Status Report on the Light Maps Production

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WA105 SB Meeting

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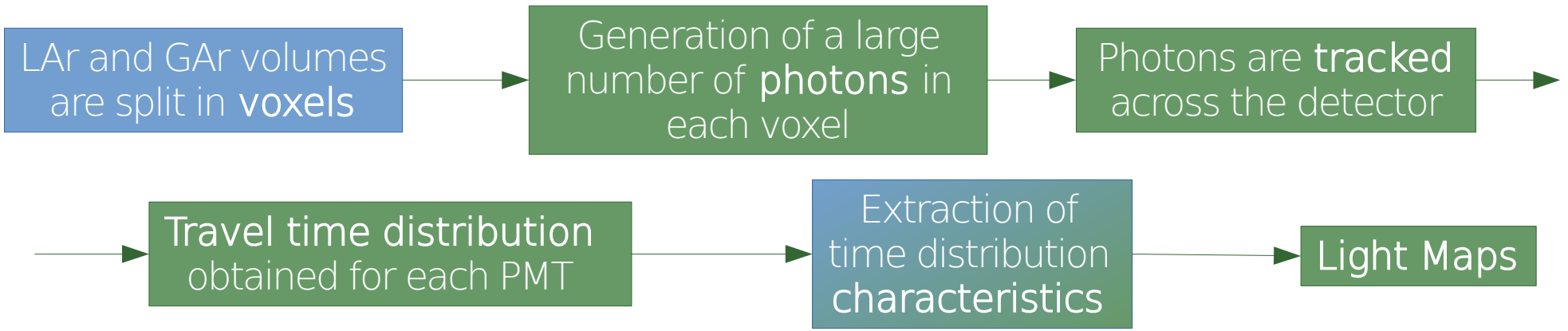
Introduction

- Today : progress on the map production

  → Extraction of the time distributions **characteristics**

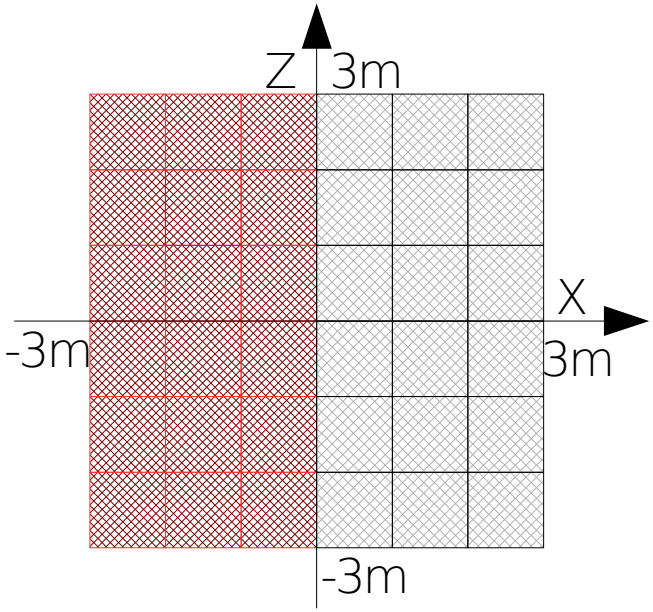
- Working chain :

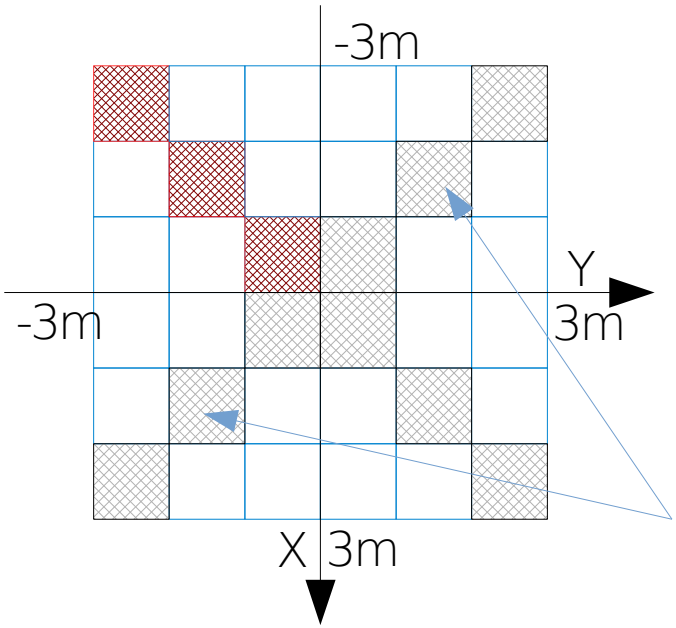


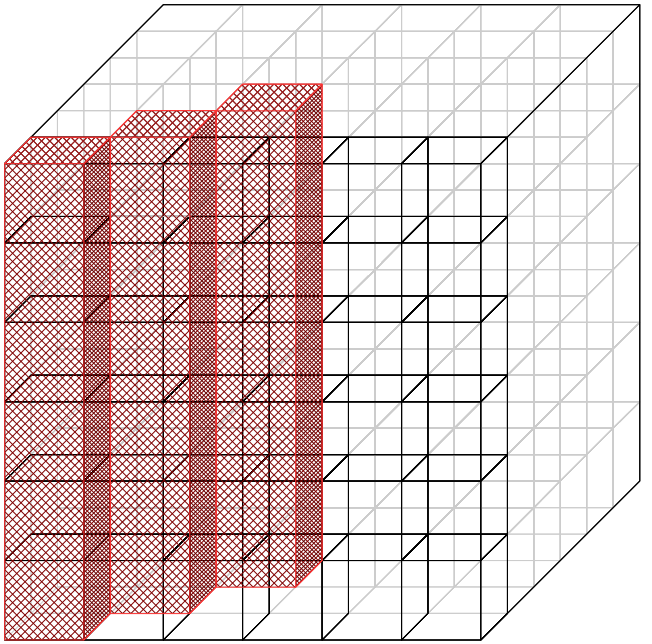
Photon Tracking and Time Distribution Generation

- Use of a **simplified** voxel map description : **(1x1x1)m³ voxels → (6x6x6) = 216 voxels**

- We look at **three** columns (18 voxels) :
  - X and Y **fixed** at -2.5m, -1.5m and -0,5m.
  - **Z = {-2.5 ; -1.5 ; -0.5 ; 0.5 ; 1.5 ; 2.5} m**







Equivalent to these voxels (given the X-Y geometry of the detector)

For the time being :
- **TPB coat** on the top of PMTs.
- Isotropic angular distribution for **both** primary photons and shifted photons.
- Infinite **absorption length.**

Extraction of time distribution characteristics

We want to reconstruct time distributions with various shapes

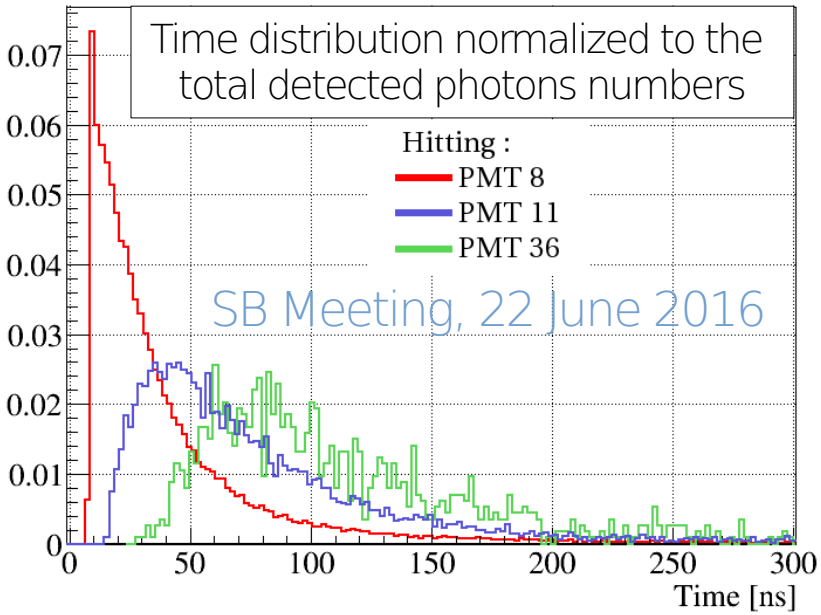
→ Example for 10^8 photons generated above PMT 8 (-1.5,-1.5,1.5) m

PMT Grid

1	2	3	4	5	6
7	8	9	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36

Y

X



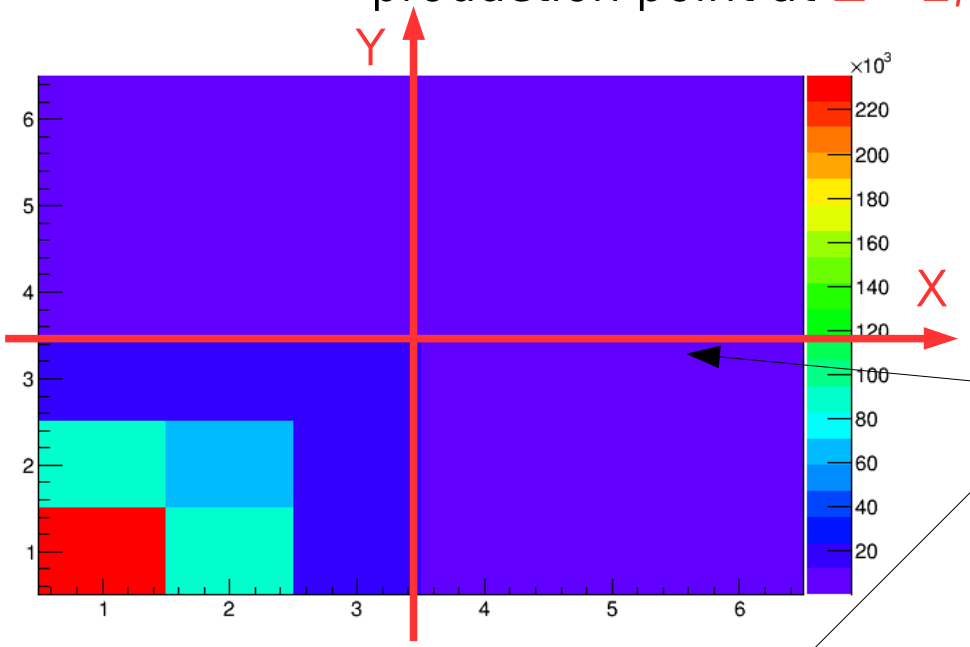
→ Depending on the voxel Z-position and the distance to the given PMT.

Number of photons ⟶ $w_0 = \dfrac{\text{Number of photons detected by the PMT}}{\text{Number of generated photons}}$

Time distribution **shape** ⟶ Parametrization

Number of photons reaching the PMTs

Number of photons detected by each PMT for a production point at Z=-2,5m

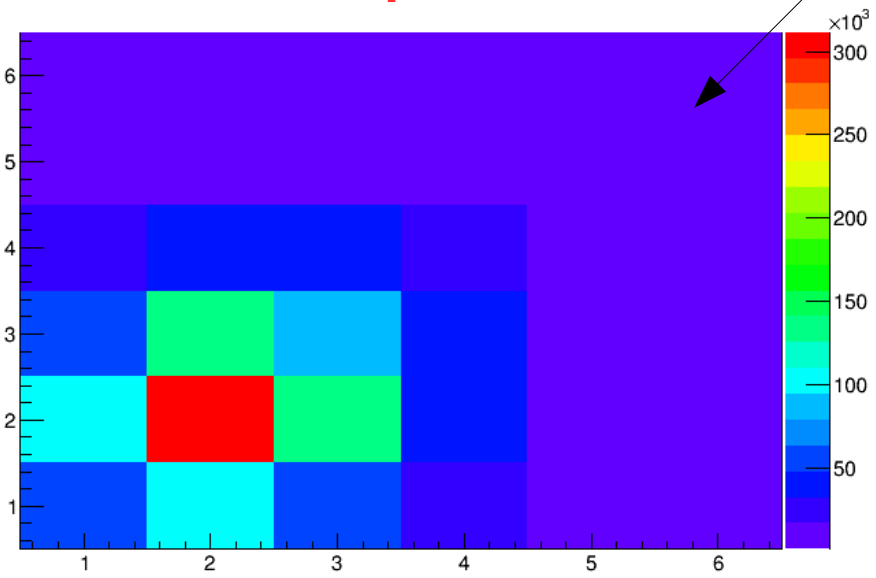


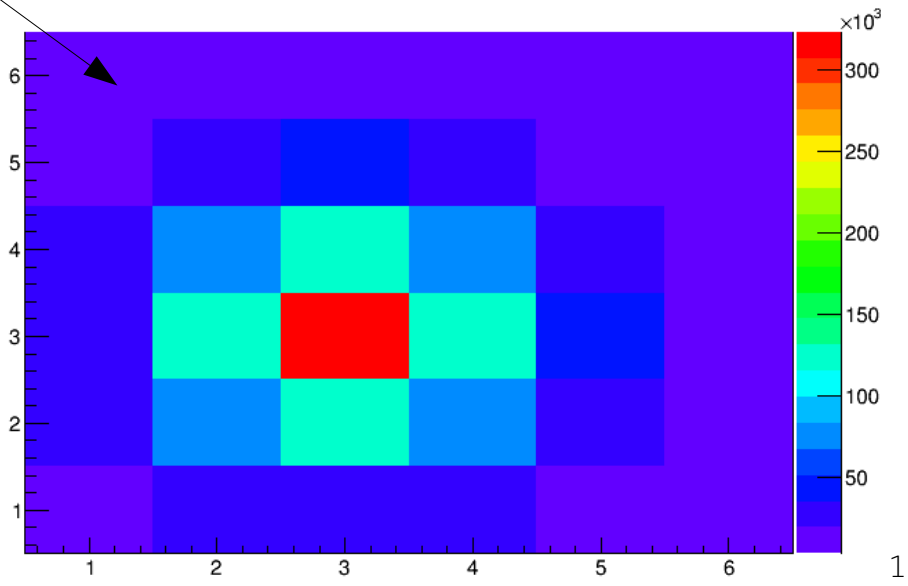
PMT Grid

6	12	18	24	30	36
5	11	17	23	29	35
4	10	16	22	28	34
3	9	15	21	27	33
2	8	14	20	26	32
1	7	13	19	25	31

Photons produced at :

- (X,Y) = (-2.5,-2.5)m (above **PMT1**)
- (X,Y) = (-1.5,-1.5)m (above **PMT8**)
- (X,Y) = (-0.5,-0.5)m (above **PMT15**)

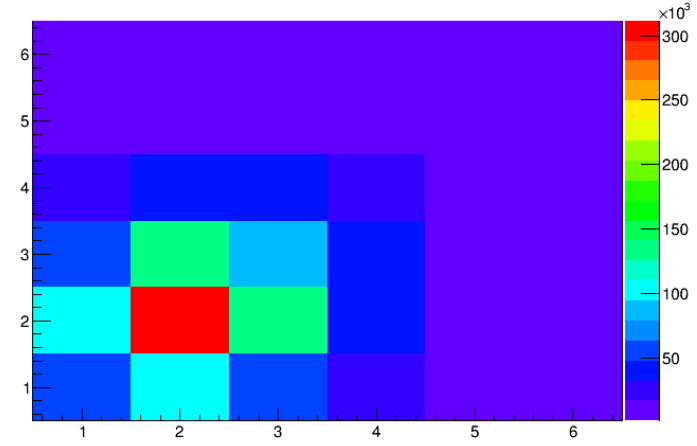




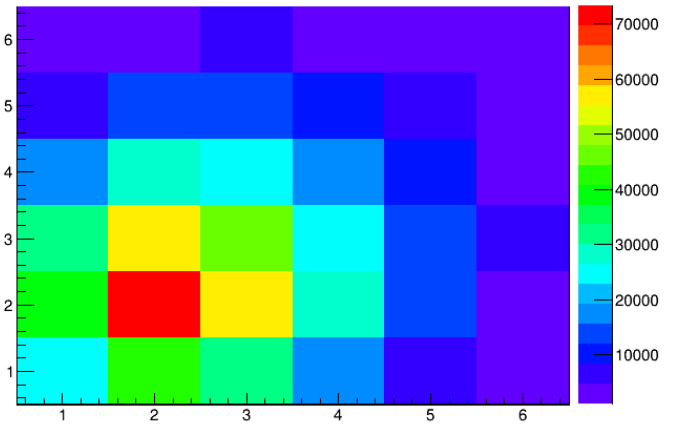
Number of photons reaching the PMTs

Number of photons detected by each PMT for a production point at **(X,Y) = (-1.5,-1.5)**

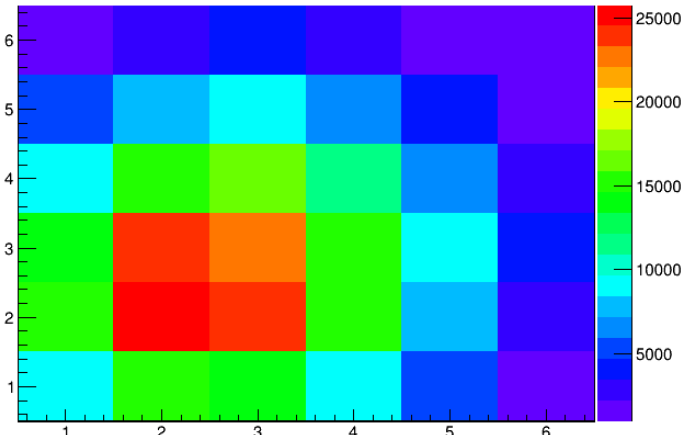
Z = -2,5m



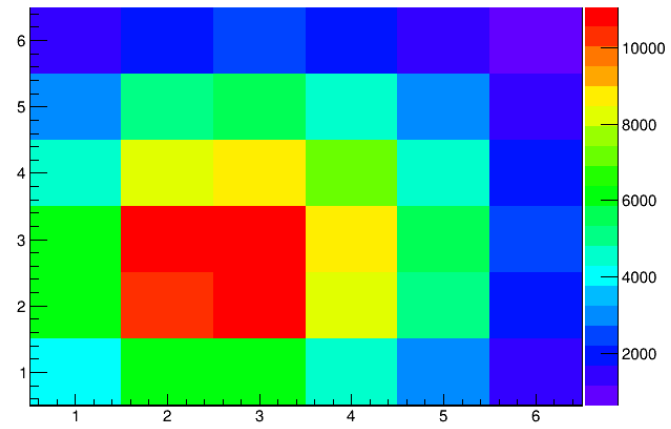
Z = -1,5m



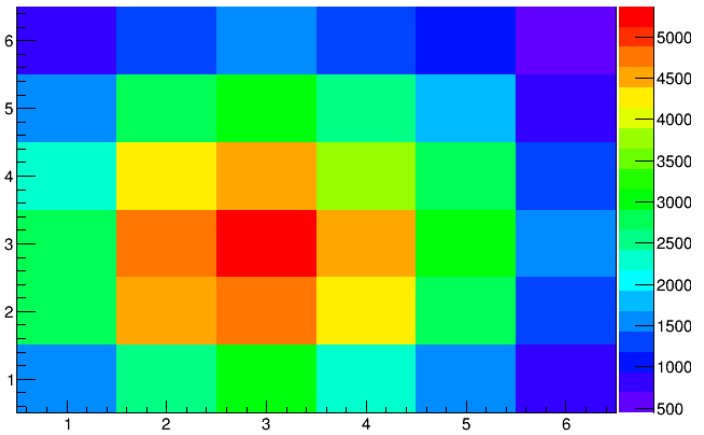
Z = -0,5m



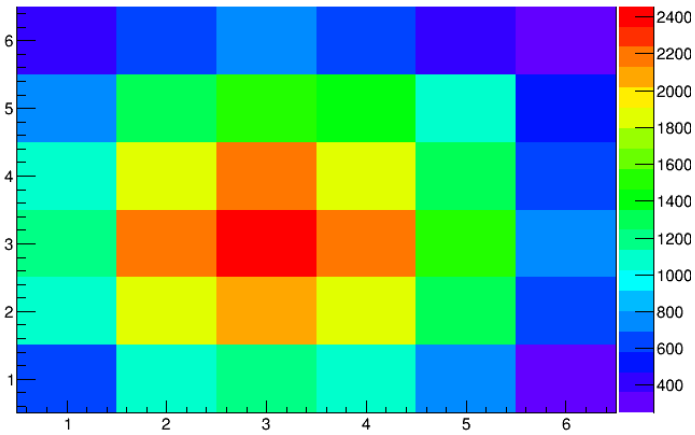
Z = 0,5m



Z = 1,5m



Z = 2,5m



→ **Spread** of the distribution

→ **Fewer** and fewer photons reach the PMTs

Time distribution shape

For the time distribution shape : We need to fit a function on the LightSim results.

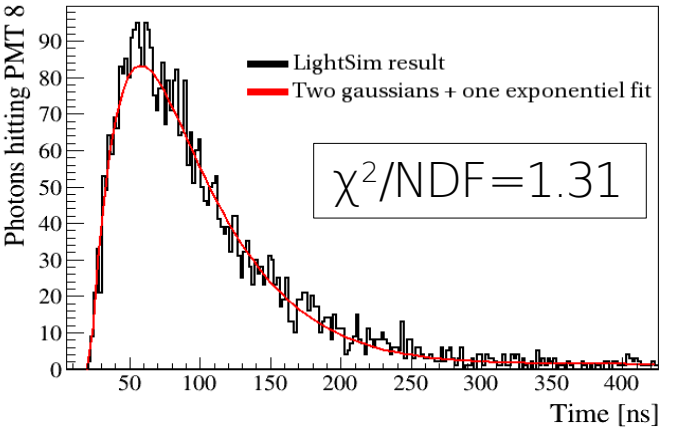
→ 3 x 6 x 36 = 648 distributions !

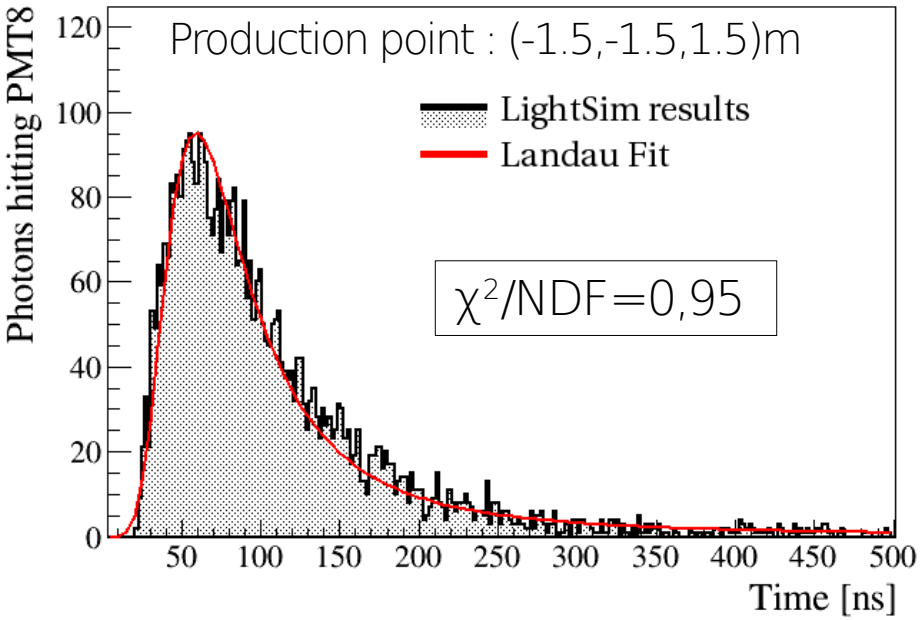
Last SB meeting (22 June 2016):

2 gaussians functions + 1 exponential function.

→ Satisfactory, but work on a limited number of distributions !

→ We need a more systematic approach.





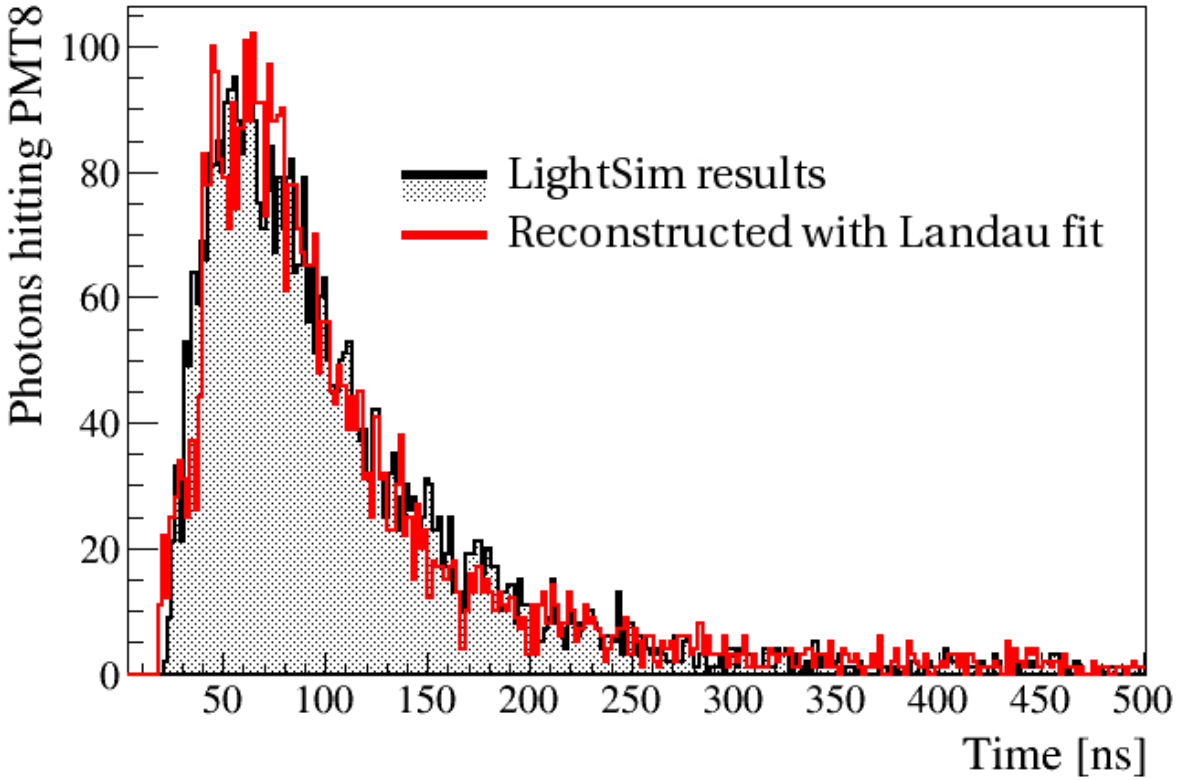
Landau Distribution

- Satisfactory fit !
- 2 additional parameters :
  - MPV (most possible value)
  - σ
- No need of the normalization coefficient : we want the shape only !

Time distribution reconstruction

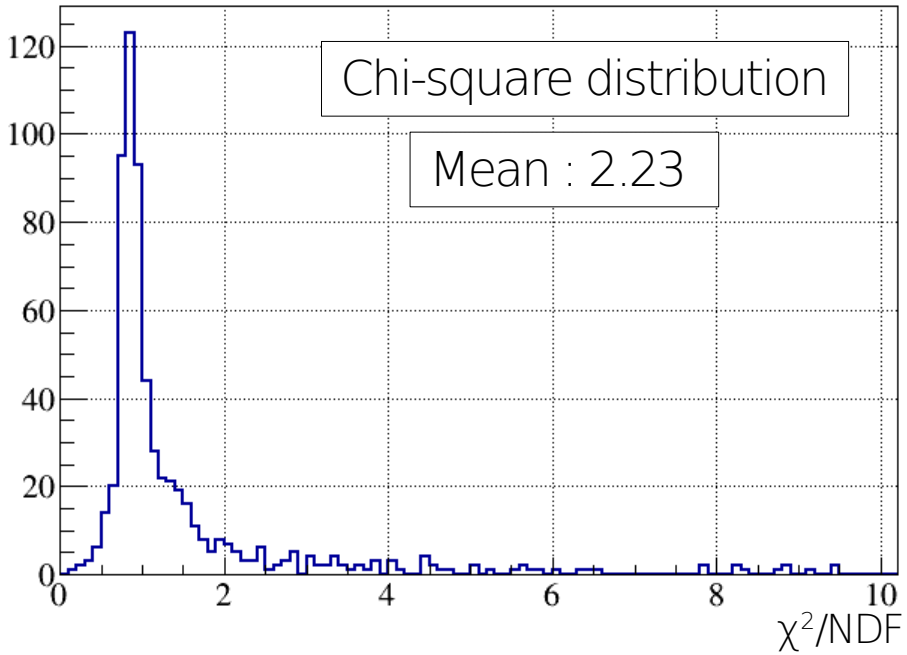
Comparison between the distribution obtain with LightSim and the "reconstructed" one based on the corresponding Landau fit.

Production point : (-1.5,-1.5,1.5)m



Reconstruction done using 3 parameters only :
MPV, σ (distribution shape) and w_0 (number of photons)

Time distribution shape

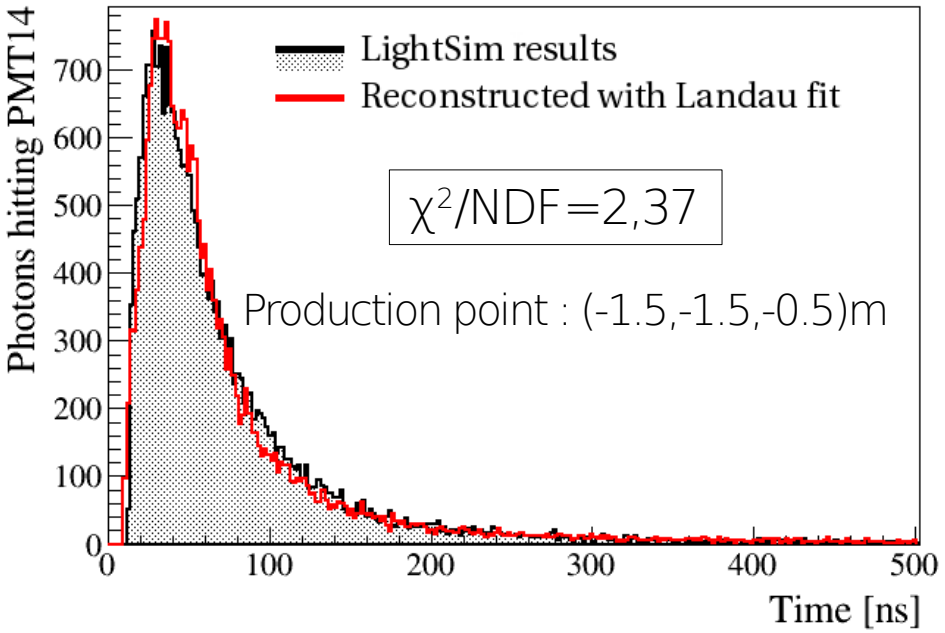


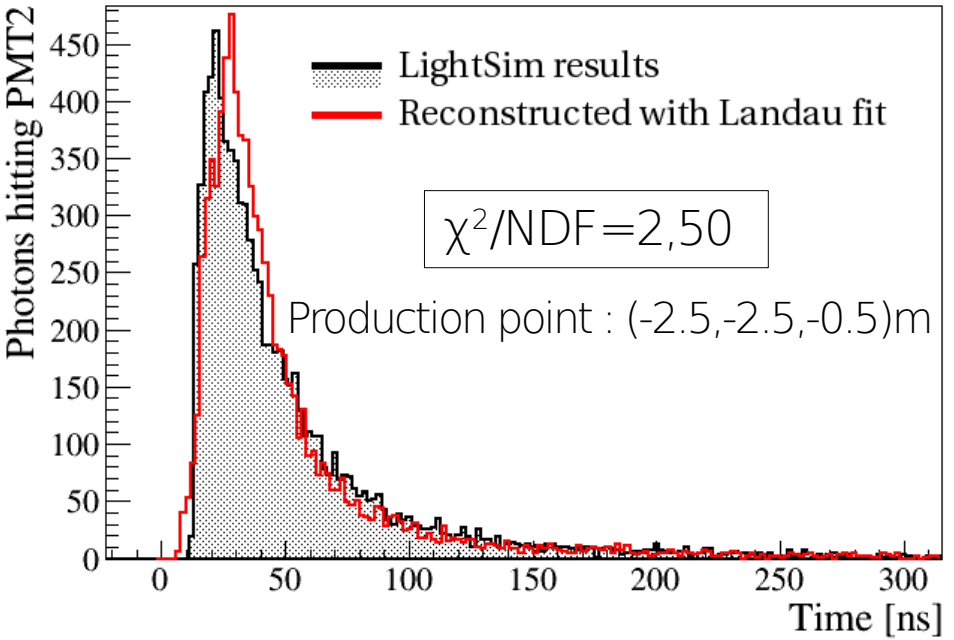
This fit must be good for as much distributions as possible

→ Test on the **648 distributions**

For the time being, we arbitrary fix a limit on the χ^2/NDF to separate "good" fits from "bad" fits.

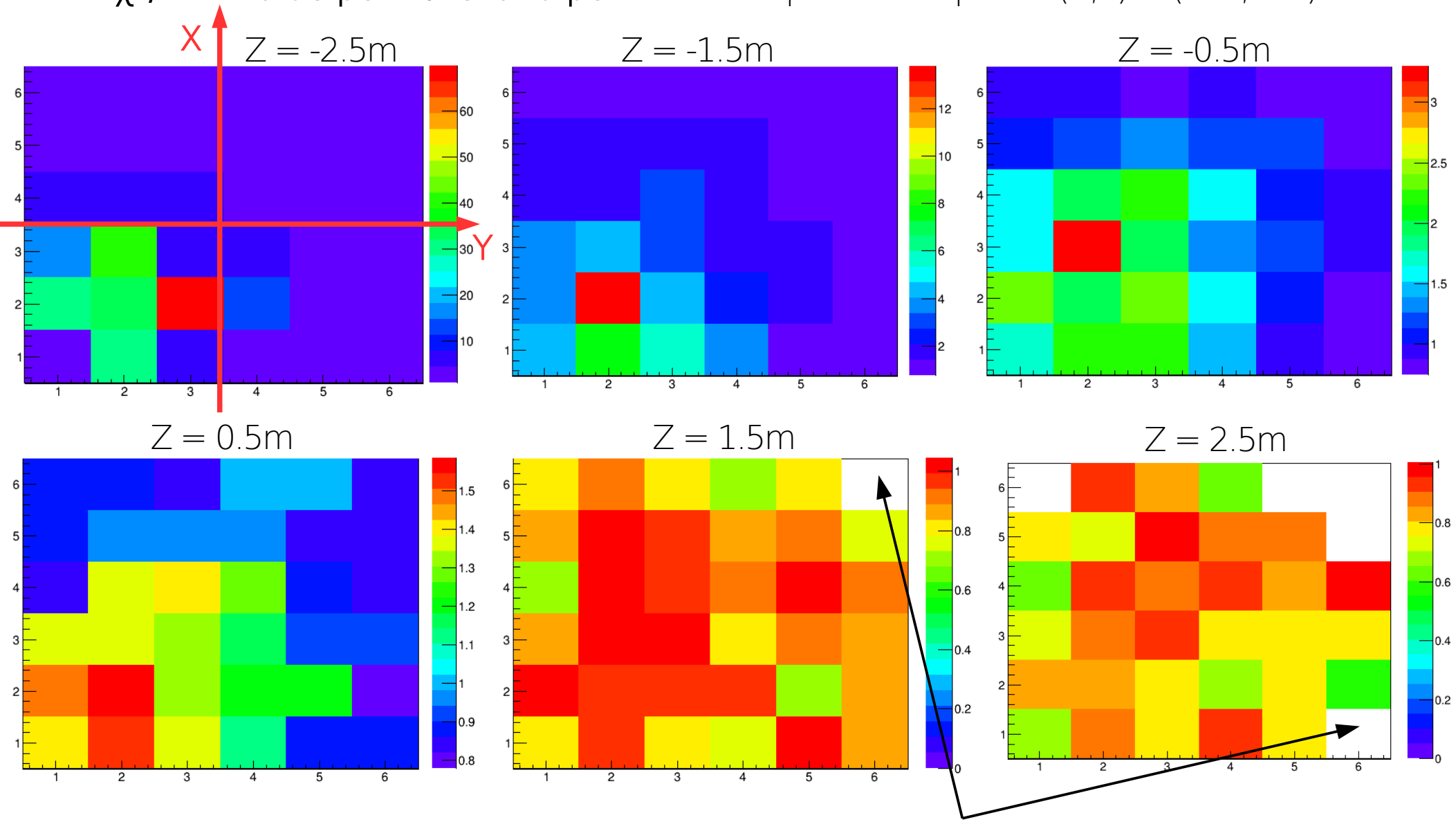
"good" fits : $\chi^2/NDF < 2.4$





Time distribution reconstruction

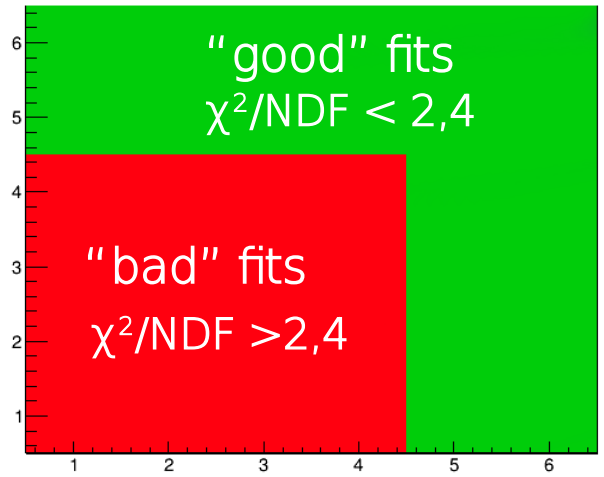
χ^2/NDF value per voxel and per PMT for a production point : (X,Y) = (-1.5,-1.5)m

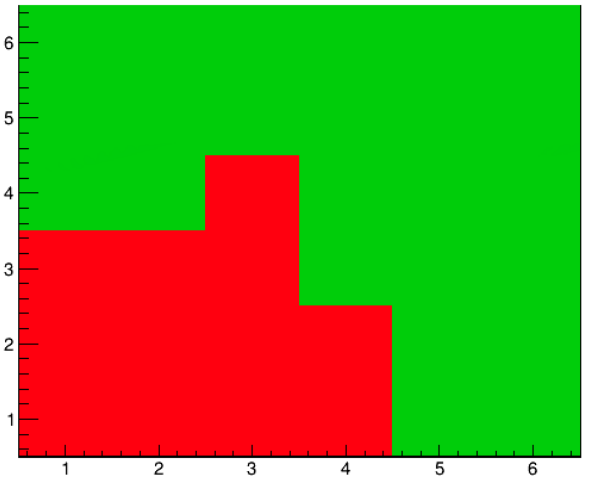


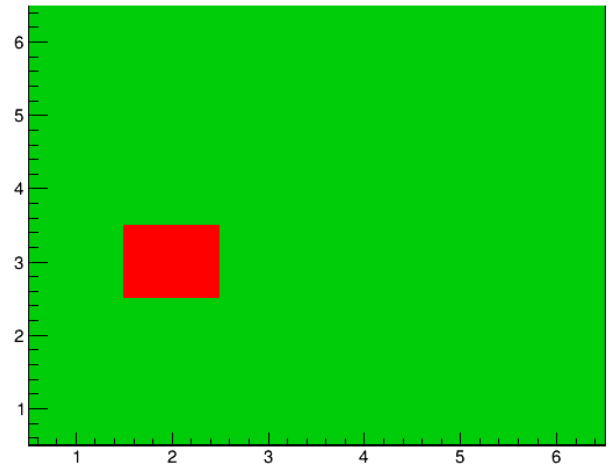
white PMTs : less than 500 photons in the distribution.

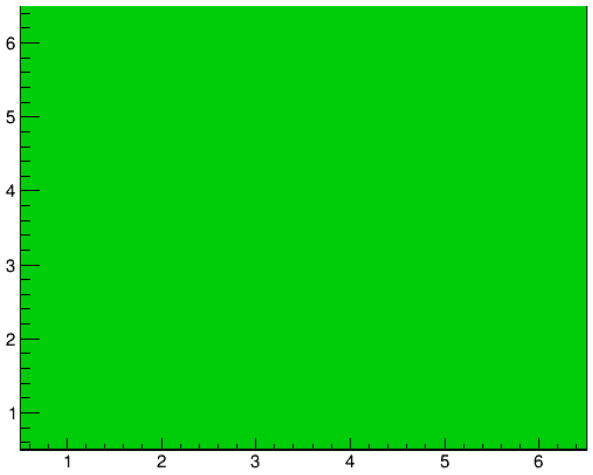
Time distribution reconstruction

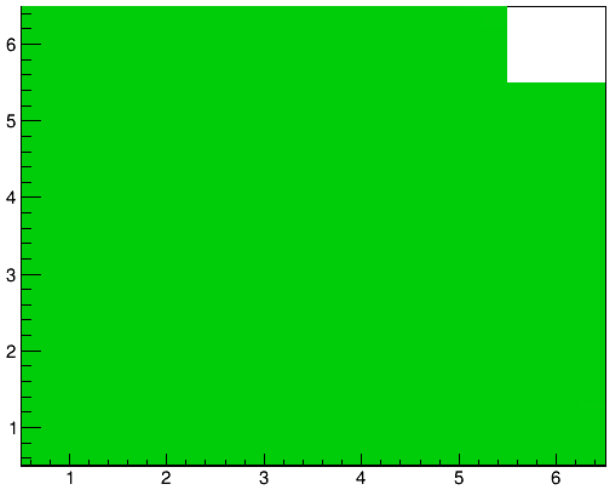
Distributions of "good" fits for a production point : (X,Y) = (-1.5,-1.5)m
(fit with landau distribution)

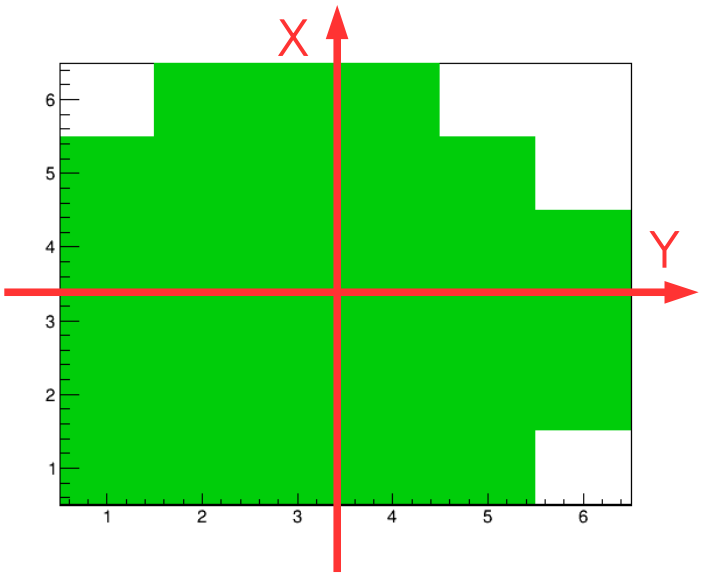












→ The fit is satisfactory in most cases !

Time distribution reconstruction

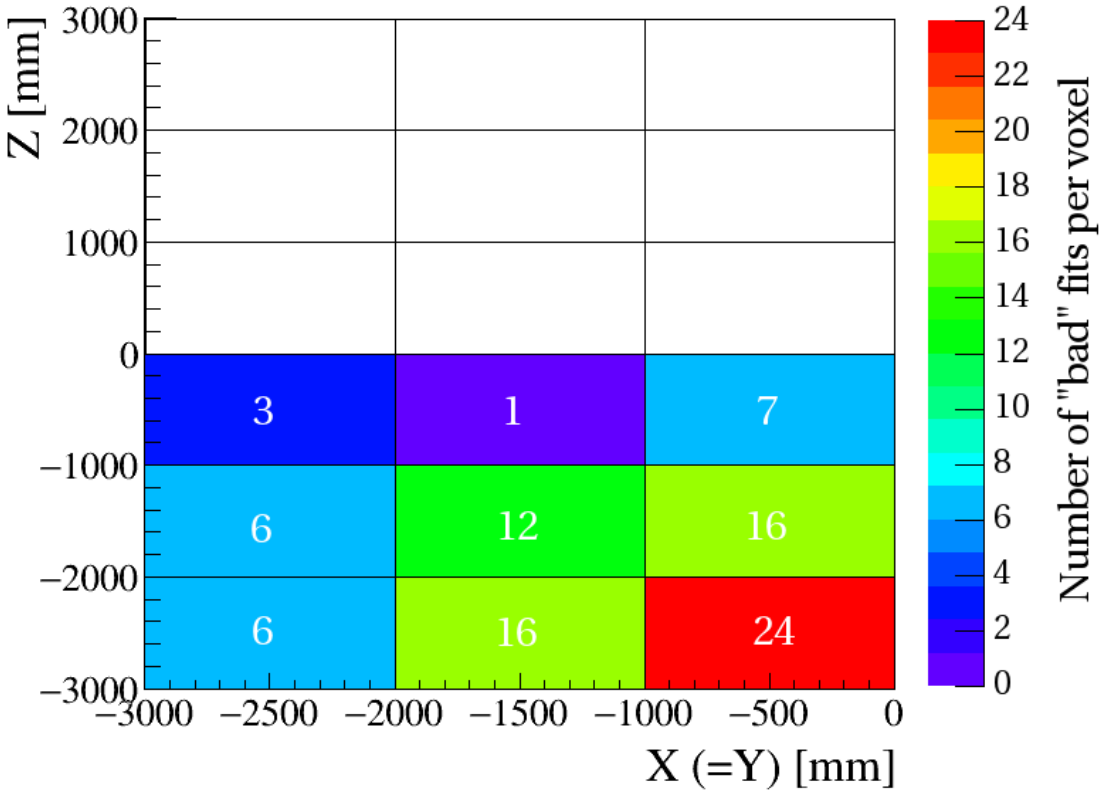
"Bad" fits for 91 distributions

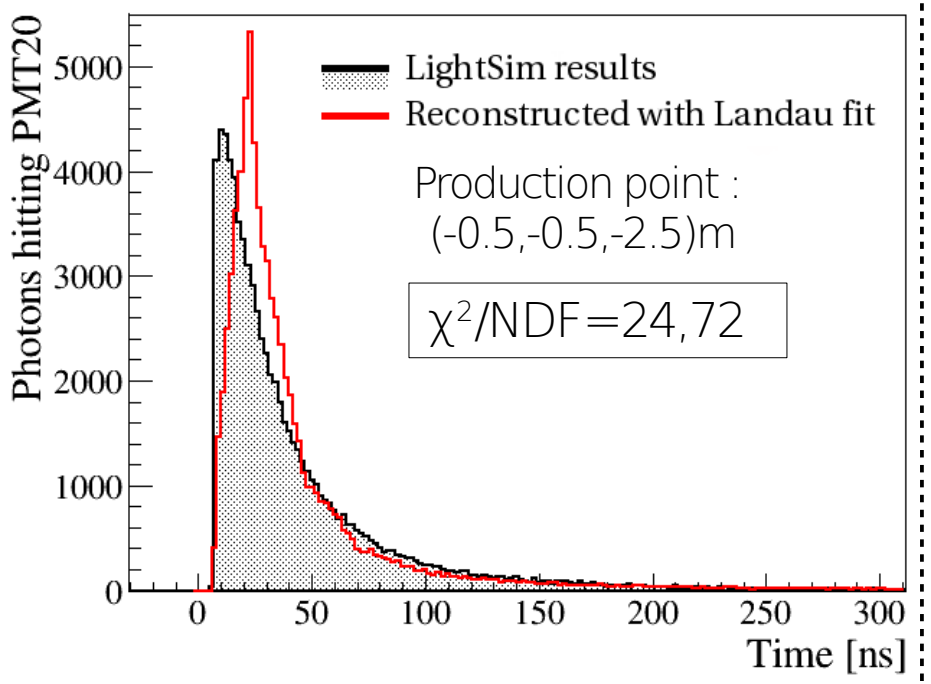
→ 15,5% of the 648 distributions.

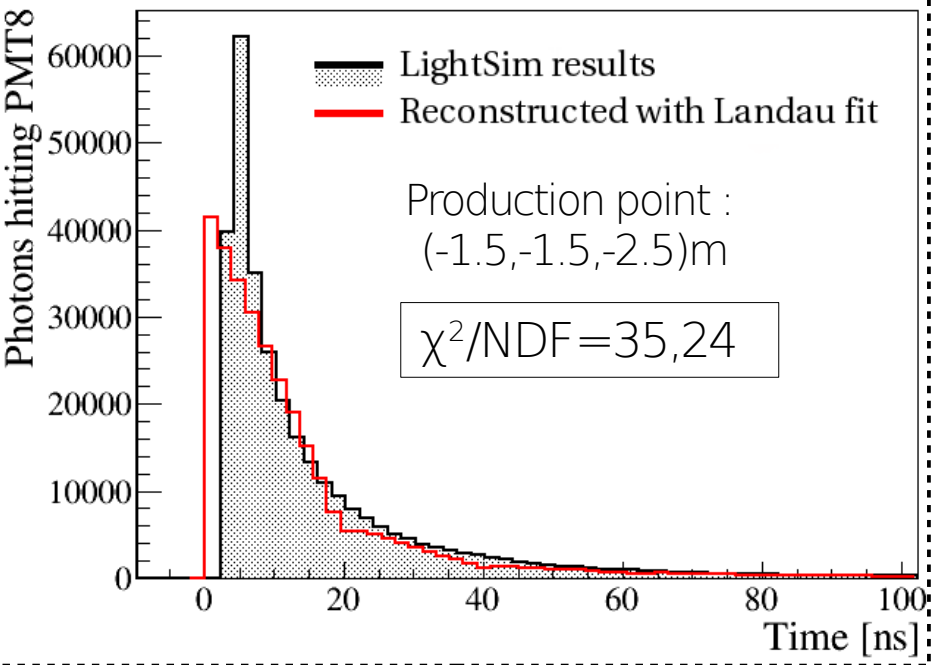
All of them for :

- Z < 0m
- PMT below the considered voxel

→ narrow distributions.







Time distribution reconstruction

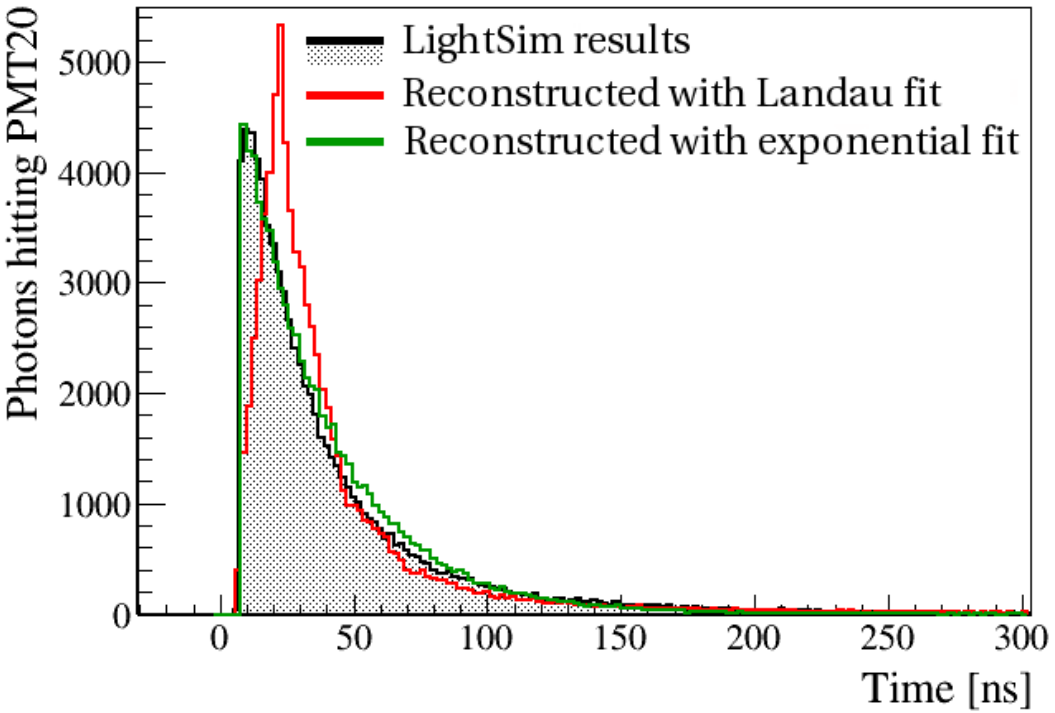
Now we look at time distributions for PMT close to the voxel

Fit and reconstruction with **one exponential distribution**.

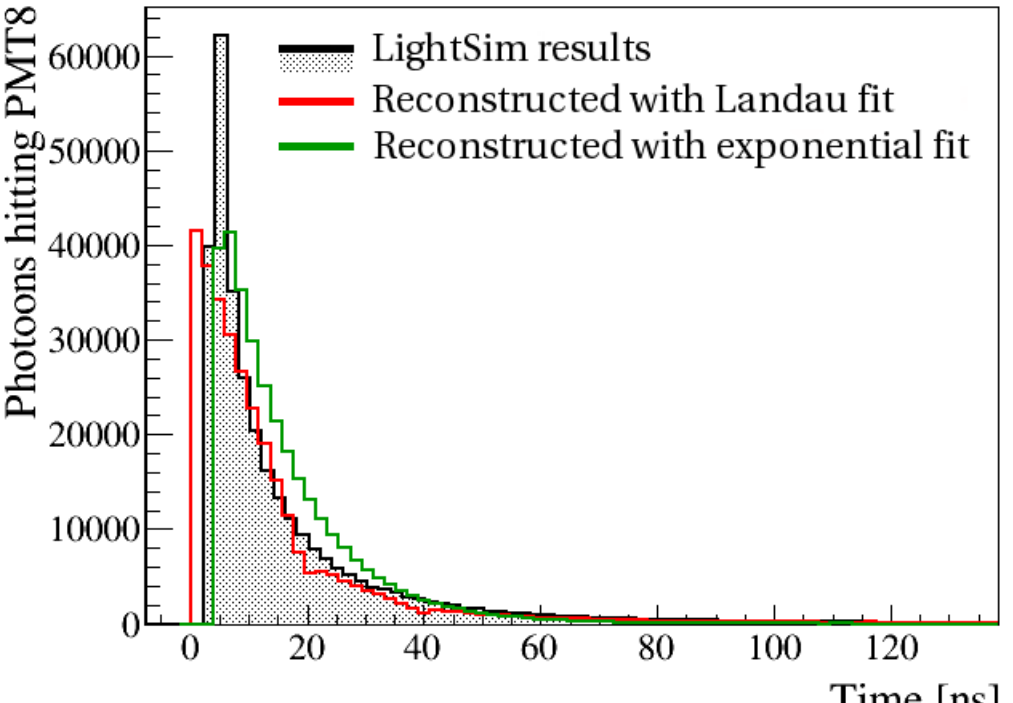
→ 3 parameters : w_0, t_{start} and τ

→ Not always **satisfactory**.

Production point : (-0.5,-0.5,-2.5)m



Production point : (-1.5,-1.5,-2.5)m



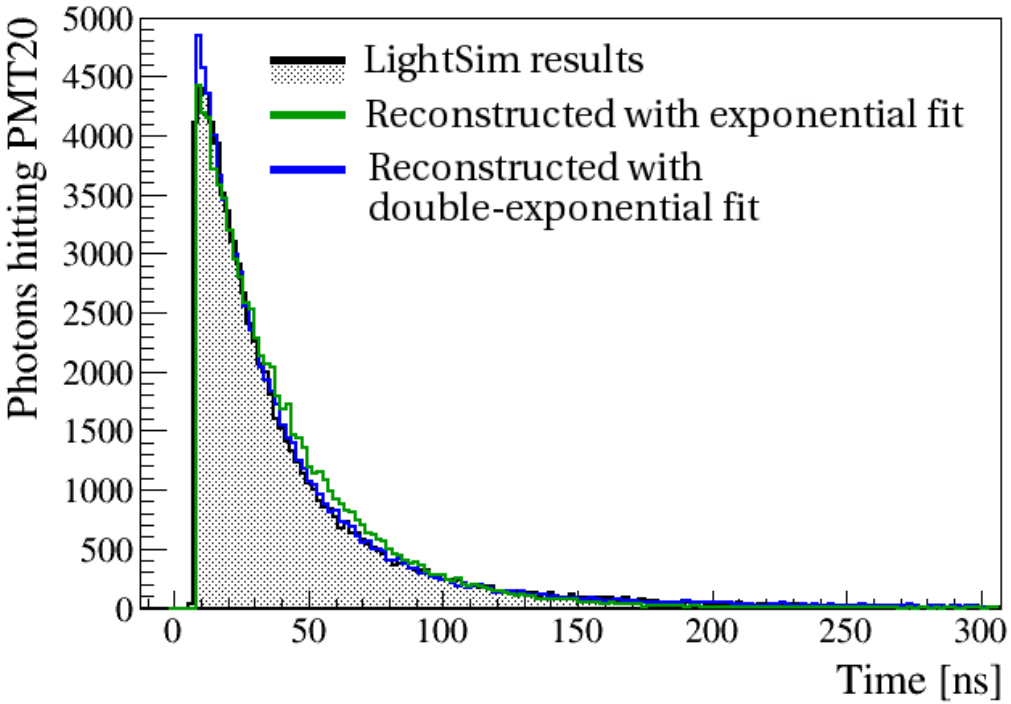
Time distribution reconstruction

Fit and reconstruction with two exponential distribution.

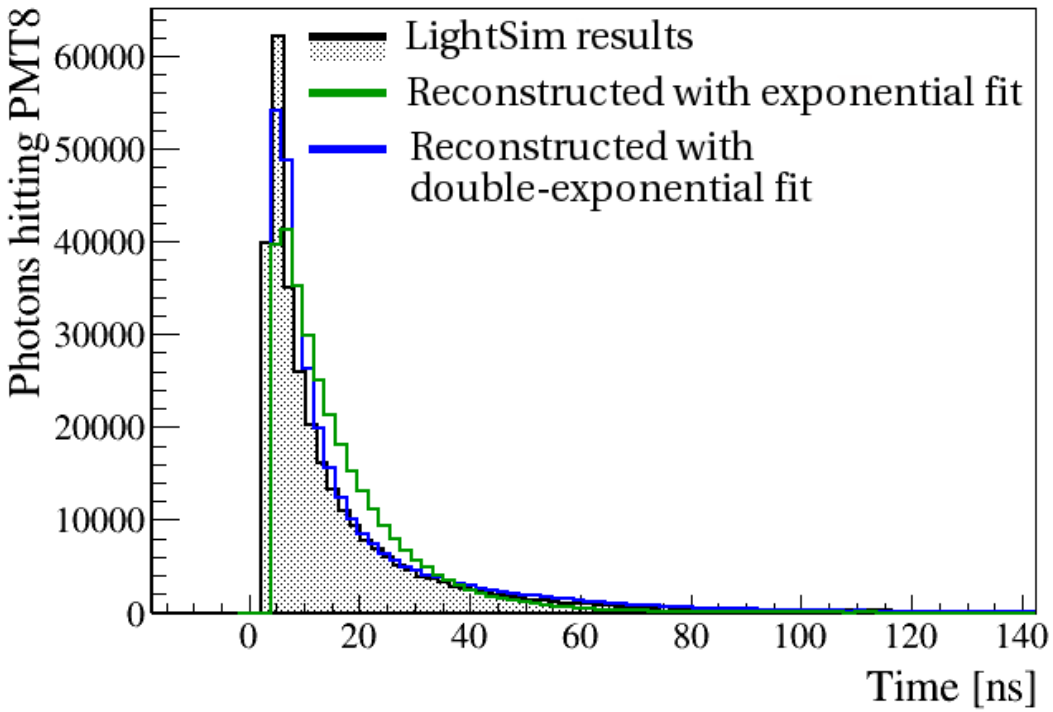
→ 5 parameters : w_0, t_{start}, τ_1, τ_2, and relative normalization (between the two exponential).

→ Broadly satisfactory !

Production point : (-0.5,-0.5,-2.5)m



Production point : (-1.5,-1.5,-2.5)m



Conclusion and Perspectives

- Work on the time distribution characteristics extraction :
  - **Landau distribution** in the general case
  - **One or two exponential distributions** for closest PMTs

- Remaining tasks for the light map production :
  - Implementation of a more appropriate **voxel structure.**
  - Implementation of the time distribution **parametrisation** presented in this presentation.
  - Modification of the **implemented geometry** to match the latest detector design (TPB and PMMA layers on the cathode, add CRP plane, etc)