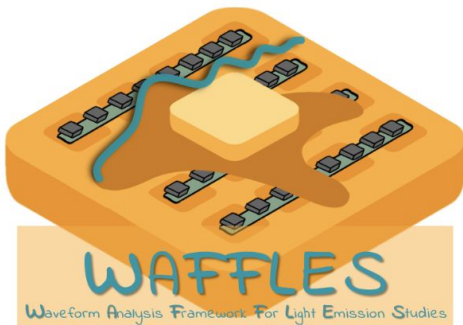# SPE template Studies for ProtoDUNE-HD

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ProtoDUNE PDS Sim/Reco meeting
September 25,2024

MOTIVATION

- One of the next steps for the ProtoDUNE HD deconvolution module is to obtain the SPE templates from WAFFLES for each of the ProtoDUNE HD channels.
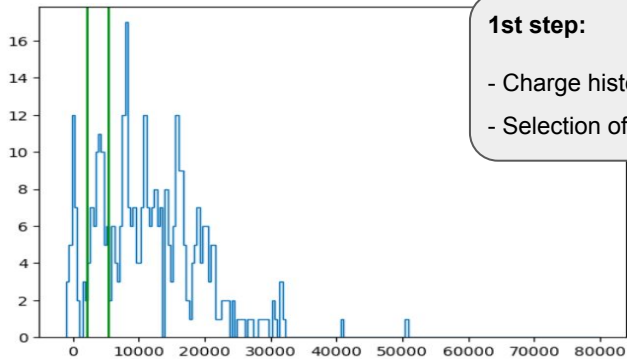

- Waffles is the NP04 PDS analysis framework Written in python, initially developed by Julio Ureña with contributions with other ~10 person.

- SPE template was obtained using Renan's script in Waffles (with few modifications).
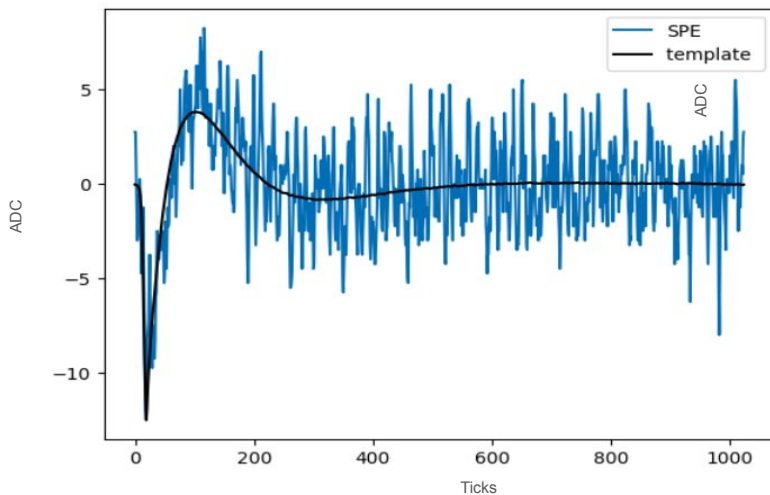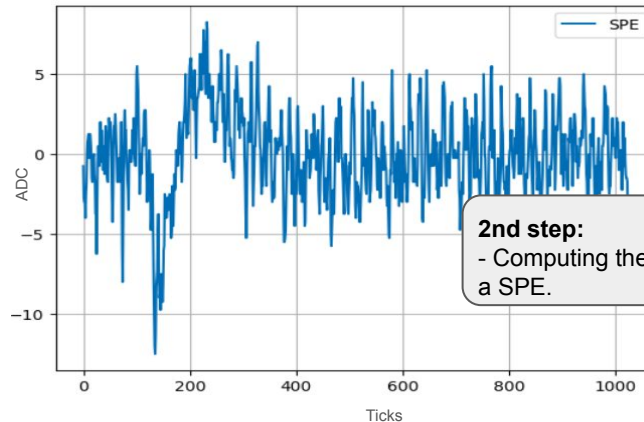
SPE templates

1st step:

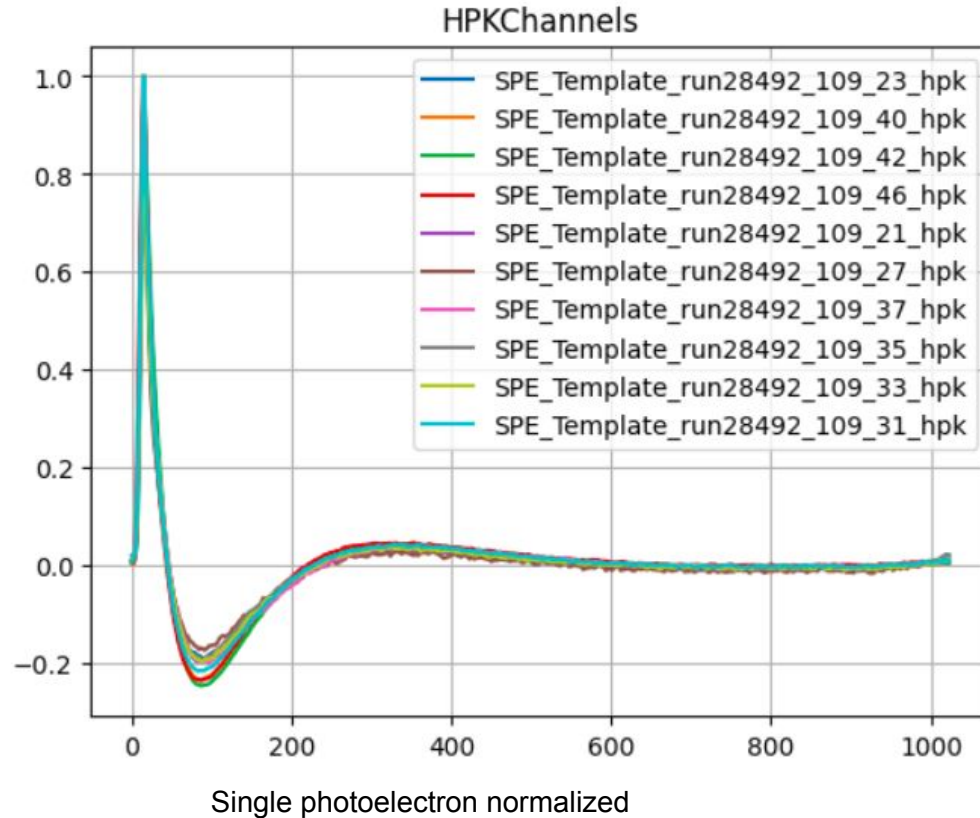- Charge histogram of a calibration run ;

- Selection of SPE Candidates.

2nd step:
- Computing the average waveform of a SPE.

Final step:

- Calculate the SPE template by

the average of the waveforms.

-Remove pretrigger.

- Apply filter to smooth.

HPKChannels

Legend:
- SPE_Template_run28492_109_23_hpk
- SPE_Template_run28492_109_40_hpk
- SPE_Template_run28492_109_42_hpk
- SPE_Template_run28492_109_46_hpk
- SPE_Template_run28492_109_21_hpk
- SPE_Template_run28492_109_27_hpk
- SPE_Template_run28492_109_37_hpk
- SPE_Template_run28492_109_35_hpk
- SPE_Template_run28492_109_33_hpk
- SPE_Template_run28492_109_31_hpk

Single photoelectron normalized

HPK APA2
SPE_Amp : 10.80081
SPE_Amp : 13.78441
SPE_Amp : 13.42734
SPE_Amp : 13.13744
SPE_Amp : 12.33993
SPE_Amp: 13.50636
SPE_Amp : 13.59418
SPE_Amp : 13.30913
SPE_Amp : 11.9144
SPE_Amp : 13.05208

FBKChannels

Legend:
- SPE_Template_run28492_109_7_fbk
- SPE_Template_run28492_109_5_fbk
- SPE_Template_run28492_109_2_fbk
- SPE_Template_run28492_109_4_fbk
- SPE_Template_run28492_109_12_fbk
- SPE_Template_run28492_109_0_fbk
- SPE_Template_run28492_109_6_fbk
- SPE_Template_run28492_109_3_fbk

Single photoelectron normalized
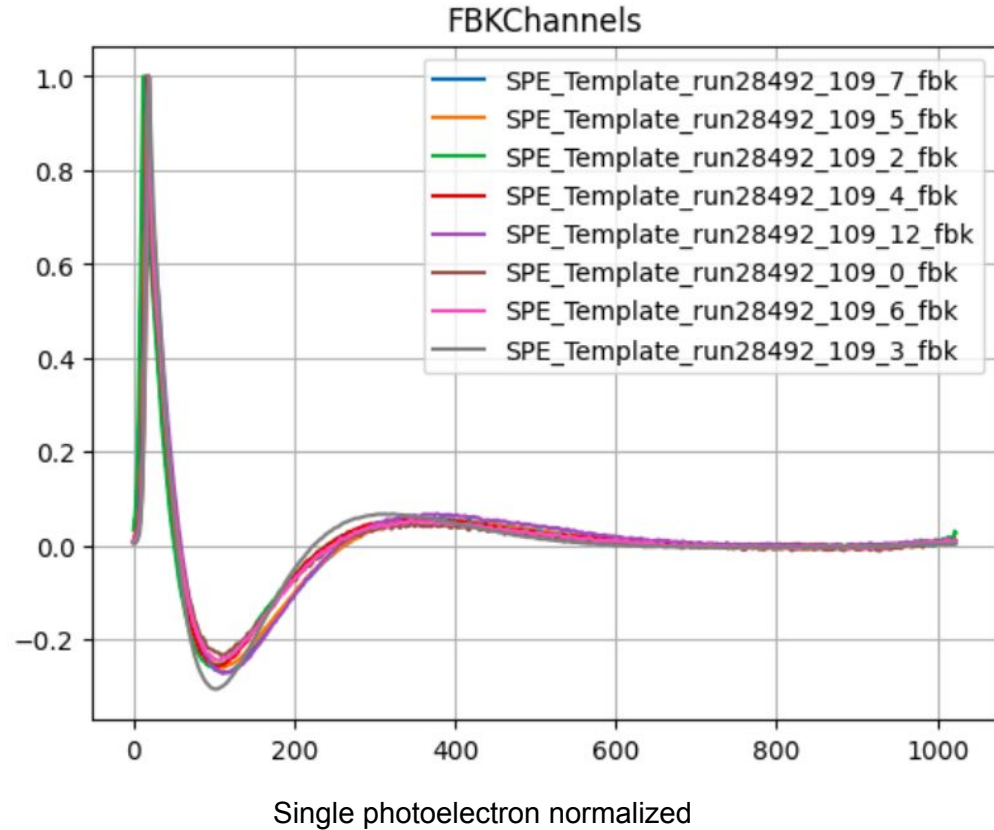
FBK APA2
SPE_Amp : 12.90302
SPE_Amp : 10.85122
SPE_Amp: 9.87513
SPE_Amp: 12.62573
SPE_Amp : 9.72592
SPE_Amp : 10.18174
SPE_Amp : 12.39731
SPE_Amp: 12.43264

SPE Template-HPK

Deconvolución: Wiener +Gauss
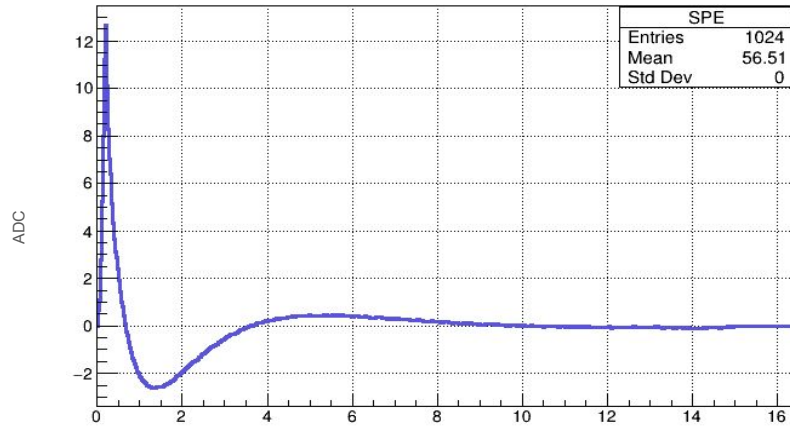
It is the average SPE channel endpoint 109 Ch46 (HPK). Obtained from Renan's Script in WAFFLES.
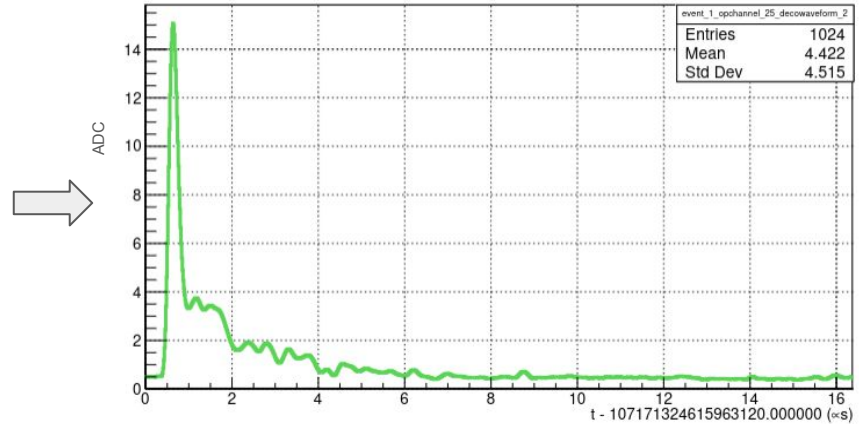
Deconvolution of the waveforms using the ProtoDUNE-HD data from the HPK channels.

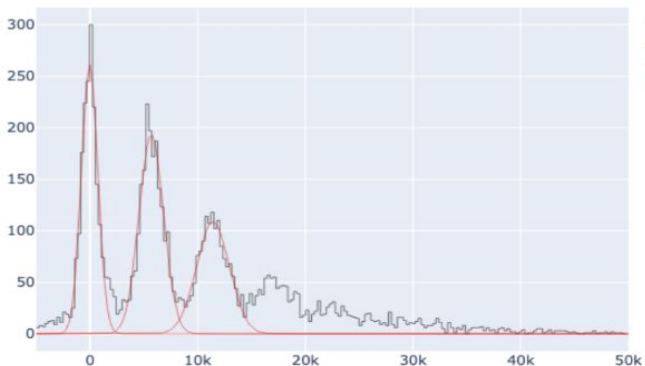The Deconvolution module works with this ProtoDUNE SPE Template!!

NEXT STEPS

It would be interesting:

- To include in the calibration process the plot with the fit of the peaks and be sure that we are only taking SPE:

    draw.plot_charge_peaks(charge_histo,3)

- Compare with other methods or scripts that are being developed to obtain the SPE template to be sure of the quality of the template.

Channel Map

APA1

104-7 150	104-5 140	104-2 130	104-0 120
104-1 151	104-3 141	104-4 131	104-6 121
104-17 152	104-15 142	104-12 132	104-10 122
104-11 153	104-13 143	104-14 133	104-16 123
105-7 154	105-5 144	105-2 134	105-0 124
105-1 155	105-3 145	105-4 135	105-6 125
105-26 156	105-24 146	105-23 136	105-21 126
105-10 157	105-12 147	105-15 137	105-17 127
107-17 158	107-15 148	107-12 138	107-10 128
107-0 159	107-2 149	107-5 139	107-7 129

APA2

109-27 110	109-25 100	109-22 90	109-20 80
109-21 111	109-23 101	109-24 91	109-26 81
109-37 112	109-35 102	109-32 92	109-30 82
109-31 113	109-33 103	109-34 93	109-36 83
109-7 114	109-5 104	109-2 94	109-0 84
109-1 115	109-3 105	109-4 95	109-6 85
109-17 116	109-15 106	109-12 96	109-10 86
109-11 117	109-13 107	109-14 97	109-16 87
109-47 118	109-45 108	109-42 98	109-40 88
109-41 119	109-43 109	109-44 99	109-46 89

APA3

111-1 70	111-3 60	111-4 50	111-6 40
111-36 71	111-34 61	111-33 51	111-31 41
111-0 72	111-2 62	111-5 52	111-7 42
111-37 73	111-35 63	111-32 53	111-30 43
111-41 74	111-43 64	111-44 54	111-46 44
111-16 75	111-14 65	111-13 55	111-11 45
111-10 76	111-12 66	111-15 56	111-17 46
111-26 77	111-24 67	111-23 57	111-21 47
111-40 78	111-42 68	111-45 58	111-47 48
111-27 79	111-25 69	111-22 59	111-20 49

APA4

112-0 30	112-2 20	112-5 10	112-7 0
112-6 31	112-4 21	112-3 11	112-1 1
112-10 32	112-12 22	112-15 12	112-17 2
112-16 33	112-14 23	112-13 13	112-11 3
113-0 34	113-2 24	113-5 14	113-7 4
112-27 35	112-25 25	112-22 15	112-20 5
112-21 36	112-23 26	112-24 16	112-26 6
112-37 37	112-35 27	112-32 17	112-30 7
112-31 38	112-33 28	112-34 18	112-36 8
112-47 39	112-45 29	112-42 19	112-40 9

Red border disconnected channels

Channel Daphne/APA

Channel LarSoft

FBK

HPK

duneprototypes/duneprototypes/Protodune/hd/ChannelMap/**DAPHNE_test5_ChannelMap_v1.txt**

Channel Map

APA1

104-7 150	104-5 140	104-2 130	104-0 120
104-1 151	104-3 141	104-4 131	104-6 121
104-17 152	104-15 142	104-12 132	104-10 122
104-11 153	104-13 143	104-14 133	104-16 123
105-7 154	105-5 144	105-2 134	105-0 124
105-1 155	105-3 145	105-4 135	105-6 125
105-26 156	105-24 146	105-23 136	105-21 126
105-10 157	105-12 147	105-15 137	105-17 127
107-17 158	107-15 148	107-12 138	107-10 128
107-0 159	107-2 149	107-5 139	107-7 129

APA2

109-27 110	109-25 100	109-22 90	109-20 80
109-21 111	109-23 101	109-24 91	109-26 81
109-37 112	109-35 102	109-32 92	109-30 82
109-31 113	109-33 103	109-34 93	109-36 83
109-7 114	109-5 104	109-2 94	109-0 84
109-1 115	109-3 105	109-4 95	109-6 85
109-17 116	109-15 106	109-12 96	109-10 86
109-11 117	109-13 107	109-14 97	109-16 87
109-47 118	109-45 108	109-42 98	109-40 88
109-41 119	109-43 109	109-44 99	109-46 89

APA3

111-1 70	111-3 60	111-4 50	111-6 40
111-36 71	111-34 61	111-33 51	111-31 41
111-0 72	111-2 62	111-5 52	111-7 42
111-37 73	111-35 63	111-32 53	111-30 43
111-41 74	111-43 64	111-44 54	111-46 44
111-16 75	111-14 65	111-13 55	111-11 45
111-10 76	111-12 66	111-15 56	111-17 46
111-26 77	111-24 67	111-23 57	111-21 47
111-40 78	111-42 68	111-45 58	111-47 48
111-27 79	111-25 69	111-22 59	111-20 49

APA4

112-0 30	112-2 20	112-5 10	112-7 0
112-6 31	112-4 21	112-3 11	112-1 1
112-10 32	112-12 22	112-15 12	112-17 2
112-16 33	112-14 23	112-13 13	112-11 3
113-0 34	113-2 24	113-5 14	113-7 4
112-27 35	112-25 25	112-22 15	112-20 5
112-21 36	112-23 26	112-24 16	112-26 6
112-37 37	112-35 27	112-32 17	112-30 7
112-31 38	112-33 28	112-34 18	112-36 8
112-47 39	112-45 29	112-42 19	112-40 9

duneprototypes / duneprototypes / Protodune / hd / ChannelMap / **DAPHNE_test5_ChannelMap_v1.txt**

| Code | Blame | 160 lines (160 loc) · 1.64 KB |

```
49    9 0 30 82
50    9 0 42 92
51    9 0 35 102
52    9 0 37 112
53    9 0 36 83
54    9 0 34 93
55    9 0 33 103
56    9 0 31 113
57    9 0 0 84       apa_2_data = [ [UniqueChannel(109, 27 ), UniqueChannel(109, 25), UniqueChannel(109, 22), UniqueChannel(109, 20 )],
58    9 0 2 94                       [UniqueChannel(109, 21 ), UniqueChannel(109, 23), UniqueChannel(109, 24), UniqueChannel(109, 26 )],
59    9 0 5 104                      [UniqueChannel(109, 37 ), UniqueChannel(109, 35), UniqueChannel(109, 32), UniqueChannel(109, 30 )],
60    9 0 7 114                      [UniqueChannel(109, 31 ), UniqueChannel(109, 33), UniqueChannel(109, 34), UniqueChannel(109, 36 )],
61    9 0 6 85                       [UniqueChannel(109, 7 ), UniqueChannel(109, 5 ), UniqueChannel(109, 2 ), UniqueChannel(109, 0  )],
62    9 0 4 95                       [UniqueChannel(109, 1  ), UniqueChannel(109, 3 ), UniqueChannel(109, 4 ), UniqueChannel(109, 6  )],
63    9 0 3 105                      [UniqueChannel(109, 17 ), UniqueChannel(109, 15), UniqueChannel(109, 12), UniqueChannel(109, 10 )],
64    9 0 1 115                      [UniqueChannel(109, 11 ), UniqueChannel(109, 13), UniqueChannel(109, 14), UniqueChannel(109, 16 )],
65    9 0 10 86                      [UniqueChannel(109, 47 ), UniqueChannel(109, 45), UniqueChannel(109, 42), UniqueChannel(109, 40 )],
66    9 0 12 96                      [UniqueChannel(109, 41 ), UniqueChannel(109, 43), UniqueChannel(109, 44), UniqueChannel(109, 46 )]]
67    9 0 15 106
68    9 0 17 116
69    9 0 16 87
70    9 0 14 97
71    9 0 13 107
72    9 0 11 117
73    9 0 40 88
74    9 0 52 98
75    9 0 45 108
```

duneprototypes/duneprototypes/Protodune/hd/ChannelMap/**DAPHNE_test5_ChannelMap_v1.txt**

github.com/DUNE/waffles/blob/main/src/waffles/np04_data/**ProtoDUNE_HD_APA_maps.py**

Thank you!!