Field response check for APA1 w

Xuyang Ning & Wenqiang Gu

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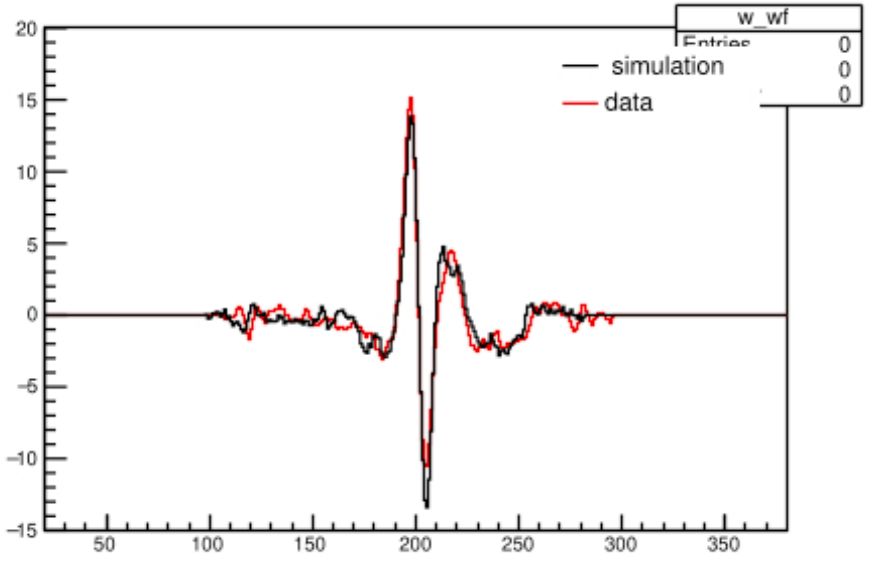
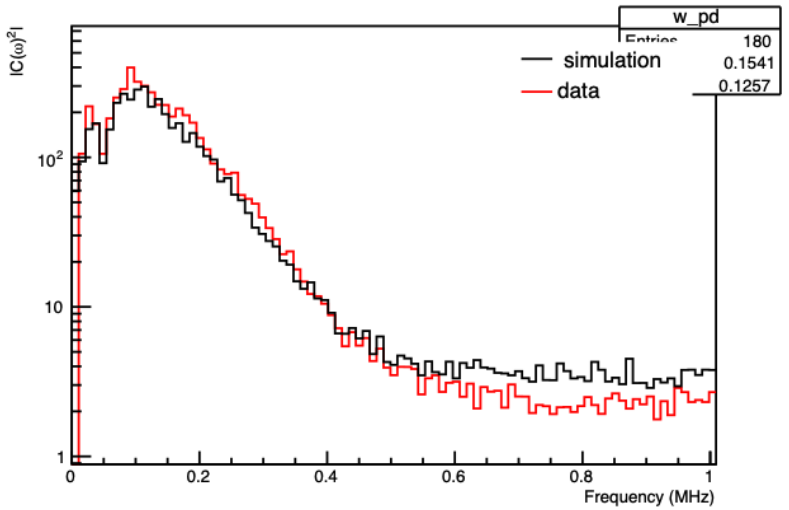
Brookhaven National Laboratory

Recap

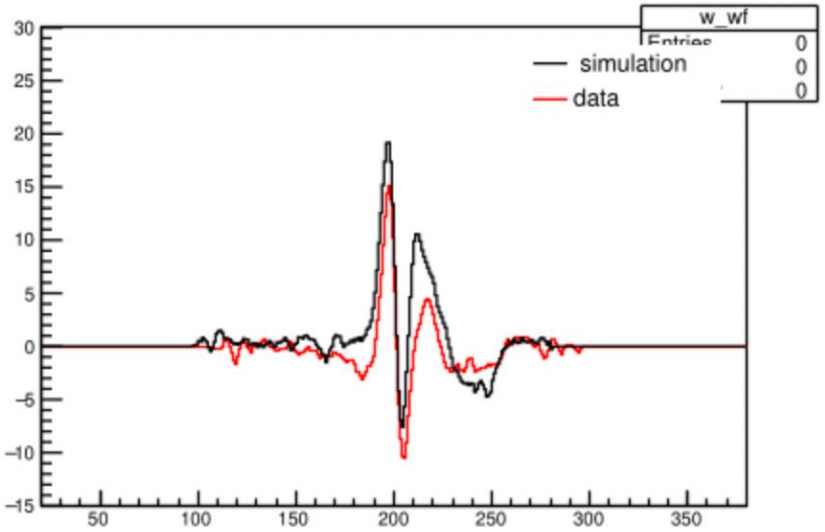
- For APA1 w plane:
- Template “fit” the shape of the data by renormalizing the electron tracks.
  - ➢“create” the shape by renormalizing the electron track at 0.4 and 0.5 pitch.
  - ➢Add time stretch.
- Signal processing may not work well.

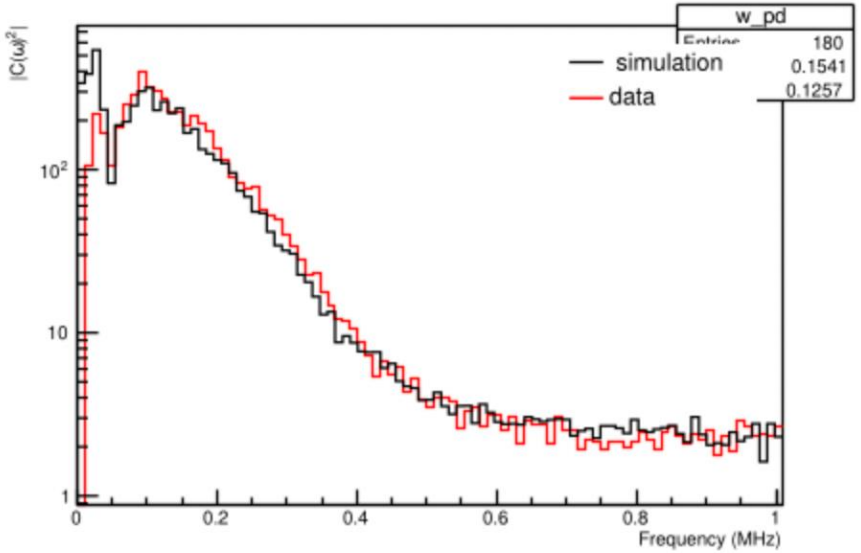




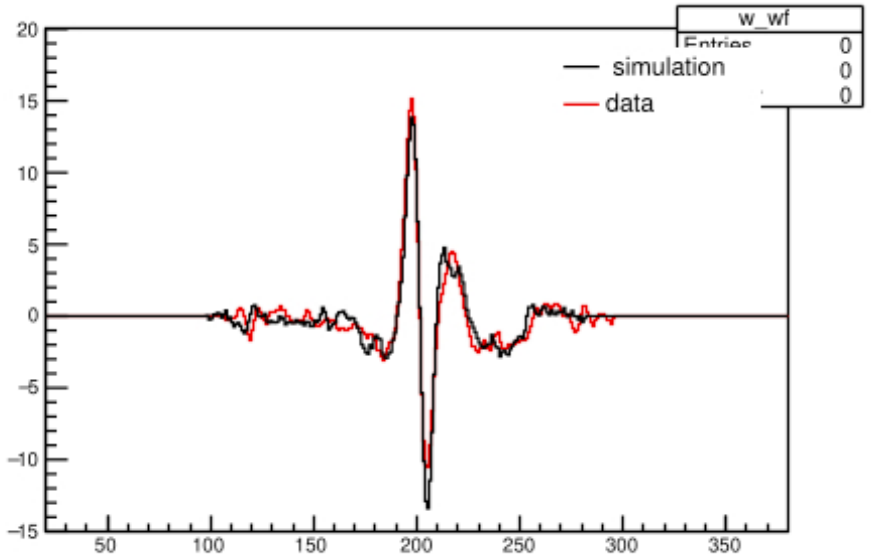
Simulation w/ and w/o CNR

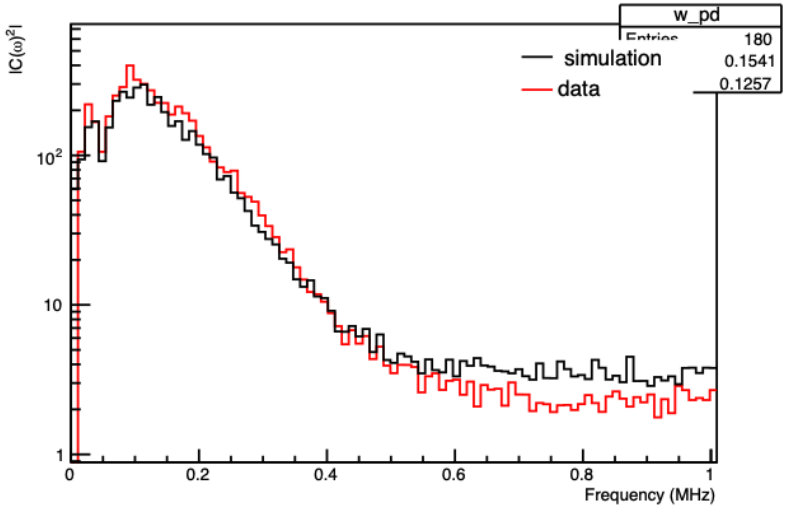
Coherent noise removal not applied





Coherent noise removal applied





Data w/ and w/o CNR

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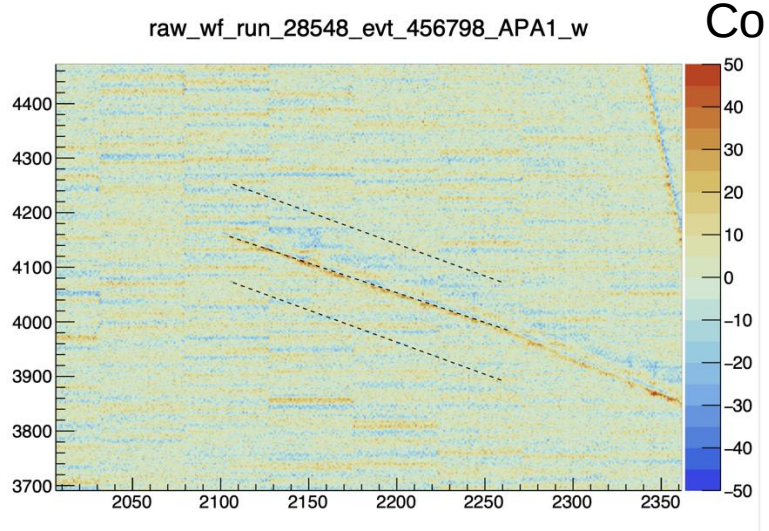
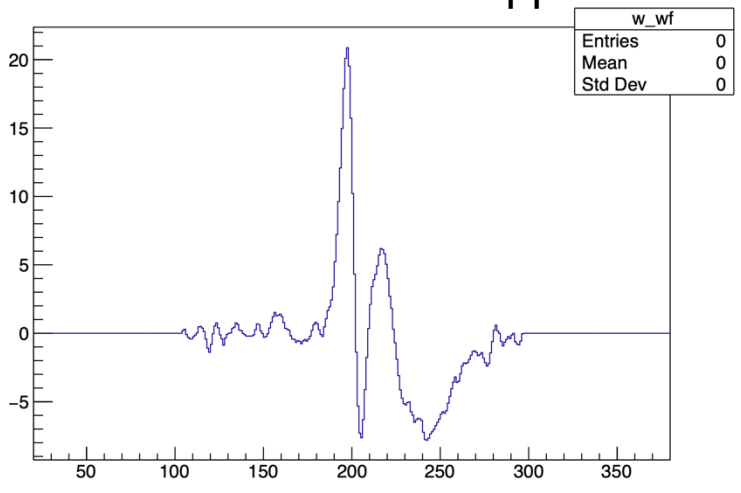
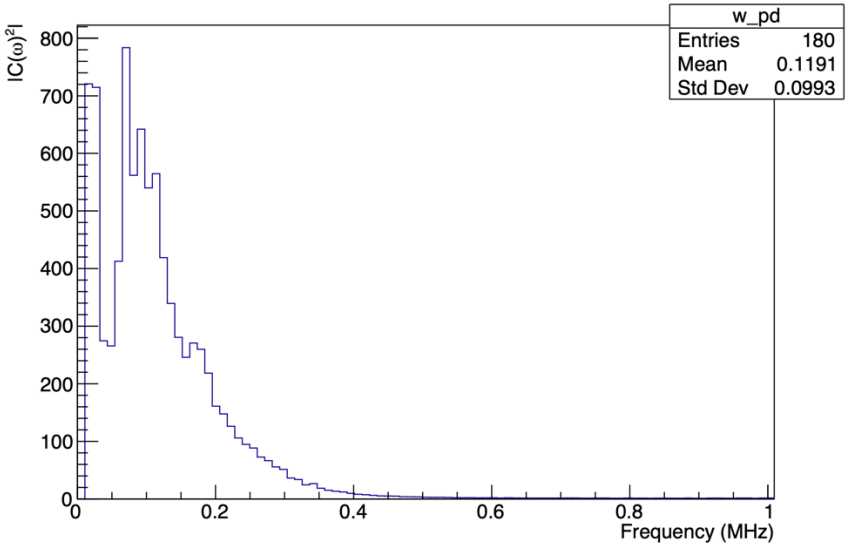
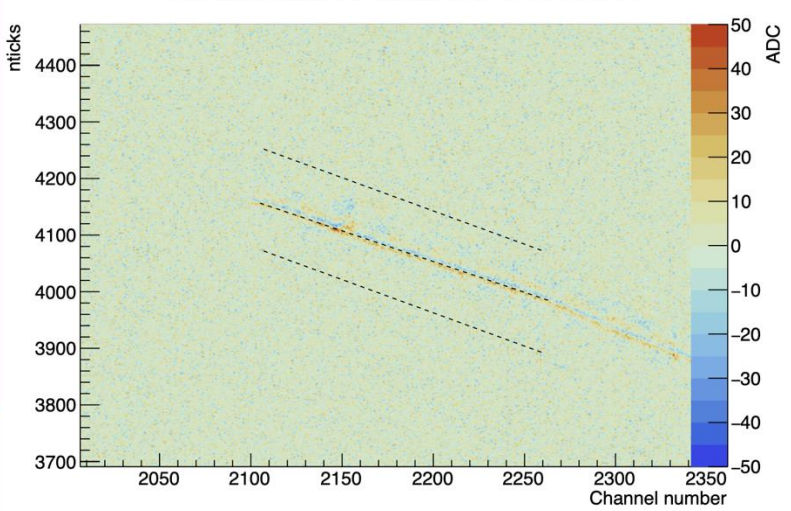
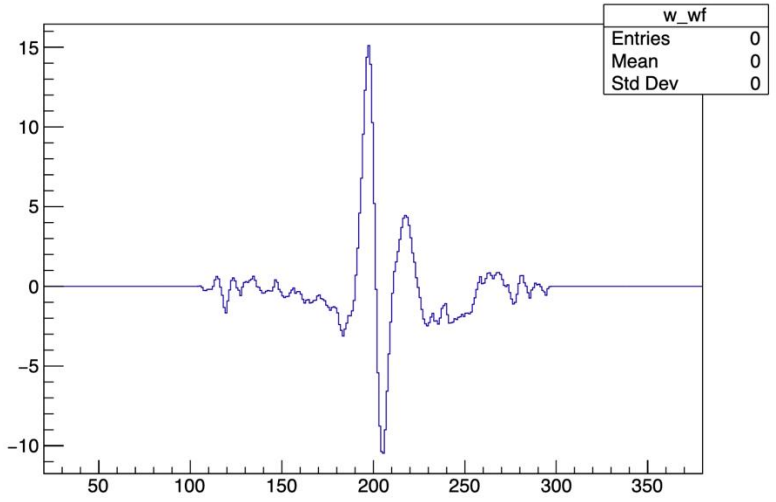


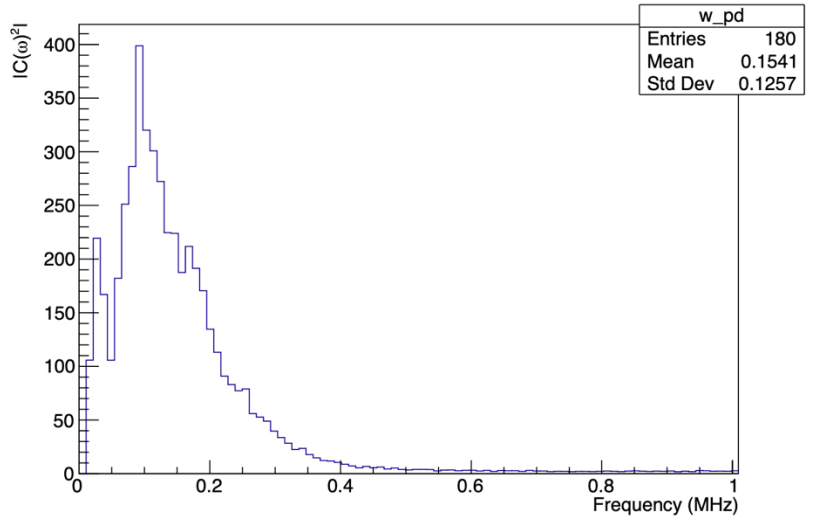




Coherent noise removal applied

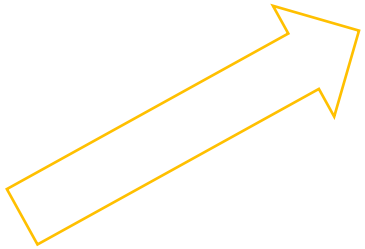






Redo everything with no CNR

- 5 Parameters
  - Different renormalizing factors to 0.4 pitch (f_5) and 0.5 pitch (f_6)
  - One starting point for the 2 electron paths
  - Two time stretch factors for 2 electron paths



- A python script to control everything:
  - Minimize T^2_{total}
  - MCMC

Generate renormalized field response from wire-cell-python

Simulation using a wire-cell-tookit

Compare data with simulation in a root script:

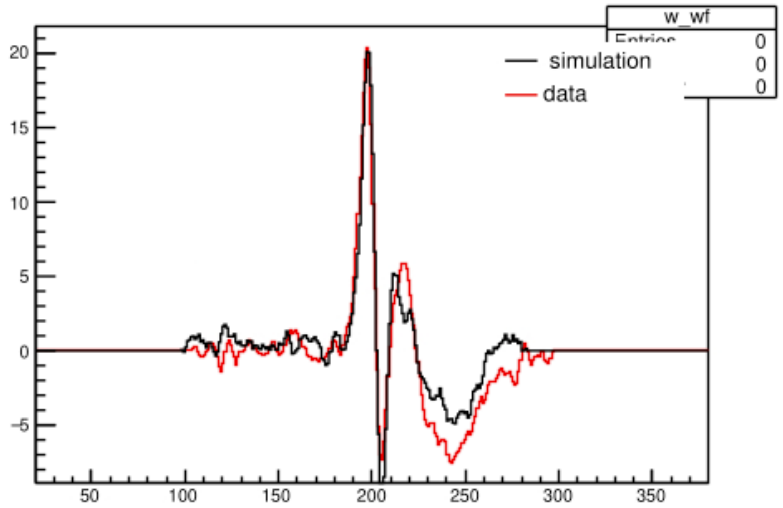
Compute a test statistic T^2_{total}

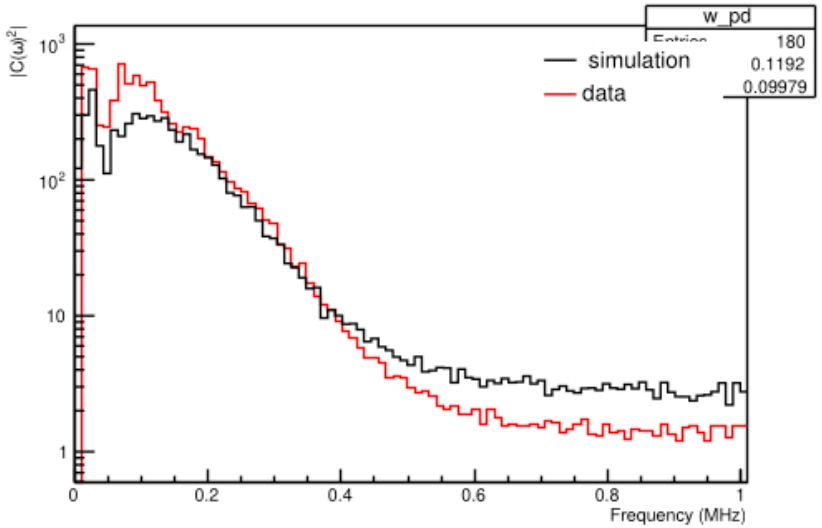
Do fitting using MCMC

- Define T^2_{total} :
  - For w plane, compare waveforms and power density spectra
  - For each plot:

$$T^2 = \sum_{i=1}^{nbins} \frac{(x_i - m_i)^2}{|m_i|} \ /nbins$$

  - T^2_{total}: For different plots in different tracks, multiply all the T^2
    - Only use 7 tracks, because the last one is strange





Do fitting using MCMC

- A very simple MCMC with the help of **OpenAI** :
  - Since the T^2_{total} is dependent on simulation, the same parameters cannot produce same result all the time.
  - MCMC only relies on the result of the last step.
  - It is easy to deal with lots of parameters.

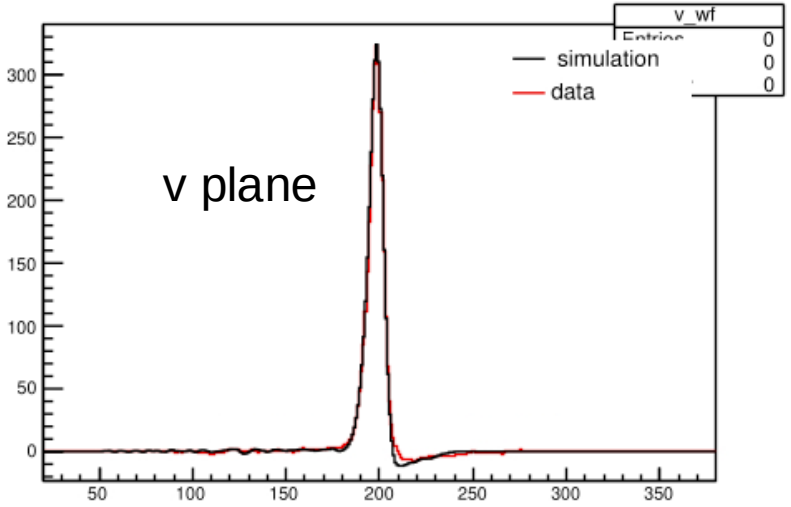
- Random walk: a new parameter set is randomly generated according to the current parameters.
  - The step size is fixed.

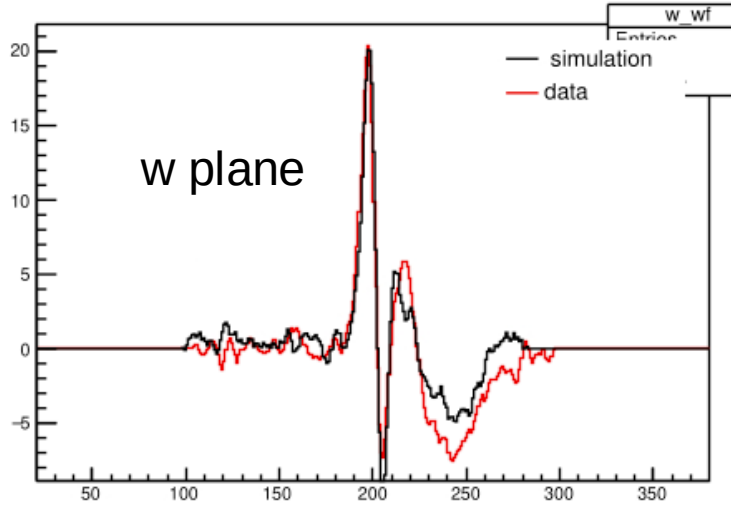
➢ If $T^2_{total}(current\ parameters) > T^2_{total}(new\ parameters)$
  ➢ Accept new parameters;
➢ Else
  ➢ $new\ parameters$ still has some chance to be accepted.
    ➢ Metropolis-Hastings acceptance rule.

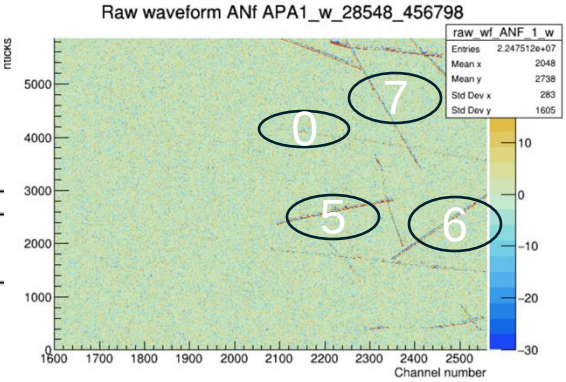
Best one this time

Track0; beam

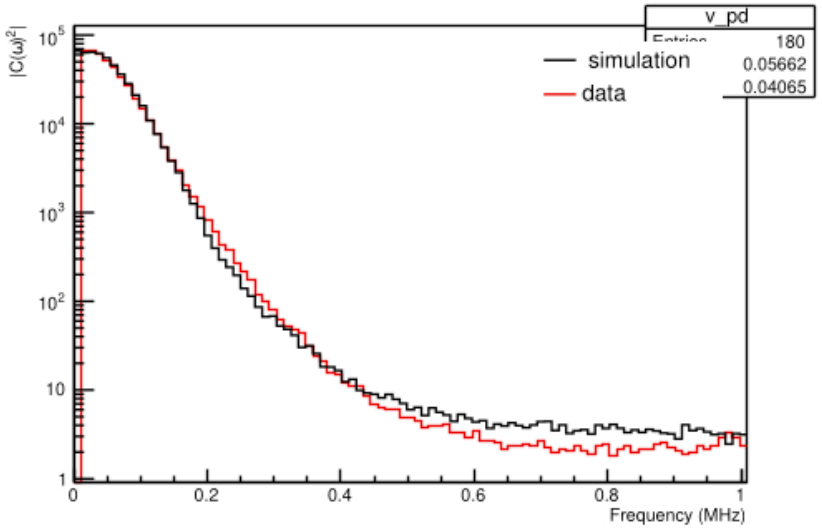
waveform

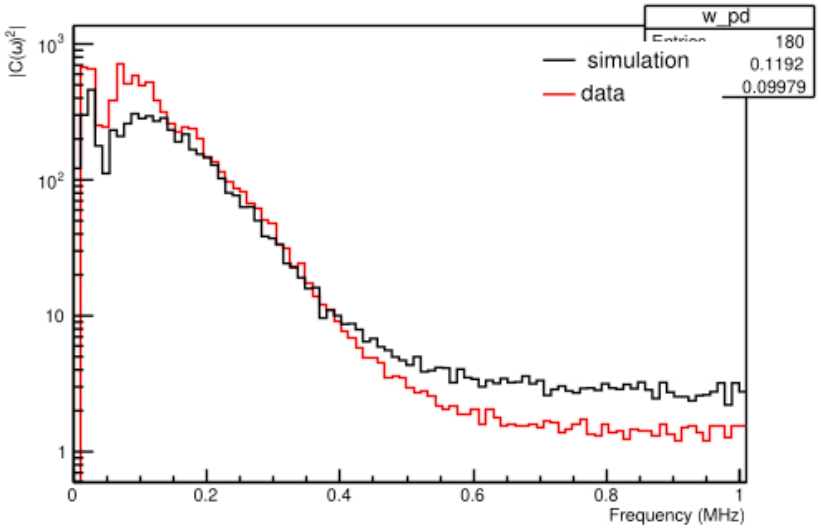






Power spectra





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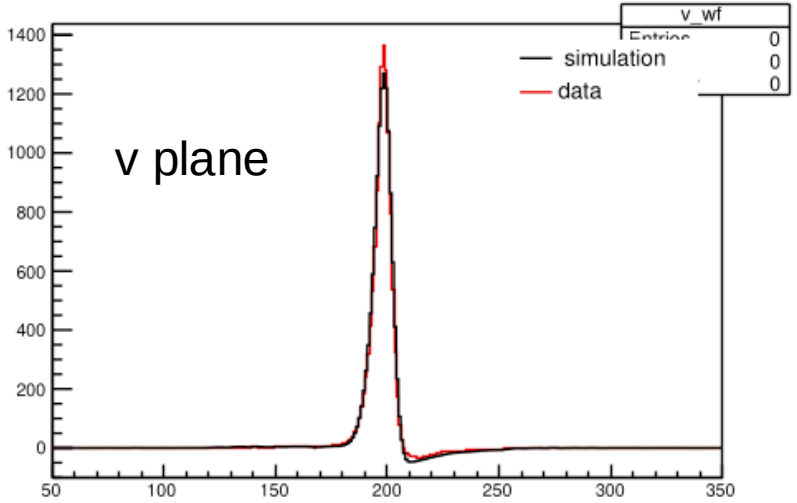
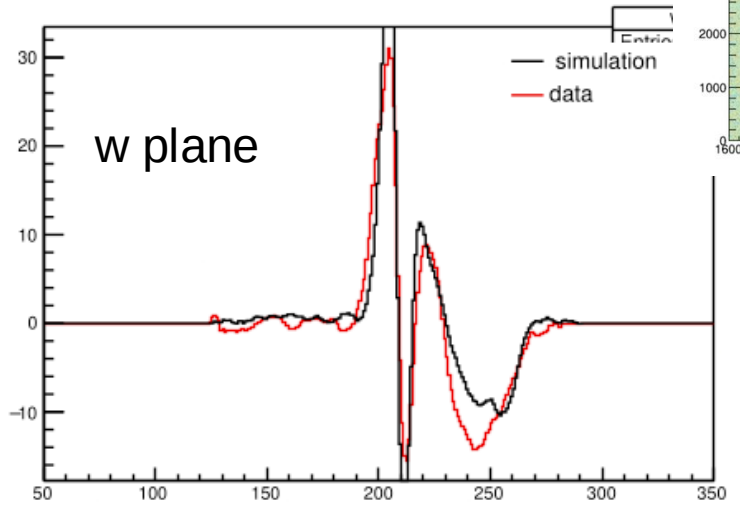
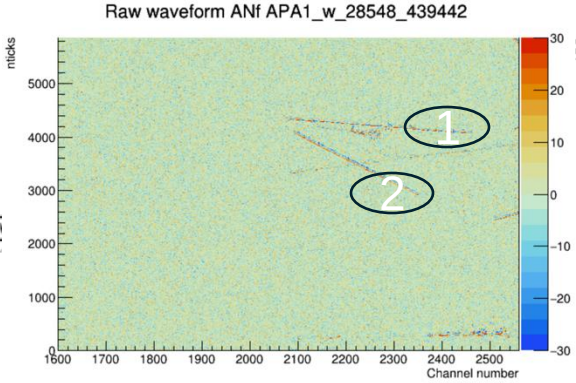
Best one this time

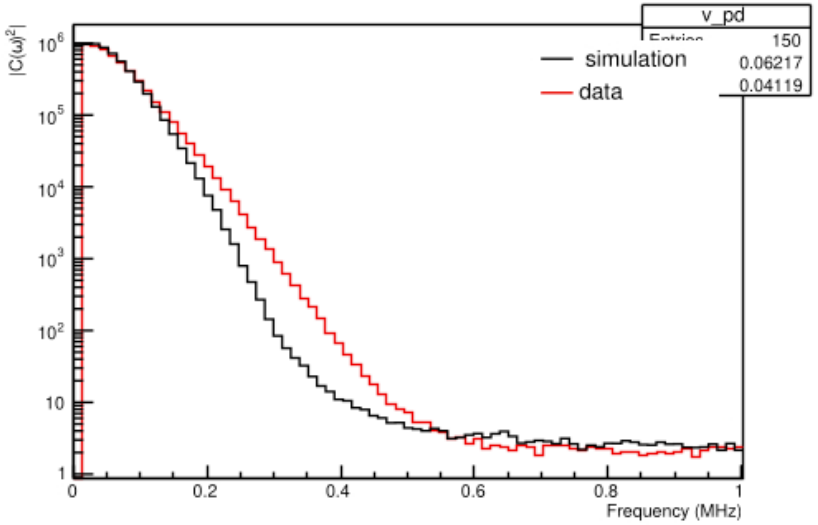
waveform

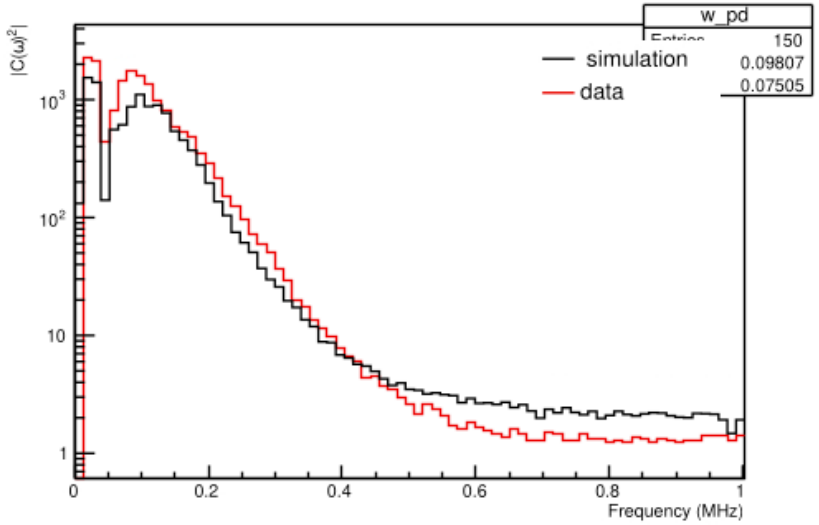






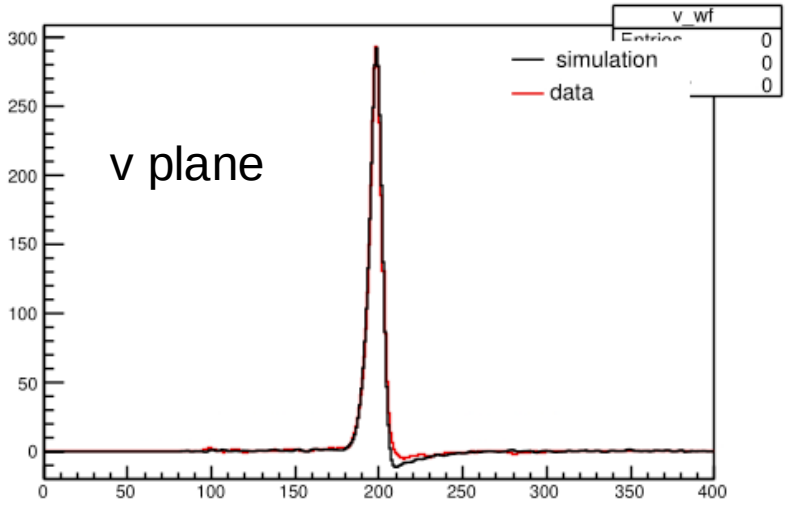
Power spectra

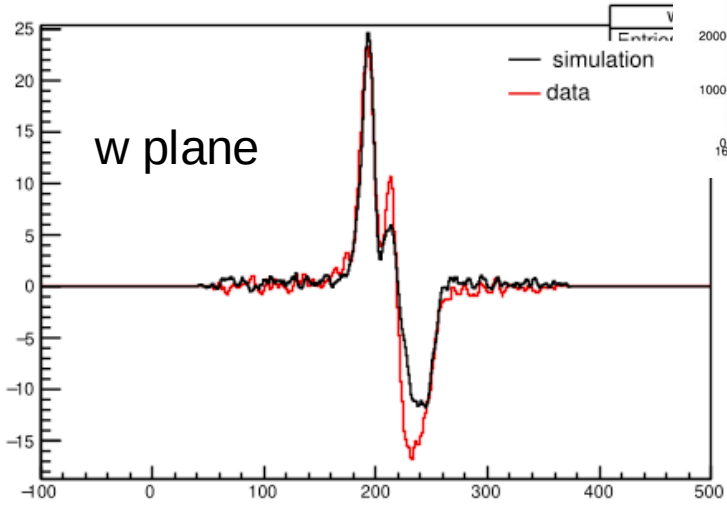


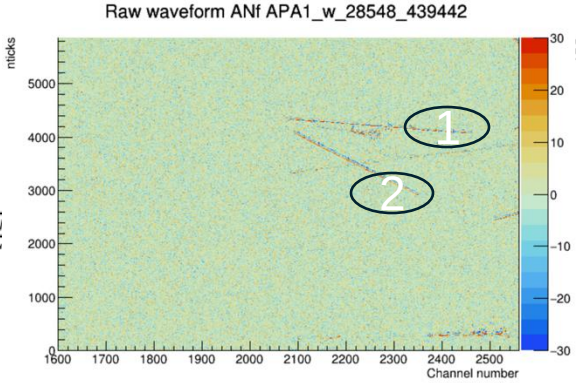


Best one this time

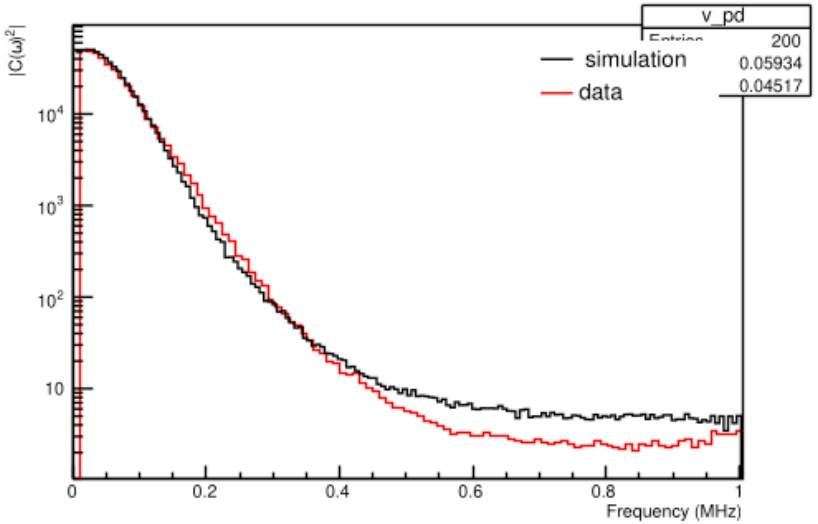
waveform

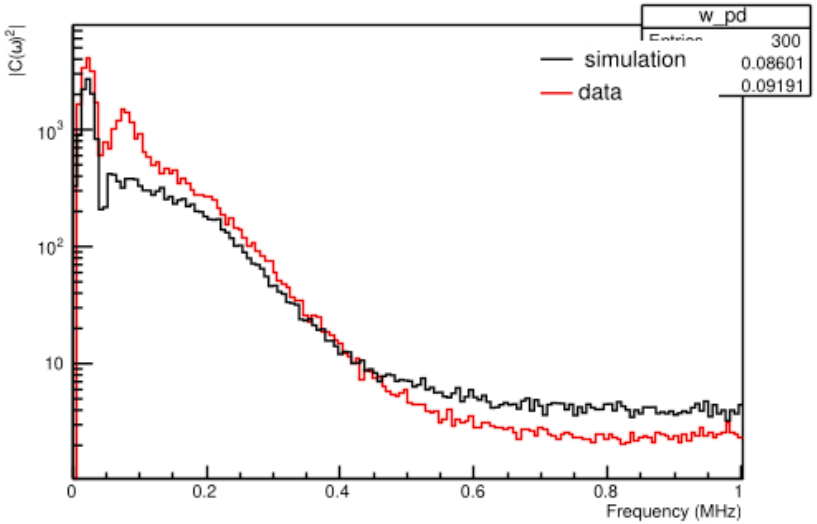






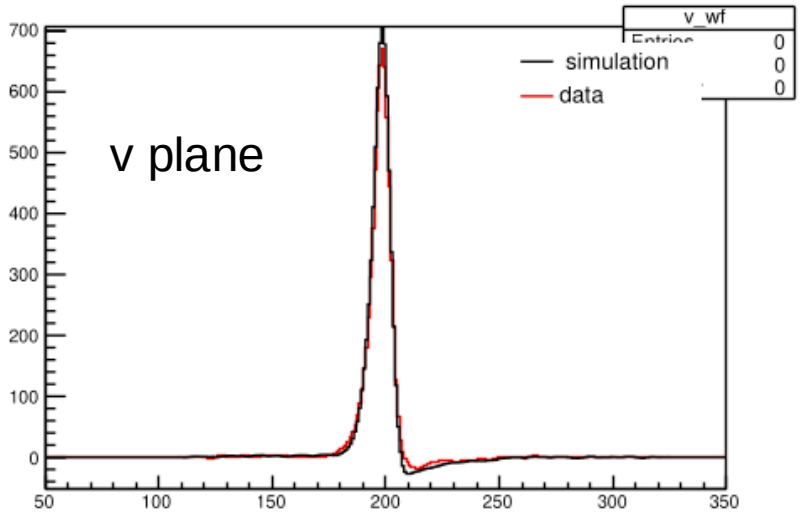
Power spectra

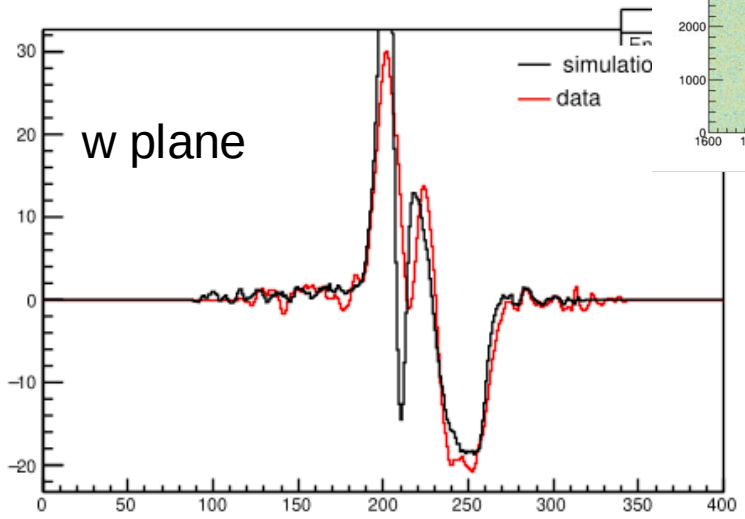


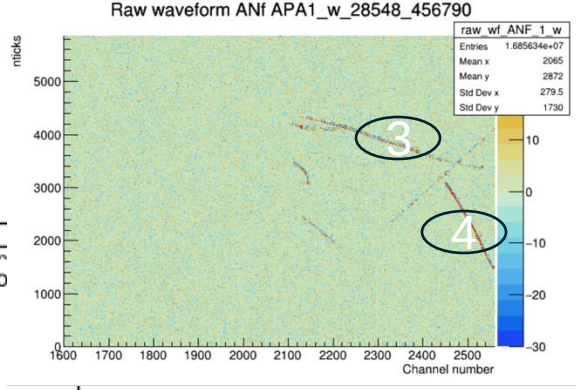


Best one this time

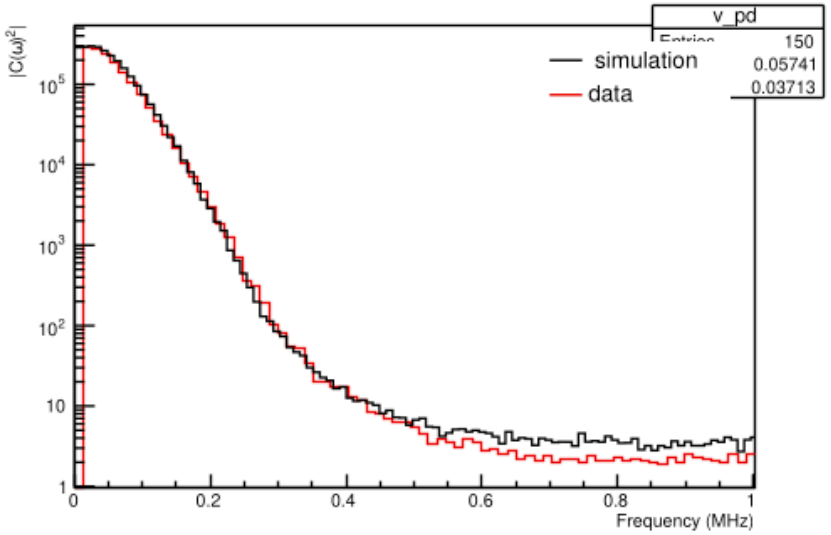
waveform

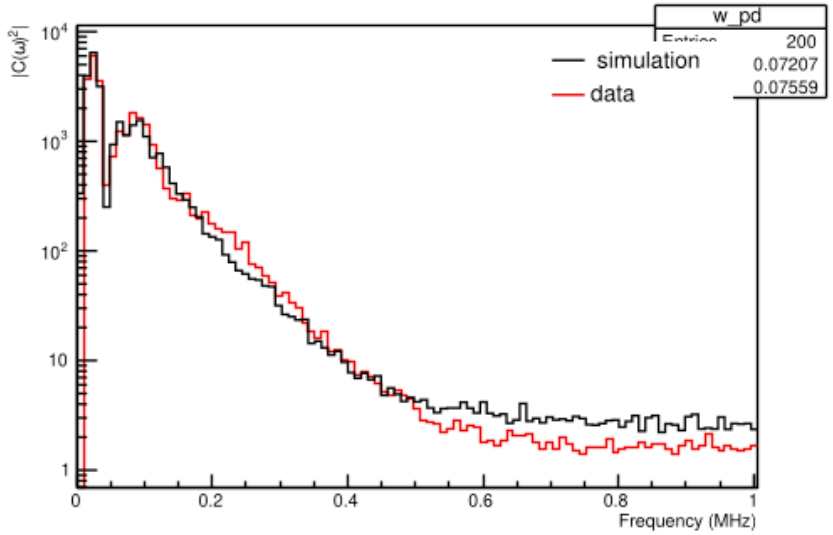






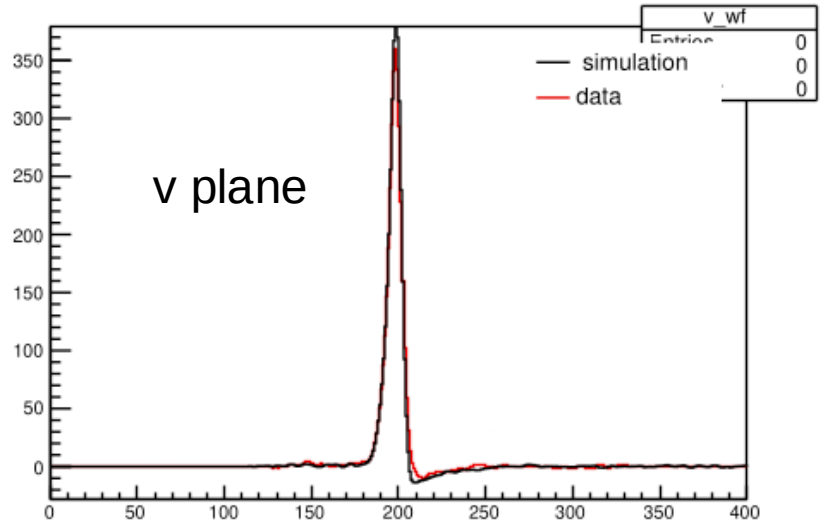
Power spectra

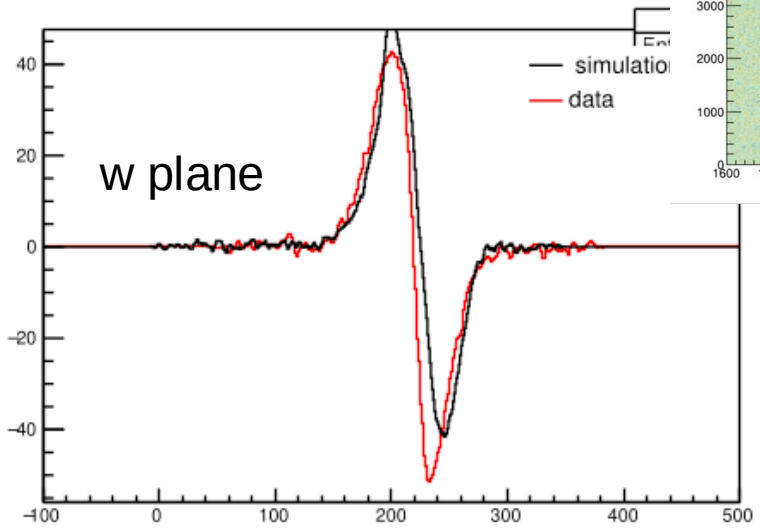


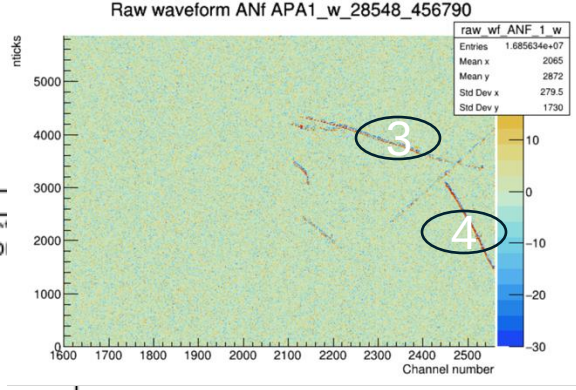


Best one this time

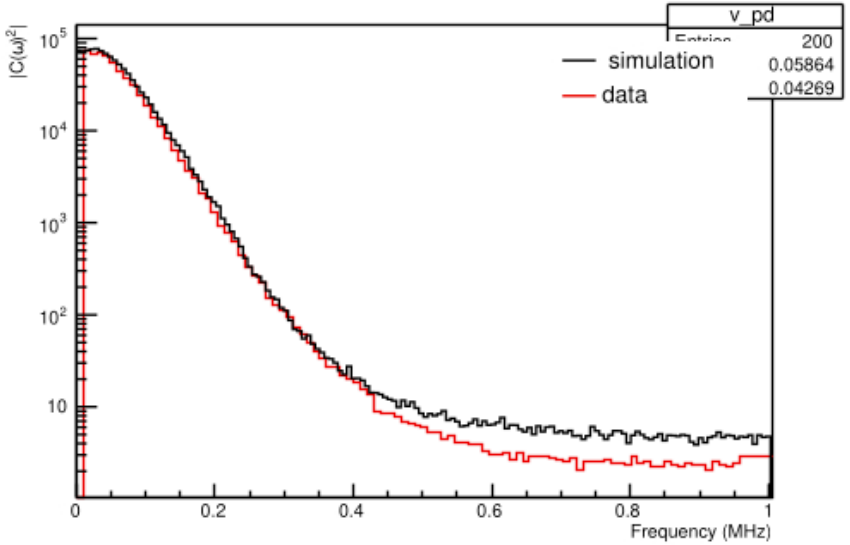
waveform

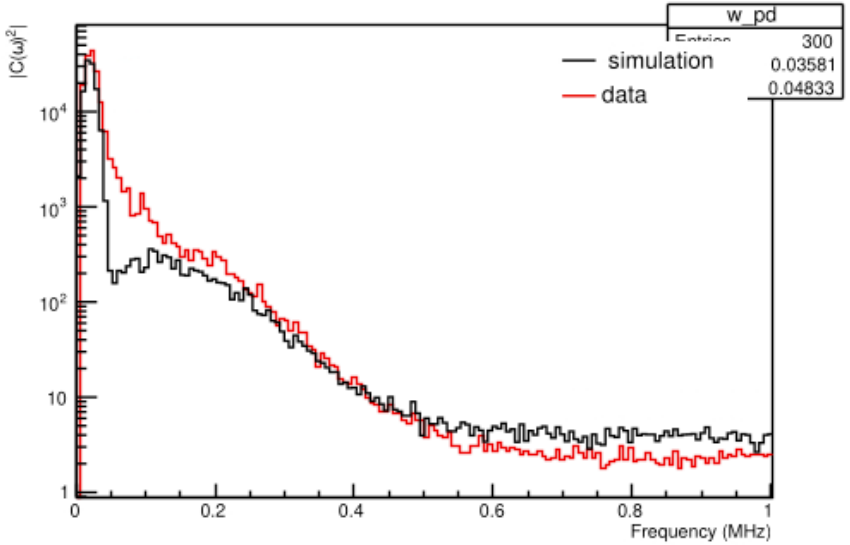






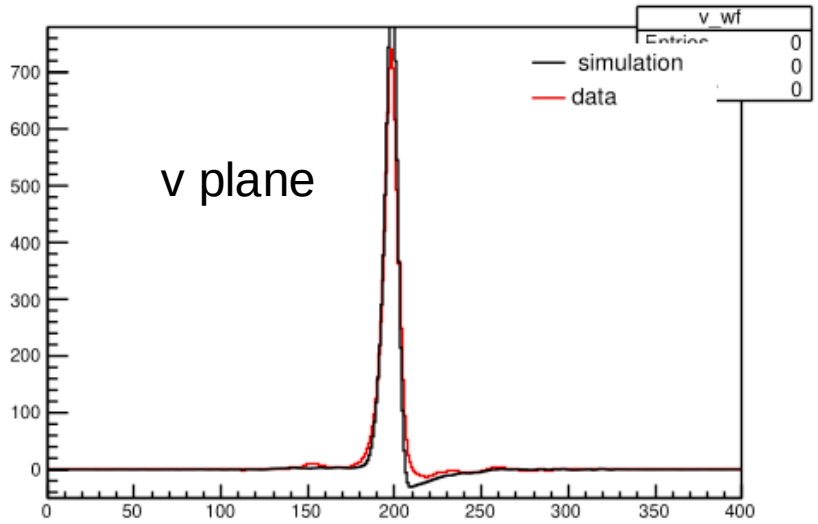
Power spectra

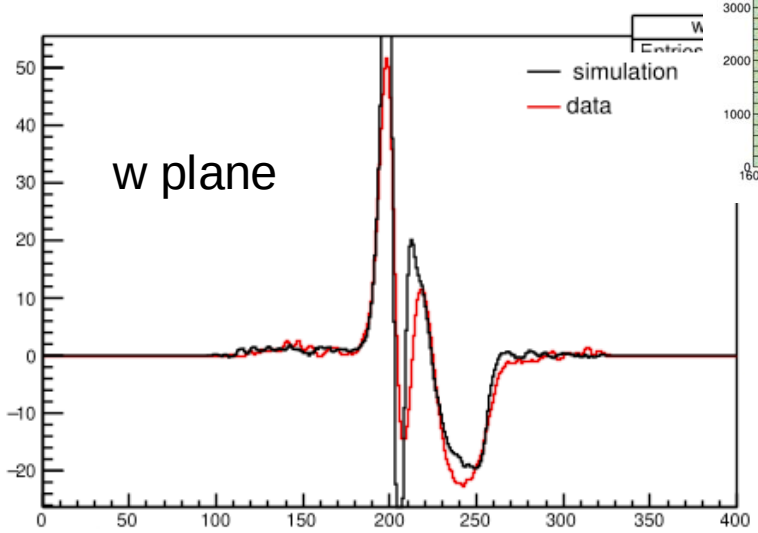


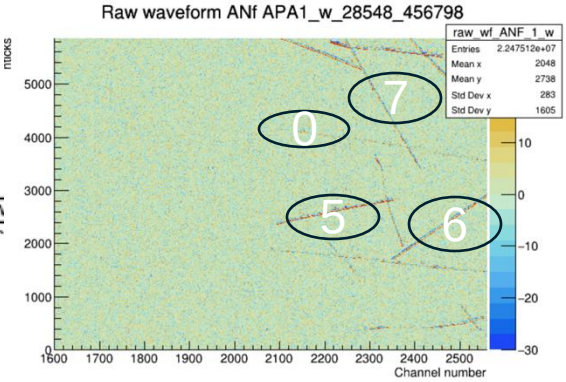


Best one this time

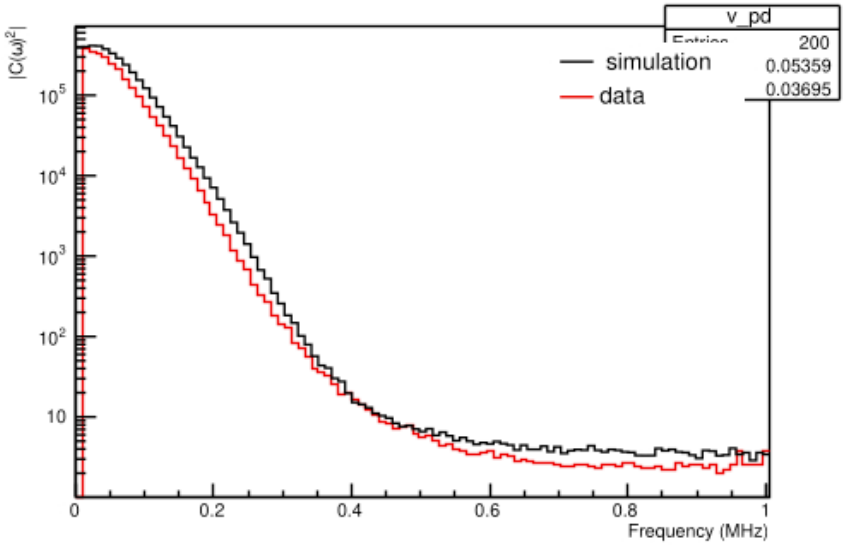
waveform

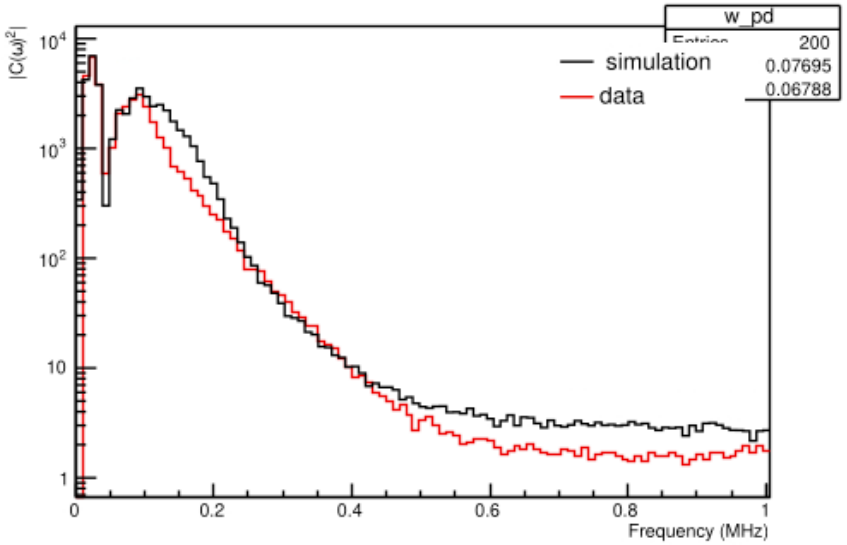






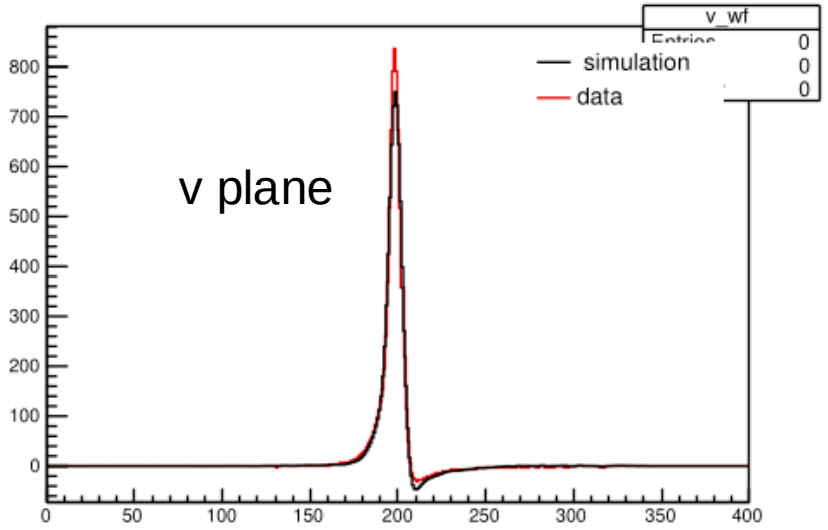
Power spectra

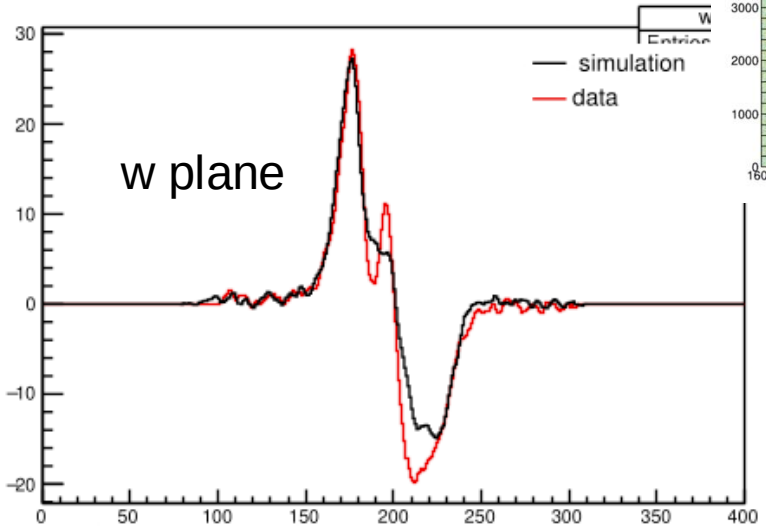


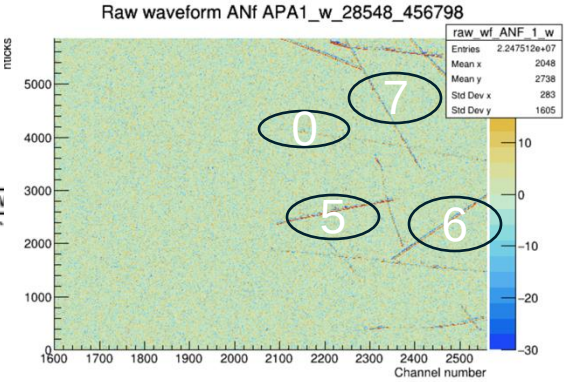


Best one this time

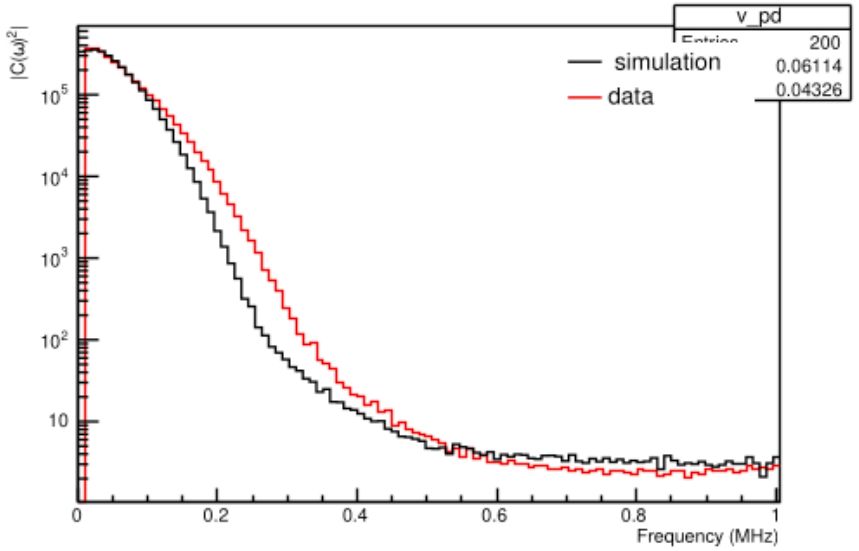
waveform

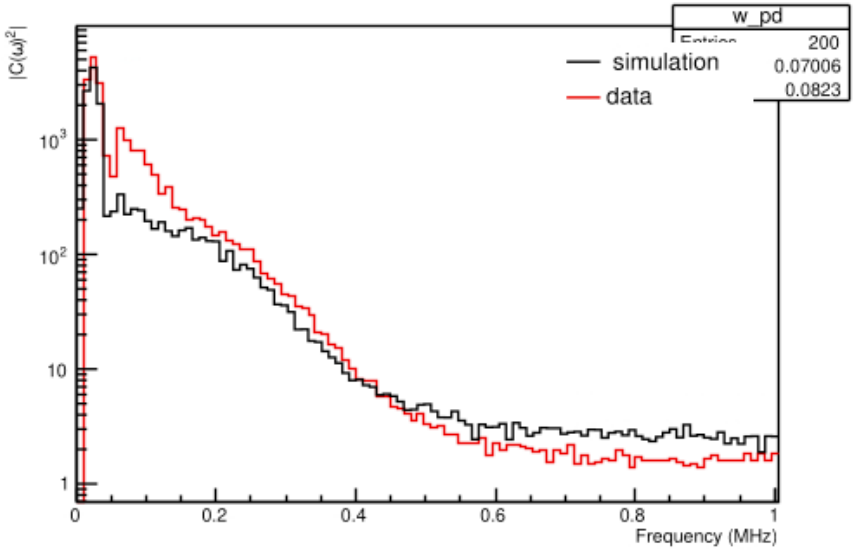






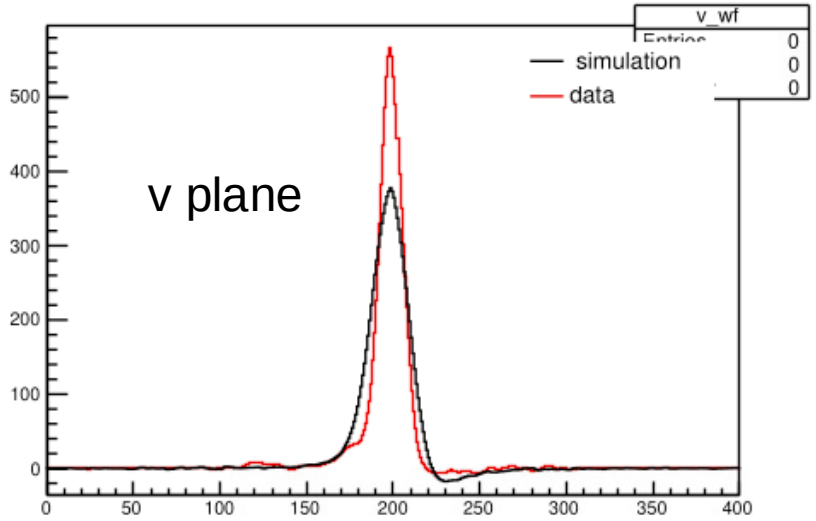
Power spectra

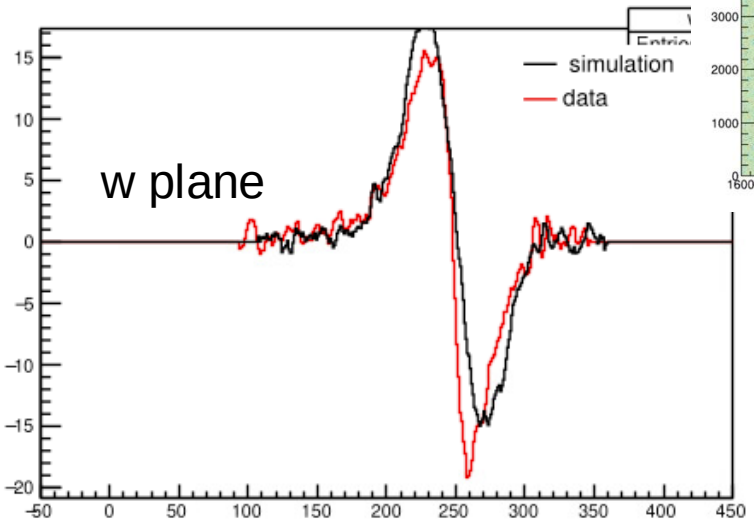


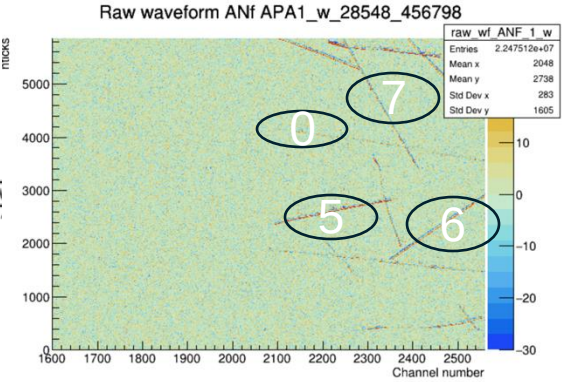


Best one this time

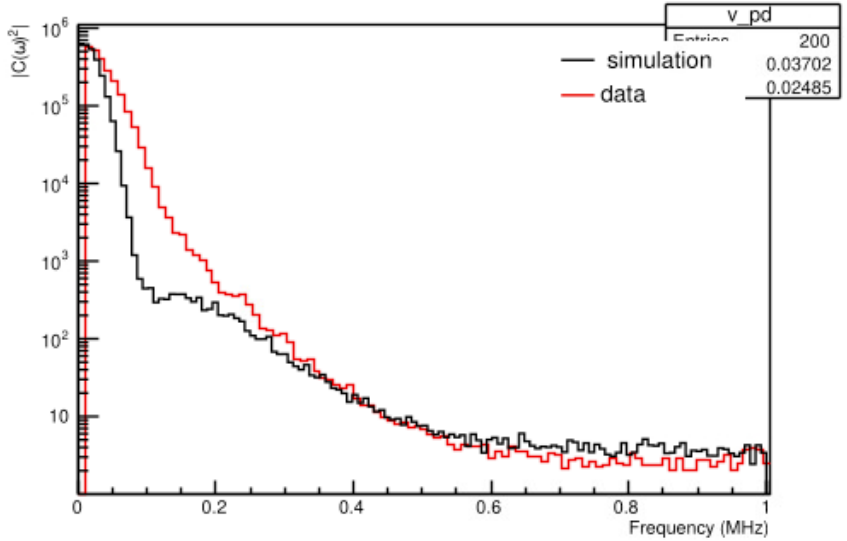
waveform

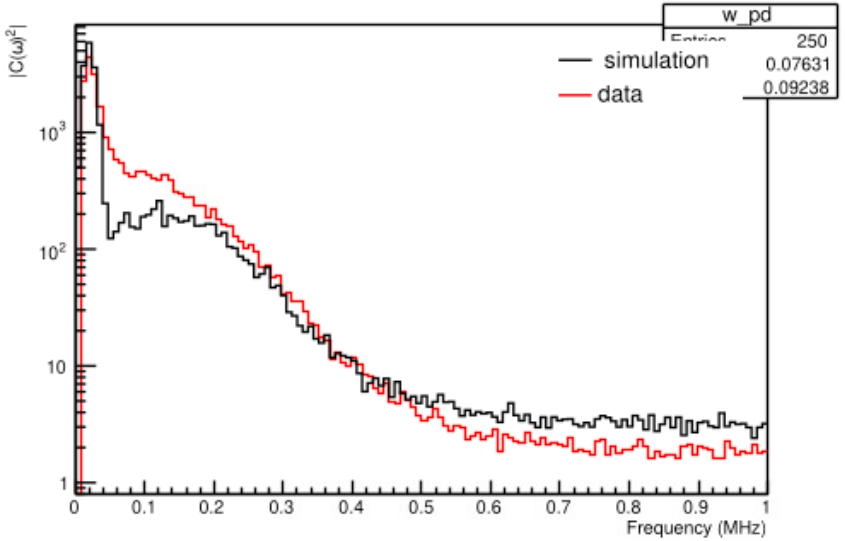




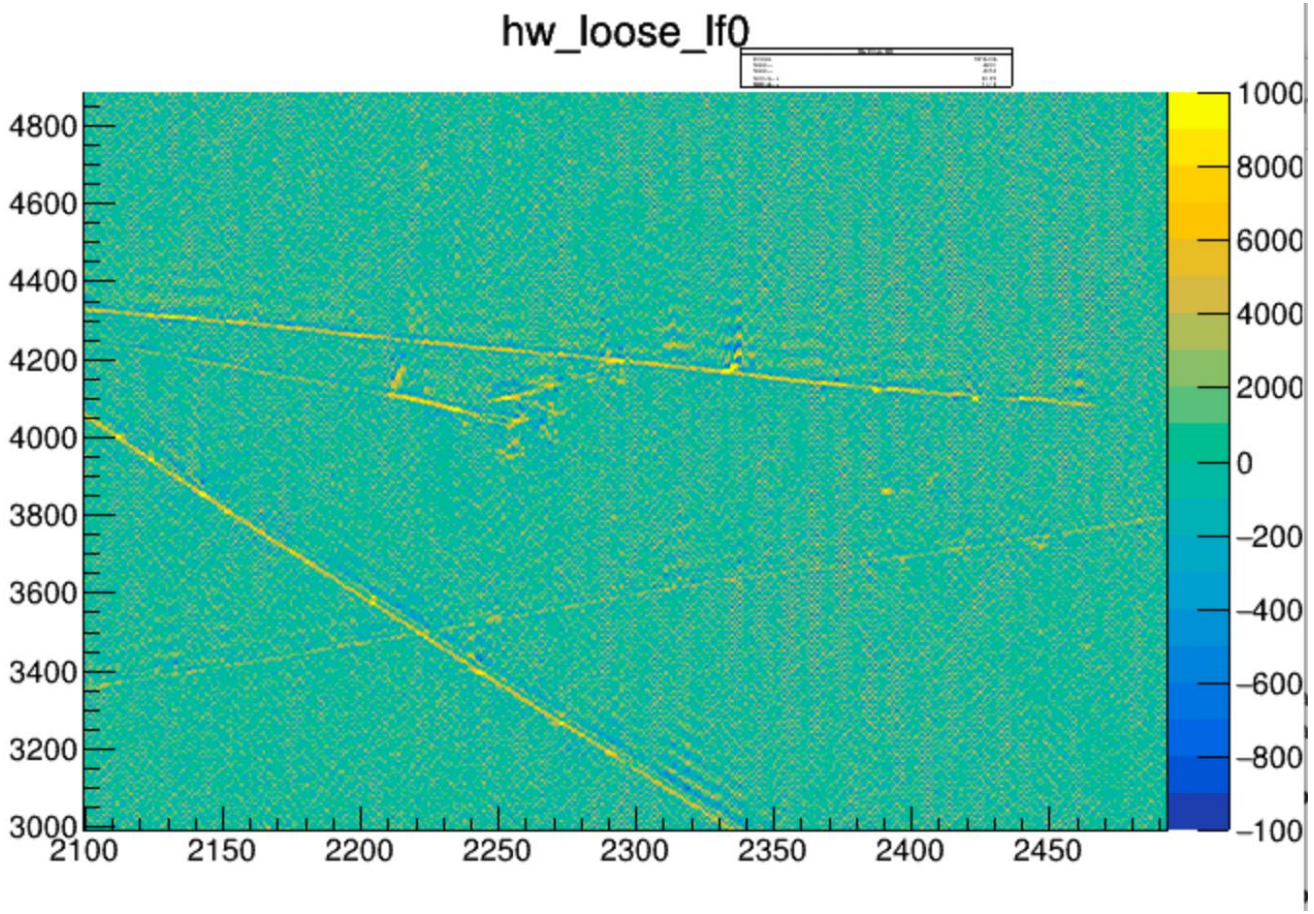


Power spectra

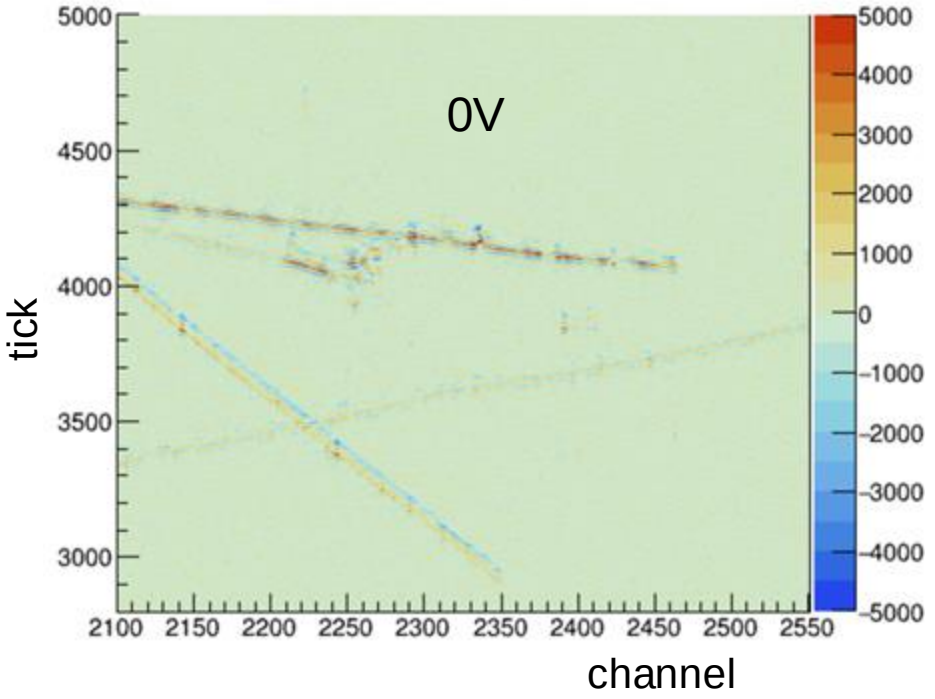


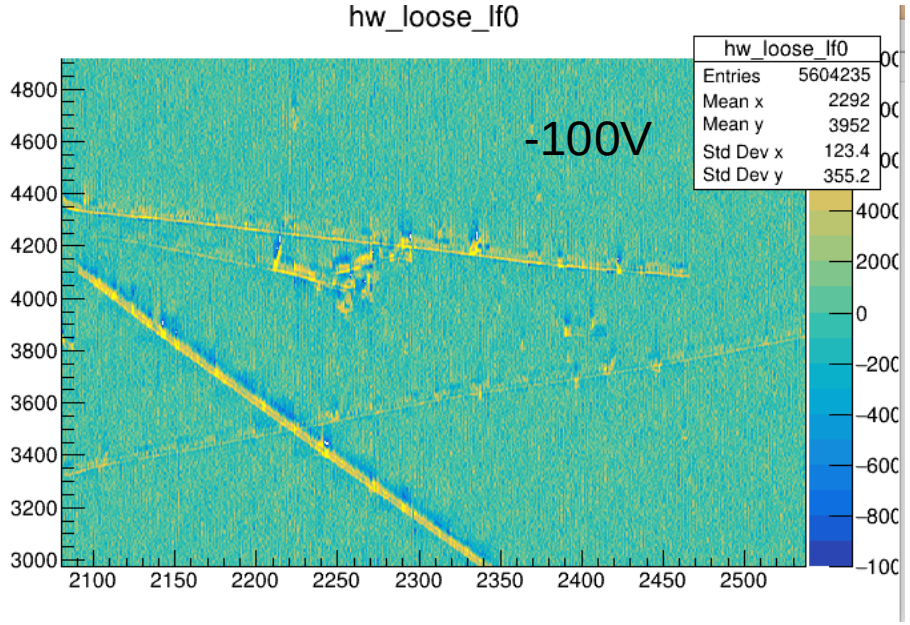


Check decon result

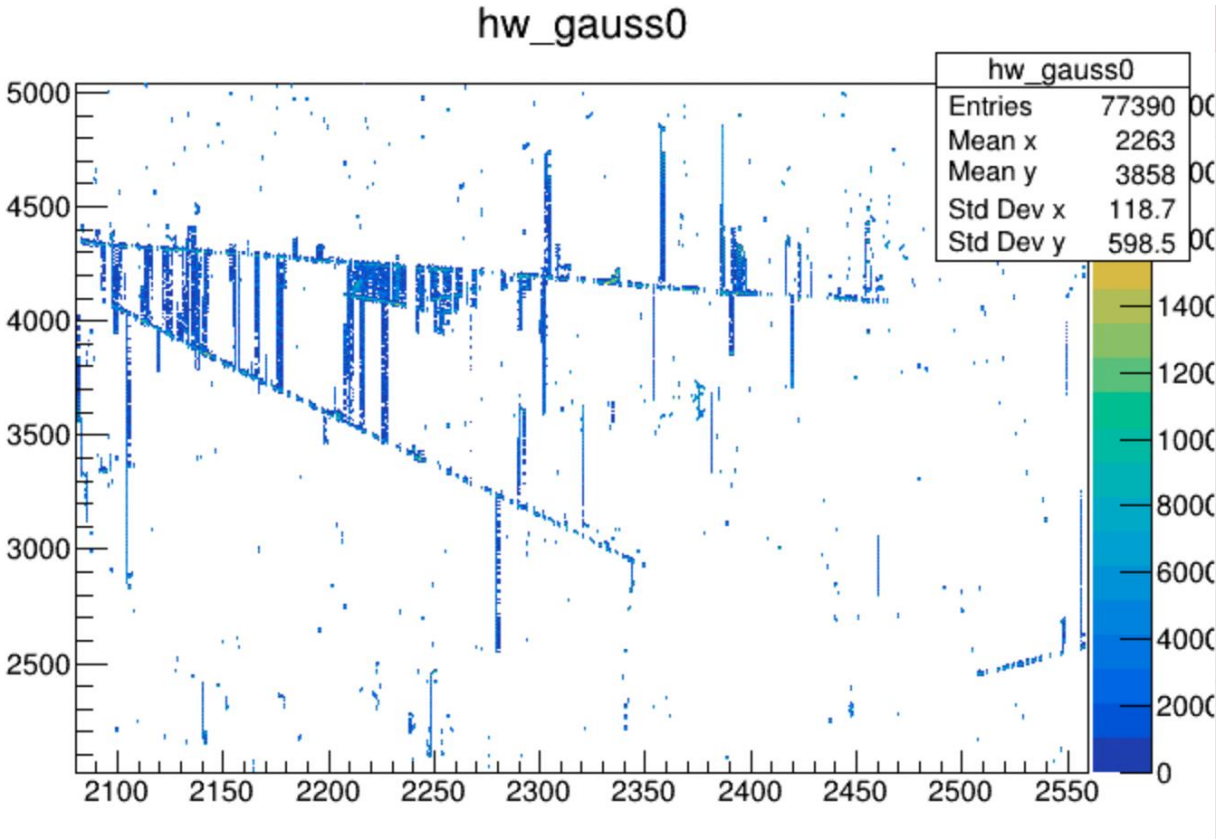


Newly fitted field response

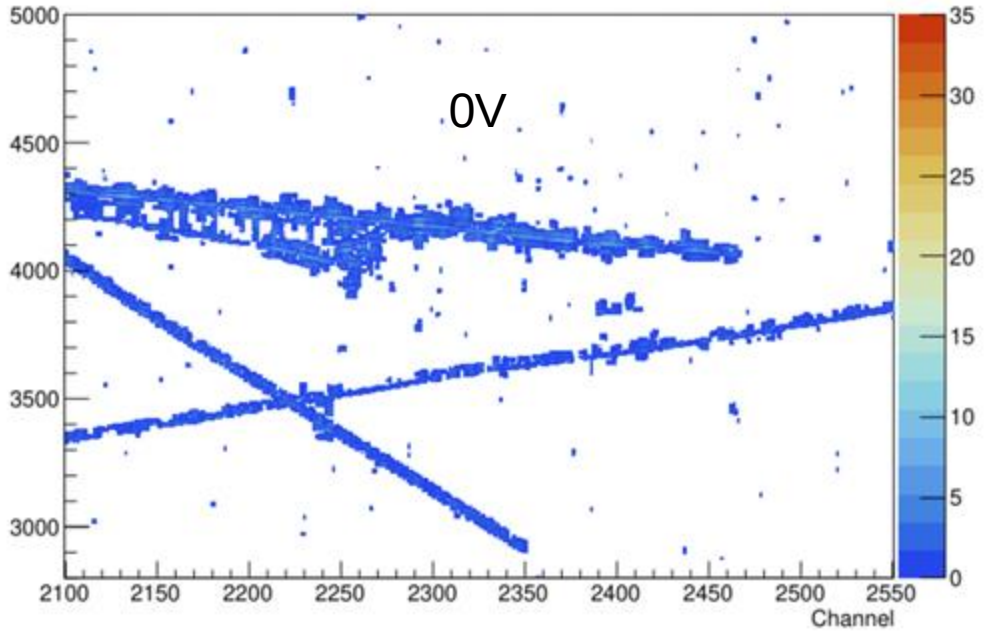


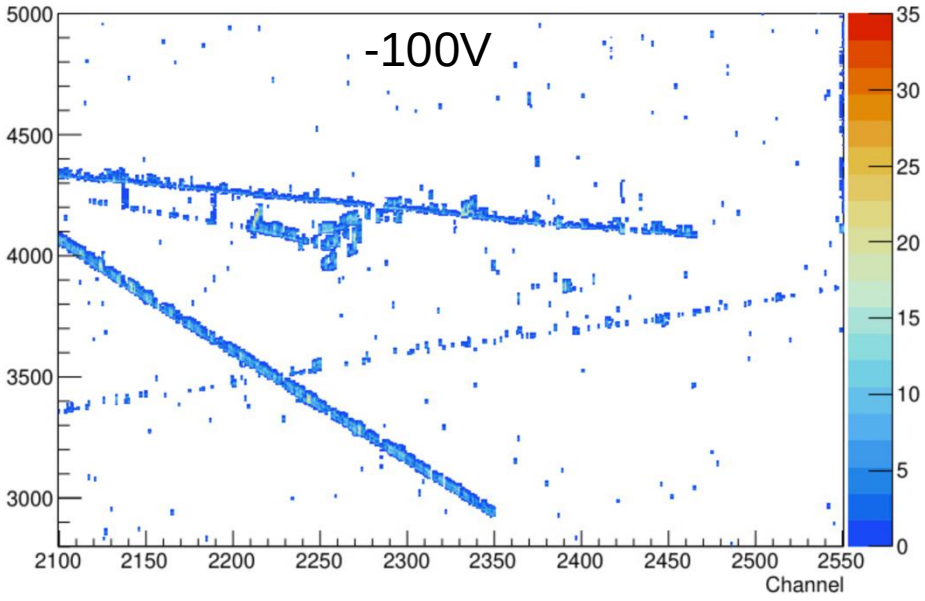


Check decon result



Newly fitted field response



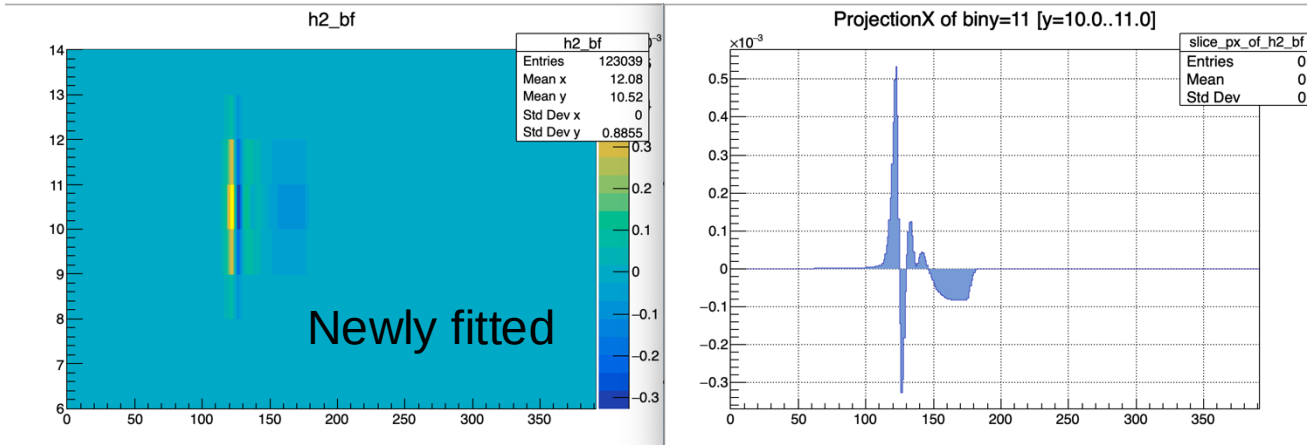


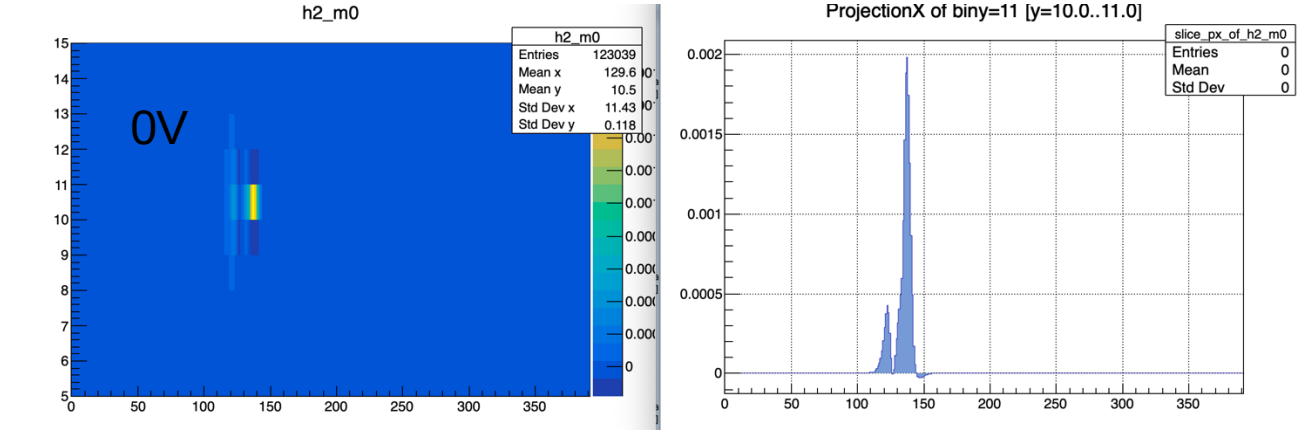
Add a ‘filter’ to help ROI

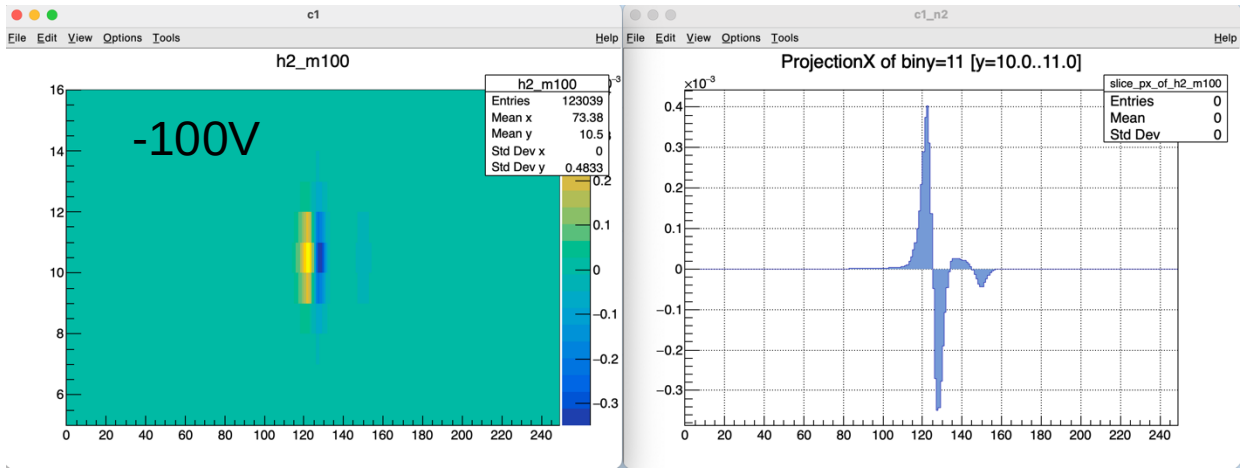
- **Overall_resp[1]**
  - overall response that combine field response and electronic response.
- A 2D “filter” can be obtained by dividing these 2D response bin by bin.

https://github.com/WireCell/wire-cell-toolkit/blob/master/sigproc/src/OmnibusSigProc.cxx#L1054

```
for (size_t i = 0; i != overall_resp[plane].size(); i++) {
    for (int j = 0; j != m_fft_nticks; j++) {
        r_resp(i, j) = overall_resp[plane].at(i).at(j);
        // if(plane==1){
        // std::cout<<r_resp(i, j)<<"\t";
        // }
    }
    //     if(plane==1){
    // std::cout<<std::endl;
    //     }
}
//         if(plane==1){
// exit(0);
//         }
```

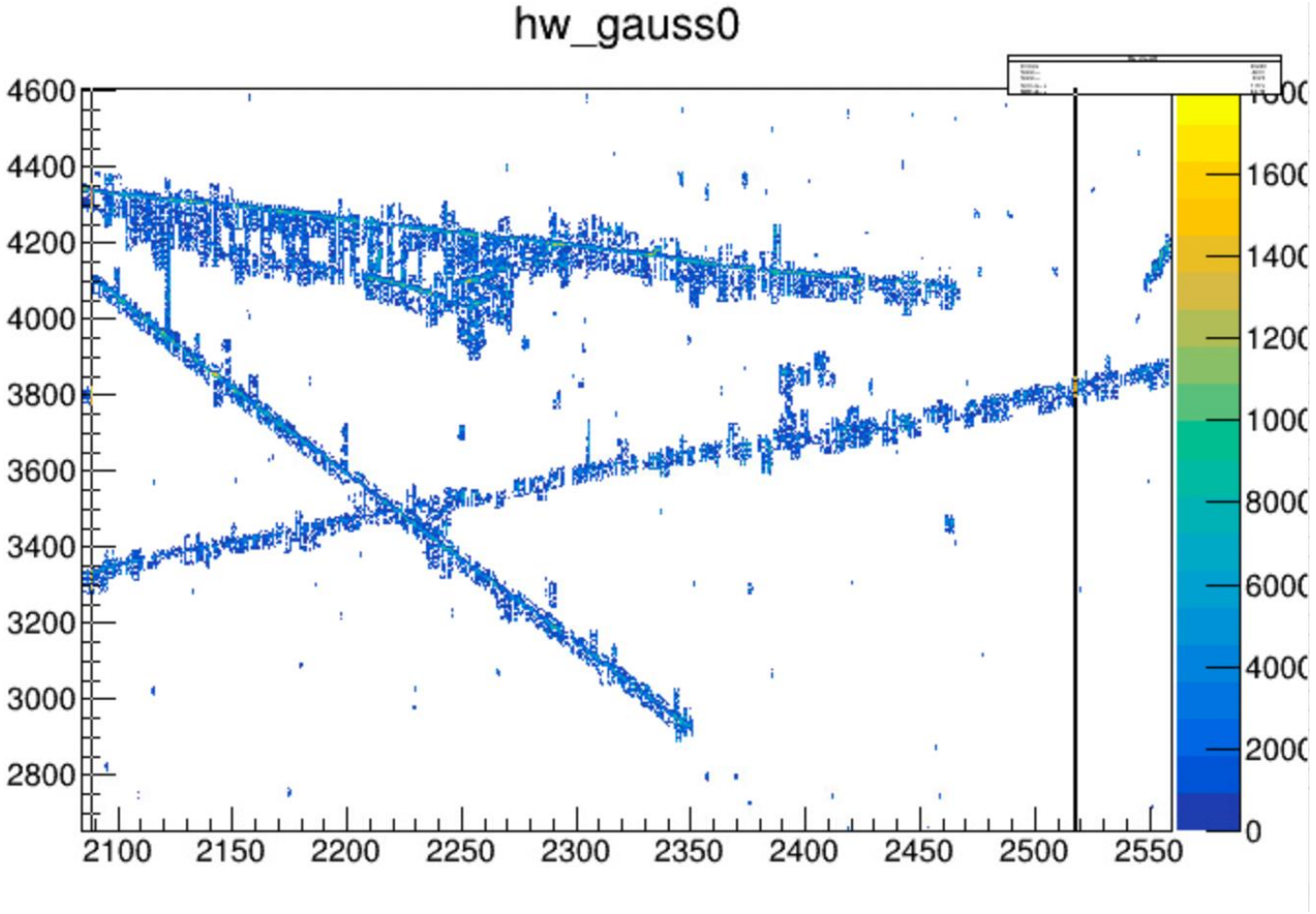






Add a 2D “filter”

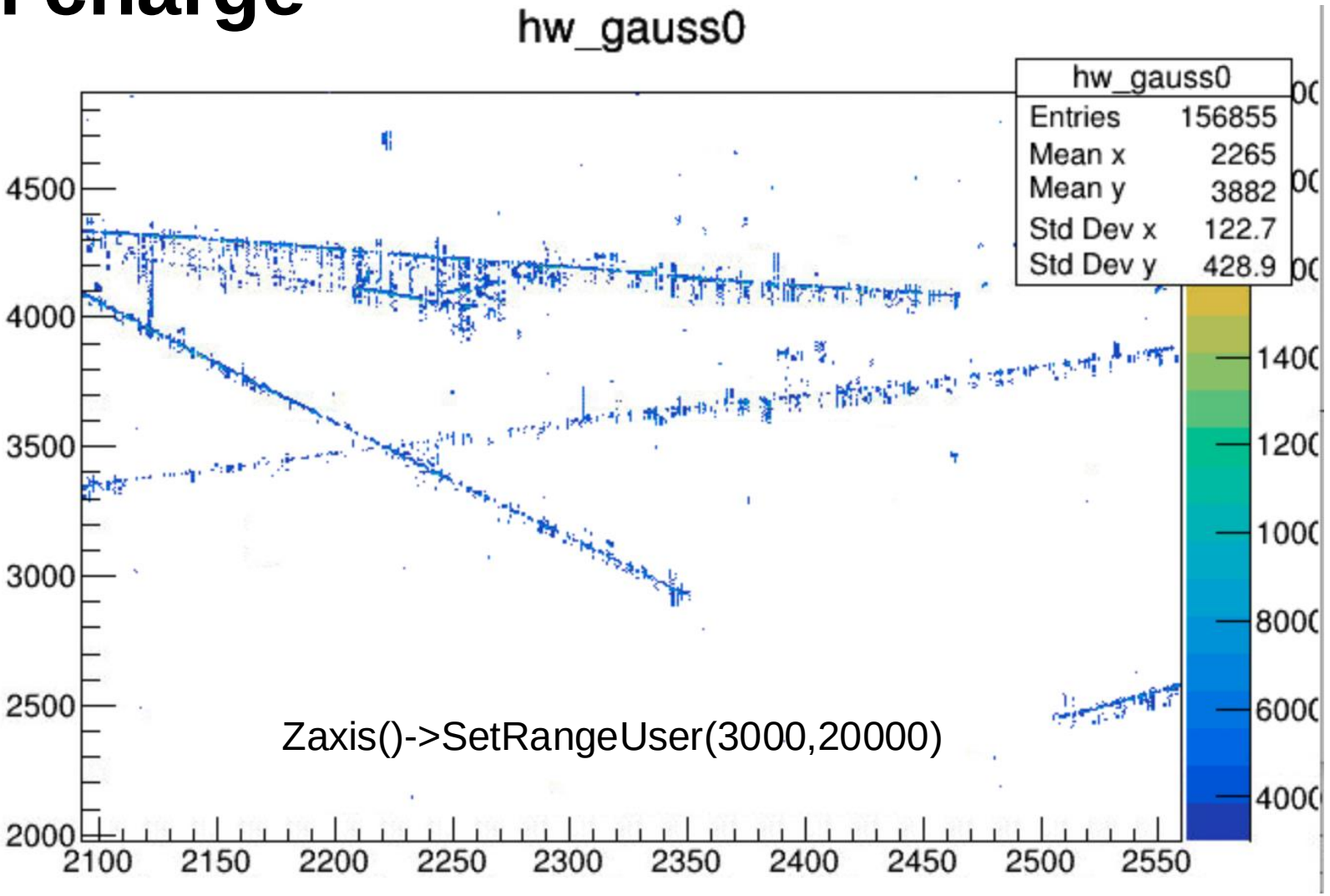
- Best fit field response for charge decon
- Use w=0V field response for ROI finding
  - Apply the 2D “filter”
  - In fact we change the overall_resp[1] before ROI finding, and reload the original field response before calculate decon charge.
- The ROI is wide but protect more region



Add a cut on decon charge

- Further add a threshold on decon charge

- I think this can be the final result for APA1 w plane field response.



- Tasks left:
  - Find a way to include the “filter” into the configuration files.
  - Do some other relevant tests, like seeing the performance in wire-cell-imaging