File name	Report-SoilF
Date	October 2016
Author	Giancarlo Dal Moro www.winmasw.com e-mail: gdm@winmasw.com

A ESAC+HVSR case study

keywords: *Rayleigh waves, Love waves, surface wave dispersion, Vs30, HVSR (Horizontal-to-Vertical Spectral Ratio), joint inversion, MASW, seismic-hazard assessment, shear-wave velocities.*

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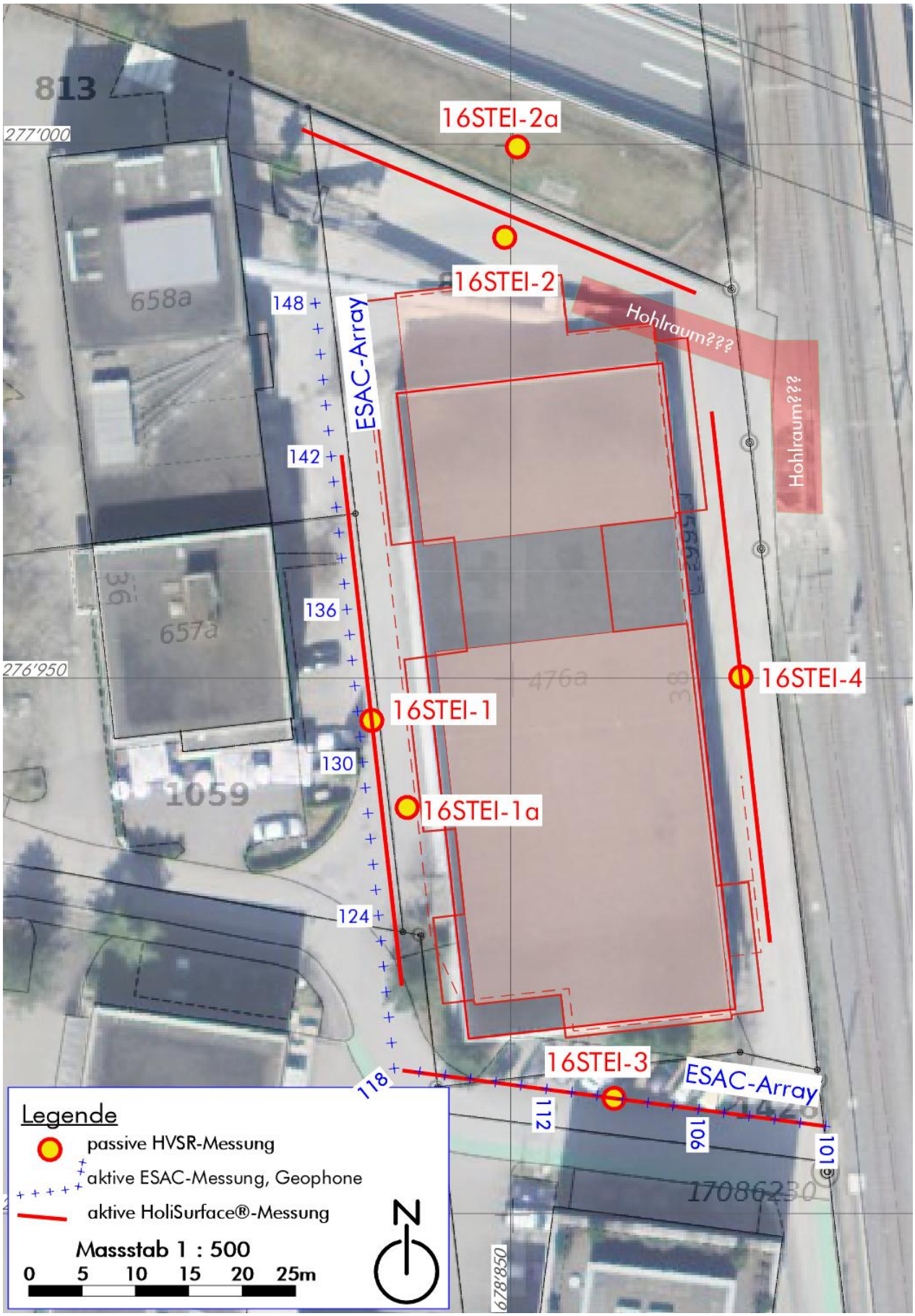
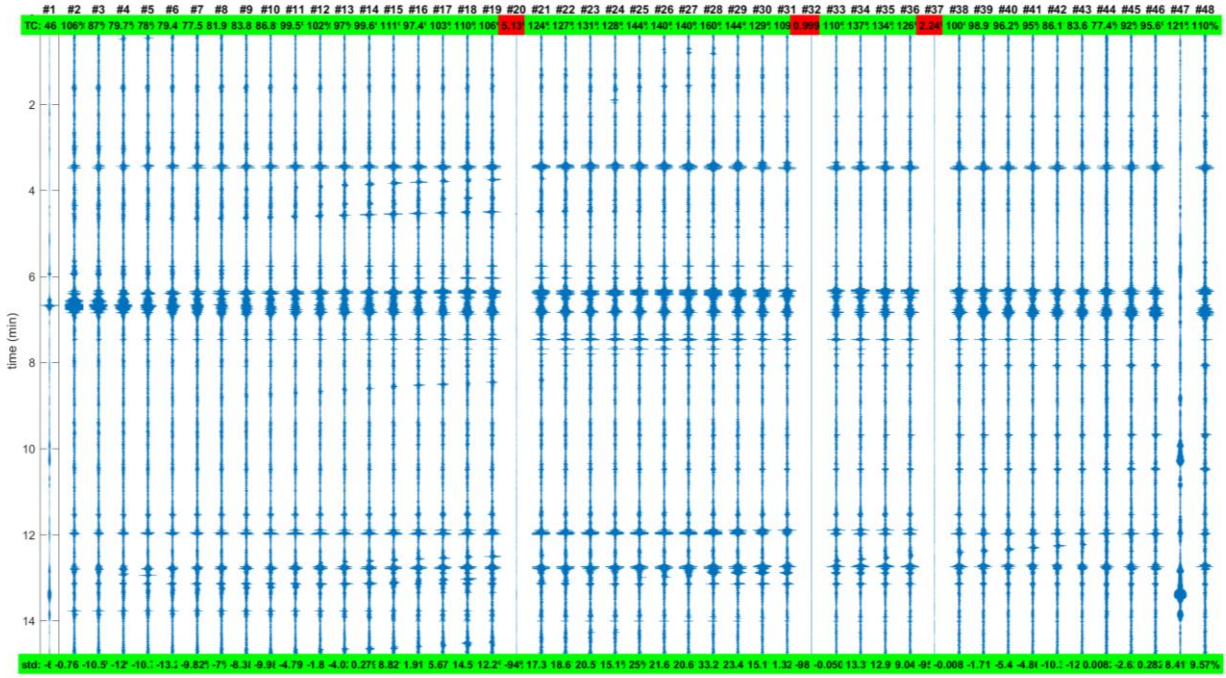
The Investigated Area

a busy and noisy urban area

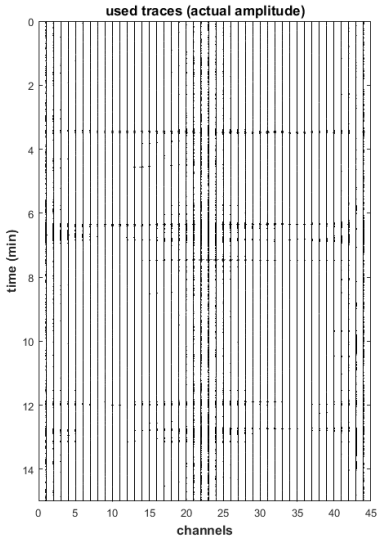

813
277'000
658a
657a
36i
1059
476a
276'950
16STEI-2a
16STEI-2
148
142
136
130
124
118
ESAC-Array
Hohlraum???
Hohlraum???
16STEI-4
16STEI-1
16STEI-1a
16STEI-3
ESAC-Array
112
106
101
1708623.0
678'850
Legende
passive HVSR-Messung
aktive ESAC-Messung, Geophone
aktive HoliSurface®-Messung
Massstab 1 : 500
0 5 10 15 20 25m
N

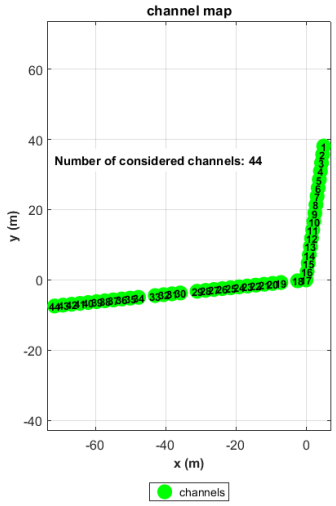
Step#1: Processing of the ESAC data to extract the effective dispersion curve of the vertical component of Rayleigh waves.

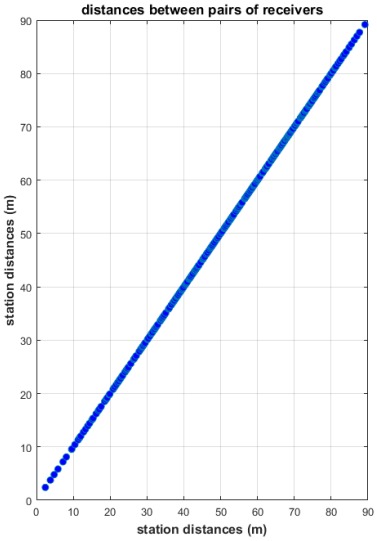
Preliminary quality check of the acquired data: three traces are automatically identified and removed as inconsistent with the dataset (we then also removed the first trace)



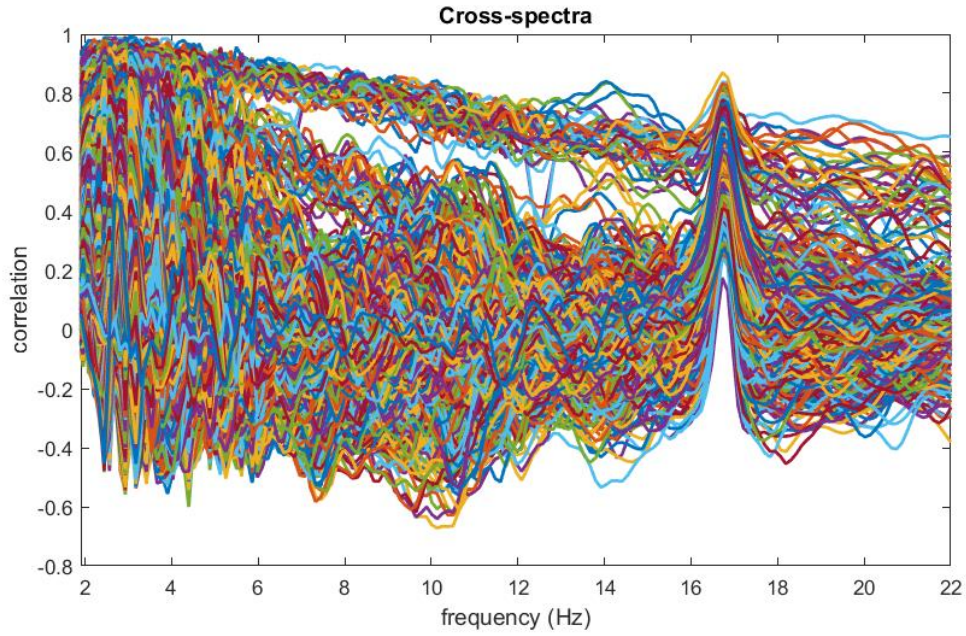
Selected traces, acquisition geometry and distances between pairs of geophones



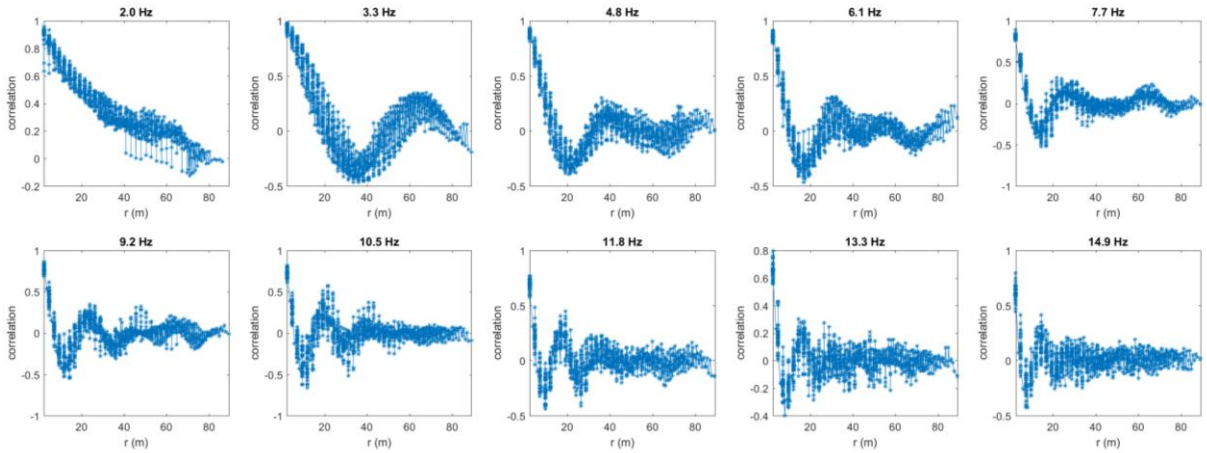




Cross-spectra of the data: it is possible to see the typical 16.7 Hz disturbance related to the railway (which anyway does not produce any significant problem in the successive processing).

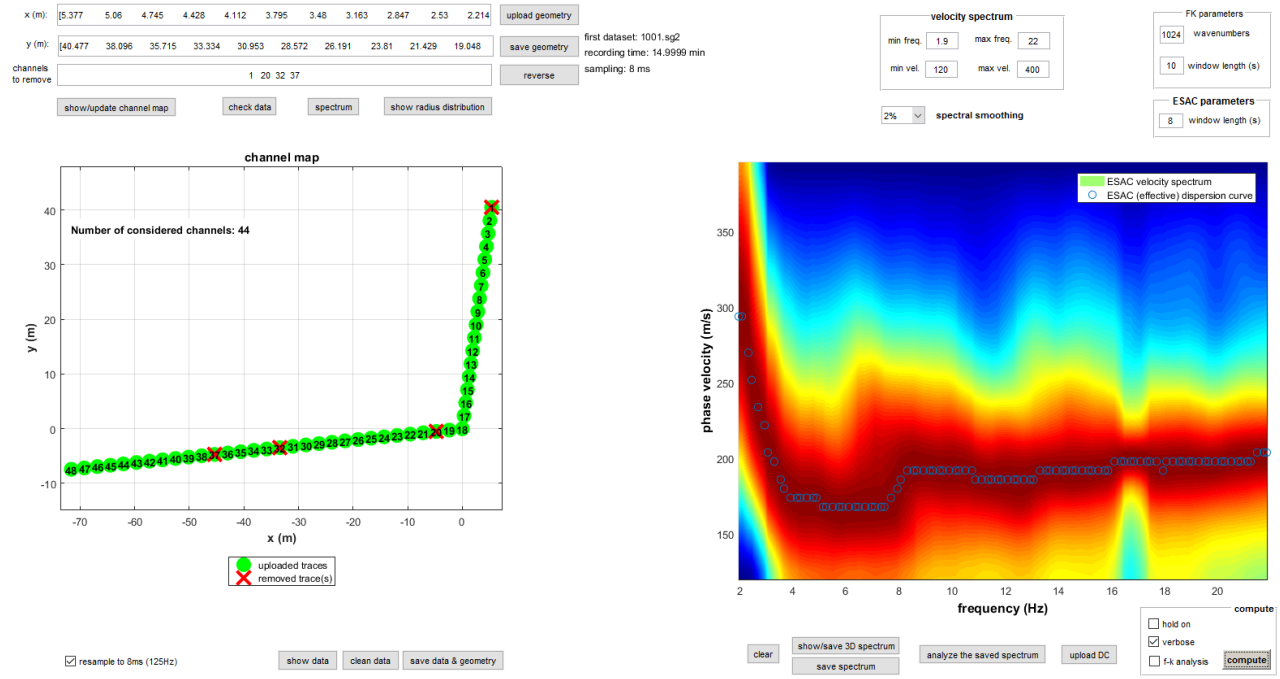


Correlation values as a function of the sensor distance (r) for a series of considered frequencies (see e.g. Ohori et al., 2002).

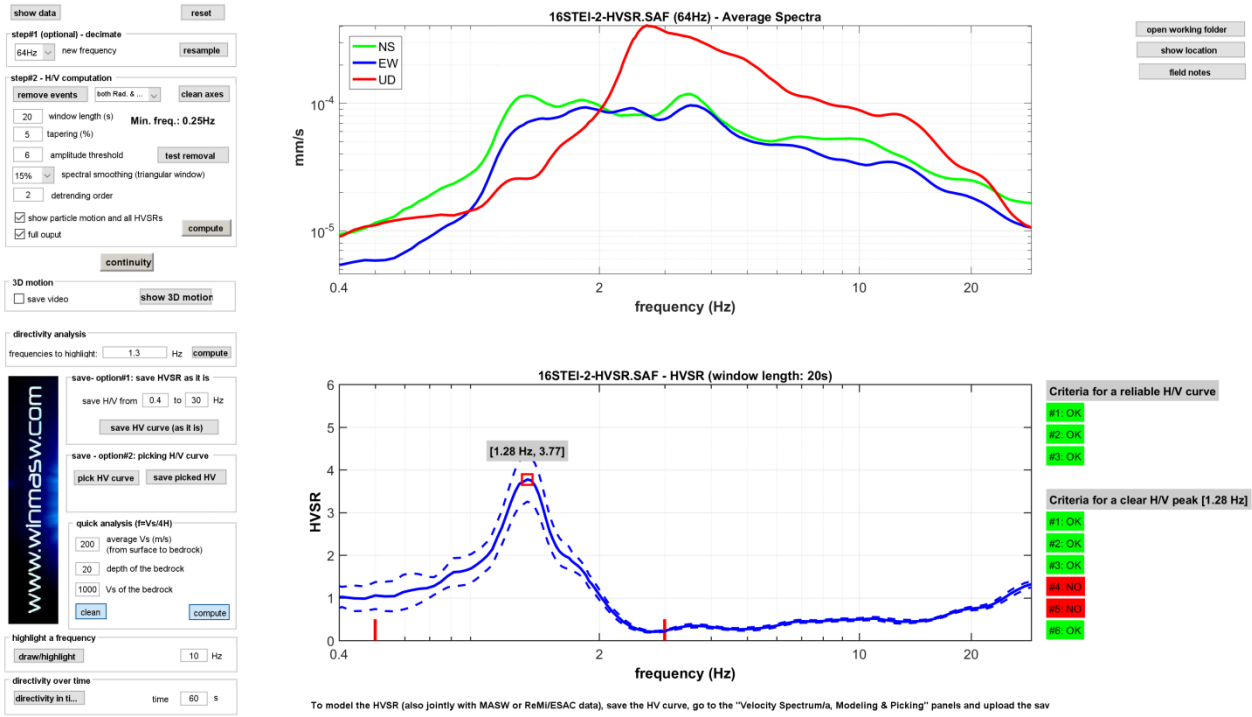


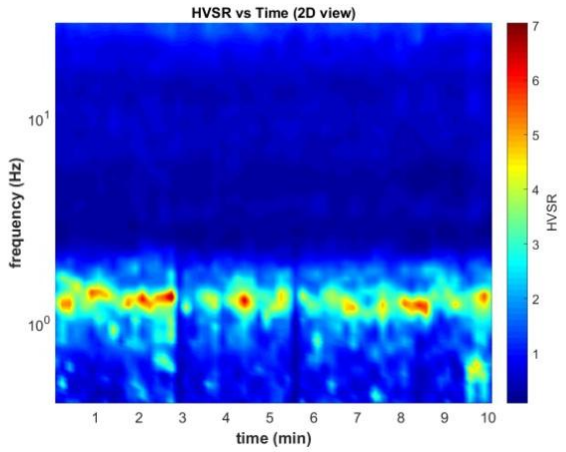
Snapshot of the final outcome of the ESAC analysis: on the left the acquisition geometry and, on the right, the dispersion of the vertical component of Rayleigh waves (effective dispersion curve).

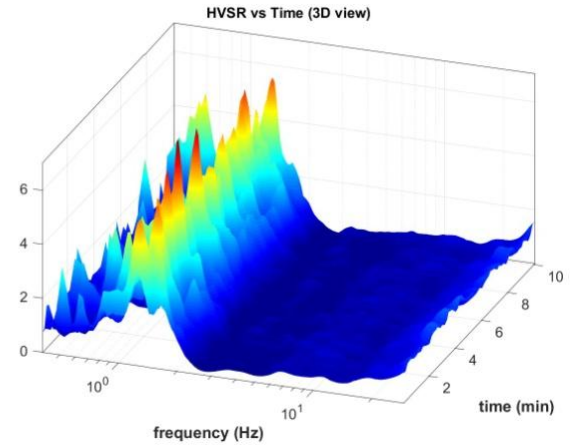
Since we adopted 4.5Hz geophones, at the lowest frequencies (between 2 and 3Hz) the phase velocities may be a bit underestimated (since the data will be analyzed jointly with the HVSR, this does not represent a serious problem).



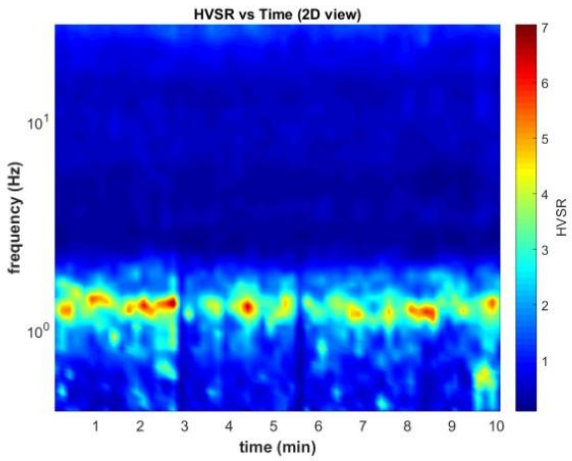
Step#2: Determination of the HVSR [HVSR#2]

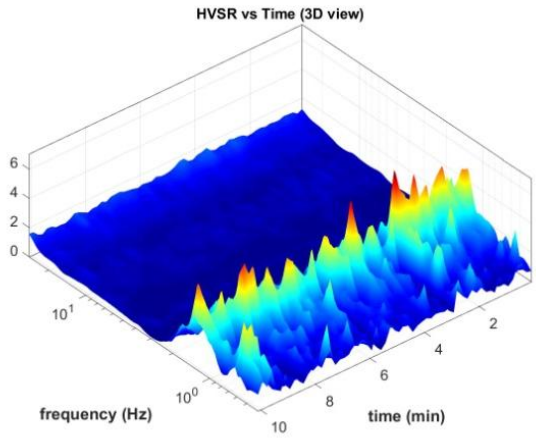


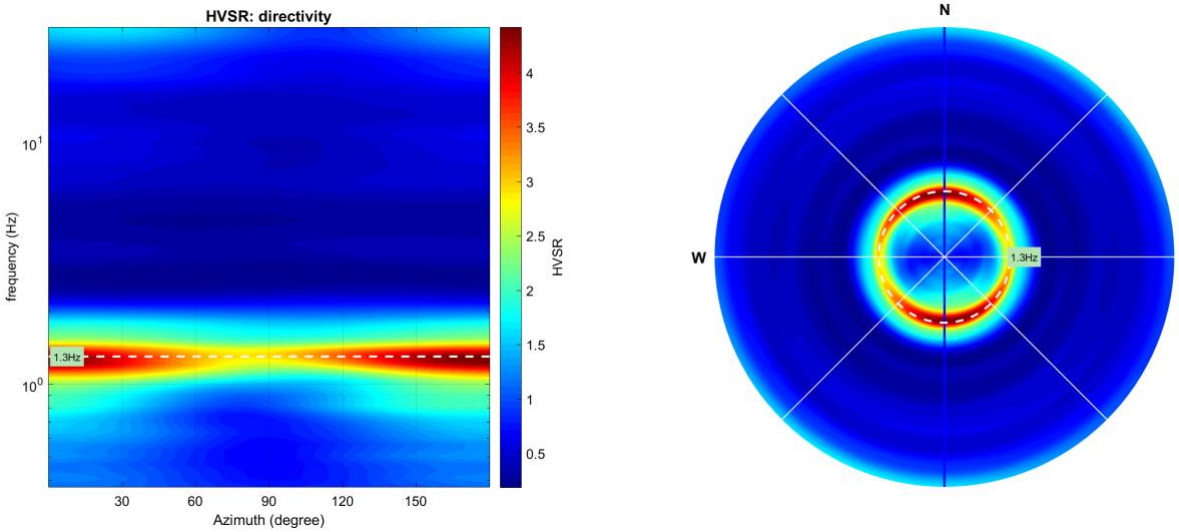




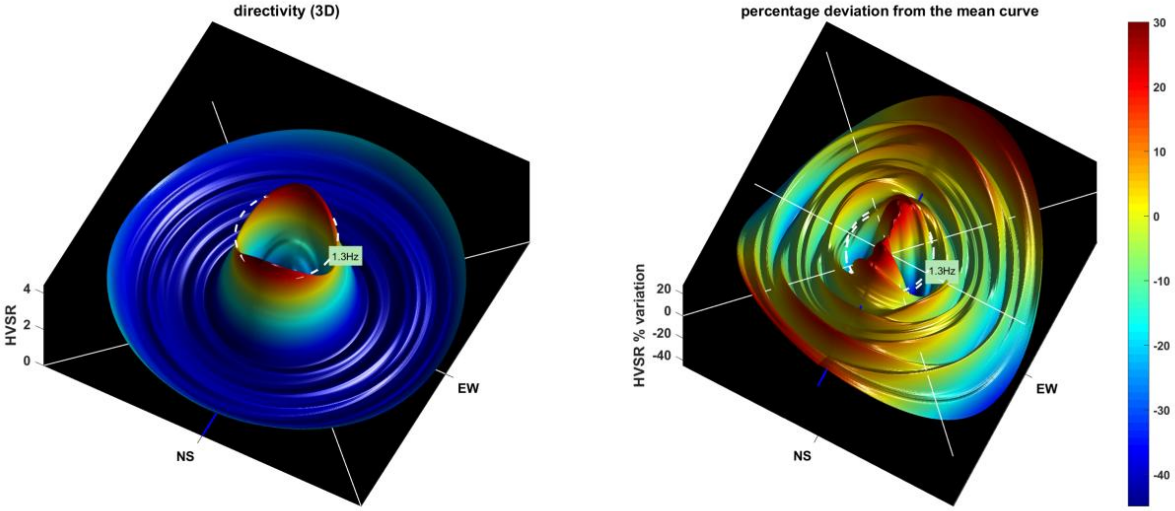
continuity of the HVSR over time

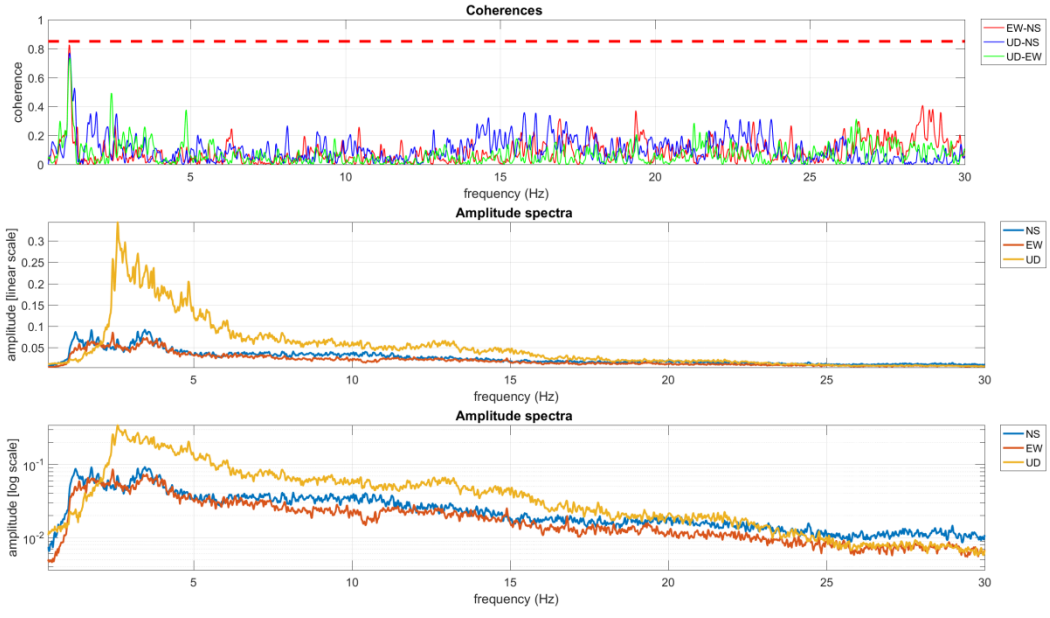




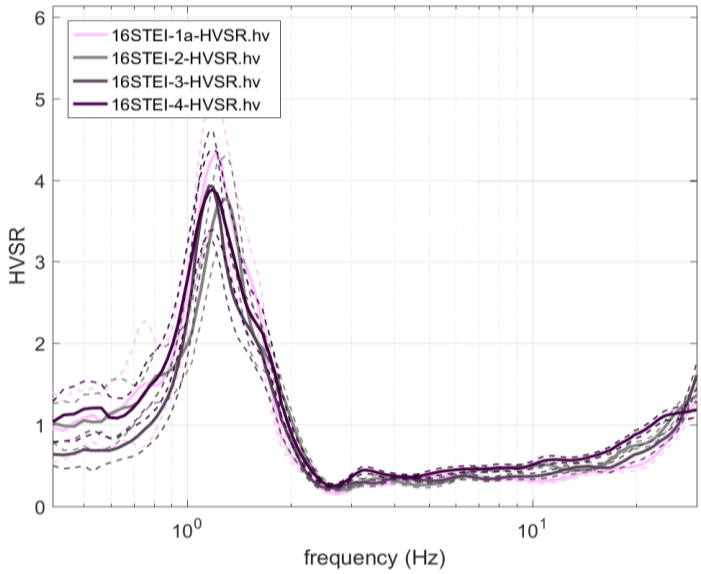


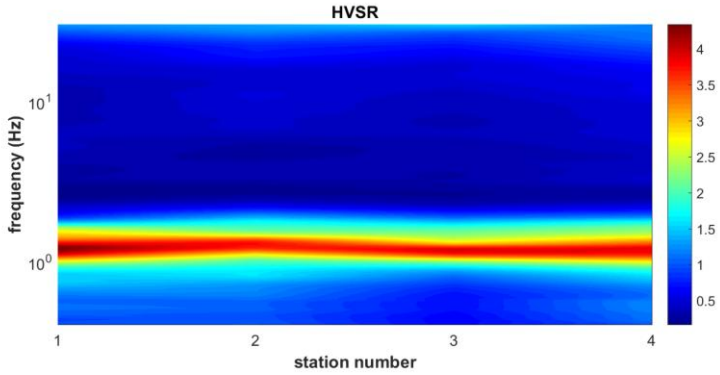
directivity of the HVSR (HVSR versus azimuth) [the HVSR peak appear larger along the NS direction]

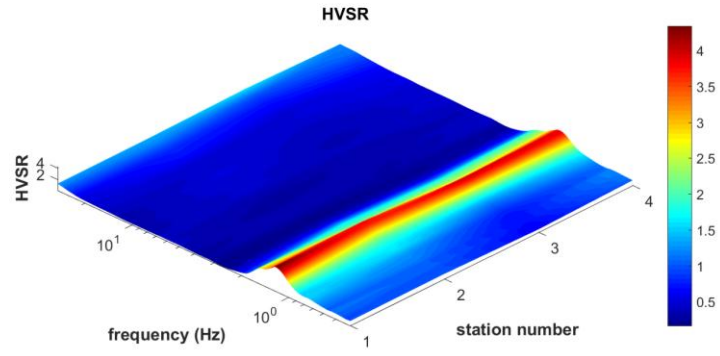


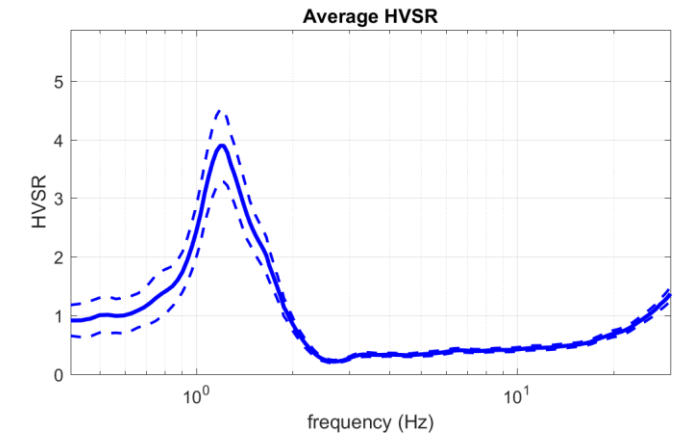


Comparison of the four HVSRs acquired in various points to quickly verify the lack of significant lateral variations.





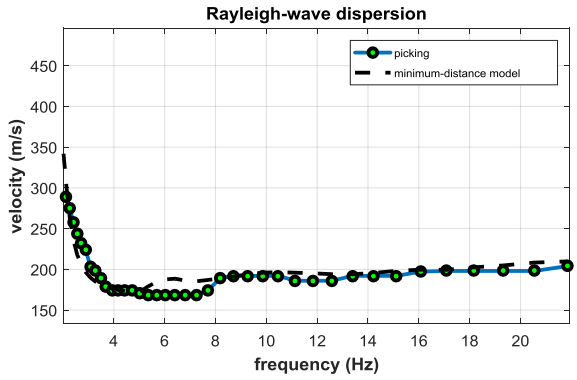


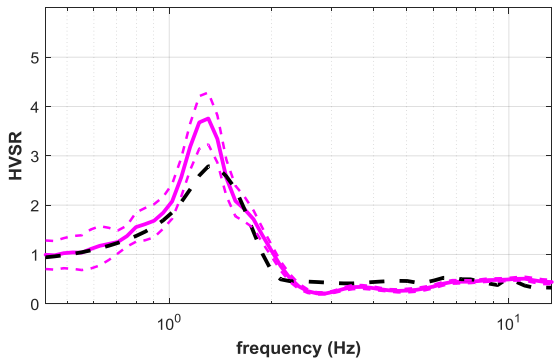


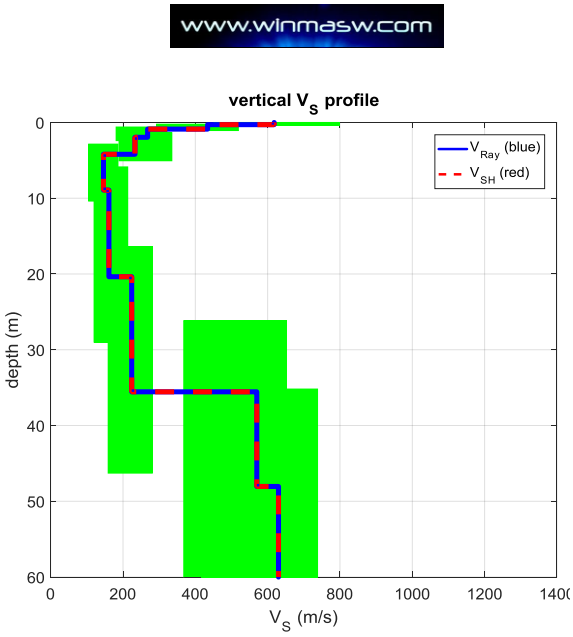
Step#3: Joint Analysis of the HVSR and the *effective* dispersion curve determined from the ESAC analysis.

Summary of the joint inversion (reported the data pertaining to the "minimum distance model" - see Dal Moro, 2010; Dal Moro et al., 2016).

It must be underlined that we do not deal with *modal* dispersion curves but refer to the *effective* one (Tokimatsu et al., 1992). Furthermore, HVSR is modelled considering both the effect of attenuation and the contribution of Love waves (so not simply as the ellipticity of Rayleigh waves - see Arai and Tokimatsu, 2004).

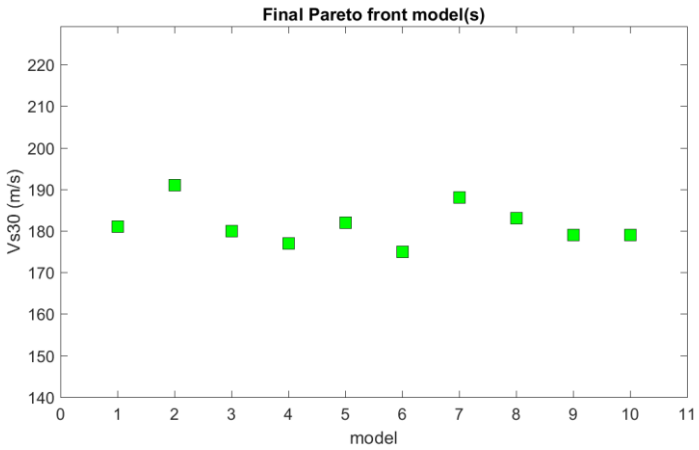






Rayleigh wave dispersion file: ESACdcORIGINAL.cdp
H/V curve: 16STEI-2-HVSR.hv
Vs30 (minimum-distance model): 183 m/s
Vs30 (mean model): 185 m/s

Vs30 values of the Pareto front models (Dal Moro; 2010; Dal Moro et al., 2015).



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website: **www.winmasw.com**

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