Results from Testing of the Novel Optical Communication Scheme with the Clockless Q-Pix Charge Readout System in Gaseous Argon

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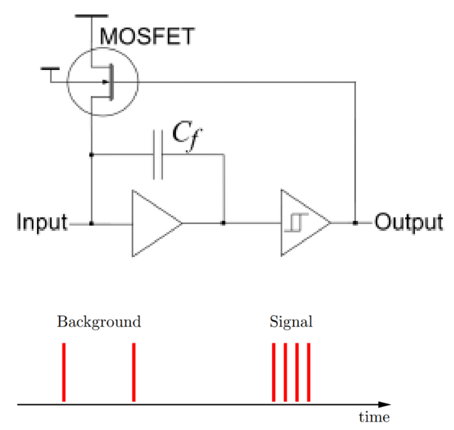
Background and Motivations

- Pixelization of large scale TPC's; e.g., DUNE far detector
- Pixel vs. wire plane:
  - better event reconstruction
  - Larger power consumption, lots of noise, lots of junk data

Alternate solution: Q-Pix

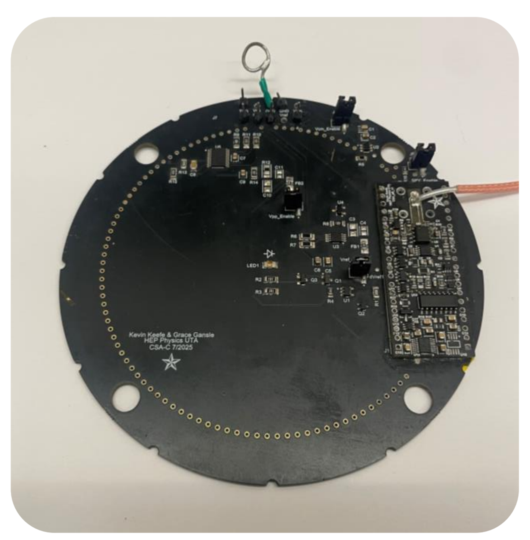
What is Q-Pix?

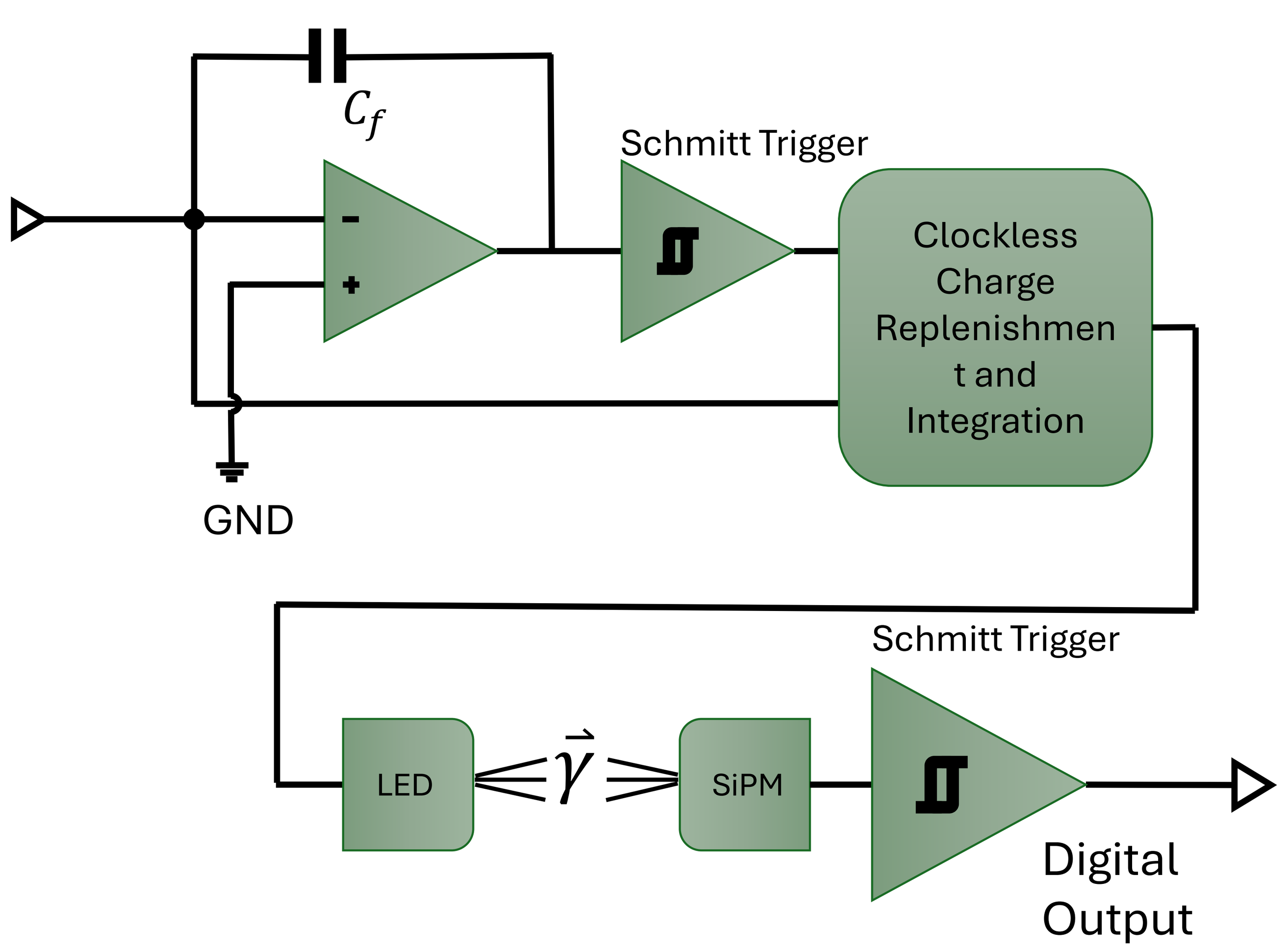
- Electronic equivalent of "least action"
- Normally "off," but turns on instantly when an event occurs
- Leads to low power, low data rate (less junk data), low noise



Novel Clockless System

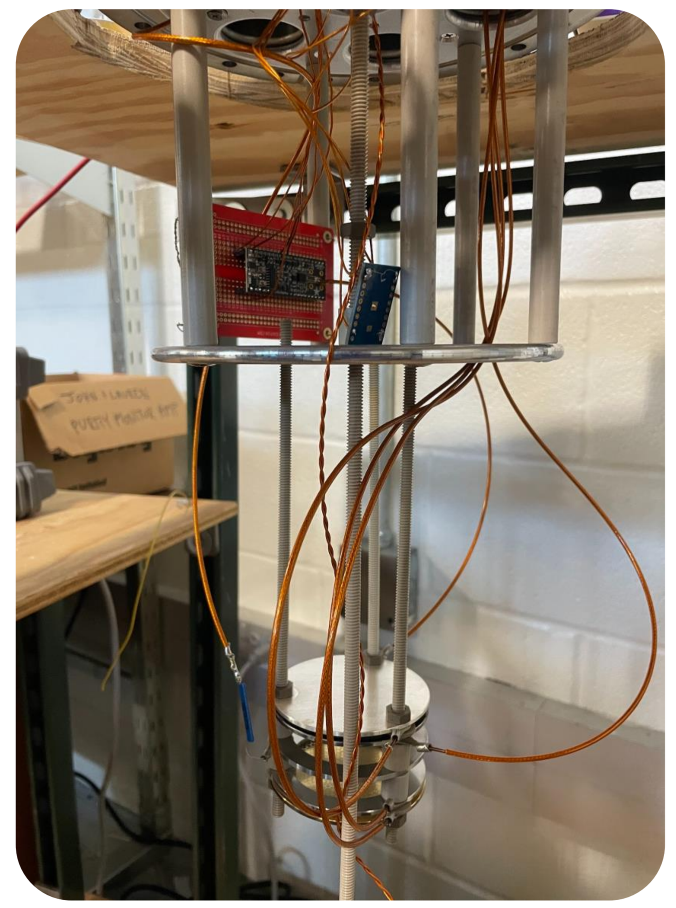
- Classic Q-Pix: uses a clock
  - Creates some noise
  - Can drift off; needs to be calibrated occasionally
- Our system: clockless
  - Only digital logic
  - Less noise
  - No need to calibrate
- Output is then fed into an LED, decoupling the signal electrically and further reducing noise
  - Optical decoupling could be used for other detectors

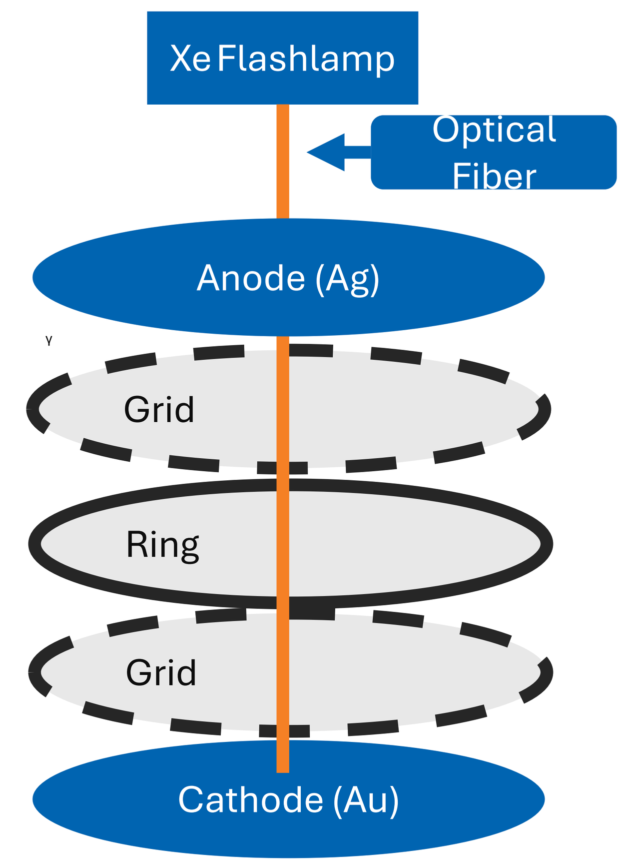




The Purity Monitor

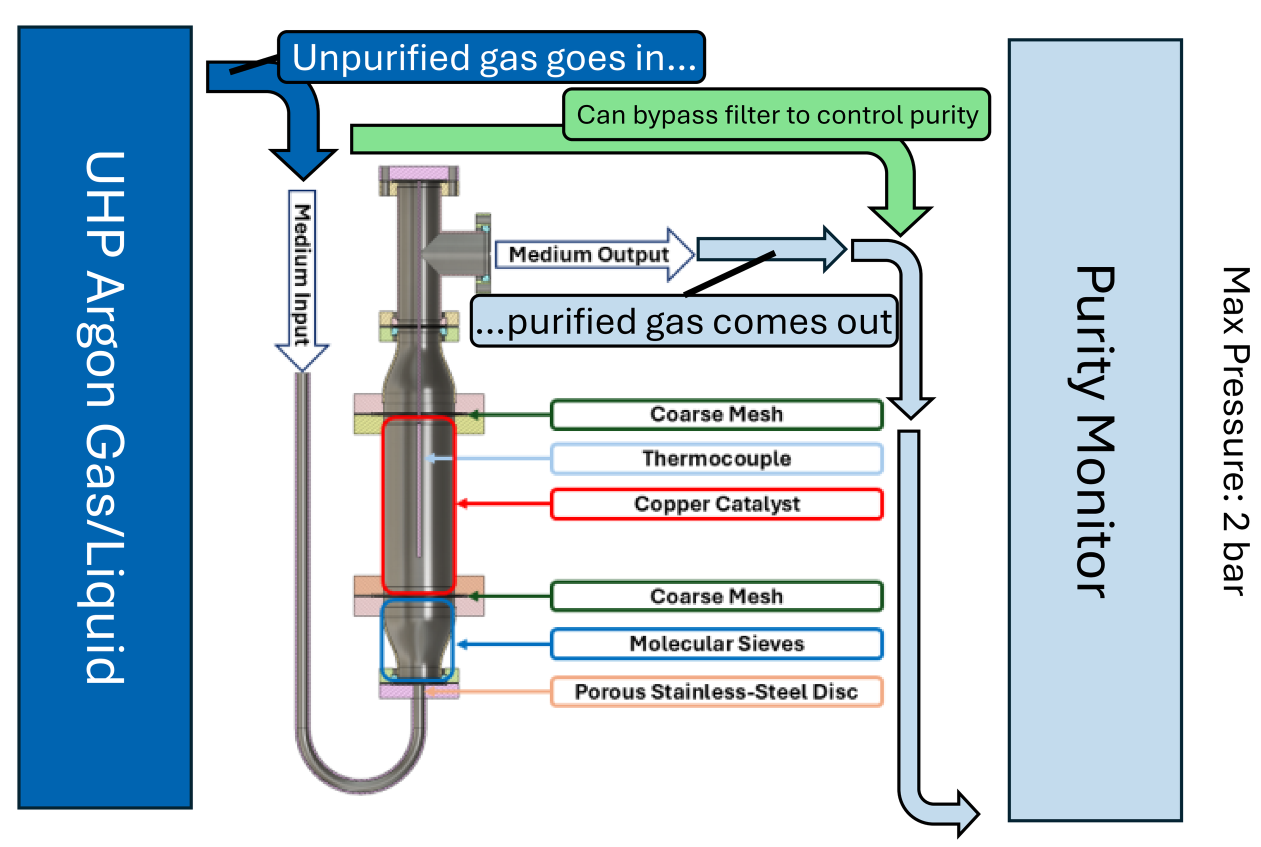
- Gas/liquid Argon TPC designed with the purpose of accurately measuring argon purity
- Uses a Xenon flashlamp to remove charge from a gold photocathode
- The charge is drifted through a short field cage (3.7cm) and collected on a silver anode plane
- Charge collection is correlated to Argon purity





Preparing the Purity Monitor

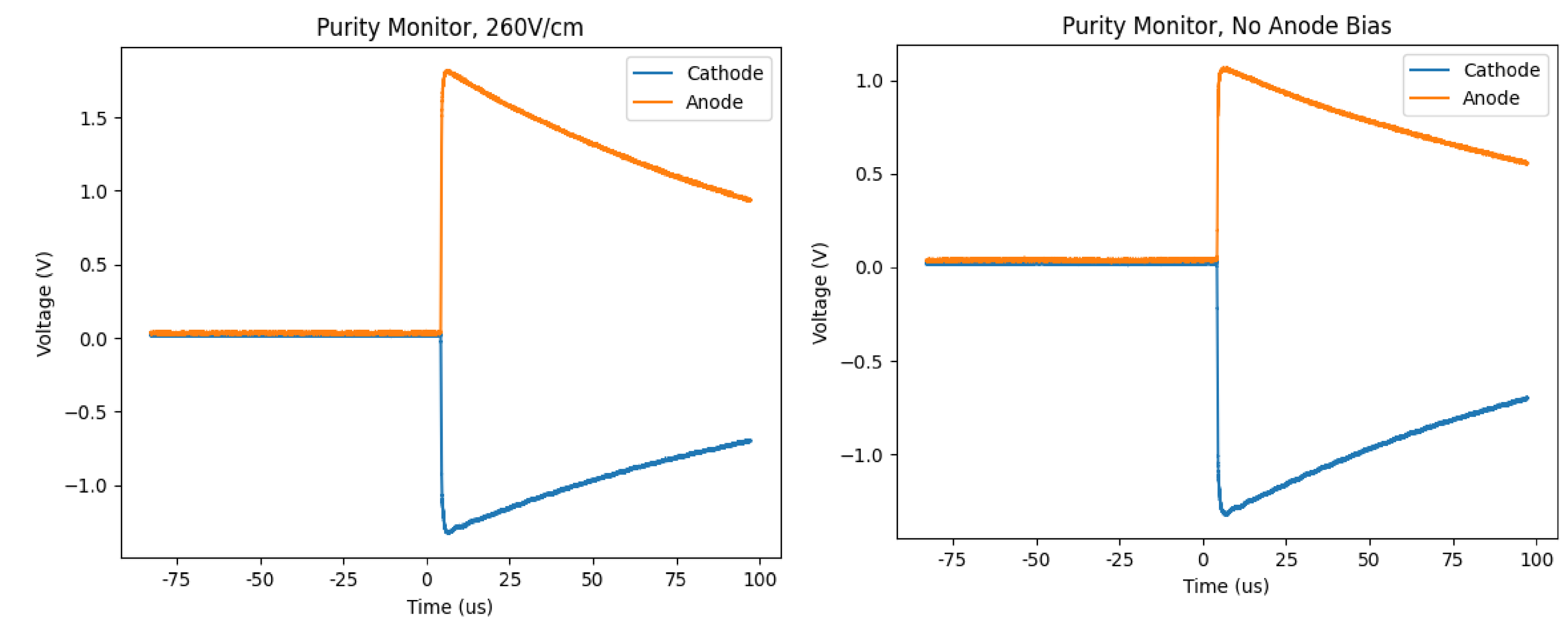
- Characterizing simplified behavior to compare and verify functionality of the electronics
- Comparison of vacuum and gas behavior to meet benchmarks for a full run of the Novel Clockless System



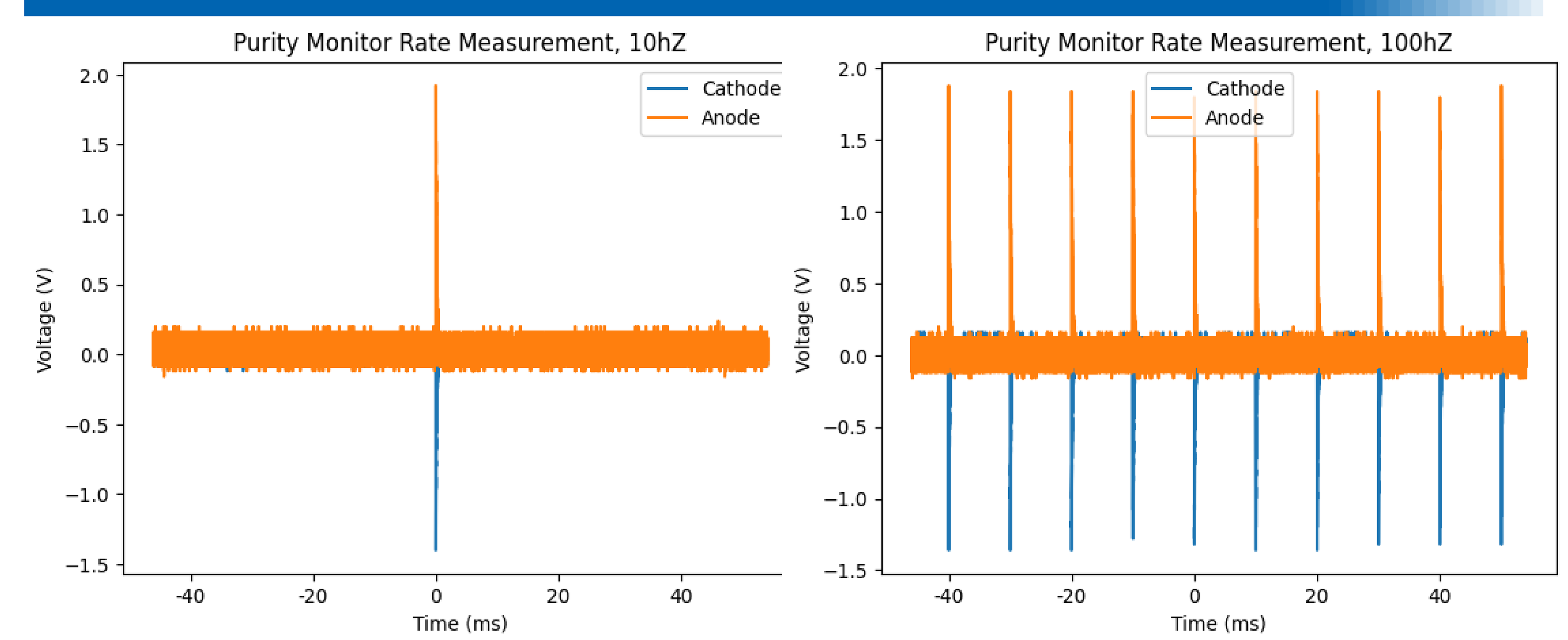
References

Q-Pix: Pixel-scale Signal Capture for Kiloton Liquid Argon TPC Detectors: Time-to-Charge Waveform Capture, Local Clocks, Dynamic Networks, arXiv:1809.10213
Triplet Lifetime in Gaseous Argon, *Eur.Phys.J.A* 55 (2019) 10, 176

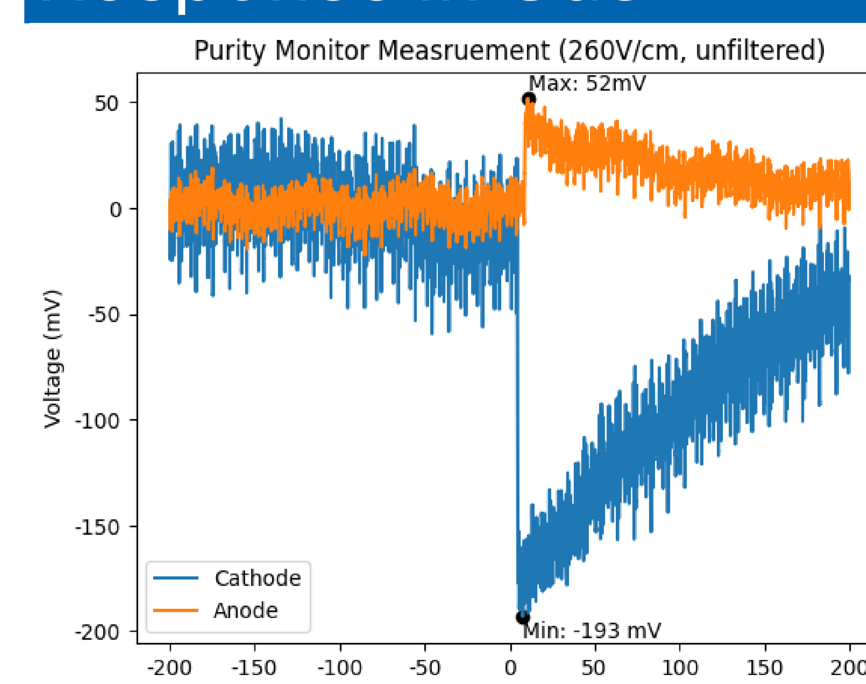
Characteristic Response



Rate Measurement in Vacuum



Response in Gas



- Charge Transport Efficiency: 27%
- Charge Transport Time: 2.92 µs
- Currently: Low signal to noise ratio
- This is expected to go down when connected to the new setup

Acknowledgments

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