General Fusion Neutron Spectrometer TDC Documentation

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Contents

1 Hardware Set-up

Wire connections for the Caen PicoTDC. Also note that the TDC is configured with the Caen Concentrator (Fers Data Concentrator DT5125) and the images below show both of their wire connections.

Figure 1: The TDC has 17 channels, including channel 0

These are input channels, where you would connect the sensors you'd want to read, i.e a laser and a SiPM.

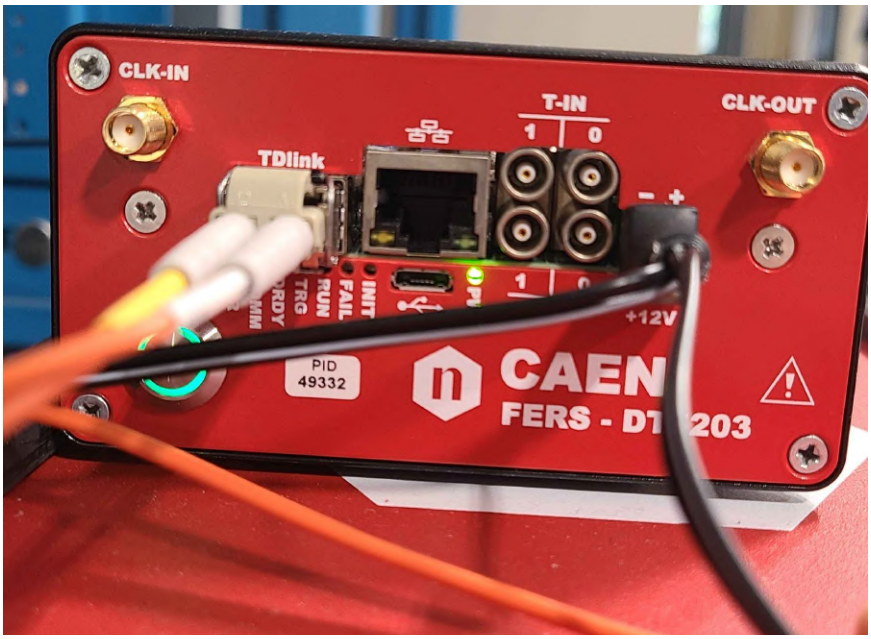


Figure 2: More wire connections for Fers-DT5203

Figure 3: Concentrator frontside

Figure 4: Concentrator backside

2 Data acquisition through Midas

2.1 Logging on and navigating the Midas frontend

Log into the General Fusion laptop using the password “GammaLaser”.
Then go to **Firefox** > **localhost:8080**.

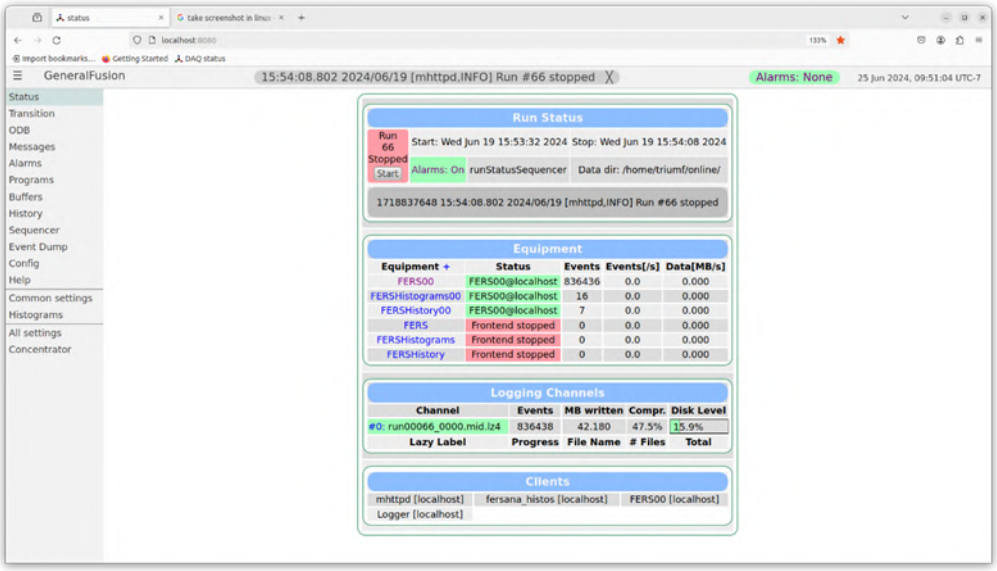


Figure 5: Midas loading page

This is the loading page. If instead you get a page saying "Unable to connect," read section 2.2. Now from the bar on the left, click on **Programs** and make sure that all programs are running. If they are not running, click **Start** for each program in the **Commands** column in the table.

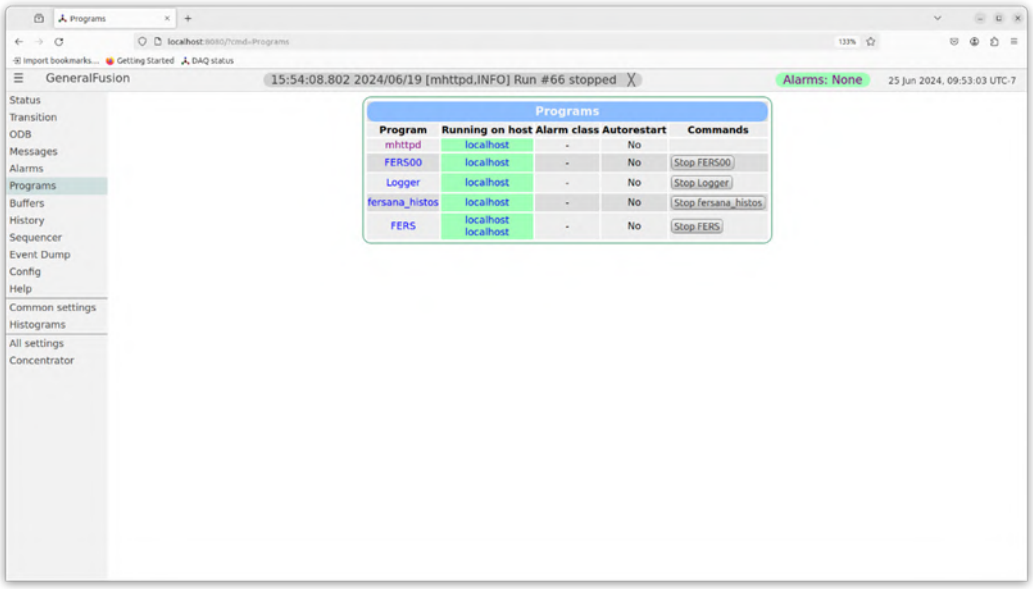


Figure 6: Programs page

Once all the programs are running, look at the left bar again and click on **Common Settings**.

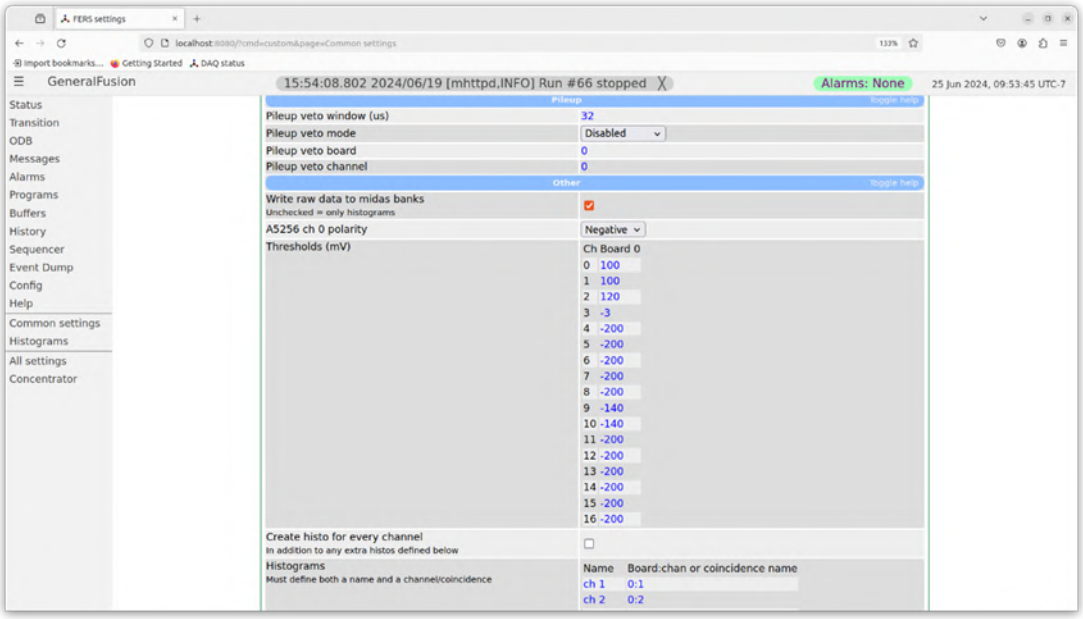


Figure 7: Common Settings window

Now if there is only one TDC channel that you want to collect data from, continue to scroll down until you reach **Thresholds(mV)** and follow the steps below. However if you need to use more than one TDC channel at once to collect data, first scroll down to the **histograms** table and fill in this into the entries for the channels that you will be using.

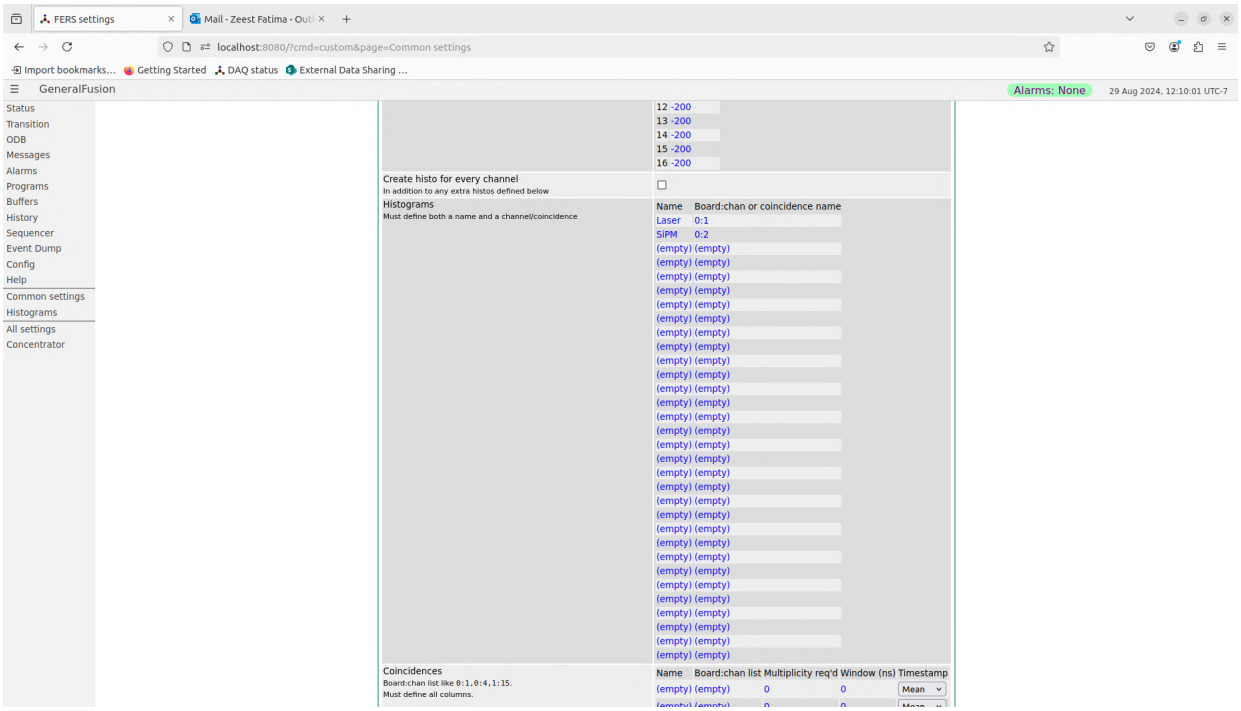
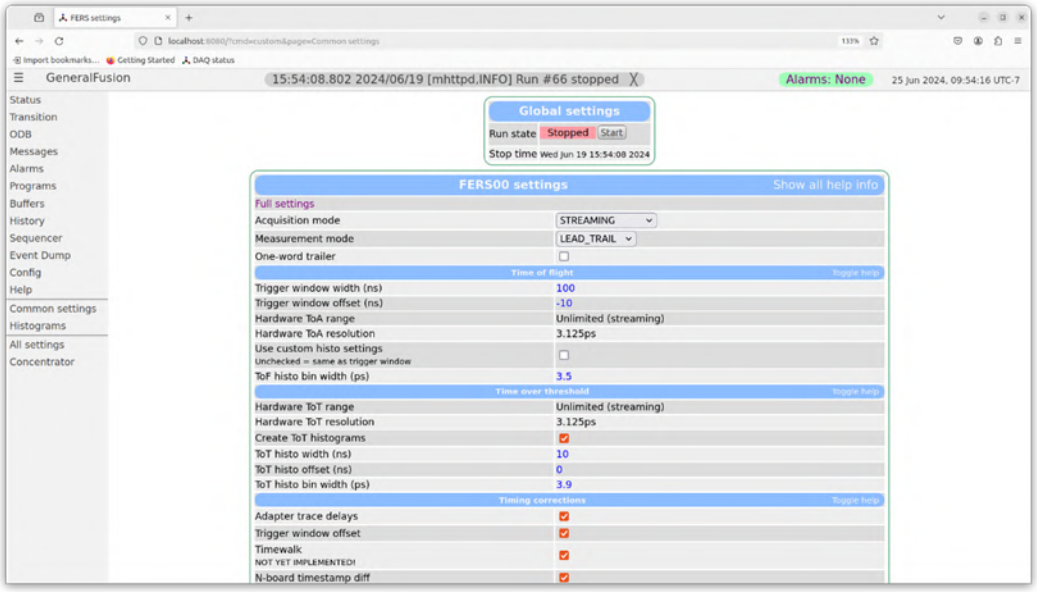


Figure 8: Add channels to collect data from

Now scroll down the table until you reach **Thresholds(mV)**. This is where you set the trigger threshold for each of the channels you'll be using. Then, once the trigger thresholds for the channels being used have been set, scroll back up and on the **Global settings** table, click **Start**.



Click **Start** at the top to save settings for the next run. Finally, from the left bar, click on **Histograms** to see live plots of Time-over-Threshold and Time-of-Flight histograms.

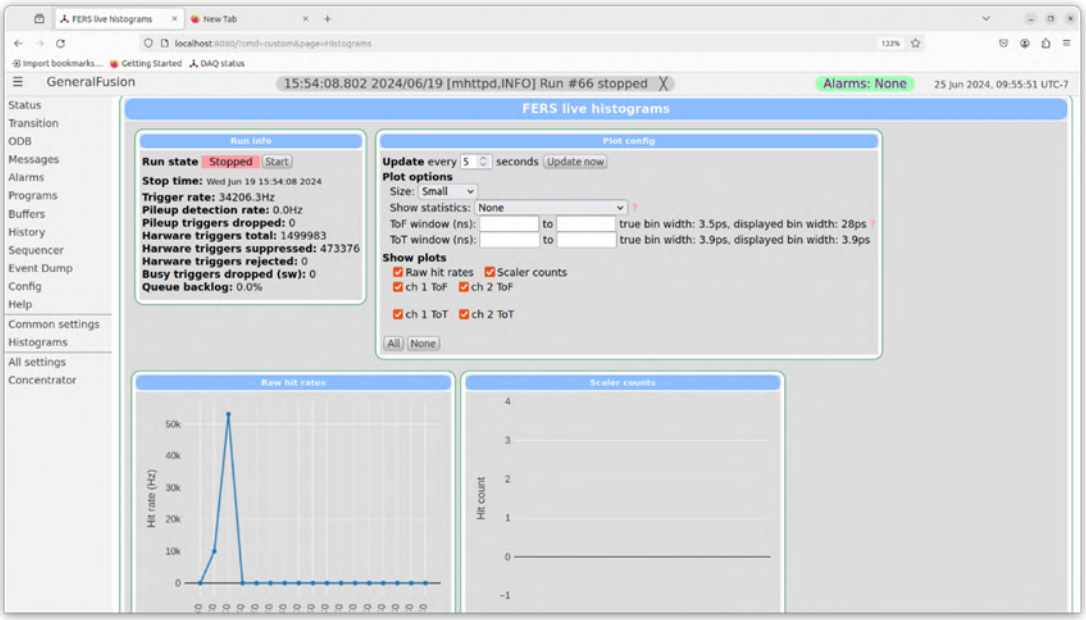


Figure 9: Histograms window

2.2 What to do if MIDAS doesn't load

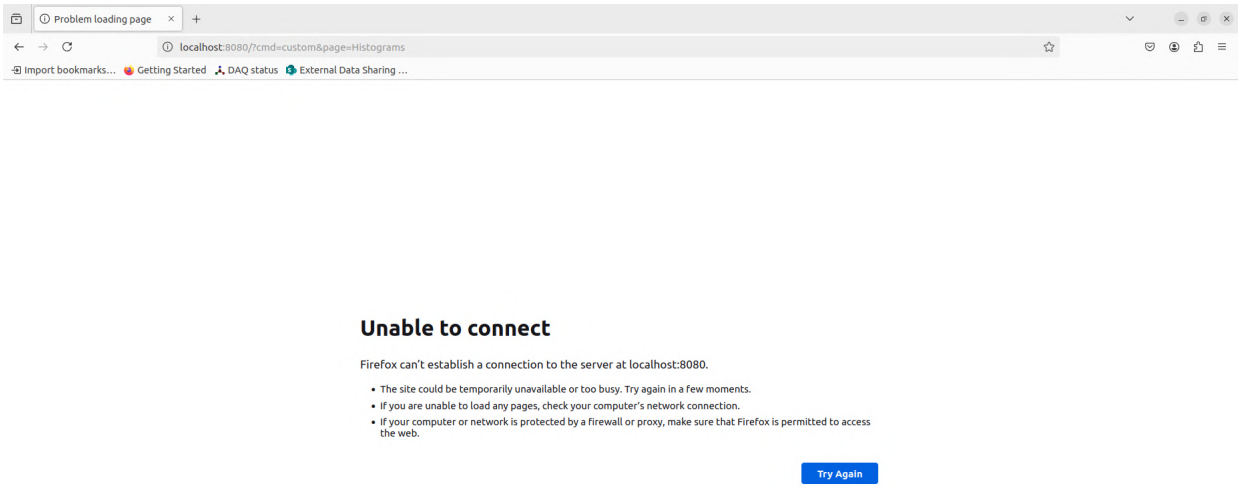


Figure 10: Midas error page

If you get this error page, it means that the Midas frontend needs to be restarted. To do that follow these steps:

- Open the bash terminal and type in these commands:

```
cd packages
cd midas
cd bin
./mhttpd
```

- Now go to the Firefox browser again and type `localhost:8080`. The midas frontend should load now.
- Then navigate to the **Programs** page on the left tab and start all the ones that are stopped.

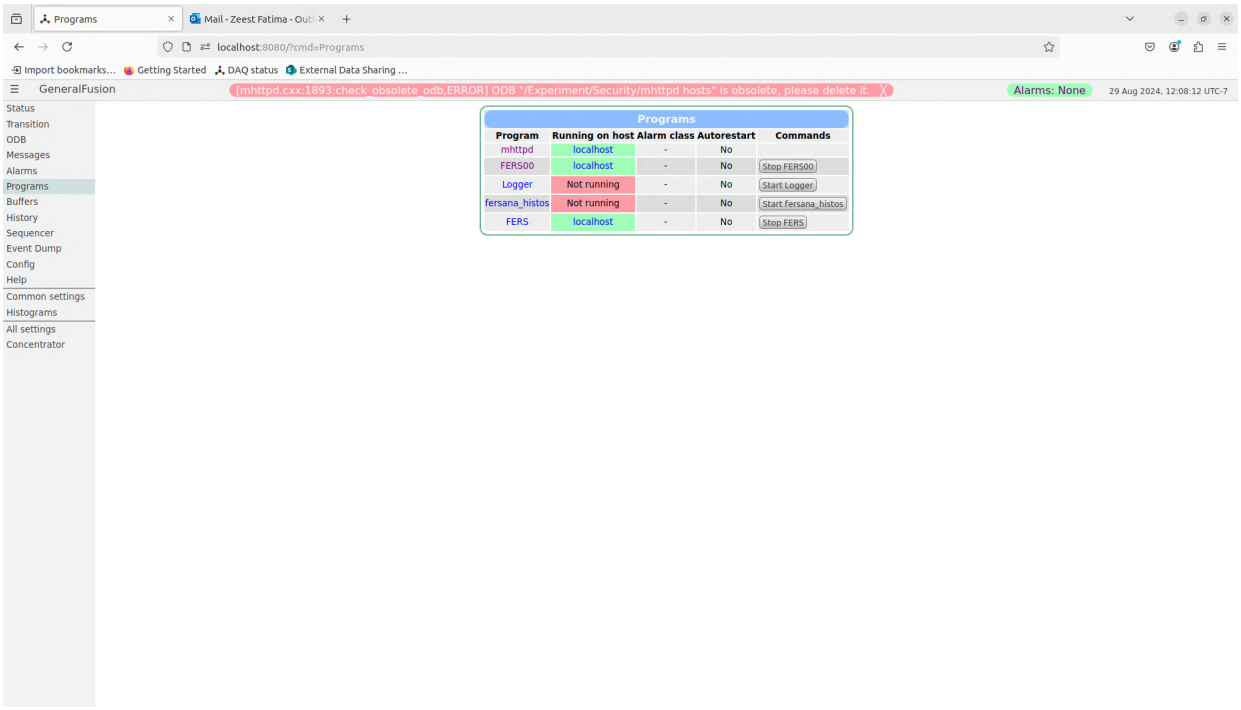


Figure 11: Start all stopped programs

2.3 Acquiring collected data:

General Fusion laptop: The data collected by the TDC is stored locally in the General Fusion laptop. To access it directly from the laptop, go to file explorer, then navigate to home/online. The files will be stored in the .lz4 format. File names of individual data runs look like `run00059_0000.mid.lz4`. There might also be multiple files for the same run, e.g. `run00059_0001.mid.lz4` and `run00059_0002.mid.lz4`.

Accessing remotely through SSH: If you are at TRIUMF on site or if you're connected to the TRIUMF VPN, you can ssh into the laptop and copy the files onto your computer. To do so, use the following command in the Windows PowerShell terminal:

```
ssh -L 8888:localhost:8080 triumf@142.90.74.161
```

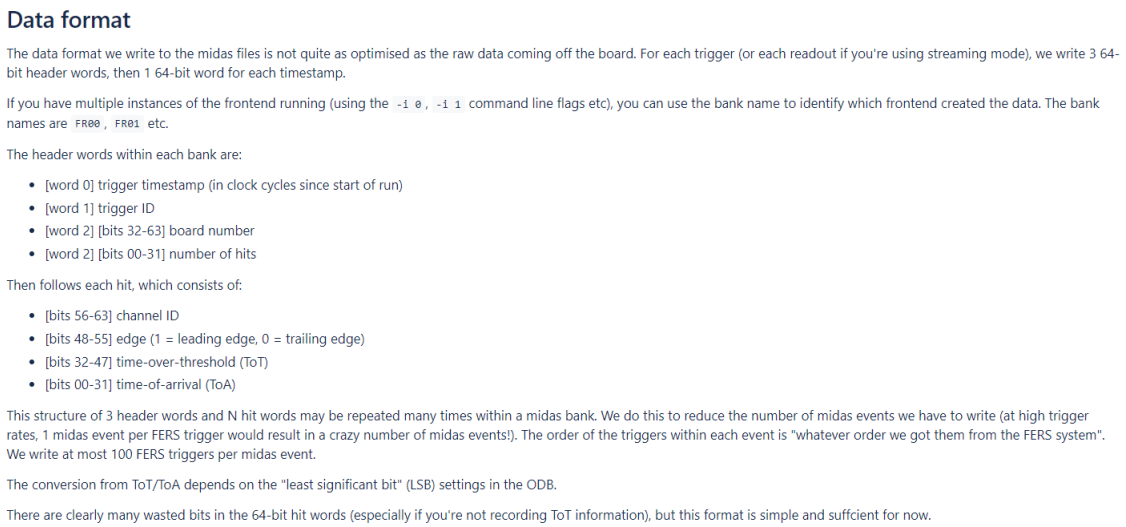
Once you have successfully ssh-ed into the laptop, you can use the following command to navigate to the home/online directory by using the command `cd online` and then using the command `ls` to look through the files in the directory, and find the file you want to download. Running the commands should look this:

```
triumf@gflap231:~$ cd online
triumf@gflap231:~/online$ ls
exptab                                          run00041_0009.mid.lz4          run00052_0003.mid.lz4
last.json                                       run00041_0009.mid.lz4.crc32c   run00052_0003.mid.lz4.crc32c
mhf_1712698521_20240409_run_transitions.dat     run00042_0000.mid.crc32c       run00053_0000.mid.crc32c
mhf_1715189877_20240508_fershistory00_0h00.dat  run00042_0000.mid.lz4          run00053_0000.mid.lz4
mhf_1715189877_20240508_fershistory00_0h01.dat  run00042_0000.mid.lz4.crc32c   run00053_0000.mid.lz4.crc32c
mhf_1715189877_20240508_fershistory00_0h02.dat  run00042_0001.mid.crc32c       run00054_0000.mid.crc32c
mhf_1715189877_20240508_fershistory00_0h03.dat  run00042_0001.mid.lz4          run00054_0000.mid.lz4
mhf_1715189877_20240508_fershistory00_0pup.dat  run00042_0001.mid.lz4.crc32c   run00054_0000.mid.lz4.crc32c
mhf_1715189877_20240508_fershistory00_0que.dat  run00042_0002.mid.crc32c       run00055_0000.mid.crc32c
mhf_1715189877_20240508_fershistory00_0t00.dat  run00042_0002.mid.lz4          run00055_0000.mid.lz4
```

Once you have found the file, you can now use the `scp` command to copy it to your computer:

```
scp triumf@142.90.74.161:/midas/file/in/laptop/path /destination/file/path
```

3 Data Analysis



Data format

The data format we write to the midas files is not quite as optimised as the raw data coming off the board. For each trigger (or each readout if you're using streaming mode), we write 3 64-bit header words, then 1 64-bit word for each timestamp.

If you have multiple instances of the frontend running (using the `-i 0`, `-i 1` command line flags etc), you can use the bank name to identify which frontend created the data. The bank names are `FR00`, `FR01` etc.

The header words within each bank are:

- [word 0] trigger timestamp (in clock cycles since start of run)
- [word 1] trigger ID
- [word 2] [bits 32-63] board number
- [word 2] [bits 00-31] number of hits

Then follows each hit, which consists of:

- [bits 56-63] channel ID
- [bits 48-55] edge (1 = leading edge, 0 = trailing edge)
- [bits 32-47] time-over-threshold (ToT)
- [bits 00-31] time-of-arrival (ToA)

This structure of 3 header words and N hit words may be repeated many times within a midas bank. We do this to reduce the number of midas events we have to write (at high trigger rates, 1 midas event per FERS trigger would result in a crazy number of midas events!). The order of the triggers within each event is "whatever order we got them from the FERS system". We write at most 100 FERS triggers per midas event.

The conversion from ToT/ToA depends on the "least significant bit" (LSB) settings in the ODB.

There are clearly many wasted bits in the 64-bit hit words (especially if you're not recording ToT information), but this format is simple and suffcient for now.

Figure 12: Data format (taken from https://bitbucket.org/ttriumfdaq/fers_5203/src/master/)

Pre-written data analysis scripts: There are some code scripts that have been written to plot Time-Over-Threshold graphs from stored data files, as well as some for other uses, including finding ToT and Single Photon Timing Resolution. These can be found at the repository below.
https://github.com/ryaneunderwood/General-Fusion-Neutron-Spectrometer/tree/main