Rayleigh and Compton scattering of 10-100 keV photons. Theoretical models and Monte Carlo simulation

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Rationale and objectives
In the energy interval of interest in diagnostic tecniques with x-rays and also microbeam radiotherapy [1,2], i.e. around 10 to 100 keV, elastic (Rayleigh) and inelastic (Compton) scattering are important interaction mechanisms. The theoretical models for these processes implemented in most general-purpose Monte Carlo (MC) codes rely on assumptions which might be too crude fo some relevant materials, for instance liquid water.

Methods
The standard approach for Rayleigh scattering is based on form factors evaluated within the independent-atom approximation [3]. Experimental form factors are availale for liquid water and some plastics and biological tissues [4,5], and we have included them in an ad hoc modification of the PENELOPE code [6]. In turn, Compton interactions are often modelled resorting to the impulse approximation with atomic Compton profiles [7]. For liquid water, we describe a more accurate representation that uses the generalized oscillator strength of this substance [8].

Results
We compare form factors and Rayleigh cross sections calculated with various models. The observed differences decrease with energy but are appreciable below around 40 keV. The implementation of experimental form factors in PENELOPE is described and preliminary simulations are presented. Analogously, Compton cross sections computed with various methods are compared, displaying again some discrepancies at low energies.

Conclusion
An accurate rerepresentation of elastic and inelastic interactions of photons beyond the conventional approaches may be relevant in several medical physics applications including microbeam radiotherapy. It would be desirable that MC codes include realistic models to better describe these processes.

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