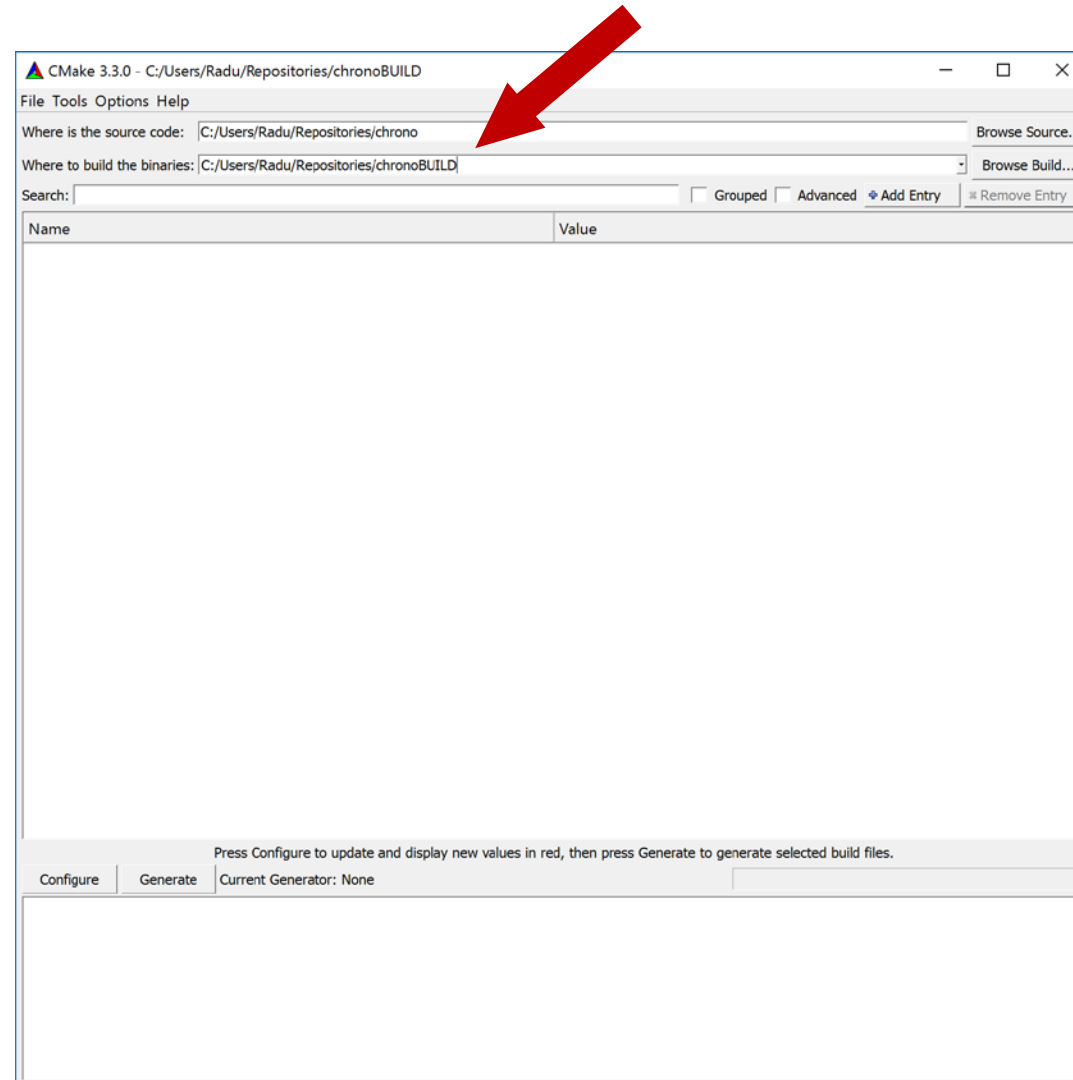
The CMake build process

- 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**

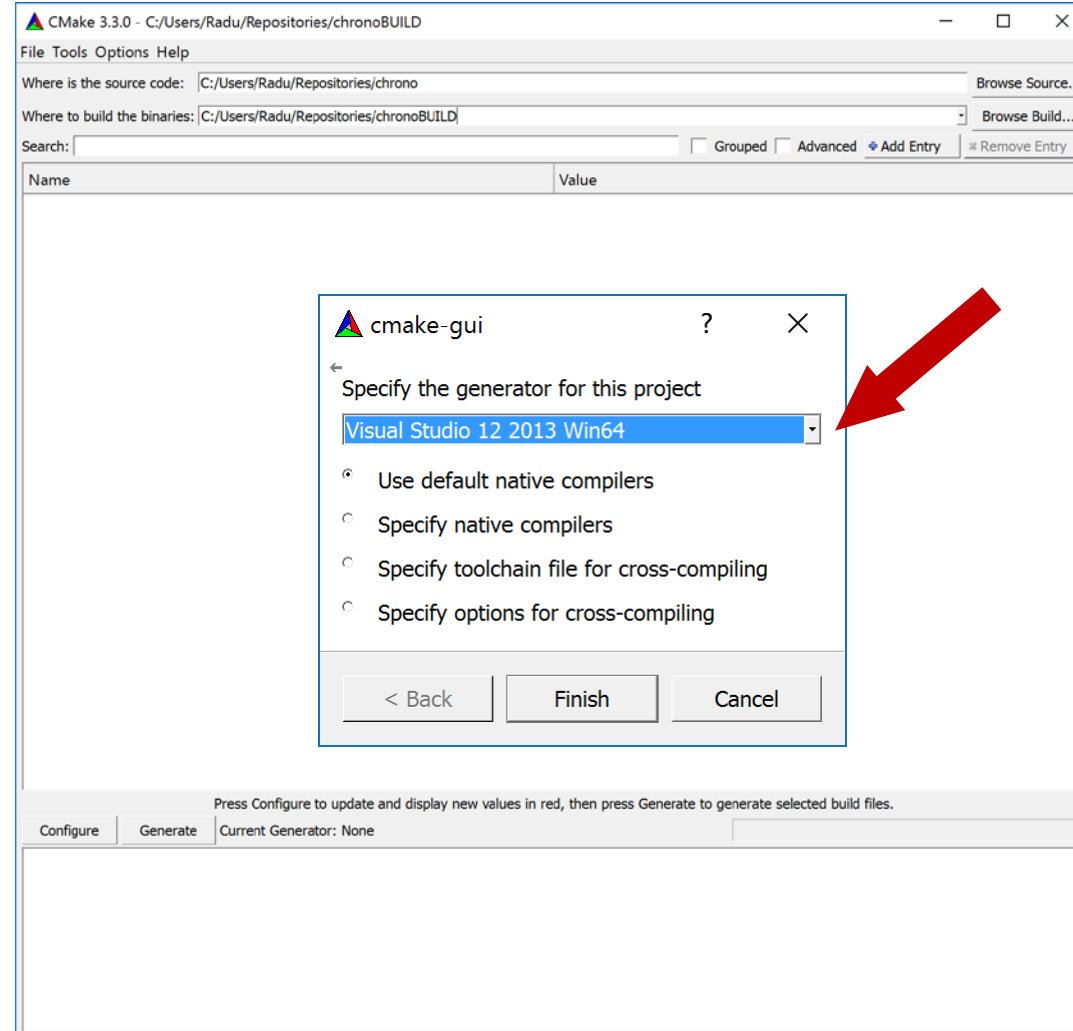
Chrono CMake configuration

Using cmake-gui on Windows

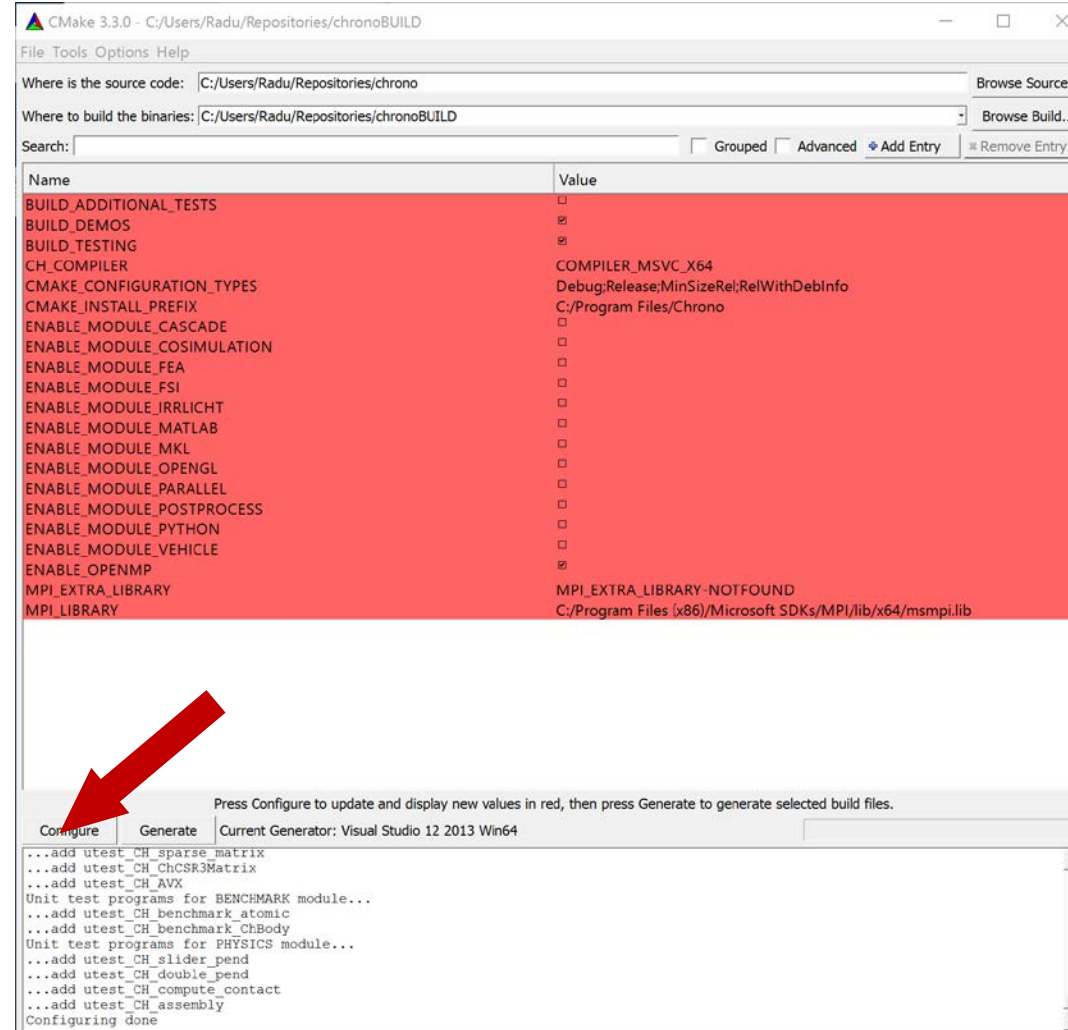
Specify source and build locations



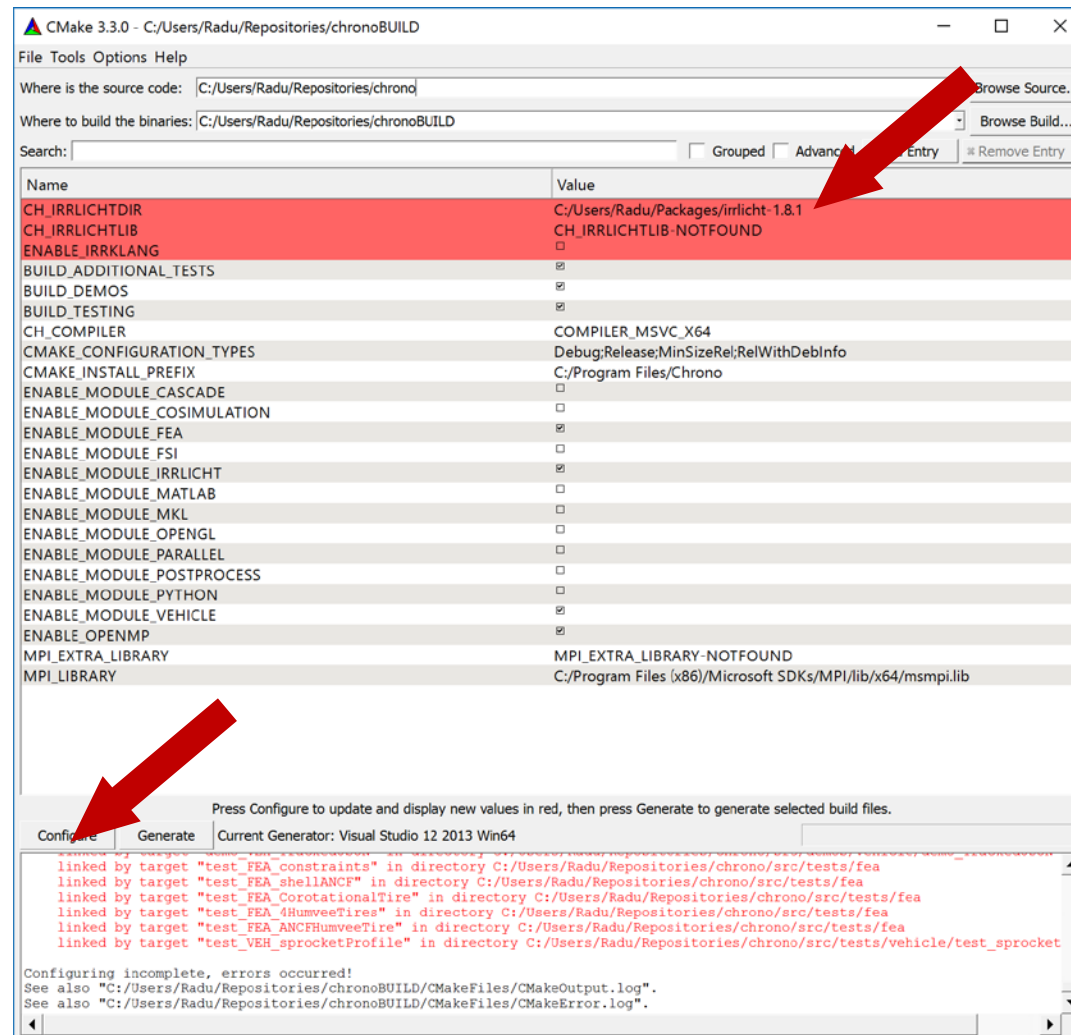
Select generator



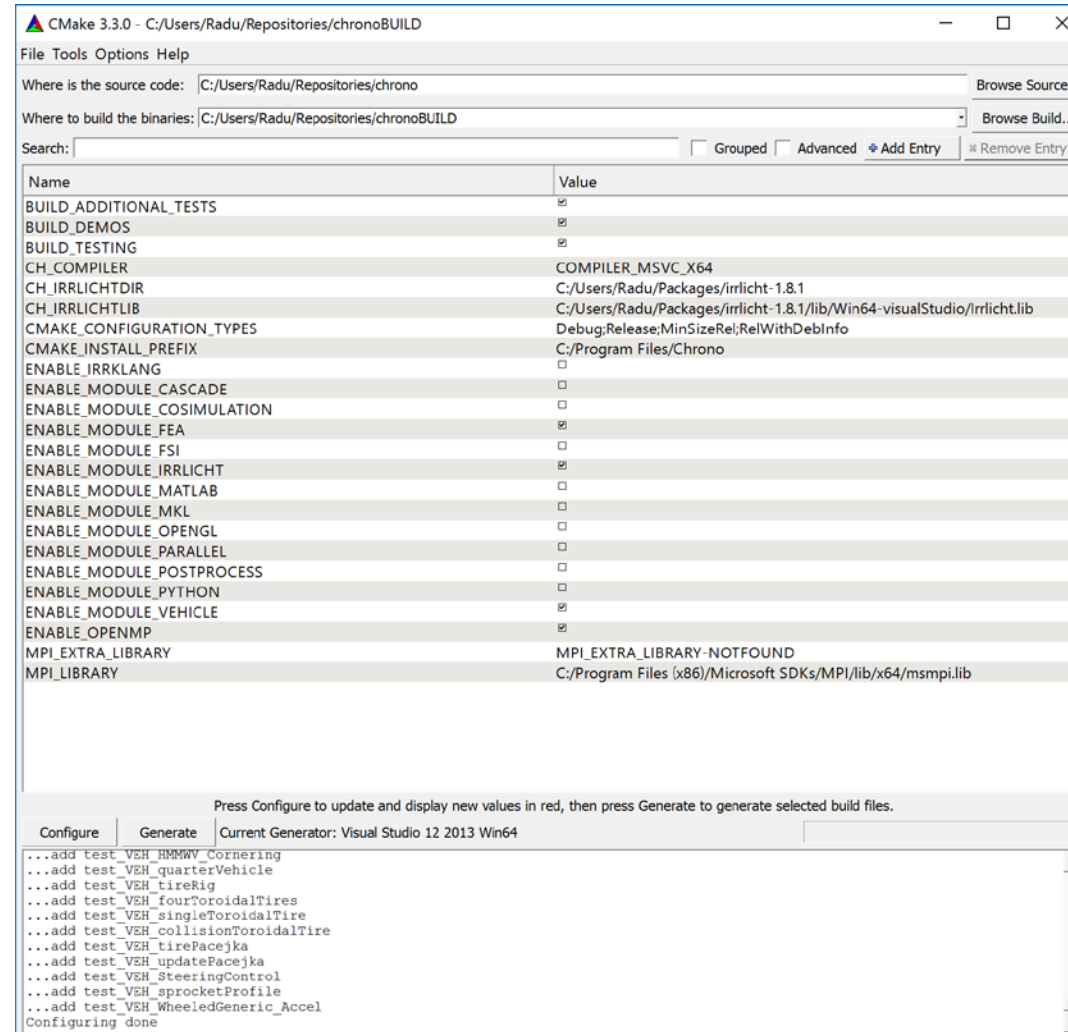
Set configuration options



Set new configuration options



Iterate until all dependencies are resolved



Generate native build files (VS solution file)

CMake 3.3.0 - C:/Users/Radu/Repositories/chronoBUILD

File Tools Options Help

Where is the source code: C:/Users/Radu/Repositories/chrono Browse Source...

Where to build the binaries: C:/Users/Radu/Repositories/chronoBUILD Browse Build...

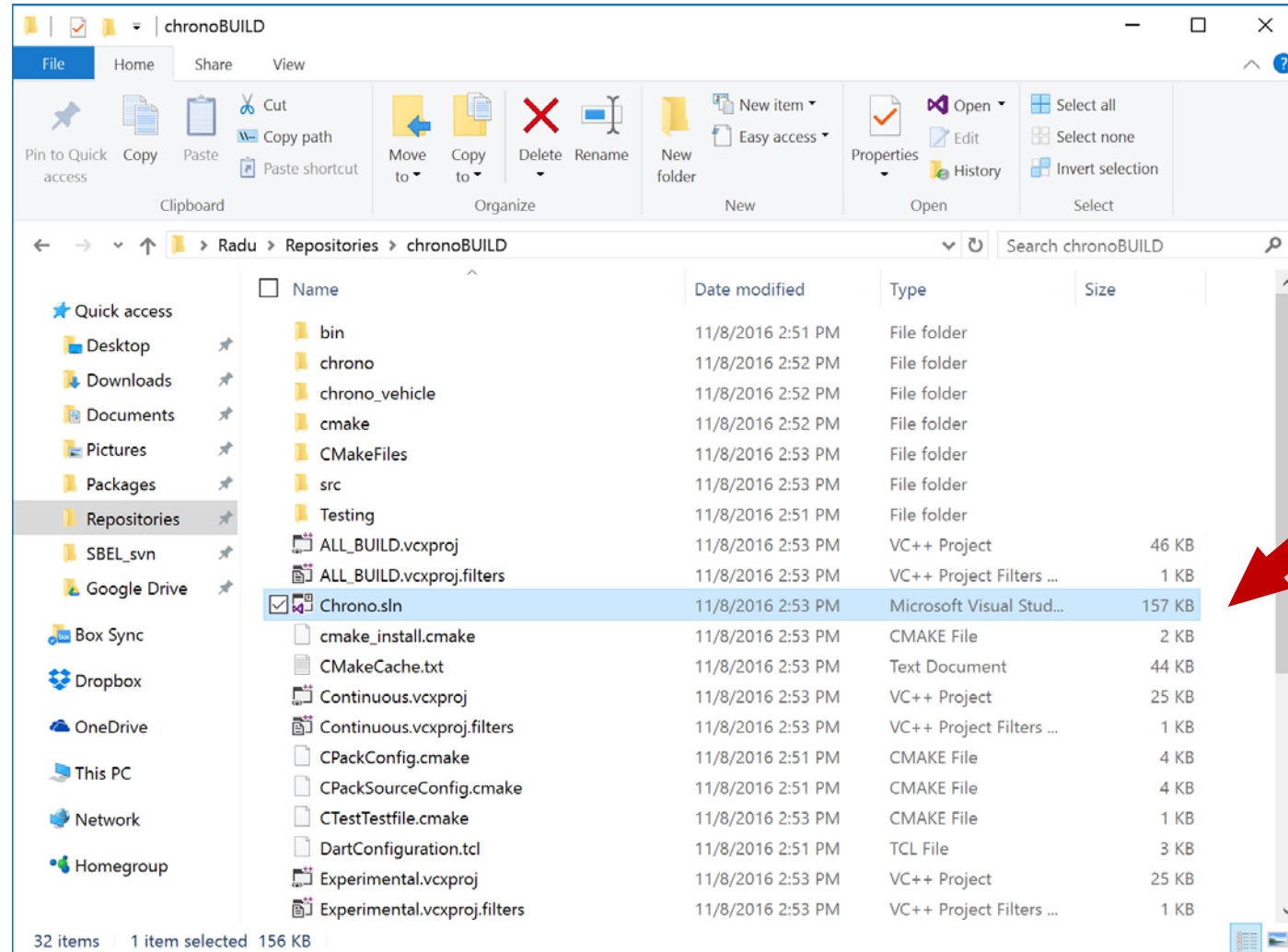
Search: Grouped Advanced ◆ Add Entry ≡ Remove Entry

Name	Value
BUILD_ADDITIONAL_TESTS	<input checked="" type="checkbox"/>
BUILD_DEMOS	<input checked="" type="checkbox"/>
BUILD_TESTING	<input checked="" type="checkbox"/>
CH_COMPILER	COMPILER_MSVC_X64
CH_IRRLICHTDIR	C:/Users/Radu/Packages/irrlight-1.8.1
CH_IRRLICHTLIB	C:/Users/Radu/Packages/irrlight-1.8.1/lib/Win64-visualStudio/irrlight.lib
CMAKE_CONFIGURATION_TYPES	Debug;Release;MinSizeRel;RelWithDebInfo
CMAKE_INSTALL_PREFIX	C:/Program Files/Chrono
ENABLE_IRRCLANG	<input type="checkbox"/>
ENABLE_MODULE_CASCADE	<input type="checkbox"/>
ENABLE_MODULE_COSIMULATION	<input type="checkbox"/>
ENABLE_MODULE_FEA	<input checked="" type="checkbox"/>
ENABLE_MODULE_FSI	<input type="checkbox"/>
ENABLE_MODULE_IRRLICHT	<input checked="" type="checkbox"/>
ENABLE_MODULE_MATLAB	<input type="checkbox"/>
ENABLE_MODULE_MKL	<input type="checkbox"/>
ENABLE_MODULE_OPENGL	<input type="checkbox"/>
ENABLE_MODULE_PARALLEL	<input type="checkbox"/>
ENABLE_MODULE_POSTPROCESS	<input type="checkbox"/>
ENABLE_MODULE_PYTHON	<input type="checkbox"/>
ENABLE_MODULE_VEHICLE	<input checked="" type="checkbox"/>
ENABLE_OPENMP	<input checked="" type="checkbox"/>
MPI_EXTRA_LIBRARY	MPI_EXTRA_LIBRARY-NOTFOUND
MPI_LIBRARY	C:/Program Files (x86)/Microsoft SDKs/MPI/lib/x64/msmpi.lib

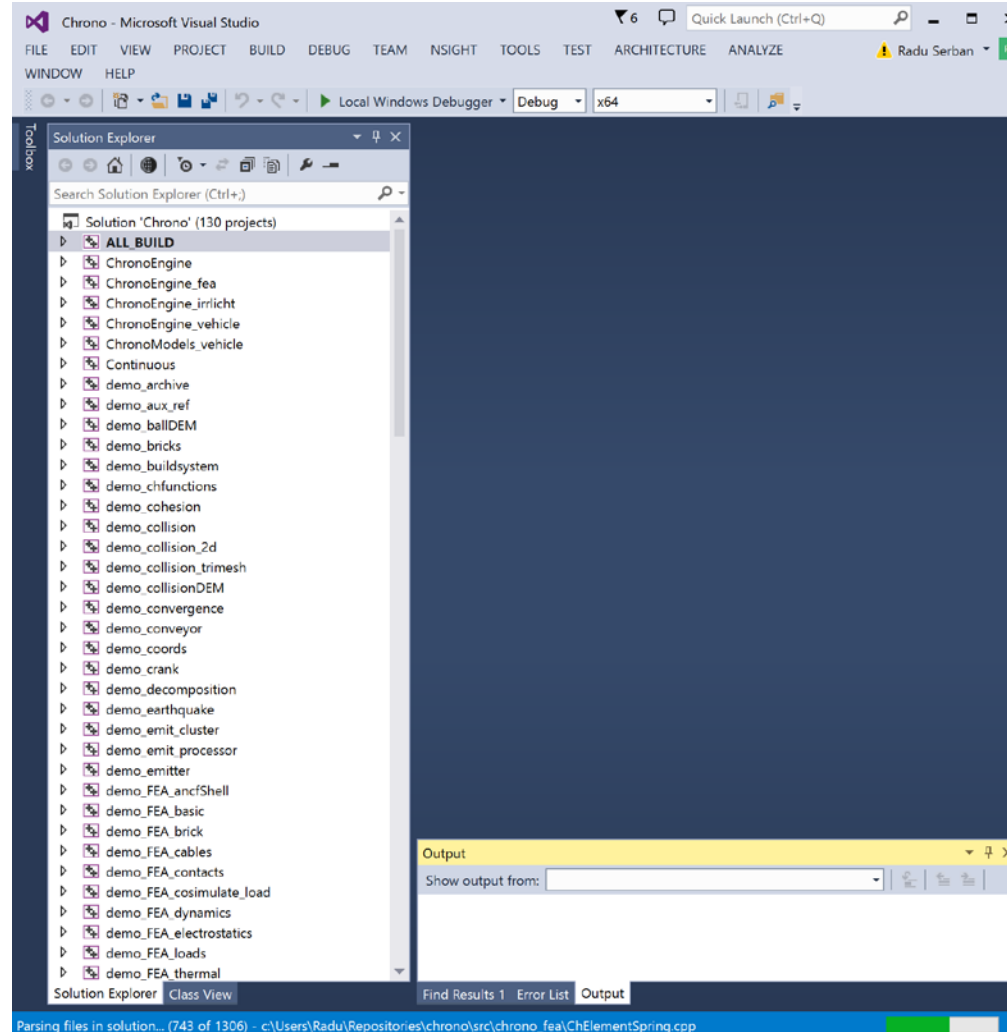
Configure Generate Current Generator: Visual Studio 12 2013 Win64

...add test_VEH_quarterVehicle
 ...add test_VEH_tireRig
 ...add test_VEH_fourToroidalTires
 ...add test_VEH_singleToroidalTire
 ...add test_VEH_collisionToroidalTire
 ...add test_VEH_tirePacejka
 ...add test_VEH_updatePacejka
 ...add test_VEH_SteeringControl
 ...add test_VEH_sprocketProfile
 ...add test_VEH_wheeledGeneric_Accel
 Configuring done
 Generating done

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 [t] to toggle advanced mode (Currently Off)
CMake Version 2.8.11
```



Default settings

```
serban@euler33:~/Repositories/chronoBUILD
Page 1 of 1
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 CMake Version 2.8.11
Press [c] to configure
Press [h] for help Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)
```

Set options

```
serban@euler33:~/Repositories/chronoBUILD
Page 1 of 1
BUILD_ADDITIONAL_TESTS *ON
BUILD_DEMOS *ON
BUILD_TESTING *ON
CH_COMPILER *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 CMake Version 2.8.11
Press [c] to configure
Press [h] for help Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently Off)
```

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)

CMake Version 2.8.11
```

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)

Generate native build files (Unix makefiles)

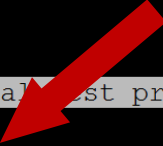
```

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

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
  
```

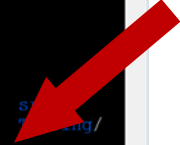
BUILD_ADDITIONAL_TESTS: Build additional test programs
 Press [enter] to edit option
 Press [c] to configure Press [g] to generate and exit
 Press [h] for help Press [q] to quit without generating
 Press [t] to toggle advanced mode (Currently Off)



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/  s
chrono/      CMakeCache.txt  compile_commands.json  CTestTestfile.cmake     lib64/  t
chrono_vehicle/ CMakeFiles/    CPackConfig.cmake     DartConfiguration.tcl    Makefile
[serban@euler33 ~/Repositories/chronoBUILD]$
```



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/ChBodyFrame.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/ChSolvmim.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
```