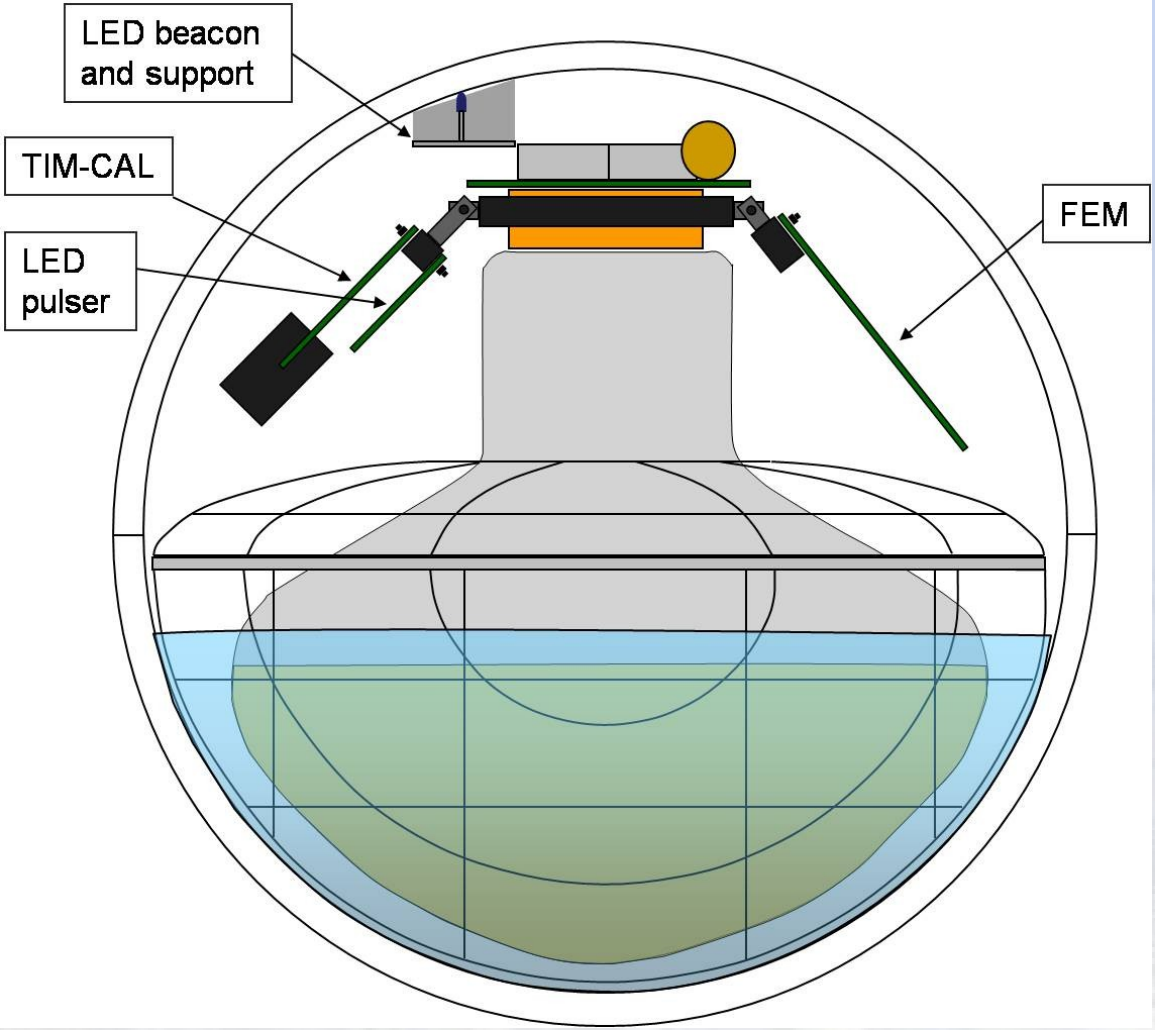
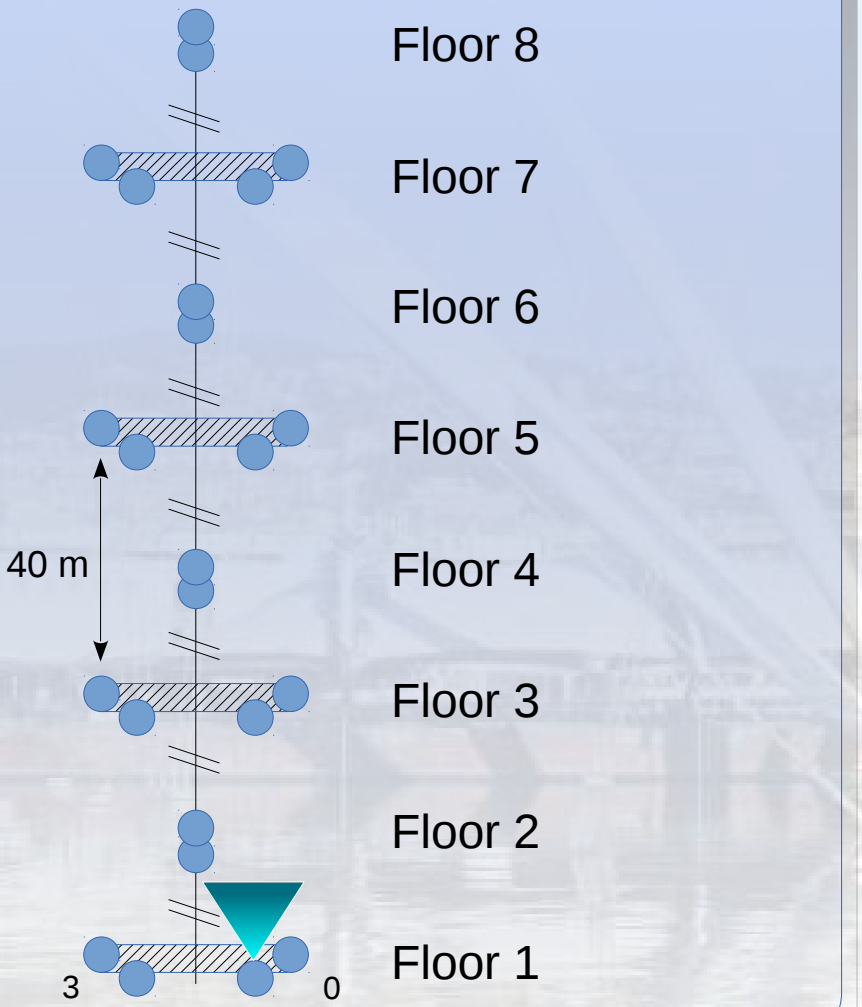
Data analysis results from LED and 40K

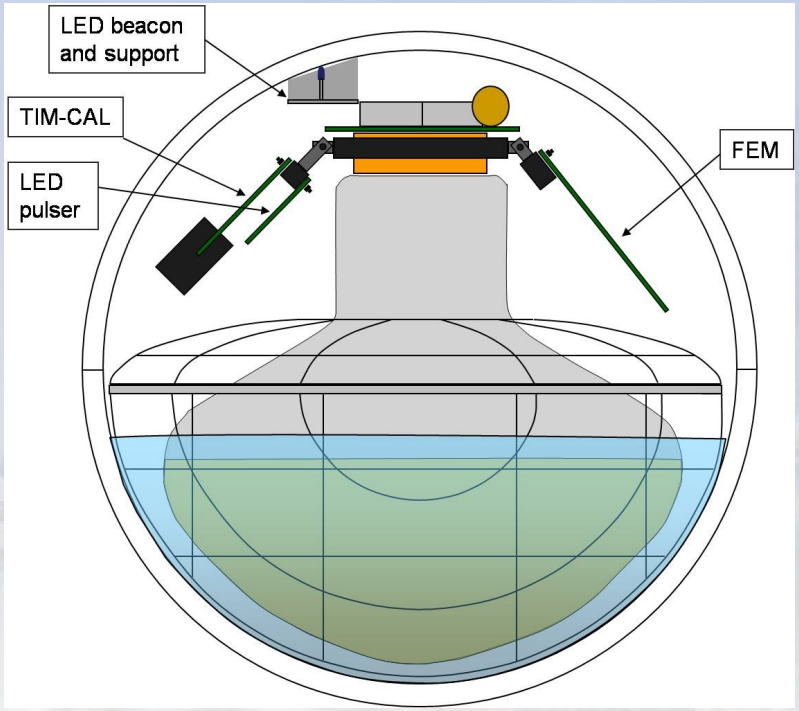


Timing measurement in the detector



- LED of the OM 11 of runs 684 to 687
- LED mean wavelength at 470 nm
- LED flash at 2 kHz

=> peaks observables within a modulo 500 us timing plot



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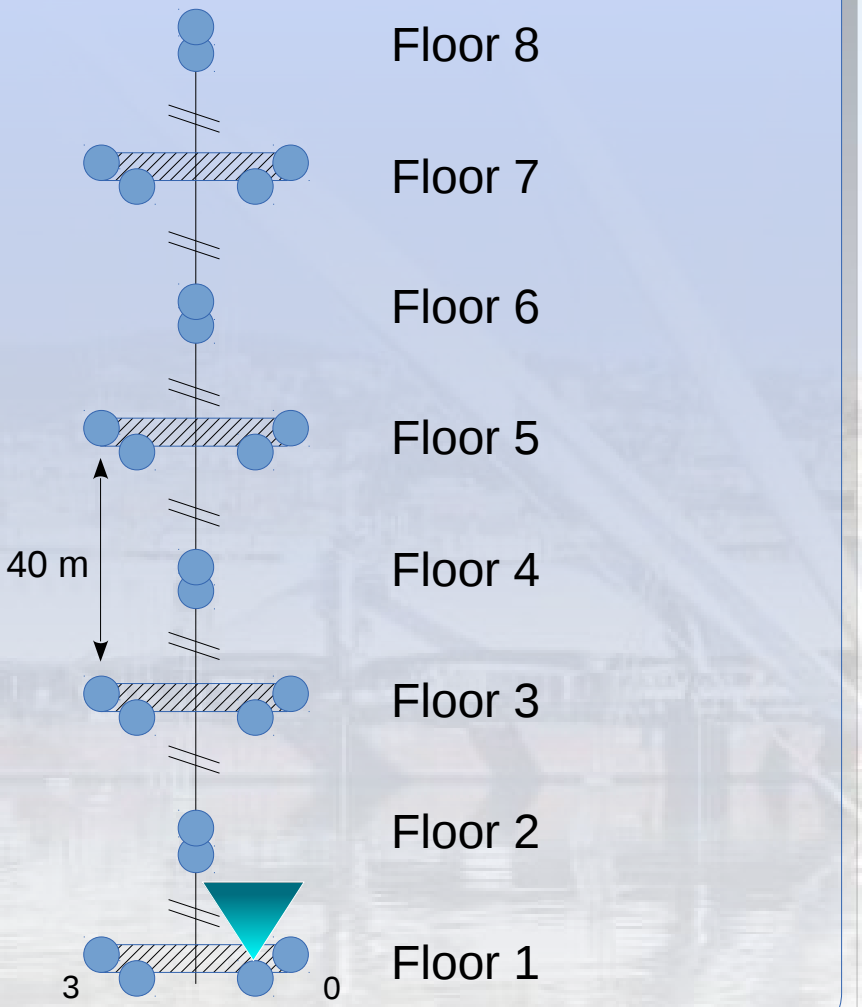
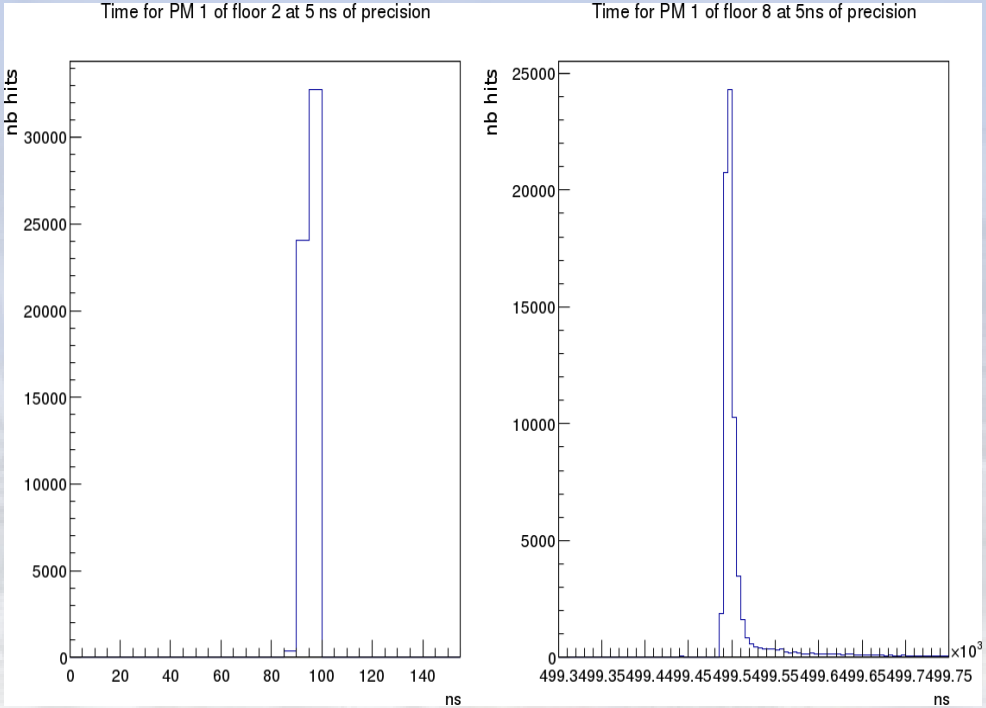
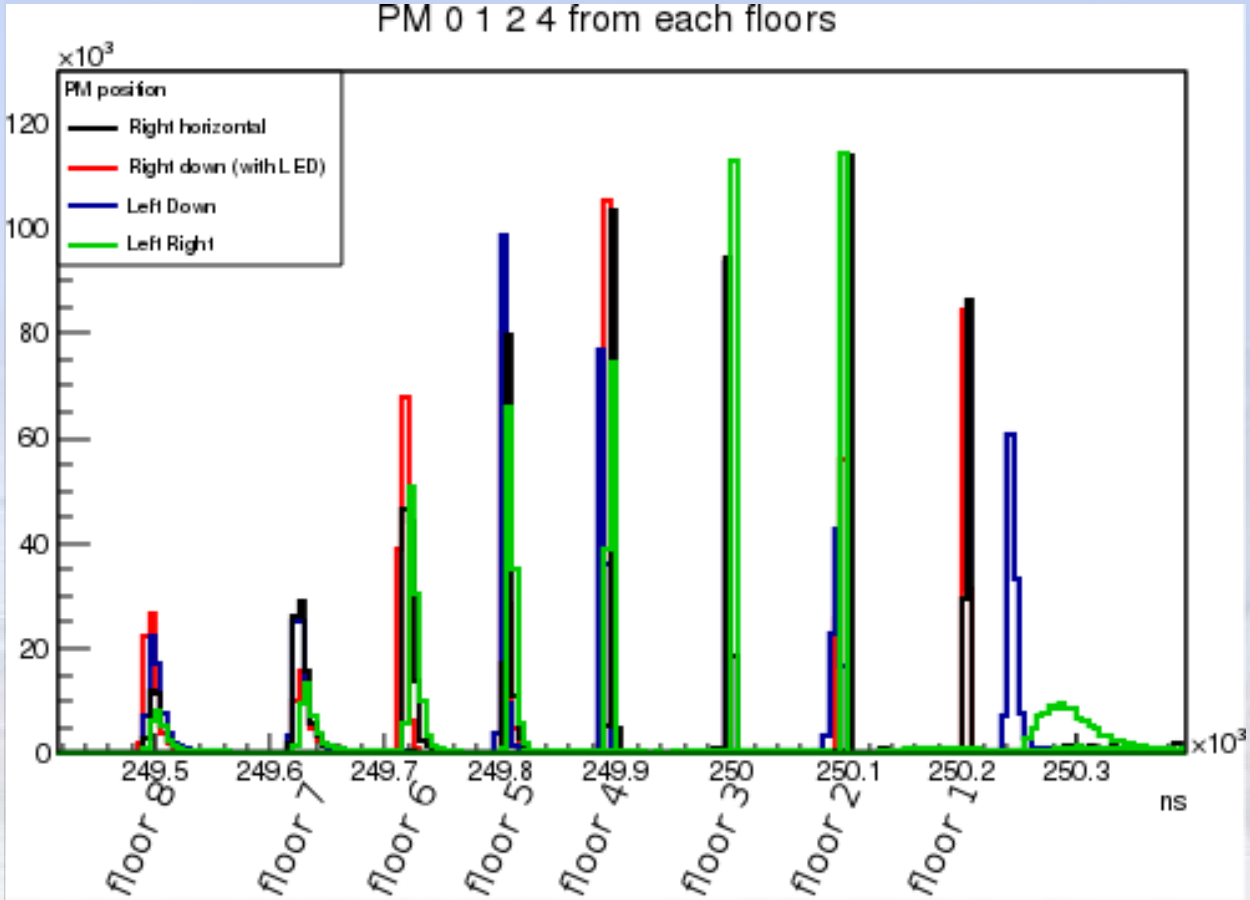


- LED of the OM 11 was used
- LED mean wavelength at 470 nm
- LED flash at 2 kHz

=> peaks observables within a modulo 500 us timing plot



Previous results summary



The distribution gives a good time distribution.

But the intensities in function of distance are not as expected

- LED positioning ?
- LED homogeneity ?
- LED used ?
- Different intensities/LED in the same run ?

A specific analysis is done to reduce the runs timing and LED

Timing results

Floor number (N)	Measured propagation time with floor 1 (floor N-1)	Theoretical time with floor 1 (floor N-1)	Differential time with floor 1 (floor N-1)
1	0 +/- 0.5	0	0
2	174 (174) +/- 0.9	186 (186)	12 (12)
3	354 (179) +/- 0.5	371 (185)	17 (5)
4	550 (195) +/- 0.4	558 (187)	8 (-9)
5	740 (189) +/- 0.3	744 (186)	4 (-4)
6	929 (188) +/- 0.5	931 (187)	2 (-2)
7	1113 (182) +/- 0.72	1118 (187)	5 (-6)
8	1302 (175) +/- 0.75	1305 (187)	6 (1)

Details in Roma collaboration meeting

As a cross check a lower intensity run was used for first floors. It correspond to 2.5 ns <=> 20 cm

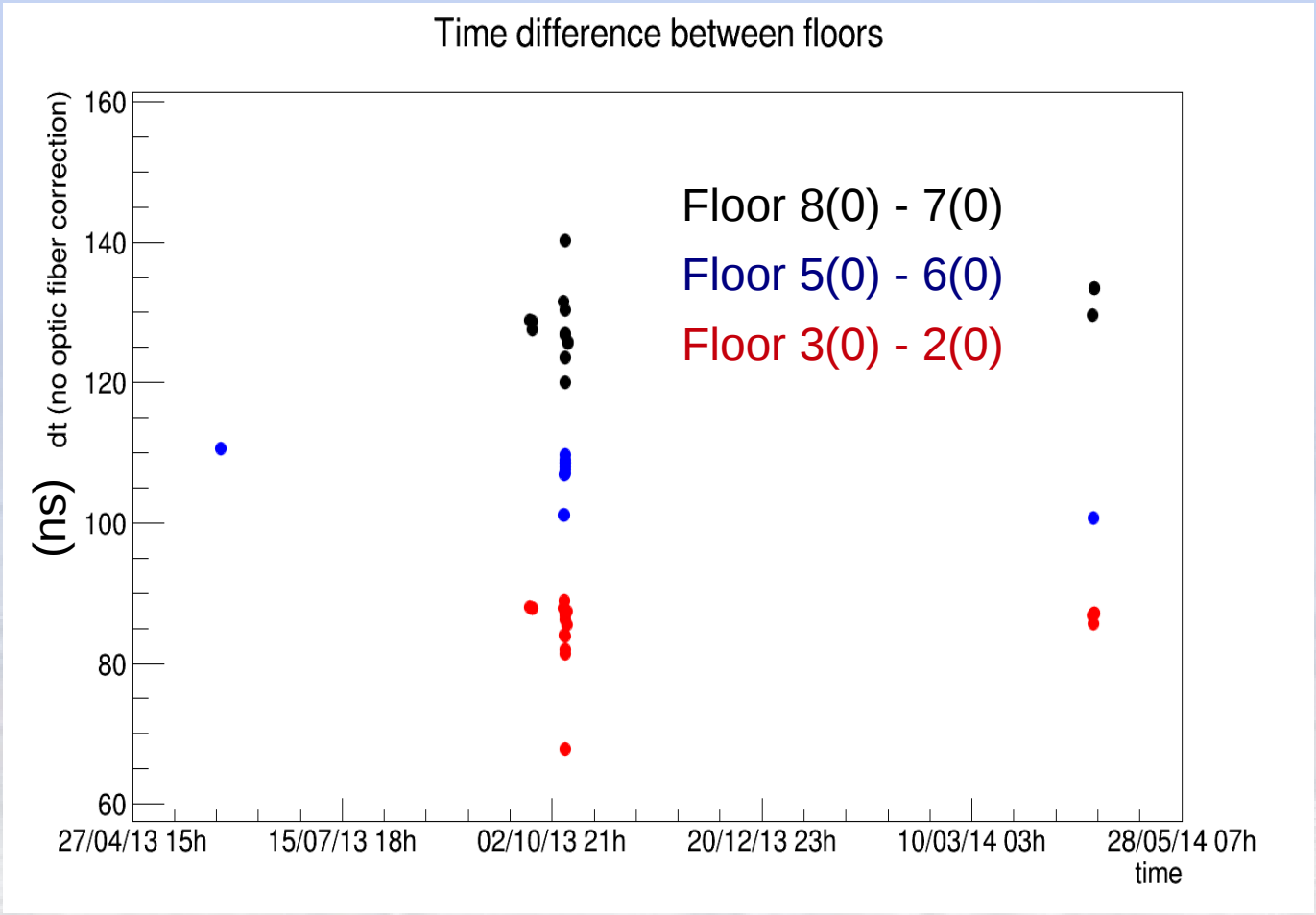
Summary of the LED run infos

Run nb	date	Lower floor signal	Higher floor signal	Has been analyzed
0684	**2013-05-30**	**1**	**8**	**X**
0687	2013-05-30	1	4	
1359	2013-09-24	4	8	
1364	2013-09-25	3	8	
1439	2013-10-07	1	8	
1440	2013-10-07	1-4	8	
1442	2013-10-07	1-4	8	
[...]		**1**	**8**	**X**
1451	**2013-10-07**	**1**	**8**	**X**
1454	2013-10-08	1	7	
1455	2013-10-08	3	8	
1456	2013-10-08	3	8	
1458	2013-10-08	4	8	
2701	**2014-04-22**	**1**	**8**	**X**
2703	2014-04-23	1	8	

- 3 different dates has been analyzed yet (6 month separated)
- 9 runs while the same day was analyzed

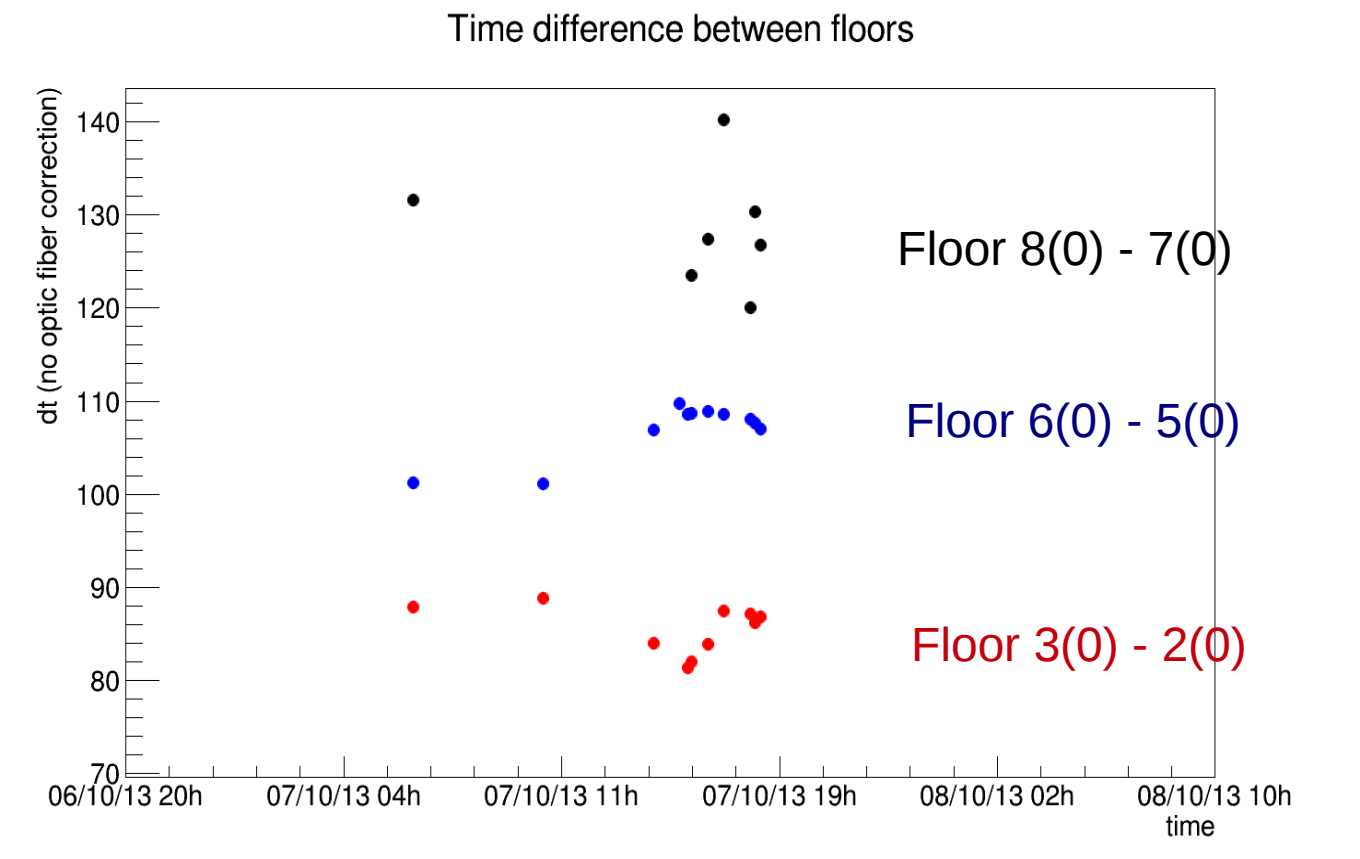
Allow to know the time evolution of the bars on different time range

Some example of the evolution



In general, during long period the shifting time is < 10 ns
Compatible expected structure movement

Some example of the evolution



Continuous variations Seems coherent

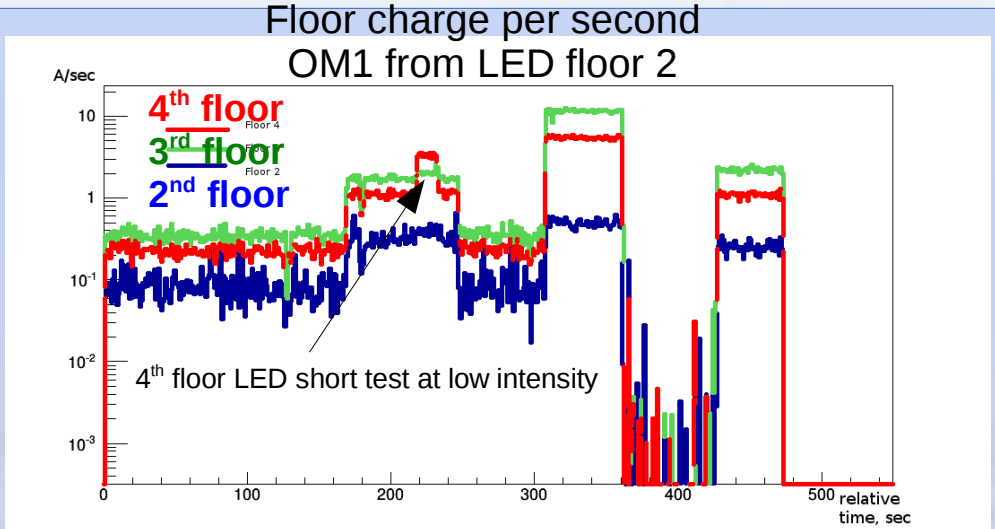
While the day the OMs position can change by few meters

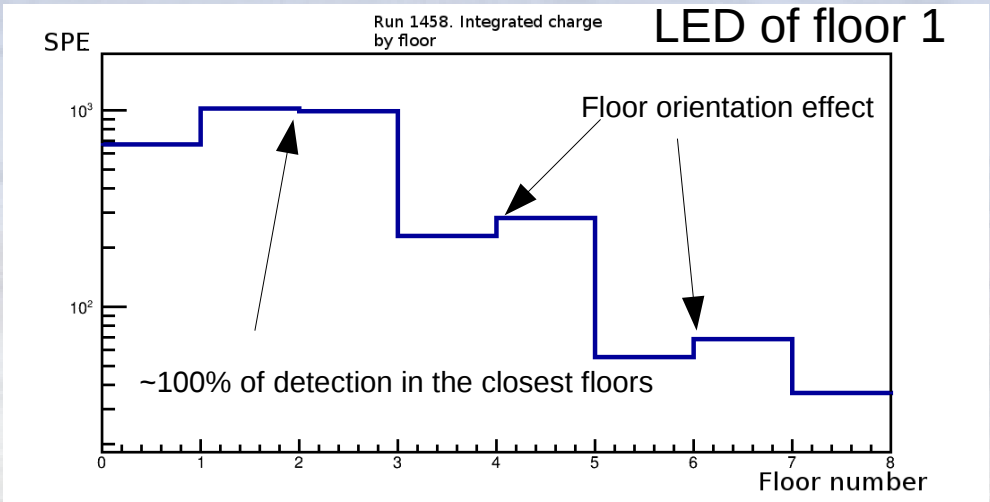
Perspectives

Can be interesting to cross-check with positioning, compass etc...

The results seems to be promising for the KM3NeT LED time calibration

(parenthesis): Further studies of the LED run characteristics





Problem:
On the experimental tower of KM3NeT-it, a single run can contain different LED test.

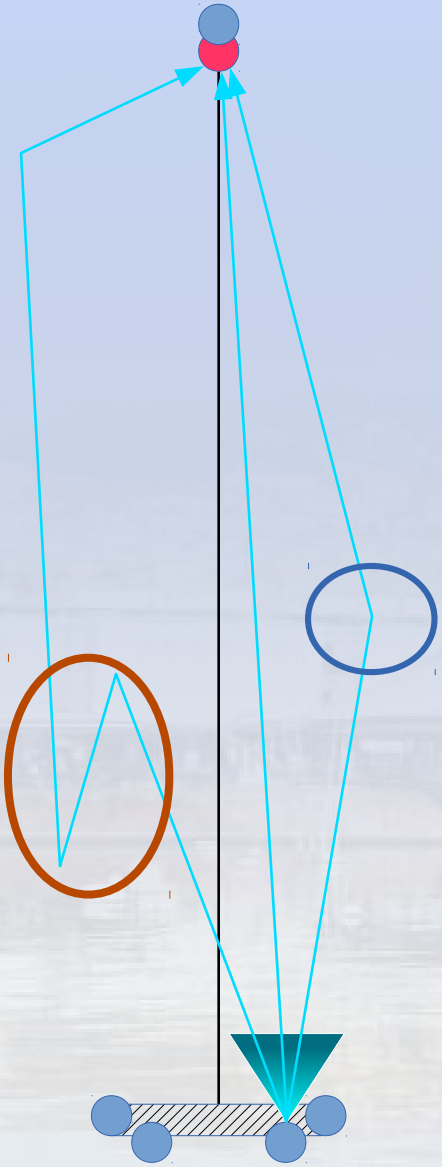
We need to filtrate it to do a proper analysis for
- absorption length (intensity)
- scattering length (wavelength, different for each floor)

The propagation in function of distance can be more understood for isolated LED tests.

Instead of taking the integrated charge, a calibrated number of pe should give a better results (work in progress)

N. Briukhanova

Scattering process



$$b_P = 1.34\,\nu_S \left(\frac{550\,nn}{\lambda}\right)^{1.7} + 0.312\,\nu_l \left(\frac{550\,nm}{\lambda}\right)^{0.3}$$

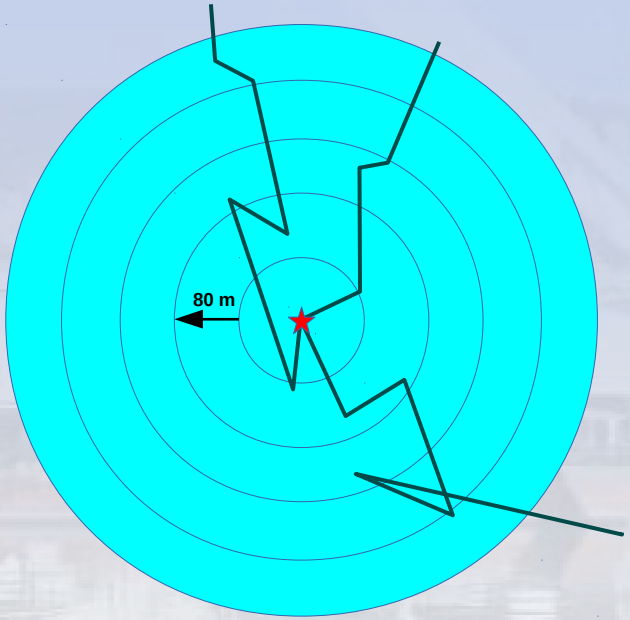
Clancy W. James
Km3 internal note

- 2 components to the scattering :
  - On molecule (isotropic angular distribution)
  - On particles (Forward going angular distribution)
- The both processes depend on the wavelength on a different exponent.
- They imply a delay in time arriving
  - In function of distance
  - In function of wavelength

Need to know the timing to deduce the water properties.
The fit method can help to extract the timing delay to the ns.

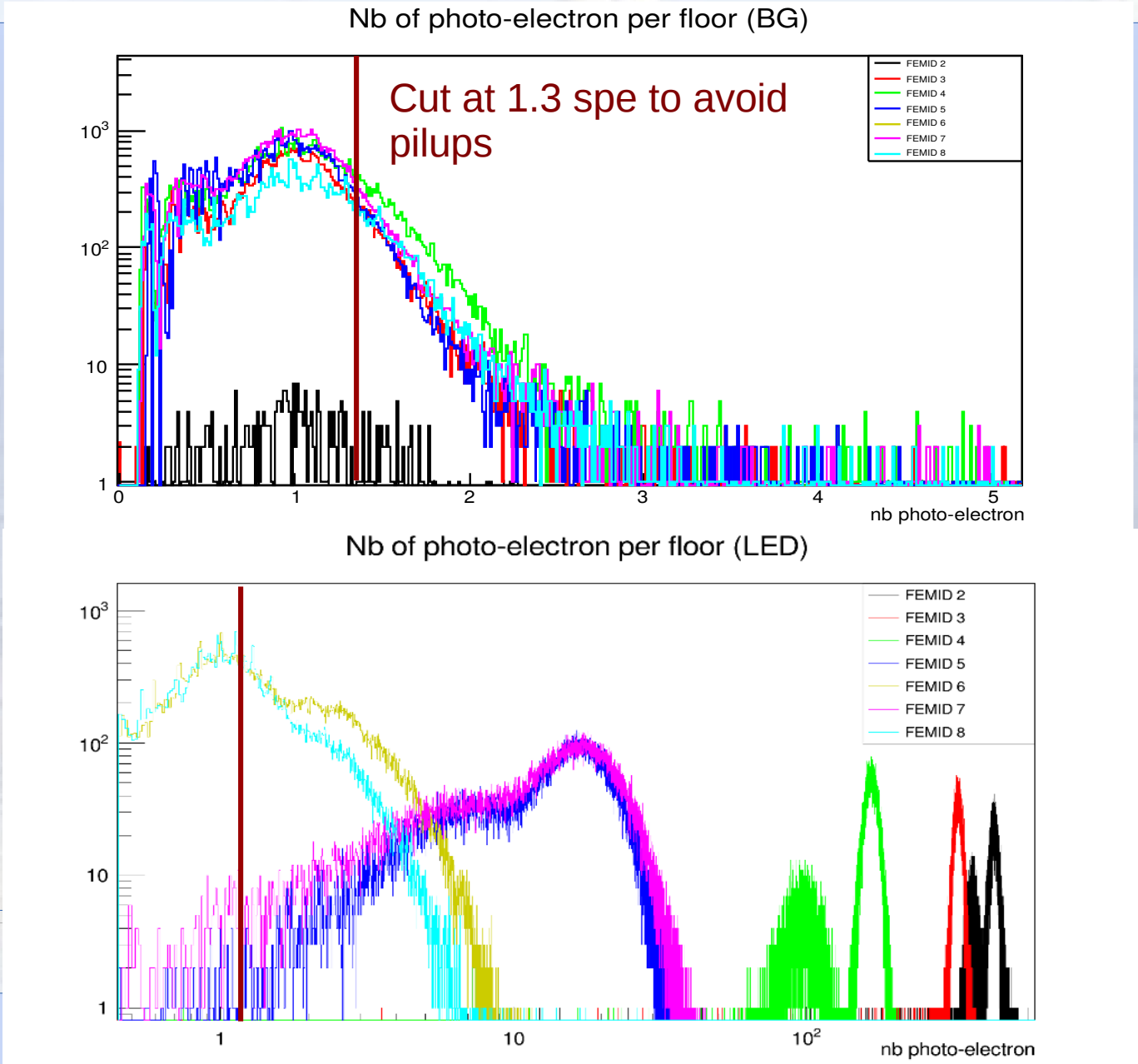
Water properties status

Principle illustration

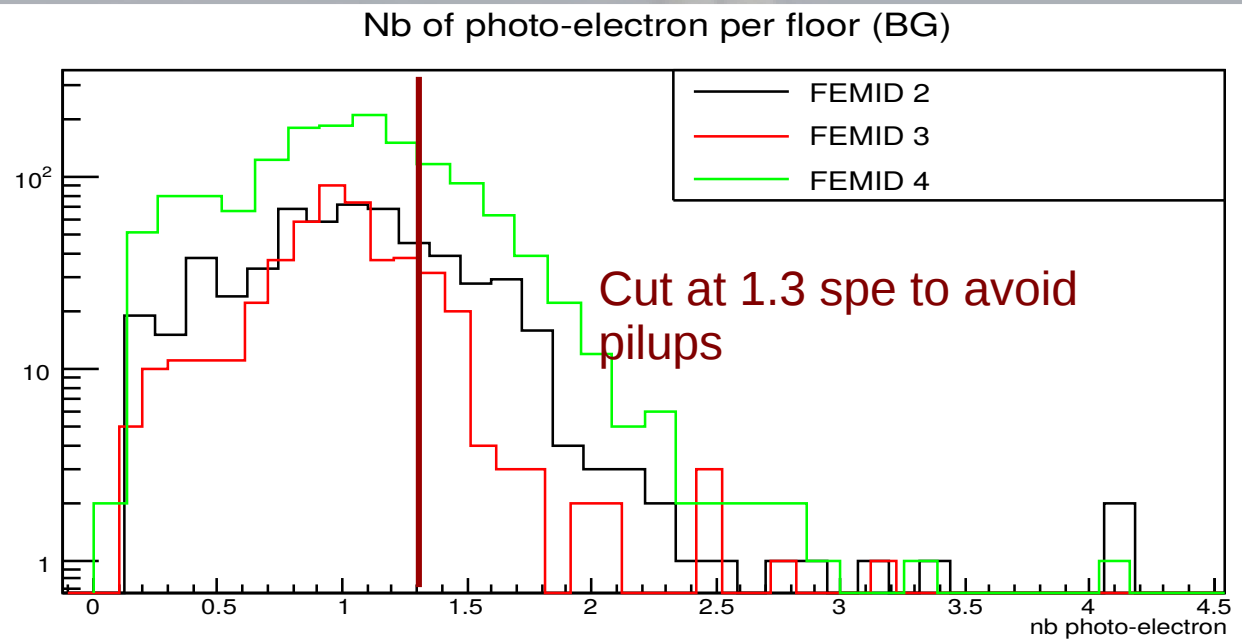


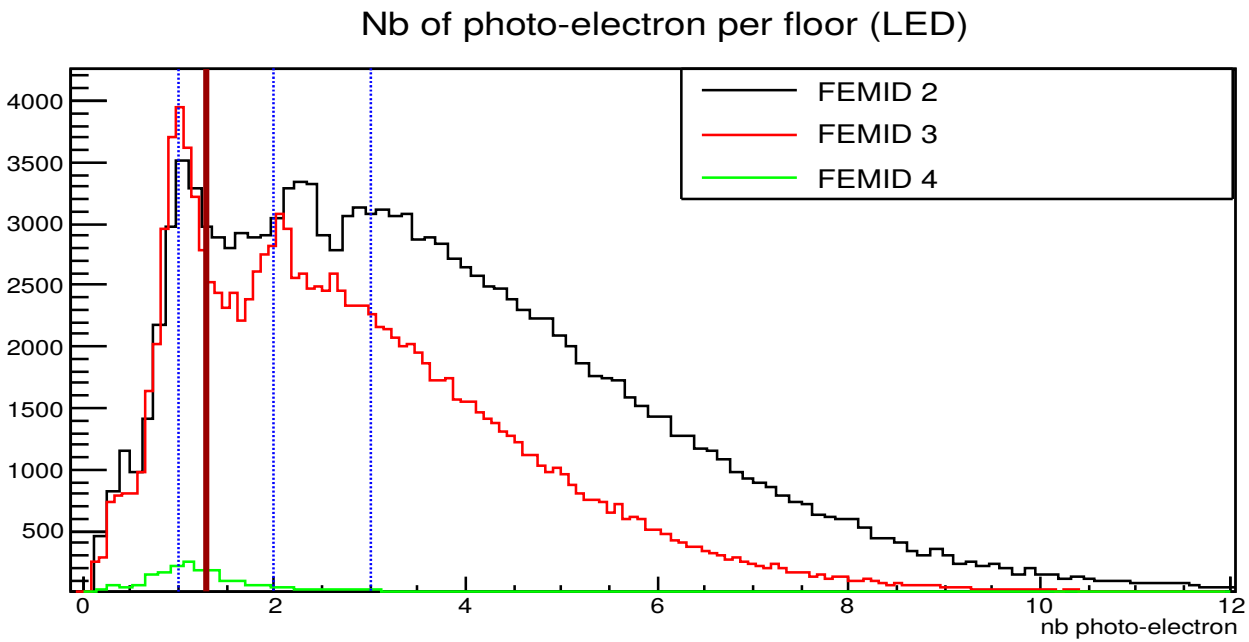
- Concentric detection sphere
  - Separated by the real floor to floor distance
- The source is in the center
- Send photons
- All the photons are kept at each level. Data kept
  - Emission direction (in fact always (0,0,1)
  - Time arrival at each sphere
  - Angle arrival
  - Incident angle
- Then the AA and LED emission are used to put a weigh to the arrival

SPE measurement High LED intensity

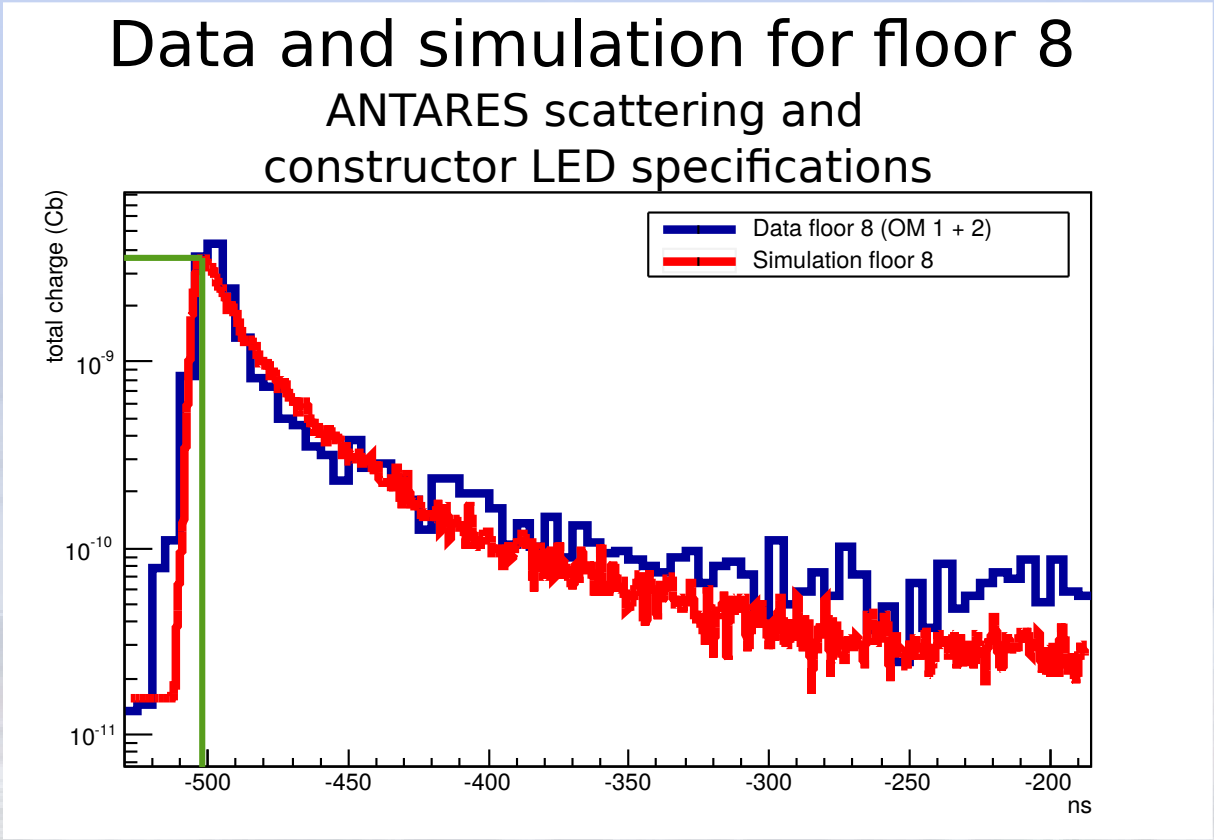


SPE measurement low LED intensity





Raw result on the floor 8



Timing and amplitude are used for the simulation adjustment on the data (green, chi2 minimization)

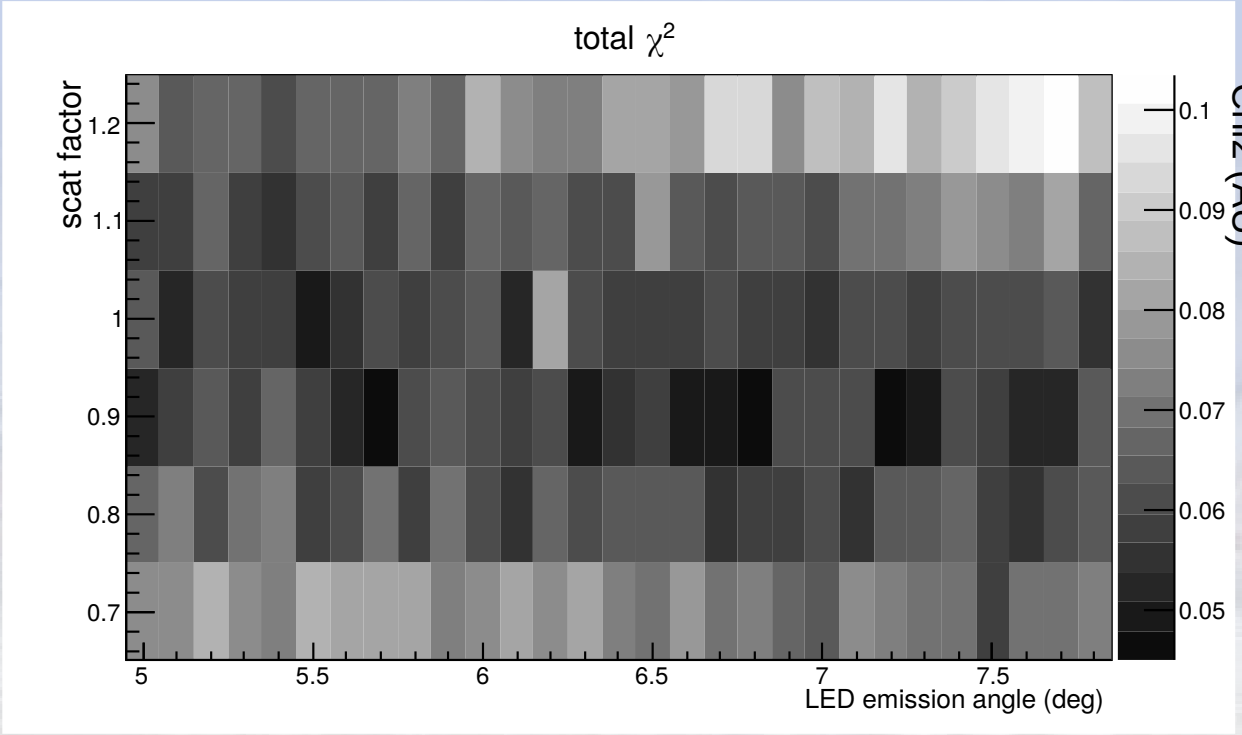
With the exact antares scattering and LED specifications.

=> Research of the minimum chi2 in function of scattering and LED angular emission

Current very preliminary results ongoing work

Water scattering of ANTARES
Events with charge < 1.3 spe
LED specifications from constructor
LED emission angle (refraction)

Under simulation:
Table of chi2 for scattering values
The preliminary best is around
0.9 X ANTARES scattering



The total chi2 is calculated as

Sqrt (chi2(floor8)^2 +
chi2(floor7)^2 +
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The chi2 is calculated comparing data and simulation the weighted with the number of events

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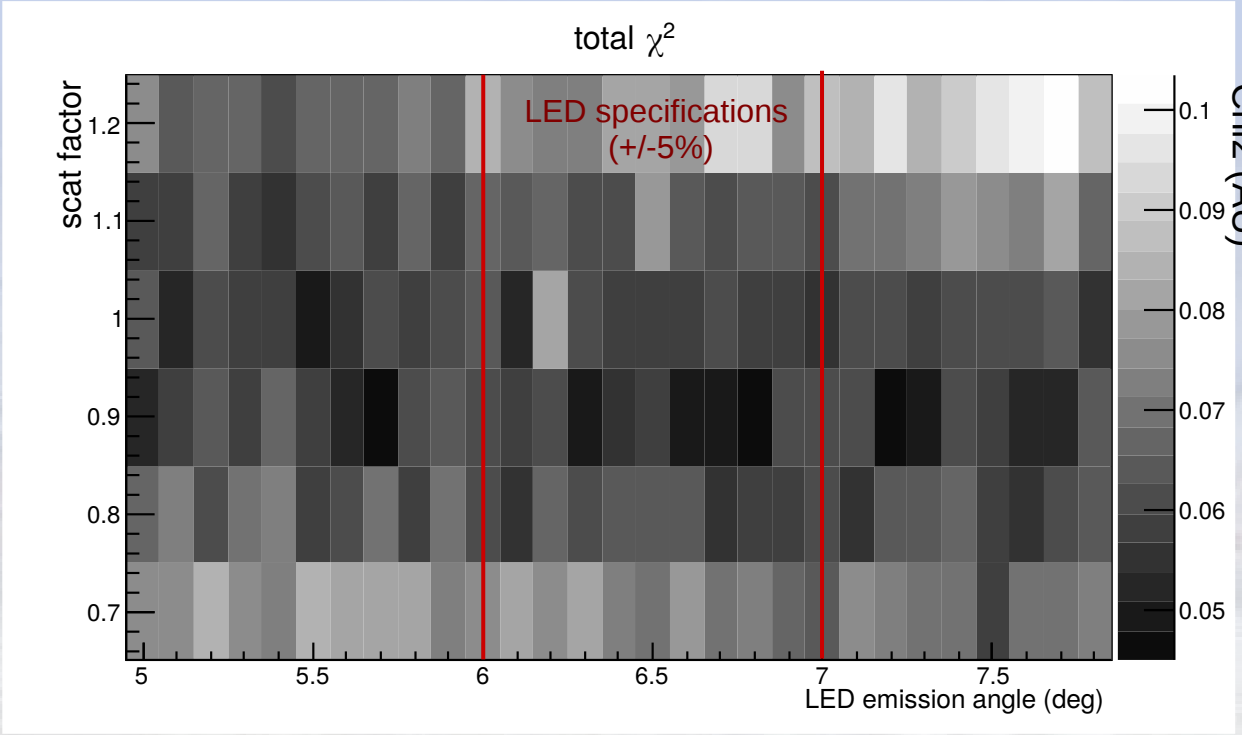

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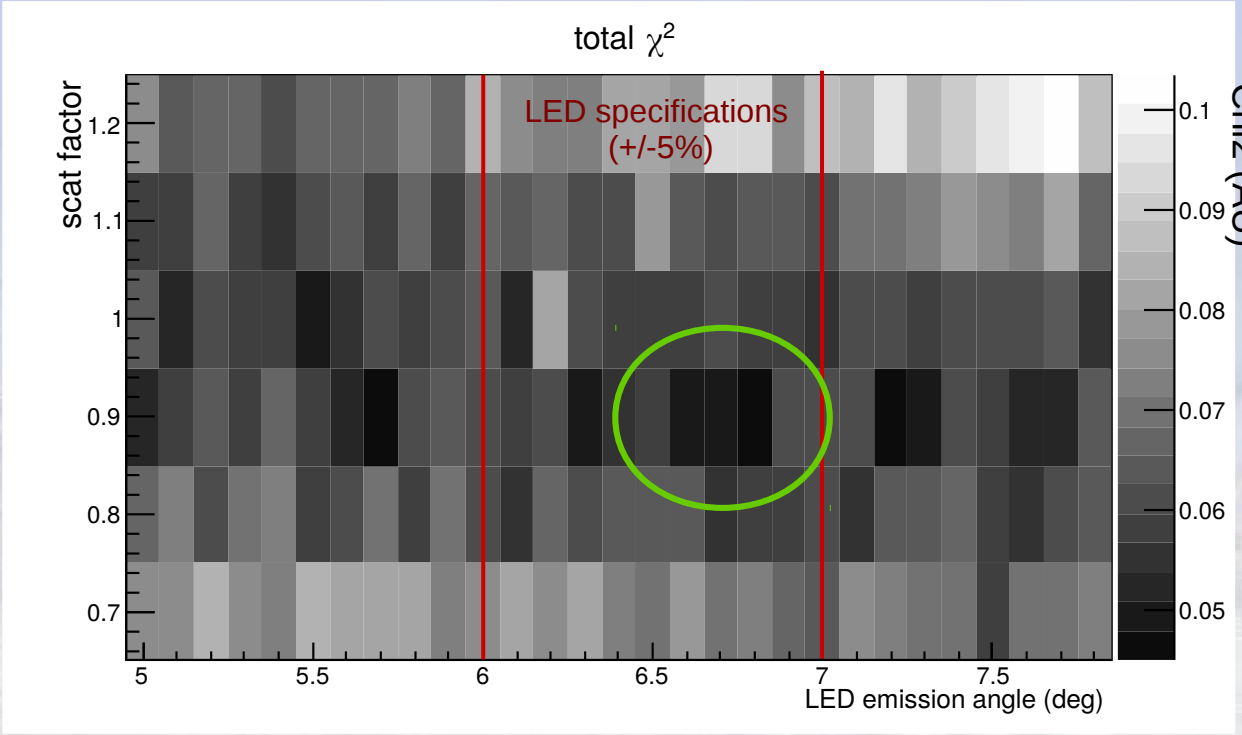

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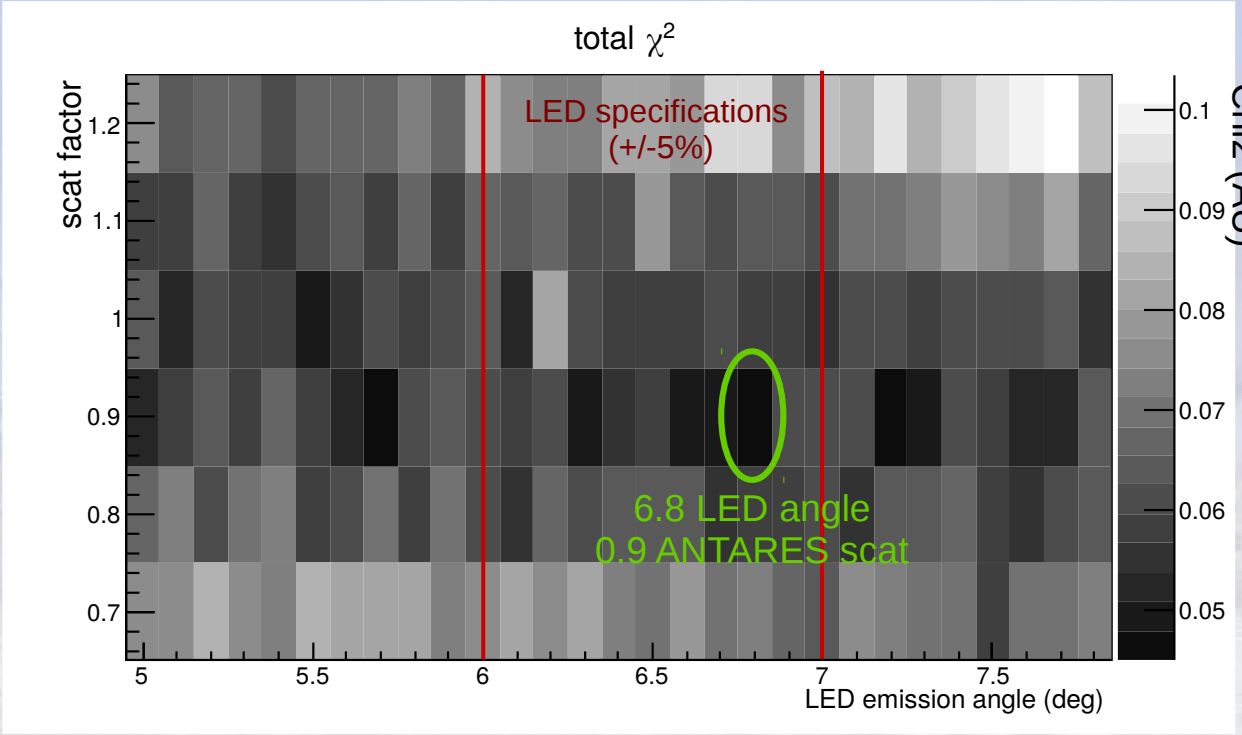

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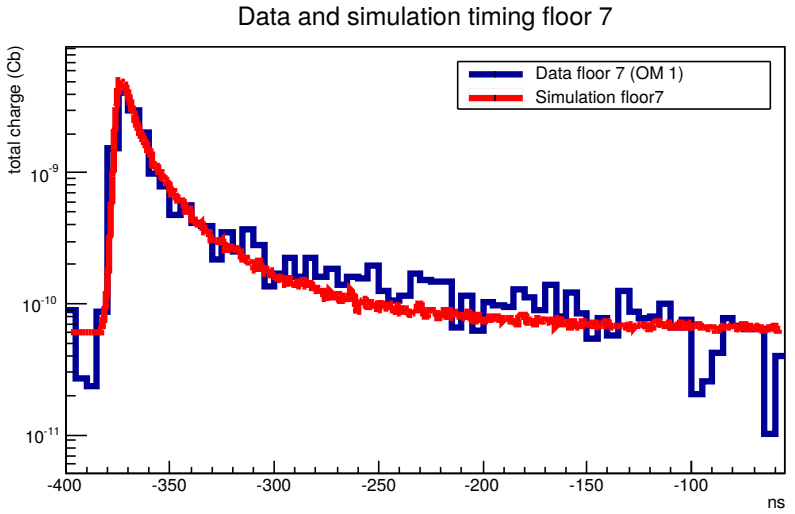

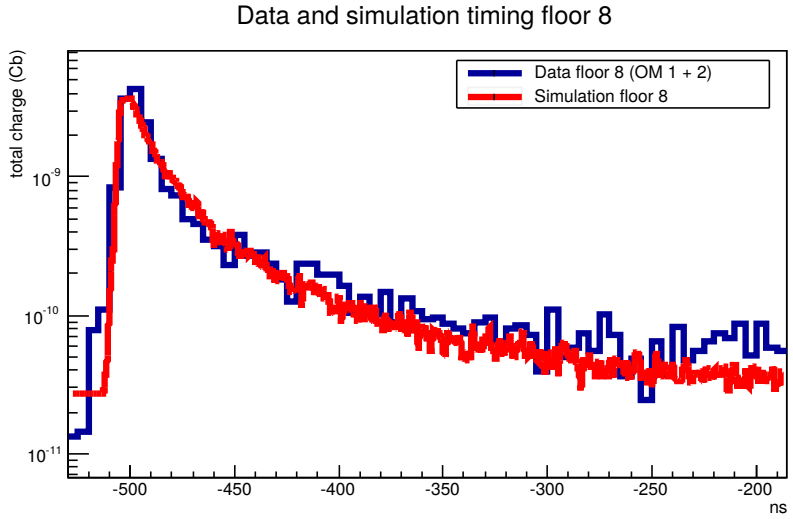

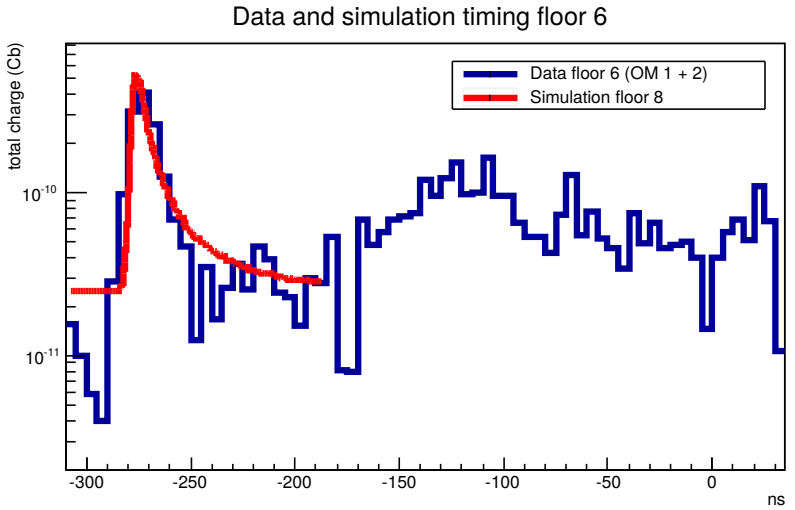

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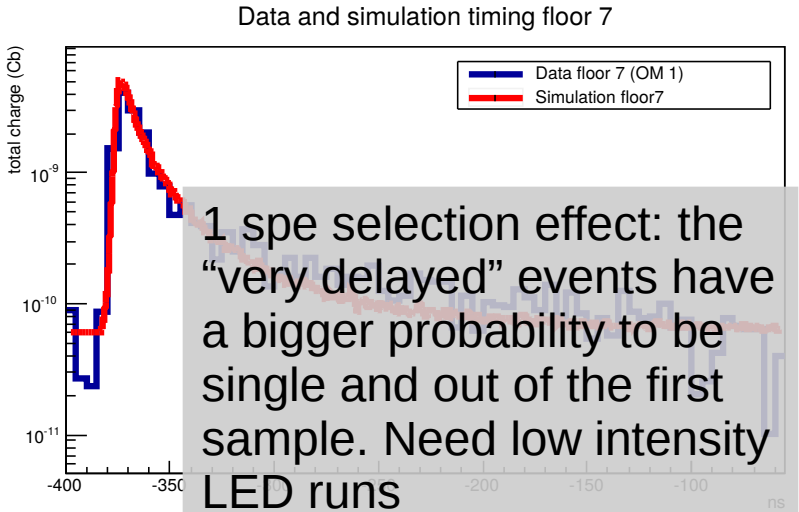
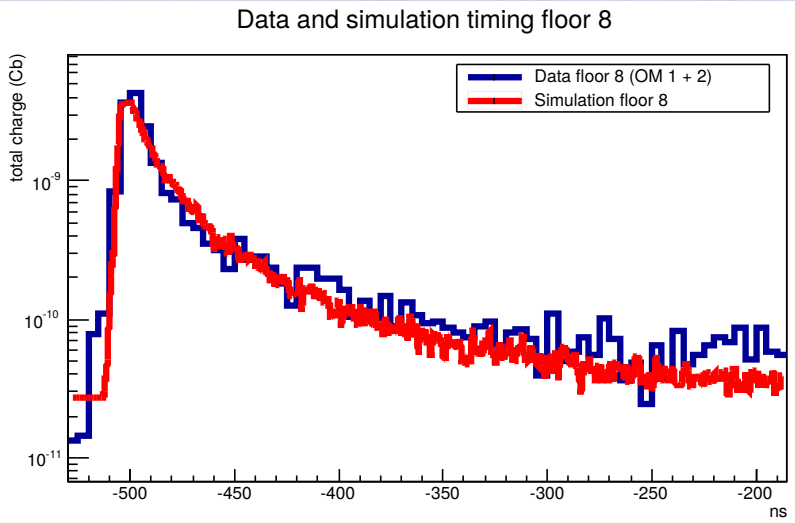
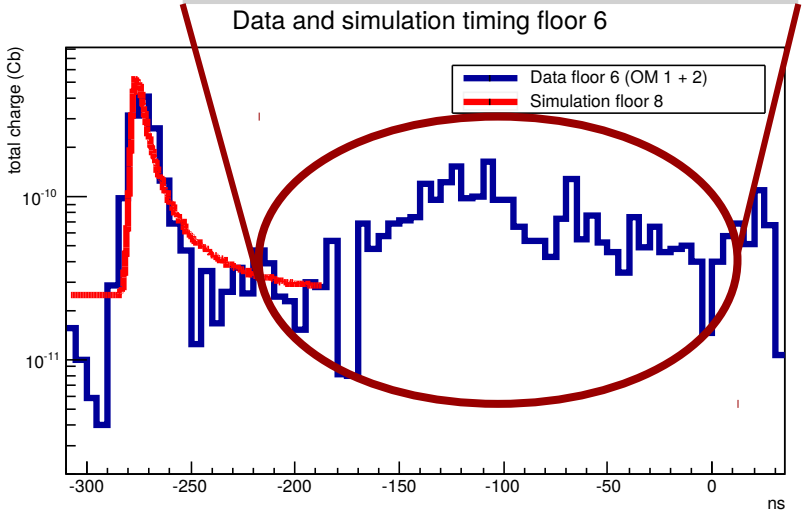
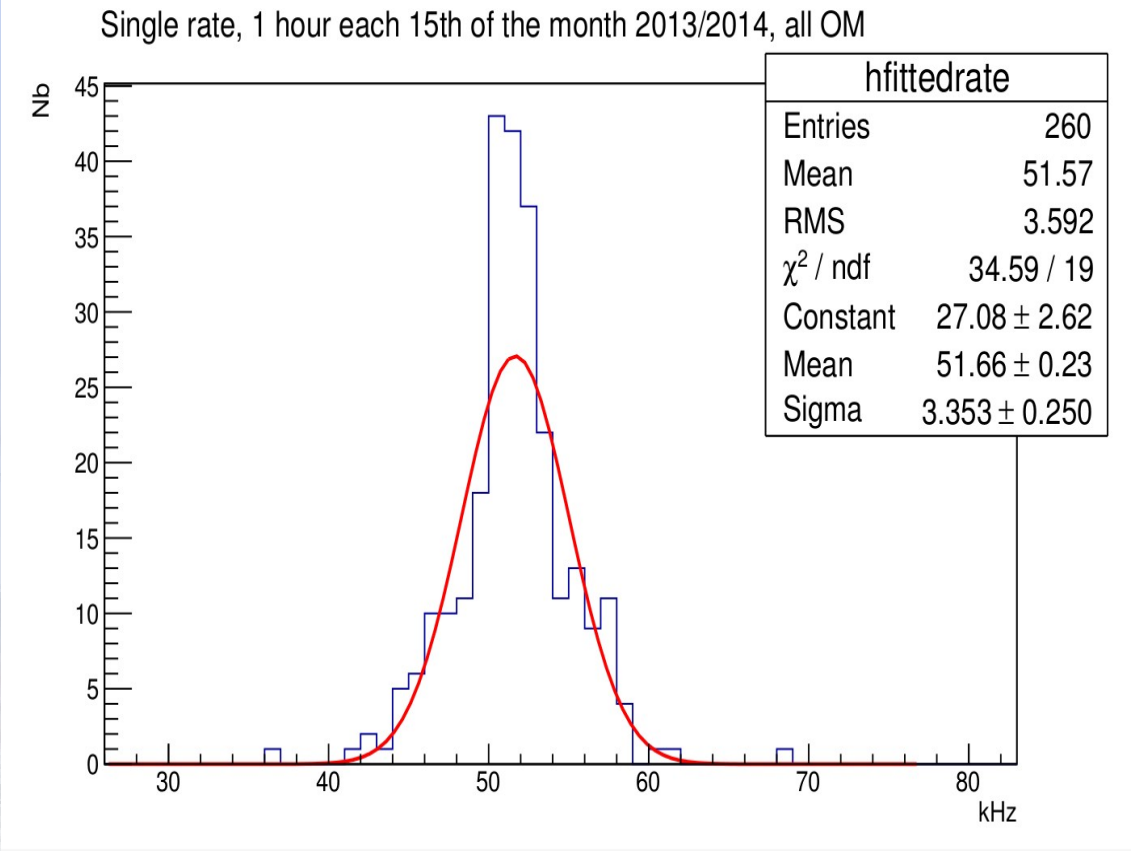


1 spe selection effect: the "very delayed" events have a bigger probability to be single and out of the first sample. Need low intensity LED runs





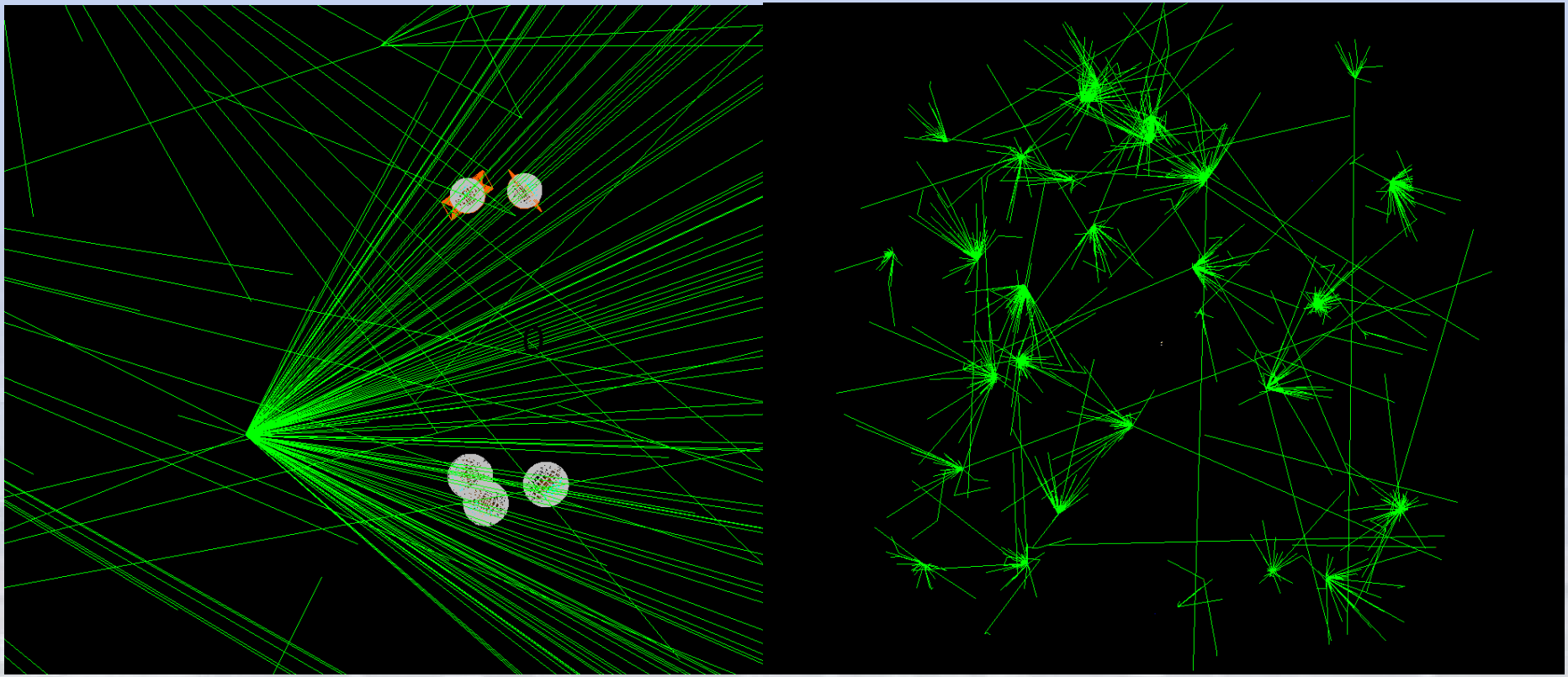
^{40}K single rate in NEMO: The data



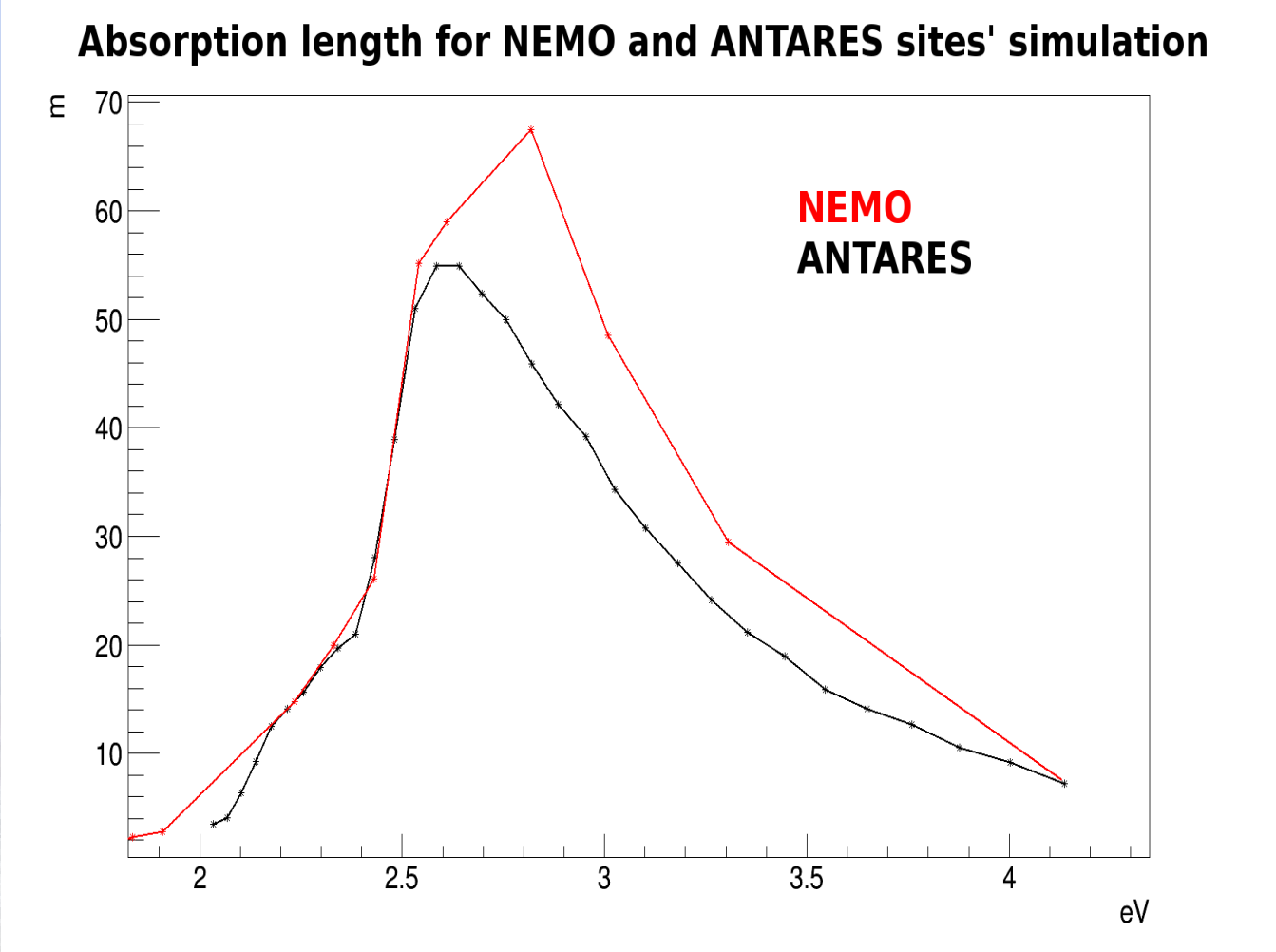
Single rate from random samples:
The baseline is extracted from samples of 1 hour (without selection) per month.

The samples showed a very good stability. Excluding the burst, almost no variation, It seems that there is a very low bioluminescence constant background.

^{40}K single rate in NEMO and ANTARES



Parameters



The single rates are independent of the scattering!

Simulation and data confrontation

Detector	set	2009	2010	2011	2012
ANTARES	coincidence rate	15.8 Hz	15.5 Hz	14.82 Hz	X
	simulation	43 ± 3 kHz	42 ± 3 kHz	41 ± 3 kHz	X
	data	51 kHz	49 kHz	46 kHz	47 kHz
	diff	8 kHz (2.7 σ)	7 kHz (2.3 σ)	5 kHz (1.7 σ)	X
KM3NeT-it	coincidence rate	X	21.6 Hz		X
	simulation	X	54 ± 3 kHz		X
	data	X	52 kHz		X
	diff	X	-2 kHz (0.7 σ)		X

The ^{40}K coincidence rate is used to calibrate the simulation,
We observe a regular decrease of the efficiency.
We consider 3 kHz of noise for ANTARES and 3.6 kHz for NEMO (glass ^{40}K and dark current)

The ANTARES rate is in agreement with the numerical calculus (J. Brunner)
An underestimation of the ANTARES rates is observed.
A very good agreement is found for NEMO

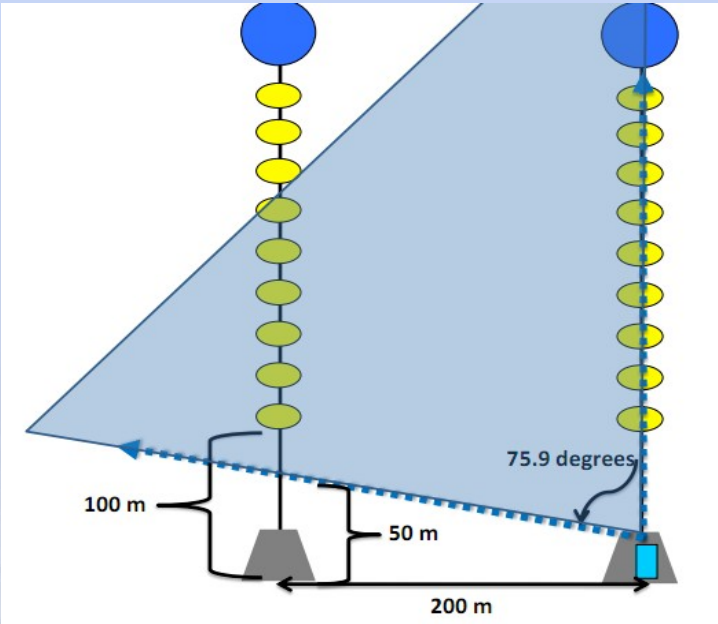
Where to find the soft and results

- All the results and the software analysis are available on

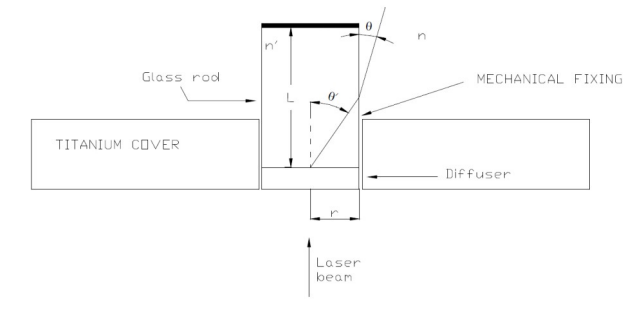
http://www.ge.infn.it/~chugon/NReader/documentation/html/Results.html

Backup

Laser setup

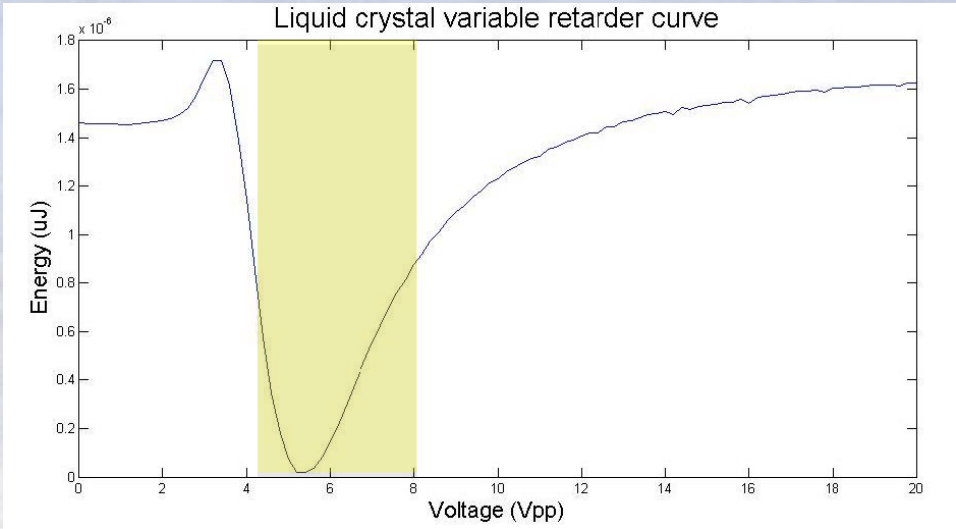


Laser range with the designed glass rod

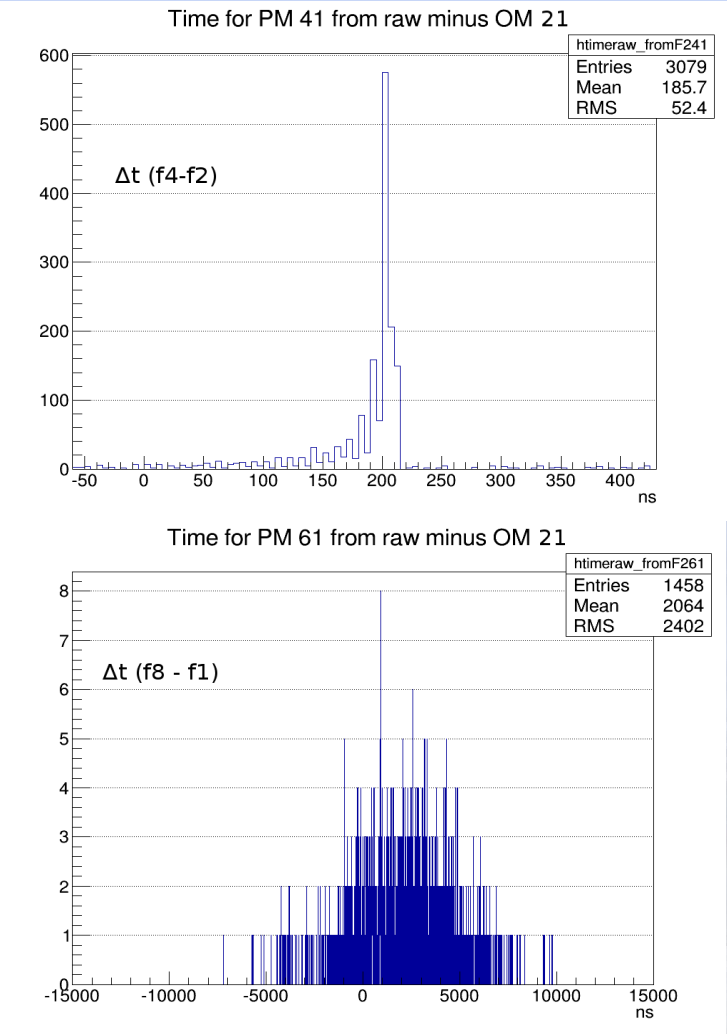


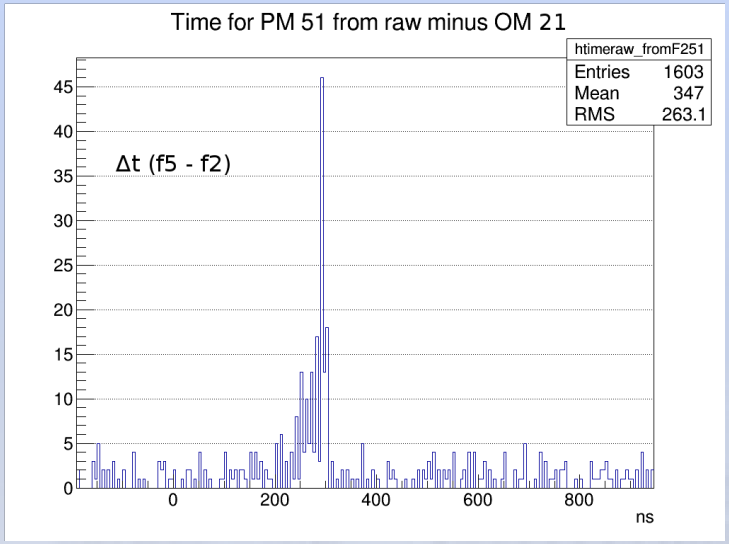
Laser Beacon installed at the base of the NEMO-PhaseII tower

- λ = 532 nm $\lambda_{att}(\lambda=532) \sim 25$ m !!
- no photo-detector close to the laser diode (yes in future)
- light propagation along the vertical not optimal for construction
  - calibrated the optical attenuator
  - measured differences $\Delta t_{1\text{-}n}$: O.K. up to 300m distance



Some results

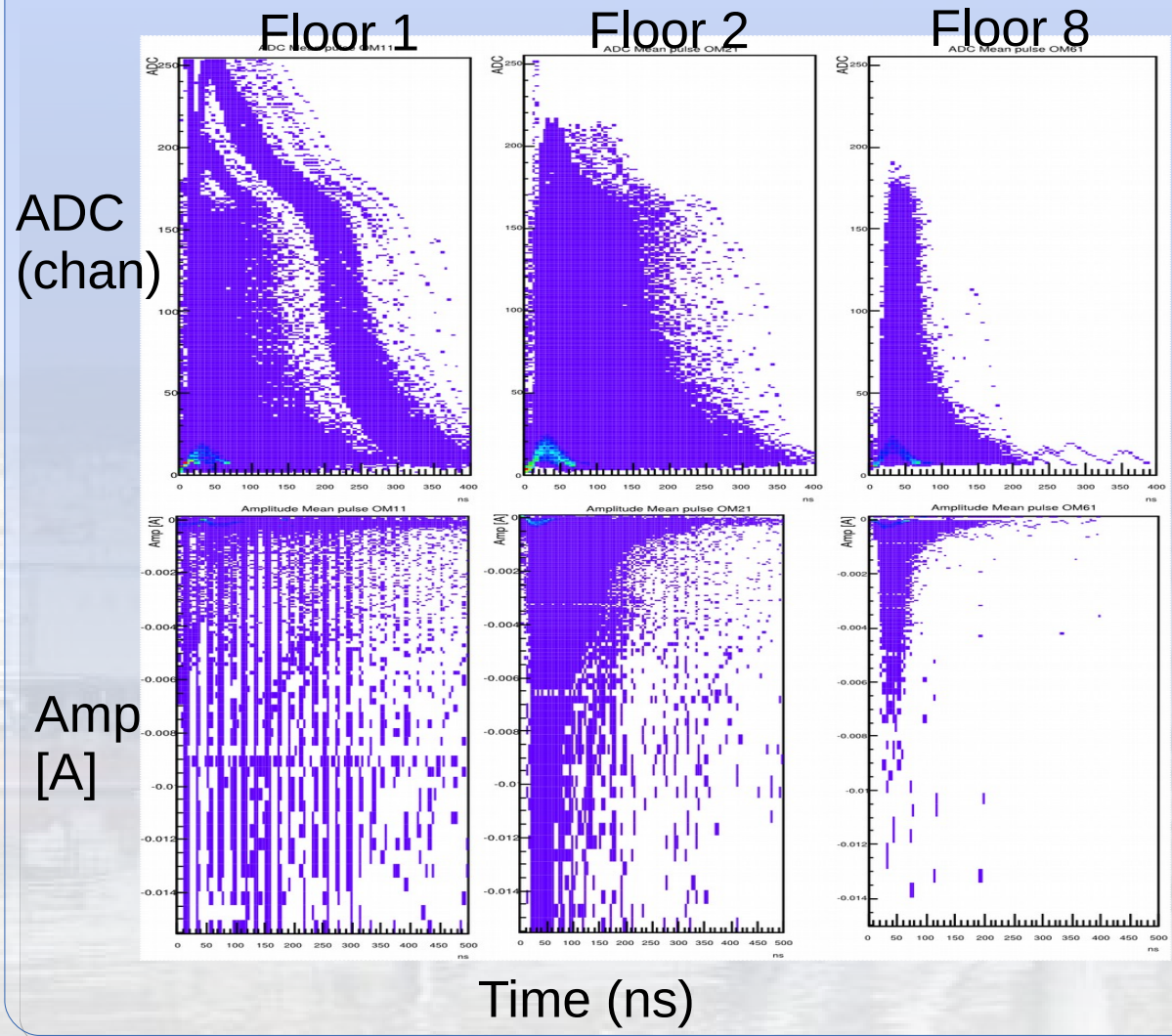




NOTHING from the 6th floor

- Laser orientation ?

What the pulses look like ?



Why the second floor is used for the "start" signal instead of the first ?

- OM 11 ADC is saturated: Lower rate, bad timing.
- The laser does not hit well the first floor ?

- OM 21 few ADC saturated: Usable rate and time

- OM61 is the latest floor, can be used to see a "normal" behavior, it is dominated by single photo-electron (almost no laser pulse reach it).

Previous conclusion

- The LED can be used for time calibration, even at high light intensity (first floors)
- The fitting method:
  - Improved the resolution to the ns
  - I need the positioning to go further.
- The scattering can be studied, needs the simulation (see tomorrow slides)

Checked up to 320 m distance

Test for a wider time range of runs

- Check evolution of the time calibration
  - While the day
  - While the year
- A lot of LED runs were done, but
  - In many runs different LED intensity were used
  - In many runs different LED were used
- Not all of them are yet usable, need more investigation if we want do go further

Summary of the LED run infos

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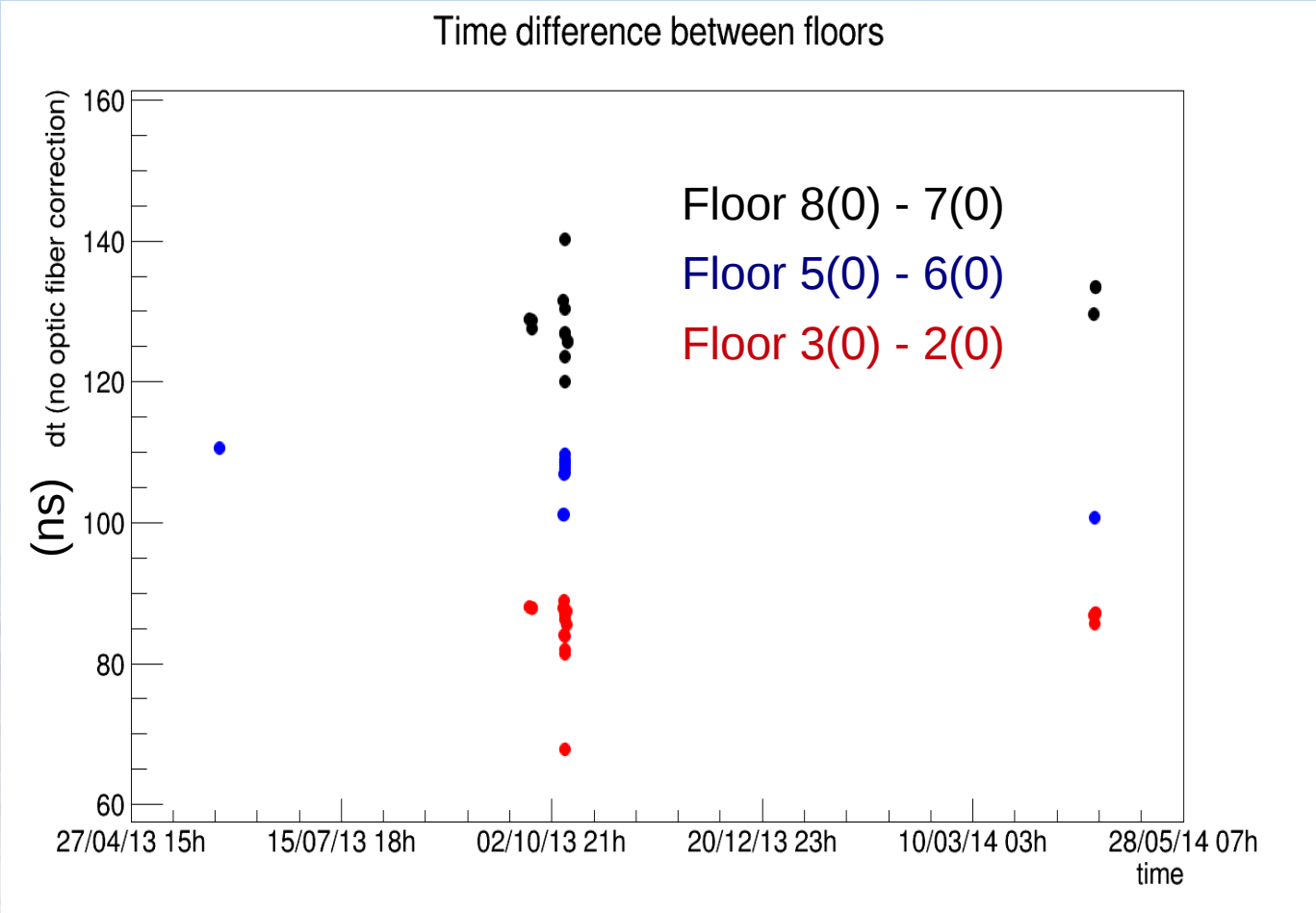
Allow to know the time evolution of the bars on different time range

Some example of the evolution



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Compatible expected structure movement

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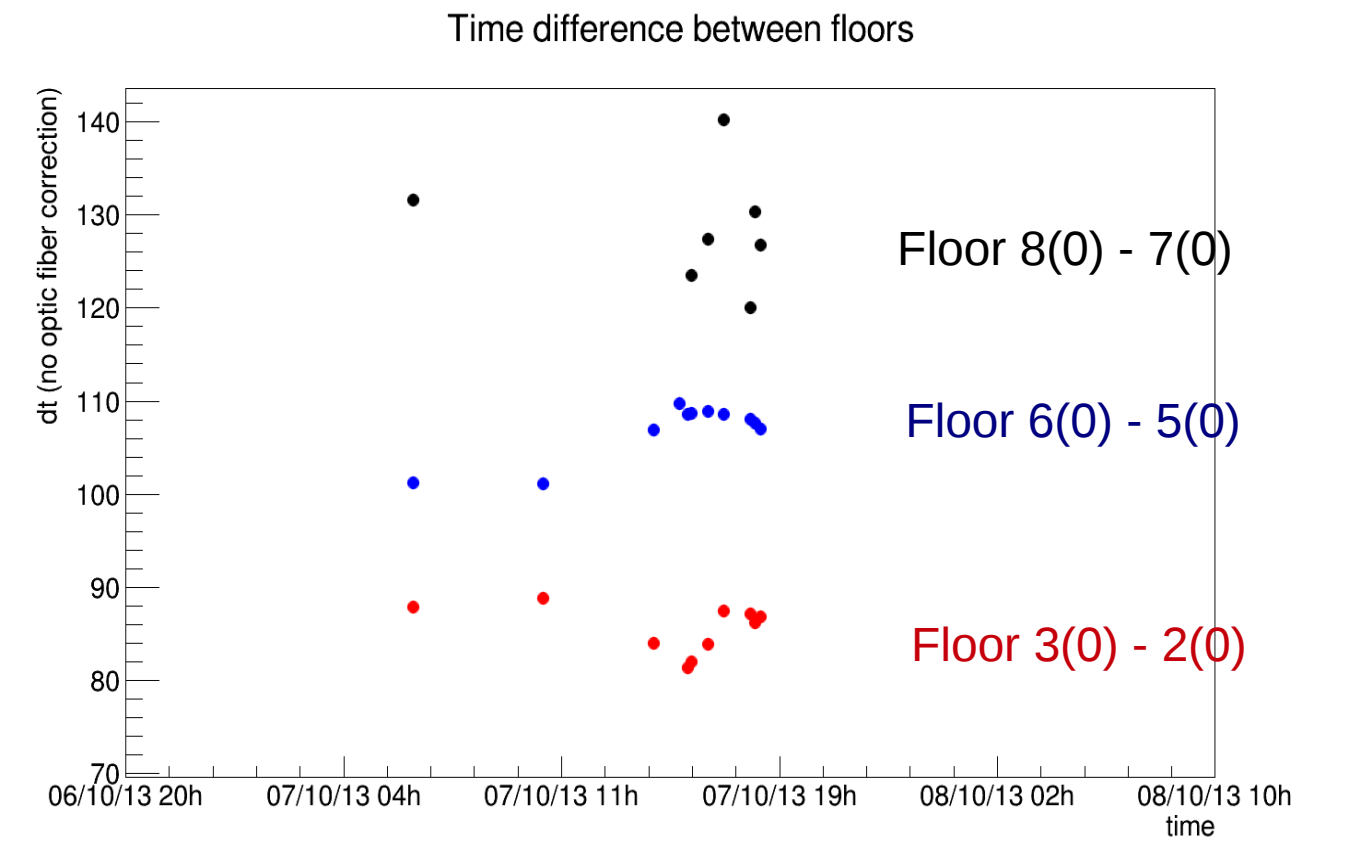


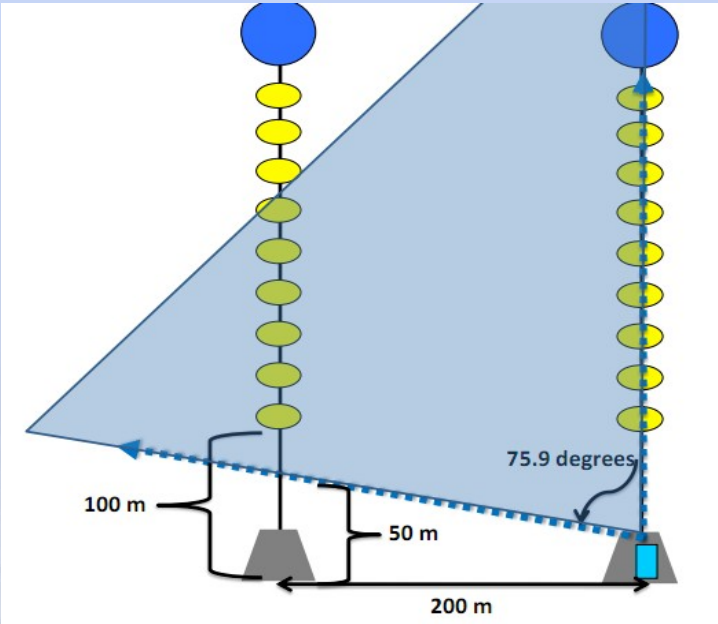
While the day the OMs position can change by few meters

Perspectives

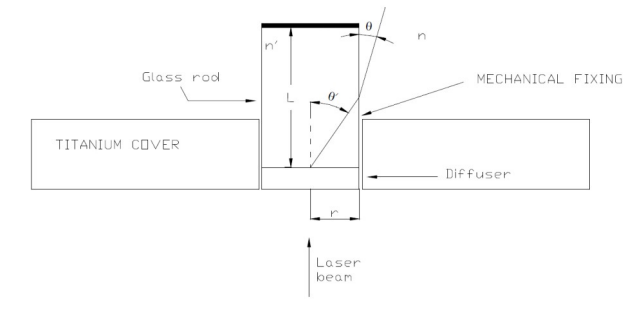
- Can be interesting to cross-check with positioning, compass etc...
- More run could be used, but it needs
  - More time
  - specific analysis to isolated the LED time

The results seems to be promising for the KM3NeT LED time calibrition

Laser setup

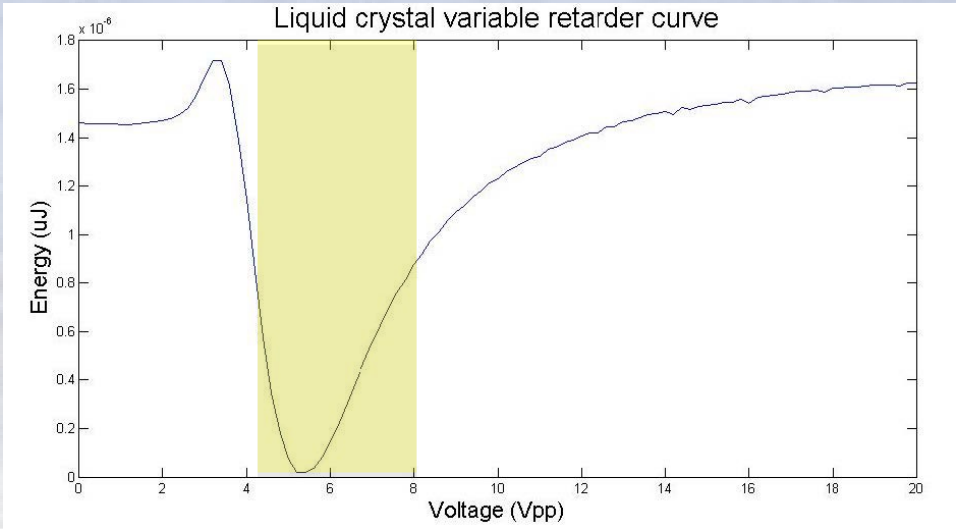


Laser range with the designed glass rod

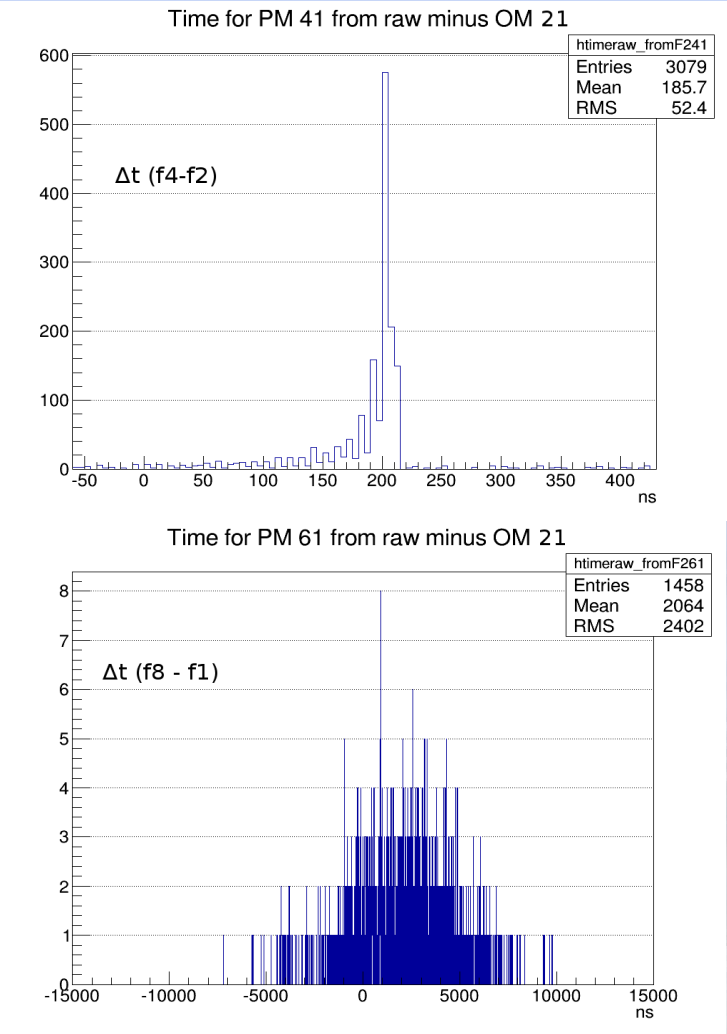


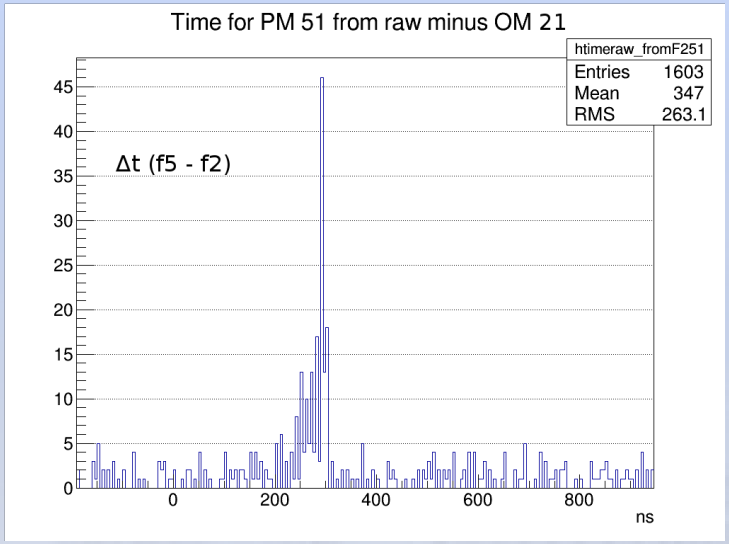
Laser Beacon installed at the base of the NEMO-PhaseII tower

- λ = 532 nm $\lambda_{att}(\lambda=532) \sim 25$ m !!
- no photo-detector close to the laser diode (yes in future)
- light propagation along the vertical not optimal for construction
  - calibrated the optical attenuator
  - measured differences $\Delta t_{1\text{-}n}$: O.K. up to 300m distance



Some results

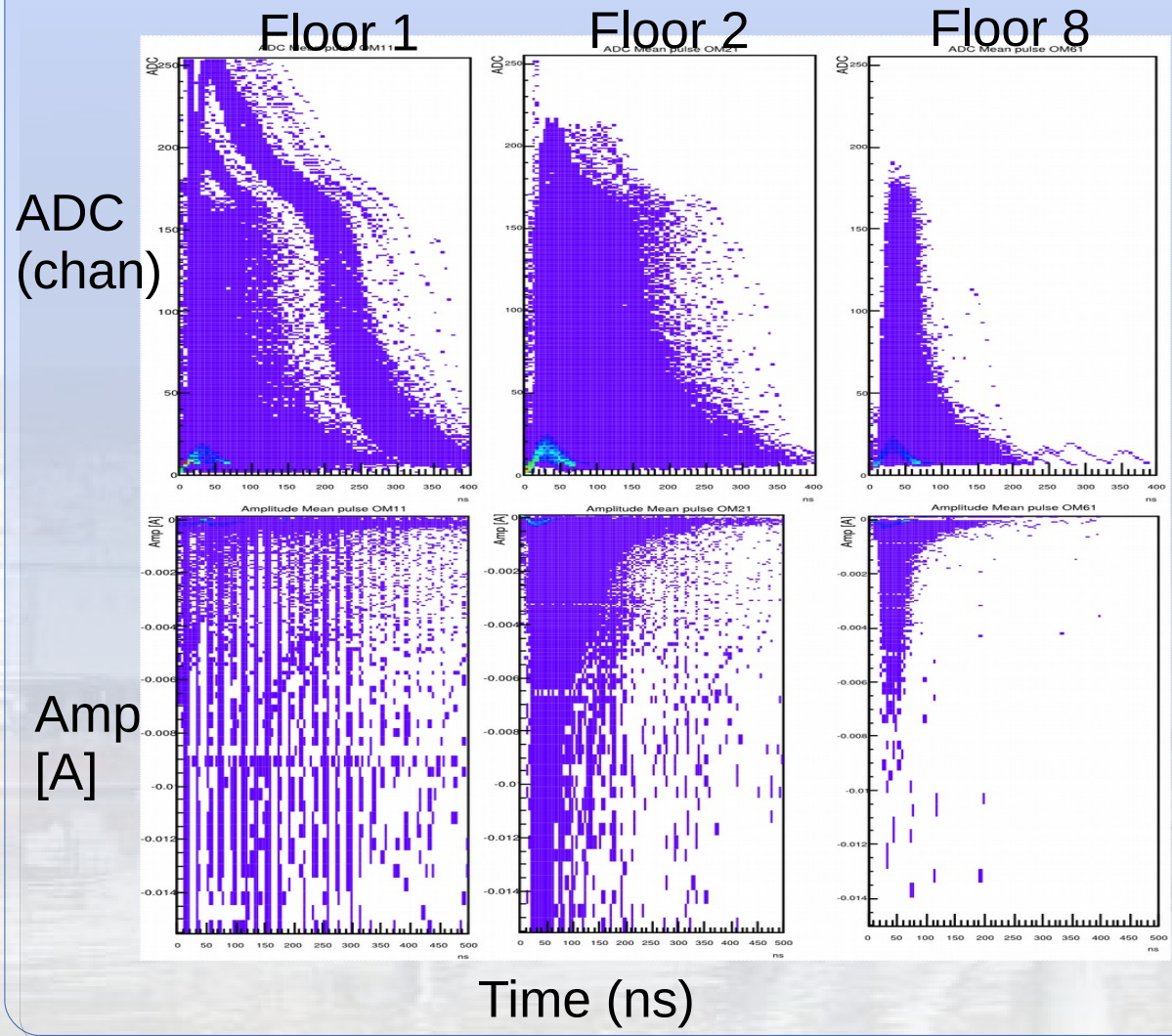




NOTHING from the 6th floor

- Laser orientation ?

What the pulses look like ?



Why the second floor is used for the "start" signal instead of the first ?

- OM 11 ADC is saturated: Lower rate, bad timing.
- The laser does not hit well the first floor ?

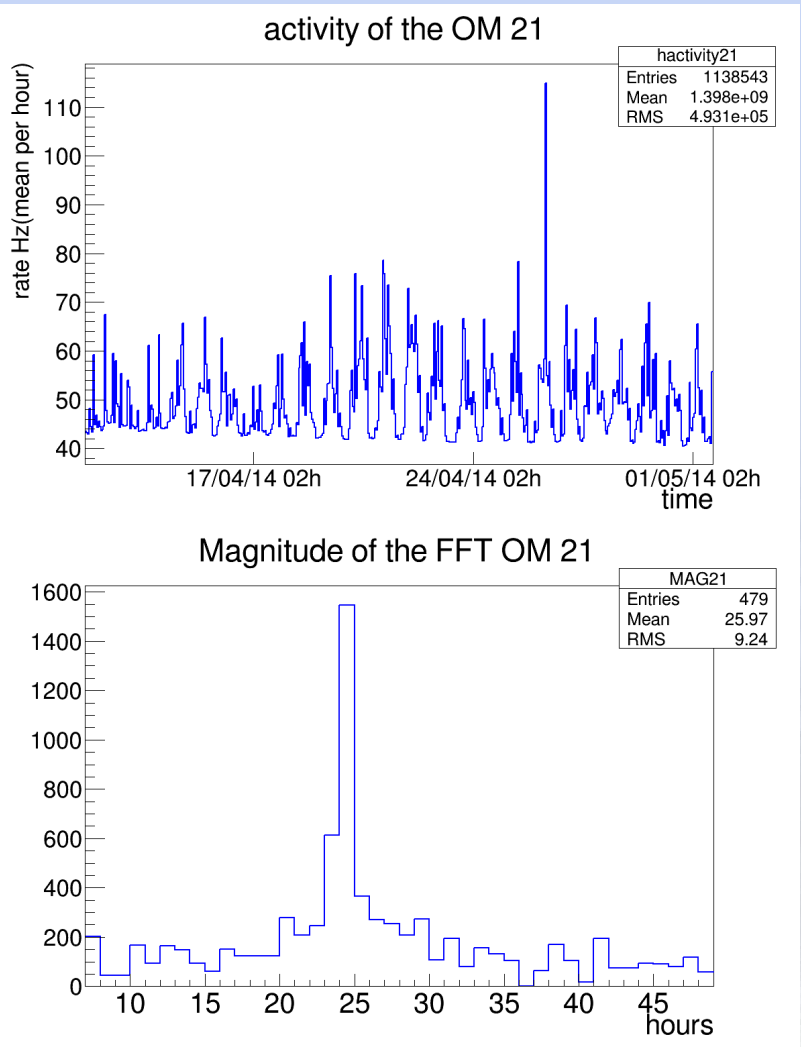
- OM 21 few ADC saturated: Usable rate and time

- OM61 is the latest floor, can be used to see a "normal" behavior, it is dominated by single photo-electron (almost no laser pulse reach it).

Conclusion

- The laser run present some difficulties
  - No good start time
  - Does not hit all of the PM
- New Laser design needs to include a precise start time (under developing by Roma group)
- Can be interesting to do a test with the PPM-DOM

Coriolis parenthesis



While I looked for the LED runs on the slow control OM rate, I saw this on every Oms

- Coriolis force ?
  - Calculated period ~20h
  - Measured period =24 h
- Activity based on the sun period ?
  - Bio activity ?
  - Deep Current ?
  - Yellow submarine ?
  - ...

If somebody want to explore it, there is some interesting things to do

- Cross check with the current components
- Check if there is a link with the PM positioning (plankton hits on the face/back)

The Slow control will be soon integrated in Nreader (intership)

Title 1

Title 2