# Validation of Dose Calculations with PENFAST (a Fast Monte Carlo Code for TPS in Radiotherapy) Using a Beam Energy Spectrum Reconstructed by a Least Squares Method

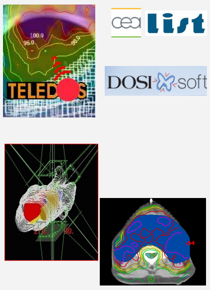
Bouchra Habib, François Tola, Jean-Marc Bordy, Bénédicte Poumarède

# Validation of dose calculations with PENFAST (a fast MC code for TPS in radiotherapy) using a beam energy spectrum reconstructed by a least squares method

B HABIB, B POUMAREDE, JM BORDY, F TOLA, J BARTHE

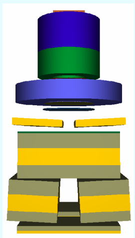
CEA, LIST, Department of Technology for Sensors and Signal Processing, F-91191 Gif-sur-Yvette, France. ✉ bouchra.habib@cea.fr

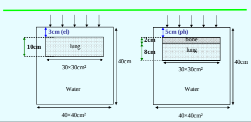
## Context and objectives



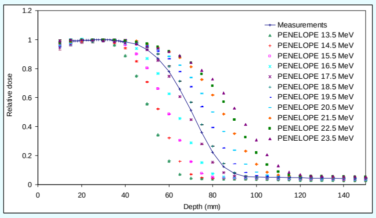
- **Conventional TPS** are **fast** but generally **not enough accurate** especially in presence of heterogeneities where the electron transport effects cannot be accurately handled with conventional deterministic dose algorithms.
- Implementation of **Monte-Carlo** (MC) methods allows **better accuracy.**
- Recently, a **fast MC dose calculation** code, named **PENFAST** (a private code) has been developed by Salvat et al (2008). PENFAST is an optimized version of the conventional MC PENELOPE code, adapted to CT **voxelized geometries.**
- In this work, PENFAST calculations of dose distributions in homogeneous and heterogeneous phantoms were compared with PENELOPE (version 2006) calculations as well as experimental data.

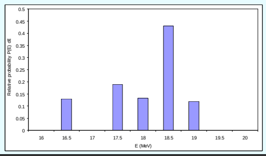
## Materials and Methods





- **PENELOPE simulation of the accelerator head**
  - Detailed modeling of the LINAC Saturne 43 (located at the French National Metrological Laboratory for ionizing radiations).
  - Primary electrons characterization using a **least squares method with no negativity constraints (NLS)** coupled with PENELOPE dose simulations in water.
- **Phase Space File calculation**
- **PENFAST simulation of dose distributions in voxelized heterogeneous phantoms**

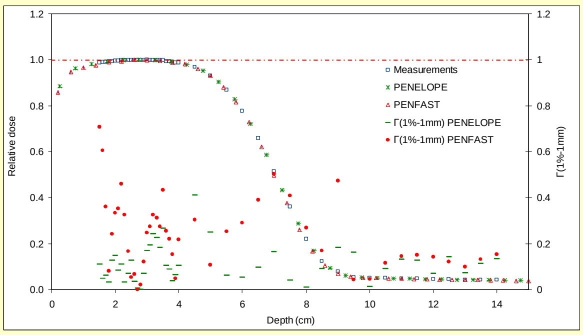


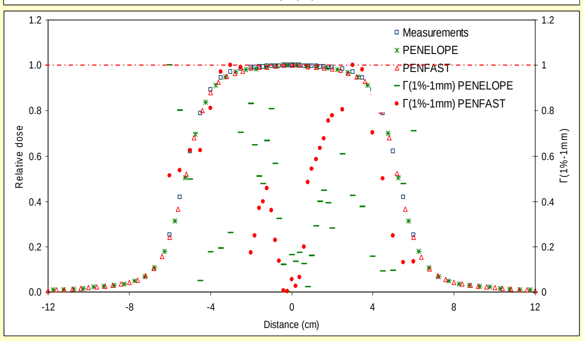
Example of an energy spectrum reconstructed by a NLS method

## Results and Discussion

- **Homogeneous phantom comparisons**

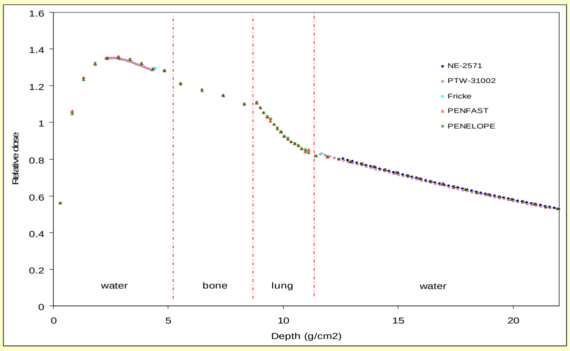



Saturne 43, electrons 18 MeV : Depth dose curves

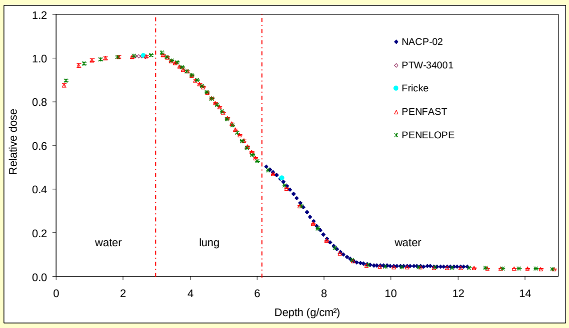



Saturne 43, electrons 18 MeV : Dose profiles

- **Heterogeneous phantom comparisons**




Saturne 43, photons 12 MV




Saturne 43, electrons 18 MeV

- PENELOPE and PENFAST dose distributions in water are within ± (1%, 1 mm) relative difference with measurements.
- PENFAST calculations are within ± 2% relative difference with measurements in the heterogeneous phantoms.

## Conclusions

- The homogeneous phantom study allows us to validate the PSF calculations and illustrates that the NLS method provides an accurate description of the radiation source energy spectrum.
- The overall excellent agreement between PENFAST and PENELOPE codes, as well as measurements, validates the accuracy of the fast MC code PENFAST for photon and electron dose calculations in clinically relevant heterogeneous phantoms and under metrological conditions.
- Complementary tests will be performed before using PENFAST in a clinical environment : small field conditions, complex compositions.

AAPM annual meeting – Houston, July 27 - 31, 2008