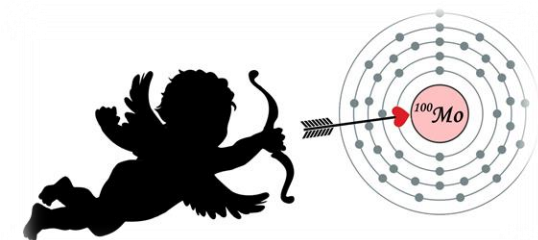


Improved Alpha Rejection by Simultaneous Use of Two Light Detectors in CUPID-Mo



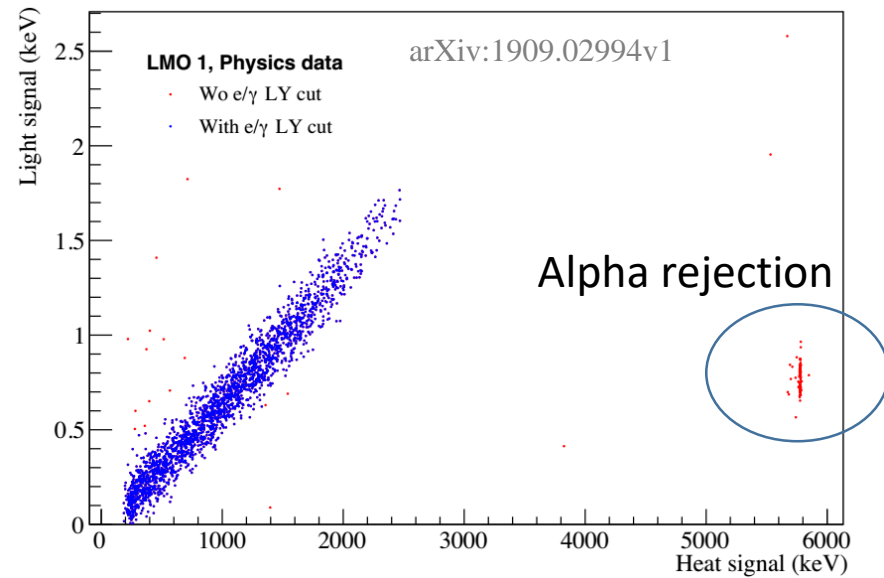
CUPID-Mo inauguration (Fourneaux, France)

Hawraa Khalife

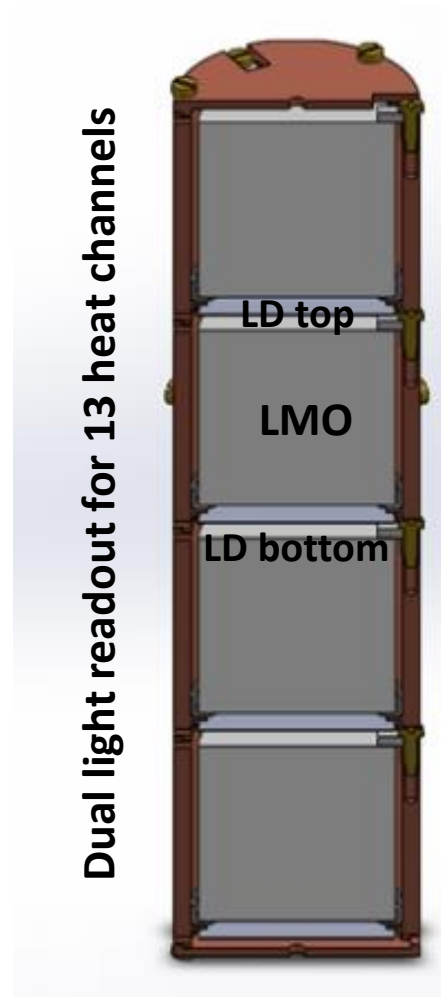
12/12/2019

Triple readout

In bolometers, dual heat-light readout helps getting rid of most of the alpha background.



In the current CUPID-Mo run, 13 heat channels are faced by two LD (should be 15, but 1 LD is lost). How can we benefit from this triple readout?



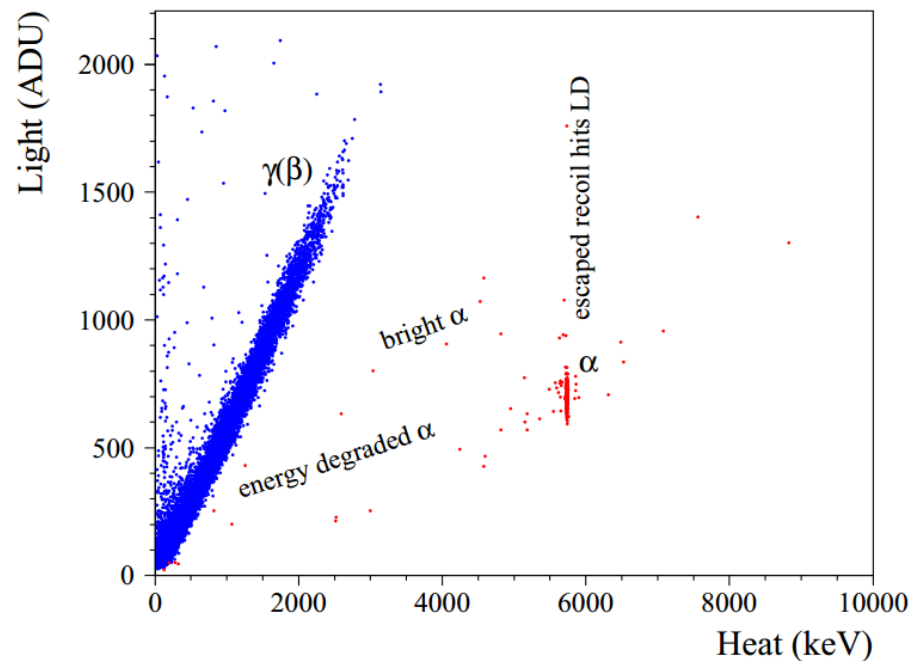
	Bottom LD	Top LD
LMO1	LD1	LD14
LMO3	LD3	LD2
LMO4	LD4	LD3
LMO6	LD6	LD5
LMO7	LD7	LD6
LMO8	LD8	LD7
LMO10	LD10	LD9
LMO11	LD11	LD10
LMO12	LD12	LD11
LMO14	LD14	LD16
LMO15	LD15	LD4
LMO16	LD16	LD17
LMO18	LD18	LD13
LMO19	LD19	LD18
LMO20	LD20	LD19

Enhanced light signal events rejection

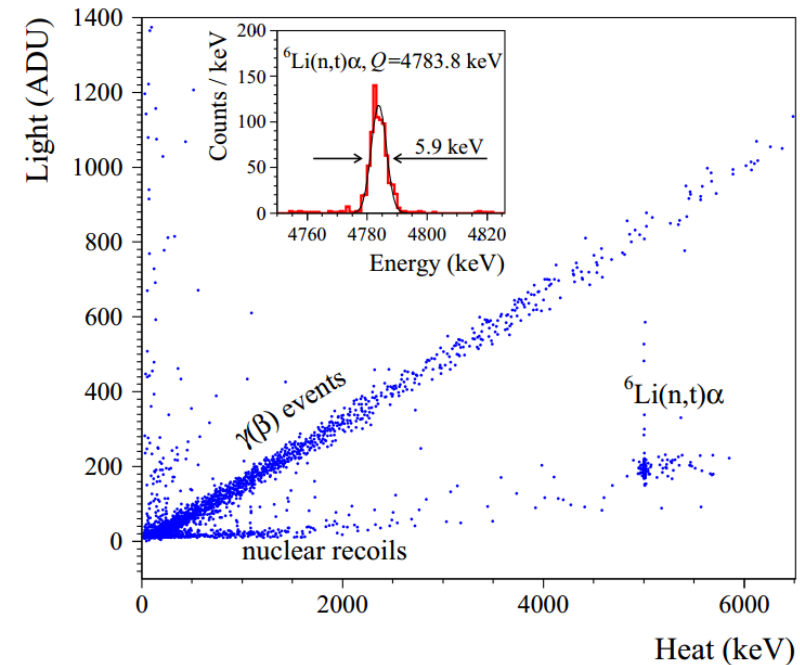
Surface events can lead to an escape of:

- Nuclear recoils
- Alpha particles
- Tritium (from thermal neutron capture in ${}^6\text{Li}$)

That can hit the light detector and give an enhanced light signal (in the γ/β region)



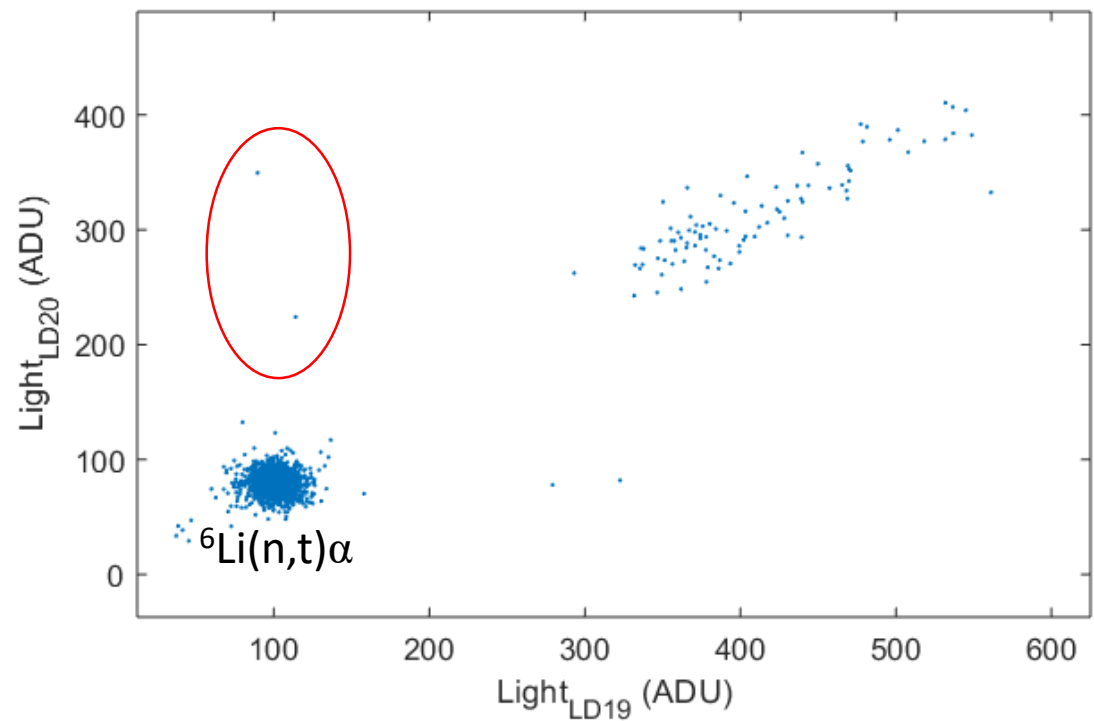
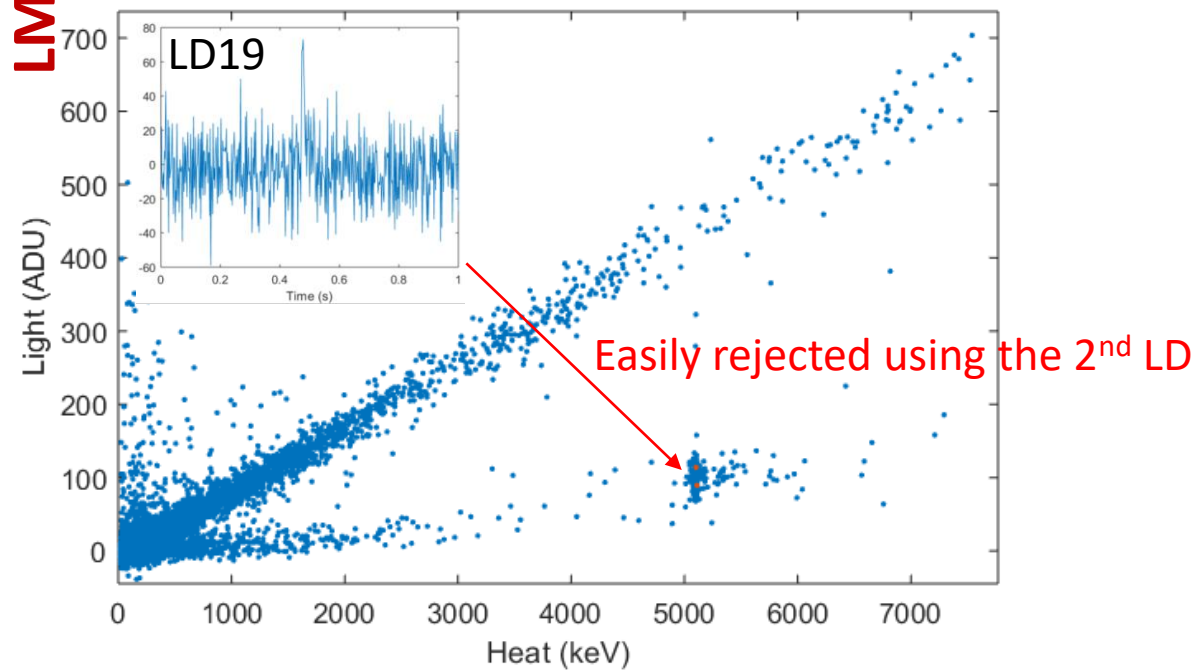
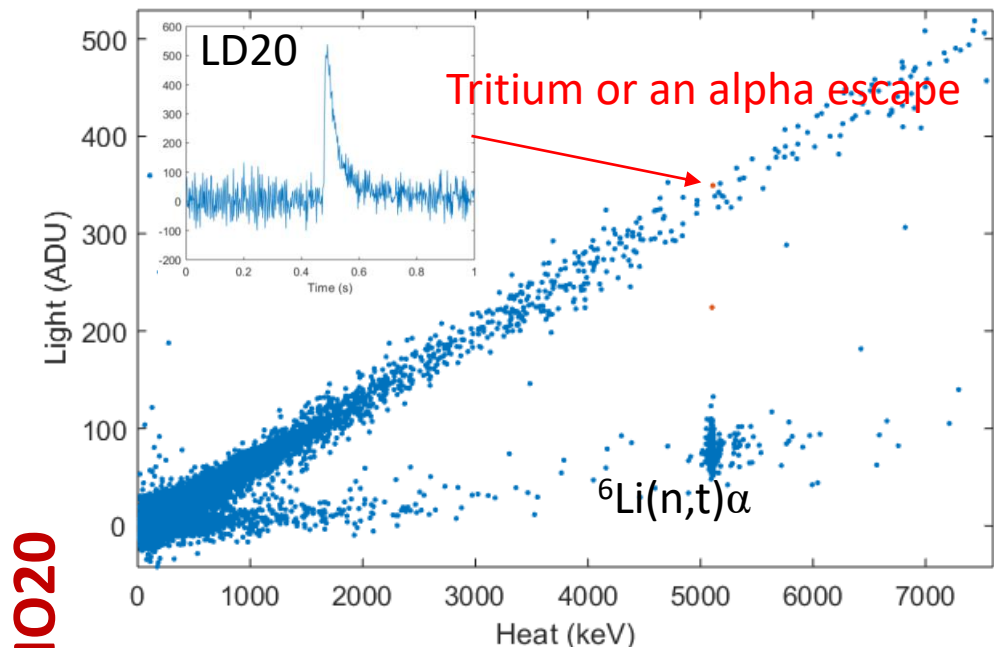
Eur. Phys. J. C (2017) 77:785



Eur. Phys. J. C (2017) 77:785

➤ These events can be identified and rejected thanks to having two LD readouts

Enhanced light signal events rejection



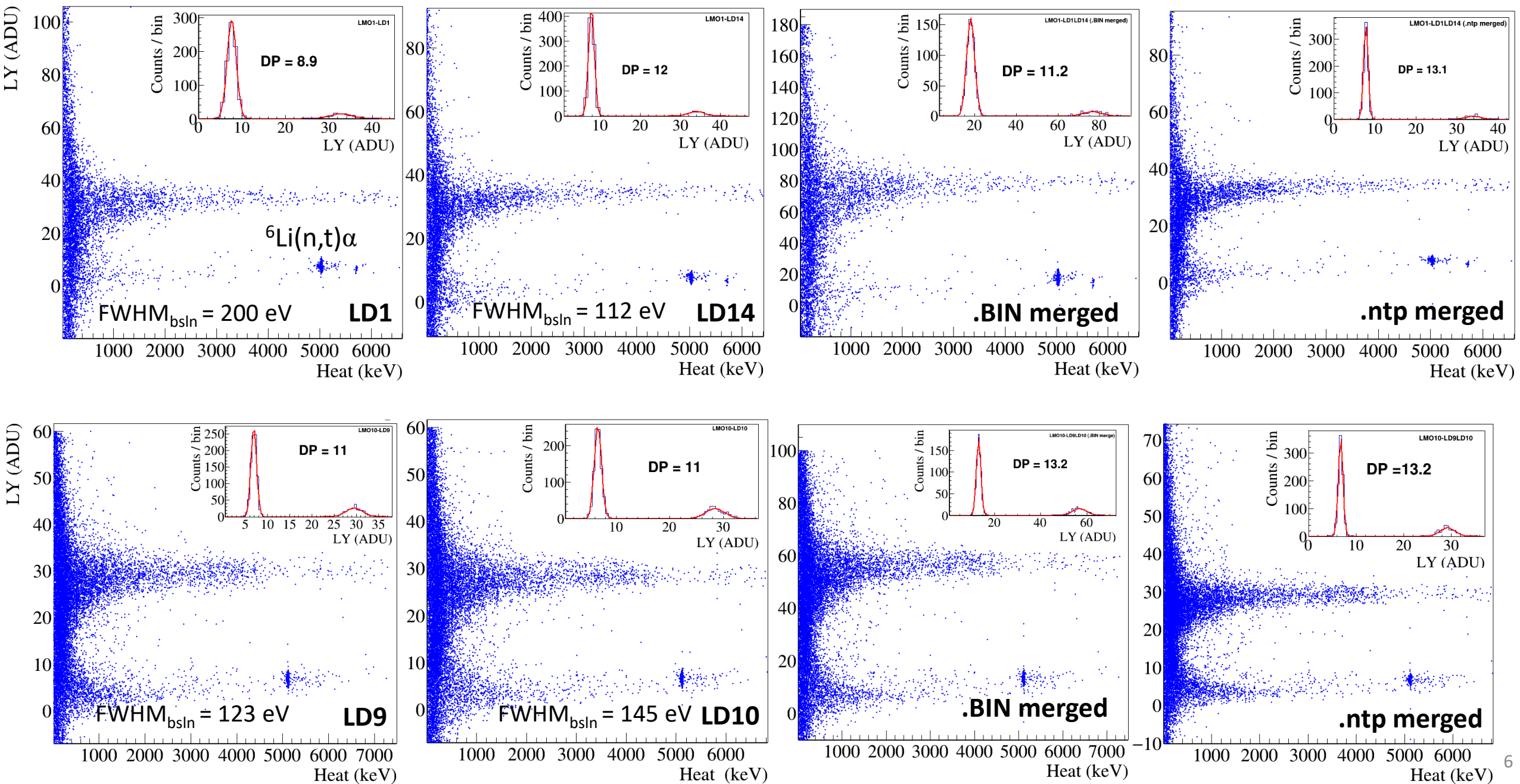
DP improvement

- It is confirmed that adding up the two LD outputs will lead to a better discrimination power. Ways to sum up:
 - **Before data processing:** adding the two binary files, i.e. summing the two windows point by point (bit by bit) [will call it .BIN merged]
 - Maximum possible gain in the signal to noise ratio $\sqrt{2}$
 - It will give pulses with a different time properties in case the two added pulses of the two LD are not similar.
 - **To be done:** weighted average of the binary files

- **After data processing:**

$$\frac{\text{Amplitude}_{LD1} \cdot \sigma_{\text{baseline LD2}}^2 + \text{Amplitude}_{LD2} \cdot \sigma_{\text{baseline LD1}}^2}{(\sigma_{\text{baseline LD1}}^2 + \sigma_{\text{baseline LD2}}^2)}$$

Weighted average
(will call it .ntp merged)



Results

LMO	Top LD		Bottom LD			
	DP	FWHM _{bsl} eV	DP	FWHM _{bsl} eV	DP (.BIN merged)	DP (.ntp merged)*
1	12	113	8.9	201	11.2	13.1
6	7.8	147	7.9	96	5.8	12.2
10	11	123	11	144	13.2	13.2
11	8.5	144	10.3	79	7.7	14.6
14	8.6	235	8.5	110	12.9	12.3
15	7	108	13.9	97	9.8	12.5
16	9.9	161	8	235	9	11.8
18	9	- *	13.4	109	18.7	13.2
19	11.7	109	10.2	160	9.9	13.6
20	10	160	10.8	- *	12.4	14.6

* Unable to calibrate due to the short period ⁶⁰Co run

The DP is improved by exploiting merging the two LD data.

Conclusion

- Two LD channels help identifying the nuclear recoil/alpha particle/tritium emitted close to crystal surface that have an enhanced light signal.
- Improve the DP after merging the two signals (weighted average)