

# QUID (Quantum Italy Deployment): Lo sviluppo in Italia della European Quantum Communication Infrastructure e le iniziative cross-border

Quantum Day  
Trento, 23 maggio 2023

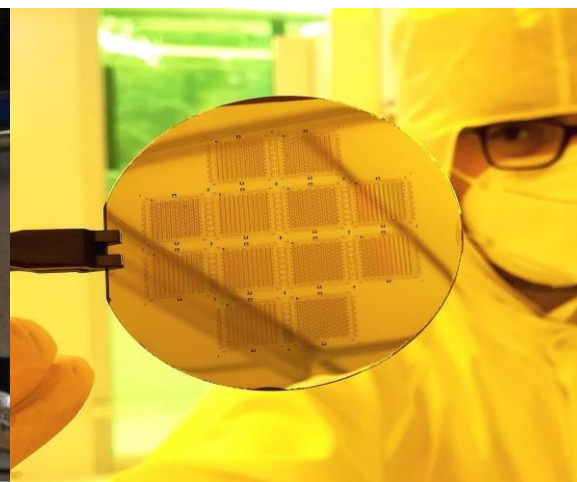
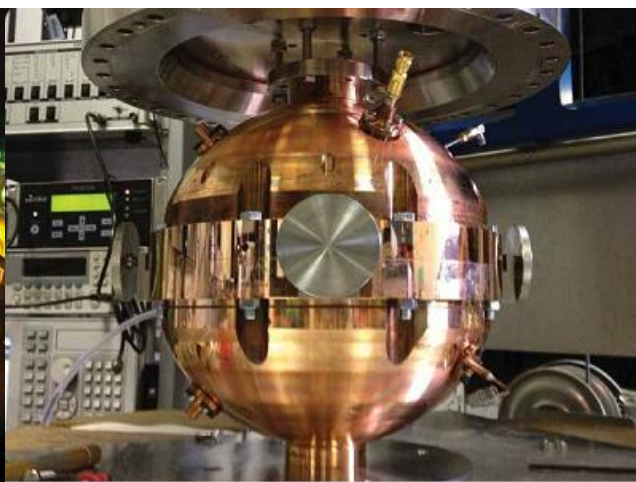
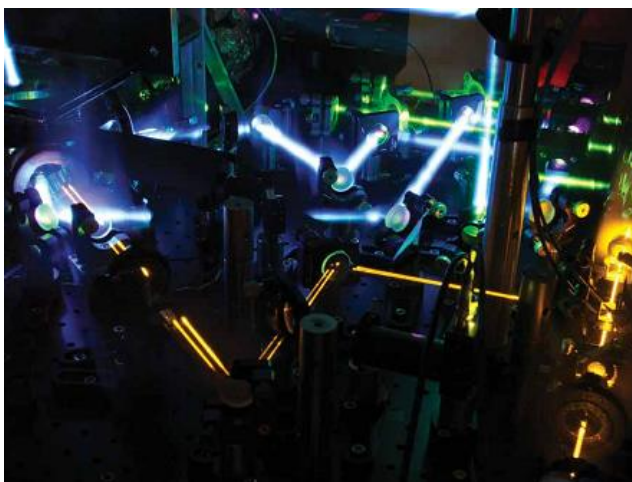
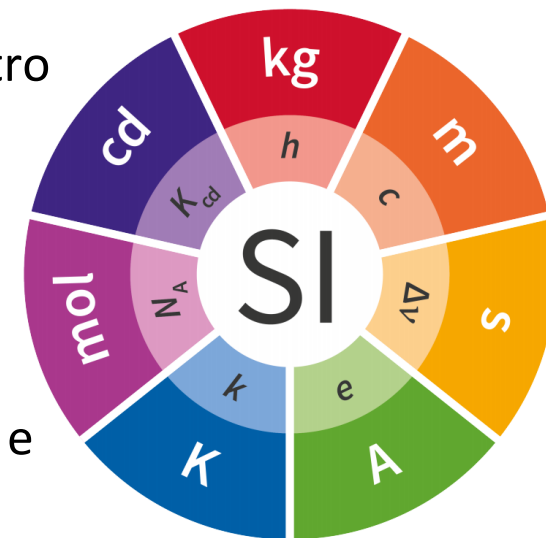
Davide Calonico  
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# INRIM IN BREVE

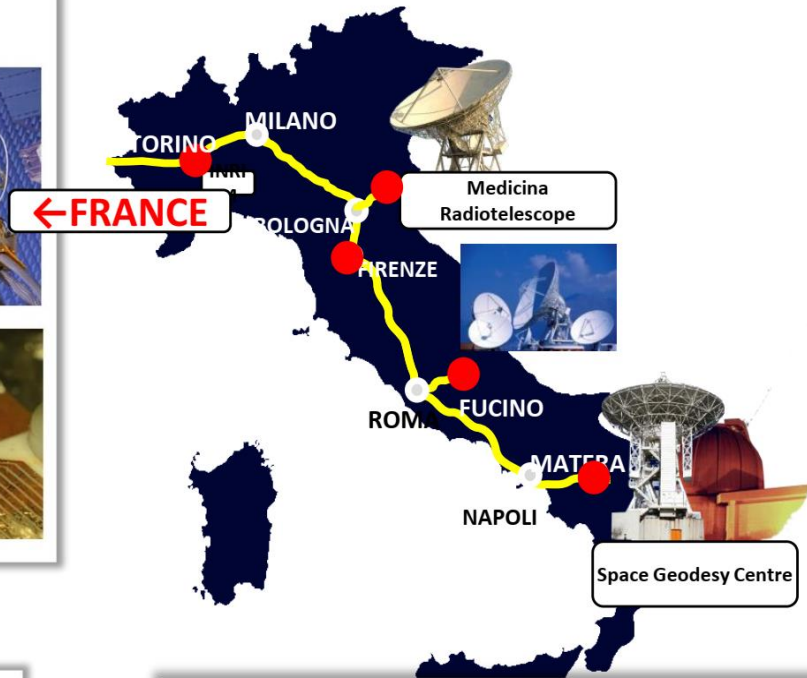
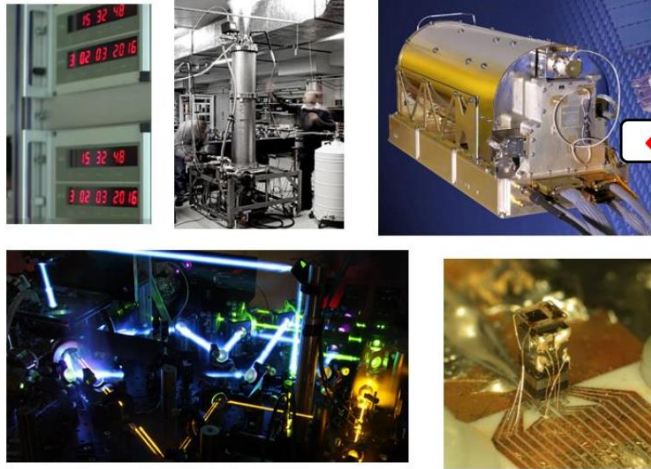


- Istituto Metrologico Nazionale – Convenzione del Metro
- Ricerca / Campioni Primari / Certificazione Misure
- 300 persone, 30 M€ bilancio
- Campus 120.000 m<sup>2</sup>
- 4° Istituto Metrologico Europeo
- 3 Divisioni Scientifiche (tra cui Metrologia Quantistica e Nanotecnologie)
- Forte relazione con Università e industria

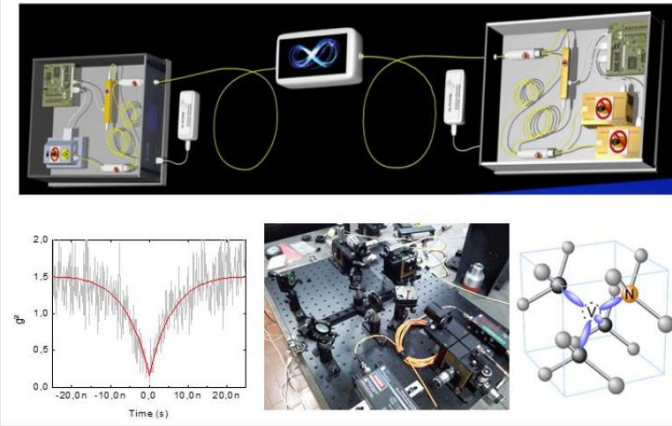


# INRIM / Metrologia Primaria e Metrologia Quantistica

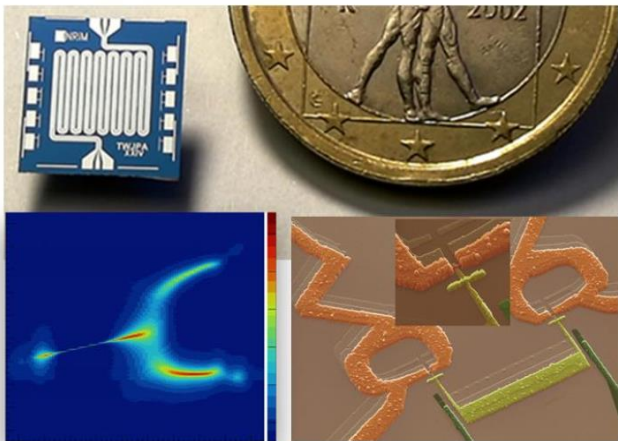
## Atomic Clocks



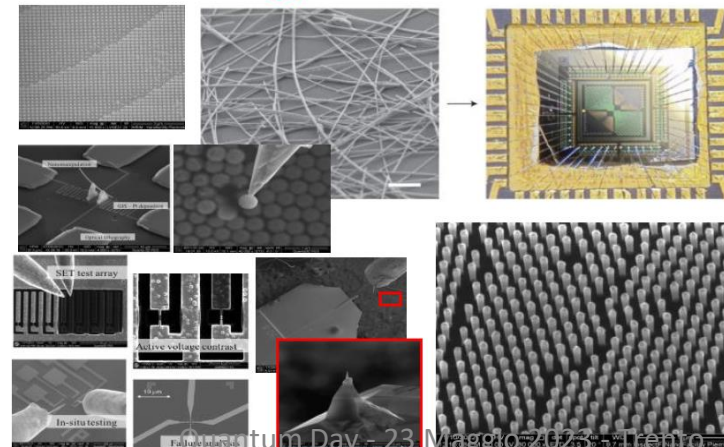
## QKD Metrology & single-photon tech



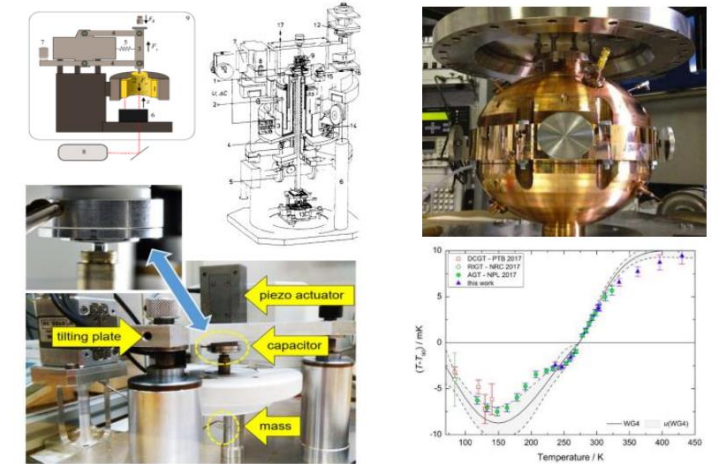
## Quantum Electronics / Nanotech



## Nanotechnology & Advanced materials



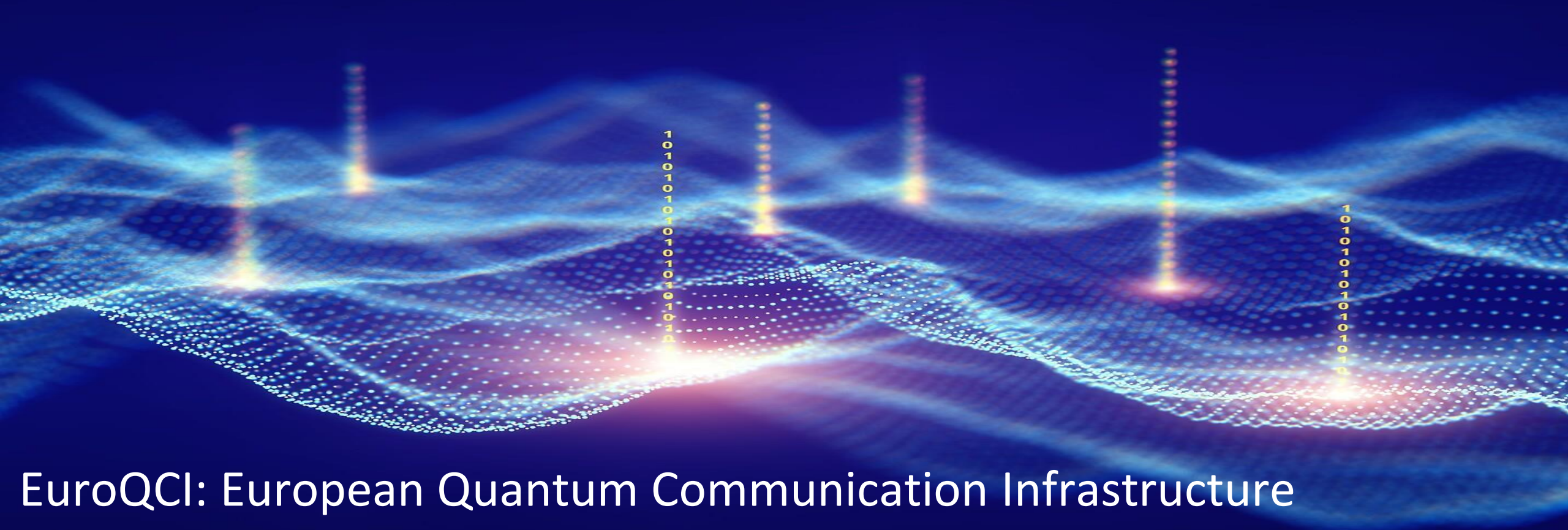
## Primary Standards + Certification



Shaping Europe's digital future

DIGIBYTE | 13 June 2019

# The future is quantum: EU countries plan ultra-secure communication network



EuroQCI: European Quantum Communication Infrastructure

# EuroQCI

## DECLARATION ON A QUANTUM COMMUNICATION INFRASTRUCTURE FOR THE EU

### All 27 EU Member States

have signed a declaration agreeing to **work together** to explore how to **build a quantum communication infrastructure (QCI)** across Europe, boosting European capabilities in **quantum technologies, cybersecurity and industrial competitiveness**.



The first operational system in the world providing Quantum Key Distribution (QKD) for the protection of government data & communications, telecommunications networks, data centres, critical infrastructure (energy, finance, etc.)

- **EuroQCI Declaration signed by all the 27 Member States**
- **Joint Action Plan supporting the national terrestrial and space implementations**

# EuroQCI: Passi principali

**2018**, Bruxelles. Expert and Industry Board: **a chi serve EuroQCI?**

**2019, June**. Bucarest, DG Connect Digital General Assembly. Firma dell'Accordo

**2019 ITALIA + 6 countries. 2022: tutti i 27 firmano EuroQCI**

**2019**, Bruxelles. **Board of Member Countries** (EC + ESA + 2 rappresentanti per MC)

**2020**, EU - Use Cases Studies

**2021-2022**, EU - General Architecture Studies OQTAVO (Leonardo, Telespazio, CNR, INRIM), QSAFE (TIM)

**2023**, EU. Inizio dello sviluppo delle componenti nazionali di EuroQCI nel **Digital European Program National EuroQCI**.  
**In Italia QUID (Quantum Italy Deployment)**

**2029**. Target: servizi QCI

# EuroQCI Overview

- An integrated satellite and terrestrial system spanning the whole EU for ultra-secure exchange of cryptographic keys (Quantum Key Distribution)
- Quantum communication infrastructure (QCI) is part of the European Cybersecurity Strategy and is **to be integrated in the new Secure Space Connectivity initiative 'IRIS<sup>2</sup>'**

## EuroQCI space segment

Distribution of quantum-secured encryption keys on a global scale

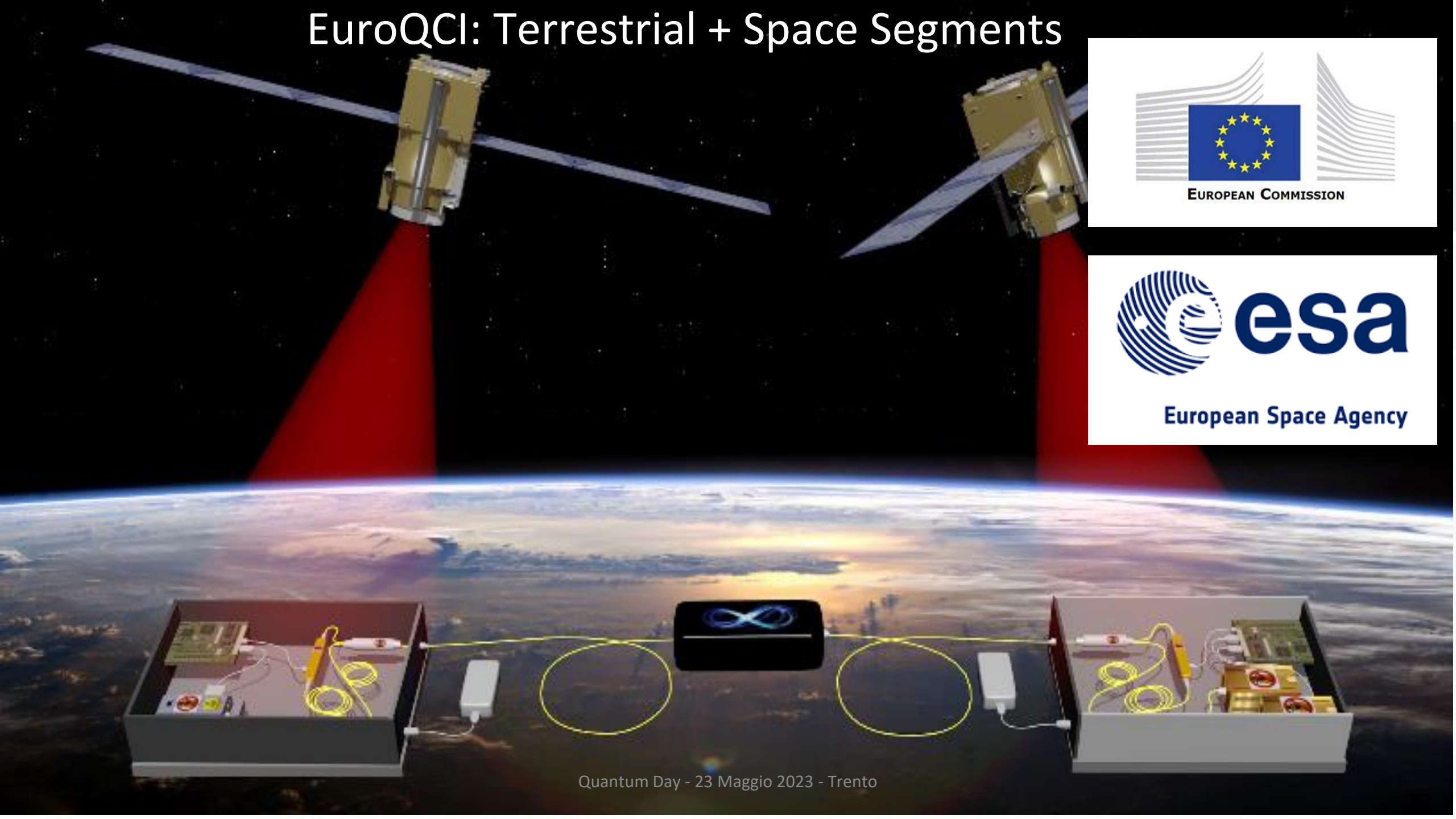


## EuroQCI terrestrial segment

Federation of national terrestrial QCI networks with cross borders connections



# EuroQCI: Terrestrial + Space Segments







# Coordinate the first deployment of national EuroQCI projects and prepare the large-scale QKD testing and certification infrastructure

TOPIC ID: DIGITAL-2021-QCI-01-EUROQCI-QKD

**Two pager to be included in presentation of DEP projects May 2023**

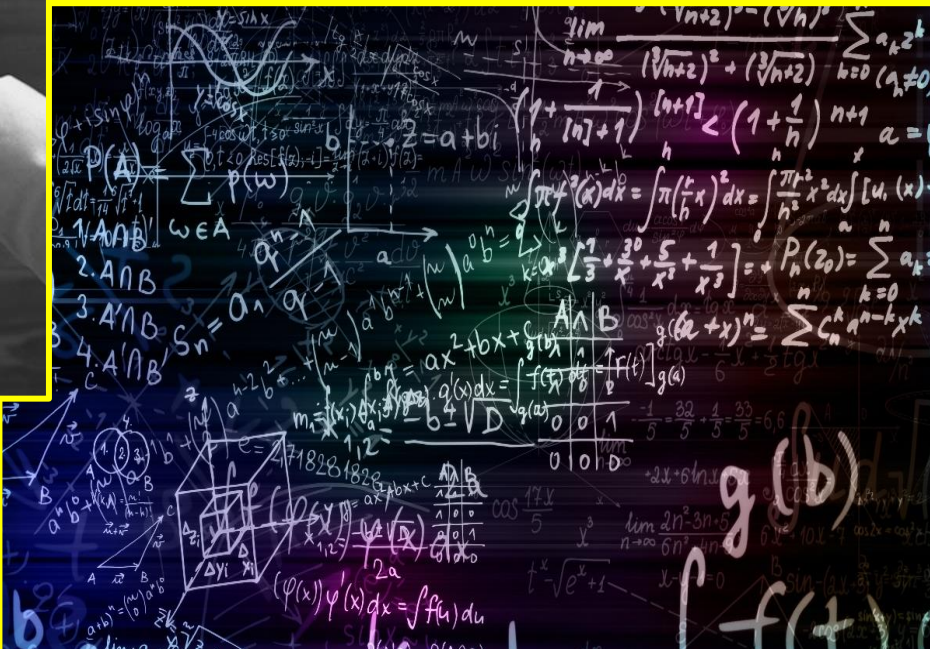


Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the granting authority can be held responsible for them.



# EuroQCI: ecosistema completo

Società / Istituzioni / Grandi Aziende / PMI / Ricerca



# QUID: Quantum Italy Deployment



- **Sviluppa l'infrastruttura di sistemi per la comunicazione quantistica a livello nazionale** per provarli e integrarli nella rete tlc
- **Crea una rete di Quantum Metropolitan Area Networks (QMAN), >14 punti in 9 città:** Torino, Milano, Bologna, Padova, Trieste, Firenze, Roma, Napoli, Matera.
- **Coinvolge 10 use cases nella QCI nazionale**
- Connessione iniziale delle QMANS **con l'Italian Quantum Backbone (IQB)**, su tutta la penisola.

# ITALY DEPLOY NATIONAL: Extensions

**Fino al 2023: INRIM Italian Quantum Backbone**  
Distribuzione Tempo Certificato, Geodesia VLBI,  
Aerospazio-Galileo, Q-man test,  
Collaborazioni con attori pubblici e privati



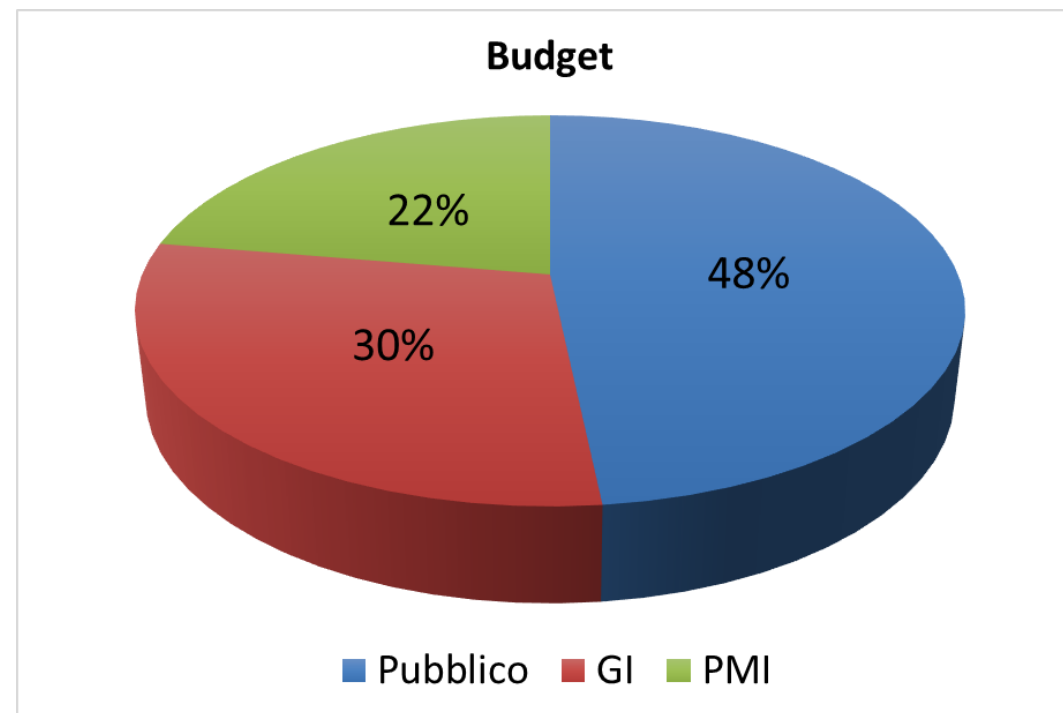
**QUID: espande IQB + operazioni iniziali di QCI**  
QKD lunga distanza / 9 Q-MAN / 10 Use Case / 18 partners  
Contemporanea Disseminazione di Tempo e Frequenza



# Consorzio Pubblico Privato

- 18 Partners: 9 pubblici + 9 privati
- Privati: 5 GI + 4 PMI
- Pubblici: 3 Enti Pubblici di Ricerca + 6 Università
- Budget: 9.45 Meuro
- Durata 30 mesi (2023-2025)

	%Budget
Pubblico	48%
Privato Totale	52%
GI	30%
PMI	22%



# PARTNERS

INRIM (Coordination)

ASI

CNR

Leonardo

Telespazio

Telsy

Thales Alenia Space

TIM

Cohaerentia

QTI

ThinkQuantum

TOP-IX

Università dell'Aquila

Politecnico di Milano

Università di Napoli

Università di Padova

Università di Roma La Sapienza

Università di Trieste



Consiglio Nazionale  
delle Ricerche



Università  
Padova



Politecnico  
Milano



Università  
Napoli



Università  
Sapienza



Università  
Aquila



Università  
Trieste



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Università di Trieste



- **Filiera completamente italiana:**  
Design, architetture, dispositivi, apparati, metodologie, gestione
- **Ecosistema neutrale**
- **Posizionamento europeo delle aziende e dei centri italiani**



Università  
Padova



Politecnico  
Milano



Università  
Napoli



Università  
Sapienza



Università  
Aquila



Università  
Trieste

# Work Packages

WP1 -Coordination

WP2 – Quantum  
Network deployment

WP3 – Quantum and  
traditional  
cybersecurity

WP4 – Innovation

INFRASTRUCTURE AND  
SYSTEMS

CLASSICAL AND  
TELECOMMUNICATION  
INTEROPERABILITY

RESEARCH



## WP2 – Quantum Network deployment

WP2: architectural and punctual deployment, and implements the main concept of QUID

- **Devices for QKD in-field: CNR, QTI, TQ, UniPD**
- **National backbone to connect the Q-MANs**, systems / initial networks.
- **14 nodes in Q-MAN, over 9 towns** (Turin, Milan, Padua, Bologna Trieste, Florence, Rome, Naples, L'Aquila).
- **2 long hauls quantum regional connections**
- **2 nodes in space-to-ground sites are realized**
- **1 free space node to a use case is involved.**

## WP3 – Quantum and traditional cybersecurity

WP3: harmonize existing and traditional cybersecurity with the quantum systems and networks

- foster the **key management in devices/nodes/interfaces.**
- management of **quantum key distribution and telecommunication operations,**

## WP4 – Innovation

WP4: innovation, techniques not yet at the highest TRL, but suited to provide solutions for the open challenges in QKD.

- **improve key rates** by new protocols and technique.
- **free-space component of the architecture search for new solutions to cope with free-space limits.**

## Work Package 3 Quantum and traditional cybersecurity

- integration of quantum and traditional cybersecurity
- fostering key management at the nodes
- improving the trusted node management
- fostering management of fiber infrastructures delaing QKD and data traffic

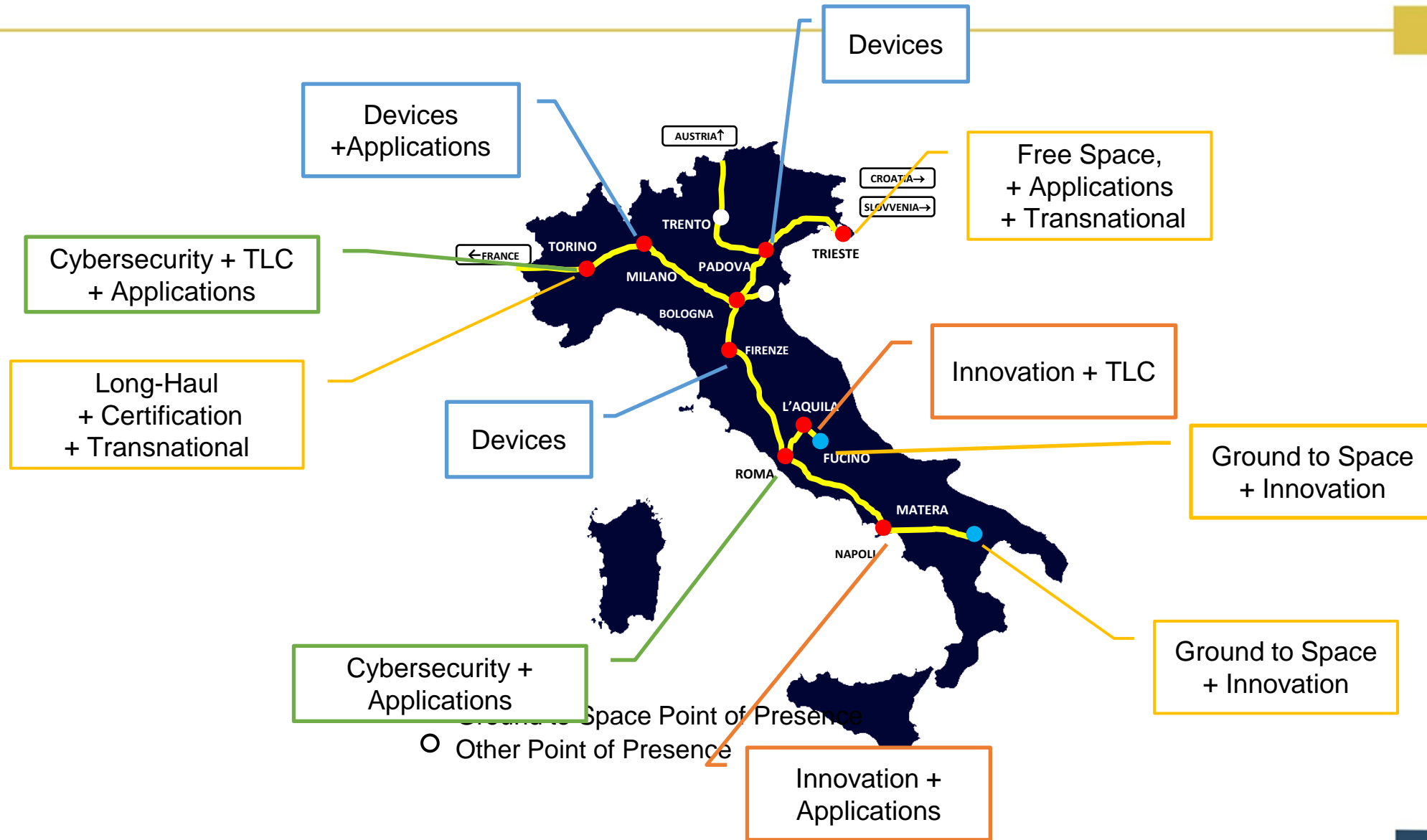
<b>T3.1</b>	<b>Classical Components and Key Management in QKD Systems</b>	Study of the interaction between classical and quantum components within QKD systems;  Analysis of Key Management architectures for different network topologies.
<b>T3.2</b>	<b>Trusted Nodes</b>	Design and realization of Trusted nodes in long-haul connections in WP2.
<b>T3.3</b>	<b>Cybersecurity on QKD terminals</b>	Development of Endpoint Detection and Response (EDR) demonstrator, oriented to the specific QKD application case.
<b>T3.4</b>	<b>Key management</b>	Design and realization of software functions for key management in existing devices (POLIMI)
<b>T3.5</b>	<b>QKD interfaces</b>	Design and Realization of interfaces between the key manager and the traditional security devices using the Quantum Keys
<b>T3.6</b>	<b>QKD and data traffic management</b>	Studying and deploying protocols to sustain data traffic and QKD in the same infrastructure (dark channels)

# Work Package 4 – Innovation

- Developing the TRL of innovative technical solutions
- Including by design this development in further consolidation of the deployment
- Preparing high-key rate solutions to sustain effective national deployment
- Preparing more effective free-space QKD deployment

<b>T4.1</b>	<b>High Key rate QKD in multicore fibers</b>	Design and realization in a dedicated testbed of new solutions to increase by a factor ten the achievable key rate. The testbed is in L'Aquila and will be connected to the Italian Quantum Backbone	<b>UNIAQ POLIMI, CNR</b>
<b>T4.2</b>	<b>High Key Rate QKD by multimodal Single Photon transmission</b>	Design and realization of a high key rate QKD transmission using pulsed laser with a supercontinuum coherent spectrum. The spectrum, composed of hundreds equally spaced modes, is pushed to the single photon per mode regime. Coherent pulsed lasers, aka optical frequency comb are already demonstrated to propagate on long distances in fibres. The single photon per mode regime is promising high key rate and lower sensitivity to attenuation in fibres. The technique will be implemented on the Italian Quantum Backbone in Matera and in Turin.	<b>ASI INRIM</b>
<b>T4.3</b>	<b>High Quantum Efficiency Superconducting Single Photon Detectors for MIR applications</b>	Design and realization in a dedicated testbed of new solutions using Superconducting Single Photon Detectors. The testbed is in Naples, campus S. Giovanni, and will be connected to the Italian Quantum Backbone	<b>UNINA</b>
<b>T4.4</b>	<b>MIR Free Space</b>	Design and realization of a free space QKD using Medium infrared wavelength, to be less sensitive to air turbulence and atmospheric attenuation.  This intends to improve the distance that can be covered by a free space connection and improve the overall key rate.	<b>CNR ASI UNITS</b>
<b>T4.5</b>	<b>Quantum dot based Free space</b>	Design and realization of a free space QKD using quantum dot sources, to improve free space performances. UNIRM node currently has an active optical link between the two buildings of the Physics department. Within QUID, the UNIRM node will improve the key performance indicators (key rate, link stability) of such a link, based on a quantum dot source generating entangled photon pairs. Furthermore, the UNIRM node will support other partners (TAS-I, TPZ) to establish free-space optical links within the project activities. Use of the Node in Fucino for experimental activity with TPZ.	<b>UNIRM TAS-I TPZ</b>

# Mettere insieme le Competenze



# Competences

1. For architecture deployment: INRIM, UniAQ, TIM, TOPIX
2. For QKD devices: Coherentia, QTI, TQ
3. For Ground-to-Space: ASI, INRIM, Leonardo, Telespazio, Thales Alenia Space, UniPD
4. For traditional cybersecurity: Leonardo, Telsy
5. For long-hauls QKD: INRIM, Leonardo
6. For innovation in Free-Space: ASI, CNR, UniRM, Uni PD, UniTS
7. For applications: PoliMI, TIM, UniNA, UniTS, UniPD
8. For Certification: INRIM
9. Multi-services (QKD, Time and Frequency): INRIM

# Use Cases

A satellite is shown in orbit above the Earth's surface. Two bright, parallel laser beams are directed from the satellite towards the planet. The Earth's curvature and atmosphere are visible, with some city lights and clouds on the surface. The background is the dark void of space with some stars.

**U1 – Governo Italiano, Roma**

**U2 – Regione Piemonte con la sua in-house CSI**

**U3 – Siti industriali a Torino (TIM, Telsy)**

**U4 – Regione Lombardia, con la sua in-house ARIA**

**U5 - Matera: interconnessione terra-spazio**

**U6 – MIMIT + Regione Campania a Napoli (MediTech)**

**U7 - Regione Campania (CESMA)**

**U8 - Porto di Trieste**

**U9 – Siti industriali a Roma (TAS-I),**

**U10 – Sito industriale Fucino (Telespazio) per Galileo**

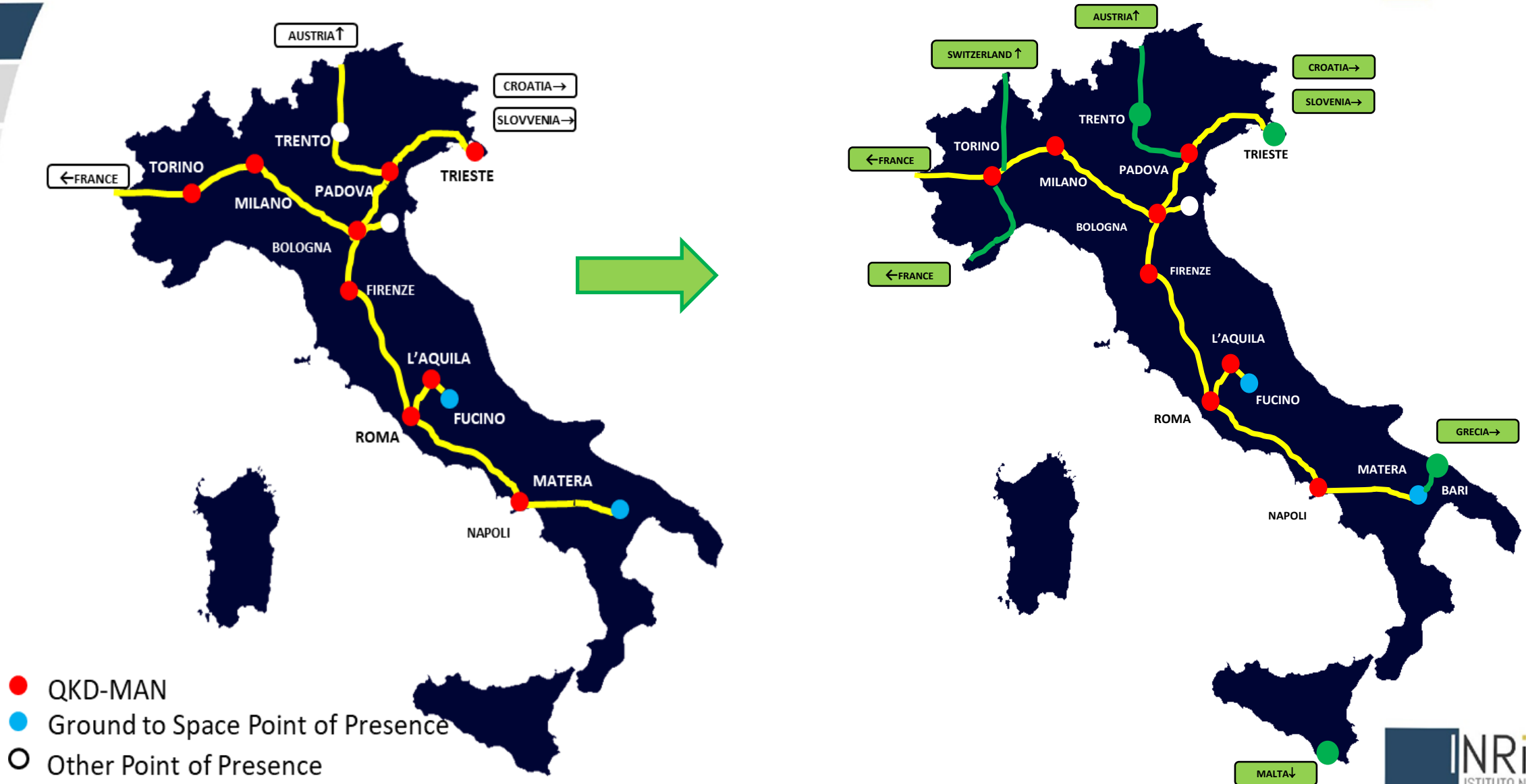
# Day-0 Supporters (Use Cases)



**Autorità di Sistema Portuale  
del Mare Adriatico Orientale**  
Porto di Trieste



# ITALY DEPLOY NATIONAL: Prospettive Cross Border



- QKD-MAN
- Ground to Space Point of Presence
- Other Point of Presence



# Opportunità

Grandi Imprese + Operatori Telecomunicazioni

Piccole e Medie Imprese

Università e EPR

PMI / CTE  
Network

Infrastruttura / Use Cases

Componenti e Servizi

Innovazione / testing / Certificazione

Applicazioni  
e Mercato

PMI/CTE Network:

- Sui Territori
- Associa Imprese e Istituzioni
- Dialoga con la Ricerca
- Guarda ai servizi con le nuove tecnologie

# Conclusioni

- QUID è la componente italiana di EuroQCI
- Coprirà tutta l'Italia con la sua infrastruttura
- E' il primo passo di sviluppo sul campo
- Devono seguire consolidamento + servizi
- Gli Use case dimostreranno le opportunità per l'ecosistema
- In questa fase l'Innovazione di atenei e centri di ricerca è molto importante
- Opportunità di interazione con i Network di PMI e il territorio
- Integrazione con altre iniziative Europee (Cross Border)

**Grazie!**

# Acknowledgements

This presentation has been developed also in the project The Project QUID (QUantum Italy Deployment) which is funded by the European Commission in the Digital Europe Programme under the grant agreement No 101091408

QUID is the Italian deployment of EuroQCI under the supervision of the Ministry of Research

