

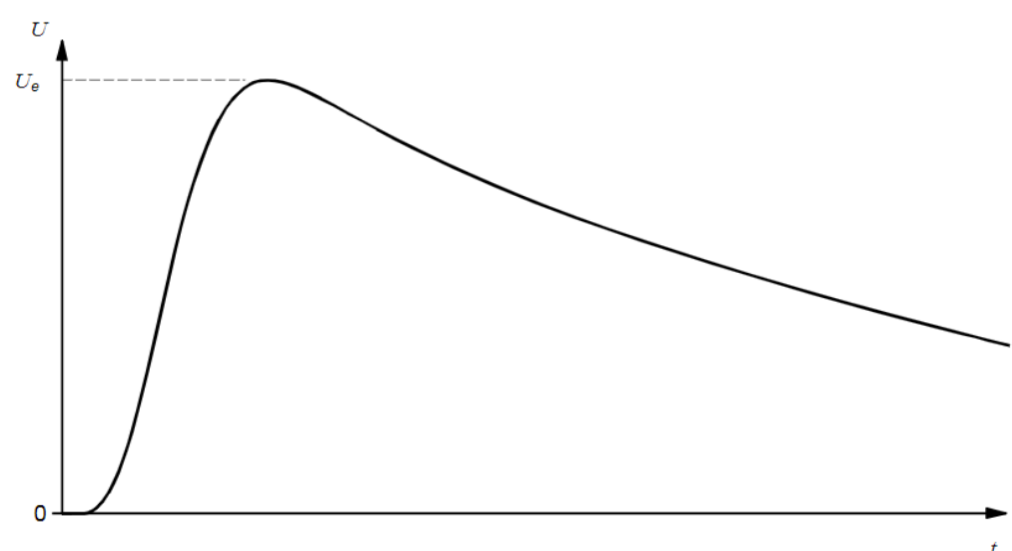
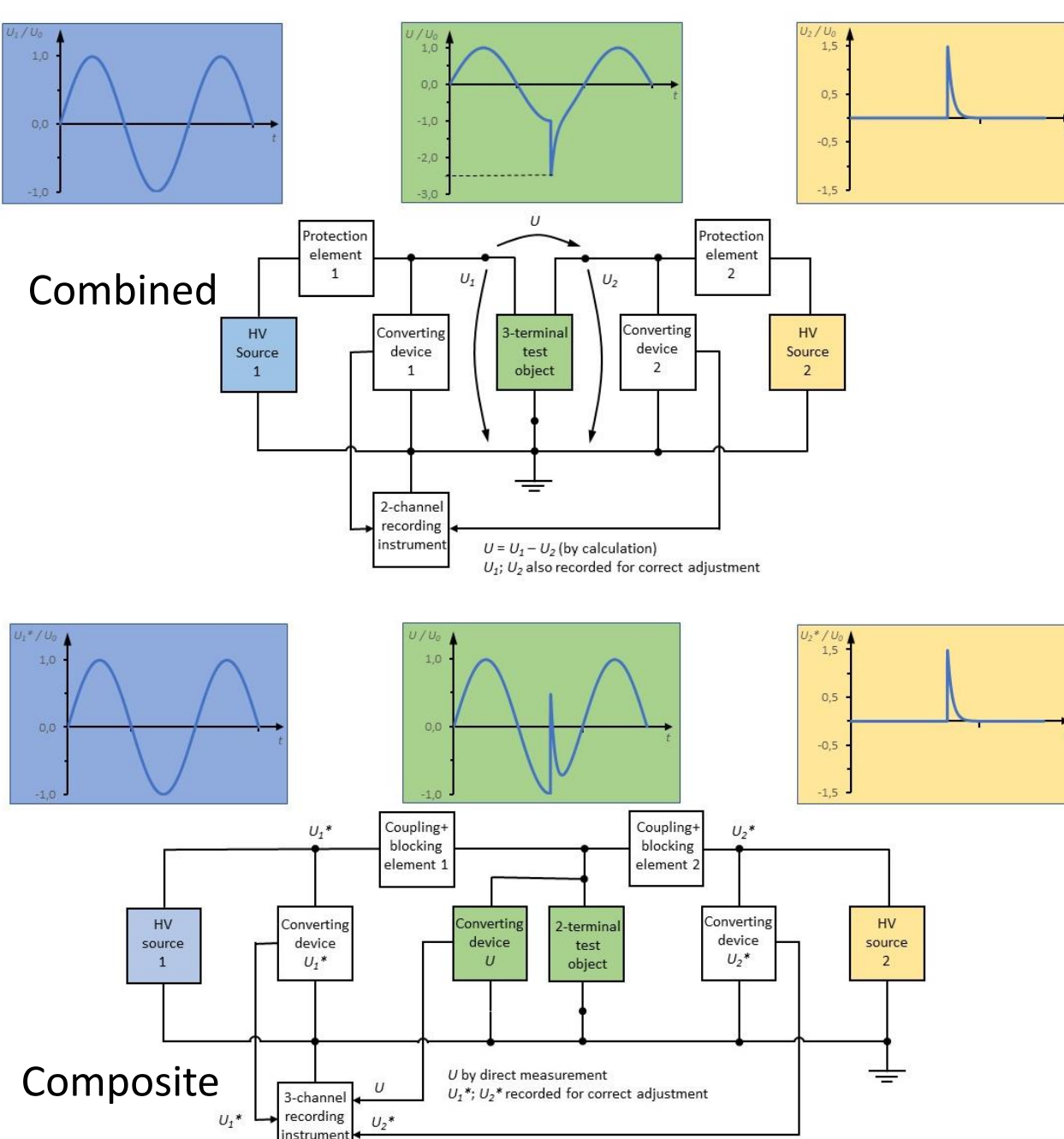
Research context and motivation

- My research activity is performed in the framework of the research area for the Laboratorio Alte Tensioni e Forti Correnti (LATFC) of Istituto Nazionale di Ricerca Metrologica (INRiM), where I'm deeply studying the problems relative of high voltage and high current calibration and test measurements. This activities are very important for the reliability of the electrical network, because an accurate measurement of the electrical phenomena enables us considering the system operation more trustable, safe for the workers and secure to function in the electrical grid.
- The increasing energy production by renewables, with the consequent reduction of the inertia of the electrical system, require an improvement of the network resilience, also reached by performing new tests on the components. With my research activity I intend to enhance my expertise on high voltage and high current tests and become an acknowledged reference scientist in the field.



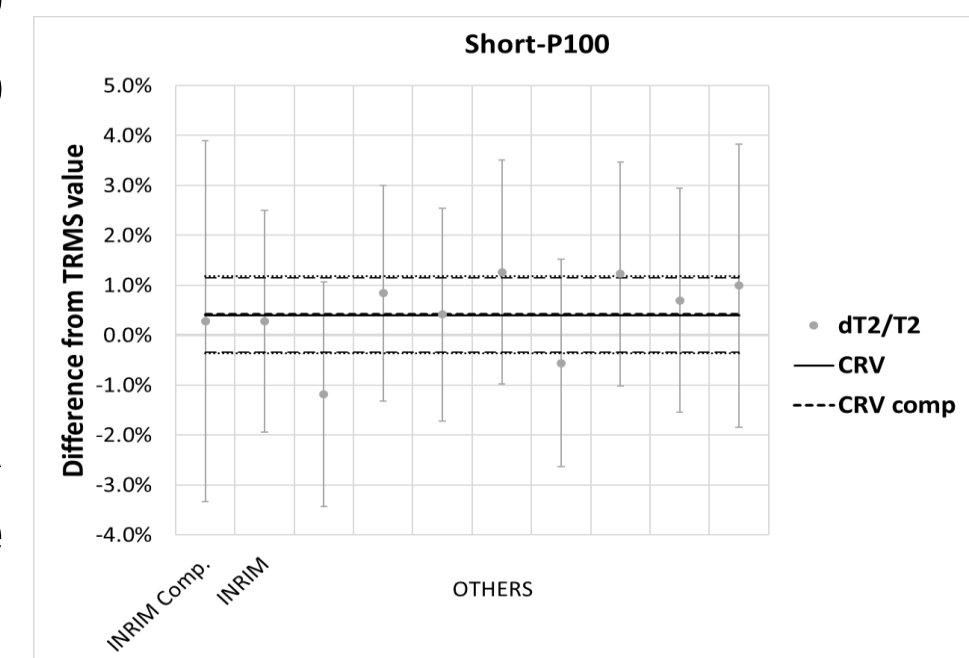
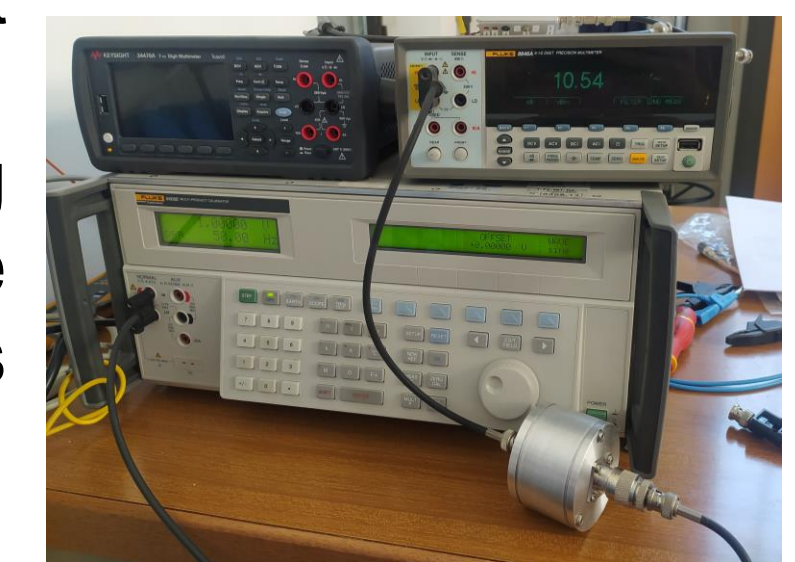
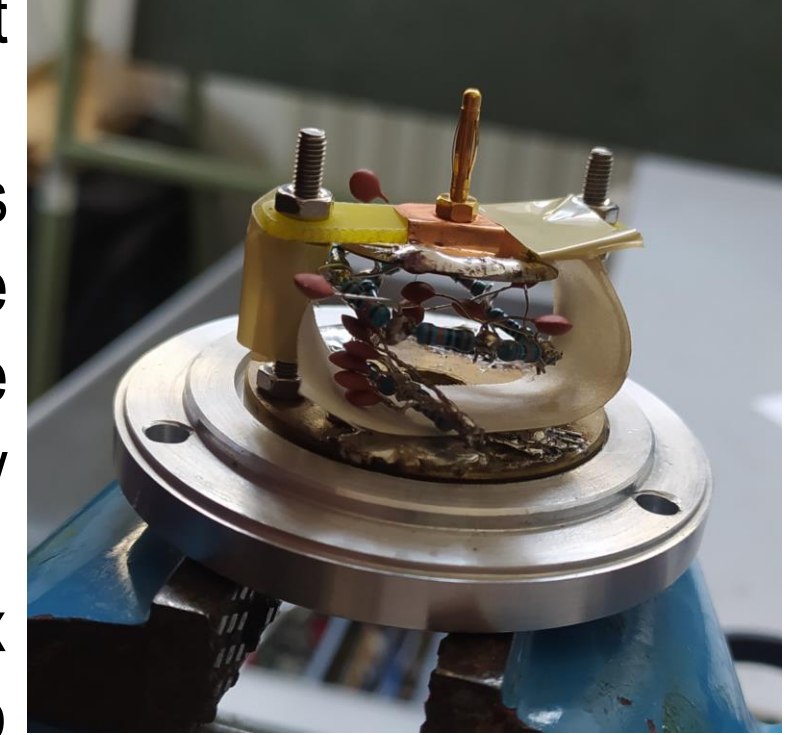
Addressed research questions/problems

- To improve the resilience of the network, with other partners of the European project HV-com² I am studying high voltage tests with combined and composite waveforms that are complex phenomena to simulate, in two different types of tests, the superposition of a lightning impulse during the normal condition of the electrical components. With this project we studied the suggestion to send to the Technical Committee for the next version of the IEC 60060 series. We need to investigate how to perform the tests and the calibrations, also considering the identification of the parameters to be measured. The first two figures show the schematic of these complex phenomena.
- Another important research question is: "How to reduce the uncertainty of the measuring systems for high voltage measurements?". Specifically in this year I focused my attention on the measurements of lightning impulse waveforms, mostly related with the European project.



Adopted methodologies

- Since I had to measure many different voltage waveforms, I chose a compensated voltage divider, that is, a configuration with resistor and capacitor in parallel that permit to have a good behavior with the step response.
- To verify the scale factor of the divider I use a calibrator as voltage source and a digital multimeter to measure the output of the divider and perform the calibration of the divider with different waveforms: DC, AC, high frequency AC.
- To develop the software capable to measure those complex waveform I had to use LabVIEW language that allows to create virtual instruments and perform many different measurements.
- To perform the reduction of the uncertainty of the lightning impulse measuring system I had to study the literature referring to the comparison and realize a sheet that permits to modify the uncertainty and recalculate all results.
- The recalculation permits to verify if our uncertainty targets were acceptable during the comparison. The verification was positive and enables us to request to the international supervisor of the results the right to indicate a lower the uncertainty on the calibration capabilities of the INRiM laboratory.
- We validate the reanalysis with the convolution method that permit to simulate the response of a measuring system under lightning impulse using the STEP response of it.
- This work was presented at the IMEKO TC4 international symposium.



Future work

- Development and realization of high voltage universal divider up to 200 kV. The divider must be able to measure precisely and with uniform scale factor many different waveforms: AC, DC, LI, SI and their composition
- The study of the changes to be made to reduce the uncertainty with the improve of the hardware and software for lightning impulse measuring system for voltages up to 600 kV
- Study of the "running arc" (experiment of the short circuit) to investigate if this kind of experiments could be used to improve the test of internal arc measurements and make some suggestions to the technical committee for reliability of electrical network and devices.

Novel contributions

- We had participated to an inter-laboratory comparison between the partner of the HV-com² European project that has the purpose to verify the capability of each partner to measure the composite and combined voltage waveform up to 1 kV.
- For this comparison I had to develop a voltage divider with a scale factor of about one hundred that permits to reduce 1 kV to 10 V in order to use a NI scope card that has 10 V as maximum scale, with time response compliance with standard for reference systems.
- Another contribution was the development of the software capable to measure those complex phenomena, this software was compared with the software developed by other participants.
- To reduce the uncertainty of the lightning impulse measuring system for voltage up to 200 kV I performed a complete reanalysis of the international comparison document EURAMET.EM-S42 to verify the feasibility of the reduction of uncertainty without performing any changes on the hardware of the system.

Submitted and published works

JOURNAL PAPERS

- Galliana, F., Bellavia, L., Caria, S.E., Perta, A.P., and Roccatò, P.E., "The Effect of Thermal Stresses on the Electrical Resistance of Crimped Connections", MAPAN, prepublished online, 2022, DOI: 10.1007/s12647-022-00574-1 (18/06/2022)
- Galliana, F., Caria, S.E., and Roccatò, P.E., "Towards a traceable divider for composite voltage waveforms below 1 kV", Electrical Engineering, no. 104, 2022, pp. 1121-1130, DOI: 10.1007/s00202-021-01368-5 (09/08/2021) issue April 2022

CONFERENCE PAPER

- Caria, S.E., and Roccatò, P.E., "Improvement of calibration capabilities with an a posteriori evaluation of the lightning impulse international comparison EURAMET.EM-S42", 25th IMEKO TC4 International Symposium, Brescia, 12-14 September 2022, pp. 171-176, accepted and presented, online publication pending.

List of attended classes

SOFT SKILLS, total hours 40 h

- 01RISRV – Public speaking (29/11/2021, 5 h)
- 01SHMRV – Entrepreneurial Finance (23/12/2021, 5 h)
- 01SWPRV – Time management (22/11/2021, 2 h)
- 01SWQRV – Responsible research and innovation, the impact on social challenges (11/01/2022, 5 h)
- 01SYBRV – Research integrity (11/02/2022, 5 h)
- 01UNXRV – Thinking out of the box (18/11/2021, 1 h)
- 01UNYRV – Personal branding (19/11/2021, 1 h)
- 02LWHRV – Communication (11/01/2022, 5 h)
- 02RHORV – The new Internet Society: entering the black-box of digital innovations (06/01/2022, 6 h)
- 08IXTRV – Project management (10/01/2022, 5 h)

HARD SKILLS, total points 141,33

- 01DOARV – Electrical demand management (23/09/2022, 25 h, not yet registered)
- 01DTORU – Measurements and Metrology for Smart Electricity Grids (25/05/2022, 25 h, not yet registered)
- 01LEVRV – Power system economics (07/09/2022, 21,33)
- 01RGRV – Optimization methods for engineering problems (07/06/2022, 50)
- 02SFURV – Programmazione scientifica avanzata in MATLAB (26/05/2022, 40)
- Summer School on Smart Grid - Salerno (07/07/2022, 30)