

SpooQySats: Quantum Key Distribution with CubeSats



Robert Bedington, Alexander Ling – CQT SpooQyLabs

QKD satellites

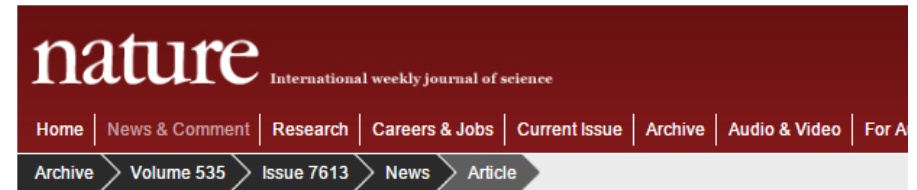
China Leads The Quantum Race While The West Plays Catch Up



Saadia M. Pekkanen, CONTRIBUTOR

I write about the IR of Japan/Asia and outer space security. [FULL BIO](#) ▾

Opinions expressed by Forbes Contributors are their own.



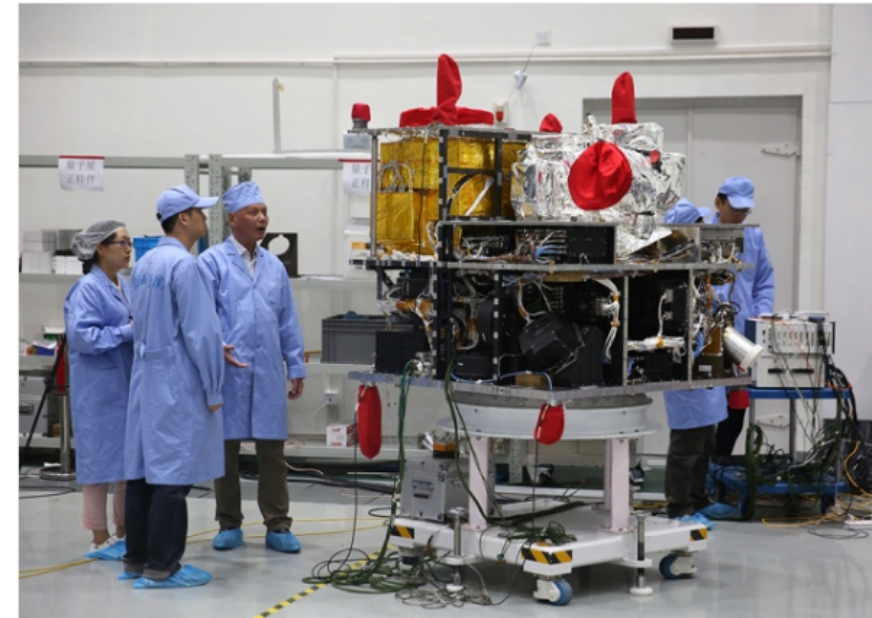
NATURE | NEWS

Chinese satellite is one giant step for the quantum internet

Craft that launched in August is first in a wave of planned quantum space experiments.

Elizabeth Gibney

27 July 2016 | Updated: 16 August 2016



Cai Yang/Xinhua via ZUMA Wire

China's 600-kilogram quantum satellite contains a crystal that produces entangled photons.

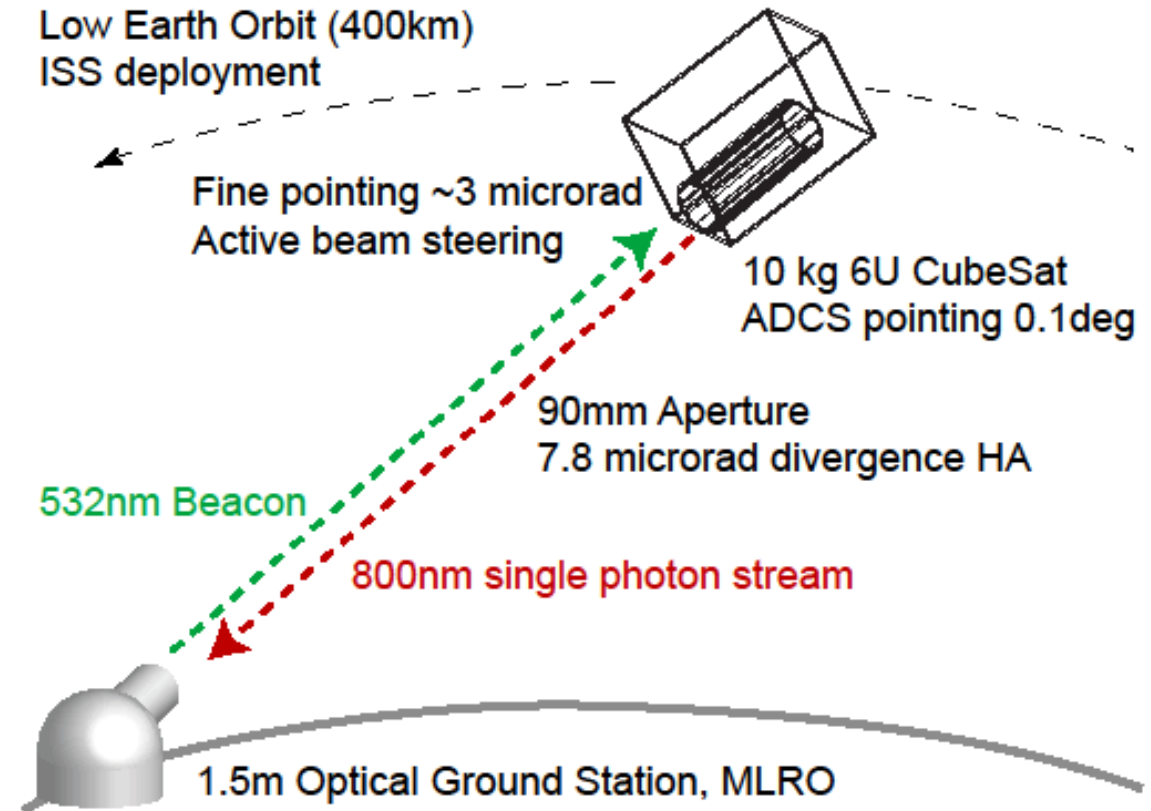
The satellite QKD vision

- Distribute single-use symmetric encryption keys to two locations.
- Symmetric encryption “secure forever”.
- Eavesdropper detection to determine privacy.
- Enables tests of fundamental physics.



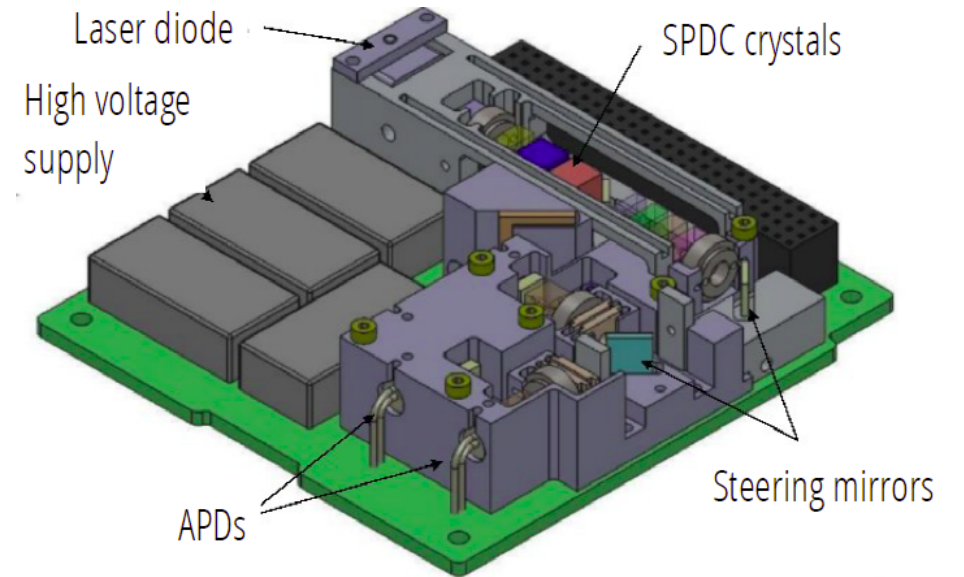
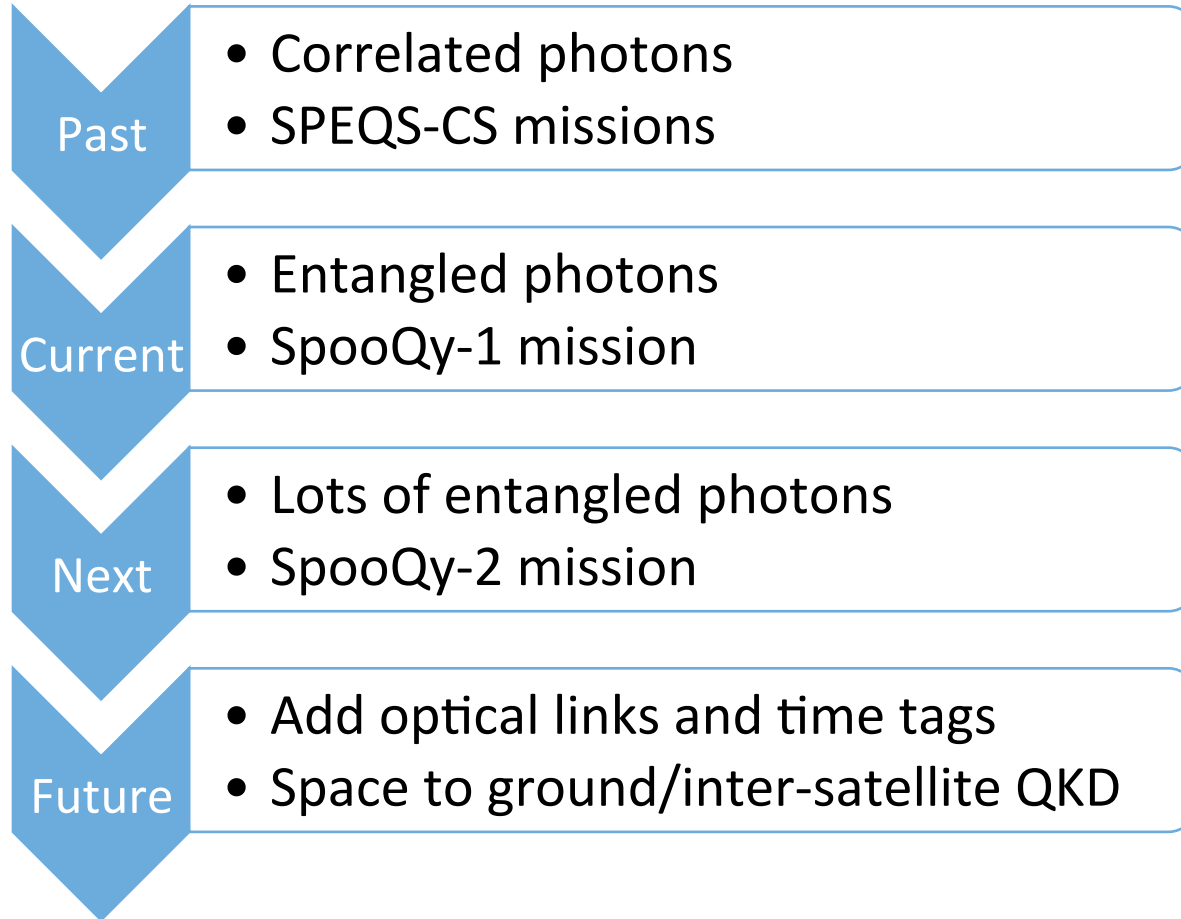
Requirements for satellite QKD

- QKD photon source, preferably on the satellite
- Low loss optical links
- Trusted satellite node
- CubeSat compatible?

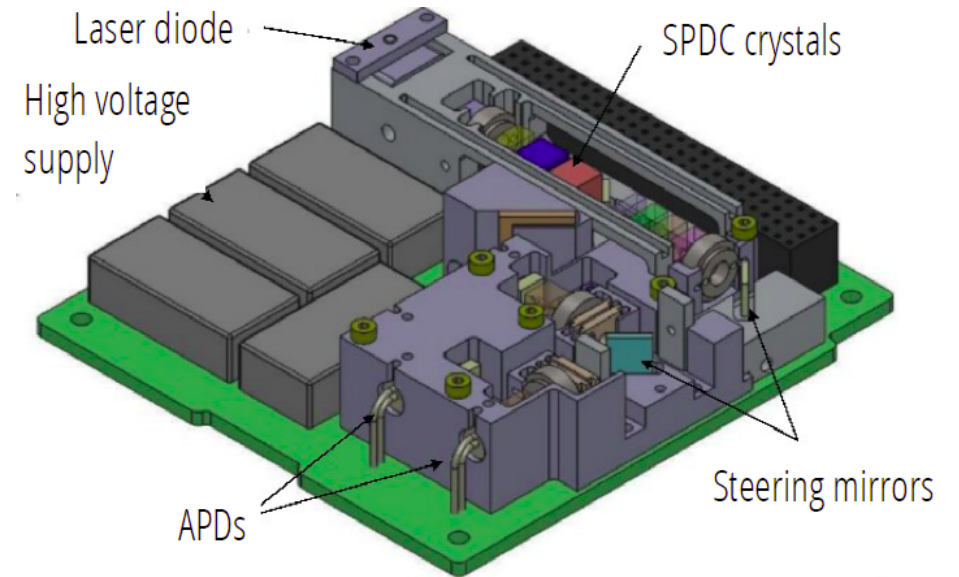
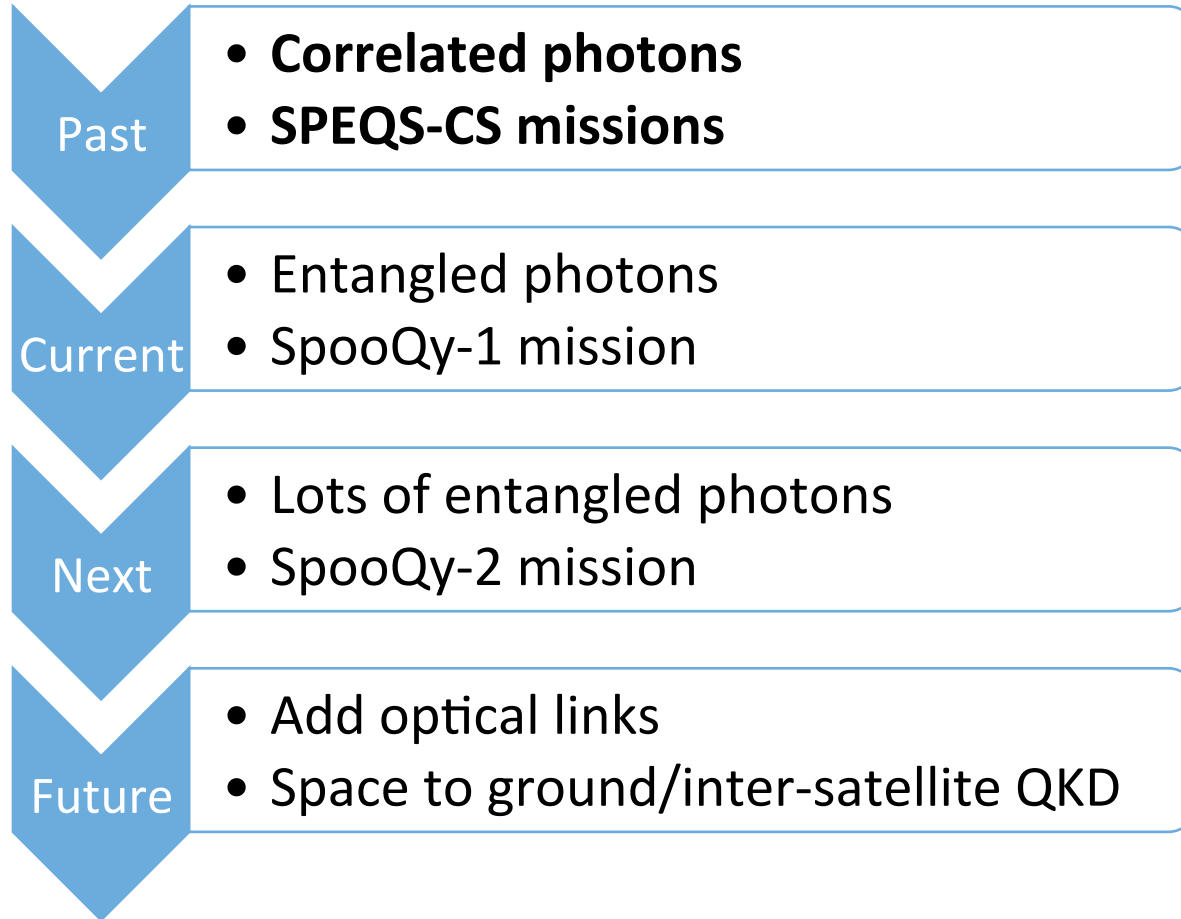


Oi, D. K. L. et al. (2016). Nanosatellites for quantum science and technology.

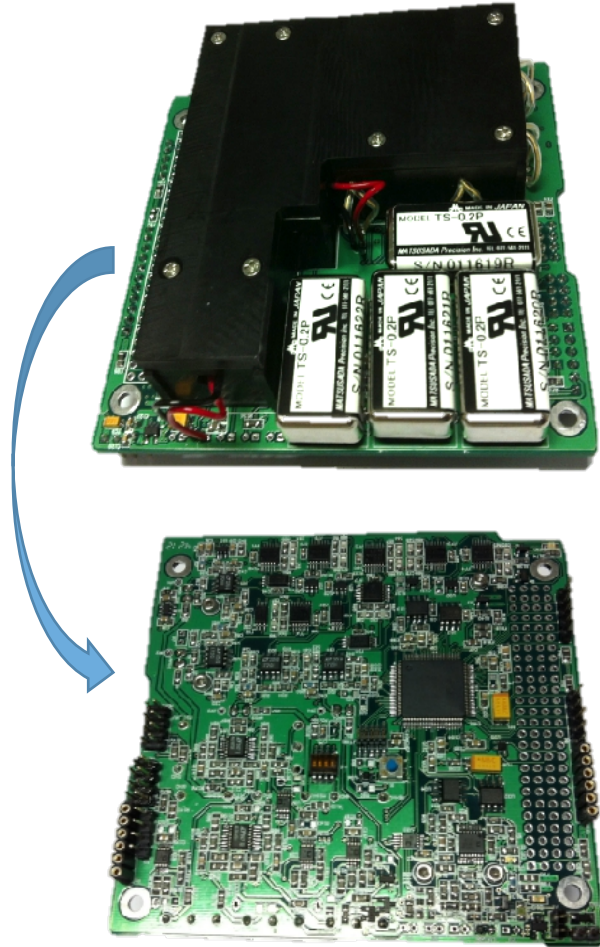
CQT development programme



Progress to space-based QKD



Correlated photon source (SPEQS-CS)



SPEQS – CS specs

- 1/3U
- < 300g
- < 2W

Key challenges

- Miniaturisation and robustness
- Optical alignment
- GM-APD
 - Radiation effects
 - Temperature stability

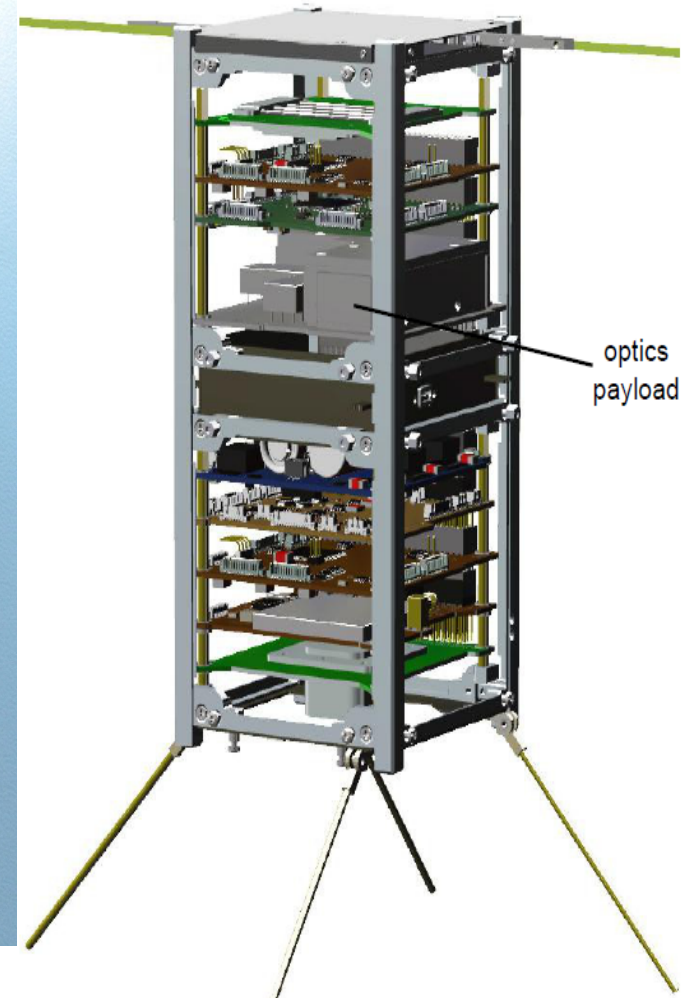
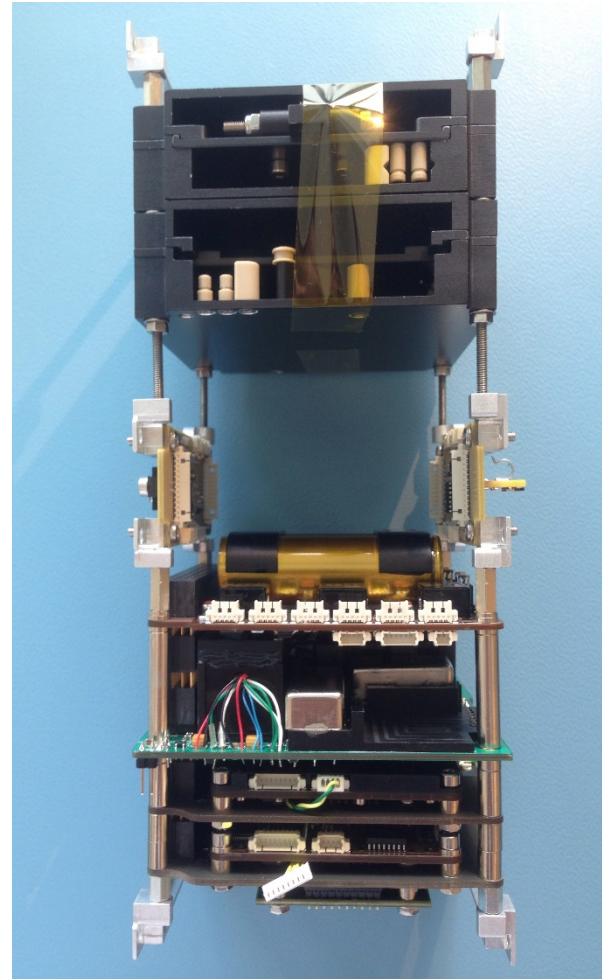
Correlated source pathfinder missions

2012/13

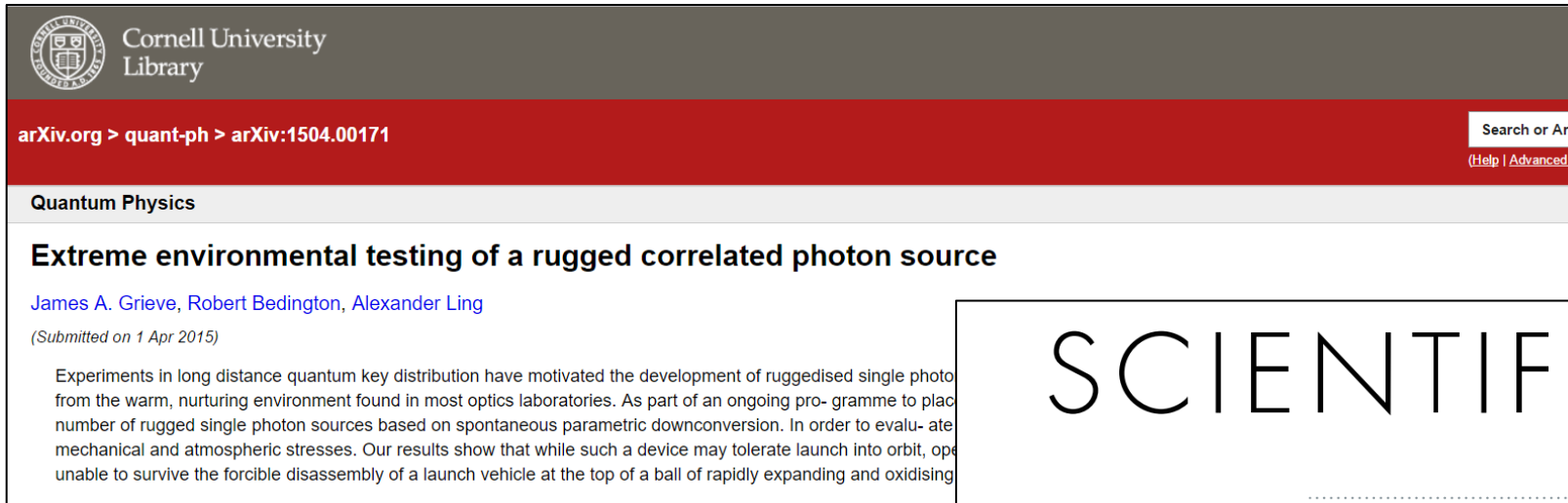
2014 *GomX-2*

2015 *Galassia*

37.5km



Explosion!



Cornell University
Library

arXiv.org > quant-ph > arXiv:1504.00171

Search or Article
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Quantum Physics

Extreme environmental testing of a rugged correlated photon source

James A. Grieve, Robert Bedington, Alexander Ling
(Submitted on 1 Apr 2015)

Experiments in long distance quantum key distribution have motivated the development of ruggedised single photon sources from the warm, nurturing environment found in most optics laboratories. As part of an ongoing programme to place a number of rugged single photon sources based on spontaneous parametric downconversion. In order to evaluate mechanical and atmospheric stresses. Our results show that while such a device may tolerate launch into orbit, it is unable to survive the forcible disassembly of a launch vehicle at the top of a ball of rapidly expanding and oxidising



SCIENTIFIC REPORTS

OPEN

The photon pair source that survived a rocket explosion

Zhongkan Tang¹, Rakhitha Chandrasekara¹, Yue Chuan Tan¹, Cliff Cheng¹, Kadir Durak¹ & Alexander Ling^{1,2}

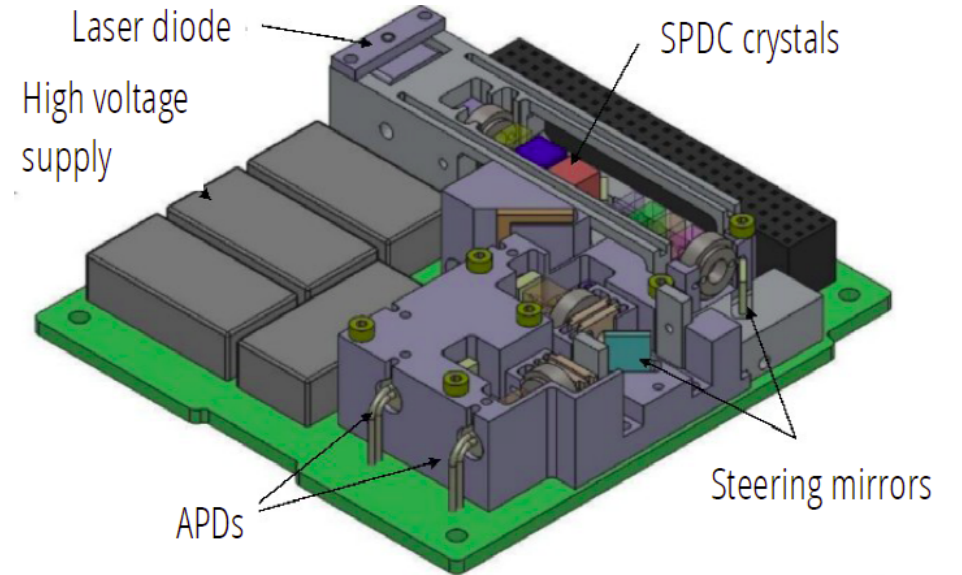
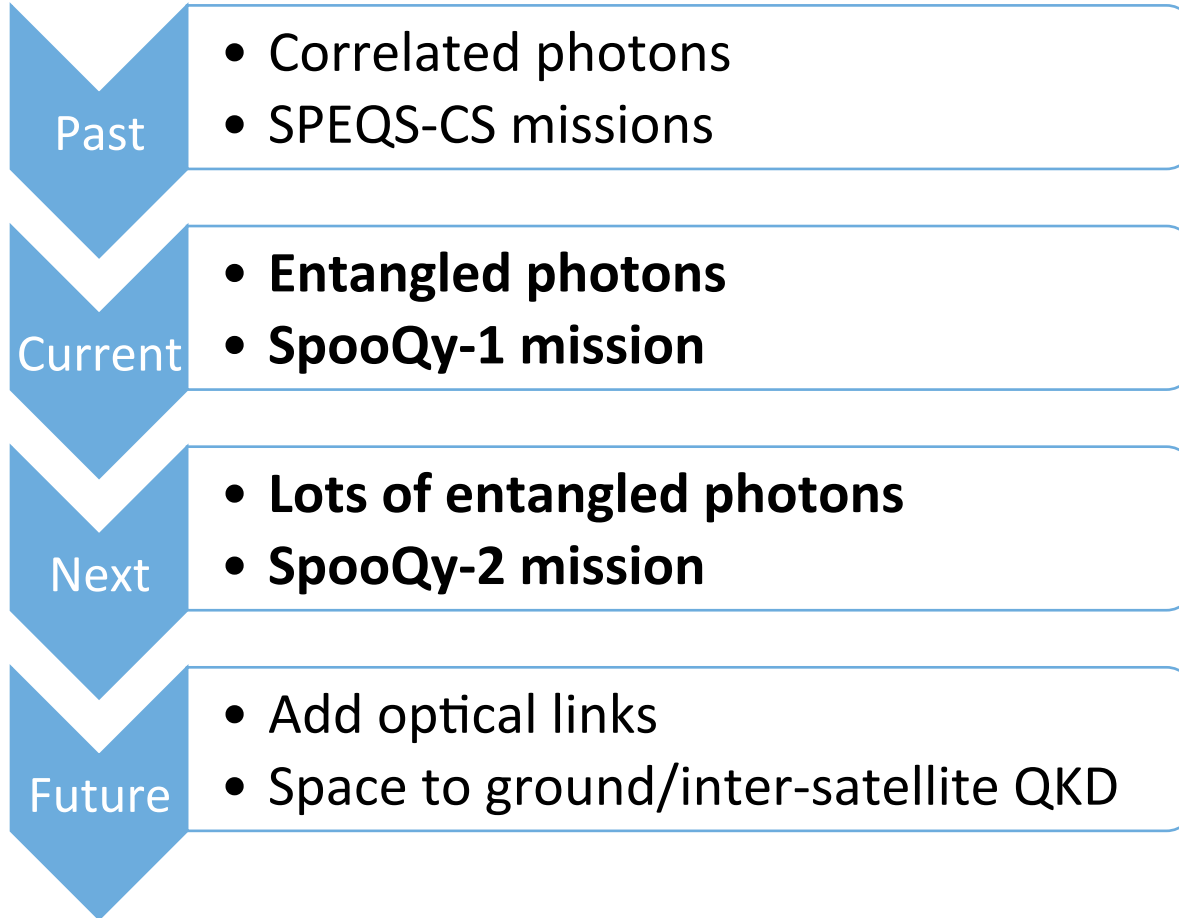
Received: 30 January 2016

Accepted: 18 April 2016

Published: 10 May 2016

We report on the performance of a compact photon pair source that was recovered intact from a failed space launch. The source had been embedded in a nanosatellite and was designed to perform pathfinder experiments leading to global quantum communication networks using spacecraft. Despite the launch vehicle explosion soon after takeoff, the nanosatellite was successfully retrieved from the accident site and the source within it was found to be fully operational. We describe the assembly technique for the rugged source. Post-recovery data is compared to baseline measurements collected before the launch attempt and no degradation in brightness or polarization correlation was observed. The survival of the source through an extreme environment provides strong evidence that it is possible to engineer rugged quantum optical systems.

Progress to space-based QKD



CQT SpooQySat demonstration programme



**GomX platform -
capability-driven missions**

SpooQy-1

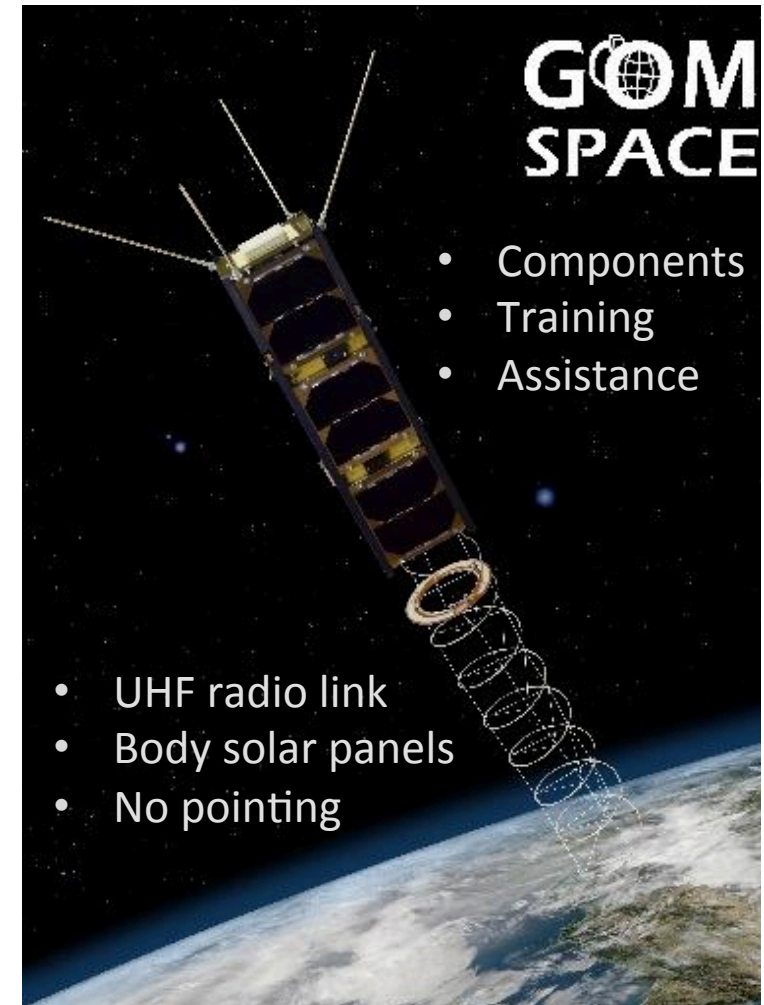
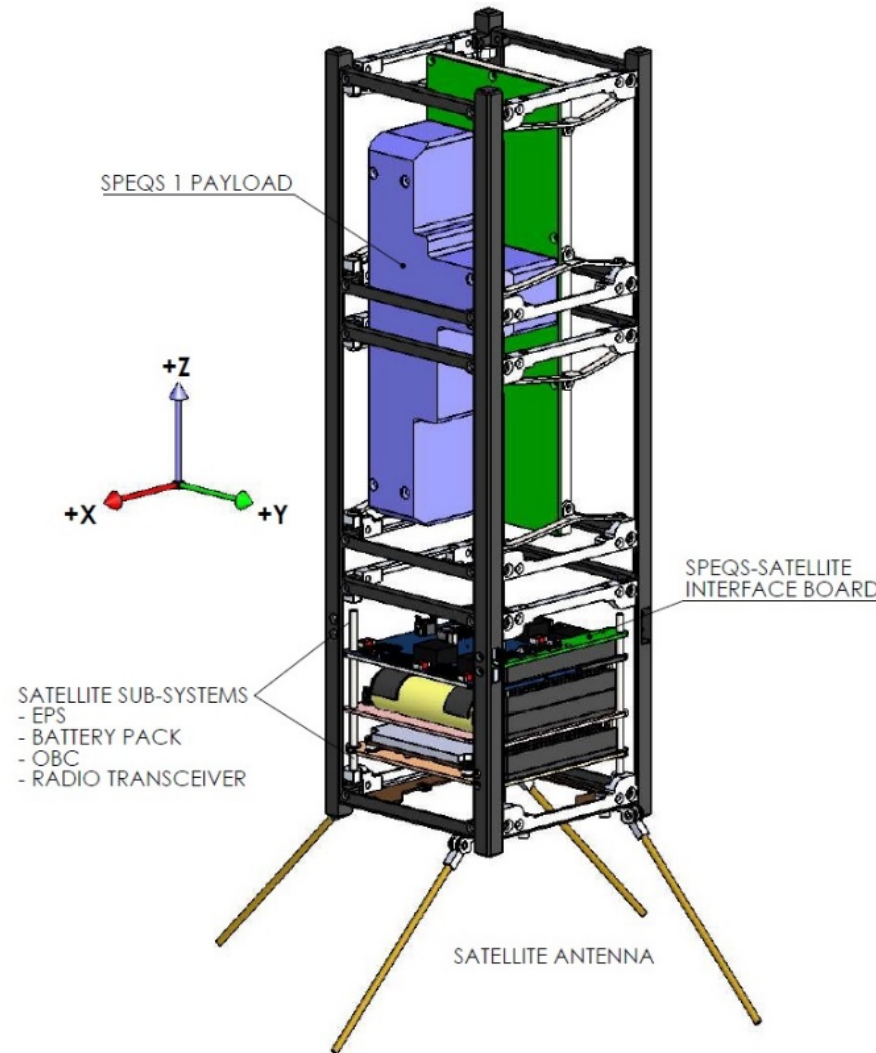
First entangled source on a
CubeSat.

Launch 2018

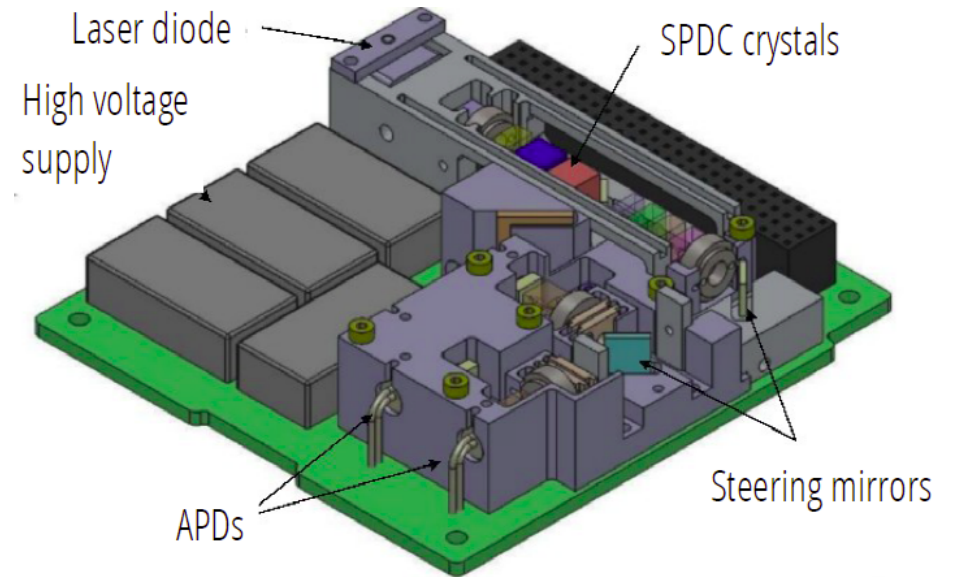
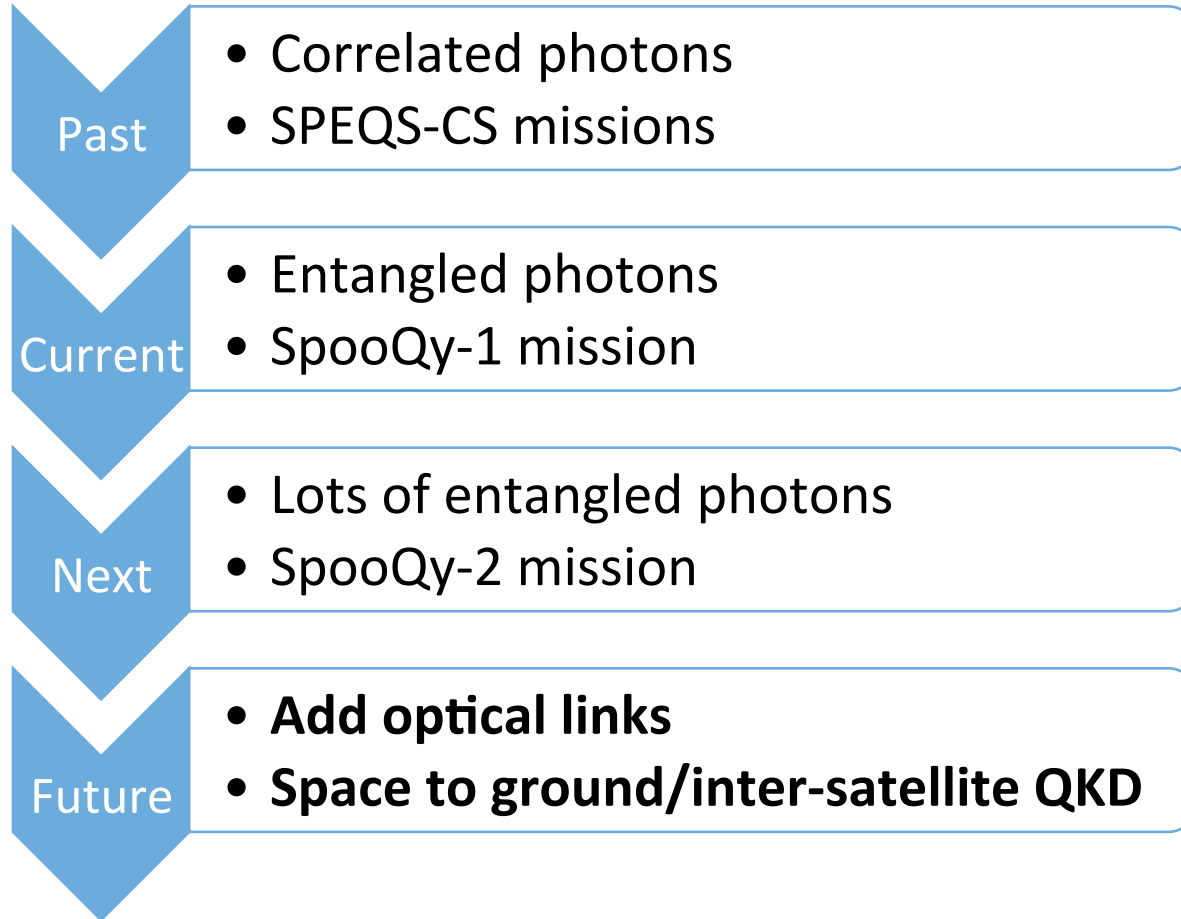
SpooQy-2

High brightness entangled
photon source.

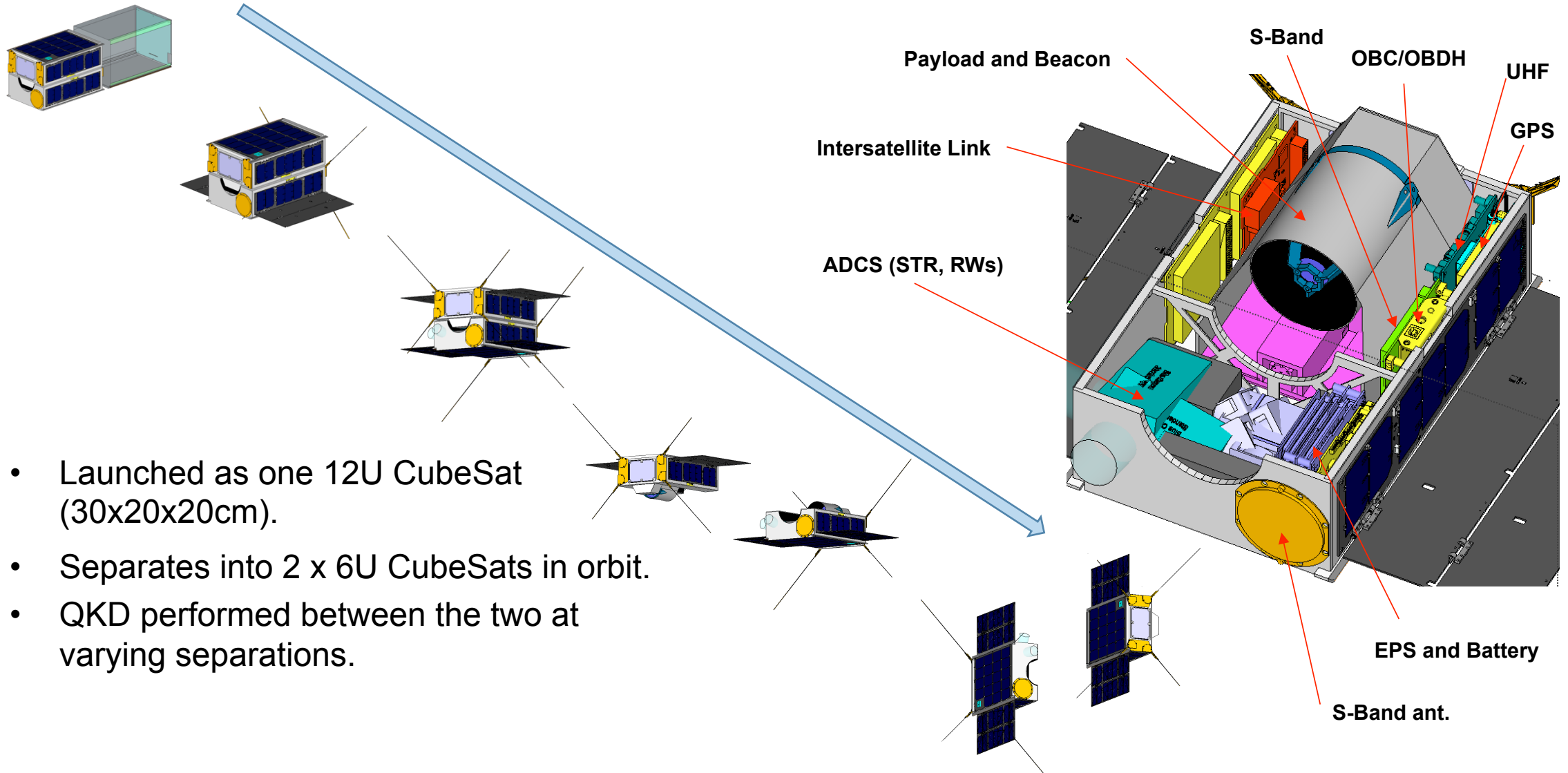
Launch 2020



Progress to space-based QKD



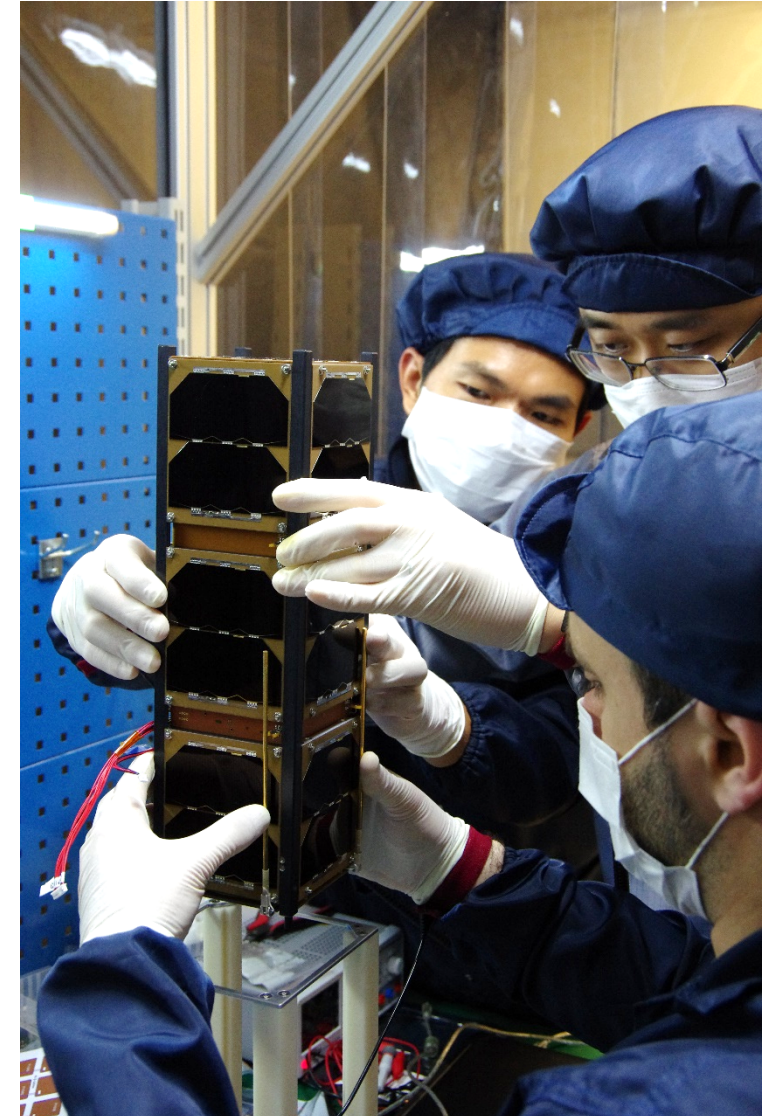
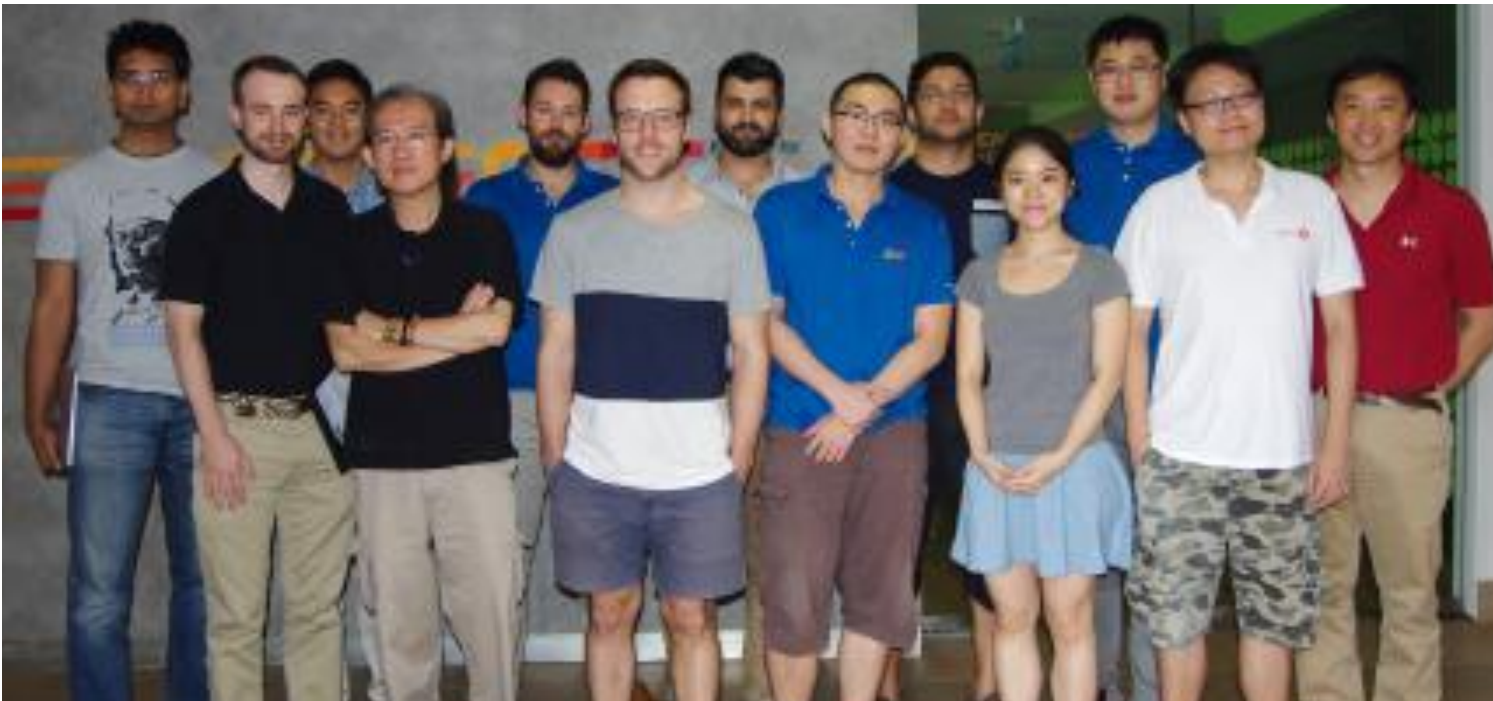
UNSW: Canberra-led Inter-satellite QKD study



- Launched as one 12U CubeSat (30x20x20cm).
- Separates into 2 x 6U CubeSats in orbit.
- QKD performed between the two at varying separations.

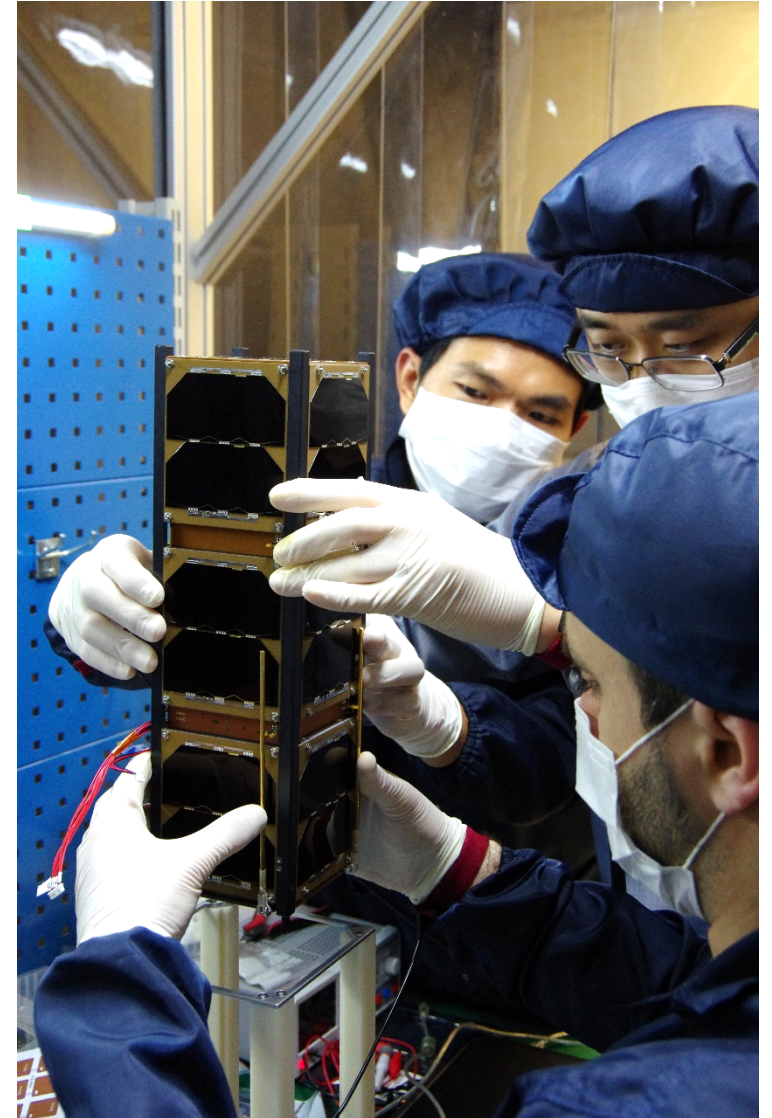
SpoQyLabs seeks engineers!

- Join our team in Singapore!
- Mechanical/thermal/electrical aerospace engineers sought



SpooQyLabs seeks engineers!

- Join our team in Singapore!
- Mechanical/thermal/electrical aerospace engineers sought
- SpooQySats tech demos
- Satellites with optical links
- Other platforms
 - Drones
 - Ships
 - Airships



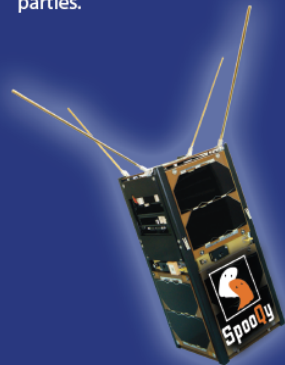
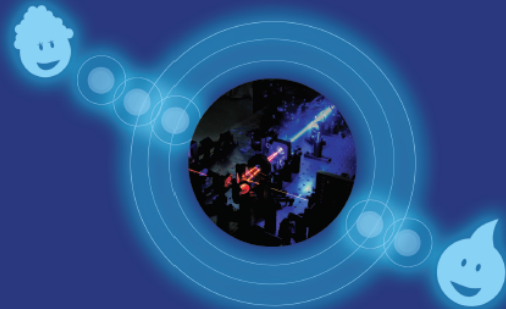


- Asian Tiger economy
- City in a garden
- English Speaking
- Hub for South East Asian destinations

More info in the registration pack

QKD CubeSats to enable global secure communication

Quantum Key Distribution (QKD) uses the quantum states of individual photons to create highly secure encryption keys, exclusively between two parties.



Since 2010, CQT in Singapore has been developing QKD technologies for CubeSats. Our first technology demonstration source is working in orbit now, with follow-on 'SpooQySat' technology demonstration CubeSats launching from 2018.

To enable global QKD we will additionally require low loss optical links between satellites and optical ground stations.



For our group website see:
www.quantumiah.org/AlexLinggroup

For overview articles on satellites see:
tinyurl.com/quantum-cubesats
tinyurl.com/SpooQySats

we are recruiting - see overleaf



Engineering vacancies in Singapore-based team!

The *Centre for Quantum Technologies (CQT)* at the National University of Singapore (NUS) is looking for talented and motivated engineers to join a dynamic team developing science-grade 'SpooQySat' CubeSats and opto-electronic instruments for state-of-the-art, quantum communications experiments. All engineers are welcome to apply. We are particularly seeking mechanical and thermal engineers.

A proven track-record in aerospace and precise optomechanical component design is desirable. Previous experience with Solidworks, Siemens SimCenter (NX) and working on scientific projects is helpful.

For our group website see:
<http://www.quantumiah.org/AlexLinggroup>

The new mechanical and thermal engineers will be responsible for the detailed mechanical designs of optomechanical instruments and their interfaces to CubeSat spacecraft and other platforms. The new mechanical and thermal engineers are expected to be able to perform some or all of the following:

NUS is consistently ranked among the world's leading universities. Singapore is a clean, vibrant, multicultural English-speaking country with very high standards of living. Salary is based on experience and skills and will be internationally competitive.

- *design components and assemblies of optical components maintained in precise alignment in the relevant environments.*
- *produce detailed, practical CAD models, with thorough FEA and thermal analysis.*
- *specify advanced materials and processing techniques and communicate effectively with machinists and manufacturers.*
- *take part in integration and assembly of CubeSat satellites and quantum optics payloads in a cleanroom environment.*
- *plan and conduct rigorous environmental testing and verification of the spacecraft and instrumentation. This will include identification of resonant frequencies and verification of internal heat flows.*

Interested candidates should send a CV, and should indicate their desired starting date. All applications, including a cover letter, should be forwarded to cqtrb@nus.edu.sg.



Meet up at the conference!
Look for the CQT/SpooQy t-shirt
or email: r.bedington@nus.edu.sg