



Fake Events From Outer PMT Pixel Activity

- A possible explanation for Niki's low energy showers
- An ND cleaning technique proposed by Niki to cut this PMT effect

Elizabeth A. Barnes

September 8, 2005



Layout

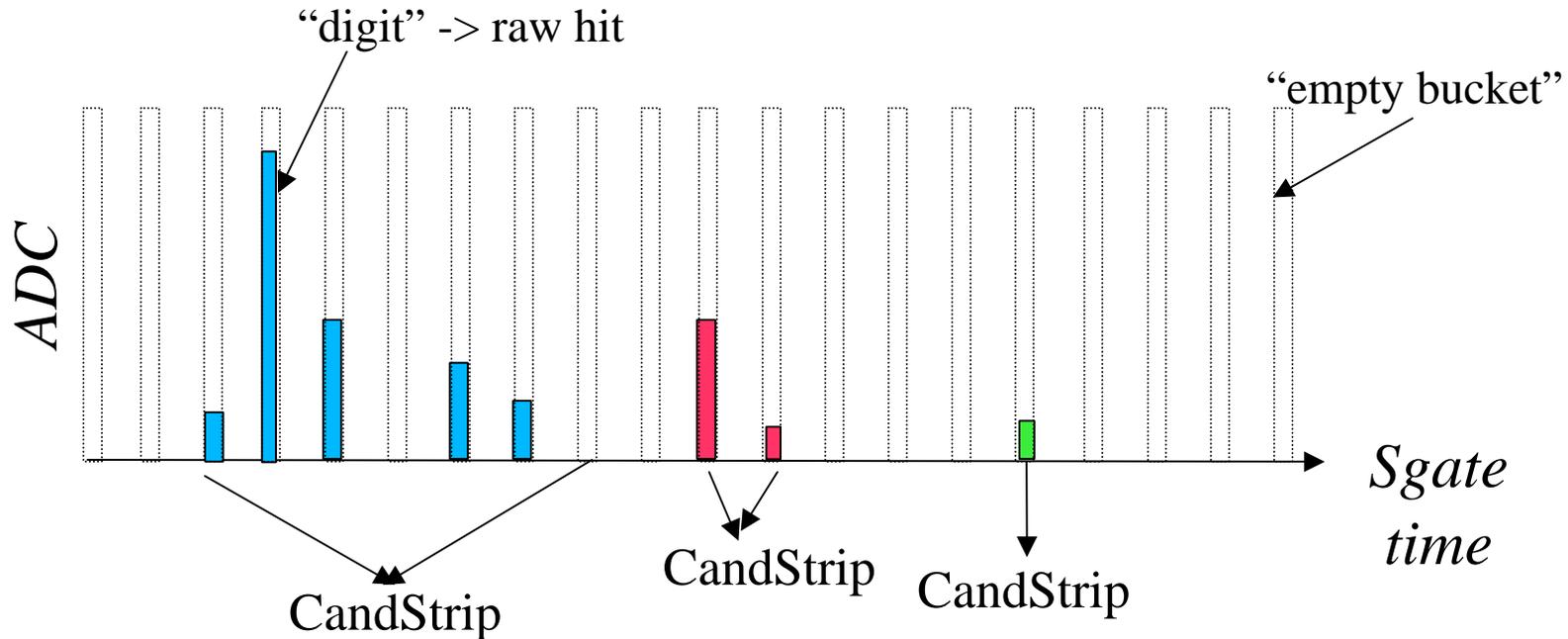
- CandData Overview
- Double Hit Strips
- Recap of Niki's Low PH Showers
- Characteristics of Fake Events
- Niki's cleaning technique of the ND



CandData Overview

- Comparing Near Detector response to beam events
- ND reads out continuously through an Sgate, and the pulses are digitized in time buckets spanning ~ 18.5 ns \rightarrow these are termed “CandDigits”
- CandDigits have information such as:
 - plane, physical strip, ADC, time from start of Sgate (ns)
- CandDigits form CandStrips, and some of these are reconstructed to form CandShowers and CandTracks

Forming CandStrips



CandStripSR looks at all raw hits at one *physical strip* in an Sgate and applies 2 cuts to group the digits into CandStrips:

- 1) each CandStrip can span a *maximum* of 7 buckets [~ 113 ns]
- 2) *maximum* of 2 empty buckets between two digits on same CandStrip



Double Hit Strips

- Double Hit Strip -> physical strip in ND that appears more than once in and Sgate, and is used in a reconstructed **event**

% strips appearing more than 1 time per snarl
in an event:

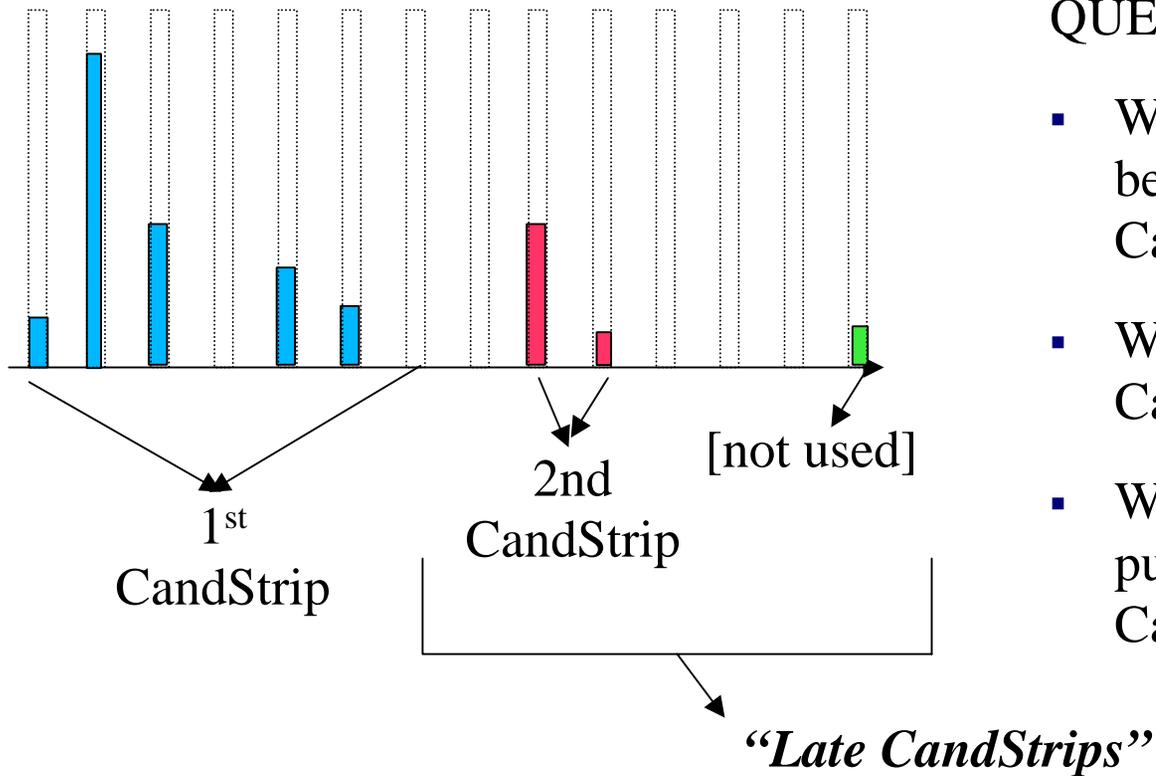
	DATA	MC
LE	2.40%	2.04%
PME	3.10%	2.12%
PHE	5.01%	3.05%

Always higher than MC percentage



Analysis of CandStrips

- What are the characteristics of these 2nd CandStrips found on one physical strip?



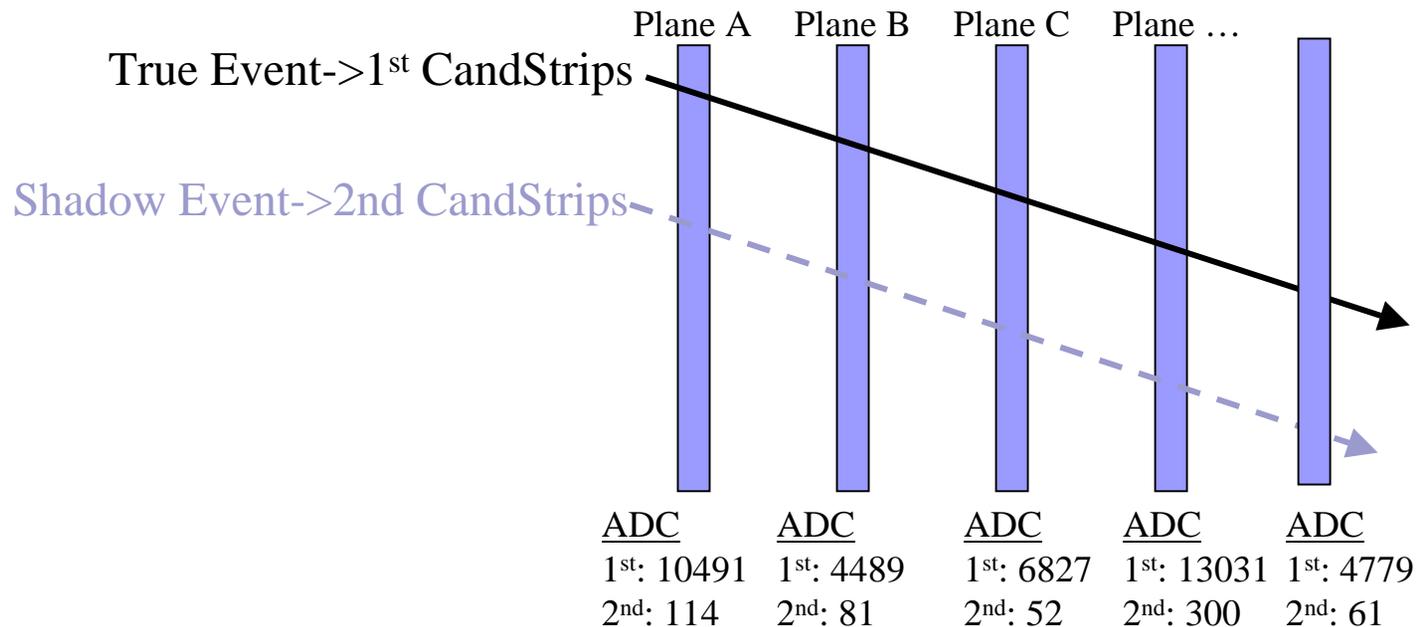
QUESTIONS:

- What is the time difference between 1st and 2nd CandStrips?
- What type of event is each CandStrip in?
- What is the difference in the pulse heights of the CandStrips?



Example: Analysis of Late CandStrip

- Looking at 1st and 2nd CandStrips that occur within 50 ns of each other:
 - Shadow Showers formed from 2nd CandStrips of very energetic shower



MOST Late CandStrips go to form a single new event that is a “shadow” of the first!!



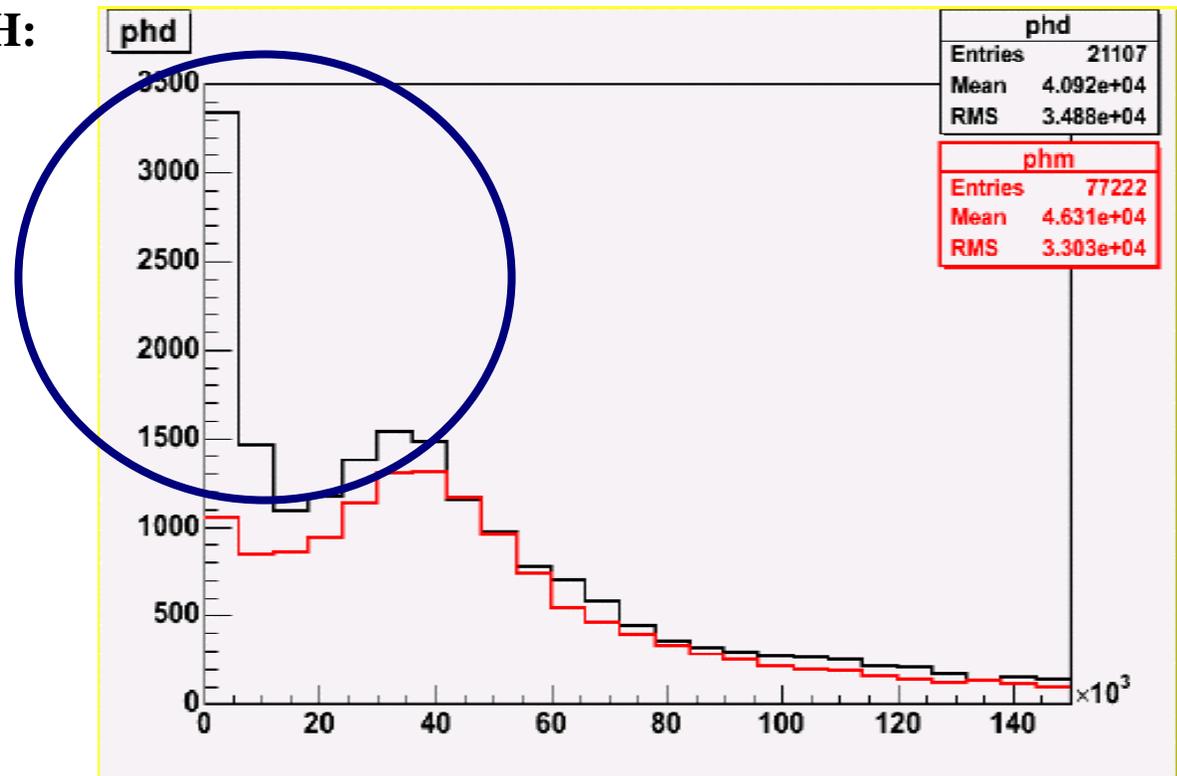
Niki's LowPH Noise

After discussing this with Niki, we hypothesized that this was the same as the low energy showers she had discovered in May that she later showed were actually effects of the outer pixels of the PMTs.

Quick Recap of what Niki saw:

N. Saoulidou
"Progress Report on LowPH Noise in LE Beam"
ND/CC Phone Mtg 05-03-05

Total Event PH:
Data Black
MC red





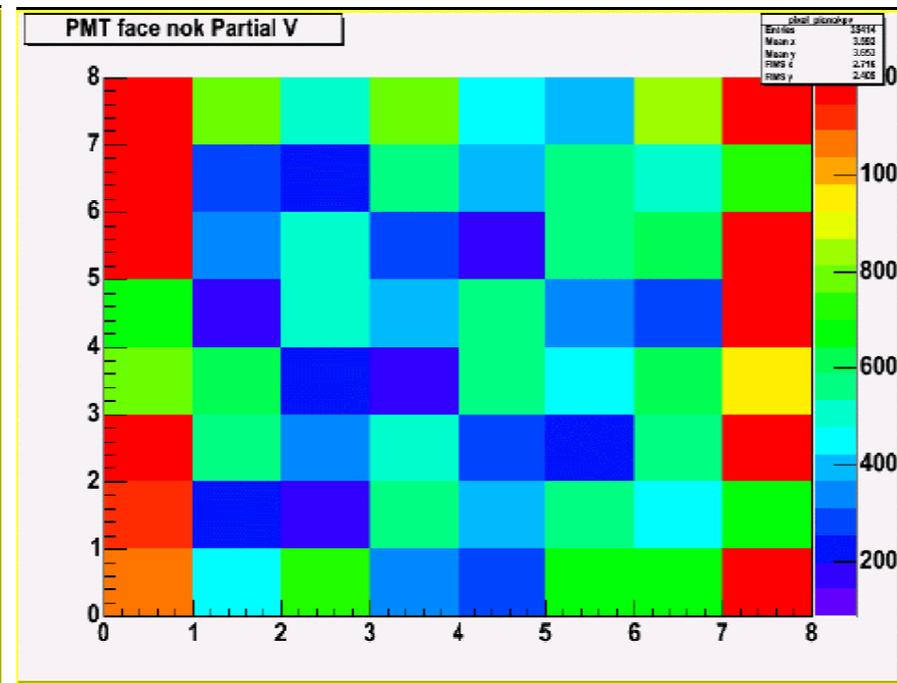
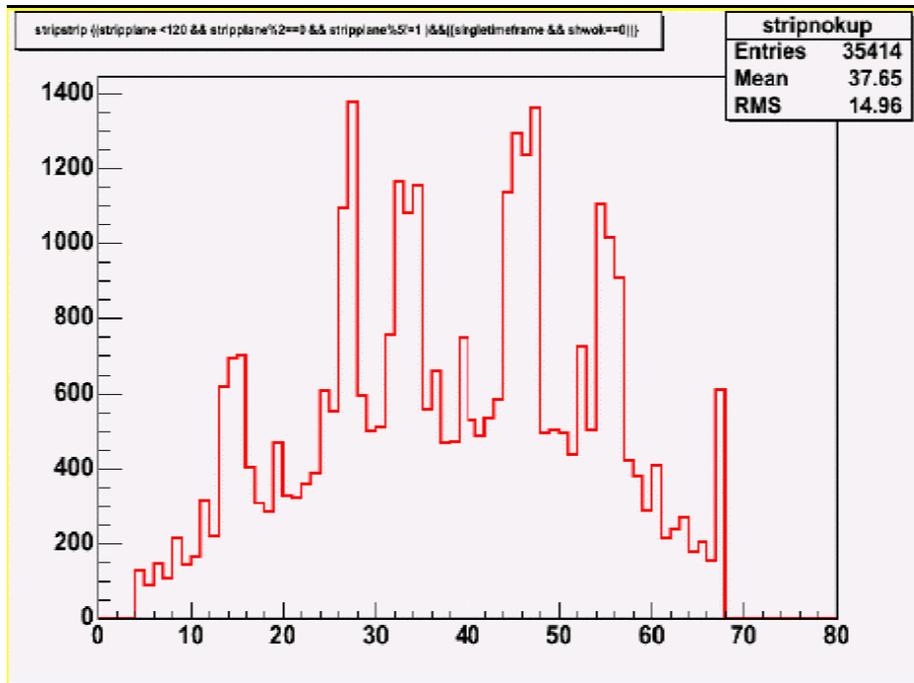
Niki's LowPH Noise cont I...

N. Saoulidou

“Progress Report on LowPH Noise in LE Beam”

ND/CC Phone Mtg 05-03-05

Strip occupancy distribution (data) (V PARTIAL PLANES) of LOW PH events.



The strips that are “hot” map one by one (for both views) in the outer PMT pixels and for nearly ALL planes. The strips are made up of single digits with a PH distribution that is similar with strips that compose “non pathological” events...



Analysis of 2nd CandStrip cont...

Niki's LowPH events share many of the same characteristics as my "shadow showers" made from Late CandStrips.

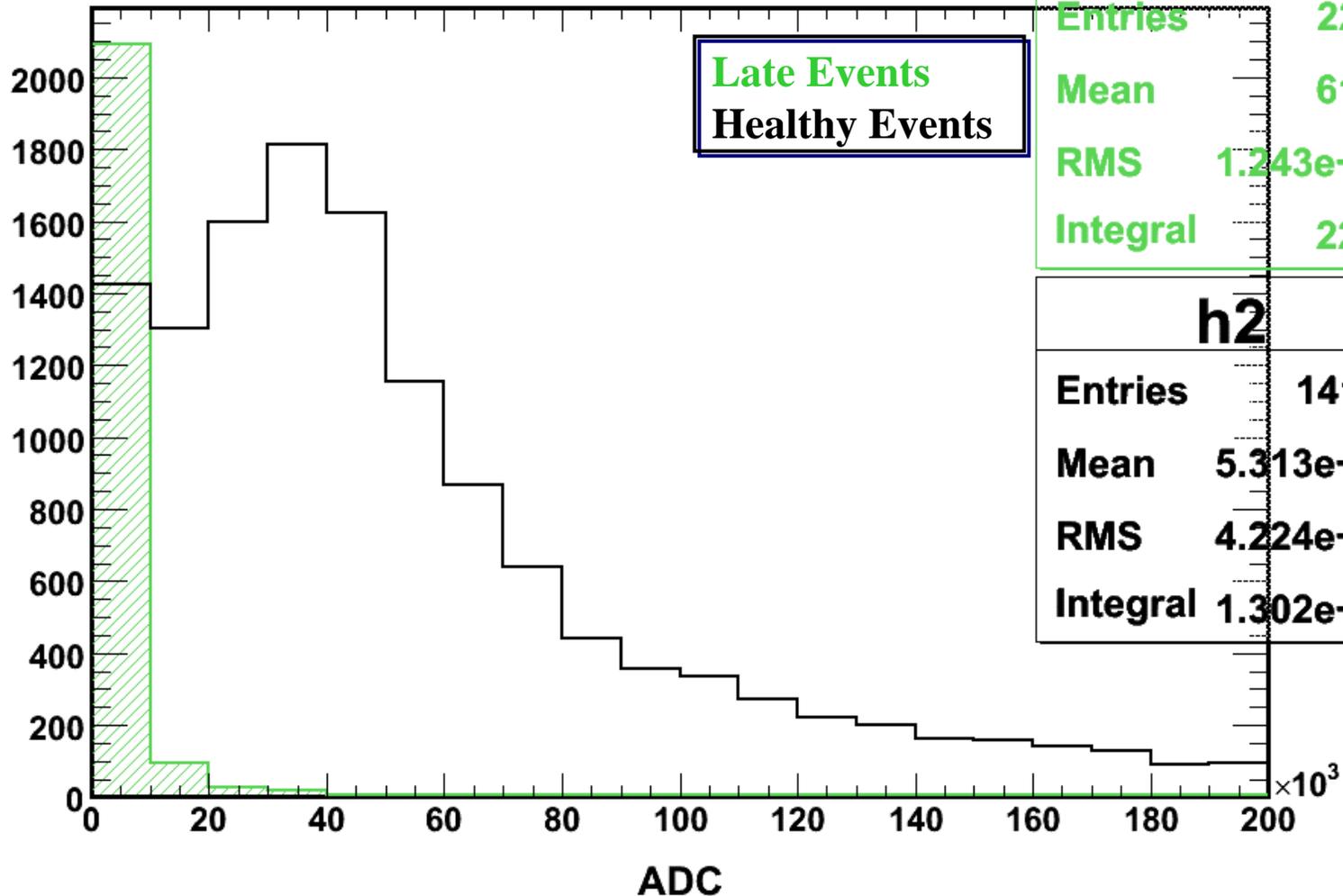
We then termed the 1st CandStrip on a physical strip as the "healthy" CandStrip and all following CandStrips as "**late**".

- **Low PH Events** are those events made of greater than **20% Late CandStrips**
- **Healthy Events** are those events made of less than **20% Late CandStrips**
- **Green -> Low PH Events (Late Events) and/or Late CandStrips**
- All plots have fiducial cuts (1m radius around beam center and $1 < z < 5$)
- Plots are **normalized to number of events** unless otherwise noted
- All data & MC used Reconstruction Software Version R1.16



ADC of Events

Data: Event ADC for Late & Healthy Events



h1	
Entries	2279
Mean	6124
RMS	1.243e+04
Integral	2269

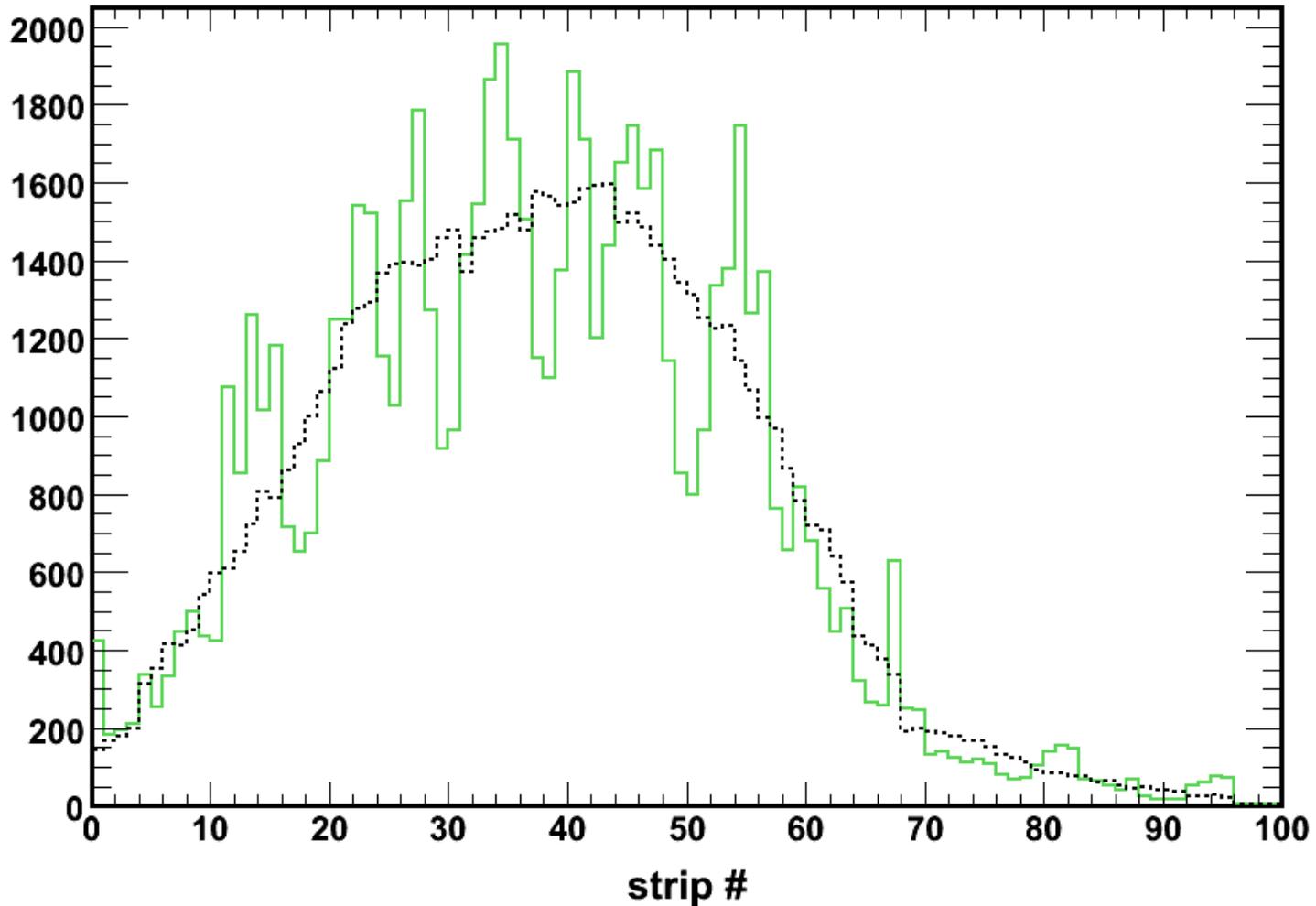
h2	
Entries	14116
Mean	5.313e+04
RMS	4.224e+04
Integral	1.302e+04



Data: Strip # of Late CandStrips

Strip Distribution

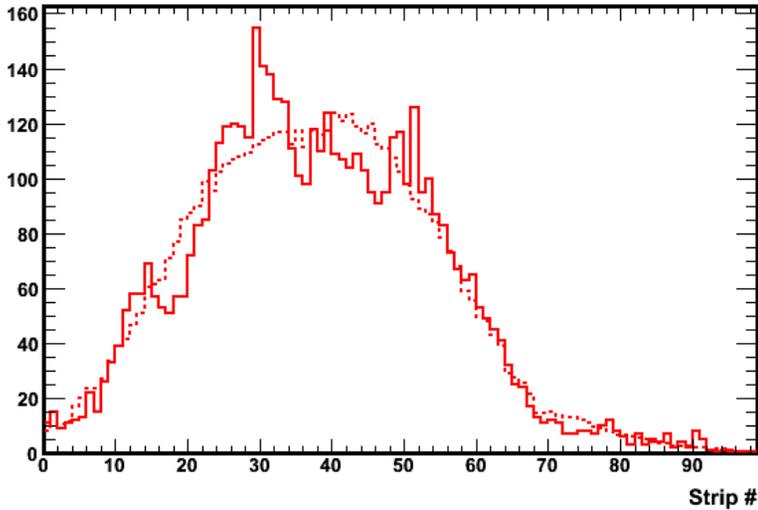
Events > 20% Late CandStrips
Events < 20% Late CandStrips





MC: Strip # of Late CandStrips

MC: StripDistribution

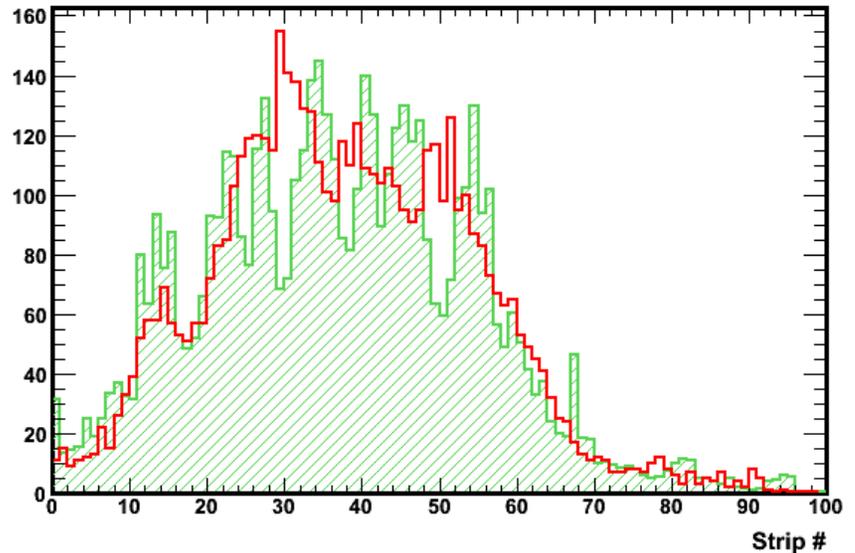


Events > 20% Late CandStrips
Events < 20% Late CandStrips

Data: Events > 20% Late CandStrips
MC: Events > 20% Late CandStrips

Normalized to number of CandStrips

Strip Distribution (MC & Data)

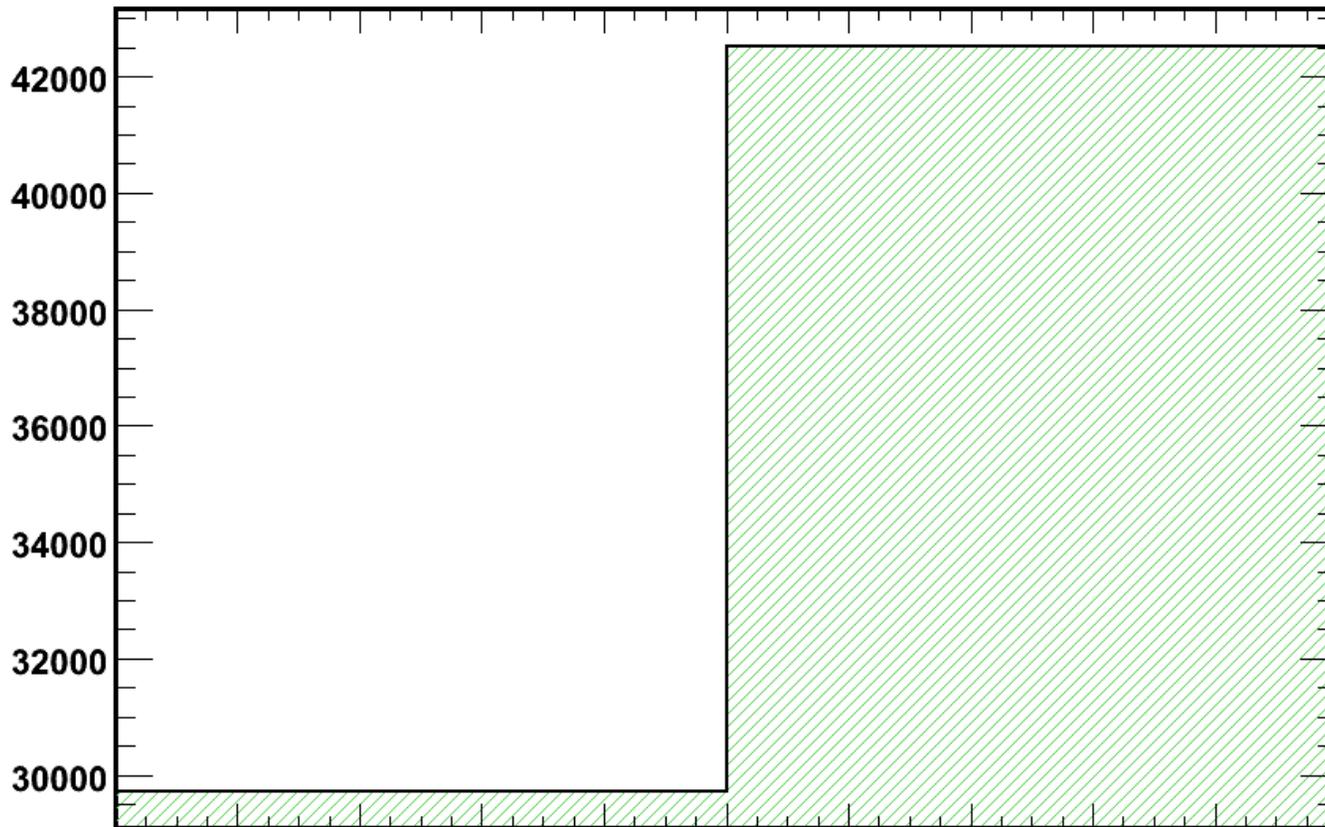




Data: Pixel Location on PMT, of Late Strips

Strip to Pixel Location for Events With >20%
Late Strips

Events > 20% Late CandStrips
Events < 20% Late CandStrips



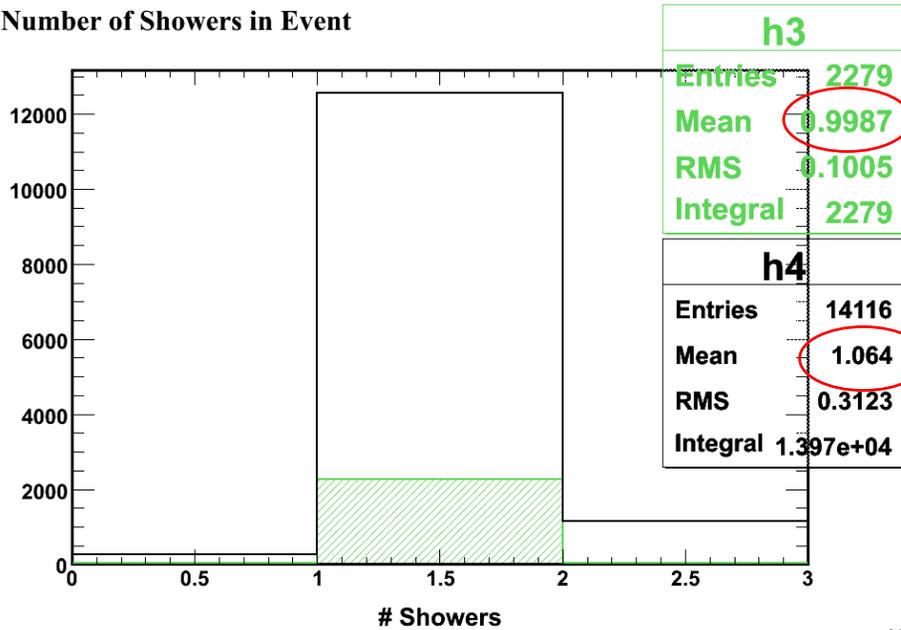
Inner Pixels

Outer Pixels



of Showers & Tracks in Late Events

Number of Showers in Event

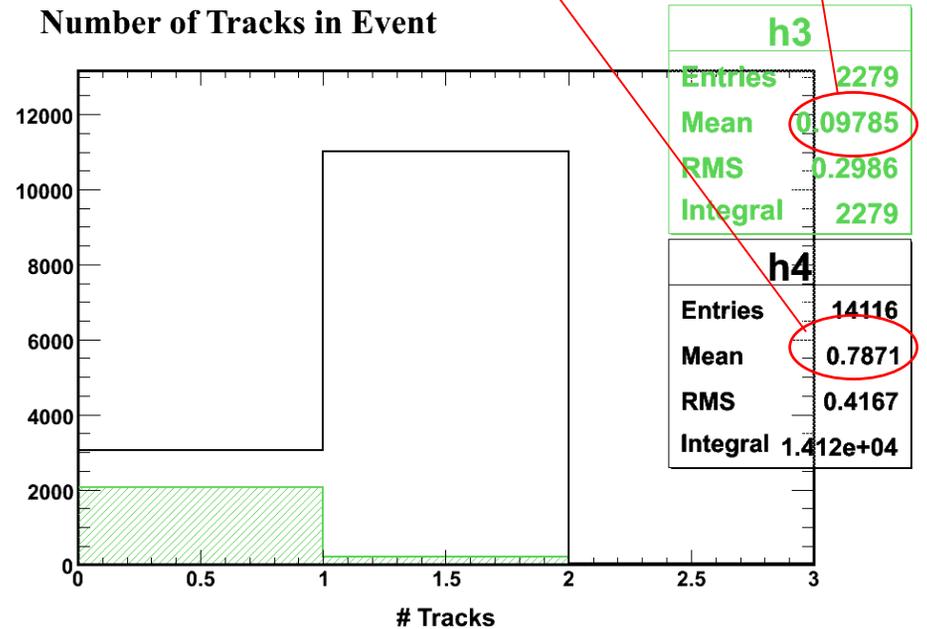


Events > 20% Late CandStrips
 Events < 20% Late CandStrips

~1.00

Showers make up the majority of Late Events

Number of Tracks in Event



0.7871

0.09785



Summary

It appears that the outer pixels of the PMTs show an after pulsing activity after an energetic track/shower has gone through. These pulses form low PH strips that subsequently form low PH events that are not due to neutrino interactions.

A simple cut of removing strips appearing more than once in an SGATE, might improve event reconstruction and remove the large excess of low PH events.