An experiment to record **seismic waves**
on a **commercial fiber optic cable**
through **interferometry measures** *with an* **ultra stable laser**.

MEGLIO

ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

A. Herrero
A. Govoni
L. Margheriti
M. Vassallo
R. Di Giovambattista
S. Stramondo

INRiM ISTITUTO NAZIONALE DI RICERCA METROLOGICA

D. Calonico
C. Clivati
R. Concas
S. Donadello
F. Levi
A. Murra

open fiber

F. Carpentieri

BAIN & COMPANY

F. Piccolo
F.S. Priuli
F. Orio
A. Romualdi

Metallurgica Bresciana S.p.A.

Once upon a time …

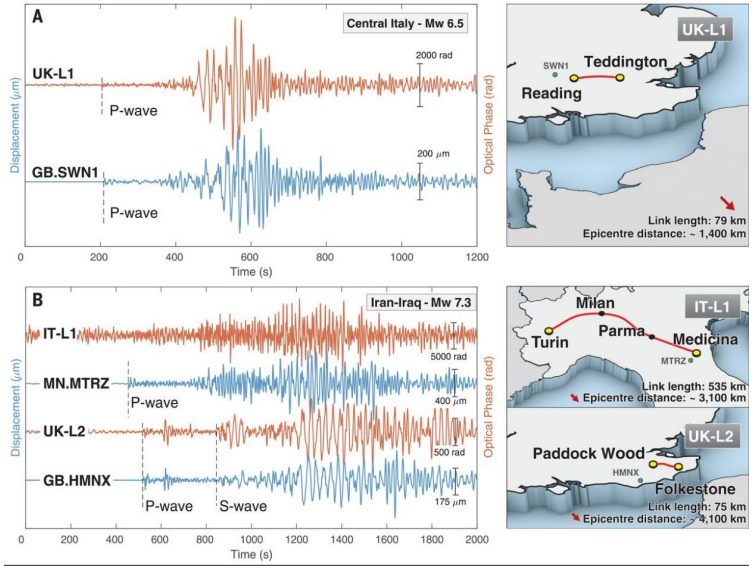
Aug. 2018

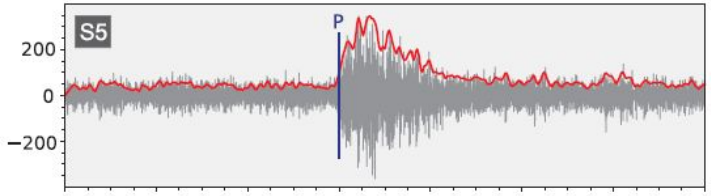
REPORT

Ultrastable laser interferometry for earthquake detection with terrestrial and submarine cables

Giuseppe Marra[1,*], Cecilia Clivati[2], Richard Luckett[3], Anna Tampellini[2,4], Jochen Kronjäger[1], Louise Wright[1], Alberto Mura[2], …
+ See all authors and affiliations

Science 03 Aug 2018:
Vol. 361, Issue 6401, pp. 486-490
DOI: 10.1126/science.aat4458





Science

Last Friday…

Optical interferometry–based array of seafloor environmental sensors using a transoceanic submarine cable

G. MarraD. M. FairweatherV. KamalovP. GaynorM. CantonoS. MulhollandB. BaptieJ. C. CastellanosG. VagenasJ.-O. GaudronJ. KronjägerI. R. HillM. SchioppoI. Barbeito EdreiraK. A. BurrowsC. ClivatiD. CalonicoA. Curtis

Science, 376 (6595), • DOI: 10.1126/science.abo1939

The consortium

Jan. 2020

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DI RICERCA METROLOGICA

Sensor and layout

Validation

Metallurgica Bresciana s.p.a.

open fiber

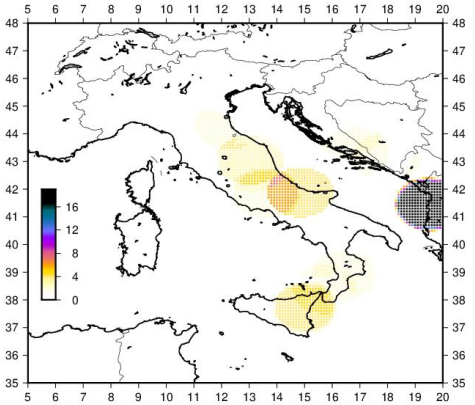
financer and network infrastructure

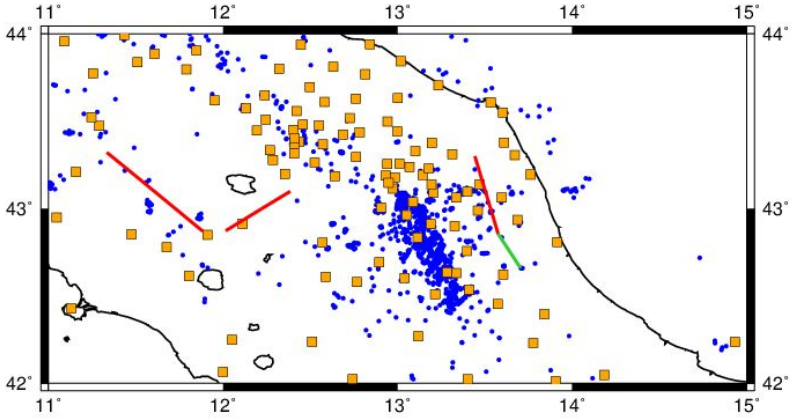
BAIN & COMPANY

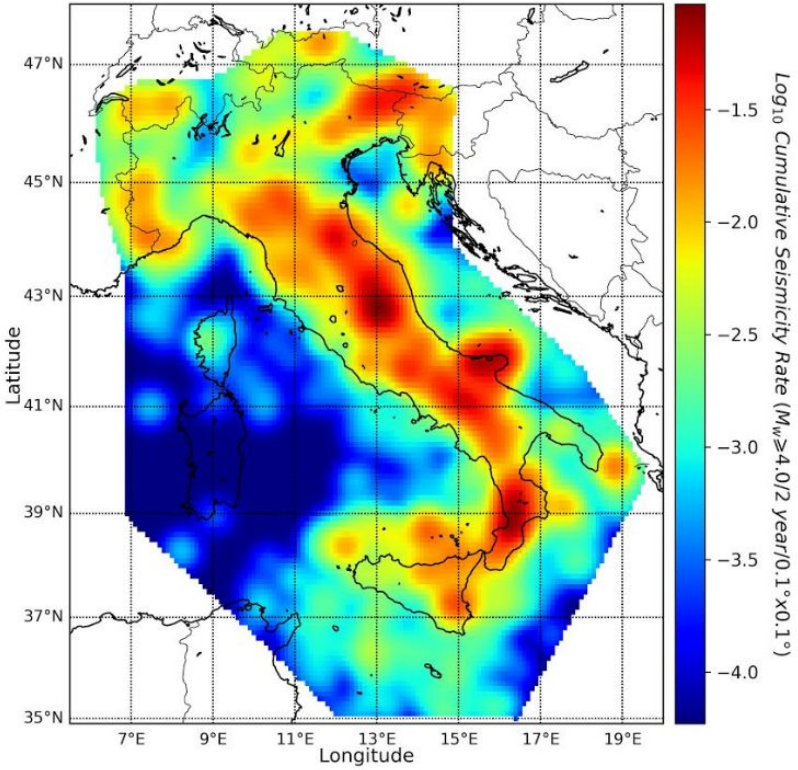
Signal processing

The fiber segment location (01/20)

Observed number of earthquakes for magnitude ⩾ 4 in the past 2 years at distance < 100 km



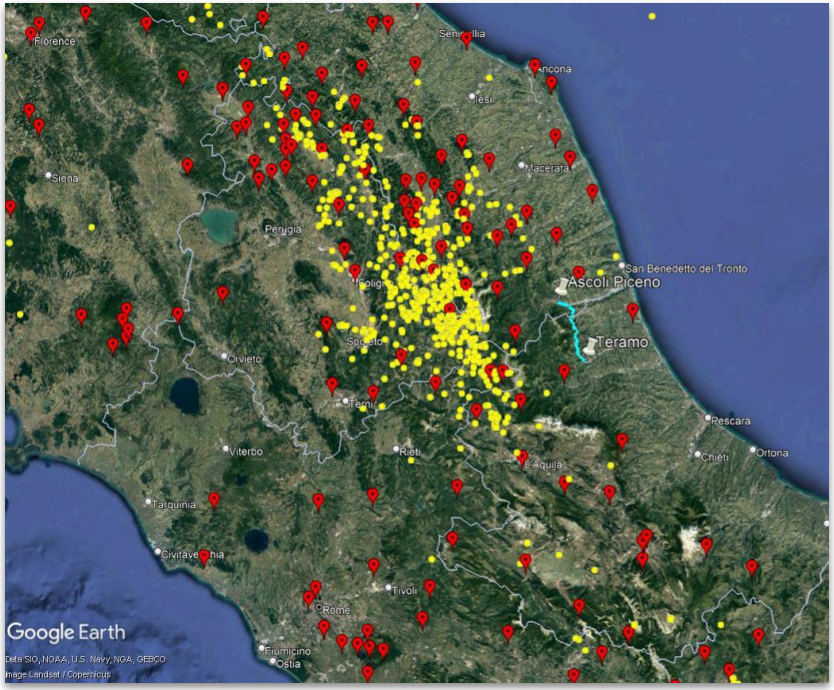




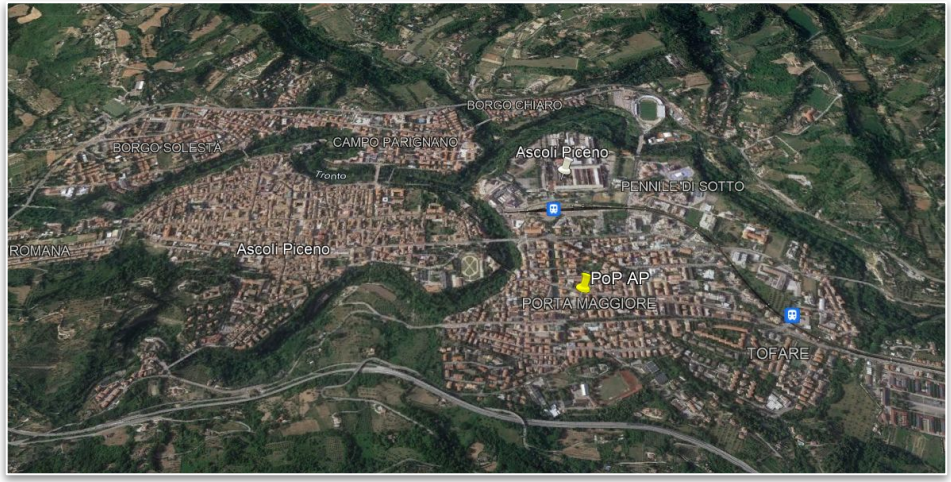
Expected seismicity rate [Log(n)] for magnitude ⩾ 4 for the next 2 years over a surface area of 0.1°x0.1° (Courtesy of G. Falcone, CPS-INGV)

The Ascoli Piceno - Teramo Cable

The “Point of Presence” (PoP) of Ascoli Piceno

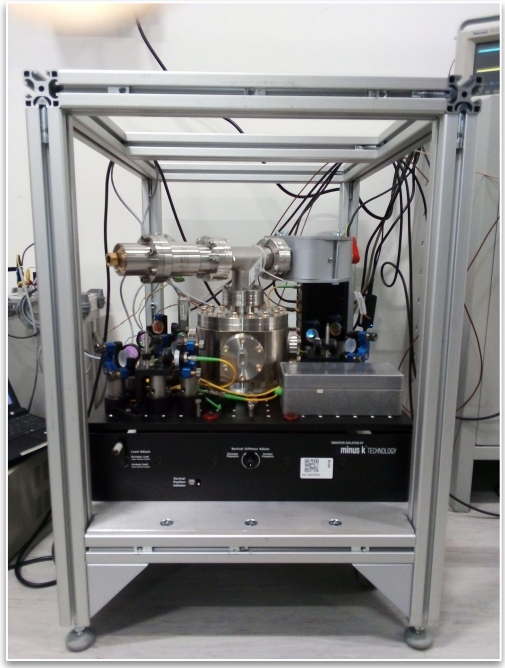


The Ascoli Piceno - Teramo Cable



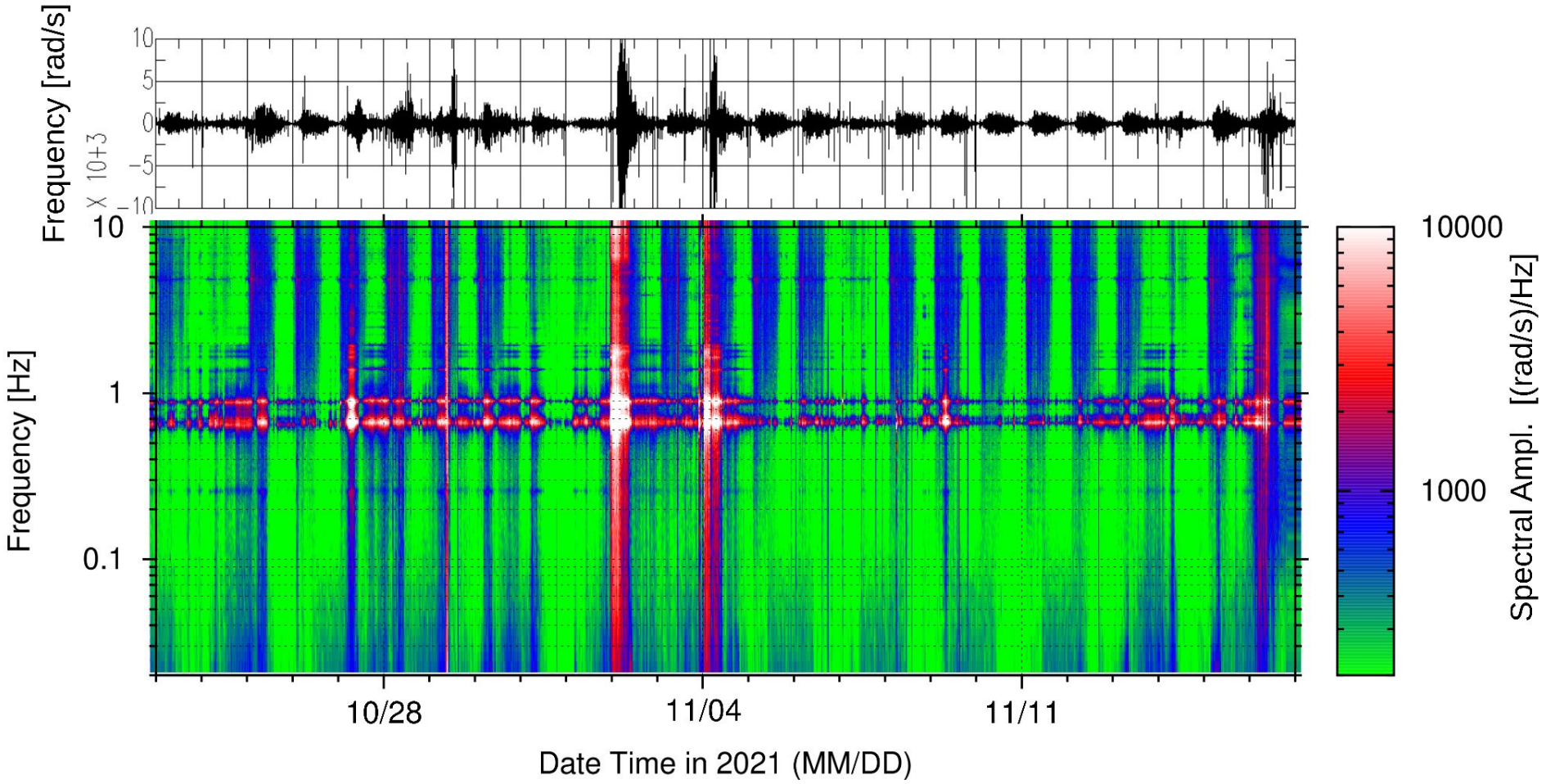
The Laser

“It is a laser diode operating on channel 44 of the ITU grid, corresponding to a 1542.14 nm wavelength (194.4 GHz). The stability is insured using a Pound-Drever-Hall technique coupled to an ultra-high finesse cavity.”



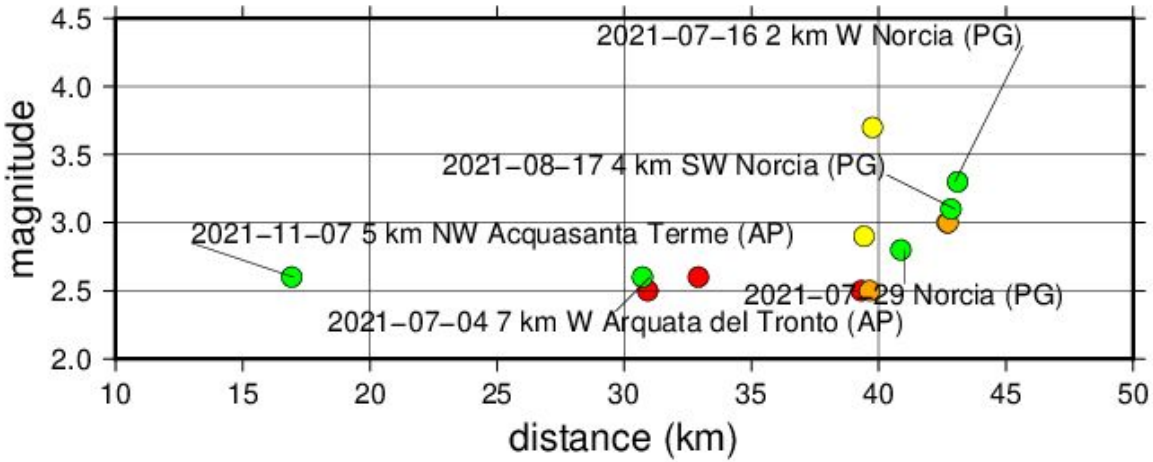
- no degradation on data transmission
- compliant with
  - connectivity
  - amplifiers
  - multiplexers
  - demultiplexers

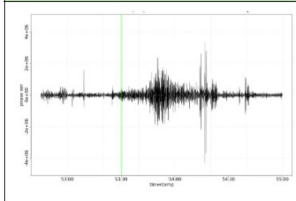
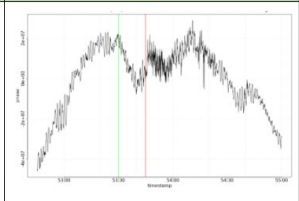
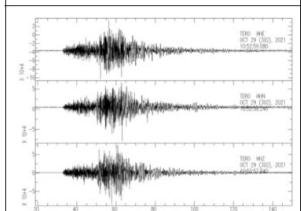
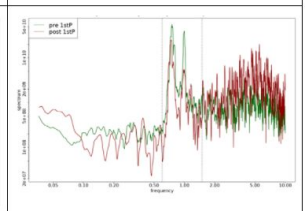
The data

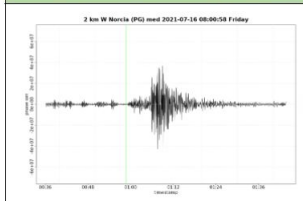
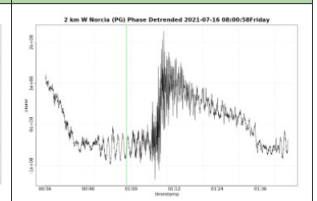
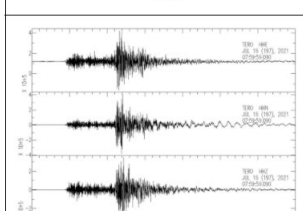
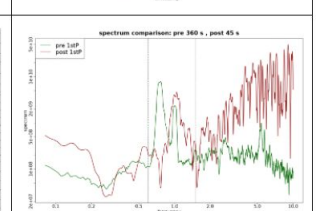

Frequency [rad/s]
10
5
0
−5
−10
X 10+3
Frequency [Hz]
10
1
0.1
10/28
11/04
11/11
Date Time in 2021 (MM/DD)
10000
1000
Spectral Ampl. [(rad/s)/Hz]

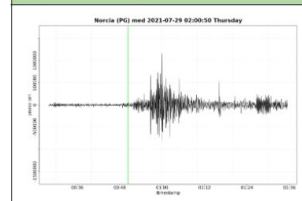
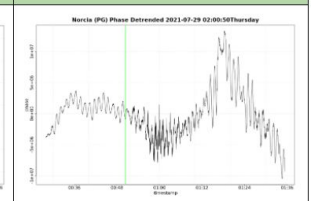
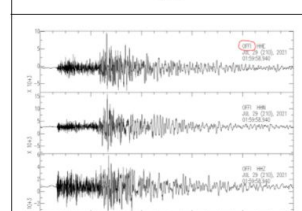
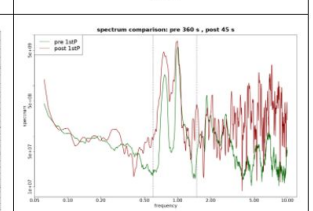
The data

Jul. 2021



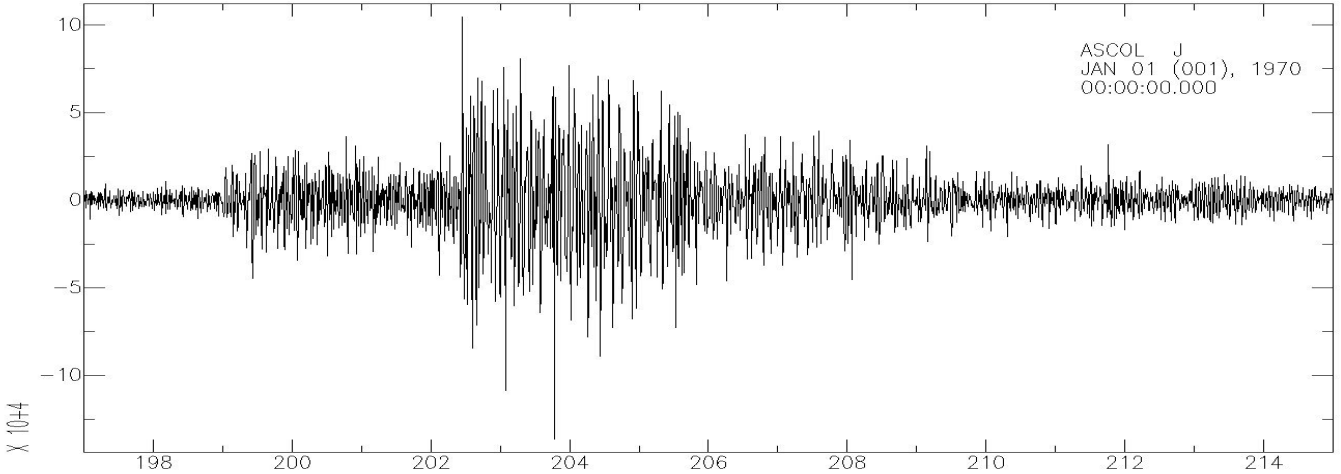
2021-10-29 Cartoceto http://terremoti.ingv.it/event/28429661	**Mag 4.1 / 116 km**
	
	

2021-07-16 2 km W Norcia (PG) http://terremoti.ingv.it/event/27575091	**Mag 3.3 / 43 km**
	
	

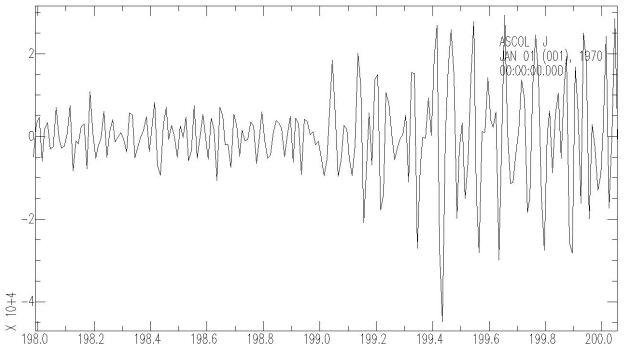
2021-07-29 Norcia (PG) http://terremoti.ingv.it/event/27722221	**Mag 2.8 / 41 km**
	
	

event 28855161

2021-11-07 5 km NW Acquasanta Terme (AP) http://terremoti.ingv.it/event/28855161	**Mag 2.6 / 17 km**



P



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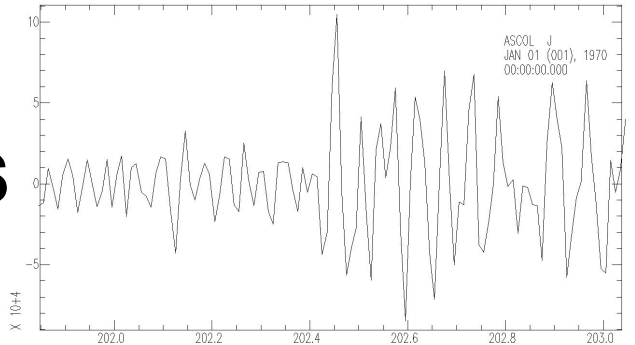
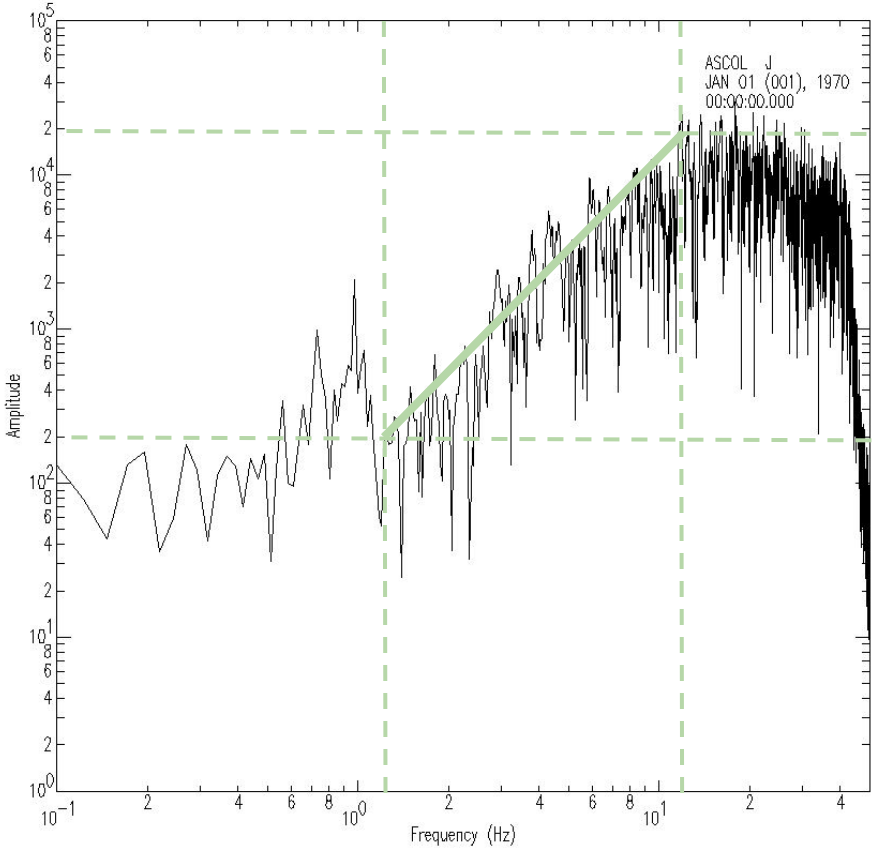


event 28855161

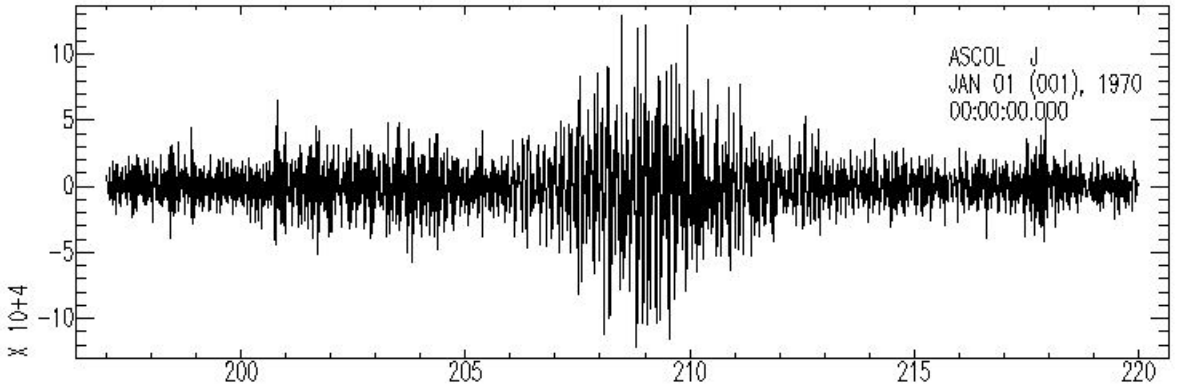
2021-11-07 5 km NW Acquasanta Terme (AP) http://terremoti.ingv.it/event/28855161	**Mag 2.6 / 17 km**

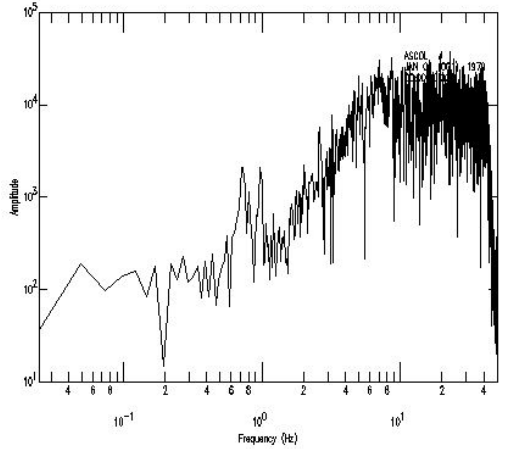


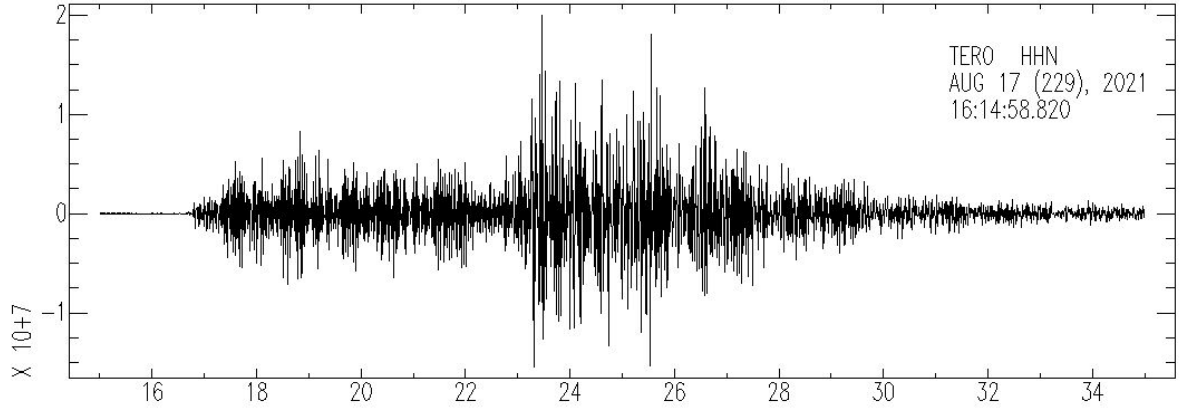
$$f_c \simeq \frac{v_r.\Delta\sigma^{\frac{1}{3}}}{\left(10^{1.5m+9.1}\right)^{\frac{1}{3}}} \simeq 13Hz$$

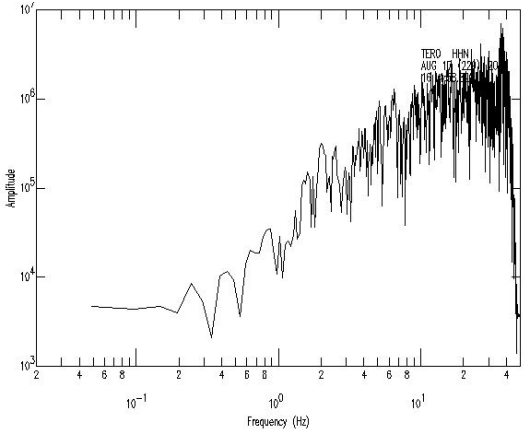
event 27995291

2021-08-17 4 km SW Norcia (PG) http://terremoti.ingv.it/event/27995291	**Mag 3.1 / 43 km**







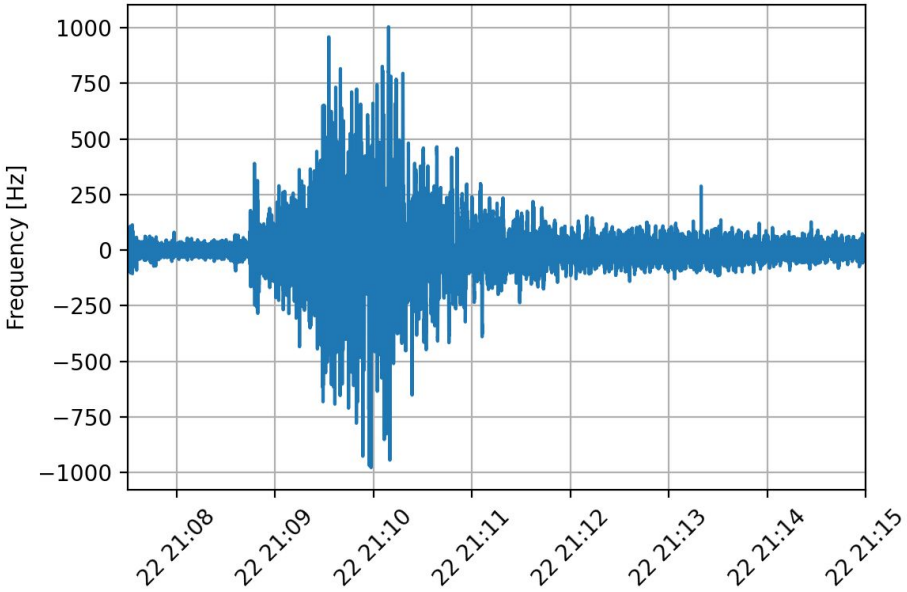


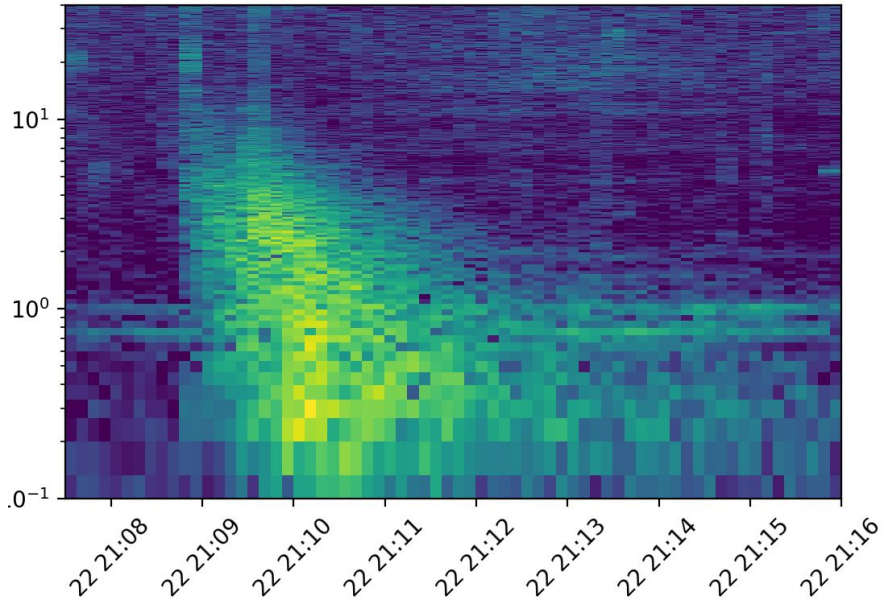
Conclusion / Perspective

- **MEGLIO**
  - The experiment is a **success**
  - The data analysis is still **undergoing** and the sensor is still active.
  - We hope that the axis Ascoli Piceno - Teramo will become an **observatory** to compare different types of sensing.
  - The **background** is very rich.

- **General**
  - Interferometry with ultra stable laser is a wonderful **complementary** tool for classic seismic networks, especially in the Italian context.
  - The association between commercial networks and fiber sensing will be a key infrastructure in the future for **Early Warning Systems** (sensing, hosting, transmission)
  - Prototype sensing means **multidisciplinary** approach between sensing, infrastructures and expertise.
  - The reuse of infrastructure is compliant with the European recommendations on **sustainability**.

22-04-2022/ M 5.5 / 360 km / Bosnia and Herzegovina





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