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**EURAMET EMPIR Research Potential Project 17RPT03**  
*A digital traceability chain for AC voltage and current*

**OVERVIEW OF THE PROJECT**

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# INTRODUCTION

- **17RPT03 DIG-AC – A digital traceability chain for AC voltage and current**
- **EURAMET EMPIR Research Potential project - June 2018 to May 2022 (after prolongation for 1 year)**
- **There is a need for a new traceability scale for current and voltage waveforms based on measurements using digital instruments (digital measurements), namely digitisers**
- **To achieve the required accuracy, this new digital traceability chain needs to be implemented and verified using a quantum standard for electrical measurements**

# Partners

**Sveučilište u Zagrebu Fakultet elektrotehnike i računarstva (FER-PEL), Croatia – project coordinator**

**Czech Metrology Institute (CMI), Czech Republic**

**Centro Español de Metrología (CEM), Spain**

**Central Office of Measures (GUM), Poland**

**Istituto Nazionale di Ricerca Metrologica (INRIM), Italy**

**Instituto Português da Qualidade, I.P. (IPQ), Portugal**

**Justervesenet (JV), Norway**

**AS Metrosert (Metrosert), Estonia**

**NPL Management Limited (NPL), United Kingdom**

**Physikalisch-Technische Bundesanstalt (PTB), Germany**

**Türkiye Bilimsel ve Teknolojik Arastırma Kurumu (TUBİTAK), Turkey**

**Universidad de Málaga (UMA), Spain**

**Collaborators : Supracon AG Jena, Germany; Left Right d.o.o., Slovenia**

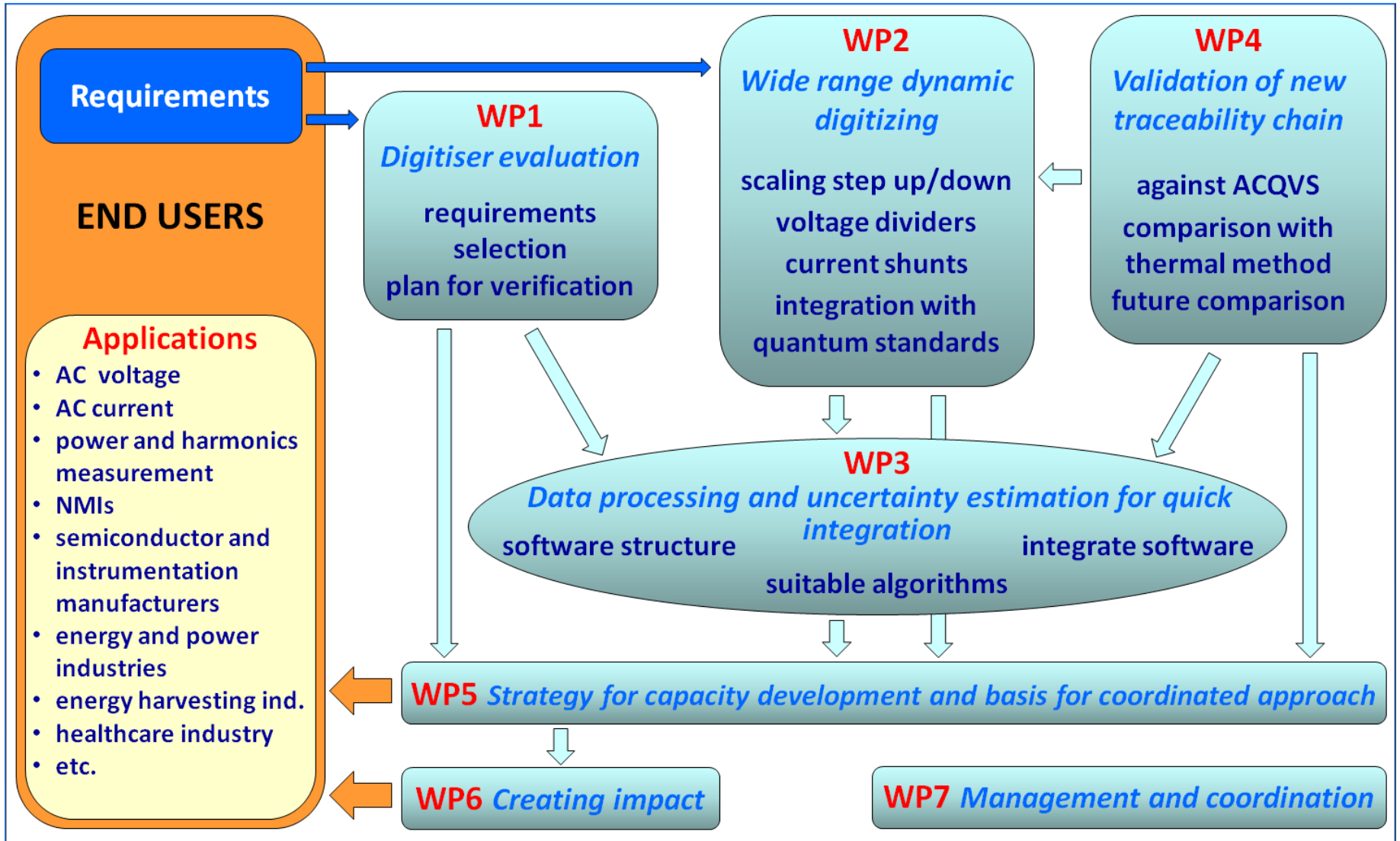


# MOTIVATION

- ❖ To cover metrological needs of AC voltage (V) and current (I) traceability using digital techniques with AC Quantum Voltage Standards (ACQVS) as fundamental references.
- ❖ To combine the outputs of the previous and on-going European funded projects (JOSY, Q-WAVE, QuADC, ACQ-PRO) for a new digital traceability scale for V and I waveforms.
- ❖ To provide coordinated development of the new digital electrical infrastructure with a rapid and uniform integration in any NMI, reducing the gaps between them.

# WORK PACKAGES

- **WP1:** Digitiser Evaluation - **TUBITAK**
- **WP2:** Wide Range Dynamic Digitising – **INRIM**
- **WP3:** Data processing and uncertainty estimation for quick integration - **CEM**
- **WP4:** Validation of the new traceability chain – **NPL**
- **WP5:** Strategy for capacity development and basis for coordinated approach – **PTB**
- **WP6:** Creating impact – **GUM**
- **WP7:** Management and coordination – **FER-PEL**



# EXCELLENCE

- ▶ **New analysis of methods and techniques for scaling  $V$  and  $I$  and integration with quantum standards, up to 1 A and up to 100 V at 10 kHz (amplitude and phase accuracy).**
- ▶ **The first integration of dividers and shunts with digitisers for wideband dynamical signals that will reduce the effect of the a/d converter on the scaling network, minimising loading and instabilities.**
- ▶ **The integration of data processing (algorithms) and uncertainty estimation as a major step forward in providing a complete AC measurement solution.**
- ▶ **A guideline for the design of the scaling section in measurement systems for quantum traceable calibrations of dynamic signals.**
- ▶ **Application of ACQVS to characterise and validate the new system and system components.**



# MAIN OBJECTIVES

## 1. WP1

**To define the digitiser requirements and metrological grade electrical parameters for digital electrical measurements for AC voltage and current, including identifying the traceability and performance requirements related to the use of AC quantum voltage standards**

# MAIN OBJECTIVES

## 2. WP2

**To develop measurement systems employing digital techniques for use at NMIs and calibration laboratories to achieve a practical realisation of step-up and step-down procedures (scaling) for electrical current and voltage, beginning with a Josephson standard as the fundamental reference**

# MAIN OBJECTIVES

## 3. WP3

**To develop publicly available methods, algorithms and software for the traceability chain of dynamic measurements, including data processing and uncertainty estimation, for use by NMIs and calibration laboratories. The methods should facilitate the quick integration of future improvements.**

# MAIN OBJECTIVES

## 4. WP4

**To validate the complete system of digital measurement of AC voltage and current, including passive coaxial current and voltage devices, algorithms, and software. To use the validated system as the basis to define the protocol for a future intercomparison of digital AC voltage and current standards between European NMIs.**

# MAIN OBJECTIVES

## 5. WP5

**For each participant, to develop an individual strategy for the long-term operation of the capacity developed, including regulatory support, research collaborations, quality schemes and accreditation. The individual strategies should ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.**

# IMPACT

- ⊙ **The outputs of the project will be relevant to the international standards (IEEE 1241-2010, IEEE 181-2011, IEEE 1057-2007, IEEE 658-2011, IEC 60748-4-3:2006), etc.**
- ⊙ **The digital electrical metrological infrastructure resulting from the project will support the development of new measurement procedures.**
- ⊙ **Availability of dynamic measurements of  $V$  and  $I$  waveforms will have impact in many stakeholder groups which are directly traceable to AC quantities.**
- ⊙ **Improved measurements of  $V$  and  $I$  waveforms due to digital traceability will lead to, amongst others, more efficient control of environment conditions and energy saving.**
- ⊙ **Dissemination: web site, papers, training, tutorials, conference presentations, industry workshop.**

# LIST OF DELIVERABLES

Deliverable number	Deliverable description
D1	Report on the selection of three digitisers and their parameters that meet the necessary requirements for digital traceability chain. This will include the performance related to the requirements of using AC quantum voltage standards.
D2	Report on the best quantum-based system verification approach for testing digitisers to provide digital traceability chain for AC voltage and current
D3	Guidelines on the development of scaling systems employing digital techniques for use at NMIs and calibration laboratories for the practical realisation of step-up and step-down procedures and scaling of electrical current and voltage
D4	Report on the integrated software for data processing and uncertainty estimation of dynamic measurements, including related methods and algorithms
D5	Paper on the validation of the complete system, including passive coaxial current and voltage devices, algorithms, and software submitted to a peer-reviewed journal
D6	Protocol for a future intercomparison of digital AC voltage and current standards between European NMIs
D7	Agreed individual strategies and coordinated strategic plan for the long-term development of FER, CEM, CMI, IPQ, JV, GUM, Metroser, NPL, INRIM, PTB and TUBITAK research capability in digital traceability chain for AC voltage and current metrology
D8	Good Practice Guide on traceability of digital dynamic measurements of AC voltage and current.
D9	Evidence of contributions to or influence on new or improved international guides, recommendations and standards with a specific focus on the following guides and committees: EURAMET TC-EM, EURAMET TC-EM SC Low Frequency, EURAMET TC-EM SC Quantum Metrology, EURAMET TC-EM SC Power and Energy. Examples of early uptake of project outputs by end-users
D10	Delivery of all technical and financial reporting documents as required by EURAMET

# DATA MANAGEMENT

- **The project will make its research data Findable, Accessible, Interoperable and Reusable (FAIR) in order to ensure that it is soundly managed**
- **The consortium will produce a suitable Data Management Plan (DMP) which will cover the following aspects:**
  - the handling of research data during and after the end of the project;
  - specification of the data that will be collected, processed or generated;
  - the methodology and standards (including data security and ethical aspects) that will be applied;
  - plans for data duration and preservation (including after the project)



# LETTERS OF SUPPORT

- **Metrosol, UK**
- **PGZ, Poland**
- **Supracon, Germany**
- **SONEL S.A., Poland**
- **NDN, Poland**
- **LCOE, Spain**
- **BBJ, Poland**
- **Anritsu, Italy**
- **PGZ, Poland**
- **CWOM, Poland**
- **IEP, Portugal**
- **INMEL, Poland**

# CONCLUSIONS

- **Overview of the Research Potential Project 17RPT03 of the EURAMET EMPIR Programme is presented**
- **It is important to mention fruitful collaboration amongst the partners from many European countries during the running of this project**
- **Project web page: <http://digac.gum.gov.pl/>**

# Thank you!