# RDRS Thrust Area Update

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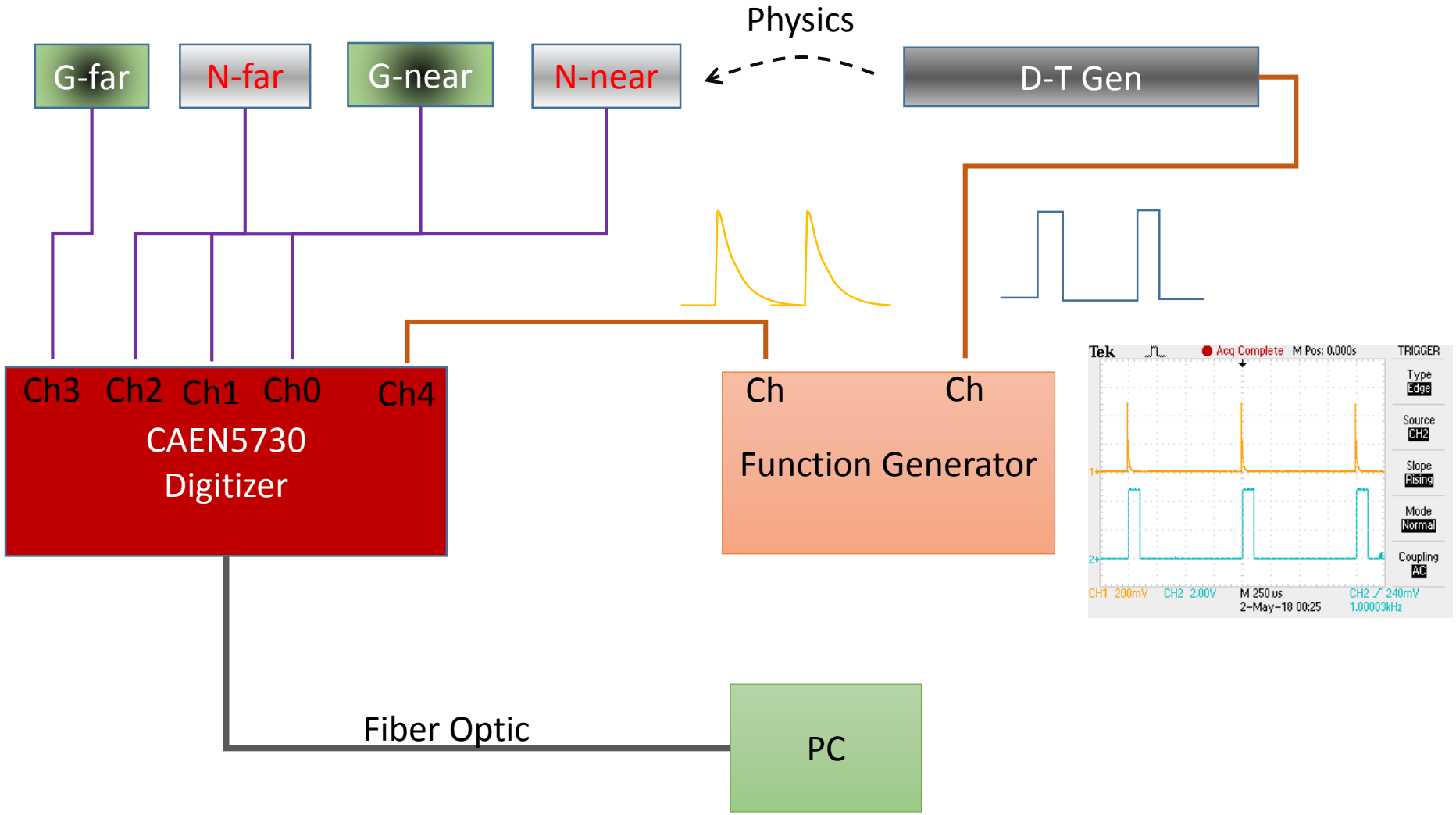
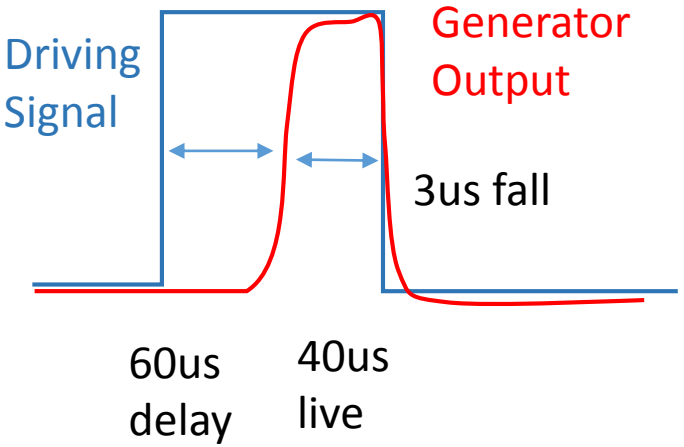
# Data Collection Scheme



# DT Generator Output

- The DT generator beam current has been unlocked with help from Fabian
  - DT generator can now be operated from 20-60 µA beam current,
  - Voltage range is 40-80 kV
- The best combination of current and voltage is 40µA :40kV
  - Lowest dead time and noise with stable neutron output
- Generator noise is now entirely removed from spectrum using decimation settings

We only assume the time response of the neutron output follows:



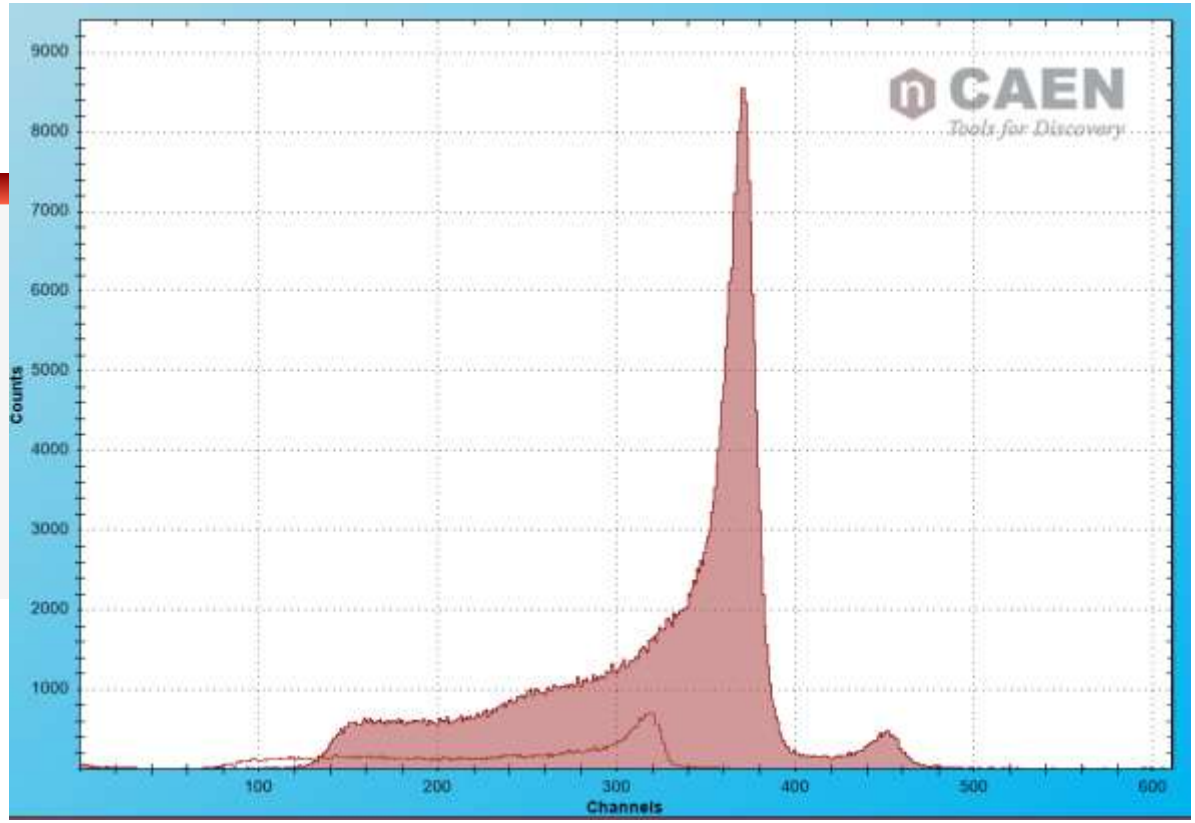
# DT Generator Output

- Neutron detectors have significantly reduced dead time thanks to reduction of output

Properties

Spectrum Board Info

| | |
|---|---|
| Board Model: | DT5730B |
| Serial Number: | 1492 |
| Channel: | 0 |
| ADC Channels: | 1024 |
| Real Time: | 134.929 s |
| Live Time: | 133.614 s |
| Dead Time: | 0.974 % |
| Spect. Counts: | 141692 |
| Total Counts: | 71174 |
| ICR: | 5.275E+002 Cnt/s |
| OCR: | 1.050E+003 Cnt/s |
| Histogram: | BF3_Near |



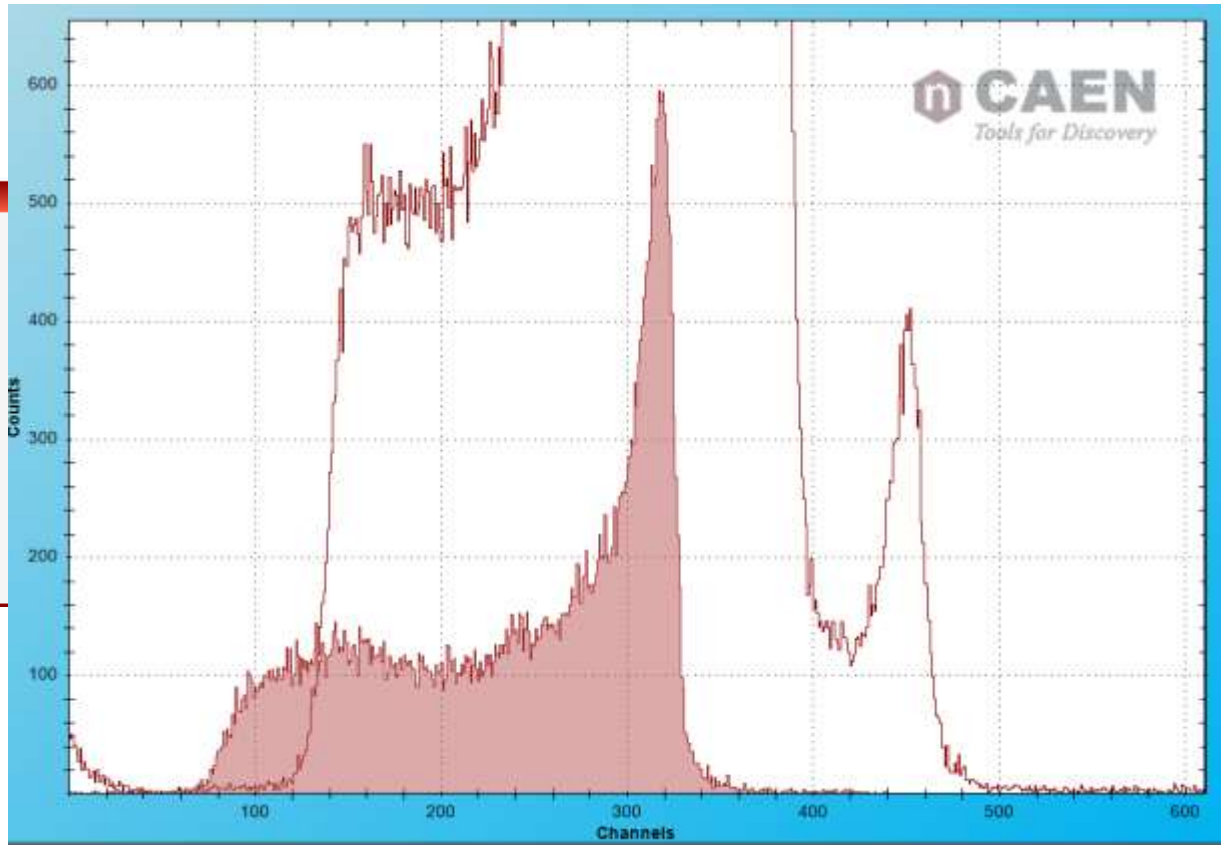
# DT Generator Output

- Neutron detectors have significantly reduced dead time thanks to reduction of output

Properties

Spectrum Board Info

| | |
|---|---|
| Board Model: | DT5730B |
| Serial Number: | 1492 |
| Channel: | 2 |
| ADC Channels: | 1024 |
| Real Time: | 108.931 s |
| Live Time: | 108.495 s |
| Dead Time: | 0.400 % |
| Spect. Counts: | 12878 |
| Total Counts: | 3232 |
| ICR: | 2.967E+001 Cnt/s |
| OCR: | 1.182E+002 Cnt/s |
| Histogram: | 3He_Far |



# DT Generator Output

- NaI detectors also behaving well, similarly low dead time

Properties

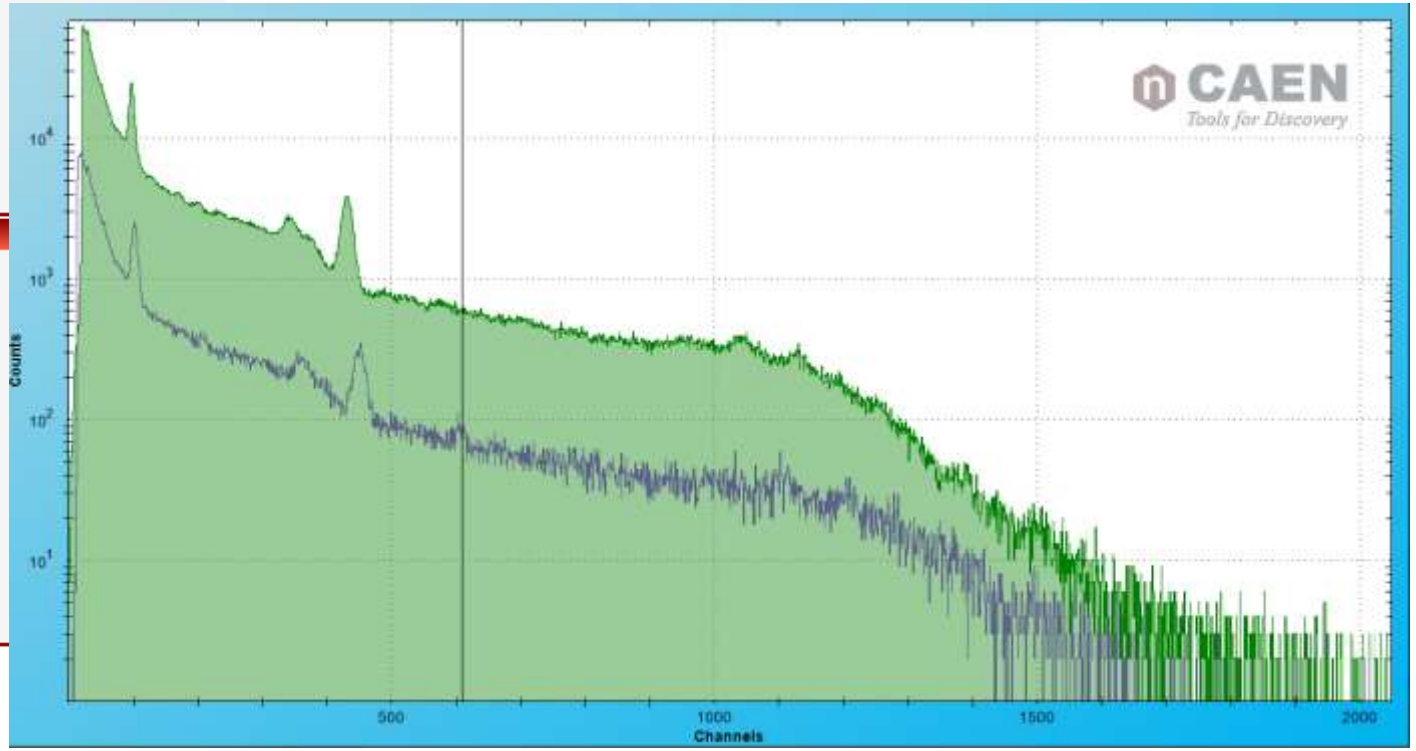
Spectrum Board Info

| | |
|---|---|
| Board Model: | DT5730B |
| Serial Number: | 1492 |
| Channel: | 1 |
| ADC Channels: | 2048 |
| Real Time: | 207.930 s |
| Live Time: | 203.915 s |
| Dead Time: | 1.931 % |
| Spect. Counts: | 808845 |
| Total Counts: | 740128 |
| ICR: | 3.560E+003 Cnt/s |
| OCR: | 3.890E+003 Cnt/s |
| Histogram: | NaI_Near |

Properties

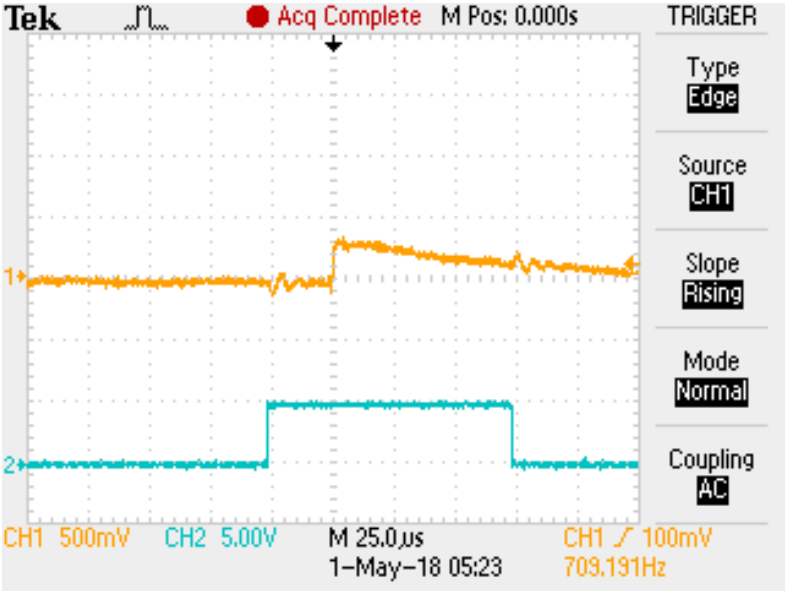
Spectrum Board Info

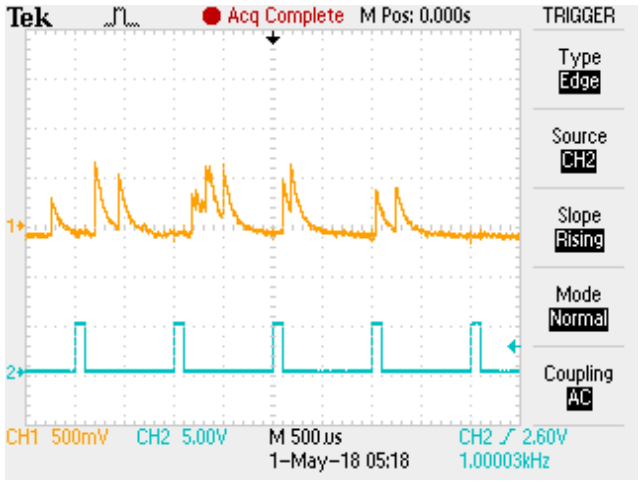
| | |
|---|---|
| Board Model: | DT5730B |
| Serial Number: | 1492 |
| Channel: | 3 |
| ADC Channels: | 2048 |
| Real Time: | 179.931 s |
| Live Time: | 178.609 s |
| Dead Time: | 0.735 % |
| Spect. Counts: | 89548 |
| Total Counts: | 88114 |
| ICR: | 4.897E+002 Cnt/s |
| OCR: | 4.977E+002 Cnt/s |
| Histogram: | NaI_Far |

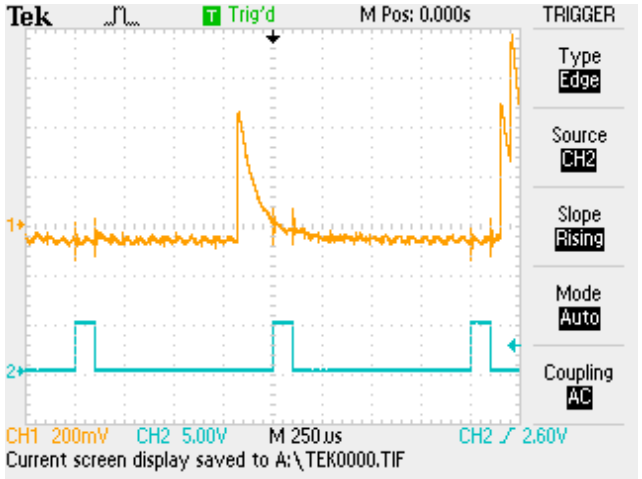


# External Timing Trigger

- DT Generator is now connected to a function generator
- Switching noise is synchronized with square wave



# List-Mode Data

- List-Mode data provides timestamps (2µs intervals) and channel data (15 bit) for each pulse event in three numbers
- ASCII format is easy to interpret, but file sizes are large

**TIMESTAMP CHANNEL EVENT_TAG**

Sensor on Ch0

5_1_2018-Test_ch000 - Notepad

File Edit Format View Help

```
HEADER0:1281
HEADER1:1792
HEADER2:513
HEADER3:770
HEADER4:35588
793462 6072 0
2487657 4630 0
2723981 6393 0
2973176 5480 0
3576909 3221 0
3806627 6007 0
4015208 4546 0
4056108 -32768 0
4057038 -32768 0
4264107 2689 0
4564343 5957 0
4765540 5563 0
4860340 4674 0
5036171 5093 0
5747110 5924 0
5785175 3970 0
7409749 5579 0
9065690 5932 0
9140009 5665 0
9217795 5768 0
9588844 5500 0
9700273 6798 0
10001978 5710 0
10428728 4630 0
```

Pulse Driver on Ch4

5_1_2018-Test_ch004 - Notepad

File Edit Format View Help

```
HEADER0:1281
HEADER1:1792
HEADER2:513
HEADER3:770
HEADER4:35588
374113 1991 0
874097 1991 0
1374082 1991 0
1874066 1991 0
2374051 1990 0
2874035 1991 0
3374020 1991 0
3874004 1991 0
4373989 1989 0
4873973 1989 0
5373958 1990 0
5873942 1991 0
6373927 1990 0
6873912 1990 0
7373896 1990 0
7873881 1991 0
8373865 1991 0
8873850 1990 0
9373834 1991 0
9873819 1990 0
10373803 1990 0
10873788 1990 0
11373772 1991 0
```

# DT Generator Output

- The DT generator beam current has been unlocked with help from Fabian
  - DT generator can now be operated from 20-60 µA beam current,
  - Voltage range is 40-80 kV

*I question this now?*

- The "best" combination of current and voltage is 40µA :40kV
  - Low dead time and noise with good neutron output

- Noise is now entirely removed from spectrum using decimation settings

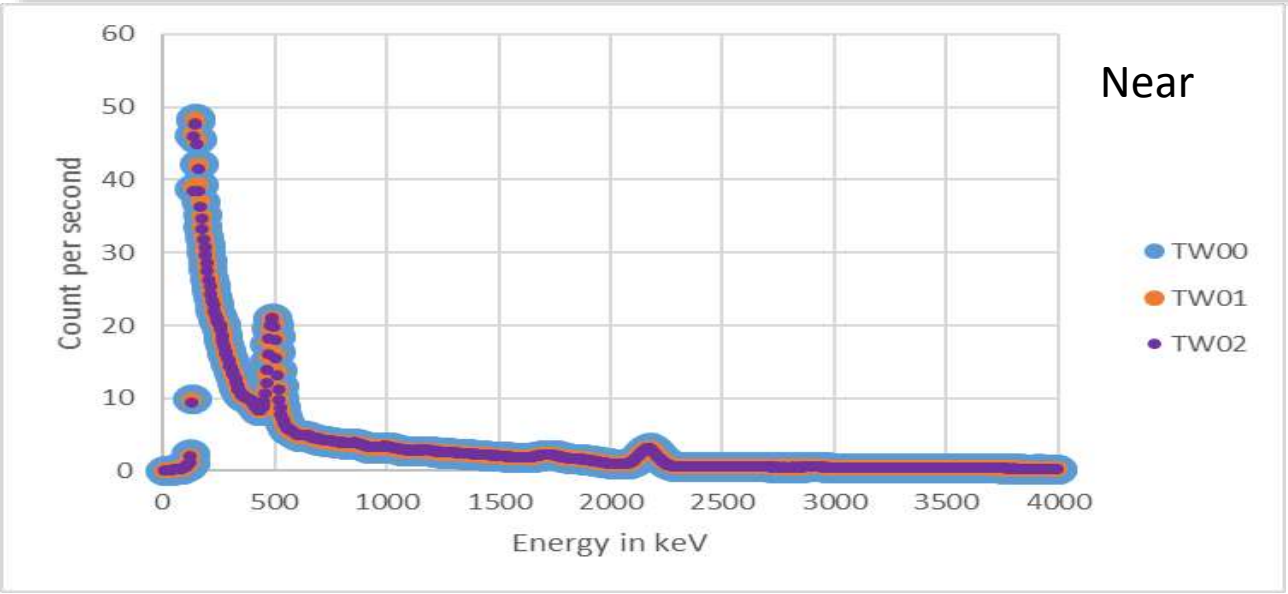
# Three Tap Water Experiments

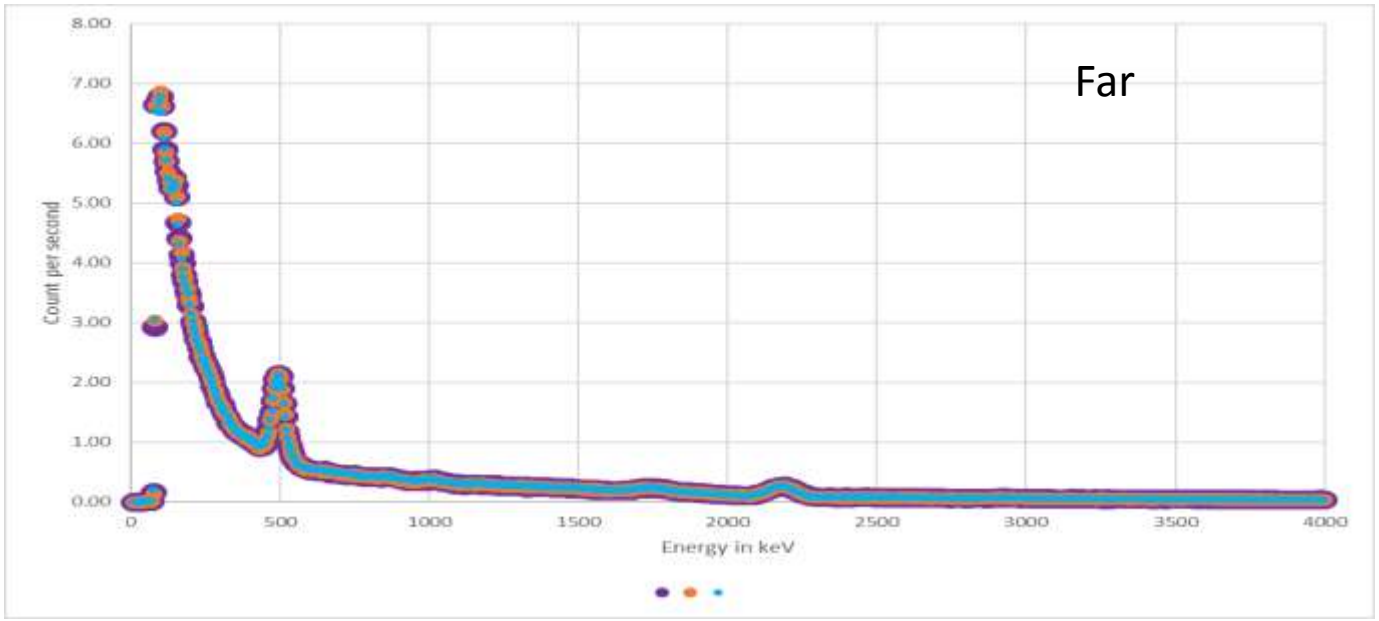
06/11/18

Long Vo

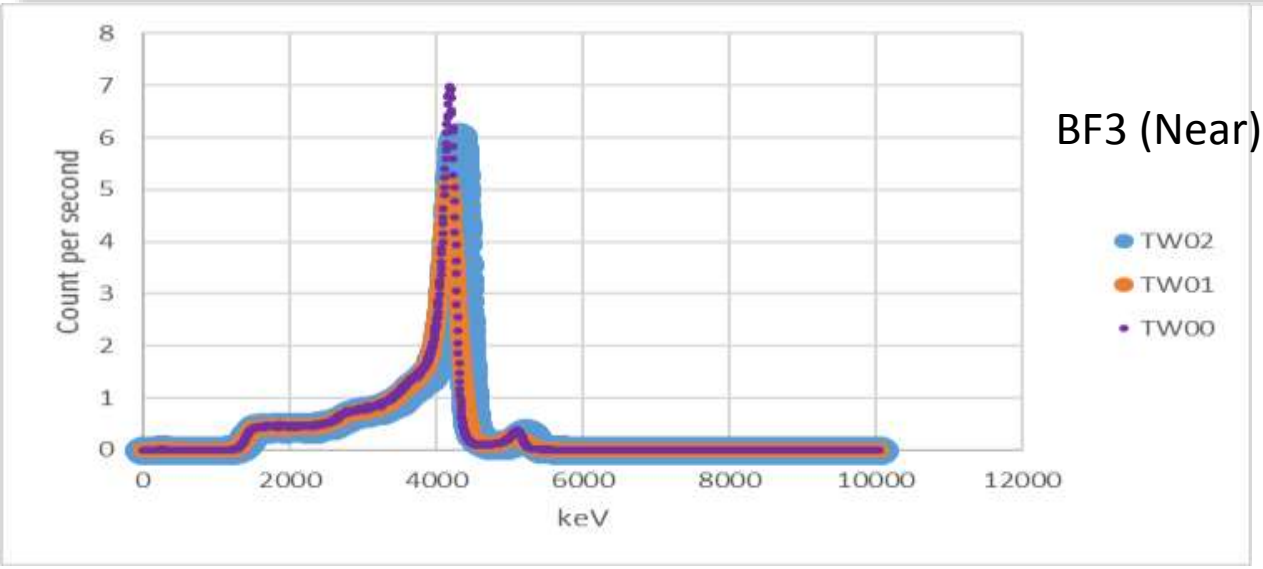
Alan Reinke & Alexi Rojas

# Repeatability of time-integrated spectra. NaI

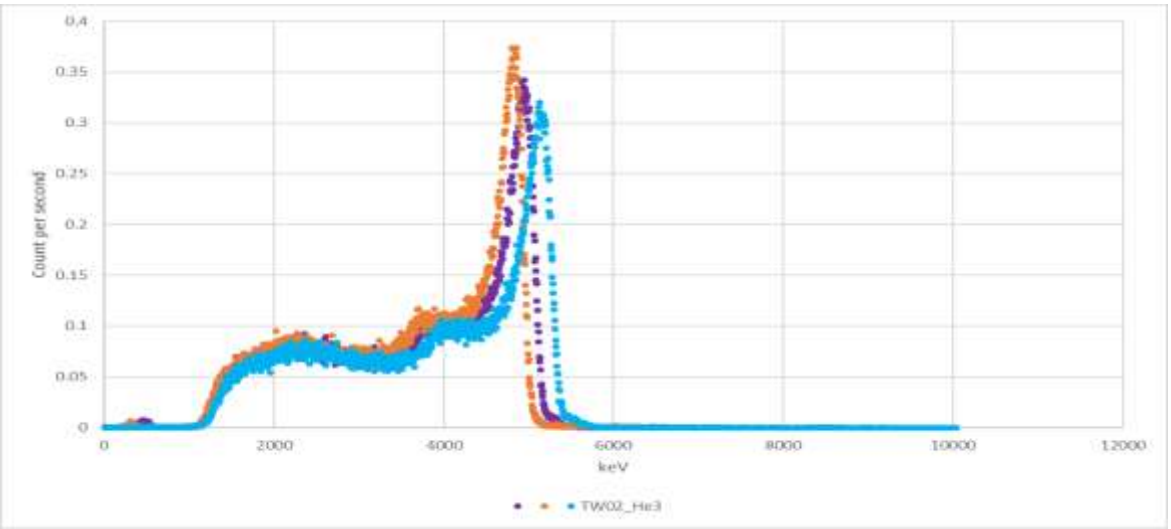


# Repeatability of Time-Integrated Spectra (BF3 and He-3)




BF3 (Near)




He-3 (Far)

# Dead-time is acceptable

- TapWater00
  1. NearNaI: 1.2%
  2. FarNaI: 0.6%
  3. NearBF3: 9.9%
  4. FarHe3: 12%
- TapWater01
  1. NearNaI: 1.2%
  2. FarNaI: 0.6%
  3. NearBF3: 13%
  4. FarHe3: 9.6%

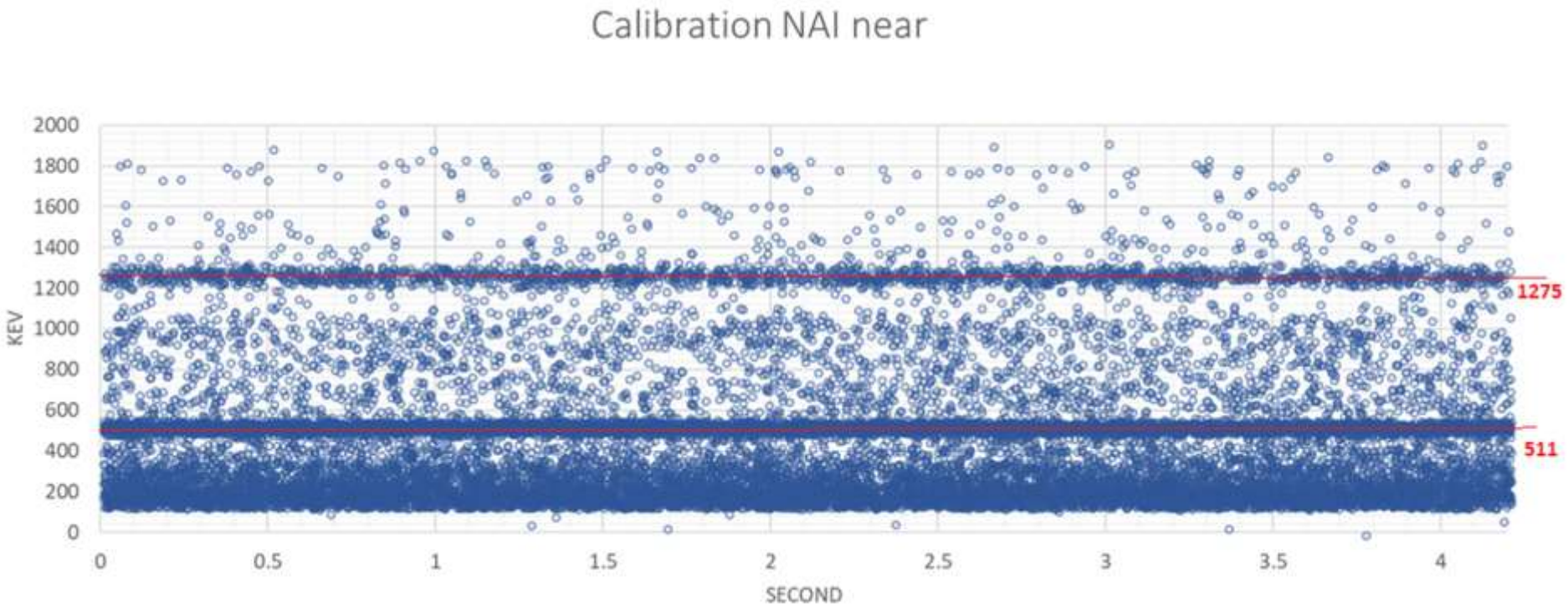
- TapWater03
  1. NearNaI: 1.2%
  2. FarNaI: 0.6%
  3. NearBF3: 12%
  4. FarHe3: 13%

$$\frac{RealTime - LiveTime}{RealTime} x100$$

# Time-Dependent Spectral Data

# NaI with Na-22 Calibration

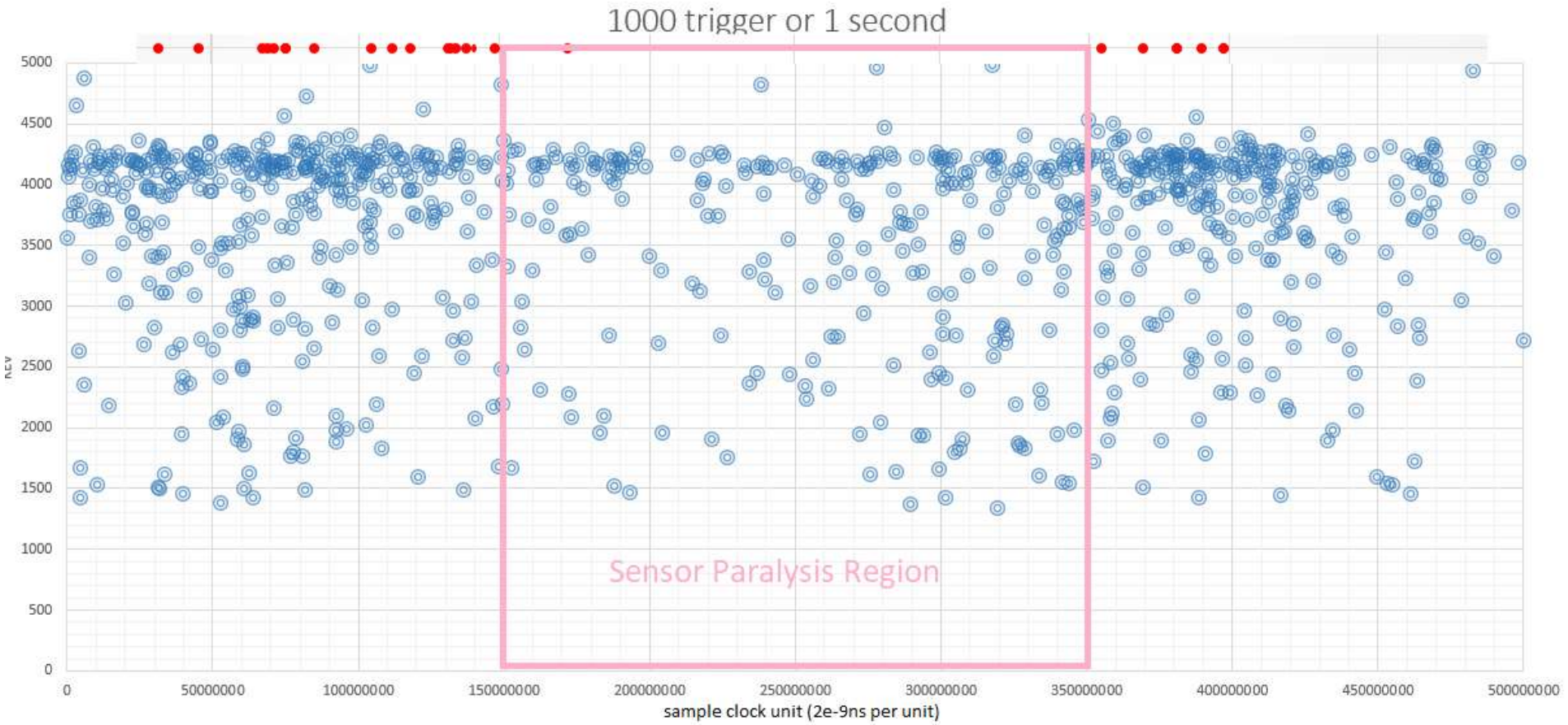
- Time progression of pulse energy spectra




From TapWater00

# BF3 (Near Sensor)

- Time progression of energy spectra

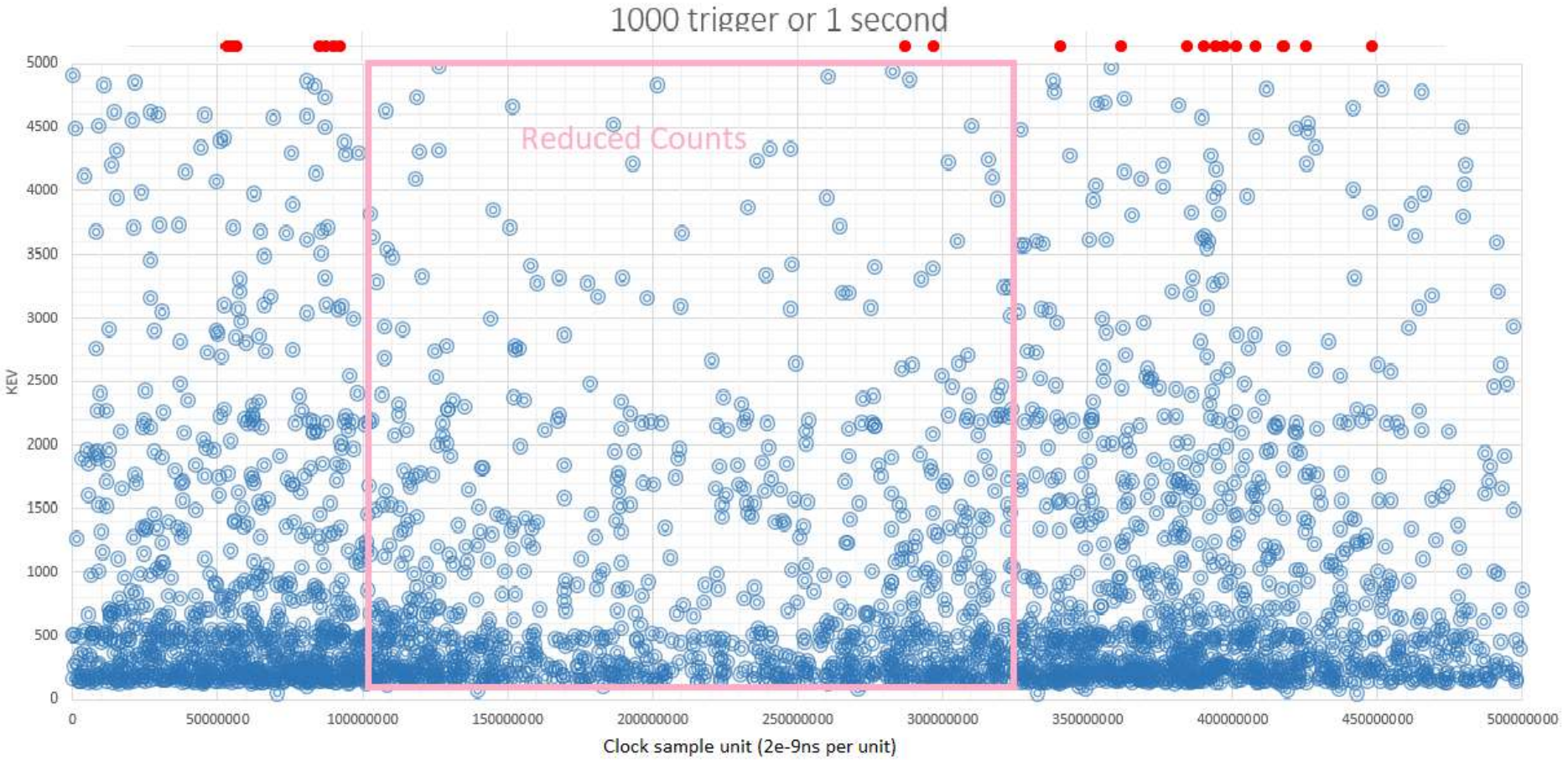



From TapWater00

Red dots identify error flags on time-stamp
(likely pile-up, or unusual waveform)

# NaI Near, Generator on

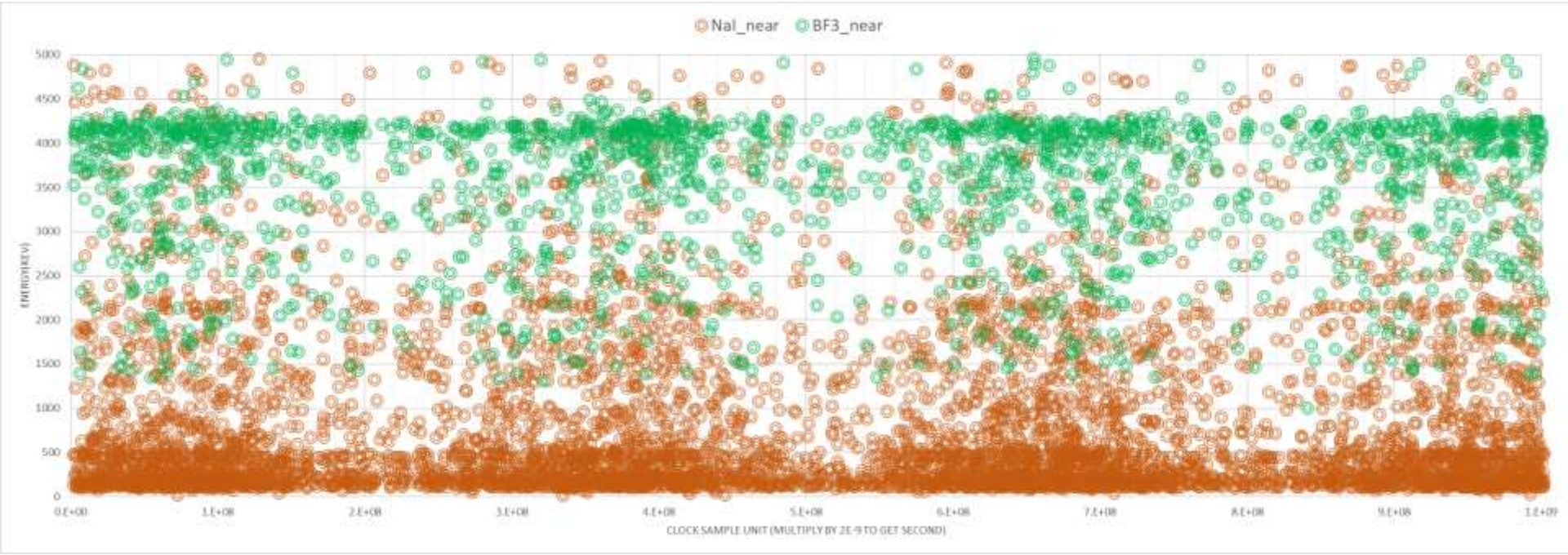
- Time progression of energy spectra

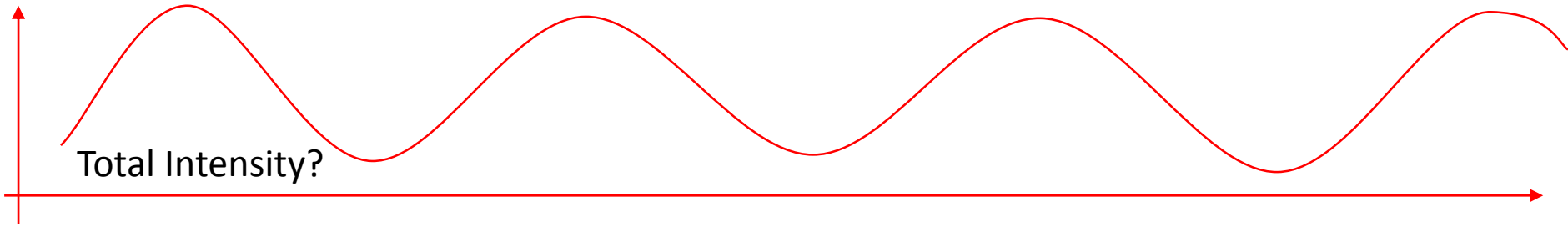



From TapWater00

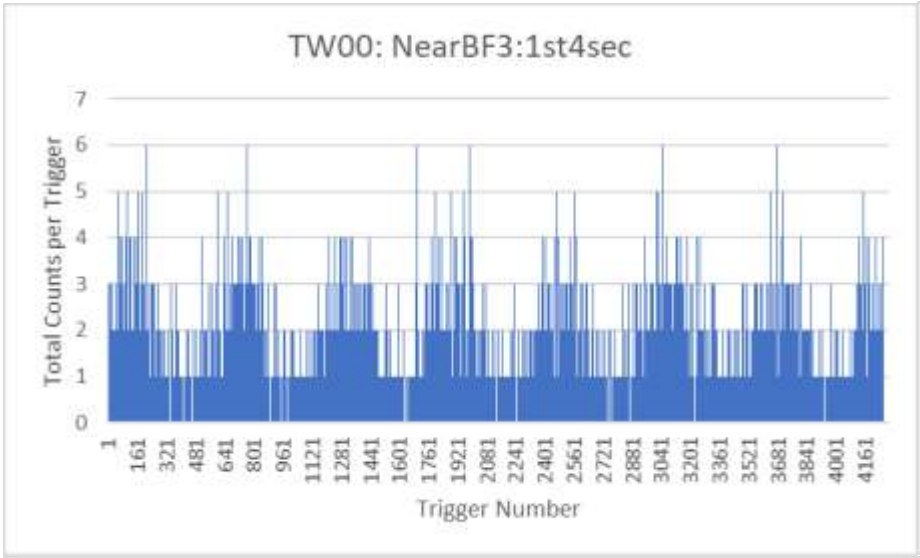
# NaI and BF3 Near

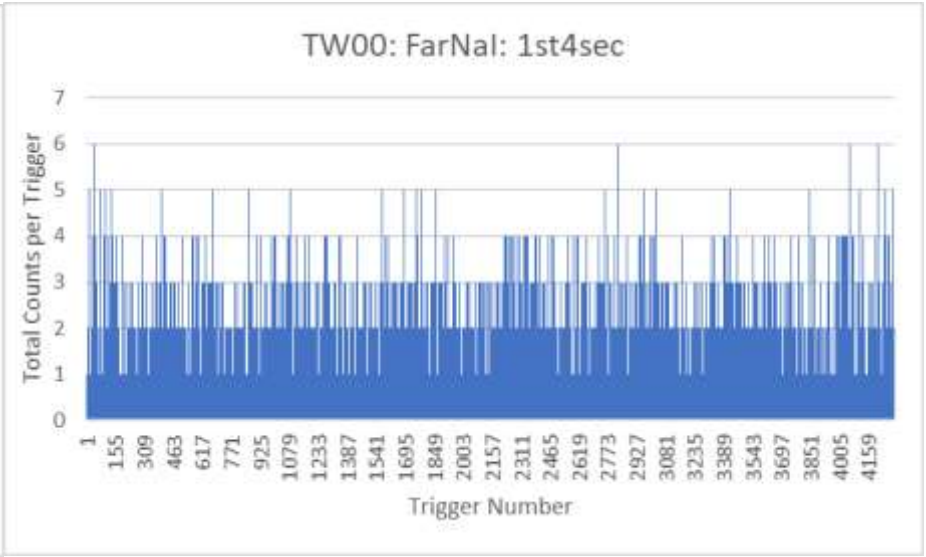
- Time progression of energy spectra over 2 seconds

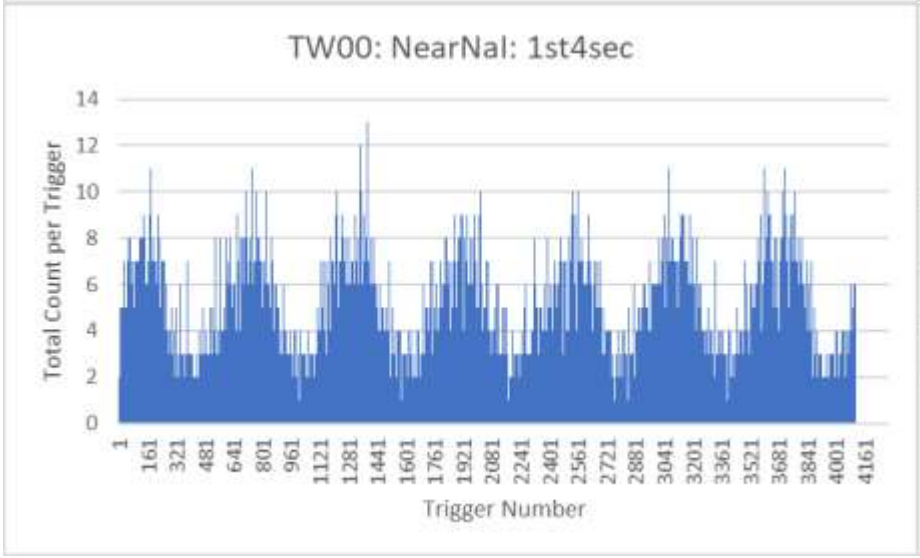


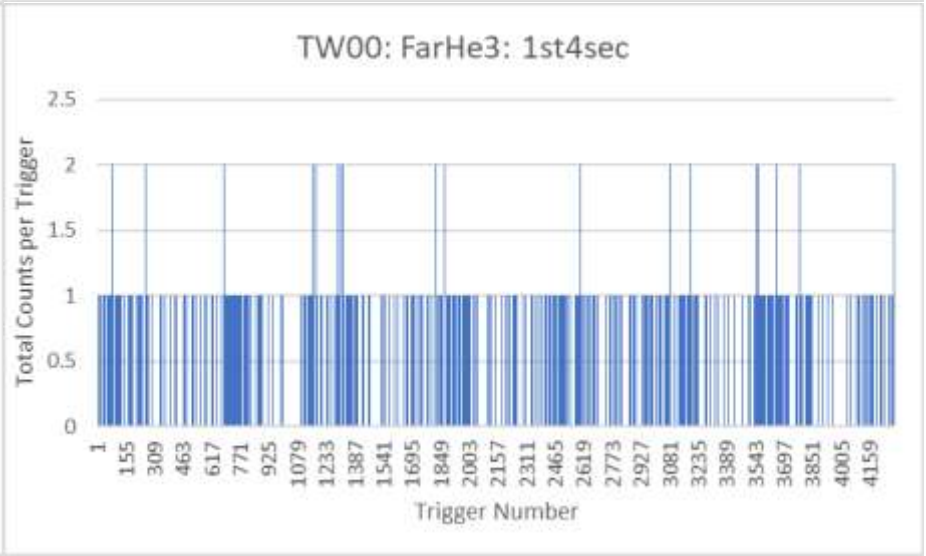



# Time-Dependent Gross Count-Rate



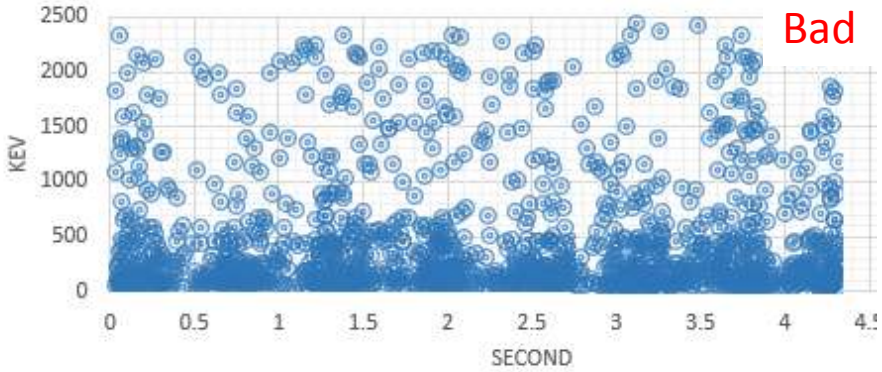



# Cyclical Output Behavior

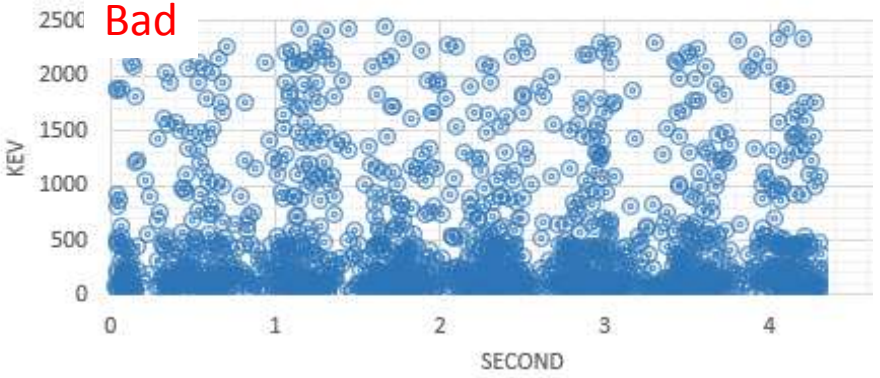
1st 4 sec
1646cts

Bad



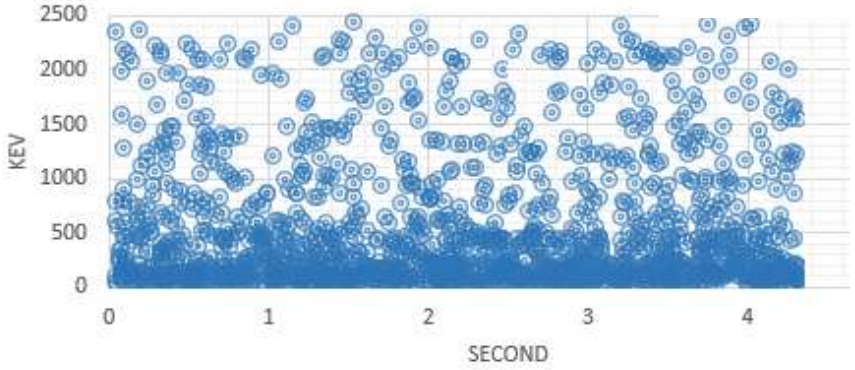

2nd 4sec
1737cts

Bad



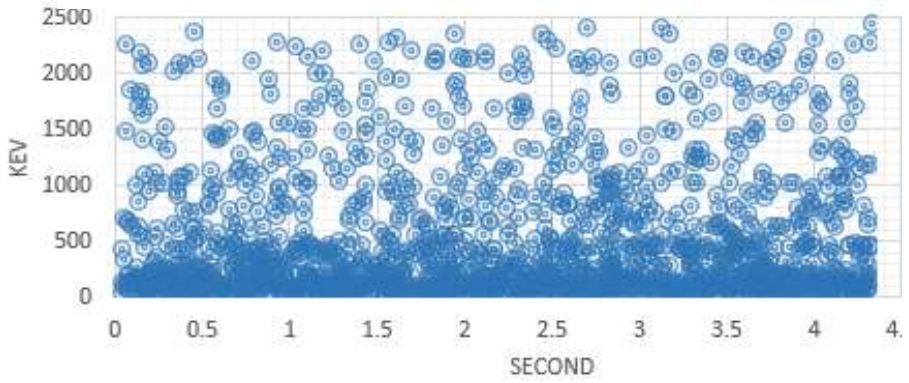

about 15 minutes in
1730cts

Not So Bad




about 35 minutes in
1796cts

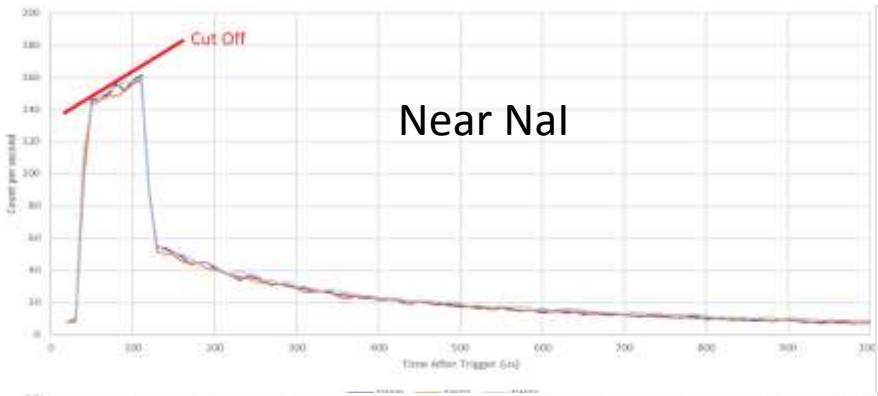
Not So Bad

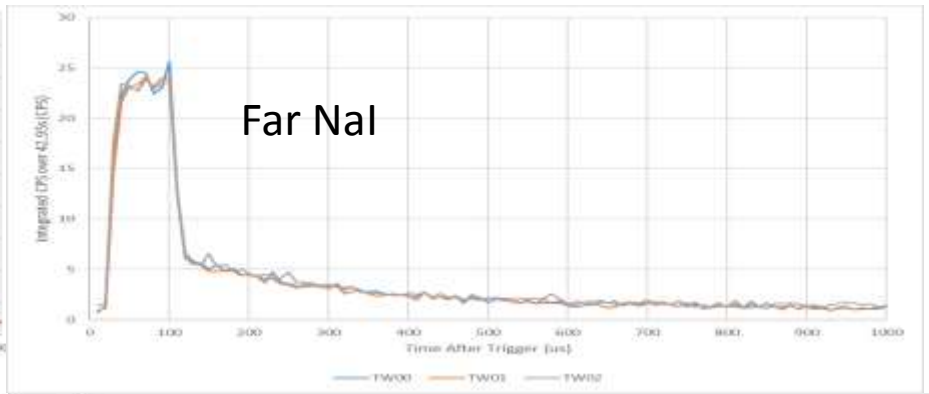


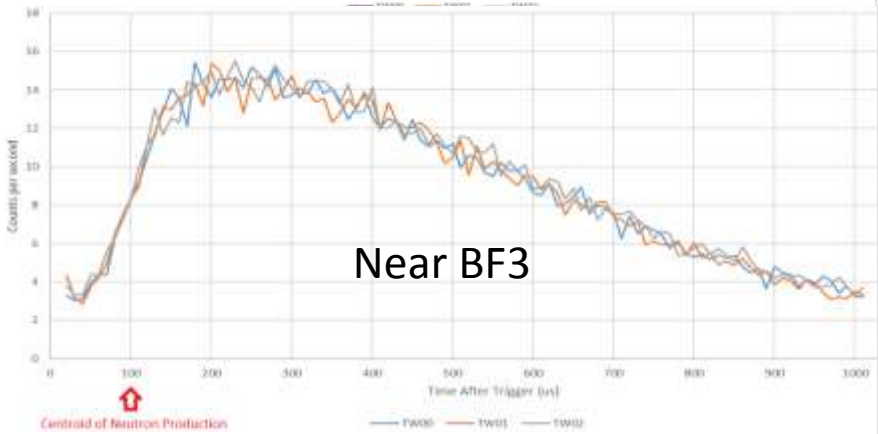
# A Look at Die-Away

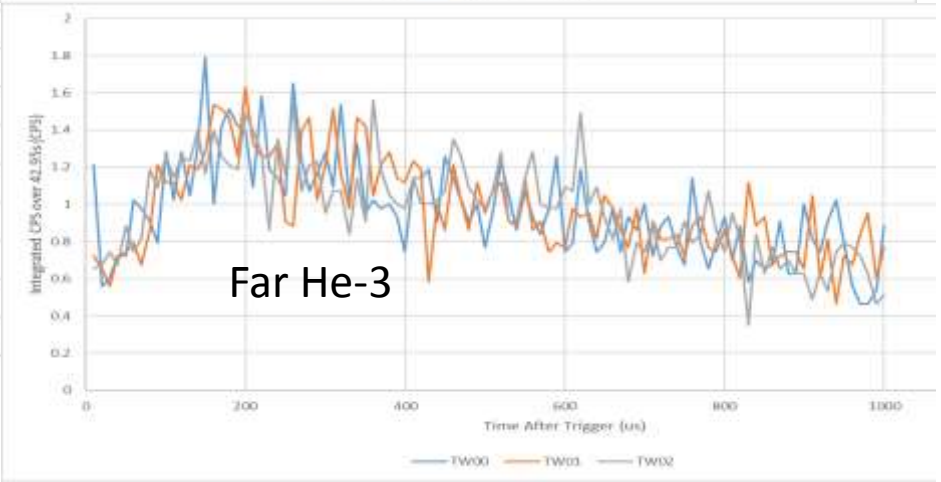
- Time between every trigger is 1000 micro-second
- Binning Time after every trigger into 10us bins
- Y-axis is count per second
- A clock rollover is ~4295triggers or 4295x(1000us)=4.295second

# Die Away


Cut Off
Near NaI

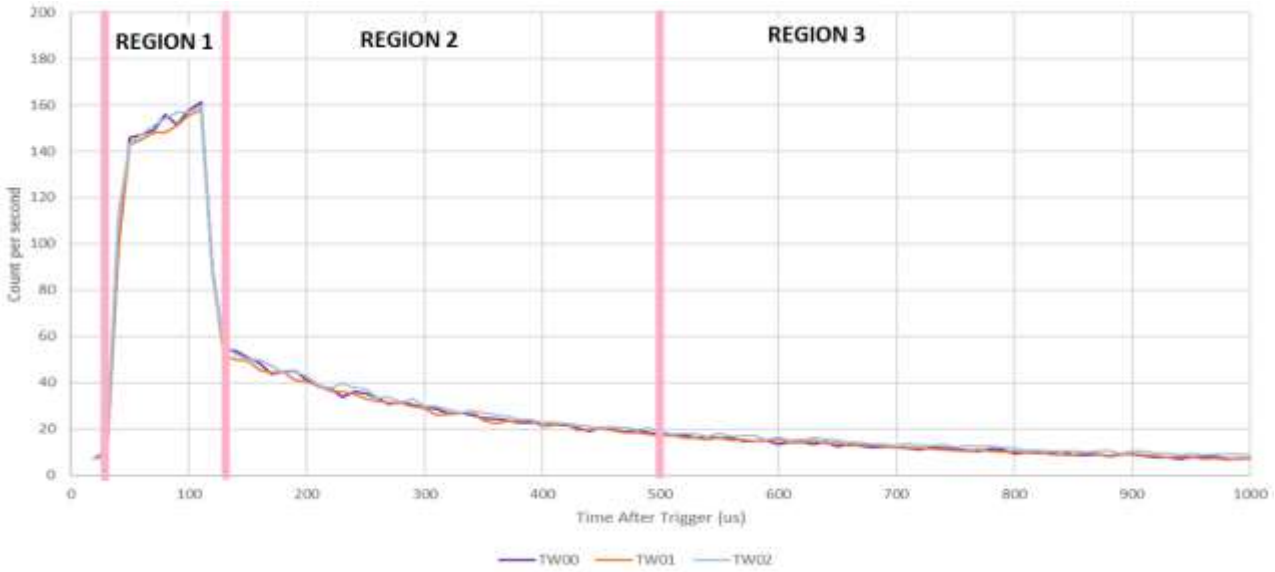

Far NaI
Time After Trigger (us)


Near BF3
Centroid of Neutron Production
Time After Trigger (us)


Far He-3
Time After Trigger (us)

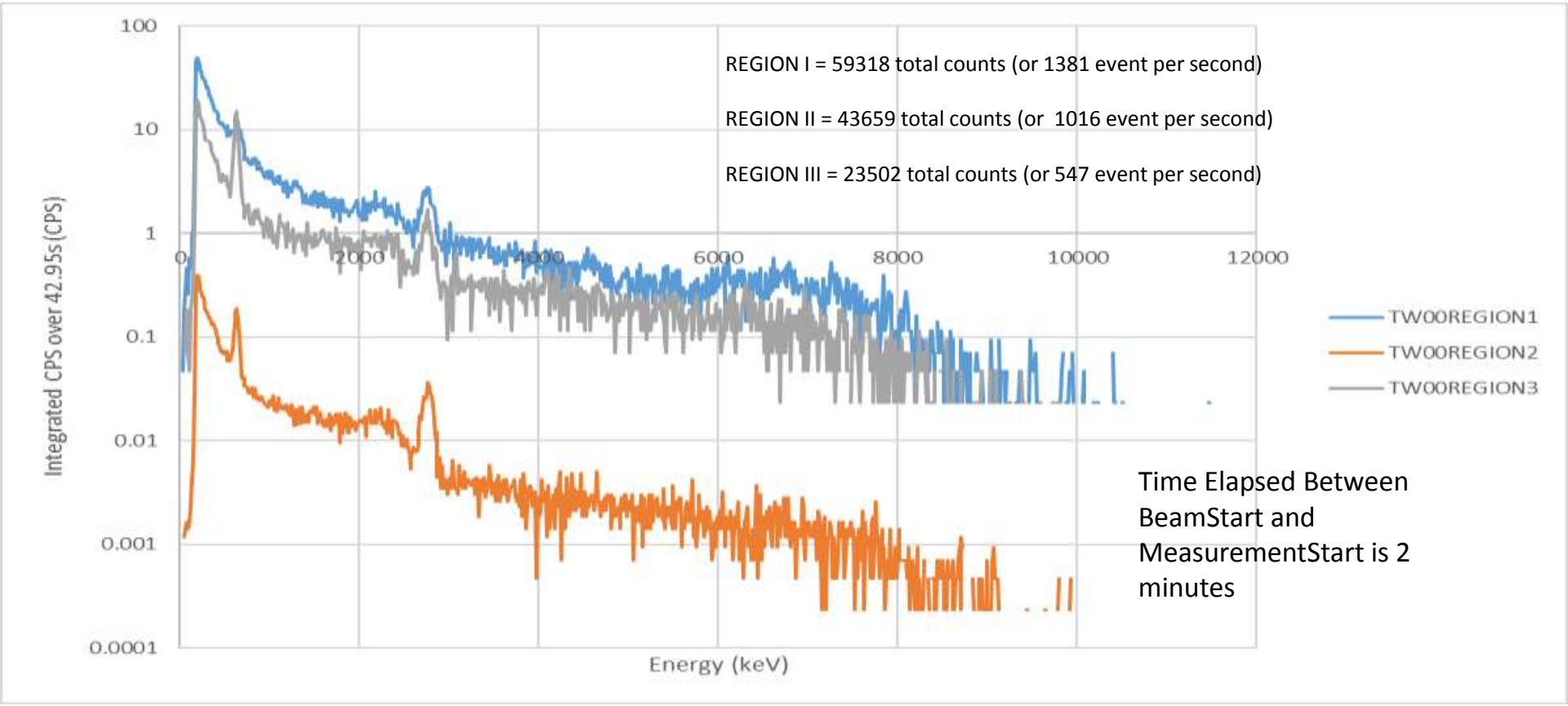
# Energies study in the divided regions

- What energies are we losing because of cut off?
- Looking at regions (20us-140us), (140us-500us), and (500us-1000us) in NaI_Near



# Pulse Region Spectra, Near NaI

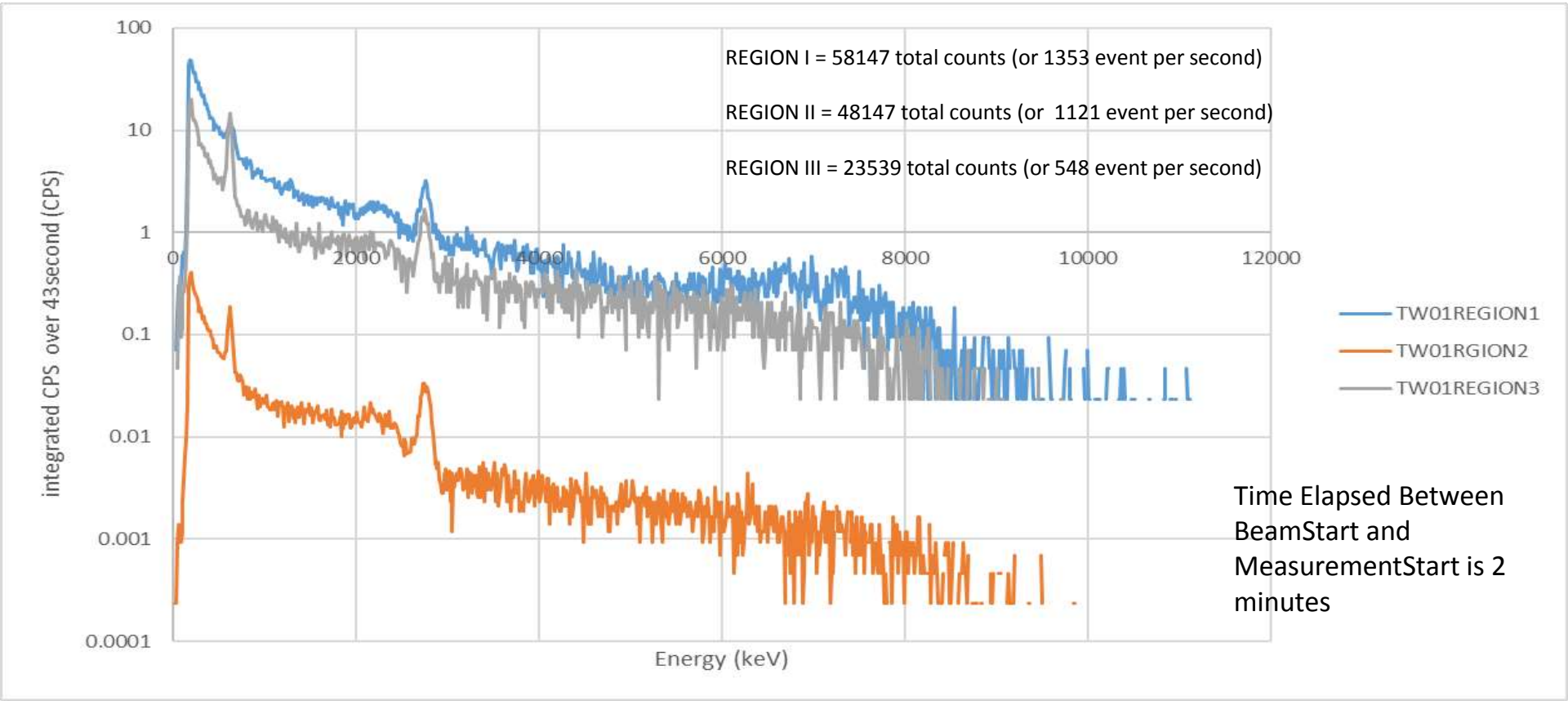
From TapWater00




Time Elapsed Between BeamStart and MeasurementStart is 2 minutes

# Pulse Region Spectra, Near NaI

From TapWater01




Time Elapsed Between BeamStart and MeasurementStart is 2 minutes

# From another source

Fast Neutron and Gamma Burst measured with
EJ-299-34 Plastic and SiPM on THermoFisher
A325 DT Generator 2KHz and 20%duty cycle

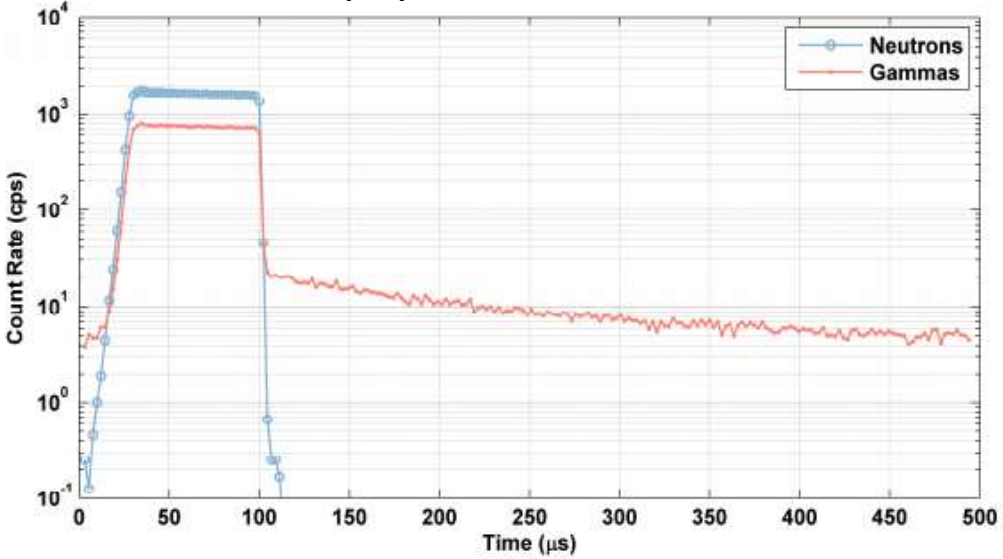



Figure 6: Fast neutron and gamma count rates over the course of a 2 kHz, 20% duty cycle burst period.

R. M. Preston, "Neutron generator burst timing measured using a pulse shape discrimination plastic scintillator with silicon photomultiplier readout"