



MilliQan Meeting

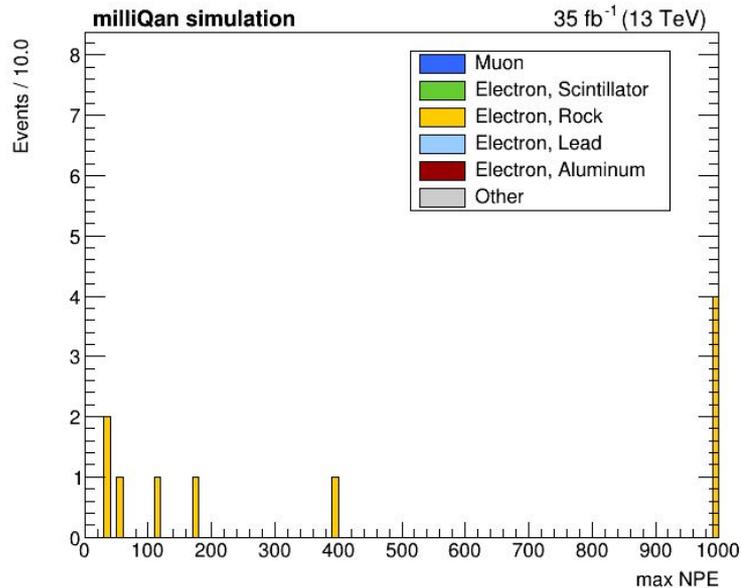
11/13/2019

Signal-like cosmic events

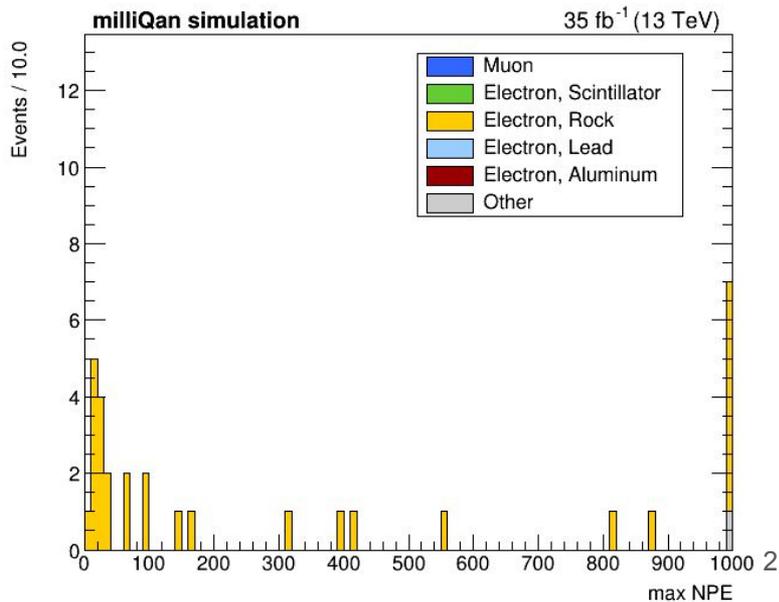


I looked at our simulated cosmic muon dataset and searched for purely signal-like events: 3-in-line hits with no direct muon interaction in the detector (via MCTruth)

3-in-line bar hits



One pulse per layer



Event Displays



In a dataset of 2,000,000 cosmic muons (1000 files of 2000 events), I observed the following nPE deposit triples in 3-in-a-row nonzero nPE deposits

- **10/34/77**
- 84/1027/5710
- **6/22/356**
- 435/1767/7439
- **16/29/787**
- 37/39/5603
- **6/66/226**
- 9/14/3960
- **16/20/109**
- **10/12/64**

The event displays are here:

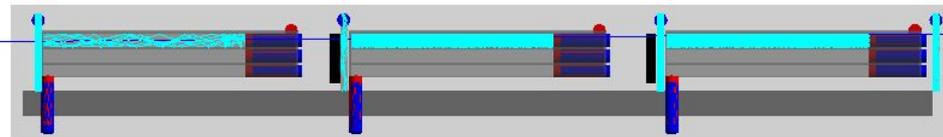
<http://uaf-10.t2.ucsd.edu/~ryan/dump/jsroot/index.htm?file=inputs/signalLikeCosmicEventsFull.root>

$M=0.1 \text{ GeV}$, $Q=0.01e$

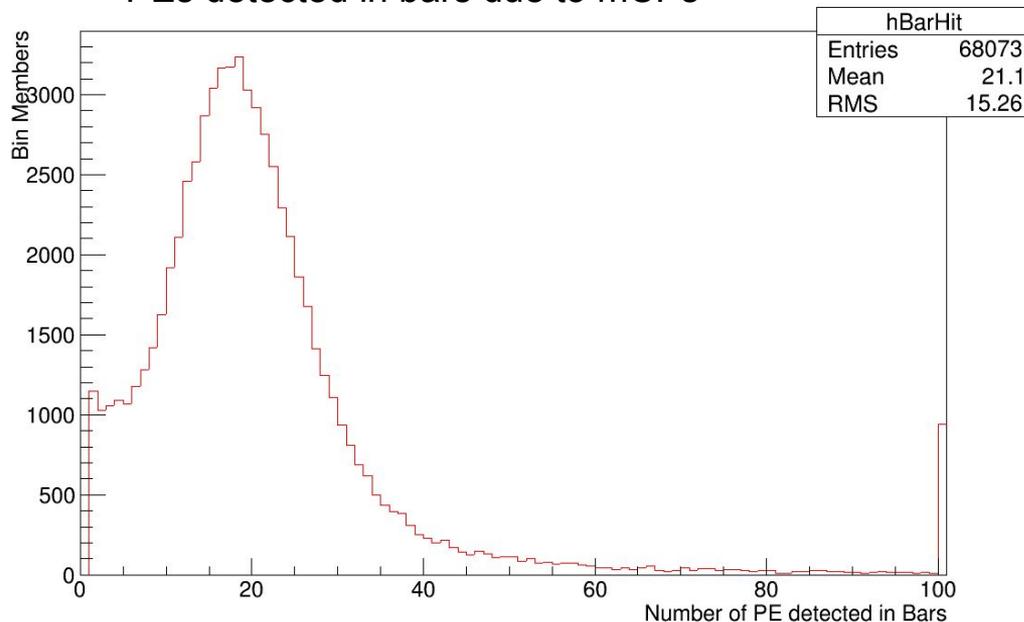
Initial mCP studies

As an initial study of mCP interactions in the demonstrator sim, I looked at:

- PEs in the between-layer slabs
- **PEs in the bars themselves**



PEs detected in bars due to mCPs



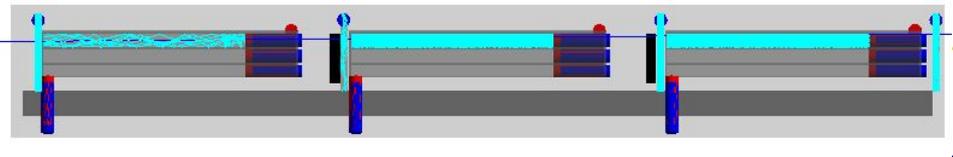
Previous estimates put mCP PE amounts at ~ 5 PE, compared to peaking at ~ 17 PE here. Accounting for scintillator surface roughness brings us to ~ 14 PE

$M=0.1 \text{ GeV}$, $Q=0.01e$

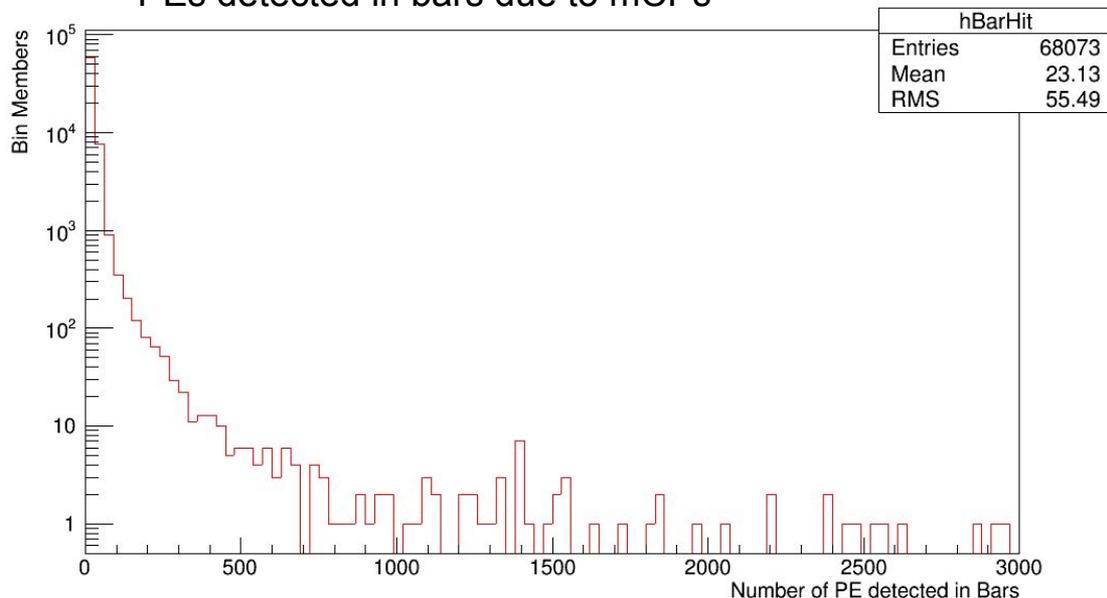
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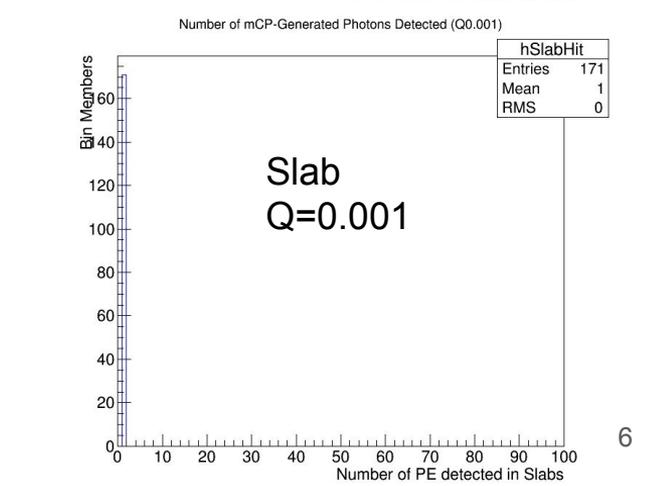
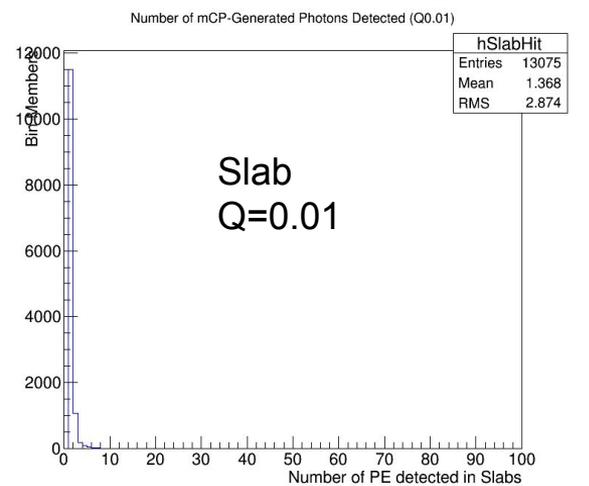
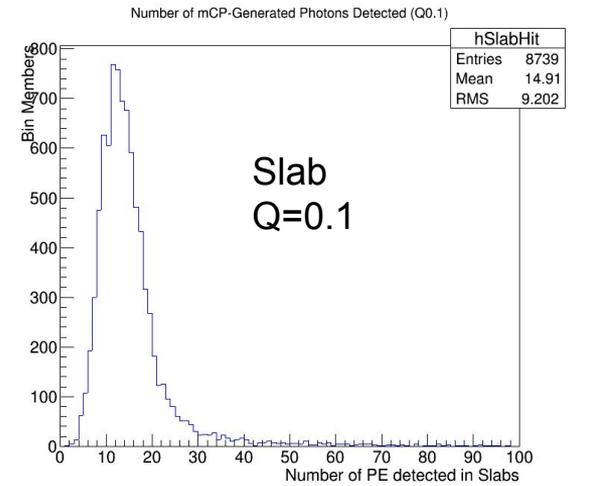
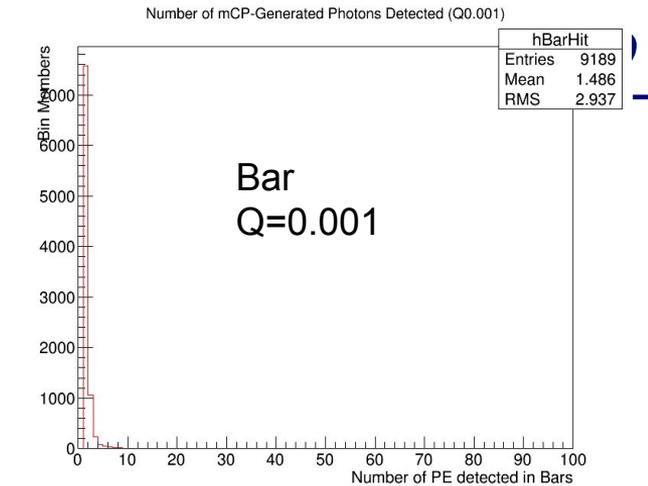
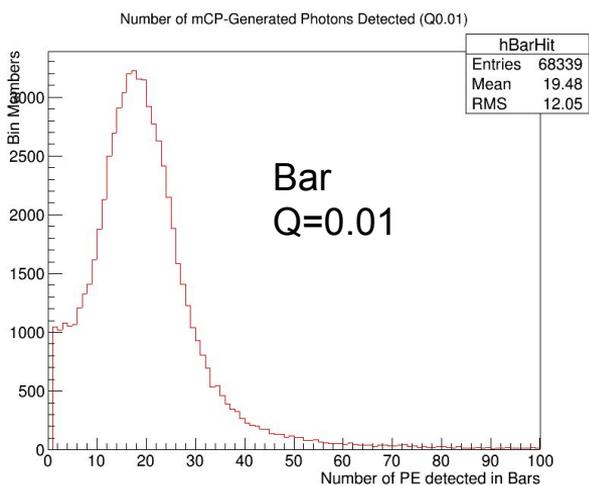
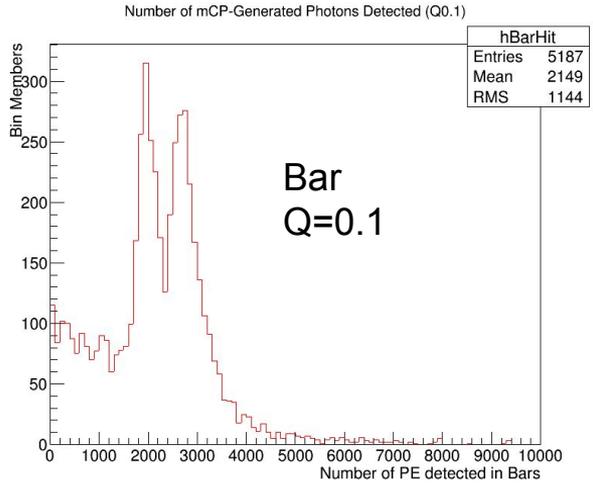


PEs detected in bars due to mCPs



There is a very long tail in mCP nPE counts, but it drops off in probability quickly. Roughly a 1.5% chance to deposit more than 100 PE for $Q=0.01e$

Recall: nPE detections in bars and slabs





Rejection of cosmic signal-like background

- For smaller charges: A Min/Max nPE ratio handles a lot of these. If we think the mCPs are minimum ionizing, a min/max ratio rejection factor of 10 (i.e. passes 10/10/90 but rejects 10/10/110) would reject 7/10 of these events. A ratio rejection factor of 5 rejects them all, but allows $Q=0.01$, for example
- For larger charges: The ratio rejection factor works here too. Strikingly, for events with large deposits (>1000 nPE in one of the in-line bars), the minimum nPE deposits were 9, 37, 84, 435. Also, for large charges, we rarely see any deposits in the slabs which should easily rule out the cosmic background



Possible future plans/discussion

- Is it worth explicitly checking how often we accept/reject signal under a particular choice of min/max rejection ratio? If so, are there particular rejection ratios we want to try?
- Are there any remaining rejection methods for signal and background that we might want to evaluate in sim?
- Unblinding soon? Paper? Timelines for these things?