

# NIR Single Photon Detector for Space and Quantum technologies application

---

09/06/2023

Johann Cussey



**Infrared Detection for Space Applications**  
7th- 9th June 2023 - Toulouse

# About AUREA Technology

- French SME founded in 2010
- 100% EU company (France)
- **Key building-blocks for Quantum Technologies**
- >300 customers worldwide
- Strong R&D (> 50% PhD in Quantum Tech.)
- Innovation Winner :
  - Prism Award 2020 Finalist
  - I-NOV 2020
  - Horizon programs
  - ESA projects



**BESANCON**  
**Bourgogne-Franche-Comté**  
**France**

# Leading provider of Quantum Optical Instruments

Key building-blocks for both Ground and Space ultra-secure QKD communications



*Entangled Photon Sources*



*Single Photon Detectors*



*Time Correlators*



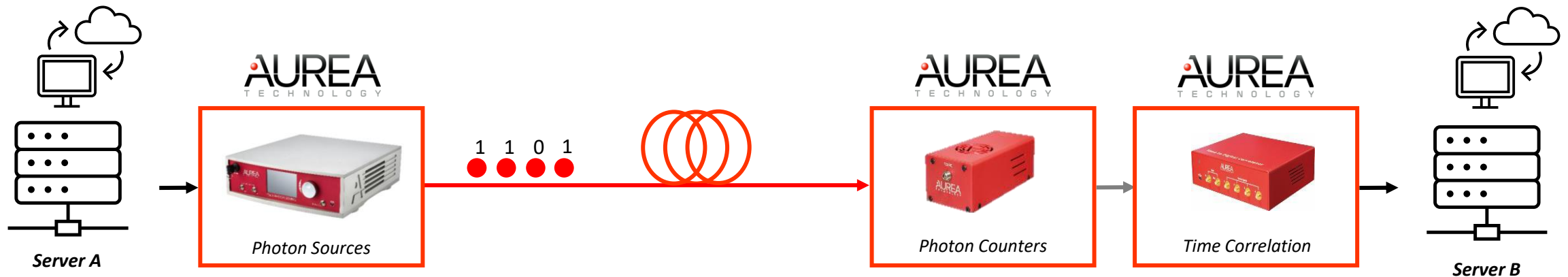
*NEW Entangled Photon Sources for Space*

**Terrestrial and Optical Ground Station**

**Space**

# Building blocks for secure optical communication

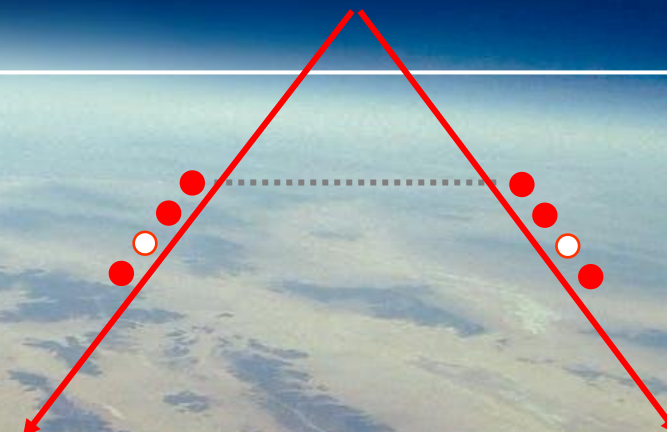
- One-Stop-Shop strategy
- Key building-blocks for custom Quantum Communication & Quantum Key Distribution System
- QKD : security based on physics principle and not on computing capacity
- EURO-QCI initiative (EU)





# Ground and Space for industrial Quantum communication

Space:  
Single or Entangled  
Photon Source at  
telecom wavelength



Ground:  
Quantum Analyser (RX) and  
Single Photon detection



Ground Station 1

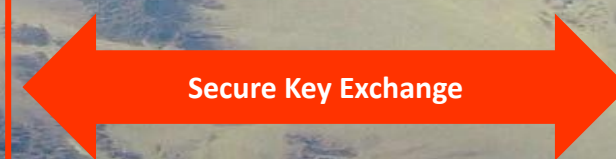


Single Photon Detection

Ground Station 2



Single Photon Detection



# Quantum technologies for Space

## ❑ IQUPHOS Project :



Development of High rate Entangled photon source



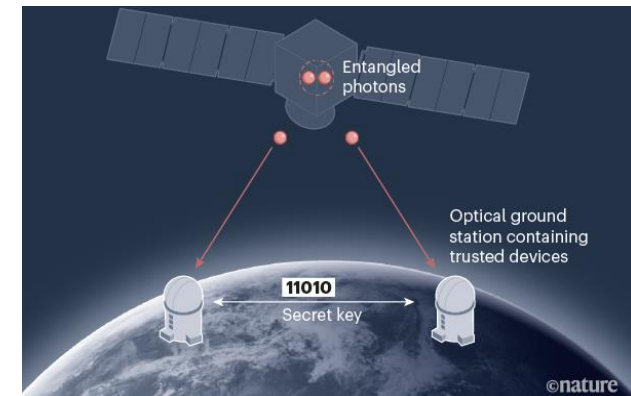
Entangled Photon Source - TRL 4 -  
200x100x100mm - < 2Kg

## ❑ TeQuants Project :



Development of QKD and QIN system for secure space communication

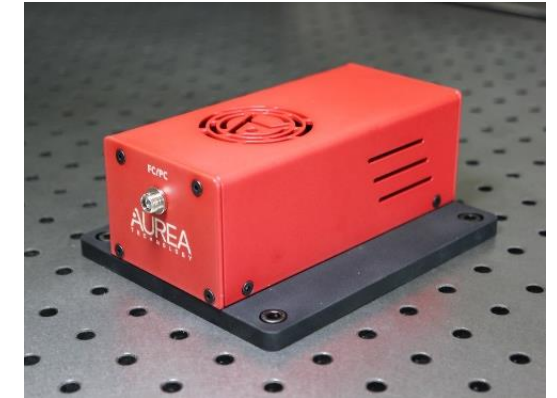
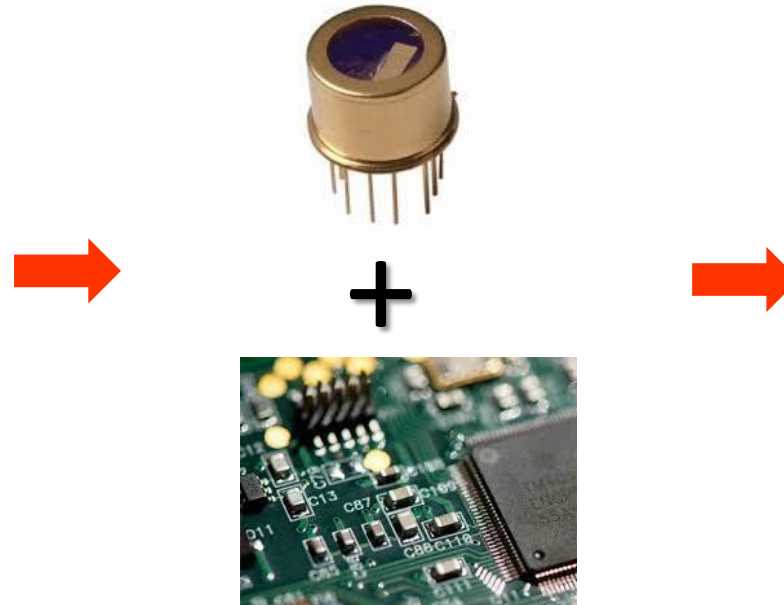
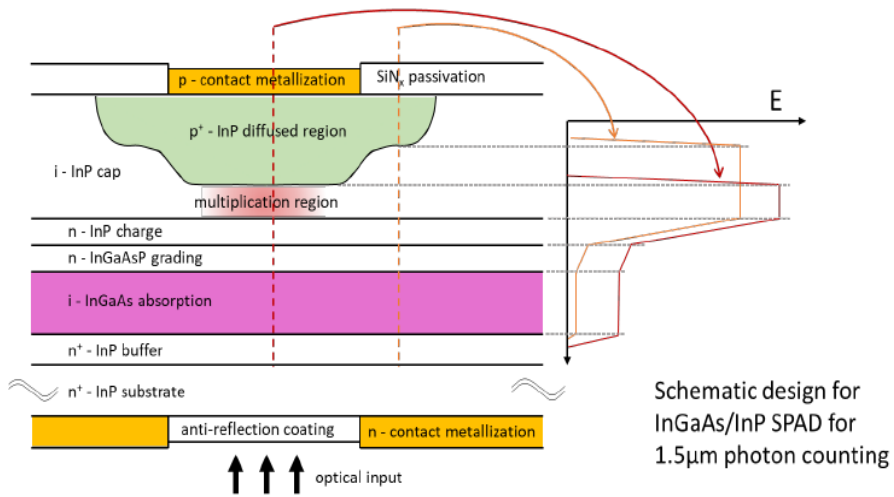
Partners :



Supported by



# NIR Single Photon Detector



Industrial single photon detector

- InGaAs/InP back illuminated Avalanche photodiode
- Geiger mode operation / Threshold detection
- Dedicated low noise Electronics
- Performances : Max Quantum efficiency 30% with DCR < 500 Counts per second

# GHz NIR Single Photon Detector



- High speed SPAD detector for Quantum ground Station

	SNSPD	SPAD	Target GHz SPAD
Quantum Efficiency (%)	>70%	30 % max	>40 %
Gate speed (Hz)	Free running	100 MHz	>1 GHz
Readout speed (MHz)	20 MHz	10 MHz	>500 MHz
Jitter	< 30ps	< 200 ps	< 90ps
Dark count (counts/sec)	<30	< 3000	<1500
Cooling	Cryogenic (Liquid Helium < 4K)	TEC	TEC
Dimensions	65cmx65cmx180cm	15cmx80cmx80 cm	TBC (15cmx10cmx10cm)
Consumption	150 W	13 W	TBC
Price	Very High	Low	Medium
Space compatibility	NA	TBD	TBD

High speed SPAD target specifications compare to other commercial NIR detector technologies



# GHz NIR Single Photon Detector

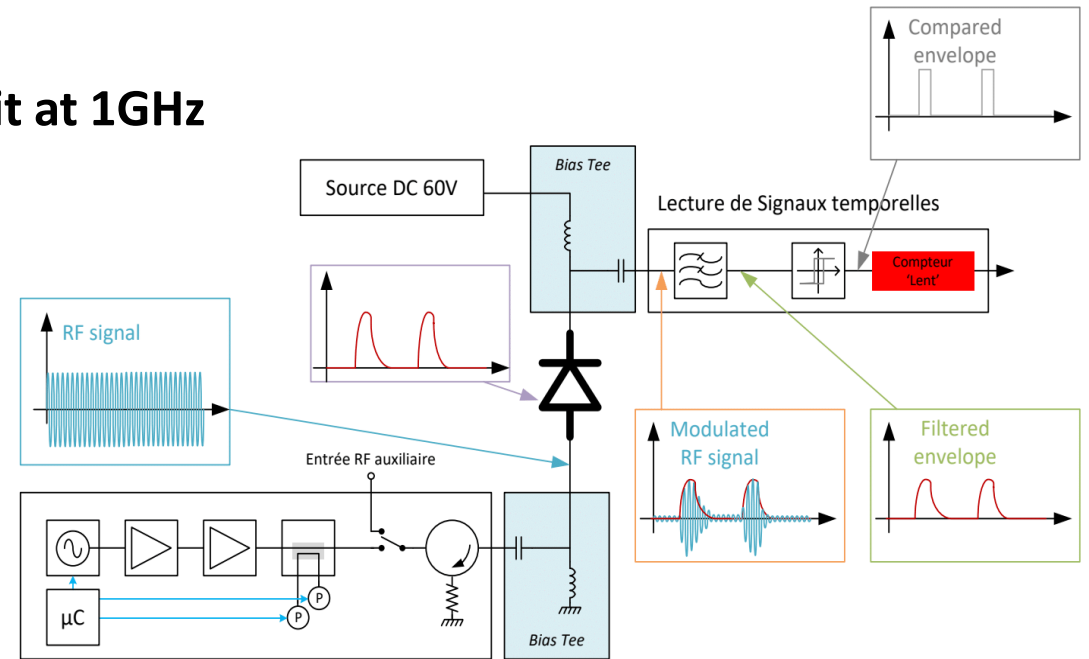


## Specifications:

- Operating sinusoidal gate frequency: 2GHz and lower limit at 1GHz
- Accurate Impedance adaptation
- High capacity of filtering for the detection module
- Low noise RF Electronics

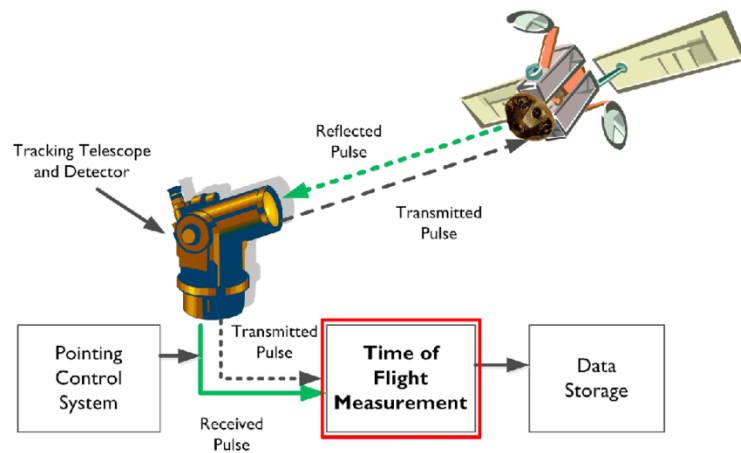
## Benefits:

- High photon output rate with low afterpulsing
- Cooling with TEC
- Small footprint and low power consumption
- Suitable for high rate gating operation in QKD pulse Qbit generation (1GHz synchronization rate)



# NIR Single Photon Detector for SLR

## Laser ranging for Space traffic Management



NIR SPAD



miniSLR<sup>®</sup> ground station - DLR

- Fiber coupled Single photon Counting detector using
- 1064 or 1550nm detection

# Conclusion

- NIR Single photon detection is critical building blocks for future Satellite Quantum Communication (EU IRIS<sup>2</sup> constellation)
- TeQuants project : AUREA develop new generation of NIR InGaAs detector for Quantum communication and Lidar application



## Perspectives :

- Study the space compatibility of InGaAs photon detector
- Need to have NIR detectors with low power consumption and small footprint
- **AUREA investigate new material/technology for photon NIR detection**

# THANK YOU !

---

**Contact:**

[Johann.cussey@aureatechnology.com](mailto:Johann.cussey@aureatechnology.com)

