Reconstruction of beam electrons in ProtoDUNE-SP photodetection system

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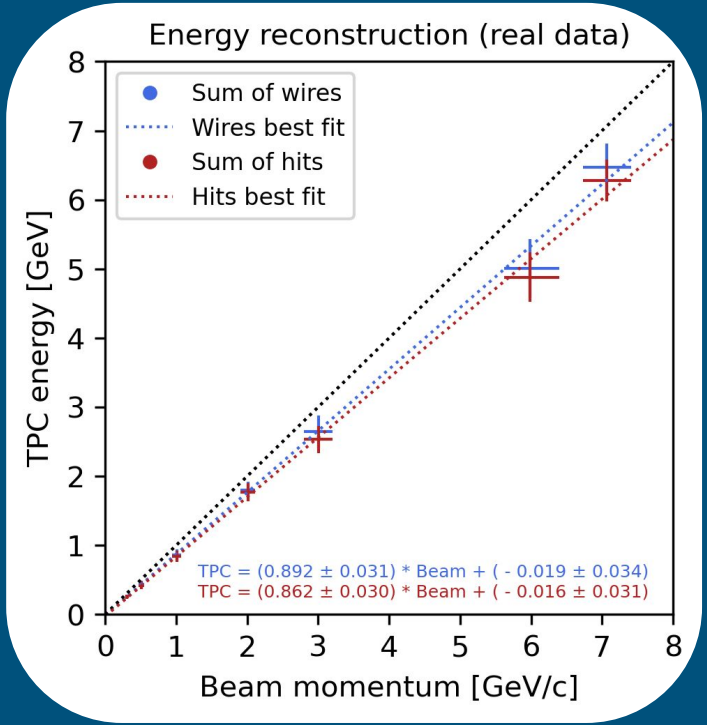
Context: charge-based reconstruction

We previously studied the reconstruction of electrons through charge in ionization showers.

Found an 89% recovery of energy through the charge-collecting wires.



Moving to photodetection methods

ProtoDUNE-SP contains several photodetection systems such as ARAPUCA, which collect light information from events.

We aim to combine our previous charge study with light information, in order to achieve a full light+charge reconstruction of events

Among other things, this could yield a more efficient energy recovery.

Event selection

We select beam electron events through a series of cuts:

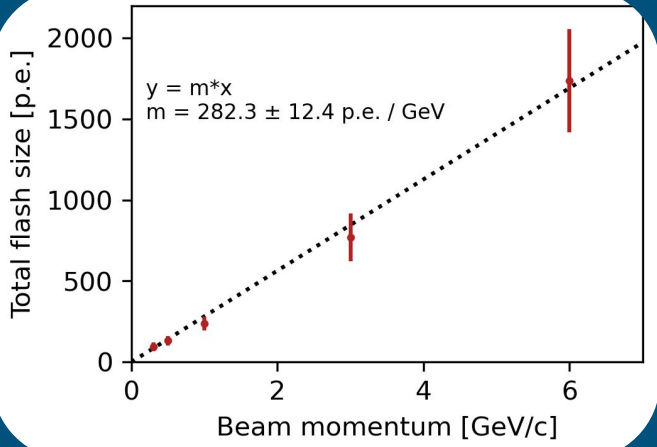
1. Cerenkov detection, low/high pressure based on beam energy
2. Charge shower direction with respect to beam direction
3. Number of hits in charge-collecting wires
4. Time of flight (< 105 ns)

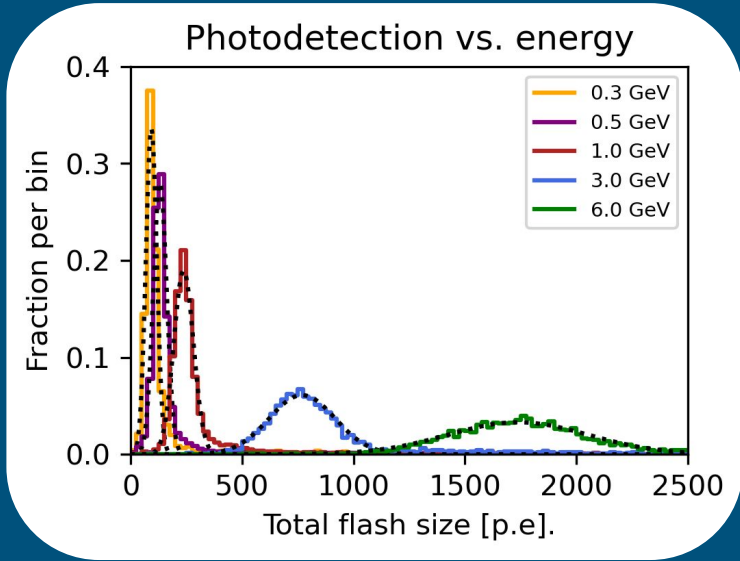
First results

By extracting the optical flash size for each event, we get a distribution for each beam energy.

Gaussian shaped, means are linearly correlated with an average of 282 photoelectrons detected per GeV

Currently working on size to energy conversion.



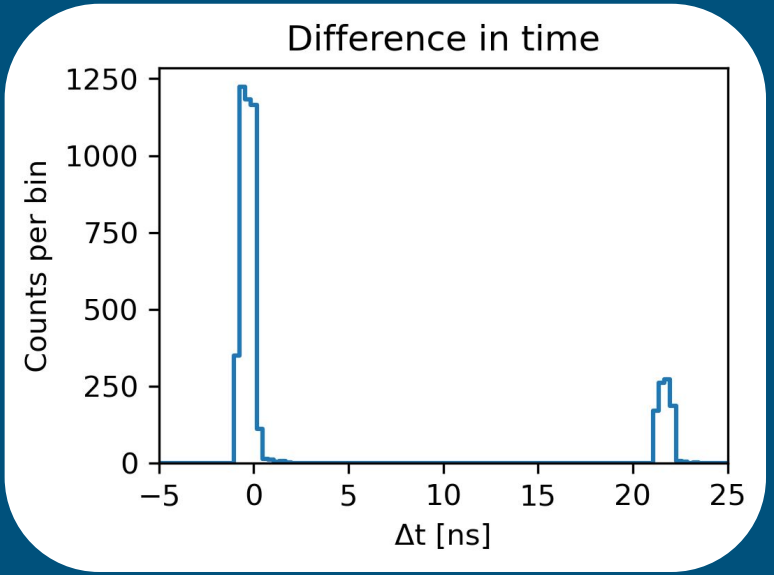


Time correlation

One quantity of interest is the correlation between the beam trigger time and the internal detection time.

Most events have a good time agreement in the order of 1 ns, with a smaller population having a considerable offset.

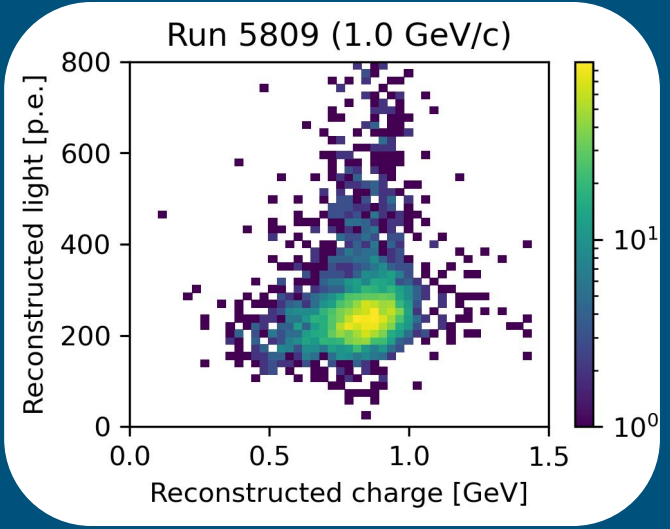
We aim to study the offset events more in detail to understand its origin.

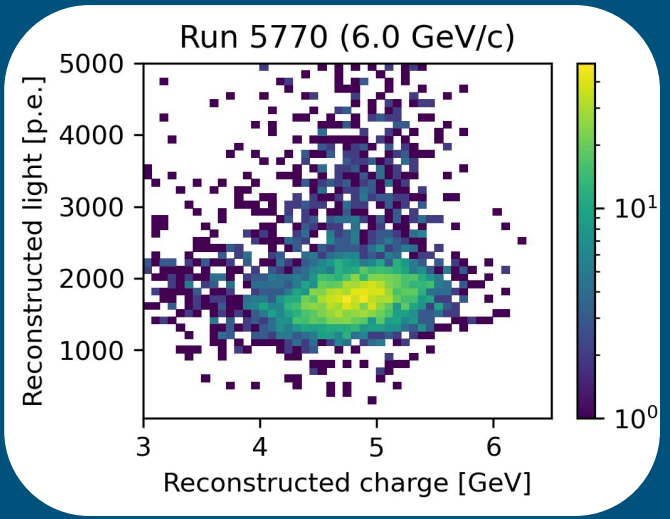


Combining charge and light

On a per-event basis, we can match the charge-based energy reconstruction to the event's flash size.

We currently observe a slight positive correlation, although a conversion from light size to energy is needed to better study the two quantities.





Next steps

In the near future we intend to:

- Convert flash sizes to energy using the LAr work function, detection efficiencies and correction maps.
- Study events with a time-offset to detect potential necessary corrections
- Study the light-charge correlation in energy-energy space
- Combine the light and energy signals of events to obtain a better reconstruction of beam electrons.