EPIC ONLINE TECHNOLOGY MEETING ON SATELLITE QUANTUM COMMUNICATION

Oct. 24th, 2022

Laurent de Forges de Parny

Thales Alenia Space

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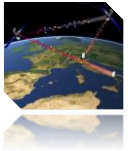
SPACE-BASED QUANTUM COMMUNICATIONS - THALES ALENIA SPACE ROADMAP

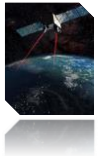
2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029

Quantum Key Distribution System design and building blocks development

LEO and GEO Quantum Key Distribution – Prepare and Measure



LEO and GEO Quantum Key Distribution – Entangled Based



Quantum Information Networks

Projects

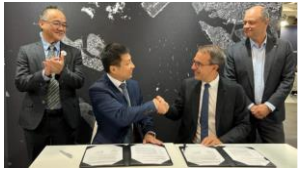
Quantum Key Distribution (QKD)

- **QSAFE / Open QKD** (EC)
- **QKD R&D**, DEP (Digital Europe Program), France QCI
- **SAGA 1G** (ESA/EC) → **SAGA 2G** (ESA/EC)
- **Secure Connectivity** (EC)
- **GEO QKD mission**
- **Terrestrial Interfaces QCI deployments of EuroQCI**
- **TeQuants**

Quantum Information Networks (QIN)

- **SOLUQS** (DGA, R&D) → **Terrestrial Interfaces QCI deployments**
- **RIQS** (CNES) → QIN Demo (SpeQtral) → QIN Deployment

SPEQTRAL AND THALES ALENIA SPACE COLLABORATE TO DEMONSTRATE SATELLITE QUANTUM COMMUNICATIONS USING ENTANGLED PHOTONS



19 SEP 2022 – IAC Paris

More info here → Satellite-based Quantum Information Networks: Use cases, Architecture, and Roadmap (2022) https://arxiv.org/abs/2202.01817

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SPACE-BASED QUANTUM COMMUNICATIONS @THALES ALENIA SPACE

Share confidential random

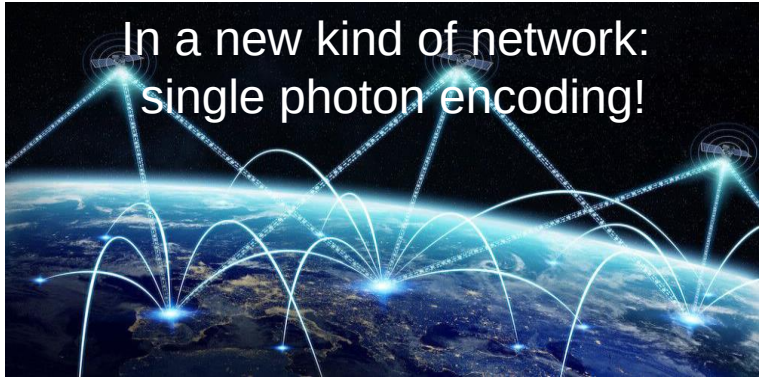
…0101010010110101… …0101010010110101…

Quantum Cryptography (QKD)

Share quantum states

|Ψ>=α|↑>+β|↓>

Quantum Internet (QIN)



Satellite-based entanglement distribution over 1200 km, Yin et al., Science **356**, 1140 (2017)

Satellite-Relayed Intercontinental Quantum Network, PRL **120**, 030501 (2018)

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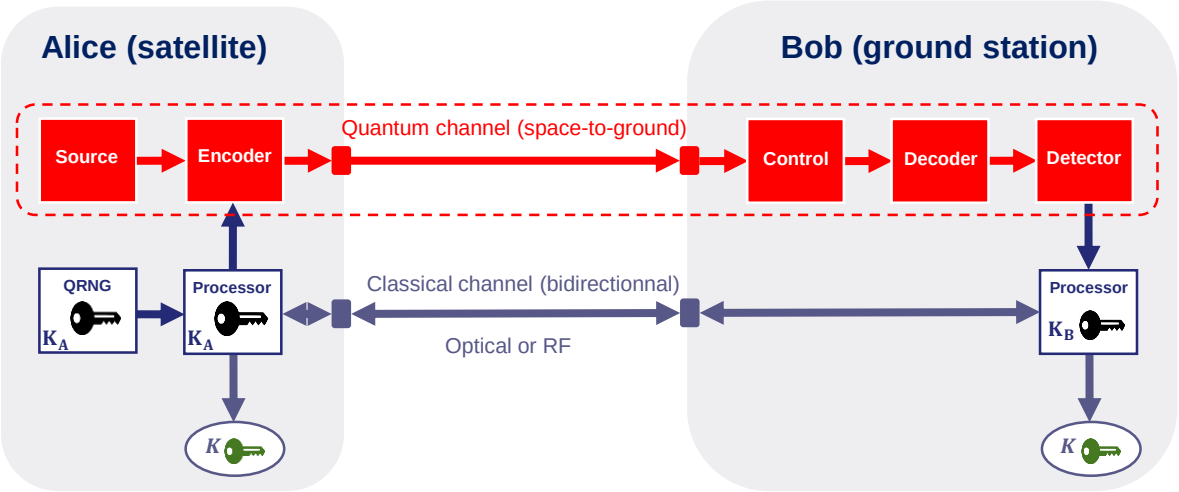
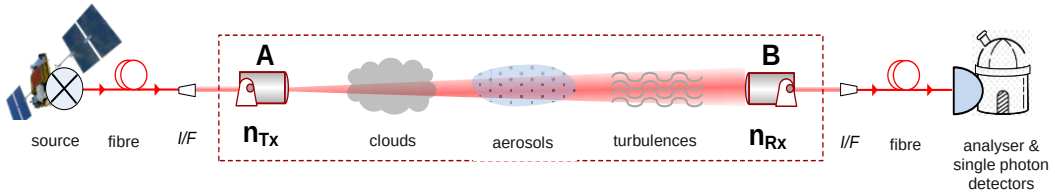
SPACE-BASED QKD SYSTEMS

Encoding quantum information at single photon level



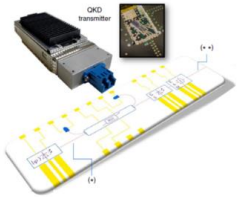


Components:

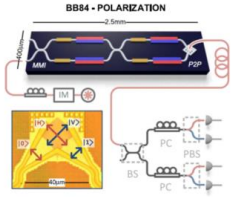
- Laser source (1550/800 nm)
- Intensity modulator
- Optical fibers, connectors
- Polarization controller
- Phase modulator (niobate waveguide)
- High birefringence fiber
- Variable attenuator
- Polarizing beam splitter
- Beam splitter
- Electronic controller (on-board & ground)
- Single photon detector (APD, SNSPD)
- QRNG
- Optical terminal (telescopes, pointing)
- Adaptive optics (ground)
- Processors (on-board & ground)

Emitter on chip perspective

Intagrated QKD source - Option 1



Integrated QKD source - Option 2



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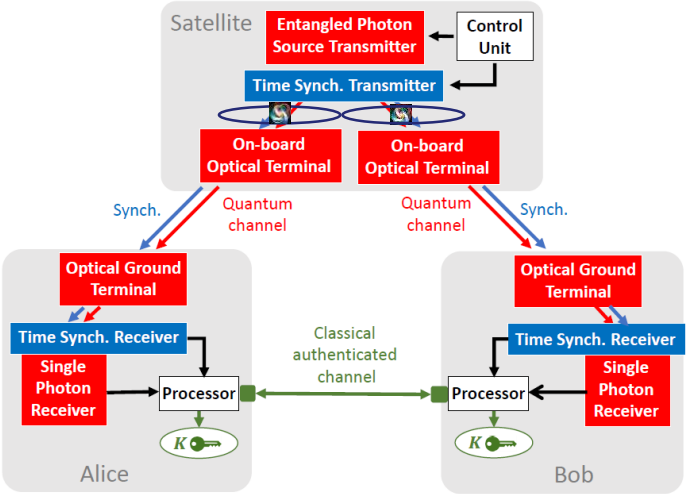
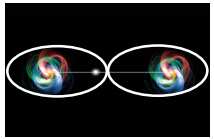
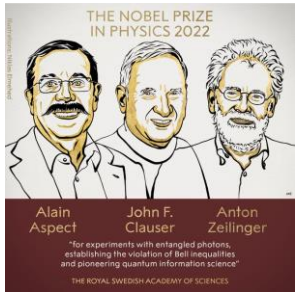
SPACE-BASED QKD AND QIN SYSTEMS



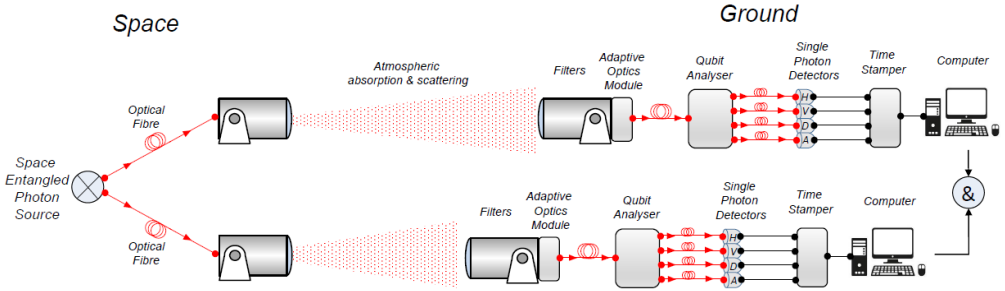
Exploiting entangled photon pairs





Components:

- Pump laser source (1550/780/400 nm)
- Non linear crystal (PPLN) waveguide
- Optical fibers, connectors
- Polarization controller
- Phase modulator (niobate waveguide)
- Variable attenuator
- Polarizing beam splitter
- Beam splitter
- Circulator
- CWDM
- Electronic controller (on-board & ground)
- Single photon detector (APD, SNSPD)
- Optical terminal (telescopes, pointing)
- Adaptive optics (ground)
- Processors (on-board & ground)



We are looking for partners to join our projects!!!

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THANK YOU!

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