

Universal measuring system for composite and combined waveforms measurements

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1. INTRODUCTION

Traditionally, high voltage laboratories have required different measuring systems to measure high voltages: DC, 50/60 Hz (AC) and impulses, all of them with very different technical requirements established in standards (IEC 60060 series [1, 2] IEC 61083 series [3]). However, the technological evolution of measuring instruments and components has allowed these measurements could be carried out through high-performance digital recorders and dividers. LCOE has developed a new universal measuring instrument [4], known as UMU (Universal Measuring Unit), for the measurements to be carried out in HV laboratories: AC 50/60 Hz, DC, Lightning impulse 1.2/50 μ s (LI) and Switching impulse 250/2500 μ s (SI).

The universal measuring system is composed by the UMU with a new software package, a short measuring cable and the modular universal divider developed in the framework of 19NRM07 HV-com² [5]. UMU is designed to be arranged in proximity to the divider limiting the length of the measurement cables. Fiber optic ensures galvanic isolation between the testing facilities and the control room where the technicians operate the computers and monitors, as well as avoiding electromagnetic interference.

This new system (Figure 1) is used for composite and combined waveforms in which high-performance and accurate equipment in the whole frequency range from DC up to MHz is needed (flat frequency response).

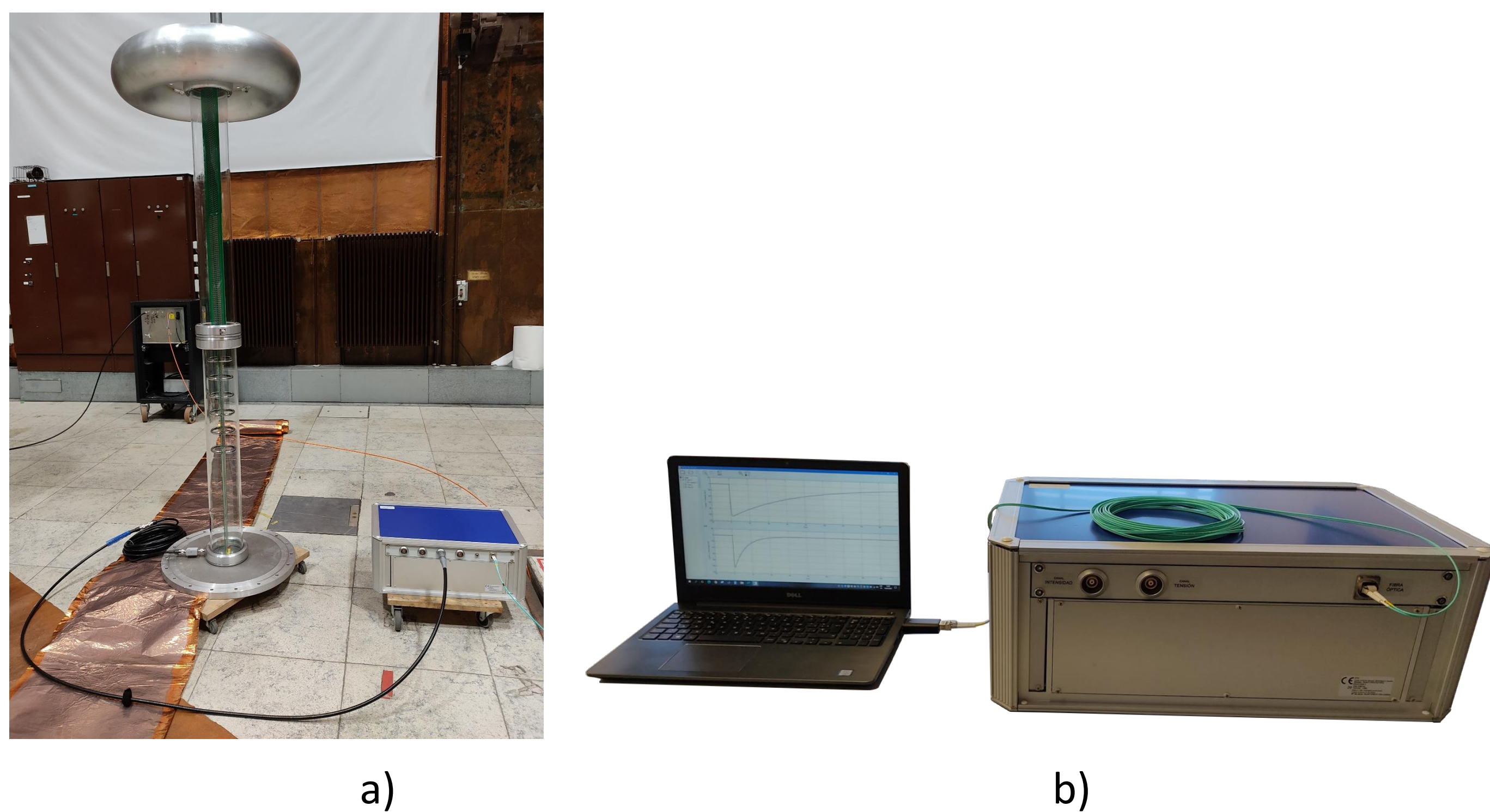


Figure 1. Universal measuring system: a) Divider + UMU; b) UMU.

2. UNIVERSAL MODULAR DIVIDER

A modular universal divider has been developed by HV-com² partners [6] based in SMD components on a circuit board. The main performances are shown in the table:

Number of boards	1	2	4
Maximum peak voltage	100 kV	200 kV	400 kV
Scale factor	1000:1	2000:1	4000:1
HV capacitance	850 pF	425 pF	212 pF
HV resistance	600 M Ω	1.2 G Ω	2.4 G Ω
Internal damping	120 Ω	240 Ω	480 Ω
External damping	125 Ω	250 Ω	500 Ω

3. UMU UNIVERSAL MEASURING INSTRUMENT

3.1. Digital recorder

UMU measuring instrument has a recorder with a suitable frequency response of up to 16 bits for power frequency (50/60 Hz), up to 12 bits with a sampling rate of 250 MS/s for LI and can work up to 1 GS/s with 8 bits. A bandwidth of up to 200 MHz guarantees its suitability for use in any measurement to be carried out in a HV laboratory. A shielding has been designed to mitigate the electromagnetic interferences produced during tests, especially when disruptive discharges occur.

3.2. Attenuator

UMU incorporates a high-bandwidth attenuator adapted to the low voltage branch of the divider and the input impedance of the digitizer. Figure 2 shows the inner enclosure of the UMU.

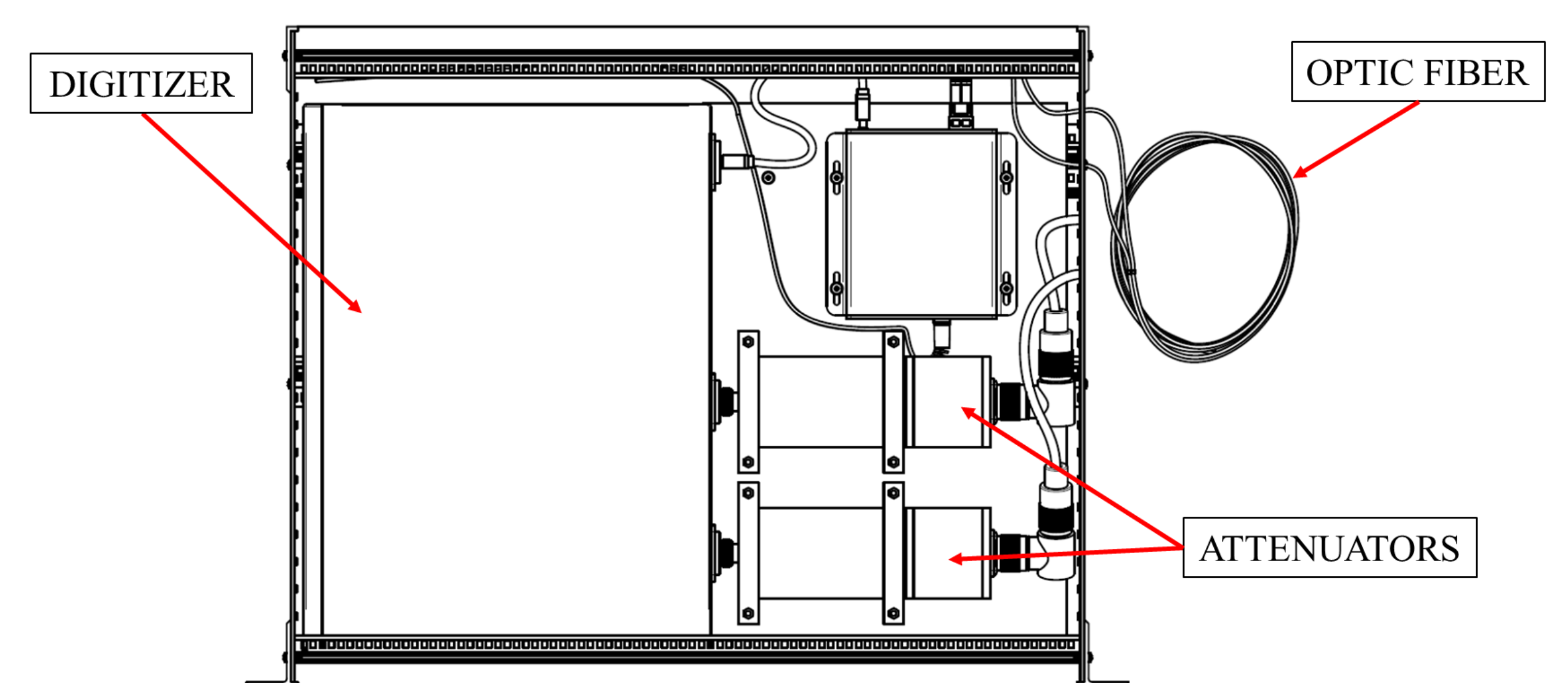


Figure 2. Inner enclosure of UMU.

3.3 Software

LCOE has improved the software, initially designed to evaluate different tests according to [1]. This new version has been developed to include combined and composite voltage waveforms analysis. A view of the user interface and the flowchart corresponding to the software analysis for composite and combined waveshapes are shown in Figure 3.

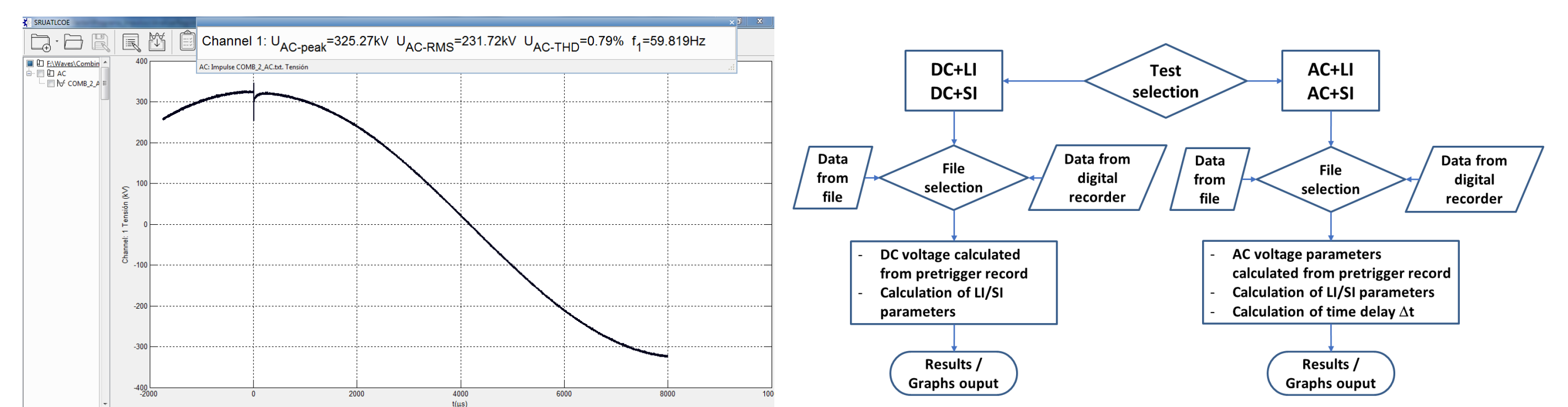


Figure 3. Software interface and flowchart.

4. CONCLUSIONS

LCOE has developed a new universal measuring system, consisting of UMU measuring instrument (+ software), a short measuring cable and the universal divider, capable of carrying out the different types of high voltage measurements : AC 50/60 Hz, DC, LI and SI. LCOE has calibrated the complete universal measuring system according to the standards.

5. REFERENCES

- [1] IEC 60060-1 "High-Voltage Test Techniques – Part 1: General definitions and test requirements", 2010.
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- [3] IEC 61083-1 "Instruments and software used for measurement in high-voltage impulse tests – Part 1: Requirements for instruments", 2001.
- [4] A. Khamlichi, F. Garnacho, J. Rovira, P. Simón, T. García, "Universal Measuring Unit for High Voltage Measurements", NordIS-22, June 2022.
- [5] EURAMET EMPIR Project: 19NRM07 HV-com² "Support for standardisation of high voltage testing with composite and combined wave shapes", 2020-2024.
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