

A-QNET Update: Quantum Background vs Altitude

Dec 17, 2024

Andrew Conrad¹, Samantha Isaac², Paul Kwiat²

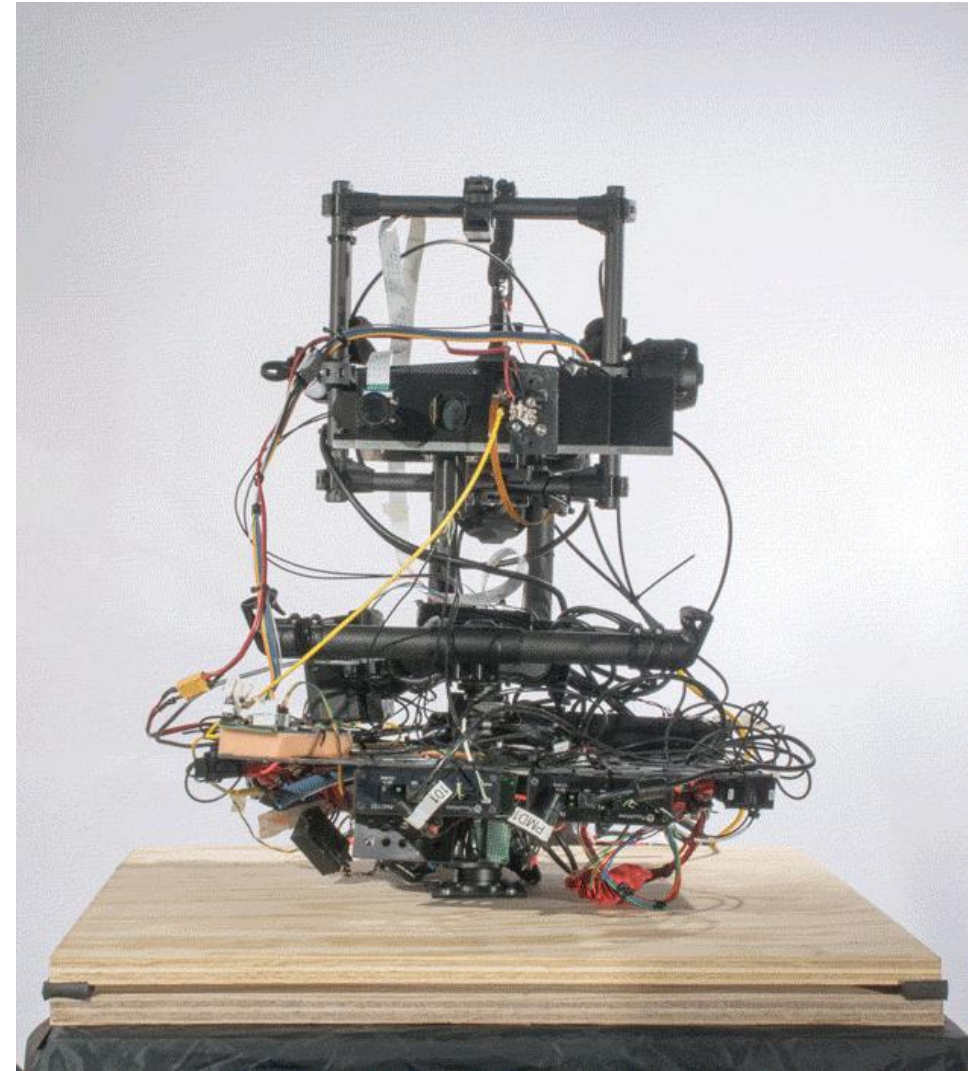
¹Electrical and Computer Engineering Department, University of Illinois Urbana-Champaign (UIUC), 306
N Wright St., Urbana, IL, USA

²Physics Department, University of Illinois Urbana-Champaign (UIUC), 1110W Green St., Urbana, IL, USA

System Design

System Overview [1,2]:

- Quantum Transmitter (Alice)
 - Quantum Key Distribution (QKD) source:
 - Resonant cavity LED
 - Decoy state
 - Polarization encoded
- Quantum Receiver (Bob)
 - Single-Photon Detectors (SPCM-AQ4C)
 - FPGA-based Time-Tagger
 - Qubit-based Time Synchronization (Post-processing)
- Pointing, Acquisition, and Tracking (PAT) system
- **Modular Design: Isolated from mobile platform**
 - *No shared power, communications, or control*



Photos courtesy Timur Javid

[1] Conrad, A., Isaac, S., Cochran, R., Sanchez-Rosales, D., Rezaei, T., Javid, T., ... & Kwiat, P. (2023, March). "Drone-based quantum communication links." In Quantum Computing, Communication, and Simulation III (Vol. 12446, pp. 99-106). SPIE.

[2] Conrad, A., Isaac, S., Cochran, R., Sanchez-Rosales, D., Wilens, B., Gutha, A., ... & Kwiat, P. (2021, March). "Drone-based quantum key distribution (QKD)." In Free-space laser communications XXXIII (Vol. 11678, pp. 177-184). SPIE.

Drone Platform



Flight Plan

Altitude Plan:

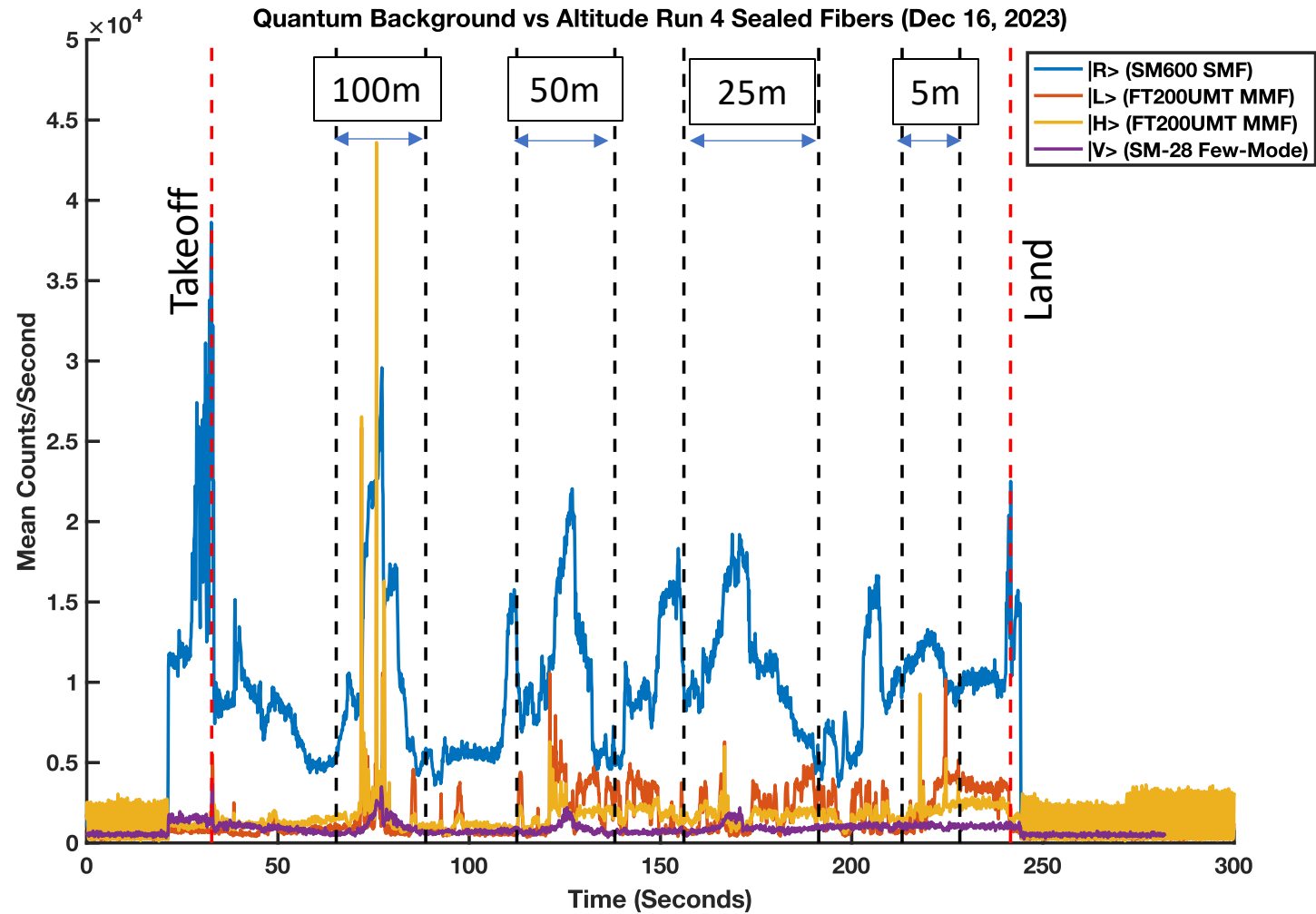
- 100m
- 50m
- 25m
- 5m

The screenshot displays the ALTA_QGroundControl v1.0.6 interface. At the top, a status bar shows mission details: Selected Waypoint (Alt diff: 0.0 m, Azimuth: 0, Distance: 0.0 m, Gradient: --, Heading: 180), Total Mission (Distance: 1 m, Time: 00:00:21), and Max telem dist: 3 m. Below this, a control panel includes radio buttons for Mission (selected), Fence, and Rally. A list of waypoints is shown on the right, with the first waypoint selected and its configuration visible: Altitude 5.00 m (Rel), Hold 1 secs, Flight Speed 3.0 m/s, and Camera settings. The main map area shows an aerial view of a residential area with a flight path and a 'Planned Home' label. A scale bar indicates 25 m. At the bottom, a 'Terrain Altitude' bar shows the planned altitudes for each waypoint (P, 1, 3, 5, 7, 9, L) and a 'Time' slider with 'No Flight Data selected..' and 'Replay Flight Data' buttons.

Drone Flight Evolution



Quantum Background vs Altitude



Note:

- MMF and Few-Mode fibers were black-jacketed
- SMF was partially black-jacketed

Summary

Summary

- Measured drone-based quantum background vs altitude and direction
- Outdoor quantum measurement/testing requires black-jacketed fibers (even at night)
- Background was not significantly different from 5m-100m altitude at night
- Slight dependence on azimuthal direction