Status Report on the Light Maps Production

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WA105 SB Meeting

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de Physique des Particules

Introduction

- Today we will present our progress on the whole map production procedure.

- Working chain :

LAr and GAr volumes are split in **voxels** → Generation of a large number of **photons** in each voxel → Photons are **tracked** across the detector → **Travel time distribution** obtained for each PMT → Extraction of time distribution **characteristics** → Light Maps

- Remark

We are currently implementing the **TPB + PMMA layers** on the cathode, and studying comparisons between the two designs (TPB coat on PMTs)

→ We plan to **present** this work in the next SB meeting.

Procedure for Light Maps Production

- Script which creates a 3D-histogram with voxel centers.

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  - Build a macro file to initialize the run :
    - Production point : voxel center
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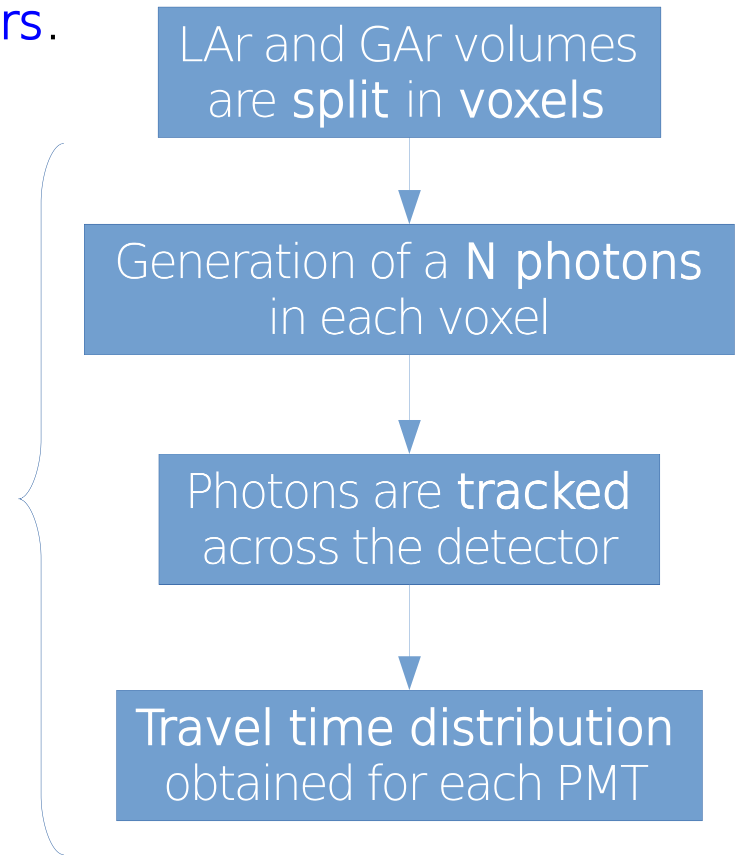
    - E = 9,69 ± 0,22 eV
    - Isotropic emission
  - Launch LightSim with the macro file

One file .root per voxel.
Each file contains **36 histograms**.



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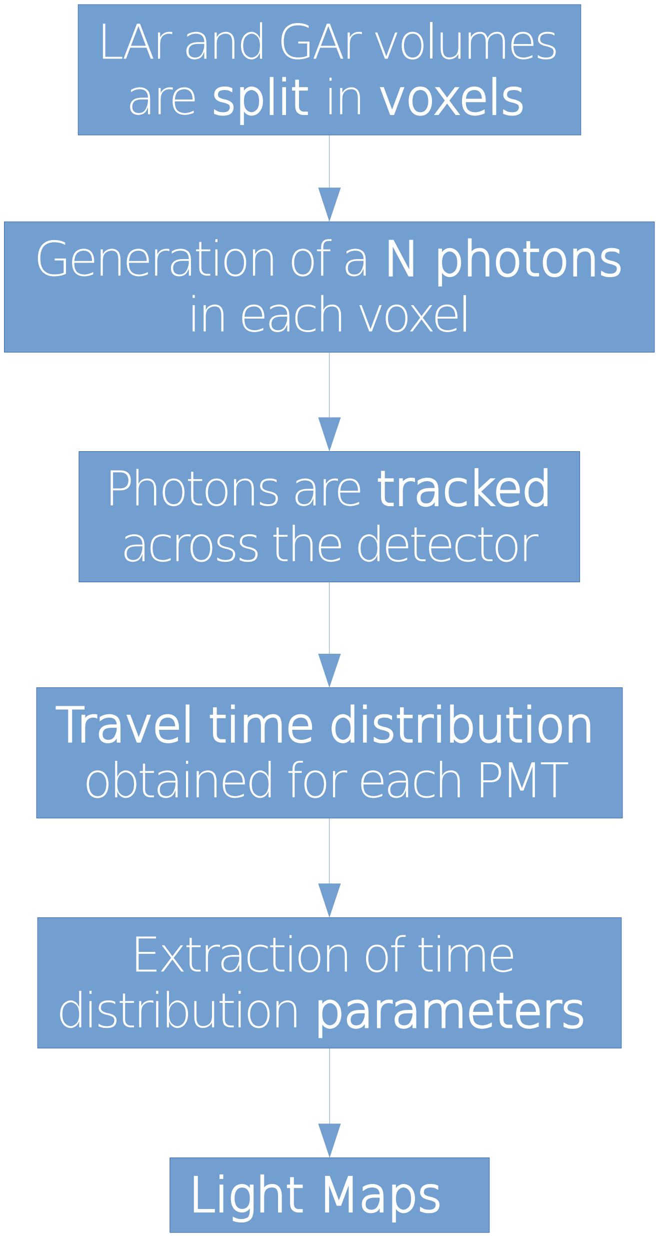
Map file (.root) with (n_{param} x 36) 3D-histograms.



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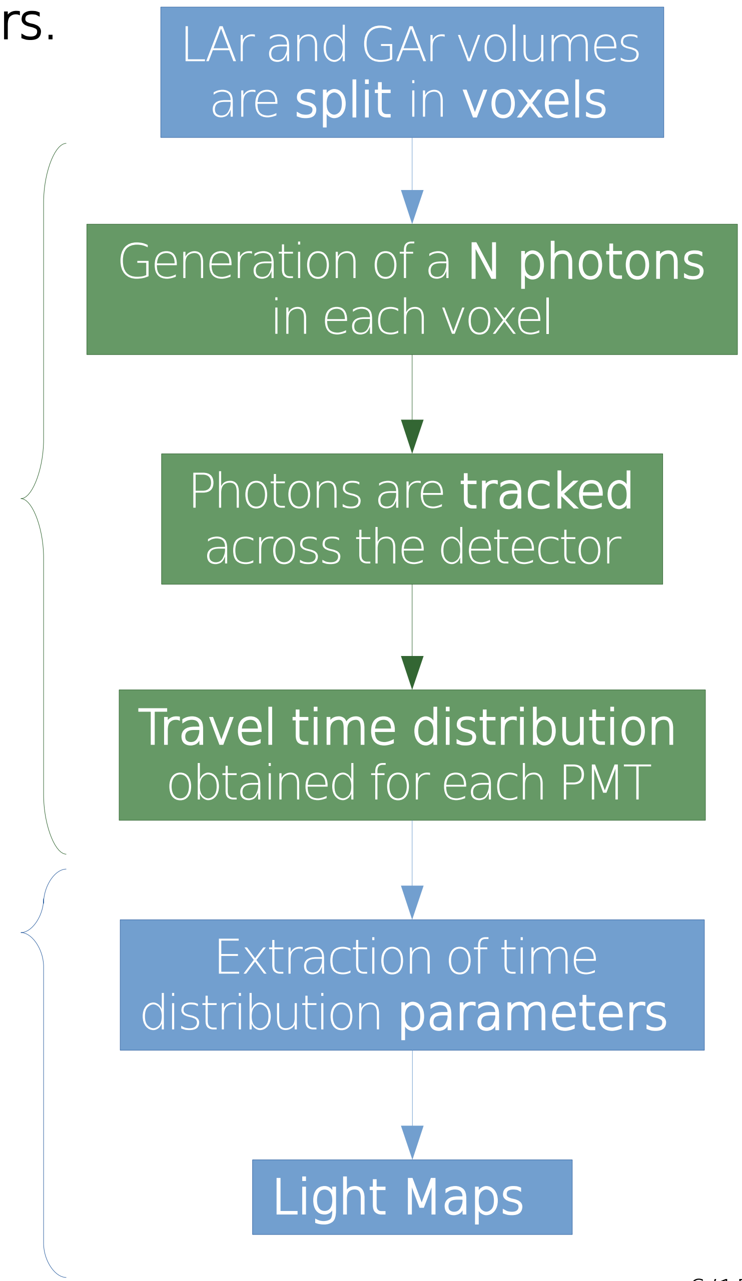


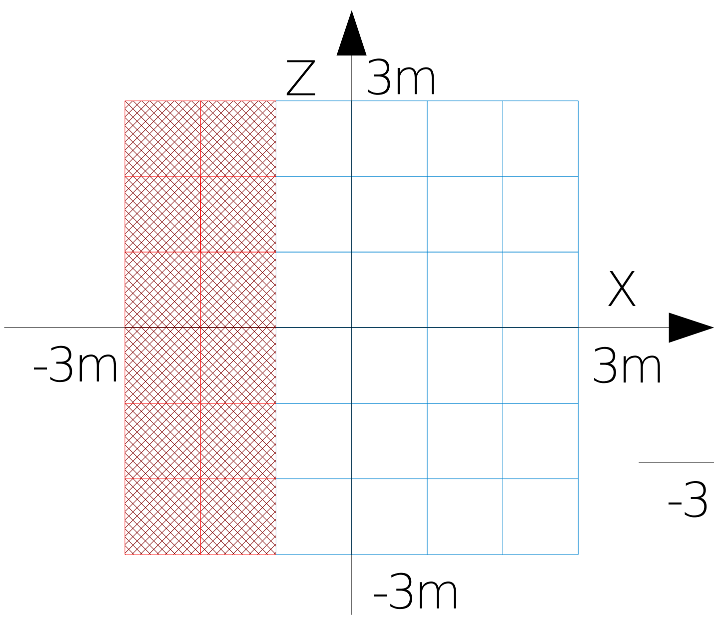
Photon Tracking and Time Distribution Generation

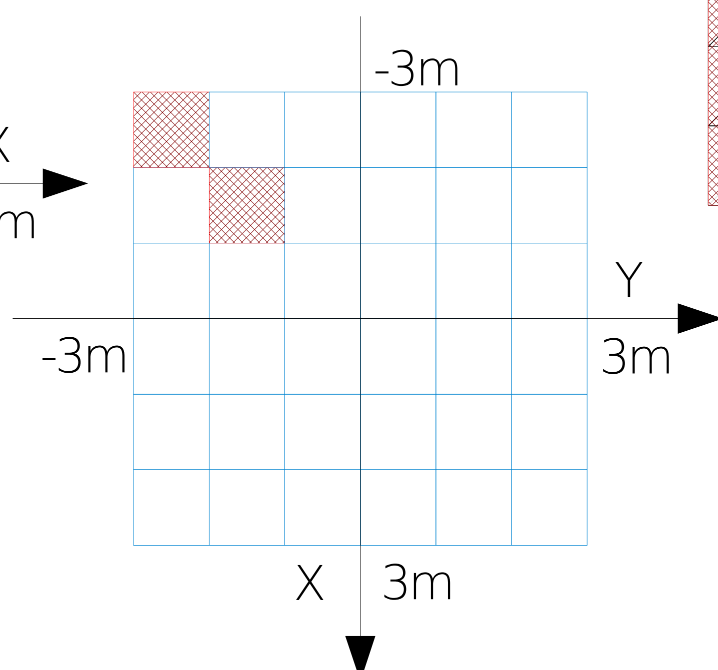
- Test of the procedure :

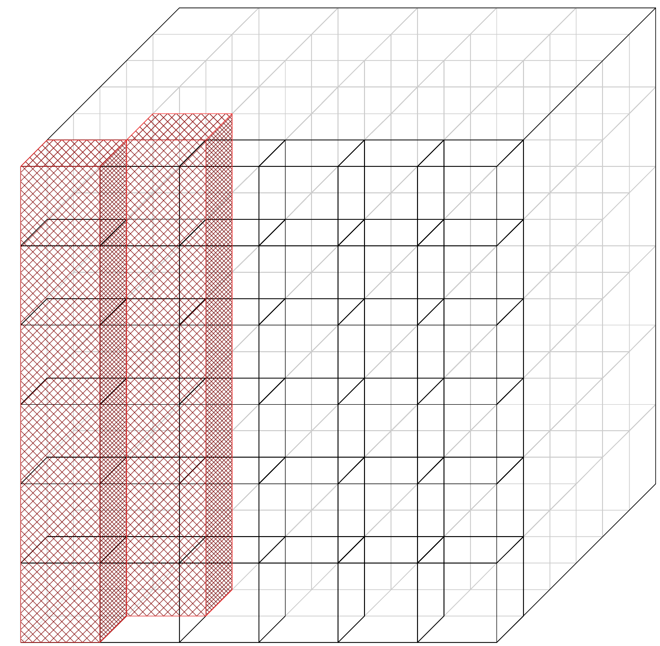
→ Use of a **simplified** voxel map description.

(1x1x1)m^3 voxels
→ (6x6x6) = 216 voxels

- We look at only two columns (12 voxels) :
  - X and Y **fixed** at -2.5m and -1.5m.
  - Z = {-2.5 ; -1.5 ; -0.5 ; 0.5 ; 1.5 ; 2.5} m





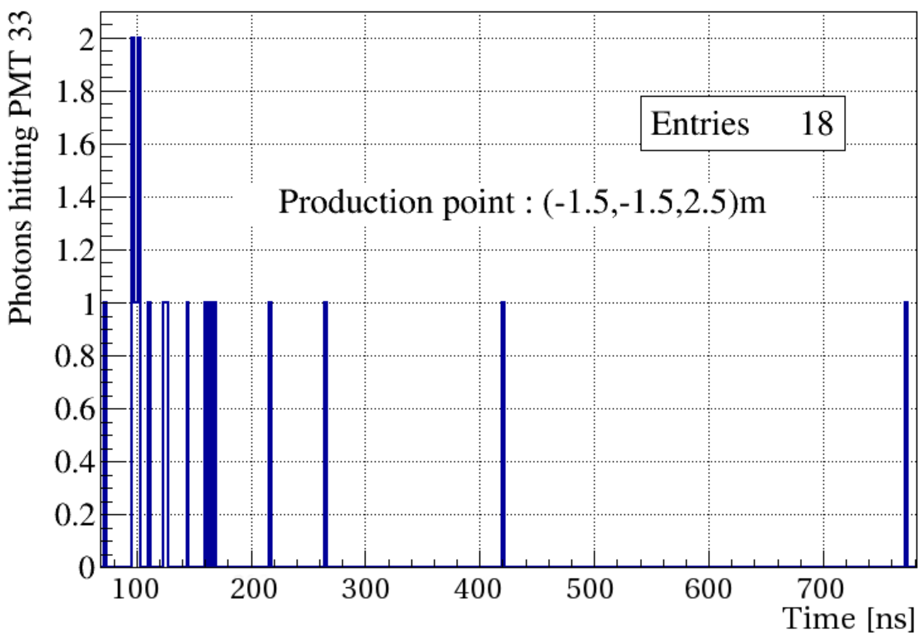


Remark :
Exploiting the **X-Y symmetry** of the detector
→ Generate photons on **¼** of the detector to save time

Photon Tracking and Time Distribution Generation

Number of photons N : First try with 10^7 photons

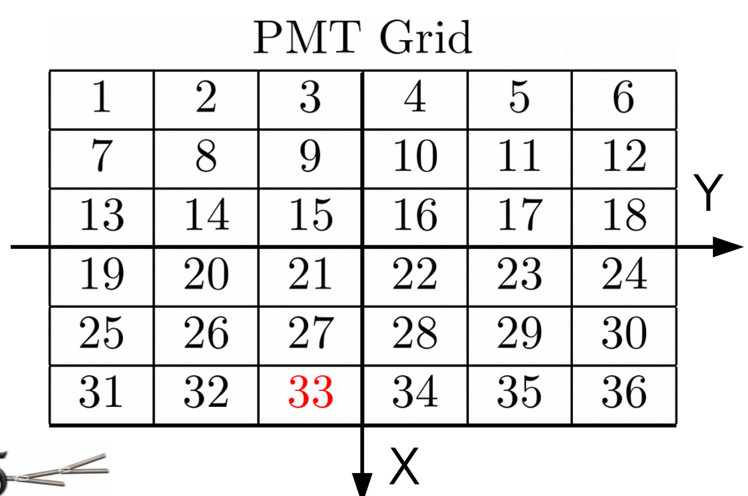
→ Most of the PMTs don't see enough photons to extract the time distribution characteristics !

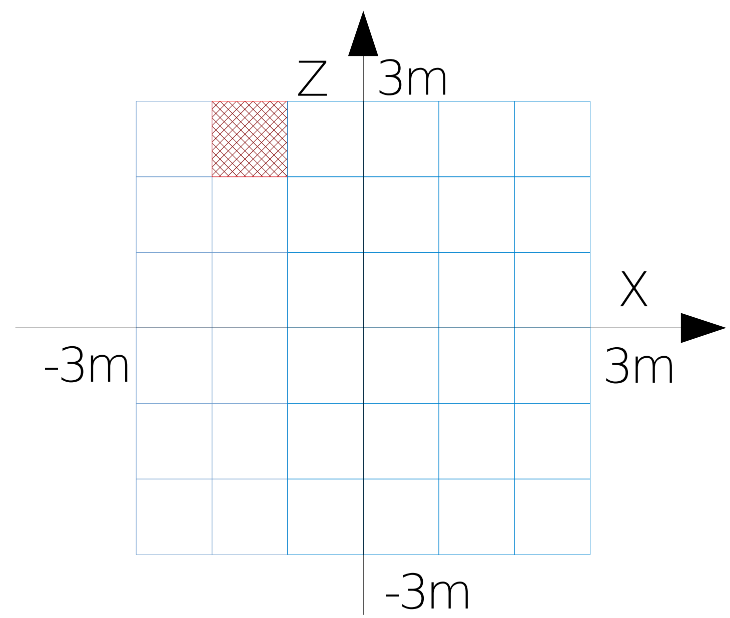


For voxel at the top of the tank :

A lot of photons are lost during the travel in LAr !

→ Only a few of them finally reach the PMTs.





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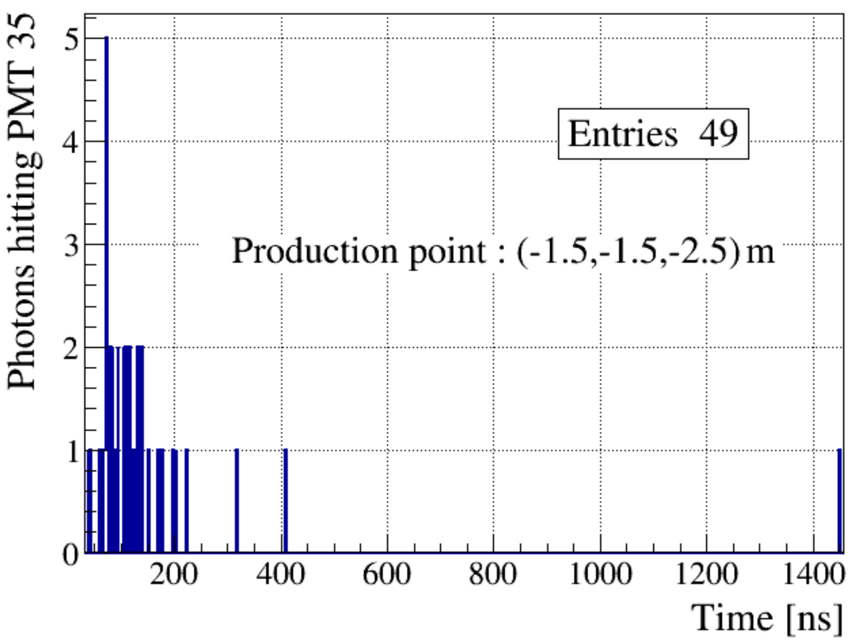
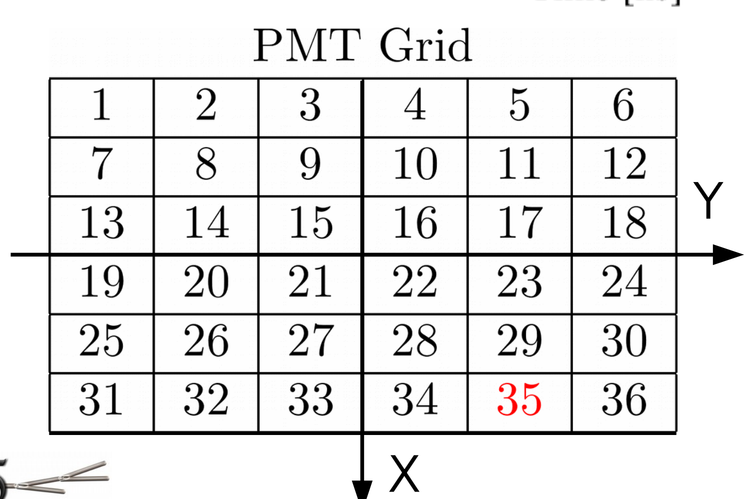
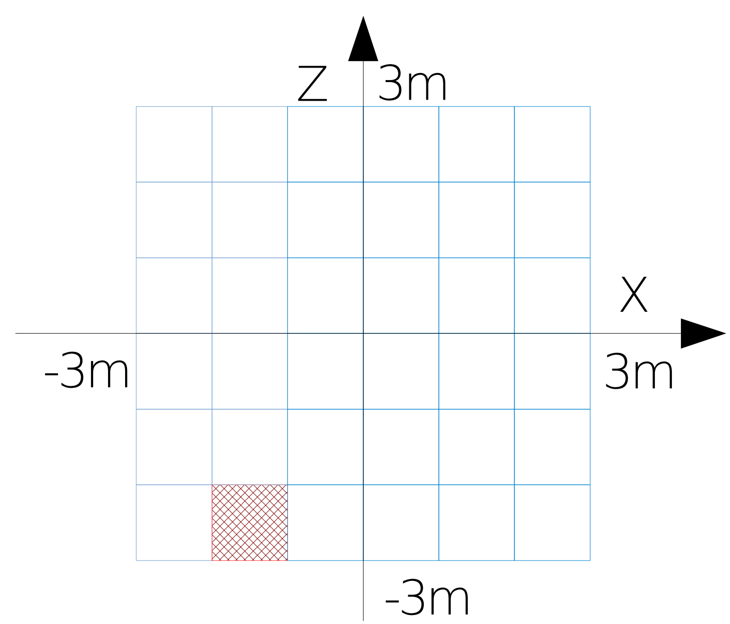




Same problem for voxels at the bottom of the tank :

→ Most of the photons will not reach distant PMTs.



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Photon Tracking and Time Distribution Generation

→ It's better with $N = 10^8$ but it is time consuming ! (~5h per voxel)

Number of voxels	Queue	N	CPU	% of distributions with less than 100 photons
6	long (CC IN2P3)	10^7	~2h30	2.5 %
		10^8	~24h	27.1%

→ We choose 10^8 photons for this study, but this number could be optimized with respect to the voxel position.

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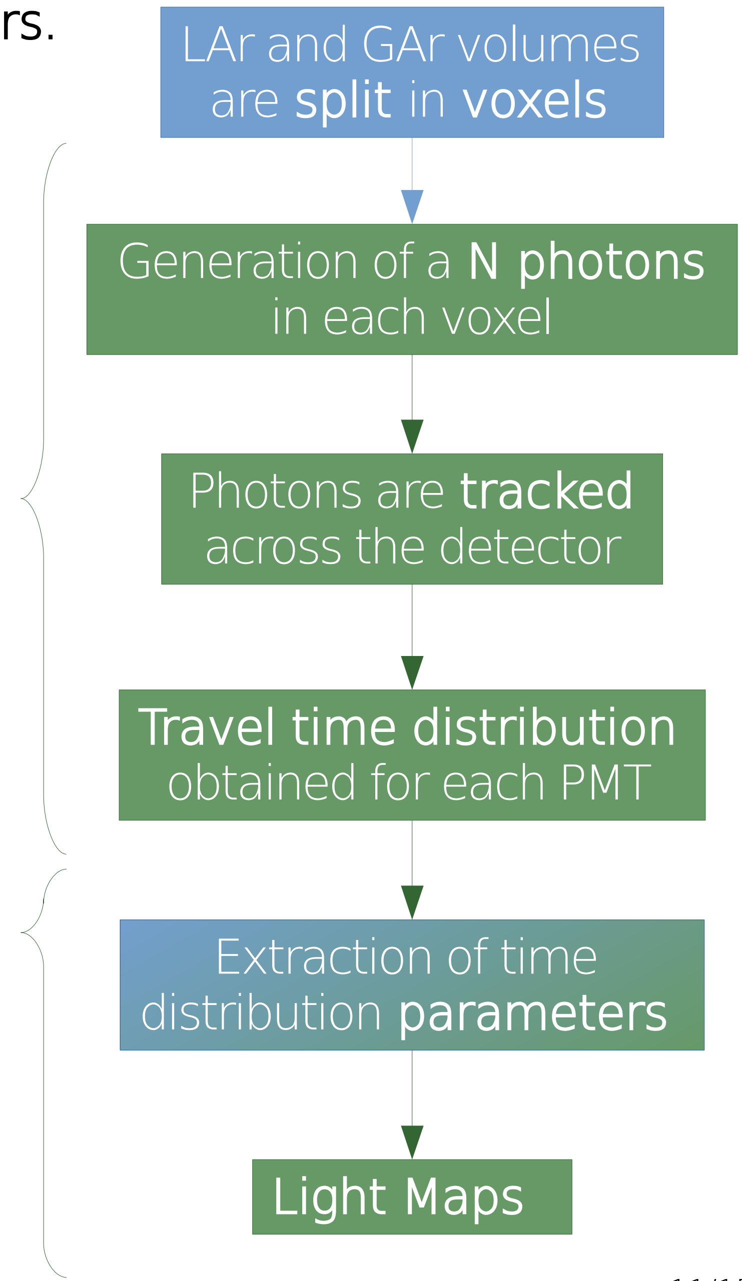

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Extraction of time distribution characteristics

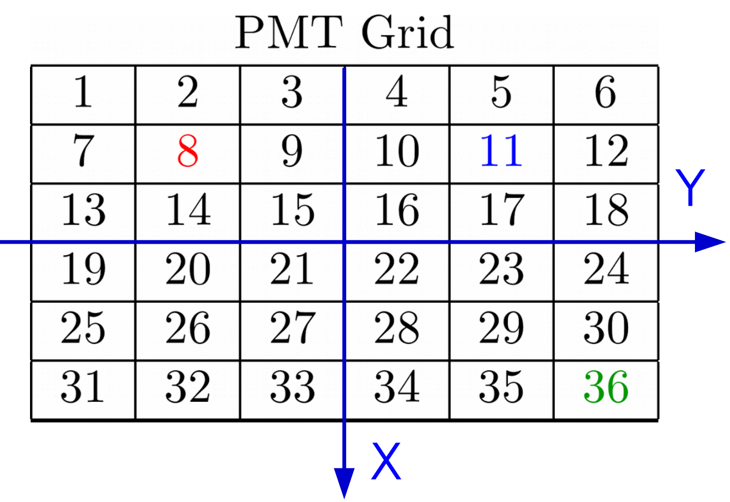
→ Which **characteristics** are needed to **reconstruct** all time distributions ?

→ WA105 SB Meeting, 20 April 2016

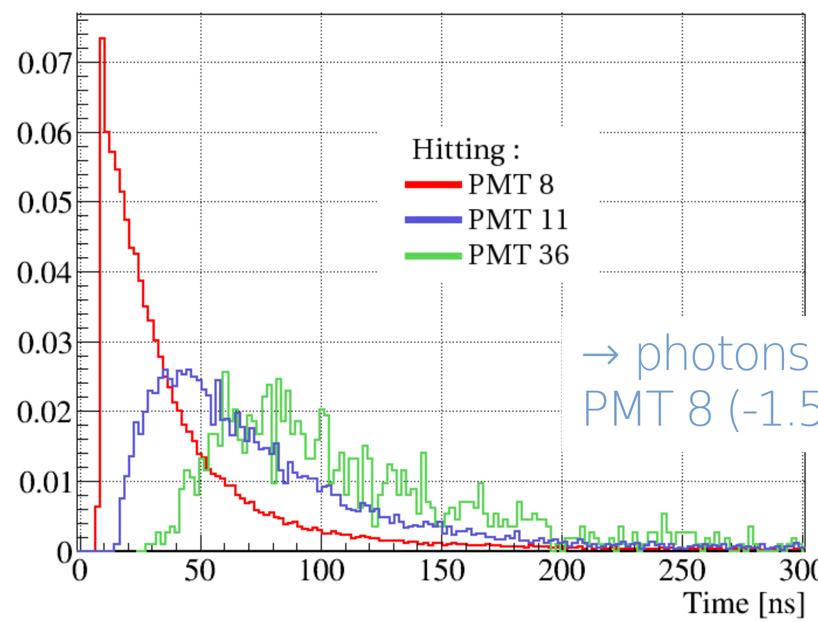
Currently for the available maps in QSCAN and LightSim, time distributions are :

- Reconstructed with 2 parameters : tpeak and trms
- Considered as exponential function starting at tpeak, with $\tau = \frac{trms}{\sqrt{2}}$

BUT :



Time distribution normalized to the total detected photons numbers



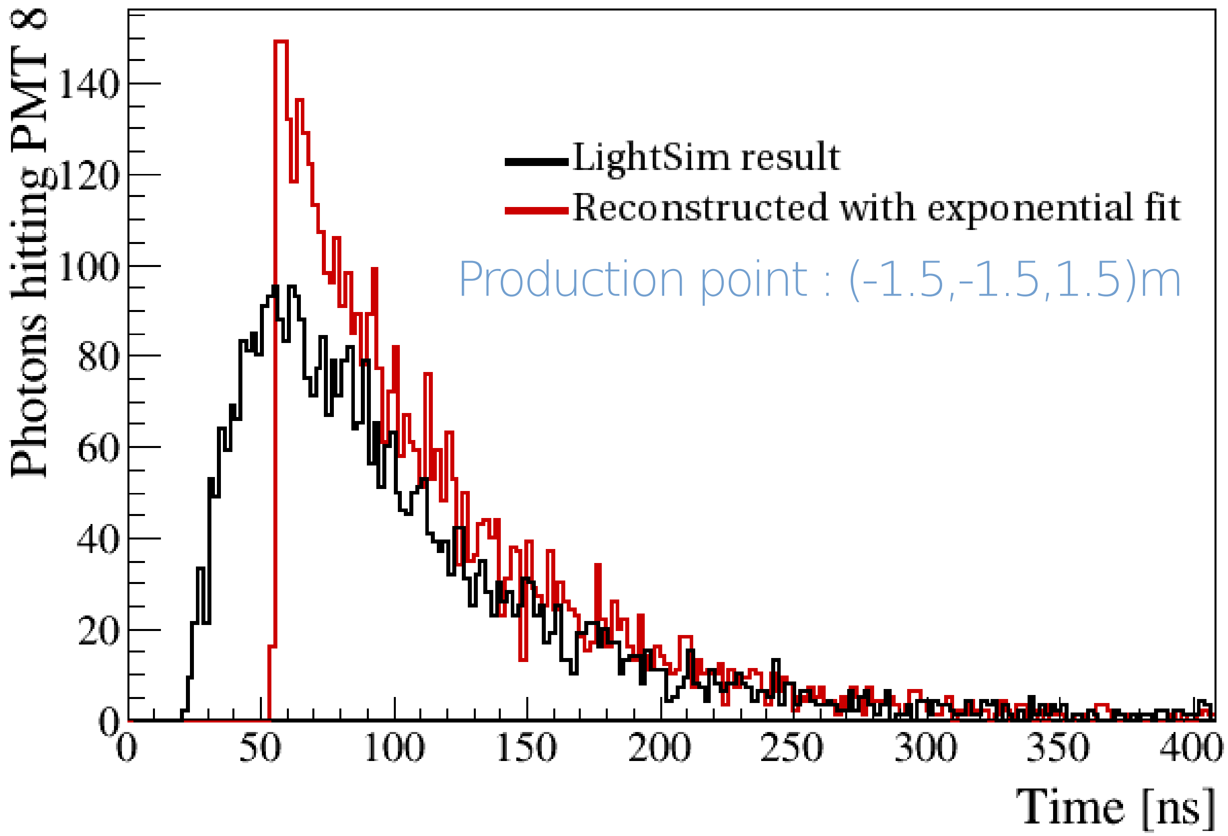
→ photons generated above PMT 8 (-1.5,-1.5,-1.5)m

→ Exponential approximation seems reasonable for the PMT8

→ It's not the case for the more distant PMTs and upper voxels !

Extraction of time distribution characteristics

Comparison between the distribution obtain with LightSim and the “reconstructed” one based on a exponential fit



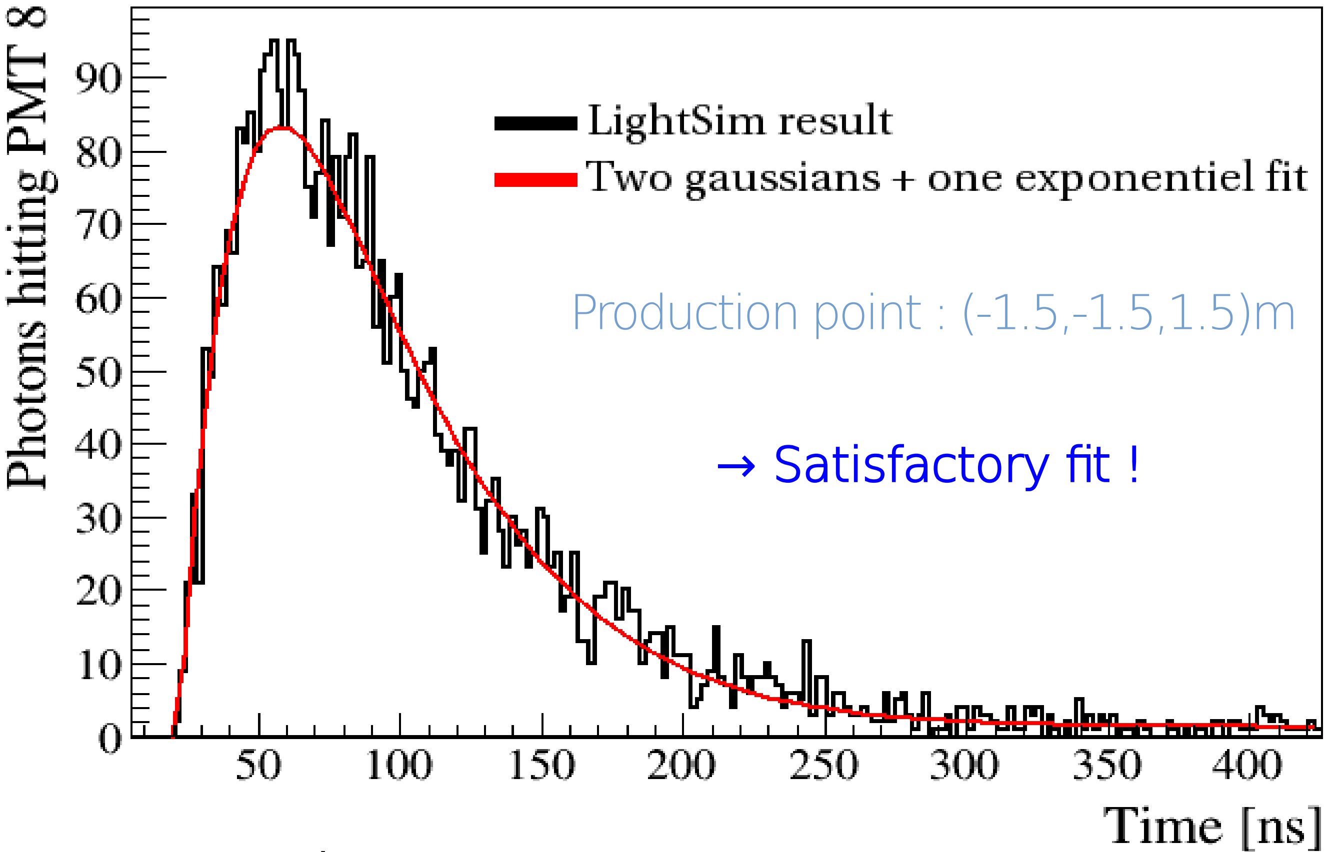
→ 2 parameters used

→ But the contribution before tpeak is not reconstructed correctly.

Extraction of time distribution characteristics

New fit : using two gaussian functions + one exponential function.

→ 4 parameters



Maps construction :

- Use an exponential fit for closer PMTs
- Use two gaussian + one exponential fit for other distributions (distant PMTs and upper voxels)

Conclusion and Perspectives

The map production procedure is completely implemented and tested :

- **Scripts** are written
- Production of a final .root with time distribution characteristics for **12 voxels**.

Next steps :

- Implementation of the **voxel structure** produced by Silvestro (available on svn)
- Optimization of the **number of photons** generated per voxel.
- Implementation of the **improved** time distribution **parametrisation** needed in the map.
- Implementation of the **TPB and PMMA layers** on the cathode. (already well-advanced)
- Modify the i**mplemented geometry** to match the latest detector design.
  (ex: PMT-cathode distance, add CRP plane, etc)
  → According to CERN-SPSC-2016-017