Xe doping analysis update

07/08/2020
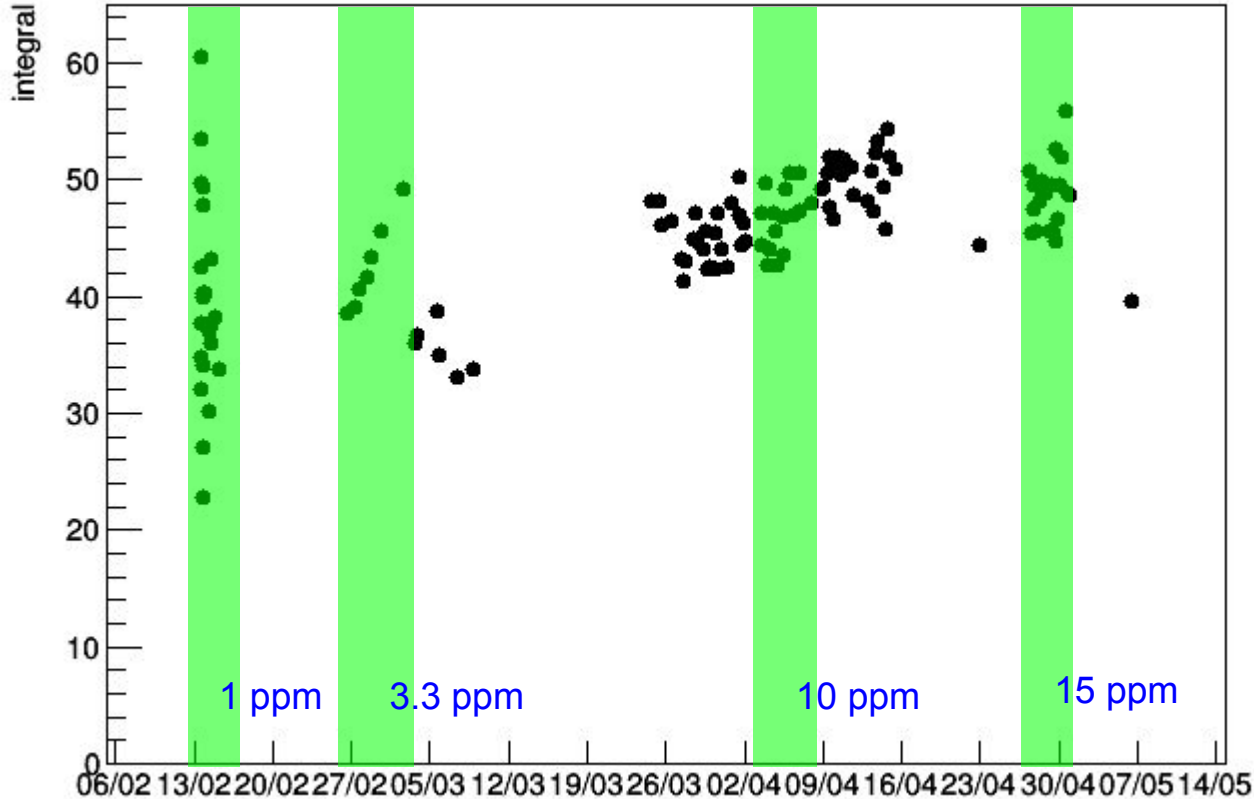
L. Bomben, C. Cattadori

Survey of the total light yield - no quartz XArapuca

Y axis is in nr. of photons!
Dots = **average** nr. of detected photons for each trigger in the run

Def.:

$$\langle LY \rangle_{NQ} = \sum_{i=1,2,3} \text{Integral}_i$$

$\langle LY \rangle_{NQ}$ ~50 post Dope3

Survey of the total light yield - quartz XArapuca

Y axis is in nr. of photons!
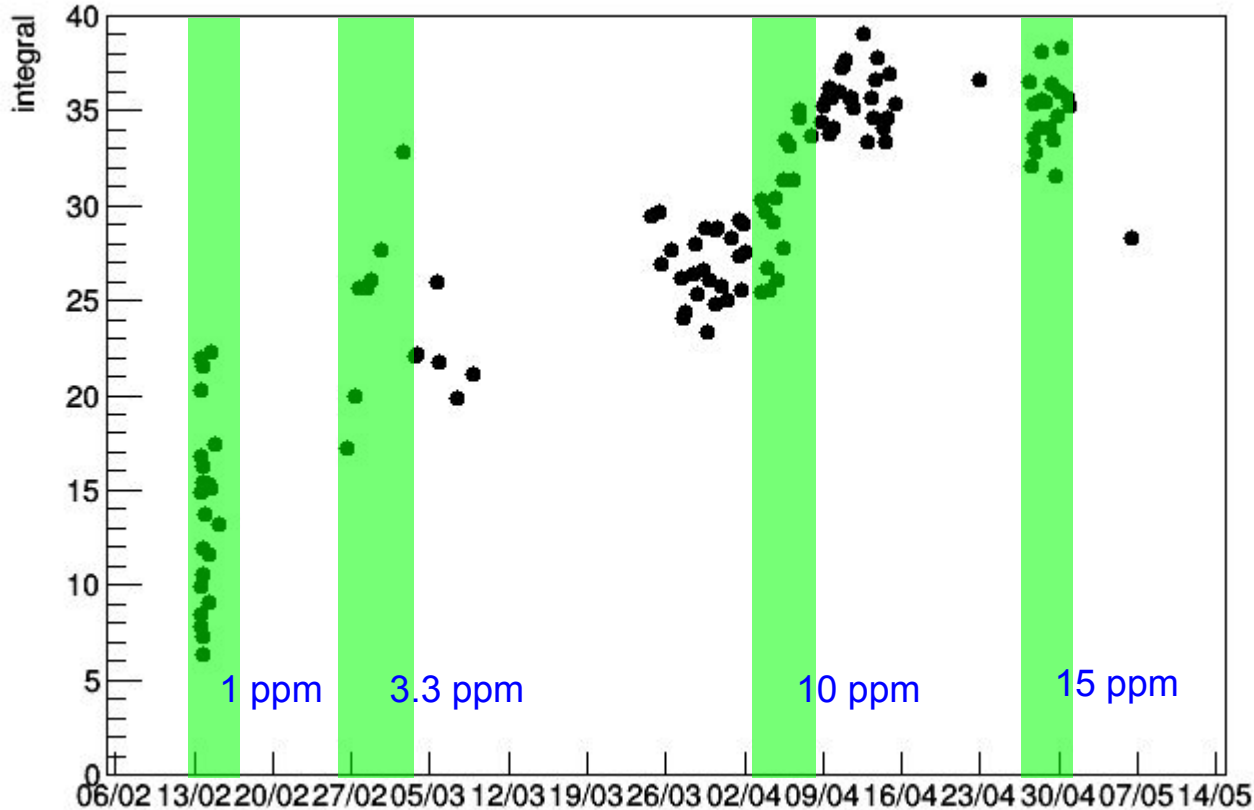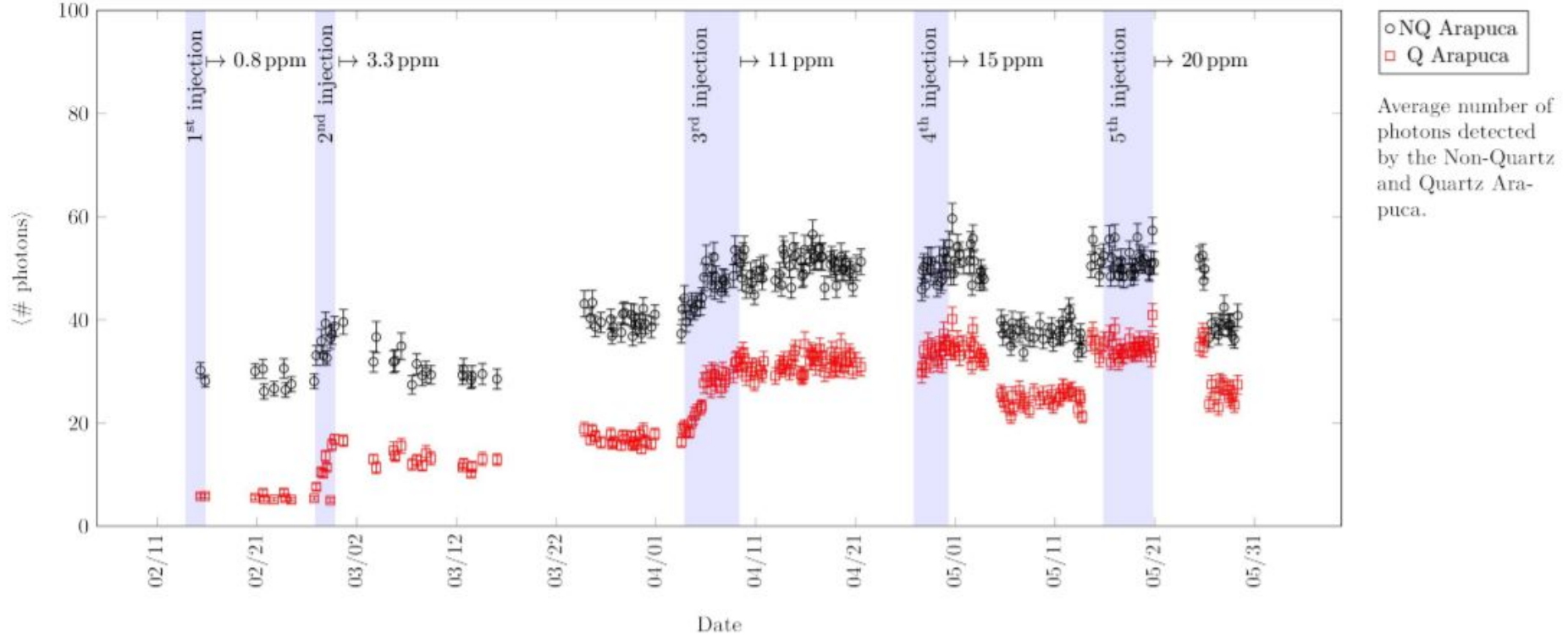Dots = **average** nr. of detected photons for each trigger in the run

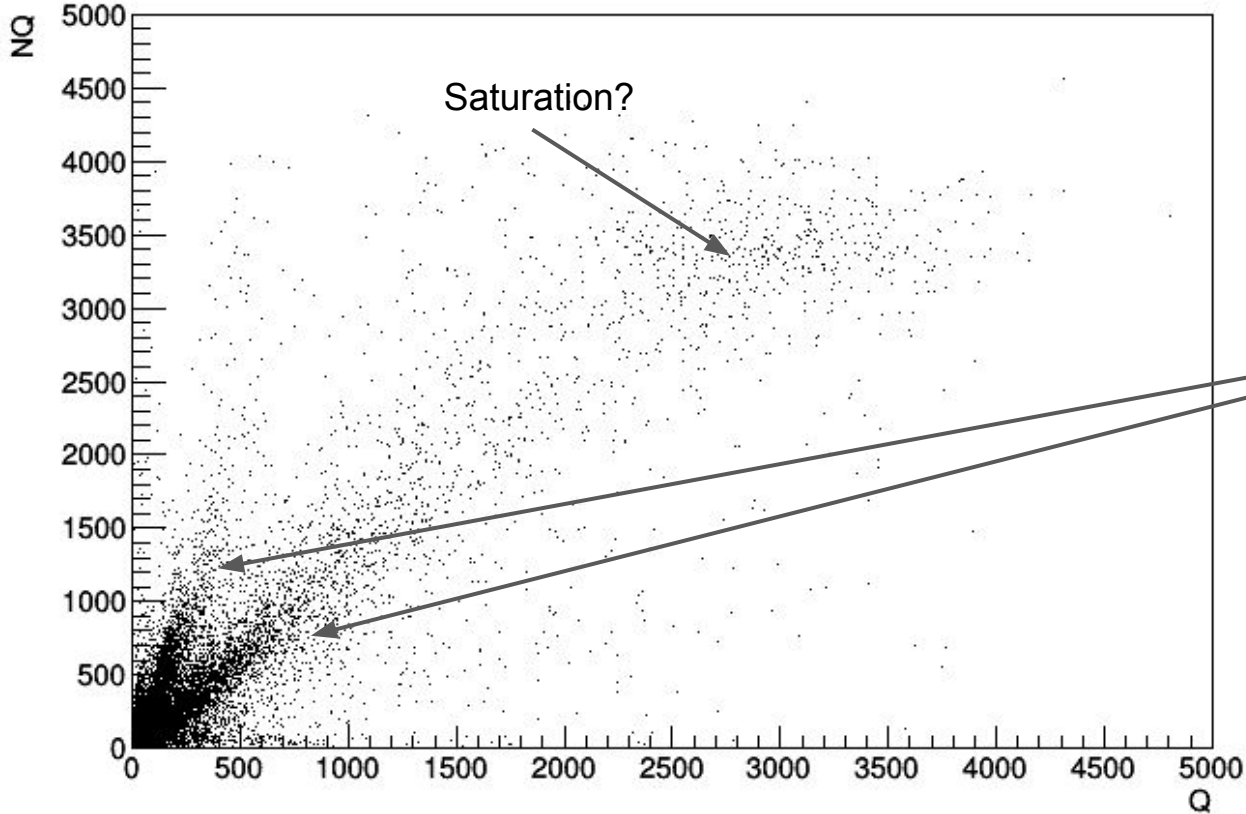*Def.:*

$$\langle LY \rangle_Q = \sum_{i=4,5,7} Integral_i$$

$\langle LY \rangle_Q$ ~35 in Dope3

Survey of the total light yield

from Niccolò Gallice & Henrique Souza's 12/06/2020 update: absolute light yields in nr. of photons are comparable with our values for both modules

NQ vs Q light yield in Dope3

- For each event in **"stable" runs post Dope3**, individual wfm is deconvolved through time domain FIR filter to turn pulses into deltas
- Absolute LY is computed for both XArapuca modules and entries in the scatter plot.
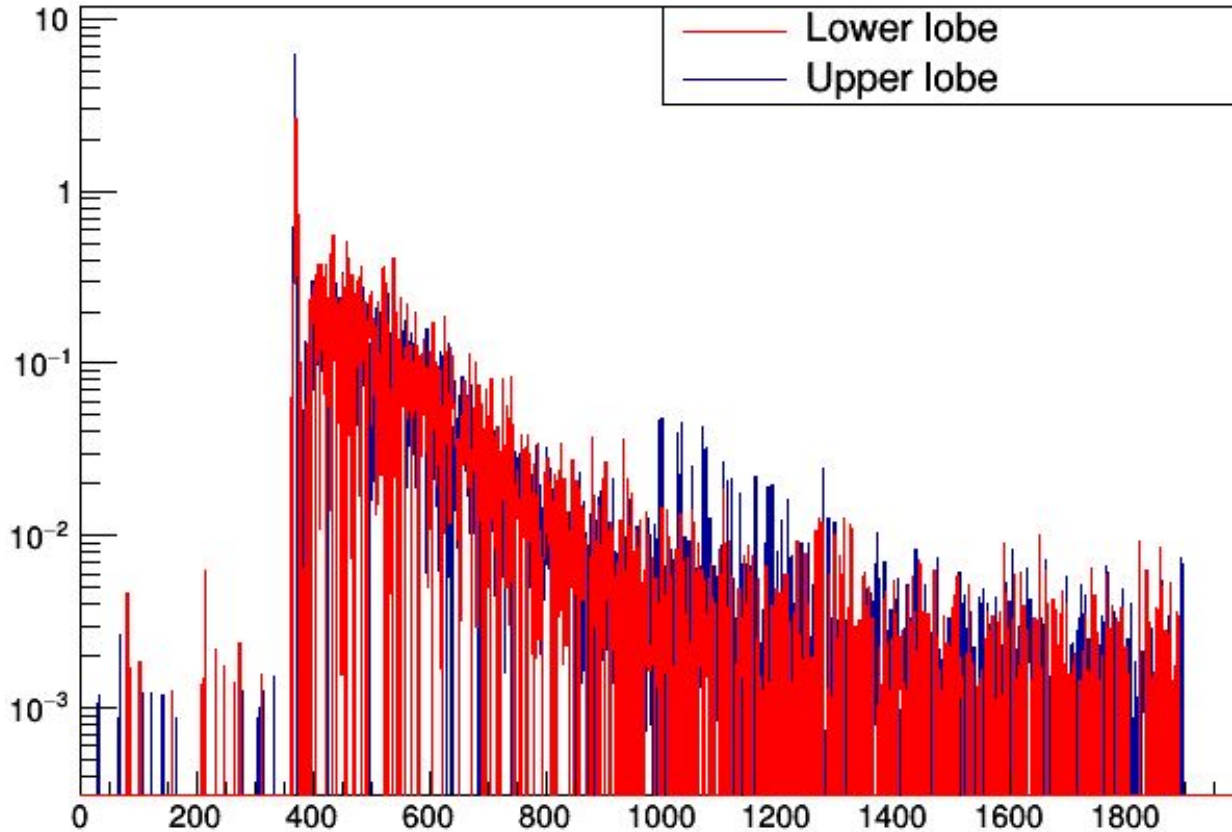- 2 "lobe" structures appear

NQ vs Q light yield in Dope3 - cuts
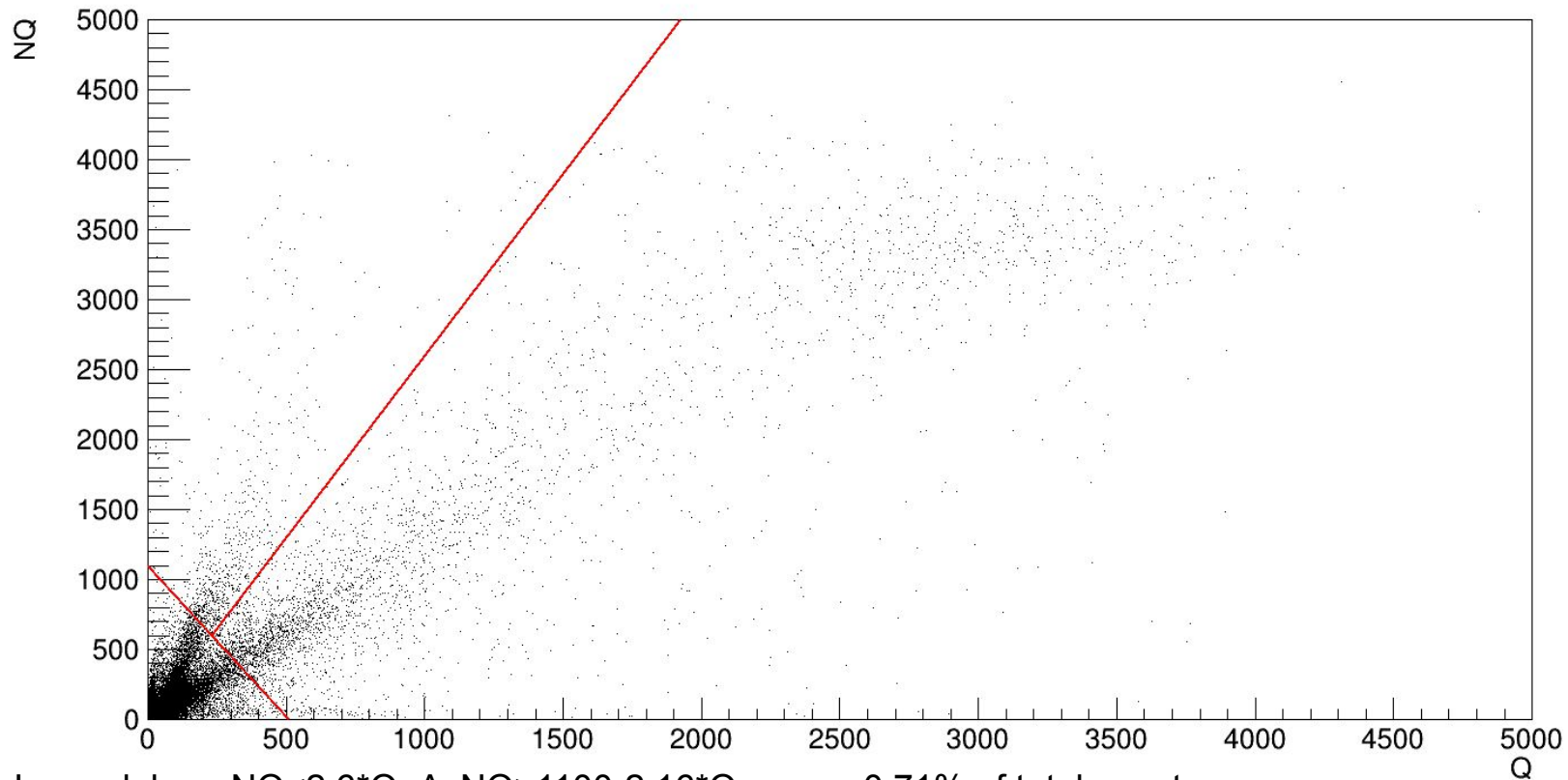
Lower lobe: $NQ < 2.6*Q$ ∧ $NQ > 1100 - 2.16*Q$ ← 0.71% of total events
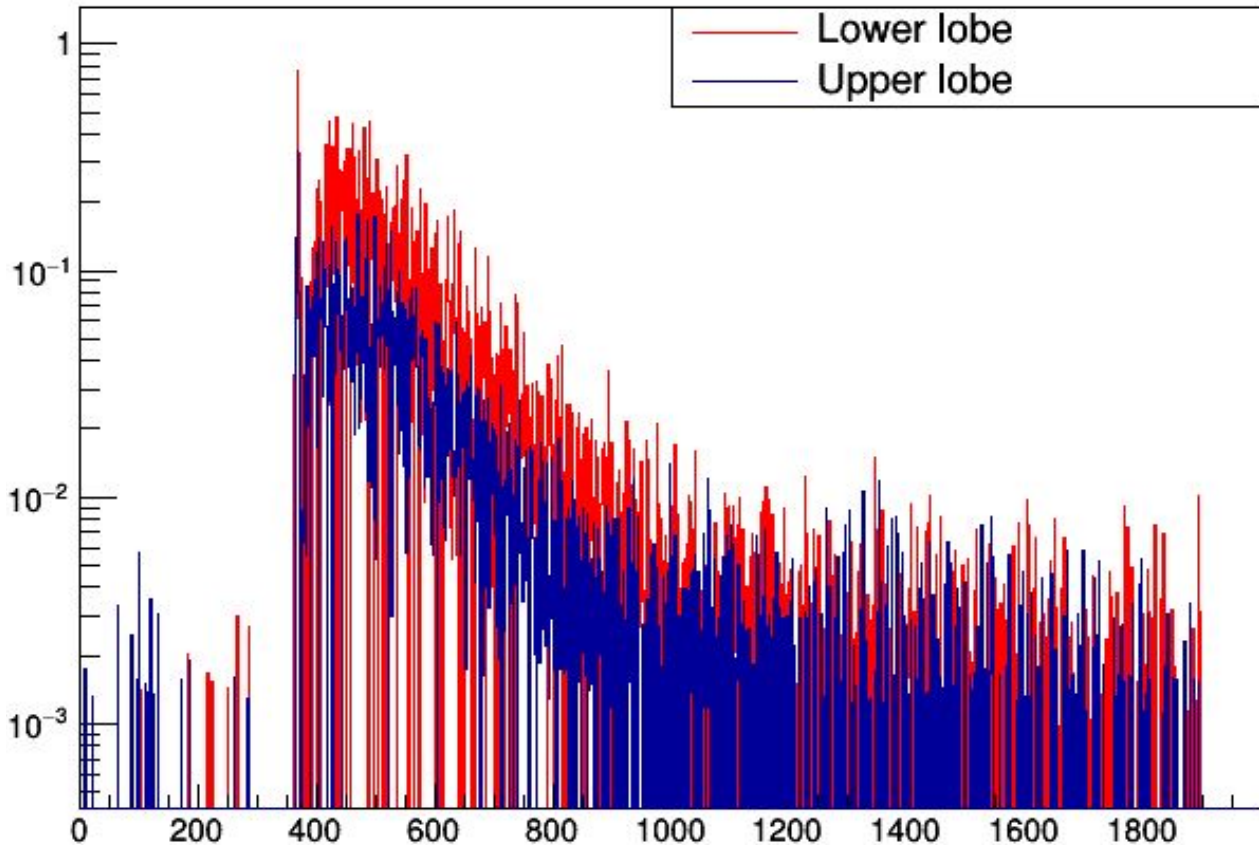Upper lobe: $NQ > 2.6*Q$ ∧ $NQ > 1100 - 2.16*Q$ ← 0.16% of total events

<wfm> in upper and lower lobes - No quartz - Dope3

- <wfm>s for events in each lobe
- upper lobe has more photons in the fast component

\<wfm> in upper and lower lobes - Quartz - Dope3

- \<wfm>s for events in each lobe
- upper lobe has same shape, less light

\<wfm> in upper and lower lobes - integrals . Dope3

	Integral	Integral$_{fast}$	Integral$_{slow}$
No quartz, lower lobe	44.9	8.5	36.4
No quartz, upper lobe	47.3	11.6	35.7
Quartz, lower lobe	38.5	2.3	36.2
Quartz, upper lobe	17.2	1.1	16.0
NQ/Q, lower lobe	1.17	3.70	1.01
NQ/Q, upper lobe	2.75	10.54	2.23
lower/upper, NQ	0.94	0.73	1.02
lower/upper, Q	2.24	2.09	2.26

fast component == first 20 ticks after trigger
slow component ==21st tick after trigger to end of \<wfm>

NQ vs Q light yield - cuts - Dope4
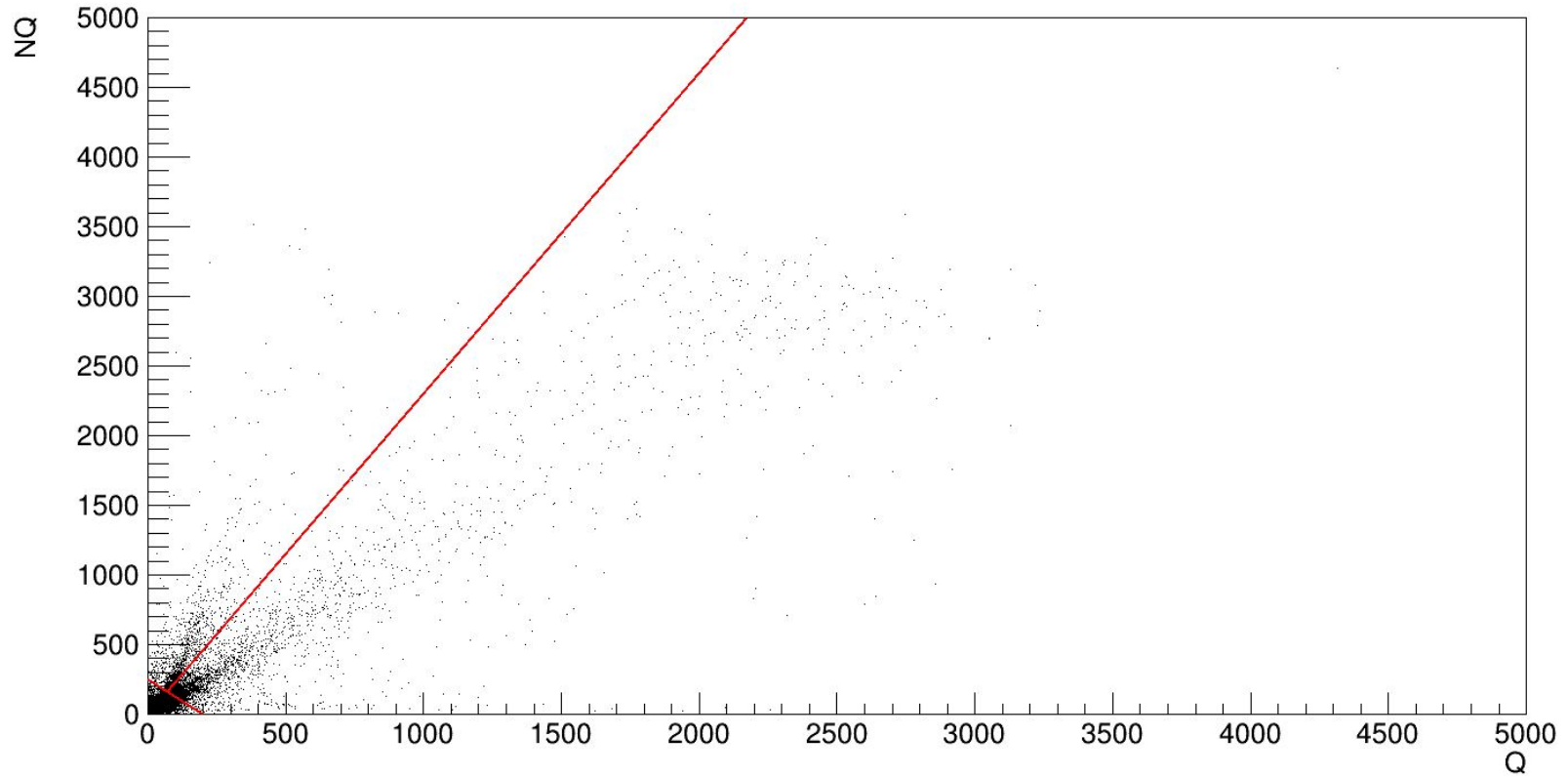
Lower lobe: NQ<2.3*Q ∧ NQ>250-1.25*Q   ← 0.76% of total events
Upper lobe: NQ>2.3*Q ∧ NQ>250-1.25*Q   ← 0.14% of total events

\<wfm> in upper and lower lobes - No quartz - Dope4

- \<wfm>s for events in each lobe
- upper lobe has more photons in the fast component

\<wfm\> in upper and lower lobes - No quartz - Dope4

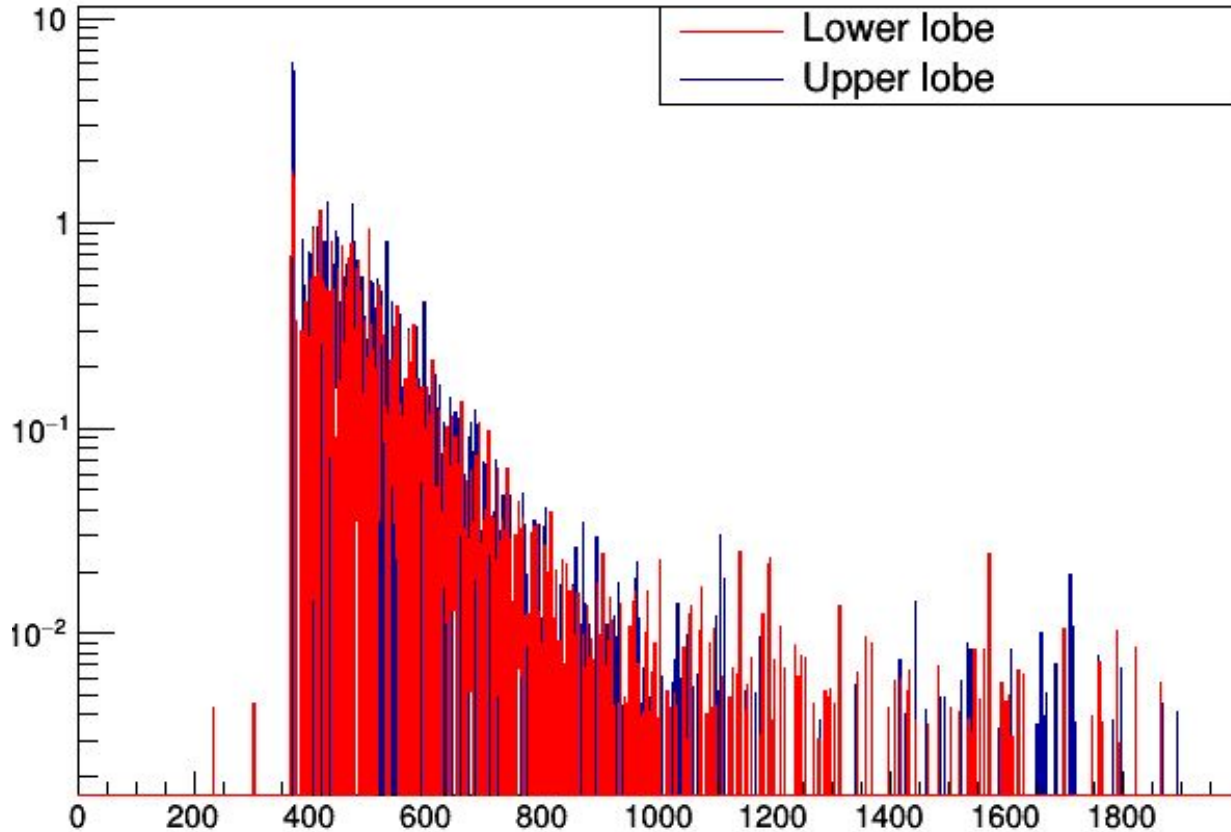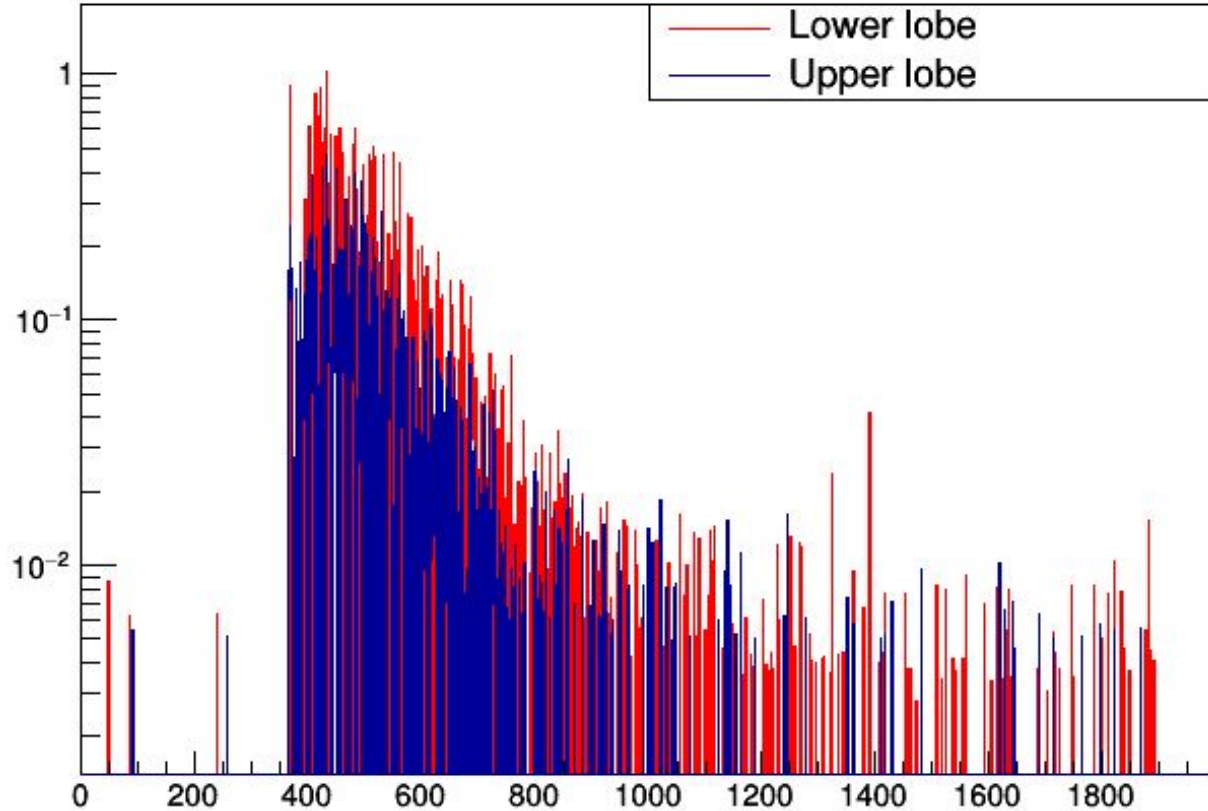- \<wfm\>s for events in each lobe
- upper lobe has same shape, less light

\<wfm> in upper and lower lobes - integrals - Dope4

	Integral	Integral$_{fast}$	Integral$_{slow}$
No quartz, lower lobe	53.7	8.8	44.9
No quartz, upper lobe	72.4	18.4	54.0
Quartz, lower lobe	41.6	1.5	40.1
Quartz, upper lobe	22.2	1.4	20.8
NQ/Q, lower lobe	1.29	5.88	1.12
NQ/Q, upper lobe	3.26	13.41	2.60
lower/upper, NQ	0.74	0.48	0.83
lower/upper, Q	1.88	1.09	1.93

fast component == first 20 ticks after trigger
slow component ==21st tick after trigger to end of \<wfm>

Conclusions

- LY_Q vs LY_{NQ} scatter plot produced for Dope3 and Dope4, confirmed "lobe" like structures
  - upper lobe(UL)=0.16% of total events (with present cuts): $LY_{NQ} \sim 3 \times LY_Q$
  - lower lobe(LL) =0.71% of total events (with present cuts): $LY_{NQ} \sim 1.2 \times LY_Q$

- <wfm> produced for each lobe and each xArapuca module; main differences appear to be
  - (UL): significantly higher fast component in NQ vs Q → (x10 in Dope3, x13 in Dope4)
  - (UL): higher slow component in NQ vs Q (>2x)
  - LY_{slow}(UL) ~= LY_{slow}(LL), but LY_{fast}(UL) > LY_{fast}(LL) (x1.5 in Dope3, x2 in Dope4)

- results consistent between dopings and with other independent analyses

- tentative interpretation:
  - fast component in NQ→ LAr scintillation light (no Cerenkov)
  - events in upper lobe because of geometry/shadowing?

To do:

- evaluate errors for <wfm>s/integrals

- repeat analysis for other Doping periods

- optimize cuts for lobes

- update LY & LY-ratios analysis to all available runs