Study of the ER f_prompt peak vs energy

Different particles give different signal shapes, and this is the basis of PSD.
Also, the same kind of particles which have different energy deposits give different signal shapes. The phenomenon arises from the amount of energy deposited, dE/dx. For example, faster electrons according to the Bethe-Bloch formula have lower dE/dx; this stimulates the slow component in S1.

On the opposite, slower electrons have higher dE/dx, therefore stimulate more the fast component in the S1 signal.
The higher the energy loss in ionization, the faster and stronger recombination takes place.

We expect ER ***f_prompt*** peaks to drift towards higher values of ***f_prompt*** for lower energy ER events and towards lower values for higher energy ER events.

A study of f_prompt ER peaks vs energy was done for Am (run 1073) and Kr (run 1061) sources.

Some values of mu and sigma for such peaks are reported, for different energy regions.

shift in f_prompt

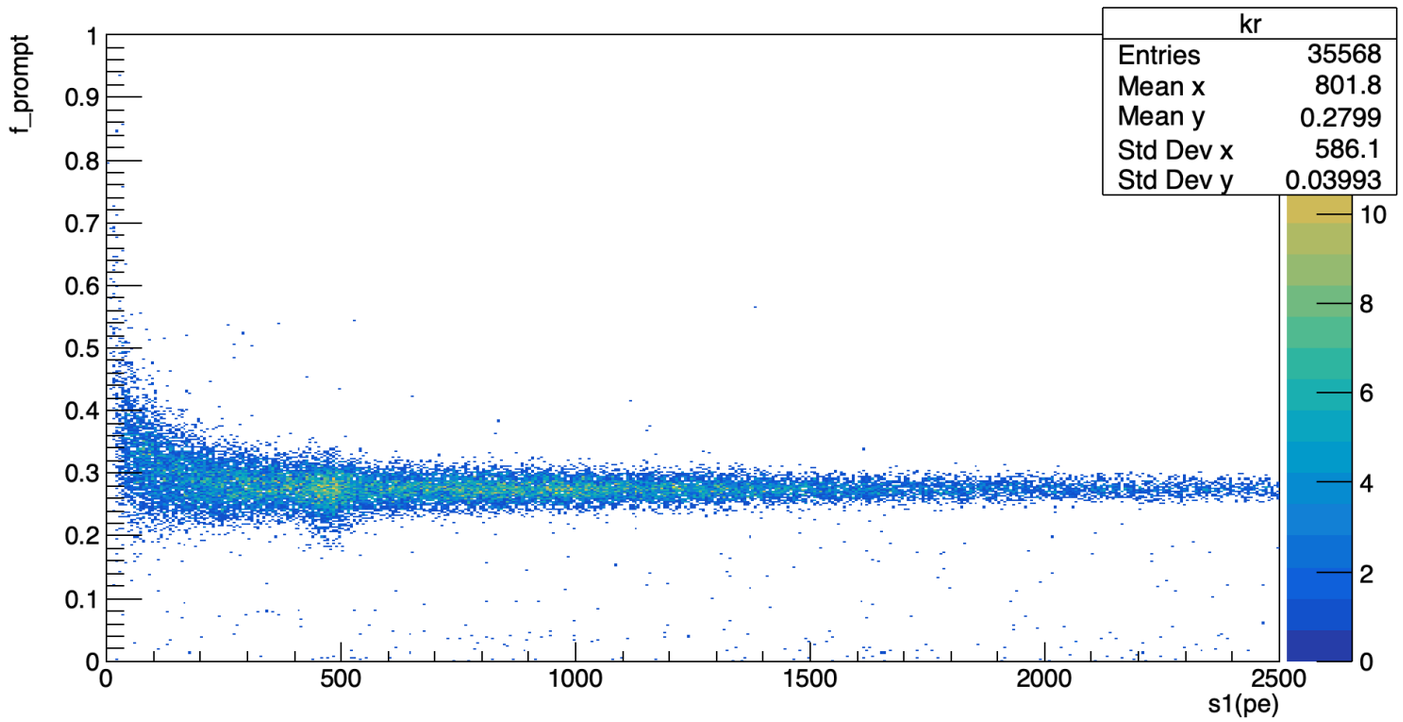
run 1073, Am, single phase

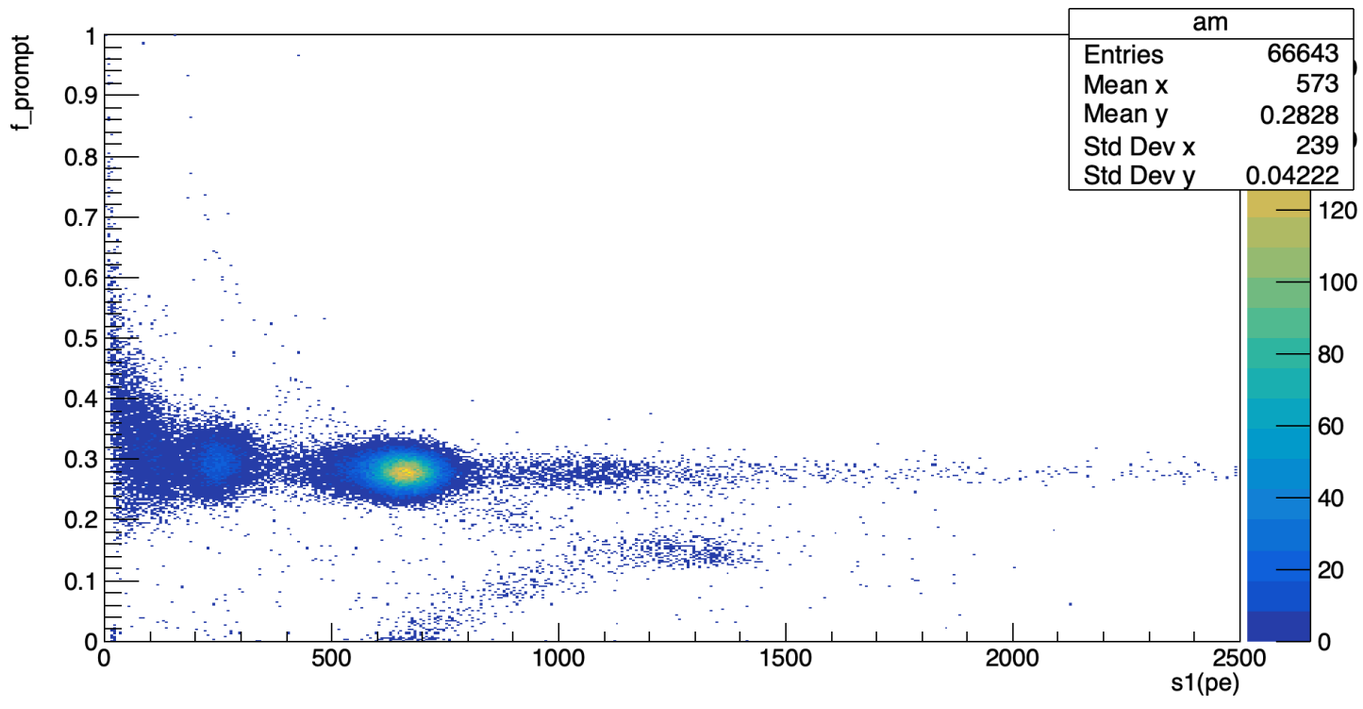
S1 Slice (PE)	f_prompt mu	f_prompt sigma
<500	0.295	0.031
500-1000	0.279	0.018
1000-1500	0.2775	0.0147
1500-2000	0.276	0.0124
2000-2500	0.2765	0.0065

run 1061, Kr, double phase

S1 Slice (PE)	f_prompt mu	f_prompt sigma
<500	0.2799	0.02853
500-1000	0.2748	0.01661
1000-1500	0.2742	0.01313
1500-2000	0.2743	0.01154
2000-2500	0.2746	0.00955

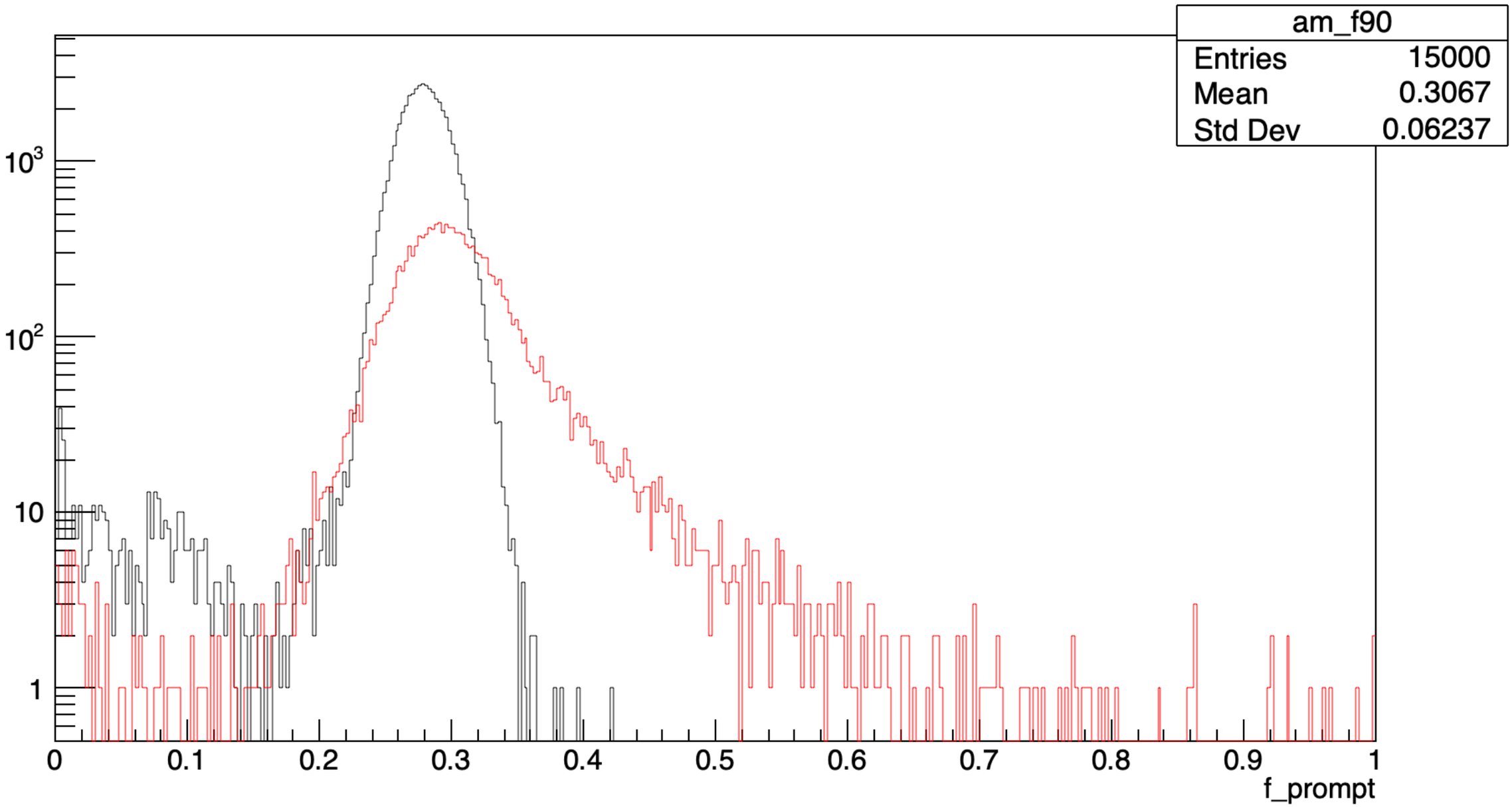
Scatter plots of f_prompt vs s1 are shown, for runs 1061 (kr-83, double phase, top) and 1073 (Am-241, single phase, bottom)



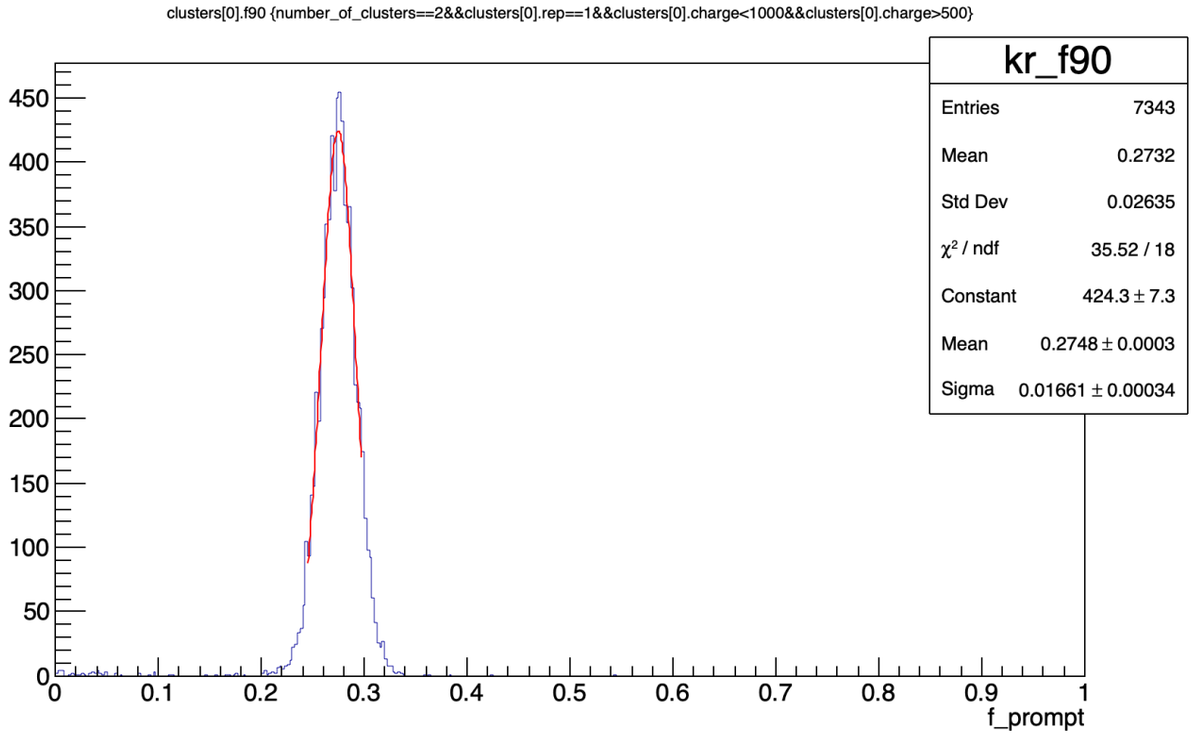


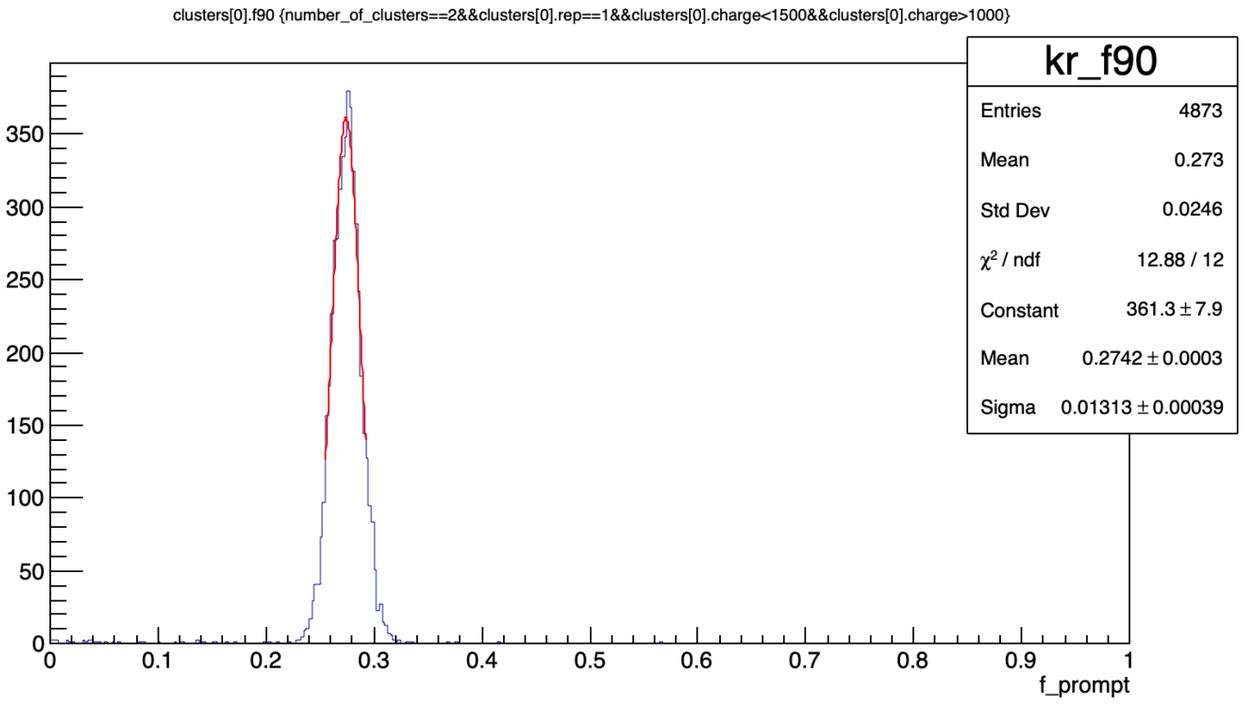
Nevertheless the scatter plots are quite different, a drift in f_prompt peaks will be observed, as shown in the following pages.

A drift in f_prompt peak is visible. Raising the s1 range, the mean value of the f_prompt peak decreases. Am-241, run 1073, single phase: in red 0-500 pe region, in black 500-1000 pe region peak is plotted.



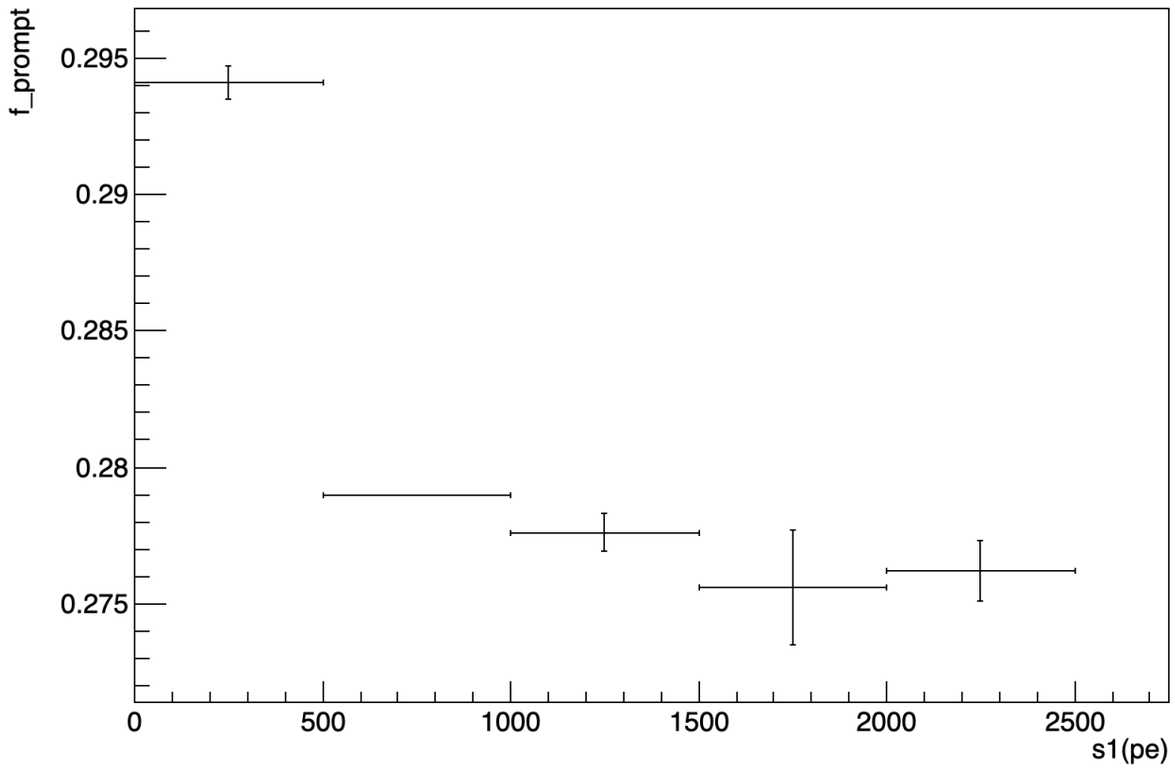
For the Kr-83 run, we can observe f_prompt peaks in the energy regions 500-1000 (top) and 1000-1500 (bottom)pe in s1.

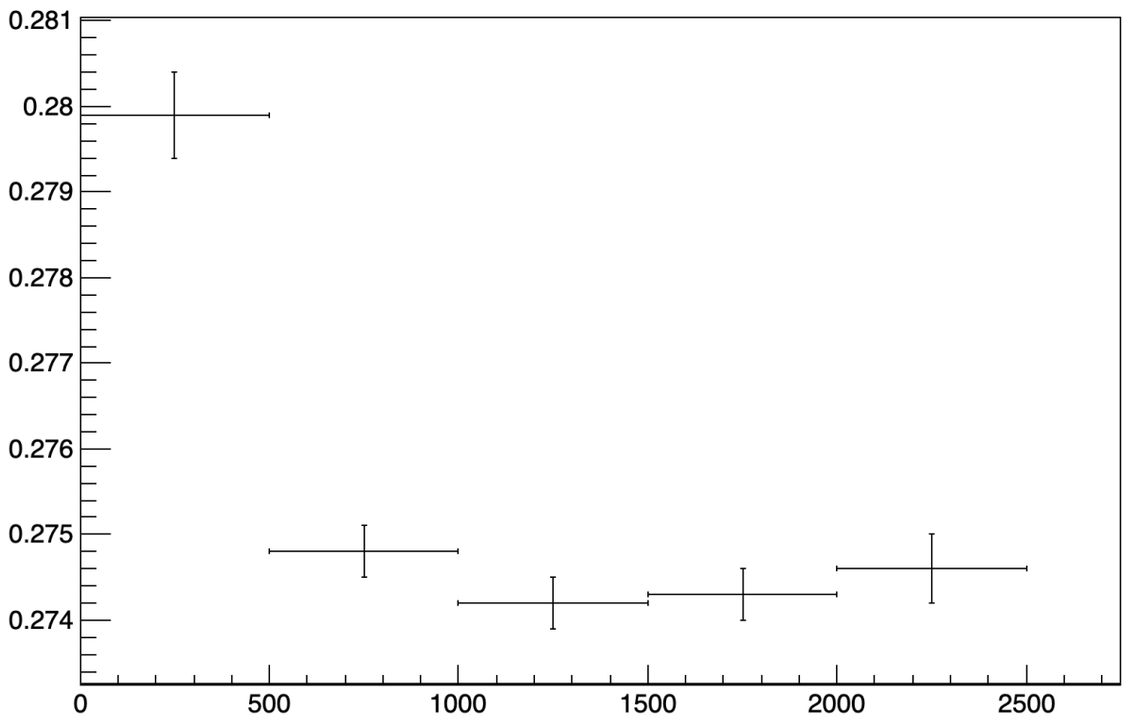




Between these 2 plots, the difference is not easy to appreciate, there is a slight difference in the mean values (0.2748 for the 0-500 pe range, and 0.2742 for the 500-1000 energy range), still f_prompt decreases for higher s1.

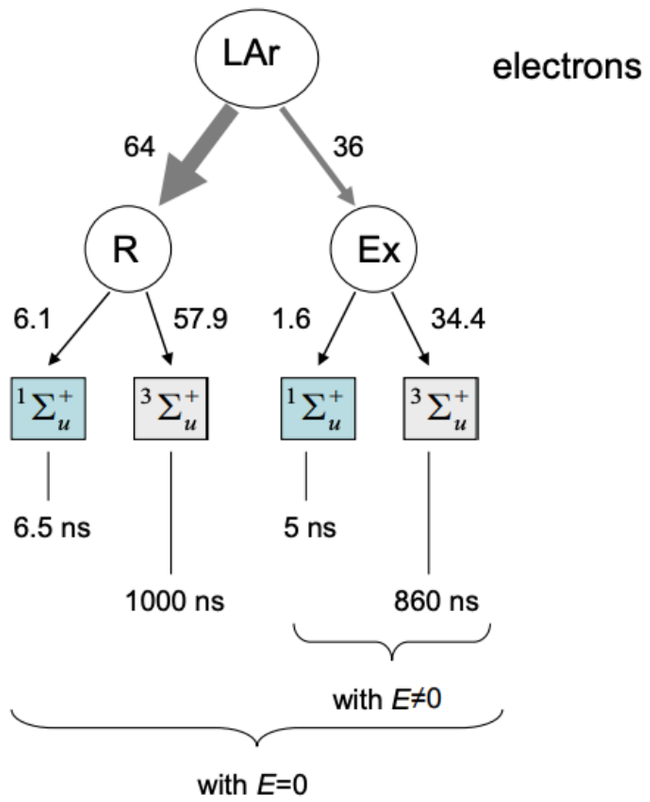
F_prompt peaks can be looked at yet in another way: plots of Am-241 (top) and Kr-83 (bottom)
f_prompt peaks vs s1; horizontal error bars represent the mean values of the f_prompt peaks in their energy "slices", while vertical error bars represent the fit errors on such values.





<— f_prompt value can vary from source to source, also according to the energy deposits by single events: for example, in the Kr run the 0-500 pe peak for f_prompt is higher in f_prompt. This can be ascribed to the fact that actually the Kr-83 peak at 41.5 keV is the result of the sum of 2 lower energy deposits, so the f_prompt is possibly higher.

Moreover, theory tells us also about differences according to the presence of a drifting field. As is visible from this picture taken from the Chepel paper*, slower components are suppressed by the presence of a drift field, which also explains the LY enhancement in runs without fields.



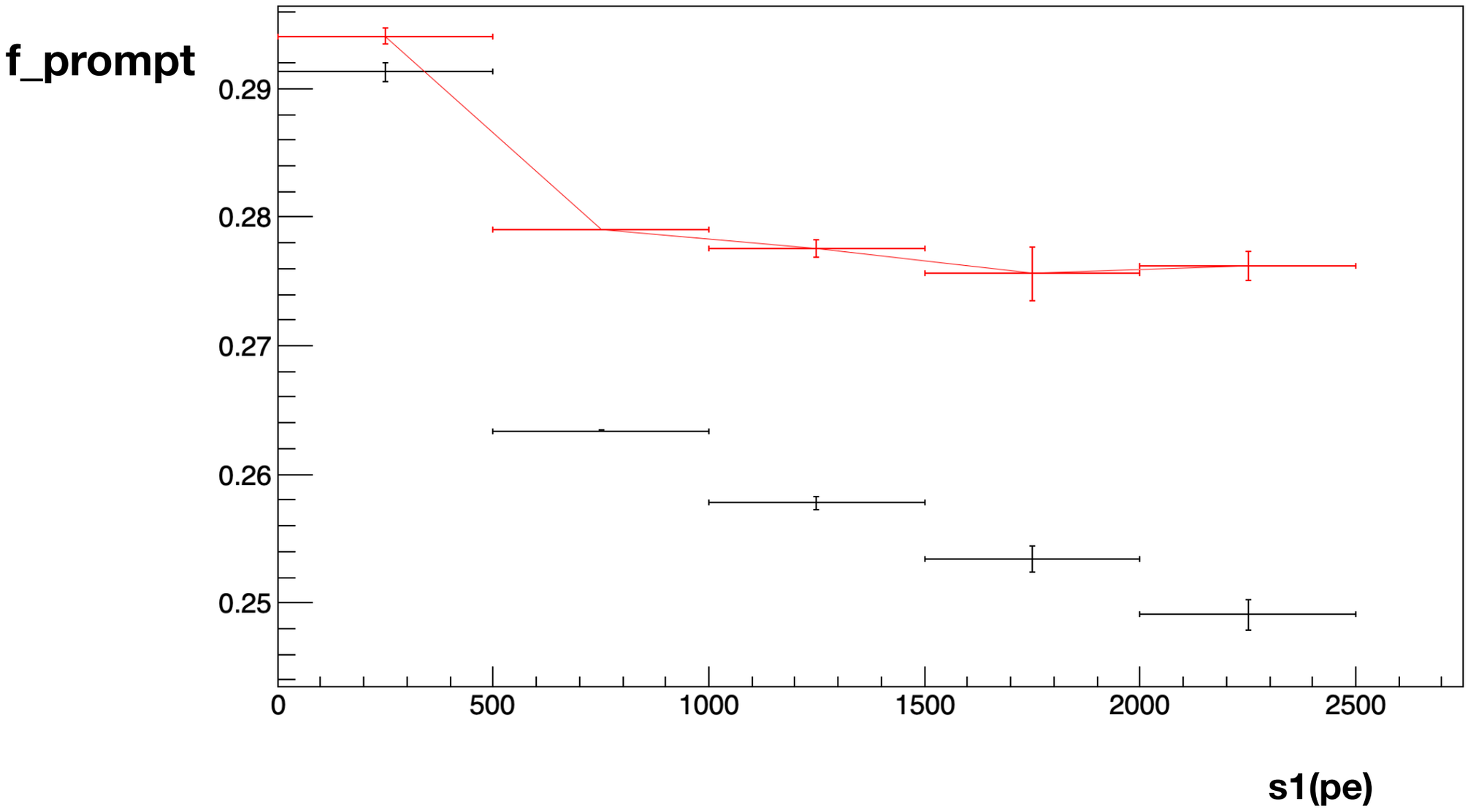
run 1071, Am, fields off, single phase

S1 Slice (PE)	f_prompt mu	f_prompt sigma
<500	0.2913	0.04294
500-1000	0.2634	0.017
1000-1500	0.2578	0.01419
1500-2000	0.2534	0.01138
2000-2500	0.2491	0.00863

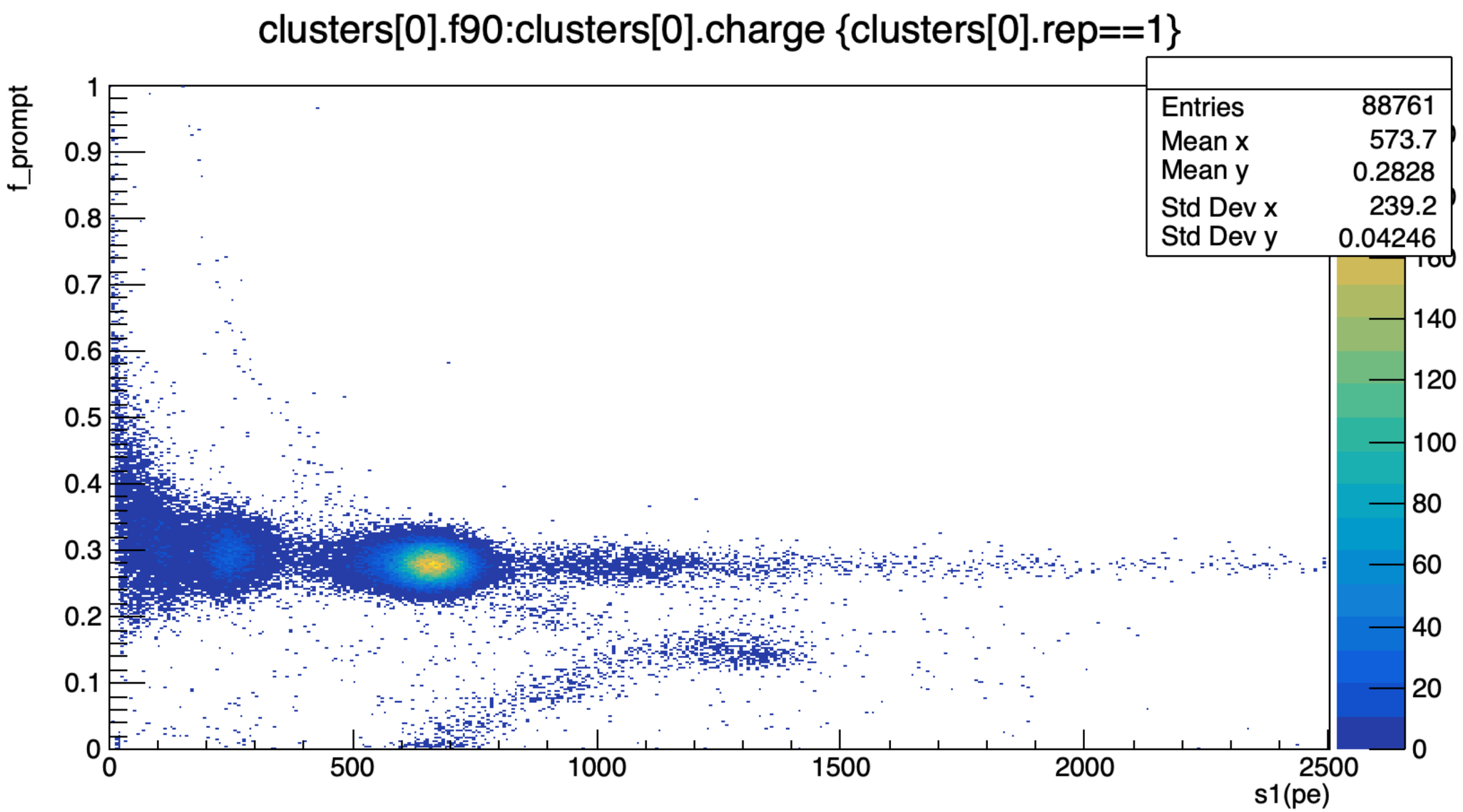
f_prompt values vs S1 are taken from run 1071, Am-241, single phase, fields off.

*V.Chepel et al., “Liquid noble gas detectors for low energy particle physics”, ArXiv: 1207.2292

f_prompt of run 1071 (fields off, black) compared to f_prompt of run 1073 (fields on, red) from Am sources in single phase. Moreover, the effect of lower f_prompt with increasing energy is in this run visible up to 2500 pe.



As for run 1073 (Am single phase), another slicing better shows the decrease of the ER f_prompt peak with increasing S1(PE). As we can see from the scatter plot of f_prompt vs S1, the best slicing looks 0-150, 150-400 and s1>400 PE.



Applying such cuts to run 1073 0-150, 150-400, and s1>400 pe, it is even more evident that f_prompt drifts towards lower values with increasing energy