Light Barrier Test Analysis

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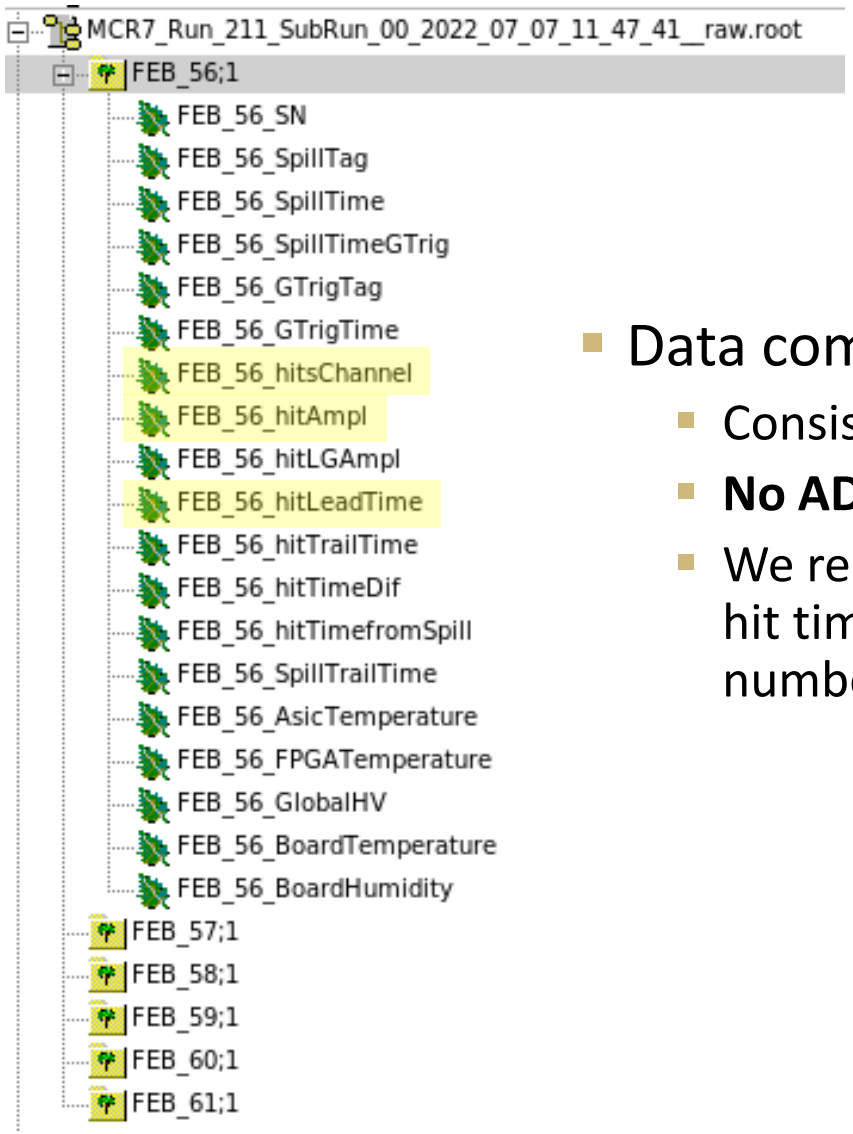
Looking at the Data



- Data comes pre-packaged in .daq files
  - Consist of data packets for individual hits
  - **No ADC waveform vs time**
  - We receive pre-packaged info from hits like hit timing, signal amplitude, channel number, etc.

Data Overload

- Data comes in 32-bit chunks that is bit-manipulated to extract relevant information in the unpacking procedure, e.g.

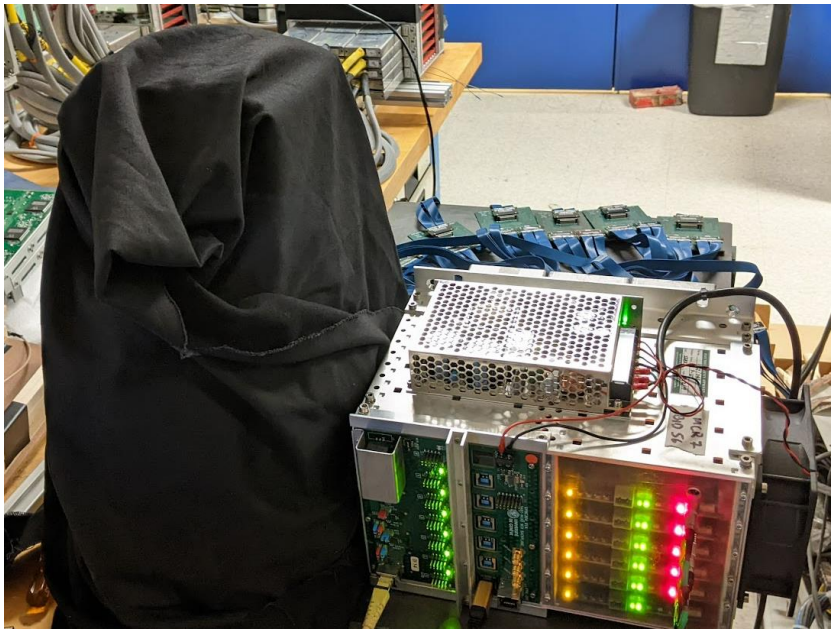
```
uint32_t MDdataWordBM::GetSpillTime() {
  if (IsValid())  return ( (*(uint32_t*)(_data) & SpillTimeMask ) >> SpillTimeShift );
  return 0;
}
```

- For the runs with no light barrier, the data stream cannot keep up with the input, and so some of the bits get missed, leading to data corruption
- All of the runs with no light barrier can have some of their data unpacked, but all eventually seg fault when the stream gets to a bad read
- From the bit I was able to unpack, there appears to be at least an **order of magnitude more hits** in these runs than those with some light barrier

Other Baselines

- Since we do not have a baseline with no light barrier to compare against, we tried something different at Penn
  - Collected data with both light barriers applied to the detector
  - Hope that combination of the CU polyester sheet and UPenn black sheet will provide a baseline that is at least as strong of a shield as either of the individuals
    - If the individual light shields are comparable to using both, that is a positive sign

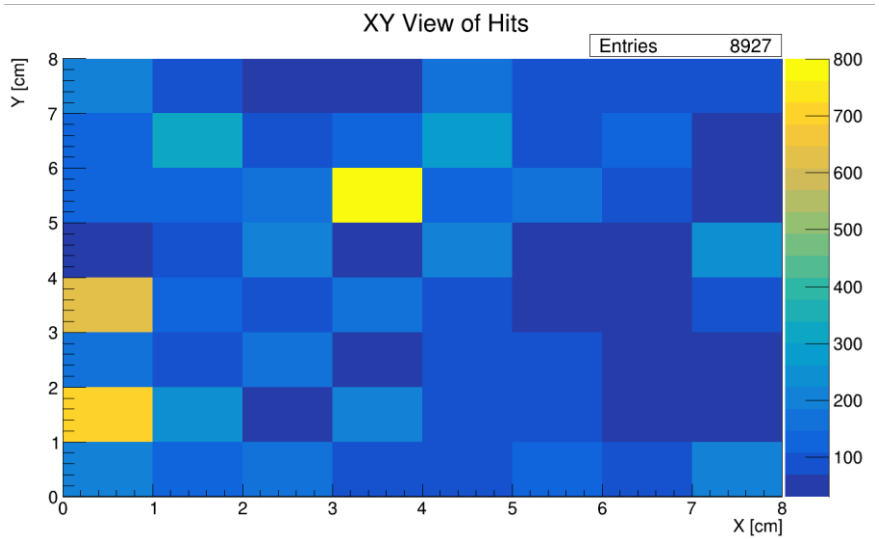
CU Polyester Light Barrier

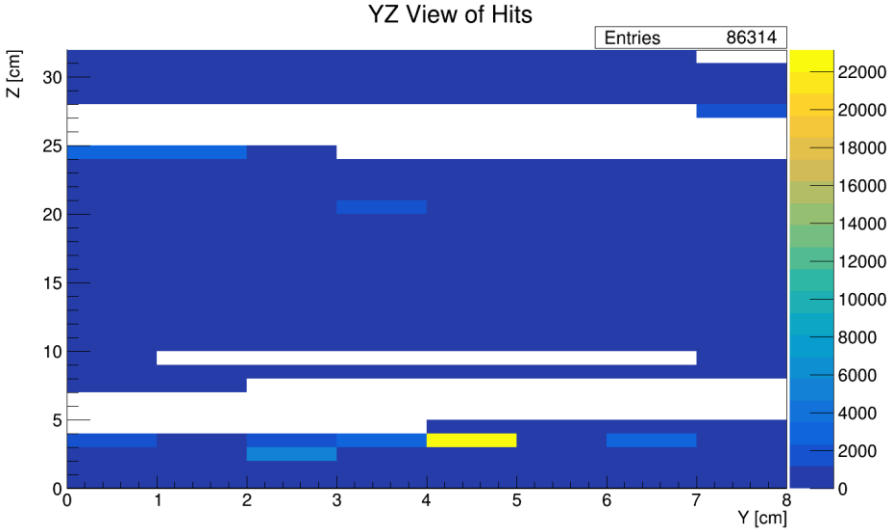


UPenn “Black Sheet”

Original Hit Count Plots

"Hits" defined in DAQ, presumably by the ADC waveform increasing beyond some threshold



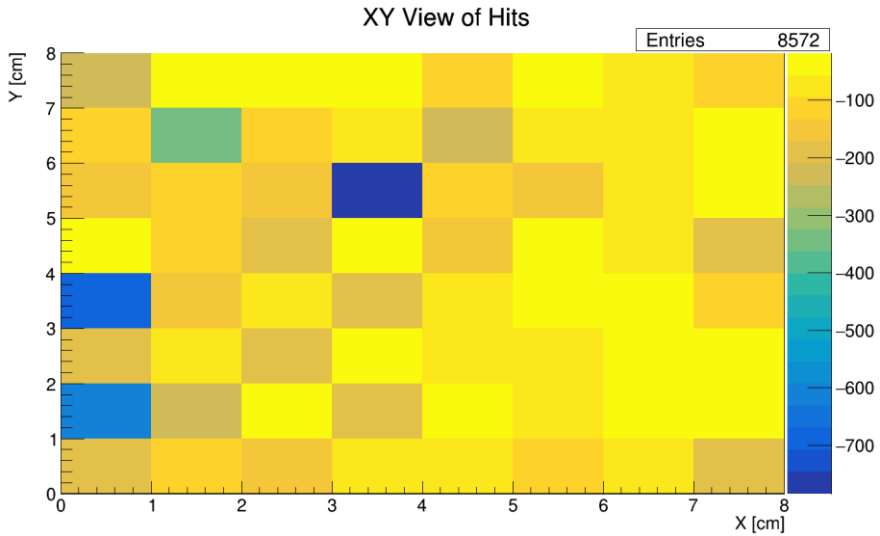


Trying to Use PE Counts

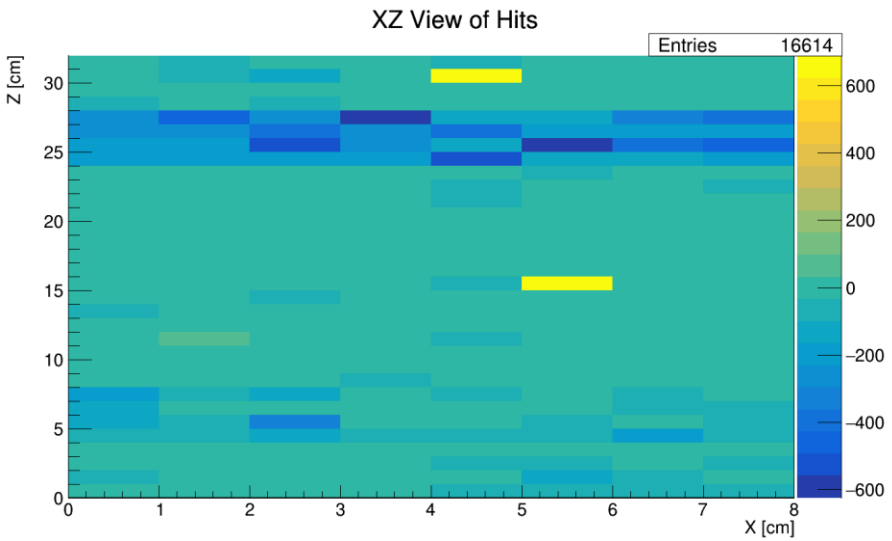
ADC amplitudes are converted to PE in the code using the following equation:

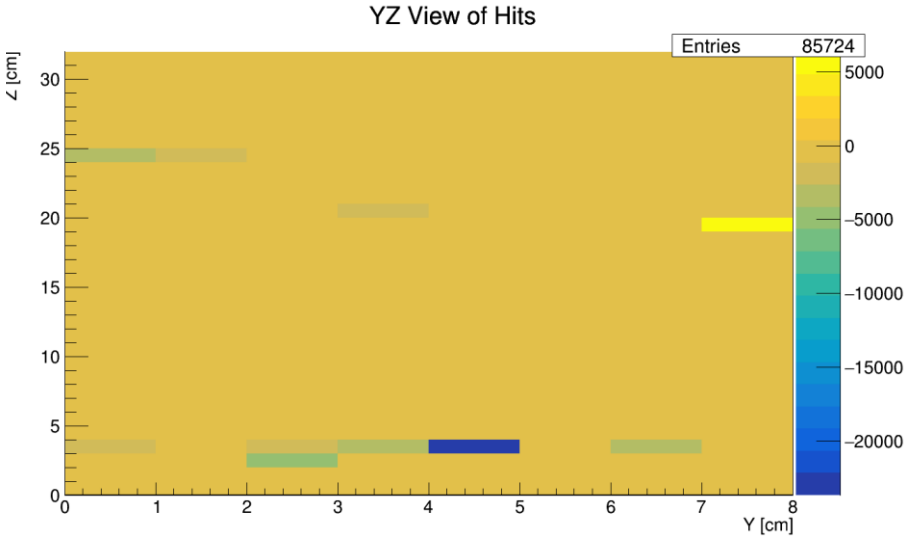
$$\frac{\mathbf{ADC} - \mathbf{Gain\_Floor}}{\mathbf{Gain\_Conversion}}$$

Each channel has its own gain values to calibrate, so it is possible the detector was not accurately calibrated prior to our data runs



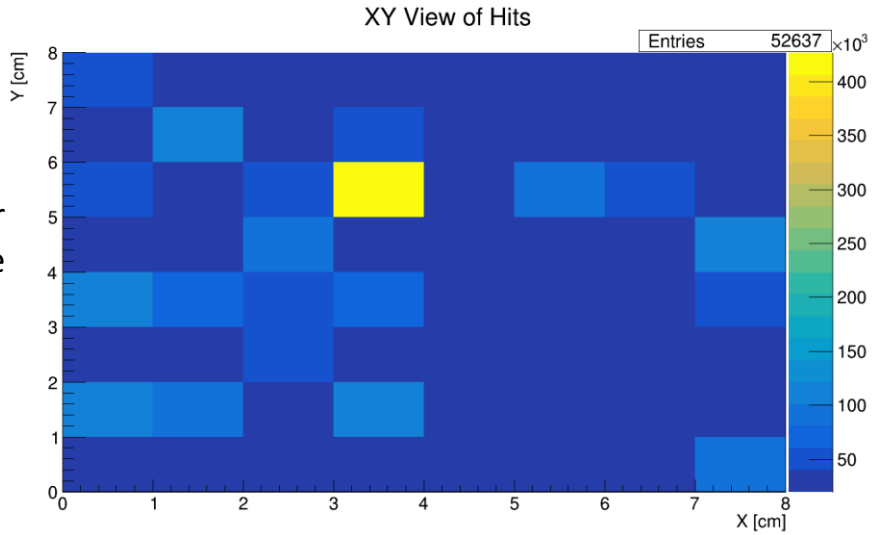
Negative PE counts

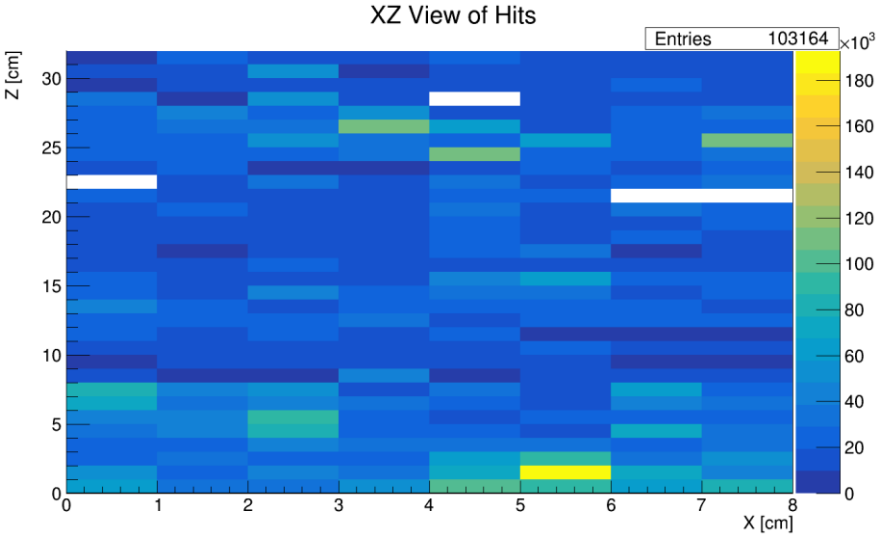


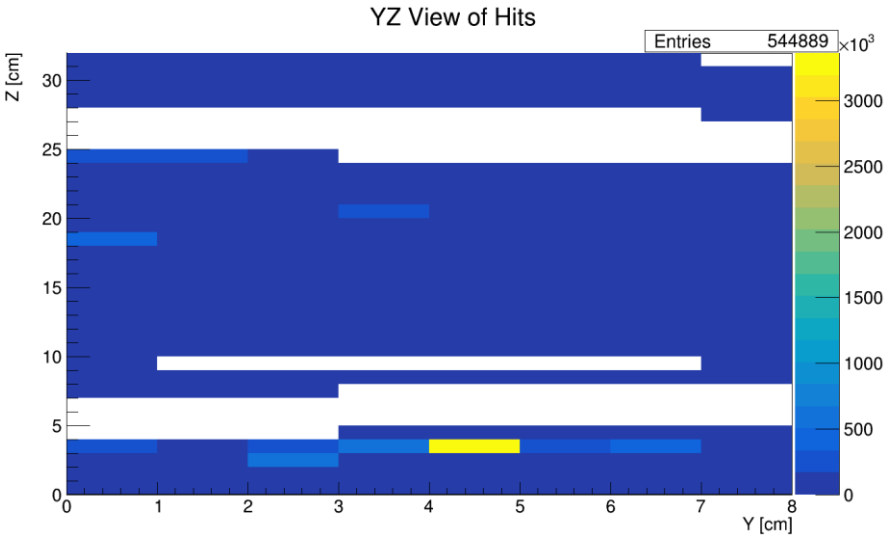


New Plan: Look at ADC

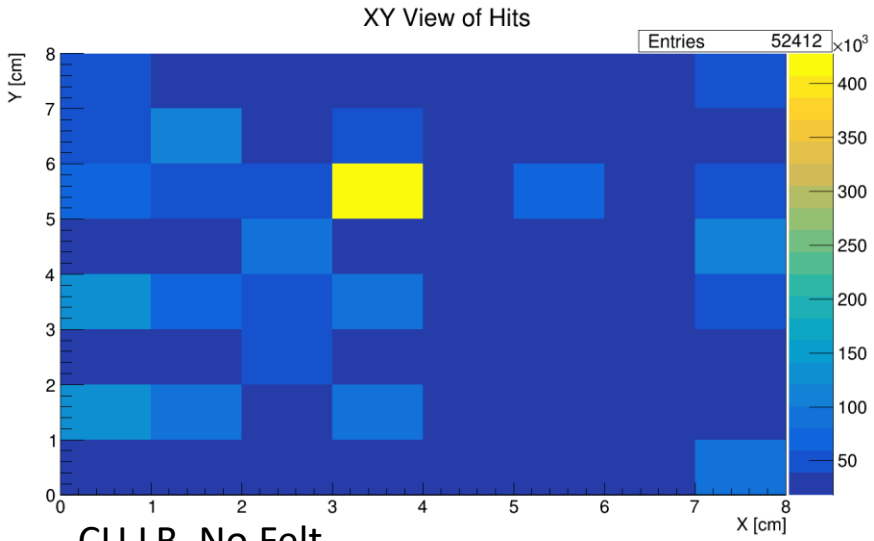
Instead of filling with 1 for each hit, now fill using the ADC peak value for each hit



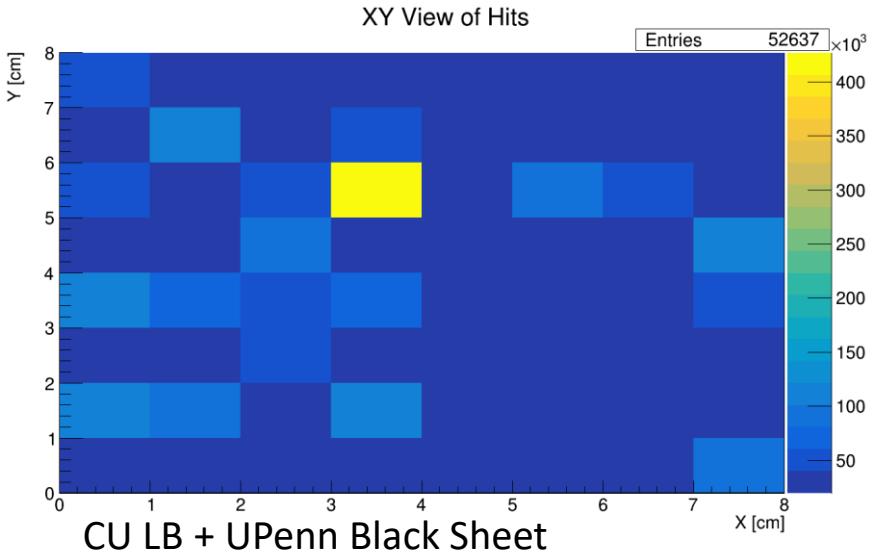




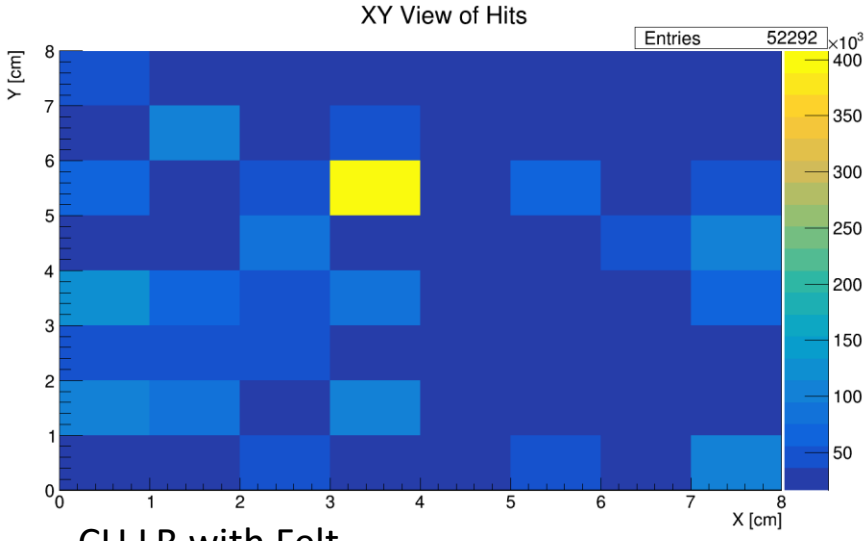
XY ADC Counts: Lights On Trials



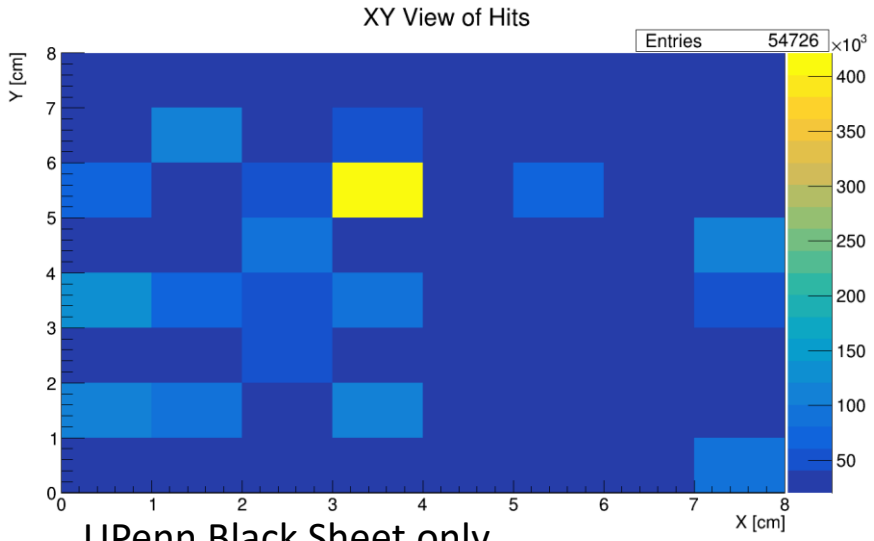
CU LB, No Felt



CU LB + UPenn Black Sheet

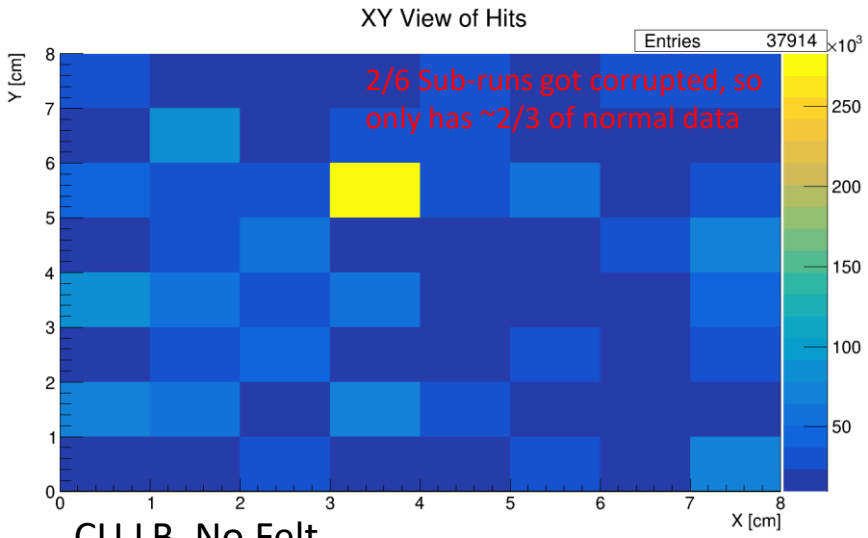


CU LB with Felt



UPenn Black Sheet only

XY ADC Counts: Lights Off Trials



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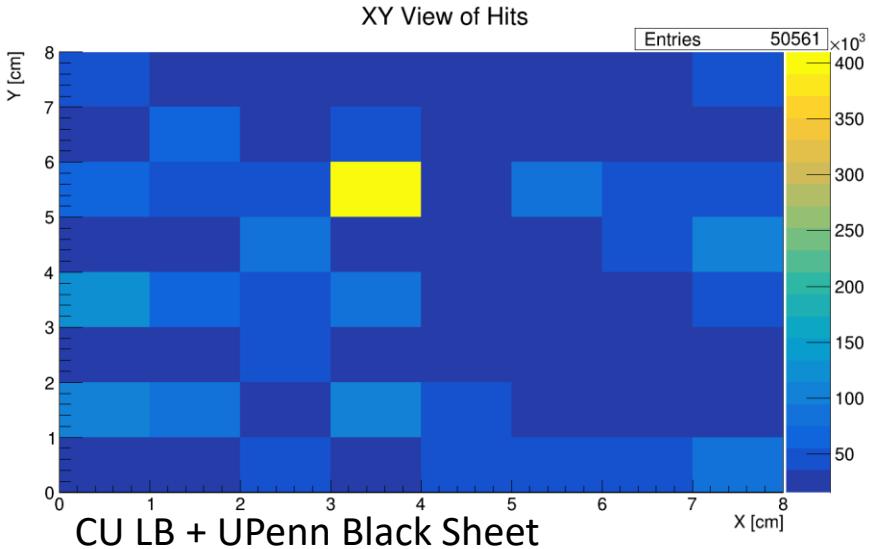

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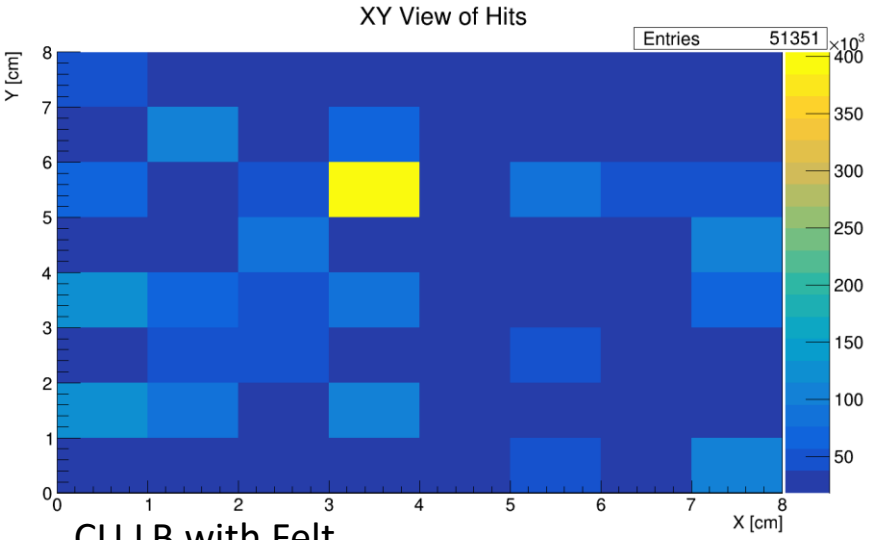

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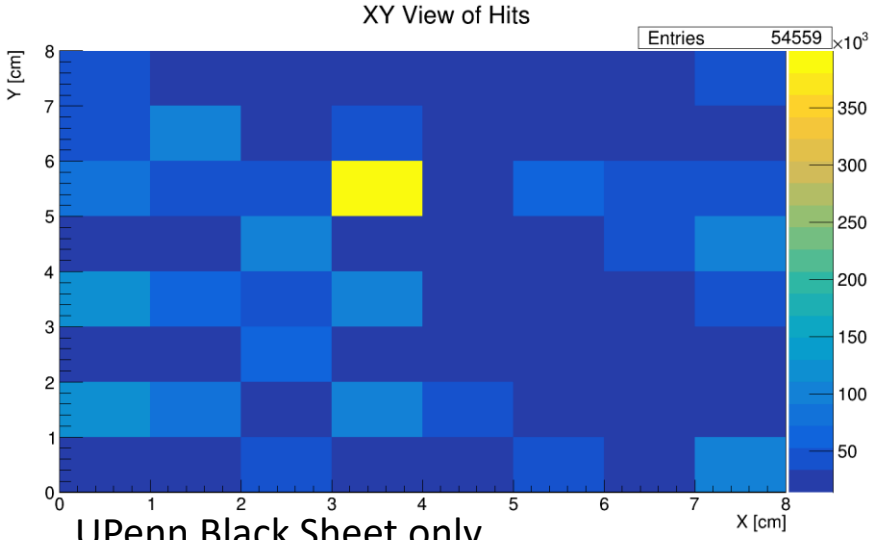
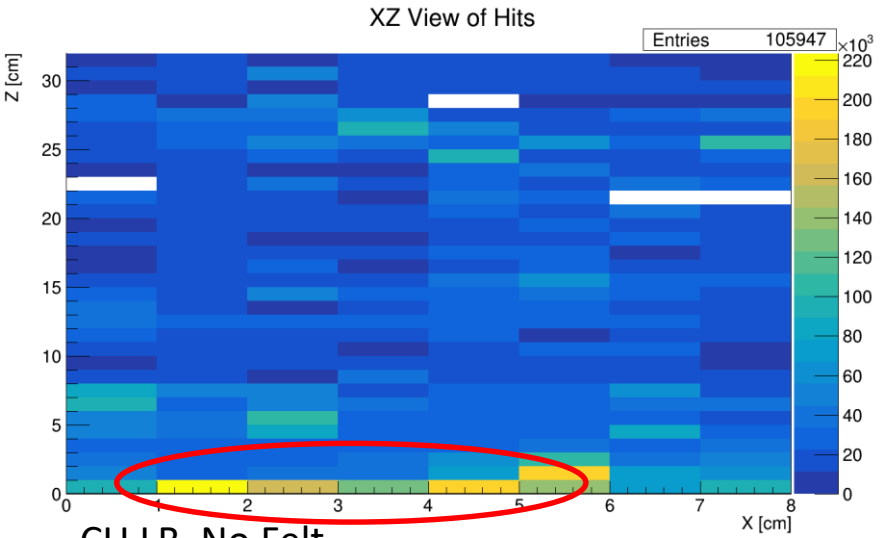


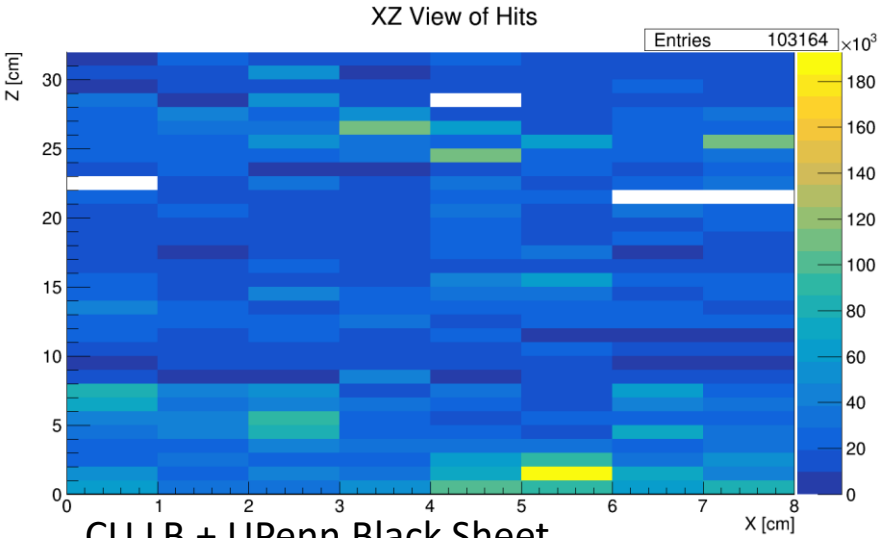
UPenn Black Sheet only

XZ ADC Counts: Lights On Trials

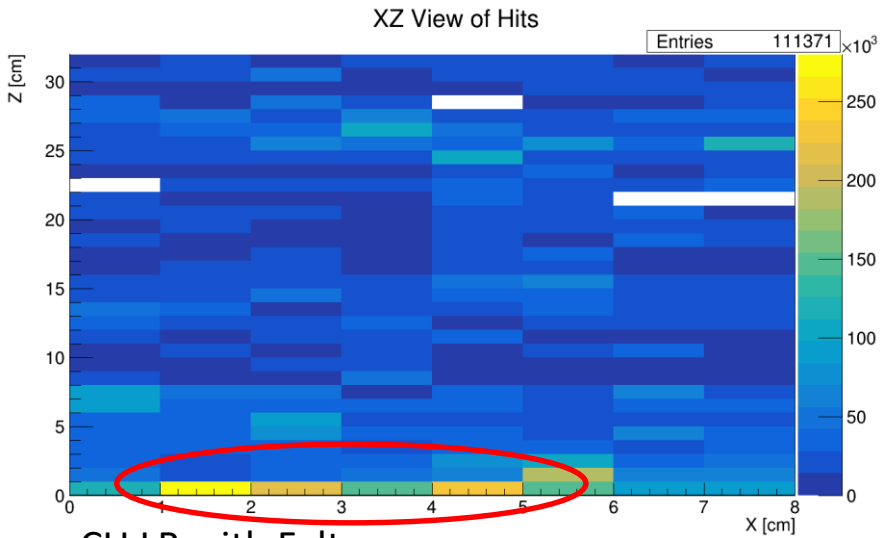


CU LB, No Felt

What's going on here?

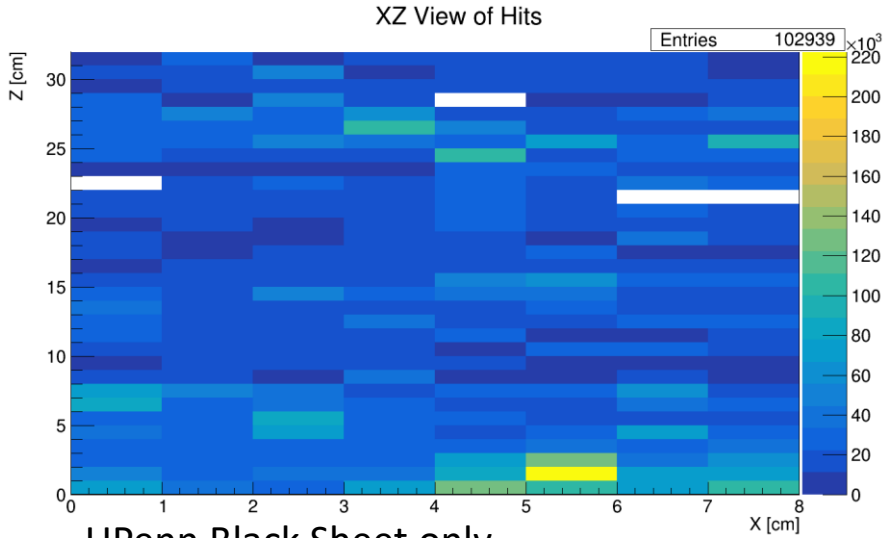


CU LB + UPenn Black Sheet



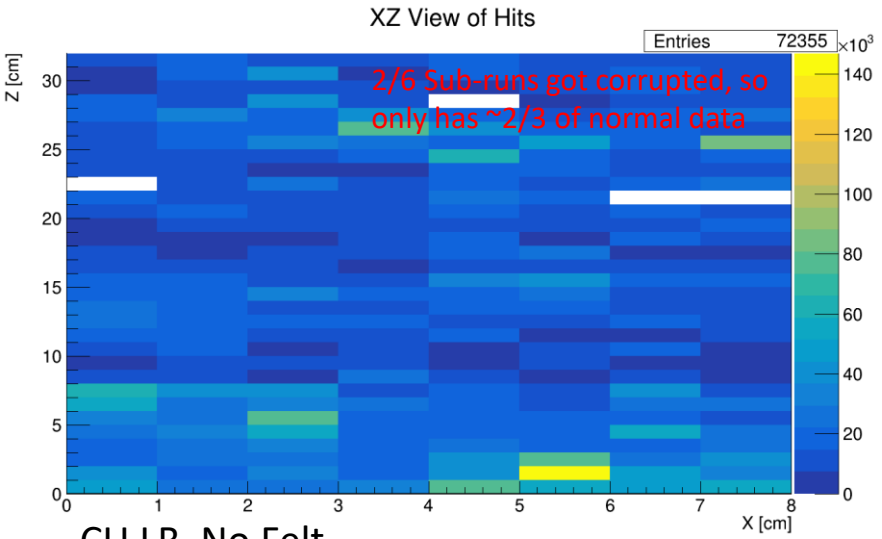
CU LB with Felt

Light leak on LB edge?



UPenn Black Sheet only

XZ ADC Counts: Lights Off Trials



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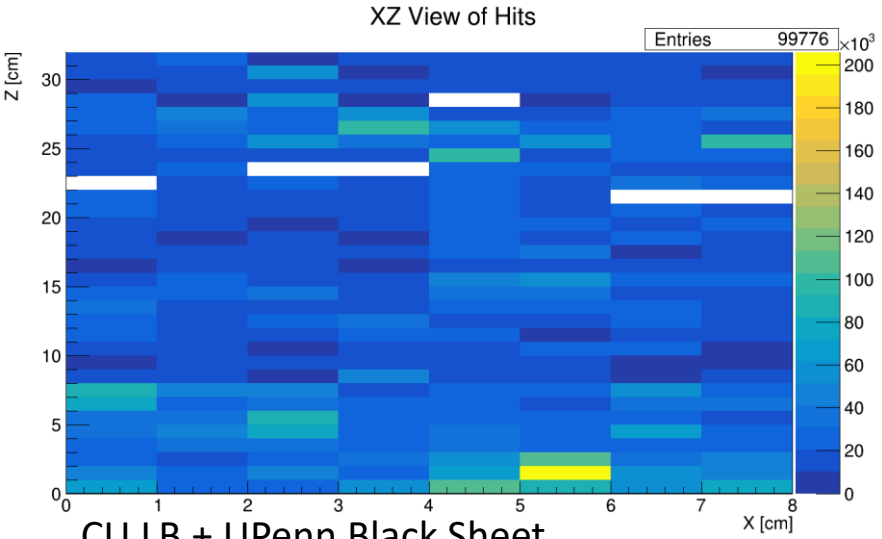

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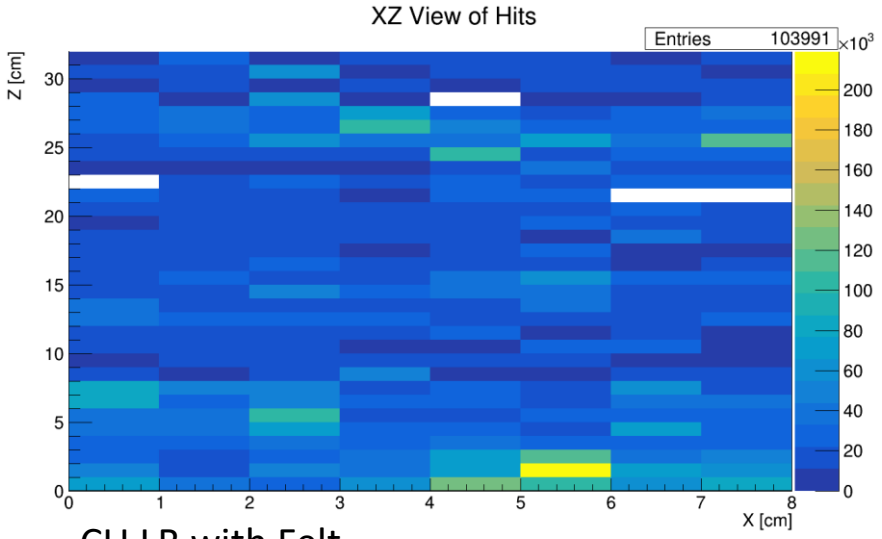
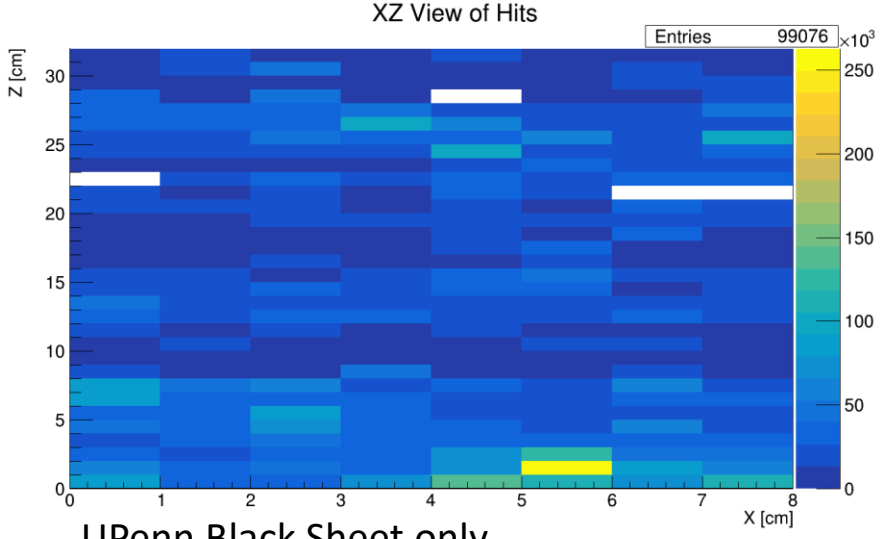
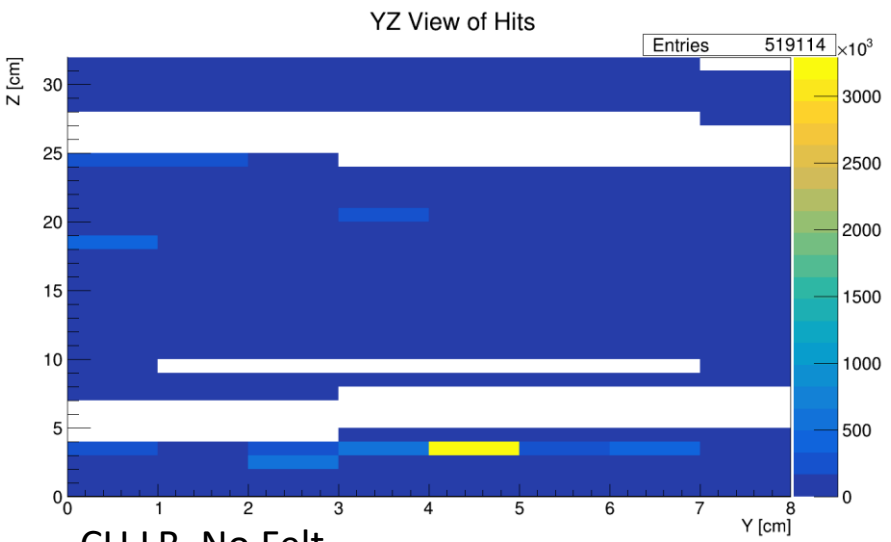


CU LB with Felt

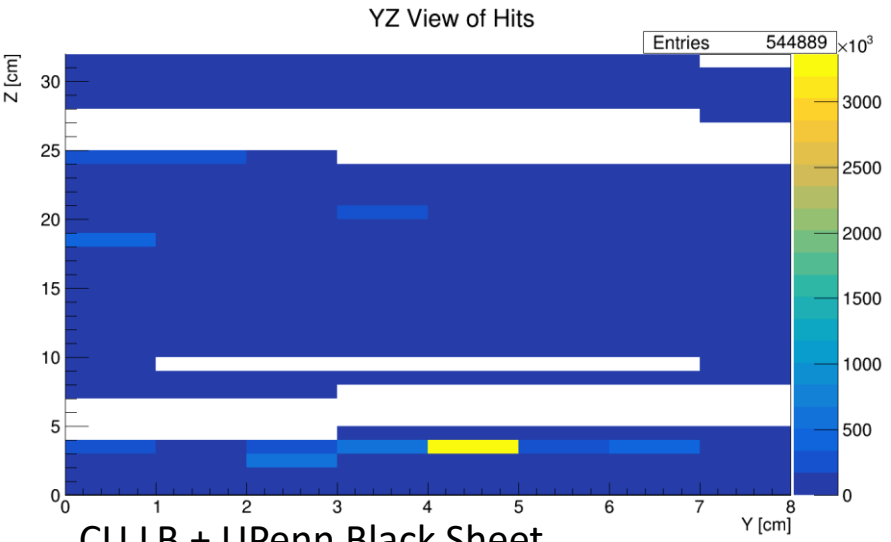


UPenn Black Sheet only

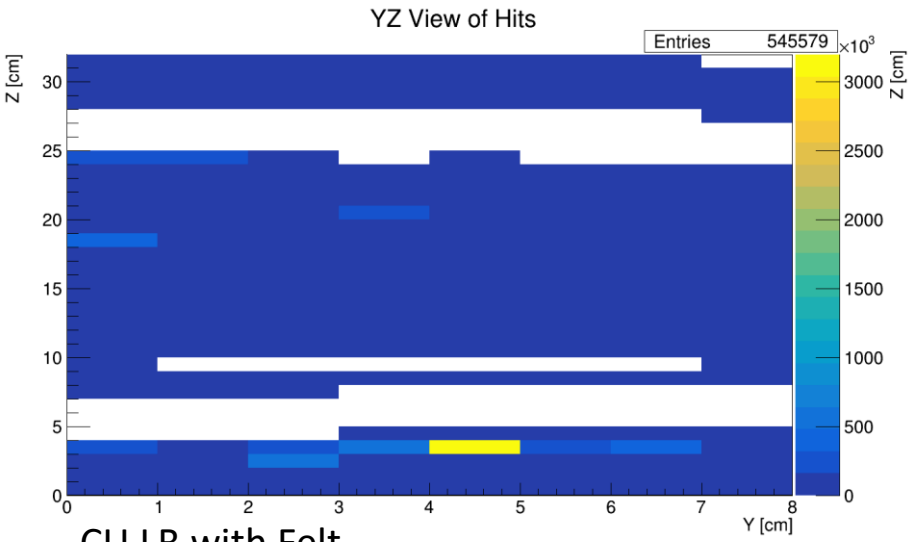
YZ ADC Counts: Lights On Trials



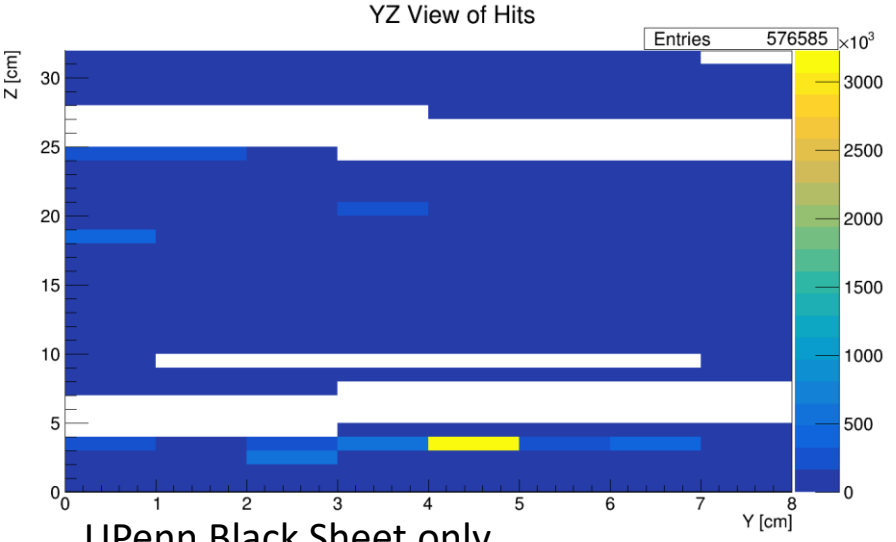
CU LB, No Felt



CU LB + UPenn Black Sheet

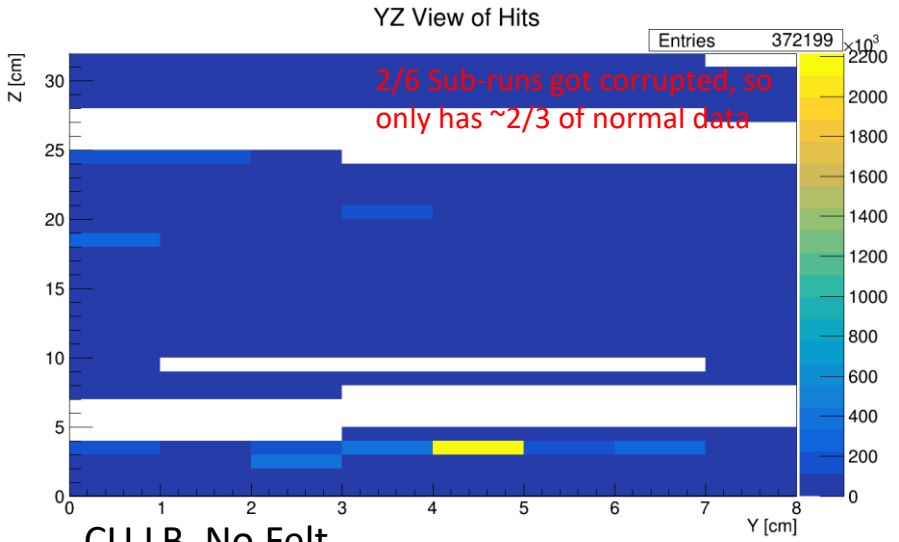


CU LB with Felt



UPenn Black Sheet only

YZ ADC Counts: Lights Off Trials



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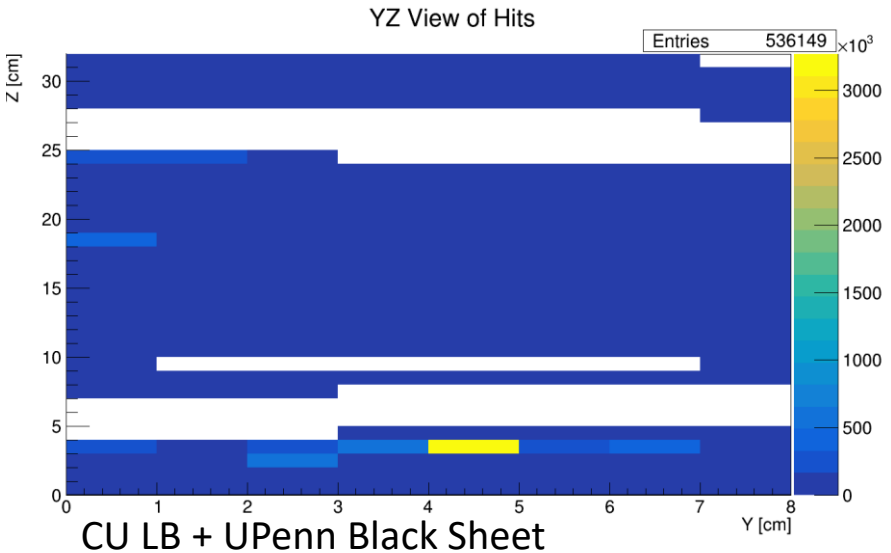
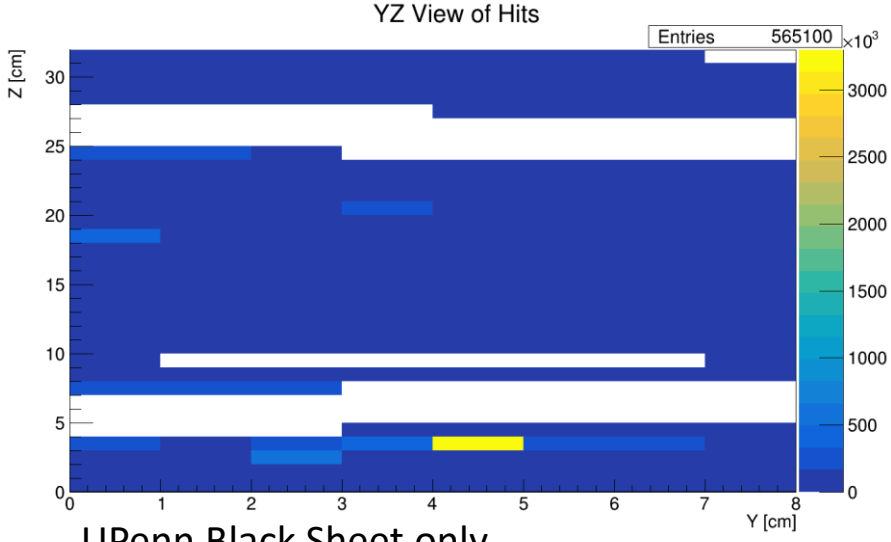


CU LB + UPenn Black Sheet

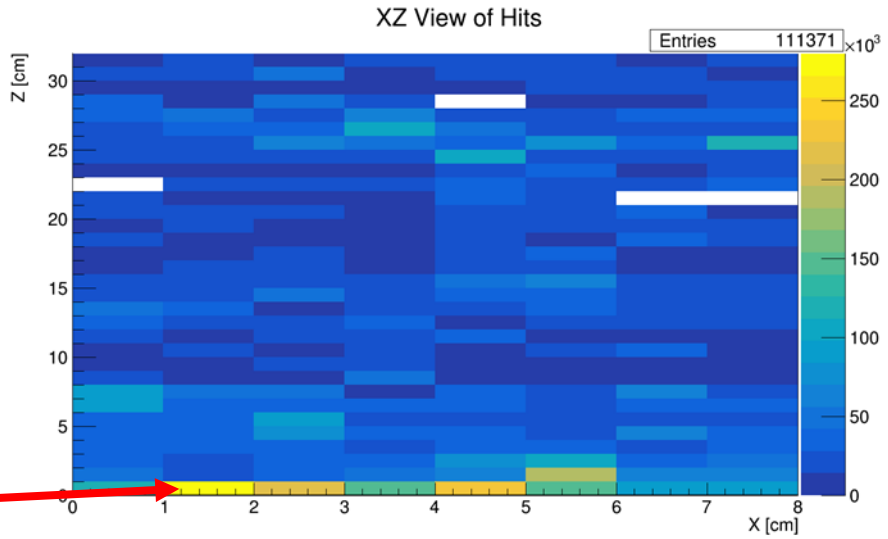
CU LB with Felt



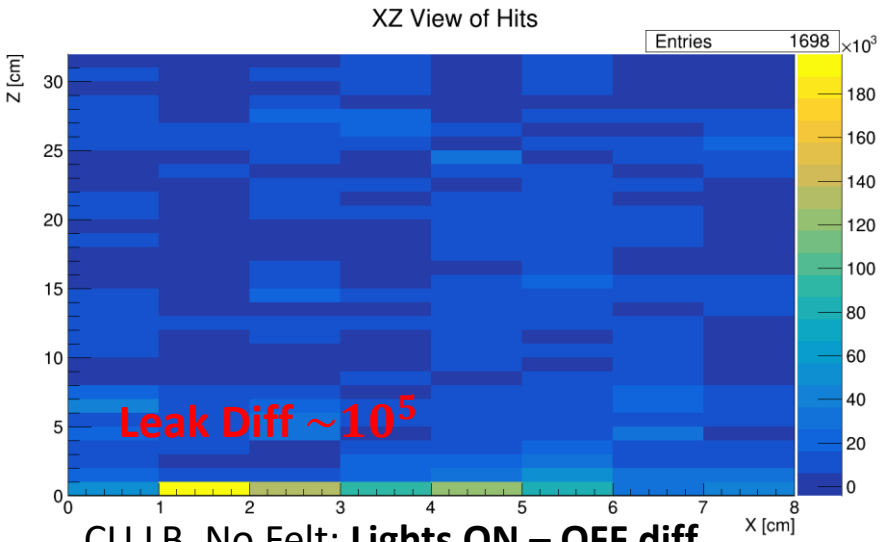
UPenn Black Sheet only

Light Leak?

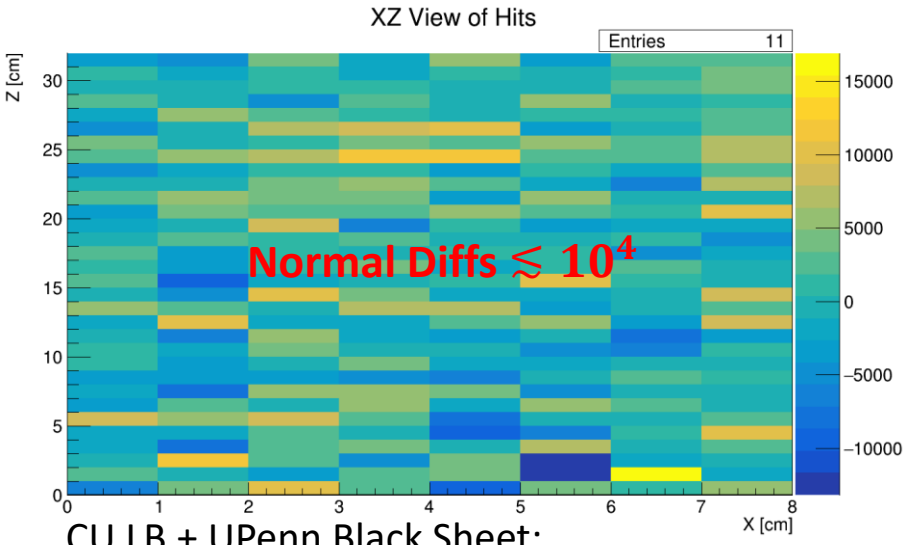
- Significantly enhanced signal in XZ edge channels; only appears when lab lights are on
- Possible that the electrical tape seal was imperfect for one of the edges, allowing some light leak.
  - Polyester did puff out on some of the faces, and attaching was difficult
- If we consider this as a light leak, others should be easily identifiable!



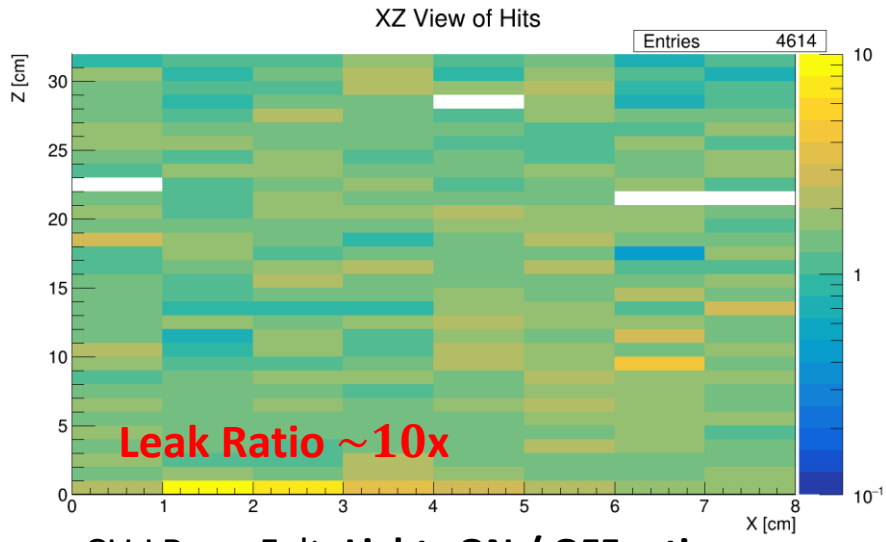
Light Leak?



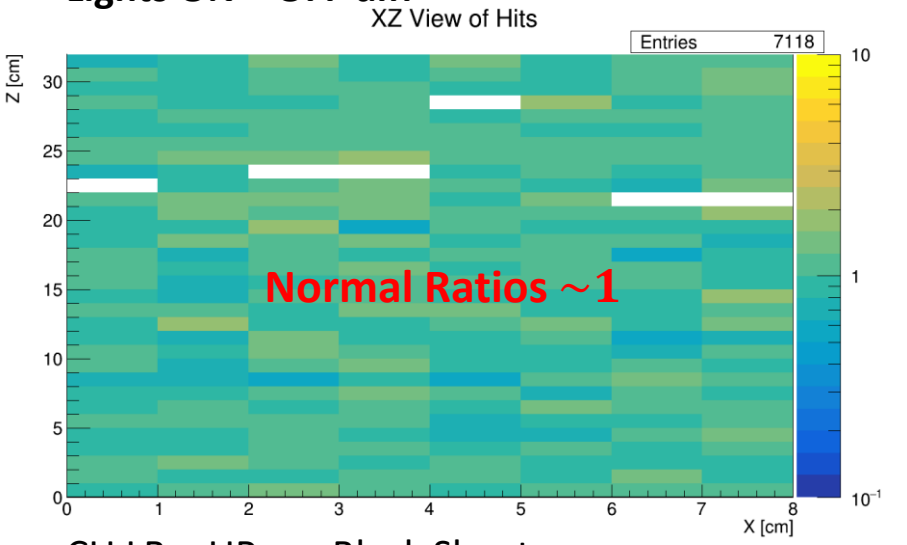
CU LB, No Felt; **Lights ON – OFF diff**



CU LB + UPenn Black Sheet;
Lights ON – OFF diff

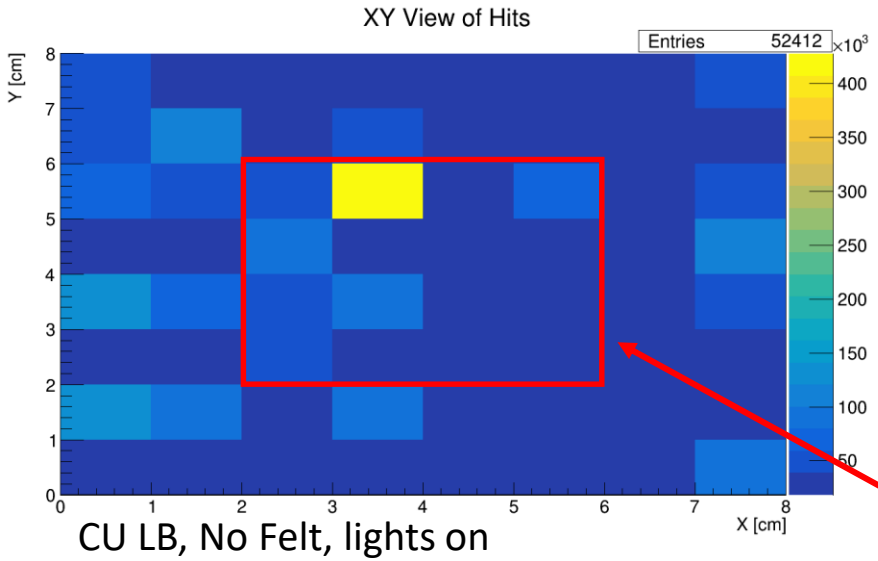


CU LB, no Felt; **Lights ON / OFF ratio**

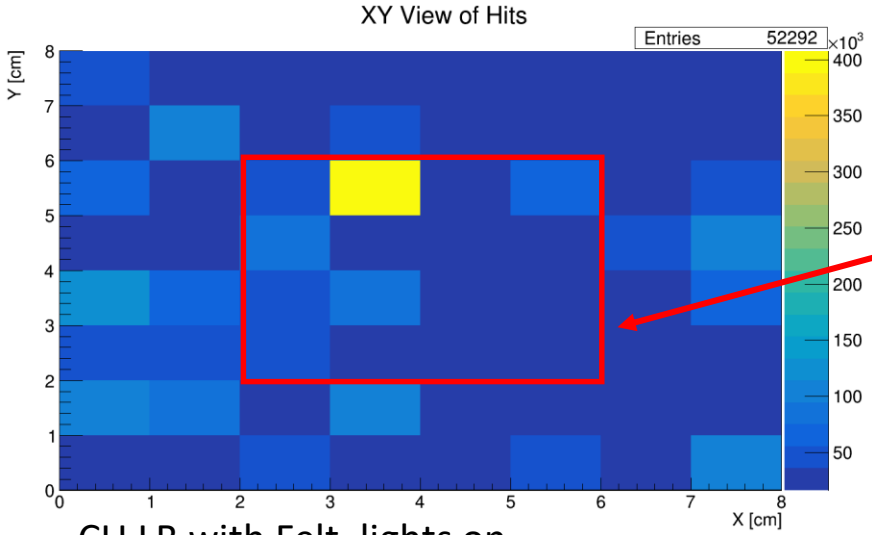


CU LB + UPenn Black Sheet;
Lights ON / OFF ratio

Effect of the Felt Rings

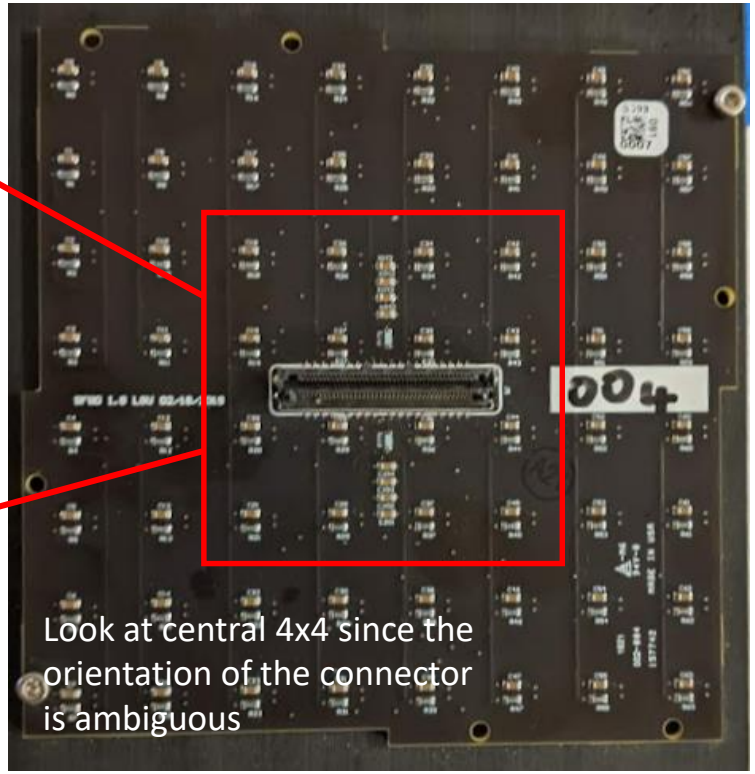


CU LB, No Felt, lights on

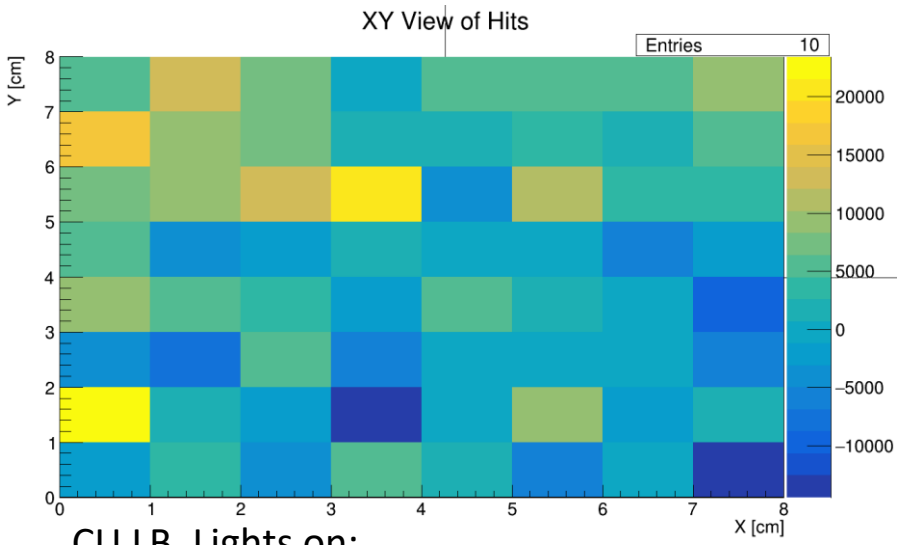


CU LB with Felt, lights on

- If we reference the edge leak as a standard, there is nothing on this scale near SAMTEC connection site
- Would see some enhanced signal in the central MPPCs for no felt runs with lights on

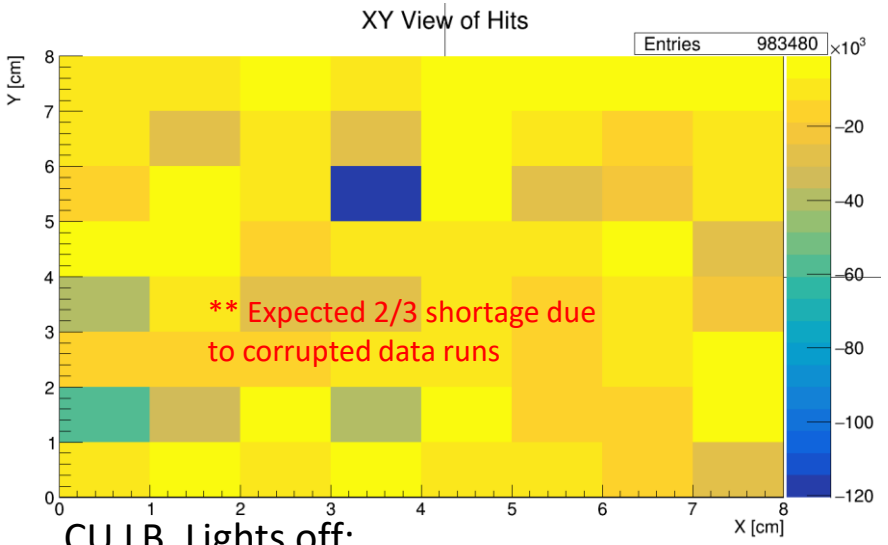


Effect of the Felt Rings – XY



CU LB, Lights on;

No felt – with felt diff



CU LB, Lights off;

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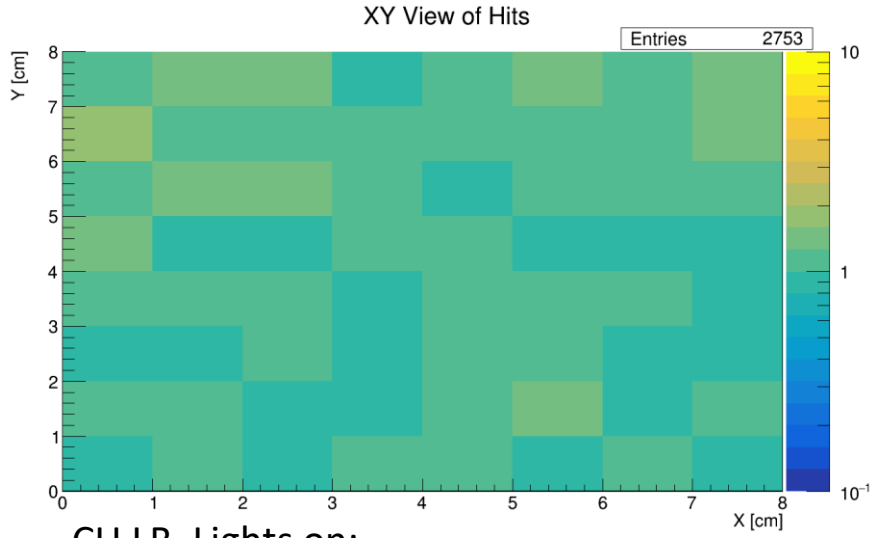
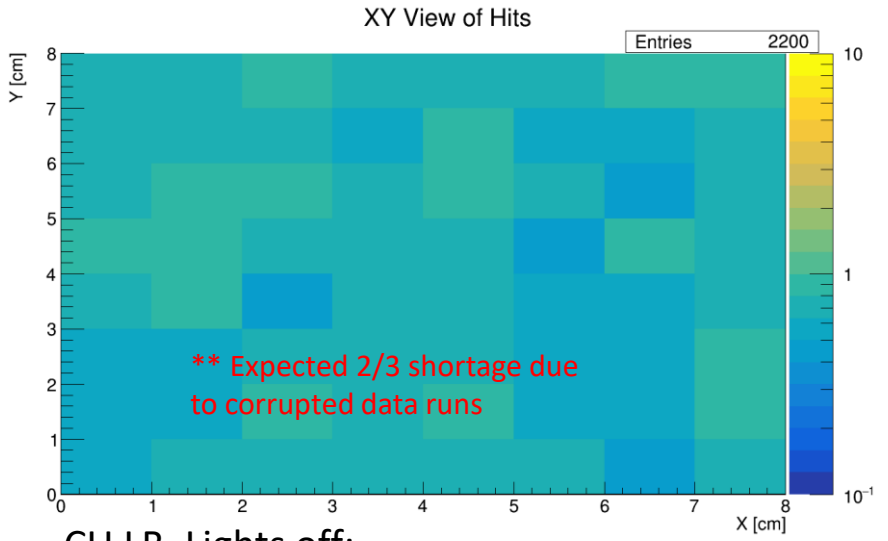


CU LB, Lights on;

No felt / with felt ratio

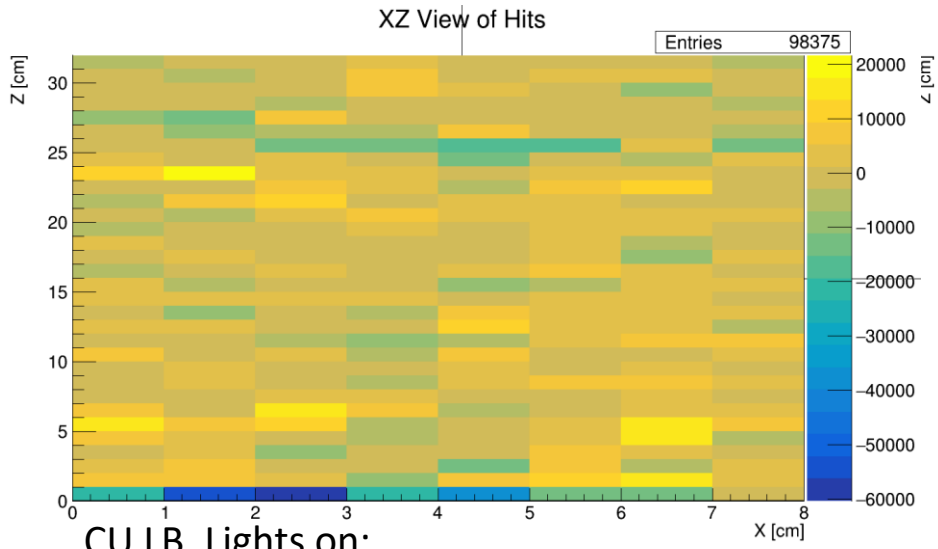


CU LB, Lights off;

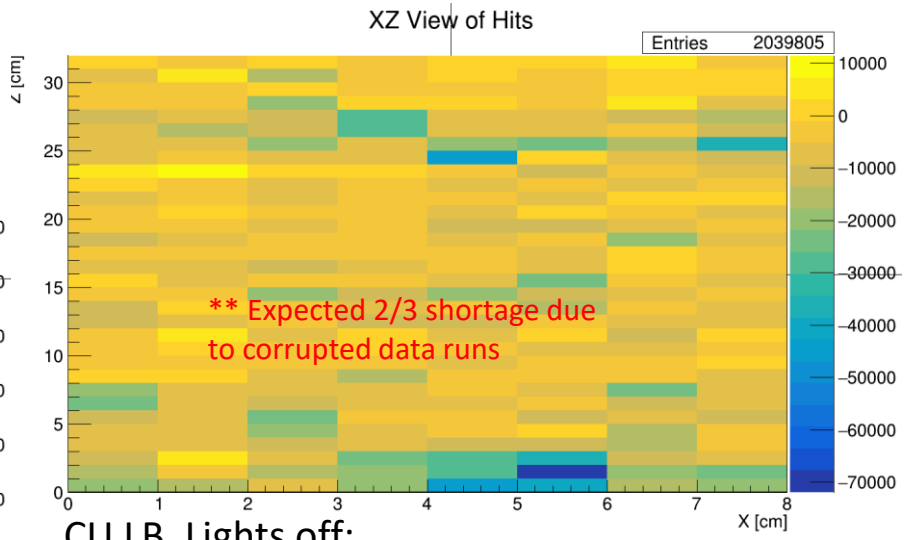
No felt / with felt ratio

* NOTE: If outlier channels were true leaks, we would expect a discrepancy between the lights on and lights off trials

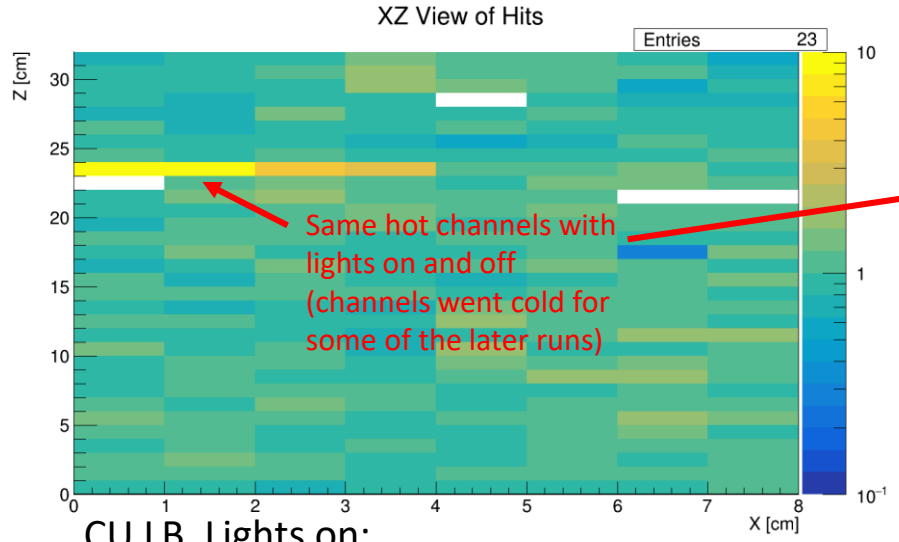
Effect of the Felt Rings – XZ



CU LB, Lights on;
No felt – with felt diff



CU LB, Lights off;
No felt – with felt diff



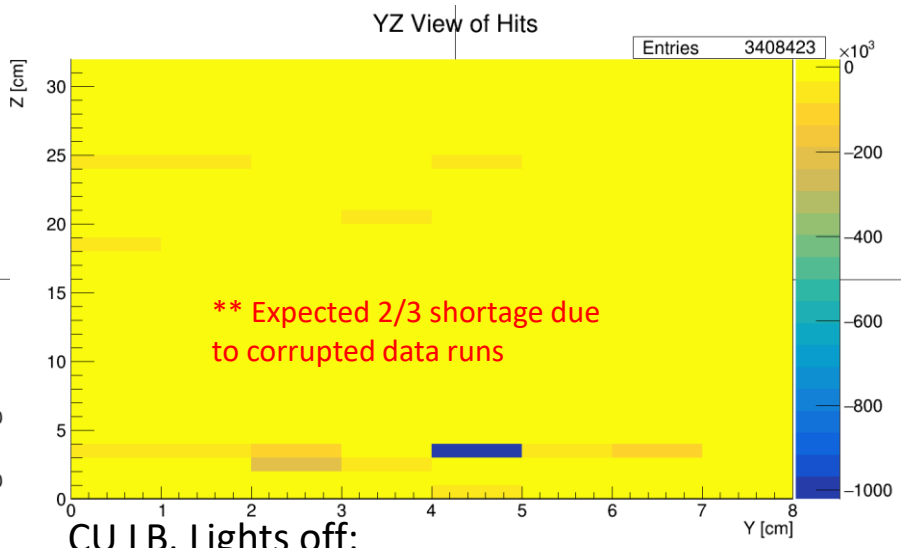
CU LB, Lights on;
No felt / with felt ratio

CU LB, Lights off;
No felt / with felt ratio

* NOTE: If outlier channels were true leaks, we would expect a discrepancy between the lights on and lights off trials

Effect of the Felt Rings – YZ

CU LB, Lights on;
No felt – with felt diff



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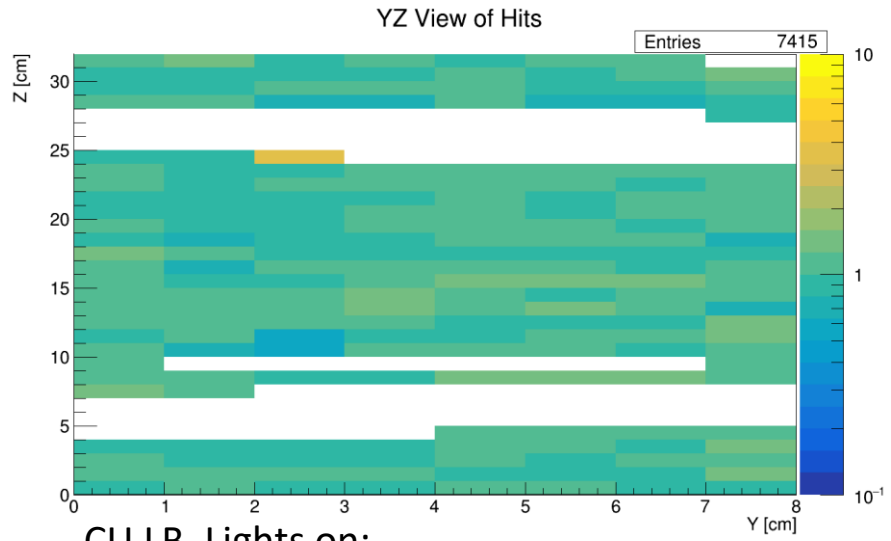

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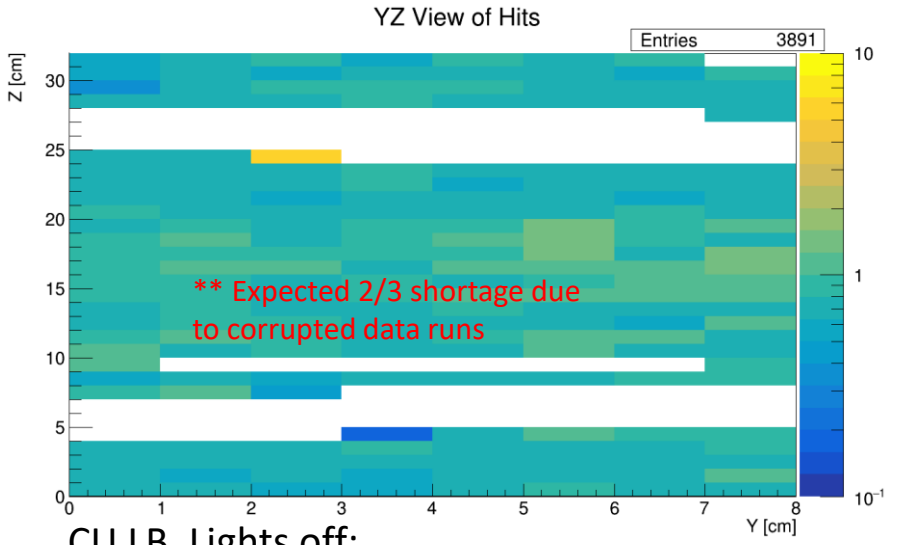


CU LB, Lights off;
No felt / with felt ratio

Conclusions

- There is no light leak near the SAMTEC connectors on the scale of the light barrier edge leak
  - The felt rings around the connectors may not be necessary
- A light leak was visible near the edge of one polyester sheet
  - Characterized by significantly amplified ADC signal (~10x higher) that only appears in runs with the lab lights on
  - Will have to be more careful when installing the light barrier
    - Ensure it lies (mostly) flat
    - Ensure no light gaps at the edges
- Overall, the CU light barrier functions at least as well as the black sheet used for the US-Japan prototype at UPenn

Backup

Test Configurations

10 Test Configurations:

Run #	Room Lights	Polyester Sheet	Felt Rings	Penn Light Barrier
202 (206)	On (Off)	Off	Off	Off
211 (212)	On (Off)	On	Off	Off
215 (216)	On (Off)	On	Off	On
219 (220)	On (Off)	On	On	Off
221 (223)	On (Off)	Off	Off	On

No Light Barrier

Polyester Only

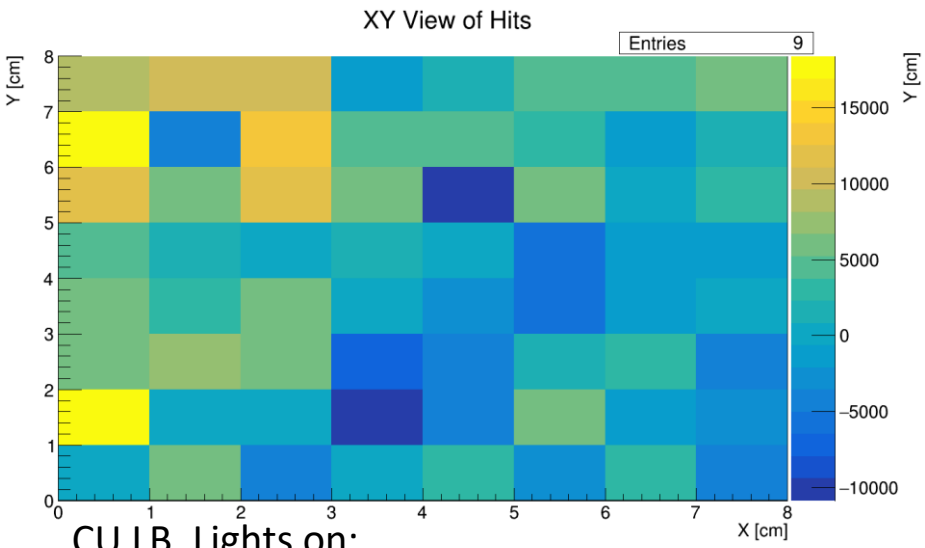
Polyester + Black Sheet

Polyester + Felt

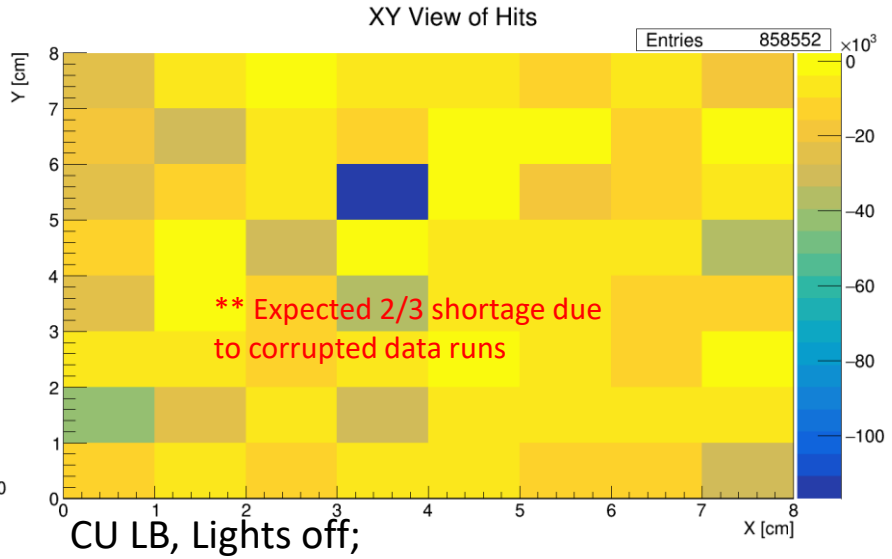
Black Sheet Only

** Room lights off ≠ completely dark in the room.
Some light from computer monitors (needed to be on to check for data collection errors) and from readout crates **

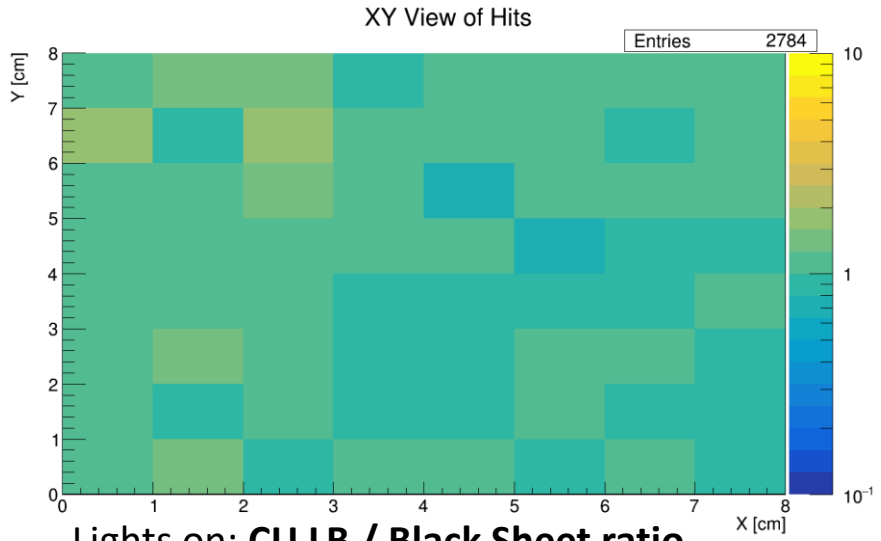
CU LB vs Upenn Black Sheet – XY



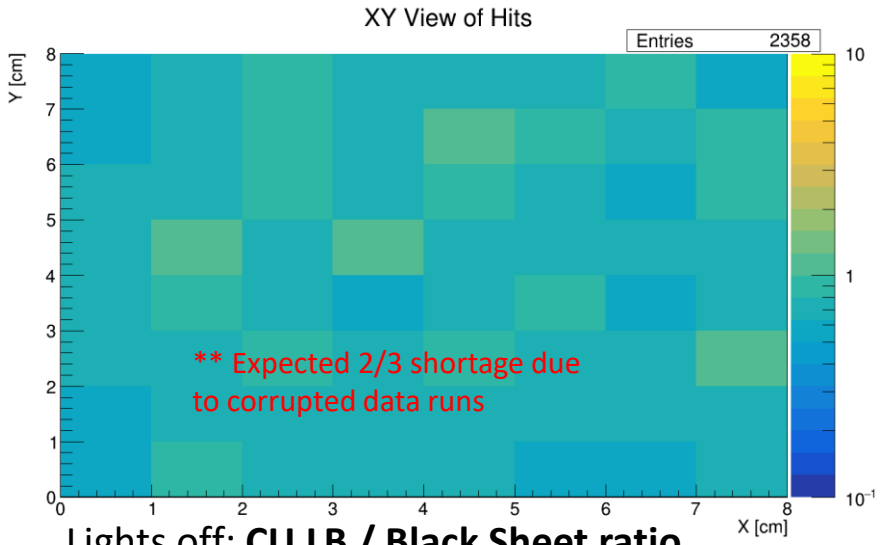
CU LB, Lights on;
No felt – with felt diff



CU LB, Lights off;
No felt – with felt diff

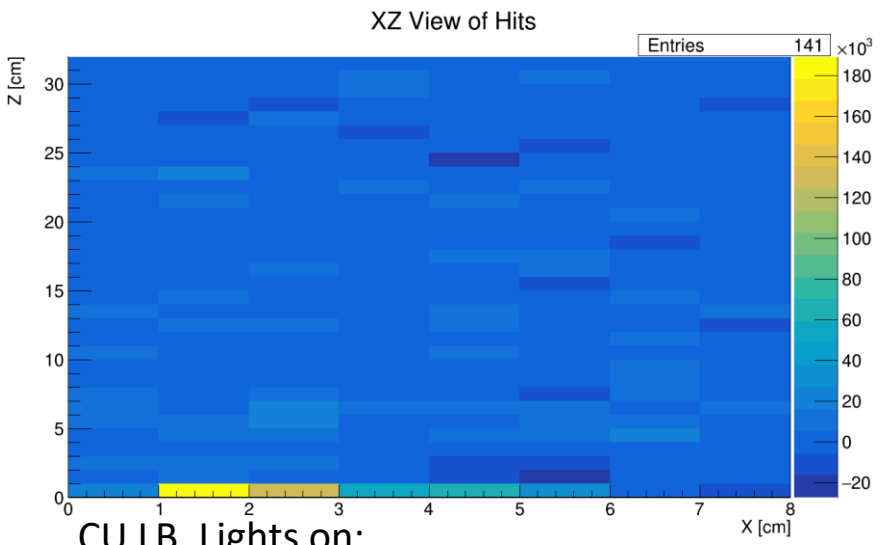


Lights on; **CU LB / Black Sheet ratio**



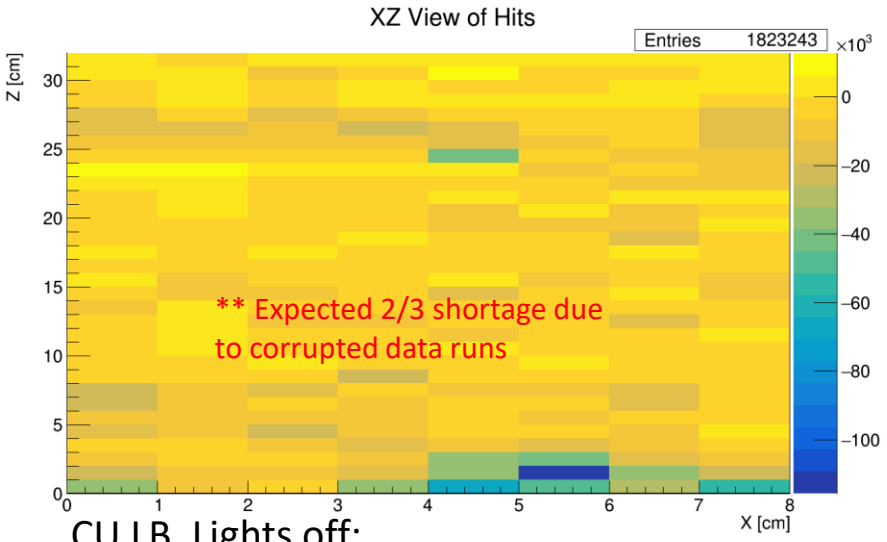
Lights off; **CU LB / Black Sheet ratio**

CU LB vs Upenn Black Sheet – XZ



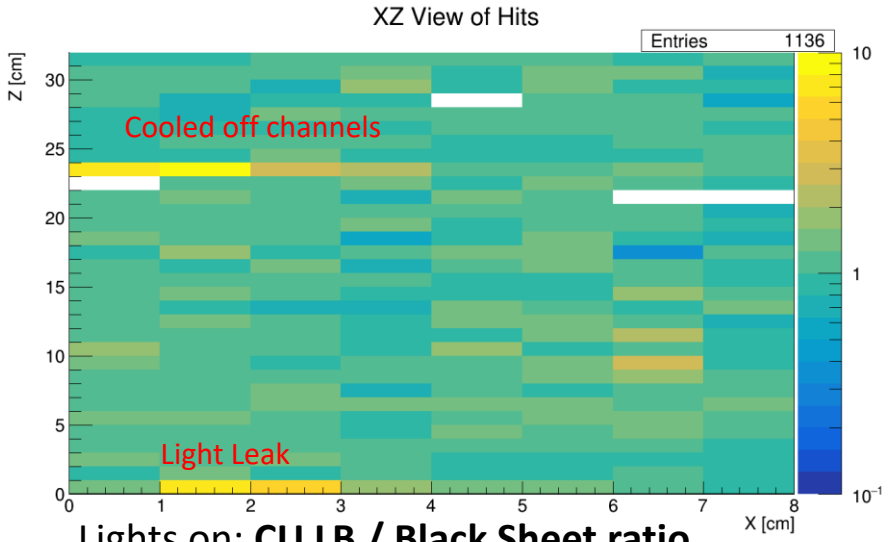
CU LB, Lights on;

No felt – with felt diff

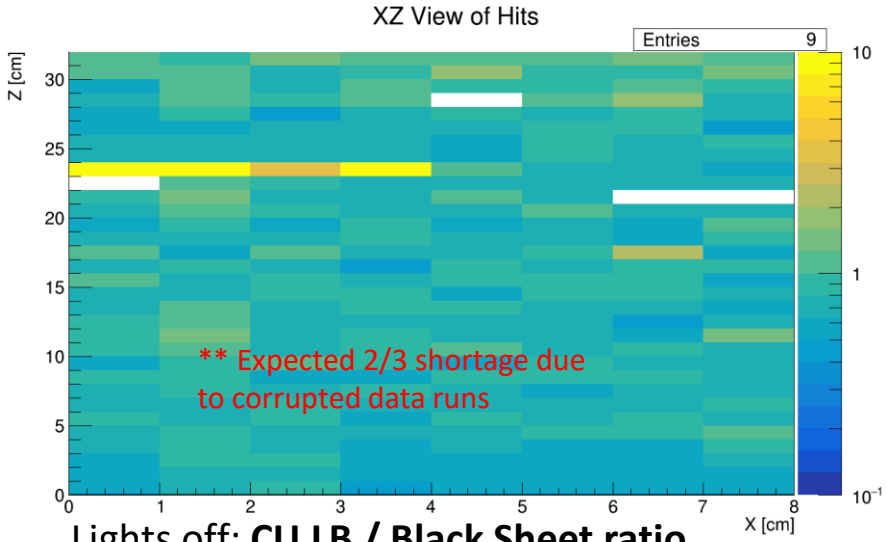


CU LB, Lights off;

No felt – with felt diff

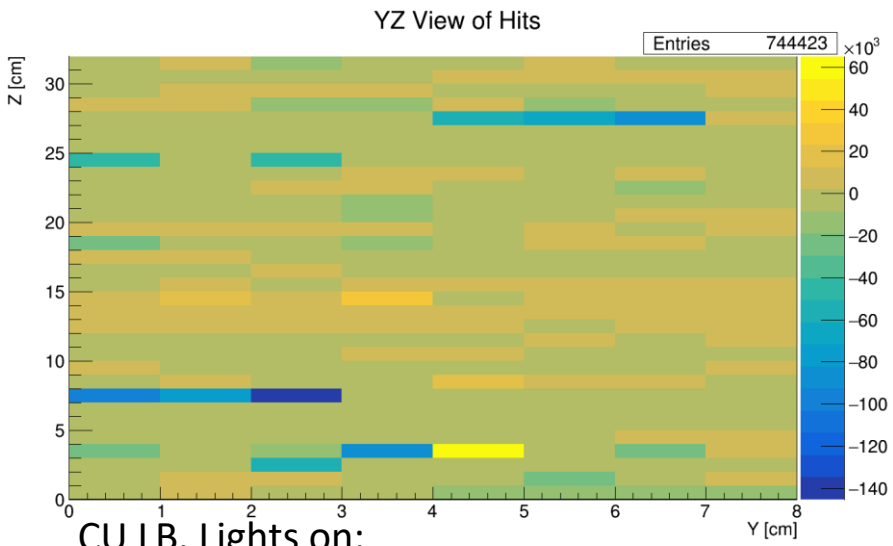


Lights on; **CU LB / Black Sheet ratio**



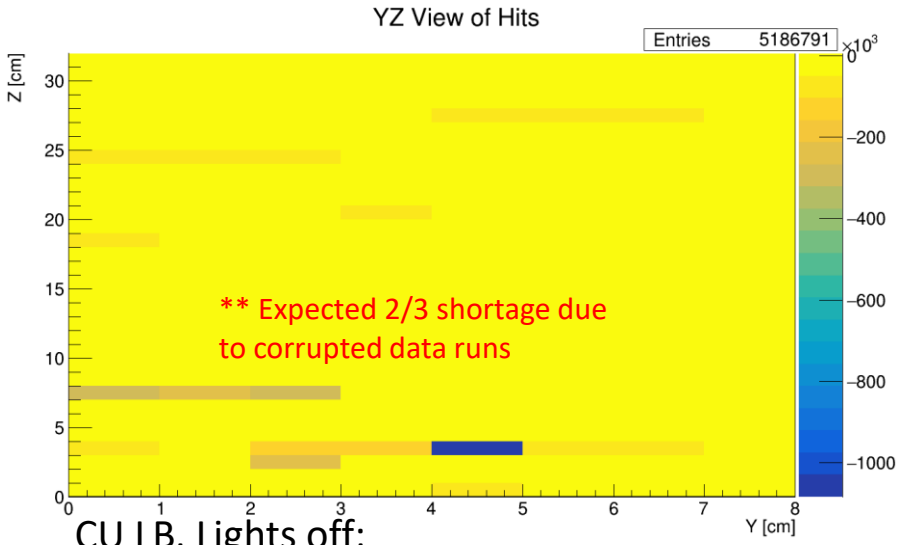
Lights off; **CU LB / Black Sheet ratio**

CU LB vs Upenn Black Sheet – YZ



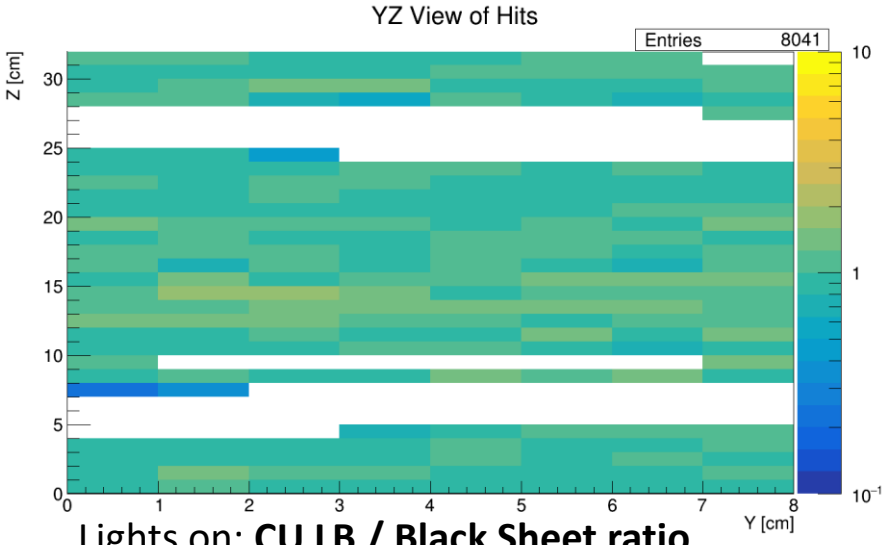
CU LB, Lights on;

No felt – with felt diff

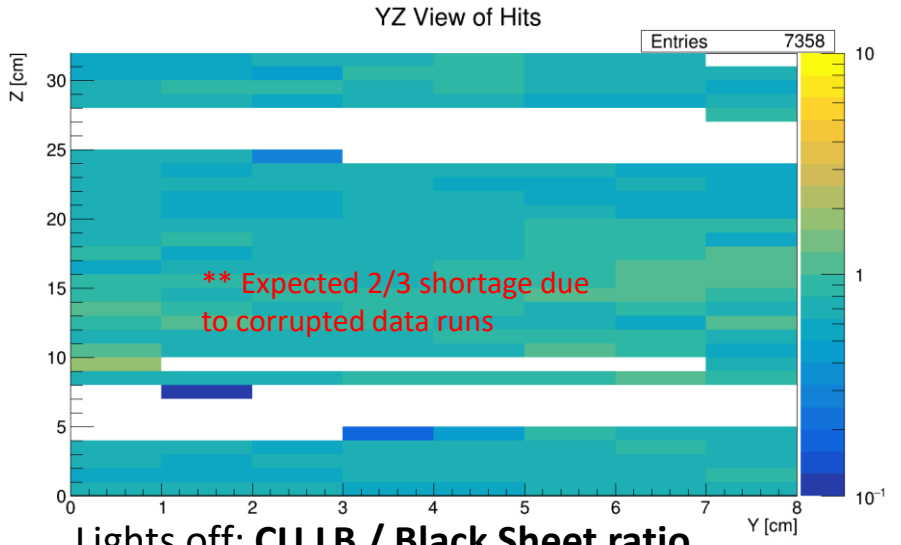


CU LB, Lights off;

No felt – with felt diff



Lights on; **CU LB / Black Sheet ratio**



Lights off; **CU LB / Black Sheet ratio**