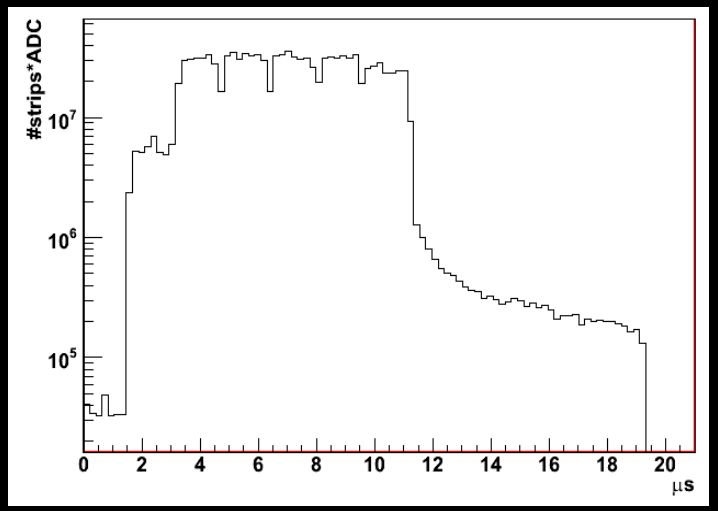
Characterizing afterpulsing with data

Tobias Raufer

NC phone meeting, Oct 28, 2005

Outline:



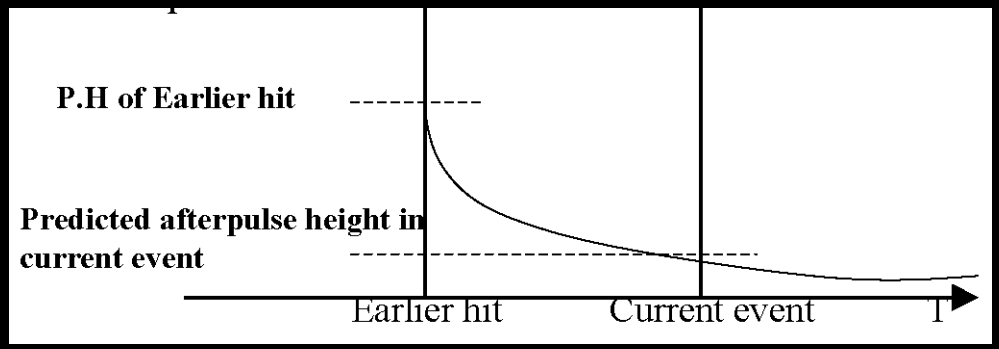
- Changes since the collaboration meeting
- Time structure in the MC
- Hunting down the details of the effect:
  - in time
  - in PMT pixel space
- Summary

Peter's suggestion

From his talk on Sept. 15:

"Make a cut on absolute expected activity due to afterpulsing", i.e.

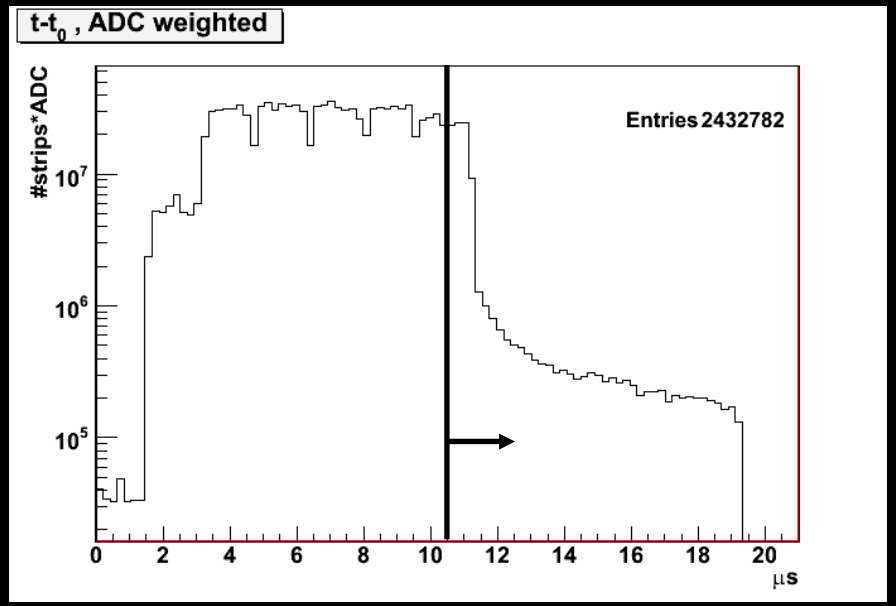
- Model afterpulsing using a sum of exponential decays



- Do it PMT-wise, because we expect wrong-pixel afterpulsing (actually, I do it plane-wise at the moment, because it's easier)
- Sum up predicted activity in a fixed size window, in order not to be biased against event size
- Cut out whole events rather than strips, in order not to distort the event energy

The model parameters

Use tail of $t-t_0$ distribution to fit the exponential decay parameters, i.e. time constant and amplitude



Use only strips more than 10.5 μs into the spill, to make sure there is no second neutrino interaction

Look at the strip time relative to the first strip in the same plane

Only use strips with no previous activity

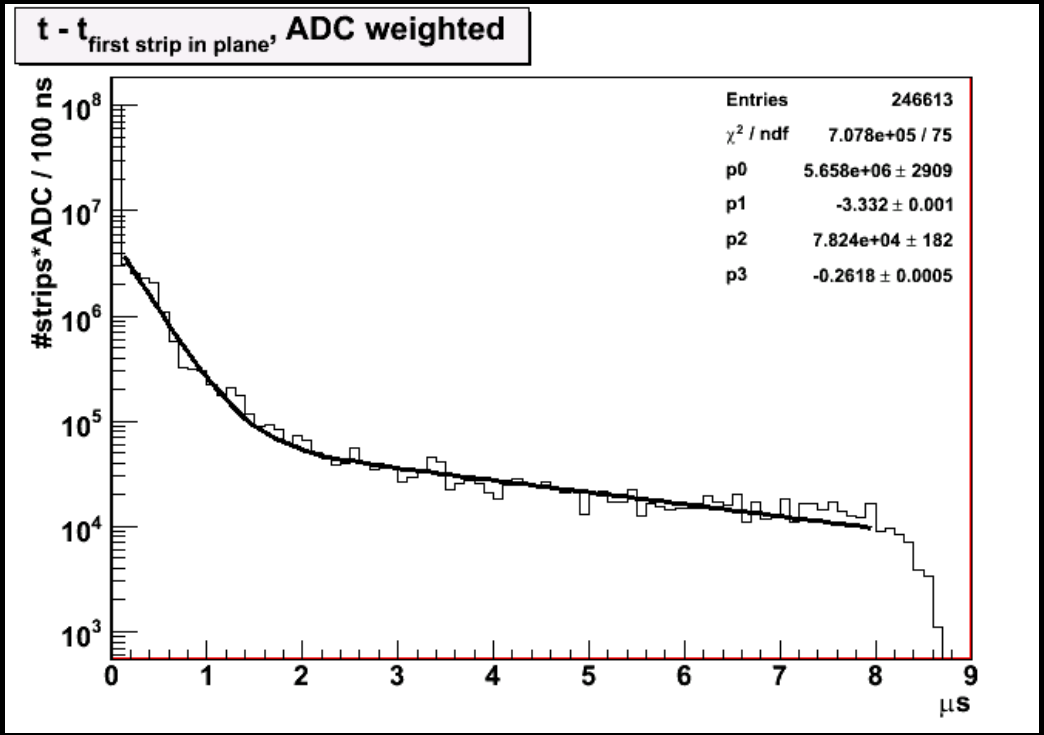
Low PH cut at 40 ADC

The model parameters (2)

Fit function: Double exponential

$$f(t) = Ae^{-t/t_1} + Be^{-t/t_2}$$

Integral of the tail:
15 % of the peak



My fit values:

t_1 = 300 ns **12.2 %**

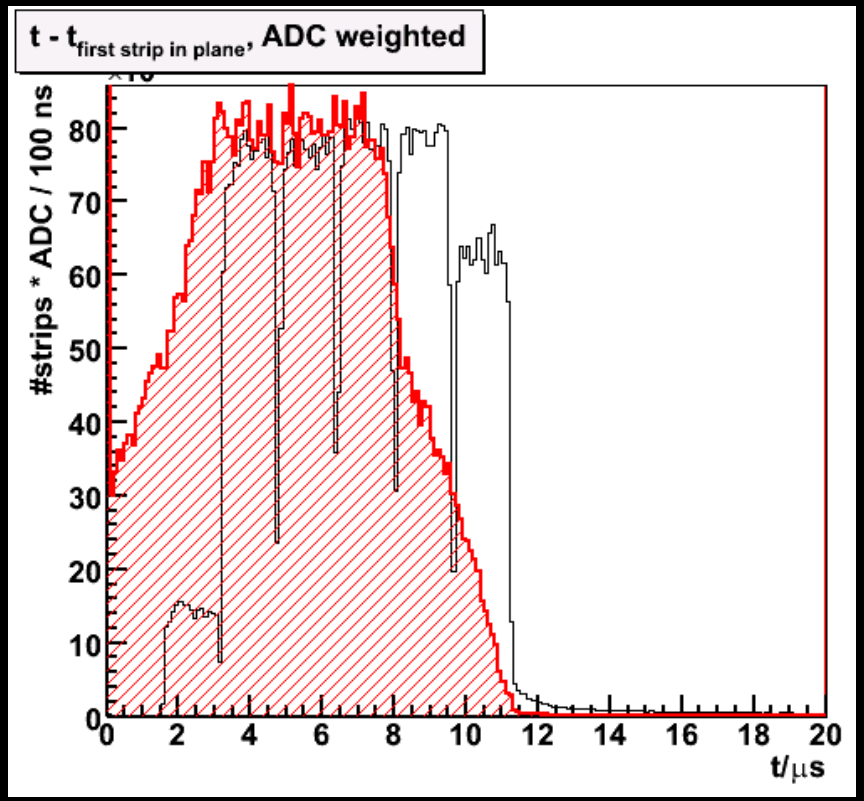
t_2 = 3.8 μs **2.8%**

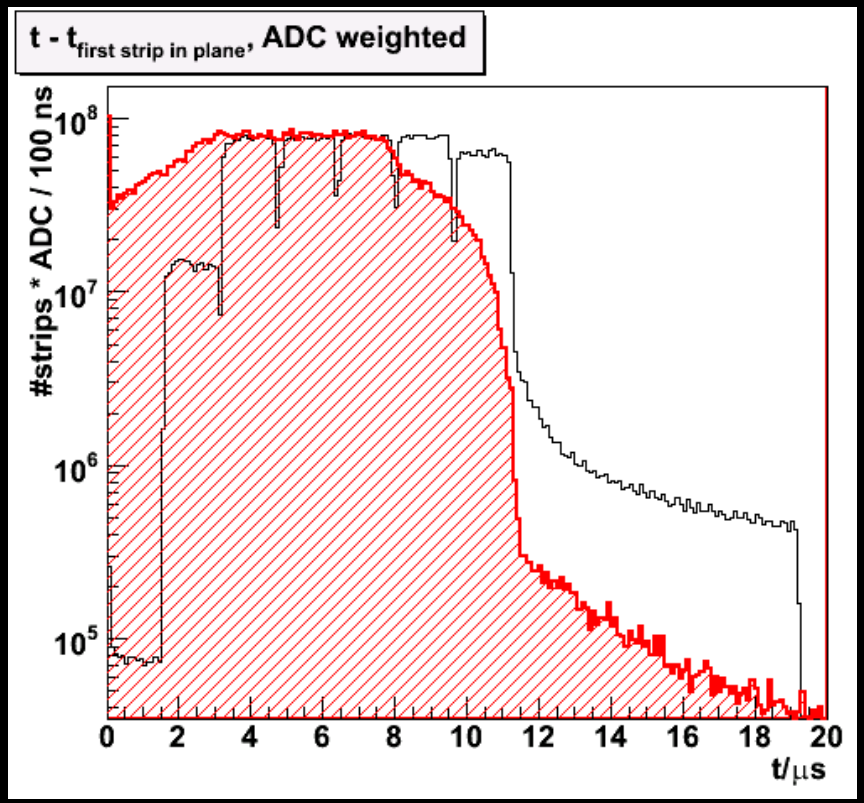
Size of the effect is much bigger than what Rustem sees!

Maybe more than just Afterpulsing?

Time structure of the MC

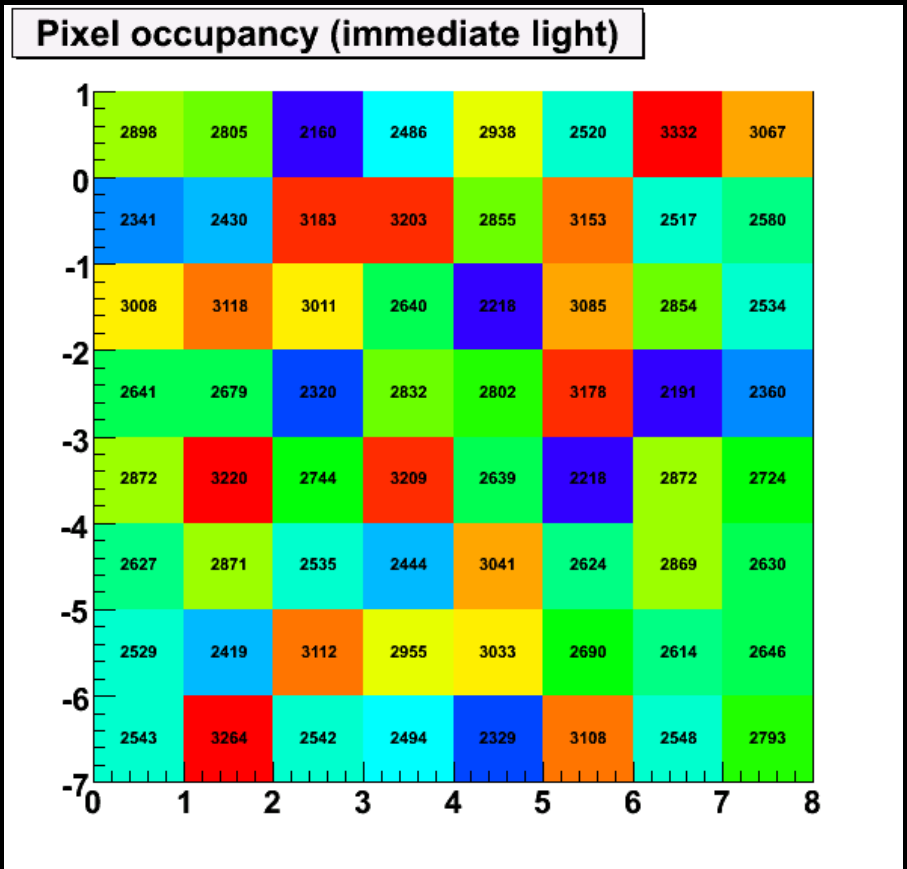
Question: What is the time structure of the MC and how much late activity is in there?





Hunting down the details

Look at effect in PMT pixel space for different time windows:



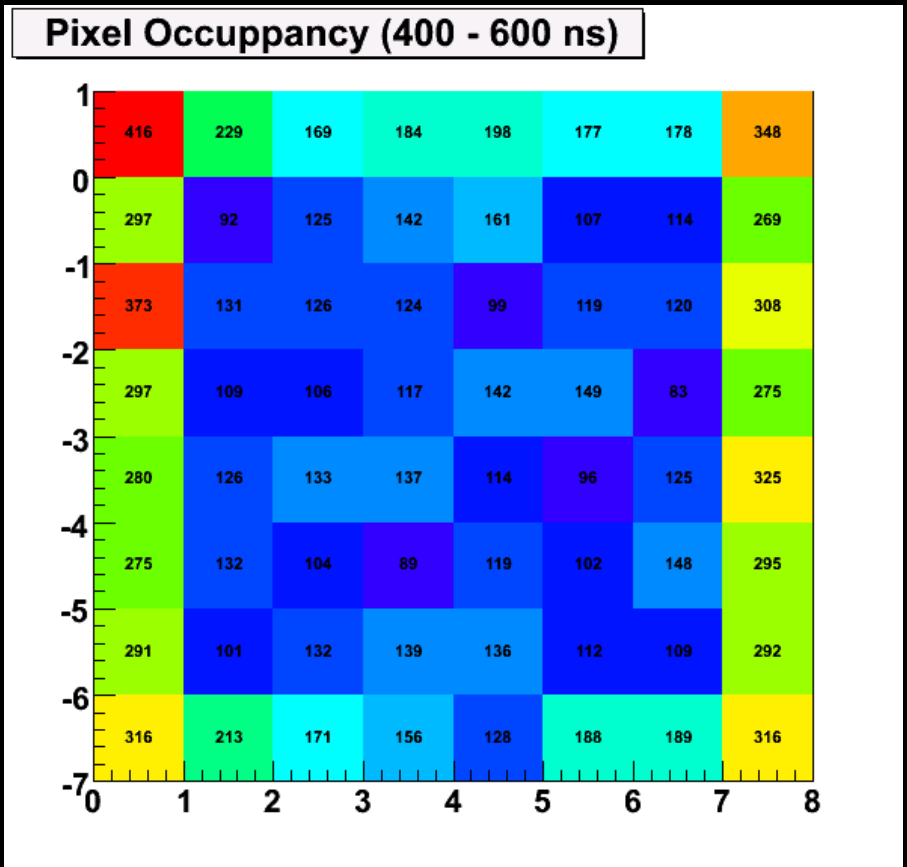
Immediate light ≡

Strips within the first 100 ns of the initial strip on the plane

Roughly uniform across PMT face, range from 2200 to 3300 entries

Hunting down the details (2)

Look at effect in PMT pixel space for different time windows:



Early Afterpulsing ≡

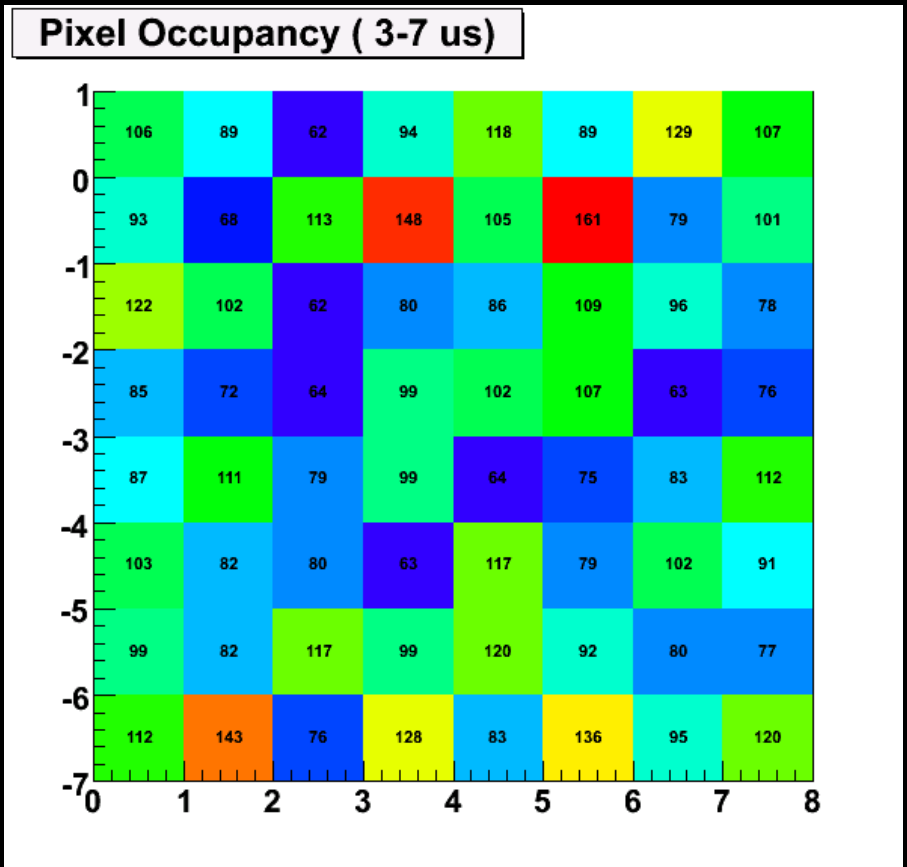
Strips within 400 to 600 ns of the initial strip on the plane

Very pronounced in the edge pixels (left and right)

Also visible in top and bottom edge, but less pronounced

Hunting down the details (3)

Look at effect in PMT pixel space for different time windows:



Late Afterpulsing ≡

Strips within 3 to 7 us of the initial strip on the plane

Uniform again, no excess in edges

Are there two different effects?

Hunting down the details (4)

- Find cases with only one significant hit in the plane, e.g. one strip > 10 pe and all other strips < 2 pe

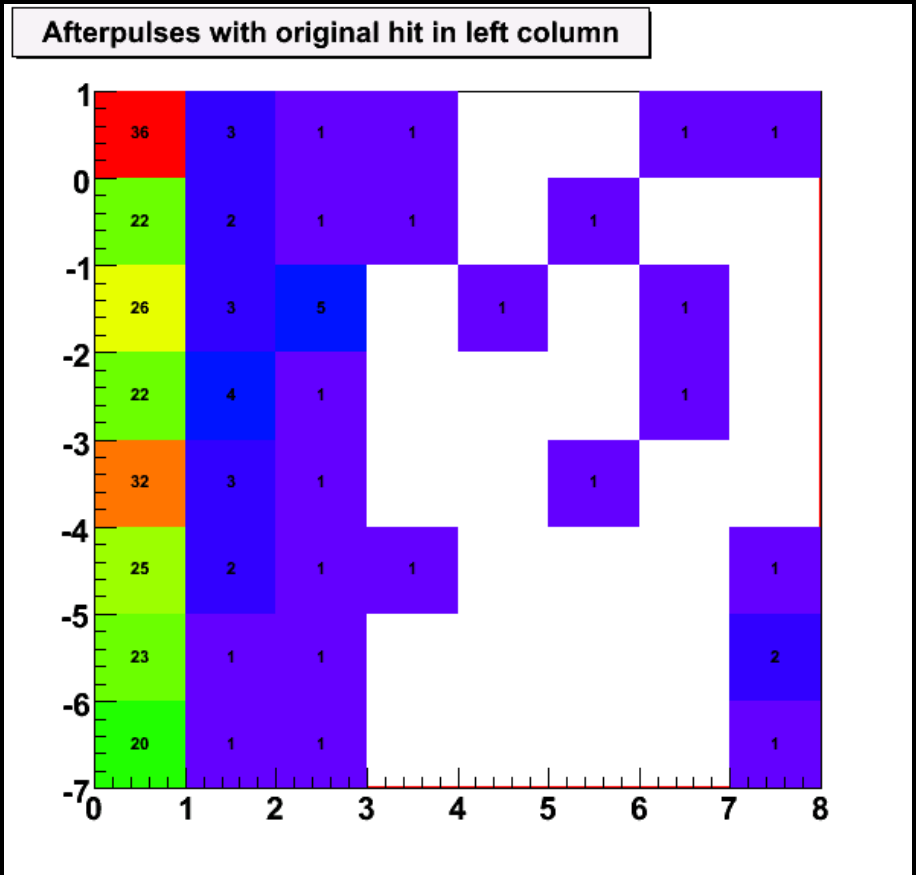
  study afterpulsing on a pixel by pixel basis

Problem:

- Everything you saw up to now was done on 24 hours of data
- This method will clearly get rid of most events
- For this meeting, I only managed to process about twice as much data → the following plots have very few entries

Pixel by pixel

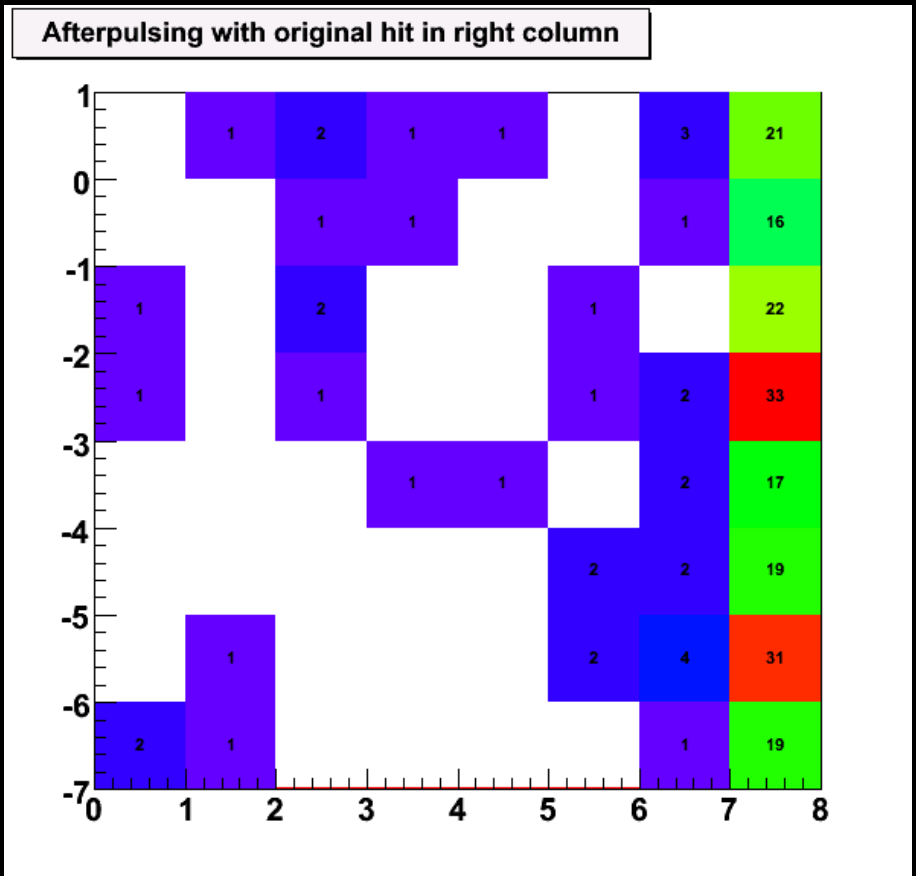
Look all afterpulses which have their parent hit in the side columns:



Most afterpulses occur in the side column. In fact, most occur in the same pixel.

Pixel by pixel (2)

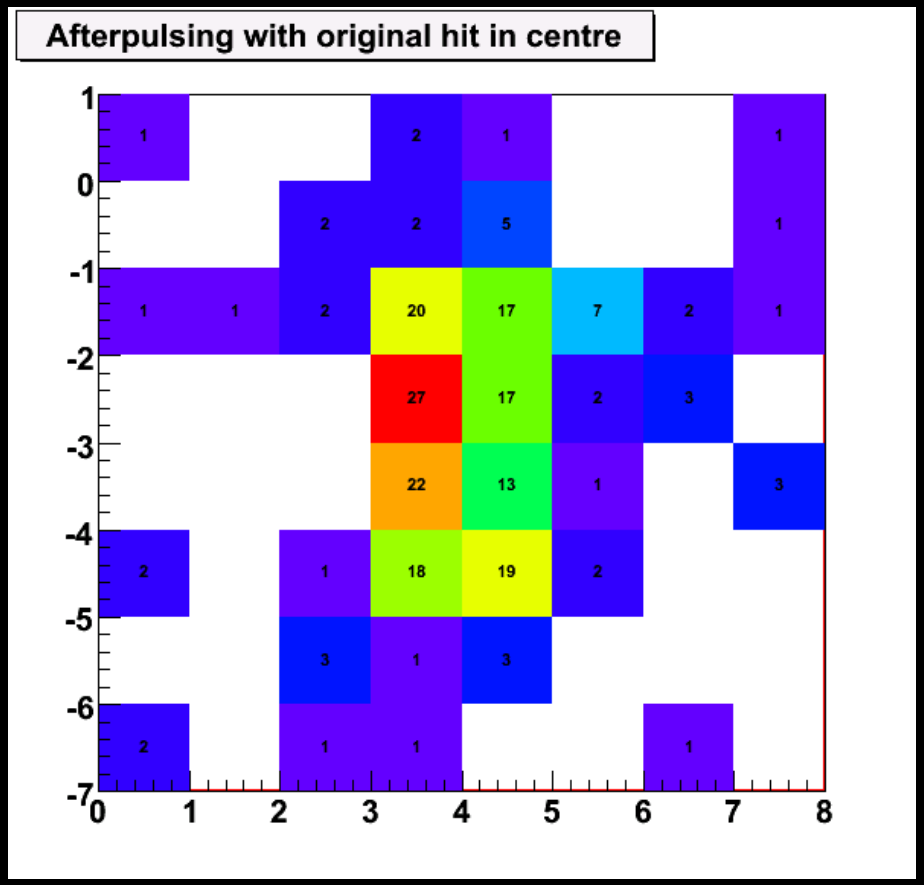
Look all afterpulses which have their parent hit in the side columns:



The same happens in the right column.

Pixel by pixel (3)

Look all afterpulses which have their parent hit in the centre of the PMT:



Looks the same to me. Statistics are of course very poor. And there is no timing cut on these plots.

Summary / To Do

- Some changes, fixes since Fermilab meeting
- Size of effect characterized in more detail
- Early and late component seem to be qualitatively different
- So what about the edge pixels? Do they create more afterpulses in the first place? This needs more investigation.
- Is the size of the effect compatible with LI studies?