Ghost Hunter Design Report

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Idea

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2. A waveform of several PEs is the supersposition of single-PE waveforms.

So, use threshold method to find the first PE and substract single-PE waveform from original waveform, in order to search for the next PE.

Find Single PE Waveform

1. Select waveform whose PE numbers $= 1$.

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2. Use cuts to ensure that signal is within the range and not to weak.
3. According to [1], the standard waveform for a single PE is:

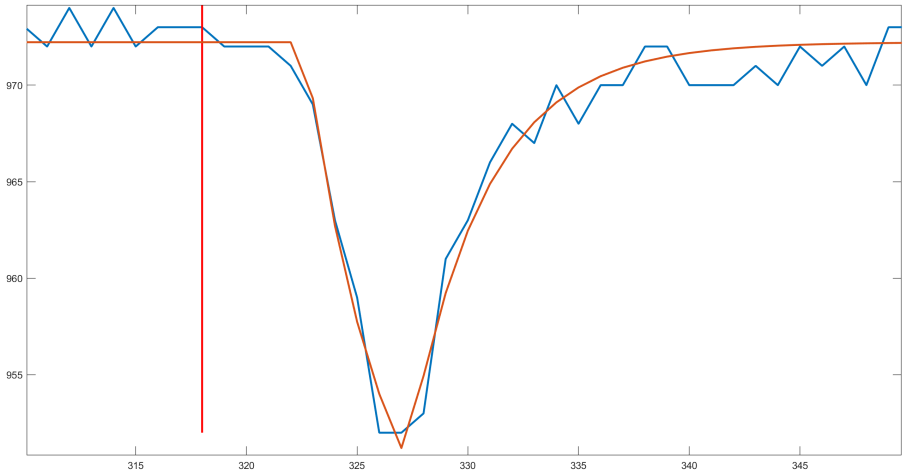
$$0 \leq t < T: \quad i_{in}(t) = I_s \left(1 - e^{-t/RC}\right)$$
$$T \leq t \leq \infty \quad i_{in}(t) = I_s \left(e^{T/RC} - 1\right) \cdot e^{-t/RC}$$

Find Single PE Waveform

Fit single PE waveform with function

$$T_1 \leqslant t < T_2: \quad U = A\left(1 - e^{-t/RC}\right)$$

$$t \geqslant T_2: \quad U = A\left[e^{(T_2 - T_1)/RC} - 1\right] e^{-t/RC}$$



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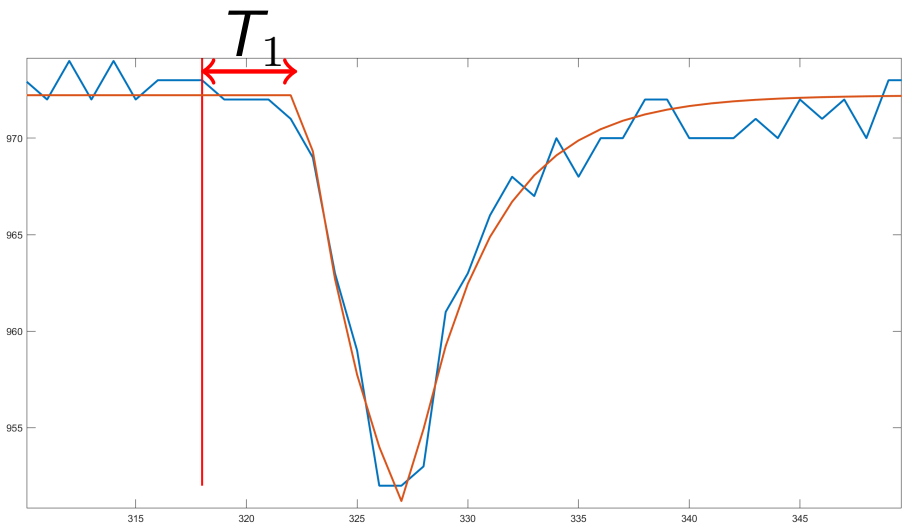

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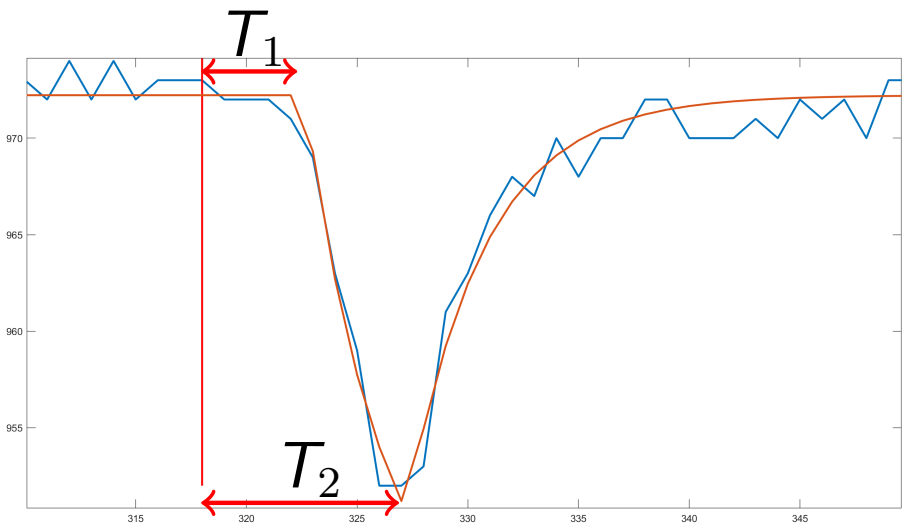
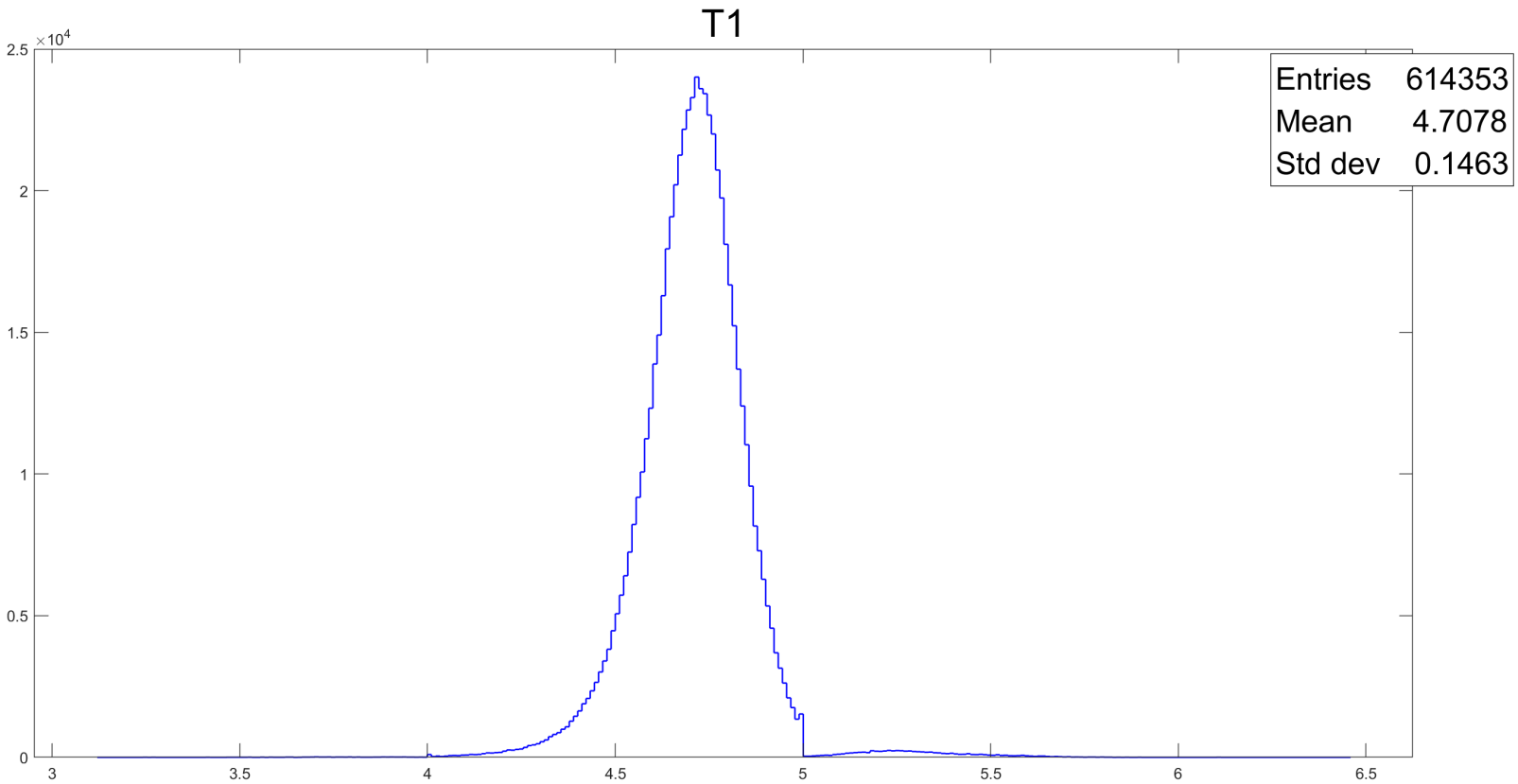
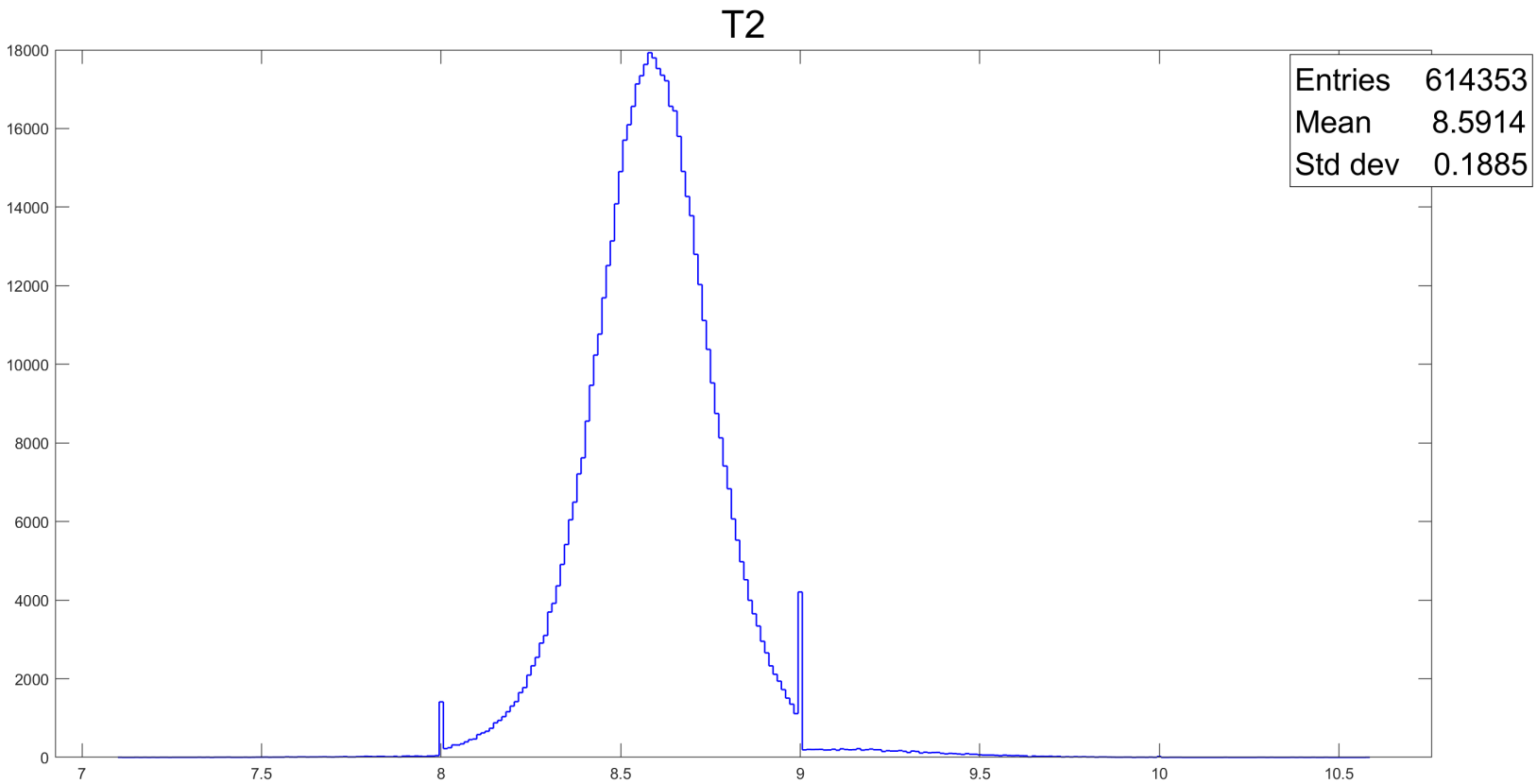


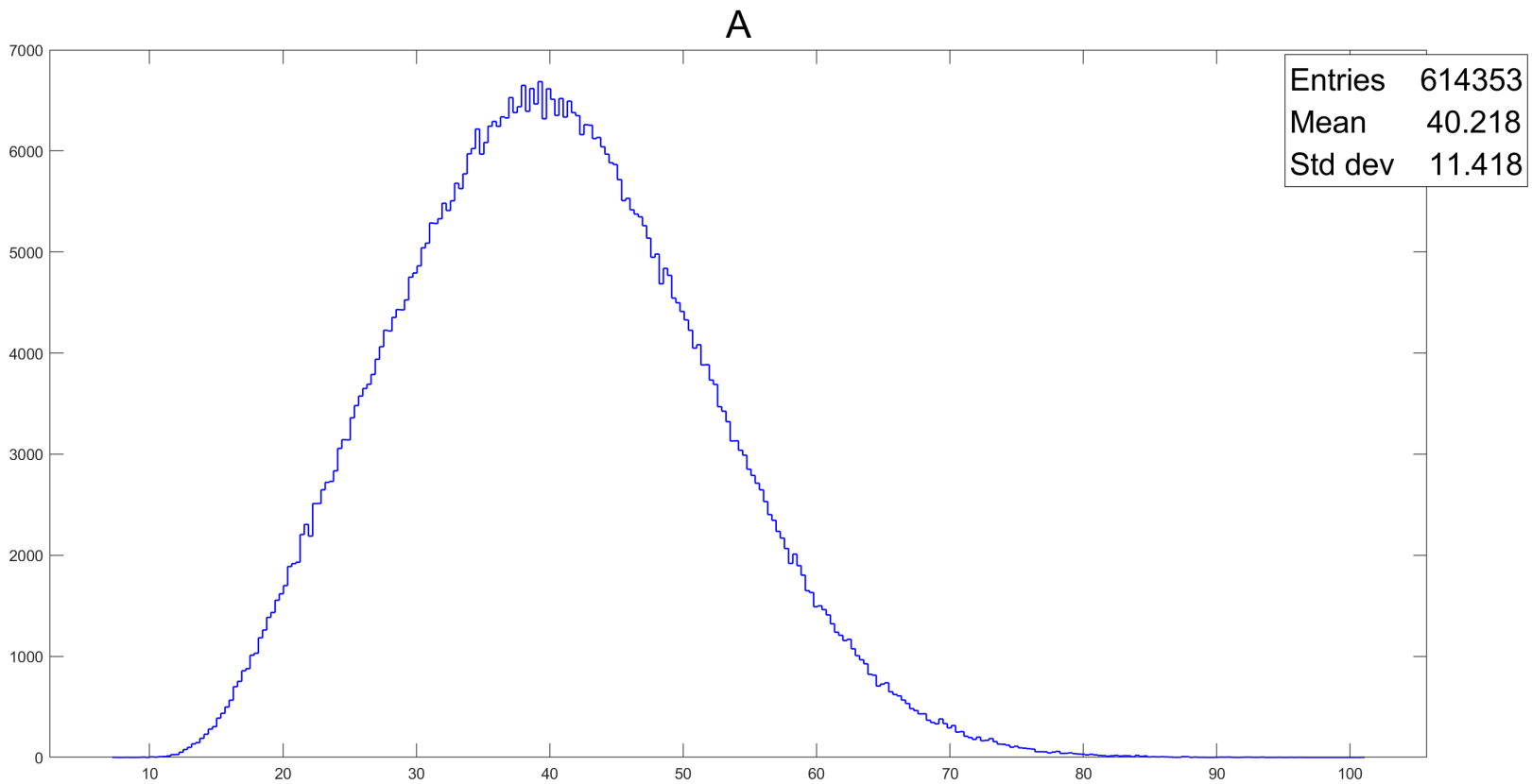
Fit Results


T1
×10^4
2.5
2
1.5
1
0.5
0
3
3.5
4
4.5
5
5.5
6
6.5
Entries 614353
Mean 4.7078
Std dev 0.1463

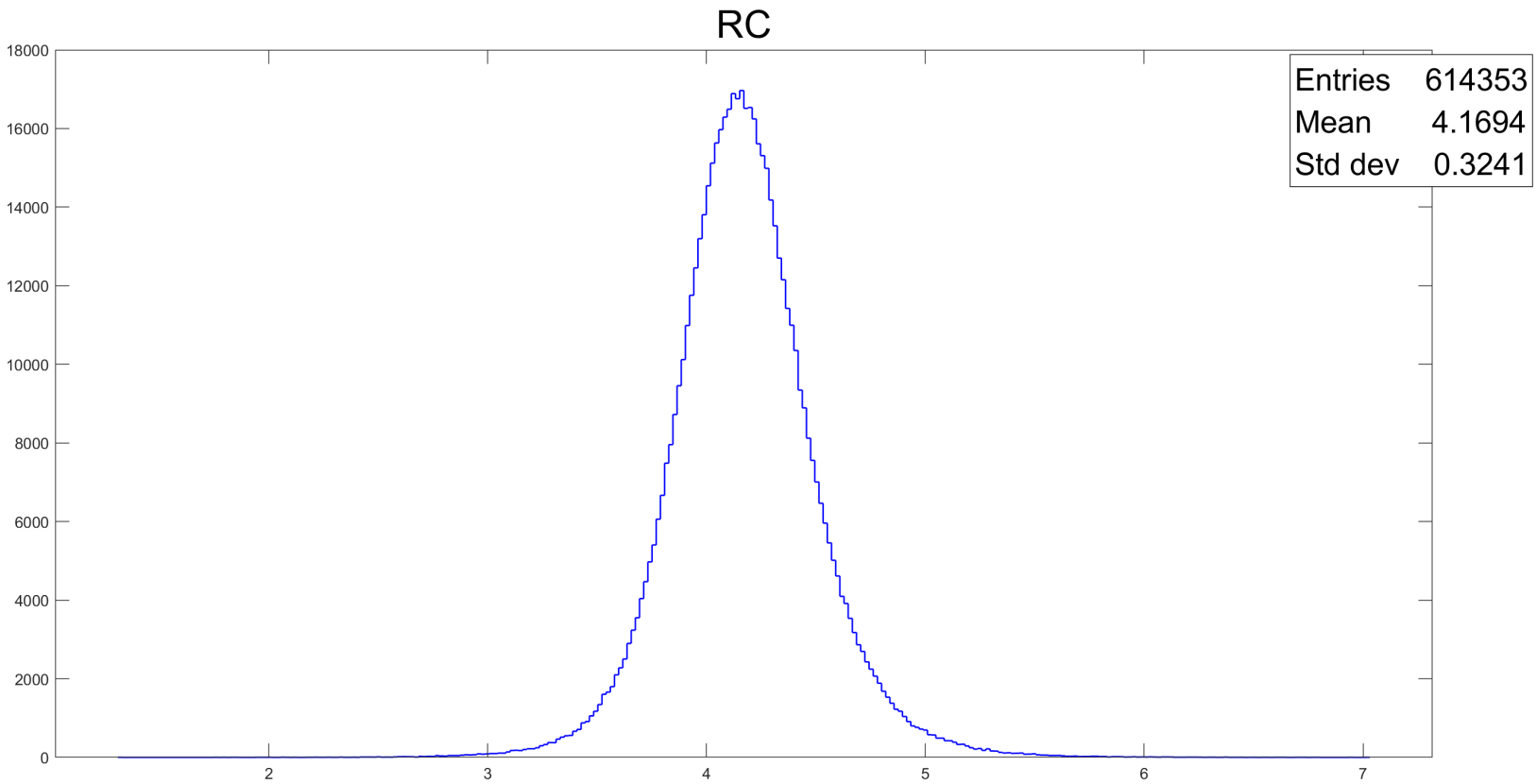
Fit Results


T2
Entries 614353
Mean 8.5914
Std dev 0.1885
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
7
7.5
8
8.5
9
9.5
10
10.5

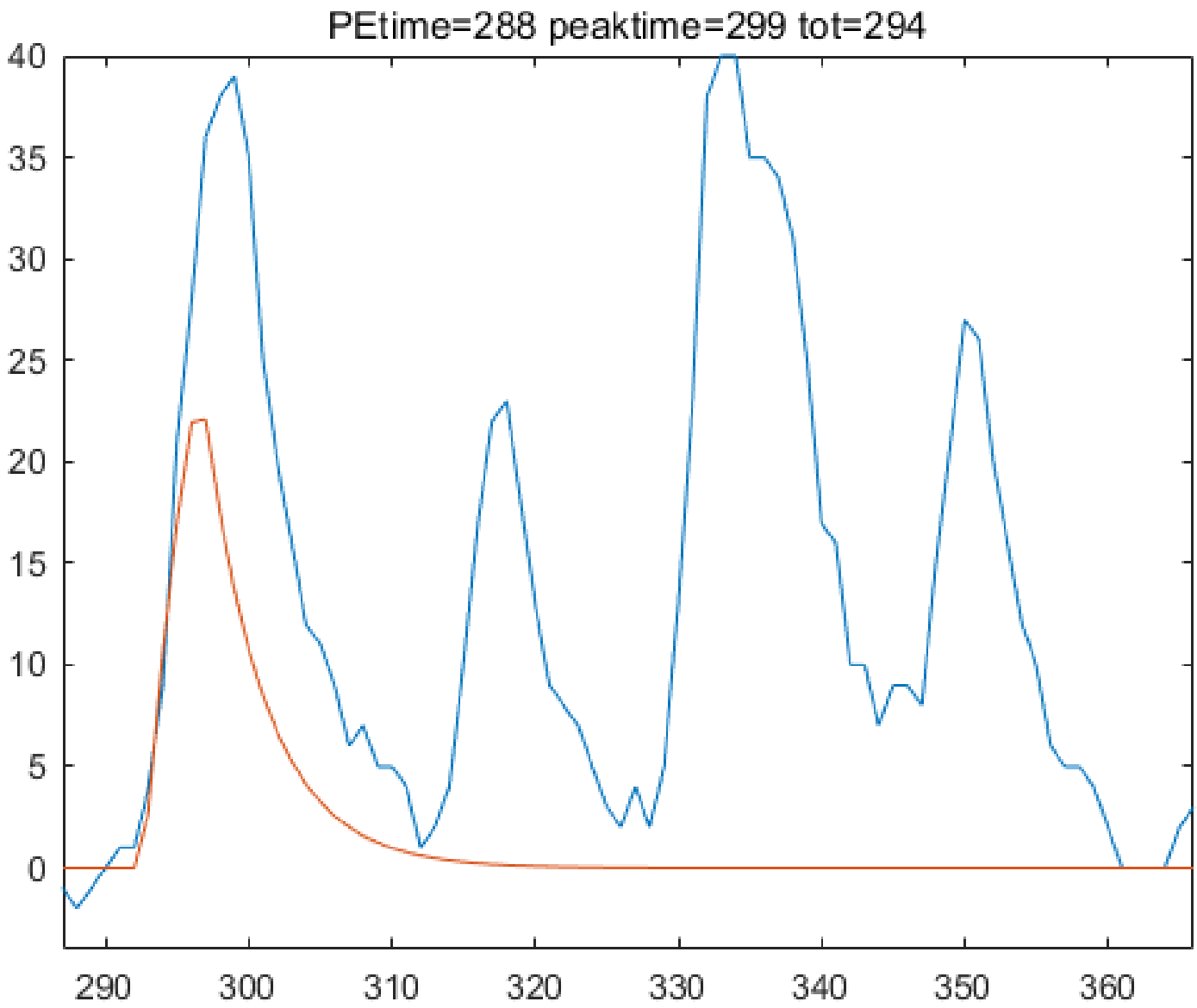
Fit Results


A
Entries 614353
Mean 40.218
Std dev 11.418
7000
6000
5000
4000
3000
2000
1000
0
10
20
30
40
50
60
70
80
90
100

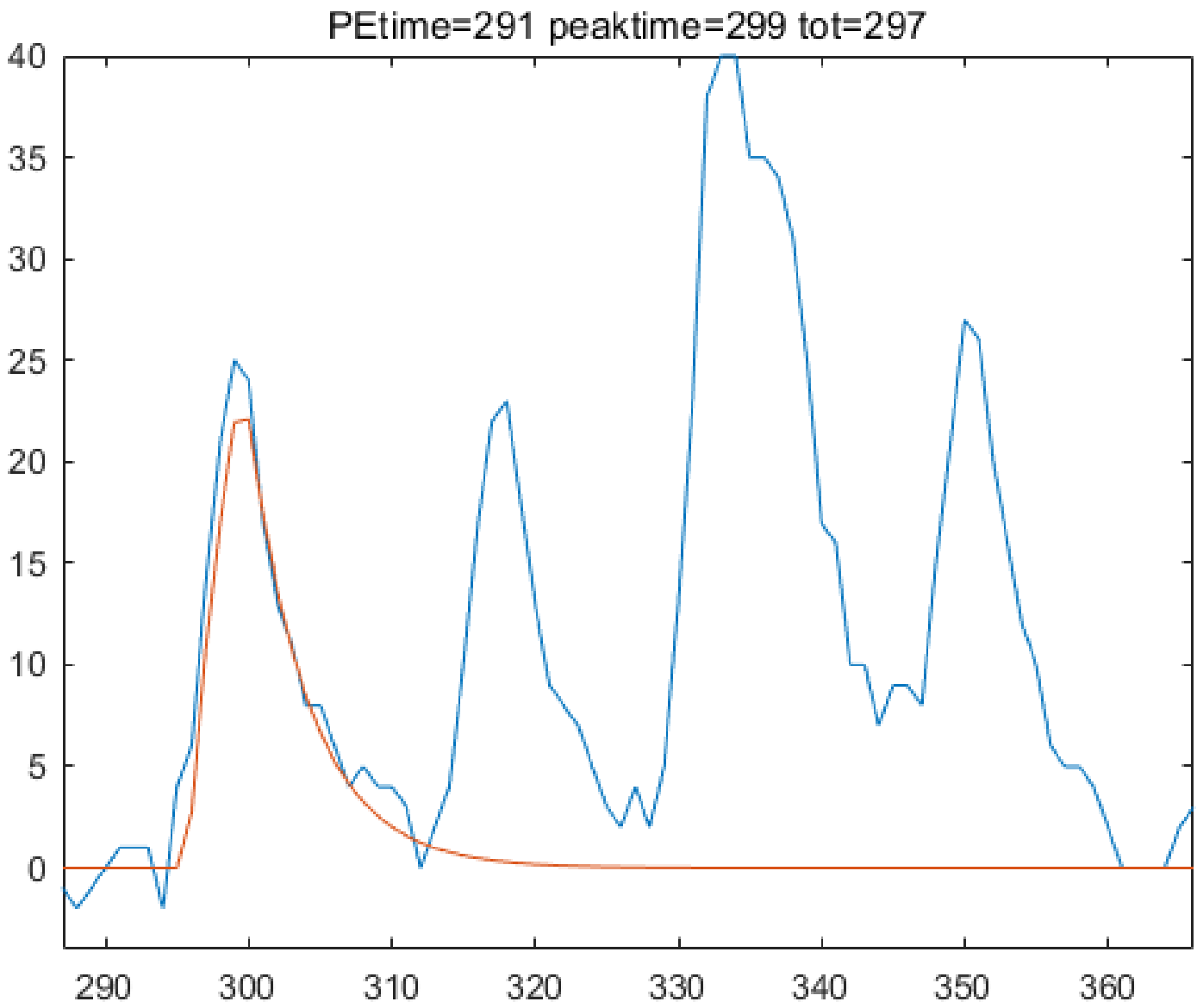
Fit Results


RC
Entries 614353
Mean 4.1694
Std dev 0.3241
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
2
3
4
5
6
7

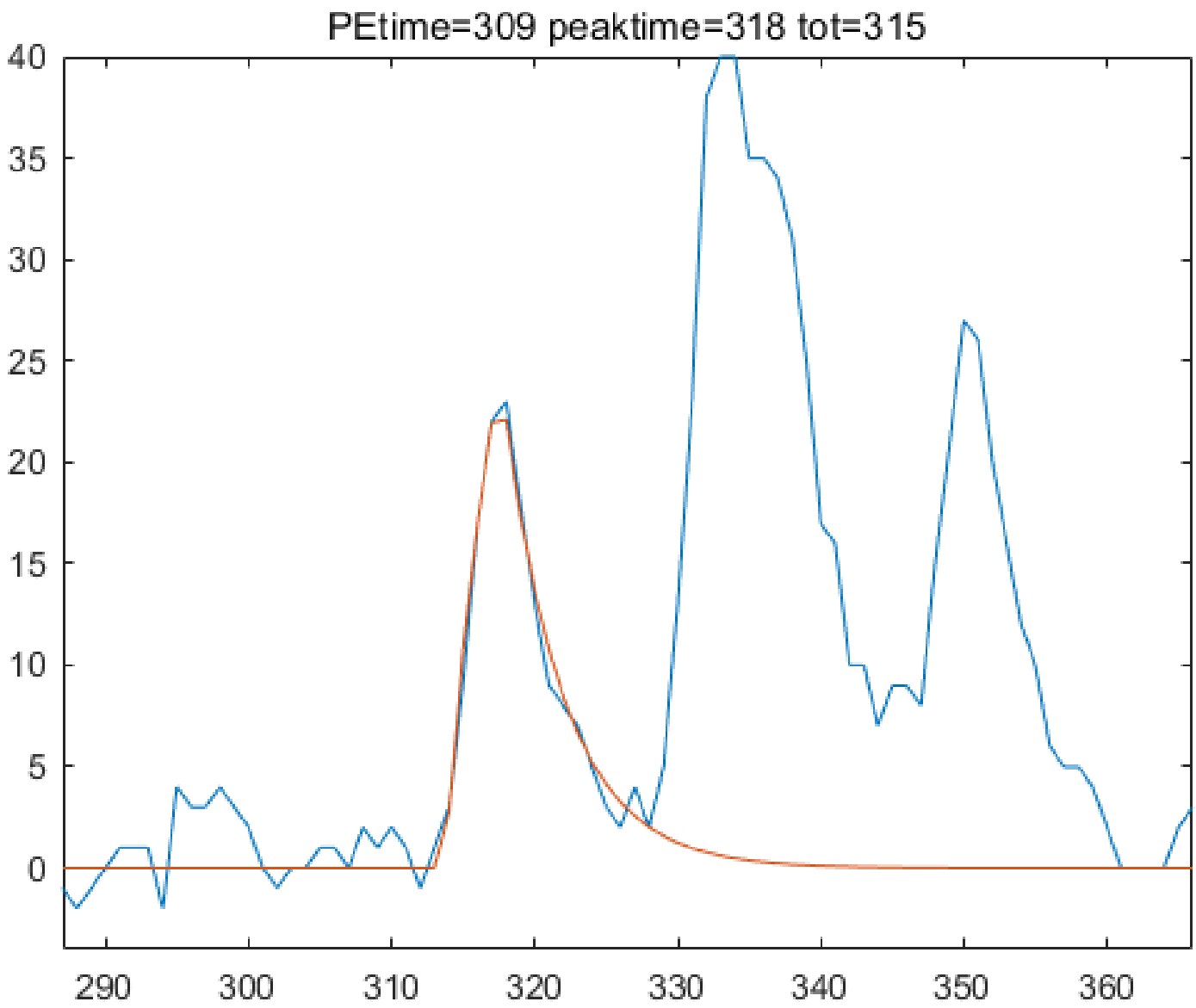
Process


PEtime=288 peaktime=299 tot=294
40
35
30
25
20
15
10
5
0
290
300
310
320
330
340
350
360

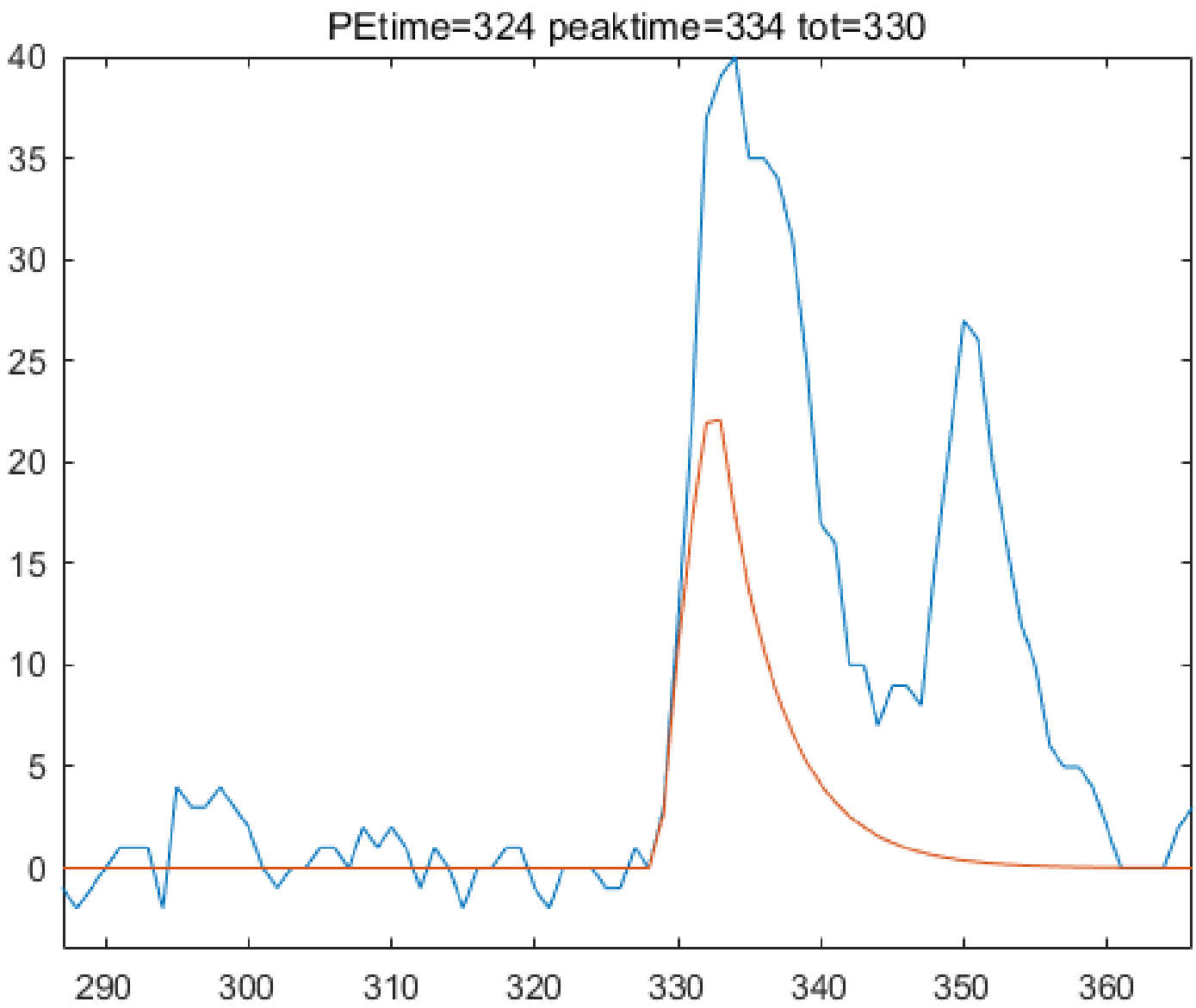
Process


PEtime=291 peaktime=299 tot=297
40
35
30
25
20
15
10
5
0
290
300
310
320
330
340
350
360

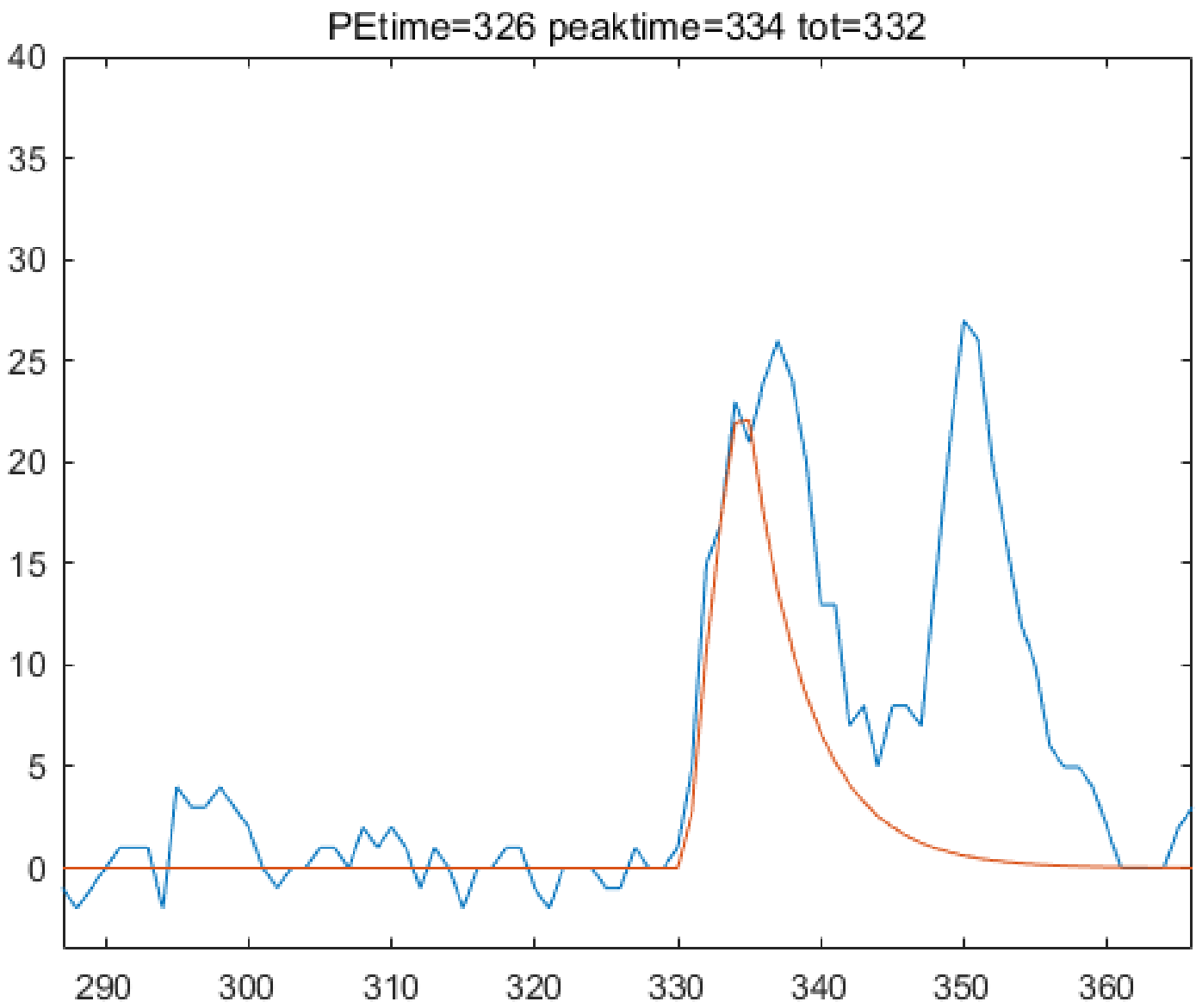
Process


PEtime=309 peaktime=318 tot=315
40
35
30
25
20
15
10
5
0
290
300
310
320
330
340
350
360

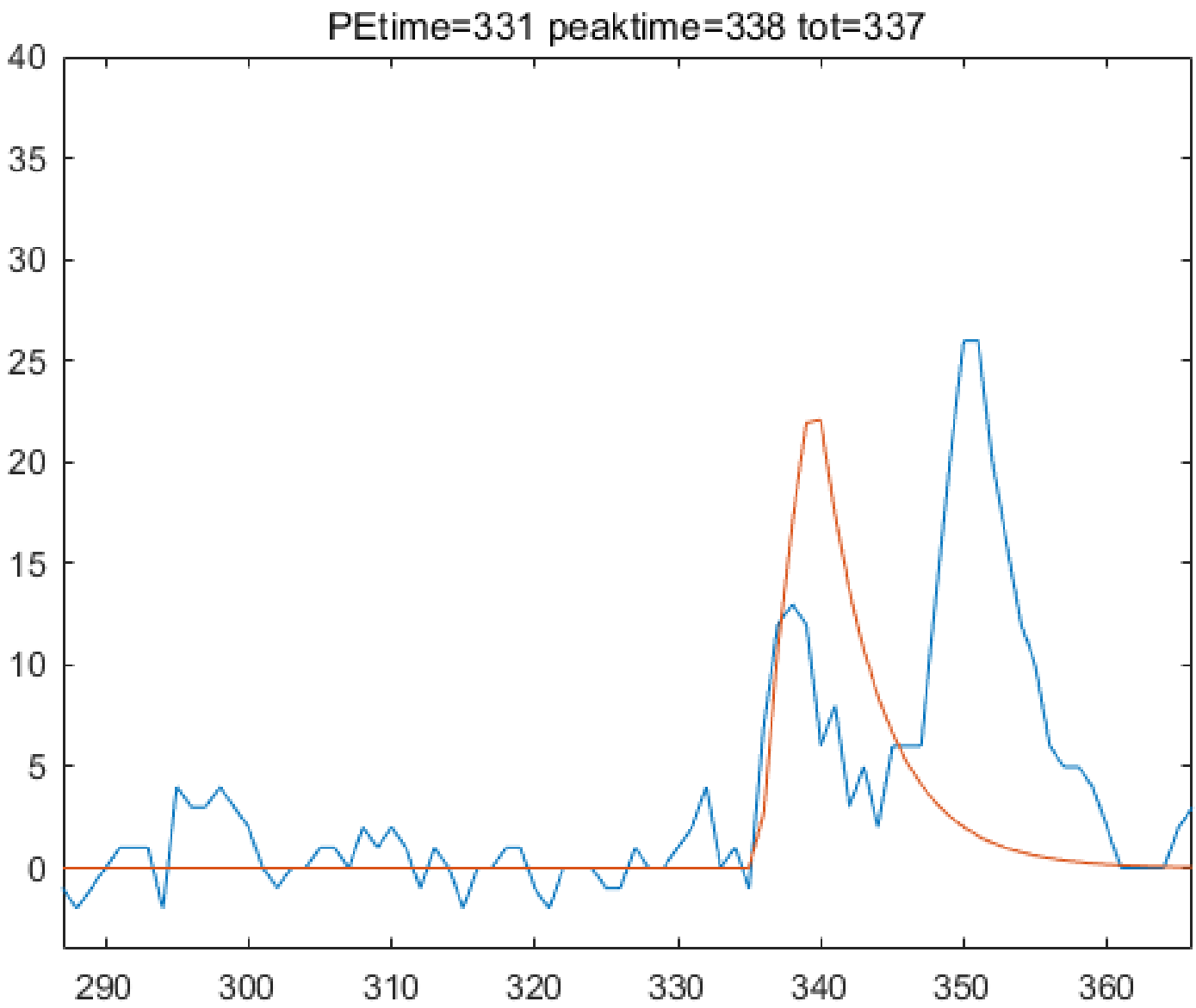
Process


PEtime=324 peaktime=334 tot=330
40
35
30
25
20
15
10
5
0
290
300
310
320
330
340
350
360

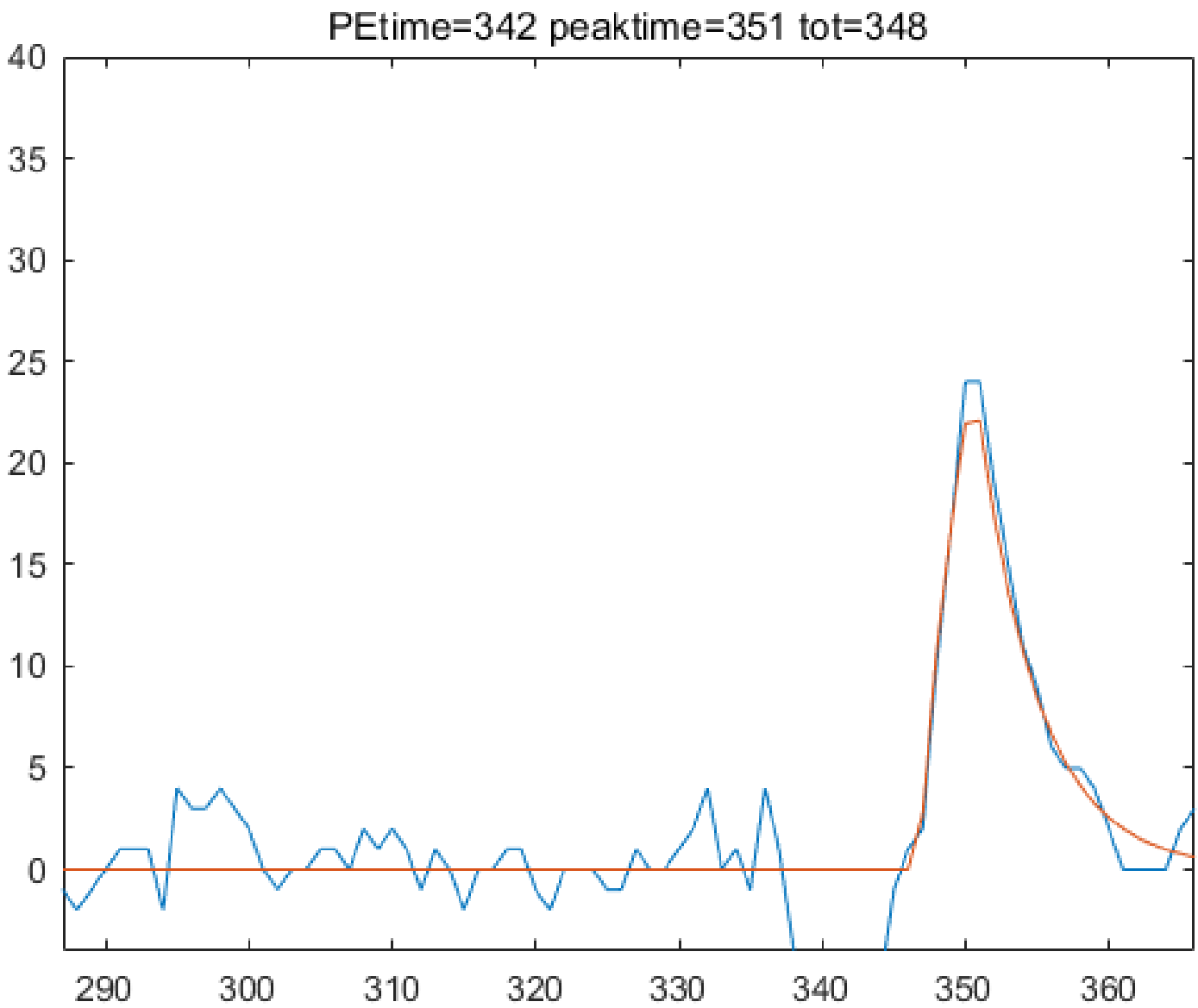
Process


PEtime=326 peaktime=334 tot=332
40
35
30
25
20
15
10
5
0
290
300
310
320
330
340
350
360

Process


PEtime=331 peaktime=338 tot=337
40
35
30
25
20
15
10
5
0
290
300
310
320
330
340
350
360

Process


PEtime=342 peaktime=351 tot=348
40
35
30
25
20
15
10
5
0
290
300
310
320
330
340
350
360

Process

answer: 288,291,309,324,326,331,342

truth : 288,291,309,324,325,329,342

wasserstein_distance = 0.4286

Exceptions

- Tiny signals.

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- Sigals in the beginging or the end.

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- Some single-PE waves does not fit well (especially the descending part) $\Rightarrow$ tail after substracting $\Rightarrow$ fake PE found.

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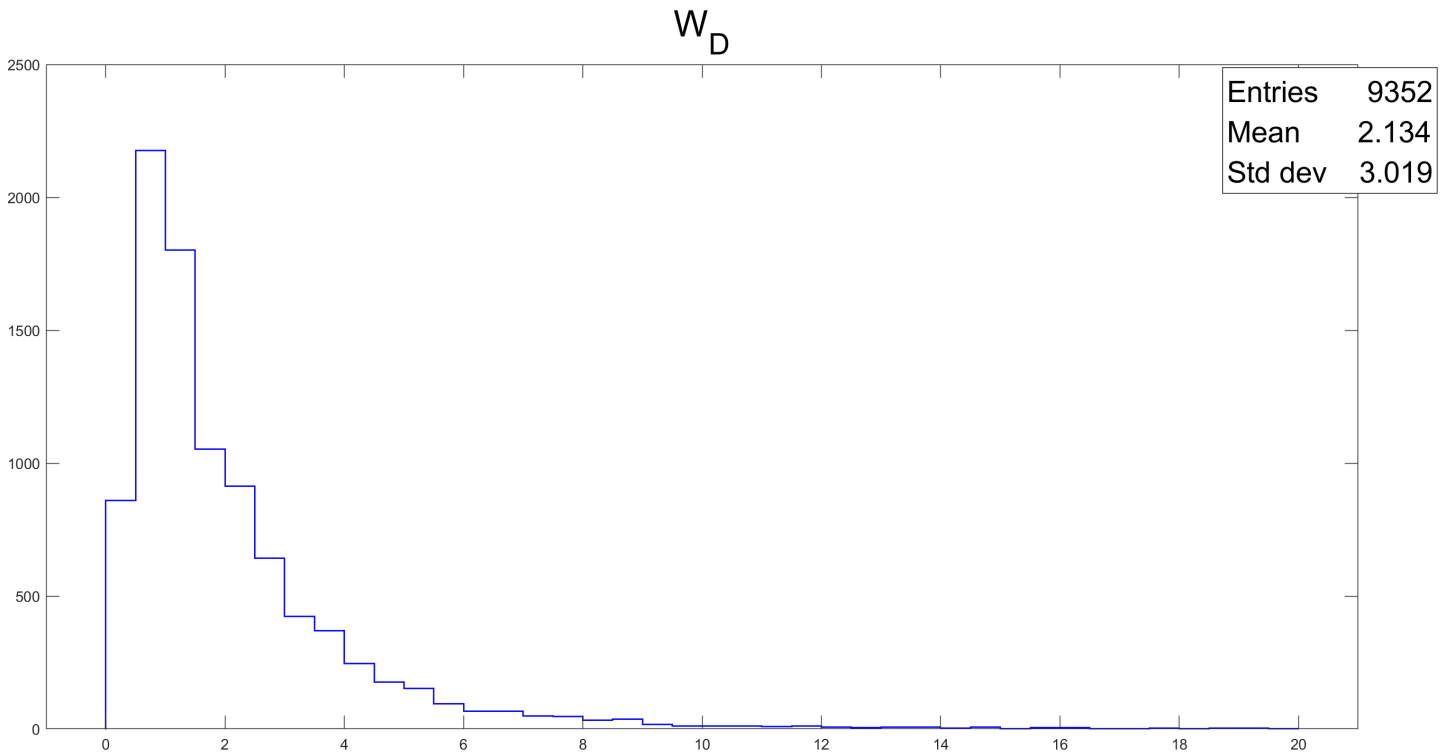
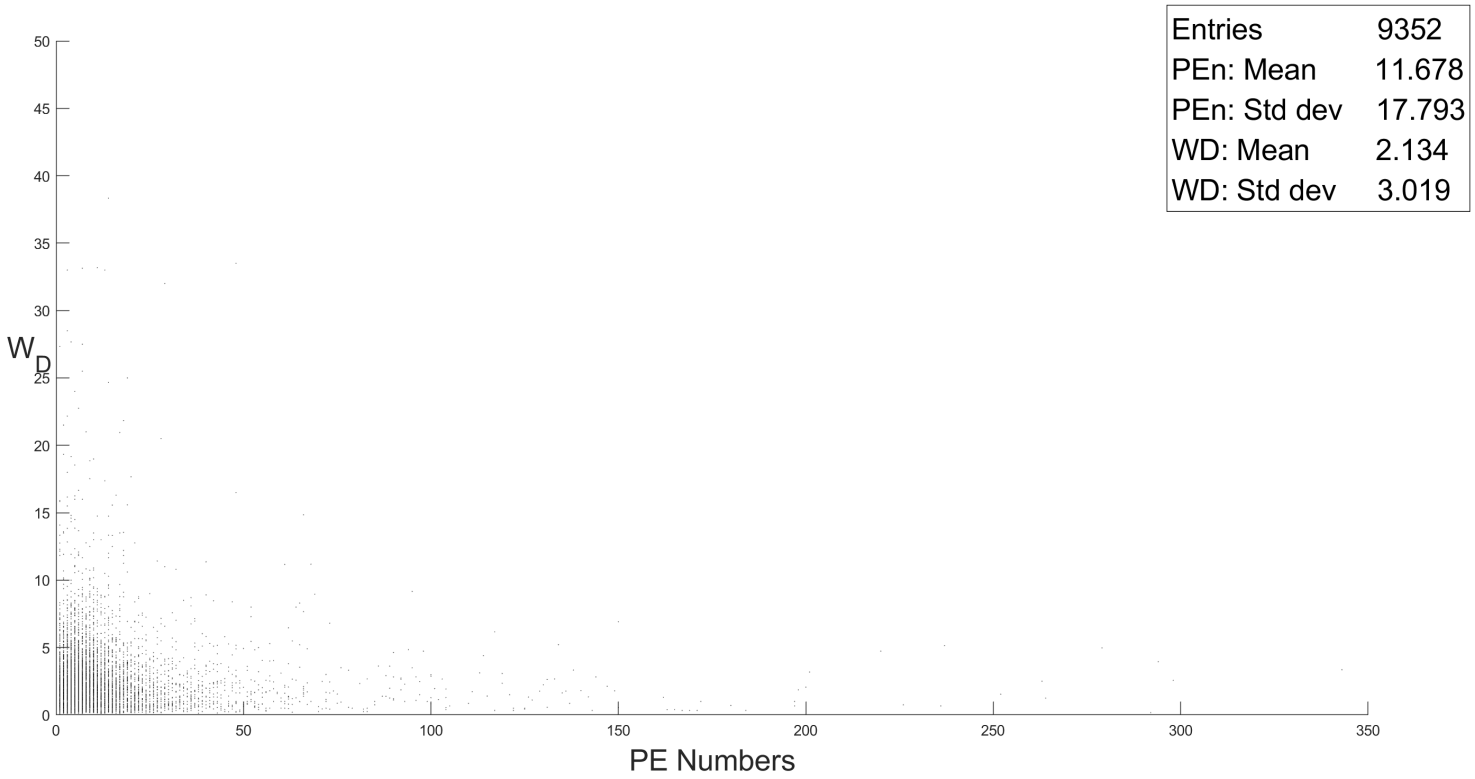
Solution: process exceptional signals separatedly; cut fake PEs.

Results


W_D
Entries 9352
Mean 2.134
Std dev 3.019
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
16
18
20

Results


Entries 9352
PEn: Mean 11.678
PEn: Std dev 17.793
WD: Mean 2.134
WD: Std dev 3.019
WD
PE Numbers
0
5
10
15
20
25
30
35
40
45
50
0
50
100
150
200
250
300
350

Results

Show filters

ID	Participant	Status	Wasserstein Distance	Poisson Distance	Message	Submission (UTC) ▼	
946	wyy	Graded	2.034	0.087	Successfully graded your submission in 433.737 seconds.	08 Jun 2019 03:53:52	
944	xswl	Graded	1.08	0.069	Successfully graded your submission in 440.114 seconds.	07 Jun 2019 12:50:29	
943	xswl	Failed	–	–	Weight array-like sum must be positive and finite. Set as None for an equal distribution of weight.	07 Jun 2019 11:40:19	
942	wyy	Graded	2.461	0.105	Successfully graded your submission in 440.575 seconds.	06 Jun 2019 14:52:22	
940	wyy	Graded	2.461	0.105	Successfully graded your submission in 424.113 seconds.	04 Jun 2019 15:19:57	
939	Tracer	Failed	–	–	Weight array-like sum must be positive and finite. Set as None for an equal distribution of weight.	03 Jun 2019 15:43:29	

Code: https://github.com/littlewu2508/Ghost-Hunter-wyy

Thanks for listening!

Reference

Helmuth Spieler.

Pulse processing and analysis.

In *IEEE NPSS Short Course, 1993 Nuclear Science Symposium, San Francisco, California*, 2002.