ETSI/IQC Quantum Safe Cryptography Conference 2026

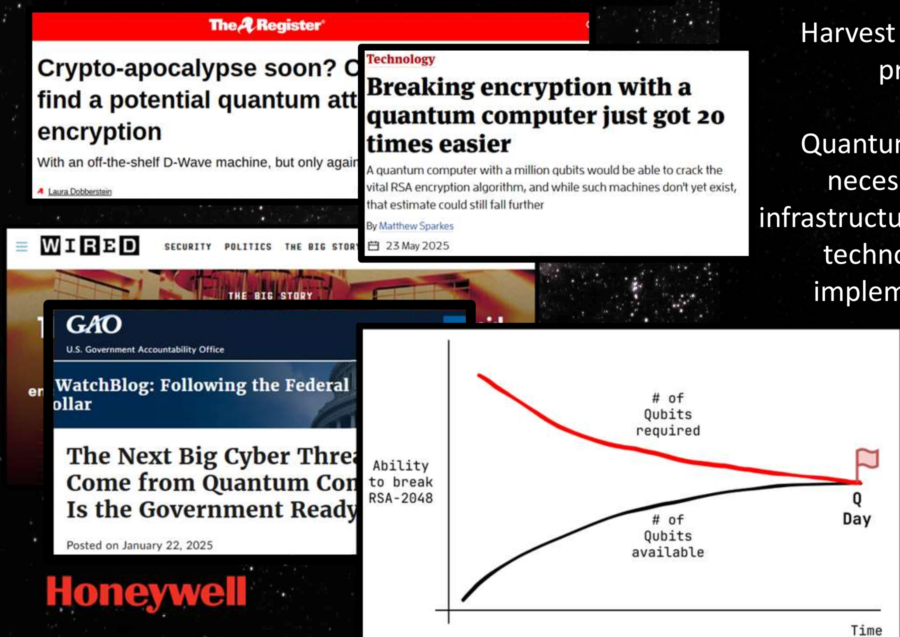
Global quantum-safe networks and test beds enabled by satellite

Presented by: Hugh Podmore, Lead Optical Systems Engineer

Honeywell Aerospace

18/06/2026

Threat
Quantum Computers



Customer Need / Problem
Data Security

Harvest Now, Decrypt Later, a clear and present danger even today

Quantum information technologies will necessitate a Quantum networking infrastructure, parallel to classical information technology but radically different in implementation which will take time.

Solution
Quantum Safe Network

Quantum key distribution (QKD) is the only known key exchange method that is mathematically proven to be secure against quantum computing attacks but limited a few hundred kms for distribution.

Honeywell solves / enable global distribution with Satellite connectivity and will first to demonstrate in North America and Europe.

This infrastructure built for QKD is the first stepping stone towards future quantum communications infrastructure.

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QUANTUM SPACE & TERRESTRIAL APPLICATIONS FOR TELECOMMUNICATIONS ENCRYPTION (Q-STATE)

Secure today and adapt to tomorrow's innovations : solutioning together, engaging today!

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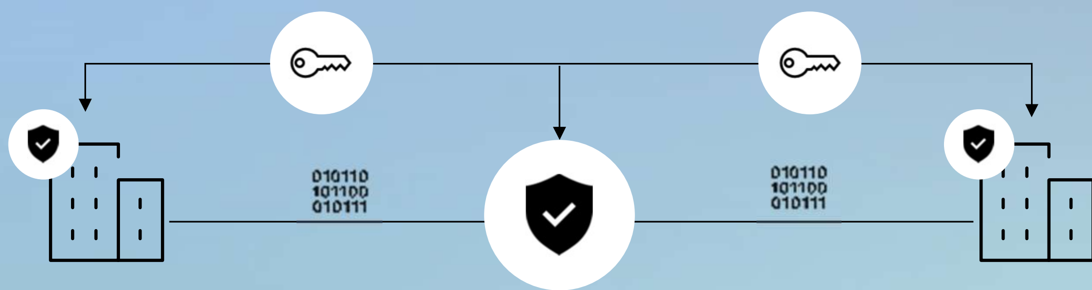
Satellite based QKD

- QKD Cryptography
- Orchestrated Cryptography
- Physics PSK Cryptography
- PKI-PQC Cryptography

Empower government agencies, and enterprises to swiftly fortify their communication infrastructures



National & Pan-national (terrestrial & subsea)
Mission-critical networks for the quantum era

NOKIA
Terrestrial based QKD

- High capacity Low latency
- Multi-layers
- Automated

Honeywell's space-based expertise complements Nokia's terrestrial QSN capabilities, enabling a comprehensive solution

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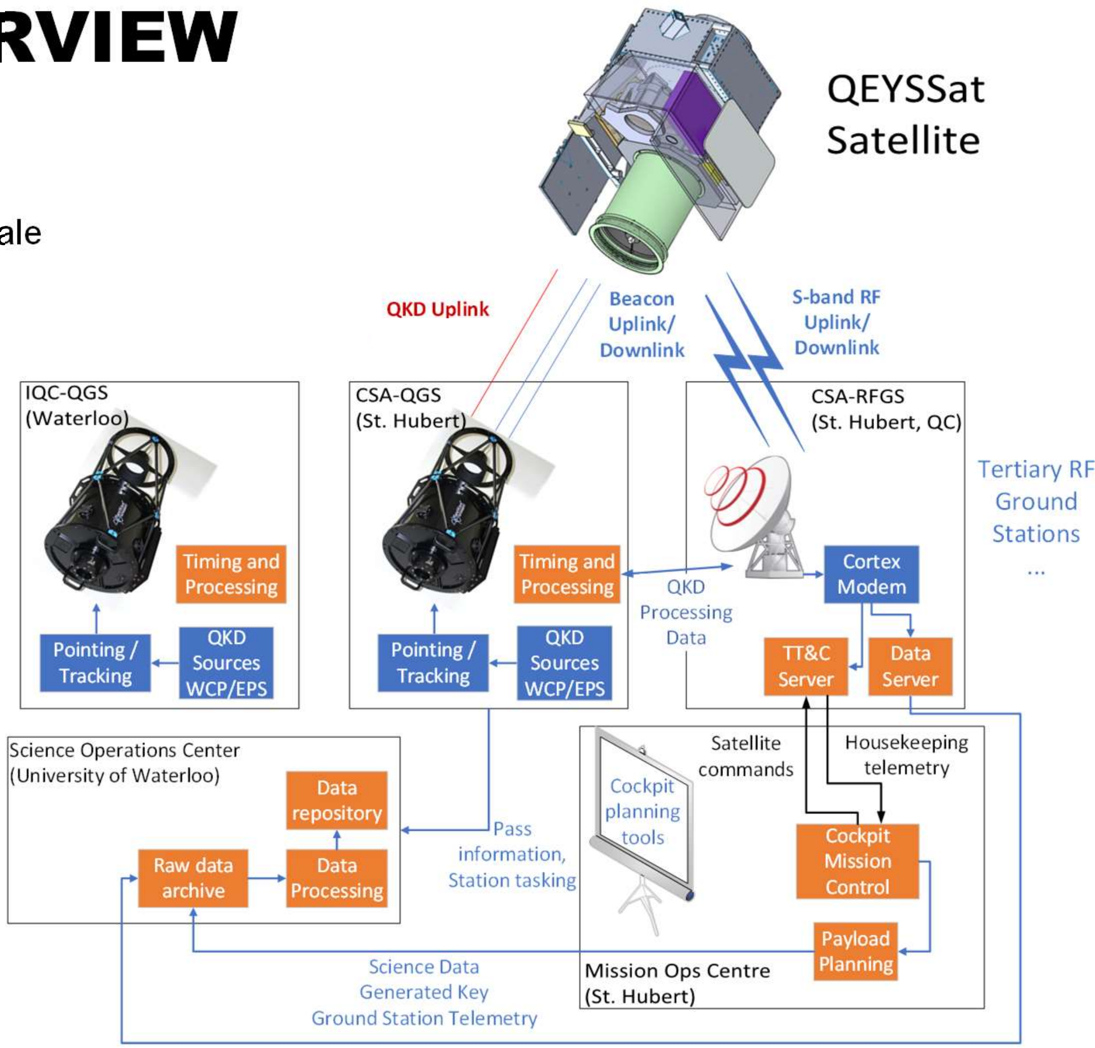
QEYSSAT MISSION OVERVIEW

Mission Objectives

1. Demonstrate secure key distribution on a global scale
2. Perform fundamental tests of quantum physics



Mission at-a-glance

- Concept studies dating back 10 years see *J-P Bourgoin et al 2013 New J. Phys. 15 023006*
- Uplink: "Bob" spacecraft, "Alice" ground stations
- Downlink: "Alice" spacecraft, "Bob" ground stations
- 600 km sun-sync orbit
- ≈8 min overhead passes
- BB84 and BBM92 protocols
- Polarization encoding
- Direct detection w/ Si-APDs
- Various quantum sources

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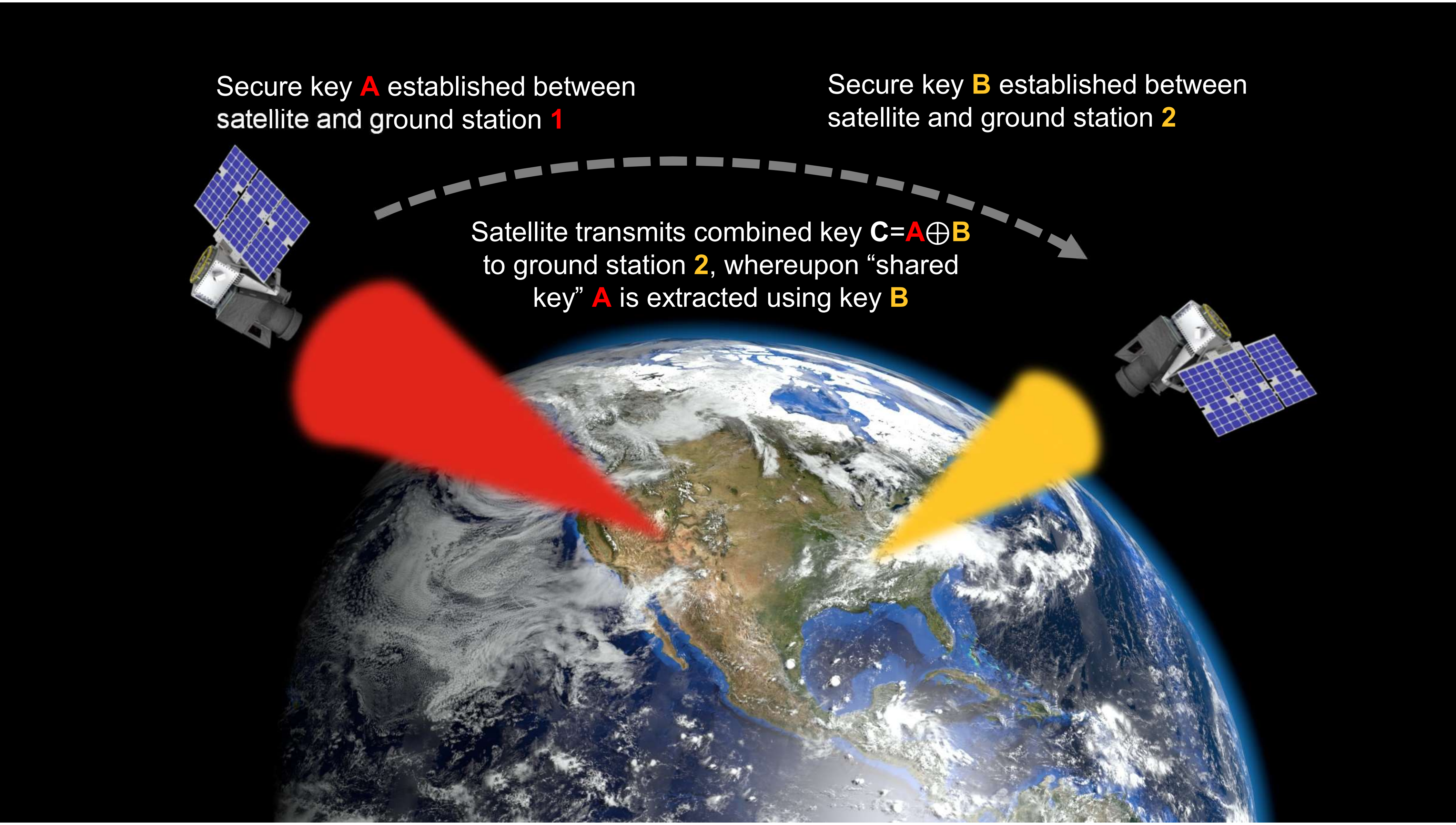

Secure key A established between satellite and ground station 1
Secure key B established between satellite and ground station 2
Satellite transmits combined key C=A⊕B to ground station 2, whereupon "shared key" A is extracted using key B

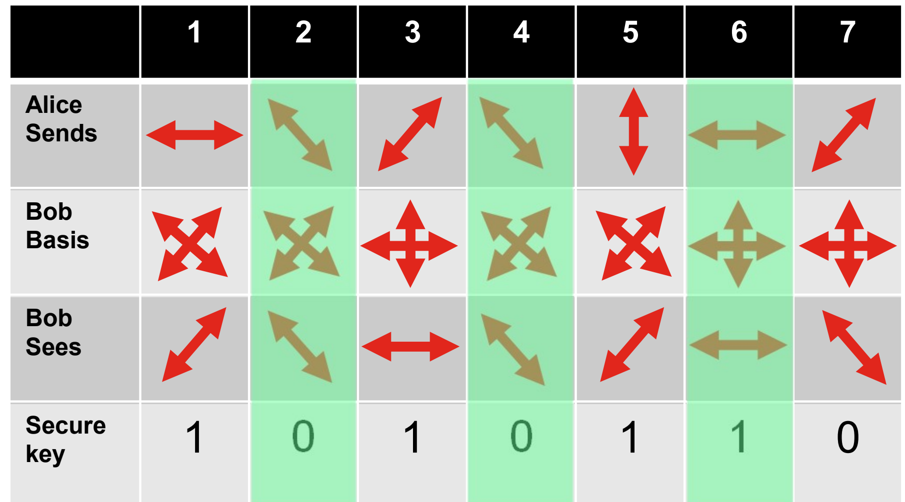
KEY CONCEPTS IN QKD

QEYSSat will use established BB84 and BBM92 protocols for key transfer

- Transmit key using single photons in two polarization bases
- Receiver randomly selects measurement basis
- Transmitter publishes basis used (but not polarization)
- "Sifted" bits form secure key

Metric of interest: key rate

- Mission level requirement to achieve >10 kbit secure key in a single overhead pass
- Higher key rate makes it easier to perform rapid distribution of keys between multiple sites
- Key rate is proportional to $R_{key} \propto N_{pulse} \times T_{Link} \times (1 - f(Error))$



$$Error_{\mu} = \frac{n_{dark}\Delta t + p_{opt}\mu\eta G_{link}}{2n_{dark}\Delta t + \mu\eta G_{link}}$$

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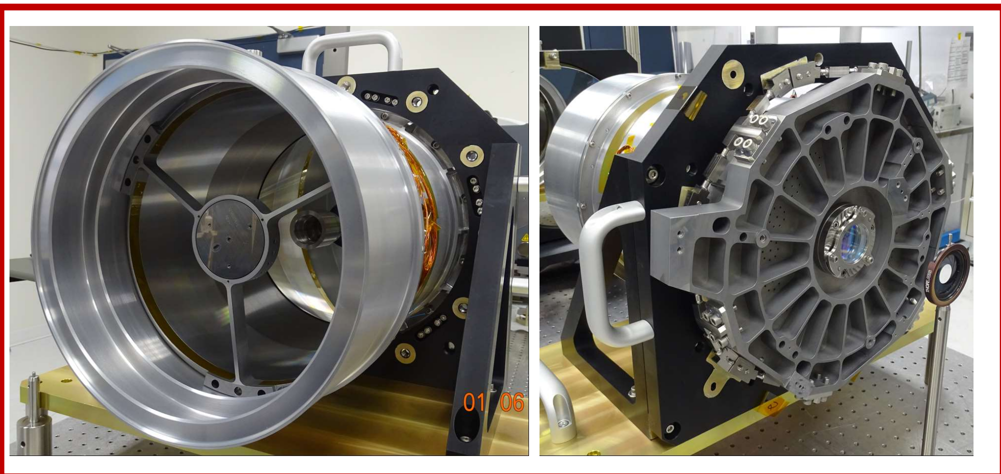
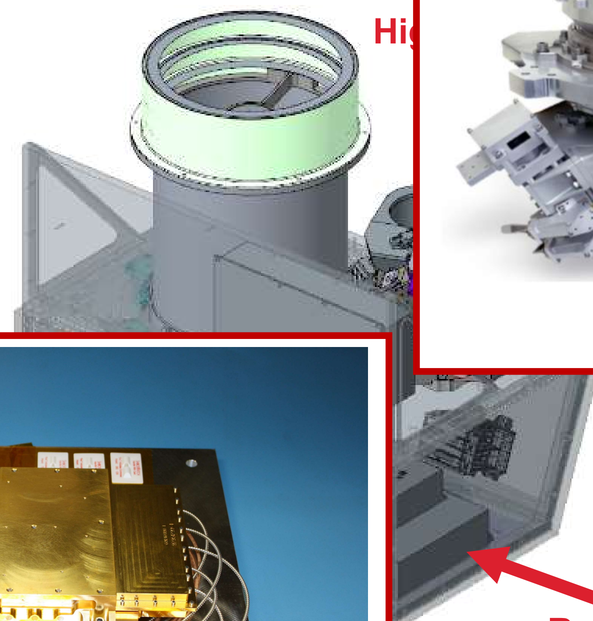
- X. Ma, B. Qi, Y. Zhao and H.-K. Lo, "Practical decoy state for quantum key distribution," Phys. Rev. A, vol. 72, p. 012326, 2005.
- J.P. Bourgoin et al, "Experimental quantum key distribution with simulated ground-to-satellite photon losses and processing limitations", Phys. Rev. A 92, 052339, 2015

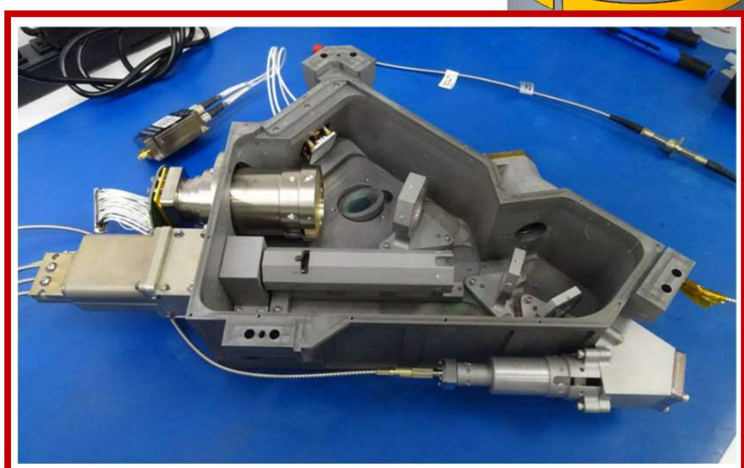
QEYSSAT TERMINAL AT-A-GLANCE

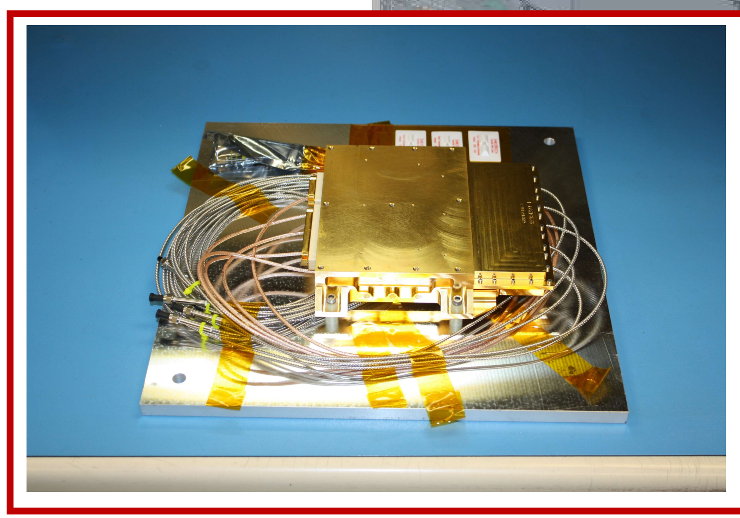


$$\frac{+ p_{opt}\mu\eta G_{link}}{\Delta t + \mu\eta G_{link}}$$



Hi





Payload control electronics

POLARIZATION-MAINTAINING OPTICS

Quantum Bit Error Rate (QBER) of payload directly measured

25 cm BB telescope average QBER measured over clear aperture at 0.03% in V/A and <0.06% in H/D

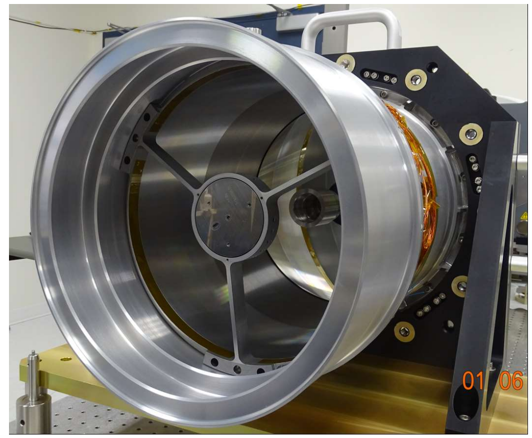
- H and D channels limited by systematics; it is likely that QBER < 0.03% in all channels

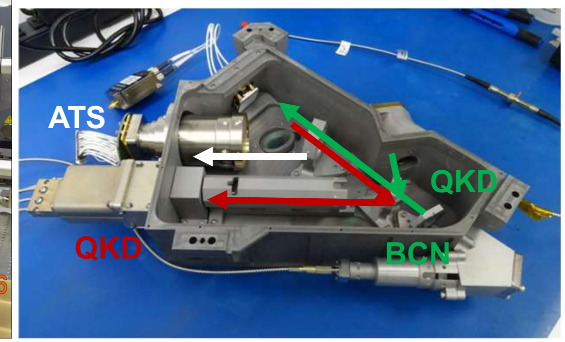
Optical bench system demonstrated average QBER <0.15% for Quantum Rx path

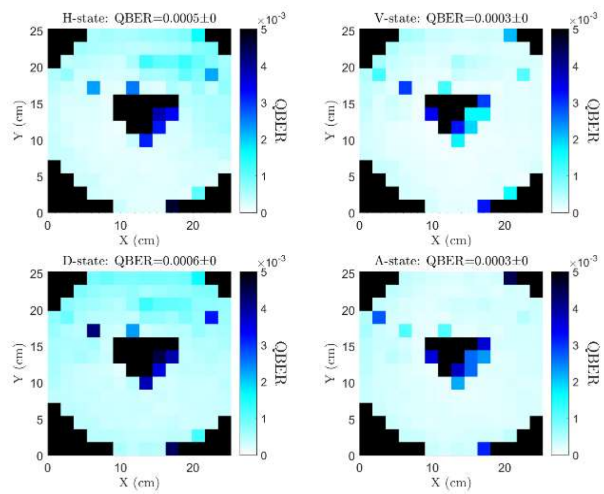
- Tight polarization control achieved over complex arrangement of >15 tilted and curved surfaces
- QM Optical bench achieved **QBER <0.2%** over TVAC and vibe in all channels

$$R_{key} \propto N_{pulse} \times T_{Link} \times \left(1 - f(Error)\right)$$

$$\boldsymbol{Error_{\mu}} = \frac{\boldsymbol{n_{dark}\Delta t + p_{opt}\mu\eta G_{link}}}{\boldsymbol{2n_{dark}\Delta t + \mu\eta G_{link}}}$$







OB Channel	QBER
Vertical	0.06%
Horizontal	0.02%
Diagonal	0.08%
Anti-diagonal	0.24%

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TRACKING SENSOR

Pixelated tracking sensor + fine-steering mirror running in highspeed control loop

High tracking accuracy over wide FOV

- <2 urad real-space centroid error over ±5.2 mrad FOV

High sensitivity

- ≈25 pW acquisition sensitivity, < 1 nW tracking sensitivity

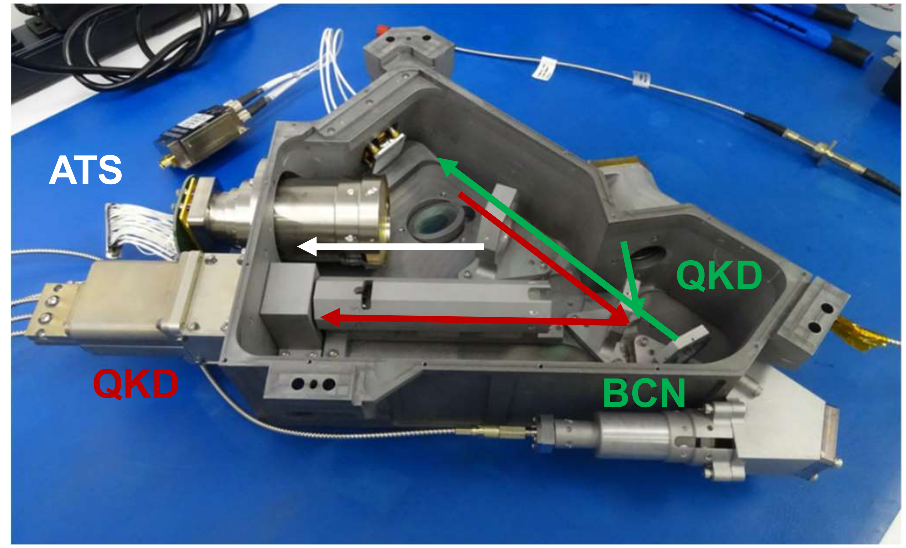
Off-center tracking

- Can re-calibrate Rx boresight anywhere within the FOV
- Can track off-center to provide point ahead correction during downlinks

Radiation testing of selected detector completed in 2019

$$R_{key} \propto N_{pulse} \times T_{Link} \times (1 - f(Error))$$

$$Error_{\mu} = \frac{n_{dark}\Delta t + p_{opt}\mu\eta G_{link}}{2n_{dark}\Delta t + \mu\eta G_{link}}$$



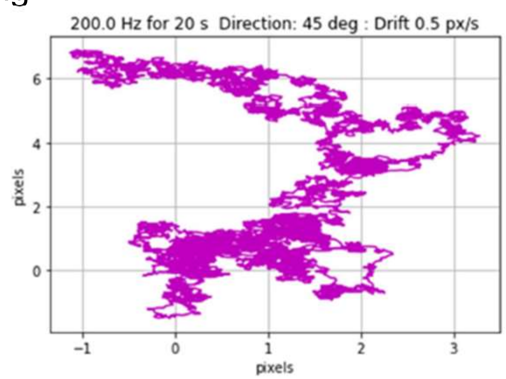
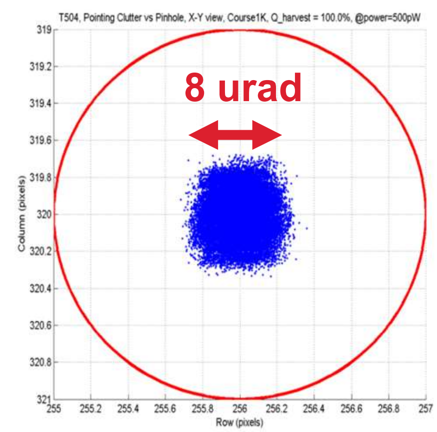


Figure 7-8: Beacon Motion Visualization



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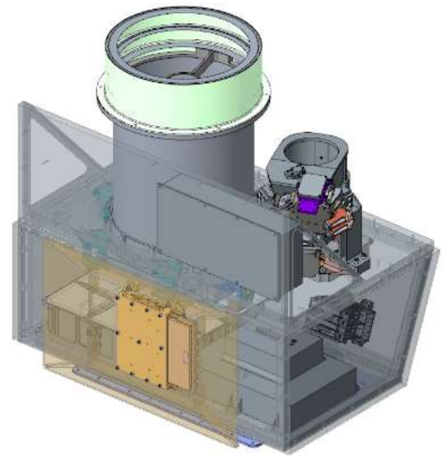
SINGLE PHOTON DETECTORS

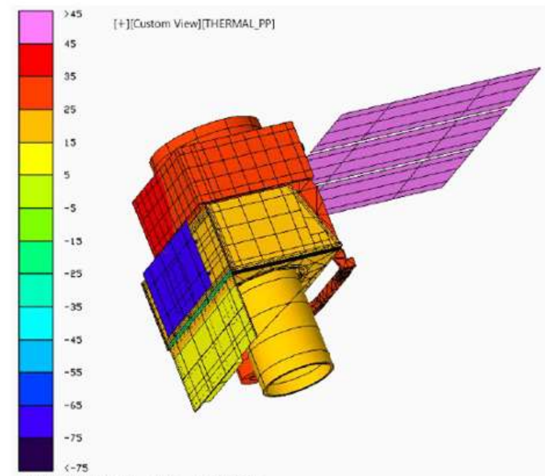
Detector dark counts are a major contributor to mission level key error rate

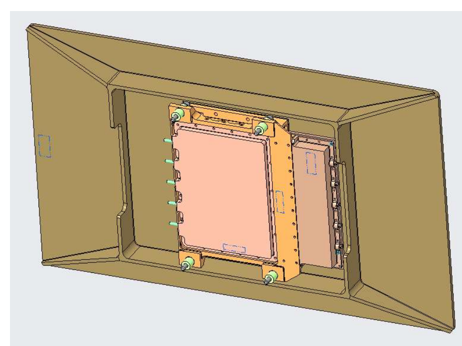
- Effect is 10x stronger than polarization errors
- Mitigated by controlling detector temperature
- Si APD radiation testing studies completed in 2015

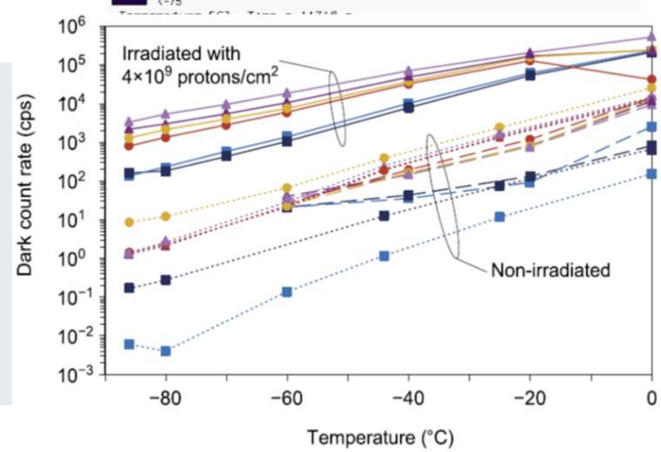
Cold radiator panel on backside of spacecraft designed to bring detectors to -90°C in concert with Peltier cooling

Physical separation from payload using MMF









$$R_{key} \propto N_{pulse} \times T_{Link} \times \left(1 - f(Error)\right)$$

$$\boldsymbol{Error_{\mu}} = \frac{\boldsymbol{n_{dark}\Delta t + p_{opt}\mu\eta G_{link}}}{\boldsymbol{2n_{dark}\Delta t + \mu\eta G_{link}}}$$

E. Anisimova et al., "Mitigating radiation damage of single photon detectors for space applications," EPJ Quantum Technology, vol. 4, p. 10, 2017.

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END-TO-END SIMULATION

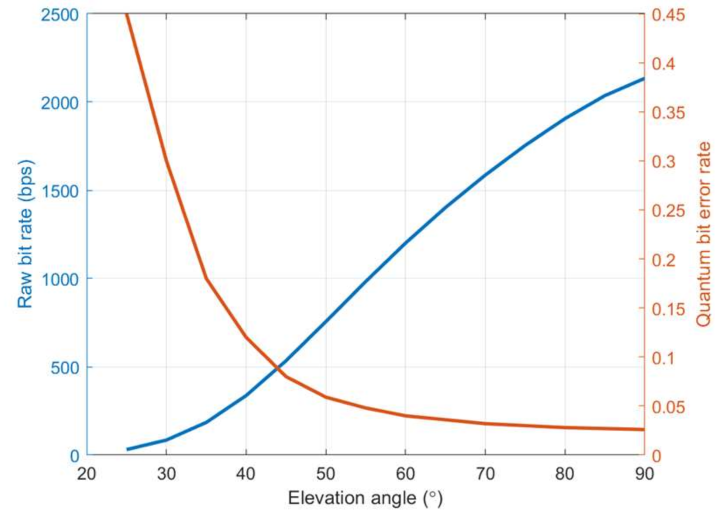
End to end link simulation

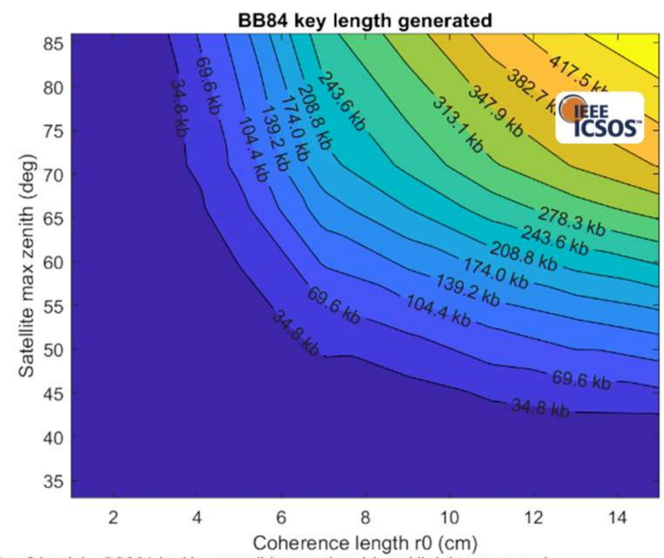
- ~450 Background counts / sec (scene + detector)
- $p_{opt} < 0.5\%$ at payload level
- 44 – 58 dB link loss
  - 10 cm uplink Tx (subaperture)
  - 25 cm Rx
  - r0 = 2.5 cm (high turbulence assumed)

$$R_{key} \propto N_{pulse} \times T_{Link} \times \left(1 - f(Error)\right)$$

$$\boldsymbol{Error_{\mu}} = \frac{\boldsymbol{n_{dark}\Delta t + p_{opt}\mu\eta G_{link}}}{\boldsymbol{2n_{dark}\Delta t + \mu\eta G_{link}}}$$

For end-to-end *testing* of our classical lasercomm systems please see *Al Scott et. al* (Poster #8)





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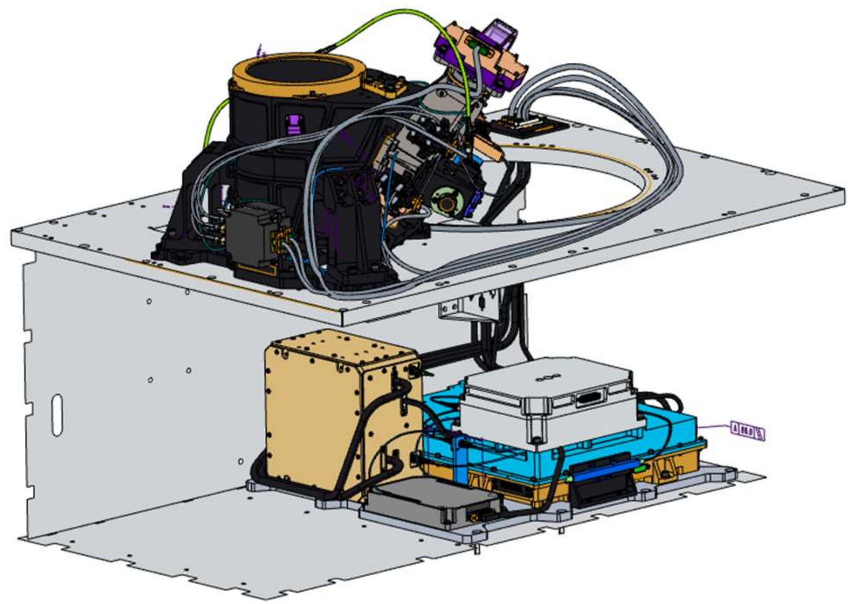
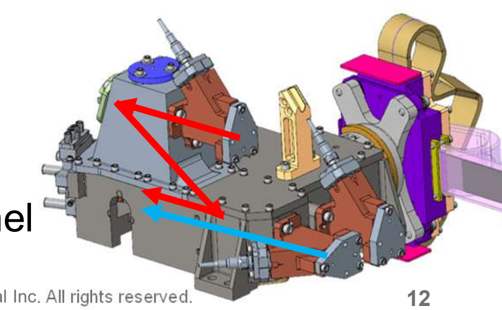
SECONDARY PAYLOAD

- **“QP2” optical communications terminal for uplink / downlink with QEYSSat ground station**
  - Coarse-steering by satellite body-pointing
  - 10 cm unobscured optical aperture
  - 1536 nm downlink / 1553 nm uplink
  - 1.25 Gbps OOK conforming to SDA OCT 2.1
- **Following Honeywell and ESA partnering announcement on the QKDSat project**
  - QP2 will support Quantum Channel downlink on top of optical comms
  - QP2 will be used as a demonstrator and test-vehicle for QKDSat mission operations in subsequent phases



QP2 modification to support WCP channel



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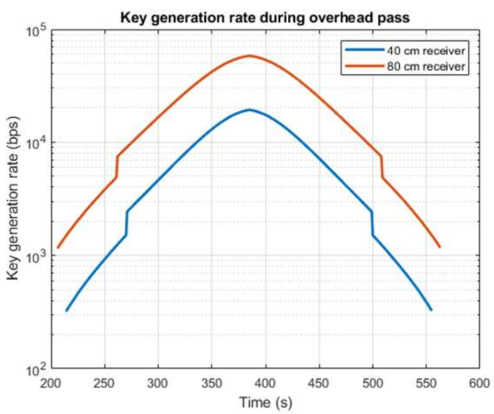
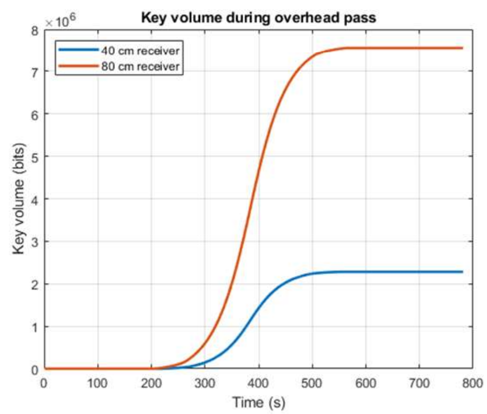
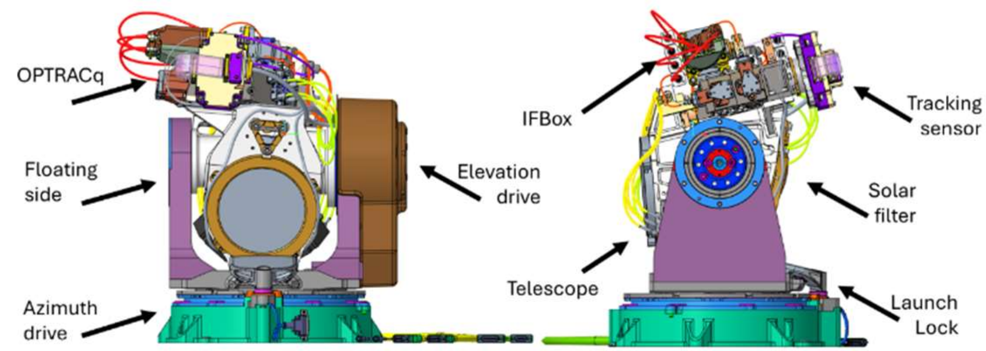
QKDSAT: QKD-AS-A-SERVICE

- **QKDSat network will leverage lessons from QEYSSat secondary payload downlink demonstration**
- **QKDSat system seeks to maximize key volume:**
  - Downlink configuration avoids “shower curtain”
  - Downlink allows scalability of key rate by receiver aperture
  - High-rate quantum source
  - Simultaneous optical comms for real-time key processing and dynamic privacy amplification







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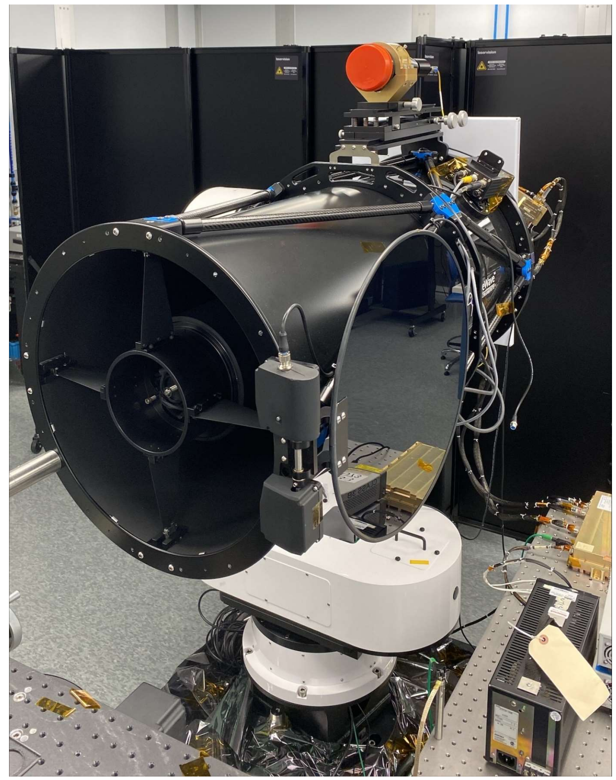
OPTICAL GROUND NETWORK

Transportable OGS Univ. Suffolk

Quantum OGS CSA



QKDSat

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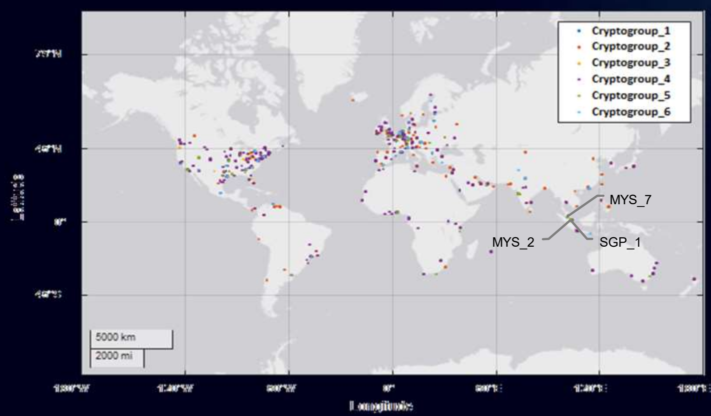
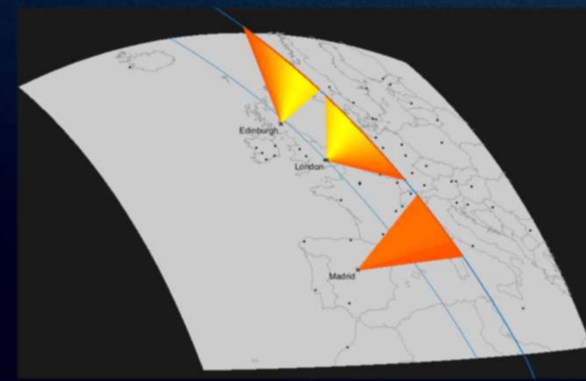
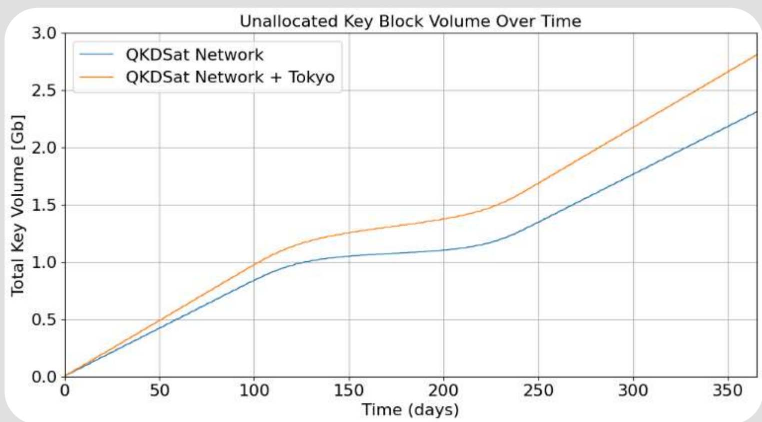
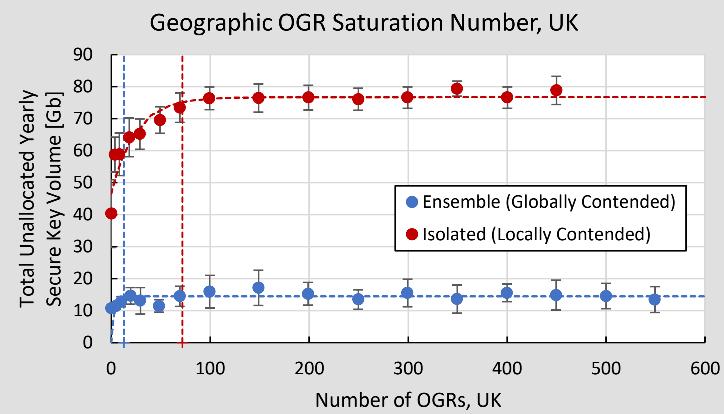
QKDSAT: SCALABLE INFRASTRUCTURE
LEVERAGE GLOBAL DEPLOYMENT ASSETS

- Multiple network users can be serviced by a single LEO satellite
- Keys are generated between satellite and ground and stored in buffers (blocks)
- Network capacity can be scaled by adding additional satellites









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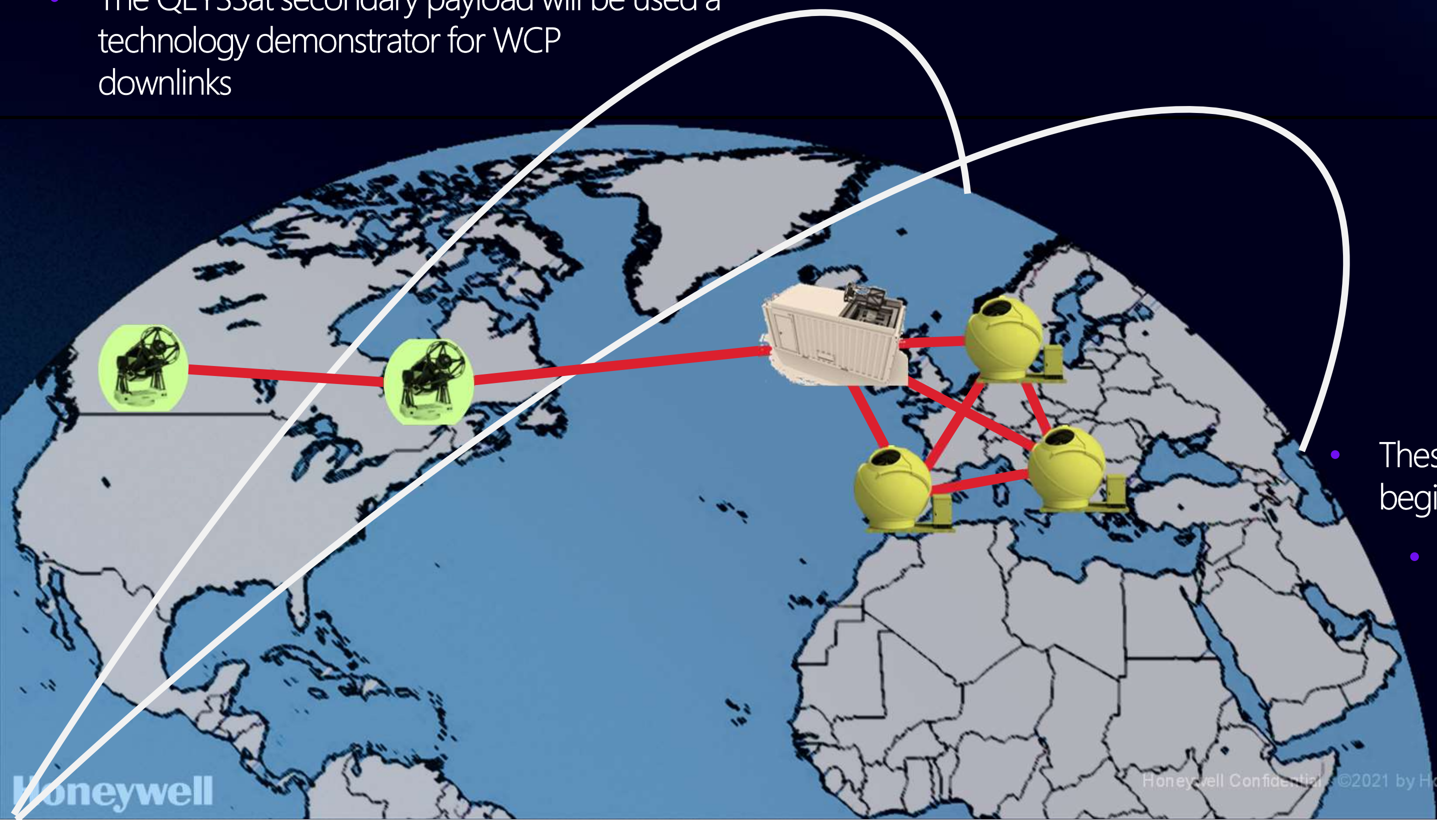
QEYSSAT AND QKDSAT
THE BEGINNINGS OF A QUANTUM NETWORK

- QEYSSat will be used as a technology demonstrator and laboratory platform for fundamental science
- The QEYSSat secondary payload will be used a technology demonstrator for WCP downlinks



- These Space and Ground assets will form the beginnings of a quantum network
  - QKDSat will deliver a high volume of keys to multiple users as an operational system
    - Follow-on missions may leverage this infrastructure for distributed quantum entanglement and networked sensing

THANK YOU

The QEYSSat mission is funded under contract from the Canadian Space Agency (CSA), and is the culmination of many successful CSA funded Science and Technology Development Program studies.

The QKDSat mission relies upon the support of the European Space Agency under the public-private-partnership framework and has benefited from years of development work performed by ArQit Ltd.