

**VTT**

# Photonics for Quantum Technologies

Sara Pourjamal

VTT



EPIC Online Technology Meeting on Quantum Computers March 2024

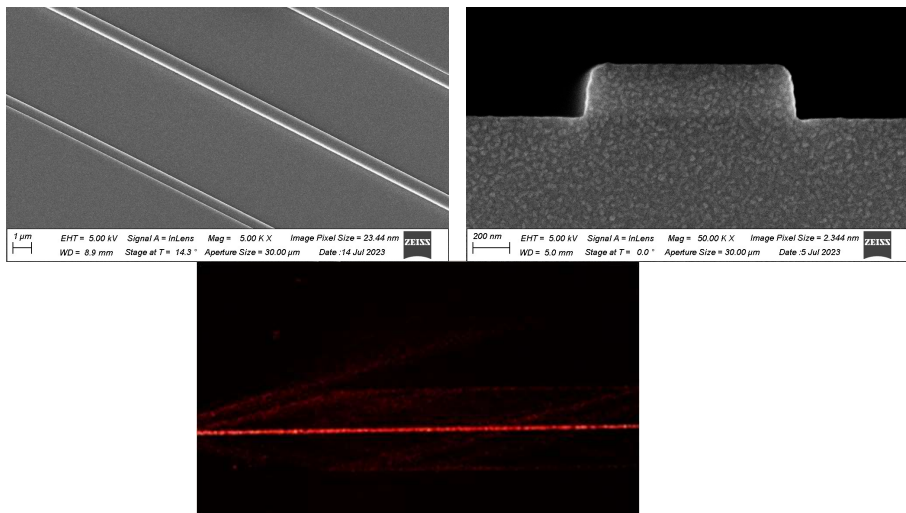


# VTT's SiPh Platforms for Quantum Technology



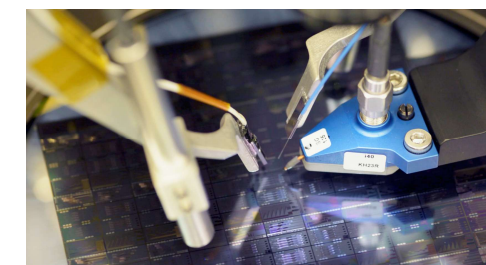
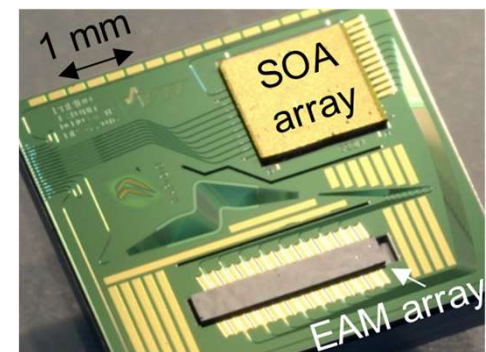
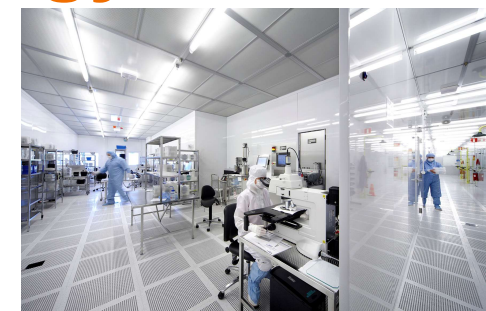
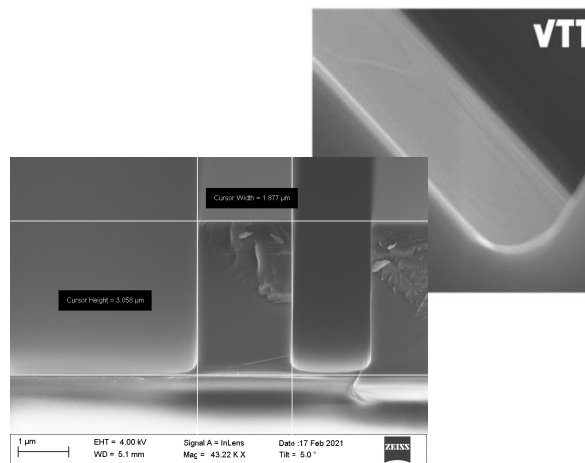
## SiN Platform

LPCVD SiN  
Waveguide losses:  
< 0.5 dB/cm @ 1550 nm



## Thick SOI Platform

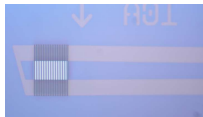
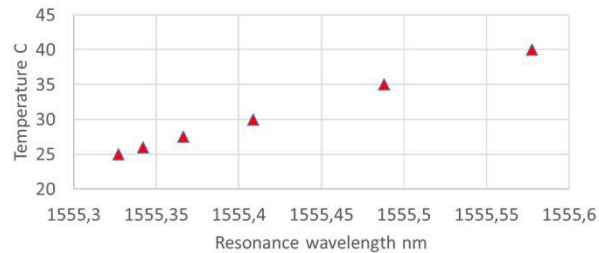
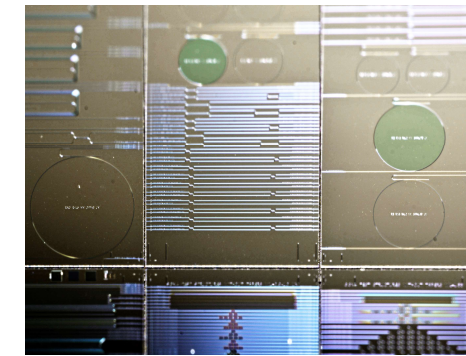
- 3 μm thickness
- 0.04 dB/cm loss



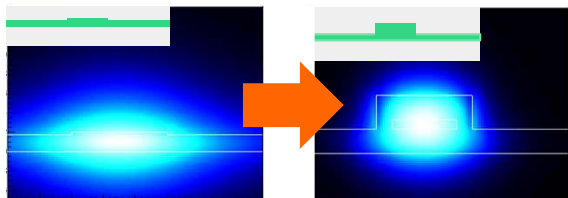
# SiN Platform

# VTT's SiN Platform

## Integrated Temperature Sensor on chip Waveguide design 900nm-1550nm



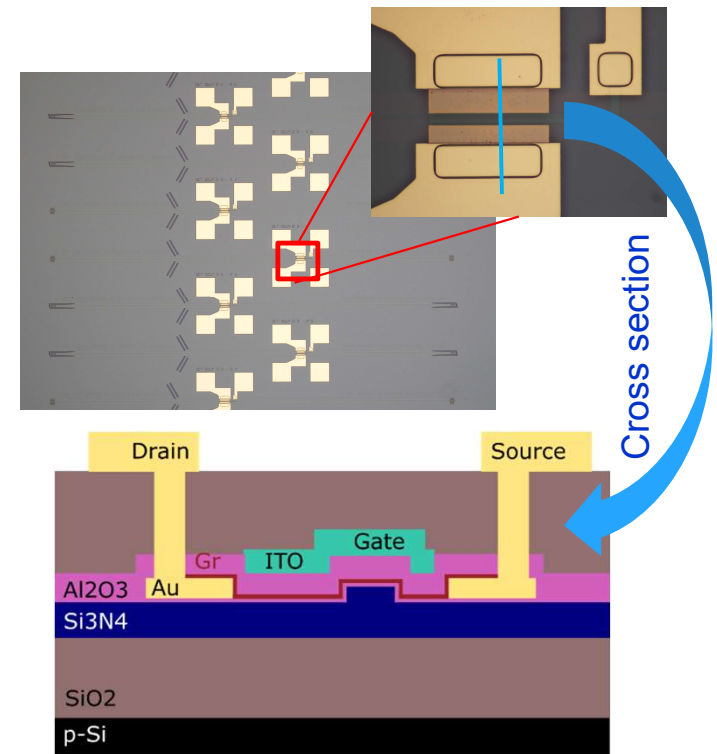
**Low Dispersion SiN waveguide**



### Responsivity @1550 nm

- No bias: 1.8 mA/W
- 100 mV bias: 725 mA/W

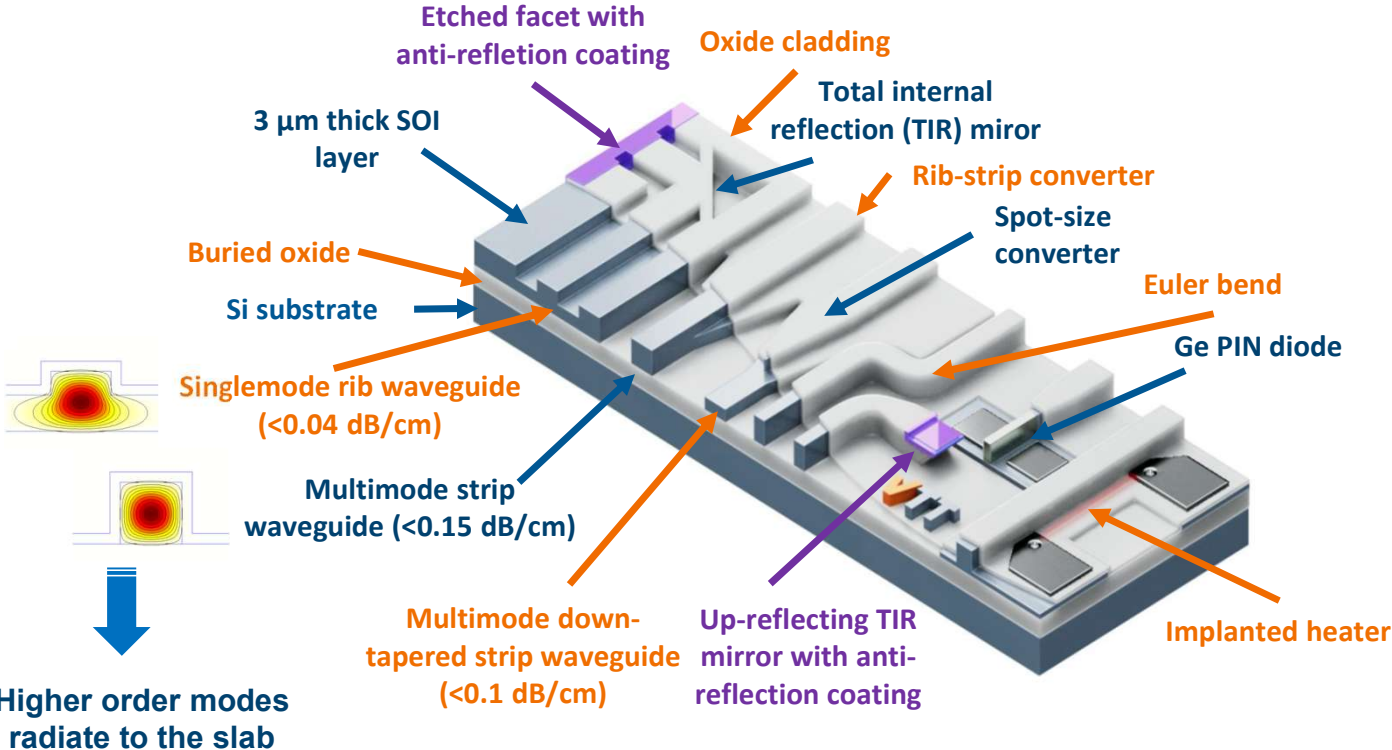
## Wafer scale Graphene PD integration On SiN Platform



# Thick SOI Platform

# VTT's Ultra-Low-Loss Thick SOI Platform

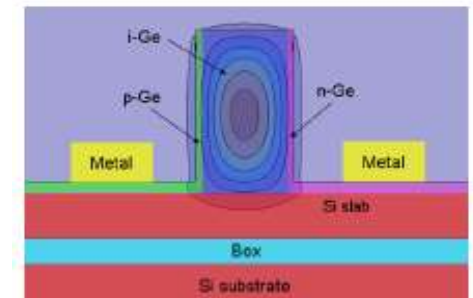
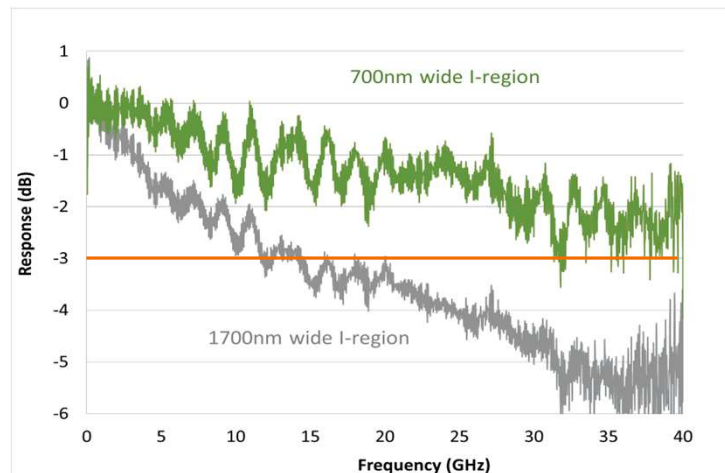
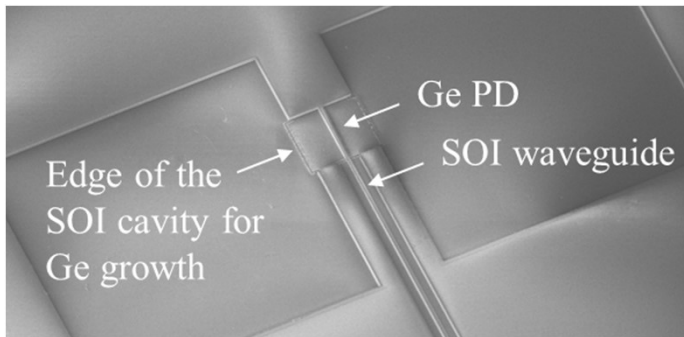
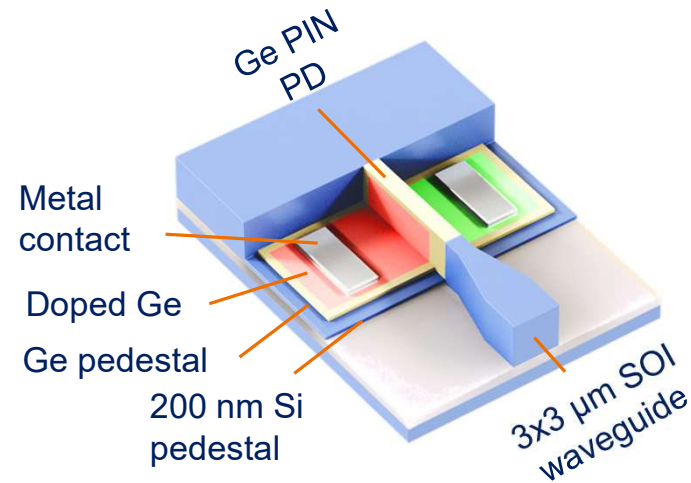
Passive and active photonic integrated circuits (PICs) in 3 μm thick silicon-on-insulator (SOI)



# Ge Detectors

# Ge Photodiode for QKD

- Default wavelength 1550 nm
  - Short average transit time
  - Transit-time-limited bandwidth **~40 GHz**
- Selective Ge epitaxy on a thin SOI pedestal

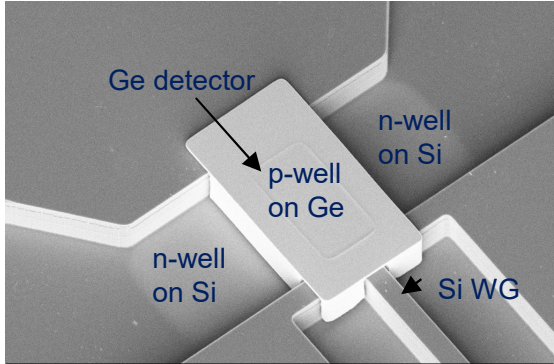




# Integrated CV-QKD receivers (Rx)

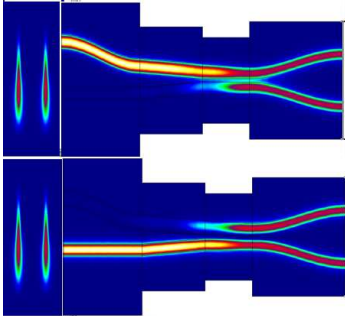
## Ge PIN PDs-Recievers for CV-QKD

- Si waveguide integrated balanced Ge PDs: linear, low dark current, high quantum efficiency, shot noise limit performances
- Optical hybrid 90
- Fast electronics

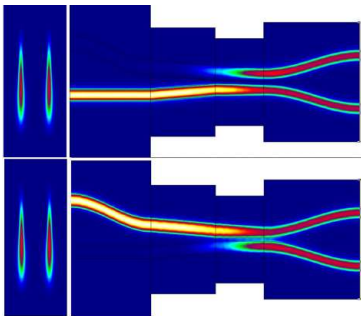


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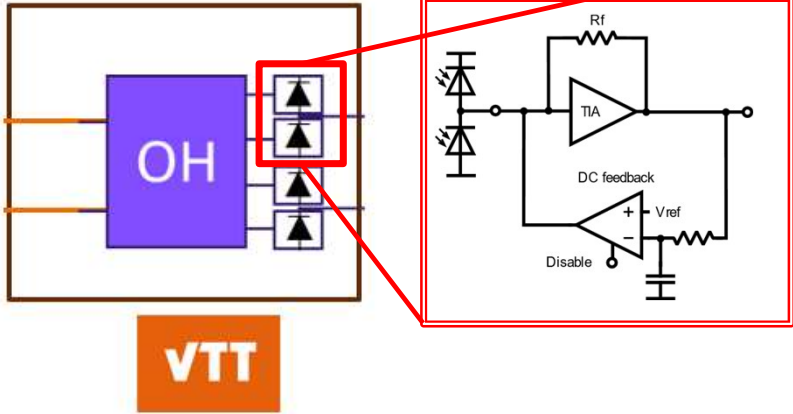
2x2 3-dB splitter (TE mode)



2x2 3-dB splitter (TM mode)



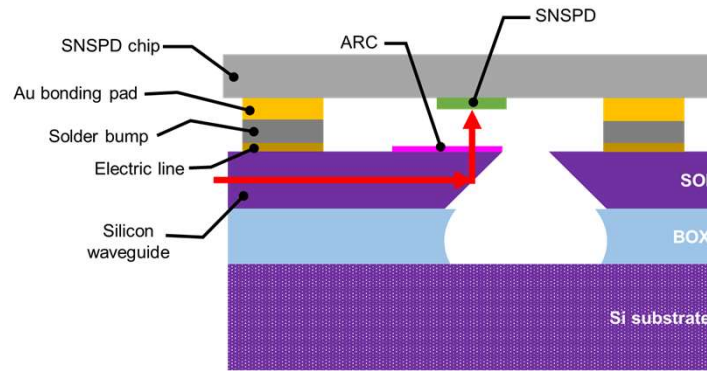
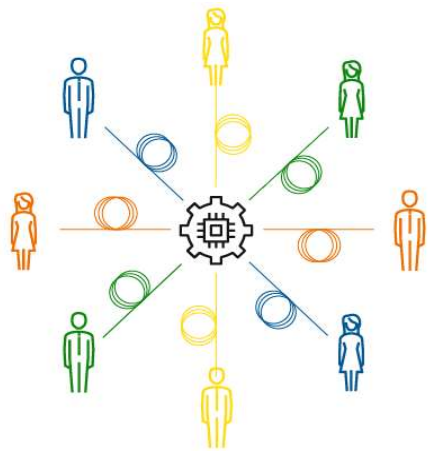
Integrated rx



# Superconducting Nanowire Single Photon Detector- SNSPD

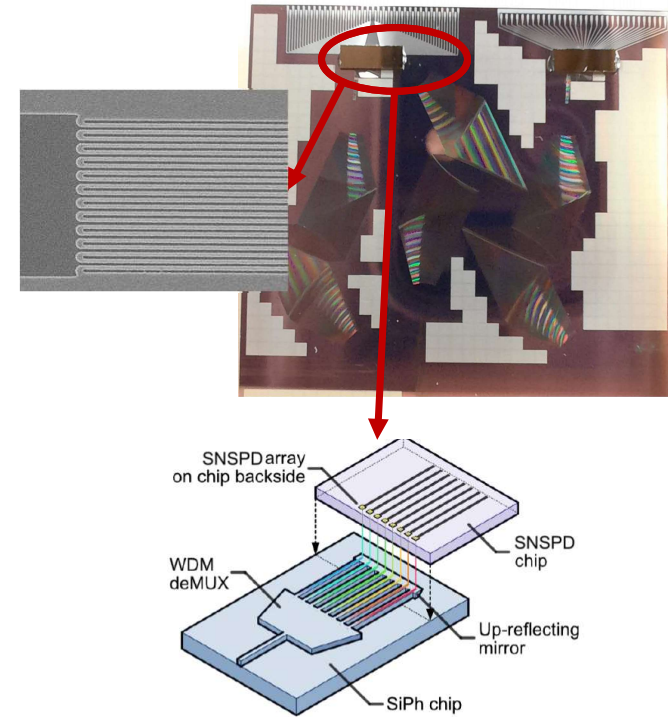
# DV-QKD Receivers- SNSPD

## Central Node DV-QKD



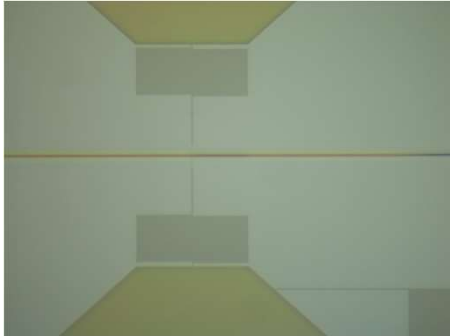
Side view

## SNSPD Chip Bonded on Up-Reflecting Mirror (URM)

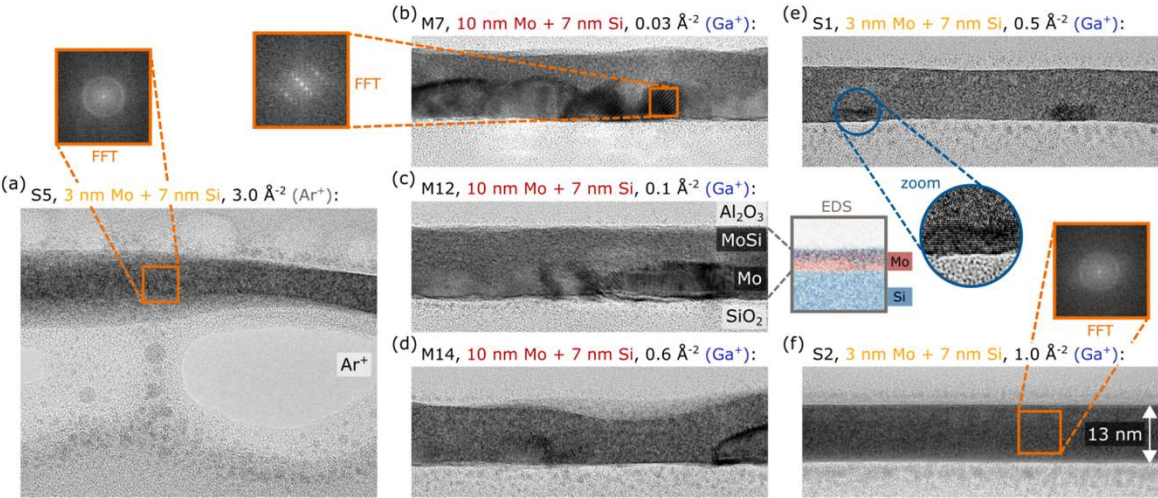


# SNSPD Development

- Material development
  - NbN SNSPD
  - Developing wafer-scale process for thin amorphous MoSi films
  - MoSi SNSPD



K. Kohopää et al. arXiv:2303.11202 (2023)



Sara Pourjamal-VTT



**Qu-Pilot** - Pilot Line for Quantum Technologies  
**Qu-Test** - Test Line for Quantum Technologies



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# Qu-Pilot - Pilot Line for Quantum Technologies

**Open Calls for SMEs and Industry Use Cases**

**QU-PILOT WILL LAUNCH AN OPEN CALL ENABLING ACCESS TO ITS SERVICES TO EXTERNAL COMPANIES IN 2024!**

Superconducting platform	Photonics platform	Semiconducting platform	Diamond platform
Computing Sensing	Communication Computing	Computing Sensing	Sensing Communication
VTT, Fraunhofer, imec, cea	cea, VTT, Fraunhofer, imec	cea, imec, VTT, CSIC, Fraunhofer	TNO, imec, Fraunhofer, Fraunhofer, Fraunhofer, AIT

- Use-cases for **European companies** through open call(s)
- Call text and criteria will be announced in June 2024
- Call closure: Sept/Oct 2024
- Indicative fund: ~150,000 € per Use Case
- Stay tuned for further details: [www.qu-pilot.eu](http://www.qu-pilot.eu)

## Qu-Pilot & Qu-Test



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## the obvious

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