



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

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LPCTs: effect of influence quantities on the accuracy of Rogowski Coils and simplified testing

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Outline

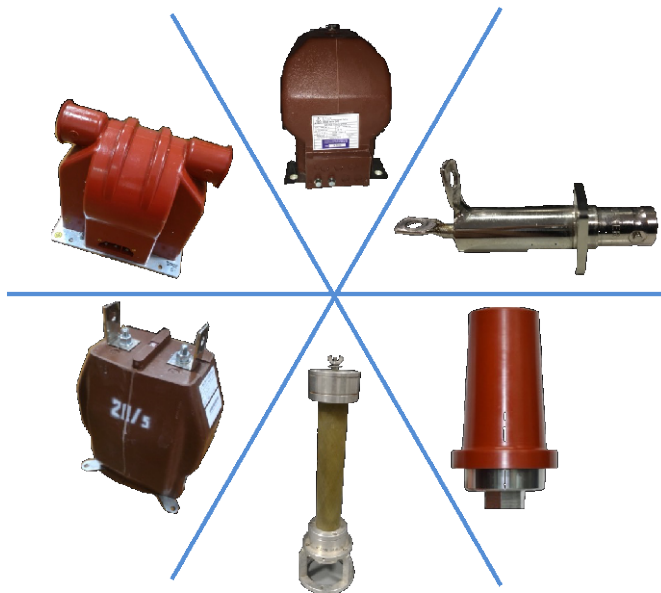
- 1 Introduction
- 2 Measurement Setup
- 3 Experimental Tests
- 4 Comments



1 Introduction



Introduction



Temperature



Humidity



Positioning/Geometry



Electric and
Magnetic Fields



Harmonics



Interharmonics



Transients



Oscillations



Swells

Introduction

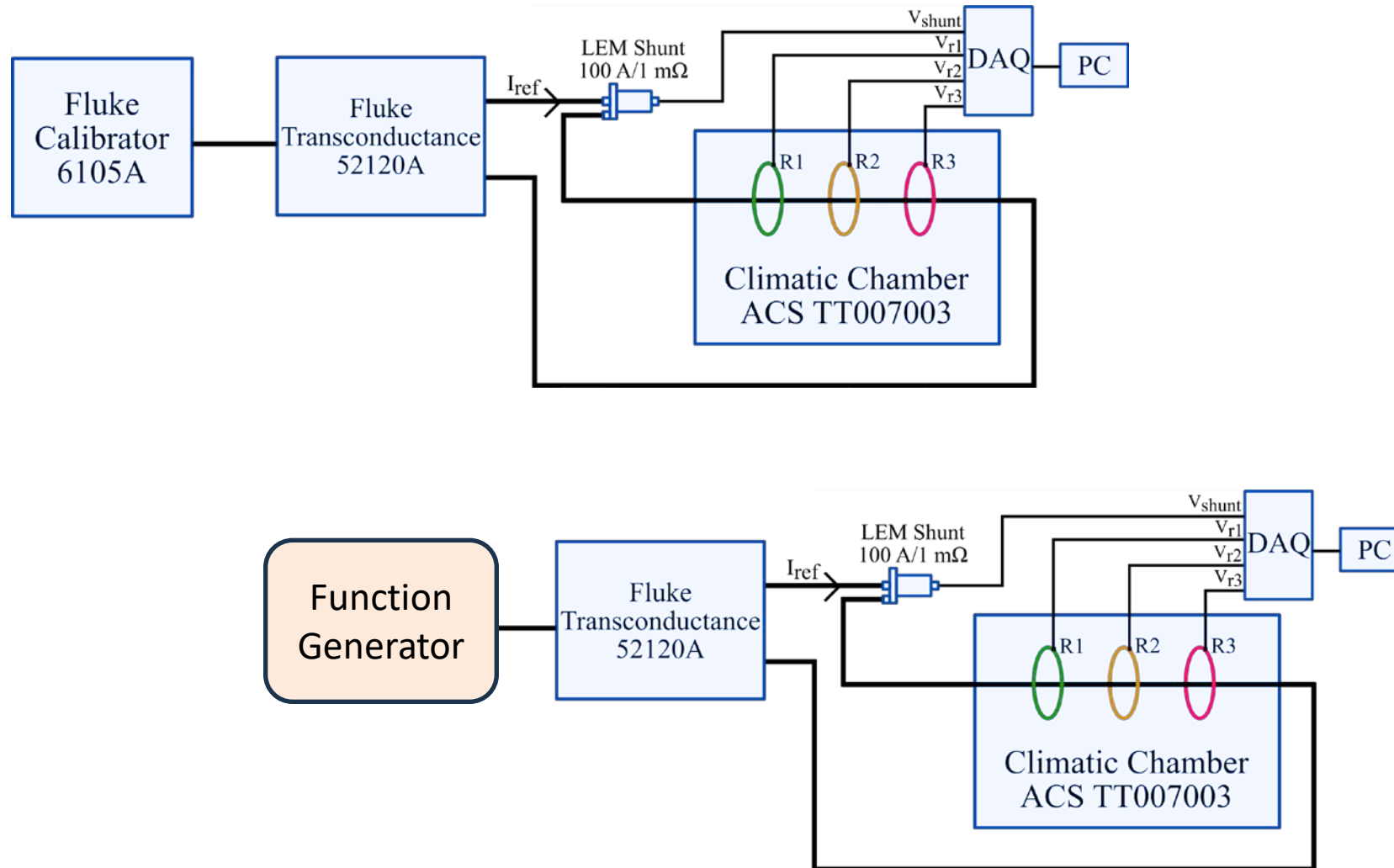
- [1] Amaripadath, D.; Roche, R.; Joseph-Auguste, L.; Istrate, D.; Fortune, D.; Braun, J.P.; Gao, F. Power quality disturbances on smart grids: Overview and grid measurement configurations. In Proceedings of the 2017 52nd International Universities Power Engineering Conference, UPEC 2017, Heraklion, Greece, 28–31 August 2017.
- [2] Sandler, R.; Brehm, M.; Slomovitz, D.; Barreto, G. Rogowski coil design for the measurement of high voltage harmonics. In Proceedings of the 2020 IEEE PES Transmission and Distribution Conference and Exhibition—Latin America, (T&D LA), Montevideo, Uruguay, 28 September-2 October 2020.
- [3] Yan, Z.H.; Ren, X.; Ren, H.; Ding, W.D. Study on Condensation of the Moisture in Current Transformers with Current Flow Considering Sharp Temperature Decrease. *Appl. Mech. Mater.* 2012, 241–244, 322–327. <https://doi.org/10.4028/www.scientific.net/amm.241-244.322>.
- [4] Ma, X.; Guo, Y.; Chen, X.; Xiang, Y.; Chen, K.-L. Impact of Coreless Current Transformer Position on Current Measurement. *IEEE Trans. Instrum. Meas.* 2019, 68, 3801–3809. <https://doi.org/10.1109/tim.2019.2927544>.



2 Measurement Setup



Measurement Setup




3 Experimental Tests



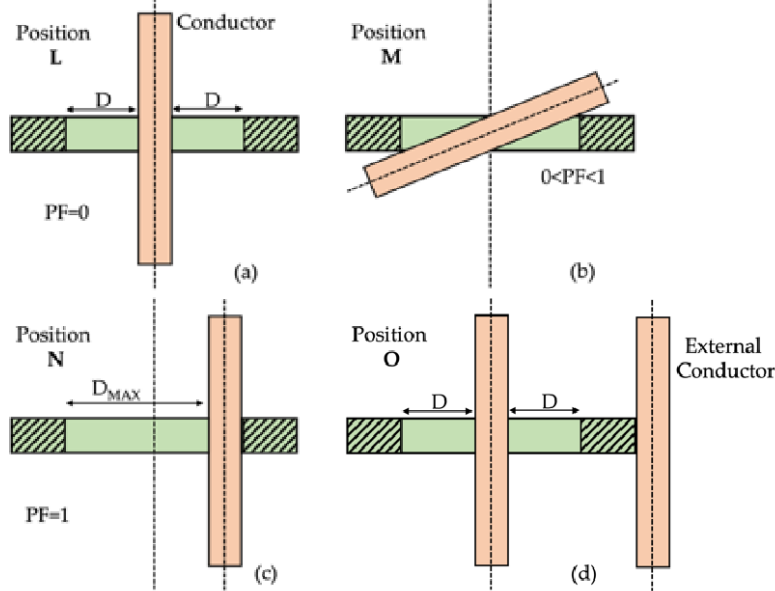
Experimental Tests

Influence Quantities



Test vs. Burden
2, 1.8, 2.2, 1, 1000
M Ω

Test vs. Position



Position L
D
D
Conductor
PF=0
(a)

Position M
0 < PF < 1
(b)

Position N
D_{MAX}
PF=1
(c)

Position O
D
D
External Conductor
(d)

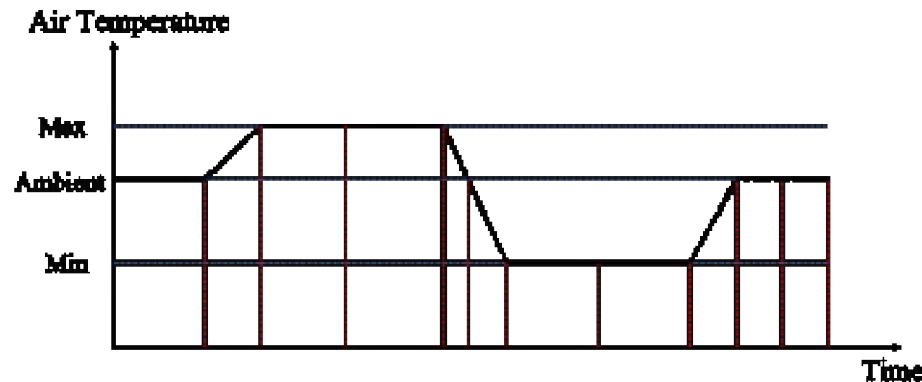
Test vs. Humidity and Temperature



-5 °C, 23 °C, 40 °C



30 %, 50 %, 80 %



Experimental Tests

Influence Quantities

Parameters

$$\varepsilon = \frac{K_r U_s - I_p}{I_p} \times 100$$

$$\Delta\varphi = \varphi_s - \varphi_p$$

Signals

- X: 50 Hz
- Y: 50 Hz, THD = 4.8 %
- Z: 50 Hz, THD = 9.2 %

Experimental Tests

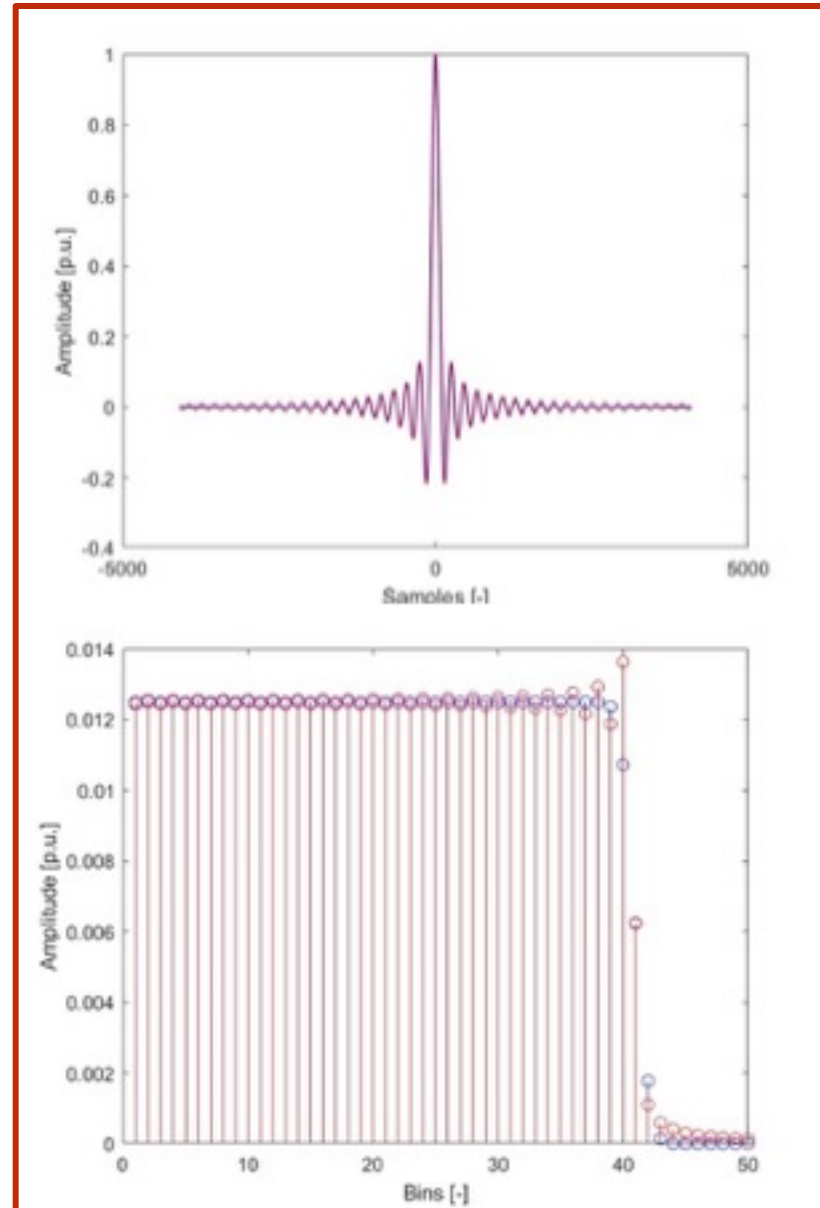
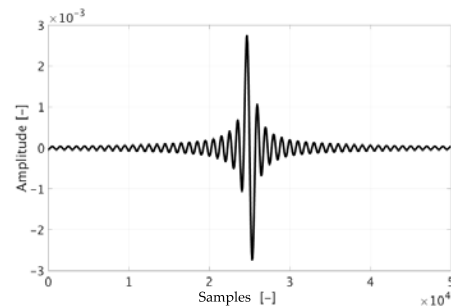
Simplified Characterization

$$Y(f) = S(f)H(f)$$

FFT

Signal	Frequency [Hz]	Amplitude [A]
S1	50	36
S2	150	36
S3	250	36
S4	350	36
S5	450	36
S6	550	36
S7	650	36
S8	750	36
S9	850	36
S10	950	36
S11	1050	36
S12	1150	36
S13	1250	36
S14	1500	36
S15	1750	36
S16	2000	36
S17	2250	36
S18	2500	36

*



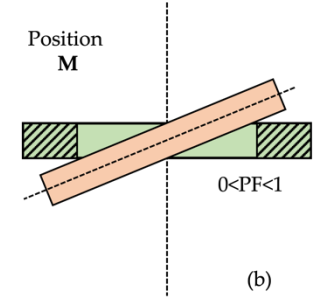
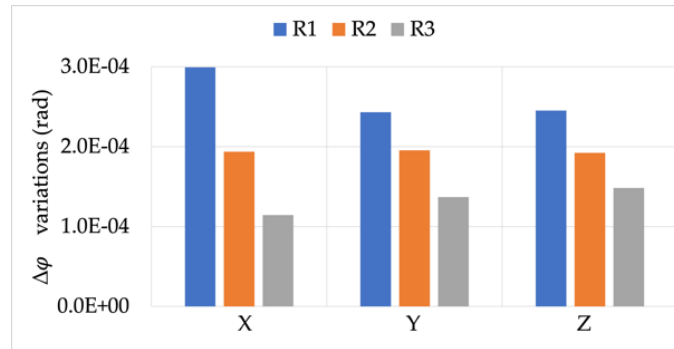
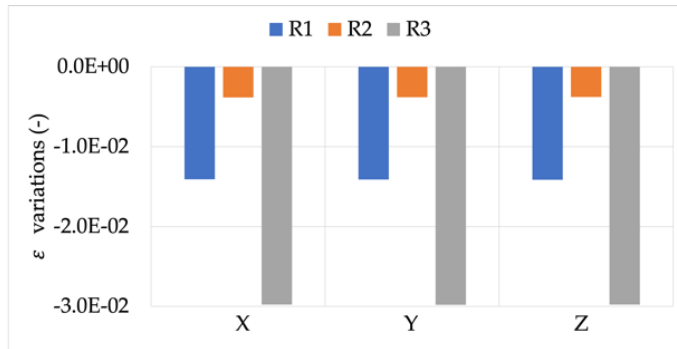
4 Results



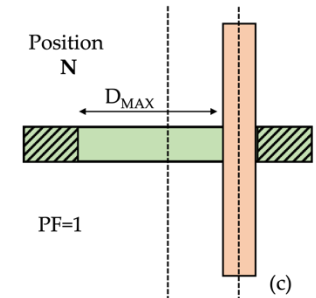
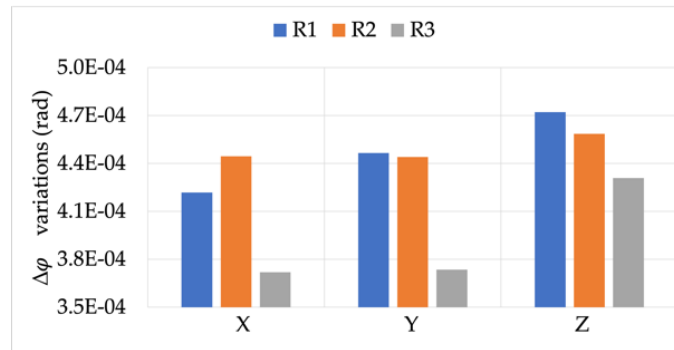
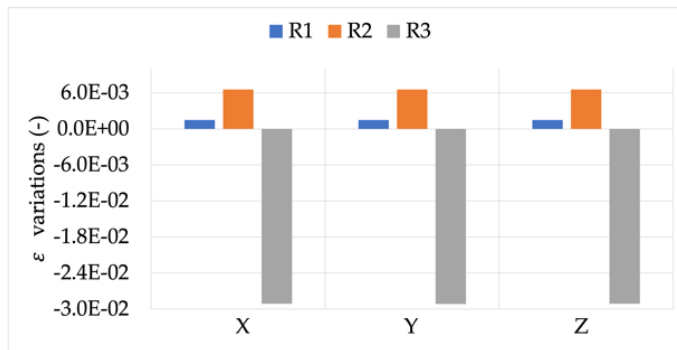
Results

Test vs. Position

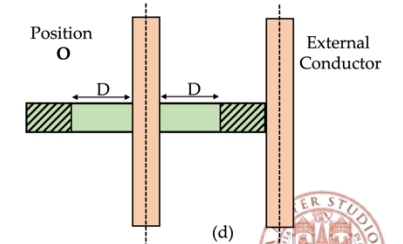
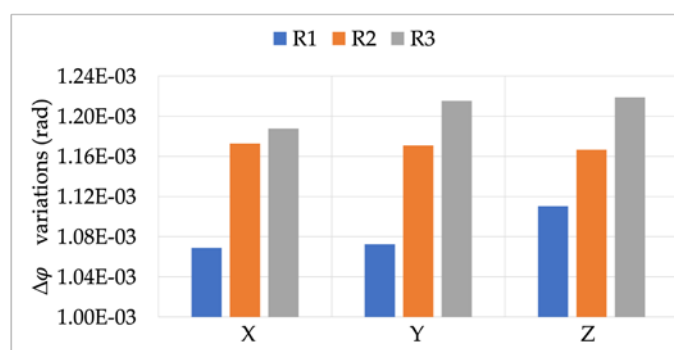
M



N

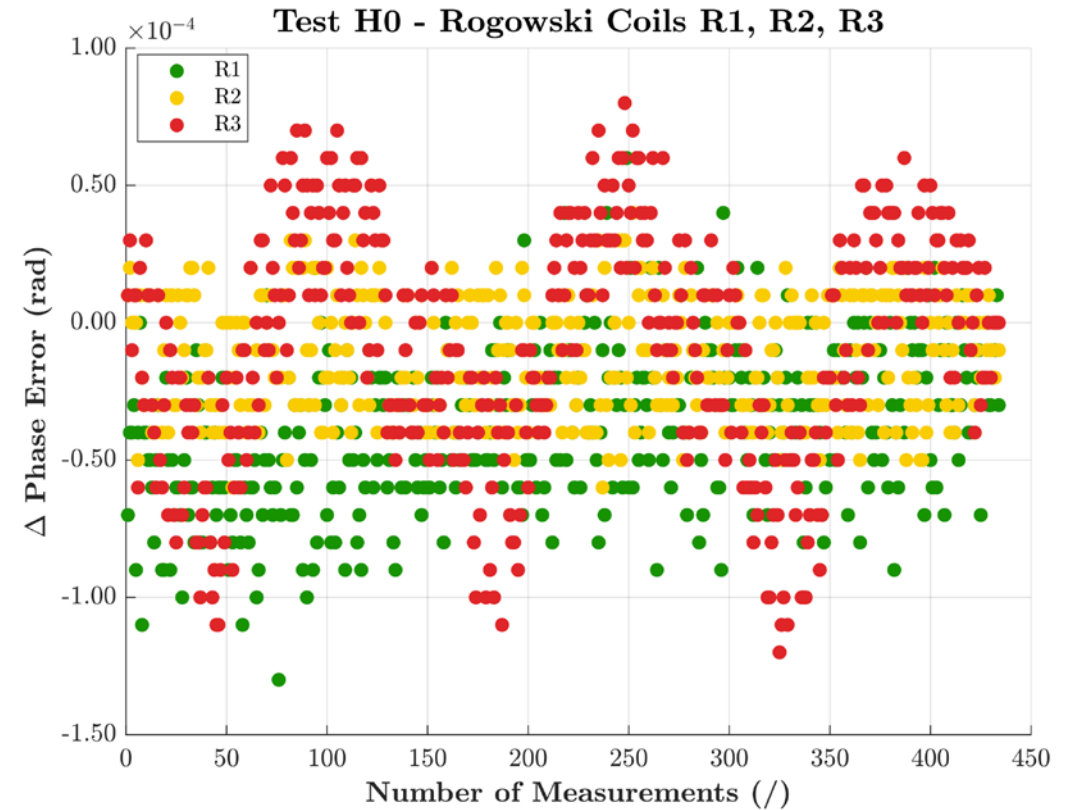
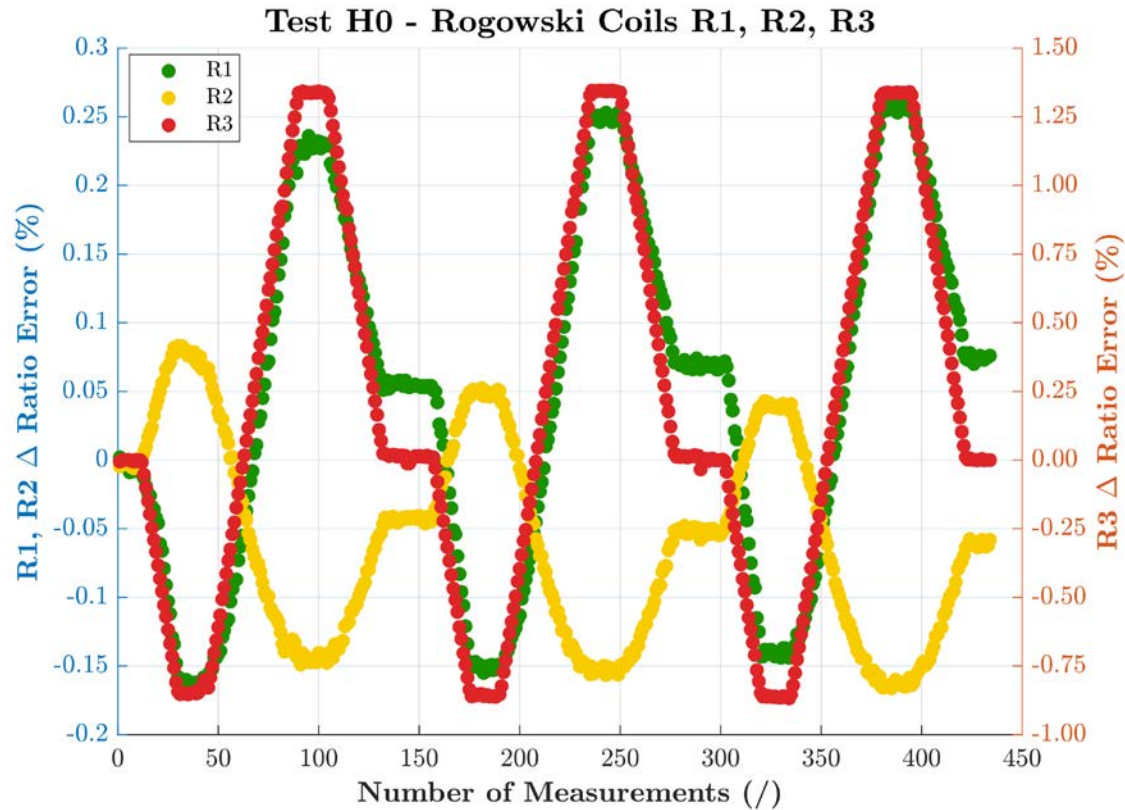


O



Results

Test vs. Temperature and Humidity



X



Comments

Need for testing

- Lack of testing procedures
- RCs show different behaviors
- RC are strongly affected
- Risk of wrong results
- Reduce testing time/cost

Pros & Cons

- Lot of tests
- Target uncertainty
- Simplified procedures
- Equipment limits
- Acceptance from standardization bodies and companies



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