APPROACH FOR TESTING VOLTAGE INSTRUMENT TRANSFORMERS IN PRESENCE OF COMBINED TEMPERATURE AND VIBRATIONS

IT4PQ Workshop
09/02/2022

IT4PQ
Instrument Transformers for Power Quality

EURAMET

LABORATOIRE NATIONAL DE MÉTROLOGIE ET D'ESSAIS
LNE

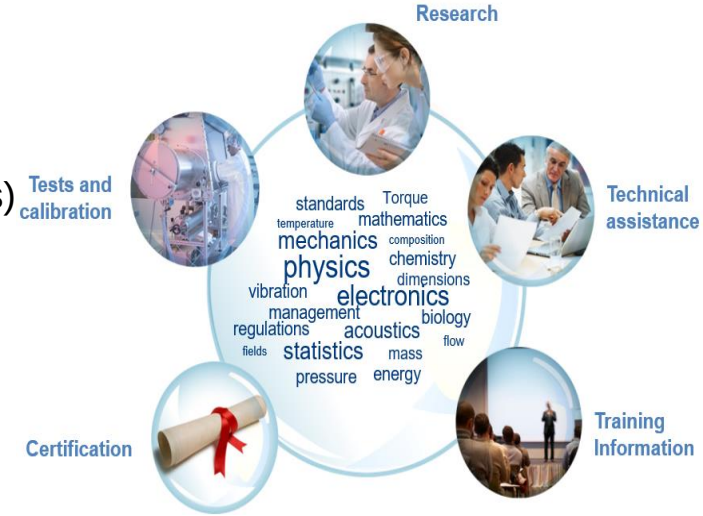
LNE IN FEW WORDS

- **8 sites**

  France (Paris, Trappes, Saint-Denis, Nîmes, Saint-Etienne, Poitiers)

  USA (Washington DC)

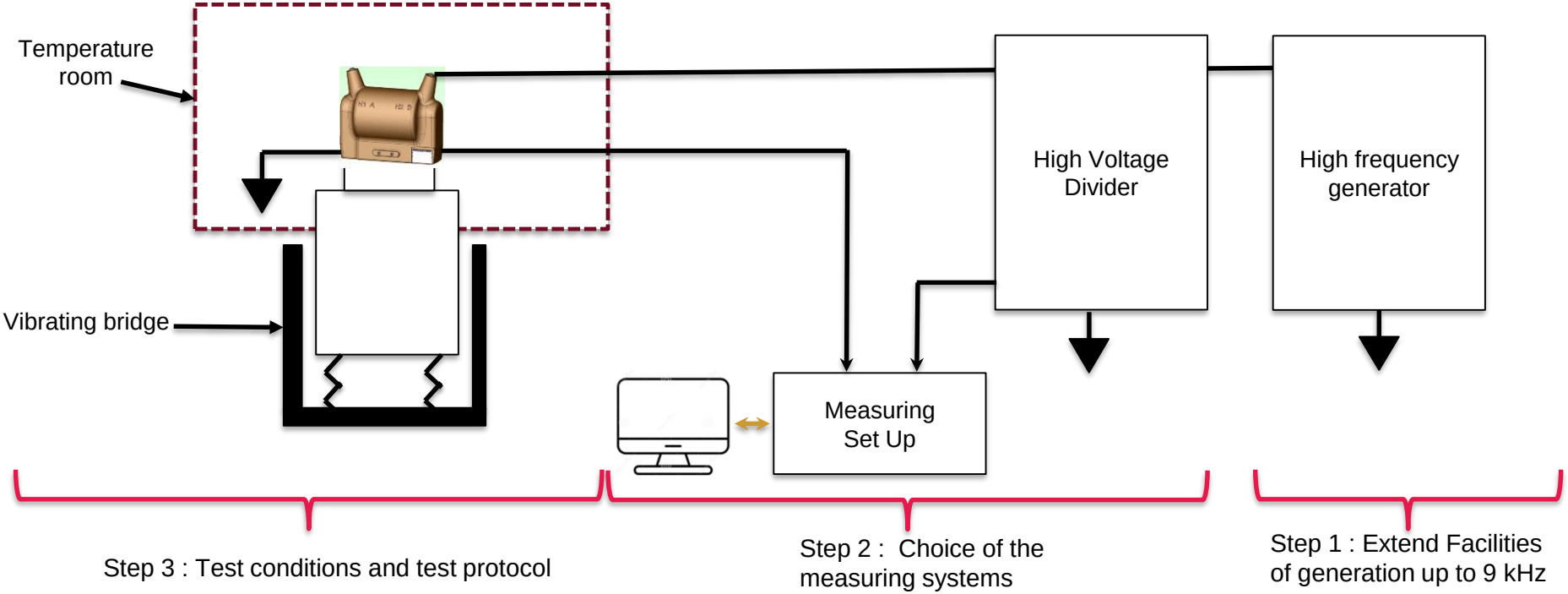
  China (Hong Kong)



- **Outstanding resources**
  - 900 staff, including ¾ of technicians, engineers, and researchers
  - 55,000 m^2 of laboratory space
  - Extensive network of partners
  - 77.2 M€ revenue including 55,6 M€ sales
  - 25 M€ investment over last five years
  - 25% of budget allocated to R&D
  - 53 colleagues in electrical division

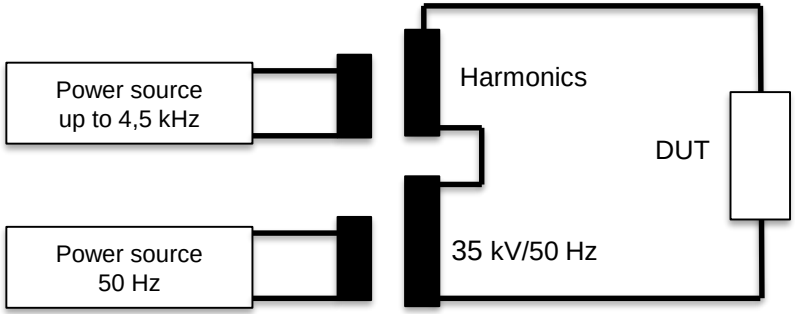
IT4PQ (WP3) LNE'S MAIN WORK

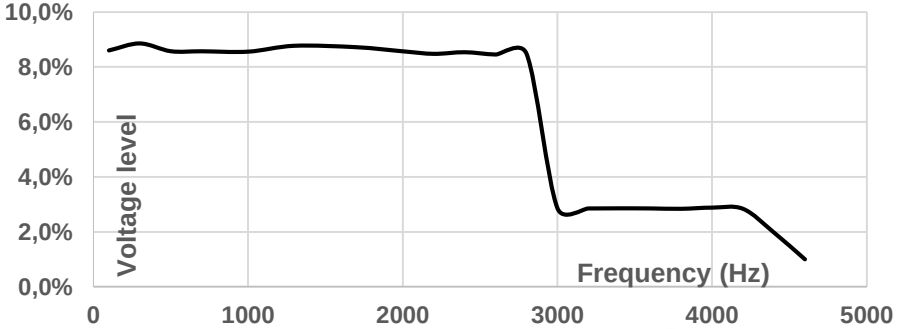
Testing voltage instrument transformers in presence of combined temperature and vibrations and for harmonics up to 9 kHz:

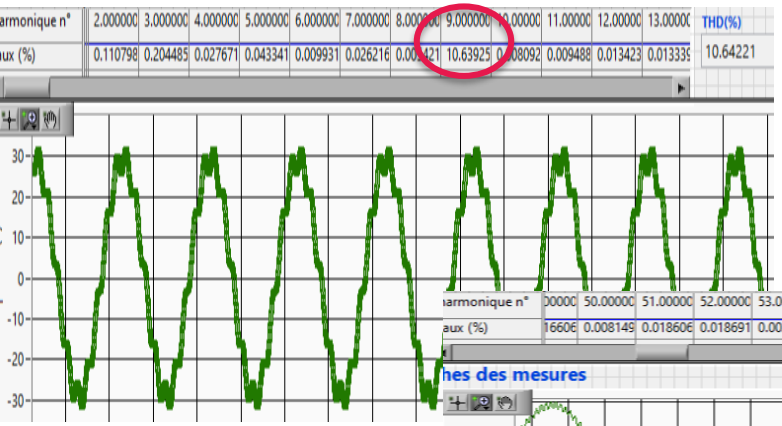


Step 1 : Extend Facilities of generation up to 9 kHz

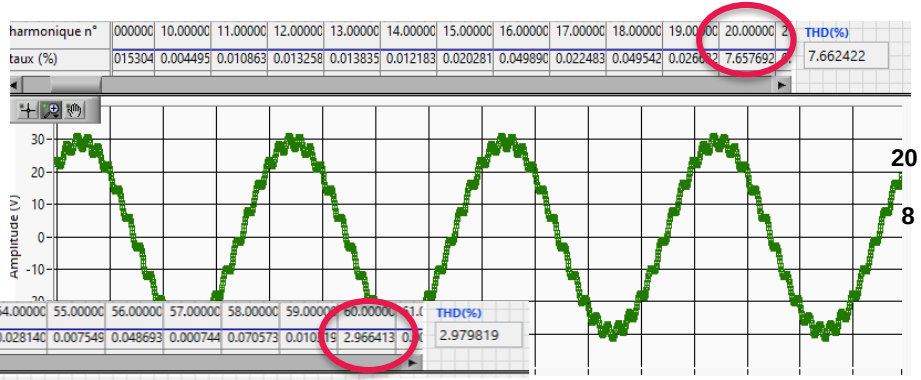
Method 1 (up to 4 kHz)



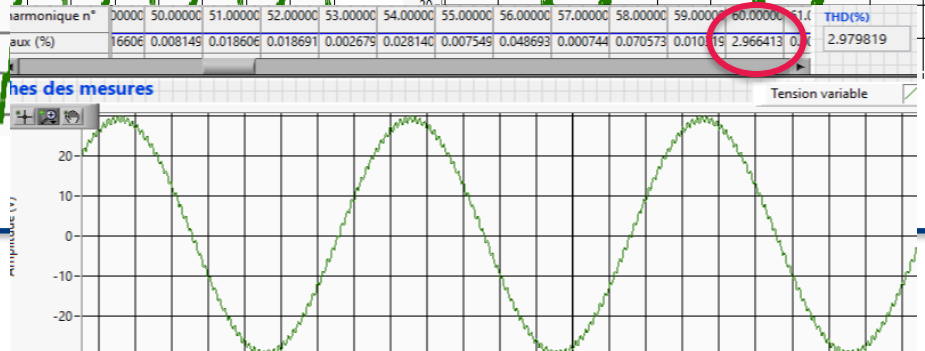




20 kV (50 Hz)
+
10 % (450 Hz)



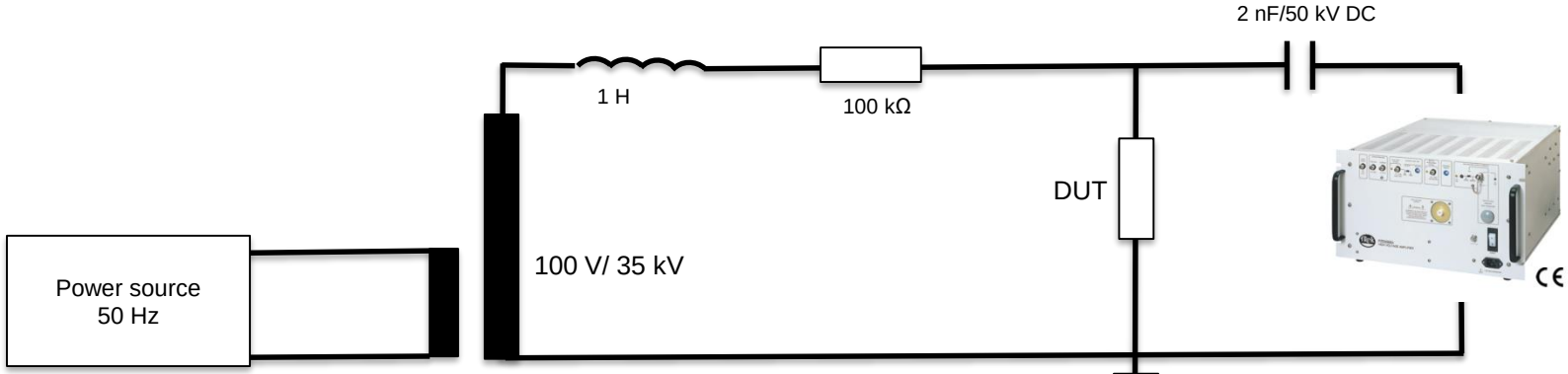
20 kV (50 Hz)
+
8 % (1 kHz)

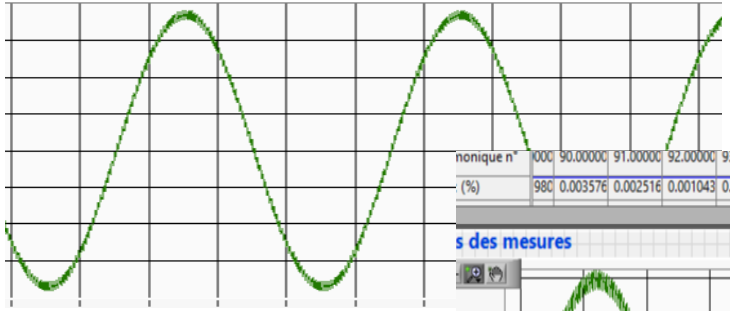


20 kV (50 Hz)
+
3 % (3 kHz)

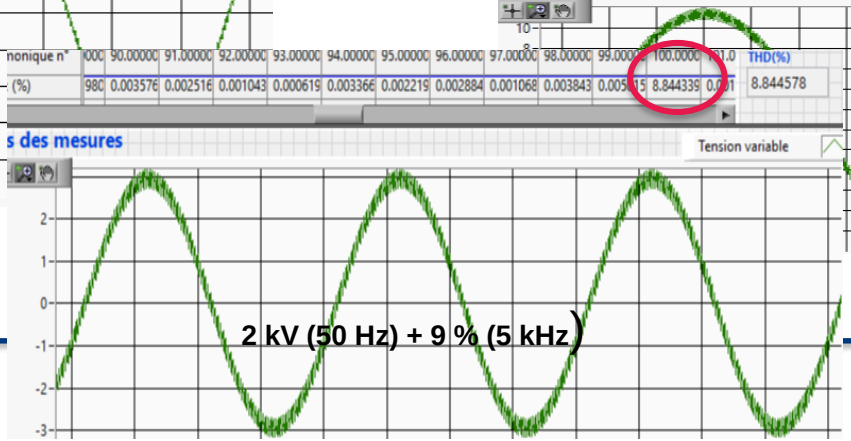
Step 1 : Extend Facilities of generation up to 9 kHz

Method 2 (4 kHz to 9 kHz)

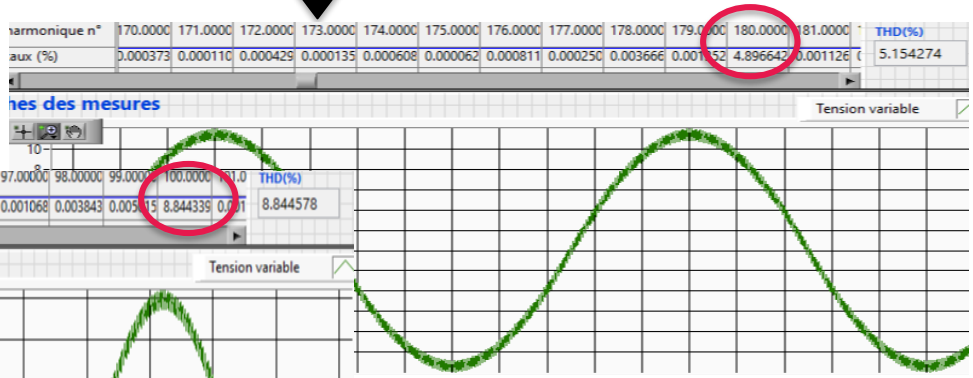




5 kV (50 Hz) + 4 % (5 kHz)



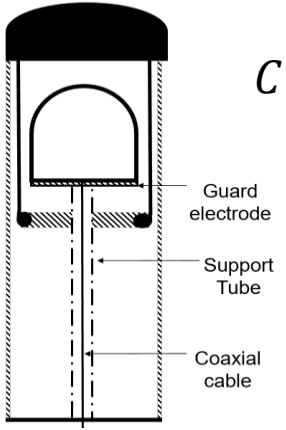
2 kV (50 Hz) + 9 % (5 kHz)



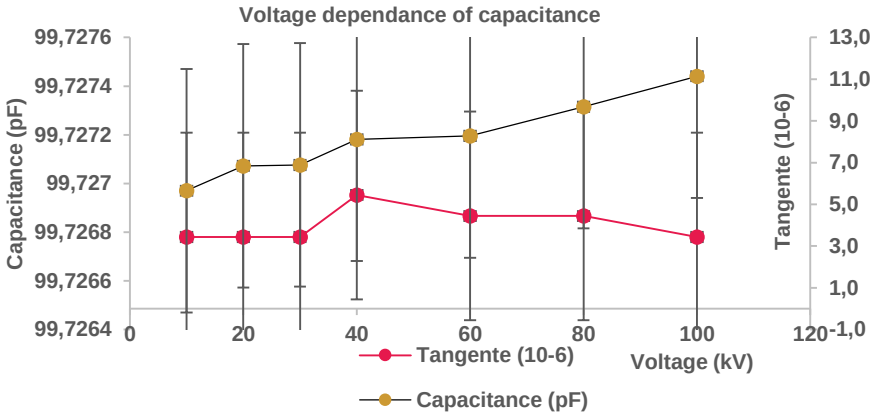
8 kV (50 Hz) + 5 % (9 kHz)

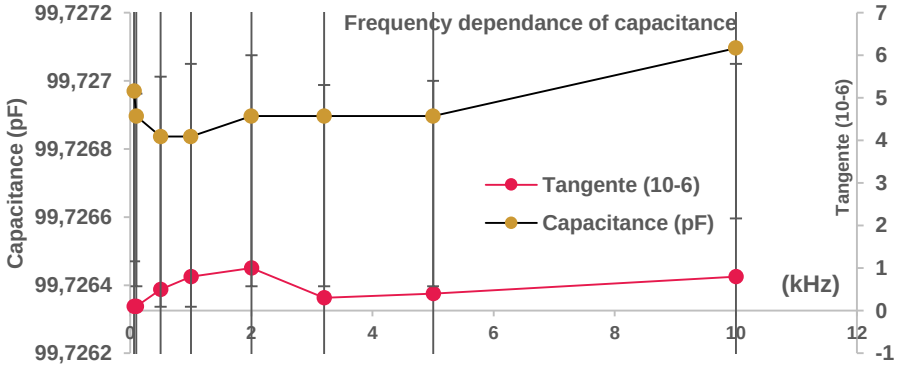
Step 2 : Choice of the measuring system

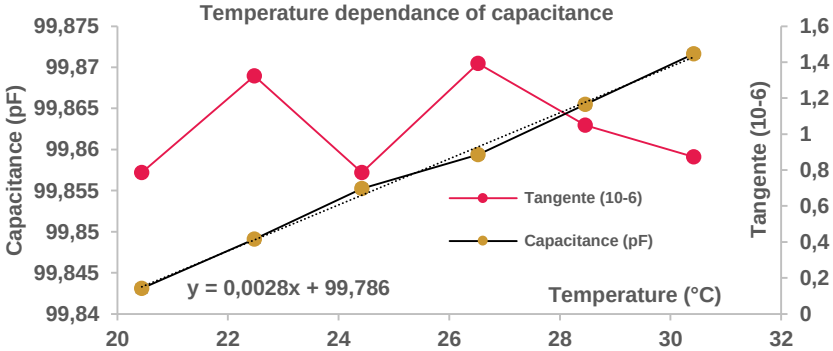
Using compressed Gas Capacitor



$$C = \frac{2\pi\varepsilon l}{ln\frac{r1}{r2}}$$

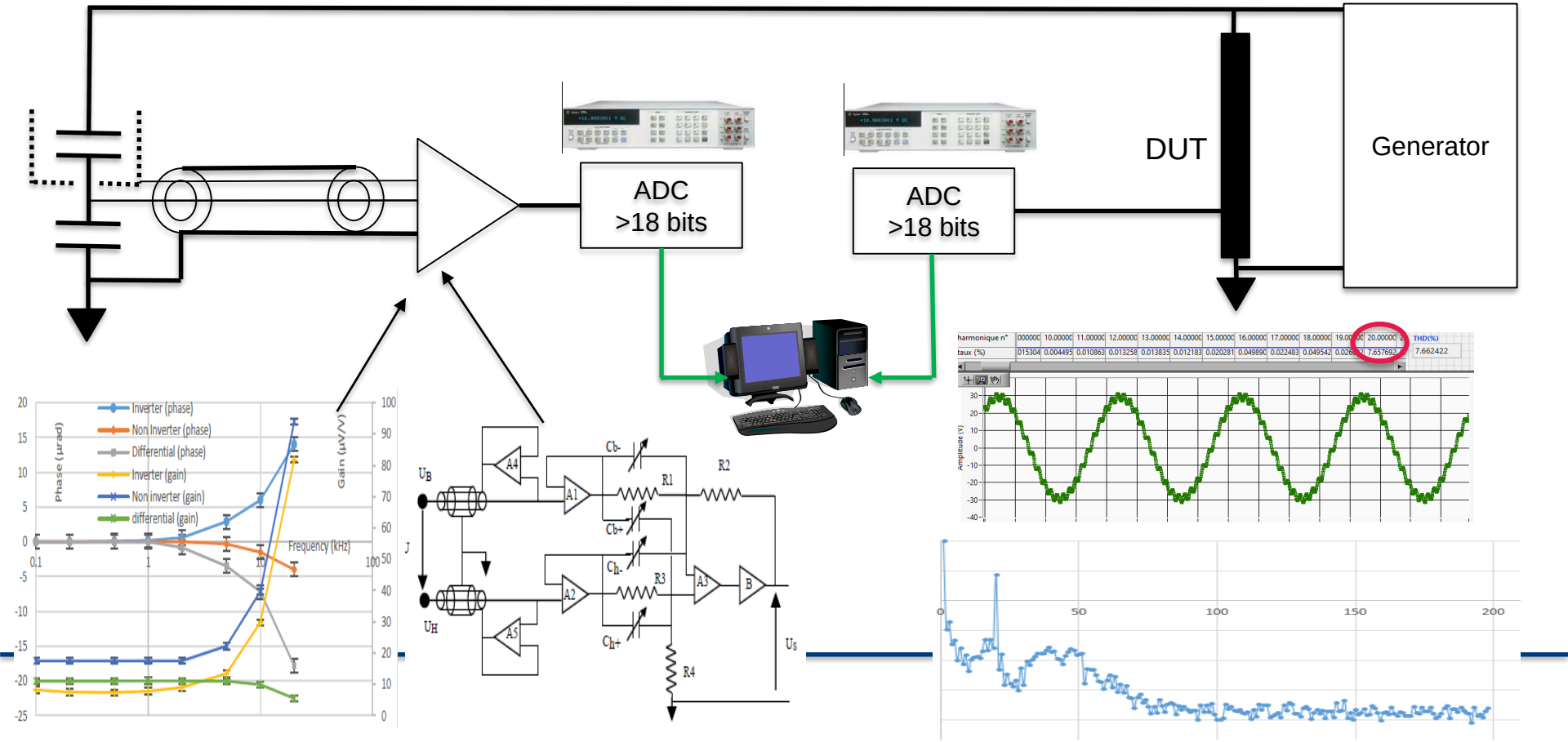






Step 2 : Choice of the measuring system

The whole system



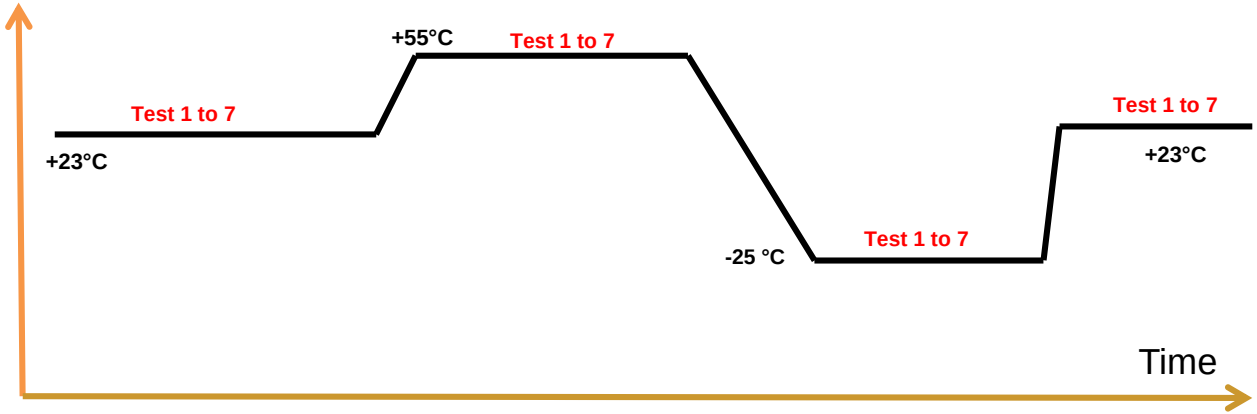
Step 3: Test conditions and test protocol

Phenomena	Frequency of vibration
Road Traffic	2 Hz to 6 Hz (maximum 30 Hz)
Seismic noise	0.1 Hz (is usually neglected)
Power transformers	100 Hz
Circuit breakers	Up to 150 Hz
Transports	10 to 150 Hz
Wind turbines	Few Hz (depends on the speed of wind)

Standard	Title	Frequency
IEC 60068-1	Environmental testing - Part 1: General and guidance	
IEC I 60068-2-6 (sinusoidal vibration)	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	1 Hz to 150 Hz
60068-2-64 (random vibration)	Environmental testing - Part 2-64: Tests - Test Fh: Vibration, broadband random and guidance	
IEC 60721-1	Classification of environmental conditions Part 1 : environmental parameters and their severities	2 Hz to 200 Hz
IEC 60721-2-9	Classification of environmental conditions – Part 2-9: Environmental conditions appearing in nature – Measured shock and vibration data – Storage, transportation and in-use	
IEC 60068-2-47	Environmental testing - Part 2-47: Tests - Mounting of specimens for vibration, impact and similar dynamic tests	

Frequencies of vibration from 1 Hz to 150 Hz will be enough for the project.

Step 3: Test conditions and test protocol



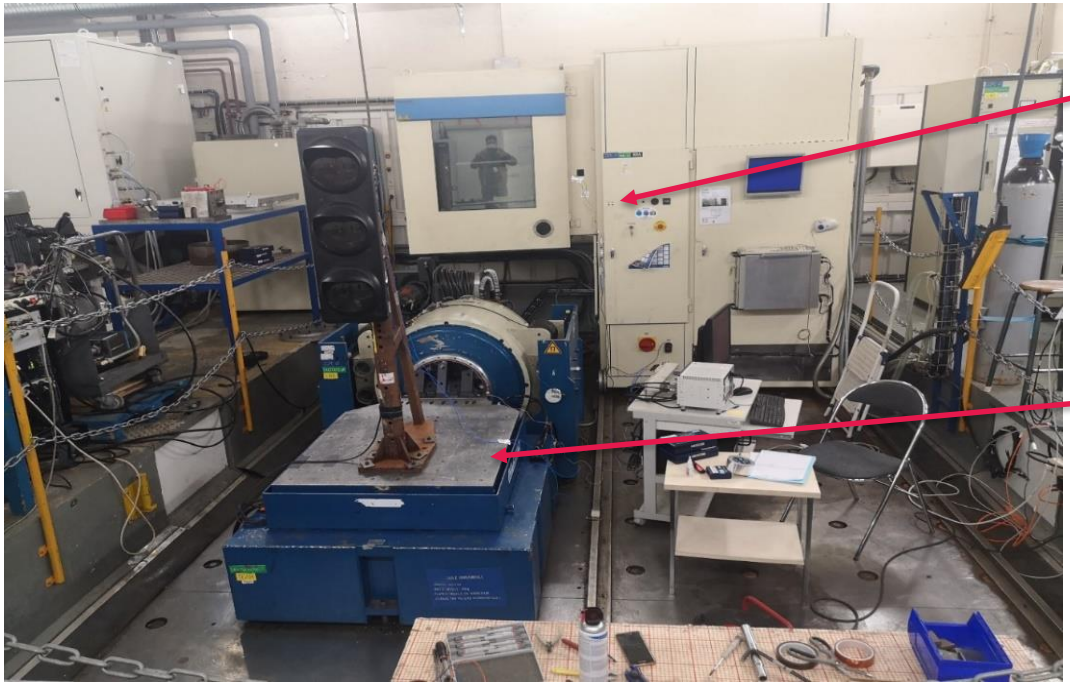
Phase 1: Combination of temperatures and vibration at 50 Hz

	23 °C	55 °C	-25 °C
Test 1	50 Hz		
Test 2	50 Hz + VB1		
Test 3	50 Hz		
Test 4	50 Hz+ VB2		
Test 5	50 Hz		
Test 6	50 Hz+ VB3		
Test 7	50 Hz		

Phase 2: Combination of temperatures, vibration + harmonics

	23 °C	55 °C	-25 °C
Test 1	50 Hz		
Test 2	50 Hz +VB1 + Harmonics		
Test 3	50 Hz		
Test 4	50 Hz + VB2 + Harmonics		
Test 5	50 Hz		
Test 6	50 Hz+ VB3 + Harmonics		
Test 7	50 Hz		

Step3: Test conditions and test protocol



Temperature room

- Temperature : - 70°C to 150 °C.
- Speed : 10 °C/min
- Humidity : 10 to 95 %
- Volume : 1,3 m3

Vibrating Bridge :

- Frequency of vibration : 3 Hz - 2000 HZ
- Peak to peak displacement: 50 mm à 75 mm
- Maximum speed : 1,8 m/s
- Force : 27 kN to 80 kN
- Charge compensation : 300 kg to 800 kg

High voltage up to 30 kV and harmonics up to 9 kHz will be implemented during the project to test HV transformers

What next

Up to Mai 2022:
Phase 1 of testing instrument transformers
(Combination of temperatures and vibrations at 50 Hz)

Up to July 2022,
Improving the generation system for frequencies above 4 kHz, the target is 20 kV/50 Hz + 400 V (9 kHz)

Up to September 2022:
Testing instrument transformers
(Combination of temperatures and vibrations at 50 Hz + harmonics)

Thank you for your attention