Update on
light attenuation studies in Qscan

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Reminder: implementation of light absorption in Qscan

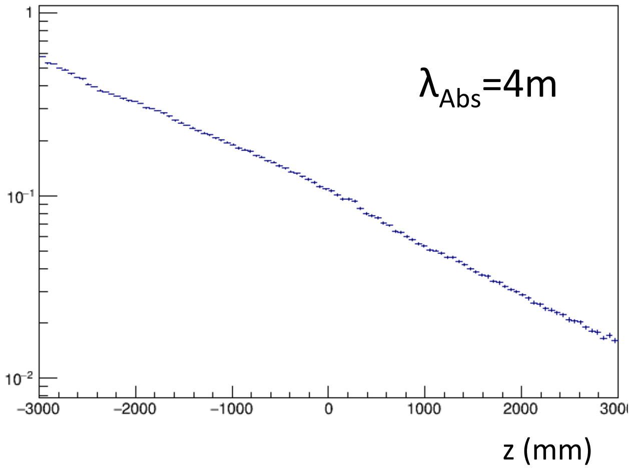
- A simple way to implement light absorption in Qscan, using the existing light maps calculated with $\lambda_{Abs}=\infty$: give to each photon a weight
  $= \exp(-(\text{travel\_time}*c/n)/\lambda_{Abs})$

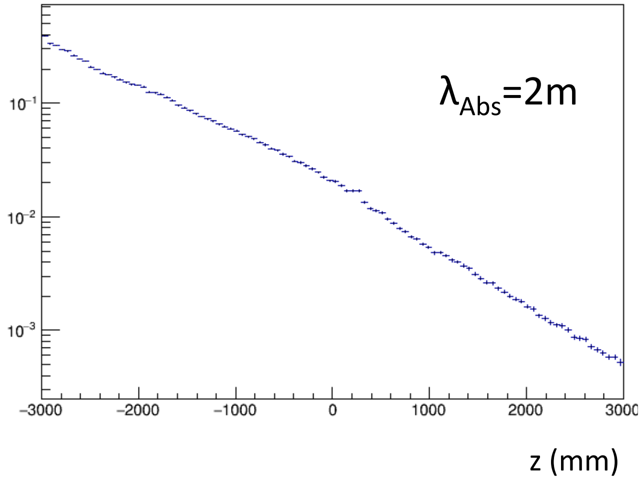
This approach has limitations for very small λ_{Abs}, as explained in the presentation by Isabelle et al. We might need the generation of new light-maps.

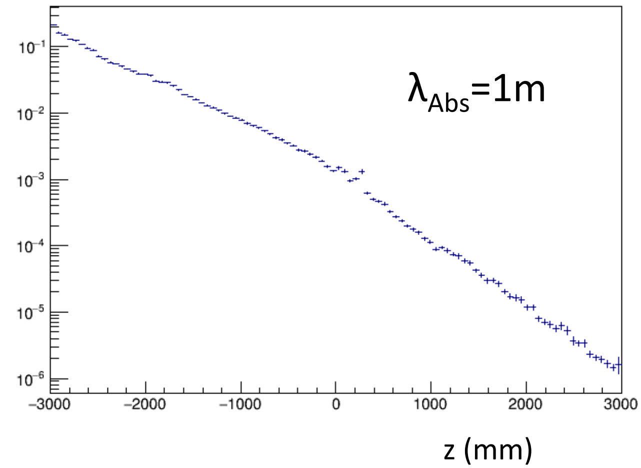
We have plotted the average value of this weight, representing the light reduction factor w.r.t. $\lambda_{Abs}=\infty$, as a function of the z coordinate of the photon production point

- at z=+3m, it represents the attenuation factor of S2; at z=0, the average attenuation of S1.

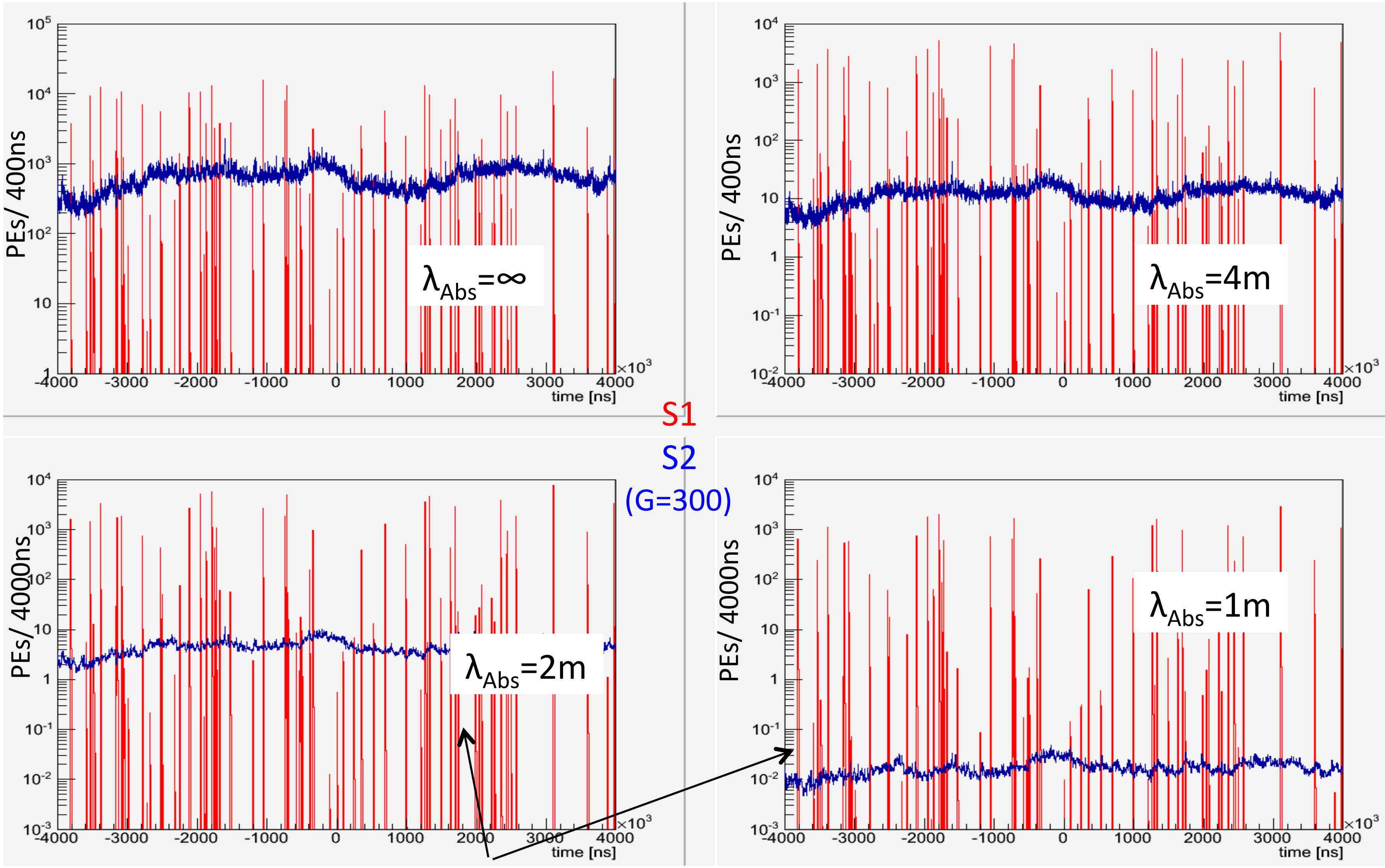
mean photon weight vs z







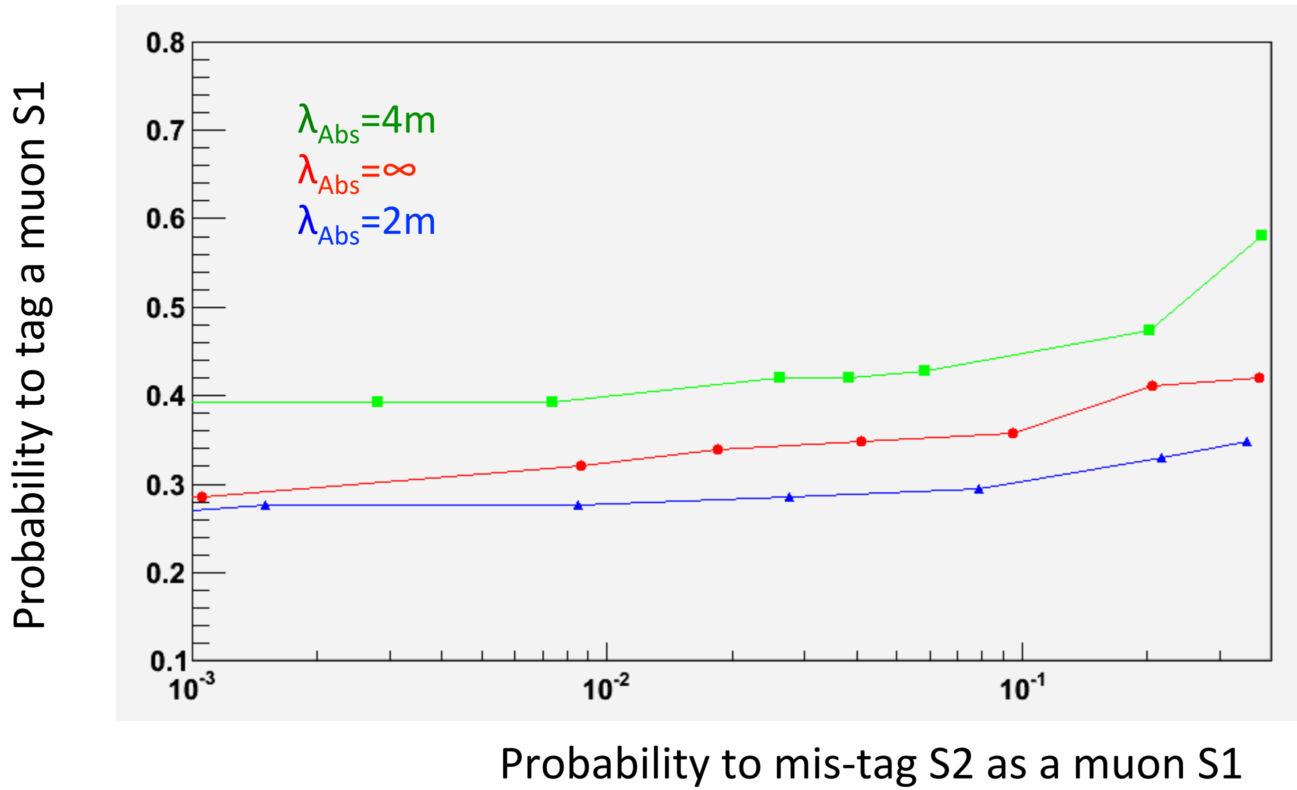
Muon bkg in 8 ms (LEM G=300), sum of 36 PMTs



Rebinned(10) to have at least few PEs per bin

Muon S1 tagging (LEM G=300), sum of 36 PMTs

With "Marie's method" (a simple threshold)

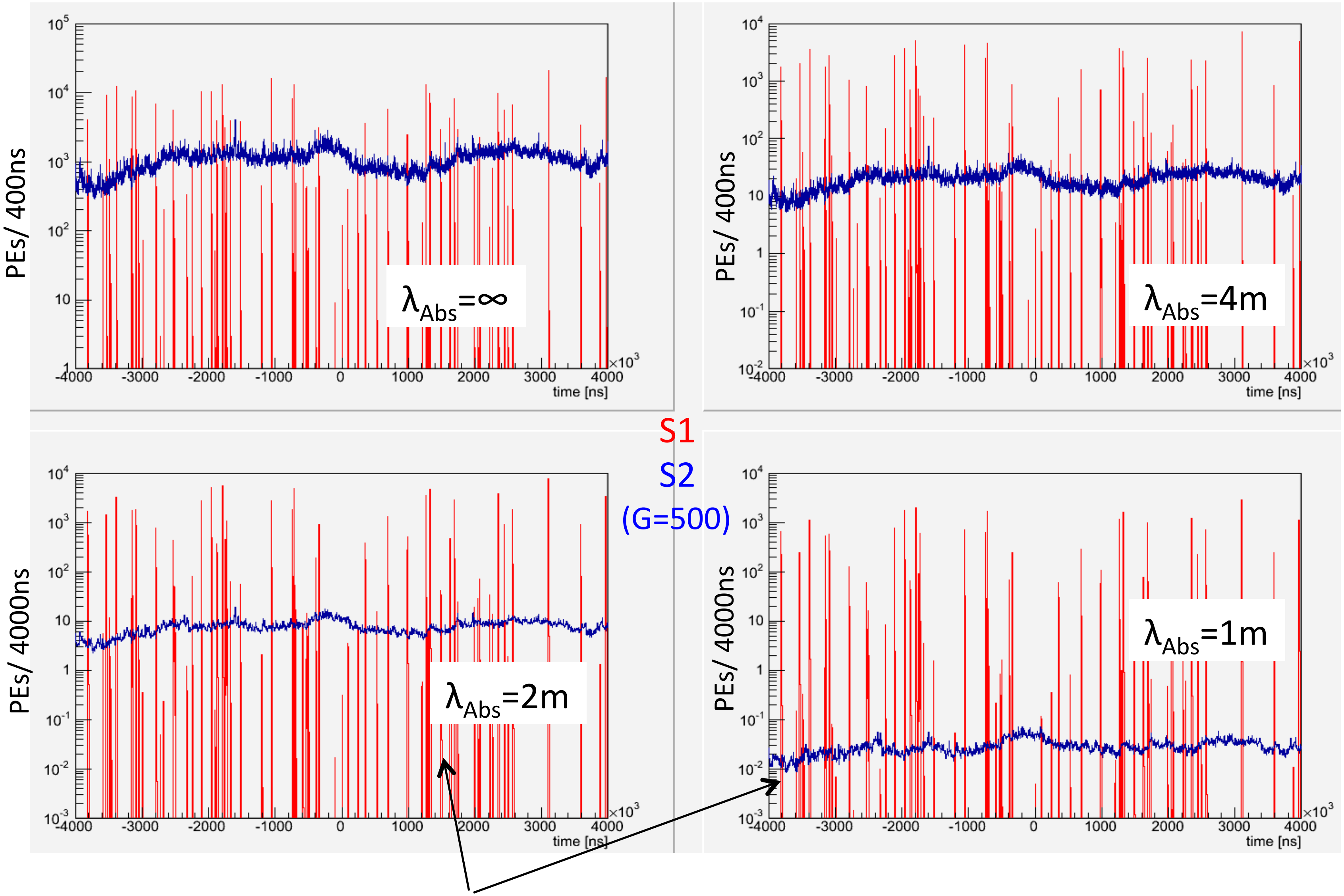


Note:
only 112 muons in the sample

With λ_{Abs}=1m, the probability to tag a muon S1 with a cut at 1(10) PEs per bin is 0.27(0.20) and S2 contamination is ~0.

Doubling the optical coverage (actually, reducing the threshold by a factor 2) increases these values to 0.30(0.21), while it has no impact with larger λ_{Abs} because of S2 contamination.

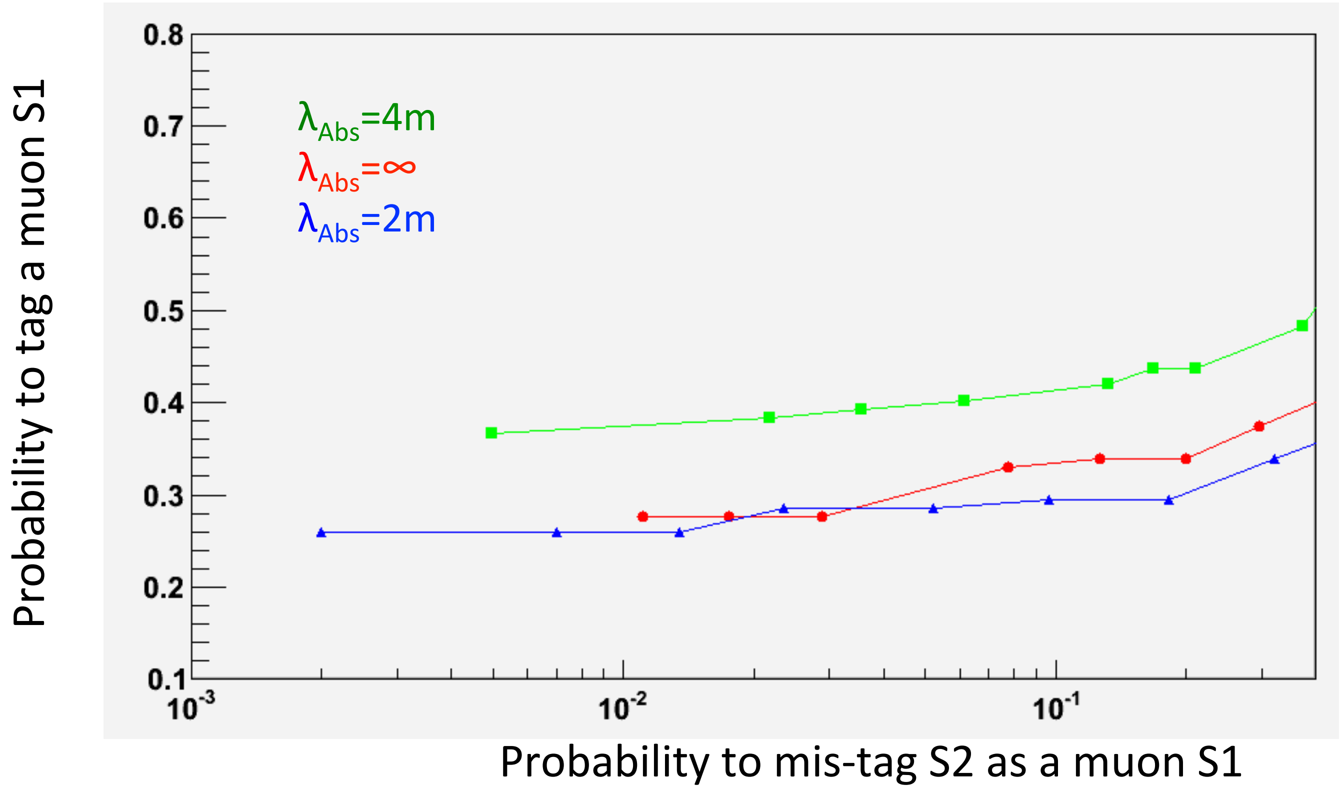
Muon bkg in 8 ms (LEM G=500), sum of 36 PMTs



Rebinned(10) to have at least few PEs per bin

Muon S1 tagging (LEM G=500), sum of 36 PMTs

With "Marie's method" (a simple threshold)



Note: only 112 muons in the sample

With λ_{Abs}=1m, the probability to tag a muon S1 with a cut at 1(10) PEs per bin is 0.27(0.20) and S2 contamination is ~0.

Doubling the optical coverage (actually, reducing the threshold by a factor 2) increases these values to 0.30(0.21), while it has no impact with larger λ_{Abs} because of S2 contamination.

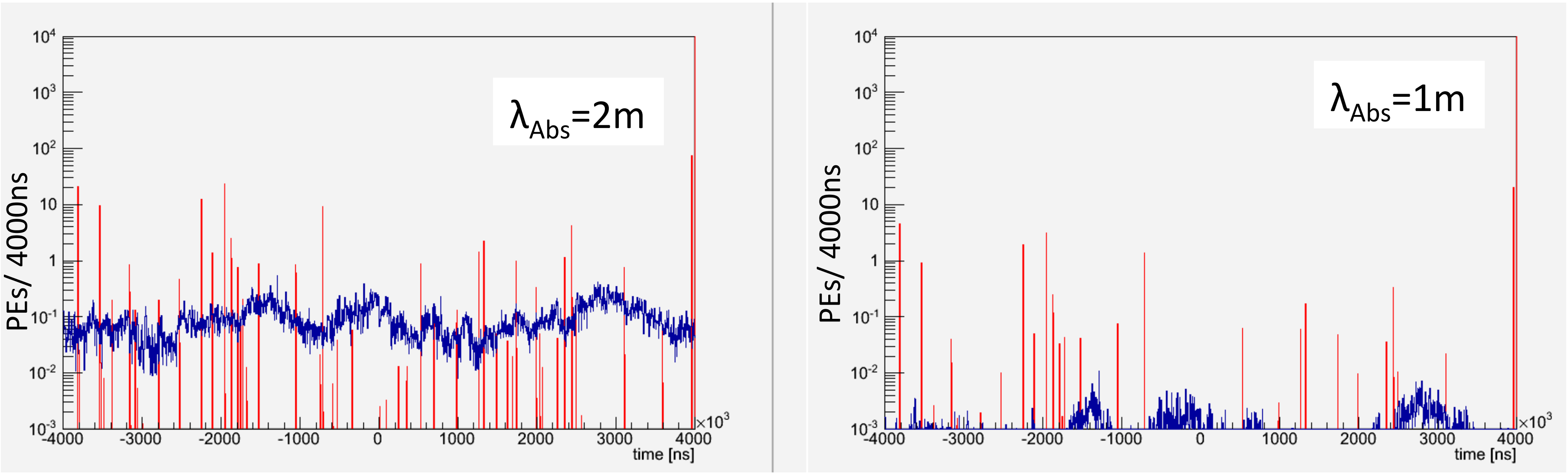
Muon S1 tagging – alternative approach

- Another possibility to tag the S1 of cosmic muons is to look at the PMT with the largest number of PEs in a given time interval
- Doubling the number of PMTs could help with this approach, because you double the chance of having a PMT near the muon
- .. but we are not able to quantify today: studies are in progress
- However, note that:
  - if we have <1PE on the total of the 36 PMTs, we will have <1PE on each PMT, so for small values of λ_{Abs} the efficiency cannot be larger than with the previous method
  - for large λ_{Abs} it has been shown (by Marie) that PMT occupancy in muon events is quite uniform, both for S1 and for S2, except maybe for very special positions/directions of the muon

- Remark: with either approach, a more sophisticated peak-finding algorithm could be used

Muon S1 tagging – alternative approach

Here is an example of what we get by taking the signal from the PMT with the largest occupancy in each 400ns bin and then grouping bins by 10 (not the best way to proceed…)



With λ_{Abs}= 2m(1m), the probability to tag a muon S1 with a cut at 1 PEs per bin is 0.11(0.04) and S2 contamination is ~0.
Doubling the optical coverage (actually, reducing the threshold by a factor 2) increases these values to 0.17(0.05).

Beam S1 measurement

- ArXiv:1405.0848 by M.Sorel: a precise measurement of scintillation is useful to improve calorimetry resolution. It would be nice to study it in WA105.
- Need statistical fluctuations <~1% => light collection efficiency **$\varepsilon > 6 \times 10^{-4}$**
- With the current light-maps, the light collection efficiency for an event at (x,y,z)=(0,0,0) is ~3.3×10^{-3} [cfr Isabelle's talk at SB on 06/07]
- When we multiply by the PMT Quantum Efficiency =0.2, we get

  $\varepsilon_{WA105} \sim 6.6 \times 10^{-4}$
  - the study could feasible if λ_{Abs} is "large", in this case doubling the PMT coverage would be useful
  - however, we will suffer from S2 contamination

- The value of **ε_{WA105}** is reduced by ~4/10/100/1000 with λ_{Abs}=10/4/2/1m
  - the study is probably not feasible if λ_{Abs} is not "large"