



EF European Federation for
Non-Destructive Testing
NDT



VERONA, 15-19 JUNE



ULTRASONICS

mini-auspex: a Python library for ultrasonic data import,
post-processing and imaging

Thiago E. Kalid

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Motivation



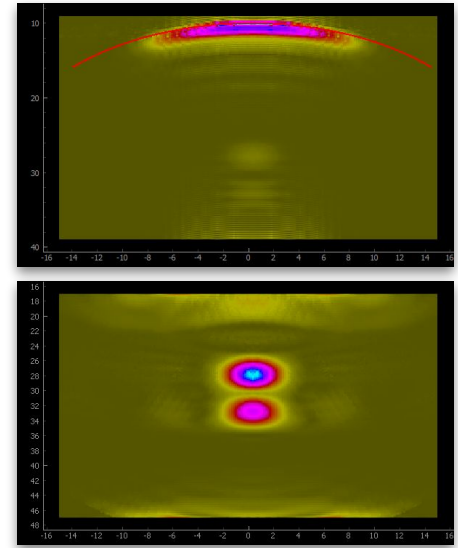
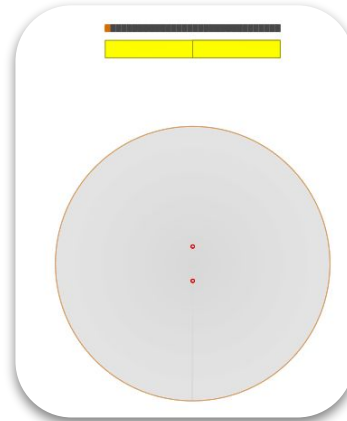
- **Large team**
 - ~25 researchers working with US NDT



- **Project AUSPEX**
 - (2018 - Present)
 - Subsea pipe inspection

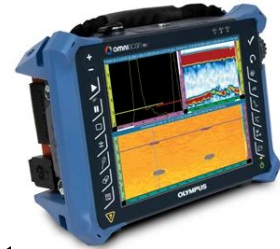
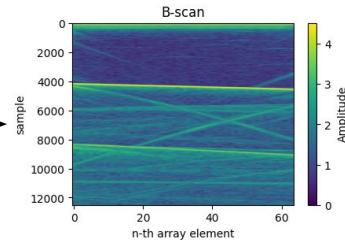
2018: start of the development of the AUSPEX toolbox

- Standardization of software routines
- Avoidance of rework
- Subsea pipe inspection: immersion testing
 - Adaptive reconstruction
 - Surface identification
- NumPy-powered
- State-of-the art algorithms
 - Flexibility of parametrization
 - Ease for adaptation and new features
- Professional-level repository management
- **Let's go to work!** 💪

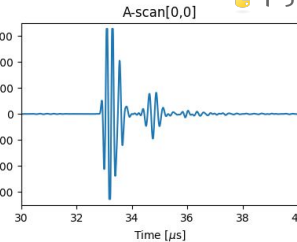


2018: start of the development of the AUSPEX toolbox

- Platform independent data structures
- Multiple acquisition systems
 - CIVA UT
 - Eddyfi Panther
 - Evident OmniScan*
 - TPAC Pioneer**



python™



2019: AUSPEX toolbox paper published in QNDE

- No ECNDT in that year 😞
- Not yet publicly available
- Good feedback: let's make it available!

46th Annual Review of Progress &
in Quantitative Nondestructive Evaluation
QNDE2019
July 14-18, 2019, Portland, OR, USA

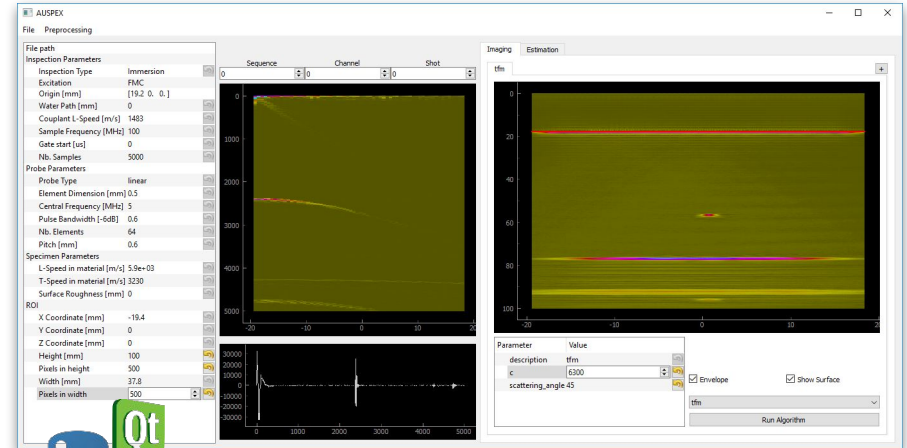
QNDE2019-1234

A TOOLBOX FOR ULTRASOUND SIGNAL PROCESSING AND IMAGE RECONSTRUCTION

Thiago A. R. Passarin; Hector L. de Moura,
Vitor O. Silva, Filipe B. G. Cândido,
Karoline A. Sato, Andréia R. de Souza,
Marco T. L. Guerreiro, Giovanni A. Guarnieri,
Daniel R. Pipa

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Petrobras Center for
Research and Development (CENPES)
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Brazil



Applications of AUSPEX toolbox

Publications powered by the AUSPEX Toolbox

- Sound speed estimation
 - 2020
 - Parametric testing
 - IEEE Sensors Journal

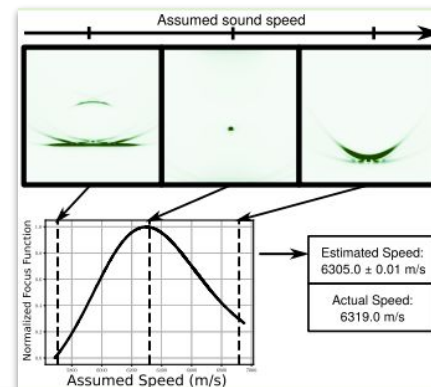


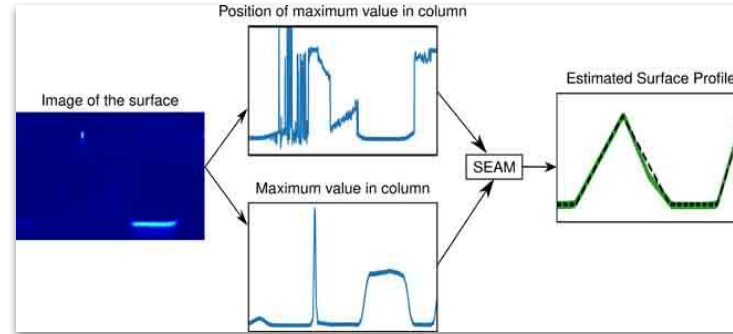
Image-Based Ultrasound Speed Estimation in Isotropic Materials

Hector Lise de Moura^{ID}, Vitor de Oliveira Silva, Giovanni Alfredo Guarneri^{ID},
Marco Tullio Lopes Guerreiro^{ID}, Thiago Alberto Rigo Passarin,
Gustavo Pinto Pires, and Daniel Rodrigues Pipa^{ID}, *Member, IEEE*

Publications powered by the AUSPEX Toolbox

- Surface identification

- 2021
- Immersion testing
- IEEE-TUFFC



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IEEE TRANSACTIONS ON ULTRASONICS, FERROELECTRICS, AND FREQUENCY CONTROL, VOL. 68, NO. 11, NOVEMBER 2021

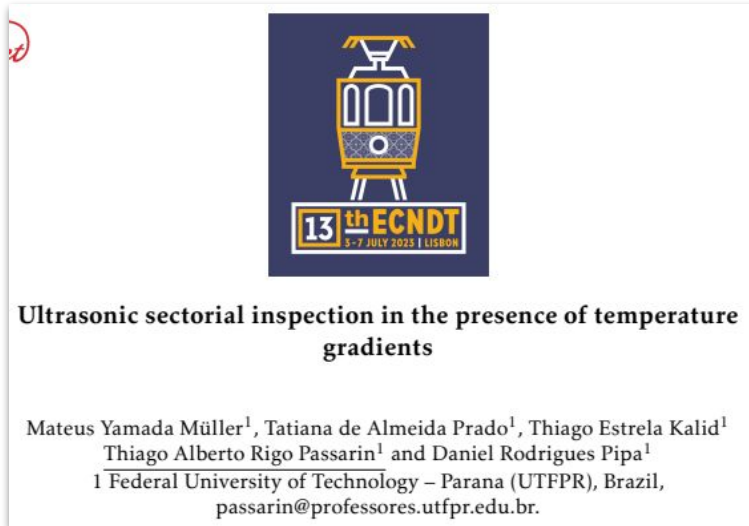


Surface Estimation via Analysis Method: A Constrained Inverse Problem Approach

Hector Lise de Moura^{1b}, Tatiana de Almeida Prado, Giovanni Alfredo Guarneri^{1b}, Thiago A. R. Passarin^{1b}, Daniel Rossato, Gustavo Pinto Pires, and Daniel Rodrigues Pipa^{1b}

Publications powered by the AUSPEX Toolbox

- Imaging in the presence of temperature gradients
 - 2023
 - Hot inspection of oil/water separation tank
 - ECNDT 2023 (Lisbon, Portugal)



Publications powered by the AUSPEX Toolbox

- Empirical assessment of directivity functions
 - 2021
 - NDT&E International

NDT&E International 119 (2021) 102402

Contents lists available at ScienceDirect

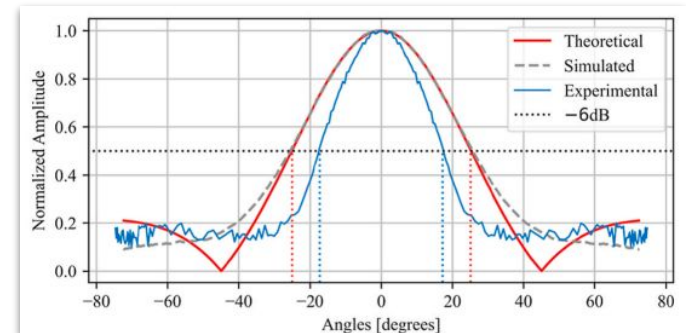
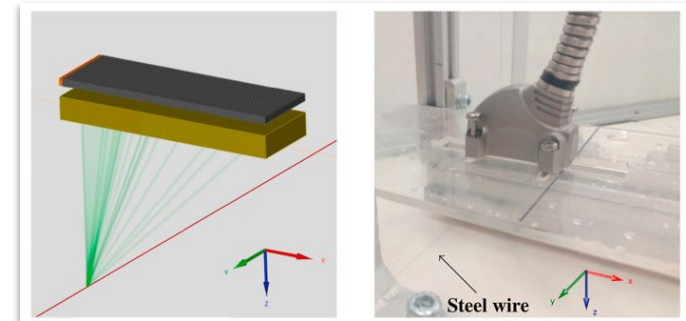
NDT and E International

journal homepage: <http://www.elsevier.com/locate/ndteint>

A straightforward method to evaluate the directivity function of ultrasound imaging systems

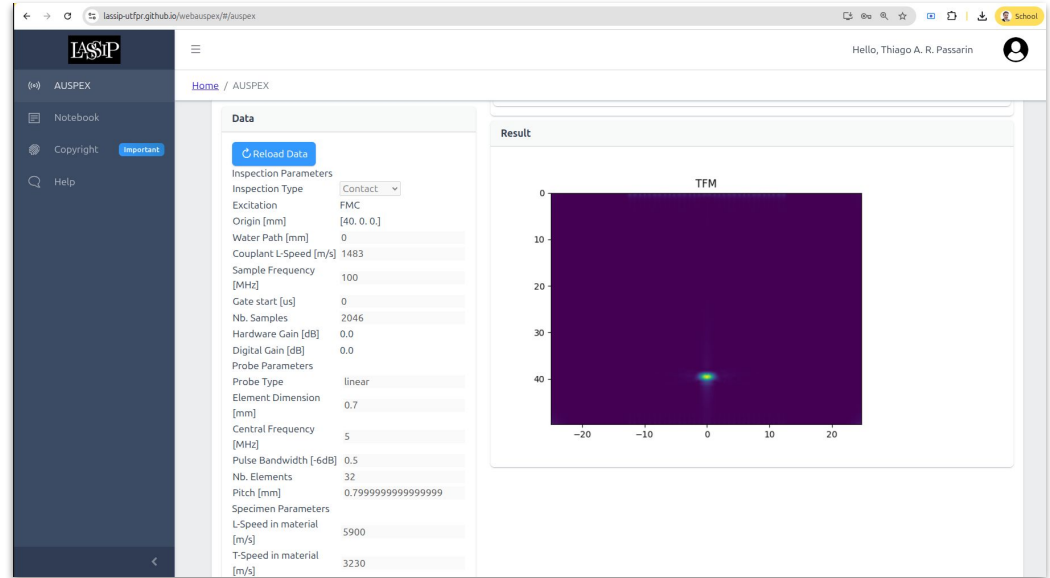
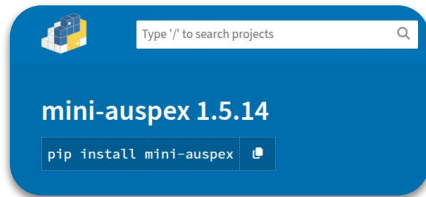
Tatiana de A. Prado^{a,*}, Hector L. Moura^a, Thiago A.R. Passarin^a, Giovanni A. Guarneri^b, Gustavo P. Pires^c, Daniel R. Pipa^a

^a Graduate Program in Electrical and Computer Engineering from the Universidade Tecnológica Federal do Paraná (UTFPR), Curitiba, PR, Brazil
^b Graduate Program in Electrical Engineering from the Universidade Tecnológica Federal do Paraná (UTFPR), Pato Branco, PR, Brazil
^c Centro de Pesquisa Leopoldo Américo Miguez de Mello (CENPES) from Petróbras, Rio de Janeiro, RJ, Brazil



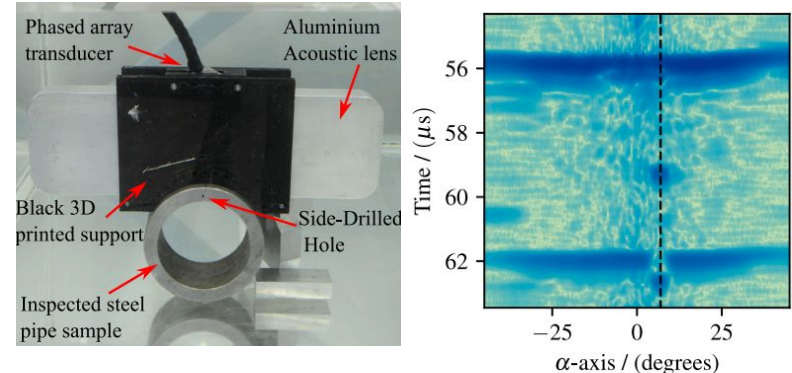
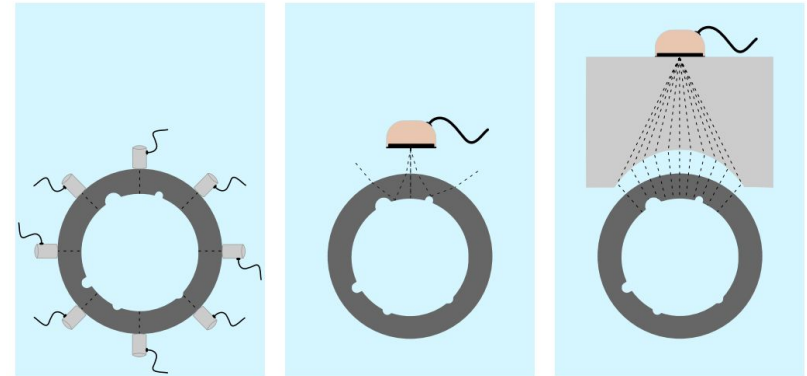
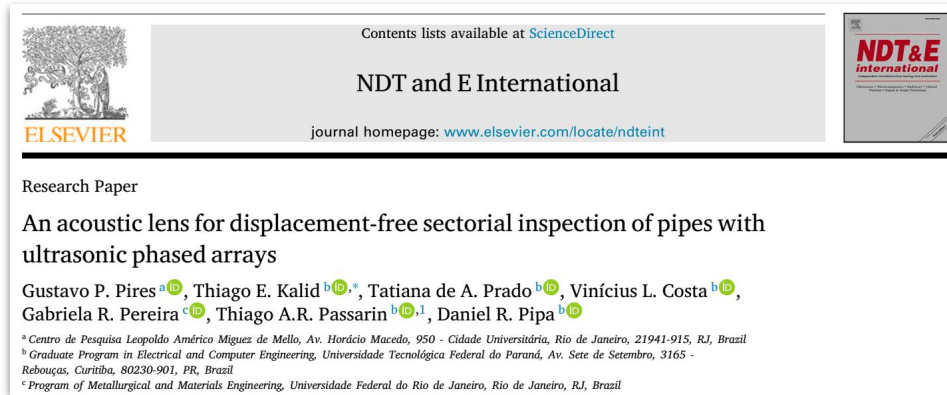
2024: Publication of WebAUSPEX app

- Web application powered by the AUSPEX toolbox
 - QNDE 2024 (Denver, USA)
 - Based on Pyodide
 - Already uses mini-auspex library
 - A specific paper was lacking!



Publications powered by the mini-auspex library

- Acoustic lens for pipe inspection
 - 2025
 - NDT&E International



Publications powered by the mini-auspex library

- In this conference



Modeling and Removal of Electronic Crosstalk Effects in Ultrasound Signals via Deconvolution

Fabio Z. Y. Wang¹, Tatiana de A. Prado¹, Thiago E. Kalid¹, Gustavo P. Pires², Glauber Brante¹, Daniel R. Pipa¹ and Thiago A. R. Passarin^{1,*}

¹ Universidade Tecnológica Federal do Paraná (UTFPR), Curitiba, Brazil. ² Centro de Pesquisa Leopoldo Américo Miguez de Mello (CENPES), Rio de Janeiro, Brazil.

*Corresponding author, E-Mail: passarin@utfpr.edu.br

Deep Learning-Based Spatial Coherence Estimation for Ultrasonic NDT

Gabriel O. Vasconcellos¹, Matheus F. Dário¹, Tatiana de A. Prado¹, and Daniel R. Pipa^{1,*}

¹ Universidade Tecnológica Federal do Paraná (UTFPR), Curitiba, Brazil.

*Corresponding author, E-Mail: gabrielvasconcellos@alunos.utfpr.edu.br

Machine learning-driven flaw detection for ultrasonic pipe inspections with acoustic lens

Thiago E. Kalid^{1,*}, André E. Lazzaretti¹, Tatiana A. Prado¹, Gustavo P. Pires², Daniel R. Pipa¹ and Thiago A. R. Passarin¹.

¹ Universidade Tecnológica Federal do Paraná (UTFPR), Curitiba, Brasil. ² Centro de Pesquisa Leopoldo Américo Miguez de Mello (CENPES), Rio de Janeiro, Brasil.

*Corresponding author, E-Mail: passarin@utfpr.edu.br

Suppression of geometrical artifacts from acoustic lenses through low-rank approximation

Vinicius L. Costa¹, Thiago E. Kalid¹, Matheus F. Dário¹, Tatiana de A. Prado¹, Gustavo P. Pires², Daniel R. Pipa¹ and Thiago A. R. Passarin^{1,*}

¹ Universidade Tecnológica Federal do Paraná (UTFPR), Curitiba, Brasil. ² Centro de Pesquisa Leopoldo Américo Miguez de Mello (CENPES), Rio de Janeiro, Brasil.

*Corresponding author, E-Mail: passarin@utfpr.edu.br

Robust virtual encoder: Using ultrasound data for compensation of depth variations in camera-based odometry

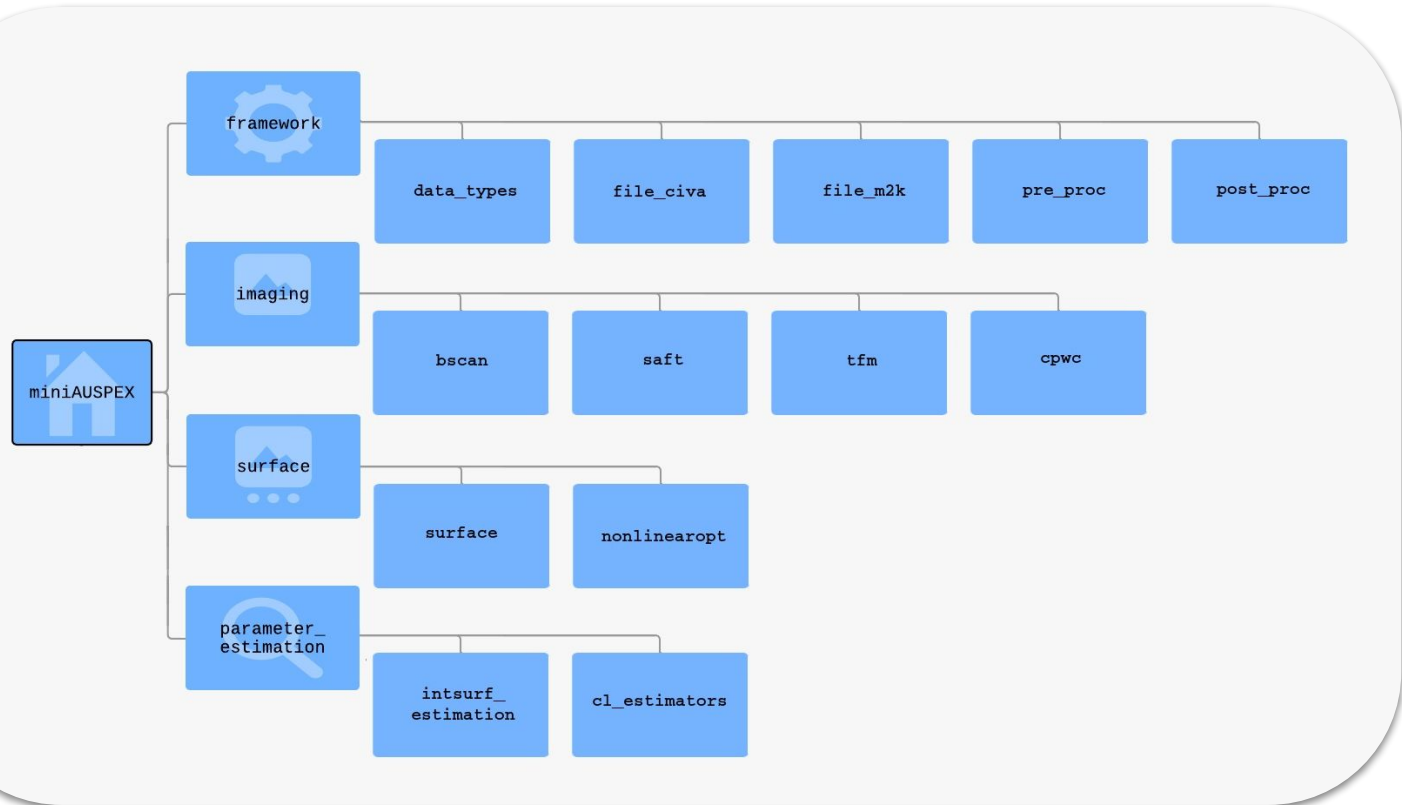
Matheus F. Dário¹, Fernando H. R. Caetano¹, Daniel Santin¹, Henrique M. Guerra¹, Huriel A. dos Santos¹, Thiago E. Kalid¹, Tatiana de A. Prado¹, Gustavo P. Pires², and Thiago A. R. Passarin^{1,*}

¹ Universidade Tecnológica Federal do Paraná (UTFPR), Curitiba, Brasil. ² Centro de Pesquisa Leopoldo Américo Miguez de Mello (CENPES), Rio de Janeiro, Brasil.

*Corresponding author, E-Mail: passarin@utfpr.edu.br

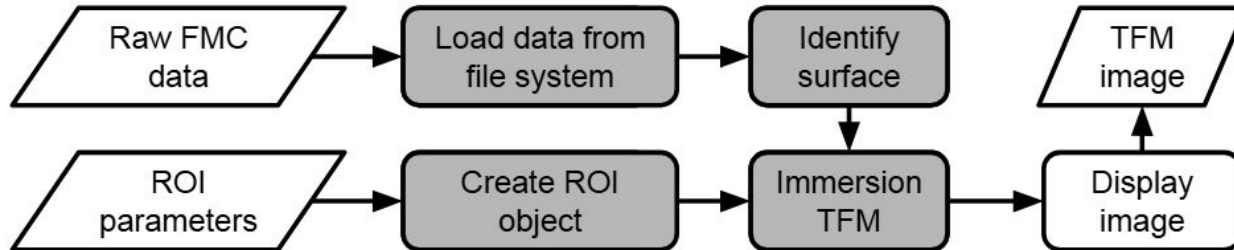
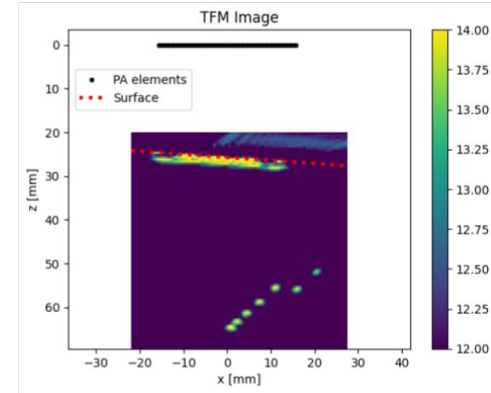
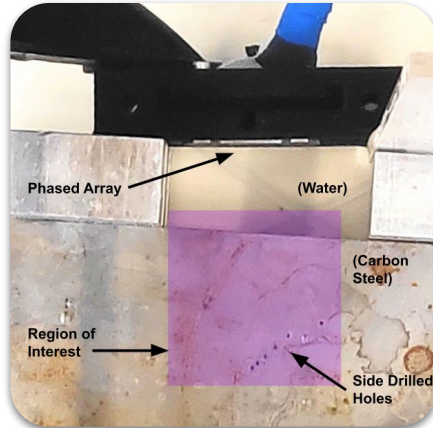
The toolbox structure

Structure of the library



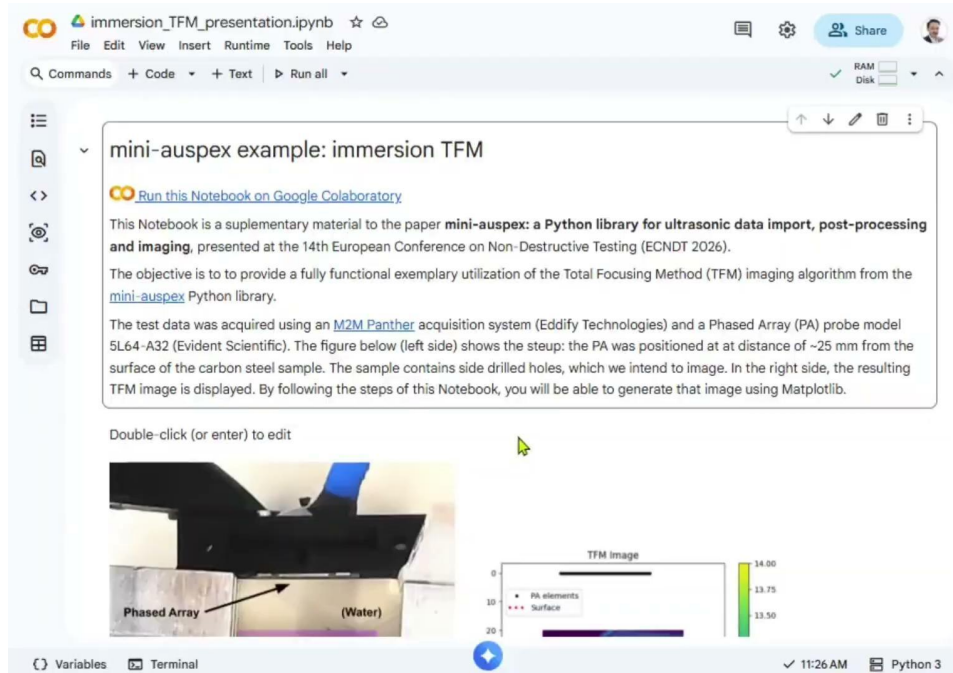
Example on Google Colaboratory

- Link in the paper



Example on Google Colaboratory

- Link in the paper



The screenshot shows a Google Colaboratory notebook interface. The title bar indicates the notebook is named 'immersion_TFM_presentation.ipynb'. The left sidebar contains icons for file management, code execution, and output viewing. The main content area is titled 'mini-auspex example: immersion TFM'. It includes a link to 'Run this Notebook on Google Colaboratory' and a detailed description of the notebook's purpose: to provide a fully functional exemplary utilization of the Total Focusing Method (TFM) imaging algorithm from the 'mini-auspex' Python library. The text describes the test data acquisition using an 'M2M Panther' system and a 'Phased Array (PA) probe model 5L64-A32'. It mentions that the figure below (left side) shows the setup: the PA was positioned at a distance of ~25 mm from the surface of the carbon steel sample, which contains side drilled holes. The right side of the figure displays the resulting TFM image. Below the text, there is a placeholder for a figure, with the instruction 'Double-click (or enter) to edit'. The figure itself is a composite image. On the left, it shows a physical setup with a 'Phased Array' probe and a '(Water)' tank. On the right, it displays a 'TFM image' plot. The plot has a y-axis ranging from 0 to 20 and a color scale on the right ranging from 13.50 to 14.00. The plot includes a legend with 'PA elements' (represented by blue dots) and 'Surface' (represented by red dots). The plot shows a horizontal line at the bottom, likely representing the surface, and a series of vertical lines above it, likely representing the PA elements.

immersion_TFM_presentation.ipynb

File Edit View Insert Runtime Tools Help

Commands + Code + Text Run all

mini-auspex example: immersion TFM

[Run this Notebook on Google Colaboratory](#)

This Notebook is a supplementary material to the paper **mini-auspex: a Python library for ultrasonic data import, post-processing and imaging**, presented at the 14th European Conference on Non-Destructive Testing (ECNDT 2026).

The objective is to provide a fully functional exemplary utilization of the Total Focusing Method (TFM) imaging algorithm from the [mini-auspex](#) Python library.

The test data was acquired using an [M2M Panther](#) acquisition system (Eddify Technologies) and a Phased Array (PA) probe model 5L64-A32 (Evident Scientific). The figure below (left side) shows the setup: the PA was positioned at a distance of ~25 mm from the surface of the carbon steel sample. The sample contains side drilled holes, which we intend to image. In the right side, the resulting TFM image is displayed. By following the steps of this Notebook, you will be able to generate that image using Matplotlib.

Double-click (or enter) to edit

Phased Array (Water)

TFM image

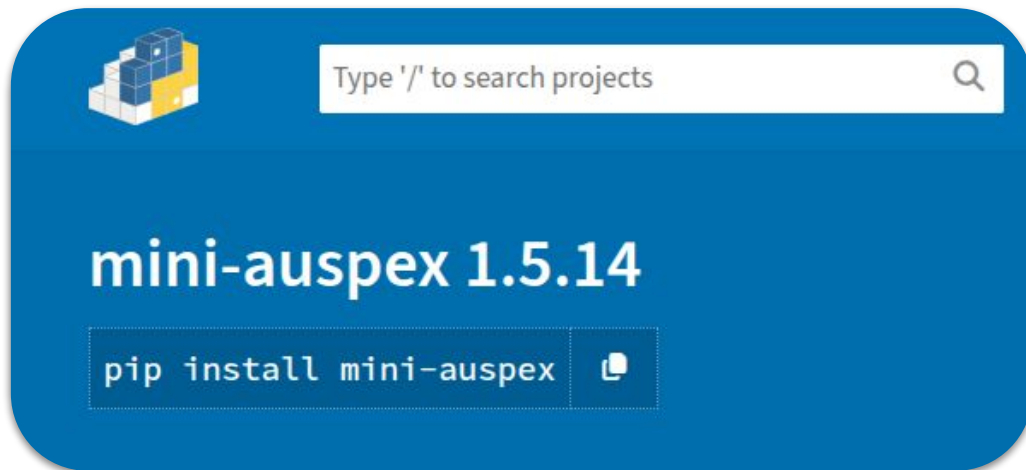
PA elements Surface

11:26 AM Python 3

Conclusions

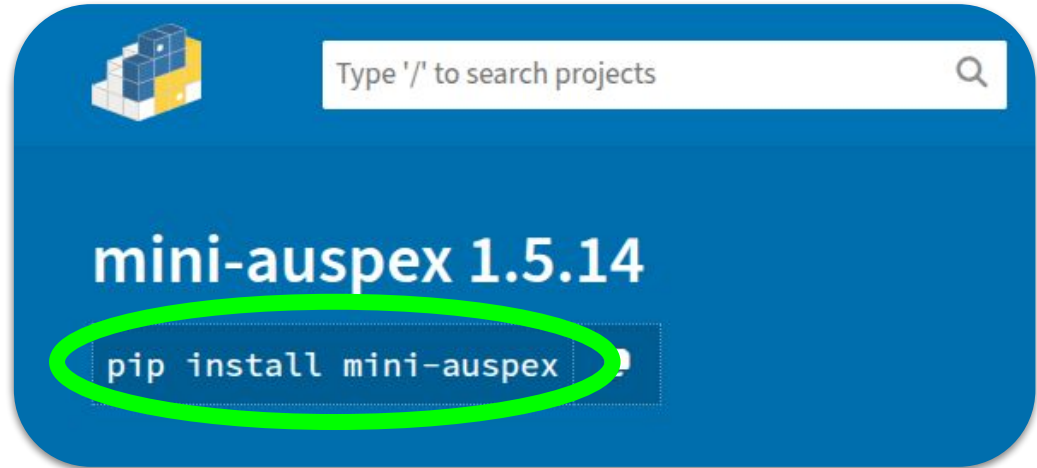
Conclusion

- Free NumPy-based ultrasound data processing library
- Useful and prolific for our group
- We hope it helps other research groups



Finally...

- Try it
- Cite it
- Give us feedback
 - Suggestions
 - Requests
 - Bug reporting



Acknowledgements

Thanks to

- UTFPR
- Petróleo Brasileiro S.A. (Petrobras)
- ANP / PRH-21.1
- Fundação Araucária
- CAPES



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VERONA, 15-19 JUNE



Thank you!

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