

Optimization of Monte Carlo codes PENELOPE 2006 and PENFAST by parallelization and reduction variance implementation

François Tola, Bénédicte Poumarède, Mehdi Gmar, Bouchra Habib

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OPTIMIZATION OF MONTE CARLO CODES PENELOPE 2006 AND PENFAST BY PARALLELIZATION AND REDUCTION VARIANCE IMPLEMENTATION

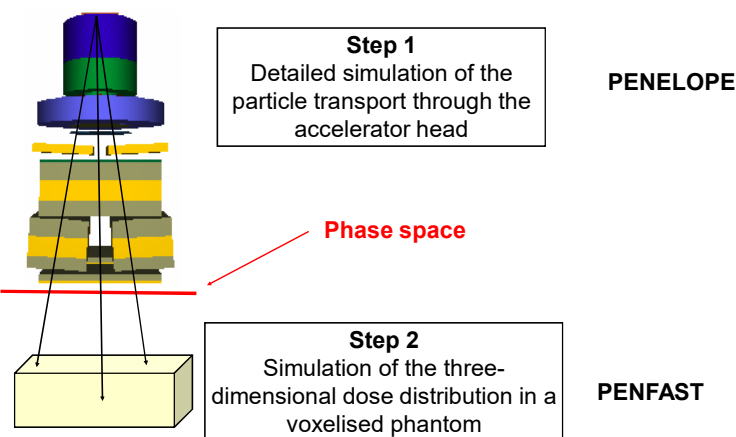
F. TOLA, B. POUMAREDE, B. HABIB, M. GMAR
 CEA, LIST, Department of technology for sensors and signal processing,
 F-91191 Gif-sur-Yvette, France.
 ✉ françois.tola@cea.fr

CONTEX AND OBJECTIVES

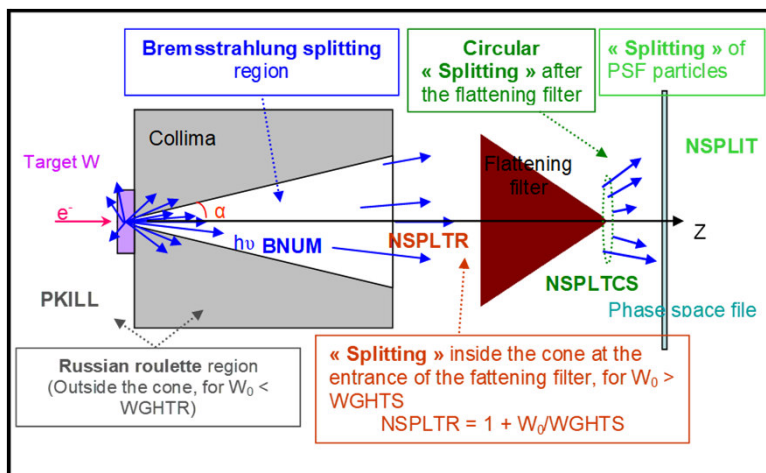
- Conventional TPS are **fast** but **not enough accurate** in presence of heterogeneities
- Introduction of MC methods allows **better accuracy**.
- Recently, a **fast MC dose calculation** code, named **PENFAST** has been developed by Salvat et al (2008). PENFAST is an optimized version of the MC PENELOPE code, adapted to CT **voxelized geometries**.
- Reduction of calculation time thanks to two methods :
 - Introduction of **variance reduction techniques** in PENELOPE 2006
 - **Parallelization** of Monte Carlo codes using MPI (Message Passing Interface) or equivalent

MATERIALS AND METHODS

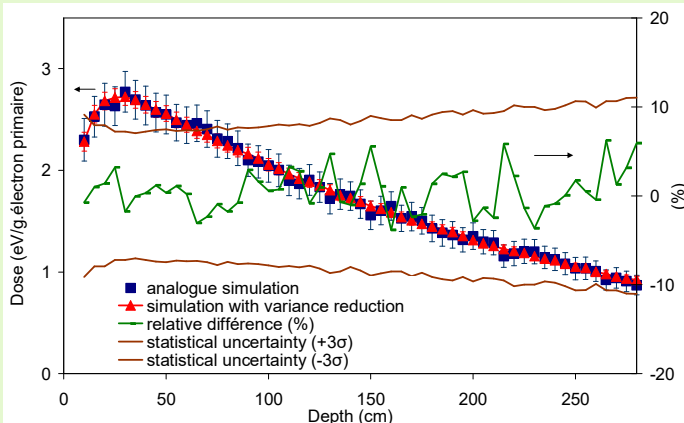
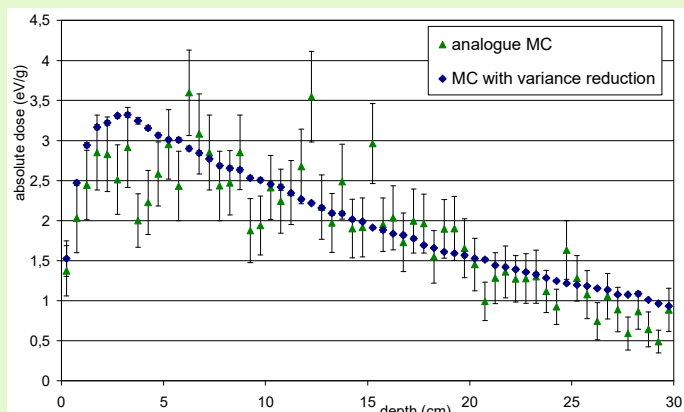
- MC calculations are split into two parts



VARIANCE REDUCTION TECHNIQUES



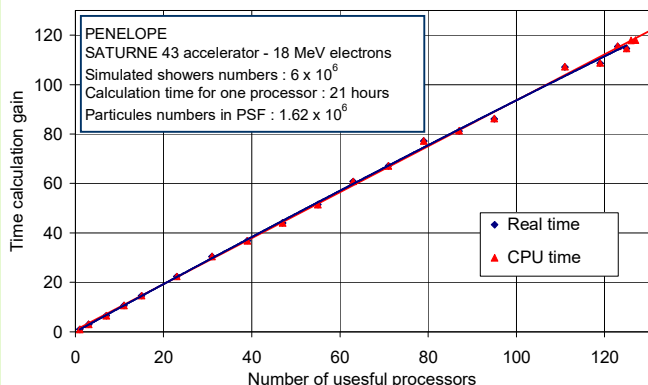
The implemented methods increase the simulation efficiency by a **factor greater than 100** compared with the analogue simulation.



PARALLELIZATION OF MONTE CARLO CODES

Parallelization of PENELOPE 2006 and PENFAST codes

- Achieved using MPI – Message Passing Interface – version mpich2 1.0.6
- Implemented in fortran 77, excepted for the random generator and PSF management
- Generator RP Brent : period of 10^{1230}
- A processor master in charge of PSF read/write operations and $N_p - 1$ slaves dedicated to the Monte Carlo calculation



CONCLUSIONS

- Monte Carlo methods lead to decrease uncertainties in dose calculation but are too time expensive
- Thanks to implementation of variance reduction techniques in the PENELOPE 2006 code, simulation time is reduced by a factor greater than 100 with unbiased results
- The use of variance reduction coupled with parallelization allow to achieve the reasonable computation time (10 min) with the required uncertainty (2 %)