Photon Detector Dynamic Range

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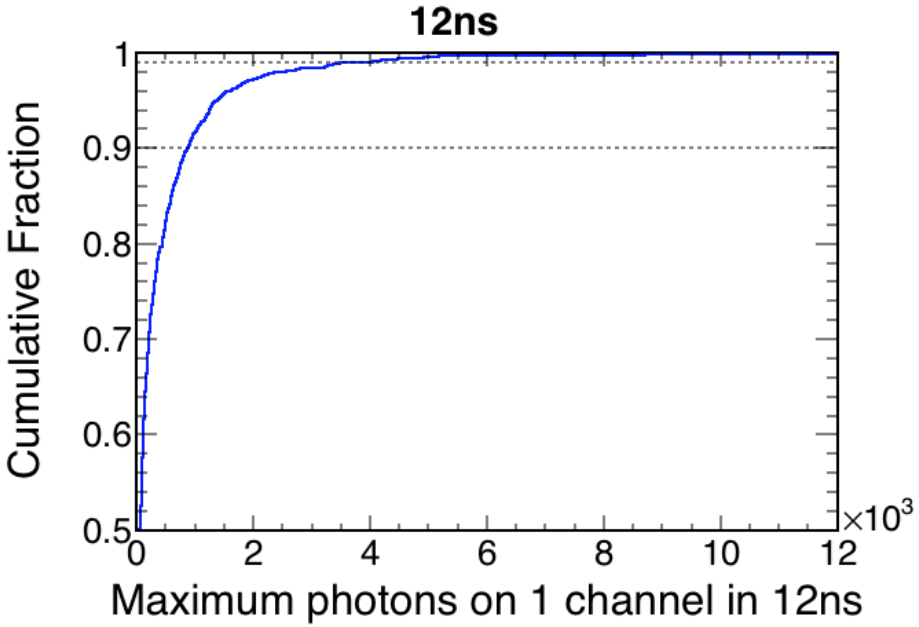
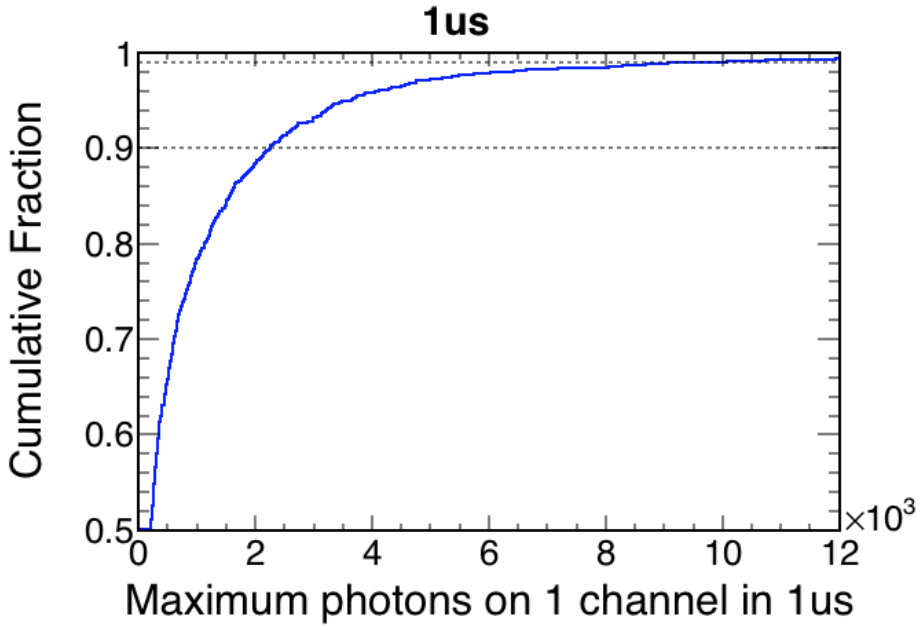
Introduction

- Low end of dynamic range is easy: 1 PE.
  - We are looking at a higher threshold to trigger readout, but we still want to see single PEs in the later part of triggered waveforms.

- Now, for the high end…
- We looked at simulated beam neutrino events, and looked at the maximum number of photons seen on each PDS channel.
  - Assumes each detector has effective area XX cm2, equiv. to YY% efficient X-ARAPUCA.
  - Assumes 4 readout channels/bar.
- Looked in different time ranges which bracket the need:
  - 12 ns – one 80 MHz tick.
  - 1 μs – ~the response time of the SiPM.
- Neither of these is quite right since later signals will be on top of somewhat decayed earlier signals.

Results





- What is plotted is the fraction of events whose peak photons is below the X-axis value.
  - Note that the axis is in thousands.

Saturation Rate	12 ns	1 μs
10%	870	2,250
1%	3,850	9,550

Conclusions

- I am confident we can tolerate a little bit of saturation in the analysis.
  - Why?
    - Because the TPC thinks they can tolerate 10%.
    - I can also imagine at least two correction algorithms.
  - But how much is too much?
- Drawing really crisp conclusions here is tough, for a few reasons:
  - We don't have an analysis of beam event resolution yet.
  - We don't have a correction algorithm for saturation developed yet.
  - The photon numbers scale with detector efficiency, which is not known to high precision yet.
- But, with all that, what can we say?
  - If we can get away from the rapidly varying part of the curves for reasonable cost, then I think this is a non-issue.
- Squinting, I think we need to see **a few thousand photons.**
  - I would call 2k borderline and 10k overkill.
  - Your interpretation may vary.
- If getting to even 2,000 photons is costly, then I think we will need to spin up some more sophisticated studies to address just how badly its needed.