SUBMARINE CABLES

Giuditta Marinaro

EMSO Strategic Workshop

Rome, 12 March

ISTITUTO NAZIONALE
DI GEOFISICA E VULCANOLOGIA

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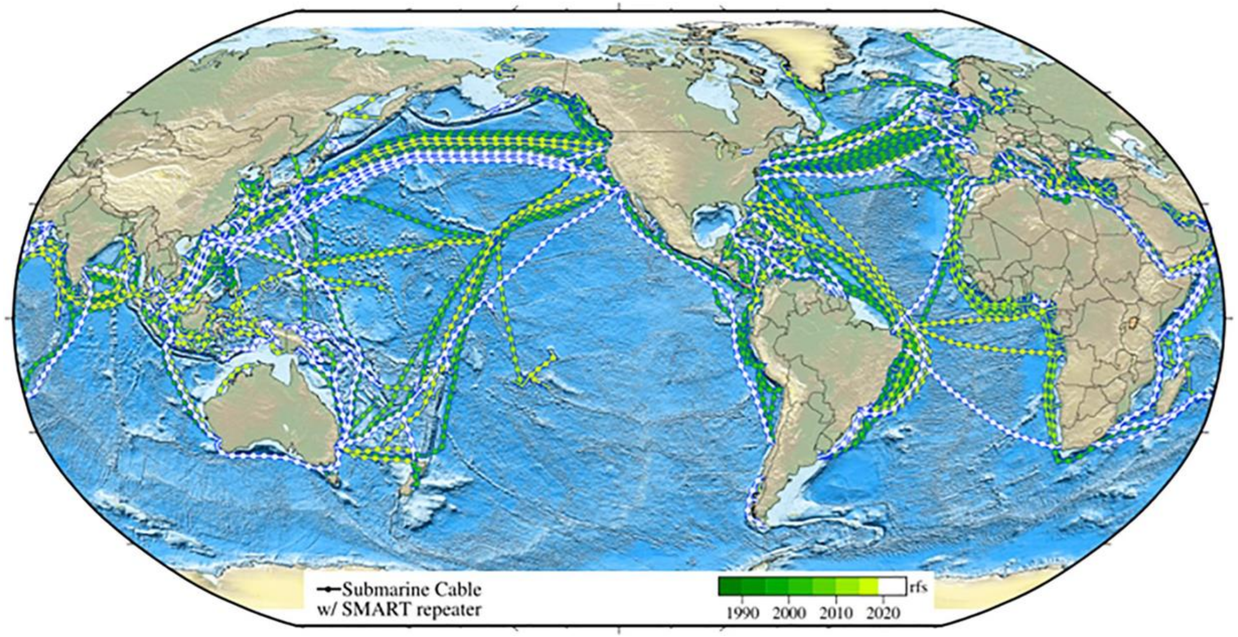
ONCE UPON THE TIME….

The SMART (Science Monitoring And Reliable Telecommunications) Cables Initiative, led by the ITU/WMO/UNESCO-IOC Joint Task Force (JTF), formed by a group of volunteers in 2012 from government agencies, research and academic institutions, and the private sector to develop a sustained SMART subsea cable network to monitor seafloor TEMPERATURE, SEISMICITY and TSUNAMI



Howe BM et al. (2019) SMART Cables for Observing the Global Ocean: Science and Implementation. *Front. Mar. Sci.* 6:424. doi: 10.3389/fmars.2019.00424

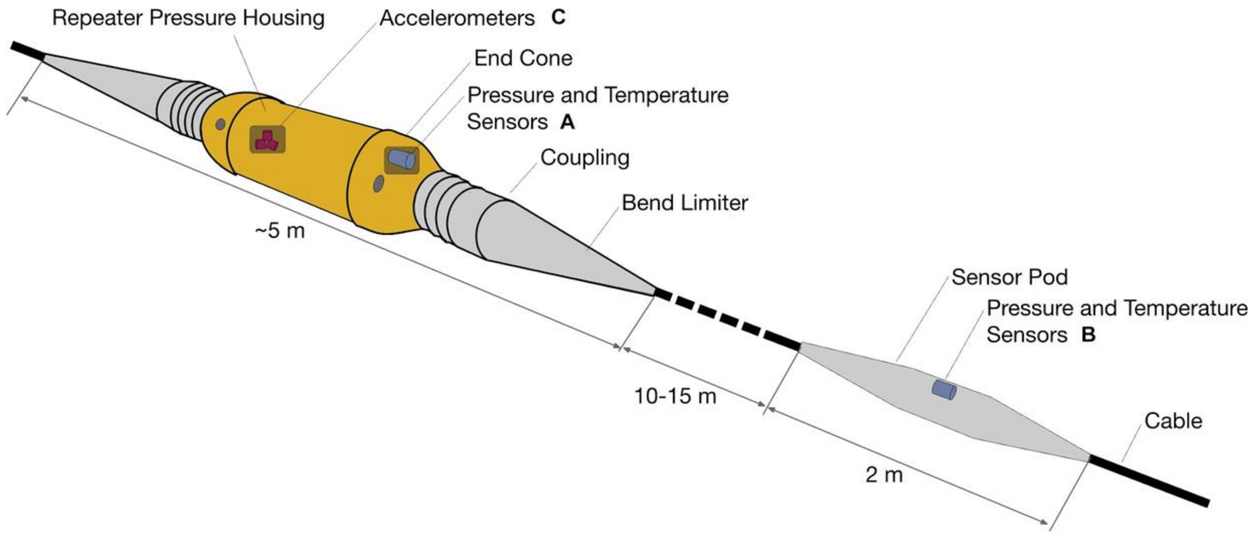
WET TEST NEEDED

ITU-WMO-UNESCO IOC Joint Task Force

Scope document and budgetary cost estimate for a wet test to demonstrate the feasibility of installing sensors external to the repeater and to provide data from such sensors for evaluation

WHITE PAPER 2015

Joint Task Force to investigate the potential of using submarine telecommunication cables for ocean and climate monitoring and disaster warning



Summary

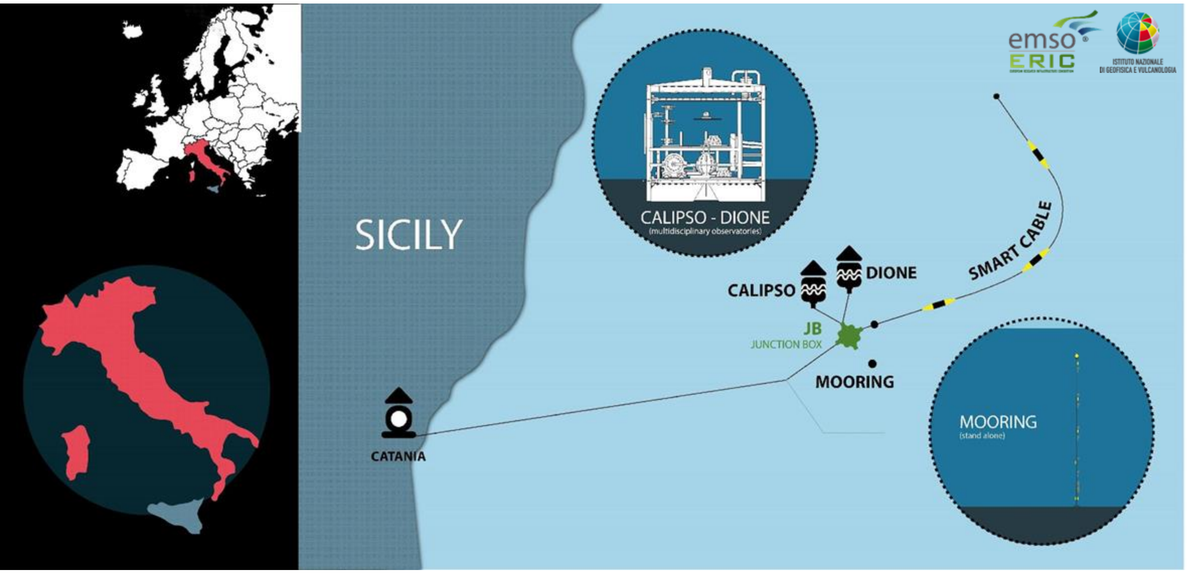
A “wet test” is the first validation of the capabilities of a “green” submarine cable system, that is, a system incorporating temperature, pressure, and acceleration sensors at fixed intervals along the cable. The wet test must provide a realistic deployment and operational scenario for the sensors and must make use of representative cable, housings, sensors and other mechanical fixtures. The wet test must be installed using conventional cable laying methods. The wet test must provide power and communications for the sensors, however the power and communications need not be those intended for an actual green system. The wet test must be deployed for months or years to permit validation of the sensor performance against existing instrumentation

INSEA WET DEMO

2019 - InSEA project: National Operative Programme – Research and Innovation 2014-2020

Initiatives in Supporting the consolidation and enhancement of EMSO infrastructure and related Activities

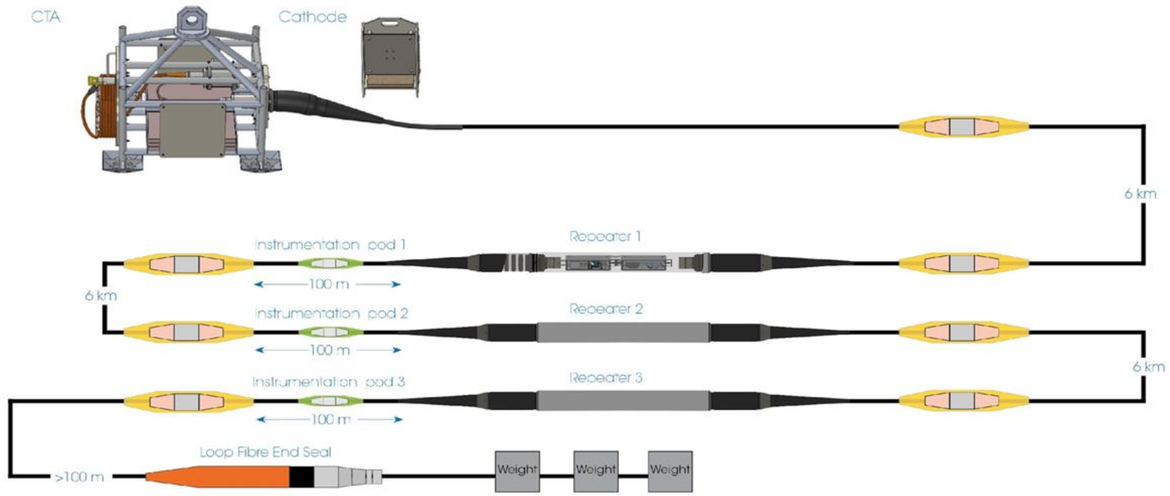
INGV takes the opportunity to enhance EMSO Western Ionian Sea and focuses on InSEA wet demo SMART cable thanks to the support of the Italian Ministry of Research



- **Strategic Location:** 25 km east of Catania, Sicily, at a depth of 2,024 m
- **High-Risk Environment**: Region characterized by **high seismic** and **tsunami activity**
- **InSEA goals:**

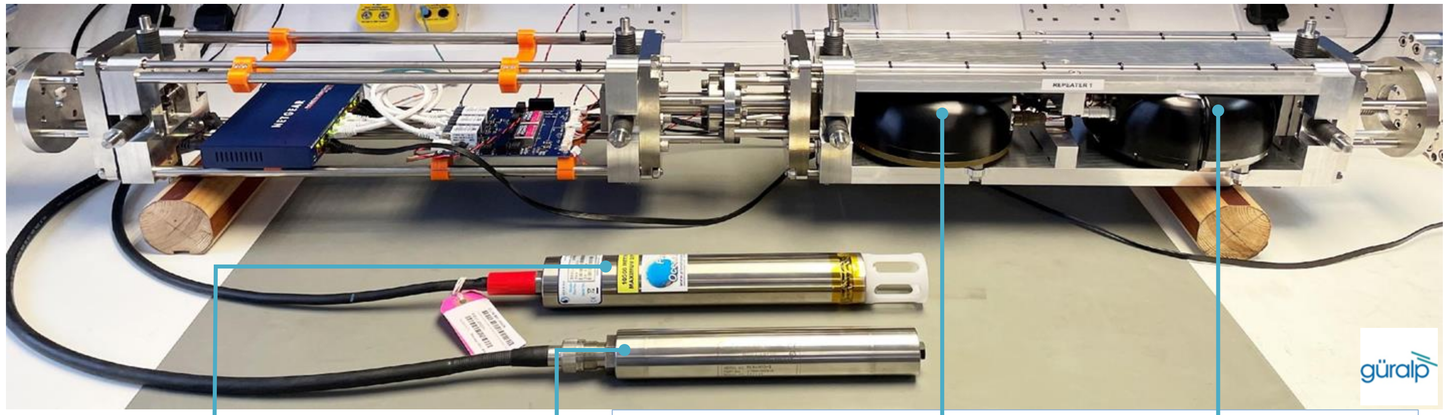
  - New Cable Termination Frame (CTF)
  - New Junction Box (JB)
  - Two state-of-the-art multidisciplinary observatories (CALIPSO and DIONE)
  - Wet demo SMART cable
  - NEREIDE data center

INSEA WET DEMO



the first time scientific sensors have been integrated into a telecom cable in a deep-sea environment

Aims to assess the performance of seismometers and environmental sensors installed in standard commercial repeater housings laid using typical procedures.



Instrument pod:

Seabird SBE 39Plus
The temperature sensor selected has an operating range between -5°C and 45°C with an accuracy of ±0.002°C.

Paroscientific 8000 Series
This APG has a depth rating of 3,000m and a precision of <0.01% full scale range.

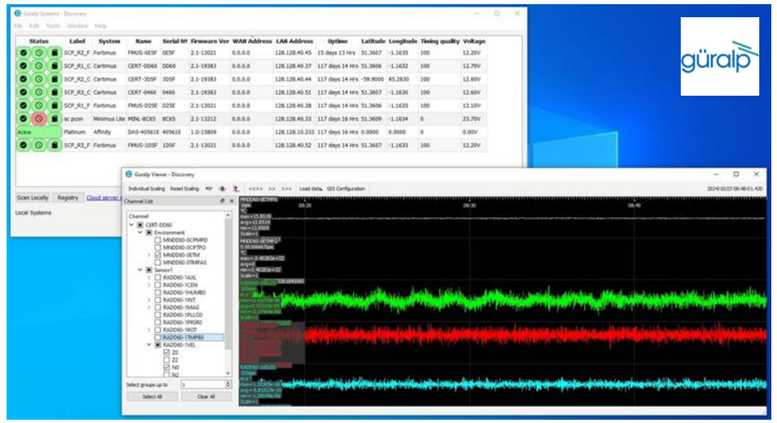
Repeater:

Fortimus
A modern force balance accelerometer with integrated digitiser. It has a flat acceleration response between DC-315 Hz.

Certimus
A triaxial broadband seismometer with a flat frequency response between 120 s and 100 Hz. Broadband, low instrument self-noise that makes it well suited for regional seismic monitoring.

Combining Fortimus and Certimus provides an ultra-wide dynamic range

DEC 2023 – SEA OPERATIONS



All the files are transferred to the INGV data server with redundant storage and open accessible

Seismic data are sent to EIDA in real-time in miniSEED format

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SMART systems around the world

Vanuatu - New Caledonia Launched

SMART Atlantic CAM Launched

MEDUSA Launched

Mayotte Launched

In plannig

Indonesia

Far North Fiber

Antarctica NZ / AU

Chatham Islands - NZ

Project Koete

Polar Connect

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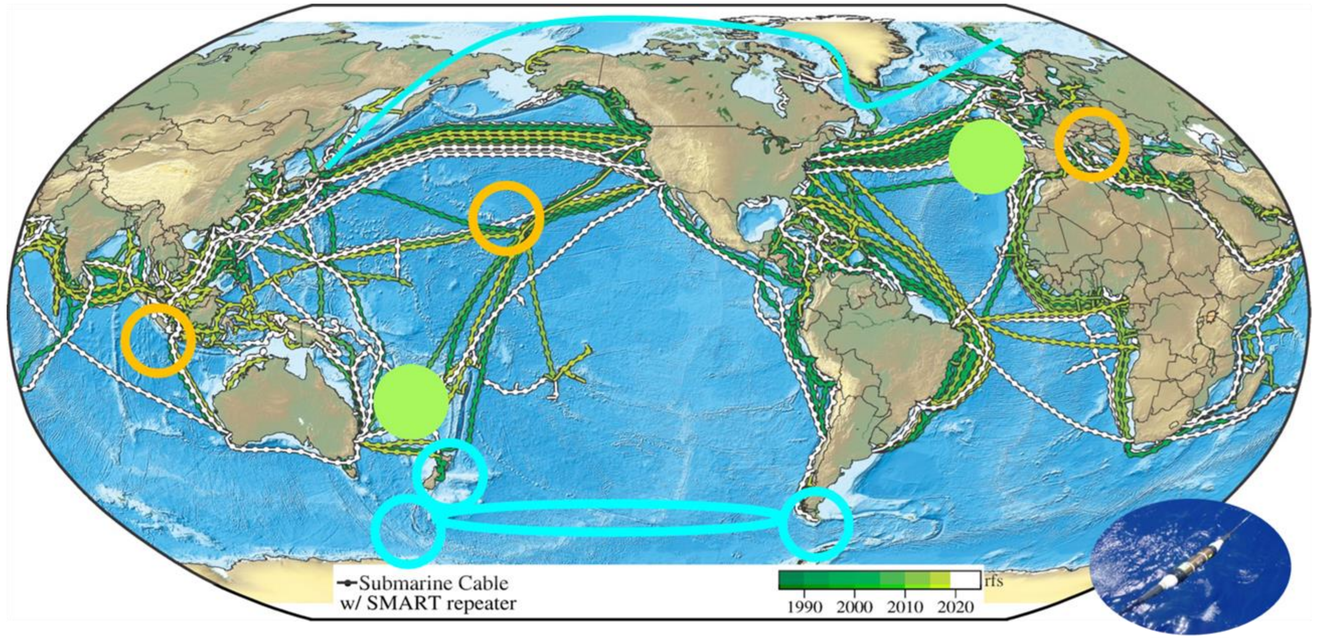
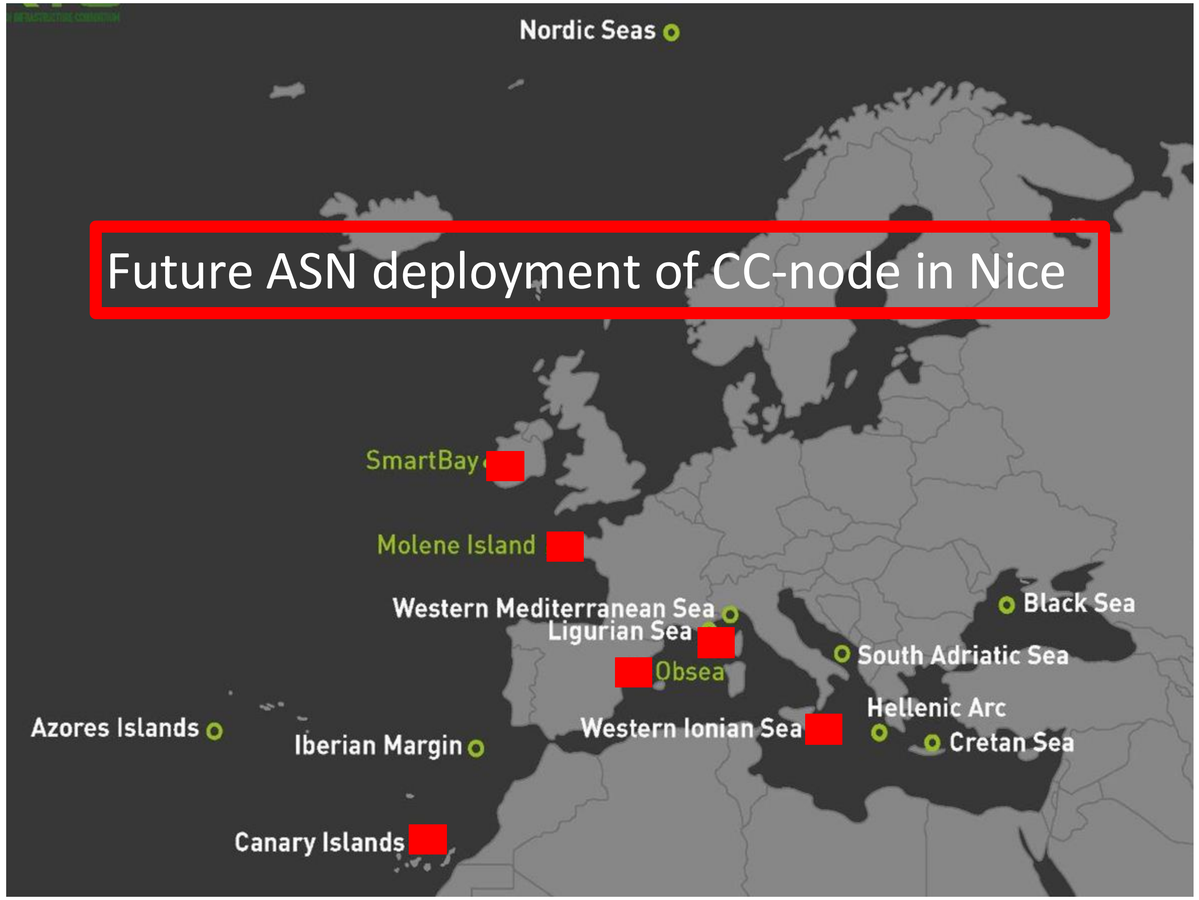


Howe et al. 2024

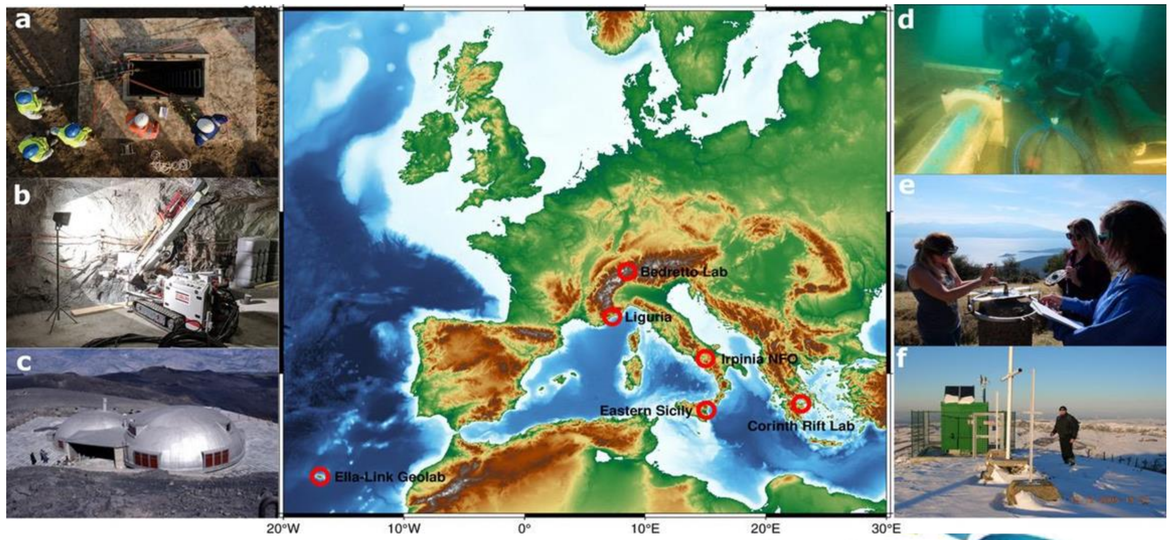
FIBER SENSING in EMSO Facilities

EMSO cabled facilities are already experimenting with the use of FO sensing



GeoInquire EU project

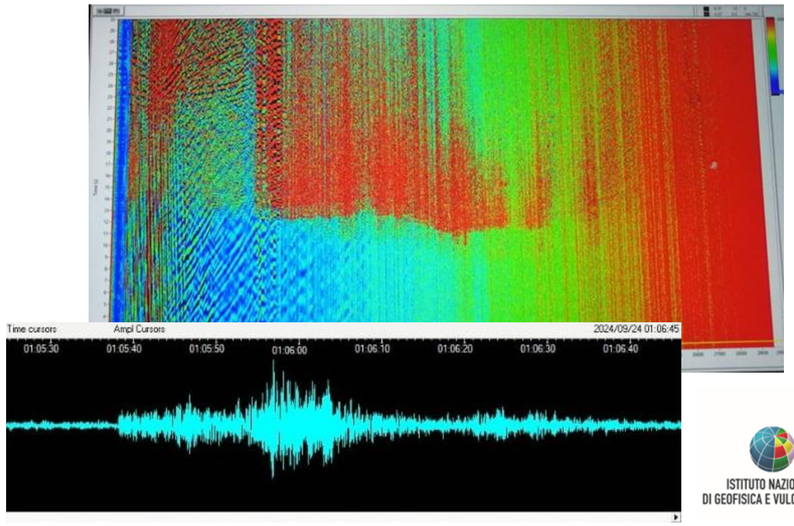
Improve access to DAS data through establishment of DAS data standards, show case interoperability of different datasets at key scientific testbeds.



WHERE WE ARE?

FROM DISTRIBUTED SINGLE POINTS OF MEASURE TO REGIONAL REAL-TIME MONITORING

FO sensing, mainly DAS, but also SOP, INTERFEROMETRY, BOTDR …



Seismic event ML 2.1 in Messina Strait recorded by DAS and CALIPSO OBS at WIS

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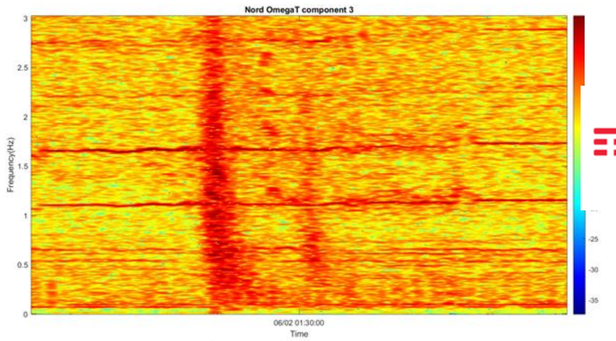
MedNautilus cable: a testbed for polarization data analysis



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Simeone et al. 2024

Google

SPARKLE

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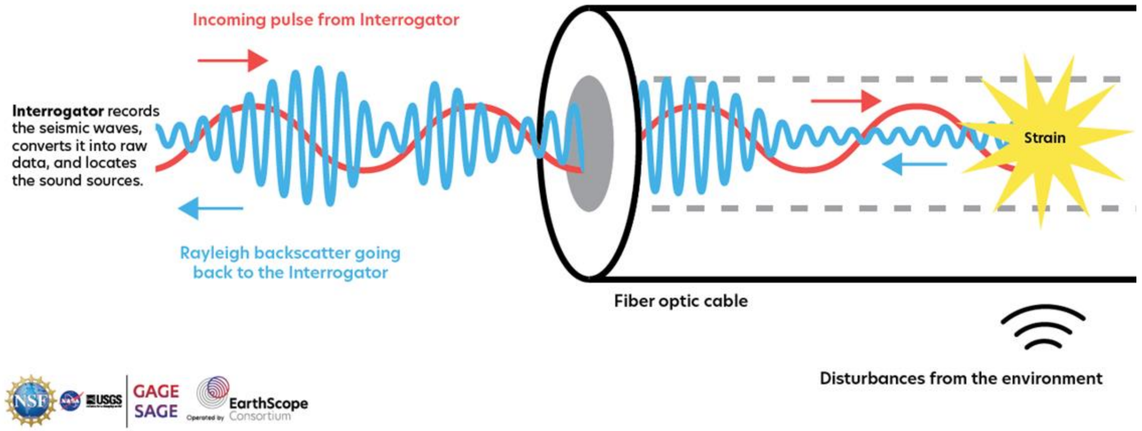
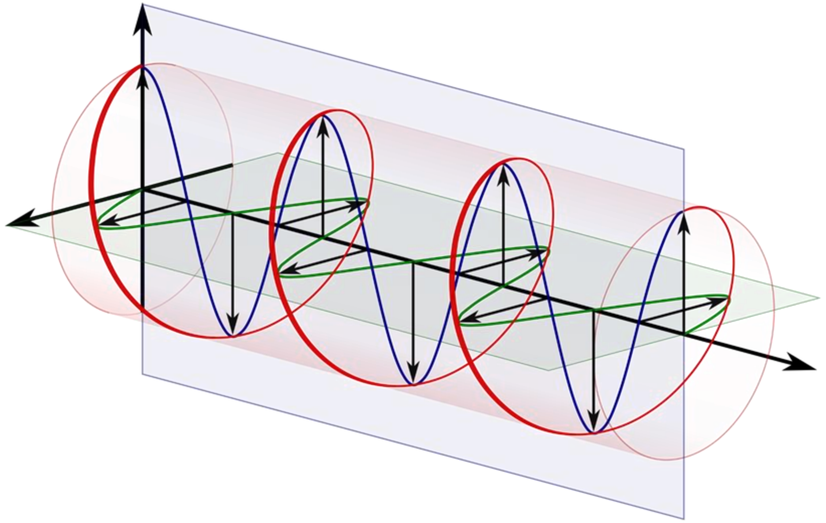
Distributed vs Integrated

Distributed Acoustic Sensing



high spatial resolution (few meters)
but limited range

State Of Polarization



works also on transoceanic cables
rough location of deformation

PROs and CONS

	DATA	POSITION	Telecom needs
SMART (single repeater)	< 50 GB/year	distributed, every 100 km	active telecom fiber
DAS	up to TB/day	up to 150 km from the coast	dark fiber
SOP	< 1TB/year	up to thousands km	active telecom fiber

To maximize results, we need a strategy that integrates and overlaps different technologies:

- DAS for short-term measurement campaigns in specific regions
- SOP to cover large distances but we are still in a prototype phase
- SMART for long term monitoring of deep environment and early warning

TECHNOLOGICAL CHALLENGE

Projects like MISTS and other national initiatives are pushing the boundaries of seismic monitoring, tsunami warning and ocean circulation studies.

Access to Fiber Optics has the potential to revolutionize offshore seismology and unlock new frontiers in underwater acoustic monitoring

A BIG TECHNOLOGICAL CHALLENGE THAT EMSO CAN LEAD

What we need?

- store large amounts of data
- implement software for on-the-fly sub-sampling of data (DAS)
- advanced mathematics and data analytics (SOP, DAS)
- edge computing in shore stations for noise removal, event detection and automatic picking (DAS, SMART repeaters)
- enthusiastic young researchers

Thank you for your attention

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Observing the ocean to save the earth