winMASW® fact sheet

winMASW® is a series of software applications for the **joint analysis of seismic data** designed in order to achieve highly-reliable V_S (shear-wave velocity) vertical profiles.
The key feature of ***winMASW***® is represented by the joint analysis of different data according to various (active and passive) techniques, offering a complete arsenal of tools capable of handling any kind of analysis and problem. **This way we can overcome the problems related to non-uniqueness of the solution and all the possible ambiguities in the data interpretation.**

Before buying your field equipment, please consider that:

1. we pioneered the concept and application of ***joint analysis*** (see our publication list @ our web site).
2. we do not provide only the software for the data analysis but an **optimized field equipment** as well (seismograph, seismic cables, geophones and so on).

winMASW® is currently available in six different versions

Lite	The entry-level version that allows the analysis of Rayleigh waves via *modal* dispersion curves (the standard "MASW" approach). This classical approach has a series of critical points that are widely illustrated in our *Elsevier* book (see next pages).
winHVSR	HVSR analysis: computation and modeling of the HVSR (*Horizontal-to-Vertical Spectral Ratio*) to estimate the Vs profile [solution is highly non-unique].
Standard	Classical MASW and ReMi techniques (Rayleigh waves) through the analysis of the *modal* dispersion curves. Please, consider that ReMi is a problematic technique (as highlighted in the *winMASW*® manual and in the Elsevier book) because the linear array generates ambiguity in the interpretation of the phase-velocity spectrum. *In order to get information about the deep layers we recommend the joint analysis of Rayleigh and Love waves together with the HVSR [winMASW-3C, Pro & Academy].*
3C	Joint analysis of Rayleigh and Love waves (via *modal* dispersion curves) also together with the HVSR curve. 1D modelling of P-wave refraction travel times. **This version represents the minimum approach we recommend** and it is a good compromise between the basic (but problematic) standard MASW approach (based just on Rayleigh waves - see *Lite* and *Standard* versions) and the very advanced procedures available in *winMASW*® *Academy*. **To work with it, we suggest and provide** twelve (12) 4.5 Hz horizontal geophones and one 3-component geophone (if chosen carefully, it allows you to do much more than HVSR – see our ***HoliSurface*** pages).
Professional	MASW analyses considering both Rayleigh and Love waves (joint analysis); ReMi (passive seismics), computation and modeling of the H/V spectral ratio (Nakamura's method), 1D modelling of refraction travel times for both P and S waves (also considering low-velocity layers), ESAC with linear *arrays*, analysis of Rayleigh-wave attenuation to estimate Q_S quality factors.
Academy	In addition to the tools implemented in the Professional version: multi-component dispersion analysis also according to the *Full Velocity Spectrum* (FVS) [synthetic seismograms] approach, ESAC (bidimensional arrays), highly sophisticated HVSR modeling, group velocities analysis, RPM (*Rayleigh Wave Particle Motion*) analysis, not equally-spaced MASW analyses, Site Response (Response Spectra) tool, several utilities for editing active and passive data, creating 2D sections, etc. It is the ***most complete version which implements an arsenal of tools and highly-innovative solutions to jointly analyze surface wave propagation according to all the multi-channel active and passive methods***. In other words, **everything you might need for an endless series of applications.**

For further details click here:

- ***winMASW®*** manual [please, download it and have a look]
- ***winMASW®*** page for further info and case studies
- **video tutorials**
- **Facebook page** for suggestions, small case studies and news

Software activation and system requirements

winMASW® works by means of an hardware key (USB dongle) and can be installed on an unlimited number of computers (to use the software it is clearly necessary to insert the winMASW USB dongle).

winMASW® runs under 64-bit *windows operating system* but, through appropriate emulators, even on Mac.

RAM: we recommend 8M (but can be used even with 4M computers).

CPU: for performing simple (classical) modal dispersion analysis, a simple dual core is enough. On the other side, to fully exploit all the features of the *Academy* version [advanced techniques] we recommend a fast multi-core CPU such as, for instance, the recent i9-9900K (8 physical cores).

Why *winMASW®*?

- ***winMASW®*** **allows you to do much more than the so-called MASW**. The **joint analysis is the only approach that allows identifying reliable solutions** and overcome the otherwise inevitable ambiguities (please, consider that we pioneered the joint inversion).
- ***winMASW®*** is a flexible software. If you choose a basic version (e.g. *Lite* or *Standard*), you can upgrade to a higher and more complete version at any time.
- by choosing ***winMASW®*** you can benefit from a relevant scientific technical support (see our **publications**) based on our long-term research activity in the field of surface wave analysis.

Educational License

The *Educational License* is reserved to Universities and scientific institutions for educational purposes only and consists in getting two USB dongles instead of just one (standard commercial license). Since we strongly believe that the use of the software for educational purposes requires the most advanced techniques for the analysis of surface waves, the *Educational License* is provided only for *winMASW®* *Academy* and *HoliSurface®*.

If a University or Research Institution intends to apply for an *Educational License*, a formal declaration (signed by the head of the Department/Faculty/Institution) regarding the merely-educational use of the software is required.

Demo version

The *winMASW®* and *HoliSurface®* software applications (in particular the *Academy* version) is a highly-sophisticate tool that, in order to be fully and properly used, requires the *training* that we are glad to provide to all our clients.

If you try to use *winMASW®* while keeping in mind simplistic and erroneous assumptions (for instance about the way modes appear and disappear in a velocity spectrum - unfortunately real-world data can be extremely counter-intuitive), you risk not to catch the real point(s) that *winMASW®* (with all its tools) attempts to address through the joint analysis of several "objects".

For these reasons no *Demo* version is currently provided but, in case of concrete interest, we are willing to analyze one of your dataset (please, strictly follow the recommendations provided in our **guidelines** and the nomenclature explained in the *Elsevier* book - paragraph 2.2).

In case you contact us just for the software [please, notice that we can provide you with the entire *acquisition system* and that hardware and software must be mutually consistent], do not forget to give us information about your equipment. In particular:
Do you have 4.5 Hz horizontal geophones?
Do you have a 3-component geophone for the HVSR (and many other applications)?

- ***Eliosoft* also provides an *acquisition system* [24-bit seismograph, seismic cables and all types of geophones]**:
  - **Horizontal and vertical geophones**

    Remember that for active (MASW) acquisitions, **twelve (12) horizontal geophones are enough and recommended. These way you can record both Rayleigh (radial component) and Love waves and can also use them for SH refraction/reflection surveys.**

    Vertical geophones allows to acquire only the vertical component of Rayleigh waves (according to both active and passive techniques, but they are often ambiguous and lead to overestimate the V_S - see the *Elsevier* book) and the P-wave refraction (which is influenced by the presence of water in the ground and, consequently, often more problematic than SH refraction).

    Vertical geophones are necessary for ReMi and ESAC acquisitions and the multi-offset RPM analysis.

    Please, consider that 10 Hz (or more) geophones are useless and not necessary for refraction studies [see our **FAQ page**].
  - **3-component geophones**

    useful for the HVSR and, if properly designed, for several other applications (vibration analyses on buildings - see for instance the GHM method which can discriminate torsional and flexural *eigenmodes* by using a single 3-component sensor), the *HoliSurface* method, UNI/DIN regulations, *Standard Spectral Ratio* (*SSR*) and *Spectral Difference* (see our pages about ***HoliSurface***®)
  - **HS *acquisition and analysis system*** [seismograph, cables and geophones] optimized for the *HoliSurface*® software application but excellent also for all the classical multi-offset methodologies (ESAC, multi-component MASW, HVSR, refraction/reflection etc.).

- **Order confirmation and shipping**

  To proceed with the purchase, please send an email to **winmasw@winmasw.com** specifying the version of ***winMASW***® you are interested in, the company data for the invoice and the shipping address. **Delivery time:** shipping via courier 3/4 days after receiving order and payment.

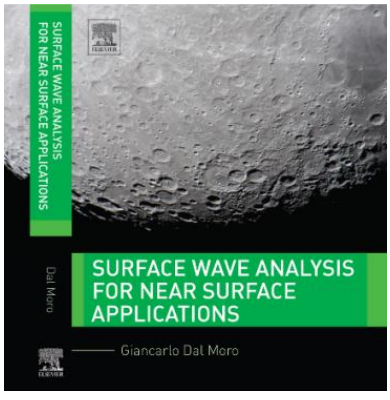
To start working efficiently we recommend and provide the following solution:

- ✓ *winMASW*® 3C: joint MASW (Rayleigh e Love waves) + HVSR
- ✓ twelve (12) 4.5 Hz horizontal geophones for the acquisition and analysis of Rayleigh (radial component) and Love waves (and SH-wave refraction/reflection).
- ✓ one 3-component geophone for HVSR and much more (see our pages about *HoliSurface*®)

Please, consider that (because of the non-uniqueness of the solution and the inevitable data ambiguity) the only way to correctly (i.e., unambiguously) determine the V_s profile is the following: joint analysis of Rayleigh and Love waves together with the HVSR.

If you are using only one of these observables, your solution is necessarily inaccurate or even fully erroneous (please, have a look to the first chapter [*Introduction*] of the *winMASW*® manual and/or to the *Elsevier* book).

***Surface Wave Analysis for Near Surface Applications* (Dal Moro G., 2014), Elsevier**



	HVSR	Lite	Standard	Professional	3C	Academy
MASW **analyses considering both Rayleigh and Love waves (and their joint inversion)**		Rayleigh waves	Rayleigh waves	✓	✓	✓
Analysis of Rayleigh-wave attenuation to determine Q_S quality factors				✓		✓
ReMi (passive seismics)			✓	✓		✓
ESAC (passive data with 2D arrays)				Only linear *arrays*		✓
Group-velocity Analyses (*Multiple Filter Analysis*) for group-velocity determination (both for Rayleigh & Love)						✓
Joint analysis of phase & group velocities						✓
Computation and modelling of the H/V spectral ratio (Nakamura's method) to estimate the resonance frequency	✓			✓	✓	✓
Band- Low- and High-pass filters		✓	✓	✓	✓	✓
Vs30 and Equivalent Vs computation	✓	✓	✓	✓	✓	✓
Spectral analyses: computation of amplitude and phase spectra and spectrograms (frequency content over time)		✓	✓	✓		✓
1D modelling of *refractions* (also considering low-velocity layers)				✓	just for P waves	✓
1D modelling of *reflections* (also considering low-velocity layers)						✓
Tool to combine two shots and obtain a dataset with a double number of channels		✓	✓	✓		✓
Elastic moduli calculation tool			✓	✓	✓	✓
Synthetic seismograms (*modal summation*) both for Rayleigh & Love waves						✓
Computation of the *apparent* (or *effective*) dispersion curves (recommended for passive datasets e.g. from ESAC analyses)						✓
Velocity-spectra inversion via synthetic seismogram computation: no need for dispersion-curve picking but longer computational times (you need a serious PC)						✓
Tool for the *vertical stacking*						✓
Tool for creating 2D sections						✓
Tool for putting in evidence specific (even "hidden") modes						✓
Tool for combining several traces acquired by a single 3-component geophone (using different offsets) and obtaining datasets useful for MASW analysis				✓	✓	✓
Tool TCEMCD (*Three-Component Extraction from Multi-Channel Data*) for efficient passive joint ESAC + HVSR acquisitions: connect your vertical geophones and our HOLI3C (3-component geophone) to your seismic cable and with this tool you will be able to extract the data for the joint analysis of dispersion (via ESAC) and HVSR						✓
Site Response (Response Spectra) panel						✓
Pure Synthetics						✓
Back-scattering analysis						✓
MASW with non-equally spaced data						✓

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