

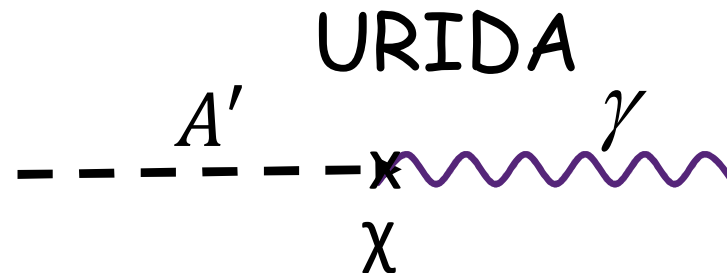
Search for Dark Photon DM in 6–8 eV energy range with URIDA experiment

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Ultraviolet Range Initiated photons from Dark photons in Ambient (URIDA)



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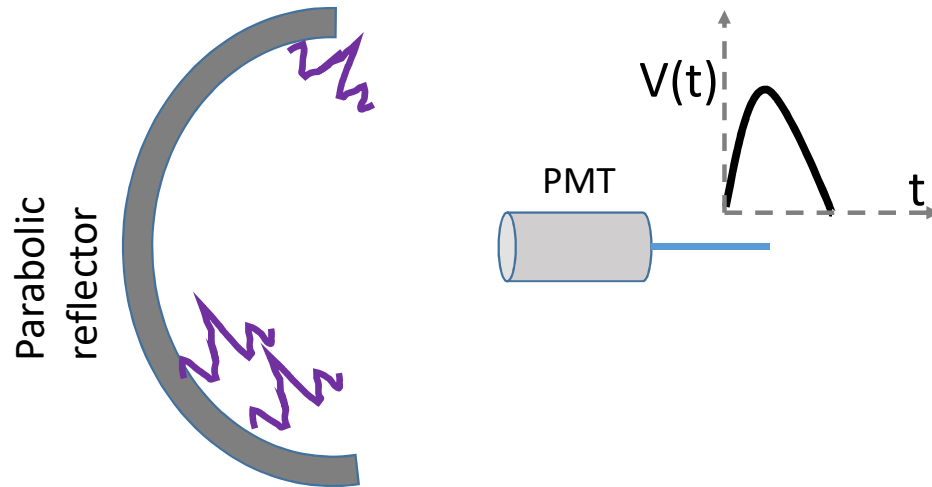
Motivation



- Dark photons can undergo kinetic conversion into vacuum ultra-violet (VUV) photons, providing a partial explanation for stratospheric temperature excursions. (Physics of the Dark Universe 2020 (28), 100497)
- A terrestrial laboratory measurement complements our proposed approach for DM detection in stratosphere with balloon borne experiments. (Symmetry 2023, 15(6), 1167)
- The study in this energy range requires vacuum conditions due to large absorption of VUV in normal atmospheric conditions with absorption length at order of centimeters.

Experimental Setup

Dish Antenna Idea



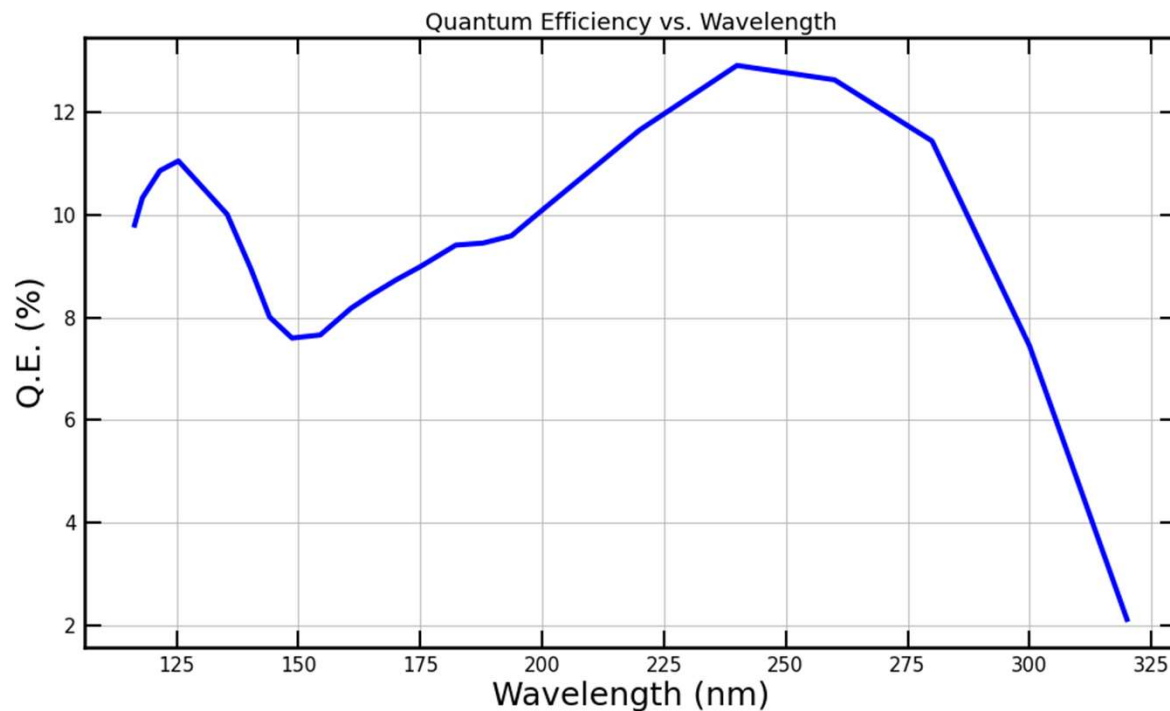
- Larger vacuum chamber
- 0.61 m diameter reflector with 0.15 m focal point

**PMT inside the vacuum Chamber
Custom made from Hamamatsu for
low pressure environments**

**The HV for operating the PMT
was set to 1350 V**

- **signal to rise above the noise**
 - **Dark rate the lowest**

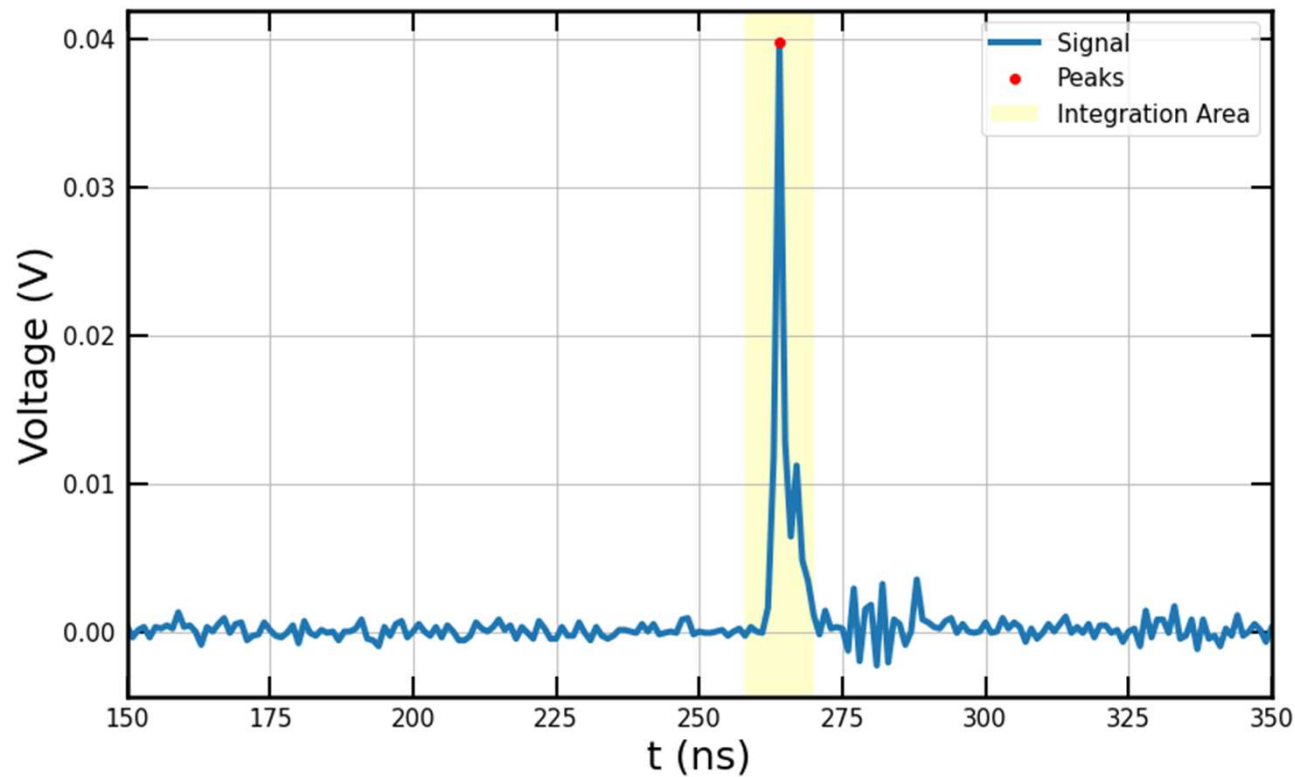
**The PMT's sensitivity is
from 100 -300 nm**



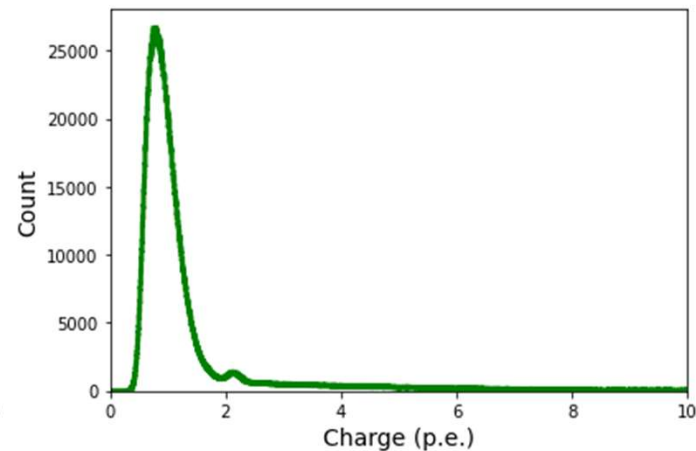
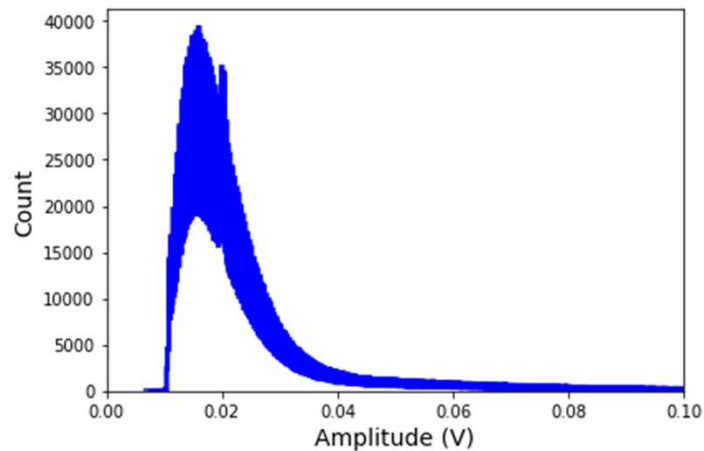
Data Collection

- A data-set of dark rate with fully enclosed PMT was collected first
- The data was collected over a three month period, with measurements of 1 week interval alternating between opening or closing a mechanical shutter located at a distance of about 0.1 m from the PMT.
- Pressure in the vacuum chamber was monitored at different times of the day with values starting from 10^{-4} Torr at the beginning of the runs and 10^{-5} Torr at the end of the 3 month period. The temperature in the room was maintained constant at 25 degrees Celsius.
- Data is acquired using a DRS4 evaluation board capturing the analog waveforms in 1 μ s trigger window.

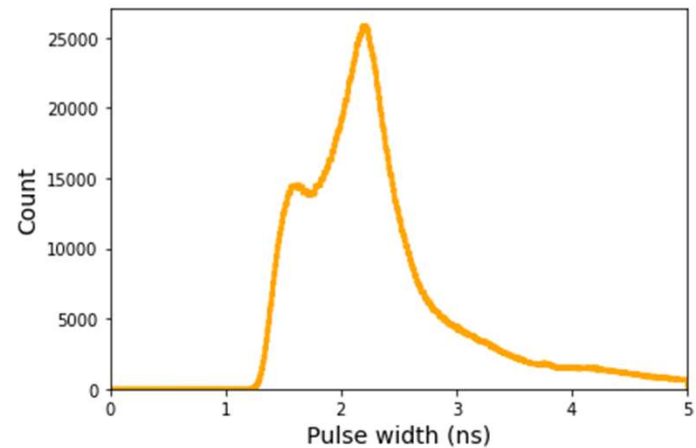
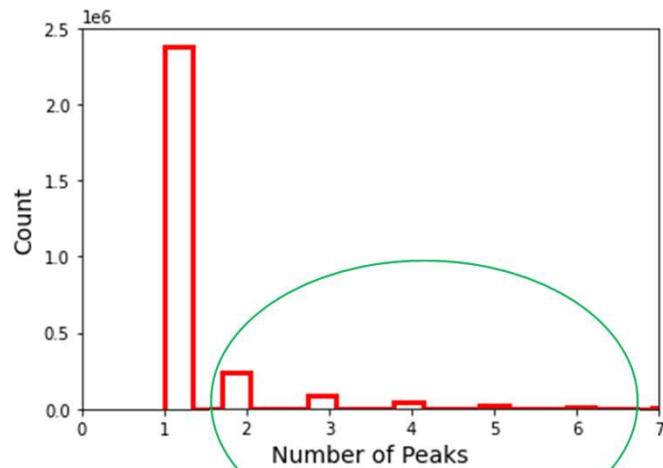
Single photon pulses



An algorithm finds amplitude and charge of the peaks , peak widths and timestamps of the events and saves for further analysis

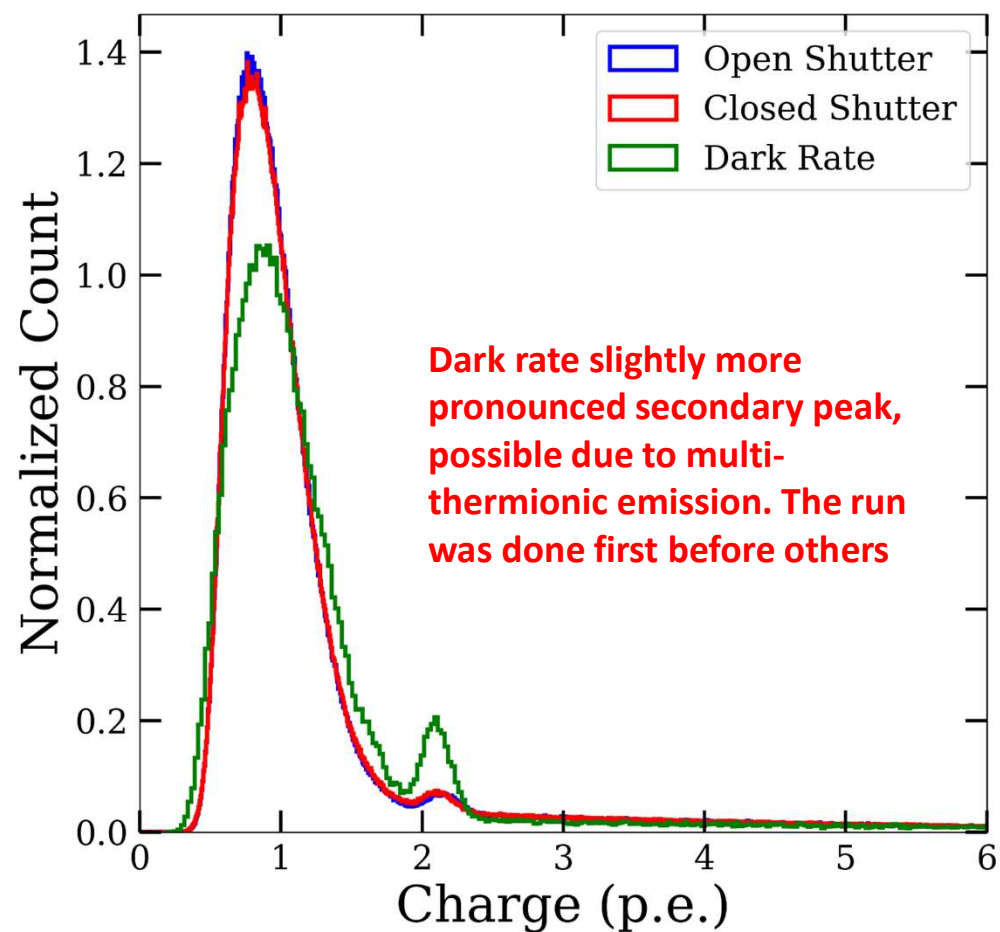
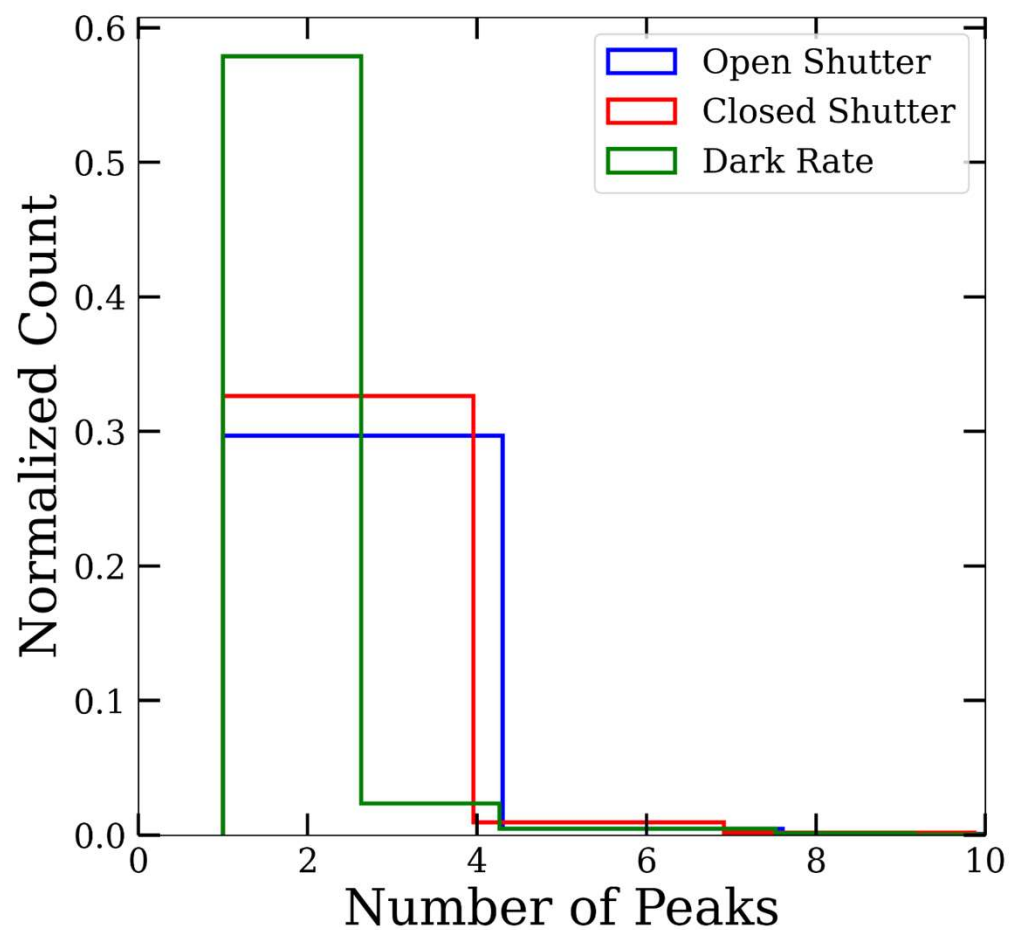


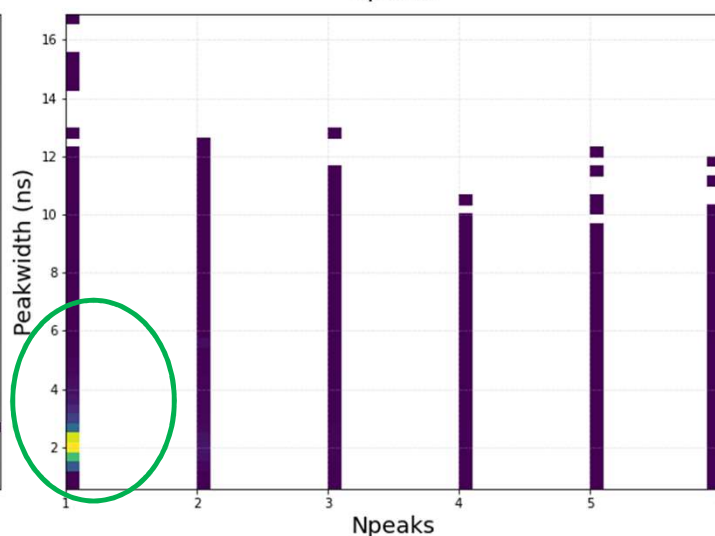
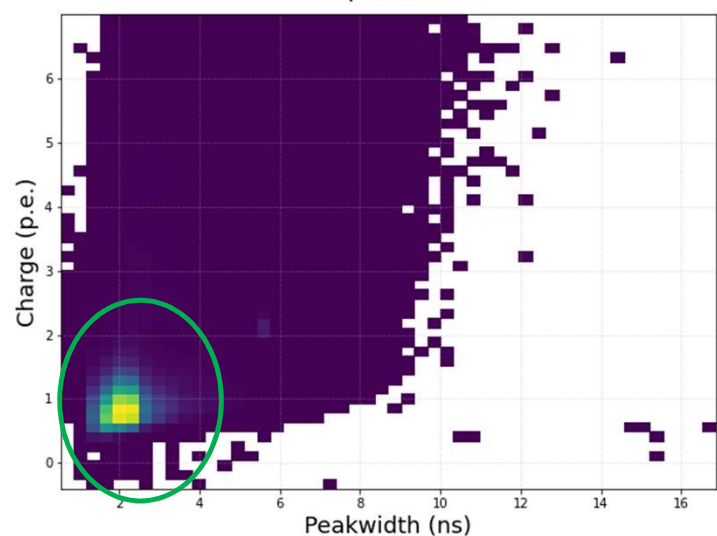
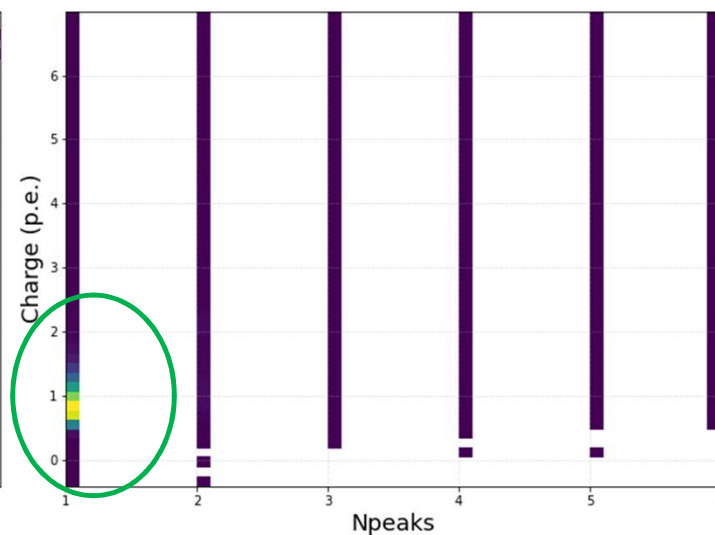
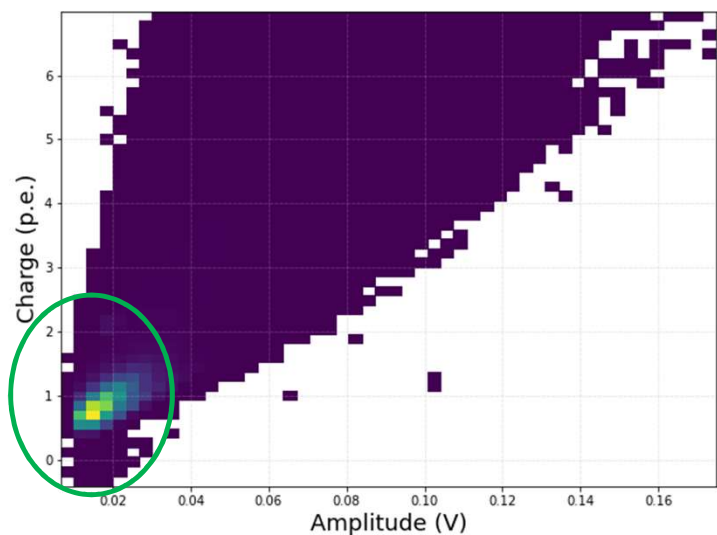
Distribution of some of
Of the data from the
open shutter case



Number of events with
peak number > 1 is about
10% . This is mostly
due to after-pulsing.

Peak number and charge distribution for three configurations.





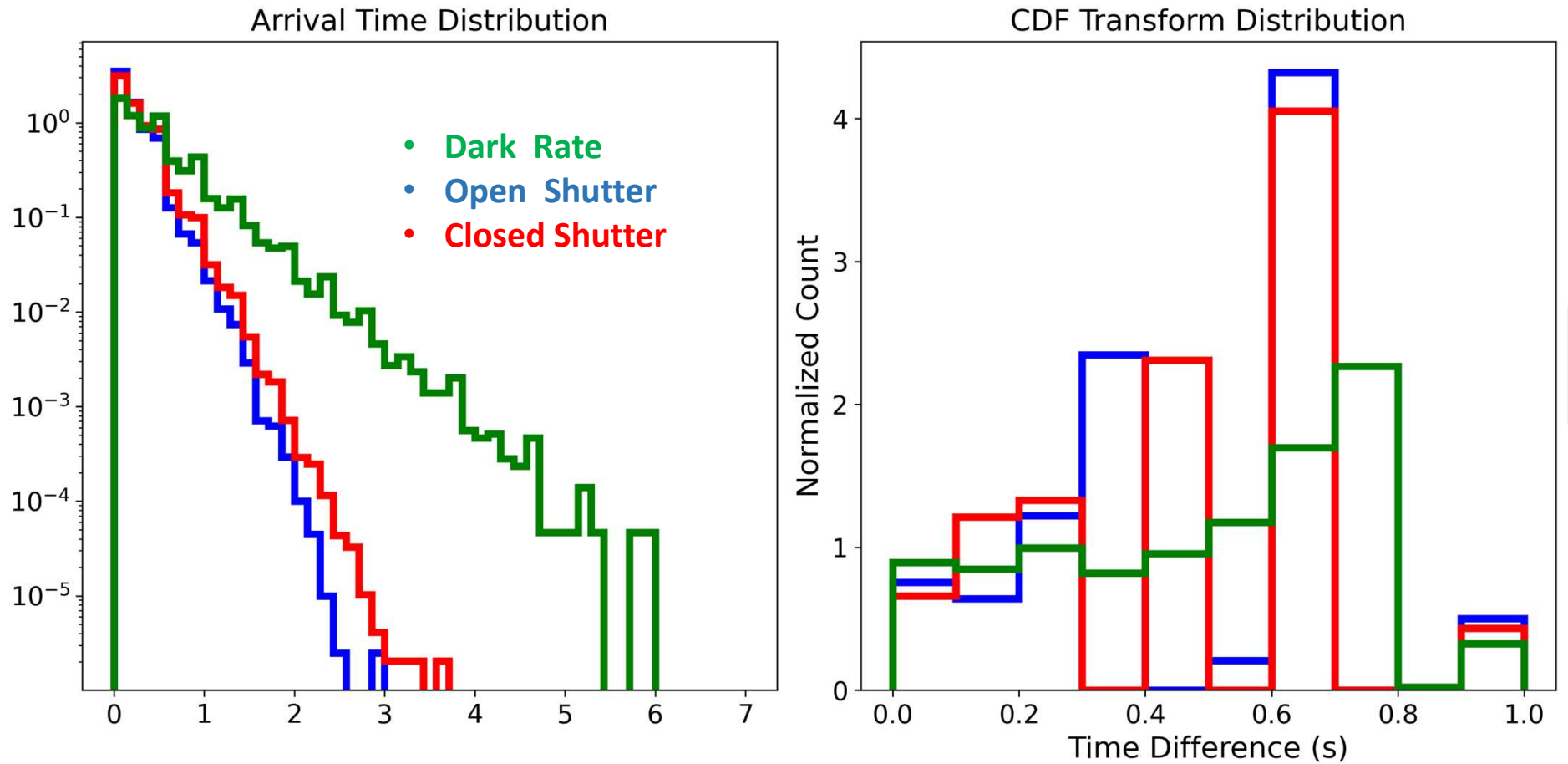
Single photon events marked with green we implement quality cuts to select these events:

charge < 2.5 p.e.

amplitude < 0.1 V

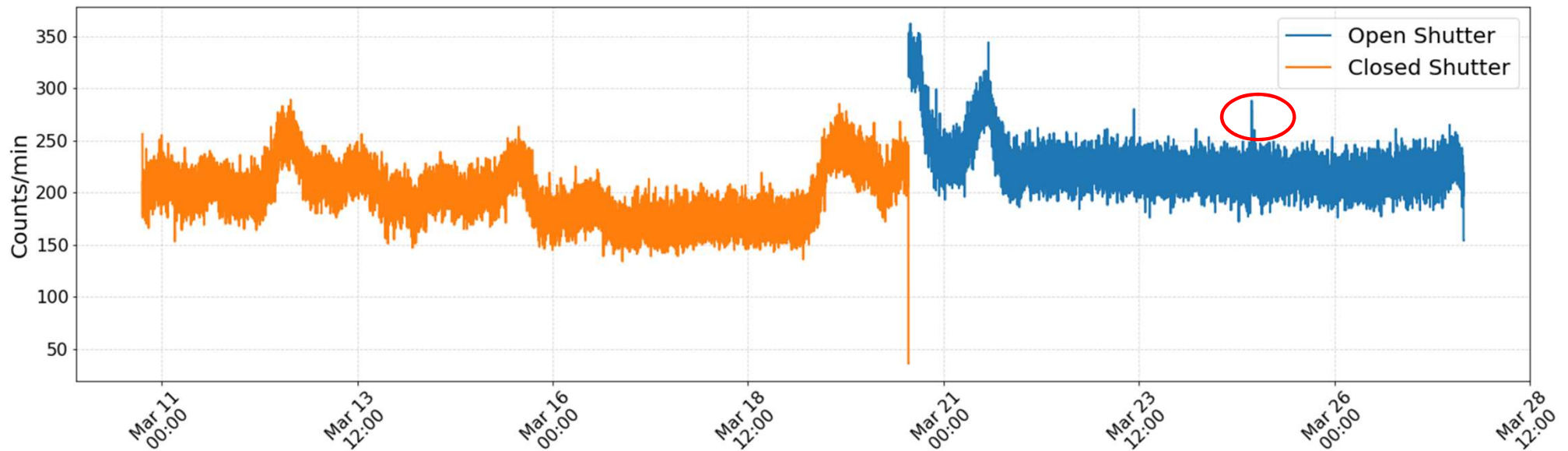
num_peaks < 2

Peak width < 4 ns



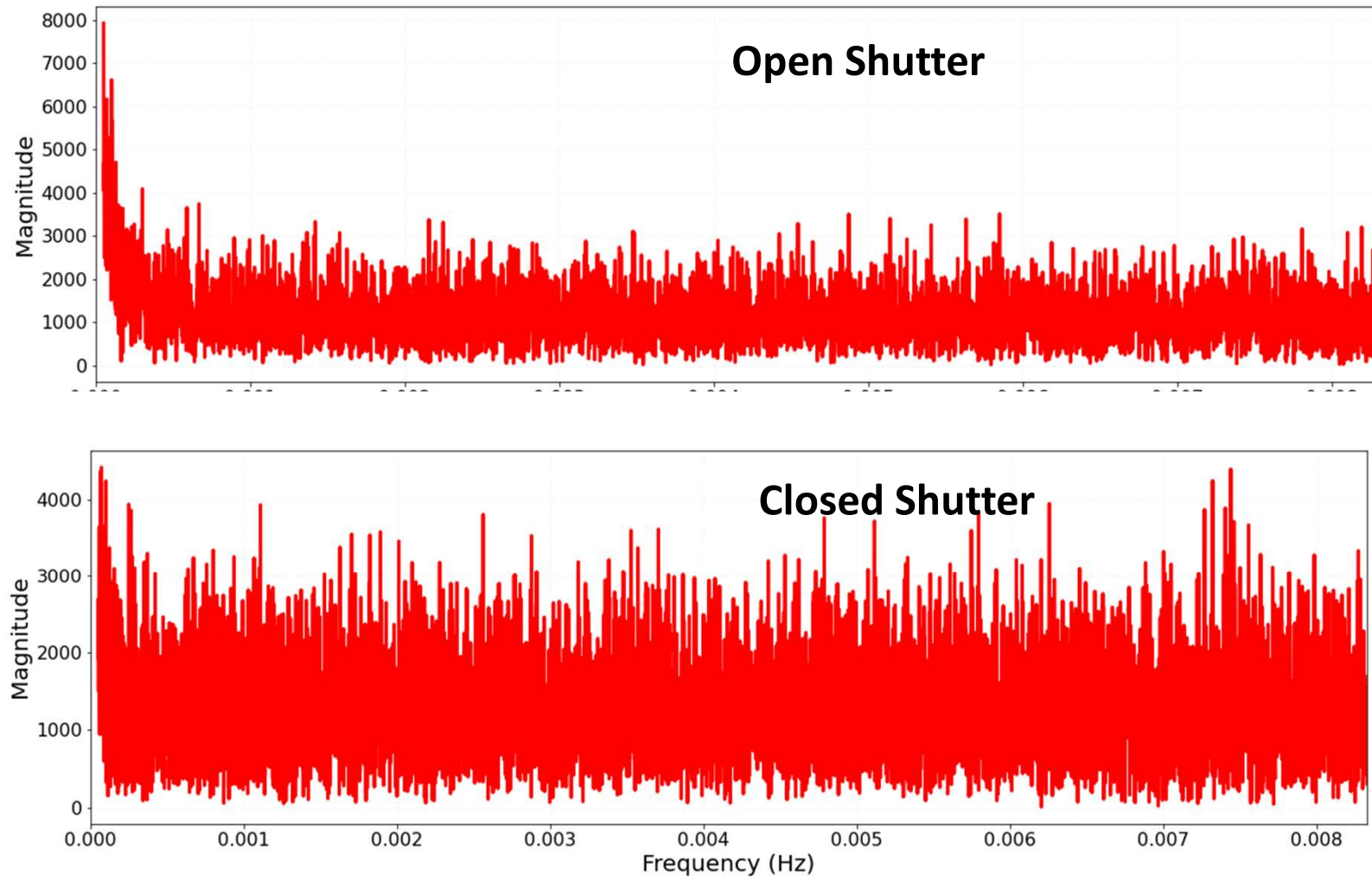
Both arrival time difference between successive events and the CDF transform show that the dark rate is closer to Poissonian distribution.

Counts per minutes for two sub-sets of data.



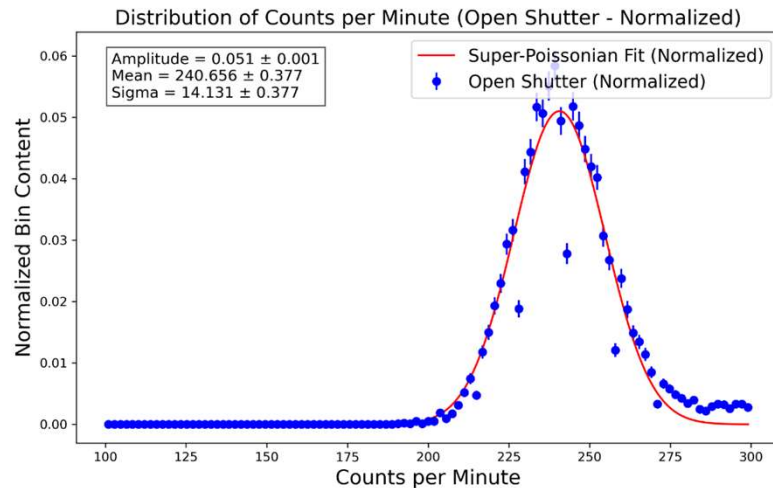
The small spikes are possible Cherenkov events from cosmic ray muons. The threshold energy for a muon to produce Cherenkov events at these typical pressures is >400 GeV, but there are Cherenkov events in the PMT's glass

Fourier Spectrum



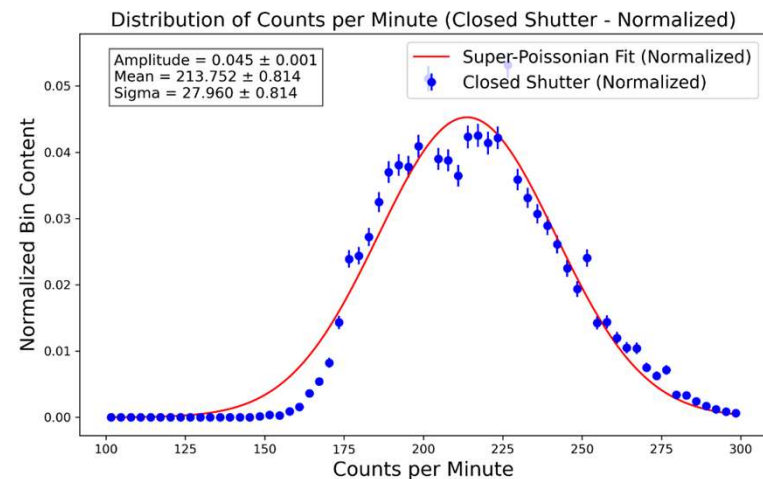
Open Shutter

Counts/s = 4.01 ± 0.01



Closed Shutter

Counts/s = 3.56 ± 0.01



**There is a difference between the two mean values for open versus closed.
Possible by a small illumination in which the reflector enhances it.**

Summary & Outlook



- URIDA experiment has been assembled and we collected about three months of data.
- In this preliminary analysis, we have narrowed down the algorithm for peak finding, we have also optimized the cuts for events of interest selection.
- A difference is noticed between the open shutter versus closed shutter counts possible due to a small illumination that enhanced by the reflector in the open shutter case. Need to understand
- Will continue with further analysis to understand all the different sources of background, possibly acquire more data
- Goal is to expend as part of a network for cross correlated measurements.