ALL HANDS ON DEAP

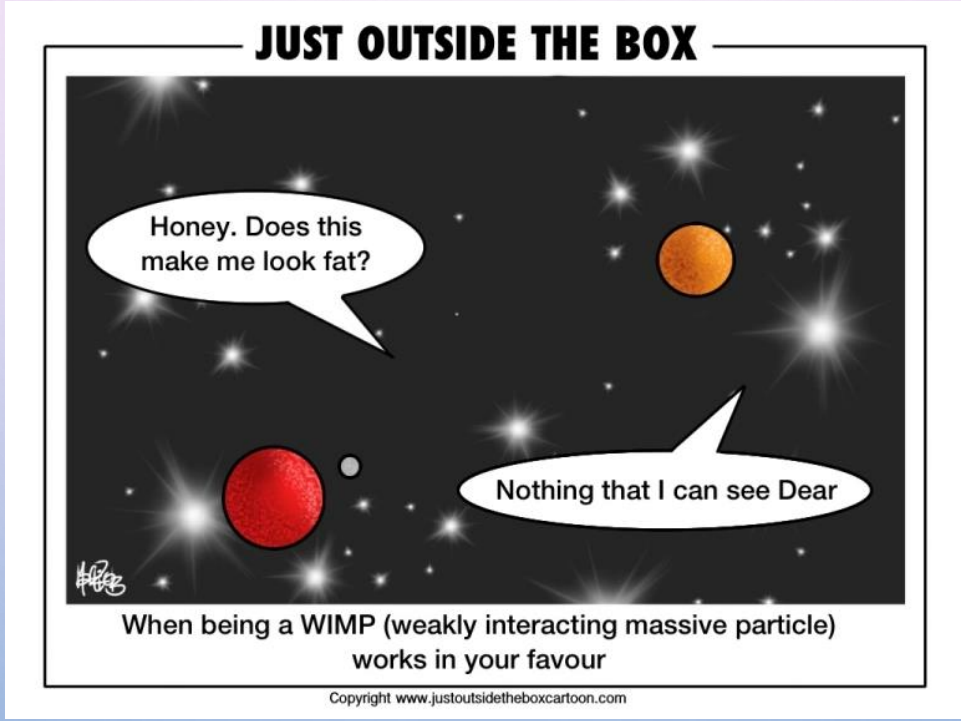
TRANG BUI

SUPERVISOR: PIERRE GOREL, CHRIS JILLINGS

OUTLINE

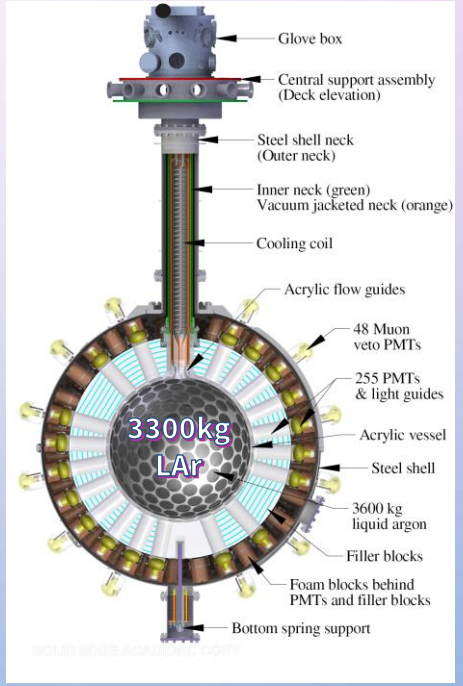
- Dark matter and DEAP-3600
- Trang underground
- Trang on surface

DARK MATTER


JUST OUTSIDE THE BOX
Honey. Does this make me look fat?
Nothing that I can see Dear
When being a WIMP (weakly interacting massive particle) works in your favour
Copyright www.justoutsidetheboxcartoon.com

DEAP-3600

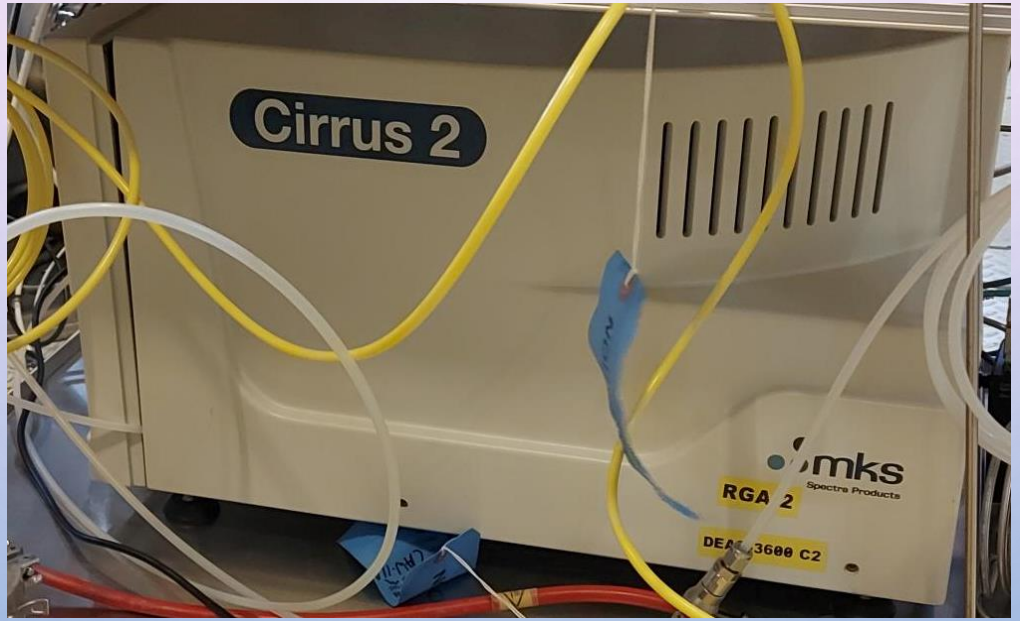
DARK MATTER EXPERIMENT USING ARGON PULSHAPE DISCRIMINATION



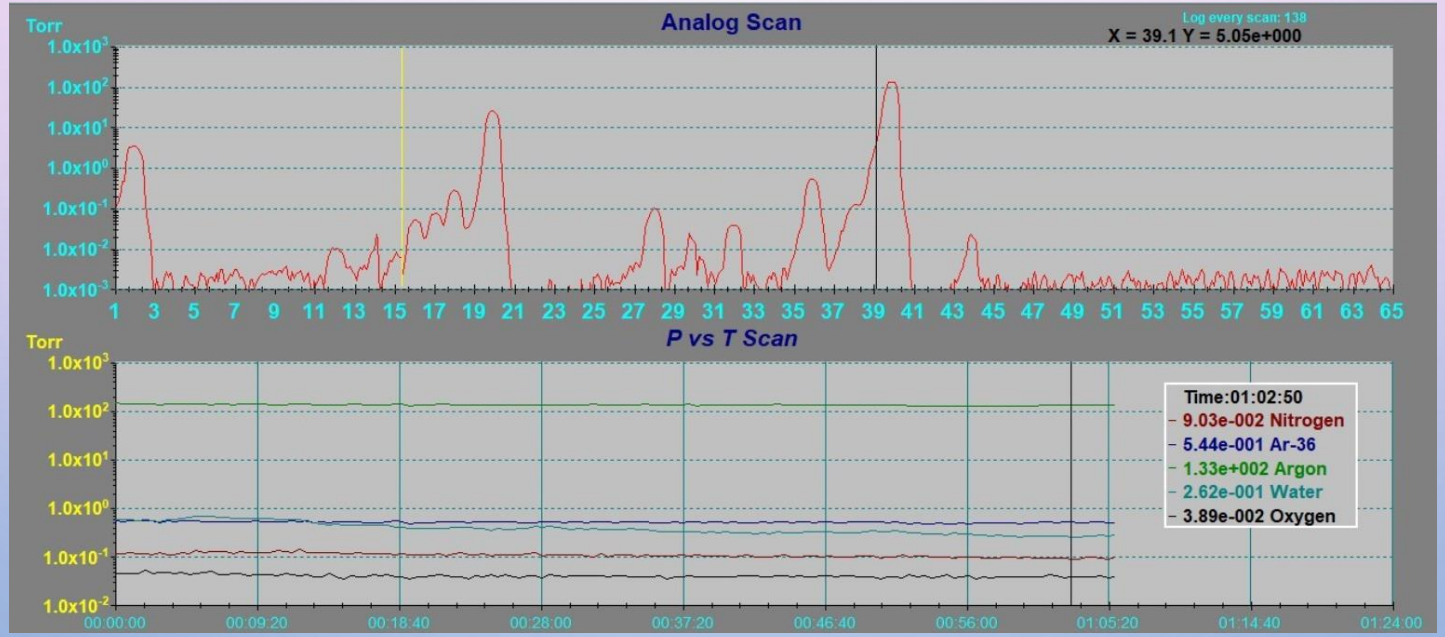
OUTLINE

Trang underground

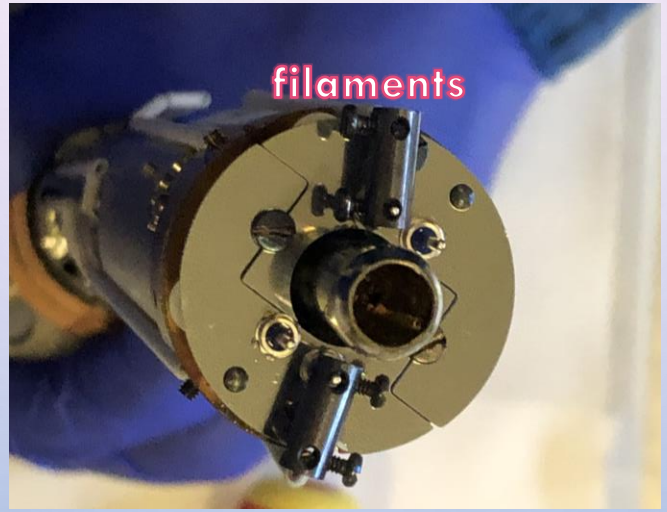
RESIDUAL GAS ANALYZER (RGA)



RESIDUAL GAS ANALYZER (RGA)

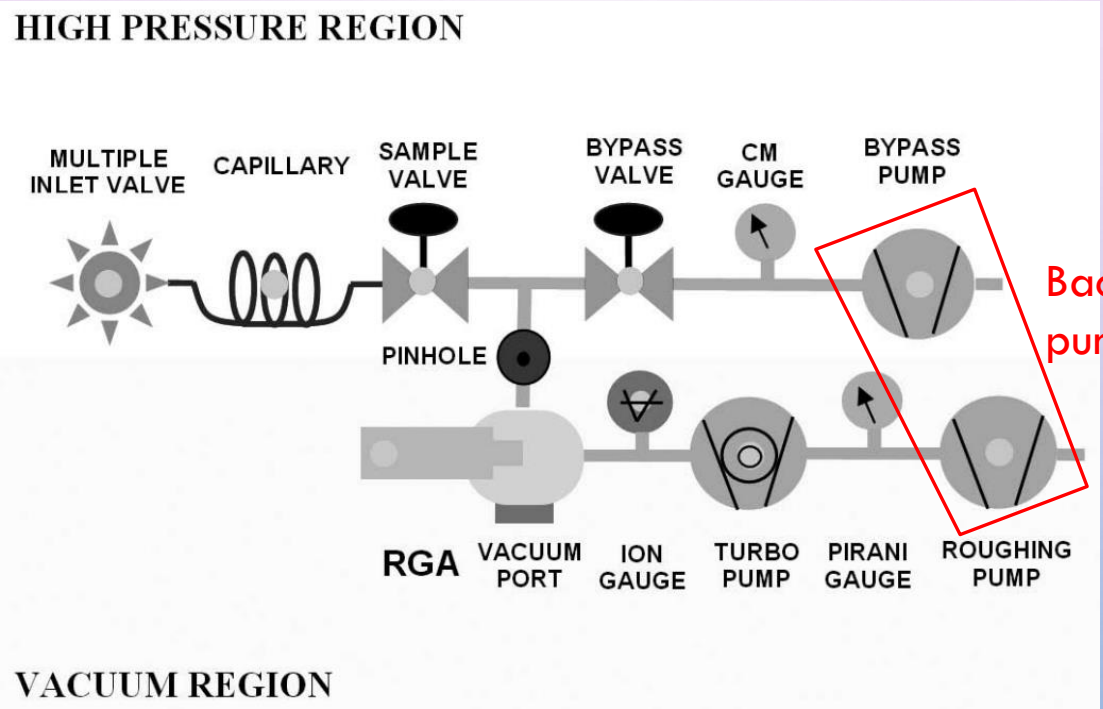


RESIDUAL GAS ANALYZER (RGA)

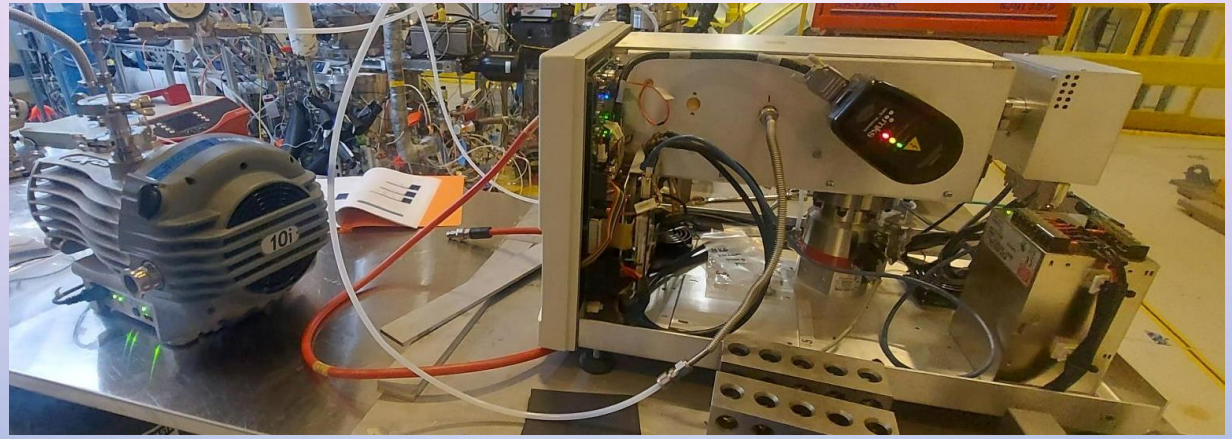


RESIDUAL GAS ANALYZER (RGA)

RESIDUAL GAS ANALYZER (RGA)



RESIDUAL GAS ANALYZER (RGA)

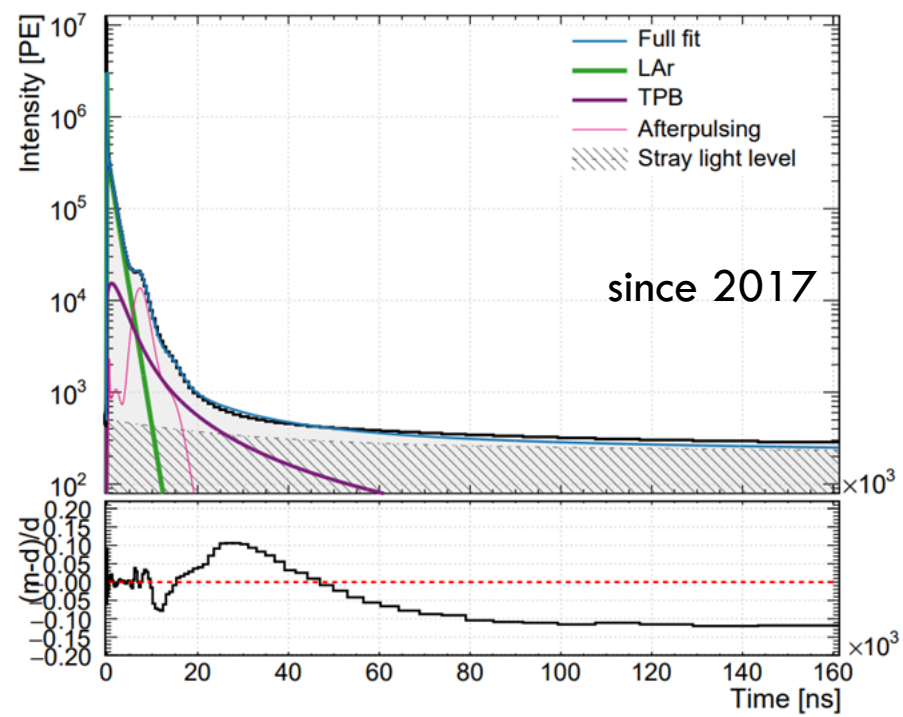


Working! YAY!

OUTLINE

Trang on surface

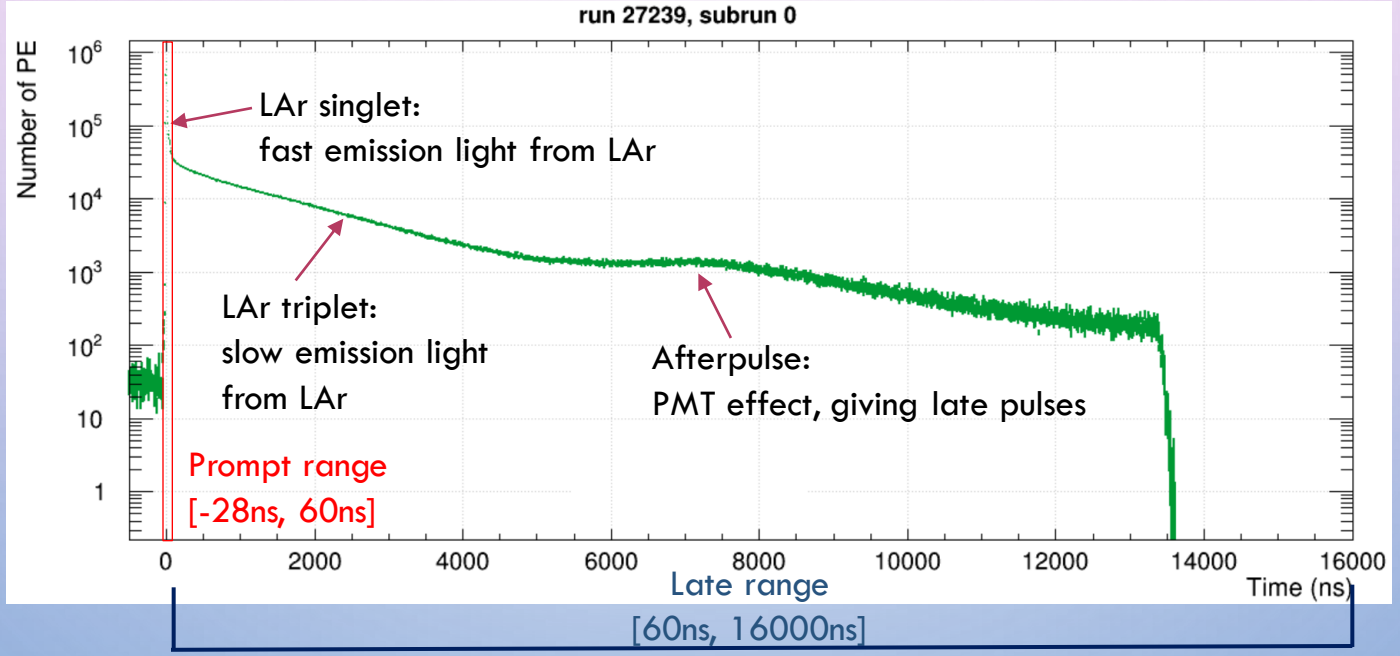
TARGET



STUDY PREVIOUS PULSESHAPE MODEL IF IT IS STILL APPLICABLE TO RECENT RUNS.

⟶ 3RD FILL ANALYSIS.

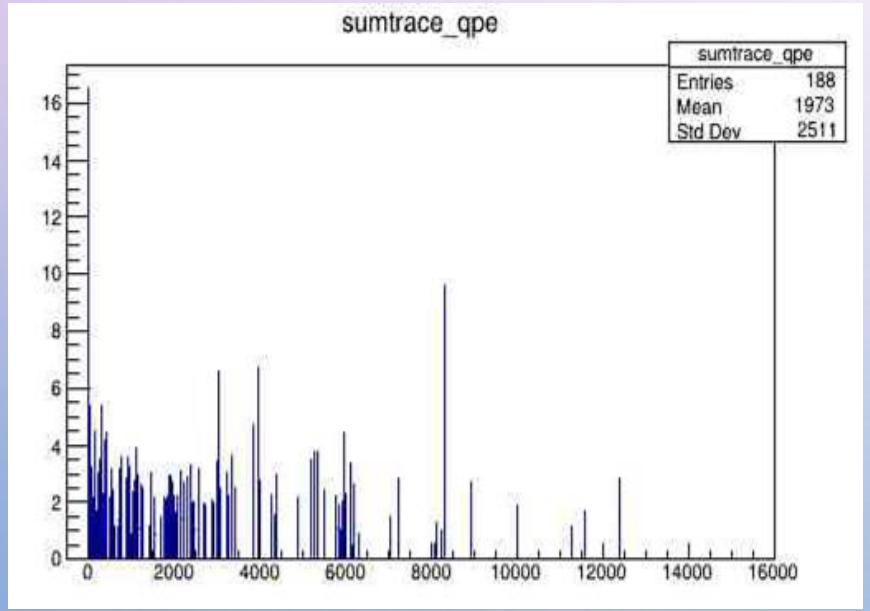
PULSESHAPE

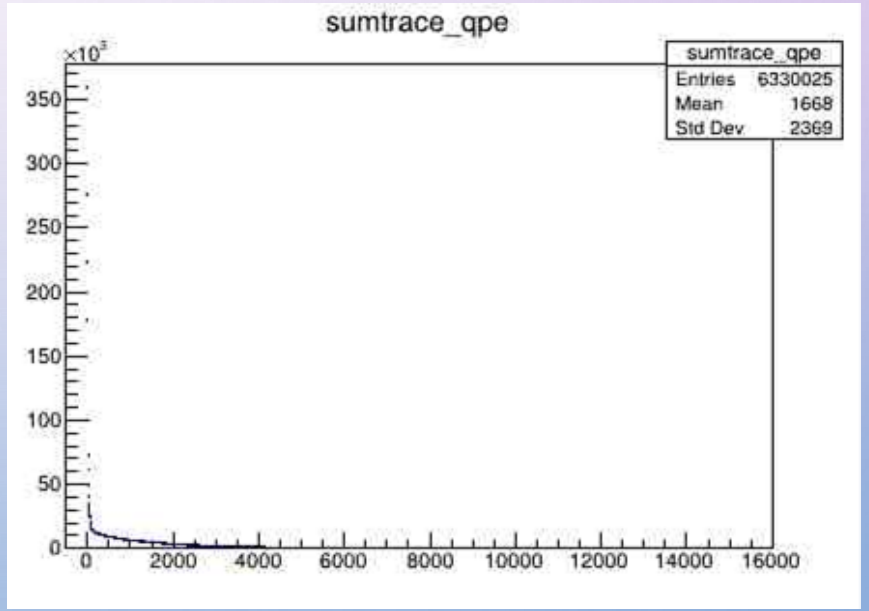

run 27239, subrun 0
Number of PE
10^6
10^5
10^4
10^3
10^2
10
1
0
2000
4000
6000
8000
10000
12000
14000
16000
Time (ns)
LAr singlet:
fast emission light from LAr
LAr triplet:
slow emission light
from LAr
Afterpulse:
PMT effect, giving late pulses
Prompt range
[-28ns, 60ns]
Late range
[60ns, 16000ns]

BIT MASK LOGIC

```
IF (!CAL->GETCUTS()->GETCUTWORD() & 0X31F8 && !DS->ISMC()) {RETURN PROCESSOR::OK; }
```

```
IF ((CAL->GETCUTS()->GETCUTWORD() & 0X31F8) && !(DS->ISMC())) {RETURN PROCESSOR::OK; }
```





Run 019503, subrun 0000, before and after

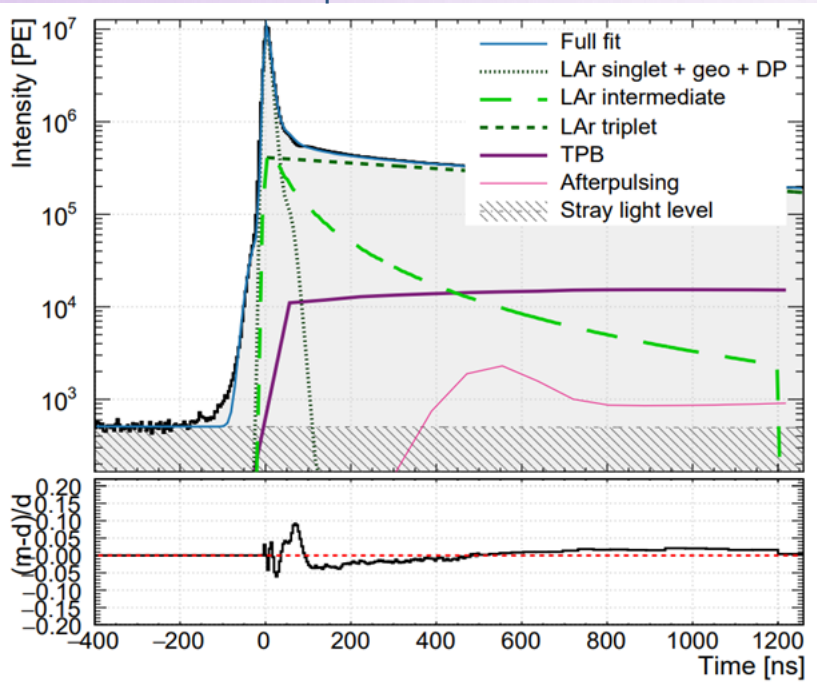
FITTING PARAMETERS

31 parameters !

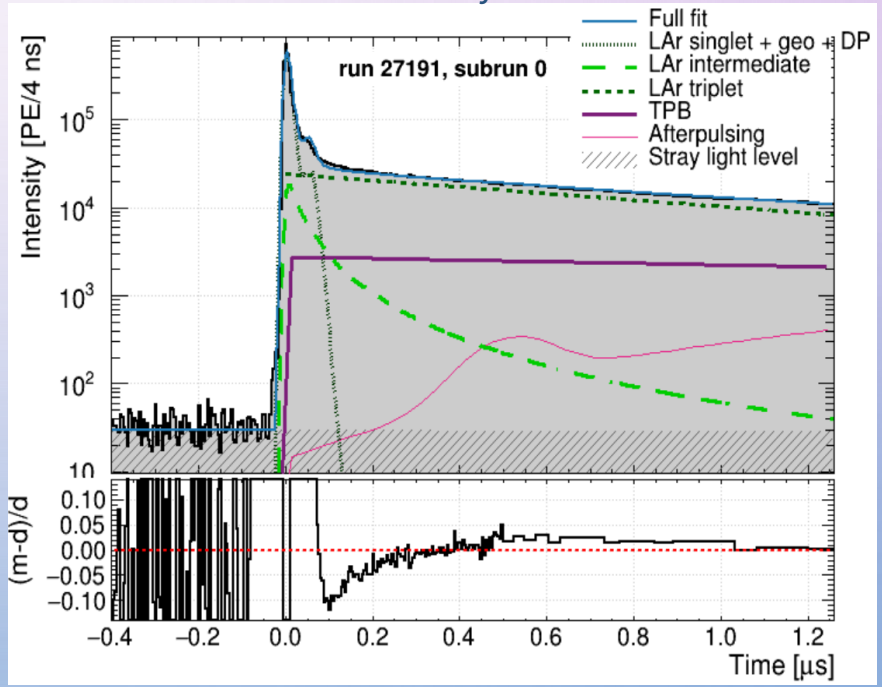
```
Minimizer is Minuit / MigradImproved
Chi2                      =      58194.9
NDf                       =          298
Edm                       =  2.15958e-07
NCalls                    =         1013
fConstant [PE/4ns]        =       29.394
fExpDec [ns]              =       1169.3   +/-   1.16655
TotalPE                   =  3.95957e+07   +/-   25247.4
fAPProb_AP1               =   0.00184592
fGausMean_AP1 [ns]        =          520
fGausSig_AP1 [ns]         =           90
fAPProb_AP2               =    0.0240748
fGausMean_AP2 [ns]        =         1803
fGausSig_AP2 [ns]         =          680
fAPProb_AP3               =    0.0340307   +/-   0.000157044
fGausMean_AP3 [ns]        =         6703
fGausSig_AP3 [ns]         =         1229
Intensity LAr triplet     =          0.7
fPromptPE                 =  2.89919e+07   +/-   11584.6
ftau TPB [ns]             =        2e+07
Normal. triplet TPB (nr)  =            1
ftauSinglet [ns]          =          8.2
fmuPEAK1 [ns]             =        -0.01
fsigPEAK1 [ns]            =          5.1
fmuPEAK2 [ns](nr)         =         2.01
fsigPEAK2 [ns](nr)        =         1.05
fmuPEAK3 [ns]             =           48
fsigPEAK3 [ns]            =           10
fPEAK1                    =         0.98
fPEAK3(nr)                =         0.08
ftr LAr interm [ns]       =           50
t_a [ns]                  =        12000
A                         =          4.6
Intensity TPB triplet     =          0.2   +/-   6.62629e-05
Intensity LAr interme (nr) =      0.00857
Intensity LAr singlet     =     0.269414   +/-   0.000452901
```

FULL FIT

expectation

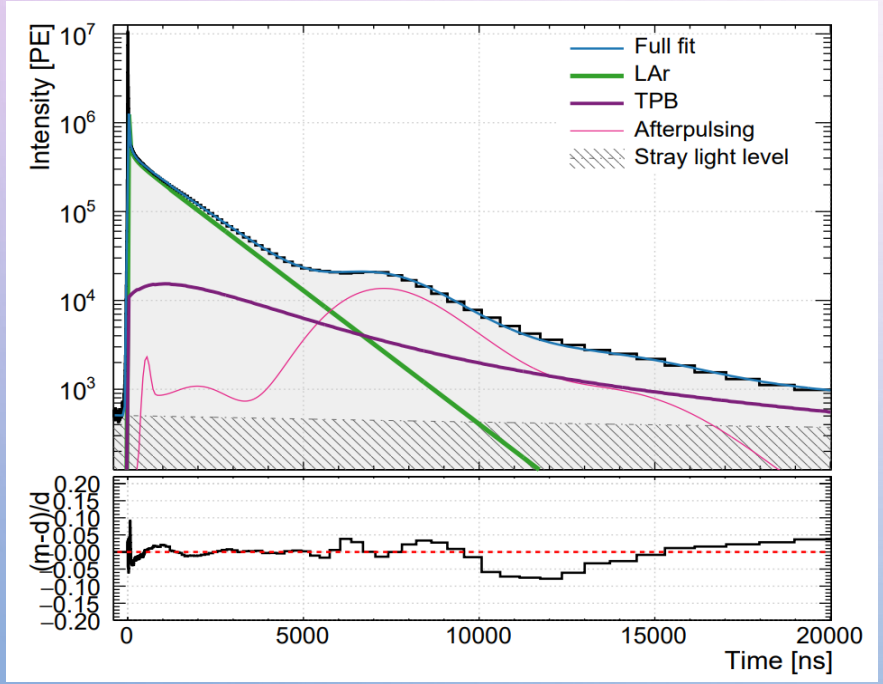


reality

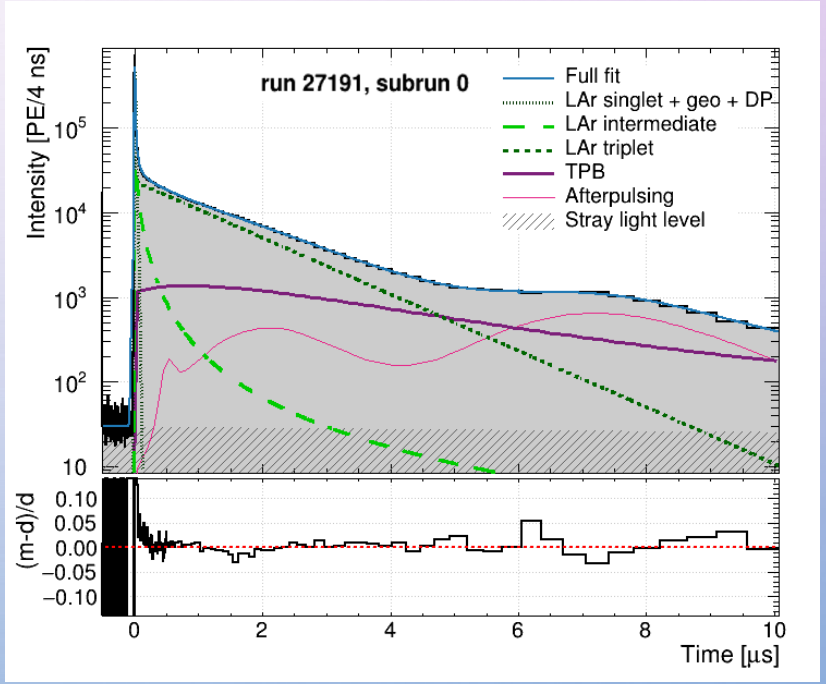


FULL FIT

expectation



reality



SUMMARY


competence
creativity
responsibility
achievement
adaptability
goals
industry
feedback
practical
initiative
real-world
challenges
networking
teamwork
development
experience
training
success
professional
opportunities
career
expertise
confidence
learning
skills
insight
exposure
ethic
work
resume
adaptation
mentorship
hands-on
connections
knowledge
collaboration
guidance
growth
projects
accomplishments
innovation
understanding
problem-solving

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[3] TPD3PULSESHAPEPAPER < MAIN < TWIKI (SNOLAB.CA)

[4] BSC THESIS: MOHAMED YOUNES SASSI (2018). AVERAGE PULSESHAPE OF LIQUID ARGON IN A DARK MATTER SEARCH EXPERIMENT.


My special appreciation for the grand supports from
my supervisors Pierre Gorel, Chris Jillings, Sean Daugherty,
my senior colleague Badamsambuu Jigmeddorj, and my dear DEAP friends!

BACKUP SLIDES

PULSESHAPE DISCRIMINATION

- Liquid scintillators emit scintillation light with different pulseshapes depending on the ionization power of the incident particle. Different ionization powers result in different excitation mechanisms of the scintillating atoms.

- Therefore cause the scintillator to have different decay times and intensities.

- By using the proprieties of these decay types we can distinguish between the excitation mechanisms and have an idea about the incident particle, this technique is called Pulse Shape Discrimination (PSD).

SIDE DEFINITIONS

- **Cross sections**: probability that a reaction will occur
- **Pulseshape:** In physics, particularly in the context of particle detectors and scintillation measurements, pulse shape refers to the characteristic pattern of light or electrical signal generated over time in response to a particle interaction. When a particle interacts with the scintillator material, it emits light pulses. The shape of these pulses (i.e., how the light intensity varies over time) provides valuable information about the nature of the interaction. Different types of particles or different energy deposits will produce pulses with distinct shapes.

SIDE QUESTIONS

- **Leak detector vs rga:** Leak detectors, in general, are fine-tuned to detect the presence of helium. Residual Gas Analyzers (RGAs) look beyond the presence of helium. They evaluate all the gases present within a space.
- **Why water hurt RGA**? Gases like nitrogen, oxygen, and argon are not strongly bound to the surfaces. This means they easily enter the gas phase and are easily pumped away. Water vapor, by contrast, clings to every surface, many molecular layers thick. As the pressure is reduced, water vapor molecules enter the gas phase but when they hit another surface they are again strongly bound. This makes it very difficult to pump away and it eventually becomes the dominant residual gas.
- **Why LAR**? Because of high scintillation light yield, high discrimination power between wimp and background. This power is from short singlet and long triplet decay time. Singlet is from NR from WIMP, triplet is from ER from background. LAr has high singlet decay because there is enough ionizing power, triplet excimer will interact with hot electron, creating singlet.
- **Why WIMP?** According to a model that when Universe was very hot, dark matter and its anti-matter annihilate, creating new particles. These particles also decayed into dark matter and its anti-matter. But temperature decreased, leading to new particles decay rate dropped while annihilation was still going on. At one point, the density of dark matter is constant. If dark matter exists, its cross section must be smaller than cross section of weak interaction. WIMP fits in this cross section range.