TCSPC_Histogram_reconstruction

June 11, 2021

1   TCSPC Histogram Reconstruction

Run the following hidden cells for preparing the code environment

```
[1]: %pylab inline
     from tqdm.notebook import tqdm as tqdm
     from ipyfilechooser import FileChooser
     from pathlib import Path
     import h5py
     import os
     import ttp
```

Populating the interactive namespace from numpy and matplotlib

```
[2]: #%% Plot Config

     SMALL_SIZE = 14
     MEDIUM_SIZE = 18
     BIG_SIZE = 22
     BIGGER_SIZE = 28

     plt.rc('font', size=SMALL_SIZE)            # controls default text sizes
     plt.rc('axes', titlesize=BIG_SIZE)         # fontsize of the axes title
     plt.rc('axes', labelsize=BIG_SIZE)         # fontsize of the x and y labels
     plt.rc('xtick', labelsize=MEDIUM_SIZE)     # fontsize of the tick labels
     plt.rc('ytick', labelsize=MEDIUM_SIZE)     # fontsize of the tick labels
     plt.rc('legend', fontsize=MEDIUM_SIZE)     # legend fontsize
     plt.rc('figure', titlesize=BIGGER_SIZE)    # fontsize of the figure title
     plt.rc('figure', titlesize=BIGGER_SIZE)    # fontsize of the figure title
     matplotlib.rcParams['figure.figsize'] = (13.0, 10.0)
```

2   Select Data

```
[9]: fc = FileChooser()
     fc.default_path='/home/labuser/dataSlowDisk'
     fc.use_dir_icons = True
     display(fc)
```

```
1912435it [00:35, 53359.40it/s]
1912435it [00:35, 54098.16it/s]
1912435it [00:34, 54856.33it/s]
1912435it [00:34, 55636.70it/s]
1912435it [00:33, 56454.18it/s]
1912435it [00:33, 57293.91it/s]
1912435it [00:32, 58160.19it/s]
1912435it [00:32, 59048.63it/s]
1912435it [00:31, 59968.09it/s]
1912435it [00:31, 60901.73it/s]

FileChooser(path='/home/labuser/dataSlowDisk', filename='',␣
 ↪title='HTML(value='', layout=Layout(display='none'…
```

[10]:
```python
filename = fc.selected
```

3 Specify parameters

[11]:
```python
sysclk_MHz=240.    # FPGA system clock (MHz)
laser_MHz=40.      # Laser repetition rate (MHz)
laser_factor=1     # Adimensional number to account for laser actual repetiton␣
 ↪frequency
nchannel = 21      # Number of active channels
kC4=48             # Time width of TCSPC histogram bin (picoseconds)
```

[12]:
```python
laser_MHz=laser_MHz*laser_factor
laser_Hz=laser_MHz*10**6
max_counter=2**16-1
sysclk_ps=1000000./sysclk_MHz #ps
print("SysClk ps:", sysclk_ps)
laser_ps=1000000./laser_MHz #ps
print("LaserClk ps:", laser_ps)
ratio=sysclk_MHz/laser_MHz
sysclk_ps=1e6/sysclk_MHz
laser_ps=1e6/laser_MHz
nbins=int(round(laser_ps/kC4))
```

```
SysClk ps: 4166.666666666667
LaserClk ps: 25000.0
```

4 Data conversion to H5 format

[13]:
```python
myReturn=ttp.convertDataRAW( filenameToRead=filename,
                    sysclk_MHz = sysclk_MHz,
                    laser_MHz=laser_MHz,
                    dwell_time_us=100.,
```

```
                    list_of_channels=np.arange(0,nchannel),
                    autoCalibration=True,
                    kC4=45.,
                    textInPlot=None,
                    compressionLevel=1,
                    makePlots=True,
                    ignorePixelLineFrame = False)
```

/mnt/Disk1T/dataSlowDisk/data-2021-02-02-BCD_cooled_Fluorescein1:1000/512x512_25
0us_FOV_25um_laser53_40MHz_data-1612264699077773_cooled_BCD_minus15_holdoff100_4
****
* Size table: 70669595
****
Convert to DataFrame
Converted

Calculate rates
Calculate cumulative step
Add cumulativeStep
Acquisition lasted: 67.9842371375 s
Scan_enable 226428.0 ratio 0.0032040370402575537 rate 3330.5955841211116
line_enable 297090.0 ratio 0.004203929568295955 rate 4369.983580151488
pixel_enable 262170.0 ratio 0.003709799101013668 rate 3856.3351011757904
Laser 32087297.0 ratio 0.4540467084889902 rate 471981.42320995015
Calculate totalphotons
kC4<=== 45.0
sysclk_ps<=== 4166.666666666667
kC4<=== 44.80286738351255
Start process
Start analysisForImg

Current frame: 1   :   3%| | 2120085/70669595 [00:00<00:11,
6138420.88it/s]

Arrays copied into analysisForImg

Current frame: 3   : : 71376195it [00:18, 3855027.79it/s]

('Total Frame:', 3)

Current frame: 3   : : 71376195it [00:32, 2228195.93it/s]
  0%| | 0/21 [00:00<?, ?it/s]

New HDF5 written
total_photon   uint8
cumulative_step   int64
arr_px   uint16
arr_px_corr   uint16
arr_py   uint16
arr_frame   uint16
```

```
dtype: object
Start conversion of 0 channel
t_0 valid_tdc_0
..


  0%|            | 0/33403326 [00:00<?, ?it/s]
 14%|          | 4676462/33403326 [00:00<00:00, 44017789.95it/s]
 27%|         | 9018891/33403326 [00:00<00:00, 43021523.26it/s]
 39%|        | 13027287/33403326 [00:00<00:00, 41994048.25it/s]
 52%|       | 17369716/33403326 [00:00<00:00, 41620012.48it/s]
 64%|      | 21378112/33403326 [00:00<00:00, 40883314.17it/s]
 76%|     | 25386508/33403326 [00:00<00:00, 40619719.69it/s]
 89%|    | 29728937/33403326 [00:00<00:00, 40759913.27it/s]
33737333it [00:00, 40387114.66it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_0"

  5%|            | 1/21 [00:11<03:44, 11.24s/it]

t_0      int16
t_L      int16
dS_0    uint16
dtype: object
Start conversion of 1 channel
t_1 valid_tdc_1
..


  0%|            | 0/33502376 [00:00<?, ?it/s]

 14%|           | 4690322/33502376 [00:00<00:00, 44497555.62it/s]

 26%|          | 8710598/33502376 [00:00<00:00, 42552611.95it/s]

 39%|         | 13065897/33502376 [00:00<00:00, 41869831.71it/s]

 51%|        | 17086173/33502376 [00:00<00:00, 40933321.53it/s]

 64%|       | 21441472/33502376 [00:00<00:00, 41179396.45it/s]

 77%|      | 25796771/33502376 [00:00<00:00, 41305504.01it/s]

 90%|     | 30152070/33502376 [00:00<00:00, 41320139.58it/s]
33737333it [00:12, 40387114.66it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_1"
```

```
 10%|          | 2/21 [00:22<03:33, 11.26s/it]
t_1      int16
t_L      int16
dS_1     uint16
dtype: object
Start conversion of 2 channel
t_2 valid_tdc_2
..


33837323it [00:10, 41320139.58it/s]


  0%|          | 0/33281123 [00:00<?, ?it/s]


 15%|          | 4992165/33281123 [00:00<00:00, 47279040.15it/s]


 28%|          | 9318708/33281123 [00:00<00:00, 45216510.00it/s]


 42%|          | 13978062/33281123 [00:00<00:00, 44656177.82it/s]


 55%|          | 18304605/33281123 [00:00<00:00, 43508556.04it/s]


 68%|          | 22631148/33281123 [00:00<00:00, 43434190.30it/s]


 81%|          | 26957691/33281123 [00:00<00:00, 43308796.15it/s]


 94%|          | 31284234/33281123 [00:00<00:00, 42850969.39it/s]
Data ready, conversion to array
Adding keys to HDF5…  "ch_2"
33737333it [00:23, 1413867.65it/s]
33837323it [00:12, 2679044.04it/s]
33613911it [00:01, 26925198.20it/s]
 14%|          | 3/21 [00:33<03:22, 11.22s/it]

t_2      int16
t_L      int16
dS_2     uint16
dtype: object
```

```
Start conversion of 3 channel
t_3 valid_tdc_3
..


  0%|            | 0/33546254 [00:00<?, ?it/s]
 14%|            | 4696468/33546254 [00:00<00:00, 43705685.12it/s]
 26%|            | 8722012/33546254 [00:00<00:00, 41765067.05it/s]
 39%|            | 13083018/33546254 [00:00<00:00, 41511876.31it/s]
 51%|            | 17108562/33546254 [00:00<00:00, 40844657.35it/s]
 63%|            | 21134106/33546254 [00:00<00:00, 40226366.42it/s]
 76%|            | 25495112/33546254 [00:00<00:00, 40433303.07it/s]
 89%|            | 29856118/33546254 [00:00<00:00, 40619494.95it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_3"
 19%|            | 4/21 [00:45<03:11, 11.27s/it]

t_3      int16
t_L      int16
dS_3     uint16
dtype: object
Start conversion of 4 channel
t_4 valid_tdc_4
..



  0%|            | 0/34343914 [00:00<?, ?it/s]

 11%|            | 3777829/34343914 [00:00<00:00, 36092741.72it/s]

 20%|            | 6868780/34343914 [00:00<00:00, 33369897.59it/s]

 30%|            | 10303170/34343914 [00:00<00:00, 32771920.51it/s]

 40%|            | 13737560/34343914 [00:00<00:00, 32723484.70it/s]

 50%|            | 17171950/34343914 [00:00<00:00, 32357836.63it/s]

 60%|            | 20606340/34343914 [00:00<00:00, 32580584.17it/s]

 70%|            | 24040730/34343914 [00:00<00:00, 32314043.09it/s]

 80%|            | 27475120/34343914 [00:00<00:00, 32662080.41it/s]

 90%|            | 30909510/34343914 [00:00<00:00, 32891827.84it/s]

100%|            | 34343900/34343914 [00:01<00:00, 33234502.29it/s]
```

```
Data ready, conversion to array
Adding keys to HDF5…  "ch_4"
 24%|          | 5/21 [00:57<03:05, 11.57s/it]

t_4      int16
t_L      int16
dS_4    uint16
dtype: object
Start conversion of 5 channel
t_5 valid_tdc_5
..

33881662it [00:18, 40619494.95it/s]


  0%|          | 0/33950107 [00:00<?, ?it/s]


 14%|          | 4753014/33950107 [00:00<00:00, 44352947.95it/s]


 26%|          | 8827026/33950107 [00:00<00:00, 43027045.88it/s]


 38%|          | 12901038/33950107 [00:00<00:00, 42155096.90it/s]


 50%|          | 16975050/33950107 [00:00<00:00, 41544032.16it/s]


 62%|          | 21049062/33950107 [00:00<00:00, 40932574.36it/s]


 74%|          | 25123074/33950107 [00:00<00:00, 40357183.41it/s]


 86%|          | 29197086/33950107 [00:00<00:00, 40104520.89it/s]


 98%|          | 33271098/33950107 [00:00<00:00, 39925892.72it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_5"
 29%|          | 6/21 [01:08<02:50, 11.36s/it]

t_5      int16
t_L      int16
dS_5    uint16
```

```
dtype: object
Start conversion of 6 channel
t_6 valid_tdc_6
..
```

34687339it [00:16, 33234502.29it/s]

```
  0%|          | 0/33947105 [00:00<?, ?it/s]
```

```
 13%|          | 4413123/33947105 [00:00<00:00, 42862057.31it/s]
```

```
 24%|          | 8147304/33947105 [00:00<00:00, 40917289.02it/s]
```

```
 34%|          | 11542014/33947105 [00:00<00:00, 38176286.05it/s]
```

```
 46%|          | 15615666/33947105 [00:00<00:00, 38114736.21it/s]
```

```
 58%|          | 19689318/33947105 [00:00<00:00, 38210105.97it/s]
```

```
 70%|          | 23762970/33947105 [00:00<00:00, 38116963.57it/s]
```

```
 81%|          | 27497151/33947105 [00:00<00:00, 37387426.62it/s]
```

```
 92%|          | 31231332/33947105 [00:00<00:00, 36748164.67it/s]
Data ready, conversion to array
Adding keys to HDF5…  "ch_6"
```

33881662it [00:35, 942481.92it/s]

```
34687339it [00:24, 1421057.45it/s]
34289601it [00:13, 2602791.83it/s]
34286571it [00:01, 25317048.13it/s]
 33%|        | 7/21 [01:19<02:40, 11.49s/it]

t_6     int16
t_L     int16
dS_6    uint16
dtype: object
Start conversion of 7 channel
t_7 valid_tdc_7
..


  0%|          | 0/33258726 [00:00<?, ?it/s]
 15%|        | 4988805/33258726 [00:00<00:00, 48848881.10it/s]
 29%|        | 9645023/33258726 [00:00<00:00, 47539480.37it/s]
 43%|        | 14301241/33258726 [00:00<00:00, 46809555.67it/s]
 57%|        | 18957459/33258726 [00:00<00:00, 46528680.70it/s]
 71%|        | 23613677/33258726 [00:00<00:00, 46318010.52it/s]
 85%|        | 28269895/33258726 [00:00<00:00, 46231284.87it/s]
 99%|        | 32926113/33258726 [00:00<00:00, 45955878.37it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_7"

 38%|        | 8/21 [01:30<02:24, 11.13s/it]

t_7     int16
t_L     int16
dS_7    uint16
dtype: object
Start conversion of 8 channel
t_8 valid_tdc_8
..



  0%|          | 0/33886814 [00:00<?, ?it/s]

 13%|        | 4405284/33886814 [00:00<00:00, 42966303.60it/s]

 25%|        | 8471700/33886814 [00:00<00:00, 41535079.61it/s]

 36%|        | 12199248/33886814 [00:00<00:00, 39868979.59it/s]

 48%|        | 16265664/33886814 [00:00<00:00, 39269870.68it/s]

 60%|        | 20332080/33886814 [00:00<00:00, 38707611.97it/s]

 72%|        | 24398496/33886814 [00:00<00:00, 38859032.05it/s]
```

```
84%|        | 28464912/33886814 [00:00<00:00, 38831808.23it/s]

96%|        | 32531328/33886814 [00:00<00:00, 38960686.35it/s]
Data ready, conversion to array
Adding keys to HDF5…  "ch_8"


43%|        | 9/21 [01:41<02:13, 11.14s/it]
t_8     int16
t_L     int16
dS_8    uint16
dtype: object
Start conversion of 9 channel
t_9 valid_tdc_9
..




 0%|        | 0/34430338 [00:00<?, ?it/s]


12%|        | 4131636/34430338 [00:00<00:00, 38907969.82it/s]


23%|        | 7918969/34430338 [00:00<00:00, 37575494.42it/s]


33%|        | 11361999/34430338 [00:00<00:00, 35707568.46it/s]


43%|        | 14805029/34430338 [00:00<00:00, 34455701.20it/s]


53%|        | 18248059/34430338 [00:00<00:00, 34007929.01it/s]


63%|        | 21691089/34430338 [00:00<00:00, 33388027.19it/s]


73%|        | 25134119/34430338 [00:00<00:00, 33015240.55it/s]


84%|        | 28921452/34430338 [00:00<00:00, 33440891.96it/s]


95%|        | 32708785/34430338 [00:00<00:00, 33766483.75it/s]
```

```
34225668it [00:12, 38960686.35it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_9"

 48%|          | 10/21 [01:53<02:04, 11.36s/it]

t_9      int16
t_L      int16
dS_9     uint16
dtype: object
Start conversion of 10 channel
t_10 valid_tdc_10
..




34774603it [00:11, 33766483.75it/s]




  0%|          | 0/35037212 [00:00<?, ?it/s]




 11%|          | 3854092/35037212 [00:00<00:00, 36016865.17it/s]




 21%|          | 7357812/35037212 [00:00<00:00, 34600185.89it/s]




 31%|          | 10861532/35037212 [00:00<00:00, 33826651.65it/s]




 41%|          | 14365252/35037212 [00:00<00:00, 33428193.34it/s]




 51%|          | 17868972/35037212 [00:00<00:00, 32990738.26it/s]




 61%|          | 21372692/35037212 [00:00<00:00, 32719198.09it/s]
```

```
 71%|          | 24876412/35037212 [00:00<00:00, 32530208.92it/s]



 81%|          | 28380132/35037212 [00:00<00:00, 32364831.93it/s]



 91%|          | 31883852/35037212 [00:00<00:00, 32164599.27it/s]



35387572it [00:01, 32305096.22it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_10"

33591287it [00:35, 944130.40it/s]
34225668it [00:25, 1365176.12it/s]
34774603it [00:13, 2512682.50it/s]
35387572it [00:01, 20808817.28it/s]
 52%|        | 11/21 [02:05<01:56, 11.69s/it]

t_10      int16
t_L       int16
dS_10     uint16
dtype: object
Start conversion of 11 channel
t_11 valid_tdc_11

..


  0%|            | 0/34138399 [00:00<?, ?it/s]
 13%|          | 4437979/34138399 [00:00<00:00, 42947432.10it/s]
 25%|          | 8534575/34138399 [00:00<00:00, 41560351.45it/s]
 37%|          | 12631171/34138399 [00:00<00:00, 40745583.78it/s]
 49%|         | 16727767/34138399 [00:00<00:00, 40122421.93it/s]
 61%|        | 20824363/34138399 [00:00<00:00, 39757088.54it/s]
 73%|       | 24920959/34138399 [00:00<00:00, 39347793.80it/s]
 85%|      | 29017555/34138399 [00:00<00:00, 39083460.47it/s]
 97%|     | 33114151/34138399 [00:00<00:00, 38911233.85it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_11"

 57%|        | 12/21 [02:16<01:43, 11.49s/it]

t_11      int16
t_L       int16
dS_11     uint16
```

```
dtype: object
Start conversion of 12 channel
t_12 valid_tdc_12
..


  0%|              | 0/33329891 [00:00<?, ?it/s]

 16%|         | 5332768/33329891 [00:00<00:00, 52935350.71it/s]

 31%|          | 10332238/33329891 [00:00<00:00, 51210186.06it/s]

 46%|          | 15331708/33329891 [00:00<00:00, 50227908.36it/s]

 61%|          | 20331178/33329891 [00:00<00:00, 49322800.44it/s]

 76%|         | 25330648/33329891 [00:00<00:00, 48750075.29it/s]

 91%|         | 30330118/33329891 [00:00<00:00, 48359092.07it/s]
Data ready, conversion to array
Adding keys to HDF5…  "ch_12"
 62%|        | 13/21 [02:26<01:27, 10.97s/it]

t_12      int16
t_L       int16
dS_12     uint16
dtype: object
Start conversion of 13 channel
t_13 valid_tdc_13
..

34479683it [00:17, 38911233.85it/s]


  0%|              | 0/33663384 [00:00<?, ?it/s]

 15%|          | 5049495/33663384 [00:00<00:00, 48181443.40it/s]

 25%|          | 8415825/33663384 [00:00<00:00, 41347700.49it/s]

 35%|          | 11782155/33663384 [00:00<00:00, 38644031.47it/s]
```

```
47%|          | 15821751/33663384 [00:00<00:00, 39111265.36it/s]


58%|          | 19524714/33663384 [00:00<00:00, 37644872.14it/s]


68%|          | 22891044/33663384 [00:00<00:00, 35490393.50it/s]


78%|          | 26257374/33663384 [00:00<00:00, 34904380.46it/s]


91%|          | 30633603/33663384 [00:00<00:00, 36656850.26it/s]
Data ready, conversion to array
Adding keys to HDF5…  "ch_13"
 67%|          | 14/21 [02:37<01:16, 10.88s/it]

t_13     int16
t_L      int16
dS_13    uint16
dtype: object
Start conversion of 14 channel
t_14 valid_tdc_14
..


33663098it [00:16, 48359092.07it/s]


  0%|          | 0/34238815 [00:00<?, ?it/s]


13%|          | 4451044/34238815 [00:00<00:00, 41289282.48it/s]


24%|          | 8217312/34238815 [00:00<00:00, 39954252.51it/s]


35%|          | 11983580/34238815 [00:00<00:00, 39102370.29it/s]


46%|          | 15749848/34238815 [00:00<00:00, 38490653.26it/s]
```

```
 57%|          | 19516116/34238815 [00:00<00:00, 37922192.52it/s]


 68%|          | 23282384/34238815 [00:00<00:00, 37527444.11it/s]


 79%|          | 27048652/34238815 [00:00<00:00, 37346396.83it/s]


 90%|          | 30814920/34238815 [00:00<00:00, 36952159.10it/s]


34581188it [00:00, 36861808.18it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_14"

34479683it [00:33, 1039162.71it/s]
33663098it [00:22, 1485431.82it/s]
33999933it [00:12, 2677622.33it/s]
34581188it [00:01, 24488760.65it/s]
 71%|        | 15/21 [02:48<01:06, 11.09s/it]

t_14      int16
t_L       int16
dS_14     uint16
dtype: object
Start conversion of 15 channel
t_15 valid_tdc_15
..


  0%|          | 0/34603169 [00:00<?, ?it/s]
 12%|          | 4152372/34603169 [00:00<00:00, 38387537.25it/s]
 21%|          | 7266651/34603169 [00:00<00:00, 35315203.23it/s]
 31%|          | 10726961/34603169 [00:00<00:00, 34735236.57it/s]
 41%|          | 14187271/34603169 [00:00<00:00, 34369912.12it/s]
 51%|          | 17647581/34603169 [00:00<00:00, 33347011.94it/s]
 60%|          | 20761860/34603169 [00:00<00:00, 32277501.88it/s]
 70%|          | 24222170/34603169 [00:00<00:00, 32328348.91it/s]
 80%|          | 27682480/34603169 [00:00<00:00, 32186891.98it/s]
 89%|          | 30796759/34603169 [00:00<00:00, 31807171.46it/s]
 99%|          | 34257069/34603169 [00:01<00:00, 32239734.83it/s]
```

```
Data ready, conversion to array
Adding keys to HDF5…  "ch_15"

 76%|        | 16/21 [03:00<00:57, 11.42s/it]

t_15      int16
t_L       int16
dS_15    uint16
dtype: object
Start conversion of 16 channel
t_16 valid_tdc_16
..




  0%|            | 0/33932258 [00:00<?, ?it/s]

 13%|            | 4411186/33932258 [00:00<00:00, 42378974.54it/s]

 24%|            | 8143728/33932258 [00:00<00:00, 40285737.97it/s]

 34%|            | 11536948/33932258 [00:00<00:00, 37145661.91it/s]

 46%|            | 15608812/33932258 [00:00<00:00, 37448279.00it/s]

 58%|            | 19680676/33932258 [00:00<00:00, 37608248.84it/s]

 70%|            | 23752540/33932258 [00:00<00:00, 37675983.11it/s]

 80%|            | 27145760/33932258 [00:00<00:00, 35034448.97it/s]

 92%|            | 31217624/33932258 [00:00<00:00, 35708054.24it/s]
Data ready, conversion to array
Adding keys to HDF5…  "ch_16"

 81%|        | 17/21 [03:12<00:45, 11.33s/it]

t_16      int16
t_L       int16
dS_16    uint16
dtype: object
Start conversion of 17 channel
t_17 valid_tdc_17
..




  0%|            | 0/33312586 [00:00<?, ?it/s]
```

```
 15%|          | 4996875/33312586 [00:00<00:00, 48049035.74it/s]


 29%|          | 9660625/33312586 [00:00<00:00, 46768354.93it/s]


 43%|          | 14324375/33312586 [00:00<00:00, 45926339.15it/s]


 57%|          | 18988125/33312586 [00:00<00:00, 45369070.84it/s]


 70%|          | 23318750/33312586 [00:00<00:00, 44342163.17it/s]


 84%|          | 27982500/33312586 [00:00<00:00, 44257555.53it/s]
34271522it [00:11, 35708054.24it/s]


 97%|          | 32313125/33312586 [00:00<00:00, 43573271.11it/s]
Data ready, conversion to array
Adding keys to HDF5…  "ch_17"
 86%|          | 18/21 [03:22<00:33, 11.04s/it]

t_17      int16
t_L       int16
dS_17     uint16
dtype: object
Start conversion of 18 channel
t_18 valid_tdc_18
..




  0%|          | 0/33569272 [00:00<?, ?it/s]



 15%|          | 5035380/33569272 [00:00<00:00, 48449838.56it/s]



 28%|          | 9399376/33569272 [00:00<00:00, 46108128.56it/s]
```

```
 41%|          | 13763372/33569272 [00:00<00:00, 44774999.70it/s]


33645625it [00:10, 43573271.11it/s]



 54%|          | 18127368/33569272 [00:00<00:00, 43832097.62it/s]



 67%|          | 22491364/33569272 [00:00<00:00, 43507095.46it/s]



 80%|          | 26855360/33569272 [00:00<00:00, 43532869.33it/s]



 94%|          | 31555048/33569272 [00:00<00:00, 43728761.10it/s]
Data ready, conversion to array
Adding keys to HDF5…  "ch_18"

34949131it [00:34, 1018036.58it/s]
34271522it [00:22, 1525526.23it/s]
33645625it [00:11, 2935665.37it/s]
33904892it [00:01, 29929514.44it/s]
 90%|          | 19/21 [03:33<00:21, 10.93s/it]

t_18       int16
t_L        int16
dS_18      uint16
dtype: object
Start conversion of 19 channel
t_19 valid_tdc_19
..


  0%|          | 0/33634049 [00:00<?, ?it/s]
 15%|          | 5045100/33634049 [00:00<00:00, 47439840.36it/s]
 28%|          | 9417520/33634049 [00:00<00:00, 45851036.88it/s]
 41%|          | 13789940/33634049 [00:00<00:00, 44979971.37it/s]
 55%|          | 18498700/33634049 [00:00<00:00, 44650788.05it/s]
 68%|          | 22871120/33634049 [00:00<00:00, 43588694.11it/s]
 81%|          | 27243540/33634049 [00:00<00:00, 43498044.21it/s]
 94%|          | 31615960/33634049 [00:00<00:00, 43392358.70it/s]
```

```
Data ready, conversion to array
Adding keys to HDF5…  "ch_19"

 95%|       | 20/21 [03:43<00:10, 10.69s/it]

t_19      int16
t_L       int16
dS_19     uint16
dtype: object
Start conversion of 20 channel
t_20 valid_tdc_20
..


  0%|           | 0/32382400 [00:00<?, ?it/s]

 23%|        | 7447952/32382400 [00:00<00:00, 71672861.08it/s]

 44%|        | 14248256/32382400 [00:00<00:00, 70033652.38it/s]

 65%|        | 21048560/32382400 [00:00<00:00, 68968268.11it/s]

 86%|        | 27848864/32382400 [00:00<00:00, 67992299.35it/s]

Data ready, conversion to array
Adding keys to HDF5…  "ch_20"

100%|       | 21/21 [03:51<00:00, 11.04s/it]

t_20      int16
t_L       int16
dS_20     uint16
dtype: object
Data saved:  /mnt/Disk1T/dataSlowDisk/data-2021-02-02-BCD_cooled_Fluorescein1:10
00/output/512x512_250us_FOV_25um_laser53_40MHz_data-1612264699077773_cooled_BCD_
minus15_holdoff100_4-raw.h5
```

5 Timing calibration of data

```python
[14]: calibDict=ttp.calculateCalibFromH5(filenameH5=myReturn['filenameH5'],     #the
      ↪HDF5 file input
                                 listChannel=range(0,nchannel) #list of
      ↪channel [0,mchannel]
                                 )
```

```
33970340it [00:15, 2169615.28it/s]
100%|       | 32382400/32382400 [00:05<00:00, 5672116.66it/s]
```

```
100%|        | 21/21 [03:10<00:00,  9.09s/it]
```

```
[15]: table_channels={}
      for i in tqdm(range(nchannel)):
          table_channels[i] = ttp.applyCalibDict(myReturn['filenameH5'],
                              channel=i,
                              calibDict=calibDict)
```

```
HBox(children=(HTML(value=''), FloatProgress(value=0.0, max=21.0),␣
 ↪HTML(value='')))
```

6   TCSPC Histograms processing

```
[16]: dt_mod={}

      for i in tqdm(range(nchannel)):

          df = table_channels[i]
          dt_mod[i] = np.mod(df['dt_'+str(i)],laser_ps)
```

```
HBox(children=(HTML(value=''), FloatProgress(value=0.0, max=21.0),␣
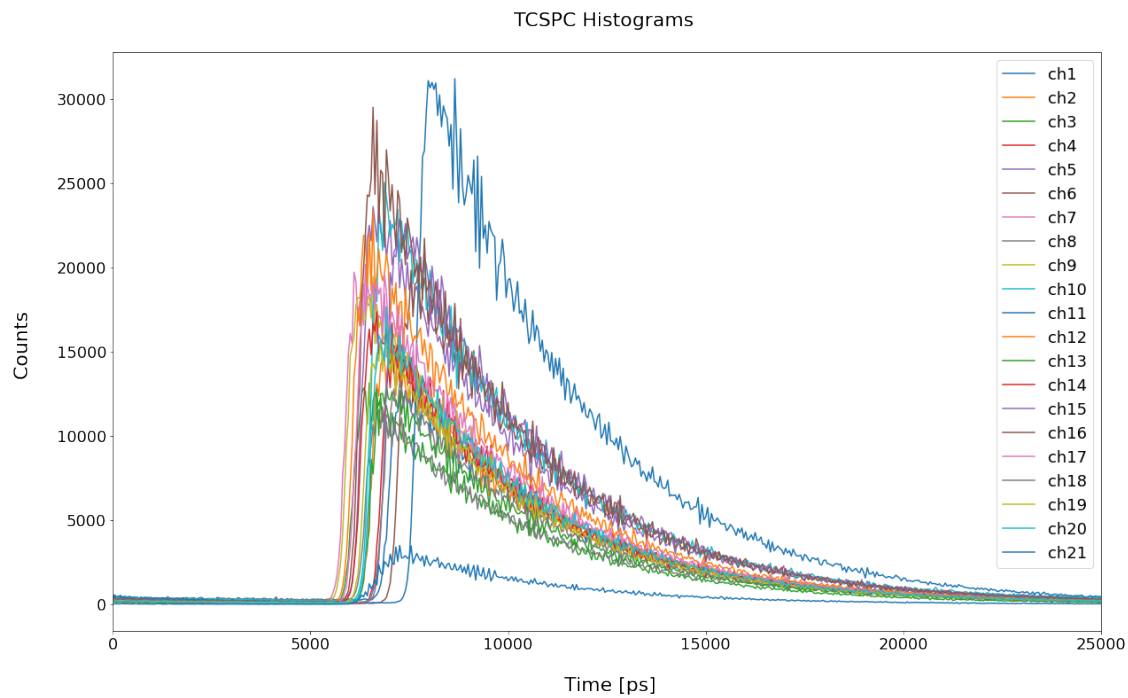 ↪HTML(value='')))
```

7   TCSPC Histograms plots

```
[17]: figure(figsize(20,12))
      fig=plt.figure()
      b={}
      decay={}
      nbins=int(round(laser_ps/kC4))
      x=linspace(0,laser_ps,nbins)
      for k in tqdm(range(nchannel)):
          decay[k],b[k]=histogram(np.flip(dt_mod[k]), range=[0,laser_ps],bins=nbins)
          decay[k]=np.flip(decay[k])
          plot(x,decay[k][:],label='ch'+str(k+1))
      legend()
      title('TCSPC Histograms \n')
      xlim(0,laser_ps)
      xlabel('\n Time [ps]')
      ylabel('Counts \n')
```

```
HBox(children=(HTML(value=''), FloatProgress(value=0.0, max=21.0),␣
 ↪HTML(value='')))
```

`[17]:` `Text(0, 0.5, 'Counts \n')`

`<Figure size 1440x864 with 0 Axes>`

`[ ]:`