

**30-31 Ottobre 2008**

**Riunione Plenaria Progetto S4**

***Stazioni accelerometriche  
Analisi delle misure di rumore***

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**Istituto  
Nazionale  
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e Vulcanologia**

## Noise analysis

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**During S6 project, noise measurements** were collected at about 40 RAN stations (mainly at Umbria, Marche and Sicily regions)

**In S4, these noise recordings are analyzed following a standard procedure**



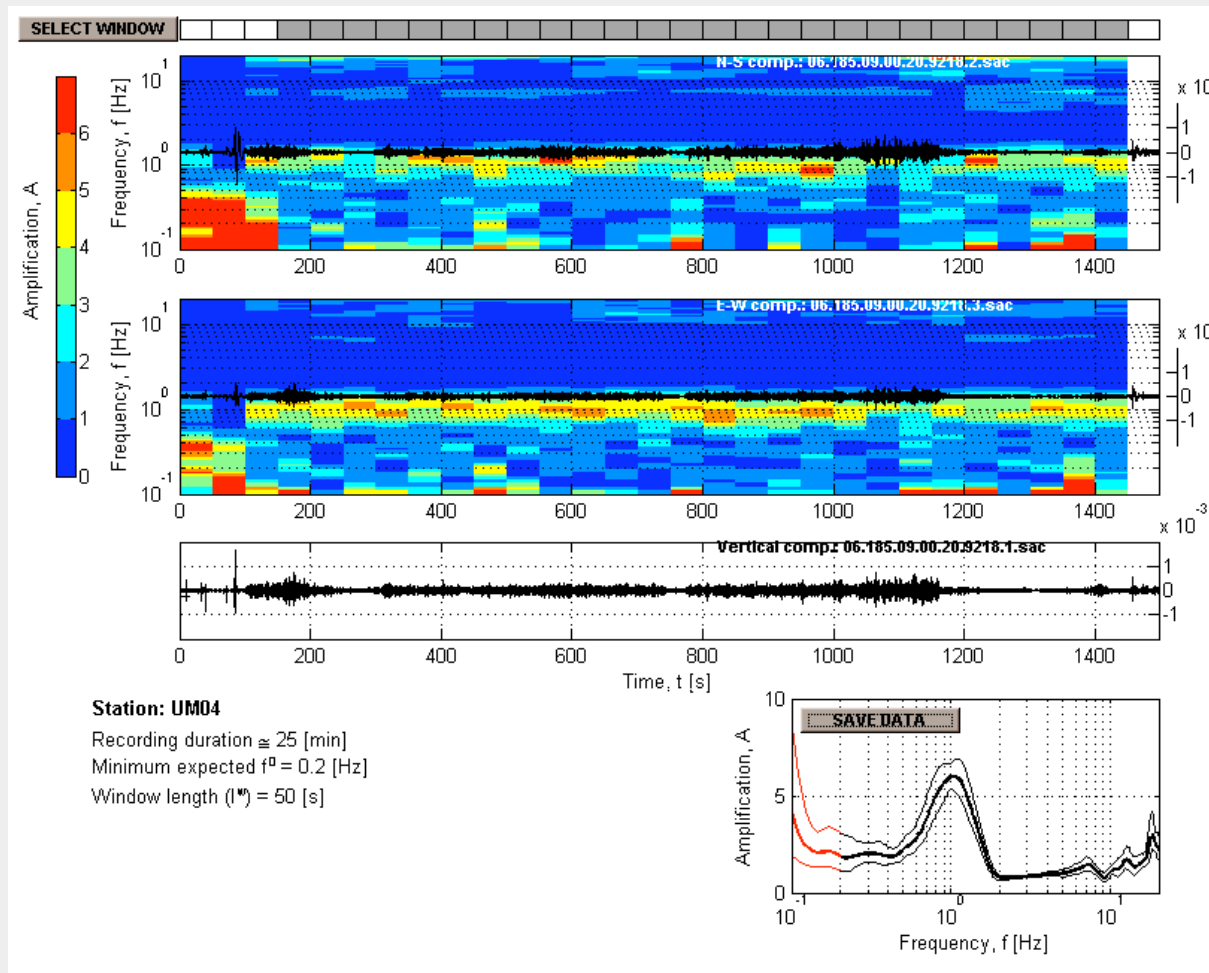
**HVNoise**

**a MatLab routine to compute HVSR from noise recordings**

# HVNoise MatLab routine

**HVNoise:** a MatLab routine to compute HVSR from noise recordings

**Input: 3 components of noise recordings (ascii or sac files)**



## **HVNoise MatLab routine**

**HVNoise computes the ratio HVSR  
between horizontal to vertical components of noise signals**

- The HVSR is calculated for**
- NS and WE components, separately**
  - geometric and arithmetic\* means  
together the standard deviations**

**Noise recordings have generally  
durations longer than 30 min.**

**In according to the recommendations  
of the "SESAME H/V User Guidelines" (SESAME, 2004):**

**Window length ( $L_w$ ) = 50 sec.  
Minimum expected  $f_0$  ( $f_{0,MIN}$ ) = 0.2 Hz**

## For each component:

### For each recording

#### Parameters

<b>1) Detrend (linear)</b>	
<b>2) Instrumental correction</b>	Poles and zeros .gse file
<b>3) Band-pass filter (Butterworth method)</b>	Window length → lower limit of the filter Sampling rate → upper limit of the filter Filter order = 4
<b>4) Time windows</b>	Window length $L_W = 50$ sec. (→ $f_{0,MIN} = 0.2$ Hz)

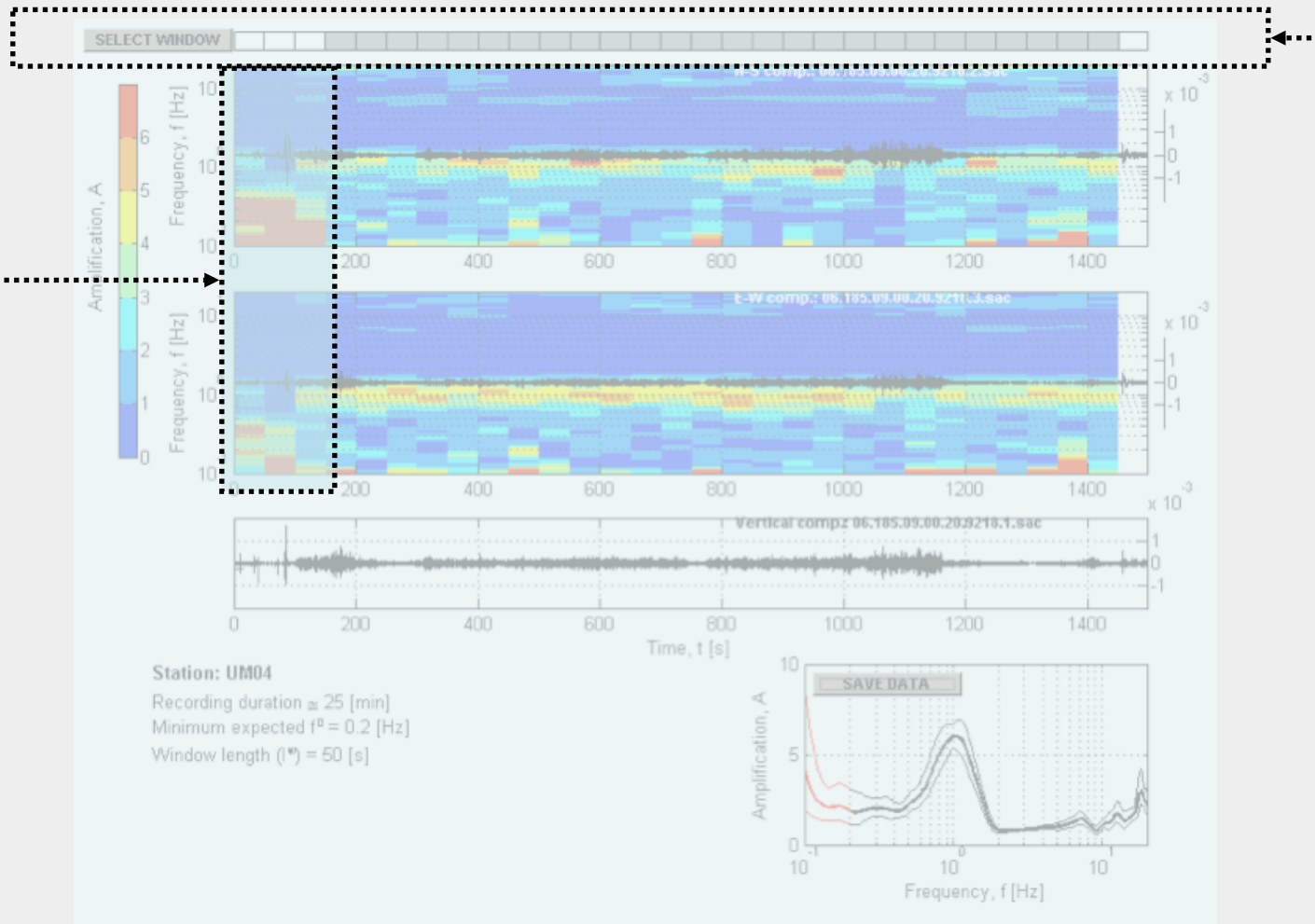
### For each window

#### Parameters

<b>1) Detrend (linear)</b>	
<b>2) Tapering</b>	Tapering dimension = <b>5 %</b> of window length ( $L_W$ )
<b>3) Fourier analysis</b>	
<b>4) Konno and Ohmachi (1998) smoothing</b>	Smoothing half-window ( $w_i$ ) = 50 exponent $b = 20$ ; sm parameter = 1

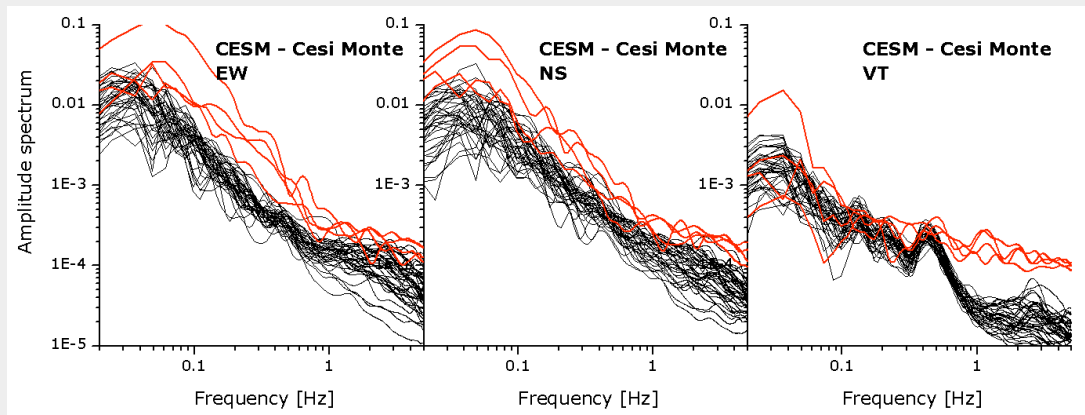
## HVNoise - interactive window selection

The windows with recording problems can be easily removed through an interactive procedure

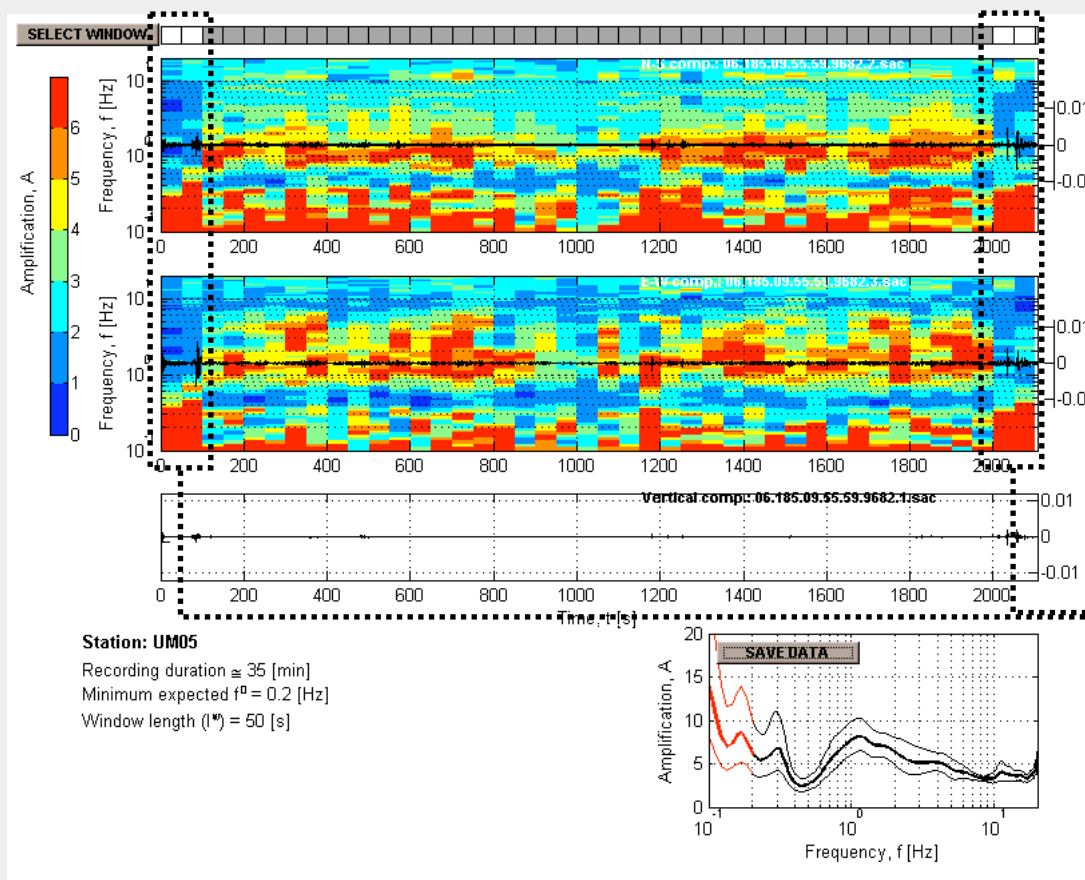


i.e. the instability of the sensor at the start of the recording  
(in this case a Lennartz LE-3D/5s)

# HVNoise - interactive window selection

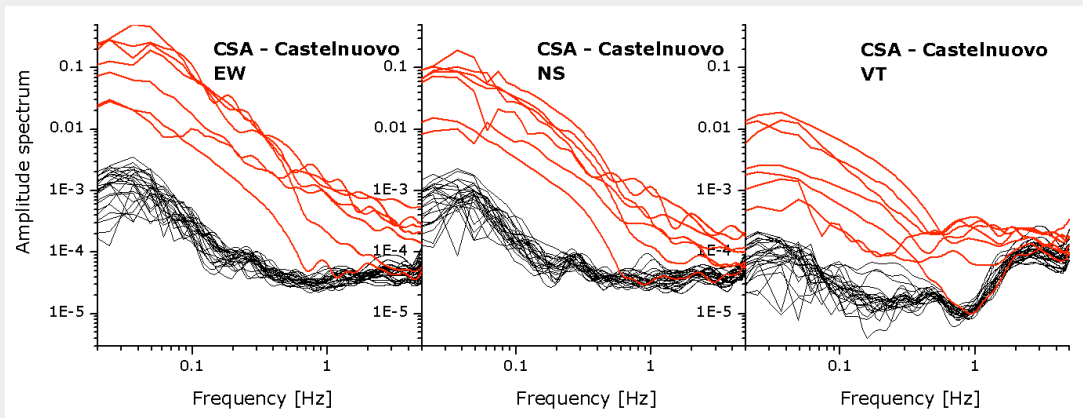


No smoothed spectra:  
Removed (red)  
Used (black)  
windows

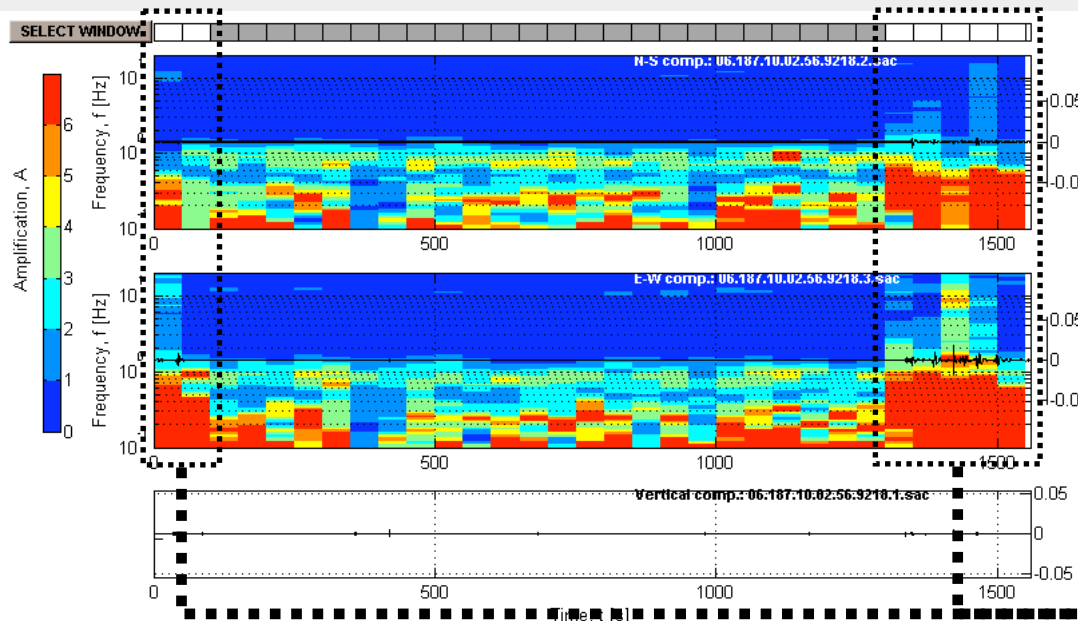


Removed windows

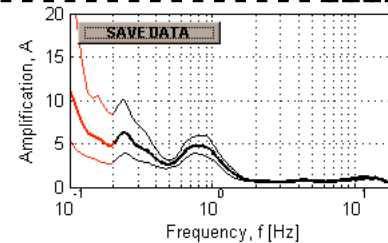
# HVNoise - interactive window selection



No smoothed spectra:  
**Removed (red)**  
**Used (black)**  
windows



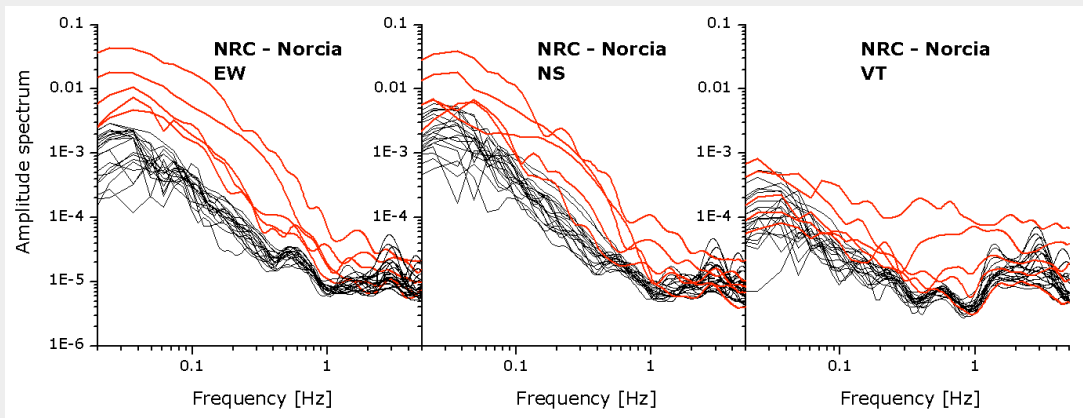
Station: UM22  
Recording duration  $\approx$  26 [min]  
Minimum expected  $f^0 = 0.2$  [Hz]  
Window length ( $l^*$ ) = 50 [s]



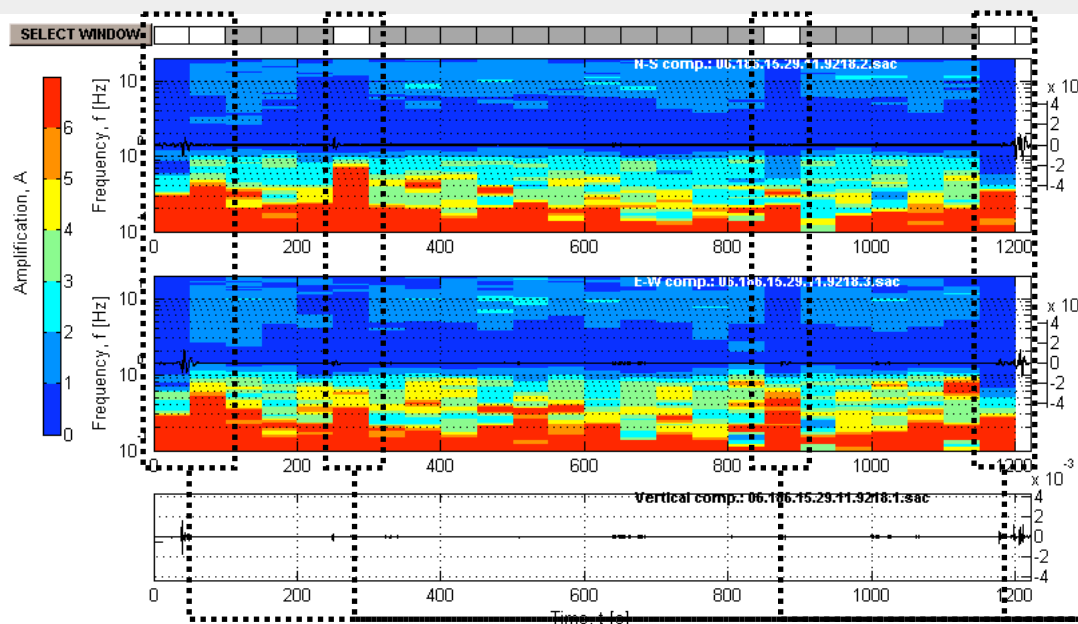
**Removed windows**



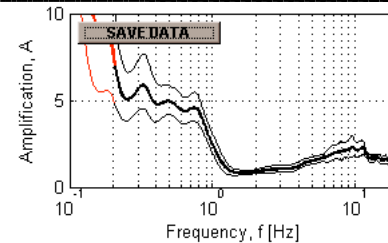
# HVNoise - interactive window selection



No smoothed spectra:  
**Removed (red)**  
**Used (black)**  
windows



Station: UM18  
Recording duration  $\approx$  20 [min]  
Minimum expected  $f^0 = 0.2$  [Hz]  
Window length ( $l^*$ ) = 50 [s]



**Removed windows**

## **Analyzed RAN stations**









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- **Umbria Marche region: 17 stations**
  - **Sicily Region: 15 stations**
    - **Others: 10 stations**

**All noise tracks were recording with  
Lennartz LE-3D/5s sensor**

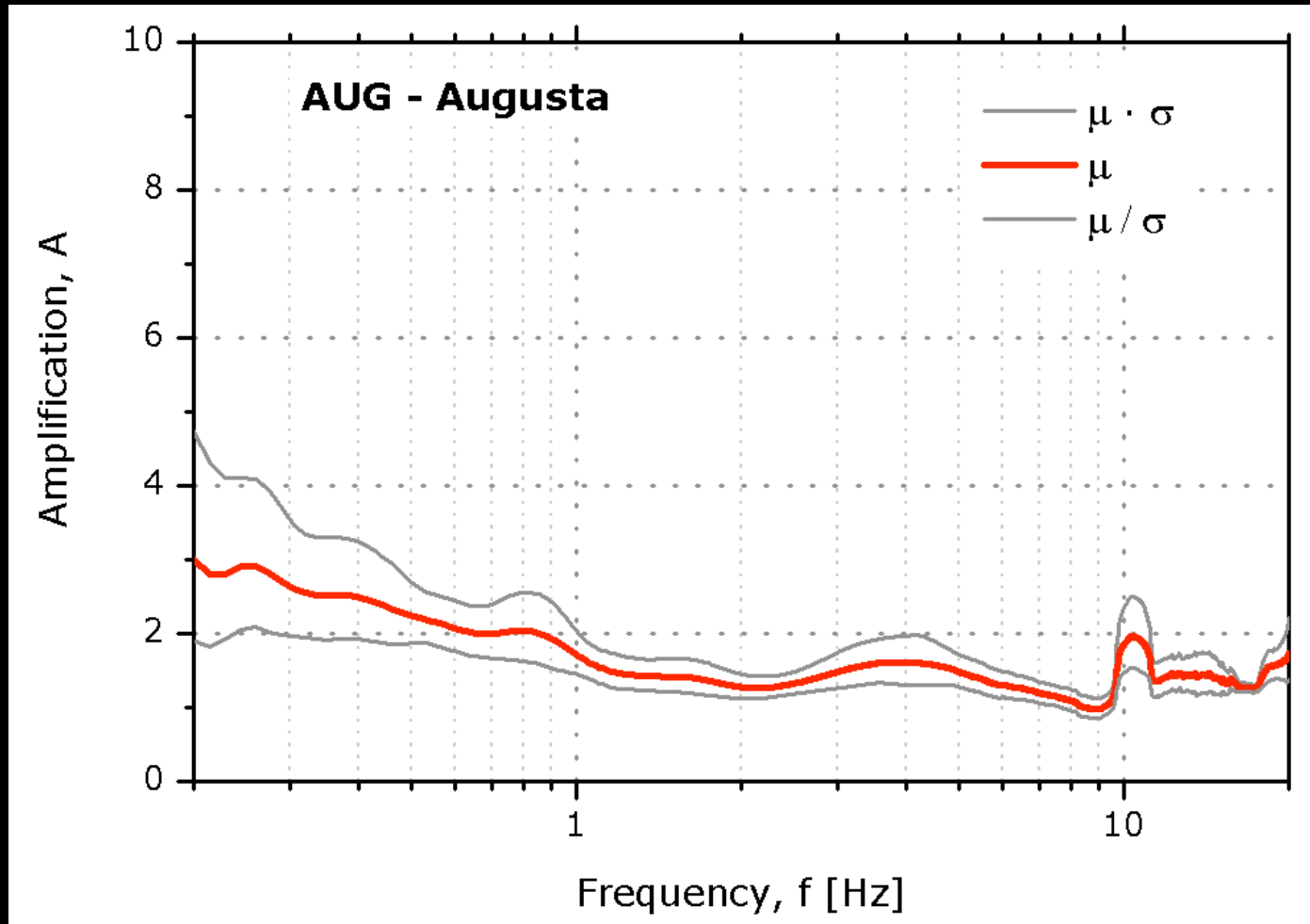
## HVNoise - output

SIGLA	f <sub>A</sub> [Hz]	NOME	Analisi
AUG	0	AUGUSTA - CABINA ENEL	 
BNT	1.9	BRONTE (CATANIA)	 
CDI	18?	CASTEL DI JUDICA	 
CLG	0	CALTAGIRONE	
ISI	0	ISPICA	
LNT	0	LENTINI	
MLZ	0	MILAZZO	
NVR	1.8-1.9	NOVARA DI SICILIA	 
PLZ	0	PALAZZOLO ACREIDE	
PPL	0	PORTOPALO DI CAPO PASSERO	
PTT	0	PATTI - CABINA PRIMARIA (MESSINA)	
RGS	1.1	RAGUSA	 
SRC	0	SIRACUSA	
TAO	0	TAORMINA	
TOR	0	TORTORICI	
ANNI	0	ANNIFO	
ASS	3.1	ASSISI	
BCC	2.2	BORGIO CERRETO - CAMPO SPORTIVO	
BCT	0	BORGIO CERRETO - TORRE	
BVG	1.0	BEVAGNA	

SIGLA	f <sub>A</sub> [Hz]	NOME	Analisi
CESM	1.0??	CESIMONTE	
CESV	2.1	CESIVALLE MACERATA	
CLC	1.1-4.0	COLFIORITO - CASERMETTE	
CLF	1.0	COLFIORITO	
CSA	0.75 0.23?	CASTELNUOVO (ASSISI)	
FSMI	0	FOLIGNO - S. MARIA INFRAPORTAS	
MTL	0	MATELICA	
NOR	0	NORCIA - LE CASTELLINA	
NRC	0.3-0.75	NORCIA	
NRZI	0.3-0.5	NORCIA - ZONA INDUSTRIALE	
SELE	3.2?	SELLANO EST (PERUGIA)	
SELW	1.6	SELLANO OVEST (PERUGIA)	
SER	7.1	SERRAVALLE DI CHIANTI	
GAI	0	GAINO - TOSCOLANO MADERNO	
SAL	1.3-1.9	SALO' SCUOLA	
ARL	16	AIROLA	
ARN	8.0	ARIENZO	
BGI	7.0-12	BAGNOLI IRPINO	
GRD	0?	GUARDIAGRELE (CHIETI)	
LDP	0	LAMA DEI PELIGNI (CHIETI)	
SCF	2.0	SCAFA	
SDM	0	SAN DEMETRIO NEI VESTINI	
STR	0	STURNO (AVELLINO)	

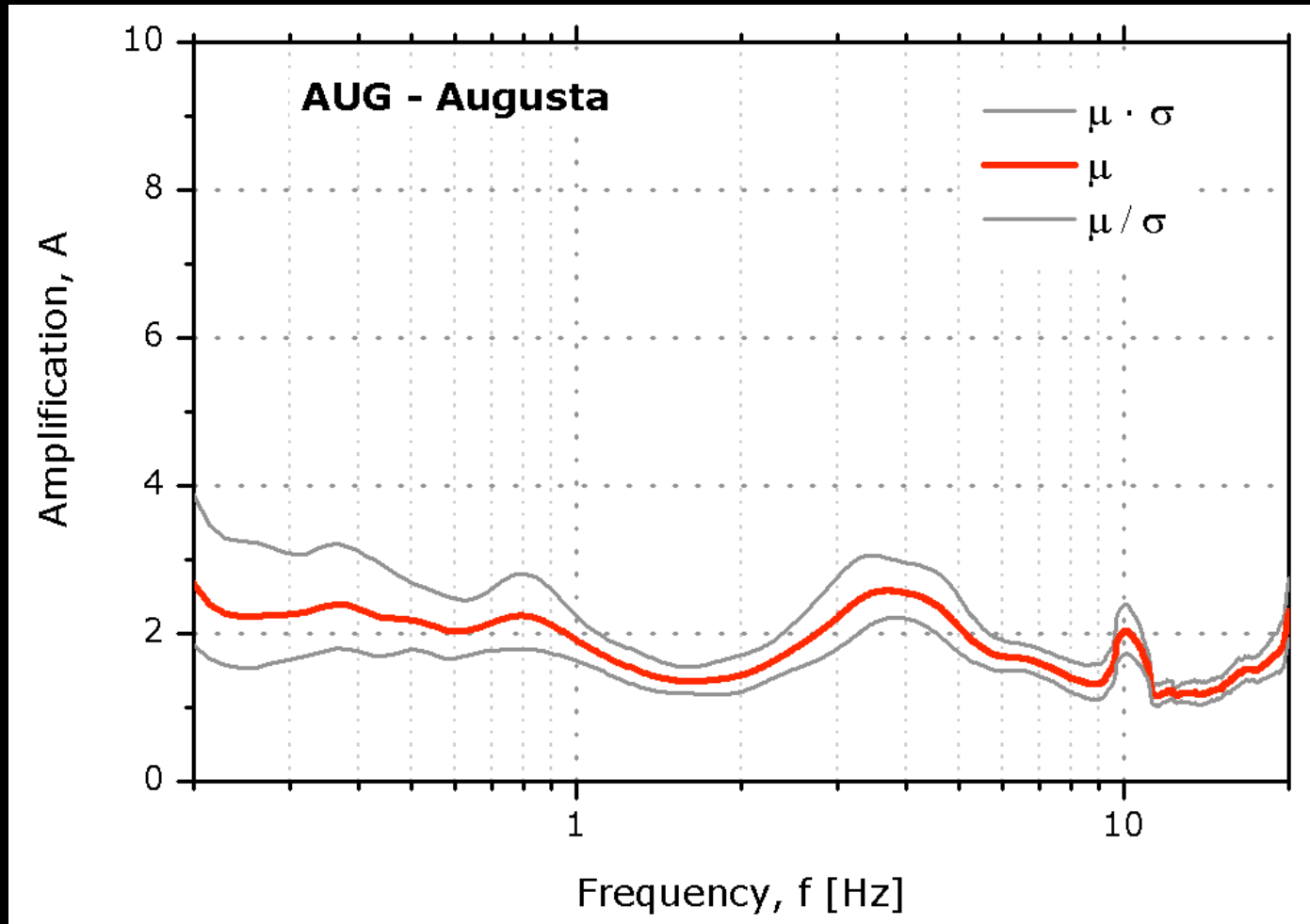


## Day recording



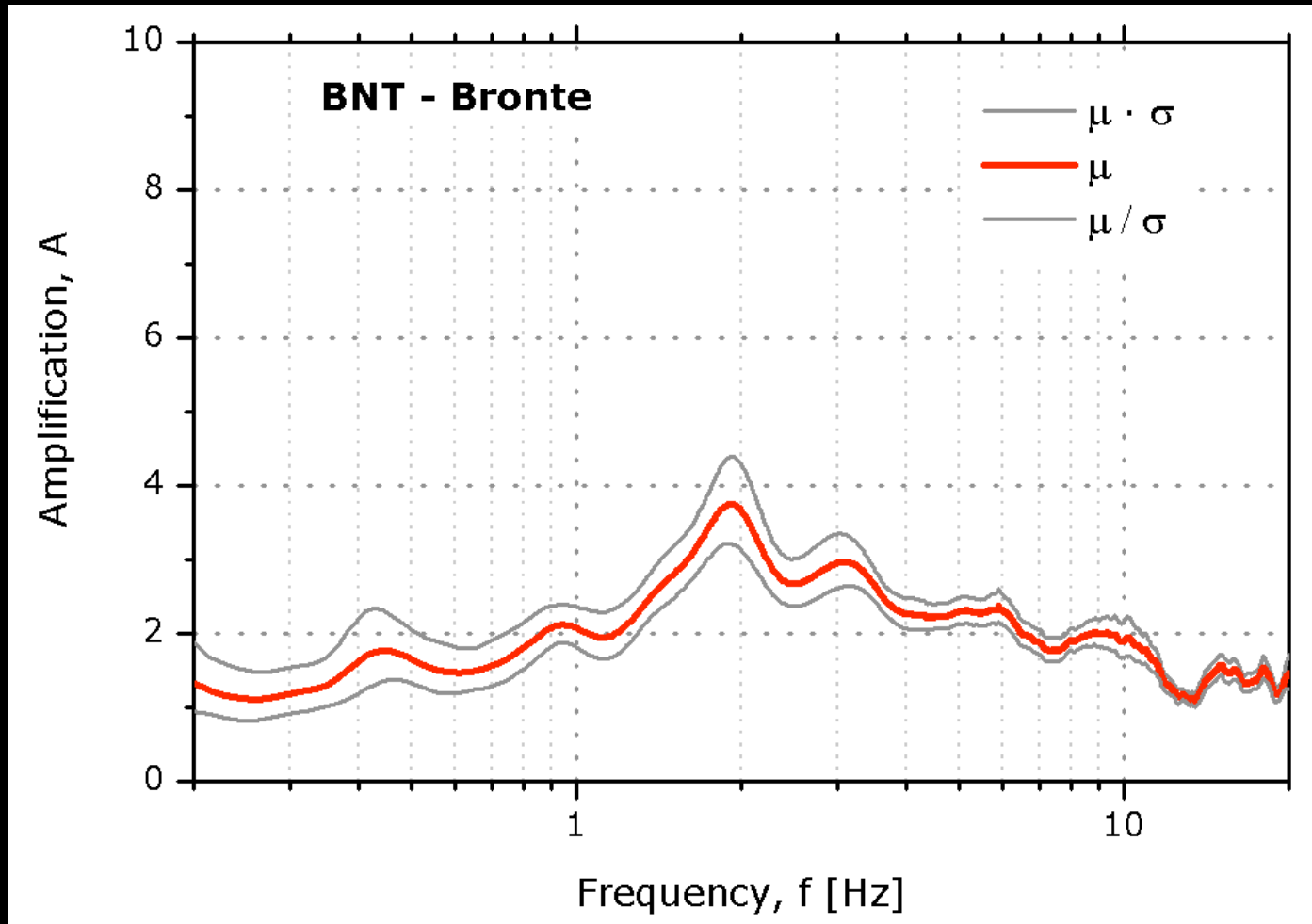


### Night recording



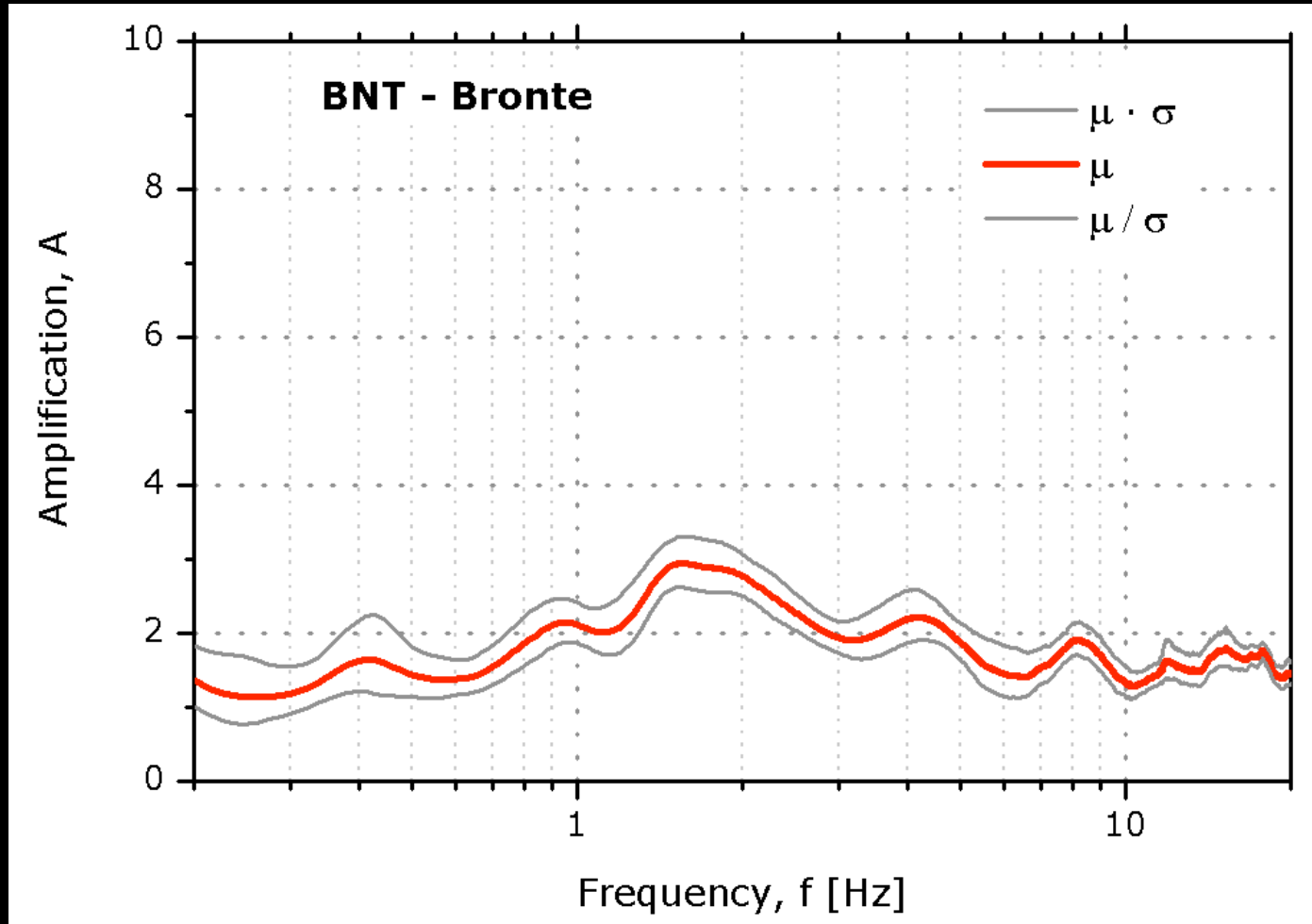


Day recording



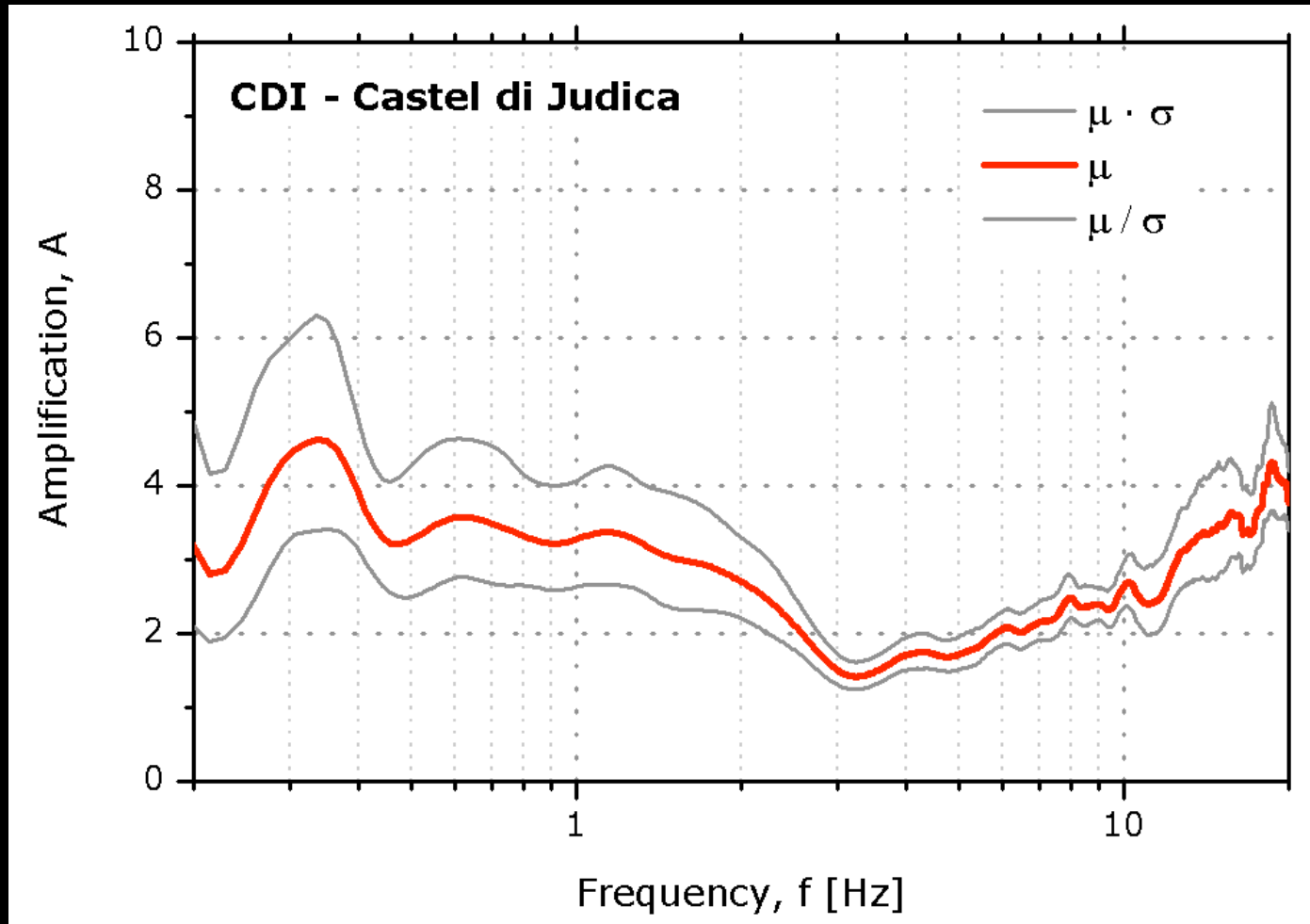


## Night recording





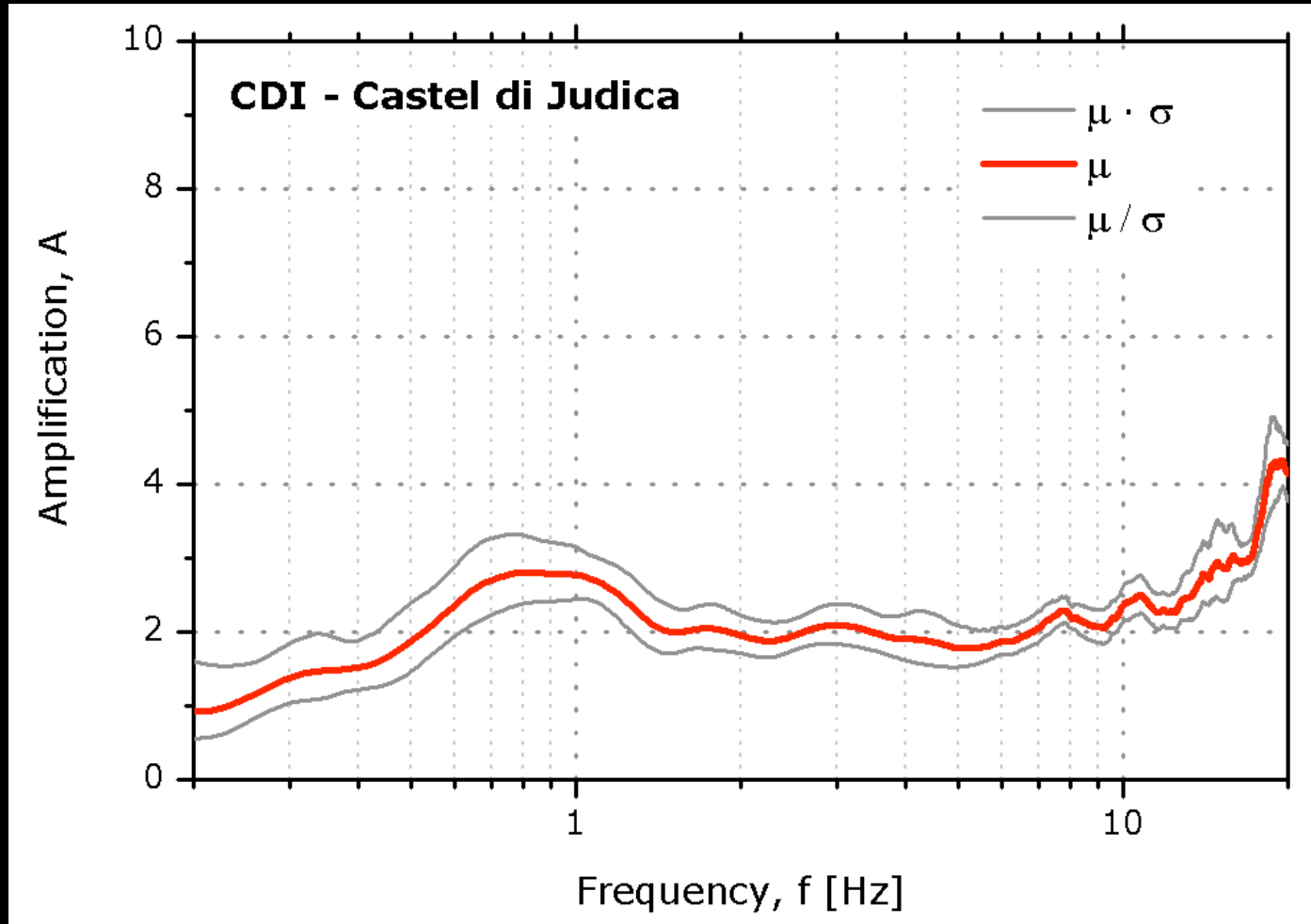
## Day recording





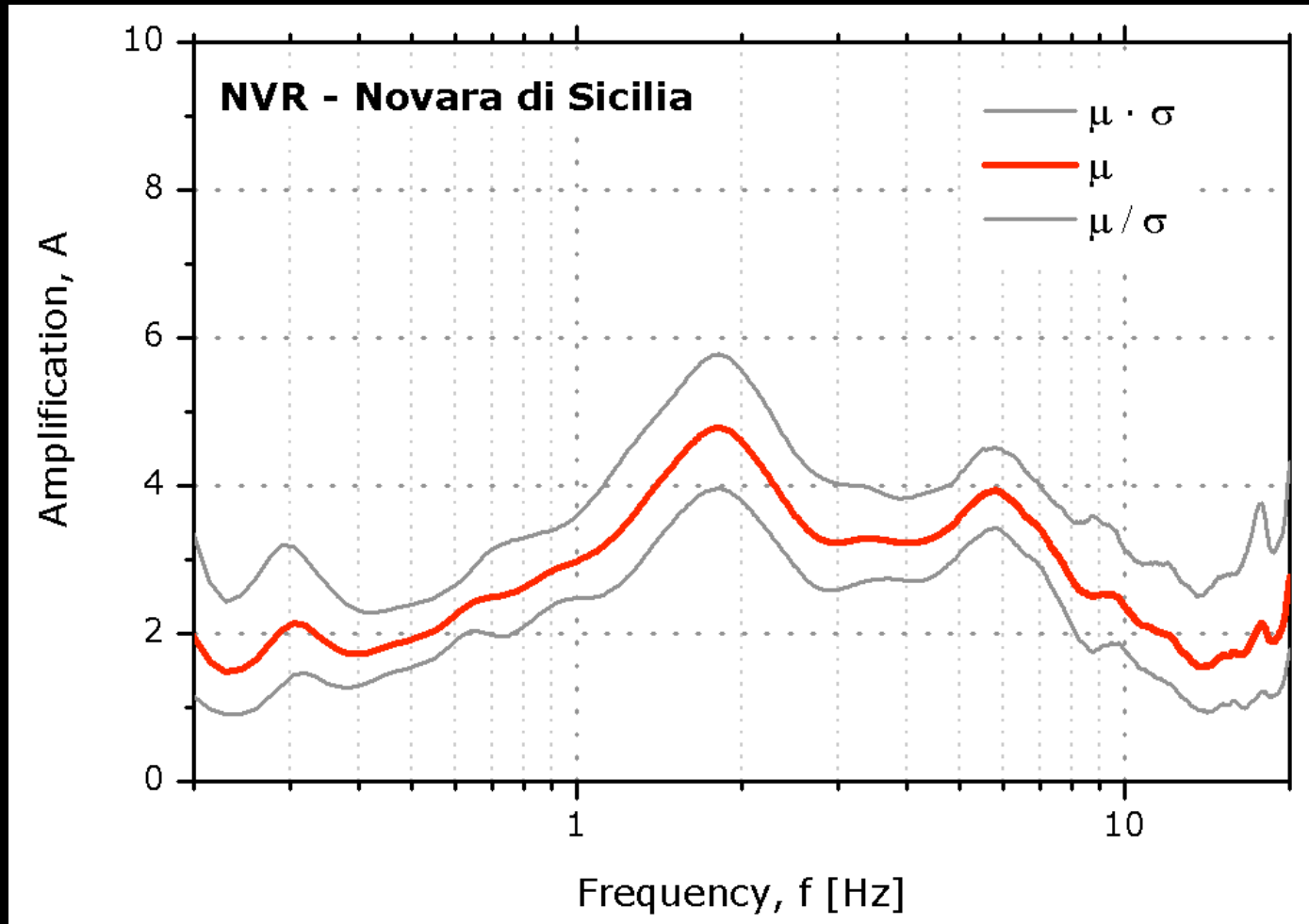


### Night recording



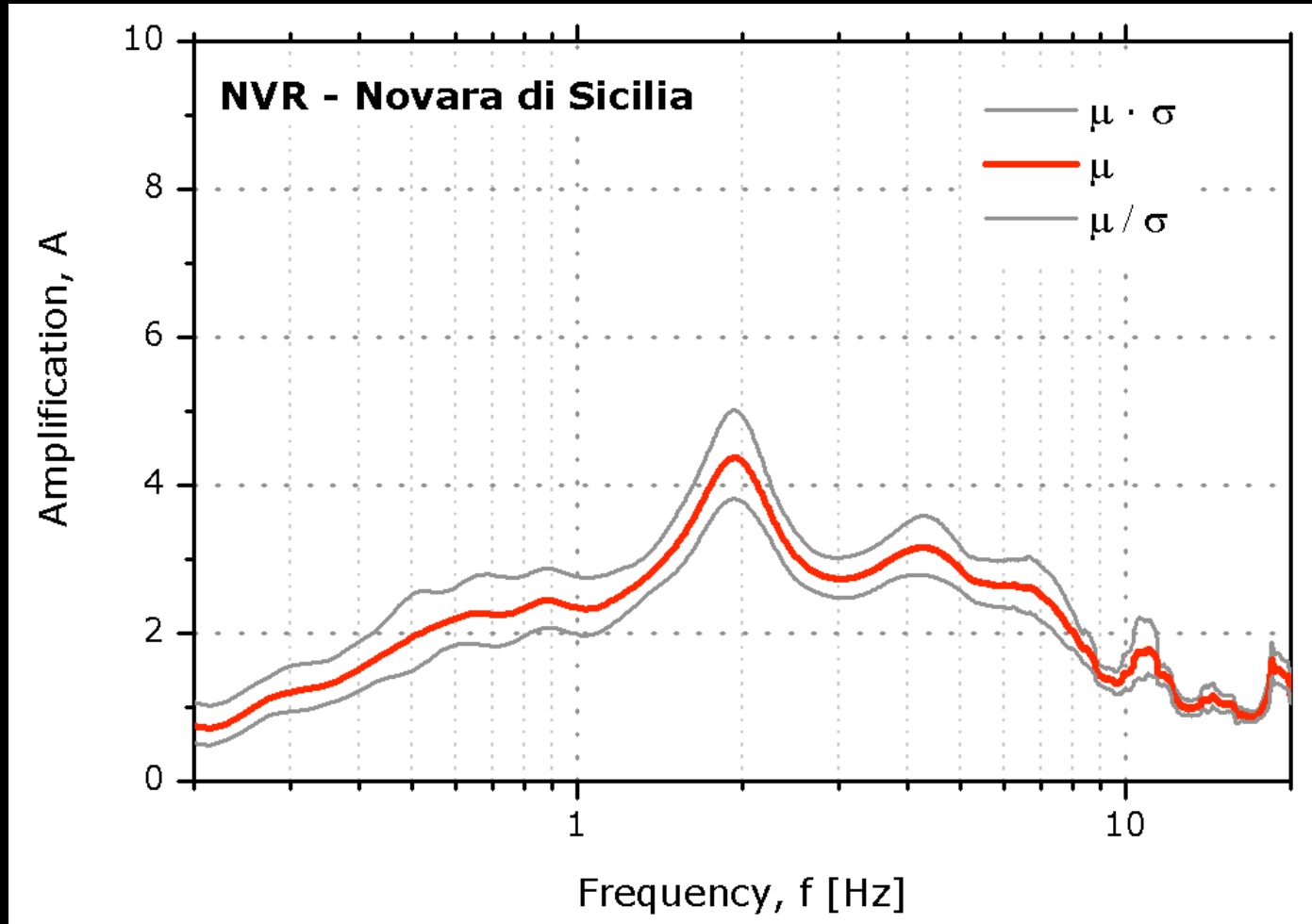


## Day recording



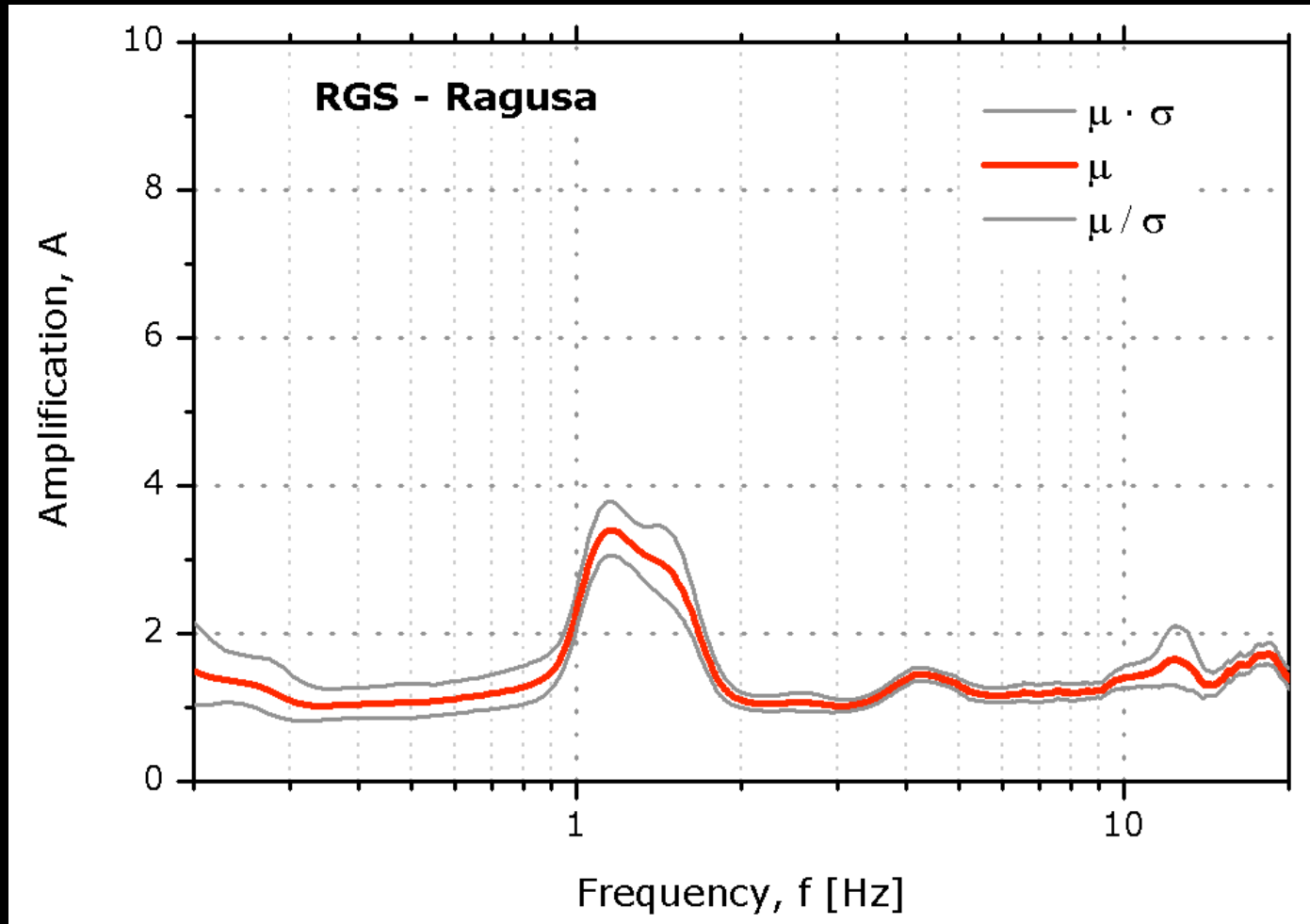


## Night recording



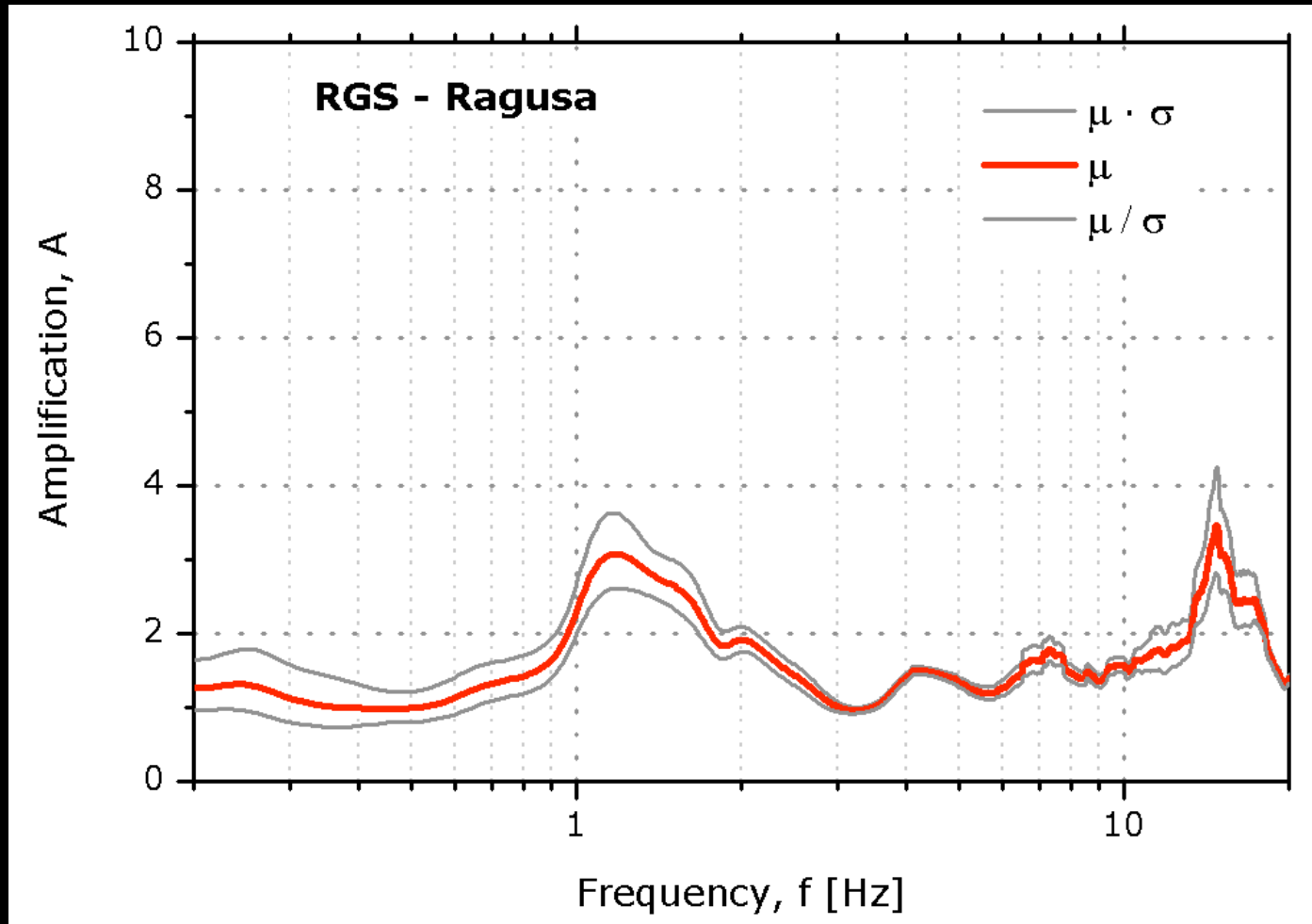


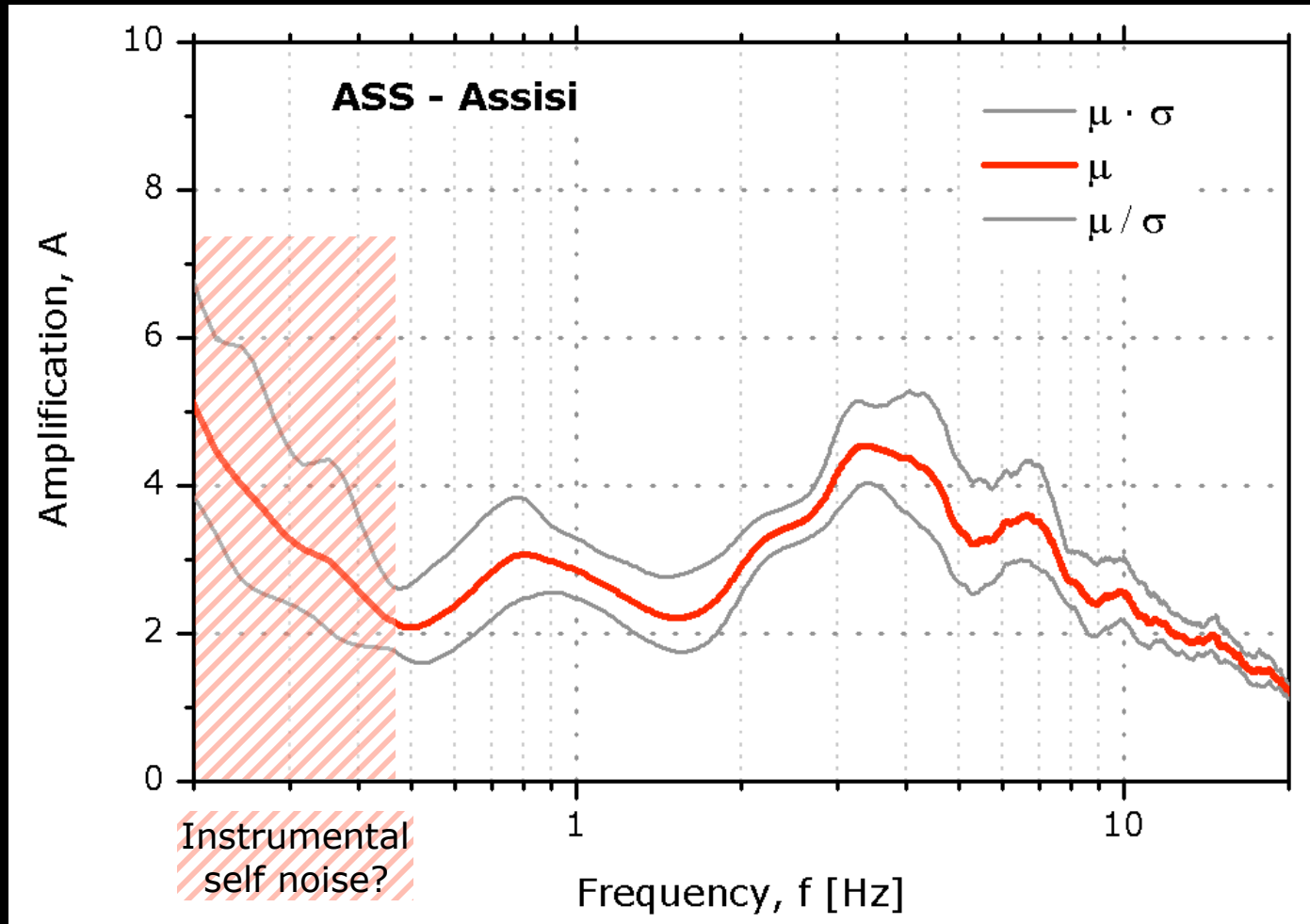
Day recording

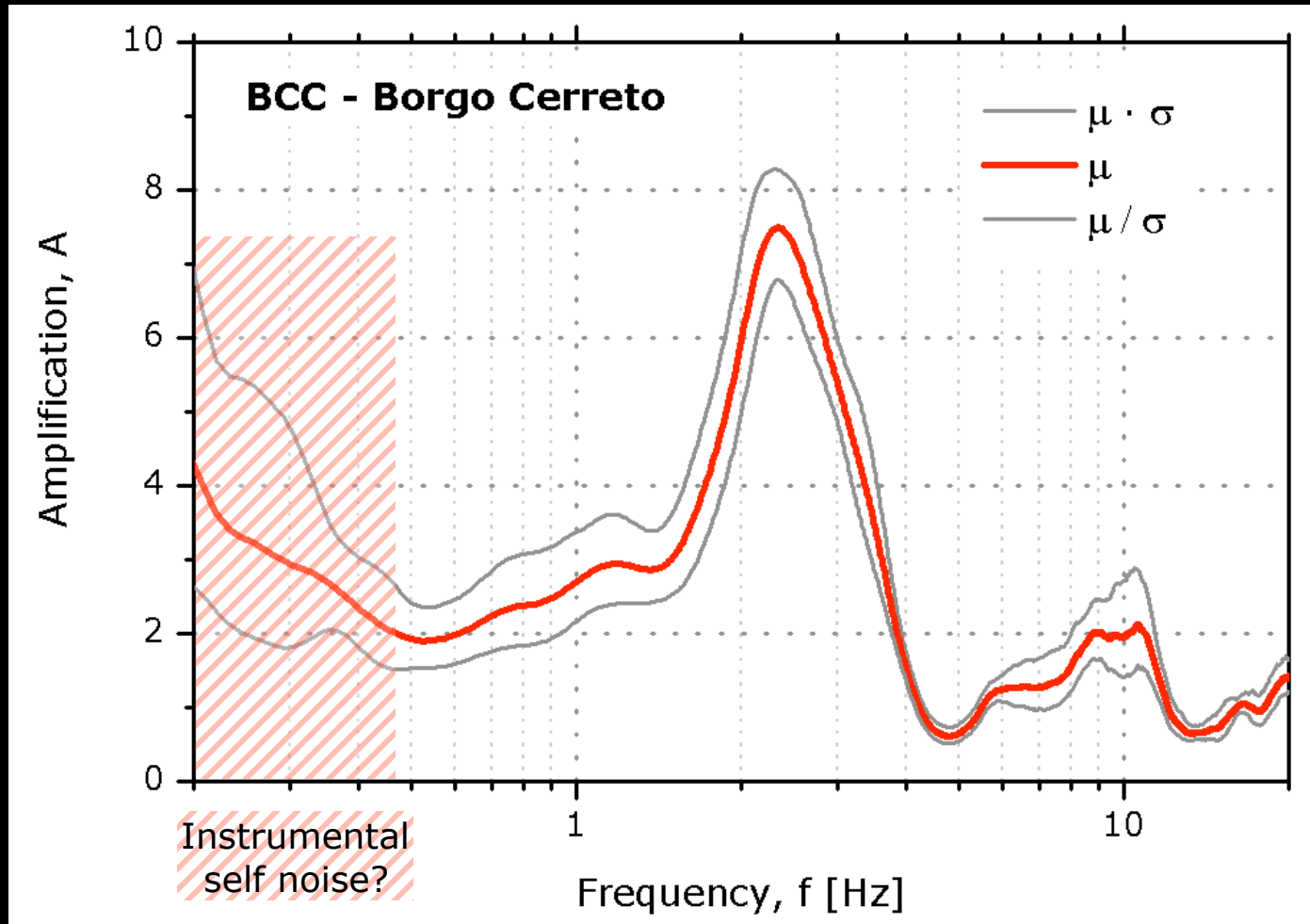


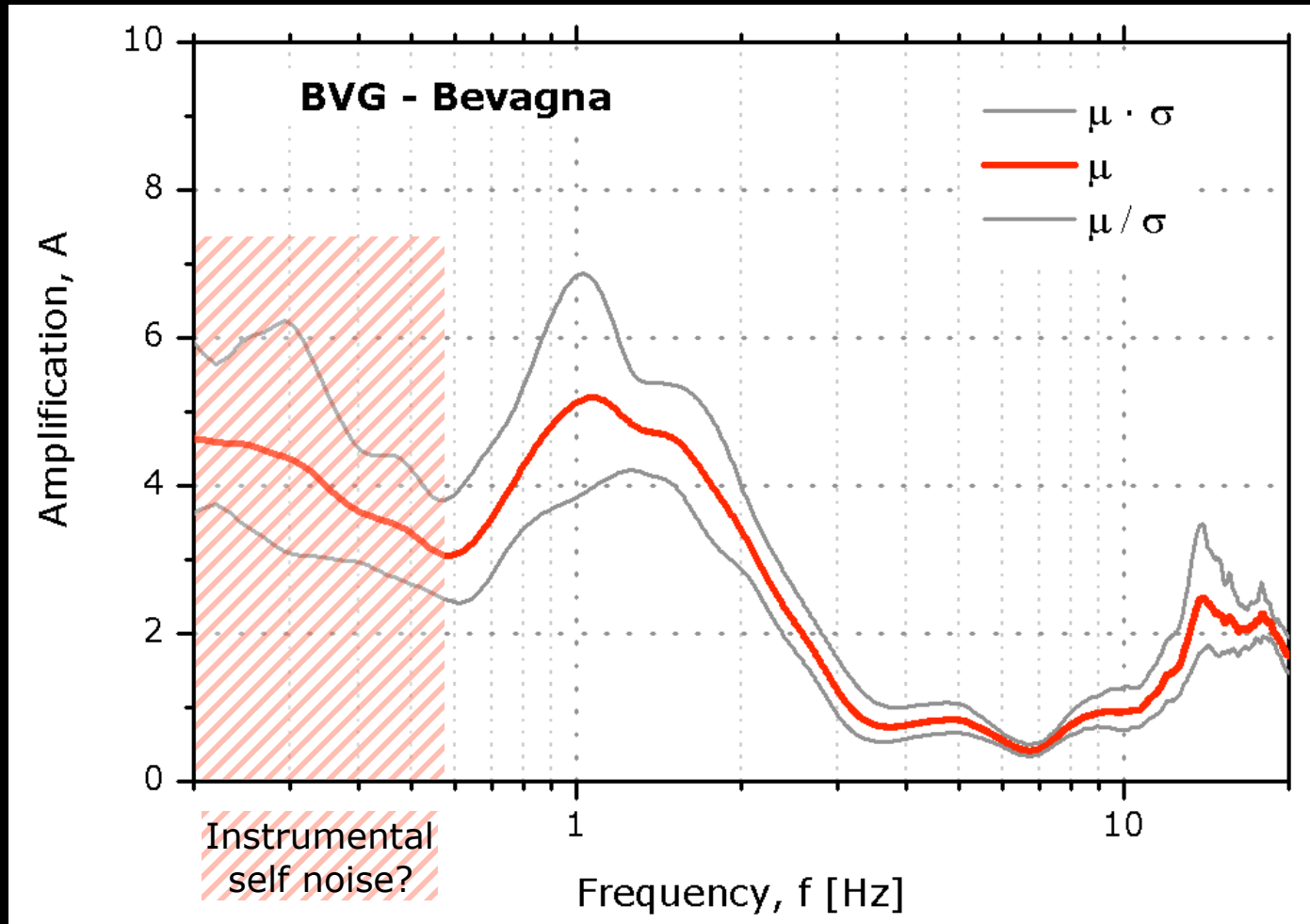


### Night recording





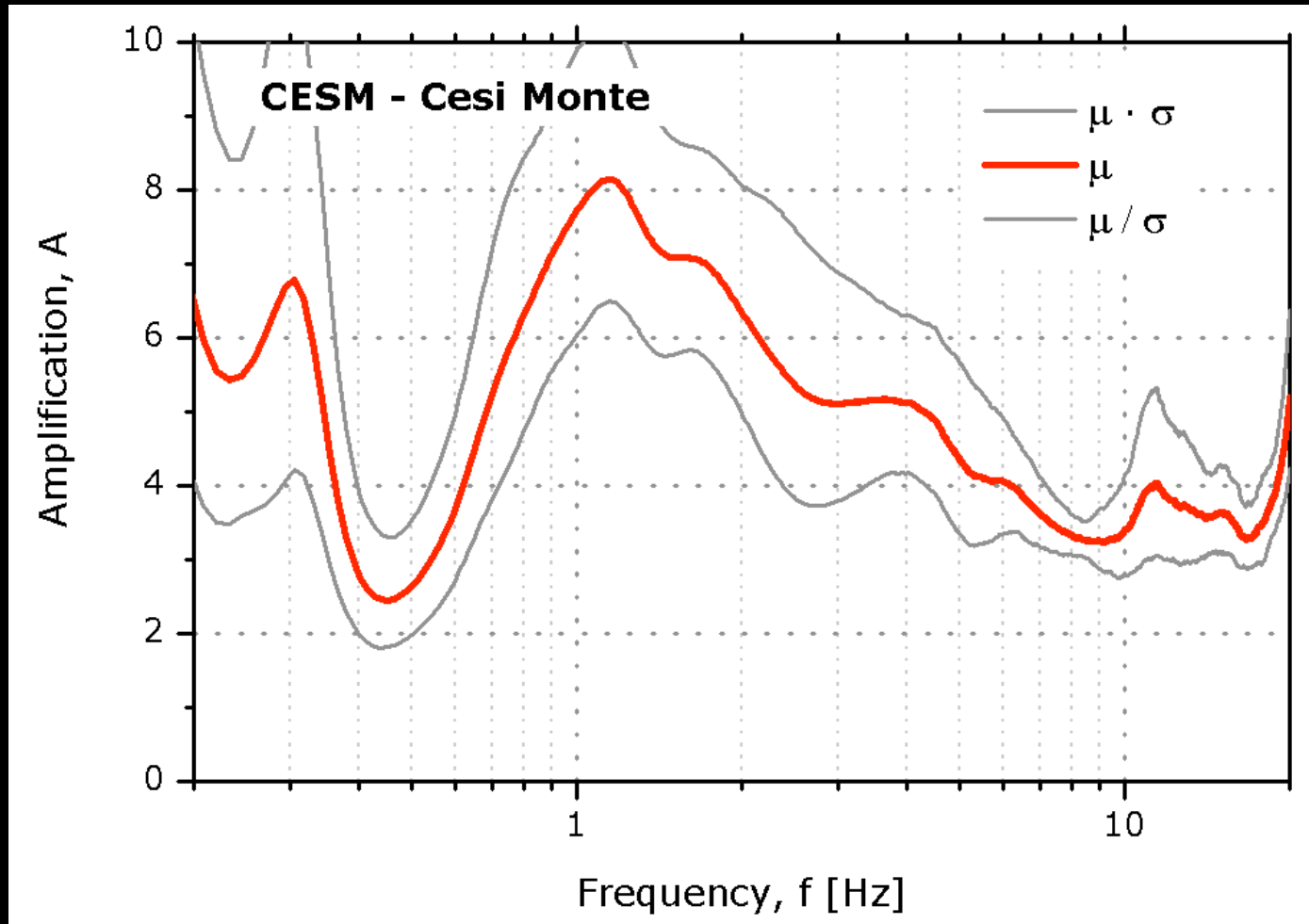


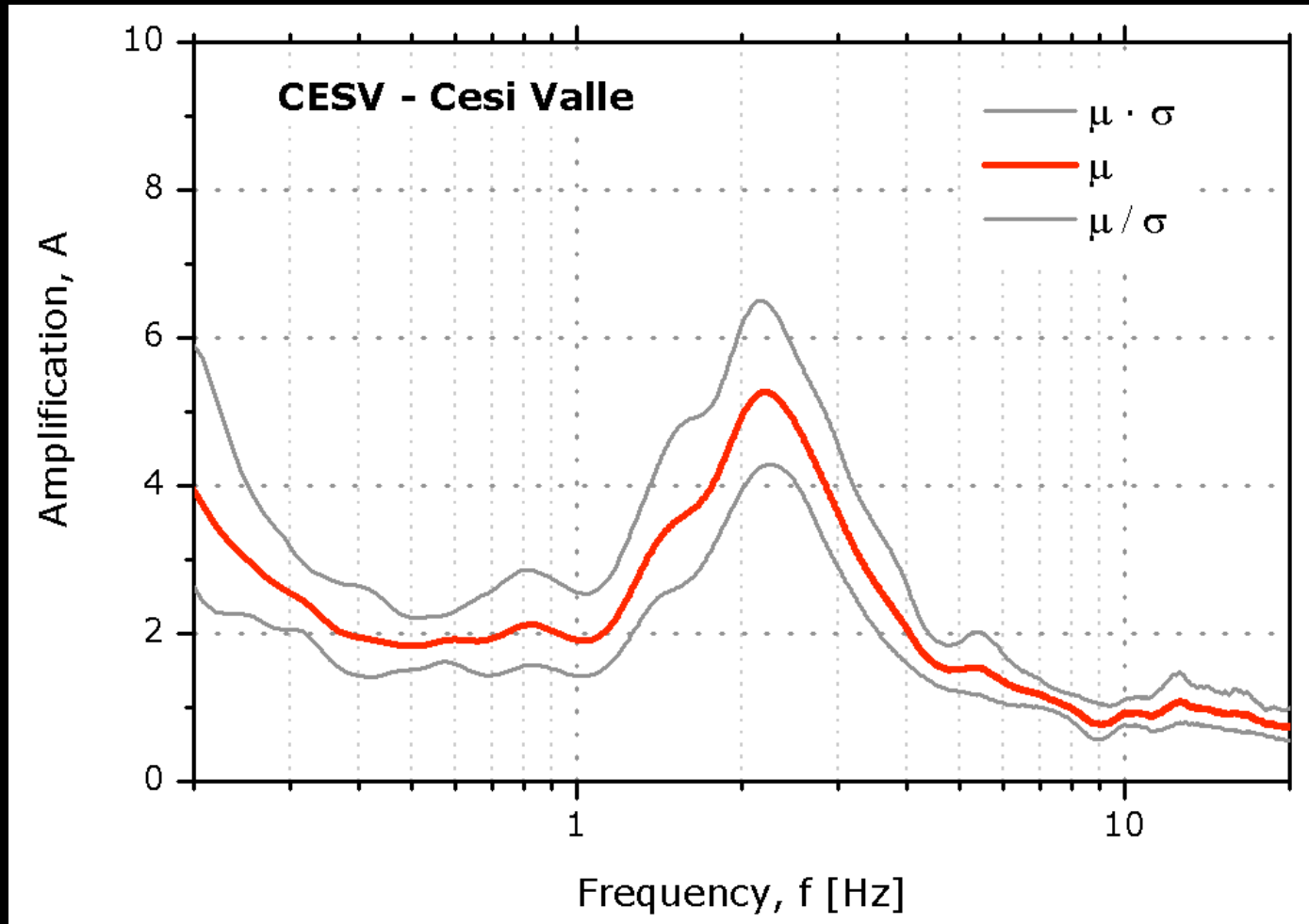


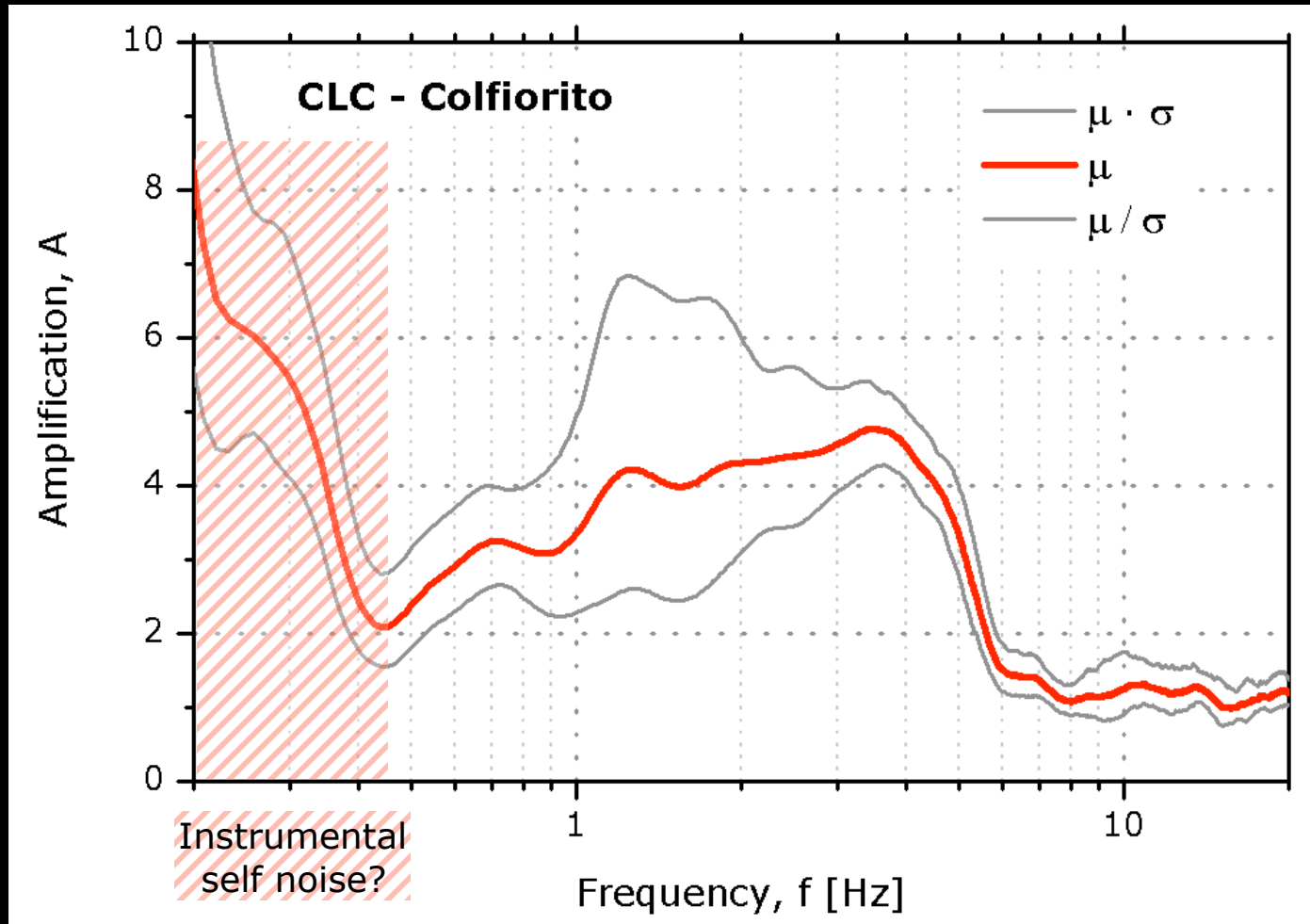


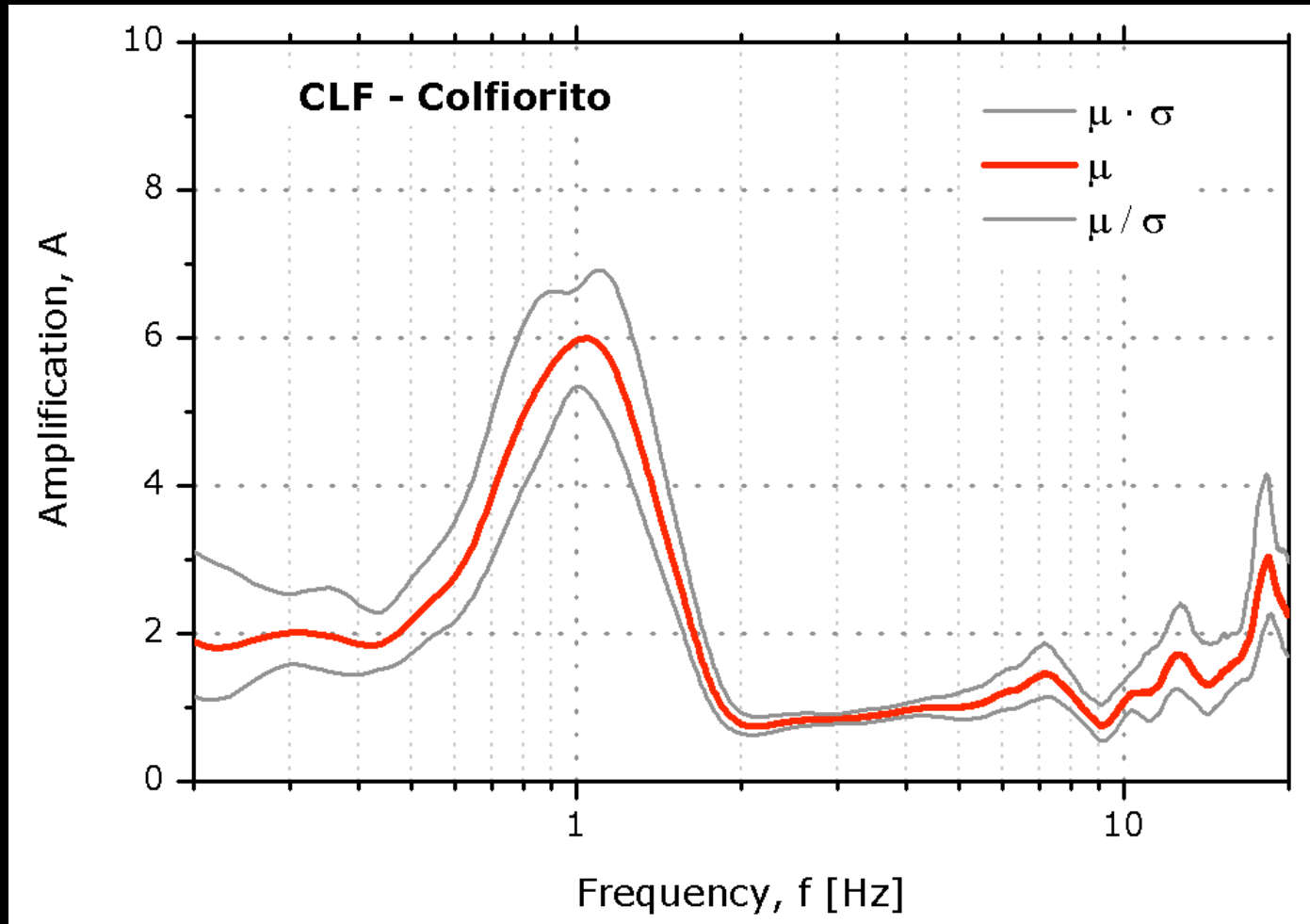


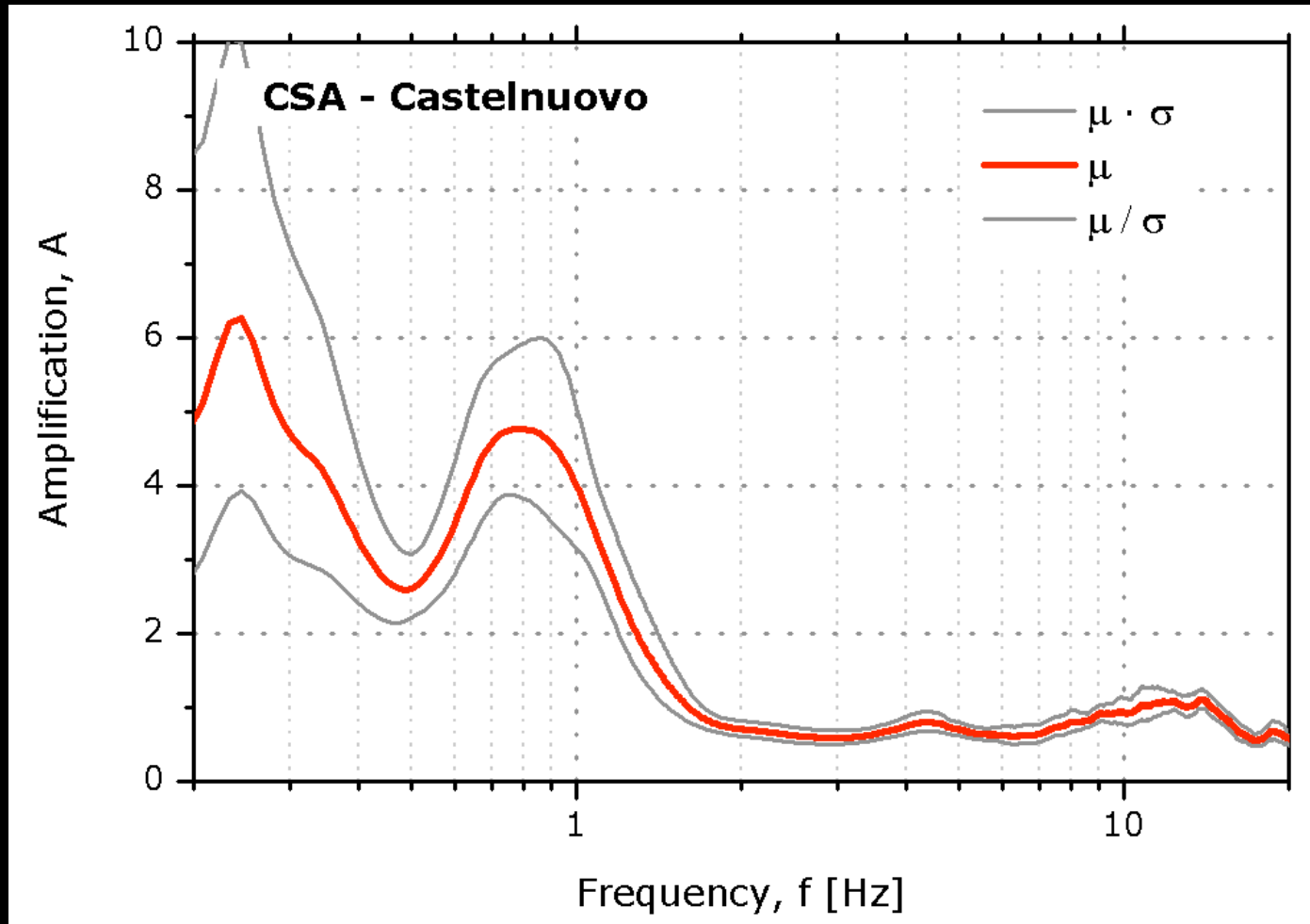
Strong wind during recording → it is a reliable acquisition?

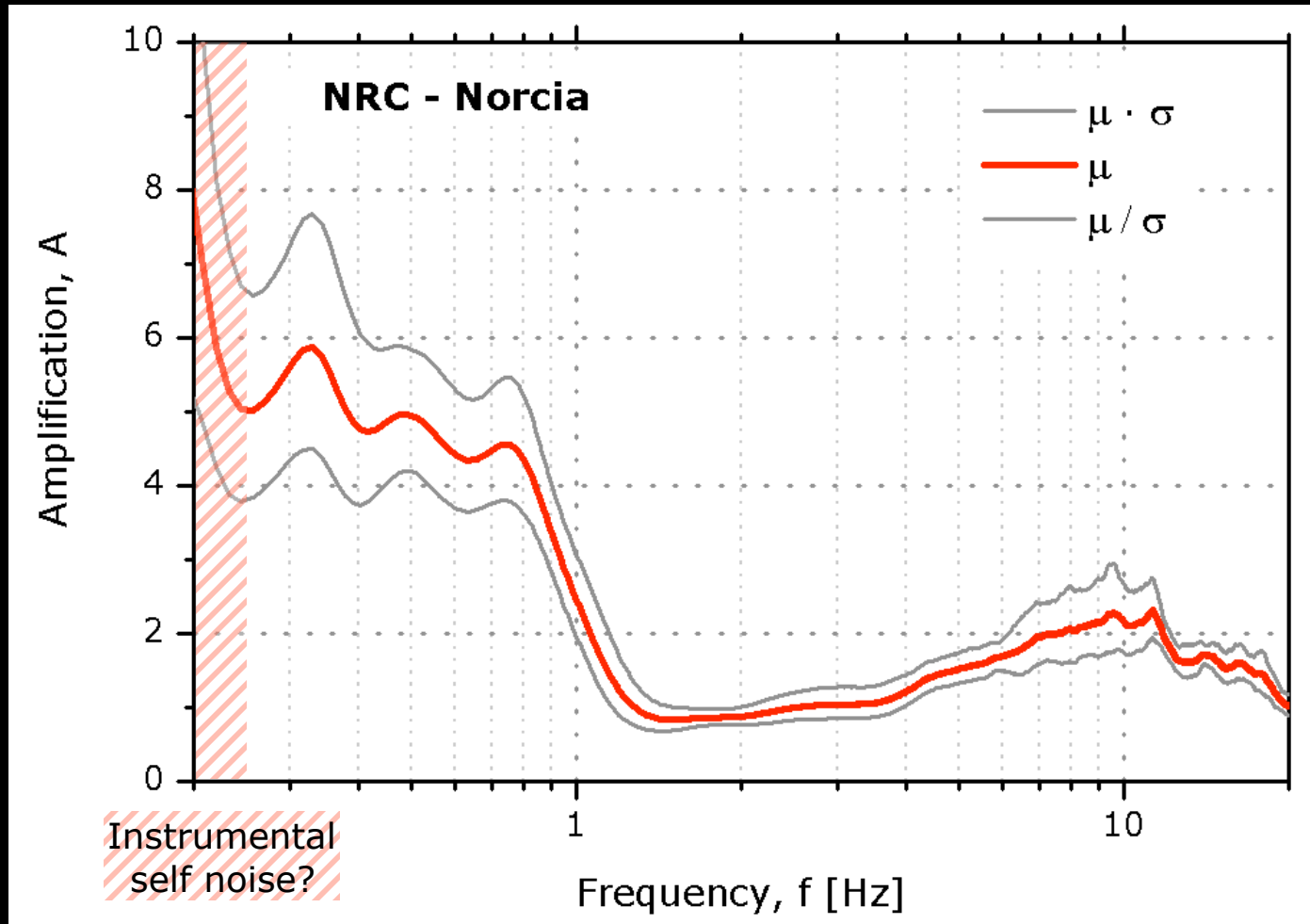


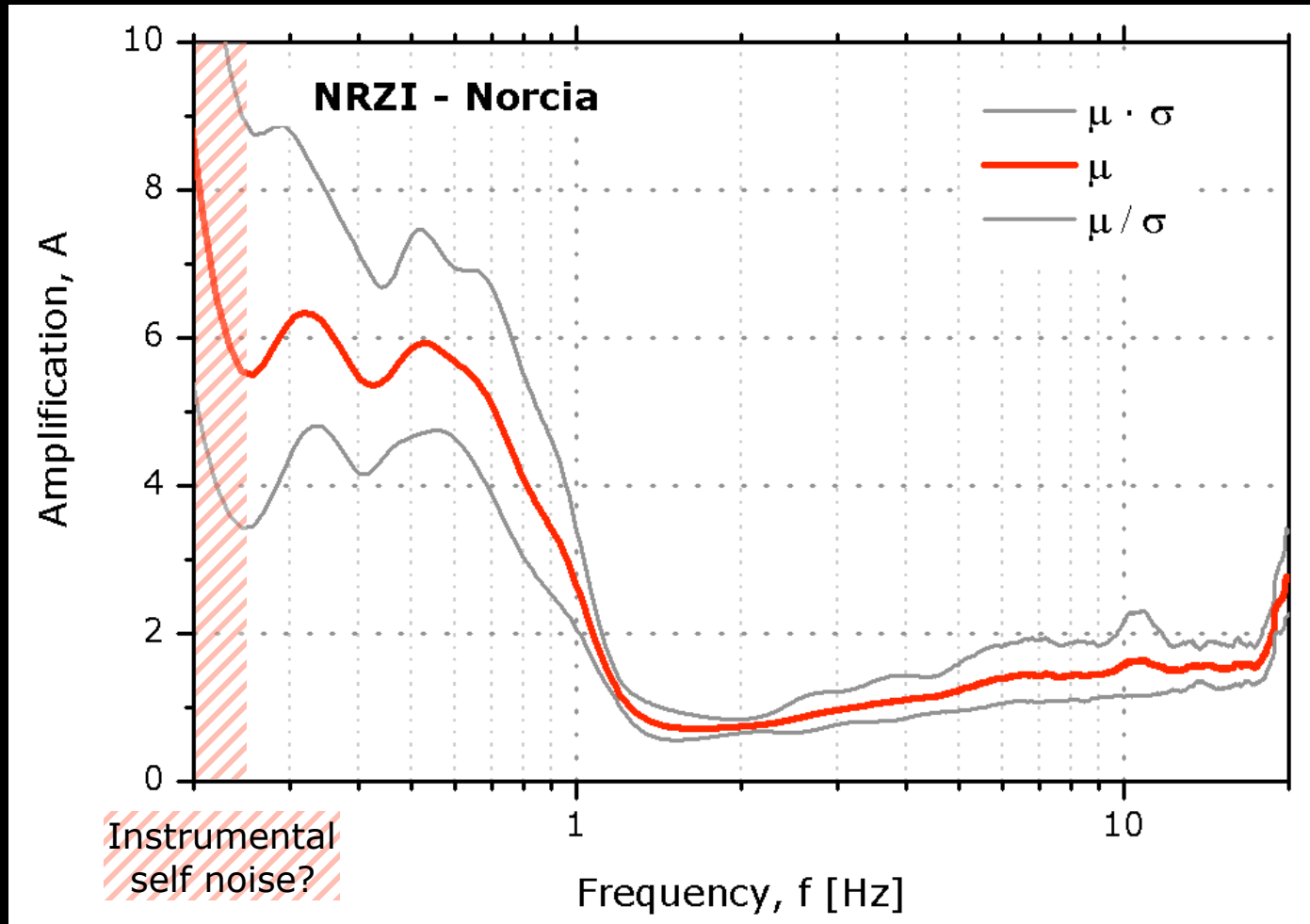


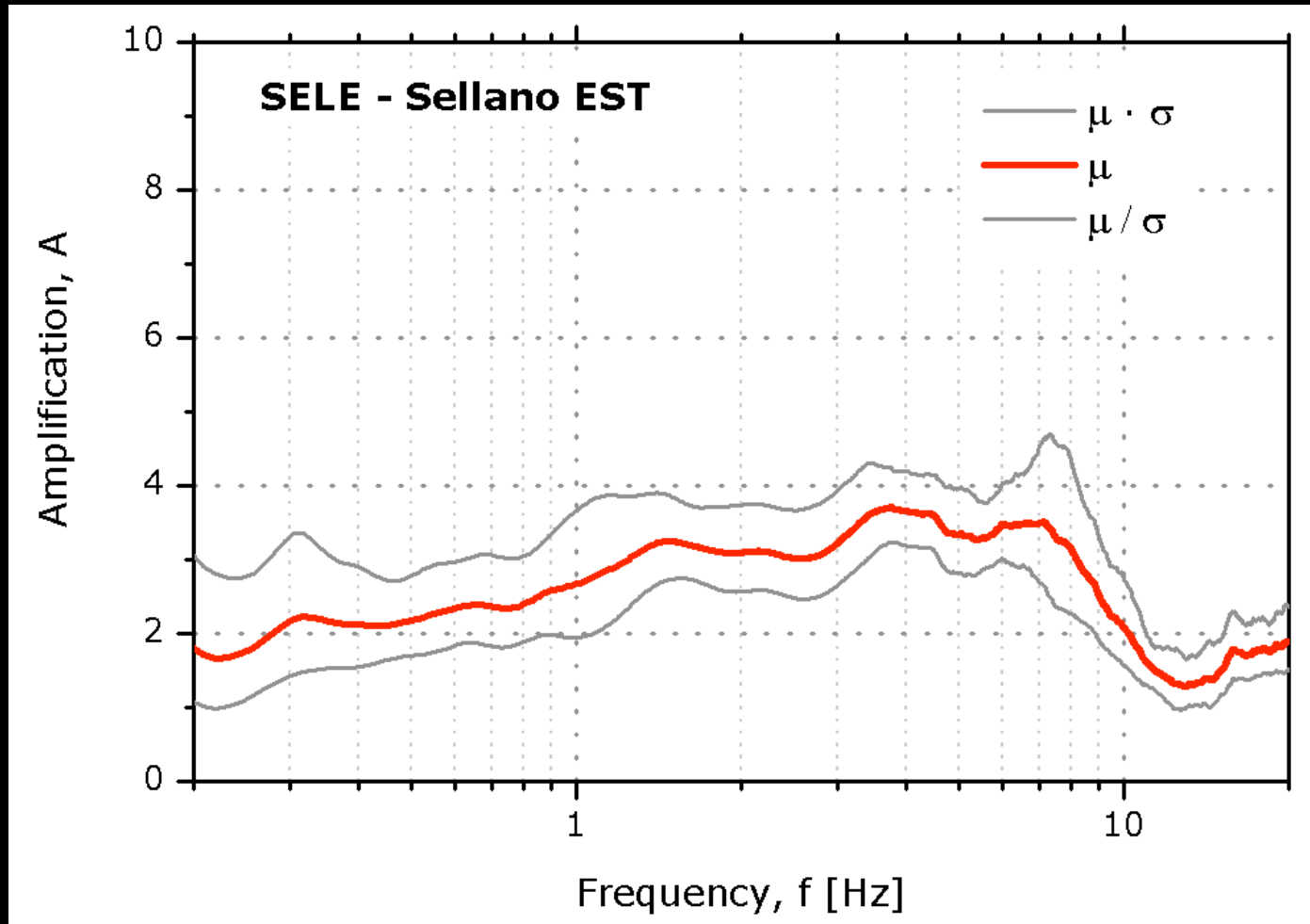




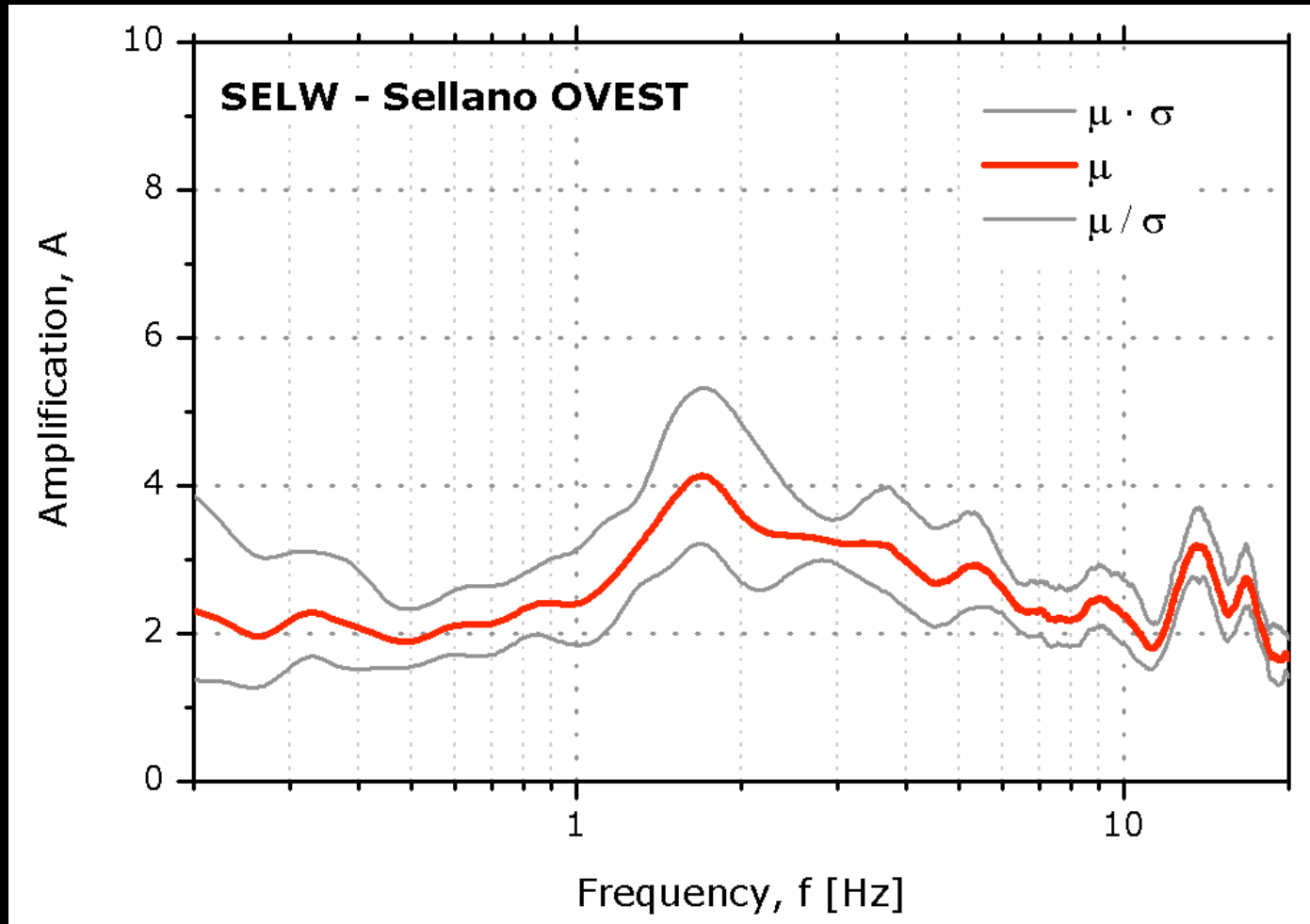


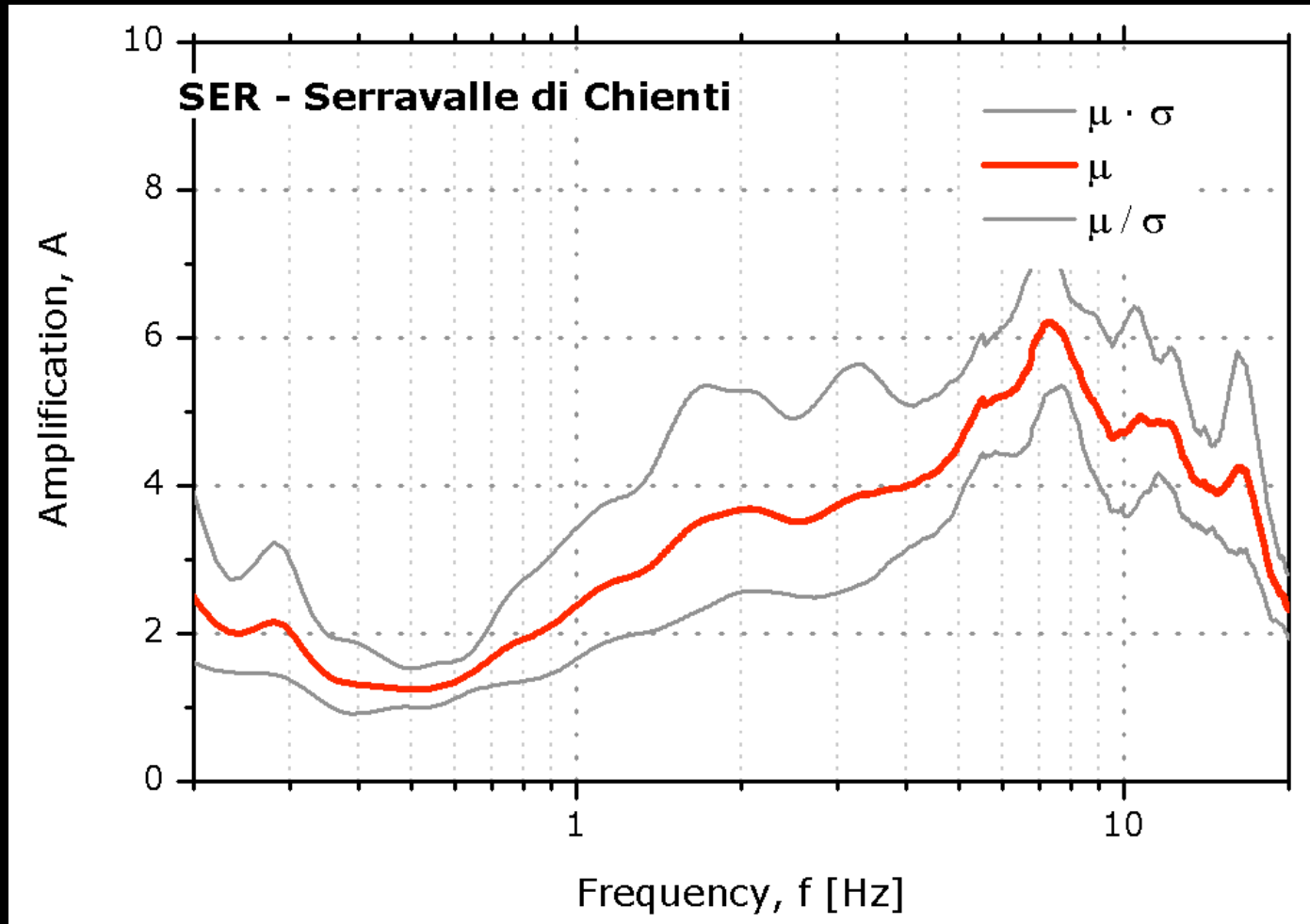


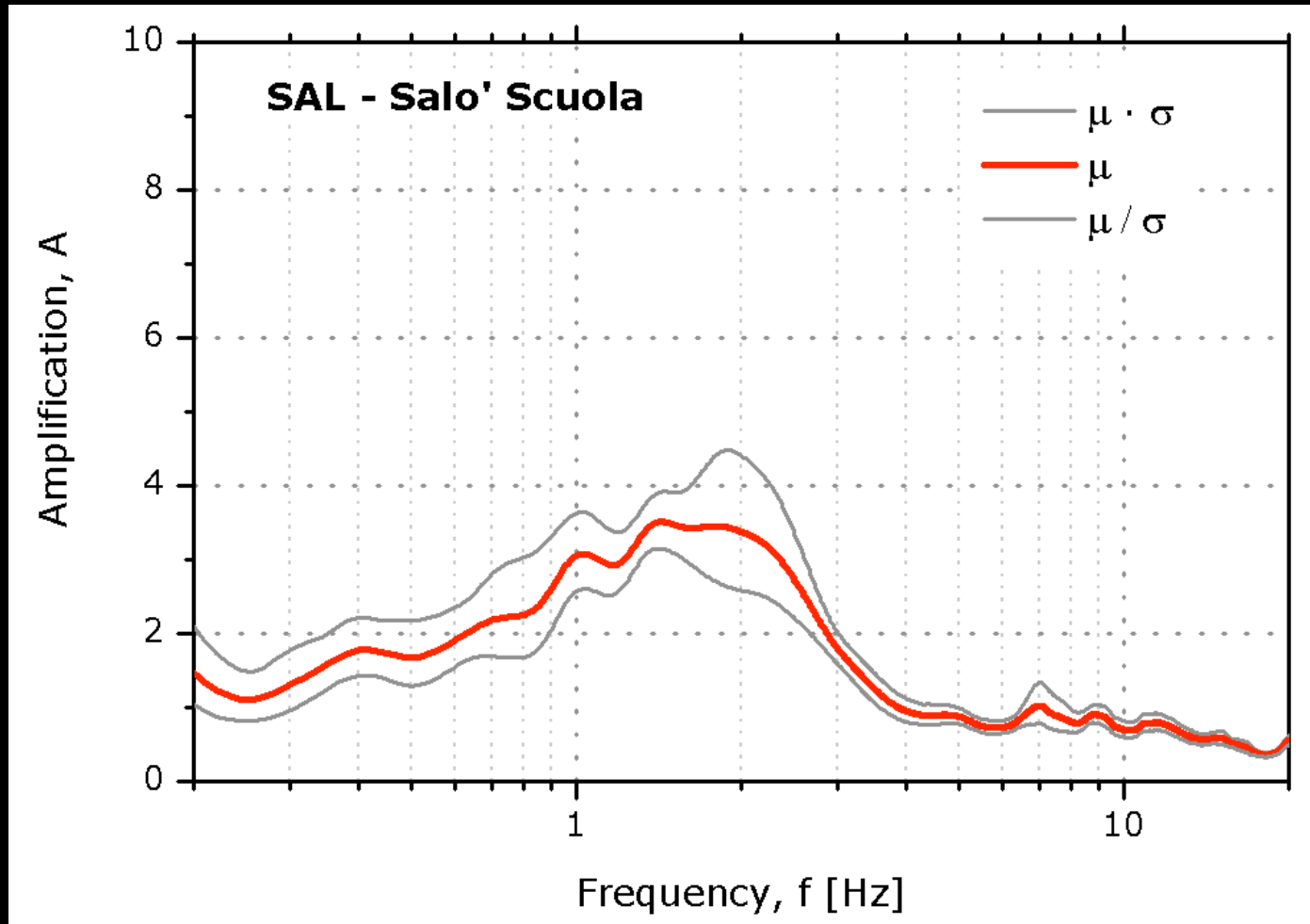


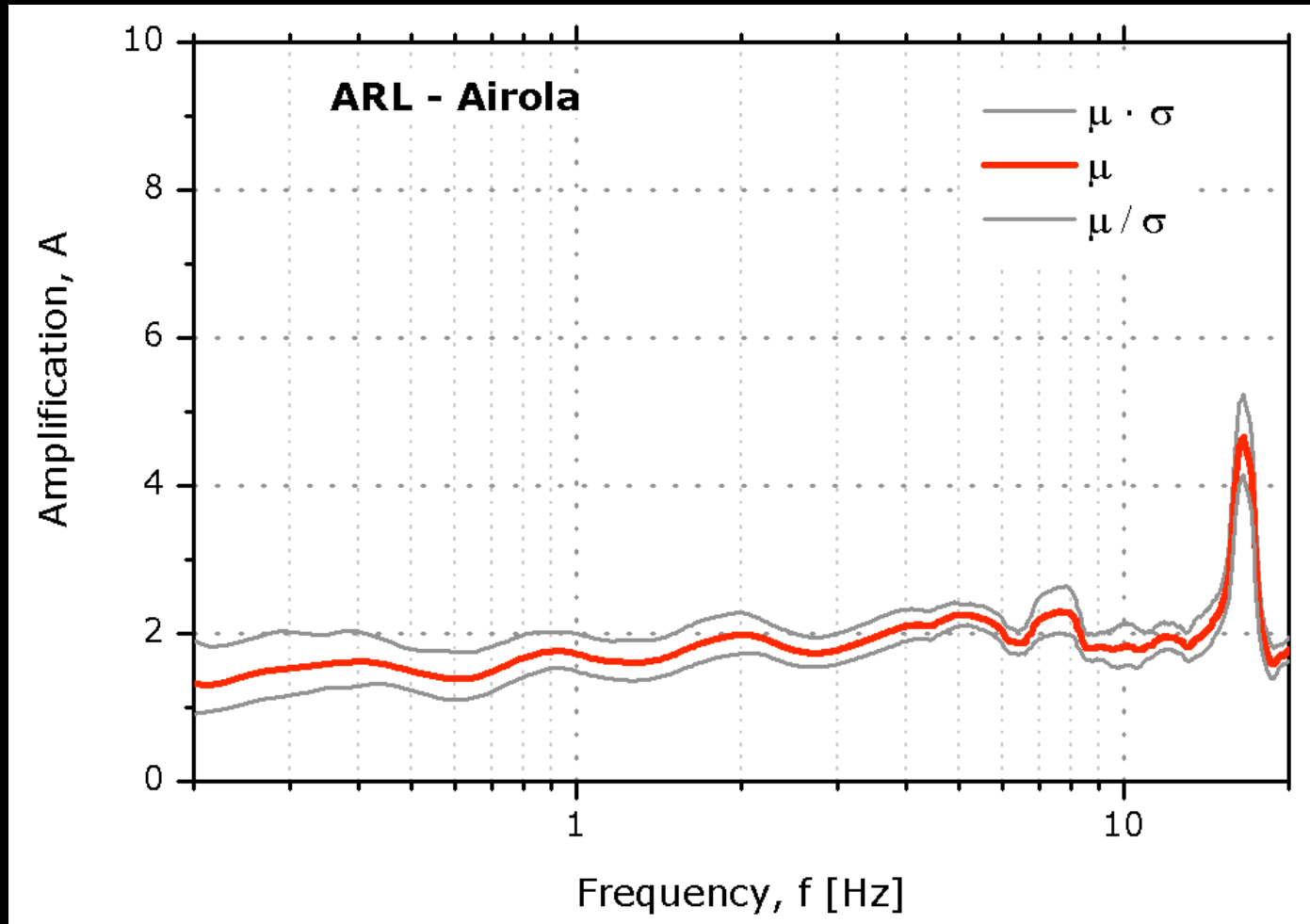


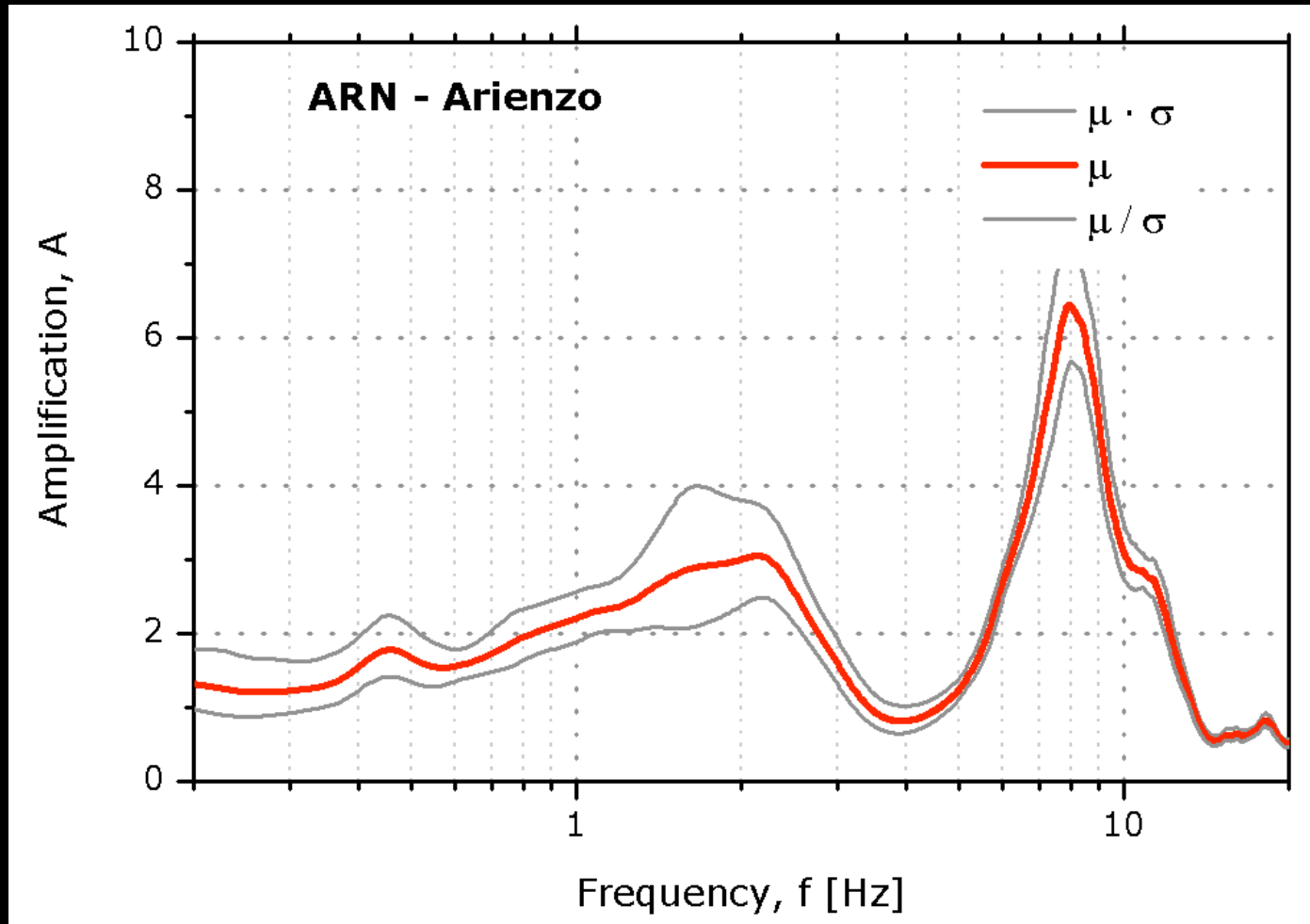


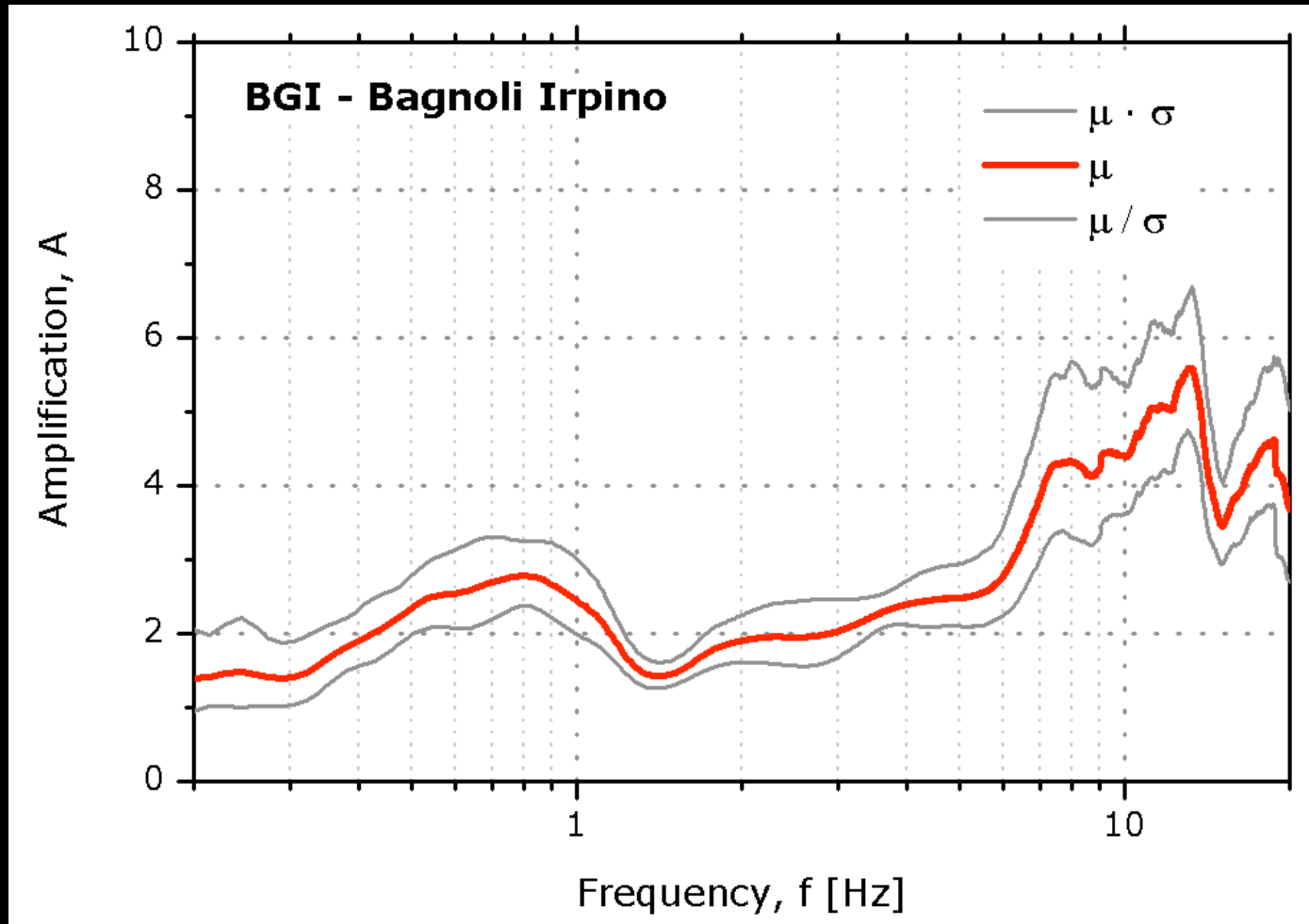


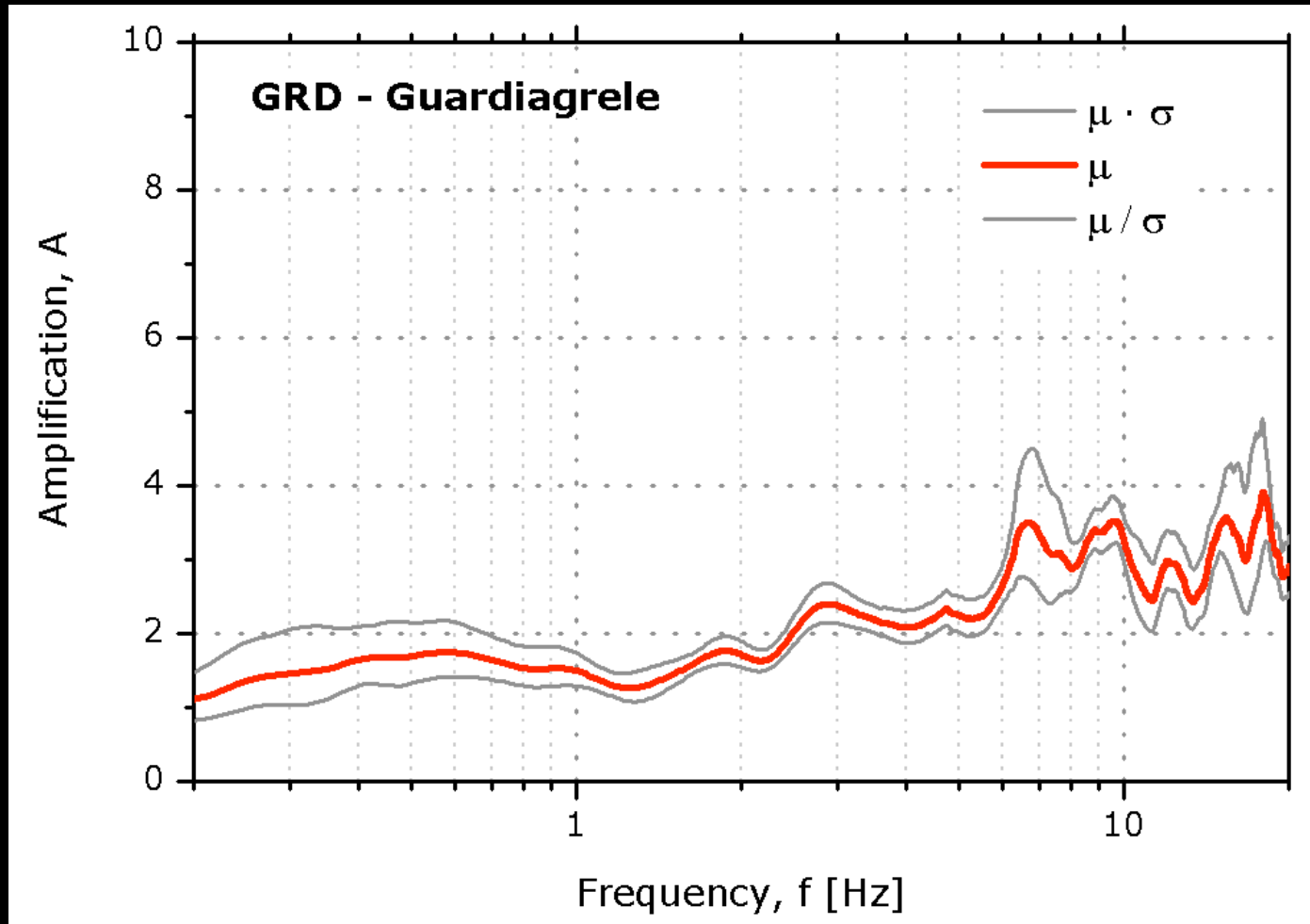


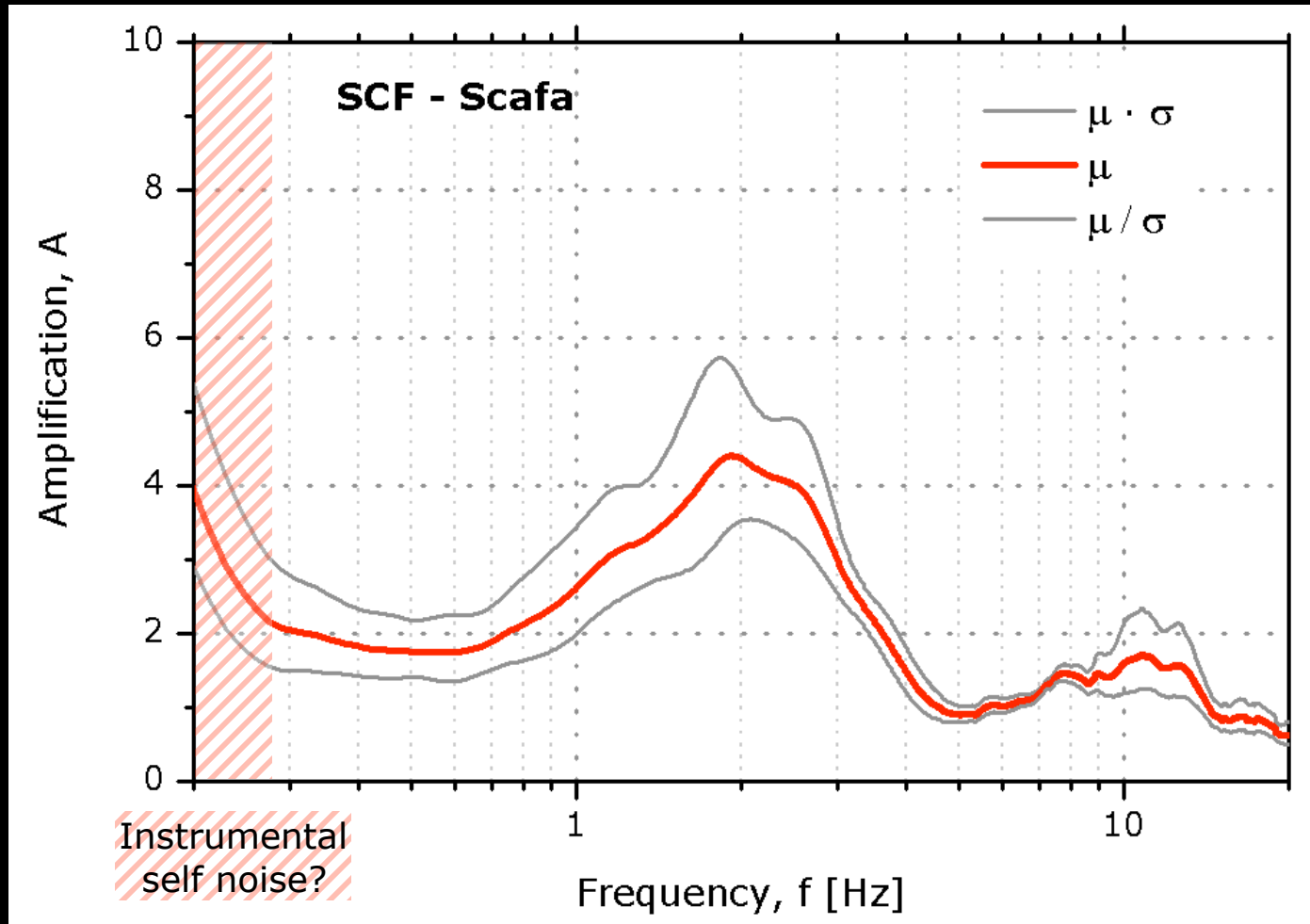














**30-31 Ottobre 2008**

**Riunione Plenaria Progetto S4**

***Stazioni accelerometriche  
Calcolo HV da terremoto***

**Puglia R., Pacor F., Luzi L., Bindi D.  
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## **Strong motion analysis**

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**For each station, the strong motion data included in ITACA will be analyzed to compute HVSR**

**A standard procedure will be implemented**



**HVquake**

**a MatLab routine to compute HVSR from strong motion data**

## PROCEDURA HVquake

Per ogni stazione si selezionano tutte le registrazioni disponibili;

- Se la stazione è **digitale**, si utilizza una finestra di noise per calcolare il rapporto segnale disturbo; gli HVSR si calcoleranno solo per le frequenze dove il rapporto segnale disturbo è  $> 3$  è maggiore di 3

Per ogni componente del moto NS, WE e UP si applica un processing standard

- Sottrazione valore medio;
- Selezione di una finestra di analisi di durata variabile calcolata con il criterio dell'energia;
- Per le **stazioni digitali**, la finestra inizia 1 sec prima dell'arrivo delle S e finisce al tempo in cui si raggiunge il 90% energia cumulata;
- Per le **stazioni analogiche**, se partono sull'arrivo S, la finestra inizia dal primo campione delle S e termina al tempo in cui si raggiunge il 90% energia cumulata;
- Se la finestra è troppo breve si aggiungono zeri fino a raggiungere durate  $T = 10s$  attraverso l'operazione di *padding*;
- Calcolo spettri di Fourier e smoothing attraverso operatore di Konno-Ohmachi con  $b=40$

## Output HVquake

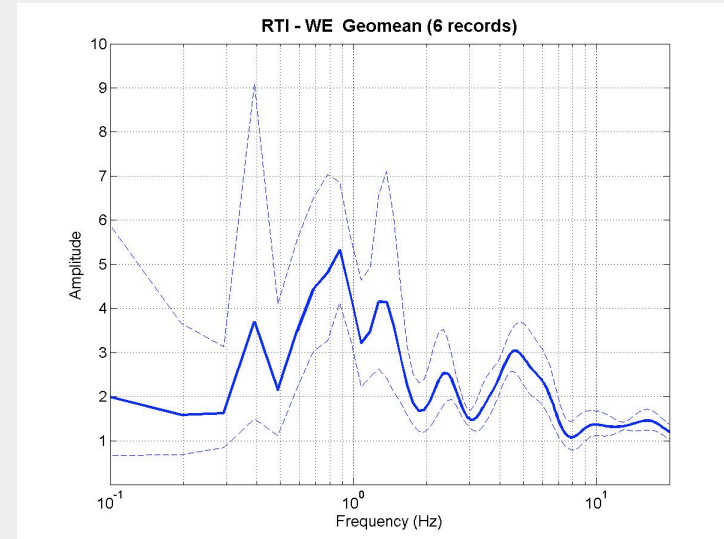
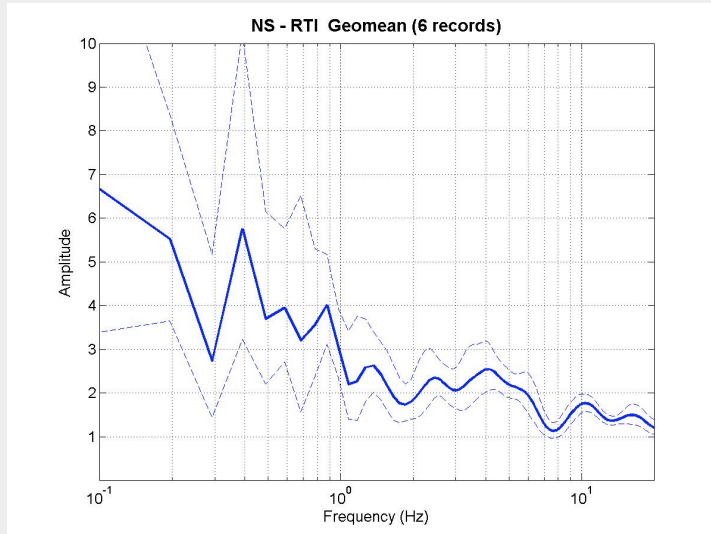
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Per ogni stazione,

- si calcola, mantenendo le componenti separate, la media geometrica ed aritmetica;
- le medie si rappresentano insieme alle deviazioni standard in scala log-lin per un totale di 4 grafici tra 0.1 e 20 Hz;
- la media e la deviazioni standard si calcolano solo se la stazione ha un numero sufficiente di registrazione (inizialmente pari a **10 sulle stazioni digitali, 5 sulle analogiche**).
- Negli altri casi si mostrano tutti gli HVSR sullo stesso grafico
- Creazione tabella con le seguenti informazioni: # di registrazioni utilizzate, tempo di arrivo delle onde S, magnitudo degli eventi, distanze epicentrali e azimuth.

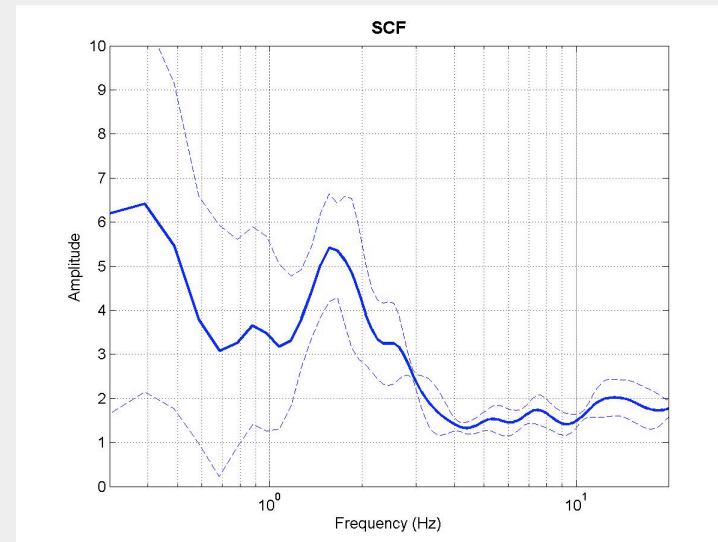
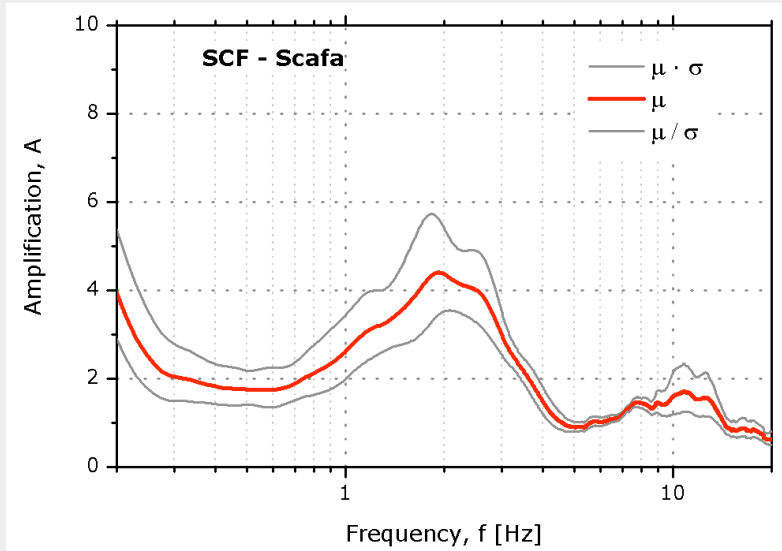
**Gli HVSR in forma grafica saranno inseriti nella scheda di stazione di ITACA**

- RTI – Geometrical mean -



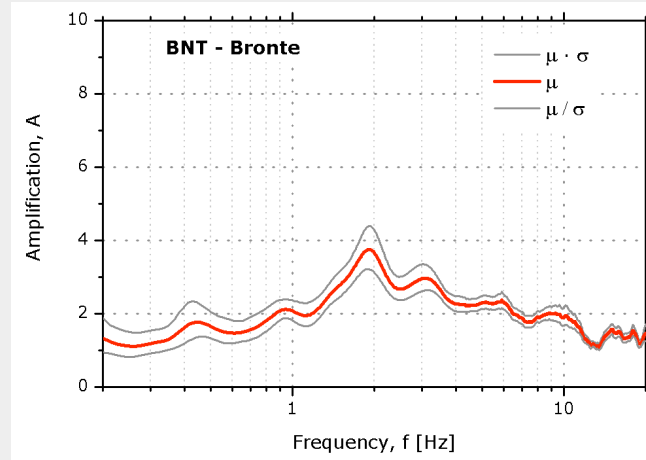
Eventi	M	Repi [km]	PGA [cm/s <sup>2</sup> ]	PGV [cm/s]
14/10/1997 15.23	5.5	52.4	33.9062	-4.0342
26/09/1997 0.33	5.6	66.1	25.4814	2.0111
26/09/1997 9.40	5.8	65	18.3831	1.785
06/10/1997 23.24	5.4	66.4	16.917	1.5188
12/10/1997 11.08	5.1	53.5	10.933	-1.4103
04/10/1997 16.13	4.5	54.5	4.5088	0.42306

- SCF – Horizontal Geometrical mean -

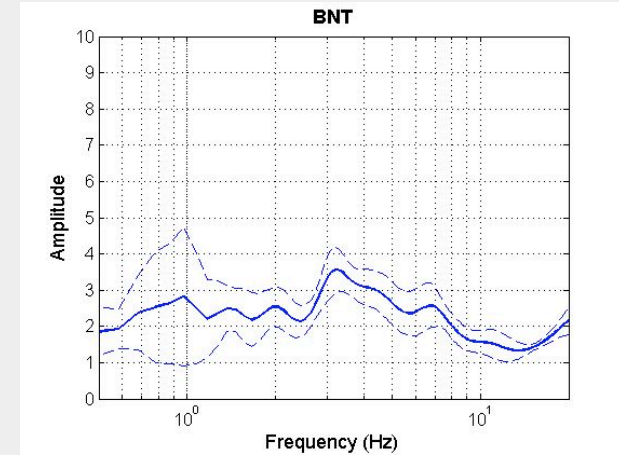


Eventi	M	Repi [km]	PGA [cm/s <sup>2</sup> ]	PGV [cm/s]
07/05/1984 17.49	5.9	SCF	63.8	132.14
25/06/1984 1.58	3.0	SCF	53.2	42.90
11/05/1984 10.41	5.7	SCF	54.6	39.26
09/06/1980 16.02	4.4	SCF	11.5	35.78

- Bronte – Digital Station

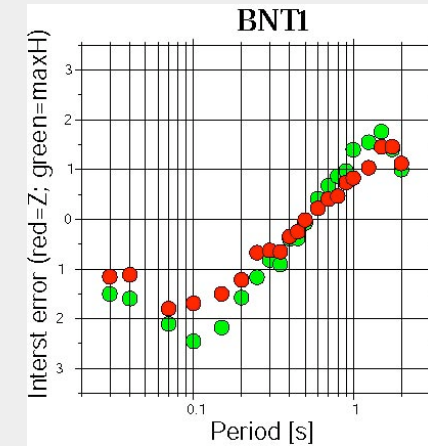
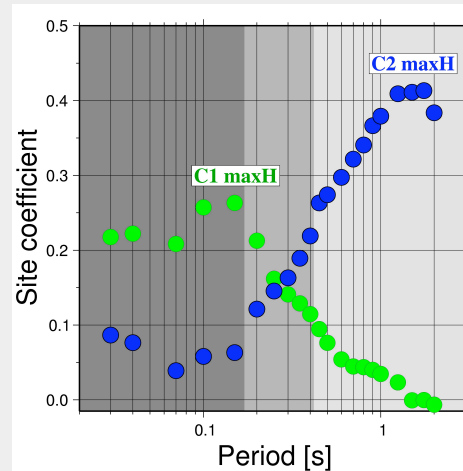


**Noise**



**Earthquake**

**Classificata Classe 1  
(Sabetta e Pugliese, 1996)**



**Da Task4**