



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA



EMPIR 19NRM05 IT4PQ

WP3 - Performance evaluation in presence of multiple influence factors

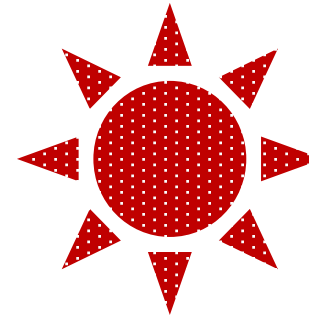
Stakeholder Workshop – February 9, 2022

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Partners involved

- ❖ UNIBO
- ❖ INRIM
- ❖ LNE
- ❖ PTB
- ❖ TUBITAK
- ❖ VSL
- ❖ TUD



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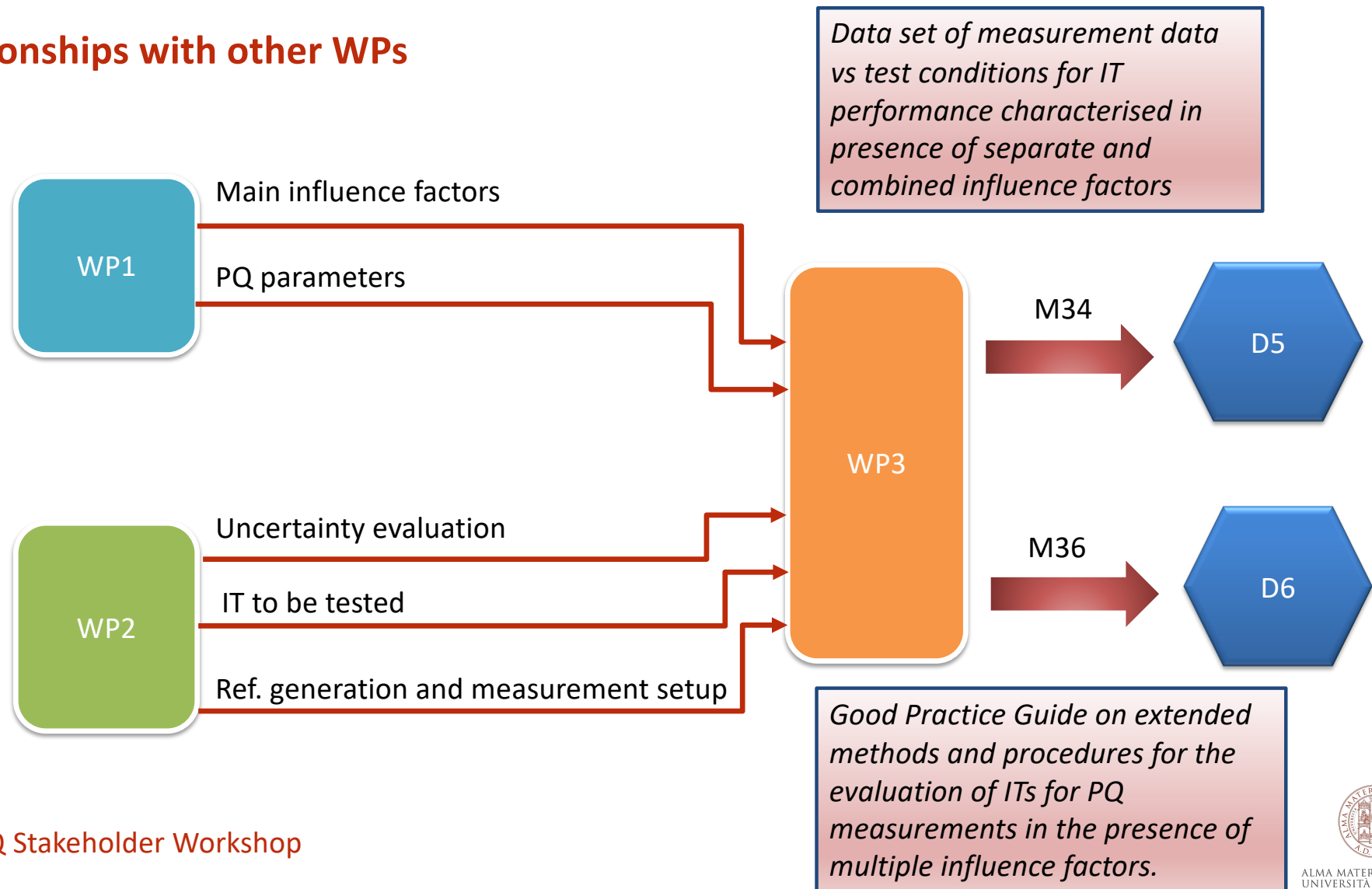
Goals

1. Evaluate the performance of ITs in PQ measurements in the presence of more than one influence factors
2. Define simplified test conditions and procedures for their evaluation

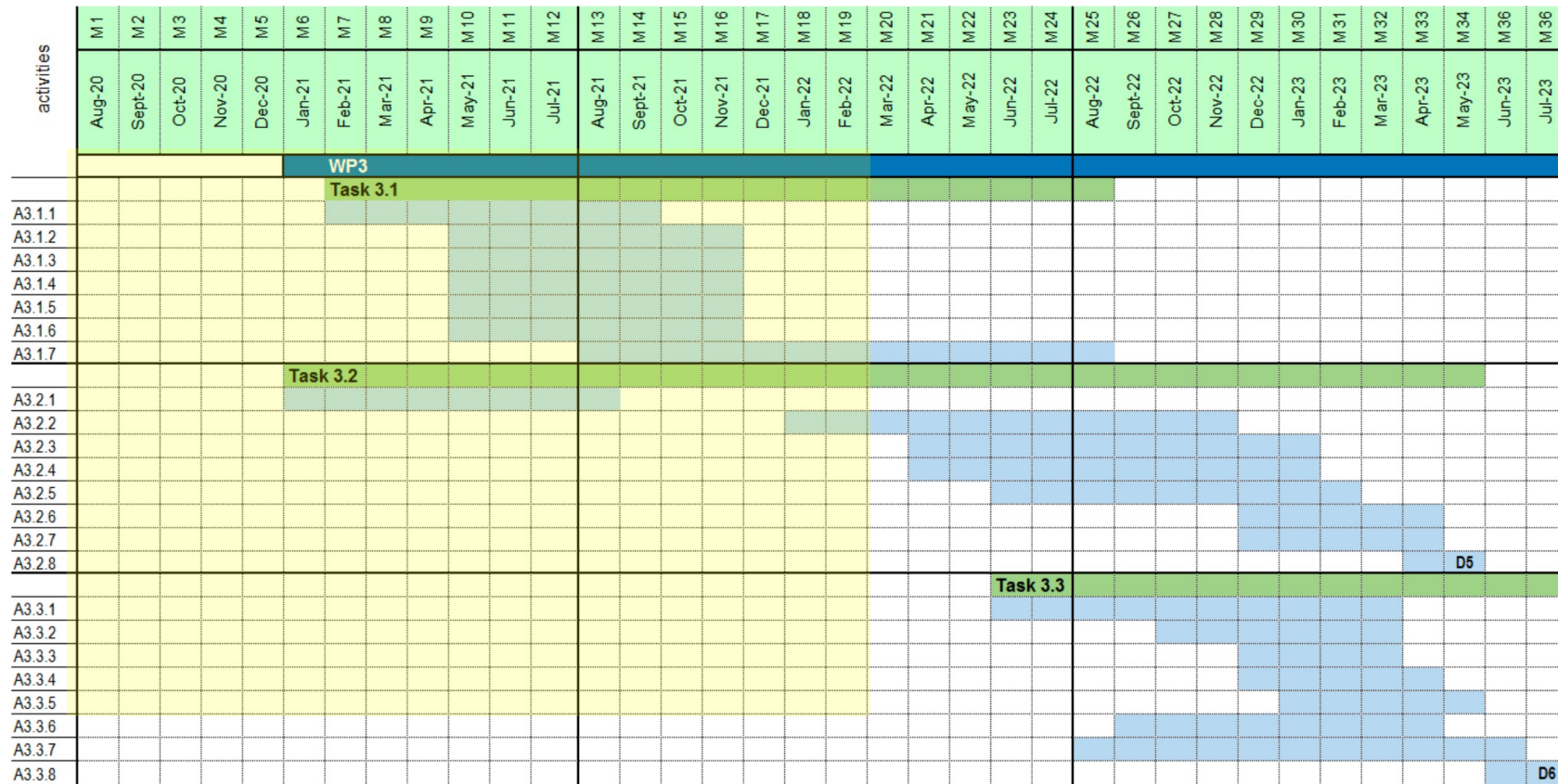
Current standards take into account the effects of several influence quantities. But:

- ❖ More of them can be present at the same time
- ❖ There is no evidence that their effect can be linearly combined
- ❖ PQ parameters are not considered

Relationships with other WPs



Time scheduling



WP organization

1. Testing conditions and adapted measurement set-ups

- ❖ Aimed at defining the testing conditions for evaluating the effect of the main influence factors on the measurement of PQ parameters and to adapt the measurement set-ups for combined analysis of influence factors.

2. Evaluation of separate and combined influence factors

- ❖ Aimed at evaluating and quantifying the influence of separate and combined influence factors on ITs. To this end, results from tests performed with both separate and combined influence factors tests will be compared.

3. Methods and procedures for the evaluation of the influence of multiple influence factors

- ❖ Aimed at defining simplified methods and procedures for the evaluation of ITs for PQ measurements in presence of combined influence factors, extending methods and procedures developed in WP2 to these more challenging test conditions.

Task 3.1

- ❖ Start: M7 (February 2021)
- ❖ End: M25 (August 2022)
- ❖ Inputs: results of A1.1.4, A1.1.5, A1.1.11, A2.1.3, A2.1.4, A2.2.2
- ❖ Output: test conditions, procedures and architectures for evaluating the effect of main influence factors on a subset of PQ indices (to task 3.2)
- ❖ Divided into 7 activities:
 1. Definition of test conditions
 2. Temperature and Vibration
 3. Adjacent Phases and Proximity Effect
 4. Burden and temperature
 5. Burden and power frequency variations
 6. Burden and adjacent phases
 7. Adaptation of reference measurement set-ups

Task 3.2

- ❖ Start: M6 (January 2021) – M18 (January 2022)
- ❖ End: M34 (May 2023)
- ❖ Inputs: A1.1.7, A2.1.6, T3.1
- ❖ Outputs:
 1. D5 «Data set of measurement data vs test conditions for IT performance characterised in presence of separate and combined influence factors ,including concise description of measurement data and test conditions», also input for task 3.3
 2. Open-access paper
- ❖ Divided into 8 activities:
 1. Analysis of data available from literature (M6)
 2. Performance tests with separate influence factor (M18)
 3. Tests carried out with combined influence factors.
 4. Uncertainty evaluation
 5. Comparison between separate and combined presence of influence factors
 6. Submission of a paper to an open-access journal
 7. Data set of measurement data vs test conditions
 8. Data set review and D5 submission

Task 3.3

- ❖ Start: M23 (June 2022)
- ❖ End: M36 (July 2023)
- ❖ Inputs: results of task 3.2
- ❖ Outputs: D6 “Good Practice Guide on extended methods and procedures for the evaluation of ITs for PQ measurements in the presence of multiple influence factors”.
- ❖ Divided into 8 activities:
 1. Criteria for significance of the effect of influence factors
 2. Definition of simplified test procedures
 3. Examples of ITs characterisations
 4. Application of simplified procedure
 5. Validation by comparison
 6. Accuracy and uncertainty limits in presence of influence factors
 7. Good practice guide
 8. Guide review and D6 submission

Progress of activities (1/6)

- ❖ All the activities are on schedule
- ❖ Test conditions and measurement setups have been defined for different kinds of influence quantities.
- ❖ Temperature: 3 temperature classes according to IEC 61869-1: $5^{\circ}/40^{\circ}$; $-25^{\circ}/40^{\circ}$; $-40^{\circ}/40^{\circ}$.

Class	Lowest temperature in °C	Highest temperature in °C	Description
3K20	+20	+25	Fully air-conditioned, enclosed places
3K21	+15	+32	Constantly tempered places
3K22	+5	+40	Tempered places
3K23	-5	+55	Enclosed places without temperature control
3K24	-25	+55	Places without temperature control

IEC 60721-3-3

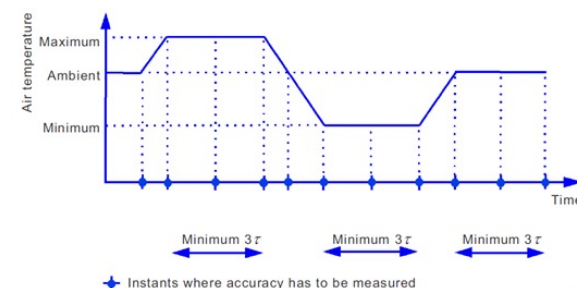


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Possible test waveform conditions for VT:

FH1 Test: Fundamental plus 1 Harmonic tone:

- Fundamental tone at rated amplitude and frequency with
- 1 superimposed harmonic with amplitude equal to 1-10 % of the rated one and harmonic order h in the range from 2^{nd} to 200^{th}



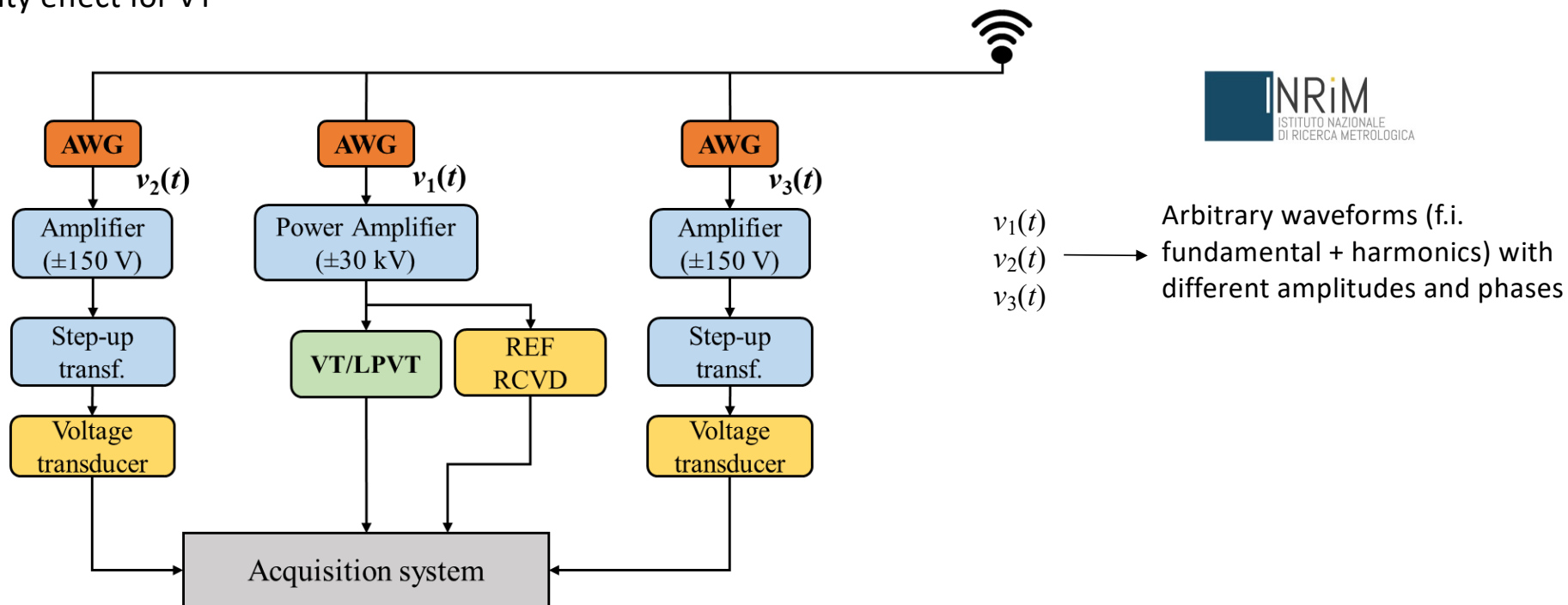
Temperature cycle from IEC 61869-6



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Progress of activities (2/6)

❖ Proximity effect for VT



Progress of activities (3/6)

❖ Power frequency variation

- ❖ IEC6189 considers different frequency variations for different kinds of IT: $\pm 1\%$ for measuring IT and -4%,+2%; for protection IT.
- ❖ PQ standard EN50160 considers different variations for interconnected or islanded grid: interconnected grid: typical $\pm 1\%$, extreme: -4%,+2%; islanded grid: typical $\pm 2\%$; extreme: $\pm 15\%$



Progress of activities (4/6)

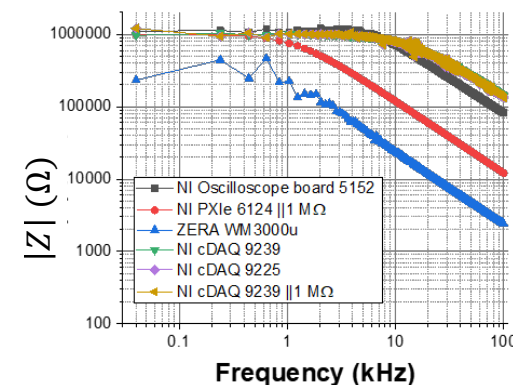
❖ Burden

- ❖ Distinction between VT, CT and LPIT
- ❖ Consideration of realistic cable lengths (capacitance, inductance) and input impedances of typical PQ measuring devices
- ❖ Burden range I (1, 2.5, 5- 10) VA (0% to 100%)
- ❖ Burden range II (10, 25, 50-100) VA (25% to 100%)
- ❖ Capacitive part up to 10 nF (from TUD)
- ❖ Normal rated burden shall be $2\text{ M}\Omega + 50\text{ pF}$
- ❖ No burden, measuring instrument with $\leq 10\text{ pF}$
- ❖ Extreme: instrument with higher capacitance: several 100 pF (excluding cable)
- ❖ Decreasing cable length \rightarrow reducing capacitance (including cable)
- ❖ Burden 1 VA up to 15 VA \rightarrow variation: 25% to 100%
- ❖ And adding inductance according cable length up to 50 m (up to $38\text{ }\mu\text{H}$) (from PTB)
- ❖ Calculations for choosing the proper cable for connecting the CT to a resistive burden

VT

LPIT

CT



Progress of activities (5/6)

❖ Temperature and vibration

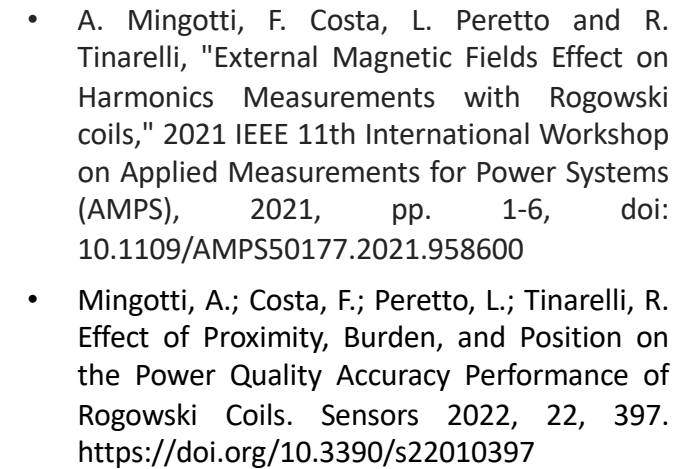
A detailed presentation will be given by LNE



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❖ Proximity effect and positioning for LPCT



Upcoming activities

- ❖ In the next weeks, all the experimental activities of task 3.2 are expected to start.

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