

Fibre sensing sulla rete dati: il progetto SENSEI

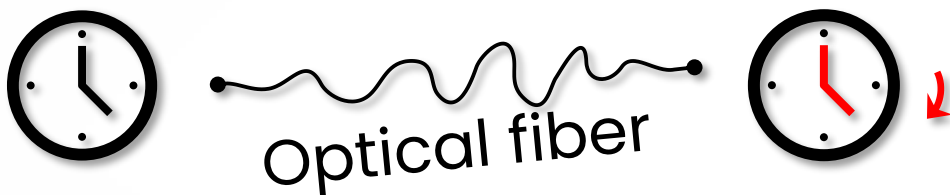
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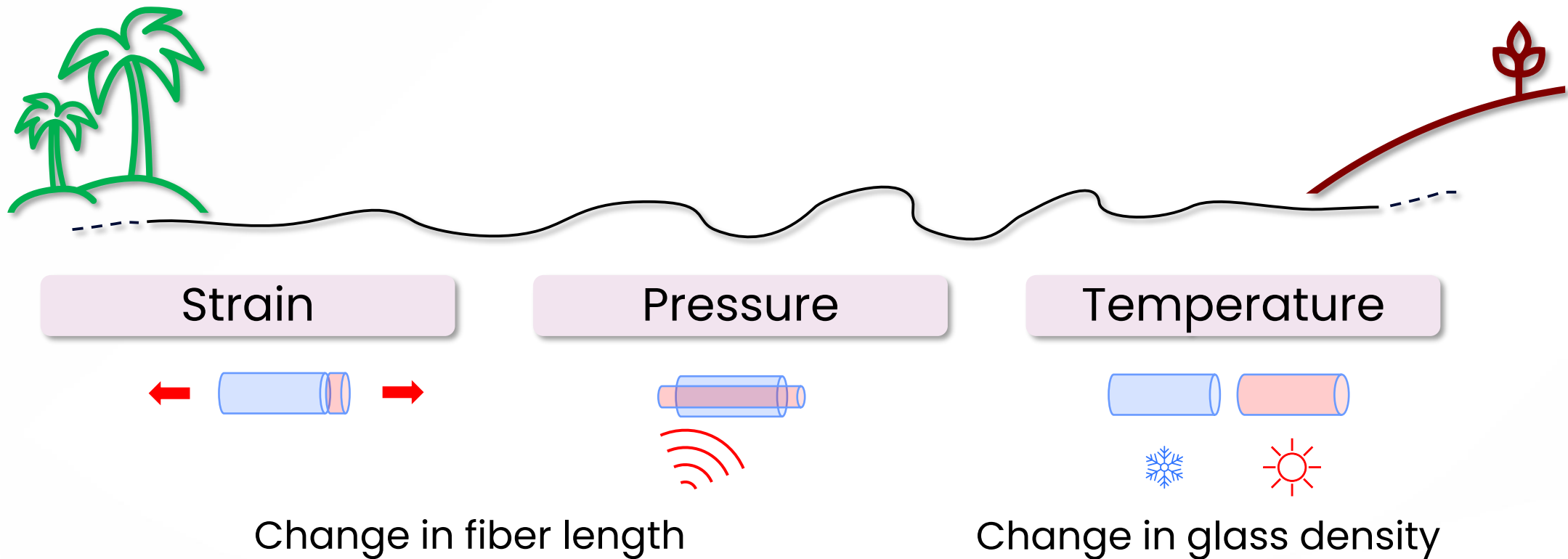
The Italian Metrology Institute

INRIM realizes and maintains in Italy the Units of the International System

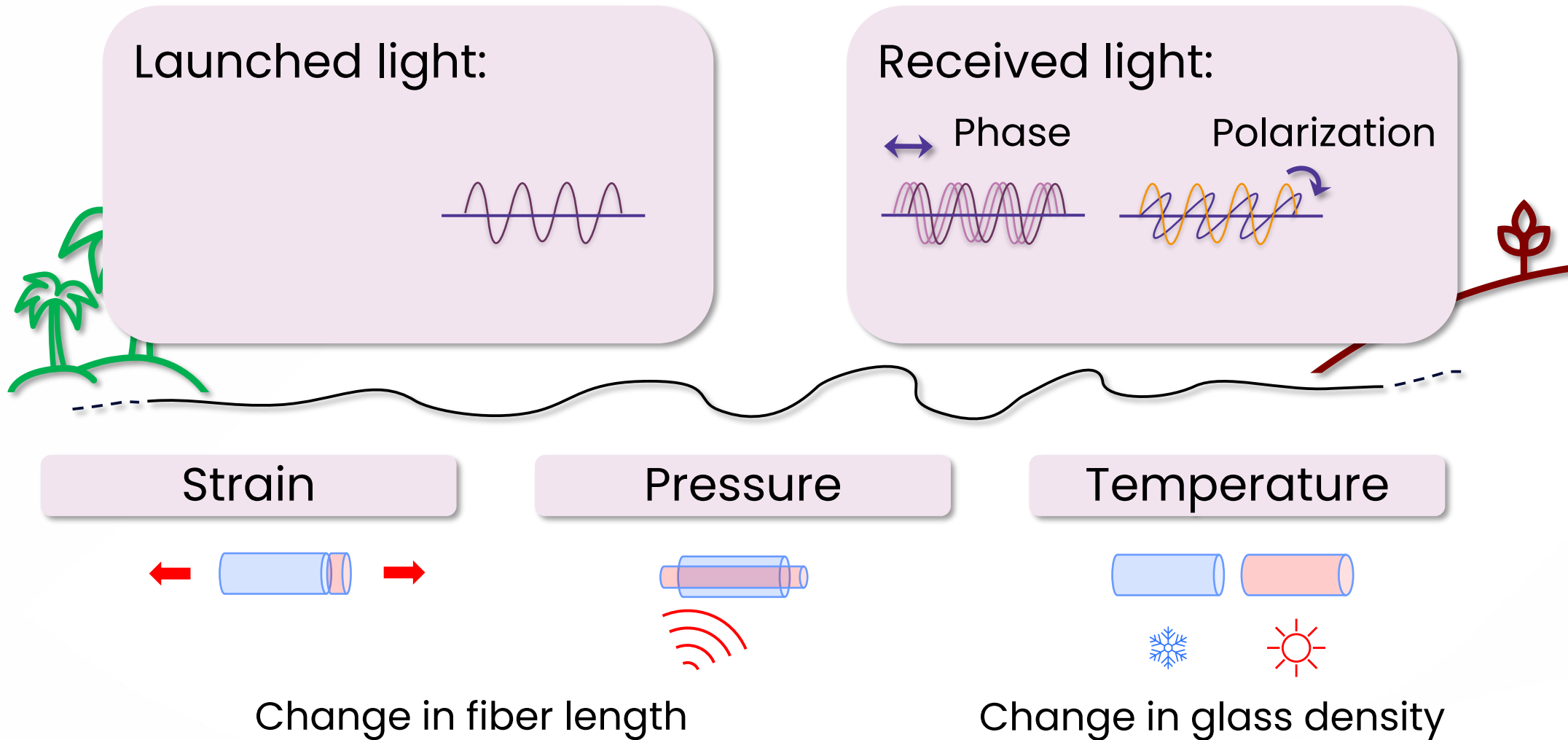
It realizes the Italian National Timescale UTC(IT) and distributes it to the users






The fiber as a sensor



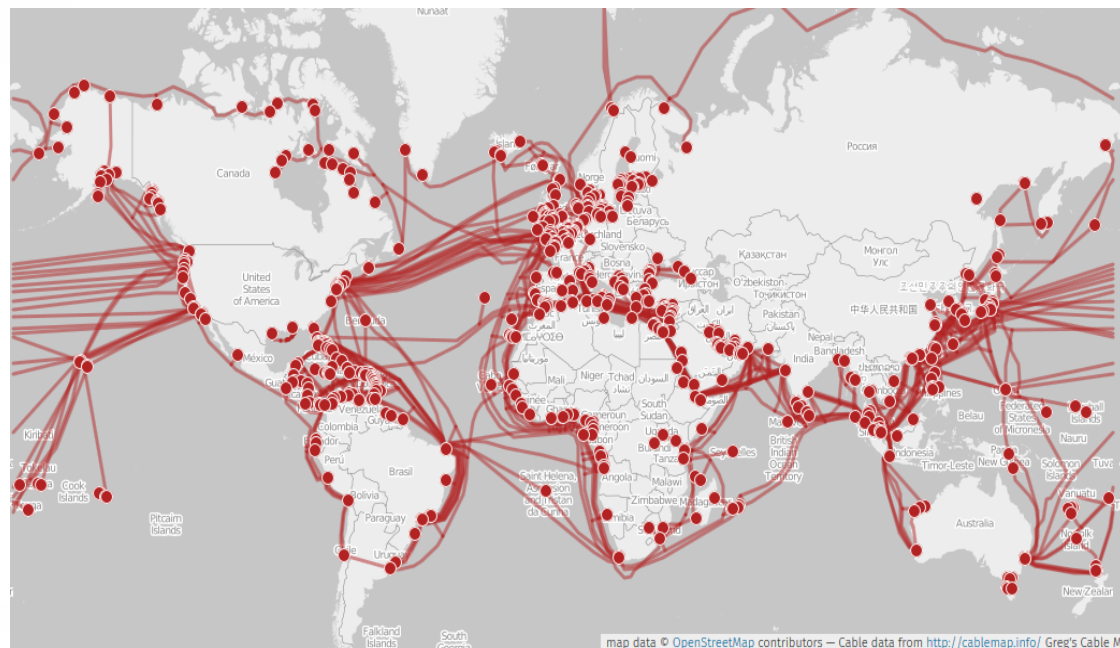
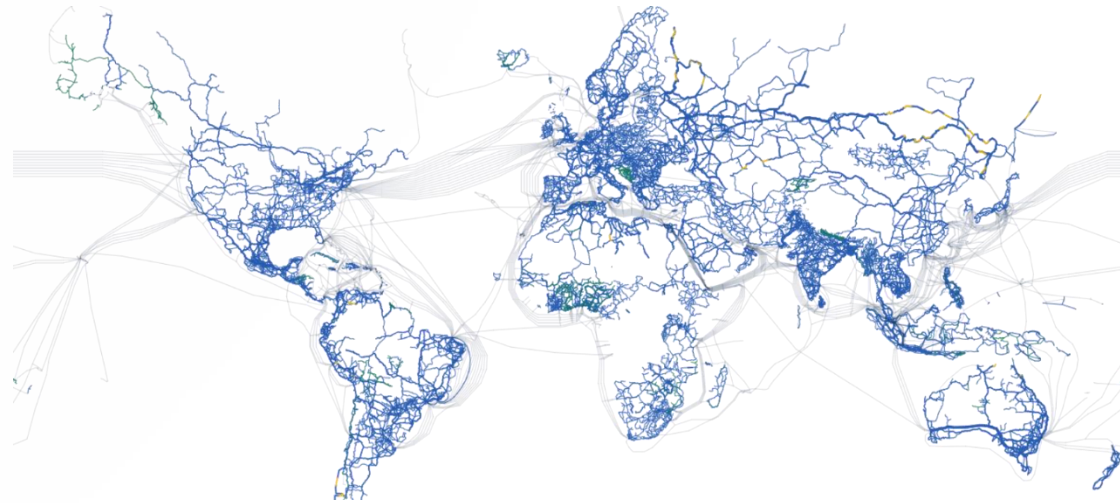
The fiber as a sensor



The fiber as a sensor

-  Earthquakes
-  Volcanos
-  Oceanographic processes
-  Marine life
-  Wind
-  Weather
-  Buildings & infrastructures
-  Infrastructure monitoring
-  Traffic
-  Human activities

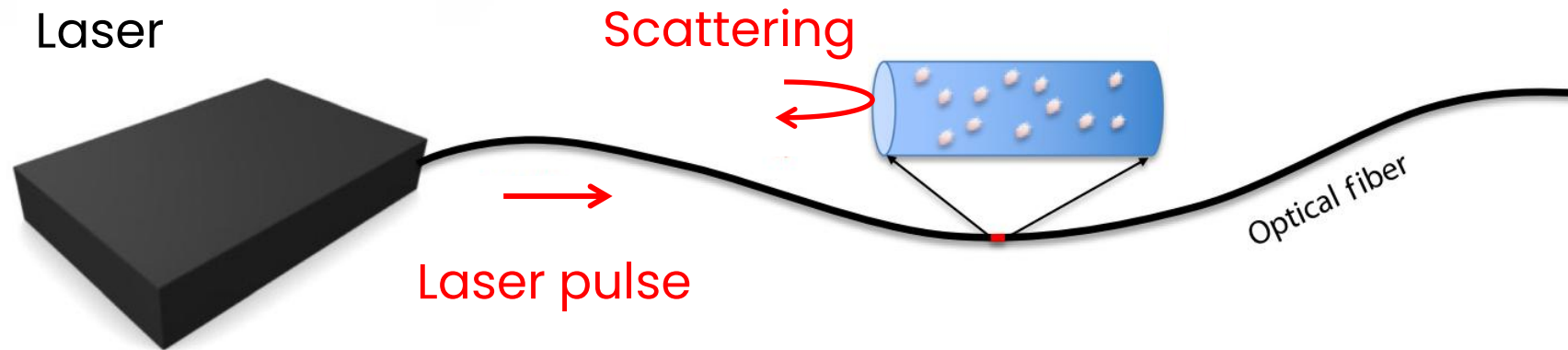
Global Network Sensing



<http://cablemap.info>
<https://bbmaps.itu.int/bbmaps/>

Sensing while carrying data

- Conventional fiber sensing exploits backscattered radiation



But:

- Conventional data networks are mostly unidirectional
- Sensing is not just about measuring

The SENSEI project



SENSEI

Smart European Networks for Sensing
the Environment and Internet quality

Programme: Horizon Europe (Digital)

Budget: 5 M€

Duration: Dec.2024–Nov. 2027

Coordination: INRIM



**Funded by
the European Union**

SENSEI in a nutshell

- Turn the global telecom. fiber network into a **pervasive distributed sensor**
- Make the network **more resilient and efficient** thanks to improved supervision ability



Science, citizen protection, alerting



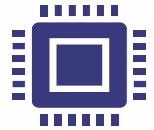
Network operation & maintenance

Target groups



Network operators:

prevent infrastructure damage, plan maintenance, minimize disruption



Photonics manufacturers and vendors:

Expansion of product portfolio



Science (Geophysics, Climate, marine ecosystems):

New sensors, better coverage, more data



Seismic monitoring & alerting:

better coverage, redundancy, early data arrival

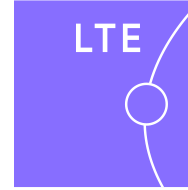


Society:

Smart cities, service quality, citizen protection

The Consortium

Research institutes
(photonics/ T&F)



Research institutes
(geoscience)



Academia
(networking & seismology)



Politecnico di Torino



L-Università ta' Malta



UNIVERSITY OF PATRAS
ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΑΤΡΩΝ

Network Operators



Companies
(photonics)



SENSEI objectives

Photonics techniques for sensing in coexistence with data traffic

Software / hardware integration into the network control architecture

Data interpretation & field tests on deployed cables

Use-cases and applications relevant to stake-holder community

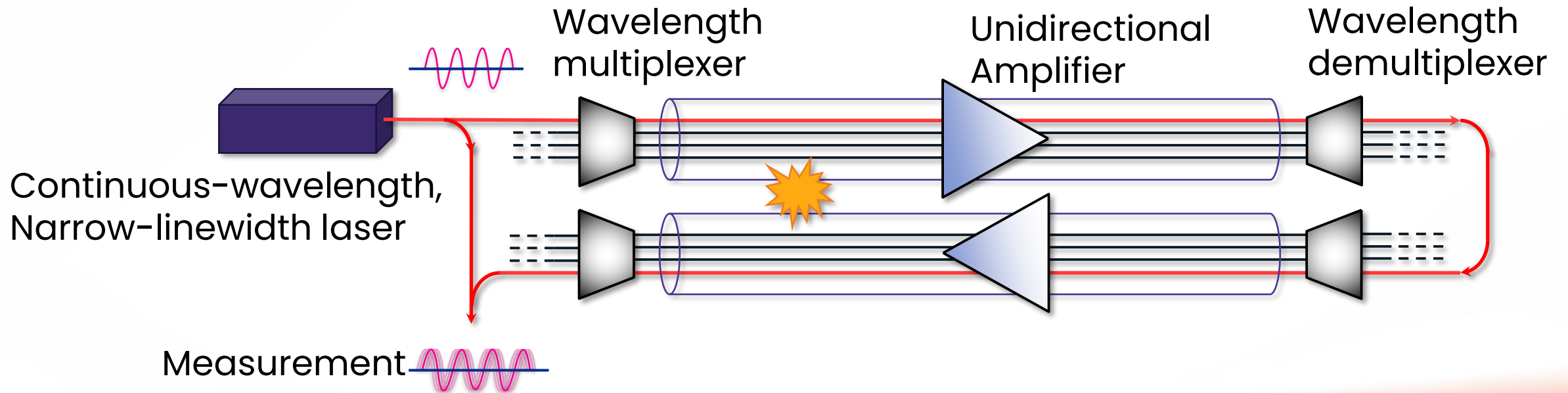
Photonics / 1: Phase analysis with very stable lasers

Science

REPORTS

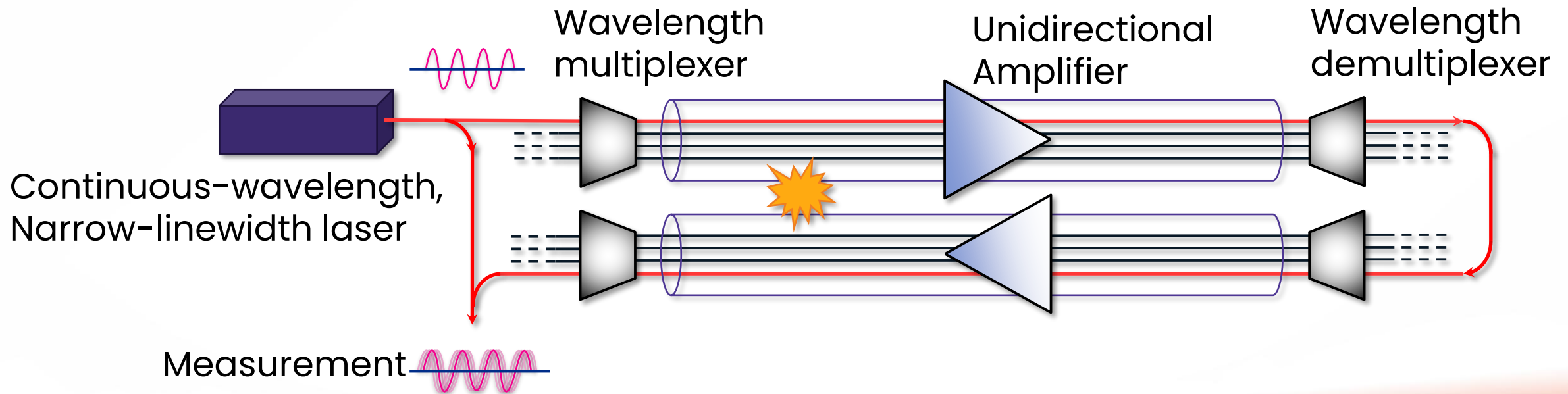
Cite as: G. Marra *et al.*, *Science*
10.1126/science.aat4458 (2018).

Ultrastable laser interferometry for earthquake detection with terrestrial and submarine cables

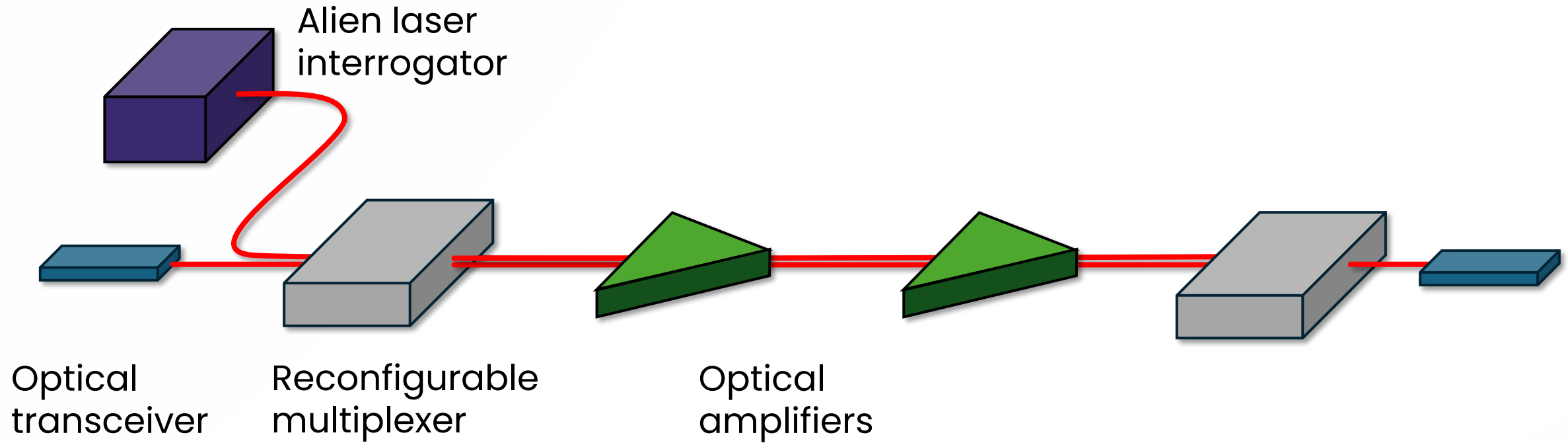


Photonics / 1: Phase analysis with very stable lasers

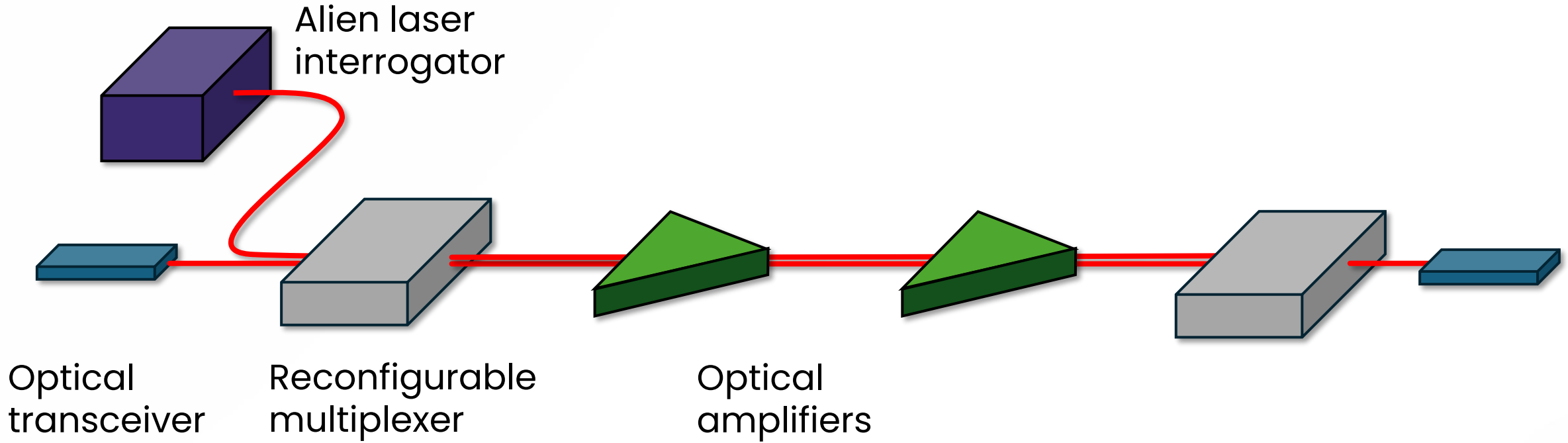
- Coexistence with data
- Able to probe long, repeated links
- Maximum reach > 1000 km



Photonics / 2: Network elements



Photonics / 2: Network elements



Polarization
(fiber deformation)

Optical power

Bit Error Rate

Signal/noise ratio

Network Integration

Detection is just the first (easy) step...



Network Integration

Detection is just the first (easy) step...



- Software/architectural integration
- AI/ML with/without trained datasets
- Edge computing
- Data-transfer, latency, synchronization...

Year 2: Field tests



Reykianes peninsula (Iceland)



Valletta Harbour (Malta)

The Italian Quantum Backbone



1800 km optical fiber operated by INRIM & GARR to distribute precision time

Connected to EU metrological network

A testbed for quantum physics and sensing



Year 3: case studies



Resource optimization & cable integrity supervision

- Automatic collection and processing of telemetry data
- Lowest-energy control
- Assess response to soft / hard failures



Integrating fiber sensing into seismic surveillance

- Continuous transmission, low latency
- Contribute to event identification, localization and magnitude estimation.

Take-home messages

- Hybridation of techniques toward improved sensing
- Detection > Interpretation > Action
- Open Science approach:
 - encourage use of SENSEI datasets
 - discuss stakeholders needs and requirements
 - discuss on data protection measures
- Sinergic use of the EU metrological fiber infrastructure

Toward an European Research Infrastructure



FOREST signatories:

- 14 National Research and Education Networks (w/ GARR)
- 12 NMIs, National Metrological Institutes (w/ INRIM)
- GEANT, consortium of the European NRENs
- 35-40 other EU scientific institutions (w/ INGV, INAF, CNR...)

Time and Frequency

Based on the EU
metrological networks

Quantum technology

Based on QUID & the
European Quantum
Comm. Infrastructure

Sensing

Based on SENSEI and
similar experiences

Acknowledgements

Thank you for your attention!

More info:
senseiproject.eu



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SENSEI
Smart European Networks for Sensing
the Environment and Internet quality



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the European Union**

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