Xe doping analysis update

04/09/2020

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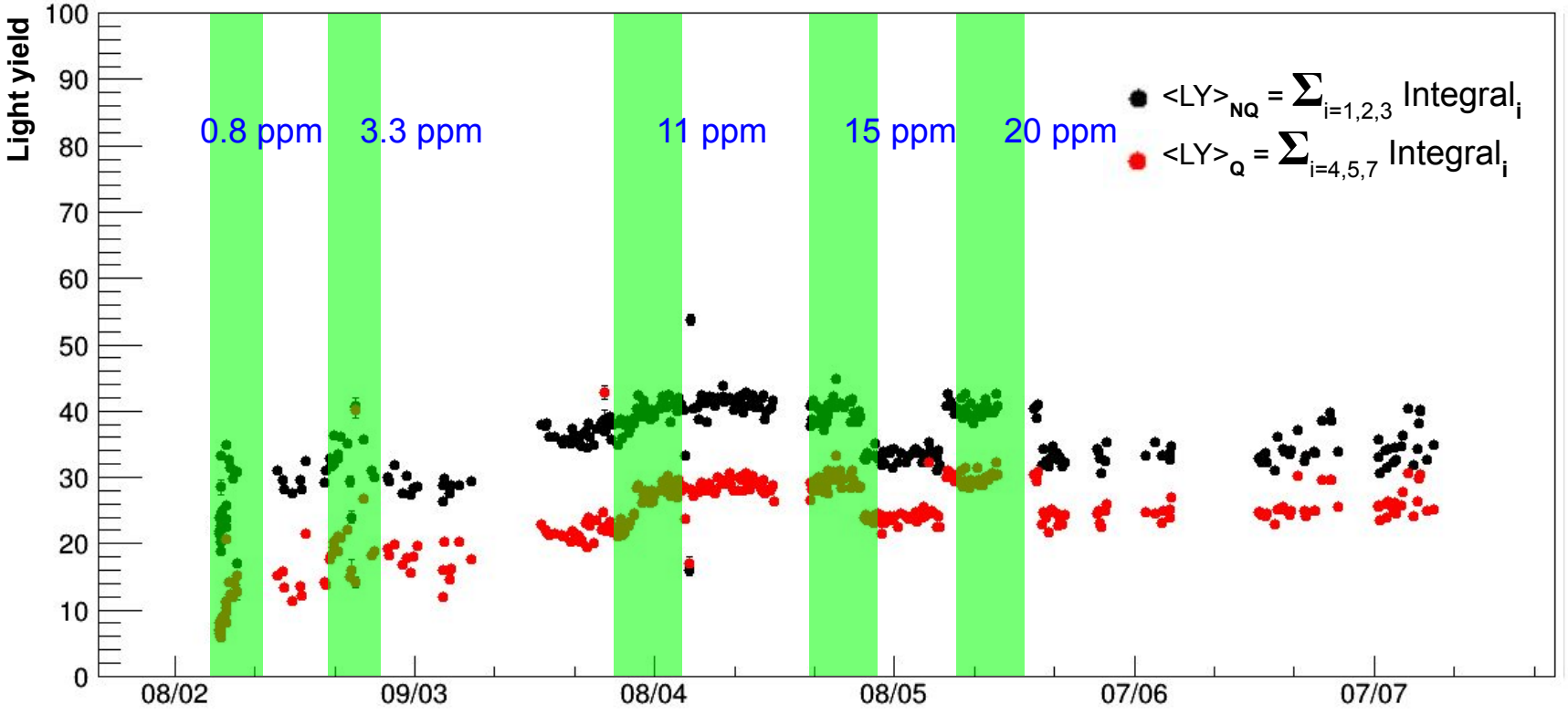
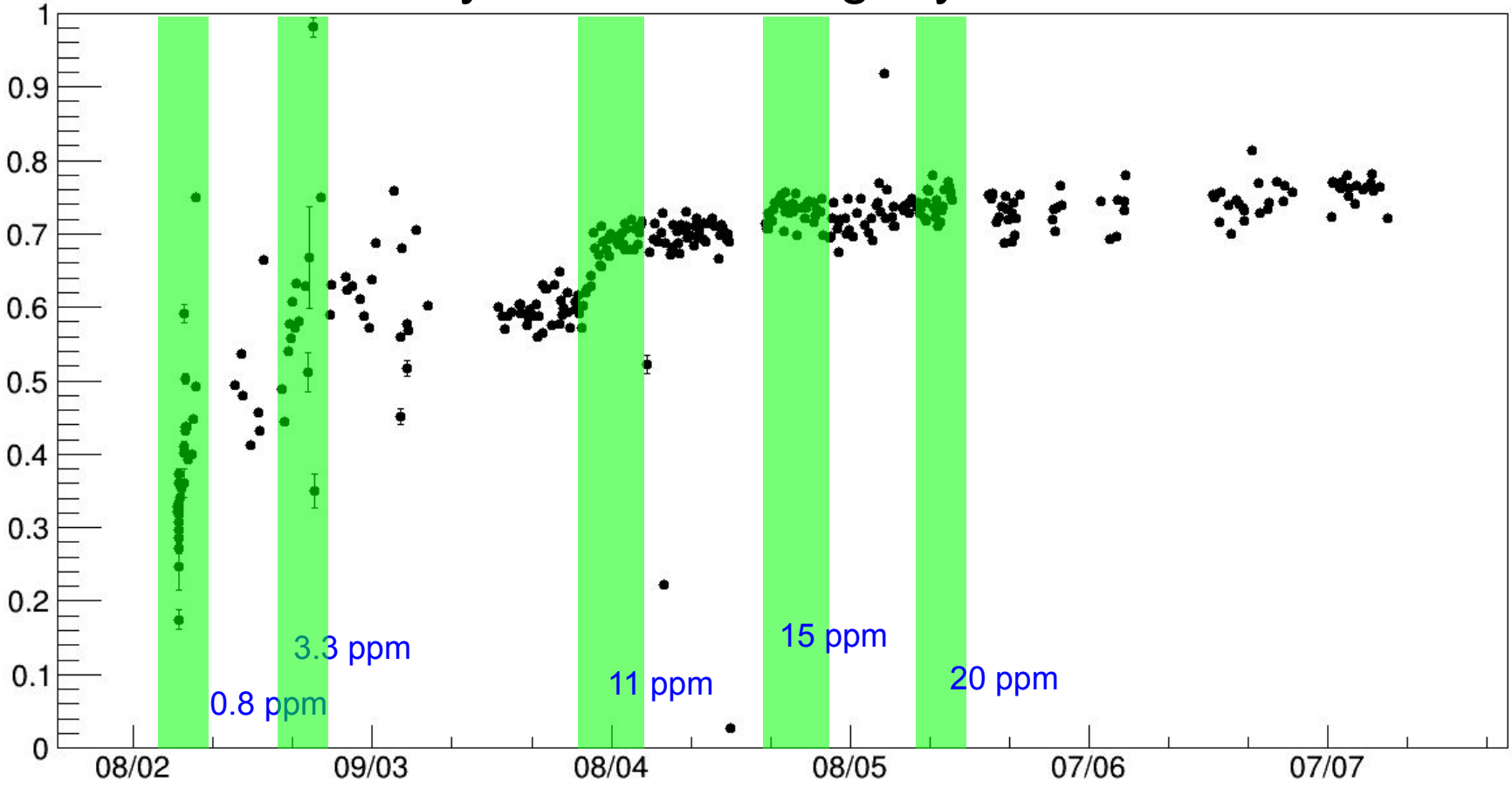
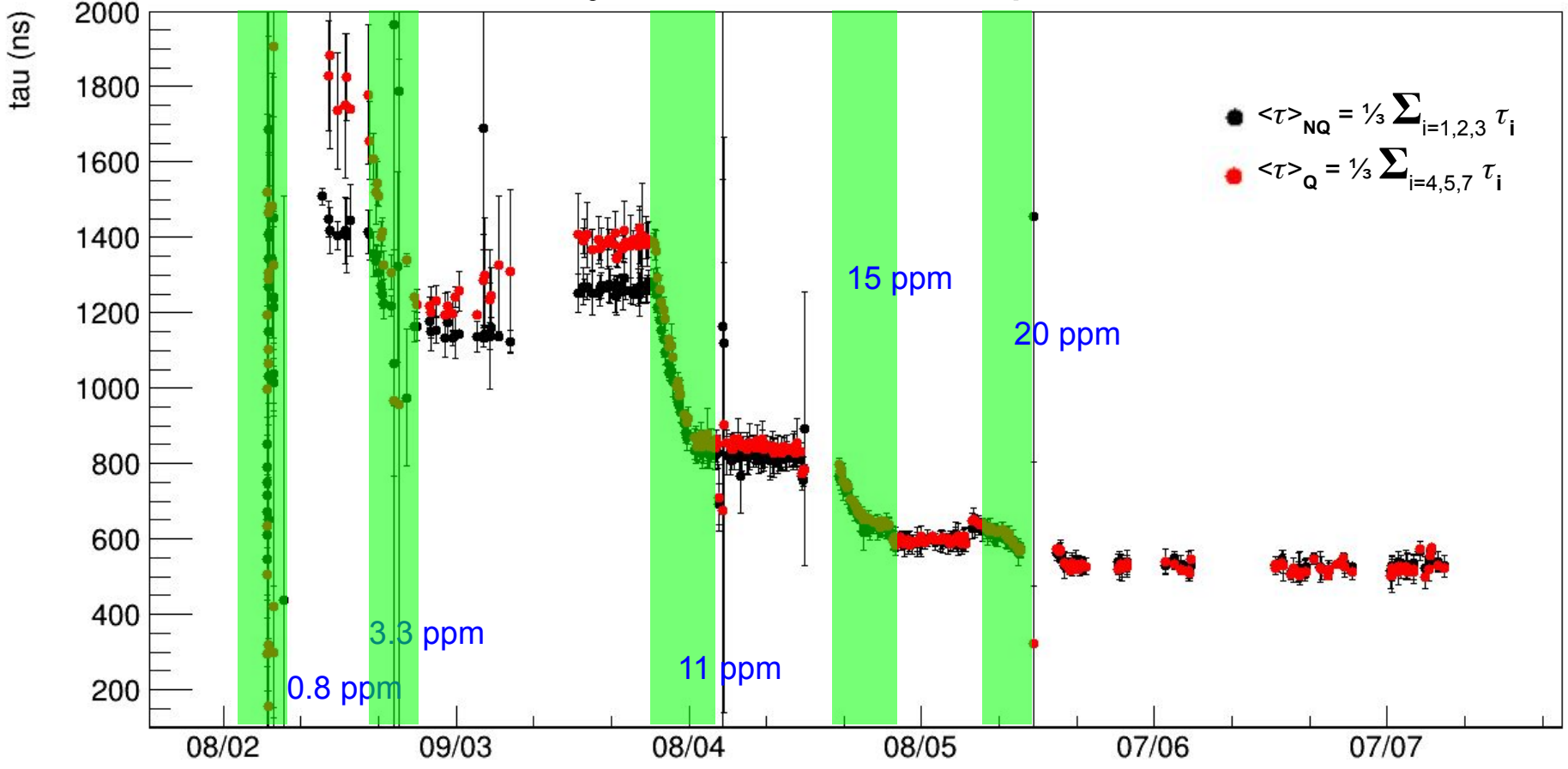
Survey of the total light yield



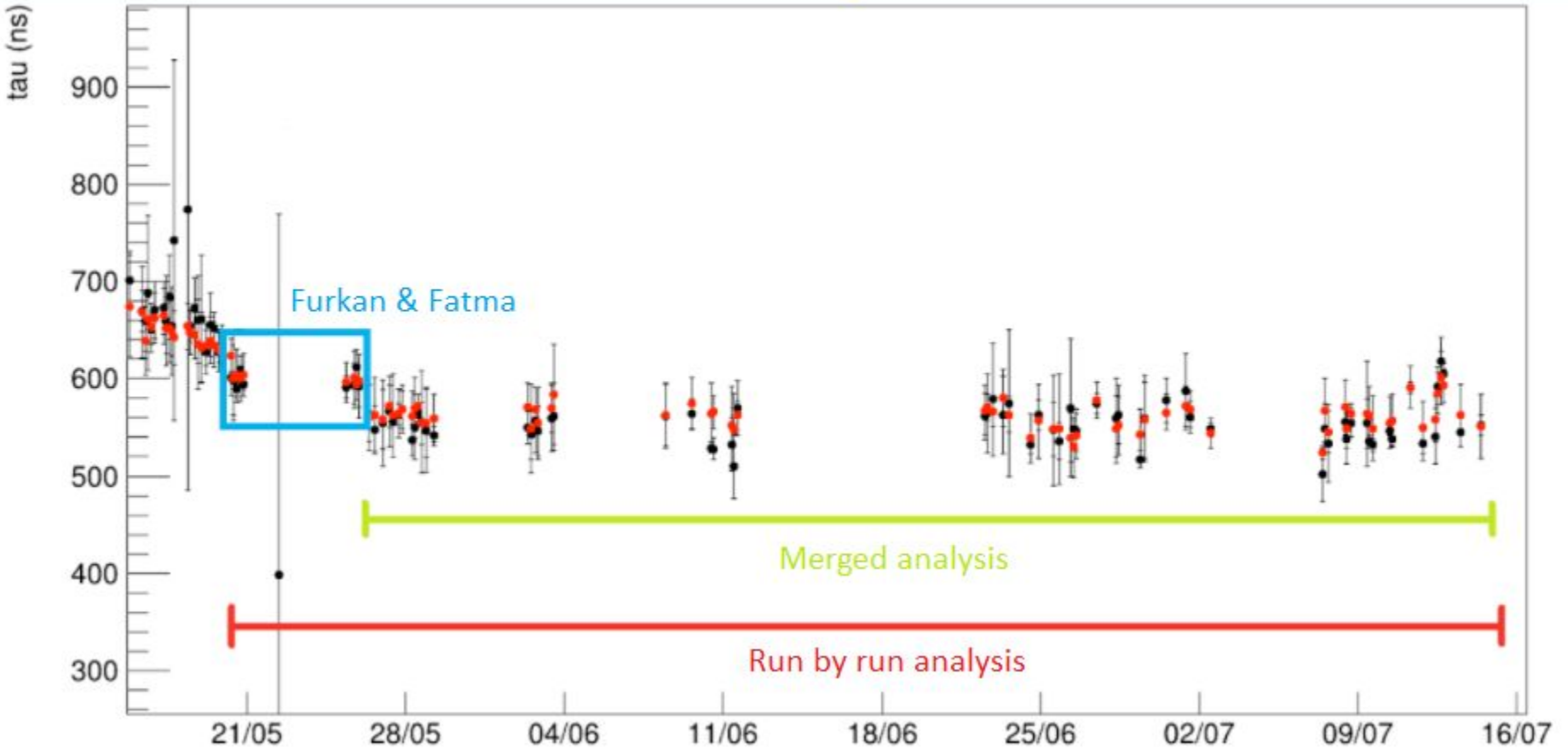
Survey of the Q/NQ light yield ratio



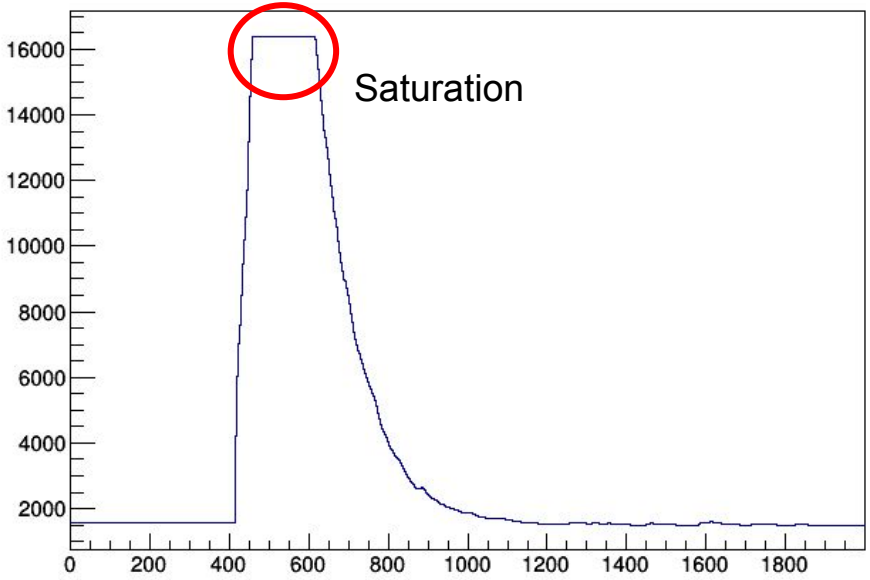
Survey of the slow component

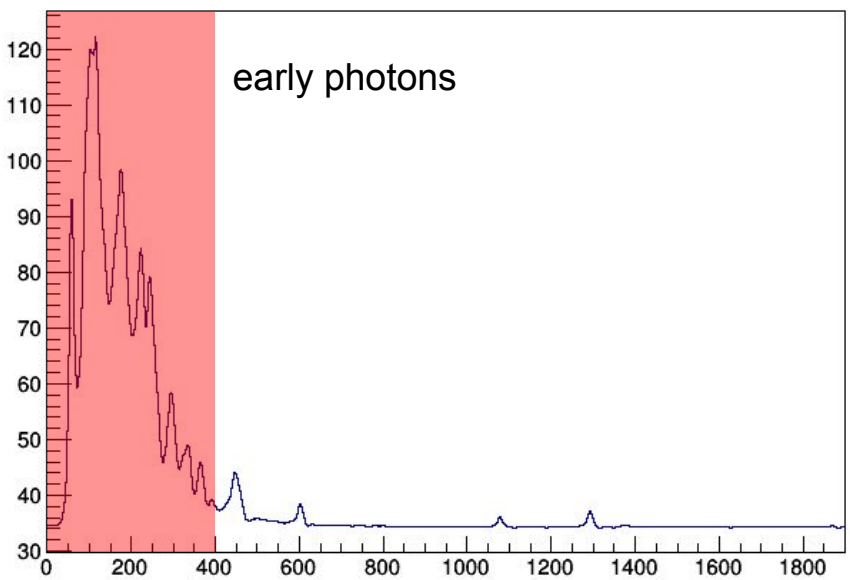


Dope5 Data Sets



Event selection in the D1 to D5 data analysis





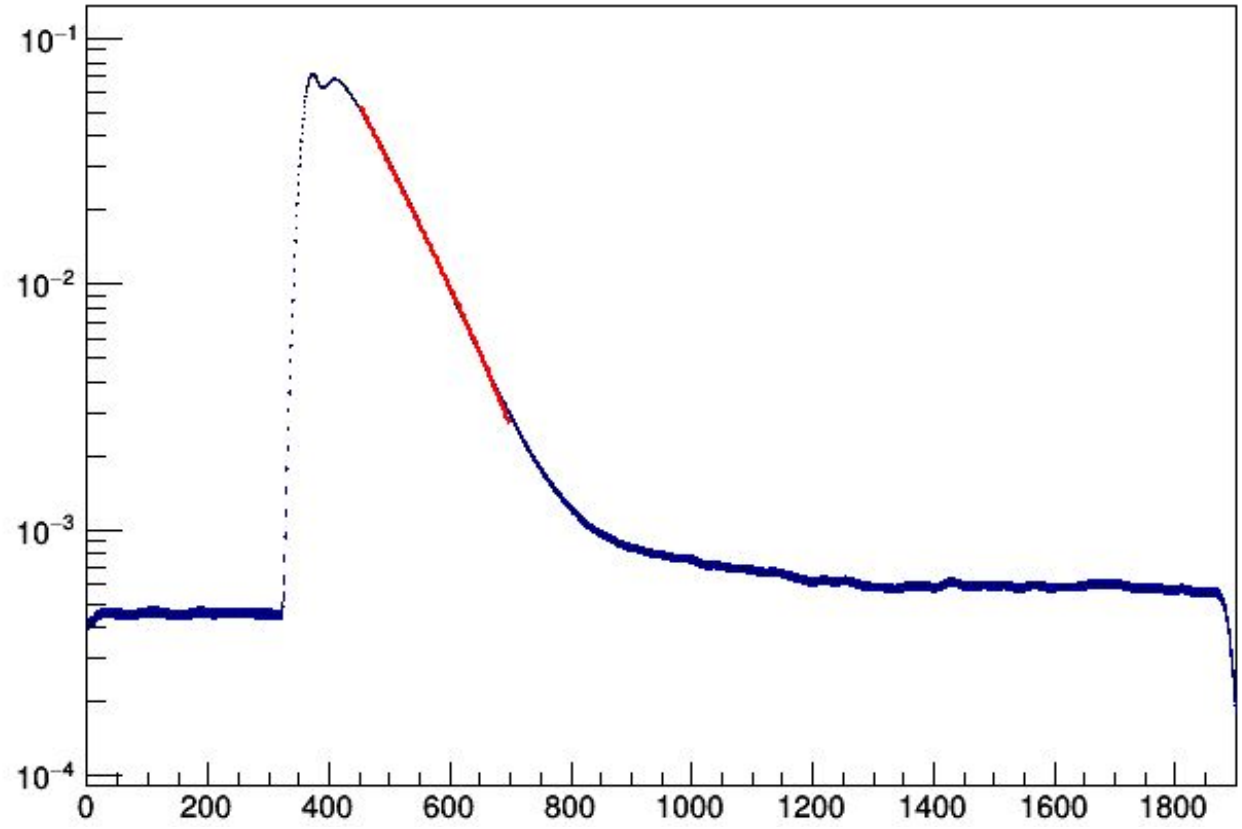
Discarded events by

- Saturation cut : events with saturation at 16000 ADC in the raw wfm
- Early cut: events with 10 or more photons in the pretrigger

Accepted events

- Late photons events (>10 ph)

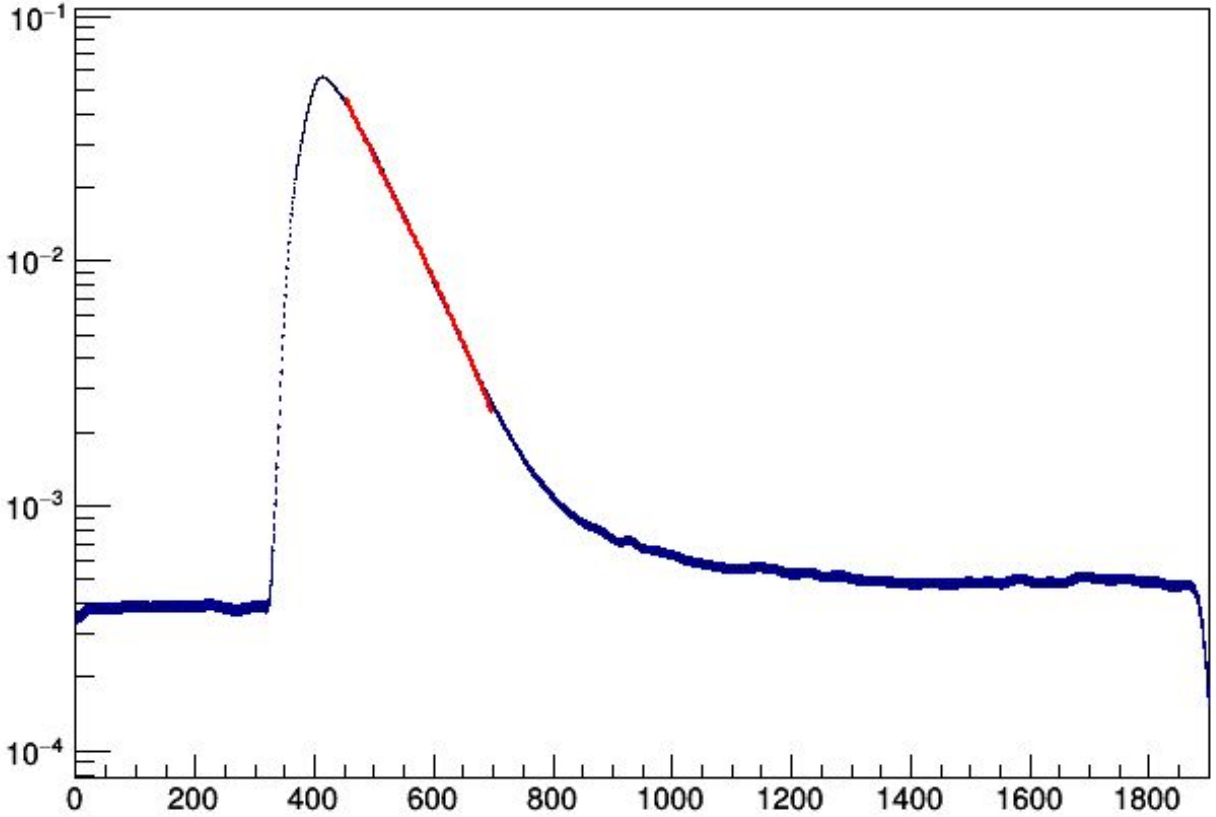
<wfm> in Dope5 - No Quartz (NQ)



- goal: find inter-calibration factor between Q and NQ xArapuca
- 1st step: compute <wfm>s for Dope5 (**late pulses are not cut**)
- done with “stable” runs at the end of D5 (from Dope5_ext_post_20 to Dope5_ext_post_90)
- <wfm> is smoothed with 21 tick-wide moving avg, applied 3 times
- fit with exp(p0+p1*x)+p2

p0	2.03 ± 0.01
p1	-1.10e-2 ± 2e-5
p2	-9.1e-4 ± 3e-5
χ^2 / ndf	9.9

<wfm> in Dope5 - Quartz (Q)

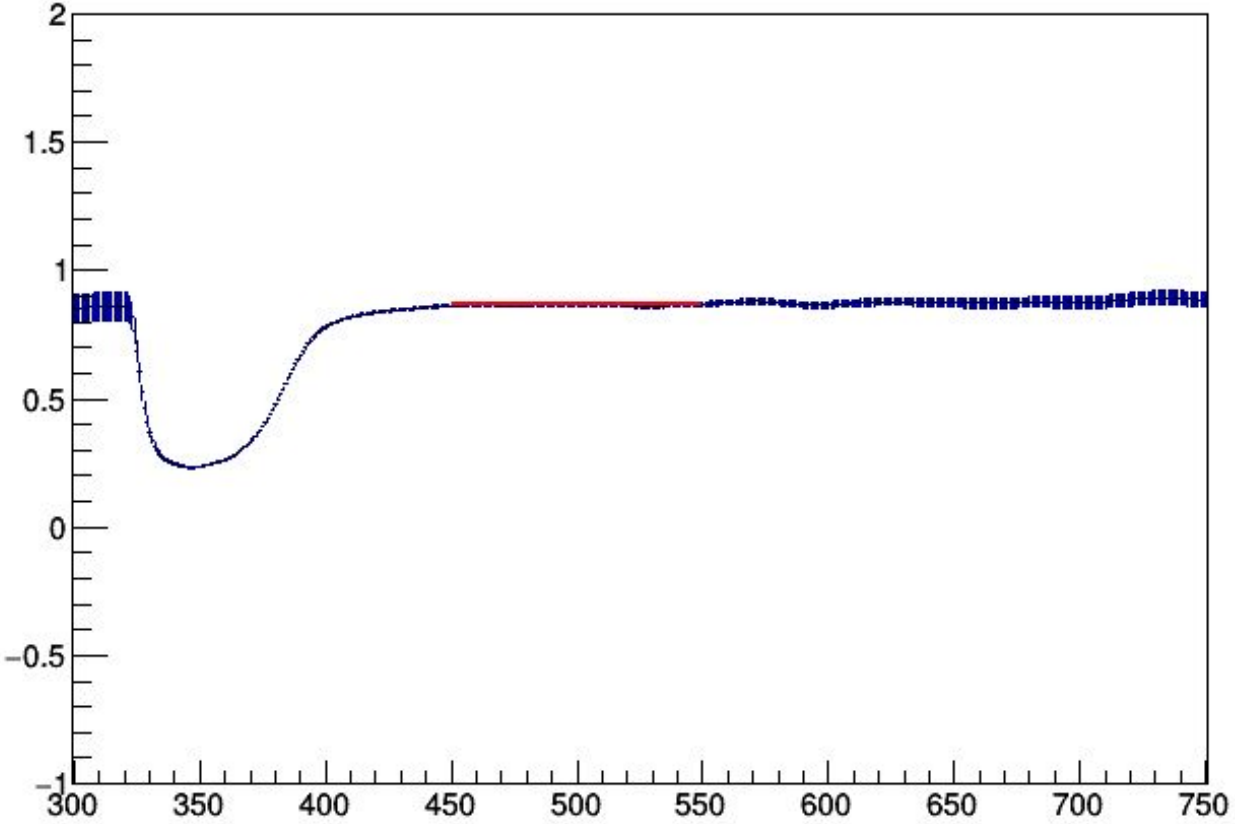


- assumption: after ~100 ticks from the trigger, the <wfm> only depends on the Xe light
- the p1 parameter is fixed to the same value as the NQ fit

p0	1.89 ± 7e-4
p1	-1.10e-2 ± 2e-5
p2	-7.3e-4 ± 8e-6
χ^2 / ndf	7.6

- the Q/NQ response ratio can then be computed as $\exp(p1_{Q}) / \exp(p1_{NQ})$
- $r_{Q/NQ} = 0.864 \pm 0.009$

<wfm> ratio in Dope5

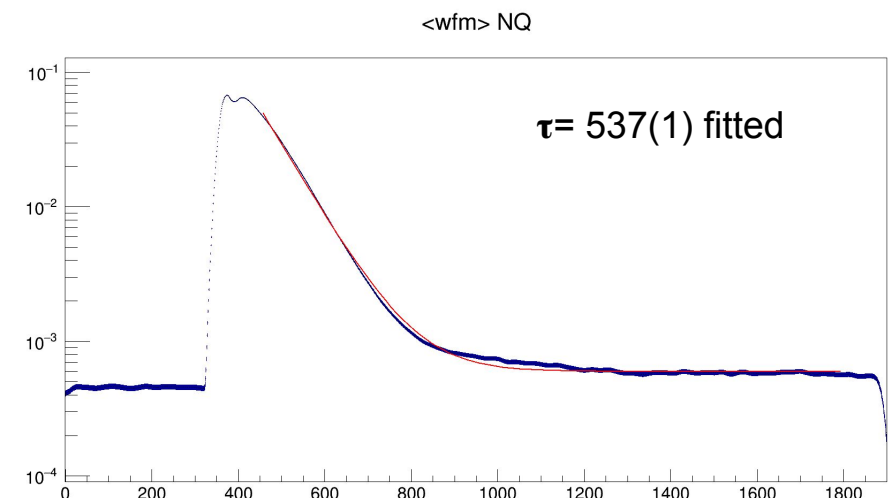


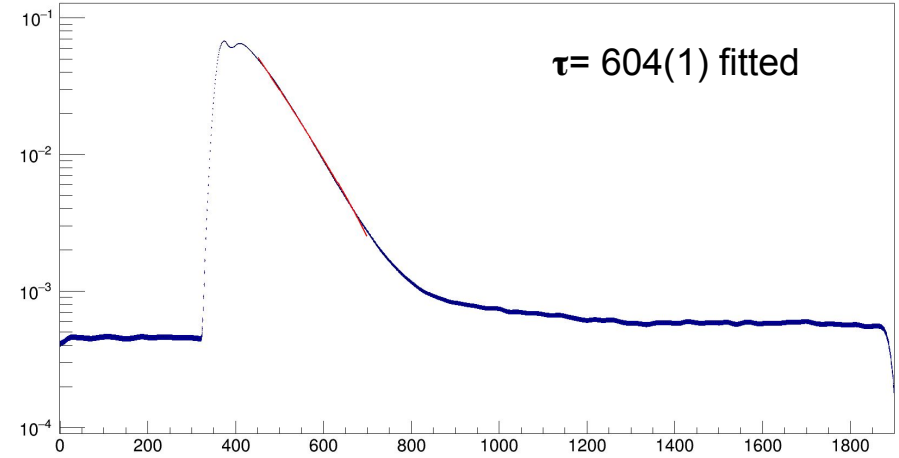
- alternative: compute a point-by-point Q/NQ ratio of the <wvfm>s
- the flat region (starting ~100 ticks after the trigger) can be fit with a constant

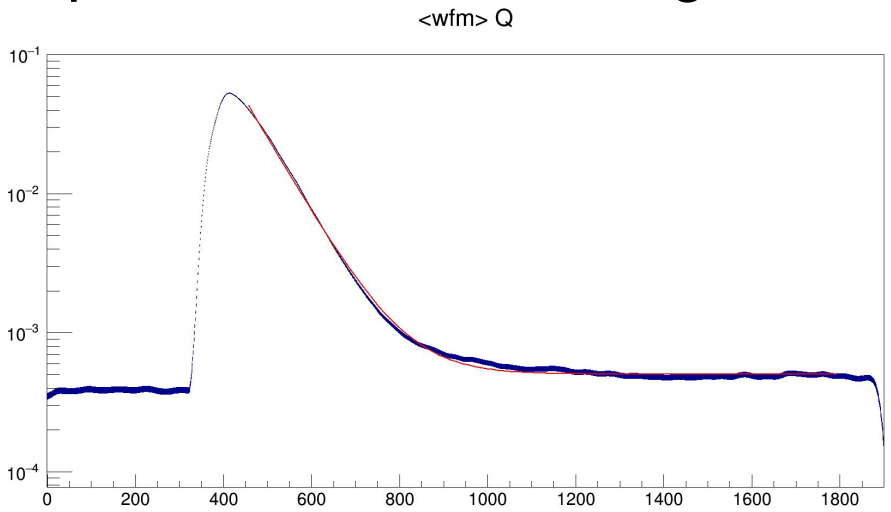
p0	0.865 ± 0.001
χ^2 / ndf	0.1

- the value is compatible within 0.08σ with the one obtained from exponential fits

Dope5 Merged Data Sets: independence from fit range



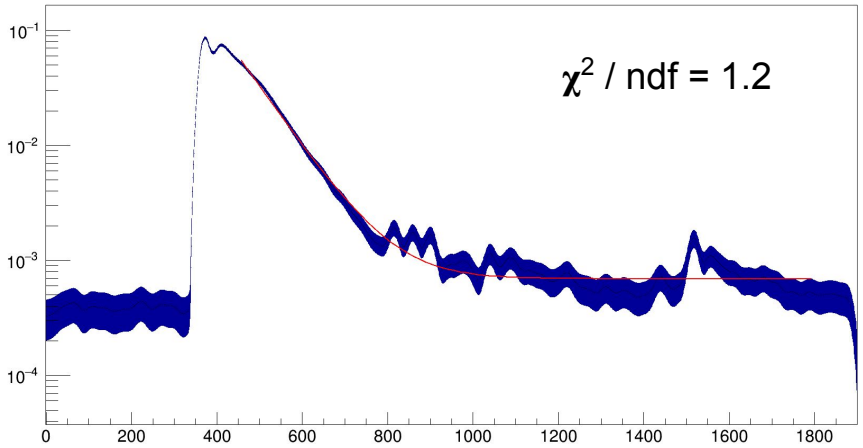




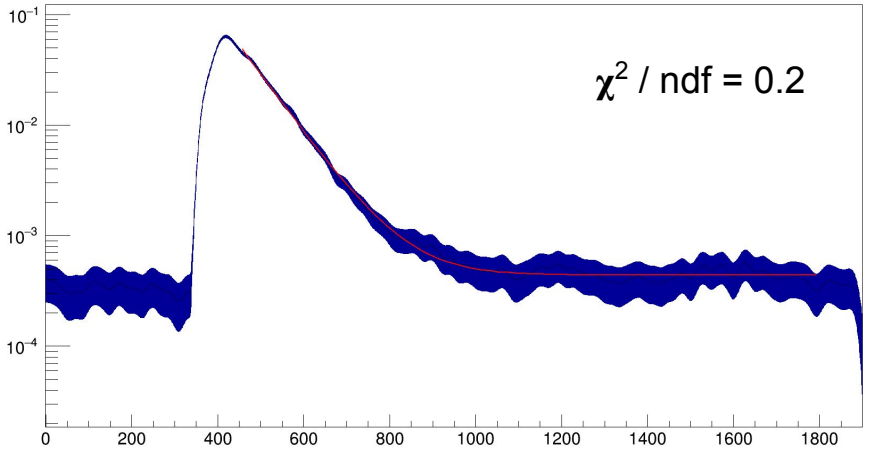
	NQ (part. tail)	NQ (whole tail)	Q (whole tail)
Amp	2.03	2.69	2.55
1/τ	-1.10e-2	-1.24e-02	-1.24e-02 *
const	-9.1e-4	6.03e-04	5.11e-04
χ^2 / ndf	9.9	5.2	

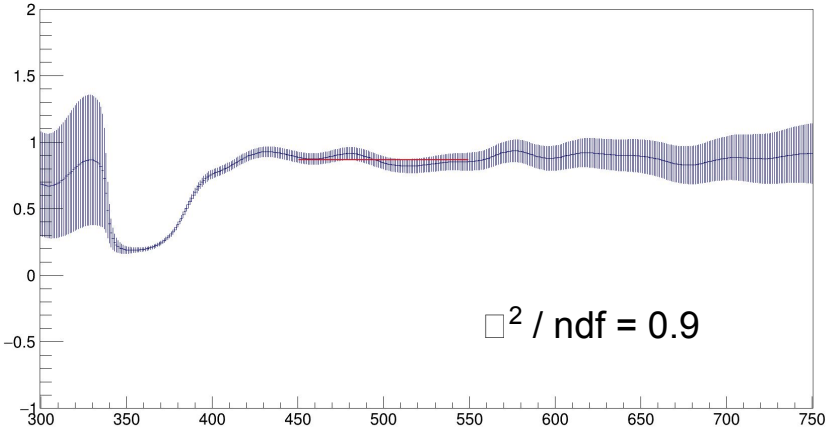
intercalibration in single Dope5 run

<wfm> NQ



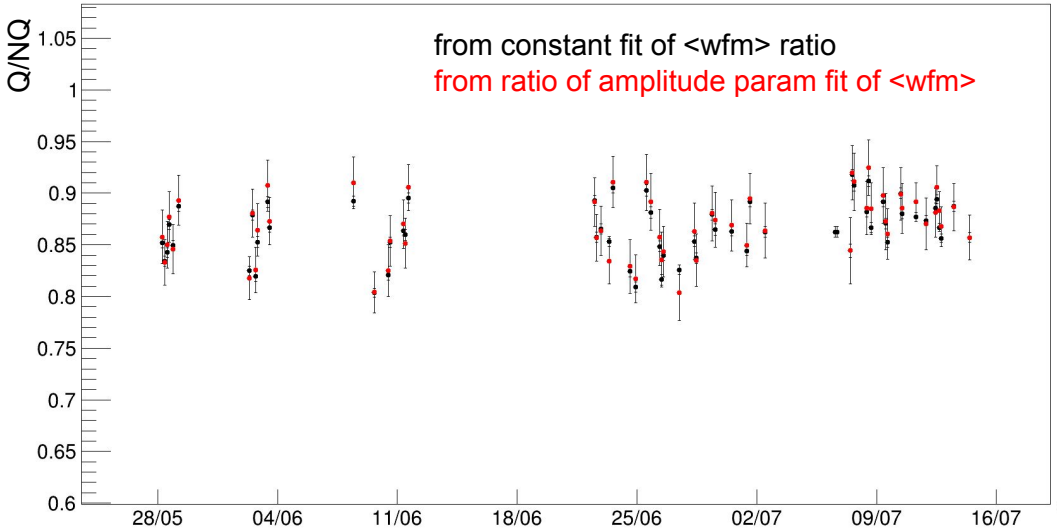
<wfm> Q

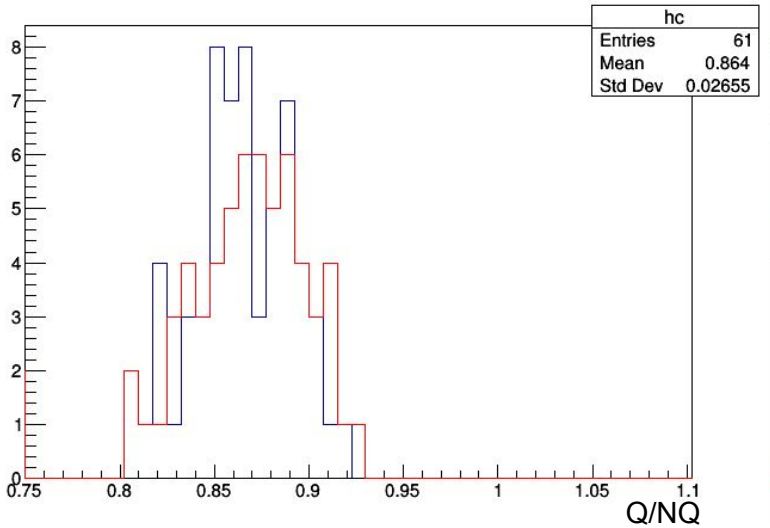




- in single runs, exponential fit of tail also works well
- fit amp: $r_{Q/NQ}$ = 0.885 ± 0.025
- <wfm> ratio: $r_{Q/NQ}$ = 0.867 ± 0.005
- compatible within 0.7σ

Dope5 Single Run analysis: NQ/Q

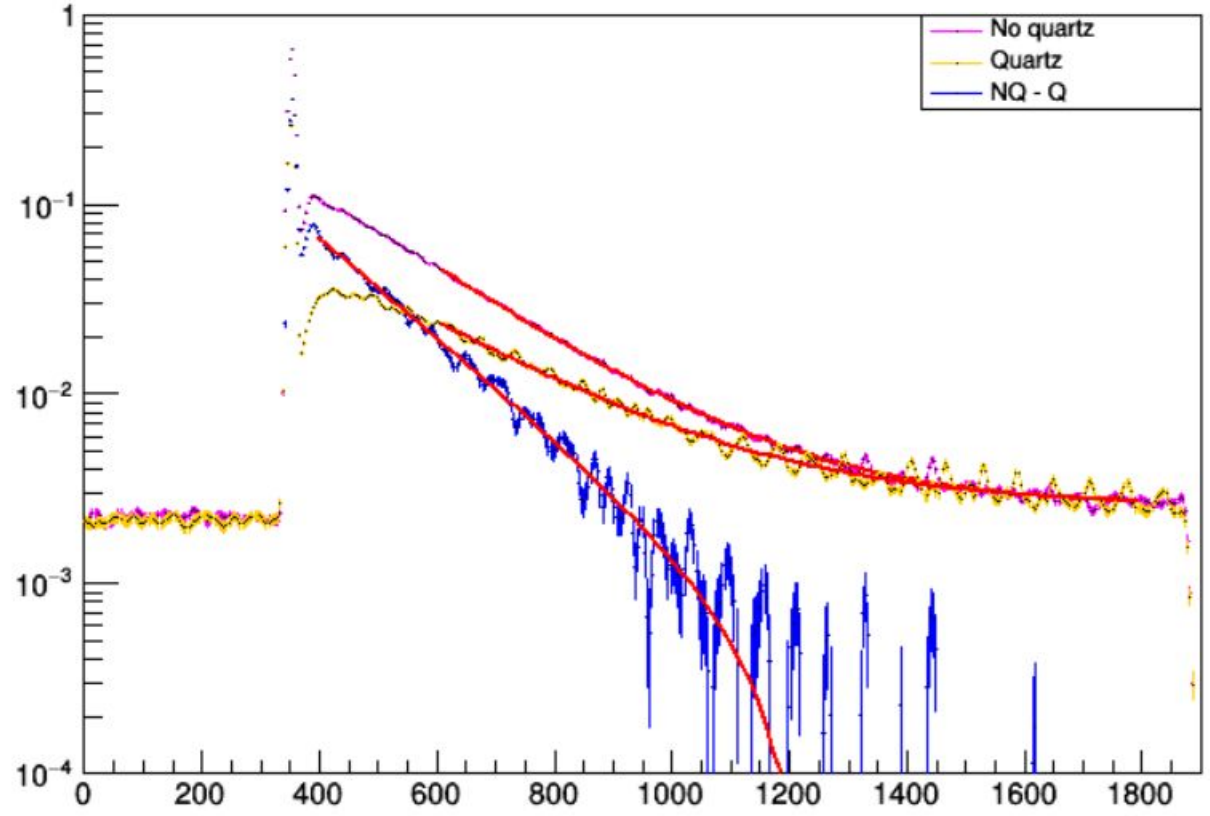




Weighted mean: 0.866 (0.003)

	Mean	Sigma
<wfm> ratio	0.864	0.026
fit amp ratio	0.869	0.029

<wfm> subtraction - Doping 1

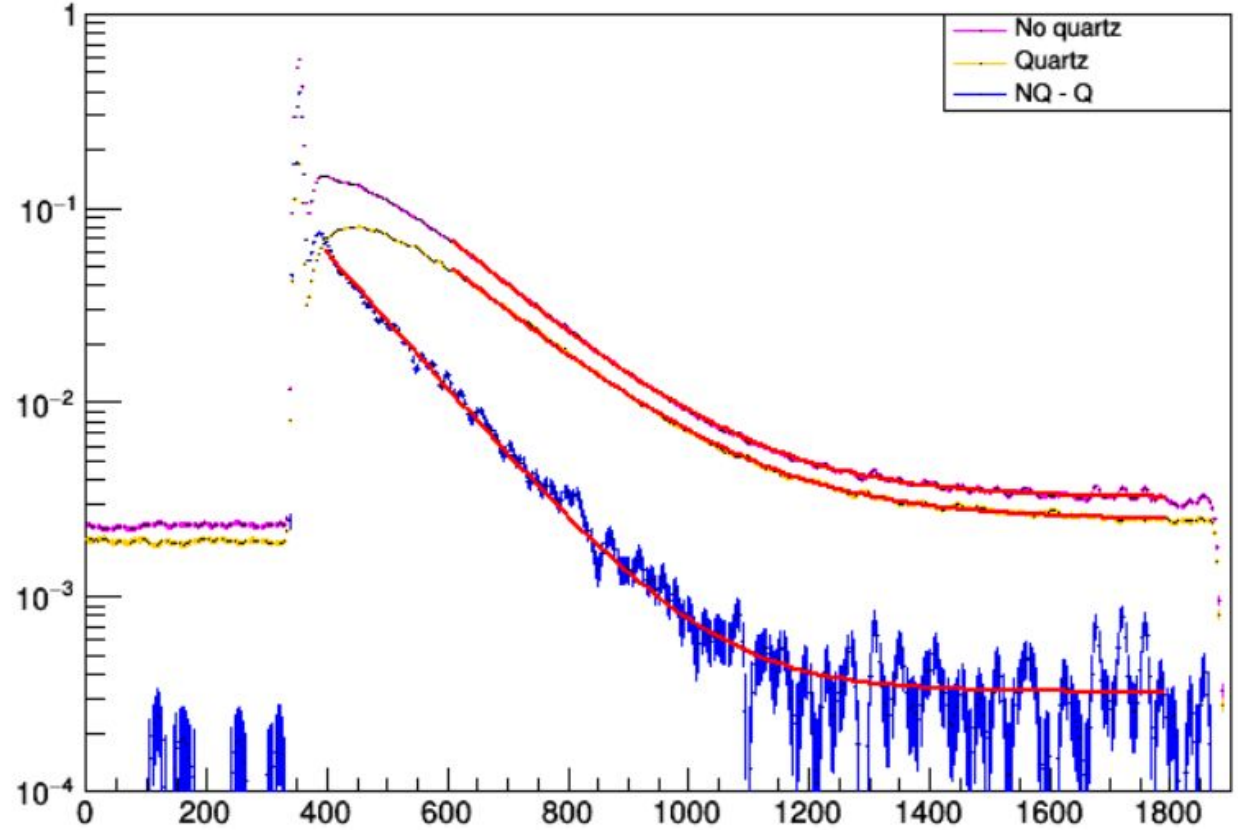


the residual Ar <wfm> can now be computed:
$\langle wfm \rangle_{Ar} = \langle wfm \rangle_{NQ} - \langle wfm \rangle_{Q} / 0.86$
runs used for D1:
Doping1_Monitoring29 to Doping1_Monitoring35

	χ^2 / ndf	τ_{slow} [ns]	LY npe
Q	1.7	1418(5)	10.2(1)
NQ	4.7	1644(11)	5.0(1)
Ar	4.2	1114(5)	4.4(1)

- $LY_{Ar} / LY_{Xe} = 0.88(1)$

<wfm> subtraction - Doping 2

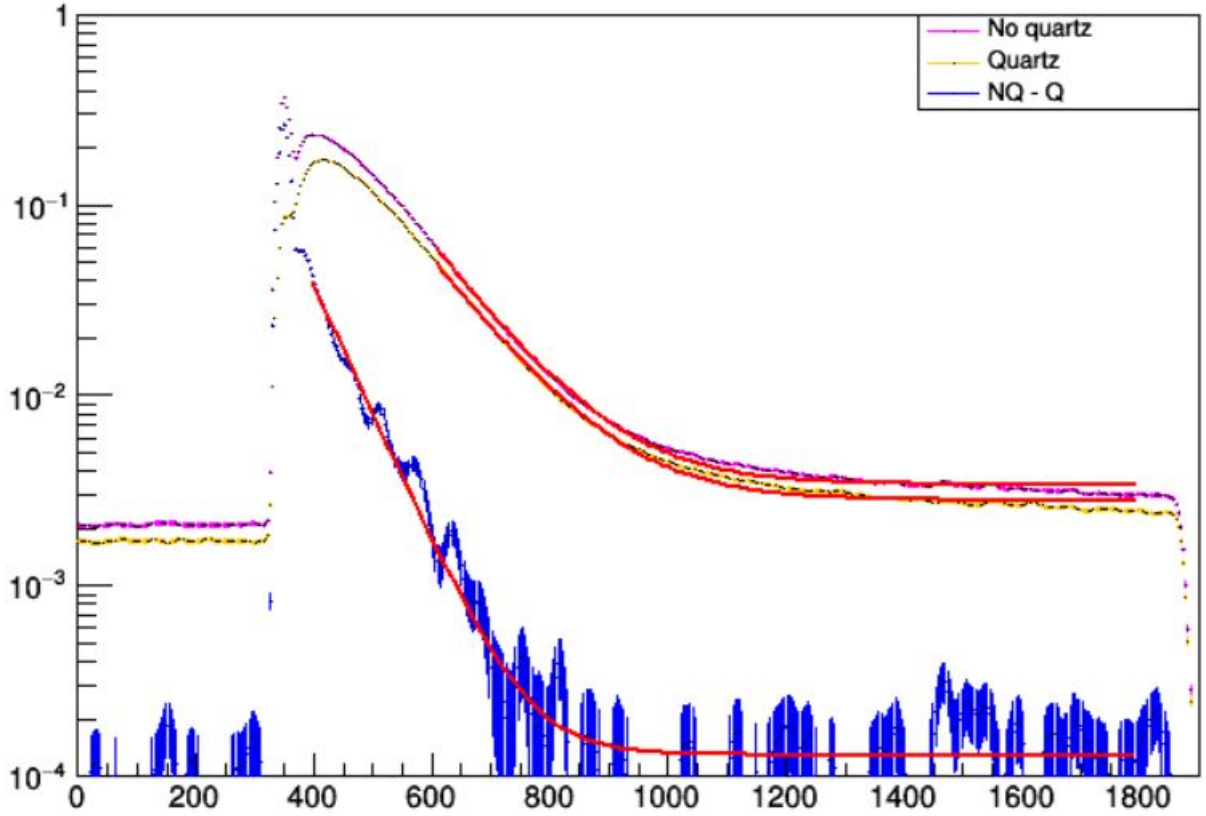


- runs used for D2: Run_ext_01 to Run_ext_29

	χ^2 / ndf	τ_{slow} [ns]	LY npe
Q	3.7	1094(2)	12.8(1)
NQ	4.8	1114(2)	7.6(1)
Ar	3.9	821(3)	3.9(1)

- $LY_{Ar} / LY_{Xe} = 0.51(1)$

<wfm> subtraction - Doping 3

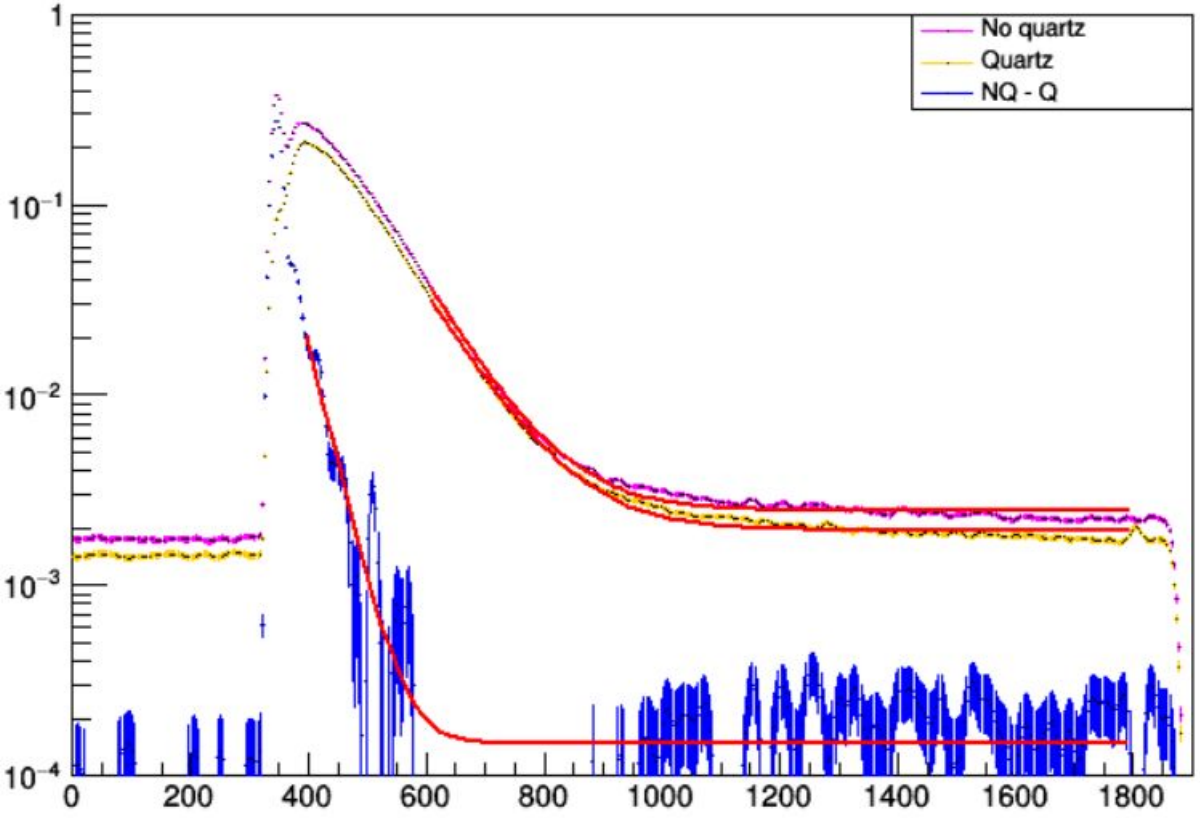


- runs used for D3: Dope3_ext_post_01 to Dope3_ext_post_62

	χ^2 / ndf	τ_{slow} [ns]	LY npe
Q	19.6	735(1)	14.3(1)
NQ	17.1	748(1)	10.1(1)
Ar	2.2	425(4)	2.6(1)

- $LY_{Ar} / LY_{Xe} = 0.26(1)$
- χ^2/ndf is affected by residual sinusoidal disturbance signal

<wfm> subtraction - Doping 4

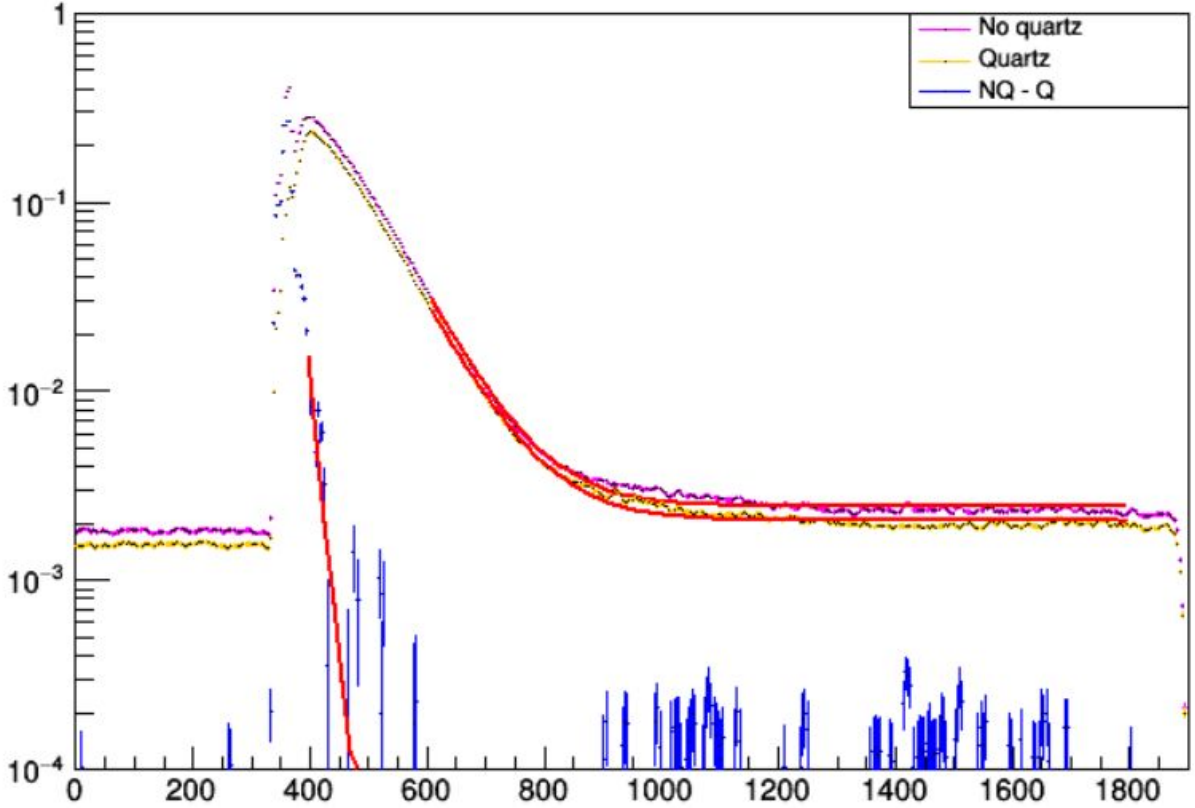


- runs used for D4: Dope4_ext_19 to Dope4_ext_post_32

	χ^2 / ndf	τ_{slow} [ns]	LY npe
Q	8.8	566(2)	12.9(1)
NQ	7.2	592(2)	9.4(1)
Ar	2.5	225(10)	2.0(1)

- $LY_{Ar} / LY_{Xe} = 0.22(1)$

<wfm> subtraction - Doping 5

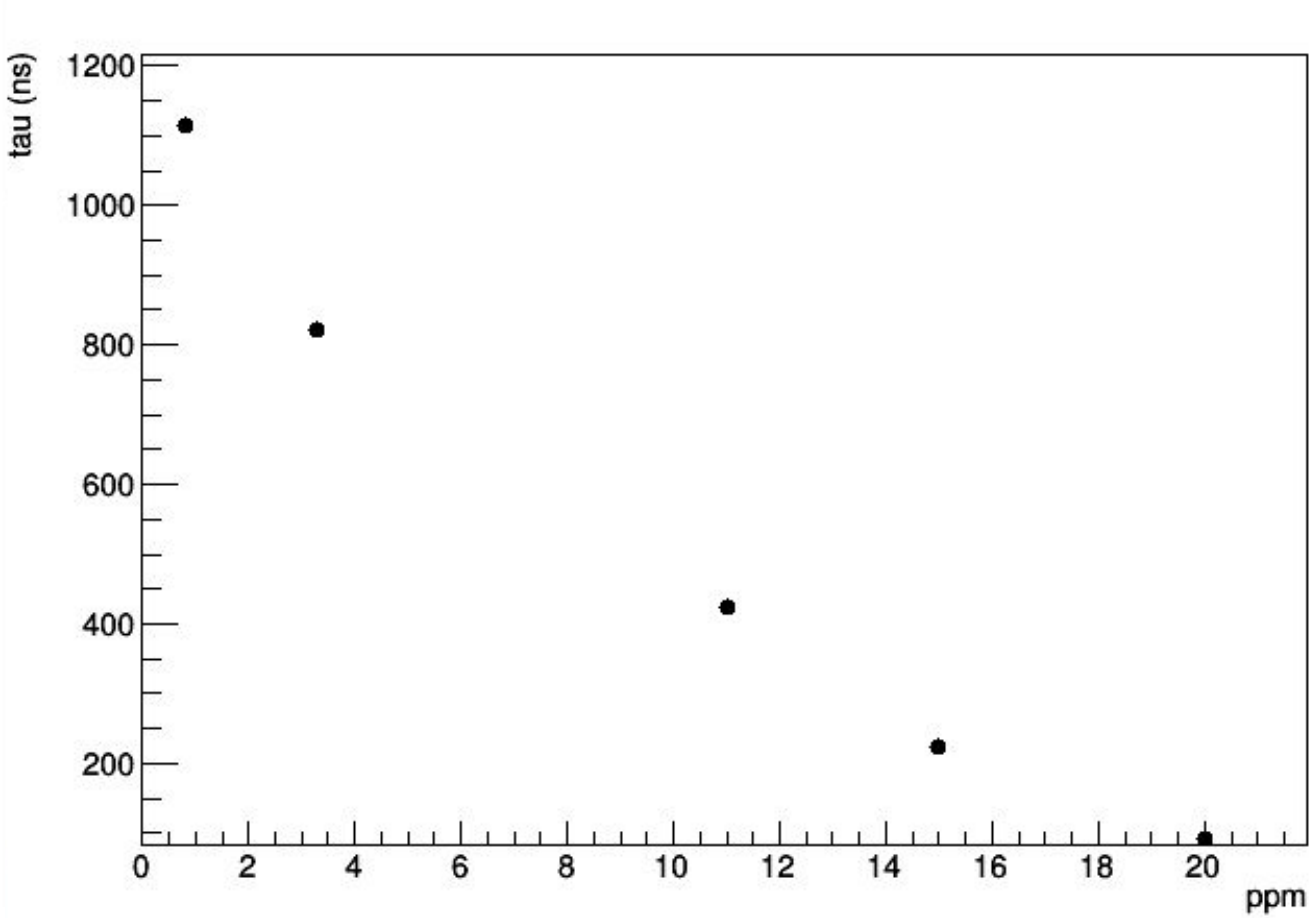


- runs used for D5: Dope5_ext_post_20 to Dope5_ext_post_90

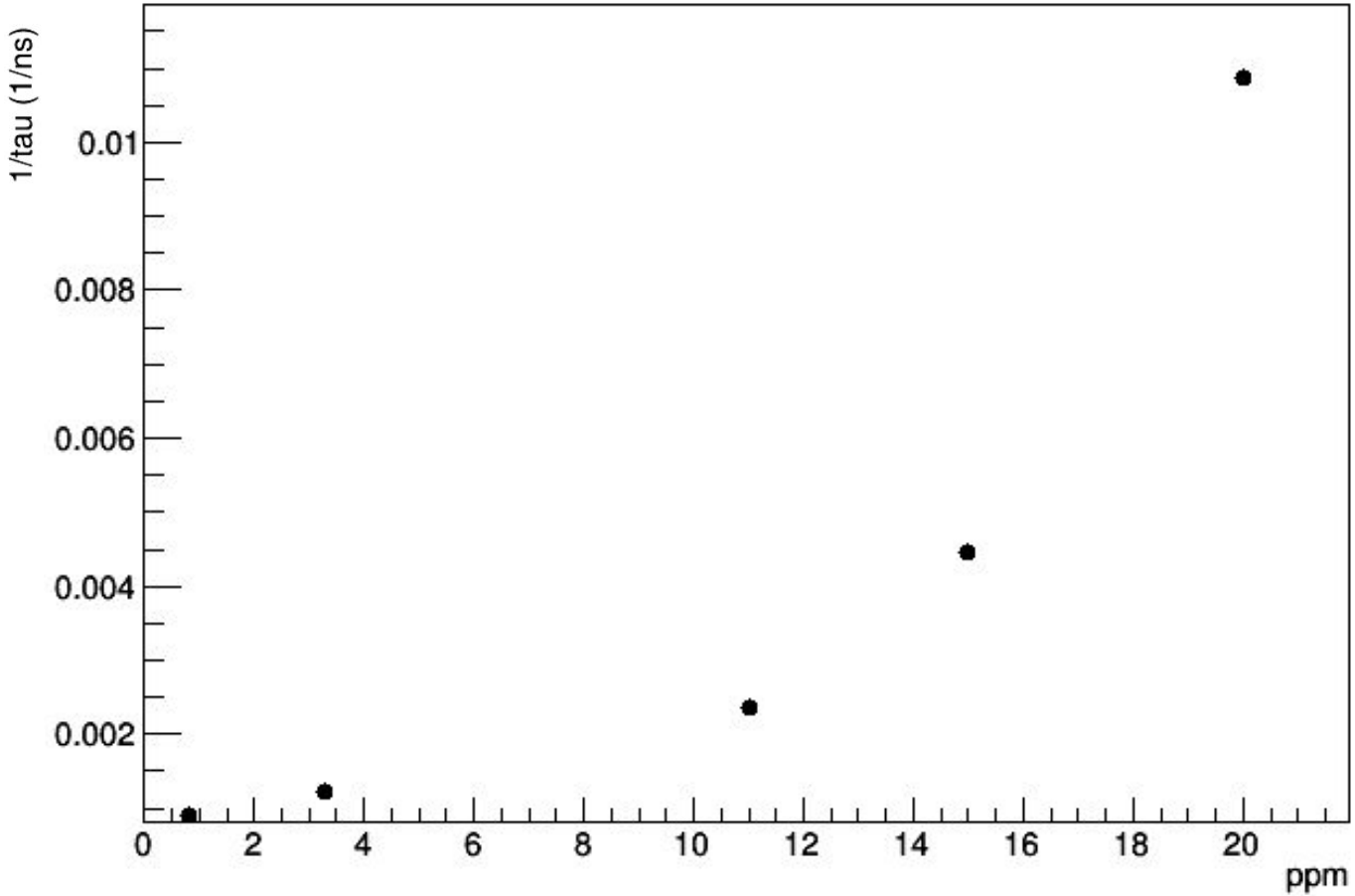
	χ^2 / ndf	τ_{slow} [ns]	LY npe
Q	13.3	510(1)	12.0(1)
NQ	10.5	525(2)	8.9(1)
Ar	3.7	92(5)	1.7(1)

- $LY_{Ar} / LY_{Xe} = 0.18(1)$

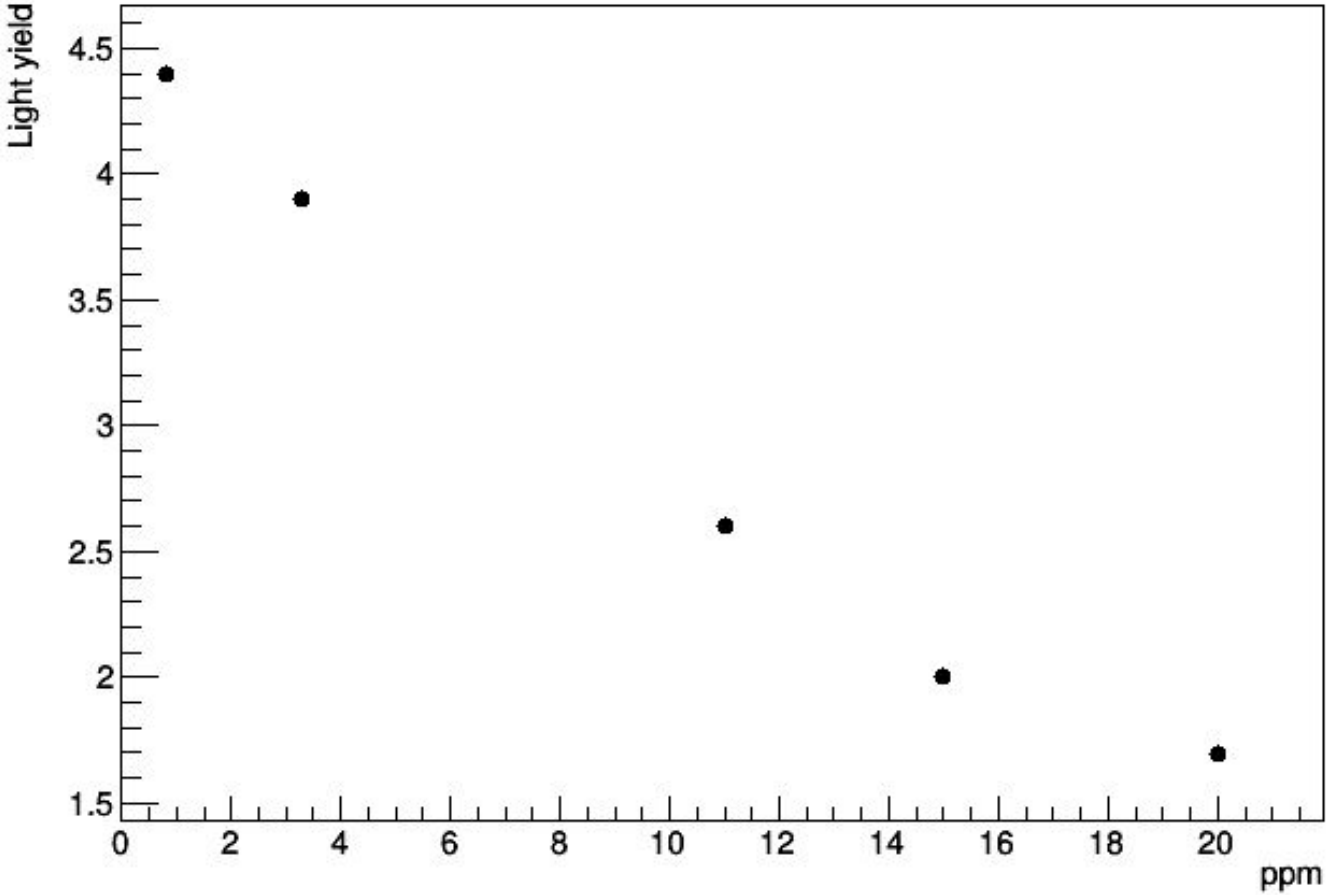
Ar τ_{slow} vs Xe concentration



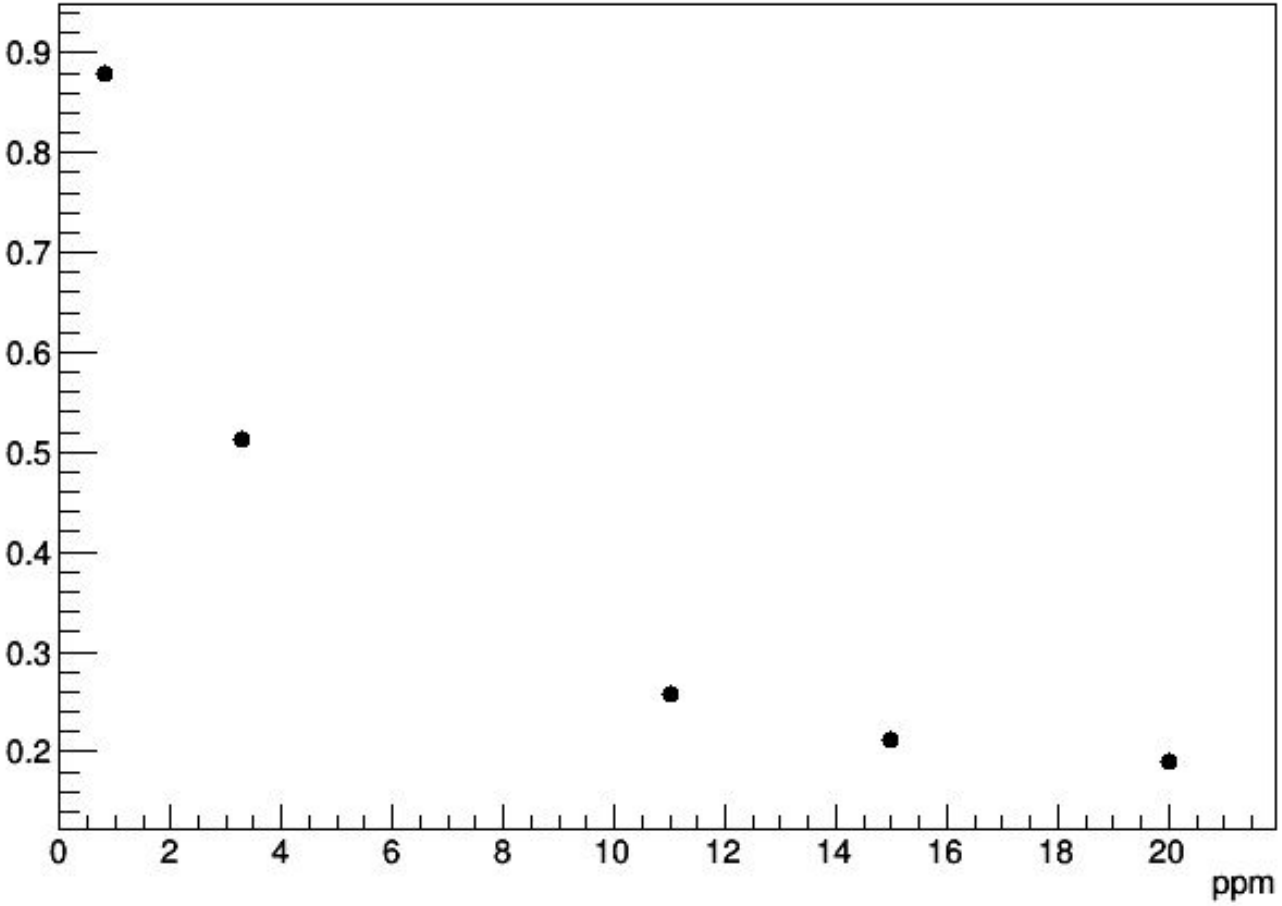
Ar $1/\tau_{slow}$ vs Xe concentration



Ar light yield vs Xe concentration



Ar/Xe light yield ratio vs Xe concentration



Conclusions

- D5 data sets: merged & individual run analysis
  - τ_{xe} = 583 - 605 ns depending from fit range. 583 ns whole pulse tail
  - Q/NQ= 0.860 (0.003)
- τ_{slow} of residual Ar <wfm> is anticorrelated with [Xe]