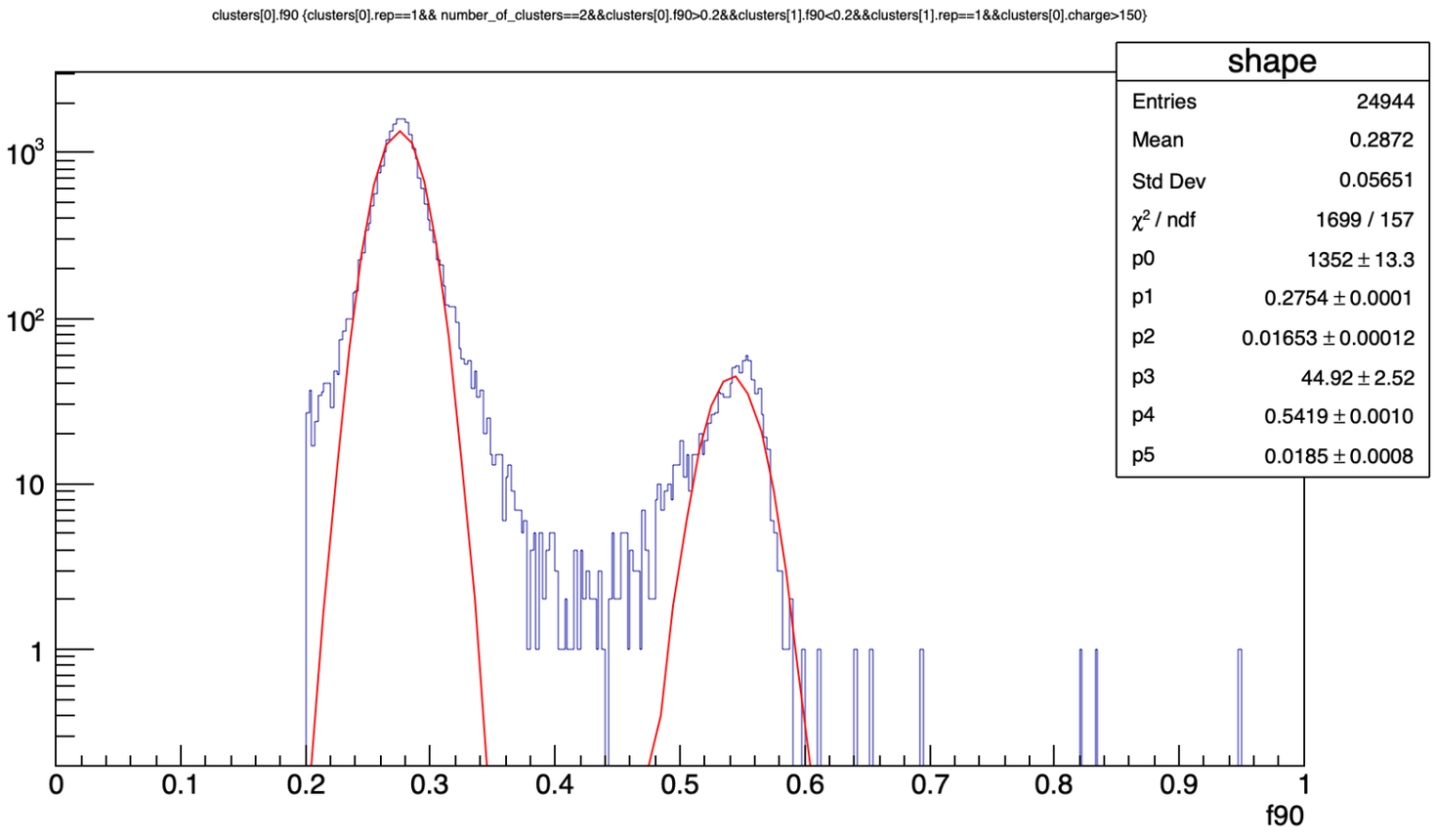
TPC analysis: PSD

New runs analysed (1197, 1198, 1199, tagged AmBe@center), with a different approach on fits, to determine the FoM (Figure of Merit) between neutron and gamma distributions.

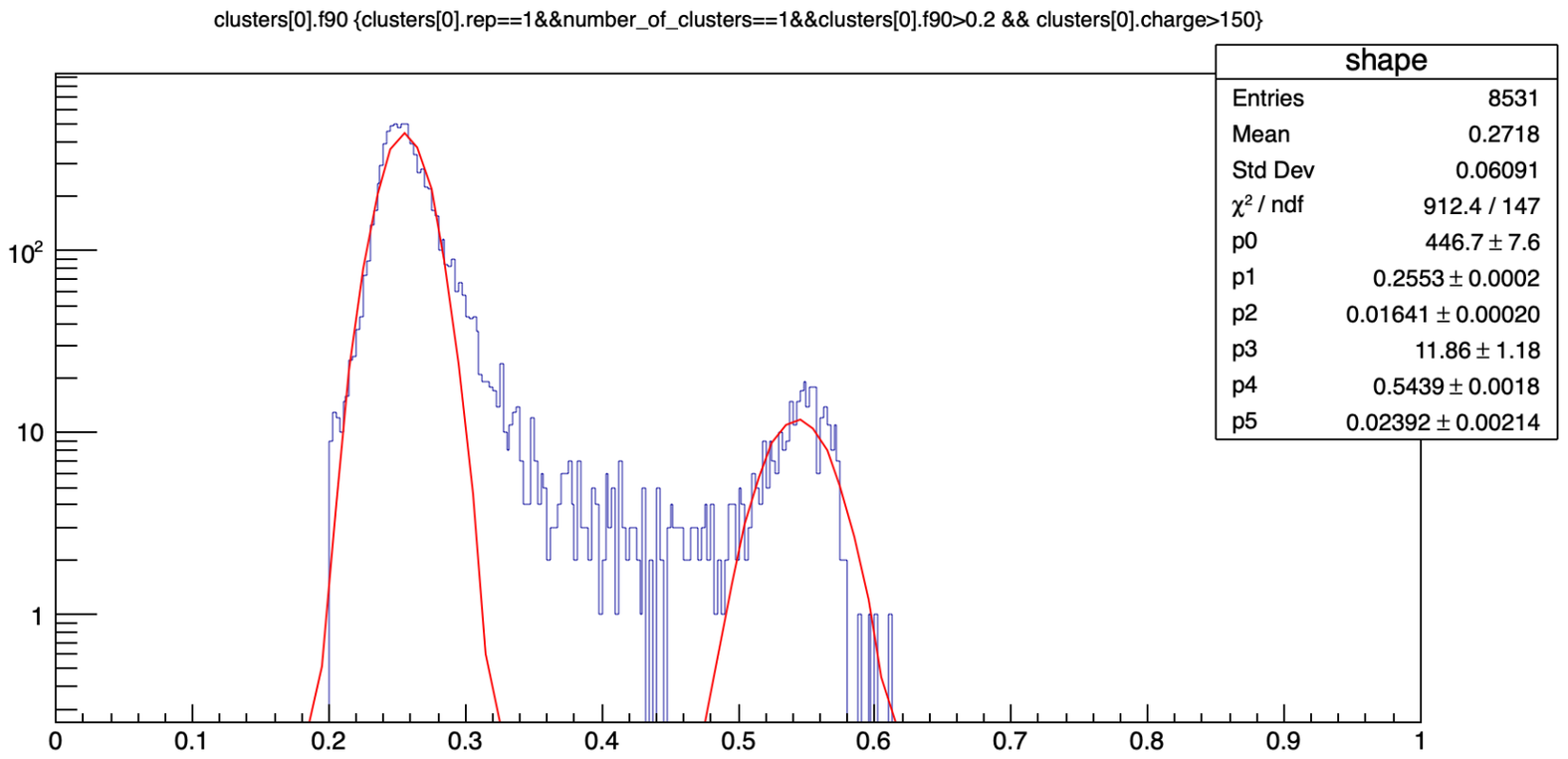
Runs have been cut and f90 has been analysed for energies > 150 PE. Parameters have been constrained to the region where the f90 peaks are present (from 0.2 to 0.6)



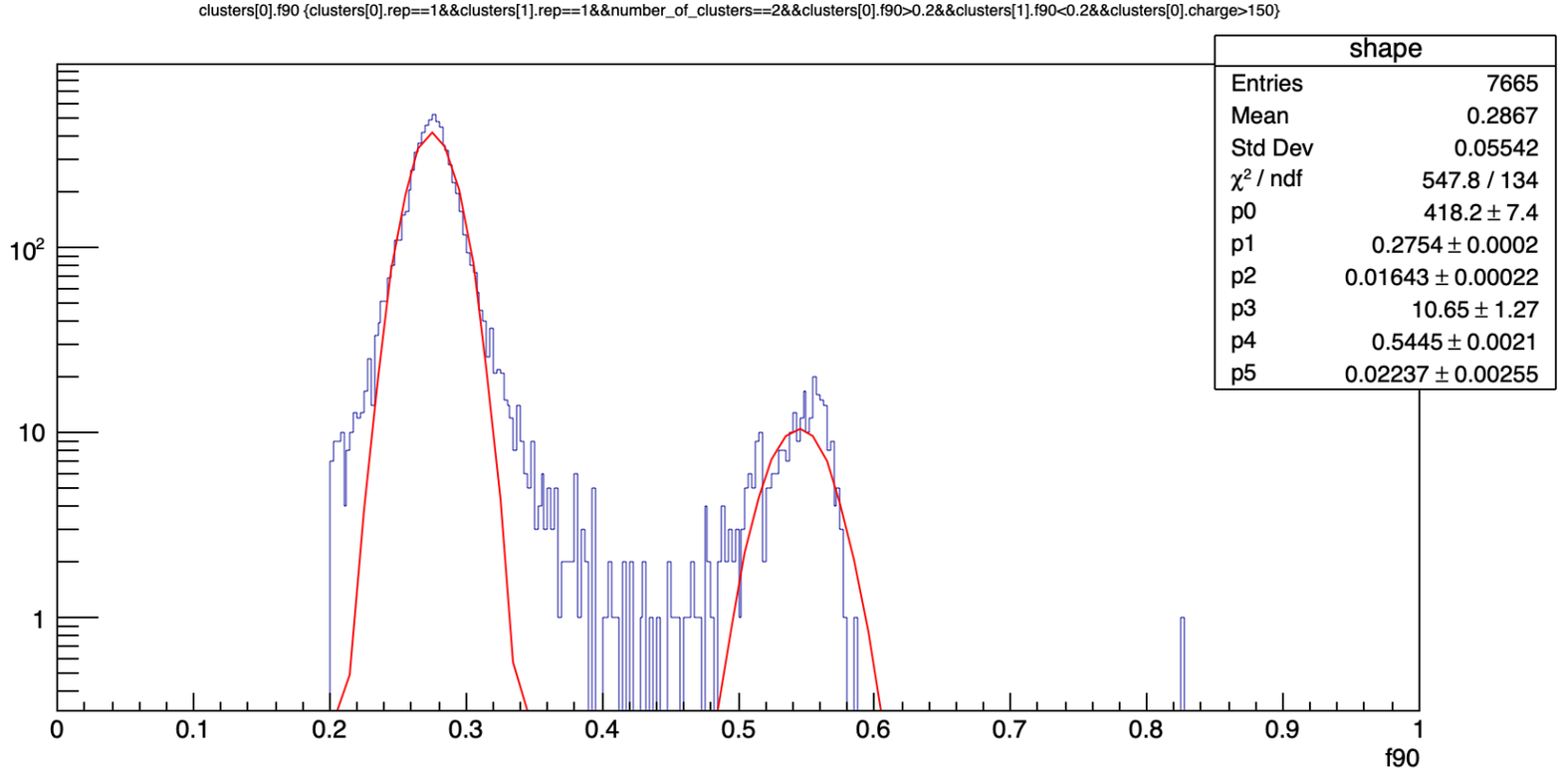
For example, here on the right: fit on f90 for run 1197.
Constraint on energy: s1>150 PE.
Cutting on energy and constraining mean values of the peaks between 0.2 and 0.6, it was possible to fit f90 with 2 gaussians.

FoM = 10.75 ± 0.03 (run 1197)
FoM = 9.95 ± 0.07 (run 1196)
FoM = 9.69 ± 0.09 (run 1999)

Run 1998 was too poor in terms of number of events, for this method.

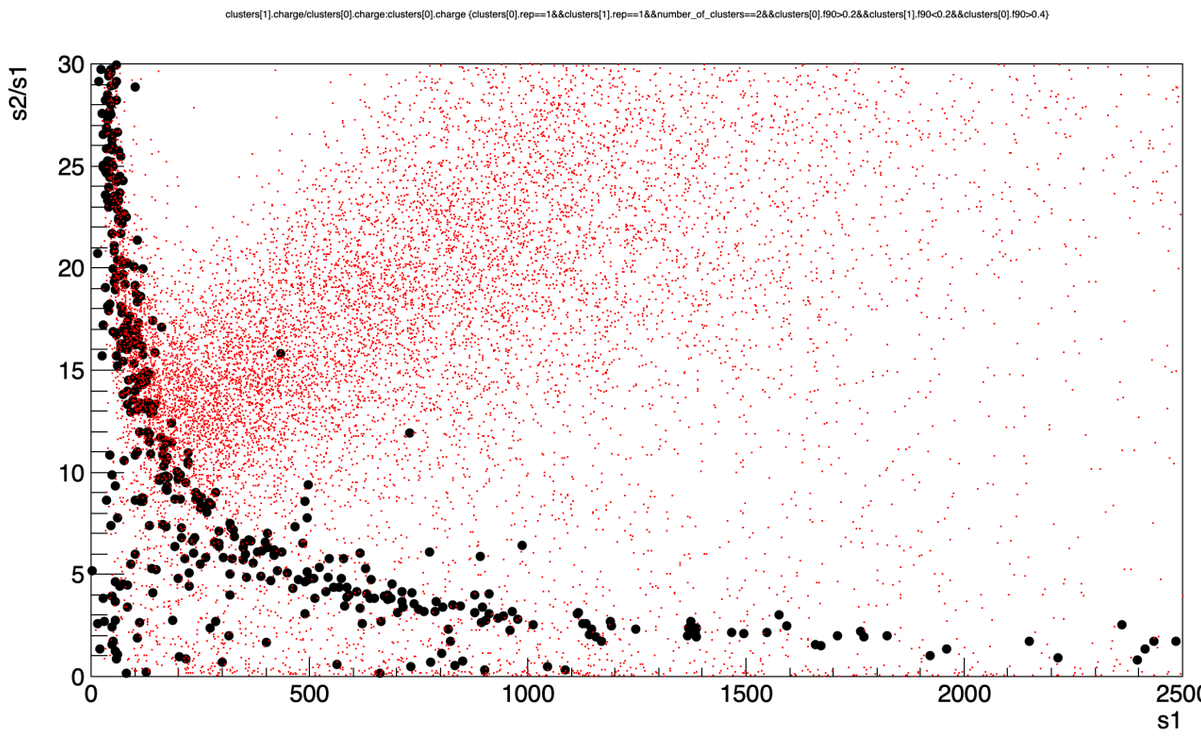


<—run 1196



<—run 1199

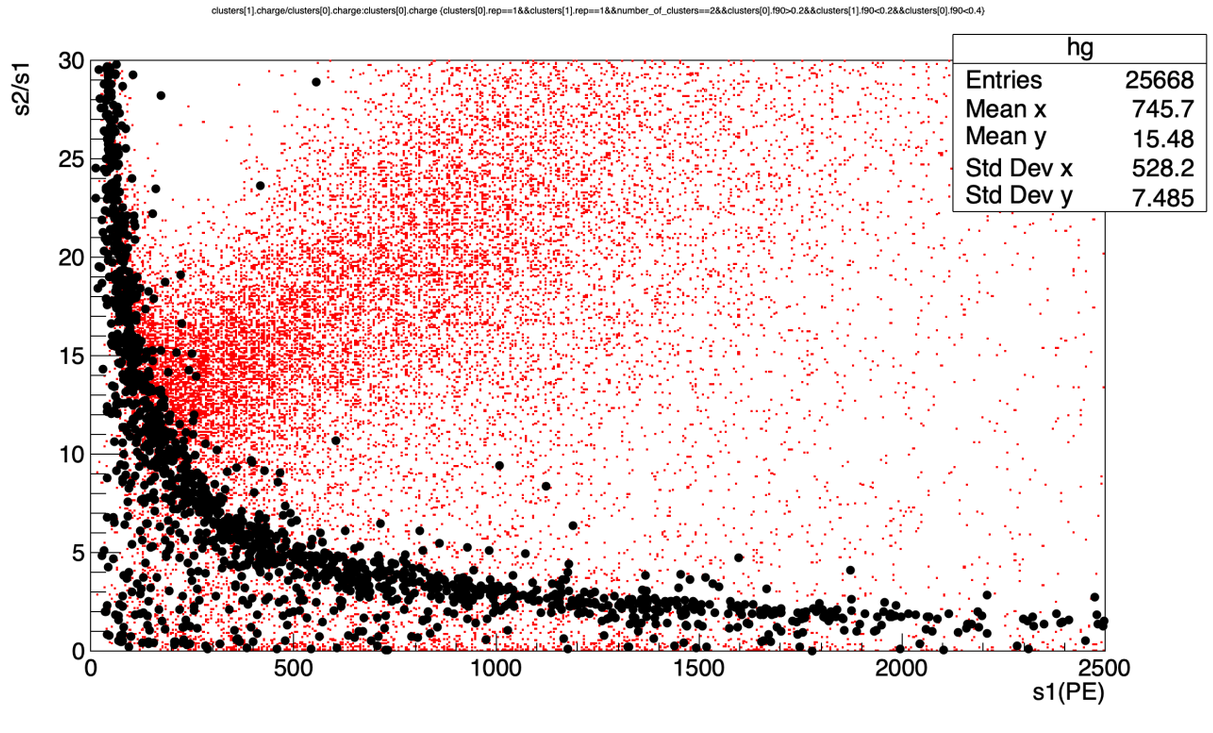
FoM values were already determined for previous runs, while there is another indicator yet to be studied: **s2/s1**. For AmBe runs starting from run 1186, s2/s1 was plotted vs s1, and constrained according to the f90 value of the events.
It is clearly visible that different regions are affected, on the plane s2/s1 vs s1, according to f90 values. In red, f90<0.4 (ER) , while in black spots we have events for f90 >0.4 (NR). Similar graphs were created for runs 1186 to 1189, and runs 1196 to 1199.

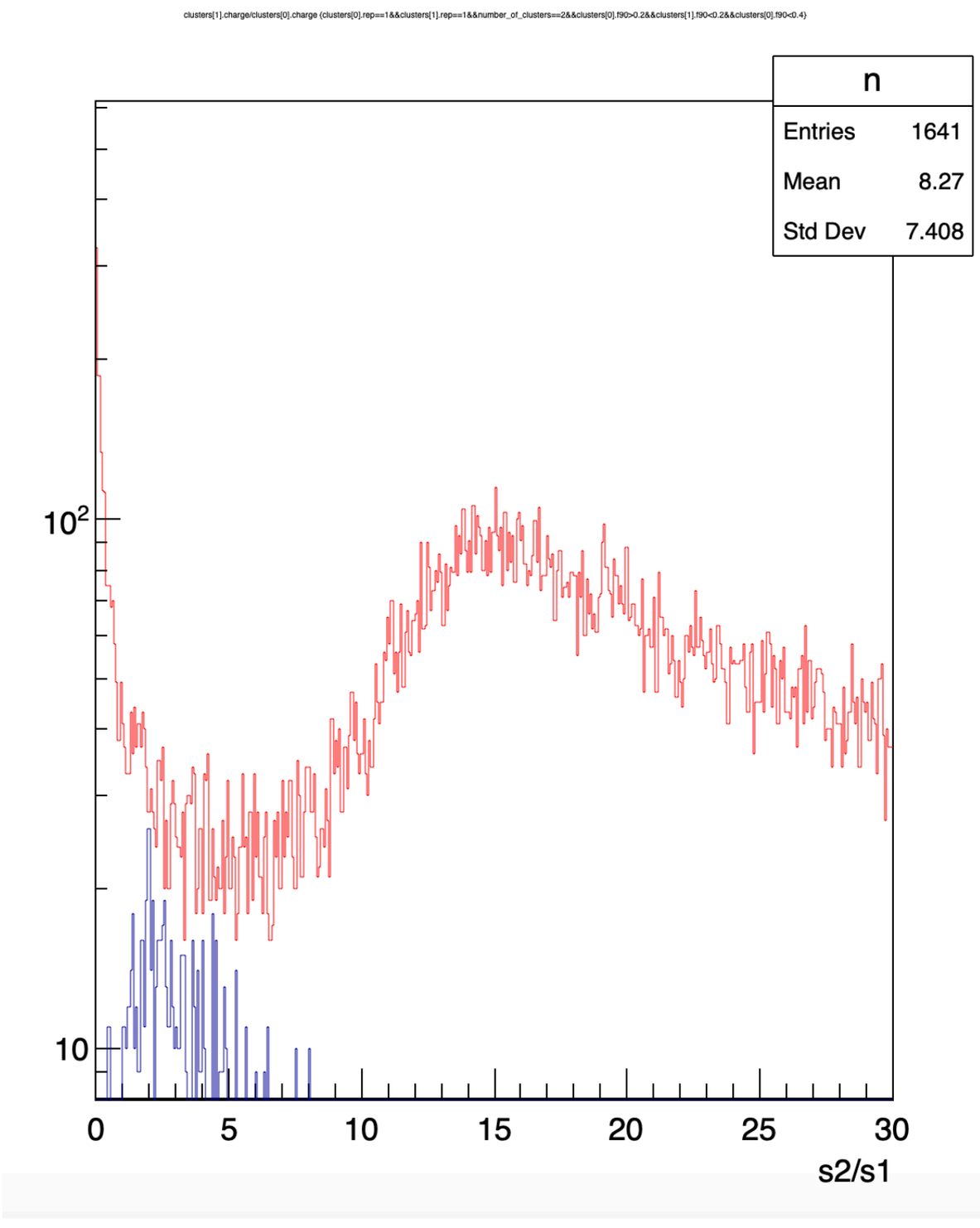


<—AmBe @ center with 4mm Pb, run 1186

tagged AmBe@center, run 1197 —>

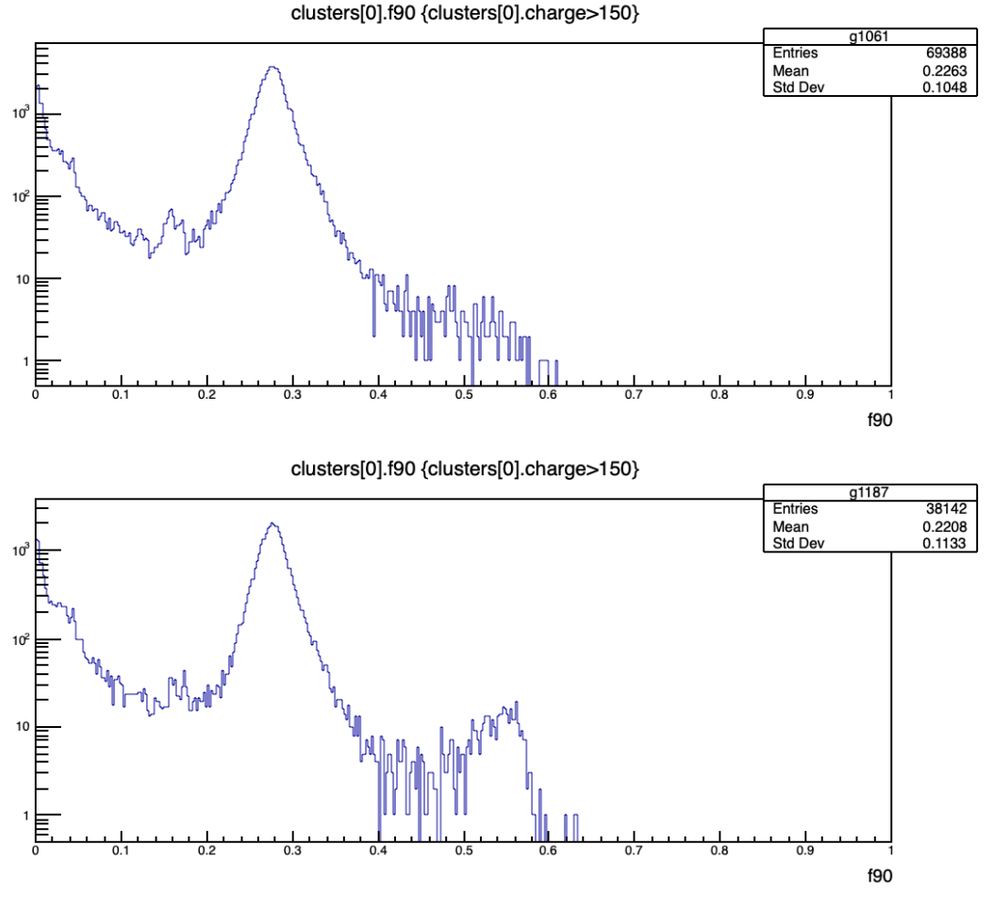
With a preliminary qualitative observation, we can infer that s2/s1 is actually a good shape indicator.

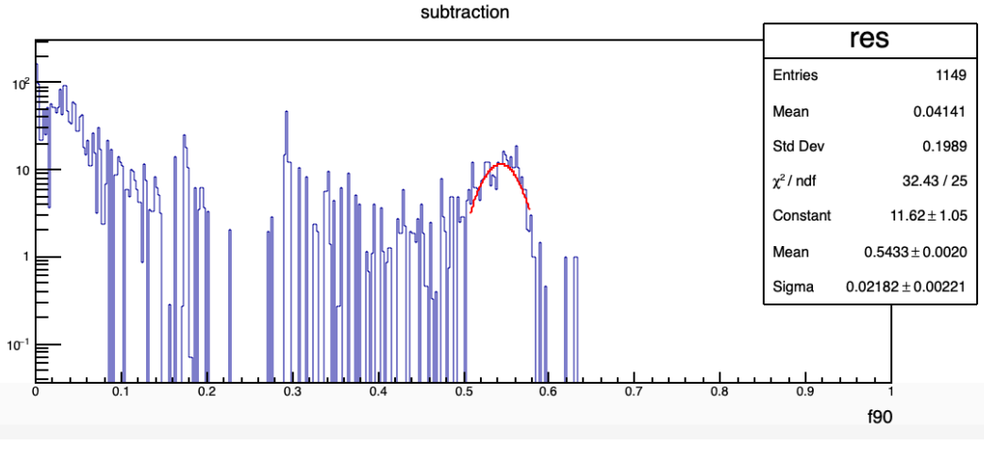




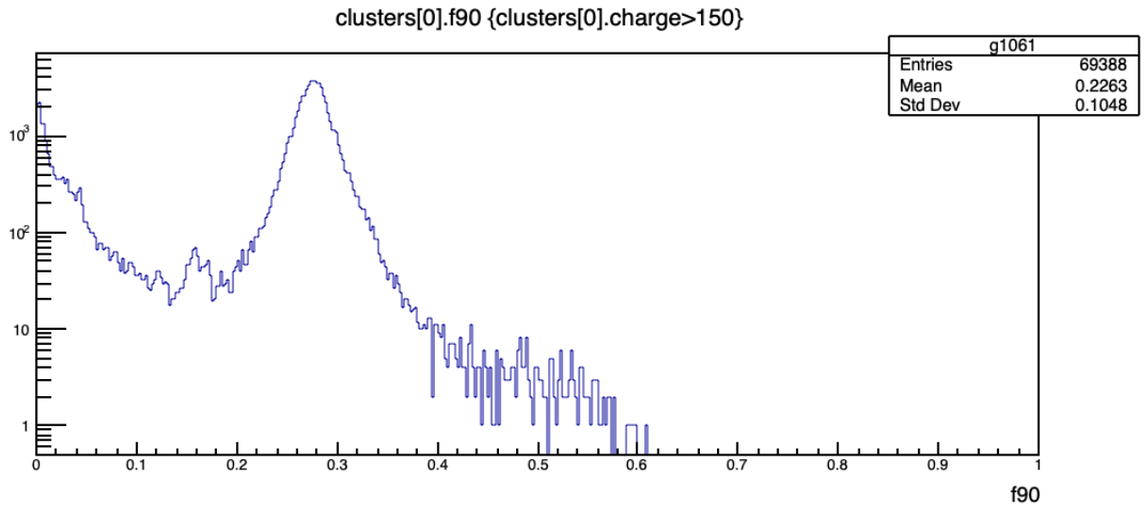
A FoM still has to be defined since, unlike for f90, there is no region of s2/s1 that is dominated by NR events, even though the regions affected by ER events (red) and NR events (blue) actually have different s2/s1 distributions…

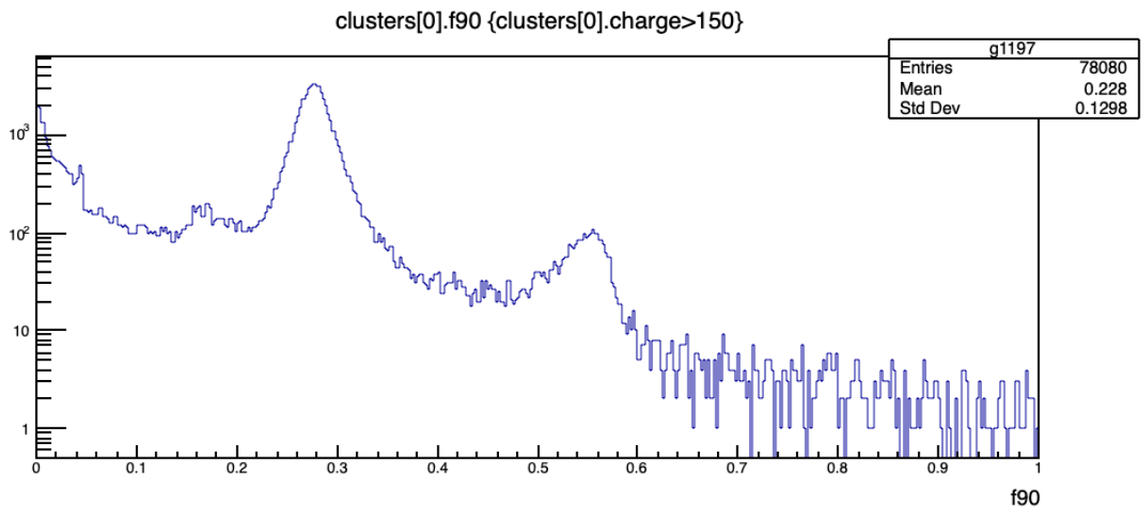
To further verify that a PSD is actually feasible with the ReD TPC, an ER dominated run (run 1061 achieved with 83Kr) was subtracted from runs containing nuclear recoils, namely runs taken with AmBe 1186, 1187, 1188, 1189 (AmBe@center + Pb thickness), and 1196, 1197, 1198 1199 (tagged AmBe @ center).
Plots of f90 are shown, for the NR dominated run, for the normalised ER dominated run, and for the subtraction. **In this way, it is proven that the region of 0.5<f90<0.6 is actually dominated by NR events.**

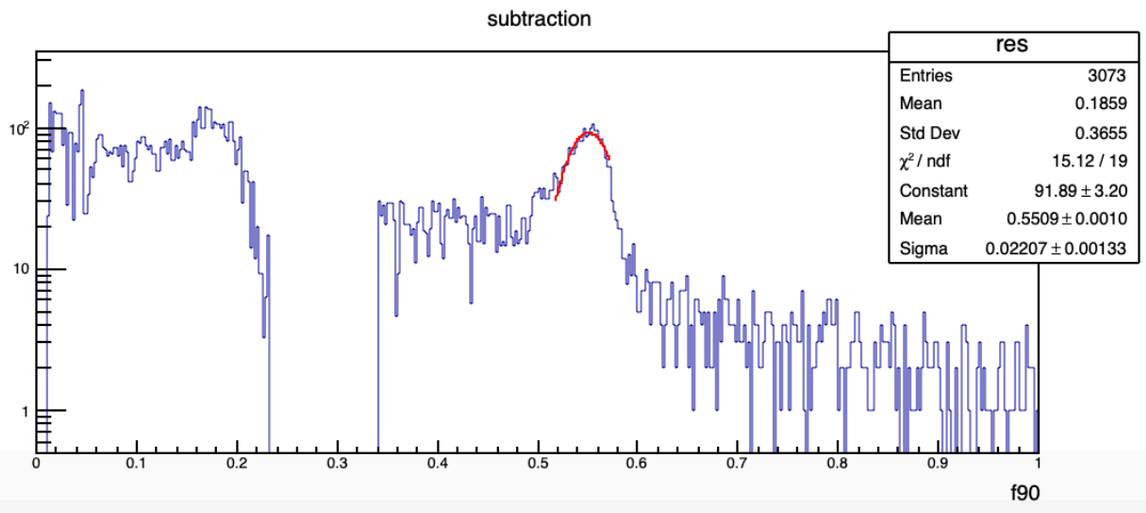




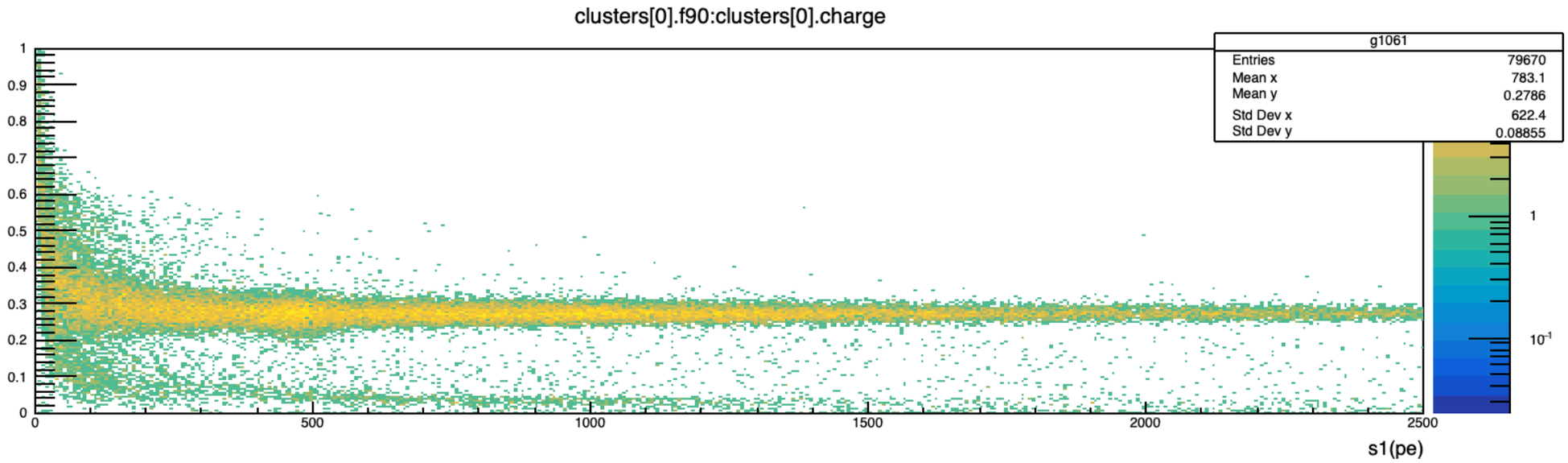
<—run 1061 (Kr-83, top), plot of f90, the only visible peak is between 0.2 and 0.3, as expected. In the middle, run 1187 (AmBe with 7.5 mm of Pb). Run 1061 was normalised and subtracted from run 1187. Subtraction f90 plot (bottom), fit shows the peak at 0.5433 for NR dominated events, as expected. As can be seen in the gap in the region for f90 between 0.2 and 0.3 (bottom graph), subtraction was effective.

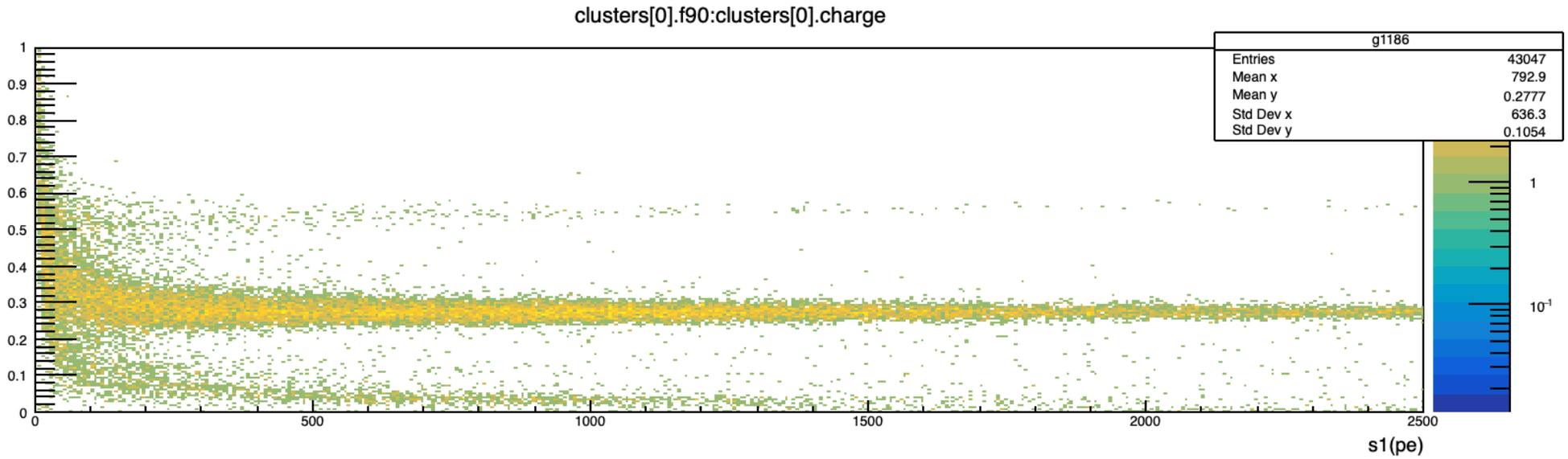


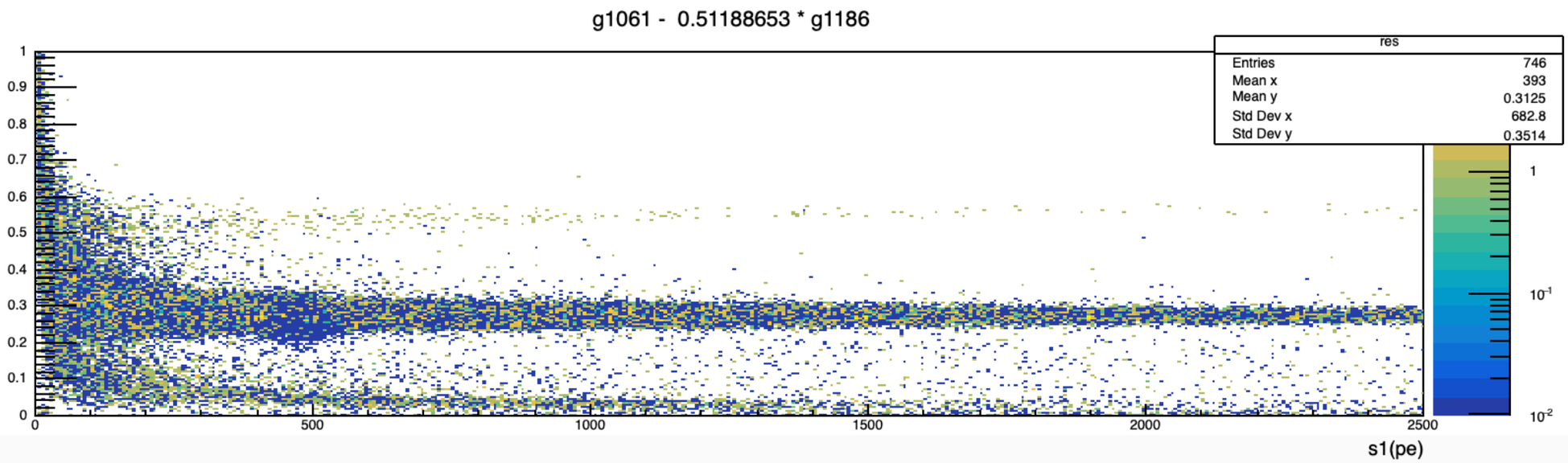




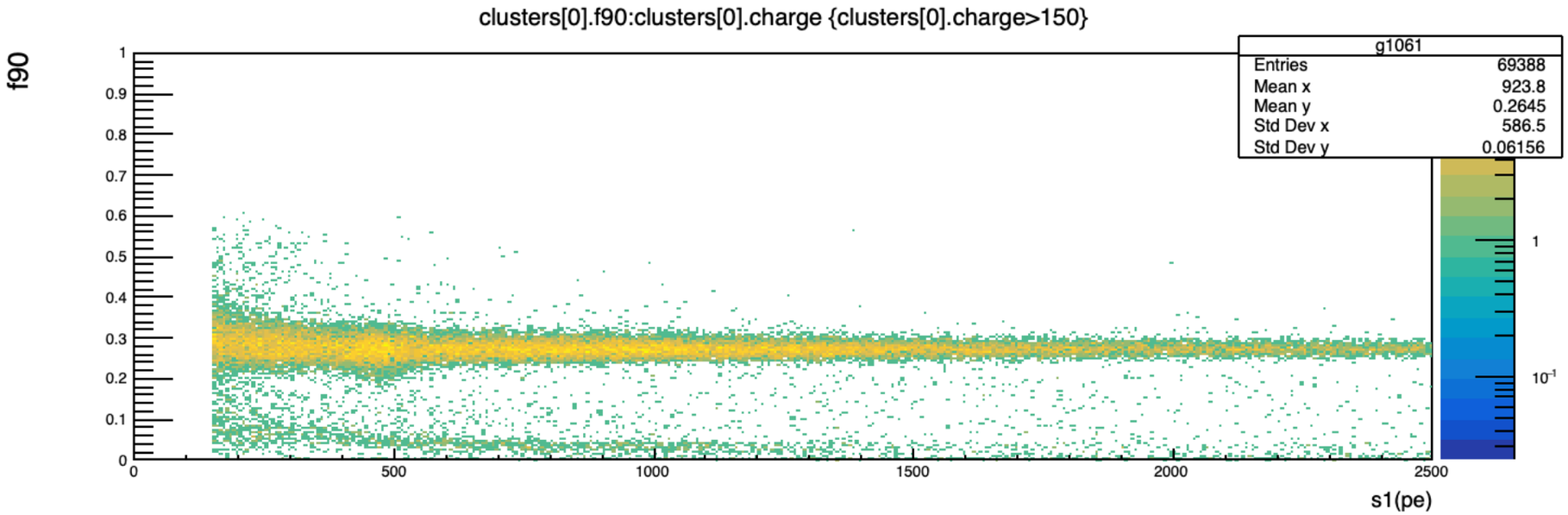
As for a further example, subtraction of normalised run 1061 (kr-83) from run 1197 (tagged AmBe @ center).
Fit of the NR dominated peak in the subtraction plot shows a mean value at 0.5509, consistent with expectations.
Subtraction was effective, as can be seen from the bottom graph.

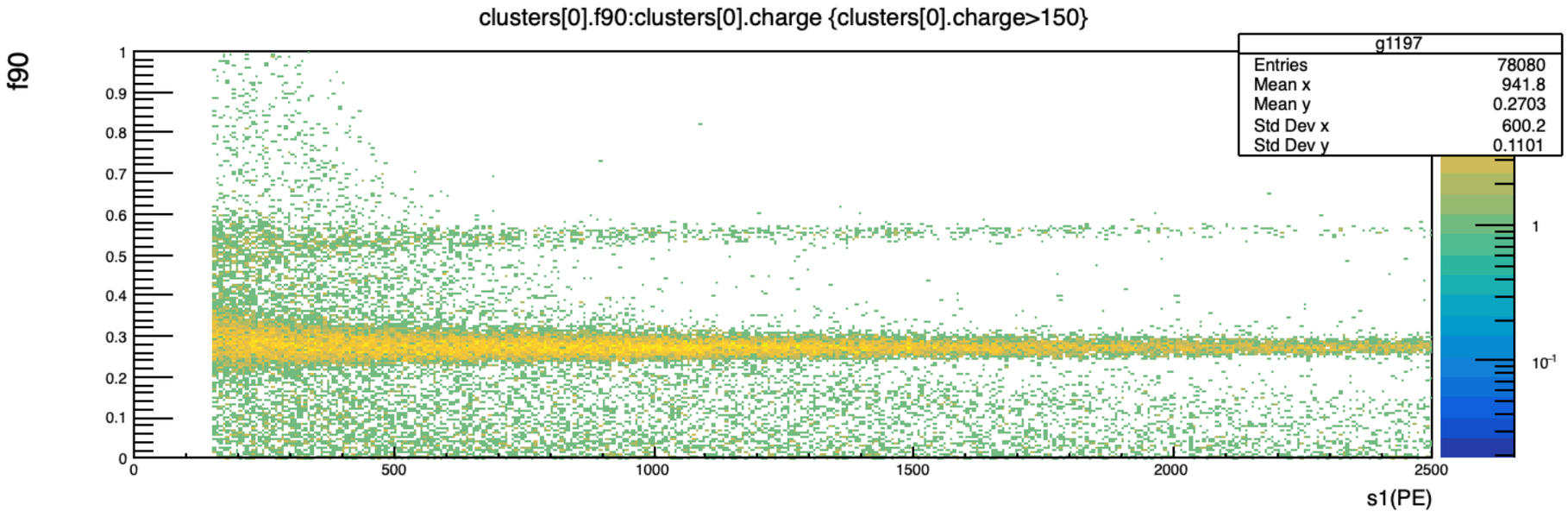


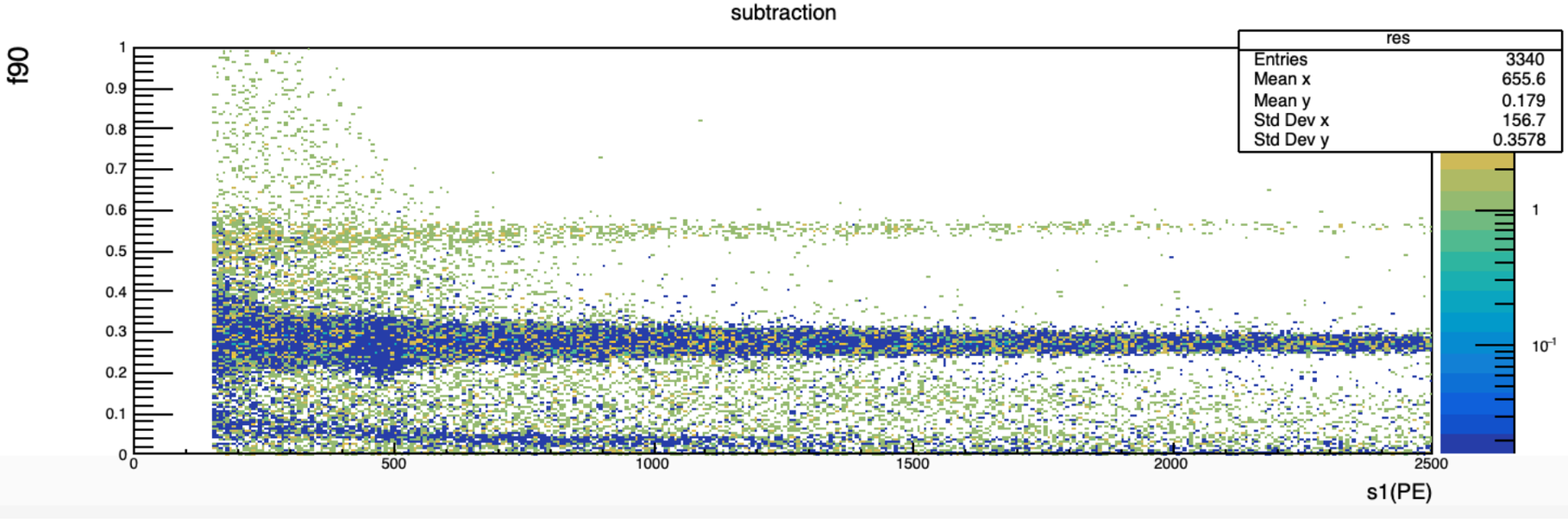




Looking at it from a f90 vs s1 point of view, the subtraction is visible in a log scale on z axis (colors on the right). Plots have been achieved for the same sets of runs (AmBe @center +Pb and tagged AmBe).
On top, run 1061 (kr-83) was normalised and subtracted from run 1186 (in the middle, AmBe @ center). The region corresponding to NR dominated events (f90 between 0.6 and 0.6) is mainly yellow-green indicating more than one event per spot represented. It remains of the same color in the bottom graph, while ER events are strongly suppressed.







Subtraction of run 1061 from run 1197 (tagged AmBe).
The effect on the z axis (colors indicating the z axis) is even more visible on this subtraction plot.