

Geant4 VMC 3.0

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For the ALICE Collaboration

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Outline

- Geant4 VMC 3.00
 - Multi-threading
 - CMake build
 - Migration to Root 6
 - Tests
 - JIRA VMC

Geant4 10.00

- Version 10.0 was released on December 6th, 2013.
 - The first major release since June 2007.
- There are several highlighted features including multi-threading capability with event parallelism
 - It offers two build options: Sequential and Multi-threaded modes
 - Selection via a CMake configuration option
`-DGEANT4_BUILD_MULTITHREADED=ON`
- Highlights presented at ALICE Offline week in March
- Three patch releases since then
- Current recommended version: **10.00.patch03**
- Version 10.1 scheduled for December 6
- See Geant4 Web site: <http://geant4.web.cern.ch/geant4/>

Towards Geant4 VMC MT

- Development of Geant4 VMC MT started at end of 2011
- The first prototype was described at CHEP 2012 poster: “The Geant4 Virtual Monte Carlo”
 - Geant4 VMC code was adapted for multi-threading using the same approach as in Geant4 MT prototype
 - ROOT output adapted to multi-threading
 - Each thread opens and writes on its own ROOT file
- Geant4 VMC 3.00.b01 since March 2014
 - Adapted to changes in the Geant4 interfaces for user applications
 - Added examples program and test main functions and CMake configuration files for building programs linked with all libraries
 - Only Linux platforms
 - In testing by O2 CWG8: prototype with ALICE geometry and more realistic event generator started from VMC A01 example

Geant4 VMC 3.0 (MT)

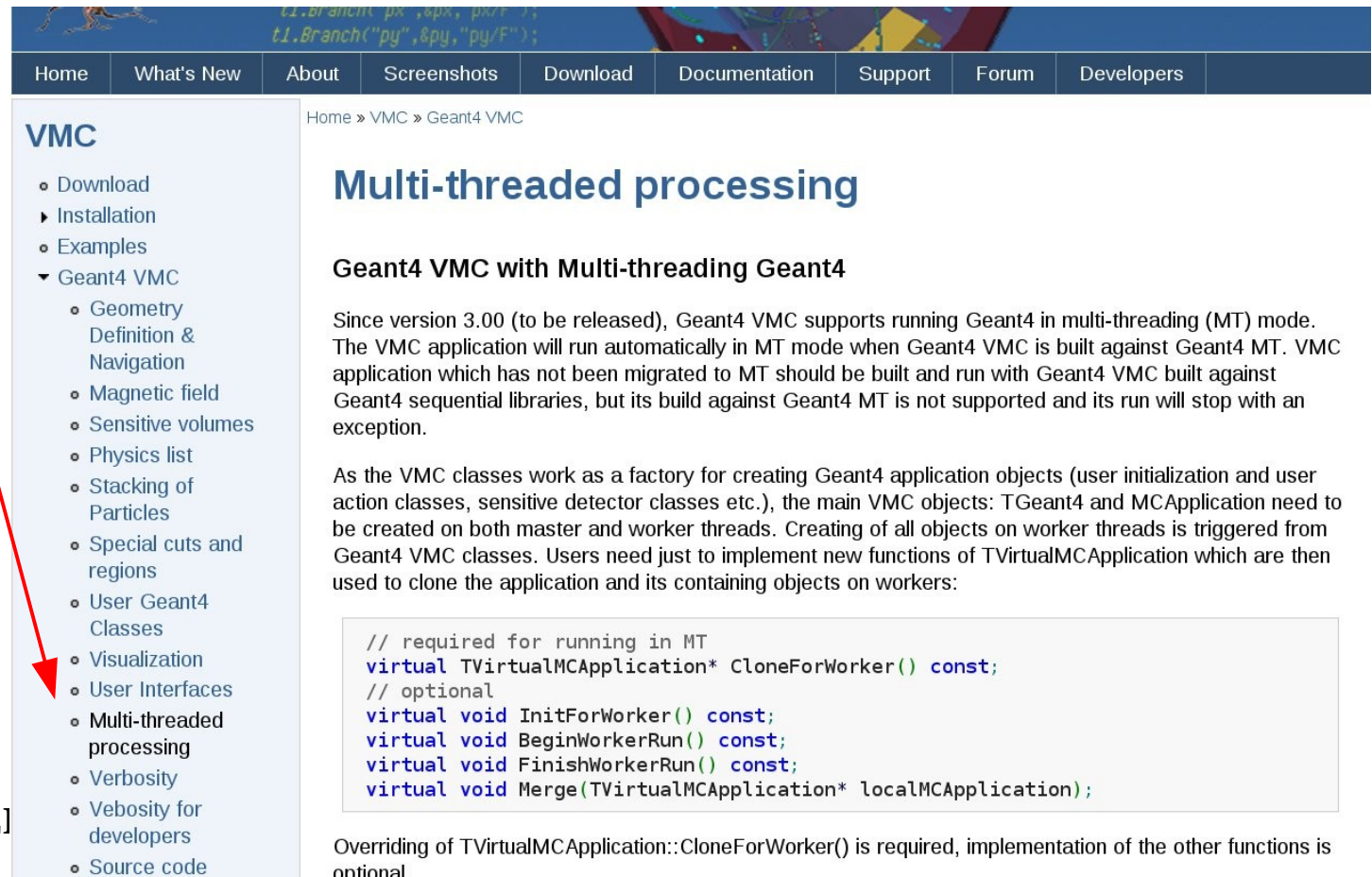
- Geant4 VMC version 3.0 which provides support for Geant4 multi-threading mode
 - Released on **17 November 2014**
- With participation of A. Gheata, CERN
 - Migration of G4Root
- Single source code for both sequential and multi-threading modes
 - VMC applications which were not migrated to MT can be built and run with the same Geant4 VMC as migrated applications
- MT mode is selected automatically when Geant4 VMC is built against Geant4 MT libraries
- All (5) VMC examples were migrated to MT and can be run in this mode both with Geant4 native and Root navigation

Geant4 VMC 3.0 (MT) - 2

- Most of MT related features presented at ALICE Offline week in March:
 - MTRoot - set of classes which take care of locking critical Root IO operations (registering ROOT object to trees etc.) in multi-threading mode
 - Migration of VMC application to MT
- The VMC application will run automatically in MT mode when Geant4 VMC is built against Geant4 MT
- This default behavior can be now changed via the option specified with creating TG4RunConfiguration (in g4Config.C)
 - This makes possible to build and run not migrated VMC application against Geant4 libraries install in MT mode

Migration of VMC applications to MT

- More detailed instructions for migration VMC applications to MT are available from VMC Web site:
 - <http://root.cern.ch/drupal/content/multi-threaded-processing>



Home » VMC » Geant4 VMC

Multi-threaded processing

Geant4 VMC with Multi-threading Geant4

Since version 3.00 (to be released), Geant4 VMC supports running Geant4 in multi-threading (MT) mode. The VMC application will run automatically in MT mode when Geant4 VMC is built against Geant4 MT. VMC application which has not been migrated to MT should be built and run with Geant4 VMC built against Geant4 sequential libraries, but its build against Geant4 MT is not supported and its run will stop with an exception.

As the VMC classes work as a factory for creating Geant4 application objects (user initialization and user action classes, sensitive detector classes etc.), the main VMC objects: TGeant4 and MCAApplication need to be created on both master and worker threads. Creating of all objects on worker threads is triggered from Geant4 VMC classes. Users need just to implement new functions of TVirtualMCAApplication which are then used to clone the application and its containing objects on workers:

```
// required for running in MT
virtual TVirtualMCAApplication* CloneForWorker() const;
// optional
virtual void InitForWorker() const;
virtual void BeginWorkerRun() const;
virtual void FinishWorkerRun() const;
virtual void Merge(TVirtualMCAApplication* localMCAApplication);
```

Overriding of TVirtualMCAApplication::CloneForWorker() is required, implementation of the other functions is optional.

ALL

Known Problems

- Problem at exit in E02 example in MT mode
 - Break (Linux) or break + hang (MAC)
 - A special stack class with use of TRef, not used in experiments
- On MAC, a special build option to build Root VMC library in multi-threading mode has to be activated by hand
 - At present, this requires a customized ROOT installation with a modification of [TMCtrls.h](#) in root/montecarlo/vmc/include

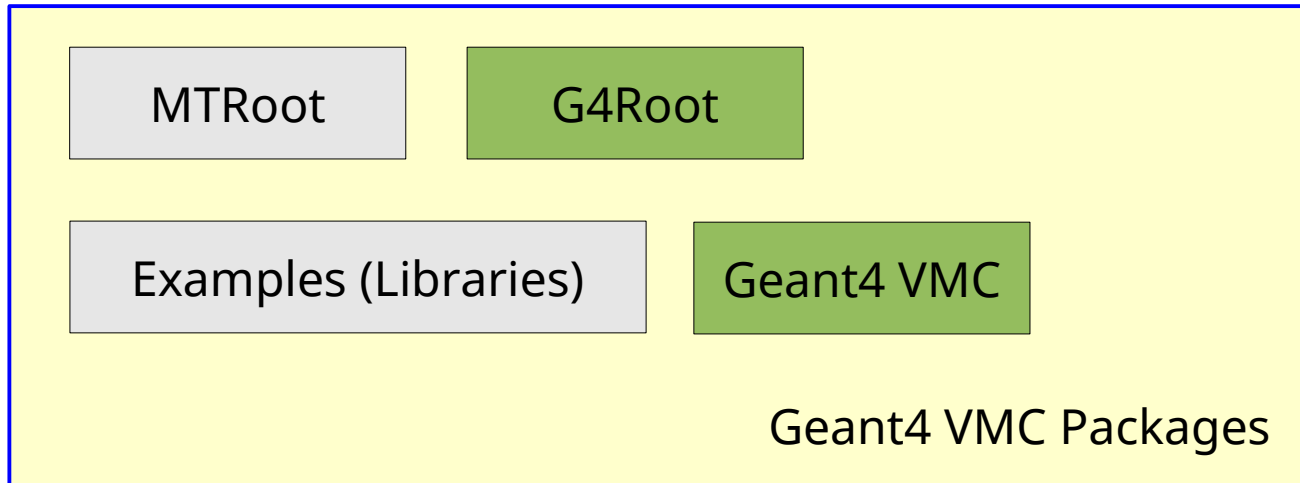
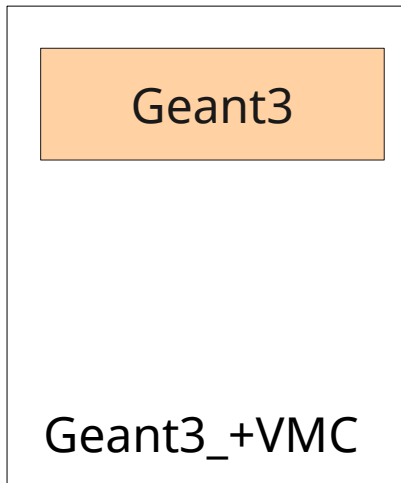
CMake

- The “old” build system based on makefiles in root/etc/vmc is replaced with CMake build
 - Inspired by Geant4 and VGM projects
- Geant4 VMC besides its “own” set of classes (built in geant4_vmc library) includes also
 - G4Root, MTRoot and Examples
 - Each with different dependencies

VMC Packages

External Packages

Optional



Application programs



CMake Build Options

Overview of available options and their default values:

<code>Geant4VMC_BUILD_G4Root</code>	Build G4Root	ON
<code>Geant4VMC_BUILD_MTRoot</code>	Build MTRoot	ON
<code>Geant4VMC_BUILD_Geant4VMC</code>	Build Geant4VMC	ON
<code>Geant4VMC_BUILD_EXAMPLES</code>	Build VMC examples	ON
<code>Geant4VMC_USE_G4Root</code>	Build with G4Root	ON
<code>Geant4VMC_USE_VGM</code>	Build with VGM	OFF
<code>Geant4VMC_USE_GEANT4_UI</code>	Build with Geant4 UI drivers	ON
<code>Geant4VMC_USE_GEANT4_VIS</code>	Build with Geant4 Vis drivers	ON
<code>Geant4VMC_USE_GEANT4_G3TOG4</code>	Build with Geant4 G3toG4 library	OFF
<code>Geant4VMC_INSTALL_EXAMPLES</code>	Install examples	ON

CMake Configuration files for VMC packages

- Configuration files per package
 - [XYZBuildProject.cmake](#), [XYZConfig.cmake.in](#)
 - XYZ = Geant4VMC, G4Root, MTRoot
 - [Geant4VMCPackagesVersion.cmake\[.in\]](#)
 - The same version number for all contained packages
 - [Geant4VMCPackagesCPack.cmake](#)
 - Generation of source tar ball (replacement for makedist.sh script)
 - The configuration files ([XYZConfig.cmake](#)), installed in the installation area, define for each package XYZ_INCLUDE_DIRS and XYZ_LIBRARIES
 - Can be used directly in the client project, no need to define FindXYZ
- Find packages
 - [FindXYZ.cmake](#), XYZ = Geant4, ROOT
- And some more utility files

Examples CMake Build Options

Overview of available options and their default values:

VMC_WITH_Geant4	Build with Geant4	OFF
VMC_WITH_Geant3	Build with Geant3	OFF
VMC_WITH_MTRoot	Build with MTRoot	ON
VMC_INSTALL_EXAMPLES	Install examples libraries and programs	ON

- If both VMC_WITH_Geant4 and VMC_WITH_Geant3 are OFF only examples libraries (independent from MC) will be built

```
$ cd /path/examples_build
$ cmake \
  -DCMAKE_MODULE_PATH=/path_to_g4vmc_or_geant3_cmake_modules
  /path/geant4_vmc/examples
```

Examples CMake Build

- Build with Geant4 (both libraries and programs)

```
$ cd /path/example_build_g4
$ cmake \
  -DVMC_WITH_Geant4=ON \
  -DGeant4VMC_DIR=/path/g4vmc_install/lib[64]/Geant4VMC-3.0.0 \
  /path/geant4_vmc/examples
```

- Build with Geant3 (both libraries and programs)

```
$ cd /path/example_build_g3
$ cmake \
  -DVMC_WITH_Geant3=ON \
  -DGeant3_DIR=/path/g3vmc_install/lib[64]/Geant3-2.0.0 \
  -DPythia6_LIB_DIR=/my_path_to_pythia6_library \
  /path/geant4_vmc/examples
```

CMake Configuration files for Examples

- Provided in both geant4_vmc/cmake and geant3/cmake
- Find and Use files for VMC and MC
 - `FindXYZ.cmake`, `UseXYZ.cmake`, XYZ = VMC, MC
- Find [V]MC
 - Find all needed packages according to configuration options
- Use [V]MC
 - Set compiler definitions, includes and libraries for all packages according to configuration options
- The examples (VMC application) CMake file can then contain only examples specific setting

Geant3 CMake

- CMake build implemented also for Geant3
- Available since **v2.0** - tagged 17 November 2014
 - The “old” Makefile based on makefiles in root/etc/vmc is removed
- Similar configuration files as in Geant4 VMC
- Identical Find[V]MC and Use[V]MC as in Geant4 VMC
 - Find[V]MC and Use[V]MC are used when building the VMC examples (provided with Geant4 VMC) programs against Geant3

Migration to ROOT 6

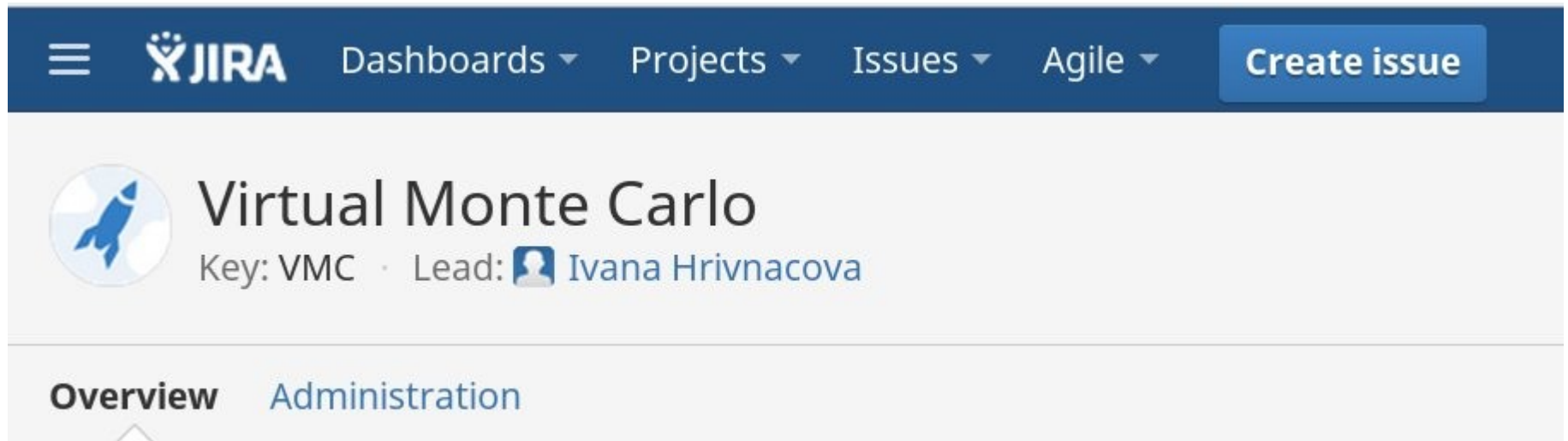
- Separated examples macros for loading libraries (load_g3|4.C) from run macros (run_g3|4.C)
 - Required for cling
- C++11
 - To be consistent within the whole project, when using Geant4 VMC with ROOT 6, also Geant4 libraries have to be built with C++11 standard via `-DGEANT4_BUILD_CXXSTD=c++11`
- Find Root
 - Updated generation of dictionaries for changes in ROOT6
 - Added generation of rootmaps (enable library-autoloading: no need for explicit `gSystem->Load()`)

Tests

- Improved test suites
 - Added a possibility to select g3/g4 test via arguments
 - Added summary messages and return codes (they allow automatically evaluate the result of the tests)
 - Possibility to define build directory via arguments
- Tested platforms:
 - Linux FC19: gcc 4.8.2, Mac OSX 10.9: clang 3.5
- Thanks to Oliver Freyermuth, Physics Institute of the University of Bonn for testing and contribution to CMake build, examples test suites, Root6 migration

JIRA VMC

- The JIRA VMC project was created a month ago in order to separated VMC related bug reports from ROOT project
 - <https://sft.its.cern.ch/jira/browse/VMC>



The screenshot shows the JIRA interface for the 'Virtual Monte Carlo' project. At the top, there is a dark blue navigation bar with the JIRA logo, a hamburger menu icon, and several menu items: 'Dashboards', 'Projects', 'Issues', and 'Agile'. A prominent blue button labeled 'Create issue' is located on the right side of this bar. Below the navigation bar, the project name 'Virtual Monte Carlo' is displayed in a large font, accompanied by a circular icon featuring a blue rocket. Underneath the project name, the project key 'Key: VMC' and the lead 'Lead: Ivana Hrivnacova' (with a small profile icon) are listed. At the bottom of the screenshot, there is a light gray navigation bar with two tabs: 'Overview' (which is currently selected and has a white underline) and 'Administration'.

Documentation

- <http://root.cern.ch/drupal/content/vmc>
- New documentation pages
 - Installing geant3
 - Installing geant4_vmc
 - Installing and Running Examples
 - Multi-threaded processing
 - Bug Reports
- Release notes:
 - http://root.cern.ch/root/vmc/geant4_vmc_versions.txt