Measurement:

Type

* Use measurement like that in <http://neutrino-classroom.org/> conservation of energy and momentum path.
* Include background events for students to “reject”.
* Students record energy and momentum data of expelled proton and muon from neutrino interaction events into Google sheets or other tool (see below).
* Students combine data in the class to make histograms of px and py calculated for the neutron in the nucleus; use histograms to find px and py using both the calculated standard deviation and the full-width half-mximum; use uncertainty principle to calculate x and y to probe the width of the nucleus of target carbon atom.
* Find pz and make a histogram to probe beam energy if possible.
* Plots and results from each masterclass institute connected in a videoconference compared together.

Data

* Require 50 datasets of 50 events each, total of 2500 events
* The 2500 events should consist of 40% measurable events, 60% background to be randomly distributed over the 50 datasets.
* (Optional, speculative.) Depending on which sort of background events are available, we can entertain a secondary measurement from background, e.g count number of muons in an event to estimate density of muons and infer shower energy, if this could work.

Tools:

ARACHNE Event Display

* Keep basic design
* Add forward and reverse buttons so students can move to the next or previous event without having to go back to the list
* Show Masterclass Dataset and Event numbers on the event display

Tabulation and Analysis of Results

* Google sheets works for small groups, may have difficulty with many (>50) students using it simultaneously (this was the experience in the CMS masterclass).
* Building a dedicated platform is the best option; QuarkNet may be able to do this based on the underlying platform for CIMA (<https://www.i2u2.org/elab/cms/cima/>).
* Other options may also exist.
* Plan is to proceed with Google sheets in 2017 until a change is warranted and available.