

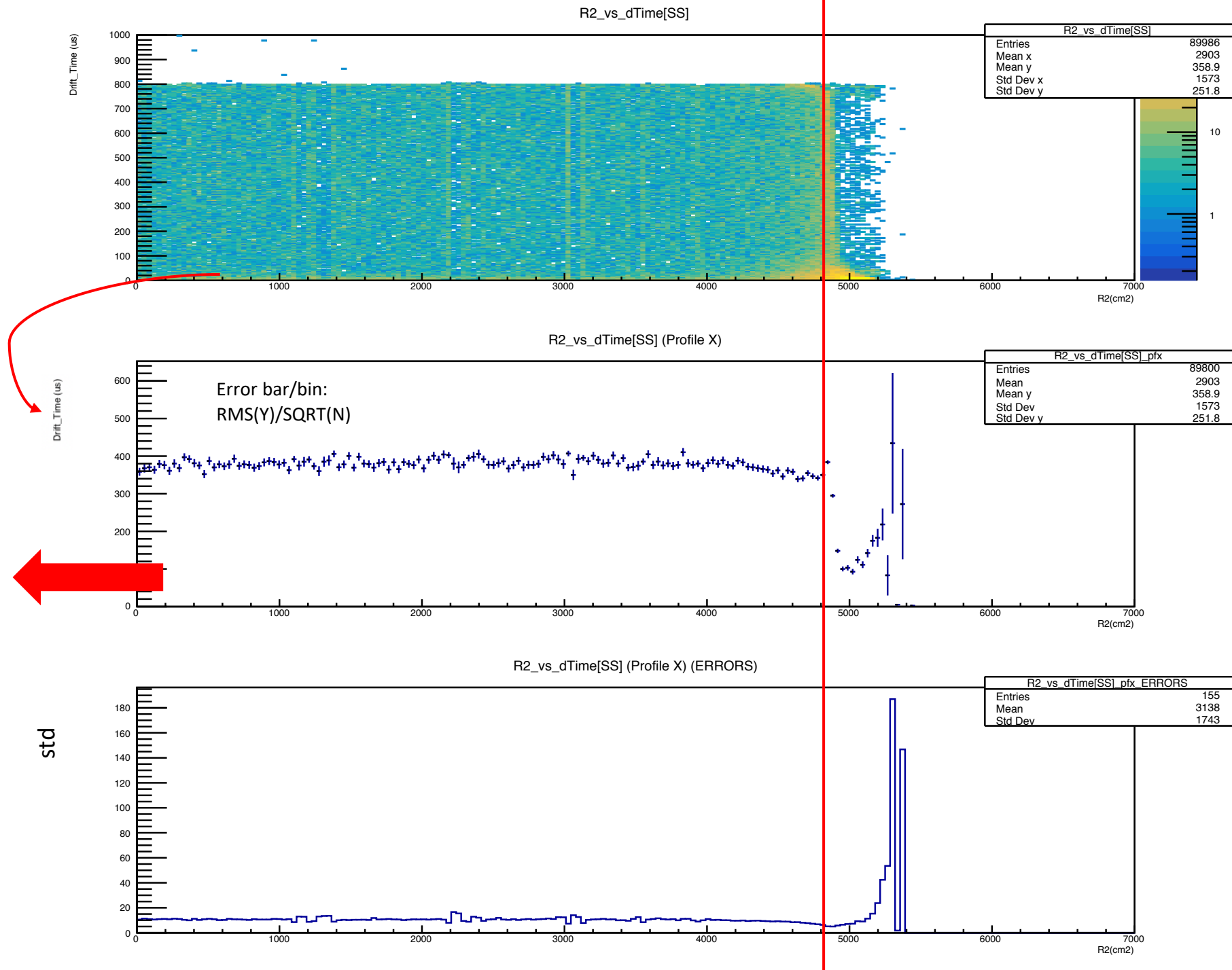
1st April 2021

- Algorithm for PREM (need to check the output on PREM website):
 - Mean within a threshold
 - Fraction for different cases
- Some thoughts for checking:
 - 1. uniform distribution (R2 vs dTime plot)
 - 2. shift of population & new appearance and disappearance of a new population (pulse parameter plots)

Profile the plot
→ keep both x, y-axis
information

Within the fiducial volume cut:

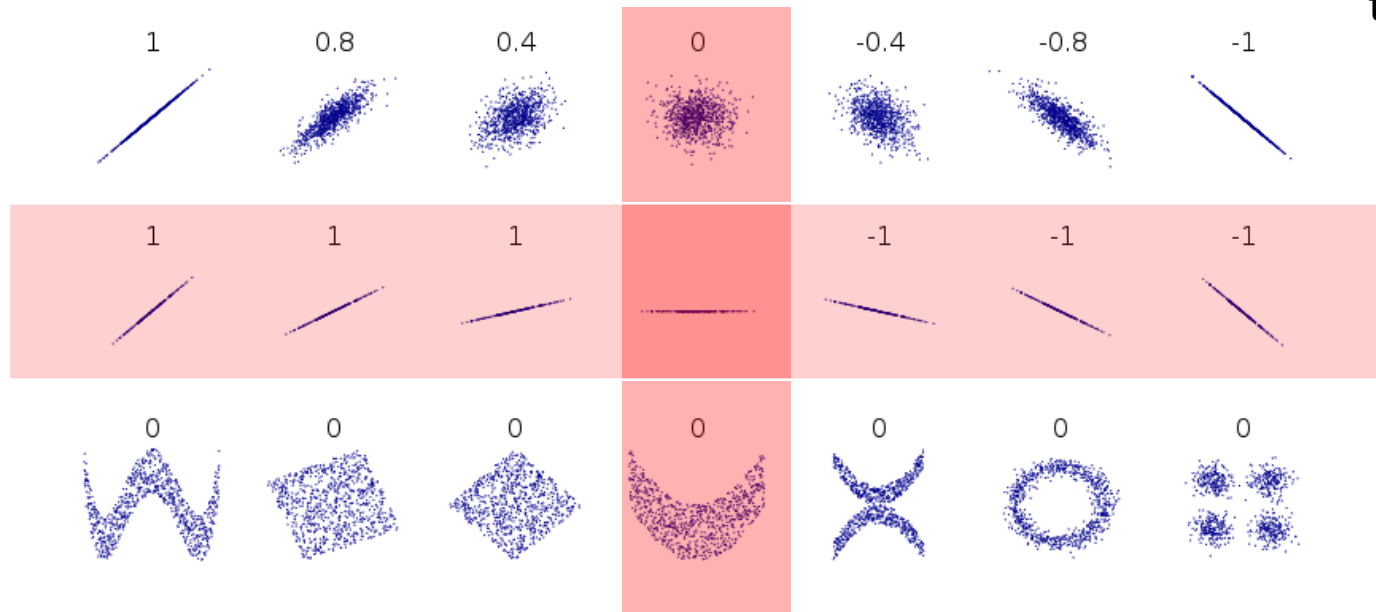
1. Create a reference
distribution with mean and
std → check each bin in the
sample distribution



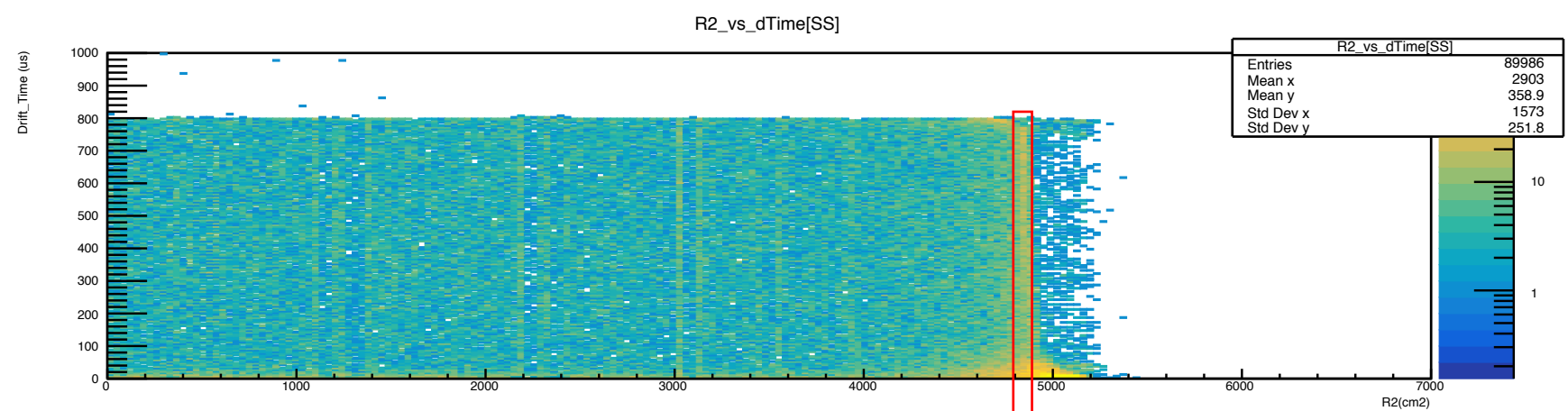
Correlation

If uniform distribution → flat line + low error bar:

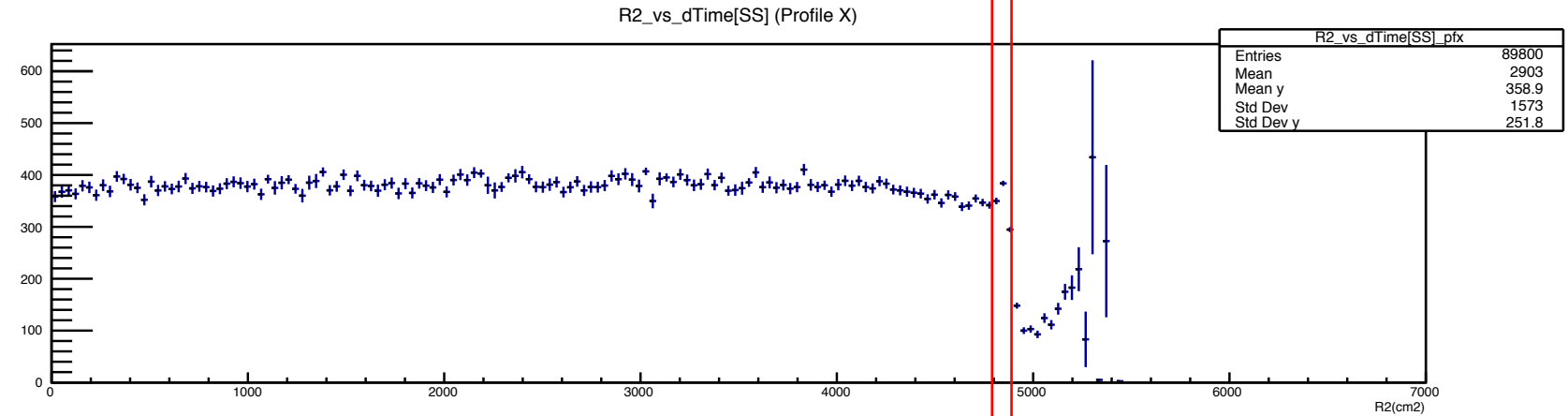
1. Correlation coefficient → 0 → data is random `GetCorrelationFactor()`
2. Y StD is small → uniform along the X-axis
3. Low Y Error Bar → uniform along the Y-axis



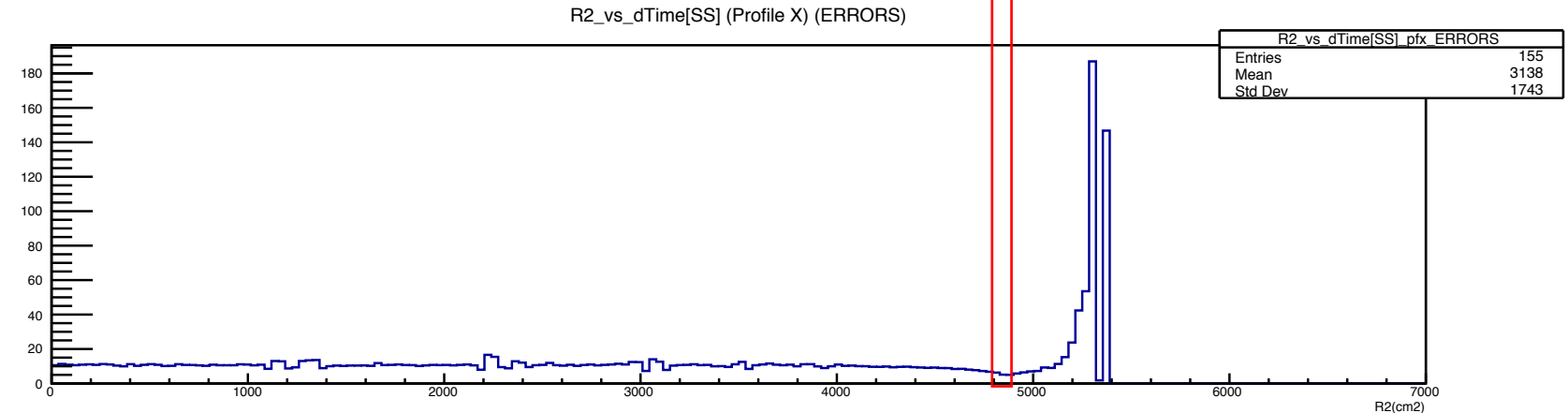
	correlation	StD
Within the red line cut	-0.167	14.318
+1 extra point at Y = 100	-0.210	27.541



Concern: it won't detect
if there is an increase
uniformly along the Y-axis
(as shown in the red
region) → check
#entries/bin

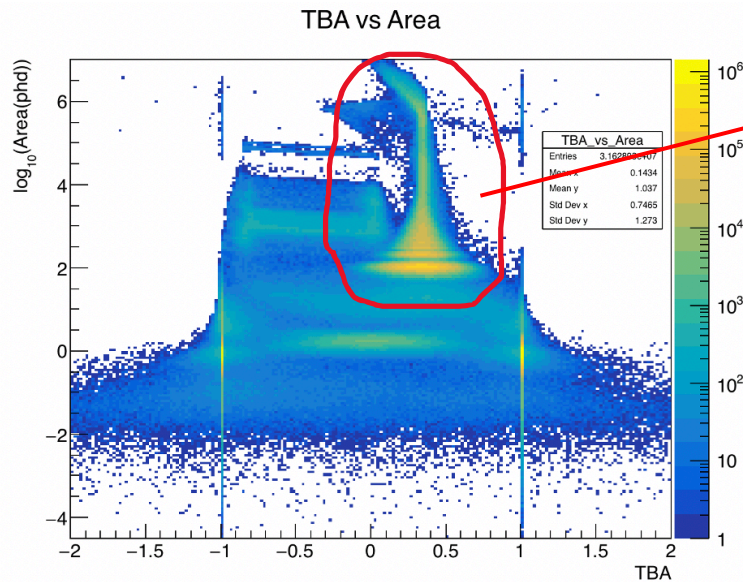


Or if this is unlikely to
happen.....



CDF

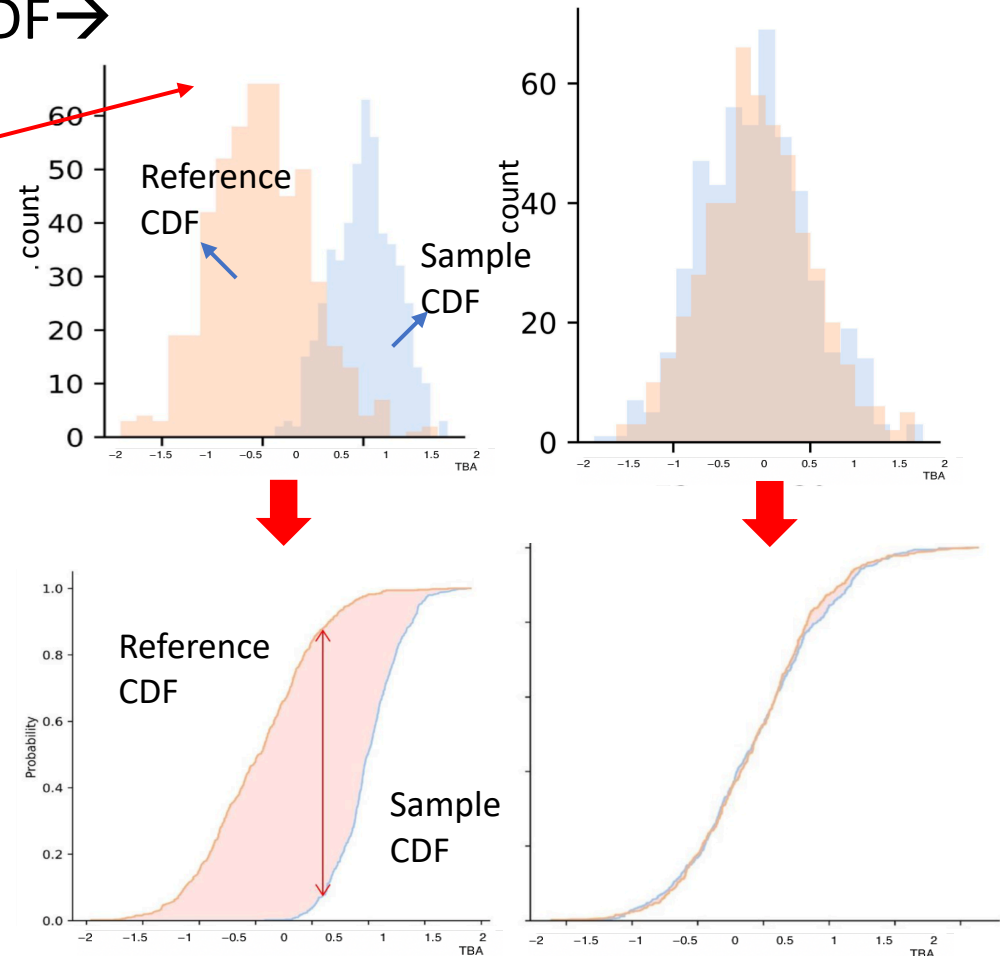
- 1st Goal → compare two distribution (sample vs. reference) → the distance between two CDF → notice the shift of population



- Normalized the distribution for a population

- Create Two CDFs: x, y
- For each interval, define what is a good number for distance

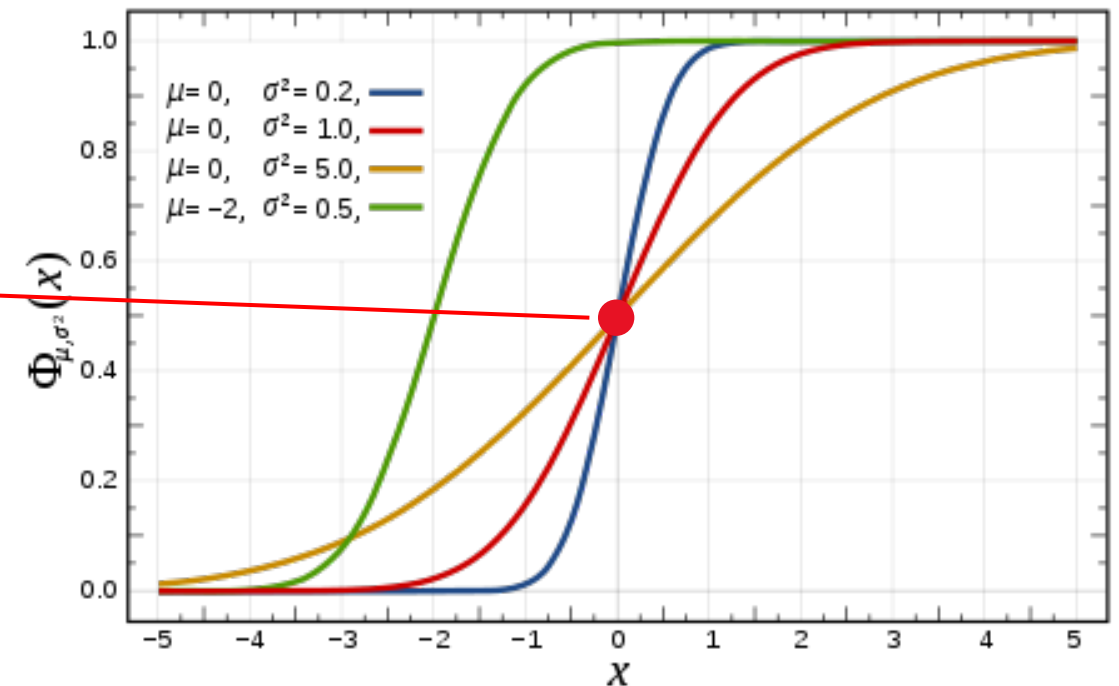
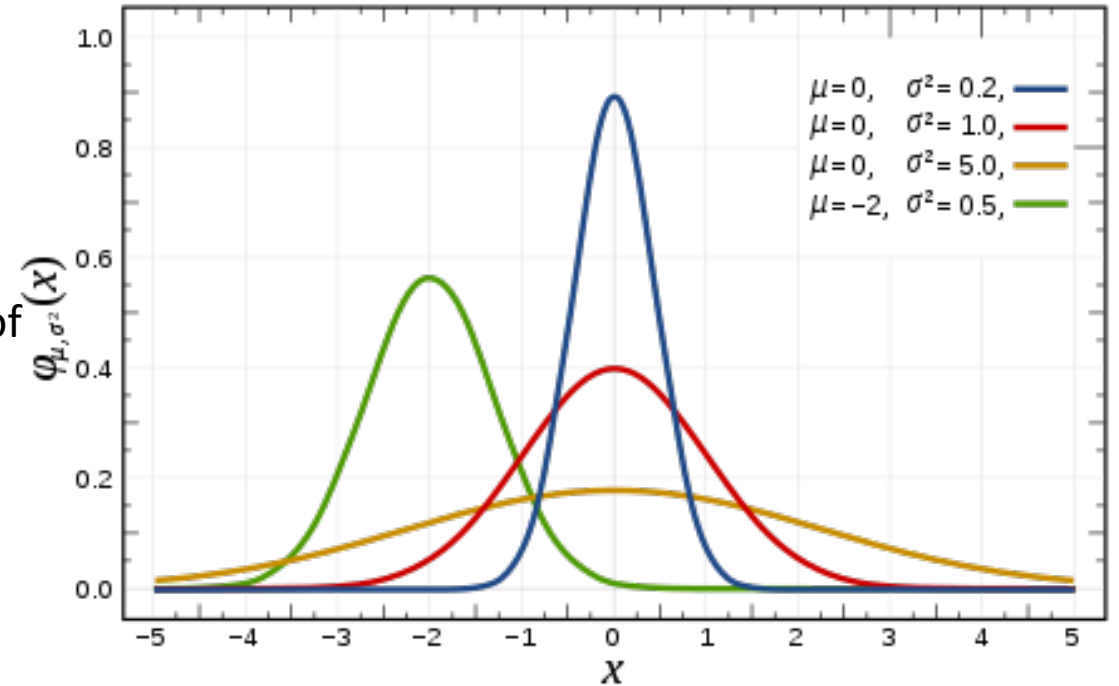
These are just to show the idea, not the real distribution from PREM plot



CDF

- 2nd Goal → appearance/disappearance of a part of the population → shape of the CDF
 - Change of amplitudes in PDFs
 - In the CDF, there will be an intersection of two distributions

y-axis:
percentage of
total entries



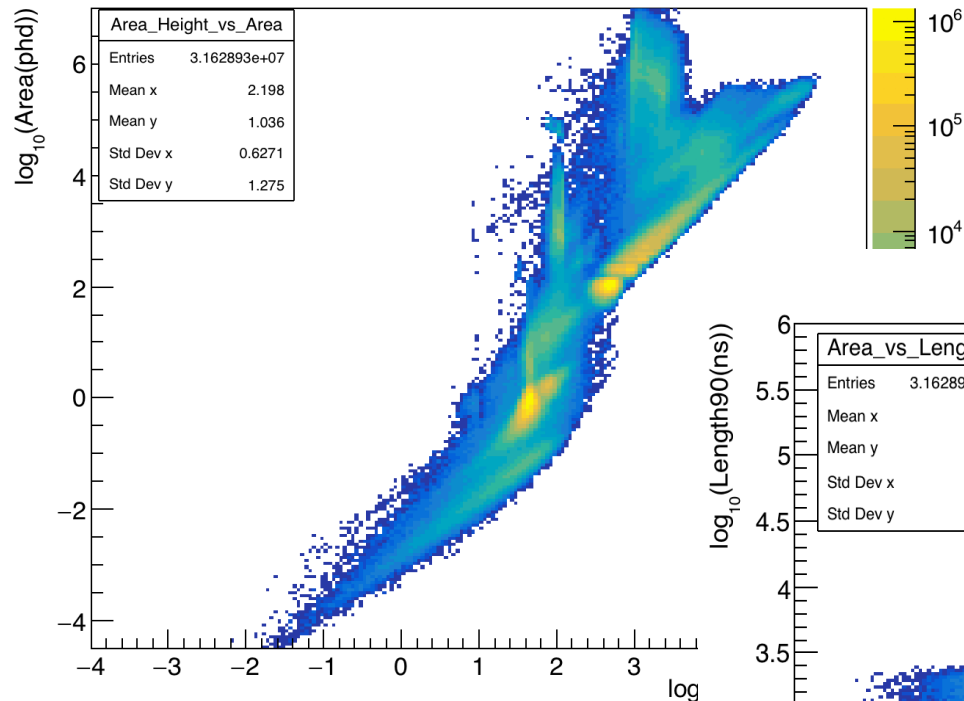
25th March 2021

- Make algorithms for PREM_TPC plots.
 - Fraction of entries for different cases (3D pulse parameter plots)
 - Mean within a range (S1, S2 spectrum)
 - Fraction/entries below a certain threshold (drift time)

Fraction

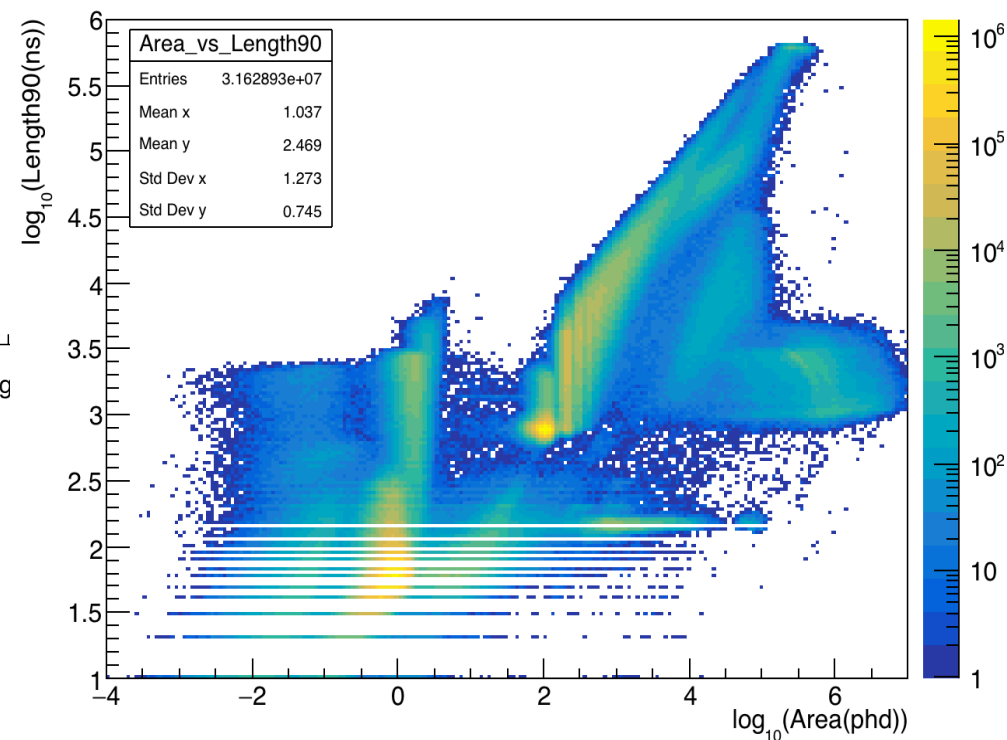
$$\text{Fraction} = \frac{\# \text{ entries of different events (S1,S2,SPE)}}{\# \text{ total entries}}$$

Area/Height vs. Area

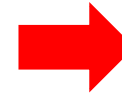
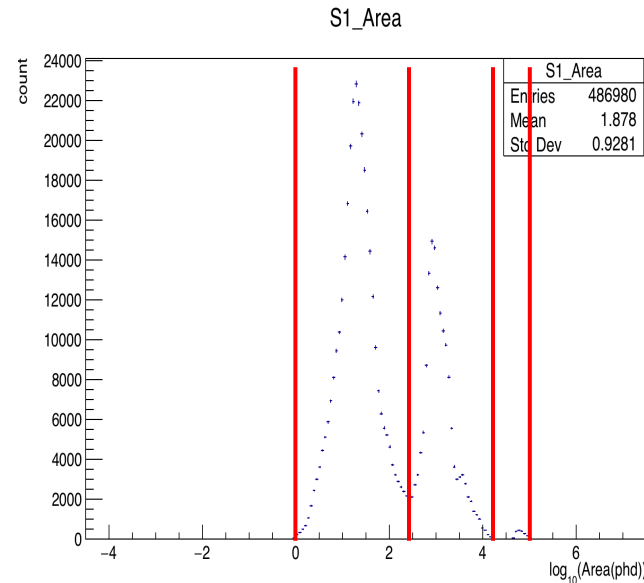
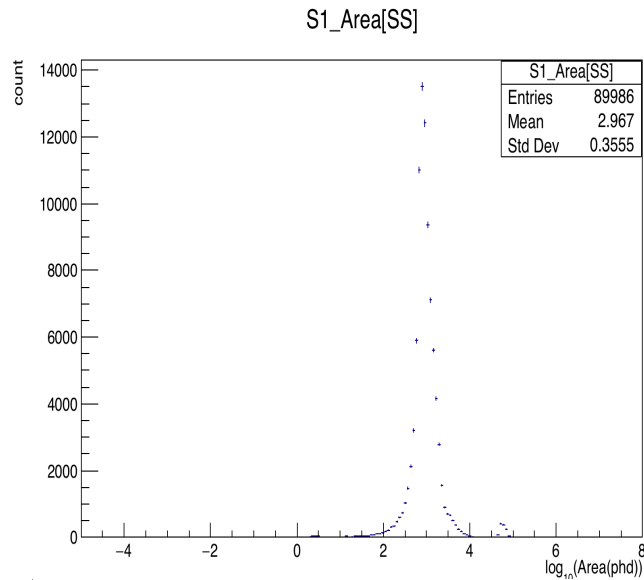


Shifter will look through the fraction

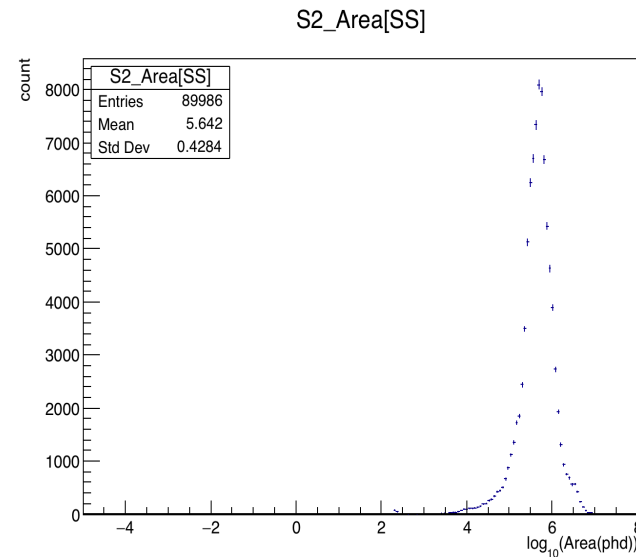
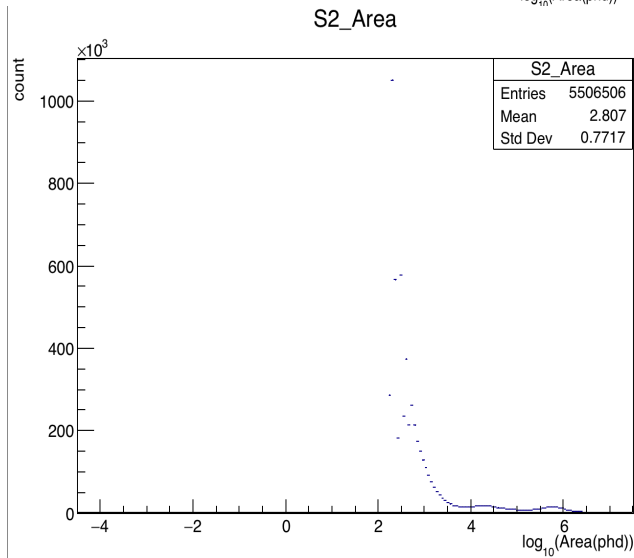
Length90 vs. Area



Mean

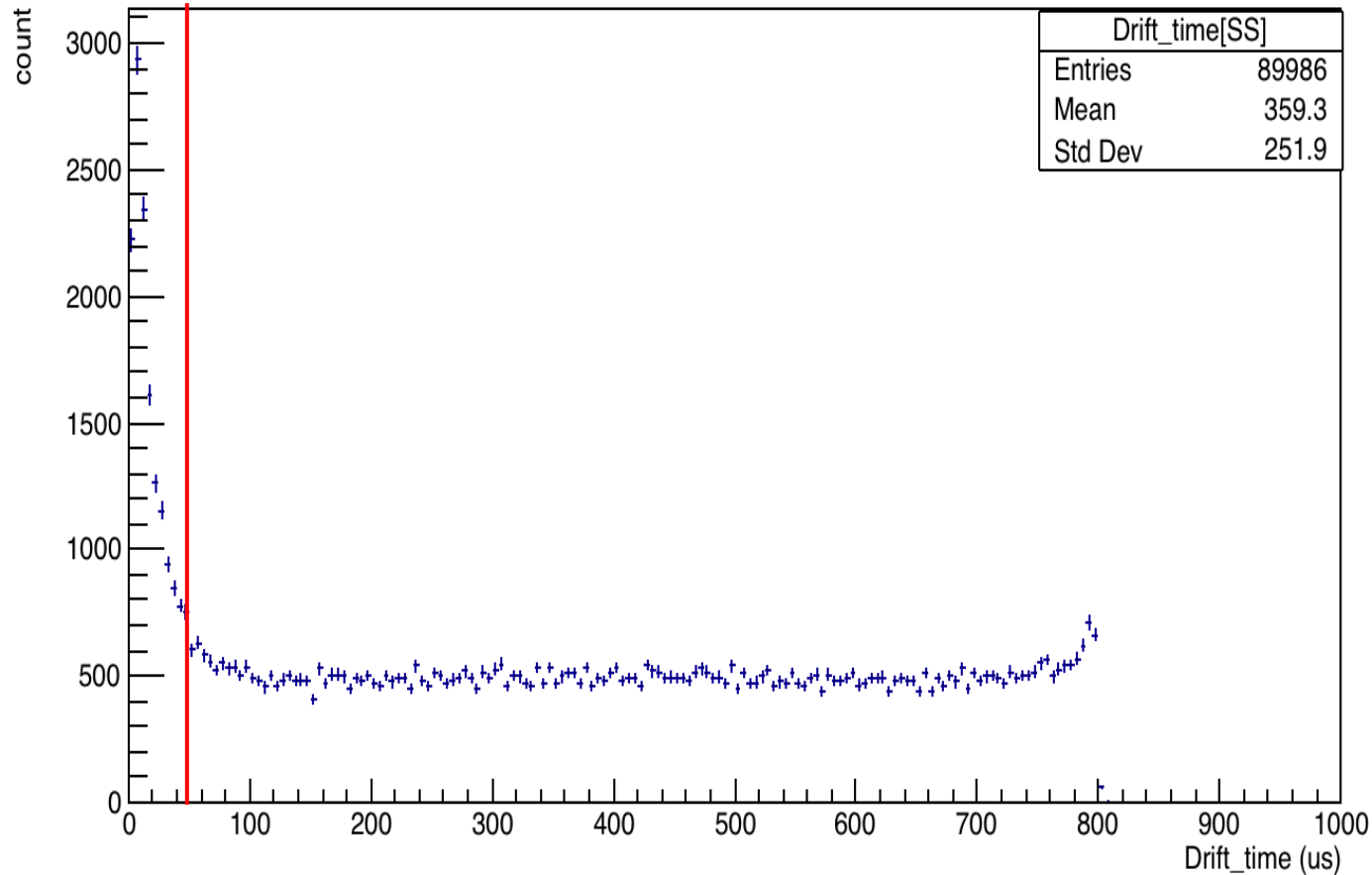


- Multiple spikes
- Define a threshold (lower bound, upper bound)
- Calculate the mean within that threshold



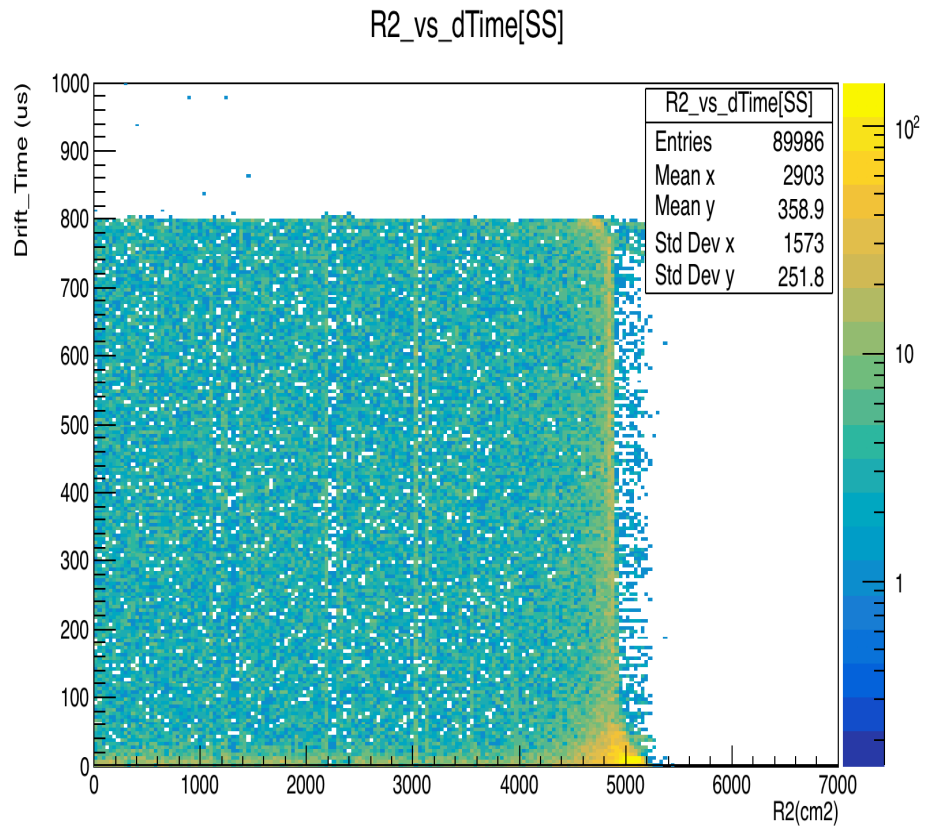
Drift time

Drift_Time[SS]

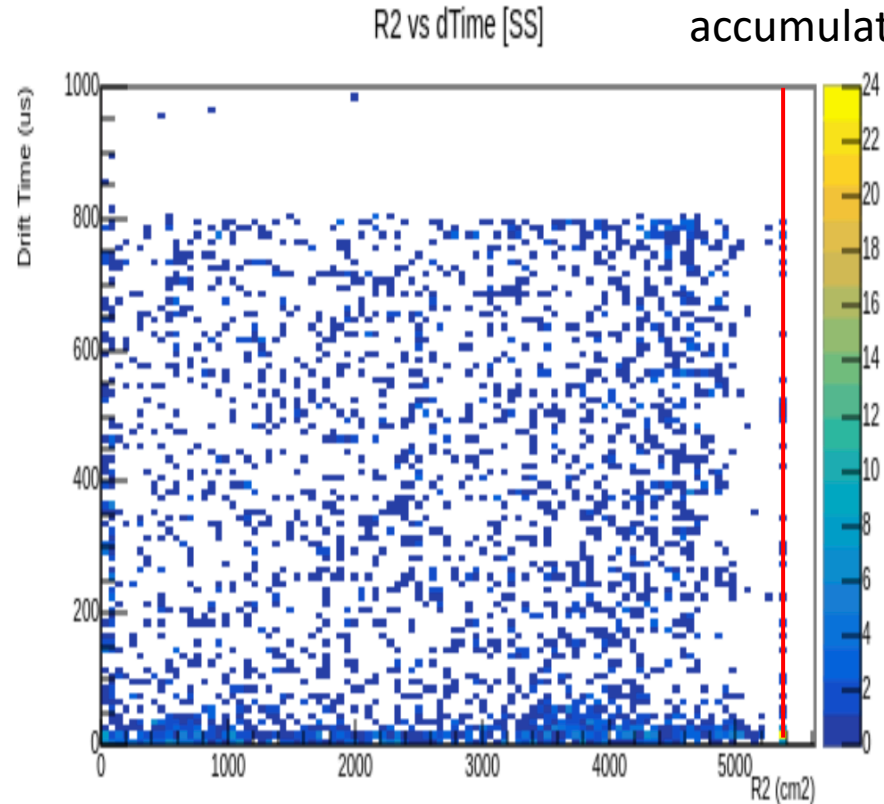


- **Main concern:** for very low drift_time, some S2 signals are created by the electrons emitted by the top gate
- **Algorithm:** for drift_time < threshold (50?) → get the #entries or the fraction

R2 vs Drift Time



PREM



UPM

Possible algorithm:

- Check the #events at the boundary of the TPC → don't want electron accumulation there

11th March 2021

- Extreme value of TBA ($TBA > 50$ or $TBA < -50$)
 - Check the RQ name for TBA
 - Calculated TBA from scratch, $TBA = (T-B)/(T+B)$
 - The output graph is exactly the same
 - The rate:
 - In total $14 + 18 = 32$ out of 800,000 $\sim 0.004\%$ (1 LZap4.7.0 root file)
 - Event types:
 - Plot TBA vs Area for different conditions $\rightarrow$ **others**
 - Learned to use Event Viewer (pretty cool!)
 - Use event viewer to look at their pulses
 - From the raw root file:
 - Get **EventID**, **Run ID**
 - From the Lzap root file:
 - Get **PulseID**
 - Plot x vs. y positions of these events

Extreme TBA value

$$\bullet T - B > a (T + B) \quad \left\{ \begin{array}{l} \bullet T > 0 \rightarrow B < 0 \ \&\& \ |B| > T \\ \bullet T < 0 \rightarrow \left\{ \begin{array}{l} B < 0 \\ B > 0 \ \&\& \ |B| \ll |T| \text{ or } a \gg 1 \end{array} \right. \\ \bullet T = 0 \rightarrow B < 0 \\ \bullet B = 0 \rightarrow T < 0 \end{array} \right.$$

$$\begin{array}{l} \bullet T - B < -a (T + B) \\ = B - T > a (T + B) \end{array} \quad \left\{ \begin{array}{l} \bullet B > 0 \rightarrow T < 0 \ \&\& \ |T| > B \\ \bullet B < 0 \rightarrow \left\{ \begin{array}{l} T < 0 \\ T > 0 \ \&\& \ |T| \ll |B| \text{ or } a \gg 1 \end{array} \right. \\ \bullet T = 0 \rightarrow B < 0 \\ \bullet B = 0 \rightarrow T < 0 \end{array} \right.$$

Pulse

PREM output:

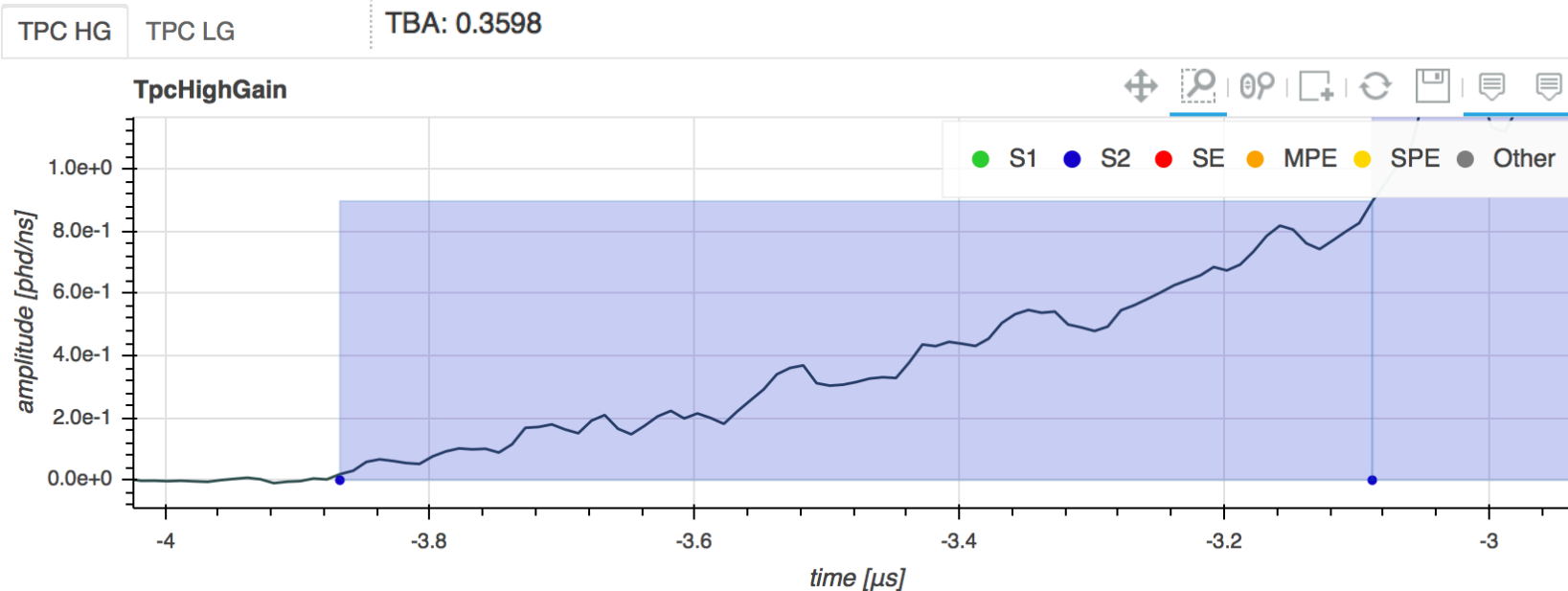
TBA: 74.5369

/global/cfs/cdirs/lz/data/MDC3/background/BACCARAT-4.11.0_DER-8.5.13/20180401/lz_201804010002_000172_035738_raw.root,172,3873653,10

raw root file

eventID
runID pulseID

Event Viewer output:



Does not match
1. Pulse type
2. TBA value

LZap 4.7.0

- Check the processing setting
- PREM input data file: using the root file from LZAP-4.7.0

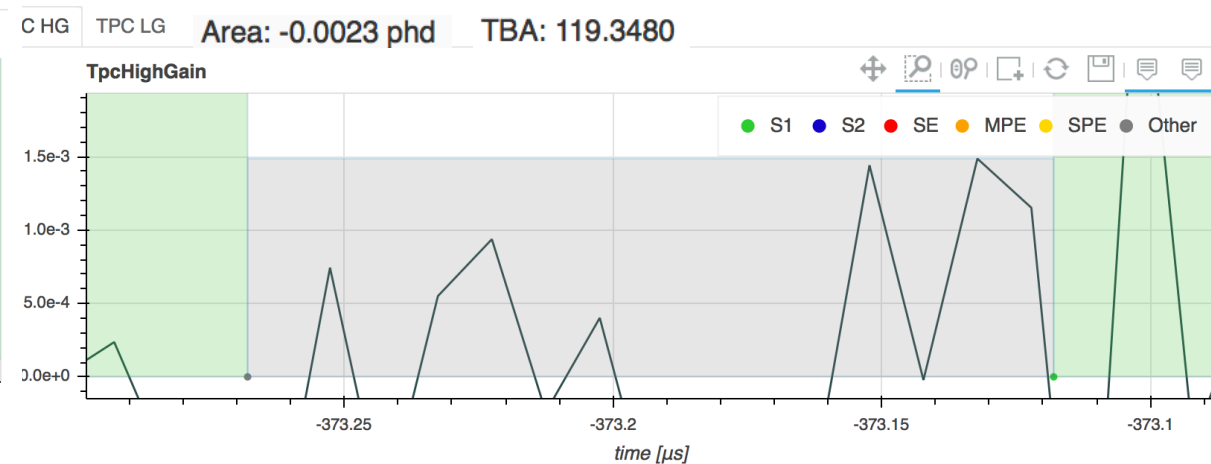
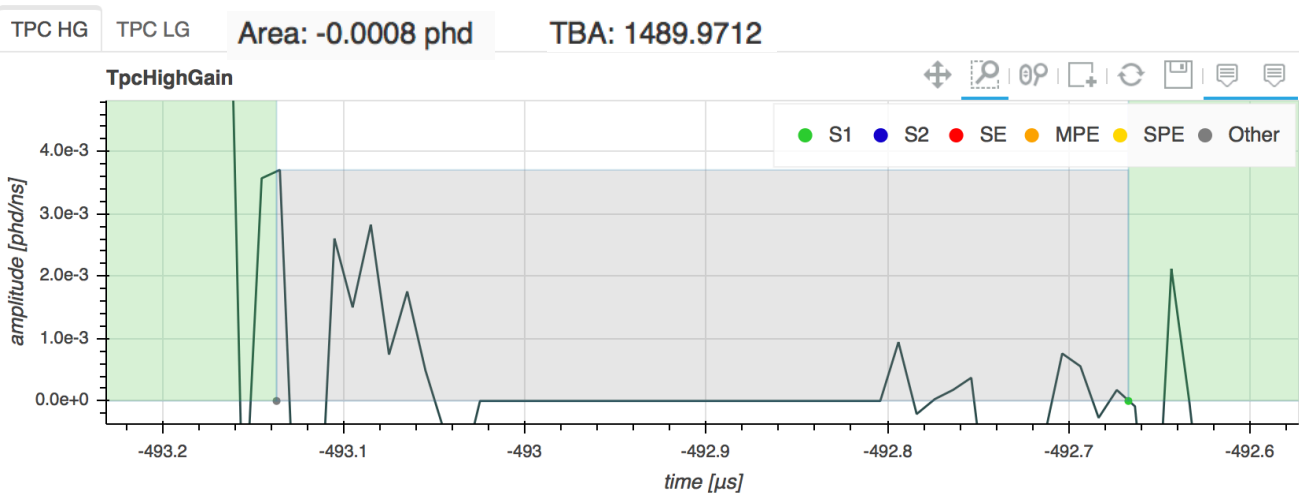
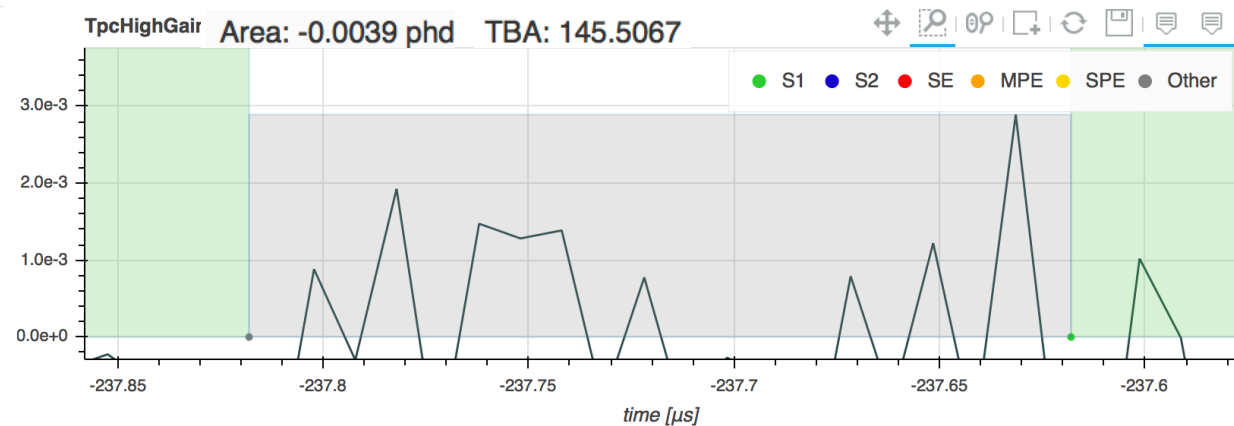
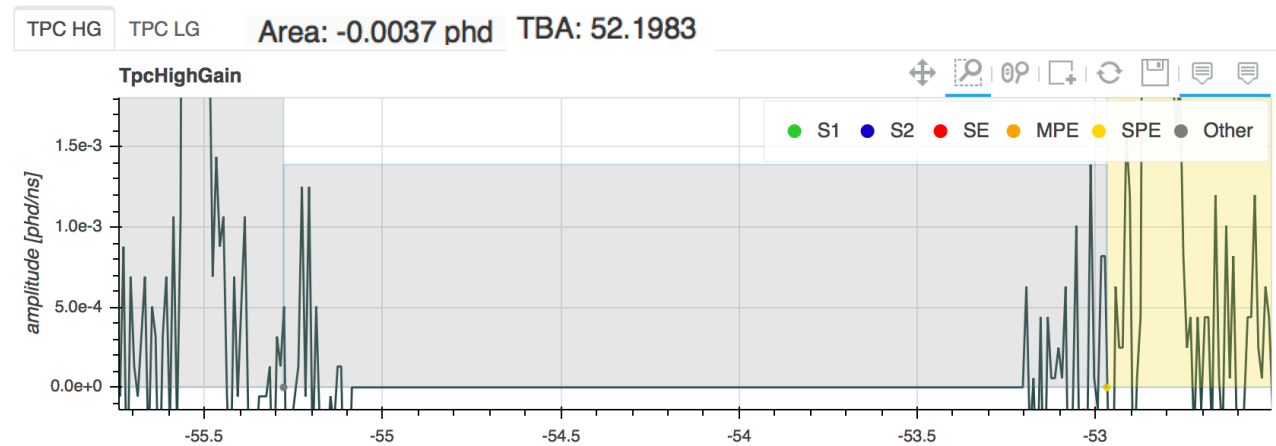
→ Default LZap version on Event Viewer: 5.0.5 → Event Viewer will process the raw root file with this LZap version
→ Change to 4.7.0

The screenshot shows the 'Processing Settings' tab of the LZap Event Viewer. The 'Current LZap version' is set to 5.0.5. The 'LZap Version input' section includes a 'format: #.#.#' field and a 'Change' button. The 'Max number of events to process' field is empty. The 'LZap steering file type' is set to 'Commissioning', with a blue arrow pointing to 'MDC3'.

File input	Sparse input	Processing Settings
Current LZap version		
5.0.5		LZap Version input
		format: #.#.#
		Change
Max number of events to process		LZap steering file type
		Commissioning

MDC3

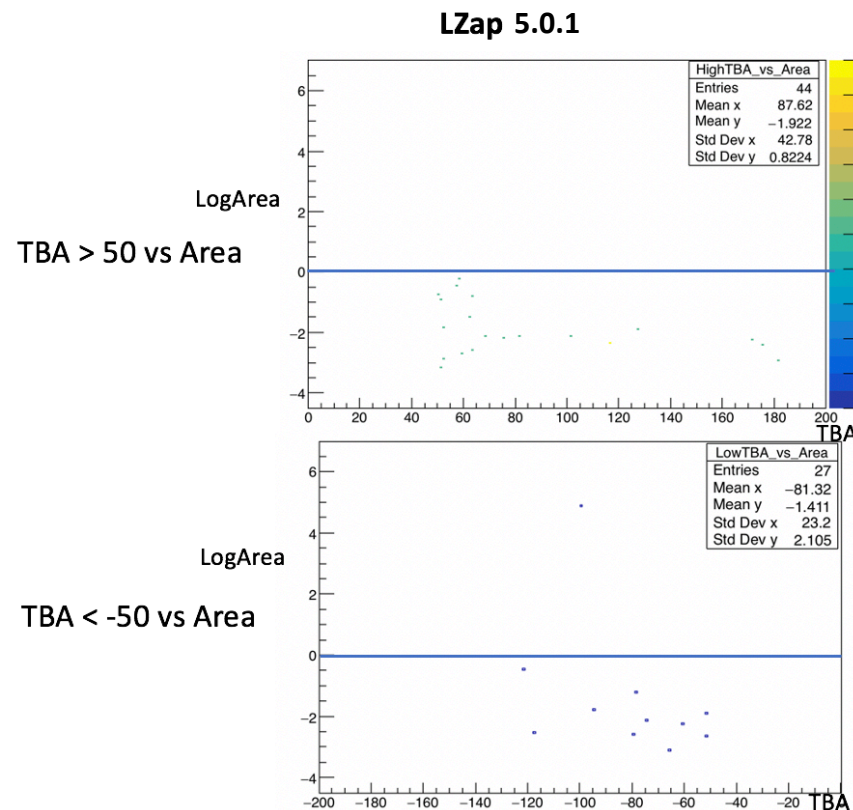
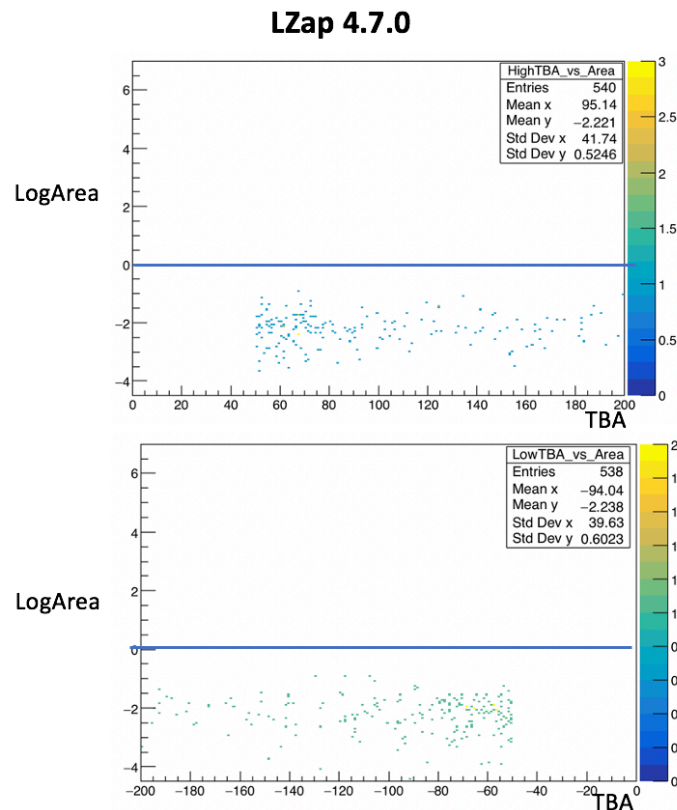
All the problems appear →



Problems with LZap version: 4.7.0

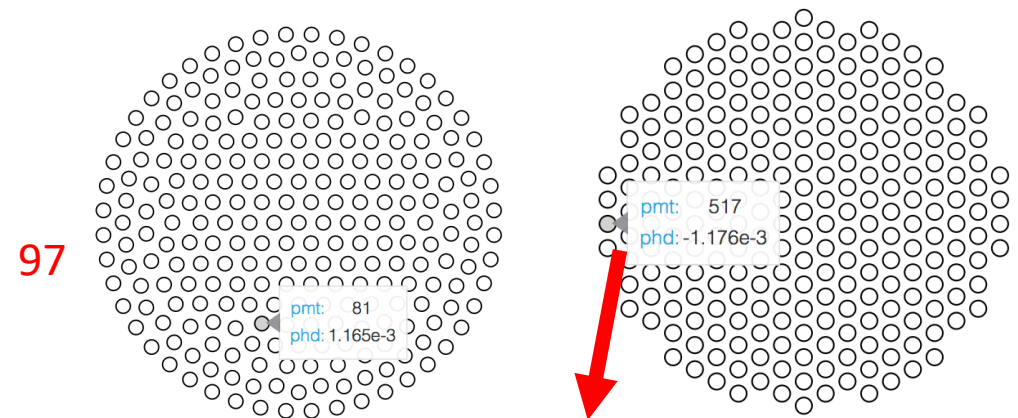
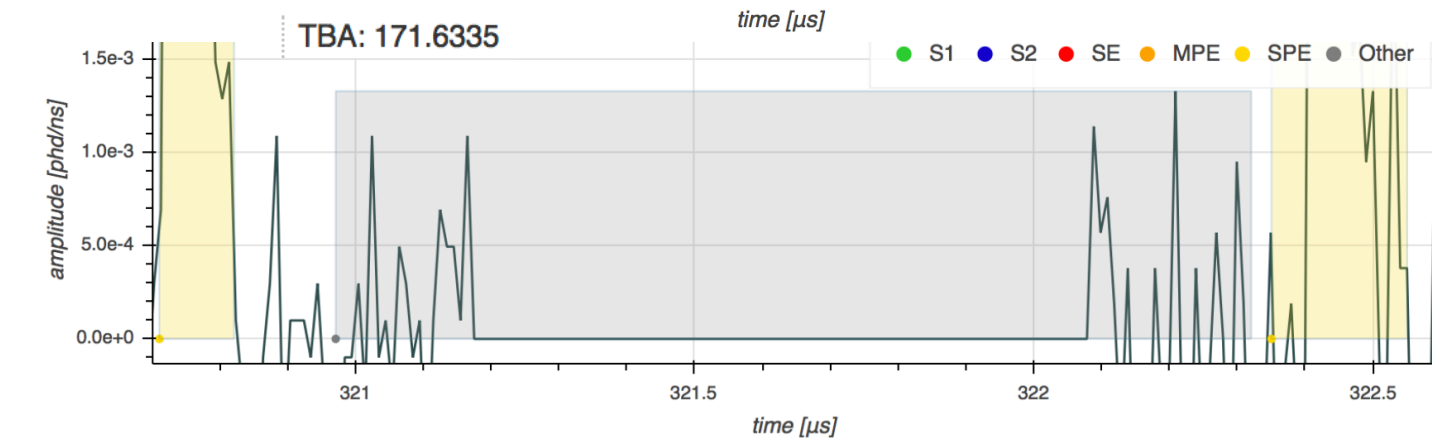
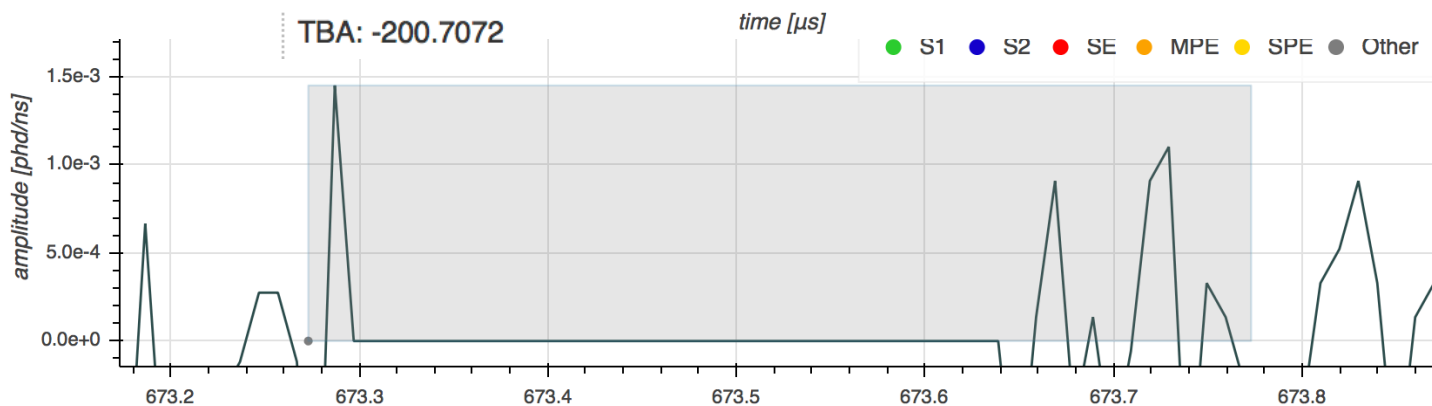
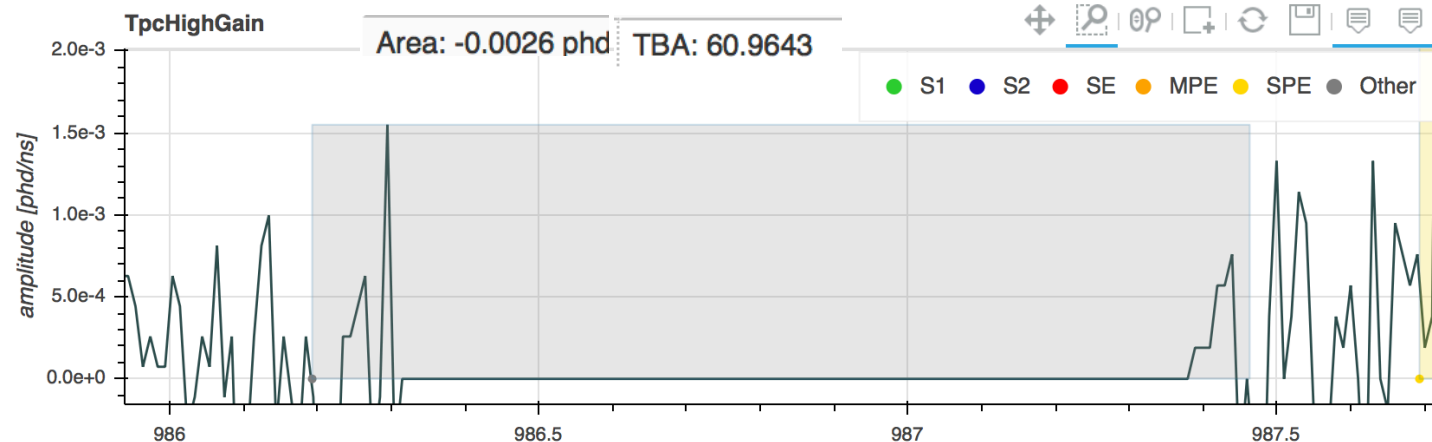
LZap 5.0.1

- Changed the input root data file to LZap 5.0.1, on the same date of root data file (20180401)
 - #Extreme TBA values decreased to $2+1 = 3$ for 1 LZap data file

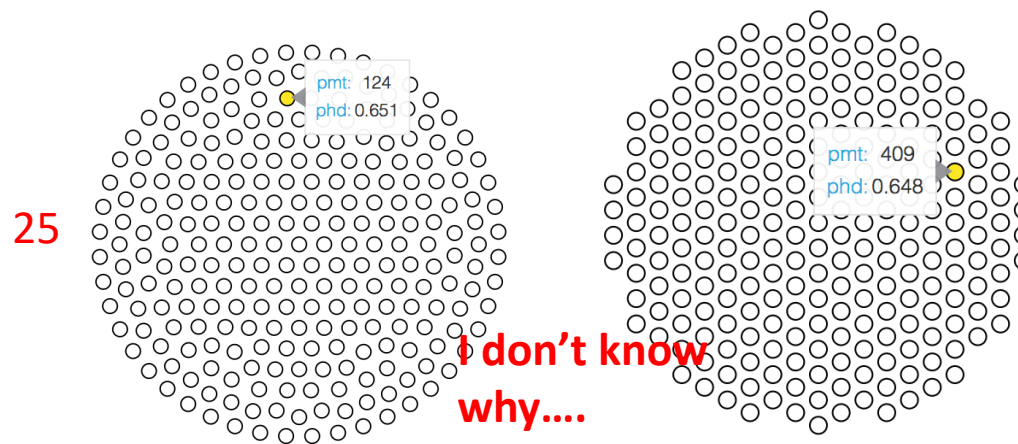
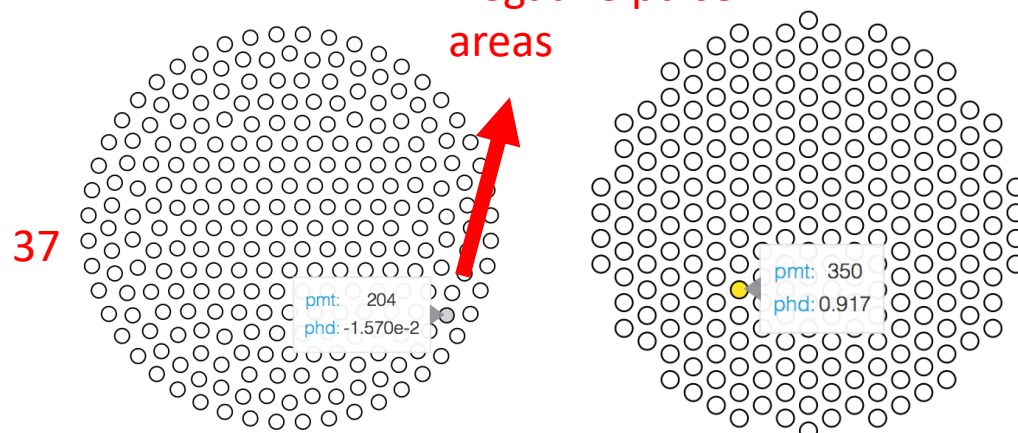


1. 8h data
2. A fraction of pulse area, < 1

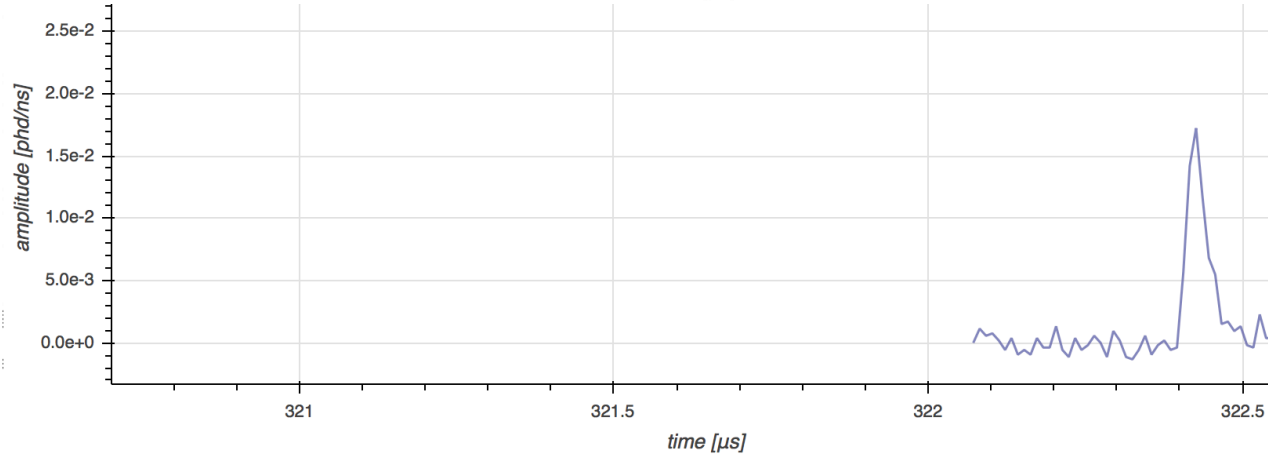
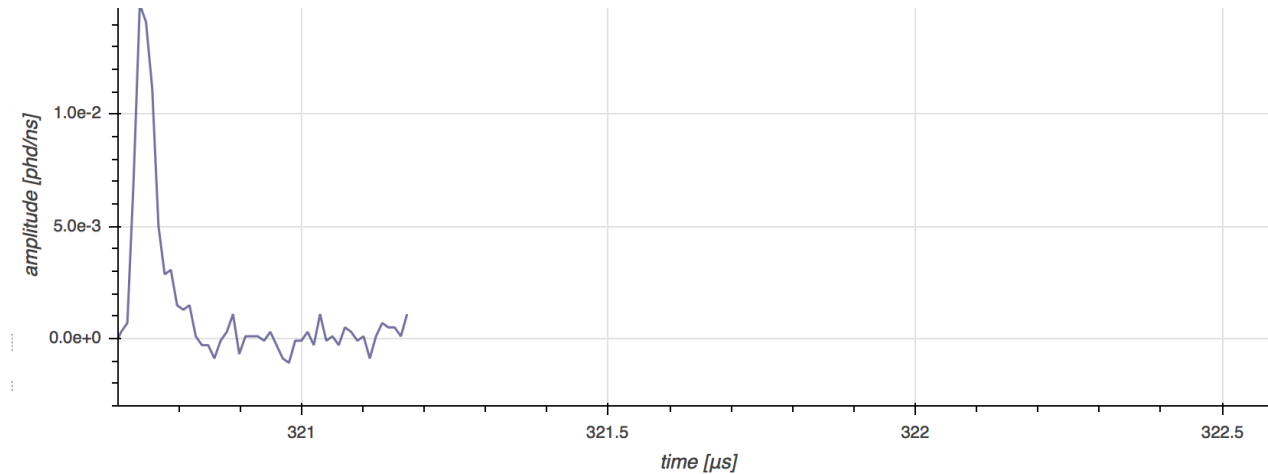
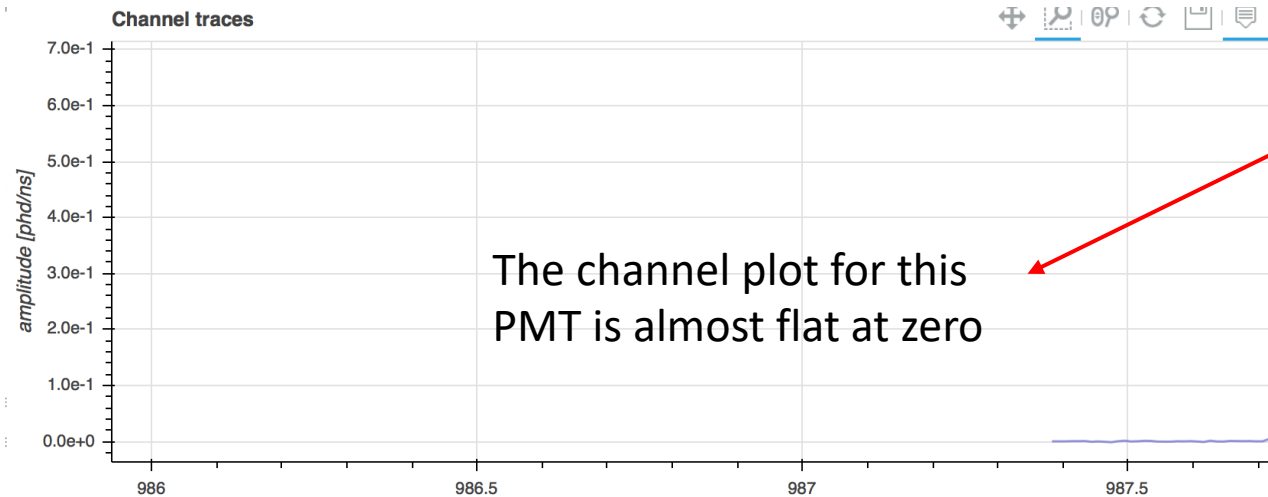
Just out of curiosity.....



Negative pulse areas

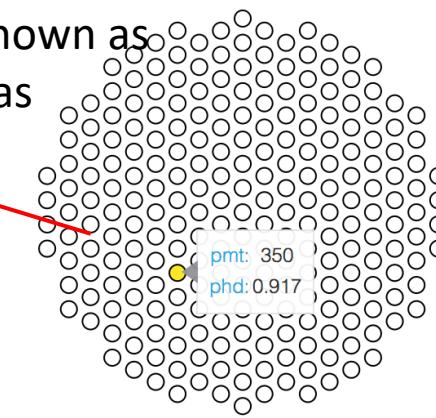


I don't know why....

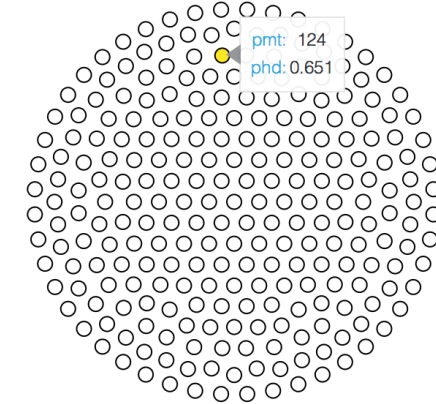


Even though the PMT 350 is shown as yellow and has 0.917phd

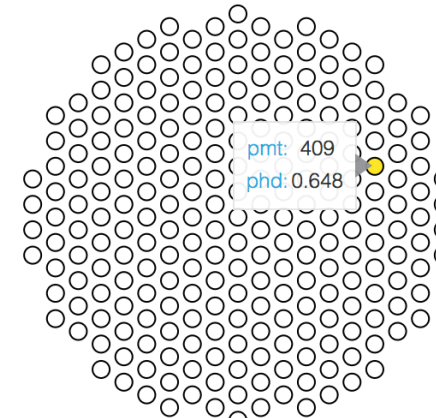
37 B

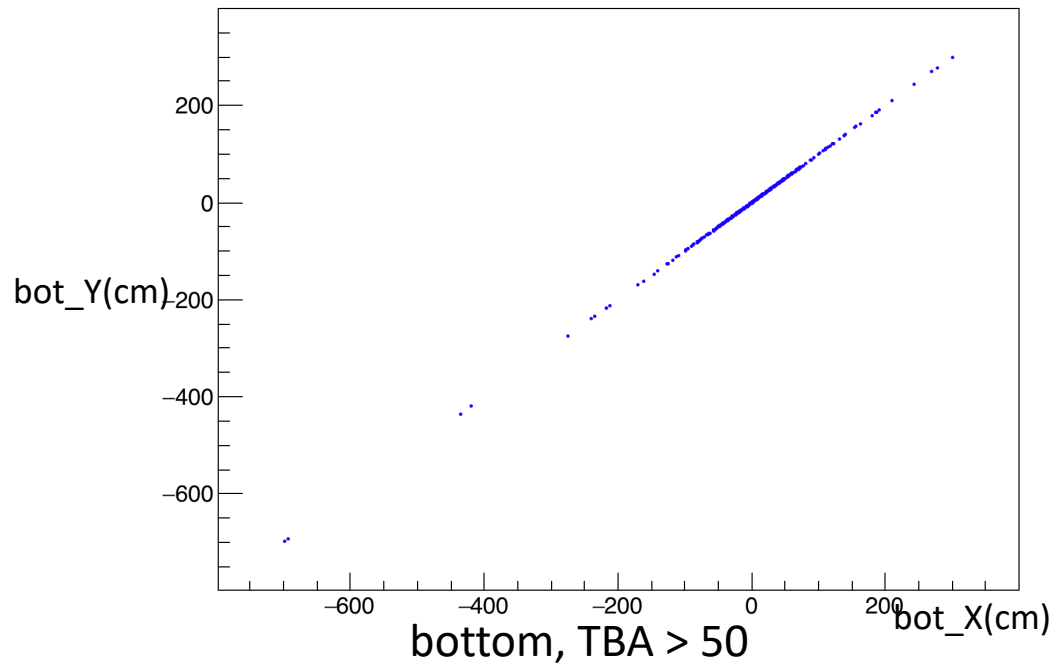


25 T



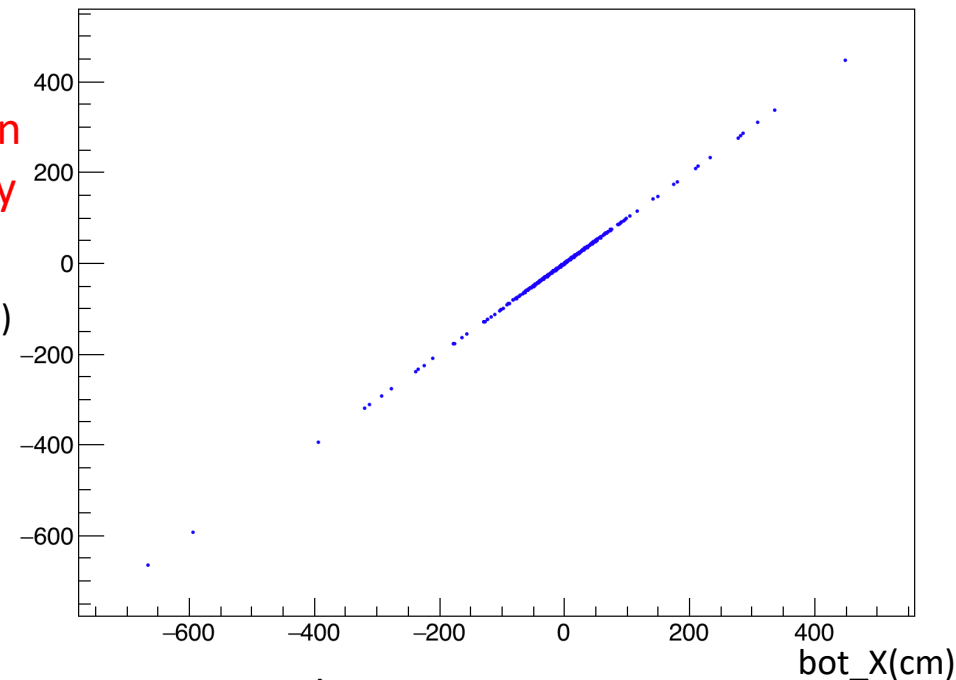
25 B



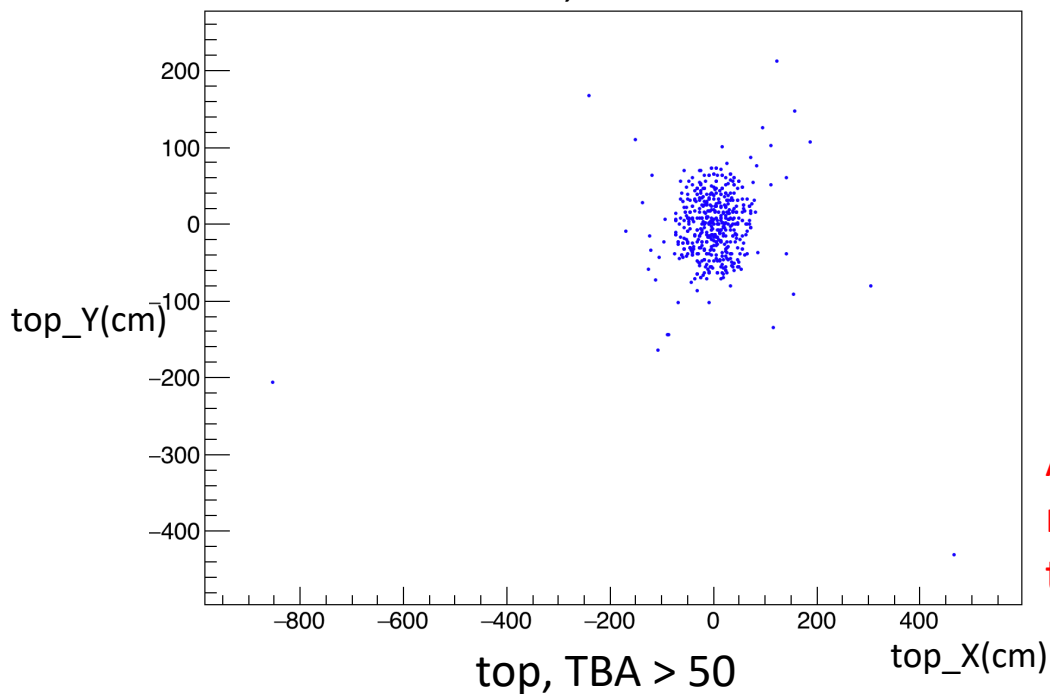


A linear
correlation in
bottom array

bot_Y (cm)



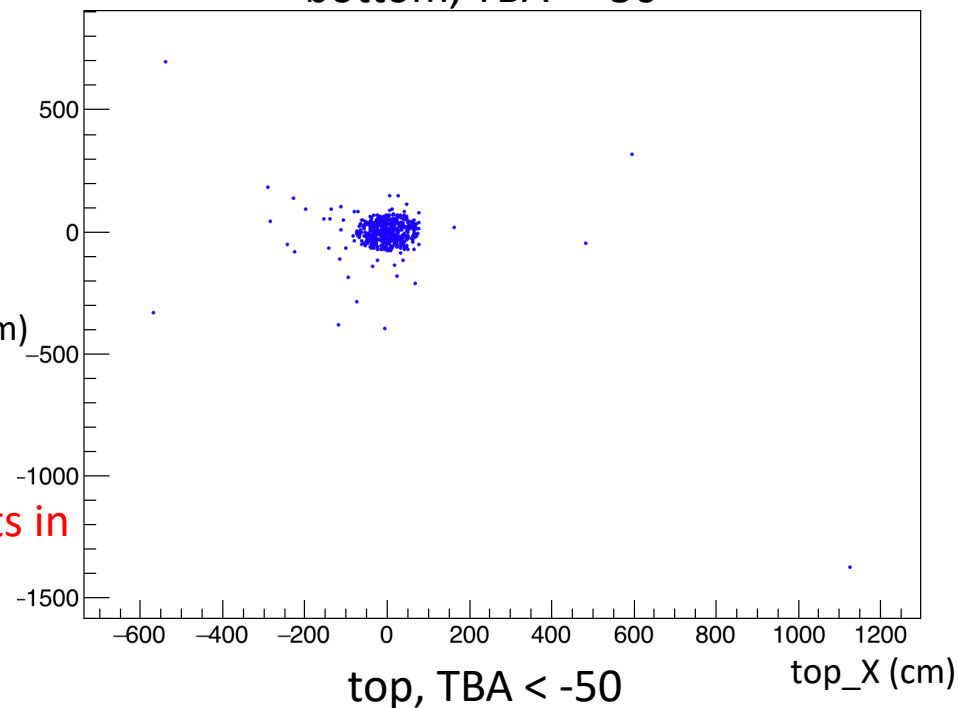
bottom, TBA < -50



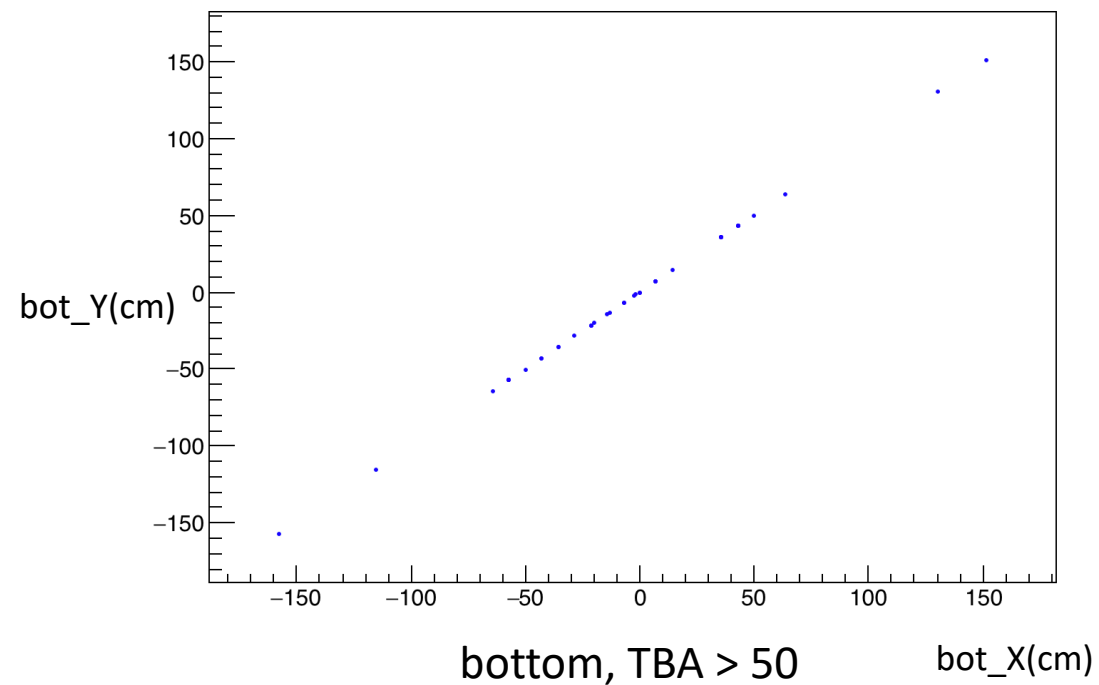
LZap 4.7.0
8h data

A cluster with
random events in
top array

top_Y (cm)

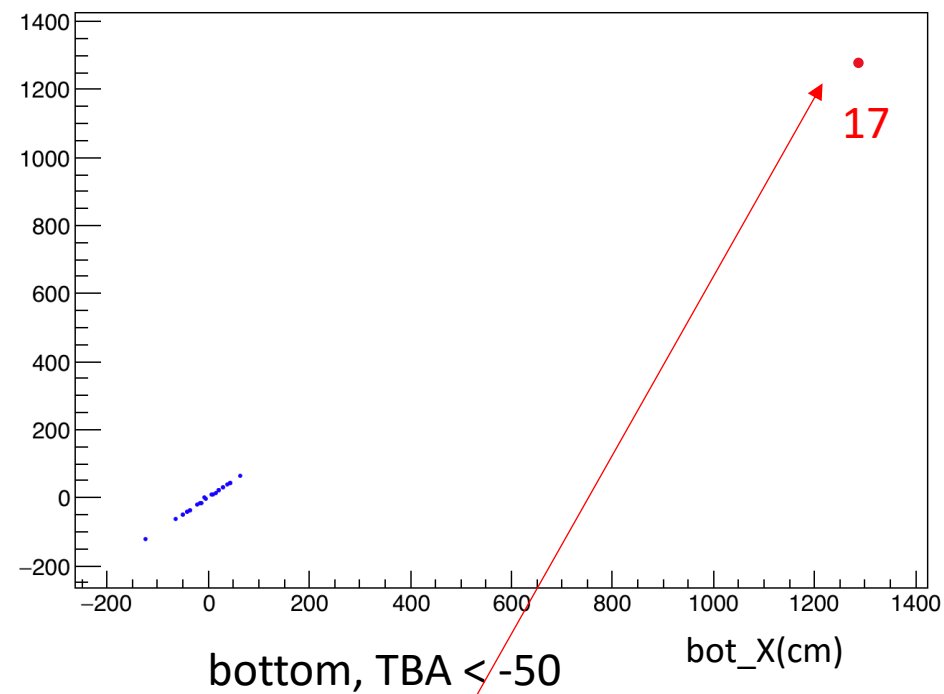


top, TBA < -50

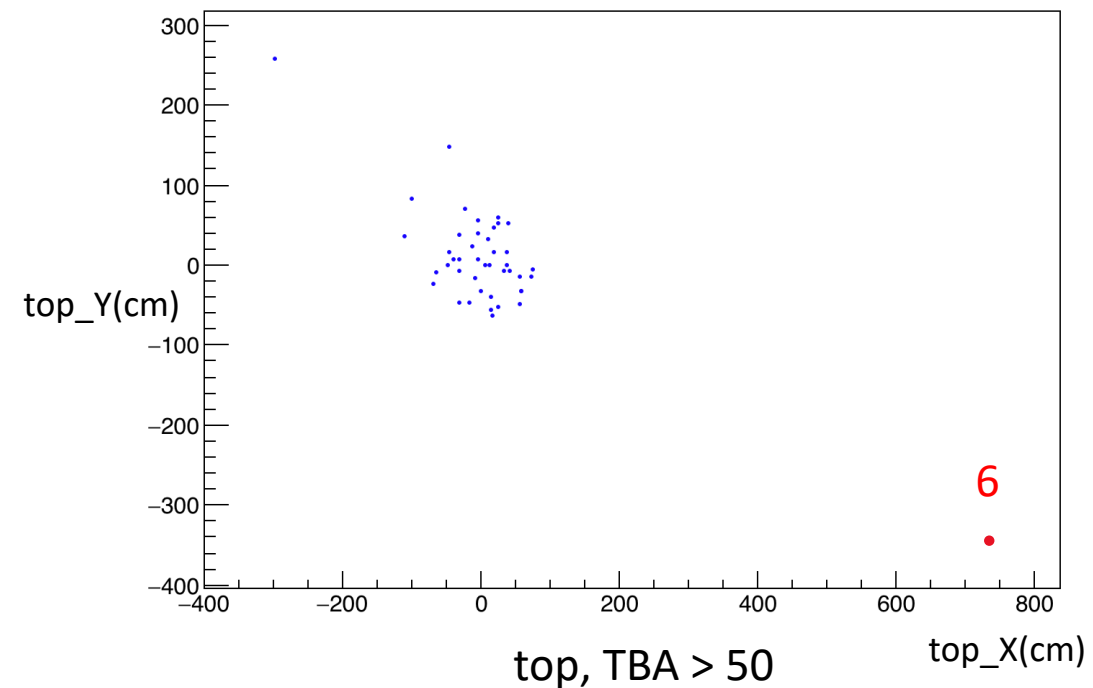


Less events in
newer LZAP
version

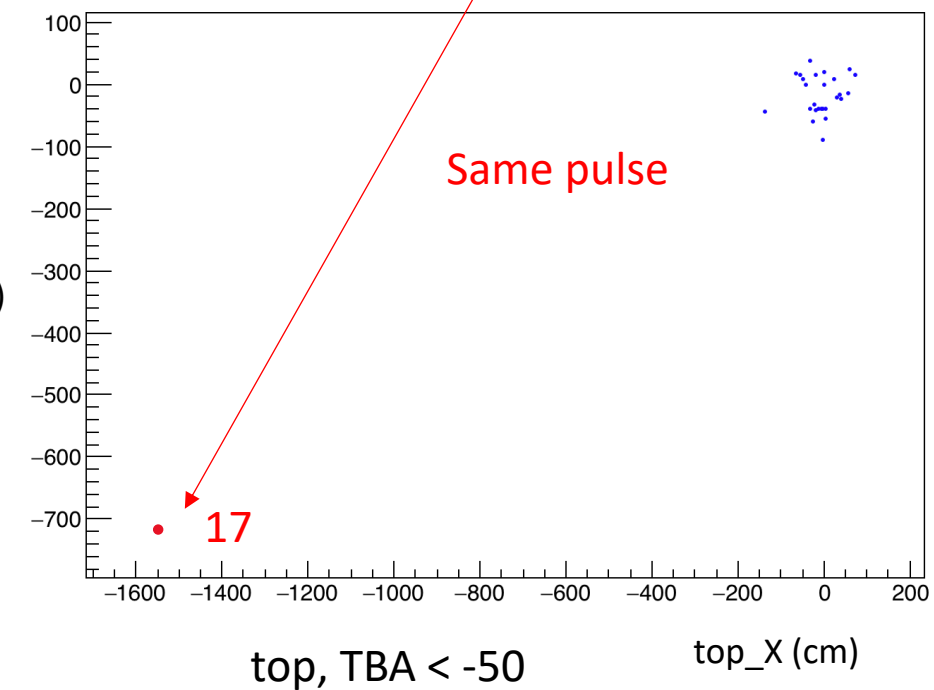
bot_Y (cm)



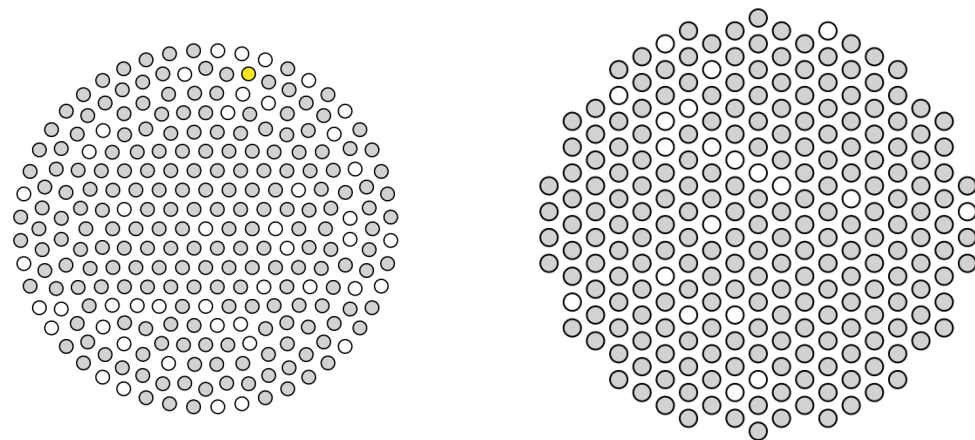
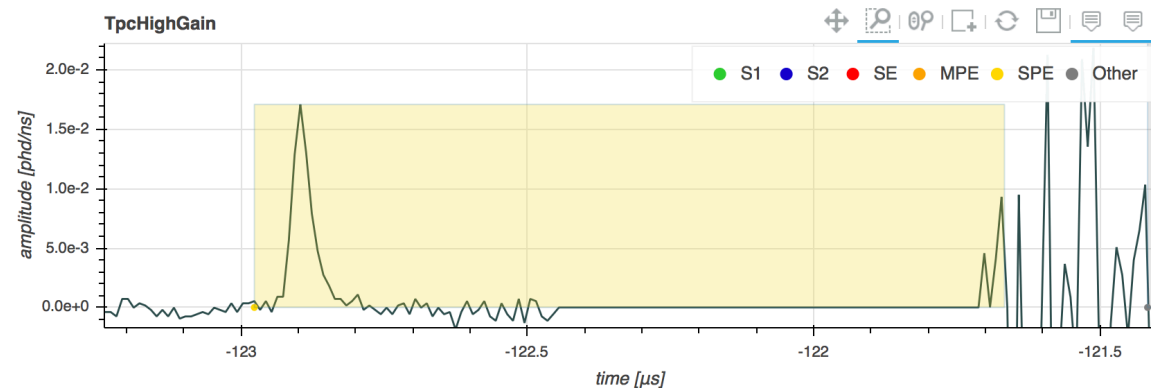
**LZap 5.0.1
8h data**



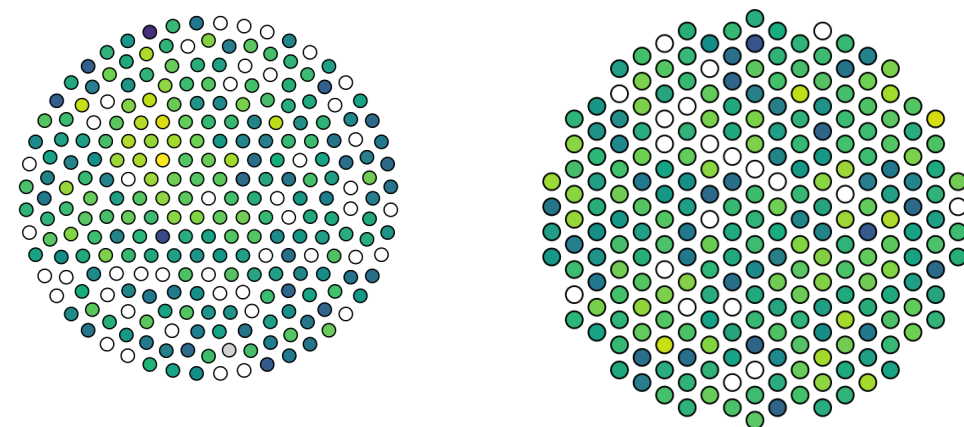
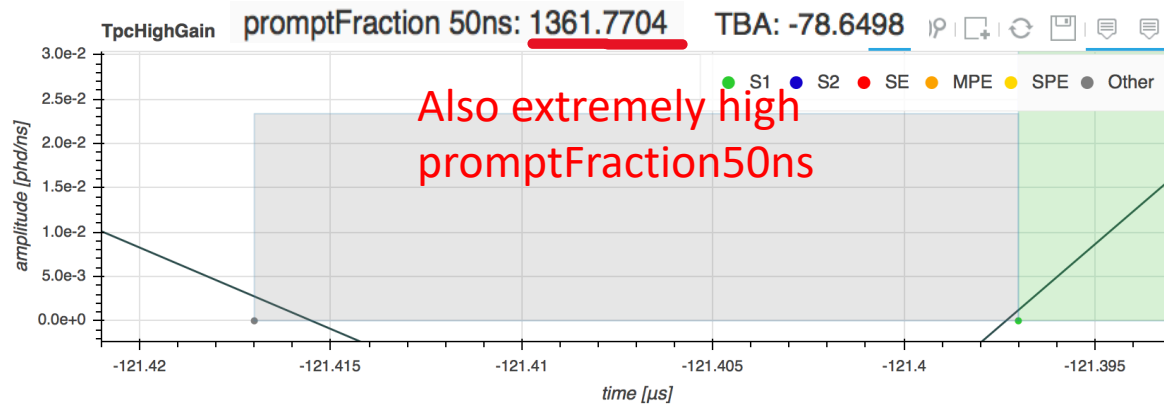
top_Y (cm)



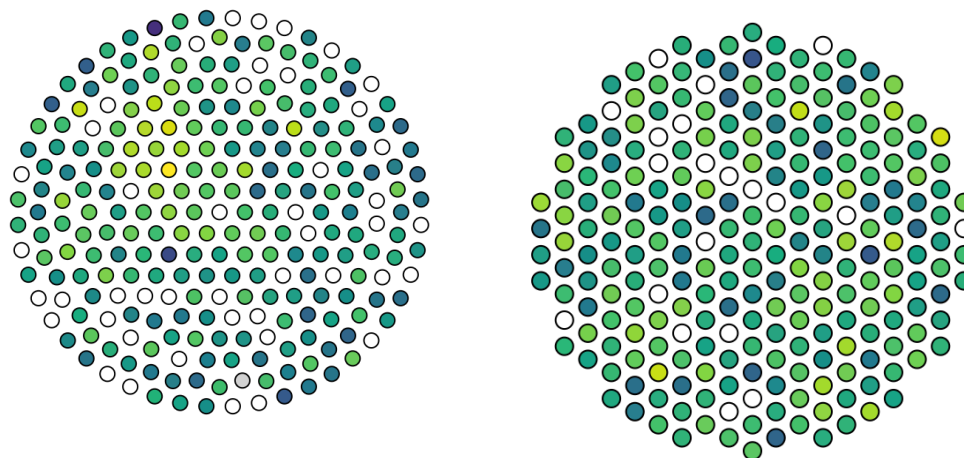
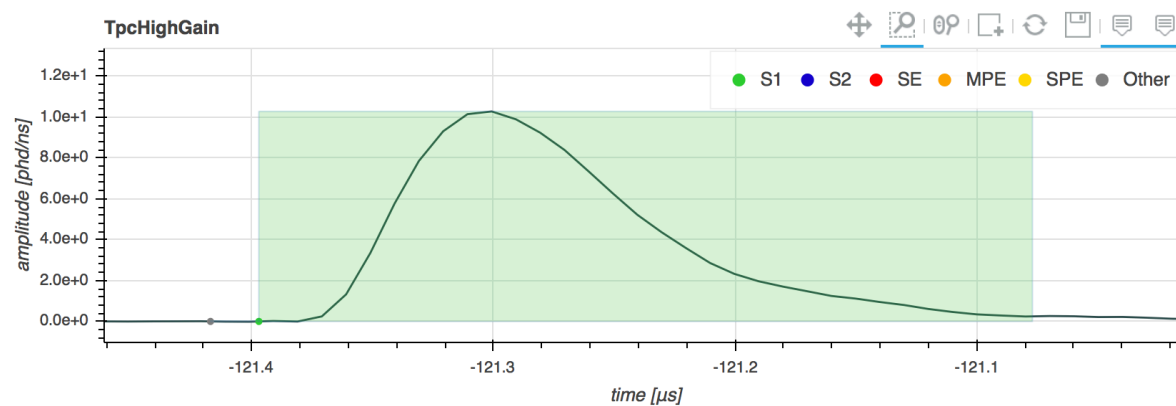
16

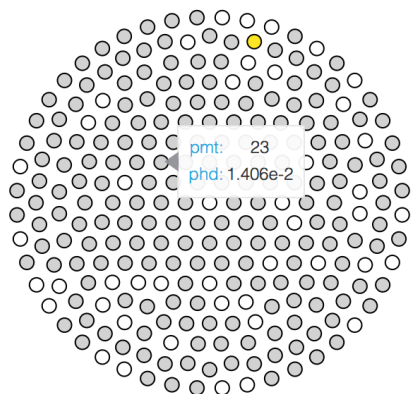


17

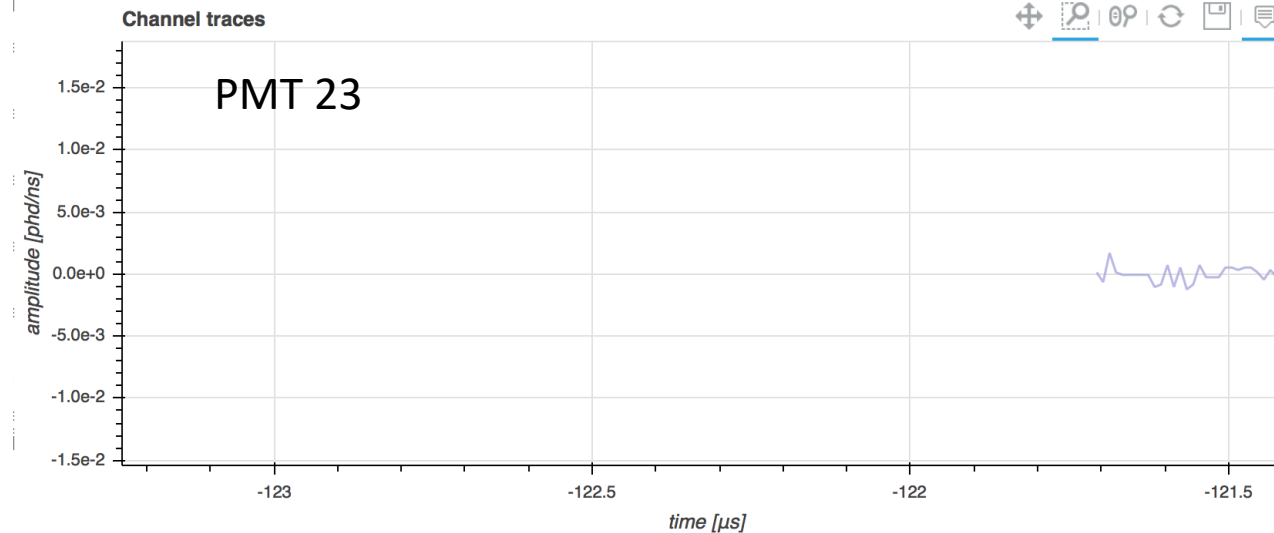


18



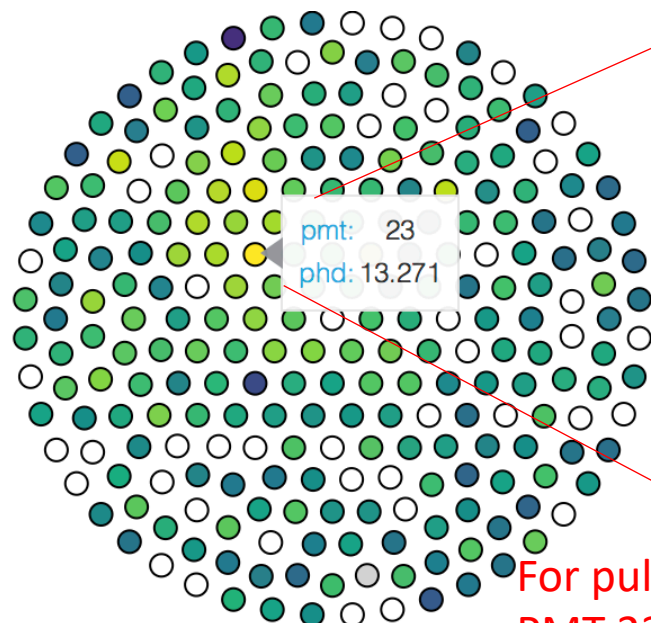


16

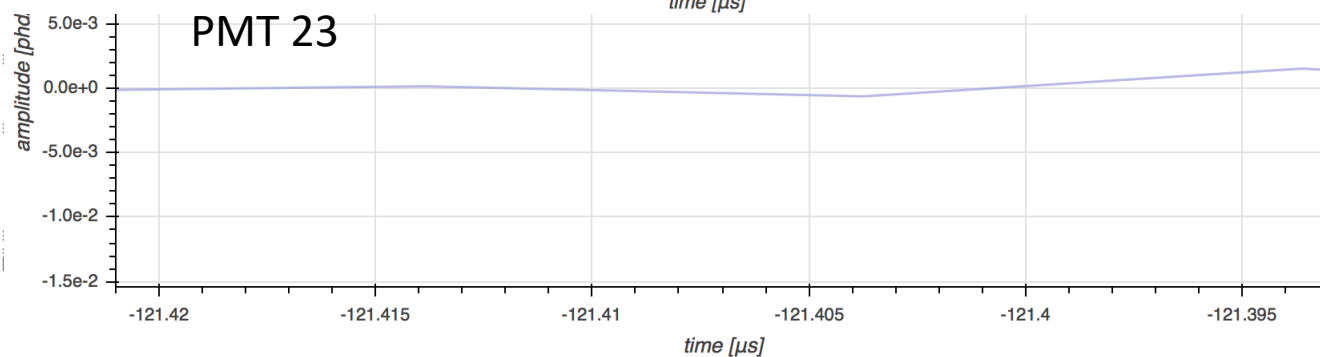


For pulse 17 (TBA = -78), PMT 23 shows 13.271 phd, but the channel plot is around zero

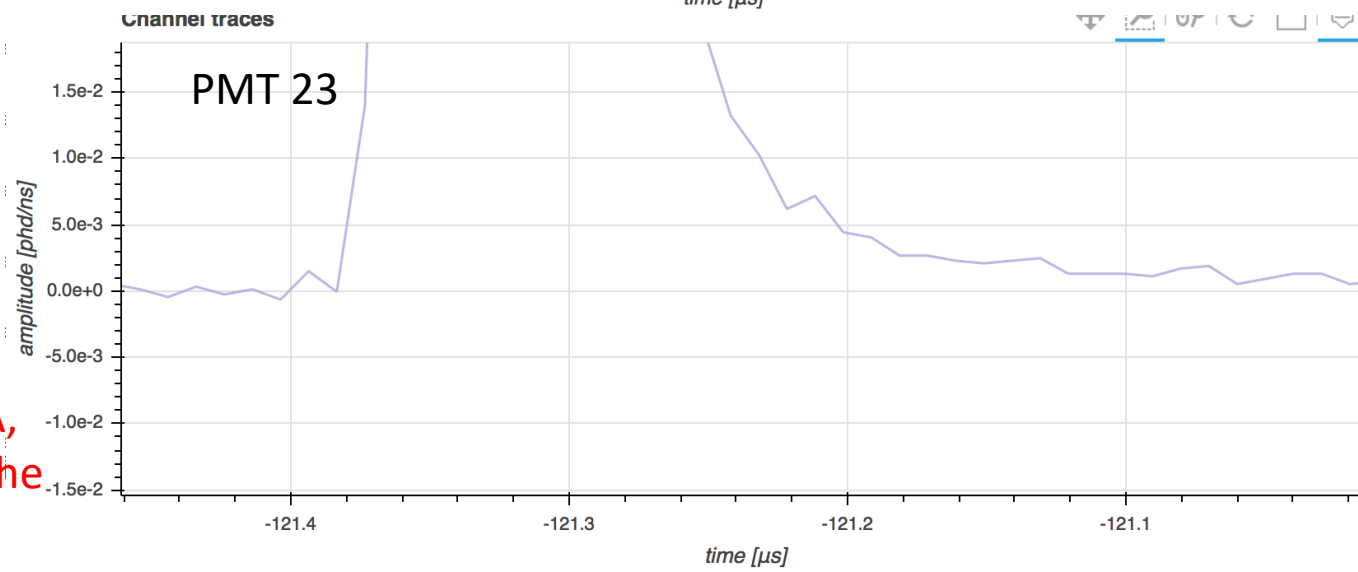
17



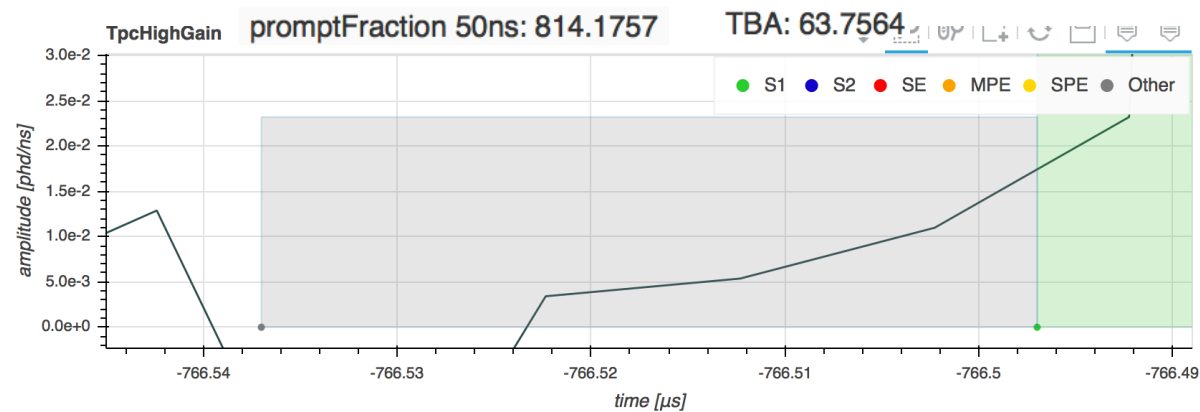
18



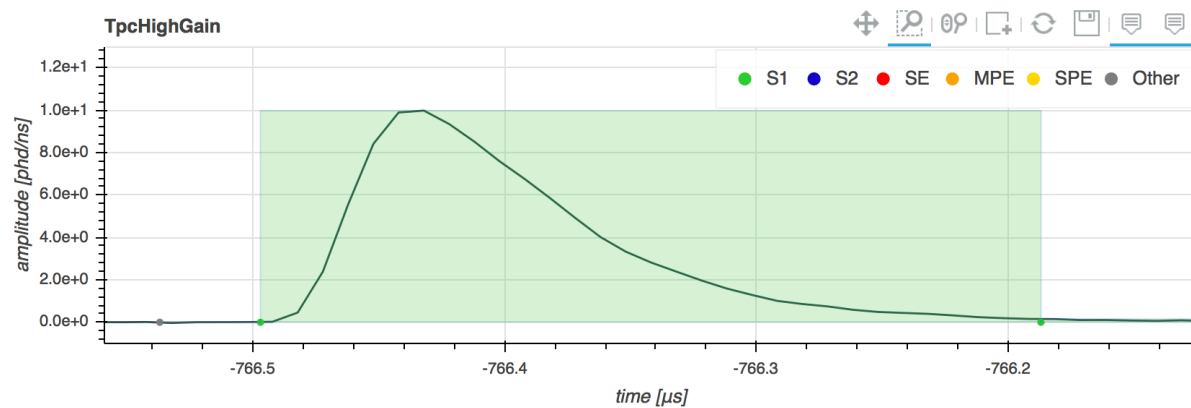
For pulse 18 with normal TBA, PMT 23 shows 13.271 phd, the channel plot looks plausible



6

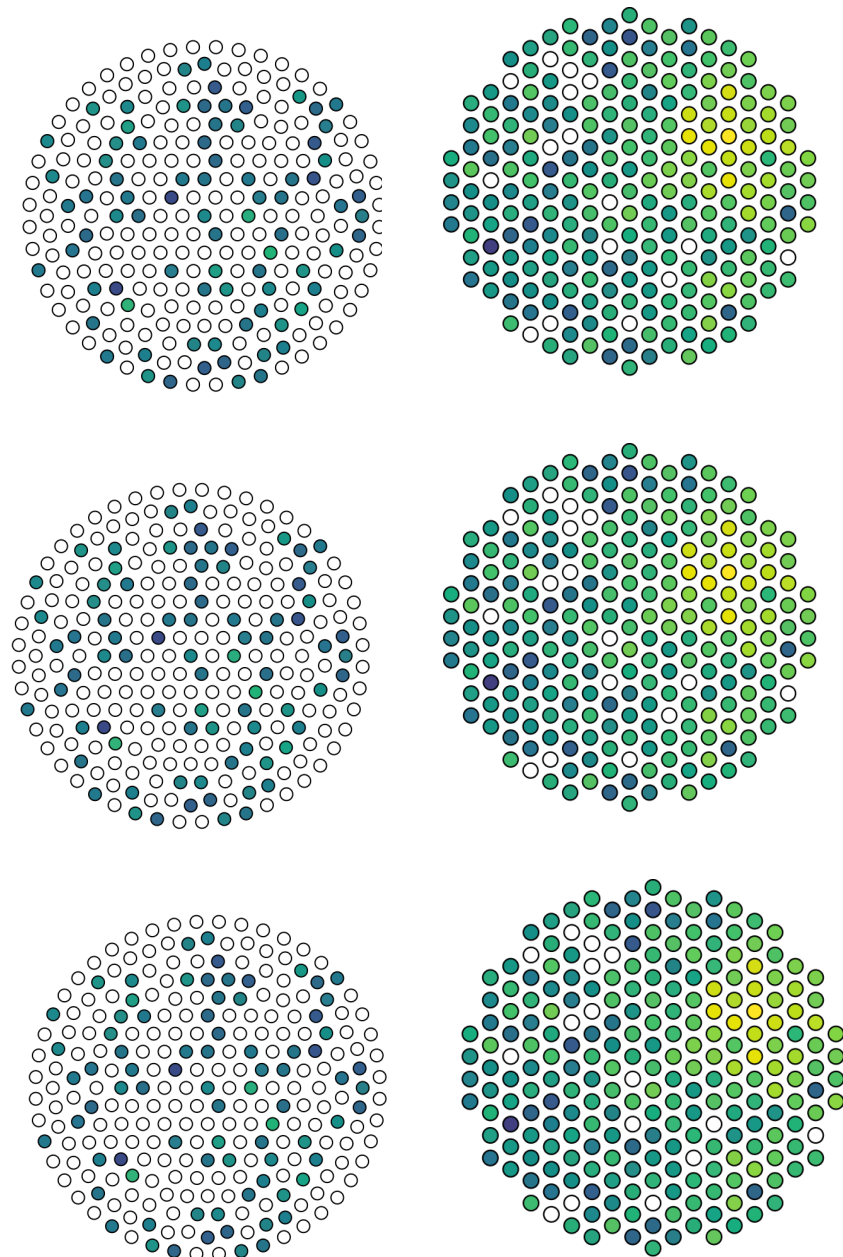
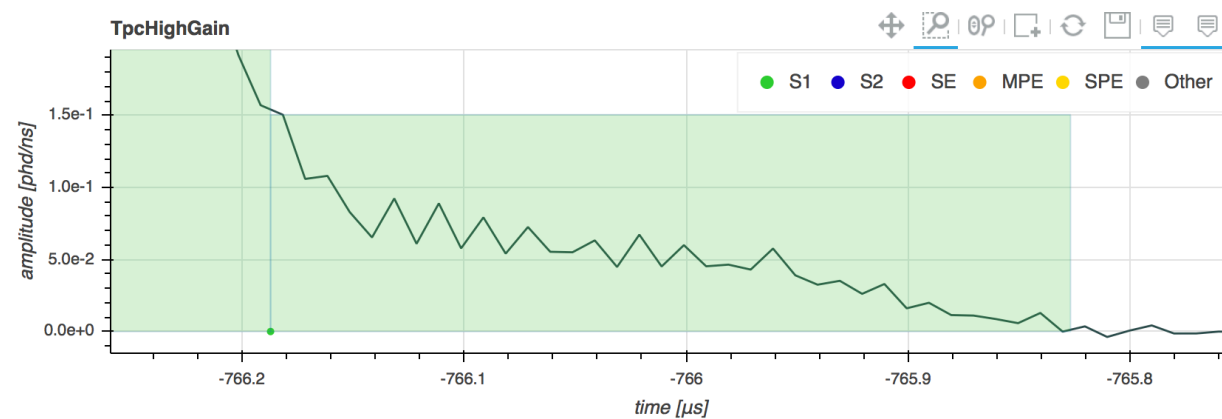


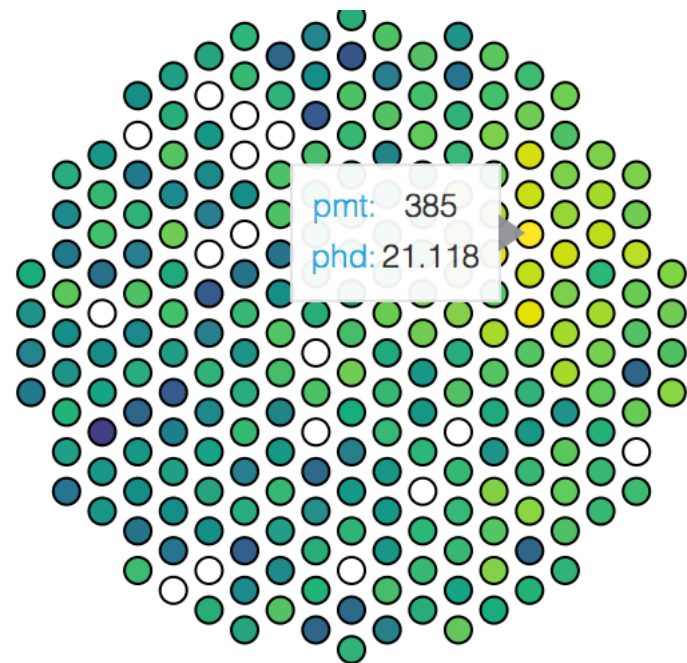
7



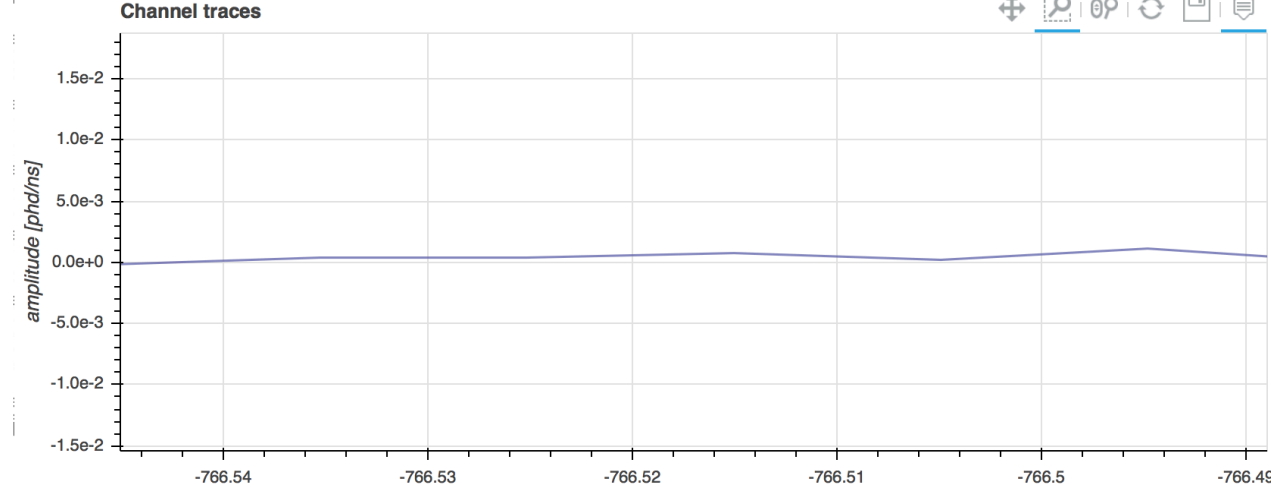
Same top and
bottom array
patterns, for
different
pulses

8

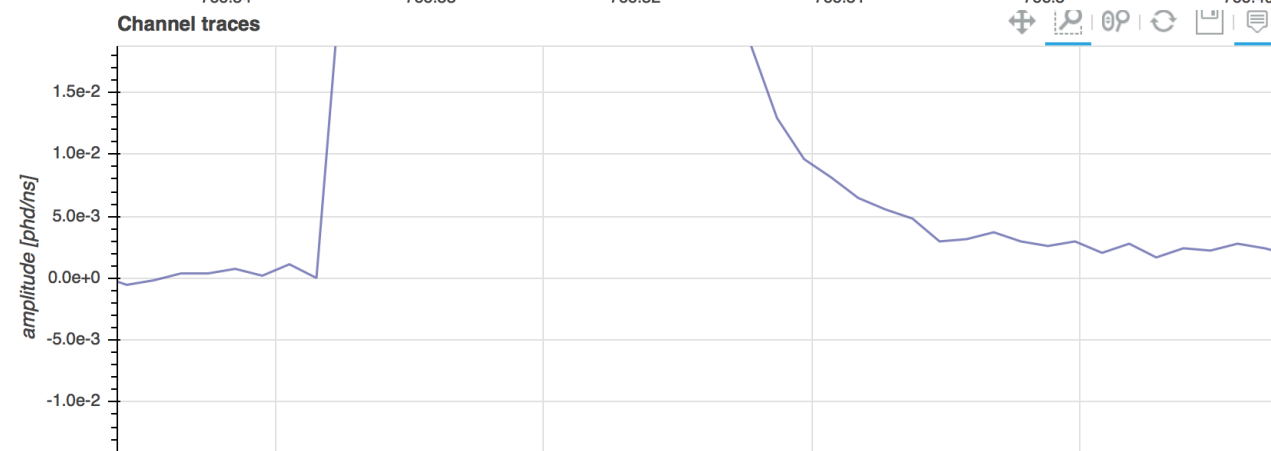




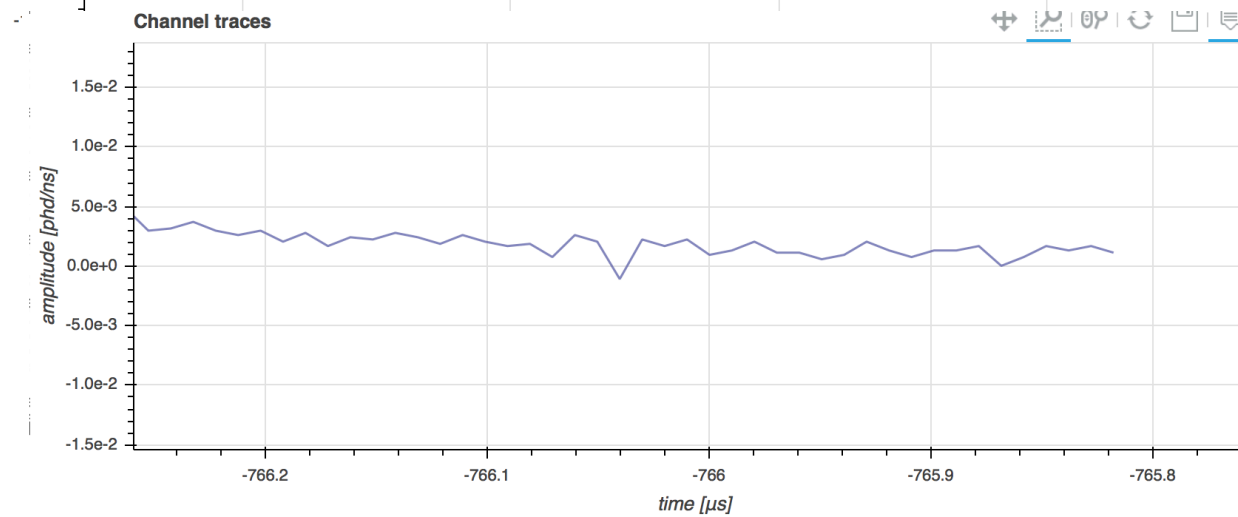
6



7



8

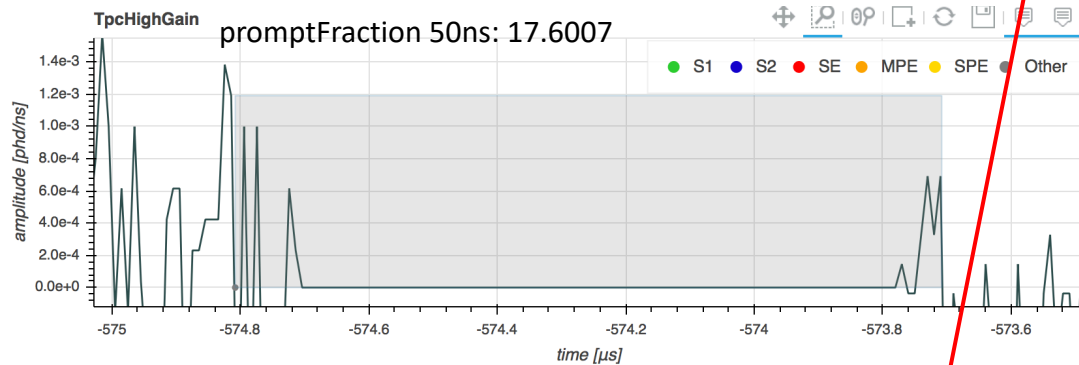


Extremely extreme TBA value

- TBA = 2130 (in LZAP 5.0.1)

Same pFraction50ns, but
TBA changed to a
reasonable value, ~-10

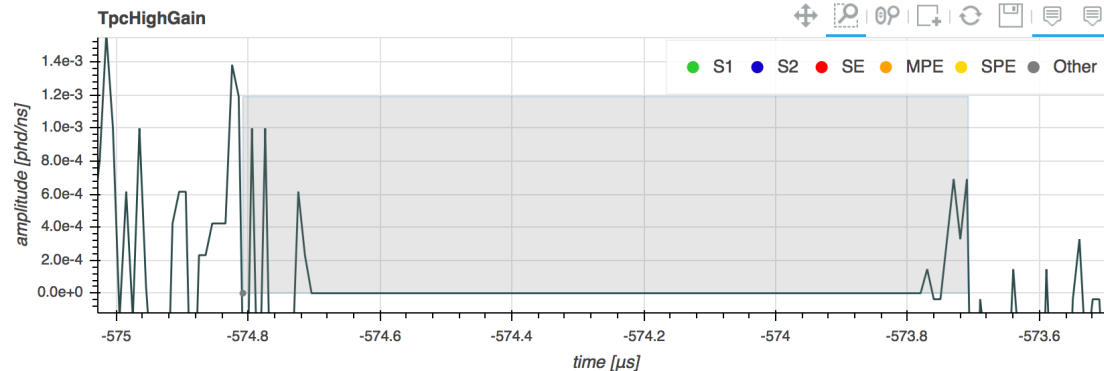
Process with Lzap 5.0.1



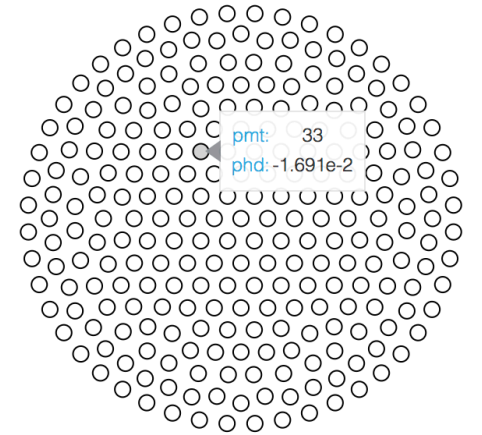
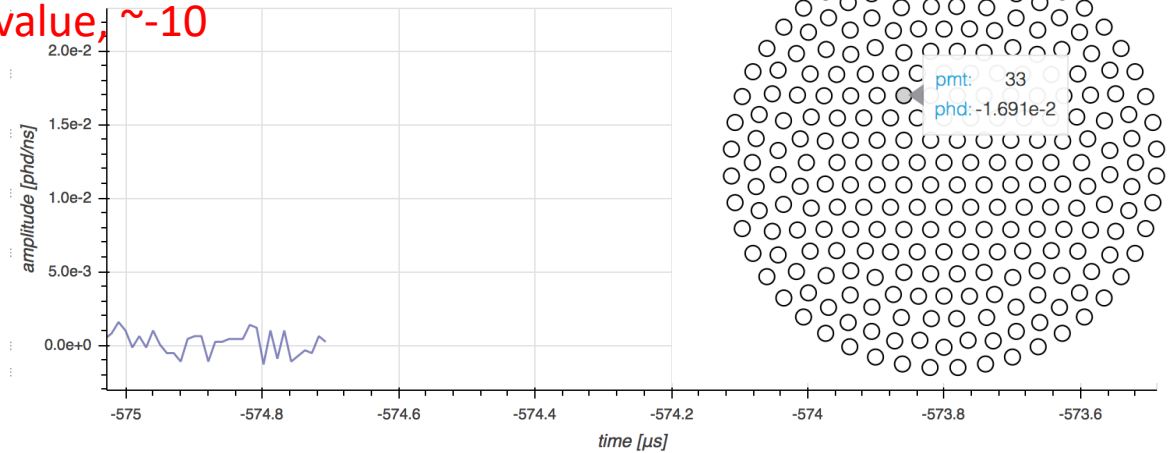
Process with Lzap 5.0.5

promptFraction 50ns: 17.6007

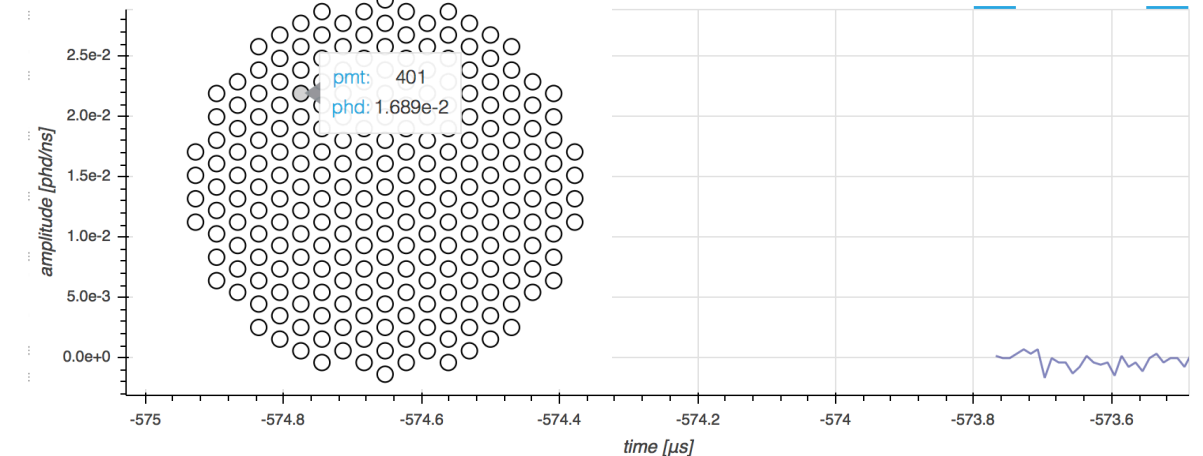
TBA: -10.8432



Channel traces



Channel traces



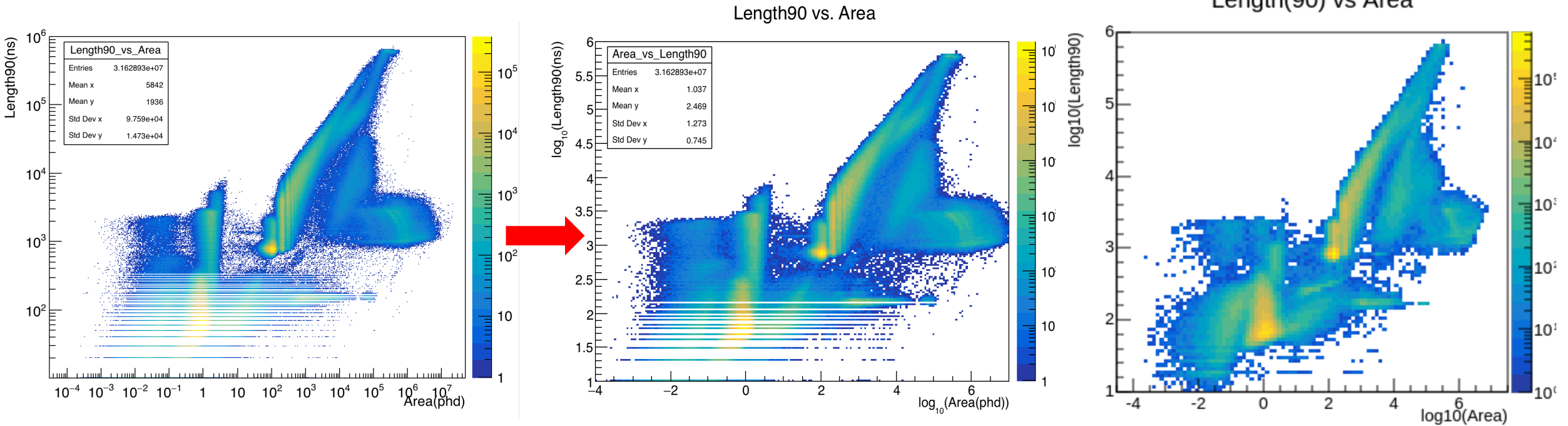
LZAP 5.0.5

- Checked for the two with weird x, y positions:
 - 6: TBA: 63.75 $\rightarrow$ -0.2737
 - 17: TBA: -78 $\rightarrow$ 0.1623
 - Using more recent Lzap version decreases the # of events with extreme TBA
 - Still same problems with PMTs and pFraction50ns
- The newest: Lzap 5.2.x

3rd March 2021

- Pulse Classification's Parameter Space:
 - Changed the scale for the PREM plot
 - Play with pFraction100
 - Sent Chico message on Slack
- Next module: Noise

Length90 vs Area

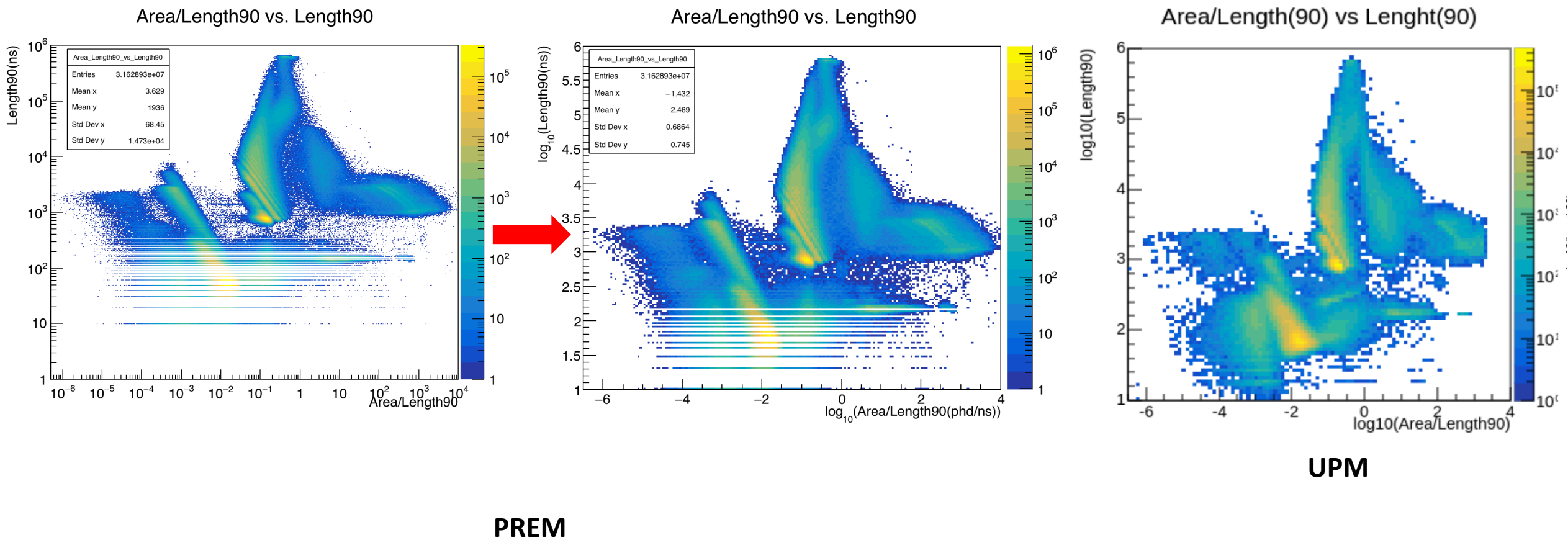


PREM

1. Change the log scale axis
2. Reduce the bin number
3. Will change the interval from 0.1 to 0.2 further reduce the stripe?

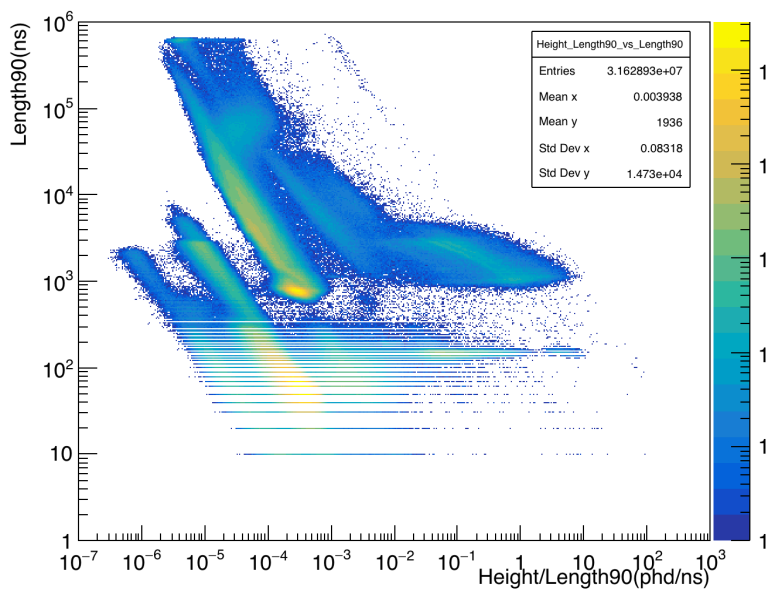
UPM

Area/Length90 vs Length90

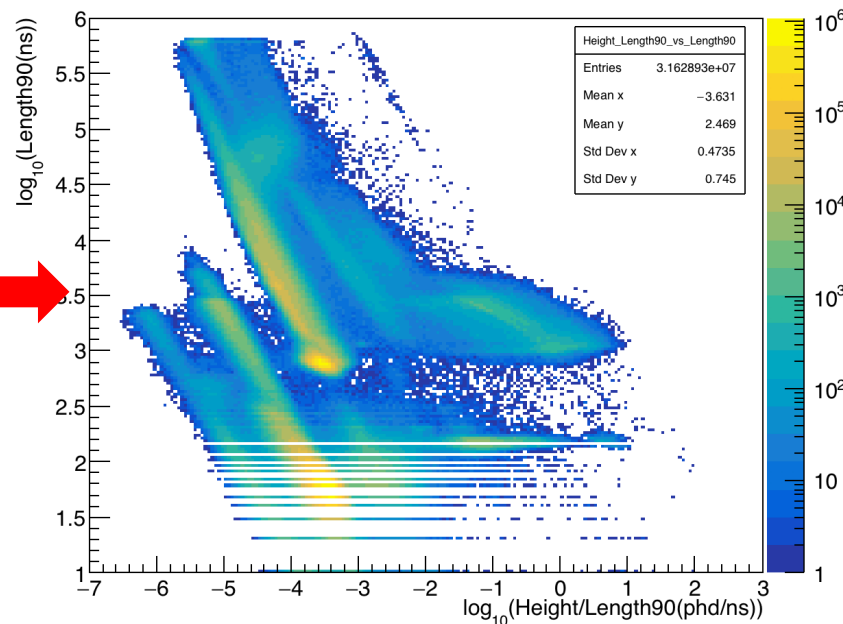


Area/Length90 vs Length90

Height/Length90 vs Length90

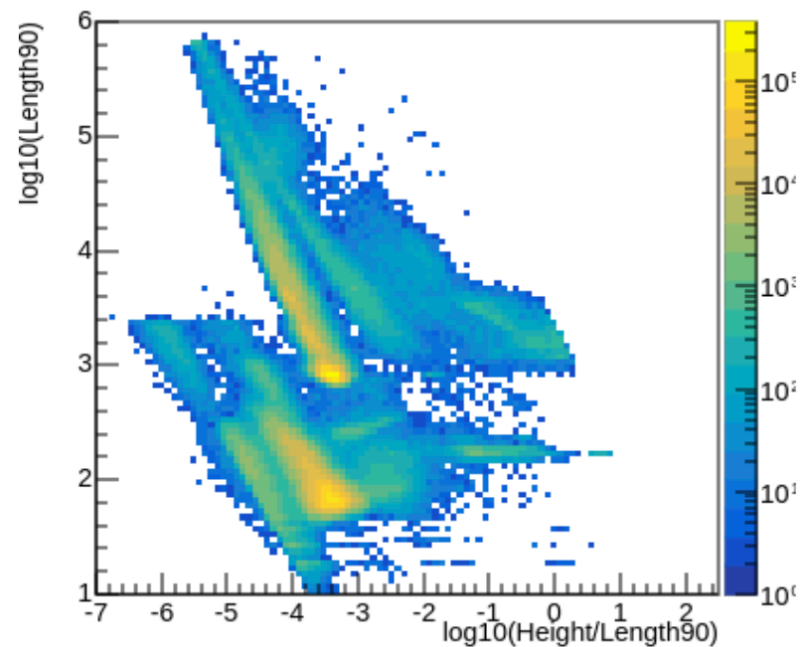


Height/Length90 vs Length90



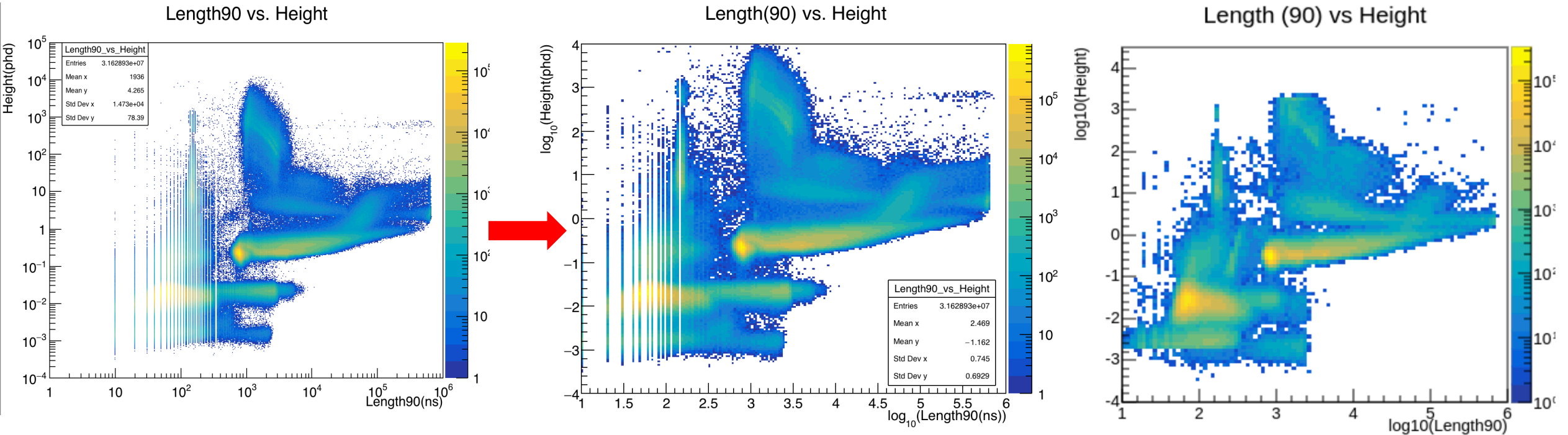
PREM

Height/Length90 vs Length90



UPM

Length 90 vs Height

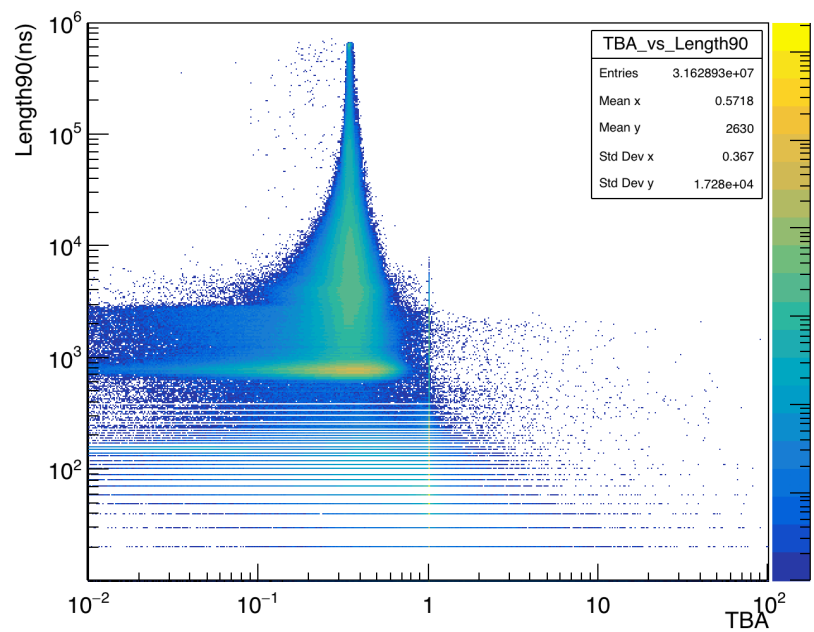


PREM

UPM

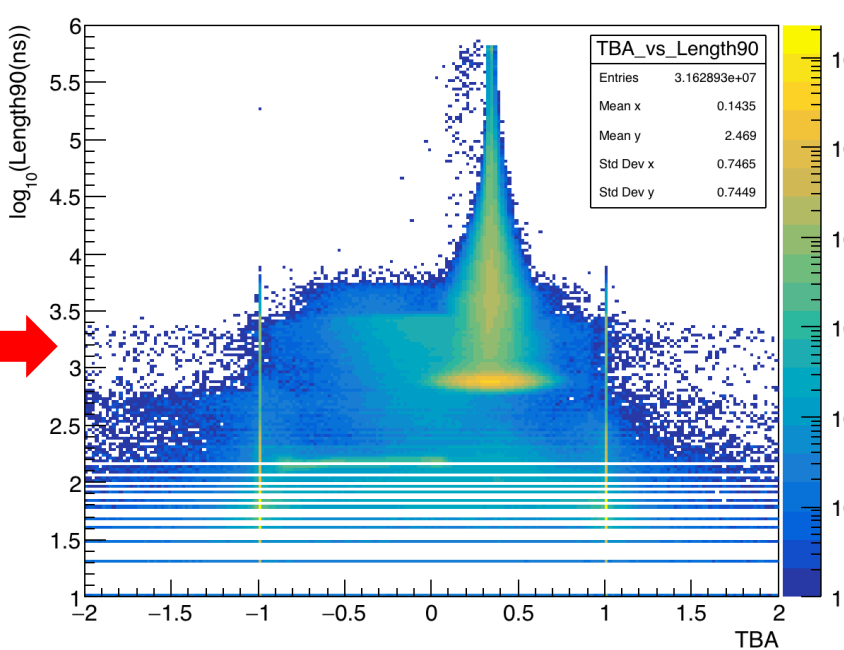
TBA vs Length90

TBA vs. Length90

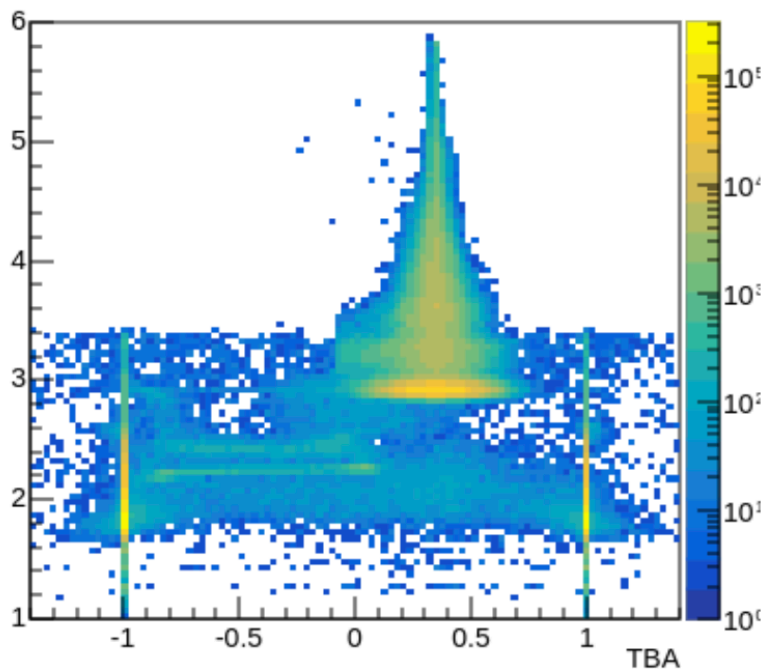


PREM

TBA vs. Length90

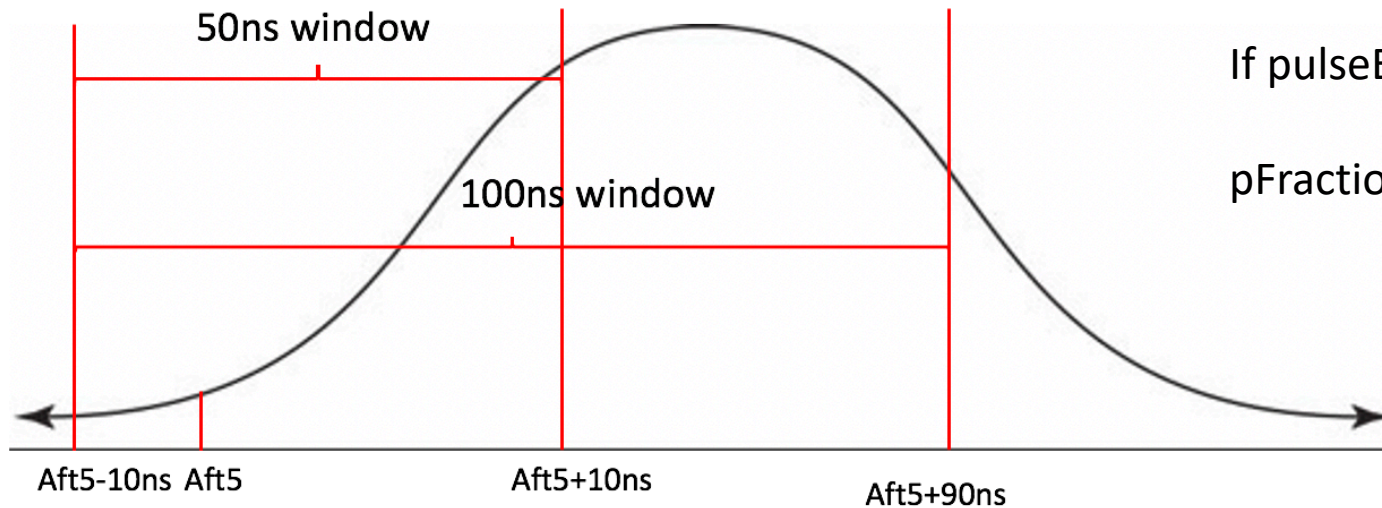


TBA vs Length(90)



UPM

Guess on the pFraction100



If pulseEndTime_ns = aft5 - 10ns:

get area_initial

If pulseEndTime_ns = aft5+90ns:

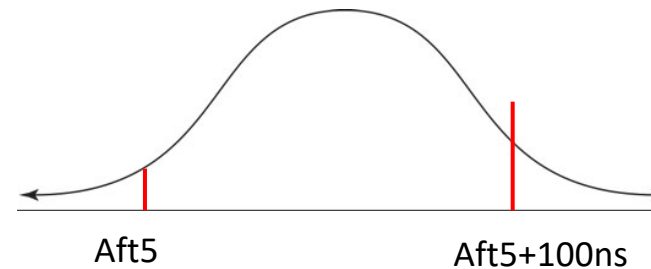
get area_final

pFraction100 = (area_final-area_initial)/total_area

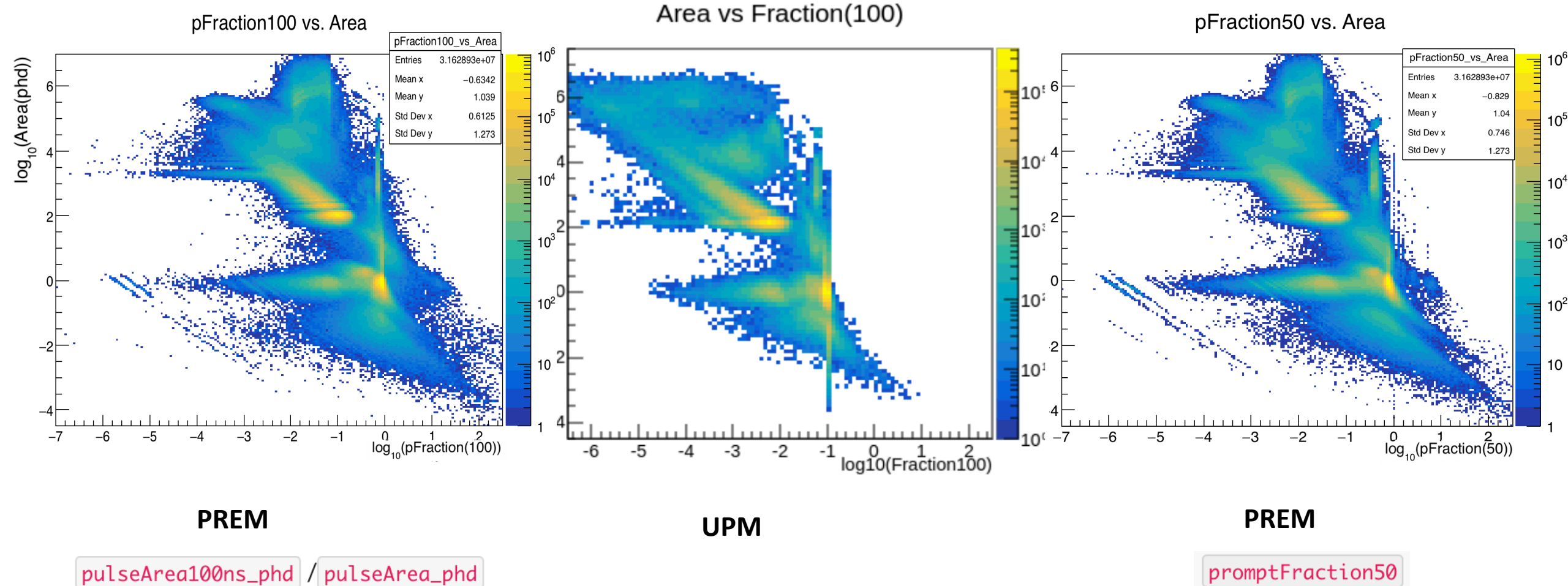


- pFraction100:

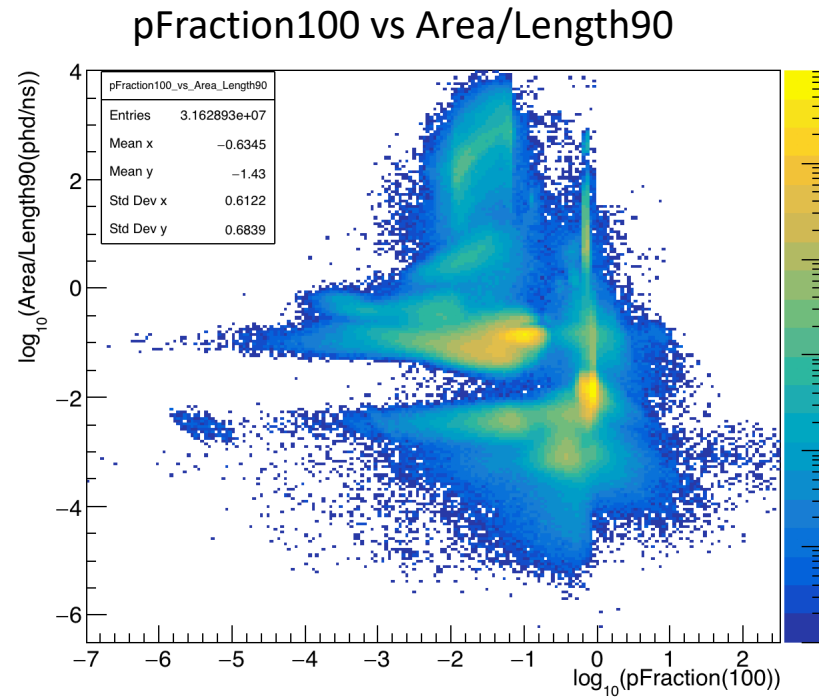
- 1. `pulseArea100ns_phd` / `pulseArea_phd`
- 2. `promptFraction50`



Area vs Fraction100

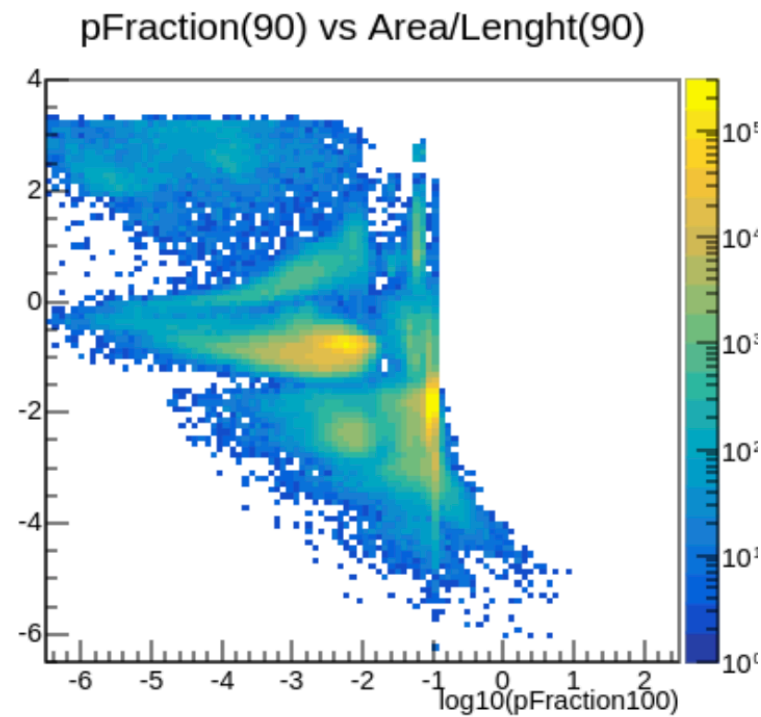


pFraction90 vs Area/Length90

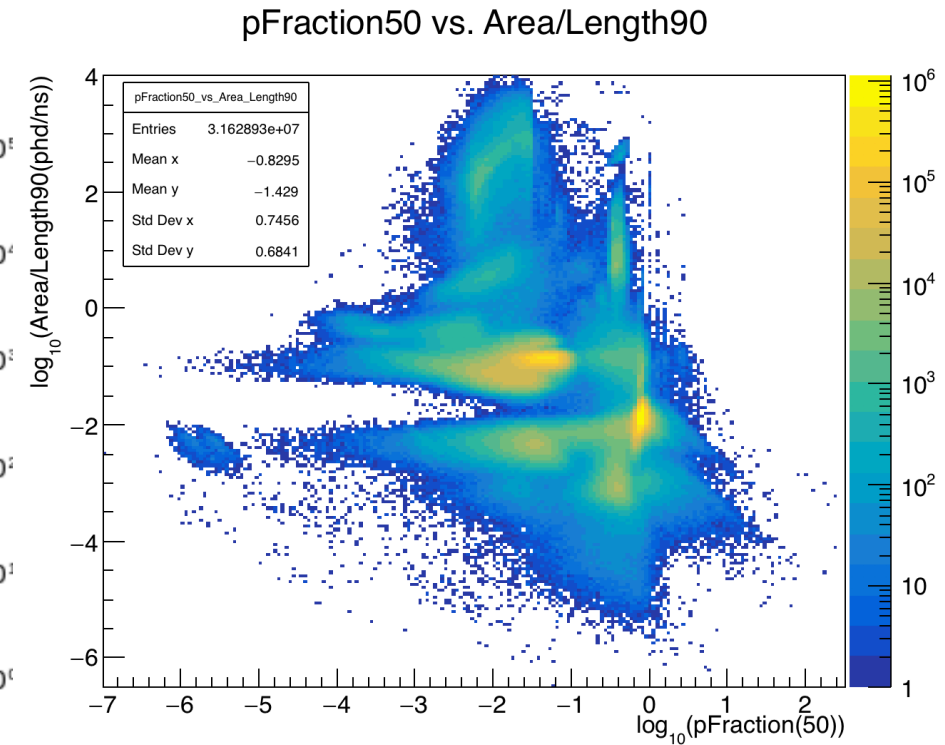


PREM

`pulseArea100ns_phd` / `pulseArea_phd`



UPM



PREM

`promptFraction50`

To do

- Noise module, which category of RQ?

25th Feb. 2021

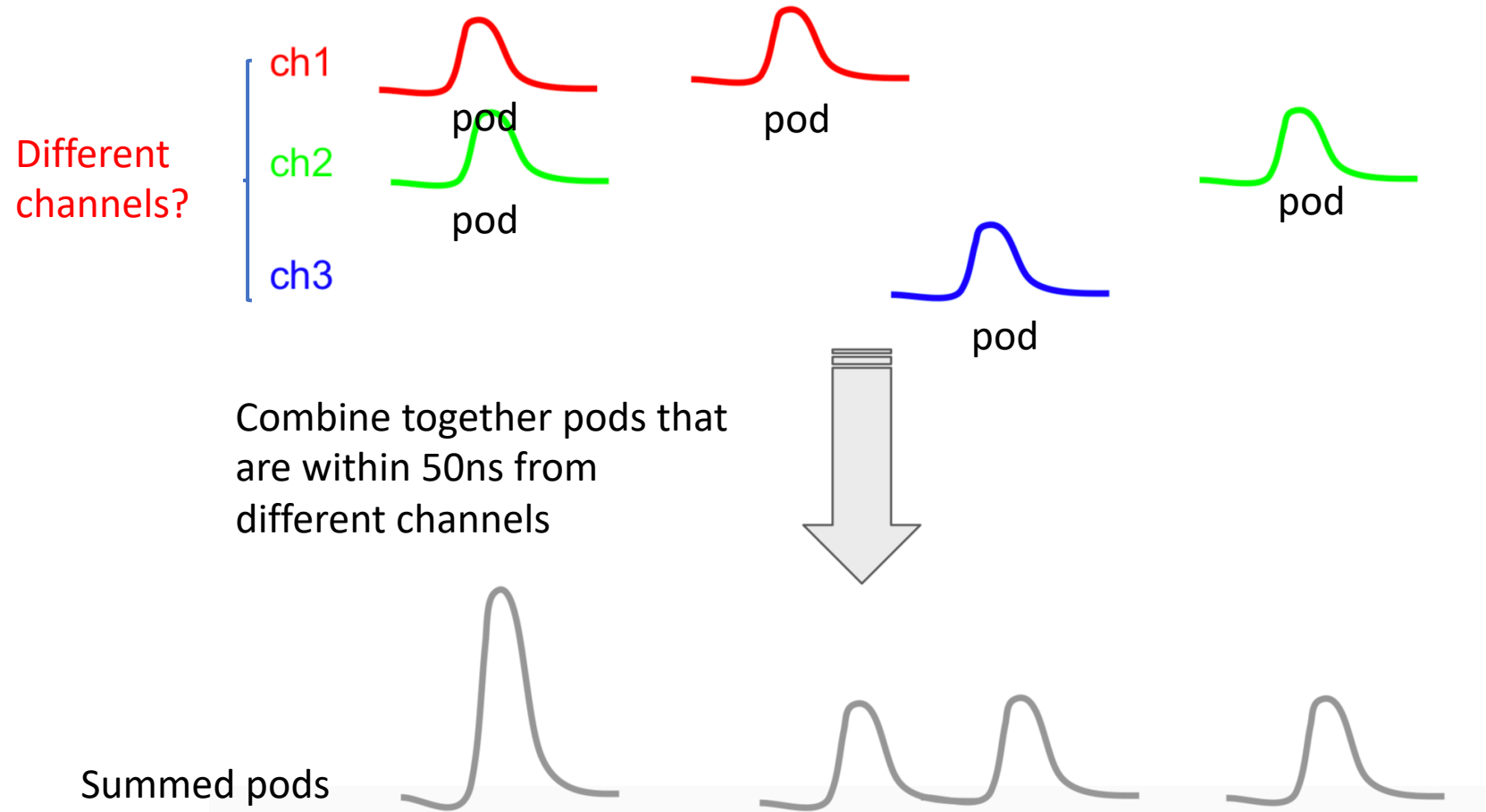
- **Physics REadiness Monitor (PREM):**

- Uses the reduced quantities (RQs) to automatically generate plots from the data
- Has shifters looking through the plots to look for the problem in the detector
- **Input data:** fully processed data after LZAP ~after 8 hours

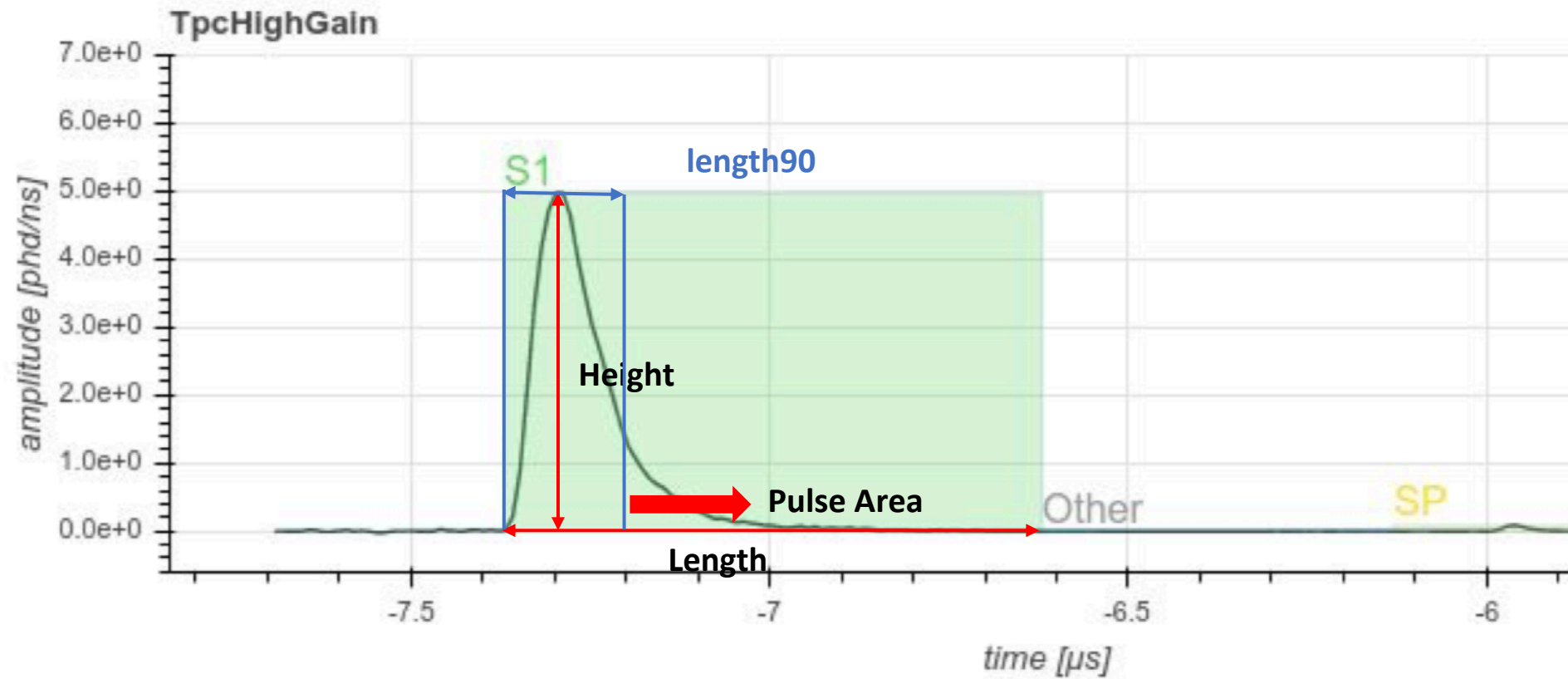
- **My goal:**

- Working on PREM_TPC module-> produce PREM plots and add them to PREM website:
 - **Pulse Classification's Parameter Space** (UPM module on Twiki); **input:** ~8h MDC3 data; all events pulse
 - [Area vs Length90](#)
 - [Area vs pFraction100](#)
 - [Length90 vs Height](#)
 - [TBA vs Area](#)
 - [TBA vs Length90](#)
 - [Height/Length90 vs Area](#)
 - [Height/Length90 vs Length90](#)
 - [Area/Height vs Area](#)
 - [Area/Height vs Area/Length90](#)
 - [Area/Length90 vs Length90](#)
 - [pFraction90 vs Area/Length90](#)
- Understand the physics process behind the plot
- Develop the proper algorithm for the plot: mean, std.....

POD



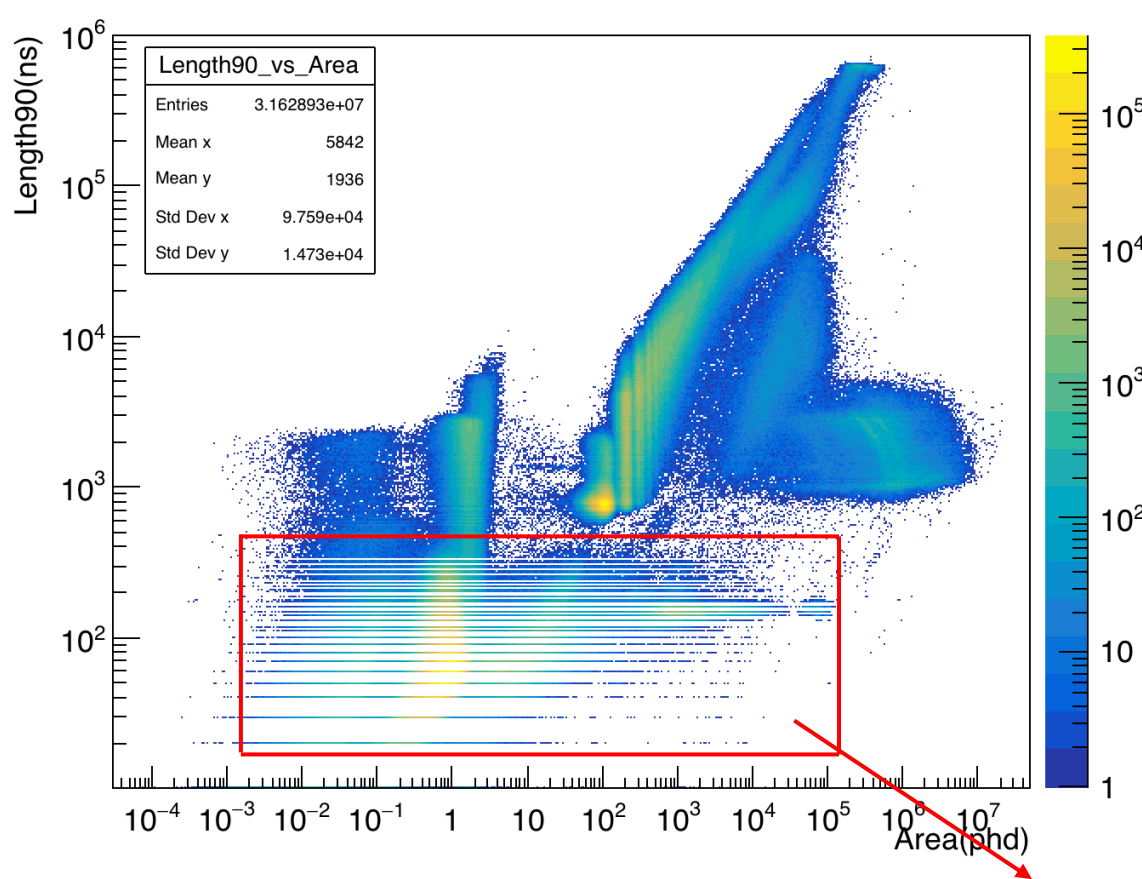
Pulse



Area vs Length90

Length90: Time at which summed pod reaches 90% of total area

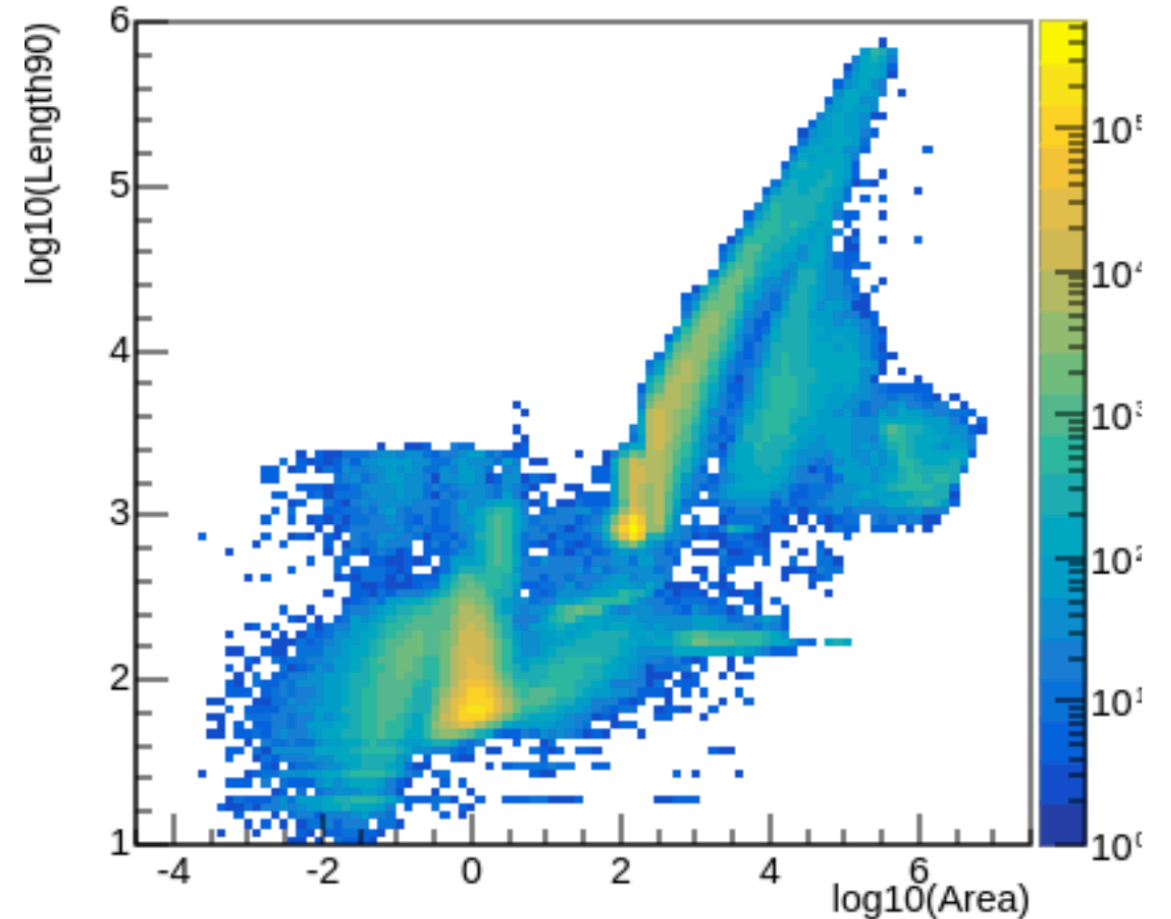
Area vs Length90



PREM

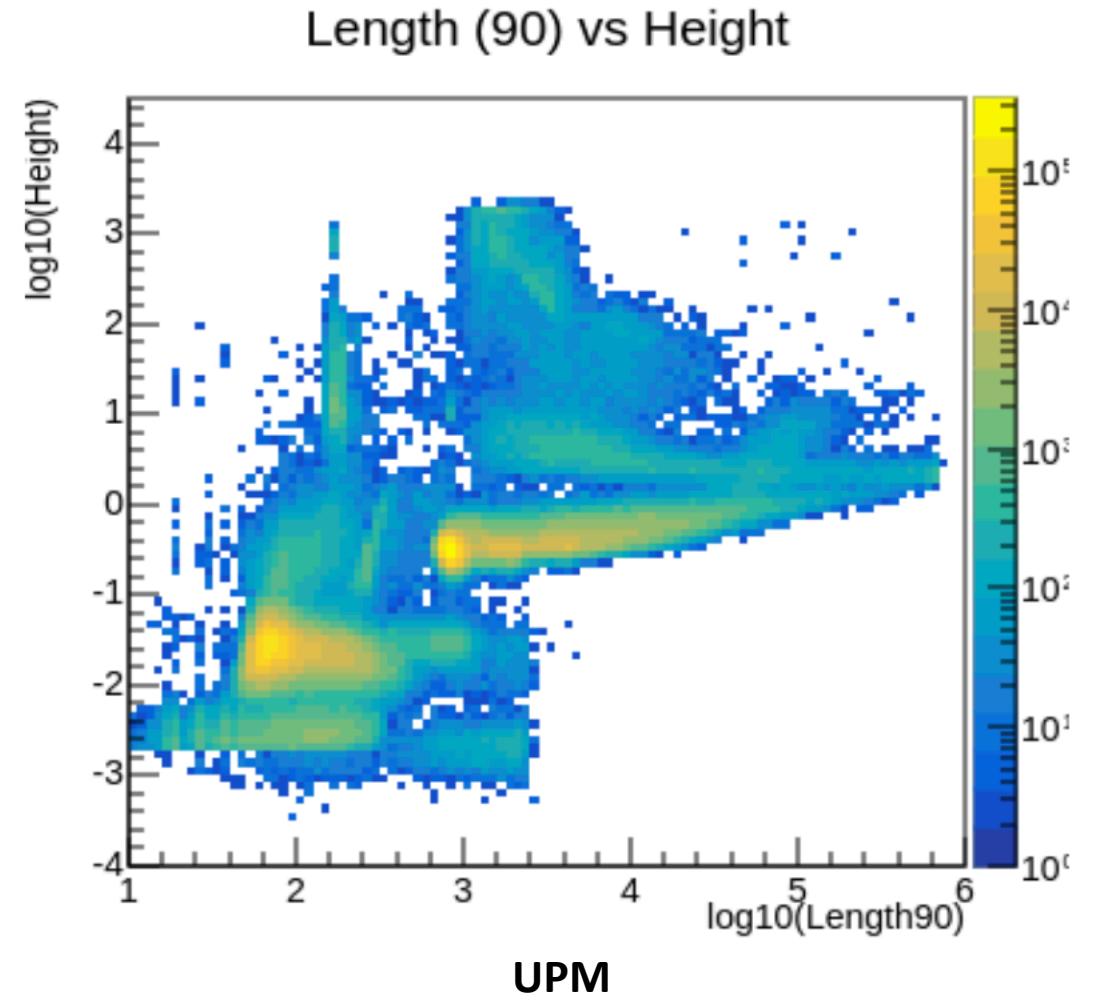
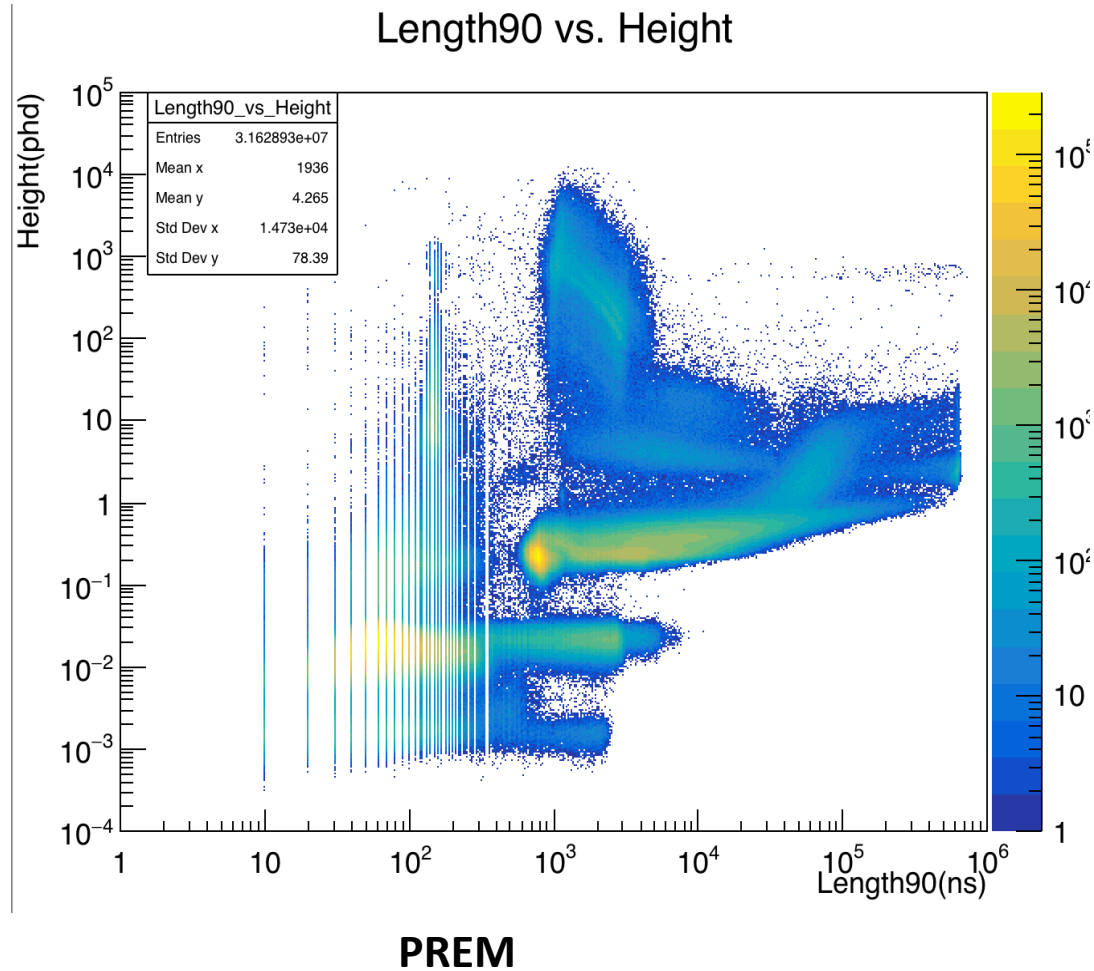
The smallest data
sample interval = 10ns

Length(90) vs Area



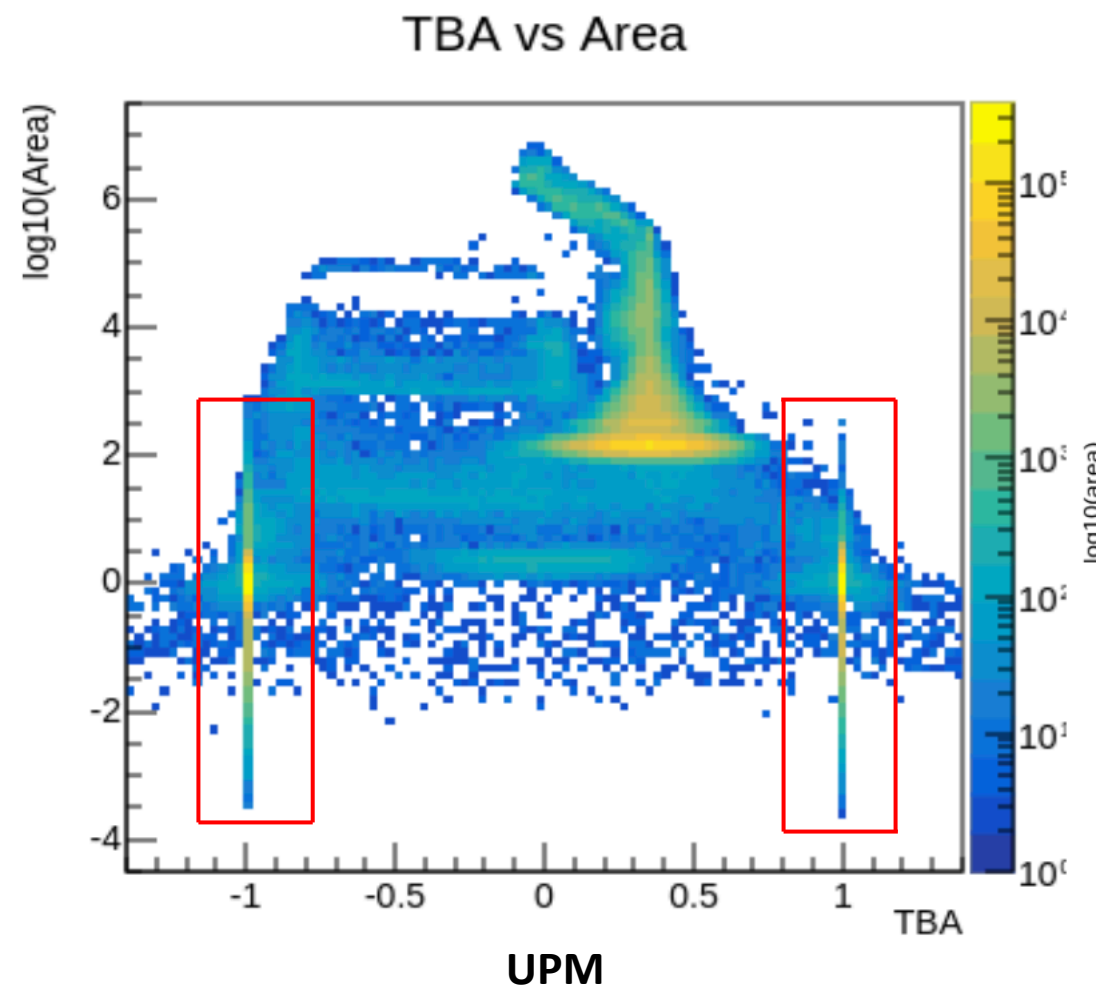
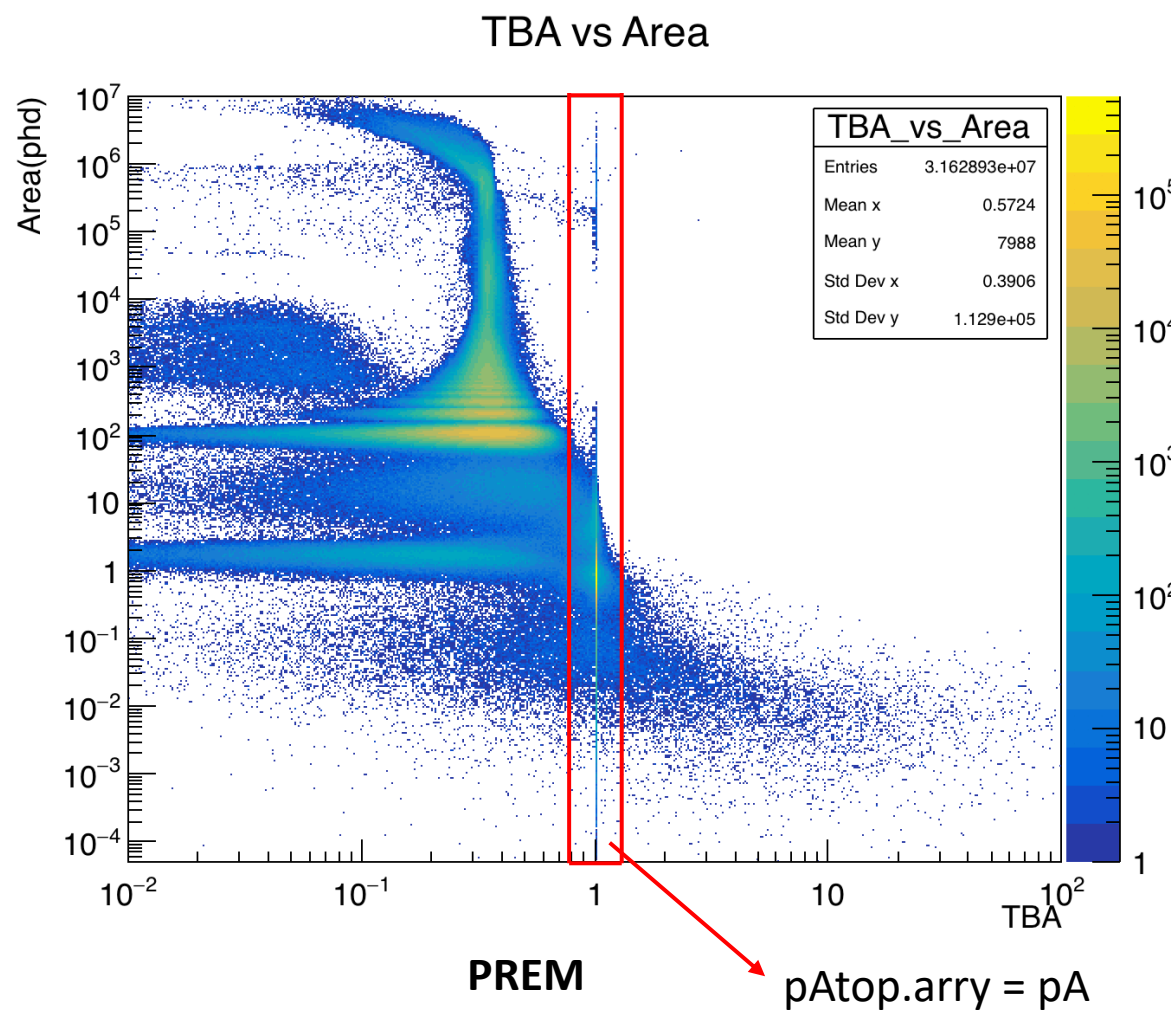
UPM

Length 90 vs Height

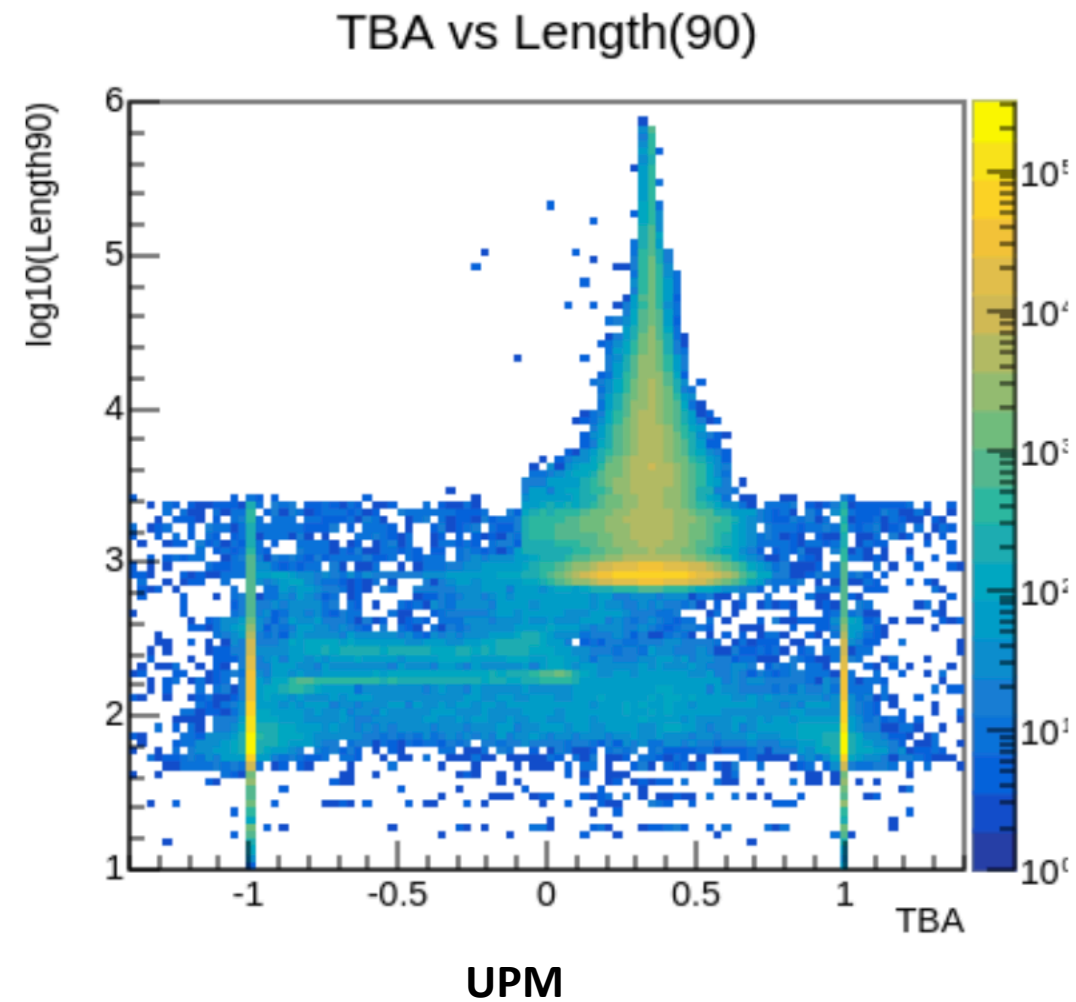
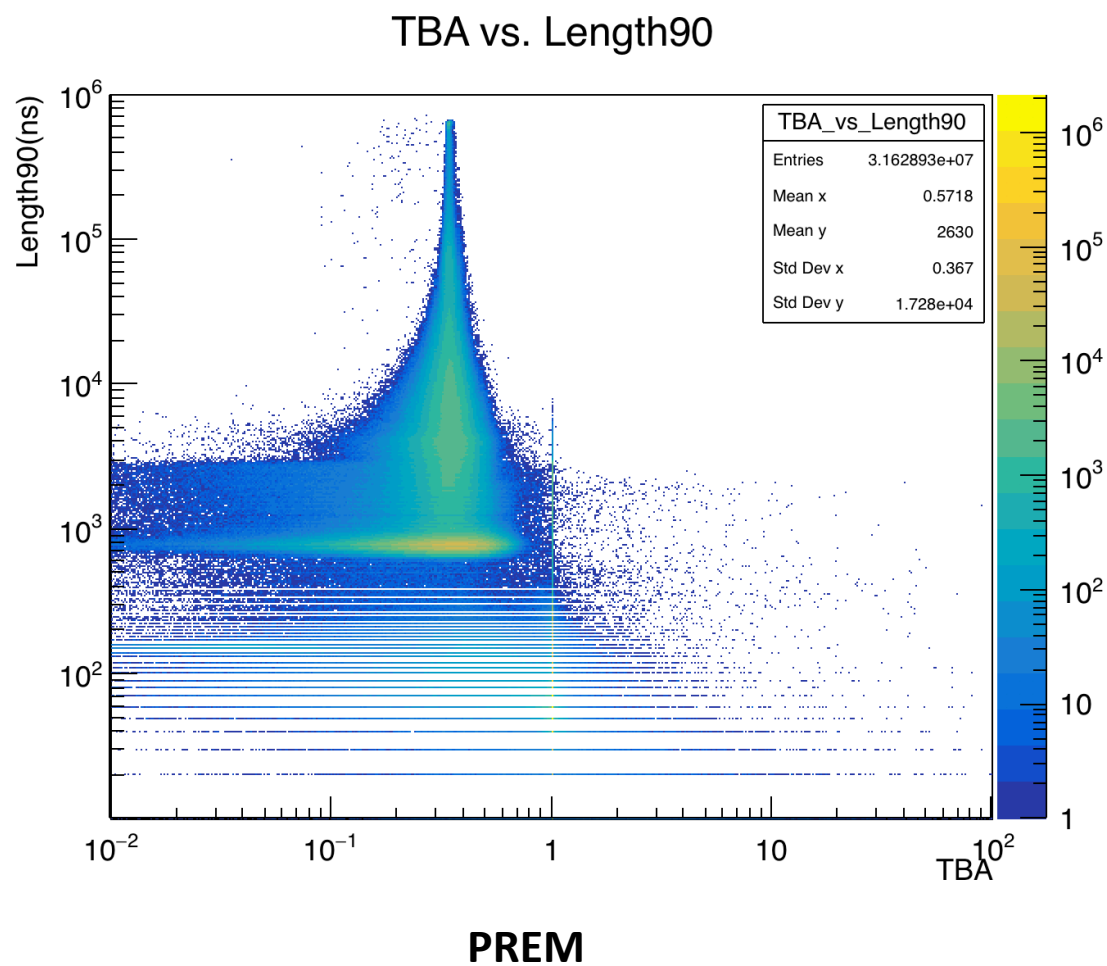


TBA vs Area

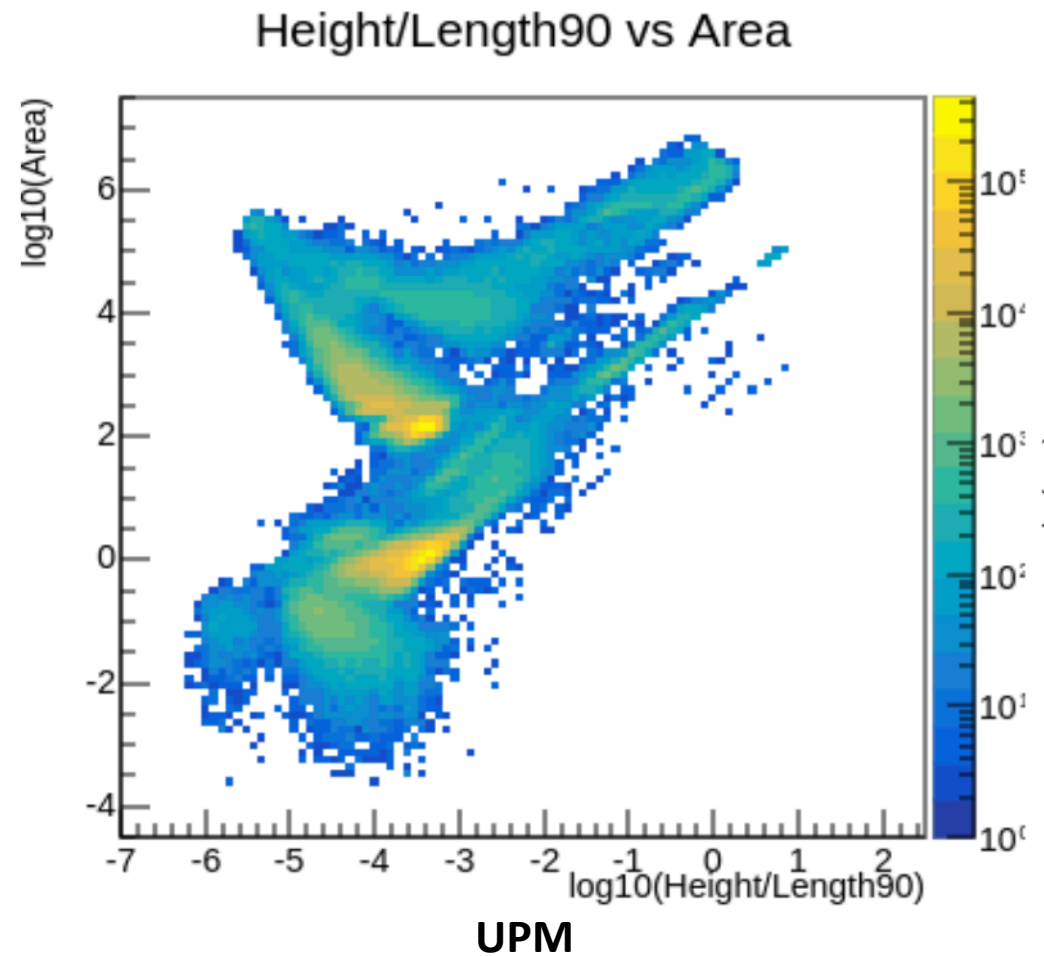
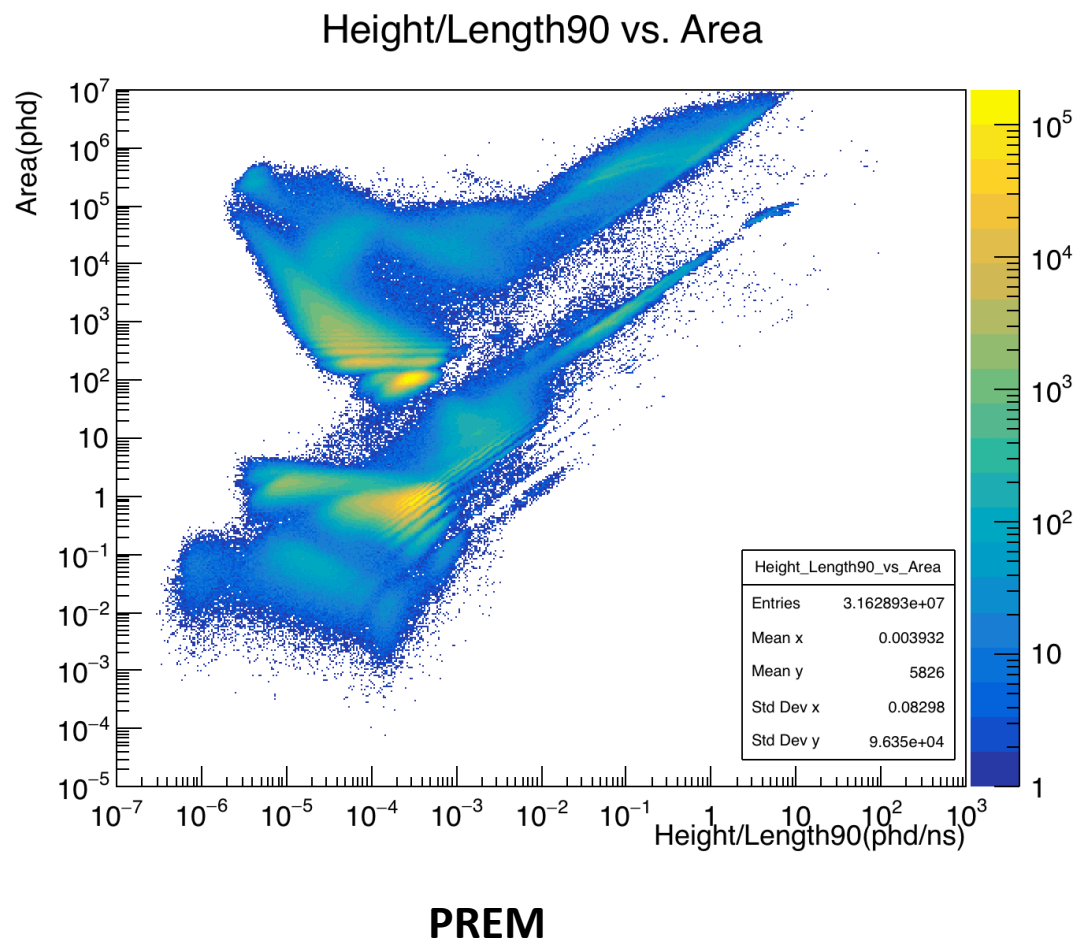
Top-bottom asymmetry (TBA) =
 $(pA_{top.array} - pA_{bot.array}) / pA$



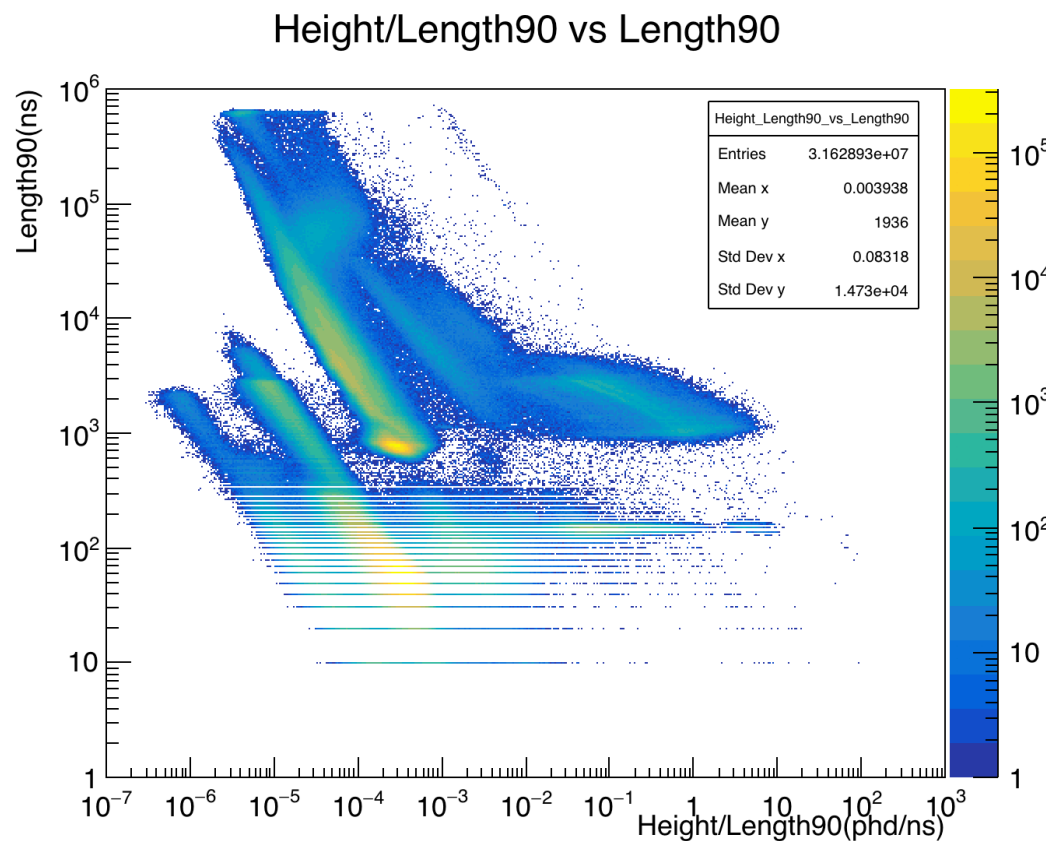
TBA vs Length90



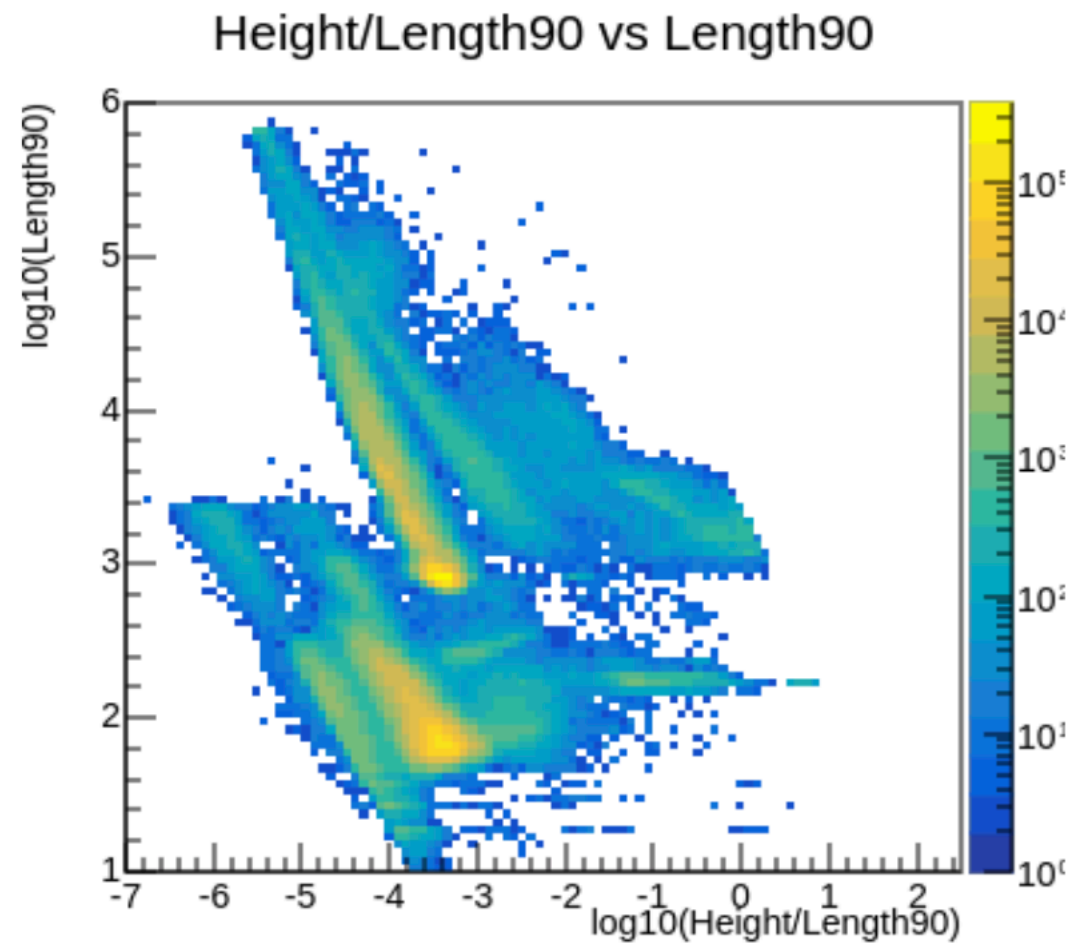
Height/Length90 vs Area



Height/Length90 vs Length90

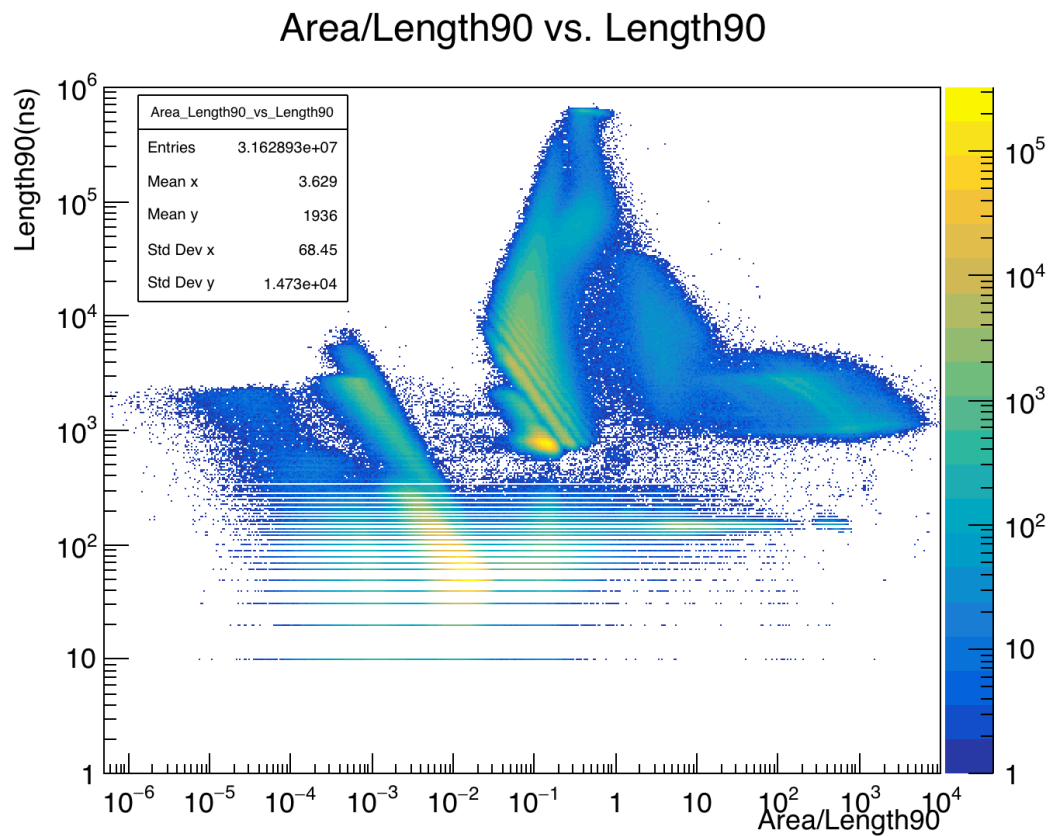


PREM

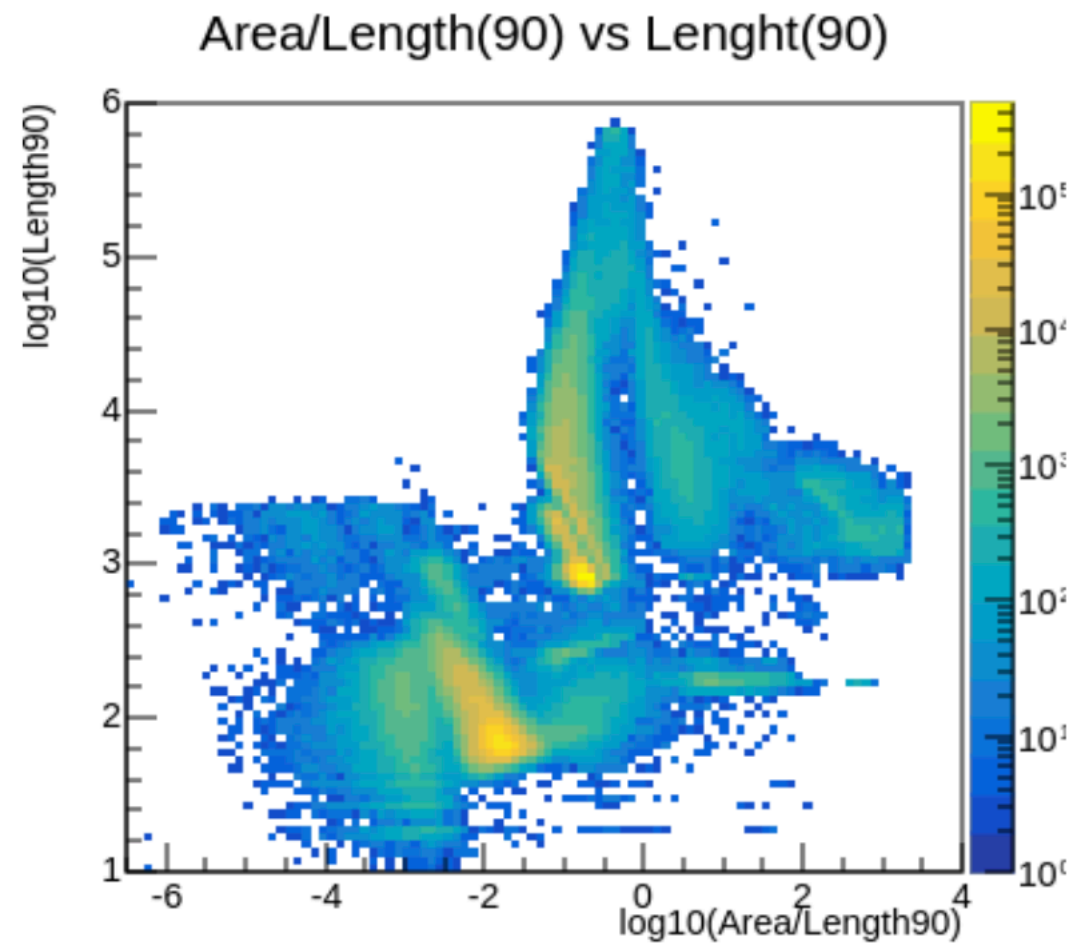


UPM

Area/Length90 vs Length90



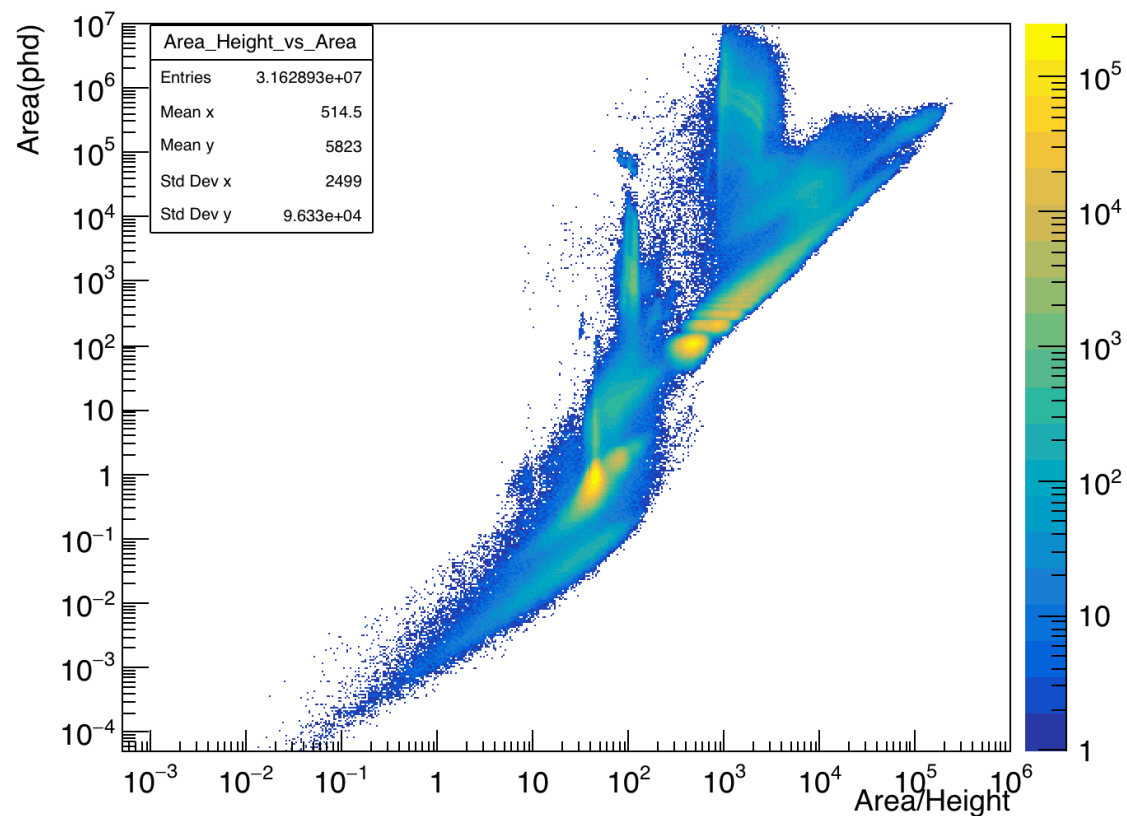
PREM



UPM

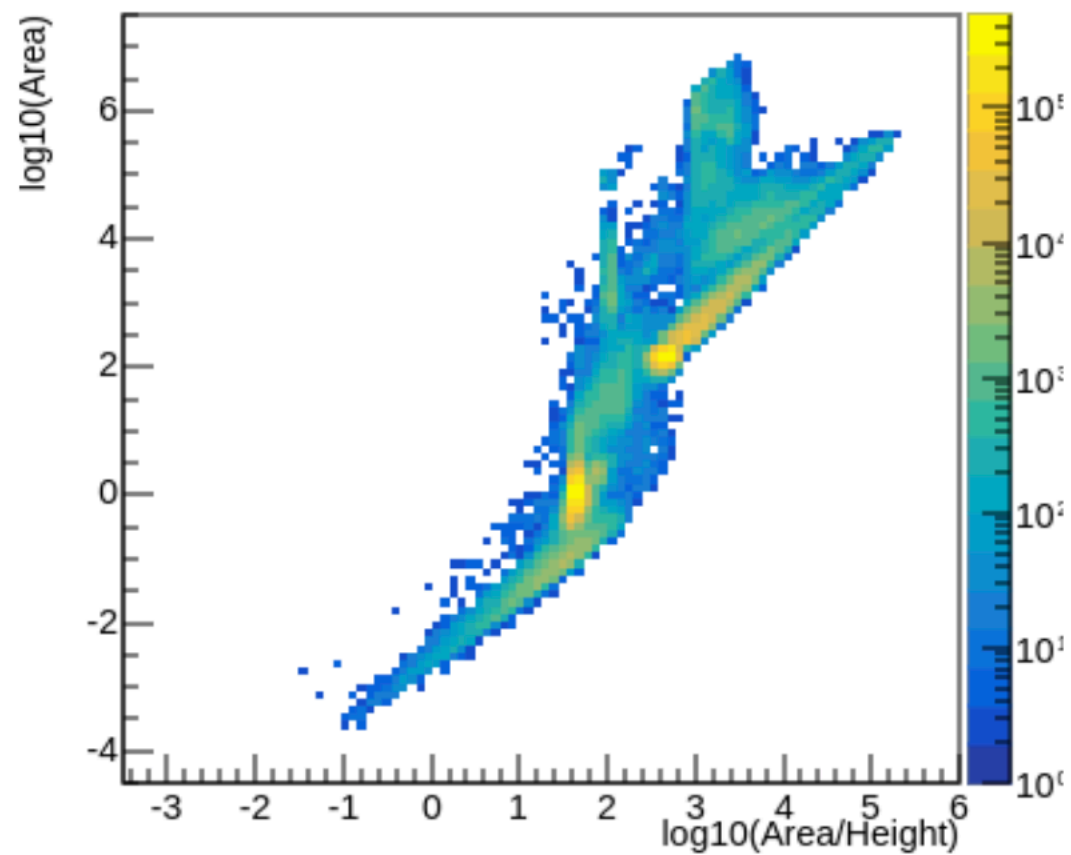
Area/Height vs Area

Area/Height vs. Area



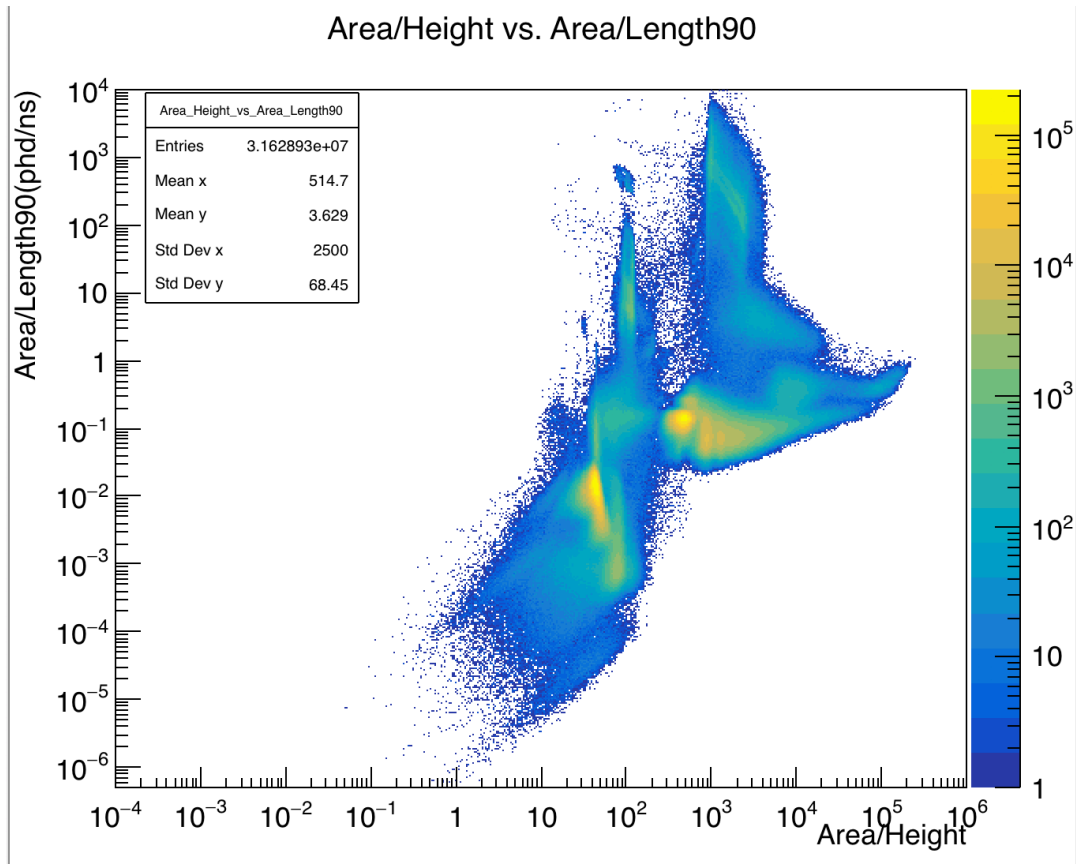
PREM

Area/Height vs Area

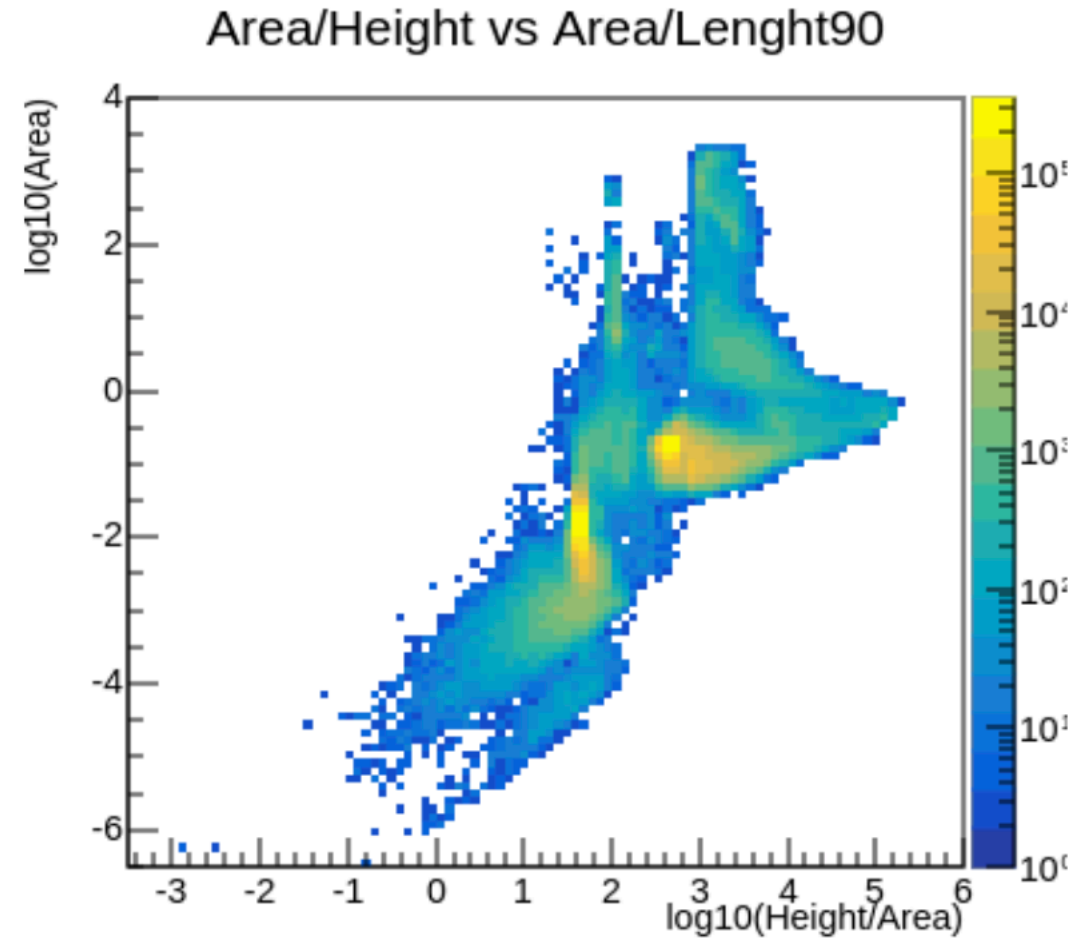


UPM

Area/Height vs Area/Length90



PREM



UPM

To do

- Clarify the RQ name of the variable **pFraction100**
- Think about the binning for Length90

18th Feb. 2021

- **1. Account:**

- LZ account: ☒
- NERSC: ☒

- **2. Code:**

- Set up cori account
- Installed Alpaca & PREM module

- **3. To do:**

- Add PREM module to Alpaca for running (environment not setting up properly?)
- Look at the Twiki page to choose a part to work on

Cori setup

- 1. Set up NERSC account and two-factor authentication (OTP) on website
- 2. Log into Cori account on terminal: `ssh user_name@cori.nersc.gov`, with password+OTP
- 3. Create a folder at: `/global/project/projectdirs/lz/users/your_username`
- 4. Set up shifter environment:
 - Write the .bashrc.ext file:
<https://luxzeplin.gitlab.io/docs/software/docs/computing/usdc/shifter.html#some-magic>
 - source .bashrc.ext
 - shifterCOS7 bash
- 5. To use git command:
 - Generate a key on cori: <https://docs.gitlab.com/ee/ssh/>
 - Add it to GitLab: <https://gitlab.com/-/profile/keys>

10th Feb. 2021

- **1. Account:**
 - LZ account: ☒
 - NERSC: in progress
- **2. Code:**
 - Installed ALPACA & PREM modules
 - Walked through PREM modules with Rachel
- **3. To do:**
 - Get the NERSC account
 - Run the code locally