REDEFINITION OF THE "FAKE-TRIGGER" CUT

CHIARA LASTORIA (CIEMAT)

3x1x1 light data/MC analysis meeting

January 22th, 2020

Introduction

Preamble

:> Due to the presence of very low energetic events uncorrelated with their position inside the detector identified as "CRT-fake" trigger, the S1 analysis presented so far (Birks' law and Rayleigh scattering length) was based on a quite "stringent" μ-like event selection: rejection of **"CRT-fake" triggers**, only **diagonal** tracks **completely inside** the **active volume**, etc..

STRINGENT muon track selection cuts

quality cuts		CRT-PMT DAQ matched ev.
quality cuts		CRT reco ev. (1 hit/panel)
quality cuts		no ADC saturation
quality cuts		no. PMT response saturation
analysis cuts		inside LAr active volume(*)
analysis cuts	no fake CRT tr.	minimum S1 ampl. (ch by ch)
analysis cuts	good ToF	-40<ToF<40
analysis cuts	min track length	L>3100 mm

:> improving the understanding of the 3x1x1 data, we started relaxing some of these cut to increase the statistics

:> in this talk, I'll present the final μ-like track selection in order to maximize the statistics redefining and relaxing the old cuts:

→ included all track length

→ included all track directions

→ taken into account the visibility change under/below cathode

→ redefinition of the "CRT-fake" trigger in two cuts:

1. rejected the events where ALL the PMTs do not see light
2. required a minimum S1 amplitude based on the n. of PE collected by the PMTs

(*) in next slides you find the three volumes definition (active, fiducial and field cage volumes)

Requirement of a minimum n. of P.E. detected

:> **Rejection** of events where **all** the **PMTs** detected an **S1 amplitude< 5* RMS (Pedestal)**

:> a **CRT-fake** trigger can be recognized considering the CRT information and/or PMT information

→ CRT: a track is reconstructed with a **ToF∉(-40; 40)ns**

→ PMT: a CRT trigger has been received with 1hit/panel, BUT **all the PMTs do not see light**

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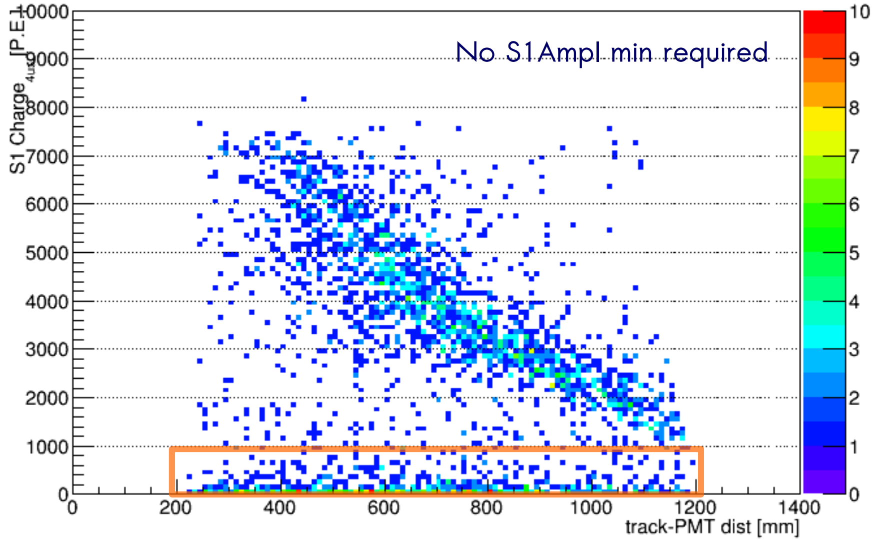
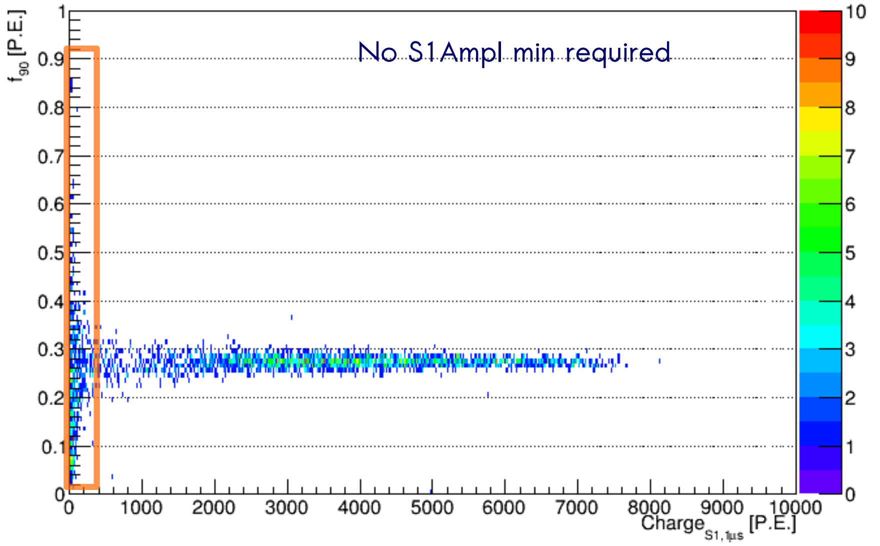
→ PMT: a CRT trigger has been received with 1hit/panel, BUT **all the PMTs do not see light**

:> considering the correlation of the light collected as a function of the track-PMT distance, accepting the events with all S1 amplitude remains the events uncorrelated with the track-PMT distance

→ for instance, comparing with the f90 it is found that the events with very low light do not have the expected value for the f90



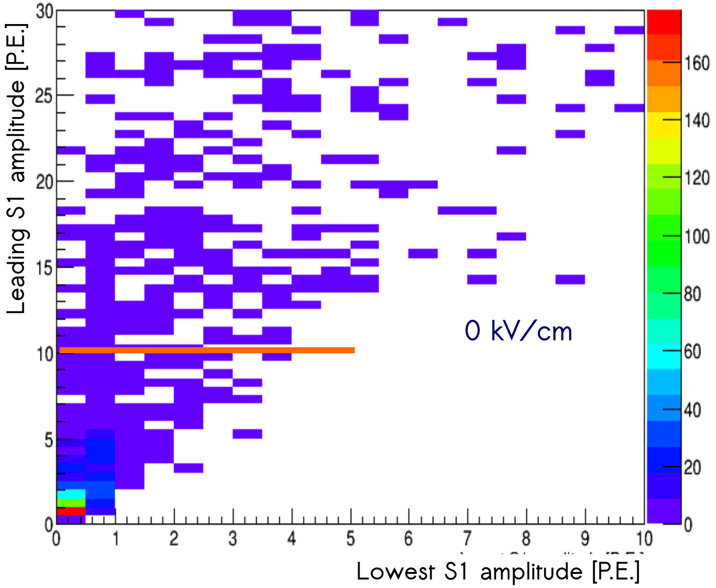


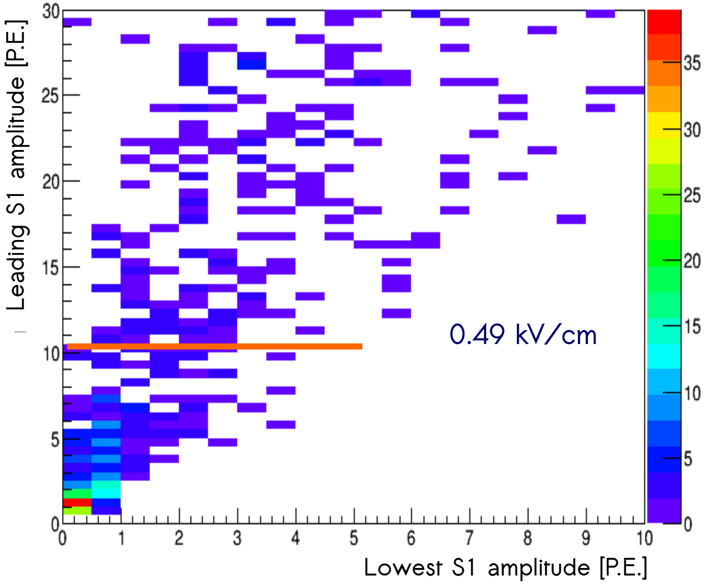
Requirement of a minimum n. of P.E. detected

:> an **additional requirement** on the **minimum S1 amplitude** is **needed**: S1Ampl>10 P. E.

→ it is expressed in n. of P.E., it is applied in the same way for all the drift values (even if there is a dependence with the drift field, the requirement is so small compared with the n. of PE generated by a crossing muon - ~10^4 P.E./MeV - that it does not affect the final result)

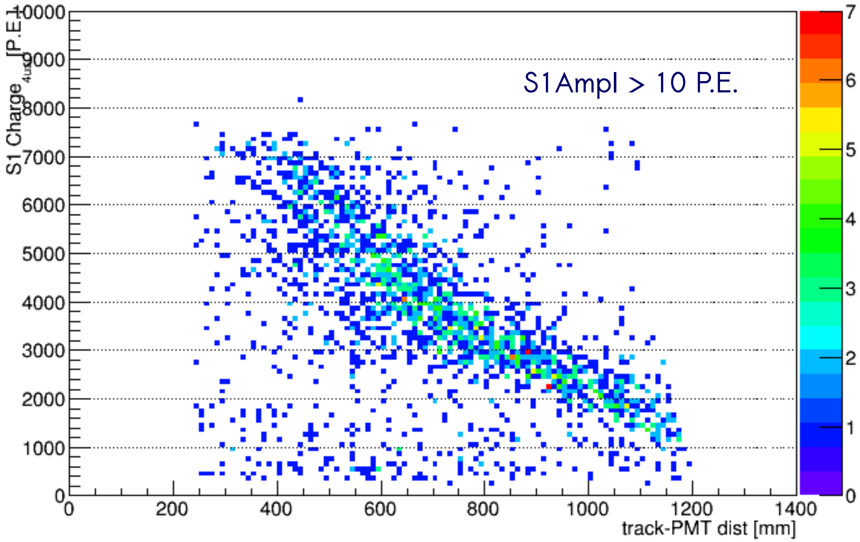
→ if needed, a possible systematic can be added to take that into account

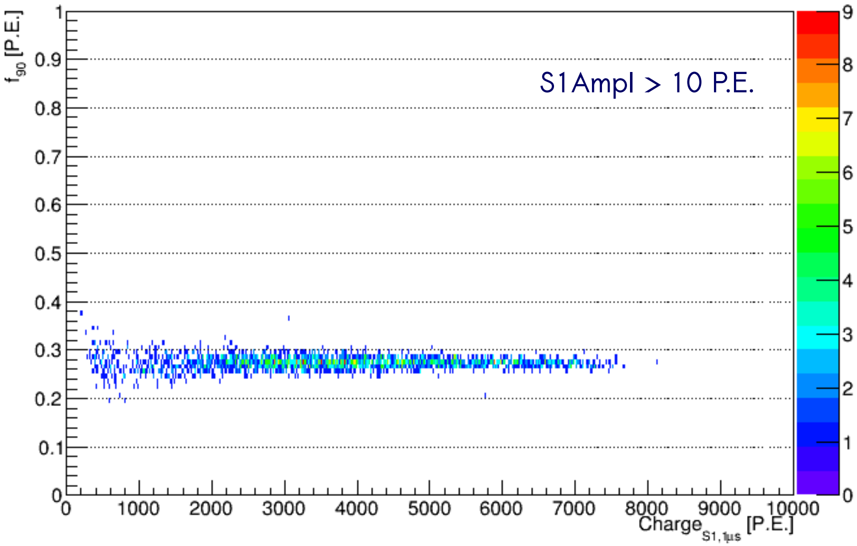




Requirement of a minimum n. of P.E. detected

:> S1 charge vs track-PMT distance and f90 vs S1 charge (here, the S1 charge is always integrated in 4us) **after additional cut on the S1 minimum amplitude**

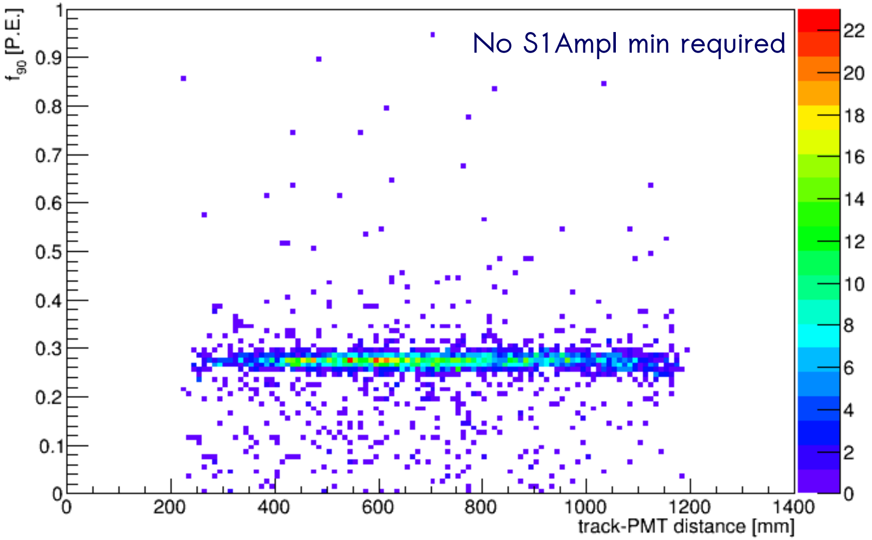


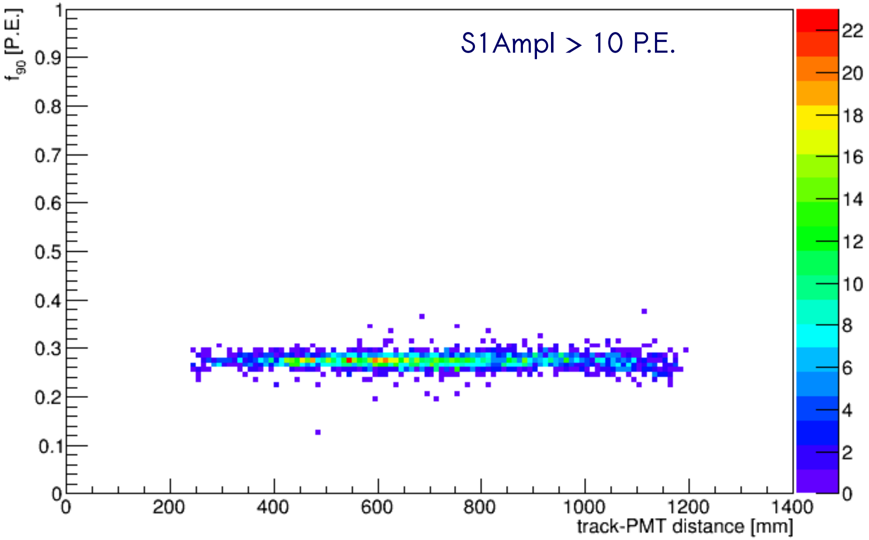


Requirement of a minimum n. of P.E. detected

:> considering the correlation of the light collected as a function of the track-PMT distance, accepting the events with all S1 amplitude remains the events uncorrelated with the track-PMT distance

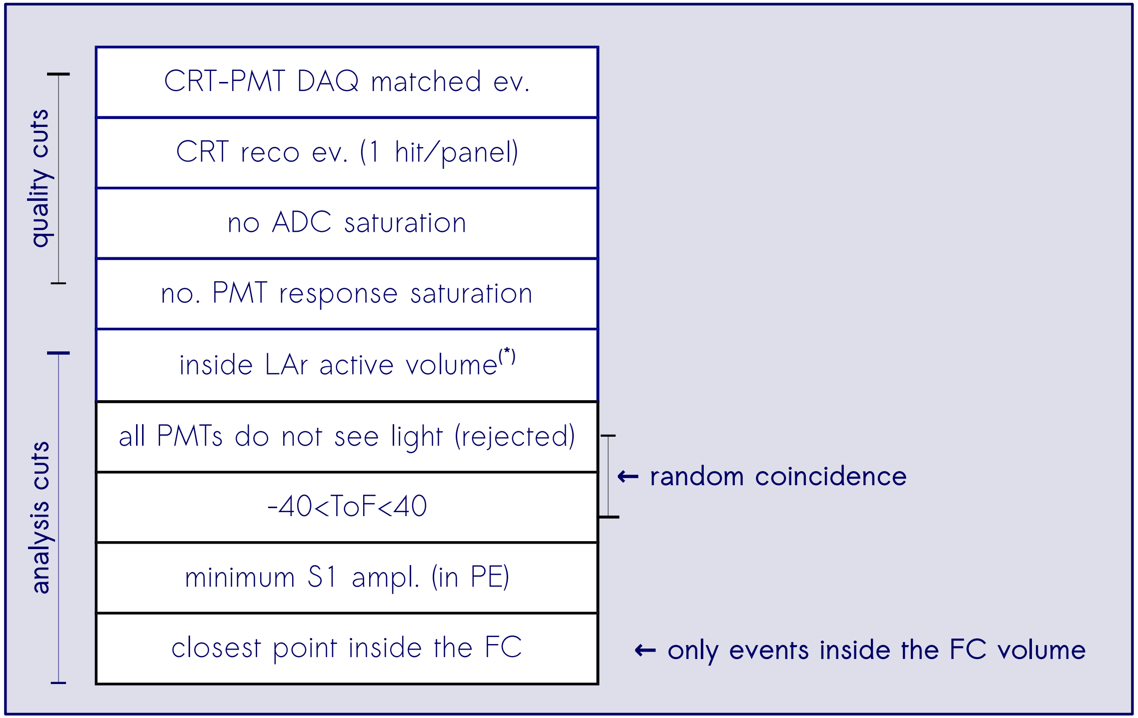
→ the **additional cut on the S1 minimum amplitude** rejects these events



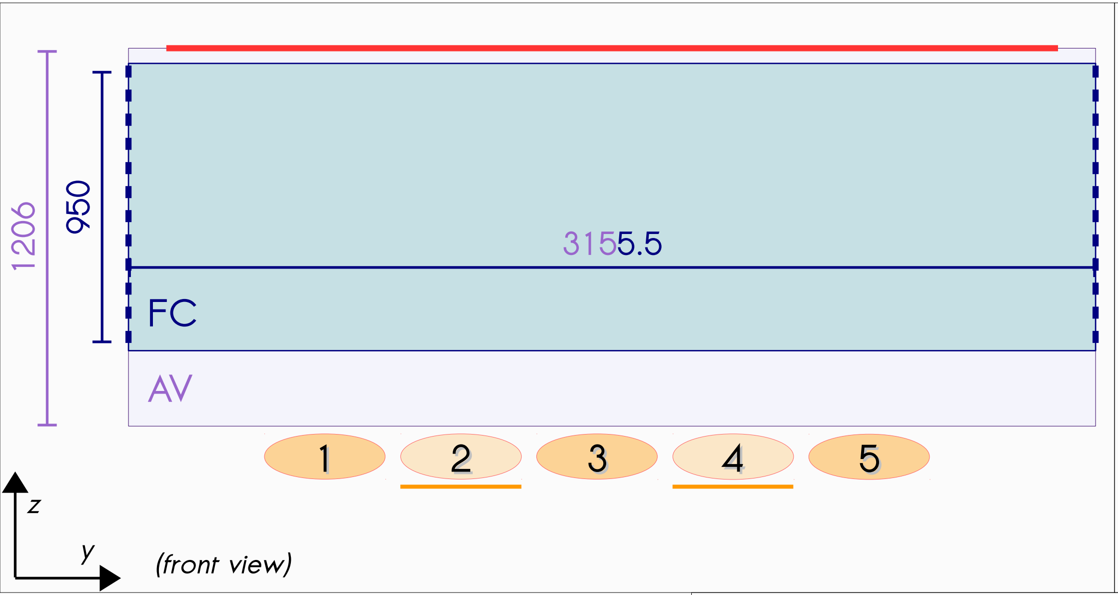


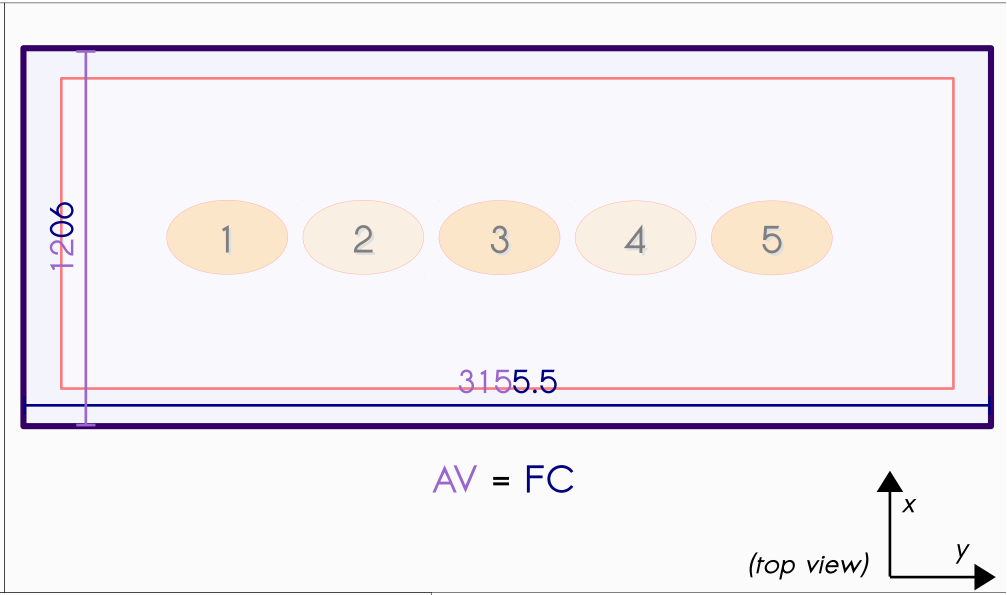
“Relaxed” muon track selection

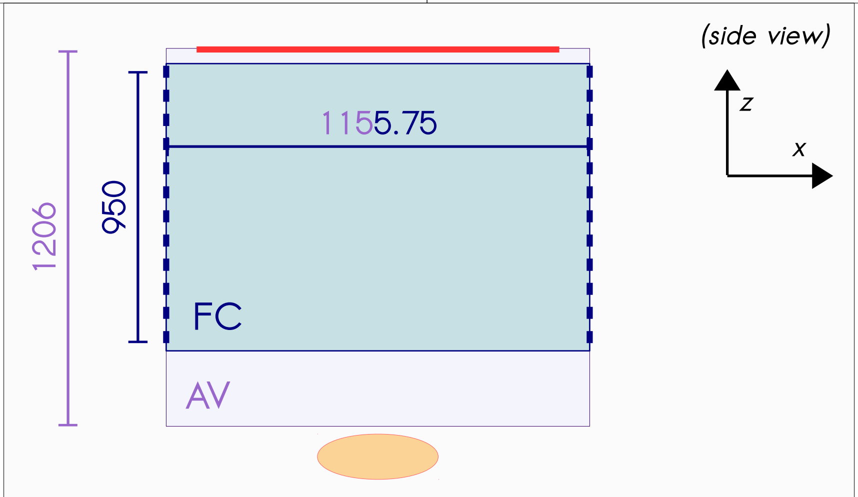
:> list of final cuts applied in from muon-like track selection



Volume definitions: active, field cage







Active volume (AV):

1155.5 x 3155.5 x 1206

Field Cage (FC) volume:

1155.5 x 3155.5 x 950

UPDATE BIRKS LAW STUDIES

CHIARA

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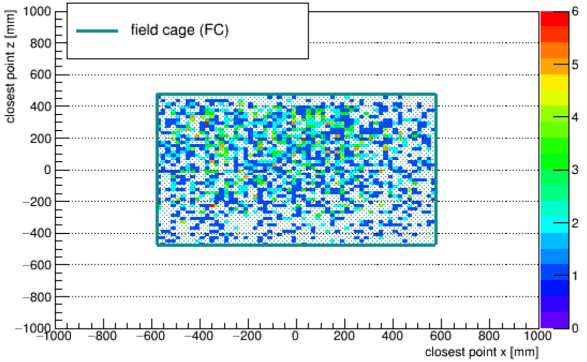
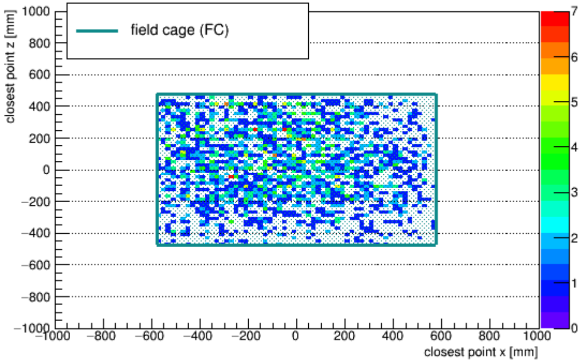
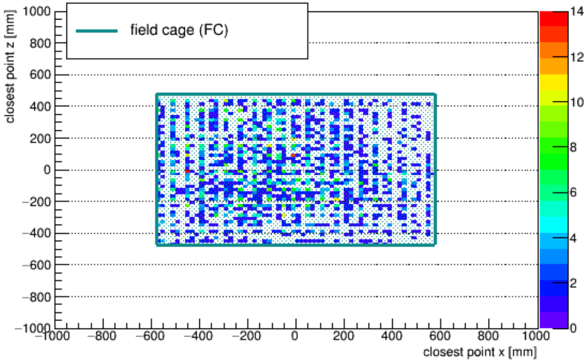
Track selection

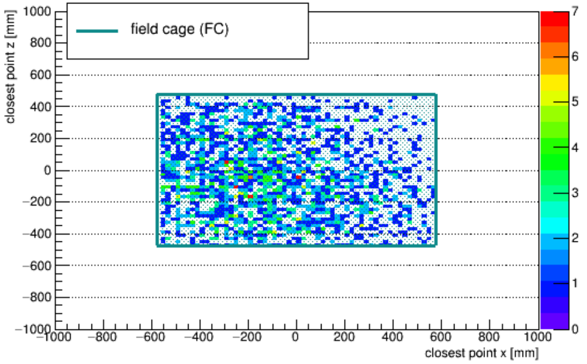
:> Due to the cathode “opacity” and given the different drift field conditions, it is important to include **only events inside the FC volume**

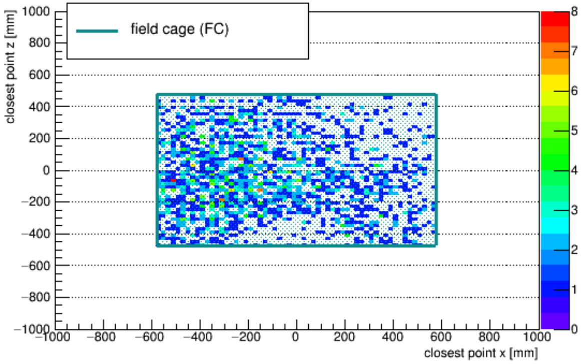
→ only tracks with the closest point inside the FC volume are accepted

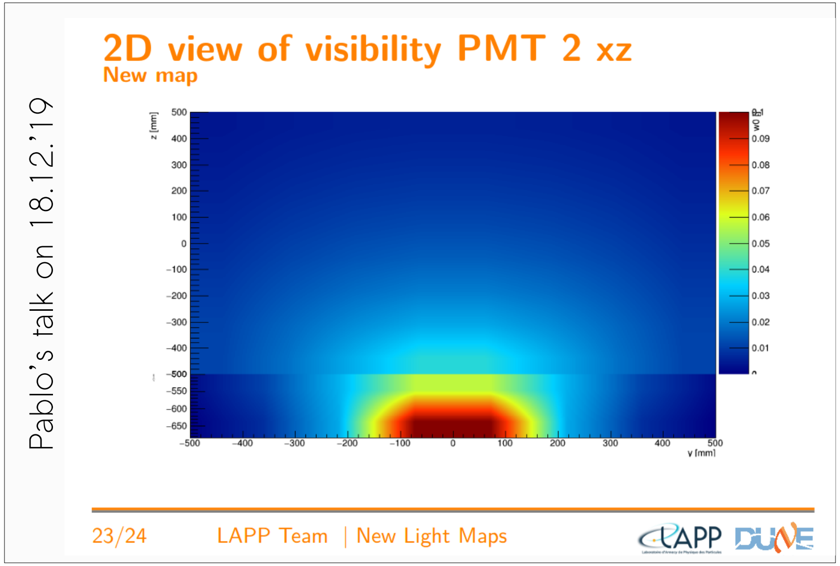








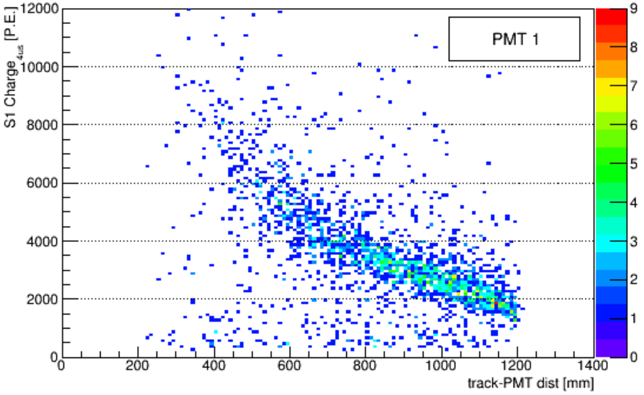


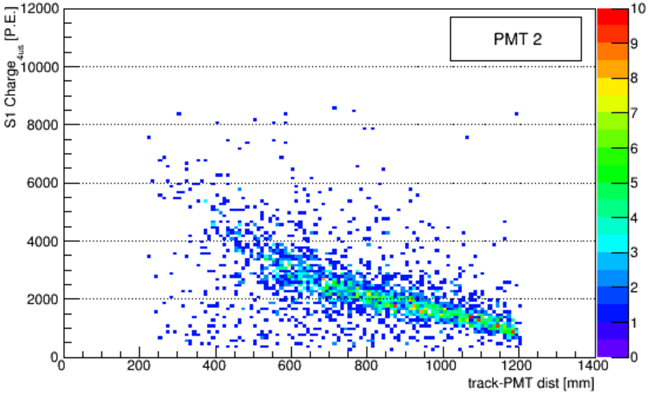


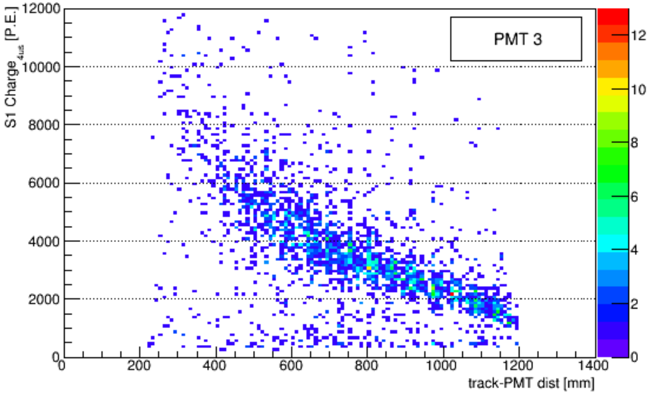
S1 charge vs track-PMT distance (0.00 kV/cm)

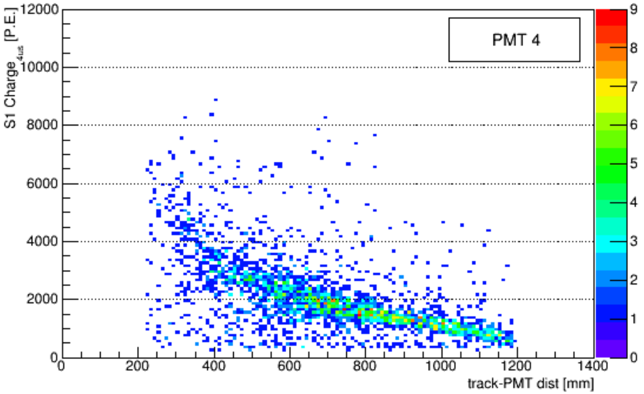
all CRT runs drift field = 0.00 kV/cm

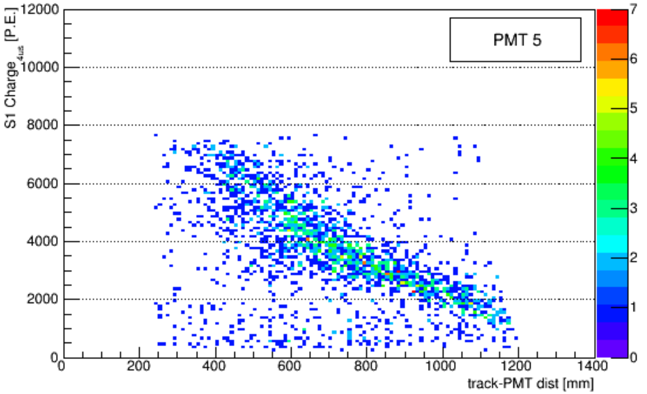
:> S1 charge vs track-PMT distance, obtained including **all** the **runs** collected **in absence of drift field**







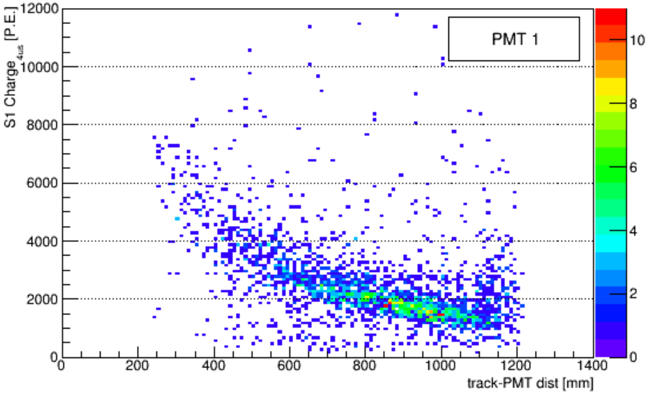


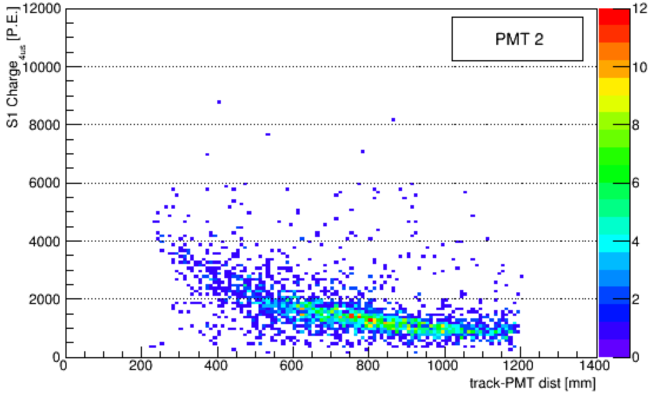


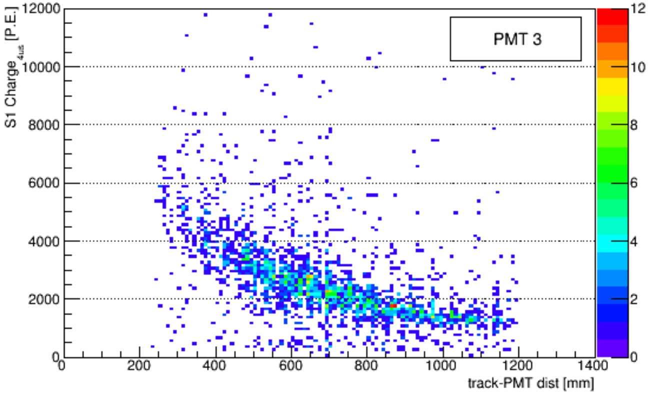
S1 charge vs track-PMT distance (0.49 kV/cm)

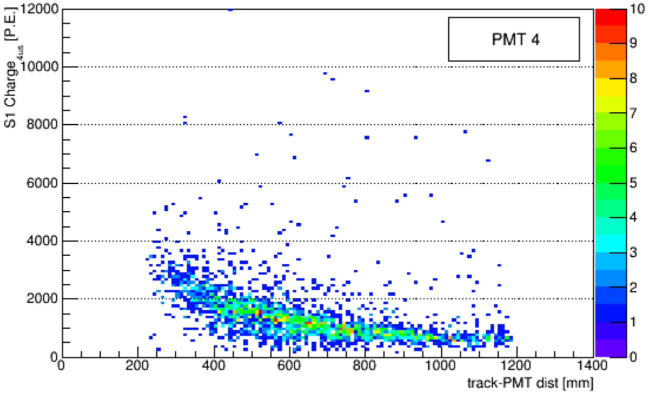
all CRT runs drift field = 0.485 kV/cm

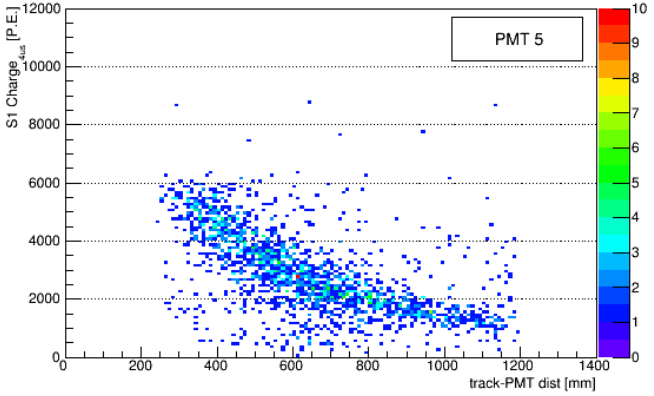
:> S1 charge vs track-PMT distance, obtained including **all** the **runs** collected **at (0.48, 0.49) kV/cm**





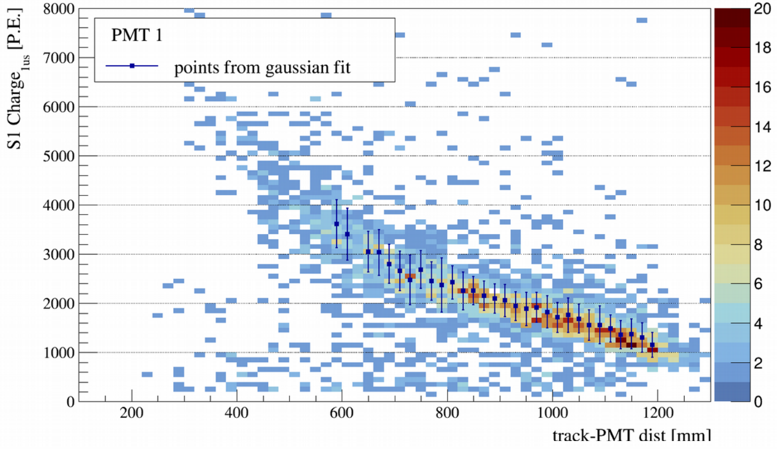


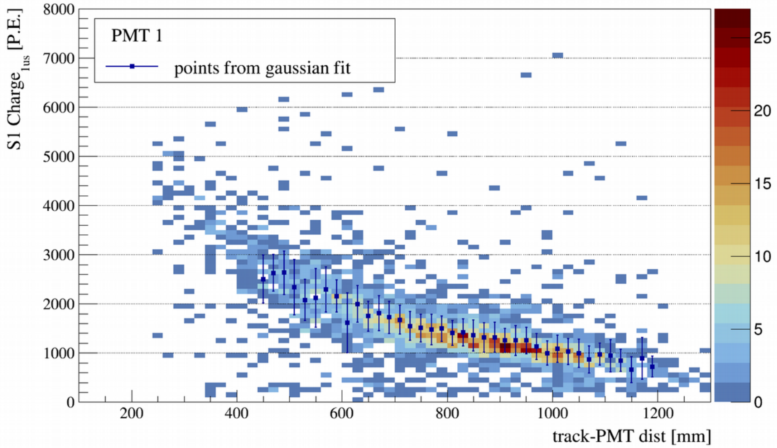


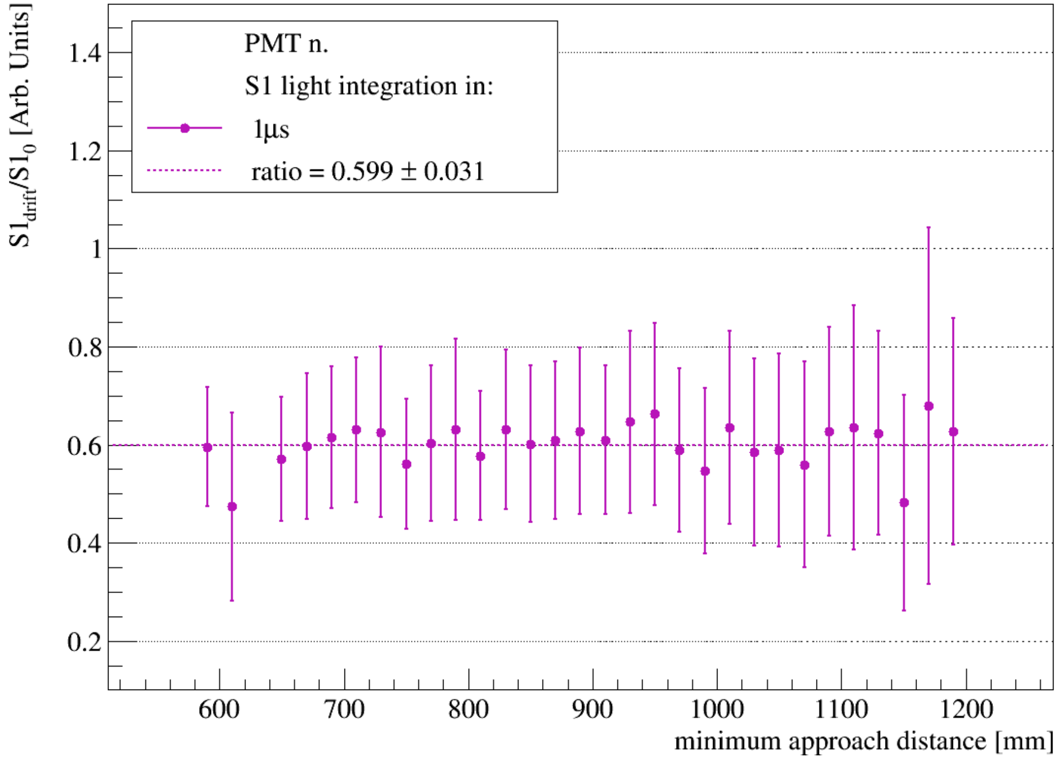


Ratio $S1_{E=0.485}/S1_0$

:> Performed a gaussian fit each 200 mm (for each integrated amount of light - 4us, 1us, 90ns - and for each channel), the error of each point is the gaussian RMS



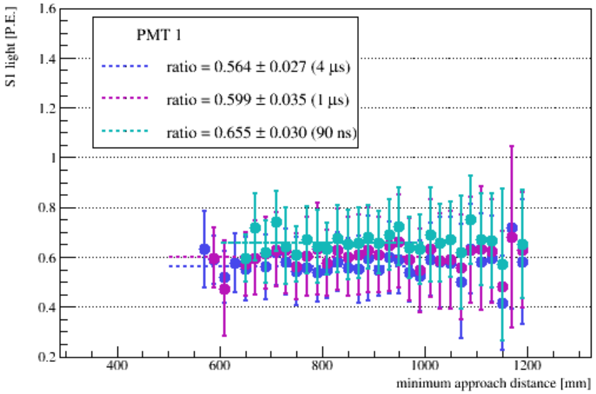


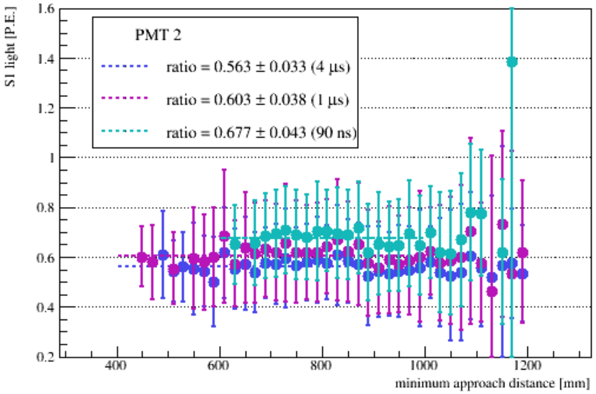


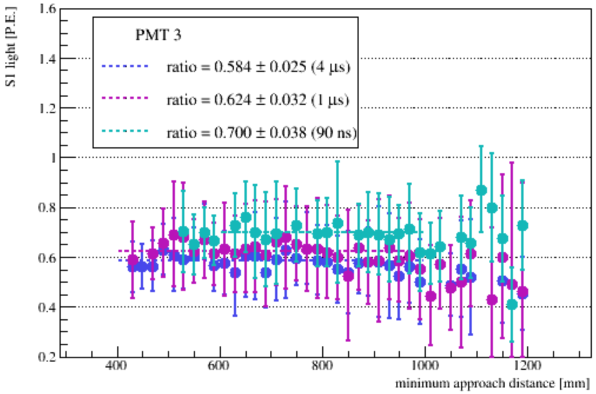
with the proper track selection, the behavior is completely flat

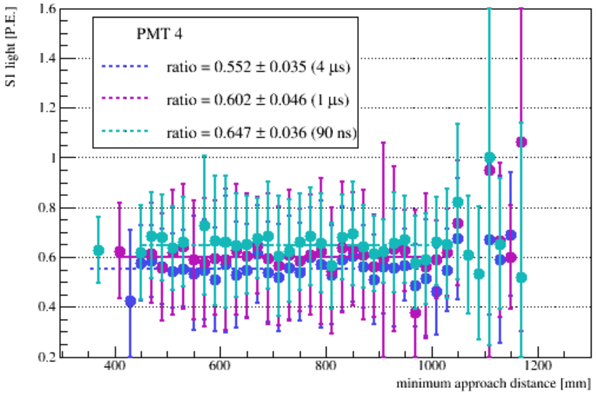
Ratio $S1_{E=0.485}/S1_0$

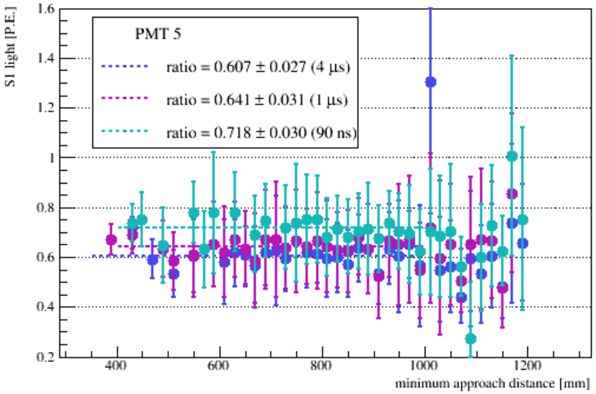
:> ratio S1drift/S10 obtained for each channel and for each amount of light integrated
(the bigger errors, are due to the less statistics)







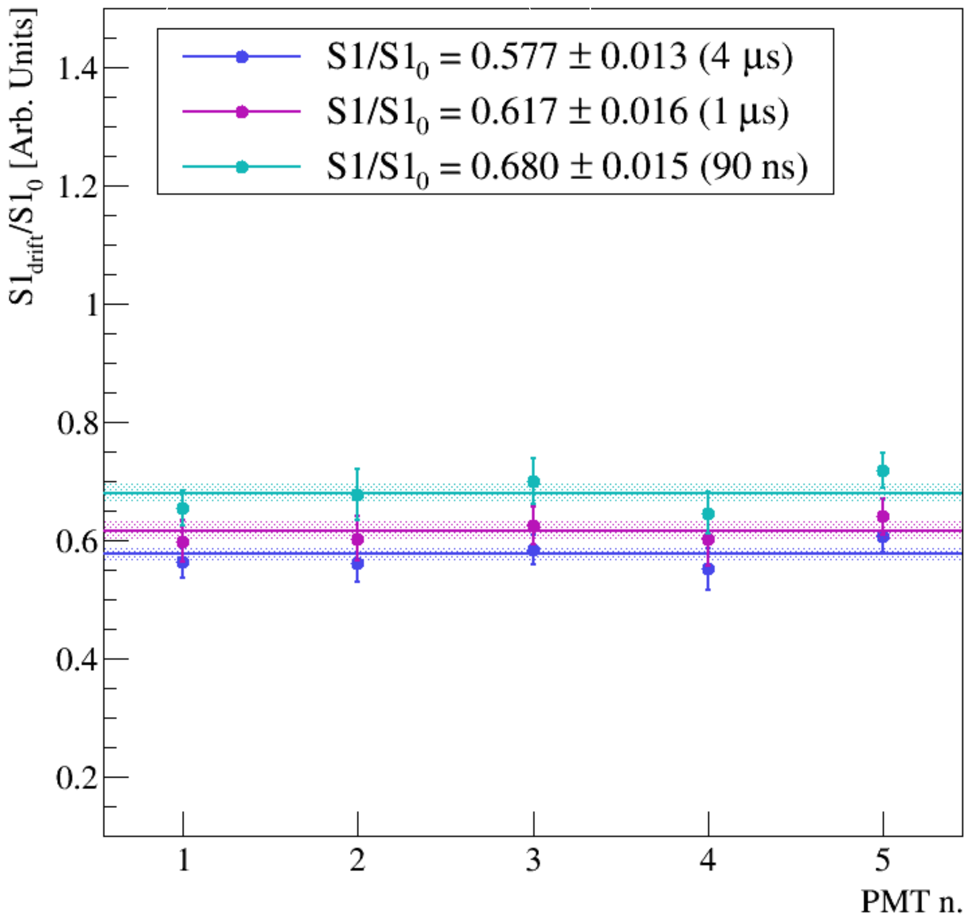




at each track-PMT distance, **all the points (4us, 1us, and 90ns) are in a mutual agreement within the error bars**
→ ∀ ch and ∀ amount of light, a poi0 fit is performed to evaluate the ratio $S1_{E=0.485}/S1_0$

Ratio $S1_{E=0.485}/S1_0$

:> ratio S1drift/S10 obtained combining the five channels (for each amount of light integrated), the error in each point comes from the pol0 fit shown in previous slide

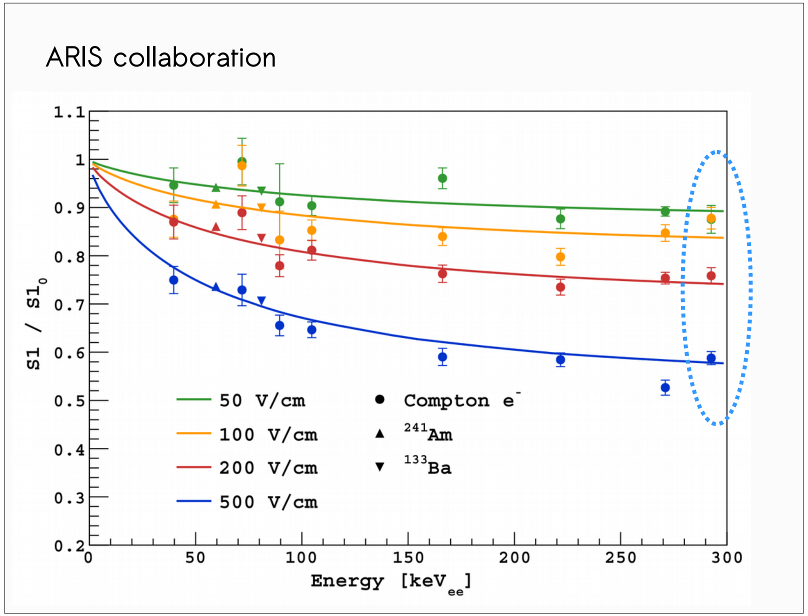


on average,

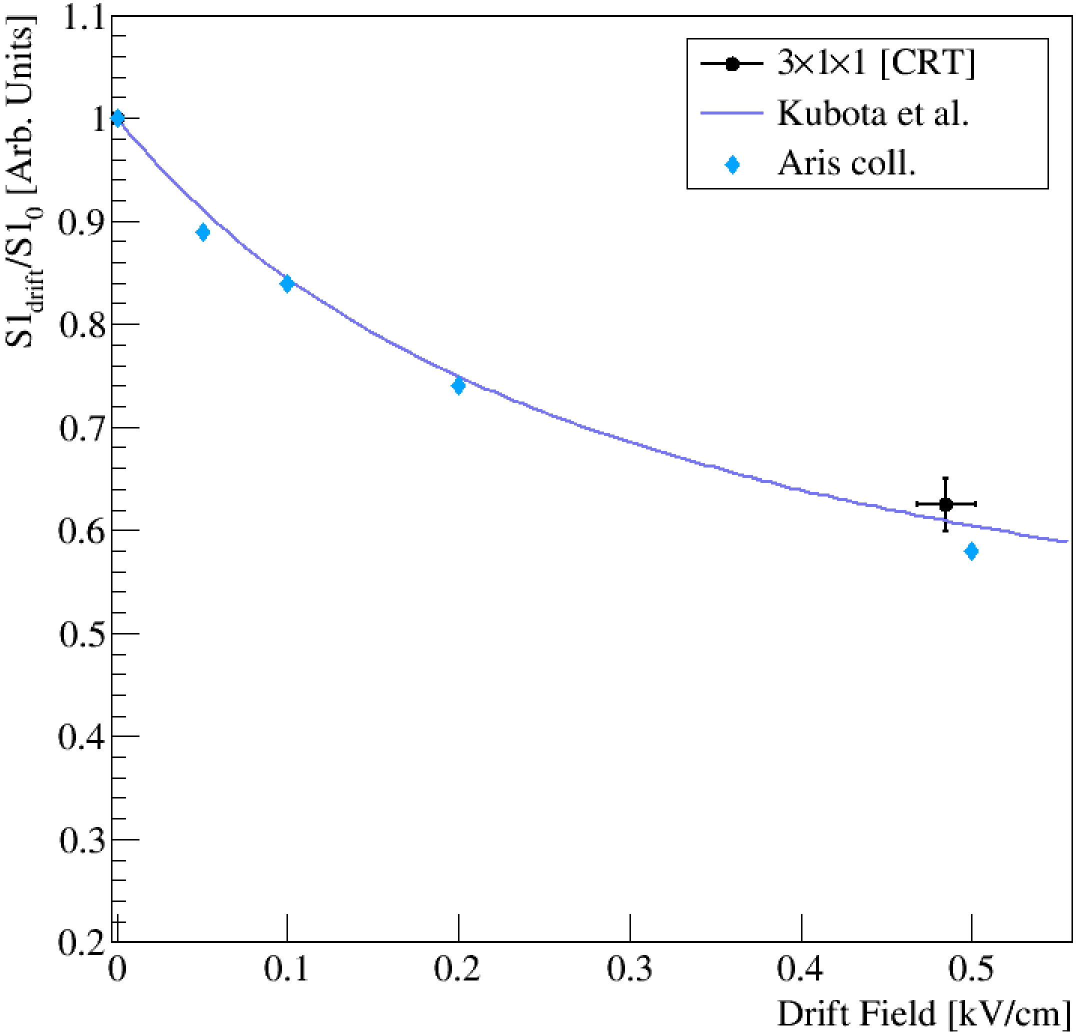
$S1_{E=0.485}/S1_0$	0.6247 ± 0.0255

Comparison with other results

:> As a first approximation, for the ARIS results, I'm considering the asymptotic value at each field applied



:> Changing the matching of the CRT runs in parallel position, an additional point at ~0.435 kV/cm can be added (ongoing)



Conclusions

:> The CRT cuts have been modified to increase the final statistics, respecting a good muon-line track selection

:> The result on the Birks' law has been updated:

→ all the runs in same drift field condition have been analyzed together

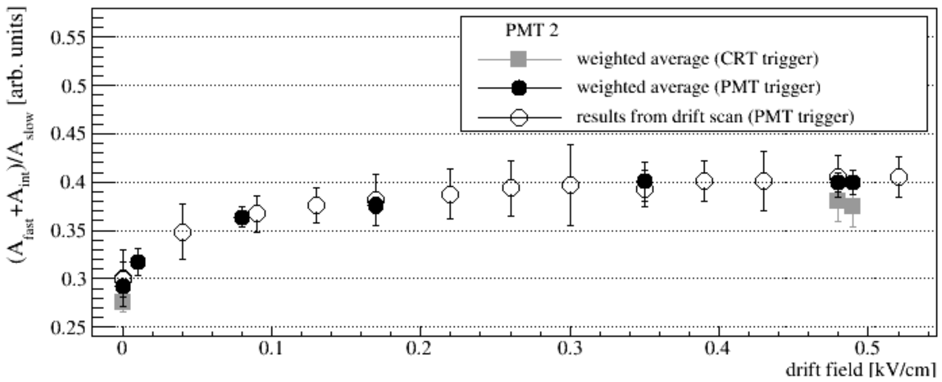
→ only the tracks inside the FC are accepted

→ to compute the ratio $S1/S1_0$, the track-PMT distance is taken into account

- with a proper track selection, this ratio does not show any dependence with the track-PMT distance

:> For a **drift field of 0.485kV/cm**, an average value of $S1_{E=0.485}/S1_0$ **= 0.6247 ± 0.0255** has been found (combining the results from the five PMTs and the three amounts of integrated light)

→ this value corresponds to a decreasing of ~37% of the light produced by recombination



→ this value is quite in agreement (error not included in this quick comparison) with the increasing of the ratio (Af+Ai)/As measured from the fit of the scintillation light profile, averaging on the NB channels, Δ(Af+Ai)/As ~ +33%

Backup slides

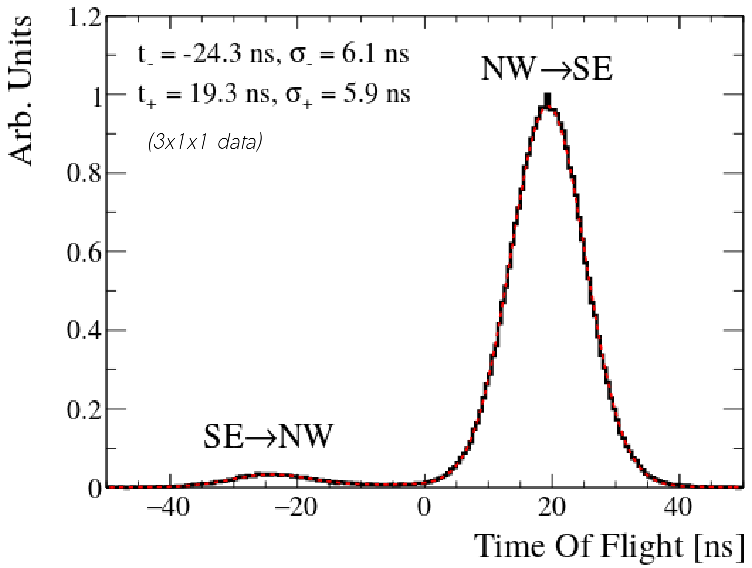
Muon selection in CRT analysis

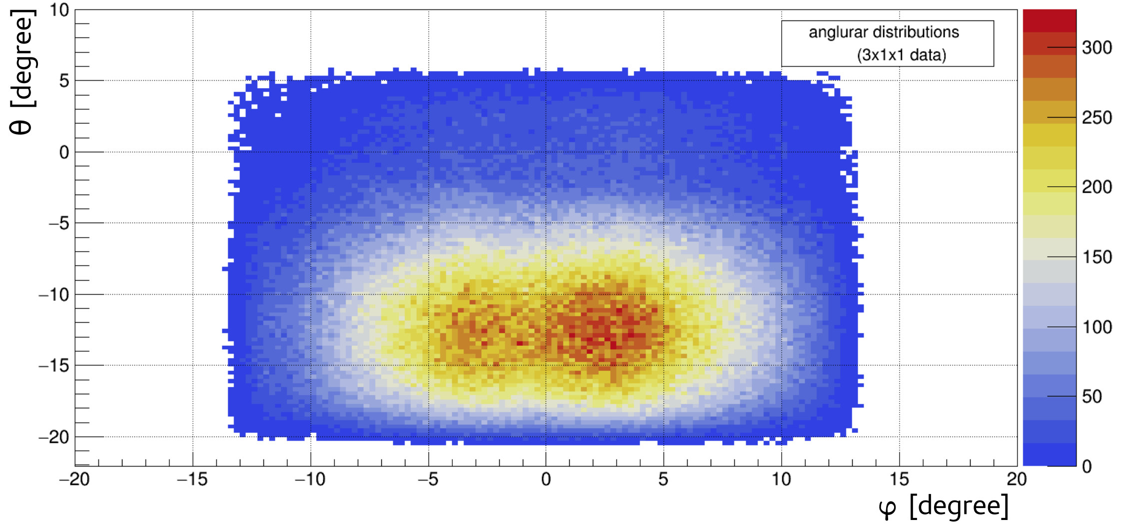
:> "quality cuts" developed to optimize the CRT and PMT performance

:> "analysis cuts" optimizes the muon-like track selection (excluding as much as possible showers triggered the CRT panels)

Muon track selection cuts

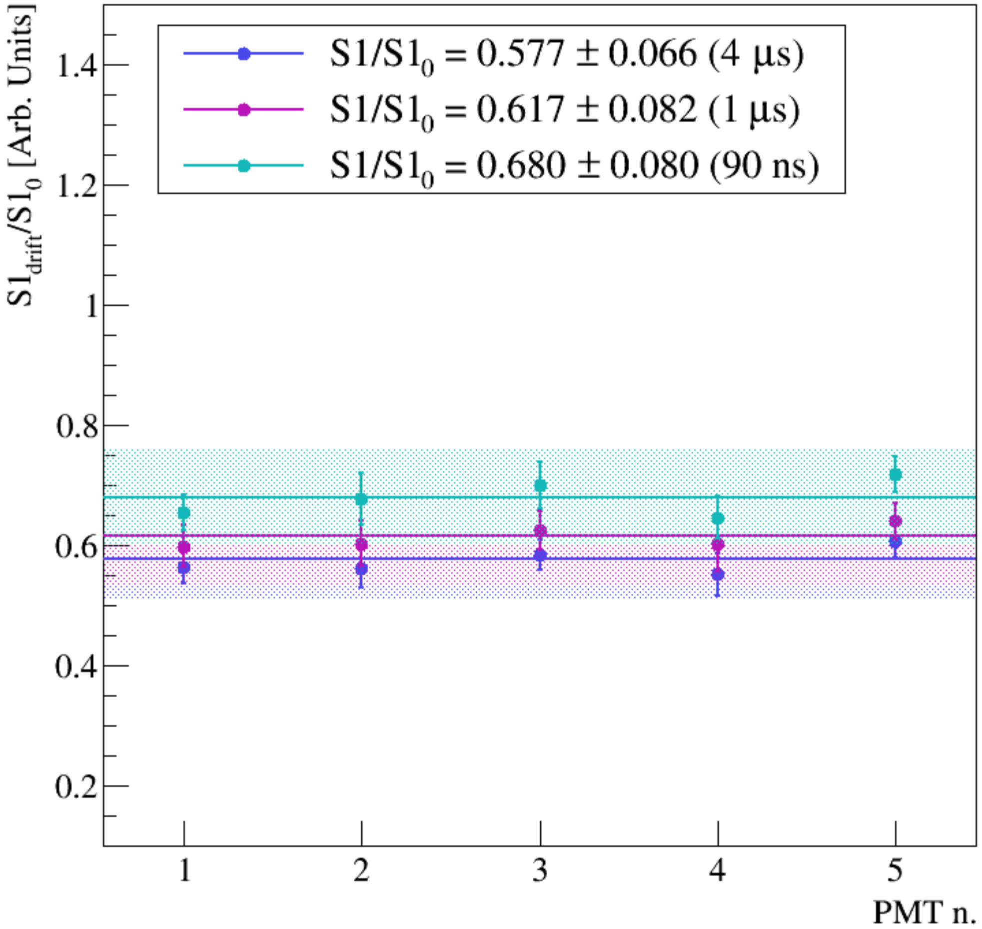
	Cut	Type
	CRT-PMT DAQ matched ev.	quality cuts
	CRT reco ev. (1 hit/panel)	quality cuts
	no ADC saturation	quality cuts
	no. PMT response saturation	quality cuts
	inside LAr active volume	analysis cuts
no fake CRT tr.	minimum S1 ampl. (ch by ch)	analysis cuts
good ToF	-40<ToF<40	analysis cuts
min track length	L>3100 mm	analysis cuts





Ratio $S1_{E=0.485}/S1_0$

:> ratio S1drift/S10 obtained combining the five channels (for each amount of light integrated)



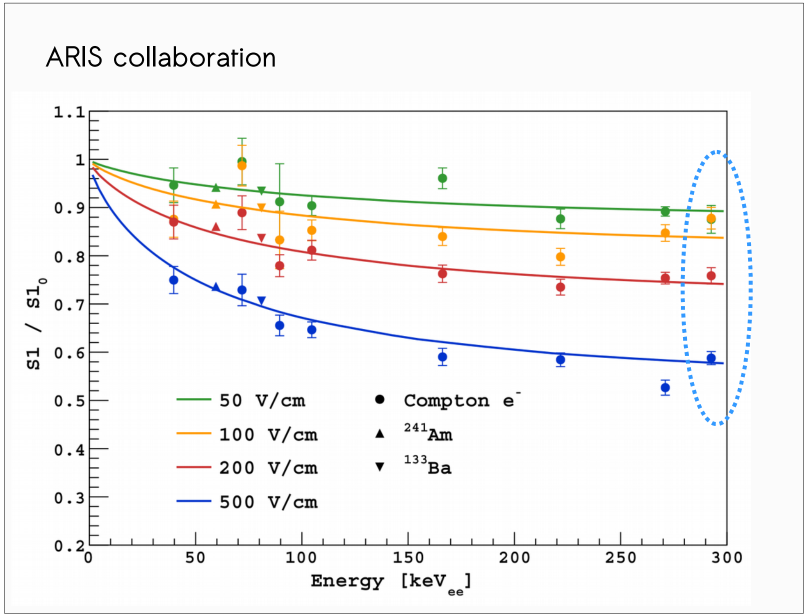
on average:

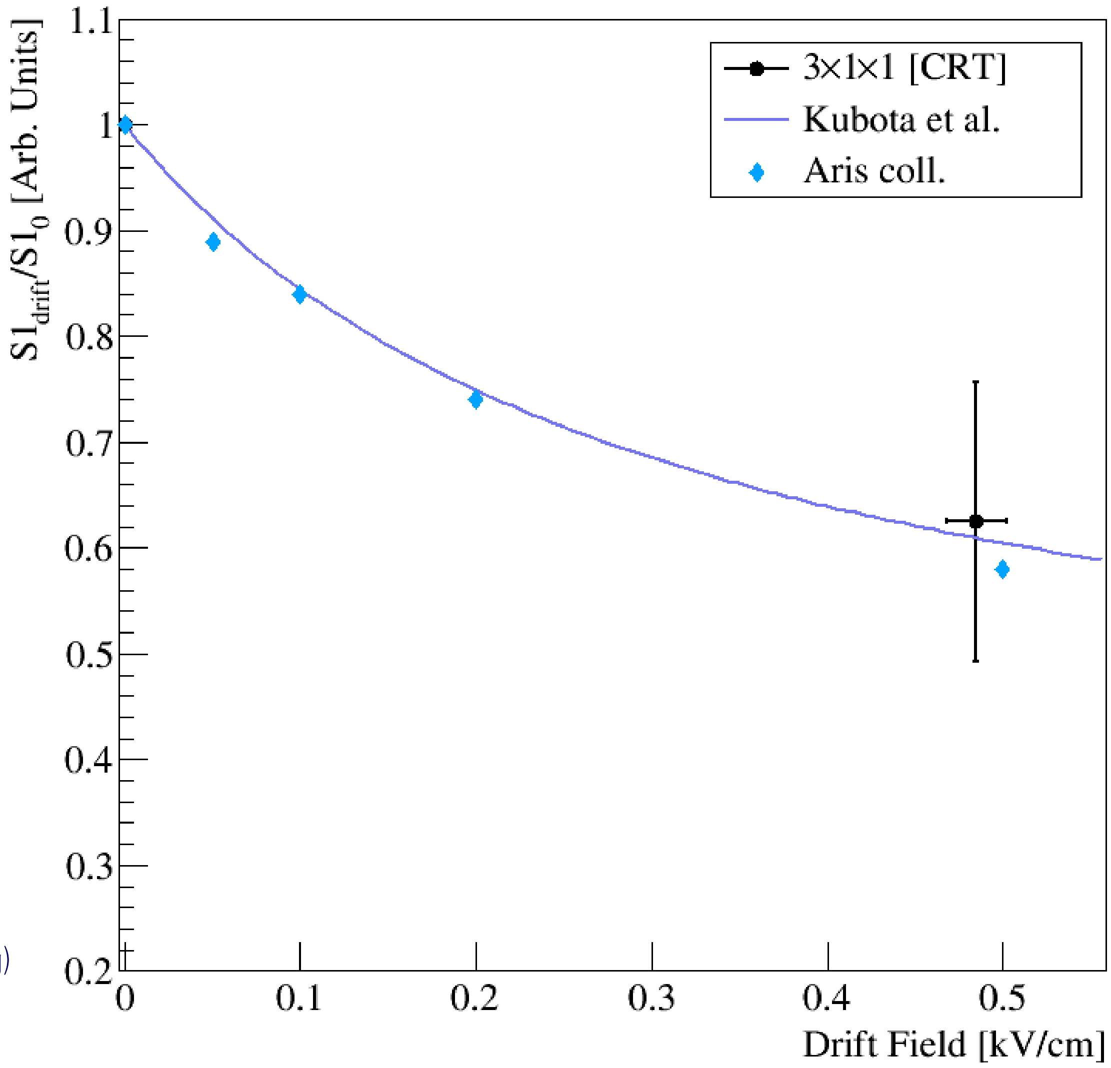
$S1_{E=0.485}/S1_0$	0.6247 ± 0.1322

here, the band error represents the standard deviation of the five points

Comparison with other results

:> As a first approximation, for the ARIS results, I'm considering the asymptotic value at each field applied





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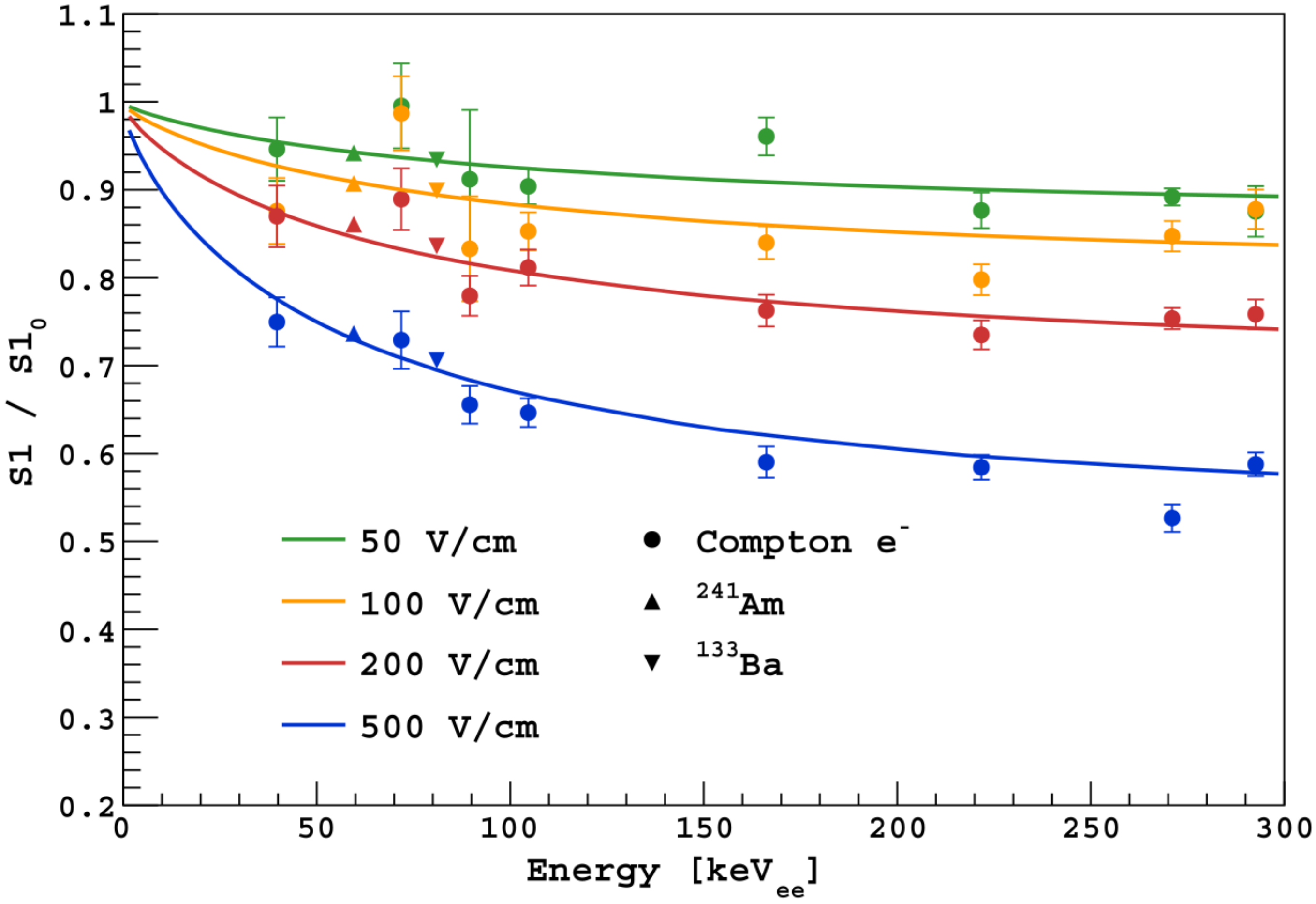
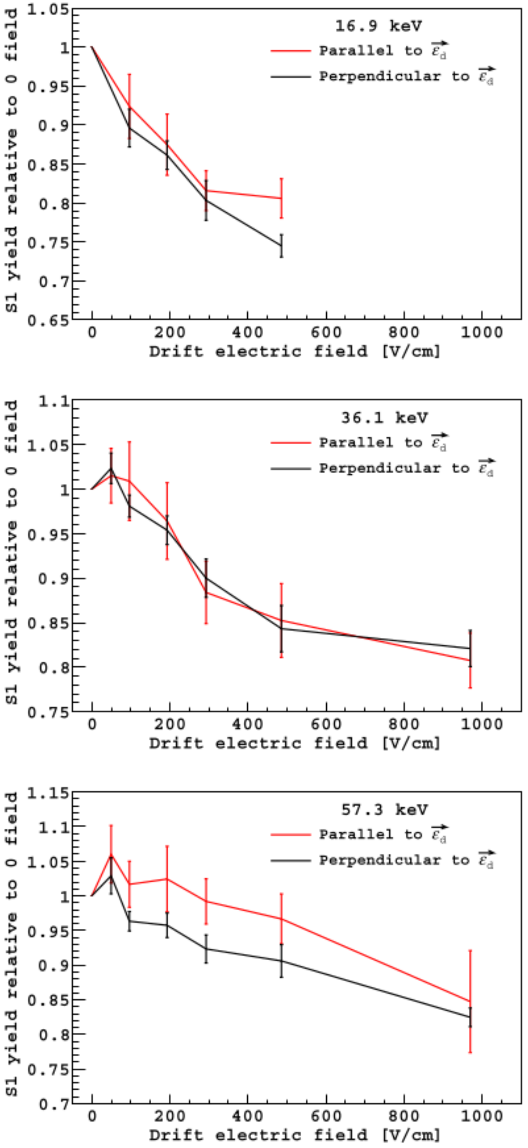
Light Yield - ARIS collaboration

:> P. Agnes et al. "Measurement of the liquid argon energy response to nuclear and electronic recoils", PHYSICAL REVIEW D 97, 112005 (2018)



Light Yield - SCENE collaboration

:> H. Cao et al. “Measurement of scintillation and ionization yield and scintillation pulse shape from nuclear recoils in liquid argon”, PHYSICAL REVIEW D 91, 092007 (2015)



Results from scintillation time profile fit

	Δ(Af+Ai)/As
Ch.0	+ 27.82 %
Ch.1	+ 36.66 %
Ch.4	+ 33.70 %