

Status of the work about light signal simulation

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Updates

- At last talk at **SB meeting** (8 February 2017):
 - Presentation of **preliminary light maps** with low statistics
 - Impact of the **PMT spacing** (1m or 65cm) on light **signal collection**
- An **issue** concerning the **detector implementation** (a part of the cathode supporting structure wasn't activated) was **fixed**
 - This issue impact **only** the results presented at **last talk** (8 February 2017)
 - This correction reduces the number of **collected photons**, but does not impact the **comparison** between the two PMT configurations
 - We have **relaunched** a map production.
- Consequences of the **reduction** of the collected photon number:
 - We have **increased** the statistics for the GAr map: $10^8 \rightarrow 5 \cdot 10^8$
 - The **landau fit** of the travel time distribution was **improved** (parameter bounds)
- **Outline**
 - Update of the study of the **PMT positioning impact** on light signal collection
 - First results on signal induced by **cosmic muons**

PMT positioning impact on light signal collection

On last talk (8 February), presentation of the impact of the PMT **spacing** on light signal collection:

- PMT every 1m^2
- PMT every 65cm^2

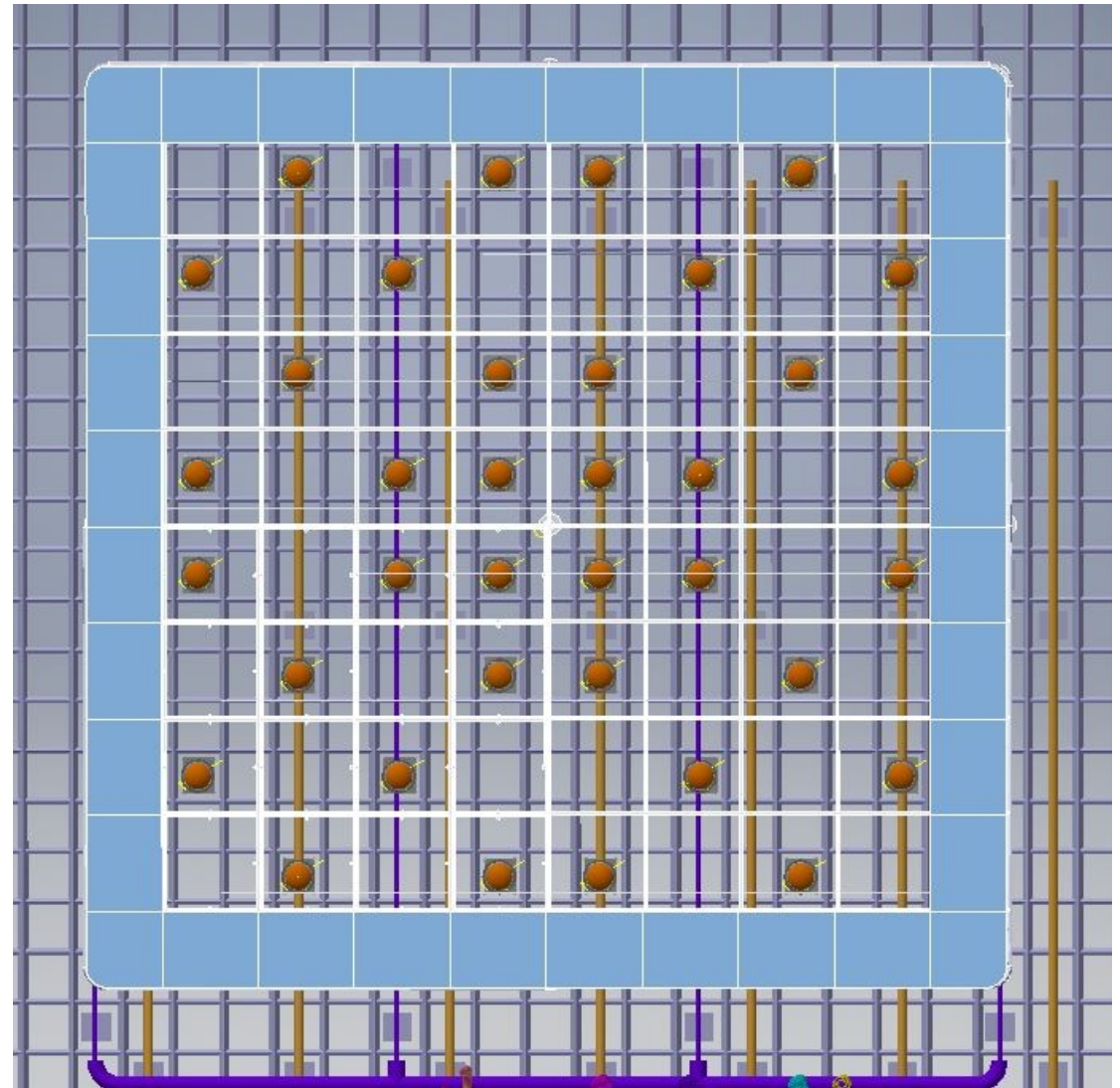
As discussed at the meeting, we have also look at a **third possibility** with PMT **non-uniformly** spaced.

→ Comparison between PMT **spaced by 65cm** and PMT **non-uniformly spaced**

Method:

Generation of 10^7 photons at different points of the detector

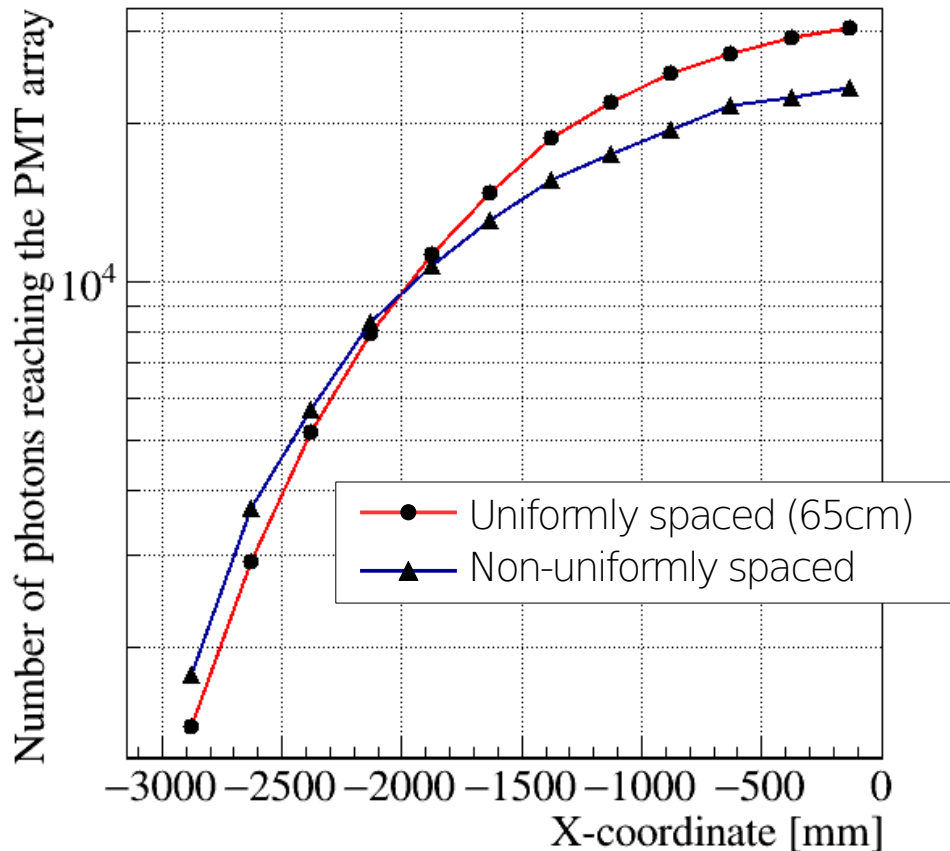
→ Number of photons **reaching the PMT array**



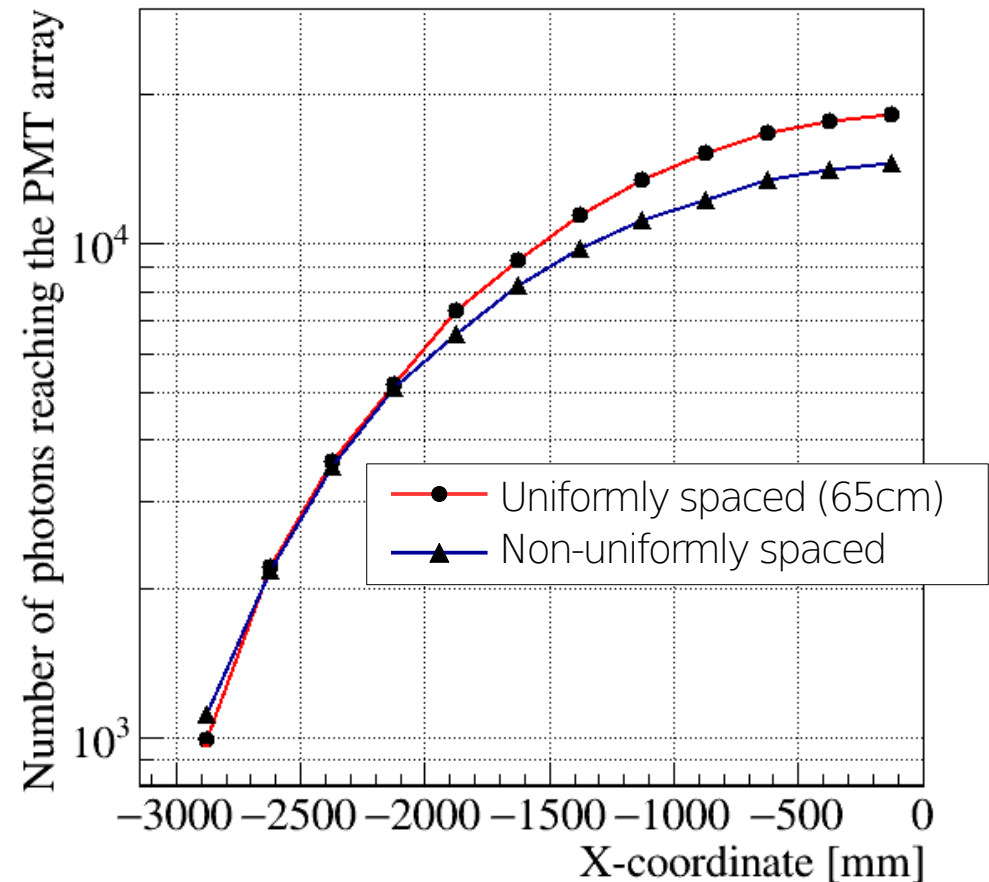
PMT positioning impact on light signal collection

Comparison between the configuration with PMTs spaced by 65cm and the third option

~1m above the cathode pipes



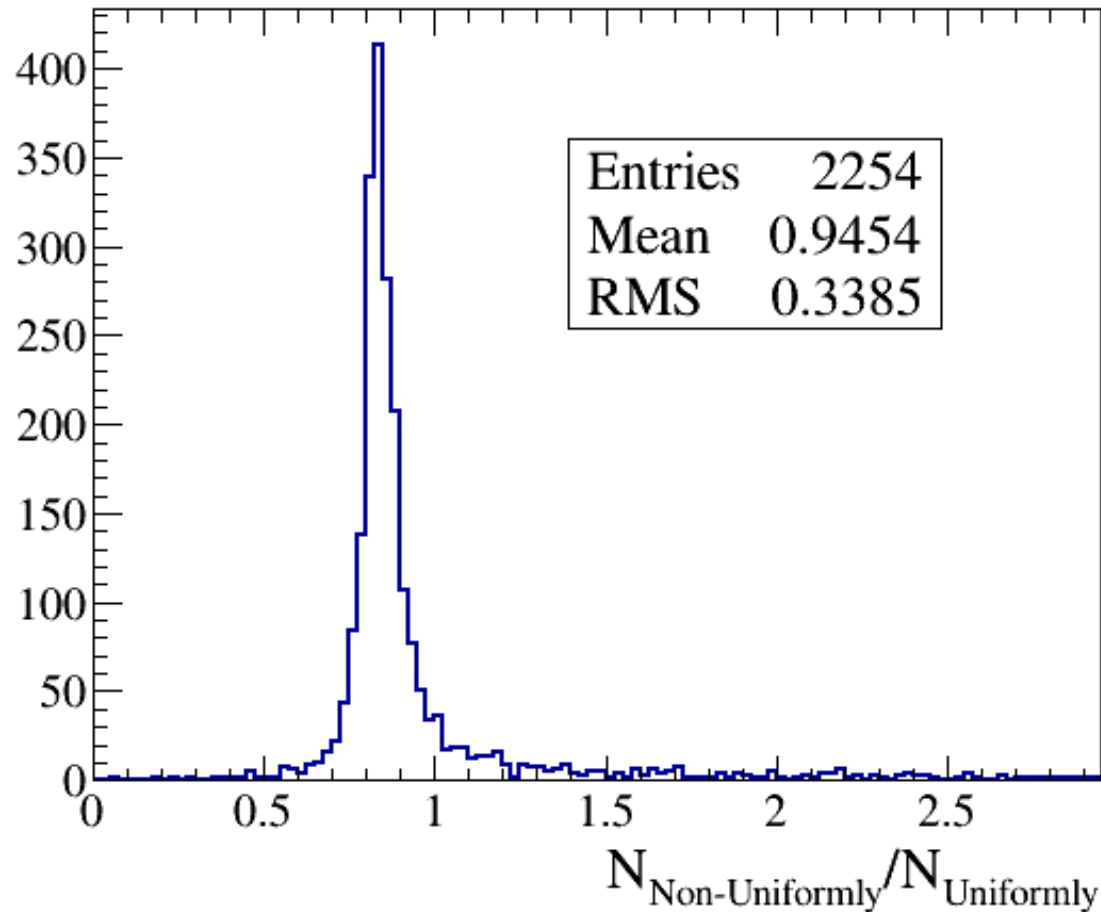
~2m above the cathode pipes



- PMTs **uniformly** spaced: **increases** the number of collected photons at the detector **center**
- PMTs **non-uniformly** spaced: **increases** this number at detector **edges** (for low Z)

PMT positioning impact on light signal collection

Computation of the ratio $\frac{N_{\text{non-uniformly}}}{N_{\text{uniformly}}}$



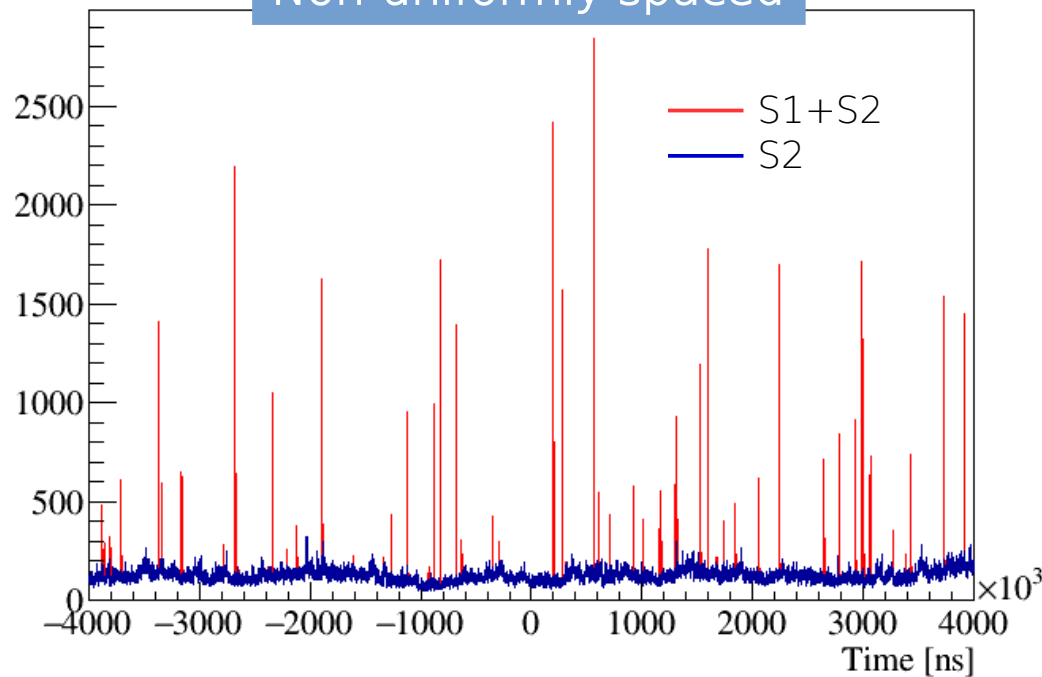
- Mean ratio of **0.95**
- The option with **PMT non-uniformly spaced slightly** reduces the number of photons reaching the PMT array.

→ What is the impact on the background induced by **cosmic muons** ?

PMT positioning impact on signal induced by cosmic muons

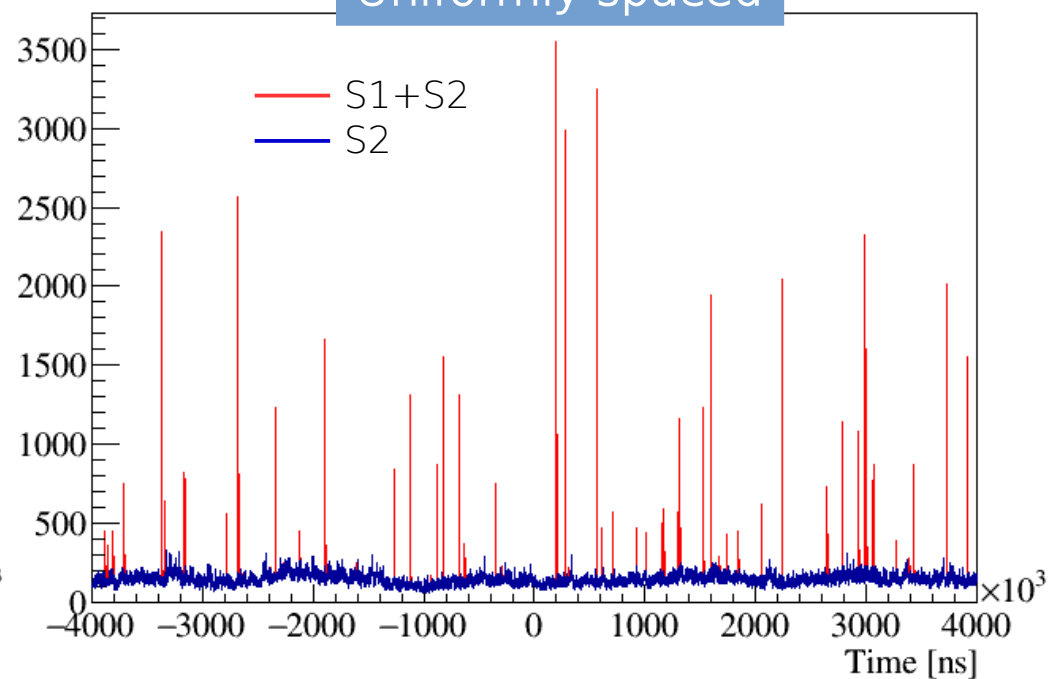
- Infinite absorption length
- PMT quantum efficiency: 0.20
- Electroluminescence gain $G=300$
- PMT and electronics response not taken into account
- Sum of the 36 PMT signals

Non-uniformly spaced



$$\begin{aligned} N_{S1} &\sim 0.13 \times 10^6 \\ N_{S2} &\sim 2.52 \times 10^6 \\ N_{S1}/N_{S2} &\sim 0.0516 \end{aligned}$$

Uniformly spaced



$$\begin{aligned} N_{S1} &\sim 0.16 \times 10^6 \\ N_{S2} &\sim 2.98 \times 10^6 \\ N_{S1}/N_{S2} &\sim 0.0537 \end{aligned}$$

→ PMTs **uniformly spaced**: the **number** of photons hitting the PMT array increases

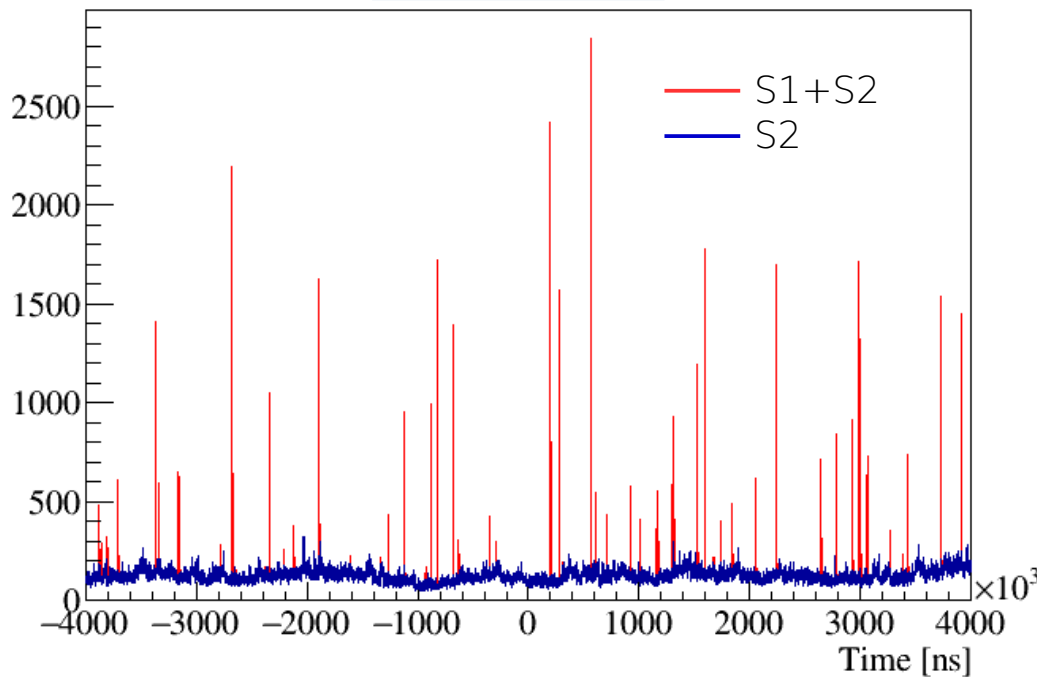
→ PMTs **non-uniformly** spaced: the **ratio** between N_{S1} and N_{S2} is a little lower

Influence of the binning on the S1/S2 discrimination

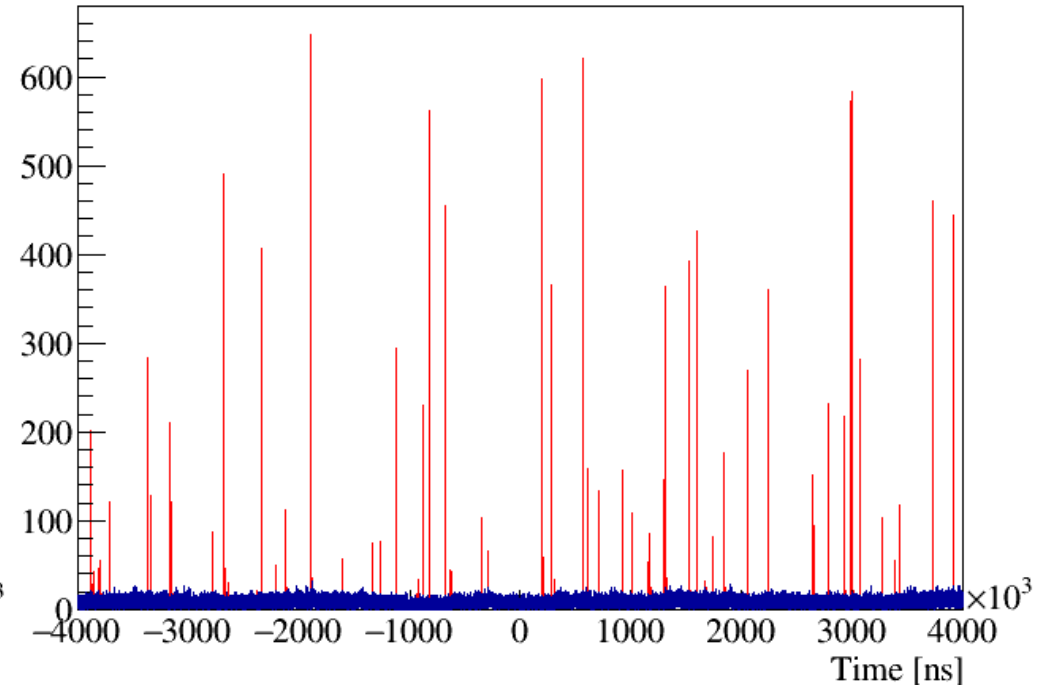
Binning used **for now**: 400ns in order to combine the **light** data with **charge collection** data.

Is it interesting to also use **25ns sample** for cosmic tagging ?

400ns/bin



25ns/bin



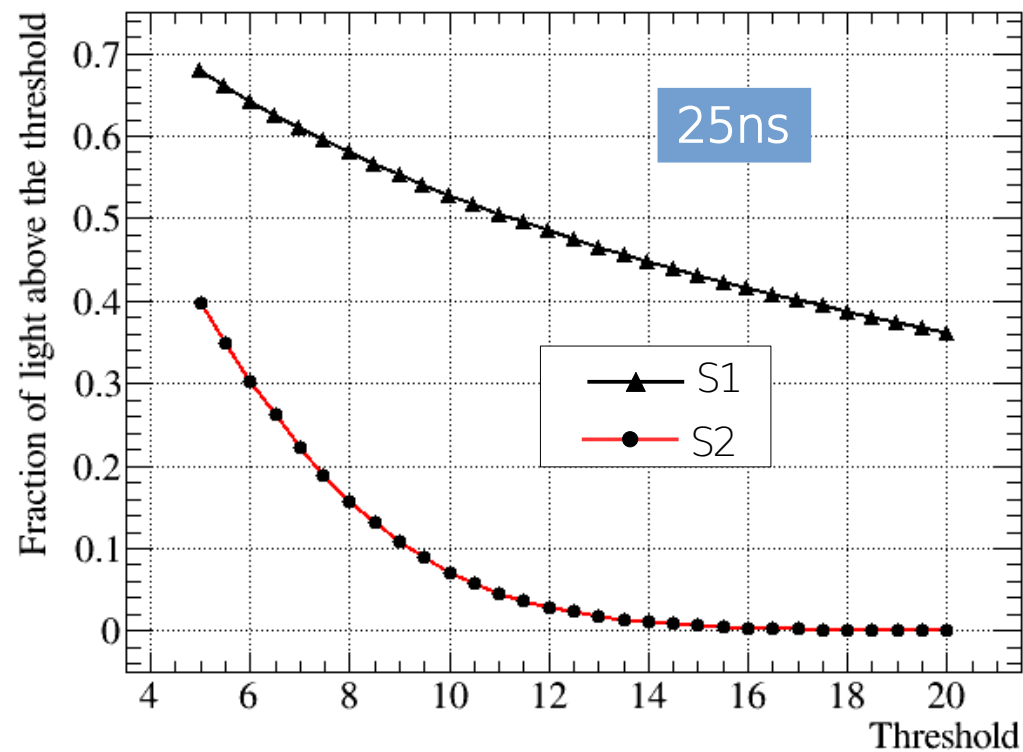
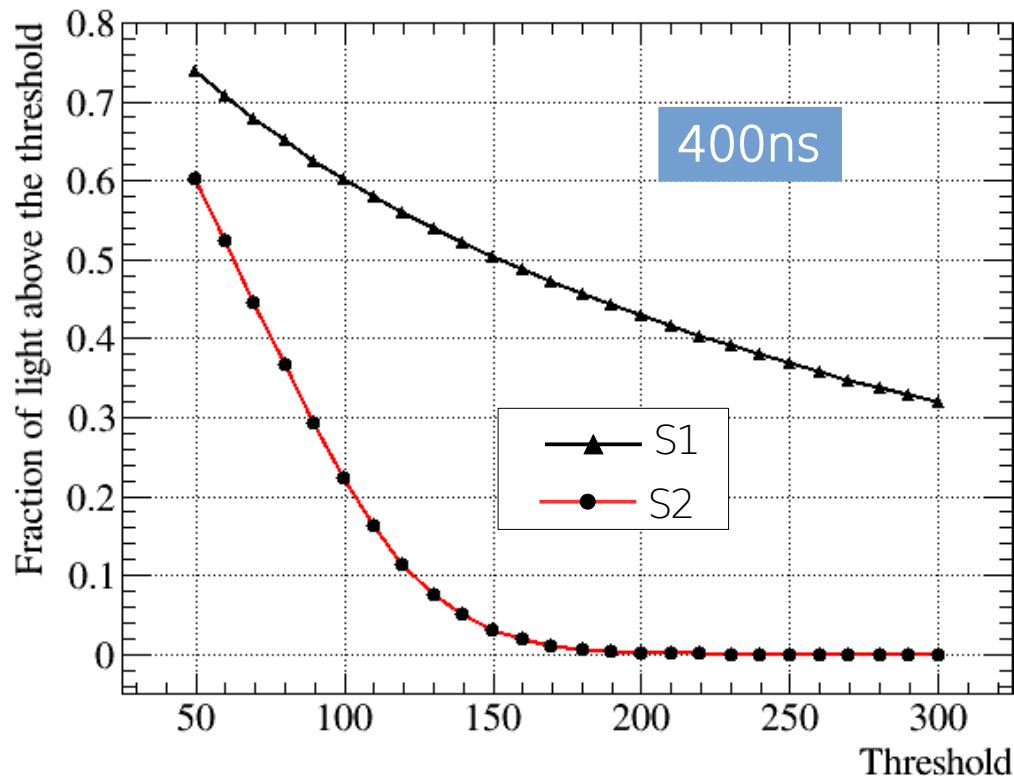
- For this slide and the next slides:
- PMT non-uniformly spaced
 - Sum of the 36 PMT signals

Impact of the binning on the S1/S2 discrimination (very preliminary results)

Threshold method (developed last year by Marie and Alessandra)

→ If the signal in a bin is **above** the threshold, it is tag as **S1** signal

→ We look at the fraction of S1 and S2 light above the threshold

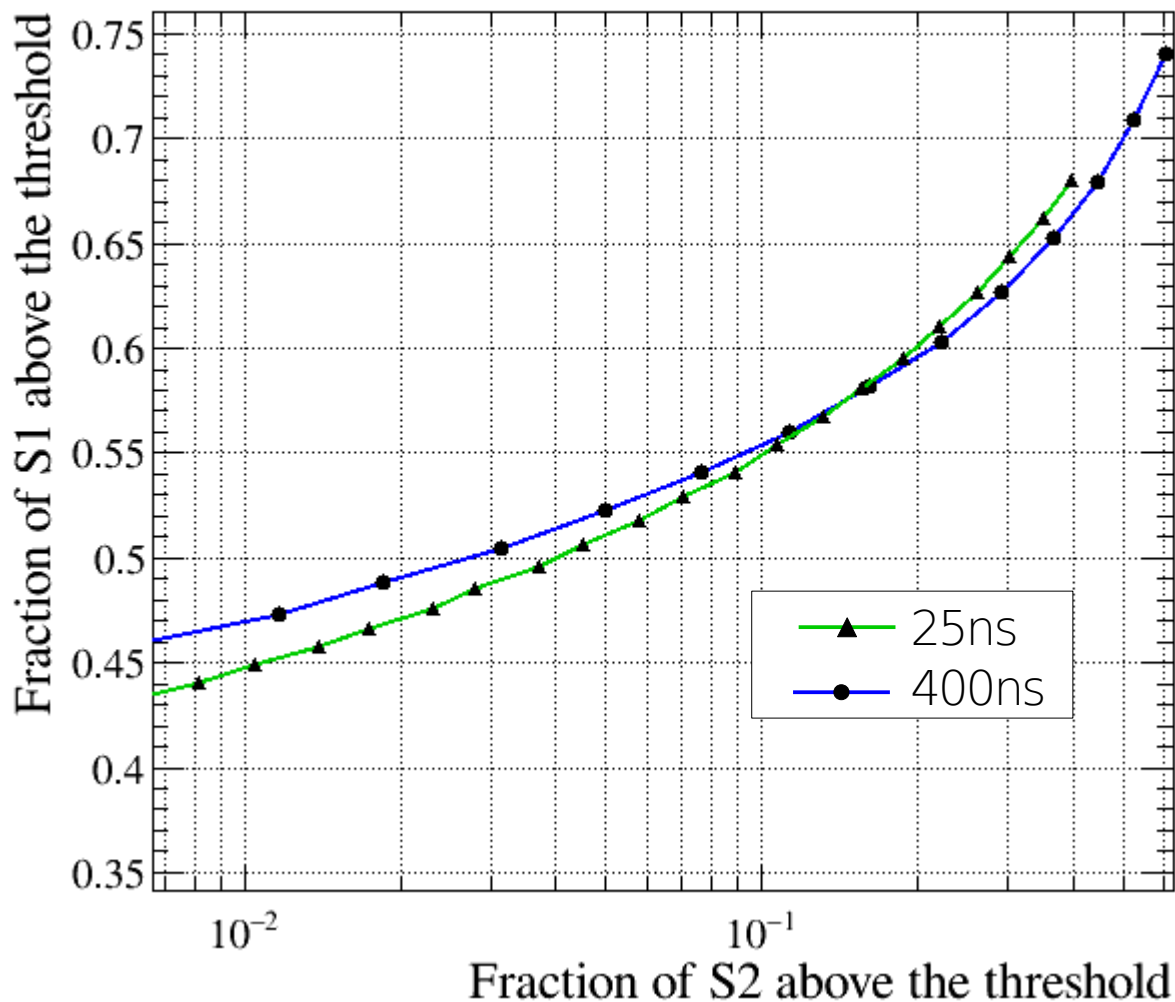


→ The trends seem similar for the two cases

Note: very preliminary results, need additional work

Impact of the binning on the S1/S2 discrimination (very preliminary results)

The aim is to keep a **great fraction of S1** light above the threshold, while having a **low fraction of S2** light.



Note: very preliminary results, need additional work

Dependence to the absorption length in LAr

The **absorption** in **LAr** is not taken into account in the **light map generation**

→ This absorption can be **implemented in Qscan** by giving a **weight** to each photon.

$$\exp\left(-\text{travel_time} \cdot \frac{c}{\lambda_{\text{Abs}} \cdot n_{\text{LAr}}}\right)$$

→ No **need** to generated **new maps** to perform preliminary studies about the absorption length

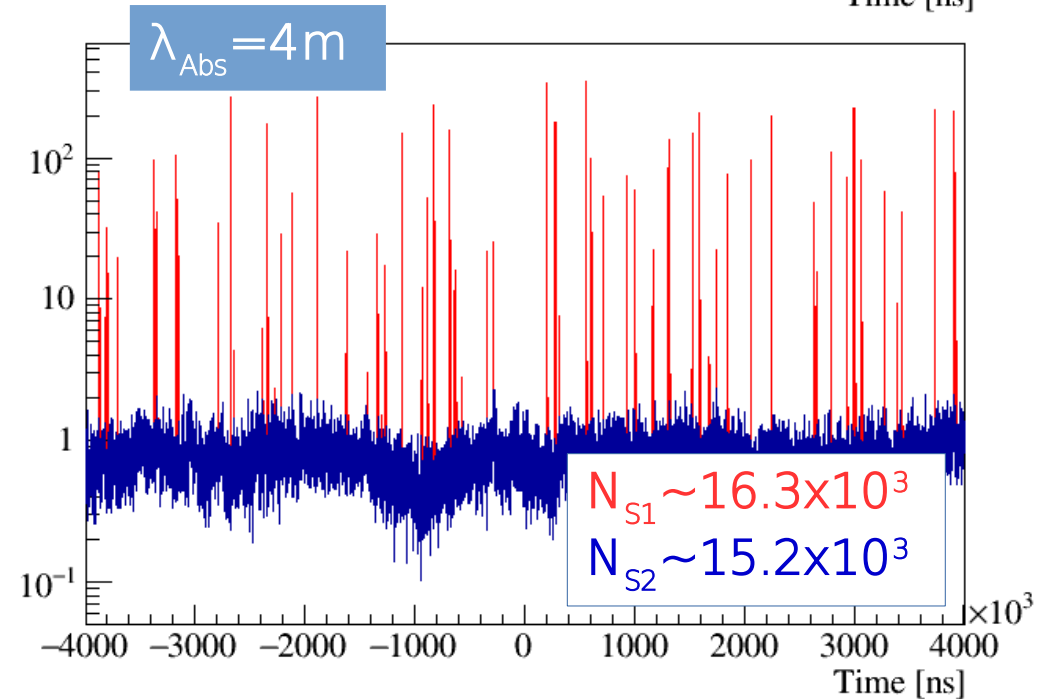
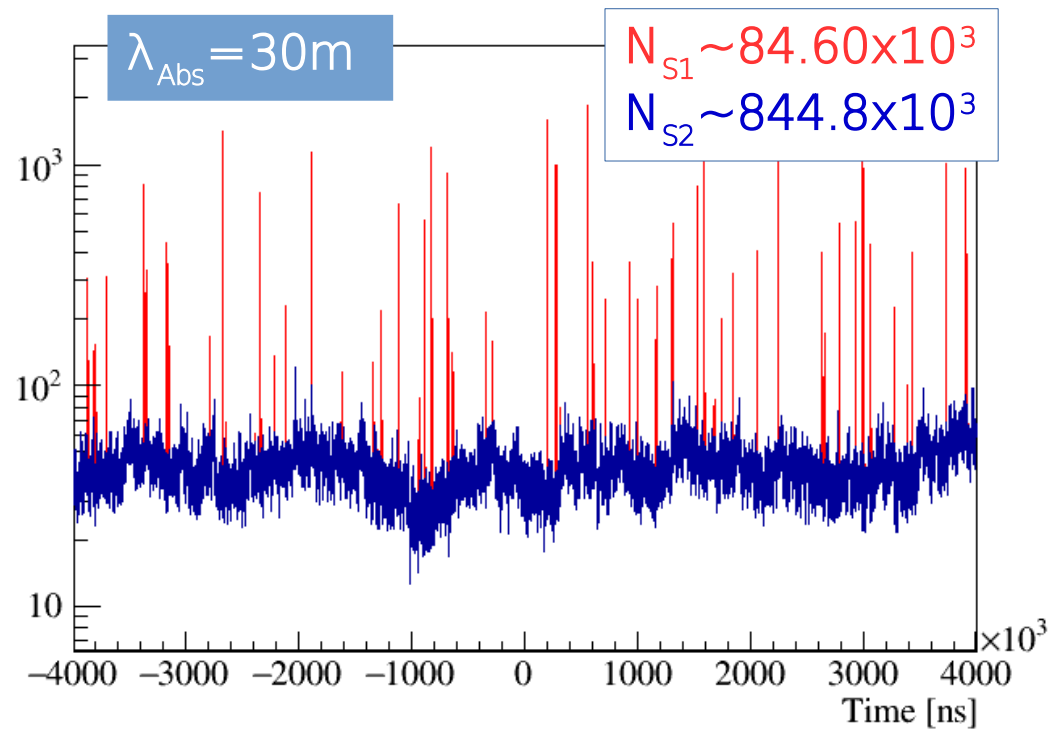
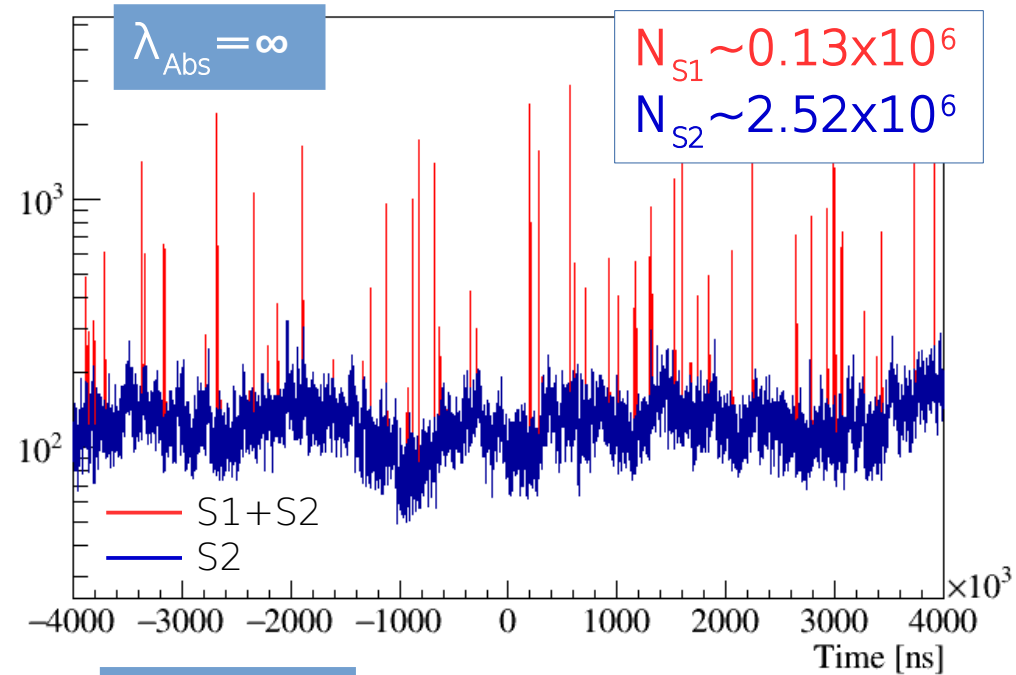
Due to this implementation, we can have a number of photons **between 0 and 1**, which is **not possible**

→ We will improve our implementation to correct this effect

Dependence to the absorption length in LAr

→ The number of photons is **globally** reduced for **S1** and **S2**

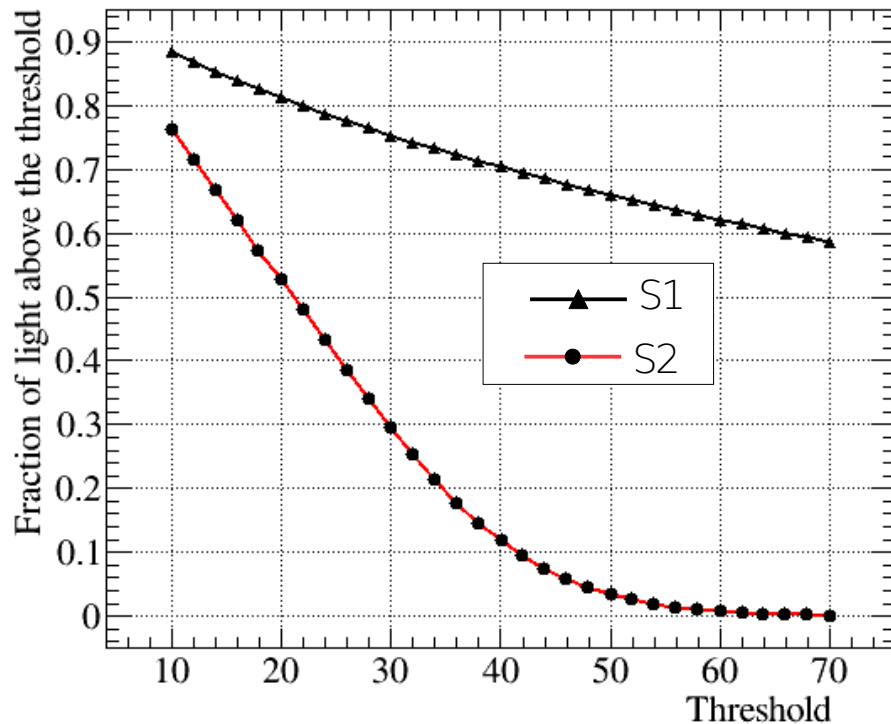
→ The **S2** signal is the **most affected**



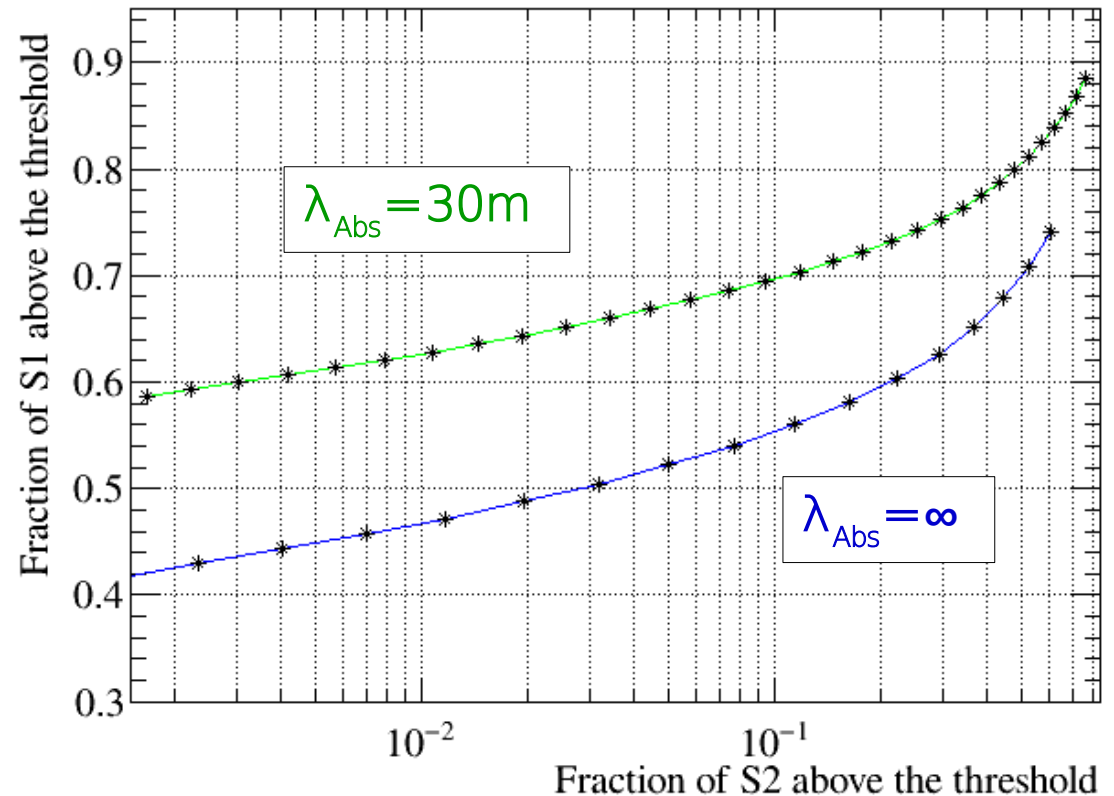
Dependence to the absorption length in LAr

Threshold method (developed last year by Marie and Alessandra)

Fraction of light above threshold
for $\lambda_{\text{Abs}} = 30\text{m}$



Comparison with $\lambda_{\text{Abs}} = \infty$



→ The fact that **S2 signal** is more affected than S1 signal is **visible**

→ For a given remaining fraction of S2, the **S1** fraction **above the threshold** is **higher**

Note: very preliminary results, need additional work

Conclusion

Light map production

- New **light maps** has been produced
 - Corresponding to the **geometry** described at last talk (8 February 2017, SB Meeting, slide 3)
 - 2 different versions: PMTs uniformly **spaced by 65cm**, and PMTs **non-uniformly** spaced
 - The **time distribution fit** has been improved
- The map version with **PMT spaced by 1m** has **not** been updated

Impact of the **PMT positioning** on light signal collection

→ The two configurations (PMTs uniformly or non-uniformly spaced) are **quite similar** for the light signal collection

Cosmics tagging

- **Preliminary** results, using the **threshold method**, has been obtained
 - Using 25ns/bin instead of 400ns/bin **does not improve** the S1/S2 ratio
 - The **absorption length** in LAr is a **crucial** parameter for the simulation and for the tagging
- **Next steps:**
 - Continue the development of the **algorithm tagging**
 - Studies with smaller **absorption lengths**
 - Studies with different **electroluminescence gain**
 - Using the signal collected **PMT by PMT**