

## CCR-UQ: ATTIVITA' SVOLTA FINO A GIUGNO 2013

The scientific scope of the UQ project is articulated over two parallel and complementary lines of research:

- 1) the quantification of the uncertainties of the physics components of Monte Carlo transport codes (with focus on Geant4)
- 2) the development of methods for the quantification of the uncertainties of simulated observables deriving from the uncertainties in the physical components used in particle transport.

The activity in the period until June 2013 concerns both lines of research.

The R&D on uncertainty quantification methods was focused on the finalization of the theoretical ground for forward uncertainty propagation in Monte Carlo codes. It involved the elaboration of methods for statistical estimation of uncertainties and their verification in a simplified simulation environment, retaining the essential conceptual characteristics of the Monte Carlo transport method. The results of this R&D phase are documented in a paper submitted to IEEE Transactions on Nuclear Science on 28 June 2013; they are novel and original achievements in the field of Monte Carlo simulation, which for the first time set the ground for Monte Carlo simulation as a quantitative predictive instrument. New mathematical methods developed for this purpose are documented in another paper to be submitted to a mathematical physics journal by the end of July 2013.

The R&D on the quantification of uncertainties of physics components concerned the validation of models for the simulation of photoionization, the validation of models for energy deposition by electrons in six Geant4 versions, the validation of Geant4 radioactive decay and the inception phase of the validation of Compton scattering and electron pair production by photons. The results on Geant4 electron energy deposition and radioactive decay are documented in three papers to be published in the August 2013 issue of IEEE Transactions on Nuclear Science; the results of the validation of photoionization simulation models are documented in a publication currently being written, which will be submitted to a journal in summer 2013.

The R&D for the validation of physics models includes improvements to the software design, refactoring of current Geant4 code and improvements to computational performance as a by-product.

### Publications:

- M. Batic, G. Hoff, M. G. Pia, P. Saracco, G. Weidenspointner  
**Validation of Geant4 simulation of electron energy deposition**  
*IEEE Trans. Nucl. Sci.*, vol. 60, no. 4, Aug. 2013
- S. Hauf, M. Kuster, M. Batic, Z. W. Bell, D. H. H. Hoffmann, P. M. Lang, S. Neff, M. G. Pia, G. Weidenspointner, A. Zoglauer  
**Radioactive Decays in Geant4**  
*IEEE Trans. Nucl. Sci.*, vol. 60, no. 4, Aug. 2013
- S. Hauf, M. Kuster, M. Batic, Z. W. Bell, D. H. H. Hoffmann, P. M. Lang, S. Neff, M. G. Pia, G. Weidenspointner, A. Zoglauer  
**Validation of Geant4-based Radioactive Decay Simulation**  
*IEEE Trans. Nucl. Sci.*, vol. 60, no. 4, Aug. 2013
- M. Batic, M. G. Pia, S. J. Cipolla  
**Corrected ISICSoo class version**  
*Comp. Phys. Comm.* vol. 184, no. 9, pp. 2232-2233, Sep. 2013

### Submitted for publication:

- P. Saracco, M. G. Pia, M. Batic  
**Theoretical ground for the propagation of uncertainties in Monte Carlo particle transport**  
*Submitted to IEEE Trans. Nucl. Sci.*, June

### Conference presentations (accepted):

#### IEEE Nuclear Science Symposium 2013

- Physics Methods for the Simulation of Photoionization (*oral*)
- Validation of Compton Scattering Monte Carlo Simulation Models (*oral*)
- Validation of Geant4 Electron Pair Production by Photons (*poster*)

- Progress with Uncertainty Quantification in Generic Monte Carlo Simulations (*oral*)
- Negative Improvements, Relative Validity and Elusive Goodness (*oral*)
- Data Analysis with R in an Experimental Physics Environment (*oral*)
- Scholarly Literature and the Press: Scientific Impact and Social Perception of HEP (*oral*)

#### **CHEP 2013**

- Scholarly literature and the media: scientific impact and social perception of HEP computing (*oral*)
- Negative improvements (*poster*)
- New physics and old errors: validating the building blocks of major Monte Carlo codes (*poster*)
- An exact framework for uncertainty quantification in Monte Carlo simulation (*poster*)

#### **SNA and Monte Carlo 2013**

- Photons revisited (*oral*)
- Uncertainty Quantification in Monte Carlo Simulation: Theoretical Foundations and Heuristic Investigations (*poster*)

#### **Geant4 Training (appointed)**

- Geant4 Short Course at IEEE Nuclear Science Symposium and Medical Imaging Conference 2013
- Geant4 Physics Validation – Refresher Course at IEEE Nuclear Science Symposium and Medical Imaging Conference 2013

#### **Scientific roles**

- Convener of Computing and Software, IEEE Nuclear Science Symposium
- Associate Editor, IEEE Transactions on Nuclear Science