

Electron Transport Simulation 3

Data meets Simulation

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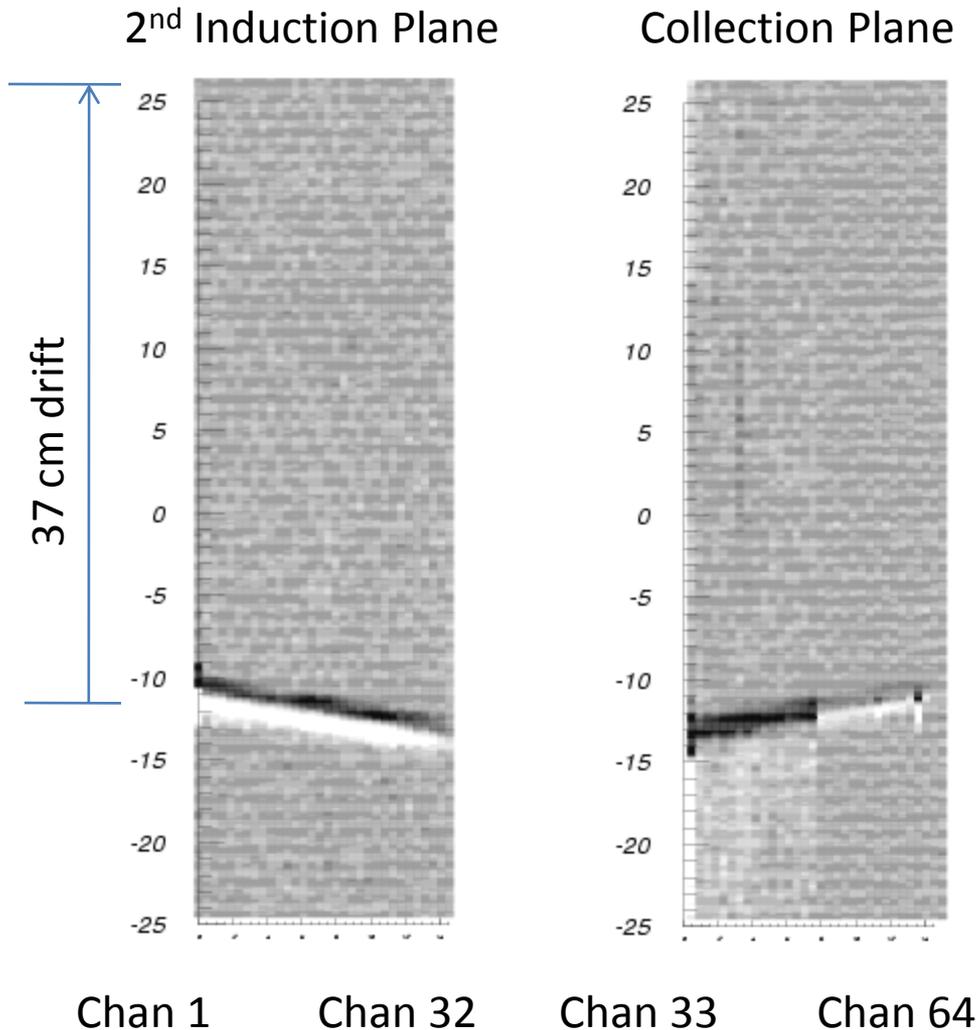
Feb 17, 2009

Method

- Compare electron transport & electronics simulation with data
 - Use Bo cosmic ray data (Run 254 Event 18)
 - Garfield inputs to simulate Bo
 - 4.7 mm wire spacing
 - 6.2 mm plane spacing
 - 150 μm wire diameter
 - Induction Plane 1 \rightarrow -360V
 - Induction Plane 2 \rightarrow 0V
 - Collection Plane \rightarrow 480V

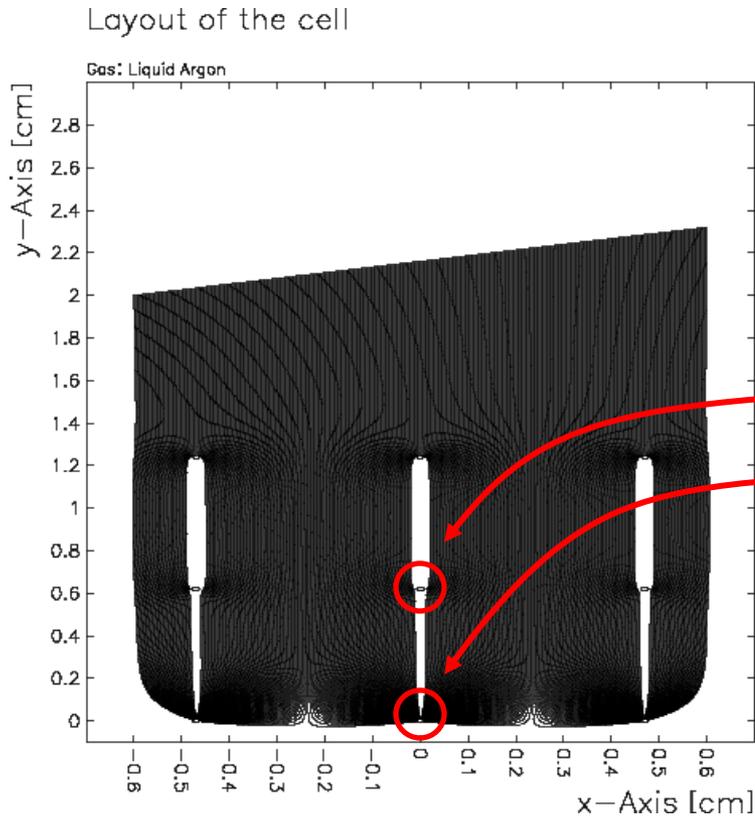
} Bias voltages for run 254

Run 254 Event 18



- “Narrow Gaussian unipolar filter”
 - 32 Chan on 2nd Induction Plane
 - 1st 16 Chan on Collection Plane
- Sample hit region in 6 adjacent channels in both planes
 - Ch 2:7, 34:39

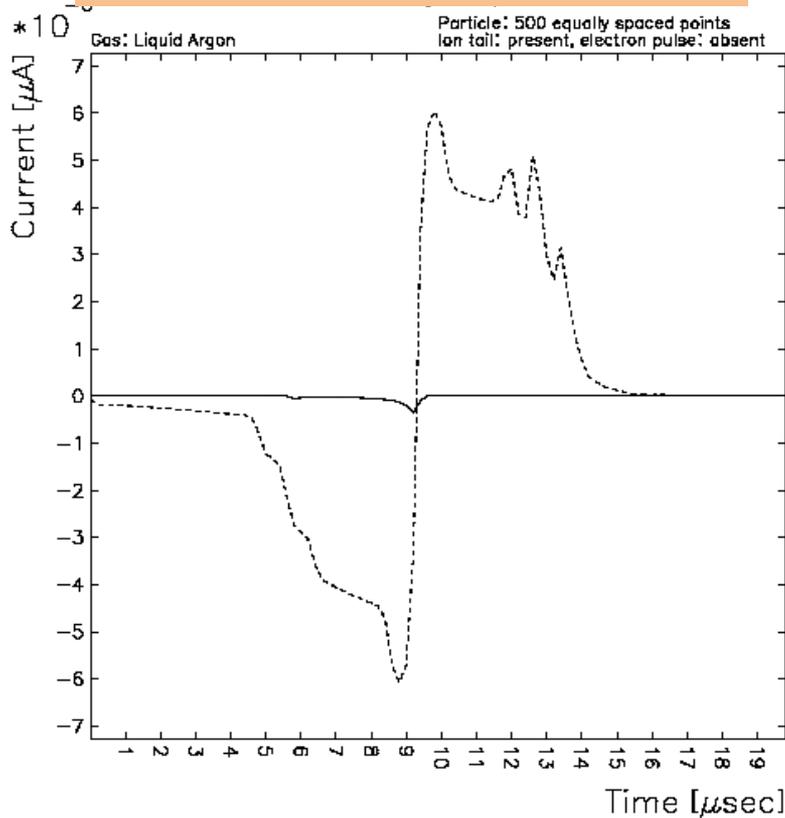
Garfield Simulation



- Track 500 electrons from 15° inclined track
- Sample signals on middle wires
 - Induction (0,0.62)
 - Collection (0,0)
- 5 Mhz sample rate is the same as Bo
- No diffusion
- No electron clustering

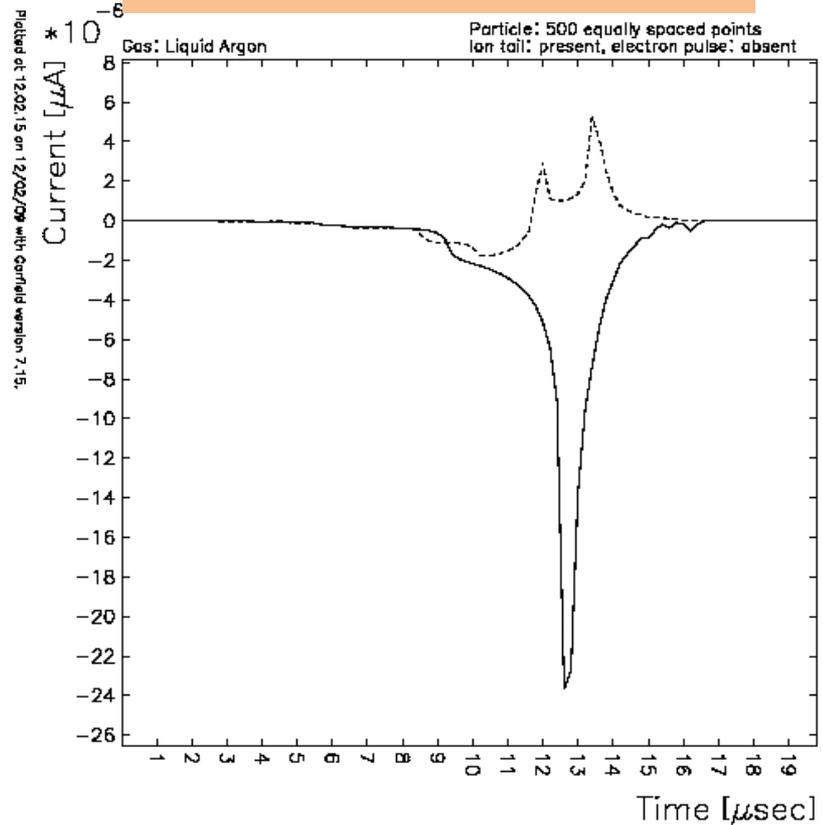
Simulated Signals

Induction Plane wire at (0,0.62)



Solid line = Direct signal
Dotted line = Induced signal

Collection Plane wire at (0,0)

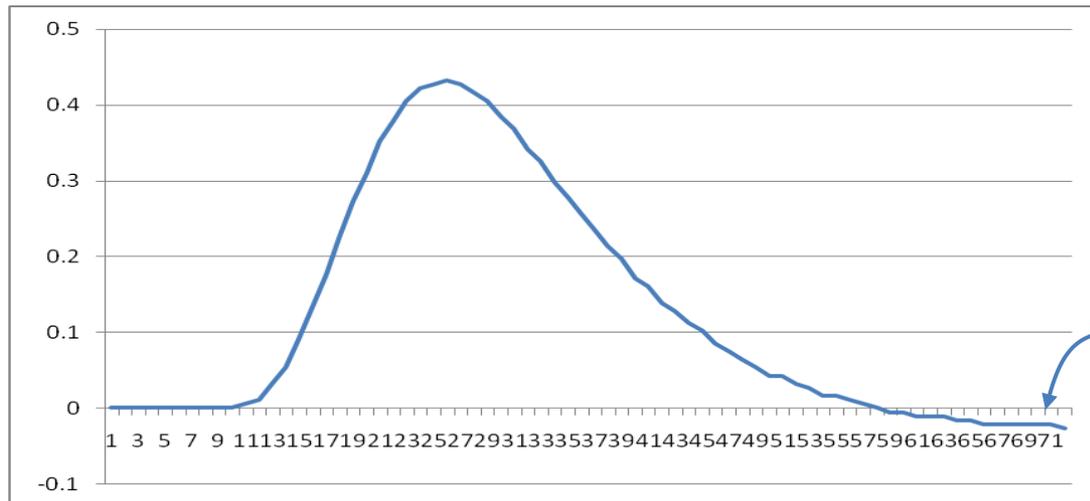


Export data points to Excel
Sum Direct & Induced signals

Electronics Response

- Bench measurement of the step function response of the narrow Gaussian unipolar filter by Dan Edmunds (MSU)

http://www.pa.msu.edu/~edmunds/LArTPC/T962/Preamp_Filter_Card/Testing/



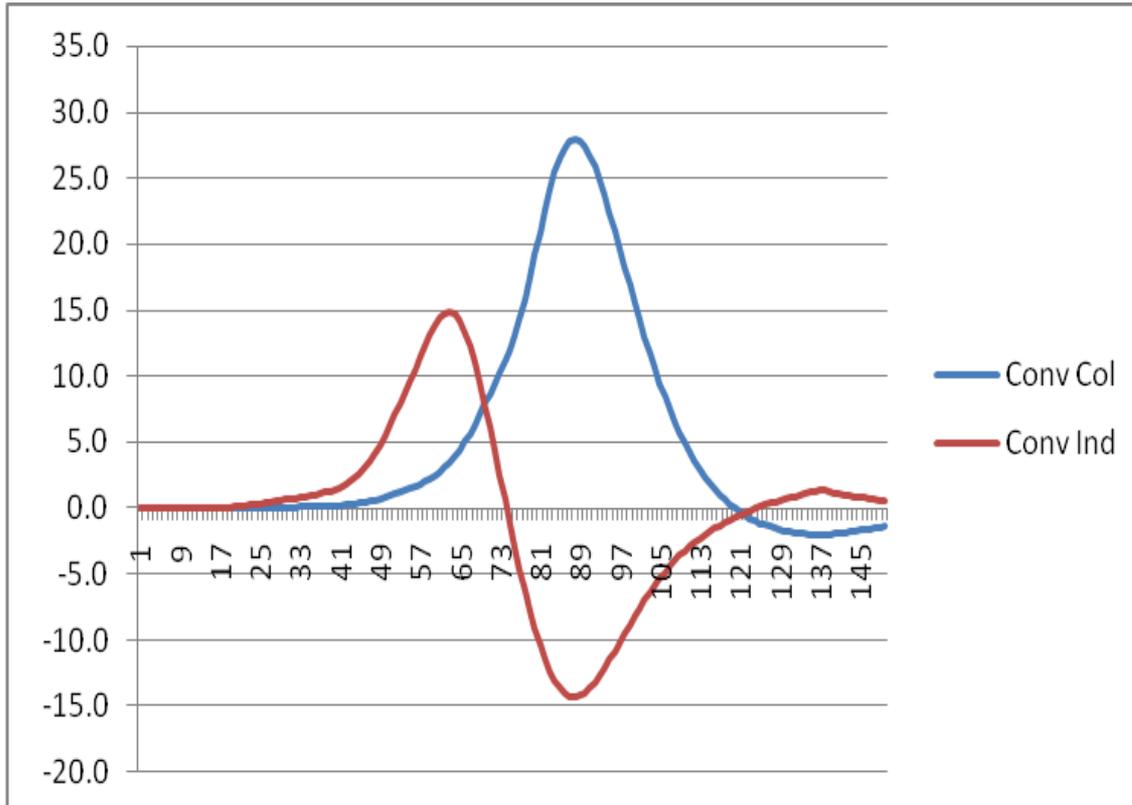
0.2 μ s bins

Removed the 400 count
ADC offset & re-scaled

Undershoot cannot be
removed without altering
the card (D-Zero spares)

Convolution

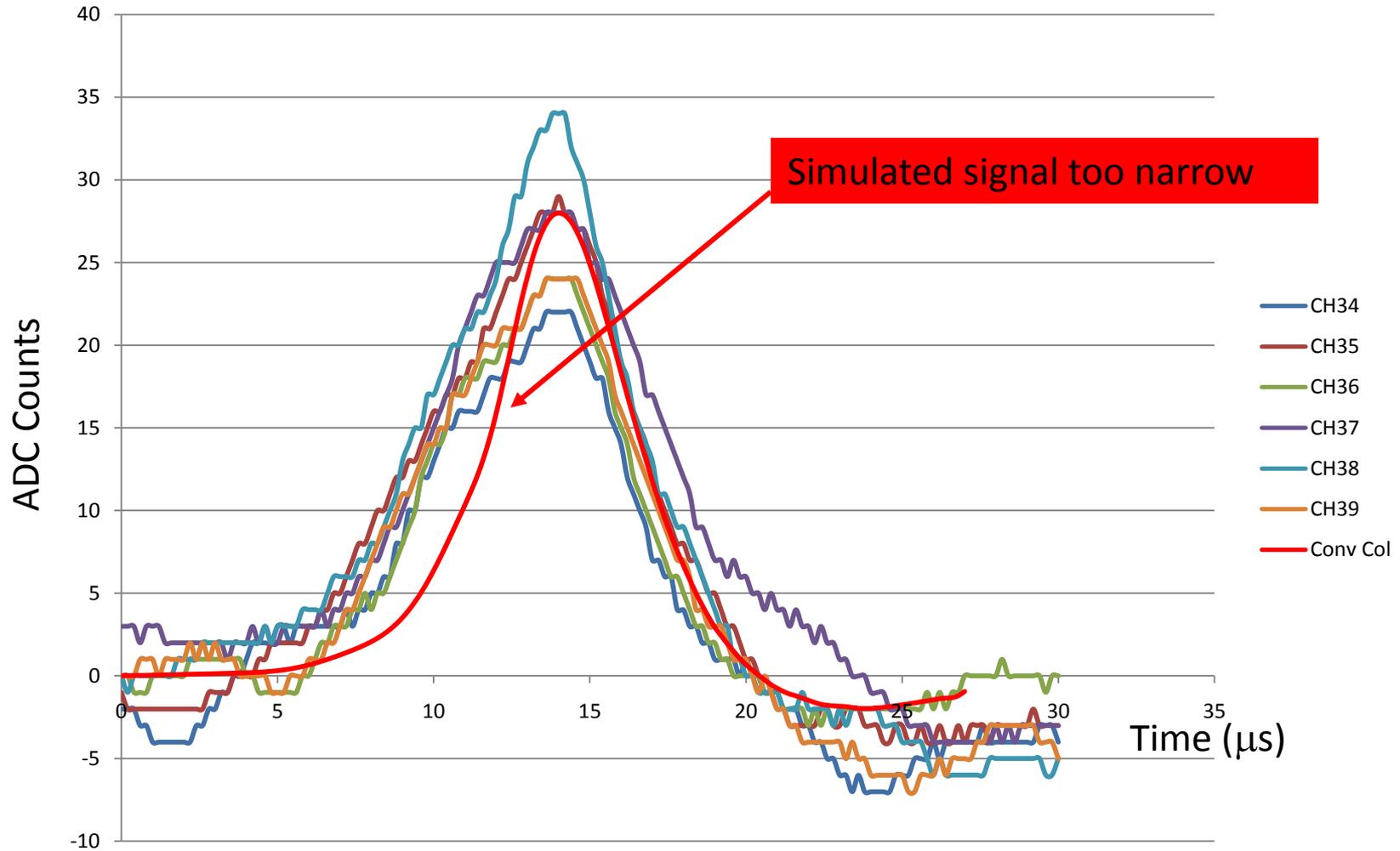
- Simulated signals (slide 5) convoluted with electronics response (slide 6) with a Visual Basic macro



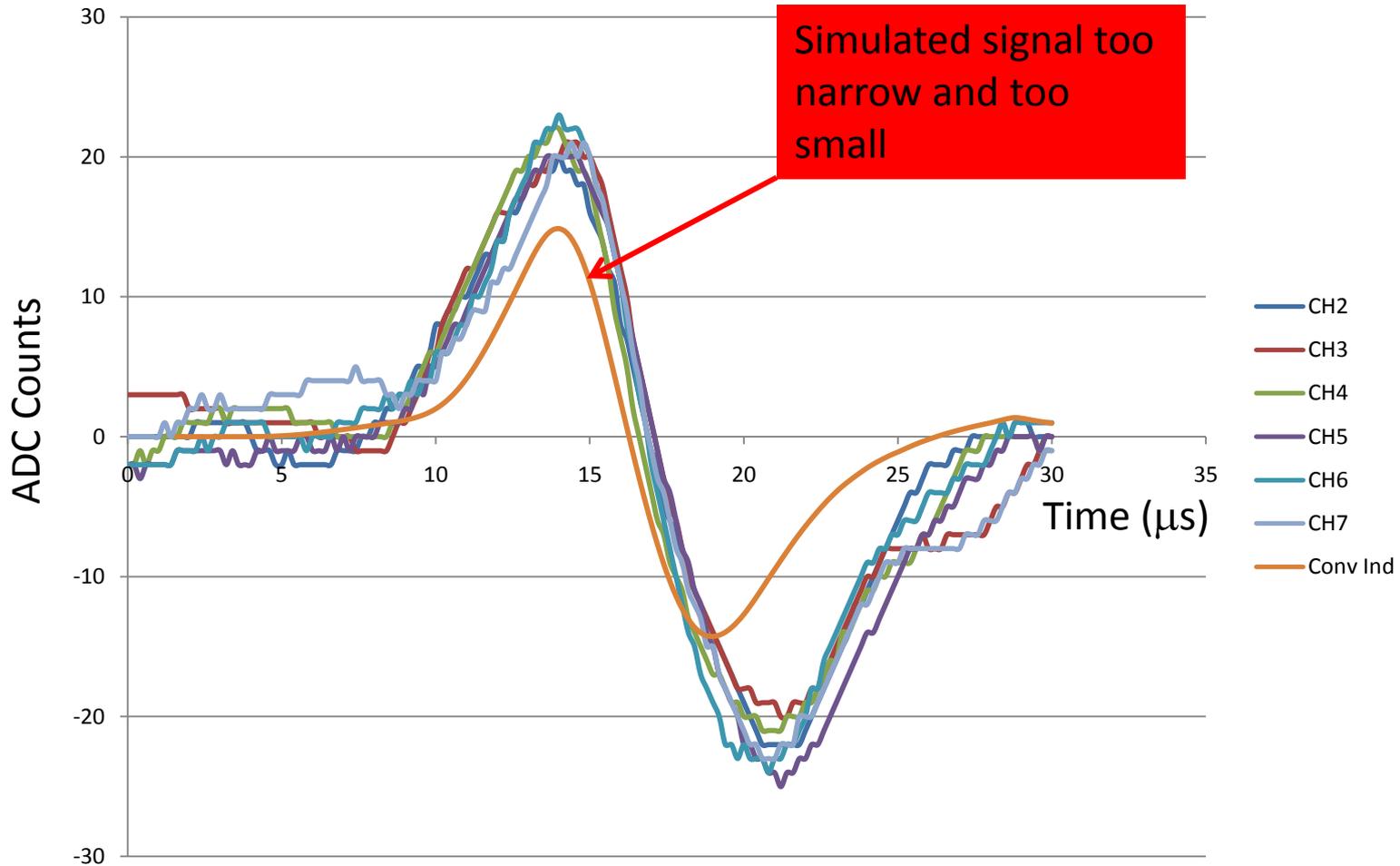
Max Conv Col PH
normalized to average
max PH of data (28
ADC counts)

Max + PH of Induction
Plane signal is 53% of
the max PH of
collection plane signal

Collection Plane



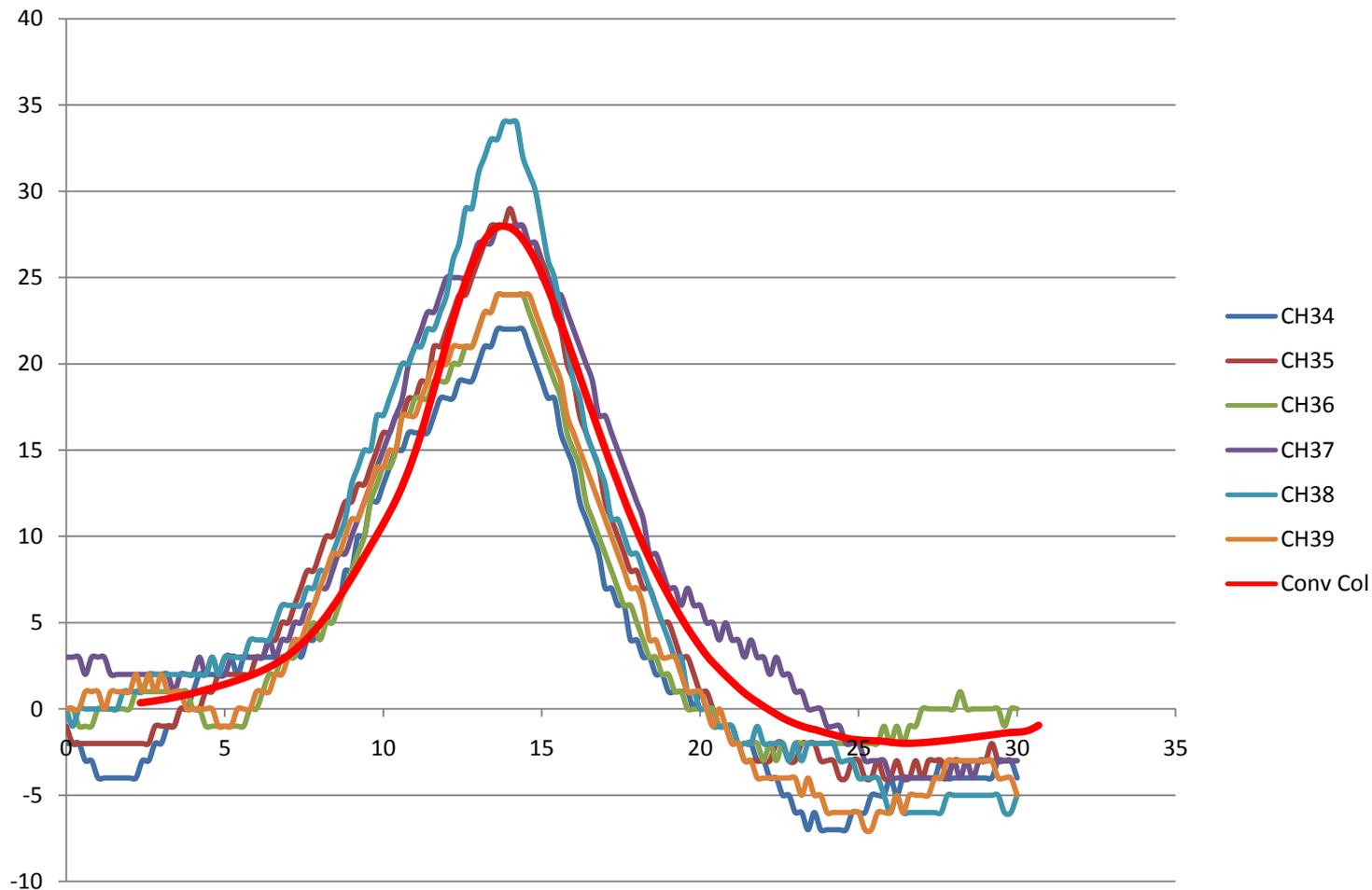
Induction Plane



Possible explanations

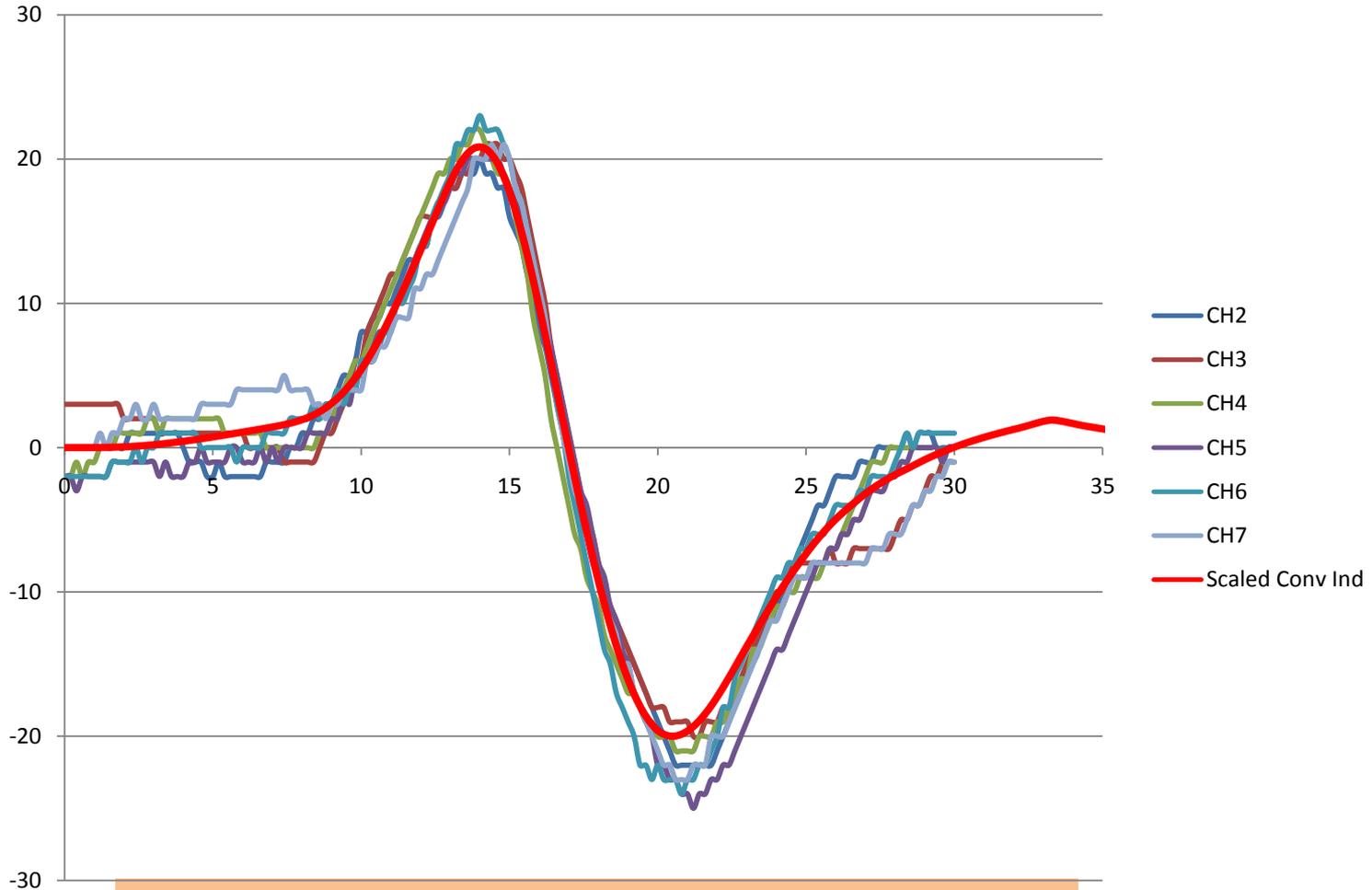
- Diffusion not simulated (**Not likely**)
 - Expect $\sigma = 0.33 \mu\text{s}$ for longitudinal diffusion coefficient of $6.2 \text{ cm}^2/\text{s}$
- 2D simulation
 - Drift time through the wire planes too low in the simulation (**Plausible**)
 - Density of electron trajectories near the induction plane wires too low in the simulation (?)

Tweaked Simulation Collection Plane



Stretch the simulated signal time scale by 1.2

Tweaked Simulation Induction Plane



*Stretch the simulated signal time scale by 1.2
Scale the simulated signal amplitude by 1.4*

Summary

- The discrepancy in the 2D collection plane signal simulation can be explained by an under-estimate of the drift time
- Simulated induction plane signals require time scaling and amplitude scaling
- There is good eye-ball agreement between the tweaked simulated signals and the data for this small dip angle track