




DAY OF PHOTONICS 2018

**Seminario pubblico del Centro PhotoNext
23 Ottobre 2018**

- **Il 21 ottobre 1983** (35 anni fa) la “General Conference of Weights And Measures” (Conferenza generale dei pesi e delle misure) standardizzò la velocità della luce in **299,792.458 m/s**
 - **E da questa derivò la nuova definizione del metro nel Sistema Internazionale**
- Seguendo la tradizione iniziata a POLITO due anni fa, abbiamo organizzato dunque un secondo evento divulgativo nel campo della fotonica
 - ... con due giorni di ritardo!!
- Approfittando anche del compleanno del **Centro PhotoNext**
 - ... con tre mesi di ritardo!!



- **Saluti istituzionali, Politecnico di Torino**
 - **Prof. Gianmario Pellegrino, delegato del Rettore per i Centri Interdipartimentali**
- **R. Gaudino e D. Milanese, POLITO** “Primo compleanno del centro PhotoNext” (15 min)
- **S. Abrate, ISMB**, “LINKS fotonici” (15 min)
- **P. Calefati, Prima Additive** “La fotonica per la manifattura 4.0” (25 min + Q&A)
- **D. Calonico, INRIM** - “Tecnologie Fotoniche per la Metrologia primaria di Tempo e Frequenza” (25 min + Q&A)
- A seguire: aperitivo e visita del Centro PhotoNext 

PHOTONEXT



...in a nutshell



- Centro Interdipartimentale del Politecnico di Torino
 - Bottom-up, Consolidator
 - Finanziato per **1.8 M€** (su tre anni, a partire da Luglio 2017)
- Forte componente sperimentale
 - PhotoNext è un laboratorio «hardware» sulla Fotonica applicata
- 4 dipartimenti coinvolti:



Coordinatore:

• **Roberto Gaudino**

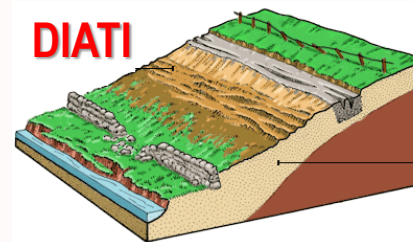
Dipartimento di Elettronica e Telecomunicazioni



Vice Coordinatore:

• **Daniel Milanese**

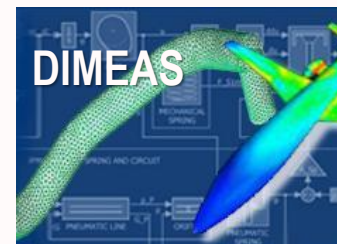
Dipartimento Scienza Applicata e Tecnologia



Responsabile DIATI

• **Alberto Godio**

Dipartimento di Ingegneria dell'Ambiente, del Territorio e delle Infrastrutture



Responsabile DIMEAS

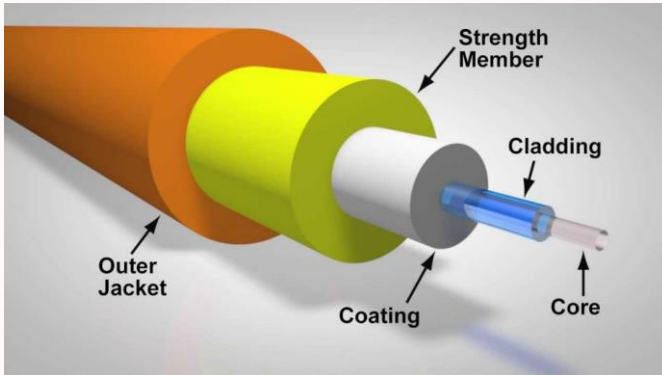
• **Paolo Maggiore**

Dipartimento di Ingegneria Meccanica e Aerospaziale

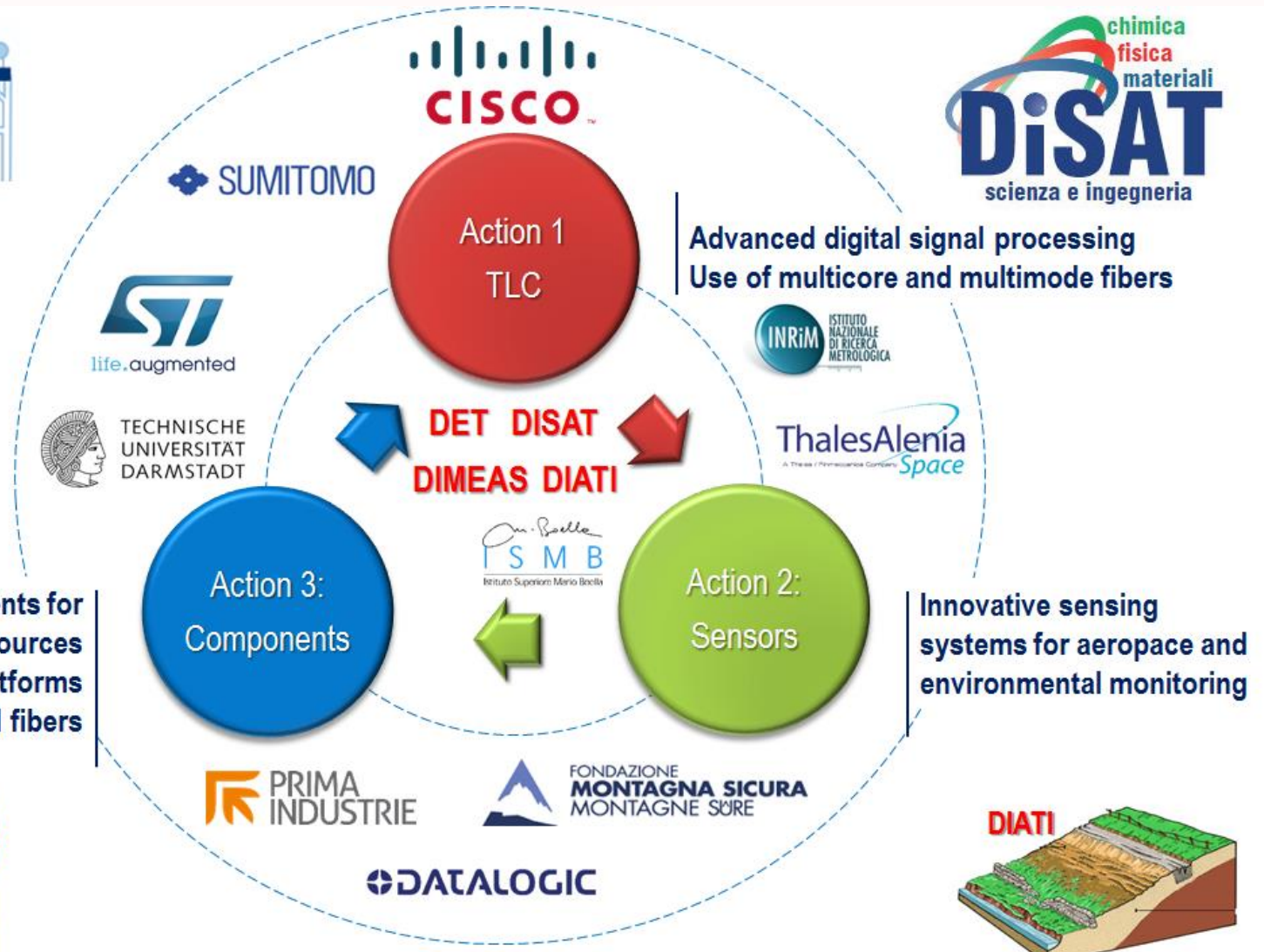
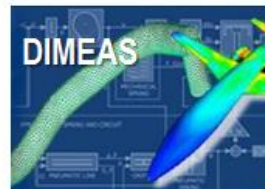
Che cosa è?

Focalizzato su tre
grandi aree della
Fotonica

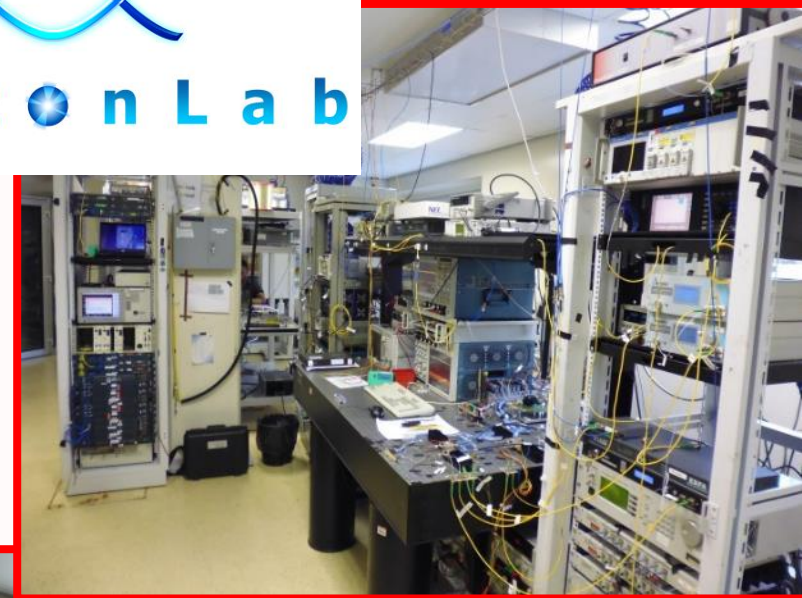
legate all'utilizzo di
fibre ottiche



New optical components for
optical sources
Silicon Photonics platforms
Novel materials and fibers



- PhotoNext coincide come spazi fisici con il laboratorio PhotonLab
 - PhotonLab esiste dal 2002 a seguito di:
 - LAQ2002: Laboratori Alta Qualità POLITO
 - Accordo ISMB-POLITO
- Il laboratorio è situato all'interno dell'Istituto Superiore "Mario Boella" (ISMB)
 - Le attività degli ultimi 15 anni sono sempre state svolte in fortissima sinergia con ISMB/LINKS
 - Stiamo lavorando per un Accordo Quadro specifico tra PhotoNext e ISMB/LINKS





Utilizzo del budget (1.8 M€ su 3 anni)

- Acquisto e aggiornamento di grandi attrezzature sperimentali nel campo della Fotonica, fondamentali per gli obiettivi del progetto








Le principali grandi attrezzature di PhotoNext




Area telecomunicazioni in fibra ottica

- Ultra-high speed arbitrary waveform generators, 4ch@ 35 GHz, 100 Gsample/s 
- Ultra-high speed oscilloscopes, 4ch @ 70 GHz 200 GSa/s 



Area Sensori

- Fully-equipped optical sensor systems, with different characteristics 
 - Bragg-grating based sensors 
 - Distributed sensors, short distance or long distance applications 
- High performance UV-VIS-NIR spectroscopy instrumentation 
- High resolution spectrophotometer 

Area Componenti e fibre speciali

- Upgrade to existing drawing tower 
- Fiber processing station 
- Pigtailling station for optical components 

Strumenti comuni

- Optical spectrum analyzer 
- Fiber splice with special extension to multicore fibers 

- **Logistica di avvio di progetto**

- Web site
- Mailing list
- Strutturazione organizzazione interna (Management Committee e Steering Committee)

- **Acquisizione strumenti**

- La maggior parte delle gare di appalto per gli strumenti principali sono già completate o avviate

- **Attività di ricerca**

- See later...

▪ **Organizzazione di seminari pubblici**

- Organizzazione di 15 seminari pubblici presso POLITO
- Partecipazione a:
 - Notte dei Ricercatori 2017
 - Salone del Libro 2018

▪ **Didattica innovativa**

- Approvazione del nuovo insegnamento di dottorato «PhotoNext: hands on course on Photonics for fiber transmission» (sperimentale e interdipartimentale DET-DISAT)
- Attività didattica presso il centro in alcuni corsi di secondo e terzo livello, tra i quali:
 - Projects and laboratory on photonic networks
 - Coherent detection: a revolution in optical communication

▪ **Tesi in cotutela tra Dipartimenti**


- 6 tesi di laurea in Ingegneria Meccanica in co-tutela (3 LT, 3LM) DISAT-DIMEAS

■ **Incontri con aziende per presentazione finalità Centro Photonext**

- 16 giugno 2017: Enel Foundation
- 26 giugno 2017: Gazprom
- 25 Agosto 2017: Open Fiber
- 19 ottobre 2017: FCA
- 8 Novembre 2017: Sutardja Center for Entrepreneurship and Technology, UCB Berkley
- 13 dicembre 2017: Prysmian Group
- 11 gennaio 2018: Luceda Photonics
- 19 Marzo 2018: OXENTIA, UK
- 17 Maggio 2018: Keysight
- 28 Maggio 2018: VDGLAB
- 5 luglio 2018: Tektronix

- **TITOLO: FIP: Tecnologie Fotoniche per l'Industria 4.0 in Piemonte**
 - **Coordinatore: Prof. Guido Perrone**
 - **Finanziato per 1.8 M€**
 - **Co-finanziato in larga misura su fondi Photonext**
 - **Fortemente sinergico con il Centro Photonext**
 - **Da Febbraio 2018 ad Agosto 2019**
- **Attività principale nell'ambito della fotonica industriale**



	Programma Operativo Regionale "Investimenti per la crescita e l'occupazione" F.E.S.R. 2014/2020	AZIONE I.1a.5.1 "Sostegno alle infrastrutture della ricerca considerate critiche/cruciali per i sistemi regionali.
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Bando: INFRA-P Sostegno a progetti per la realizzazione, il rafforzamento e l'ampliamento di IR pubbliche

- **Gruppo Prof. Marco Barla, DISEG**

- Monitoraggio ottico metropolitana di Torino

- **Gruppo Prof. Bartolomeo Montrucchio, DAUIN**

- Realizzazione di software dedicato per sensoristica ottica e realtà aumentata

- **Gruppo Prof. Beppe Ferro**

- Monitoraggio ponti

- **Centri PIC4SER e SmartData**

- Progetto G7-African Innovation Leaders

- **Gruppo Prof. Belingardi (DIMEAS e Centro CARS)**

- per collaborazioni con FCA

- **Centro PIC4SER**

- Comunicazioni ottiche in spazio libero (in definizione)



PHOTONEXT: ACTION 1: TELECOM

- Focus on fiber optic communications from a system level perspective
 - Our main interest are in the physical layer
 - Analysis of fiber propagation
 - Transmission techniques
- Main research areas
 - Long haul and high capacity fiber systems
 - Capacity of 20-50 Tbit/s per fiber over very long distances (from 200 km to 9000 km)
 - Optical access networks and support to 5G networks
 - Low-cost optical transmission and 5G applications in the access segment (Fiber To The Home and Fronthauling)
 - Optical ultra-high bit rate link for data centers
 - Hundreds of Gigabit/s over <2km

▪ Cisco Photonics

- Attività di ricerca su vari aspetti relative alle trasmissioni oltre i 100 Gbit/s per lunghezza d'onda



▪ TIM Telecom Italia Lab, Torino

- Attività su soluzioni di reti ottiche di accesso di prossima generazione (HS-PON, beyond 10G per wavelength)



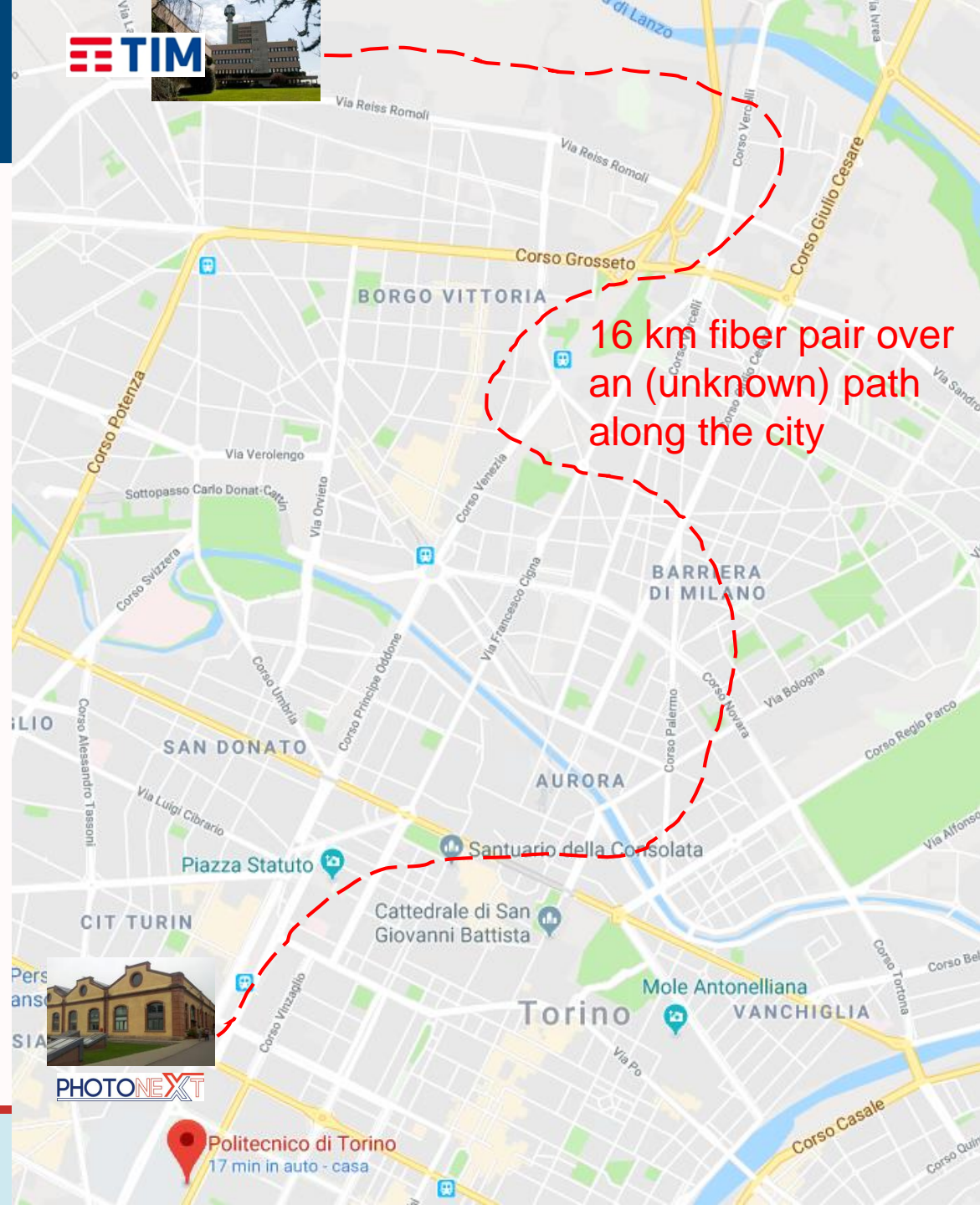
▪ OCLARO

- Ottimizzazione di sistemi di trasmissione coerente dal punto di vista del modulatore ottico



A proposito di TIM...

- La settimana scorsa è stato installato un collegamento in fibra da 16 km tra:
 - Centro PhotoNext
 - Telecom Italia Lab, Torino, Via Reiss Romoli
- Il collegamento, installato in modalità “dark fiber” e dunque totalmente dedicato, verrà usato per esperimenti congiunti di livello fisico tra POLITO e TIM



- **INRIM**: distribuzione di segnali metrologici su fibra



P1.SC4.62

Introducing DSP-based Coherent Receivers for Wide-area Reference Frequency Distribution in Metrology Applications

A. Tampellini^(1,3), C. Clivati⁽¹⁾, M. Pizzocaro⁽¹⁾, D. Calonico⁽¹⁾, S. Straullu⁽²⁾, V. Curri⁽³⁾, R. Gaudino⁽³⁾

⁽¹⁾ Istituto Nazionale di Ricerca Metrologica, c.clivati@inrim.it

⁽²⁾ Istituto Superiore Mario Boella, via P. C. Boggio 61, 10138 Torino - Italy, straullu@ismb.it

⁽³⁾ Politecnico di Torino, C. so Duca degli Abruzzi 24, 10129 Torino - Italy, roberto.gaudino@polito.it

Abstract: *We present the advantages of dual-polarization coherent receivers and digital signal processing in metrology applications for high accuracy frequency distribution over long-distance fiber links. We experimentally demonstrate optical frequency distribution at 10^{-16} accuracy on a 300 km installed fiber link.*

■ EU H2020 “Marie Curie” Individual Fellowship action

- Call: H2020-MSCA-IF-2018, deadline September 2018
- On distributed optical sensing in access networks
- POLITO Budget: 168.277,20 €
 - One Post-doc for 2 years

■ MIUR PRIN Projects

- AVALON (Principal Investigator R. Gaudino)
 - On alternative usage of Optical Access Networks
 - Sensing and optical monitoring
 - Time and frequency distribution
 - Radio over fiber (for radar applications)
 - Quantum key distribution

■ MIUR PRIN Projects

- FIRST: (Unit coordinator: A. Carena)
 - Fiber Infrastructure for Research on Space-Division Multiplexed Transmission
 - The first field trial for SDM technologies

Keysight Technologies

M8196A 92 GSa/s Arbitrary Waveform
Generator



M8196A in a 2-slot AXIe chassis

- + high performance Optical Spectrum Analyzer
- + special fiber splicer
- + lasers, semiconductor optical amplifiers

DP070000SX ATi
Performance
Oscilloscope

200 Gsample/s
70 GHz

Tektronix



Complimenti ai due “OSA FELLOWS” del Gruppo!



■ OSA FELLOW 2019

- **Pierluigi Poggiolini**
- "For fundamental contributions to the understanding and modeling of WDM systems and for the analysis of the limits imposed by fiber nonlinearities on the performance of fiber communication links".



■ OSA FELLOW 2017



Gabriella Bosco

Politecnico di Torino, Italy

"for pioneering contributions to the modeling and design of coherent optical communication systems"



The Optical Networking and Communication Conference & Exhibition

2019 OFC Committees

General Chairs

Gabriella Bosco, Politecnico di Torino, Italy

Jörg-Peter Elbers, ADVA Optical Networking SE, Germany

Laurent Schares, IBM TJ Watson Research Center, USA

- **16 Maggio 2019**
- **International Day of Light**
 - <https://www.lightday.org/>




Steering Committee



Why May 16th?

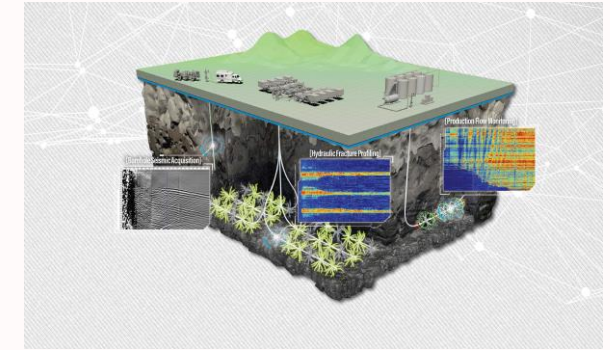
The International Day of Light will be held on May 16th every year, the anniversary of the first successful operation of the laser in 1960 by physicist and engineer, Theodore Maiman. The laser is a perfect example of how a scientific discovery can yield revolutionary benefits to society in communications, healthcare and many other fields.

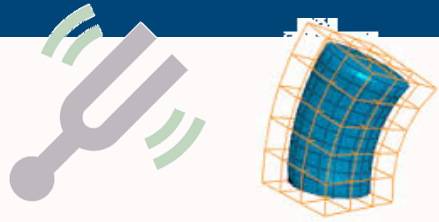
For interest, you can find [here](#) some of the laser history, but note that the International Day of Light is not just about lasers and science. It also includes aspects of art, culture, entertainment – everywhere light is present in fact!

The background of the slide features a series of glowing, curved light trails in shades of blue and purple, creating a sense of motion and energy.

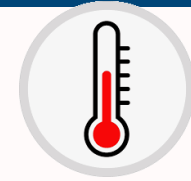
PHOTONEXT: ACTION 2: SENSORI

- **AIM:** to leverage existing expertise in optical sensing for:
 - Aerospace
 - Environmental monitoring
 - Harsh Environment
 - Automotive
- **Overall investment:** 300,000 € for new equipment to go beyond SOA and provide useful service to companies and develop new applications

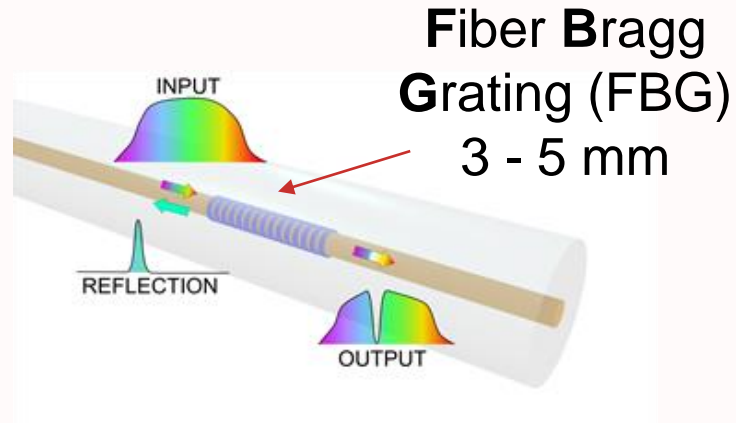




Sensing of strain, temperature and vibrations

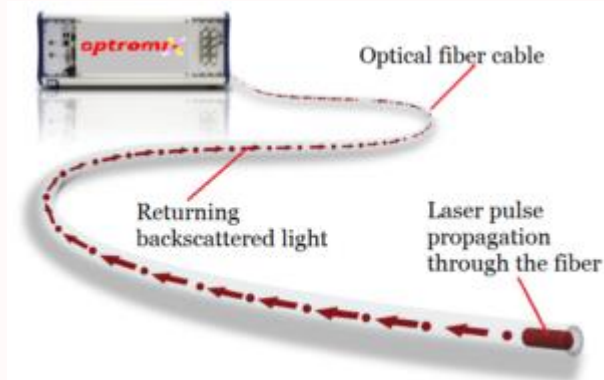


- Point sensing

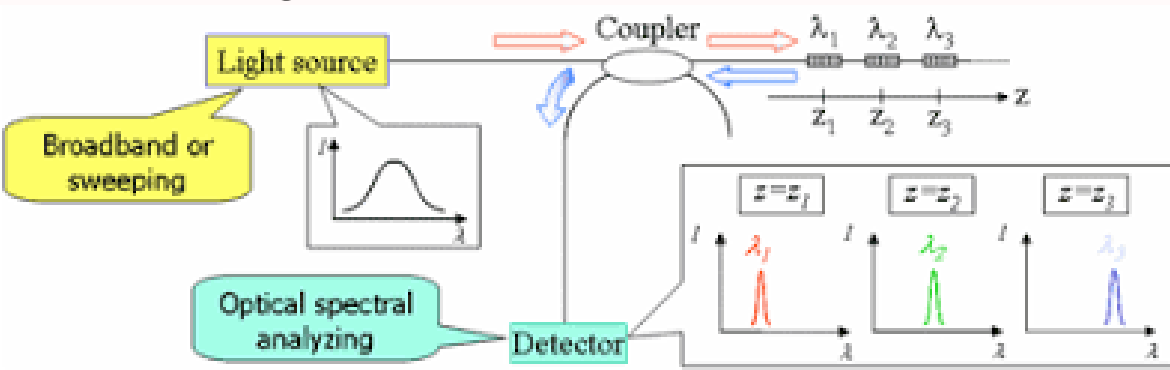
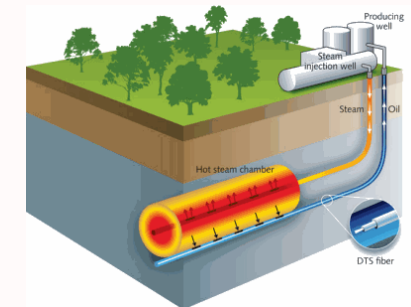
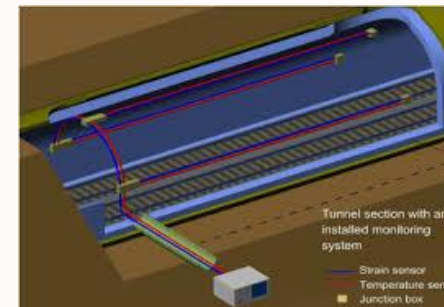


- Multiplexing
- Sensing up to 2km

- Distributed sensing



- Resolution 10 cm
- Sensing up to 30 km

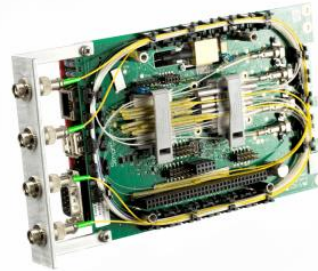


- High resolution Fiber Bragg Grating (FBG) optical interrogators up to 2.5 kHz from 40 to 160 sensing points

2 ×



1 ×



1 ×

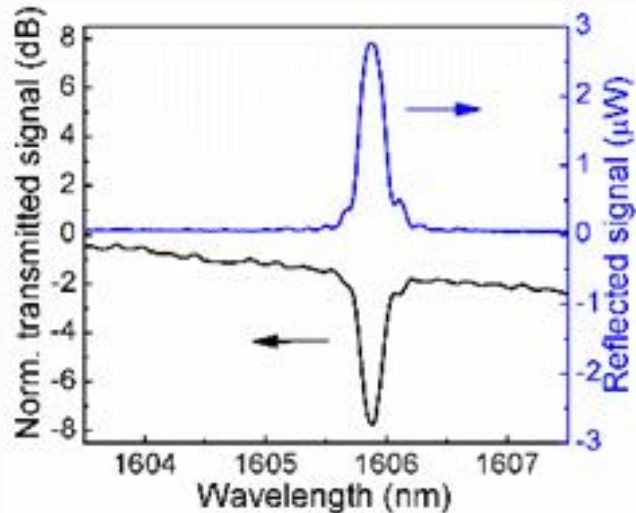
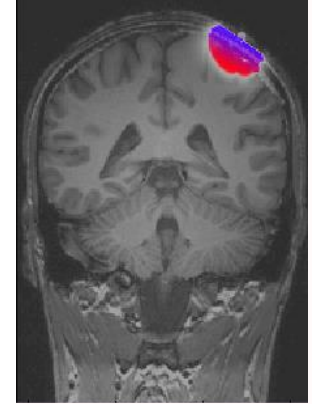
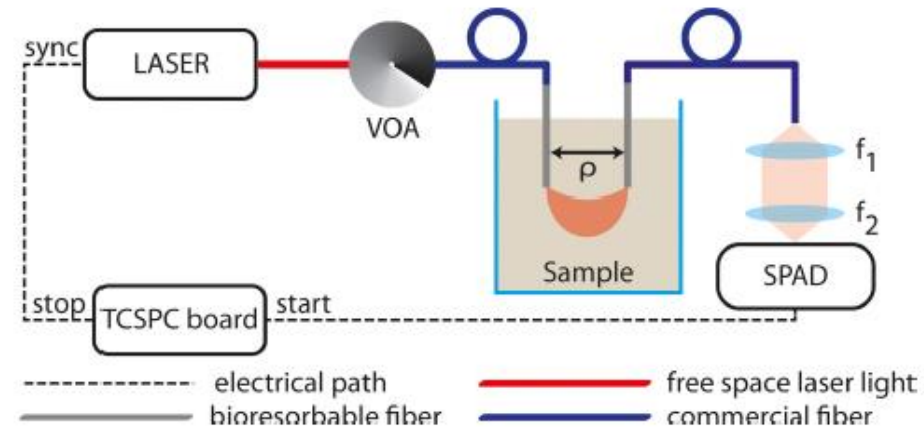


- Test bench for thermal, mechanical and vibrational analysis and calibration
- Special Bragg gratings for composite monitoring
- Optical accelerometers
- Optical test benches for sensors installation and calibration

To buy

- Interrogator for distributed sensing

L. Di Sieno, D. Janner, D. Milanese et al. (2017) “Towards the use of bioresorbable fibers in time-domain diffuse optics”



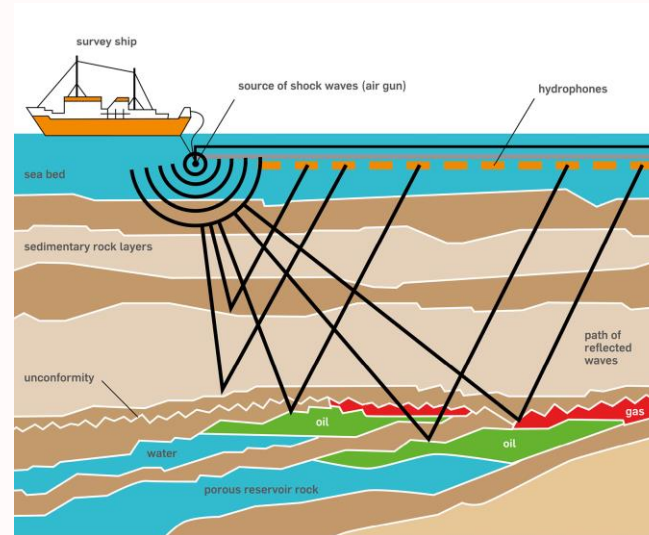
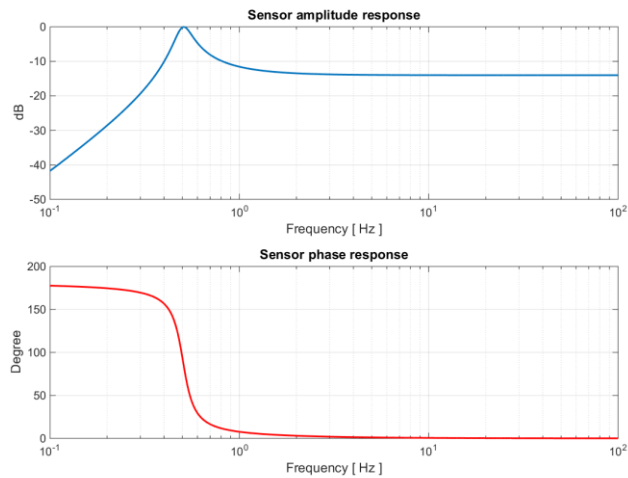
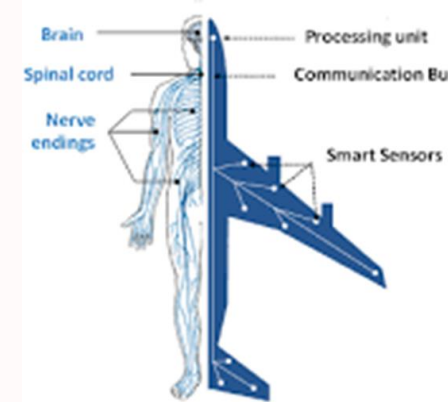
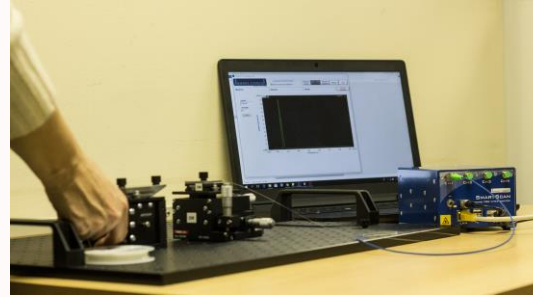
D. Pugliese, D. Milanese et al. (2018) “Bioresorbable optical fiber Bragg gratings”

Optics Letters

OSA News Release TG



Calibration bench for FBGs and testing on POLITO Team ICARUS



Design of seismic optical
accelerometers for application in
oil and gas/geothermal monitoring
and geophysical exploration

- Development of custom software interface for remote interrogation of multiple points and augmented reality – *prof. B. Montrucchio (DAUIN)*
- Measurement of tunnel deformation in Torino Underground – *prof. Barla (DISEG)*
- Structural health monitoring of civil infrastructures – *prof. G. Ferro (DISEG)*
- Testing of FRP materials for automotive applications – *prof. G. Belingardi (DIMEAS)*
- Contact with local industries in aerospace applications
- 8 publications on international journals and conferences

An abstract background featuring several glowing, curved light trails in shades of blue and purple, resembling fiber optic cables or data paths, set against a dark blue background with bokeh effects.

PHOTONEXT: ACTION 3: COMPONENTI

Overall investment 750,000 € in equipment for:

- Multifunctional specialty optical fibers
- Test bench for silicon photonic integrated circuits
- Components for high power laser sources (→ Infra-P)

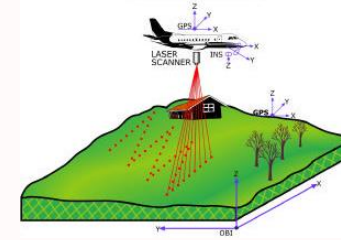
- Optical fiber splicer (including PM and LMA fibers)
- High precision optical fiber cleaver
- Optical spectrum analyzer (600 – 1600 nm)



Future plans: Synergy with the FIP (INFRA-P) research project proposal:

- FBG writing setup – femtosecond laser source
- Picosecond laser for materials processing
- High power laser beam characterization equipment
- Fiber processing equipment (micromachining, tapering, etc.)
- Thin film deposition equipment

- **Multifunctional specialty optical fibers:**



- Er, Yb and Yb/Er doped optical fiber power amplifiers for LIDAR applications

- With DATALOGIC:

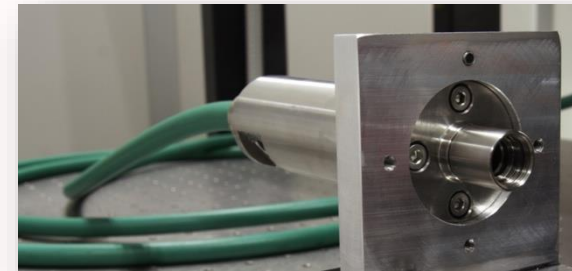
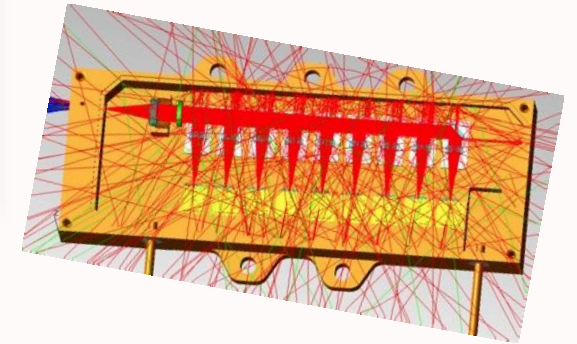
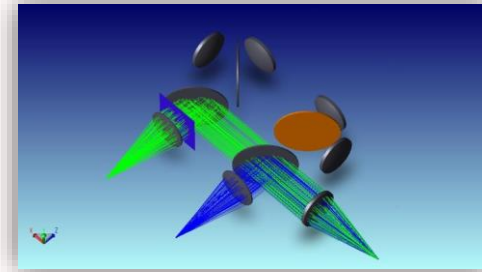
- Delivery of pulsed fiber lasers for micromachining and texturing of different materials
- Testing of commercial optical fibers for laser cavities



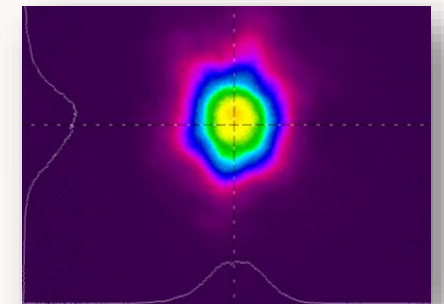
- **Silicon photonic integrated circuits**
 - Design of silicon photonic integrated circuits, including both passive and active (modulators, photodetector, lasers ...) components
 - Realise the designed circuits in Multi-Wafer-Project using a silicon photonic foundry
 - Characterization and testing of silicon photonic integrated circuits

■ Components for high power laser sources

- High power beam combining architectures (free space kW beams and for multi-emitter diodes)
- High peak power (ps-fs pulses) fiber beam delivery systems



industrial grade cable based on innovative hollow core optical fibers



- CALIBER - CompAct eye-safe Lidar source for AirBorne lasER scanning (2017-2019) – funded by NATO
- Supporting ISMB key projects on Airborne Lidar systems for Laser Zentrum Hannover and AFL (USA)
- STAMP – “Sviluppo Tecnologico dell’Additive Manufacturing in Piemonte”
- BOREALIS – “The 3A energy class flexible machine for the new additive and subtractive manufacturing on next generation of complex 3d metal parts”
- CISCO sponsored research agreements (2016-2018): photodetectors and laser sources for integration in silicon photonics platform
- Europractice Stimulation Action (2017-2018) - Grant for First Silicon Photonic Fabrication
- Project: flexible-grid switching architecture based on micro-ring resonators
- 10 publications on International Journals and conferences