VD Bottom Cold Electronics
update on the analysis of channels with abnormal-RMS noise

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U.S. CRP and BDE meeting
01/19/2022

CE near-term efforts & man power

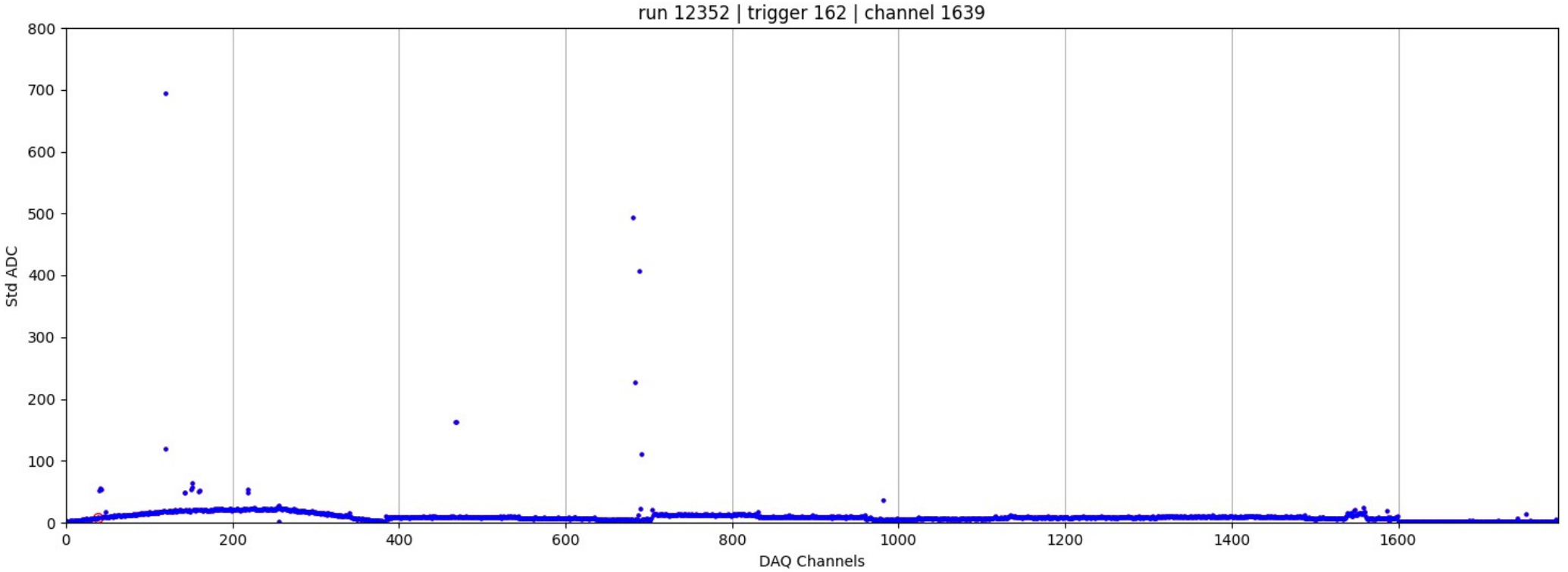
- CERN
  - VD ColdBox
  - APA test
- BNL
  - CE testing (FEMB, ASICs)
    - Which university and lab partners are going to be available for CE testing?
  - CE grounding optimization studies using CRU test setup
-

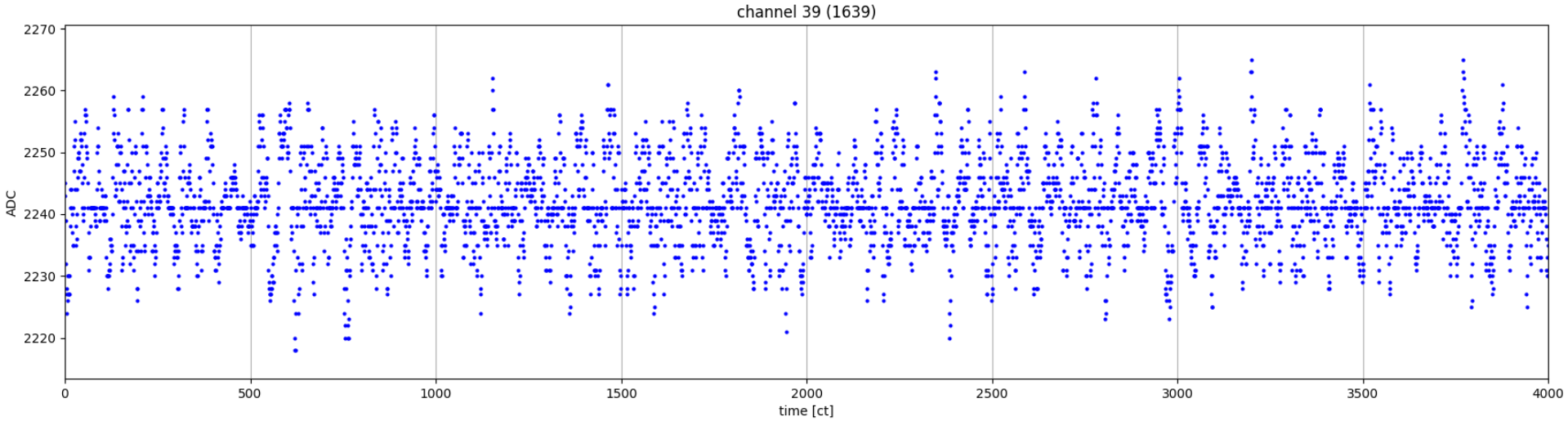
List of identified outliers

- Based on run 12352
- Channels with noise level above average

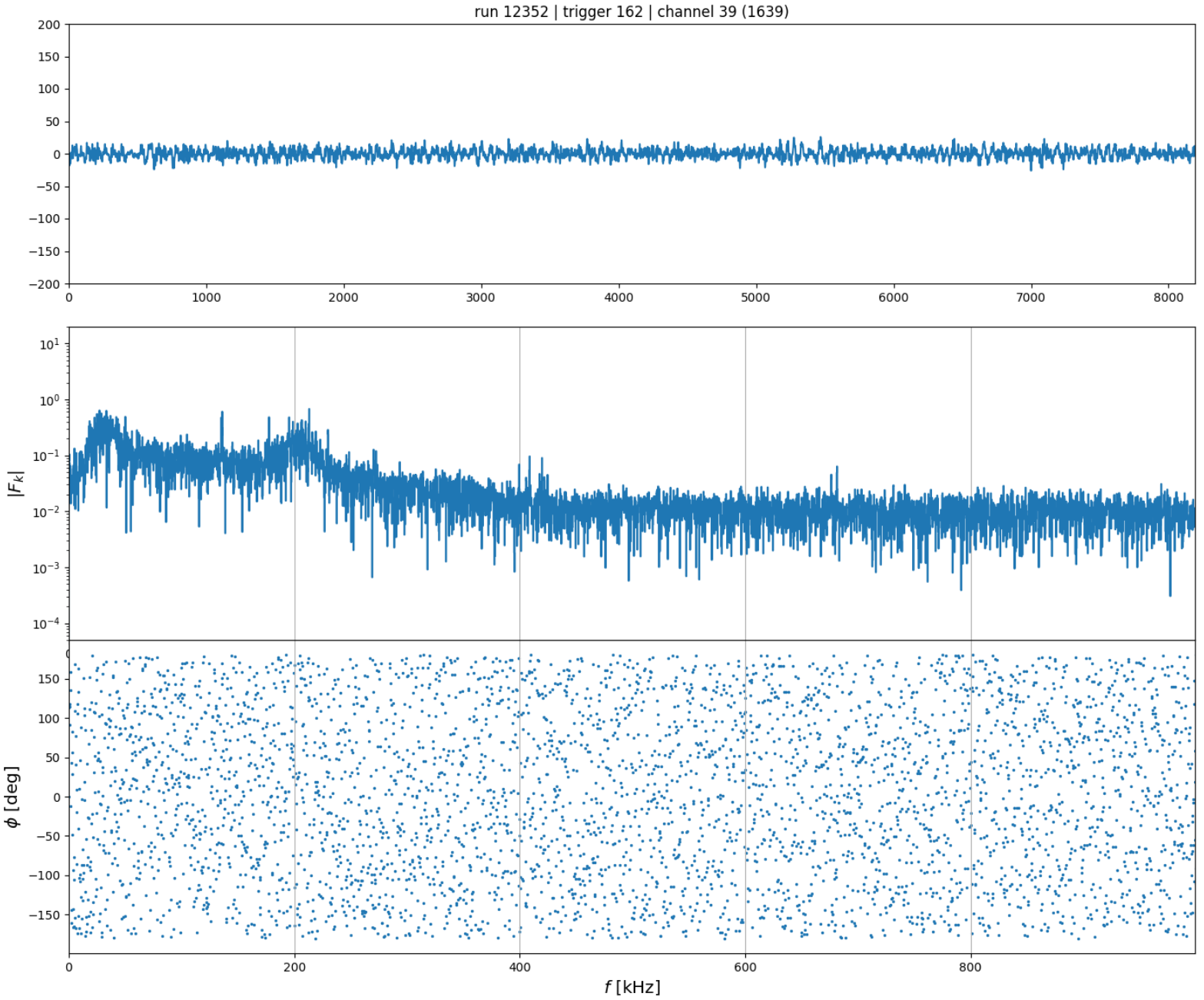
  1640, 1641, 1643, 1719, 1720, 1742, 1743, 1750, 1751, 1752, 1759, 1760, 1818, 1819, 1854, 1856, 2068, 2069, 2281, 2284, 2288, 2290, 2291, 2304, 2431, 2582, 3187, 3199, 3320, 3343, 3353
- Channels with noise level below average:
  1855, 3189

1639 – normal channel

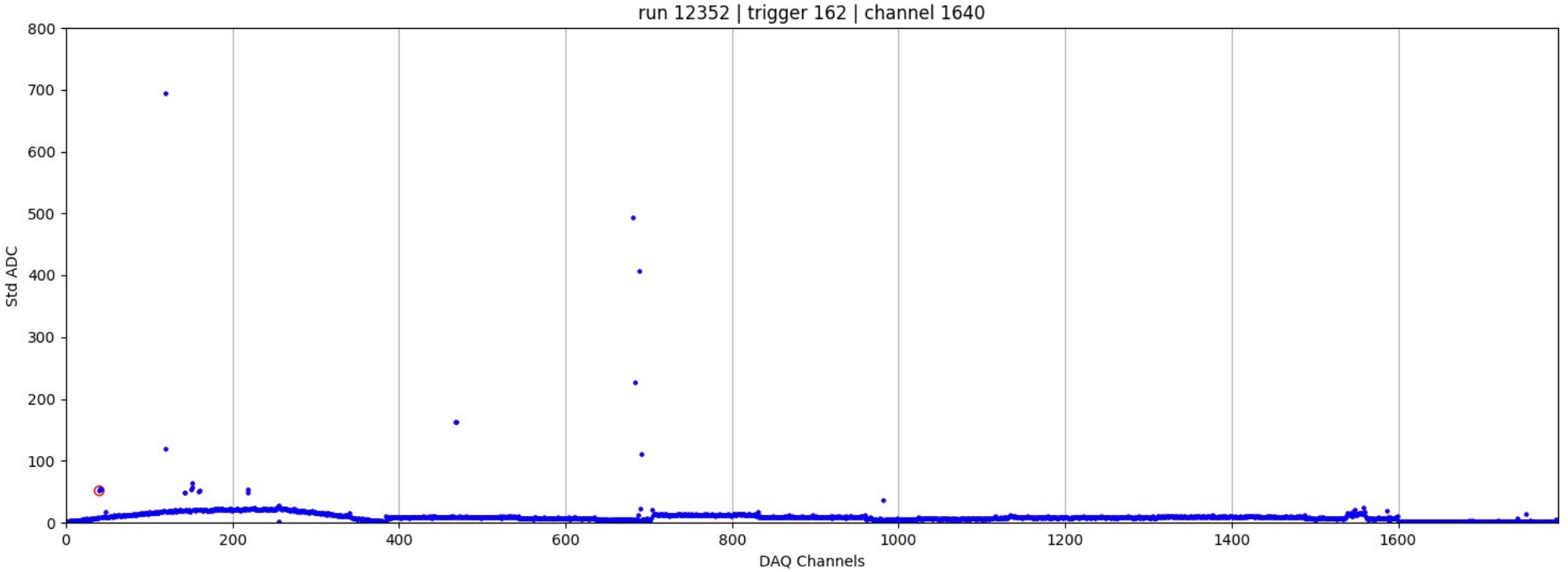


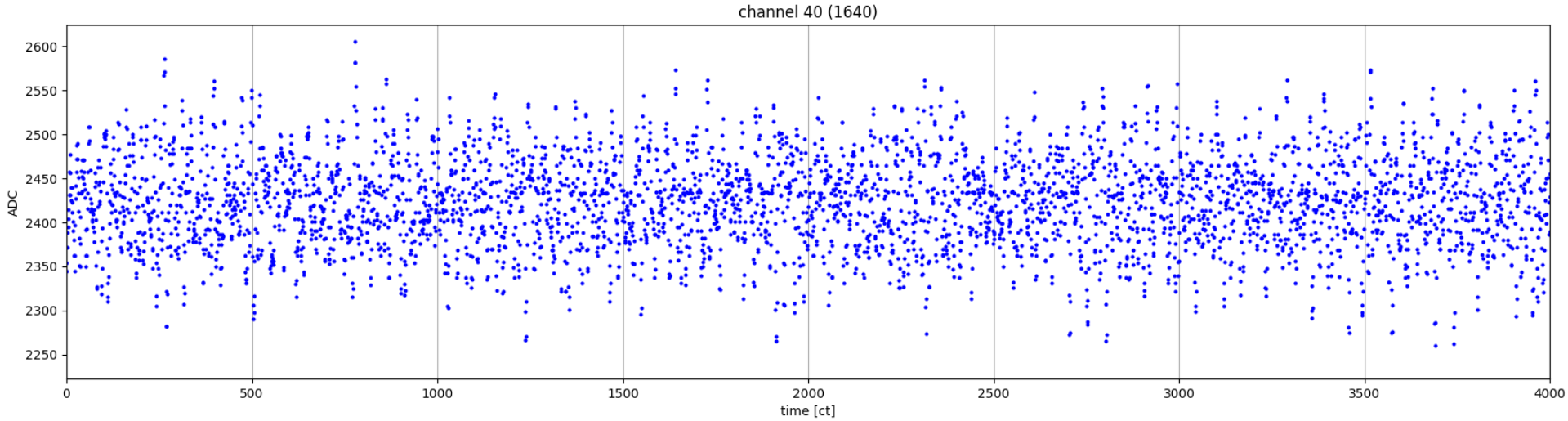


1639 – normal chanel

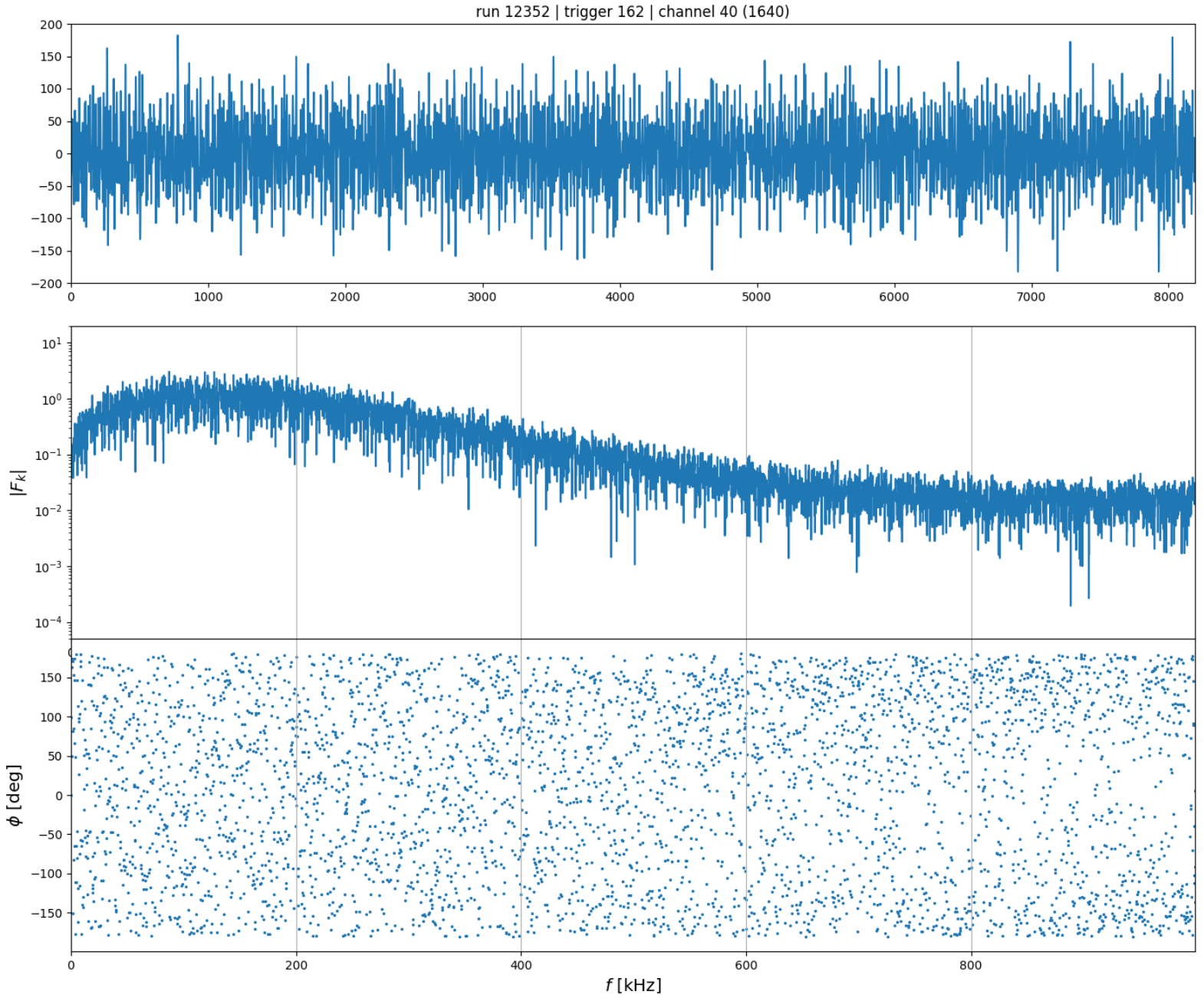


1640

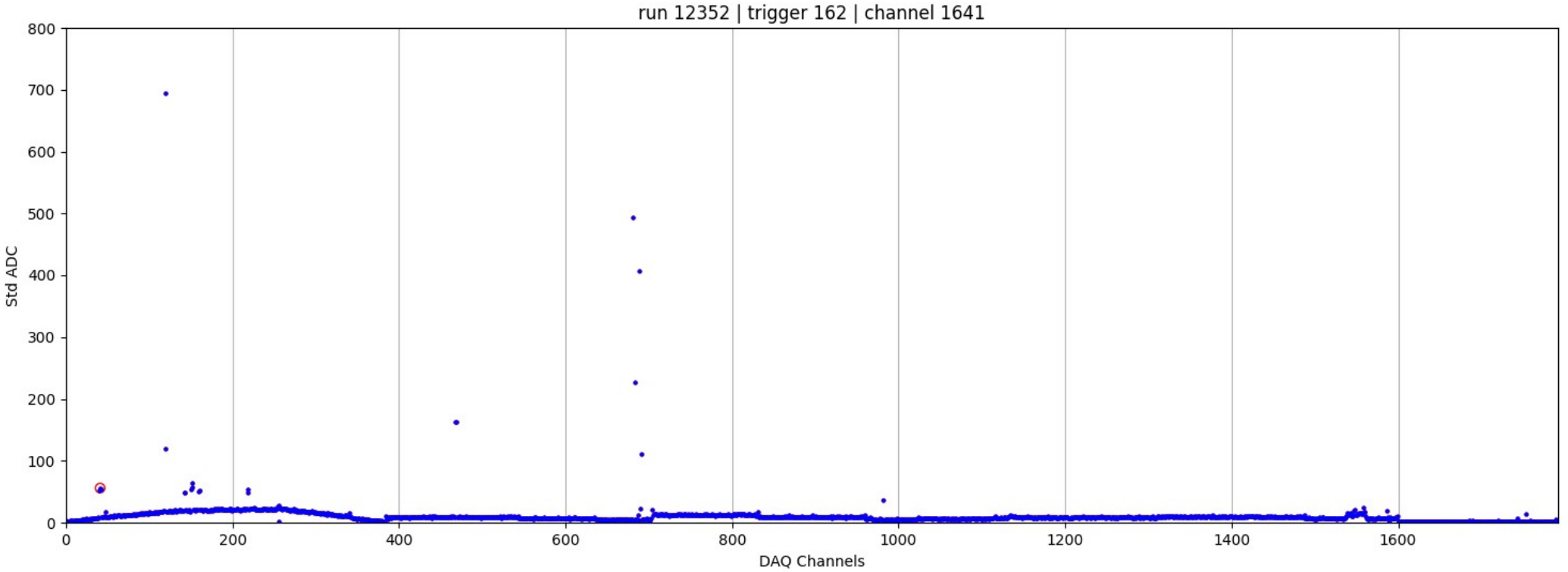

run 12352 | trigger 162 | channel 1640
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

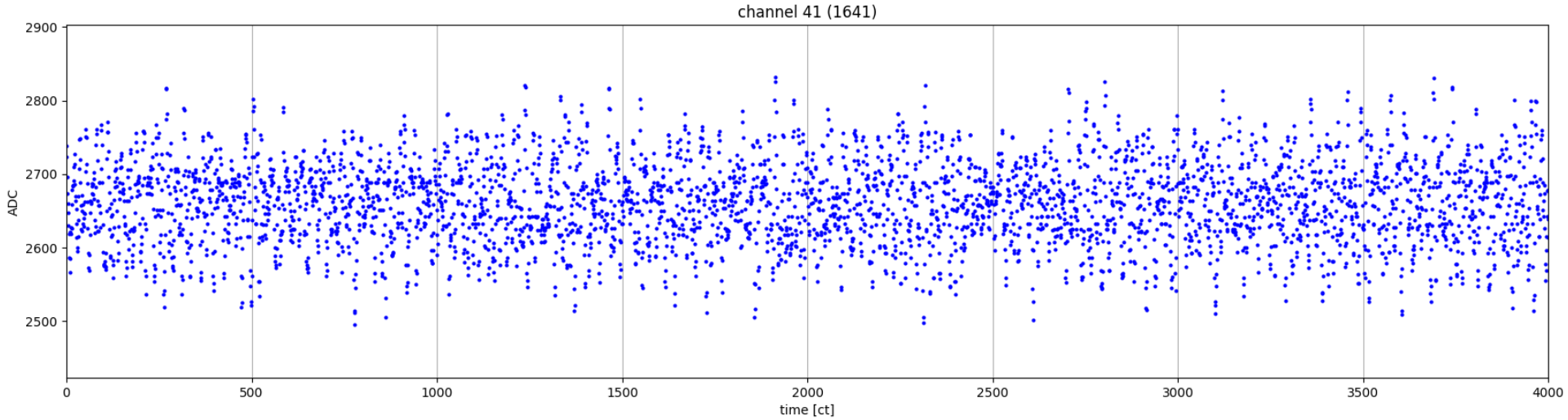

channel 40 (1640)
ADC
time [ct]
2250
2300
2350
2400
2450
2500
2550
2600
0
500
1000
1500
2000
2500
3000
3500
4000

1640

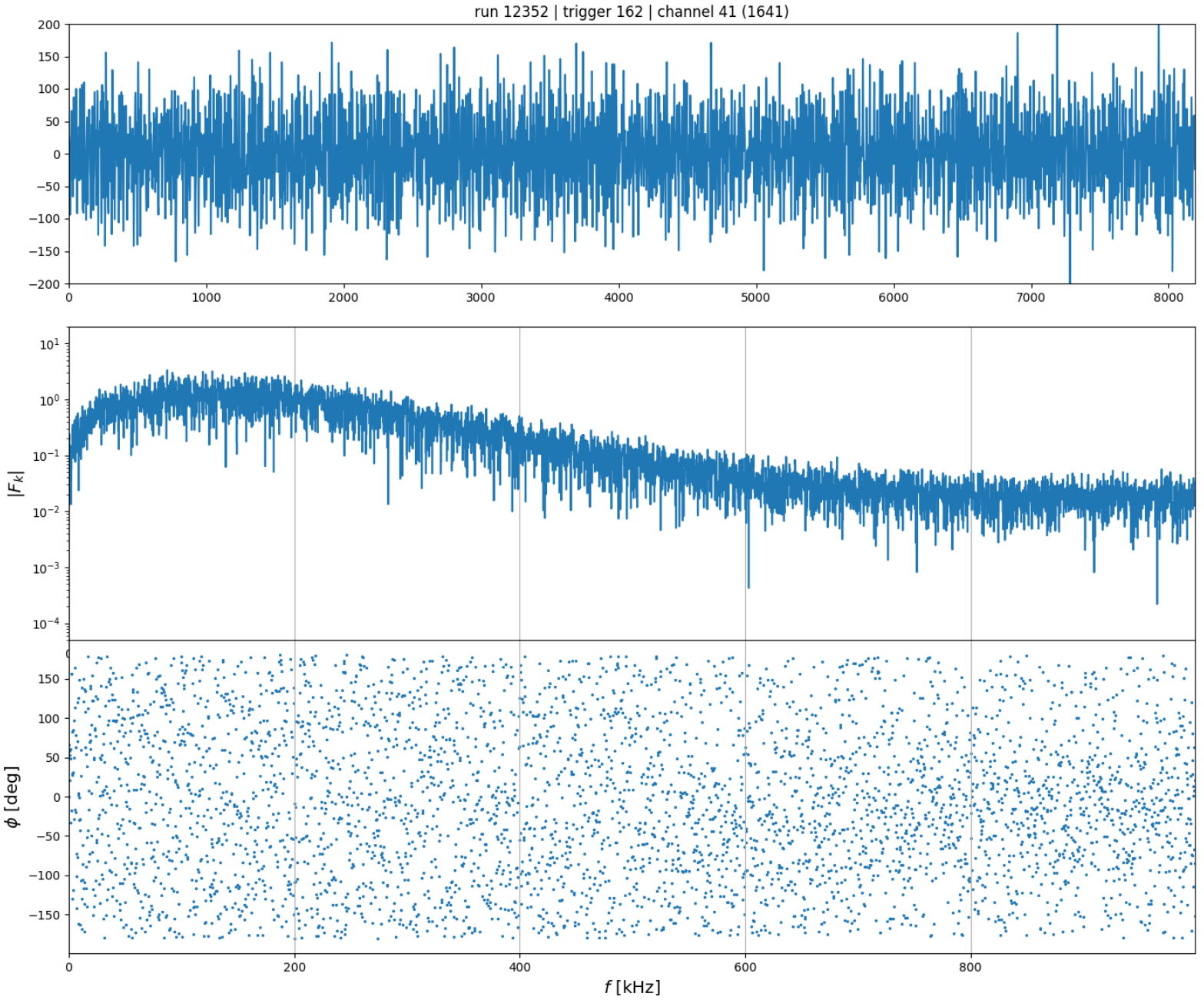


1641


run 12352 | trigger 162 | channel 1641
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

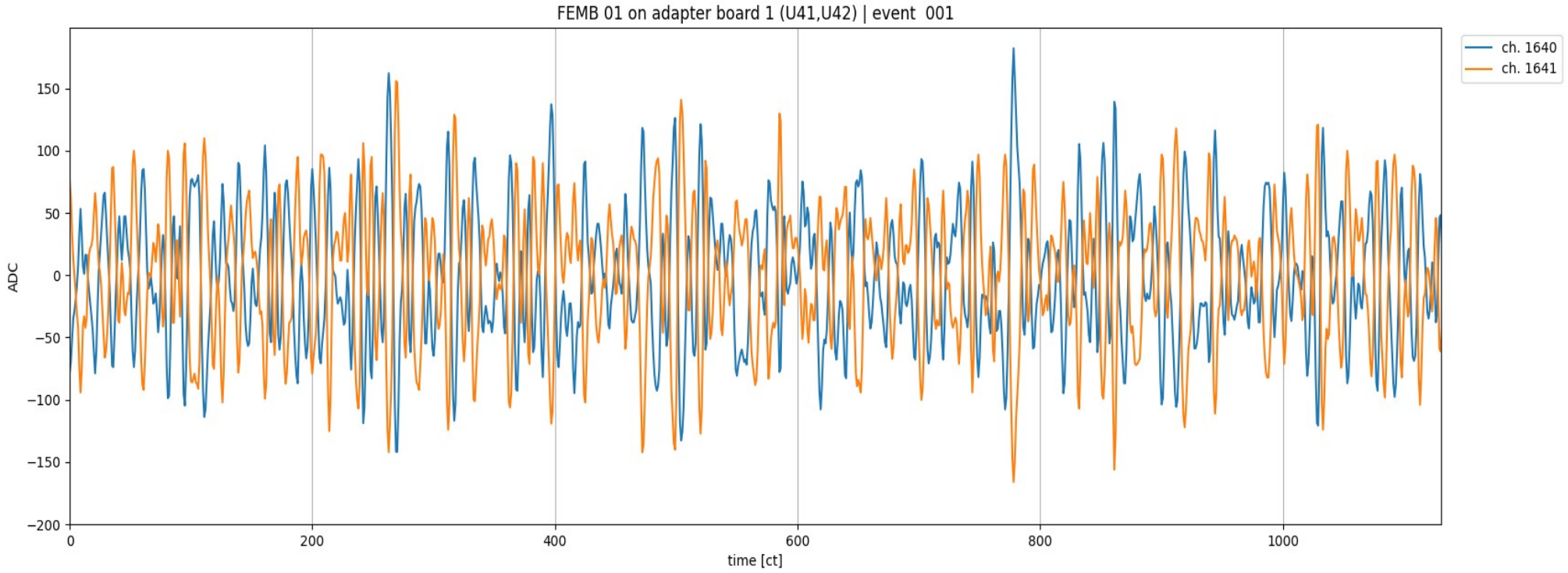

channel 41 (1641)
ADC
time [ct]
2500
2600
2700
2800
2900
0
500
1000
1500
2000
2500
3000
3500
4000

1641



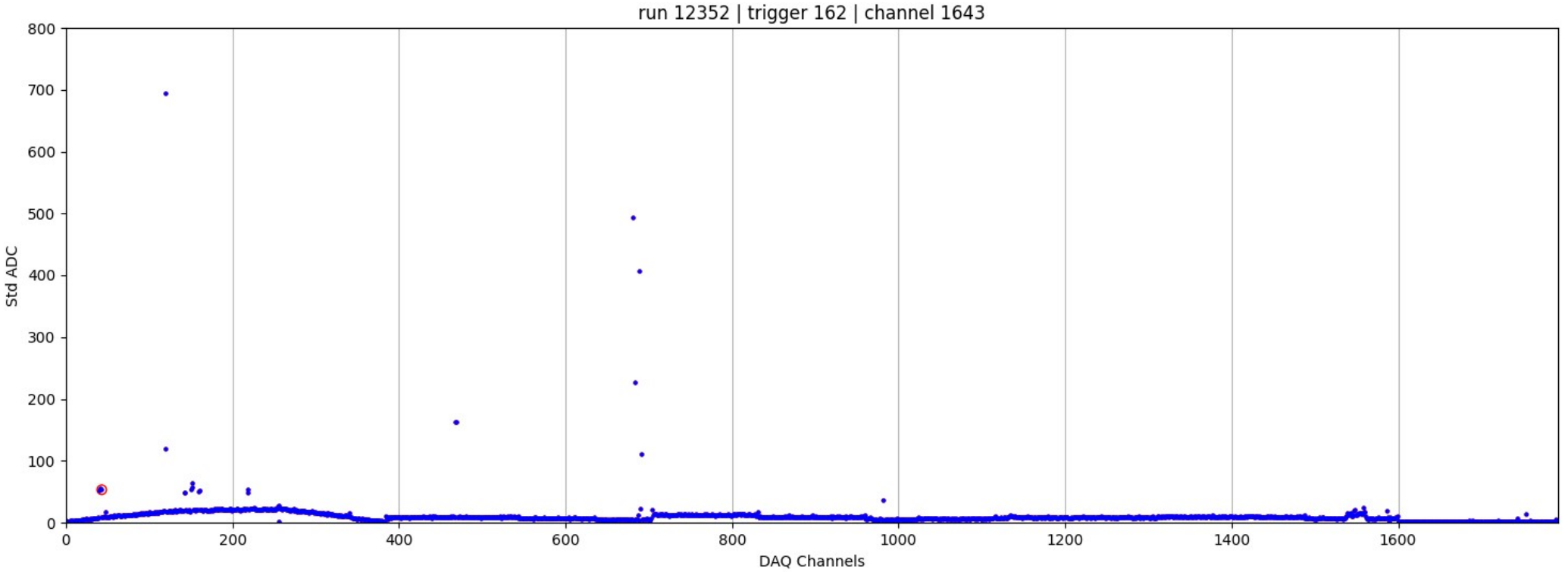
Raw wf, channels 1640 and 1641

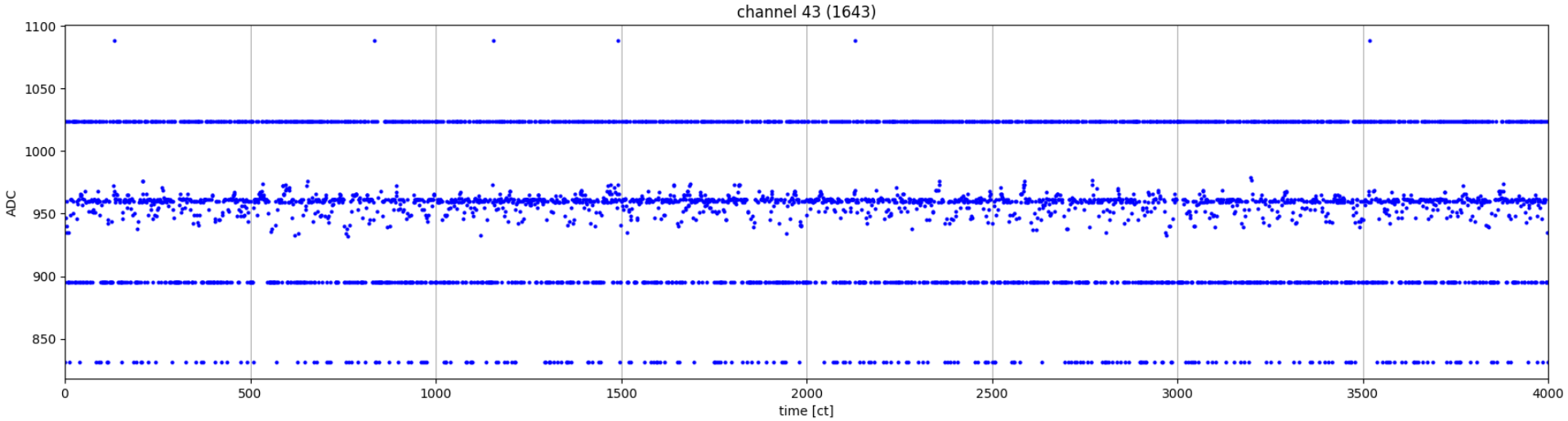
Strips U41,U42



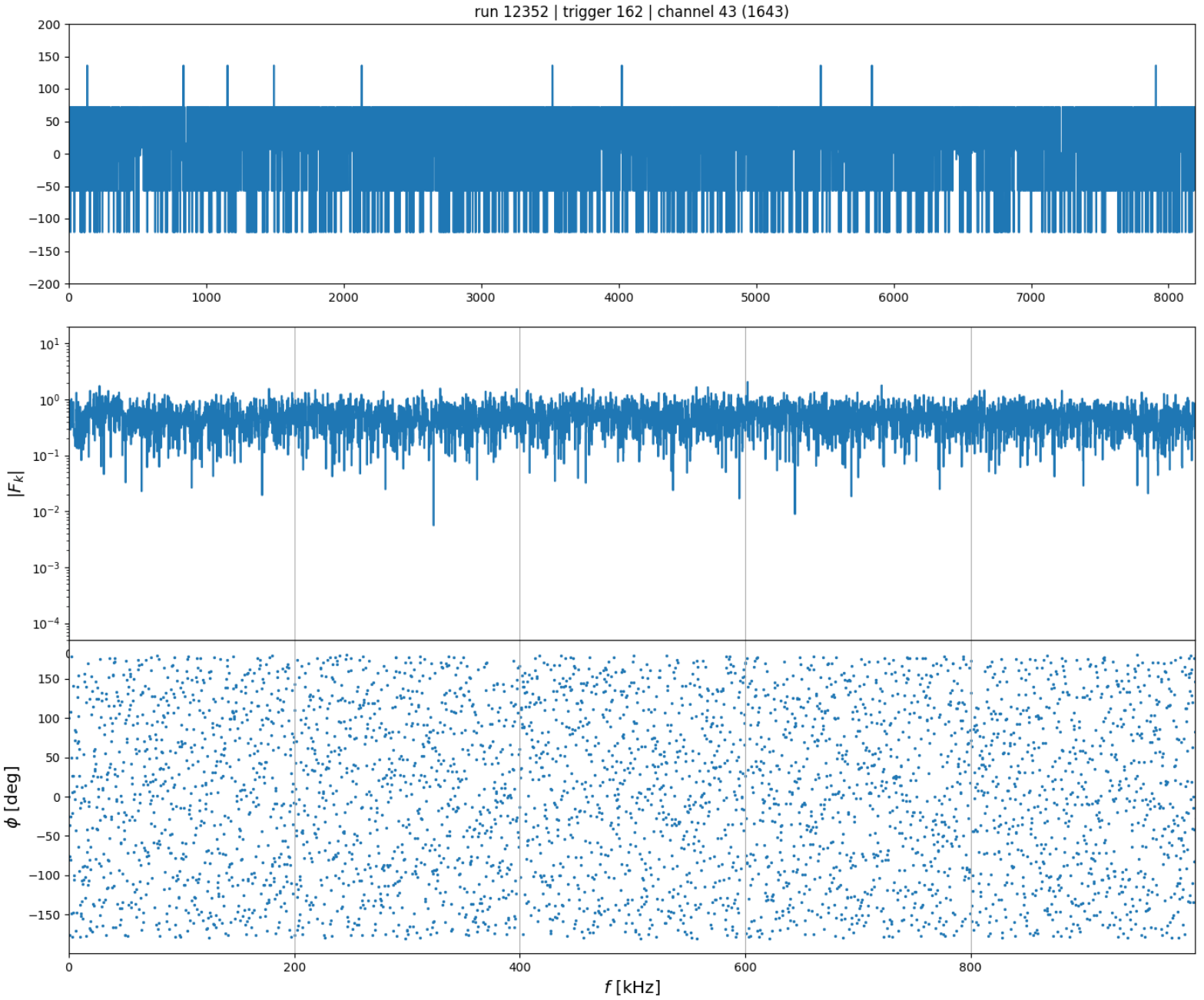
Anti-correlated “noise”

1643

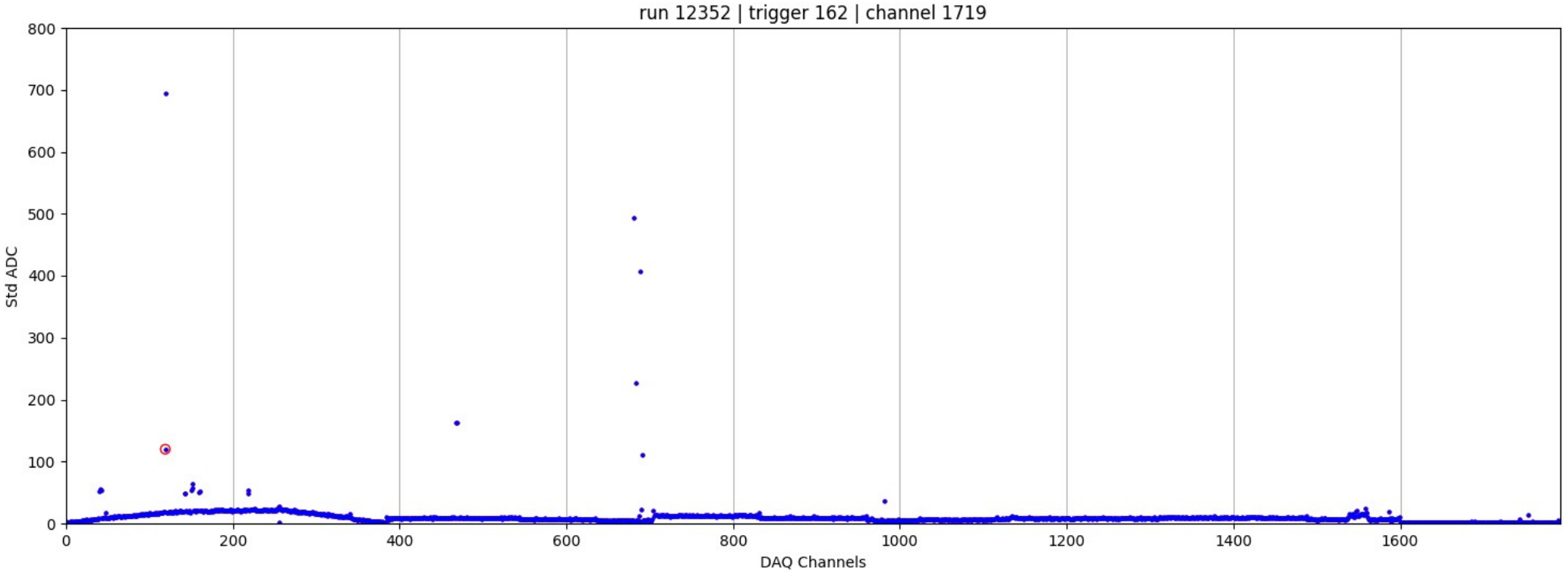

run 12352 | trigger 162 | channel 1643
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

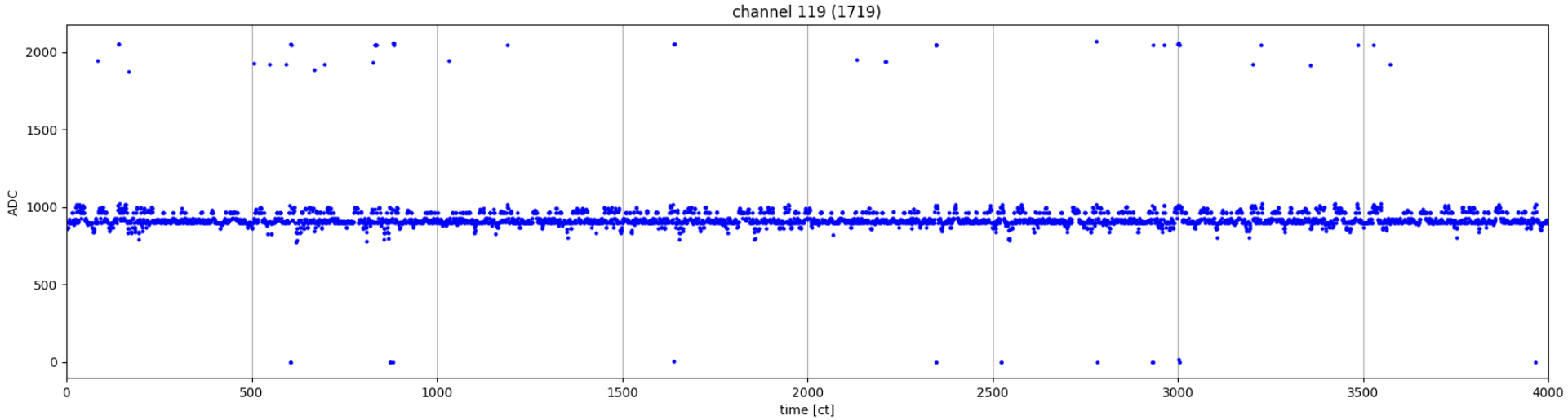

channel 43 (1643)
ADC
time [ct]
850
900
950
1000
1050
1100
0
500
1000
1500
2000
2500
3000
3500
4000

1643

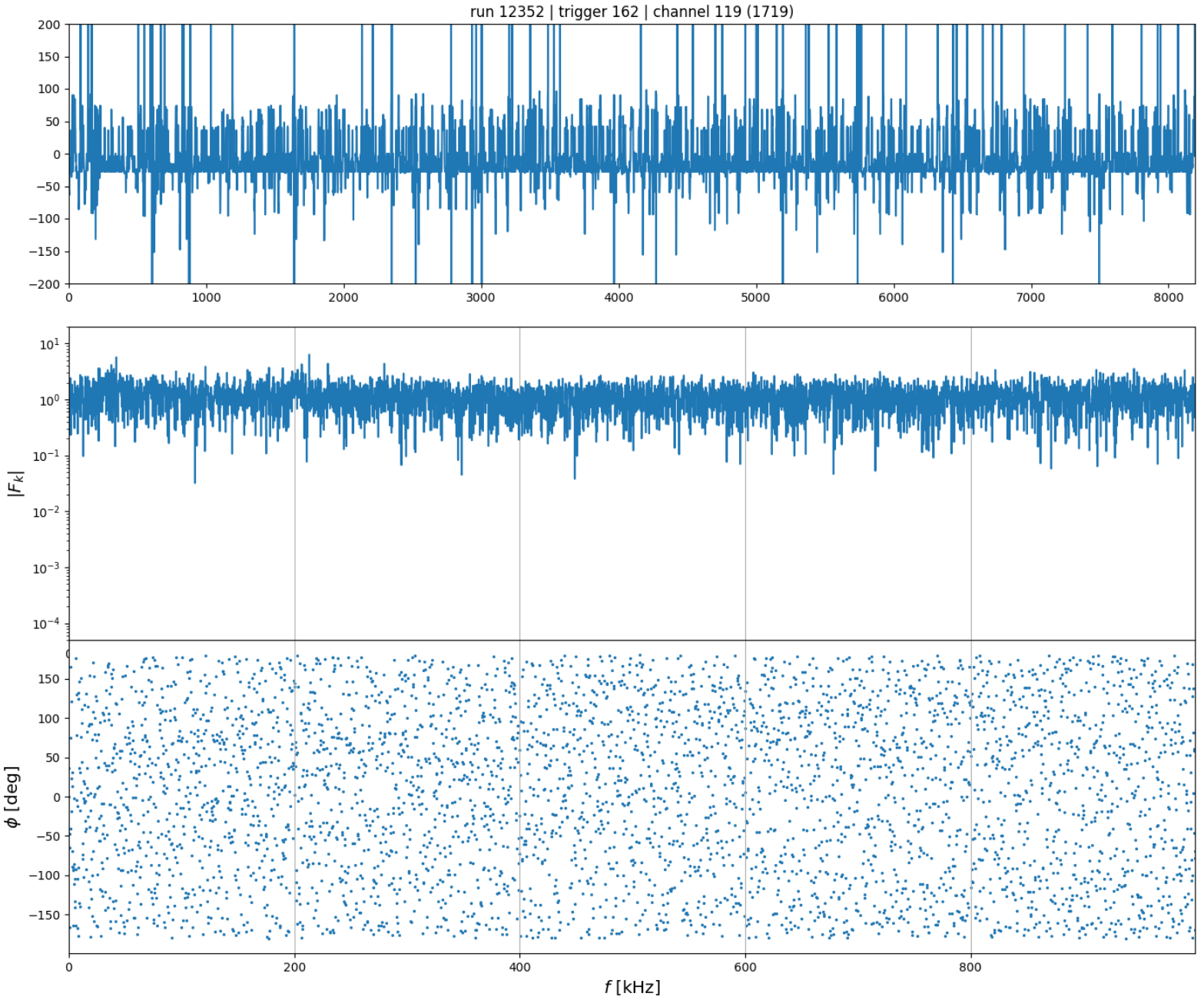


1719

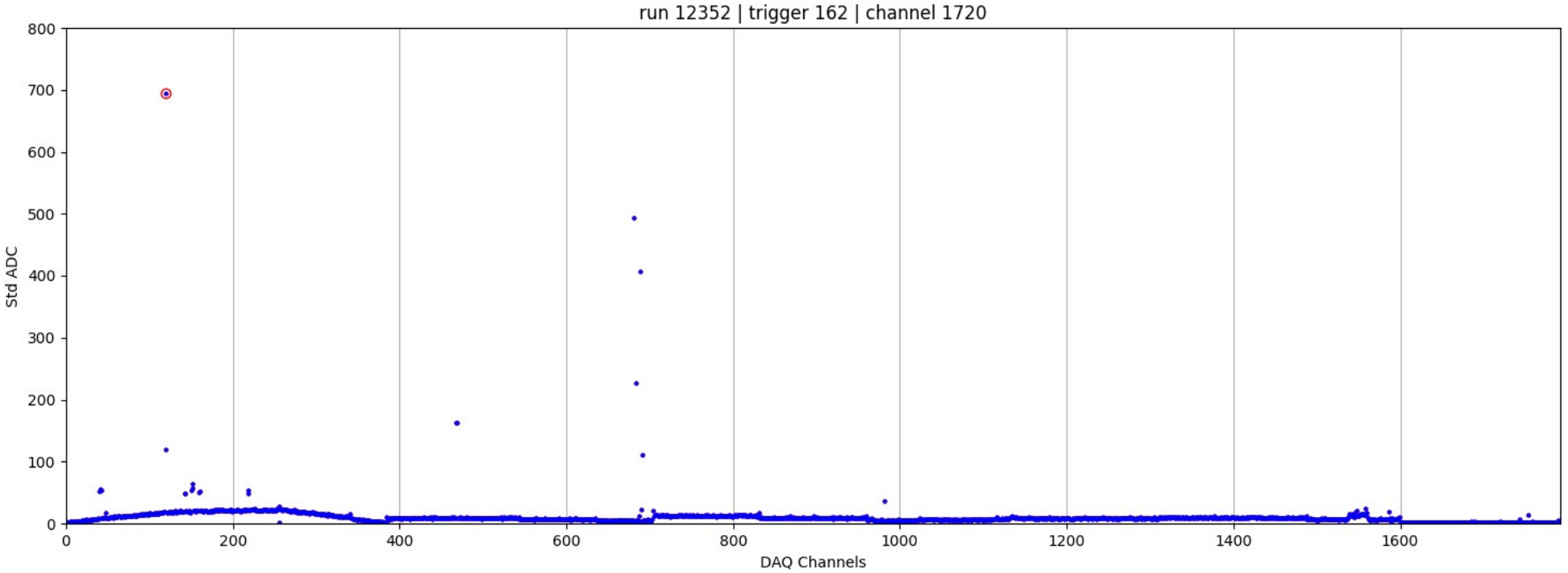

run 12352 | trigger 162 | channel 1719
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

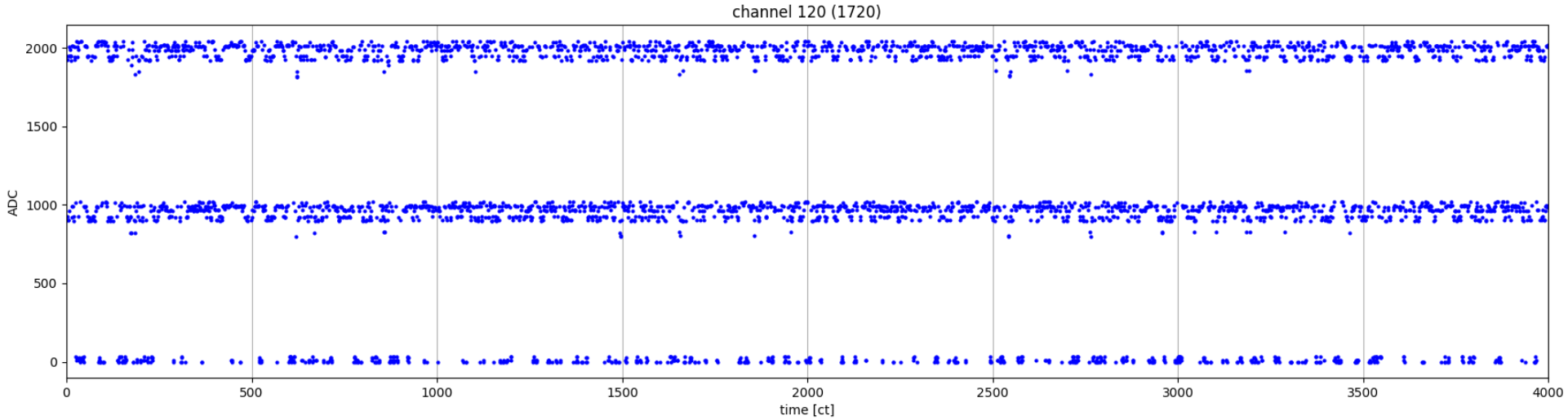

channel 119 (1719)
ADC
time [ct]
0
500
1000
1500
2000
0
500
1000
1500
2000
2500
3000
3500
4000

1719

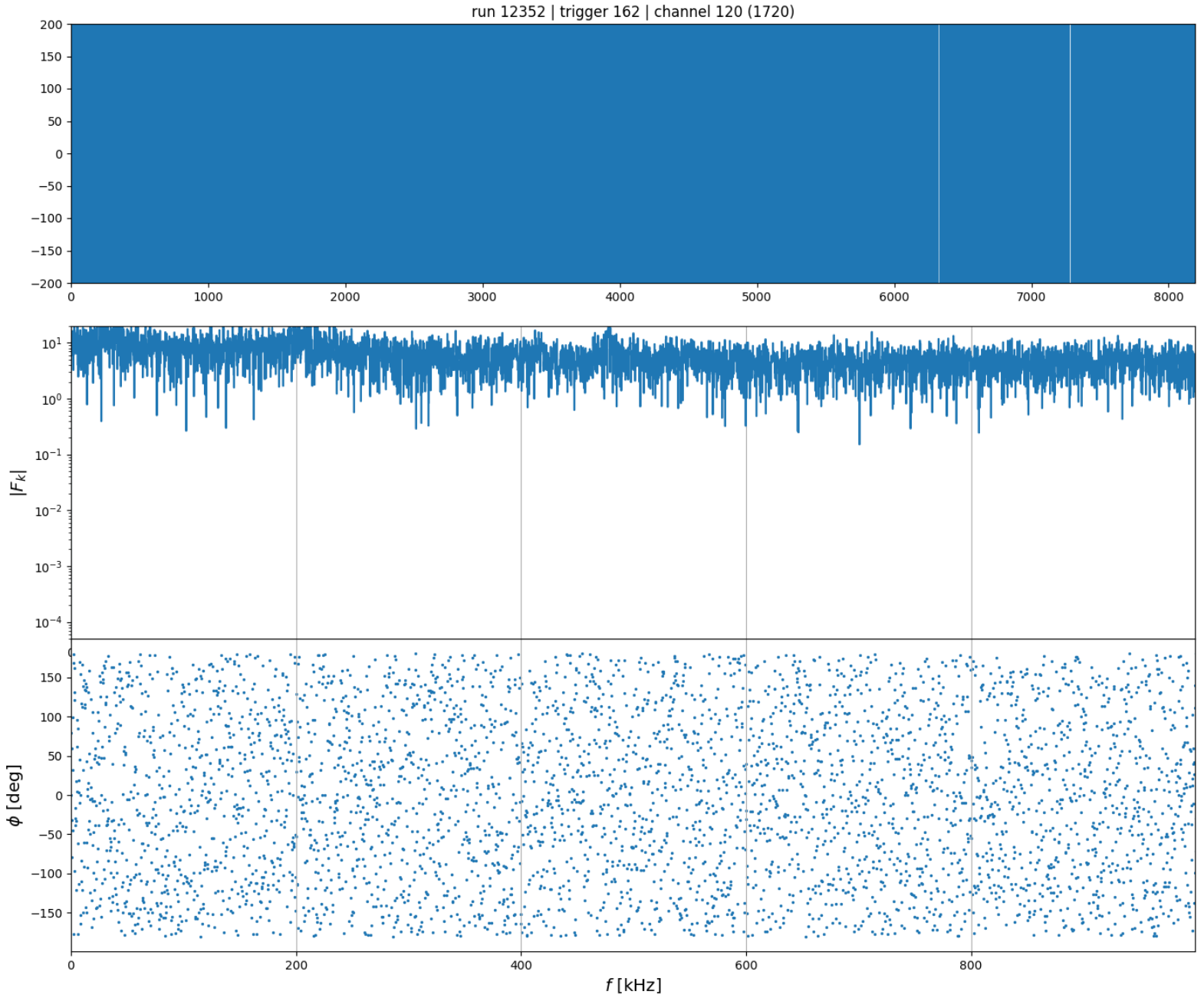


1720

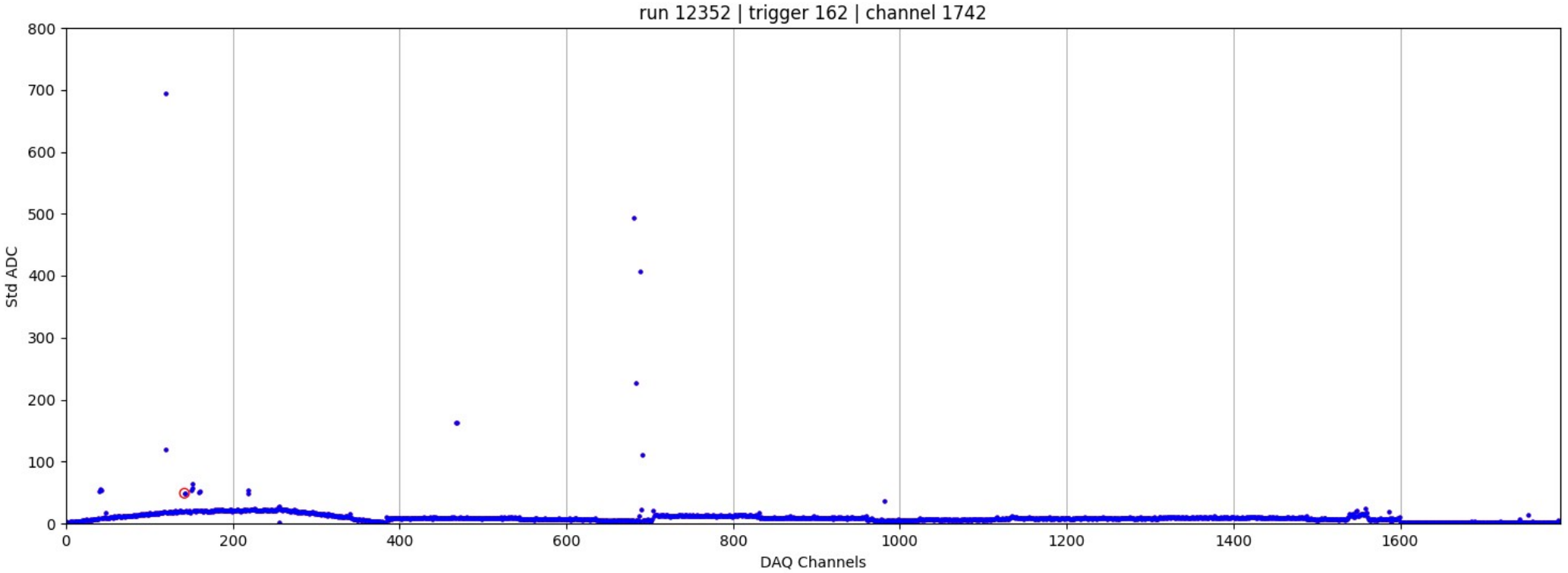

run 12352 | trigger 162 | channel 1720
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

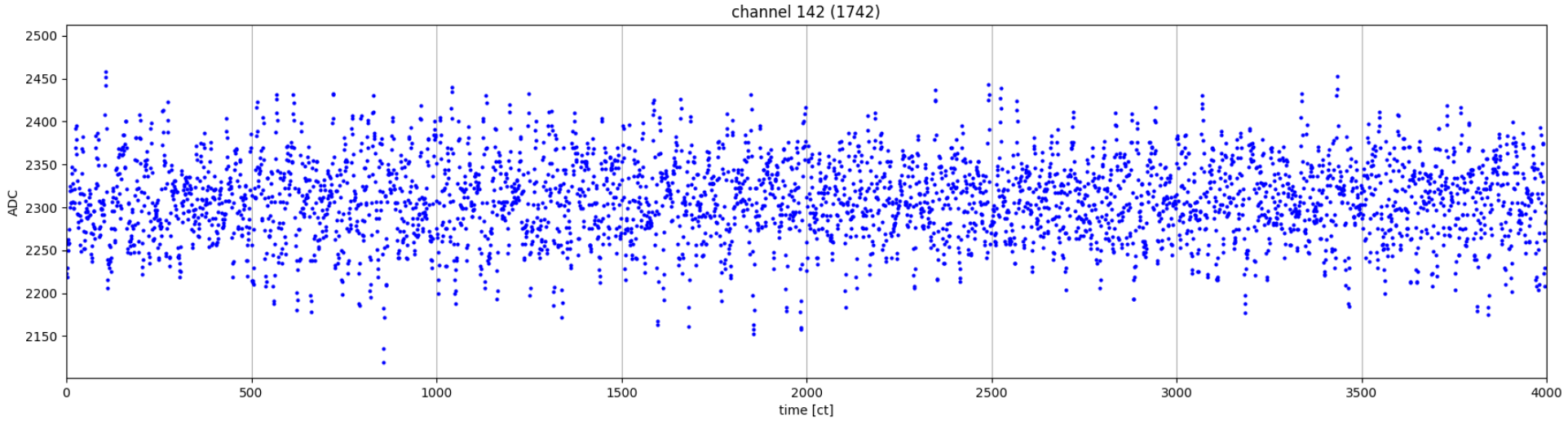

channel 120 (1720)
ADC
time [ct]
0
500
1000
1500
2000
0
500
1000
1500
2000
2500
3000
3500
4000

1720

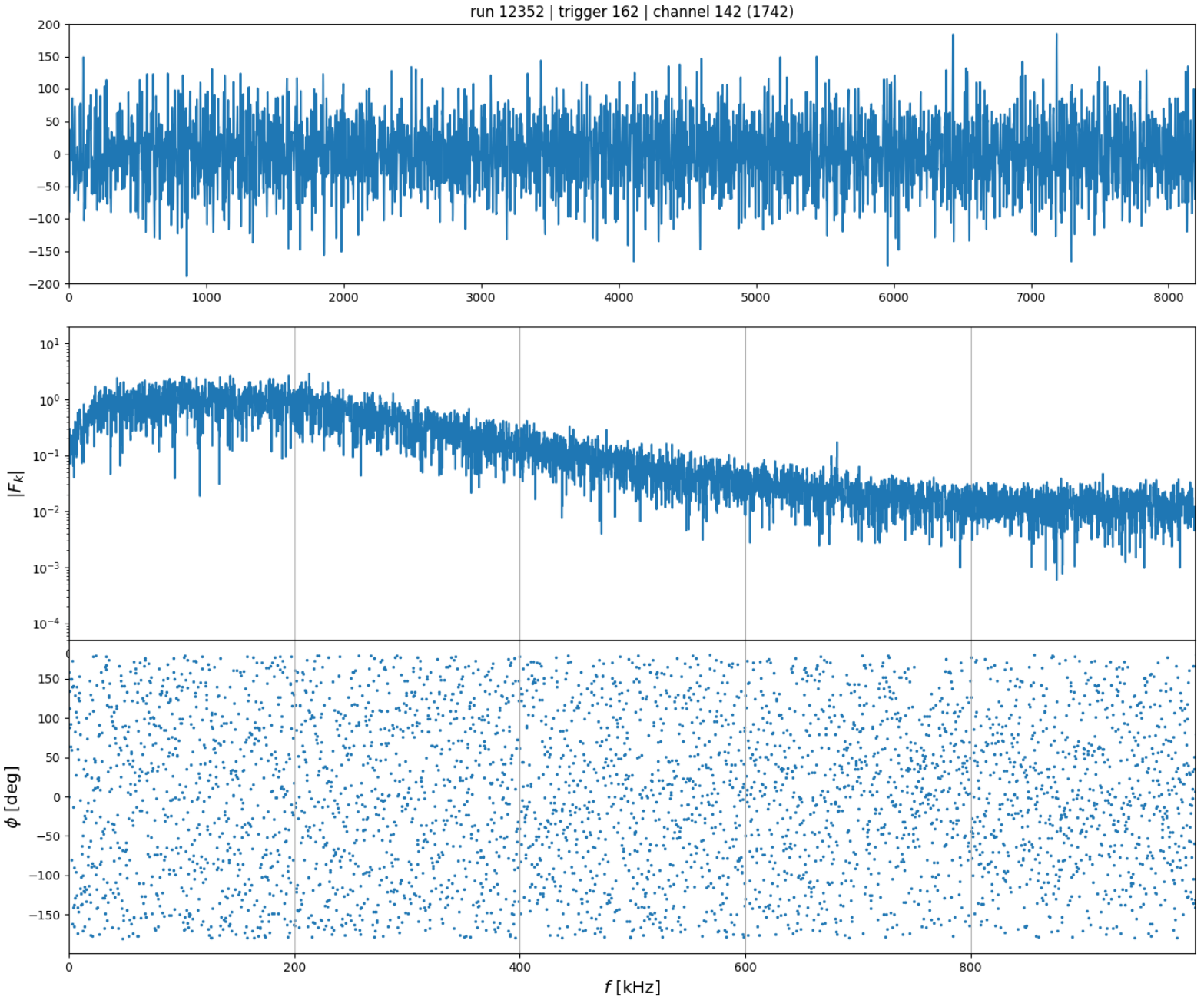

run 12352 | trigger 162 | channel 120 (1720)
200
150
100
50
0
−50
−100
−150
−200
0
1000
2000
3000
4000
5000
6000
7000
8000
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
$|F_k|$
150
100
50
0
−50
−100
−150
ϕ [deg]
0
200
400
600
800
f [kHz]

1742

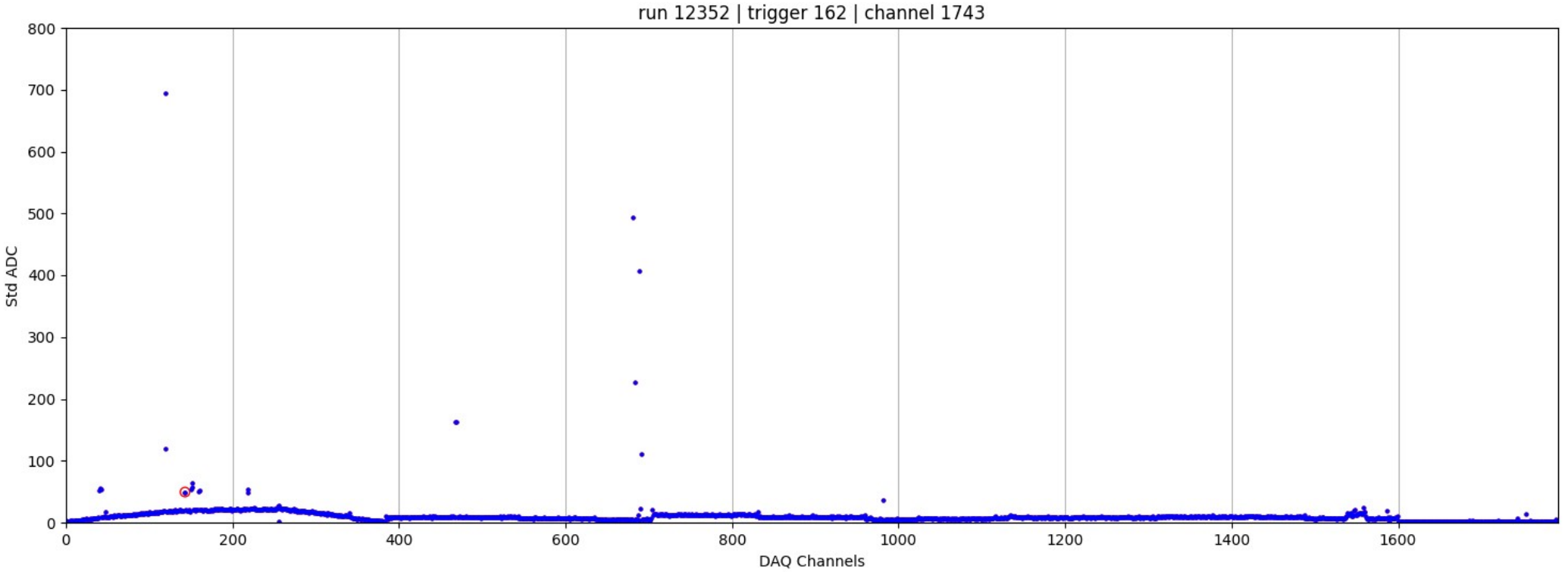

run 12352 | trigger 162 | channel 1742
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

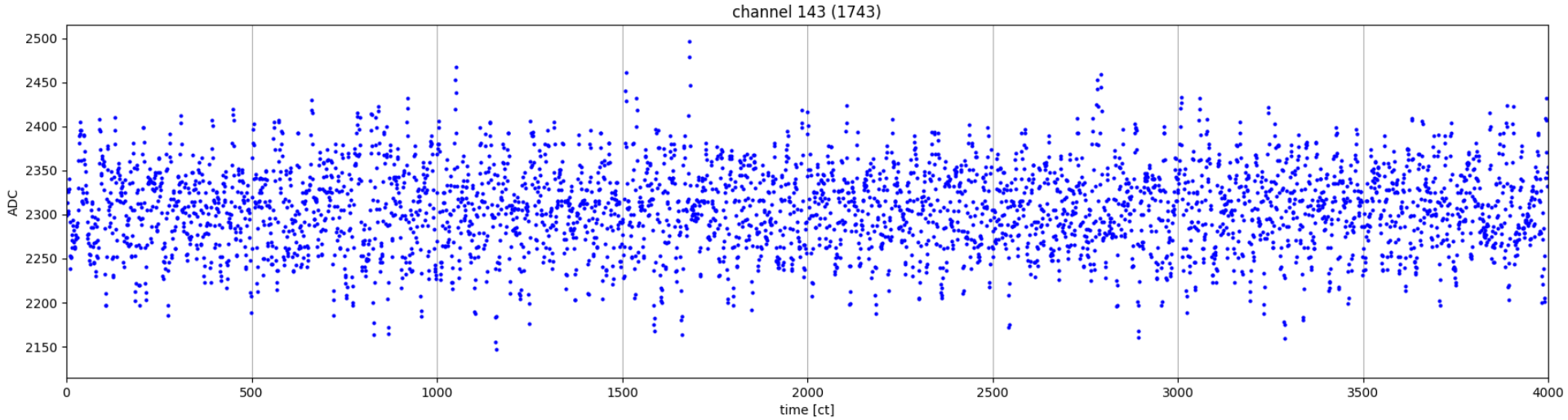

channel 142 (1742)
ADC
time [ct]
2150
2200
2250
2300
2350
2400
2450
2500
0
500
1000
1500
2000
2500
3000
3500
4000

1742

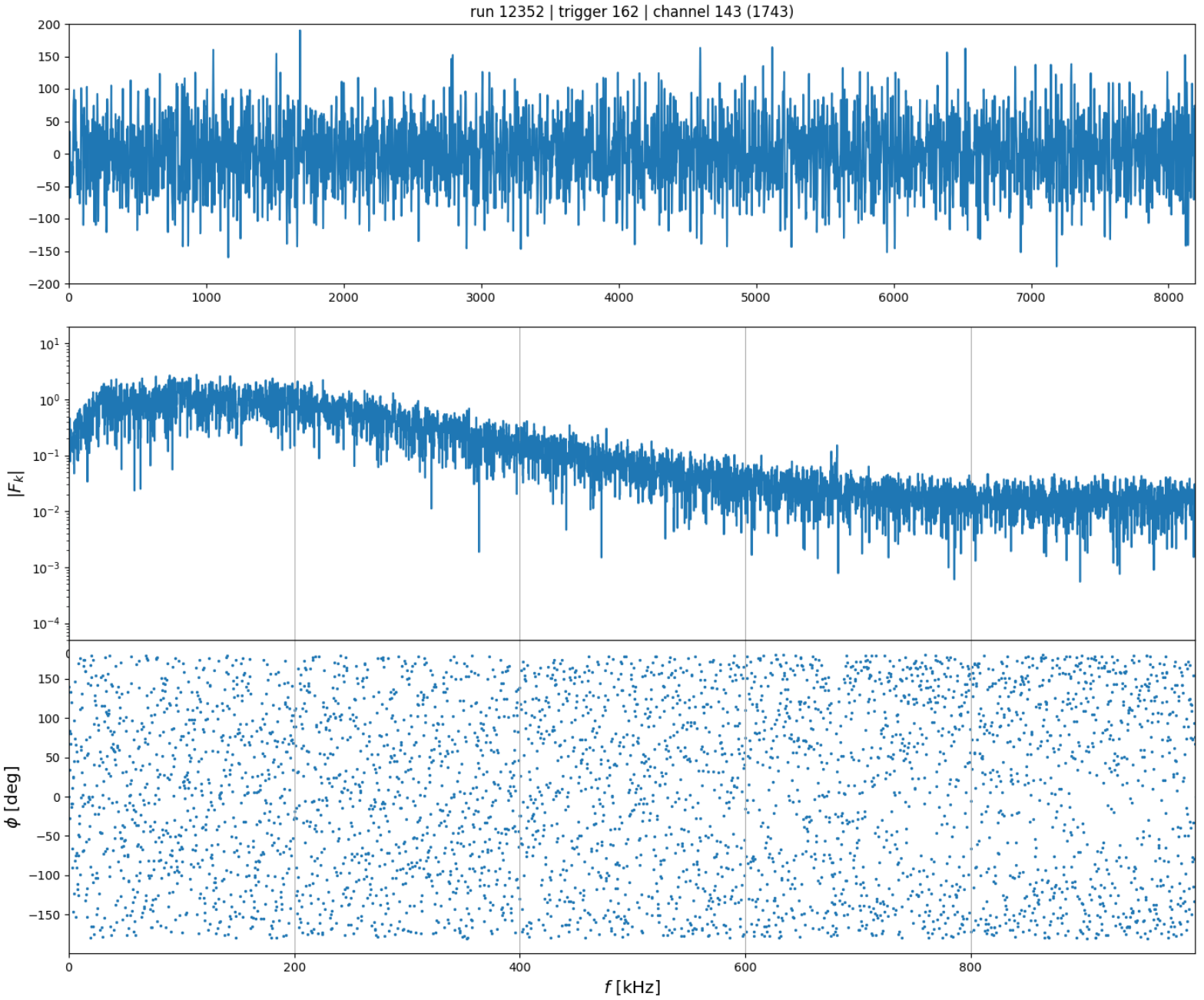


1743

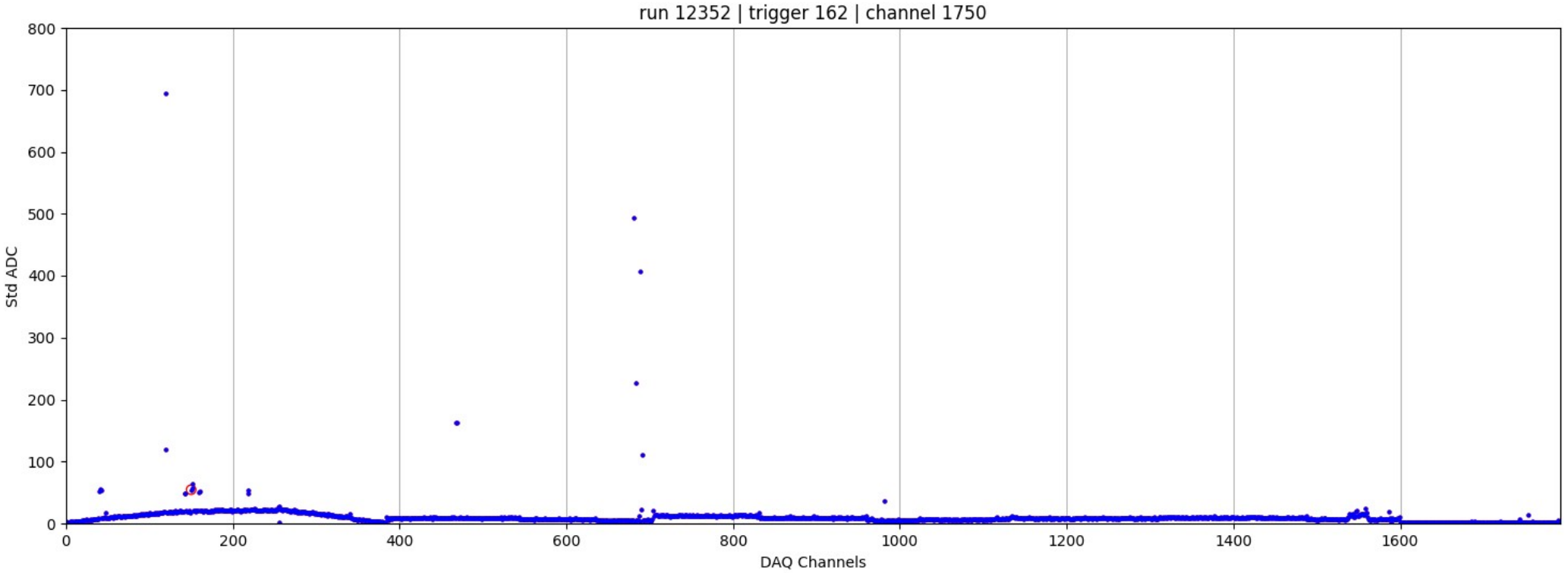

run 12352 | trigger 162 | channel 1743
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

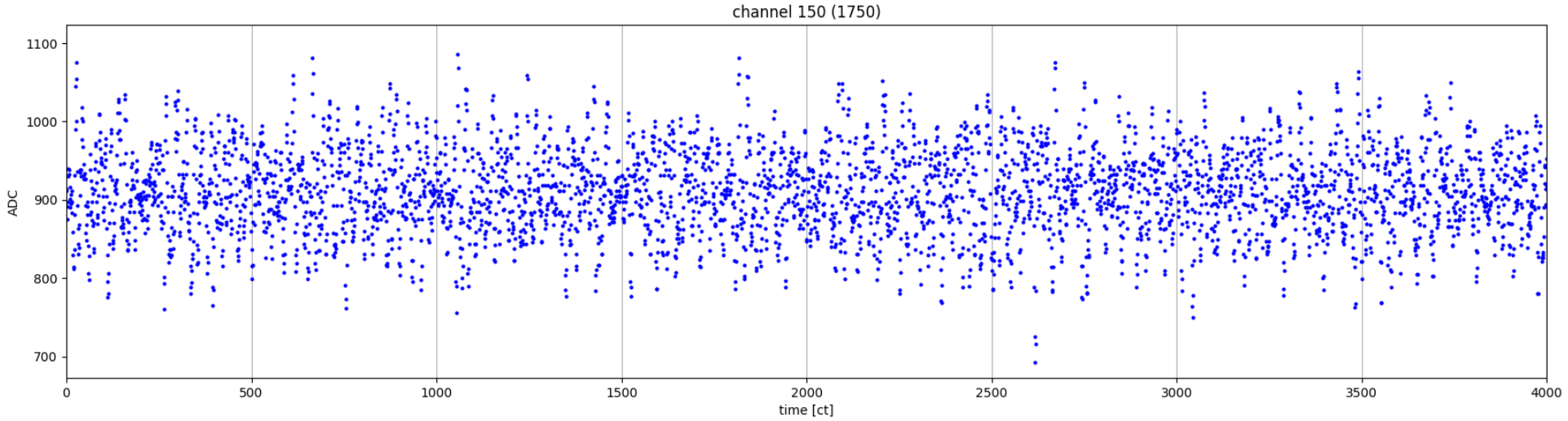

channel 143 (1743)
ADC
time [ct]
2150
2200
2250
2300
2350
2400
2450
2500
0
500
1000
1500
2000
2500
3000
3500
4000

1743

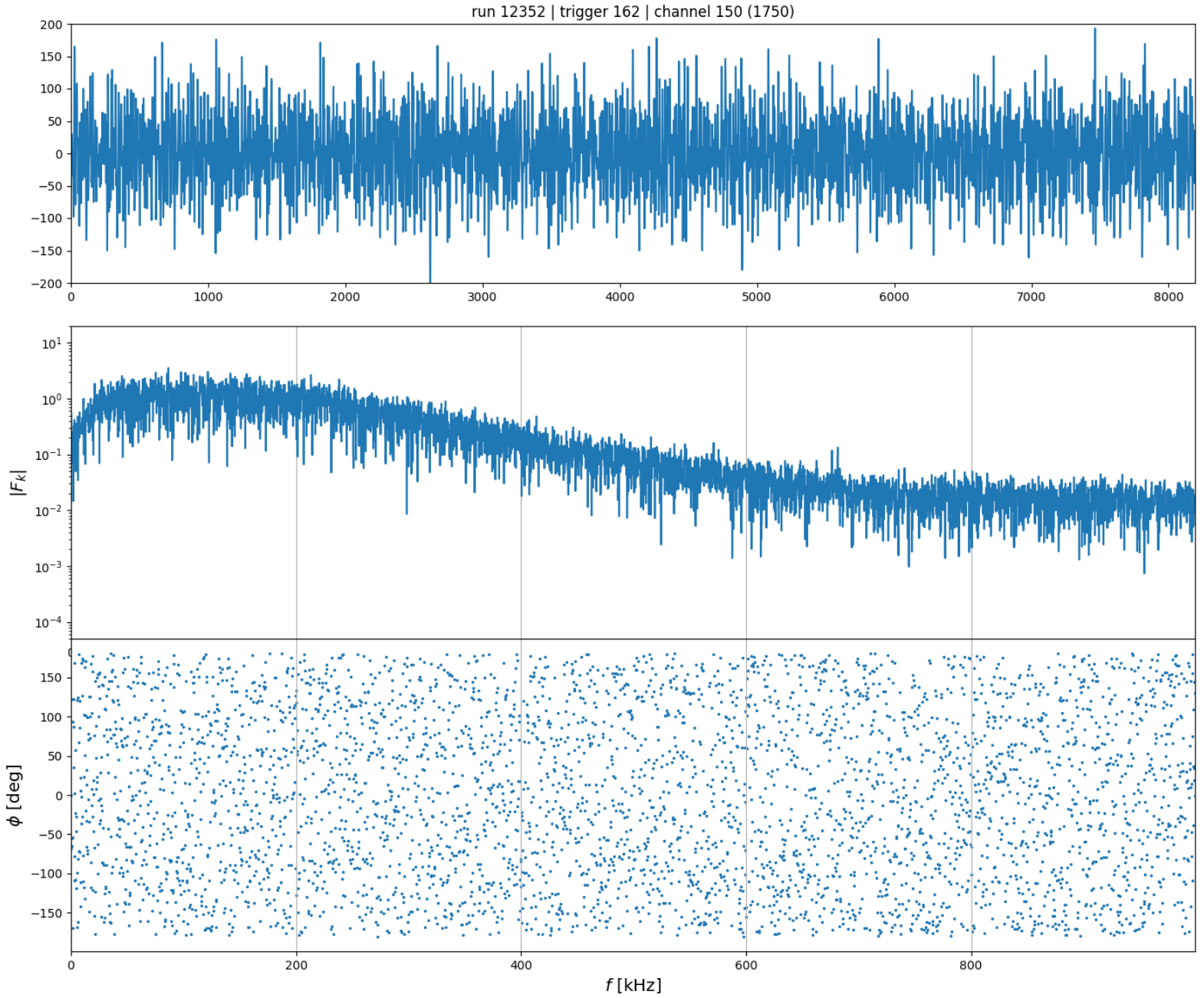


1750

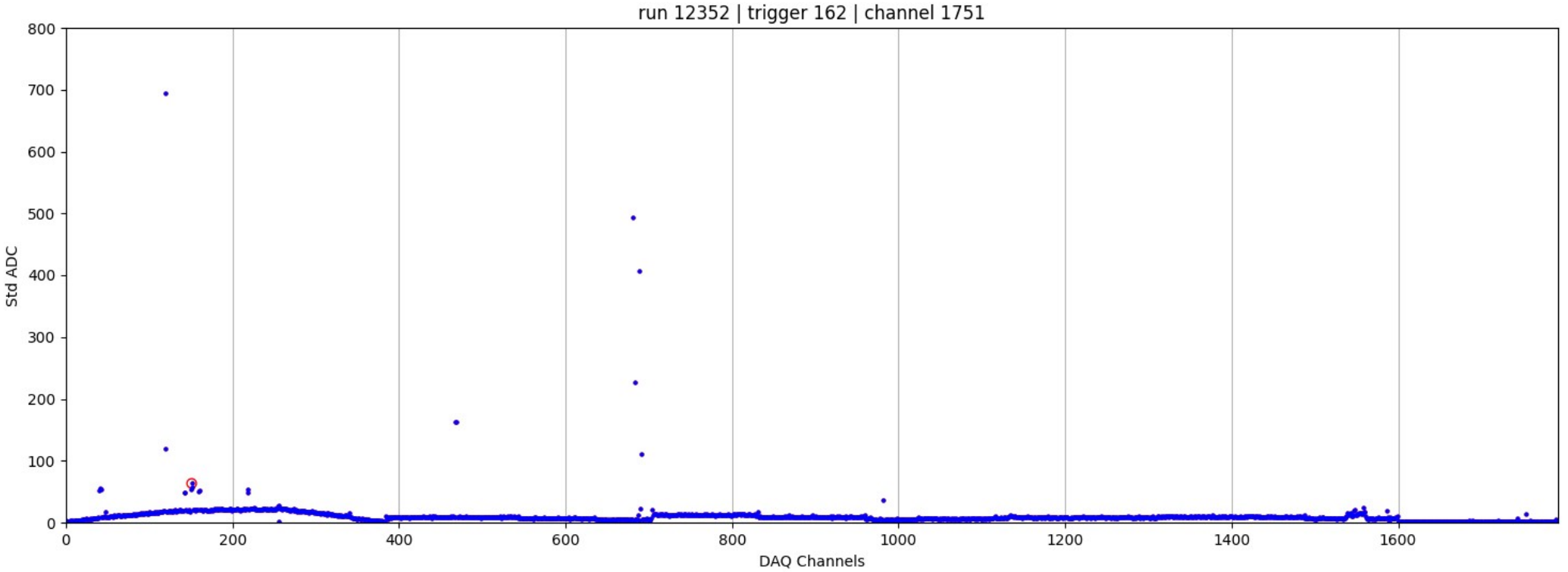

run 12352 | trigger 162 | channel 1750
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

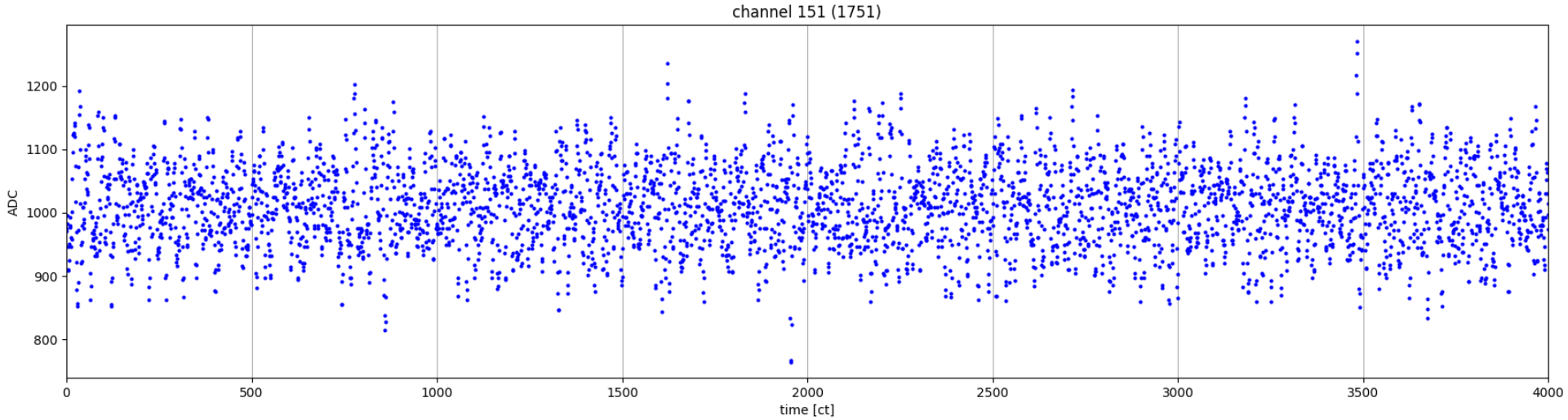

channel 150 (1750)
ADC
time [ct]
700
800
900
1000
1100
0
500
1000
1500
2000
2500
3000
3500
4000

1750

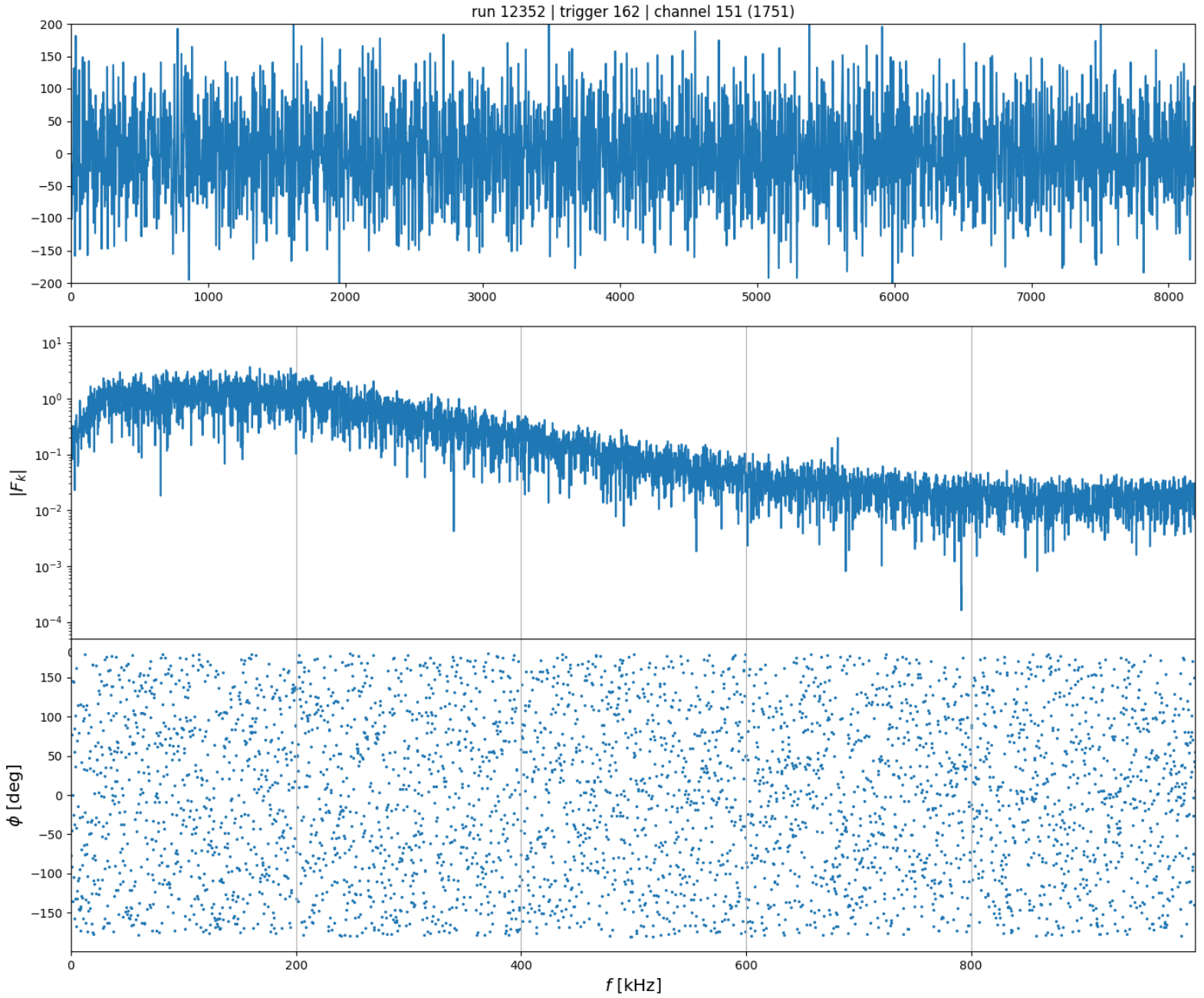


1751

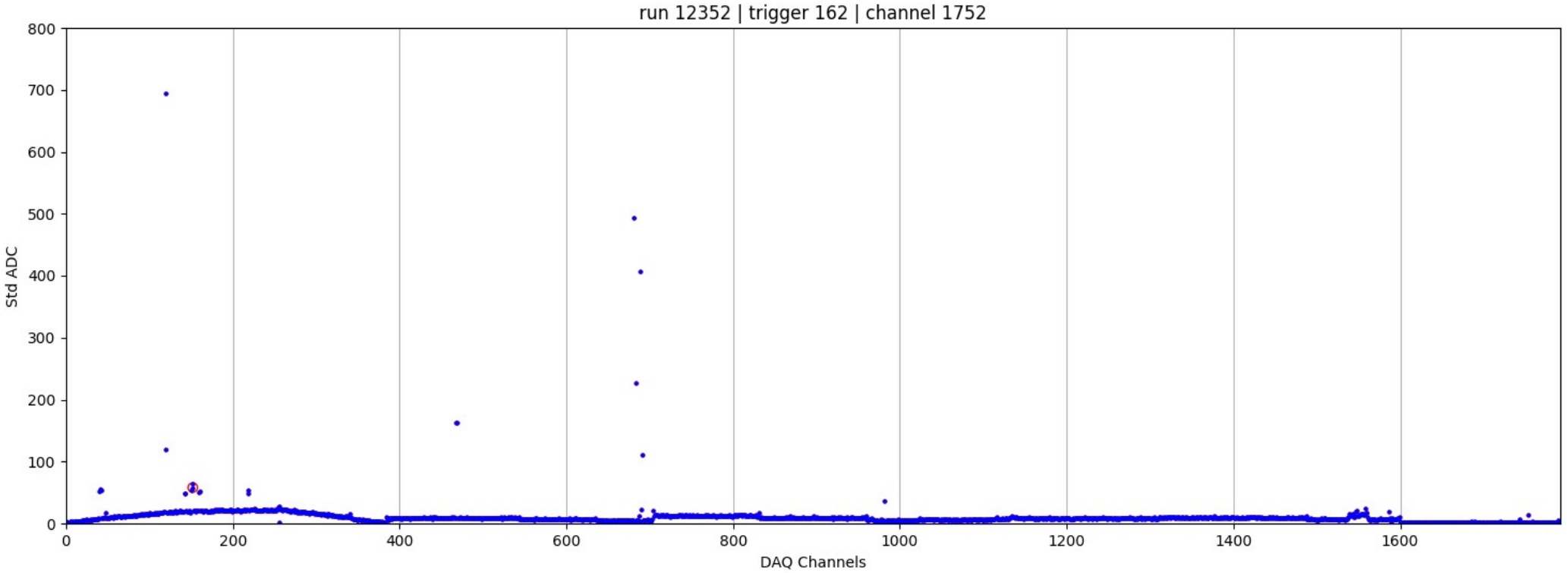

run 12352 | trigger 162 | channel 1751
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

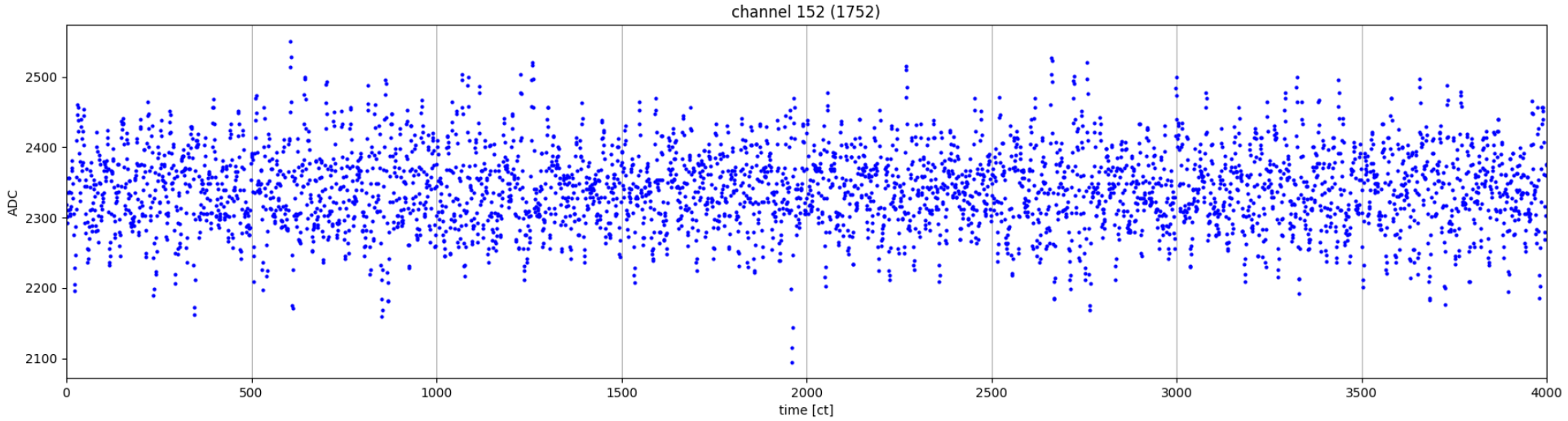

channel 151 (1751)
ADC
time [ct]
800
900
1000
1100
1200
0
500
1000
1500
2000
2500
3000
3500
4000

1751

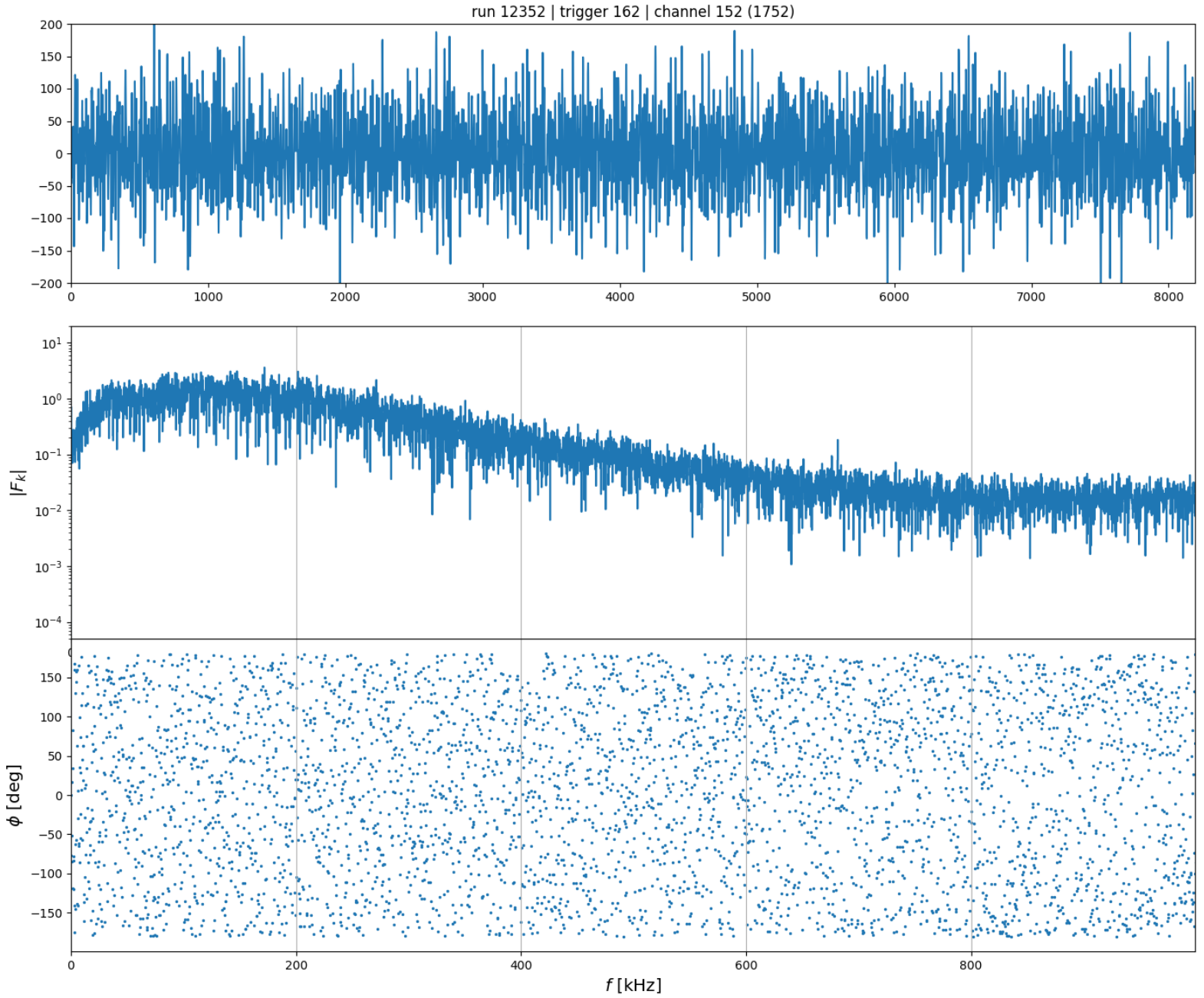


1752

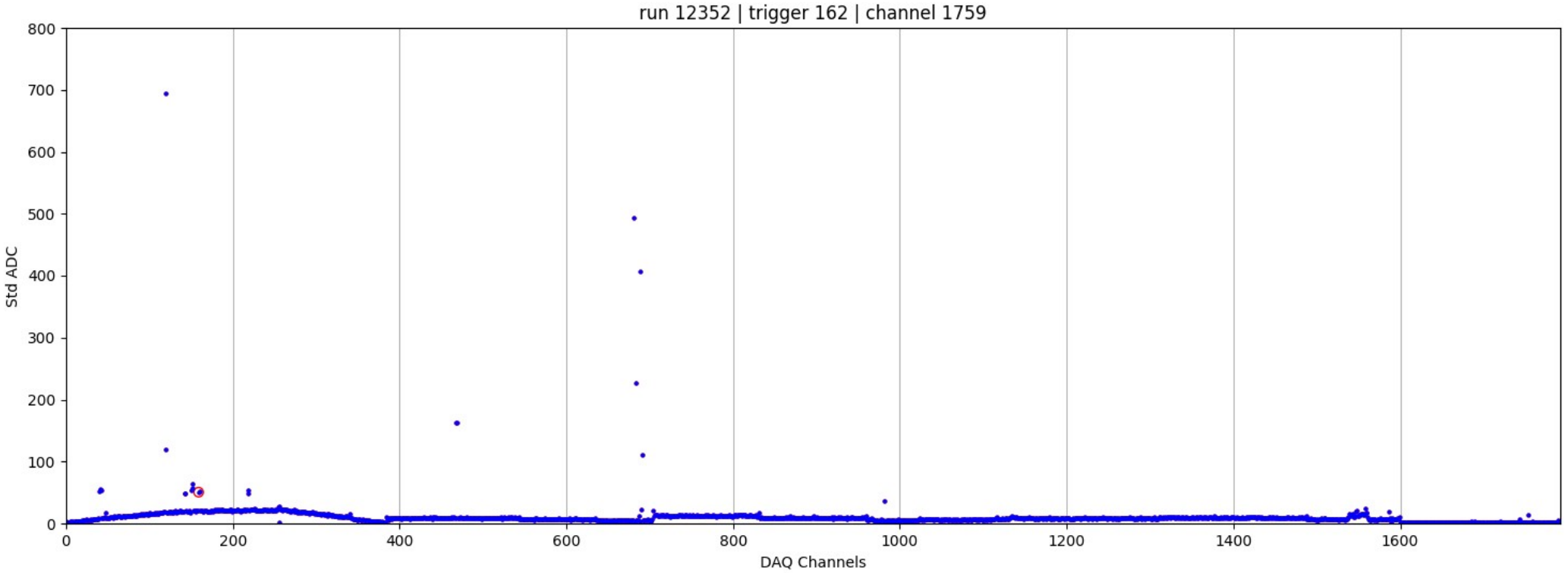

run 12352 | trigger 162 | channel 1752
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

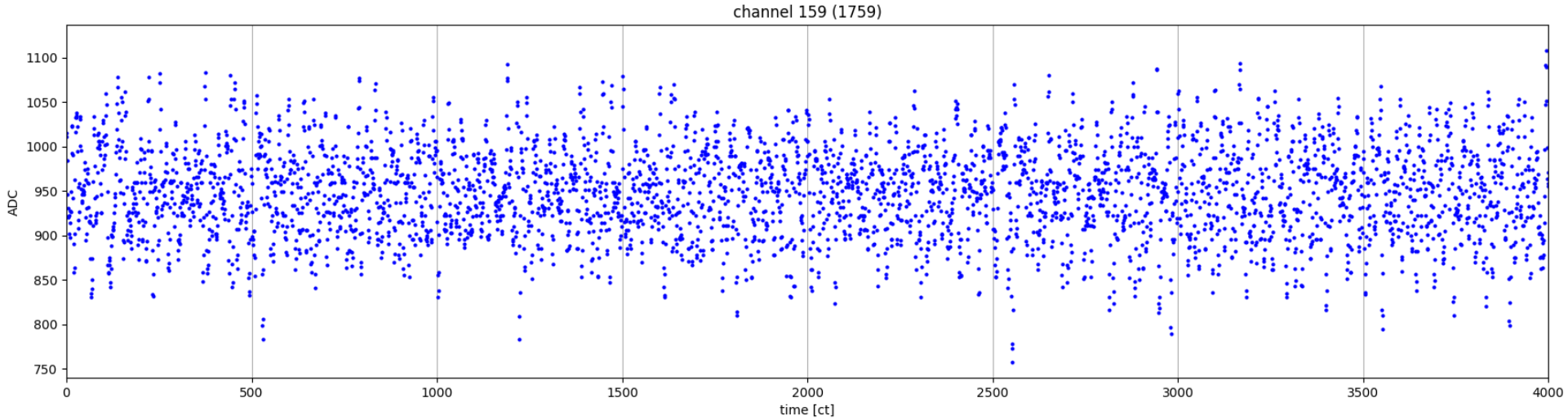

channel 152 (1752)
ADC
time [ct]
2100
2200
2300
2400
2500
0
500
1000
1500
2000
2500
3000
3500
4000

1752

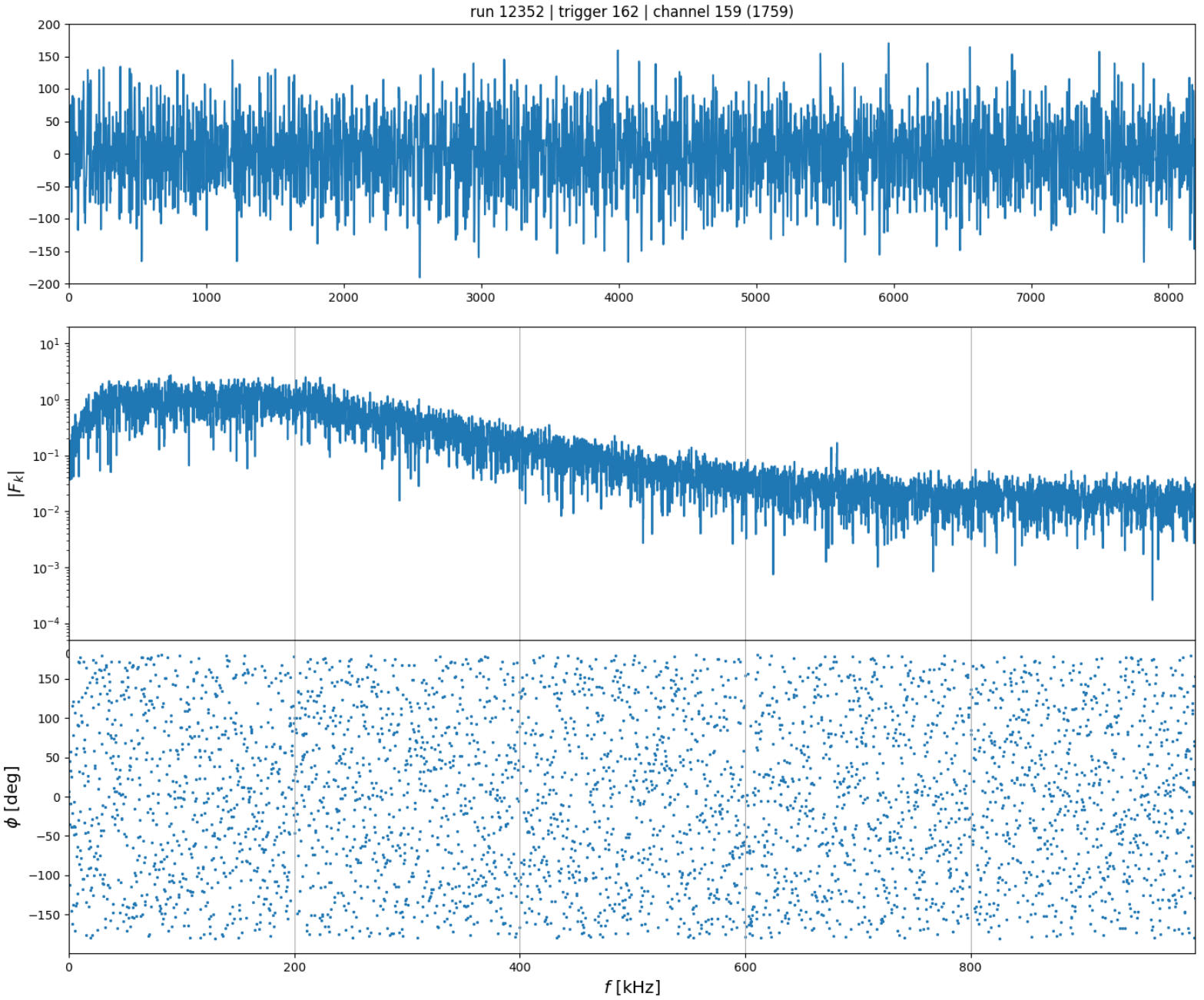


1759

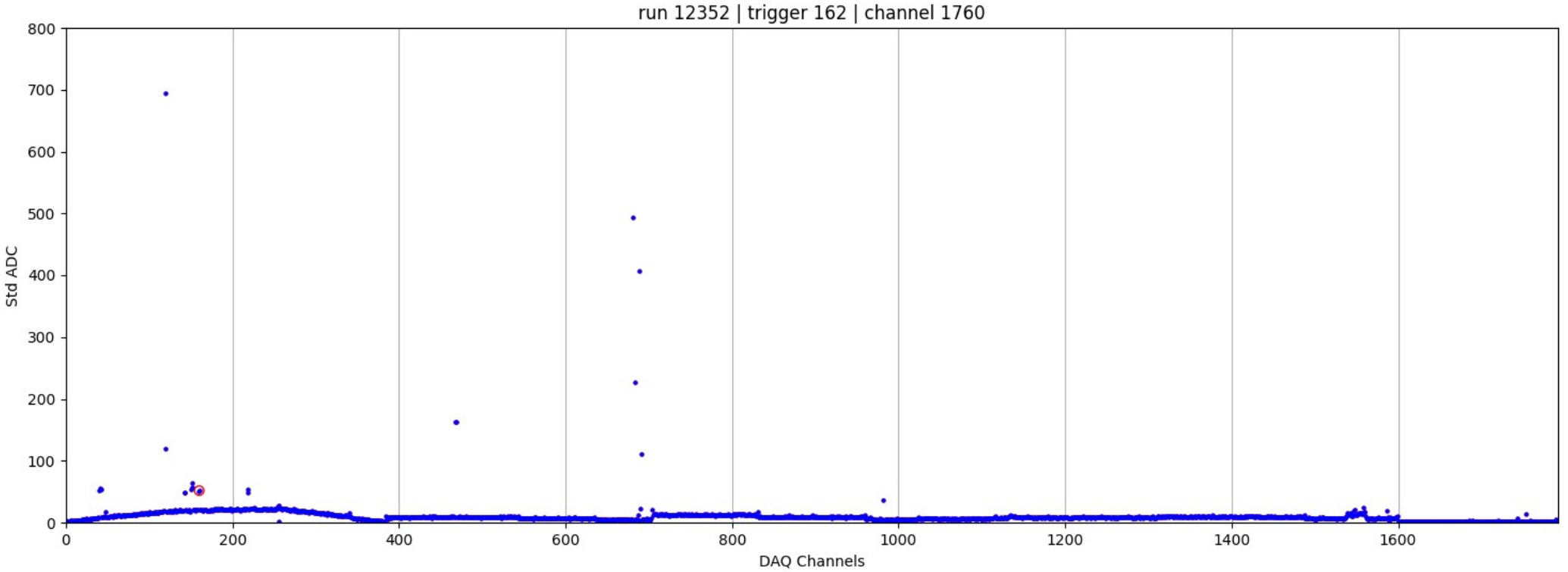

run 12352 | trigger 162 | channel 1759
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

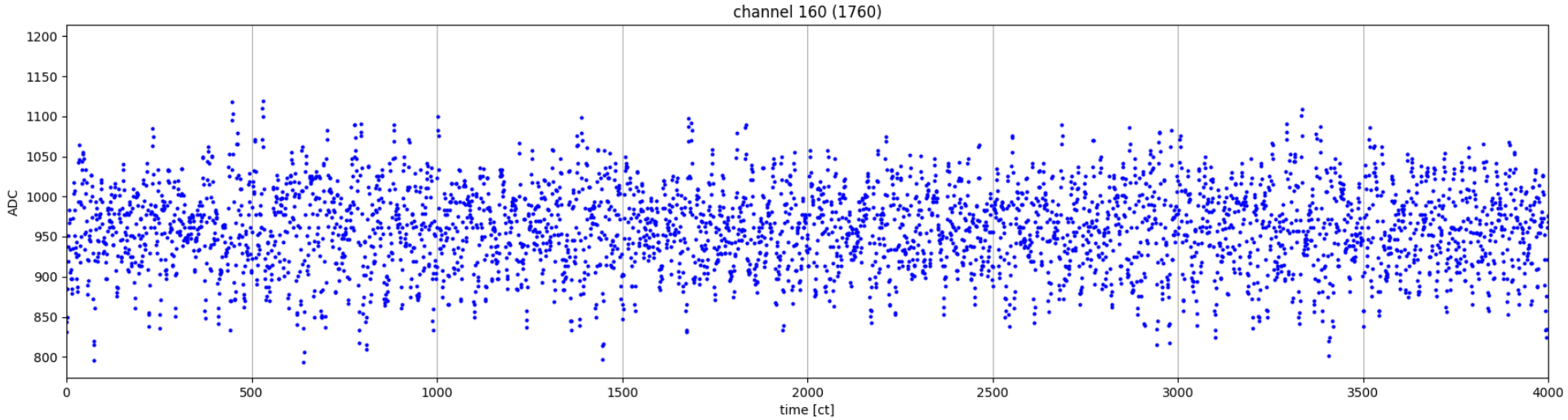

channel 159 (1759)
ADC
time [ct]
750
800
850
900
950
1000
1050
1100
0
500
1000
1500
2000
2500
3000
3500
4000

1759

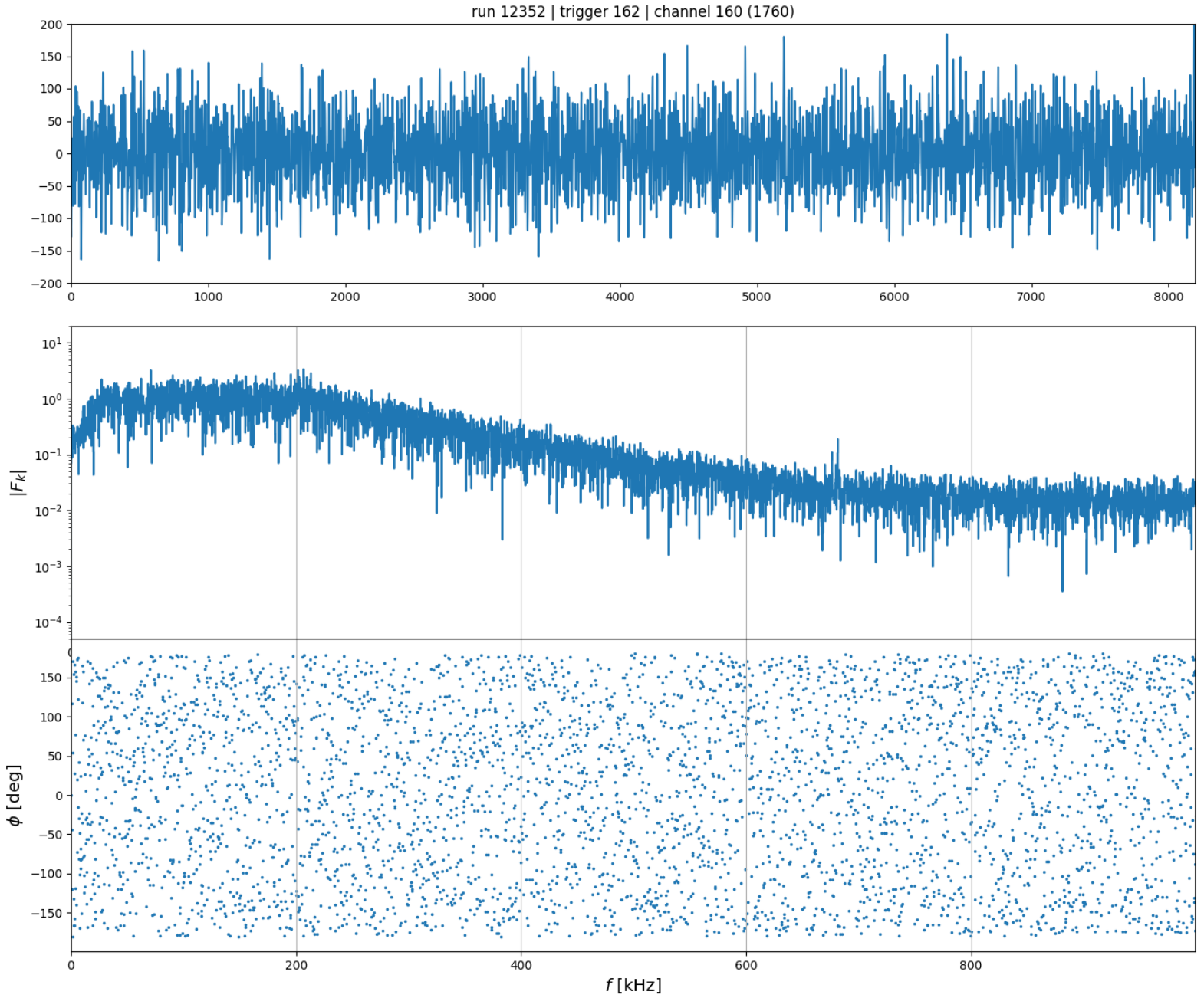


1760

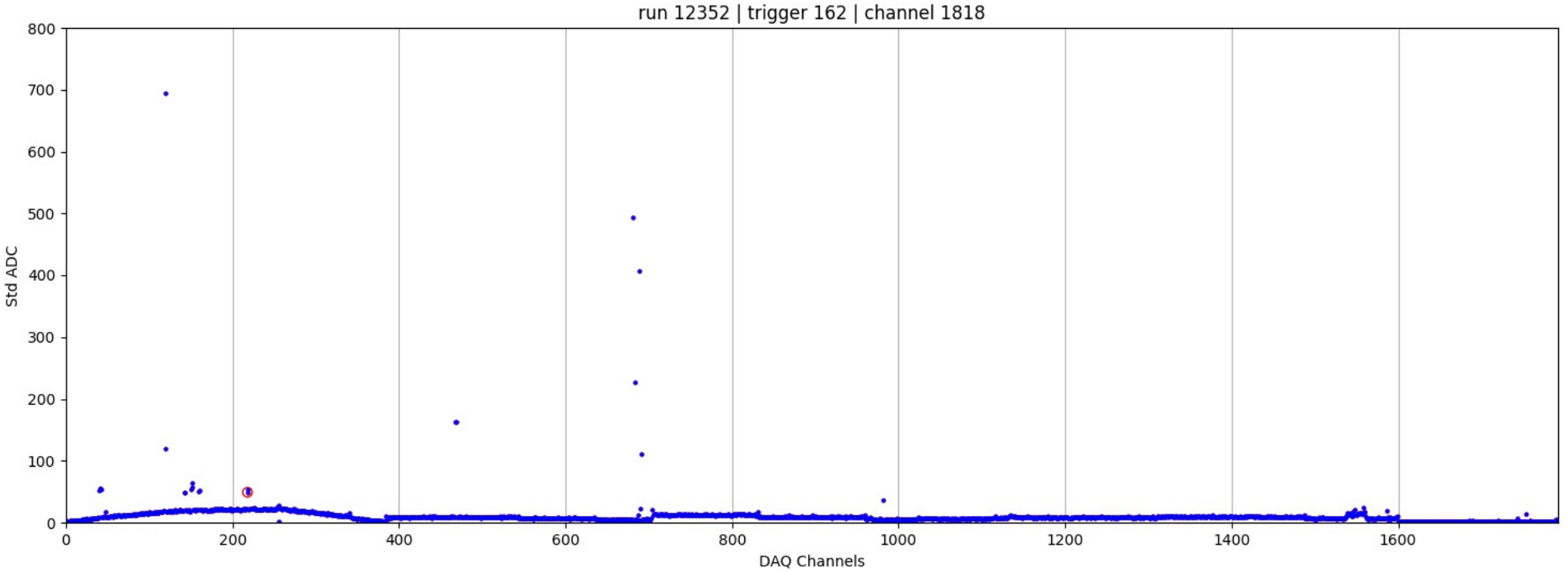

run 12352 | trigger 162 | channel 1760
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

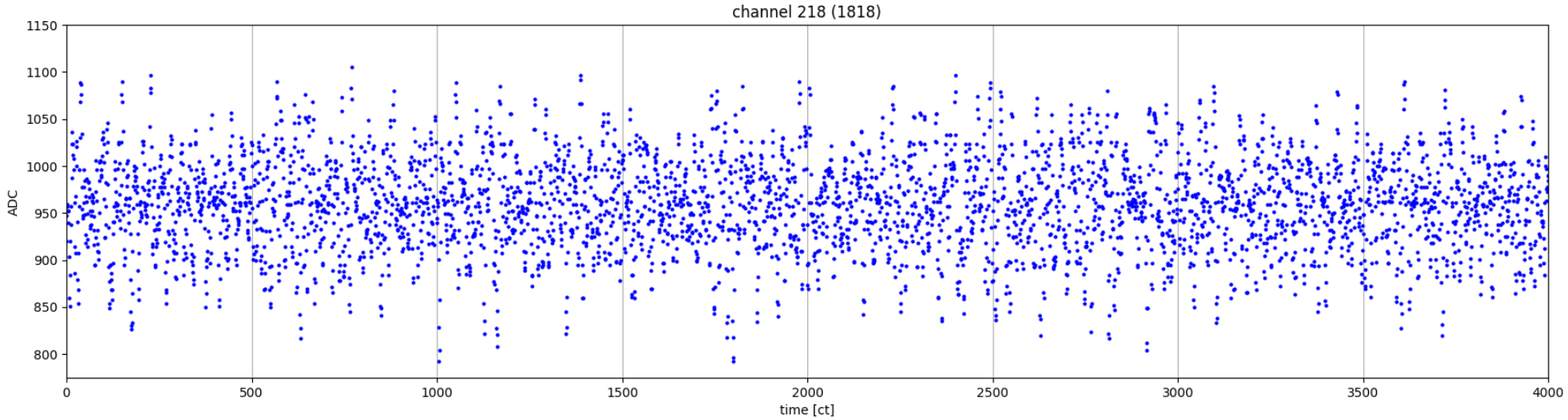

channel 160 (1760)
ADC
time [ct]
800
850
900
950
1000
1050
1100
1150
1200
0
500
1000
1500
2000
2500
3000
3500
4000

1760

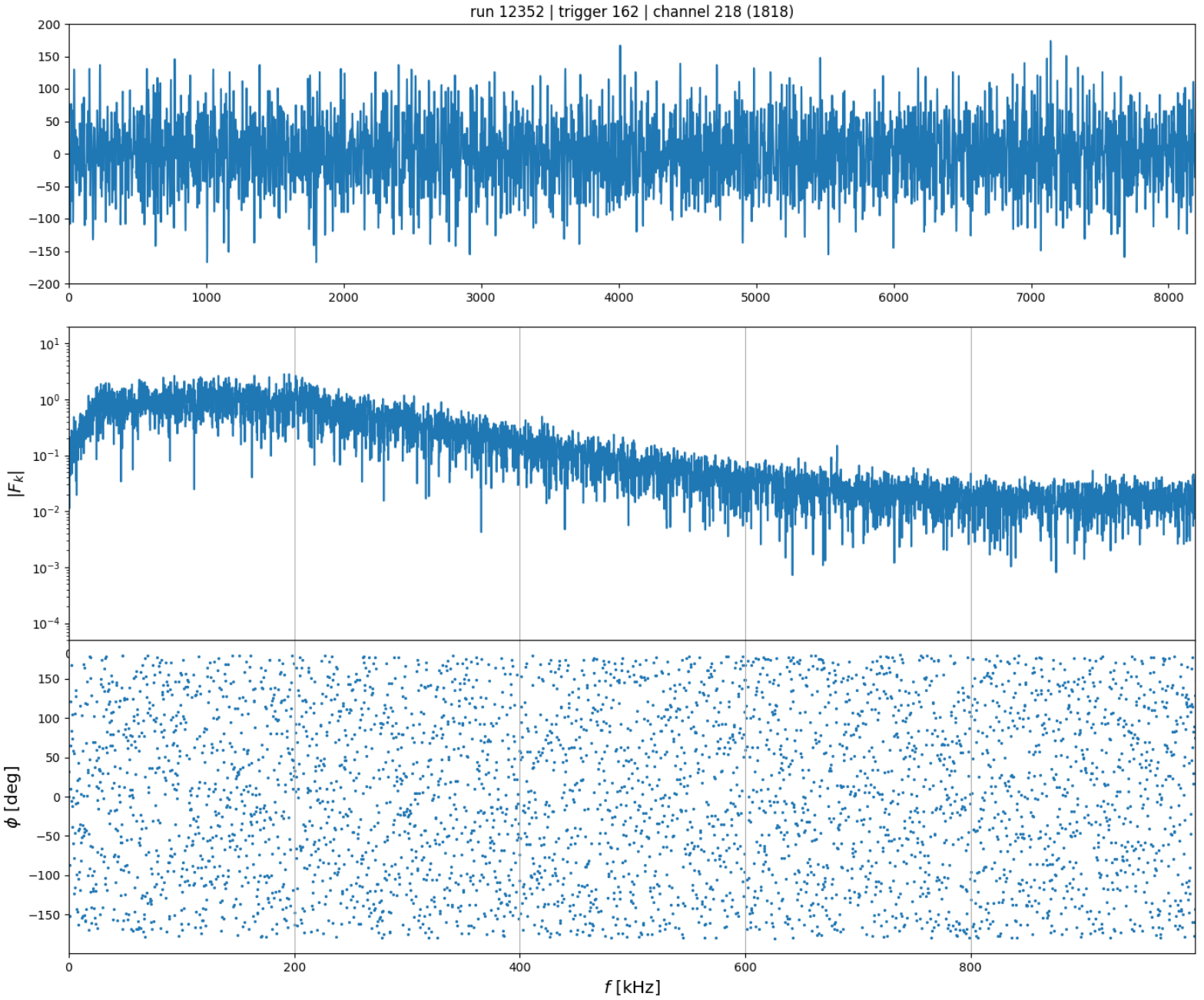


1818

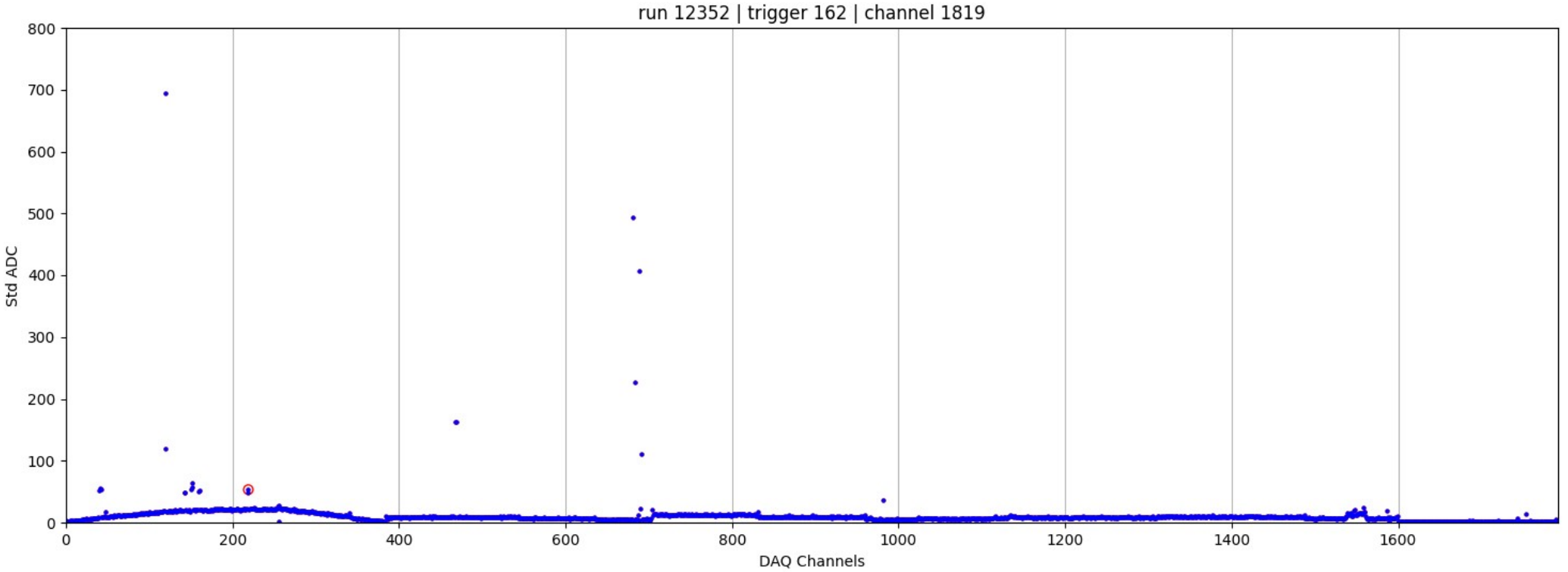

run 12352 | trigger 162 | channel 1818
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

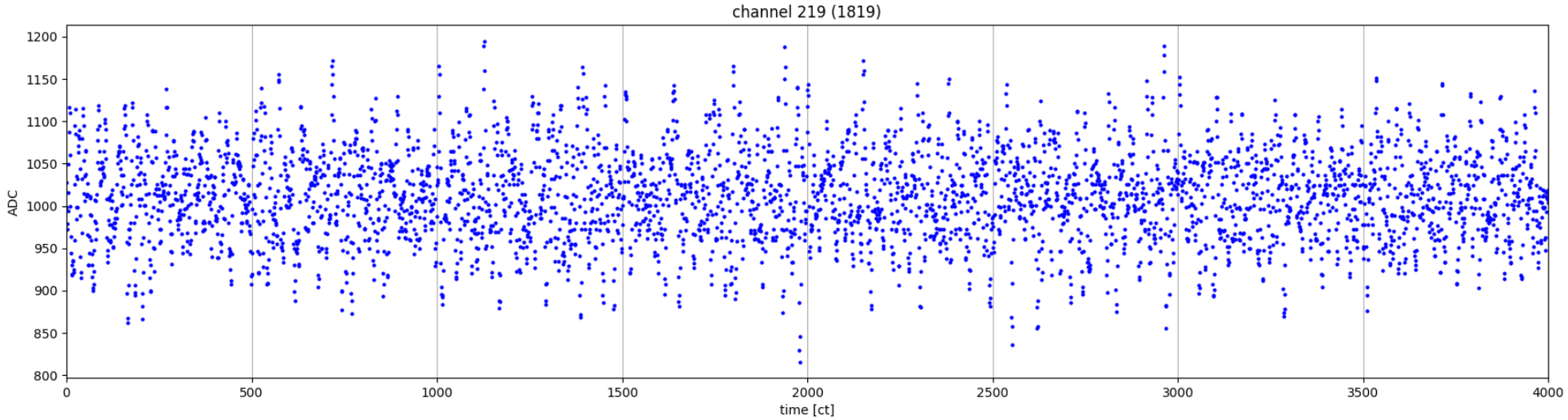

channel 218 (1818)
ADC
time [ct]
800
850
900
950
1000
1050
1100
1150
0
500
1000
1500
2000
2500
3000
3500
4000

1818

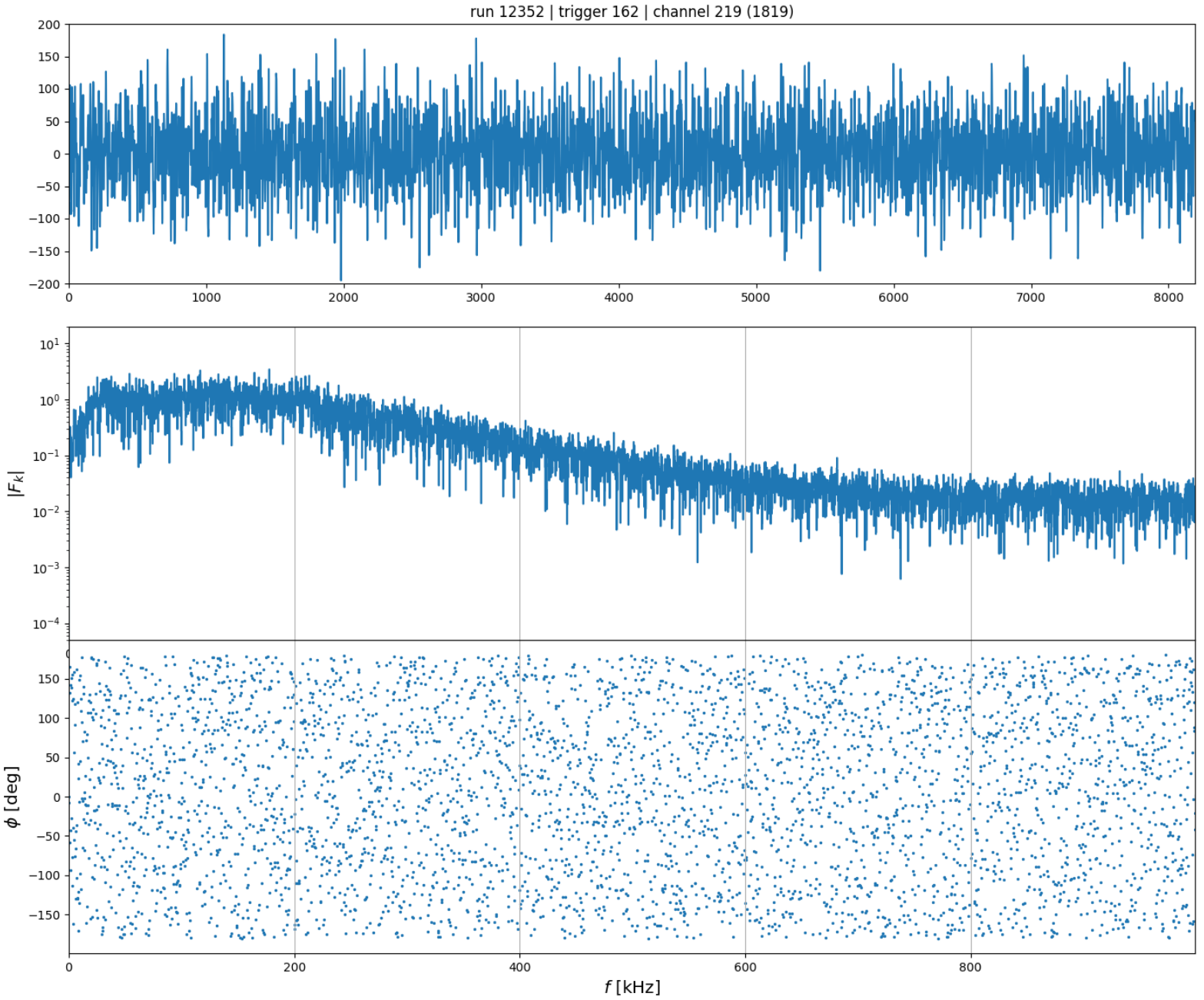


1819

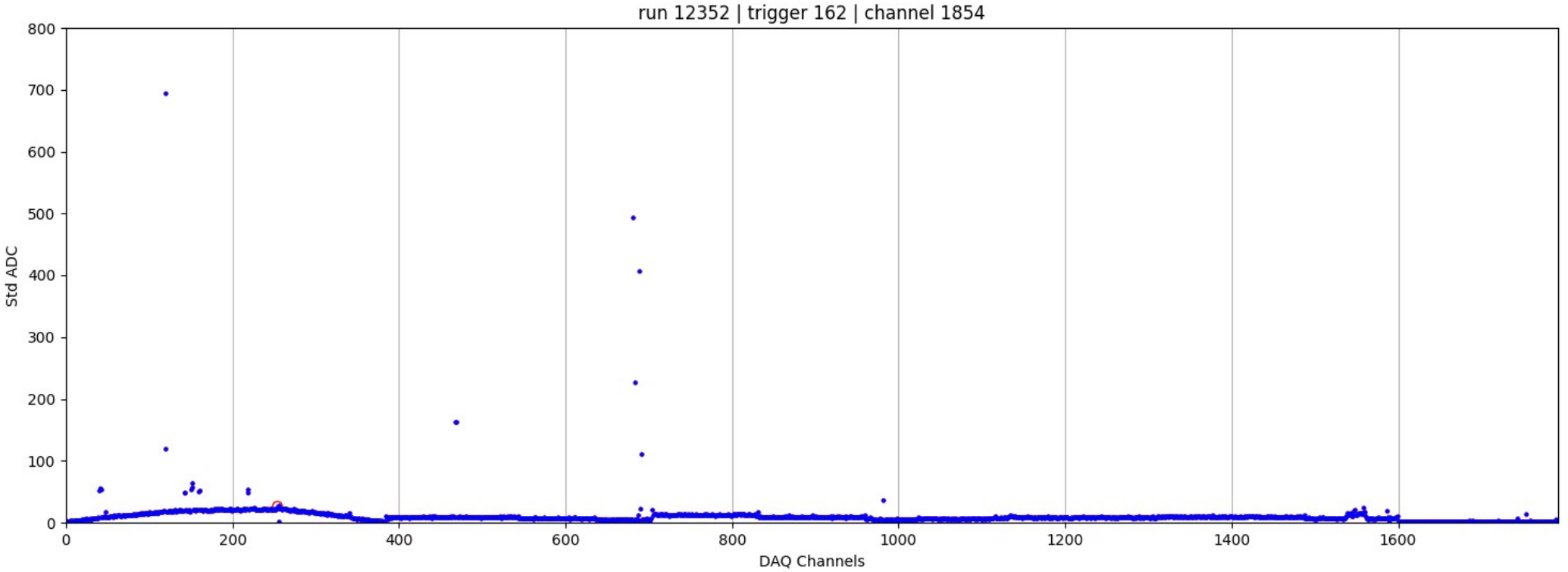

run 12352 | trigger 162 | channel 1819
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

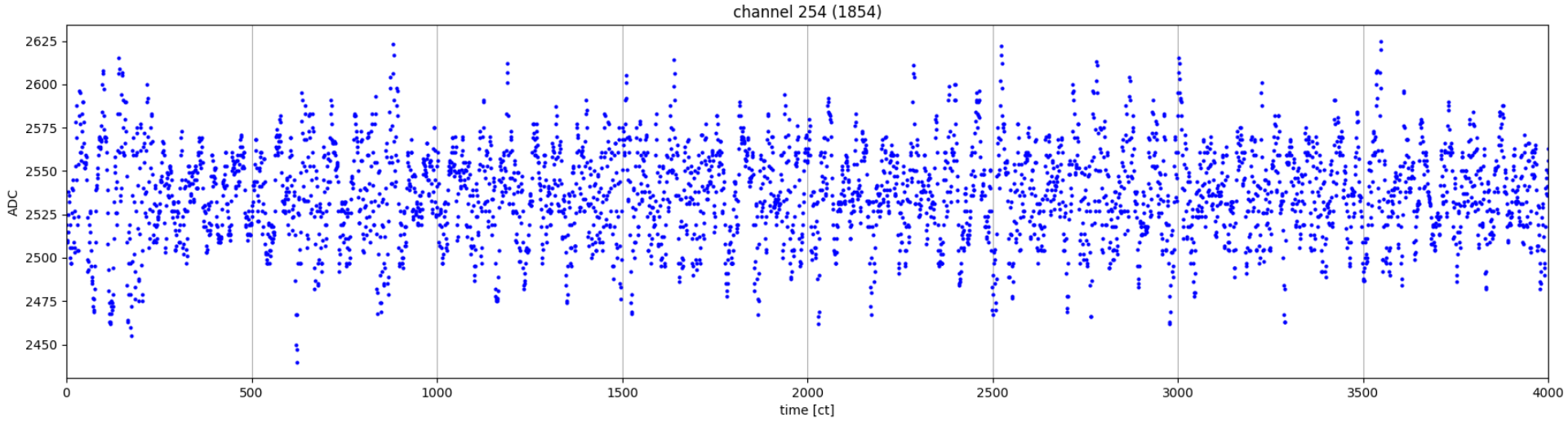

channel 219 (1819)
ADC
time [ct]
800
850
900
950
1000
1050
1100
1150
1200
0
500
1000
1500
2000
2500
3000
3500
4000

1819

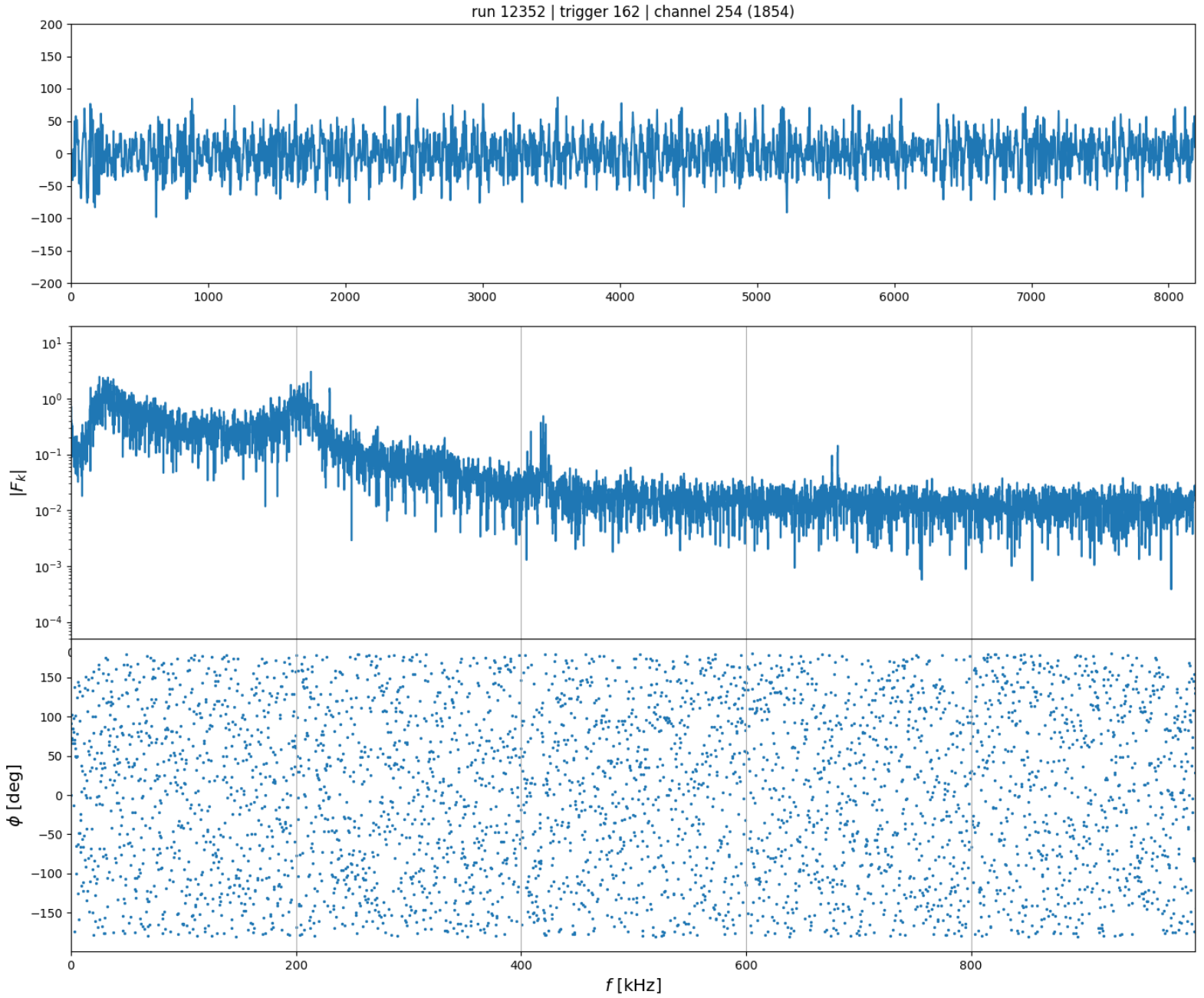


1854

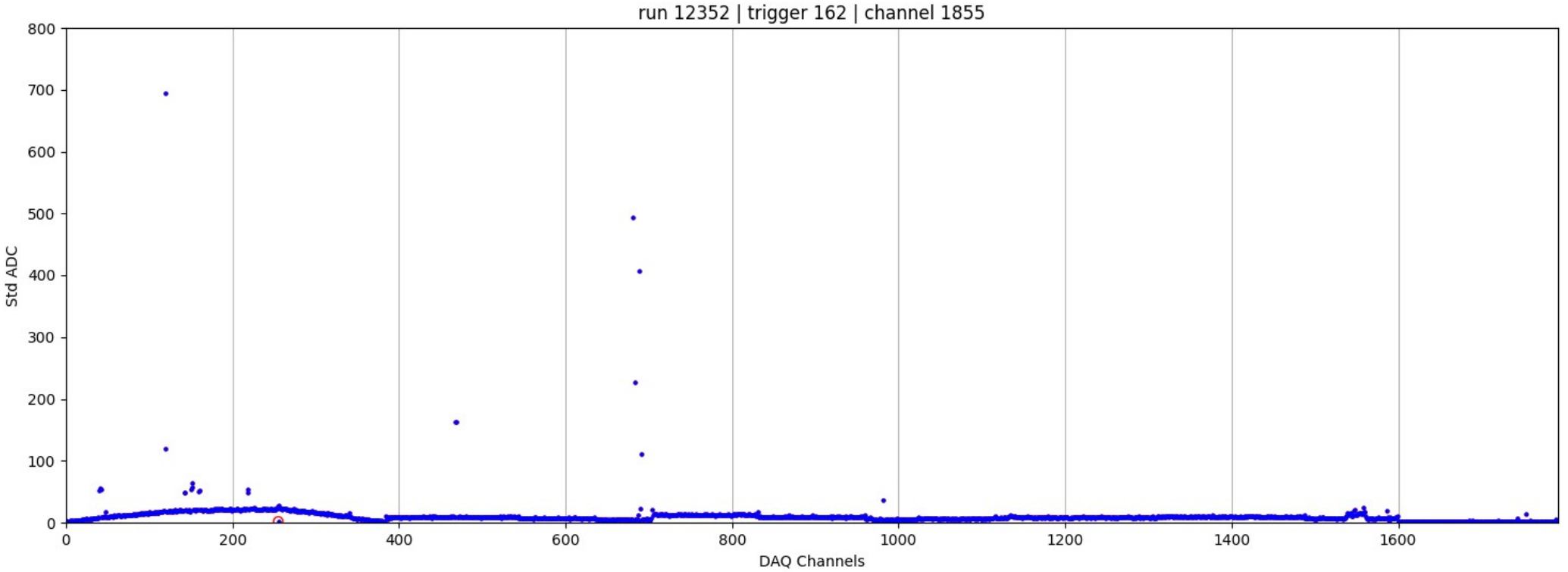

run 12352 | trigger 162 | channel 1854
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

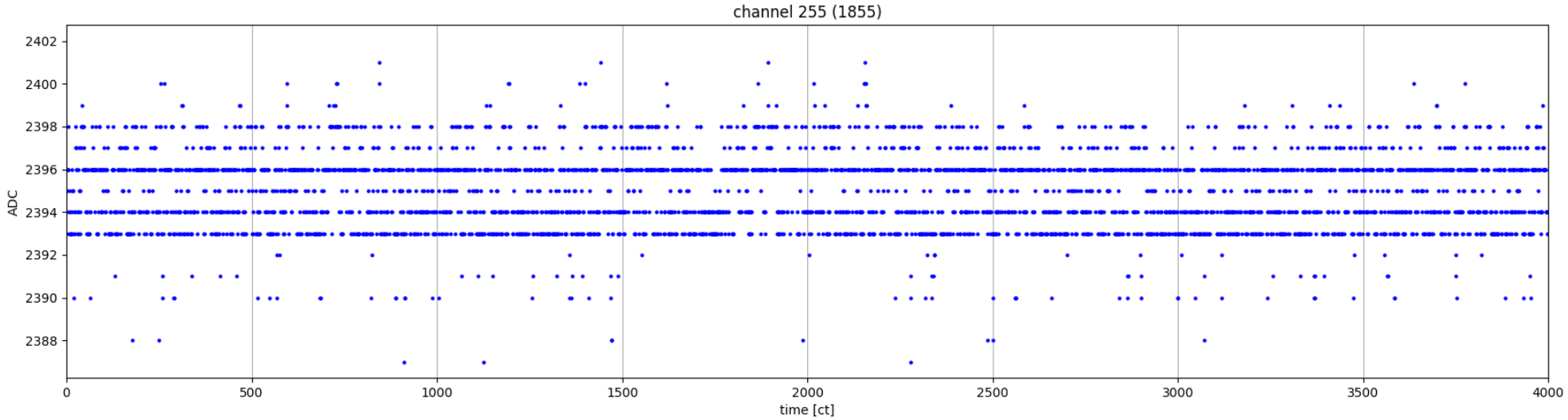

channel 254 (1854)
ADC
time [ct]
2450
2475
2500
2525
2550
2575
2600
2625
0
500
1000
1500
2000
2500
3000
3500
4000

1854

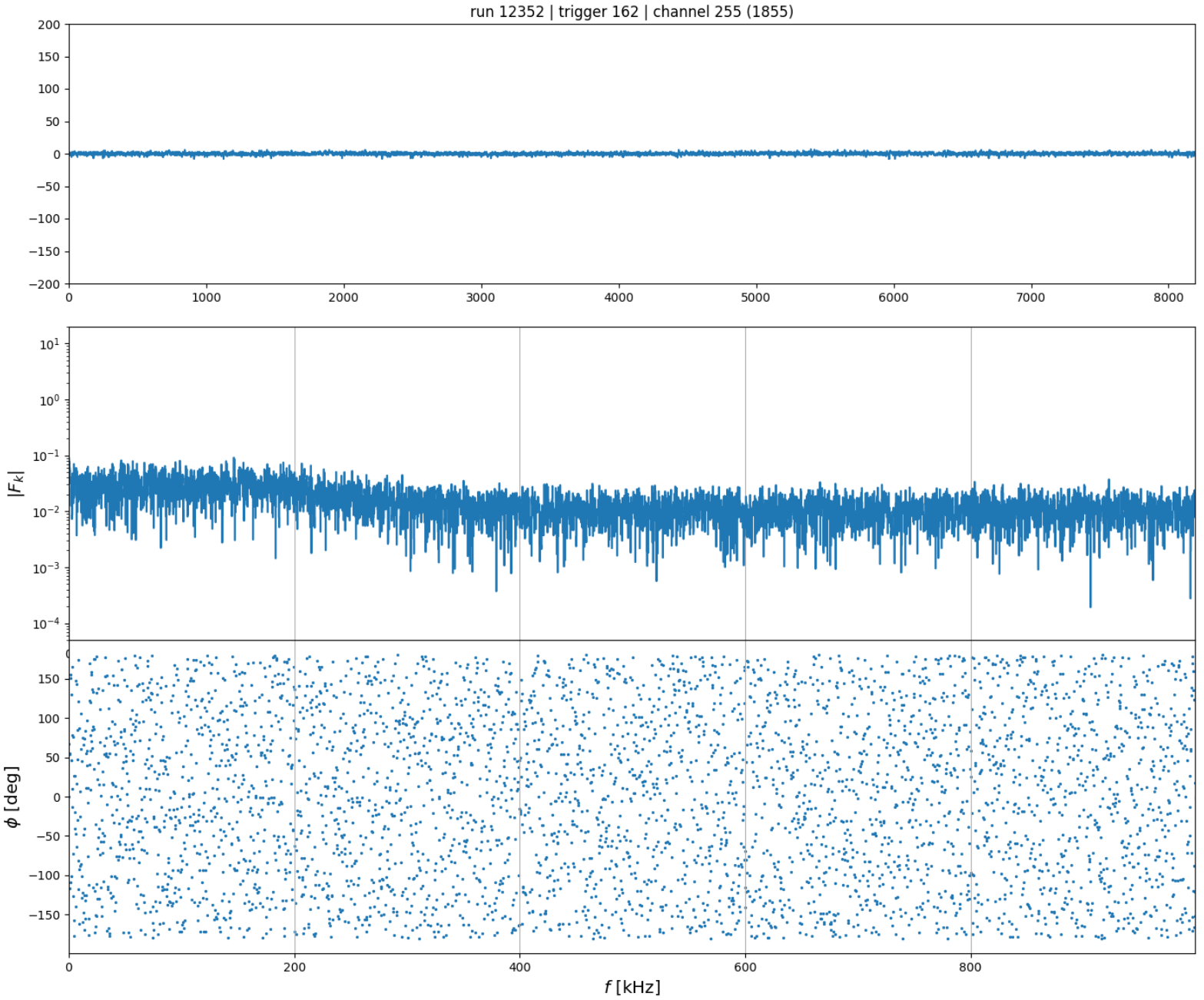


1855

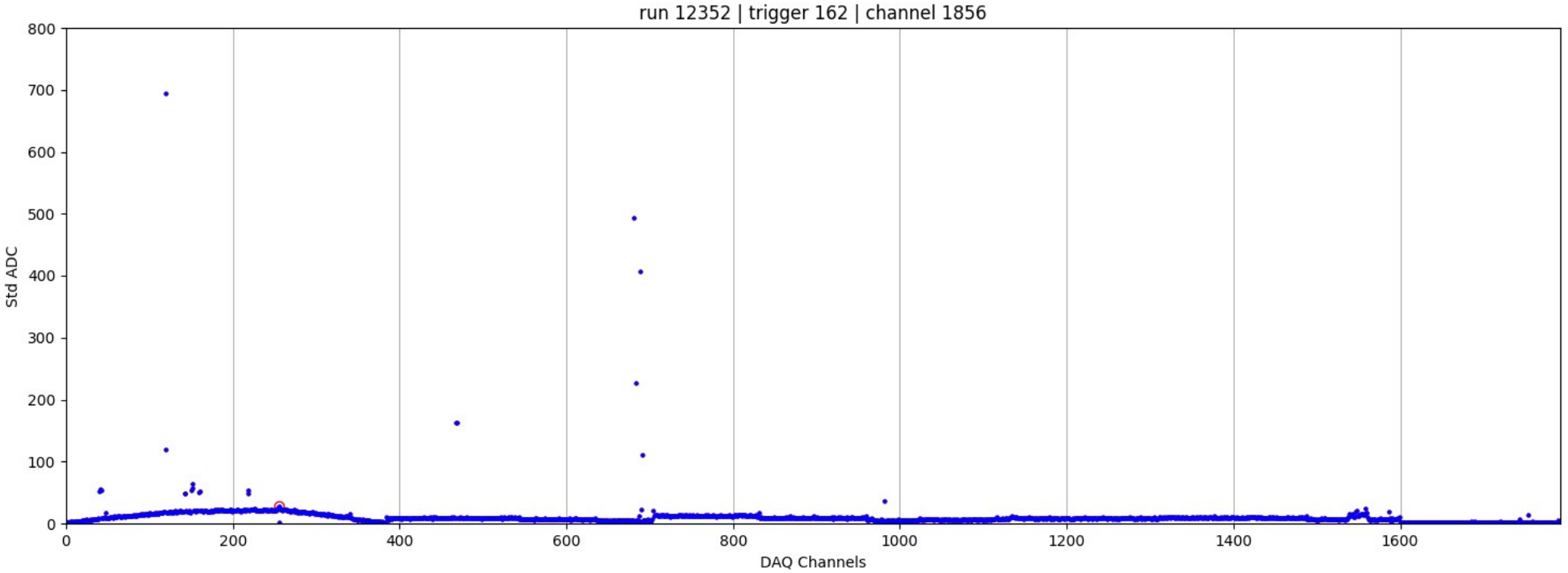

run 12352 | trigger 162 | channel 1855
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

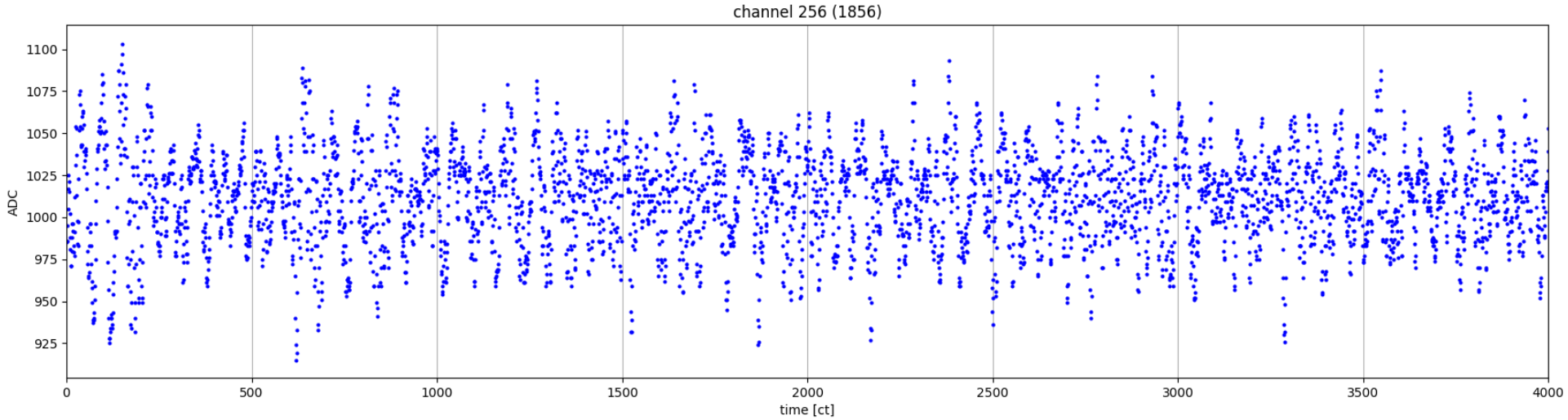

channel 255 (1855)
ADC
time [ct]
2388
2390
2392
2394
2396
2398
2400
2402
0
500
1000
1500
2000
2500
3000
3500
4000

1855

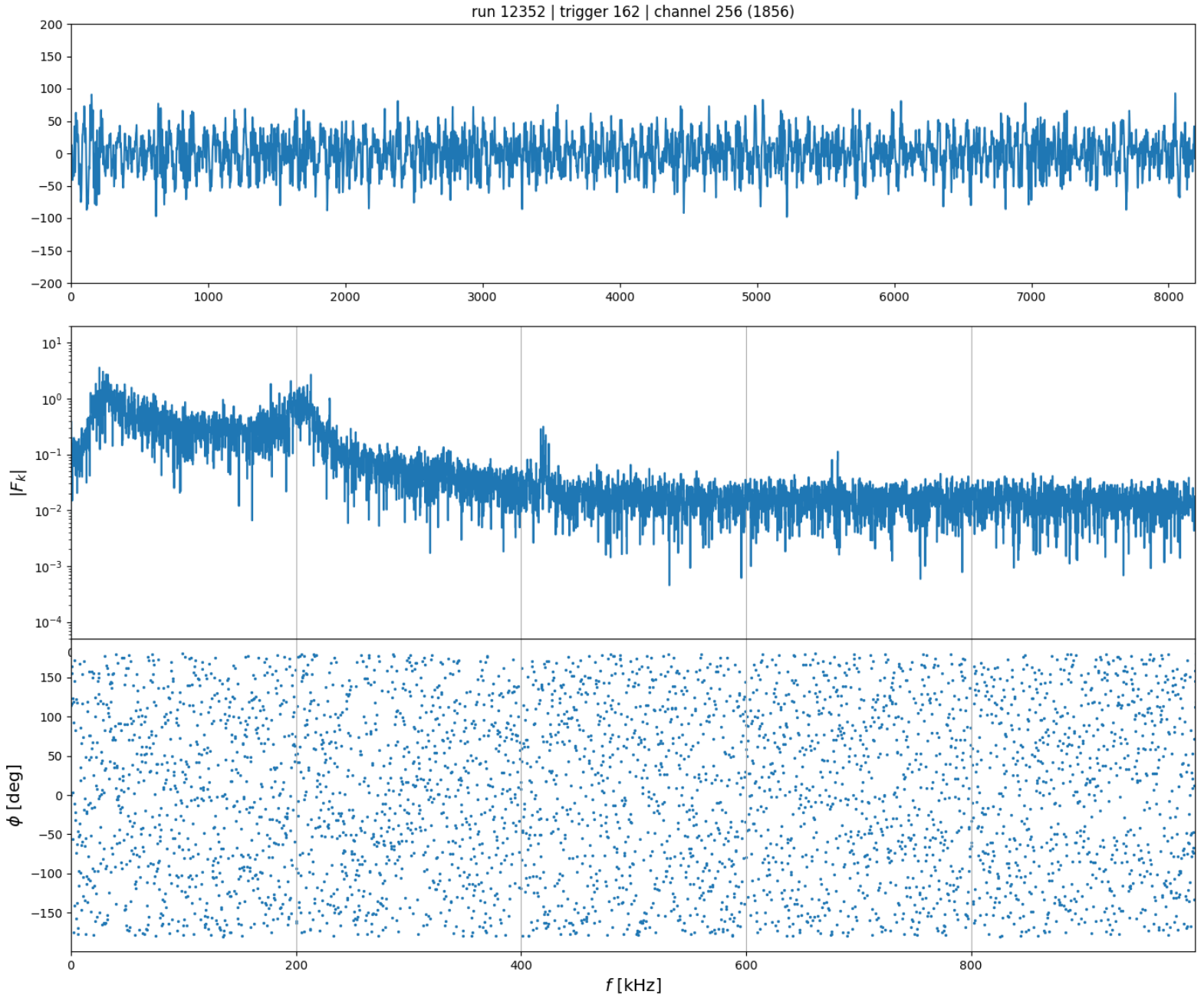


1856

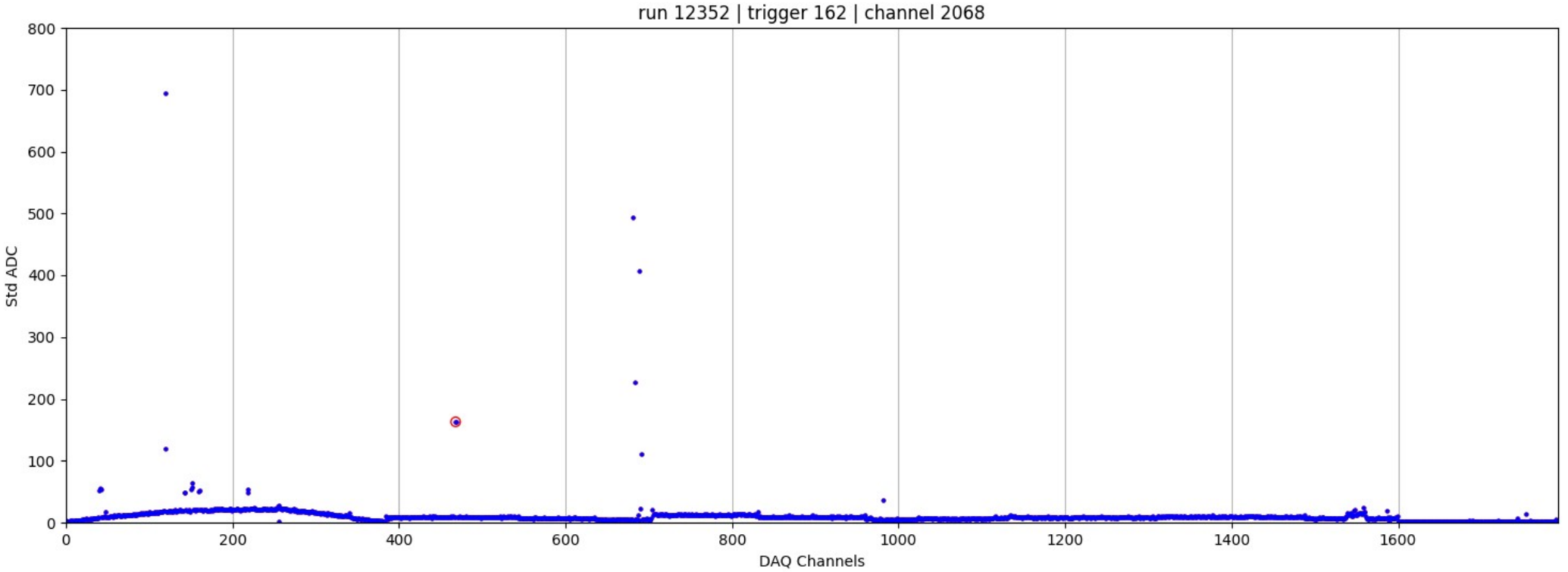

run 12352 | trigger 162 | channel 1856
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

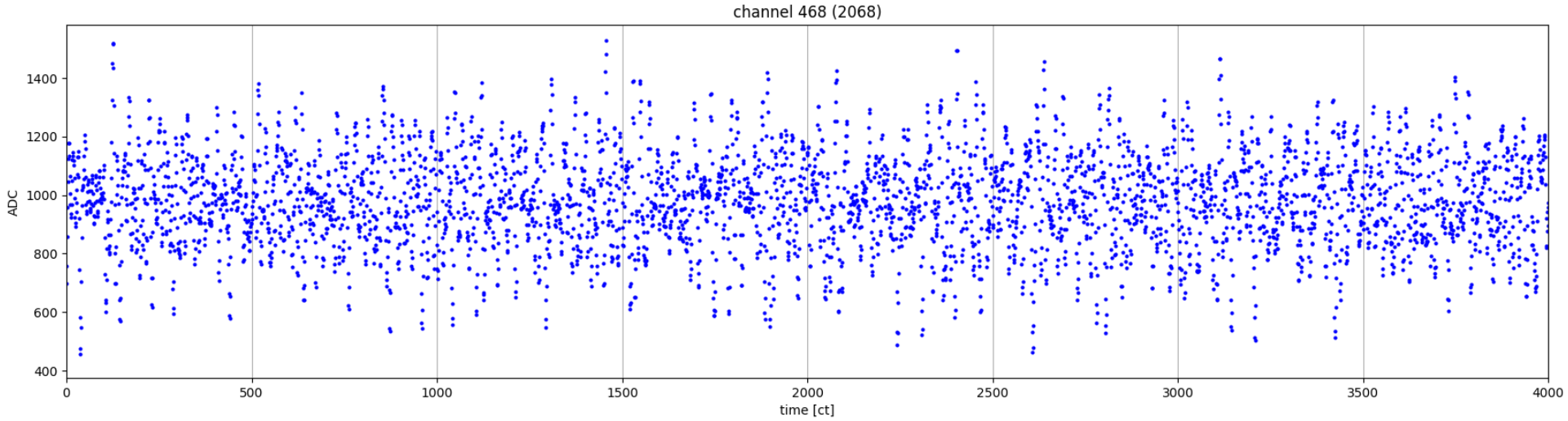

channel 256 (1856)
ADC
time [ct]
925
950
975
1000
1025
1050
1075
1100
0
500
1000
1500
2000
2500
3000
3500
4000

1856

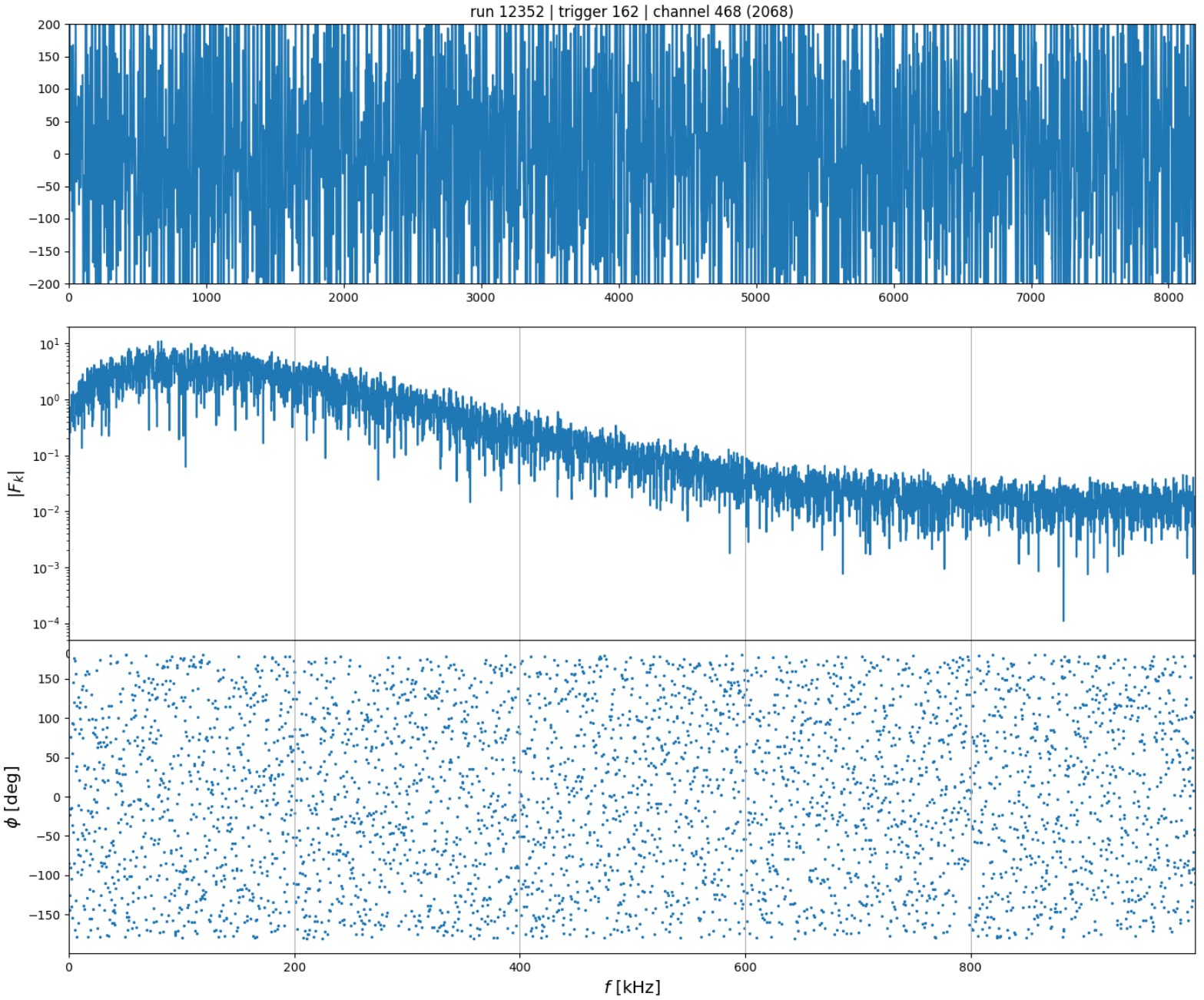


2068

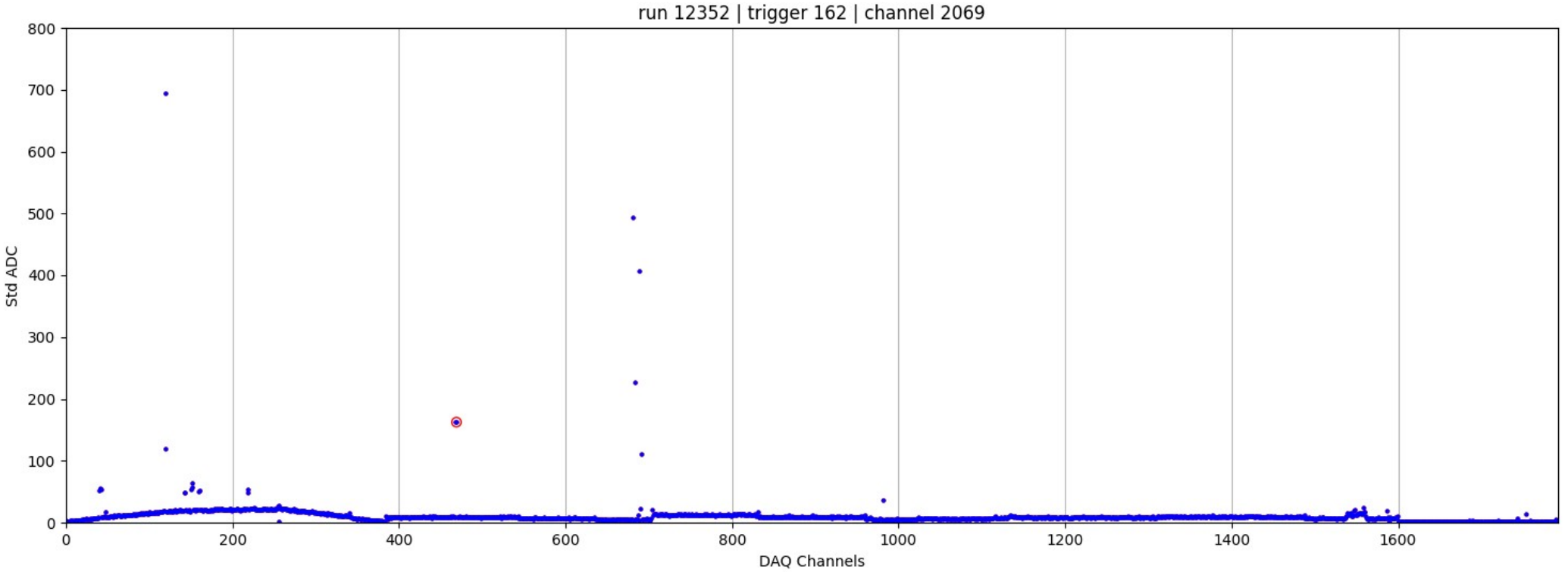

run 12352 | trigger 162 | channel 2068
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

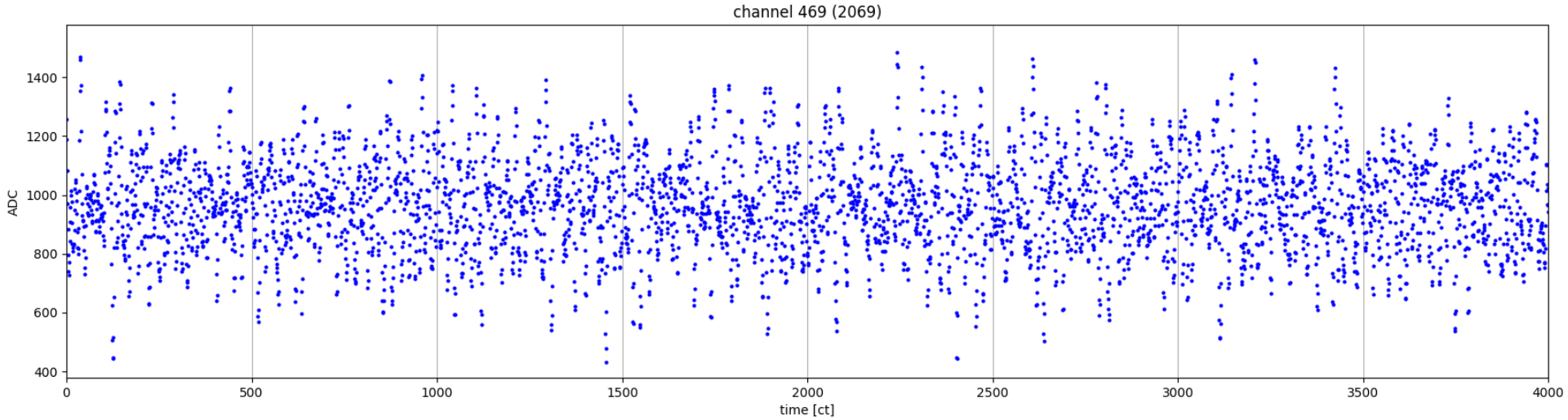

channel 468 (2068)
ADC
time [ct]
400
600
800
1000
1200
1400
0
500
1000
1500
2000
2500
3000
3500
4000

2068

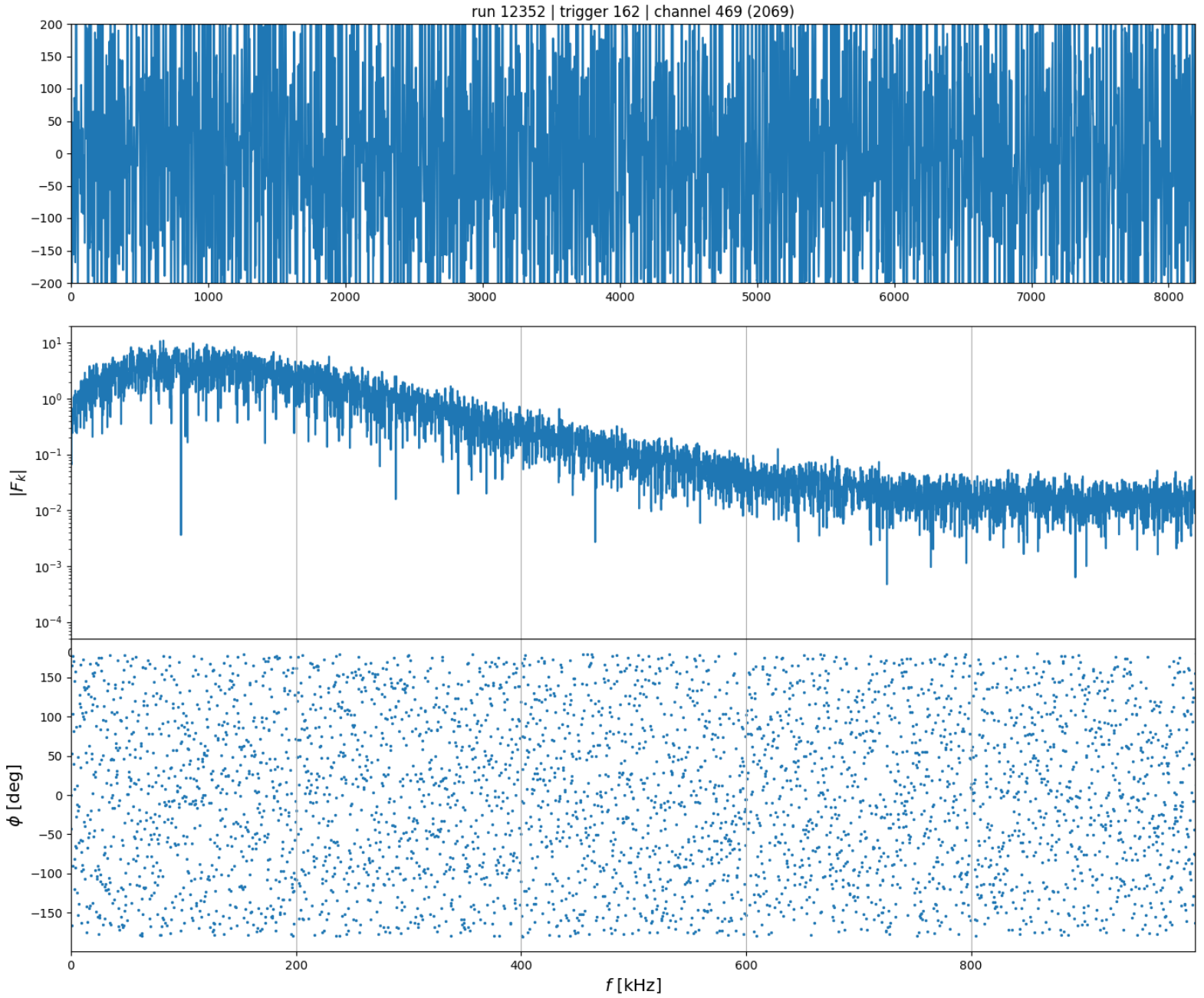

run 12352 | trigger 162 | channel 468 (2068)
200
150
100
50
0
−50
−100
−150
−200
0
1000
2000
3000
4000
5000
6000
7000
8000
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
$|F_k|$
150
100
50
0
−50
−100
−150
ϕ [deg]
0
200
400
600
800
f [kHz]

2069


run 12352 | trigger 162 | channel 2069
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

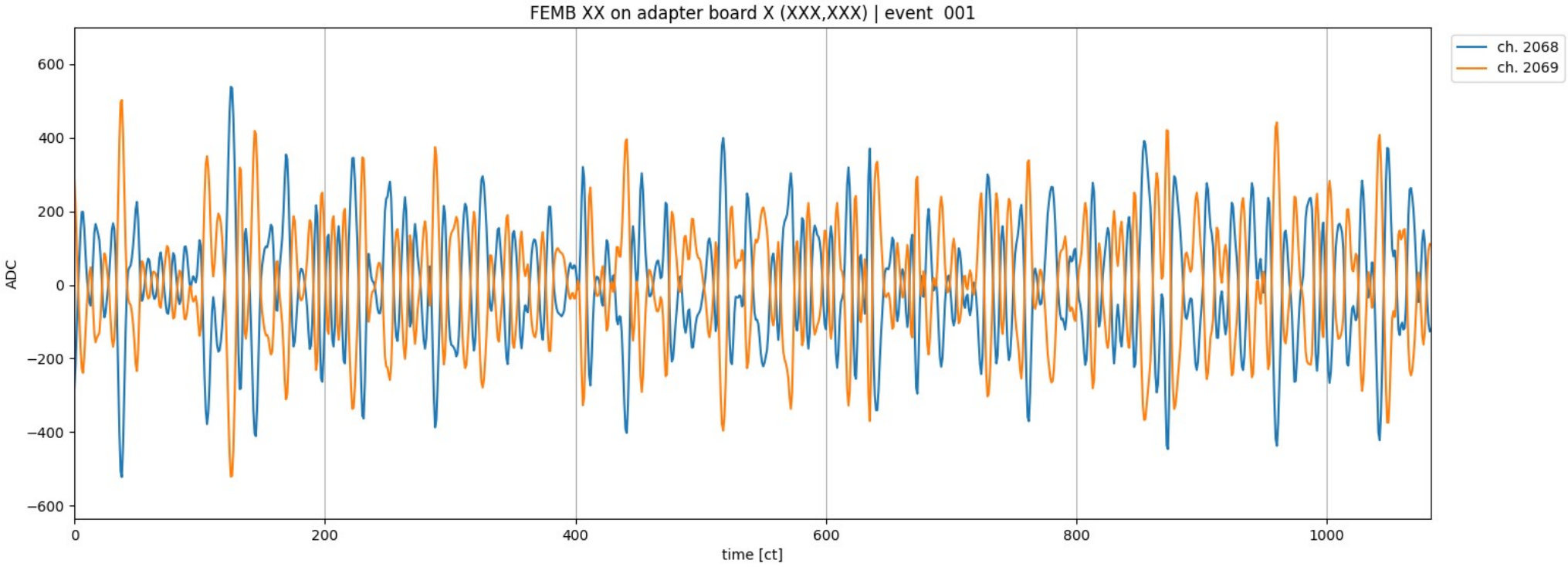

channel 469 (2069)
ADC
time [ct]
400
600
800
1000
1200
1400
0
500
1000
1500
2000
2500
3000
3500
4000

2069



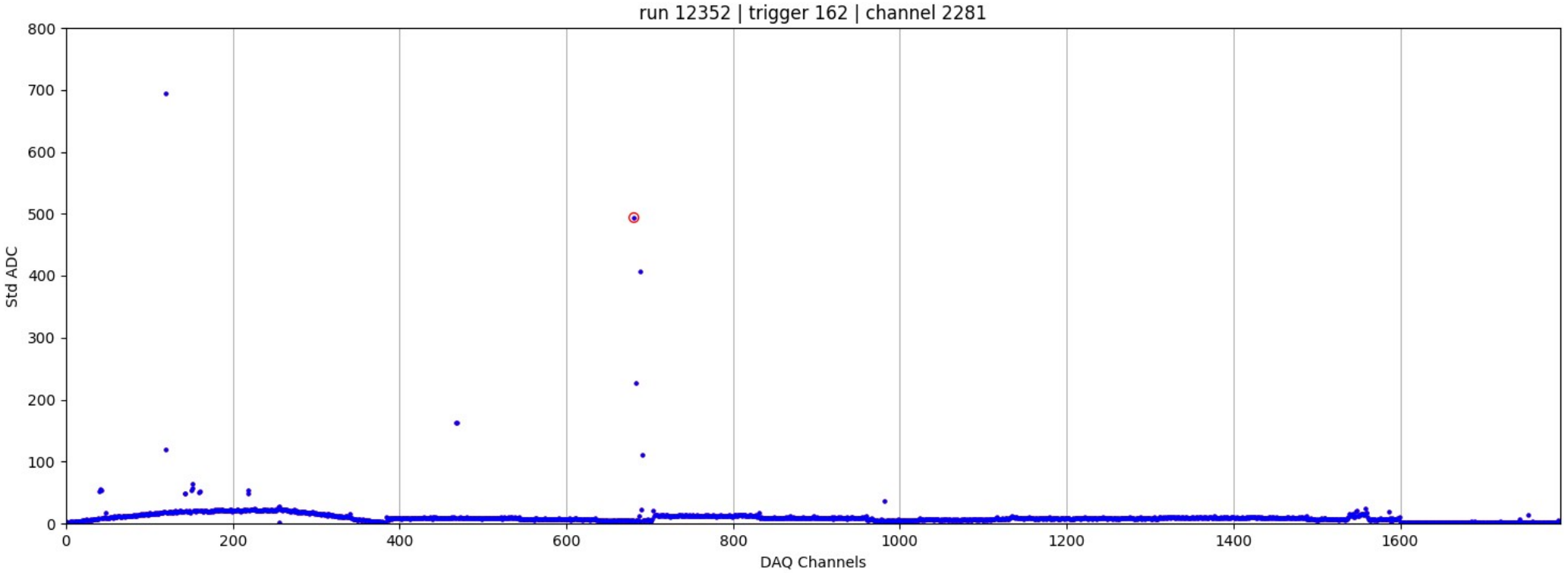
Raw wf, channels 2431 and 2304

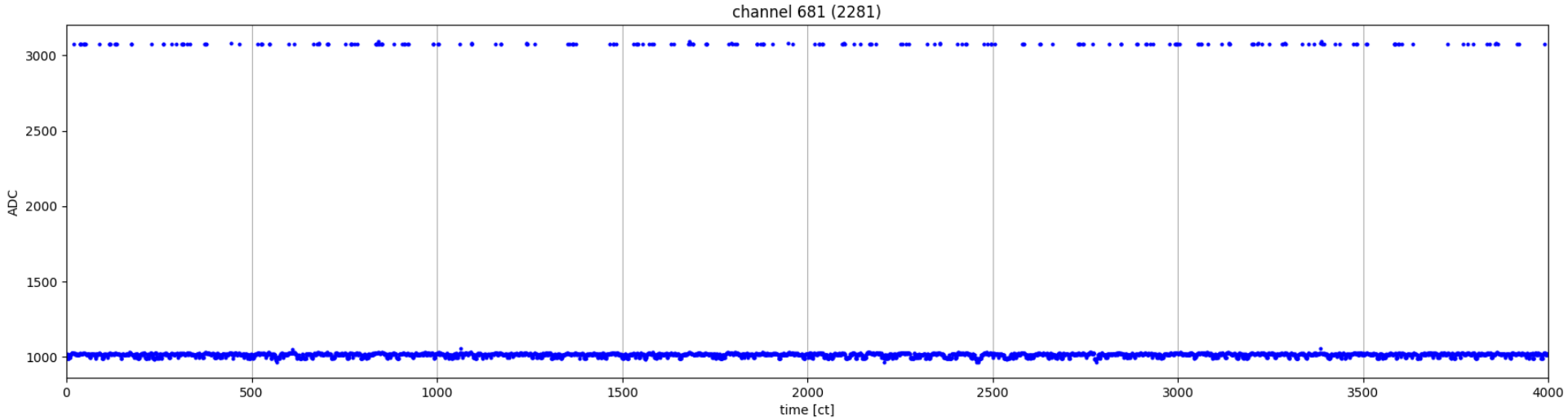
Strips Y85,Y86



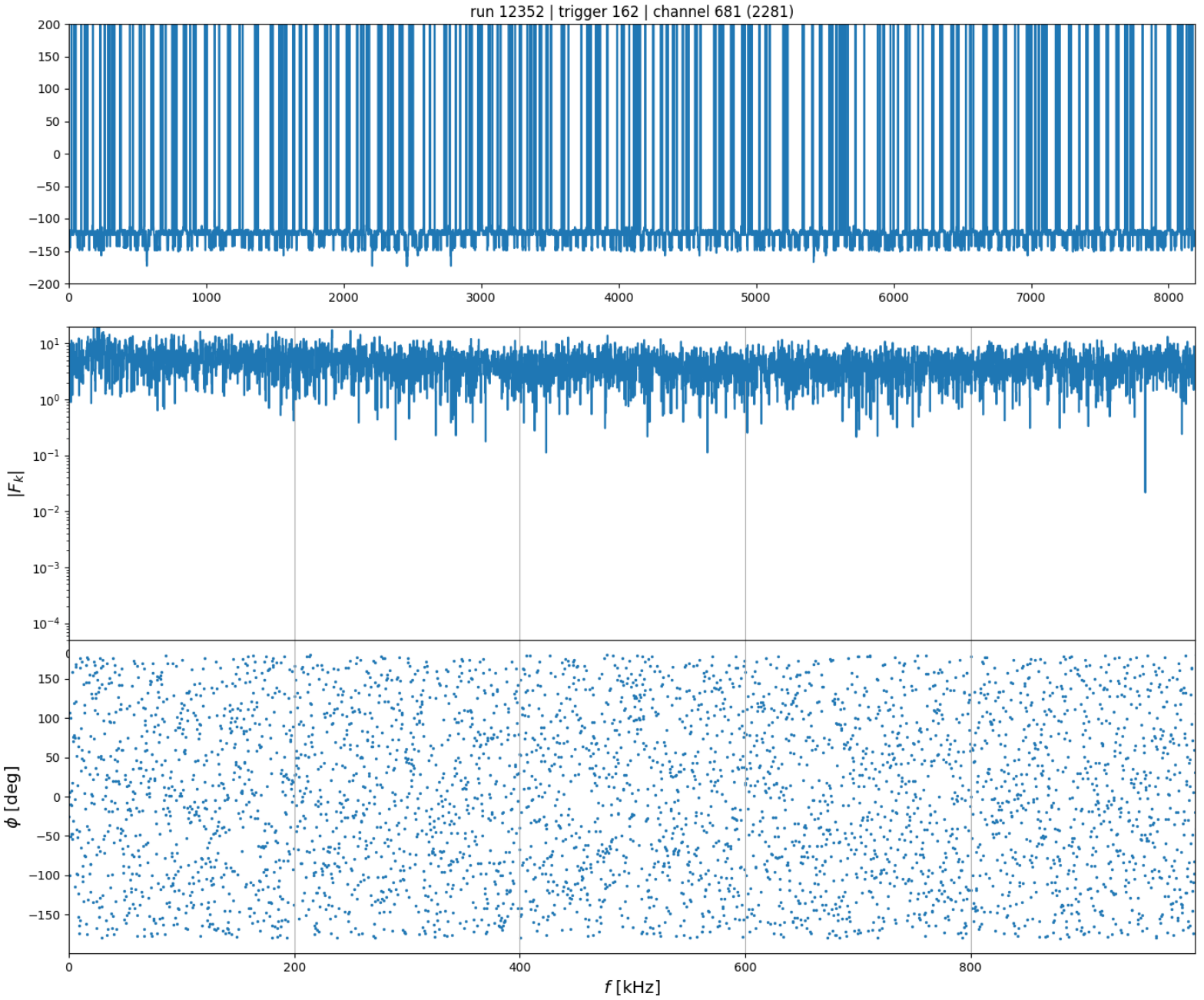
Anti-correlated “noise”

2281

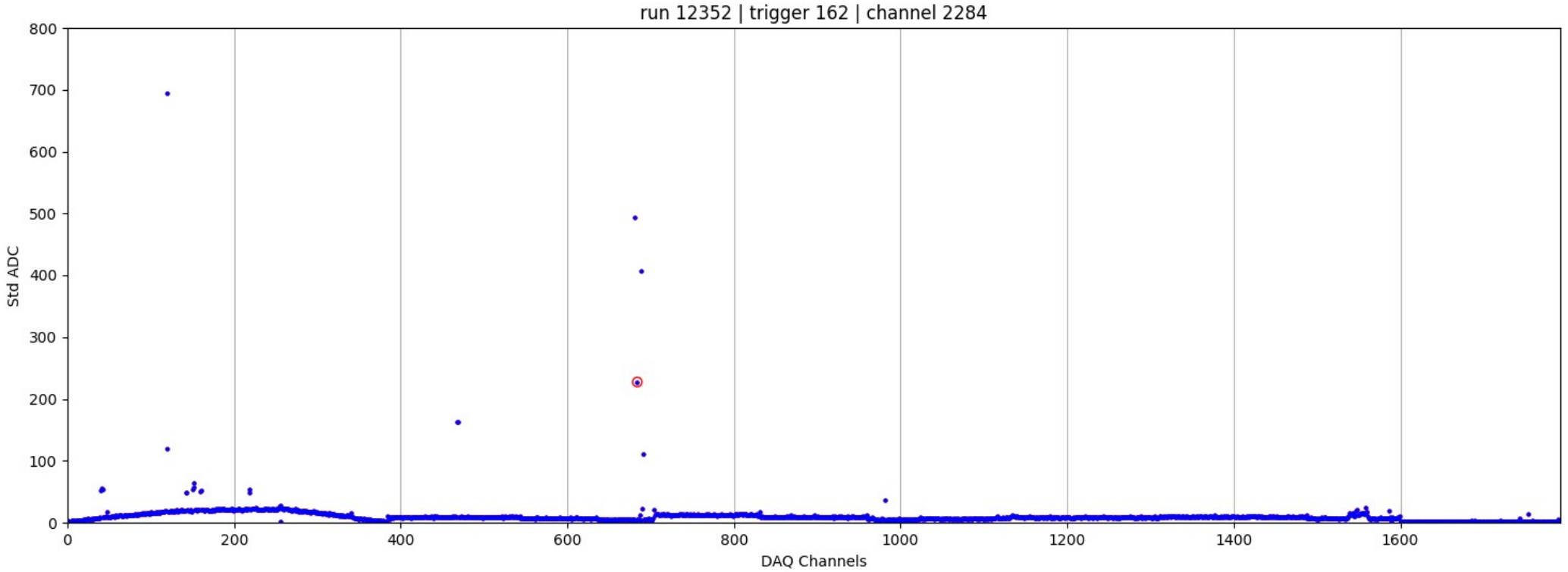

run 12352 | trigger 162 | channel 2281
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

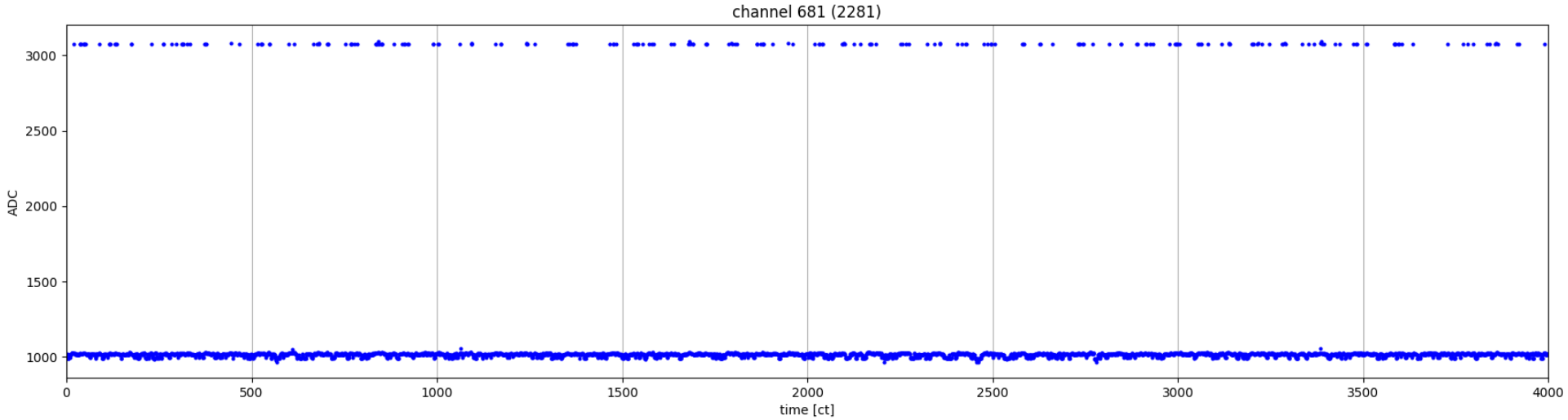

channel 681 (2281)
ADC
time [ct]
1000
1500
2000
2500
3000
0
500
1000
1500
2000
2500
3000
3500
4000

2281

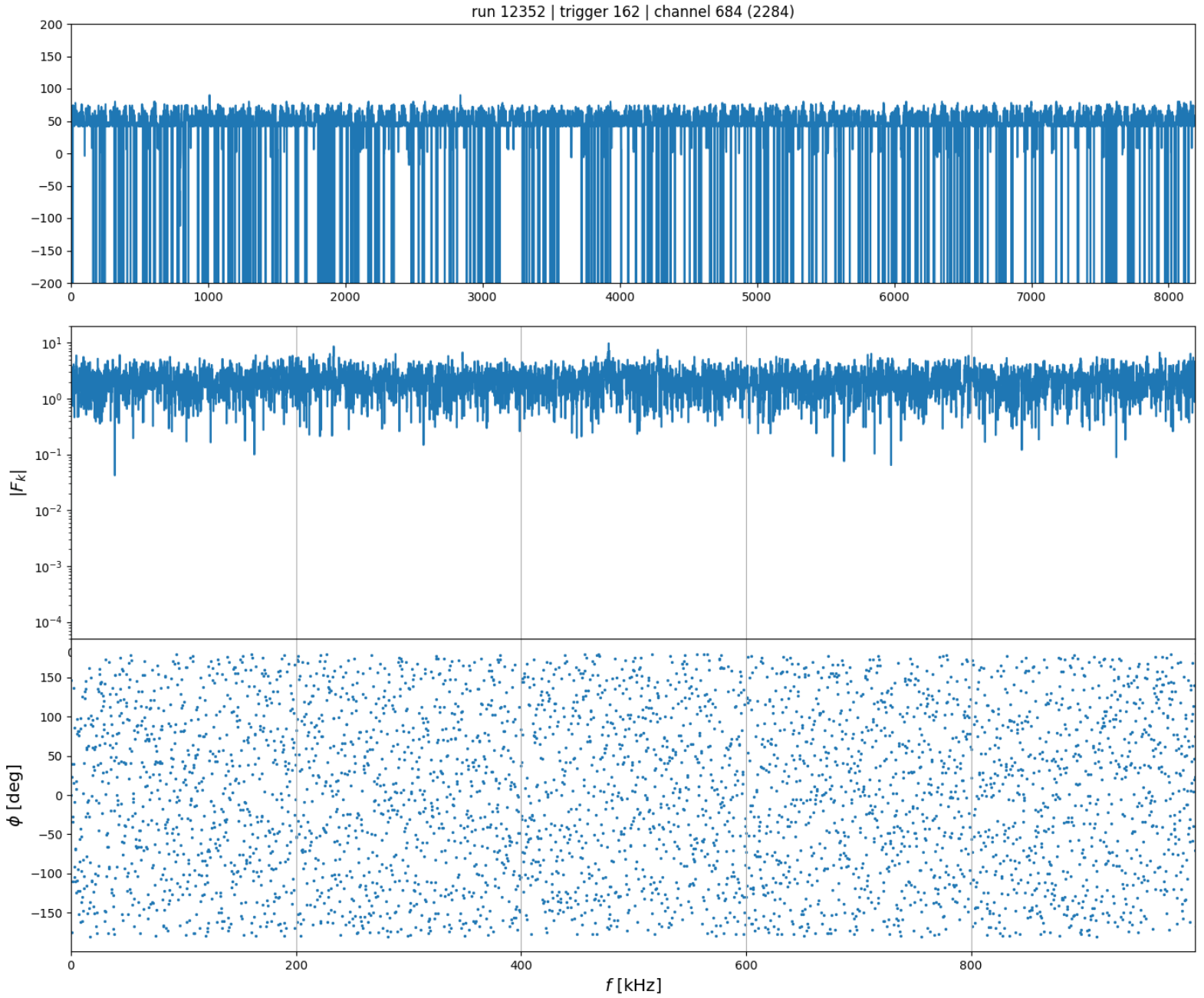


2284

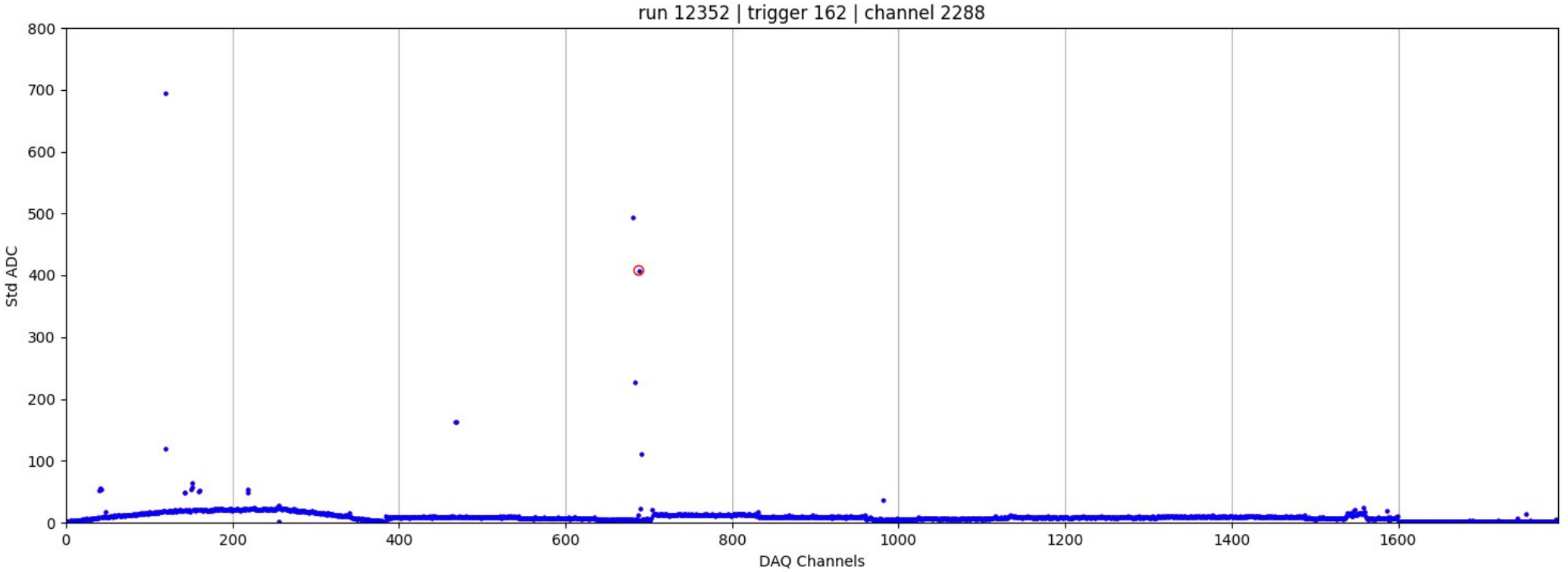

run 12352 | trigger 162 | channel 2284
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

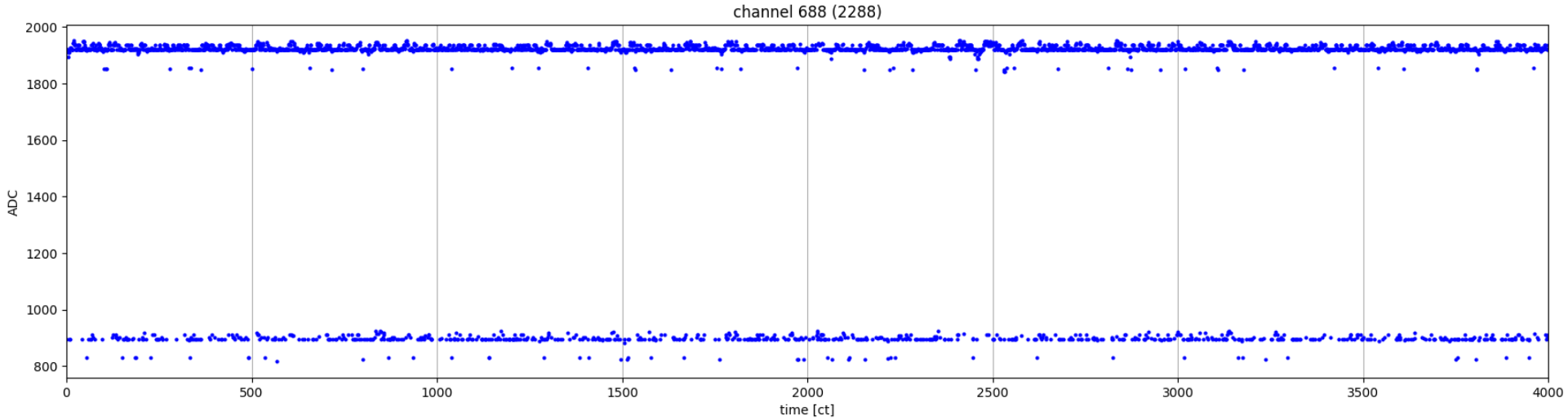

channel 681 (2281)
ADC
time [ct]
1000
1500
2000
2500
3000
0
500
1000
1500
2000
2500
3000
3500
4000

2284

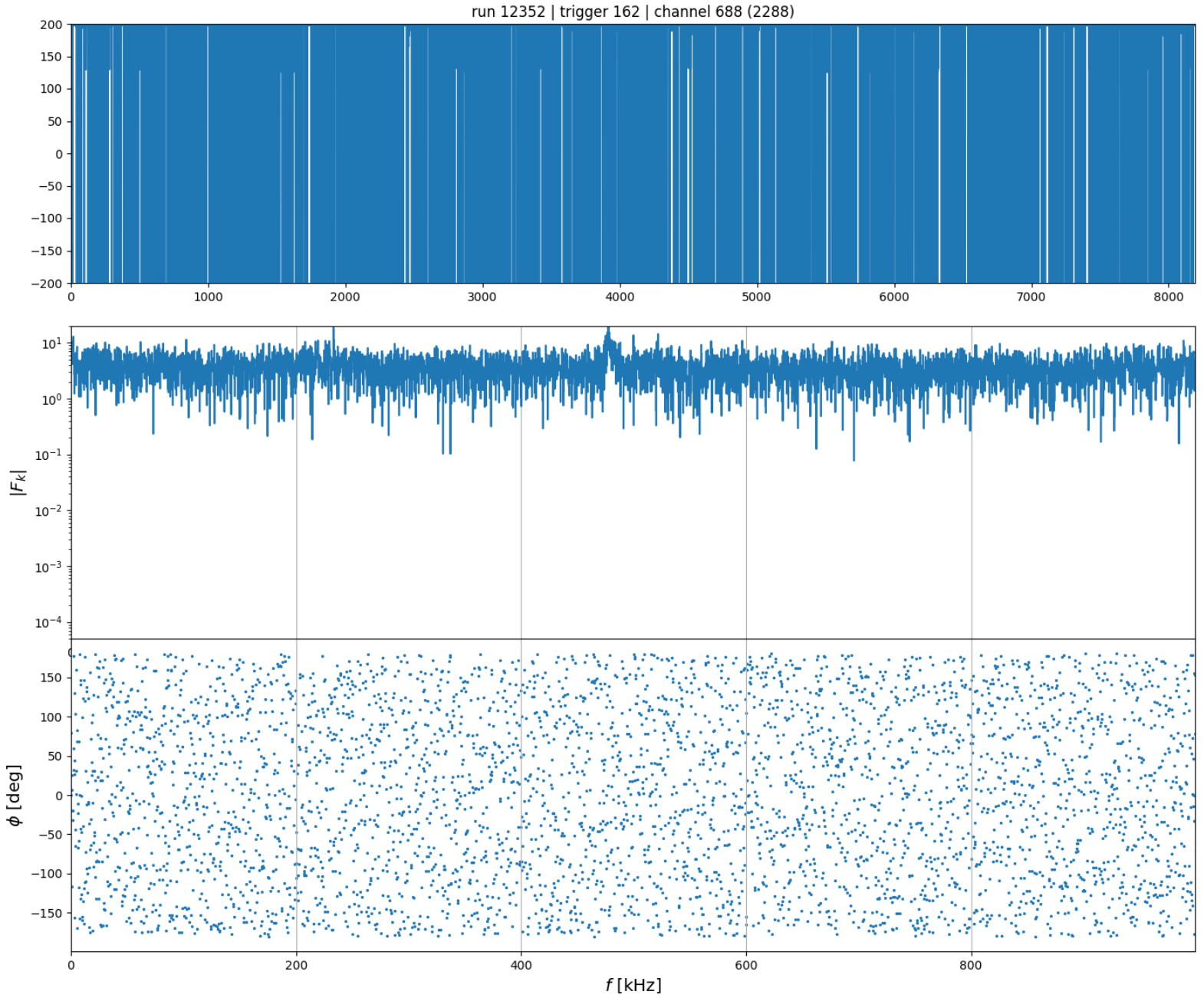


2288

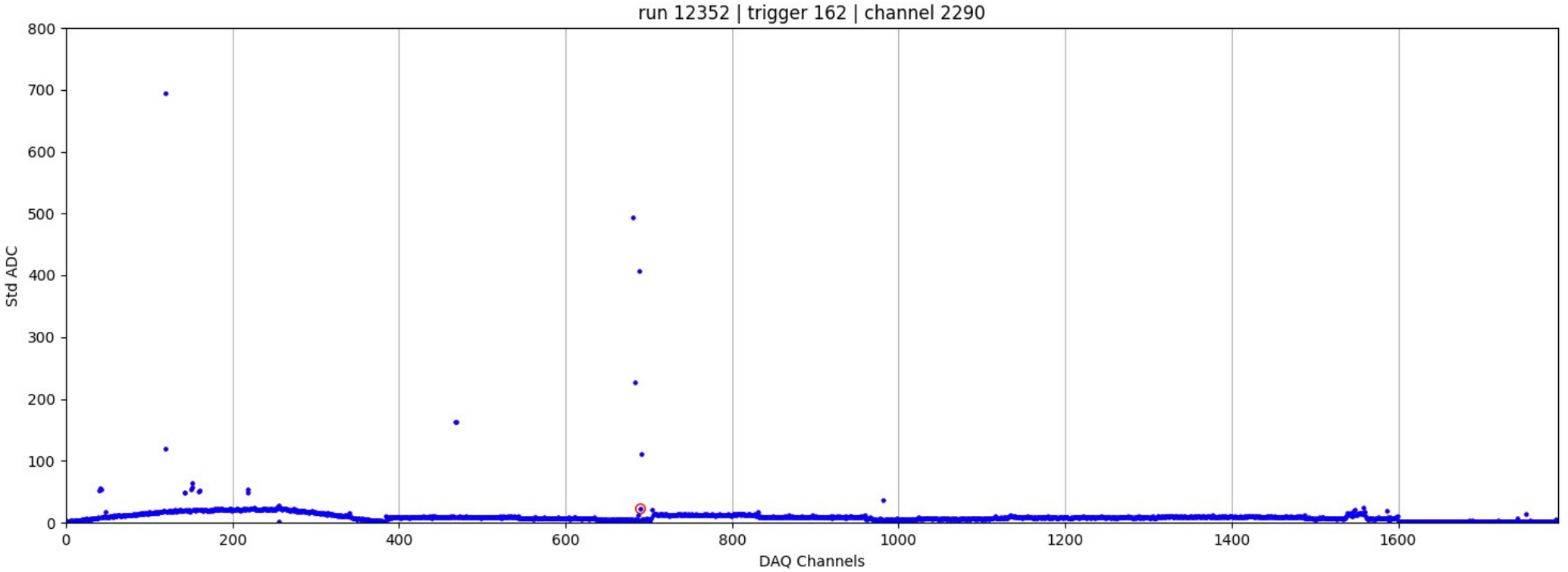

run 12352 | trigger 162 | channel 2288
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

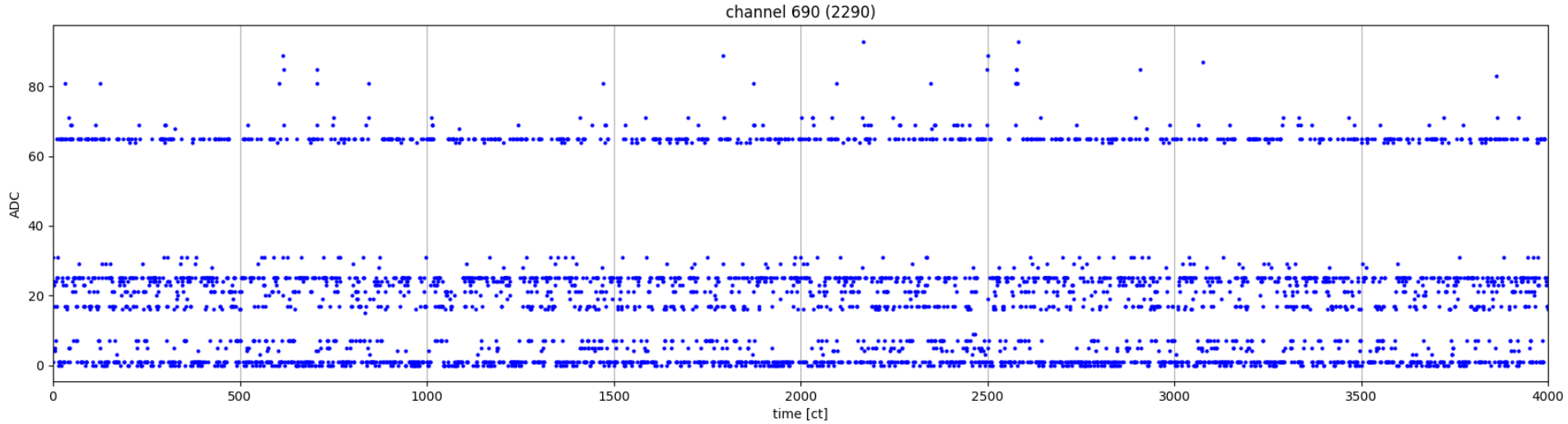

channel 688 (2288)
ADC
time [ct]
800
1000
1200
1400
1600
1800
2000
0
500
1000
1500
2000
2500
3000
3500
4000

2288

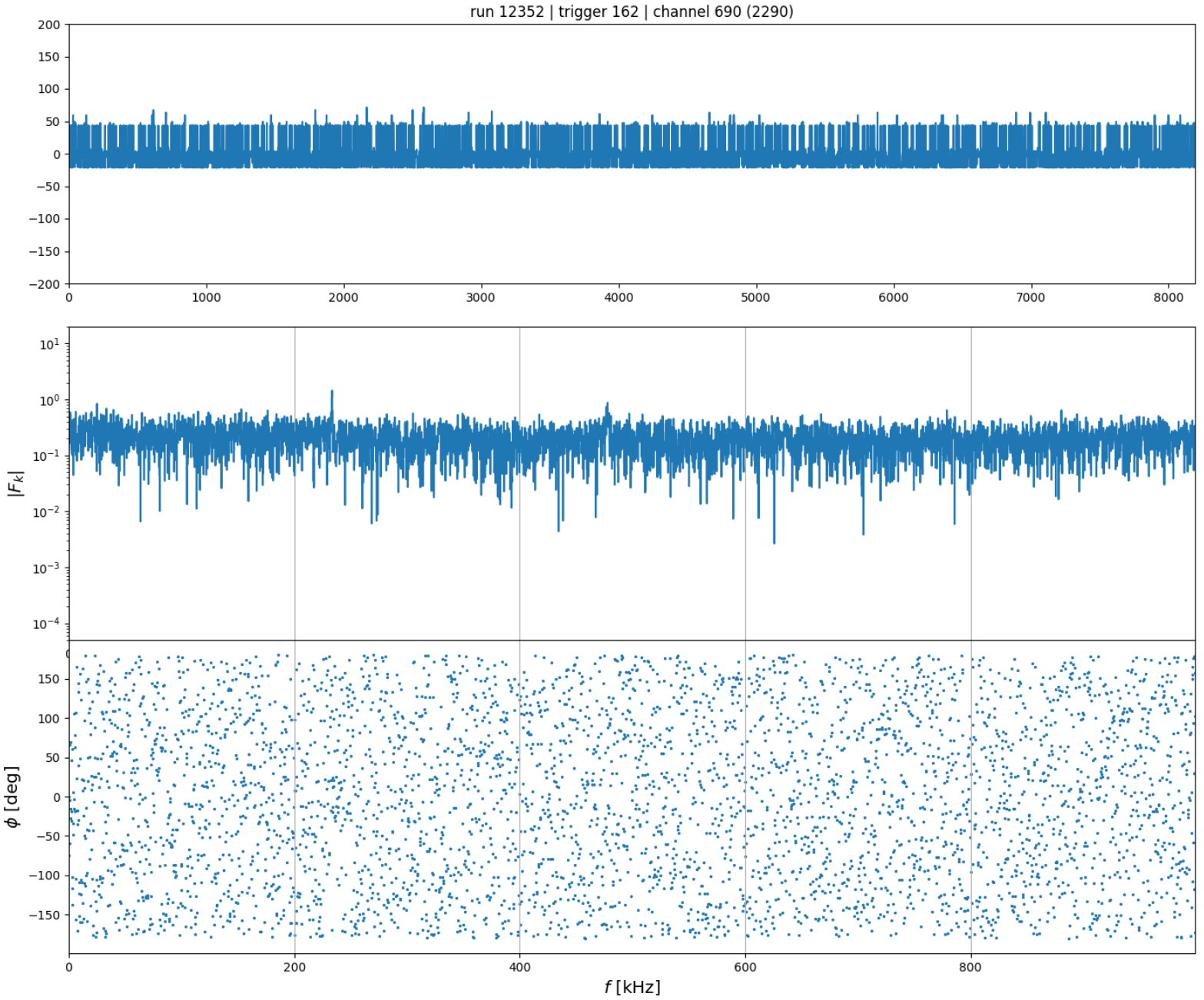

run 12352 | trigger 162 | channel 688 (2288)
200
150
100
50
0
−50
−100
−150
−200
0
1000
2000
3000
4000
5000
6000
7000
8000
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
$|F_k|$
150
100
50
0
−50
−100
−150
ϕ [deg]
0
200
400
600
800
f [kHz]

2290

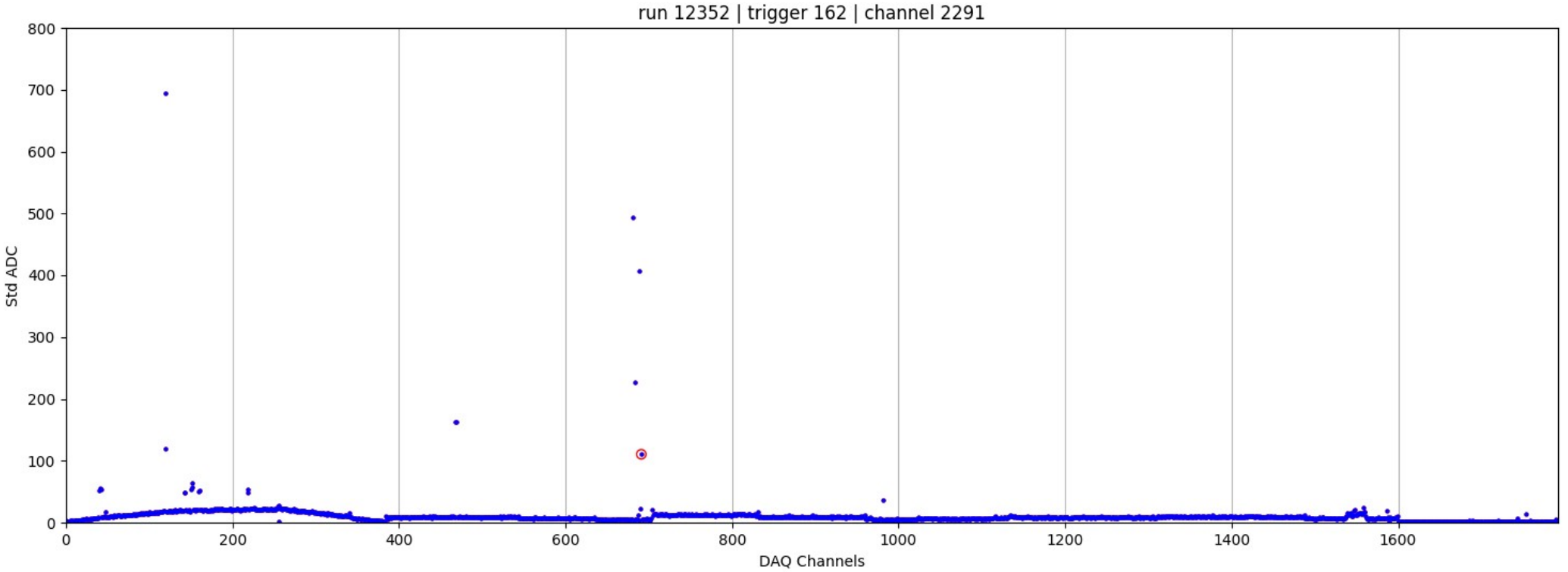

run 12352 | trigger 162 | channel 2290
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

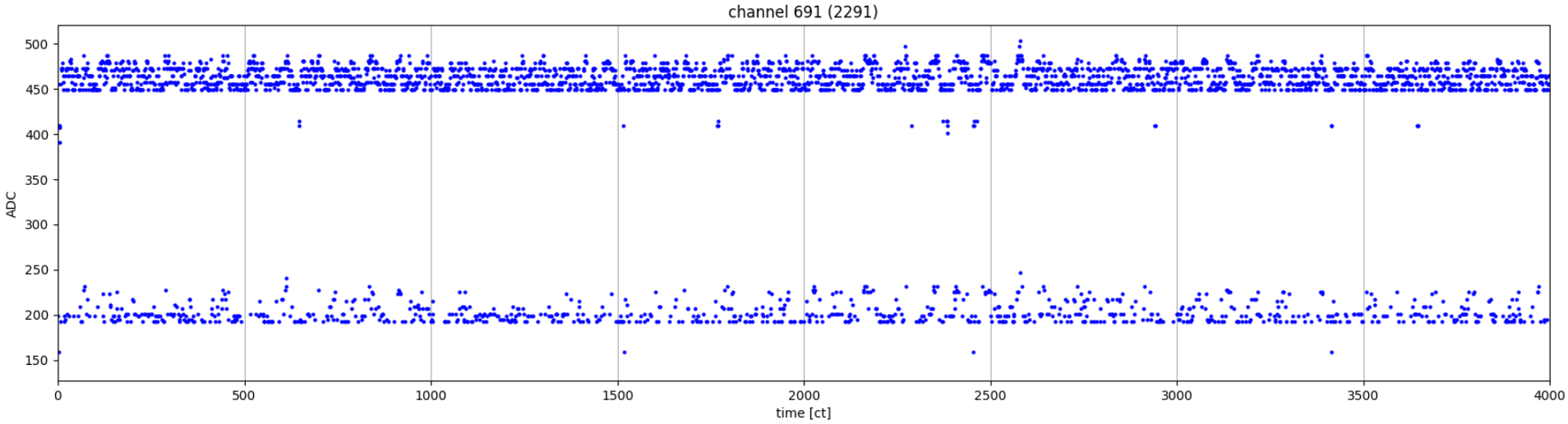

channel 690 (2290)
ADC
time [ct]
0
20
40
60
80
0
500
1000
1500
2000
2500
3000
3500
4000

2290

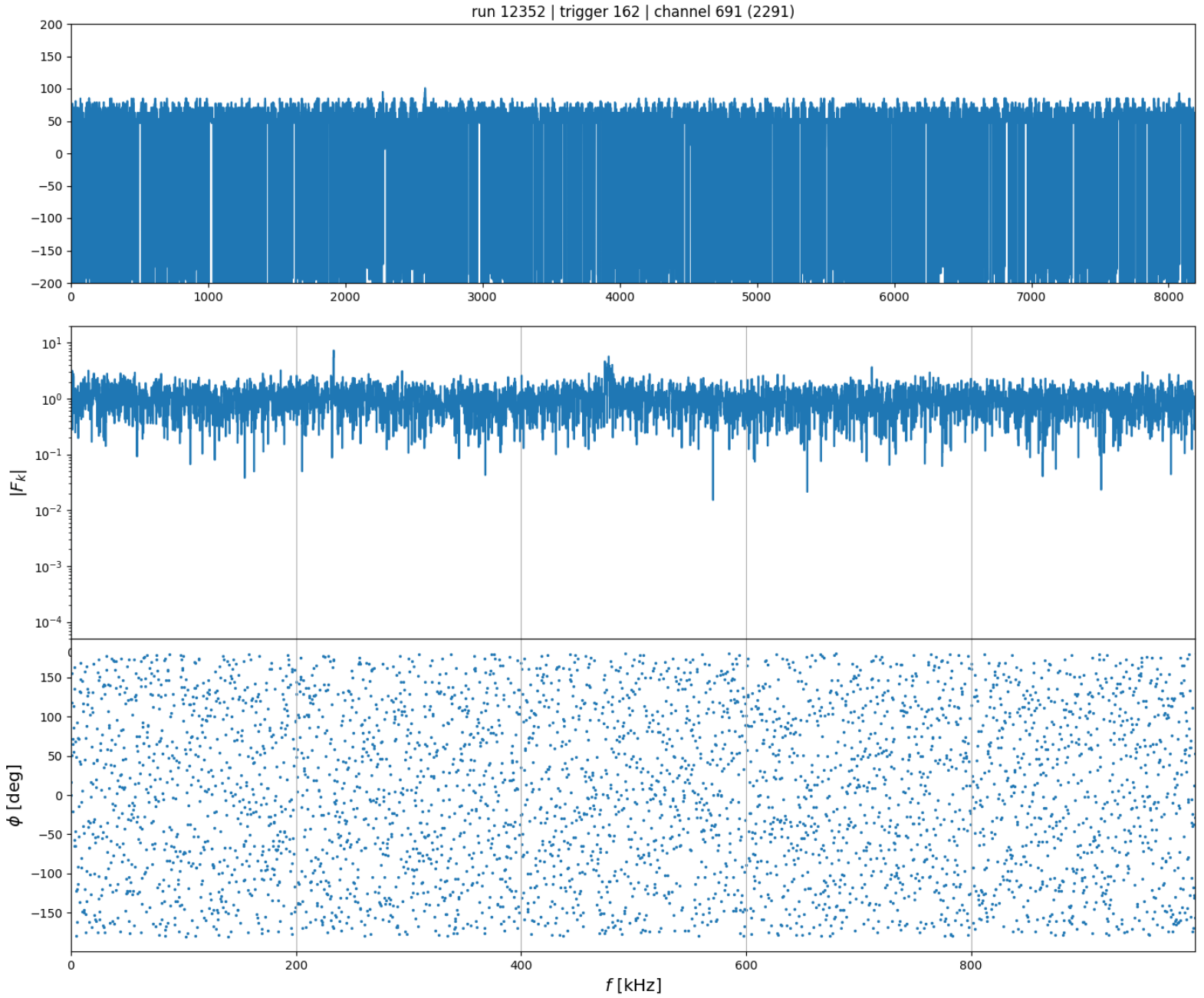


2291

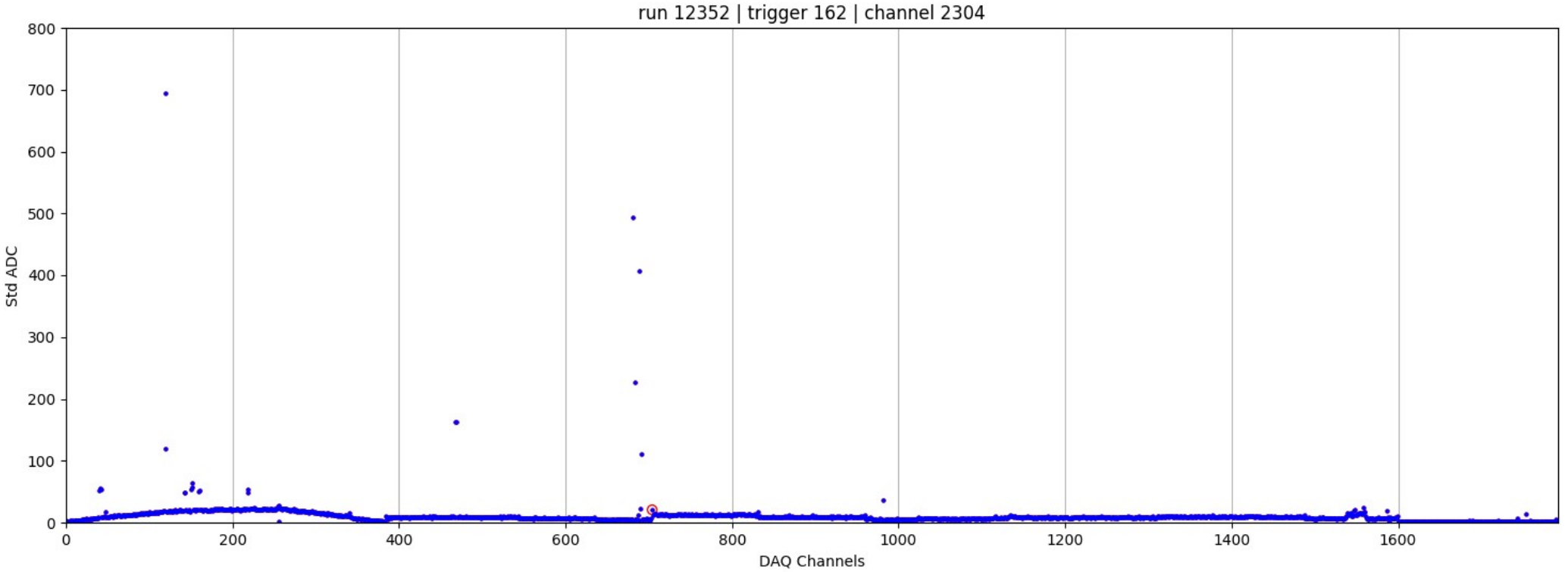

run 12352 | trigger 162 | channel 2291
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

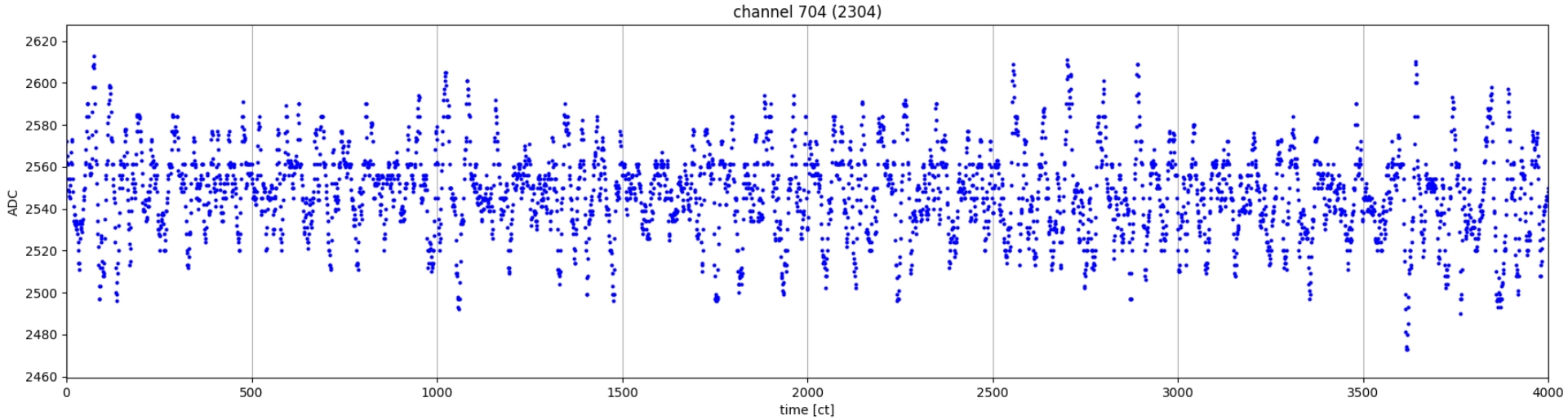

channel 691 (2291)
ADC
time [ct]
150
200
250
300
350
400
450
500
0
500
1000
1500
2000
2500
3000
3500
4000

2291

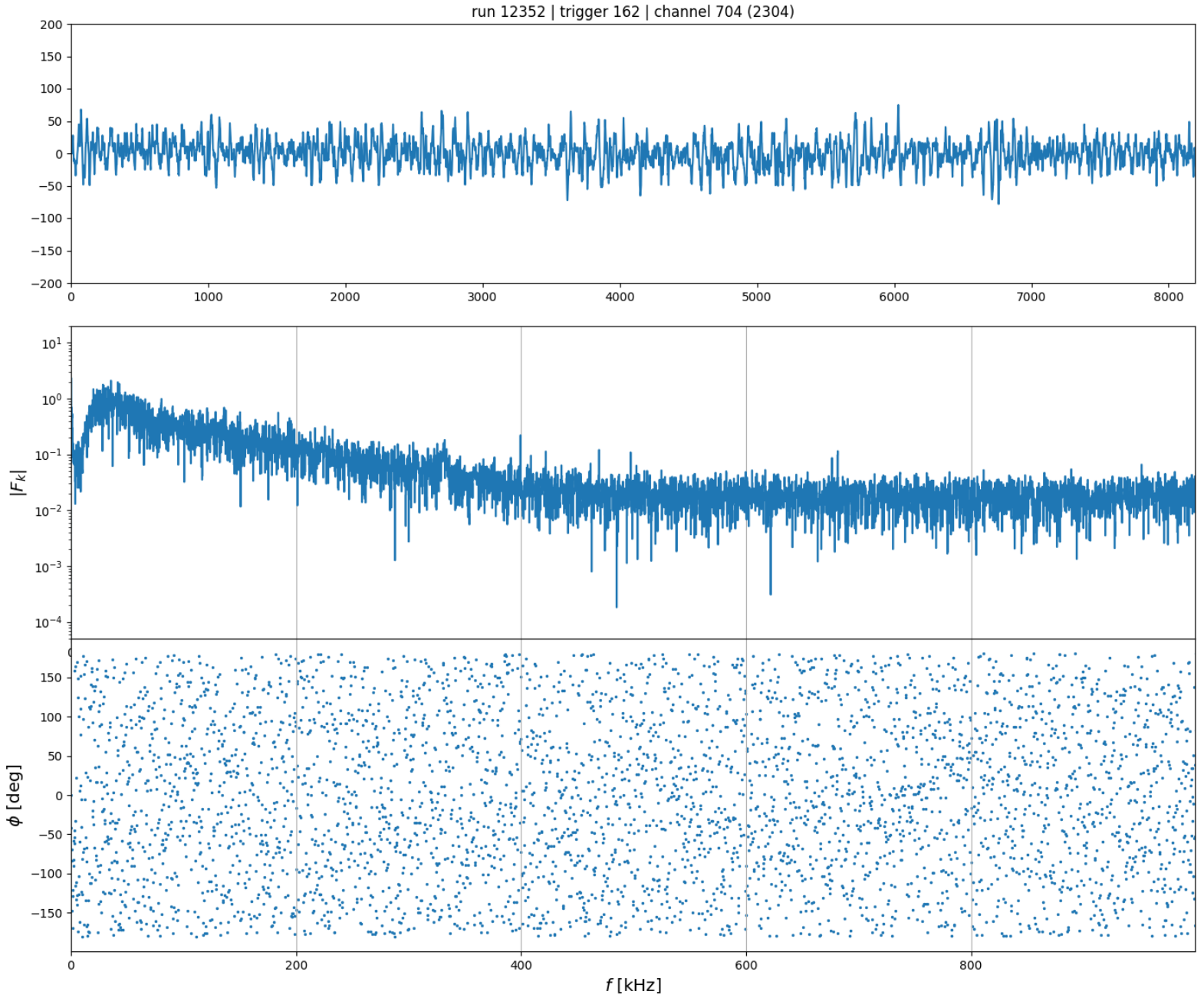


2304

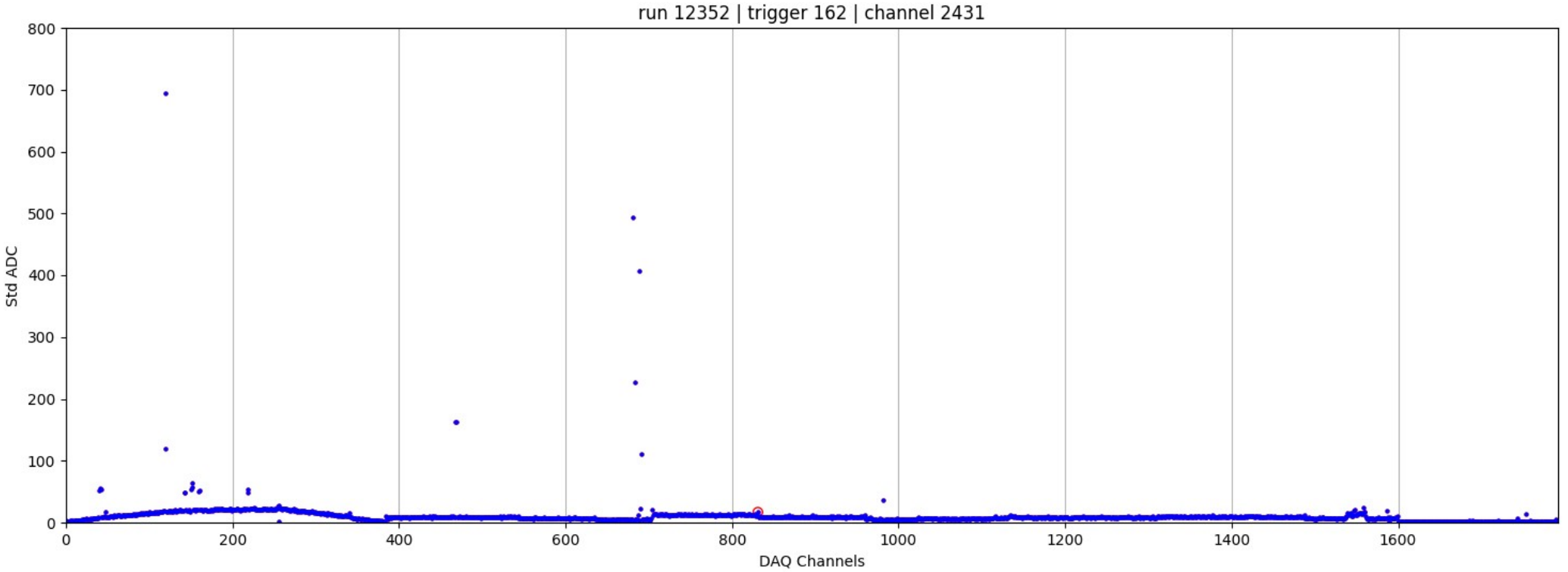

run 12352 | trigger 162 | channel 2304
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

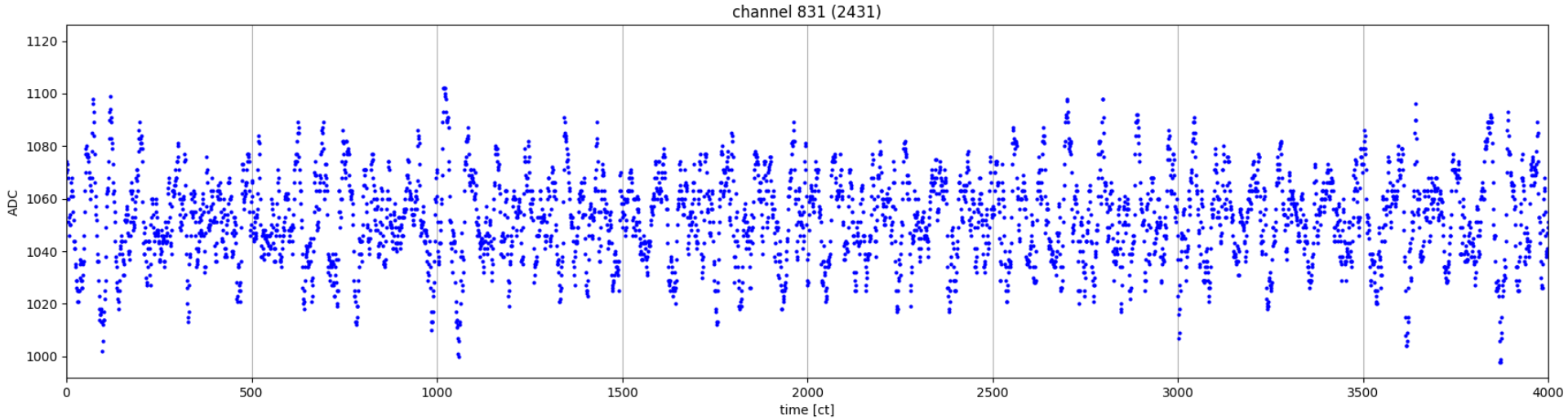

channel 704 (2304)
ADC
time [ct]
2460
2480
2500
2520
2540
2560
2580
2600
2620
0
500
1000
1500
2000
2500
3000
3500
4000

2304

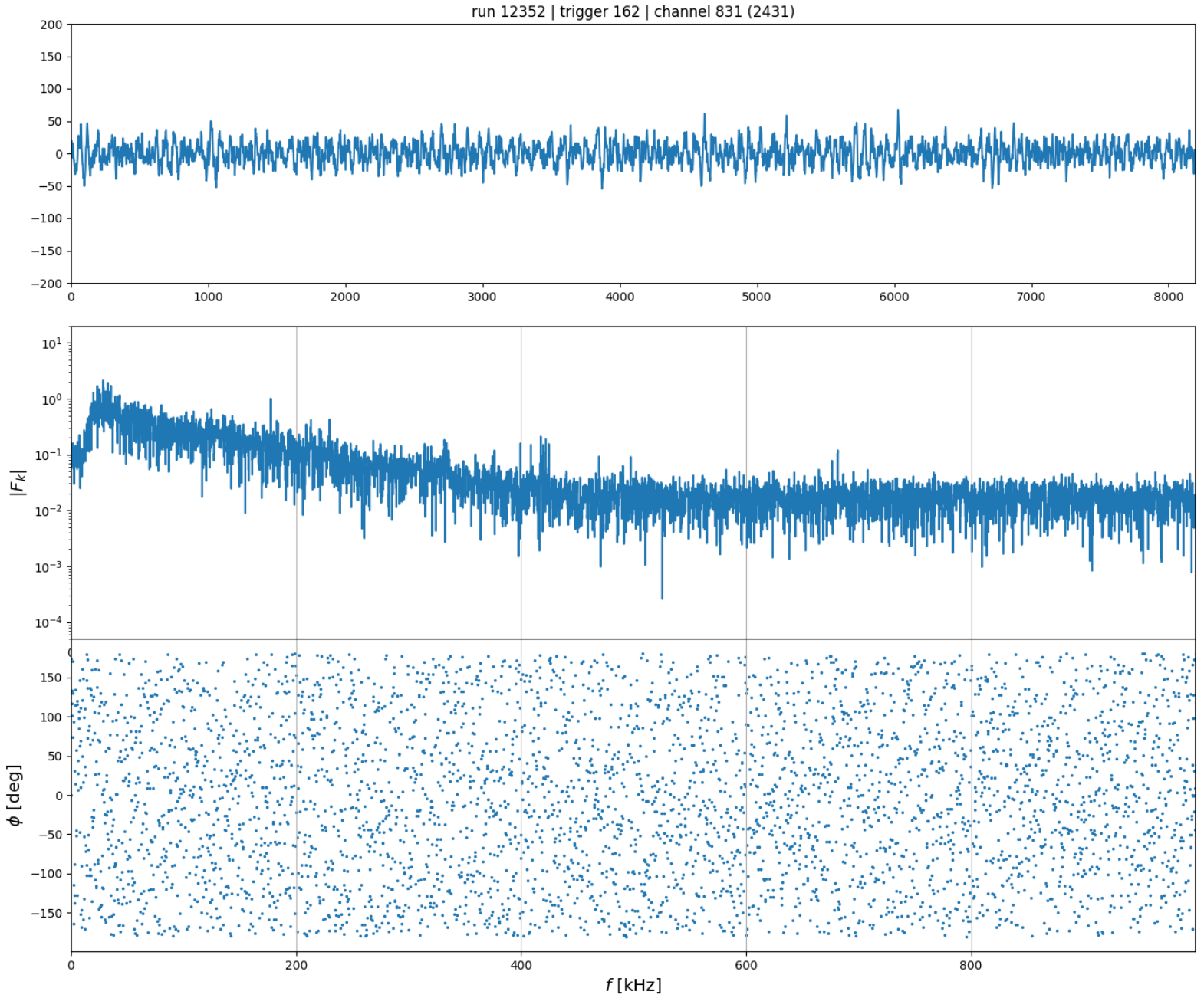


2431


run 12352 | trigger 162 | channel 2431
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

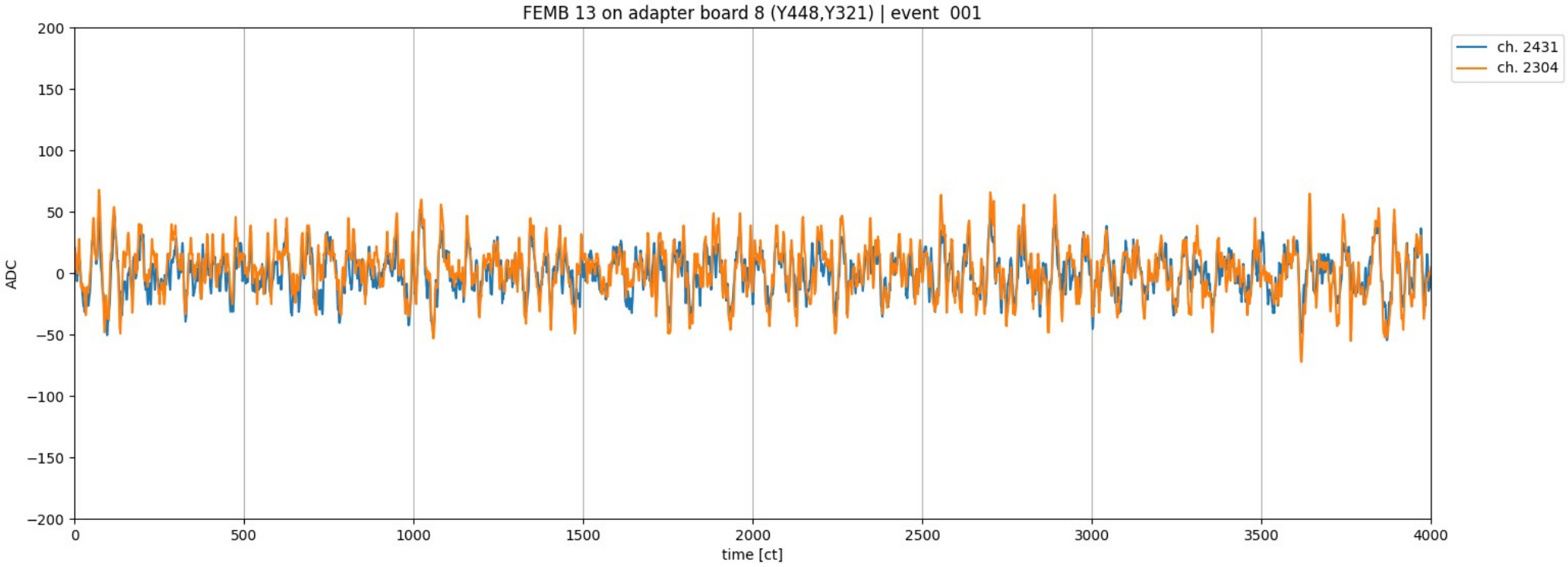

channel 831 (2431)
ADC
time [ct]
1000
1020
1040
1060
1080
1100
1120
0
500
1000
1500
2000
2500
3000
3500
4000

2431



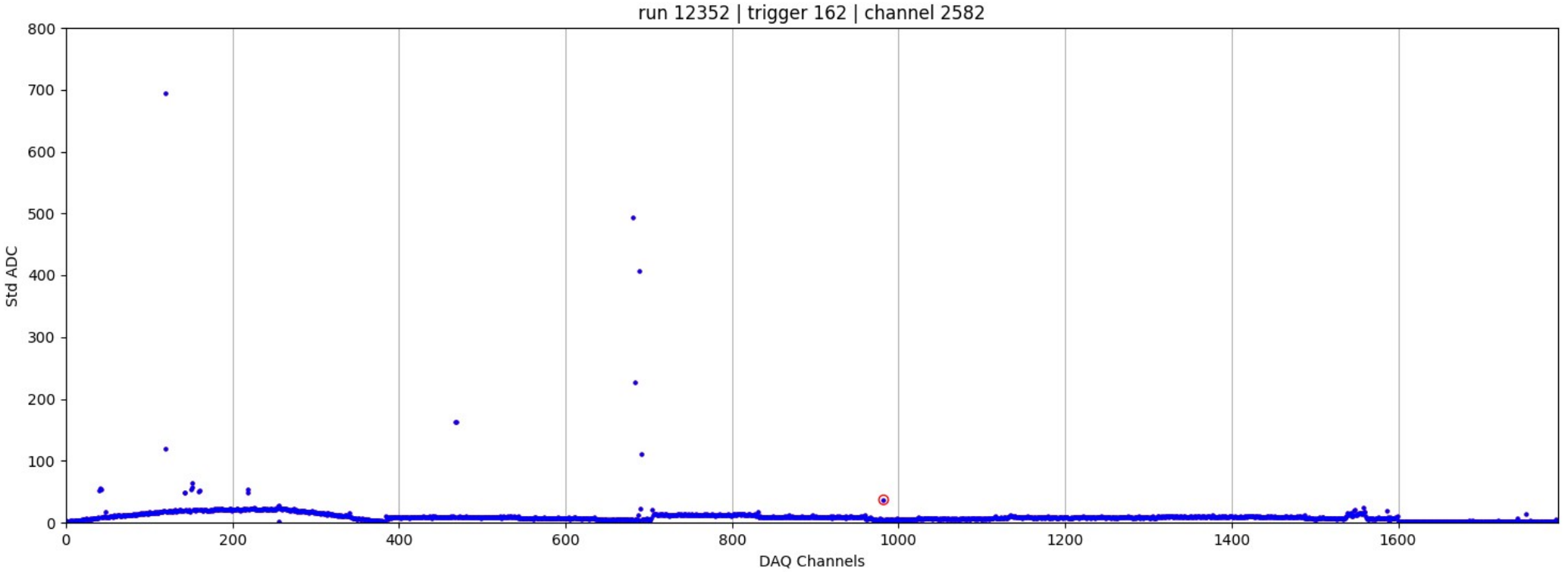
Raw wf, channels 2431 and 2304

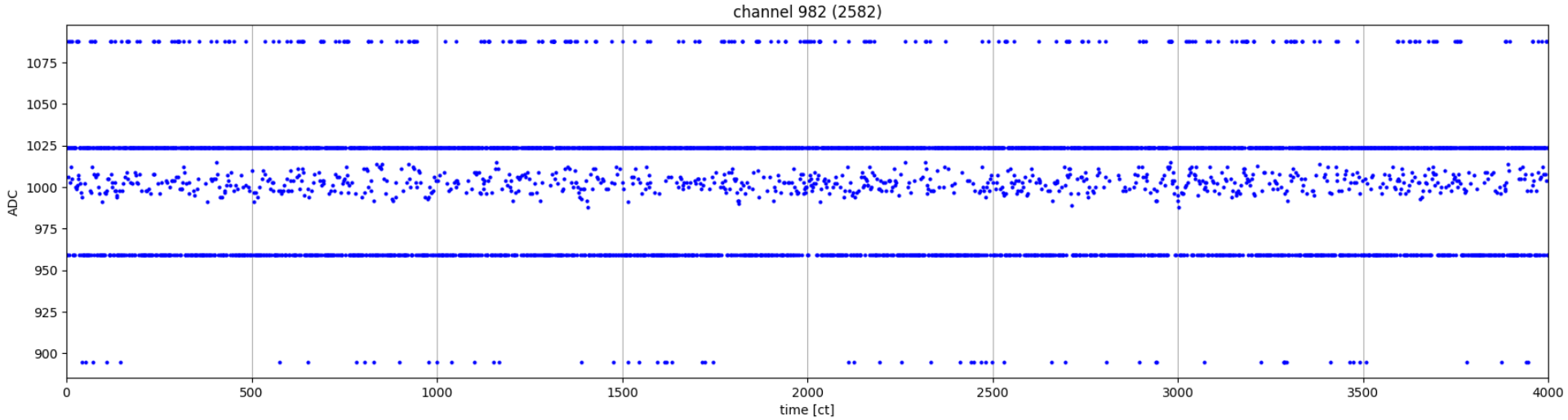
Strips Y321,Y448



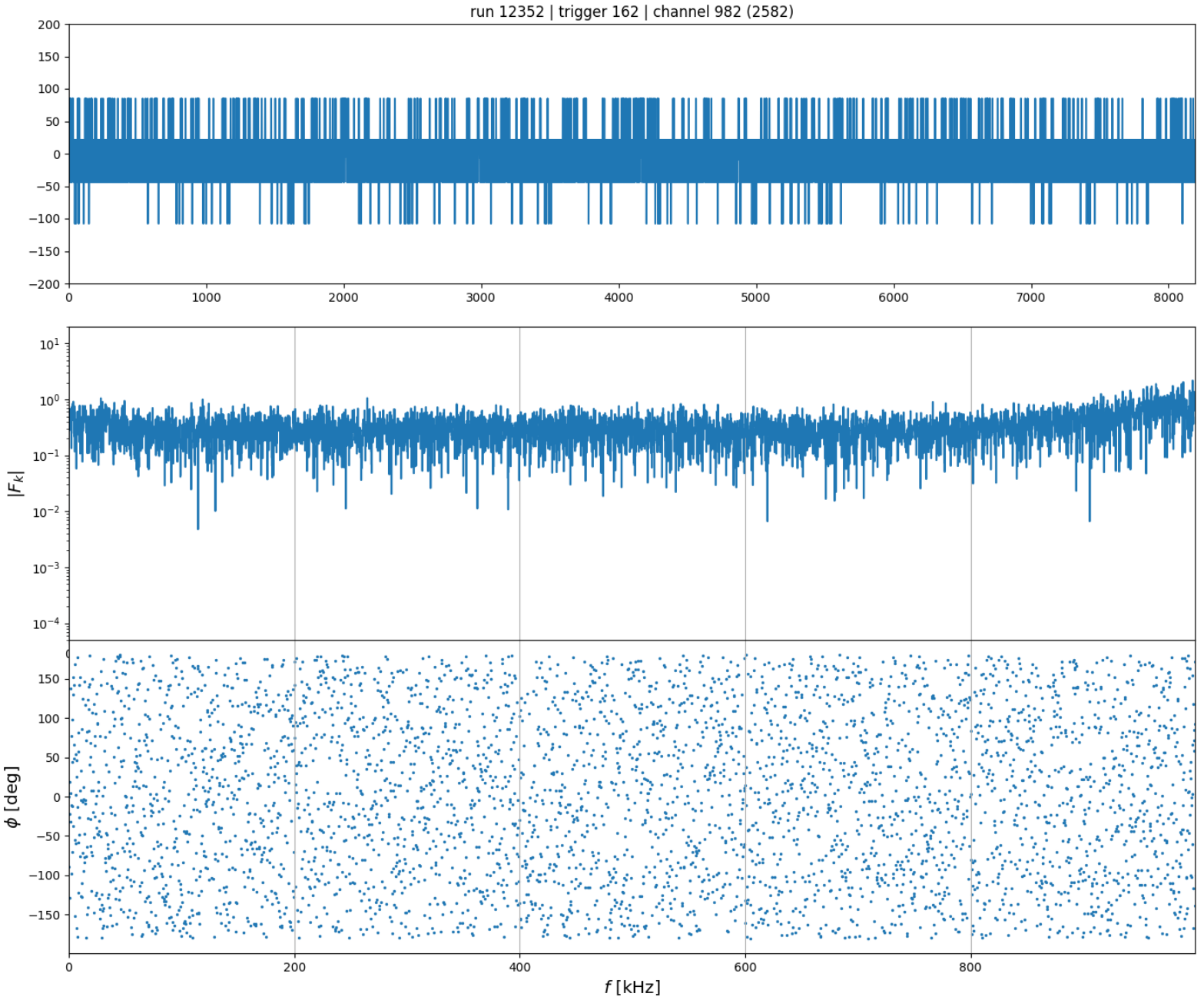
Correlated “noise”

2582

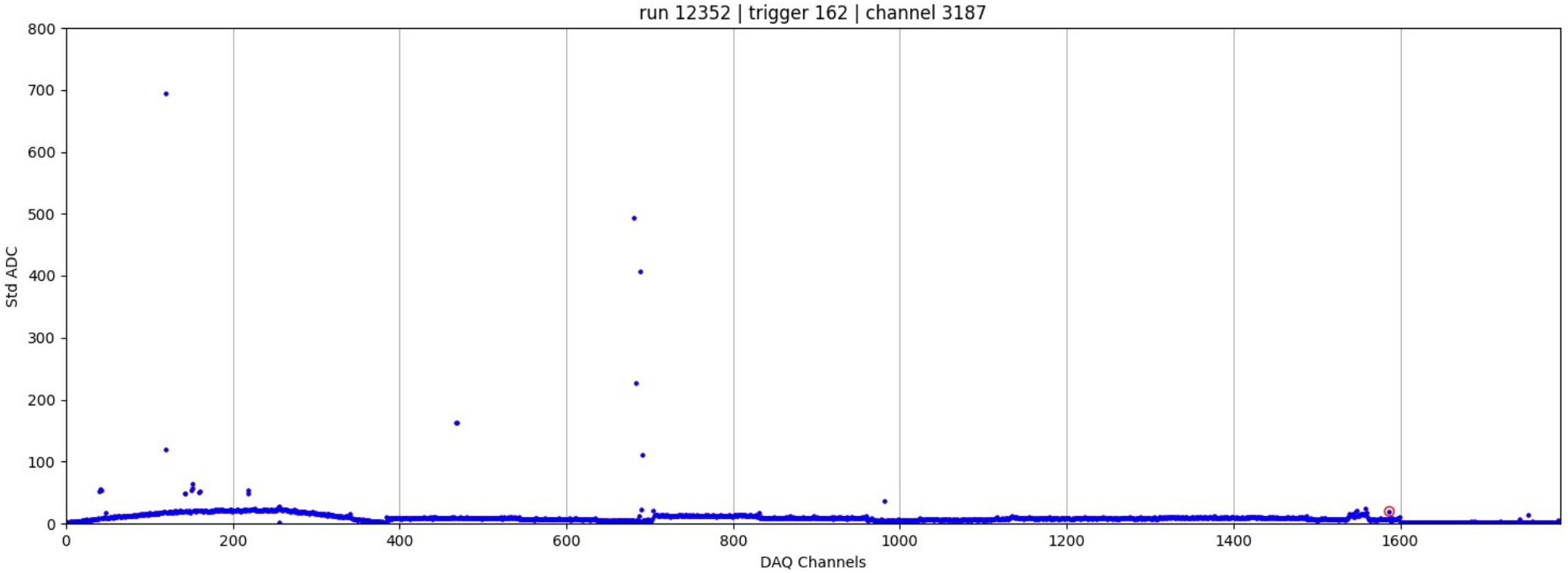

run 12352 | trigger 162 | channel 2582
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

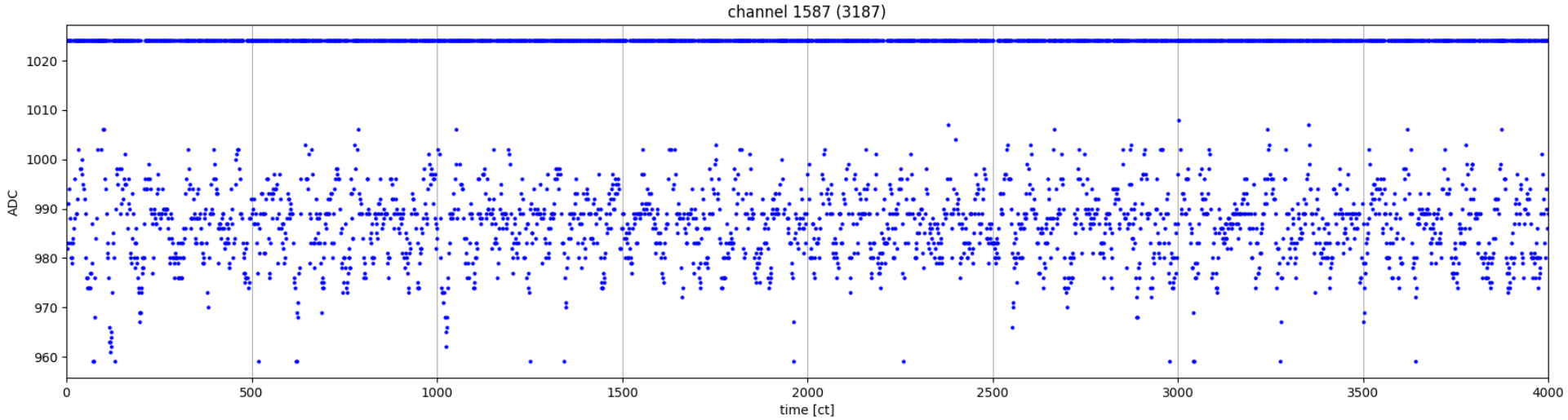

channel 982 (2582)
ADC
time [ct]
900
925
950
975
1000
1025
1050
1075
0
500
1000
1500
2000
2500
3000
3500
4000

2582

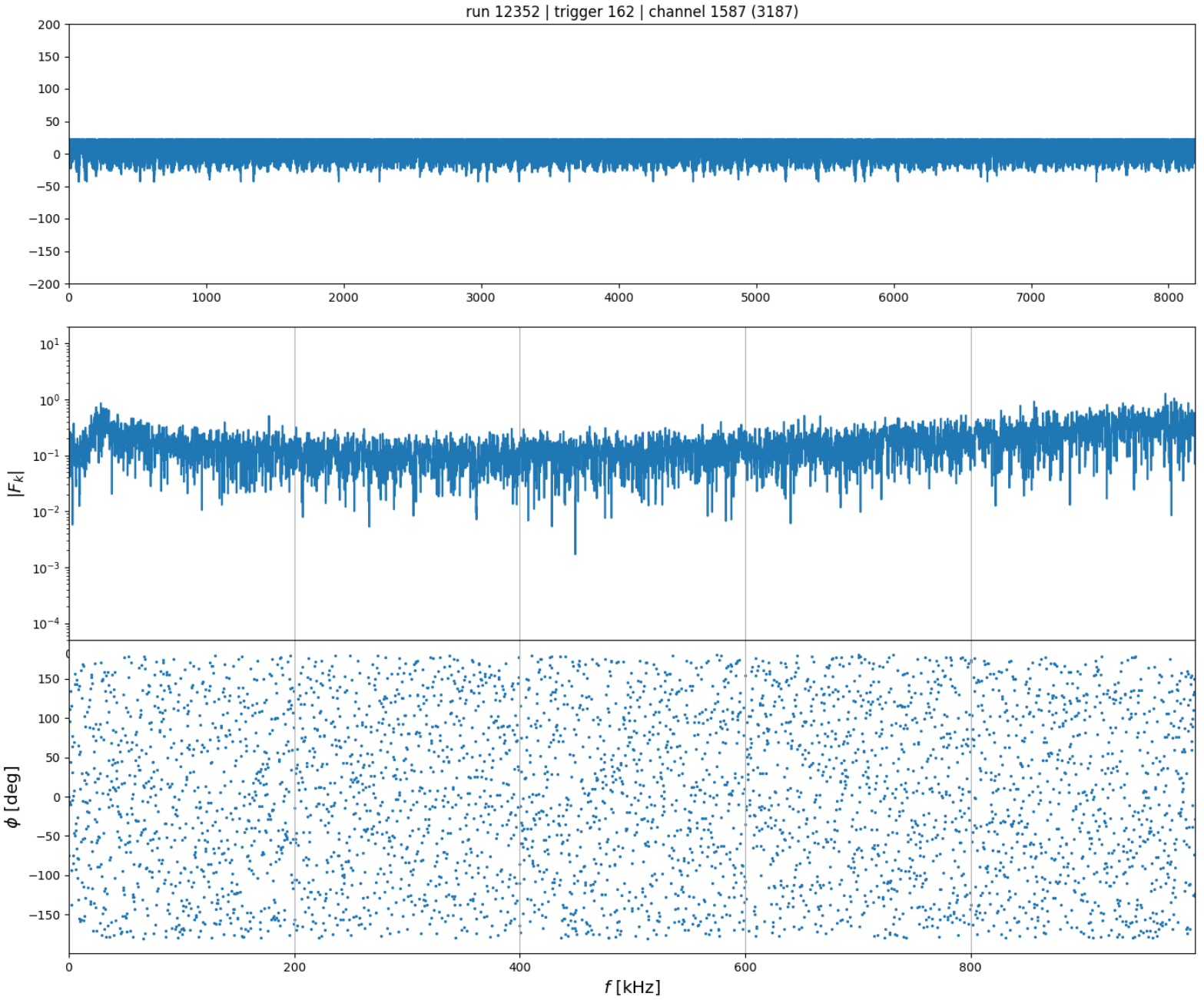


3187

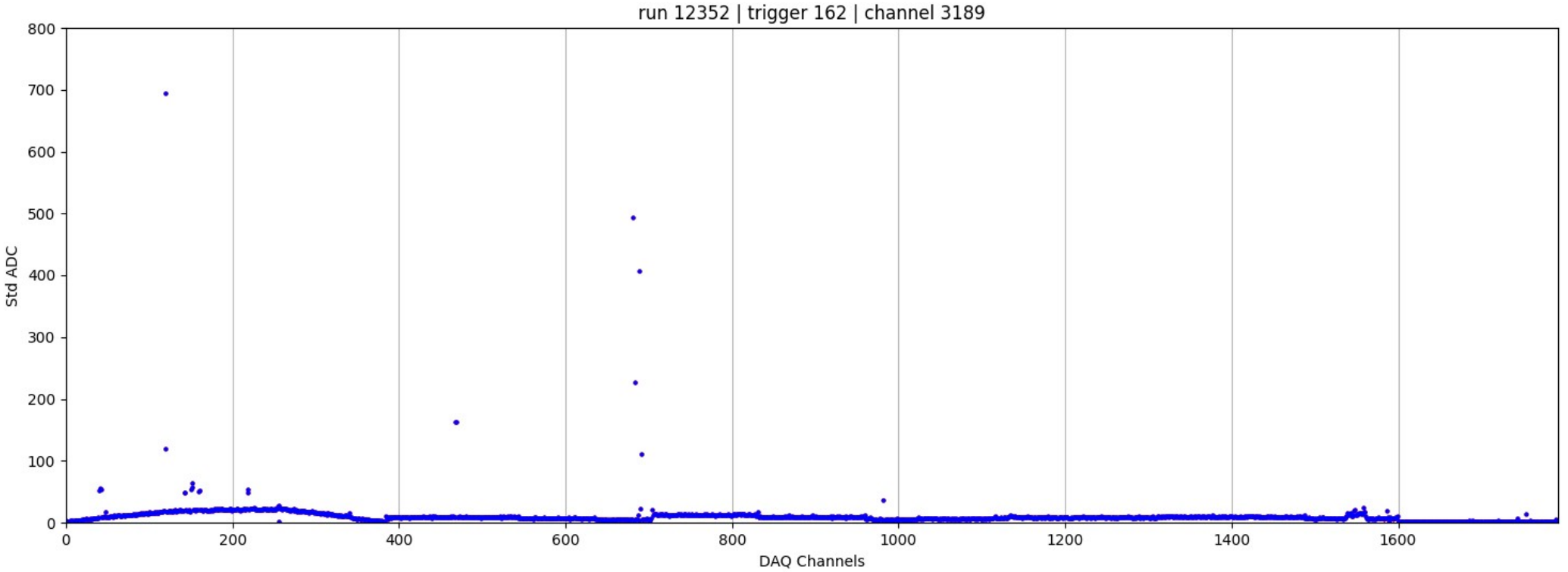

run 12352 | trigger 162 | channel 3187
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

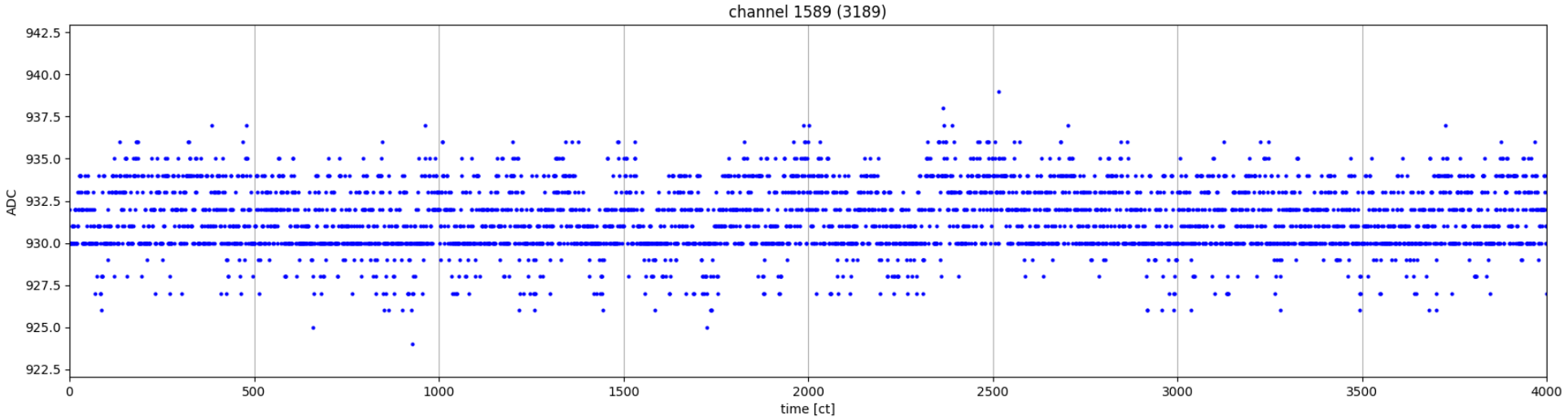

channel 1587 (3187)
ADC
time [ct]
960
970
980
990
1000
1010
1020
0
500
1000
1500
2000
2500
3000
3500
4000

3187

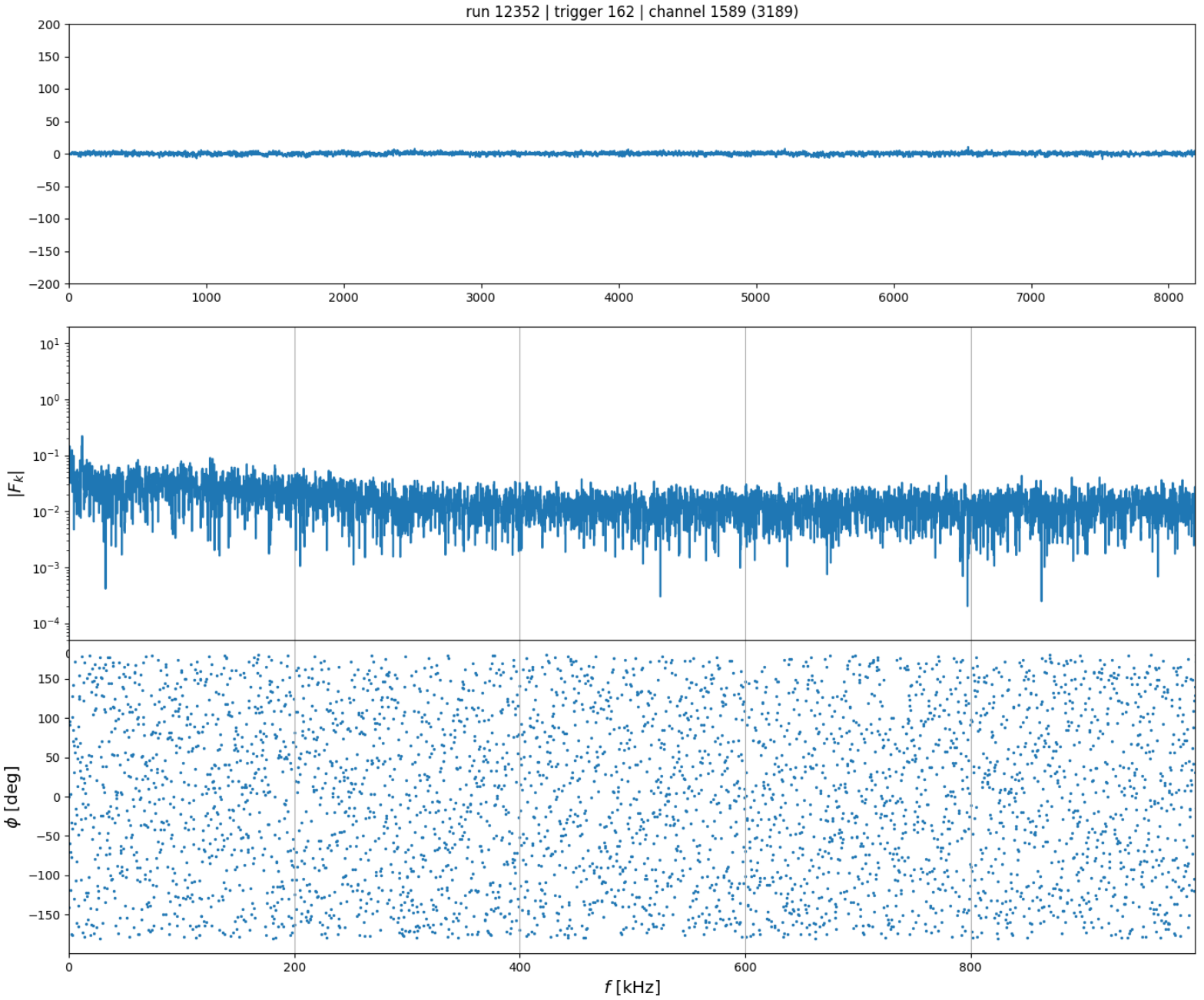


3189

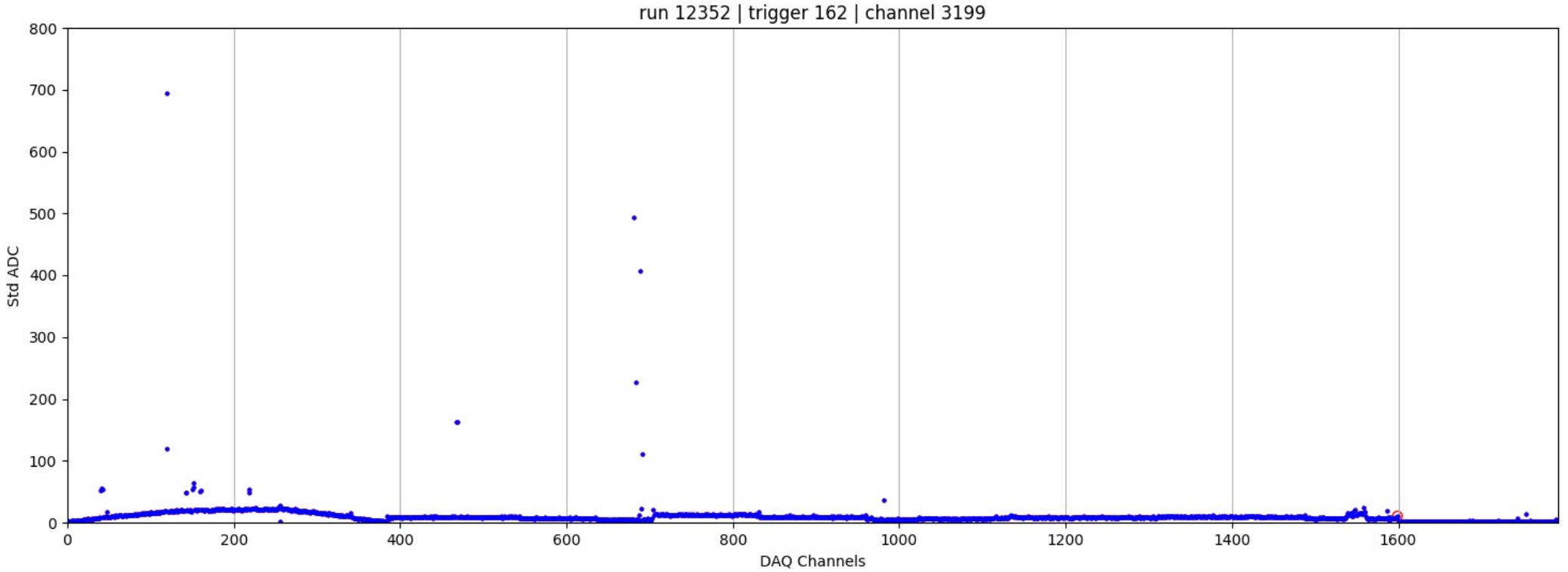

run 12352 | trigger 162 | channel 3189
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

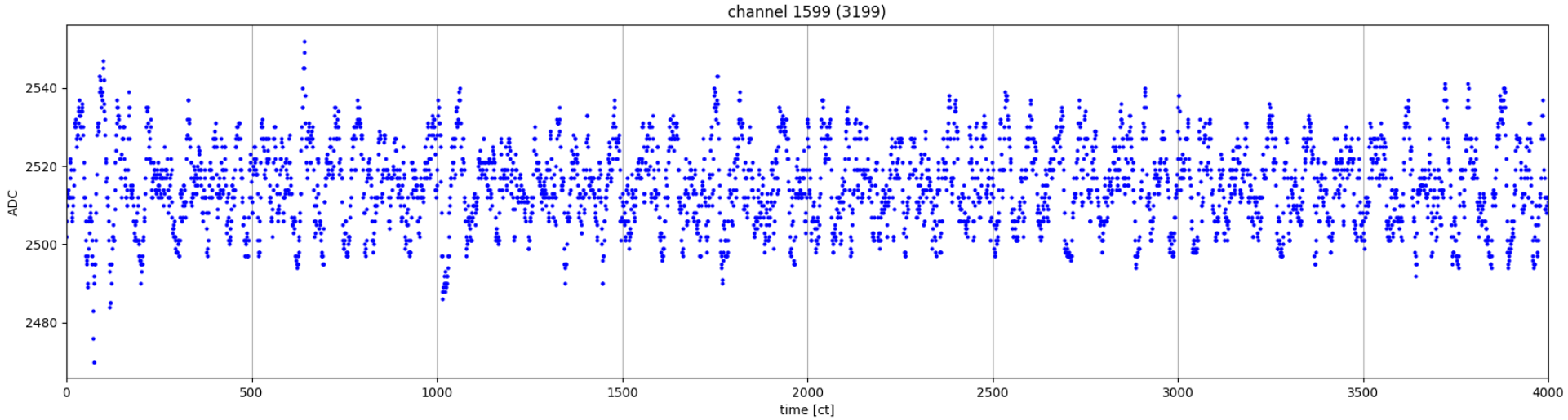

channel 1589 (3189)
ADC
time [ct]
922.5
925.0
927.5
930.0
932.5
935.0
937.5
940.0
942.5
0
500
1000
1500
2000
2500
3000
3500
4000

3189

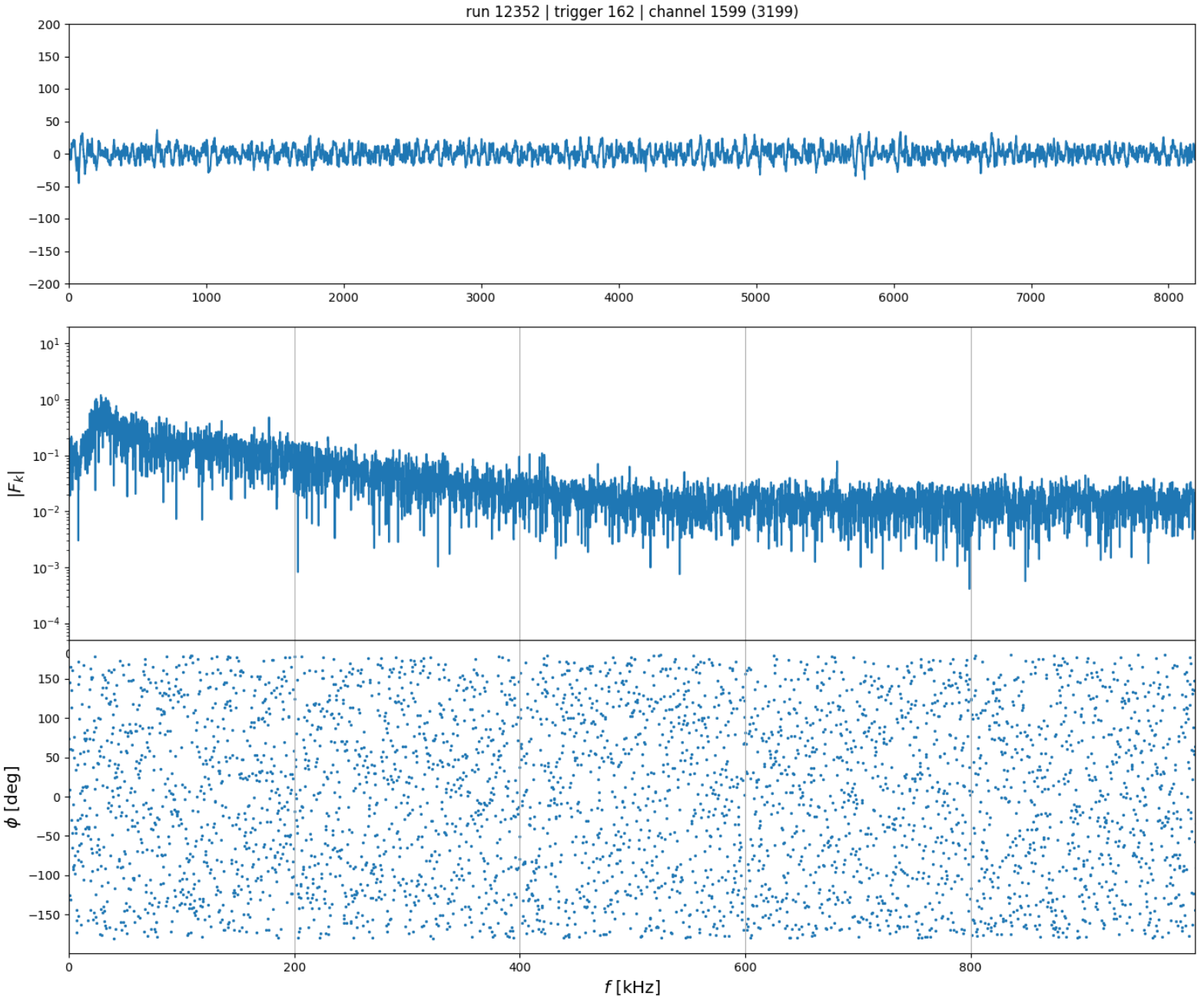


3199

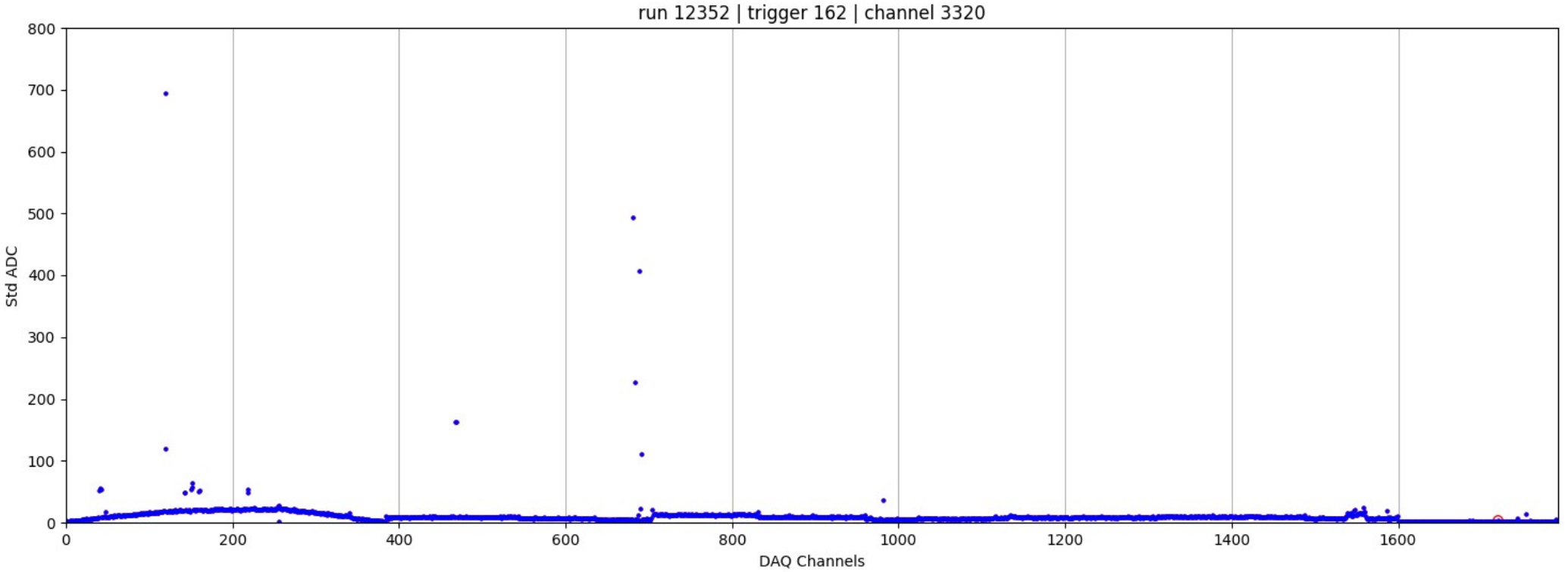

run 12352 | trigger 162 | channel 3199
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

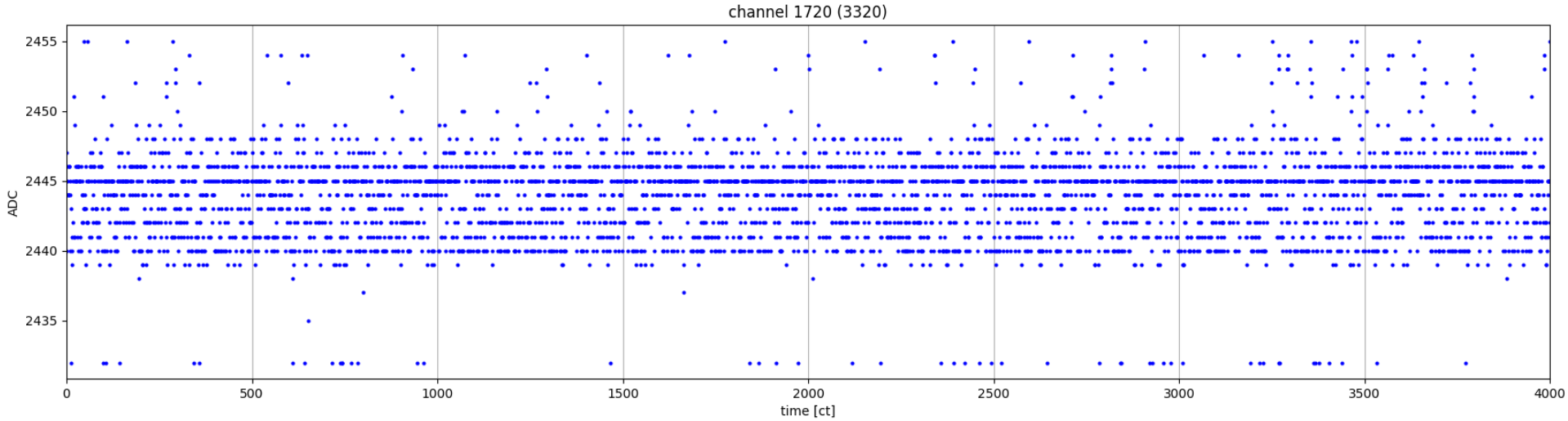

channel 1599 (3199)
ADC
time [ct]
2480
2500
2520
2540
0
500
1000
1500
2000
2500
3000
3500
4000

3199

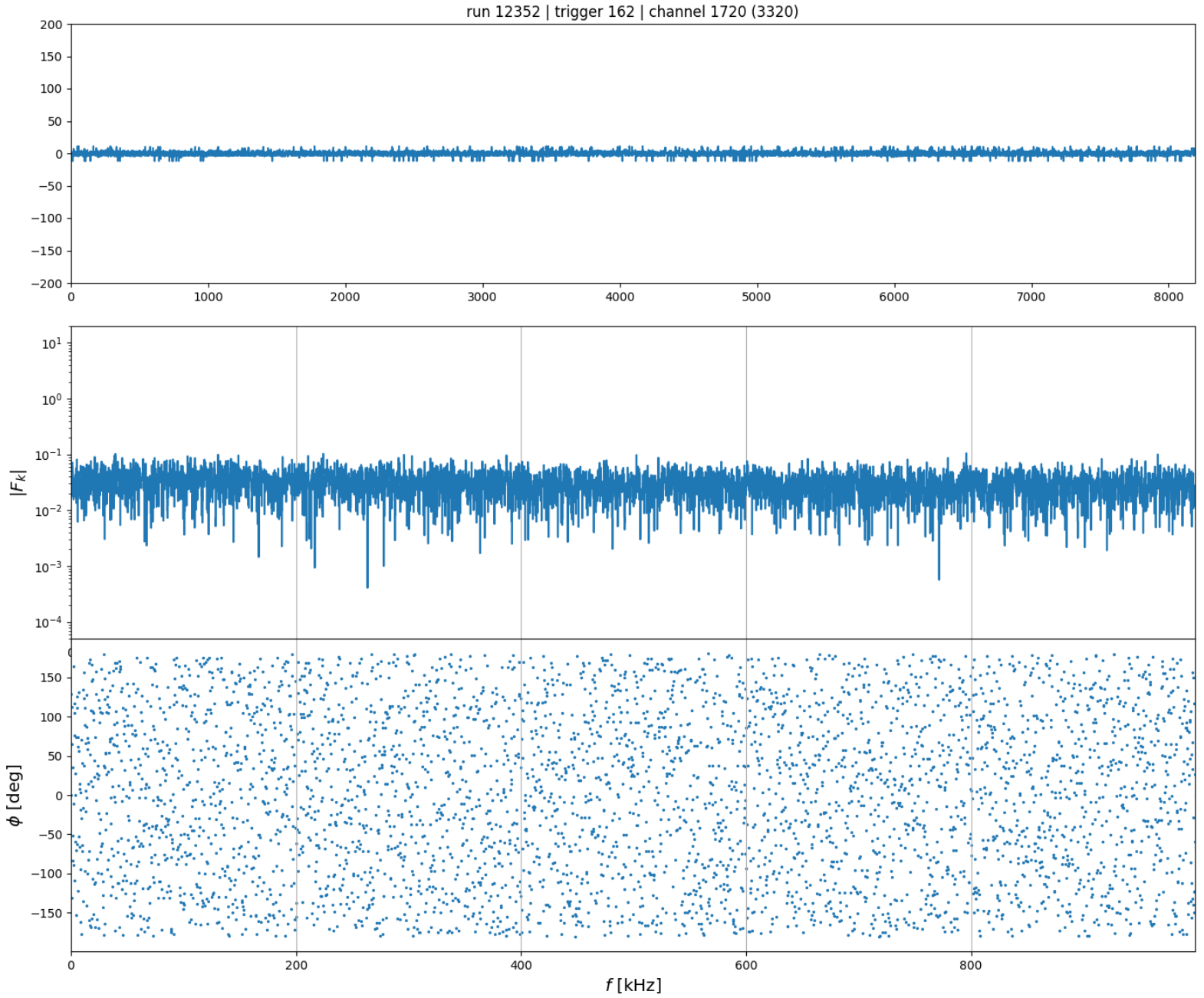


3320

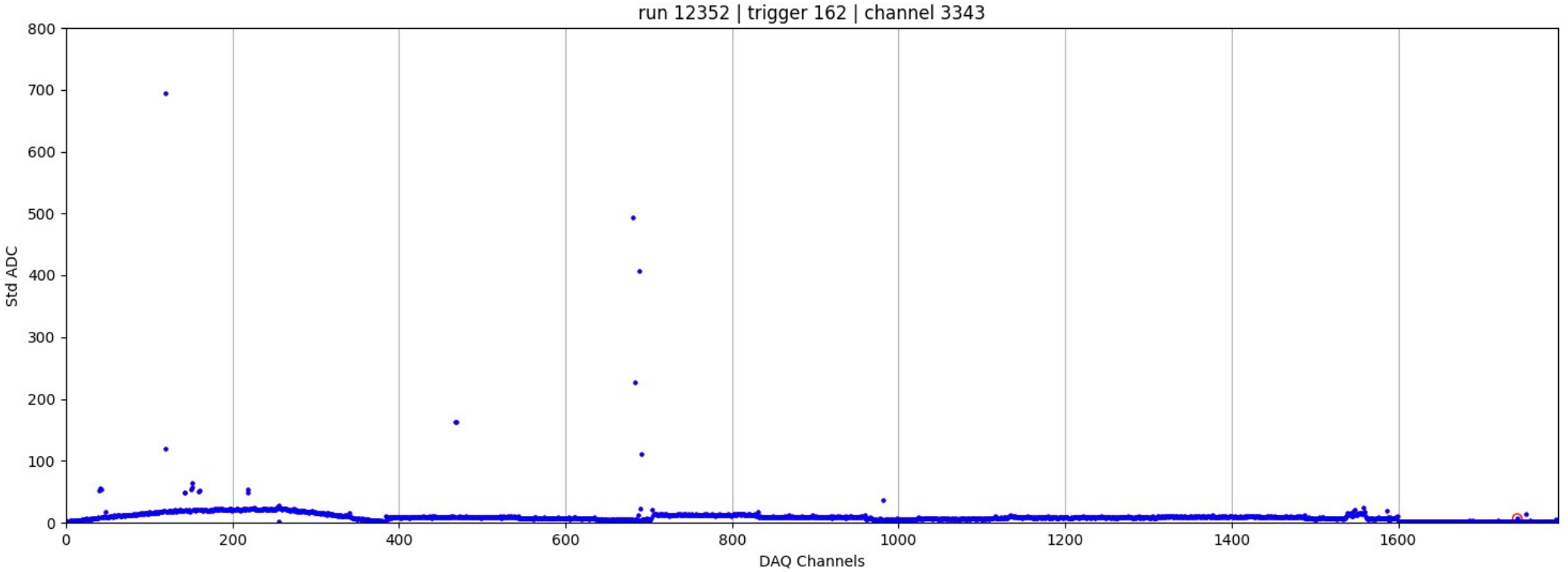

run 12352 | trigger 162 | channel 3320
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

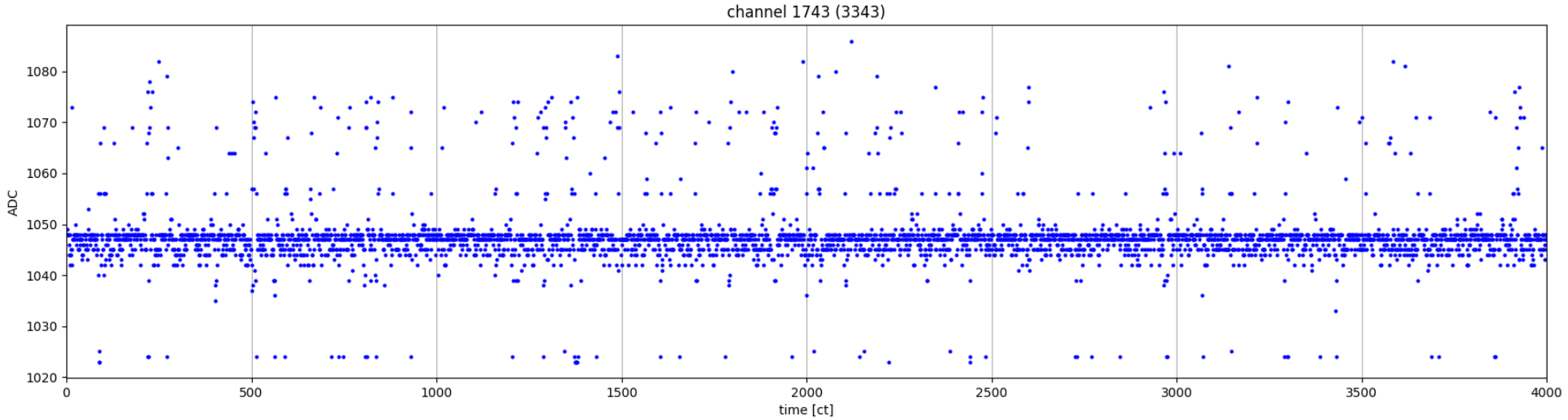

channel 1720 (3320)
ADC
time [ct]
2435
2440
2445
2450
2455
0
500
1000
1500
2000
2500
3000
3500
4000

3320

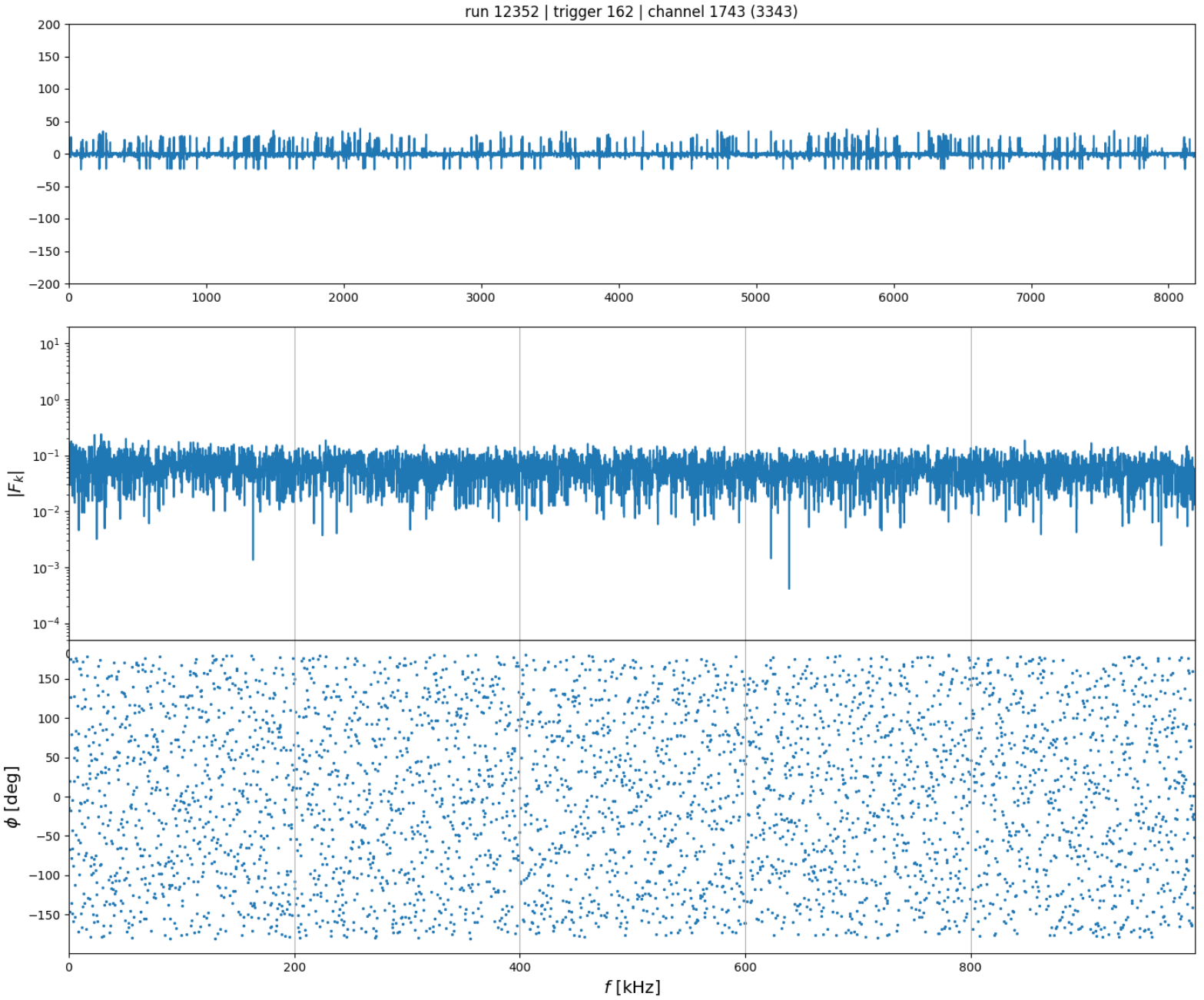


3343

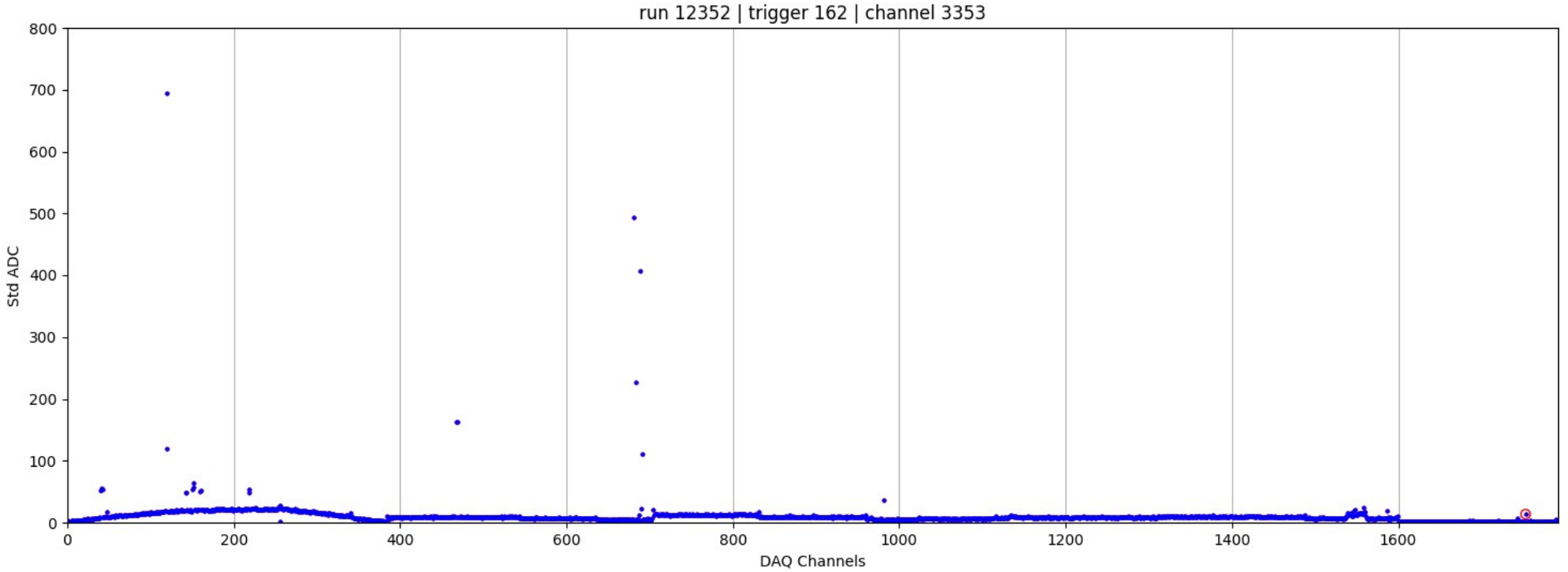

run 12352 | trigger 162 | channel 3343
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600

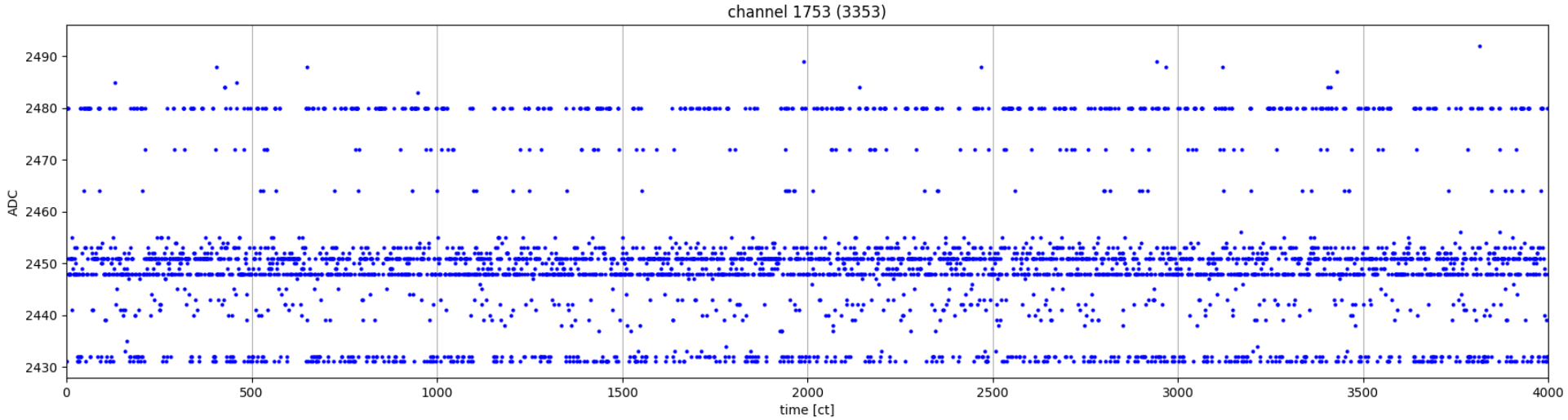

channel 1743 (3343)
ADC
time [ct]
1020
1030
1040
1050
1060
1070
1080
0
500
1000
1500
2000
2500
3000
3500
4000

3343

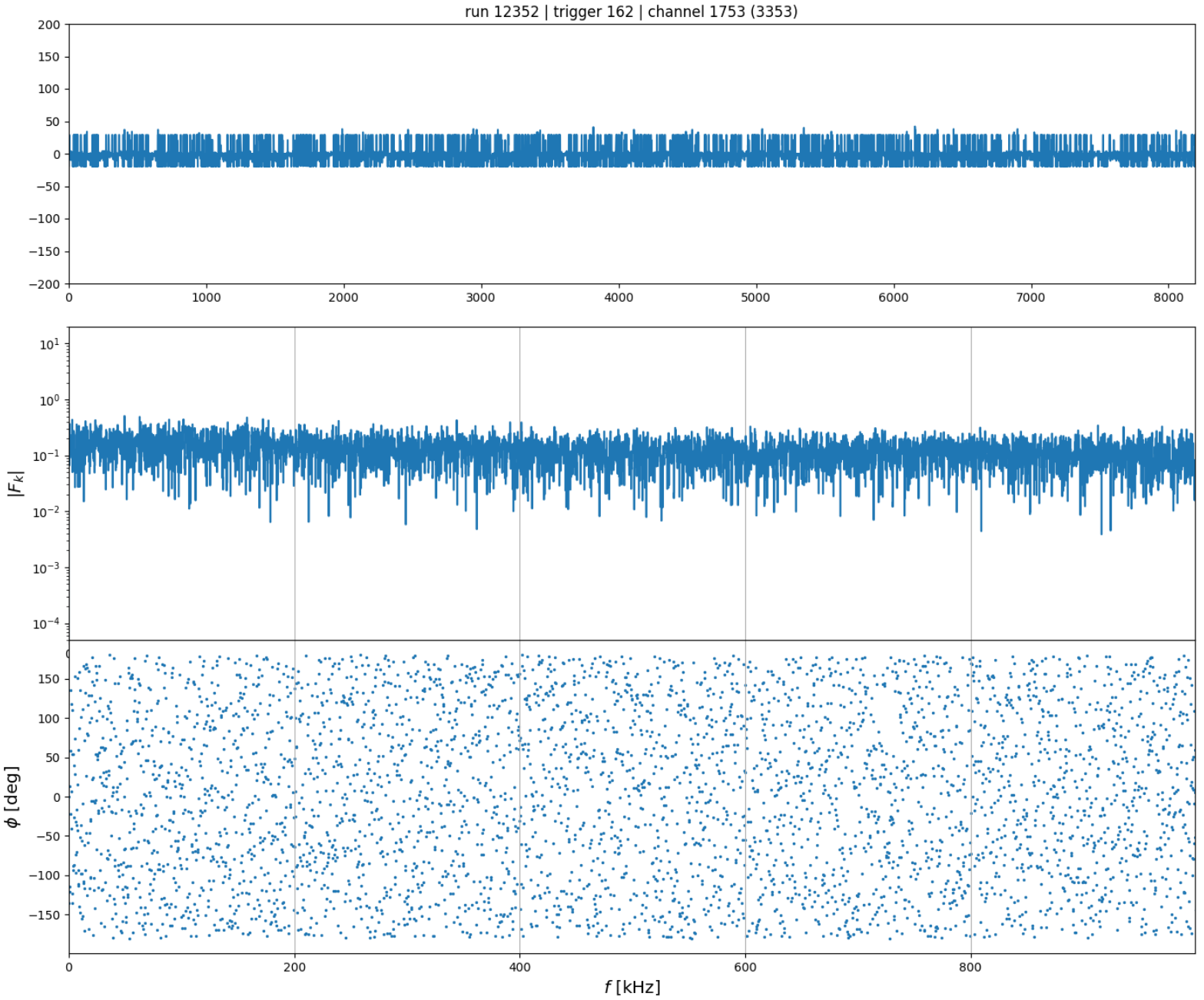


3353


run 12352 | trigger 162 | channel 3353
Std ADC
DAQ Channels
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600


channel 1753 (3353)
ADC
time [ct]
2430
2440
2450
2460
2470
2480
2490
0
500
1000
1500
2000
2500
3000
3500
4000

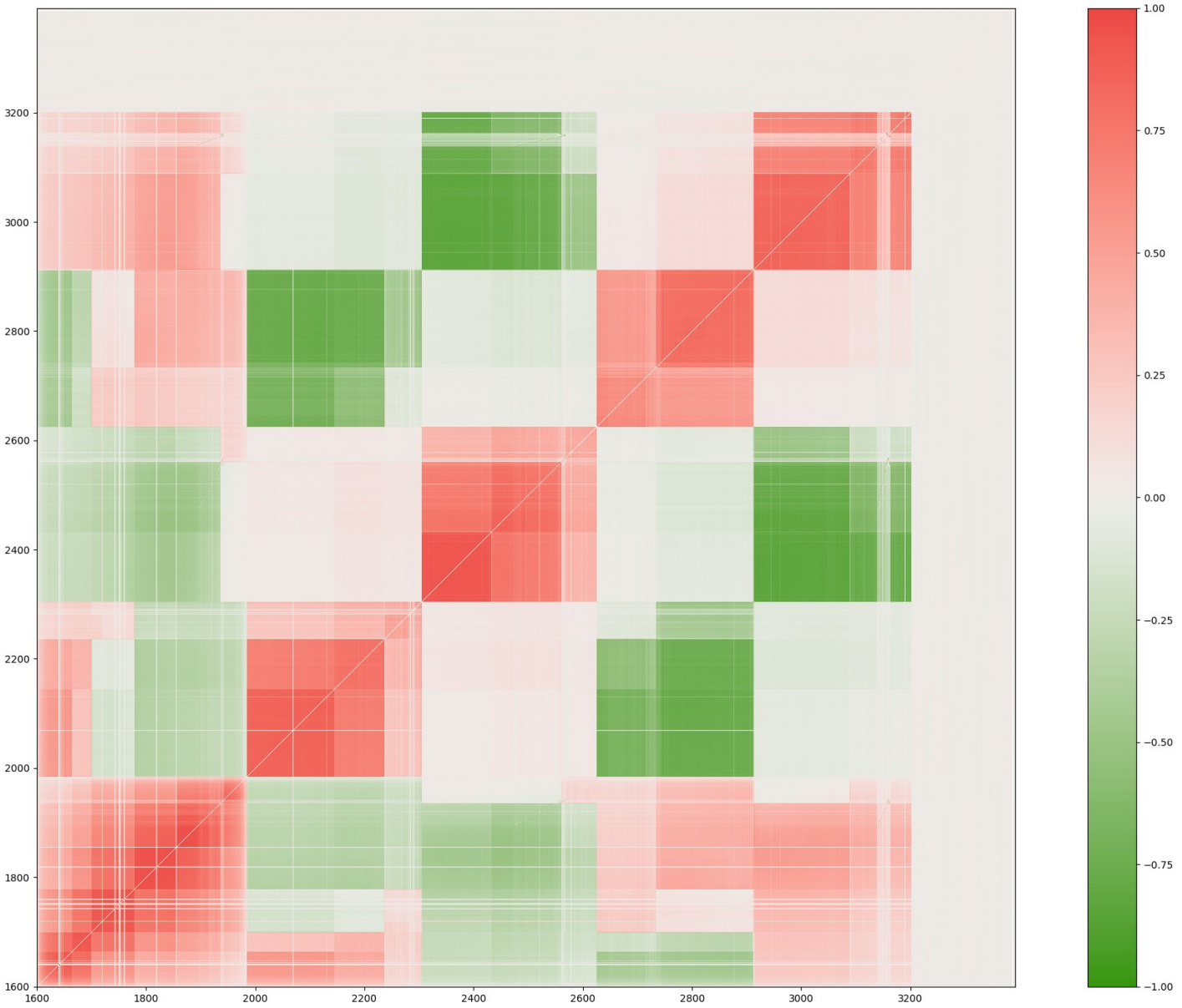
3353



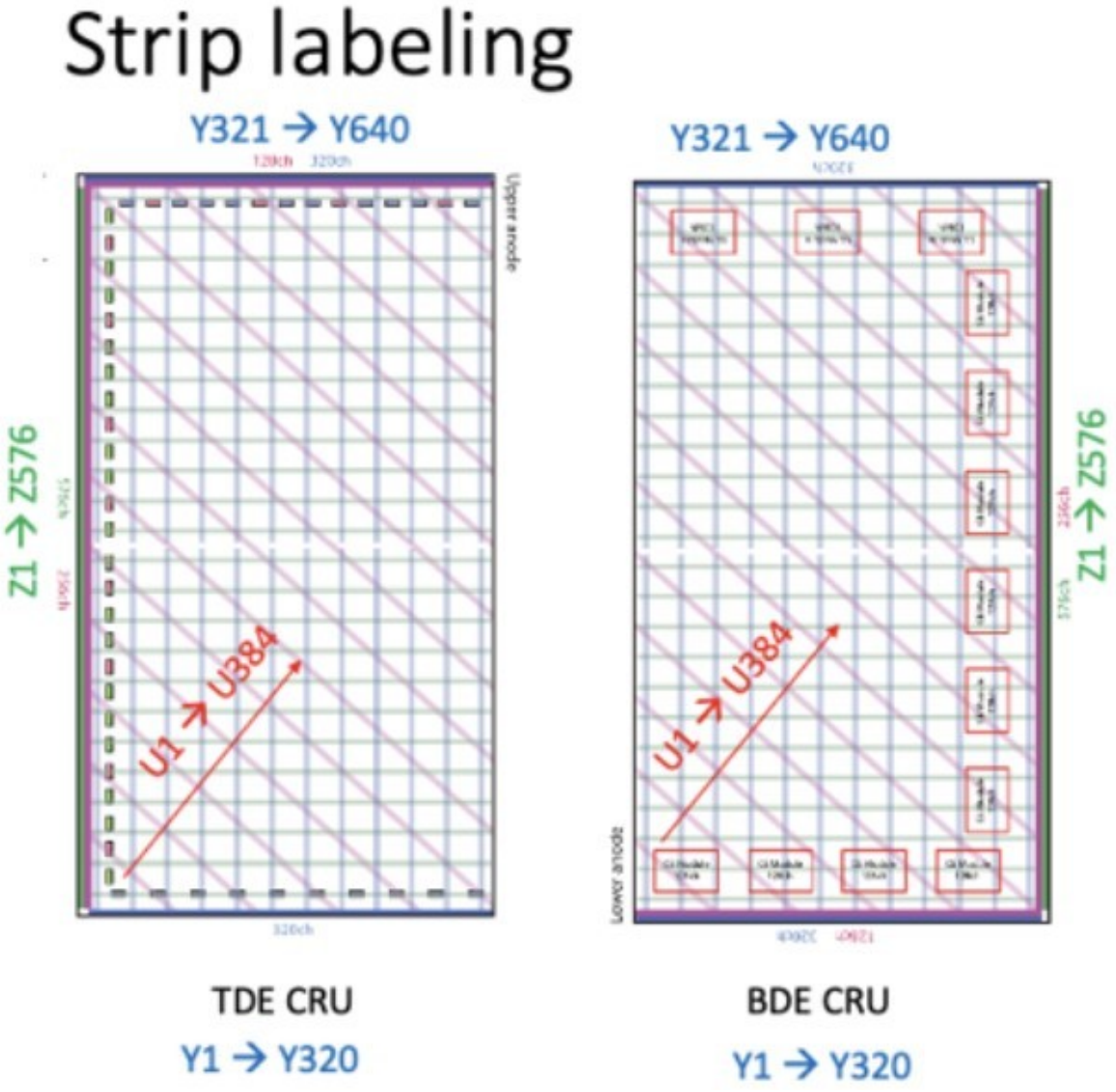
Conclusion

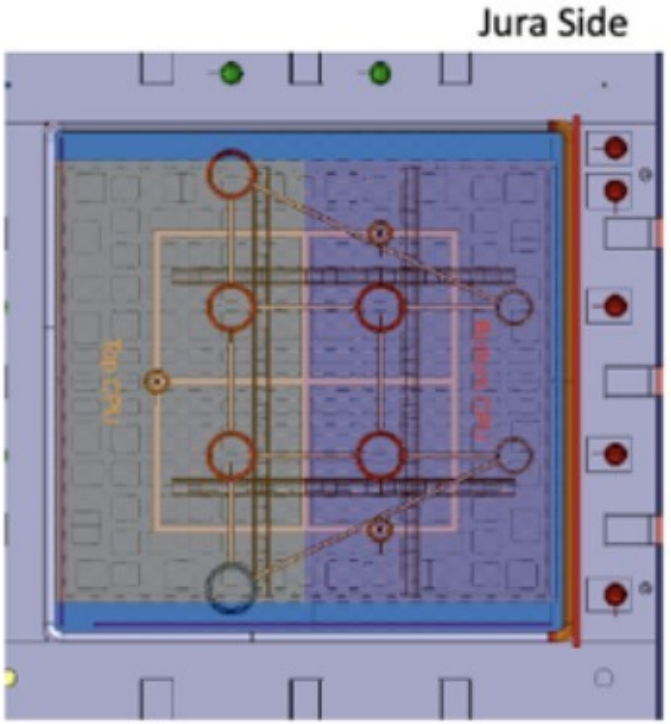
- The outliers are channels with
  - ADC problems (stuck bit?)
  - Disconnected channels
  - Shorted pairs of strips?
    TODO: check if strips are shorted in pairs U40/U41, Y85/Y86
-

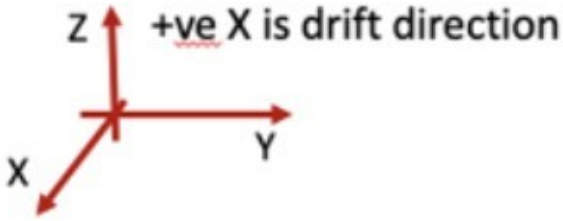
Pearson correlation between channels



Strip numbering (from Nitish)





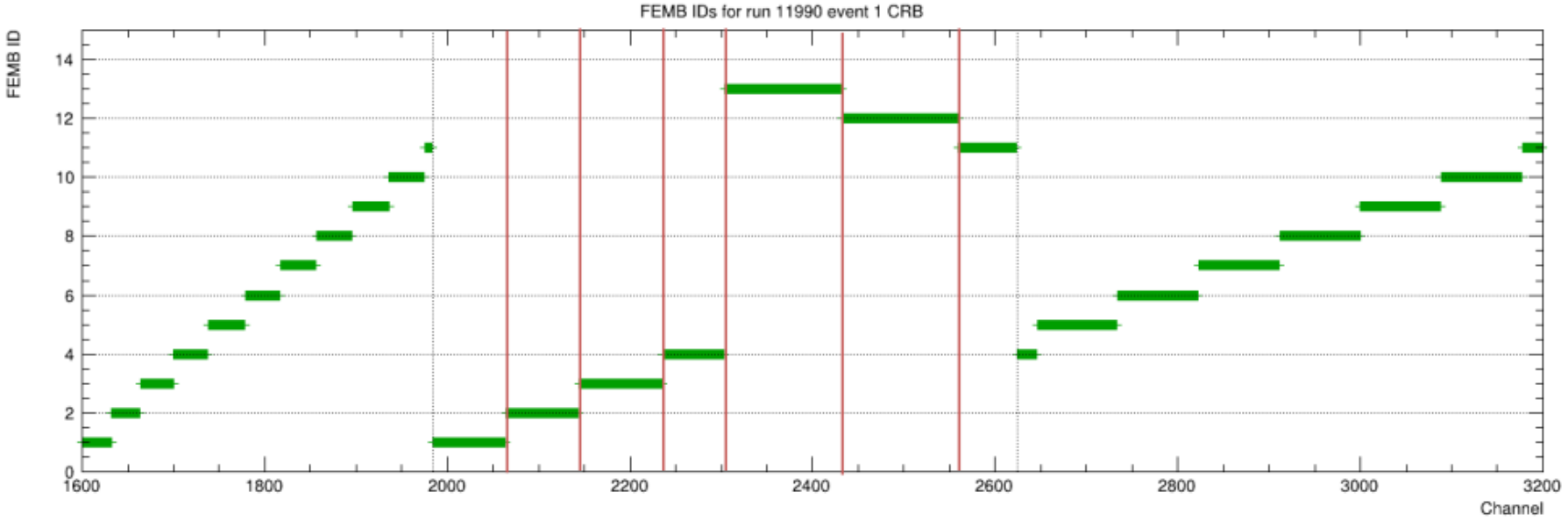


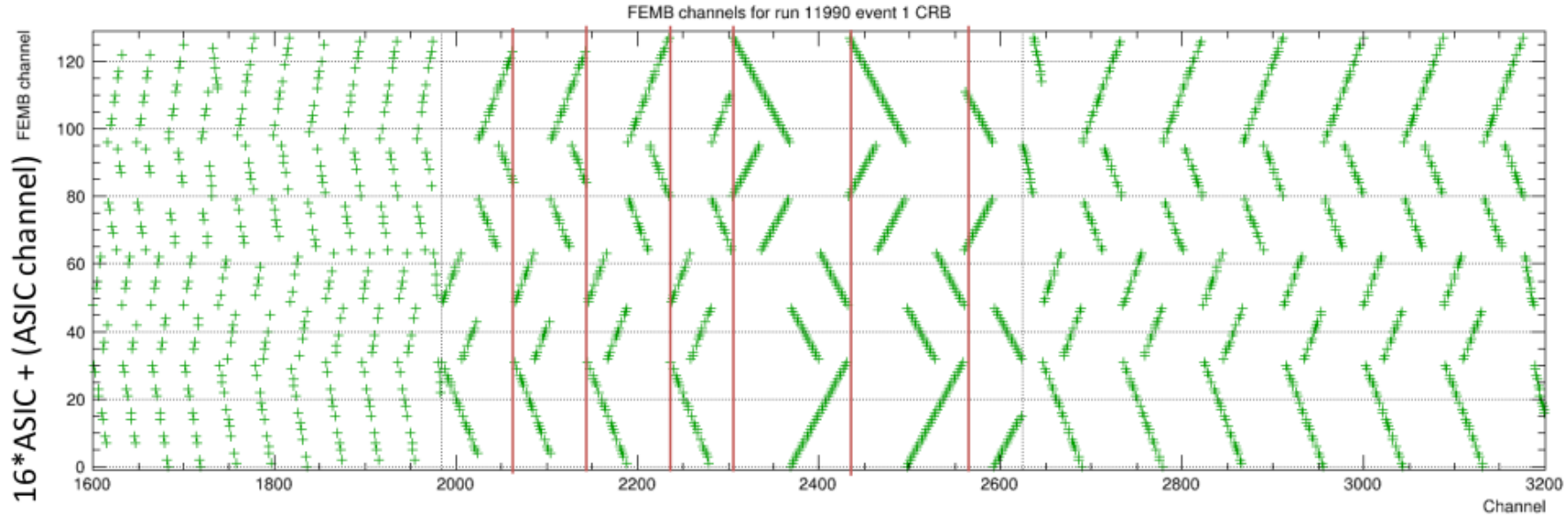
Strip layout (from Wenqiang)

Merge the active volume

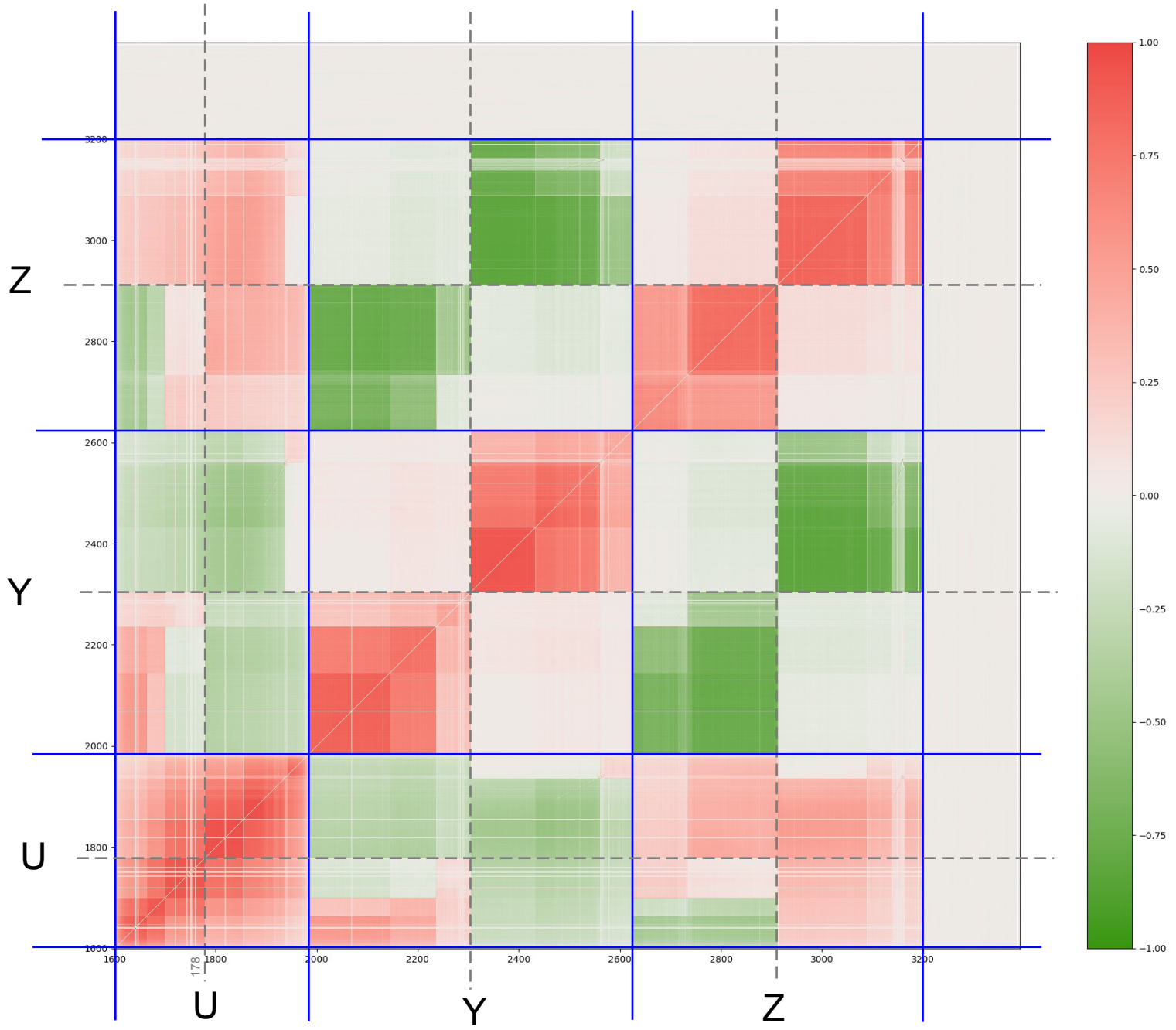
Use anode split 1 as an example,
similar for the split 2

FEMB ID and channel

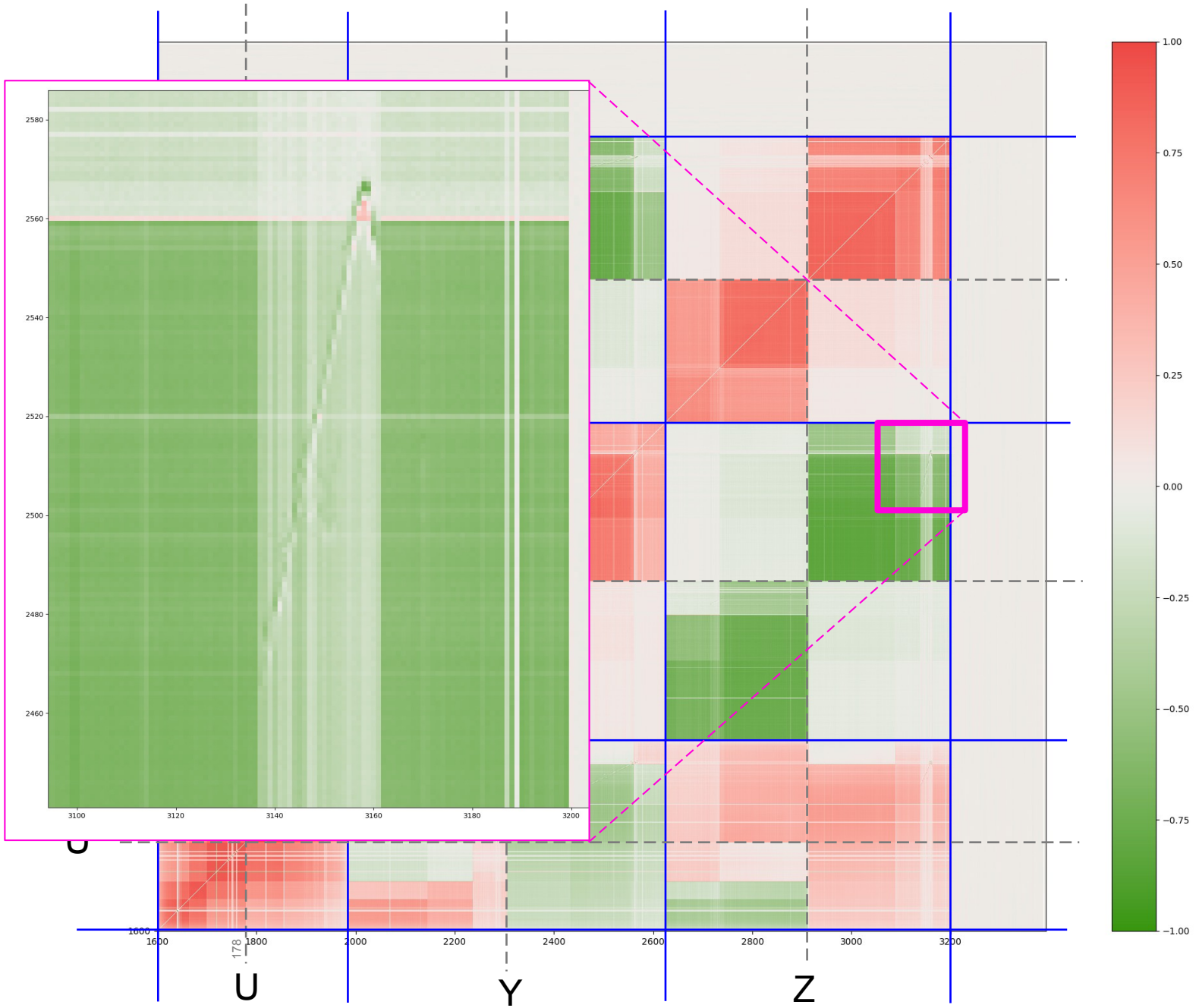




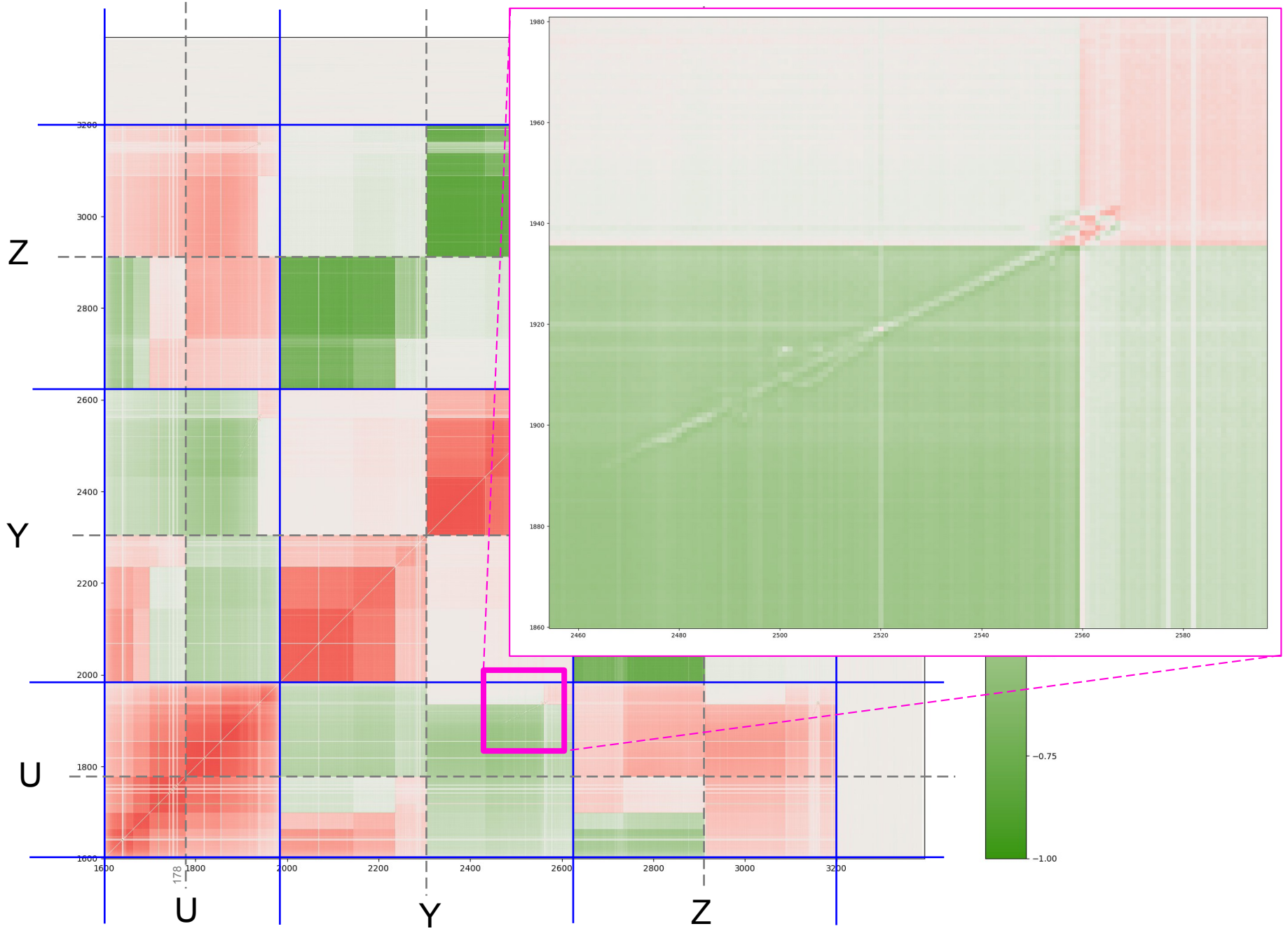
Pearson correlation between channels



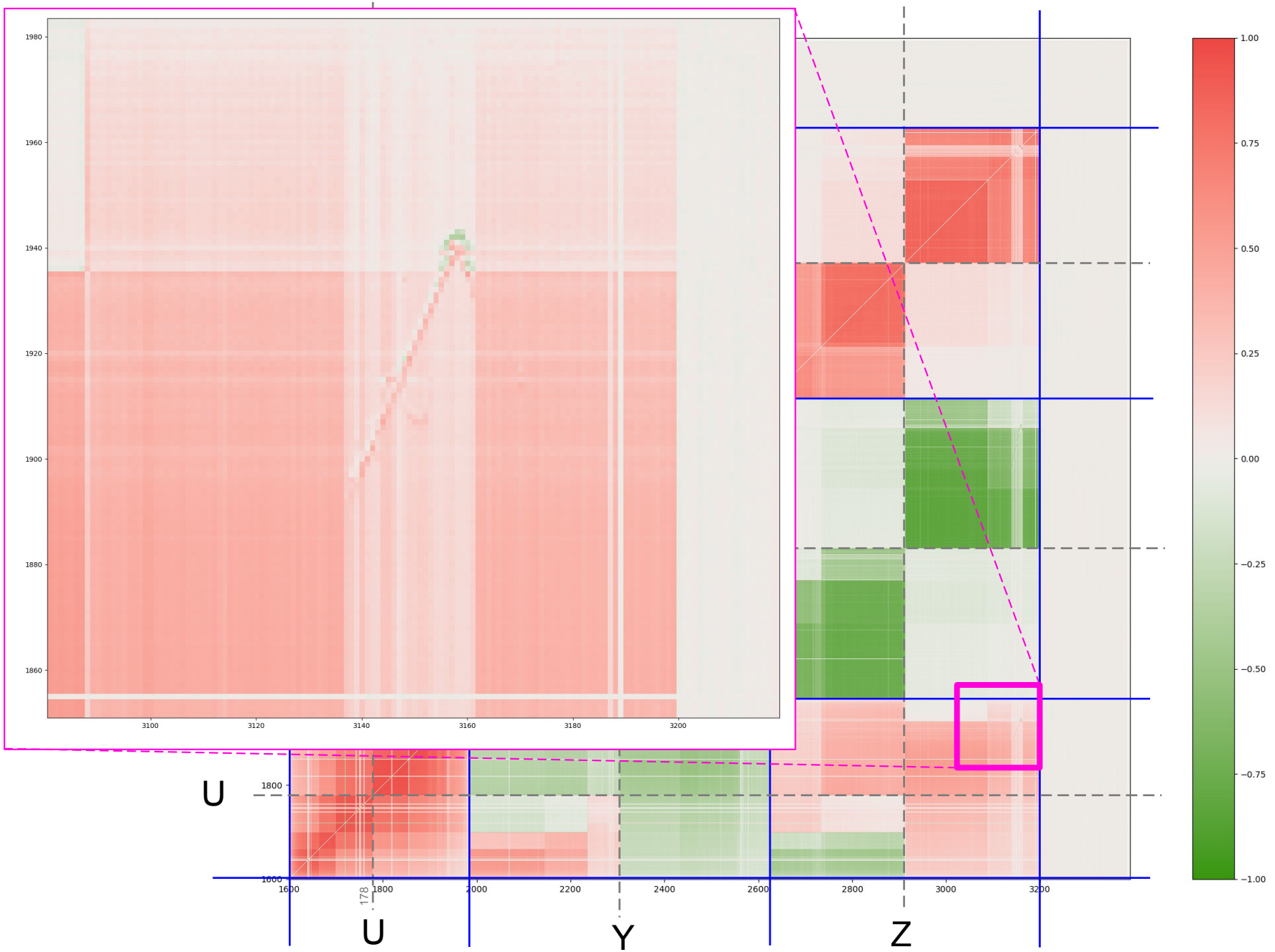
Track captured – YZ view



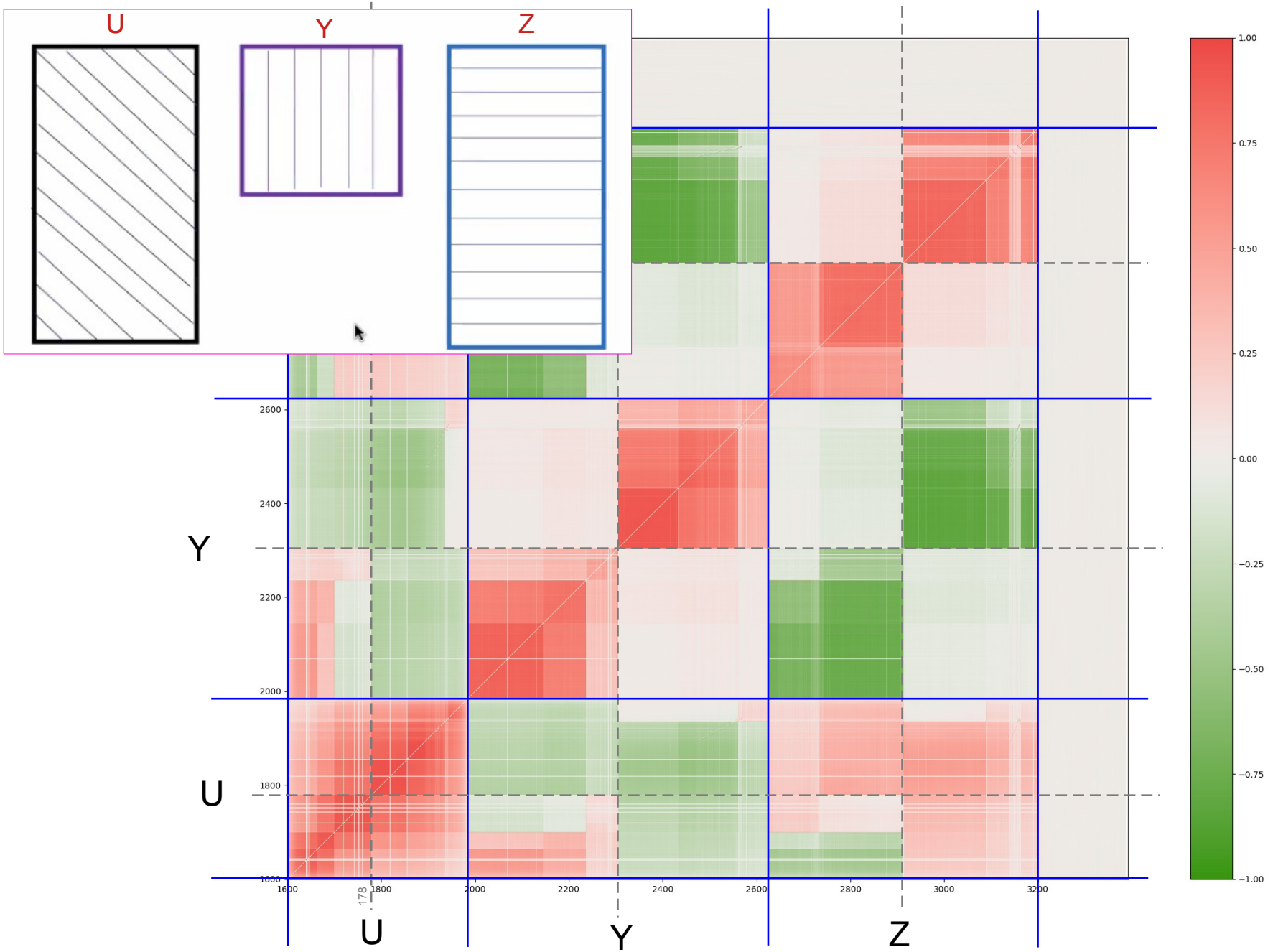
Track captured – UY view



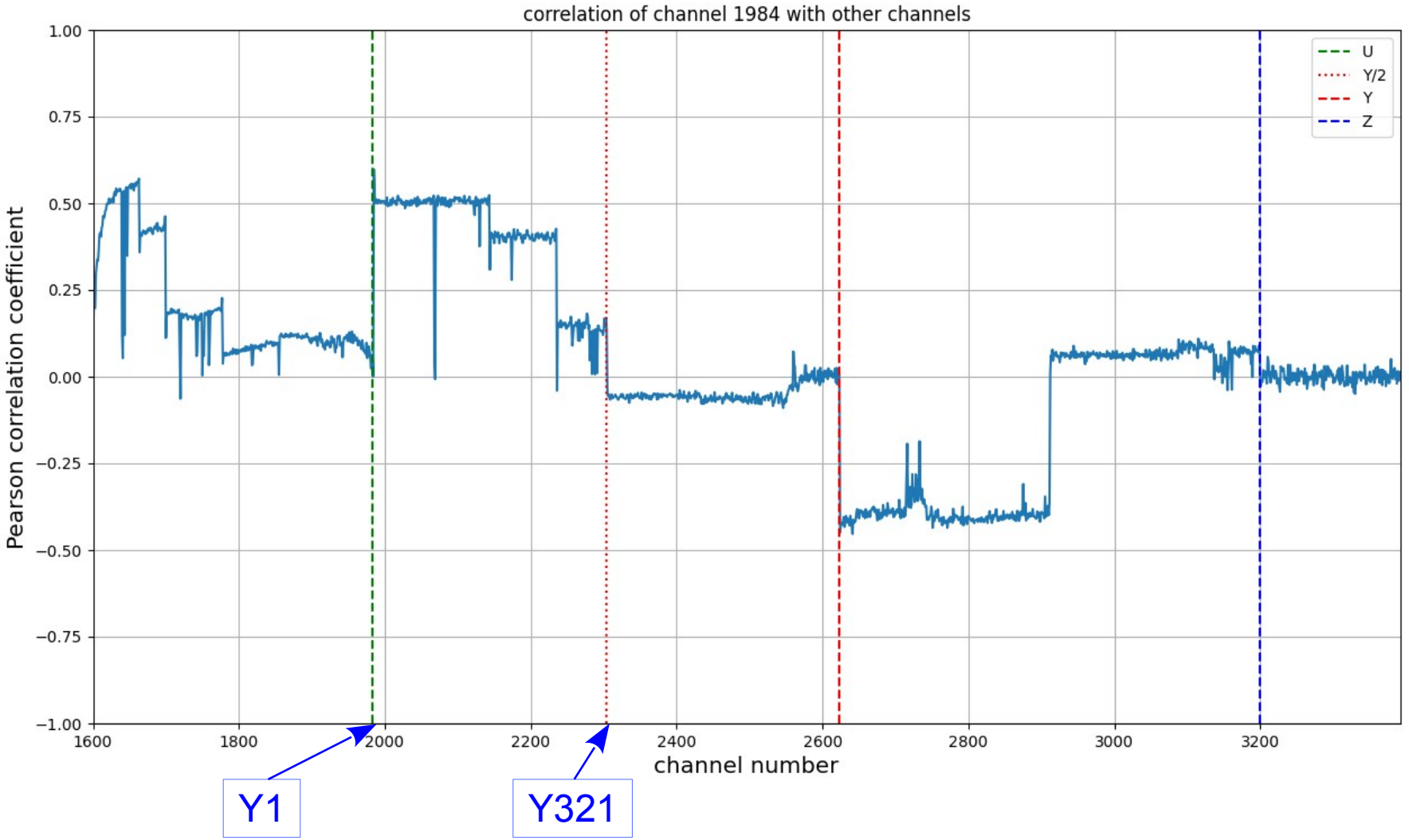
Track captured – UZ view



Pearson correlation between channels

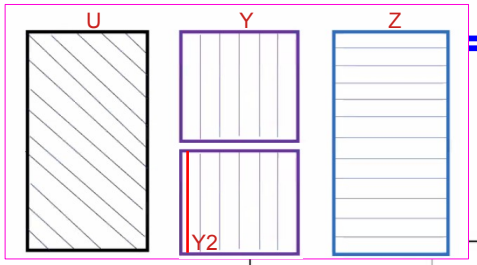


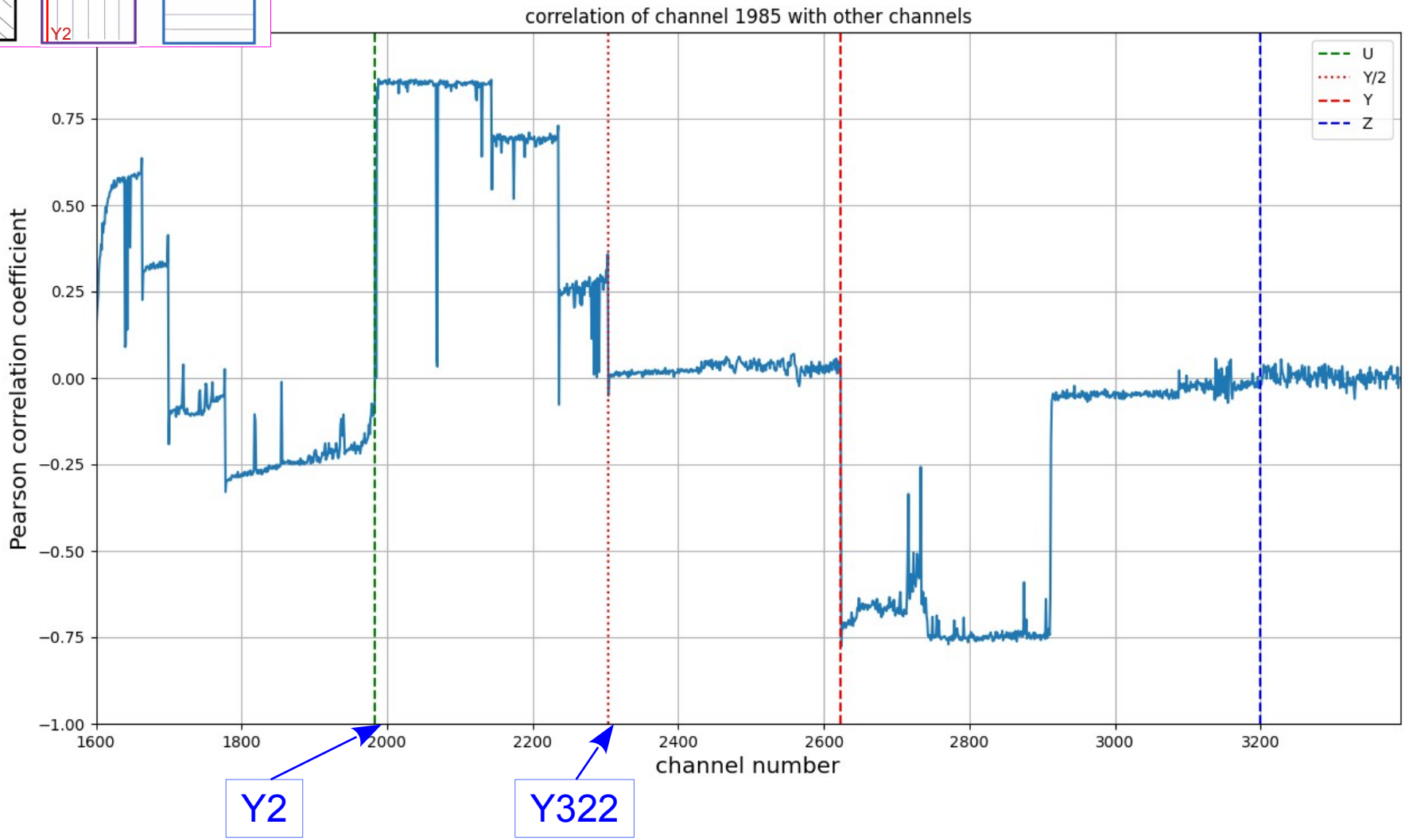
Y1



Low correlation with neighboring channels being read out at the opposite side of CRP

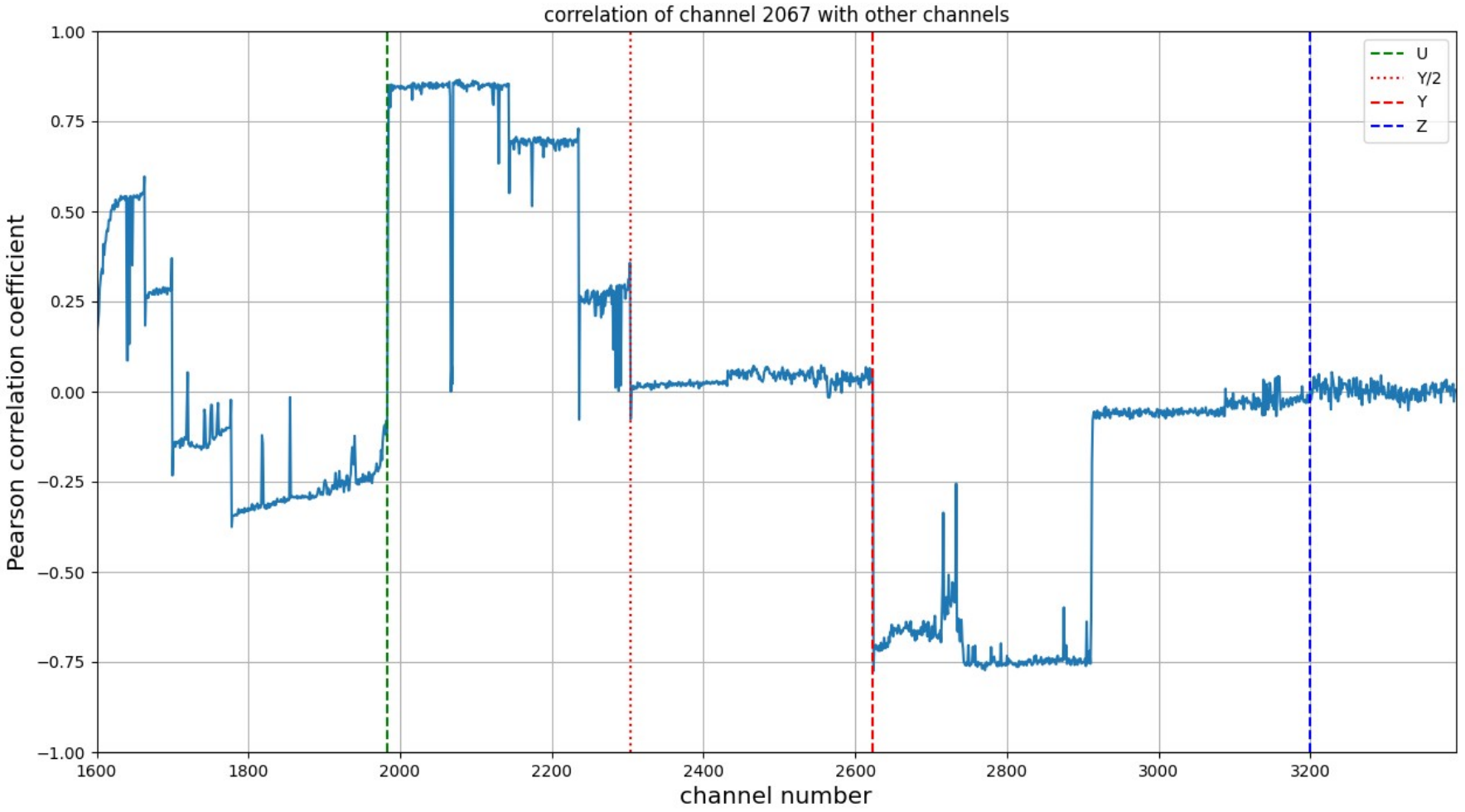
Y2



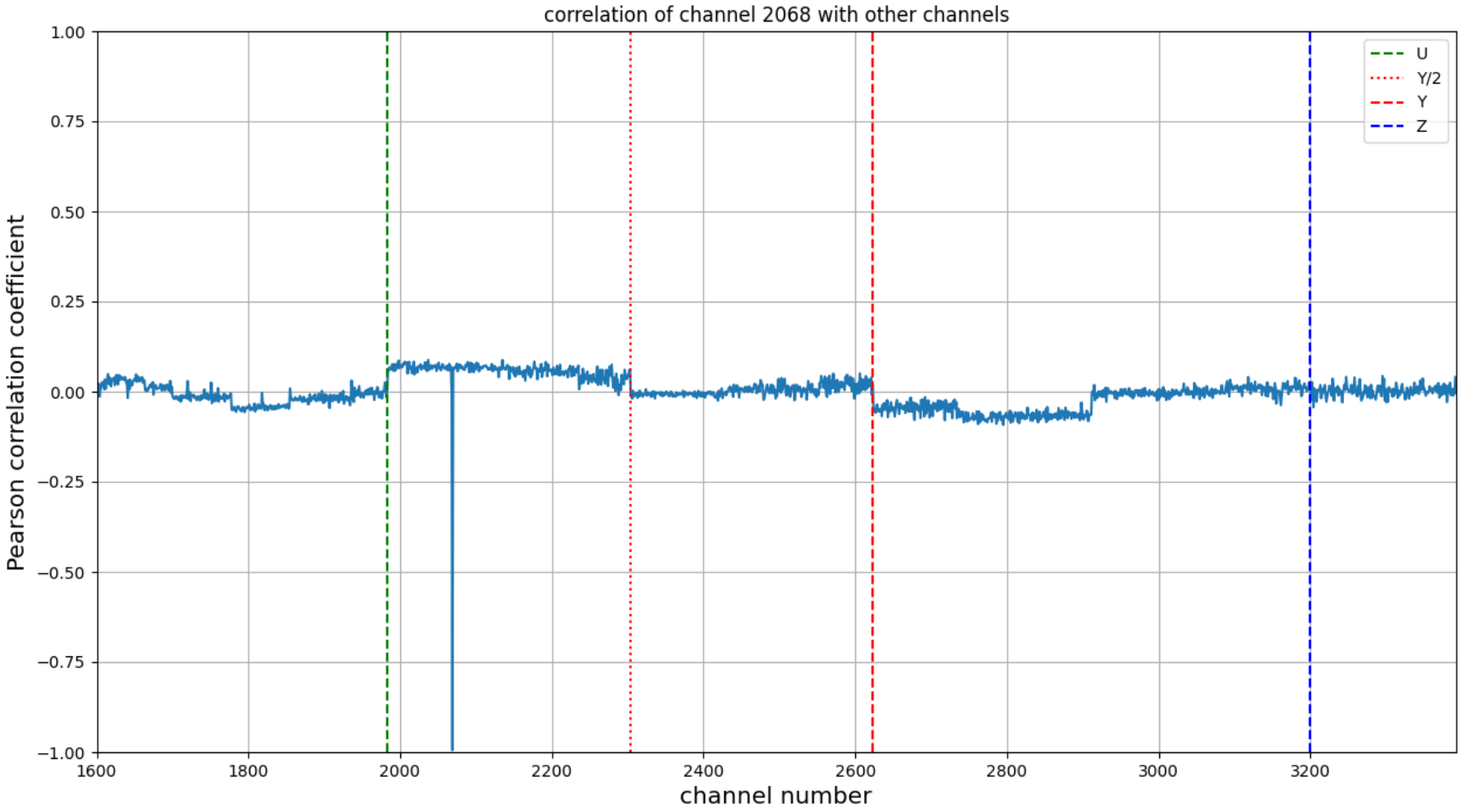


Low correlation with neighboring channels being read out at the opposite side of CRP

Y84

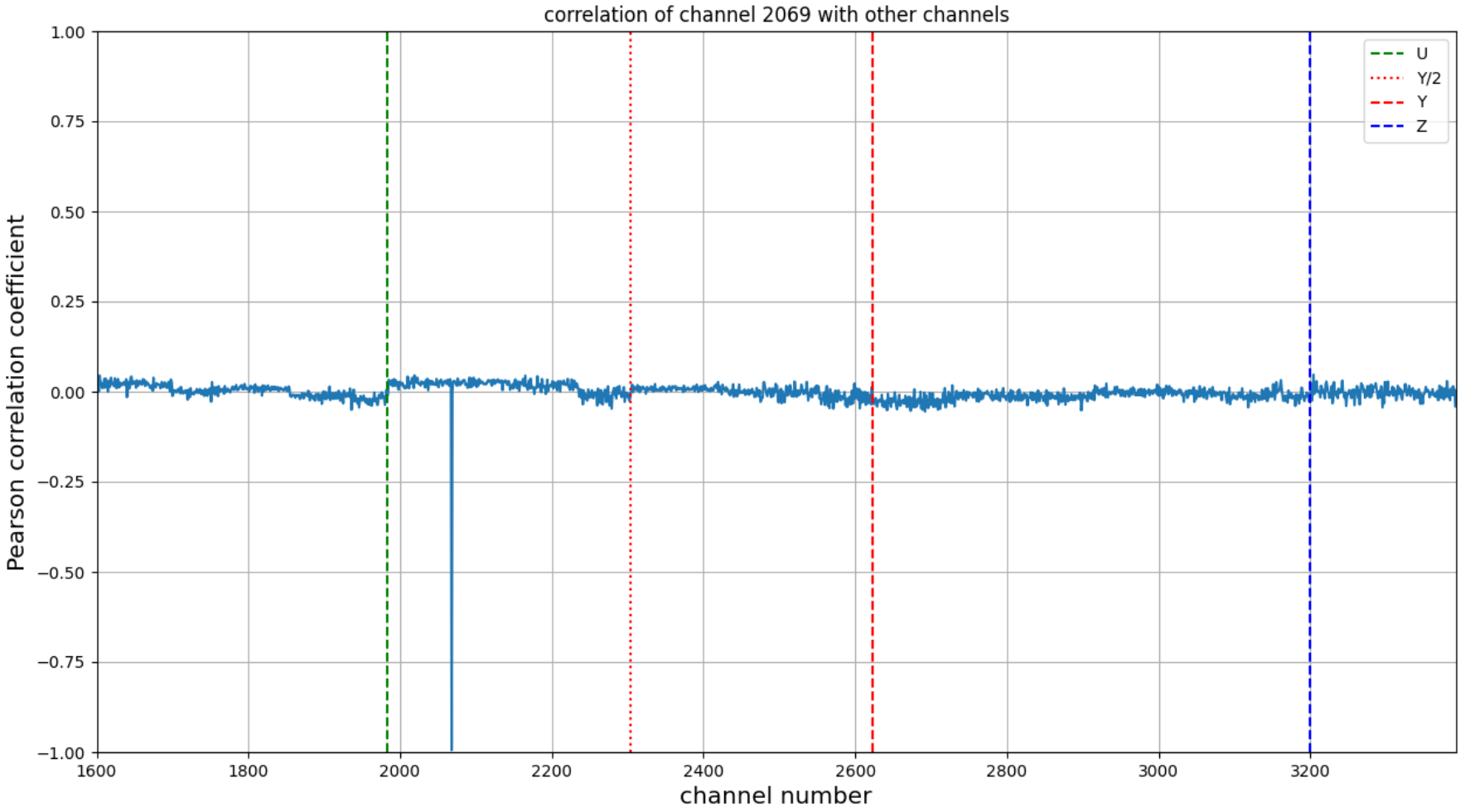

correlation of channel 2067 with other channels
Pearson correlation coefficient
channel number
U
Y/2
Y
Z
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
1600
1800
2000
2200
2400
2600
2800
3000
3200

Y85



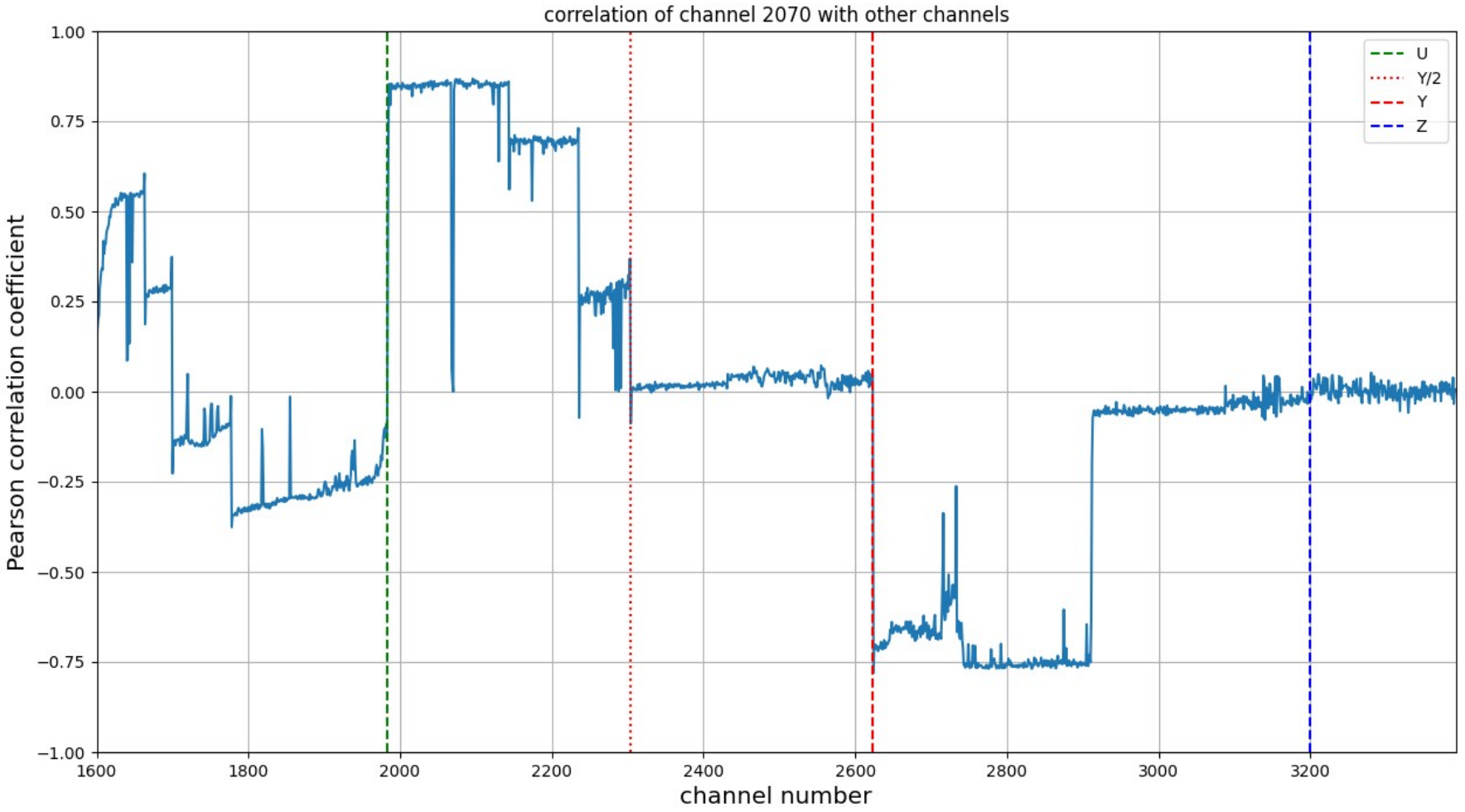
Almost 100% correlation with Y86. Low correlation with other channels

Y86

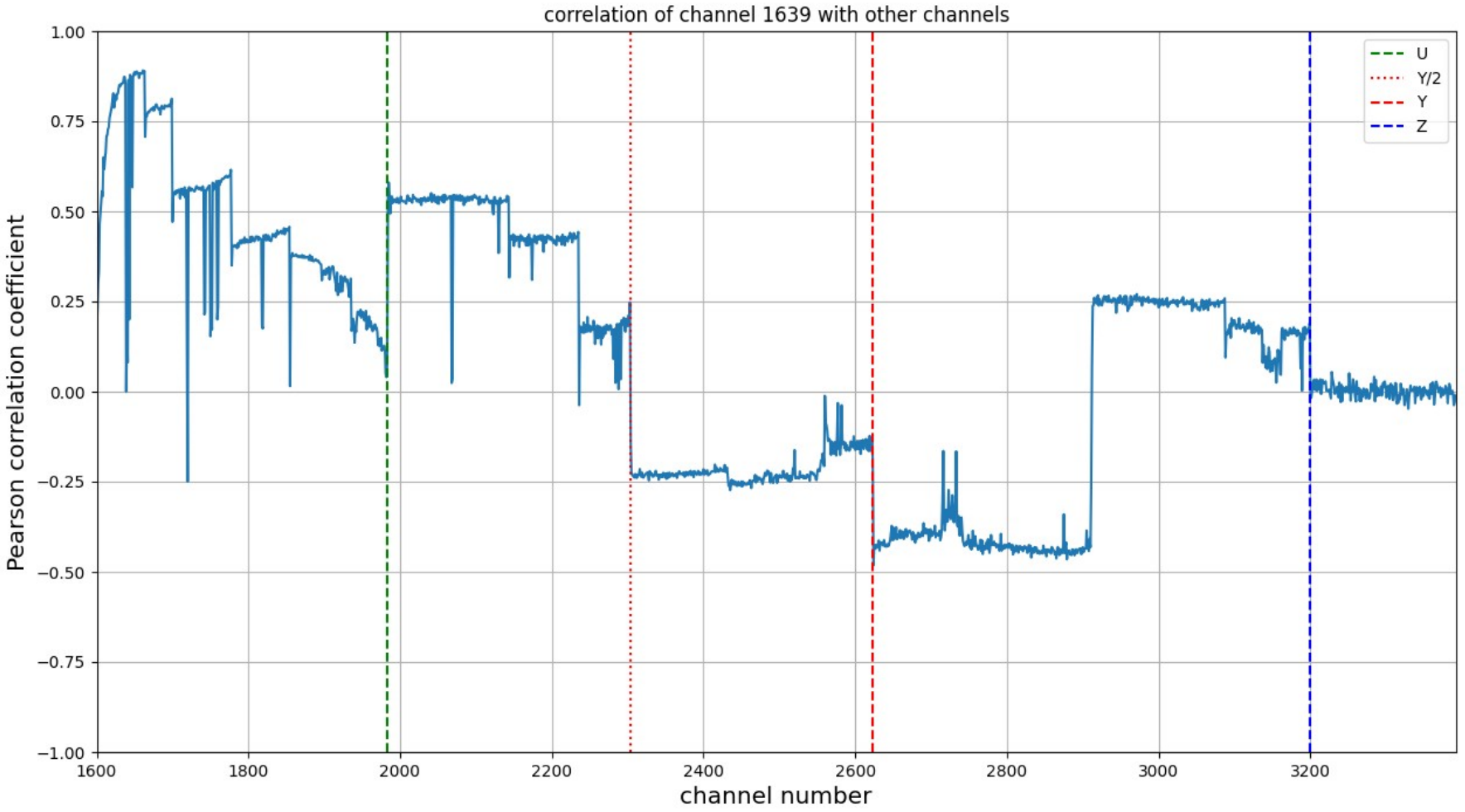


Almost 100% correlation with Y85. Low correlation with other channels

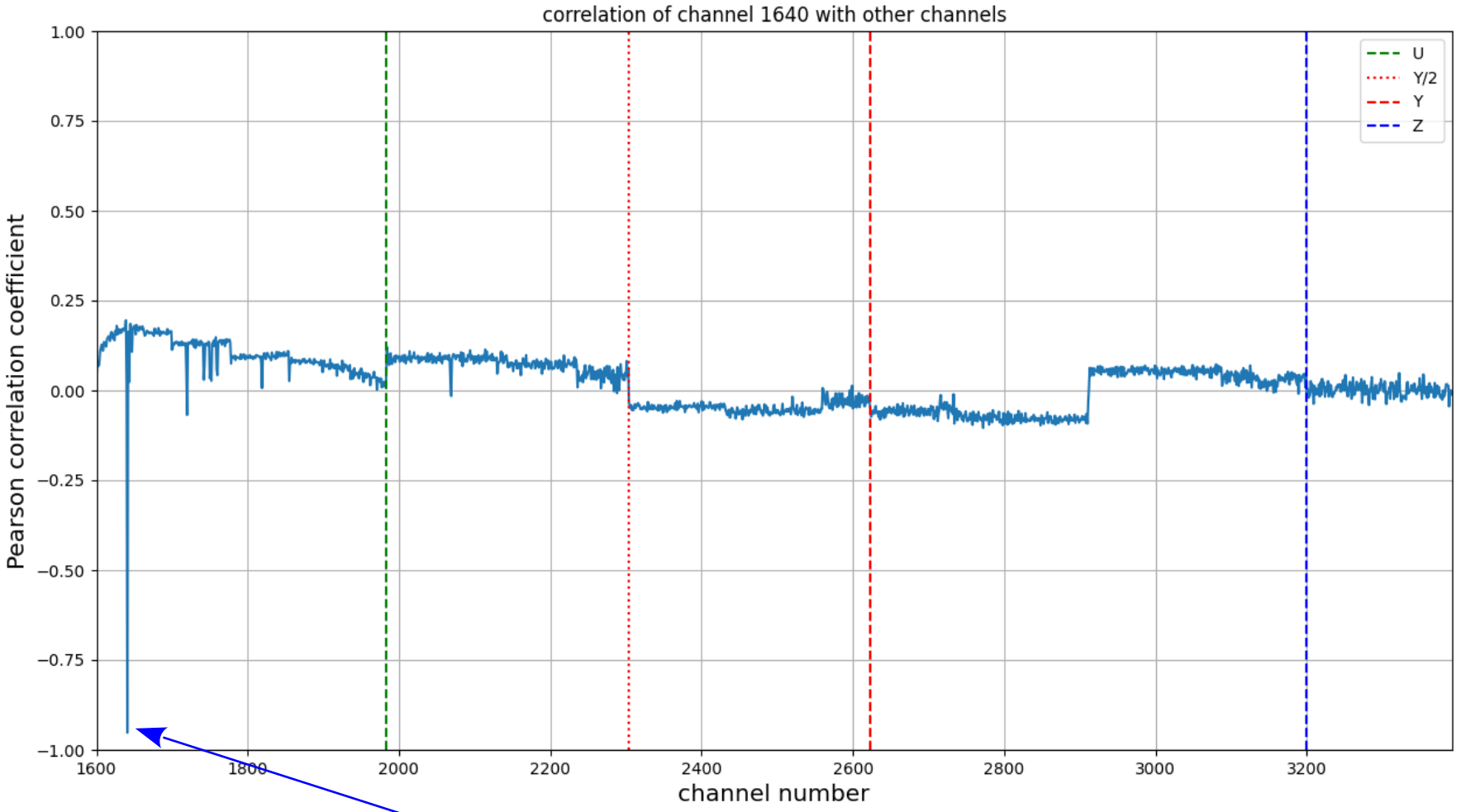
Y87


correlation of channel 2070 with other channels
Pearson correlation coefficient
channel number
U
Y/2
Y
Z
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
1600
1800
2000
2200
2400
2600
2800
3000
3200

U40

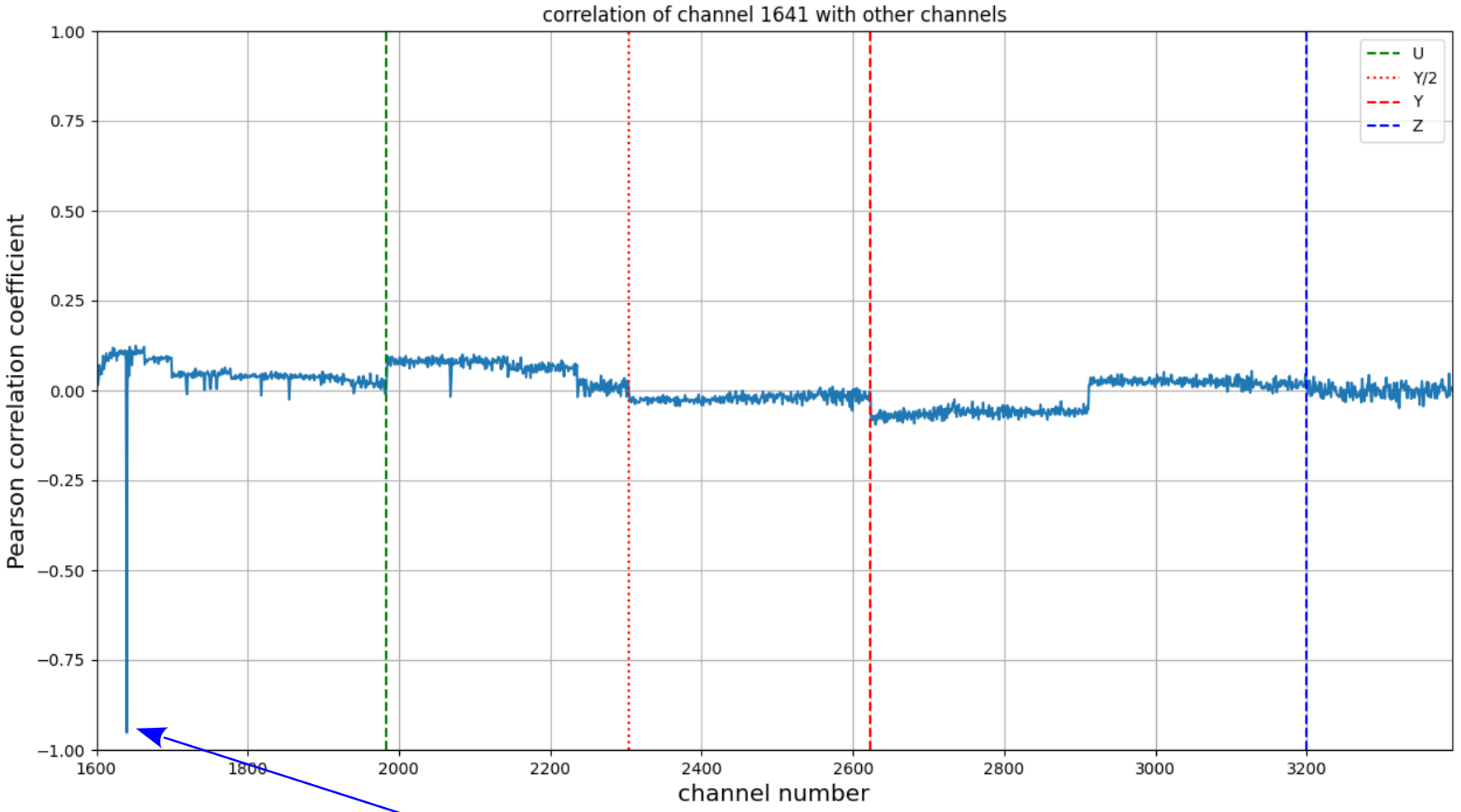

correlation of channel 1639 with other channels
Pearson correlation coefficient
channel number
U
Y/2
Y
Z
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
1600
1800
2000
2200
2400
2600
2800
3000
3200

U41



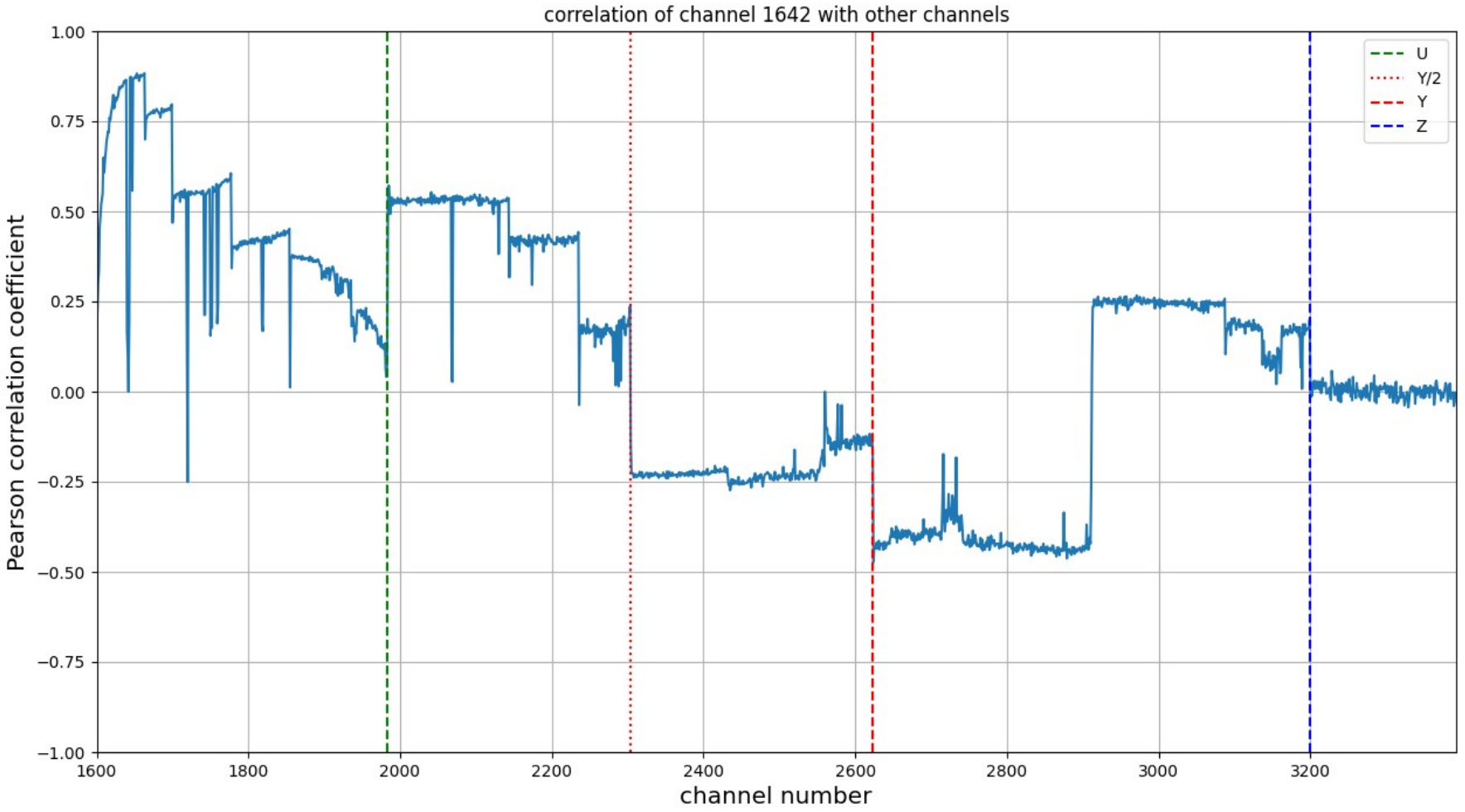
Almost 100% correlation with U42. Low correlation with other channels

U42



Almost 100% correlation with U41. Low correlation with other channels

U43


correlation of channel 1642 with other channels
Pearson correlation coefficient
channel number
U
Y/2
Y
Z
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
1600
1800
2000
2200
2400
2600
2800
3000
3200

Conclusion

- Channels Y1 and Y321 are neighbors, but the correlation is small (and negative). There is a small common mode (current flows in the same direction, but the strips are read out from opposite ends of CRP, hens negative correlation coefficient).
- Channels Y1 and Y2 are neighbors, the correlation is significant and positive (the strips are read out from the same CRP side and using same FEMB).
- Thus, the major "noise" pickup mechanism is not through strips (or we should see Y1 and Y321 strongly correlated).
- First half of Y strips is (FEMBs 1-4) strongly correlates with 1st half of Z strips (FEMBs 4-7). All FEMBs are installed on the same CRP quadrant.
  Second half of Y strips is (FEMBs 11-13) strongly correlats with 2nd half of Z strips (FEMBs 8-11). All FEMBs are installed on the same CRP quadrant.
- Strips Y85 and Y86 are special – they are strongly ant-correlated (current flows between the channels). Are these shorted strips?
-