

# 18<sup>th</sup> Geant4 Collaboration Meeting

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## Advanced examples: updates and plan

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*on behalf of the Advanced Examples Working Group*

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# Outline

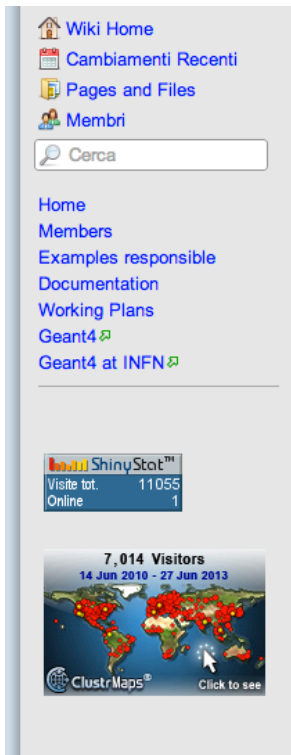
- **Generalities, members and coordination**
- **Existing and currently maintained examples**
  - Report on updates and new developments
- **Plan and coming examples**
  - New examples in Geant4.10
  - Migration to G4tools and MT

# Coordination and web page

*coordinator:* G.A.P. Cirrone (INFN-LNS)

*deputy:* L. Pandola (INFN-LNS)

- **23 members**
- **22 examples** (+ 2 new example coming)



The sidebar contains a navigation menu with the following items: Wiki Home, Cambiamenti Recenti, Pages and Files, Membri, and a search box labeled 'Cerca'. Below the menu are links for Home, Members, Examples responsible, Documentation, Working Plans, Geant4, and Geant4 at INFN. At the bottom, there are two statistics widgets: 'ShinyStat' showing 11055 total visits and 1 online user, and 'ClustrMaps' showing 7,014 visitors from June 14, 2010, to June 27, 2013.

home

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**ADVANCED EXAMPLES  
WIKI PAGES**

## THE GEANT4 "ADVANCED EXAMPLES" Working Group

THESE ARE THE OFFICIAL PAGES OF THE GEANT4 ADVANCED EXAMPLES WORKING GROUP.  
THE OLD PAGES (<http://www.ge.infn.it/geant4/examples/index.html>) ARE NOT MORE UPDATED WITH THE OCCURRED  
NEW DEVELOPMENTS AND IMPROVMENTS

The **Advanced examples** illustrate **realistic applications of Geant4** in typical experimental environments.  
They are developed in collaboration with user groups expert in the corresponding experimental domain.  
The examples code can be [downloaded](#) together with the Geant4 Toolkit in the directory `geant4/examples/advanced`  
You can navigate in the left-side bar to get updated information on the examples status, developments and results

<http://geant4advancedexampleswg.wikispaces.com/>

*All the examples pages (except one) have been migrated on wiki → no external link*

# Examples and responsables (I)

Example	Responsible	Description
<b>air_shower</b>	T. Bernardo	Detection system for cosmic ray shower simulation
<b>ams_Ecal</b>	M.Maire	Simulation of an Electromagnetic calorimeter
<b>brachytherapy</b>	S.Guatelli	Dosimetry for endocavitary, interstitial and superficial brachytherapy
<b>composite_calorimeter</b>	A.Dotti	A composite electromagnetic and hadronic calorimeter
<b>ChargeExchange MC</b>	A. Radkov	Simulation of charge exchange real experiment performed at the Petesburg Nuclear Physics Institute (PNPI, Russia)
<b>dnaphysics</b>	S, Incerti	Simulation of a track structure in liquid water using the Geant4 DNA very low energy processes
<b>eRosita</b>	M.G.Pia, D.Schlosser, G.Weidenspointner	PIXE simulation with Geant4
<b>gammaknife</b>	F. Romano	A device for Stereotactic Radiosurgery with Co60 sources for treatment of cerebral diseases
<b>gammaray_telescope</b>	F.Longo	A simplified typical gamma-ray telescope (such as GLAST), with advanced description of the detector response
<b>hadrontherapy</b>	G.A.P.Cirrone	Simulation of a transport beam line for proton and ion therapy
<b>human_phantom</b>	S. Guatelli	Internal dosimetry

# Examples and responsables (II)

Example	Responsible	Description
<b>lort_therapy</b>	C.Casarino, G.Russo	Simulation of a IORT device
<b>lAr_Calorimeter</b>	A.Dotti	Simulation of the Forward Liquid Argon Calorimeter of the ATLAS Detector at LHC
<b>medical_linac</b>	C.Andenna, B.Caccia G.A.P.Cirrone	A typical LINAC accelerator for IMRT, similar to one used in the clinical practice
<b>microbeam</b>	S.Incerti	Simulation of a cellular irradiation microbeam line using a high resolution cellular phantom
<b>microdosimetry</b>	S.Incerti	Simulation of a track structure in liquid water using the Geant4 DNA very low energy processes
<b>nanobeam</b>	S.Incerti	Simulation of a nanobeam line facility
<b>purging_magnet</b>	J.Apostolakis	Electrons travelling through the magnetic field of a strong purging magnet in a radiotherapy treatment head
<b>radioprotection</b>	S.Guatelli, J. Davis	Microdosimetry with diamonds and silicum detectors for radioprotection in space missions
<b>underground_physics</b>	A.Howard	A simplified typical dark matter detector (such as the Boulby Mine experiment)
<b>xray_fluorescence</b>	A.Mantero	Elemental composition of material samples through X-ray fluorescence spectra
<b>xray_telescope</b>	G.Santin	A simplified typical X-ray telescope (such as XMM-Newton or Chandra)

# Recent updates and developments

- General maintenance and cleaning of obsolete methods
- Migration to G4Analysis tools and MT
- Recent new developments:
  - Hadrontherapy
  - Brachytherapy
  - Radioprotection
  - Human\_phantom
- New examples
  - DNA\_geometry
  - DNA\_chemistry

# Hadrontherapy

- Recent developments:
  - migration to MT (in progress)
  - dedicated class for dose average LET computations (in release 10)
  - improving class-interface to LEM for biological effects computations (internal)
  - simulation of an energy selector system for laser-driven proton beams at ELIMED facility (internal)
- Plan for 2014:
  - extension of class-interface for RBE computations to other biological models: LEM II, III, IV, MKM
  - Simulation of a focalizing system for ELIMED

**Plans for advanced examples:**  
brachytherapy, radioprotection and  
human\_phantom

Susanna Guatelli

CMRP, University of Wollongong,  
Australia



# Brachytherapy

- **Features introduced in 2012-2013**
  - Geant4 analysis component
  - G4 Radioactive Decay module
  - General Particle Source
  - Use of mesh
- **Next developments (2013-2014):**
  - Migration to MT
  - Directory with validation suite w.r.t. TG43

# Radioprotection

- **2012:** Geant4 analysis component introduced
- **Plan for 2013-2014:**
  - Extend the example to the study of novel detectors for radiation protection in space and aviation
    - Same example but with extended functionality
  - Show how to characterise a novel detector
    - Silicon microdosimetry
    - DeltaE-E silicon telescope
  - Show how to model interplanetary space environment
  - Migration to MT

# Human\_phantom

- **2012:** Geant4 analysis component introduced
- **In 2013-2014:**
  - Migration to MT
  - Show how to integrate in a realistic case an analytical human phantom with a DICOM interface

# 2 additional examples for Geant4-DNA

- « dnachemistry » by M. Karamitros (CNRS, France)
  - Simulation of production, diffusion and mutual interaction of molecular species
  - Extraction of radical concentrations
  - User class for time step actions
- « dnageometry » by C. Villagrasa et al. (IRSN, France)
  - High resolution geometrical model of cell nucleus down to DNA bases
  - Can be used to predict direct damages of ionising radiation on DNA
- Will be released in Geant4 10
- See more details during **plenary session 7 (EM)**

# Migration to G4Analysis tools

<b>air_shower</b>	<b>lort_therapy</b>
<b>ams_Ecal</b>	<b>IAr_Calorimeter</b>
<b>brachytherapy</b>	<b>medical_linac</b>
<b>composite_calorimeter</b>	<b>microbeam</b>
<b>ChargeExchangeMC</b>	<b>microdosimetry</b>
<b>dnaphysics</b>	<b>nanobeam</b>
<b>eRosita</b>	<b>purging_magnet</b>
<b>gammaknife</b>	<b>radioprotection</b>
<b>gammaray_telescope</b>	<b>underground_physics</b>
<b>hadrontherapy</b>	<b>xray_fluorescence</b>
<b>human_phantom</b>	<b>xray_telescope</b>

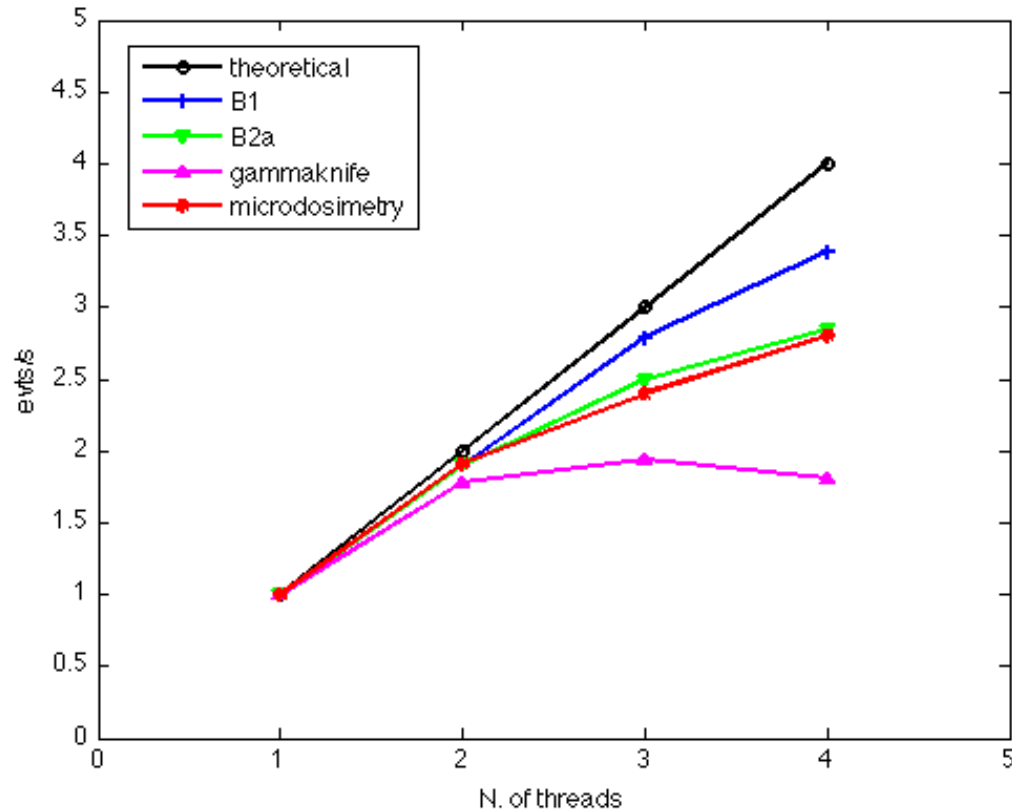
- 50% of examples migrated
- 50% not necessary or not yet done

# Migration to MT

air_shower	lort_therapy
ams_Ecal	IAr_Calorimeter
brachytherapy	medical_linac
composite_calorimeter	microbeam
ChargeExchangeMC	microdosimetry
dnaphysics	nanobeam
eRosita	purging_magnet
gammaknife	radioprotection
gammaray_telescope	underground_physics
hadrontherapy	xray_fluorescence
human_phantom	xray_telescope

- 50% migrated, including on going examples
- 50% not yet done

# Preliminary tests of performance



- Comparisons respect to B1 example
- 10.0 beta release
- To be done with the last reference tag

*Systematic tests to check the improving of performances and eventual bugs in the migration to MT*

# Workplan for 2013

- Migration/optimization of examples in Geant4-MT (1)
- Migration of the analysis to the Geant4 native analysis tools for a few selected examples (1)
- Migration of the analysis to the Geant4 native analysis tools for all applicable examples (2)
- Check that all advanced examples build correctly with cmake (1)
- General code cleaning of examples (2)
- New advanced example about radiation damage in micro-circuits (2) [\*]
- Development of a dedicated class for average LET calculations in the Hadrontherapy example (2)
- Implementation of the DICOM interface in the iort\_therapy example (2)

[\*] Optional, and subject to the availability of manpower



# Summary and conclusions

- General review of the code and maintenance
- New developments have been carried out
- Two new examples in Geant4.10
- More than half of the examples migrated both to G4Analysis tools and MT
- Tests to be performed before the release