Study of the absorption length effect on the light signal response

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Introduction

- Report of the light response simulation for various absorption lengths in Liquid Argon λ_{ABS} using LightSim program

  $\lambda_{ABS} = \infty$ No absorption - used for the current light maps

  $\lambda_{ABS} = 30$ m mesured value obtained for a ppm N_2 contamination level, result published in ref. arXiv: 1306.4605 V2

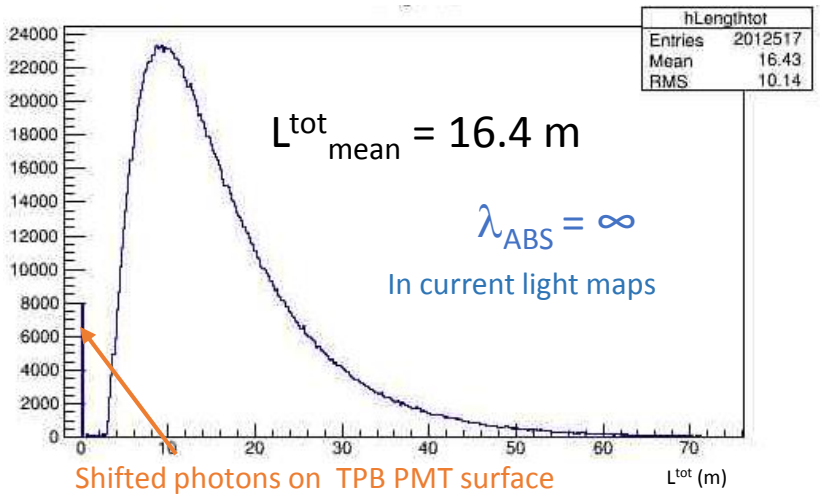
  $\lambda_{ABS} = 10$ m , 4m, 2m.

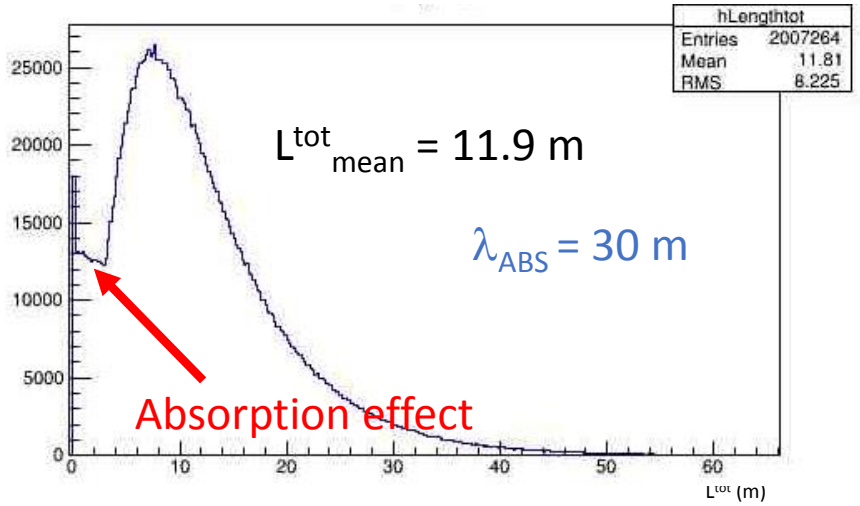
Reminder : Rayleigh scattering and reflectivity effects are taken into account:

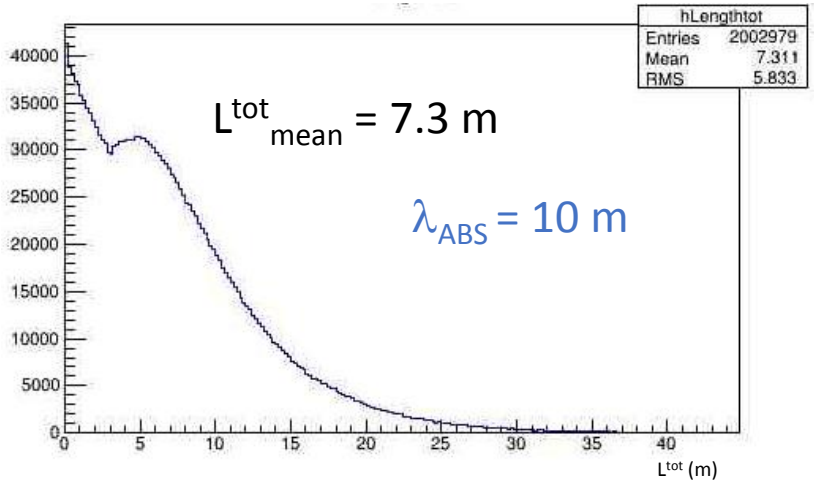
Rayleigh scattering length $\lambda_{RS} = 55$ cm for VUV
Field cage and Tank surface : 100% absorption

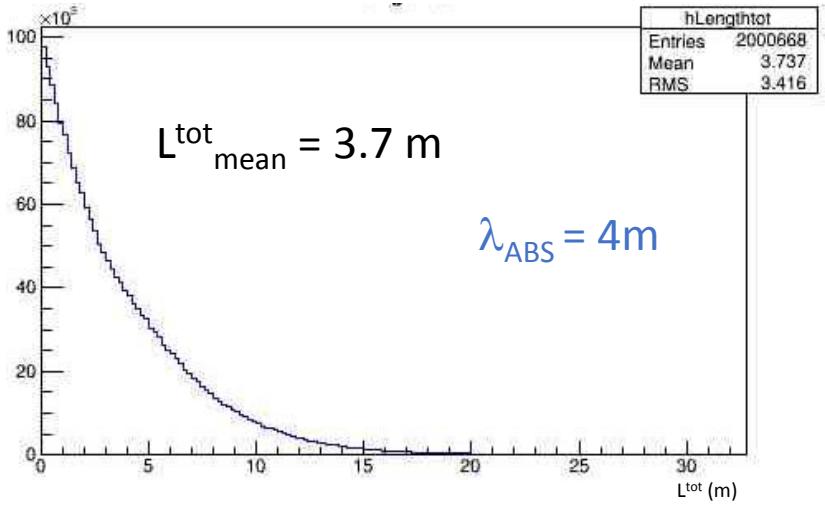
Total travelled distance L^{tot} of the photons versus absorption length in Liquid Argon λ_{ABS}

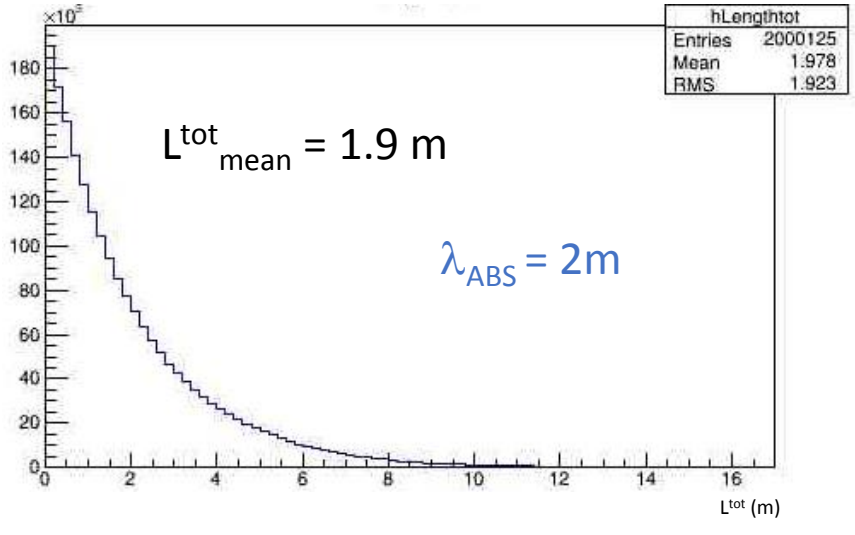
2.10^6 photons generated in the detector center X=0, Y=0, Z=0







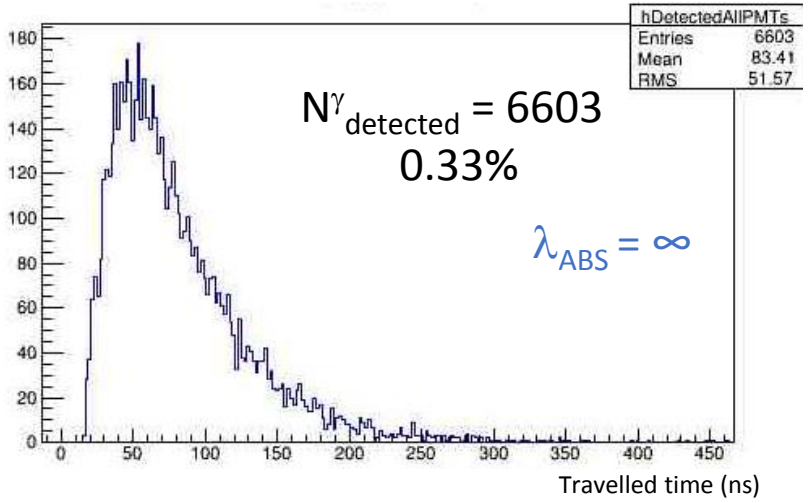


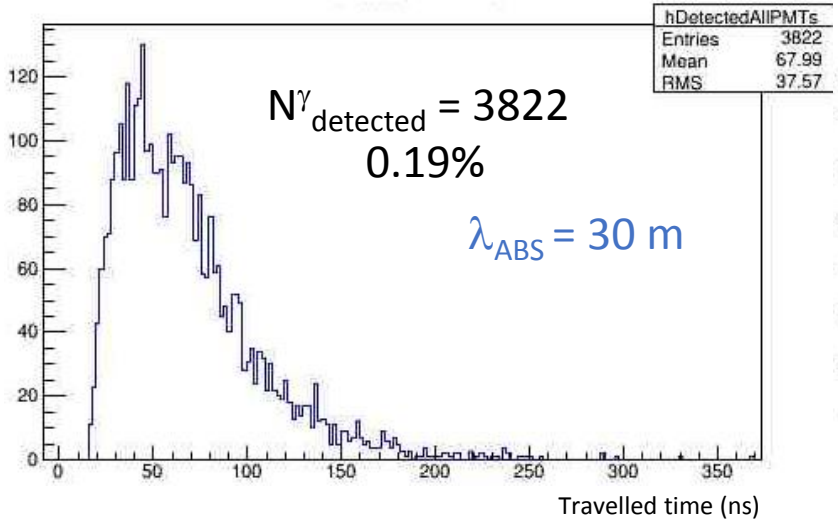


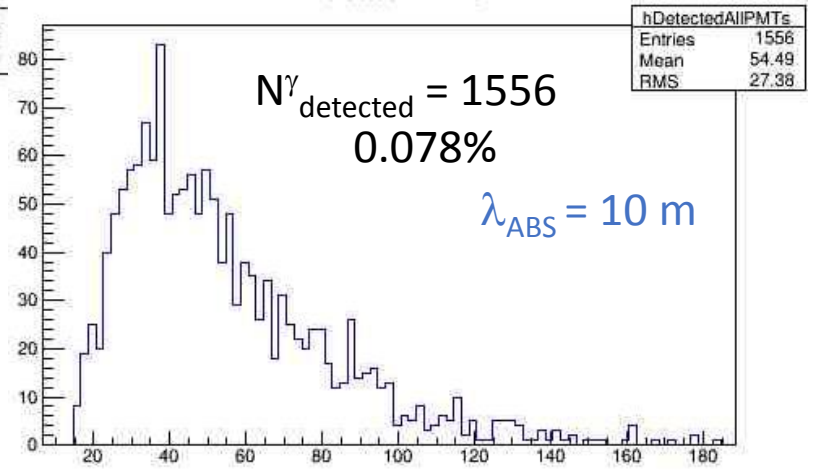
As expected, for a short absorption length, the absorption processus becomes dominant

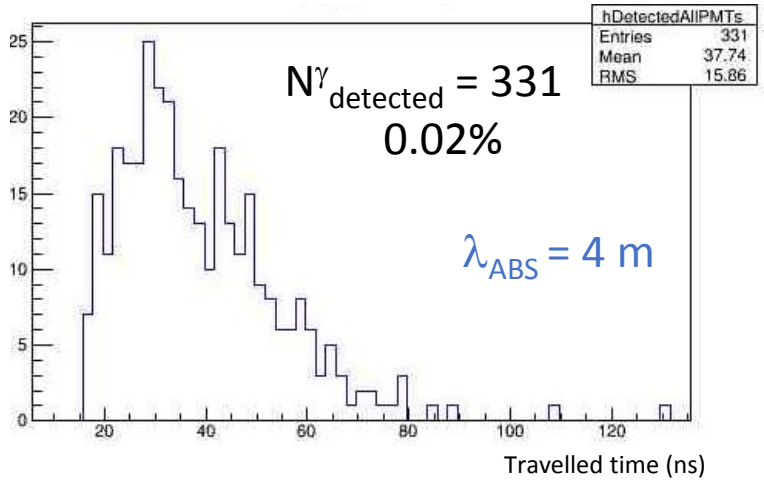
Light signal response on all PMTs versus absorption length in Liquid Argon λ_{ABS}

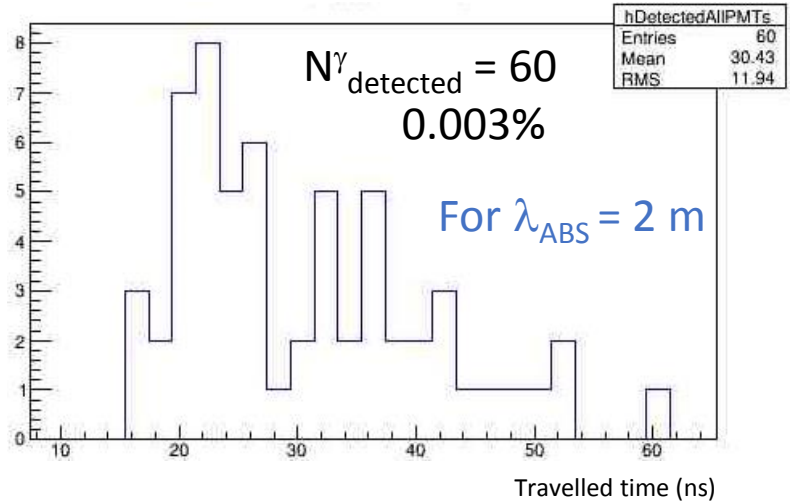
2.10^6 photons generated in detector center in X=0, Y=0, Z=0

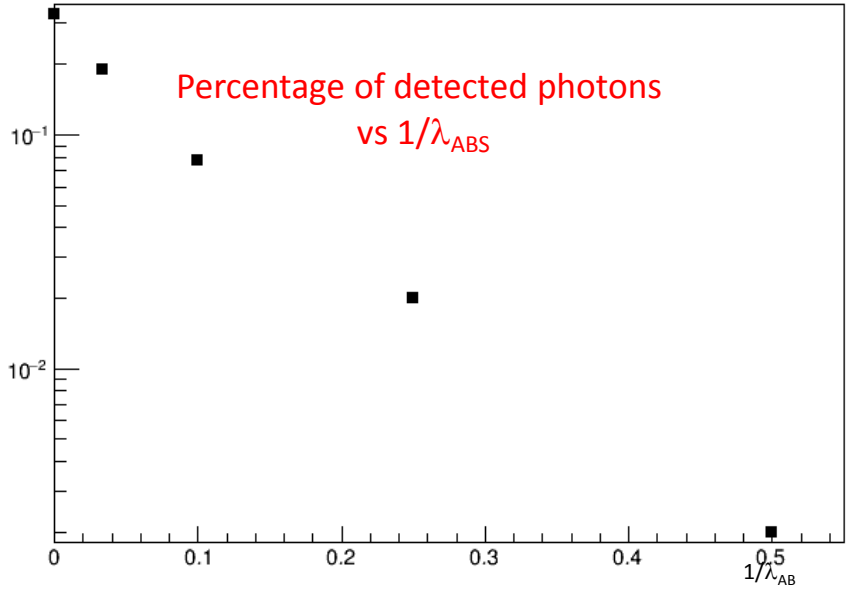






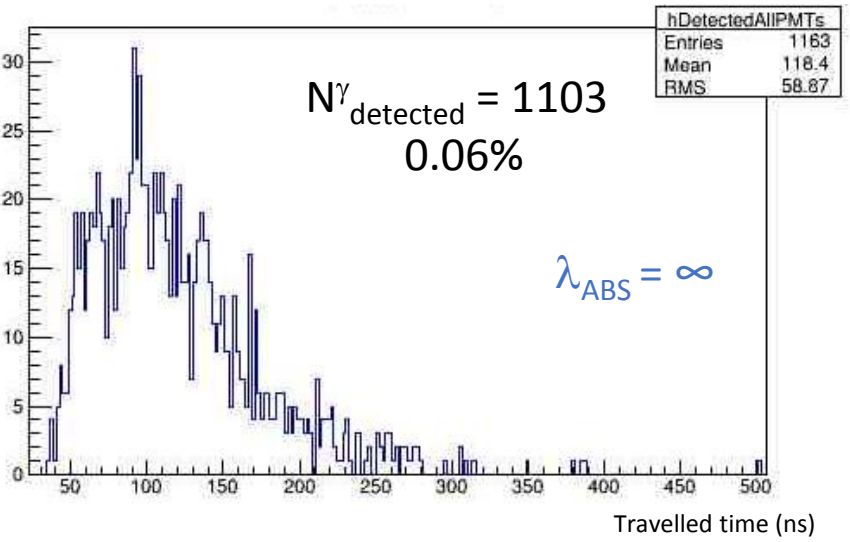


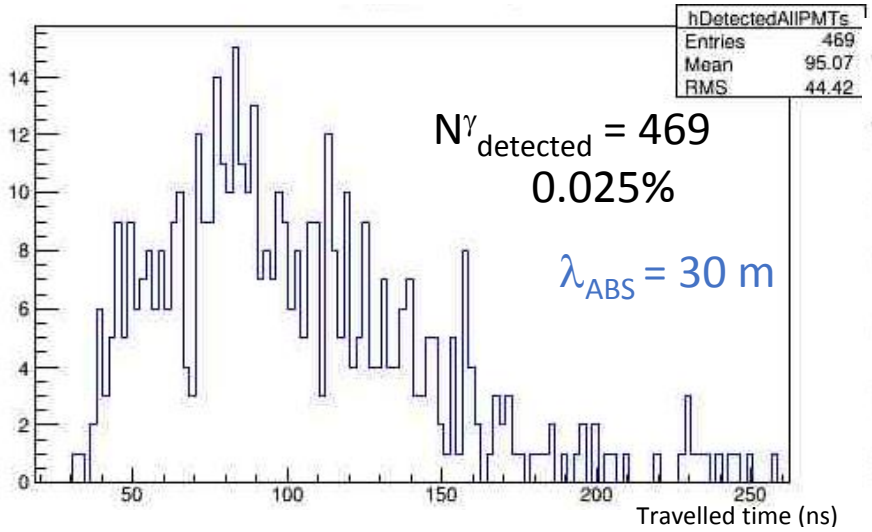


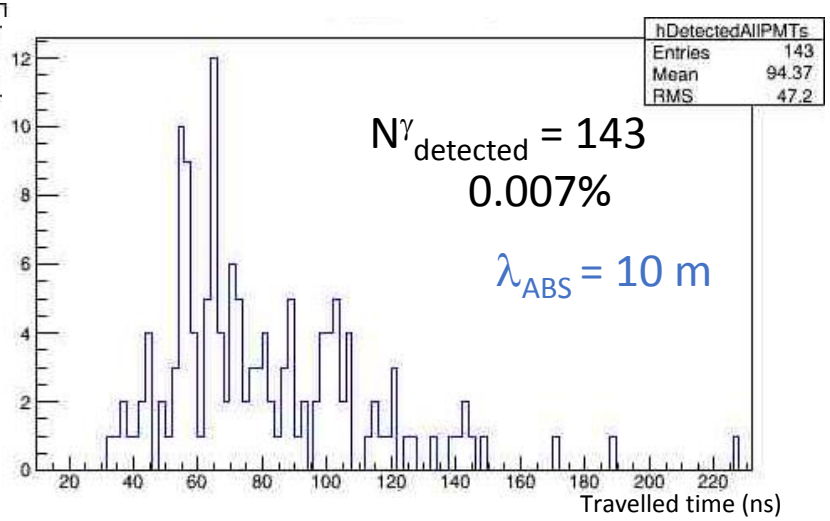


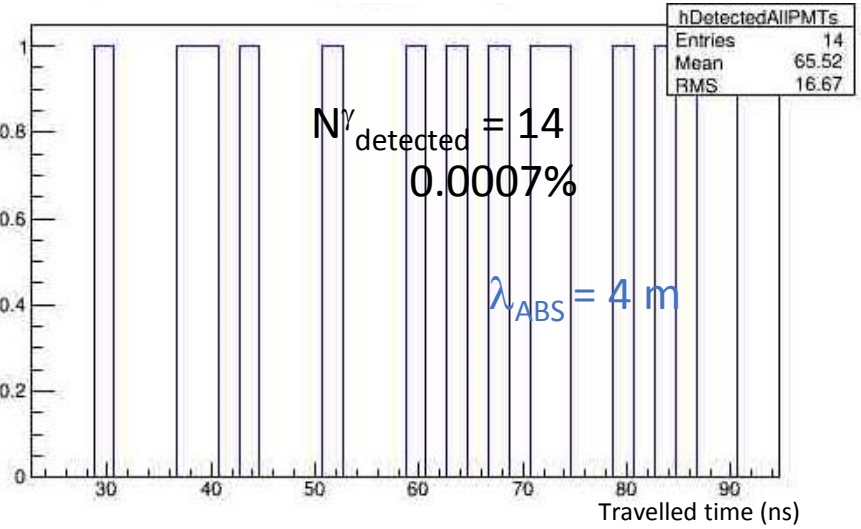
Light signal response on all PMTs versus the absorption length in Liquid Argon λ_{ABS}

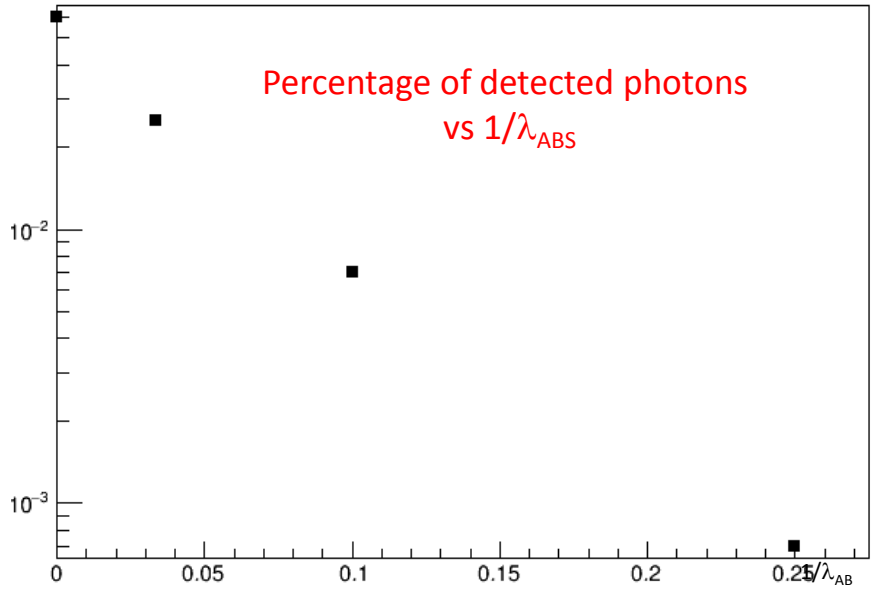
2.10^6 photons generated in X=0, Y=0, Z = 2500 mm





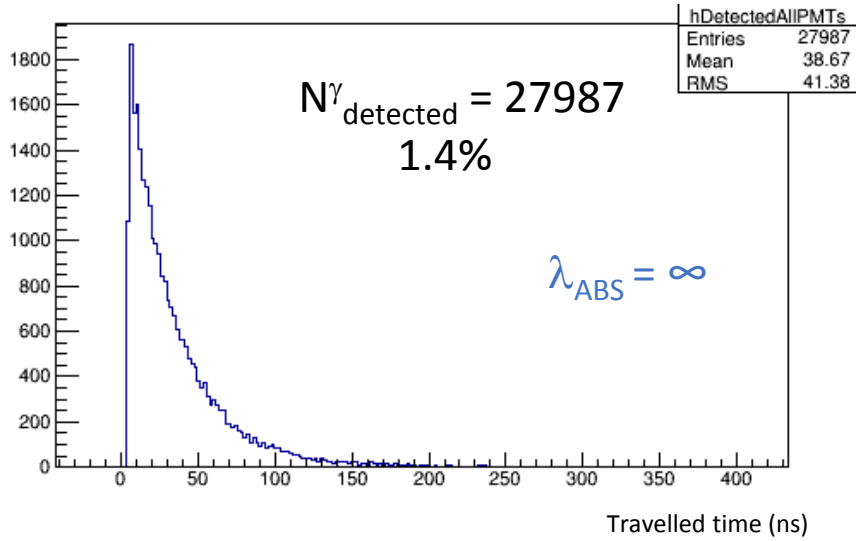


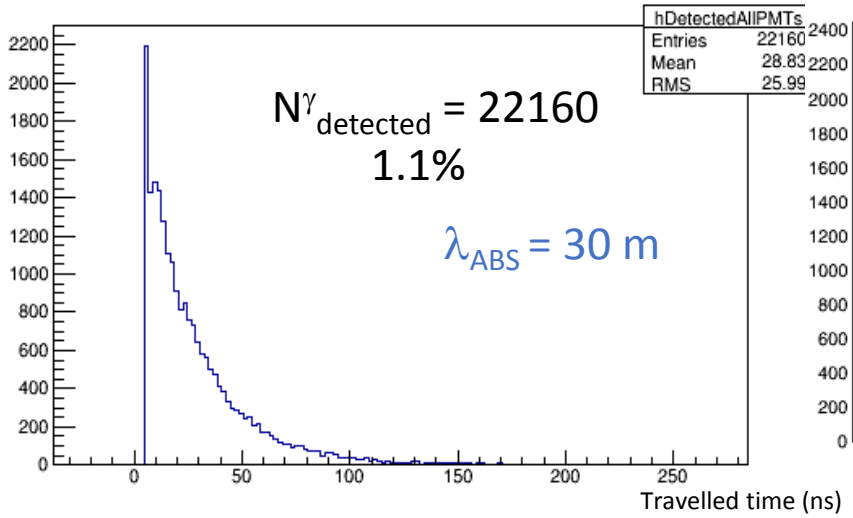


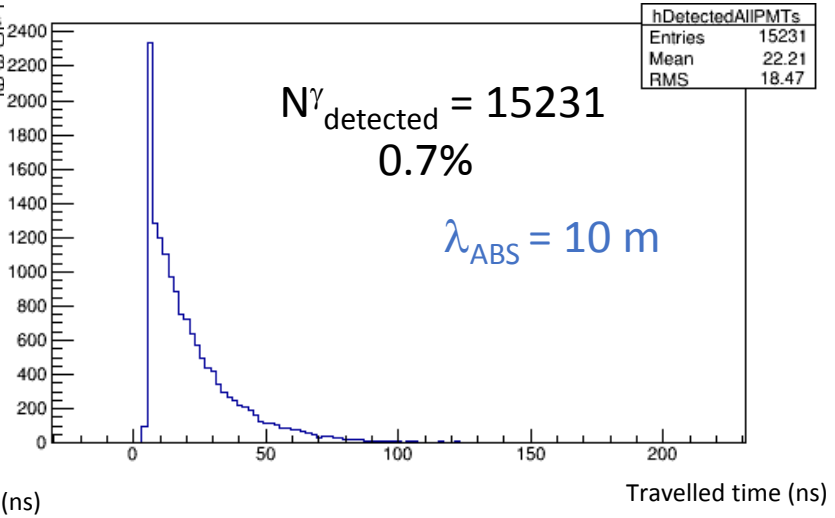


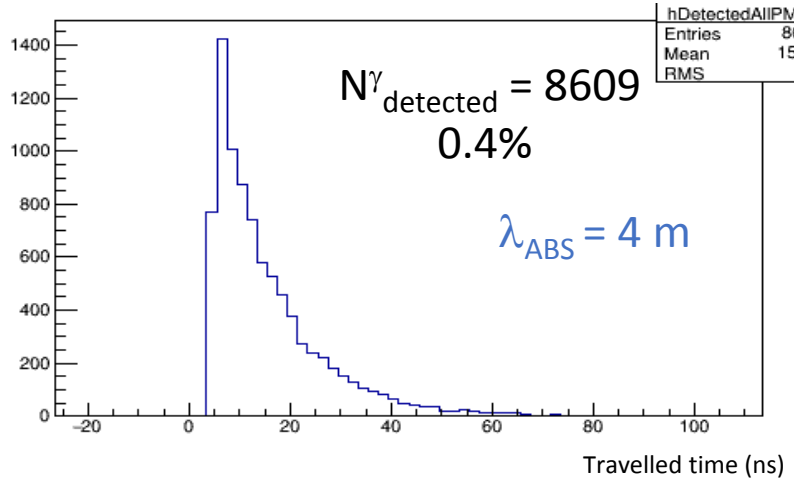
Light signal response on all PMTs versus the absorption length in Liquid Argon λ_{ABS}

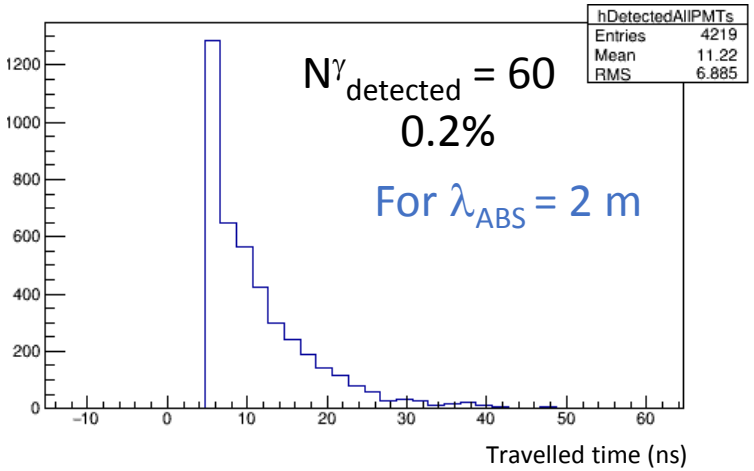
2.10^6 photons generated in X=0, Y=0, Z = -2500 mm

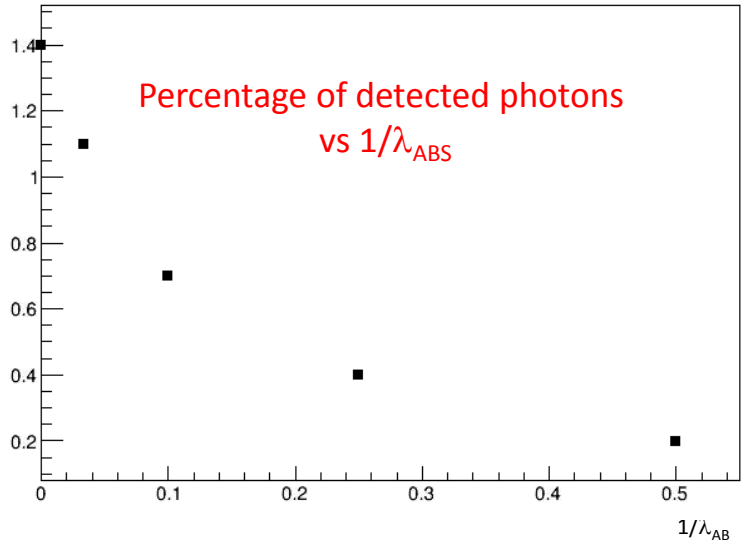










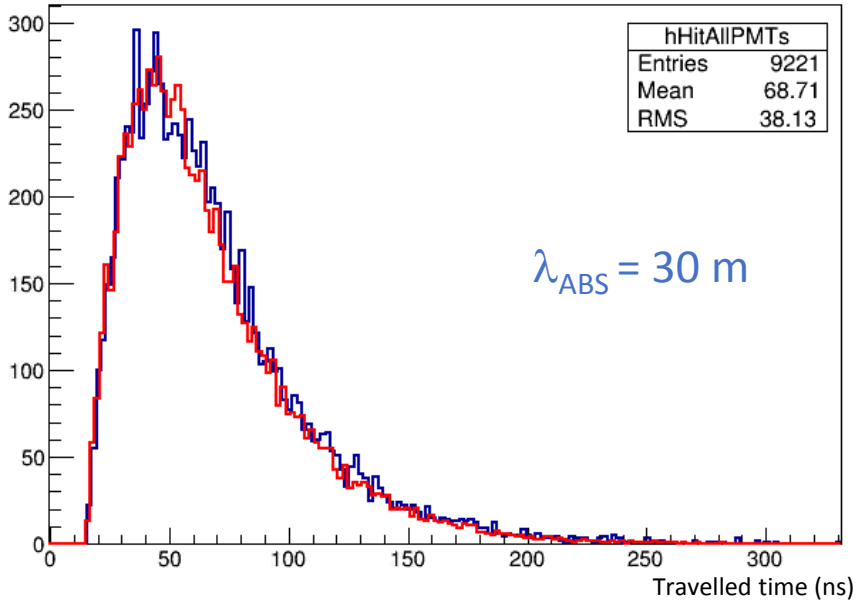


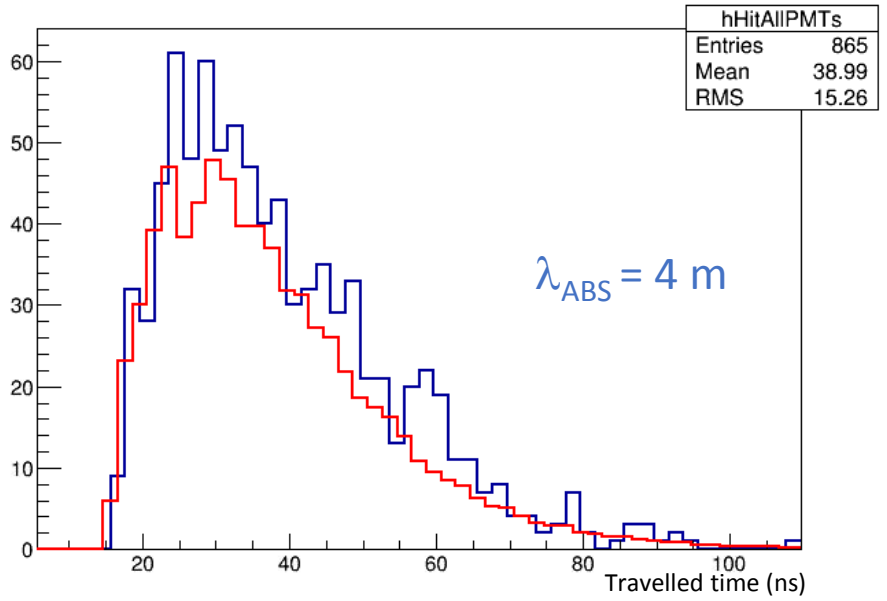
Comparison between Geant4 simulation results including absorption processus and a classical absorption model with an exponential exp(-travelled distance/ λ_{ABS})

In blue : Geant4 travelled time distribution for λ_{ABS} = 30m

In red : Travelled time distribution obtained by using the $\lambda_{ABS} = \infty$ distribution * exp ((-travelled time * C/n)/ λ_{ABS})

n : refractive indice of LAr





The comparison shows a good agreement

This hypothesis is used to study effect of λ_{ABS} with Qscan (see Alessandra slides)