Doc-db #42837

Wideband Aging v2

New and Improved (?)

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CRV Meeting #337
8/2/22

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Improvements to Analysis

- Improved fit function
  - Gaus + Landau + pol2 → Gaus + pol2
  - pol2 term = ‘noise’ term... Are we independent of form here? Try pol1
- Removing low statistics channels
  - Looking at integral of the PE distributions can tell me whether or not they are suitable channels to fit, we can cut on this integral
- Plot chi2 / DOF
  - I realized that I had never been plotting chi2 / DOF, only full chi2, so these are new
- Optimized range for fit
- Include newest runs (1036 - 1043)

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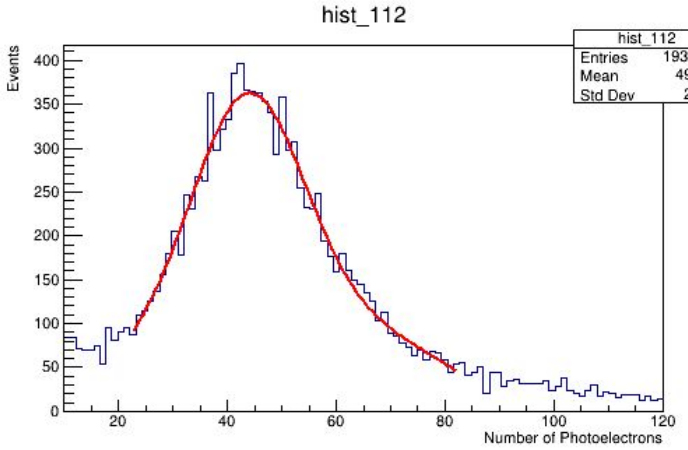
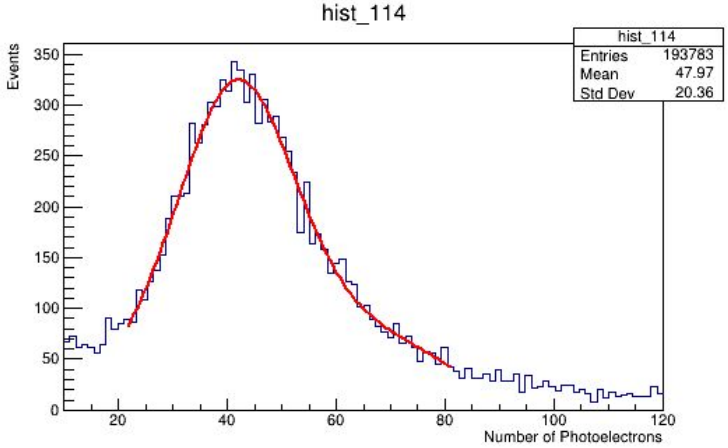
Some Improved PE Fits

- After removing the Landau term and optimizing the range of my fits, they look very clean!
- Some examples to the right
- I don't see any shifted fits like before or fits with random large spikes that shouldn't be there
- Fit = Gaus + pol2
  - Initial parameters come from a pure Gaus fit
- Range = (MaxBin - 20, MaxBin + 40)





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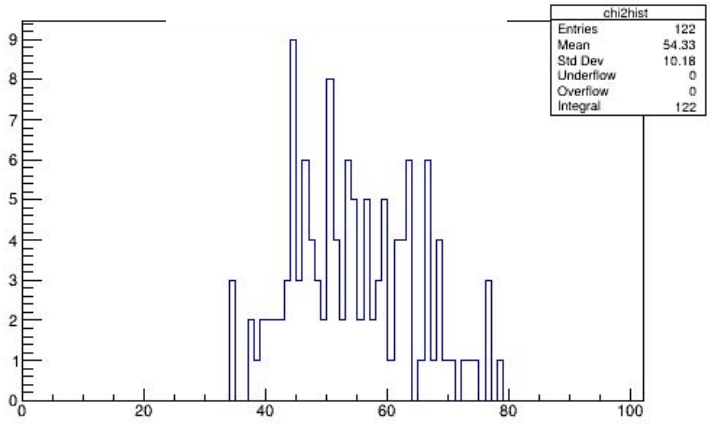
New Chi2 / DOF Distributions

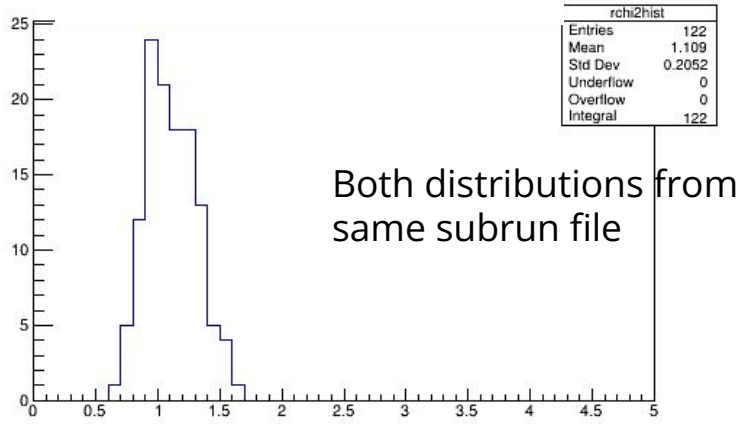
NDF = usually 49…
PE fits = 60 bins, fit with 6 parameters

- Let’s talk chi2 distributions again…
- I realized recently that I had never plotted chi2 / DOF, only ever total chi2
- Chi2 / DOF distributions look much more reasonable

Chi2 Distribution



Reduced Chi2 Distribution



Both distributions from same subrun file

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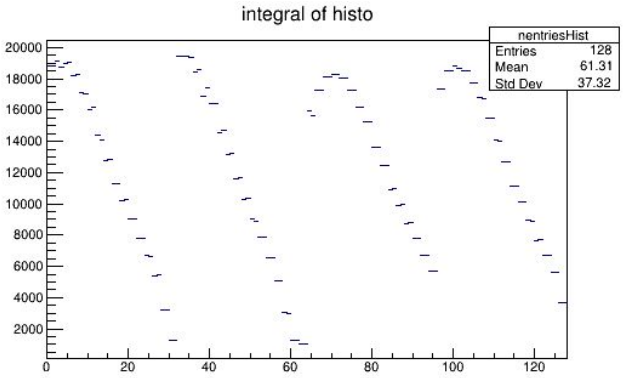
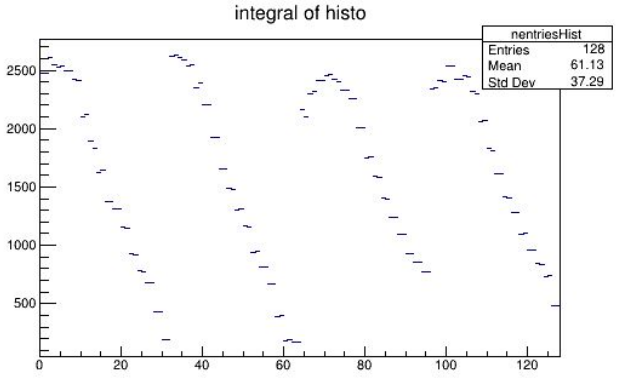
Cutting on Integral of PE Distribution

- Applying this cut has been really successful in taking out the low statistics channels that were giving me problems in the past
- I found that a good level to cut on is an integral of ~2000
- For reasonably large runs, this only cuts a few channels on the edge (top plot)
- For smaller runs, like last subrun of run, dataset does not have many events at all, almost all channels are cut out (bottom plot)





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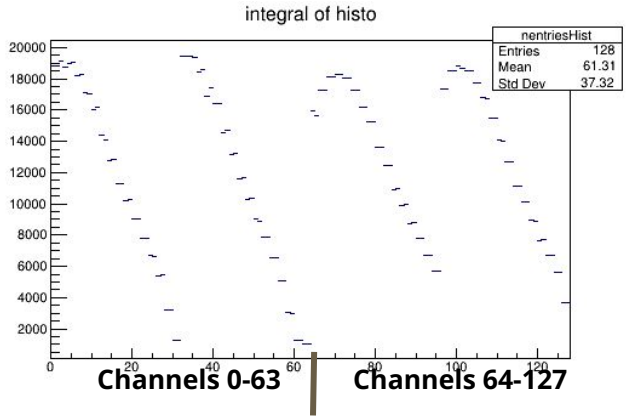
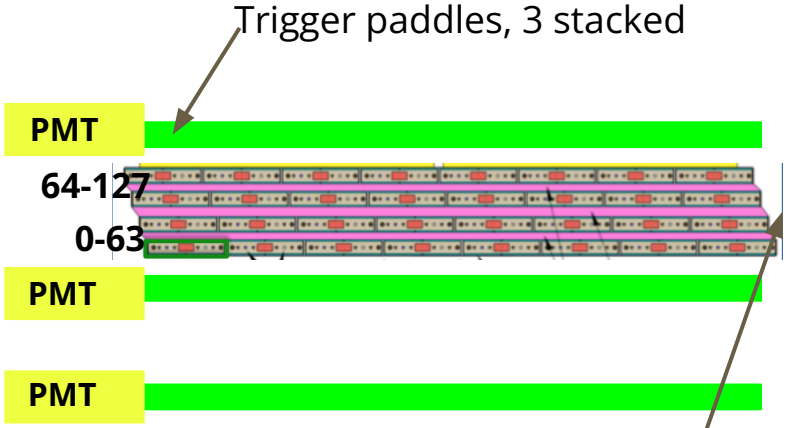
Geometry of Module 127 and FEBs

- If we think about the way that this module is connected to its FEBs, I can make some guesses about why the integral plot has this shape between the 1st and 2nd halves:
  - FEB0: first half of plot = bottom 2 layers of module
  - FEB1: second half of plot = top 2 layers of module
  - Typically, we have FEB0 connected to top and FEB1 connected to bottom, but this module was historically ‘swapped’ around, we knew this
  - General shape: non-linear effects from one-sided PMT readout, lose efficiency far from PMT





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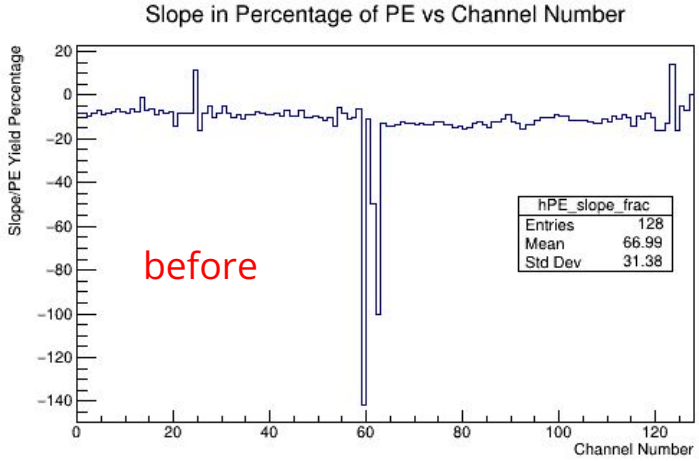
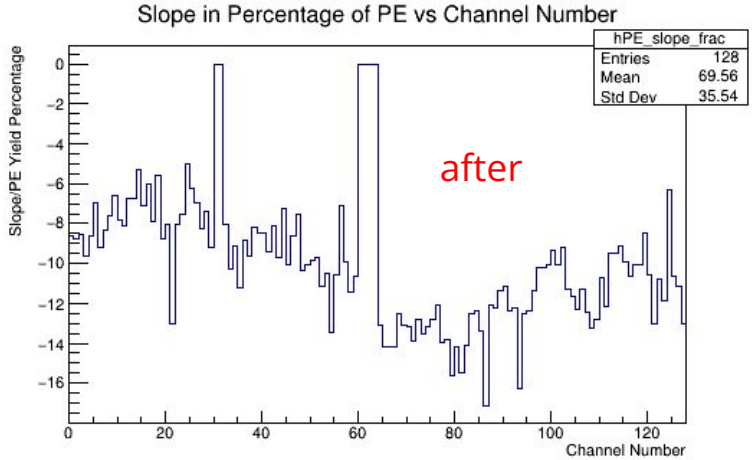
Integral Cut Results

- This cut does completely remove a few channels from the analysis, because there are not any points left in the aging plots to fit
- When I applied this cut at this stage, I set the PE yield to 0 for a particular channel in a given subrun; if there are no points left, the aging rate was set to 0%





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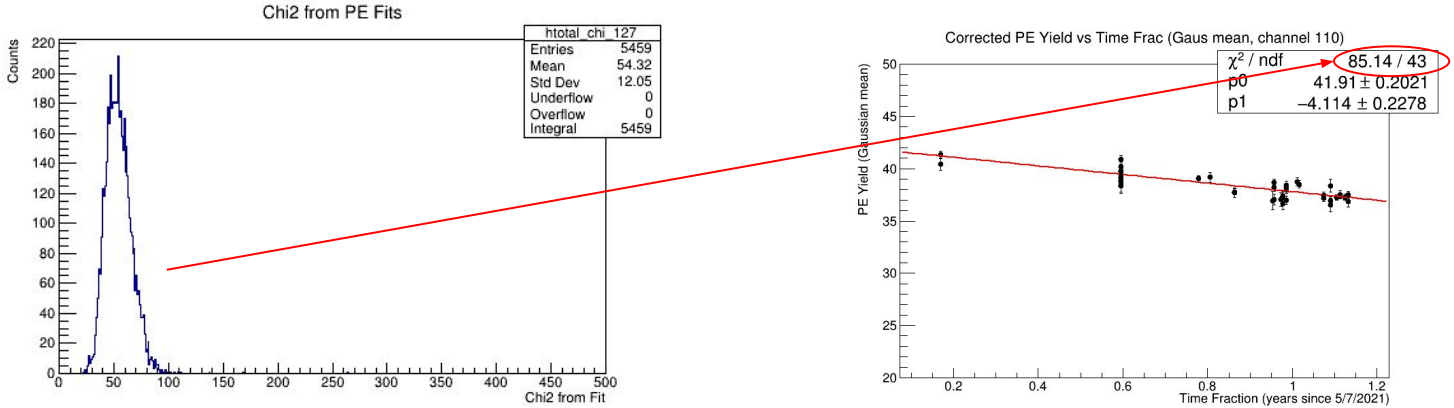
Cut on Total Chi2 Contributions

- The cut that I added on total chi2 contributions for a given data point had a much smaller effect
- For this cut, I decided to cut on any points above 3σ in my full chi2 distribution
  - Full chi2 mean = 54.32, std dev = 12.05 → cut on any point with chi2 > 90.47



Contributions from each point are added up here in aging plots

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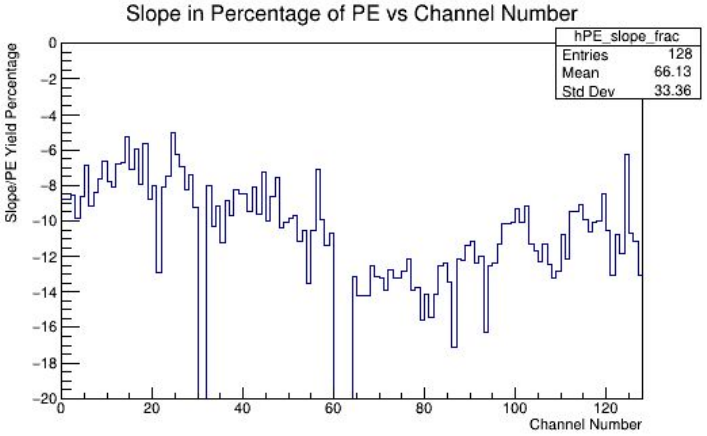
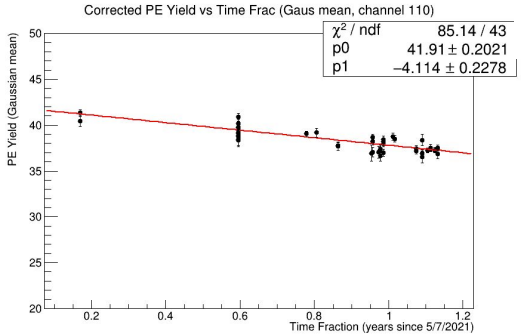
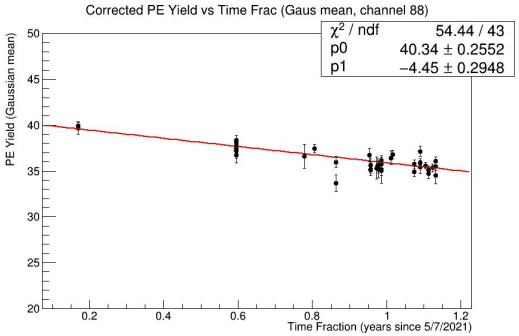
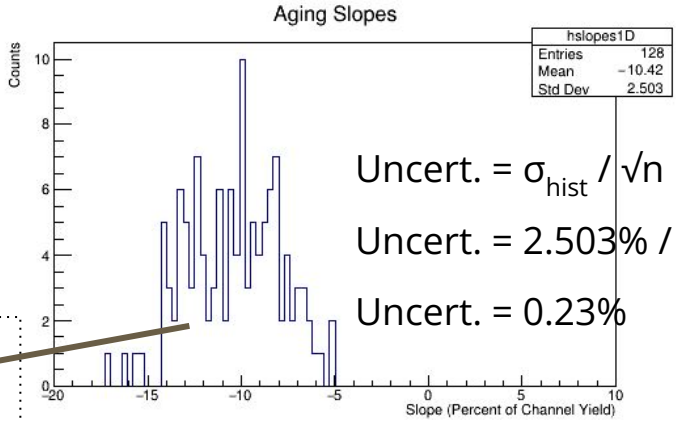
Big Reveal (?)

- Most channels are very clean now, a few channels are completely removed by integral cuts









Uncert. = σ_{hist} / √n

Uncert. = 2.503% / √122

Uncert. = 0.23%

Final estimation:
10.42% aging ± 0.23%

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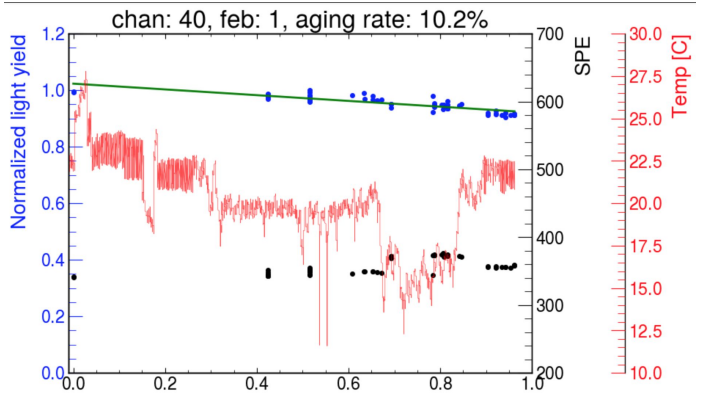
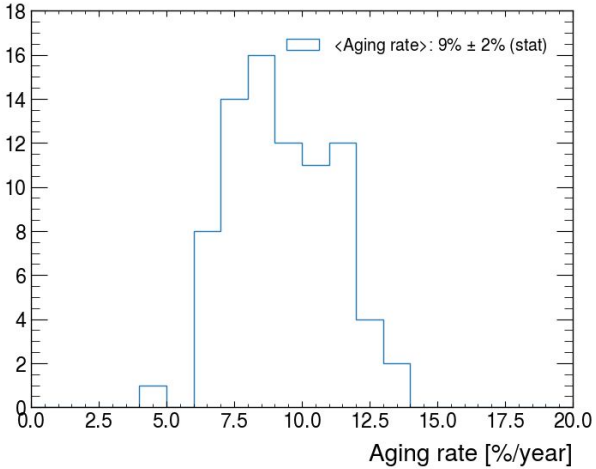
Yuri's Analysis

- To verify my results, Yuri did an independent aging study using Ralf's reconstruction algorithm
- Yuri reports an average aging rate of 9%/yr
- This is consistent with my measurement of 10.42% ± 0.22%





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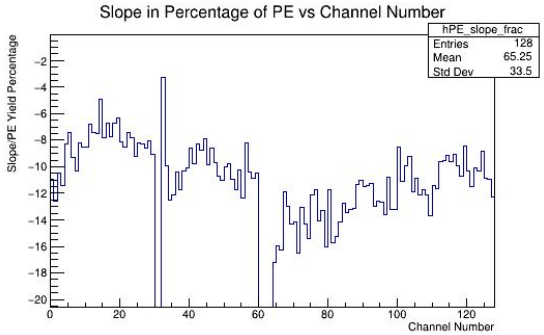
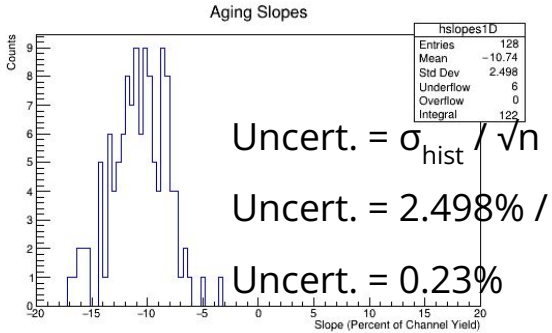
Sensitivity to Form of Noise Term

- I presented my old work at the Scintillation R & D Meeting that meets ~monthly and I got a good suggestion:
  - If my pol2 term truly describes the low-amplitude noisy tail of my PE distributions, then changing the form from pol2 to something else should not have a big effect on aging rate
- To investigate this, I changed my pol2 (polynomial) term to pol1 (linear)
- Results: very small change in overall mean aging rate

Sensitivity to Form of Noise Term



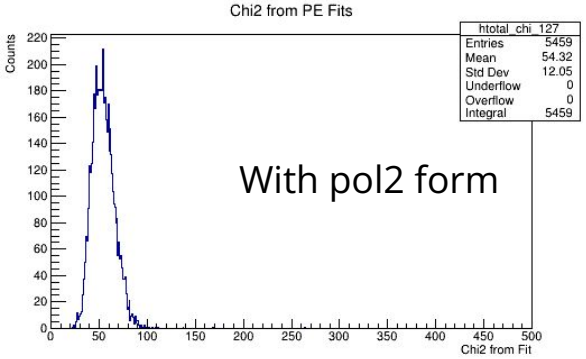
- Results from fit with pol1 term result in a very close mean aging rate
  - Pol1: -10.74% ± 0.23%
  - Pol2: -10.42% ± 0.23%
- However, chi2 increases
- Mean does not change = not sensitive to form :)

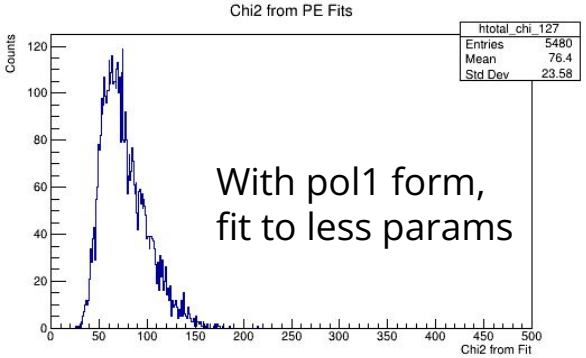


Uncert. = σ_{hist} / √n

Uncert. = 2.498% / √122

Uncert. = 0.23%





Conclusion

- My fits have improved considerably with removal of Landau term
- Chi2 / DOF distributions look nice
- Cuts like integral of PE distribution or chi2 of PE distribution fit are very useful in removing channels that are susceptible to bad fitting
- Aging rate looks to be ~10% / year 😕

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Not Really Backup… Let’s Talk More

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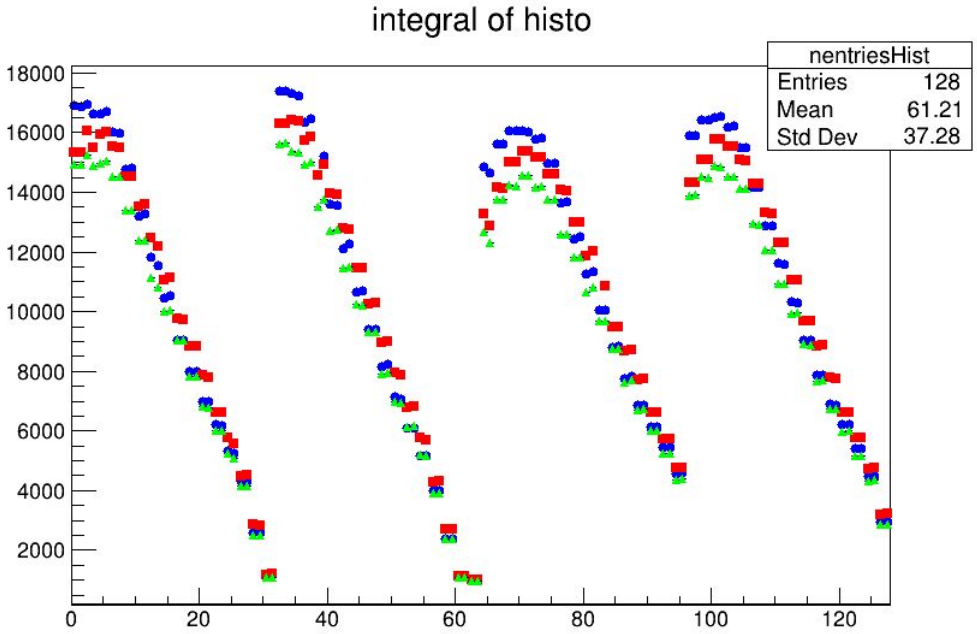
Overlaying Integral Plots

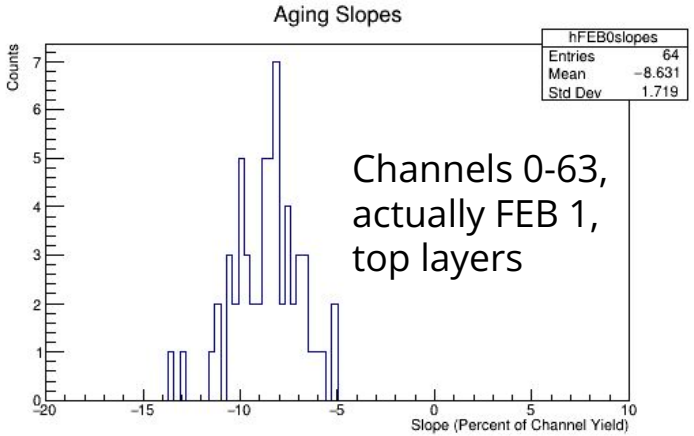


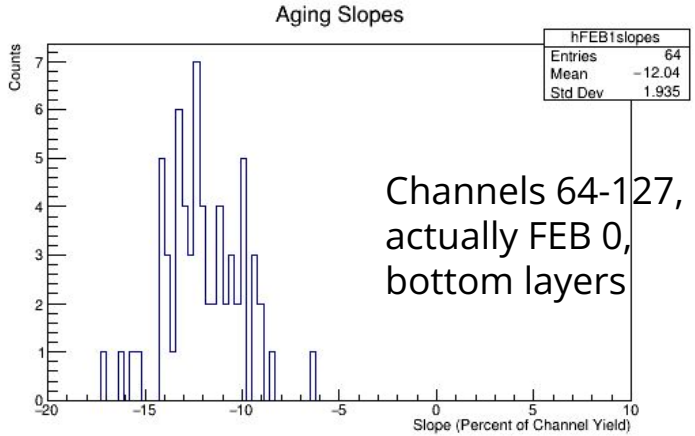
- Run 66_0 = blue circles
- Run 1022_0 = red squares
- Run 1033_0 = green triangles

- These subruns must be roughly the same size, close in integral

FEB Dependence of Aging Rate?

- Something peculiar in the graph of slopes by channel is that it appears that the first half and second half of the plot have different averages
- If we plot channels 0-63 and 64-127 separately, we can see this effect
- Not sure what to make of this - top and bottom layers of module; FEBs 0,1





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March 17

- If you looked closely at the results and plots from Yuri's studies, you may have noticed that he plotted single PE values over the year
- These values suddenly jump, but should be constant with time
- This sudden jump happens on March 17
  - On this day, we installed fans near the FEBs. Later, these were swapped for heat sinks
  - Concern: did this change in FEB temperature result in change in gain of SiPMs or other FEB electronics?
  - SPE: 376 → 391 units, fan install corresponded to 20 C drop
  - Ralf: 30 degree change → 0.1V bias change, so this temp could have increased SPE
- Yuri: plot aging with split for before/after March 17

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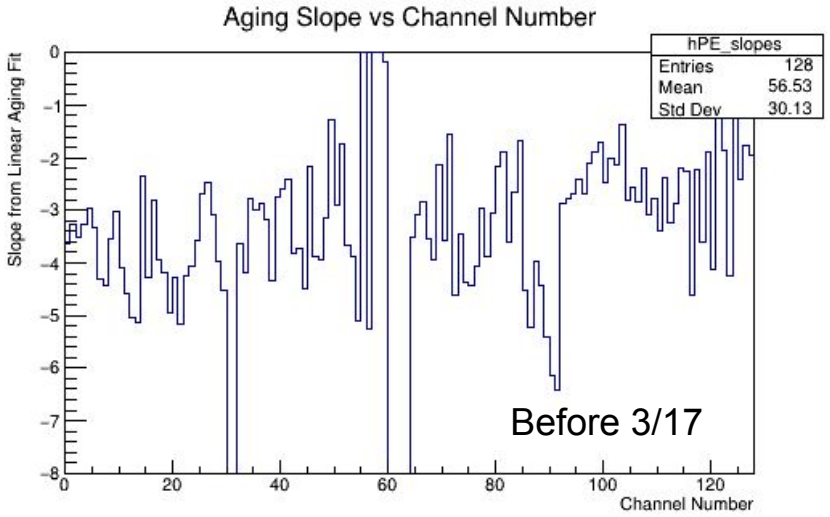
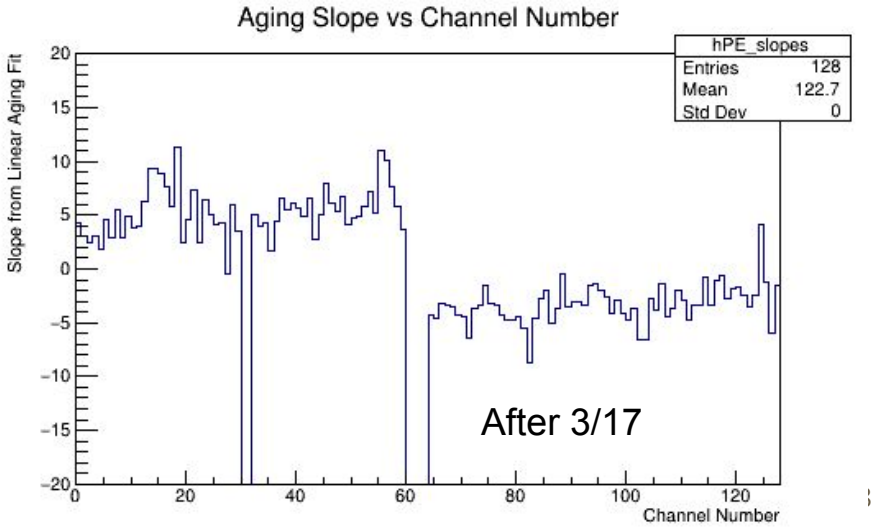
Before/After March 17

- Splitting the files before/after March 17 gives me really different results…
- These plots are just slope of my linear aging plots, not percent of total PE yield in each channel **(pay attention to range on y-axis)**





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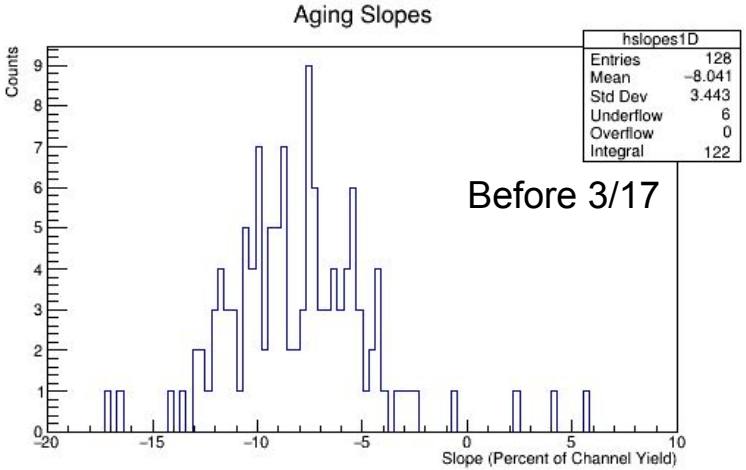
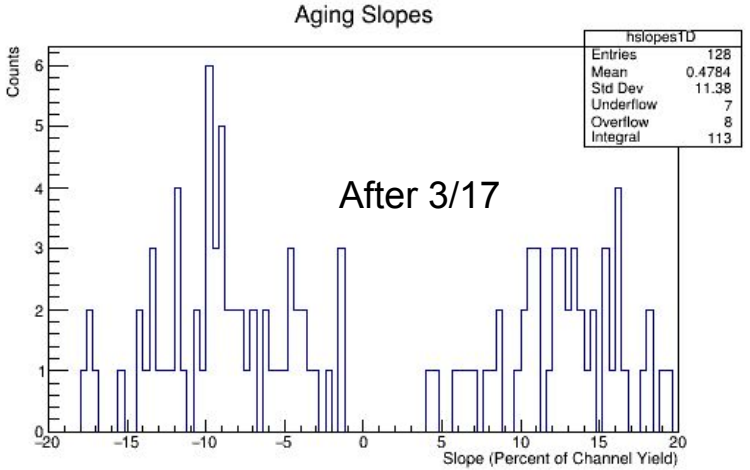
Before/After March 17

- These plots are the percent of the PE yield in the channel, on a 1D histo
- Very clear distinction before and after 3/17, but why is FEB1 after 3/17 all positive slopes??





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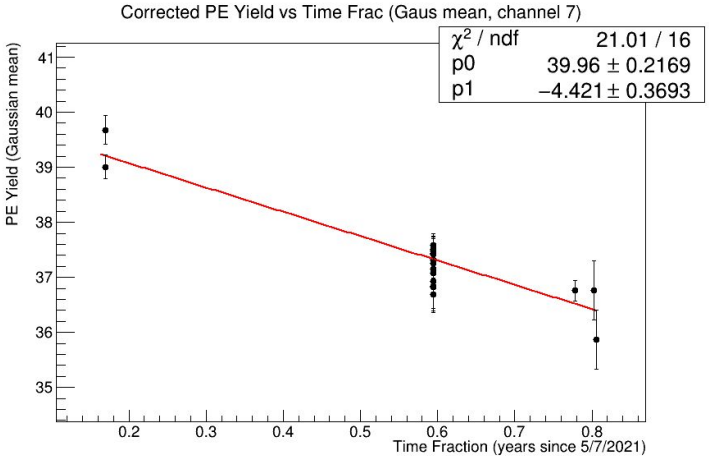
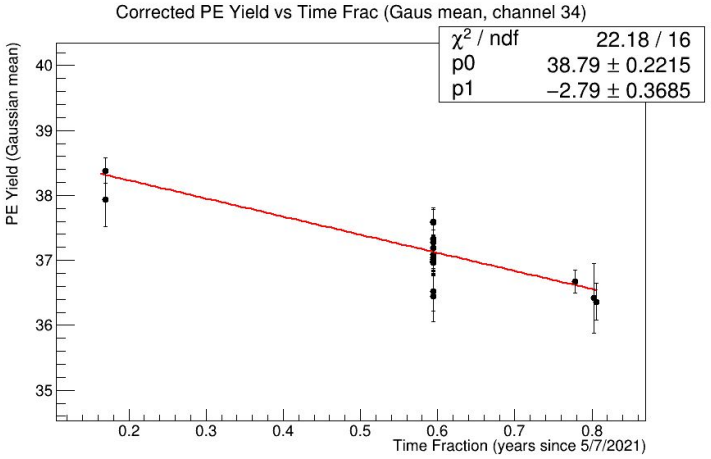
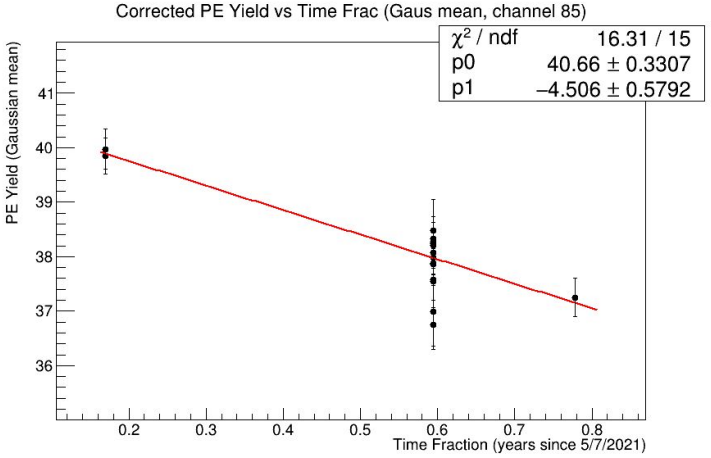
Before March 17 Aging Plots







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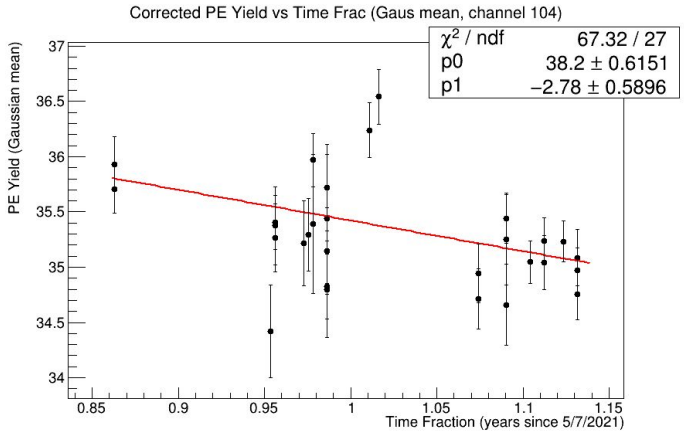
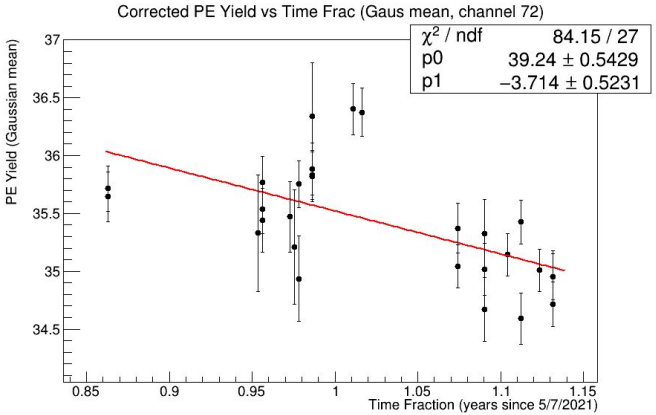
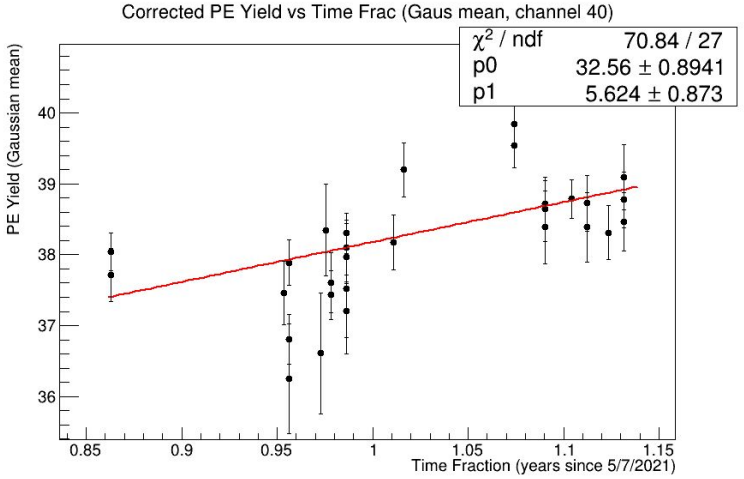
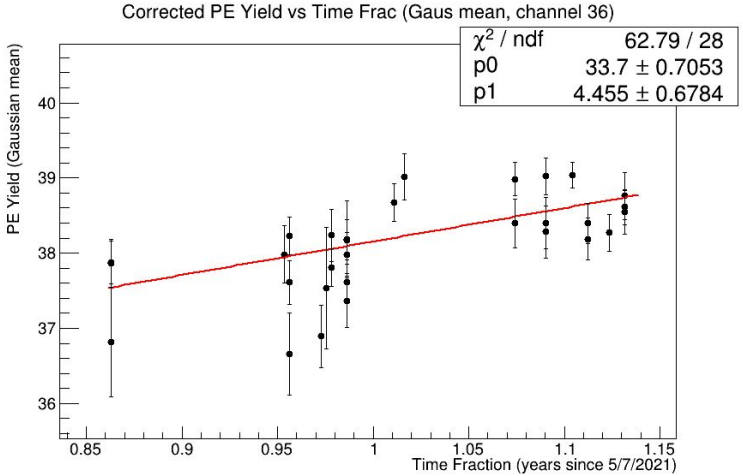
After March 17 Aging Plots









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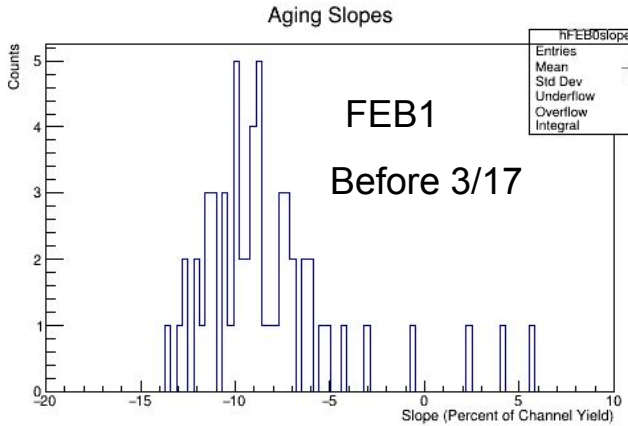
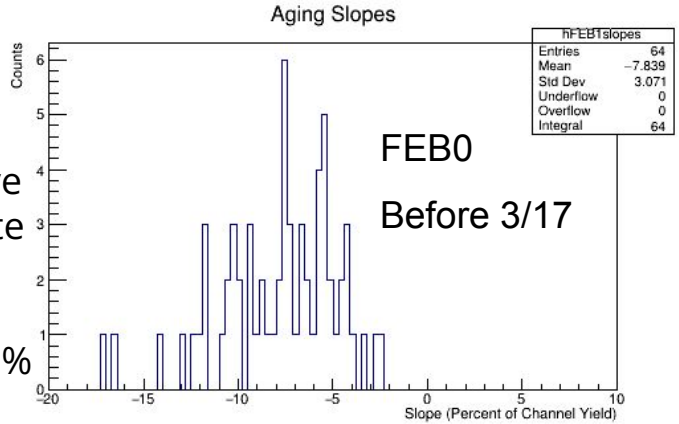
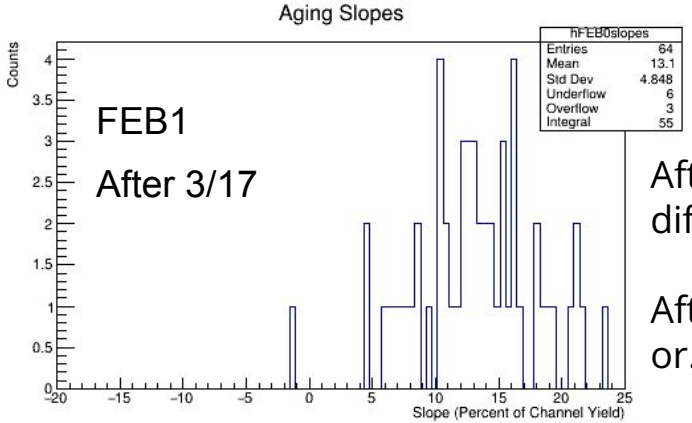


Before 3/17, both FEBs give a similar, smaller aging rate than overall

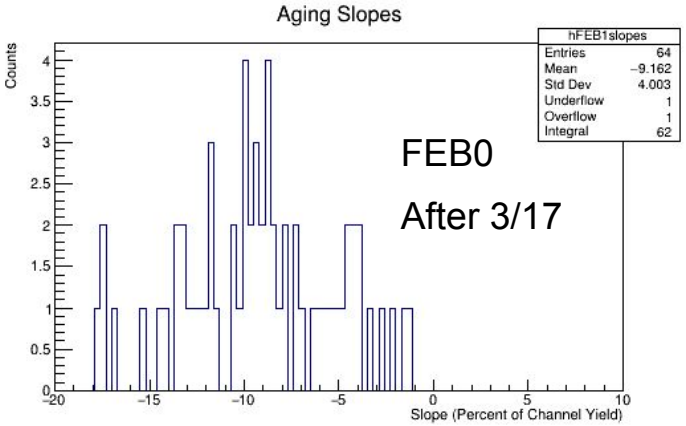
Before 3/17: -8.04% ± 0.31%





After 3/17, both FEBs give a different aging rate

After 3/17: -9.61% ± 0.50%
or…. + 13.1% ± 0.65%



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Remarks

- Yuri and I both noticed a difference in aging between FEB0 and FEB1…
  - Before 3/17 it looks like FEB0 and FEB1 have roughly the same aging rates
  - After 3/17 not sure what happens but half of the channels seem to produce a positive aging slope
- Before March 17 looks like there is a slightly different average aging rate of ~8% / yr compared with ~9-10% / yr that Yuri and I both arrived at when analyzing all runs
- March 17 = fans installed near FEBs… Did something happen at the beginning of May too around t = 1.0? A/C turned back on?

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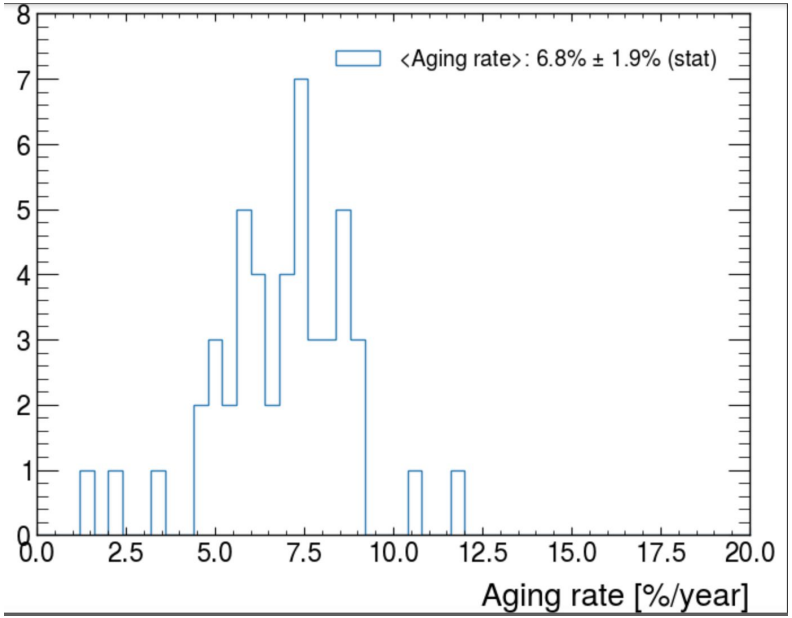
Yuri Before 3/17?

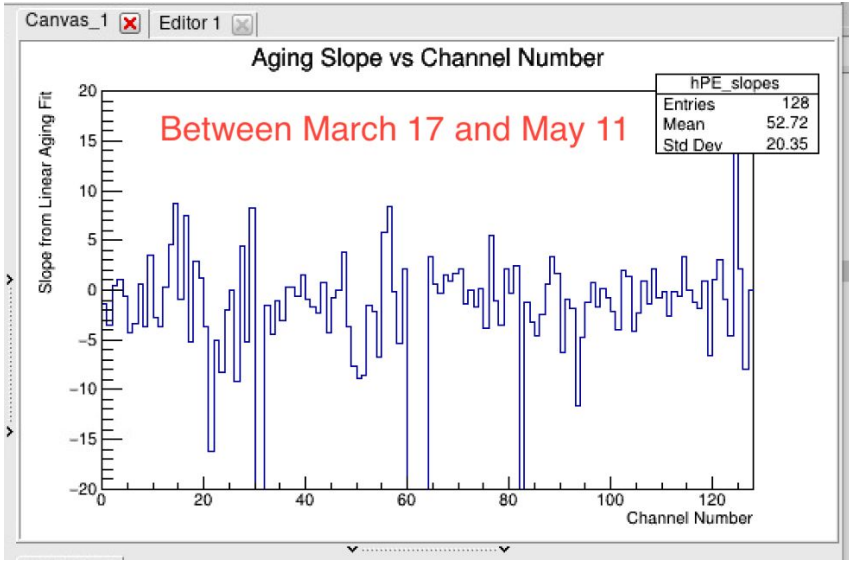
- I just noticed this updated plot in Yuri's notebook… his results for before 3/17 I believe

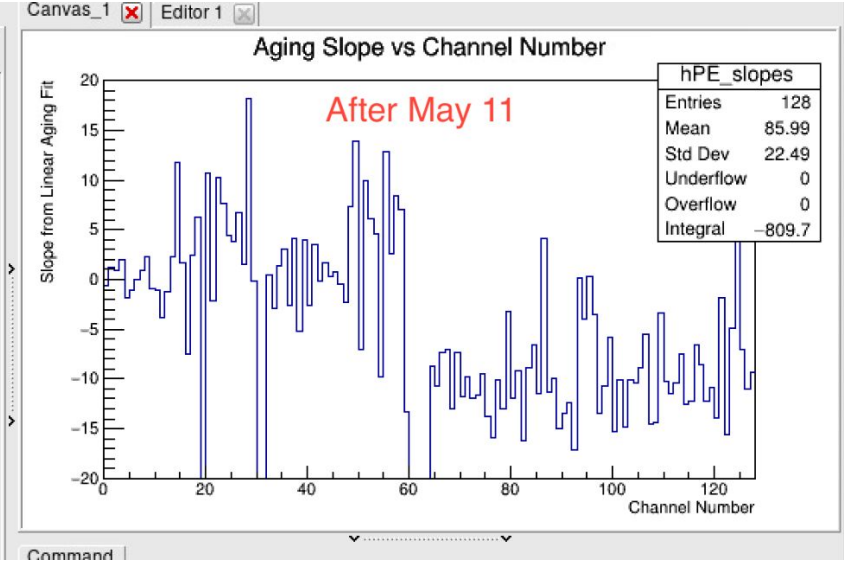


Addendum

Splitting March 17 - May 11 and May 11 - June 24

- I did another split by date this morning after we discussed the possible jump after t = 1 in my graphs, where it appears that the AC turned back on in early May
- These plots show the aging slope in PEs/yr, not the slope as a fraction of yield in each channel





Conclusions on March - May and May - onward

- From March 17 - May 11, it looks like the two halves of the module behave in the same way, the aging slopes are similar between the two halves
    - These slopes are also similar to what we see before March 17
- After May 11, there are obvious differences between the two halves of the module
    - Messages say that I noticed that the A/C was on that day, but what else could have happened? Is this all attributed to A/C?