

# Cherenkov Reconstruction Tests

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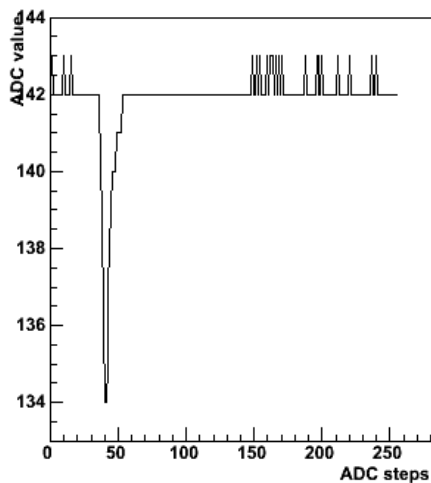
# Overview of Changes

- Current Ckov classes in G4MICE 2.4.0:
  - CkovRec.cc associates fADC channels with Ckov detectors.
  - Generic fADC class is used to integrate the fADC pulses (this does not work for negative pulses (?)).
  - CkovDigit class provides only one field for a photo electron count per PMT (4 per detector).
- Our modifications:
  - New CkovRec.cc which associates fADCs, runs multi-peak finding, generates coincidences, integrates peaks and reports maximum coincidence in event.
  - Fills CkovDigit vector in MICEEvent with #PE per tube (for now)
  - Future: Change to CkovDigit to hold more information?

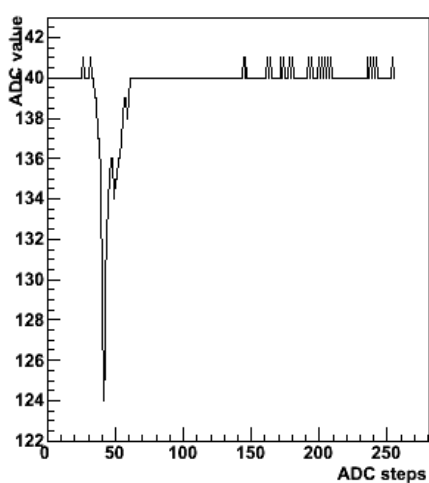
# fAdc Pulse Integration

- Ckobs use the only 1731 fAdcs (2ns steps, 8 bit).
- fAdcs produce negative pulses which need different integration method.

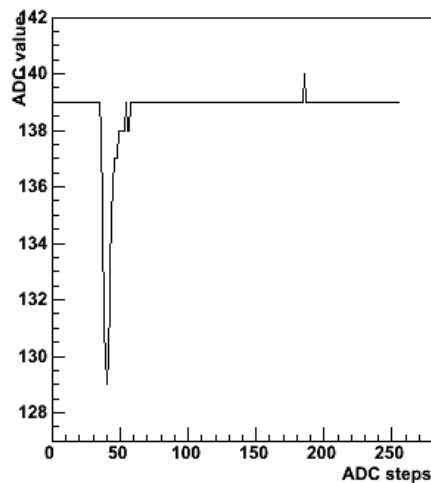
fADC spectrum of event 3700 and channel 0



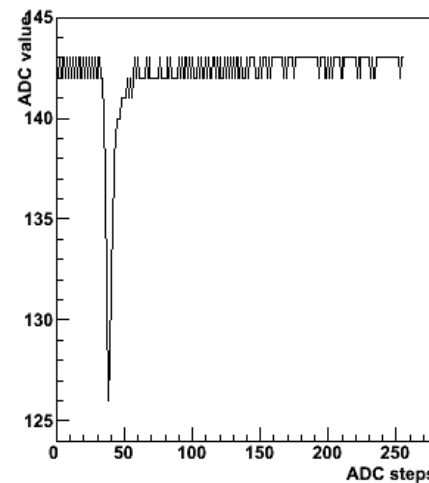
fADC spectrum of event 3700 and channel 1



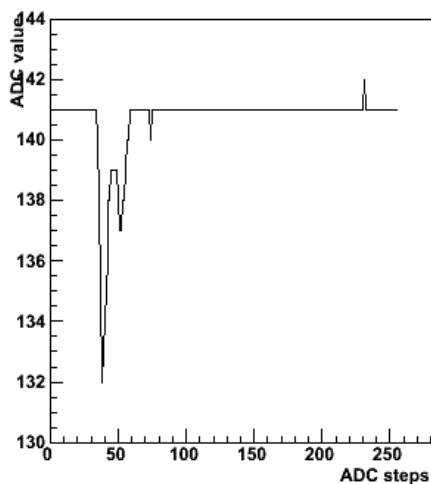
fADC spectrum of event 3700 and channel 2



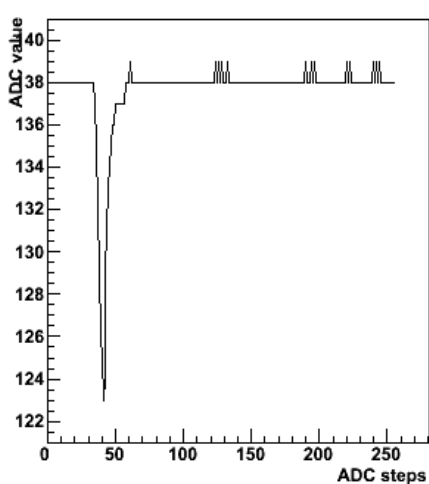
fADC spectrum of event 3700 and channel 3



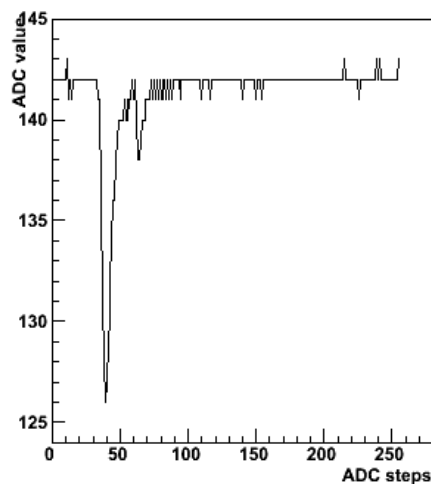
fADC spectrum of event 3700 and channel 4



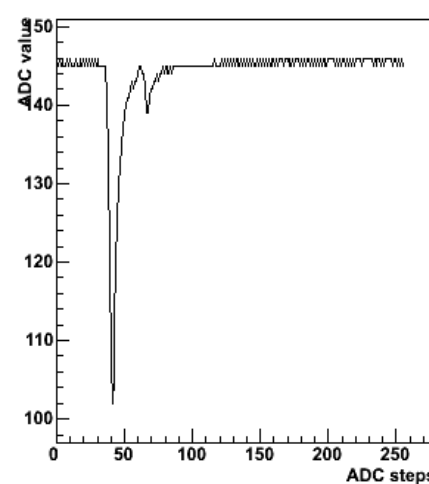
fADC spectrum of event 3700 and channel 5



fADC spectrum of event 3700 and channel 6



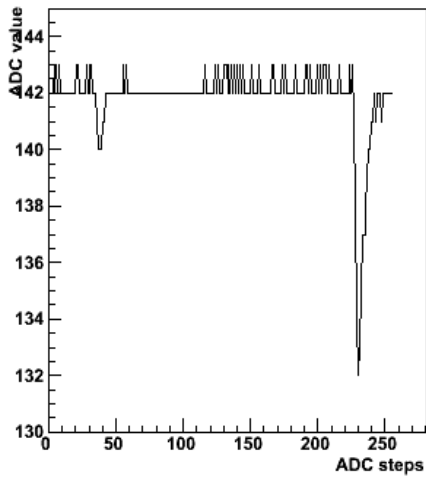
fADC spectrum of event 3700 and channel 7



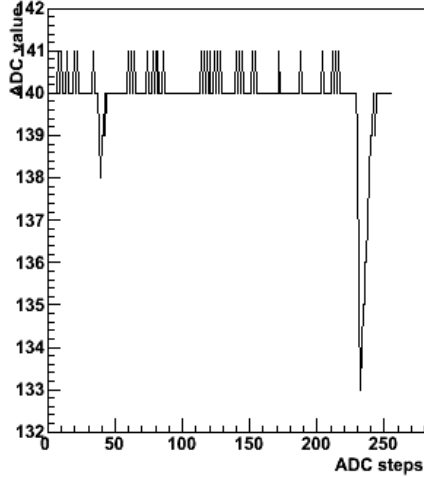
# fADC Pulse Integration - Example

- Event can sometimes have multiple pulses.
- We report pulses of greatest coincidence.

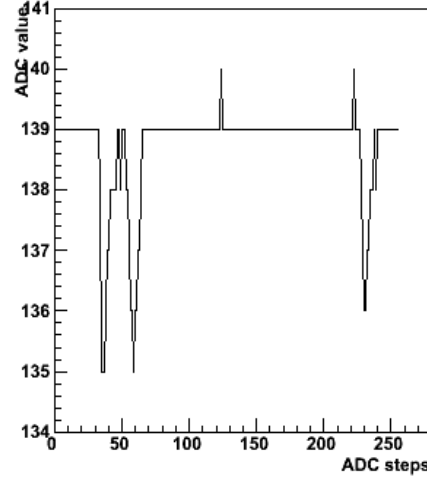
fADC spectrum of event 5900 and channel 0



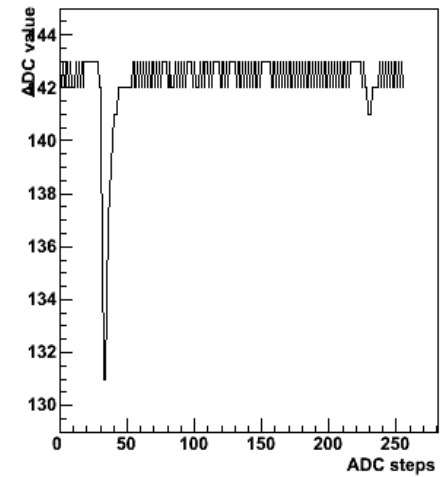
fADC spectrum of event 5900 and channel 1



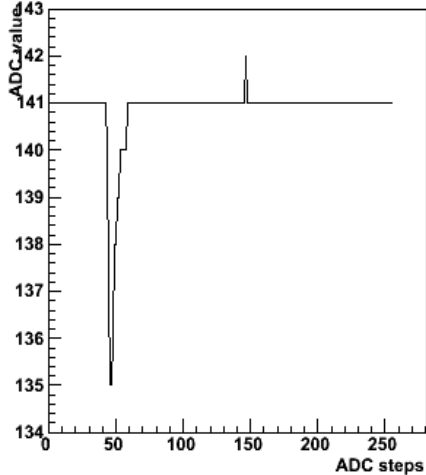
fADC spectrum of event 5900 and channel 2



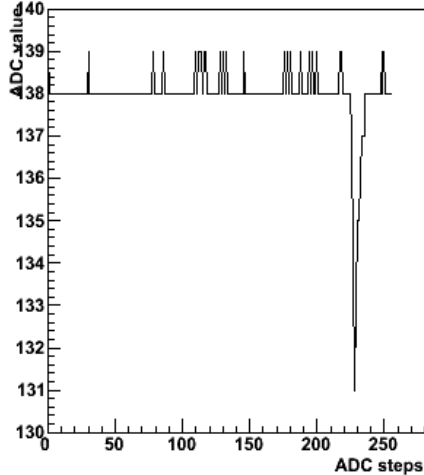
fADC spectrum of event 5900 and channel 3



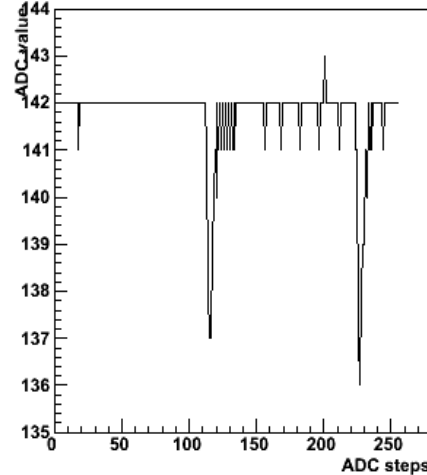
fADC spectrum of event 5900 and channel 4



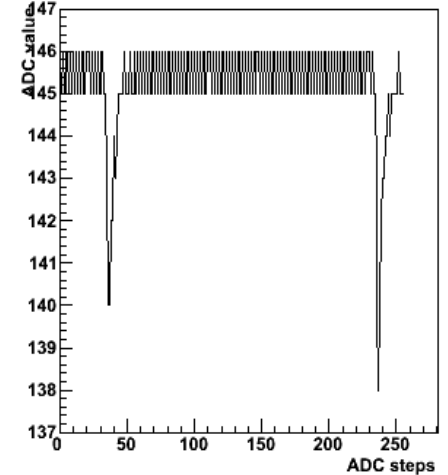
fADC spectrum of event 5900 and channel 5



fADC spectrum of event 5900 and channel 6



fADC spectrum of event 5900 and channel 7



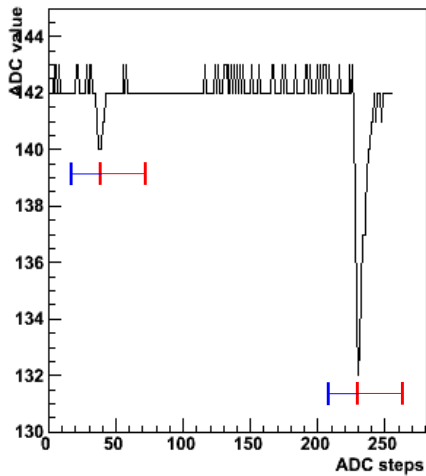
# fAdc Pulse Integration

- Signal finding and integration procedure:
  - Scan signal for user defined peaks above threshold (2 counts).
  - Save position of global maximum in timing array.
  - Integrate global peak 20 counts before and 40 counts after position.
  - Remove this area from the signal and repeat the procedure until no more peaks are found.
- Report signal based on maximum coincidence:
  - Scan timing arrays for each Ckov counter for all possible peak combinations.
  - Find coincidences in timing within a certain tolerance (20 counts).
  - Report event of maximum coincidence by setting the #PE values in the CkovDigit vector to the values at this position.
  - Break ties with maximum light output.

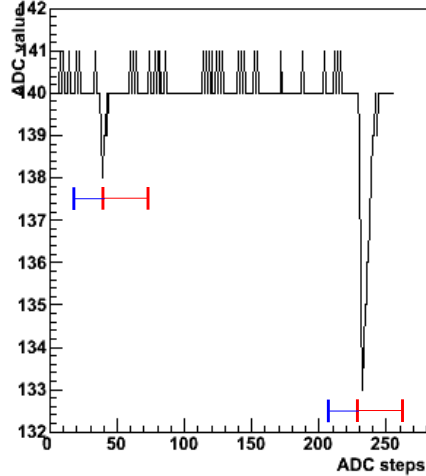
# fADC Pulse Integration

- Event with multiple candidates.
- Report event with highest coincidence.

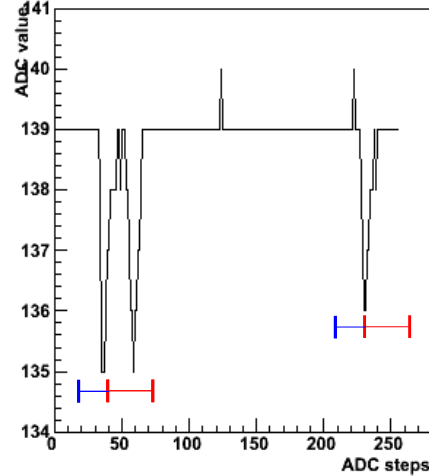
fADC spectrum of event 5900 and channel 0



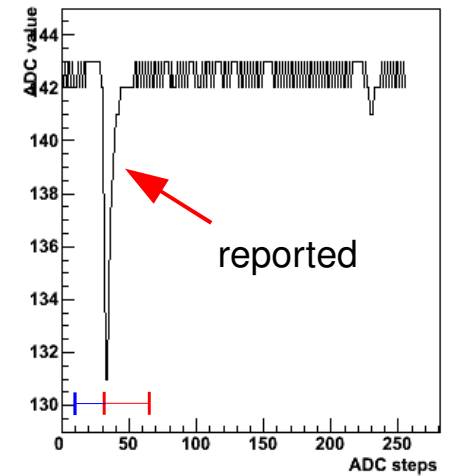
fADC spectrum of event 5900 and channel 1



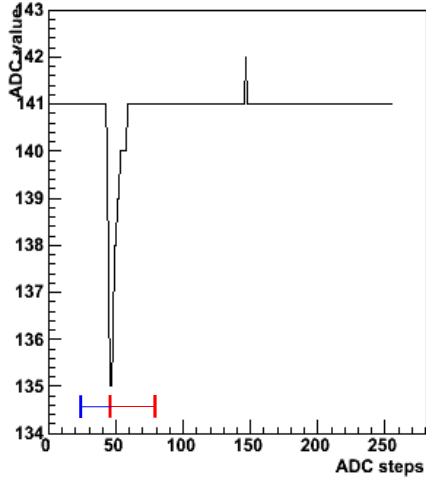
fADC spectrum of event 5900 and channel 2



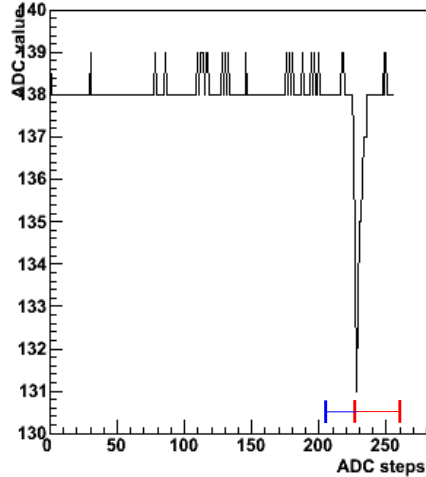
fADC spectrum of event 5900 and channel 3



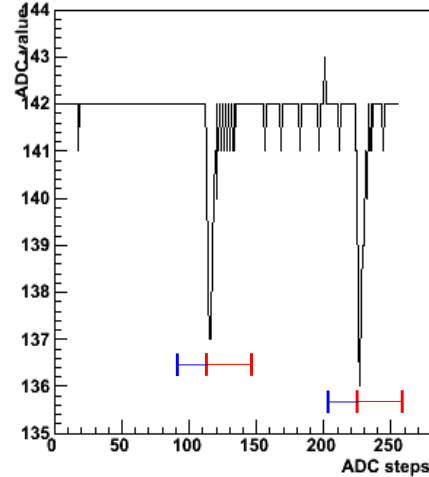
fADC spectrum of event 5900 and channel 4



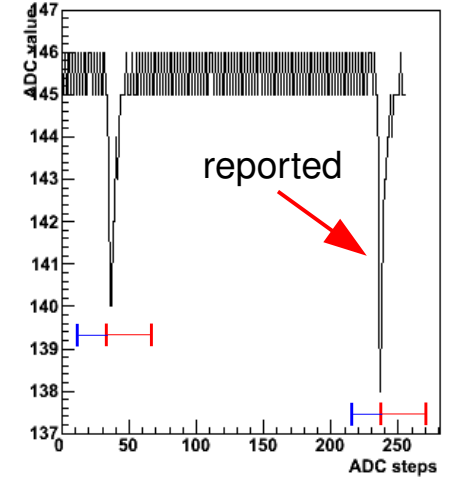
fADC spectrum of event 5900 and channel 5



fADC spectrum of event 5900 and channel 6

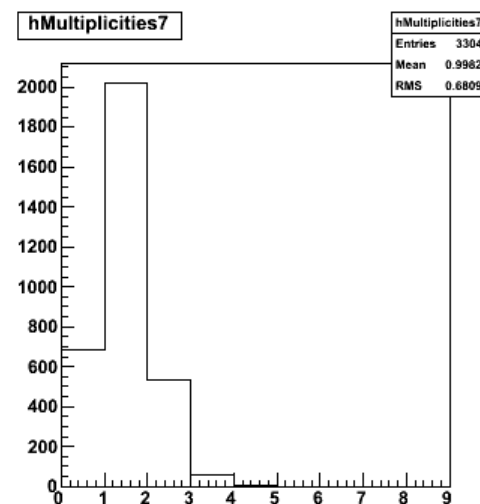
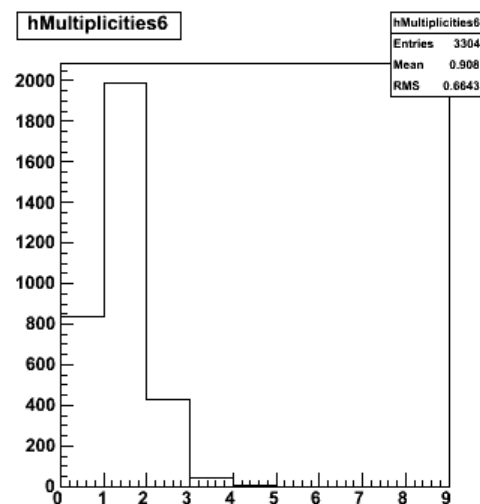
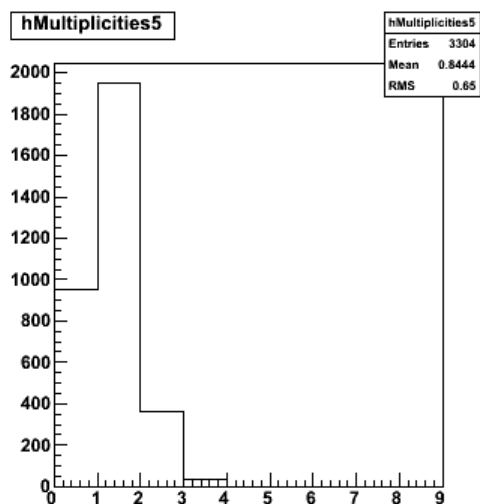
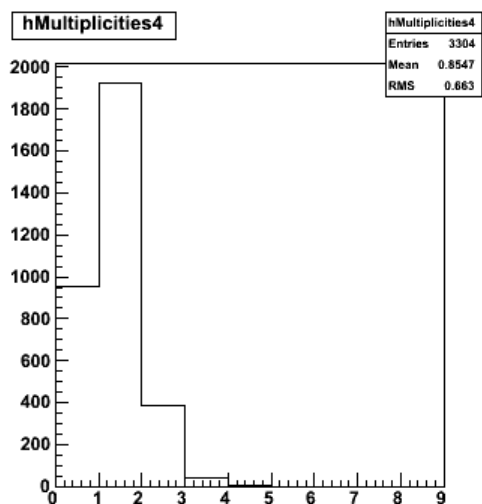
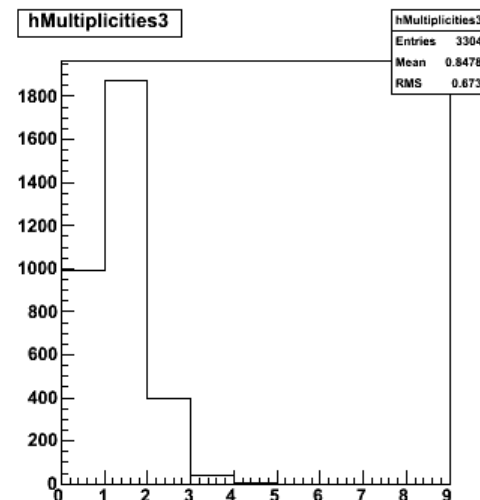
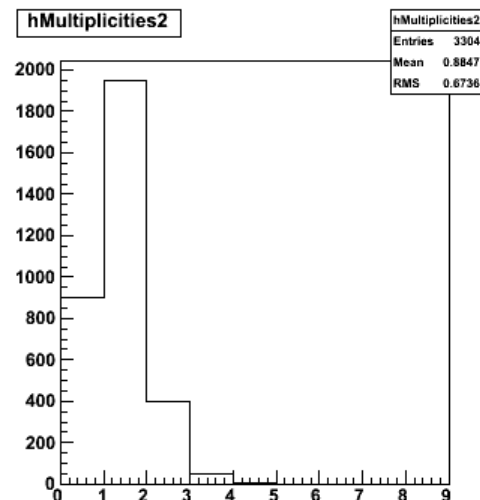
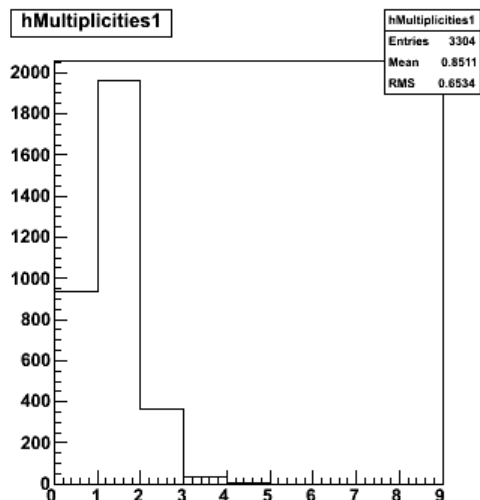
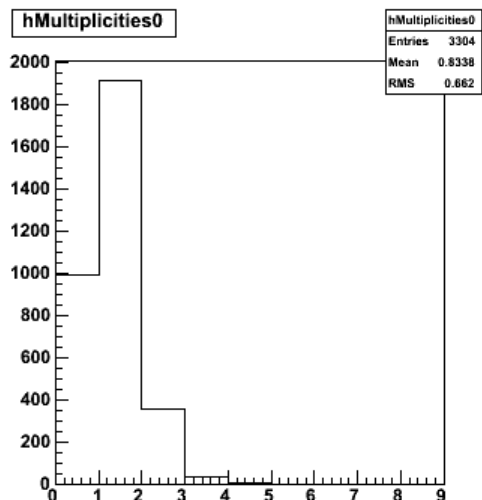


fADC spectrum of event 5900 and channel 7



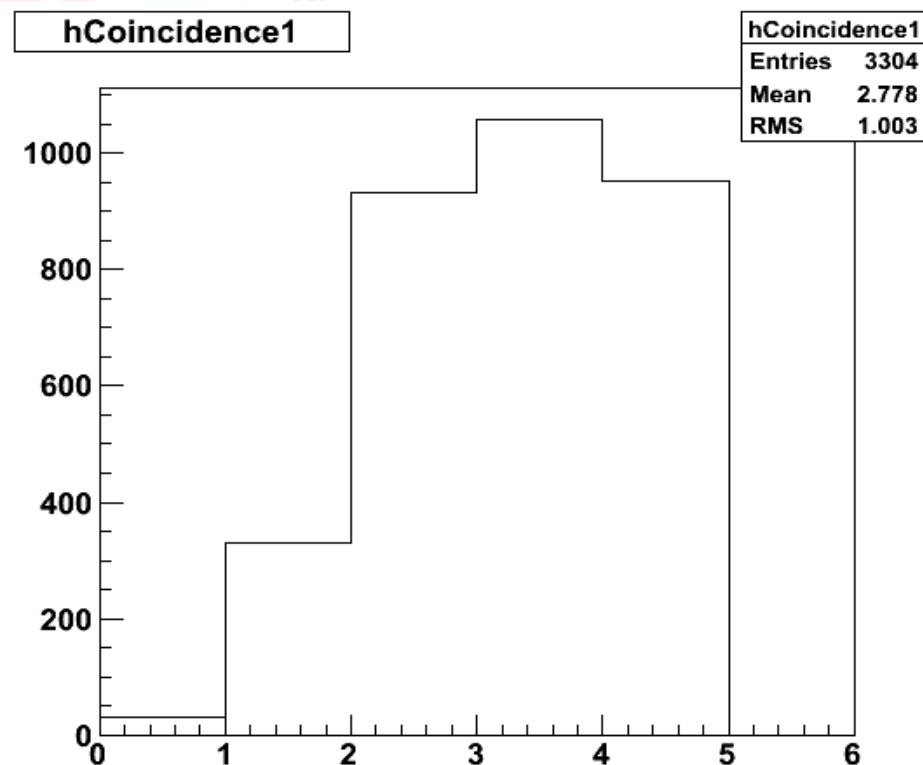
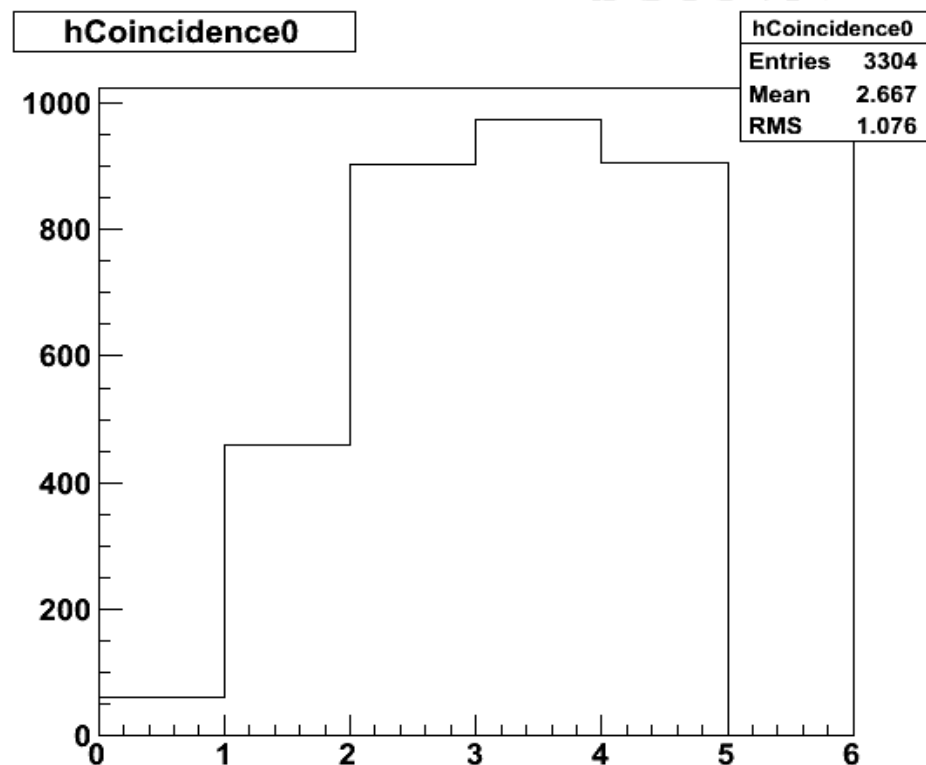
# fAdc Signal Multiplicities Per Channel

- All channel show similar multiplicities.
- Single events are most common in the detector.



# fAdc Signal Multiplicities Per Channel

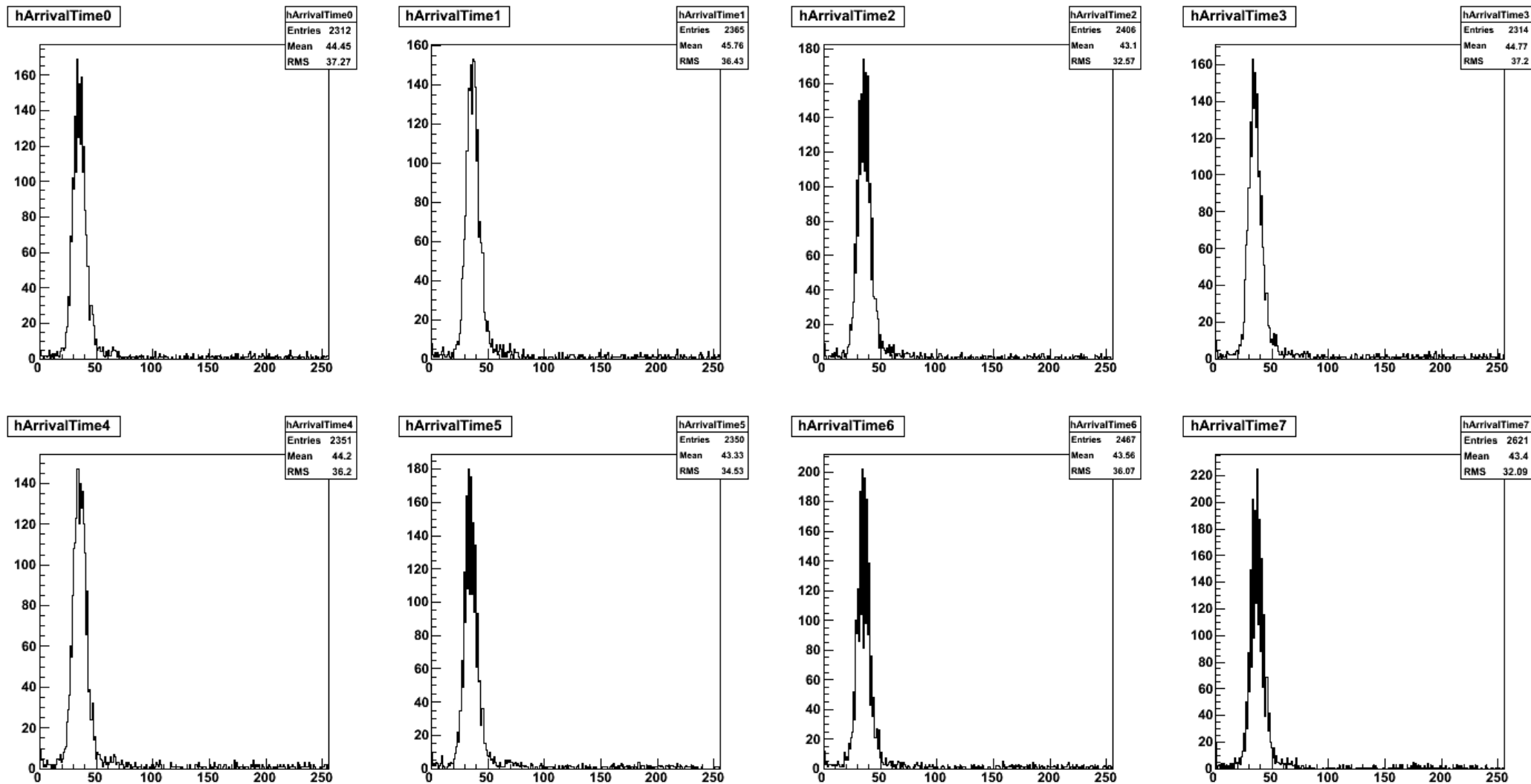
- The coincidence frequencies between detectors is comparable.
- Double, triple and quadruple coincidences seem to occur equally likely.
- There is almost always a signal present (non zero coincidence). This could be the effect of the light produced by the glass (?) since many events are below threshold for the Aerogel.





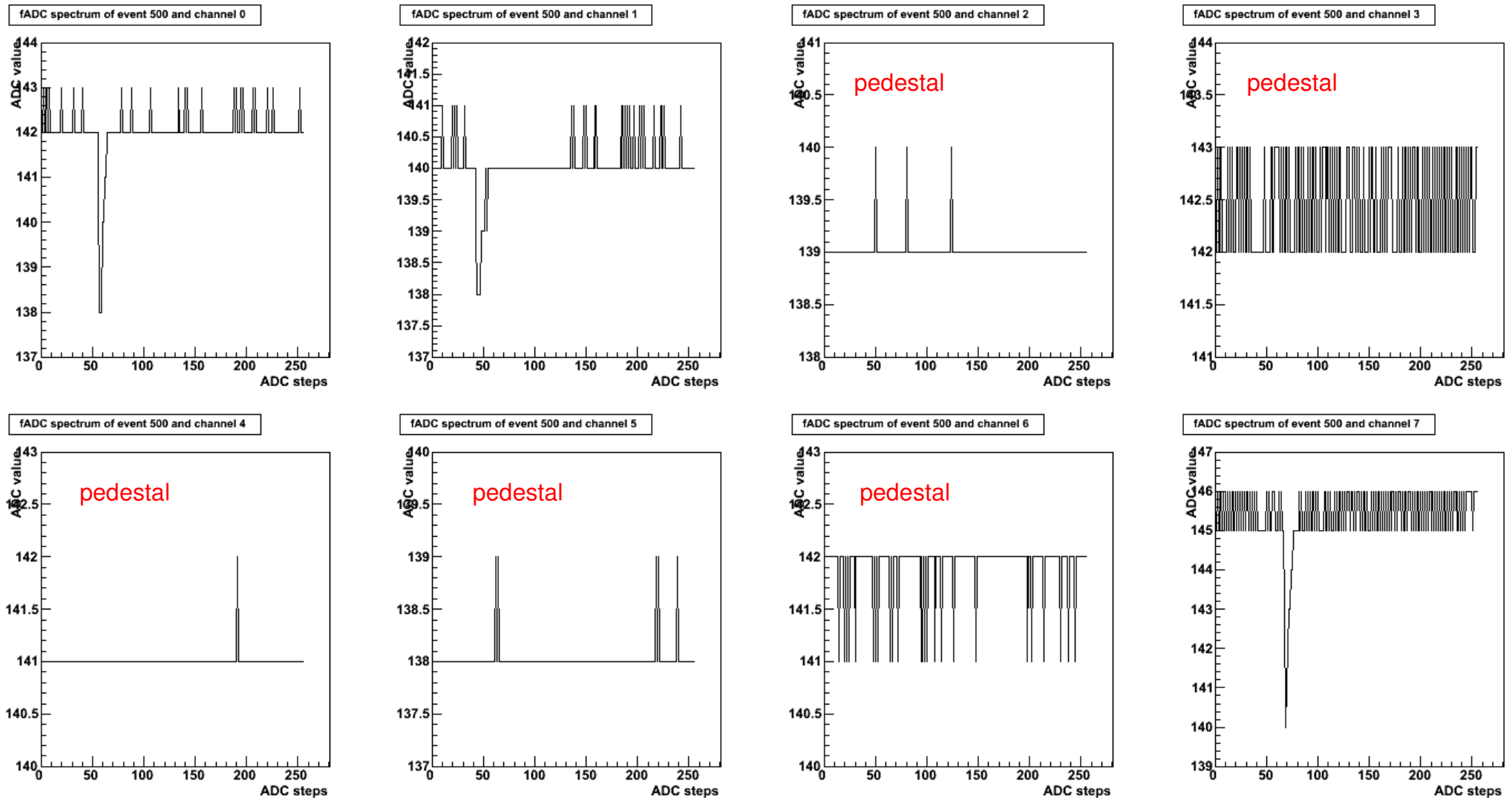
# fAdc Arrival Time Distributions

- Each channel shows a dominant arrival time of about 90 ns for each trigger.
- Out of time arrivals are quite rare.



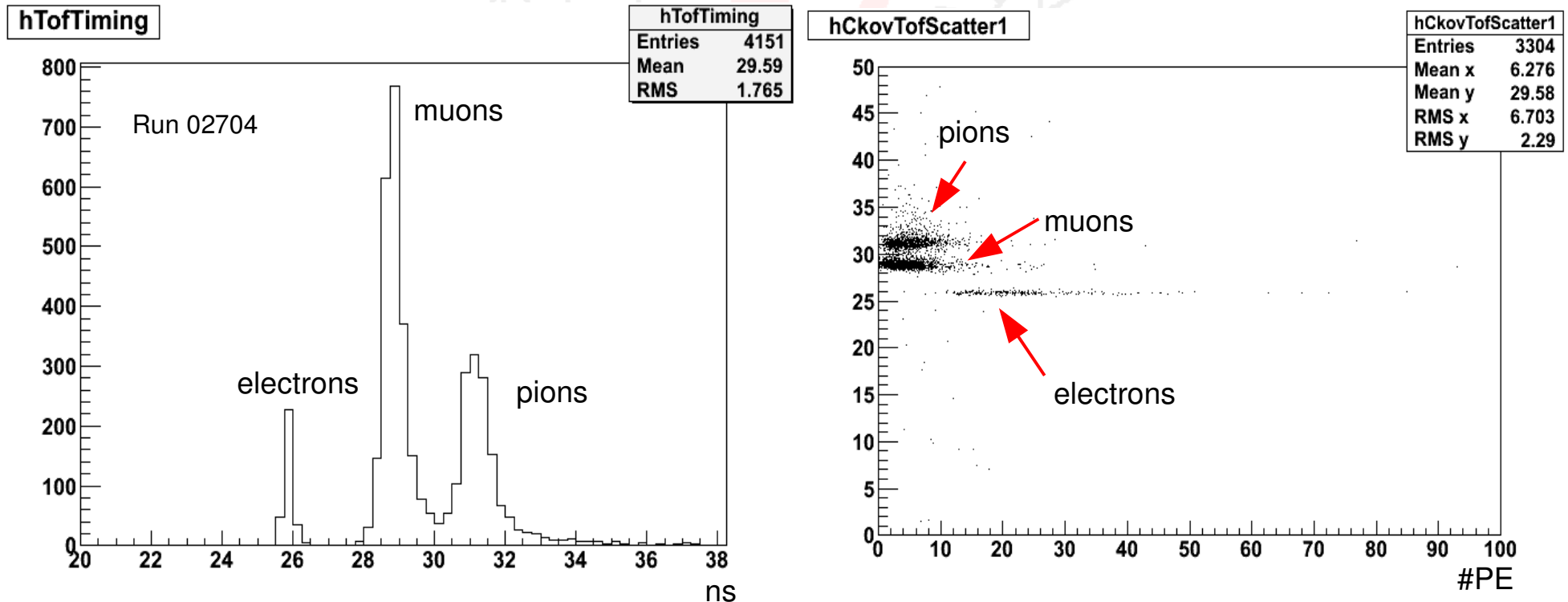
# fAdc Automatic Pedestal Calibration

- Integrator readjusts pedestal value when event has only background noise.
- Pedestal values can also be set manually on a global scale.



# Momentum Estimations (Muon/Pion)

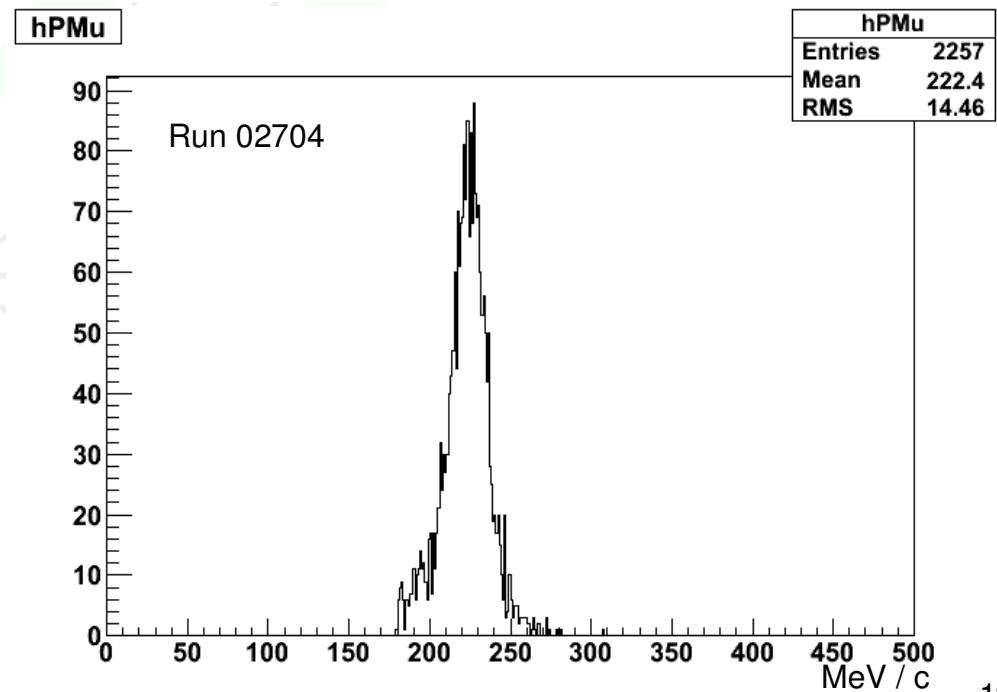
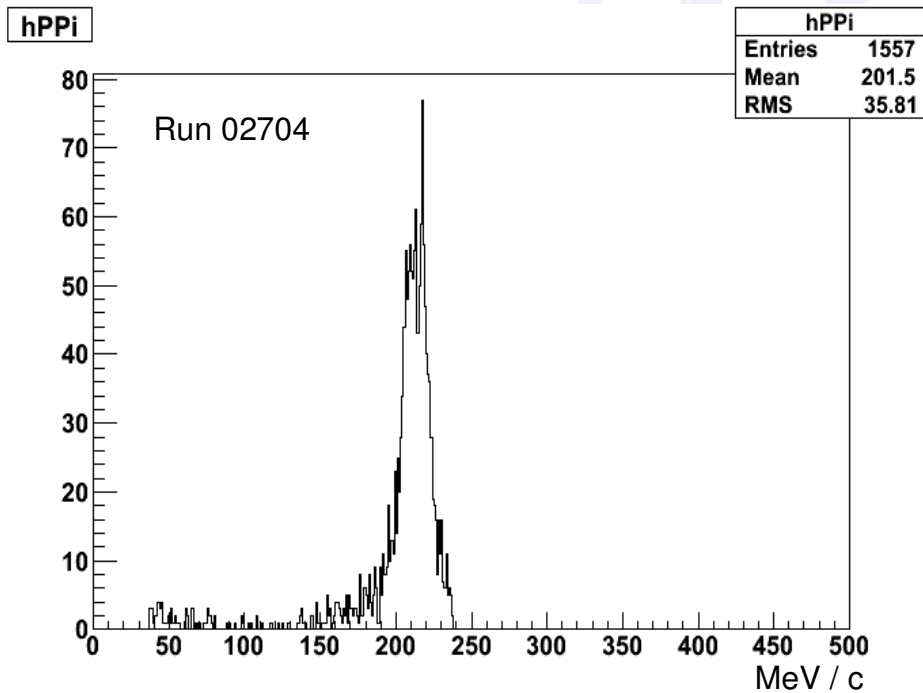
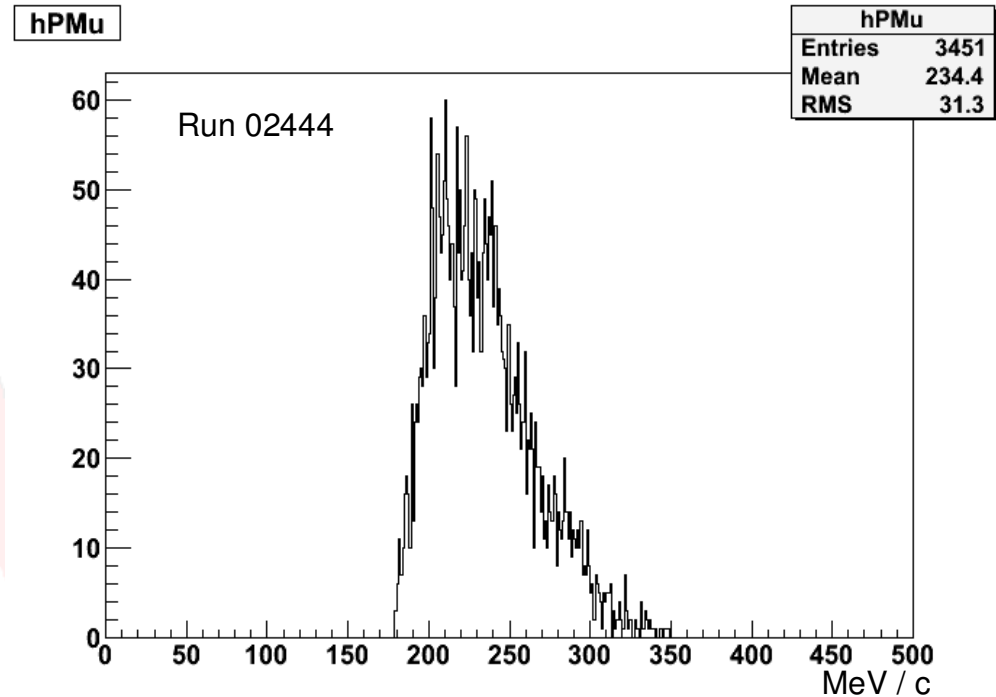
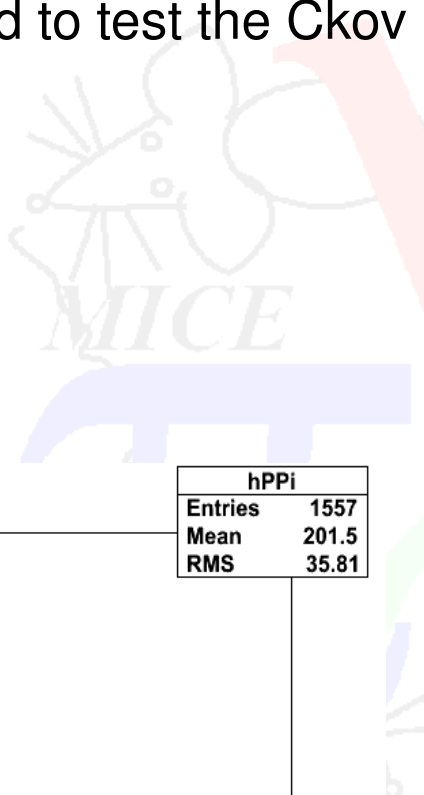
- We use the time of flight between TOF 0 and TOF 1 to estimate the momentum for muons and pions.
- Particles are well separated in time difference plot (mass determination).
- Ckov light output follows general expectations, but...



- Particles seem to show light below threshold!

# Momentum Estimations

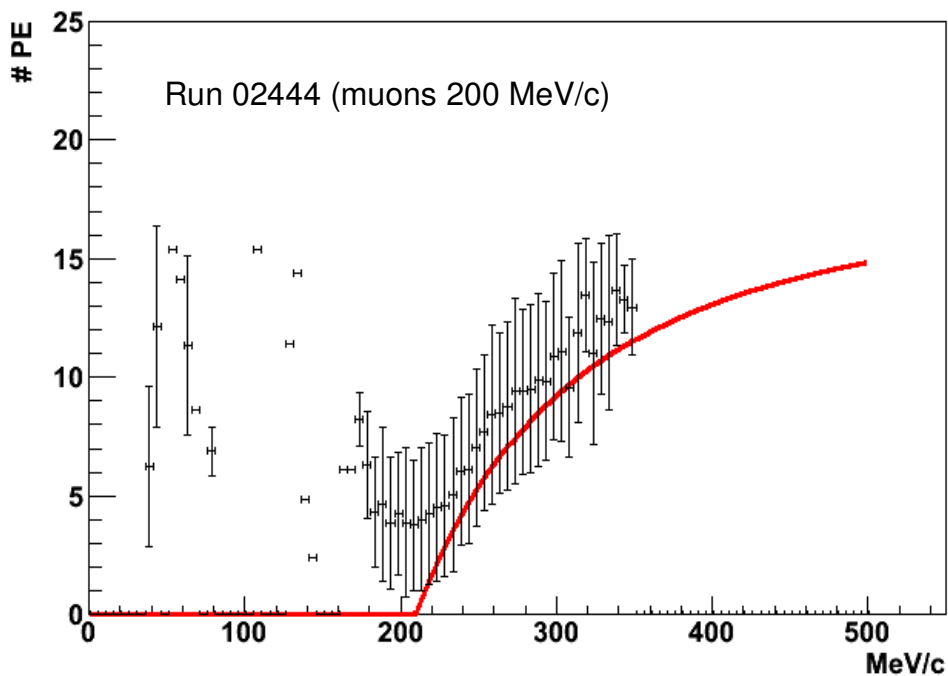
- Momentum spectrum width seems to differ between runs
- Wide widths are good to test the Ckov light yield.



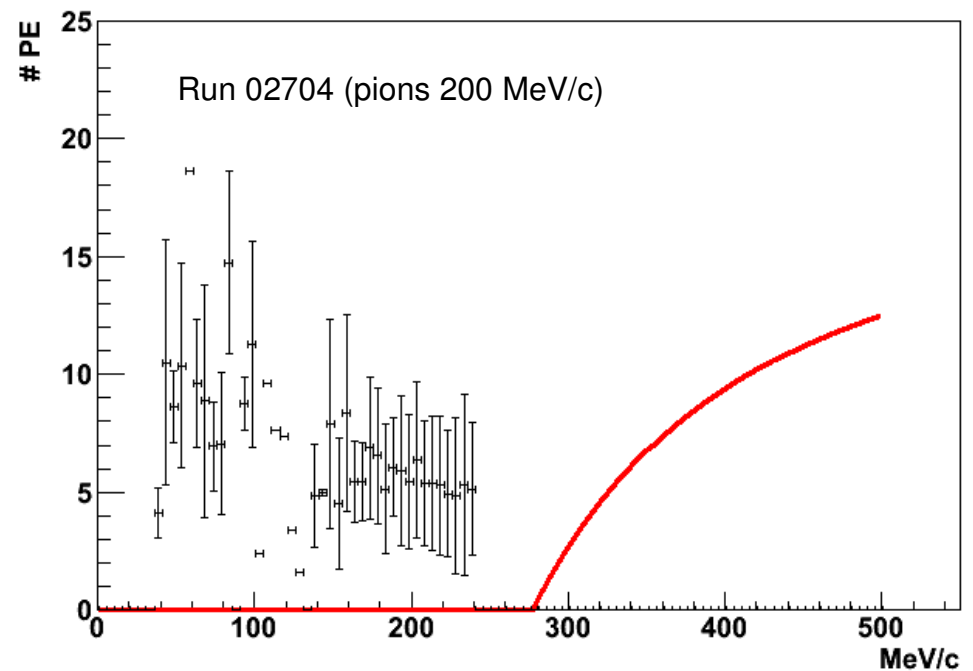
# Momentum vs Light Yield

- Average Ckov light yield follows expected path fairly well.
- Muons produce light before pions which is shown by the graphs.
- No momentum data available for electrons (too relativistic).
- BUT!! Extra light is produced below threshold (3 to 5 PE) !

Graph



Graph



- We believe the Cherenkov light produced by the glass in the Ckov counters is released instead of trapped.

# Summary

- We need to replace current Ckov reco code in M4MICE.
- Using a peak and coincidence finding algorithm seems to produce good results.
- Almost all peaks occur in narrow window around 90 ns.
- Ckov shows expected mean light response.
- Glass plate seems to be producing extra light and may have to be replaced.
- Would like to test with higher momentum runs (2 GB download limitation?).

Thank You