



# Network eAcademy

Quantum Tech & OTFN

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Task Leader WP6-T1 in GÉANT GN5-2

Infoshare <https://events.geant.org/event/1849/>

May 07, 2025

Public (PU)

## Latest Additions to Network eAcademy

- The Network eAcademy Training Portal now covers
  - new research areas of **Quantum Technology**
  - and **Time and Frequency Networks**
  - Access through Network eAcademy:



### Network eAcademy Training Portal



- Access via <https://wiki.geant.org/display/NETDEV/Network+eAcademy>

# Access in Network eAcademy Training Portal

Pages / NETDEV Home / Network eAcademy

## Network eAcademy Training Portal

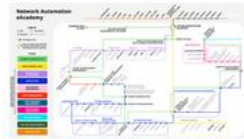
Created by Susanne Nägele-Jackson, last modified on Dec 09, 2024



### Network Training

This Training Portal is offering courses focused on the research and education community, with external references that can be useful for us and examples that can be closer to our use cases. It is training by the community for the community. We will be publishing new classes regularly; all classes are online courses that you can follow and complete at your own pace.

### Network Automation



Take network automation classes to learn about orchestration, automation and virtualisation of networks. Get started with network architecture, data modeling, data formats and protocols and CI/CD and then move on towards intelligent networks using data analytics and AI.

[Learn more about Network Automation...](#)

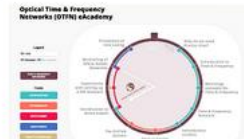
### Quantum Technology



Follow our Quantum technology track to learn about basics such as QuBits, Qubit Entanglement and Teleportation. Find out about Quantum Key Distribution and quantum simulation. Or learn the latest on standards and APIs.

[Learn more about Quantum Technology...](#)

### Time and Frequency Networks



Follow our track for Time and Frequency Networks to learn about the basic metrology concepts of time and frequency, or find out about working with White Rabbit in networks. Other learning units will offer an insight into Optical Carrier Distribution, or the ELSTAB system, which is which is used for Time and Frequency dissemination via optical fibers.

[Learn more about Time and Frequency Networks...](#)

[Back to top](#)

### Info | Infosharing ++ Events

- all upcoming and past events
- **New in Network Automation: Process Flow Orchestration, Hypervisor-based Virtualisation: KVM, Nagios**



Meet us on the first Tuesday of every month

One hour for questions & answers  
Just drop us an email at

[network-eacademy@lists.geant.org](mailto:network-eacademy@lists.geant.org)

and we will send you the link.


### Watch our video:

Towards Service Automation for Research and Education



# Quantum Technology Training (I)

- <https://wiki.geant.org/display/NETDEV/Quantum+Technology+Training>



**Introduction**

- Quantum Algebra Class
  - Qubits (30)
  - Operator Multiplications: Variants (30)
  - Mathematical Operators (30)
  - Qubit Entanglement (30)
  - Teleportation (30)

**Quantum Simulation**

- IBM Qiskit (10)

**Quantum Standardisation**

- ETSI Standard Key Exchange APIs (30)

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**Explore the training map**  
(click on areas of interest to select courses)

**Quantum Tech eAcademy**

**Legend**

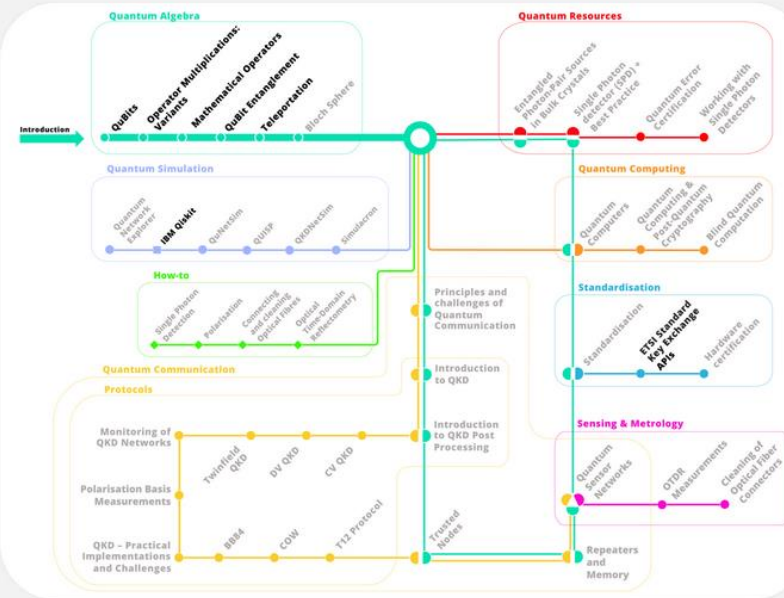
- Unit / Document / Video
- Released / Not released
- Exchange point

**Introduction** Start here: The thick line marks introductory units

**Exchange point:** From this station onwards, you can continue the course in any direction

**Tracks**

- GENERAL INTRODUCTION
- QUANTUM RESOURCES
- QUANTUM SIMULATION
- QUANTUM COMMUNICATION
- QUANTUM COMPUTING
- SENSING & METROLOGY
- STANDARDISATION
- HOW-TO



Area for text links

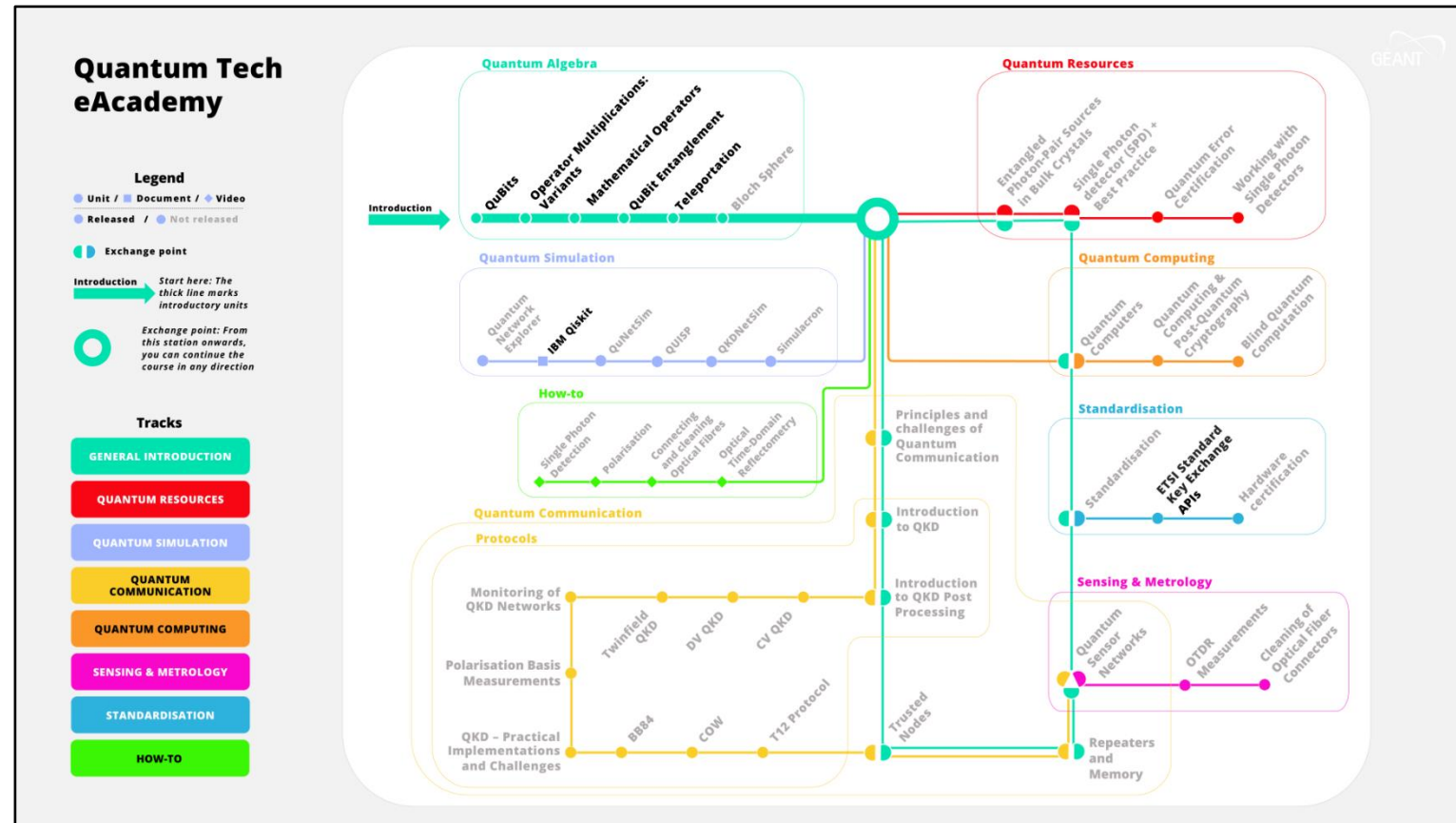
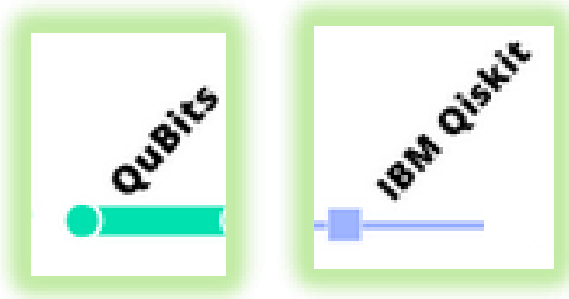
Area for text metro map links

# Quantum Technology Training (II)

- <https://wiki.geant.org/display/NETDEV/Quantum+Technology+Training>

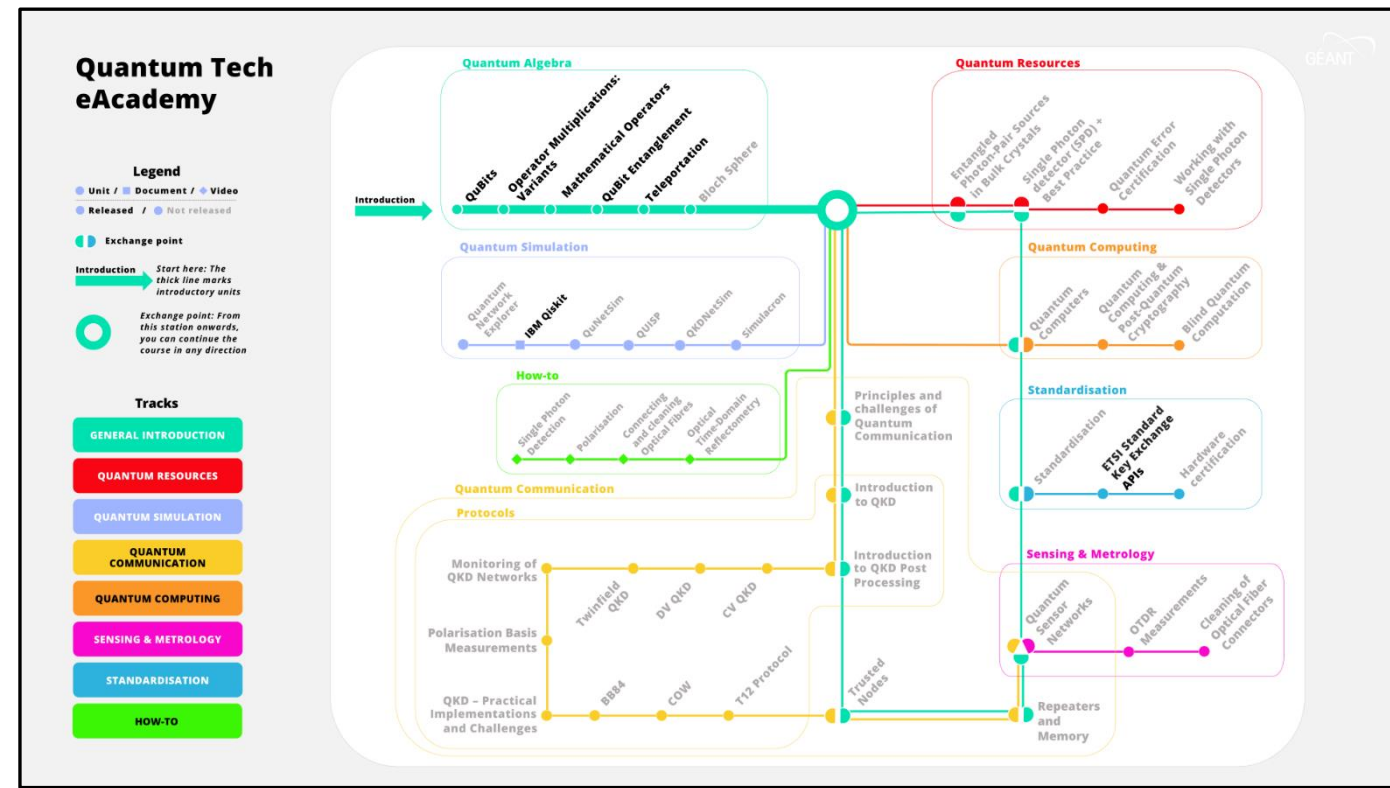
## • Metro map

- Dark titles are clickable units
- Light grey titles are units soon to come
- Circles take you to a Moodle LU (Learning Unit)
- Squares take you to documents



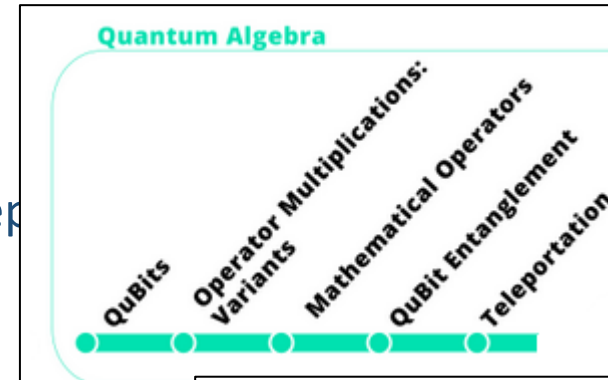
# Quantum Technology Training (II)

- <https://wiki.geant.org/display/NETDEV/Quantum+Technology+Training>
- Quantum Tech Metro map
  - Green line for Introduction courses
  - Quantum algebra class to learn about
    - QuBit Entanglement and
    - Teleportation
  - Light blue line for Quantum simulation
  - Red line for Quantum resources
  - Yellow line for Quantum communication
  - Pink line for Sensing & Metrology
  - Medium blue line for Standardisation
  - Amber line for Quantum Computing
  - Light green line for Hands-on videos



# Quantum Technology Training (III)

- **Concept: Quantum Algebra Class**
  - 5 learning units to understand main concepts of entanglement and teleportation
- **Coming soon:**
  - Introduction to QKD
  - Simulacron
  - Learning Unit: Entangled-Photon-Pair Sources in Bulk Crystals
  - Learning Unit: Introduction to QKD Post Processing
  - **New Concept: Four How-to-videos:**
    - Connecting and Cleaning Optical Fibres
    - Single Photon Detection
    - Polarisation
    - Optical Time-Domain Reflectometry

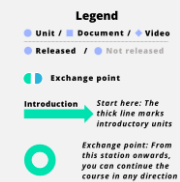


## Introduction to QuBits, Quantum Algebra, Entanglement and Teleportation

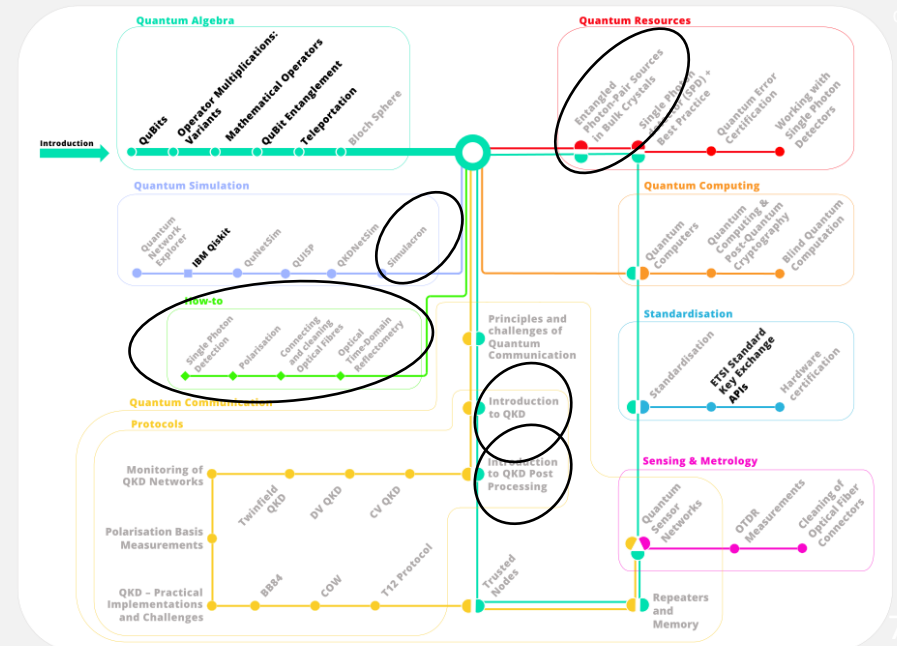
(by Peter Kaufmann (DFN) and the Quantum Training Development Team)

Welcome to this learning unit which is the third in a sequence of units covering the topic of Quantum Algebra. The purpose of the Quantum Algebra class is to introduce the basic theoretical principles of QuBits, their quantum entanglement and the process of teleportation. These aspects are the fundamentals used in quantum computers, quantum networks and quantum security. For the understanding of the physics, some mathematical background aspects from the area of "Operator Algebra" are required.

## Quantum Tech eAcademy



### Tracks



# QT Access via GLAD

GLAD  
GEANT LEARNING & DEVELOPMENT

Home Dashboard My courses Site administration All courses

Technical skills / Network / Quantum Technology

## Quantum Technology

Category Settings Recycle bin More ▾

Technical skills / Network / Quantum Technology

Search courses

More ▾

### Quantum Tech eAcademy

**Would you like to learn more about the exciting world of Qubits and all the fascinating new Quantum Technologies that are based on them?**

Then follow our series of new courses in the GÉANT eAcademy track called "Quantum Technology" Here you can explore *Qubit fundamentals*, *Quantum communication and protocols* or explore *simulators and simulator platforms*.

We recommend starting with our Quantum Algebra Class for an easy grasp of basic concepts of entanglement and teleportation.

Questions or feedback? Please contact [qtraining@lists.geant.org](mailto:qtraining@lists.geant.org)

Quantum Algebra: Qubits

Quantum Algebra: Operator Multiplication: Variants

Quantum Algebra: Mathematical Operators

Quantum Algebra: Qubit Entanglement

Quantum Algebra: Teleportation

ETSI Standard Key Exchange APIs

- <https://e-academy.geant.org/>

- All courses

- Technical Skills

- Network

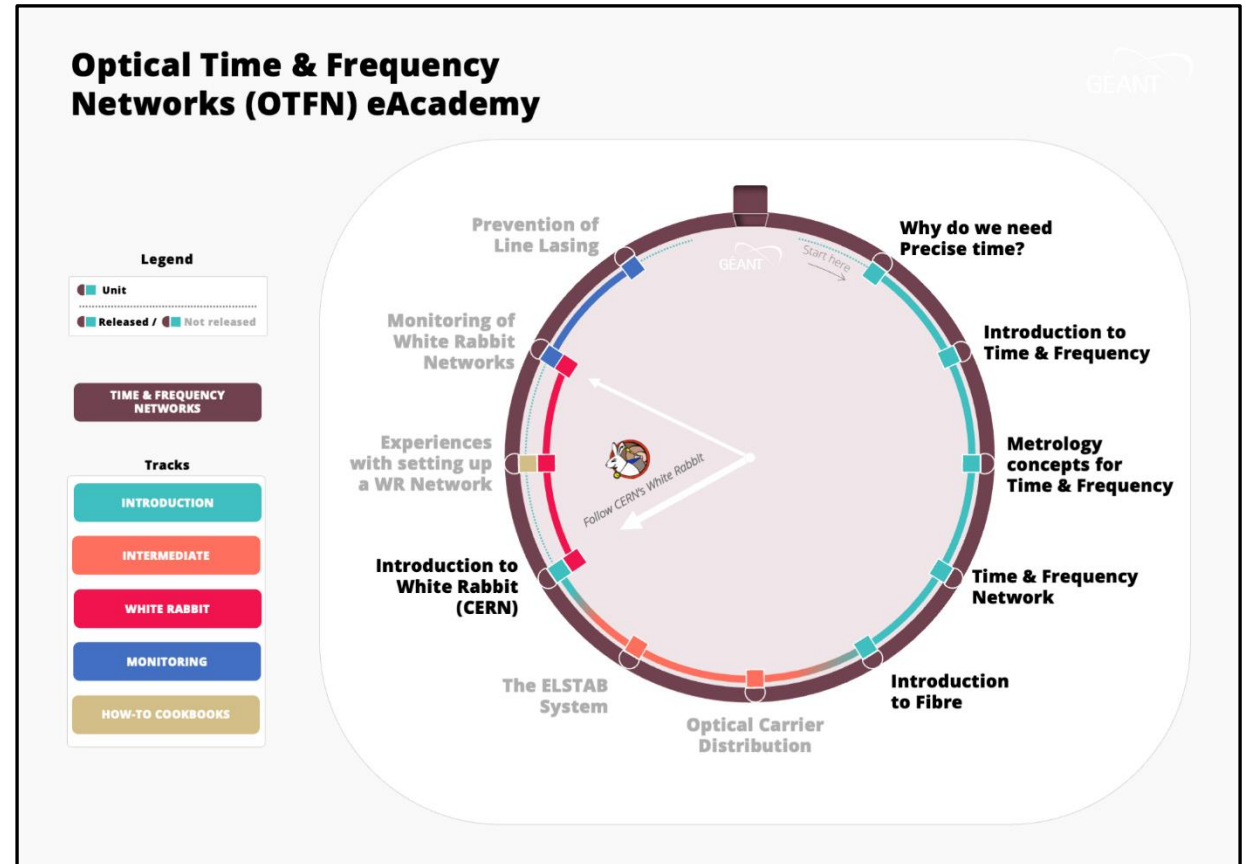
- Quantum Technology



# Training in Time and Frequency Networks

- <https://wiki.geant.org/display/NETDEV/Time+and+Frequency+Networks+Training>

- Dark titles are clickable units
- Light grey titles are LU to come
- Green line for Introduction courses
- Orange Line for advanced courses
- Red line for White Rabbit
  - NeA for NREN related material
  - More details via link to CERN
- Medium blue line for Monitoring
- Beige line: How-to Cookbooks



# OTFN Access via GLAD

The screenshot shows a web interface for the Geant Academy. At the top, there is a breadcrumb trail: "Technical skills / Network / Time and Frequency Networks". Below this is the main heading "Time and Frequency Networks". A navigation bar contains "Category", "Settings", "Recycle bin", and "More". A search bar is present with the text "Search courses" and a magnifying glass icon. Below the search bar, there are five course cards, each with a title and a thumbnail image. The courses are: "Why Do We Need Precise Time?", "Introduction to Time and Frequency", "Metrology Concepts for Time and Frequency", "Time and Frequency Network", and "Introduction to Fibre". Each card has a right-pointing arrow icon.

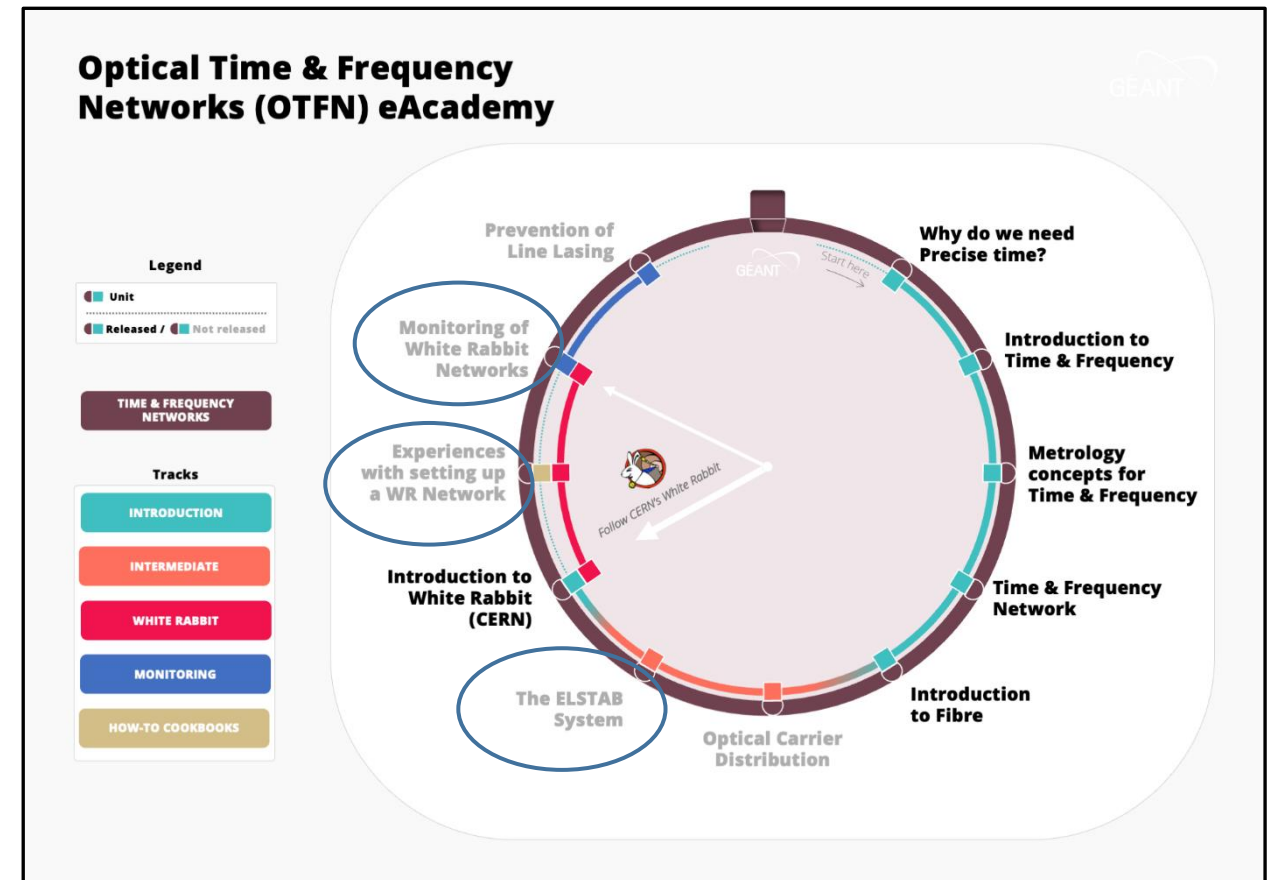
- <https://e-academy.geant.org/>
  - All courses
    - Technical Skills
      - Network
        - Time and Frequency Networks

# Training in Time and Frequency Networks

- <https://wiki.geant.org/display/NETD/EV/Time+and+Frequency+Networks+Training>

- **Coming soon:**

- Experiences with Setting Up a WR System
- The ELSTAB System
- Monitoring of White Rabbit Networks



# General Class Structure (I)

## • Overview information

- available on demand
- Indicators for duration / commitment
- Prerequisites (if any)
- Certificate of Completion!

### Why Do We Need Precise Time?

Course

Settings

Participants

Grades

Reports

More ▾

OVERVIEW

Main Goals

Applications

Transportation methods

GNSS System Risks

Use cases - 5G

Use Cases - Science

Use Cases - Financial Sector

Use Cases - Power Grids

Use Cases - Defence Sector

Use Cases - Distributed Installations

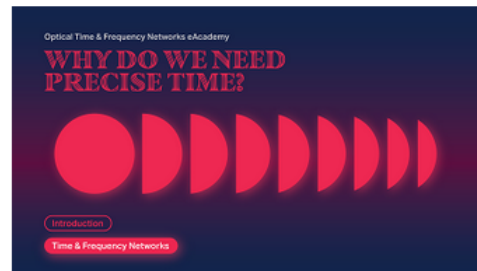
Useful Links

Quiz

Feedback & Certificate

What's Next?

#### Welcome to the Course: Why Do We Need Precise Time?



COURSE DATE:



On demand

DURATION:



About 30 minutes

COMMITMENT:



About 30 minutes

REQUIREMENT:



None

COURSE TYPE:



Self paced

CREDENTIAL:



Certificate of Completion


#### Course summary

(by Wojbor Bogacki and Krzysztof Turza (PSNC)<sup>1</sup> and the Time and Frequency Networks Training Development Team)

# General Class Structure (II)


- Main Goals
- Video /pdf sections
- Exercise sections
- Useful links
- Quiz
- Feedback & Certificate
- What's Next?
- **For questions please contact**
  - **network-eacademy@lists.geant.org**

### Main Goals



This video contains the introduction to Single Photon Avalanche Diode (SPAD) Technology, mainly explaining the distinction between macroscopic and single-photon level intensities and providing information about the importance of avoiding detector saturation to maintain measurement accuracy.

It will also explain how the single photon avalanche diode works together with data acquisition and an interface where the operation parameters can be set by the user.



ters. If you want to turn on the subtitles in the video, press

### Short quiz on mathematical operators

Quiz Settings Questions Results Question bank More ▾

Back

**Question 1**  
Not yet answered  
Marked out of 1.00

I, H, X, Y, Z are operators.

Select one:

True

False

Flag question Edit question

Next page



## ETSI Standard

004 Specification Functions and Parameters


Ane Sanz (UPV/EHU)

Quantum Training Developer

Course Settings Participants Grades Reports More ▾

INTRODUCTION Quantum Algebra Class Identity Operator Hadamard Operator Exercise 1 Pauli Operator X Pauli Operator Z Pauli Operator Y Operator Applications Exercise 2 Useful Links Quiz Feedback & Certificate What's Next? Results

### Need some exercises?



Let's have a look at the **Identity Operator** again:

$$I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$I * |0\rangle = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} * \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

How did we get this result? again:


$$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} * \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$1 * 1 + 0 * 0 = 1$  (upper value)  
and  
 $0 * 1 + 1 * 0 = 0$  (lower value)

Now let's try this for the **Hadamard Operator H**:

### What's Next?

You have now completed this learning unit. We hope it has sparked further interest and that you will explore other learning units. If you have any questions about this learning unit or any other learning units, please feel free to contact us at [qtraining@lists.geant.org](mailto:qtraining@lists.geant.org). We would love to hear from you!



For more Quantum Algebra learning units, continue with:

- ✓ Qubits
- ✓ Operator Multiplication; Variants
- ✓ Mathematical Operators
- ✗ QuBit Entanglement
- ✗ Teleportation
- ✗ Bloch Sphere

For more learning units in our series, go back to [Quantum Technology](#).



# Thank You

[www.geant.org](http://www.geant.org)



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the European Union