Study of the absorption length effect on the light signal response

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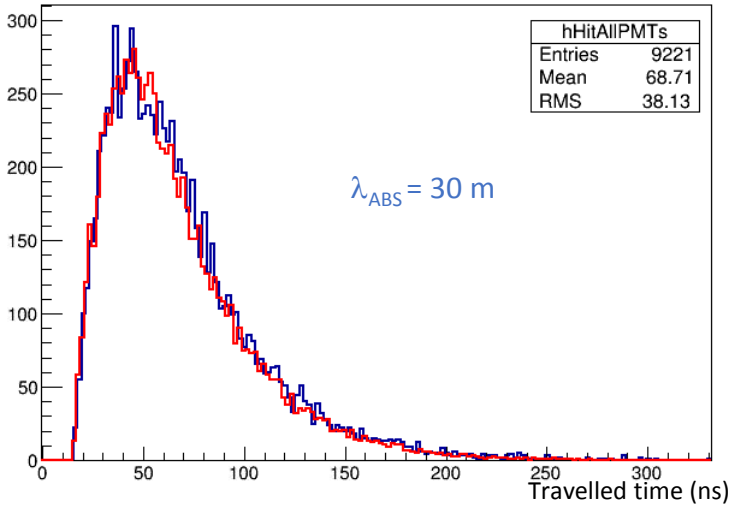
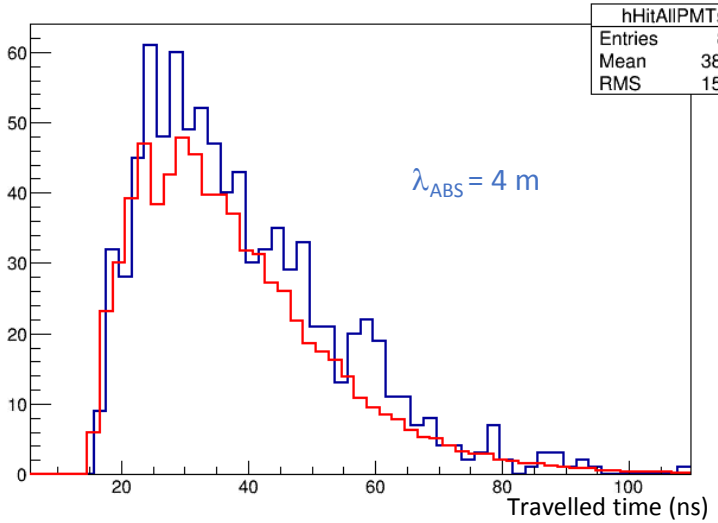
Introduction

- Last SB meeting (6 jul 2016) we have presented for various absorption lengths a comparison between Geant4 simulation results and a classical absorption model with an exponential exp(-travelled distance/ λ_{ABS}) used by Qscan studies.





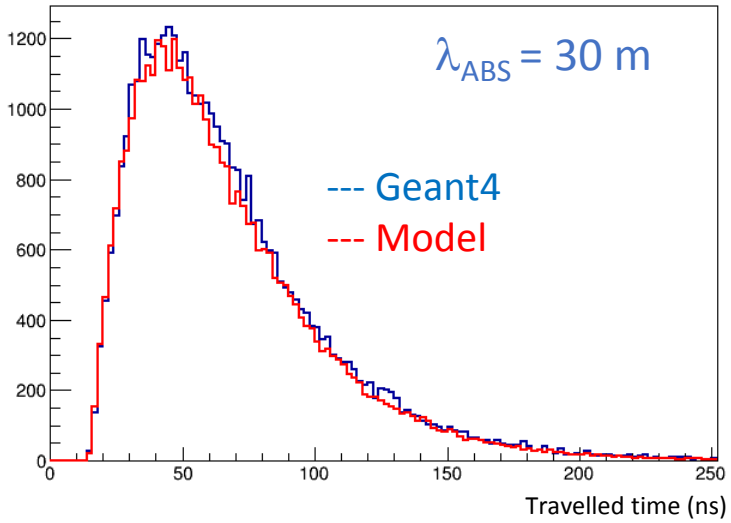
In blue :
Geant4 travelled time distribution
In red :
Travelled time distribution obtained by using
the $\lambda_{ABS} = \infty$ distribution * exp ((-travelled time * C/n)/ λ_{ABS})
n : refractive indice of LAr

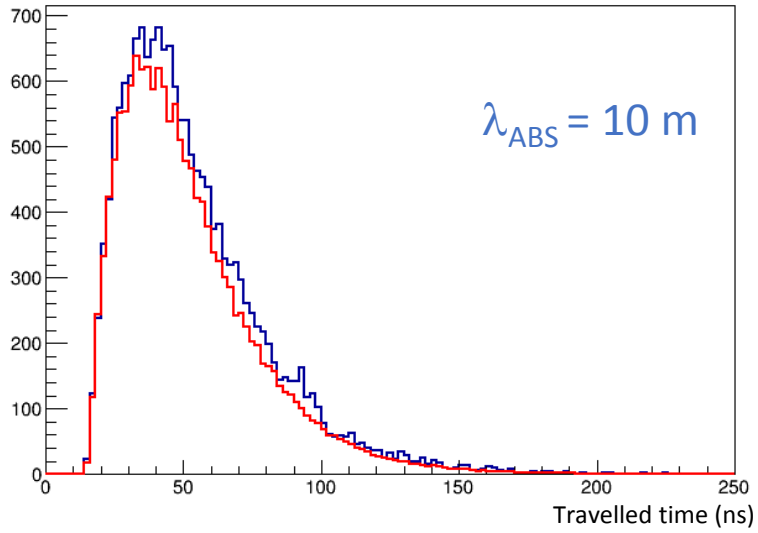
- We have improved this study by increasing the statistics and for various photons generation points in the detector.
- I present here the updated results.

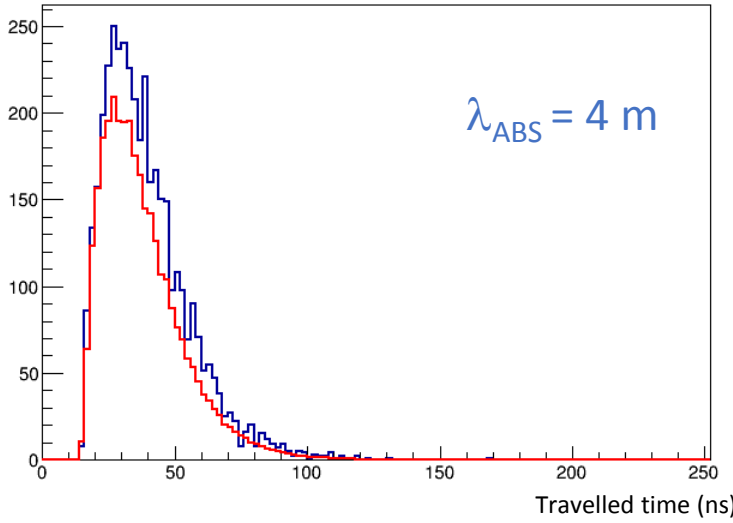
Reminder : Rayleigh scattering and reflectivity effects are taken into account: Rayleigh scattering length λ_{RS} = 55 cm for VUV and Field cage and Tank surface : 100% absorption

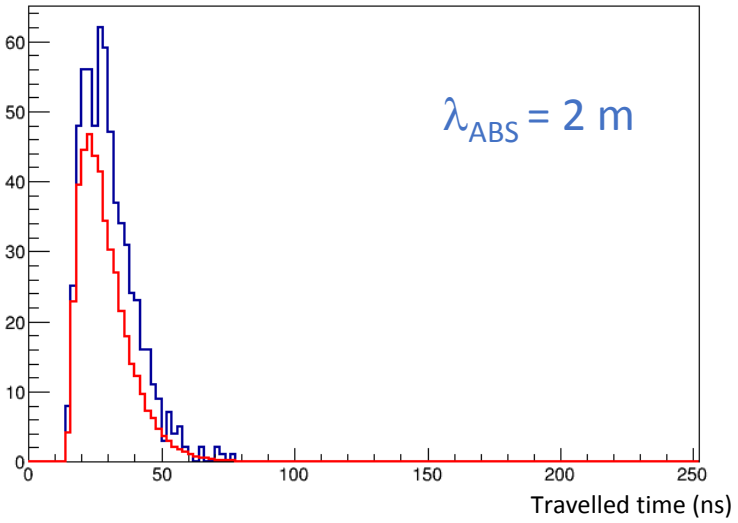
Comparison between Geant4 simulation results and a classical absorption model with an exponential exp(-travelled distance/ λ_{ABS})

10^7 photons generated at the detector center (X=0, Y=0, Z=0)









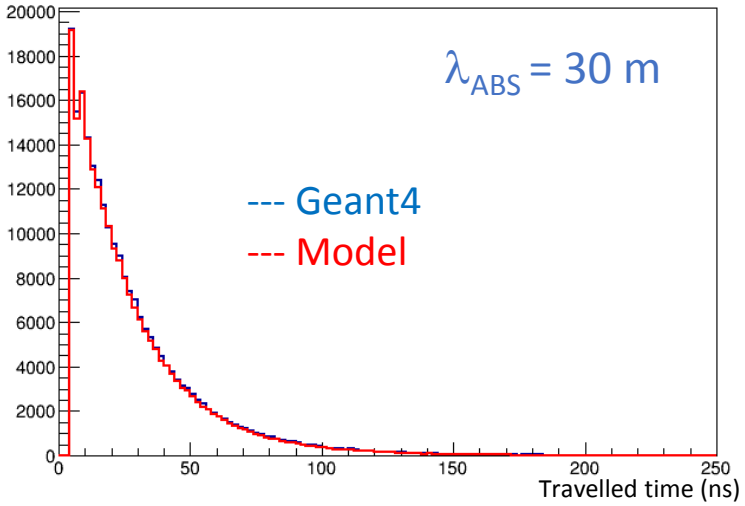
Loss in % = $(N_{Geant4} - N_{Model})/N_{Geant4}$

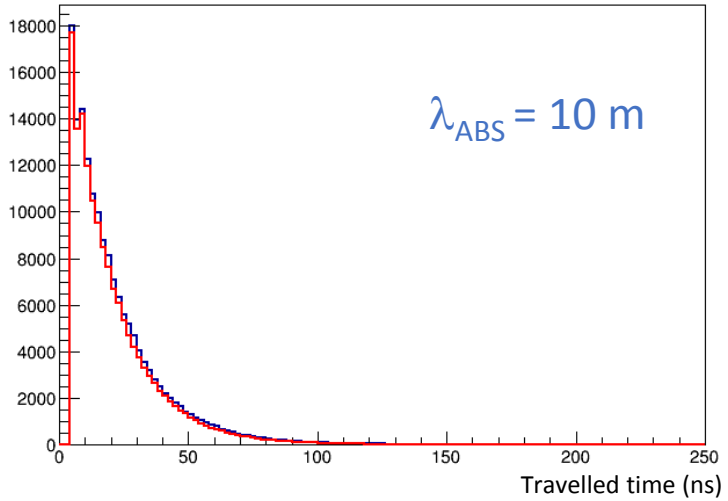
λ_{ABS} = 30m	4.9 %
λ_{ABS} = 10m	10.4 %
λ_{ABS} = 4m	19.9 %
λ_{ABS} = 2m	30.5 %

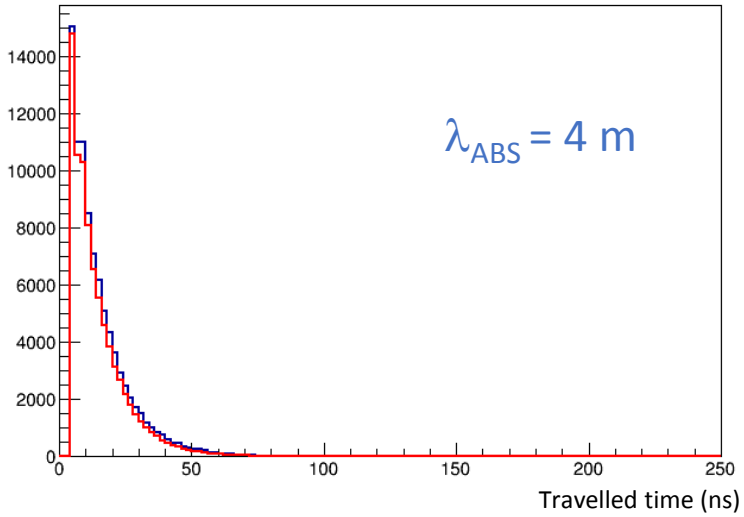
The loss increases when the absorption length decreases

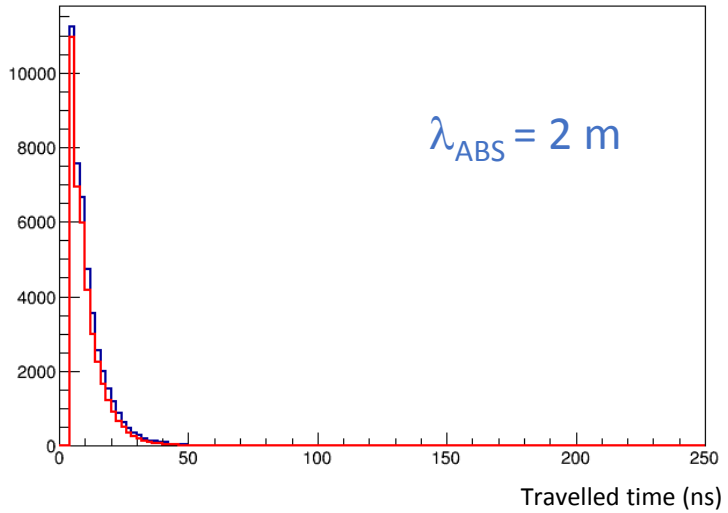
Comparison between Geant4 simulation results including absorption processus and a classical absorption model with an exponential exp(-travelled distance/ λ_{ABS})

10^7 photons generated at the bottom of the detector (X = 0 mm, Y = 0, Z = - 2500 mm)









Loss in % = $(N_{Geant4} - N_{Model})/N_{Geant4}$

λ_{ABS} = 30m	2.1 %
λ_{ABS} = 10m	5.2 %
λ_{ABS} = 4m	8.2 %
λ_{ABS} = 2m	11.1 %

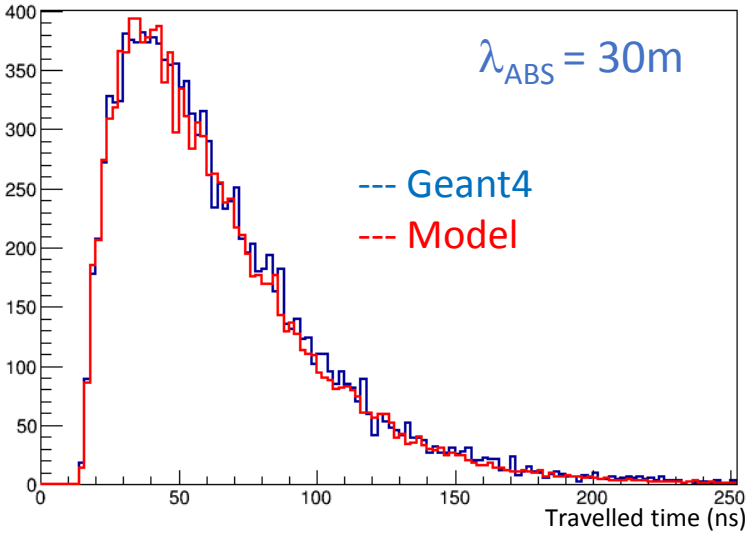
The loss is reduced when the photons are generated at the bottom of detector

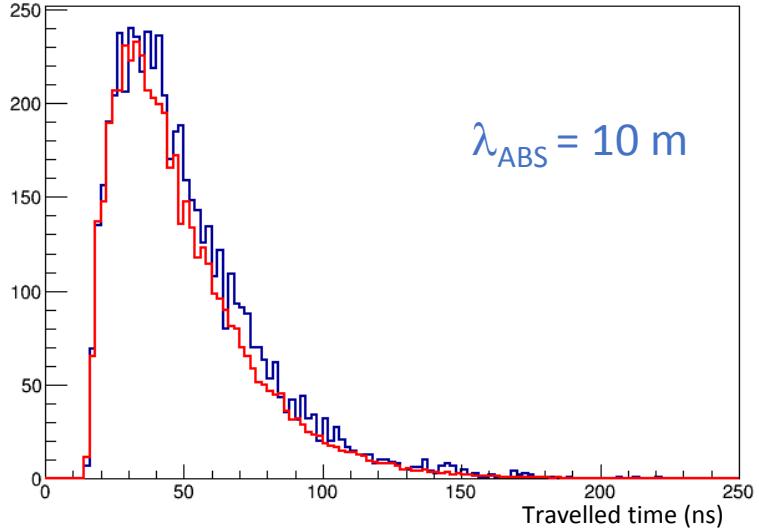
This may be explained by the fact that the photons are less subject to Rayleigh scattering

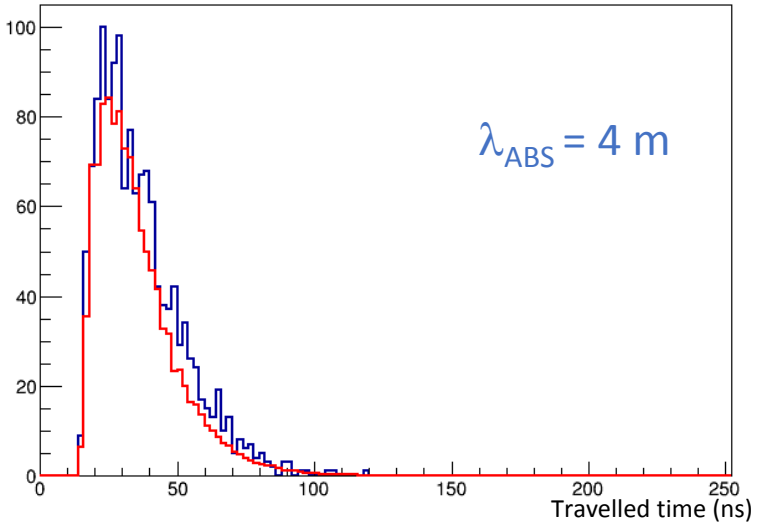
Comparison between Geant4 simulation results including absorption processus and a classical absorption model with an exponential exp(-travelled distance/ λ_{ABS})

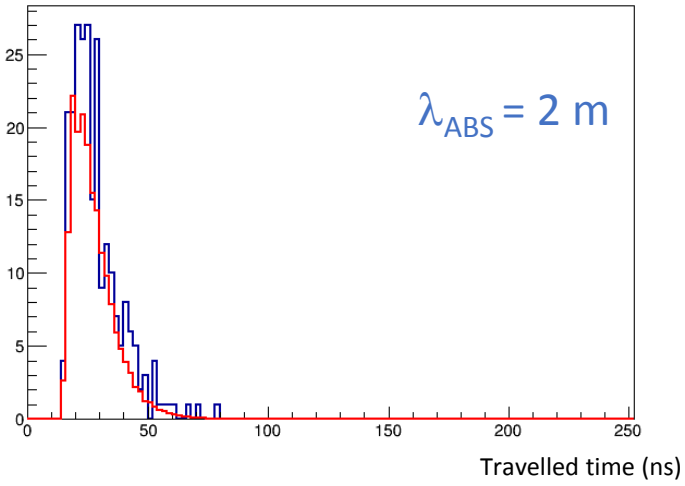
10^7 photons generated near the field cage surface (X = 2800 mm, Y = 0, Z = 0)

Absorption of field cage surface = 100%









Loss in % = $(N_{Geant4} - N_{Model})/N_{Geant4}$

λ_{ABS} = 30m	3.1 %
λ_{ABS} = 10m	9.8 %
λ_{ABS} = 4m	16.6 %
λ_{ABS} = 2m	25.1 %

The loss is reduced when the photons are generated near the field cage surface.
This may be explained by the fact that more photons are absorbed by the surface

Conclusion

This comparison shows that the difference between Geant4 and the model is dependant of

--- the absorption length

--- the position in the detector

Thus a more carefull study is needed to use the modelisation instead of Geant4 simulation.