NON-INVASIVE TRANSDUCERS for HIGH VOLTAGE and HIGH CURRENTS

EMRP Power and Energy
JRP T4.J01, Work package 5

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ISTITUTO NAZIONALE DI RICERCA METROLOGICA

The issue

The need for more accurate energy and power measurements and PQ assessment on the MV and HV grids calls for the use of current and voltage transducers with enhanced and metrologically validated performances.

Non-conventional transducers for on-site use

- *High accuracy*
- *Traceable*
- *Enhanced frequency response*
- *Characterised over the actual operating conditions*
- *Non-invasive, low power output, safe, movable and light*

WORK PACKAGE 5

Task 5.1

The development and characterization of on-site high AC high current MSs for the MV grid.

MIKES, SMU

Task 5.2

Impulse current and short-circuit current measurement

CMI, LNE

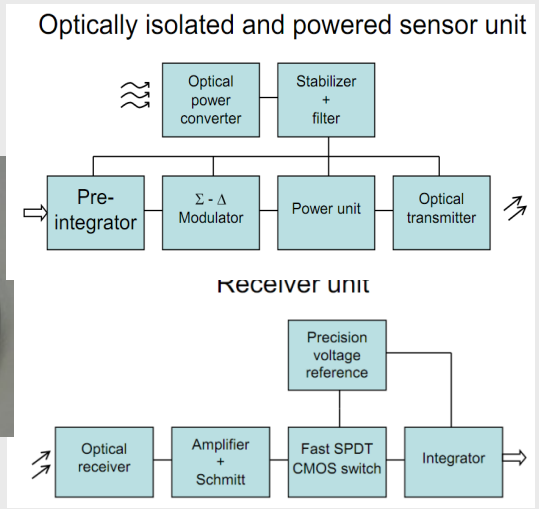
Task 5.3

The development and characterization of a MV voltage transducer for on-site use

CMI, INRIM

Task 5.1 Development and characterization of on-site AC high current measuring systems

Goal: Measurements up to 10 kA with uncertainty of hundreds of ppm for ratio error and hundreds of microradians for phase displacement at 50 Hz.
Measurements of current harmonics with relaxed uncertainty.



MIKES

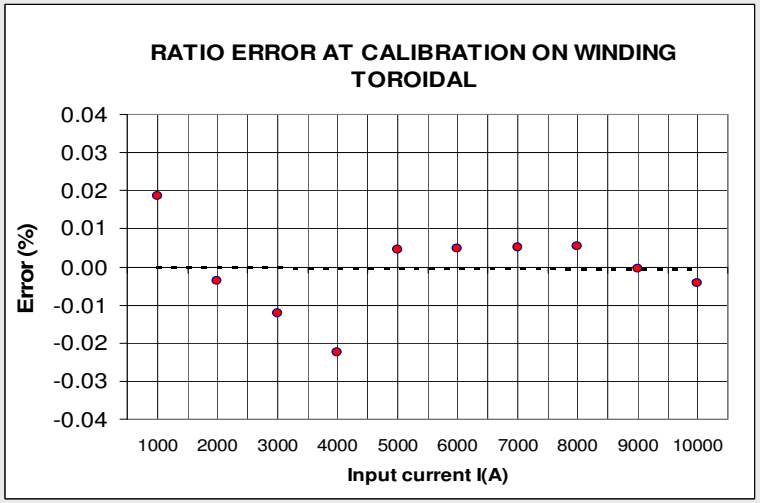
Optimisation of split-core RC (Rocoil Ltd).

SMU:

Flexible and openable RC (Applied Precision Ltd); galvanic separation was achieved by optical fibers for data and power transfer.

SMU activity

- Characterisation of the system in the current range (1 to 10) kA by measurement of linearity of ratio error and phase error
- Evaluation of the effect of the internal conductor position



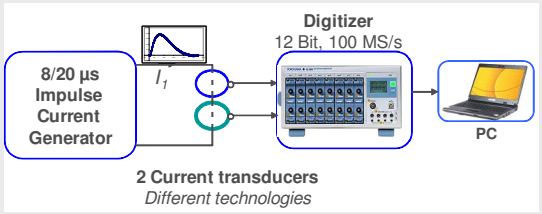
Ratio error =± 0,02%
phase error <0.05 deg in the whole evaluated range from 1 kA to 10 kA

Task 5.2 Impulse current and short-circuit current measurement

Aim: Measurement of impulses and fast transients up to 60 kA with uncertainties better than 0.1%

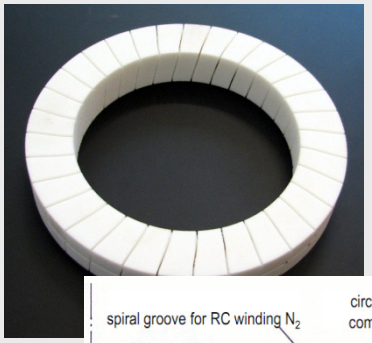
LNE

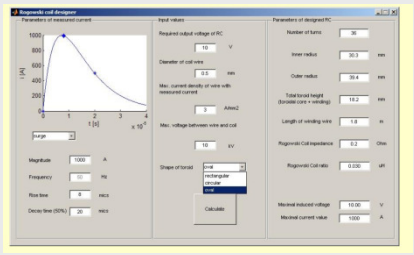
Use of a Pearson coil (working standard) and a RC (transfer standard) plus a 100 MS/s digitiser

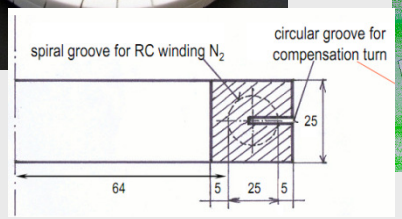


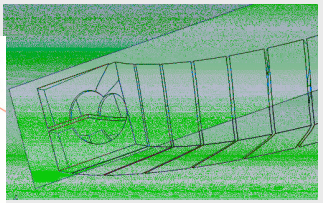
CMI

Use of suitably designed and built reference RCs





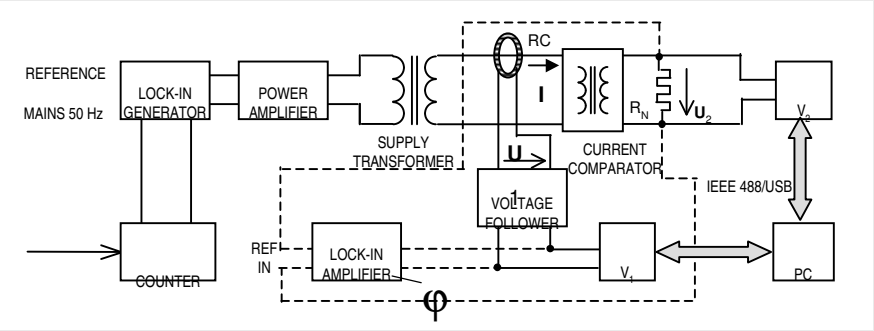




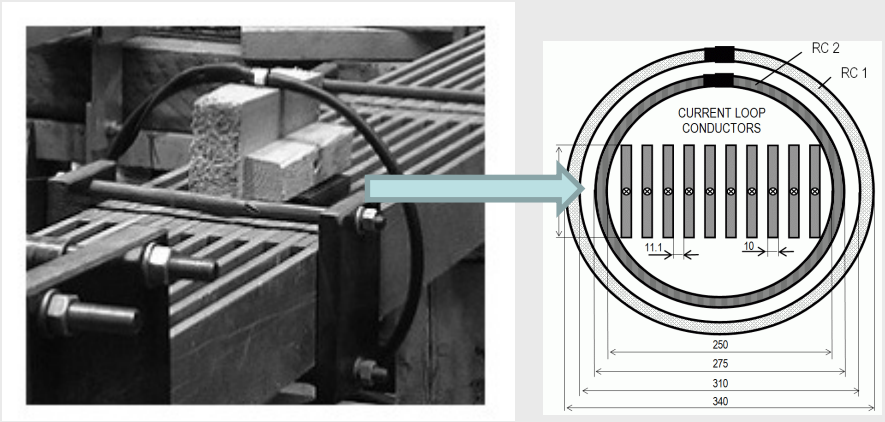
CMI

- Development of a simulation tool for RC design for impulse current measurement and its application to the set up of RCs for 8/20 µs impulse measurements.

- Determination of the RC constant at 50 Hz from measured current and voltage output.
  Uncertainty: 270 ppm



- Set up of a circuit for the calibration of a Rogowski coil with integrators at 50 Hz from 1 to 30 kA.
  Uncertainty: < 500 ppm



Task 5.3 Development and characterization of a MV voltage transducer for on-site use

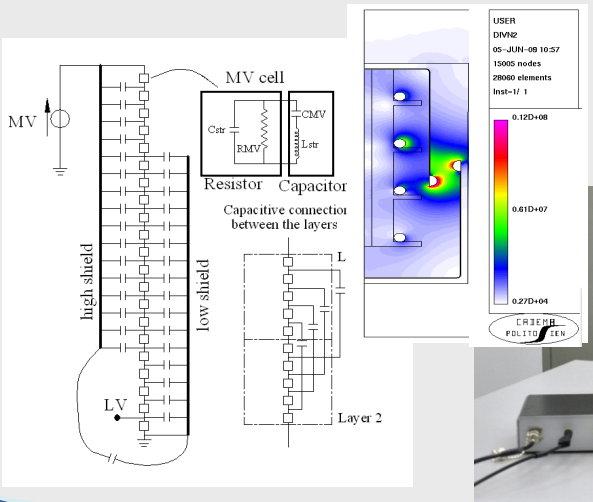
Objective: *on-site* measurement up to 30 kV with uncertainty ≤500 ppm and <0.7 mrad (at 50 Hz)

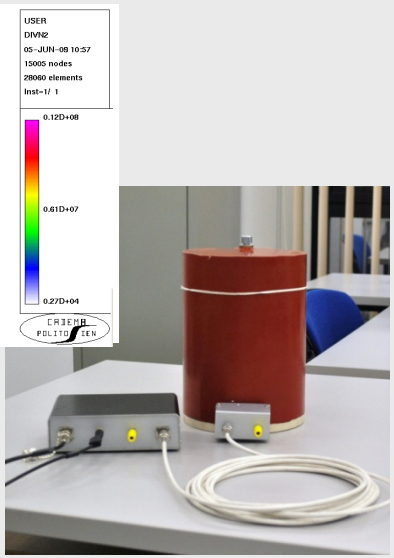
INRIM

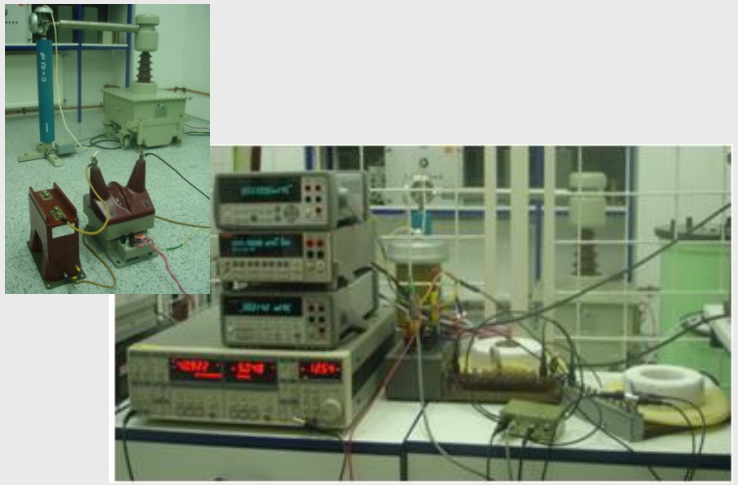
Design, development and characterisation of a RC shielded divider + matching stage

CMI

Set up of MV divider calibration chains







Divider final configuration

Dimensions: *h*=220 mm ϕ=170 mm
Weight: 10 kg
Ratio: 30 kV/100 V + matching stage 30 kV/1 V
Uncertainty: (on-site at 50 Hz)
520 ppm - 330 µrad

Set up of MV dividers calibration chains at CMI

- 50 Hz standard VT+ Agilent 3458A voltmeters:
  standard VT + inductive voltage divider +
  lock-in amplifier
  uncertainty: 200 ppm, 300 µrad
- At low frequency capacitive voltage divider
- At high frequency impulse measurements

On-site measurements

- **MIKES**

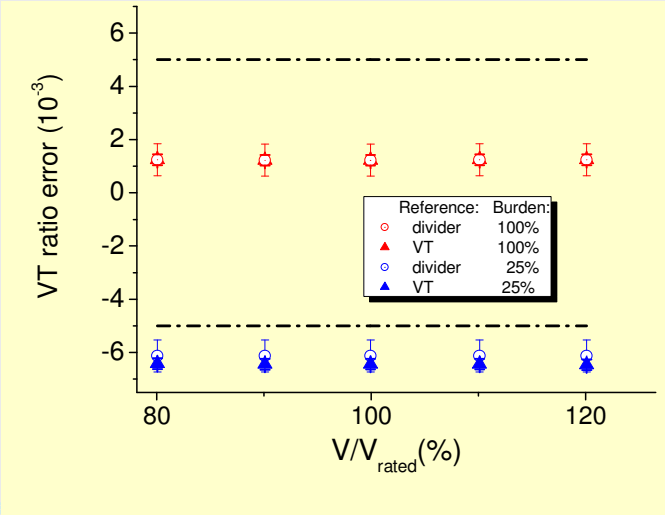
On-site calibrations in transformer test field, 50 Hz

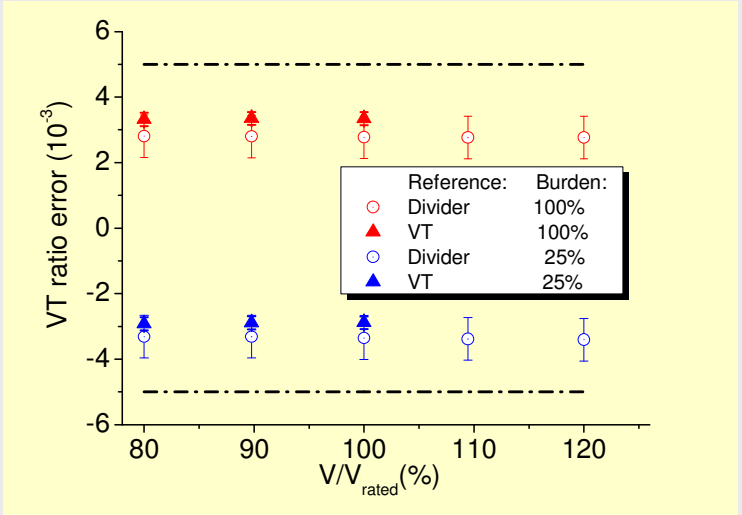
- **INRIM**

On-site calibrations of MV/LV voltage transformers

MV/LV 1.5 MVA substation:
6.3/√3 kV/100 V/√3 V VT

MV/LV 1.25 MVA substation:
22 kV /√3 kV/100 V /√3 V VT





WP5 Achievements

- **Characterised hardware**
- **Definition and experimentation of calibration procedures**
- **On-site experimentation**

Impact

On-site use of the developed systems (e.g. substations, railway environment, ..) of

- Calibrations of measuring transducers
- PQ, P&E measurements

EMRP JRP METROLOGY FOR SMART GRIDs

Presentations

High current ac metrology using Rogowski coils

by Jari Hallstrom (MIKES)

Measurement of high impulse currents by Rogowski and Pearson coils

by Daniela Istrate (LNE)

Dissemination of results

- **Peer-review papers** (IEEE Trans. On IM),
- **Conference papers** (CPEM 2010, IMEKO TC4 Conference - x, ISH09,…)
- **Knowledge transfer**: (Metrologia e Qualità Torino,..)

On-site use of the developed systems (e.g. substations, railway environment) for

- PQ, P&E measurements
- Calibrations of measuring transducers

EMRP JRP METROLOGY FOR SMART GRIDs