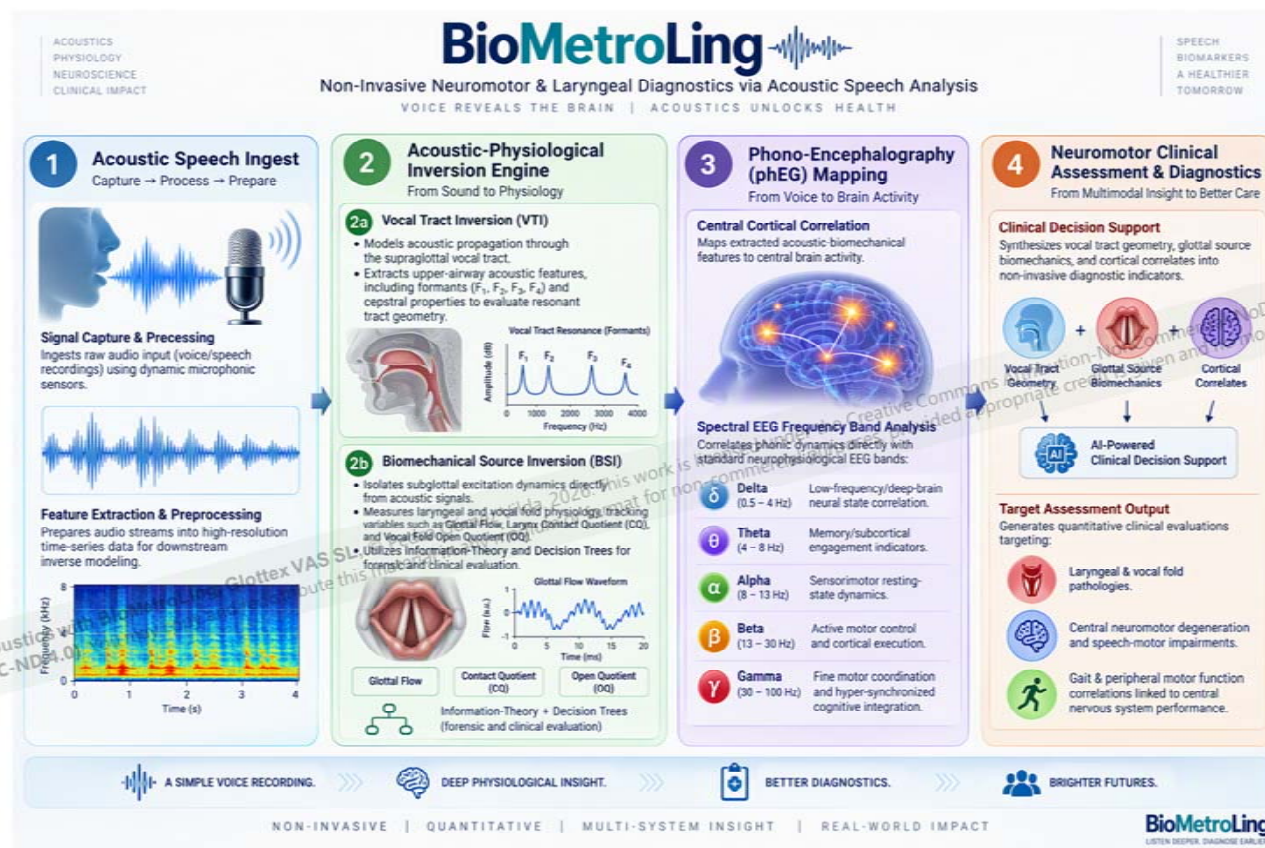


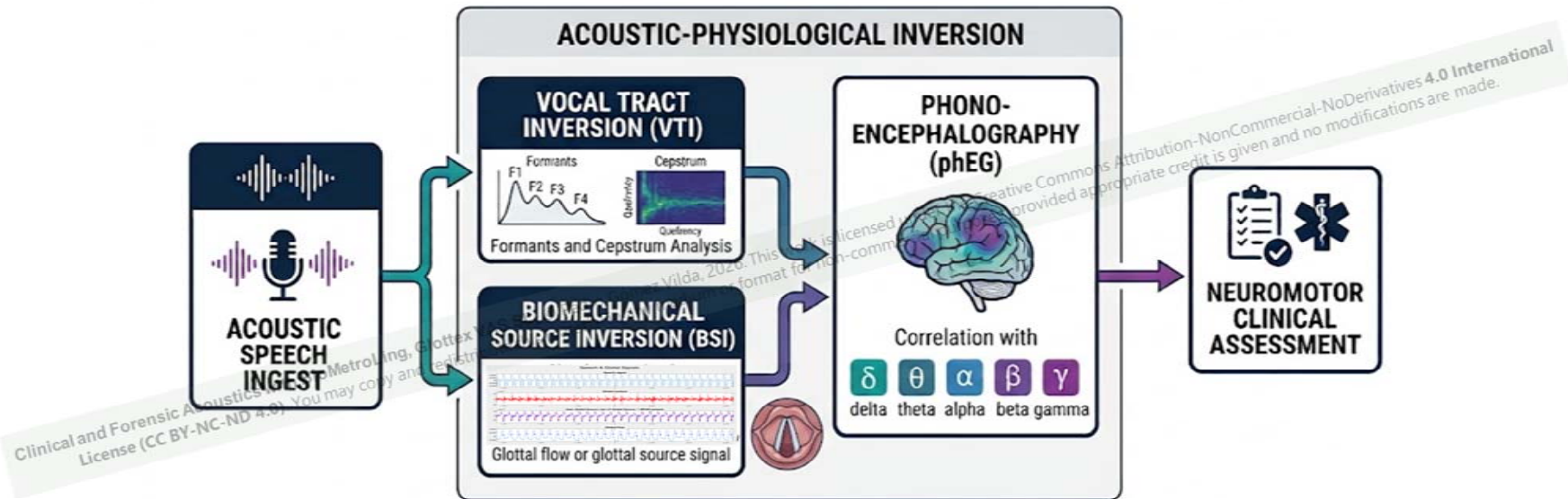


First steps with BioMetroLing v.1.9

Clinical and Forensic Acoustics with BioMetroLing, Glottex VAS SL, © Pedro Gómez Vilda, 2026. This work is licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND 4.0). You may copy and redistribute this material in any medium or format for non-commercial purposes, provided appropriate credit is given and no modifications are made.

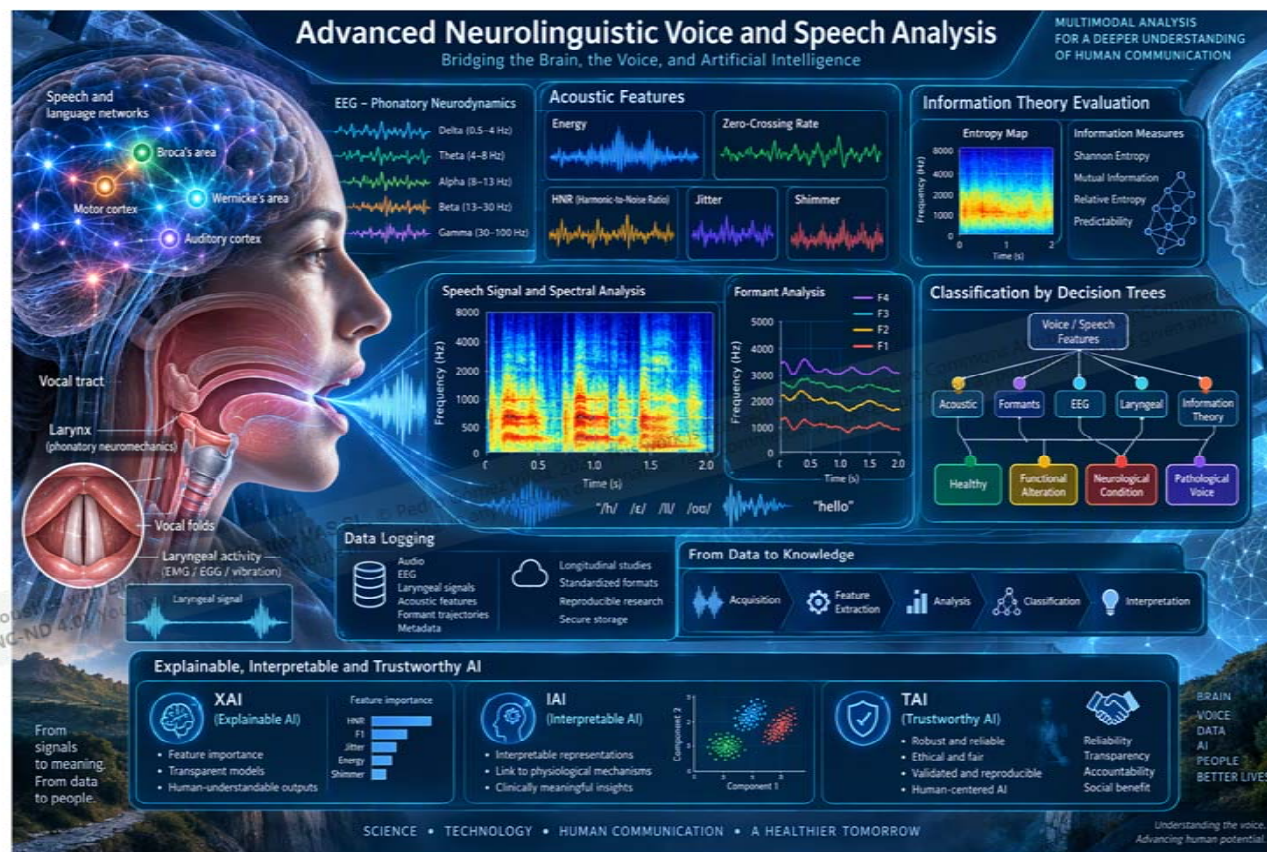


BioMetroLing: MEDICAL AI SYSTEM ARCHITECTURE



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BioMetroLing is an AI-driven medical system architecture that performs non-invasive neuromotor and laryngeal clinical assessment by processing acoustic speech signals through parallel Vocal Tract and Biomechanical Source Inversion, mapping extracted physiological parameters directly to central Phono-Encephalography (phEG) cortical EEG bands (delta, theta, alpha, beta, gamma) using multiple-feature multiple-sample evaluation and assessment by Information Theory and Decision Tree Classification.



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Derivatives 4.0 International
Modifications are made.

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Advanced Neurolinguistic Voice and Speech Analysis Platform

The platform extracts, quantifies, and classifies features across multiple domains:

Acoustic domain: energy, zero-crossing rate, harmonic-to-noise ratio (HNR), jitter, and shimmer

Articulatory-acoustic domain: formant range, dynamics, and articulatory behavior

Neurodynamic domain: EEG band activity associated with speech production

Neuromechanical domain: laryngeal activity during phonation

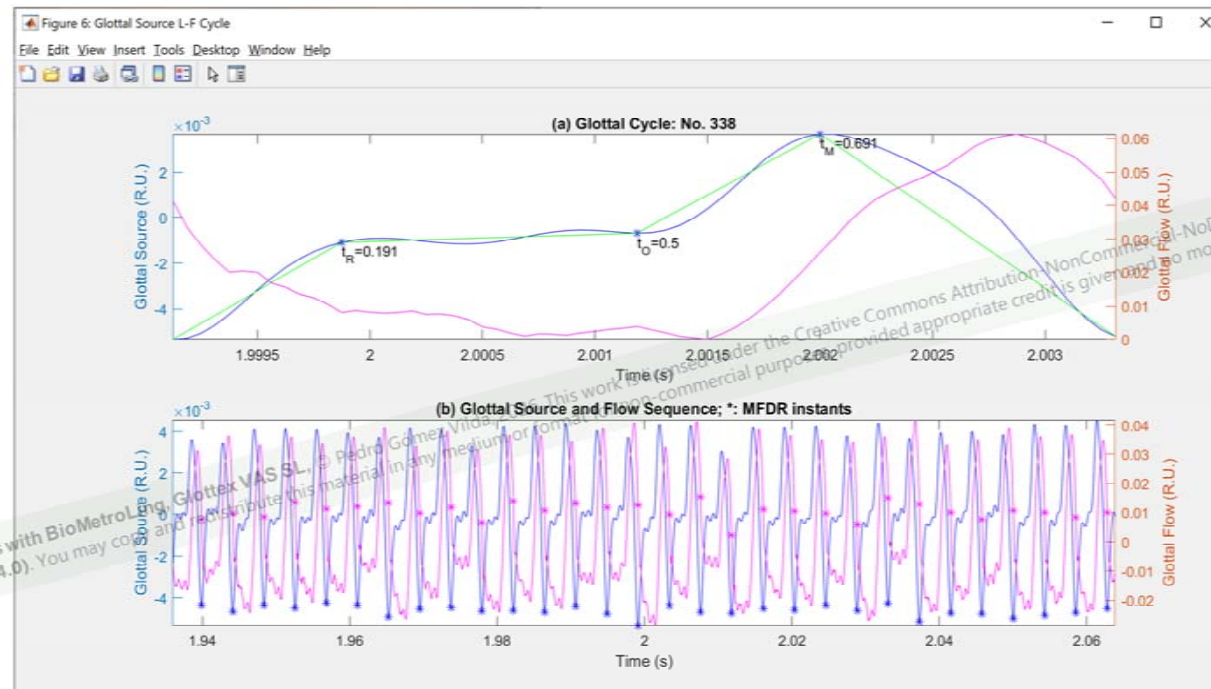
Data logging and traceability

Information theory-based evaluation

Decision tree-based classification

Integration of Explainable AI (XAI), Interpretable AI (IAI), and Trustworthy AI (TAI) principles

The glottal source



Normative female R1141, $f_s = 16$ kHz, LPC order=24

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BioMetroLing estimates speech neuromotor traits by reconstructing the glottal source signal (the derivative of the glottal flow waveform) using advanced inverse filtering techniques and biomechanical model inversion of the vocal folds. Consequently, accurate estimation of the glottal pattern is essential. The upper panel depicts the glottal source (blue), its triangular model approximation (green), and the glottal flow waveform (purple) for a representative glottal cycle. The lower panel shows the same signals across several consecutive glottal cycles. The blue and purple stars mark the Maximum Flow Declination Rate (MFDR), a key event associated with the abrupt pressure drop in the supraglottal cavity that excites the vocal tract and gives rise to vocal tract resonances (formants).



First steps



BioMetroLingConfig.mat	12/10/2026 11:39	MATLAB Data	2 KB
FluenModEvalConfig.mat	18/11/2025 16:00	MATLAB Data	2 KB
LogoNeuMinNet600x660.png	24/08/2025 18:54	Archivo PNG	285 KB
LogoNeuSpeLab2500x1250.png	24/08/2025 19:12	Archivo PNG	242 KB
MyAppInstaller_web.exe	12/10/2026 16:58	Aplicación	4,107 KB
play.ico	14/02/2018 18:30	Icono	4 KB
rgray.mat	28/01/2007 0:56	MATLAB Data	2 KB
stop.ico	14/02/2018 18:32	Icono	4 KB
Introducing_BioMetroLing_v19.pdf	12/10/2026 17:36	Documento Adobe A...	4,993 KB
BioMetroLing_installer.zip	12/10/2026 17:49	Carpeta comprimida ...	7,221 KB

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We will have received a **BioMetroLing_Installer.zip** file with the following contents:

- The application installer: **MyAppInstaller_web.exe**
- The user's application notes file: **Introducing_BioMetroLing_v19.pdf**
- The license file: **BioMetroLingConfig.mat**
- Other execution files:
 - FluenModEvalConfig.mat
 - BioMetroLingConfig.mat
 - LogoNeuMinNet600x660.png
 - LogoNeuSpeLab2500x1250.png
 - play.ico

stop.ico

We will proceed as follows:

1. Copy **MyAppInstaller_web.exe** into a folder of your choice, for example:

..\BioMetroTools\BioMetroLing19

2. Run **MyAppInstaller_web.exe** with administrator privileges (**RMB***).

3. Follow the steps suggested by the installer wizard using the default settings.

4. Verify that the following files are present in that folder:

BioMetroLing.exe

FluenModEvalConfig.mat

BioMetroLingConfig.mat

LogoNeuMinNet600x660.png

LogoNeuSpeLab2500x1250.png

play.ico

stop.ico

5. If any of these files are missing, they can be added from the compressed file **BioMetroLing_Installer.zip**.

6. Verify that the following folder has been created:

..\Program Files\BioMetroTools\BioMetroLingProf19\Applications



First steps (2)

Este equipo > Disco local (C:) > Archivos de programa > BioMetroTools > BioMetroLing19 > application

Photo Print				
☐ Nombre	Fecha	Tipo	Tamaño	
BioMetroLing.exe	12/10/2026 10:24	Aplicación	2,536 KB	
BioMetroLingConfig....	12/10/2026 11:20	MATLAB Data	2 KB	
BioMetroLingProf19....	12/10/2026 17:30	Documento de texto	0 KB	
FluenModEvalConfig...	12/10/2026 12:41	MATLAB Data	2 KB	
icon.ico	09/10/2025 1:51	Icono	9 KB	
LogoNeuMinNet600...	24/08/2025 18:54	Archivo PNG	285 KB	
LogoNeuSpeLab250...	24/08/2025 19:12	Archivo PNG	242 KB	
play.ico	14/02/2018 18:30	Icono	4 KB	
readme.txt	12/10/2026 10:24	Documento de texto	2 KB	
rgray.mat	28/01/2007 0:56	MATLAB Data	2 KB	
splash.png	24/08/2025 18:54	Archivo PNG	285 KB	
stop.ico	14/02/2018 18:32	Icono	4 KB	

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We will proceed as follows:

1. Copy **MyAppInstaller_web.exe** into a folder of your choice, for example:
..\BioMetroTools\BioMetroLing19
2. Run **MyAppInstaller_web.exe** with administrator privileges (**RMB***).
3. Follow the steps suggested by the installer wizard using the default settings.
4. Verify that the following files are present in that folder:
 - BioMetroLing.exe
 - FluenModEvalConfig.mat
 - BioMetroLingConfig.mat
 - LogoNeuMinNet600x660.png

LogoNeuSpeLab2500x1250.png

play.ico

stop.ico

1.If any of these files are missing, they can be added from the compressed file **BioMetroLing_Installer.zip**.

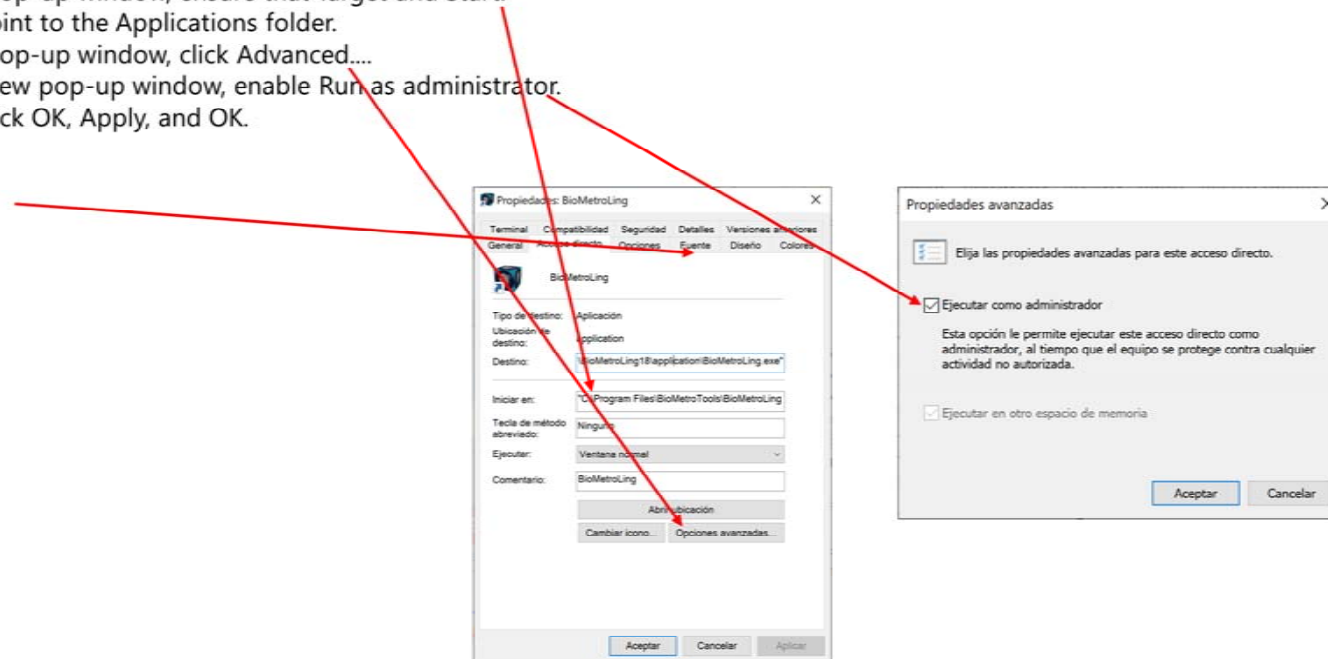
2.Verify that the following folder has been created:

..\Program Files\BioMetroTools\BioMetroLingProf19\Applications

* **RMB**: Right Mouse Button; **LMB**: Left Mouse Button.

First steps (3)

We create a desktop shortcut, if deemed convenient, with administrator privileges, as follows:
 In Applications, right-click (RMB) on BioMetroLing.exe and select Create Shortcut.
 On the Desktop, right-click the BioMetroLing shortcut and select Properties.
 In the pop-up window, ensure that Target and Start: both point to the Applications folder.
 In the pop-up window, click Advanced....
 In the new pop-up window, enable Run as administrator.
 Then click OK, Apply, and OK.

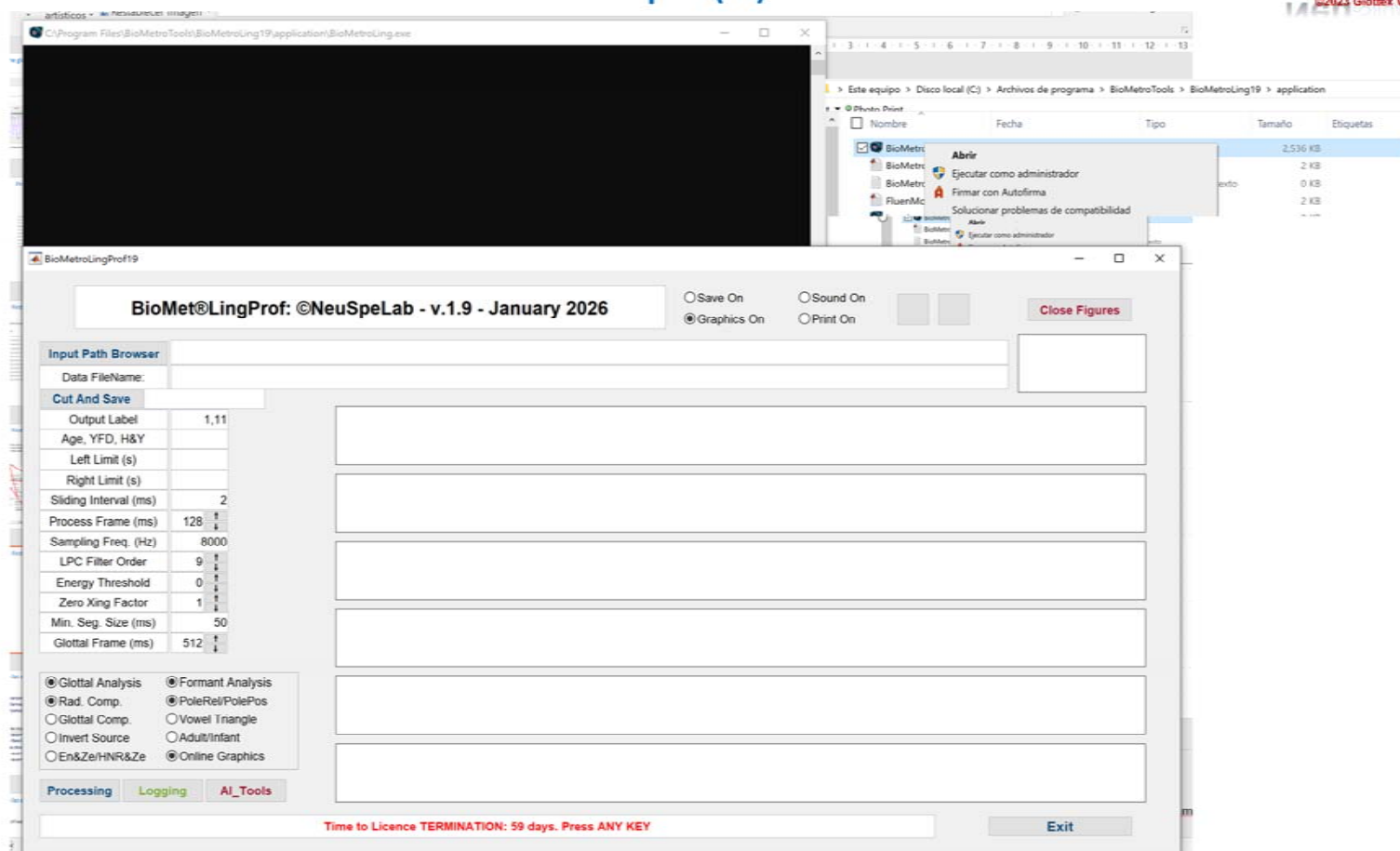


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Create a shortcut on the Desk



First steps (4)



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Launch **BioMetroLing.exe** from the folder where it was installed or from the desktop shortcut using administrator privileges.

Verify that it opens displaying a message similar to:

Time to licence TERMINATION xxxx days. Press ANY KEY...

If a different message appears, such as "**ERROR 00: License UNAVAILABLE...**", left-click (LMB) on the message line and verify that the path specified for the **BioMetroLingConfig.mat** file is correct. Capture the MS-DOS screen using **Print Screen (PrtSc)** and send it to pedrogvilda@telefonica.net.

If you wish to exit the application, always do so, whenever possible, through **EXIT** so that the last execution configuration can be saved.

Never close the MS-DOS window that appears in the background, as it serves as a support resource in the event that execution errors occur.



Open and check

BioMet@LingProf: ©NeuSpeLab - v.1.9 - January 2026

☐ Save On ☐ Sound On
☒ Graphics On ☐ Print On

Close Figures

Input Path Browser

Data FileName:

Cut And Save

Output Label	1,11
Age, YPD, H&Y	
Left Limit (s)	
Right Limit (s)	
Sliding Interval (ms)	2
Process Frame (ms)	128
Sampling Freq (Hz)	8000
LPC Filter Order	9
Energy Threshold	0
Zero Xing Factor	1
Min Seg Size (ms)	50
Global Frame (ms)	512

☒ Global Analysis ☒ Feature Analysis
☒ Rad. Comp. ☒ Phoneme Clusters
☒ Global Comp. ☒ Vowel Triangle
☐ Adult/Infant ☒ Online Graphics
☐ En&Ze+NR&Ze

Processing Logging AI_Tools

Time to Licence TERMINATION: 8298 days. Press ANY KEY

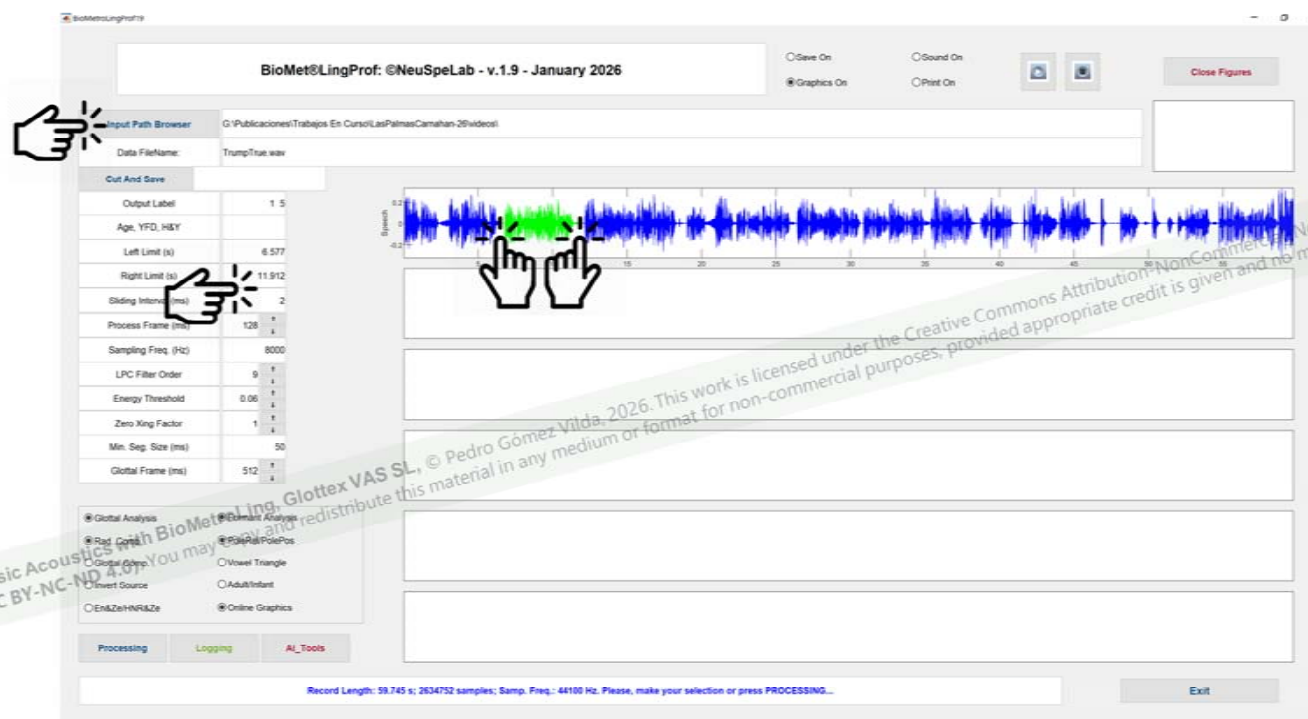
Exit

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The bottom message line informs of licence term validity. Accept clicking on it with Left Mouse Button (LMB)



Select segment for analysis



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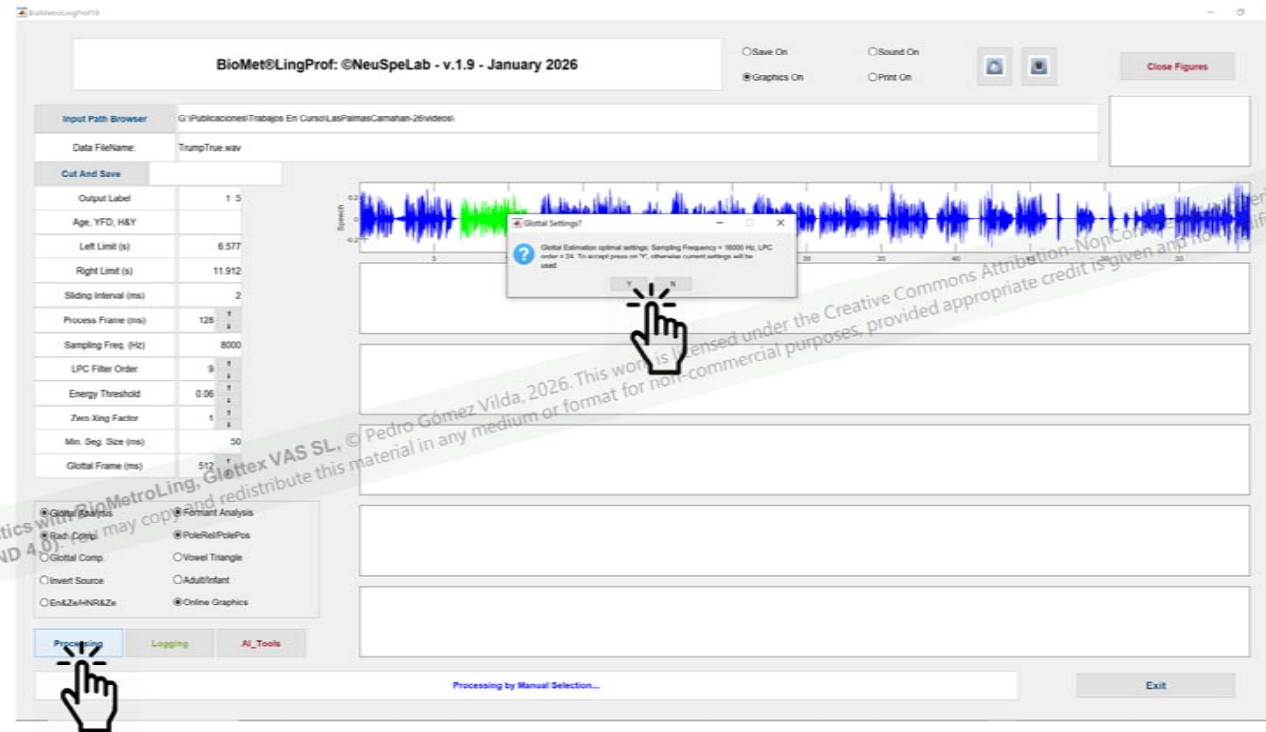
Select a .wav file using the Input Path Browser.

If the selected file is a stereo, a warning will appear in the bottom message line. It will assume that the file is equally loaded in both channels, and average them. Press any key.

Select a segment with LMB (left side) and RMB (right mouse button: right side), or edit the Left Limit (s) and Right Limit (s) text windows. The segment will be highlighted in green.



Confirm execution settings

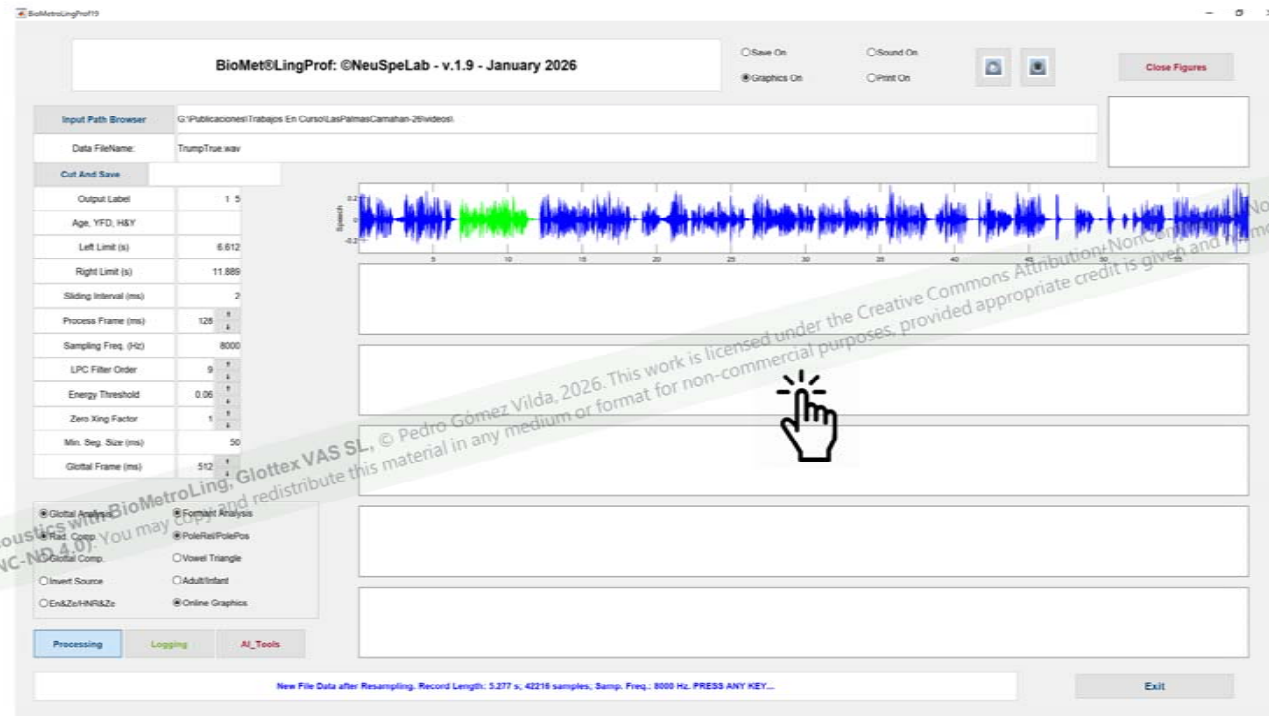


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Click on Processing and check Glottal Settings; accept in Y or reject in N, to change settings if desired. Observe that the pop-up suggests settings for optimal glottal source estimation, which not need to be the best ones for formant estimation. For optimal first two formant estimation, N is suggested as the best option (Processing Frame (ms) = 68, Sampling Freq. (Hz) = 8000, LPC Filter Order = 9).



Check signal settings and execute

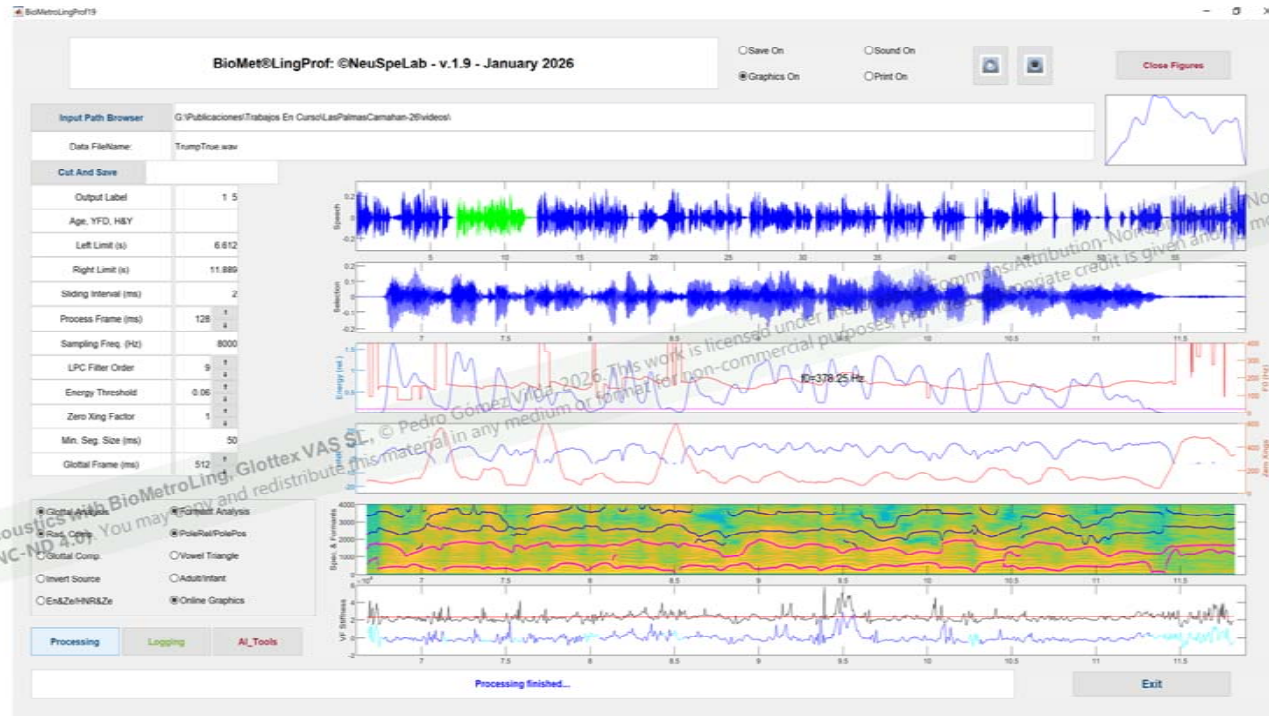


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See signal details (in the bottom message line: Recording Length, number of samples, and sampling frequency. To launch execution, click anywhere the LMB on the GUI.

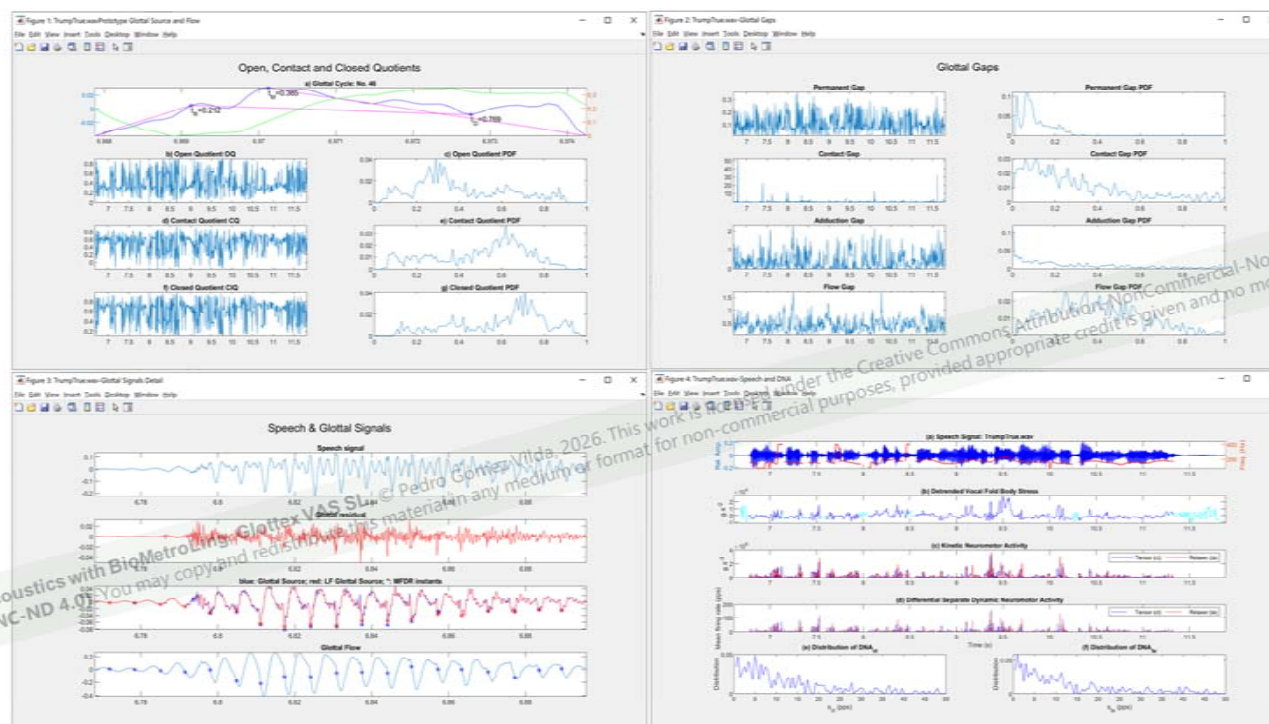


Check execution results



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The selected segment will be shown in the Selection window. The signal Energy envelope (blue), and the F0 (red) will be shown right below. The HNR (blue) and the zero crossings (red) will follow downstream. Immediate below the first four formants will be displayed over the harmonic spectrum (the first two formants in purple). The last bottom row will plot the vocal fold stiffness (black) and its trend (red), as well as their unbiased estimation (blue), the unvoiced fragments in cyan.

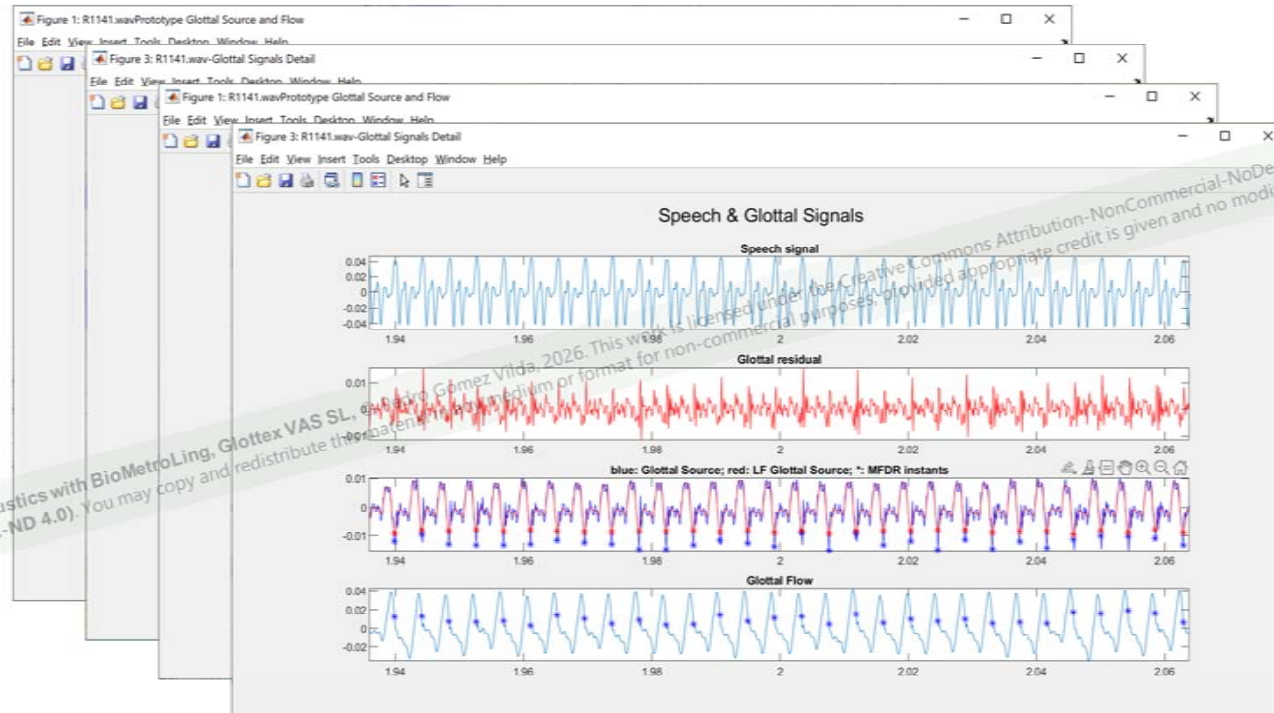


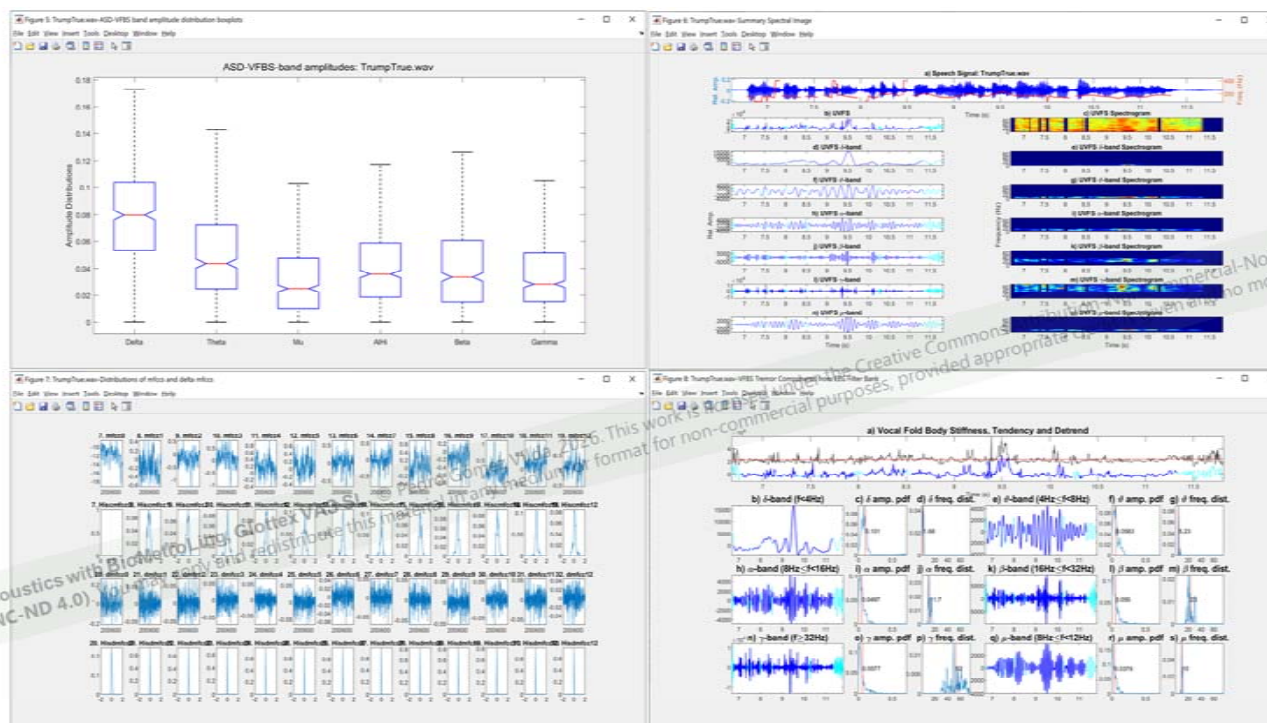
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Top left: Glottal Source (blue) and Flow (Green), Open, Contact, and Closed Quotients (left) and their amplitude distributions (right); Top right: Glottal Gaps Permanent, Contact, Adduction, and Flow (left) and their amplitude distributions (right); Bottom left: Speech; Glottal residual, Glottal source (blue) and its low-band estimate (red); Glottal Flow. Bottom right: Speech Signal (blue) and F0 (red); Detrended Vocal Fold Body stress (blue and cyan); Kinematic Neuromotor Activity (tensor in blue, relaxer in red); Differential Separate Dynamic Neuromotor Activity; Cryothyroid (left) and Thyroarytenoid (right) distributions.

Check glottal source correct estimation

The acute peak of the glottal waveform must have negative polarity; otherwise, enable the 'Invert Source' option.

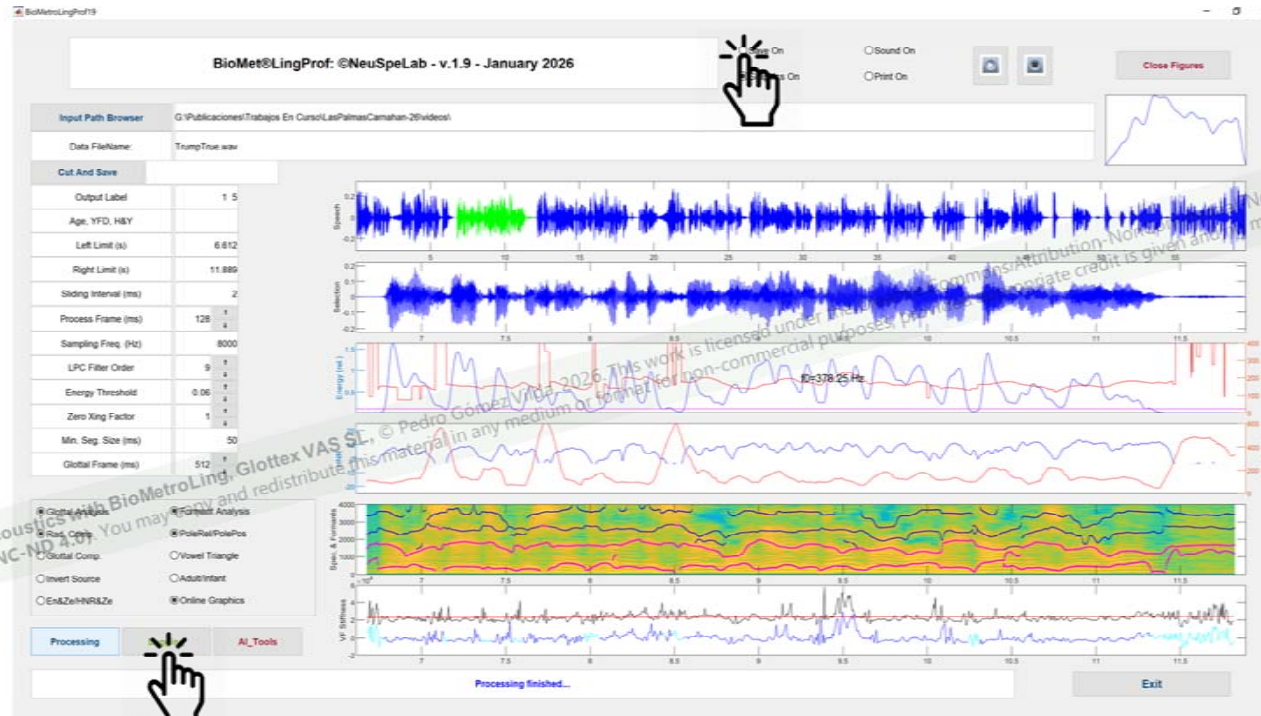




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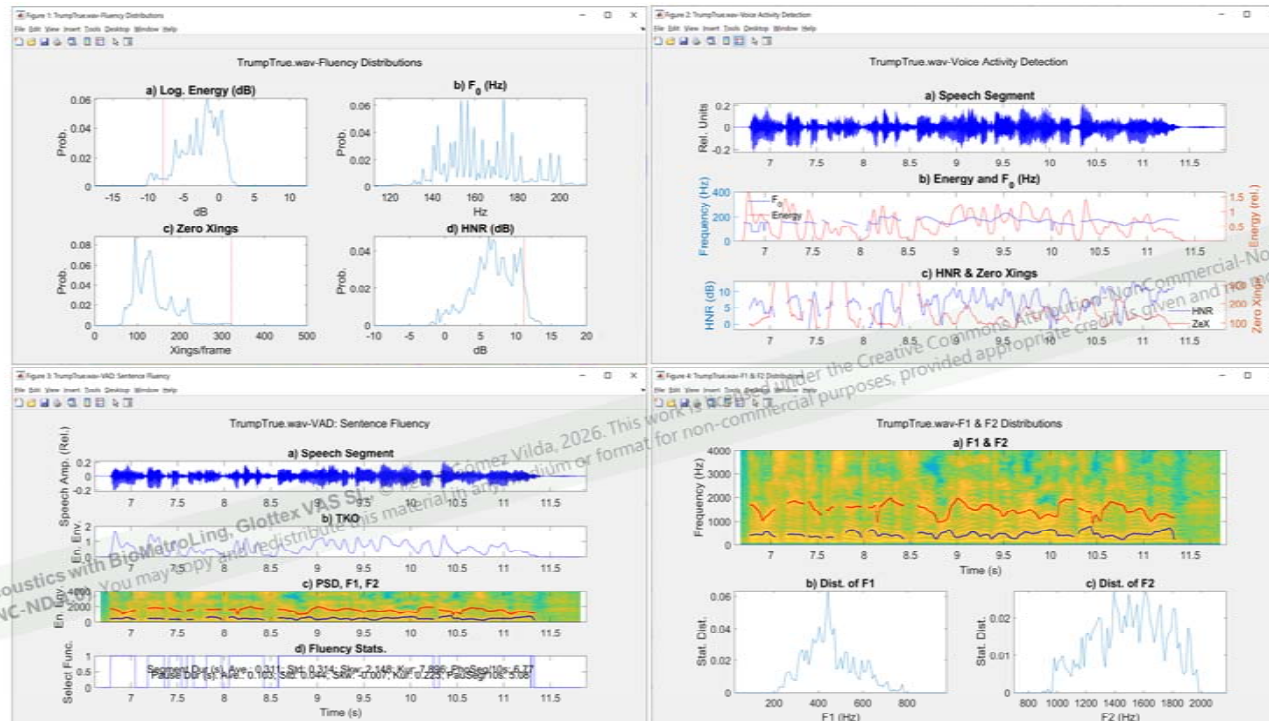
Top left: Vocal Fold Body Strain PhonEEG-band amplitude Distributions for Autistic Spectrum Disorder studies and others related. Top right: Speech signal (blue) and F0 (red), band amplitudes (left) and spectrograms (right). Bottom left: Mel-cepstrum, and delta-Mel-cepstrum coefficients and their amplitude distributions. Bottom right: Vocal Fold Body Stiffness, tendency, and detrend, amplitudes, amplitude distributions, and frequency distributions.

View and save more results



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Results from formant estimations are available clicking LMB on Logging. To save these results in the input path subfolder \results select the radiobutton Save On prior to click on Logging.

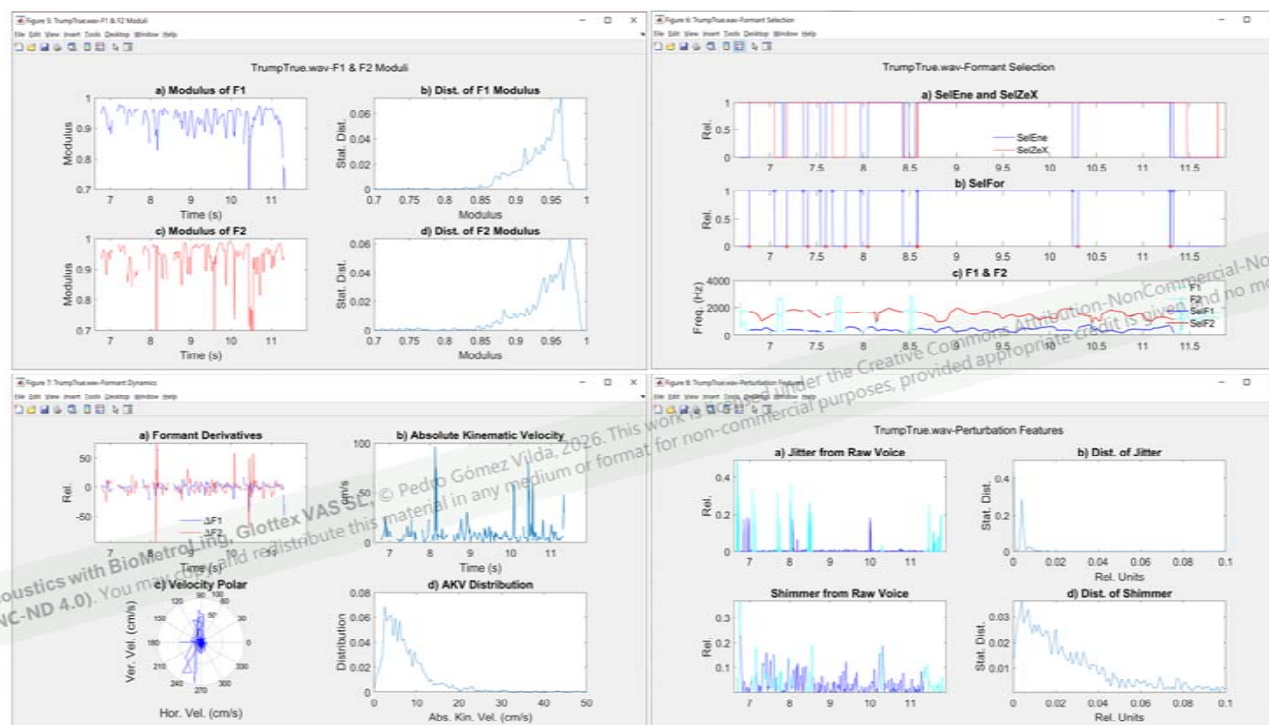


Upper left (left-to-right, top-to-bottom): amplitude distributions of the logarithm of the signal squared-envelope ($\log En$), fundamental frequency (F_0), zero-crossing rate, and harmonic-to-noise ratio (HNR).

Upper right (top-to-bottom): speech waveform; F_0 (blue) and $\log En$ (red); HNR (blue) and zero-crossing rate (red).

Lower left (top-to-bottom): speech waveform, $\log En$, spectrogram with the first two formants overlaid (F_1 : blue, F_2 : red), and speech segmentation into voiced and unvoiced intervals, together with the corresponding mean, standard deviation, skewness, and kurtosis values.

Lower right: spectrogram with superimposed formant tracks and the corresponding formant amplitude distributions.



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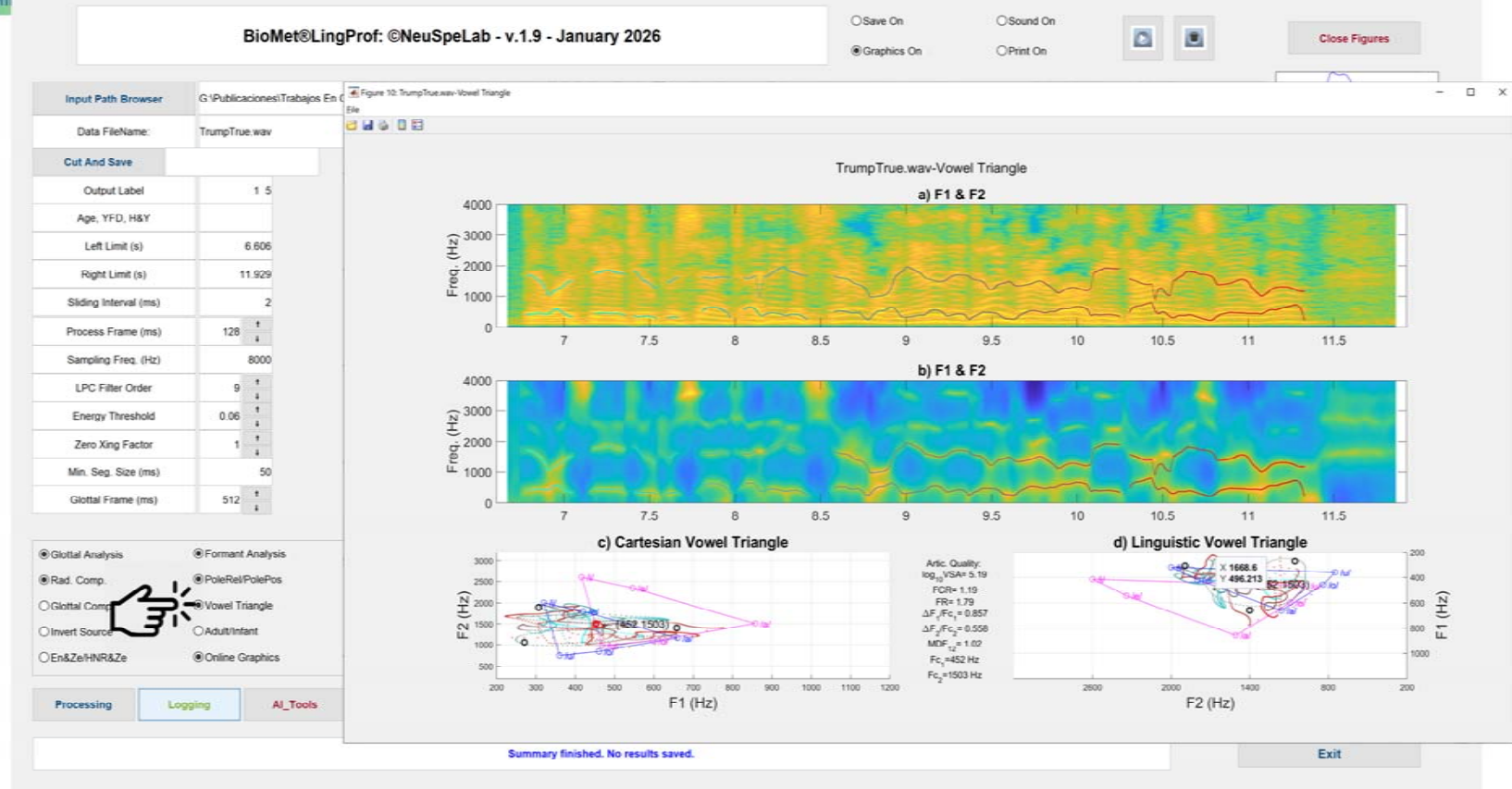
Upper left: magnitude of the pole associated with F1 (blue) and its amplitude distribution; magnitude of the pole associated with F2 (red) and its amplitude distribution.

Upper right: segmentation of voiced and unvoiced intervals using $\log En$ and zero-crossing rate (ZeXing), combined speech signal, and formant selection.

Lower left: first derivatives of the first two formants; the square root of their summed magnitudes, defined as the **Absolute Kinematic Velocity (AKV)**; polar-coordinate representation of the formant derivatives; and the amplitude distribution of AKV.

Lower right: jitter trajectories in voiced (blue) and unvoiced (cyan) intervals with their corresponding amplitude distribution; and shimmer trajectories in voiced (blue) and unvoiced (cyan) intervals with their corresponding amplitude distribution.

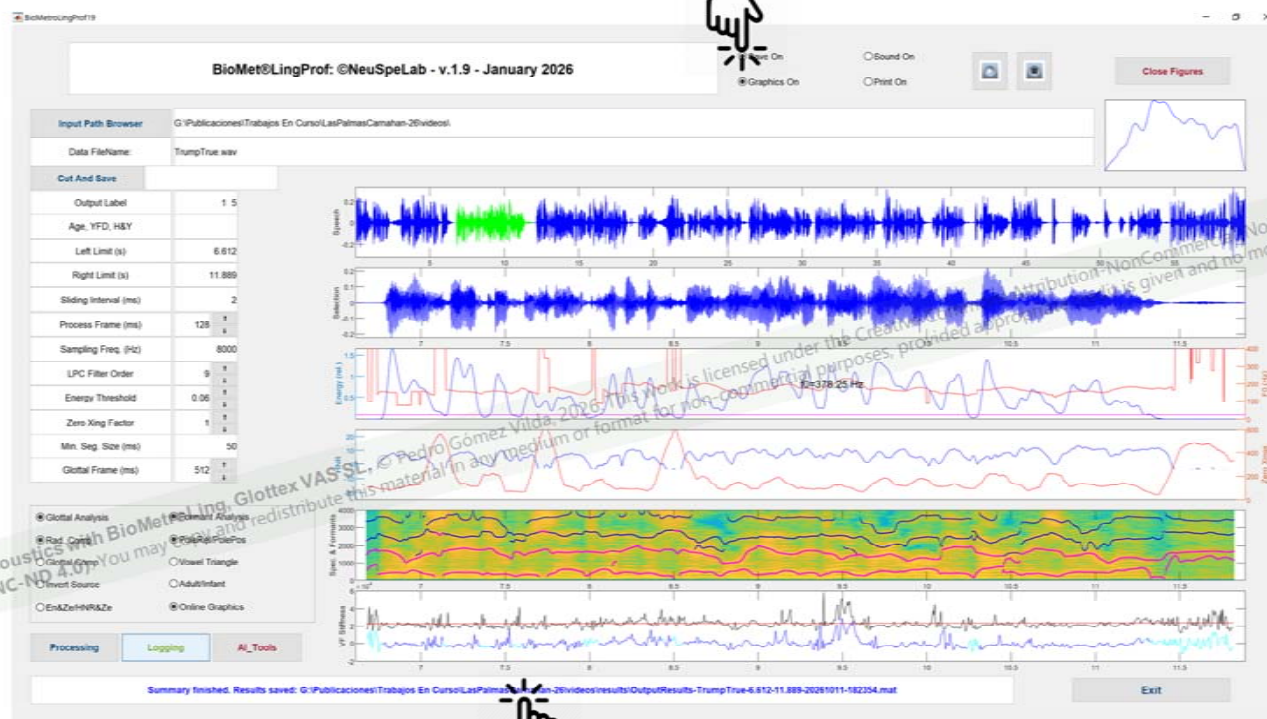
Formant dynamics on the vowel triangle



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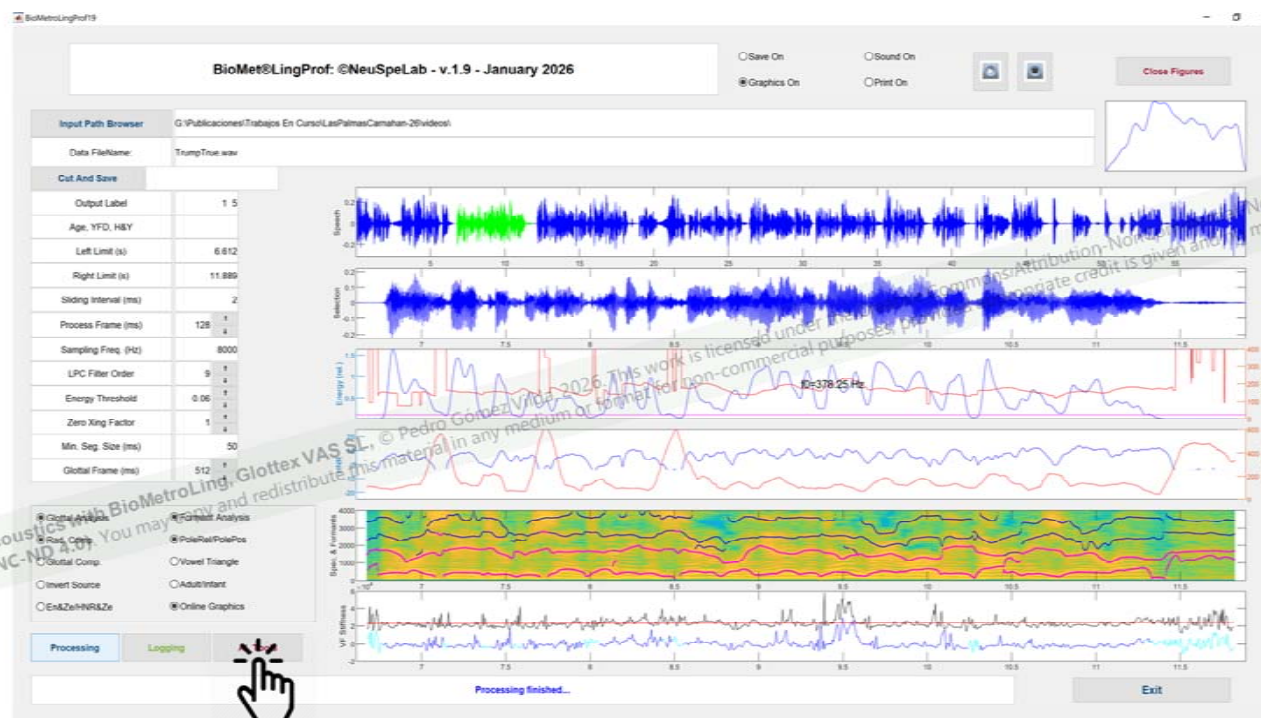
If the 'Vowel Triangle' radio button is selected with the left mouse button (LMB), the point defined by {F1, F2} will be mapped either onto linear Cartesian axes or onto the inverted axes conventionally used in linguistics. To indicate temporal progression, the formants and their corresponding points are color-coded from cyan to red. The average boundaries of the adult male vowel triangle are shown with blue lines, while those of the adult female vowel triangle are shown with mauve lines. The circles indicate the approximate positions of the five sustained cardinal vowels according to their IPA notation: [a:, e:, i:, o:, u:].

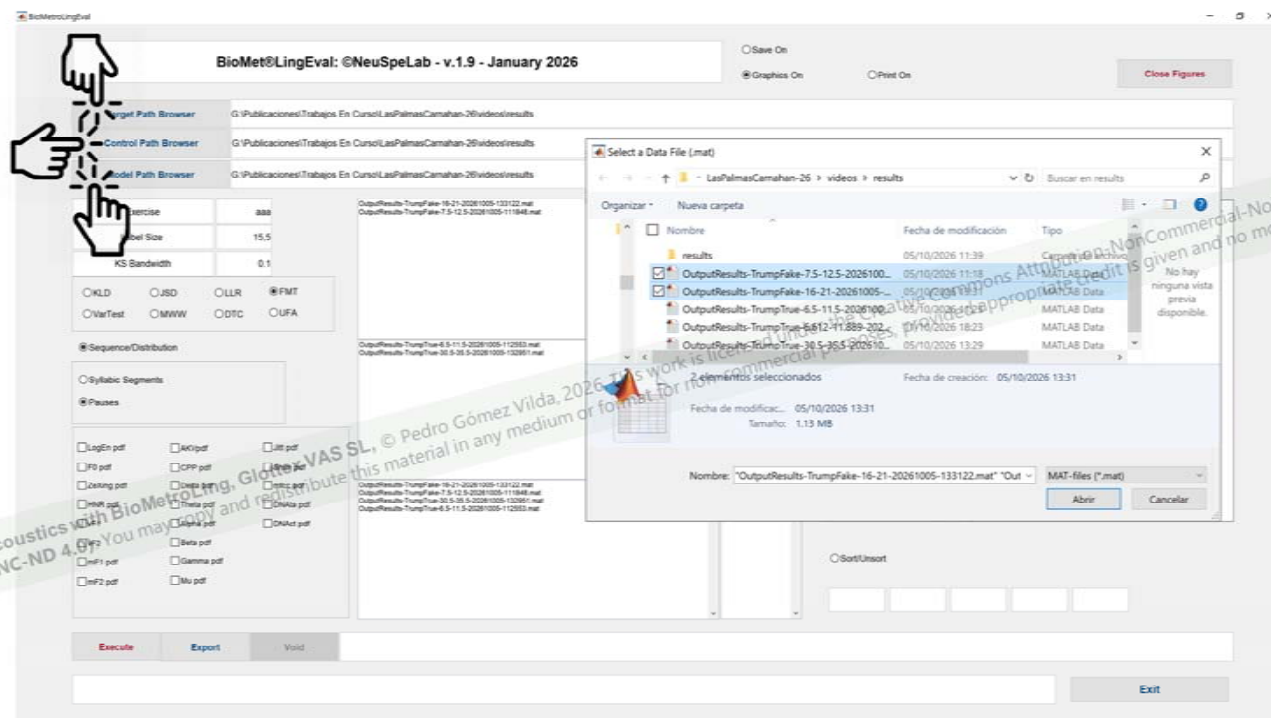
Saving results



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When the radiobutton Save On is activated, a .mat file containing the distributions of the analysis is produced under in a subfolder of the Input Path named \results, as shown in the bottom message line. These files can be used in further evaluation processes using the pop-up AI_Tools GUI.

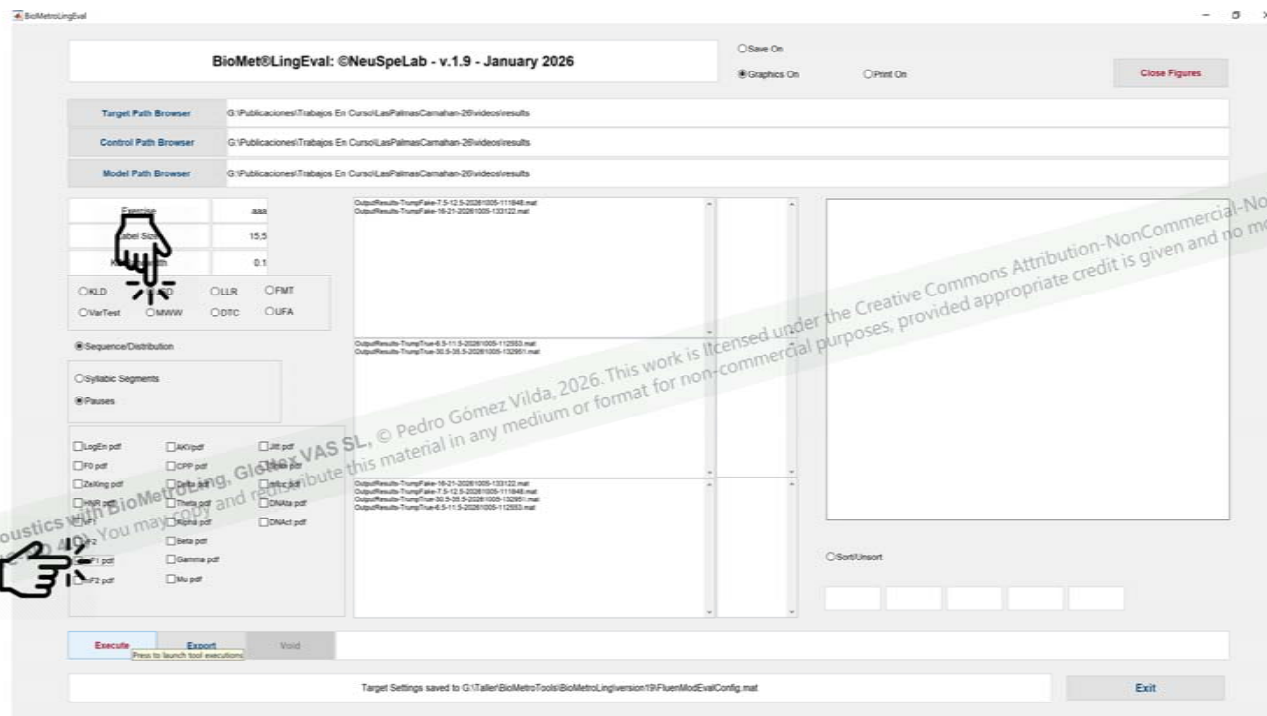




The AI_Tools GUI is devised to compare results from a set of Target .mat files with a set of Control .mat files, using a set of reference Model .mat files. The respective set files may be selected clicking on the corresponding Browser buttons, which open Explorer-like windows.



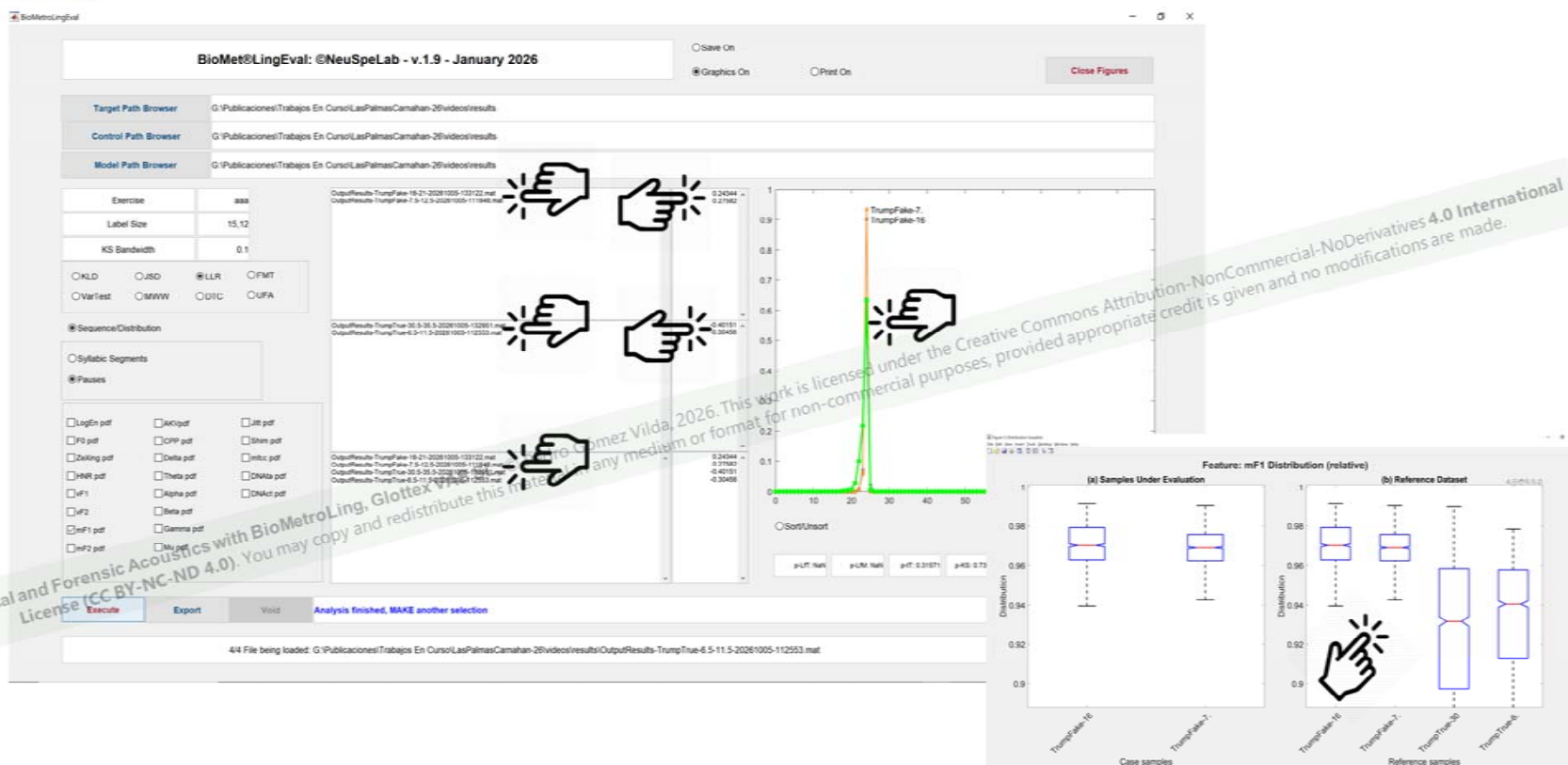
Evaluation and assessment



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The evaluation tools available include: Kulback-Leibler Divergence (KLD), Jensen-Shannon Distance (JSD), Log-Likelihood Ratio (LLR), Variance parametric t-Test (VarTest), and Mann-Whitney-Wilcoxon non-parametric test (MWW). The assessment tools include: Decision-Tree Classification (DTC), U-shape Assessment (UFA), and Forensic Match Tests (FMT). The features for testing include: Logarithmic Energy Envelope (LogEn), F0, Zero Crossings (ZeXing), Harmonic-Noise Ratio (HNR), First formant value (vF1), Second formant value (vF2), First formant's associated pole-modulus (mF1), Second formant's associated pole-modulus (mF2), Absolute Kinematic Velocity (AKV), Cepstral Peak Prominence (CPP), Delta phoneEGG band (Delta), Theta phoneEGG band (Theta), Alpha phoneEEG band (Alpha), Beta phoneEEG band (Beta), Gamma phoneEEG band (Gamma), Mu phoneEEG band (Mu), Jitter, Shimmer (Shim), Mel-Cepstral Coefficients (mfcc), Dynamic Neuomotor Activity of the thyro-arytenoid joint (DNAta), and Dynamic Neuomotor Activity of the crico-thyroid joint (DNAct). Some evaluations must be performed only on a single feature (KLD, JSD, VarTest, MWW), whereas others require a minimum of three features (FMT).

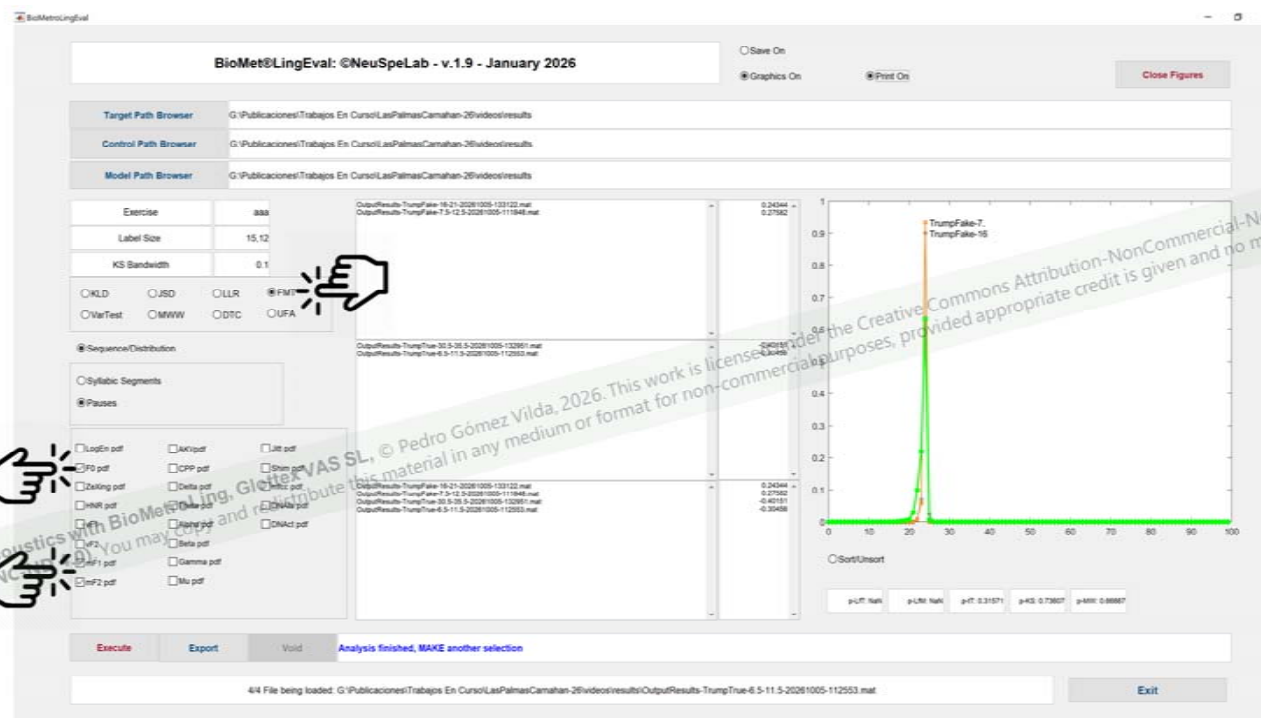
Single-feature multiple-sample evaluation



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The LLR evaluation compares feature distributions from each sample in the Target set and the Control set vs the average of distributions in the Model set. In the present case, the Target set produces positive LLRs with respect to the Model set, whereas the Control set produces negative LLRs with respect to the Models. The right window shows the Target set in orange, whereas the Model set is shown in green. The boxplots show a synopsis of the comparison.

Multiple-feature multiple-sample evaluation



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The FMT evaluation compares the Target set feature-by-feature individual distributions vs the Control set average distributions, and produces a pop-up Dashboard with individual and global scores, explaining each individual feature contribution relevance to the global score.



To learn more

- More info on BioMet[®]Ling will be released through the NeuMinNet platform on a regular basis (<https://neuminnet.ulpgc.es>)
- New releases will be announced on the same terms.
- A free-to-use open licence with a 60-day validity will be periodically updated upon request.
- Extensions and further info may be requested free of compromise to pedrogvilda@telefonica.net
- Slides distributed under an International License (CC BY-NC-ND 4.0)