

VTT Technical Research Centre of Finland

Supplementary comparison EURAMET.EM-S42, comparison of lightning impulse (LI) reference measuring systems

Hällström, J; Elg, A-P; Havunen, J; Garnacho, F

Published in:
Metrologia

DOI:
[10.1088/0026-1394/58/1A/01001](https://doi.org/10.1088/0026-1394/58/1A/01001)

Published: 17/12/2020

Document Version
Peer reviewed version

[Link to publication](#)

Please cite the original version:

Hällström, J., Elg, A-P., Havunen, J., & Garnacho, F. (2020). Supplementary comparison EURAMET.EM-S42, comparison of lightning impulse (LI) reference measuring systems. *Metrologia*, 58(1A).
<https://doi.org/10.1088/0026-1394/58/1A/01001>



VTT
<http://www.vtt.fi>
P.O. box 1000FI-02044 VTT
Finland

By using VTT's Research Information Portal you are bound by the following Terms & Conditions.

I have read and I understand the following statement:

This document is protected by copyright and other intellectual property rights, and duplication or sale of all or part of any of this document is not permitted, except duplication for research use or educational purposes in electronic or print form. You must obtain permission for any other use. Electronic or print copies may not be offered for sale.

Supplementary comparison EURAMET.EM-S42
Comparison of lightning impulse (LI) reference measuring systems

FINAL REPORT

J. Hällström¹, A-P. Elg², J. Havunen¹ and F. Garnacho³

¹ VTT Technical Research Centre of Finland Ltd
National Metrology Institute VTT MIKES
Tekniikantie 1, 02150 Espoo, Finland

² RISE Research Institutes of Sweden
Brinellgatan 4, 50115 Borås, Sweden

³ Laboratorio Central Oficial de Electrotecnia (LCOE)
José Gutiérrez Abascal 2, 28006 Madrid, SPAIN

Table of contents

| | |
|--|-----|
| 1. Introduction..... | 4 |
| 2. Participants and organisation of the comparison..... | 4 |
| 3. Travelling standard and measurement instructions..... | 7 |
| 4. Methods of measurement..... | 10 |
| 5. Repeated measurements of the pilot institute, behaviour of the travelling system..... | 11 |
| 6. Analysis of comparison data set | 11 |
| 7. Comparison results | 16 |
| 8. Traceability | 20 |
| 9. Conclusions and final remarks..... | 20 |
| 10. References..... | 21 |
| Annex A - Excel template for reporting of comparison results | 22 |
| Annex B - Performance of the transfer reference system | 23 |
| Annex C - Results reported by participants..... | 32 |
| Annex D - Sample uncertainty budgets reported by participants..... | 49 |
| Annex E - Comparison results for each waveform | 85 |
| Annex F - Compatibility indexes | 146 |
| Annex G - Sample waveforms | 149 |
| Annex H - Link to intercomparison organized in 1999 - 2002 | 159 |
| Annex I - Description of IATTE corrective actions..... | 162 |

List of tables

| | |
|---|----|
| Table 2-1. Comparison participants..... | 5 |
| Table 2-2. Schedule of the comparison..... | 6 |
| Table 3-1. Impulse shapes and respective voltage levels for the comparison..... | 8 |
| Table 6-1. Overview of the measurements performed by the participants. | 12 |
| Table 7-1. Ambient conditions. | 16 |
| Table 7-2. Divider and transmission cable characteristics of each participating laboratory. | 17 |
| Table 7-3. Attenuator, digitizer and software characteristics of each participating laboratory. | 17 |
| Table 7-4. Overview of calculated CRV values and their uncertainties. | 19 |
| Table 8-1. Source of traceability..... | 20 |
| Table B-1. Divider scale factor measurements during the comparison..... | 24 |
| Table B-2. Divider component values calibrations before and after comparison, $U = 0.05 \%$, $k = 2$ | 26 |
| Table B-3. Overview of the impulse calibration results during the circulation for long front impulse. | 28 |
| Table B-4. Estimated expanded uncertainty contributions for the TRMS due to differences in laboratory setups..... | 30 |

| | |
|--|-----|
| Table B-5. Estimated uncertainty contributions for the TRMS. | 31 |
| Table H-1. Old system reading difference from VTT new reference system. | 161 |

List of figures

| | |
|--|-----|
| Figure 3-1. Transfer reference measurement system. | 8 |
| Figure 3-2. Schematic of the measurement set-up. | 10 |
| Figure 3-3. Top view of the test geometry. | 10 |
| Figure B-1. Change of scale factor after application of ten 700 kV impulses. | 23 |
| Figure B-2. Divider scale factor measurements during the comparison. | 25 |
| Figure B-3. Divider components. | 25 |
| Figure B-4. Test voltage calibration results using the circulating calibrator. | 26 |
| Figure B-5. Front time calibration results using the circulating calibrator. | 27 |
| Figure B-6. Time to half-value calibration results using the circulating calibrator. | 27 |
| Figure B-7. Test voltage calibration results using VTT MIKES and circulating (MIC) calibrator. | 28 |
| Figure B-8. Front time calibration results using VTT MIKES and circulating (MIC) calibrator. | 29 |
| Figure B-9. Time to half-value calibration results using VTT MIKES and circulating (MIC) calibrator. ... | 29 |
| Figure H-1. Arrangement for the lightning impulse voltage comparison. | 160 |
| Figure H-2. Sample of positive impulse with 0.84 μ s front. | 160 |

1. Introduction

This is the Final report of the EURAMET comparison EURAMET.EM-S42, "Comparison of Lightning Impulse (LI) Reference Measuring Systems" (Reg. No. 1391).

| | |
|--|---|
| Metrology area, branch | Electricity and Magnetism, High Voltage and Current |
| Description | Lightning impulse voltage parameters |
| Time of measurement | 2016-2019 |
| Status | Final |
| Measurand(s) | As defined in IEC 60060-1:2010: Test voltage value, U_t Front time, T_1 Time to half-value, T_2 Relative overshoot, β' Time to chopping, T_c |
| Parameter(s) | Test voltage value: from -700 kV to 700 kV Full impulse shape: 0.84/60 μ s and 1.56/60 μ s Chopped impulse shape: $T_c=0.5 \mu$ s |
| Transfer device(s) | Commercial voltage divider and digitizer |
| Comparison type | Supplementary comparison |
| Consultative Committee | CCEM (Consultative Committee for Electricity and Magnetism) |
| Related regional metrology organizations | EURAMET APMP COOMET SIM |

The scope of the comparison was the validation of NMI CMCs for quantities related to lightning impulse voltage (CMC classification 8.4.1 and 8.4.2) for test voltage values in the range from 100 kV to 700 kV.

No previous large-scale comparison lightning impulse voltage comparison has been arranged within EURAMET. A bilateral lightning impulse comparison (EUROMET.EM-S2) was performed on voltages up to 400 kV in 1998 to 1999 [9].

Between 1999 and 2002 a comparison project was organized by funding from the Commission of the European Communities Standards, Measurements, and Testing Programme under Contract EU-SMT-CT98-2270. Results of that comparison were not registered into the EURAMET comparison database.

2. Participants and organisation of the comparison

2.1. Co-ordinator and members of the support group

The pilot laboratory for the comparison was RISE.

Co-ordinator: Alf-Peter Elg, +46 706 955734, alf.elg@ri.se

Support group, appointed by the EURAMET technical committee for electricity and magnetism:

Jari Hällström (VTT MIKES), jari.hallstrom@vtt.fi

Fernando Garnacho (FFII), fernando.garnacho@ffii.es

2.2. List of participants

Out of the 13 participating laboratories, nine National Metrology Institutes (NMI) are signatories of the Multilateral Recognition Arrangement (MRA), and two Designated Institutes (DI) are listed in MRA. In two participating countries, arrangements for the traceable calibrations for impulse voltages are arranged by an institute without NMI or DI status.

JHILL consists of six high-voltage laboratories, academic advisors and related industries; and is active as an organization representing Japan in the field of high voltage technique and testing. Participation of JHILL was authorized by the National Metrology Institute of Japan (NMIJ).

IATTE is a high voltage institute belonging to the National University of Tucuman. Participation of IATTE was authorized by the National Institute of Industrial Technology (INTI), Argentina.

List of participants is shown in Table 2-1.

Table 2-1. Comparison participants

| No | Country | Institute | Acronym | Status | Region | Contact person |
|----|-----------|--|---------|--------------------|---------|---|
| 1 | Sweden | RISE Research Institutes of Sweden | RISE | NMI | EURAMET | Dr. Alf-Peter Elg alf.elg@ri.se |
| 2 | Finland | VTT Technical Research Centre of Finland, National Metrology Institute VTT MIKES | VTT | NMI | EURAMET | Dr. Jari Hällström jari.hallstrom@vtt.fi |
| 3 | Spain | LCOE-FFII, High Voltage Technological Centre | LCOE | DI | EURAMET | Prof. Fernando Garnacho fernando.garnacho@ffii.es |
| 4 | France | Laboratoire national de métrologie et d'essais | LNE | NMI | EURAMET | Mohamed Agazar Mohamed.Agazar@lne.fr |
| 5 | Germany | Physikalisch-Technische Bundesanstalt | PTB | NMI | EURAMET | Dr. Johann Meisner johann.meisner@ptb.de |
| 6 | Italy | Istituto Nazionale di Ricerca Metrologica | INRIM | NMI | EURAMET | Dr. Paolo Roccato p.roccato@inrim.it |
| 7 | Turkey | TÜBİTAK National Metrology Institute | TUBITAK | NMI | EURAMET | Dr. Ahmet Mersev ahmet.merev@tubitak.gov.tr |
| 8 | Japan | Japan High-voltage Testing Laboratory Liaison | JHILL | Other ¹ | APMP | Takayuki Wakimoto wakimoto@calibration.jp |
| 9 | China | National Institute of Metrology | NIM | NMI | APMP | Dr. Wei Zhao zhaowei@nim.ac.cn |
| 10 | Australia | National Measurement Institute | NMIA | NMI | APMP | Dr. Yi Li yi.li@measurement.gov.au |
| 11 | Argentina | Instituto de alta tensión y transmisión de energía | IATTE | Other ² | SIM | Prof. Ricardo Díaz rdiaz@herrera.unt.edu.ar |
| 12 | Canada | National Research Council | NRC | NMI | SIM | Dr. Harold Parks harold_parks@nrc-cnrc.gc.ca |
| 13 | Russia | Russian Research Institute for Metrological Service | VNIIMS | DI | COOMET | Tatiana Dubrovskaya dubrovskaya_ta@vniims.ru |

¹ Participation authorized by NMIJ AIST (Japanese NMI)

² Participation authorized by INTI (Argentinian NMI)

2.3. Organisation and comparison schedule

EURAMET, CIPM and CCEM guidance was followed in organizing this comparison [2, 3, 4]. The comparison was carried out in 2 loops with 1 travelling standard, which was provided for this comparison by HIGHVOLT Prüftechnik Dresden GmbH. The first circulation of the standards was within EU, from November 2016 to August 2017. The second circulation was for non-EU participants, from September 2017 to March 2019. The system was checked by the pilot laboratory before the EU circulation, between the two circulations, and after the non-EU circulation, to establish a drift rate for the standards and to detect value changes related to transport. The detailed time schedule for the comparison is given in Table 2-2.

Three weeks was originally allowed for measurements in each lab. One week was reserved for each transport inside EU, and two weeks outside EU due to expected delays in customs.

To inform each participant on the state of the comparison and provide other information, a calendar was created onto the EURAMET comparison toolbox at <https://euramet.org/comparison-toolbox>.

Table 2-2. Schedule of the comparison.

| Institute | Country | Measurements started | Measurements completed | Transport or delay time (days) | Time in lab (days) | Loop | Customs formalities |
|----------------------|-----------|----------------------|------------------------|--------------------------------|--------------------|------|----------------------|
| RISE1 | Sweden | 2016-11-25 | 2016-11-25 | | 0.5 | 1 | - |
| VTT | Finland | 2016-11-25 | 2016-11-25 | 0 | 0.5 | 1 | - |
| PTB ¹ | Germany | 2016-11-26 | 2016-11-26 | 1 | 1 | 1 | - |
| INRIM ² | Italy | 2017-04-04 | 2017-05-12 | 129 | 38 | 1 | - |
| LCOE | Spain | 2017-05-18 | 2017-06-06 | 11 | 10 | 1 | - |
| LNE | France | 2017-06-12 | 2017-06-21 | 4 | 16 | 1 | - |
| RISE2 | Sweden | 2017-06-27 | 2017-07-28 | 5 | 31 | 1 | - |
| PTB | Germany | 2017-07-31 | 2017-08-19 | 3 | 19 | 1/2 | Temp. export from EU |
| TUBITAK ³ | Turkey | 2017-10-09 | 2017-12-08 | 51 | 60 | 2 | Temporary import |
| IATTE | Argentina | 2018-01-08 | 2018-02-08 | 31 | 31 | 2 | Temporary import |
| NMIA | Australia | 2018-02-27 | 2018-04-20 | 19 | 52 | 2 | Temporary import |
| VNIIMS | Russia | 2018-06-18 | 2018-06-29 | 59 | 11 | 2 | Temporary import |
| NIM | China | 2018-09-03 | 2018-09-23 | 66 | 20 | 2 | Temporary import |
| JHILL | Japan | 2018-10-31 | 2018-11-26 | 38 | 26 | 2 | Temporary import |
| NRC | Canada | 2018-12-17 | 2019-02-15 | 21 | 60 | 2 | Temporary import |
| RISE3 | Sweden | 2019-03-11 | 2019-03-31 | 24 | 20 | 2 | Return to EU |

¹ PTB measurements failed in November 2016. They were repeated in July/August 2017.

² The long time between PTB and INRIM was needed for scheduling the comparison.

³ One of the calibrator heads failed. Repair by the manufacturer caused additional delay.

2.4. Unexpected incidents

- PTB made their measurements first in November 2016. When doing the analysis, they discovered that halfway through the measurement their transient recorder front-end had failed. The recorder was permanently taken out of use and replaced. When this was discovered, the transfer reference measuring system (TRMS) was already on the way to the next lab, INRIM. A new time slot was

given to PTB to repeat the measurements in August 2017 before sending the TRMS to next laboratory, TUBITAK. All participants have given their acceptance to include the August 2017 results into this comparison.

- The low voltage calibration head for the short front (LI 0.84/60 μ s) used for checking the stability of the digitizer of the TRMS was found to be faulty in September 2018 while it was used in TUBITAK. It was sent for repair to the manufacturer, which caused additional delay. The incident has no effect on the performance of the TRMS.
- An oil leak discovered on arrival to INRIM. The divider was refilled, and new gaskets were installed.
- NMIA found a small amount of oil leakage before shipping to the next participating laboratory. The rag underneath the oil filling hole was found wetted with oil. The leakage might have been due to the fact that the divider had been placed horizontally in the transit case for a few weeks and the sealing gasket was deformed. It is estimated that the oil leakage was less than 10 ml.
- The divider arrived for the final test at RISE where it was discovered that 750 ml oil was missing out of 10 l. The oil was refilled before the measurements.
- The measured DC scale factor remained stable within 0.05 % from November 2016 to January 2018. Eight laboratories performed their measurements during that period. From February 2018 to February 2019 an approximately linear drift of about -0.35 % was observed. Five laboratories performed their measurement during that period, and a correction was applied to the respective TRMS test value readings.

3. Travelling standard and measurement instructions

3.1. Description of the standards

The transfer reference measuring system consists of a measurement system from HIGHVOLT Prüftechnik Dresden GmbH (items 1 and 2), and auxiliary devices from HIGHVOLT and VTT MIKES (item 3). The divider and the transient recorder are shown in Figure 3-1. [1]

1. Reference measuring system
Type: HIGHVOLT SMR 10/700
Nominal voltage: 700kV LI
Dimensions (see Figure 3-1): H = 2462 mm, AxA = 1000 x 1000 mm², Mass 50 kg
Scale factor: approx. 950
2. Transient recorder
Type: MIAS 200-12/2C
Maximum sample rate: 200 MS/s
Resolution: 12 bits
Maximum input voltage: 1 kV
3. Auxiliary equipment:
 - a. Impulse voltage calibrator, for checking performance of the transient recorder
Type: MIC 330, LI 0.84/60, LI 1.56/60
 - b. Step voltage generator, for checking performance of the divider
Type: Aivon, Nominal voltage: 200 V
 - c. Chopping gap, for generation of chopped impulses
Type: MIKES, Nominal voltage: 150 kV

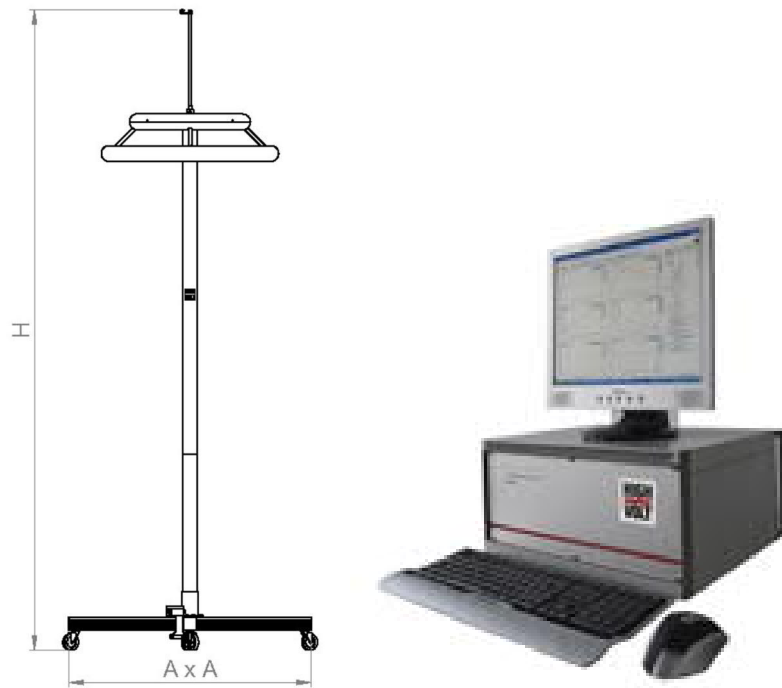


Figure 3-1. Transfer reference measurement system.

3.2. Measured quantities and conditions of measurement

The measured quantities are defined in Annex B of IEC 60060-1:2010:

- Test voltage (U_t),
- Front time (T_1),
- Time to half-value (T_2),
- Time to chopping (T_c), and
- Relative overshoot magnitude (β').

The impulse shapes and respective voltage levels for the comparison are listed in Table 3-1. Due to large number of combinations, a set of preferred measurements was agreed on. [1]

No limits were set to temperature and humidity, as their control in high voltage environment is seldom possible. However, they had to be reported.

Table 3-1. Impulse shapes and respective voltage levels for the comparison.

| Shape | Preferred voltage levels [kV] | Additional voltage levels [kV] |
|------------------------------------|--|---|
| 0.84/60 | +200, -200 | +100, +300, +400, +500, +600, +700, -100, -300, -400, -500, -600, -700 |
| 1.56/60 | 100, 200, 300, 400, 500, 600, 700, -200 | -100, -300, -400, -500, -600, -700 |
| Front chopped $T_c = 0.5 \mu s$ | About -150, using circulated gap | none |

3.3. Measurement instructions

The TRMS must be kept in the laboratory before the measurements for at least 24 hours so that it reaches stable temperature. It is recommended to keep the ambient temperature on the value (23 ± 2) °C. [1]

The data of the ambient conditions during the measurements must be given in the measurement report.

3.3.1. Transfer system checks before comparison measurements

The following checks aim at collecting data to follow-up the stability of the travelling system and components. They are not used for any revision of the scale factors during the circulation.

3.3.1.1. Impulse calibration

The transfer digitizer is calibrated using the impulse calibrator circulating with the system. Calibration is automatic, controlled by computer program. Calibration is done with positive and negative polarity. (Time required: c. 1 hour for each impulse shape.)

3.3.1.2. Scale factor measurement

The scale factor of the transfer divider is checked by direct voltage.

3.3.1.3. Step response measurement

The travelling step generator shall be mounted on wall at the height of the divider according to Fig. C.3a in IEC 60060-2:2010.

3.3.1.4. Interference test of the transfer system

The interference test shall be performed according to 5.12 in IEC 60060-2:2010 using the circulating gap.

3.3.2. Home system checks before comparison measurements

Participants shall calibrate all relevant instruments of their own system before the comparison measurements and prepare uncertainty estimates for U_t , T_1 , T_C , T_2 and β' measurement. The interference test according to 5.12 in IEC 60060-2:2010 using the circulating gap should be performed simultaneously both for the circulating system and the home system in the comparison setup.

3.3.3. High voltage setup

The results (U_t , T_1 , T_C , T_2 and β') obtained with the circulating reference system (divider with cable, digitizer) shall be compared with those obtained by participant's reference system. Each measurement is a set of ten impulses. For the setup, see Figure 3-2 and Figure 3-3. The high voltage lead from the impulse generator must be connected on top of an insulator or front capacitor (height c. 250 cm). The chopping gap must replace the insulator or it must be connected in parallel with the front capacitor. Connections, as wide and as short as possible, should be used for the chopping gap.

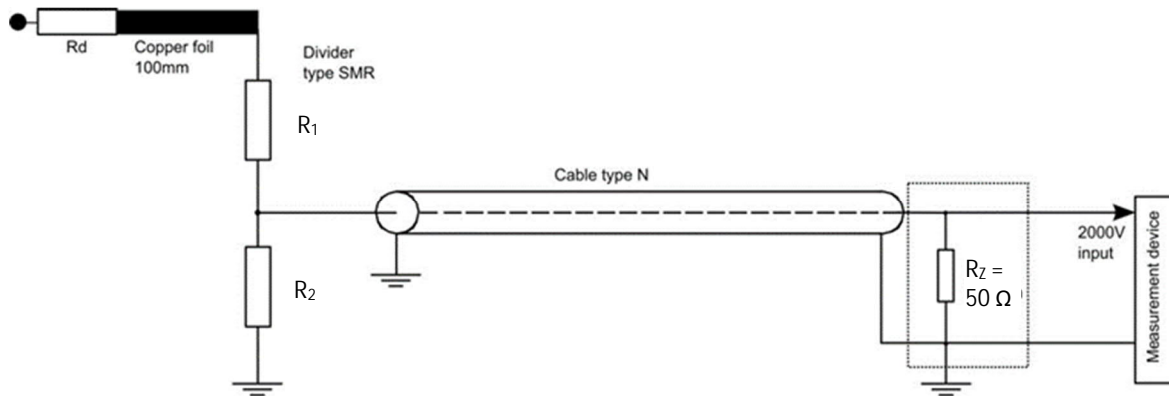


Figure 3-2. Schematic of the measurement set-up.

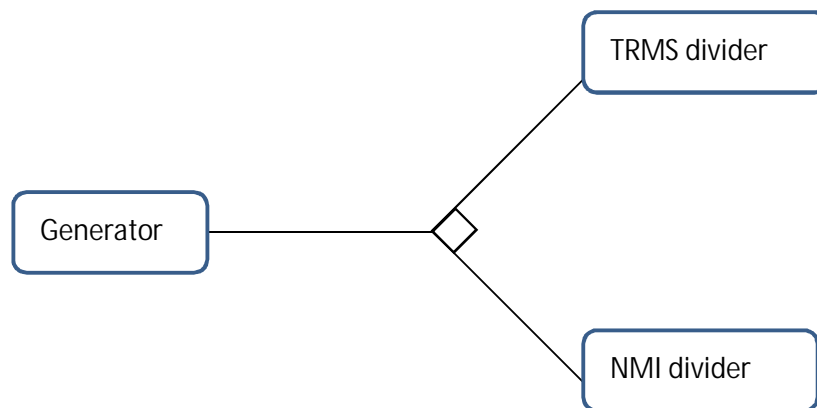


Figure 3-3. Top view of the test geometry.

About 20 cm wide Y-formed grounding plate of copper or aluminium is recommended to be used as ground return on the floor from both dividers to the insulator / front capacitor / chopping gap and from there to the impulse generator. To avoid oscillations after chopping the loop formed by the front capacitor, the chopping gap should be as small as possible.

3.4. Deviations from the protocol

The comparison was carried out as described in the protocol with two exceptions:

- modifications in the comparison schedule were necessary, and
- instead of uploading the reports to the EURAMET comparison toolbox, the participants were asked to send them directly to the coordinators by email.

4. Methods of measurement

All participants performed the measurement by comparing the readings of the TRMS with those of their own impulse voltage measurement system.

5. Repeated measurements of the pilot institute, behaviour of the travelling system

An overview of measurements by pilot institutes and of the behaviour of the travelling system is in Annex B. Gain correction and additional uncertainty contributions due to transfer TRMS instability were introduced to the analysis shown in Annex C and Annex E.

6. Analysis of comparison data set

6.1. Basic strategy

Each participant was asked to upload the results to the EURAMET comparison toolbox within 6 weeks after completing the measurements⁴.

The following documents were requested:

1. PDF copy of the signed report (e.g. calibration certificate) and
2. Excel worksheets presenting the results for each measurement point. The template available in the comparison toolbox was to be used without modification.

The report was requested to contain at least the following:

- description of the measuring set-up including the electrical circuit configuration;
- traceability scheme; if the traceability to the SI is provided by another NMI, the name of the NMI must be stated (needed to identify possible sources of correlation);
- description of the measurement procedure;
- the ambient conditions of the measurement: the temperature and humidity with limits of variation.
- summary of the results with a complete uncertainty budget(s) in accordance with the principles of the Guide to the Expression of Uncertainty in Measurement⁵, including degrees of freedom for every component and calculation of the coverage factor; such an analysis is a prerequisite to be considered in the calculation of the comparison reference value; it is also an essential part of the final report which will appear in the BIPM Key Comparison Database.

In addition to the comparison results, the participants were requested to upload other files, so that the pilots can follow the status of the travelling system. Guidance for this was given in a separate document.

6.2. Results of the participating institutes

The participants were asked to do as many measurements as deemed reasonable distributed in time over the whole period allocated to the laboratory. An overview is shown in Table 6-1. Preferred impulse shapes are shown by bold on grey background.

All participants measured the preferred non-chopped measurement values up to 200 kV.

⁴ it was found that using the toolbox adds in this case an unnecessary step to the collection of results. The participants were instructed to send the reporting files directly to the coordinators.

⁵ BIPM Guide JCGM 100:2008

The pilot laboratory measured the preferred measurement values up to 500 kV three times during the comparison.

Table 6-1. Overview of the measurements performed by the participants.

| | RISE1 | VTT | PTB | INRIM | LCOE | LINE | RISE2 | TUBITAK | IATTE | NMIA | VNIIMS | NIM | JHILL | NRC | RISE3 |
|--------------|-------|-----|-----|-------|------|------|-------|---------|-------|------|--------|-----|-------|-----|-------|
| Short-N700 | | | | | X | | | X | | | | | | | |
| Short-N600 | | | | | X | | | X | | | X | X | | | |
| Short-N500 | | | | | X | | | X | X | | X | X | X | | |
| Short-N400 | | | | | X | | | X | | | X | X | X | | |
| Short-N300 | | | | | X | X | | X | | X | X | X | X | | |
| Short-N200 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Short-N100 | | | | X | X | X | | X | | X | X | X | X | X | |
| Short-P100 | | | | X | X | X | | X | | X | X | X | X | X | |
| Short-P200 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Short-P300 | | | | | X | X | | X | | X | X | X | X | | |
| Short-P400 | | | | X | X | | | X | | | X | X | X | | |
| Short-P500 | | | | | X | | | X | X | | X | X | X | | |
| Short-P600 | | | | X | X | | | X | | | X | X | | | |
| Short-P700 | | | | | X | | | X | | | | | | | |
| Long-N700 | | | | | X | | | X | | | | X | | | |
| Long-N600 | | | | | X | | | X | | | X | X | | | |
| Long-N500 | | | | | X | | | X | X | | X | X | X | | |
| Long-N400 | | | | | X | | | X | | | X | X | X | | |
| Long-N300 | | | | | X | X | | X | X | X | X | X | X | | |
| Long-N200 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Long-N100 | | | | X | X | X | | X | | X | X | X | X | X | |
| Long-P100 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Long-P200 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Long-P300 | X | X | X | X | X | X | X | X | X | X | X | X | X | | X |
| Long-P400 | X | X | X | X | X | | X | X | X | | X | X | X | | X |
| Long-P500 | X | | X | X | X | | X | X | X | | X | X | X | | X |
| Long-P600 | X | | X | X | X | | | X | X | | X | X | | | |
| Long-P700 | | | X | | X | | | X | | | | X | | | |
| Chopped-P150 | | | X | | | | | X | | X | | | | | X |
| Chopped-N150 | X | X | X | X | X | X | X | X | X | X | X | X | X | | |

The readings of the TRMS were compared with the readings from the local reference measuring system. An EXCEL template (see Annex A) was provided to unify the handling of the readings.

The TRMS test voltage (U_t) relative measurement error was calculated from

$$E_m [\%] = \frac{U_{TRMS} - U_{REF}}{U_{REF}} \cdot 100 ,$$

where: E_m : Measurement error of the TRMS.
 U_{TRMS} : U_t value obtained by means of the TRMS.
 U_{REF} : U_t value obtained by means of the local reference measuring system.

The relative measurement errors for T_1 and T_2 are calculated in the same way as for the test voltage.

The absolute measurement error for β' is calculated from

$$E_m [\%] = \beta'_{TRMS} - \beta'_{REF} .$$

The average TRMS error and experimental standard deviation were calculated in each case from the results of ten impulses.

6.3. Uncertainty of measurement

All participants provided their results with the associated uncertainties of measured parameters together with an uncertainty budget. The uncertainties were reported using coverage factor $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The uncertainty of the measurement was to be estimated according to the BIPM Guide to the expression of Uncertainty in Measurement (JCGM 100:2008). [5]

A list of the principal components of the uncertainty budget to be evaluated by each participant could not be included in the technical protocol. It is supposed that each participating laboratory applies a different method depending on its facilities. Therefore, a list of the principal components, relevant for all participants, cannot be presented.

Sample uncertainty budgets provided by the participants are shown in Annex D.

6.4. Results of the participating institutes

Annex C shows the results by laboratory, as reported to the coordinators.

6.5. Calculation of comparison reference values

The following results were excluded from the calculation of the comparison reference values (CRV):

1. The pilot laboratory, RISE, performed the measurements three times. All three RISE results were used for estimating the uncertainty component of the transfer standard due to stability, and only the results from the RISE2 were included in the CRV calculation.
2. Traceability to IATTE measurements comes partly from NIM, China; and partly from a German accredited calibration laboratory. Also, IATTE referred to IEEE4:2013 instead of IEC 60060-1:2010 for their parameter evaluation routines. IATTE results were excluded from the CRV calculation.

The comparison reference value, CRV, is calculated separately for each impulse waveform and for each measured parameter. The CRV is considered as an estimation of the measurand according to the measurements provided by the participating laboratories. [6]

This estimation, y , is determined as a weighted mean of the provided results where the weights are the inverse values of the squares of the associated standard uncertainties. However, that cannot be applied in case where some of the measurements are not consistent with the others.

The number of participating laboratories, N , depends on the considered voltage level, parameter and polarity. It varies from 1 to 13.

The inputs for CRV calculation are the errors provided by the participants for the TRMS readings, x_i , $i = 1, 2, \dots, N$, and the corresponding standard uncertainties, $u(x_i)$, $i = 1, 2, \dots, N$.

The procedure is implemented in four steps:

- 1) Determination of the comparison reference value CRV (y), using the inverse values of the squares of the uncertainties as the weights:

$$y = \frac{\sum_{i=1}^N x_i u^{-2}(x_i)}{\sum_{i=1}^N u^{-2}(x_i)} .$$

- 2) Calculation of standard uncertainty of CRV, $u(y)$:

$$u(y) = \frac{1}{\sqrt{\sum_{i=1}^N u^{-2}(x_i)}} .$$

- 3) Consistency of results

A χ^2 test has been applied to carry out an overall consistency check of the results obtained (i.e. if all results can be regarded as belonging to the same statistical ensemble). For each measured parameter, the observed chi-squared value χ_{obs}^2 has been determined as:

$$\chi_{\text{obs}}^2 = \sum_{i=1}^N \frac{(x_i - y)^2}{u^2(x_i)} .$$

The number of degrees of freedom is $\nu = N - 1$, for N results.

The consistency check is considered failed if

$$\text{Pr}\{ \chi^2(\nu) > \chi_{\text{obs}}^2 \} < 5\% ,$$

where Pr denotes "probability of".

If the chi-squared test fails, then the laboratory with the largest $|d_i|$ value (see below for definition) is excluded from the determination of the CRV and the consistency check repeated. The process is then repeated as needed.

- 4) Exclusion of incompatible results

Compatibility index, d_i , is defined as the ratio between the difference from the reference value and the standard uncertainty:

$$d_i = \frac{\Delta x_i}{u(\Delta x_i)} = \frac{x_i - y}{\sqrt{u^2(x_i) - u^2(y)}} .$$

The compatibility index $|d_i|$ describes the deviation from the CRV in relation to the calculated standard uncertainty of the deviation.

The standard uncertainties of the differences corresponding to those laboratories whose results have not been considered in the reference value calculation are obtained applying the following expression:

$$u^2(\Delta x_i) = u^2(x_i) + u^2(y),$$

since now the values are not correlated.

Calculated reference values are shown in Annex E.

6.6. Degrees of equivalence (DoE)

6.6.1. Compatibility of each laboratory with the estimate of CRV:

In each case, the degree of equivalence (DoE or E_n) of laboratory i , $i = 1, 2, \dots, N$, with the CRV is determined as the pair of values for the deviation from the CRV and the uncertainty of this deviation $[\Delta x_i, U(\Delta x_i)]$ according to the expressions:

$$E_n = \frac{\Delta x_i}{U(\Delta x_i)},$$

$$\Delta x_i = x_i - y \text{ and}$$

$$U(\Delta x_i) = 2 \cdot u(\Delta x_i), \quad (1)$$

where $u(\Delta x_i)$ is obtained applying the following expression:

$$u^2(\Delta x_i) = u^2(x_i) - u^2(y). \quad (2)$$

Note 1: The factor 2 in expression (1) above indicates a coverage factor of 95 % corresponding to a Gaussian distribution function.

Note 2: Expression (2) establishes a difference of two variances as consequence of the mutual dependence (or correlation) between x_i and CRV.

6.6.2. Compatibility between any two laboratories:

Compatibility between laboratory i , $i = 1, 2, \dots, N$ and laboratory j , $j = 1, 2, \dots, N$, with $i \neq j$, $[\Delta x_{i,j}, U(\Delta x_{i,j})]$ is obtained according to:

$$\Delta x_{i,j} = x_i - x_j \text{ and}$$

$$U(\Delta x_{i,j}) = 2 \cdot u(\Delta x_{i,j}). \quad (3)$$

$u(\Delta x_{i,j})$ is calculated applying the following expression:

$$u^2(\Delta x_{i,j}) = u^2(x_i) + u^2(x_j).$$

Note 3: The difference $\Delta x_{i,j}$ between the measurements of the laboratories x_i and x_j does not depend on the corresponding reference value, because:

$$\Delta x_{i,j} = \Delta x_i - \Delta x_j = (x_i - CRV) - (x_j - CRV) = x_i - x_j.$$

Note 4: Expressions for $U(\Delta x_i)$ and $U(\Delta x_{i,j})$ in expressions (1) and (3) are based on Gaussian distribution of measurands.

The compatibility index between two laboratories is analysed using the following expression for $d_{i,j}$:

$$d_{i,j} = \frac{\Delta x_{i,j}}{u(\Delta x_{i,j})} = \frac{x_i - x_j}{\sqrt{u^2(x_i) + u^2(x_j)}}.$$

If $|d_{i,j}| \leq 2$ then results of the corresponding laboratories are considered compatible.

The compatibility indexes between any two laboratories are available on request.

7. Comparison results

7.1. Measurements conditions

Table 7-1 shows ambient conditions in each participating laboratory during corresponding measurements.

Table 7-1. Ambient conditions.

| Laboratory | Temperature (°C) | Humidity (RH%) |
|------------|------------------|----------------|
| RISE1 | 22.8 ± 1 | 40 ± 5 |
| VTT | 22 ± 2 | 36 ± 10 |
| INRIM | 23 ± 2 | - |
| LCOE | 21 ± 2 | < 60 |
| LNE | 23 ± 1 | < 60 |
| RISE2 | 22.8 ± 1 | 40 ± 5 |
| PTB | 21 ± 1 | - |
| TUBITAK | 23.4 ± 1.6 | 48 ± 8 |
| IATTE | 25 - 30 | 40 - 68 |
| NMIA | 23 - 25 | 57 - 71 |
| VNIIMS | 23 ± 1 | 30 - 60 |
| NIM | 22.6 - 24.4 | 28 - 64 |
| JHILL | 19 - 22 | 60 - 89 |
| NRC | 23 ± 2 | 5 - 25 |
| RISE3 | 22 ± 2 | 19 ± 5 |

7.2. Instrumentation used by the participating laboratories

The divider and transmission cable details of each laboratory are shown in Table 7-2 and the low voltage attenuator, digitizer and software characteristics are listed in Table 7-3.

Table 7-2. Divider and transmission cable characteristics of each participating laboratory.

| Lab | Divider type | Divider Z_{in} | Divider make | Divider U_{max} | Divider model | Divider damping resistor R_d | Cable type | Cable length |
|---------|-------------------------|---------------------------------|----------------|-------------------|---------------|--------------------------------|---------------------|--------------|
| RISE1 | Resistive | 7.7 k Ω | Highvolt | 500 kV | SMR500 | 250 Ω | Belden triax | 5 m |
| RISE1b | Resistive | 12.3 k Ω | Passoni Villa | 750 kV | | 200 Ω | Belden triax | 5 m |
| VTT | Resistive | 10 k Ω | Self | 400 kV | HUT400 | 250 Ω | Belden 9888 | 15 m |
| INRIMa | Resistive | 6 k Ω | Self | 200 kV | SAGI 304 | | | 15 m |
| INRIMb | Resistive | 8 k Ω | Haefely | 600 kV | R600 | | | 15 m |
| LCOE | Resistive | 8.4 k Ω / 2.7 k Ω | ASEA / Haefely | 700 / 300 kV | YDSA / R-300 | - / 294 Ω | Triax-75 Ω | 15 m |
| LNE | Resistive | 24 k Ω | Self | 420 kV | Gary1 | 217 Ω | Triax-75 Ω | 25 m |
| RISE2 | Resistive | 7.7 k Ω | Highvolt | 500 kV | SMR500 | 250 Ω | Belden triax | 5 m |
| PTB | Damped capacitive | | Self | 1000 kV | PZT-1000 | | RG214 | 25 m |
| TUBITAK | Resistive | 10 k Ω | Highvolt | 700 kV | SMR 10/700 | 250 Ω | RG214/U 50 Ω | 25 m |
| IATTE | Resistive | 45 k Ω | Haefely | 600 kV | | 309 Ω | 75 Ω | 20 m |
| NMIA | Resistive | 3.3 k Ω | Self | 350 kV | D1 | 330 Ω | 50 Ω | 20 m |
| VNIIMS | Capacitive | | Highvolt | 1000 kV | | | 75 Ω | 10 m |
| NIM | Oil insulated Resistive | 5 k Ω | Self | 700 kV | D700v2 | 300 Ω | RG 217 | 20 m |
| JHILL | Resistive | 10 k Ω | Tama Electric | 500 kV | NIT-STD-001 | 287 Ω | 8D-SFA | 20 m |
| NRC | Resistive | 10 k Ω | Self | 400 kV | R8 | 200 Ω | RG214 | 10 m |
| RISE3 | Resistive | 7.7 k Ω | Highvolt | 500 kV | SMR500 | 250 Ω | Belden triax | 5 m |

Table 7-3. Attenuator, digitizer and software characteristics of each participating laboratory.

| Lab | Attenuator/termination type | Attenuator/termination ratio | Digitizer make | Digitizer type | Software make | Software standard |
|---------|-----------------------------|------------------------------|----------------|----------------|---------------|------------------------------------|
| RISE1 | Resistive | 20.2:1 and 5.00:1 | NI | PXI-5124 | Self | IEC60060-1:2010 |
| VTT | Resistive | 3.3:1 and 28:1 | NI | PXI-5124 | Self | IEC60060-1:2010 |
| INRIMa | | | NI | PXI-5124 | Self | IEC60060-1:2010 |
| INRIMb | | | NI | PXI-5124 | Self | IEC60060-1:2010 |
| LCOE | Resistive | 2.95 / 15.2 | Yokogawa | DL850 | LCOE | IEC60060-1:2010 |
| LNE | | | Dr. Strauss | TR-AS 200-14 | Dr. Strauss | |
| RISE2 | Resistive | 20.2:1 and 5.00:1 | NI | PXI-5124 | Self | IEC60060-1:2010 |
| PTB | | | Dr. Strauss | TR-AS 200-14 | | |
| TUBITAK | Resistive | 1:1 | Dr. Strauss | TR-AS 200-12 | Dr. Strauss | IEC60060-1:2010 |
| IATTE | Resistive | 1:1 | Dr. Strauss | TR-AS 100-10 | Dr. Strauss | IEEE4:2013 |
| IATTE1 | | | | | VTT | IEC60060-1:2010 |
| NMIA | Resistive | 40:1 | Tektronix | TDS 782A | Self | IEC 60060-1:2010, IEC 61083-2:2013 |
| VNIIMS | | | Highvolt | MIAS | MIAS | IEC60060-1:2010 |
| NIM | Resistive | 32:1 | NI | PXI-5164 | Self | IEC60060-1:2010 |
| JHILL | | | Dr. Strauss | TR-AS 100-14 | CRIEPI | IEC60060-1:2010 |
| NRC | Resistive | 25:1 | NI | PXIe-5122 | Self | IEC60060-1:2010 |
| RISE3 | Resistive | 20.2:1 and 5.00:1 | NI | PXI-5124 | Self | IEC60060-1:2010 |

7.3. Comparison results

7.3.1. Detailed comparison results

The comparison results for each impulse shape, together with comparison reference values and compatibilities to the reference value are shown in Annex E.

7.3.2. Overview of CRV distribution

An overview of the calculated CRV values is shown in Table 7-4.

The fact that CRV values were significantly greater than zero merely confirms that the transfer reference system had systematic errors, which were not corrected for during the comparison.

The average of CRV values for U_t of the full impulse with short front time was +0.32% for the negative and +0.35% for the positive polarities, respectively, and with long front time +0.34% and +0.52%. This means that the transfer system had a consistent positive systematic error in U_t . The error is most likely due to differences between the nominal (used during the comparison) and actual impulse scale factors of the divider and the digitizer.

The average of CRV values for T_1 were +2.6% for short front, and +1.1% for long front impulses, respectively, which means the values measured by the transfer system had positive error. Also, this error was dependent on impulse front time. One possible reason for the systematic error could be e.g. the deformation of the impulse shape in the signal cable. This effect on resistive dividers has been highlighted in some publications during the last decade, see e.g. [7, 8].

The average of CRV values for T_2 were in the range from -0.25% to -0.52%. This indicates that there is again a systematic error in the measurement of the transfer system. One possible reason for the systematic error could be deformation of the impulse shape in the signal cable, as for T_1 .

The average CRV values for β' range from -0.12% to 0.08%, which indicates that there is no significant systematic error in the measurement of the transfer system for this parameter. Note that both β' and its uncertainty are absolute, not relative, contrary to the other parameters in Table 7-4. See chapter 6.2.

The average CRV values for U_e and T_c for front chopped impulses have significantly higher uncertainties than the CRVs for full impulse parameters.

Table 7-4. Overview of calculated CRV values and their expanded uncertainties (k=2).

| Short negative | U _t | | T ₁ | | T ₂ | | β' | |
|-------------------|----------------|--------|----------------|--------|----------------|--------|---------|------------------|
| | CRV | U(CRV) | CRV | U(CRV) | CRV | U(CRV) | CRV [%] | U(CRV) [%], abs. |
| Short-N100 | 0.18 % | 0.20 % | 2.46 % | 0.98 % | 0.35 % | 0.78 % | -0.18 | 0.26 |
| Short-N200 | 0.27 % | 0.16 % | 1.80 % | 0.78 % | 0.20 % | 0.67 % | -0.21 | 0.17 |
| Short-N300 | 0.32 % | 0.22 % | 2.63 % | 1.04 % | 0.16 % | 0.90 % | -0.23 | 0.28 |
| Short-N400 | 0.47 % | 0.30 % | 2.54 % | 1.20 % | -0.32 % | 0.98 % | 0.03 | 0.31 |
| Short-N500 | 0.46 % | 0.31 % | 2.48 % | 1.25 % | -0.49 % | 1.00 % | -0.09 | 0.31 |
| Short-N600 | 0.25 % | 0.29 % | 3.17 % | 1.40 % | -0.75 % | 1.12 % | -0.07 | 0.37 |
| Short-N700 | 0.28 % | 0.44 % | 3.05 % | 2.12 % | -0.93 % | 1.57 % | -0.04 | 0.58 |
| Mean | 0.32 % | 0.27 % | 2.59 % | 1.25 % | -0.25 % | 1.00 % | -0.11 | 0.33 |
| Stdev of mean | 0.12 % | 0.10 % | 0.98 % | 0.47 % | -0.10 % | 0.38 % | -0.04 | 0.12 |

| Short positive | U _t | | T ₁ | | T ₂ | | β' | |
|-------------------|----------------|--------|----------------|--------|----------------|--------|---------|------------------|
| | CRV | U(CRV) | CRV | U(CRV) | CRV | U(CRV) | CRV [%] | U(CRV) [%], abs. |
| Short-P100 | 0.31 % | 0.22 % | 2.41 % | 0.98 % | 0.41 % | 0.78 % | -0.18 | 0.26 |
| Short-P200 | 0.40 % | 0.17 % | 1.63 % | 0.78 % | 0.31 % | 0.67 % | -0.23 | 0.17 |
| Short-P300 | 0.33 % | 0.22 % | 2.61 % | 1.04 % | 0.02 % | 0.83 % | -0.24 | 0.28 |
| Short-P400 | 0.35 % | 0.25 % | 2.55 % | 1.17 % | -0.36 % | 0.97 % | 0.06 | 0.30 |
| Short-P500 | 0.54 % | 0.31 % | 2.97 % | 1.26 % | -0.52 % | 1.00 % | -0.03 | 0.31 |
| Short-P600 | 0.30 % | 0.28 % | 3.10 % | 1.36 % | -0.82 % | 1.10 % | 0.02 | 0.35 |
| Short-P700 | 0.23 % | 0.44 % | 3.31 % | 2.13 % | -0.89 % | 1.58 % | -0.24 | 0.61 |
| Mean | 0.35 % | 0.27 % | 2.65 % | 1.25 % | -0.26 % | 0.99 % | -0.12 | 0.32 |
| Stdev of mean | 0.13 % | 0.10 % | 1.00 % | 0.47 % | -0.10 % | 0.37 % | -0.05 | 0.12 |

| Long negative | U _t | | T ₁ | | T ₂ | | β' | |
|------------------|----------------|--------|----------------|--------|----------------|--------|---------|------------------|
| | CRV | U(CRV) | CRV | U(CRV) | CRV | U(CRV) | CRV [%] | U(CRV) [%], abs. |
| Long-N100 | 0.63 % | 0.22 % | 1.96 % | 0.68 % | -0.18 % | 0.44 % | 0.05 | 0.24 |
| Long-N200 | 0.63 % | 0.17 % | 1.46 % | 0.52 % | -0.16 % | 0.37 % | -0.04 | 0.12 |
| Long-N300 | 0.31 % | 0.26 % | 1.46 % | 0.83 % | -0.40 % | 0.46 % | -0.02 | 0.25 |
| Long-N400 | 0.09 % | 0.33 % | 0.86 % | 0.95 % | -0.64 % | 0.54 % | 0.20 | 0.28 |
| Long-N500 | 0.06 % | 0.33 % | 1.27 % | 0.95 % | -0.74 % | 0.56 % | 0.09 | 0.28 |
| Long-N600 | 0.30 % | 0.29 % | 0.44 % | 1.23 % | -0.94 % | 0.62 % | 0.18 | 0.33 |
| Long-N700 | 0.37 % | 0.36 % | 0.57 % | 1.36 % | -0.61 % | 0.80 % | 0.11 | 0.44 |
| Mean | 0.34 % | 0.28 % | 1.15 % | 0.93 % | -0.53 % | 0.54 % | 0.08 | 0.28 |
| Stdev of mean | 0.13 % | 0.11 % | 0.43 % | 0.35 % | -0.20 % | 0.21 % | 0.03 | 0.10 |

| Long positive | U _t | | T ₁ | | T ₂ | | β' | |
|------------------|----------------|--------|----------------|--------|----------------|--------|---------|------------------|
| | CRV | U(CRV) | CRV | U(CRV) | CRV | U(CRV) | CRV [%] | U(CRV) [%], abs. |
| Long-P100 | 0.46 % | 0.16 % | 1.63 % | 0.53 % | 0.09 % | 0.38 % | -0.09 | 0.12 |
| Long-P200 | 0.64 % | 0.17 % | 1.47 % | 0.52 % | -0.04 % | 0.37 % | 0.02 | 0.12 |
| Long-P300 | 0.54 % | 0.17 % | 1.38 % | 0.56 % | -0.17 % | 0.38 % | -0.11 | 0.12 |
| Long-P400 | 0.55 % | 0.19 % | 0.83 % | 0.60 % | -0.43 % | 0.43 % | 0.17 | 0.13 |
| Long-P500 | 0.47 % | 0.21 % | 0.86 % | 0.69 % | -0.62 % | 0.49 % | 0.18 | 0.14 |
| Long-P600 | 0.38 % | 0.25 % | 0.93 % | 0.94 % | -1.02 % | 0.62 % | 0.22 | 0.31 |
| Long-P700 | 0.58 % | 0.34 % | 0.77 % | 1.16 % | -0.60 % | 0.75 % | 0.11 | 0.43 |
| Mean | 0.52 % | 0.22 % | 1.12 % | 0.71 % | -0.40 % | 0.49 % | 0.07 | 0.19 |
| Stdev of mean | 0.20 % | 0.08 % | 0.42 % | 0.27 % | -0.15 % | 0.18 % | 0.03 | 0.07 |

| Chopped | U _e | | T _c | |
|---------------|----------------|--------|----------------|--------|
| | CRV | U(CRV) | CRV | U(CRV) |
| Chopped-P150 | 0.40 % | 0.58 % | 1.32 % | 1.81 % |
| Chopped-N150 | -1.04 % | 0.47 % | 0.11 % | 0.91 % |
| Mean | -0.32 % | 0.53 % | 0.71 % | 1.36 % |
| Stdev of mean | -0.22 % | 0.37 % | 0.50 % | 0.96 % |

8. Traceability

8.1. Traceability of participating institutes

Each national metrology institute carried out the comparison measurements using their own national standard for lightning impulse voltage. The traceability of the impulse parameters measured is based on several quantities, including at least dc voltage, resistance, capacitance and time. Table 8-1 lists the sources of traceability for the participating laboratories.

Table 8-1. Source of traceability

| Laboratory | In house | Other |
|------------|----------|-------------------|
| RISE1 | X | |
| VTT | X | |
| INRIM | X | |
| LCOE | X | |
| LNE | X | |
| RISE2 | X | |
| PTB | X | |
| TUBITAK | X | |
| IATTE | | IATTE / DKD / NIM |
| NMIA | X | |
| VNIIMS | X | |
| NIM | X | |
| JHILL | | NMIJ |
| NRC | X | |
| RISE3 | X | |

8.2. Link to earlier EU funded comparison

An EU funded international comparison of lightning and switching impulse voltage measuring systems was arranged between 1999 and 2002 (EU-SMT4-CT98-2270). The number of participants was 26, including the coordinator. This comparison was not registered in EURAMET comparison database.

VTT MIKES compared the transfer reference system used during that comparison with the system VTT MIKES used in this comparison. Results are shown in Annex H.

9. Conclusions and final remarks

9.1. Conclusions

The scatter of the comparison results was surprisingly large.

The transfer reference showed minor drift. However, this drift was corrected, and even without correction it would not have limited the uncertainty of this comparison. Neither the calibration results for the divider scale factor, nor the results of the repeated impulse calibration of the digitizer can explain the scatter of the comparison result.

Therefore it is quite certain that the scatter was not due to the instability of the transfer system, as the repeated calibrations of the transfer system by the pilot laboratory do not support that conclusion.

The conclusion we have drawn is that laboratories may have underestimated the uncertainties due to e.g. the different impulse shapes, different high-voltage connections or different grounding systems used in their comparison measurements. To partially cover this, an uncertainty component for repeatability based on the three calibrations performed by the pilot in different times and locations has been added. However, this instability component may not fully cover the effects due to variations in individual laboratories.

More stringent requirements should be defined in future comparisons for the calibration setup to reach lower uncertainties.

9.2. Comments from participants

VNIIMS: "The measuring system that was used as a mobile standard system for the round comparisons was not reliable and stable enough to use it for such comparisons and several times failed. A more stable and highly reliable system should be used for such comparisons.

It is necessary to provide additional investigation and there is a suggestion to continue studying this issue under a new bilateral or some 3-parties project of supplementary comparisons (so that to lessen the time and distances within the comparisons project) with some of the NMIs that successfully participated the EM-S42 due to importance of the topic of metrological and scientific investigation under EURAMET.EM-S42 comparisons."

PTB: "In the case of measuring points with only a very small number of participants and a large spread of the results, the result overview may lead to a misleading interpretation of the ability of individual laboratories."

10. References

- [1] A-P. Elg, J. Hällström and F. Garnacho, "Supplementary comparison EURAMET.EM-S42 Comparison of lightning impulse (LI) Reference Measuring Systems" Technical protocol dated 2019-01-27.
- [2] EURAMET Guide on Comparisons, EURAMET Guide No. 4, Version 1.0 (05/2016)
- [3] CIPM MRA-D-05: Measurement comparisons in the CIPM MRA
- [4] CCEM Guidelines for Planning, Organizing, Conducting and Reporting Key, Supplementary and Pilot Comparisons, dated 2015-05-25
- [5] BIPM-IEC-ISO-OIML. Guide to the Expression of the Uncertainty in Measurement 2008.
- [6] Cox M. G.: The Evaluation of Key Comparison Data. Metrology 39, pp. 589-595, 2002.
- [7] S. Sato et al.: Influence of Measuring Cable on Lightning Impulse Parameters, Electronics and Communications in Japan, Vol. 93, No. 6, 2010.
- [8] A. Bergman et al.: Influence of coaxial cable on response of high-voltage resistive dividers, The 20th International Symposium on High Voltage Engineering, Buenos Aires, Argentina, 2017.
- [9] <https://www.bipm.org/kcdb/comparison?id=793>

Annex A - Excel template for reporting of comparison results

| Type your results on yellow cells Settings and comparison results is shown in green cells Please do not change formatting of this excel. You can ignore the possible compatibility error during saving | | | | | | | | | |
|---|-----|-------|--------|-------|--------|------|-------|-------|-------|
| Digitizer LV range HV range Voltage T1 | | | | | | | | | |
| 2 V 380 kV 202 kV 0.8 μs | | | | | | | | | |
| TRMS values from Sheet4 Recordid Range[V] Div. Sf Ut [kV] T1 or Tc T2[μs] β1 [%] β2 [%] | | | | | | | | | |
| Type in lab values Ut [kV] T1 or Tc T2[μs] β1 [%] β2 [%] | | | | | | | | | |
| Calculated errors dU/U dT1/T1 or dT2/T2 dTc/Tc dβ1 [%] | | | | | | | | | |
| Intermediate results dU/U dT1/T1 or dT2/T2 dTc/Tc dβ1 [%] | | | | | | | | | |
| Final results - calibrated TRMS errors dU/U dT1/T1 or dT2/T2 dTc/Tc dβ1 [%] | | | | | | | | | |
| Comparison result Overall uncertainty (k=2) | | | | | | | | | |
| 1 | 1.5 | 950.0 | 202.12 | 0.851 | 41.00 | 2.8 | 2.0 | 2.0 | 2.0 |
| 2 | 1.5 | 953.3 | 202.08 | 0.853 | 40.99 | 2.7 | 2.1 | 2.1 | 2.1 |
| 3 | 1.5 | 953.3 | 202.08 | 0.852 | 40.97 | 2.7 | 2.2 | 2.2 | 2.2 |
| 4 | 1.5 | 953.3 | 202.05 | 0.846 | 40.99 | 2.6 | 2.3 | 2.3 | 2.3 |
| 5 | 1.5 | 953.3 | 202.11 | 0.850 | 40.99 | 2.6 | 2.4 | 2.4 | 2.4 |
| 6 | 1.5 | 953.3 | 202.11 | 0.851 | 41.02 | 2.7 | 2.5 | 2.5 | 2.5 |
| 7 | 1.5 | 953.3 | 202.11 | 0.852 | 41.00 | 2.7 | 2.6 | 2.6 | 2.6 |
| 8 | 1.5 | 953.3 | 202.04 | 0.851 | 41.01 | 2.7 | 2.7 | 2.7 | 2.7 |
| 9 | 1.5 | 953.3 | 202.14 | 0.837 | 40.96 | 2.6 | 2.8 | 2.8 | 2.8 |
| 10 | 1.5 | 953.3 | 202.07 | 0.850 | 40.99 | 2.8 | 2.9 | 2.9 | 2.9 |
| Average | | | 202.09 | 0.849 | 40.992 | 2.69 | 2.45 | 2.45 | 2.45 |
| Stdev(abs.) | | | 0.03 | 0.005 | 0.017 | 0.07 | 0.30 | 0.30 | 0.30 |
| Stdev (rel.) | | | 0.02% | 0.55% | 0.04% | | 0.17% | 0.15% | 0.15% |
| Copy and paste data from Sheet4 exported from MIAS system to Sheet4 in this file | | | | | | | | | |
| Naming of results excel files: LAB-IMPULSE-VOLTAGE.xls Where IMPULSE is "long", "short" or "chopped" Examples: VIT-long-P700.xls PTB-chopped-N150.xls | | | | | | | | | |
| Average 2 * stdev. of mean Lab. system uncertainty (k=2) | | | | | | | | | |
| 0.57% 0.108% 1.00% | | | | | | | | | |
| 0.6% 0.49% 2.0% | | | | | | | | | |
| -0.2% 0.10% 1.0% | | | | | | | | | |
| 0.2 0.19 1.0 | | | | | | | | | |
| Final results - calibrated TRMS errors dU/U dT1/T1 or dT2/T2 dTc/Tc dβ1 [%] | | | | | | | | | |
| 0.6% 0.6% 2.1% | | | | | | | | | |
| -0.2% 1.0% 1.0% | | | | | | | | | |
| 0.2 1.0 1.0 | | | | | | | | | |

Annex B - Performance of the transfer reference system

B-1 Divider scale factor

B-1.1 Short time stability

The short time stability of the dc scale factor of the TRMS divider was tested by VTT MIKES on 28.11.2016. Measured change and self-heating effect is summarized in Figure B-1.

- Before the test the measured dc scale factor was 944.56 ± 0.1
- Ten 700 kV impulses were delivered to the divider with 30 s interval
- After the application of the ten impulses, the scale factor of the divider was repeatedly measured for 10 minutes, and it stabilized to value of 944.84 ± 0.1 .

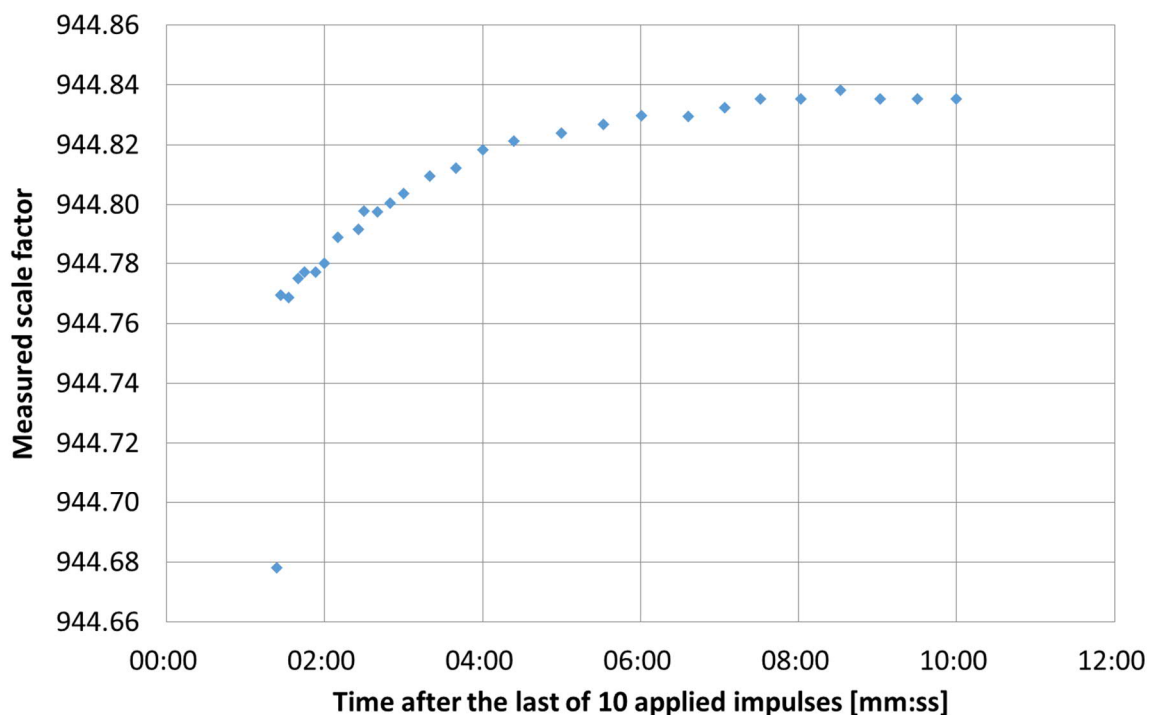


Figure B-1. Change of scale factor after application of ten 700 kV impulses.

B-1.2 Scale factor calibrations during the comparison

The participants were asked to measure the dc scale factor of the divider both before and after their measurement session.

The measured scale factor remained stable within $\pm 0.06\%$ from the beginning of the comparison, November 2016, until January 2018. The average value was 944.67, and two standard deviations of mean was 0.06 (0.006 %).

From February 2018 to February 2019 the scale factor drifted c. -0.35 %. In the final checks in March and April 2019, the measured scale factor was in halfway of the extreme values measured during the comparison. The probable reason for the scale factor change is the drift observed in the value of the 50 Ω termination resistor at the digitized end of the measuring cable.

The results of the divider scale factor checks performed by the participating laboratories are listed in Table B-1, and shown graphically in Figure B-2. The correction factors shown in Table B-1 are applied to correct the test voltage value readings of the TRMS.

Table B-1. Divider scale factor measurements during the comparison.

| Lab | | Date | Temperature °C | Scale factor SF | Uncertainty k=2, [abs.] | From average SF | Correction factor |
|-----------|--------|------------|-------------------|--------------------|----------------------------|--------------------|----------------------|
| RISE1 | Before | 25.11.2016 | 22 ± 2 | 944.58 | 0.11 | -0.01 % | 1.0000 |
| | After | 25.11.2016 | 22 ± 2 | 944.70 | 0.10 | 0.00 % | |
| VTT MIKES | Before | 25.11.2016 | 22 ± 2 | 944.70 | 0.09 | 0.00 % | 1.0001 |
| | After | 25.11.2016 | 22 ± 2 | 944.80 | 0.07 | 0.01 % | |
| INRIMa | Before | 4.4.2017 | 20.0 | 944.60 | | -0.01 % | 1.0000 |
| | After | 12.5.2017 | 23.0 | 944.70 | | 0.00 % | |
| LCOE | Before | 18.5.2017 | 22.0 | 944.80 | | 0.01 % | 1.0000 |
| | After | 6.6.2017 | 20.4 | 944.50 | | -0.02 % | |
| LNE | Before | 6.6.2017 | 23.0 | 944.81 | 0.2 | 0.01 % | 1.0001 |
| | After | 22.6.2017 | 22.8 | 944.80 | 0.2 | 0.01 % | |
| RISE2 | Before | 21.7.2017 | 23 ± 2 | 944.55 | 0.10 | -0.01 % | 0.9999 |
| | After | 24.7.2017 | 23 ± 2 | 944.56 | 0.10 | -0.01 % | |
| PTB | Before | 1.8.2017 | 23 ± 2 | 944.55 | 0.10 | -0.01 % | 0.9998 |
| | After | 17.8.2017 | 23 ± 2 | 944.44 | 0.10 | -0.02 % | |
| TUBITAK | Before | 13.10.2017 | 24.3 | 944.70 | 0.10 | 0.00 % | 1.0000 |
| | After | 13.10.2017 | 24.3 | 944.60 | 0.10 | -0.01 % | |
| IATTE | Before | 10.1.2018 | 26 - 29 | 944.85 | 0.15 | 0.02 % | 1.0002 |
| | After | 19.1.2018 | 26 - 28 | 944.80 | 0.10 | 0.01 % | |

average RISE1 - IATTE

944.67

2 * stdev of mean RISE1 - IATTE

0.06

2 * stdev of mean RISE1 - IATTE

0.006 %

| | | | | | | | |
|--------|--------|------------|--------|--------|------|---------|--------|
| NMIA | Before | 5.3.2018 | 22.9 | 944.27 | 0.11 | -0.04 % | 0.9994 |
| | After | 21.3.2018 | 22.5 | 944.02 | 0.11 | -0.07 % | |
| VNIIMS | Before | 20.6.2018 | 22.5 | 943.50 | | -0.12 % | 0.9988 |
| | After | 28.6.2018 | 22.5 | 943.50 | | -0.12 % | |
| NIM | Before | 7.9.2018 | | 943.60 | 0.10 | -0.11 % | 0.9988 |
| | After | 23.9.2018 | 23.1 | 943.50 | 0.10 | -0.12 % | |
| JHILL | Before | 2.11.2018 | | 943.16 | | -0.16 % | 0.9983 |
| | After | 22.11.2018 | | 943.01 | | -0.18 % | |
| NRC | Before | 15.1.2019 | 23.0 | 941.49 | 0.05 | -0.34 % | 0.9967 |
| | After | 15.2.2019 | 23.0 | 941.62 | 0.05 | -0.32 % | |
| RISE3 | Before | 18.3.2019 | 22 ± 2 | 943.49 | 0.10 | -0.12 % | 0.9988 |
| | After | 20.3.2019 | 22 ± 2 | 943.49 | 0.10 | -0.12 % | |

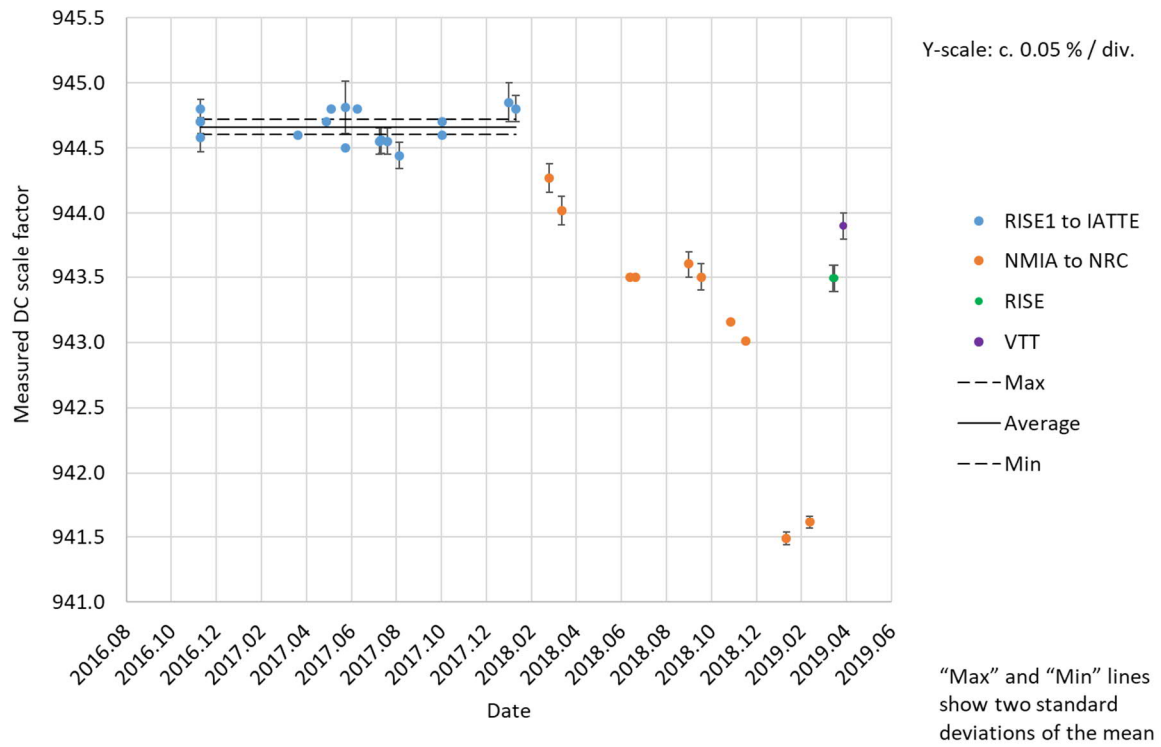


Figure B-2. Divider scale factor measurements during the comparison.

B-1.3 Divider component calibrations before and after the comparison

The reason for the divider scale factor change was revealed by examination of the calibration results of the individual divider components. The divider components are shown in Figure B-3, and their values before and after comparison in Table B-2. Before values by HIGHVOLT, and after values by RISE. The +0.9 % change in the termination resistor R_z explains the direction and order of magnitude of the scale factor change shown in Figure B-2. The scale factor can be calculated from formula

$$\frac{U_{in}}{U_{out}} = \frac{R_d + R_{HV} + R_{LVres}}{R_{LVres}} * \frac{R_c + R_z}{R_z}$$

$$\text{where } R_{LVres} = \frac{R_{LV} * (R_c + R_z)}{R_{LV} + R_c + R_z}$$

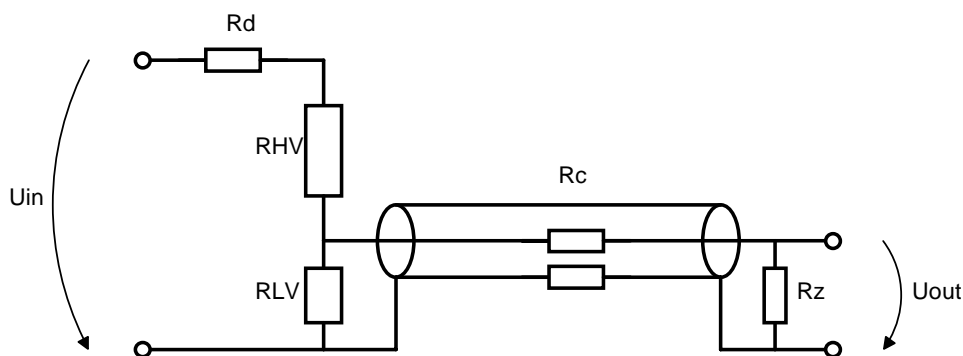


Figure B-3. Divider components.

Table B-2. Divider component values calibrations before and after comparison, U = 0.05 %, k = 2.

| | | 2013-08-14 | 2019-04-01 | Change |
|----------------------------------|--------|------------|------------|---------|
| Damping resistor | Rd | 262.42 | 262.47 | 0.02 % |
| High voltage resistor | RHV | 10145 | 10145 | 0.00 % |
| Low voltage resistor | RLV | 14.197 | 14.187 | -0.07 % |
| Termination resistor | Rz | 50.137 | 50.587 | 0.90 % |
| Cable and termination resistance | Rz+Rc | 50.390 | 50.834 | 0.88 % |
| Resulting low voltage resistance | RLVres | 11.076 | 11.092 | 0.14 % |
| Calculated scale factor | SF | 945.36 | 943.90 | -0.15 % |

Nominal scale factor, which was used by the digitizer during the comparison, was 953.3. This is 0.9 % off from the average value measured during the EU loop, 944.7.

B-2 Digitizer

B-2.1 Impulse voltage calibrations during the comparison

Each participant calibrated the digitizer using the impulse voltage calibrator circulated with the system. The circulated calibrator had two calibrator head one with short front (0.84 μs) and another with long (1.56 μs). The short front calibrator had to be repaired once during the comparison, and even after the repair the results obtained with it were not stable. The results of the long front calibration using the circulating calibrator are shown in Figures B-4 to B-6.

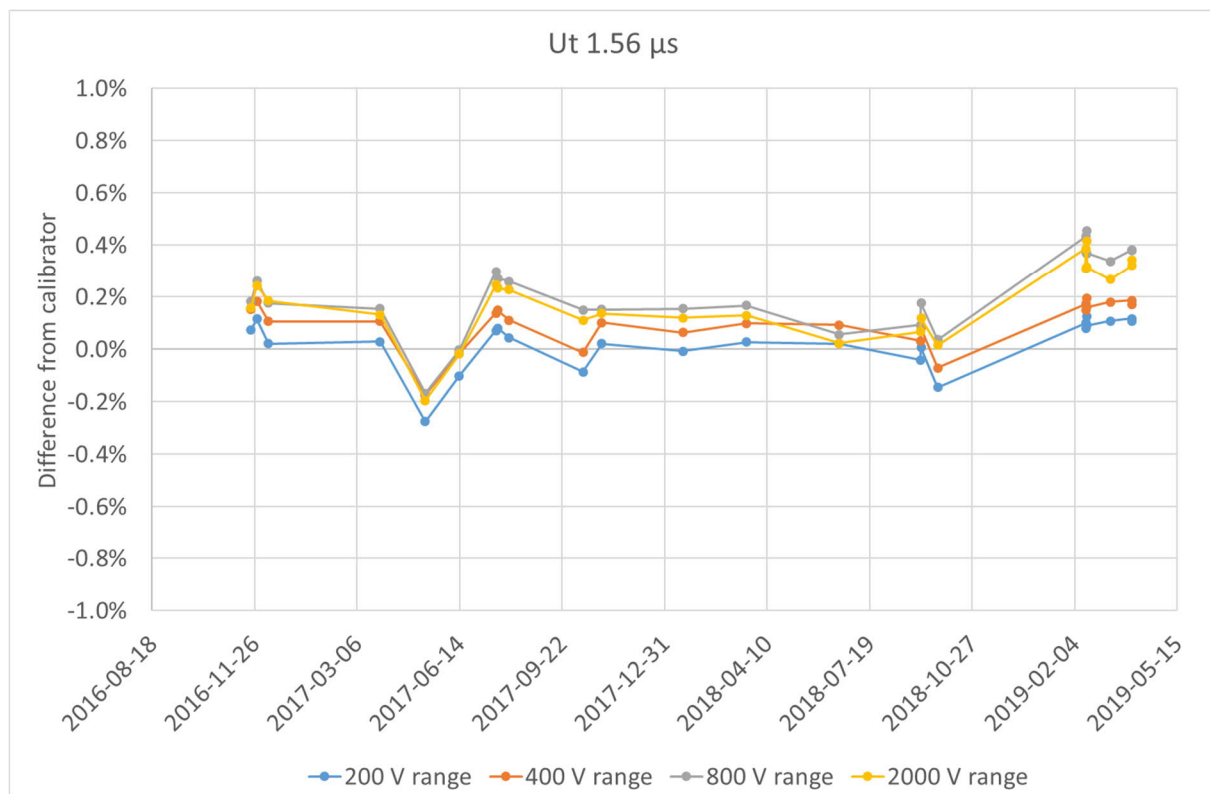


Figure B-4. Test voltage calibration results using the circulating calibrator.

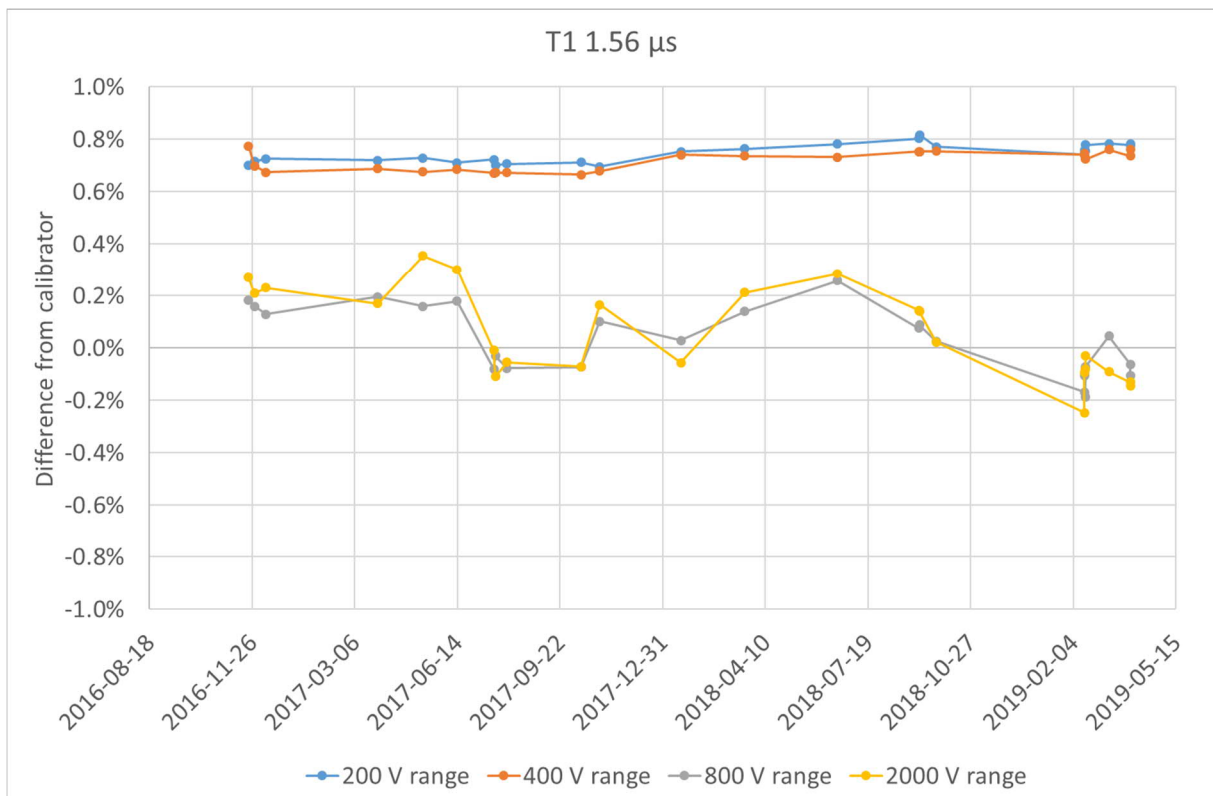


Figure B-5. Front time calibration results using the circulating calibrator.

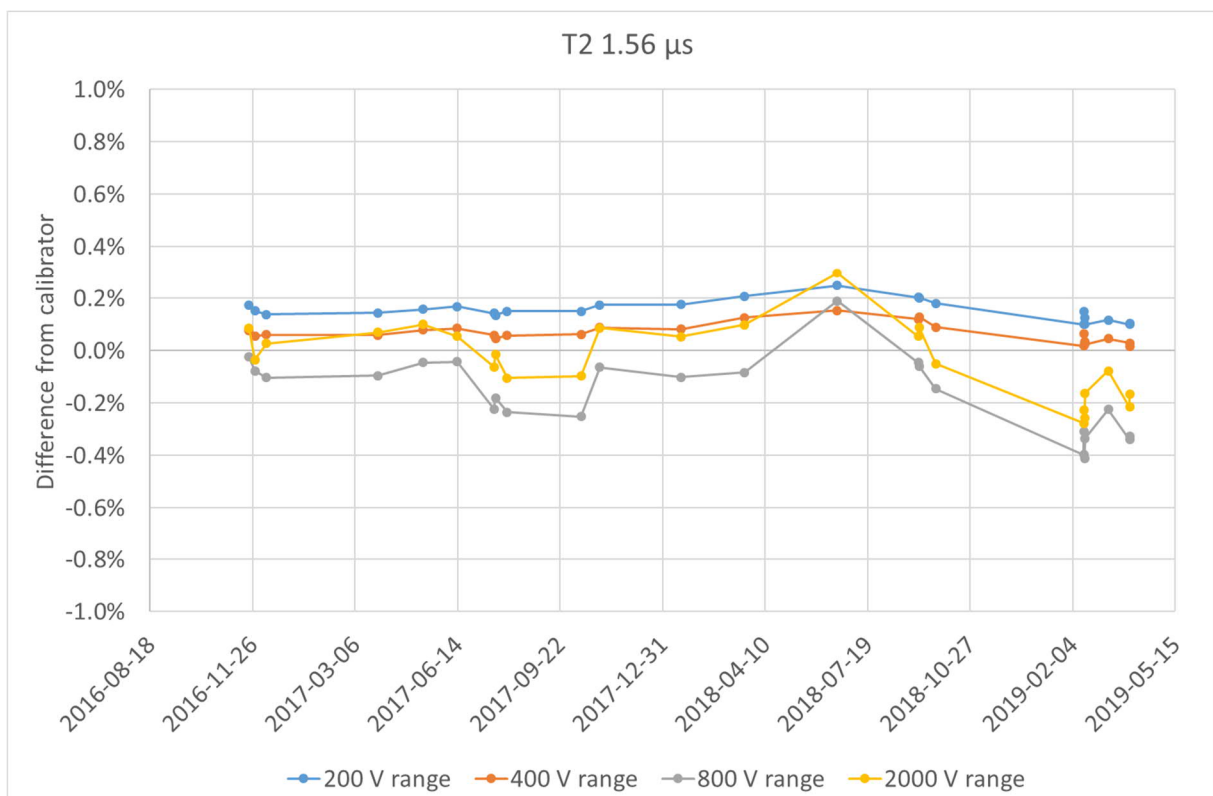


Figure B-6. Time to half-value calibration results using the circulating calibrator.

Overview of the impulse calibration results are shown for the long front impulse in Table B-3. The maximum scatters are taken as uncertainty contributions for digitizer stability, i.e. 0.30 % for U_t , 0.34 % for T_1 and 0.28 % for T_2 .

Table B-3. Overview of the impulse calibration results during the circulation for long front impulse.

| Travelling calibrator | 200 V range | | | 400 V range | | | 800 V range | | | 2000 V range | | |
|-----------------------|-------------|--------|--------|-------------|--------|--------|-------------|--------|---------|--------------|--------|---------|
| | U_t | T_1 | T_2 | U_t | T_1 | T_2 | U_t | T_1 | T_2 | U_t | T_1 | T_2 |
| Mean | 0.02 % | 0.75 % | 0.15 % | 0.10 % | 0.72 % | 0.07 % | 0.21 % | 0.03 % | -0.16 % | 0.18 % | 0.06 % | -0.03 % |
| 2* Stdev | 0.19 % | 0.07 % | 0.07 % | 0.18 % | 0.07 % | 0.07 % | 0.30 % | 0.25 % | 0.28 % | 0.28 % | 0.34 % | 0.27 % |
| N | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 | 24 |
| 2* Stdev of mean | 0.04 % | 0.01 % | 0.02 % | 0.04 % | 0.01 % | 0.01 % | 0.06 % | 0.05 % | 0.06 % | 0.06 % | 0.07 % | 0.06 % |

B-2.2 Impulse voltage calibrations before and after comparison

The stability of the digitizer was checked before and again after the comparison using VTT MIKES long front reference calibrator. The results are shown in Figures B-7 to B-9. The changes from before to after calibrations for the ranges used in the comparison are less than 0.2 % for U_t , 0.5 % for T_1 and 0.3 % for T_2 .

At the same times, the digitizer was calibrated also using the circulating calibrator. Systematic, but stable, difference between the two calibrators was found. These systematic changes were less than 0.06 % for U_t , 0.31 % for T_1 and 0.11 % for T_2 . These maximum values are taken as uncertainty contributions due to the calibrator instability.

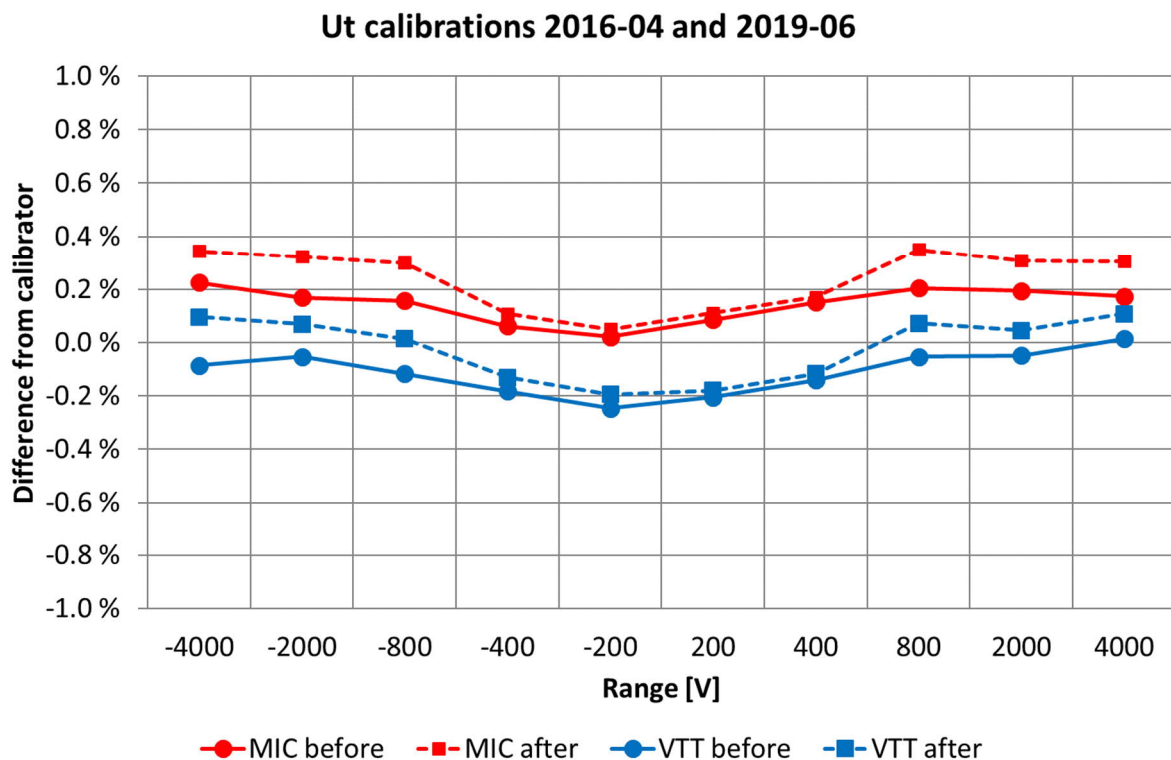


Figure B-7. Test voltage calibration results using VTT MIKES and circulating (MIC) calibrator.

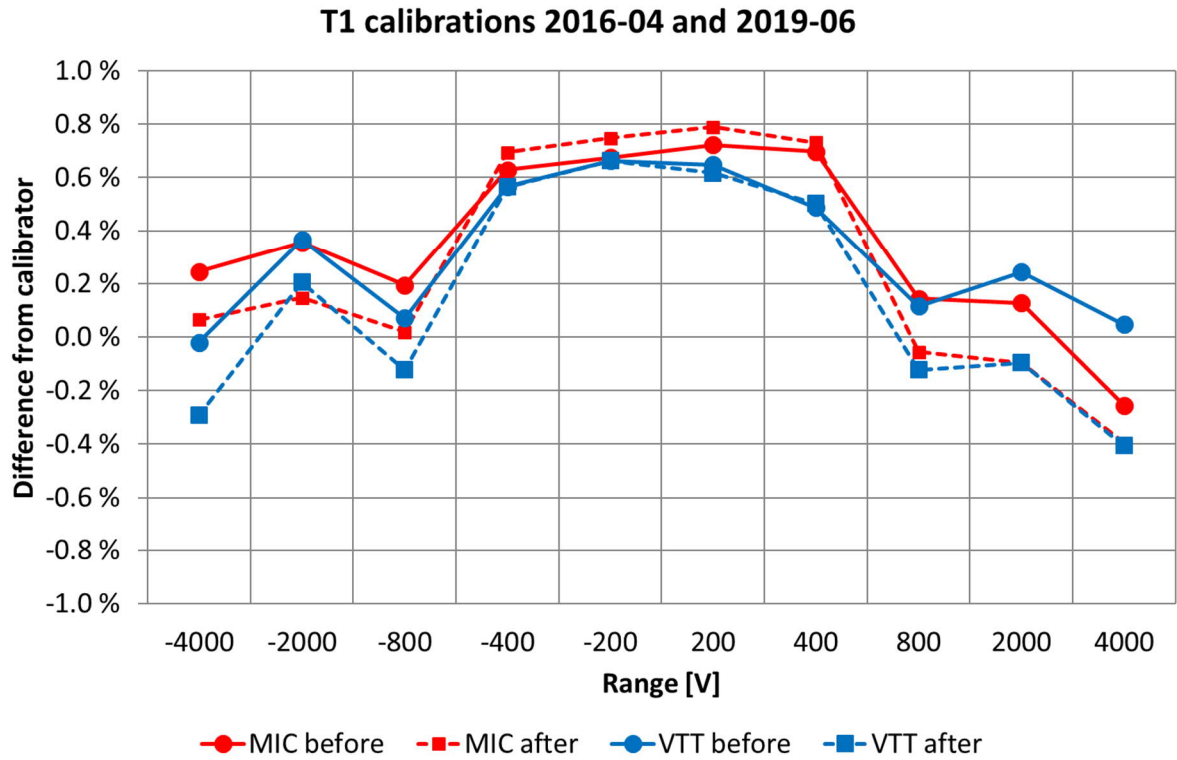


Figure B-8. Front time calibration results using VTT MIKES and circulating (MIC) calibrator.

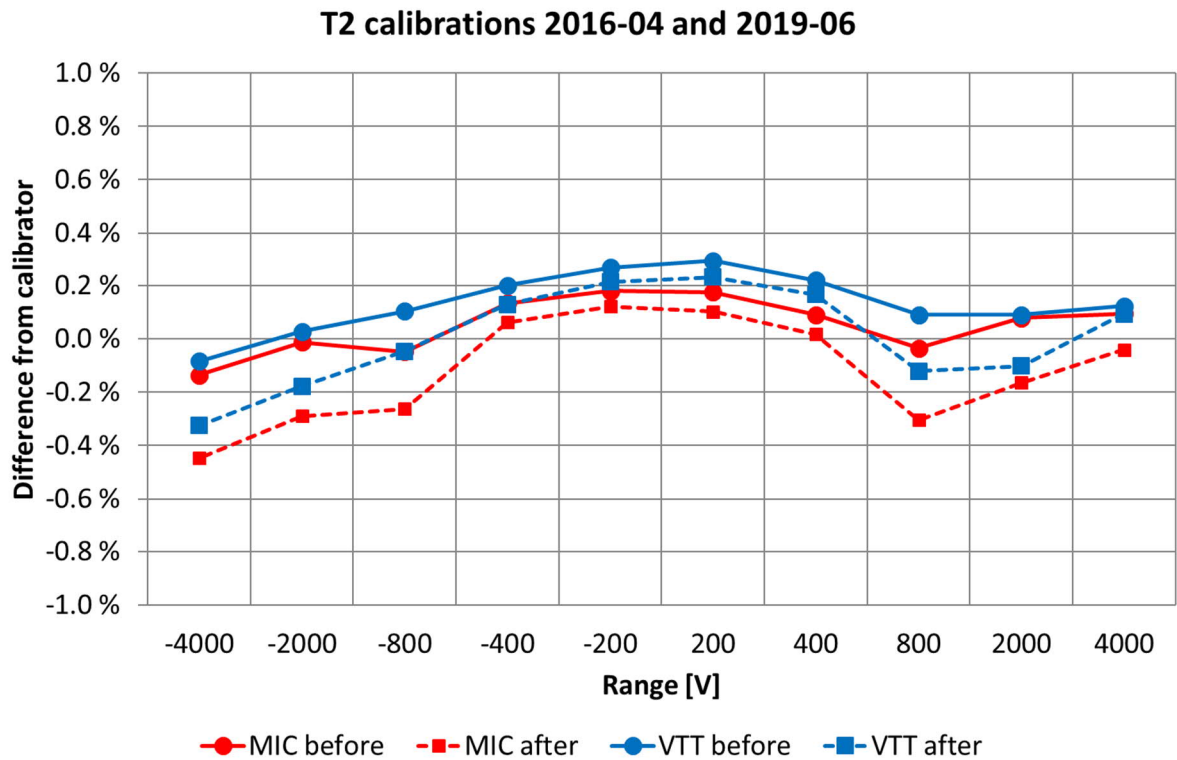


Figure B-9. Time to half-value calibration results using VTT MIKES and circulating (MIC) calibrator.

B-3 Repeatability

The three calibrations by RISE were used as basis for estimating the level of uncertainty related with different setups in the participating laboratories. This uncertainty contribution is due to e.g.

- changes in positioning and grounding of the TRMS and laboratory systems in the high voltage hall and control room; and
- changes in applied impulse waveform, including influence of different front oscillations.

The semi-range of the maximum difference of the values of the same waveform on different voltage levels measured by the pilot laboratory was treated as a type B component with a reducing factor of $\sqrt{3}$.

This type B contribution was evaluated separately for short front, long front and chopped impulses. The overview of the resulting expanded uncertainty contributions are listed in Table B-4.

Table B-4. Estimated expanded uncertainty contributions for the TRMS due to differences in laboratory setups.

| | U_t / U_e | T_1 / T_c | T_2 | β' |
|-------------|-------------|-------------|--------|----------|
| Short front | 0.17 % | 1.87 % | 1.99 % | 0.28 |
| Long front | 0.18 % | 0.45 % | 0.80 % | 0.12 |
| Chopped | 0.41 % | 1.18 % | | |

B-4 Corrections and uncertainties of TRMS readings

The scale factor corrections listed in Table B-1 are applied to the test voltage value reported by the TRMS, and they have been applied to the results shown in Annexes C and E. No other corrections based on TRMS calibrations are performed.

The uncertainties estimated in clauses B-1 and B-2 are included in the uncertainties shown in Annexes C and E.

The uncertainties shown in Table B-4 due to differences in the laboratory setups are taken into account only in the statistical analysis of the results presented in Annexes E and F.

Table B-5 shows the uncertainty budgets for the combined effect due to TRMS instability and differences in setups in the pilot laboratory. They may not fully include influence of variations of comparison setup in the participating laboratories. They also do not include components that remain stable during the two loops of the comparison period.

Table B-5. Estimated uncertainty contributions for the TRMS.

| U_t | Source of uncertainty | Contribution (k = 2) |
|----------------------------------|--|----------------------|
| Short front and long front | Divider SF, after applied correction (B-1) | 0.10 % |
| | Impulse calibrator stability (B-2.2) | 0.06 % |
| | Scatter of digitizer calibrations (B-2.1) | 0.30 % |
| | Setup repeatability (B-3) | 0.18 % |
| | Expanded uncertainty | 0.37 % |

| T_1 | Source of uncertainty | Contribution (k = 2) |
|-------------|---|----------------------|
| Short front | Impulse calibrator stability (B-2.2) | 0.31 % |
| | Scatter of digitizer calibrations (B-2.1) | 0.34 % |
| | Setup repeatability (B-3) | 1.87 % |
| | Expanded uncertainty | 1.93 % |

| T_1 | Source of uncertainty | Contribution (k = 2) |
|------------|---|----------------------|
| Long front | Impulse calibrator stability (B-2.2) | 0.31 % |
| | Scatter of digitizer calibrations (B-2.1) | 0.34 % |
| | Setup repeatability (B-3) | 0.45 % |
| | Expanded uncertainty | 0.65 % |

| T_2 | Source of uncertainty | Contribution (k = 2) |
|-------------|---|----------------------|
| Short front | Impulse calibrator stability (B-2.2) | 0.11 % |
| | Scatter of digitizer calibrations (B-2.1) | 0.28 % |
| | Setup repeatability (B-3) | 1.99 % |
| | Expanded uncertainty | 2.02 % |

| T_2 | Source of uncertainty | Contribution (k = 2) |
|------------|---|----------------------|
| Long front | Impulse calibrator stability (B-2.2) | 0.11 % |
| | Scatter of digitizer calibrations (B-2.1) | 0.28 % |
| | Setup repeatability (B-3) | 0.80 % |
| | Expanded uncertainty | 0.86 % |

| U_E | Source of uncertainty | Contribution (k = 2) |
|-------|---|----------------------|
| | Impulse calibrator stability (B-2.2) | 0.11 % |
| | Scatter of digitizer calibrations (B-2.1) | 0.06 % |
| | Setup repeatability (B-3) | 0.41 % |
| | Expanded uncertainty | 0.43 % |

| T_c | Source of uncertainty | Contribution (k = 2) |
|-------|---|----------------------|
| | Impulse calibrator stability (B-2.2) | 0.11 % |
| | Scatter of digitizer calibrations (B-2.1) | 0.34 % |
| | Setup repeatability (B-3) | 1.18 % |
| | Expanded uncertainty | 1.23 % |

Annex C - Results reported by participants

The results reported by the participating laboratories are shown in the following pages.

- The TRMS readings for U_t are corrected using the values listed in Table B-1.
- The uncertainties due to instability of the TRMS listed in Table B-4 are quadratically added the uncertainties reported by the participants.
- Due to failure in the template automation, reference system T_1 values were erroneously reported for T_c comparison for some participants. The coordinators have collected the correct values from the travelling system database, and used them for the following participants:
 - o RISE1
 - o VTT MIKES
 - o INRIM
 - o LNE
 - o RISE2
 - o TUBITAK
 - o IATTE
 - o NIM
- Re-evaluated measurement results from IATTE are shown as IATTE1. For more details see Annex H.

RISE1

Correction and uncertainties: 1.0000

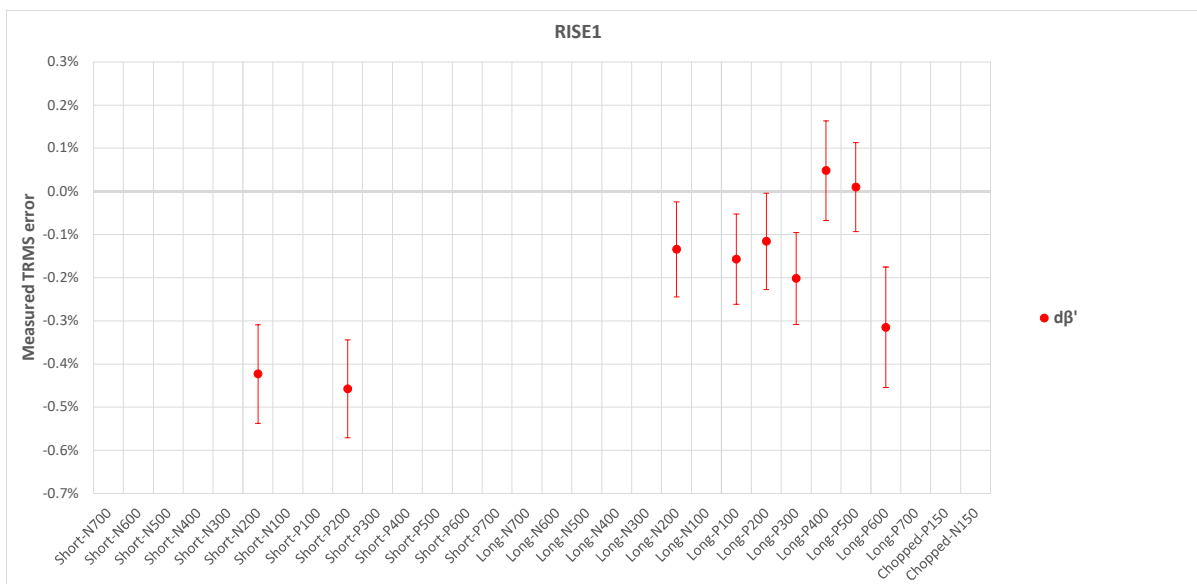
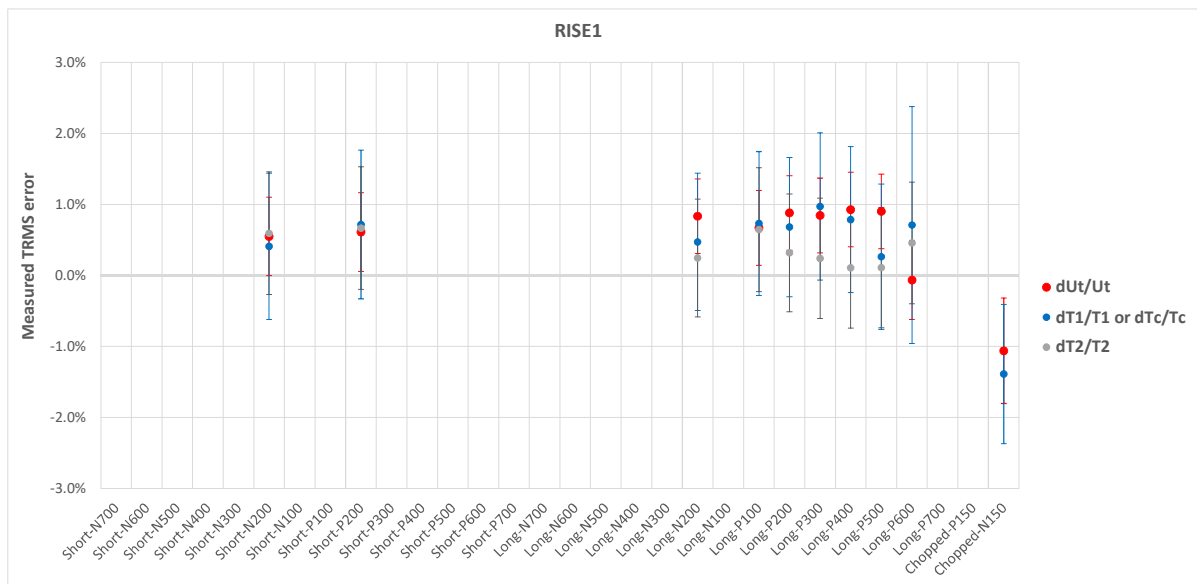
RISE1

0.33%

0.46%

0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N200 | -199.68 | 0.846 | 40.39 | 2.69 | -198.60 | 0.842 | 40.15 | 3.11 | 0.5% | 0.6% | 0.4% | 1.0% | 0.6% | 0.9% | -0.4 | 0.1 |
| Short-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P200 | 199.45 | 0.849 | 40.43 | 2.58 | 198.24 | 0.843 | 40.17 | 3.04 | 0.6% | 0.6% | 0.7% | 1.0% | 0.7% | 0.9% | -0.5 | 0.1 |
| Short-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N200 | -200.22 | 1.579 | 43.51 | -1.00 | -198.57 | 1.571 | 43.40 | -0.87 | 0.8% | 0.5% | 0.5% | 1.0% | 0.2% | 0.8% | -0.1 | 0.1 |
| Long-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P100 | 100.88 | 1.578 | 43.54 | -1.05 | 100.20 | 1.566 | 43.26 | -0.89 | 0.7% | 0.5% | 0.7% | 1.0% | 0.6% | 0.9% | -0.2 | 0.1 |
| Long-P200 | 200.04 | 1.581 | 43.52 | -1.00 | 198.29 | 1.570 | 43.38 | -0.88 | 0.9% | 0.5% | 0.7% | 1.0% | 0.3% | 0.8% | -0.1 | 0.1 |
| Long-P300 | 298.96 | 1.593 | 43.49 | -1.04 | 296.45 | 1.577 | 43.39 | -0.84 | 0.8% | 0.5% | 1.0% | 1.0% | 0.2% | 0.8% | -0.2 | 0.1 |
| Long-P400 | 402.23 | 1.593 | 43.51 | -0.93 | 398.54 | 1.581 | 43.46 | -0.97 | 0.9% | 0.5% | 0.8% | 1.0% | 0.1% | 0.8% | 0.0 | 0.1 |
| Long-P500 | 504.89 | 1.606 | 43.67 | -0.95 | 500.37 | 1.602 | 43.63 | -0.96 | 0.9% | 0.5% | 0.3% | 1.0% | 0.1% | 0.8% | 0.0 | 0.1 |
| Long-P600 | 603.52 | 1.647 | 45.16 | -0.99 | 603.91 | 1.636 | 44.95 | -0.68 | -0.1% | 0.6% | 0.7% | 1.7% | 0.5% | 0.9% | -0.3 | 0.1 |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-N150 | -161.88 | 0.590 | | | -163.62 | 0.598 | #N/A | #N/A | -1.1% | 0.7% | -1.4% | 1.0% | | | | |



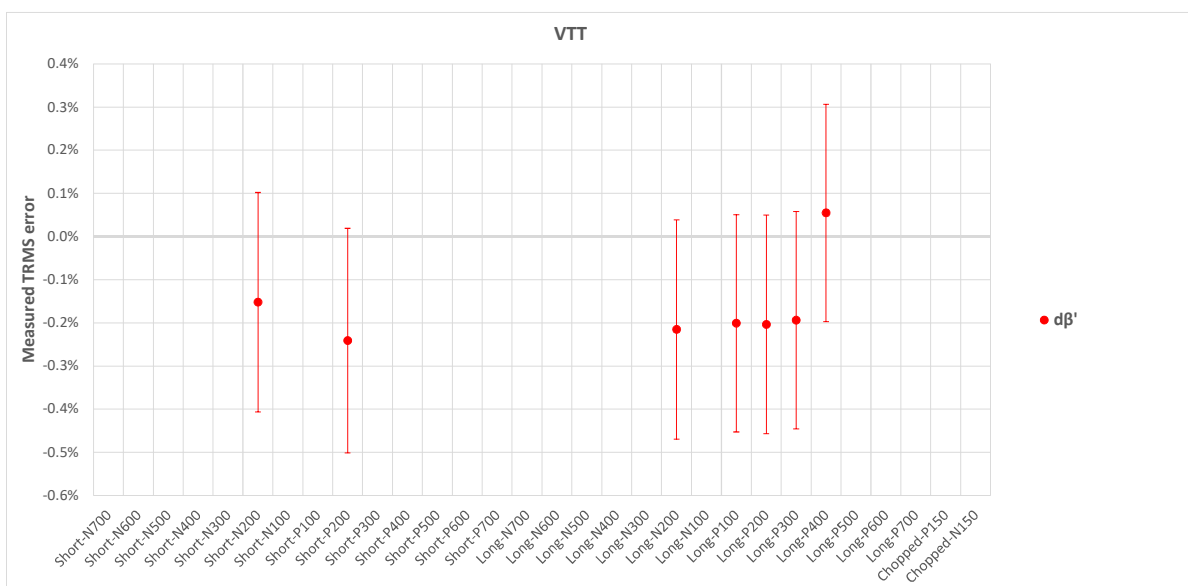
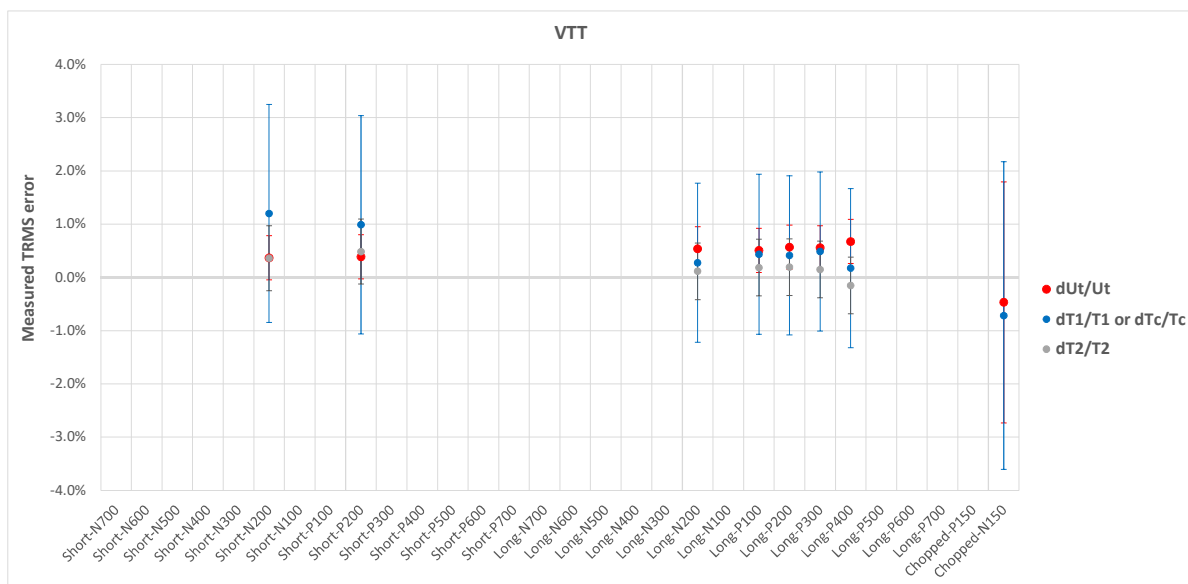
VTT

Correction and uncertainties: 1.0000

VTT

0.33% 0.46% 0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N200 | -202.28 | 0.854 | 40.98 | 2.78 | -201.54 | 0.844 | 40.83 | 2.93 | 0.4% | 0.4% | 1.2% | 2.0% | 0.4% | 0.6% | -0.2 | 0.3 |
| Short-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P200 | 202.09 | 0.849 | 40.99 | 2.69 | 201.32 | 0.842 | 40.80 | 2.93 | 0.4% | 0.4% | 1.0% | 2.1% | 0.5% | 0.6% | -0.2 | 0.3 |
| Short-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N200 | -199.00 | 1.591 | 44.11 | -1.01 | -197.94 | 1.586 | 44.06 | -0.79 | 0.5% | 0.4% | 0.3% | 1.5% | 0.1% | 0.5% | -0.2 | 0.3 |
| Long-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P100 | 99.73 | 1.590 | 44.16 | -1.02 | 99.23 | 1.583 | 44.08 | -0.82 | 0.5% | 0.4% | 0.4% | 1.5% | 0.2% | 0.5% | -0.2 | 0.3 |
| Long-P200 | 199.73 | 1.592 | 44.13 | -0.98 | 198.60 | 1.585 | 44.04 | -0.78 | 0.6% | 0.4% | 0.4% | 1.5% | 0.2% | 0.5% | -0.2 | 0.3 |
| Long-P300 | 297.46 | 1.599 | 44.12 | -1.03 | 295.81 | 1.592 | 44.05 | -0.84 | 0.6% | 0.4% | 0.5% | 1.5% | 0.1% | 0.5% | -0.2 | 0.3 |
| Long-P400 | 396.19 | 1.596 | 44.04 | -0.91 | 393.53 | 1.593 | 44.11 | -0.96 | 0.7% | 0.4% | 0.2% | 1.5% | -0.2% | 0.5% | 0.1 | 0.3 |
| Long-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-N150 | -173.39 | 0.472 | | | -174.17 | 0.476 | #N/A | #N/A | -0.5% | 2.3% | -0.7% | 2.9% | | | | |



INRIM

Correction and uncertainties:

1.0000

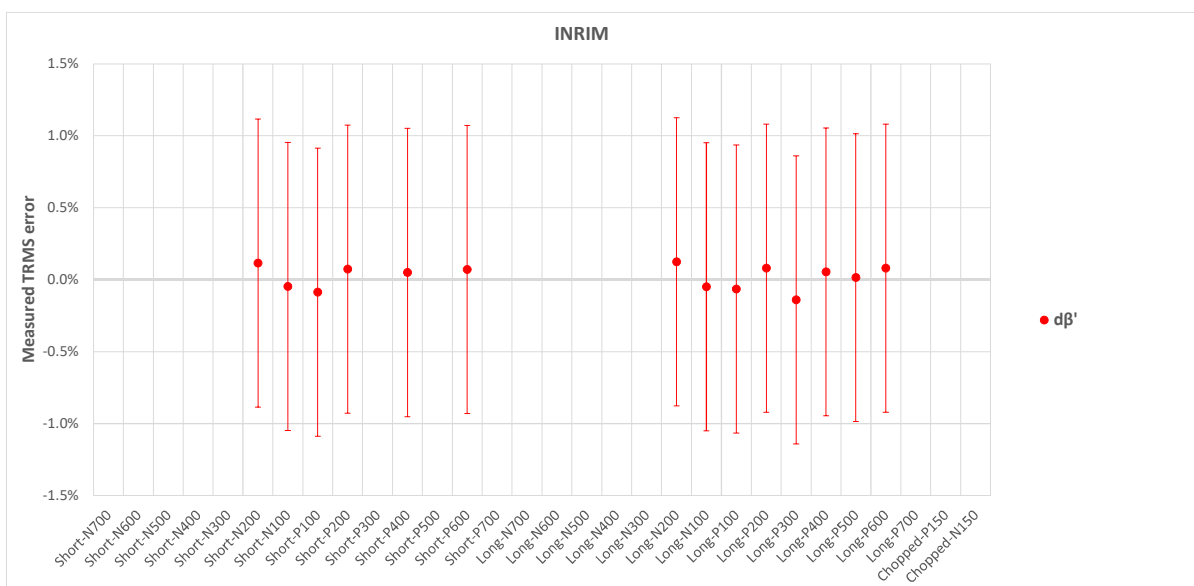
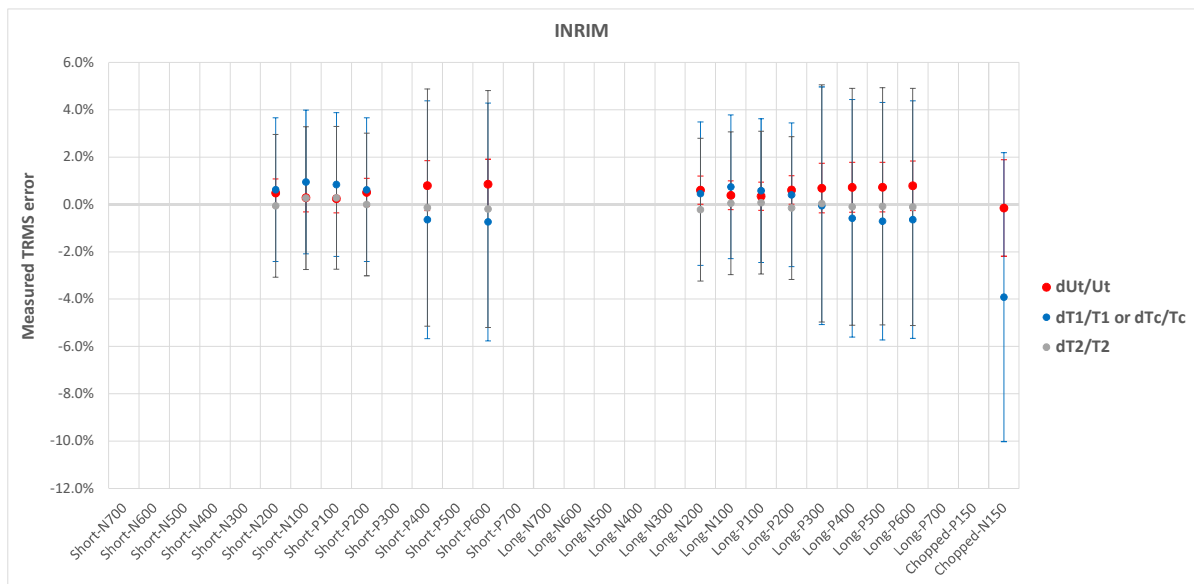
0.33%

0.46%

0.30%

INRIM

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|------------------------------|---------------------|------------------|---------------|------------------------------|---------------------|------------------|--------------------|------|---------------------------|------|------------|------|-------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N200 | -201.76 | 0.845 | 41.20 | -0.96 | -200.80 | 0.839 | 41.22 | -1.08 | 0.5% | 0.6% | 0.6% | 3.0% | -0.1% | 3.0% | 0.1 | 1.0 |
| Short-N100 | -101.87 | 0.843 | 41.17 | -0.89 | -101.58 | 0.835 | 41.06 | -0.84 | 0.3% | 0.6% | 0.9% | 3.0% | 0.3% | 3.0% | 0.0 | 1.0 |
| Short-P100 | 101.96 | 0.847 | 41.15 | -0.82 | 101.71 | 0.840 | 41.03 | -0.73 | 0.2% | 0.6% | 0.8% | 3.0% | 0.3% | 3.0% | -0.1 | 1.0 |
| Short-P200 | 201.84 | 0.848 | 41.18 | -0.92 | 200.82 | 0.843 | 41.18 | -0.99 | 0.5% | 0.6% | 0.6% | 3.0% | 0.0% | 3.0% | 0.1 | 1.0 |
| Short-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P400 | 411.56 | 0.844 | 42.10 | -1.08 | 408.31 | 0.850 | 42.15 | -1.13 | 0.8% | 1.1% | -0.6% | 5.0% | -0.1% | 5.0% | 0.1 | 1.0 |
| Short-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P600 | 604.75 | 0.862 | 42.61 | -1.31 | 599.63 | 0.869 | 42.70 | -1.38 | 0.9% | 1.1% | -0.7% | 5.0% | -0.2% | 5.0% | 0.1 | 1.0 |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N200 | -200.79 | 1.553 | 43.03 | -1.10 | -199.59 | 1.546 | 43.12 | -1.23 | 0.6% | 0.6% | 0.5% | 3.0% | -0.2% | 3.0% | 0.1 | 1.0 |
| Long-N100 | -100.51 | 1.554 | 43.03 | -1.14 | -100.12 | 1.543 | 43.01 | -1.09 | 0.4% | 0.6% | 0.7% | 3.0% | 0.1% | 3.0% | 0.0 | 1.0 |
| Long-P100 | 100.52 | 1.547 | 42.99 | -1.11 | 100.17 | 1.538 | 42.96 | -1.04 | 0.3% | 0.6% | 0.6% | 3.0% | 0.1% | 3.0% | -0.1 | 1.0 |
| Long-P200 | 200.69 | 1.561 | 43.07 | -1.15 | 199.48 | 1.555 | 43.13 | -1.23 | 0.6% | 0.6% | 0.4% | 3.0% | -0.1% | 3.0% | 0.1 | 1.0 |
| Long-P300 | 304.26 | 1.576 | 43.75 | -1.25 | 302.18 | 1.577 | 43.74 | -1.11 | 0.7% | 1.1% | -0.1% | 5.0% | 0.0% | 5.0% | -0.1 | 1.0 |
| Long-P400 | 403.07 | 1.576 | 43.93 | -1.16 | 400.17 | 1.585 | 43.97 | -1.22 | 0.7% | 1.1% | -0.6% | 5.0% | -0.1% | 5.0% | 0.1 | 1.0 |
| Long-P500 | 503.91 | 1.541 | 44.15 | -1.33 | 500.25 | 1.553 | 44.19 | -1.35 | 0.7% | 1.1% | -0.7% | 5.0% | -0.1% | 5.0% | 0.0 | 1.0 |
| Long-P600 | 587.63 | 1.560 | 44.02 | -1.09 | 583.05 | 1.570 | 44.06 | -1.17 | 0.8% | 1.1% | -0.6% | 5.0% | -0.1% | 5.0% | 0.1 | 1.0 |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-N150 | -152.35 | 0.588 | | | -152.58 | 0.613 | #N/A | #N/A | -0.2% | 2.0% | -3.9% | 6.1% | | | | |



LCOE

Correction and uncertainties: 1.0000

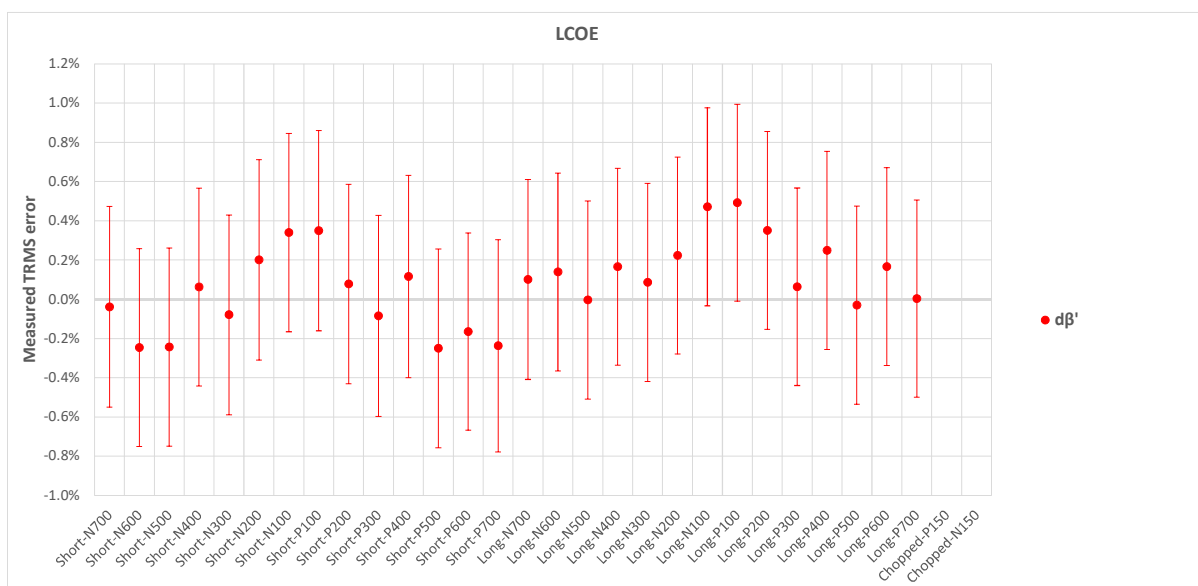
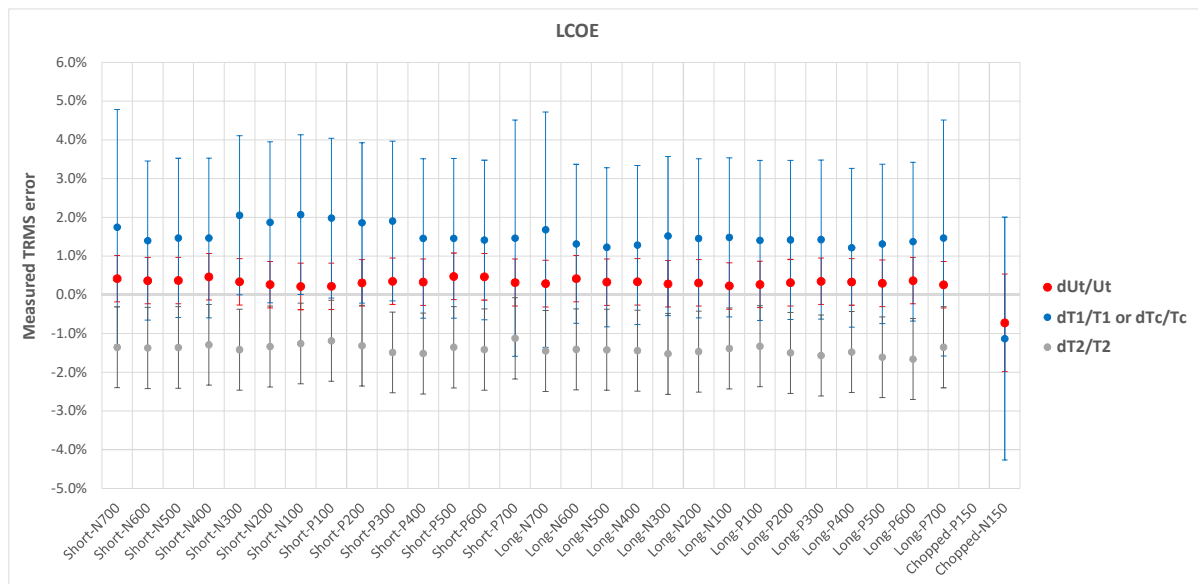
LCOE

0.33%

0.46%

0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | -697.49 | 0.873 | 55.84 | 2.27 | -694.58 | 0.858 | 56.61 | 2.31 | 0.4% | 0.6% | 1.7% | 3.0% | -1.4% | 1.0% | 0.0 | 0.5 |
| Short-N600 | -598.74 | 0.864 | 56.20 | 1.18 | -596.58 | 0.852 | 56.98 | 1.43 | 0.4% | 0.6% | 1.4% | 2.1% | -1.4% | 1.0% | -0.2 | 0.5 |
| Short-N500 | -500.29 | 0.865 | 55.93 | 1.31 | -498.46 | 0.853 | 56.70 | 1.56 | 0.4% | 0.6% | 1.5% | 2.1% | -1.4% | 1.1% | -0.2 | 0.5 |
| Short-N400 | -400.77 | 0.858 | 55.65 | 1.47 | -398.92 | 0.846 | 56.38 | 1.40 | 0.5% | 0.6% | 1.5% | 2.1% | -1.3% | 1.0% | 0.1 | 0.5 |
| Short-N300 | -300.28 | 0.858 | 55.61 | 1.46 | -299.28 | 0.840 | 56.41 | 1.54 | 0.3% | 0.6% | 2.1% | 2.1% | -1.4% | 1.0% | -0.1 | 0.5 |
| Short-N200 | -199.54 | 0.854 | 55.43 | 1.66 | -199.02 | 0.838 | 56.18 | 1.46 | 0.3% | 0.6% | 1.9% | 2.1% | -1.3% | 1.0% | 0.2 | 0.5 |
| Short-N100 | -99.76 | 0.862 | 55.49 | 1.82 | -99.55 | 0.844 | 56.19 | 1.48 | 0.2% | 0.6% | 2.1% | 2.1% | -1.3% | 1.0% | 0.3 | 0.5 |
| Short-P100 | 100.16 | 0.861 | 55.46 | 1.87 | 99.94 | 0.845 | 56.13 | 1.52 | 0.2% | 0.6% | 2.0% | 2.1% | -1.2% | 1.0% | 0.3 | 0.5 |
| Short-P200 | 199.79 | 0.855 | 55.48 | 1.59 | 199.17 | 0.840 | 56.22 | 1.51 | 0.3% | 0.6% | 1.9% | 2.1% | -1.3% | 1.0% | 0.1 | 0.5 |
| Short-P300 | 300.28 | 0.878 | 55.32 | 1.52 | 299.23 | 0.862 | 56.16 | 1.60 | 0.3% | 0.6% | 1.9% | 2.1% | -1.5% | 1.0% | -0.1 | 0.5 |
| Short-P400 | 401.04 | 0.879 | 55.44 | 1.61 | 399.73 | 0.867 | 56.30 | 1.49 | 0.3% | 0.6% | 1.5% | 2.1% | -1.5% | 1.0% | 0.1 | 0.5 |
| Short-P500 | 501.05 | 0.885 | 55.74 | 1.34 | 498.68 | 0.873 | 56.51 | 1.59 | 0.5% | 0.6% | 1.5% | 2.1% | -1.4% | 1.1% | -0.3 | 0.5 |
| Short-P600 | 600.64 | 0.869 | 56.76 | 1.57 | 597.86 | 0.857 | 57.58 | 1.73 | 0.5% | 0.6% | 1.4% | 2.1% | -1.4% | 1.0% | -0.2 | 0.5 |
| Short-P700 | 697.76 | 0.861 | 55.81 | 2.13 | 695.56 | 0.849 | 56.45 | 2.37 | 0.3% | 0.6% | 1.5% | 3.1% | -1.1% | 1.1% | -0.2 | 0.5 |
| Long-N700 | -700.34 | 1.560 | 57.93 | 0.28 | -698.32 | 1.535 | 58.78 | 0.18 | 0.3% | 0.6% | 1.7% | 3.0% | -1.5% | 1.0% | 0.1 | 0.5 |
| Long-N600 | -601.19 | 1.556 | 58.97 | 0.19 | -598.70 | 1.536 | 59.81 | 0.05 | 0.4% | 0.6% | 1.3% | 2.1% | -1.4% | 1.0% | 0.1 | 0.5 |
| Long-N500 | -501.20 | 1.545 | 58.63 | 0.27 | -499.56 | 1.526 | 59.47 | 0.27 | 0.3% | 0.6% | 1.2% | 2.1% | -1.4% | 1.0% | 0.0 | 0.5 |
| Long-N400 | -400.73 | 1.541 | 58.41 | 0.36 | -399.39 | 1.521 | 59.26 | 0.19 | 0.3% | 0.6% | 1.3% | 2.1% | -1.4% | 1.0% | 0.2 | 0.5 |
| Long-N300 | -301.05 | 1.544 | 58.09 | 0.25 | -300.21 | 1.521 | 58.99 | 0.16 | 0.3% | 0.6% | 1.5% | 2.1% | -1.5% | 1.0% | 0.1 | 0.5 |
| Long-N200 | -199.74 | 1.578 | 58.11 | 0.40 | -199.13 | 1.556 | 58.98 | 0.18 | 0.3% | 0.6% | 1.5% | 2.1% | -1.5% | 1.0% | 0.2 | 0.5 |
| Long-N100 | -99.73 | 1.583 | 58.18 | 0.65 | -99.50 | 1.560 | 59.00 | 0.18 | 0.2% | 0.6% | 1.5% | 2.1% | -1.4% | 1.0% | 0.5 | 0.5 |
| Long-P100 | 99.87 | 1.582 | 58.19 | 0.64 | 99.60 | 1.560 | 58.97 | 0.15 | 0.3% | 0.6% | 1.4% | 2.1% | -1.3% | 1.0% | 0.5 | 0.5 |
| Long-P200 | 200.12 | 1.573 | 58.15 | 0.42 | 199.50 | 1.551 | 59.03 | 0.07 | 0.3% | 0.6% | 1.4% | 2.1% | -1.5% | 1.0% | 0.4 | 0.5 |
| Long-P300 | 301.04 | 1.545 | 58.12 | 0.32 | 300.00 | 1.524 | 59.05 | 0.26 | 0.3% | 0.6% | 1.4% | 2.1% | -1.6% | 1.0% | 0.1 | 0.5 |
| Long-P400 | 401.25 | 1.543 | 58.27 | 0.34 | 399.93 | 1.525 | 59.15 | 0.10 | 0.3% | 0.6% | 1.2% | 2.1% | -1.5% | 1.0% | 0.2 | 0.5 |
| Long-P500 | 501.31 | 1.552 | 58.49 | 0.27 | 499.83 | 1.532 | 59.45 | 0.30 | 0.3% | 0.6% | 1.3% | 2.1% | -1.6% | 1.0% | 0.0 | 0.5 |
| Long-P600 | 600.71 | 1.556 | 58.86 | 0.18 | 598.54 | 1.535 | 59.85 | 0.01 | 0.4% | 0.6% | 1.4% | 2.1% | -1.7% | 1.0% | 0.2 | 0.5 |
| Long-P700 | 699.70 | 1.560 | 57.84 | 0.17 | 697.90 | 1.537 | 58.63 | 0.16 | 0.3% | 0.6% | 1.5% | 3.0% | -1.4% | 1.0% | 0.0 | 0.5 |
| Chopped-P150 | | | | | | | | | | | | | | | | |
| Chopped-N150 | -166.60 | 0.605 | | | -167.82 | 0.612 | | | -0.7% | 1.3% | -1.1% | 3.1% | | | | |



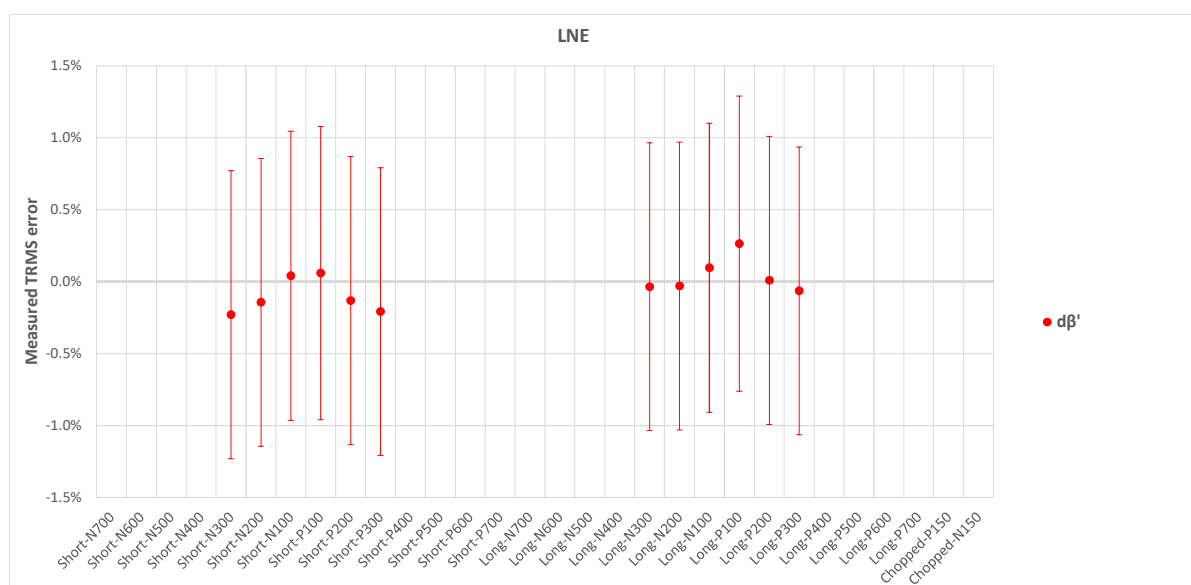
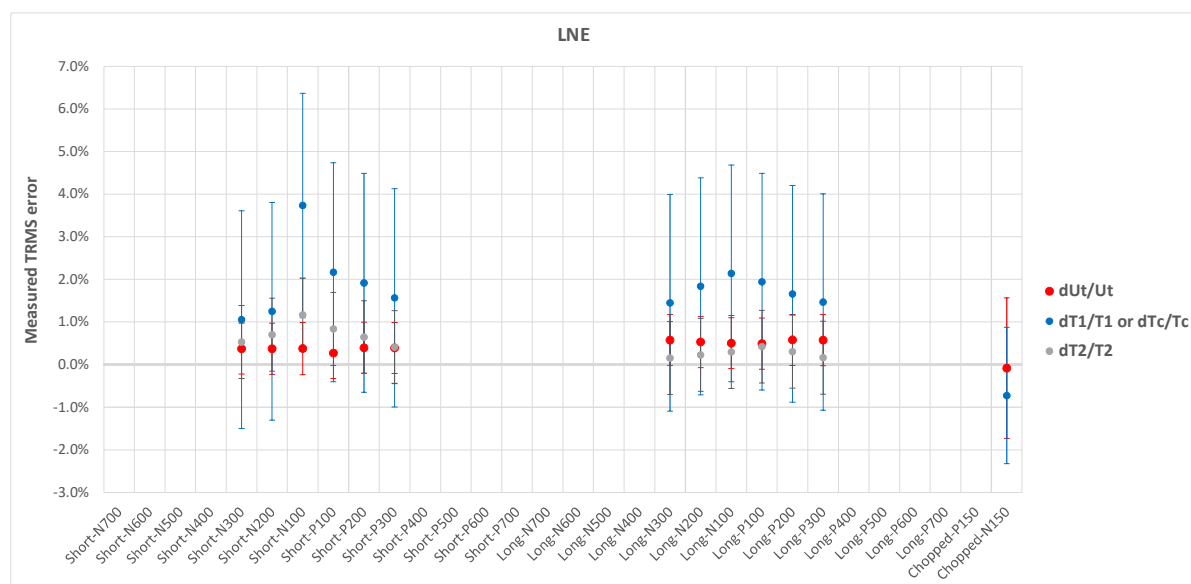
LNE

Correction and uncertainties: 1.0001

LNE

0.33% 0.46% 0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | -298.78 | 0.893 | 52.52 | -0.12 | -297.63 | 0.884 | 52.24 | 0.11 | 0.4% | 0.6% | 1.1% | 2.6% | 0.5% | 0.9% | -0.2 | 1.0 |
| Short-N200 | -198.30 | 0.891 | 51.66 | -0.11 | -197.54 | 0.880 | 51.30 | 0.03 | 0.4% | 0.6% | 1.3% | 2.6% | 0.7% | 0.9% | -0.1 | 1.0 |
| Short-N100 | -107.80 | 0.912 | 51.43 | 0.04 | -107.38 | 0.879 | 50.83 | 0.00 | 0.4% | 0.6% | 3.7% | 2.6% | 1.2% | 0.9% | 0.0 | 1.0 |
| Short-P100 | 104.17 | 0.907 | 51.21 | 0.08 | 103.88 | 0.888 | 50.79 | 0.02 | 0.3% | 0.6% | 2.2% | 2.6% | 0.8% | 0.9% | 0.1 | 1.0 |
| Short-P200 | 200.26 | 0.898 | 51.57 | -0.13 | 199.45 | 0.881 | 51.24 | 0.00 | 0.4% | 0.6% | 1.9% | 2.6% | 0.6% | 0.9% | -0.1 | 1.0 |
| Short-P300 | 301.75 | 0.898 | 52.50 | -0.14 | 300.54 | 0.884 | 52.29 | 0.07 | 0.4% | 0.6% | 1.6% | 2.6% | 0.4% | 0.9% | -0.2 | 1.0 |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | -298.66 | 1.536 | 53.56 | 0.15 | -296.91 | 1.514 | 53.48 | 0.19 | 0.6% | 0.6% | 1.5% | 2.5% | 0.2% | 0.9% | 0.0 | 1.0 |
| Long-N200 | -198.13 | 1.538 | 52.76 | 0.10 | -197.06 | 1.510 | 52.64 | 0.13 | 0.5% | 0.6% | 1.8% | 2.5% | 0.2% | 0.9% | 0.0 | 1.0 |
| Long-N100 | -100.80 | 1.535 | 52.29 | 0.19 | -100.29 | 1.503 | 52.14 | 0.09 | 0.5% | 0.6% | 2.1% | 2.5% | 0.3% | 0.9% | 0.1 | 1.0 |
| Long-P100 | 102.02 | 1.533 | 52.35 | 0.39 | 101.51 | 1.504 | 52.13 | 0.12 | 0.5% | 0.6% | 1.9% | 2.5% | 0.4% | 0.9% | 0.3 | 1.0 |
| Long-P200 | 200.10 | 1.544 | 52.80 | 0.14 | 198.92 | 1.518 | 52.64 | 0.13 | 0.6% | 0.6% | 1.7% | 2.5% | 0.3% | 0.9% | 0.0 | 1.0 |
| Long-P300 | 298.37 | 1.545 | 53.62 | 0.14 | 296.63 | 1.523 | 53.54 | 0.21 | 0.6% | 0.6% | 1.5% | 2.5% | 0.2% | 0.9% | -0.1 | 1.0 |
| Long-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-N150 | -138.47 | 0.565 | | | -138.57 | 0.569 | #N/A | #N/A | -0.1% | 1.6% | -0.7% | 1.6% | | | | |



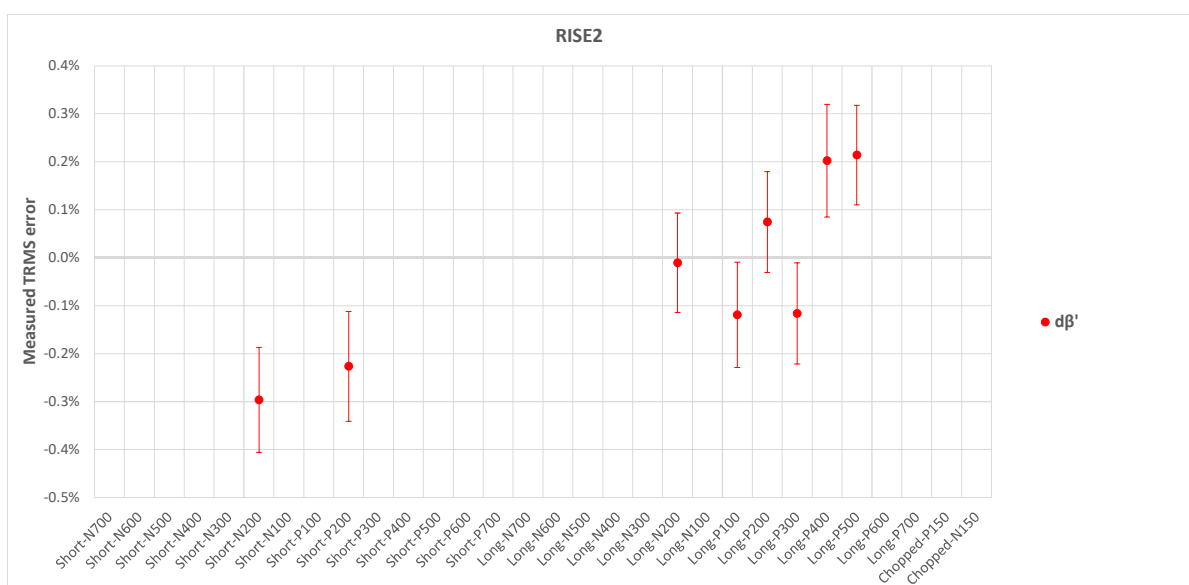
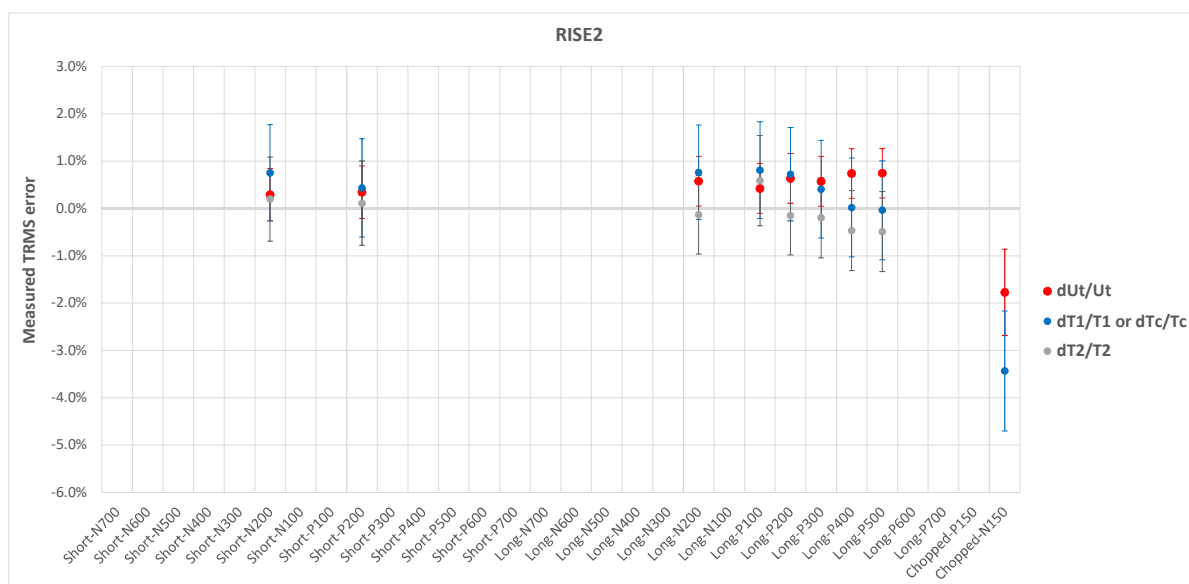
RISE2

Correction and uncertainties: 0.9999

RISE2

0.33% 0.46% 0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N200 | -198.03 | 0.840 | 40.35 | 2.79 | -197.47 | 0.834 | 40.27 | 3.09 | 0.3% | 0.6% | 0.8% | 1.0% | 0.2% | 0.9% | -0.3 | 0.1 |
| Short-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P200 | 197.44 | 0.840 | 40.33 | 2.75 | 196.78 | 0.837 | 40.29 | 2.98 | 0.3% | 0.6% | 0.4% | 1.0% | 0.1% | 0.9% | -0.2 | 0.1 |
| Short-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N200 | -200.82 | 1.596 | 43.59 | -1.00 | -199.69 | 1.584 | 43.65 | -0.99 | 0.6% | 0.5% | 0.8% | 1.0% | -0.1% | 0.8% | 0.0 | 0.1 |
| Long-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P100 | 99.02 | 1.599 | 43.56 | -0.98 | 98.62 | 1.586 | 43.30 | -0.87 | 0.4% | 0.5% | 0.8% | 1.0% | 0.6% | 1.0% | -0.1 | 0.1 |
| Long-P200 | 196.78 | 1.600 | 43.52 | -0.94 | 195.56 | 1.589 | 43.58 | -1.02 | 0.6% | 0.5% | 0.7% | 1.0% | -0.2% | 0.8% | 0.1 | 0.1 |
| Long-P300 | 296.59 | 1.605 | 43.57 | -1.04 | 294.93 | 1.598 | 43.66 | -0.92 | 0.6% | 0.5% | 0.4% | 1.0% | -0.2% | 0.8% | -0.1 | 0.1 |
| Long-P400 | 399.19 | 1.602 | 43.56 | -0.78 | 396.30 | 1.602 | 43.77 | -0.98 | 0.7% | 0.5% | 0.0% | 1.0% | -0.5% | 0.8% | 0.2 | 0.1 |
| Long-P500 | 497.64 | 1.613 | 43.68 | -0.87 | 494.02 | 1.613 | 43.89 | -1.08 | 0.7% | 0.5% | 0.0% | 1.0% | -0.5% | 0.8% | 0.2 | 0.1 |
| Long-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-N150 | 180.58 | 0.501 | | | 183.89 | 0.519 | #N/A | #N/A | -1.8% | 0.9% | -3.4% | 1.3% | | | | |



PTB

Correction and uncertainties: 0.9998

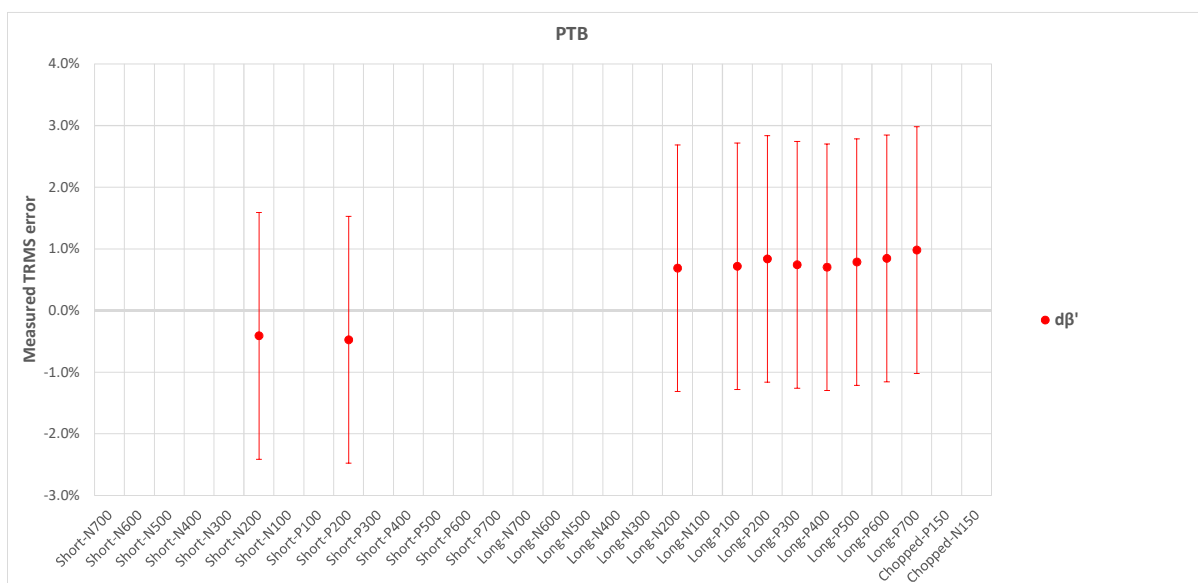
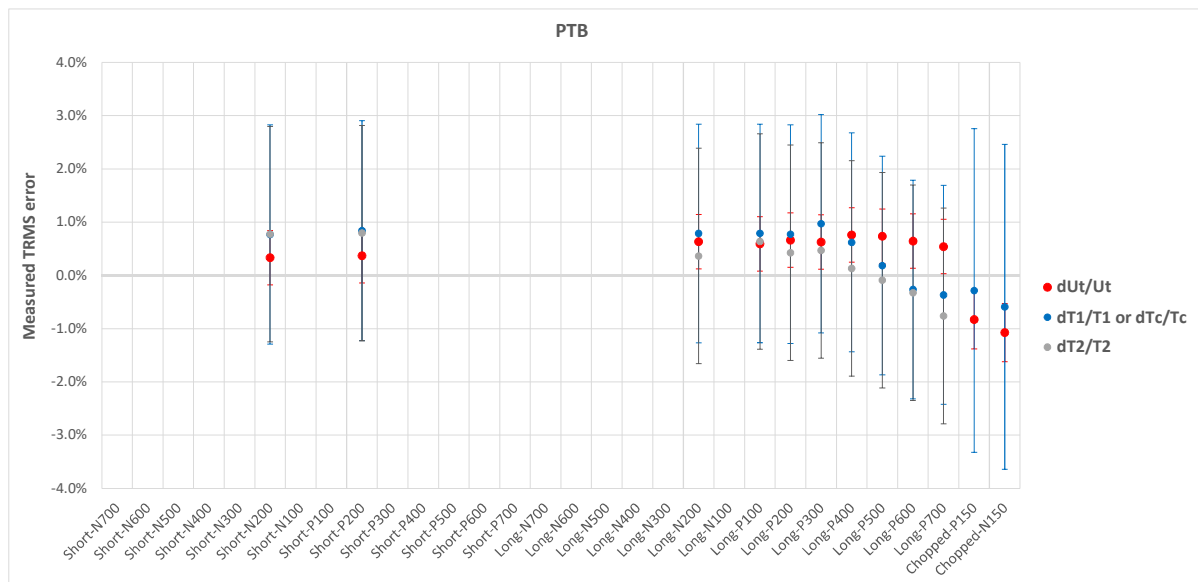
PTB

0.33%

0.46%

0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N200 | -191.88 | 0.857 | 44.22 | 2.81 | -191.28 | 0.851 | 43.88 | 3.22 | 0.3% | 0.5% | 0.8% | 2.1% | 0.8% | 2.0% | -0.4 | 2.0 |
| Short-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P200 | 195.01 | 0.859 | 44.22 | 2.81 | 194.33 | 0.852 | 43.87 | 3.29 | 0.4% | 0.5% | 0.8% | 2.1% | 0.8% | 2.0% | -0.5 | 2.0 |
| Short-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N200 | -199.16 | 1.559 | 47.14 | 0.00 | -197.94 | 1.547 | 46.97 | -0.69 | 0.6% | 0.5% | 0.8% | 2.1% | 0.4% | 2.0% | 0.7 | 2.0 |
| Long-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P100 | 96.17 | 1.555 | 47.21 | 0.00 | 95.62 | 1.542 | 46.91 | -0.72 | 0.6% | 0.5% | 0.8% | 2.1% | 0.6% | 2.0% | 0.7 | 2.0 |
| Long-P200 | 195.75 | 1.543 | 47.20 | 0.00 | 194.50 | 1.531 | 47.00 | -0.84 | 0.7% | 0.5% | 0.8% | 2.1% | 0.4% | 2.0% | 0.8 | 2.0 |
| Long-P300 | 292.19 | 1.554 | 47.22 | 0.00 | 290.43 | 1.539 | 47.00 | -0.74 | 0.6% | 0.5% | 1.0% | 2.1% | 0.5% | 2.0% | 0.7 | 2.0 |
| Long-P400 | 398.45 | 1.558 | 47.19 | 0.00 | 395.52 | 1.548 | 47.13 | -0.70 | 0.8% | 0.5% | 0.6% | 2.1% | 0.1% | 2.0% | 0.7 | 2.0 |
| Long-P500 | 505.08 | 1.563 | 47.14 | 0.00 | 501.49 | 1.560 | 47.19 | -0.79 | 0.7% | 0.5% | 0.2% | 2.1% | -0.1% | 2.0% | 0.8 | 2.0 |
| Long-P600 | 607.62 | 1.562 | 47.34 | 0.00 | 603.86 | 1.566 | 47.49 | -0.85 | 0.6% | 0.5% | -0.3% | 2.1% | -0.3% | 2.0% | 0.8 | 2.0 |
| Long-P700 | 690.47 | 1.572 | 47.59 | 0.00 | 686.89 | 1.578 | 47.96 | -0.98 | 0.5% | 0.5% | -0.4% | 2.1% | -0.8% | 2.0% | 1.0 | 2.0 |
| Chopped-P150 | 149.62 | 0.502 | | | 148.41 | 0.500 | | | -0.8% | 0.6% | -0.3% | 3.0% | | | | |
| Chopped-N150 | -150.43 | 0.506 | | | -148.84 | 0.503 | | | -1.1% | 0.5% | -0.6% | 3.1% | | | | |



TUBITAK

Correction and uncertainties:

1.0000

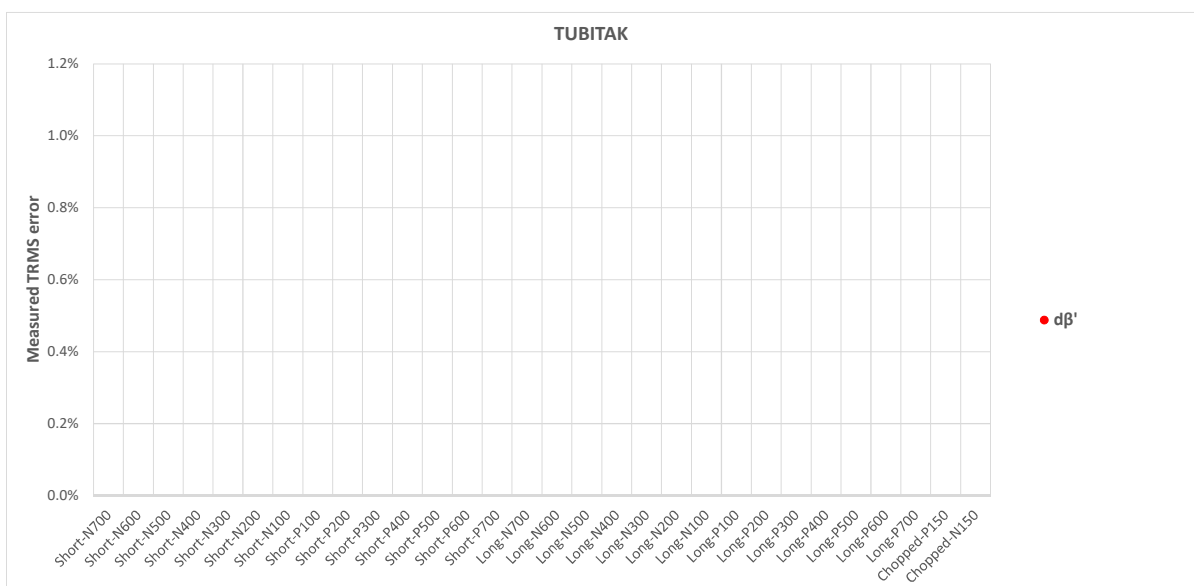
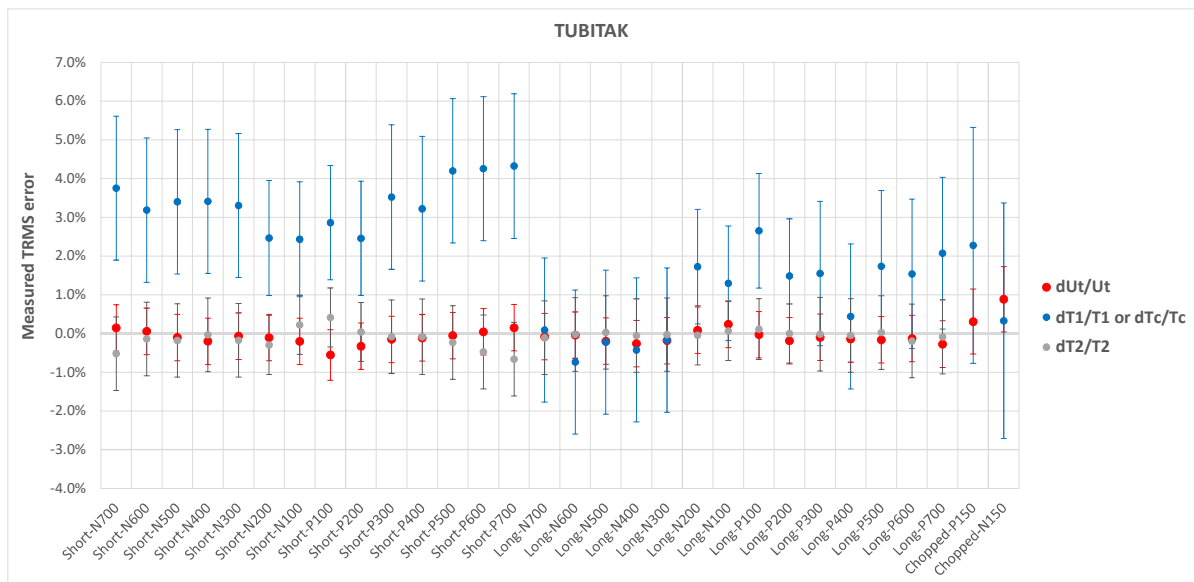
0.33%

0.46%

0.30%

TUBITAK

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | -699.18 | 0.889 | 58.23 | 0.49 | -698.15 | 0.857 | 58.54 | #N/A | 0.1% | 0.6% | 3.8% | 1.9% | -0.5% | 0.9% | | |
| Short-N600 | -600.44 | 0.886 | 58.00 | 0.61 | -600.11 | 0.859 | 58.09 | #N/A | 0.1% | 0.6% | 3.2% | 1.9% | -0.1% | 0.9% | | |
| Short-N500 | -500.25 | 0.884 | 57.68 | 0.79 | -500.77 | 0.855 | 57.78 | #N/A | -0.1% | 0.6% | 3.4% | 1.9% | -0.2% | 0.9% | | |
| Short-N400 | -399.80 | 0.883 | 57.50 | 0.81 | -400.61 | 0.853 | 57.52 | #N/A | -0.2% | 0.6% | 3.4% | 1.9% | 0.0% | 1.0% | | |
| Short-N300 | -301.39 | 0.880 | 57.34 | 0.83 | -301.60 | 0.851 | 57.44 | #N/A | -0.1% | 0.6% | 3.3% | 1.9% | -0.2% | 0.9% | | |
| Short-N200 | -203.14 | 0.881 | 57.22 | 0.94 | -203.35 | 0.860 | 57.39 | #N/A | -0.1% | 0.6% | 2.5% | 1.5% | -0.3% | 0.8% | | |
| Short-N100 | -100.00 | 0.881 | 57.36 | 0.34 | -100.20 | 0.860 | 57.23 | #N/A | -0.2% | 0.6% | 2.4% | 1.5% | 0.2% | 0.8% | | |
| Short-P100 | 101.01 | 0.881 | 57.48 | 0.52 | 101.58 | 0.856 | 57.24 | #N/A | -0.6% | 0.7% | 2.9% | 1.5% | 0.4% | 0.8% | | |
| Short-P200 | 201.95 | 0.877 | 57.34 | 0.99 | 202.61 | 0.856 | 57.31 | #N/A | -0.3% | 0.6% | 2.5% | 1.5% | 0.0% | 0.8% | | |
| Short-P300 | 301.59 | 0.879 | 57.33 | 0.83 | 302.04 | 0.849 | 57.37 | #N/A | -0.2% | 0.6% | 3.5% | 1.9% | -0.1% | 0.9% | | |
| Short-P400 | 401.16 | 0.883 | 57.59 | 0.82 | 401.61 | 0.856 | 57.64 | #N/A | -0.1% | 0.6% | 3.2% | 1.9% | -0.1% | 1.0% | | |
| Short-P500 | 501.60 | 0.888 | 57.79 | 0.61 | 501.88 | 0.852 | 57.92 | #N/A | -0.1% | 0.6% | 4.2% | 1.9% | -0.2% | 1.0% | | |
| Short-P600 | 601.93 | 0.896 | 57.98 | 0.47 | 601.66 | 0.859 | 58.26 | #N/A | 0.0% | 0.6% | 4.3% | 1.9% | -0.5% | 1.0% | | |
| Short-P700 | 700.25 | 0.901 | 58.28 | 0.24 | 699.21 | 0.864 | 58.67 | #N/A | 0.1% | 0.6% | 4.3% | 1.9% | -0.7% | 1.0% | | |
| Long-N700 | -699.00 | 1.539 | 60.21 | 0.27 | -699.59 | 1.537 | 60.27 | #N/A | -0.1% | 0.6% | 0.1% | 1.9% | -0.1% | 0.9% | | |
| Long-N600 | -601.12 | 1.536 | 60.10 | 0.30 | -601.38 | 1.547 | 60.12 | #N/A | 0.0% | 0.6% | -0.7% | 1.9% | 0.0% | 0.9% | | |
| Long-N500 | -500.89 | 1.532 | 59.81 | 0.37 | -501.89 | 1.536 | 59.79 | #N/A | -0.2% | 0.6% | -0.2% | 1.9% | 0.0% | 0.9% | | |
| Long-N400 | -401.24 | 1.528 | 59.62 | 0.18 | -402.29 | 1.534 | 59.66 | #N/A | -0.3% | 0.6% | -0.4% | 1.9% | -0.1% | 0.9% | | |
| Long-N300 | -300.72 | 1.525 | 59.51 | 0.21 | -301.27 | 1.527 | 59.53 | #N/A | -0.2% | 0.6% | -0.2% | 1.9% | 0.0% | 1.0% | | |
| Long-N200 | -201.45 | 1.525 | 59.42 | 0.27 | -201.28 | 1.499 | 59.45 | #N/A | 0.1% | 0.6% | 1.7% | 1.5% | 0.0% | 0.8% | | |
| Long-N100 | -101.02 | 1.529 | 59.44 | 0.06 | -100.78 | 1.510 | 59.40 | #N/A | 0.2% | 0.6% | 1.3% | 1.5% | 0.1% | 0.8% | | |
| Long-P100 | 100.68 | 1.527 | 59.44 | 0.35 | 100.71 | 1.488 | 59.37 | #N/A | 0.0% | 0.6% | 2.7% | 1.5% | 0.1% | 0.8% | | |
| Long-P200 | 201.53 | 1.519 | 59.44 | 0.50 | 201.91 | 1.496 | 59.44 | #N/A | -0.2% | 0.6% | 1.5% | 1.5% | 0.0% | 0.8% | | |
| Long-P300 | 300.15 | 1.526 | 59.49 | 0.37 | 300.44 | 1.503 | 59.50 | #N/A | -0.1% | 0.6% | 1.5% | 1.9% | 0.0% | 1.0% | | |
| Long-P400 | 401.47 | 1.497 | 59.56 | 0.28 | 402.03 | 1.490 | 59.59 | #N/A | -0.1% | 0.6% | 0.4% | 1.9% | 0.0% | 0.9% | | |
| Long-P500 | 500.10 | 1.514 | 59.80 | 0.40 | 500.91 | 1.488 | 59.79 | #N/A | -0.2% | 0.6% | 1.7% | 2.0% | 0.0% | 0.9% | | |
| Long-P600 | 598.07 | 1.533 | 60.01 | 0.34 | 598.86 | 1.509 | 60.13 | #N/A | -0.1% | 0.6% | 1.5% | 1.9% | -0.2% | 1.0% | | |
| Long-P700 | 699.99 | 1.534 | 60.27 | 0.20 | 701.91 | 1.503 | 60.32 | #N/A | -0.3% | 0.6% | 2.1% | 2.0% | -0.1% | 1.0% | | |
| Chopped-P150 | 155.82 | 0.576 | | | 155.35 | 0.563 | | #N/A | 0.3% | 0.8% | 2.3% | 3.0% | | | | |
| Chopped-N150 | -145.90 | 0.533 | | | -144.62 | 0.531 | | #N/A | 0.9% | 0.8% | 0.3% | 3.0% | | | | |



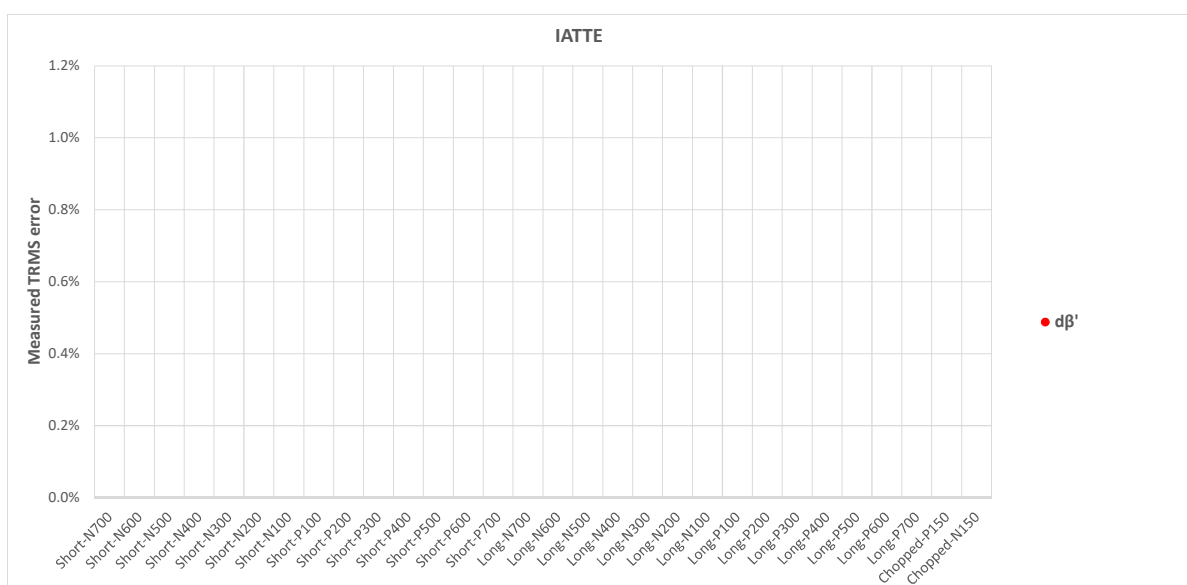
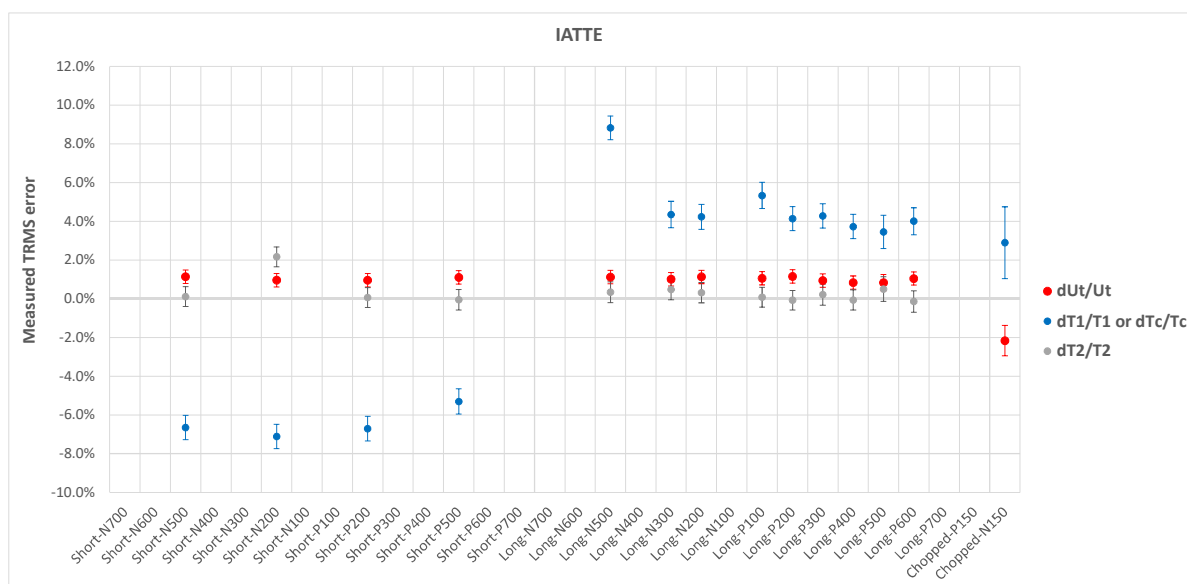
IATTE

Correction and uncertainties: 1.0002

IATTE

0.33% 0.46% 0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | -499.49 | 0.746 | 47.93 | -0.23 | -493.77 | 0.799 | 47.88 | #N/A | 1.1% | 0.3% | -6.7% | 0.6% | 0.1% | 0.5% | | |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N200 | -199.73 | 0.743 | 47.16 | -0.35 | -197.79 | 0.800 | 46.16 | #N/A | 1.0% | 0.3% | -7.1% | 0.6% | 2.2% | 0.5% | | |
| Short-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P200 | 201.11 | 0.745 | 47.18 | -0.35 | 199.17 | 0.799 | 47.15 | #N/A | 1.0% | 0.3% | -6.7% | 0.6% | 0.1% | 0.5% | | |
| Short-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | 501.63 | 0.765 | 47.98 | -0.20 | 496.05 | 0.807 | 48.00 | #N/A | 1.1% | 0.3% | -5.3% | 0.6% | 0.0% | 0.5% | | |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | -501.86 | 1.393 | 47.05 | -0.11 | -496.21 | 1.280 | 46.89 | #N/A | 1.1% | 0.3% | 8.8% | 0.6% | 0.3% | 0.5% | | |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | -300.27 | 1.610 | 49.48 | 0.09 | -297.20 | 1.543 | 49.25 | #N/A | 1.0% | 0.3% | 4.3% | 0.7% | 0.5% | 0.5% | | |
| Long-N200 | -202.14 | 1.612 | 49.26 | 0.14 | -199.84 | 1.546 | 49.10 | #N/A | 1.1% | 0.3% | 4.2% | 0.6% | 0.3% | 0.5% | | |
| Long-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P100 | 99.75 | 1.617 | 49.34 | 0.05 | 98.68 | 1.535 | 49.30 | #N/A | 1.1% | 0.3% | 5.3% | 0.7% | 0.1% | 0.5% | | |
| Long-P200 | 202.79 | 1.613 | 49.30 | 0.14 | 200.44 | 1.549 | 49.33 | #N/A | 1.2% | 0.3% | 4.1% | 0.6% | -0.1% | 0.5% | | |
| Long-P300 | 300.09 | 1.612 | 49.52 | 0.09 | 297.24 | 1.546 | 49.42 | #N/A | 0.9% | 0.3% | 4.3% | 0.6% | 0.2% | 0.5% | | |
| Long-P400 | 403.41 | 1.610 | 49.73 | 0.28 | 400.00 | 1.552 | 49.76 | #N/A | 0.8% | 0.3% | 3.7% | 0.6% | -0.1% | 0.5% | | |
| Long-P500 | 500.84 | 1.410 | 47.12 | -0.09 | 496.61 | 1.363 | 46.88 | #N/A | 0.8% | 0.4% | 3.5% | 0.9% | 0.5% | 0.6% | | |
| Long-P600 | 550.25 | 1.410 | 47.25 | -0.12 | 544.44 | 1.356 | 47.32 | #N/A | 1.0% | 0.3% | 4.0% | 0.7% | -0.1% | 0.5% | | |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-N150 | -136.22 | 0.507 | | | -139.20 | 0.493 | #N/A | #N/A | -2.2% | 0.8% | 2.9% | 1.9% | | | | |



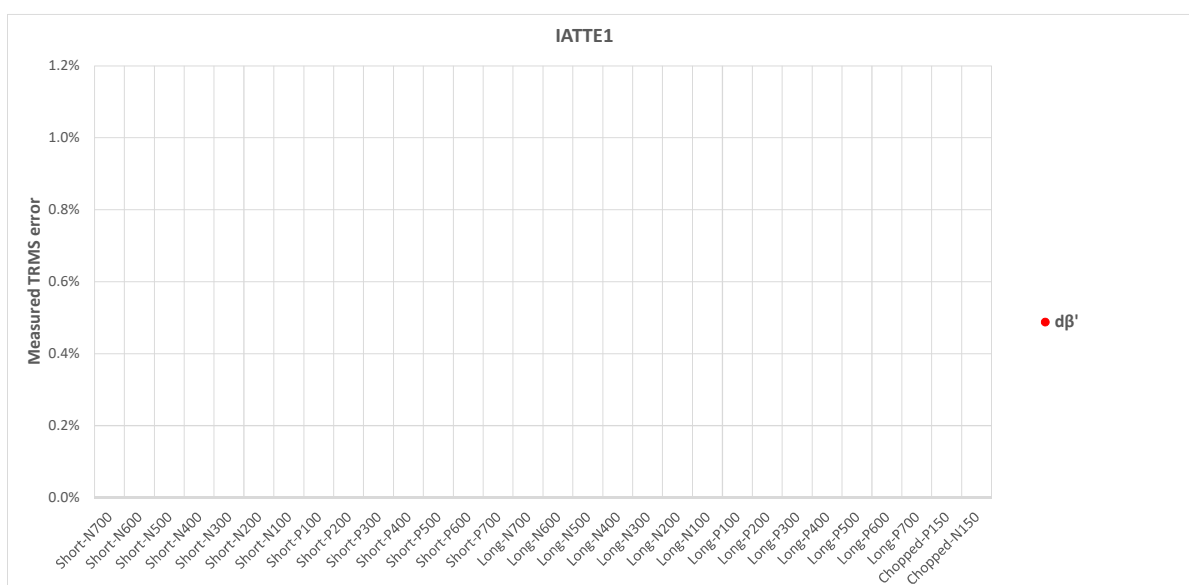
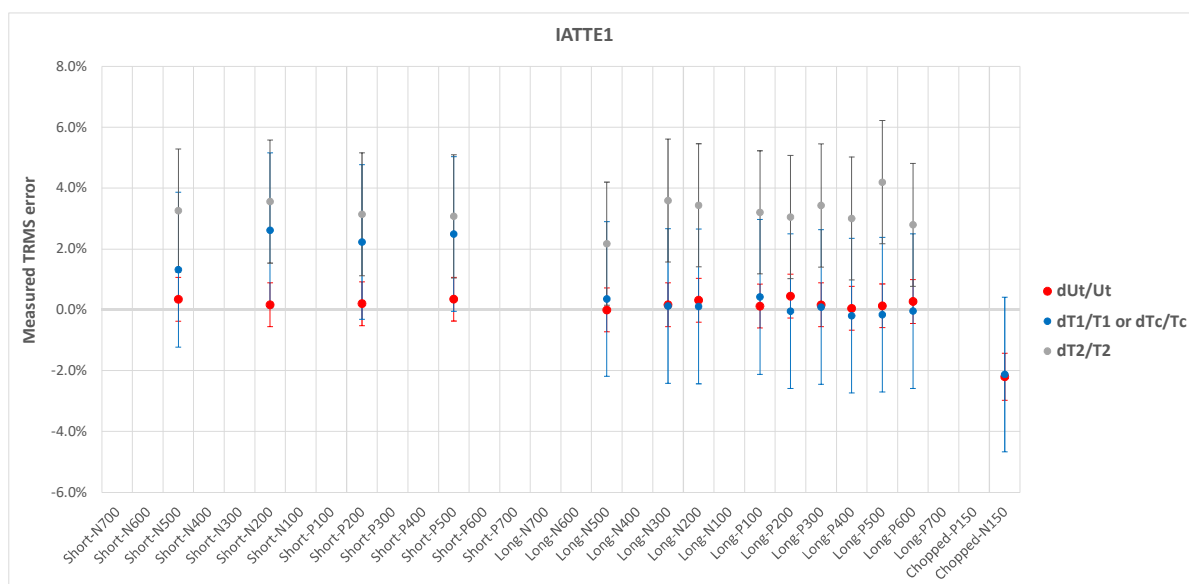
IATTE1

Correction and uncertainties: 1.0002

IATTE1

0.33% 0.46% 0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|-------|--------------------------|-------|------------|-------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | -499.49 | 0.746 | 47.93 | -0.23 | -497.75 | 0.736 | 46.42 | #N/A | 0.35 % | 0.7 % | 1.3 % | 2.5 % | 3.3 % | 2.0 % | | |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N200 | -199.73 | 0.743 | 47.16 | -0.35 | -199.39 | 0.724 | 45.54 | #N/A | 0.17 % | 0.7 % | 2.6 % | 2.5 % | 3.6 % | 2.0 % | | |
| Short-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P200 | 201.11 | 0.745 | 47.18 | -0.35 | 200.70 | 0.729 | 45.74 | #N/A | 0.20 % | 0.7 % | 2.2 % | 2.5 % | 3.1 % | 2.0 % | | |
| Short-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | 501.63 | 0.765 | 47.98 | -0.20 | 499.87 | 0.746 | 46.55 | #N/A | 0.35 % | 0.7 % | 2.5 % | 2.5 % | 3.1 % | 2.0 % | | |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | -501.86 | 1.393 | 47.05 | -0.11 | -501.88 | 1.388 | 46.05 | #N/A | 0.00 % | 0.7 % | 0.4 % | 2.5 % | 2.2 % | 2.0 % | | |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | -300.27 | 1.610 | 49.48 | 0.09 | -299.77 | 1.608 | 47.77 | #N/A | 0.17 % | 0.7 % | 0.1 % | 2.5 % | 3.6 % | 2.0 % | | |
| Long-N200 | -202.14 | 1.612 | 49.26 | 0.14 | -201.50 | 1.610 | 47.62 | #N/A | 0.32 % | 0.7 % | 0.1 % | 2.5 % | 3.4 % | 2.0 % | | |
| Long-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P100 | 99.75 | 1.617 | 49.34 | 0.05 | 99.63 | 1.610 | 47.81 | #N/A | 0.12 % | 0.7 % | 0.4 % | 2.5 % | 3.2 % | 2.0 % | | |
| Long-P200 | 202.79 | 1.613 | 49.30 | 0.14 | 201.88 | 1.614 | 47.84 | #N/A | 0.45 % | 0.7 % | 0.0 % | 2.5 % | 3.1 % | 2.0 % | | |
| Long-P300 | 300.09 | 1.612 | 49.52 | 0.09 | 299.60 | 1.611 | 47.88 | #N/A | 0.16 % | 0.7 % | 0.1 % | 2.5 % | 3.4 % | 2.0 % | | |
| Long-P400 | 403.41 | 1.610 | 49.73 | 0.28 | 403.22 | 1.613 | 48.28 | #N/A | 0.05 % | 0.7 % | -0.2 % | 2.5 % | 3.0 % | 2.0 % | | |
| Long-P500 | 500.84 | 1.410 | 47.12 | -0.09 | 500.18 | 1.412 | 45.22 | #N/A | 0.13 % | 0.7 % | -0.2 % | 2.5 % | 4.2 % | 2.0 % | | |
| Long-P600 | 550.25 | 1.410 | 47.25 | -0.12 | 548.74 | 1.411 | 45.97 | #N/A | 0.28 % | 0.7 % | 0.0 % | 2.5 % | 2.8 % | 2.0 % | | |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-N150 | -136.22 | 0.507 | | | -139.26 | 0.518 | | | -2.2 % | 0.8 % | -2.1 % | 2.5 % | | | | |



NMIA

Correction and uncertainties:

0.9994

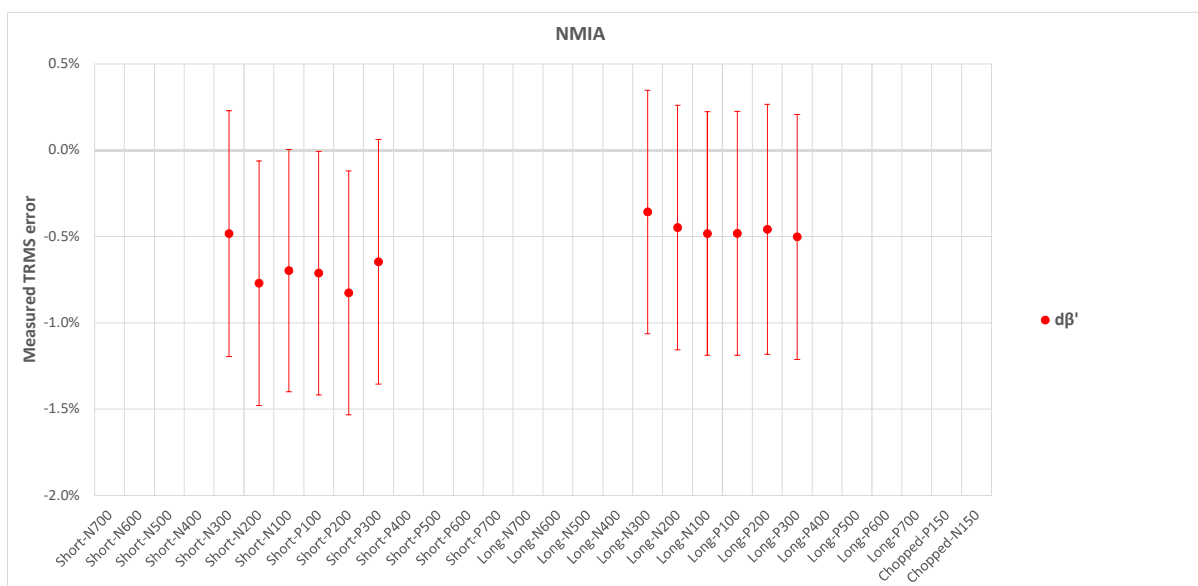
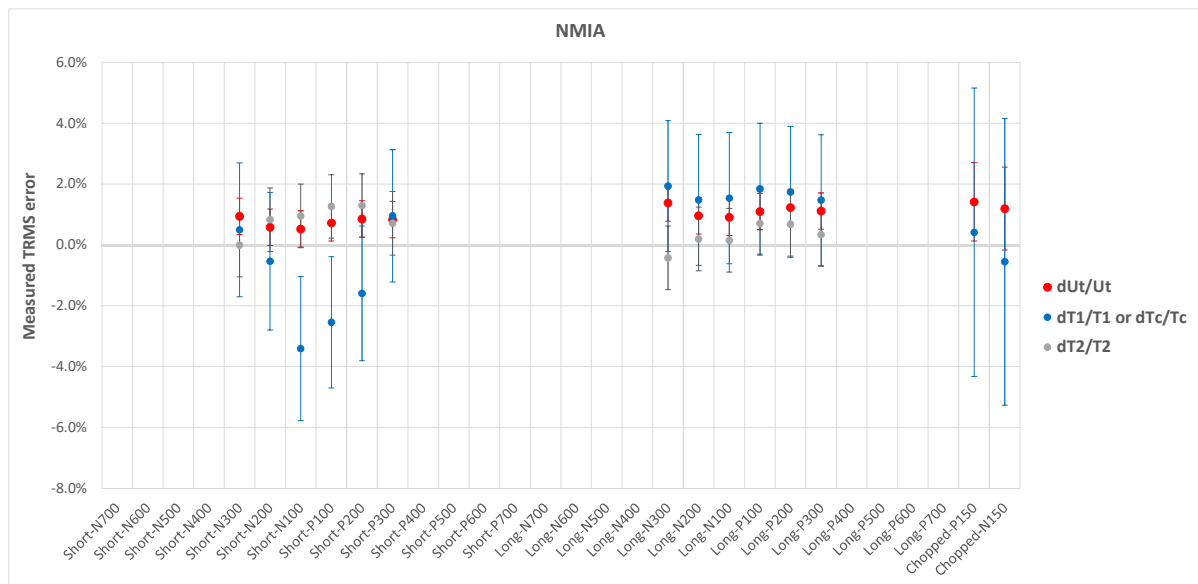
0.33%

0.46%

0.30%

NMIA

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | -291.39 | 0.829 | 60.03 | 1.63 | -288.85 | 0.825 | 60.03 | 2.11 | 0.9% | 0.6% | 0.5% | 2.2% | 0.0% | 1.0% | -0.5 | 0.7 |
| Short-N200 | -200.61 | 0.829 | 59.83 | 1.50 | -199.56 | 0.834 | 59.34 | 2.27 | 0.6% | 0.6% | -0.5% | 2.3% | 0.8% | 1.0% | -0.8 | 0.7 |
| Short-N100 | -99.80 | 0.827 | 59.93 | 1.31 | -99.33 | 0.856 | 59.36 | 2.01 | 0.5% | 0.6% | -3.4% | 2.4% | 1.0% | 1.0% | -0.7 | 0.7 |
| Short-P100 | 100.83 | 0.806 | 59.81 | 1.40 | 100.16 | 0.828 | 59.06 | 2.11 | 0.7% | 0.6% | -2.5% | 2.2% | 1.3% | 1.0% | -0.7 | 0.7 |
| Short-P200 | 202.50 | 0.807 | 59.84 | 1.46 | 200.91 | 0.820 | 59.08 | 2.29 | 0.9% | 0.6% | -1.6% | 2.2% | 1.3% | 1.0% | -0.8 | 0.7 |
| Short-P300 | 290.42 | 0.835 | 60.08 | 1.51 | 288.20 | 0.827 | 59.65 | 2.16 | 0.8% | 0.6% | 1.0% | 2.2% | 0.7% | 1.0% | -0.6 | 0.7 |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | -294.62 | 1.546 | 58.97 | -0.54 | -290.78 | 1.516 | 59.22 | -0.18 | 1.4% | 0.6% | 1.9% | 2.2% | -0.4% | 1.0% | -0.4 | 0.7 |
| Long-N200 | -202.51 | 1.546 | 58.55 | -0.45 | -200.70 | 1.524 | 58.43 | 0.00 | 1.0% | 0.6% | 1.5% | 2.2% | 0.2% | 1.0% | -0.4 | 0.7 |
| Long-N100 | -101.44 | 1.578 | 58.30 | -0.26 | -100.58 | 1.554 | 58.21 | 0.22 | 0.9% | 0.6% | 1.5% | 2.2% | 0.2% | 1.0% | -0.5 | 0.7 |
| Long-P100 | 101.27 | 1.586 | 58.43 | -0.40 | 100.23 | 1.557 | 58.02 | 0.08 | 1.1% | 0.6% | 1.8% | 2.2% | 0.7% | 1.0% | -0.5 | 0.7 |
| Long-P200 | 202.43 | 1.572 | 58.67 | -0.47 | 200.09 | 1.545 | 58.28 | -0.01 | 1.2% | 0.6% | 1.7% | 2.2% | 0.7% | 1.0% | -0.5 | 0.7 |
| Long-P300 | 294.80 | 1.573 | 59.05 | -0.54 | 291.73 | 1.550 | 58.85 | -0.03 | 1.1% | 0.6% | 1.5% | 2.2% | 0.3% | 1.0% | -0.5 | 0.7 |
| Long-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | 138.32 | 0.490 | | | 136.47 | 0.488 | #N/A | #N/A | 1.4% | 1.3% | 0.4% | 4.7% | | | | |
| Chopped-N150 | -146.50 | 0.576 | | | -144.87 | 0.579 | #N/A | #N/A | 1.2% | 1.4% | -0.5% | 4.7% | | | | |



VNIIMS

Correction and uncertainties: 0.9988

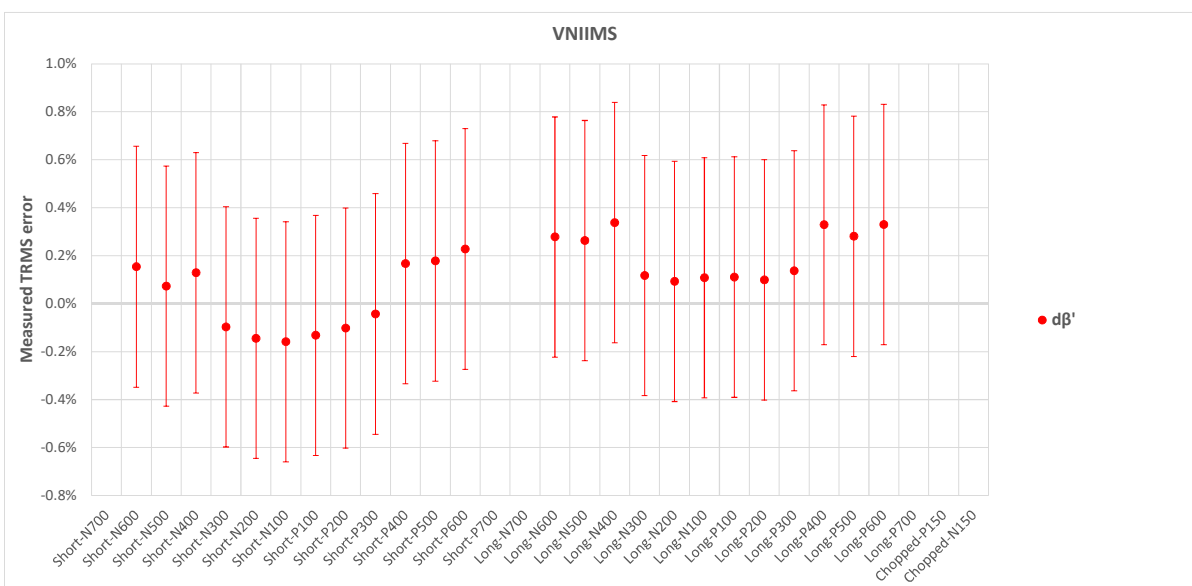
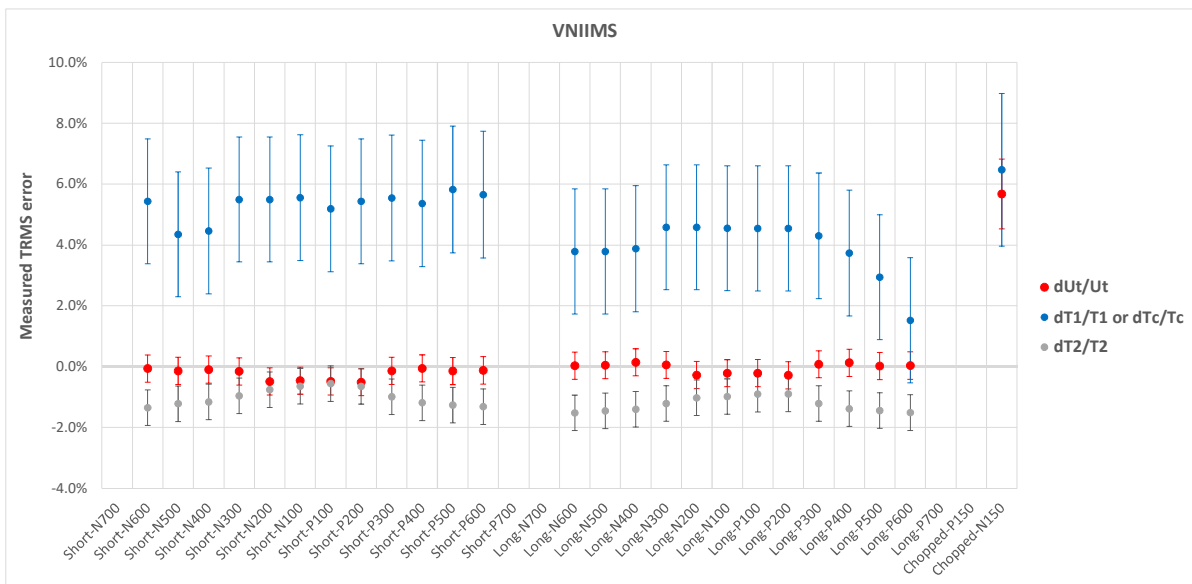
VNIIMS

0.33%

0.46%

0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | N/A | N/A | N/A | N/A | | | | | | | | |
| Short-N600 | -619.50 | 0.970 | 45.69 | -1.60 | -620.62 | 0.920 | 46.32 | -1.75 | -0.1% | 0.4% | 5.4% | 2.1% | -1.3% | 0.6% | 0.2 | 0.5 |
| Short-N500 | -518.70 | 0.960 | 45.60 | -1.55 | -520.04 | 0.920 | 46.16 | -1.63 | -0.1% | 0.4% | 4.3% | 2.1% | -1.2% | 0.6% | 0.1 | 0.5 |
| Short-N400 | -413.31 | 0.960 | 45.53 | -1.49 | -414.21 | 0.919 | 46.06 | -1.62 | -0.1% | 0.4% | 4.5% | 2.1% | -1.2% | 0.6% | 0.1 | 0.5 |
| Short-N300 | -317.53 | 0.960 | 45.58 | -1.69 | -318.40 | 0.910 | 46.02 | -1.59 | -0.2% | 0.4% | 5.5% | 2.1% | -1.0% | 0.6% | -0.1 | 0.5 |
| Short-N200 | -211.31 | 0.960 | 45.53 | -1.60 | -212.60 | 0.910 | 45.87 | -1.45 | -0.5% | 0.4% | 5.5% | 2.1% | -0.8% | 0.6% | -0.1 | 0.5 |
| Short-N100 | -108.16 | 0.969 | 45.53 | -1.59 | -108.78 | 0.918 | 45.83 | -1.43 | -0.5% | 0.4% | 5.6% | 2.1% | -0.6% | 0.6% | -0.2 | 0.5 |
| Short-P100 | 108.08 | 0.971 | 45.56 | -1.57 | 108.73 | 0.923 | 45.81 | -1.44 | -0.5% | 0.4% | 5.2% | 2.1% | -0.6% | 0.6% | -0.1 | 0.5 |
| Short-P200 | 209.78 | 0.970 | 45.58 | -1.58 | 211.11 | 0.920 | 45.87 | -1.48 | -0.5% | 0.4% | 5.4% | 2.1% | -0.6% | 0.6% | -0.1 | 0.5 |
| Short-P300 | 315.27 | 0.971 | 45.61 | -1.65 | 316.07 | 0.920 | 46.06 | -1.61 | -0.1% | 0.4% | 5.5% | 2.1% | -1.0% | 0.6% | 0.0 | 0.5 |
| Short-P400 | 410.60 | 0.982 | 45.60 | -1.52 | 411.33 | 0.932 | 46.15 | -1.69 | -0.1% | 0.4% | 5.4% | 2.1% | -1.2% | 0.6% | 0.2 | 0.5 |
| Short-P500 | 515.00 | 1.000 | 45.74 | -1.64 | 516.36 | 0.945 | 46.32 | -1.82 | -0.1% | 0.4% | 5.8% | 2.1% | -1.3% | 0.6% | 0.2 | 0.5 |
| Short-P600 | 614.23 | 1.010 | 45.94 | -1.78 | 615.71 | 0.956 | 46.55 | -2.00 | -0.1% | 0.4% | 5.7% | 2.1% | -1.3% | 0.6% | 0.2 | 0.5 |
| Short-P700 | | | | | N/A | N/A | N/A | N/A | | | | | | | | |
| Long-N700 | | | | | N/A | N/A | N/A | N/A | | | | | | | | |
| Long-N600 | -615.92 | 1.370 | 46.54 | -1.38 | -616.46 | 1.320 | 47.26 | -1.66 | 0.0% | 0.4% | 3.8% | 2.1% | -1.5% | 0.6% | 0.3 | 0.5 |
| Long-N500 | -512.35 | 1.370 | 46.42 | -1.35 | -512.72 | 1.320 | 47.10 | -1.61 | 0.0% | 0.4% | 3.8% | 2.1% | -1.5% | 0.6% | 0.3 | 0.5 |
| Long-N400 | -414.20 | 1.366 | 46.33 | -1.27 | -414.11 | 1.315 | 46.99 | -1.60 | 0.1% | 0.4% | 3.9% | 2.1% | -1.4% | 0.6% | 0.3 | 0.5 |
| Long-N300 | -310.40 | 1.370 | 46.38 | -1.47 | -310.59 | 1.310 | 46.95 | -1.58 | 0.1% | 0.4% | 4.6% | 2.1% | -1.2% | 0.6% | 0.1 | 0.5 |
| Long-N200 | -206.71 | 1.370 | 46.30 | -1.39 | -207.53 | 1.310 | 46.78 | -1.48 | -0.3% | 0.4% | 4.6% | 2.1% | -1.0% | 0.6% | 0.1 | 0.5 |
| Long-N100 | -105.35 | 1.379 | 46.33 | -1.37 | -105.70 | 1.319 | 46.79 | -1.48 | -0.2% | 0.4% | 4.5% | 2.1% | -1.0% | 0.6% | 0.1 | 0.5 |
| Long-P100 | 105.24 | 1.380 | 46.35 | -1.37 | 105.59 | 1.320 | 46.77 | -1.48 | -0.2% | 0.4% | 4.5% | 2.1% | -0.9% | 0.6% | 0.1 | 0.5 |
| Long-P200 | 204.88 | 1.380 | 46.32 | -1.36 | 205.71 | 1.320 | 46.74 | -1.46 | -0.3% | 0.4% | 4.5% | 2.1% | -0.9% | 0.6% | 0.1 | 0.5 |
| Long-P300 | 307.98 | 1.383 | 46.39 | -1.44 | 308.11 | 1.326 | 46.96 | -1.58 | 0.1% | 0.4% | 4.3% | 2.1% | -1.2% | 0.6% | 0.1 | 0.5 |
| Long-P400 | 411.55 | 1.390 | 46.38 | -1.28 | 411.51 | 1.340 | 47.03 | -1.61 | 0.1% | 0.4% | 3.7% | 2.1% | -1.4% | 0.6% | 0.3 | 0.5 |
| Long-P500 | 509.20 | 1.400 | 46.51 | -1.34 | 509.69 | 1.360 | 47.19 | -1.62 | 0.0% | 0.4% | 2.9% | 2.1% | -1.4% | 0.6% | 0.3 | 0.5 |
| Long-P600 | 612.17 | 1.400 | 46.74 | -1.43 | 612.67 | 1.379 | 47.45 | -1.76 | 0.0% | 0.4% | 1.5% | 2.1% | -1.5% | 0.6% | 0.3 | 0.5 |
| Long-P700 | | | | | | | | | | | | | | | | |
| Chopped-P150 | | | | | | | | | | | | | | | | |
| Chopped-N150 | 153.44 | 0.593 | | | 145.37 | 0.557 | | | 5.7% | 1.1% | 6.5% | 2.5% | | | | |



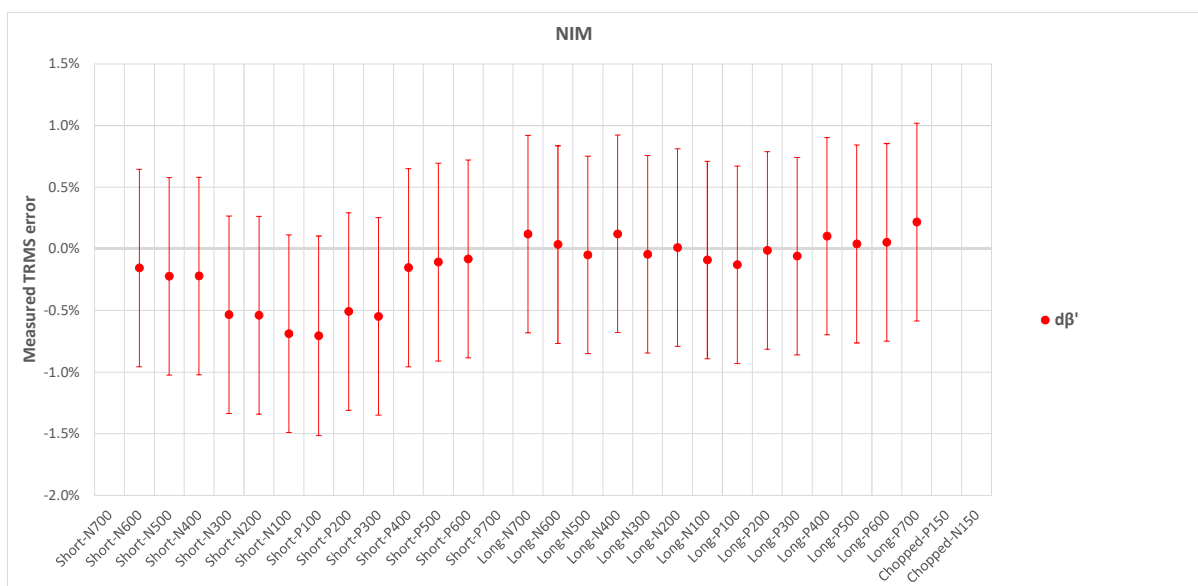
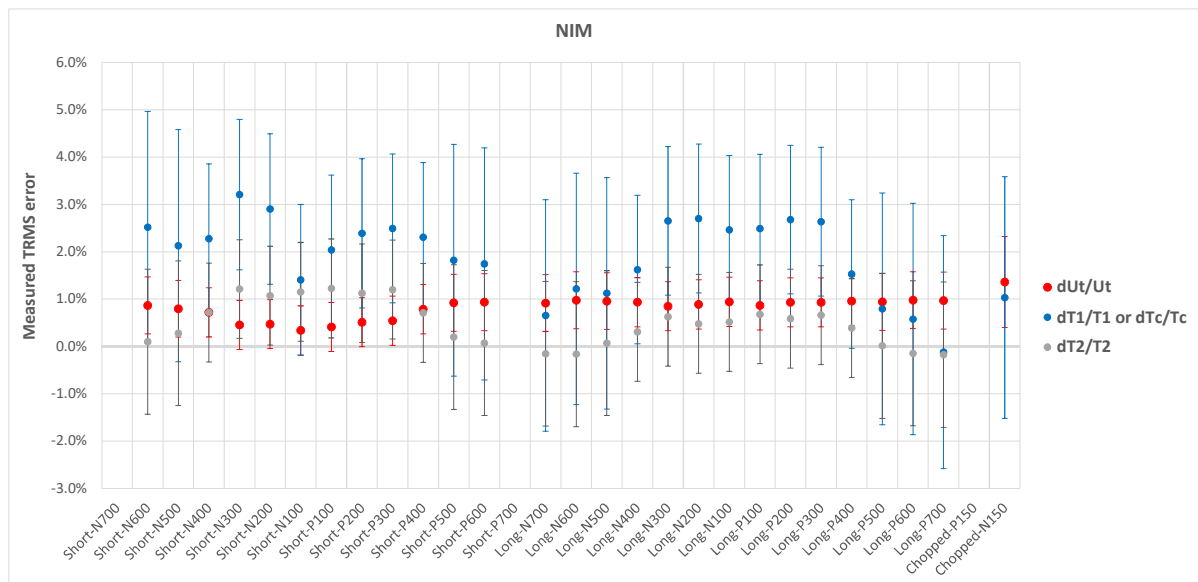
NIM

Correction and uncertainties: 0.9988

NIM

0.33% 0.46% 0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | | | | | | | | | | | | |
| Short-N600 | -602.00 | 0.892 | 60.29 | 5.37 | -597.55 | 0.870 | 60.23 | 5.52 | 0.9% | 0.6% | 2.5% | 2.4% | 0.1% | 1.5% | -0.2 | 0.8 |
| Short-N500 | -510.98 | 0.885 | 59.92 | 5.32 | -507.55 | 0.867 | 59.76 | 5.55 | 0.8% | 0.6% | 2.1% | 2.5% | 0.3% | 1.5% | -0.2 | 0.8 |
| Short-N400 | -397.03 | 0.885 | 59.69 | 5.41 | -394.67 | 0.865 | 59.26 | 5.63 | 0.7% | 0.5% | 2.3% | 1.6% | 0.7% | 1.0% | -0.2 | 0.8 |
| Short-N300 | -298.12 | 0.854 | 62.69 | 3.75 | -297.13 | 0.827 | 61.94 | 4.28 | 0.5% | 0.5% | 3.2% | 1.6% | 1.2% | 1.0% | -0.5 | 0.8 |
| Short-N200 | -194.95 | 0.854 | 61.61 | 3.78 | -194.27 | 0.829 | 60.96 | 4.32 | 0.5% | 0.5% | 2.9% | 1.6% | 1.1% | 1.0% | -0.5 | 0.8 |
| Short-N100 | -97.58 | 0.858 | 60.89 | 3.75 | -97.37 | 0.846 | 60.20 | 4.44 | 0.3% | 0.5% | 1.4% | 1.6% | 1.2% | 1.0% | -0.7 | 0.8 |
| Short-P100 | 97.49 | 0.843 | 60.94 | 3.84 | 97.21 | 0.826 | 60.20 | 4.54 | 0.4% | 0.5% | 2.0% | 1.6% | 1.2% | 1.0% | -0.7 | 0.8 |
| Short-P200 | 194.79 | 0.853 | 61.32 | 3.95 | 194.04 | 0.833 | 60.64 | 4.45 | 0.5% | 0.5% | 2.4% | 1.6% | 1.1% | 1.0% | -0.5 | 0.8 |
| Short-P300 | 297.99 | 0.855 | 62.63 | 3.60 | 296.74 | 0.834 | 61.89 | 4.15 | 0.5% | 0.5% | 2.5% | 1.6% | 1.2% | 1.0% | -0.5 | 0.8 |
| Short-P400 | 396.27 | 0.891 | 59.66 | 5.26 | 393.65 | 0.871 | 59.24 | 5.41 | 0.8% | 0.5% | 2.3% | 1.6% | 0.7% | 1.0% | -0.2 | 0.8 |
| Short-P500 | 510.01 | 0.891 | 60.29 | 5.08 | 505.96 | 0.875 | 60.17 | 5.19 | 0.9% | 0.6% | 1.8% | 2.4% | 0.2% | 1.5% | -0.1 | 0.8 |
| Short-P600 | 598.13 | 0.894 | 60.58 | 4.89 | 593.30 | 0.879 | 60.54 | 4.98 | 0.9% | 0.6% | 1.7% | 2.5% | 0.1% | 1.5% | -0.1 | 0.8 |
| Short-P700 | | | | | | | | | | | | | | | | |
| Long-N700 | -701.33 | 1.544 | 62.83 | 0.42 | -695.80 | 1.534 | 62.93 | 0.30 | 0.9% | 0.6% | 0.7% | 2.4% | -0.2% | 1.5% | 0.1 | 0.8 |
| Long-N600 | -609.26 | 1.565 | 62.44 | 0.58 | -604.10 | 1.546 | 62.55 | 0.55 | 1.0% | 0.6% | 1.2% | 2.4% | -0.2% | 1.5% | 0.0 | 0.8 |
| Long-N500 | -502.96 | 1.563 | 61.84 | 0.58 | -498.80 | 1.545 | 61.80 | 0.63 | 1.0% | 0.6% | 1.1% | 2.4% | 0.1% | 1.5% | 0.0 | 0.8 |
| Long-N400 | -399.71 | 1.565 | 61.39 | 0.62 | -396.49 | 1.540 | 61.20 | 0.50 | 0.9% | 0.5% | 1.6% | 1.6% | 0.3% | 1.0% | 0.1 | 0.8 |
| Long-N300 | -296.34 | 1.619 | 60.06 | 0.12 | -294.19 | 1.577 | 59.68 | 0.17 | 0.9% | 0.5% | 2.7% | 1.6% | 0.6% | 1.0% | 0.0 | 0.8 |
| Long-N200 | -200.34 | 1.604 | 59.42 | 0.11 | -198.81 | 1.562 | 59.13 | 0.10 | 0.9% | 0.5% | 2.7% | 1.6% | 0.5% | 1.0% | 0.0 | 0.8 |
| Long-N100 | -100.06 | 1.613 | 58.73 | 0.03 | -99.25 | 1.574 | 58.42 | 0.12 | 0.9% | 0.5% | 2.5% | 1.6% | 0.5% | 1.0% | -0.1 | 0.8 |
| Long-P100 | 99.59 | 1.607 | 58.82 | 0.05 | 98.85 | 1.568 | 58.43 | 0.18 | 0.9% | 0.5% | 2.5% | 1.6% | 0.7% | 1.0% | -0.1 | 0.8 |
| Long-P200 | 199.72 | 1.618 | 59.22 | 0.15 | 198.11 | 1.576 | 58.88 | 0.17 | 0.9% | 0.5% | 2.7% | 1.6% | 0.6% | 1.0% | 0.0 | 0.8 |
| Long-P300 | 295.95 | 1.626 | 60.13 | 0.11 | 293.57 | 1.584 | 59.74 | 0.17 | 0.9% | 0.5% | 2.6% | 1.6% | 0.7% | 1.0% | -0.1 | 0.8 |
| Long-P400 | 399.00 | 1.570 | 61.57 | 0.56 | 395.70 | 1.547 | 61.33 | 0.46 | 1.0% | 0.5% | 1.5% | 1.6% | 0.4% | 1.0% | 0.1 | 0.8 |
| Long-P500 | 502.09 | 1.577 | 61.89 | 0.52 | 498.00 | 1.565 | 61.89 | 0.48 | 0.9% | 0.6% | 0.8% | 2.4% | 0.0% | 1.5% | 0.0 | 0.8 |
| Long-P600 | 605.97 | 1.586 | 62.65 | 0.43 | 600.82 | 1.577 | 62.74 | 0.38 | 1.0% | 0.6% | 0.6% | 2.4% | -0.1% | 1.5% | 0.1 | 0.8 |
| Long-P700 | 697.05 | 1.572 | 62.98 | 0.27 | 691.19 | 1.574 | 63.09 | 0.05 | 1.0% | 0.6% | -0.1% | 2.5% | -0.2% | 1.5% | 0.2 | 0.8 |
| Chopped-P150 | | | | | | | | | | | | | | | | |
| Chopped-N150 | -145.11 | 0.464 | | | -143.34 | 0.459 | | | 1.4% | 1.0% | 1.0% | 2.6% | | | | |



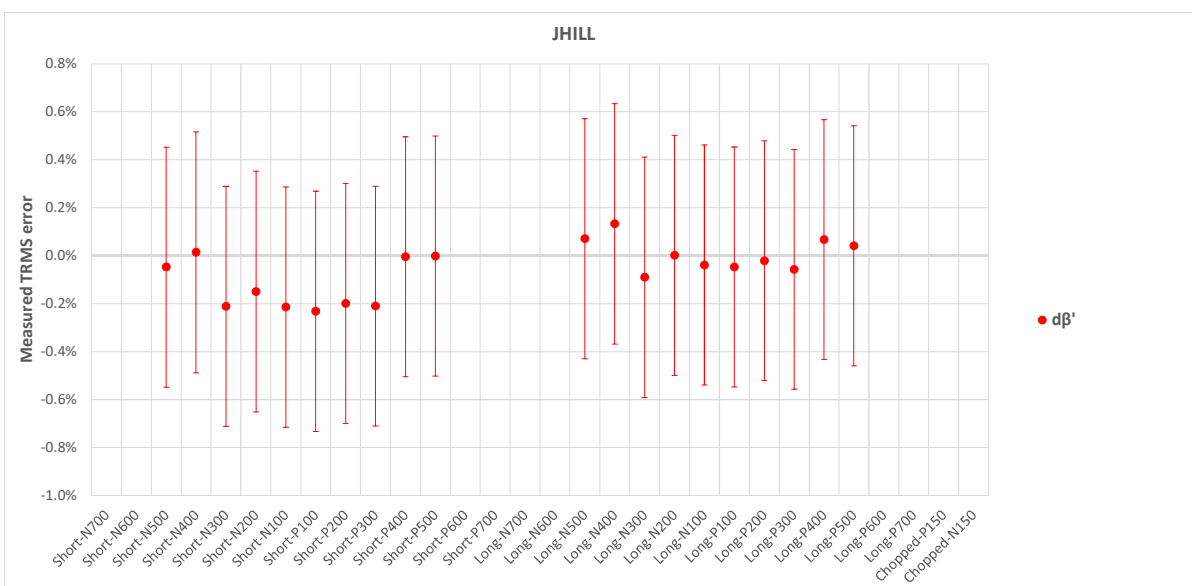
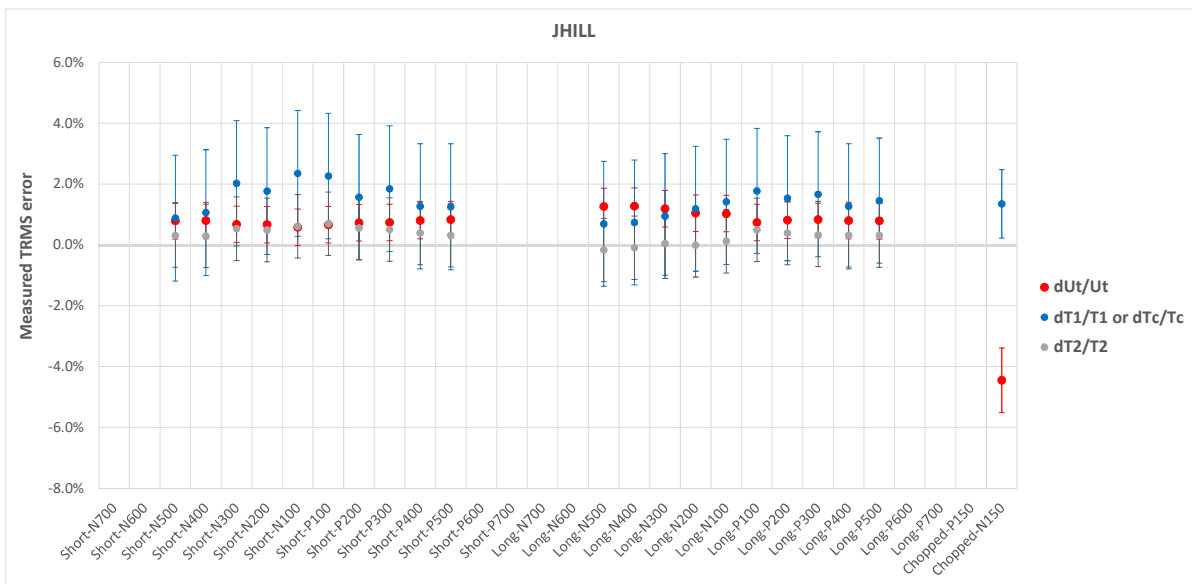
JHILL

Correction and uncertainties: 0.9983

JHILL

0.33% 0.46% 0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | | | | | | | | | | | | |
| Short-N600 | | | | | | | | | | | | | | | | |
| Short-N500 | -504.22 | 0.834 | 64.10 | 0.11 | -501.12 | 0.827 | 63.90 | 0.15 | 0.8% | 0.6% | 0.9% | 2.1% | 0.3% | 1.0% | 0.0 | 0.5 |
| Short-N400 | -403.48 | 0.831 | 63.89 | 0.17 | -400.95 | 0.822 | 63.69 | 0.16 | 0.8% | 0.6% | 1.1% | 2.1% | 0.3% | 1.0% | 0.0 | 0.5 |
| Short-N300 | -302.59 | 0.837 | 63.87 | -0.02 | -301.07 | 0.821 | 63.53 | 0.19 | 0.7% | 0.6% | 2.0% | 2.1% | 0.5% | 1.0% | -0.2 | 0.5 |
| Short-N200 | -201.65 | 0.836 | 63.70 | 0.07 | -200.65 | 0.821 | 63.39 | 0.22 | 0.7% | 0.6% | 1.8% | 2.1% | 0.5% | 1.0% | -0.1 | 0.5 |
| Short-N100 | -100.50 | 0.832 | 63.76 | 0.00 | -100.09 | 0.813 | 63.37 | 0.22 | 0.6% | 0.6% | 2.4% | 2.1% | 0.6% | 1.0% | -0.2 | 0.5 |
| Short-P100 | 100.65 | 0.832 | 63.78 | -0.03 | 100.15 | 0.814 | 63.33 | 0.21 | 0.7% | 0.6% | 2.3% | 2.1% | 0.7% | 1.0% | -0.2 | 0.5 |
| Short-P200 | 201.73 | 0.848 | 63.67 | 0.05 | 200.61 | 0.835 | 63.32 | 0.24 | 0.7% | 0.6% | 1.6% | 2.1% | 0.6% | 1.0% | -0.2 | 0.5 |
| Short-P300 | 302.27 | 0.842 | 63.77 | 0.02 | 300.55 | 0.827 | 63.44 | 0.23 | 0.7% | 0.6% | 1.8% | 2.1% | 0.5% | 1.0% | -0.2 | 0.5 |
| Short-P400 | 402.59 | 0.840 | 63.91 | 0.20 | 400.05 | 0.830 | 63.66 | 0.20 | 0.8% | 0.6% | 1.3% | 2.1% | 0.4% | 1.0% | 0.0 | 0.5 |
| Short-P500 | 502.32 | 0.859 | 64.16 | 0.15 | 499.00 | 0.849 | 63.95 | 0.15 | 0.8% | 0.6% | 1.3% | 2.1% | 0.3% | 1.0% | 0.0 | 0.5 |
| Short-P600 | | | | | | | | | | | | | | | | |
| Short-P700 | | | | | | | | | | | | | | | | |
| Long-N700 | | | | | | | | | | | | | | | | |
| Long-N600 | | | | | | | | | | | | | | | | |
| Long-N500 | -504.05 | 1.569 | 60.47 | 0.03 | -498.59 | 1.558 | 60.57 | -0.04 | 1.3% | 0.6% | 0.7% | 2.1% | -0.2% | 1.0% | 0.1 | 0.5 |
| Long-N400 | -404.24 | 1.563 | 60.24 | 0.10 | -399.84 | 1.551 | 60.30 | -0.03 | 1.3% | 0.6% | 0.7% | 2.1% | -0.1% | 1.0% | 0.1 | 0.5 |
| Long-N300 | -303.14 | 1.560 | 60.14 | -0.08 | -300.08 | 1.545 | 60.11 | 0.01 | 1.2% | 0.6% | 0.9% | 2.1% | 0.0% | 1.0% | -0.1 | 0.5 |
| Long-N200 | -202.34 | 1.560 | 59.96 | 0.00 | -200.58 | 1.542 | 59.96 | -0.01 | 1.0% | 0.6% | 1.2% | 2.1% | 0.0% | 1.0% | 0.0 | 0.5 |
| Long-N100 | -100.72 | 1.557 | 59.97 | -0.06 | -99.87 | 1.536 | 59.90 | -0.02 | 1.0% | 0.6% | 1.4% | 2.1% | 0.1% | 1.0% | 0.0 | 0.5 |
| Long-P100 | 100.59 | 1.527 | 60.03 | -0.09 | 100.02 | 1.500 | 59.73 | -0.04 | 0.7% | 0.6% | 1.8% | 2.1% | 0.5% | 1.0% | 0.0 | 0.5 |
| Long-P200 | 201.70 | 1.565 | 59.97 | -0.01 | 200.41 | 1.542 | 59.73 | 0.01 | 0.8% | 0.6% | 1.5% | 2.1% | 0.4% | 1.0% | 0.0 | 0.5 |
| Long-P300 | 302.90 | 1.558 | 60.04 | -0.05 | 300.90 | 1.532 | 59.85 | 0.01 | 0.8% | 0.6% | 1.7% | 2.1% | 0.3% | 1.0% | -0.1 | 0.5 |
| Long-P400 | 402.70 | 1.559 | 60.29 | 0.04 | 400.19 | 1.539 | 60.10 | -0.02 | 0.8% | 0.6% | 1.3% | 2.1% | 0.3% | 1.0% | 0.1 | 0.5 |
| Long-P500 | 503.69 | 1.592 | 60.61 | -0.01 | 500.57 | 1.570 | 60.42 | -0.05 | 0.8% | 0.6% | 1.5% | 2.1% | 0.3% | 1.0% | 0.0 | 0.5 |
| Long-P600 | | | | | | | | | | | | | | | | |
| Long-P700 | | | | | | | | | | | | | | | | |
| Chopped-P150 | | | | | | | | | | | | | | | | |
| Chopped-N150 | -154.25 | 0.550 | | | -161.70 | 0.542 | | | -4.4% | 1.1% | 1.4% | 1.1% | | | | |



NRC

Correction and uncertainties:

0.9967

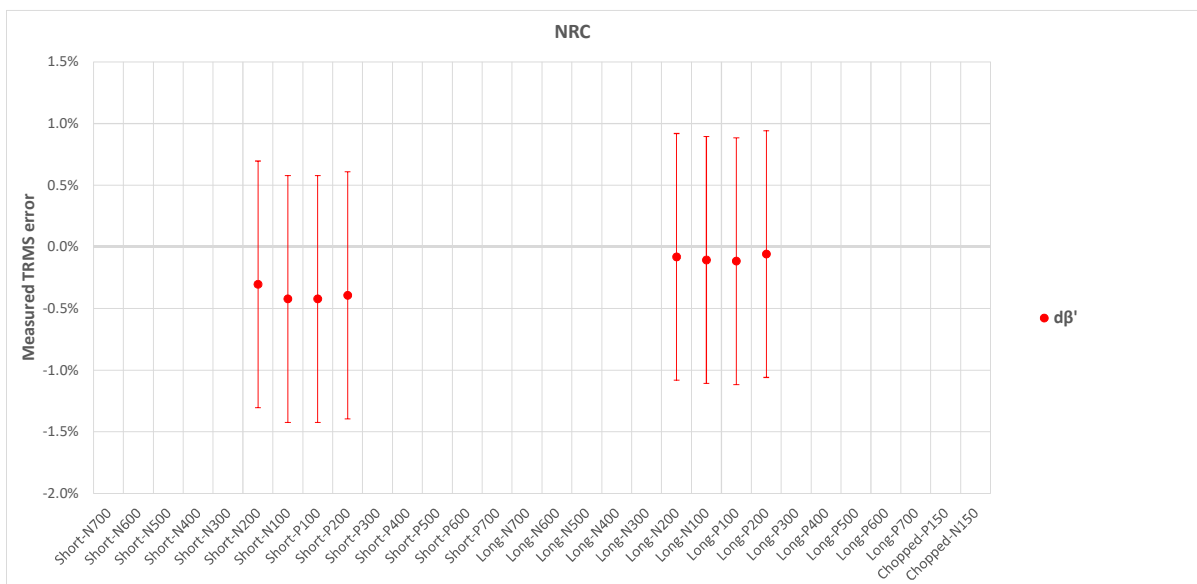
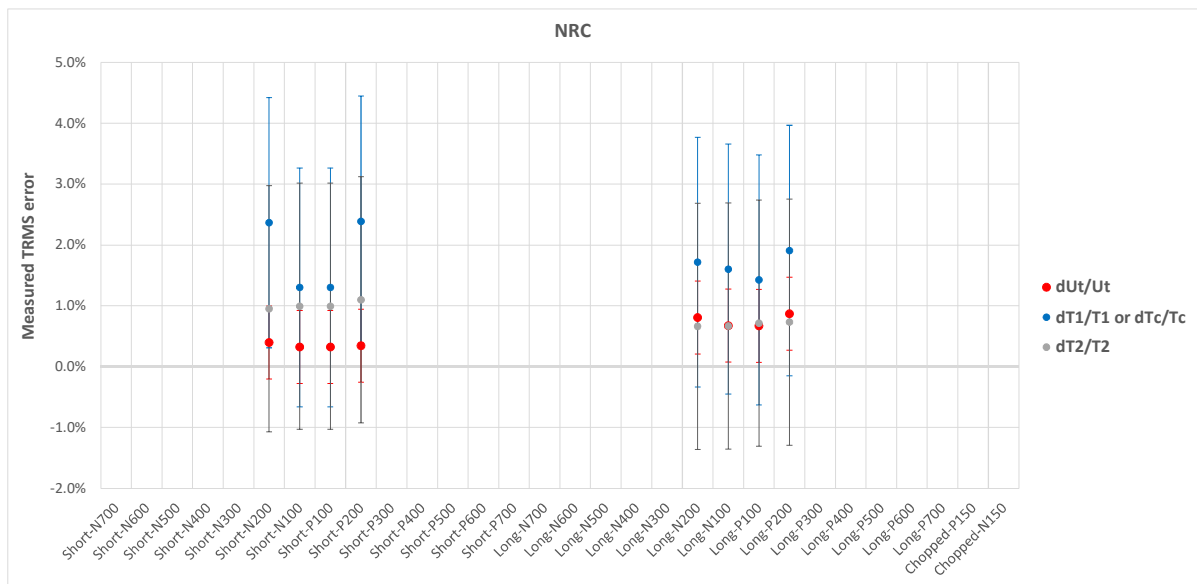
0.33%

0.46%

0.30%

NRC

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N200 | -200.05 | 0.862 | 61.77 | 0.30 | -199.92 | 0.843 | 61.19 | 0.61 | 0.4% | 0.6% | 2.4% | 2.1% | 1.0% | 2.0% | -0.3 | 1.0 |
| Short-N100 | -98.98 | 0.854 | 61.66 | 0.17 | -98.99 | 0.843 | 61.06 | 0.60 | 0.3% | 0.6% | 1.3% | 2.0% | 1.0% | 2.0% | -0.4 | 1.0 |
| Short-P100 | -98.98 | 0.854 | 61.66 | 0.17 | -98.99 | 0.843 | 61.06 | 0.60 | 0.3% | 0.6% | 1.3% | 2.0% | 1.0% | 2.0% | -0.4 | 1.0 |
| Short-P200 | 199.92 | 0.861 | 61.82 | 0.24 | 199.90 | 0.841 | 61.15 | 0.64 | 0.3% | 0.6% | 2.4% | 2.1% | 1.1% | 2.0% | -0.4 | 1.0 |
| Short-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N200 | -198.09 | 1.559 | 59.77 | 0.00 | -197.15 | 1.533 | 59.37 | 0.08 | 0.8% | 0.6% | 1.7% | 2.1% | 0.7% | 2.0% | -0.1 | 1.0 |
| Long-N100 | -100.14 | 1.558 | 59.71 | -0.03 | -99.79 | 1.534 | 59.32 | 0.08 | 0.7% | 0.6% | 1.6% | 2.1% | 0.7% | 2.0% | -0.1 | 1.0 |
| Long-P100 | 100.15 | 1.556 | 59.77 | -0.01 | 99.81 | 1.534 | 59.35 | 0.10 | 0.7% | 0.6% | 1.4% | 2.1% | 0.7% | 2.0% | -0.1 | 1.0 |
| Long-P200 | 199.29 | 1.560 | 59.85 | -0.01 | 198.23 | 1.531 | 59.42 | 0.05 | 0.9% | 0.6% | 1.9% | 2.1% | 0.7% | 2.0% | -0.1 | 1.0 |
| Long-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-N150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |



RISE3

Correction and uncertainties: 0.9988

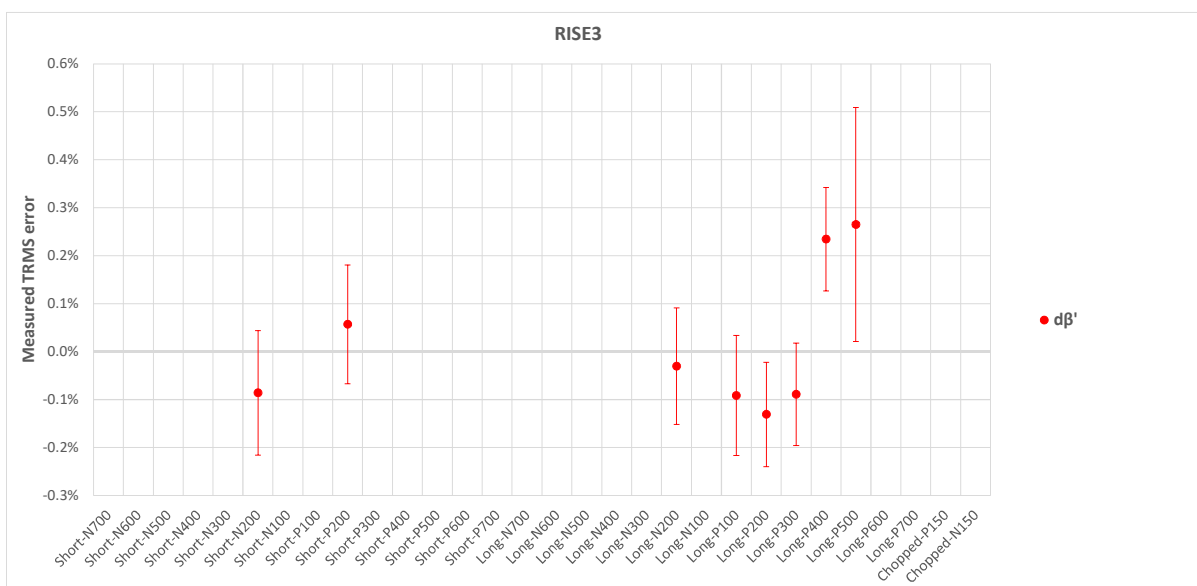
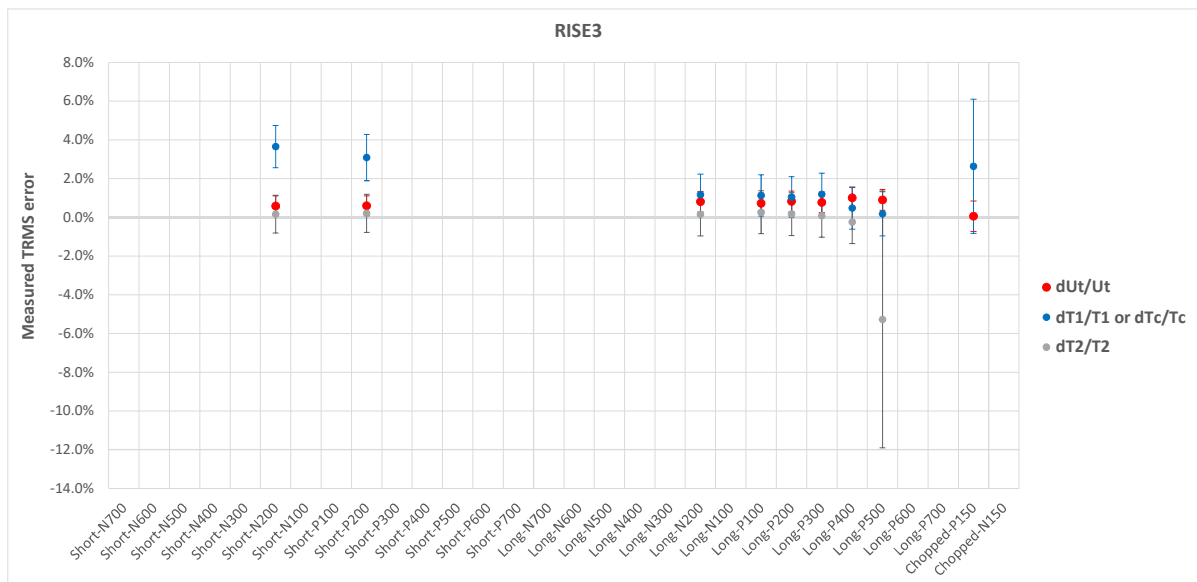
RISE3

0.33%

0.46%

0.30%

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|---------------------------|------------------|---------------|--------------|---------------------------|------------------|---------------|--------------------|------|--------------------------|------|------------|------|----------------|-------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | θ' [%] | dU/U_t | U | dT_1/T_1 or dT_c/T_c | U | dT_2/T_2 | U | $d\theta'$ [%] | U [%] |
| Short-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-N200 | -200.55 | 0.882 | 60.31 | 0.96 | -199.62 | 0.851 | 60.21 | 1.05 | 0.6% | 0.5% | 3.7% | 1.1% | 0.2% | 1.0% | -0.1 | 0.1 |
| Short-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P200 | 200.73 | 0.889 | 60.45 | 0.88 | 199.77 | 0.862 | 60.33 | 0.82 | 0.6% | 0.5% | 3.1% | 1.2% | 0.2% | 1.0% | 0.1 | 0.1 |
| Short-P300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Short-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N500 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N400 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N300 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-N200 | -200.24 | 1.605 | 63.60 | 0.15 | -198.86 | 1.586 | 63.50 | 0.18 | 0.8% | 0.5% | 1.2% | 1.1% | 0.1% | 1.1% | 0.0 | 0.1 |
| Long-N100 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P100 | 99.35 | 1.597 | 63.48 | 0.26 | 98.75 | 1.580 | 63.31 | 0.36 | 0.7% | 0.5% | 1.1% | 1.1% | 0.3% | 1.1% | -0.1 | 0.1 |
| Long-P200 | 199.96 | 1.620 | 63.63 | -0.02 | 198.55 | 1.603 | 63.52 | 0.11 | 0.8% | 0.5% | 1.0% | 1.1% | 0.2% | 1.1% | -0.1 | 0.1 |
| Long-P300 | 299.68 | 1.650 | 63.91 | -0.04 | 297.75 | 1.630 | 63.85 | 0.05 | 0.8% | 0.5% | 1.2% | 1.1% | 0.1% | 1.1% | -0.1 | 0.1 |
| Long-P400 | 401.08 | 1.650 | 64.04 | 0.20 | 397.57 | 1.642 | 64.20 | -0.04 | 1.0% | 0.5% | 0.5% | 1.1% | -0.2% | 1.1% | 0.2 | 0.1 |
| Long-P500 | 500.02 | 1.656 | 61.52 | -0.03 | 496.15 | 1.653 | 64.94 | -0.30 | 0.9% | 0.5% | 0.2% | 1.1% | -5.3% | 6.6% | 0.3 | 0.2 |
| Long-P600 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Long-P700 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| Chopped-P150 | 156.39 | 0.523 | | | 156.49 | 0.510 | #N/A | #N/A | 0.1% | 0.8% | 2.6% | 3.5% | | | | |
| Chopped-N150 | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |



Annex D - Sample uncertainty budgets reported by participants

RISEUncertainty budget for standard lightning impulses ($T_1 = 0.84 \mu\text{s}$, $< 500 \text{ kV}$):

| Digitizer | Contributions to standard uncertainty | | | |
|-----------------------------------|---------------------------------------|--------------|--------------|--------------|
| | U_p | T_1 | T_2 | β |
| U_{ref} | 0.080% | 0% | 0% | |
| Linearity U_{B1} | 0.169% | 0.293% | 0.307% | |
| Dynamic U_{B2} | 0.095% | 0.084% | 0.158% | |
| Short term U_{B3} | 0% | 0% | 0% | |
| Long term U_{B4} | 0% | 0% | 0% | |
| Temperature U_{B5} | 0.066% | 0.009% | 0.005% | |
| Proximity U_{B6} | 0% | 0% | 0% | |
| Software U_{B7} | 0.019% | 0.188% | 0.037% | 0.050% |
| Divider SMR | | | | |
| U_{ref} | 0.034% | 0.247% | 0.268% | |
| Linearity U_{B1} | 0.013% | 0% | 0% | |
| Dynamic U_{B2} | 0.057% | 0.096% | 0.077% | |
| Short term U_{B3} | 0.008% | 0% | 0% | |
| Long term U_{B4} | 0.064% | 0% | 0% | |
| Temperature U_{B5} | 0.032% | 0% | 0% | |
| Proximity U_{B6} | 0.005% | 0.050% | 0.006% | |
| Total standard uncertainty | 0.24% | 0.45% | 0.45% | 0.05% |
| Expanded uncertainty (k=2) | 0.48% | 0.90% | 0.89% | 0.10% |

Uncertainty budget for standard lightning impulses ($T_1 = 1.56 \mu\text{s}$, $< 500 \text{ kV}$):

| Digitizer | Contributions to standard uncertainty | | | |
|-----------------------------------|---------------------------------------|--------------|--------------|--------------|
| | U_p | T_1 | T_2 | β |
| U_{ref} | 0.080% | 0% | 0% | |
| Linearity U_{B1} | 0.129% | 0.189% | 0.229% | |
| Dynamic U_{B2} | 0.064% | 0.044% | 0.096% | |
| Short term U_{B3} | 0% | 0% | 0% | |
| Long term U_{B4} | 0% | 0% | 0% | |
| Temperature U_{B5} | 0.066% | 0.009% | 0.005% | |
| Proximity U_{B6} | 0% | 0% | 0% | |
| Software U_{B7} | 0.023% | 0.188% | 0.037% | 0.050% |
| Divider SMR | | | | |
| U_{ref} | 0.034% | 0.247% | 0.148% | |
| Linearity U_{B1} | 0.013% | 0% | 0% | |
| Dynamic U_{B2} | 0.057% | 0.096% | 0.077% | |
| Short term U_{B3} | 0.008% | 0% | 0% | |
| Long term U_{B4} | 0.064% | 0% | 0% | |
| Temperature U_{B5} | 0.032% | 0% | 0% | |
| Proximity U_{B6} | 0.005% | 0.050% | 0.006% | |
| Total standard uncertainty | 0.20% | 0.38% | 0.30% | 0.05% |
| Expanded uncertainty (k=2) | 0.41% | 0.76% | 0.60% | 0.10% |

Uncertainty budget for standard lightning impulses ($T_1 = 0.84 \mu\text{s}$, 500 - 750 kV):

| Digitizer | Contributions to standard uncertainty | | | |
|-----------------------------------|---------------------------------------|--------------|--------------|--------------|
| | U_p | T_1 | T_2 | β |
| U_{ref} | 0.080% | 0% | 0% | |
| Linearity U_{B1} | 0.169% | 0.293% | 0.307% | |
| Dynamic U_{B2} | 0.095% | 0.084% | 0.158% | |
| Short term U_{B3} | 0% | 0% | 0% | |
| Long term U_{B4} | 0% | 0% | 0% | |
| Temperature U_{B5} | 0.066% | 0.009% | 0.005% | |
| Proximity U_{B6} | 0% | 0% | 0% | |
| Software U_{B7} | 0.019% | 0.188% | 0.037% | 0.050% |
| Divider Passoni | | | | |
| U_{ref} | 0.034% | 0.313% | 0.253% | |
| Linearity U_{B1} | 0.013% | 0% | 0% | |
| Dynamic U_{B2} | 0.057% | 0.570% | 0.092% | |
| Short term U_{B3} | 0.008% | 0% | 0% | |
| Long term U_{B4} | 0.064% | 0% | 0% | |
| Temperature U_{B5} | 0.032% | 0% | 0% | |
| Proximity U_{B6} | 0.005% | 0.350% | 0.006% | |
| Total standard uncertainty | 0.24% | 0.82% | 0.44% | 0.05% |
| Expanded uncertainty (k=2) | 0.48% | 1.64% | 0.88% | 0.10% |

Uncertainty budget for standard lightning impulses ($T_1 = 1.56 \mu\text{s}$, 500 - 750 kV):

| Digitizer | Contributions to standard uncertainty | | | |
|-----------------------------------|---------------------------------------|--------------|--------------|--------------|
| | U_p | T_1 | T_2 | β |
| U_{ref} | 0.080% | 0% | 0% | |
| Linearity U_{B1} | 0.129% | 0.189% | 0.229% | |
| Dynamic U_{B2} | 0.064% | 0.044% | 0.096% | |
| Short term U_{B3} | 0% | 0% | 0% | |
| Long term U_{B4} | 0% | 0% | 0% | |
| Temperature U_{B5} | 0.066% | 0.009% | 0.005% | |
| Proximity U_{B6} | 0% | 0% | 0% | |
| Software U_{B7} | 0.019% | 0.188% | 0.037% | 0.050% |
| Divider Passoni | | | | |
| U_{ref} | 0.034% | 0.313% | 0.253% | |
| Linearity U_{B1} | 0.013% | 0% | 0% | |
| Dynamic U_{B2} | 0.057% | 0.570% | 0.092% | |
| Short term U_{B3} | 0.008% | 0% | 0% | |
| Long term U_{B4} | 0.064% | 0% | 0% | |
| Temperature U_{B5} | 0.032% | 0% | 0% | |
| Proximity U_{B6} | 0.005% | 0.350% | 0.006% | |
| Total standard uncertainty | 0.20% | 0.79% | 0.37% | 0.05% |
| Expanded uncertainty (k=2) | 0.41% | 1.57% | 0.74% | 0.10% |

Uncertainty budget for front-chopped lightning impulses:

| Digitizer | Contributions to standard uncertainty | |
|-----------------------------------|---------------------------------------|--------------|
| | U_p | T_c |
| u_{ref} | 0.080% | - |
| Linearity u_{B1} | 0.169% | 0.307% |
| Dynamic u_{B2} | 0.095% | 0.158% |
| Short term u_{B3} | 0.000% | - |
| Long term u_{B4} | 0.000% | - |
| Temperature u_{B5} | 0.066% | 0.005% |
| Proximity u_{B6} | 0.000% | - |
| Software u_{B7} | 0.332% | 0.428% |
| Divider SMR | | |
| u_{ref} | 0.002% | 0.504% |
| Linearity u_{B1} | 0.013% | - |
| Dynamic u_{B2} | 0.057% | 0.077% |
| Short term u_{B3} | 0.008% | - |
| Long term u_{B4} | 0.064% | - |
| Temperature u_{B5} | 0.032% | - |
| Proximity u_{B6} | 0.005% | 0.006% |
| Total standard uncertainty | 0.41% | 0.75% |
| Expanded uncertainty (k=2) | 0.82% | 1.50% |

VTT

Uncertainty budget for standard lightning impulses with short front ($T_1 = 0.84 \mu\text{s}$):

| | U_t | T_1 | T_2 | β' |
|--|---------|--------|---------|----------|
| Digitizer | | | | |
| Software uncertainty according to IEC 61083 test data generator | 0.02 % | 0.35 % | 0.05 % | 0.07 % |
| Digitizer calibration with calculable impulse voltage calibrator | 0.05 % | 0.13 % | 0.07 % | - |
| Linearity | 0.03 % | - | - | - |
| Temperature | 0.02 % | - | - | - |
| Calculable impulse voltage calibrator uncertainty | 0.025 % | 0.23 % | 0.145 % | - |
| Divider | | | | |
| Scale factor u_{ref} | 0.01 % | 0.87 % | 0.20 % | 0.10 % |
| Linearity u_{B1} | 0.06 % | - | - | - |
| Dynamic u_{B2} | 0.06 % | 0.21 % | 0.05 % | - |
| Short-term stability u_{B3} | 0.06 % | - | - | - |
| Long-term stability u_{B4} | 0.004 % | - | - | - |
| Temperature u_{B5} | 0.03 % | - | - | - |
| Proximity u_{B6} | - | 0.01 % | 0.02 % | - |
| Total standard uncertainty | 0.13 % | 0.99 % | 0.27 % | 0.12 % |
| Expanded uncertainty ($k = 2$) | 0.25 % | 1.99 % | 0.53 % | 0.25 % |

Uncertainty budget for standard lightning impulses with long front ($T_1 = 1.56 \mu\text{s}$):

| | U_t | T_1 | T_2 | β' |
|--|---------|--------|---------|----------|
| Digitizer | | | | |
| Software uncertainty according to IEC 61083 test data generator | 0.02 % | 0.35 % | 0.05 % | 0.07 % |
| Digitizer calibration with calculable impulse voltage calibrator | 0.05 % | 0.13 % | 0.07 % | - |
| Linearity | 0.03 % | - | - | - |
| Temperature | 0.02 % | - | - | - |
| Calculable impulse voltage calibrator uncertainty | 0.025 % | 0.23 % | 0.145 % | - |
| Divider | | | | |
| Scale factor u_{ref} | 0.01 % | 0.53 % | 0.13 % | 0.10 % |
| Linearity u_{B1} | 0.06 % | - | - | - |
| Dynamic u_{B2} | 0.06 % | 0.21 % | 0.05 % | - |
| Short-term stability u_{B3} | 0.06 % | - | - | - |
| Long-term stability u_{B4} | 0.004 % | - | - | - |
| Temperature u_{B5} | 0.03 % | - | - | - |
| Proximity u_{B6} | - | 0.01 % | 0.02 % | - |
| Total standard uncertainty | 0.13 % | 0.71 % | 0.22 % | 0.12 % |
| Expanded uncertainty ($k = 2$) | 0.25 % | 1.42 % | 0.44 % | 0.25 % |

Uncertainty budget for front-chopped lightning impulses:

| | u | T_c |
|--|---------|--------|
| Digitizer | | |
| Software uncertainty according to IEC 61083 test data generator | 0.38 % | 0.32 % |
| Digitizer calibration with calculable impulse voltage calibrator | 0.05 % | - |
| Linearity | 0.03 % | - |
| Temperature | 0.02 % | - |
| Calculable impulse voltage calibrator uncertainty | 0.025 % | - |
| Sample rate effect | 1.00 % | 1.00 % |
| Divider | | |
| Scale factor u_{ref} | 0.01 % | 0.87 % |
| Linearity u_{B1} | 0.06 % | - |
| Dynamic u_{B2} | 0.06 % | 0.21 % |
| Short-term stability u_{B3} | 0.10 % | - |
| Long-term stability u_{B4} | 0.004 % | - |
| Temperature u_{B5} | 0.03 % | - |
| Proximity u_{B6} | - | - |
| | | |
| | | |
| Total standard uncertainty | 1.08 % | 1.38 % |
| | | |
| Expanded uncertainty ($k = 2$) | 2.16 % | 2.76 % |

For all measurements the effective degrees of freedom $\nu_{\text{eff}} > 100$.

INRIM

Uncertainty budget for full impulses, $100 \text{ kV} \leq U_p \leq 200 \text{ kV}$

| Contribution | Description | U_p | T_1 | T_2 | β |
|----------------------------|------------------------|-------|-------|-------|---------|
| u_{ref} | Reference SF | 0.11% | 0.22% | 0.22% | 0.11% |
| u_A | Linearity | 0.10% | 0.15% | 0.15% | 0.10% |
| μ_{B1} | Dynamic | 0.10% | 1.40% | 1.40% | 0.40% |
| μ_{B2} | Short term stability | 0.10% | 0.10% | 0.10% | 0.10% |
| μ_{B3} | Long term stability | 0.10% | 0.10% | 0.10% | 0.10% |
| μ_{B4} | Temperature (DT 10° C) | 0.08% | 0.16% | 0.16% | 0.08% |
| μ_{B5} | Proximity | 0.00% | 0.00% | 0.00% | 0.00% |
| μ_{B6} | Software | 0.02% | 0.43% | 0.08% | 0.200% |
| Total standard uncertainty | | 0.24% | 1.50% | 1.44% | 0.50% |
| Expanded uncertainty (k=2) | | 0.48% | 3.01% | 2.89% | 1.00% |

Uncertainty budget for full impulses, $200 \text{ kV} < U_p \leq 600 \text{ kV}$

| Contribution | Description | U_p | T_1 | T_2 | β |
|----------------------------|------------------------|-------|-------|-------|---------|
| u_{ref} | Reference SF | 0.22% | 0.44% | 0.44% | 0.11% |
| u_A | Linearity | 0.30% | 0.15% | 0.15% | 0.10% |
| μ_{B1} | Dynamic | 0.20% | 2.40% | 2.40% | 0.40% |
| μ_{B2} | Short term stability | 0.15% | 0.15% | 0.15% | 0.10% |
| μ_{B3} | Long term stability | 0.20% | 0.20% | 0.20% | 0.10% |
| μ_{B4} | Temperature (DT 10° C) | 0.08% | 0.16% | 0.16% | 0.08% |
| μ_{B5} | Proximity | 0.00% | 0.00% | 0.00% | 0.00% |
| μ_{B6} | Software | 0.02% | 0.43% | 0.08% | 0.200% |
| Total standard uncertainty | | 0.50% | 2.50% | 2.46% | 0.50% |
| Expanded uncertainty (k=2) | | 1.00% | 5.00% | 4.93% | 1.00% |

Uncertainty budget for front chopped impulses, $200 \text{ kV} < U_p \leq 600 \text{ kV}$

| Contribution | Description | U_p | T_C |
|----------------------------|------------------------|-------|-------|
| u_{ref} | Reference SF | 0.70% | 0.50% |
| u_A | Linearity | 0.30% | 0.15% |
| μ_{B1} | Dynamic | 0.40% | 2.40% |
| μ_{B2} | Short term stability | 0.10% | 0.10% |
| μ_{B3} | Long term stability | 0.10% | 0.10% |
| μ_{B4} | Temperature (DT 10° C) | 0.08% | 0.16% |
| μ_{B5} | Proximity | 0.00% | 0.00% |
| μ_{B6} | Software | 0.49% | 1.05% |
| Total standard uncertainty | | 1.00% | 2.68% |
| Expanded uncertainty (k=2) | | 2.00% | 5.36% |

For all measurements the effective degrees of freedom $\nu_{eff} > 100$.

LCOE

Uncertainty budget for standard lightning impulses ($T_1 = 0.84 \mu\text{s}$, $U \leq 600 \text{ kV}$)

| LCOE Measuring System up to 600 kV | Contributions to standard uncertainty | | | |
|------------------------------------|---------------------------------------|---------------|---------------|---------------|
| | U_t | T_1 | T_2 | β |
| HV Divider U_{B1} | 0.002 % | 0.600 % | 0.350 % | 0.002 % |
| Scope U_{B2} | 0.030 % | 0.344 % | 0.005 % | 0 % |
| Short term U_{B3} | 0.006 % | 0 % | 0 % | 0 % |
| Dynamic behaviour U_{B4} | 0.202 % | 0 % | 0 % | 0.231 % |
| Non-linearity effect U_{B5} | 0 % | 0 % | 0 % | 0 % |
| Long-term stability U_{B6} | 0.058 % | 0 % | 0 % | 0 % |
| Temperature U_{B7} | 0 % | 0 % | 0 % | 0 % |
| Software effect U_{B8} | 0.008 % | 0.087 % | 0.017 % | 0.029 % |
| Proximity effect U_{B9} | 0 % | 0 % | 0 % | 0 % |
| TRMS resolution U_{B10} | 0.029 % | 0 % | 0 % | 0 % |
| Expanded uncertainty (k=2) | 0.43 % | 1.40 % | 0.71 % | 0.48 % |

Uncertainty budget for standard lightning impulses ($T_1 = 1.56 \mu\text{s}$, $U \leq 600 \text{ kV}$)

| LCOE Measuring System up to 600 kV | Contributions to standard uncertainty | | | |
|------------------------------------|---------------------------------------|---------------|---------------|---------------|
| | U_t | T_1 | T_2 | β |
| HV Divider U_{B1} | 0.002 % | 0.600 % | 0.350 % | 0.002 % |
| Scope U_{B2} | 0.010 % | 0.185 % | 0.005 % | 0 % |
| Short term U_{B3} | 0.006 % | 0 % | 0 % | 0 % |
| Dynamic behaviour U_{B4} | 0.173 % | 0 % | 0 % | 0.231 % |
| Non-linearity effect U_{B5} | 0 % | 0 % | 0 % | 0 % |
| Long-term stability U_{B6} | 0.058 % | 0 % | 0 % | 0 % |
| Temperature U_{B7} | 0 % | 0 % | 0 % | 0 % |
| Software effect U_{B8} | 0.008 % | 0.087 % | 0.017 % | 0.029 % |
| Proximity effect U_{B9} | 0 % | 0 % | 0 % | 0 % |
| TRMS resolution U_{B10} | 0.029 % | 0 % | 0 % | 0 % |
| Expanded uncertainty (k=2) | 0.37 % | 1.30 % | 0.71 % | 0.48 % |

Uncertainty budget for standard lightning impulses ($T_1 = 0.84 \mu\text{s}$, U 600-700 kV)

| LCOE Measuring System from 600 kV to 700 kV | Contributions to standard uncertainty | | | |
|--|---------------------------------------|---------------|---------------|---------------|
| | U_t | T_1 | T_2 | β |
| HV Divider U_{B1} | 0.002 % | 1.250 % | 0.450 % | 0.002 % |
| Scope U_{B2} | 0.030 % | 0.344 % | 0.005 % | 0 % |
| Short term U_{B3} | 0.006 % | 0 % | 0 % | 0 % |
| Dynamic behaviour U_{B4} | 0.202 % | 0 % | 0 % | 0.231 % |
| Non-linearity effect U_{B5} | 0.043 % | 0.664 % | 0.043 % | 0 % |
| Long-term stability U_{B6} | 0.058 % | 0 % | 0 % | 0 % |
| Temperature U_{B7} | 0 % | 0 % | 0 % | 0 % |
| Software effect U_{B8} | 0.008 % | 0.087 % | 0.017 % | 0.029 % |
| Proximity effect U_{B9} | 0 % | 0 % | 0 % | 0 % |
| TRMS resolution U_{B10} | 0.029 % | 0 % | 0 % | 0 % |
| Expanded uncertainty (k=2) | 0.45 % | 2.94 % | 0.91 % | 0.48 % |

Uncertainty budget for standard lightning impulses ($T_1 = 1.56 \mu\text{s}$, U 600-700 kV):

| LCOE Measuring System from 600 kV to 700 kV | Contributions to standard uncertainty | | | |
|--|---------------------------------------|---------------|---------------|---------------|
| | U_t | T_1 | T_2 | β |
| HV Divider U_{B1} | 0.002 % | 1.250 % | 0.450 % | 0.002 % |
| Scope U_{B2} | 0.010 % | 0.185 % | 0.005 % | 0 % |
| Short term U_{B3} | 0.006 % | 0 % | 0 % | 0 % |
| Dynamic behaviour U_{B4} | 0.173 % | 0 % | 0 % | 0.231 % |
| Non-linearity effect U_{B5} | 0.014 % | 0.144 % | 0.029 % | 0 % |
| Long-term stability U_{B6} | 0.058 % | 0 % | 0 % | 0 % |
| Temperature U_{B7} | 0 % | 0 % | 0 % | 0 % |
| Software effect U_{B8} | 0.008 % | 0.087 % | 0.017 % | 0.029 % |
| Proximity effect U_{B9} | 0 % | 0 % | 0 % | 0 % |
| TRMS resolution U_{B10} | 0.029 % | 0 % | 0 % | 0 % |
| Expanded uncertainty (k=2) | 0.38 % | 2.56 % | 0.91 % | 0.48 % |

Uncertainty budget for front-chopped lightning impulses ($T_c = 0.50 \mu\text{s}$, U 150 kV)

| LCOE Measuring System Front-chopped | Contributions to standard uncertainty | | | |
|--|---------------------------------------|---------------|-------|---------|
| | U_t | T_c | T_2 | β |
| HV Divider U_{B1} | 0.002 % | 0.600 % | - | - |
| Scope U_{B2} | 0.015 % | 0.577 % | - | - |
| Short term U_{B3} | 0.006 % | 0 % | - | - |
| Dynamic behaviour U_{B4} | 0.433 % | 1.155 % | - | - |
| Non-linearity effect U_{B5} | 0 % | 0 % | - | - |
| Long-term stability U_{B6} | 0.058 % | 0 % | - | - |
| Temperature U_{B7} | 0 % | 0 % | - | - |
| Software effect U_{B8} | 0.329 % | 0.144 % | - | - |
| Proximity effect U_{B9} | 0 % | 0 % | - | - |
| TRMS resolution U_{B10} | 0.029 % | 0 % | - | - |
| Expanded uncertainty (k=2) | 1.15 % | 2.99 % | - | - |

LNE

8.1. UNCERTAINTY COMPONENTS FOR THE PEAK VALUE

8.1.1. Calibration of the reference divider (GARY1) at low voltage

The scale factor S of the reference divider has been determined according to LNE procedure at 200 V for the frequencies of 60 Hz, 1 kHz and 10 kHz. The scale factor is the ratio between the input voltage V_e and the output voltage V_s .

The uncertainty is calculated as follow:

$$u^2(S) = u^2(V_e) + u^2(V_s)$$

Uncertainty of calibration of the voltmeters:

$$U1 = 1.10^{-4} \cdot U \quad (k = 2)$$

$$U2 = 1.10^{-4} \cdot U \quad (k = 2)$$

Drift between two calibrations (< 50 $\mu\text{V}/\text{V}$ per year):

$$U3 = 5.10^{-5} \cdot U \quad (k = 2\sqrt{3})$$

$$U4 = 5.10^{-5} \cdot U \quad (k = 2\sqrt{3})$$

Influence of temperature on voltmeters (< $1.10^{-5}/\text{C}^\circ$) with 2 $^\circ\text{C}$ maximum deviation:

$$U5 = 2.10^{-5} \cdot U \quad (k = 2\sqrt{3})$$

$$U6 = 2.10^{-5} \cdot U \quad (k = 2\sqrt{3})$$

Resolution of the voltmeters:

$$U7 = 1.10^{-5} \cdot U \quad (k = 2\sqrt{3})$$

$$U8 = 1.10^{-5} \cdot U \quad (k = 2\sqrt{3})$$

Reading instabilities and generator instabilities:

$$U9 = 1.10^{-5} \cdot U \quad (k = 2\sqrt{3})$$

$$U10 = 1.10^{-5} \cdot U \quad (k = 2\sqrt{3})$$

8.1.2. Extrapolation of the scale factor at high voltage

Self-heating of the reference divider:

The temperature coefficient of the scale factor of the divider is less than 10 ppm/ $^\circ\text{C}$. We have estimated that the temperature change of the resistive wire is equal at maximum to 100 $^\circ\text{C}$ when a lightning impulse of 400 kV is applied. The self heating of the divider is then less than $(100 \text{ }^\circ\text{C} - 23 \text{ }^\circ\text{C}) \cdot 100 \text{ ppm}$.

$$U11 = 7,7.10^{-4} \cdot S \quad (k = 2\sqrt{3})$$

Influence of frequency (less than $1.10^{-4} \cdot S$):

$$U12 = 1.10^{-4} \cdot S \quad (k = 2\sqrt{3})$$

Drift of the scale factor before and after the H.V measurements (less than $1.10^{-4}.S$):

$$U13 = 1.10^{-4}.S \quad (k = 2\sqrt{3})$$

Error of the divider:

The convolution technique has been used to determine the reference divider's errors
These errors are less than 0,15 %.

$$U14 = 1,5.10^{-3}.S \quad (k = 2\sqrt{3})$$

For a chopped LI at 0,5 μ s, these errors is less than 1,5 %.

$$U14 = 15.10^{-3}.U \quad (k = 2\sqrt{3})$$

Linearity of the reference divider:

The HV linearity has been estimated less than 0,5 % up to 400 kV.

$$U15 = 5.10^{-3}.U \quad (k = 2\sqrt{3})$$

Reproducibility of the H.V set up:

It has a null effect because all the measurements have been performed with the same set up configuration (Earth connexion, Coaxial cable configuration, same distances, same HV connexions...etc).

Proximity effect:

Neglected because the scale factor has been measured at the same configuration of the main calibration. The divider is completely shielded and that reduce at zero the proximity effect.

Influence of a paralleled divider:

Neglected because the divider is composed with a low HV impedance (24 k Ω).

Temperature effect:

Correlated with the drift of the scale factor before and after H.V measurements and with the self-heating of the divider. This effect is neglected.

Disturbance effect:

The disturbances has been measured for both dividers and they are less than 0,4 % for each one.

$$U16 = 4.10^{-3}.U \quad (k = 2\sqrt{3})$$

8.1.3. Components due to the digitizer**Calibration of the calibrator KAL1000:**

$$U17 = 1.10^{-3}.U \quad (k = 2)$$

Temperature effect of the KAL1000:

The calibration of the KAL1000 is performed at $(23 \pm 1)^\circ\text{C}$. The relative variation for this range of temperature is less than 0,1 %.

$$U_{18} = 1 \cdot 10^{-3} \cdot U \quad (k = 2 \cdot \sqrt{2})$$

Drift of the KAL 1000:

The drift between two calibrations is less than 0,2 %

$$U_{19} = 2 \cdot 10^{-3} \cdot U \quad (k = 2\sqrt{3})$$

Errors of the digitizer:

The calibration of the digitizer before the main calibration has been performed. The errors include offset effect, temperature effect, the drift, the bandwidth effect, non linearity of ADC, frequency sampling effect, the time base effect and the internal noise effect. The maximum error is less than 0,1 % up to 400 V.

$$U_{20} = 1 \cdot 10^{-3} \cdot U \quad (k = 2\sqrt{3})$$

For chopped LI at $0,5 \mu\text{s}$, the error determined by a step response from $0,25 \mu\text{s}$ to $5 \mu\text{s}$ is less than 1 %.

$$U_{20} = 1 \cdot 10^{-2} \cdot U \quad (k = 2\sqrt{3})$$

Uncertainty of the software:

The software has been validated according to IEC61083-2, the uncertainty of the software is

$$U_{21} = 8 \cdot 10^{-4} \cdot U \quad (k = 2)$$

For chopped LI :

$$U_{21} = 8 \cdot 10^{-3} \cdot U \quad (k = 2)$$

8.2. UNCERTAINTY COMPONENTS FOR THE FRONT TIME (T1)

Time base of the digitizer:

This uncertainty is neglected because the error is less than 15 μ s/s.

Measurement of particular points (30 % et 90 %):

The error of measurement of the time between 30 % and 90 % of peak value is less than 5 ns. For a front time of 0.84 μ s the uncertainty is :

$$U1 = 6,2 \text{ ms/s} \quad (k = 2\sqrt{3})$$

For a front time of 1,56 μ s the uncertainty is :

$$U1 = 4,0 \text{ ms/s} \quad (k = 2\sqrt{3})$$

For a chopped LI at 0,5 μ s the uncertainty is :

$$U1 = 10,4 \text{ ms/s} \quad (k = 2)$$

Influence of the peak value :

The uncertainty of the peak value influences the uncertainty of front time by a factor "f" equal to 4,1 for full LI and equal to 1,8 for chopped LI at 0,5 μ s (factors determined with mathematic formulas). The uncertainty of the peak value has to be multiplied by this factor. The obtained uncertainty includes offset effect, temperature effect, the drift, the bandwidth effect, non linearity of ADC, frequency sampling effect, the time base effect and the internal noise effect.

$$U2 = f \times U_{\text{Peak}} \quad (k = 2)$$

Error of the divider:

The convolution technique has been used to determine the reference divider's errors. These errors are less than 1,5 %.

$$U3 = 15 \text{ ms/s} \quad (k = 2\sqrt{3})$$

Error of the digitizer:

The convolution technique has been used to determine the digitizer's errors. These errors are less than 0,2 %.

$$U4 = 2 \text{ ms/s} \quad (k = 2\sqrt{3})$$

Uncertainty of the software:

The software has been validated according to IEC61083-2, the uncertainty of the software is

$$U5 = 12,6 \text{ ms/s} \quad (k = 2)$$

8.3. UNCERTAINTY COMPONENT FOR THE TIME TO CHOPPING (TC)

Time base of the digitizer:

This uncertainty is neglected because the error is less than 15 $\mu\text{s/s}$.

Measurement from the origin to time to chopping:

The error of measurement of the time between the origin to time to chopping is less than 5 ns. For a time to chopping of 0.5 μs the uncertainty is :

$$U1 = 10 \text{ ms/s} \quad (k = 2\sqrt{3})$$

Influence of the peak value:

The uncertainty of the peak value influences the uncertainty of front time by a factor "f" equal to 0,31 for time to chopping at 0,5 μs (factor determined with mathematic formulas). The uncertainty of the peak value has to be multiplied by this factor. The obtained uncertainty includes offset effect, temperature effect, the drift, the bandwidth effect, non linearity of ADC, frequency sampling effect, the time base effect and the internal noise effect.

$$U2 = f \times U_{\text{Peak}} \quad (k=2)$$

Error of the divider:

The convolution technique has been used to determine the reference divider's errors. These errors are less than 2 %.

$$U3 = 20 \text{ ms/s} \quad (k = 2\sqrt{3})$$

Error of the digitizer:

The convolution technique has been used to determine the digitizer's errors. These errors are less than 0,2 %.

$$U4 = 2 \text{ ms/s} \quad (k = 2\sqrt{3})$$

Uncertainty of the software:

The software has been validated according to IEC61083-2, the uncertainty of the software is

$$U5 = 8,8 \text{ ms/s} \quad (k = 2)$$

8.4. UNCERTAINTY COMPONENT FOR THE TIME TO HALF VALUE (T2)

Time base of the digitizer:

This uncertainty is neglected because the error is less than 15 μ s/s.

Measurement of particular point (zero to 50 %):

The error of measurement of the time between zero and 50 % of peak value is less than 5 ns. For a time to half value of 50 μ s the uncertainty is :

$$U1 = 0,01 \text{ ms/s} \quad (k = 2\sqrt{3})$$

Influence of the peak value:

The uncertainty of the peak value influences the uncertainty of front time by a factor "f" of 1,4 for time to chopping at 0,5 μ s (factor determined with mathematic formulas). The uncertainty of the peak value has to be multiplied by this factor. The obtained uncertainty includes offset effect, temperature effect, the drift, the bandwidth effect, non linearity of ADC, frequency sampling effect, the time base effect and the internal noise effect.

$$U2 = f \times U_{\text{Peak}} \quad (k=2)$$

Error of the divider:

The convolution technique has been used to determine the reference divider's errors. These errors are less than 0,1 %.

$$U3 = 1 \text{ ms/s} \quad (k = 2\sqrt{3})$$

Error of the digitizer:

The convolution technique has been used to determine the digitizer's errors. These errors are less than 0,5 %.

$$U4 = 5 \text{ ms/s} \quad (k = 2\sqrt{3})$$

Uncertainty of the software:

The software has been validated according to IEC61083-2, the uncertainty of the software is

$$U5 = 4,0 \text{ ms/s} \quad (k = 2)$$

9. UNCERTAINTY OF MEASUREMENTS

| Wave shape | Uncertainty of measurement in % (k=2) | | | |
|------------------------|--|------------------|---------------------------|-------------------------------|
| | Peak Value Vc | Front time T1 | Time to chopping Tc | Time to Half Value (T2) |
| 0,84/50 μ s | 0,5 | 2,5 | - | 0,8 |
| 1,56/50 μ s | 0,5 | 2,5 | - | 0,8 |
| Chopped at 0,5 μ s | 1,5 | 3,0 | 1,5 | - |

PTB

List of the uncertainty contributions for the scale factor:

| Größe | Beschreibung |
|---------------------|--|
| F_N | Scale factor of the entire impulse measuring system |
| F_T | Scale factor of the divider |
| F_{DR} | Scale factor of the transient recorder |
| F_{DRS} | Scale factor of the transient recorder with attenuator |
| F_{TAC} | Scale factor of the divider at 500 V / 1 kHz |
| δF_I | Mean deviation of F_{TAC} to F_T |
| δF_F | Influence of the length of the front time |
| δF_{EMV} | Influence of interferences |
| δF_{SW} | Influence of the Software |
| δF_{Temp} | Influence of the Temperature |
| δF_D | Drift |
| δF_{DRNL} | Non-linearity of the transient recorder |
| δF_{rausch} | Noise of the transient recorder |
| δF_{quant} | Quantization error of the transient recorder |
| δF_{DRS} | Deviation of the attenuators |

Uncertainty Budgets:

F_N : Teilungsverhältnis der gesamten Stoßspannungsmesseinrichtung

| Quantity | Value | Standard Uncertainty | Distribution | Sensitivity Coefficient | Uncertainty Contribution | Index |
|---------------------|--------------|--------------------------|--------------|-------------------------|--------------------------|--------|
| F_T | 3616.00 V/V | 5.44 V/V | | | | |
| F_{DR} | 1.00000 V/V | $1.26 \cdot 10^{-3}$ V/V | | | | |
| F_{TAC} | 3616.00 V/V | 3.10 V/V | normal | 1.0 | 3.1 V/V | 19.1 % |
| ΔF_I | 0.0 V/V | 3.46 V/V | rectangular | 1.0 | 3.5 V/V | 23.8 % |
| δF_F | 0.0 | 0.808 | rectangular | 1.0 | 0.81 V/V | 1.3 % |
| δF_{EMV} | 0.0 V/V | 2.42 V/V | rectangular | 1.0 | 2.4 V/V | 11.7 % |
| δF_{SW} | 0.0 V/V | 0.808 V/V | rectangular | 1.0 | 0.81 V/V | 1.3 % |
| δF_{Temp} | 0.0 V/V | 0.912 V/V | rectangular | 1.0 | 0.91 V/V | 1.7 % |
| δF_D | 0.0 V/V | | | | | |
| F_{DRS} | 1.000000 V/V | $500 \cdot 10^{-6}$ V/V | normal | 3600 | 1.8 V/V | 6.5 % |
| δF_{DRS} | 0.0 V/V | $577 \cdot 10^{-6}$ V/V | rectangular | 3600 | 2.1 V/V | 8.7 % |
| δF_{DRNL} | 0.0 V/V | $577 \cdot 10^{-6}$ V/V | rectangular | 3600 | 2.1 V/V | 8.7 % |
| δF_{rausch} | 0.0 V/V | $577 \cdot 10^{-6}$ V/V | rectangular | 3600 | 2.1 V/V | 8.7 % |
| δF_{quant} | 0.0 V/V | $577 \cdot 10^{-6}$ V/V | rectangular | 3600 | 2.1 V/V | 8.7 % |
| F_N | 3616.00 V/V | 7.09 V/V | | | | |

Results:

| Quantity | Value | Expanded Uncertainty | Coverage factor | Coverage |
|----------|----------|----------------------|-----------------|--------------|
| F_N | 3616 V/V | 0.39 % (relative) | 2.00 | 95% (normal) |

List of the uncertainty contributions for the front time

| Größe | Beschreibung |
|--------------------------|---|
| T_1 | Front time |
| T_{1A} | Mean value from 10 measurements |
| δT_{30} | Time at 30 % of the peak value |
| δT_{90} | Time at 90 % of the peak value |
| $\delta T_{1\text{sin}}$ | Traceability with equivalent sinusoidal voltage (equivalent front time) |
| $\delta T_{1\text{NL}}$ | Influence of the non-linearity |
| $\delta T_{1\text{dyn}}$ | Influence of the dynamic behaviour of the measurement system |
| $\delta T_{1\text{EMV}}$ | Influence of interferences on the front time |

Uncertainty Budgets:

T_1 : Stirnzeit

| Quantity | Value | Standard Uncertainty | Distribution | Sensitivity Coefficient | Uncertainty Contribution | Index |
|--------------------------|-----------------------|----------------------------------|--------------|-------------------------|---------------------------------|--------|
| T_{1A} | 1.20000 μs | $2.21 \cdot 10^{-3} \mu\text{s}$ | normal | 1.0 | $2.2 \cdot 10^{-3} \mu\text{s}$ | 3.5 % |
| δT_{30} | 0.0 μs | $3.46 \cdot 10^{-3} \mu\text{s}$ | rectangular | 1.0 | $3.5 \cdot 10^{-3} \mu\text{s}$ | 8.7 % |
| δT_{90} | 0.0 μs | $3.46 \cdot 10^{-3} \mu\text{s}$ | rectangular | 1.0 | $3.5 \cdot 10^{-3} \mu\text{s}$ | 8.7 % |
| $\delta T_{1\text{sin}}$ | 0.0 μs | $1.15 \cdot 10^{-3} \mu\text{s}$ | rectangular | 1.0 | $1.2 \cdot 10^{-3} \mu\text{s}$ | 1.0 % |
| $\delta T_{1\text{NL}}$ | 0.0 μs | $577 \cdot 10^{-6} \mu\text{s}$ | rectangular | 1.0 | $580 \cdot 10^{-6} \mu\text{s}$ | 0.2 % |
| $\delta T_{1\text{dyn}}$ | 0.0 μs | $231 \cdot 10^{-6} \mu\text{s}$ | rectangular | 1.0 | $230 \cdot 10^{-6} \mu\text{s}$ | 0.0 % |
| $\delta T_{1\text{EMV}}$ | 0.0 μs | 0.0104 μs | rectangular | 1.0 | 0.010 μs | 77.9 % |
| T_1 | 1.2000 μs | 0.0118 μs | | | | |

Results:

| Quantity | Value | Expanded Uncertainty | Coverage factor | Coverage |
|----------|---------------------|----------------------|-----------------|--------------|
| T_1 | 1.200 μs | 2.0 % (relative) | 2.00 | 95% (normal) |

List of the uncertainty contributions for the time to half value:

| Größe | Beschreibung |
|--------------------------|---|
| T_2 | Time to half value |
| T_{2A} | Mean value of ten measurements |
| δT_{30} | Time at 30 % of the peak value |
| δT_{90} | Time at 90 % of the peak value |
| δT_{50} | Time at 50 % of the peak value |
| $\delta T_{2\text{sin}}$ | Traceability with equivalent sinusoidal voltage (equivalent time to half value) |
| $\delta T_{2\text{NL}}$ | Influence of the non-linearity |
| $\delta T_{2\text{dyn}}$ | Influence of the dynamic behaviour of the measurement system |
| $\delta T_{2\text{EMV}}$ | Influence of the interferences on the time to half value |

Uncertainty Budgets: T_2 : Rückenhalbwertszeit

| Quantity | Value | Standard Uncertainty | Distribution | Sensitivity Coefficient | Uncertainty Contribution | Index |
|--------------------------|-----------------------|------------------------------------|--------------|-------------------------|-----------------------------------|--------|
| T_{2A} | 50.0000 μs | 0.0632 μs | normal | 1.0 | 0.063 μs | 2.1 % |
| δT_{30} | 0.0 μs | $3.46 \cdot 10^{-3}$ μs | rectangular | 1.0 | $3.5 \cdot 10^{-3}$ μs | 0.0 % |
| δT_{90} | 0.0 μs | $3.46 \cdot 10^{-3}$ μs | rectangular | 1.0 | $3.5 \cdot 10^{-3}$ μs | 0.0 % |
| δT_{50} | 0.0 μs | 0.115 μs | rectangular | 1.0 | 0.12 μs | 6.8 % |
| $\delta T_{2\text{sin}}$ | 0.0 μs | 0.133 μs | rectangular | 1.0 | 0.13 μs | 9.1 % |
| $\delta T_{2\text{NL}}$ | 0.0 μs | 0.133 μs | rectangular | 1.0 | 0.13 μs | 9.1 % |
| $\delta T_{2\text{dyn}}$ | 0.0 μs | 0.289 μs | rectangular | 1.0 | 0.29 μs | 42.8 % |
| $\delta T_{2\text{EMV}}$ | 0.0 μs | 0.242 μs | rectangular | 1.0 | 0.24 μs | 30.2 % |
| T_2 | 50.000 μs | 0.441 μs | | | | |

Results:

| Quantity | Value | Expanded Uncertainty | Coverage factor | Coverage |
|----------|---------------------|----------------------|-----------------|--------------|
| T_2 | 50.00 μs | 1.8 % (relative) | 2.00 | 95% (normal) |

List of the uncertainty contributions for the time to chopping

| Größe | Beschreibung |
|-------------------|---|
| T_C | Time to chopping |
| T_{CA} | Mean value from ten measurements |
| δT_{30} | Time at 30 % of the peak value |
| δT_{90} | Time at 90 % of the peak value |
| δT_{10} | Time at 10 % of the peak value |
| δT_{70} | Time at 70 % of the peak value |
| δT_{Csin} | Traceability with equivalent sinusoidal voltage (equivalent time to chopping) |
| δT_{CNL} | Influence of the non-linearity |
| δT_{Cdyn} | Influence of the dynamic behaviour of the measurement system |
| δT_{CEMV} | Influence of the interferences on the time to chopping |

Uncertainty Budgets:

T_C : Time to chopping

| Quantity | Value | Standard Uncertainty | Distribution | Sensitivity Coefficient | Uncertainty Contribution | Index |
|-------------------|-----------------------|----------------------------------|--------------|-------------------------|---------------------------------|--------|
| T_{CA} | 0.50000 μs | $1.58 \cdot 10^{-3} \mu\text{s}$ | normal | 1.0 | $1.6 \cdot 10^{-3} \mu\text{s}$ | 4.8 % |
| δT_{30} | 0.0 μs | $3.46 \cdot 10^{-3} \mu\text{s}$ | rectangular | 1.0 | $3.5 \cdot 10^{-3} \mu\text{s}$ | 22.9 % |
| δT_{90} | 0.0 μs | $3.46 \cdot 10^{-3} \mu\text{s}$ | rectangular | 1.0 | $3.5 \cdot 10^{-3} \mu\text{s}$ | 22.9 % |
| δT_{10} | 0.0 μs | $4.62 \cdot 10^{-3} \mu\text{s}$ | rectangular | 1.0 | $4.6 \cdot 10^{-3} \mu\text{s}$ | 40.8 % |
| δT_{70} | 0.0 μs | $1.15 \cdot 10^{-3} \mu\text{s}$ | rectangular | 1.0 | $1.2 \cdot 10^{-3} \mu\text{s}$ | 2.5 % |
| δT_{Csin} | 0.0 μs | $577 \cdot 10^{-6} \mu\text{s}$ | rectangular | 1.0 | $580 \cdot 10^{-6} \mu\text{s}$ | 0.6 % |
| δT_{CNL} | 0.0 μs | $866 \cdot 10^{-6} \mu\text{s}$ | rectangular | 1.0 | $870 \cdot 10^{-6} \mu\text{s}$ | 1.4 % |
| δT_{Cdyn} | 0.0 μs | $866 \cdot 10^{-6} \mu\text{s}$ | rectangular | 1.0 | $870 \cdot 10^{-6} \mu\text{s}$ | 1.4 % |
| δT_{CEMV} | 0.0 μs | $1.15 \cdot 10^{-3} \mu\text{s}$ | rectangular | 1.0 | $1.2 \cdot 10^{-3} \mu\text{s}$ | 2.5 % |
| T_C | 0.50000 μs | $7.23 \cdot 10^{-3} \mu\text{s}$ | | | | |

Results:

| Quantity | Value | Expanded Uncertainty | Coverage factor | Coverage |
|----------|---------------------|----------------------|-----------------|--------------|
| T_C | 0.500 μs | 2.9 % (relative) | 2.00 | 95% (normal) |

Overview of the results of the uncertainty analysis

| | value | Expanded measurement uncertainty |
|--------------------|-------------------|----------------------------------|
| Scale factor | 3616 V/V | 0,4 % |
| Front time | 1,2 μs | 2 % |
| Time to half value | 50 μs | 2 % |
| Time to chopping | 0,5 μs | 3 % |

TUBITAK

Uncertainty budget for long and short LI wave shape, (1 kV < U < 200 kV):

| Digitizer Dr.Strauss | Contribution to Standard Uncertainty | | |
|---|---|------------------------------|------------------------------|
| | U_p (%) | T₁ (%) | T₂ (%) |
| <i>U_{ref1}</i> | 0.04 | 0.4 | 0.25 |
| Linearity <i>U_{ref1-B1}</i> | 0.11 | 1.1 | 0.5 |
| Dynamic <i>U_{ref1-B2}</i> | 0.1 | 0.1 | 0.14 |
| Short term <i>U_{ref1-B3}</i> | 0.02 | 0 | 0.16 |
| Long term <i>U_{ref1-B4}</i> | 0.02 | 0 | 0 |
| Temperature <i>U_{ref1-B5}</i> | 0.025 | 0.01 | 0.01 |
| Software <i>U_{ref1-B6}</i> | 0.02 | 0.2 | 0.02 |
| Divider SMR10/700 | | | |
| <i>U_{ref2}</i> | 0.36 | 0.3 | 0.2 |
| Linearity <i>U_{ref2-B1}</i> | 0.23 | 0 | 0 |
| Dynamic <i>U_{ref2-B2}</i> | 0.1 | 0.1 | 0.07 |
| Short term <i>U_{ref2-B3}</i> | 0.008 | 0 | 0 |
| Long term <i>U_{ref2-B4}</i> | 0.05 | 0 | 0 |
| Temperature <i>U_{ref2-B5}</i> | 0.03 | 0 | 0 |
| Proximity <i>U_{ref2-B6}</i> | 0.007 | 0.1 | 0.01 |
| Correction Error <i>U_{ref2-B7}</i> | 0.4 | 0 | 0 |
| Total standard uncertainty | 0.34 | 0.70 | 0.35 |
| Expanded uncertainty (k=2) | 0.68 | 1.40 | 0.70 |

Uncertainty budget for long and short LI wave shape, (200 kV < U < 700 kV):

| Digitizer Dr.Strauss | Contribution to Standard Uncertainty | | |
|---|---|------------------------------|------------------------------|
| | U_p (%) | T₁ (%) | T₂ (%) |
| <i>U_{ref1}</i> | 0.04 | 0.6 | 0.3 |
| Linearity <i>U_{ref1-B1}</i> | 0.11 | 1.35 | 0.65 |
| Dynamic <i>U_{ref1-B2}</i> | 0.1 | 0.2 | 0.14 |
| Short term <i>U_{ref1-B3}</i> | 0.02 | 0 | 0.16 |
| Long term <i>U_{ref1-B4}</i> | 0.02 | 0 | 0 |
| Temperature <i>U_{ref1-B5}</i> | 0.025 | 0.01 | 0.01 |
| Software <i>U_{ref1-B6}</i> | 0.02 | 0.2 | 0.02 |
| Divider SMR10/700 | | | |
| <i>U_{ref2}</i> | 0.36 | 0.5 | 0.3 |
| Linearity <i>U_{ref2-B1}</i> | 0.23 | 0 | 0 |
| Dynamic <i>U_{ref2-B2}</i> | 0.1 | 0.1 | 0.07 |
| Short term <i>U_{ref2-B3}</i> | 0.008 | 0 | 0 |
| Long term <i>U_{ref2-B4}</i> | 0.05 | 0 | 0 |
| Temperature <i>U_{ref2-B5}</i> | 0.03 | 0 | 0 |
| Proximity <i>U_{ref2-B6}</i> | 0.007 | 0.2 | 0.01 |
| Correction Error <i>U_{ref2-B7}</i> | 0.4 | 0 | 0 |
| Total standard uncertainty | 0.34 | 0.90 | 0.45 |
| Expanded uncertainty (k=2) | 0.68 | 1.80 | 0.90 |

Uncertainty budget for Chopped LI wave shape, (1 kV < U < 200 kV):

| Digitizer Dr.Strauss | Contribution to Standard Uncertainty | | |
|---|---|------------------------------|------------------------------|
| | U_p (%) | T₁ (%) | T₂ (%) |
| <i>U_{ref1}</i> | 0.14 | 1.7 | 1.7 |
| Linearity <i>U_{ref1-B1}</i> | 0.25 | 1.8 | 1.8 |
| Dynamic <i>U_{ref1-B2}</i> | 0.1 | 0.1 | 0.1 |
| Short term <i>U_{ref1-B3}</i> | 0.08 | 0 | 0 |
| Long term <i>U_{ref1-B4}</i> | 0.07 | 0 | 0 |
| Temperature <i>U_{ref1-B5}</i> | 0.025 | 0.1 | 0.1 |
| Software <i>U_{ref1-B6}</i> | 0.02 | 0.2 | 0.2 |
| Divider SMR10/700 | | | |
| <i>U_{ref2}</i> | 0.5 | 1.1 | 1.1 |
| Linearity <i>U_{ref2-B1}</i> | 0.34 | 0 | 0 |
| Dynamic <i>U_{ref2-B2}</i> | 0.1 | 0.1 | 0.1 |
| Short term <i>U_{ref2-B3}</i> | 0.01 | 0 | 0 |
| Long term <i>U_{ref2-B4}</i> | 0.09 | 0 | 0 |
| Temperature <i>U_{ref2-B5}</i> | 0.03 | 0 | 0 |
| Proximity <i>U_{ref2-B6}</i> | 0.07 | 0.5 | 0.5 |
| Correction Error <i>U_{ref2-B7}</i> | 0.4 | 0 | 0 |
| Total standard uncertainty | 0.44 | 1.49 | 1.49 |
| Expanded uncertainty (k=2) | 0.89 | 3.00 | 3.00 |

IATTE

Nominal value of the divider Scale Factor: in order to compensate the possible deviation of the voltmeters, the Nominal Scale Factor is calculated as the mean value from the mean values obtained from four measurements on two different voltages and exchanging the two voltmeters:

| Contribution uncertainty Type A | | | | |
|---------------------------------|-----------------|--------------------|-------------------------------|--------------------------------|
| Series | SF _i | Standard deviation | | |
| 1 | 1199.187 | 0.005 | | |
| 2 | 1199.204 | 0.004 | | |
| 3 (voltmeters changed) | 1199.560 | 0.004 | | |
| 4 (voltmeters changed) | 1199.559 | 0.006 | | |
| | Mean value | Std. Dev. | Uncertainty Type A u [abs] | Uncertainty Type A u [p.u.] |
| Nominal value of SF | 1199.38 | 0.01 | 0.003 | 2.6 E-6 |

The voltage measurements were made at 29 °C. The nominal accuracy of the voltmeters is given at 23 °C ± 5 °C: (0.0045 % read. +0.0010 % range) for 1000 V and (0.004 % read. +0.0007 % range) for 1 V.

Outside of this temperature range the temperature coefficient correction should be given by:
(0.0005 % read.+0.0001 % range).

| Uncertainty budget – Combined uncertainty uc and Expanded uncertainty U | | | | | |
|---|----------|----------------------|-----------------------|-------------------------|--|
| Magnitude | Value | Standard uncertainty | Degree of freedom | Sensitivity coefficient | Contribution to the combined uncertainty |
| U _{hv} /U _{lv} (Type A) | 1199.378 | 0.003 | 9 | 1 | 0.003 |
| V1/V2 (Voltmeters) | 0 | 0.084 | 50 | 1 | 0.084 |
| V1/V2 (Thermometer) | 0 | 2.9 E-06 | ∞ | 1 | 0.0000029 |
| F _x | 1199.378 | - | 180 | - | -- |
| Expanded uncertainty U (95% confidence) | | | k=2 | | |
| | | | 1199.38 ± 0.17 | | |

Nominal Scale Factor of the divider (k=2): 1199.38 ± 0.17

Uncertainties of the digitizer provided by the manufacturer (Calibration certificate #307-DKD-K11701/03-09):

For full wave lightning impulse LI the uncertainties [pu] are:

$$U_p = 0,005 \quad T_1 = 0,017 \quad T_2 = 0,017$$

For chopped lightning impulse LIC the uncertainties [pu] are:

$$U_p = 0,007 \quad T_1 = 0,017 \quad T_2 = 0,017$$

System Uncertainty (k=2) for Full wave

| U_p | T_1 | T_2 |
|--------------|-------------|-----------|
| 0.64% | 2.5% | 2% |

System Uncertainty (k=2) for Chopped wave.

| U_p | T_c |
|-------------|-------------|
| 0.7% | 2.5% |

NMIA

Test voltage for full lightning impulse

| <i>N</i> | Uncertainty Components | Distribution | Type | Semi-Range, <i>a</i> (%) | Divisor, <i>d</i> | Deg. of Freedom, <i>n</i> | Std. Uncertainty, <i>u_i</i> | Sensitivity Factor, <i>c_i</i> | <i>c_iu_i</i> | <i>(c_iu_i)²</i> | <i>(c_iu_i)/n_i</i> |
|----------|--|--------------|------|--------------------------|-------------------|---------------------------|--|--|-----------------------------------|---|---|
| 1 | Reference digitiser dynamic scale factor | normal | B | 0.17 | 2.00 | 60.5 | 0.08500 | 1.0 | 8.50E-02 | 7.23E-03 | 8.63E-07 |
| 2 | Reference digitiser voltage non-linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 3 | Reference digitiser drift since last calibration | rectangular | B | 0.1 | 1.73 | 5.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 2.22E-06 |
| 4 | Reference divider ratio uncertainty | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 5 | Reference divider voltage linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 6 | Step response of HV reference divider | rectangular | B | 0.15 | 1.73 | 10.0 | 0.08660 | 1.0 | 8.66E-02 | 7.50E-03 | 5.63E-06 |
| 7 | Reference attenuator ratio | rectangular | B | 0.05 | 1.73 | 10.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 6.94E-08 |
| 8 | Test digitiser/attenuator ratio short term stability | rectangular | B | 0.05 | 1.73 | 5.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 1.39E-07 |
| 9 | Reference attenuator voltage linearity | rectangular | B | 0.05 | 1.73 | 10.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 6.94E-08 |
| 10 | Reference digitiser effective vertical resolution | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 11 | Proximity effect on the reference divider | rectangular | B | 0.1 | 1.73 | 5.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 2.22E-06 |
| 12 | HV interference in LV circuit | rectangular | B | 0.05 | 1.73 | 5.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 1.39E-07 |
| 13 | Software for reference system | rectangular | B | 0.1 | 1.73 | 9.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.23E-06 |
| 14 | Standard uncertainty of the set of impulses | normal | A | 0.02 | 1.00 | 9.0 | 0.01532 | 1.0 | 1.53E-02 | 2.35E-04 | 6.11E-09 |
| 15 | Rounding of reported results | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| 16 | Rounding of uncertainty | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| | | | | | | | | Sums | 7.64E-01 | 4.33E-02 | 1.70E-05 |
| | | | | | | | | Combined standard uncertainty (<i>u_c</i>) | | 2.08E-01 | |
| | | | | | | | | Effective degrees of freedom (<i>v_{eff}</i>) | | 110.03 | |
| | | | | | | | | Coverage factor (<i>k</i>) | | 2.0 | |
| | | | | | | | | Expanded uncertainty (<i>U</i>) (%) | | 0.5 | |

Front time for full lightning impulse

| N° | Uncertainty Components | Distribution | Type | Semi-Range, a (%) | Divisor, d | Deg. of Freedom, n | Std. Uncertainty, u_i | Sensitivity Factor, c_i | $c_i u_i$ | $(c_i u_i)^2$ | $(c_i u_i)^2/n_i$ |
|----|---|--------------|------|---------------------|--------------|----------------------|-------------------------|--|-----------|---------------|-------------------|
| 1 | Reference digitiser voltage non-linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05780 | 2.8 | 1.62E-01 | 2.62E-02 | 6.86E-05 |
| 2 | Reference divider voltage linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 2.8 | 1.62E-01 | 2.61E-02 | 6.83E-05 |
| 3 | Step response of HV reference divider | rectangular | B | 1.2 | 1.73 | 10.0 | 0.69282 | 1.0 | 6.93E-01 | 4.80E-01 | 2.30E-02 |
| 4 | Reference attenuator voltage linearity | rectangular | B | 0.05 | 1.73 | 10.0 | 0.02887 | 2.8 | 8.08E-02 | 6.53E-03 | 4.27E-06 |
| 5 | Step response of HV reference divider | rectangular | B | 0.15 | 1.73 | 10.0 | 0.08660 | 2.8 | 2.42E-01 | 5.88E-02 | 3.46E-04 |
| 6 | Proximity effect on the reference divider | rectangular | B | 0.1 | 1.73 | 5.0 | 0.05774 | 2.8 | 1.62E-01 | 2.61E-02 | 1.37E-04 |
| 7 | HV interference in LV circuit | rectangular | B | 0.05 | 1.73 | 5.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 1.39E-07 |
| 8 | Software for reference system | rectangular | B | 0.6 | 1.73 | 7.0 | 0.34641 | 1.0 | 3.46E-01 | 1.20E-01 | 2.06E-03 |
| 9 | Standard uncertainty of the set of impulses | normal | A | 0.53 | 1.00 | 9.0 | 0.53444 | 1.0 | 5.34E-01 | 2.86E-01 | 9.06E-03 |
| 10 | Rounding of reported results | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| 11 | Rounding of uncertainty | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| | | | | | | | | Sums | 2.47E+00 | 1.03E+00 | 3.48E-02 |
| | | | | | | | | Combined standard uncertainty (u_c) | | 1.02E+00 | |
| | | | | | | | | Effective degrees of freedom (ν_{eff}) | | 30.61 | |
| | | | | | | | | Coverage factor (k) | | 2.0 | |
| | | | | | | | | Expanded uncertainty (U) (%) | | 2.1 | |

Time to half-value for full lightning impulse

| N° | Uncertainty Components | Distribution | Type | Semi-Range, a (%) | Divisor, d | Deg. of Freedom, n | Std. Uncertainty, u_i | Sensitivity Factor, c_i | $c u_i$ | $(c u_i)^2$ | $(c u_i)/n_i$ |
|--|---|--------------|------|---------------------|--------------|----------------------|-------------------------|---------------------------|----------|-------------|---------------|
| 1 | Reference digitiser voltage non-linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 2.4 | 1.39E-01 | 1.92E-02 | 3.69E-05 |
| 2 | Reference digitiser T2 uncertainty | rectangular | B | 0.3 | 1.73 | 6.0 | 0.17341 | 1.0 | 1.73E-01 | 3.01E-02 | 1.51E-04 |
| 3 | Reference divider voltage linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 2.4 | 1.39E-01 | 1.92E-02 | 3.69E-05 |
| 4 | Step response of HV reference divider | rectangular | B | 0.6 | 1.73 | 10.0 | 0.34641 | 1.0 | 3.46E-01 | 1.20E-01 | 1.44E-03 |
| 5 | Reference attenuator voltage linearity | rectangular | B | 0.05 | 1.73 | 10.0 | 0.02887 | 2.4 | 6.93E-02 | 4.80E-03 | 2.30E-06 |
| 6 | Reference digitiser effective vertical resolution | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 2.4 | 1.39E-01 | 1.92E-02 | 3.69E-05 |
| 7 | Proximity effect on the reference divider | rectangular | B | 0.1 | 1.73 | 5.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 2.22E-06 |
| 8 | HV interference in LV circuit | rectangular | B | 0.05 | 1.73 | 5.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 1.39E-07 |
| 9 | Software for reference system | rectangular | B | 0.2 | 1.73 | 7.0 | 0.11547 | 1.0 | 1.15E-01 | 1.33E-02 | 2.54E-05 |
| 10 | Standard uncertainty of the set of impulses | normal | A | 0.03 | 1.00 | 9.0 | 0.03475 | 1.0 | 3.48E-02 | 1.21E-03 | 1.62E-07 |
| 11 | Rounding of reported results | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| 12 | Rounding of uncertainty | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| Sums | | | | | | | | | 1.30E+00 | 2.33E-01 | 1.73E-03 |
| Combined standard uncertainty (u_c) | | | | | | | | | | 4.83E-01 | |
| Effective degrees of freedom (ν_{eff}) | | | | | | | | | | 31.31 | |
| Coverage factor (k) | | | | | | | | | | 2.0 | |
| Expanded uncertainty (U) (%) | | | | | | | | | | 1.0 | |

Overshoot for full lightning impulse

| N° | Uncertainty Components | Distribution | Type | Semi-Range, a (%) | Divisor, d | Deg. of Freedom, n | Std. Uncertainty, u_i | Sensitivity Factor, c_i | cu_i | $(cu_i)^2$ | $(cu_i)/n_i$ |
|----|---|--------------|------|---------------------|--------------|----------------------|-------------------------|--|----------|------------|--------------|
| 1 | Reference digitiser voltage non-linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 2 | Reference divider voltage linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 3 | Step response of HV reference divider | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 4 | Reference attenuator voltage linearity | rectangular | B | 0.05 | 1.73 | 10.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 6.94E-08 |
| 5 | Reference digitiser effective vertical resolution | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 6 | Proximity effect on the reference divider | rectangular | B | 0.1 | 1.73 | 5.0 | 0.05774 | 2.0 | 1.15E-01 | 1.33E-02 | 3.56E-05 |
| 7 | HV interference in LV circuit | rectangular | B | 0.05 | 1.73 | 5.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 1.39E-07 |
| 8 | Software for reference system | rectangular | B | 0.4 | 1.73 | 7.0 | 0.23094 | 1.0 | 2.31E-01 | 5.33E-02 | 4.06E-04 |
| 9 | Standard uncertainty of the set of impulses | normal | A | 0.09 | 1.00 | 9.0 | 0.09180 | 1.0 | 9.18E-02 | 8.43E-03 | 7.89E-05 |
| 10 | Rounding of reported results | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| 11 | Rounding of uncertainty | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| | | | | | | | | Sums | 7.85E-01 | 9.18E-02 | 4.54E-04 |
| | | | | | | | | Combined standard uncertainty (u_c) | | 3.03E-01 | |
| | | | | | | | | Effective degrees of freedom (ν_{eff}) | | 18.53 | |
| | | | | | | | | Coverage factor (k) | | 2.1 | |
| | | | | | | | | Expanded uncertainty (U) (%) | | 0.7 | |

Test voltage for front-chopped lightning impulse

| N° | Uncertainty Components | Distribution | Type | Semi-Range, a (%) | Divisor, d | Deg. of Freedom, n | Std. Uncertainty, u_i | Sensitivity Factor, c_i | $c u_i$ | $(c u_i)^2$ | $(c u_i)^2/n_i$ |
|--|--|--------------|------|---------------------|--------------|----------------------|-------------------------|---------------------------|----------|-------------|-----------------|
| 1 | Reference digitiser dynamic scale factor | normal | B | 0.17 | 2.00 | 60.5 | 0.08500 | 1.0 | 8.50E-02 | 7.23E-03 | 8.63E-07 |
| 2 | Reference digitiser voltage non-linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 3 | Reference digitiser drift since last calibration | rectangular | B | 0.1 | 1.73 | 5.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 2.22E-06 |
| 4 | Reference divider ratio uncertainty (front chopped) | rectangular | B | 0.5 | 2.00 | 10.0 | 0.25000 | 1.0 | 2.50E-01 | 6.25E-02 | 3.91E-04 |
| 5 | Reference divider voltage linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 6 | Step response of HV reference divider | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 7 | Reference attenuator ratio | rectangular | B | 0.05 | 1.73 | 10.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 6.94E-08 |
| 8 | Test digitiser/attenuator ratio short term stability | rectangular | B | 0.05 | 1.73 | 5.0 | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 1.39E-07 |
| 9 | Reference attenuator voltage linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 10 | Effective reference digitiser vertical resolution | rectangular | B | 0.2 | 1.73 | 10.0 | 0.11547 | 1.0 | 1.15E-01 | 1.33E-02 | 1.78E-05 |
| 11 | Proximity effect on the reference divider | rectangular | B | 0.2 | 1.73 | 5.0 | 0.11547 | 1.0 | 1.15E-01 | 1.33E-02 | 3.56E-05 |
| 12 | HV interference in LV circuit | rectangular | B | 0.1 | 1.73 | 5.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 2.22E-06 |
| 13 | Software for reference system | rectangular | B | 0.4 | 1.73 | 10.0 | 0.23094 | 1.0 | 2.31E-01 | 5.33E-02 | 2.84E-04 |
| 14 | standard uncertainty of the set of impulses | normal | A | 0.41 | 1.00 | 9.0 | 0.41342 | 1.0 | 4.13E-01 | 1.71E-01 | 3.25E-03 |
| 15 | Rounding of reported results | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| 16 | Rounding of uncertainty | rectangular | B | 0.05 | 1.73 | inf | 0.02887 | 1.0 | 2.89E-02 | 8.33E-04 | 0 |
| Sums | | | | | | | | 1.67E+00 | 3.44E-01 | 3.98E-03 | |
| Combined standard uncertainty (u_c) | | | | | | | | | | 5.87E-01 | |
| Effective degrees of freedom (ν_{eff}) | | | | | | | | | | 29.70 | |
| Coverage factor (k) | | | | | | | | | | 2.0 | |
| Expanded uncertainty (U) (%) | | | | | | | | | | 1.2 | |

Time to chopping for front-chopped lightning impulse

| N° | Uncertainty Components | Distribution | Type | Semi-Range, a (%) | Divisor, d | Deg. of Freedom, n | Std. Uncertainty, u_i | Sensitivity Factor, c_i | $c u_i$ | $(c u_i)^2$ | $(c u_i)/n_i$ |
|----|---|--------------|------|---------------------|--------------|----------------------|-------------------------|--|----------|-------------|---------------|
| 1 | Reference digitiser voltage non-linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 2 | Reference digitiser Tc uncertainty | rectangular | B | 0.6 | 1.73 | 5.0 | 0.34682 | 1.0 | 3.47E-01 | 1.20E-01 | 2.89E-03 |
| 3 | Reference divider voltage linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 4 | Step response of HV reference divider | rectangular | B | 1 | 1.73 | 10.0 | 0.57735 | 1.0 | 5.77E-01 | 3.33E-01 | 1.11E-02 |
| 5 | Reference attenuator voltage linearity | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 6 | Reference digitiser effective vertical resolution | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 7 | Proximity effect on the reference divider | rectangular | B | 0.2 | 1.73 | 5.0 | 0.11547 | 1.0 | 1.15E-01 | 1.33E-02 | 3.56E-05 |
| 8 | HV interference in LV circuit | rectangular | B | 0.1 | 1.73 | 10.0 | 0.05774 | 1.0 | 5.77E-02 | 3.33E-03 | 1.11E-06 |
| 9 | Software for reference system | rectangular | B | 0.6 | 1.73 | 10.0 | 0.34641 | 1.0 | 3.46E-01 | 1.20E-01 | 1.44E-03 |
| 10 | standard uncertainty of the set of impulses | normal | A | 1.929 | 1.00 | 9.0 | 1.92866 | 1.0 | 1.93E+00 | 3.72E+00 | 1.54E+00 |
| 11 | Rounding of reported results | rectangular | B | 0.05 | 2.00 | inf | 0.02500 | 1.0 | 2.50E-02 | 6.25E-04 | 0 |
| 12 | Rounding of uncertainty | rectangular | B | 0.05 | 2.00 | inf | 0.02500 | 1.0 | 2.50E-02 | 6.25E-04 | 0 |
| | | | | | | | | Sums | 3.65E+00 | 4.32E+00 | 1.55E+00 |
| | | | | | | | | Combined standard uncertainty (u_c) | | 2.08E+00 | |
| | | | | | | | | Effective degrees of freedom (ν_{eff}) | | 12.04 | |
| | | | | | | | | Coverage factor (k) | | 2.2 | |
| | | | | | | | | Expanded uncertainty (U) (%) | | 4.6 | |

VNIIMS

Uncertainty budget for standard lightning impulses
($T_1 = 0.84 \mu\text{s}$. $T_1 = 1.56 \mu\text{s}$. HV up to 1000 kV):

| Digitizer | Contributions to standard uncertainty | | | |
|-----------------------------------|---------------------------------------|-----------|-------------|-------------|
| | U_p | T_1 | T_2 | β' |
| U_{ref} | 0.05% | 0.7% | 0.1% | |
| Linearity u_{B1} | 0.1% | 0.3% | 0.1% | |
| Dynamic u_{B2} | 0.075% | 0.2% | 0.05% | |
| Short-term stability u_{B3} | 0.01% | 0 | 0 | |
| Long-term stability u_{B4} | 0 | 0 | 0 | |
| Temperature u_{B5} | 0.01% | 0.01% | 0.01% | |
| Proximity u_{B6} | 0 | 0 | 0 | |
| Software u_{B7} | 0.02% | 0.2% | 0.1% | |
| Divider HIVOLT | | | | |
| U_{ref} | 0.03% | 0.5% | 0.1% | |
| Linearity u_{B1} | 0.01% | 0 | 0 | |
| Dynamic u_{B2} | 0.04% | 0.2% | 0.1% | |
| Short-term stability u_{B3} | 0 | 0 | 0 | |
| Long-term stability u_{B4} | 0.03% | 0 | 0 | |
| Temperature u_{B5} | 0.02% | 0 | 0 | |
| Proximity u_{B6} | 0.005% | 0.2% | 0.1% | |
| Total standard uncertainty | 0.15% | 1% | 0.25% | 0.25% |
| Expanded uncertainty (k=2) | 0.3% | 2% | 0.5% | 0.5% |

Uncertainty budget for front-chopped lightning impulses:

| Digitizer | Contributions to standard uncertainty | |
|-----------------------------------|---------------------------------------|--------------|
| | U_p | T_c |
| U_{ref} | 0.15% | - |
| Linearity u_{B1} | 0.2% | 0.35% |
| Dynamic u_{B2} | 0.15% | 0.3% |
| Short-term stability u_{B3} | 0 | - |
| Long-term stability u_{B4} | 0 | - |
| Temperature u_{B5} | 0.01% | 0.015% |
| Proximity u_{B6} | 0 | - |
| Software u_{B7} | 0.45% | 0.55% |
| Divider HIVOLT | | |
| U_{ref} | 0.01% | 0.55% |
| Linearity u_{B1} | 0 | - |
| Dynamic u_{B2} | 0.05% | 0.4% |
| Short-term stability u_{B3} | 0 | - |
| Long-term stability u_{B4} | 0.02% | - |
| Temperature u_{B5} | 0.01% | - |
| Proximity u_{B6} | 0.005% | 0.4% |
| Total standard uncertainty | 0.5% | 1.25% |
| Expanded uncertainty (k=2) | 1% | 2.50% |

NIMUncertainty budget for test voltage U_t of 100 kV to 400 kV full lightning impulse

| Quantity X_i | Estimate (%) x_i | Standard uncertainty (%) $u_{rel}(x_i)$ | Distribution | Evaluation type | Sensitivity coefficient c_i | Uncertainty contribution (%) $u(R_i)$ | Degree of freedom ν_i |
|---|--------------------------|---|--------------|--------------------|-------------------------------------|---|---------------------------------|
| Linearity of the divider | / | 0.09 | rectangular | B | 1 | 0.09 | 10 |
| Ratio of the divider | / | 0.06 | rectangular | B | 1 | 0.06 | 10 |
| Short-term stability of the divider | / | 0.06 | rectangular | B | 1 | 0.06 | 10 |
| Ambient temperature on the divider | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Proximity effect on the divider | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| High Frequency loss of the cable | / | 0.06 | rectangular | B | 1 | 0.06 | 5 |
| Ratio of the attenuator | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Linearity of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Dynamic Scale Factor | / | 0.10 | normal | B | 1 | 0.10 | 60.5 |
| Temperature coefficient of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Resolution of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Long-term stability of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Software | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Interference | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Standard uncertainty of the set of impulses | / | 0.01 | normal | A | 1 | 0.01 | 9 |
| R_x | 0.0 | | | | | | |
| Combined standard uncertainty: | | | | | | 0.193 | |
| Effective degrees of freedom: | | | | | | 95.2 | |
| Expanded uncertainty (95% coverage factor): | | | | | | 0.38 | |

Uncertainty budget for front time T_f of 100 kV to 400 kV full lightning impulse

| Quantity X_i | Estimate (%) x_i | Standard uncertainty (%) $u(x_i)$ | Distribution | Evaluation type | Sensitivity coefficient c_i | Uncertainty contribution (%) $u(R_i)$ | Degree of freedom ν_i |
|---|--------------------------|---|--------------|--------------------|-------------------------------------|---|---------------------------------|
| Step Response of the measuring system | 0.2 | 0.46 | rectangular | B | 1 | 0.46 | 10 |
| Linearity of the divider | / | 0.12 | rectangular | B | 2.8 | 0.34 | 10 |
| Proximity effect on the divider | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| High Frequency loss of the cable | / | 0.29 | rectangular | B | 1 | 0.29 | 5 |
| Linearity of the attenuator | / | 0.03 | rectangular | B | 2.8 | 0.08 | 10 |
| Linearity of the digitizer | / | 0.03 | rectangular | B | 2.8 | 0.08 | 10 |
| Resolution of the digitizer | / | 0.03 | rectangular | B | 2.8 | 0.08 | 10 |
| Long-term stability of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Software | / | 0.24 | rectangular | B | 1 | 0.24 | 10 |
| Interference | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| Standard uncertainty of the set of impulses | / | 0.13 | normal | A | 1 | 0.13 | 9 |
| R_x | 0.2 | | | | | | |
| Combined standard uncertainty: | | | | | | 0.731 | |
| Effective degrees of freedom: | | | | | | 37.4 | |
| Expanded uncertainty (95% coverage factor): | | | | | | 1.48 | |

Uncertainty budget for time to half value T_2 of 100 kV to 400 kV full lightning impulse

| Quantity X_i | Estimate (%) x_i | Standard uncertainty (%) $u(x_i)$ | Distribution | Evaluation type | Sensitivity coefficient c_i | Uncertainty contribution (%) $u(R_i)$ | Degree of freedom ν_i |
|---|-----------------------|--------------------------------------|--------------|-----------------|----------------------------------|--|------------------------------|
| Step Response of the measuring system | 0.1 | 0.23 | rectangular | B | 1 | 0.23 | 10 |
| Linearity of the divider | / | 0.06 | rectangular | B | 2.4 | 0.14 | 10 |
| Short-term stability of the divider | / | 0.12 | rectangular | B | 2.4 | 0.29 | 10 |
| Proximity effect on the divider | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| High Frequency loss of the cable | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| Linearity of the attenuator | / | 0.03 | rectangular | B | 2.4 | 0.07 | 10 |
| Linearity of the digitizer | / | 0.03 | rectangular | B | 2.4 | 0.07 | 10 |
| Resolution of the digitizer | / | 0.03 | rectangular | B | 2.4 | 0.07 | 10 |
| Long-term stability of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Software | / | 0.12 | rectangular | B | 1 | 0.12 | 10 |
| Interference | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| Standard uncertainty of the set of impulses | / | 0.08 | normal | A | 1 | 0.08 | 9 |
| R_x | 0.1 | | | | | | |
| Combined standard uncertainty: | | | | | | 0.487 | |
| Effective degrees of freedom: | | | | | | 48.1 | |
| Expanded uncertainty (95% coverage factor): | | | | | | 0.98 | |

Table 9. Uncertainty budget for test voltage U_t of 500 kV to 700 kV full lightning impulse

| Quantity X_i | Estimate (%) x_i | Standard uncertainty (%) $u_{rel}(x_i)$ | Distribution | Evaluation type | Sensitivity coefficient c_i | Uncertainty contribution (%) $u_{rel}(R_i)$ | Degree of freedom ν_i |
|---|-----------------------|--|--------------|-----------------|----------------------------------|--|------------------------------|
| Linearity of the divider | / | 0.17 | rectangular | B | 1 | 0.17 | 10 |
| Ratio of the divider | / | 0.06 | rectangular | B | 1 | 0.06 | 10 |
| Short-term stability of the divider | / | 0.06 | rectangular | B | 1 | 0.06 | 10 |
| Ambient temperature on the divider | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Proximity effect on the divider | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| High Frequency loss of the cable | / | 0.06 | rectangular | B | 1 | 0.06 | 5 |
| Ratio of the attenuator | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Linearity of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Dynamic Scale Factor | / | 0.10 | normal | B | 1 | 0.10 | 60.5 |
| Temperature coefficient of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Resolution of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Long-term stability of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Software | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Interference | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Standard uncertainty of the set of impulses | / | 0.06 | normal | A | 1 | 0.06 | 9 |
| R_x | 0.0 | | | | | | |
| Combined standard uncertainty: | | | | | | 0.248 | |
| Effective degrees of freedom: | | | | | | 40.6 | |
| Expanded uncertainty (95% coverage factor): | | | | | | 0.50 | |

Table 10. Uncertainty budget for front time T_1 of 500 kV to 700 kV full lightning impulse

| Quantity X_i | Estimate (%) x_i | Standard uncertainty (%) $u(x_i)$ | Distribution | Evaluation type | Sensitivity coefficient c_i | Uncertainty contribution (%) $u(R_i)$ | Degree of freedom ν_i |
|---|--------------------------|--|--------------|--------------------|-------------------------------------|--|------------------------------------|
| Step Response of the measuring system | 0.2 | 0.46 | rectangular | B | 1 | 0.46 | 10 |
| Linearity of the divider | / | 0.24 | rectangular | B | 2.8 | 0.67 | 10 |
| Proximity effect on the divider | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| High Frequency loss of the cable | / | 0.29 | rectangular | B | 1 | 0.29 | 5 |
| Linearity of the attenuator | / | 0.12 | rectangular | B | 2.8 | 0.34 | 10 |
| Linearity of the digitizer | / | 0.24 | rectangular | B | 2.8 | 0.67 | 10 |
| Resolution of the digitizer | / | 0.03 | rectangular | B | 2.8 | 0.08 | 10 |
| Long-term stability of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Software | / | 0.24 | rectangular | B | 1 | 0.24 | 10 |
| Interference | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| Standard uncertainty of the set of impulses | / | 0.13 | normal | A | 1 | 0.13 | 9 |
| R_x | 0.2 | | | | | | |
| Combined standard uncertainty: | | | | | | 1.193 | |
| Effective degrees of freedom: | | | | | | 41.8 | |
| Expanded uncertainty (95% coverage factor): | | | | | | 2.41 | |

Table 11. Uncertainty budget for time to half value T_2 of 500 kV to 700 kV full lightning impulse

| Quantity X_i | Estimate (%) x_i | Standard uncertainty (%) $u(x_i)$ | Distribution | Evaluation type | Sensitivity coefficient c_i | Uncertainty contribution (%) $u(R_i)$ | Degree of freedom ν_i |
|---|--------------------------|--|--------------|--------------------|-------------------------------------|--|------------------------------------|
| Step Response of the measuring system | 0.1 | 0.23 | rectangular | B | 1 | 0.23 | 10 |
| Linearity of the divider | / | 0.17 | rectangular | B | 2.4 | 0.41 | 10 |
| Short-term stability of the divider | / | 0.12 | rectangular | B | 2.4 | 0.29 | 10 |
| Proximity effect on the divider | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| High Frequency loss of the cable | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| Linearity of the attenuator | / | 0.12 | rectangular | B | 2.4 | 0.29 | 10 |
| Linearity of the digitizer | / | 0.12 | rectangular | B | 2.4 | 0.29 | 10 |
| Resolution of the digitizer | / | 0.03 | rectangular | B | 2.4 | 0.07 | 10 |
| Long-term stability of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Software | / | 0.12 | rectangular | B | 1 | 0.12 | 10 |
| Interference | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| Standard uncertainty of the set of impulses | / | 0.08 | normal | A | 1 | 0.08 | 9 |
| R_x | 0.1 | | | | | | |
| Combined standard uncertainty: | | | | | | 0.734 | |
| Effective degrees of freedom: | | | | | | 55.0 | |
| Expanded uncertainty (95% coverage factor): | | | | | | 1.47 | |

Uncertainty budget for relative overshoot magnitude β' of 100 kV to 700 kV full lightning impulse

| Quantity X_i | Estimate (%) x_i | Standard uncertainty (%) $u(x_i)$ | Distribution | Evaluation type | Sensitivity coefficient c_i | Uncertainty contribution (%) $u(R_i)$ | Degree of freedom ν_i |
|---|--------------------------|--|--------------|--------------------|-------------------------------------|--|------------------------------------|
| Step Response of the measuring system | / | 0.23 | rectangular | B | 1 | 0.23 | 10 |
| Linearity of the divider | / | 0.06 | rectangular | B | 1 | 0.06 | 10 |
| Short-term stability of the divider | / | 0.12 | rectangular | B | 1 | 0.12 | 10 |
| Proximity effect on the divider | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| High Frequency loss of the cable | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| Linearity of the attenuator | / | 0.12 | rectangular | B | 1 | 0.12 | 10 |
| Linearity of the digitizer | / | 0.12 | rectangular | B | 1 | 0.12 | 10 |
| Resolution of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Software | / | 0.06 | rectangular | B | 1 | 0.06 | 10 |
| Interference | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| Standard uncertainty of the set of impulses | / | 0.08 | normal | A | 1 | 0.08 | 9 |
| R_x | 0.0 | | | | | | |
| Combined standard uncertainty: | | | | | | 0.392 | |
| Effective degrees of freedom: | | | | | | 49.9 | |
| Expanded uncertainty (95% coverage factor): | | | | | | 0.79 | |

Uncertainty budget for extreme value of the test voltage U_e of front chopped lightning impulse

| Quantity X_i | Estimate (%) x_i | Standard uncertainty (%) $u(x_i)$ | Distribution | Evaluation type | Sensitivity coefficient c_i | Uncertainty contribution (%) $u(R_i)$ | Degree of freedom ν_i |
|---|--------------------------|--|--------------|--------------------|-------------------------------------|--|------------------------------------|
| Step Response of the measuring system | / | 0.29 | rectangular | B | 1 | 0.29 | 10 |
| Linearity of the divider | / | 0.12 | rectangular | B | 1 | 0.12 | 10 |
| Ratio of the divider | / | 0.12 | rectangular | B | 1 | 0.12 | 10 |
| Ambient temperature on the divider | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Proximity effect on the divider | / | 0.06 | rectangular | B | 1 | 0.06 | 5 |
| High Frequency loss of the cable | / | 0.17 | rectangular | B | 1 | 0.17 | 5 |
| Ratio of the attenuator | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Linearity of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Dynamic Scale Factor | / | 0.05 | rectangular | B | 1 | 0.05 | 60.5 |
| Resolution of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 10 |
| Long-term stability of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Software | / | 0.17 | rectangular | B | 1 | 0.17 | 10 |
| Interference | / | 0.12 | rectangular | B | 1 | 0.12 | 5 |
| Standard uncertainty of the set of impulses | / | 0.05 | normal | A | 1 | 0.05 | 9 |
| R_x | 0.0 | | | | | | |
| Combined standard uncertainty: | | | | | | 0.445 | |
| Effective degrees of freedom: | | | | | | 37.6 | |
| Expanded uncertainty (95% coverage factor): | | | | | | 0.90 | |

Uncertainty budget for time to chopping T_c of front chopped lightning impulse

| Quantity X_i | Estimate (%) x_i | Standard uncertainty (%) $u(x_i)$ | Distribution | Evaluation type | Sensitivity coefficient c_i | Uncertainty contribution (%) $u(R_i)$ | Degree of freedom ν_i |
|---|--------------------------|---|--------------|--------------------|-------------------------------------|--|------------------------------------|
| Step Response of the measuring system | 0.5 | 0.87 | rectangular | B | 1 | 0.87 | 5 |
| Linearity of the divider | / | 0.06 | rectangular | B | 3 | 0.18 | 10 |
| Proximity effect on the divider | / | 0.29 | rectangular | B | 1 | 0.29 | 5 |
| High Frequency loss of the cable | / | 0.29 | rectangular | B | 1 | 0.29 | 5 |
| Linearity of the attenuator | / | 0.03 | rectangular | B | 3 | 0.09 | 10 |
| Linearity of the digitizer | / | 0.03 | rectangular | B | 3 | 0.09 | 10 |
| Resolution of the digitizer | / | 0.03 | rectangular | B | 3 | 0.09 | 10 |
| Long-term stability of the digitizer | / | 0.03 | rectangular | B | 1 | 0.03 | 5 |
| Software | 0.5 | 0.58 | rectangular | B | 1 | 0.58 | 10 |
| Interference | / | 0.24 | rectangular | B | 1 | 0.24 | 5 |
| Standard uncertainty of the set of impulses | / | 0.12 | normal | A | 1 | 0.12 | 9.0 |
| R_x | 1.0 | | | | | | |
| | | Combined standard uncertainty: | | | | 1.179 | |
| | | Effective degrees of freedom: | | | | 14.9 | |
| | | Expanded uncertainty (95% coverage factor): | | | | 2.51 | |

JHILL

Uncertainty budget (k=2) for full impulse measurement:

(a) Peak value measurement

| | Factor of uncertainty | Value [%] |
|----------------|---|-----------|
| u ₁ | Combined standard uncertainty of the reference measuring system | 0.25 |
| u ₂ | Non-linearity contribution to standard uncertainty in comparison test | 0.106 |
| u ₃ | Nominal-epoch contribution to standard uncertainty in comparison test | 0.081 |
| u ₄ | Statistical Type-A uncertainty in comparison test | 0.009 |
| u _c | Combined standard uncertainty | 0.284 |
| U | Expanded uncertainty (k=2) | 0.6 |

(b) Front time measurement

| | Factor of uncertainty | Value [%] |
|----------------|---|-----------|
| u ₁ | Combined standard uncertainty of the reference measuring system | 1.0 |
| u ₂ | Non-linearity contribution to standard uncertainty in comparison test | 0.439 |
| u ₃ | Nominal-epoch contribution to standard uncertainty in comparison test | 0.277 |
| u ₄ | Statistical Type-A uncertainty in comparison test | 0.171 |
| u _c | Combined standard uncertainty | 1.140 |
| U | Expanded uncertainty (k=2) | 2.3 |

(c) Time to half-value measurement

| | Factor of uncertainty | Value [%] |
|----------------|---|-----------|
| u ₁ | Combined standard uncertainty of the reference measuring system | 0.5 |
| u ₂ | Non-linearity contribution to standard uncertainty in comparison test | 0.171 |
| u ₃ | Nominal-epoch contribution to standard uncertainty in comparison test | 0.124 |
| u ₄ | Statistical Type-A uncertainty in comparison test | 0.018 |
| u _c | Combined standard uncertainty | 0.543 |
| U | Expanded uncertainty (k=2) | 1.1 |

Uncertainty budget (k=2) for chopped impulse measurement:

(a) Peak value measurement

| | Factor of uncertainty | Value [%] |
|----------------|---|-----------|
| u ₁ | Combined standard uncertainty of the reference measuring system | 0.5 |
| u ₂ | Statistical Type-A uncertainty in comparison test | 0.086 |
| u _c | Combined standard uncertainty | 0.507 |
| U | Expanded uncertainty (k=2) | 1.1 |

(b) Front time measurement

| | Factor of uncertainty | Value [%] |
|----------------|---|-----------|
| u ₁ | Combined standard uncertainty of the reference measuring system | 0.5 |
| u ₂ | Statistical Type-A uncertainty in comparison test | 0.119 |
| u _c | Combined standard uncertainty | 0.514 |
| U | Expanded uncertainty (k=2) | 1.1 |

NRC

The following type B uncertainty components are combined with type A uncertainties based both on repeated measurements on the same day as well as day-to-day variations.

**Components of the Uncertainty Budget for the measurement of the
Front Time of a Full Lightning Impulse**

| Component of the Uncertainty Budget | Estimated Standard Uncertainty (ms/s) | Comments |
|---|--|---|
| Effect of the Uncertainty of voltage measurement at 30% peak voltage | 2.1 | Estimated based on dv/dt at 30% of peak Voltage |
| Effect of the Uncertainty of voltage measurement at 90% peak value | 4.6 | Estimated based on dv/dt at 90% of peak Voltage |
| Actual resolution of the digitizer, determination of interval start | 0.29 | Semi-interval/ $\sqrt{3}$ |
| Actual resolution of the digitizer, determination of interval end | 0.29 | Semi-interval/ $\sqrt{3}$ |
| Scale factor of the digitizer clock | 0.29 | Calibrated |
| Linearity of digitizer clock | 0.58 | Measured |
| Response characteristics | 0.29 | Calculated as less than resolution |
| Interference | 0 | Included in the voltage uncertainty |
| Proximity effect | 0.29 | None detected |
| Software evaluation | 8 | Estimate based on experience |
| Combined Expanded Uncertainty (coverage factor $k = 2$) | 19 | |

**Components of the Uncertainty Budget for the Measurement of the
Time to Half-Value of a Full Lightning Impulse**

| Component of the Uncertainty Budget | Estimated Standard Uncertainty (ms/s) | Comments |
|--|--|---|
| Effect of the Uncertainty of voltage measurement at 50% peak voltage | 0.4 | Estimated based on dv/dt at 50% of Peak Voltage |
| Effect of the Uncertainty of voltage measurement at virtual zero | 0.4 | Estimate based on experience |
| Actual resolution of the digitizer, determination of interval start | 0.29 | Semi-interval/ $\sqrt{3}$ |
| Actual resolution of the digitizer, determination of interval end | 0.29 | Semi-interval/ $\sqrt{3}$ |
| Scale factor of the digitizer clock | 0.29 | Calibrated |
| Linearity of digitizer clock | 0.58 | Measured |
| Response characteristics | 0.58 | Calculated as less than resolution |
| Interference | 0 | Included in the voltage uncertainty |
| Proximity effect | 0.29 | None detected |
| Software evaluation | 10 | Estimate based on experience |
| Combined Expanded Uncertainty (coverage factor $k = 2$) | 20 | |

**Components of the Uncertainty Budget for the Measurement of
Peak Voltage of a Full Lightning Impulse**

| Component of the Uncertainty Budget | Estimated Standard Uncertainty (mV/V) | Comments |
|--|--|------------------------------------|
| Voltage calibration of the digitizer | 0.025 | Measured |
| Linearity of the digitizer | 0.025 | Measured |
| Actual resolution of the digitizer, base level | 0.2 | Semi-interval/ $\sqrt{3}$ |
| Actual resolution of the digitizer, peak measurement | 0.2 | Semi-interval/ $\sqrt{3}$ |
| Differential Non-linearity | 0.8 | Verified by DNL test |
| Scale factor of the divider | 0.01 | Measured |
| Effect of temperature on ratio | 0.016 | Measured, linear interpolation |
| Effect of self-heating on ratio | 0.2 | Not detectable |
| Response characteristics | 0.2 | Calculated as less than resolution |
| Interference | 0.2 | None detected |
| Proximity effect | 0.2 | None detected |
| Combined Expanded Uncertainty (coverage factor $k = 2$) | 1.9 | |

Annex E - Comparison results for each waveform

The comparison results for each impulse shape together with comparison reference values are shown on the following pages.

The following results were excluded from the calculation of the comparison reference values (CRV) before starting the process described in clause 6.5:

- The pilot laboratory, RISE, performed the measurements three times. The three RISE results were used for estimating the uncertainty component of the transfer standard due to stability, and only the results from the RISE2 were included in CRV calculation.
- Traceability to IATTE measurements comes partly from NIM, China; and partly from German accredited calibration laboratory. Also, IATTE referred to IEEE4:2013 instead of IEC 60060-1:2010 for their parameter evaluation routines. IATTE results were excluded from the CRV calculation.
- Re-evaluated IATTE measurement results are shown as IATTE1. For more details see Annex I.

Explanation for the numbers of the "Exclude" column on the following pages:

0 : Excluded before starting the analysis process.

1, 2, ... : Order of additional exclusions needed to reach $Pr > 5 \%$

The results shown in this Annex are collected from Annex C.

Short-N100

Short-N100

Setup uncertainties:

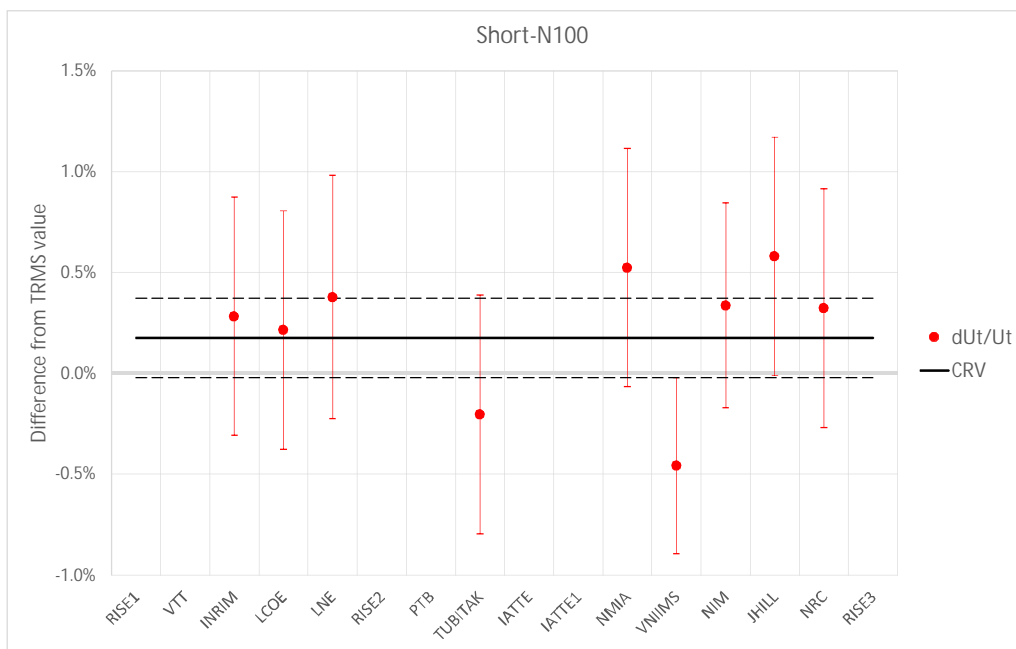
0.17 %

1.87 %

1.99 %

0.28

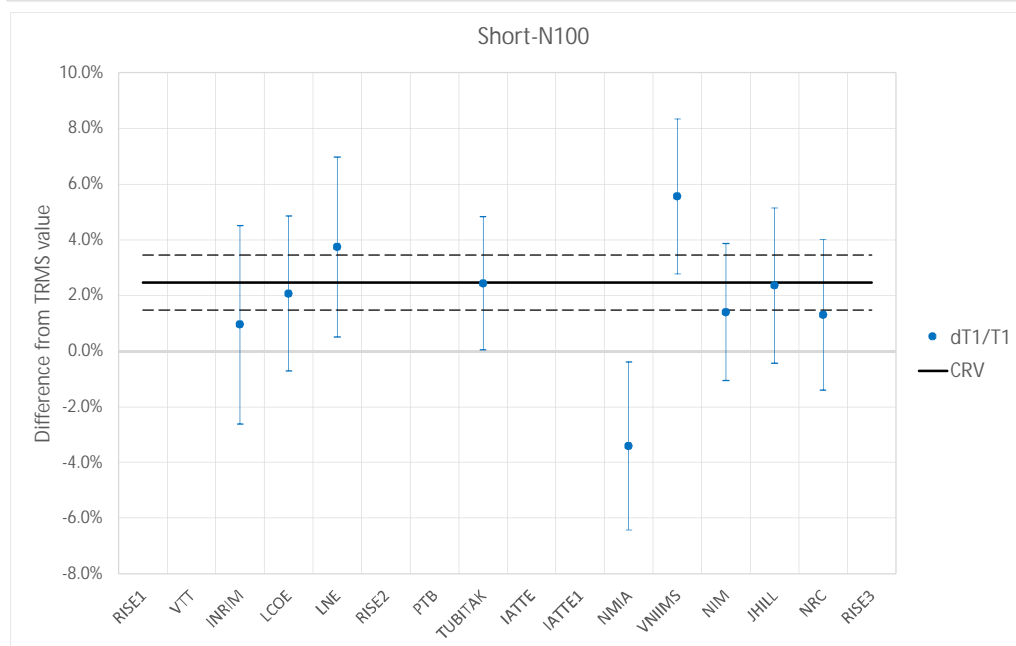
| Lab | Digitizer range [V] | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | | |
|---------|---------------------|---------------------|---------------------------------------|---------------------|--------|---------------------|---------------------------------------|---------------------|--------|---------------------------------|--------|--|--------|---------------------------------|--------|---------|------|------|
| | | U _t [kV] | T ₁ or T _c [μs] | T ₂ [μs] | β' [%] | U _t [kV] | T ₁ or T _c [μs] | T ₂ [μs] | β' [%] | dU _t /U _t | U | dT ₁ /T ₁ dT _c /T _c | U | dT ₂ /T ₂ | U | dβ' [%] | U | |
| RISE1 | | | | | | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A |
| VTT | | | | | | | | | | | | | | | | | | |
| INRIM | | -101.87 | 0.843 | 41.17 | -0.89 | -101.58 | 0.835 | 41.06 | -0.84 | 0.28 % | 0.62 % | 0.95 % | 3.57 % | 0.27 % | 3.61 % | -0.05 | 1.04 | |
| LCOE | | -99.76 | 0.862 | 55.49 | 1.82 | -99.55 | 0.844 | 56.19 | 1.48 | 0.21 % | 0.62 % | 2.07 % | 2.78 % | -1.26 % | 2.25 % | 0.34 | 0.58 | |
| LNE | | -107.80 | 0.912 | 51.43 | 0.04 | -107.38 | 0.879 | 50.83 | 0.00 | 0.38 % | 0.64 % | 3.74 % | 3.23 % | 1.17 % | 2.17 % | 0.04 | 1.04 | |
| RISE2 | | | | | | | | | | | | | | | | | | |
| PTB | | | | | | | | | | | | | | | | | | |
| TUBITAK | | -100.00 | 0.881 | 57.36 | 0.34 | -100.20 | 0.860 | 57.23 | | -0.20 % | 0.62 % | 2.43 % | 2.39 % | 0.22 % | 2.13 % | | | |
| IATTE | | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | | |
| IATTE1 | | | | | | | | | | | | | | | | | | |
| NMIA | | -99.80 | 0.827 | 59.93 | 1.31 | -99.33 | 0.856 | 59.36 | 2.01 | 0.52 % | 0.62 % | -3.41 % | 3.02 % | 0.95 % | 2.25 % | -0.70 | 0.76 | |
| VNIIMS | | -108.16 | 0.969 | 45.53 | -1.59 | -108.78 | 0.918 | 45.83 | -1.43 | -0.46 % | 0.48 % | 5.56 % | 2.78 % | -0.64 % | 2.07 % | -0.16 | 0.57 | |
| NIM | | -97.58 | 0.858 | 60.89 | 3.75 | -97.37 | 0.846 | 60.20 | 4.44 | 0.34 % | 0.55 % | 1.40 % | 2.46 % | 1.15 % | 2.25 % | -0.69 | 0.85 | |
| JHILL | | -100.50 | 0.832 | 63.76 | 0.00 | -100.09 | 0.813 | 63.37 | 0.22 | 0.58 % | 0.62 % | 2.35 % | 2.79 % | 0.61 % | 2.25 % | -0.21 | 0.57 | |
| NRC | | -98.98 | 0.854 | 61.66 | 0.17 | -98.99 | 0.843 | 61.06 | 0.60 | 0.32 % | 0.62 % | 1.30 % | 2.71 % | 0.99 % | 2.84 % | -0.42 | 1.04 | |
| RISE3 | | | | | | | | | | | | | | | | | | |



U_t

| Lab | Δx _t | U(Δx _t) | En | Excl. |
|---------|-----------------|---------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.11 % | 0.59 % | 0.18 | |
| LCOE | 0.04 % | 0.59 % | 0.07 | |
| LNE | 0.20 % | 0.60 % | 0.34 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.38 % | 0.59 % | -0.64 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 0.35 % | 0.59 % | 0.59 | |
| VNIIMS | -0.63 % | 0.44 % | -1.46 | |
| NIM | 0.16 % | 0.51 % | 0.32 | |
| JHILL | 0.40 % | 0.59 % | 0.69 | |
| NRC | 0.15 % | 0.59 % | 0.25 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.18 % | 0.20 % | 13 % |



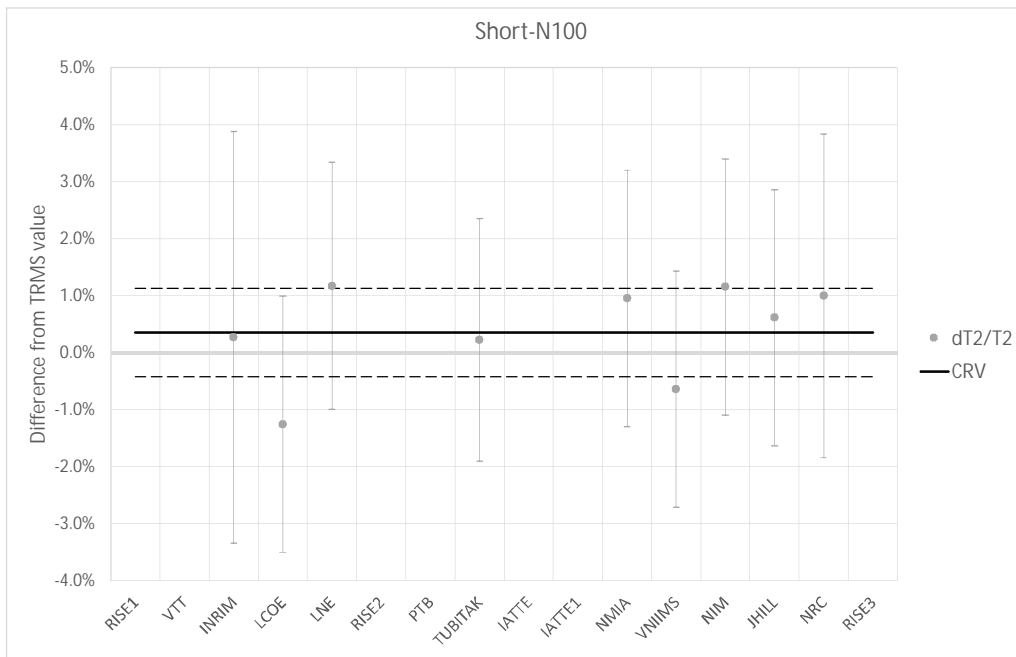
T₁

| Lab | Δx _t | U(Δx _t) | En | Excl. |
|---------|-----------------|---------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -1.51 % | 3.43 % | -0.44 | |
| LCOE | -0.39 % | 2.60 % | -0.15 | |
| LNE | 1.28 % | 3.08 % | 0.41 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.03 % | 2.18 % | -0.01 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -5.87 % | 3.17 % | -1.85 | 1 |
| VNIIMS | 3.09 % | 2.61 % | 1.19 | |
| NIM | -1.06 % | 2.25 % | -0.47 | |
| JHILL | -0.11 % | 2.61 % | -0.04 | |
| NRC | -1.16 % | 2.53 % | -0.46 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 2.46 % | 0.98 % | 35 % |

Short-N100

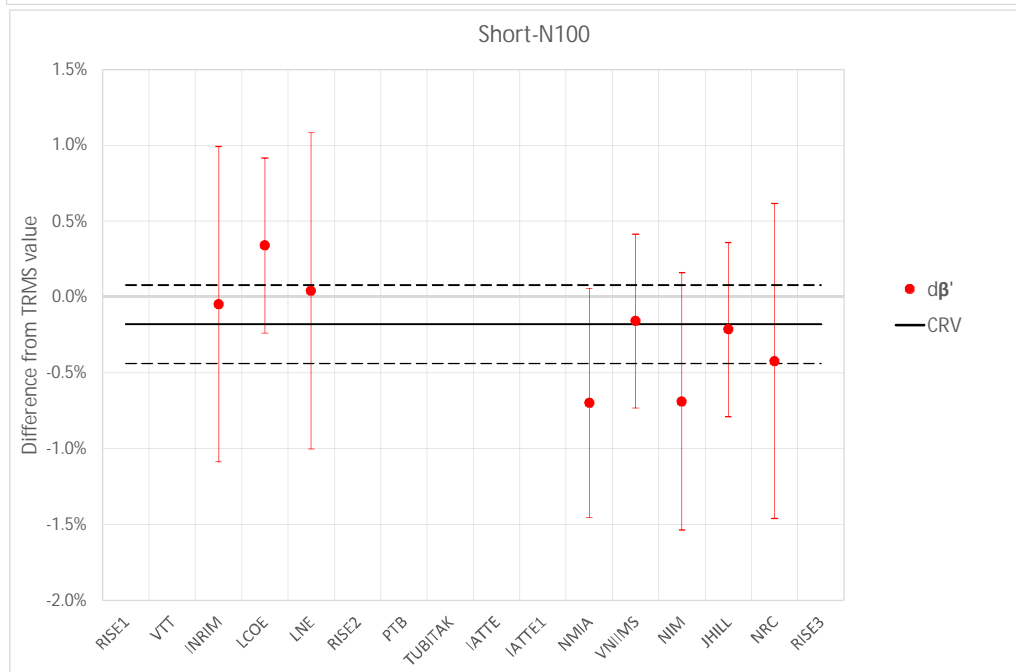
Short-N100



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -0.08 % | 3.53 % | -0.02 | |
| LCOE | -1.61 % | 2.11 % | -0.76 | |
| LNE | 0.82 % | 2.02 % | 0.40 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.13 % | 1.98 % | -0.06 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 0.60 % | 2.11 % | 0.29 | |
| VNIIMS | -0.99 % | 1.92 % | -0.52 | |
| NIM | 0.80 % | 2.11 % | 0.38 | |
| JHILL | 0.26 % | 2.11 % | 0.12 | |
| NRC | 0.64 % | 2.73 % | 0.24 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.35 % | 0.78 % | 80 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.13 | 1.01 | 0.13 | |
| LCOE | 0.52 | 0.52 | 1.01 | |
| LNE | 0.22 | 1.01 | 0.22 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.52 | 0.71 | -0.73 | |
| VNIIMS | 0.02 | 0.51 | 0.04 | |
| NIM | -0.51 | 0.81 | -0.63 | |
| JHILL | -0.03 | 0.51 | -0.07 | |
| NRC | -0.24 | 1.01 | -0.24 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.18 | 0.26 | 42 % |

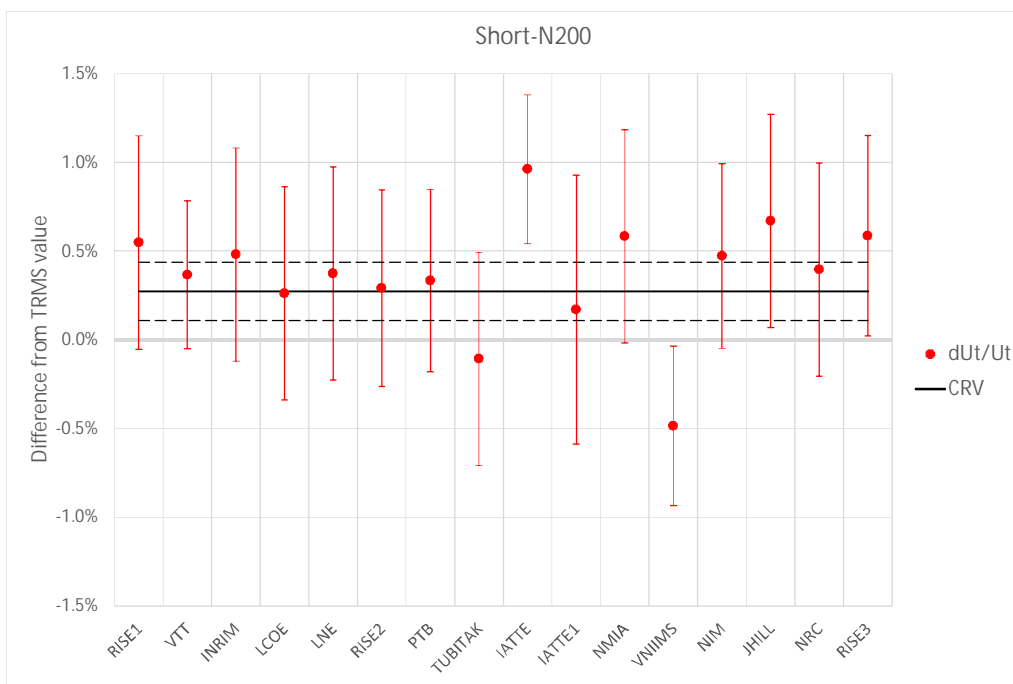
Short-N200

Short-N200

Setup uncertainties:

0.17 % 1.87 % 1.99 % 0.28

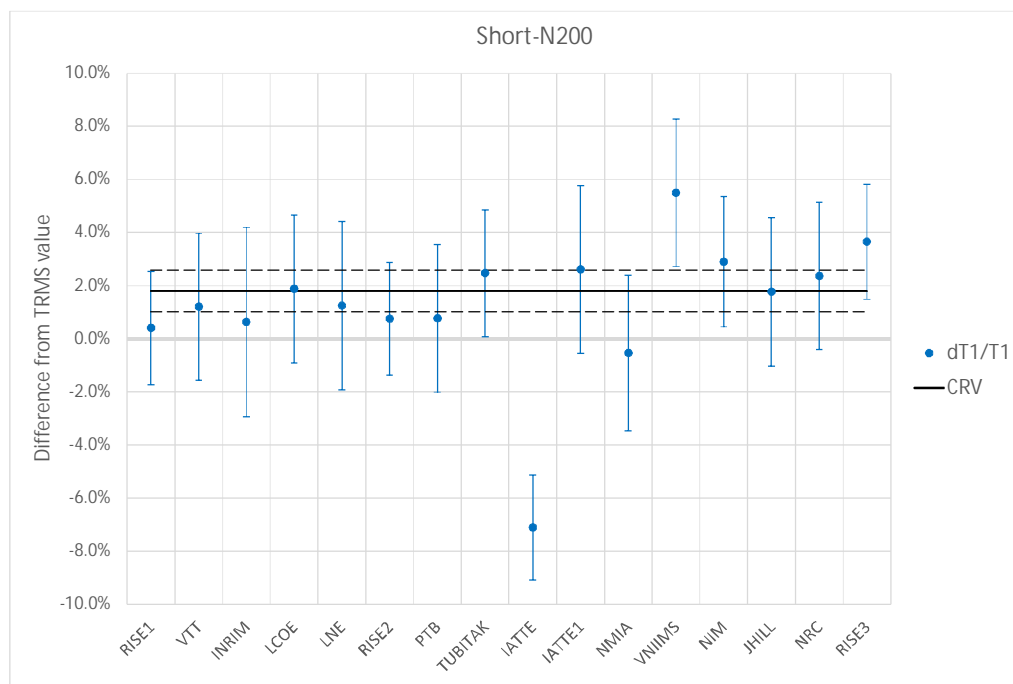
| Lab | Digitizer range [V] | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------------|---------------|---------------------------|------------------|--------------|--------------|---------------------------|------------------|--------------|--------------------|--------|------------|--------|------------|--------|---------------|------|
| | | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 | U | dT_2/T_2 | U | $d\beta'$ [%] | U |
| RISE1 | | -199.68 | 0.846 | 40.39 | 2.69 | -198.60 | 0.842 | 40.15 | 3.11 | 0.55 % | 0.58 % | 0.41 % | 2.14 % | 0.59 % | 2.17 % | -0.42 | 0.30 |
| VTT | | -202.28 | 0.854 | 40.98 | 2.78 | -201.54 | 0.844 | 40.83 | 2.93 | 0.37 % | 0.45 % | 1.20 % | 2.77 % | 0.36 % | 2.08 % | -0.15 | 0.38 |
| INRIM | | -201.76 | 0.845 | 41.20 | -0.96 | -200.80 | 0.839 | 41.22 | -1.08 | 0.48 % | 0.62 % | 0.62 % | 3.57 % | -0.06 % | 3.61 % | 0.12 | 1.04 |
| LCOE | | -199.54 | 0.854 | 55.43 | 1.66 | -199.02 | 0.838 | 56.18 | 1.46 | 0.26 % | 0.62 % | 1.87 % | 2.79 % | -1.34 % | 2.25 % | 0.20 | 0.58 |
| LNE | | -198.30 | 0.891 | 51.66 | -0.11 | -197.54 | 0.880 | 51.30 | 0.03 | 0.37 % | 0.62 % | 1.25 % | 3.17 % | 0.70 % | 2.17 % | -0.14 | 1.04 |
| RISE2 | | -198.03 | 0.840 | 40.35 | 2.79 | -197.47 | 0.834 | 40.27 | 3.09 | 0.29 % | 0.58 % | 0.75 % | 2.13 % | 0.20 % | 2.18 % | -0.30 | 0.30 |
| PTB | | -191.88 | 0.857 | 44.22 | 2.81 | -191.28 | 0.851 | 43.88 | 3.22 | 0.33 % | 0.54 % | 0.77 % | 2.78 % | 0.78 % | 2.84 % | -0.41 | 2.02 |
| TUBITAK | | -203.14 | 0.881 | 57.22 | 0.94 | -203.35 | 0.860 | 57.39 | 0.00 | -0.11 % | 0.62 % | 2.47 % | 2.39 % | -0.30 % | 2.13 % | | |
| IATTE | | -199.73 | 0.743 | 47.16 | -0.35 | -197.79 | 0.800 | 46.16 | N/A | 0.96 % | 0.39 % | -7.11 % | 1.97 % | 2.17 % | 2.05 % | N/A | N/A |
| IATTE1 | | -199.73 | 0.743 | 47.16 | -0.35 | -199.39 | 0.724 | 45.54 | 0.00 | 0.17 % | 0.74 % | 2.61 % | 3.16 % | 3.56 % | 2.84 % | | |
| NMIA | | -200.61 | 0.829 | 59.83 | 1.50 | -199.56 | 0.834 | 59.34 | 2.27 | 0.58 % | 0.62 % | -0.54 % | 2.93 % | 0.83 % | 2.25 % | -0.77 | 0.76 |
| VNIIMS | | -211.31 | 0.960 | 45.53 | -1.60 | -212.60 | 0.910 | 45.87 | -1.45 | -0.49 % | 0.48 % | 5.49 % | 2.78 % | -0.75 % | 2.07 % | -0.15 | 0.57 |
| NIM | | -194.95 | 0.854 | 61.61 | 3.78 | -194.27 | 0.829 | 60.96 | 4.32 | 0.47 % | 0.55 % | 2.90 % | 2.45 % | 1.07 % | 2.25 % | -0.54 | 0.85 |
| JHILL | | -201.65 | 0.836 | 63.70 | 0.07 | -200.65 | 0.821 | 63.39 | 0.22 | 0.67 % | 0.62 % | 1.77 % | 2.80 % | 0.49 % | 2.25 % | -0.15 | 0.57 |
| NRC | | -200.05 | 0.862 | 61.77 | 0.30 | -199.92 | 0.843 | 61.19 | 0.61 | 0.40 % | 0.62 % | 2.37 % | 2.78 % | 0.95 % | 2.84 % | -0.30 | 1.04 |
| RISE3 | | -200.55 | 0.882 | 60.31 | 0.96 | -199.62 | 0.851 | 60.21 | 1.05 | 0.59 % | 0.54 % | 3.65 % | 2.16 % | 0.16 % | 2.22 % | -0.09 | 0.31 |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | 0.28 % | 0.60 % | 0.46 | 0 |
| VTT | 0.09 % | 0.42 % | 0.23 | |
| INRIM | 0.21 % | 0.60 % | 0.34 | |
| LCOE | -0.01 % | 0.60 % | -0.02 | |
| LNE | 0.10 % | 0.60 % | 0.17 | |
| RISE2 | 0.02 % | 0.55 % | 0.03 | |
| PTB | 0.06 % | 0.51 % | 0.12 | |
| TUBITAK | -0.38 % | 0.60 % | -0.63 | |
| IATTE | 0.69 % | 0.42 % | 1.65 | 0 |
| IATTE1 | -0.10 % | 0.76 % | -0.14 | 0 |
| NMIA | 0.31 % | 0.60 % | 0.52 | |
| VNIIMS | -0.76 % | 0.45 % | -1.69 | |
| NIM | 0.20 % | 0.52 % | 0.38 | |
| JHILL | 0.40 % | 0.60 % | 0.66 | |
| NRC | 0.12 % | 0.60 % | 0.21 | |
| RISE3 | 0.31 % | 0.56 % | 0.56 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.27 % | 0.16 % | 15 % |



T_1

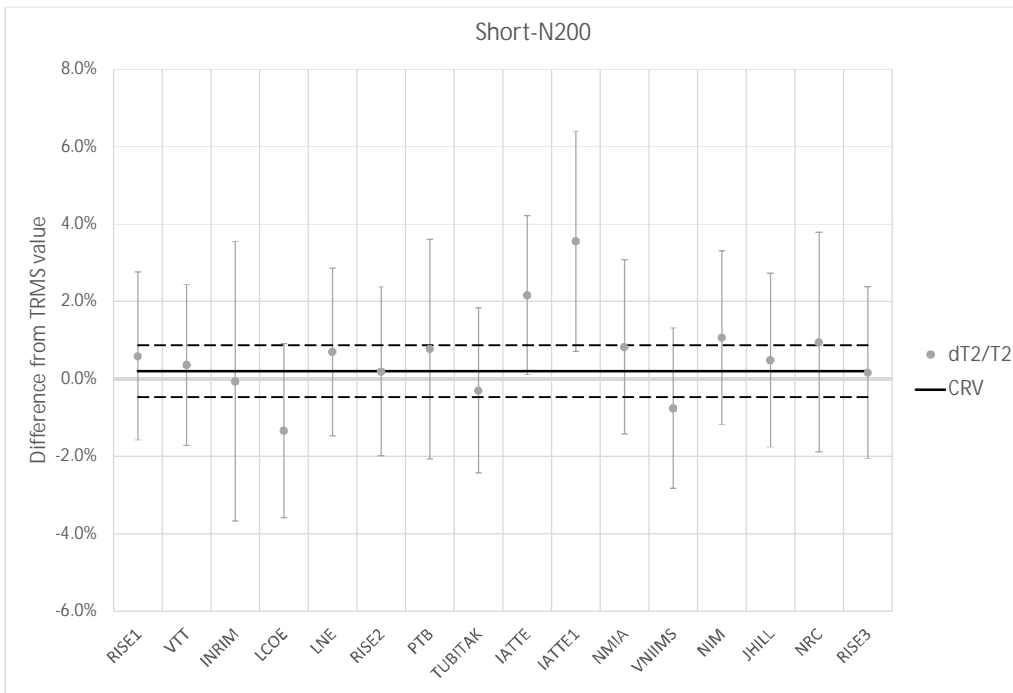
| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -1.39 % | 2.27 % | -0.61 | 0 |
| VTT | -0.60 % | 2.66 % | -0.22 | |
| INRIM | -1.18 % | 3.48 % | -0.34 | |
| LCOE | 0.07 % | 2.68 % | 0.03 | |
| LNE | -0.55 % | 3.07 % | -0.18 | |
| RISE2 | -1.05 % | 1.98 % | -0.53 | |
| PTB | -1.03 % | 2.67 % | -0.39 | |
| TUBITAK | 0.67 % | 2.25 % | 0.30 | |
| IATTE | -8.91 % | 2.12 % | -4.19 | 0 |
| IATTE1 | 0.82 % | 3.25 % | 0.25 | 0 |
| NMIA | -2.33 % | 2.83 % | -0.83 | |
| VNIIMS | 3.70 % | 2.66 % | 1.39 | |
| NIM | 1.10 % | 2.33 % | 0.47 | |
| JHILL | -0.03 % | 2.69 % | -0.01 | |
| NRC | 0.57 % | 2.67 % | 0.21 | |
| RISE3 | 1.85 % | 2.30 % | 0.81 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 1.80 % | 0.78 % | 28 % |

Short-N200

Short-N200

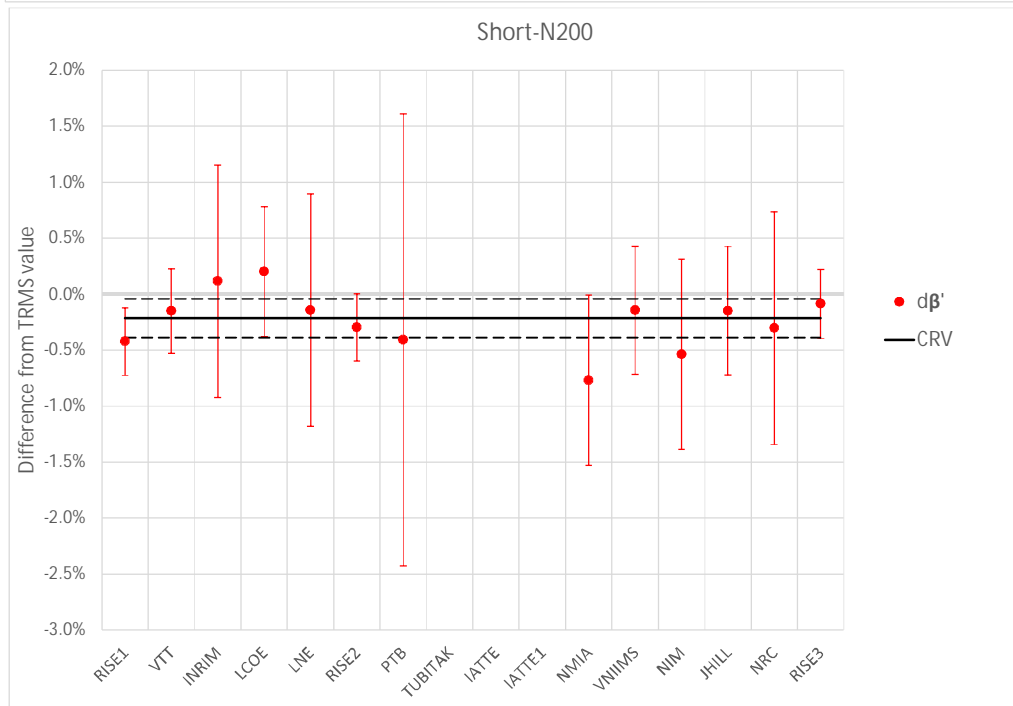
T₂



| Lab | Δx _i | U(Δx _i) | En | Excl. |
|---------|-----------------|---------------------|-------|-------|
| RISE1 | 0.39 % | 2.27 % | 0.17 | 0 |
| VTT | 0.16 % | 1.97 % | 0.08 | |
| INRIM | -0.26 % | 3.55 % | -0.07 | |
| LCOE | -1.54 % | 2.15 % | -0.72 | |
| LNE | 0.50 % | 2.06 % | 0.24 | |
| RISE2 | -0.01 % | 2.08 % | 0.00 | |
| PTB | 0.57 % | 2.76 % | 0.21 | |
| TUBITAK | -0.50 % | 2.02 % | -0.25 | |
| IATTE | 1.96 % | 2.16 % | 0.91 | 0 |
| IATTE1 | 3.35 % | 2.92 % | 1.15 | 0 |
| NMIA | 0.63 % | 2.15 % | 0.29 | |
| VNIIMS | -0.96 % | 1.96 % | -0.49 | |
| NIM | 0.87 % | 2.15 % | 0.40 | |
| JHILL | 0.29 % | 2.14 % | 0.13 | |
| NRC | 0.75 % | 2.76 % | 0.27 | |
| RISE3 | -0.04 % | 2.32 % | -0.02 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.20 % | 0.67 % | 95 % |

β' [%]



| Lab | Δx _i | U(Δx _i) | En | Excl. |
|---------|-----------------|---------------------|-------|-------|
| RISE1 | -0.21 | 0.35 | -0.60 | 0 |
| VTT | 0.06 | 0.34 | 0.19 | |
| INRIM | 0.33 | 1.03 | 0.32 | |
| LCOE | 0.42 | 0.56 | 0.75 | |
| LNE | 0.07 | 1.02 | 0.07 | |
| RISE2 | -0.08 | 0.25 | -0.33 | |
| PTB | -0.20 | 2.01 | -0.10 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.56 | 0.74 | -0.75 | |
| VNIIMS | 0.07 | 0.55 | 0.13 | |
| NIM | -0.32 | 0.83 | -0.39 | |
| JHILL | 0.06 | 0.55 | 0.12 | |
| NRC | -0.09 | 1.02 | -0.09 | |
| RISE3 | 0.13 | 0.35 | 0.36 | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.21 | 0.17 | 84 % |

Short-N300

Short-N300

Setup uncertainties:

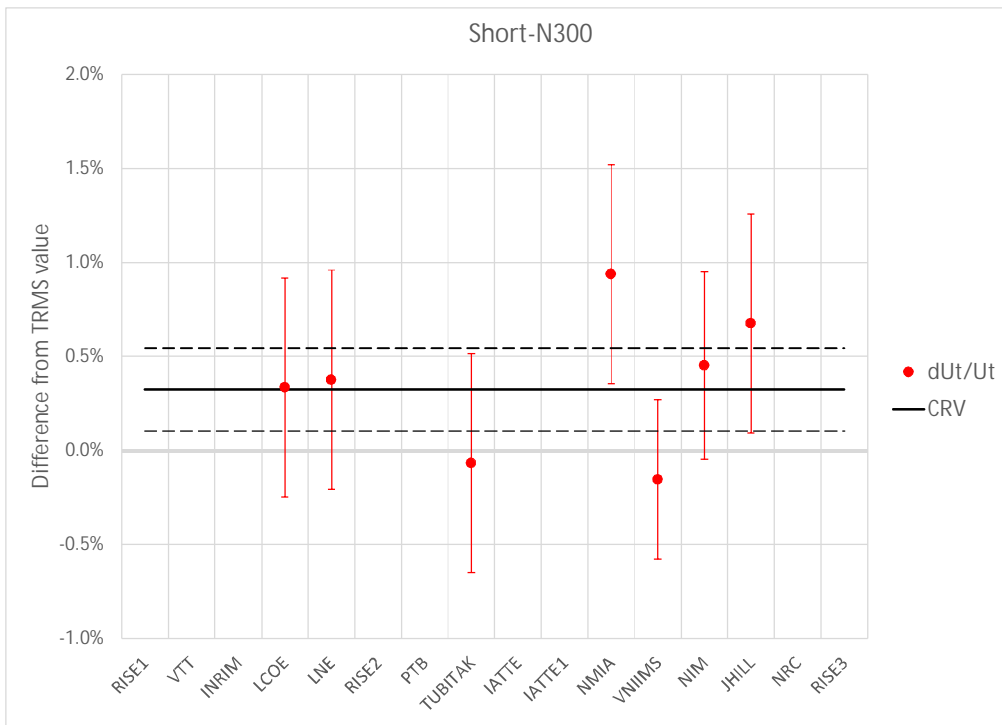
0.17 %

1.87 %

1.99 %

0.28

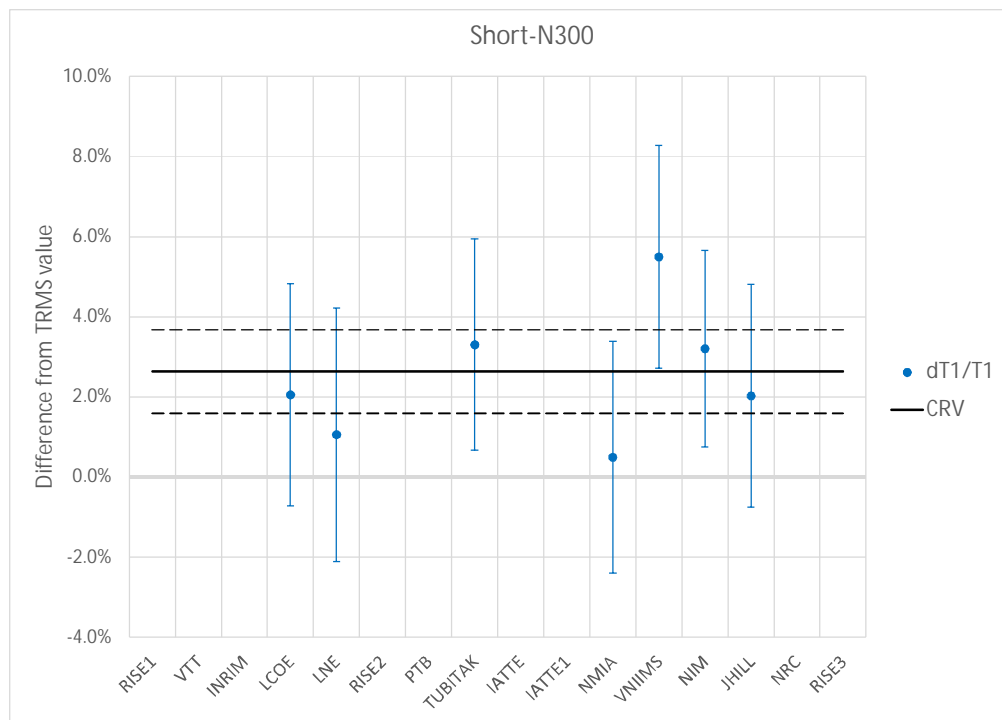
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -300.28 | 0.858 | 55.61 | 1.46 | -299.28 | 0.840 | 56.41 | 1.54 | 0.34 % | 0.62 % | 2.05 % | 2.78 % | -1.42 % | 2.25 % | -0.08 | 0.58 |
| LNE | -298.78 | 0.893 | 52.52 | -0.12 | -297.63 | 0.884 | 52.24 | 0.11 | 0.38 % | 0.62 % | 1.06 % | 3.17 % | 0.53 % | 2.17 % | -0.23 | 1.04 |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -301.39 | 0.880 | 57.34 | 0.83 | -301.60 | 0.851 | 57.44 | #N/A | -0.07 % | 0.62 % | 3.31 % | 2.64 % | -0.18 % | 2.20 % | | #N/A |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | -291.39 | 0.829 | 60.03 | 1.63 | -288.85 | 0.825 | 60.03 | 2.11 | 0.94 % | 0.62 % | 0.50 % | 2.89 % | 0.00 % | 2.25 % | -0.48 | 0.77 |
| VNIIMS | -317.53 | 0.960 | 45.58 | -1.69 | -318.40 | 0.910 | 46.02 | -1.59 | -0.15 % | 0.48 % | 5.49 % | 2.78 % | -0.96 % | 2.07 % | -0.10 | 0.57 |
| NIM | -298.12 | 0.854 | 62.69 | 3.75 | -297.13 | 0.827 | 61.94 | 4.28 | 0.45 % | 0.55 % | 3.21 % | 2.45 % | 1.21 % | 2.25 % | -0.53 | 0.85 |
| JHILL | -302.59 | 0.837 | 63.87 | -0.02 | -301.07 | 0.821 | 63.53 | 0.19 | 0.68 % | 0.62 % | 2.03 % | 2.78 % | 0.54 % | 2.25 % | -0.21 | 0.57 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.01 % | 0.58 % | 0.02 | |
| LNE | 0.05 % | 0.58 % | 0.09 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.39 % | 0.58 % | -0.67 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 0.62 % | 0.58 % | 1.06 | |
| VNIIMS | -0.48 % | 0.42 % | -1.13 | |
| NIM | 0.13 % | 0.50 % | 0.26 | |
| JHILL | 0.35 % | 0.58 % | 0.61 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.32 % | 0.22 % | 9 % |



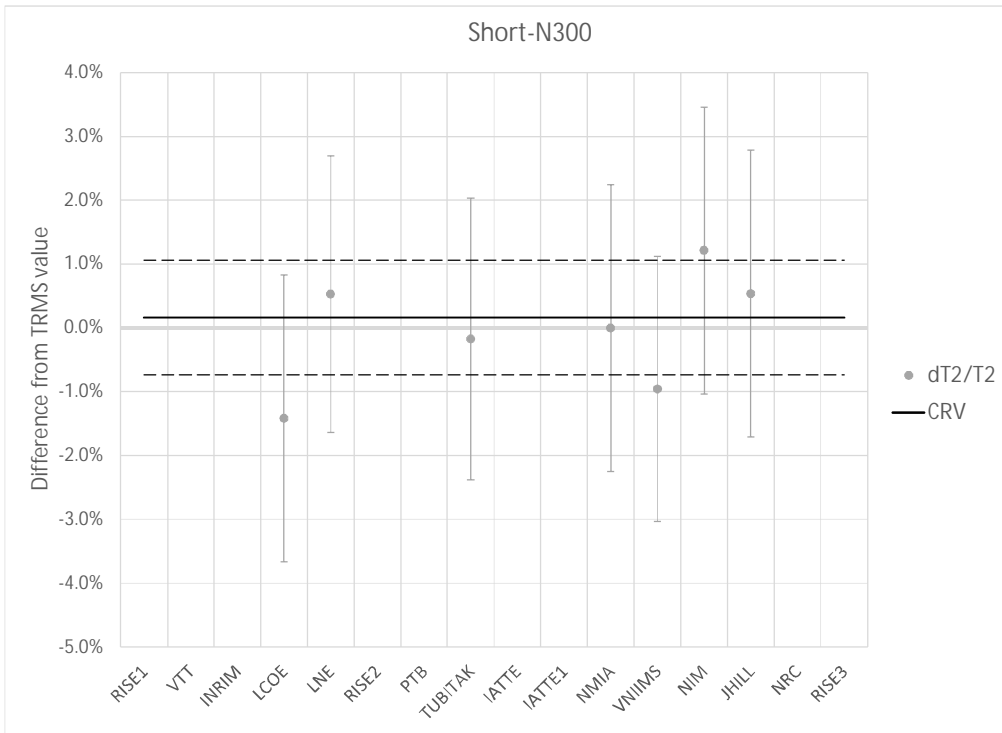
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.58 % | 2.57 % | -0.22 | |
| LNE | -1.57 % | 2.99 % | -0.53 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.68 % | 2.42 % | 0.28 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -2.13 % | 2.69 % | -0.79 | |
| VNIIMS | 2.86 % | 2.57 % | 1.11 | |
| NIM | 0.58 % | 2.22 % | 0.26 | |
| JHILL | -0.60 % | 2.58 % | -0.23 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 2.63 % | 1.04 % | 22 % |

Short-N300

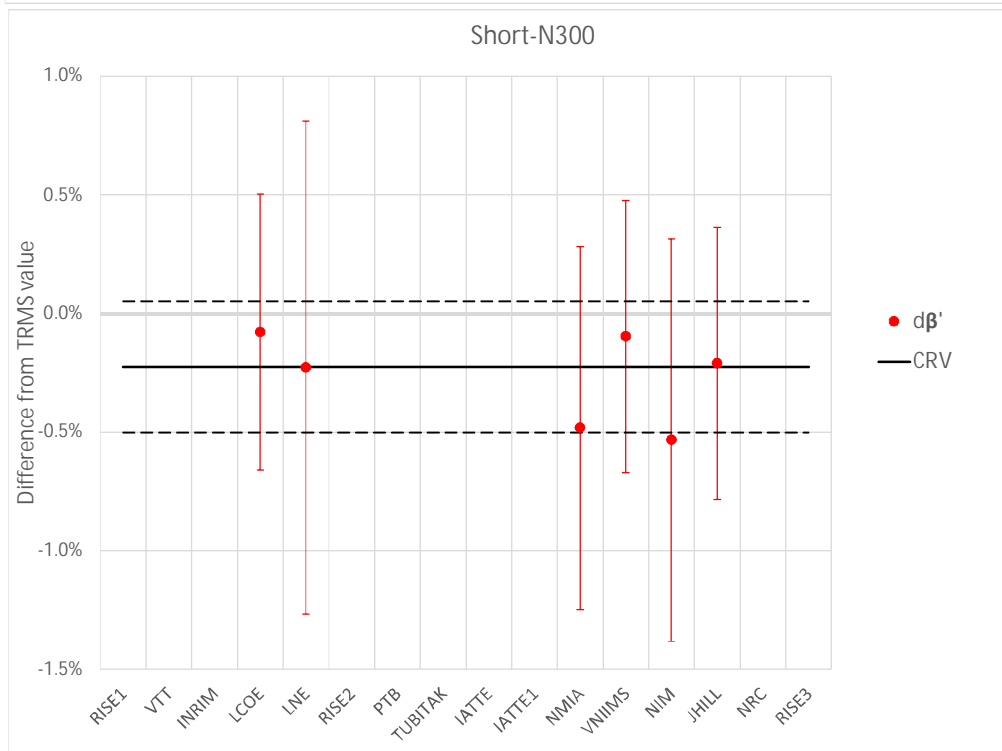
Short-N300



T₂

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -1.58 % | 2.42 % | -0.65 | 2 |
| LNE | 0.37 % | 1.97 % | 0.19 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.34 % | 2.01 % | -0.17 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.16 % | 2.06 % | -0.08 | |
| VNIIMS | -1.12 % | 1.87 % | -0.60 | |
| NIM | 1.05 % | 2.06 % | 0.51 | |
| JHILL | 0.38 % | 2.06 % | 0.18 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.16 % | 0.90 % | 79 % |



β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.15 | 0.51 | 0.29 | |
| LNE | 0.00 | 1.00 | 0.00 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.26 | 0.71 | -0.36 | |
| VNIIMS | 0.13 | 0.50 | 0.26 | |
| NIM | -0.31 | 0.80 | -0.38 | |
| JHILL | 0.01 | 0.50 | 0.03 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.23 | 0.28 | 92 % |

Short-N400

Short-N400

Setup uncertainties:

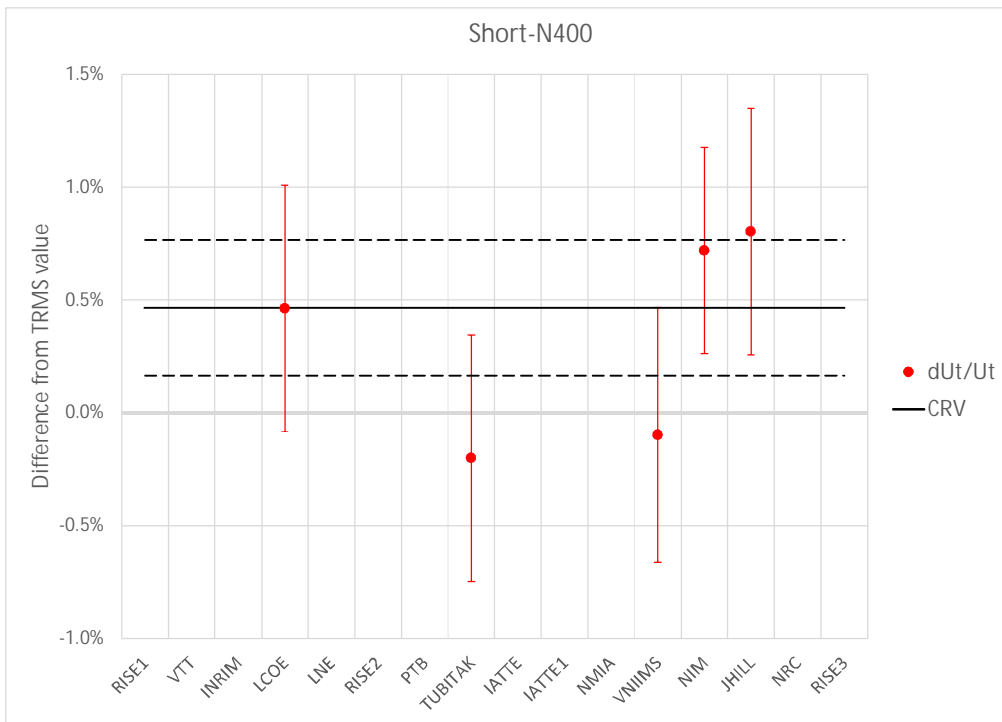
0.17 %

1.87 %

1.99 %

0.28

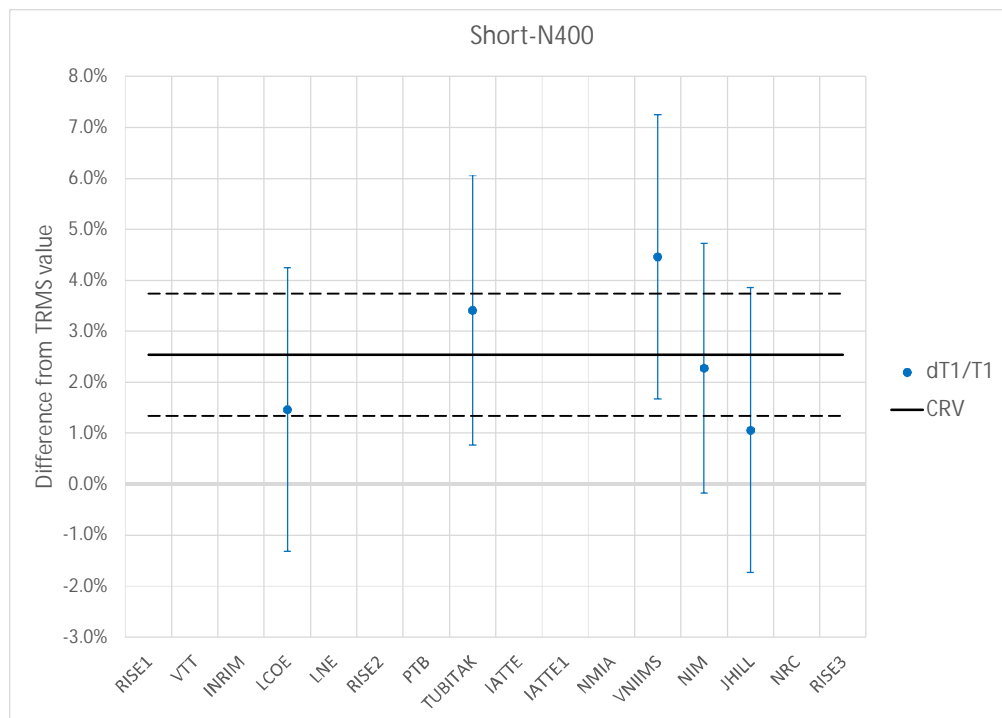
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -400.77 | 0.858 | 55.65 | 1.47 | -398.92 | 0.846 | 56.38 | 1.40 | 0.46 % | 0.62 % | 1.47 % | 2.78 % | -1.29 % | 2.25 % | 0.06 | 0.58 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -399.80 | 0.883 | 57.50 | 0.81 | -400.61 | 0.853 | 57.52 | #N/A | -0.20 % | 0.62 % | 3.41 % | 2.64 % | -0.03 % | 2.21 % | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | -413.31 | 0.960 | 45.53 | -1.49 | -414.21 | 0.919 | 46.06 | -1.62 | -0.10 % | 0.48 % | 4.46 % | 2.79 % | -1.16 % | 2.07 % | 0.13 | 0.57 |
| NIM | -397.03 | 0.885 | 59.69 | 5.41 | -394.67 | 0.865 | 59.26 | 5.63 | 0.72 % | 0.55 % | 2.28 % | 2.45 % | 0.72 % | 2.25 % | -0.22 | 0.85 |
| JHILL | -403.48 | 0.831 | 63.89 | 0.17 | -400.95 | 0.822 | 63.69 | 0.16 | 0.80 % | 0.62 % | 1.06 % | 2.79 % | 0.30 % | 2.25 % | 0.01 | 0.57 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.00 % | 0.55 % | 0.00 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.67 % | 0.55 % | -1.22 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.56 % | 0.56 % | -1.00 | 1 |
| NIM | 0.25 % | 0.46 % | 0.56 | |
| JHILL | 0.34 % | 0.55 % | 0.62 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.47 % | 0.30 % | 9 % |



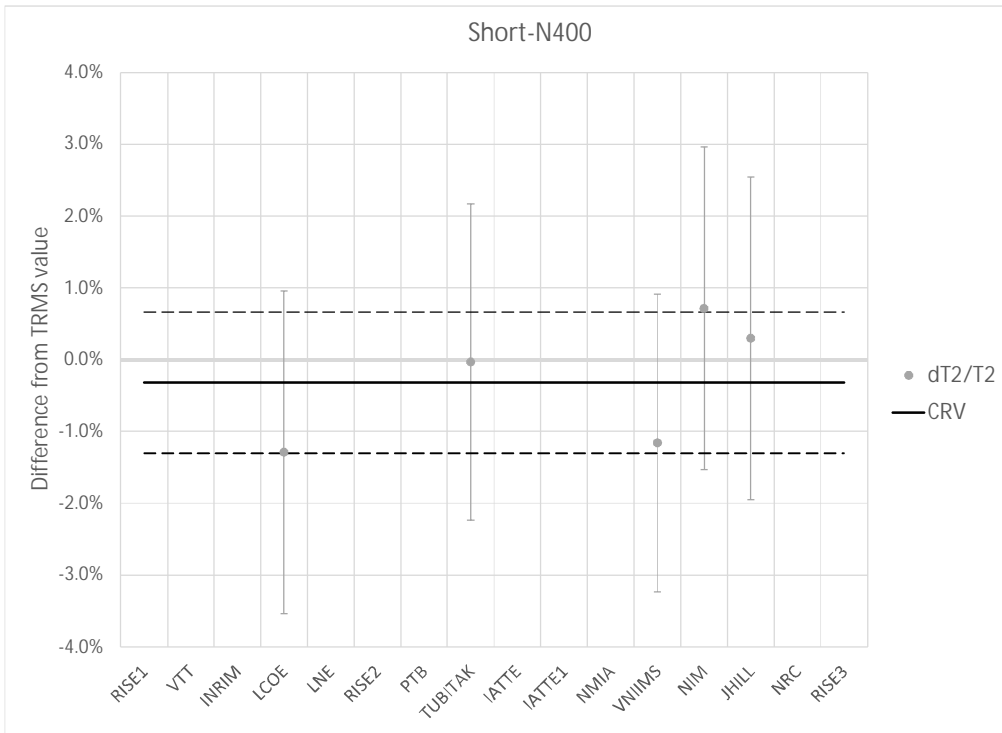
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -1.07 % | 2.51 % | -0.43 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.87 % | 2.35 % | 0.37 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 1.92 % | 2.52 % | 0.76 | |
| NIM | -0.26 % | 2.13 % | -0.12 | |
| JHILL | -1.48 % | 2.52 % | -0.59 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 2.54 % | 1.20 % | 39 % |

Short-N400

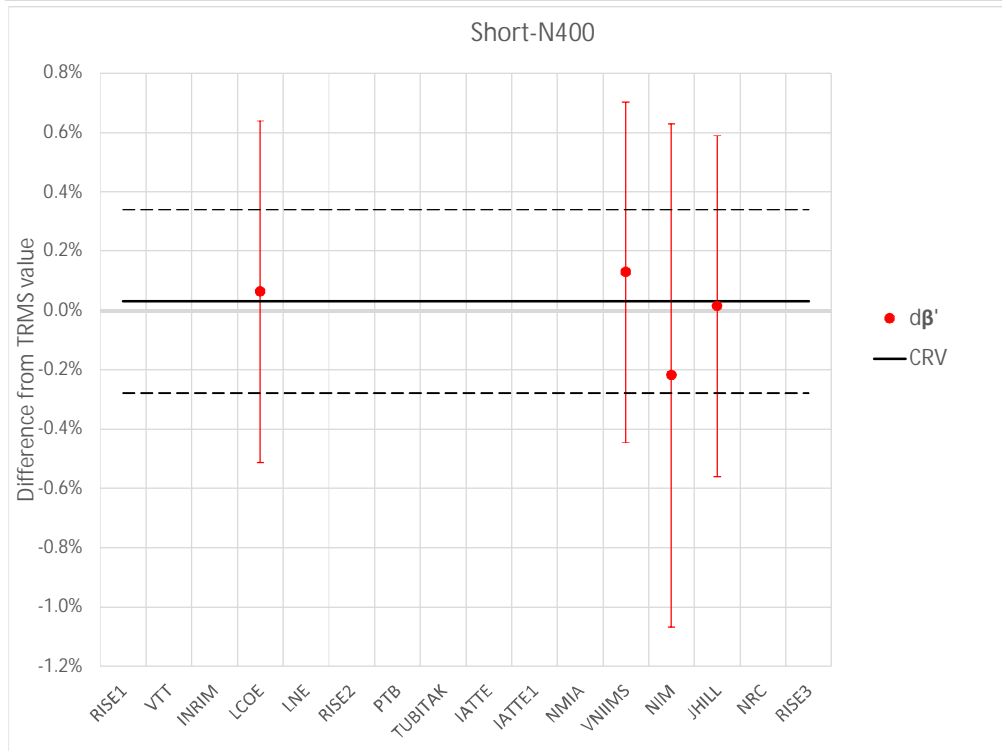
Short-N400



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.97 % | 2.02 % | -0.48 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.29 % | 1.97 % | 0.15 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.84 % | 1.83 % | -0.46 | |
| NIM | 1.04 % | 2.02 % | 0.51 | |
| JHILL | 0.62 % | 2.02 % | 0.31 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.32 % | 0.98 % | 62 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.03 | 0.49 | 0.07 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.10 | 0.48 | 0.20 | |
| NIM | -0.25 | 0.79 | -0.32 | |
| JHILL | -0.02 | 0.48 | -0.03 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.03 | 0.31 | 92 % |

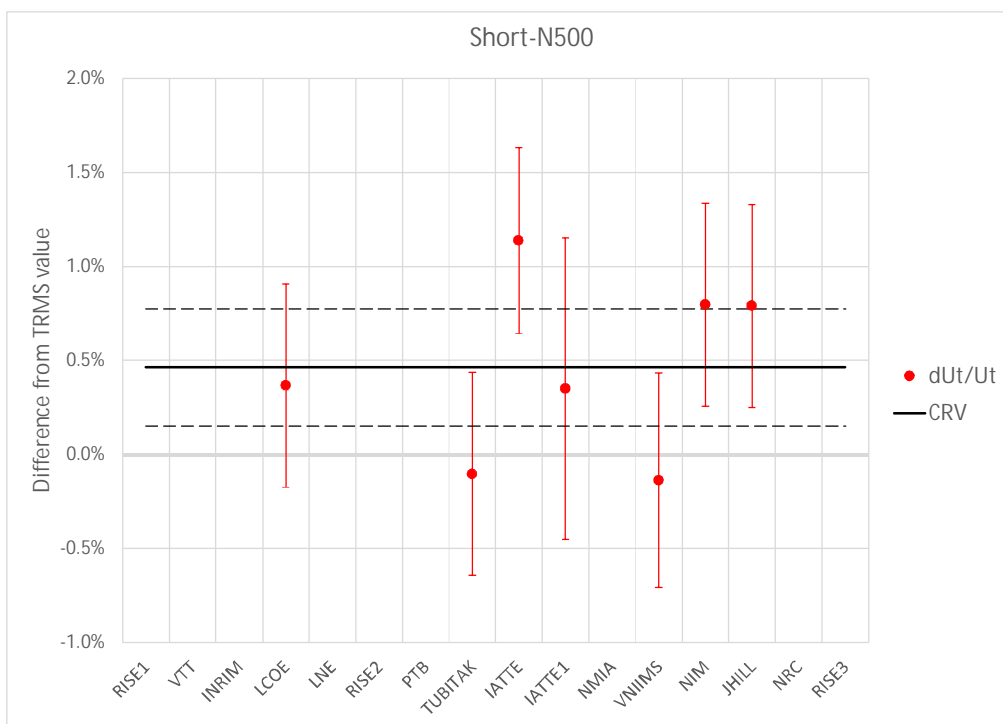
Short-N500

Short-N500

Setup uncertainties:

0.17 % 1.87 % 1.99 % 0.28

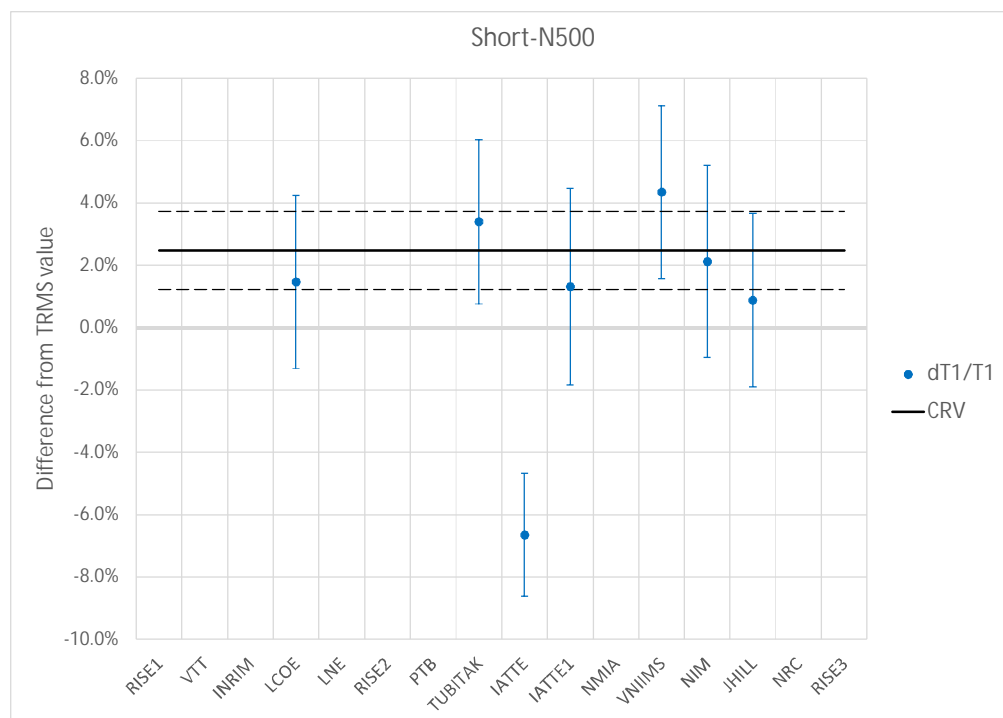
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -500.29 | 0.865 | 55.93 | 1.31 | -498.46 | 0.853 | 56.70 | 1.56 | 0.37 % | 0.62 % | 1.47 % | 2.78 % | -1.36 % | 2.25 % | -0.24 | 0.58 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -500.25 | 0.884 | 57.68 | 0.79 | -500.77 | 0.855 | 57.78 | #N/A | -0.10 % | 0.62 % | 3.40 % | 2.64 % | -0.18 % | 2.20 % | #N/A | #N/A |
| IATTE | -499.49 | 0.746 | 47.93 | -0.23 | -493.77 | 0.799 | 47.88 | #N/A | 1.14 % | 0.39 % | -6.65 % | 1.97 % | 0.11 % | 2.05 % | #N/A | #N/A |
| IATTE1 | -499.49 | 0.746 | 47.93 | -0.23 | -497.75 | 0.736 | 46.42 | #N/A | 0.35 % | 0.74 % | 1.32 % | 3.16 % | 3.26 % | 2.84 % | #N/A | #N/A |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | -518.70 | 0.960 | 45.60 | -1.55 | -520.04 | 0.920 | 46.16 | -1.63 | -0.14 % | 0.48 % | 4.35 % | 2.78 % | -1.22 % | 2.07 % | 0.07 | 0.57 |
| NIM | -510.98 | 0.885 | 59.92 | 5.32 | -507.55 | 0.867 | 59.76 | 5.55 | 0.80 % | 0.62 % | 2.13 % | 3.08 % | 0.28 % | 2.51 % | -0.22 | 0.85 |
| JHILL | -504.22 | 0.834 | 64.10 | 0.11 | -501.12 | 0.827 | 63.90 | 0.15 | 0.79 % | 0.62 % | 0.89 % | 2.79 % | 0.31 % | 2.25 % | -0.05 | 0.57 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.10 % | 0.54 % | -0.18 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.57 % | 0.54 % | -1.05 | |
| IATTE | 0.68 % | 0.50 % | 1.36 | 0 |
| IATTE1 | -0.11 % | 0.80 % | -0.14 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.60 % | 0.57 % | -1.05 | 1 |
| NIM | 0.33 % | 0.54 % | 0.62 | |
| JHILL | 0.33 % | 0.54 % | 0.61 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.46 % | 0.31 % | 13 % |



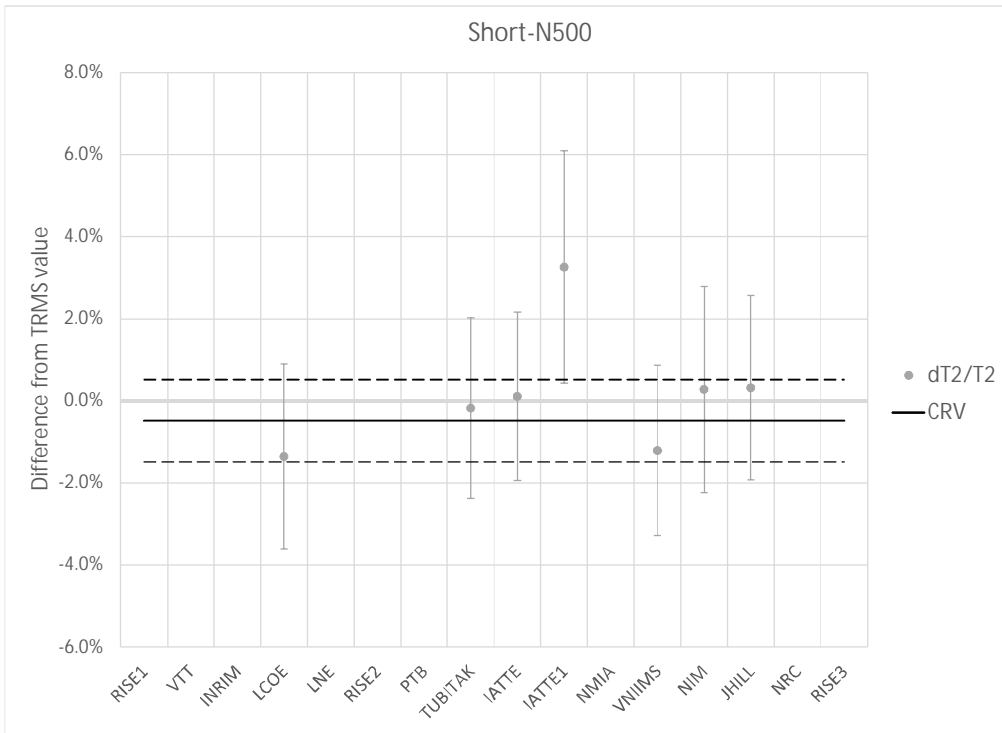
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -1.02 % | 2.48 % | -0.41 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.92 % | 2.32 % | 0.40 | |
| IATTE | -9.13 % | 2.34 % | -3.91 | 0 |
| IATTE1 | -1.16 % | 3.40 % | -0.34 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 1.87 % | 2.48 % | 0.75 | |
| NIM | -0.35 % | 2.82 % | -0.13 | |
| JHILL | -1.60 % | 2.49 % | -0.64 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 2.48 % | 1.25 % | 38 % |

Short-N500

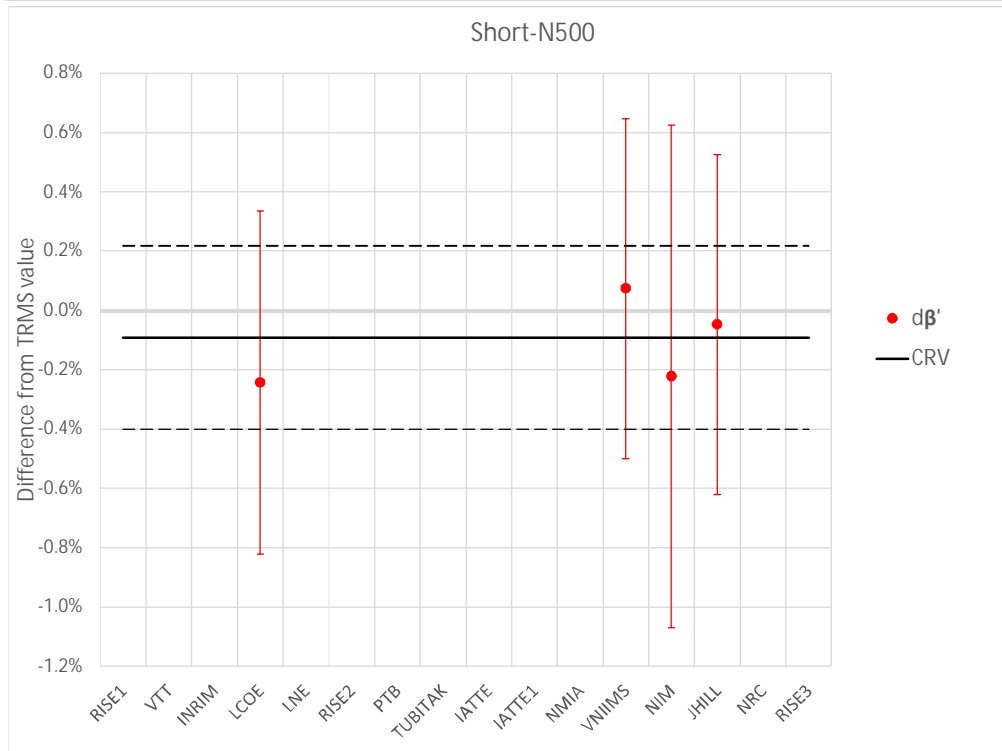
Short-N500



T_2

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.88 % | 2.01 % | -0.43 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.31 % | 1.96 % | 0.16 | |
| IATTE | 0.60 % | 2.29 % | 0.26 | 0 |
| IATTE1 | 3.74 % | 3.01 % | 1.24 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.73 % | 1.81 % | -0.40 | |
| NIM | 0.76 % | 2.30 % | 0.33 | |
| JHILL | 0.80 % | 2.01 % | 0.40 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.49 % | 1.00 % | 73 % |



β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.15 | 0.49 | -0.31 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.16 | 0.48 | 0.34 | |
| NIM | -0.13 | 0.79 | -0.17 | |
| JHILL | 0.04 | 0.48 | 0.09 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.09 | 0.31 | 87 % |

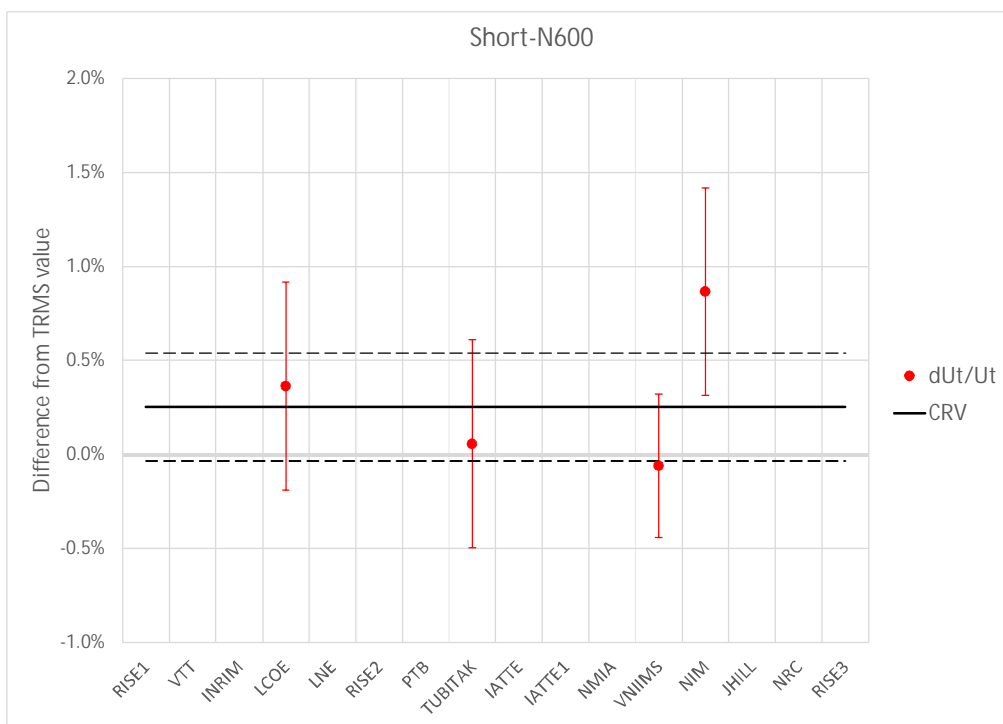
Short-N600

Short-N600

Setup uncertainties:

0.17 % 1.87 % 1.99 % 0.28

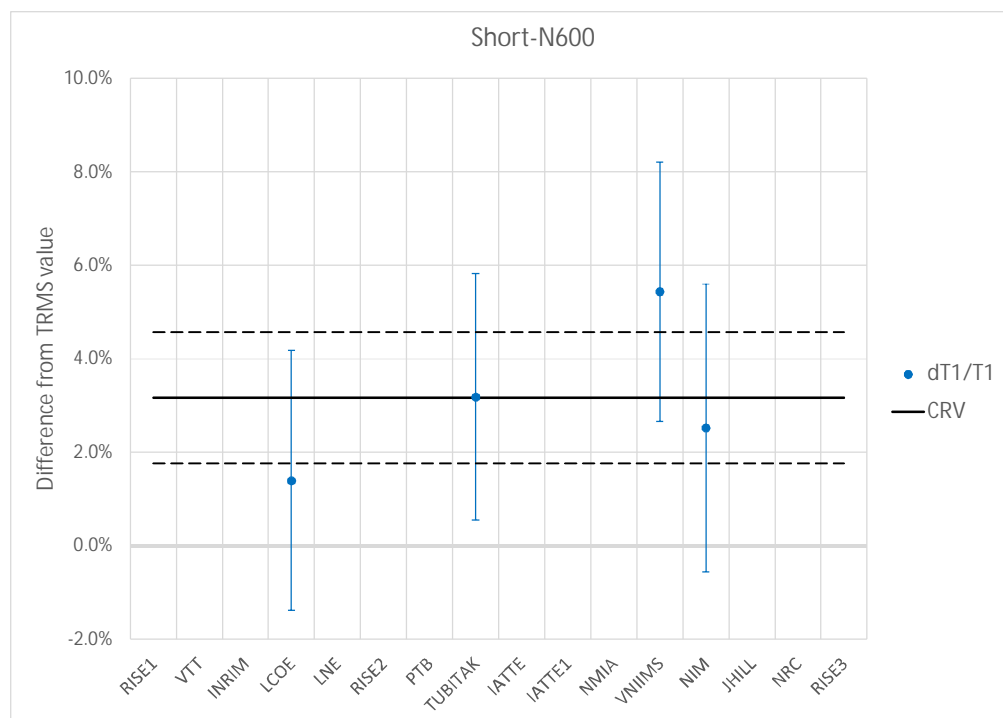
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -598.74 | 0.864 | 56.20 | 1.18 | -596.58 | 0.852 | 56.98 | 1.43 | 0.36 % | 0.62 % | 1.40 % | 2.78 % | -1.37 % | 2.25 % | -0.25 | 0.58 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -600.44 | 0.886 | 58.00 | 0.61 | -600.11 | 0.859 | 58.09 | #N/A | 0.06 % | 0.62 % | 3.19 % | 2.64 % | -0.14 % | 2.21 % | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | -619.50 | 0.970 | 45.69 | -1.60 | -620.62 | 0.920 | 46.32 | -1.75 | -0.06 % | 0.48 % | 5.43 % | 2.78 % | -1.35 % | 2.07 % | 0.15 | 0.57 |
| NIM | -602.00 | 0.892 | 60.29 | 5.37 | -597.55 | 0.870 | 60.23 | 5.52 | 0.87 % | 0.62 % | 2.52 % | 3.08 % | 0.10 % | 2.51 % | -0.16 | 0.85 |
| JHILL | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.11 % | 0.55 % | 0.20 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.20 % | 0.55 % | -0.35 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.31 % | 0.38 % | -0.82 | |
| NIM | 0.62 % | 0.55 % | 1.11 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.25 % | 0.29 % | 11 % |



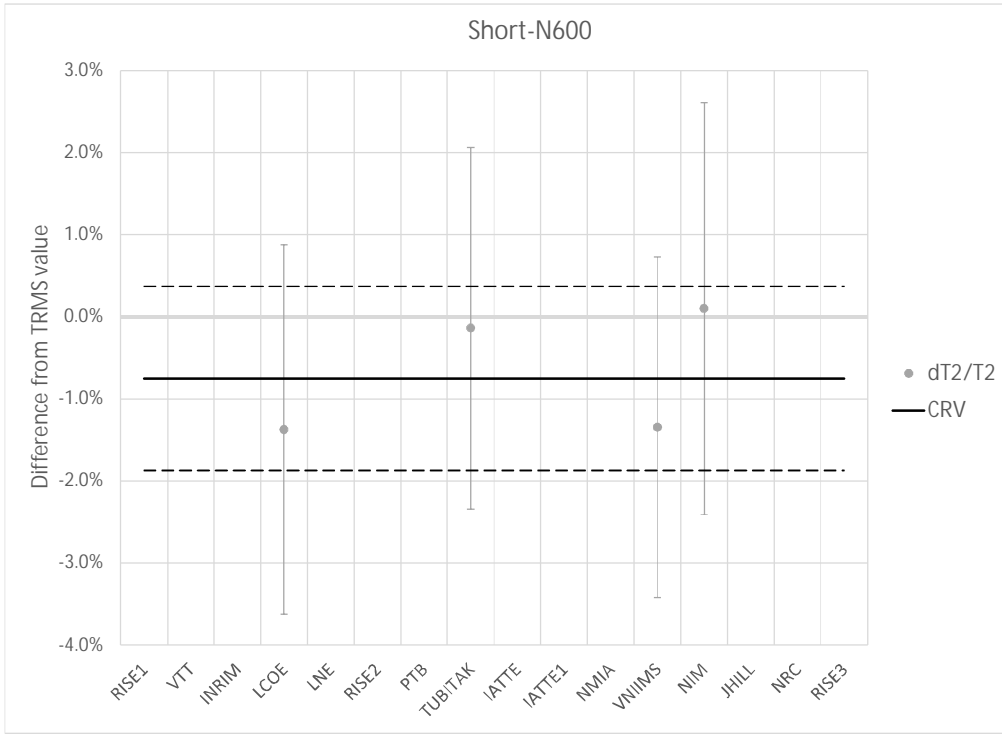
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -1.77 % | 2.40 % | -0.74 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.02 % | 2.24 % | 0.01 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 2.27 % | 2.40 % | 0.95 | |
| NIM | -0.65 % | 2.74 % | -0.24 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 3.17 % | 1.40 % | 22 % |

Short-N600

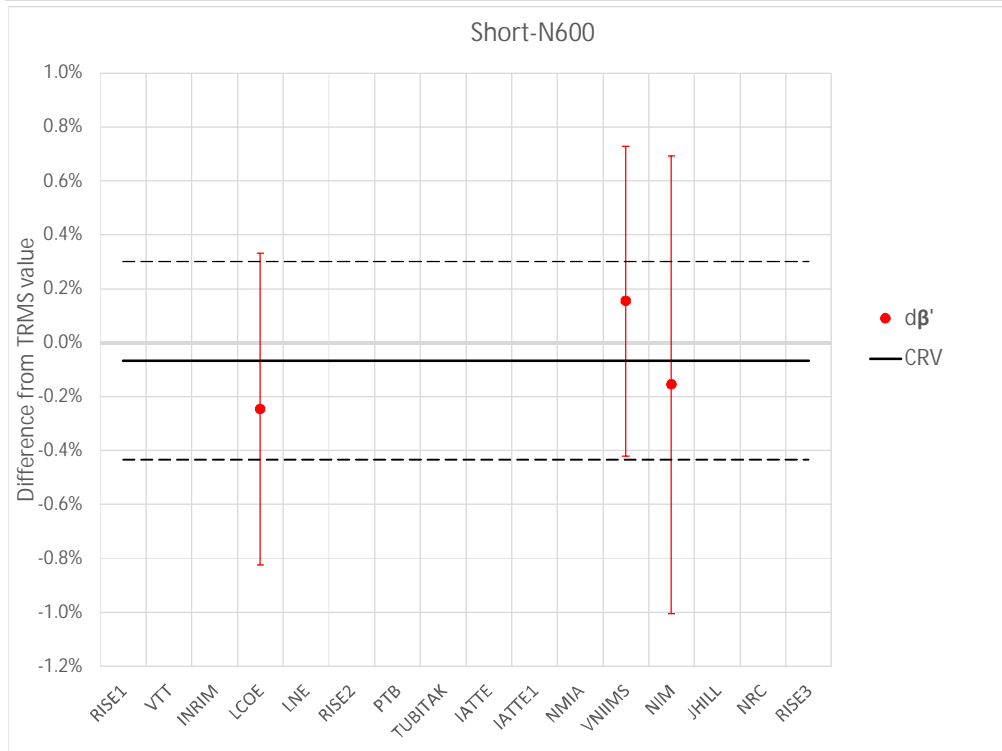
Short-N600



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.62 % | 1.95 % | -0.32 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.61 % | 1.90 % | 0.32 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.59 % | 1.74 % | -0.34 | |
| NIM | 0.85 % | 2.25 % | 0.38 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.75 % | 1.12 % | 70 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.18 | 0.45 | -0.40 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.22 | 0.44 | 0.50 | |
| NIM | -0.09 | 0.76 | -0.12 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.07 | 0.37 | 60 % |

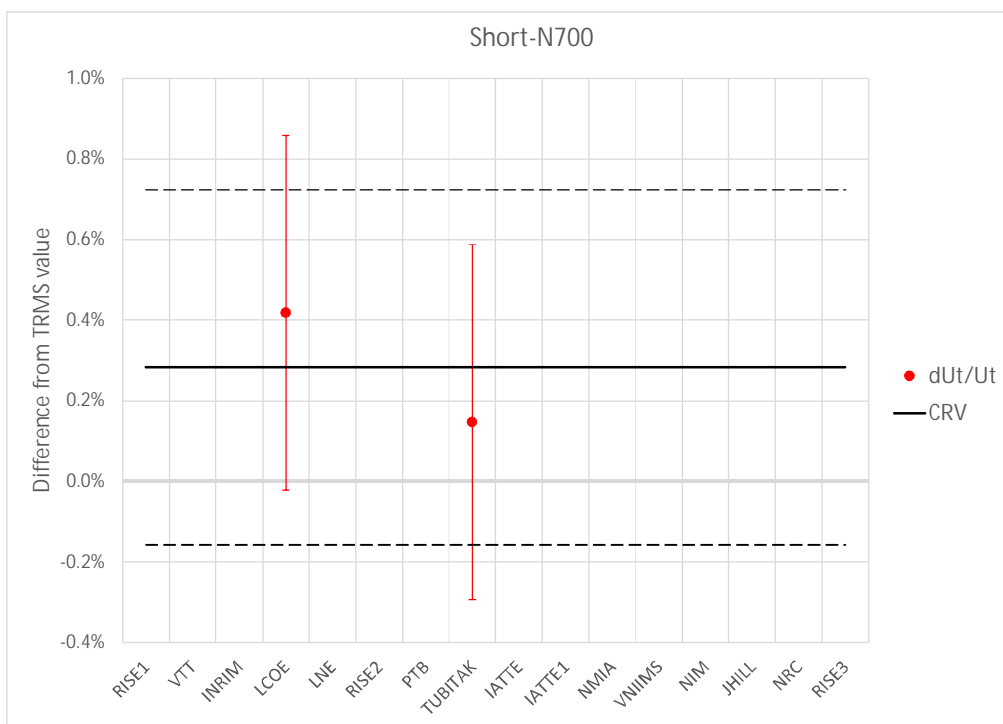
Short-N700

Short-N700

Setup uncertainties:

0.17 % 1.87 % 1.99 % 0.28

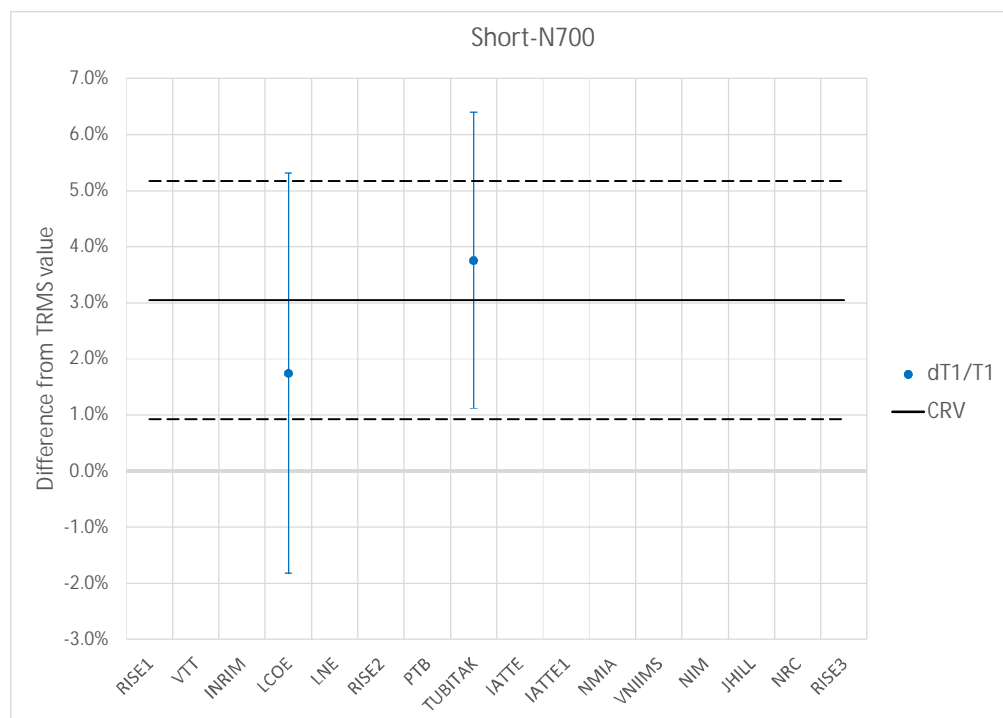
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -697.49 | 0.873 | 55.84 | 2.27 | -694.58 | 0.858 | 56.61 | 2.31 | 0.42 % | 0.62 % | 1.75 % | 3.57 % | -1.36 % | 2.25 % | -0.04 | 0.58 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -699.18 | 0.889 | 58.23 | 0.49 | -698.15 | 0.857 | 58.54 | #N/A | 0.15 % | 0.62 % | 3.76 % | 2.64 % | -0.52 % | 2.20 % | #N/A | #N/A |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| JHILL | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.14 % | 0.44 % | 0.31 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.14 % | 0.44 % | -0.31 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.28 % | 0.44 % | 54 % |



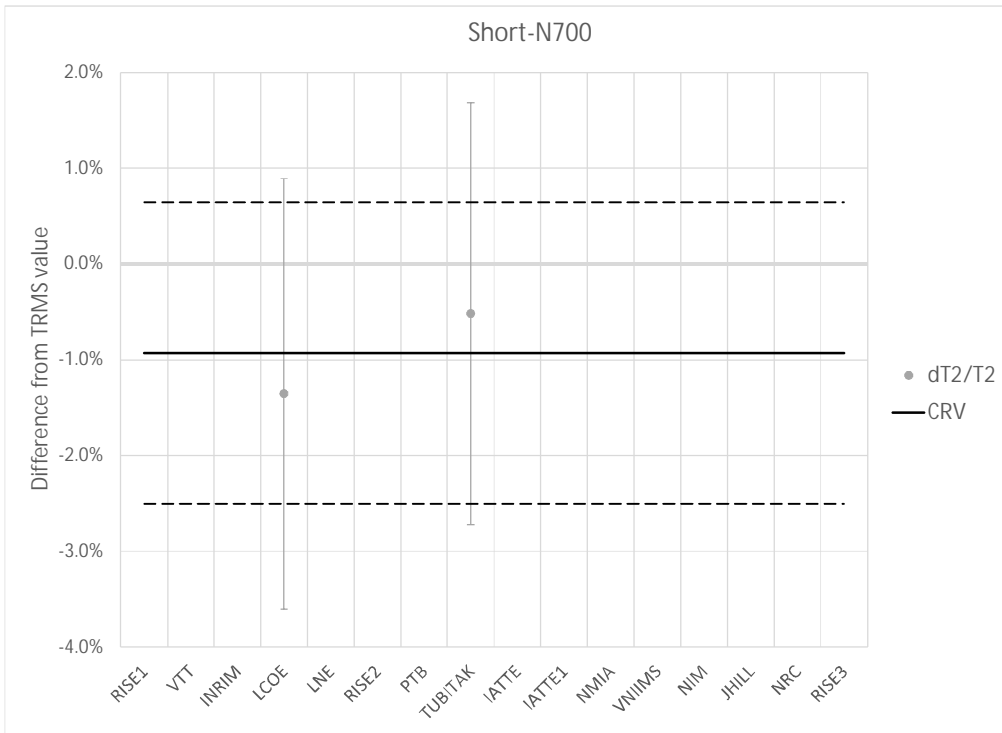
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -1.30 % | 2.87 % | -0.45 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.71 % | 1.57 % | 0.45 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 3.05 % | 2.12 % | 37 % |

Short-N700

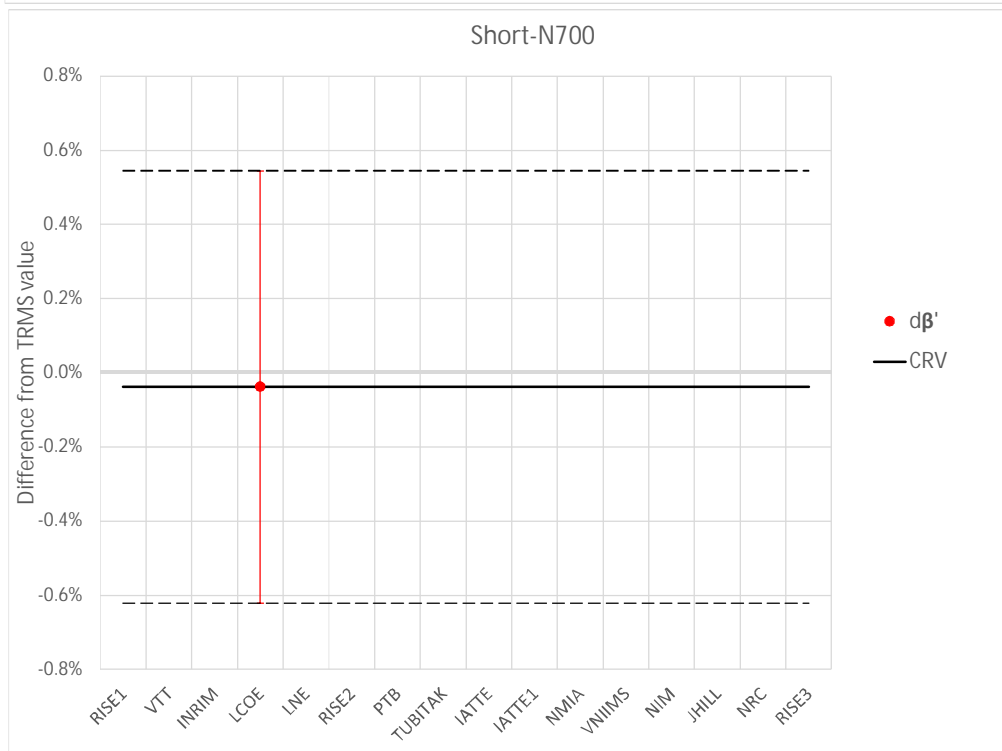
Short-N700



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.43 % | 1.60 % | -0.27 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.41 % | 1.54 % | 0.27 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.93 % | 1.57 % | 60 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|---------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.00 | 0.00 | #DIV/0! | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|-------|
| -0.04 | 0.58 | #NUM! |

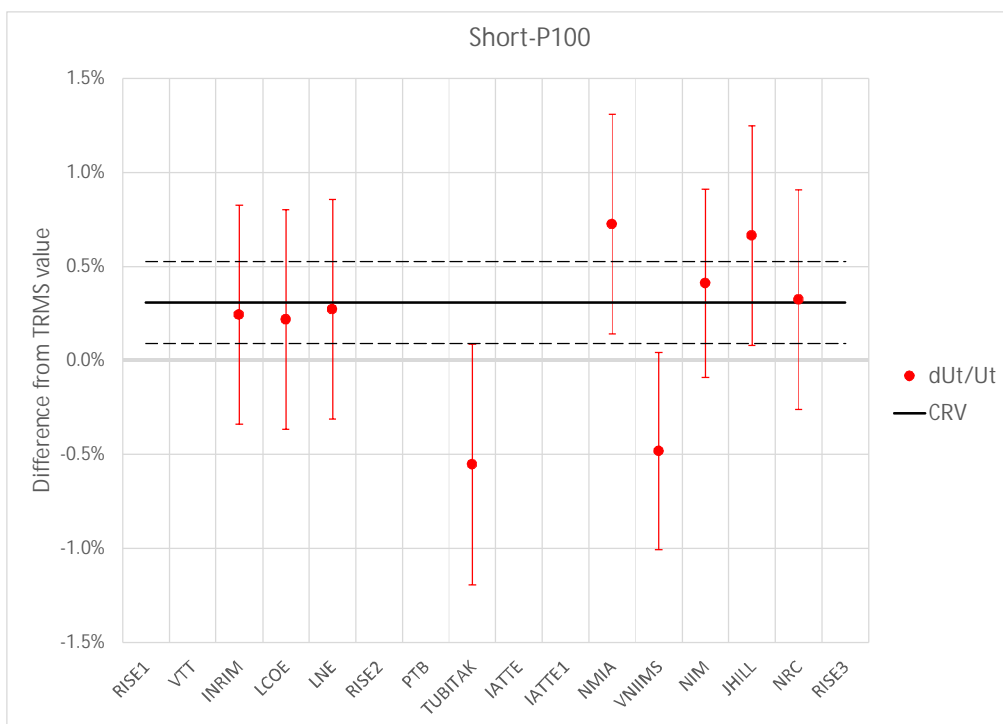
Short-P100

Short-P100

Setup uncertainties:

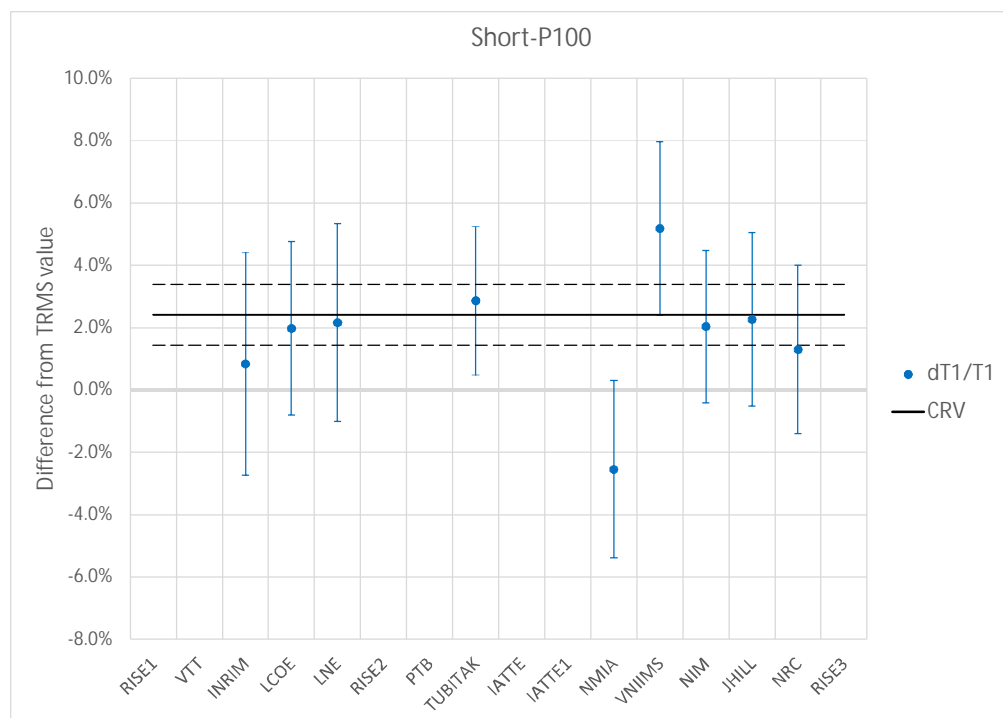
0.17% 1.87% 1.99% 0.28

| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|-------|--------------------------|-------|------------|-------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | 101.96 | 0.847 | 41.15 | -0.82 | 101.71 | 0.840 | 41.03 | -0.73 | 0.24% | 0.62% | 0.84% | 3.57% | 0.28% | 3.61% | -0.09 | 1.04 |
| LCOE | 100.16 | 0.861 | 55.46 | 1.87 | 99.94 | 0.845 | 56.13 | 1.52 | 0.22% | 0.62% | 1.98% | 2.78% | -1.19% | 2.25% | 0.35 | 0.58 |
| LNE | 104.17 | 0.907 | 51.21 | 0.08 | 103.88 | 0.888 | 50.79 | 0.02 | 0.27% | 0.62% | 2.17% | 3.18% | 0.84% | 2.17% | 0.06 | 1.06 |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | 101.01 | 0.881 | 57.48 | 0.52 | 101.58 | 0.856 | 57.24 | #N/A | -0.55% | 0.68% | 2.86% | 2.38% | 0.41% | 2.13% | #N/A | #N/A |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | 100.83 | 0.806 | 59.81 | 1.40 | 100.16 | 0.828 | 59.06 | 2.11 | 0.73% | 0.62% | -2.54% | 2.85% | 1.26% | 2.25% | -0.71 | 0.76 |
| VNIIMS | 108.08 | 0.971 | 45.56 | -1.57 | 108.73 | 0.923 | 45.81 | -1.44 | -0.48% | 0.48% | 5.19% | 2.79% | -0.56% | 2.07% | -0.13 | 0.57 |
| NIM | 97.49 | 0.843 | 60.94 | 3.84 | 97.21 | 0.826 | 60.20 | 4.54 | 0.41% | 0.55% | 2.04% | 2.45% | 1.23% | 2.25% | -0.70 | 0.86 |
| JHILL | 100.65 | 0.832 | 63.78 | -0.03 | 100.15 | 0.814 | 63.33 | 0.21 | 0.66% | 0.62% | 2.27% | 2.78% | 0.70% | 2.25% | -0.23 | 0.57 |
| NRC | -98.98 | 0.854 | 61.66 | 0.17 | -98.99 | 0.843 | 61.06 | 0.60 | 0.32% | 0.62% | 1.30% | 2.71% | 0.99% | 2.84% | -0.42 | 1.04 |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -0.07% | 0.58% | -0.11 | |
| LCOE | -0.09% | 0.58% | -0.15 | |
| LNE | -0.04% | 0.58% | -0.06 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.86% | 0.64% | -1.35 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 0.42% | 0.58% | 0.71 | |
| VNIIMS | -0.79% | 0.53% | -1.50 | 1 |
| NIM | 0.10% | 0.50% | 0.21 | |
| JHILL | 0.36% | 0.58% | 0.61 | |
| NRC | 0.02% | 0.58% | 0.03 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|-----|
| 0.31% | 0.22% | 20% |

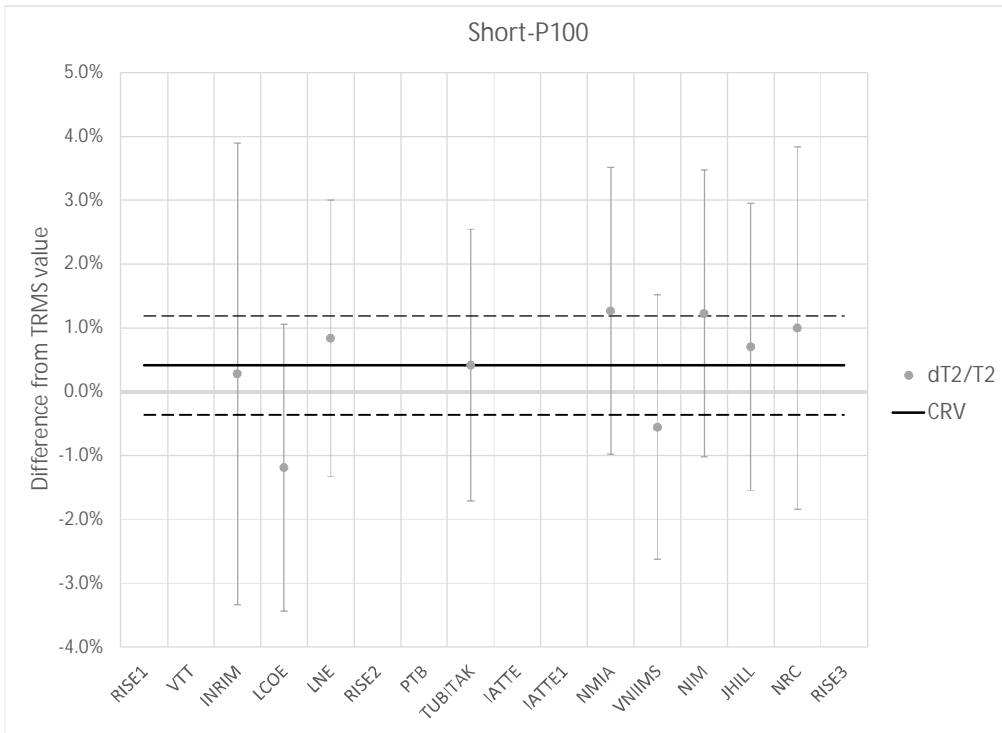


| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -1.57% | 3.43% | -0.46 | |
| LCOE | -0.43% | 2.61% | -0.17 | |
| LNE | -0.25% | 3.03% | -0.08 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.45% | 2.17% | 0.21 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -4.95% | 3.02% | -1.64 | 1 |
| VNIIMS | 2.78% | 2.61% | 1.06 | |
| NIM | -0.37% | 2.24% | -0.17 | |
| JHILL | -0.15% | 2.61% | -0.06 | |
| NRC | -1.11% | 2.53% | -0.44 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|-----|
| 2.41% | 0.98% | 57% |

Short-P100

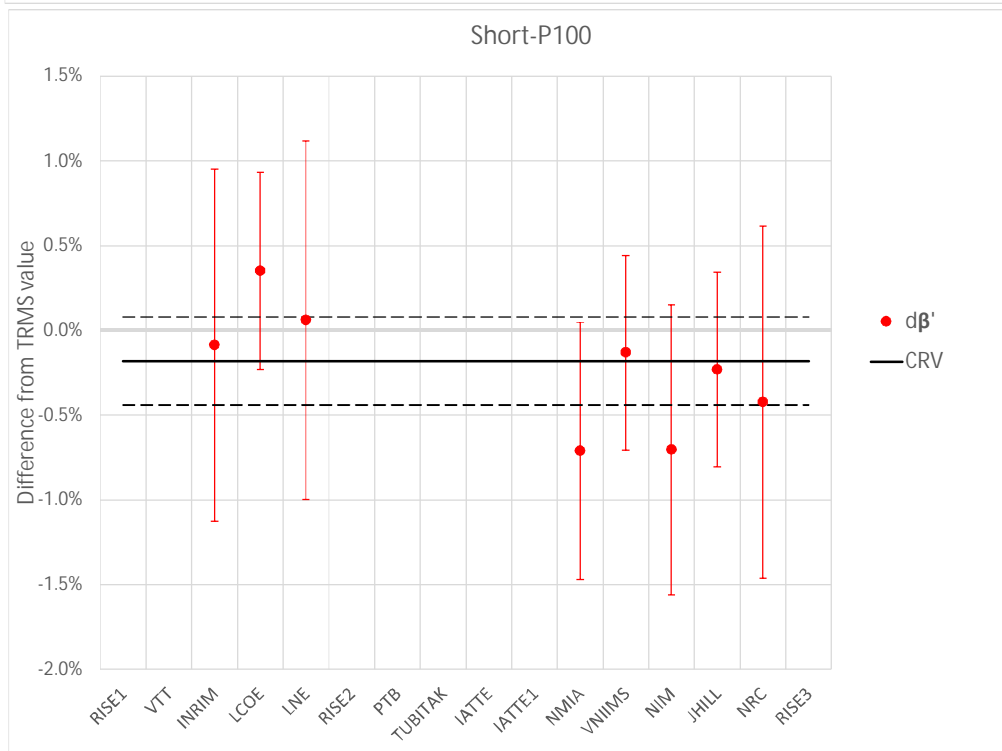
Short-P100



| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.41 % | 0.78 % | 82 % |

T_2

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -0.13 % | 3.53 % | -0.04 | |
| LCOE | -1.60 % | 2.11 % | -0.76 | |
| LNE | 0.43 % | 2.02 % | 0.21 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.00 % | 1.98 % | 0.00 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 0.85 % | 2.11 % | 0.40 | |
| VNIIMS | -0.97 % | 1.92 % | -0.50 | |
| NIM | 0.81 % | 2.11 % | 0.39 | |
| JHILL | 0.29 % | 2.11 % | 0.14 | |
| NRC | 0.58 % | 2.73 % | 0.21 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |



| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.18 | 0.26 | 40 % |

β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.09 | 1.01 | 0.09 | |
| LCOE | 0.53 | 0.52 | 1.02 | |
| LNE | 0.24 | 1.02 | 0.23 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.53 | 0.71 | -0.75 | |
| VNIIMS | 0.05 | 0.51 | 0.10 | |
| NIM | -0.52 | 0.82 | -0.64 | |
| JHILL | -0.05 | 0.51 | -0.10 | |
| NRC | -0.24 | 1.01 | -0.24 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

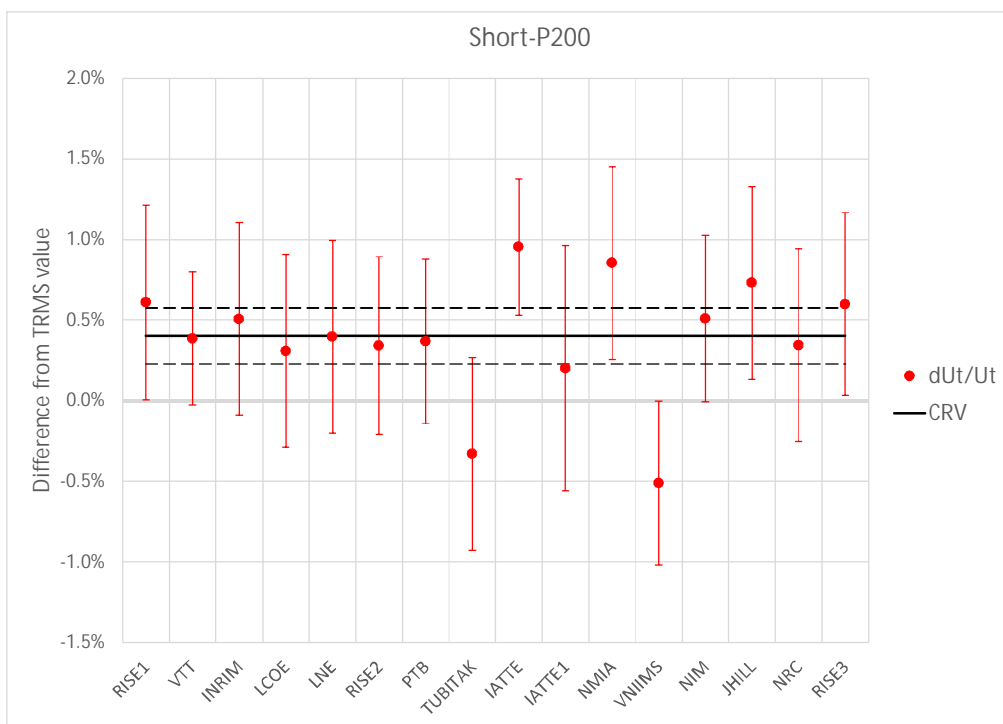
Short-P200

Short-P200

Setup uncertainties:

0.17 % 1.87 % 1.99 % 0.28

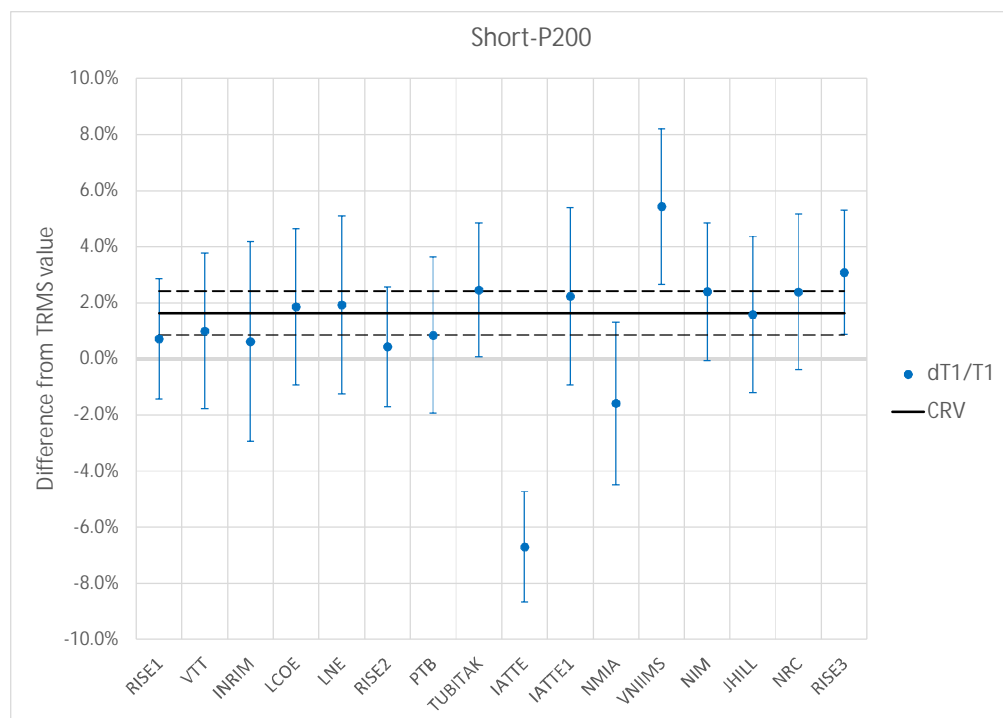
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|-------|--------------------------|-------|------------|-------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | 199.45 | 0.849 | 40.43 | 2.58 | 198.24 | 0.843 | 40.17 | 3.04 | 0.61% | 0.58% | 0.72% | 2.14% | 0.67% | 2.17% | -0.46 | 0.30 |
| VTT | 202.09 | 0.849 | 40.99 | 2.69 | 201.32 | 0.842 | 40.80 | 2.93 | 0.39% | 0.45% | 0.99% | 2.77% | 0.48% | 2.08% | -0.24 | 0.38 |
| INRIM | 201.84 | 0.848 | 41.18 | -0.92 | 200.82 | 0.843 | 41.18 | -0.99 | 0.51% | 0.62% | 0.62% | 3.57% | 0.00% | 3.61% | 0.07 | 1.04 |
| LCOE | 199.79 | 0.855 | 55.48 | 1.59 | 199.17 | 0.840 | 56.22 | 1.51 | 0.31% | 0.62% | 1.86% | 2.79% | -1.32% | 2.25% | 0.08 | 0.58 |
| LNE | 200.26 | 0.898 | 51.57 | -0.13 | 199.45 | 0.881 | 51.24 | 0.00 | 0.40% | 0.62% | 1.92% | 3.18% | 0.65% | 2.17% | -0.13 | 1.04 |
| RISE2 | 197.44 | 0.840 | 40.33 | 2.75 | 196.78 | 0.837 | 40.29 | 2.98 | 0.34% | 0.58% | 0.43% | 2.14% | 0.11% | 2.18% | -0.23 | 0.30 |
| PTB | 195.01 | 0.859 | 44.22 | 2.81 | 194.33 | 0.852 | 43.87 | 3.29 | 0.37% | 0.54% | 0.84% | 2.79% | 0.80% | 2.84% | -0.48 | 2.02 |
| TUBITAK | 201.95 | 0.877 | 57.34 | 0.99 | 202.61 | 0.856 | 57.31 | N/A | -0.33% | 0.62% | 2.46% | 2.38% | 0.04% | 2.13% | N/A | N/A |
| IATTE | 201.11 | 0.745 | 47.18 | -0.35 | 199.17 | 0.799 | 47.15 | N/A | 0.95% | 0.39% | -6.71% | 1.97% | 0.06% | 2.06% | N/A | N/A |
| IATTE1 | 201.11 | 0.745 | 47.18 | -0.35 | 200.70 | 0.729 | 45.74 | N/A | 0.20% | 0.74% | 2.23% | 3.16% | 3.14% | 2.84% | N/A | N/A |
| NMIA | 202.50 | 0.807 | 59.84 | 1.46 | 200.91 | 0.820 | 59.08 | 2.29 | 0.86% | 0.62% | -1.59% | 2.90% | 1.30% | 2.25% | -0.83 | 0.76 |
| VNIIMS | 209.78 | 0.970 | 45.58 | -1.58 | 211.11 | 0.920 | 45.87 | -1.48 | -0.51% | 0.48% | 5.43% | 2.78% | -0.65% | 2.07% | -0.10 | 0.57 |
| NIM | 194.79 | 0.853 | 61.32 | 3.95 | 194.04 | 0.833 | 60.64 | 4.45 | 0.51% | 0.55% | 2.39% | 2.44% | 1.12% | 2.25% | -0.51 | 0.85 |
| JHILL | 201.73 | 0.848 | 63.67 | 0.05 | 200.61 | 0.835 | 63.32 | 0.24 | 0.73% | 0.62% | 1.57% | 2.78% | 0.56% | 2.25% | -0.20 | 0.57 |
| NRC | 199.92 | 0.861 | 61.82 | 0.24 | 199.90 | 0.841 | 61.15 | 0.64 | 0.35% | 0.62% | 2.39% | 2.78% | 1.10% | 2.84% | -0.39 | 1.04 |
| RISE3 | 200.73 | 0.889 | 60.45 | 0.88 | 199.77 | 0.862 | 60.33 | 0.82 | 0.60% | 0.54% | 3.08% | 2.22% | 0.20% | 2.22% | 0.06 | 0.31 |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | 0.21% | 0.60% | 0.35 | 0 |
| VTT | -0.02% | 0.41% | -0.04 | |
| INRIM | 0.11% | 0.60% | 0.18 | |
| LCOE | -0.09% | 0.60% | -0.16 | |
| LNE | 0.00% | 0.60% | -0.01 | |
| RISE2 | -0.06% | 0.55% | -0.11 | |
| PTB | -0.03% | 0.51% | -0.06 | |
| TUBITAK | -0.73% | 0.60% | -1.22 | |
| IATTE | 0.55% | 0.42% | 1.31 | 0 |
| IATTE1 | -0.20% | 0.76% | -0.26 | 0 |
| NMIA | 0.45% | 0.60% | 0.76 | |
| VNIIMS | -0.91% | 0.51% | -1.79 | 1 |
| NIM | 0.11% | 0.52% | 0.21 | |
| JHILL | 0.33% | 0.60% | 0.55 | |
| NRC | -0.06% | 0.60% | -0.10 | |
| RISE3 | 0.20% | 0.57% | 0.35 | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|-----|
| 0.40% | 0.17% | 51% |



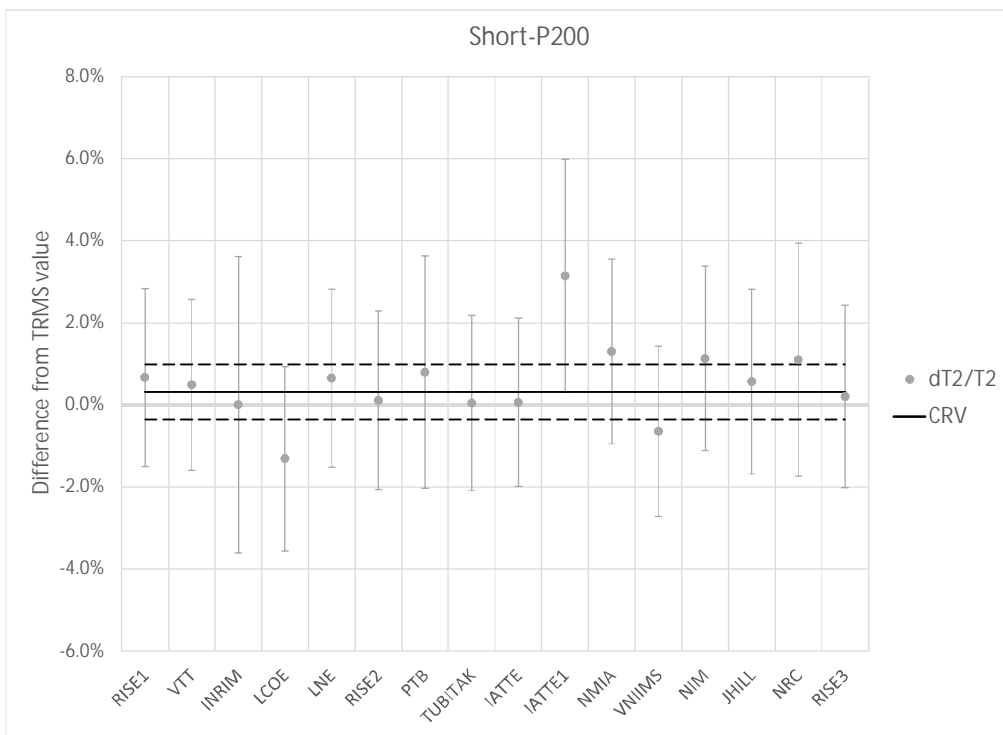
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.92% | 2.28% | -0.40 | 0 |
| VTT | -0.64% | 2.66% | -0.24 | |
| INRIM | -1.02% | 3.48% | -0.29 | |
| LCOE | 0.22% | 2.68% | 0.08 | |
| LNE | 0.28% | 3.08% | 0.09 | |
| RISE2 | -1.20% | 1.99% | -0.60 | |
| PTB | -0.79% | 2.67% | -0.30 | |
| TUBITAK | 0.82% | 2.25% | 0.37 | |
| IATTE | -8.34% | 2.12% | -3.93 | 0 |
| IATTE1 | 0.60% | 3.25% | 0.18 | 0 |
| NMIA | -3.22% | 2.79% | -1.15 | |
| VNIIMS | 3.80% | 2.66% | 1.43 | |
| NIM | 0.76% | 2.32% | 0.33 | |
| JHILL | -0.06% | 2.67% | -0.02 | |
| NRC | 0.76% | 2.67% | 0.28 | |
| RISE3 | 1.45% | 2.35% | 0.62 | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|-----|
| 1.63% | 0.78% | 15% |

Short-P200

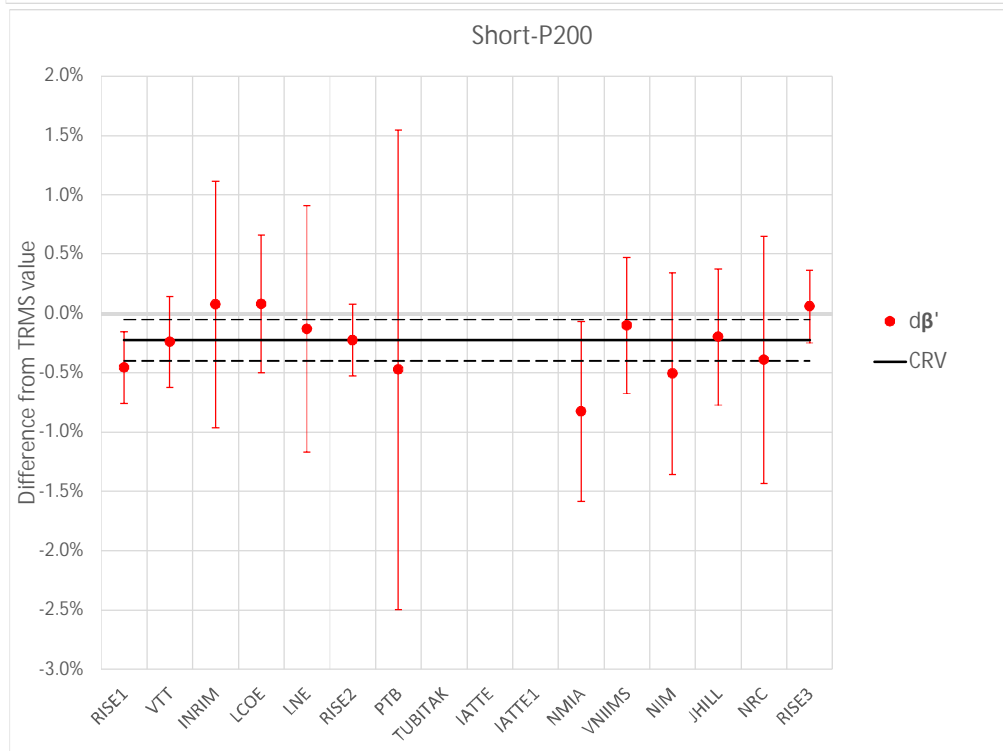
Short-P200



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | 0.35 % | 2.27 % | 0.16 | 0 |
| VTT | 0.17 % | 1.97 % | 0.09 | |
| INRIM | -0.31 % | 3.55 % | -0.09 | |
| LCOE | -1.63 % | 2.14 % | -0.76 | |
| LNE | 0.33 % | 2.06 % | 0.16 | |
| RISE2 | -0.20 % | 2.08 % | -0.10 | |
| PTB | 0.48 % | 2.76 % | 0.18 | |
| TUBITAK | -0.27 % | 2.02 % | -0.14 | |
| IATTE | -0.25 % | 2.16 % | -0.12 | 0 |
| IATTE1 | 2.83 % | 2.92 % | 0.97 | 0 |
| NMIA | 0.98 % | 2.15 % | 0.46 | |
| VNIIMS | -0.96 % | 1.96 % | -0.49 | |
| NIM | 0.81 % | 2.14 % | 0.38 | |
| JHILL | 0.25 % | 2.14 % | 0.12 | |
| NRC | 0.79 % | 2.76 % | 0.29 | |
| RISE3 | -0.11 % | 2.32 % | -0.05 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.31 % | 0.67 % | 93 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | -0.23 | 0.35 | -0.66 | 0 |
| VTT | -0.01 | 0.34 | -0.04 | |
| INRIM | 0.30 | 1.02 | 0.29 | |
| LCOE | 0.30 | 0.55 | 0.55 | |
| LNE | 0.10 | 1.03 | 0.09 | |
| RISE2 | 0.00 | 0.25 | 0.00 | |
| PTB | -0.25 | 2.01 | -0.12 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.60 | 0.74 | -0.81 | |
| VNIIMS | 0.12 | 0.55 | 0.23 | |
| NIM | -0.28 | 0.83 | -0.34 | |
| JHILL | 0.03 | 0.55 | 0.05 | |
| NRC | -0.17 | 1.03 | -0.16 | |
| RISE3 | 0.28 | 0.35 | 0.81 | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.23 | 0.17 | 91 % |

Short-P300

Short-P300

Setup uncertainties:

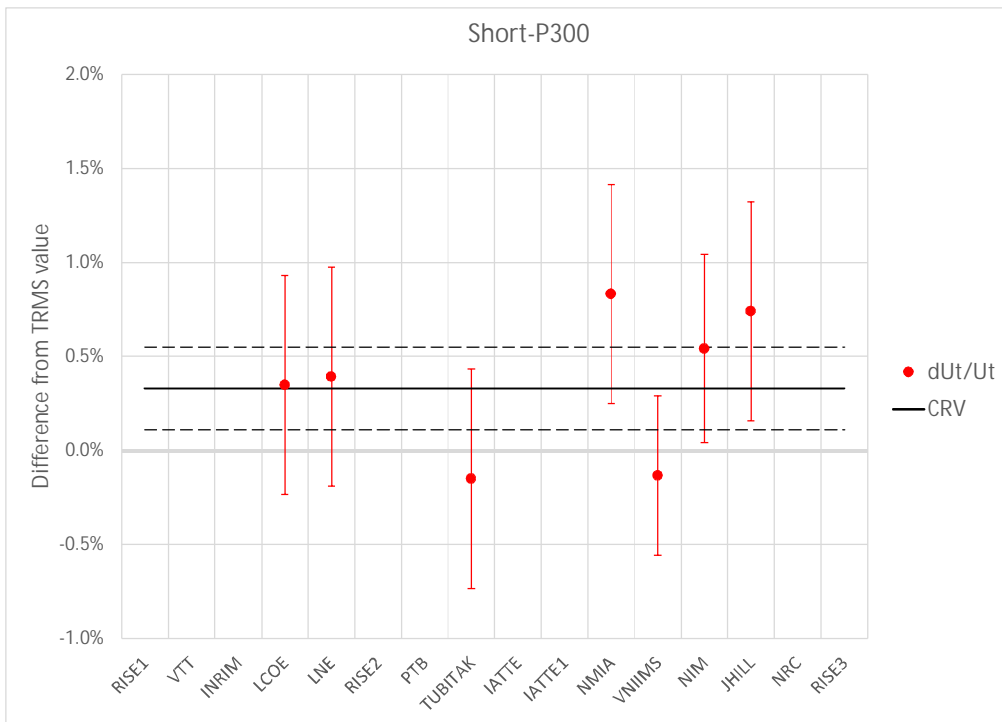
0.17 %

1.87 %

1.99 %

0.28

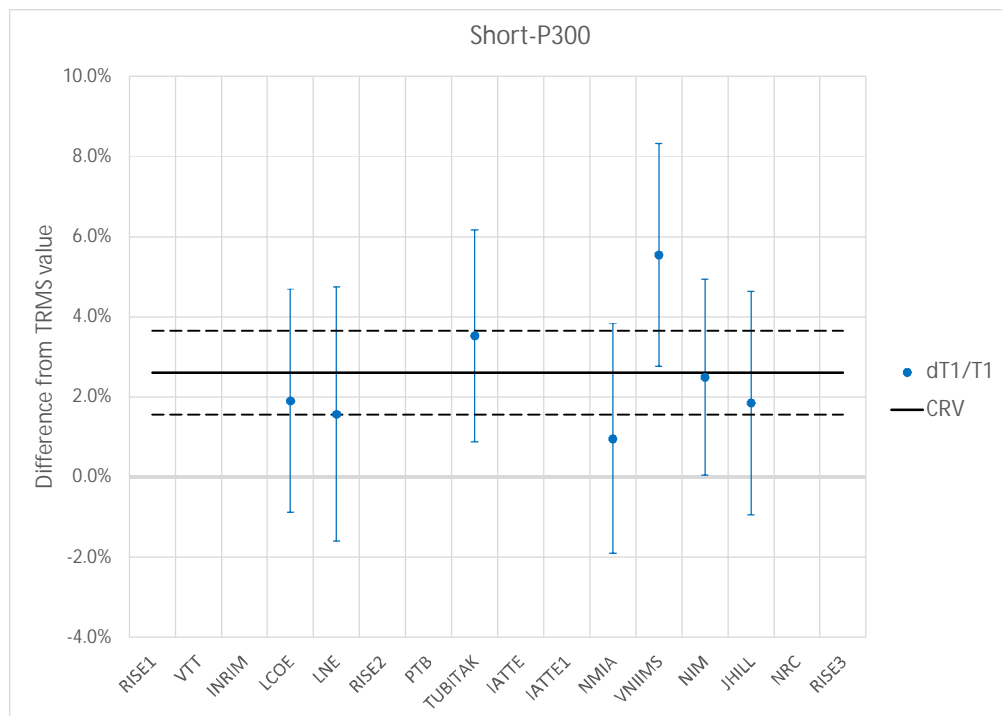
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | | | | | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | 300.28 | 0.878 | 55.32 | 1.52 | 299.23 | 0.862 | 56.16 | 1.60 | 0.35 % | 0.62 % | 1.90 % | 2.79 % | -1.49 % | 2.25 % | -0.08 | 0.58 |
| LNE | 301.75 | 0.898 | 52.50 | -0.14 | 300.54 | 0.884 | 52.29 | 0.07 | 0.39 % | 0.62 % | 1.57 % | 3.17 % | 0.41 % | 2.17 % | -0.21 | 1.04 |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | 301.59 | 0.879 | 57.33 | 0.83 | 302.04 | 0.849 | 57.37 | #N/A | -0.15 % | 0.62 % | 3.52 % | 2.64 % | -0.08 % | 2.20 % | | #N/A |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | 290.42 | 0.835 | 60.08 | 1.51 | 288.20 | 0.827 | 59.65 | 2.16 | 0.83 % | 0.62 % | 0.96 % | 2.87 % | 0.71 % | 2.25 % | -0.65 | 0.76 |
| VNIIMS | 315.27 | 0.971 | 45.61 | -1.65 | 316.07 | 0.920 | 46.06 | -1.61 | -0.13 % | 0.48 % | 5.54 % | 2.78 % | -0.99 % | 2.07 % | -0.04 | 0.57 |
| NIM | 297.99 | 0.855 | 62.63 | 3.60 | 296.74 | 0.834 | 61.89 | 4.15 | 0.54 % | 0.55 % | 2.49 % | 2.44 % | 1.20 % | 2.25 % | -0.55 | 0.85 |
| JHILL | 302.27 | 0.842 | 63.77 | 0.02 | 300.55 | 0.827 | 63.44 | 0.23 | 0.74 % | 0.62 % | 1.85 % | 2.79 % | 0.51 % | 2.25 % | -0.21 | 0.57 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.02 % | 0.58 % | 0.03 | |
| LNE | 0.06 % | 0.58 % | 0.11 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.48 % | 0.58 % | -0.82 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 0.50 % | 0.58 % | 0.86 | |
| VNIIMS | -0.46 % | 0.42 % | -1.10 | |
| NIM | 0.21 % | 0.50 % | 0.43 | |
| JHILL | 0.41 % | 0.58 % | 0.71 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.33 % | 0.22 % | 8 % |



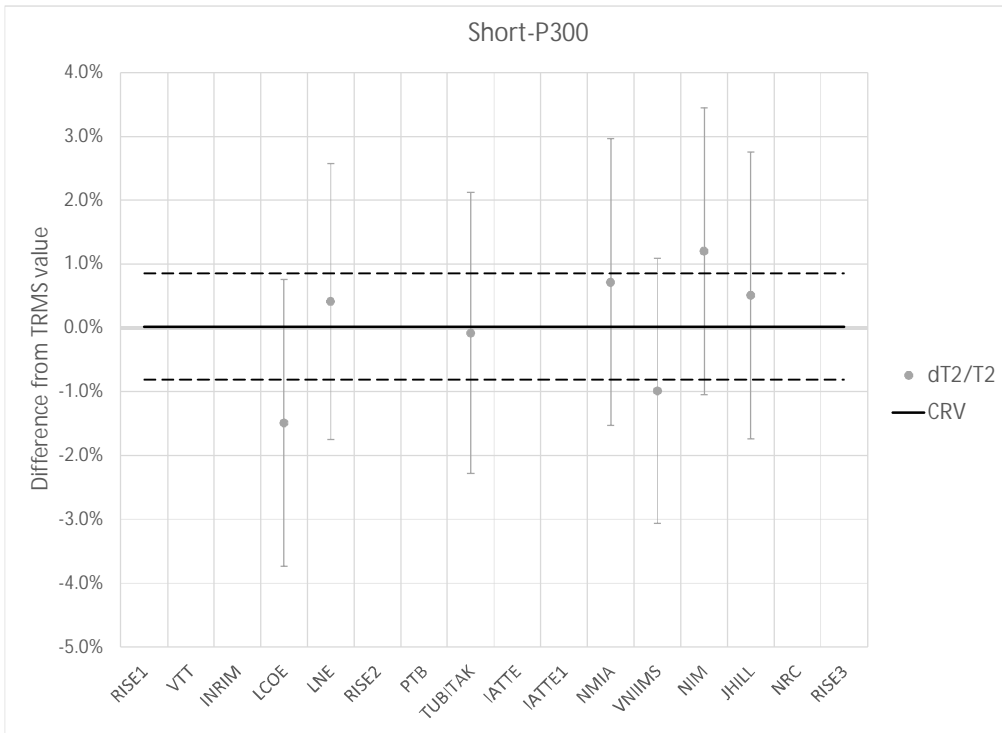
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.70 % | 2.58 % | -0.27 | |
| LNE | -1.04 % | 2.99 % | -0.35 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.92 % | 2.43 % | 0.38 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -1.65 % | 2.67 % | -0.62 | |
| VNIIMS | 2.94 % | 2.58 % | 1.14 | |
| NIM | -0.11 % | 2.21 % | -0.05 | |
| JHILL | -0.76 % | 2.59 % | -0.29 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 2.61 % | 1.04 % | 30 % |

Short-P300

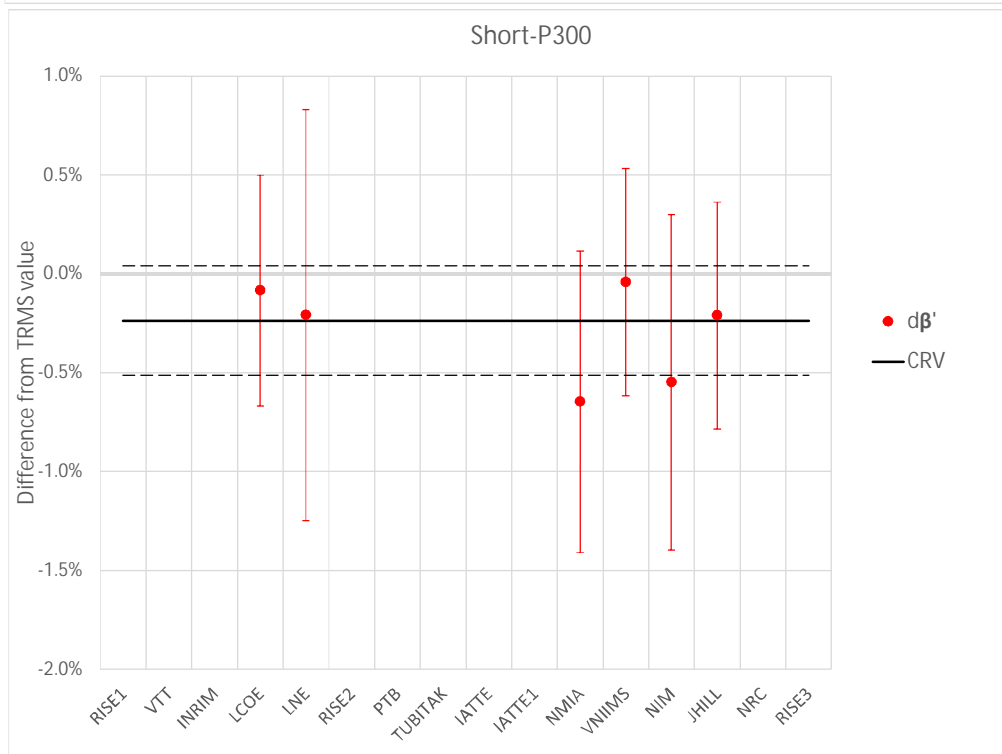
Short-P300



T₂

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -1.51 % | 2.09 % | -0.72 | |
| LNE | 0.39 % | 2.00 % | 0.20 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.10 % | 2.04 % | -0.05 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 0.70 % | 2.09 % | 0.33 | |
| VNIIMS | -1.01 % | 1.90 % | -0.53 | |
| NIM | 1.18 % | 2.09 % | 0.57 | |
| JHILL | 0.49 % | 2.09 % | 0.24 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.02 % | 0.83 % | 60 % |



β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.15 | 0.51 | 0.30 | |
| LNE | 0.03 | 1.00 | 0.03 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.41 | 0.71 | -0.58 | |
| VNIIMS | 0.19 | 0.50 | 0.38 | |
| NIM | -0.31 | 0.80 | -0.39 | |
| JHILL | 0.03 | 0.50 | 0.05 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.24 | 0.28 | 79 % |

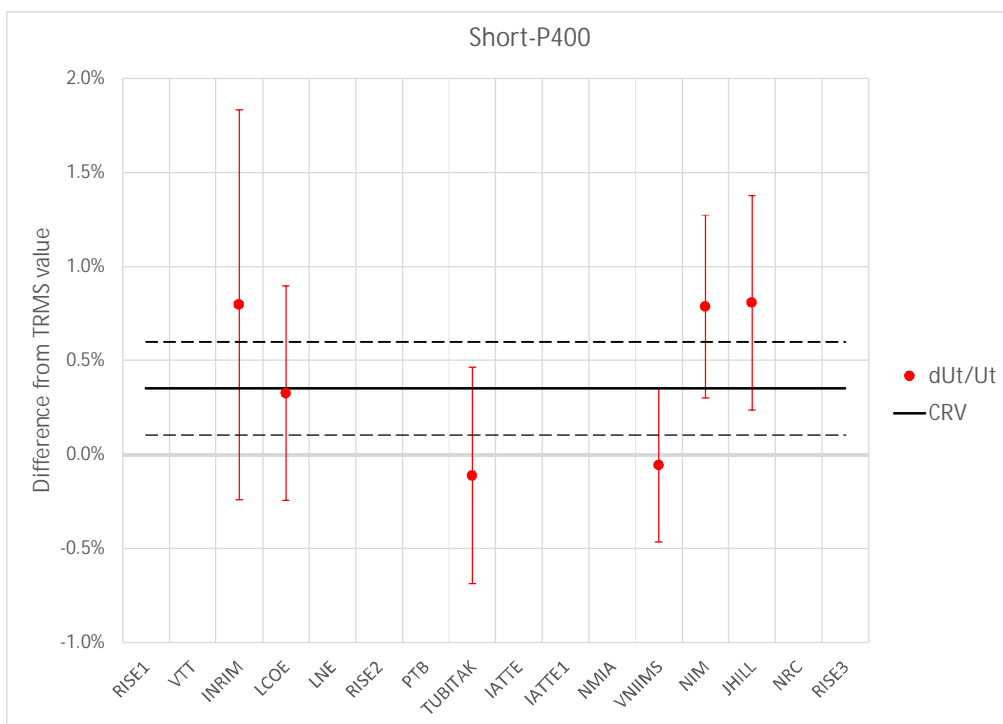
Short-P400

Short-P400

Setup uncertainties:

0.17 % 1.87 % 1.99 % 0.28

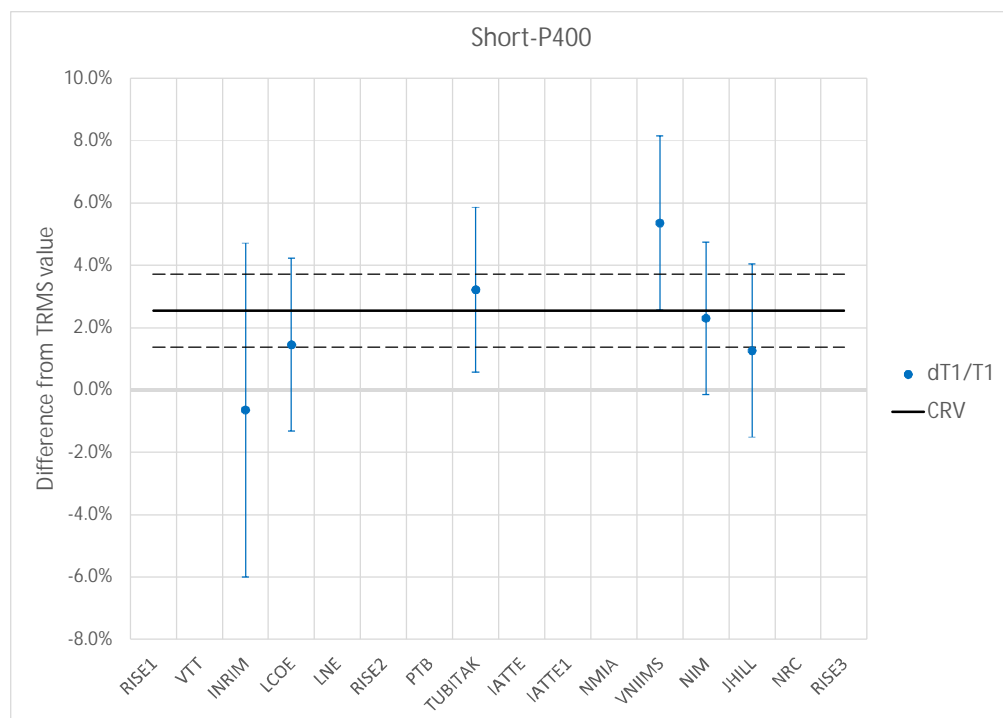
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | 411.56 | 0.844 | 42.10 | -1.08 | 408.31 | 0.850 | 42.15 | -1.13 | 0.80 % | 1.07 % | -0.65 % | 5.36 % | -0.13 % | 5.39 % | 0.05 | 1.04 |
| LCOE | 401.04 | 0.879 | 55.44 | 1.61 | 399.73 | 0.867 | 56.30 | 1.49 | 0.33 % | 0.62 % | 1.46 % | 2.78 % | -1.52 % | 2.25 % | 0.12 | 0.59 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | 401.16 | 0.883 | 57.59 | 0.82 | 401.61 | 0.856 | 57.64 | #N/A | -0.11 % | 0.63 % | 3.22 % | 2.64 % | -0.09 % | 2.22 % | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | 410.60 | 0.982 | 45.60 | -1.52 | 411.33 | 0.932 | 46.15 | -1.69 | -0.06 % | 0.48 % | 5.37 % | 2.80 % | -1.19 % | 2.07 % | 0.17 | 0.57 |
| NIM | 396.27 | 0.891 | 59.66 | 5.26 | 393.65 | 0.871 | 59.24 | 5.41 | 0.79 % | 0.55 % | 2.31 % | 2.44 % | 0.71 % | 2.25 % | -0.15 | 0.85 |
| JHILL | 402.59 | 0.840 | 63.91 | 0.20 | 400.05 | 0.830 | 63.66 | 0.20 | 0.81 % | 0.62 % | 1.27 % | 2.78 % | 0.39 % | 2.25 % | 0.00 | 0.57 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.45 % | 1.04 % | 0.43 | |
| LCOE | -0.02 % | 0.57 % | -0.04 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.46 % | 0.58 % | -0.80 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.41 % | 0.41 % | -1.00 | |
| NIM | 0.44 % | 0.49 % | 0.90 | |
| JHILL | 0.46 % | 0.57 % | 0.80 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.35 % | 0.25 % | 6 % |



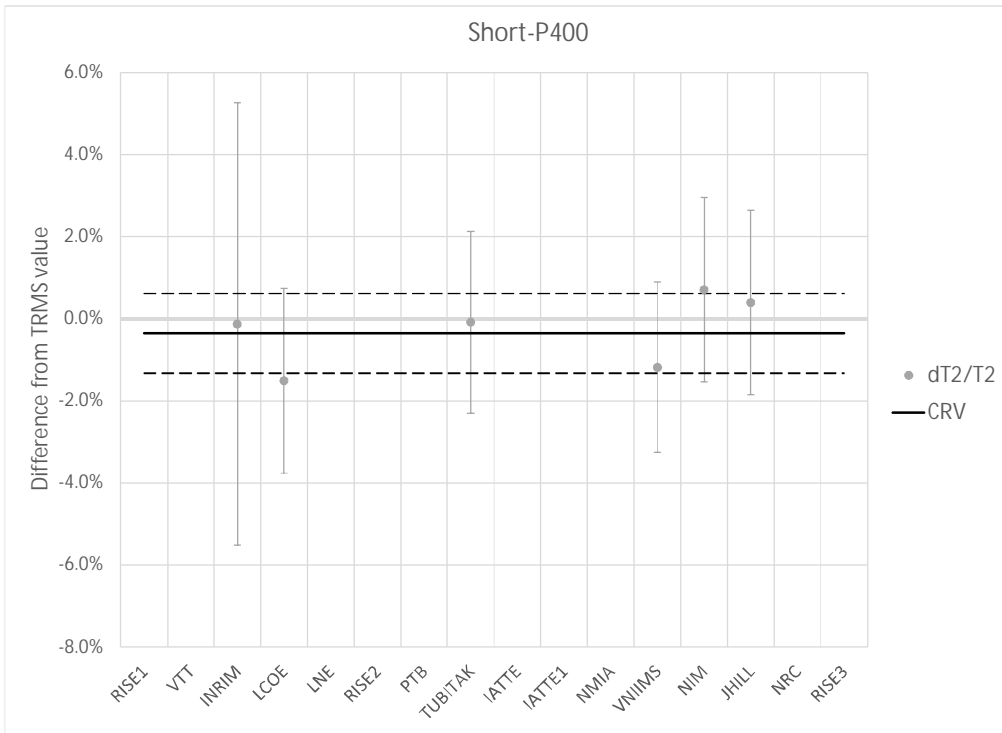
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -3.19 % | 5.23 % | -0.61 | |
| LCOE | -1.09 % | 2.52 % | -0.43 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.67 % | 2.37 % | 0.28 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 2.82 % | 2.54 % | 1.11 | |
| NIM | -0.24 % | 2.15 % | -0.11 | |
| JHILL | -1.28 % | 2.52 % | -0.51 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 2.55 % | 1.17 % | 20 % |

Short-P400

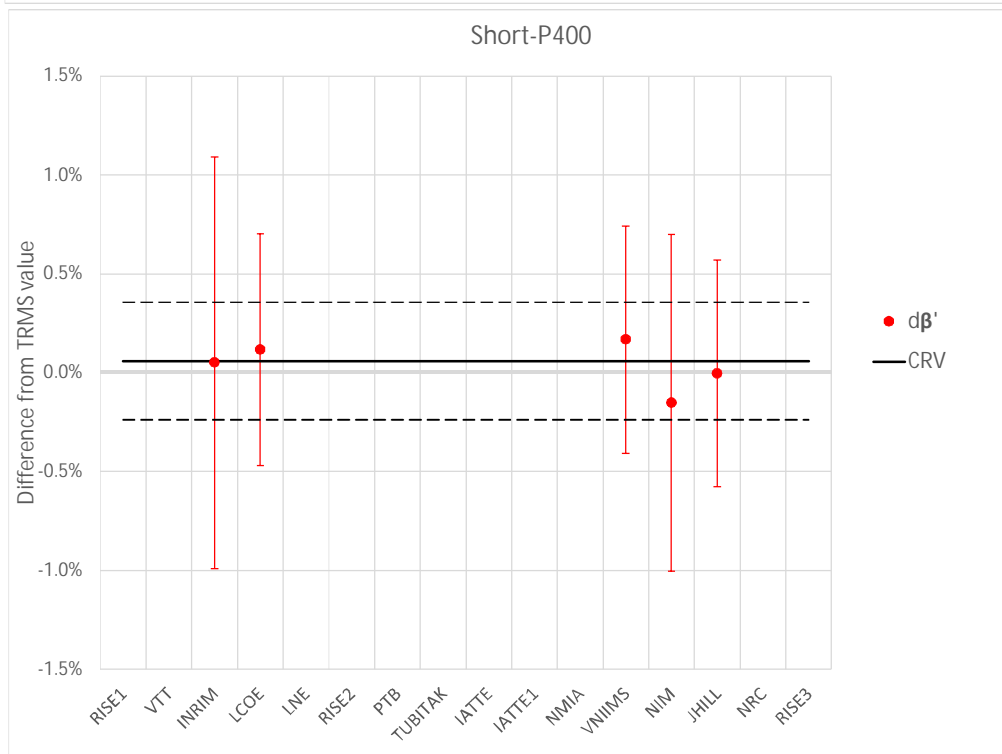
Short-P400



T_2

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.23 % | 5.30 % | 0.04 | |
| LCOE | -1.16 % | 2.03 % | -0.57 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.27 % | 1.99 % | 0.14 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.83 % | 1.83 % | -0.45 | |
| NIM | 1.07 % | 2.03 % | 0.53 | |
| JHILL | 0.75 % | 2.03 % | 0.37 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.36 % | 0.97 % | 68 % |



β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -0.01 | 1.00 | -0.01 | |
| LCOE | 0.06 | 0.51 | 0.11 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.11 | 0.49 | 0.22 | |
| NIM | -0.21 | 0.80 | -0.27 | |
| JHILL | -0.06 | 0.49 | -0.13 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.06 | 0.30 | 98 % |

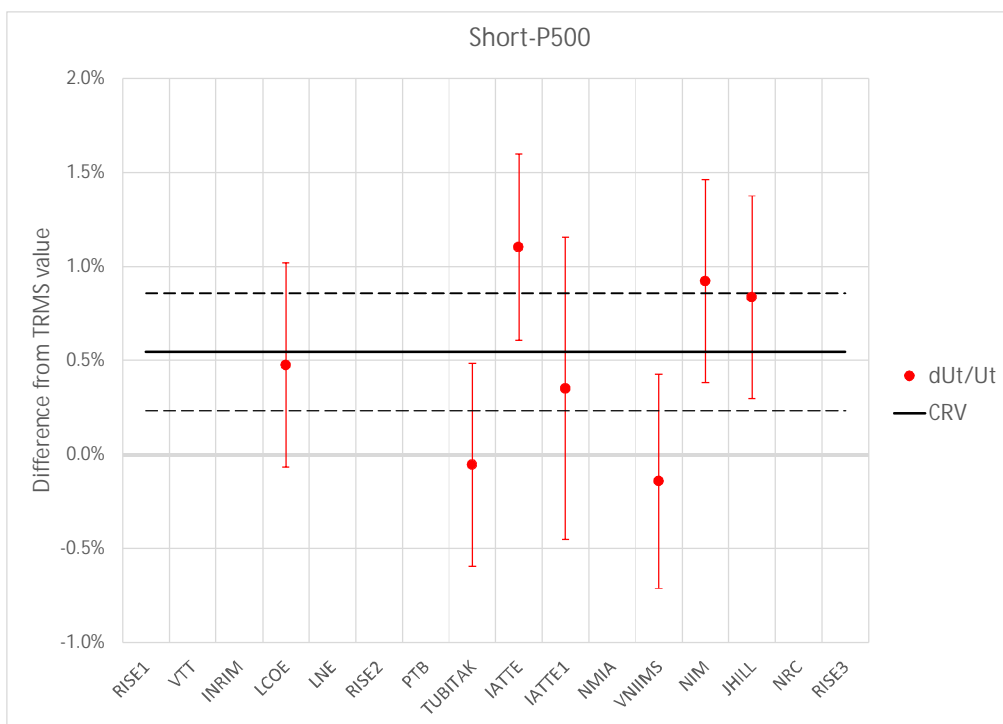
Short-P500

Short-P500

Setup uncertainties:

0.17 % 1.87 % 1.99 % 0.28

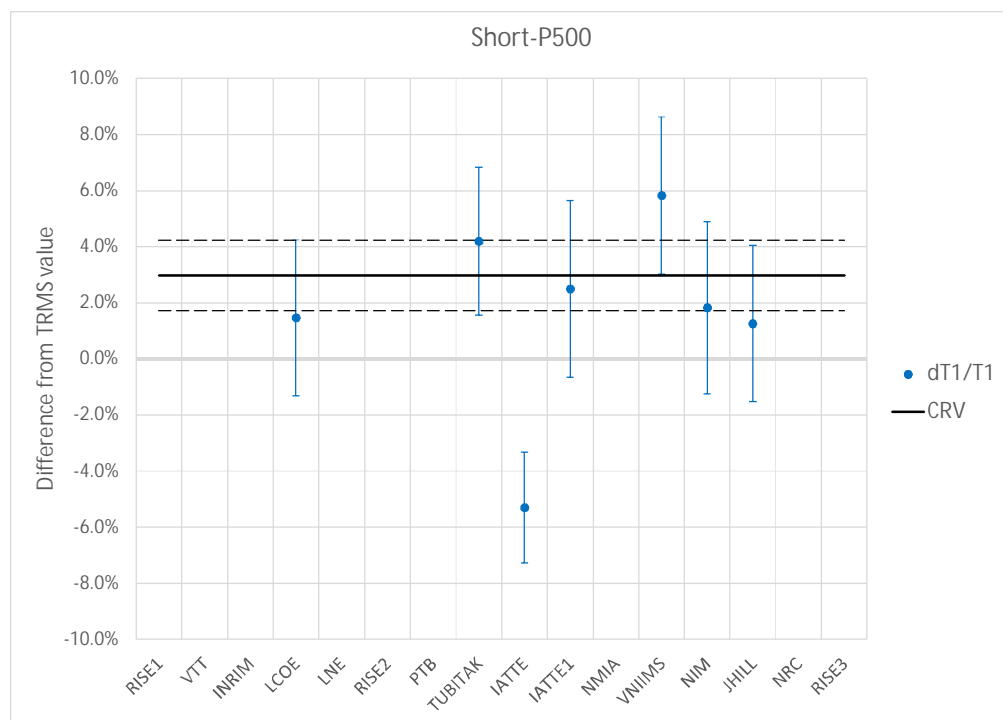
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | 501.05 | 0.885 | 55.74 | 1.34 | 498.68 | 0.873 | 56.51 | 1.59 | 0.48 % | 0.63 % | 1.46 % | 2.78 % | -1.35 % | 2.25 % | -0.25 | 0.58 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | 501.60 | 0.888 | 57.79 | 0.61 | 501.88 | 0.852 | 57.92 | #N/A | -0.05 % | 0.62 % | 4.20 % | 2.64 % | -0.23 % | 2.21 % | | |
| IATTE | 501.63 | 0.765 | 47.98 | -0.20 | 496.05 | 0.807 | 48.00 | #N/A | 1.10 % | 0.39 % | -5.30 % | 1.98 % | -0.05 % | 2.06 % | | |
| IATTE1 | 501.63 | 0.765 | 47.98 | -0.20 | 499.87 | 0.746 | 46.55 | #N/A | 0.35 % | 0.74 % | 2.49 % | 3.16 % | 3.07 % | 2.84 % | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | 515.00 | 1.000 | 45.74 | -1.64 | 516.36 | 0.945 | 46.32 | -1.82 | -0.14 % | 0.48 % | 5.82 % | 2.80 % | -1.26 % | 2.07 % | 0.18 | 0.57 |
| NIM | 510.01 | 0.891 | 60.29 | 5.08 | 505.96 | 0.875 | 60.17 | 5.19 | 0.92 % | 0.62 % | 1.82 % | 3.08 % | 0.20 % | 2.51 % | -0.11 | 0.85 |
| JHILL | 502.32 | 0.859 | 64.16 | 0.15 | 499.00 | 0.849 | 63.95 | 0.15 | 0.84 % | 0.62 % | 1.26 % | 2.79 % | 0.32 % | 2.25 % | 0.00 | 0.57 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.07 % | 0.54 % | -0.13 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.60 % | 0.54 % | -1.11 | |
| IATTE | 0.56 % | 0.50 % | 1.13 | 0 |
| IATTE1 | -0.19 % | 0.80 % | -0.24 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.69 % | 0.57 % | -1.21 | 1 |
| NIM | 0.38 % | 0.54 % | 0.70 | |
| JHILL | 0.29 % | 0.54 % | 0.54 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.54 % | 0.31 % | 11 % |



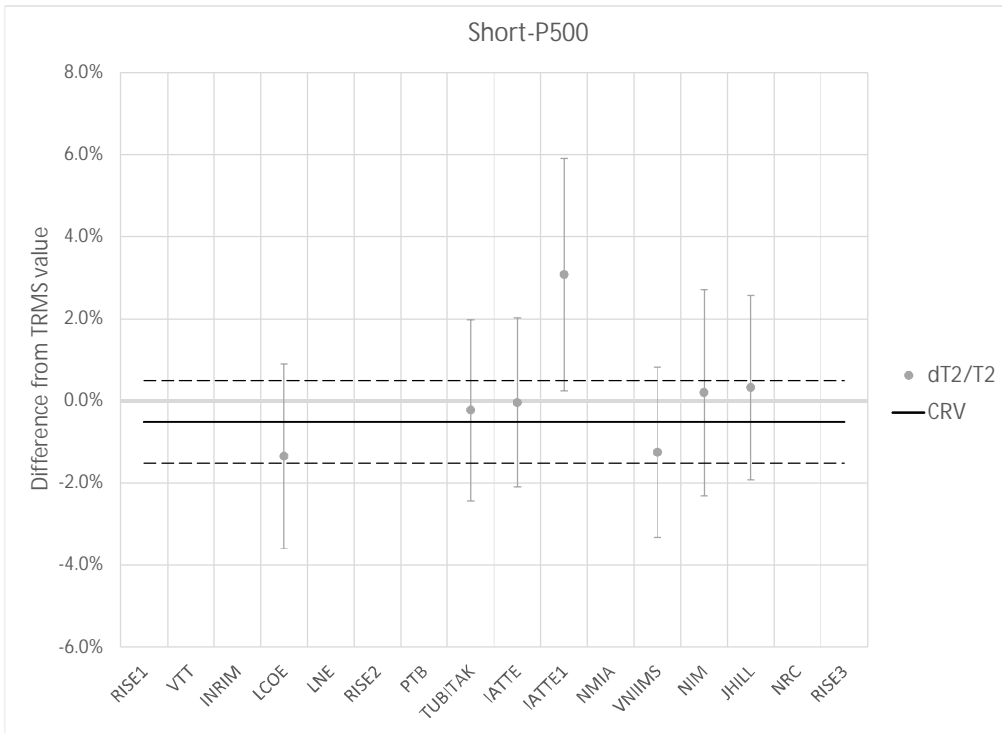
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -1.52 % | 2.48 % | -0.61 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 1.23 % | 2.32 % | 0.53 | |
| IATTE | -8.28 % | 2.34 % | -3.53 | 0 |
| IATTE1 | -0.48 % | 3.40 % | -0.14 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 2.85 % | 2.50 % | 1.14 | |
| NIM | -1.16 % | 2.81 % | -0.41 | |
| JHILL | -1.72 % | 2.49 % | -0.69 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 2.97 % | 1.26 % | 8 % |

Short-P500

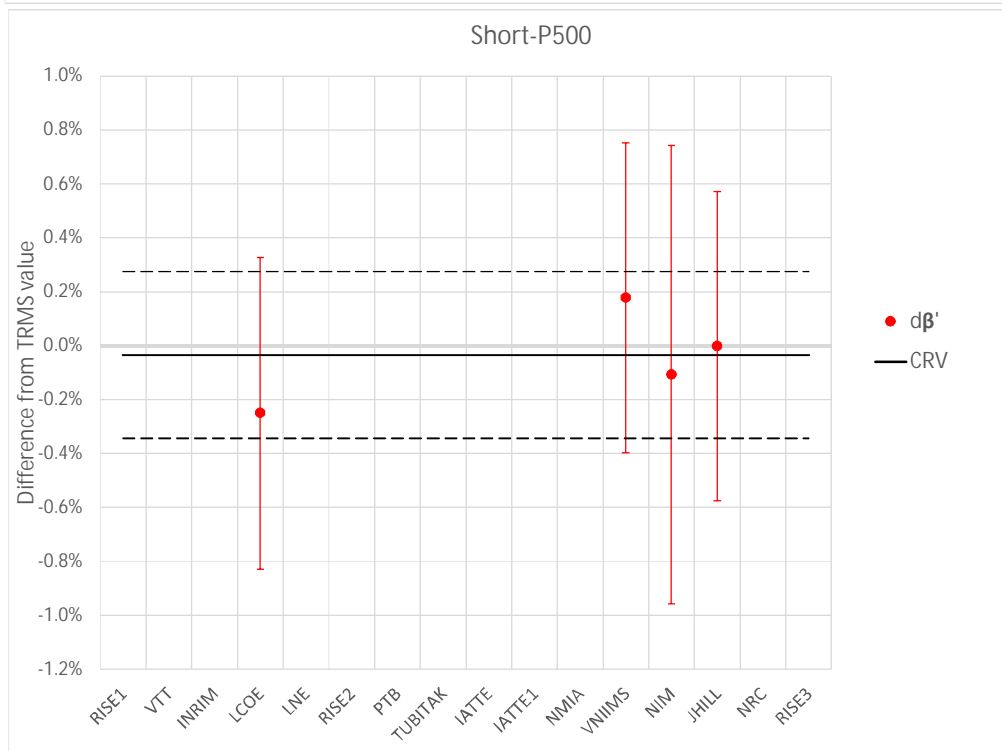
Short-P500



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.84 % | 2.01 % | -0.42 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.29 % | 1.96 % | 0.15 | |
| IATTE | 0.47 % | 2.29 % | 0.21 | 0 |
| IATTE1 | 3.59 % | 3.01 % | 1.19 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.74 % | 1.81 % | -0.41 | |
| NIM | 0.71 % | 2.30 % | 0.31 | |
| JHILL | 0.84 % | 2.01 % | 0.42 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.52 % | 1.00 % | 73 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.22 | 0.49 | -0.44 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.21 | 0.48 | 0.44 | |
| NIM | -0.07 | 0.79 | -0.09 | |
| JHILL | 0.03 | 0.48 | 0.07 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.03 | 0.31 | 77 % |

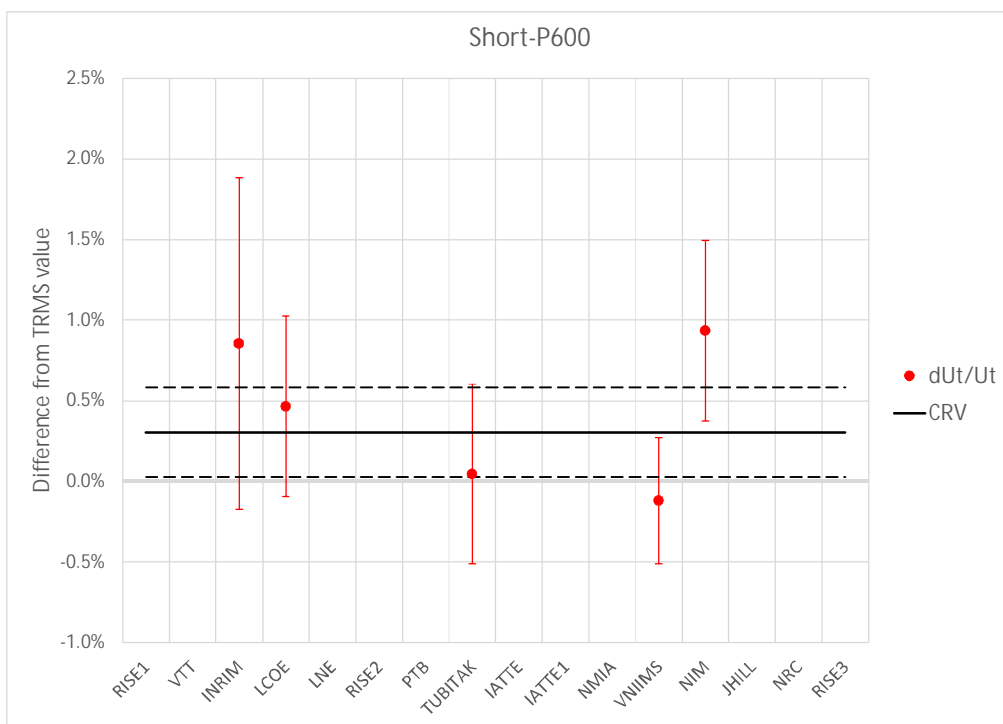
Short-P600

Short-P600

Setup uncertainties:

0.17% 1.87% 1.99% 0.28

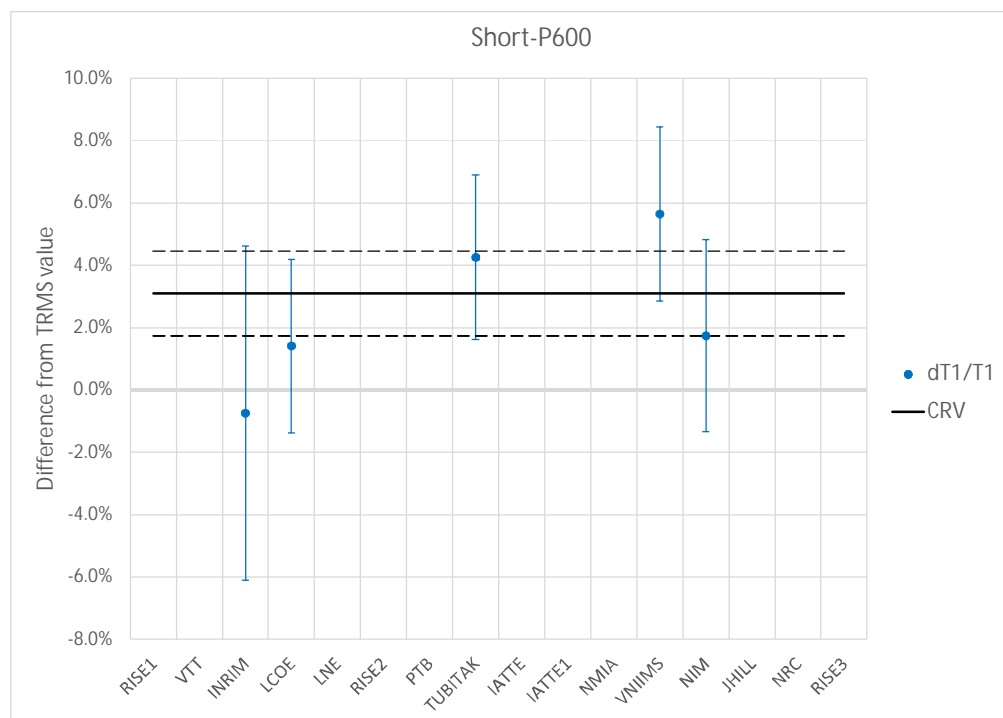
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|-------|--------------------------|-------|------------|-------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | 604.75 | 0.862 | 42.61 | -1.31 | 599.63 | 0.869 | 42.70 | -1.38 | 0.85% | 1.07% | -0.74% | 5.36% | -0.19% | 5.39% | 0.07 | 1.04 |
| LCOE | 600.64 | 0.869 | 56.76 | 1.57 | 597.86 | 0.857 | 57.58 | 1.73 | 0.47% | 0.63% | 1.41% | 2.78% | -1.41% | 2.25% | -0.16 | 0.58 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | 601.93 | 0.896 | 57.98 | 0.47 | 601.66 | 0.859 | 58.26 | #N/A | 0.04% | 0.62% | 4.26% | 2.64% | -0.48% | 2.21% | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | 614.23 | 1.010 | 45.94 | -1.78 | 615.71 | 0.956 | 46.55 | -2.00 | -0.12% | 0.48% | 5.65% | 2.80% | -1.31% | 2.07% | 0.23 | 0.57 |
| NIM | 598.13 | 0.894 | 60.58 | 4.89 | 593.30 | 0.879 | 60.54 | 4.98 | 0.93% | 0.63% | 1.74% | 3.08% | 0.07% | 2.51% | -0.08 | 0.85 |
| JHILL | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.55% | 1.03% | 0.53 | |
| LCOE | 0.16% | 0.56% | 0.29 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.26% | 0.56% | -0.46 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.42% | 0.39% | -1.09 | |
| NIM | 0.63% | 0.56% | 1.13 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|----|
| 0.30% | 0.28% | 6% |



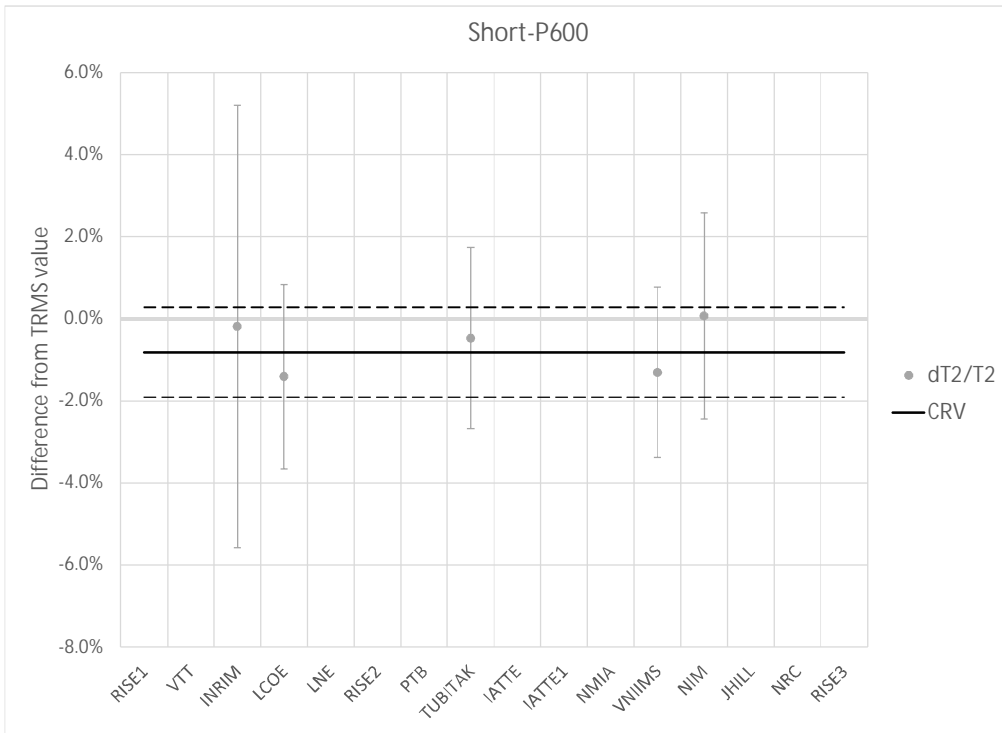
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -3.83% | 5.19% | -0.74 | |
| LCOE | -1.68% | 2.43% | -0.69 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 1.16% | 2.26% | 0.51 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 2.56% | 2.45% | 1.04 | |
| NIM | -1.35% | 2.77% | -0.49 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|----|
| 3.10% | 1.36% | 8% |

Short-P600

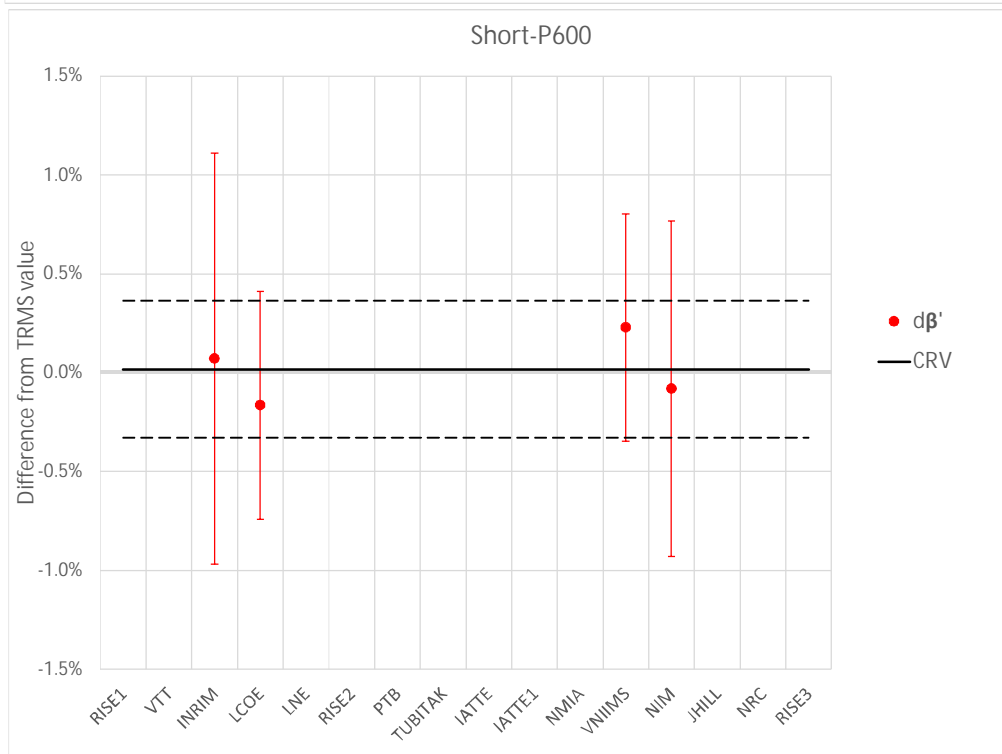
Short-P600



T₂

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.62 % | 5.28 % | 0.12 | |
| LCOE | -0.59 % | 1.96 % | -0.30 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.34 % | 1.91 % | 0.18 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIIMS | -0.49 % | 1.76 % | -0.28 | |
| NIM | 0.89 % | 2.26 % | 0.39 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.82 % | 1.10 % | 89 % |



β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.05 | 0.98 | 0.05 | |
| LCOE | -0.18 | 0.46 | -0.40 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIIMS | 0.21 | 0.46 | 0.46 | |
| NIM | -0.10 | 0.78 | -0.13 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.02 | 0.35 | 80 % |

Short-P700

Short-P700

Setup uncertainties:

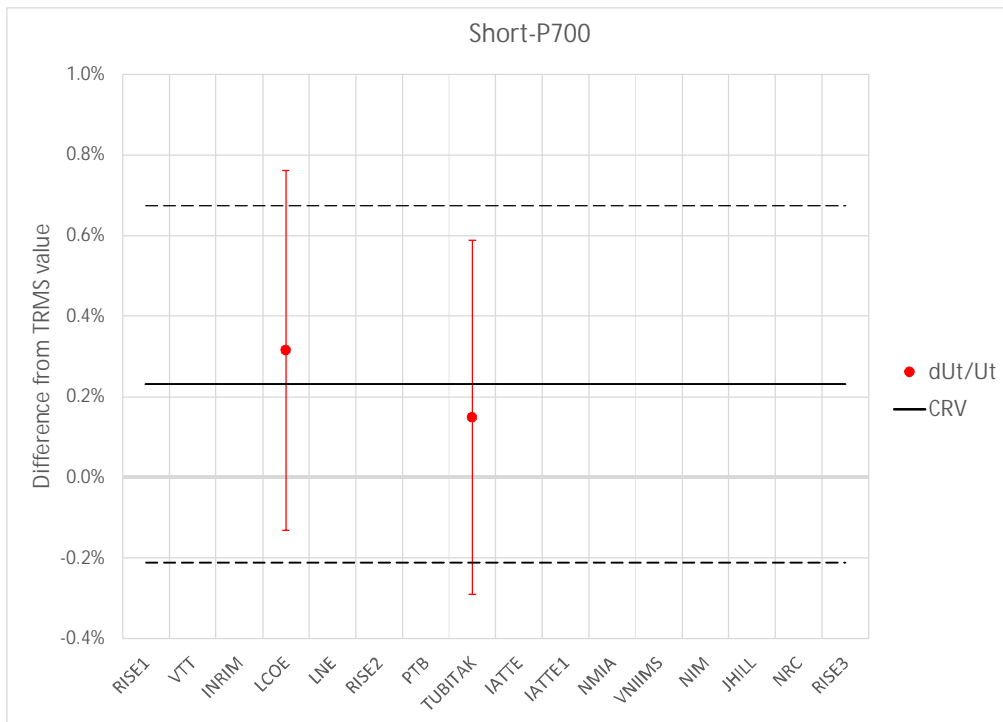
0.17 %

1.87 %

1.99 %

0.28

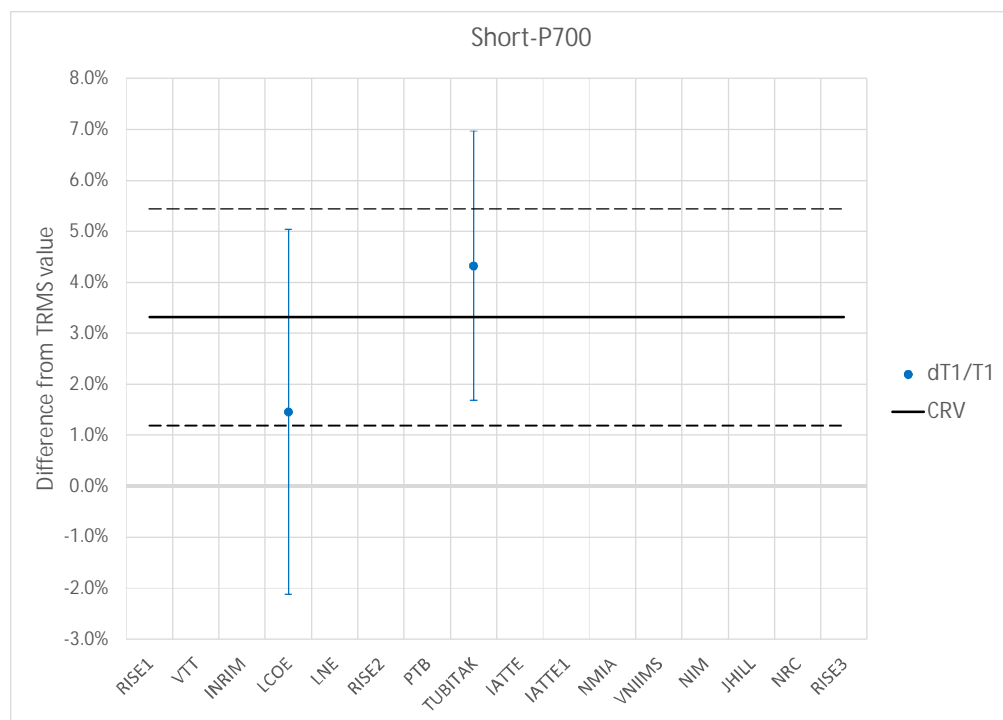
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | 697.76 | 0.861 | 55.81 | 2.13 | 695.56 | 0.849 | 56.45 | 2.37 | 0.32 % | 0.63 % | 1.46 % | 3.58 % | -1.12 % | 2.25 % | -0.24 | 0.61 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | 700.25 | 0.901 | 58.28 | 0.24 | 699.21 | 0.864 | 58.67 | #N/A | 0.15 % | 0.62 % | 4.32 % | 2.64 % | -0.66 % | 2.21 % | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| JHILL | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.08 % | 0.45 % | 0.19 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.08 % | 0.44 % | -0.19 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.23 % | 0.44 % | 71 % |



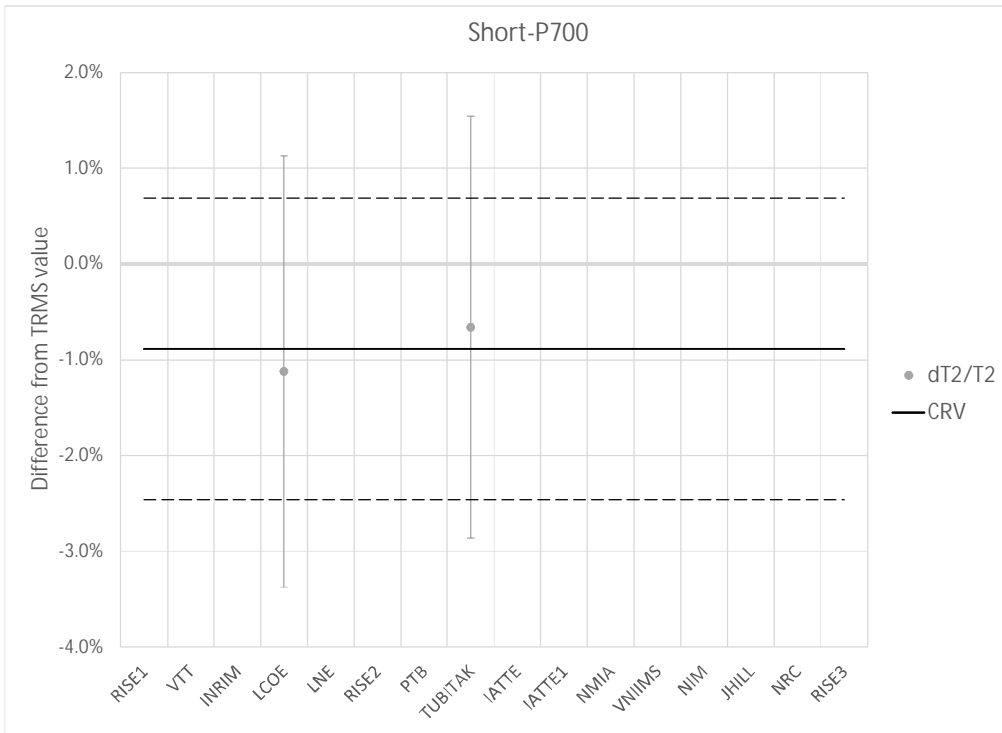
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -1.85 % | 2.88 % | -0.64 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 1.01 % | 1.57 % | 0.64 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 3.31 % | 2.13 % | 20 % |

Short-P700

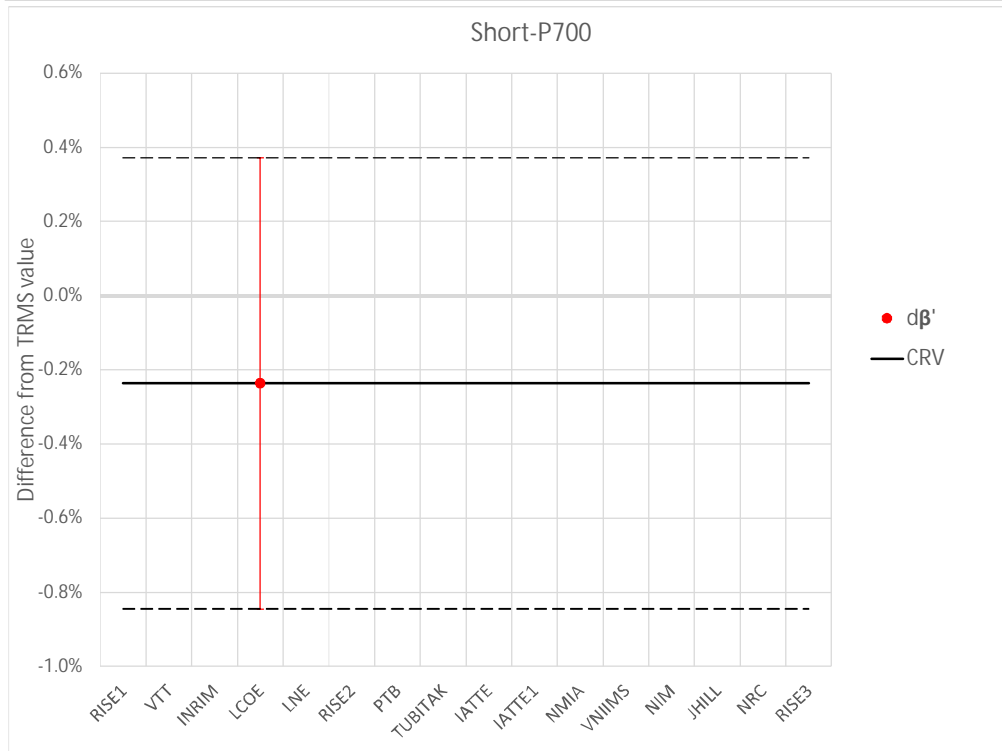
Short-P700



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.24 % | 1.61 % | -0.15 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.23 % | 1.54 % | 0.15 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.89 % | 1.58 % | 77 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|---------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.00 | 0.00 | #DIV/0! | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|-------|
| -0.24 | 0.61 | #NUM! |

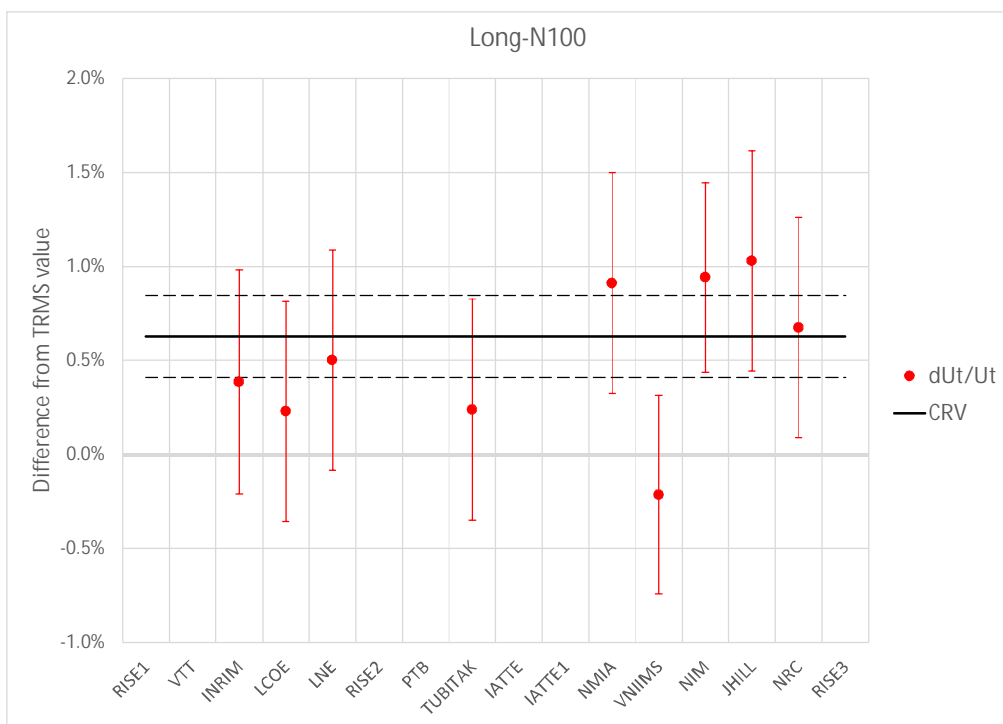
Long-N100

Long-N100

Setup uncertainties:

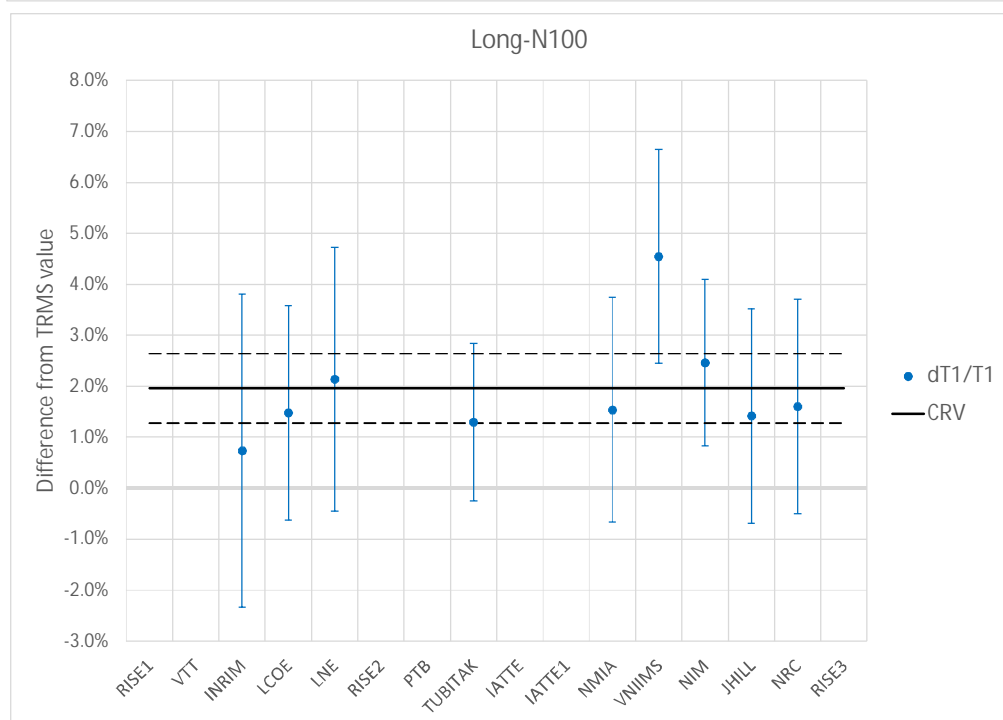
0.18 % 0.45 % 0.80 % 0.12

| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | -100.51 | 1.554 | 43.03 | -1.14 | -100.12 | 1.543 | 43.01 | -1.09 | 0.39 % | 0.64 % | 0.74 % | 3.07 % | 0.05 % | 3.12 % | -0.05 | 1.01 |
| LCOE | -99.73 | 1.583 | 58.18 | 0.65 | -99.50 | 1.560 | 59.00 | 0.18 | 0.23 % | 0.63 % | 1.48 % | 2.10 % | -1.39 % | 1.32 % | 0.47 | 0.52 |
| LNE | -100.80 | 1.535 | 52.29 | 0.19 | -100.29 | 1.503 | 52.14 | 0.09 | 0.50 % | 0.63 % | 2.14 % | 2.59 % | 0.30 % | 1.17 % | 0.10 | 1.01 |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -101.02 | 1.529 | 59.44 | 0.06 | -100.78 | 1.510 | 59.40 | #N/A | 0.24 % | 0.63 % | 1.30 % | 1.54 % | 0.06 % | 1.11 % | | #N/A |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | -101.44 | 1.578 | 58.30 | -0.26 | -100.58 | 1.554 | 58.21 | 0.22 | 0.91 % | 0.63 % | 1.54 % | 2.20 % | 0.15 % | 1.32 % | -0.48 | 0.72 |
| VNIIMS | -105.35 | 1.379 | 46.33 | -1.37 | -105.70 | 1.319 | 46.79 | -1.48 | -0.21 % | 0.48 % | 4.55 % | 2.10 % | -0.98 % | 0.99 % | 0.11 | 0.51 |
| NIM | -100.06 | 1.613 | 58.73 | 0.03 | -99.25 | 1.574 | 58.42 | 0.12 | 0.94 % | 0.55 % | 2.46 % | 1.63 % | 0.52 % | 1.32 % | -0.09 | 0.81 |
| JHILL | -100.72 | 1.557 | 59.97 | -0.06 | -99.87 | 1.536 | 59.90 | -0.02 | 1.03 % | 0.63 % | 1.42 % | 2.10 % | 0.12 % | 1.32 % | -0.04 | 0.51 |
| NRC | -100.14 | 1.558 | 59.71 | -0.03 | -99.79 | 1.534 | 59.32 | 0.08 | 0.68 % | 0.63 % | 1.60 % | 2.10 % | 0.67 % | 2.17 % | -0.11 | 1.01 |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -0.24 % | 0.60 % | -0.41 | |
| LCOE | -0.40 % | 0.59 % | -0.68 | |
| LNE | -0.13 % | 0.59 % | -0.21 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.39 % | 0.59 % | -0.66 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 0.28 % | 0.59 % | 0.49 | |
| VNIIMS | -0.84 % | 0.53 % | -1.59 | 1 |
| NIM | 0.31 % | 0.50 % | 0.62 | |
| JHILL | 0.40 % | 0.59 % | 0.69 | |
| NRC | 0.05 % | 0.59 % | 0.08 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.63 % | 0.22 % | 36 % |

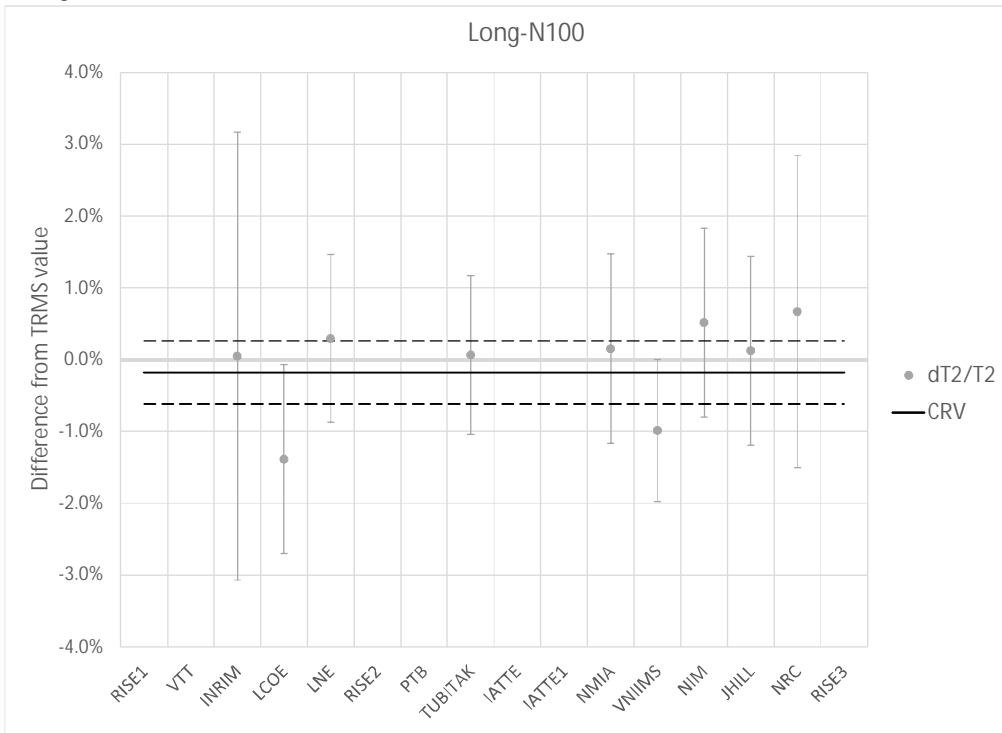


| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -1.22 % | 2.99 % | -0.41 | |
| LCOE | -0.48 % | 1.99 % | -0.24 | |
| LNE | 0.18 % | 2.49 % | 0.07 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.66 % | 1.39 % | -0.48 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.42 % | 2.09 % | -0.20 | |
| VNIIMS | 2.59 % | 1.99 % | 1.30 | |
| NIM | 0.50 % | 1.49 % | 0.34 | |
| JHILL | -0.54 % | 1.99 % | -0.27 | |
| NRC | -0.36 % | 1.99 % | -0.18 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 1.96 % | 0.68 % | 38 % |

Long-N100

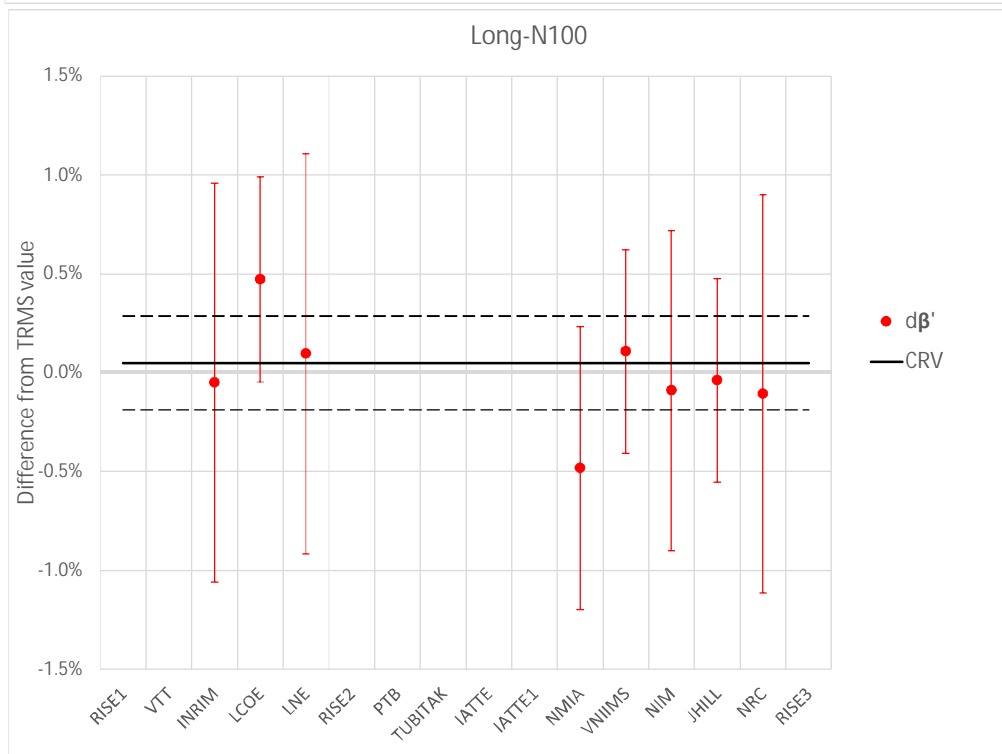
Long-N100



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.23 % | 3.09 % | 0.07 | |
| LCOE | -1.21 % | 1.24 % | -0.97 | |
| LNE | 0.48 % | 1.09 % | 0.44 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.24 % | 1.01 % | 0.24 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 0.33 % | 1.24 % | 0.27 | |
| VNIIMS | -0.80 % | 0.89 % | -0.91 | |
| NIM | 0.70 % | 1.24 % | 0.56 | |
| JHILL | 0.30 % | 1.24 % | 0.25 | |
| NRC | 0.85 % | 2.13 % | 0.40 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.18 % | 0.44 % | 34 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -0.10 | 0.98 | -0.10 | |
| LCOE | 0.42 | 0.46 | 0.92 | |
| LNE | 0.05 | 0.98 | 0.05 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.53 | 0.68 | -0.79 | |
| VNIIMS | 0.06 | 0.46 | 0.13 | |
| NIM | -0.14 | 0.77 | -0.18 | |
| JHILL | -0.09 | 0.46 | -0.19 | |
| NRC | -0.16 | 0.98 | -0.16 | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.05 | 0.24 | 62 % |

Long-N200

Long-N200

Setup uncertainties:

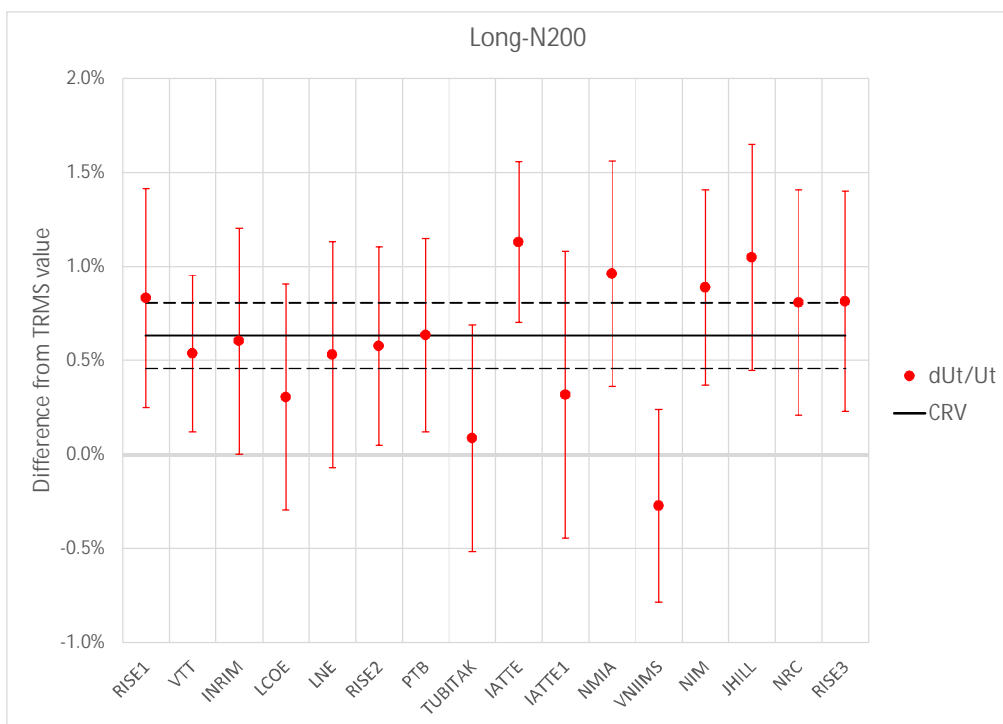
0.18 %

0.45 %

0.80 %

0.12

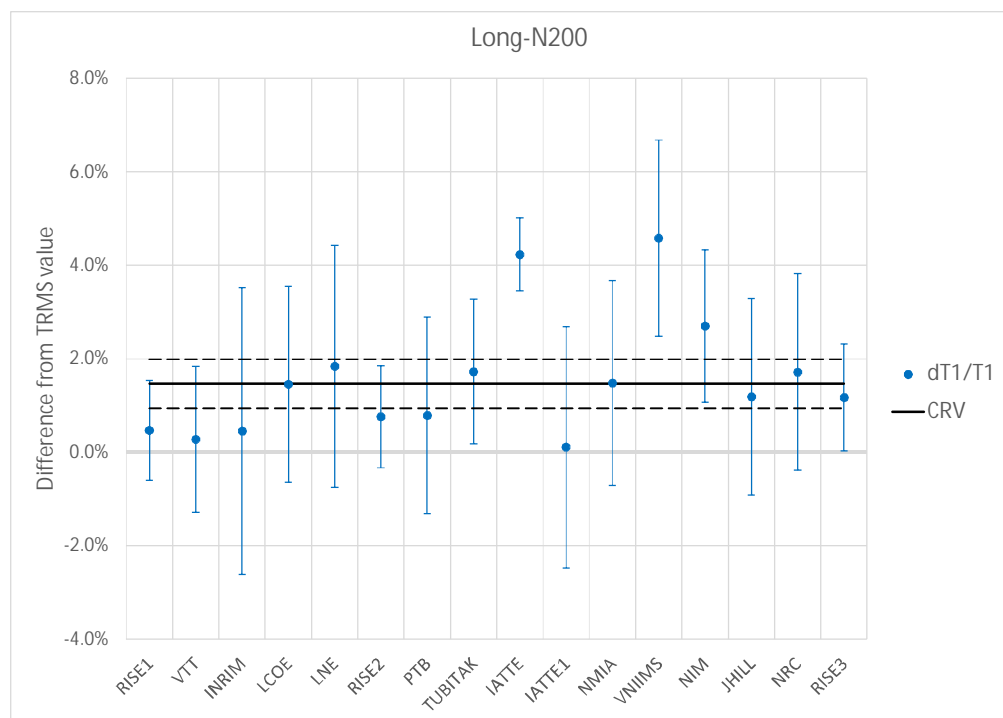
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U |
| RISE1 | -200.22 | 1.579 | 43.51 | -1.00 | -198.57 | 1.571 | 43.40 | -0.87 | 0.83 % | 0.56 % | 0.47 % | 1.07 % | 0.25 % | 1.15 % | -0.13 | 0.16 |
| VTT | -199.00 | 1.591 | 44.11 | -1.01 | -197.94 | 1.586 | 44.06 | -0.79 | 0.54 % | 0.45 % | 0.28 % | 1.56 % | 0.12 % | 0.96 % | -0.22 | 0.28 |
| INRIM | -200.79 | 1.553 | 43.03 | -1.10 | -199.59 | 1.546 | 43.12 | -1.23 | 0.60 % | 0.63 % | 0.45 % | 3.07 % | -0.22 % | 3.12 % | 0.12 | 1.01 |
| LCOE | -199.74 | 1.578 | 58.11 | 0.40 | -199.13 | 1.556 | 58.98 | 0.18 | 0.31 % | 0.63 % | 1.46 % | 2.10 % | -1.47 % | 1.32 % | 0.22 | 0.52 |
| LNE | -198.13 | 1.538 | 52.76 | 0.10 | -197.06 | 1.510 | 52.64 | 0.13 | 0.53 % | 0.63 % | 1.84 % | 2.59 % | 0.23 % | 1.17 % | -0.03 | 1.01 |
| RISE2 | -200.82 | 1.596 | 43.59 | -1.00 | -199.69 | 1.584 | 43.65 | -0.99 | 0.58 % | 0.56 % | 0.76 % | 1.09 % | -0.13 % | 1.15 % | -0.01 | 0.16 |
| PTB | -199.16 | 1.559 | 47.14 | 0.00 | -197.94 | 1.547 | 46.97 | -0.69 | 0.63 % | 0.54 % | 0.79 % | 2.10 % | 0.36 % | 2.17 % | 0.69 | 2.00 |
| TUBITAK | -201.45 | 1.525 | 59.42 | 0.27 | -201.28 | 1.499 | 59.45 | N/A | 0.09 % | 0.63 % | 1.72 % | 1.55 % | -0.04 % | 1.11 % | | |
| IATTE | -202.14 | 1.612 | 49.26 | 0.14 | -199.84 | 1.546 | 49.10 | N/A | 1.13 % | 0.39 % | 4.23 % | 0.79 % | 0.32 % | 0.96 % | | |
| IATTE1 | -202.14 | 1.612 | 49.26 | 0.14 | -201.50 | 1.610 | 47.62 | N/A | 0.32 % | 0.74 % | 0.11 % | 2.58 % | 3.44 % | 2.17 % | | |
| NMIA | -202.51 | 1.546 | 58.55 | -0.45 | -200.70 | 1.524 | 58.43 | 0.00 | 0.96 % | 0.63 % | 1.48 % | 2.20 % | 0.20 % | 1.32 % | -0.45 | 0.72 |
| VNIIMS | -206.71 | 1.370 | 46.30 | -1.39 | -207.53 | 1.310 | 46.78 | -1.48 | -0.27 % | 0.48 % | 4.58 % | 2.10 % | -1.02 % | 0.99 % | 0.09 | 0.52 |
| NIM | -200.34 | 1.604 | 59.42 | 0.11 | -198.81 | 1.562 | 59.13 | 0.10 | 0.89 % | 0.55 % | 2.70 % | 1.63 % | 0.48 % | 1.32 % | 0.01 | 0.81 |
| JHILL | -202.34 | 1.560 | 59.96 | 0.00 | -200.58 | 1.542 | 59.96 | -0.01 | 1.05 % | 0.63 % | 1.19 % | 2.10 % | -0.01 % | 1.32 % | 0.00 | 0.51 |
| NRC | -198.09 | 1.559 | 59.77 | 0.00 | -197.15 | 1.533 | 59.37 | 0.08 | 0.81 % | 0.63 % | 1.72 % | 2.10 % | 0.66 % | 2.18 % | -0.08 | 1.01 |
| RISE3 | -200.24 | 1.605 | 63.60 | 0.15 | -198.86 | 1.586 | 63.50 | 0.18 | 0.81 % | 0.56 % | 1.17 % | 1.15 % | 0.15 % | 1.37 % | -0.03 | 0.17 |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | 0.20 % | 0.58 % | 0.34 | 0 |
| VTT | -0.10 % | 0.42 % | -0.23 | |
| INRIM | -0.03 % | 0.60 % | -0.05 | |
| LCOE | -0.33 % | 0.60 % | -0.54 | |
| LNE | -0.10 % | 0.60 % | -0.17 | |
| RISE2 | -0.06 % | 0.53 % | -0.11 | |
| PTB | 0.00 % | 0.51 % | 0.00 | |
| TUBITAK | -0.55 % | 0.60 % | -0.90 | |
| IATTE | 0.50 % | 0.43 % | 1.16 | 0 |
| IATTE1 | -0.32 % | 0.76 % | -0.41 | 0 |
| NMIA | 0.33 % | 0.60 % | 0.55 | |
| VNIIMS | -0.91 % | 0.51 % | -1.77 | 1 |
| NIM | 0.26 % | 0.52 % | 0.49 | |
| JHILL | 0.42 % | 0.60 % | 0.69 | |
| NRC | 0.18 % | 0.60 % | 0.29 | |
| RISE3 | 0.18 % | 0.59 % | 0.31 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.63 % | 0.17 % | 58 % |



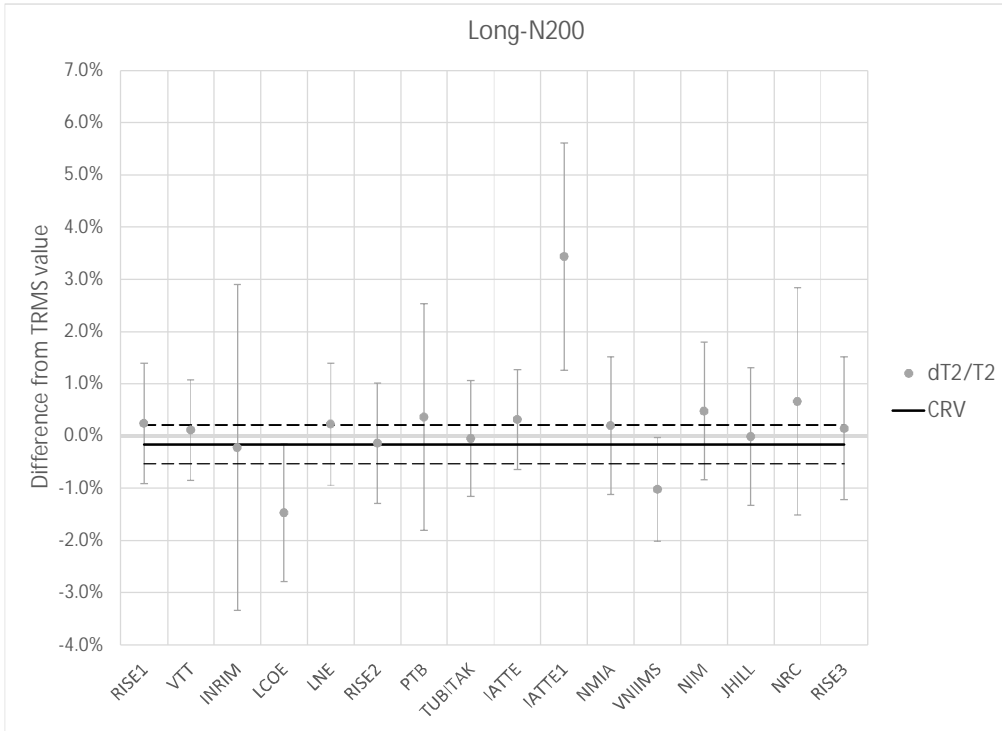
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.99 % | 1.19 % | -0.83 | 0 |
| VTT | -1.19 % | 1.47 % | -0.81 | |
| INRIM | -1.01 % | 3.02 % | -0.33 | |
| LCOE | -0.01 % | 2.04 % | 0.00 | |
| LNE | 0.37 % | 2.53 % | 0.15 | |
| RISE2 | -0.70 % | 0.96 % | -0.73 | |
| PTB | -0.68 % | 2.04 % | -0.33 | |
| TUBITAK | 0.26 % | 1.46 % | 0.18 | |
| IATTE | 2.77 % | 0.94 % | 2.93 | 0 |
| IATTE1 | -1.35 % | 2.63 % | -0.51 | 0 |
| NMIA | 0.02 % | 2.13 % | 0.01 | |
| VNIIMS | 3.12 % | 2.03 % | 1.53 | |
| NIM | 1.24 % | 1.55 % | 0.80 | |
| JHILL | -0.28 % | 2.04 % | -0.14 | |
| NRC | 0.25 % | 2.03 % | 0.12 | |
| RISE3 | -0.29 % | 1.26 % | -0.23 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 1.46 % | 0.52 % | 13 % |

Long-N200

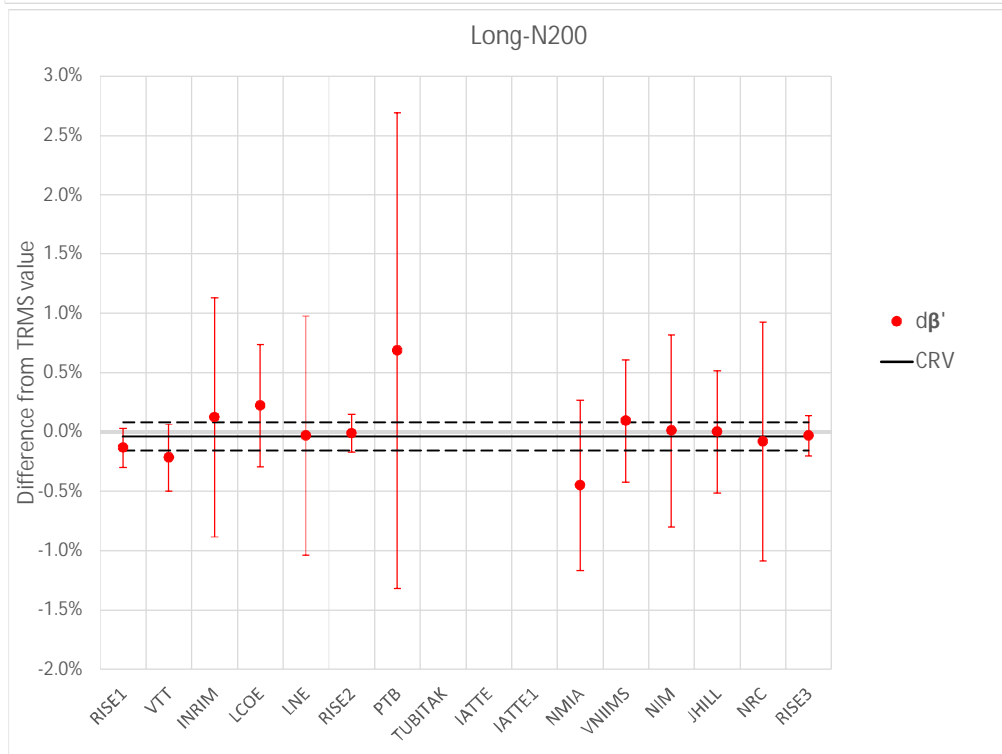
Long-N200



| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | 0.41 % | 1.21 % | 0.34 | 0 |
| VTT | 0.27 % | 0.89 % | 0.31 | |
| INRIM | -0.06 % | 3.10 % | -0.02 | |
| LCOE | -1.31 % | 1.26 % | -1.04 | |
| LNE | 0.39 % | 1.11 % | 0.35 | |
| RISE2 | 0.03 % | 1.09 % | 0.02 | |
| PTB | 0.52 % | 2.14 % | 0.24 | |
| TUBITAK | 0.11 % | 1.04 % | 0.11 | |
| IATTE | 0.48 % | 1.03 % | 0.46 | 0 |
| IATTE1 | 3.60 % | 2.21 % | 1.63 | 0 |
| NMIA | 0.36 % | 1.26 % | 0.28 | |
| VNIIMS | -0.86 % | 0.92 % | -0.94 | |
| NIM | 0.64 % | 1.26 % | 0.51 | |
| JHILL | 0.15 % | 1.26 % | 0.12 | |
| NRC | 0.82 % | 2.14 % | 0.38 | |
| RISE3 | 0.31 % | 1.42 % | 0.22 | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.16 % | 0.37 % | 54 % |

T_2



| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.10 | 0.20 | -0.48 | 0 |
| VTT | -0.18 | 0.25 | -0.70 | |
| INRIM | 0.16 | 1.00 | 0.16 | |
| LCOE | 0.26 | 0.50 | 0.52 | |
| LNE | 0.01 | 1.00 | 0.01 | |
| RISE2 | 0.03 | 0.10 | 0.26 | |
| PTB | 0.72 | 2.00 | 0.36 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.41 | 0.71 | -0.58 | |
| VNIIMS | 0.13 | 0.50 | 0.26 | |
| NIM | 0.05 | 0.80 | 0.06 | |
| JHILL | 0.04 | 0.50 | 0.08 | |
| NRC | -0.04 | 1.00 | -0.04 | |
| RISE3 | 0.01 | 0.21 | 0.03 | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.04 | 0.12 | 89 % |

β' [%]

Long-N300

Long-N300

Setup uncertainties:

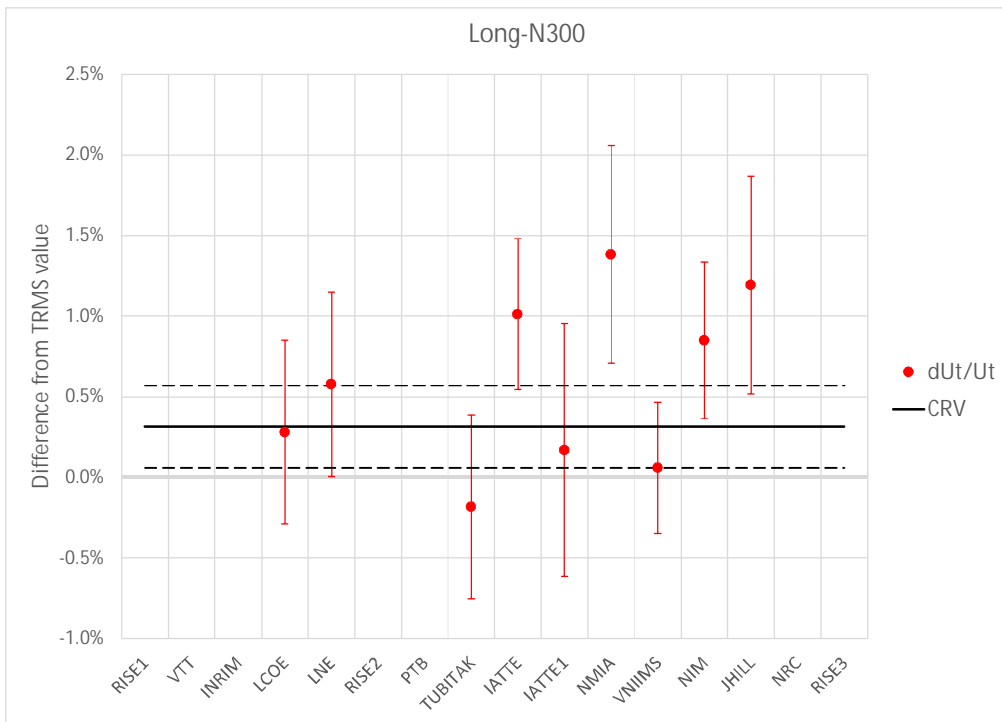
0.18 %

0.45 %

0.80 %

0.12

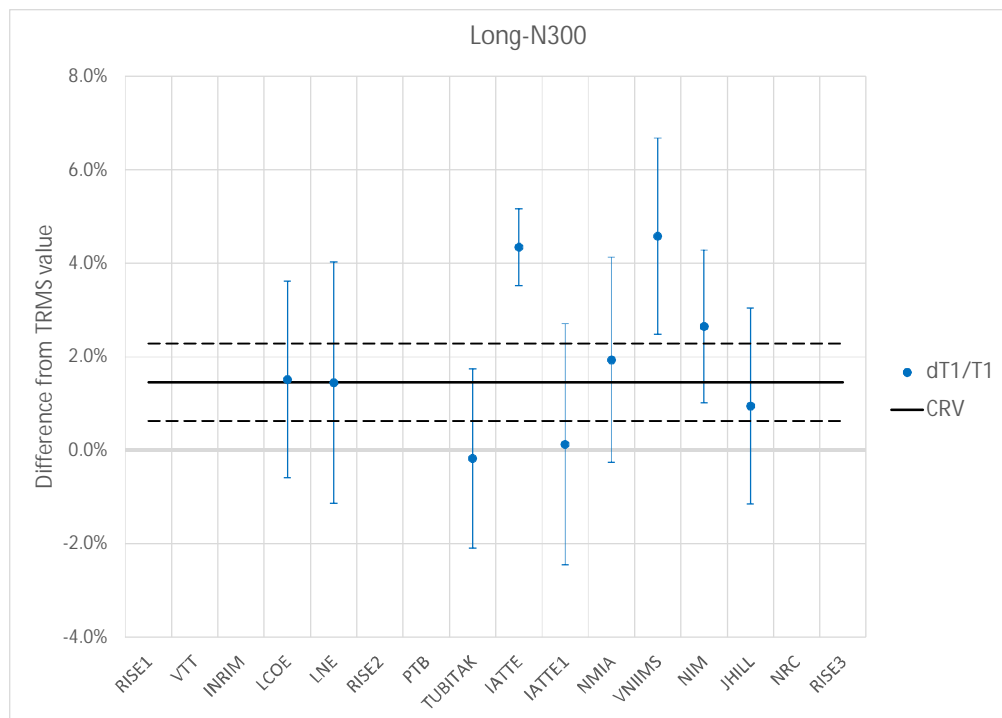
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -301.05 | 1.544 | 58.09 | 0.25 | -300.21 | 1.521 | 58.99 | 0.16 | 0.28 % | 0.63 % | 1.52 % | 2.10 % | -1.52 % | 1.32 % | 0.09 | 0.52 |
| LNE | -298.66 | 1.536 | 53.56 | 0.15 | -296.91 | 1.514 | 53.48 | 0.19 | 0.58 % | 0.63 % | 1.45 % | 2.58 % | 0.15 % | 1.17 % | -0.04 | 1.01 |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -300.72 | 1.525 | 59.51 | 0.21 | -301.27 | 1.527 | 59.53 | #N/A | -0.18 % | 0.63 % | -0.17 % | 1.92 % | -0.03 % | 1.24 % | | #N/A |
| IATTE | -300.27 | 1.610 | 49.48 | 0.09 | -297.20 | 1.543 | 49.25 | #N/A | 1.01 % | 0.39 % | 4.35 % | 0.82 % | 0.47 % | 0.96 % | | |
| IATTE1 | -300.27 | 1.610 | 49.48 | 0.09 | -299.77 | 1.608 | 47.77 | #N/A | 0.17 % | 0.74 % | 0.13 % | 2.58 % | 3.59 % | 2.17 % | | |
| NMIA | -294.62 | 1.546 | 58.97 | -0.54 | -290.78 | 1.516 | 59.22 | -0.18 | 1.38 % | 0.63 % | 1.94 % | 2.20 % | -0.42 % | 1.32 % | -0.36 | 0.72 |
| VNIIMS | -310.40 | 1.370 | 46.38 | -1.47 | -310.59 | 1.310 | 46.95 | -1.58 | 0.06 % | 0.48 % | 4.58 % | 2.10 % | -1.21 % | 0.99 % | 0.12 | 0.51 |
| NIM | -296.34 | 1.619 | 60.06 | 0.12 | -294.19 | 1.577 | 59.68 | 0.17 | 0.85 % | 0.55 % | 2.65 % | 1.63 % | 0.63 % | 1.32 % | -0.04 | 0.81 |
| JHILL | -303.14 | 1.560 | 60.14 | -0.08 | -300.08 | 1.545 | 60.11 | 0.01 | 1.19 % | 0.63 % | 0.95 % | 2.10 % | 0.05 % | 1.32 % | -0.09 | 0.51 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.03 % | 0.57 % | -0.06 | |
| LNE | 0.26 % | 0.57 % | 0.46 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.50 % | 0.57 % | -0.87 | |
| IATTE | 0.70 % | 0.47 % | 1.49 | 0 |
| IATTE1 | -0.15 % | 0.79 % | -0.19 | 0 |
| NMIA | 1.07 % | 0.68 % | 1.58 | 1 |
| VNIIMS | -0.25 % | 0.41 % | -0.63 | |
| NIM | 0.54 % | 0.49 % | 1.10 | |
| JHILL | 0.88 % | 0.68 % | 1.30 | 2 |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.31 % | 0.26 % | 8 % |



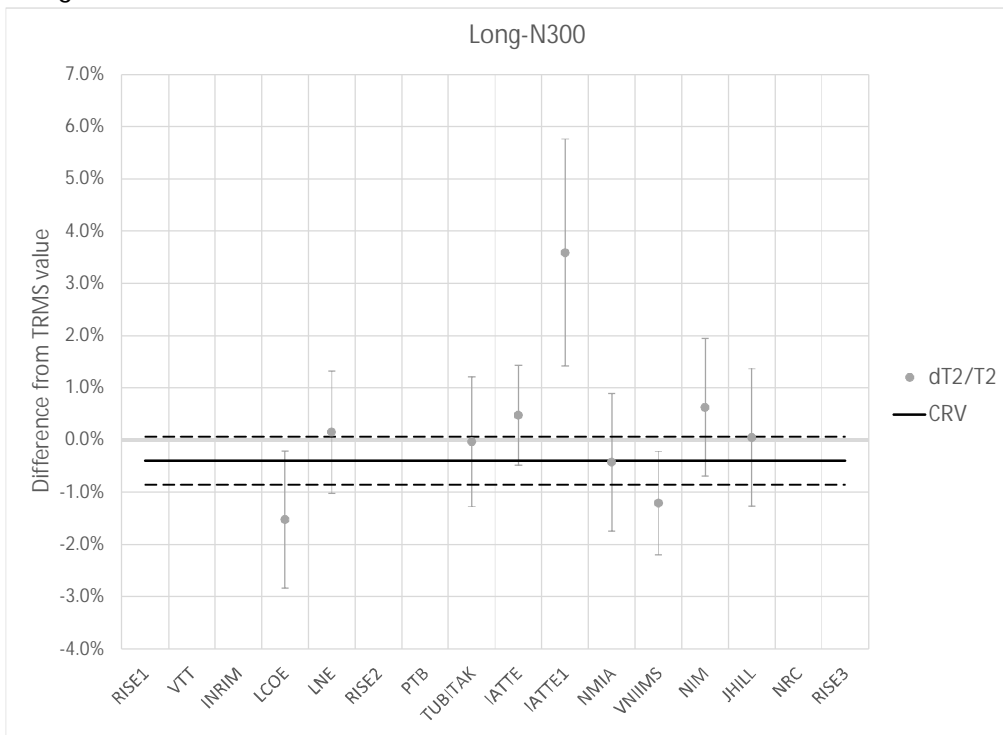
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.06 % | 1.93 % | 0.03 | |
| LNE | -0.01 % | 2.45 % | 0.00 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -1.63 % | 1.73 % | -0.94 | |
| IATTE | 2.89 % | 1.17 % | 2.48 | 0 |
| IATTE1 | -1.33 % | 2.71 % | -0.49 | 0 |
| NMIA | 0.48 % | 2.04 % | 0.23 | |
| VNIIMS | 3.12 % | 2.26 % | 1.38 | 1 |
| NIM | 1.19 % | 1.41 % | 0.85 | |
| JHILL | -0.51 % | 1.93 % | -0.26 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 1.46 % | 0.83 % | 36 % |

Long-N300

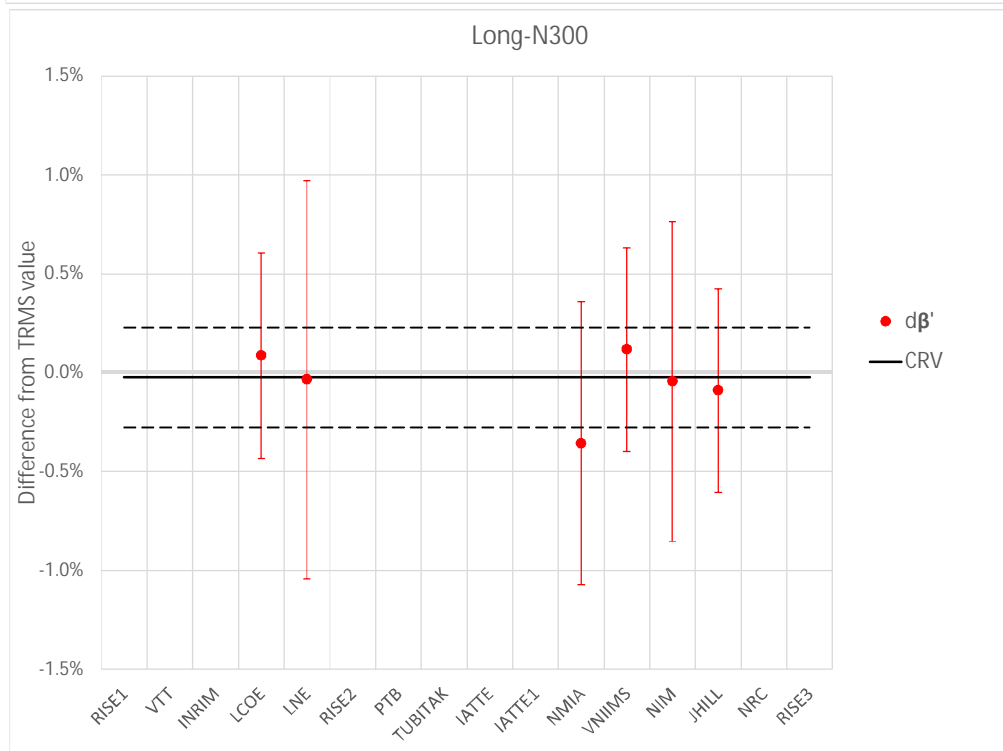
Long-N300



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -1.13 % | 1.23 % | -0.91 | |
| LNE | 0.55 % | 1.08 % | 0.51 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.37 % | 1.15 % | 0.32 | |
| IATTE | 0.87 % | 1.06 % | 0.82 | 0 |
| IATTE1 | 3.99 % | 2.22 % | 1.79 | 0 |
| NMIA | -0.03 % | 1.23 % | -0.02 | |
| VNIIMS | -0.81 % | 0.88 % | -0.92 | |
| NIM | 1.02 % | 1.23 % | 0.83 | |
| JHILL | 0.45 % | 1.23 % | 0.36 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.40 % | 0.46 % | 14 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.11 | 0.45 | 0.24 | |
| LNE | -0.01 | 0.98 | -0.01 | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.33 | 0.67 | -0.50 | |
| VNIIMS | 0.14 | 0.45 | 0.31 | |
| NIM | -0.02 | 0.77 | -0.03 | |
| JHILL | -0.07 | 0.45 | -0.15 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.02 | 0.25 | 92 % |

Long-N400

Long-N400

Setup uncertainties:

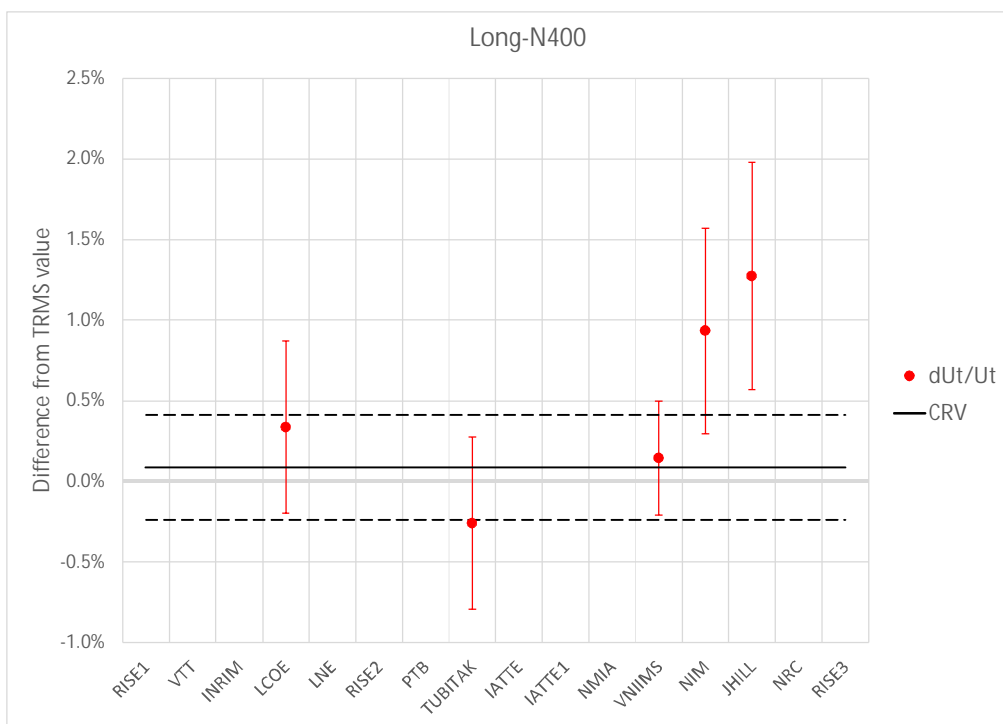
0.18 %

0.45 %

0.80 %

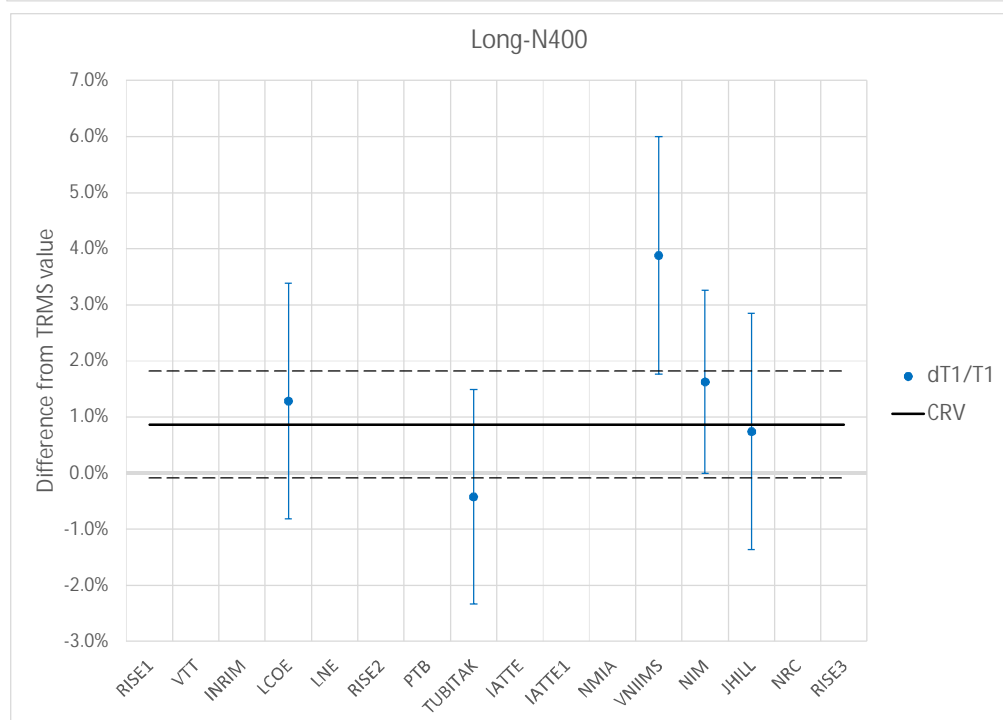
0.12

| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -400.73 | 1.541 | 58.41 | 0.36 | -399.39 | 1.521 | 59.26 | 0.19 | 0.34 % | 0.63 % | 1.28 % | 2.10 % | -1.44 % | 1.32 % | 0.17 | 0.52 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -401.24 | 1.528 | 59.62 | 0.18 | -402.29 | 1.534 | 59.66 | #N/A | -0.26 % | 0.63 % | -0.42 % | 1.91 % | -0.05 % | 1.24 % | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | -414.20 | 1.366 | 46.33 | -1.27 | -414.11 | 1.315 | 46.99 | -1.60 | 0.14 % | 0.48 % | 3.88 % | 2.12 % | -1.40 % | 0.99 % | 0.34 | 0.52 |
| NIM | -399.71 | 1.565 | 61.39 | 0.62 | -396.49 | 1.540 | 61.20 | 0.50 | 0.93 % | 0.55 % | 1.62 % | 1.63 % | 0.31 % | 1.32 % | 0.12 | 0.81 |
| JHILL | -404.24 | 1.563 | 60.24 | 0.10 | -399.84 | 1.551 | 60.30 | -0.03 | 1.27 % | 0.63 % | 0.74 % | 2.10 % | -0.09 % | 1.32 % | 0.13 | 0.52 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.25 % | 0.53 % | 0.47 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.35 % | 0.53 % | -0.65 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.06 % | 0.35 % | 0.16 | |
| NIM | 0.85 % | 0.64 % | 1.33 | 2 |
| JHILL | 1.19 % | 0.71 % | 1.68 | 1 |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.09 % | 0.33 % | 38 % |

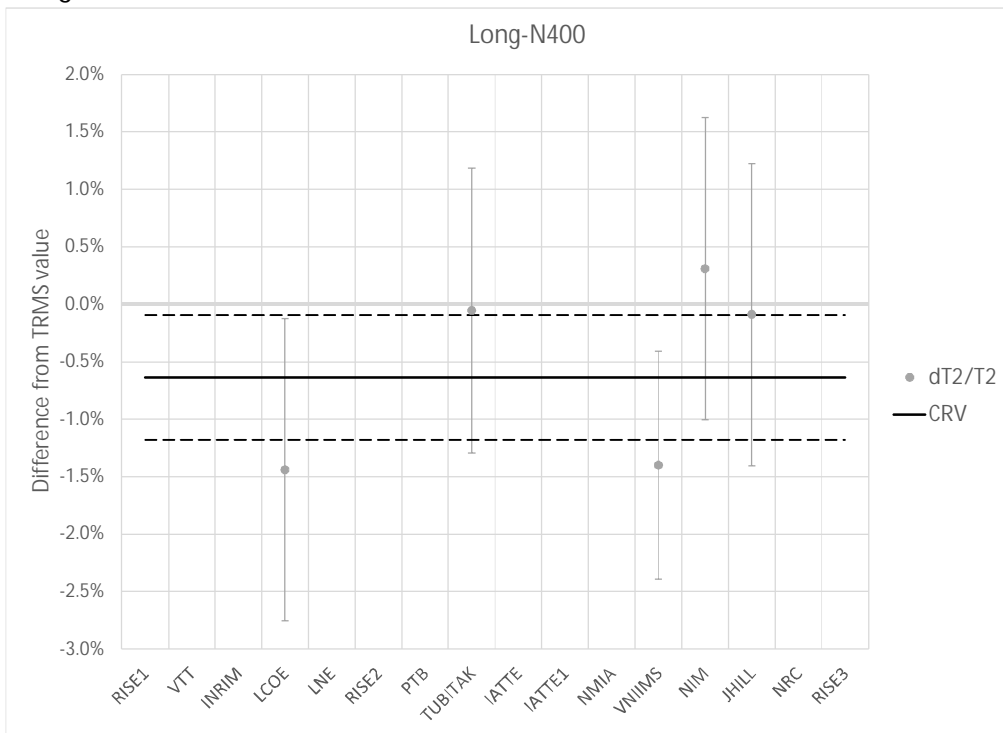


| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.42 % | 1.87 % | 0.22 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -1.29 % | 1.66 % | -0.78 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 3.02 % | 2.32 % | 1.30 | 1 |
| NIM | 0.76 % | 1.33 % | 0.57 | |
| JHILL | -0.12 % | 1.87 % | -0.07 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.86 % | 0.95 % | 42 % |

Long-N400

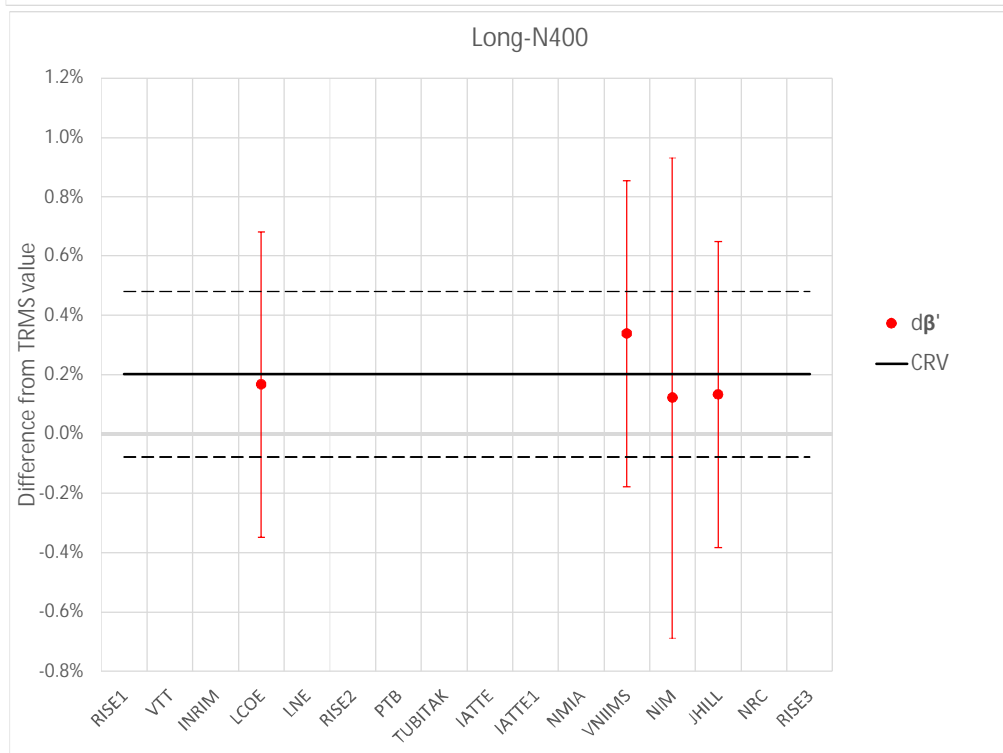
Long-N400



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.80 % | 1.20 % | -0.67 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.58 % | 1.12 % | 0.52 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.76 % | 0.83 % | -0.92 | |
| NIM | 0.95 % | 1.20 % | 0.79 | |
| JHILL | 0.55 % | 1.20 % | 0.46 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.64 % | 0.54 % | 11 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.04 | 0.43 | -0.08 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.14 | 0.43 | 0.32 | |
| NIM | -0.08 | 0.76 | -0.11 | |
| JHILL | -0.07 | 0.43 | -0.16 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.20 | 0.28 | 94 % |

Long-N500

Long-N500

Setup uncertainties:

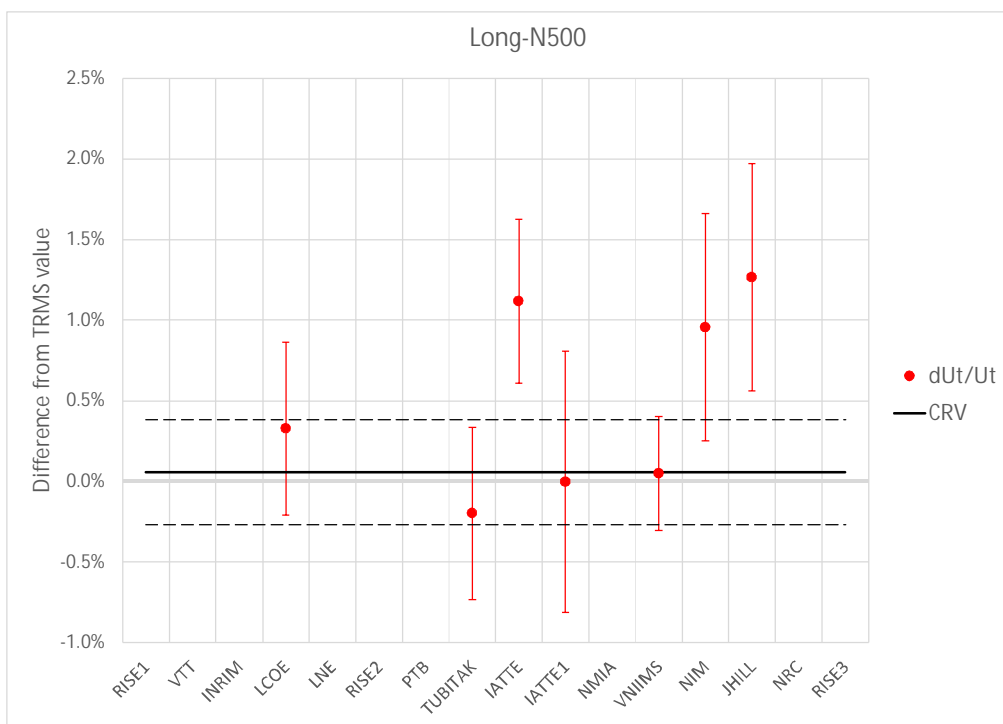
0.18 %

0.45 %

0.80 %

0.12

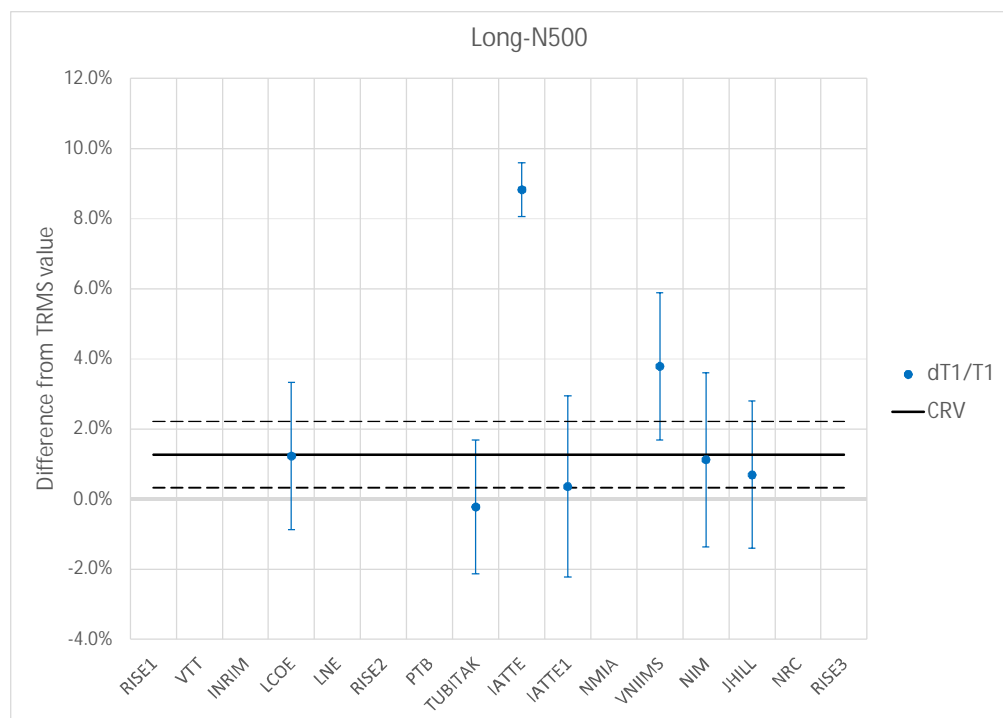
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -501.20 | 1.545 | 58.63 | 0.27 | -499.56 | 1.526 | 59.47 | 0.27 | 0.33 % | 0.63 % | 1.23 % | 2.10 % | -1.42 % | 1.32 % | 0.00 | 0.52 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -500.89 | 1.532 | 59.81 | 0.37 | -501.89 | 1.536 | 59.79 | #N/A | -0.20 % | 0.63 % | -0.22 % | 1.91 % | 0.03 % | 1.24 % | | |
| IATTE | -501.86 | 1.393 | 47.05 | -0.11 | -496.21 | 1.280 | 46.89 | #N/A | 1.12 % | 0.39 % | 8.83 % | 0.76 % | 0.34 % | 0.96 % | | |
| IATTE1 | -501.86 | 1.393 | 47.05 | -0.11 | -501.88 | 1.388 | 46.05 | #N/A | 0.00 % | 0.74 % | 0.36 % | 2.58 % | 2.17 % | 2.17 % | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | -512.35 | 1.370 | 46.42 | -1.35 | -512.72 | 1.320 | 47.10 | -1.61 | 0.05 % | 0.48 % | 3.79 % | 2.10 % | -1.45 % | 0.99 % | 0.26 | 0.52 |
| NIM | -502.96 | 1.563 | 61.84 | 0.58 | -498.80 | 1.545 | 61.80 | 0.63 | 0.96 % | 0.63 % | 1.12 % | 2.49 % | 0.07 % | 1.73 % | -0.05 | 0.81 |
| JHILL | -504.05 | 1.569 | 60.47 | 0.03 | -498.59 | 1.558 | 60.57 | -0.04 | 1.27 % | 0.63 % | 0.69 % | 2.10 % | -0.16 % | 1.32 % | 0.07 | 0.51 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.27 % | 0.54 % | 0.51 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.26 % | 0.53 % | -0.48 | |
| IATTE | 1.06 % | 0.51 % | 2.09 | 0 |
| IATTE1 | -0.06 % | 0.81 % | -0.08 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.01 % | 0.35 % | -0.02 | |
| NIM | 0.90 % | 0.71 % | 1.28 | 2 |
| JHILL | 1.21 % | 0.71 % | 1.71 | 1 |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.06 % | 0.33 % | 49 % |



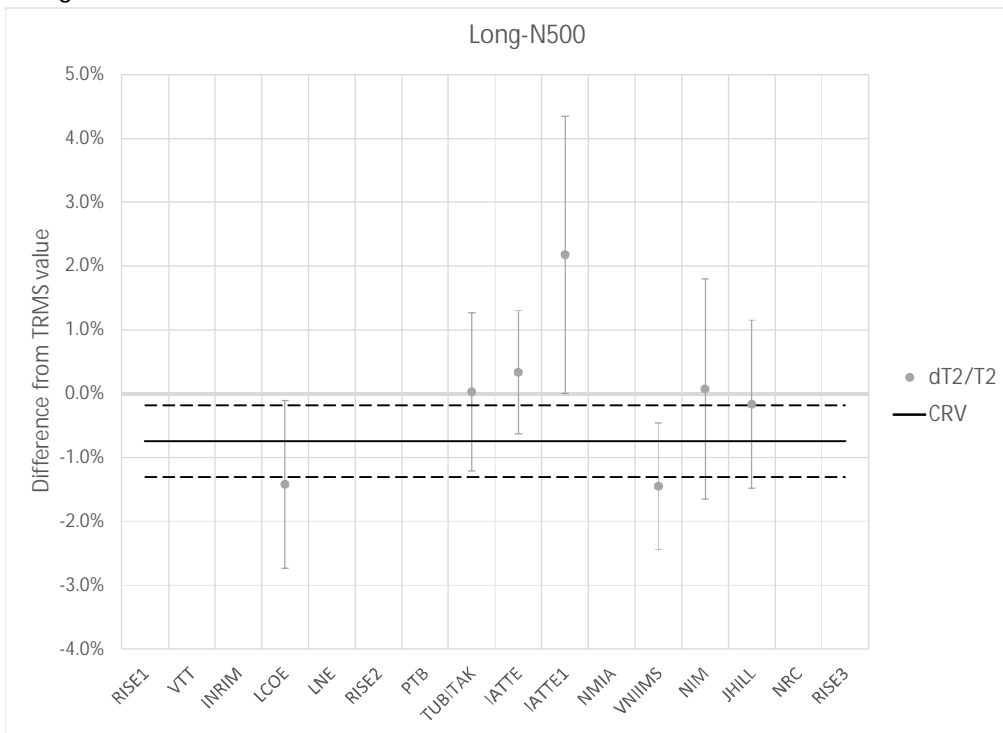
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.04 % | 1.88 % | -0.02 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -1.49 % | 1.66 % | -0.90 | |
| IATTE | 7.56 % | 1.22 % | 6.22 | 0 |
| IATTE1 | -0.91 % | 2.75 % | -0.33 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 2.52 % | 1.88 % | 1.34 | |
| NIM | -0.15 % | 2.30 % | -0.06 | |
| JHILL | -0.57 % | 1.88 % | -0.31 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 1.27 % | 0.95 % | 7 % |

Long-N500

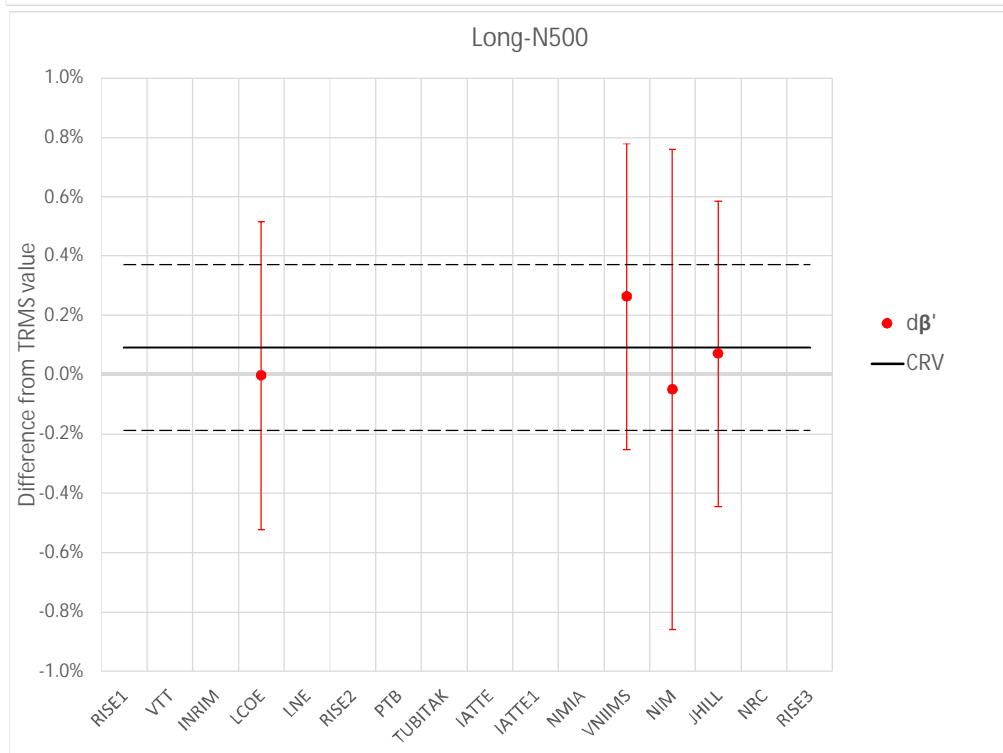
Long-N500



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.68 % | 1.19 % | -0.57 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.77 % | 1.11 % | 0.70 | |
| IATTE | 1.08 % | 1.12 % | 0.97 | 0 |
| IATTE1 | 2.92 % | 2.25 % | 1.30 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.71 % | 0.82 % | -0.87 | |
| NIM | 0.81 % | 1.63 % | 0.50 | |
| JHILL | 0.58 % | 1.19 % | 0.49 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.74 % | 0.56 % | 18 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.10 | 0.44 | -0.22 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.17 | 0.43 | 0.40 | |
| NIM | -0.14 | 0.76 | -0.19 | |
| JHILL | -0.02 | 0.43 | -0.05 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.09 | 0.28 | 87 % |

Long-N600

Long-N600

Setup uncertainties:

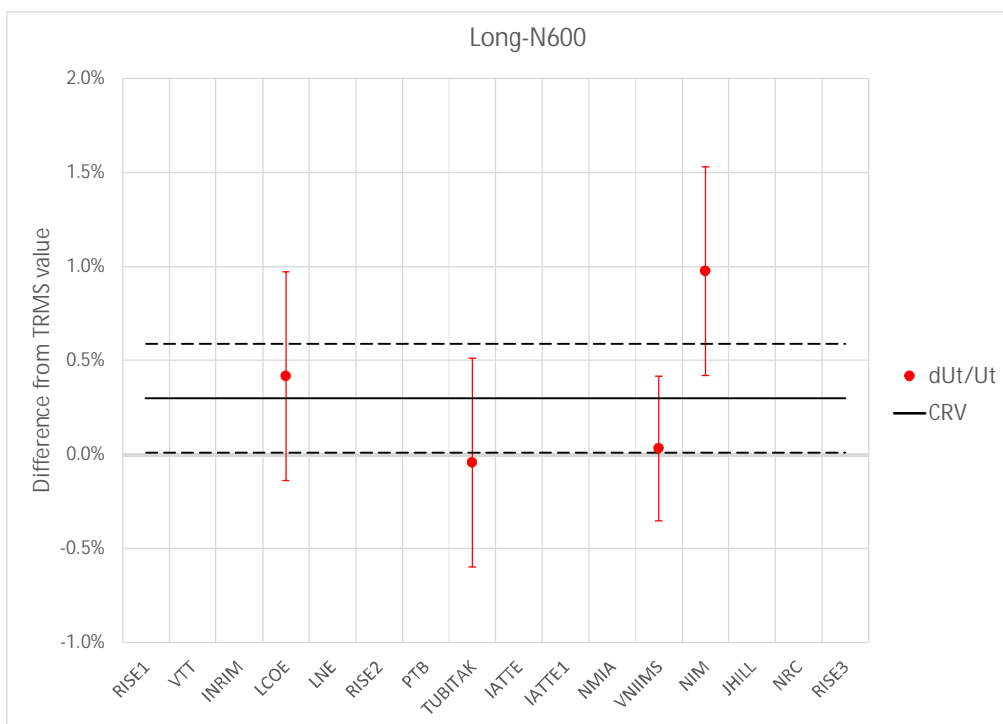
0.18 %

0.45 %

0.80 %

0.12

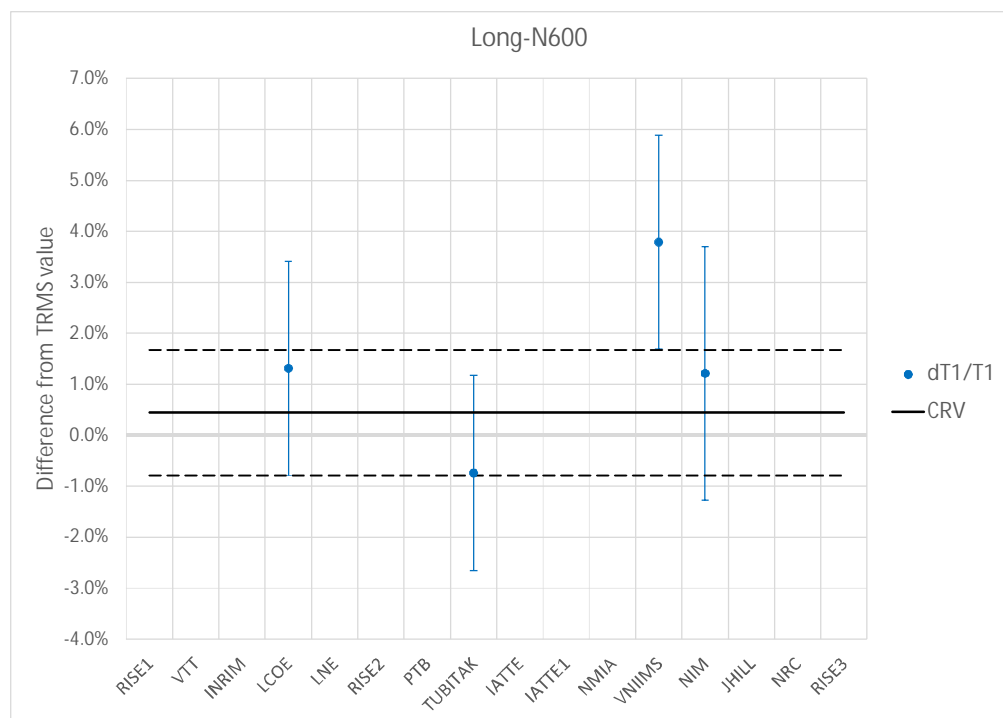
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -601.19 | 1.556 | 58.97 | 0.19 | -598.70 | 1.536 | 59.81 | 0.05 | 0.42 % | 0.63 % | 1.31 % | 2.10 % | -1.41 % | 1.32 % | 0.14 | 0.52 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -601.12 | 1.536 | 60.10 | 0.30 | -601.38 | 1.547 | 60.12 | #N/A | -0.04 % | 0.63 % | -0.74 % | 1.91 % | -0.02 % | 1.24 % | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | -615.92 | 1.370 | 46.54 | -1.38 | -616.46 | 1.320 | 47.26 | -1.66 | 0.03 % | 0.48 % | 3.79 % | 2.10 % | -1.52 % | 0.99 % | 0.28 | 0.51 |
| NIM | -609.26 | 1.565 | 62.44 | 0.58 | -604.10 | 1.546 | 62.55 | 0.55 | 0.97 % | 0.63 % | 1.22 % | 2.49 % | -0.16 % | 1.73 % | 0.03 | 0.81 |
| JHILL | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.12 % | 0.56 % | 0.21 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.34 % | 0.56 % | -0.61 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.27 % | 0.38 % | -0.69 | |
| NIM | 0.68 % | 0.56 % | 1.22 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.30 % | 0.29 % | 6 % |



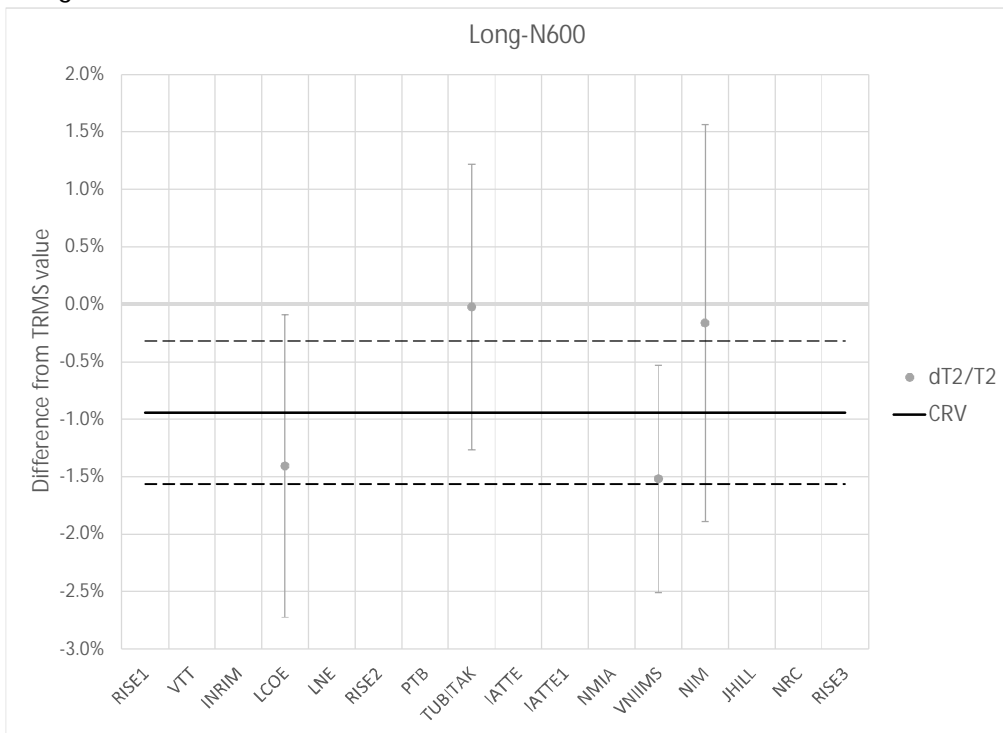
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.87 % | 1.71 % | 0.51 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -1.18 % | 1.47 % | -0.80 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 3.34 % | 2.43 % | 1.37 | 1 |
| NIM | 0.77 % | 2.16 % | 0.36 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.44 % | 1.23 % | 27 % |

Long-N600

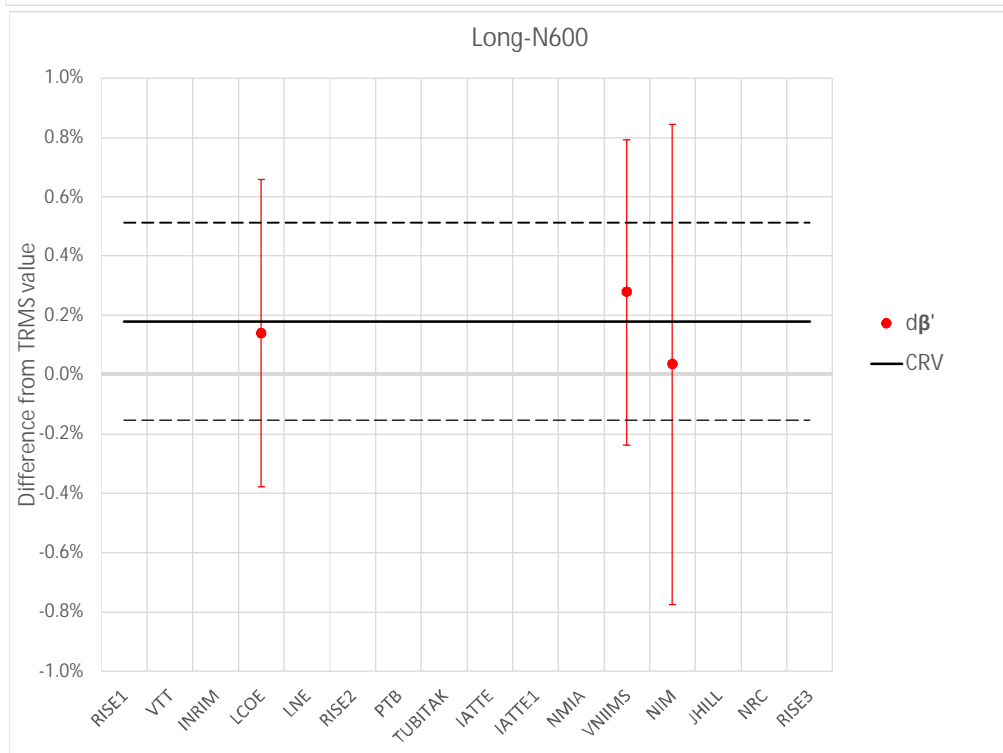
Long-N600



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.47 % | 1.16 % | -0.40 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.92 % | 1.07 % | 0.85 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.58 % | 0.77 % | -0.75 | |
| NIM | 0.78 % | 1.61 % | 0.48 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.94 % | 0.62 % | 18 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.04 | 0.40 | -0.10 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.10 | 0.39 | 0.25 | |
| NIM | -0.14 | 0.74 | -0.20 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.18 | 0.33 | 86 % |

Long-N700

Long-N700

Setup uncertainties:

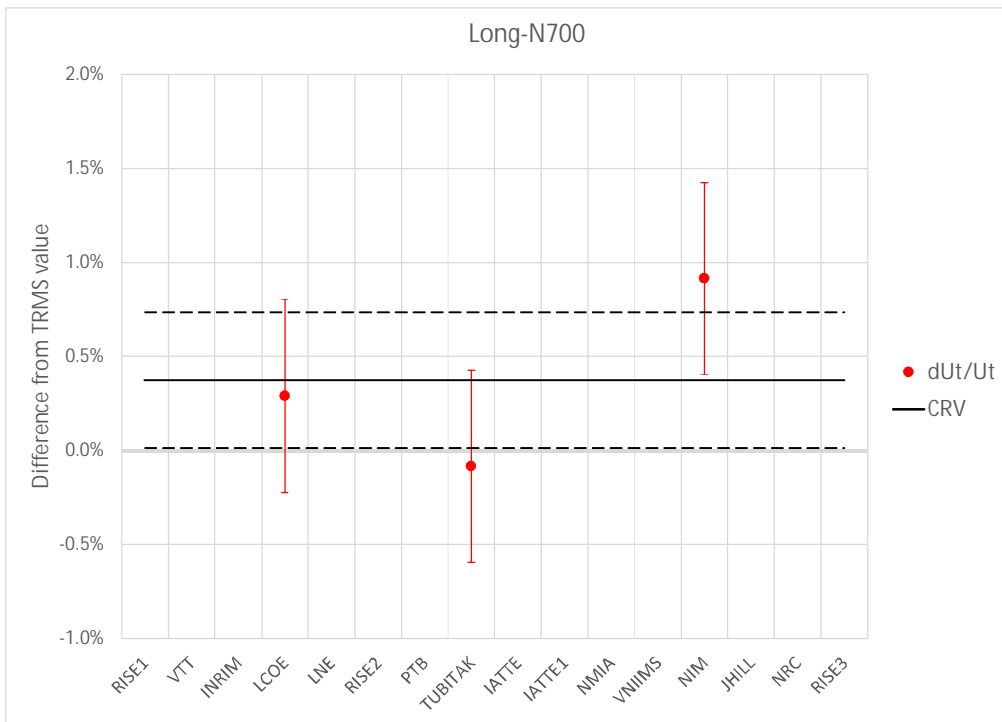
0.18 %

0.45 %

0.80 %

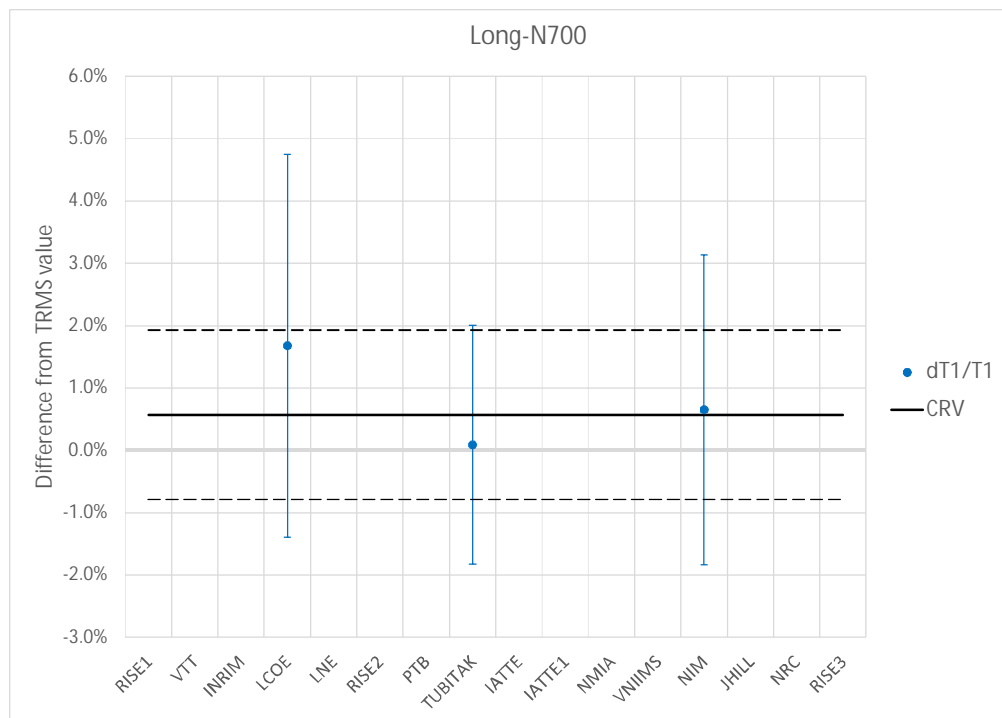
0.12

| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | -700.34 | 1.560 | 57.93 | 0.28 | -698.32 | 1.535 | 58.78 | 0.18 | 0.29 % | 0.63 % | 1.68 % | 3.07 % | -1.45 % | 1.32 % | 0.10 | 0.52 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| TUBITAK | -699.00 | 1.539 | 60.21 | 0.27 | -699.59 | 1.537 | 60.27 | #N/A | -0.08 % | 0.63 % | 0.09 % | 1.91 % | -0.11 % | 1.24 % | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NIM | -701.33 | 1.544 | 62.83 | 0.42 | -695.80 | 1.534 | 62.93 | 0.30 | 0.91 % | 0.63 % | 0.65 % | 2.49 % | -0.15 % | 1.73 % | 0.12 | 0.81 |
| JHILL | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.08 % | 0.51 % | -0.16 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.46 % | 0.51 % | -0.90 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | 0.54 % | 0.51 % | 1.06 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.37 % | 0.36 % | 7 % |

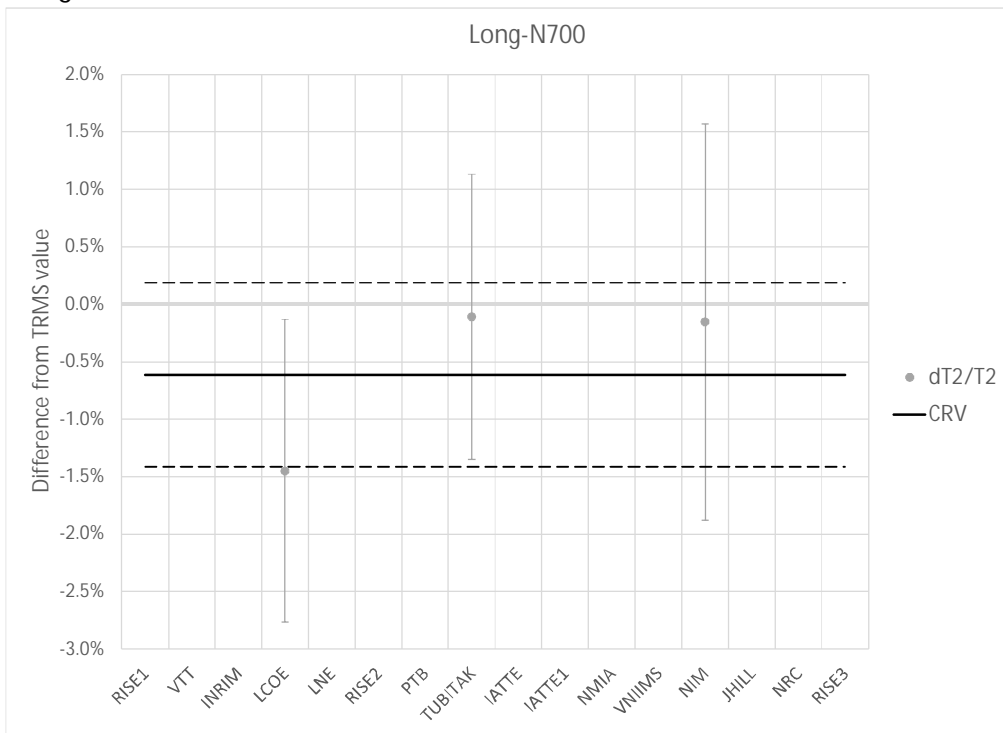


| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 1.11 % | 2.75 % | 0.40 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | -0.48 % | 1.35 % | -0.36 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | 0.08 % | 2.08 % | 0.04 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.57 % | 1.36 % | 68 % |

Long-N700

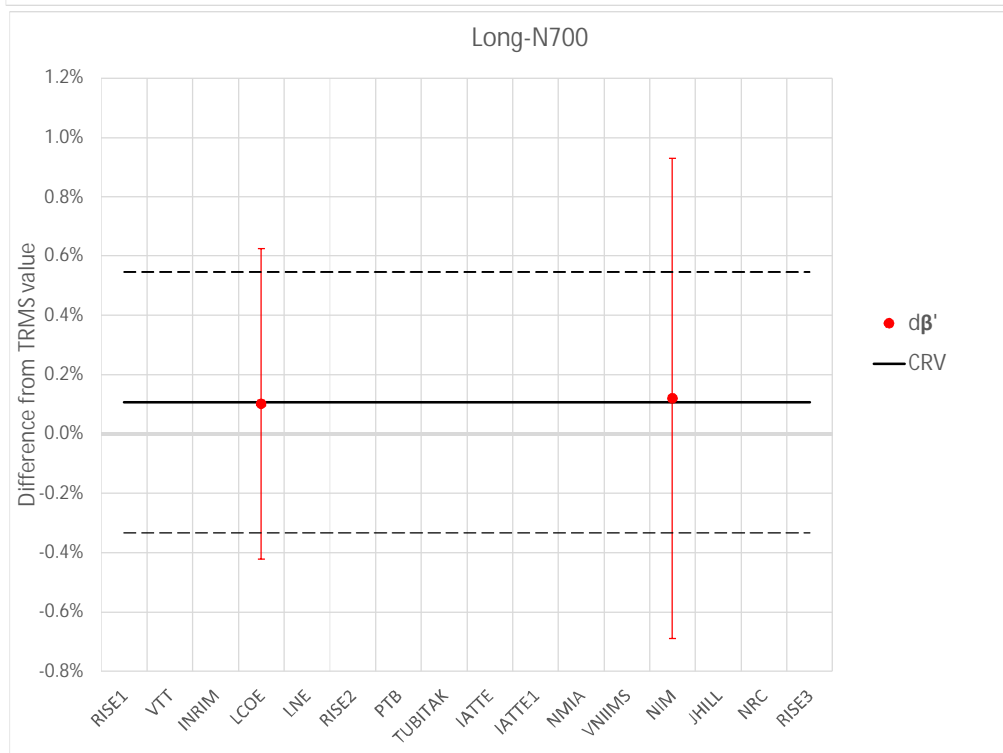
Long-N700



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.84 % | 1.05 % | -0.80 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | 0.50 % | 0.95 % | 0.53 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | 0.46 % | 1.53 % | 0.30 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.61 % | 0.80 % | 28 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.01 | 0.28 | -0.02 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | 0.01 | 0.68 | 0.02 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.11 | 0.44 | 97 % |

Long-P100

Long-P100

Setup uncertainties:

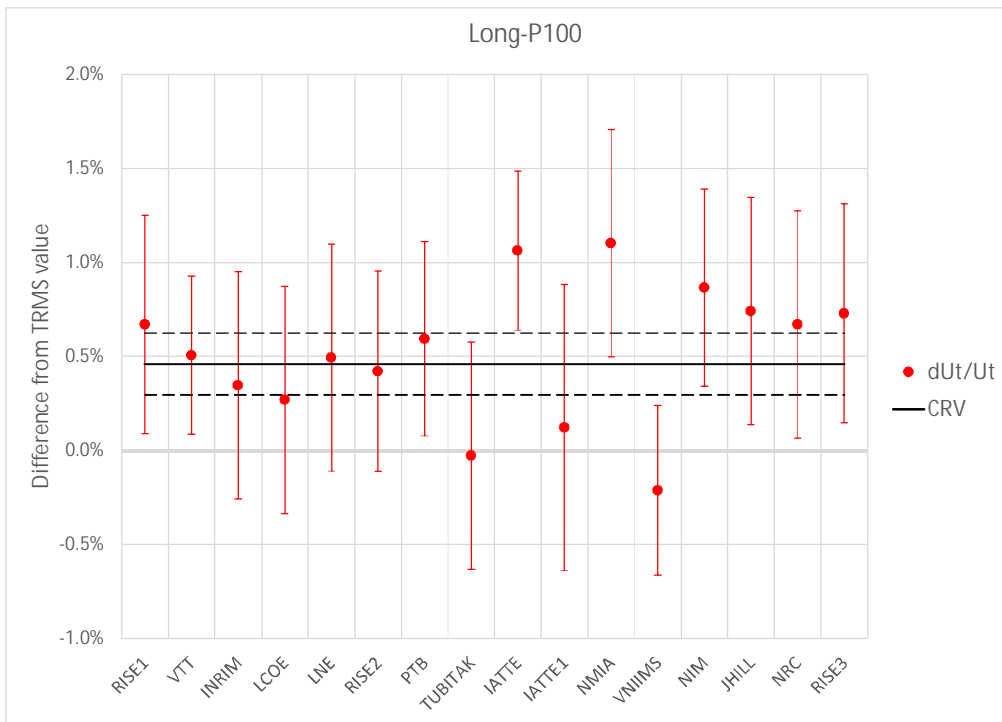
0.18 %

0.45 %

0.80 %

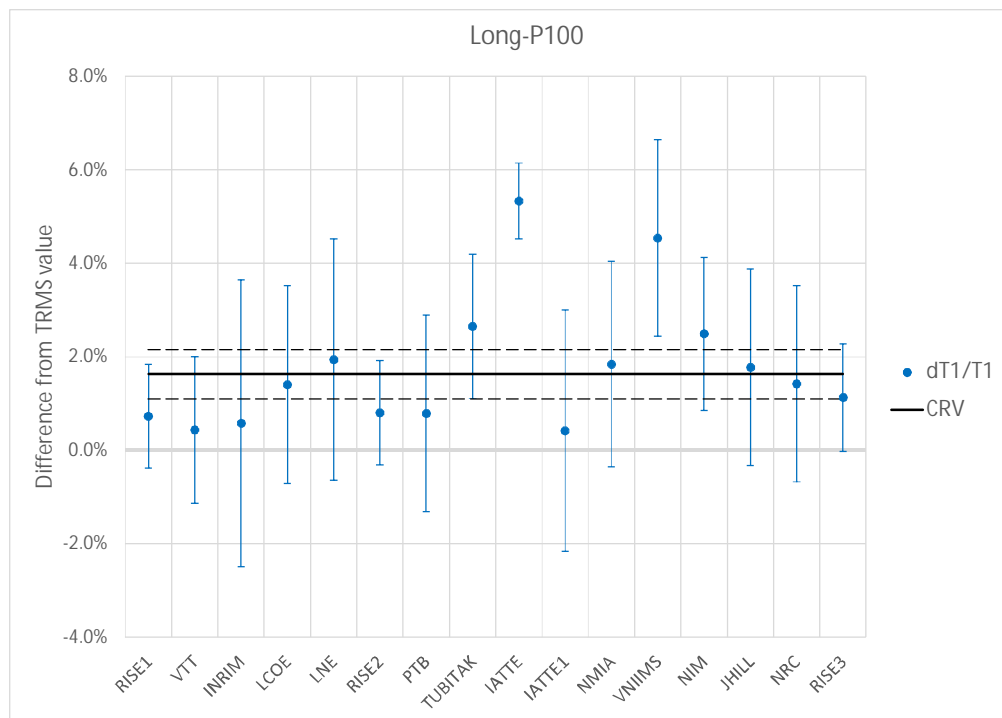
0.12

| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | 100.88 | 1.578 | 43.54 | -1.05 | 100.20 | 1.566 | 43.26 | -0.89 | 0.67 % | 0.56 % | 0.73 % | 1.11 % | 0.65 % | 1.18 % | -0.16 | 0.16 |
| VTT | 99.73 | 1.590 | 44.16 | -1.02 | 99.23 | 1.583 | 44.08 | -0.82 | 0.51 % | 0.45 % | 0.43 % | 1.57 % | 0.18 % | 0.96 % | -0.20 | 0.28 |
| INRIM | 100.52 | 1.547 | 42.99 | -1.11 | 100.17 | 1.538 | 42.96 | -1.04 | 0.35 % | 0.63 % | 0.58 % | 3.07 % | 0.07 % | 3.12 % | -0.06 | 1.01 |
| LCOE | 99.87 | 1.582 | 58.19 | 0.64 | 99.60 | 1.560 | 58.97 | 0.15 | 0.27 % | 0.63 % | 1.41 % | 2.11 % | -1.33 % | 1.32 % | 0.49 | 0.52 |
| LNE | 102.02 | 1.533 | 52.35 | 0.39 | 101.51 | 1.504 | 52.13 | 0.12 | 0.49 % | 0.63 % | 1.94 % | 2.58 % | 0.42 % | 1.17 % | 0.26 | 1.03 |
| RISE2 | 99.02 | 1.599 | 43.56 | -0.98 | 98.62 | 1.586 | 43.30 | -0.87 | 0.42 % | 0.56 % | 0.81 % | 1.12 % | 0.59 % | 1.25 % | -0.12 | 0.16 |
| PTB | 96.17 | 1.555 | 47.21 | 0.00 | 95.62 | 1.542 | 46.91 | -0.72 | 0.59 % | 0.54 % | 0.79 % | 2.10 % | 0.64 % | 2.17 % | 0.72 | 2.00 |
| TUBITAK | 100.68 | 1.527 | 59.44 | 0.35 | 100.71 | 1.488 | 59.37 | N/A | -0.03 % | 0.63 % | 2.65 % | 1.55 % | 0.11 % | 1.12 % | | |
| IATTE | 99.75 | 1.617 | 49.34 | 0.05 | 98.68 | 1.535 | 49.30 | N/A | 1.06 % | 0.39 % | 5.33 % | 0.81 % | 0.08 % | 0.95 % | | |
| IATTE1 | 99.75 | 1.617 | 49.34 | 0.05 | 99.63 | 1.610 | 47.81 | N/A | 0.12 % | 0.74 % | 0.43 % | 2.58 % | 3.21 % | 2.17 % | | |
| NMIA | 101.27 | 1.586 | 58.43 | -0.40 | 100.23 | 1.557 | 58.02 | 0.08 | 1.10 % | 0.63 % | 1.85 % | 2.20 % | 0.71 % | 1.32 % | -0.48 | 0.72 |
| VNIIMS | 105.24 | 1.380 | 46.35 | -1.37 | 105.59 | 1.320 | 46.77 | -1.48 | -0.21 % | 0.48 % | 4.55 % | 2.10 % | -0.90 % | 0.99 % | 0.11 | 0.52 |
| NIM | 99.59 | 1.607 | 58.82 | 0.05 | 98.85 | 1.568 | 58.43 | 0.18 | 0.87 % | 0.55 % | 2.49 % | 1.63 % | 0.68 % | 1.32 % | -0.13 | 0.81 |
| JHILL | 100.59 | 1.527 | 60.03 | -0.09 | 100.02 | 1.500 | 59.73 | -0.04 | 0.74 % | 0.63 % | 1.78 % | 2.10 % | 0.50 % | 1.32 % | -0.05 | 0.51 |
| NRC | 100.15 | 1.556 | 59.77 | -0.01 | 99.81 | 1.534 | 59.35 | 0.10 | 0.67 % | 0.63 % | 1.43 % | 2.10 % | 0.72 % | 2.17 % | -0.12 | 1.01 |
| RISE3 | 99.35 | 1.597 | 63.48 | 0.26 | 98.75 | 1.580 | 63.31 | 0.36 | 0.73 % | 0.56 % | 1.13 % | 1.15 % | 0.26 % | 1.37 % | -0.09 | 0.17 |



| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | 0.21 % | 0.58 % | 0.36 | 0 |
| VTT | 0.05 % | 0.42 % | 0.11 | |
| INRIM | -0.11 % | 0.60 % | -0.19 | |
| LCOE | -0.19 % | 0.60 % | -0.31 | |
| LNE | 0.03 % | 0.60 % | 0.06 | |
| RISE2 | -0.04 % | 0.53 % | -0.07 | |
| PTB | 0.13 % | 0.52 % | 0.26 | |
| TUBITAK | -0.49 % | 0.60 % | -0.81 | |
| IATTE | 0.60 % | 0.42 % | 1.43 | 0 |
| IATTE1 | -0.34 % | 0.76 % | -0.44 | 0 |
| NMIA | 0.64 % | 0.60 % | 1.07 | |
| VNIIMS | -0.67 % | 0.45 % | -1.48 | |
| NIM | 0.41 % | 0.52 % | 0.78 | |
| JHILL | 0.28 % | 0.60 % | 0.47 | |
| NRC | 0.21 % | 0.60 % | 0.35 | |
| RISE3 | 0.27 % | 0.58 % | 0.46 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.46 % | 0.16 % | 7 % |

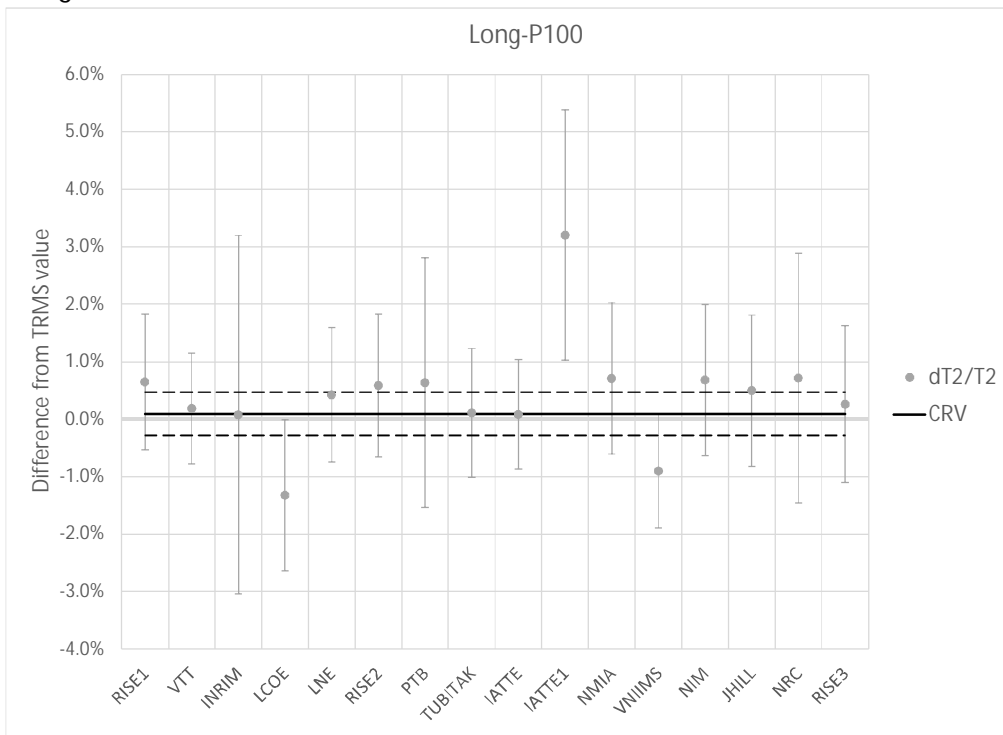


| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | -0.90 % | 1.23 % | -0.73 | 0 |
| VTT | -1.19 % | 1.48 % | -0.81 | |
| INRIM | -1.04 % | 3.02 % | -0.35 | |
| LCOE | -0.22 % | 2.05 % | -0.11 | |
| LNE | 0.32 % | 2.53 % | 0.12 | |
| RISE2 | -0.82 % | 0.98 % | -0.83 | |
| PTB | -0.84 % | 2.03 % | -0.41 | |
| TUBITAK | 1.02 % | 1.45 % | 0.70 | |
| IATTE | 3.71 % | 0.97 % | 3.83 | 0 |
| IATTE1 | -1.20 % | 2.63 % | -0.46 | 0 |
| NMIA | 0.22 % | 2.14 % | 0.10 | |
| VNIIMS | 2.92 % | 2.03 % | 1.43 | |
| NIM | 0.86 % | 1.55 % | 0.56 | |
| JHILL | 0.15 % | 2.03 % | 0.07 | |
| NRC | -0.20 % | 2.03 % | -0.10 | |
| RISE3 | -0.50 % | 1.27 % | -0.39 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 1.63 % | 0.53 % | 13 % |

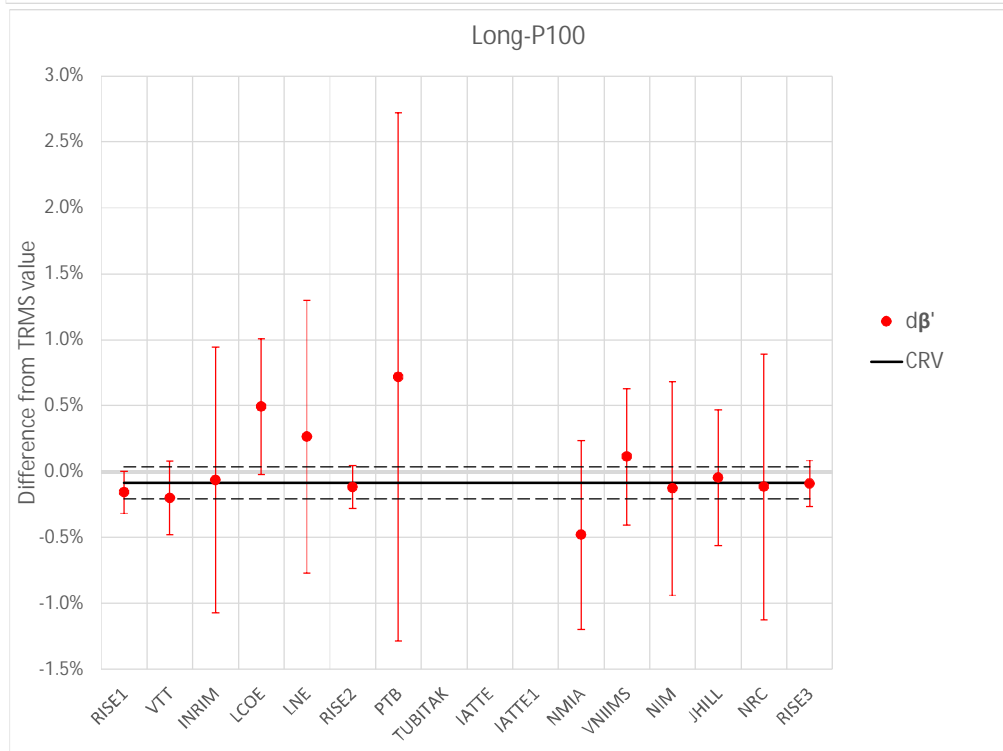
Long-P100

Long-P100



| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.09 % | 0.38 % | 34 % |

T₂



| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.09 | 0.12 | 55 % |

β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.07 | 0.20 | -0.36 | 0 |
| VTT | -0.12 | 0.25 | -0.46 | |
| INRIM | 0.02 | 1.00 | 0.02 | |
| LCOE | 0.58 | 0.50 | 1.15 | |
| LNE | 0.35 | 1.03 | 0.34 | |
| RISE2 | -0.03 | 0.11 | -0.30 | |
| PTB | 0.80 | 2.00 | 0.40 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.40 | 0.71 | -0.56 | |
| VNIIMS | 0.20 | 0.50 | 0.39 | |
| NIM | -0.04 | 0.80 | -0.05 | |
| JHILL | 0.04 | 0.50 | 0.08 | |
| NRC | -0.03 | 1.00 | -0.03 | |
| RISE3 | -0.01 | 0.21 | -0.03 | 0 |

Long-P200

Long-P200

Setup uncertainties:

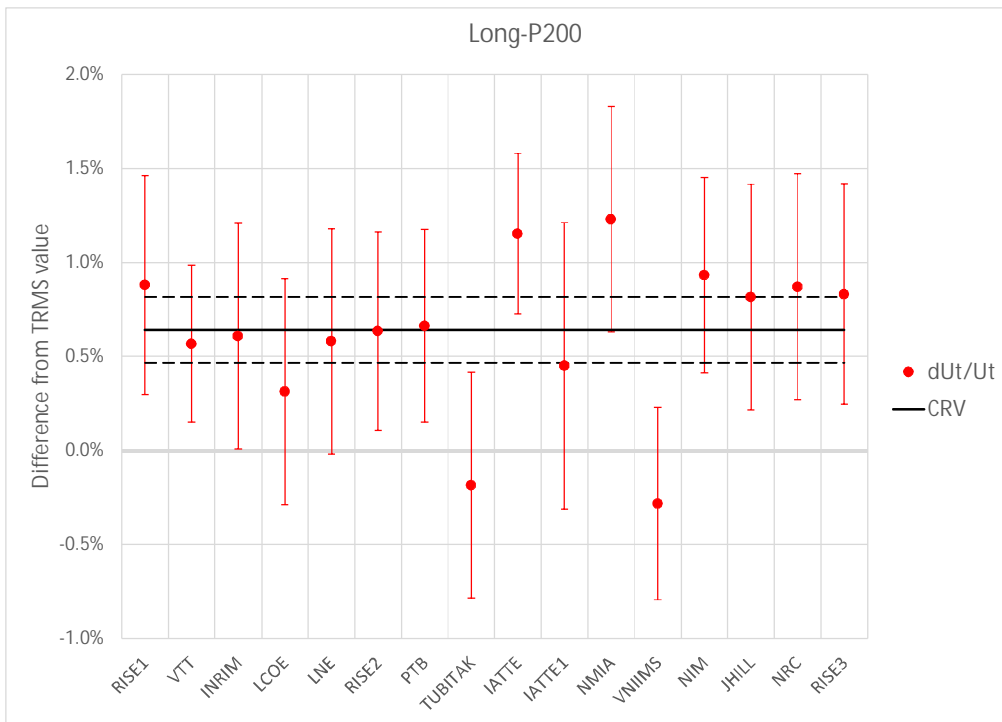
0.18 %

0.45 %

0.80 %

0.12

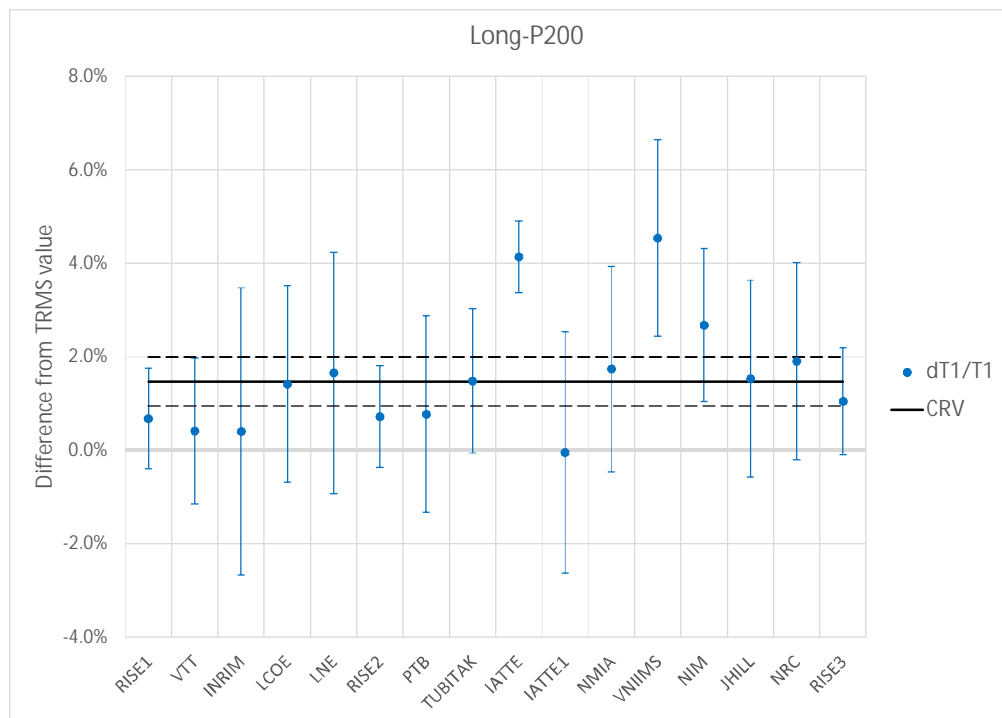
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | 200.04 | 1.581 | 43.52 | -1.00 | 198.29 | 1.570 | 43.38 | -0.88 | 0.88 % | 0.56 % | 0.68 % | 1.08 % | 0.32 % | 1.15 % | -0.12 | 0.16 |
| VTT | 199.73 | 1.592 | 44.13 | -0.98 | 198.60 | 1.585 | 44.04 | -0.78 | 0.57 % | 0.45 % | 0.41 % | 1.56 % | 0.19 % | 0.96 % | -0.20 | 0.28 |
| INRIM | 200.69 | 1.561 | 43.07 | -1.15 | 199.48 | 1.555 | 43.13 | -1.23 | 0.61 % | 0.63 % | 0.41 % | 3.07 % | -0.15 % | 3.12 % | 0.08 | 1.01 |
| LCOE | 200.12 | 1.573 | 58.15 | 0.42 | 199.50 | 1.551 | 59.03 | 0.07 | 0.31 % | 0.63 % | 1.42 % | 2.10 % | -1.50 % | 1.32 % | 0.35 | 0.52 |
| LNE | 200.10 | 1.544 | 52.80 | 0.14 | 198.92 | 1.518 | 52.64 | 0.13 | 0.58 % | 0.63 % | 1.66 % | 2.58 % | 0.30 % | 1.17 % | 0.01 | 1.01 |
| RISE2 | 196.78 | 1.600 | 43.52 | -0.94 | 195.56 | 1.589 | 43.58 | -1.02 | 0.63 % | 0.56 % | 0.72 % | 1.08 % | -0.15 % | 1.15 % | 0.07 | 0.16 |
| PTB | 195.75 | 1.543 | 47.20 | 0.00 | 194.50 | 1.531 | 47.00 | -0.84 | 0.66 % | 0.54 % | 0.77 % | 2.10 % | 0.43 % | 2.18 % | 0.84 | 2.00 |
| TUBITAK | 201.53 | 1.519 | 59.44 | 0.50 | 201.91 | 1.496 | 59.44 | N/A | -0.19 % | 0.63 % | 1.49 % | 1.54 % | 0.00 % | 1.11 % | | N/A |
| IATTE | 202.79 | 1.613 | 49.30 | 0.14 | 200.44 | 1.549 | 49.33 | N/A | 1.15 % | 0.39 % | 4.14 % | 0.77 % | -0.07 % | 0.95 % | | |
| IATTE1 | 202.79 | 1.613 | 49.30 | 0.14 | 201.88 | 1.614 | 47.84 | N/A | 0.45 % | 0.74 % | -0.04 % | 2.58 % | 3.05 % | 2.17 % | | |
| NMIA | 202.43 | 1.572 | 58.67 | -0.47 | 200.09 | 1.545 | 58.28 | -0.01 | 1.23 % | 0.63 % | 1.74 % | 2.20 % | 0.68 % | 1.32 % | -0.46 | 0.73 |
| VNIIMS | 204.88 | 1.380 | 46.32 | -1.36 | 205.71 | 1.320 | 46.74 | -1.46 | -0.28 % | 0.48 % | 4.55 % | 2.10 % | -0.89 % | 0.99 % | 0.10 | 0.52 |
| NIM | 199.72 | 1.618 | 59.22 | 0.15 | 198.11 | 1.576 | 58.88 | 0.17 | 0.93 % | 0.55 % | 2.68 % | 1.63 % | 0.59 % | 1.32 % | -0.01 | 0.81 |
| JHILL | 201.70 | 1.565 | 59.97 | -0.01 | 200.41 | 1.542 | 59.73 | 0.01 | 0.82 % | 0.63 % | 1.54 % | 2.10 % | 0.40 % | 1.32 % | -0.02 | 0.51 |
| NRC | 199.29 | 1.560 | 59.85 | -0.01 | 198.23 | 1.531 | 59.42 | 0.05 | 0.87 % | 0.63 % | 1.91 % | 2.11 % | 0.73 % | 2.17 % | -0.06 | 1.01 |
| RISE3 | 199.96 | 1.620 | 63.63 | -0.02 | 198.55 | 1.603 | 63.52 | 0.11 | 0.83 % | 0.56 % | 1.05 % | 1.14 % | 0.17 % | 1.37 % | -0.13 | 0.16 |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | 0.24 % | 0.58 % | 0.41 | 0 |
| VTT | -0.07 % | 0.42 % | -0.18 | |
| INRIM | -0.03 % | 0.60 % | -0.05 | |
| LCOE | -0.33 % | 0.60 % | -0.55 | |
| LNE | -0.06 % | 0.60 % | -0.10 | |
| RISE2 | -0.01 % | 0.53 % | -0.01 | |
| PTB | 0.02 % | 0.51 % | 0.04 | |
| TUBITAK | -0.83 % | 0.60 % | -1.37 | |
| IATTE | 0.51 % | 0.43 % | 1.20 | 0 |
| IATTE1 | -0.19 % | 0.76 % | -0.25 | 0 |
| NMIA | 0.59 % | 0.60 % | 0.98 | |
| VNIIMS | -0.92 % | 0.51 % | -1.80 | 1 |
| NIM | 0.29 % | 0.52 % | 0.56 | |
| JHILL | 0.17 % | 0.60 % | 0.29 | |
| NRC | 0.23 % | 0.60 % | 0.38 | |
| RISE3 | 0.19 % | 0.59 % | 0.32 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.64 % | 0.17 % | 19 % |



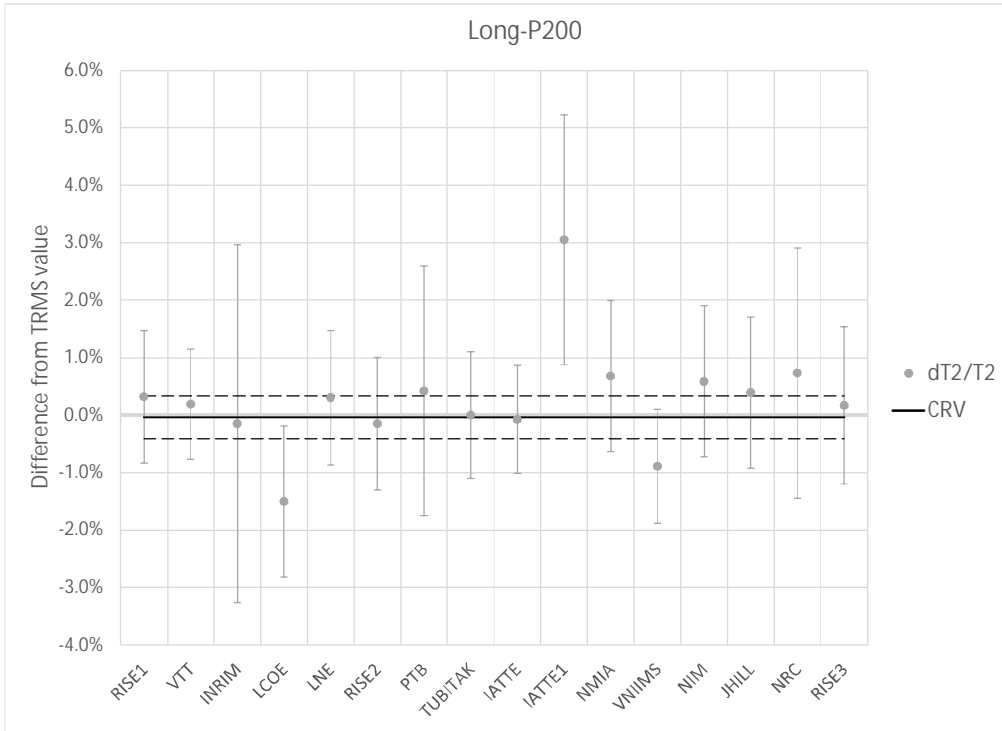
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.79 % | 1.20 % | -0.66 | 0 |
| VTT | -1.06 % | 1.47 % | -0.72 | |
| INRIM | -1.06 % | 3.02 % | -0.35 | |
| LCOE | -0.05 % | 2.04 % | -0.03 | |
| LNE | 0.19 % | 2.53 % | 0.07 | |
| RISE2 | -0.75 % | 0.95 % | -0.79 | |
| PTB | -0.70 % | 2.03 % | -0.34 | |
| TUBITAK | 0.01 % | 1.45 % | 0.01 | |
| IATTE | 2.67 % | 0.93 % | 2.86 | 0 |
| IATTE1 | -1.52 % | 2.63 % | -0.58 | 0 |
| NMIA | 0.27 % | 2.13 % | 0.13 | |
| VNIIMS | 3.07 % | 2.03 % | 1.51 | |
| NIM | 1.21 % | 1.55 % | 0.78 | |
| JHILL | 0.07 % | 2.04 % | 0.03 | |
| NRC | 0.44 % | 2.04 % | 0.21 | |
| RISE3 | -0.42 % | 1.26 % | -0.33 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 1.47 % | 0.52 % | 15 % |

Long-P200

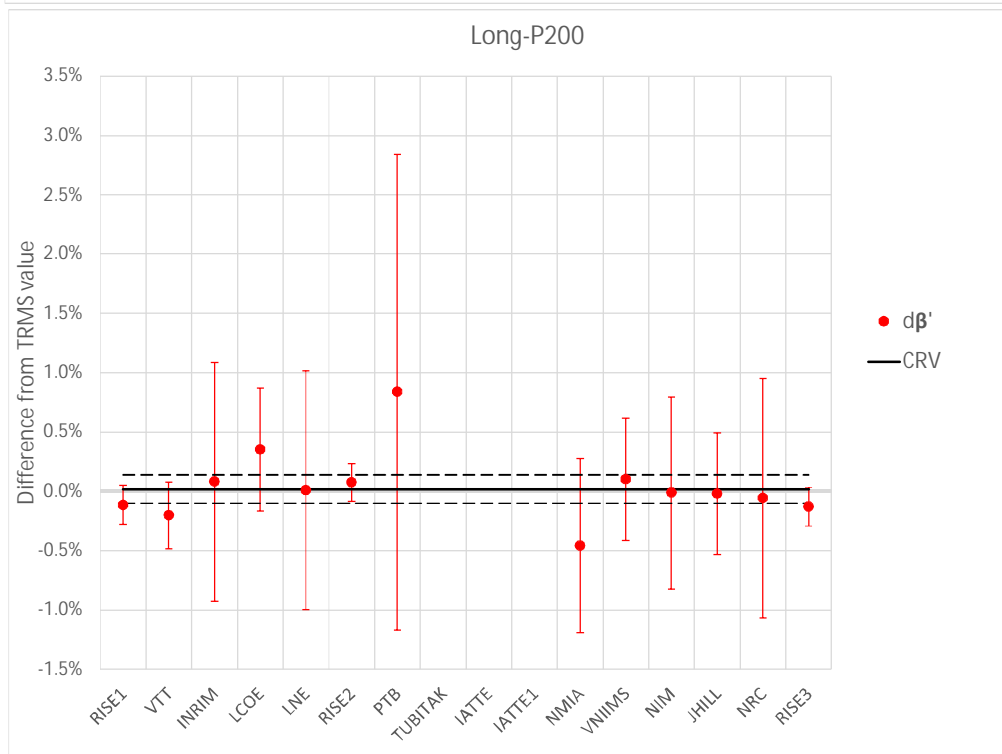
Long-P200



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | 0.36 % | 1.21 % | 0.29 | 0 |
| VTT | 0.23 % | 0.89 % | 0.26 | |
| INRIM | -0.11 % | 3.10 % | -0.04 | |
| LCOE | -1.46 % | 1.26 % | -1.16 | |
| LNE | 0.34 % | 1.11 % | 0.31 | |
| RISE2 | -0.11 % | 1.09 % | -0.10 | |
| PTB | 0.46 % | 2.14 % | 0.22 | |
| TUBITAK | 0.04 % | 1.04 % | 0.03 | |
| IATTE | -0.03 % | 1.02 % | -0.03 | 0 |
| IATTE1 | 3.09 % | 2.21 % | 1.40 | 0 |
| NMIA | 0.72 % | 1.26 % | 0.57 | |
| VNIIMS | -0.85 % | 0.92 % | -0.93 | |
| NIM | 0.63 % | 1.26 % | 0.50 | |
| JHILL | 0.43 % | 1.26 % | 0.34 | |
| NRC | 0.77 % | 2.14 % | 0.36 | |
| RISE3 | 0.21 % | 1.42 % | 0.15 | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.04 % | 0.37 % | 38 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | -0.13 | 0.20 | -0.66 | 0 |
| VTT | -0.22 | 0.25 | -0.88 | |
| INRIM | 0.06 | 1.00 | 0.06 | |
| LCOE | 0.33 | 0.50 | 0.66 | |
| LNE | -0.01 | 1.00 | -0.01 | |
| RISE2 | 0.06 | 0.11 | 0.53 | |
| PTB | 0.82 | 2.00 | 0.41 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.48 | 0.72 | -0.66 | |
| VNIIMS | 0.08 | 0.50 | 0.16 | |
| NIM | -0.03 | 0.80 | -0.04 | |
| JHILL | -0.04 | 0.50 | -0.08 | |
| NRC | -0.08 | 1.00 | -0.08 | |
| RISE3 | -0.15 | 0.20 | -0.74 | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.02 | 0.12 | 71 % |

Long-P300

Long-P300

Setup uncertainties:

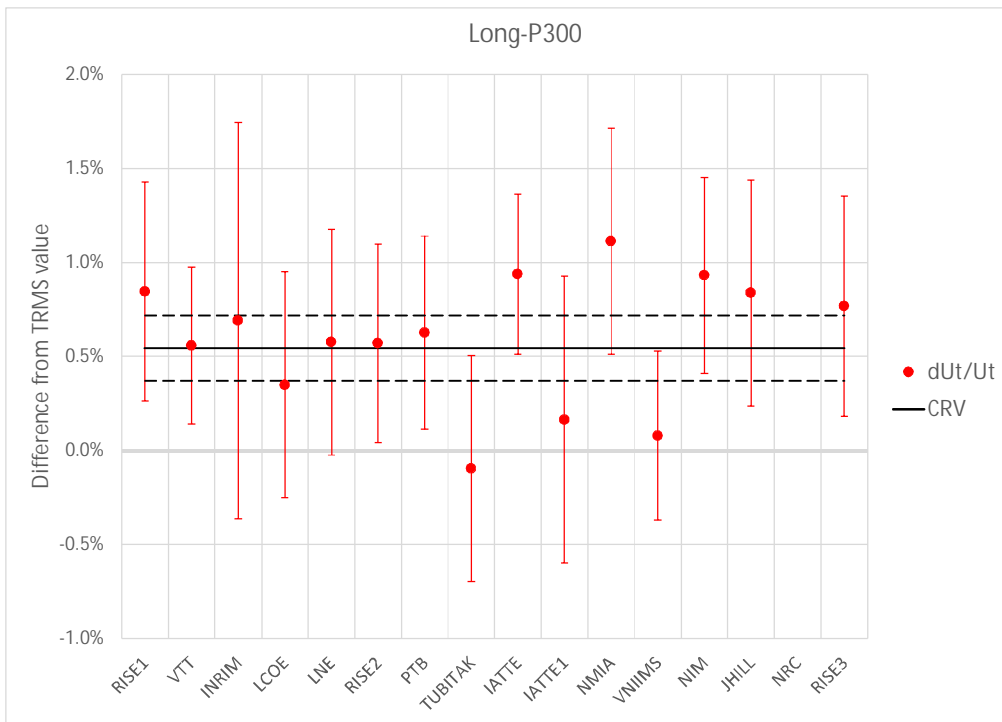
0.18 %

0.45 %

0.80 %

0.12

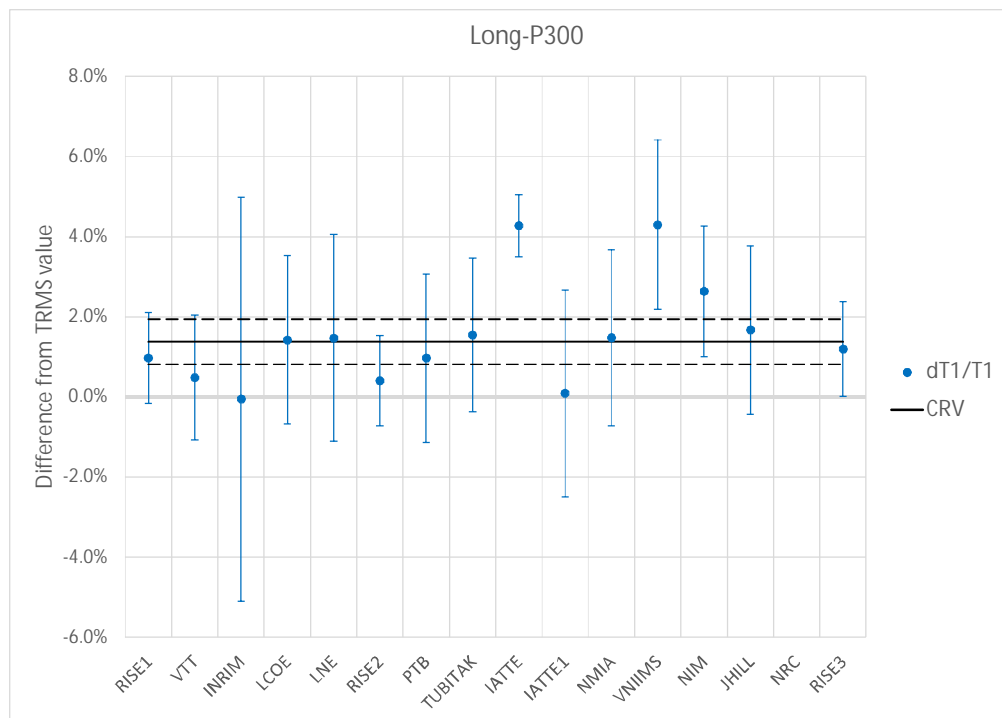
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | 298.96 | 1.593 | 43.49 | -1.04 | 296.45 | 1.577 | 43.39 | -0.84 | 0.84 % | 0.56 % | 0.97 % | 1.13 % | 0.24 % | 1.17 % | -0.20 | 0.16 |
| VTT | 297.46 | 1.599 | 44.12 | -1.03 | 295.81 | 1.592 | 44.05 | -0.84 | 0.56 % | 0.45 % | 0.49 % | 1.56 % | 0.15 % | 0.96 % | -0.19 | 0.28 |
| INRIM | 304.26 | 1.576 | 43.75 | -1.25 | 302.18 | 1.577 | 43.74 | -1.11 | 0.69 % | 1.07 % | -0.06 % | 5.04 % | 0.04 % | 5.07 % | -0.14 | 1.01 |
| LCOE | 301.04 | 1.545 | 58.12 | 0.32 | 300.00 | 1.524 | 59.05 | 0.26 | 0.35 % | 0.63 % | 1.43 % | 2.10 % | -1.57 % | 1.32 % | 0.06 | 0.52 |
| LNE | 298.37 | 1.545 | 53.62 | 0.14 | 296.63 | 1.523 | 53.54 | 0.21 | 0.58 % | 0.63 % | 1.47 % | 2.58 % | 0.16 % | 1.17 % | -0.06 | 1.01 |
| RISE2 | 296.59 | 1.605 | 43.57 | -1.04 | 294.93 | 1.598 | 43.66 | -0.92 | 0.57 % | 0.56 % | 0.41 % | 1.12 % | -0.20 % | 1.16 % | -0.12 | 0.16 |
| PTB | 292.19 | 1.554 | 47.22 | 0.00 | 290.43 | 1.539 | 47.00 | -0.74 | 0.63 % | 0.54 % | 0.97 % | 2.10 % | 0.47 % | 2.18 % | 0.74 | 2.00 |
| TUBITAK | 300.15 | 1.526 | 59.49 | 0.37 | 300.44 | 1.503 | 59.50 | N/A | -0.10 % | 0.63 % | 1.55 % | 1.92 % | -0.02 % | 1.24 % | N/A | N/A |
| IATTE | 300.09 | 1.612 | 49.52 | 0.09 | 297.24 | 1.546 | 49.42 | N/A | 0.94 % | 0.39 % | 4.28 % | 0.77 % | 0.21 % | 0.97 % | N/A | N/A |
| IATTE1 | 300.09 | 1.612 | 49.52 | 0.09 | 299.60 | 1.611 | 47.88 | N/A | 0.16 % | 0.74 % | 0.09 % | 2.58 % | 3.43 % | 2.17 % | N/A | N/A |
| NMIA | 294.80 | 1.573 | 59.05 | -0.54 | 291.73 | 1.550 | 58.85 | -0.03 | 1.11 % | 0.63 % | 1.48 % | 2.20 % | 0.35 % | 1.32 % | -0.50 | 0.72 |
| VNIIMS | 307.98 | 1.383 | 46.39 | -1.44 | 308.11 | 1.326 | 46.96 | -1.58 | 0.08 % | 0.48 % | 4.30 % | 2.11 % | -1.21 % | 0.99 % | 0.14 | 0.51 |
| NIM | 295.95 | 1.626 | 60.13 | 0.11 | 293.57 | 1.584 | 59.74 | 0.17 | 0.93 % | 0.55 % | 2.64 % | 1.63 % | 0.66 % | 1.32 % | -0.06 | 0.81 |
| JHILL | 302.90 | 1.558 | 60.04 | -0.05 | 300.90 | 1.532 | 59.85 | 0.01 | 0.84 % | 0.63 % | 1.67 % | 2.10 % | 0.33 % | 1.32 % | -0.06 | 0.51 |
| NRC | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| RISE3 | 299.68 | 1.650 | 63.91 | -0.04 | 297.75 | 1.630 | 63.85 | 0.05 | 0.77 % | 0.56 % | 1.19 % | 1.18 % | 0.08 % | 1.37 % | -0.09 | 0.16 |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | 0.30 % | 0.58 % | 0.52 | 0 |
| VTT | 0.01 % | 0.42 % | 0.03 | |
| INRIM | 0.15 % | 1.05 % | 0.14 | |
| LCOE | -0.19 % | 0.60 % | -0.32 | |
| LNE | 0.03 % | 0.60 % | 0.05 | |
| RISE2 | 0.03 % | 0.53 % | 0.05 | |
| PTB | 0.08 % | 0.51 % | 0.16 | |
| TUBITAK | -0.64 % | 0.60 % | -1.06 | |
| IATTE | 0.39 % | 0.43 % | 0.92 | 0 |
| IATTE1 | -0.38 % | 0.76 % | -0.50 | 0 |
| NMIA | 0.57 % | 0.60 % | 0.95 | |
| VNIIMS | -0.47 % | 0.45 % | -1.04 | |
| NIM | 0.39 % | 0.52 % | 0.74 | |
| JHILL | 0.29 % | 0.60 % | 0.49 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | 0.22 % | 0.59 % | 0.38 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.54 % | 0.17 % | 14 % |



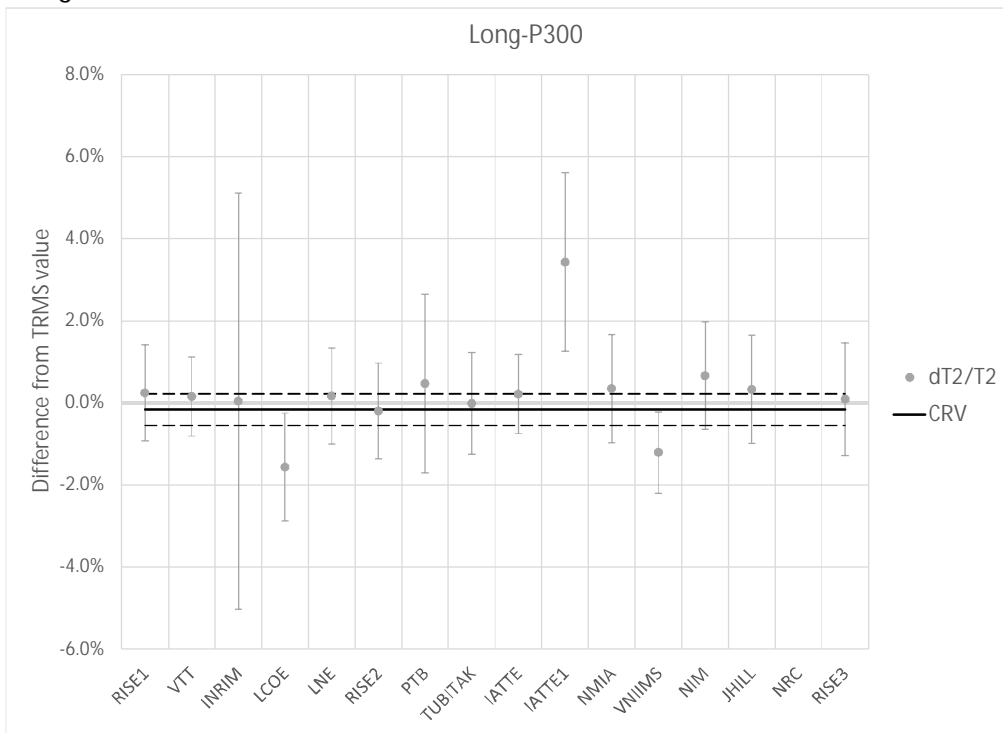
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.41 % | 1.26 % | -0.32 | 0 |
| VTT | -0.89 % | 1.46 % | -0.61 | |
| INRIM | -1.43 % | 5.01 % | -0.29 | |
| LCOE | 0.05 % | 2.03 % | 0.02 | |
| LNE | 0.09 % | 2.52 % | 0.04 | |
| RISE2 | -0.97 % | 0.97 % | -1.00 | |
| PTB | -0.41 % | 2.02 % | -0.20 | |
| TUBITAK | 0.17 % | 1.83 % | 0.09 | |
| IATTE | 2.90 % | 0.96 % | 3.03 | 0 |
| IATTE1 | -1.29 % | 2.64 % | -0.49 | 0 |
| NMIA | 0.10 % | 2.12 % | 0.05 | |
| VNIIMS | 2.92 % | 2.04 % | 1.43 | |
| NIM | 1.26 % | 1.53 % | 0.82 | |
| JHILL | 0.29 % | 2.02 % | 0.14 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | -0.18 % | 1.31 % | -0.14 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 1.38 % | 0.56 % | 14 % |

Long-P300

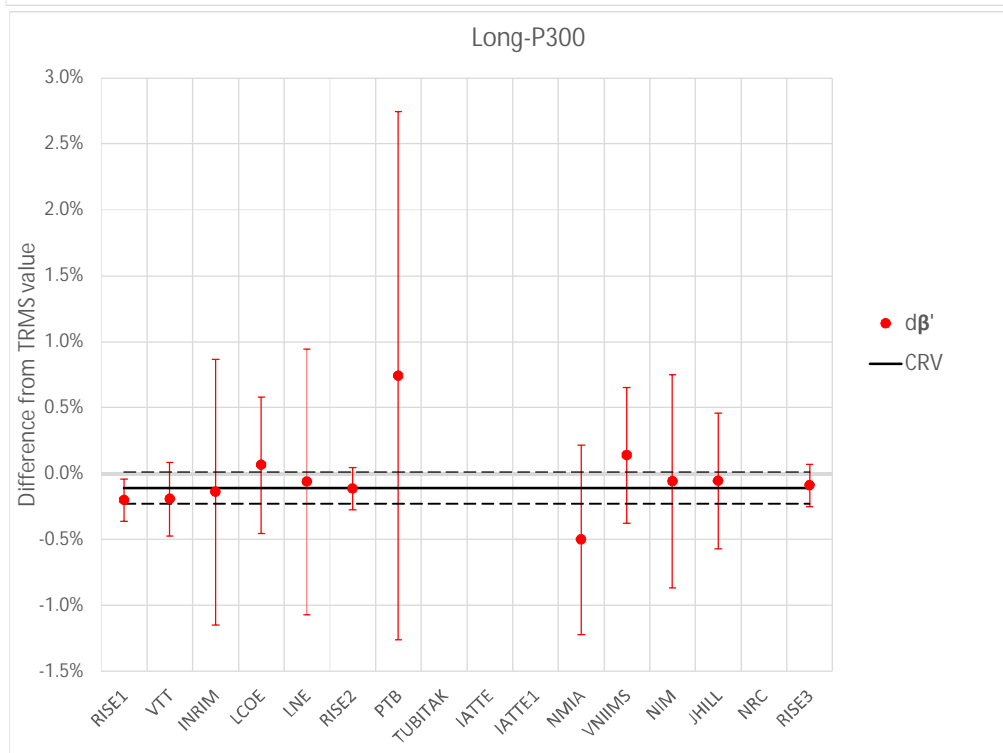
Long-P300



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | 0.41 % | 1.23 % | 0.33 | 0 |
| VTT | 0.32 % | 0.88 % | 0.36 | |
| INRIM | 0.21 % | 5.06 % | 0.04 | |
| LCOE | -1.40 % | 1.26 % | -1.11 | |
| LNE | 0.33 % | 1.11 % | 0.30 | |
| RISE2 | -0.03 % | 1.10 % | -0.03 | |
| PTB | 0.64 % | 2.14 % | 0.30 | |
| TUBITAK | 0.15 % | 1.18 % | 0.13 | |
| IATTE | 0.38 % | 1.04 % | 0.37 | 0 |
| IATTE1 | 3.60 % | 2.21 % | 1.63 | 0 |
| NMIA | 0.51 % | 1.26 % | 0.41 | |
| VNIIMS | -1.04 % | 0.91 % | -1.14 | |
| NIM | 0.83 % | 1.26 % | 0.66 | |
| JHILL | 0.50 % | 1.26 % | 0.40 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | 0.25 % | 1.43 % | 0.18 | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.17 % | 0.38 % | 23 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | -0.09 | 0.20 | -0.46 | 0 |
| VTT | -0.08 | 0.25 | -0.33 | |
| INRIM | -0.03 | 1.00 | -0.03 | |
| LCOE | 0.17 | 0.50 | 0.35 | |
| LNE | 0.05 | 1.00 | 0.05 | |
| RISE2 | -0.01 | 0.11 | -0.06 | |
| PTB | 0.85 | 2.00 | 0.43 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.39 | 0.71 | -0.55 | |
| VNIIMS | 0.25 | 0.50 | 0.49 | |
| NIM | 0.05 | 0.80 | 0.06 | |
| JHILL | 0.05 | 0.50 | 0.11 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | 0.02 | 0.20 | 0.10 | 0 |

| CRV | U(CRV) | Pr |
|-------|--------|------|
| -0.11 | 0.12 | 93 % |

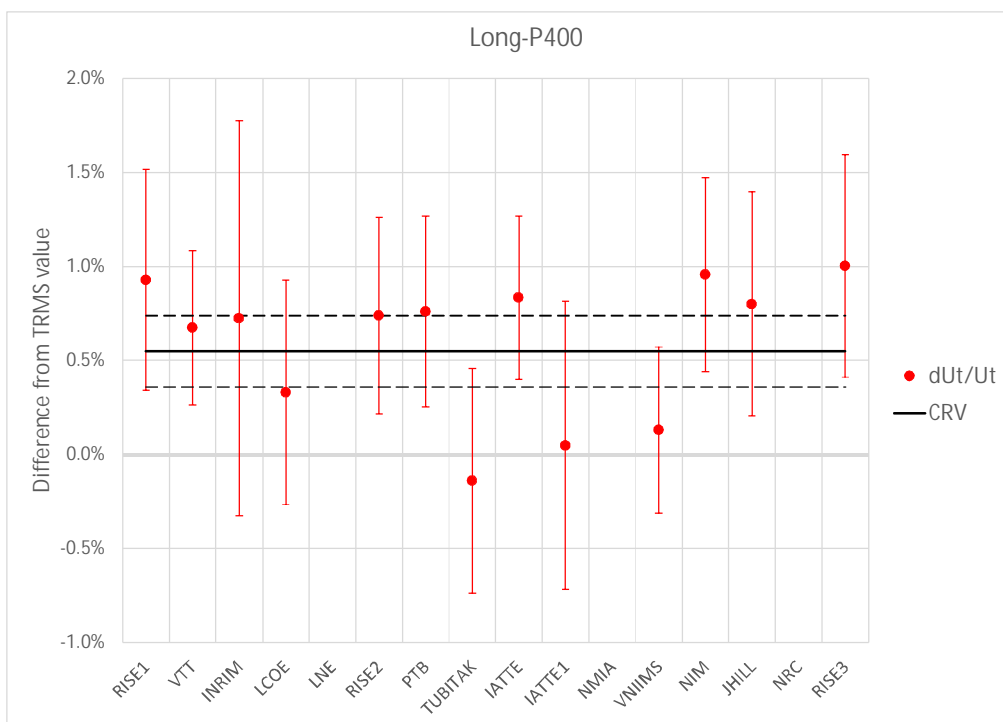
Long-P400

Long-P400

Setup uncertainties:

0.18 % 0.45 % 0.80 % 0.12

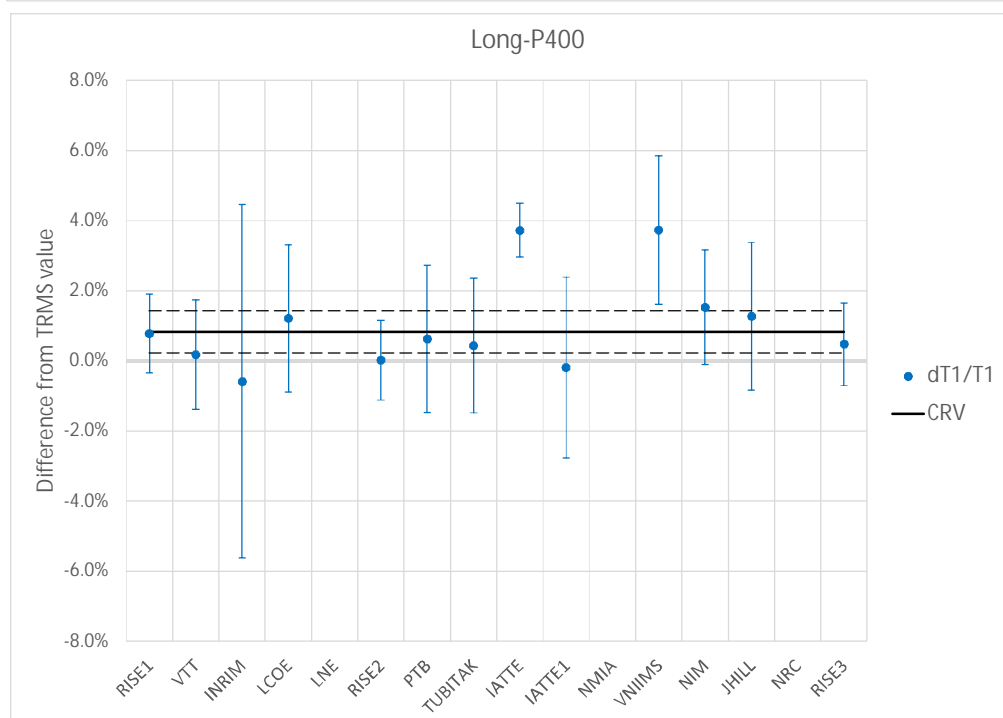
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | 402.23 | 1.593 | 43.51 | -0.93 | 398.54 | 1.581 | 43.46 | -0.97 | 0.93 % | 0.56 % | 0.79 % | 1.12 % | 0.11 % | 1.17 % | 0.05 | 0.17 |
| VTT | 396.19 | 1.596 | 44.04 | -0.91 | 393.53 | 1.593 | 44.11 | -0.96 | 0.67 % | 0.45 % | 0.17 % | 1.56 % | -0.15 % | 0.96 % | 0.05 | 0.28 |
| INRIM | 403.07 | 1.576 | 43.93 | -1.16 | 400.17 | 1.585 | 43.97 | -1.22 | 0.72 % | 1.07 % | -0.59 % | 5.04 % | -0.10 % | 5.07 % | 0.05 | 1.01 |
| LCOE | 401.25 | 1.543 | 58.27 | 0.34 | 399.93 | 1.525 | 59.15 | 0.10 | 0.33 % | 0.63 % | 1.21 % | 2.10 % | -1.48 % | 1.32 % | 0.25 | 0.52 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | 399.19 | 1.602 | 43.56 | -0.78 | 396.30 | 1.602 | 43.77 | -0.98 | 0.74 % | 0.56 % | 0.02 % | 1.14 % | -0.47 % | 1.16 % | 0.20 | 0.17 |
| PTB | 398.45 | 1.558 | 47.19 | 0.00 | 395.52 | 1.548 | 47.13 | -0.70 | 0.76 % | 0.54 % | 0.62 % | 2.10 % | 0.13 % | 2.18 % | 0.70 | 2.00 |
| TUBITAK | 401.47 | 1.497 | 59.56 | 0.28 | 402.03 | 1.490 | 59.59 | #N/A | -0.14 % | 0.63 % | 0.44 % | 1.92 % | -0.05 % | 1.24 % | #N/A | #N/A |
| IATTE | 403.41 | 1.610 | 49.73 | 0.28 | 400.00 | 1.552 | 49.76 | #N/A | 0.83 % | 0.39 % | 3.73 % | 0.77 % | -0.06 % | 0.96 % | | |
| IATTE1 | 403.41 | 1.610 | 49.73 | 0.28 | 403.22 | 1.613 | 48.28 | #N/A | 0.05 % | 0.74 % | -0.19 % | 2.58 % | 3.00 % | 2.17 % | #N/A | #N/A |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | 411.55 | 1.390 | 46.38 | -1.28 | 411.51 | 1.340 | 47.03 | -1.61 | 0.13 % | 0.48 % | 3.73 % | 2.11 % | -1.38 % | 0.99 % | 0.33 | 0.51 |
| NIM | 399.00 | 1.570 | 61.57 | 0.56 | 395.70 | 1.547 | 61.33 | 0.46 | 0.96 % | 0.55 % | 1.53 % | 1.63 % | 0.39 % | 1.32 % | 0.10 | 0.81 |
| JHILL | 402.70 | 1.559 | 60.29 | 0.04 | 400.19 | 1.539 | 60.10 | -0.02 | 0.80 % | 0.63 % | 1.27 % | 2.10 % | 0.32 % | 1.32 % | 0.07 | 0.51 |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | 401.08 | 1.650 | 64.04 | 0.20 | 397.57 | 1.642 | 64.20 | -0.04 | 1.00 % | 0.56 % | 0.48 % | 1.18 % | -0.25 % | 1.37 % | 0.23 | 0.16 |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | 0.38 % | 0.59 % | 0.65 | 0 |
| VTT | 0.13 % | 0.41 % | 0.31 | |
| INRIM | 0.18 % | 1.05 % | 0.17 | |
| LCOE | -0.22 % | 0.60 % | -0.37 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | 0.19 % | 0.52 % | 0.37 | |
| PTB | 0.21 % | 0.51 % | 0.42 | |
| TUBITAK | -0.69 % | 0.60 % | -1.15 | |
| IATTE | 0.29 % | 0.43 % | 0.66 | 0 |
| IATTE1 | -0.50 % | 0.77 % | -0.65 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.42 % | 0.44 % | -0.95 | |
| NIM | 0.41 % | 0.52 % | 0.79 | |
| JHILL | 0.25 % | 0.60 % | 0.42 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | 0.45 % | 0.59 % | 0.77 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.55 % | 0.19 % | 12 % |



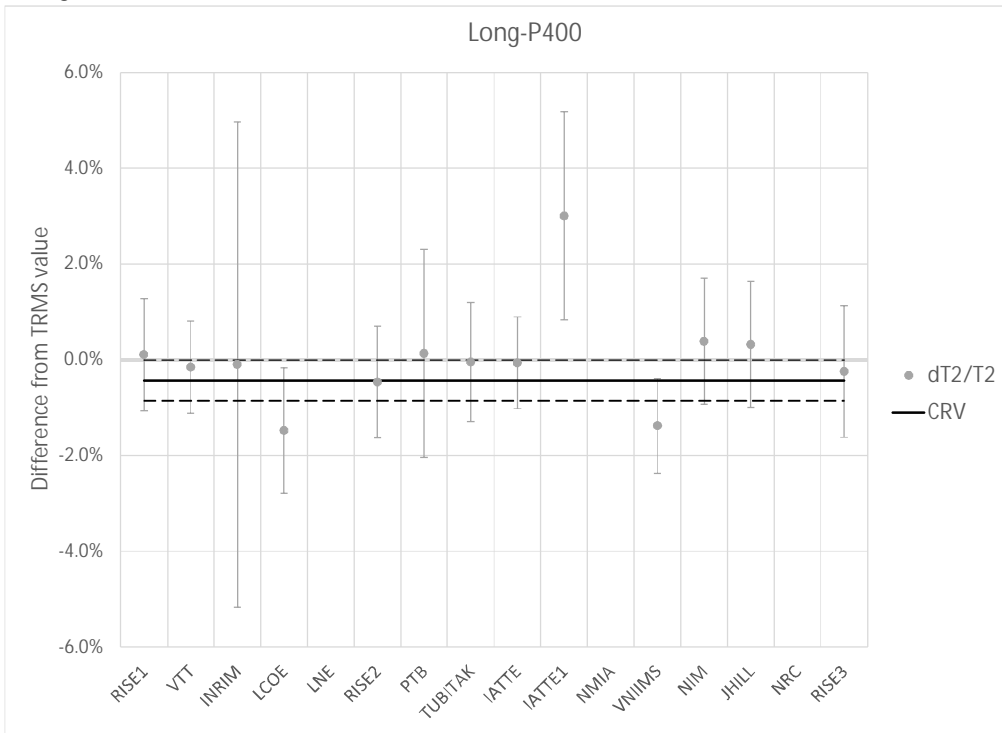
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.04 % | 1.27 % | -0.03 | 0 |
| VTT | -0.65 % | 1.44 % | -0.45 | |
| INRIM | -1.41 % | 5.01 % | -0.28 | |
| LCOE | 0.39 % | 2.01 % | 0.19 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | -0.81 % | 0.97 % | -0.84 | |
| PTB | -0.21 % | 2.02 % | -0.10 | |
| TUBITAK | -0.39 % | 1.83 % | -0.21 | |
| IATTE | 2.90 % | 0.98 % | 2.97 | 0 |
| IATTE1 | -1.02 % | 2.65 % | -0.39 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 2.90 % | 2.03 % | 1.43 | |
| NIM | 0.70 % | 1.52 % | 0.46 | |
| JHILL | 0.44 % | 2.02 % | 0.22 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | -0.35 % | 1.32 % | -0.27 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.83 % | 0.60 % | 16 % |

Long-P400

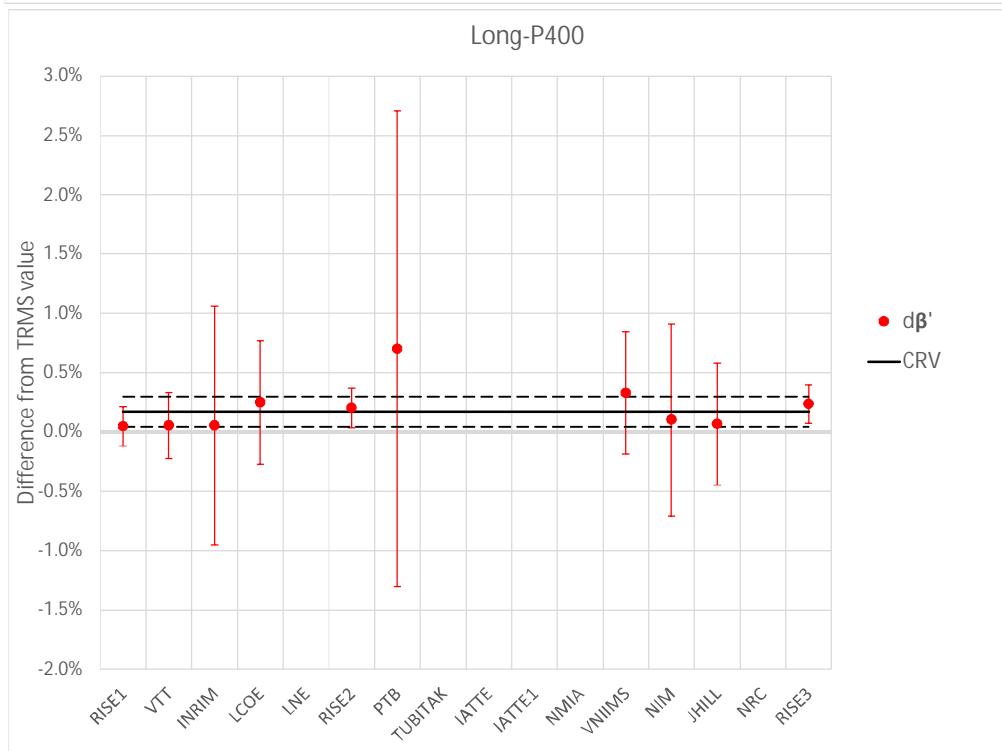
Long-P400



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | 0.54 % | 1.24 % | 0.43 | 0 |
| VTT | 0.28 % | 0.86 % | 0.33 | |
| INRIM | 0.33 % | 5.05 % | 0.07 | |
| LCOE | -1.05 % | 1.24 % | -0.84 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | -0.03 % | 1.08 % | -0.03 | |
| PTB | 0.56 % | 2.13 % | 0.26 | |
| TUBITAK | 0.38 % | 1.17 % | 0.33 | |
| IATTE | 0.37 % | 1.05 % | 0.35 | 0 |
| IATTE1 | 3.44 % | 2.22 % | 1.55 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIIMS | -0.95 % | 0.89 % | -1.06 | |
| NIM | 0.82 % | 1.24 % | 0.66 | |
| JHILL | 0.76 % | 1.24 % | 0.61 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | 0.19 % | 1.44 % | 0.13 | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.43 % | 0.43 % | 26 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | -0.12 | 0.21 | -0.59 | 0 |
| VTT | -0.12 | 0.25 | -0.47 | |
| INRIM | -0.12 | 1.00 | -0.12 | |
| LCOE | 0.08 | 0.50 | 0.15 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | 0.03 | 0.11 | 0.28 | |
| PTB | 0.53 | 2.00 | 0.26 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIIMS | 0.16 | 0.50 | 0.32 | |
| NIM | -0.07 | 0.80 | -0.09 | |
| JHILL | -0.10 | 0.50 | -0.21 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | 0.06 | 0.21 | 0.31 | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.17 | 0.13 | 97 % |

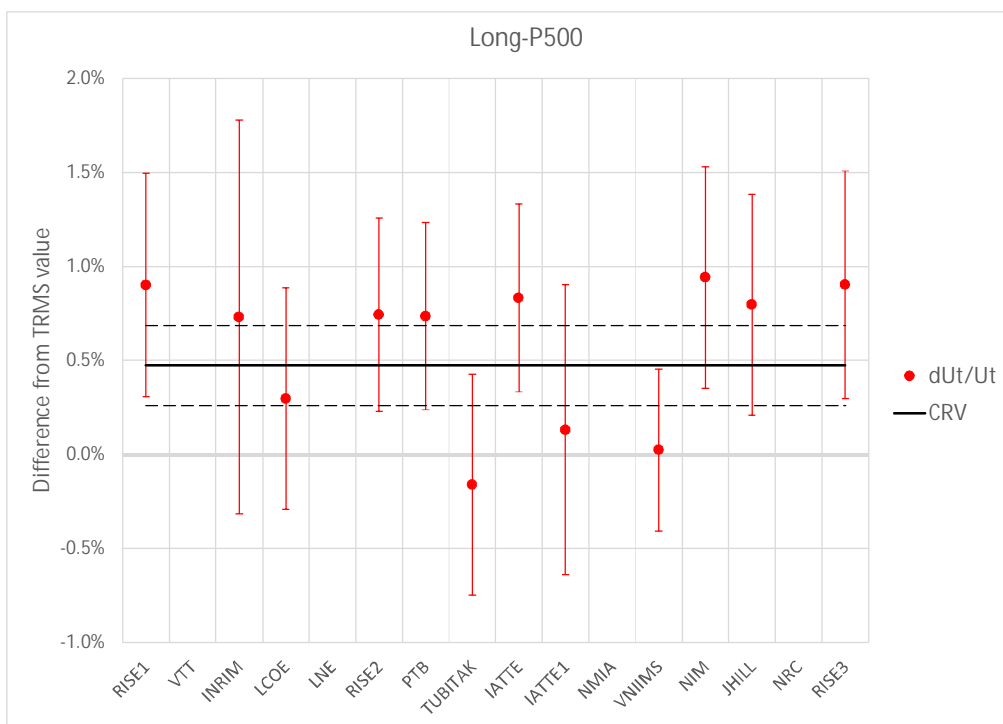
Long-P500

Long-P500

Setup uncertainties:

0.18 % 0.45 % 0.80 % 0.12

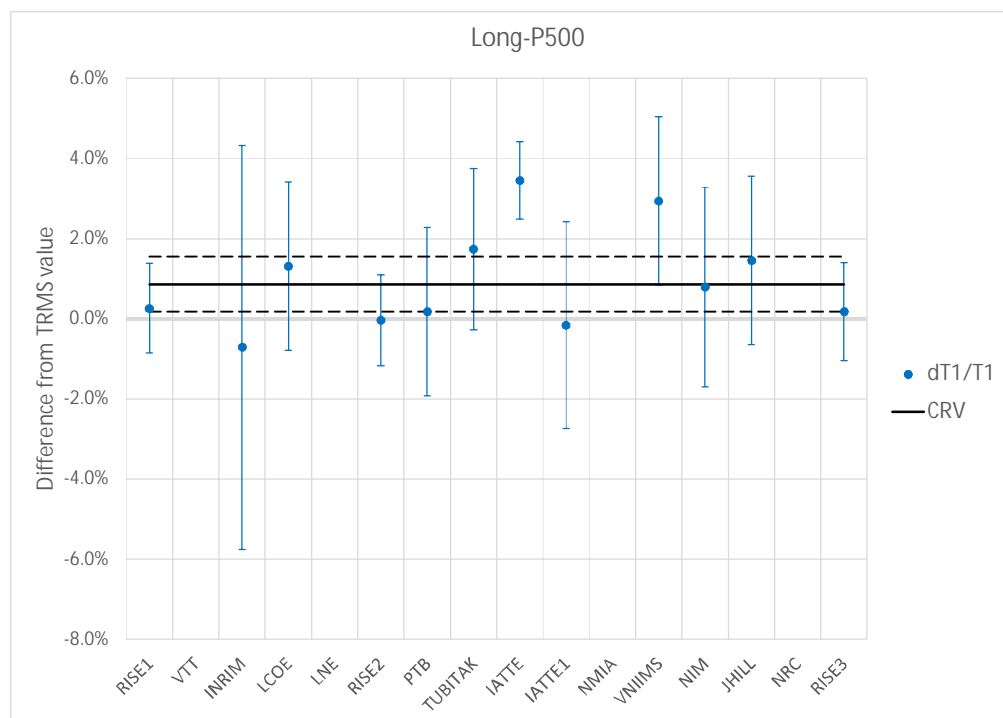
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | 504.89 | 1.606 | 43.67 | -0.95 | 500.37 | 1.602 | 43.63 | -0.96 | 0.90 % | 0.56 % | 0.26 % | 1.12 % | 0.11 % | 1.17 % | 0.01 | 0.16 |
| VTT | | | | | | | | | | | | | | | | |
| INRIM | 503.91 | 1.541 | 44.15 | -1.33 | 500.25 | 1.553 | 44.19 | -1.35 | 0.73 % | 1.07 % | -0.71 % | 5.04 % | -0.08 % | 5.07 % | 0.01 | 1.01 |
| LCOE | 501.31 | 1.552 | 58.49 | 0.27 | 499.83 | 1.532 | 59.45 | 0.30 | 0.30 % | 0.63 % | 1.31 % | 2.10 % | -1.61 % | 1.32 % | -0.03 | 0.52 |
| LNE | | | | | | | | | | | | | | | | |
| RISE2 | 497.64 | 1.613 | 43.68 | -0.87 | 494.02 | 1.613 | 43.89 | -1.08 | 0.74 % | 0.56 % | -0.04 % | 1.14 % | -0.49 % | 1.16 % | 0.21 | 0.16 |
| PTB | 505.08 | 1.563 | 47.14 | 0.00 | 501.49 | 1.560 | 47.19 | -0.79 | 0.74 % | 0.54 % | 0.18 % | 2.10 % | -0.09 % | 2.18 % | 0.79 | 2.00 |
| TUBITAK | 500.10 | 1.514 | 59.80 | 0.40 | 500.91 | 1.488 | 59.79 | #N/A | -0.16 % | 0.63 % | 1.74 % | 2.01 % | 0.02 % | 1.24 % | #N/A | #N/A |
| IATTE | 500.84 | 1.410 | 47.12 | -0.09 | 496.61 | 1.363 | 46.88 | #N/A | 0.83 % | 0.45 % | 3.45 % | 0.97 % | 0.50 % | 1.02 % | #N/A | #N/A |
| IATTE1 | 500.84 | 1.410 | 47.12 | -0.09 | 500.18 | 1.412 | 45.22 | #N/A | 0.13 % | 0.74 % | -0.16 % | 2.58 % | 4.20 % | 2.17 % | #N/A | #N/A |
| NMIA | | | | | | | | | | | | | | | | |
| VNIIMS | 509.20 | 1.400 | 46.51 | -1.34 | 509.69 | 1.360 | 47.19 | -1.62 | 0.02 % | 0.48 % | 2.94 % | 2.10 % | -1.44 % | 0.99 % | 0.28 | 0.52 |
| NIM | 502.09 | 1.577 | 61.89 | 0.52 | 498.00 | 1.565 | 61.89 | 0.48 | 0.94 % | 0.63 % | 0.79 % | 2.49 % | 0.01 % | 1.73 % | 0.04 | 0.81 |
| JHILL | 503.69 | 1.592 | 60.61 | -0.01 | 500.57 | 1.570 | 60.42 | -0.05 | 0.80 % | 0.63 % | 1.46 % | 2.10 % | 0.32 % | 1.32 % | 0.04 | 0.51 |
| NRC | | | | | | | | | | | | | | | | |
| RISE3 | 500.02 | 1.656 | 61.52 | -0.03 | 496.15 | 1.653 | 64.94 | -0.30 | 0.90 % | 0.57 % | 0.18 % | 1.22 % | -5.27 % | 6.68 % | 0.27 | 0.27 |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | 0.43 % | 0.60 % | 0.72 | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.26 % | 1.05 % | 0.25 | |
| LCOE | -0.18 % | 0.59 % | -0.30 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | 0.27 % | 0.51 % | 0.53 | |
| PTB | 0.26 % | 0.50 % | 0.53 | |
| TUBITAK | -0.63 % | 0.59 % | -1.08 | |
| IATTE | 0.36 % | 0.50 % | 0.72 | 0 |
| IATTE1 | -0.34 % | 0.77 % | -0.44 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.45 % | 0.43 % | -1.04 | |
| NIM | 0.47 % | 0.59 % | 0.80 | |
| JHILL | 0.32 % | 0.59 % | 0.55 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | 0.43 % | 0.61 % | 0.71 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.47 % | 0.21 % | 6 % |



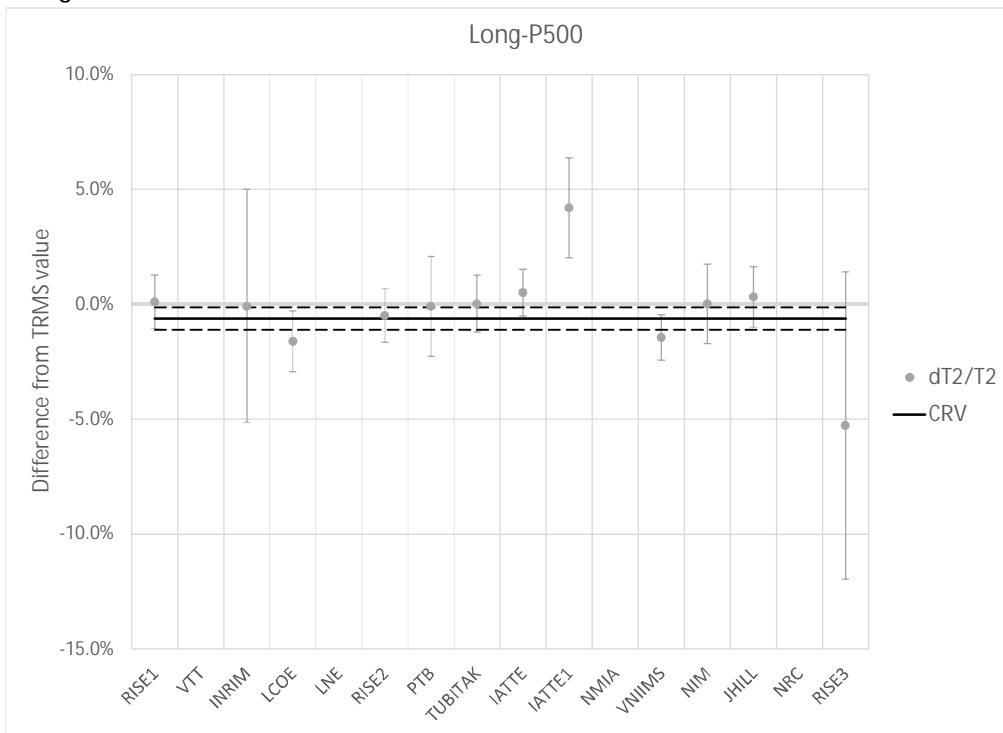
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.60 % | 1.31 % | -0.46 | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -1.57 % | 4.99 % | -0.32 | |
| LCOE | 0.45 % | 1.99 % | 0.23 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | -0.90 % | 0.91 % | -0.99 | |
| PTB | -0.68 % | 1.99 % | -0.34 | |
| TUBITAK | 0.87 % | 1.89 % | 0.46 | |
| IATTE | 2.59 % | 1.19 % | 2.18 | 0 |
| IATTE1 | -1.02 % | 2.67 % | -0.38 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 2.08 % | 1.99 % | 1.05 | |
| NIM | -0.07 % | 2.39 % | -0.03 | |
| JHILL | 0.59 % | 1.99 % | 0.30 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | -0.68 % | 1.40 % | -0.49 | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.86 % | 0.69 % | 29 % |

Long-P500

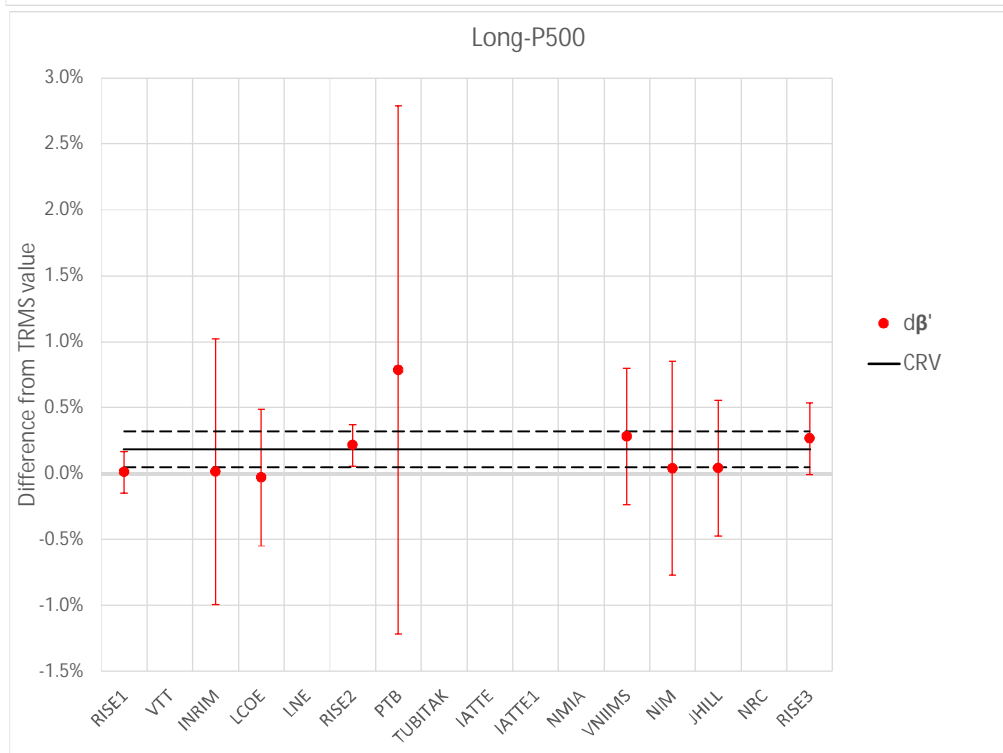
Long-P500



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | 0.73 % | 1.26 % | 0.58 | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.54 % | 5.05 % | 0.11 | |
| LCOE | -0.99 % | 1.22 % | -0.81 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | 0.13 % | 1.05 % | 0.12 | |
| PTB | 0.53 % | 2.12 % | 0.25 | |
| TUBITAK | 0.65 % | 1.14 % | 0.57 | |
| IATTE | 1.12 % | 1.13 % | 0.99 | 0 |
| IATTE1 | 4.82 % | 2.23 % | 2.16 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIIMS | -0.82 % | 0.86 % | -0.95 | |
| NIM | 0.63 % | 1.66 % | 0.38 | |
| JHILL | 0.94 % | 1.22 % | 0.77 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | -4.65 % | 6.70 % | -0.69 | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.62 % | 0.49 % | 25 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | -0.17 | 0.21 | -0.83 | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -0.17 | 1.00 | -0.17 | |
| LCOE | -0.21 | 0.50 | -0.43 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | 0.03 | 0.08 | 0.37 | |
| PTB | 0.60 | 2.00 | 0.30 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIIMS | 0.10 | 0.50 | 0.20 | |
| NIM | -0.14 | 0.80 | -0.18 | |
| JHILL | -0.14 | 0.50 | -0.29 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | 0.08 | 0.30 | 0.27 | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.18 | 0.14 | 93 % |

Long-P600

Long-P600

Setup uncertainties:

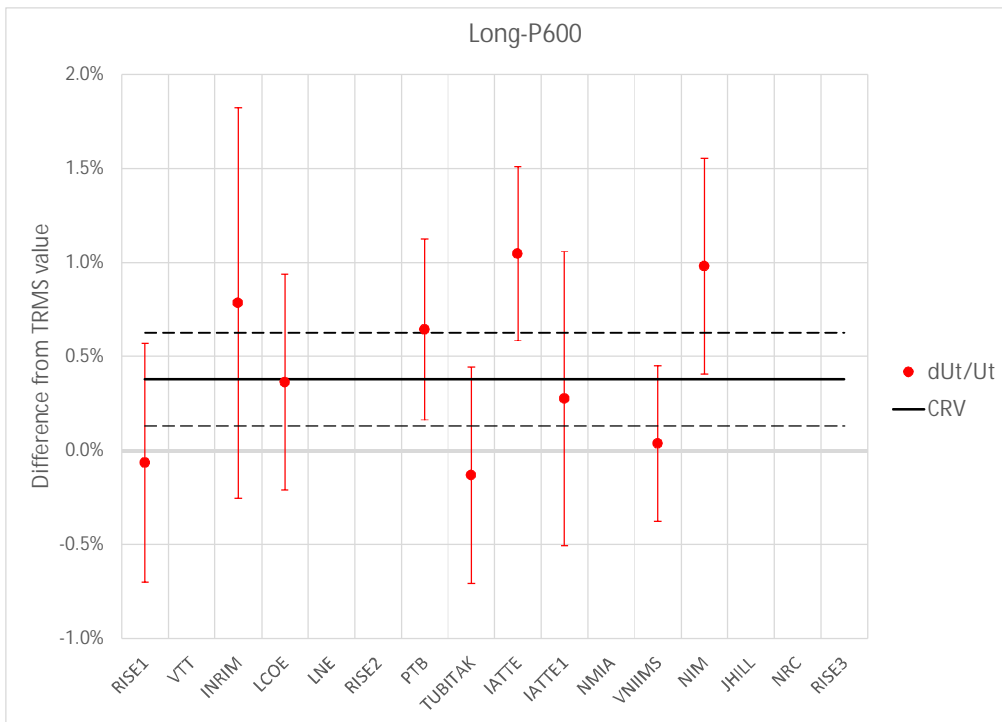
0.18 %

0.45 %

0.80 %

0.12

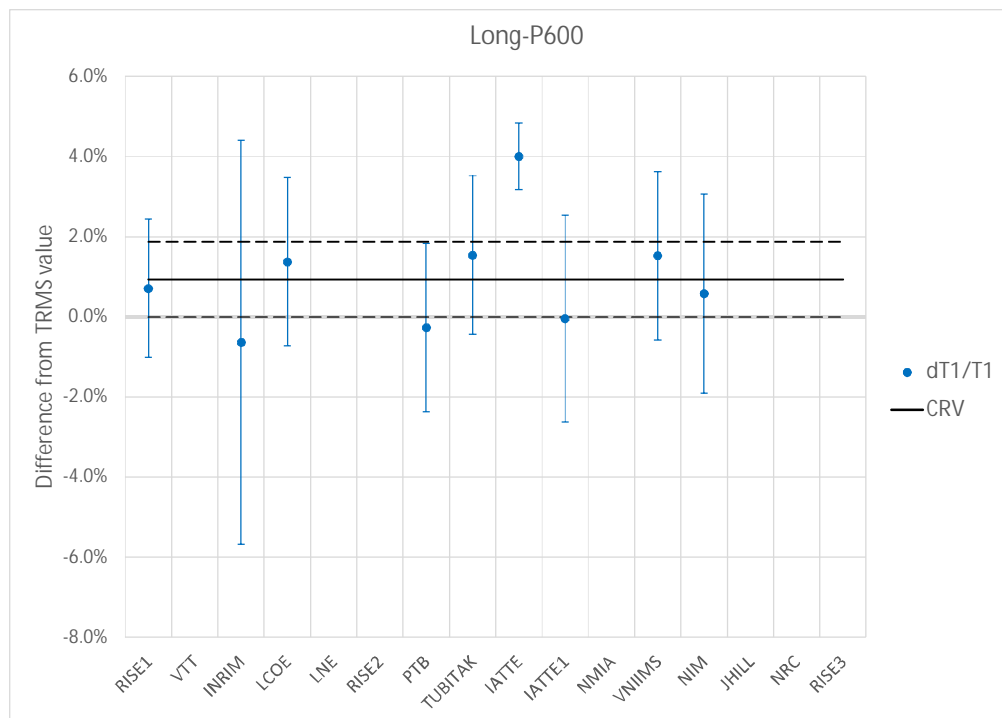
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | 603.52 | 1.647 | 45.16 | -0.99 | 603.91 | 1.636 | 44.95 | -0.68 | -0.06 % | 0.59 % | 0.71 % | 1.73 % | 0.46 % | 1.17 % | -0.32 | 0.18 |
| VTT | | | | | | | | | | | | | | | | |
| INRIM | 587.63 | 1.560 | 44.02 | -1.09 | 583.05 | 1.570 | 44.06 | -1.17 | 0.79 % | 1.07 % | -0.64 % | 5.04 % | -0.11 % | 5.07 % | 0.08 | 1.01 |
| LCOE | 600.71 | 1.556 | 58.86 | 0.18 | 598.54 | 1.535 | 59.85 | 0.01 | 0.36 % | 0.63 % | 1.37 % | 2.10 % | -1.66 % | 1.32 % | 0.17 | 0.52 |
| LNE | | | | | | | | | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | 607.62 | 1.562 | 47.34 | 0.00 | 603.86 | 1.566 | 47.49 | -0.85 | 0.64 % | 0.54 % | -0.26 % | 2.10 % | -0.33 % | 2.18 % | 0.85 | 2.00 |
| TUBITAK | 598.07 | 1.533 | 60.01 | 0.34 | 598.86 | 1.509 | 60.13 | | -0.13 % | 0.63 % | 1.54 % | 1.98 % | -0.19 % | 1.24 % | | |
| IATTE | 550.25 | 1.410 | 47.25 | -0.12 | 544.44 | 1.356 | 47.32 | | 1.05 % | 0.39 % | 4.01 % | 0.83 % | -0.14 % | 0.97 % | | |
| IATTE1 | 550.25 | 1.410 | 47.25 | -0.12 | 548.74 | 1.411 | 45.97 | | 0.28 % | 0.74 % | -0.04 % | 2.58 % | 2.79 % | 2.17 % | | |
| NMIA | | | | | | | | | | | | | | | | |
| VNIIMS | 612.17 | 1.400 | 46.74 | -1.43 | 612.67 | 1.379 | 47.45 | -1.76 | 0.04 % | 0.48 % | 1.52 % | 2.11 % | -1.51 % | 0.99 % | 0.33 | 0.52 |
| NIM | 605.97 | 1.586 | 62.65 | 0.43 | 600.82 | 1.577 | 62.74 | 0.38 | 0.98 % | 0.63 % | 0.58 % | 2.49 % | -0.14 % | 1.73 % | 0.05 | 0.81 |
| JHILL | | | | | | | | | | | | | | | | |
| NRC | | | | | | | | | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.44 % | 0.64 % | -0.70 | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.41 % | 1.04 % | 0.39 | |
| LCOE | -0.01 % | 0.57 % | -0.03 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | 0.27 % | 0.48 % | 0.55 | |
| TUBITAK | -0.51 % | 0.57 % | -0.89 | |
| IATTE | 0.67 % | 0.46 % | 1.45 | 0 |
| IATTE1 | -0.10 % | 0.78 % | -0.13 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.34 % | 0.41 % | -0.82 | |
| NIM | 0.60 % | 0.57 % | 1.05 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|-----|
| 0.38 % | 0.25 % | 8 % |



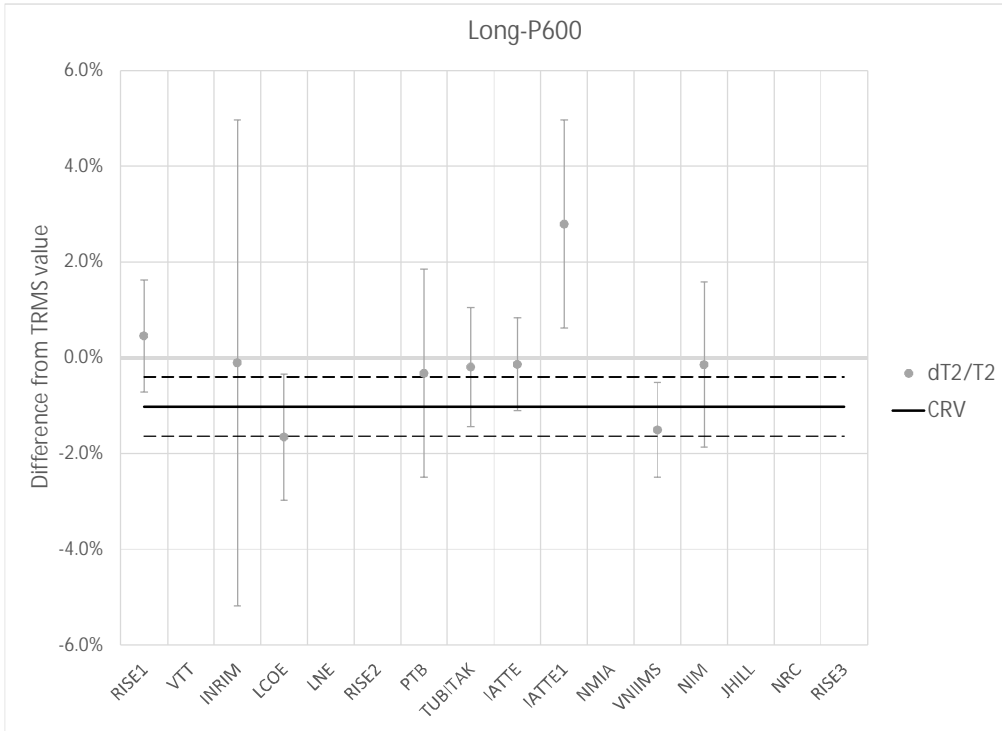
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.22 % | 1.97 % | -0.11 | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -1.57 % | 4.95 % | -0.32 | |
| LCOE | 0.44 % | 1.88 % | 0.23 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | -1.19 % | 1.88 % | -0.64 | |
| TUBITAK | 0.61 % | 1.74 % | 0.35 | |
| IATTE | 3.08 % | 1.25 % | 2.46 | 0 |
| IATTE1 | -0.97 % | 2.75 % | -0.35 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.59 % | 1.89 % | 0.31 | |
| NIM | -0.35 % | 2.30 % | -0.15 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.93 % | 0.94 % | 76 % |

Long-P600

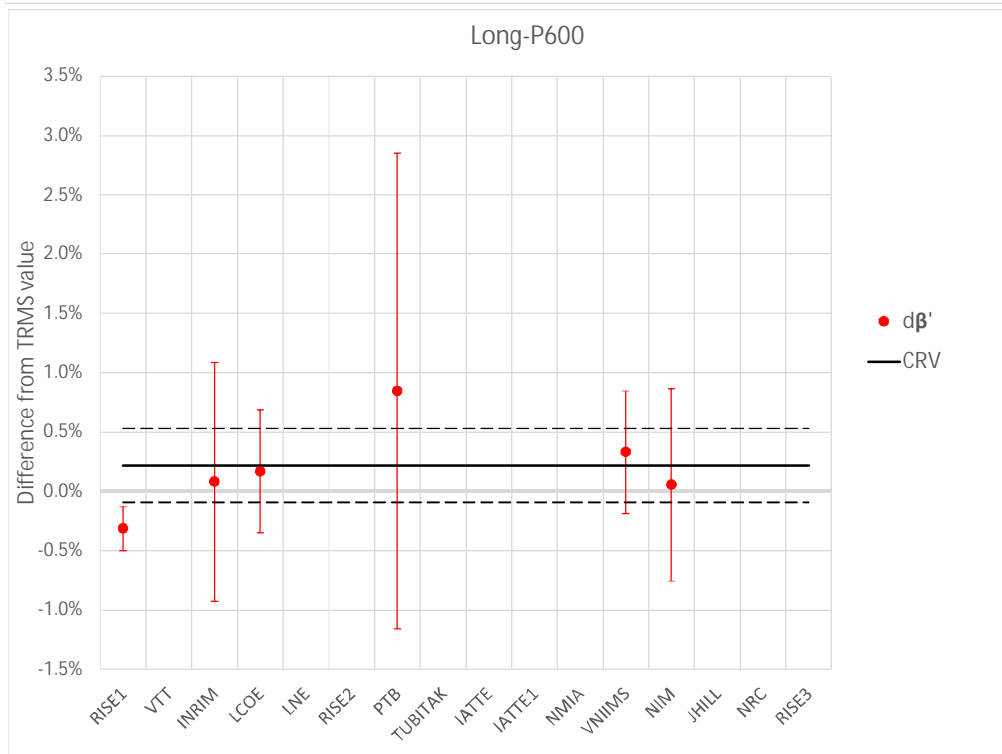
Long-P600



T₂

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | 1.48 % | 1.33 % | 1.11 | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | 0.91 % | 5.03 % | 0.18 | |
| LCOE | -0.64 % | 1.16 % | -0.55 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | 0.69 % | 2.26 % | 0.31 | 0 |
| TUBITAK | 0.83 % | 1.08 % | 0.77 | |
| IATTE | 0.88 % | 1.15 % | 0.77 | 0 |
| IATTE1 | 3.81 % | 2.26 % | 1.69 | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | -0.49 % | 0.77 % | -0.63 | |
| NIM | 0.88 % | 1.61 % | 0.54 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -1.02 % | 0.62 % | 30 % |



β' [%]

| Lab | Δx_i | U(Δx_i) | En | Excl. |
|---------|--------------|-------------------|-------|-------|
| RISE1 | -0.53 | 0.36 | -1.47 | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | -0.14 | 0.96 | -0.14 | |
| LCOE | -0.05 | 0.41 | -0.12 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | 0.63 | 1.98 | 0.32 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | 0.11 | 0.41 | 0.27 | |
| NIM | -0.16 | 0.75 | -0.22 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.22 | 0.31 | 93 % |

Long-P700

Long-P700

Setup uncertainties:

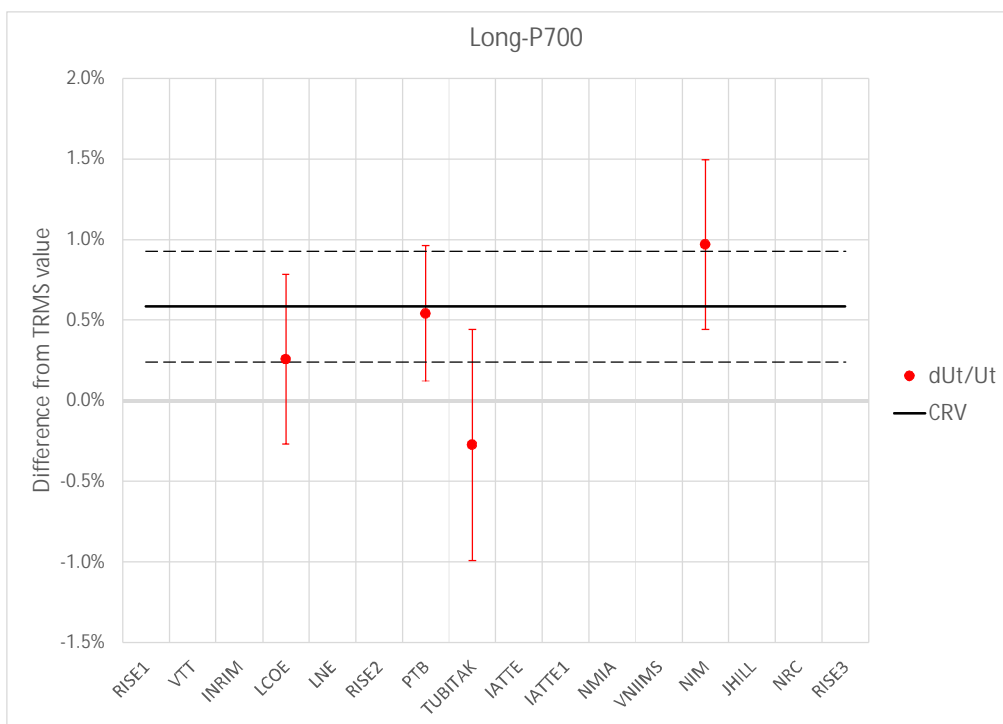
0.18 %

0.45 %

0.80 %

0.12

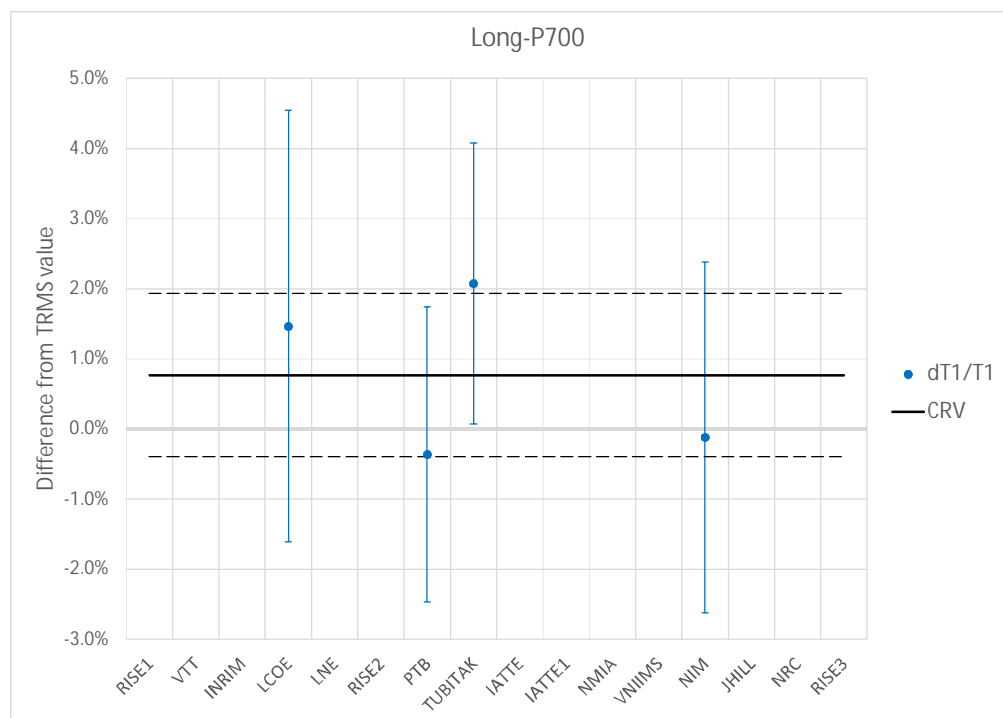
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|--------|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | 699.70 | 1.560 | 57.84 | 0.17 | 697.90 | 1.537 | 58.63 | 0.16 | 0.26 % | 0.63 % | 1.47 % | 3.08 % | -1.35 % | 1.32 % | 0.00 | 0.52 |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | 690.47 | 1.572 | 47.59 | 0.00 | 686.89 | 1.578 | 47.96 | -0.98 | 0.54 % | 0.54 % | -0.37 % | 2.10 % | -0.76 % | 2.18 % | 0.98 | 2.00 |
| TUBITAK | 699.99 | 1.534 | 60.27 | 0.20 | 701.91 | 1.503 | 60.32 | #N/A | -0.27 % | 0.63 % | 2.07 % | 2.01 % | -0.09 % | 1.25 % | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VNIIMS | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NIM | 697.05 | 1.572 | 62.98 | 0.27 | 691.19 | 1.574 | 63.09 | 0.05 | 0.97 % | 0.63 % | -0.12 % | 2.50 % | -0.18 % | 1.73 % | 0.22 | 0.81 |
| JHILL | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.33 % | 0.53 % | -0.62 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | -0.04 % | 0.42 % | -0.10 | |
| TUBITAK | -0.86 % | 0.72 % | -1.20 | 1 |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | 0.39 % | 0.53 % | 0.73 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.58 % | 0.34 % | 27 % |



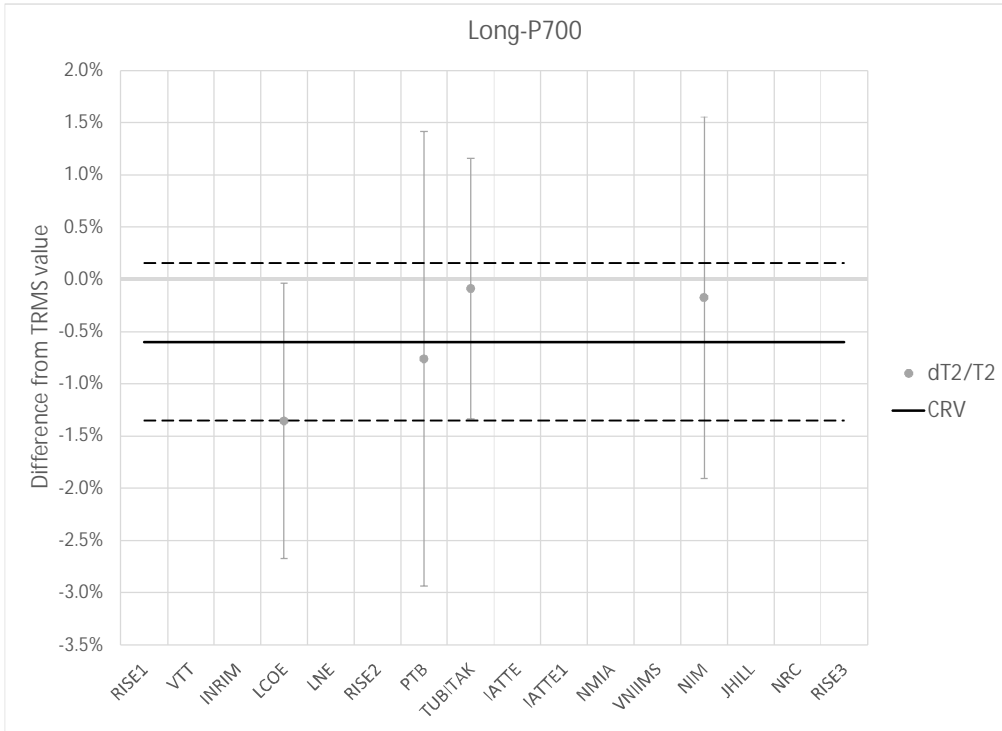
T_1

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | 0.70 % | 2.85 % | 0.24 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | -1.13 % | 1.75 % | -0.65 | |
| TUBITAK | 1.31 % | 1.64 % | 0.80 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | -0.89 % | 2.22 % | -0.40 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.77 % | 1.16 % | 31 % |

Long-P700

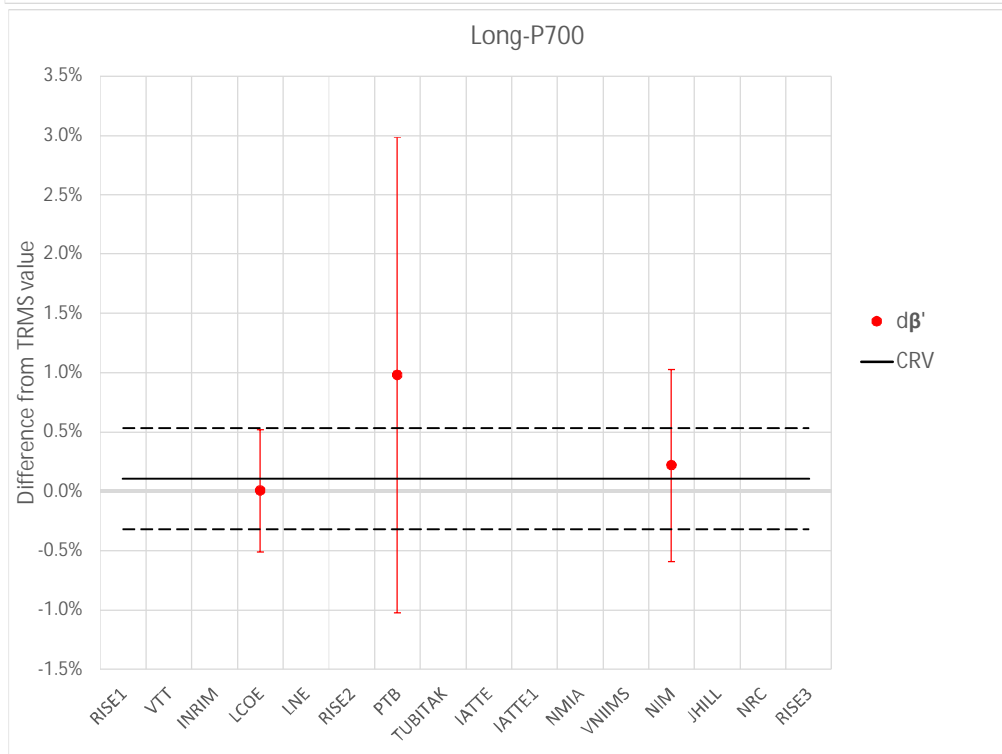
Long-P700



T_2

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.76 % | 1.08 % | -0.70 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | -0.16 % | 2.04 % | -0.08 | |
| TUBITAK | 0.51 % | 1.00 % | 0.51 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | 0.42 % | 1.56 % | 0.27 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -0.60 % | 0.75 % | 52 % |



β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | -0.10 | 0.29 | -0.35 | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | 0.87 | 1.96 | 0.45 | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | 0.11 | 0.69 | 0.16 | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|------|--------|------|
| 0.11 | 0.43 | 61 % |

Chopped-P150

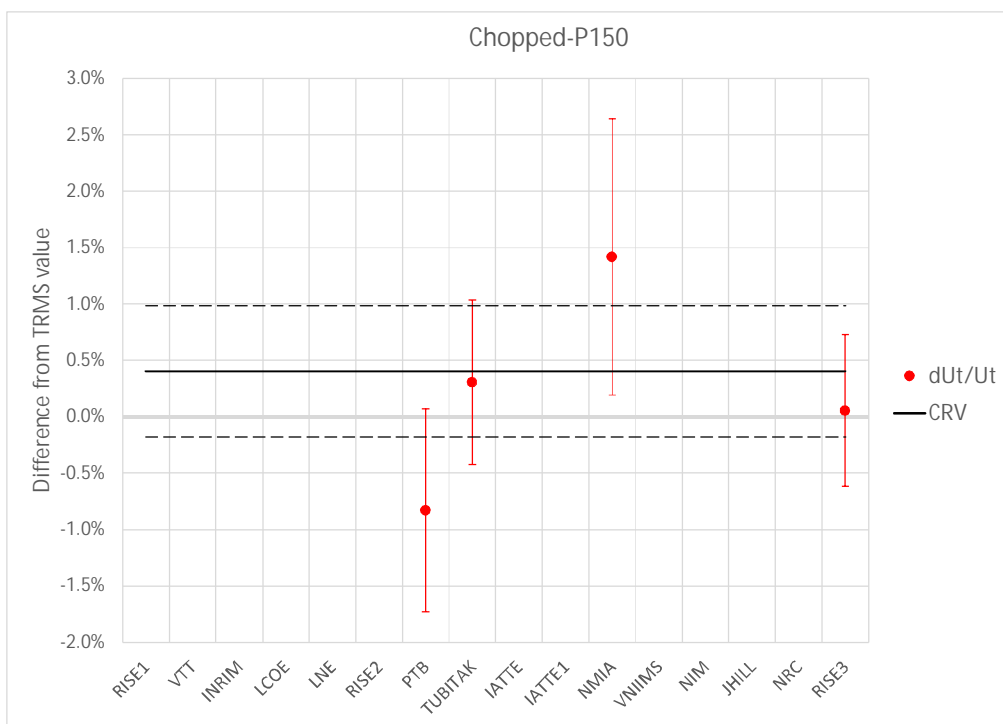
Chopped-P150

Setup uncertainties:

0.41 %

1.18 %

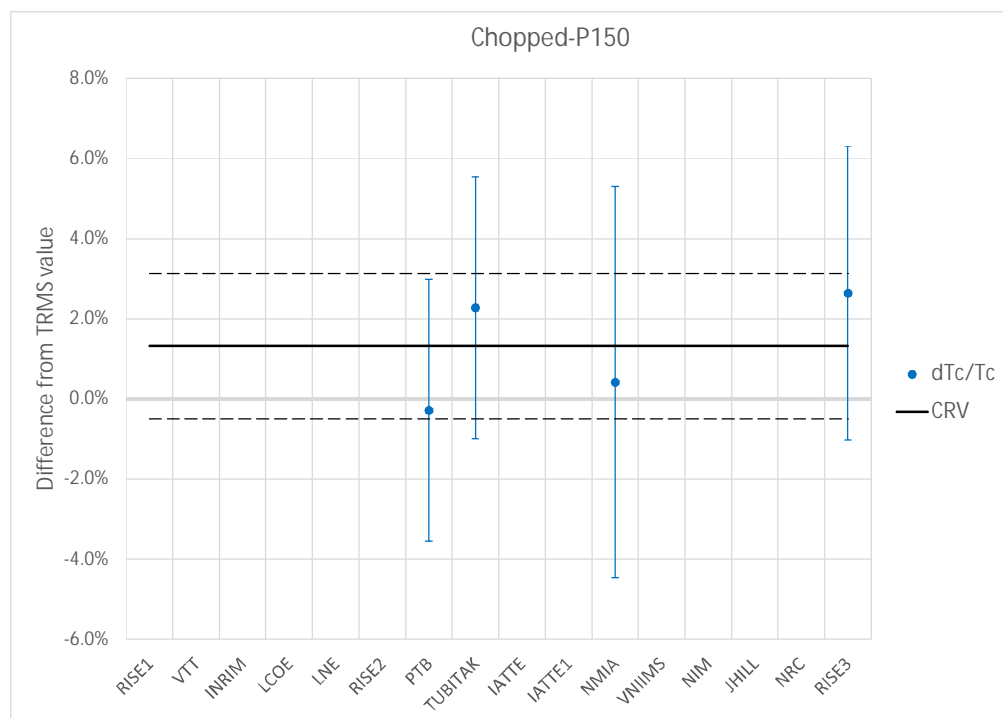
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|---|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| VTT | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| INRIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LCOE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| LNE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE2 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| PTB | 149.62 | 0.502 | | | 148.41 | 0.500 | | | -0.83 % | 0.69 % | -0.28 % | 3.26 % | | | | |
| TUBITAK | 155.82 | 0.576 | | | 155.35 | 0.563 | | | 0.31 % | 0.93 % | 2.28 % | 3.26 % | | | | |
| IATTE | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| IATTE1 | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NMIA | 138.32 | 0.490 | | | 136.47 | 0.488 | | | 1.42 % | 1.36 % | 0.42 % | 4.88 % | | | | |
| VNIIMS | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NIM | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| JHILL | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| NRC | | | | | #N/A | #N/A | #N/A | #N/A | | | | | | | | |
| RISE3 | 156.39 | 0.523 | | | 156.49 | 0.510 | | | 0.05 % | 0.89 % | 2.64 % | 3.67 % | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | #N/A | #N/A | #N/A | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | -1.23 % | 0.90 % | -1.37 | 11 |
| TUBITAK | -0.10 % | 0.73 % | -0.13 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | 1.01 % | 1.22 % | 0.83 | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | -0.35 % | 0.67 % | -0.52 | |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.40 % | 0.58 % | 23 % |



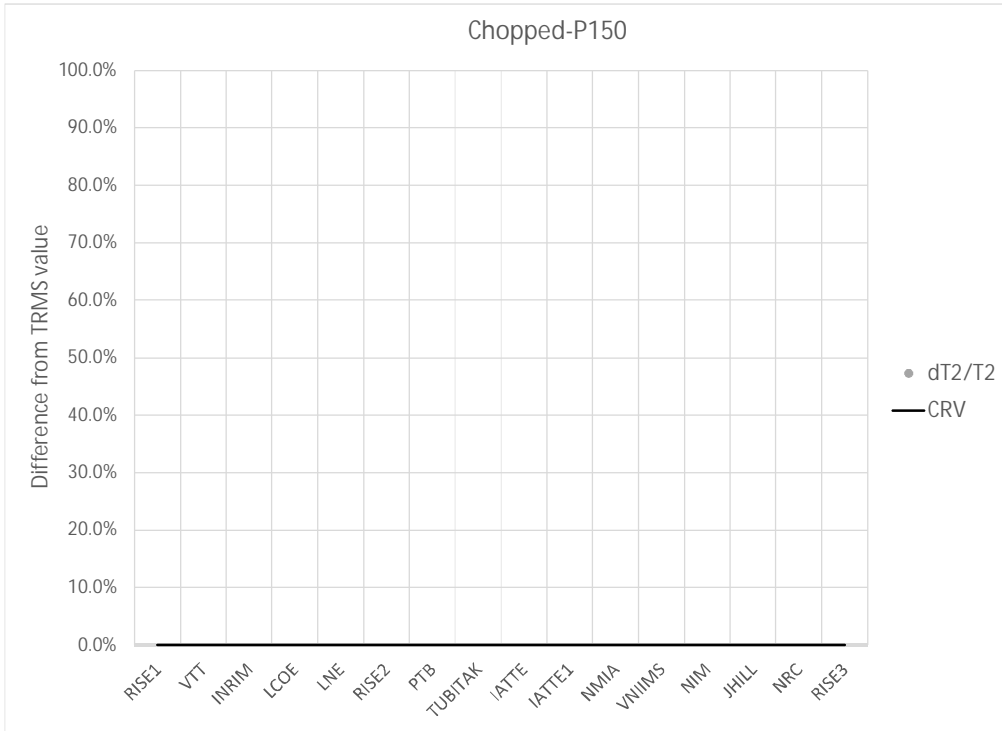
T_c

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | #N/A | #N/A | #N/A | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | -1.60 % | 2.71 % | -0.59 | |
| TUBITAK | 0.96 % | 2.71 % | 0.35 | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | -0.90 % | 4.53 % | -0.20 | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | 1.32 % | 3.19 % | 0.41 | |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 1.32 % | 1.81 % | 58 % |

Chopped-P150

Chopped-P150



T_2

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | #N/A | #N/A | #N/A | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | 0 |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | |

| CRV | U(CRV) | Pr |
|---------|---------|-------|
| #DIV/0! | #DIV/0! | #NUM! |



β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | #N/A | #N/A | #N/A | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | 0 |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | |

| CRV | U(CRV) | Pr |
|---------|---------|-------|
| #DIV/0! | #DIV/0! | #NUM! |

Chopped-N150

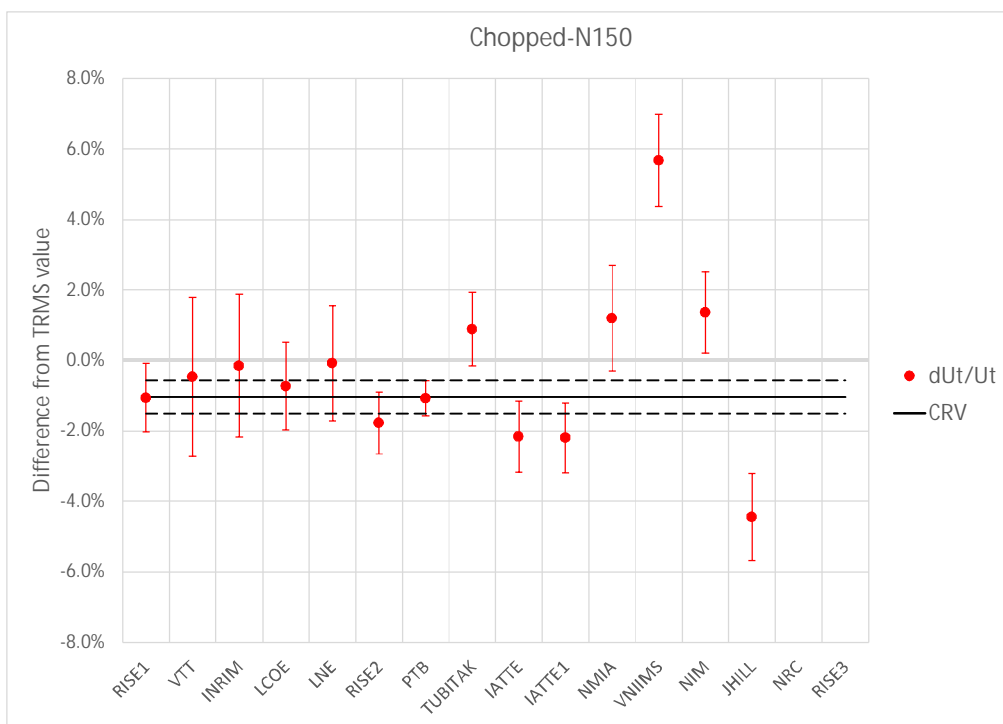
Chopped-N150

Setup uncertainties:

0.41 %

1.18 %

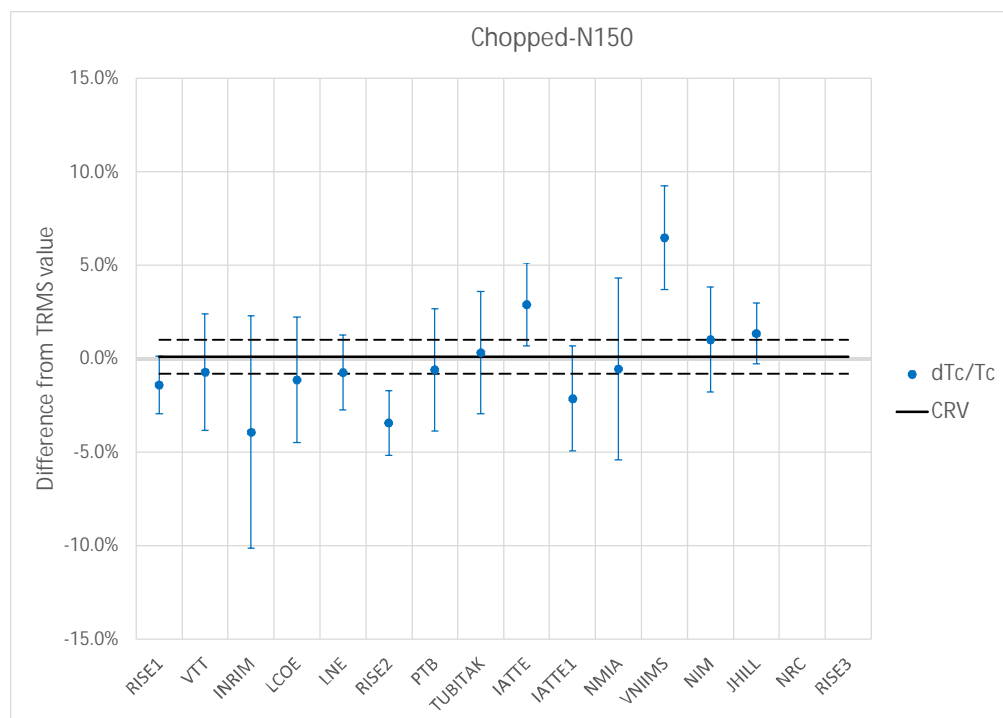
| Lab | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------|---------------|------------------------------|---------------------|-----------------|---------------|------------------------------|---------------------|-----------------|--------------------|--------|--------------------------|--------|------------|---|------------------|----------|
| | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | U_t [kV] | T_1 or T_c [μ s] | T_2 [μ s] | β' [%] | dU_t/U_t | U | dT_1/T_1 dT_c/T_c | U | dT_2/T_2 | U | $d\beta'$ [%] | U [%] |
| RISE1 | -161.88 | 0.590 | | | -163.62 | 0.598 | | | -1.06 % | 0.85 % | -1.39 % | 1.54 % | | | | |
| VTT | -173.39 | 0.472 | | | -174.17 | 0.476 | | | -0.47 % | 2.30 % | -0.72 % | 3.12 % | | | | |
| INRIM | -152.35 | 0.588 | | | -152.58 | 0.613 | | | -0.15 % | 2.08 % | -3.92 % | 6.22 % | | | | |
| LCOE | -166.60 | 0.605 | | | -167.82 | 0.612 | | | -0.73 % | 1.33 % | -1.13 % | 3.35 % | | | | |
| LNE | -138.47 | 0.565 | | | -138.57 | 0.569 | | | -0.08 % | 1.70 % | -0.73 % | 1.99 % | | | | |
| RISE2 | 180.58 | 0.501 | | | 183.89 | 0.519 | | | -1.77 % | 1.00 % | -3.43 % | 1.73 % | | | | |
| PTB | -150.43 | 0.506 | | | -148.84 | 0.503 | | | -1.07 % | 0.68 % | -0.59 % | 3.27 % | | | | |
| TUBITAK | -145.90 | 0.533 | | | -144.62 | 0.531 | | | 0.89 % | 0.94 % | 0.33 % | 3.26 % | | | | |
| IATTE | -136.22 | 0.507 | | | -139.20 | 0.493 | | | -2.16 % | 0.89 % | 2.90 % | 2.20 % | | | | |
| IATTE1 | -136.22 | 0.507 | | | -139.26 | 0.518 | | | -2.20 % | 0.88 % | -2.12 % | 2.80 % | | | | |
| NMIA | -146.50 | 0.576 | | | -144.87 | 0.579 | | | 1.20 % | 1.42 % | -0.55 % | 4.86 % | | | | |
| VNIIMS | 153.44 | 0.593 | | | 145.37 | 0.557 | | | 5.68 % | 1.22 % | 6.47 % | 2.78 % | | | | |
| NIM | -145.11 | 0.464 | | | -143.34 | 0.459 | | | 1.36 % | 1.05 % | 1.03 % | 2.81 % | | | | |
| JHILL | -154.25 | 0.550 | | | -161.70 | 0.542 | | | -4.45 % | 1.14 % | 1.35 % | 1.63 % | | | | |
| NRC | | | | | | | | | | | | | | | | |
| RISE3 | | | | | | | | | | | | | | | | |



U_t

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -0.02 % | 0.97 % | -0.02 | 0 |
| VTT | 0.57 % | 2.25 % | 0.25 | |
| INRIM | 0.89 % | 2.02 % | 0.44 | |
| LCOE | 0.31 % | 1.24 % | 0.25 | |
| LNE | 0.95 % | 1.63 % | 0.58 | |
| RISE2 | -0.74 % | 0.88 % | -0.84 | |
| PTB | -0.04 % | 0.49 % | -0.08 | |
| TUBITAK | 1.92 % | 1.05 % | 1.83 | 4 |
| IATTE | -1.12 % | 1.01 % | -1.11 | 0 |
| IATTE1 | -1.16 % | 1.00 % | -1.17 | 0 |
| NMIA | 2.23 % | 1.50 % | 1.49 | 5 |
| VNIIMS | 6.71 % | 1.31 % | 5.13 | 1 |
| NIM | 2.40 % | 1.15 % | 2.09 | 3 |
| JHILL | -3.41 % | 1.24 % | -2.76 | 2 |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|--------|------|
| -1.04 % | 0.47 % | 46 % |



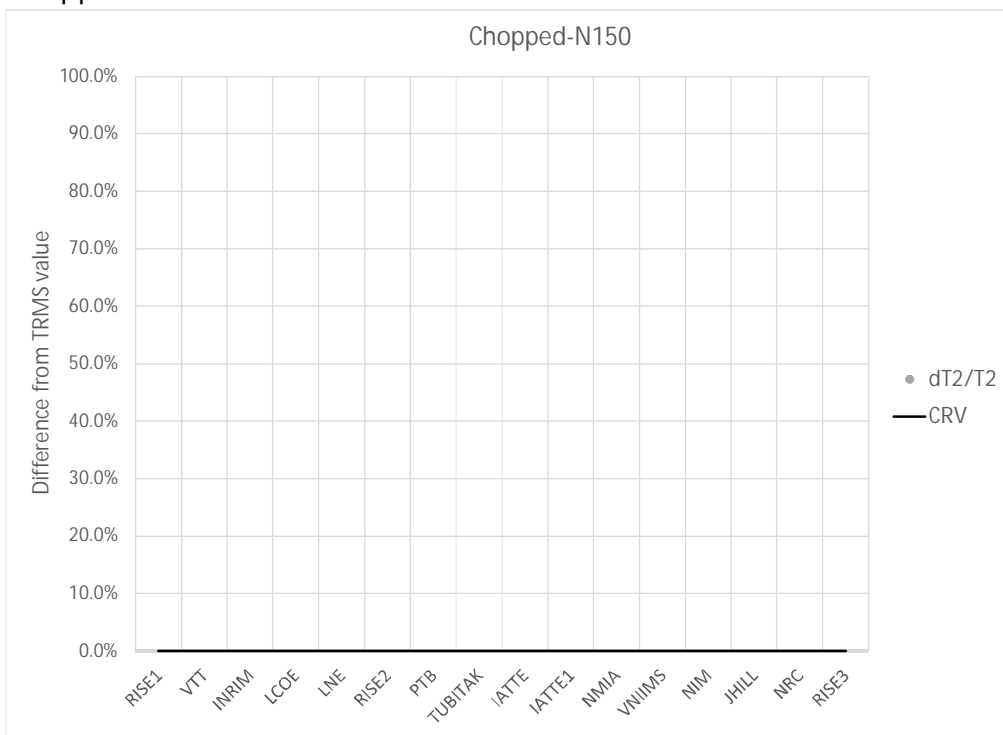
T_c

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|-------|-------|
| RISE1 | -1.50 % | 1.79 % | -0.84 | 0 |
| VTT | -0.83 % | 2.99 % | -0.28 | |
| INRIM | -4.03 % | 6.15 % | -0.65 | |
| LCOE | -1.24 % | 3.22 % | -0.39 | |
| LNE | -0.84 % | 1.77 % | -0.47 | |
| RISE2 | -3.54 % | 1.96 % | -1.81 | 2 |
| PTB | -0.70 % | 3.14 % | -0.22 | |
| TUBITAK | 0.22 % | 3.13 % | 0.07 | |
| IATTE | 2.79 % | 2.38 % | 1.17 | 0 |
| IATTE1 | -2.23 % | 2.95 % | -0.76 | 0 |
| NMIA | -0.66 % | 4.77 % | -0.14 | |
| VNIIMS | 6.36 % | 2.92 % | 2.18 | 1 |
| NIM | 0.92 % | 2.66 % | 0.35 | |
| JHILL | 1.24 % | 1.35 % | 0.92 | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|--------|--------|------|
| 0.11 % | 0.91 % | 62 % |

Chopped-N150

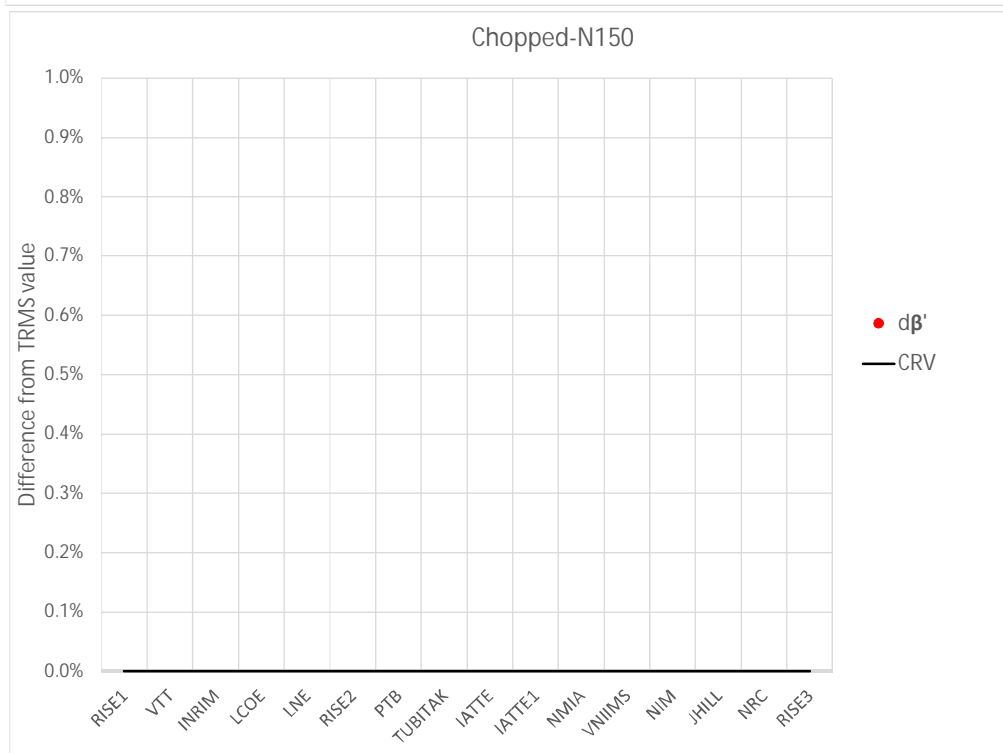
Chopped-N150



T_2

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | #N/A | #N/A | #N/A | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|---------|-------|
| #DIV/0! | #DIV/0! | #NUM! |



β' [%]

| Lab | Δx_i | $U(\Delta x_i)$ | En | Excl. |
|---------|--------------|-----------------|------|-------|
| RISE1 | #N/A | #N/A | #N/A | 0 |
| VTT | #N/A | #N/A | #N/A | |
| INRIM | #N/A | #N/A | #N/A | |
| LCOE | #N/A | #N/A | #N/A | |
| LNE | #N/A | #N/A | #N/A | |
| RISE2 | #N/A | #N/A | #N/A | |
| PTB | #N/A | #N/A | #N/A | |
| TUBITAK | #N/A | #N/A | #N/A | |
| IATTE | #N/A | #N/A | #N/A | 0 |
| IATTE1 | #N/A | #N/A | #N/A | 0 |
| NMIA | #N/A | #N/A | #N/A | |
| VNIIMS | #N/A | #N/A | #N/A | |
| NIM | #N/A | #N/A | #N/A | |
| JHILL | #N/A | #N/A | #N/A | |
| NRC | #N/A | #N/A | #N/A | |
| RISE3 | #N/A | #N/A | #N/A | 0 |

| CRV | U(CRV) | Pr |
|---------|---------|-------|
| #DIV/0! | #DIV/0! | #NUM! |

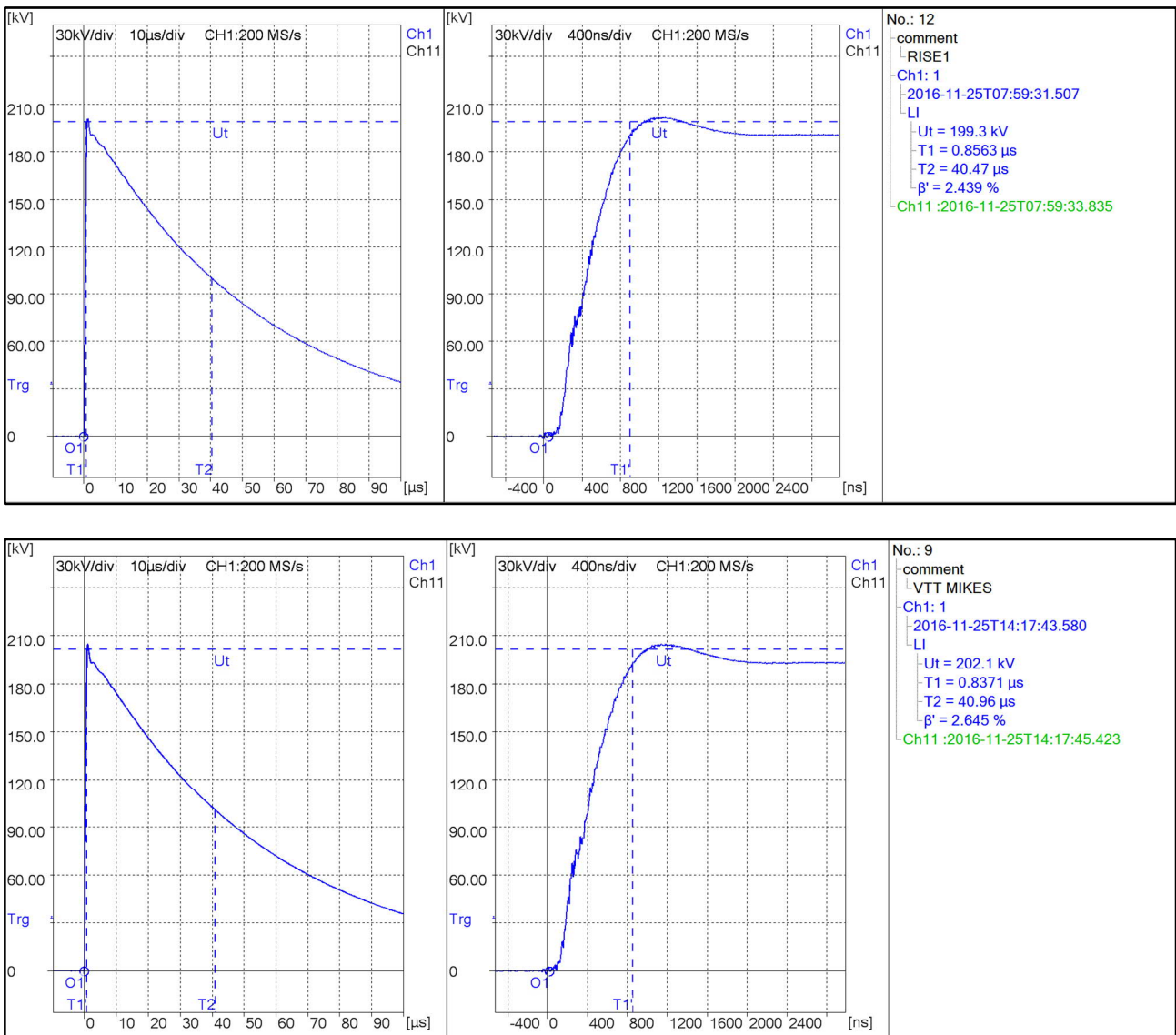
Annex F - Compatibility indexes

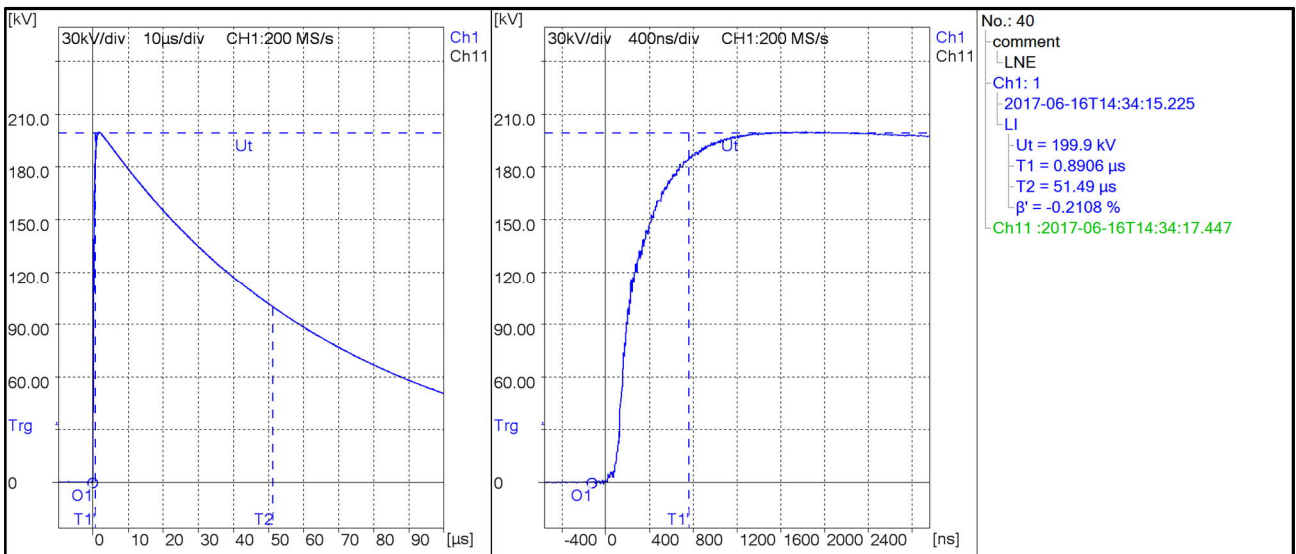
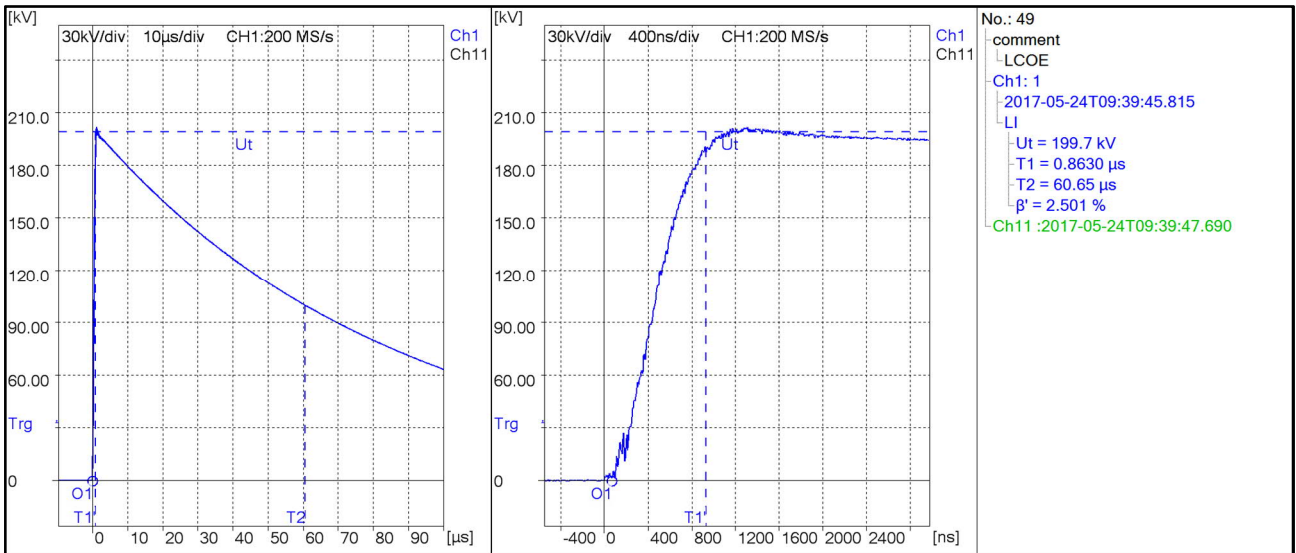
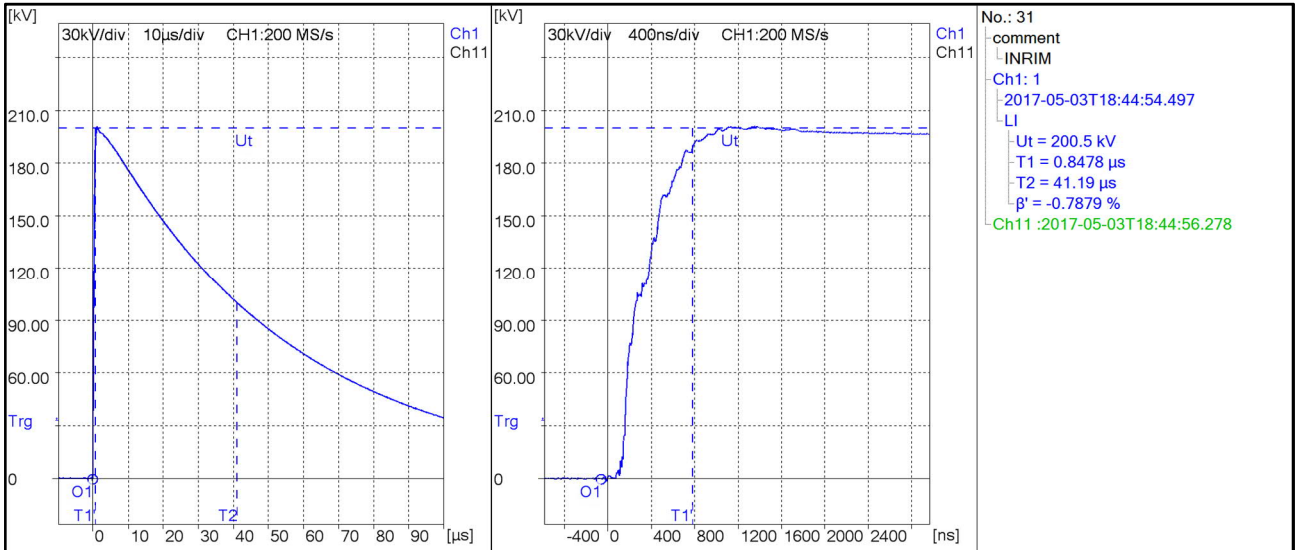
The compatibility of each laboratory with the comparison reference value, and the number of cases with $|E_n| > 1$ and $|E_n| > 1.5$.

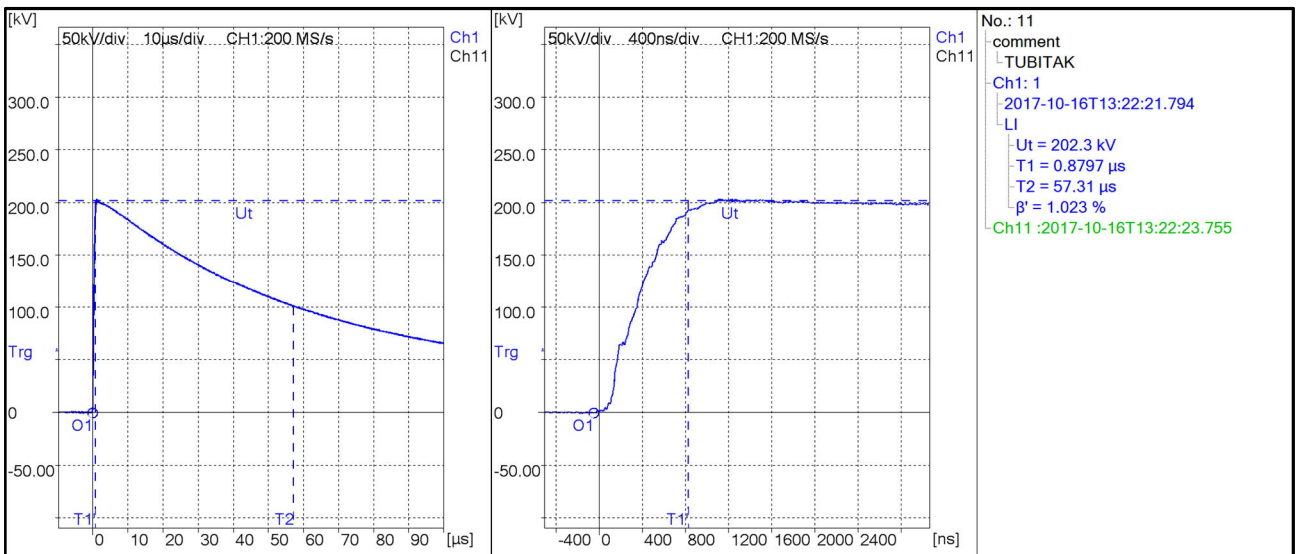
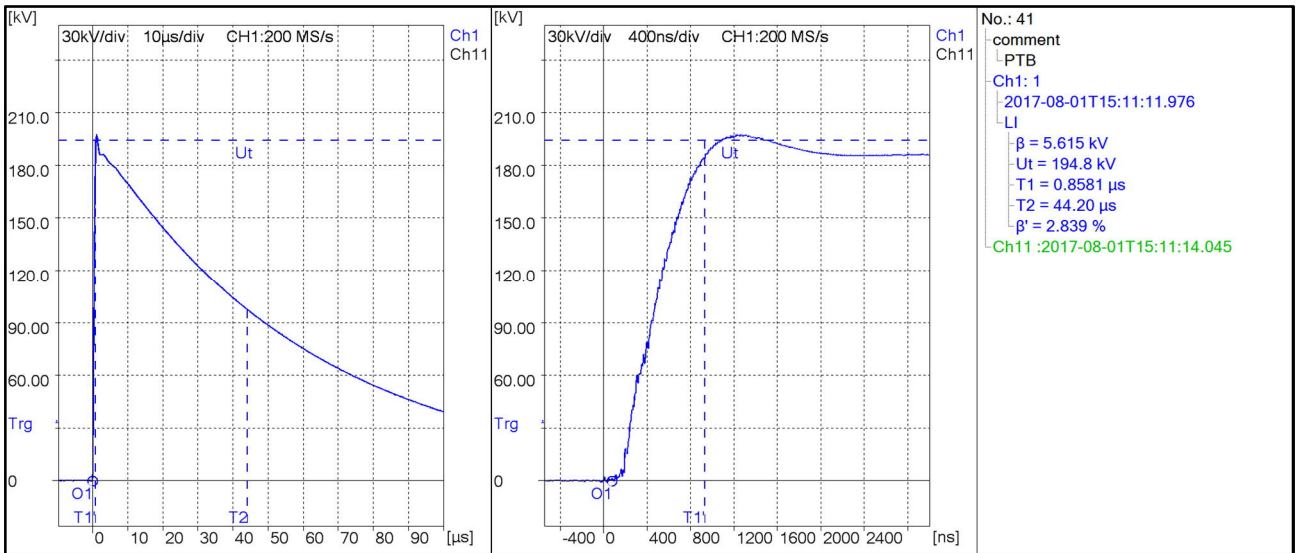
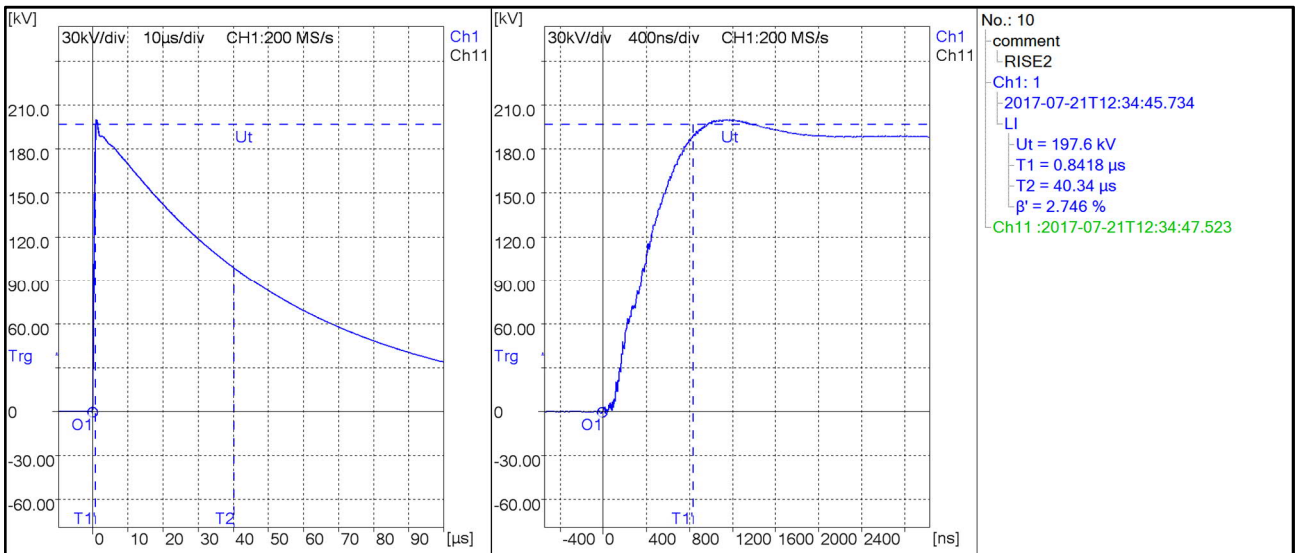
Annex G - Sample waveforms

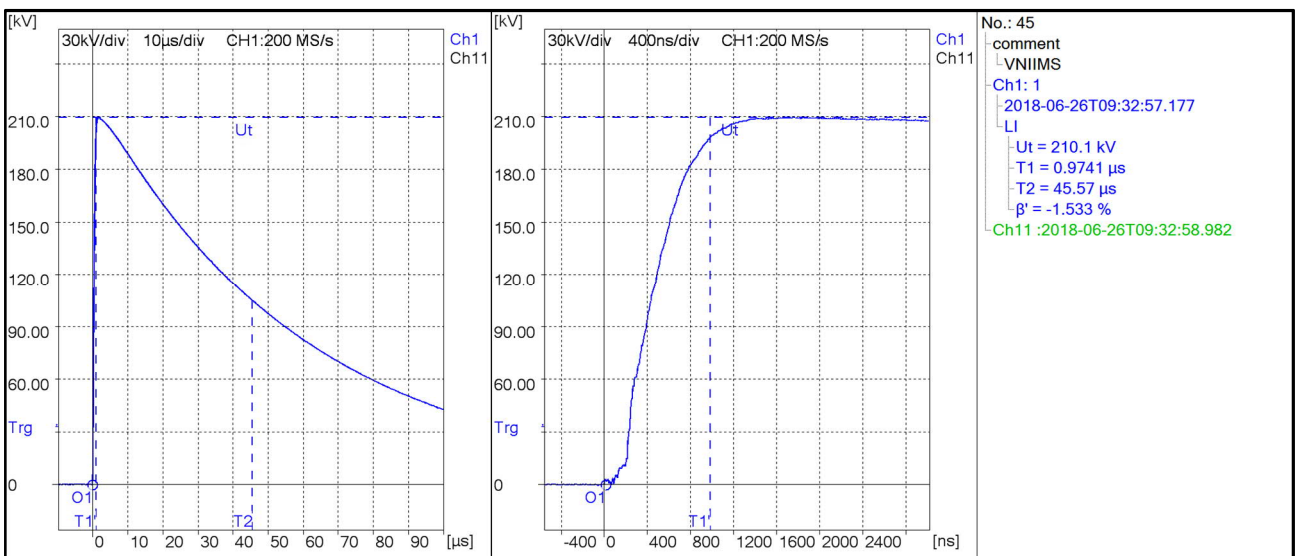
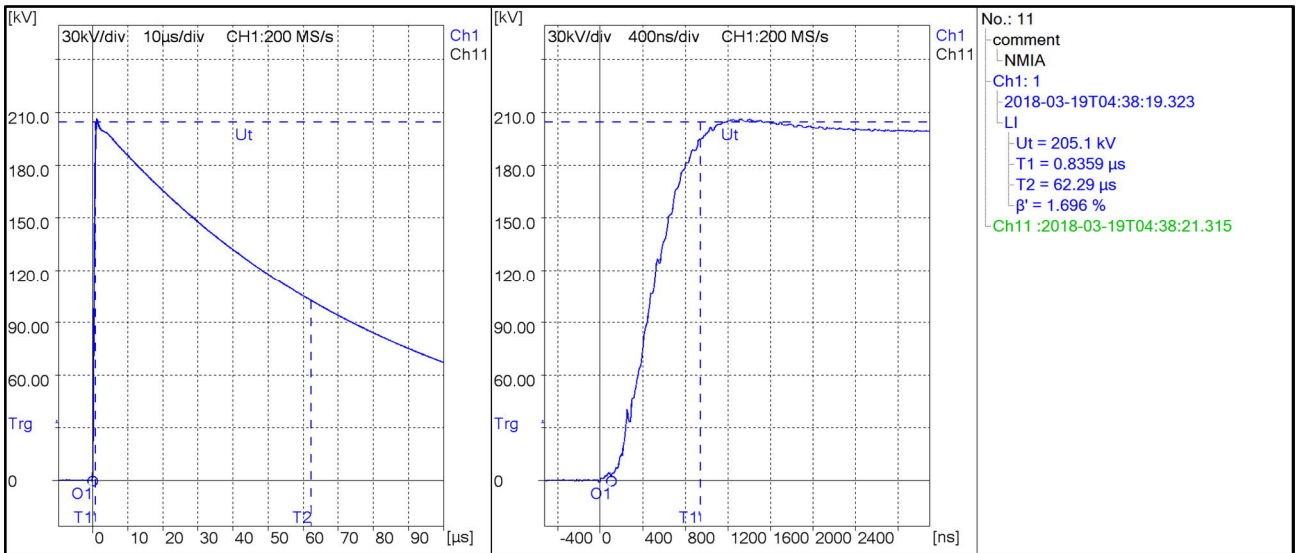
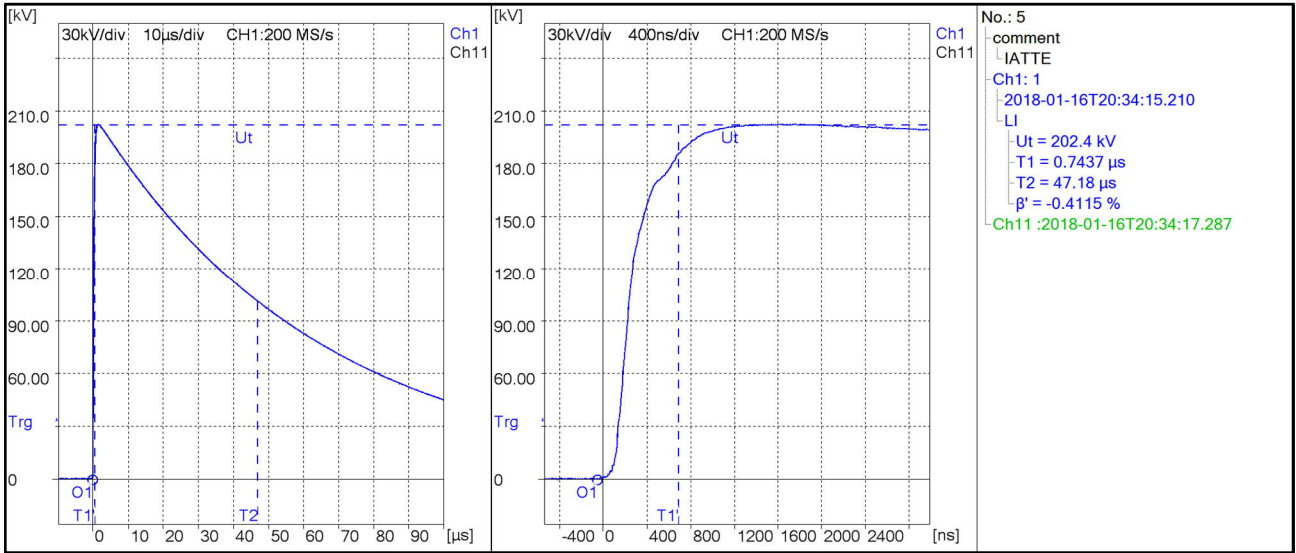
The high voltage impulse generator each have their limitations. To provide some insight into the scatter, one full and one front chopped impulse from each participant is shown in this annex.

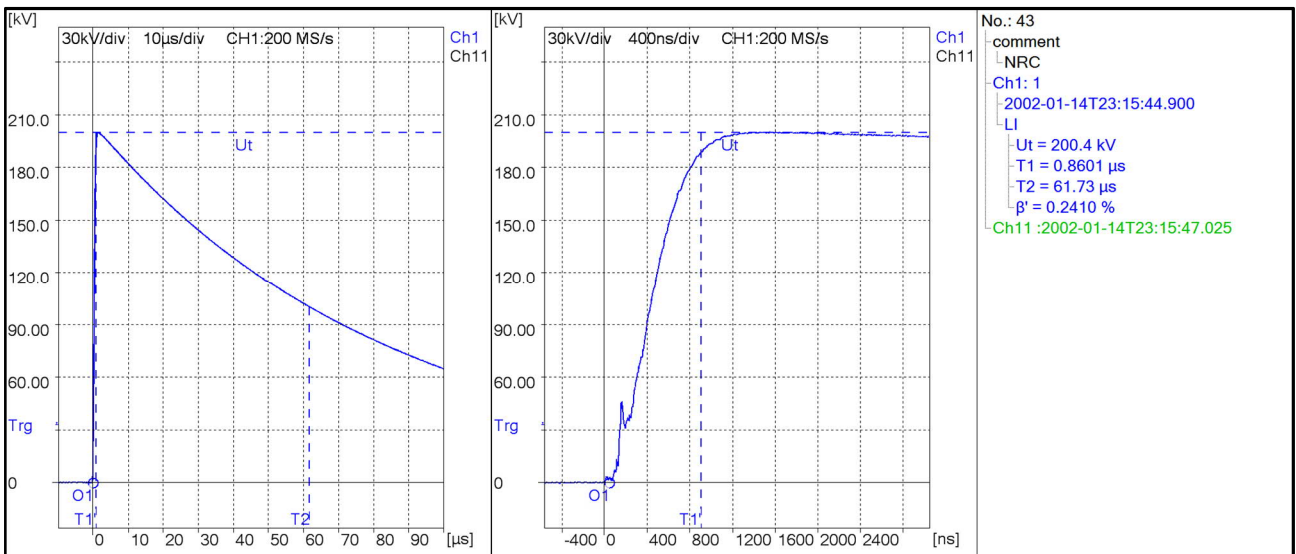
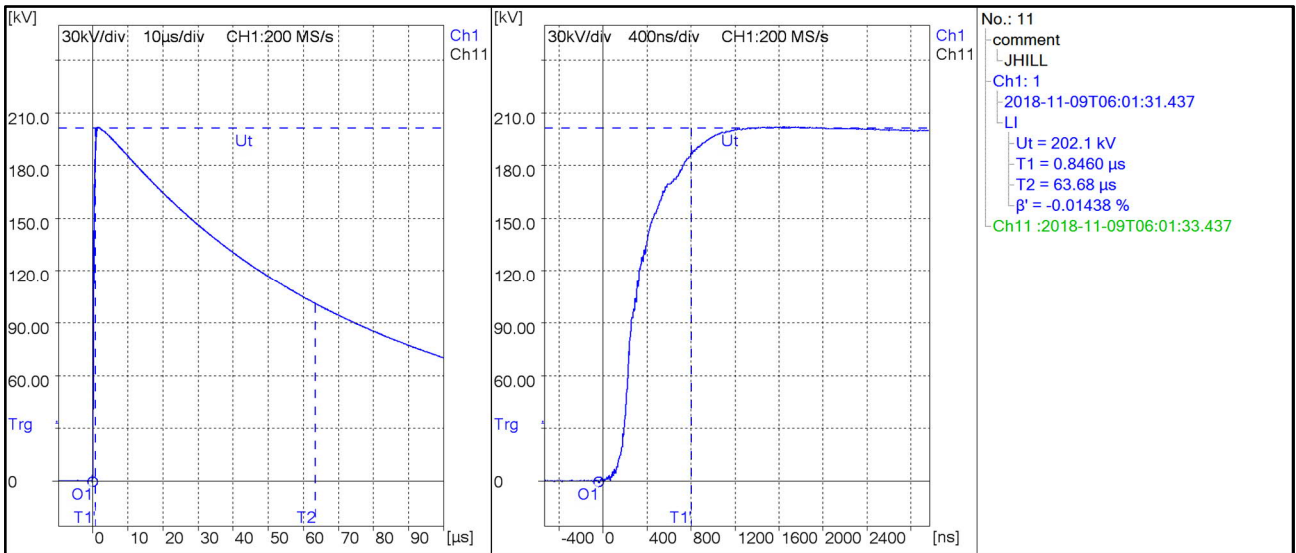
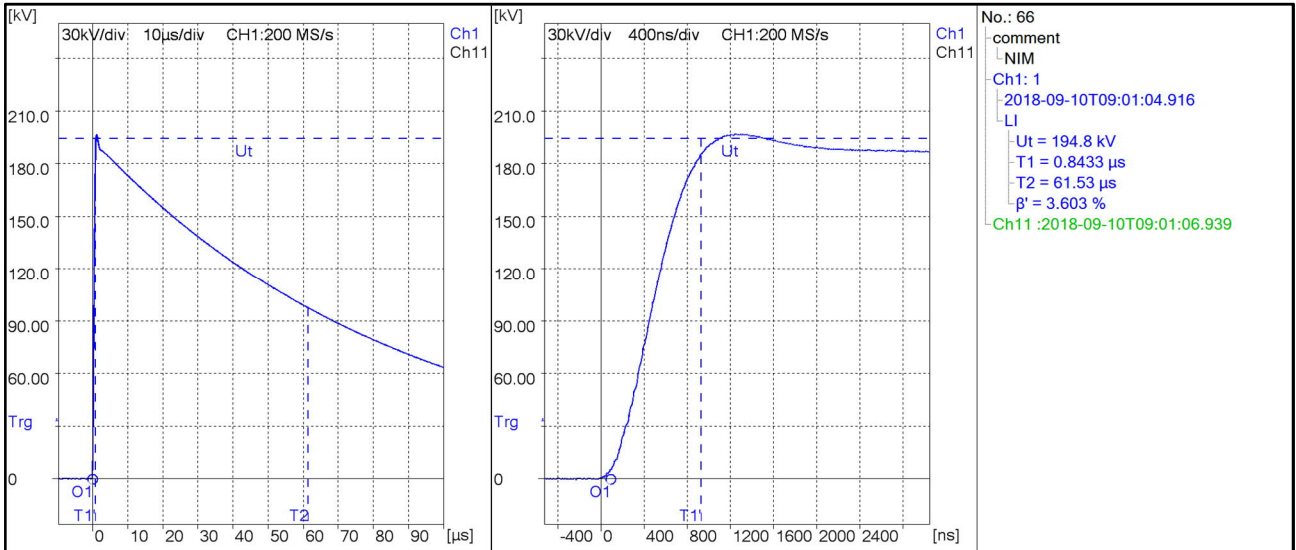
All full impulse samples show positive short front 200 kV impulse. Negative front chopped impulse sample is chosen, when available. Name of the participant is indicated on the comment section on the right hand side of each figure.

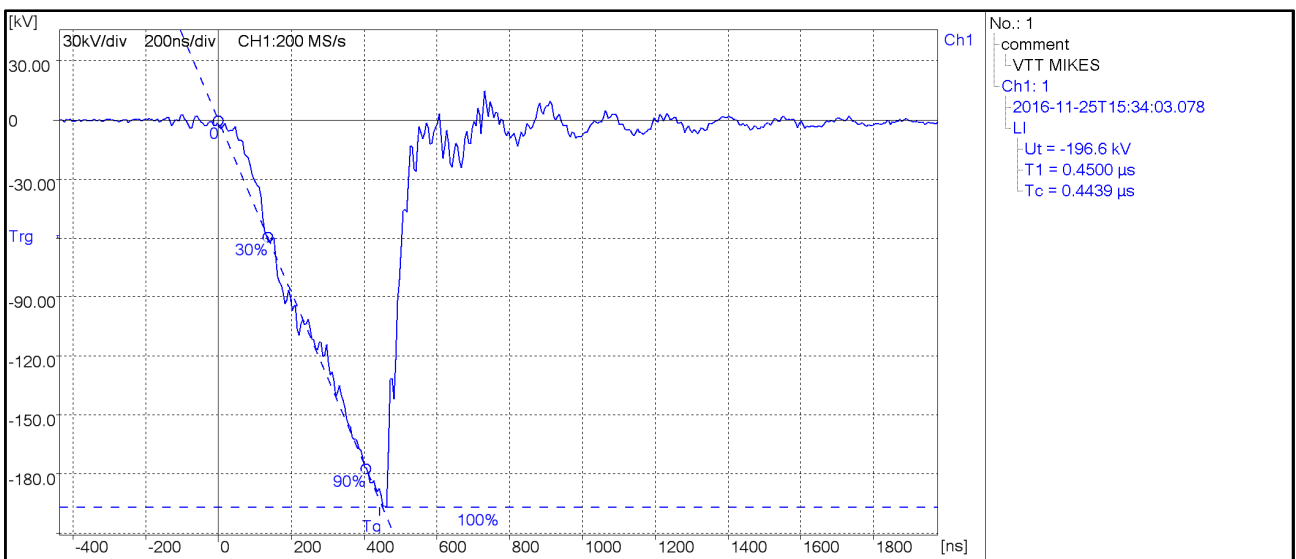
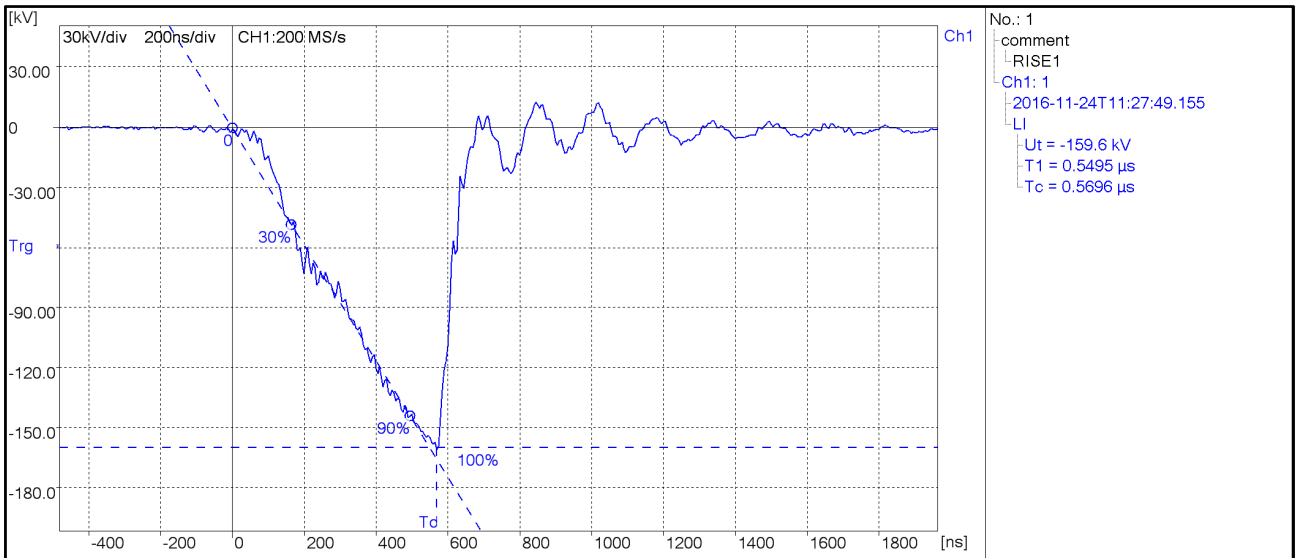
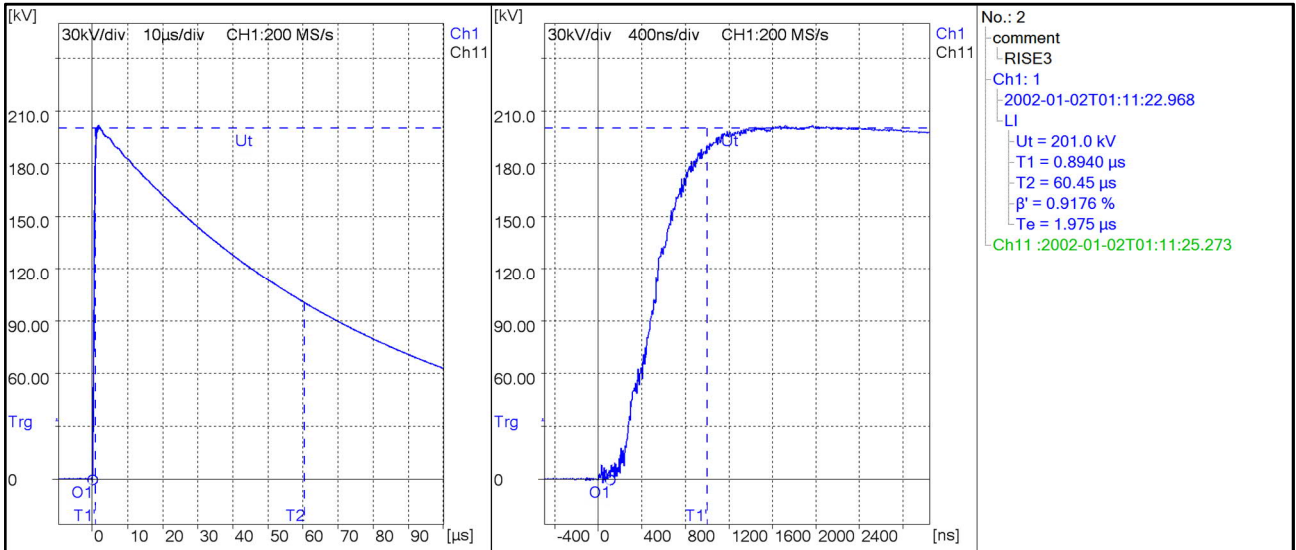


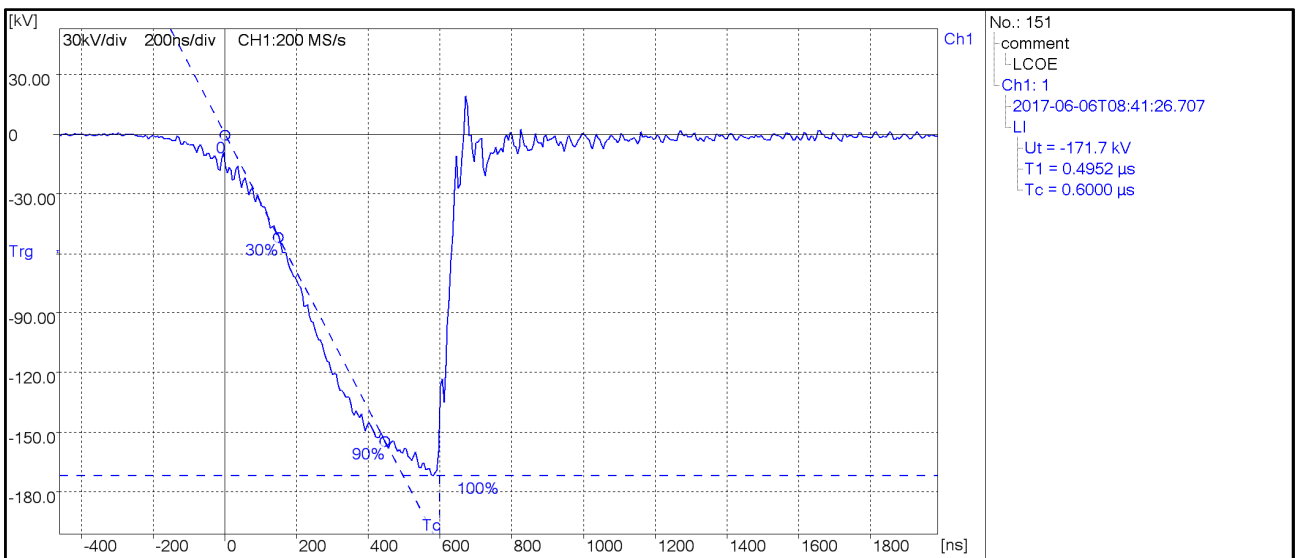
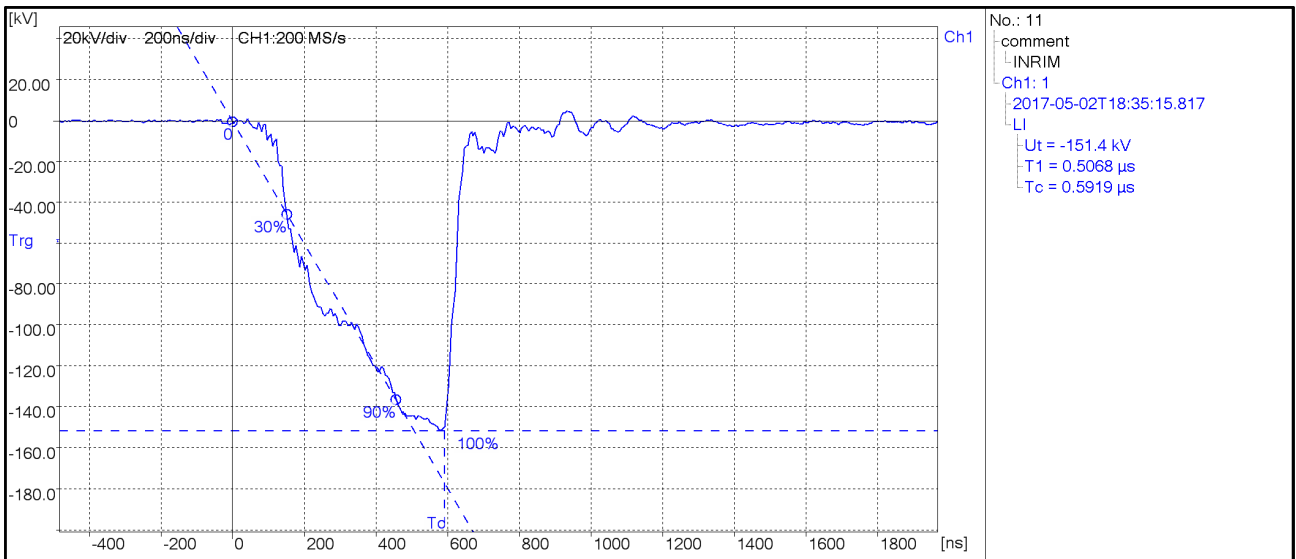
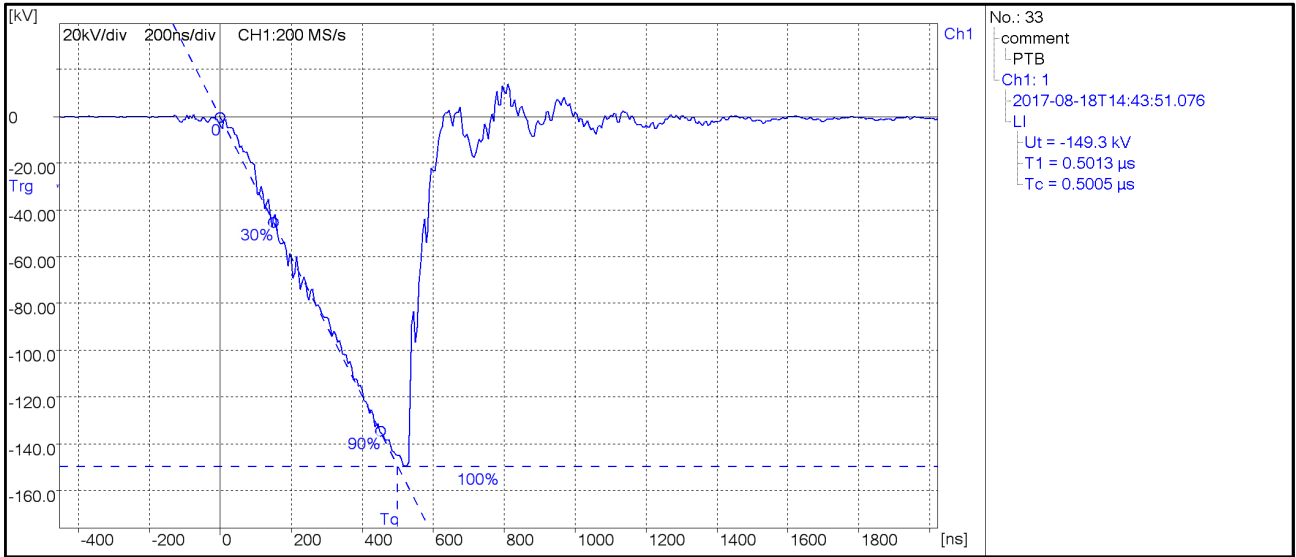


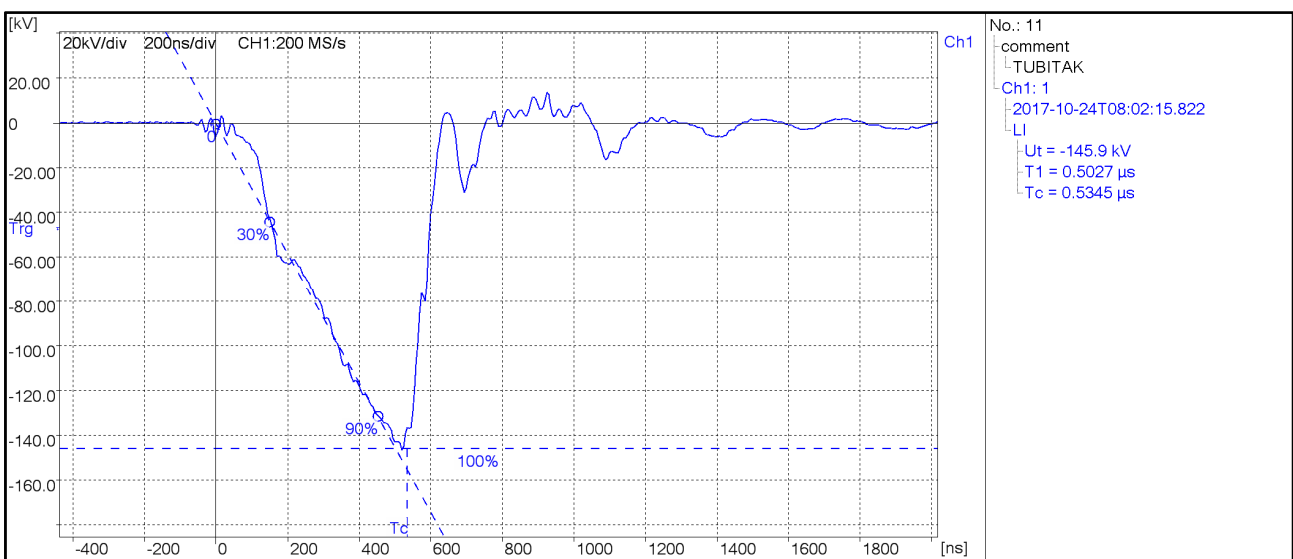
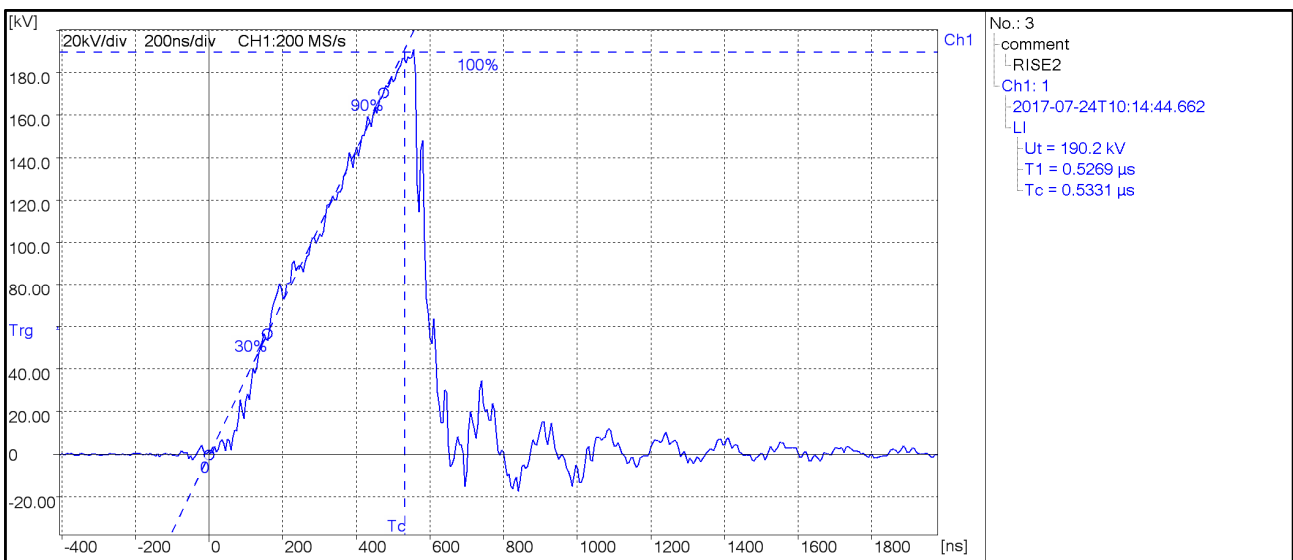
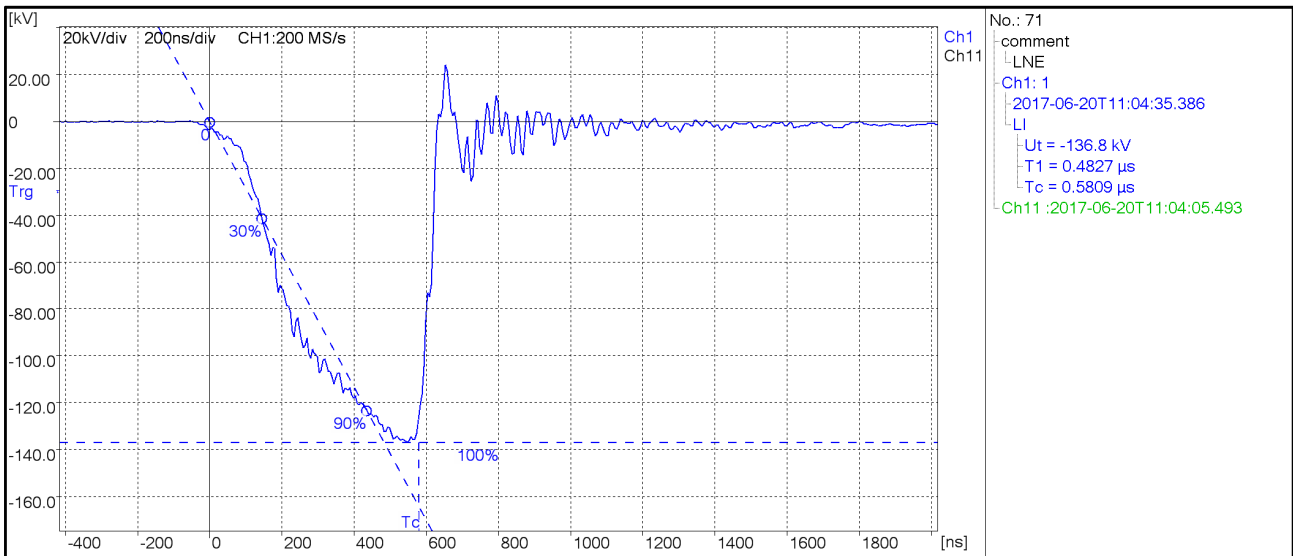


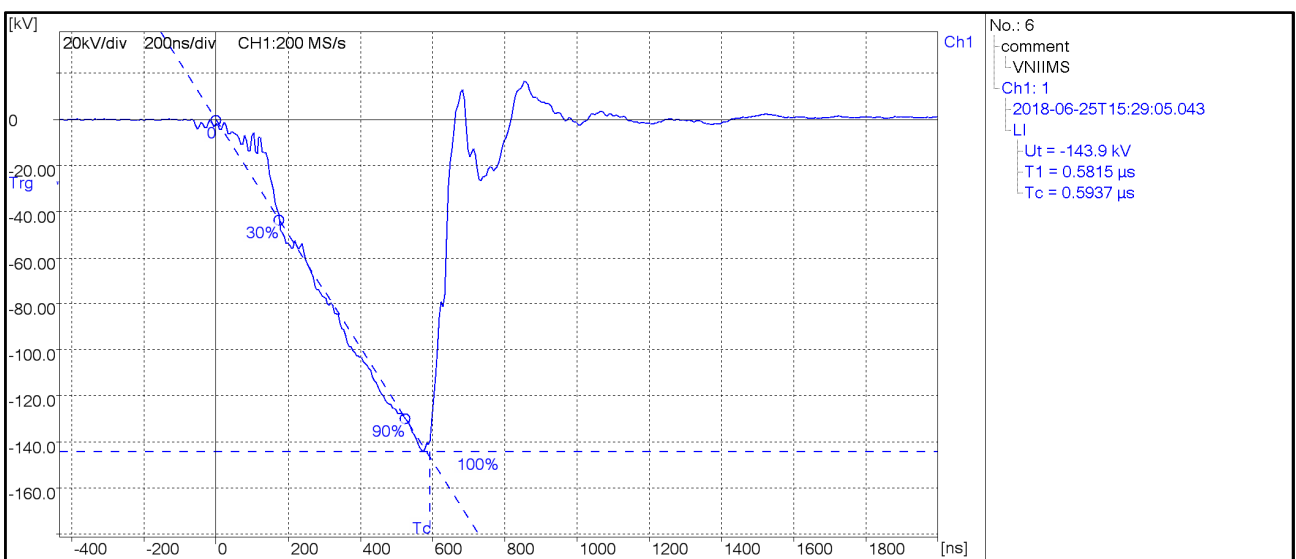
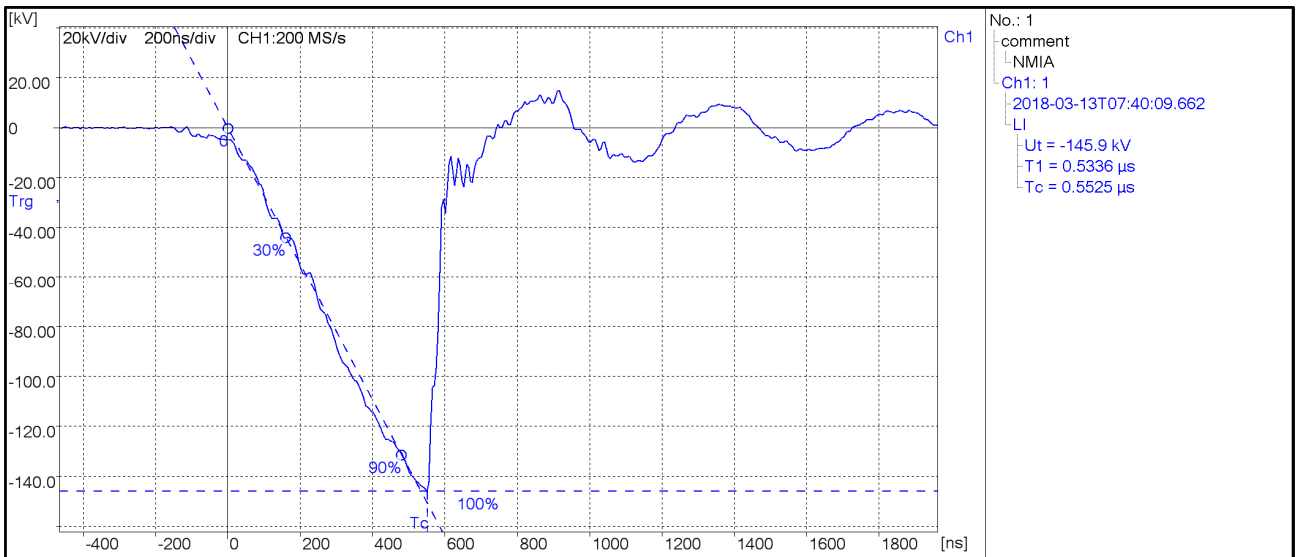
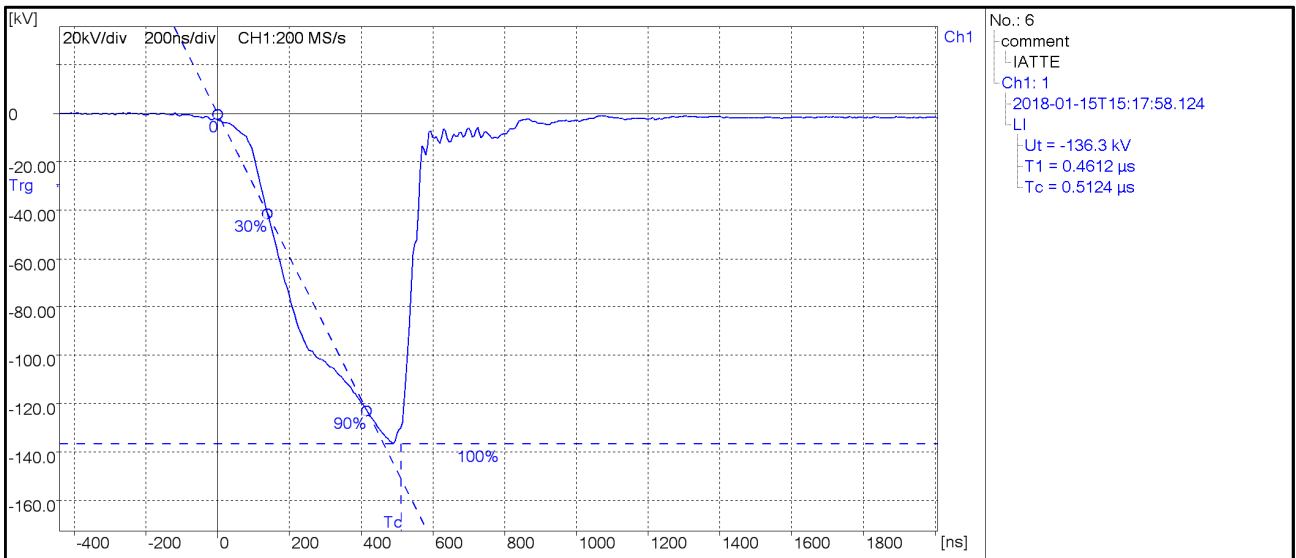


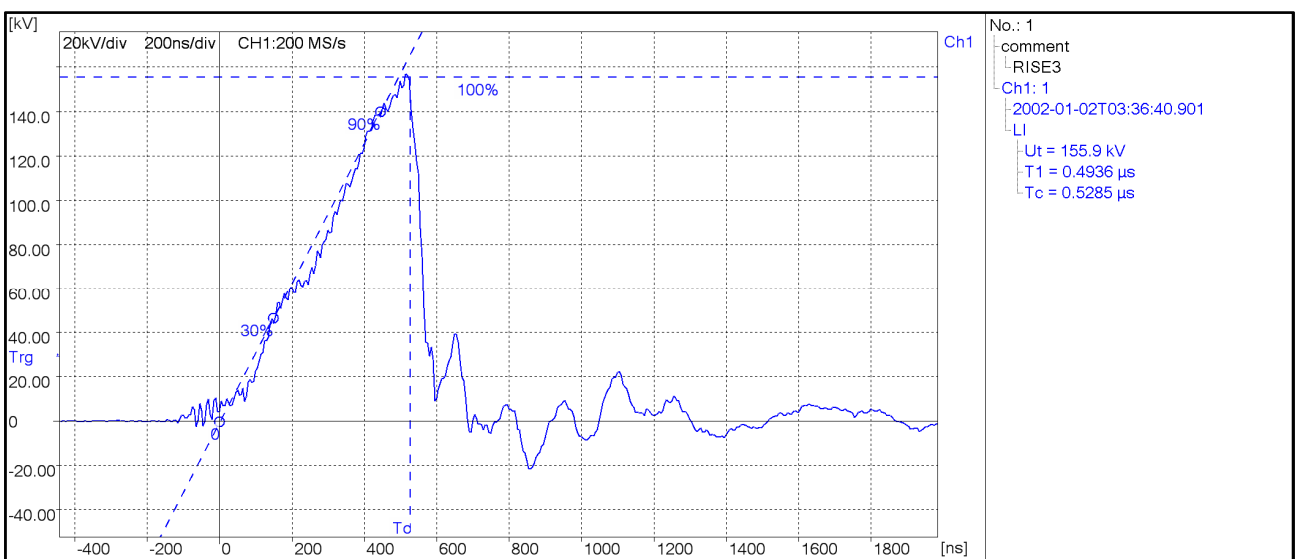
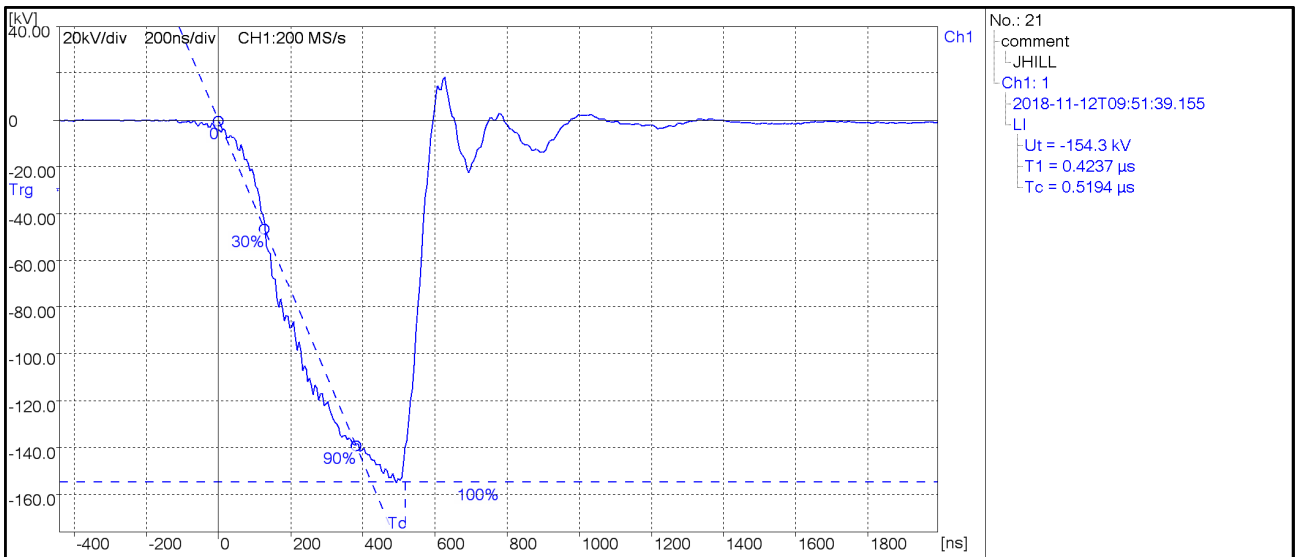
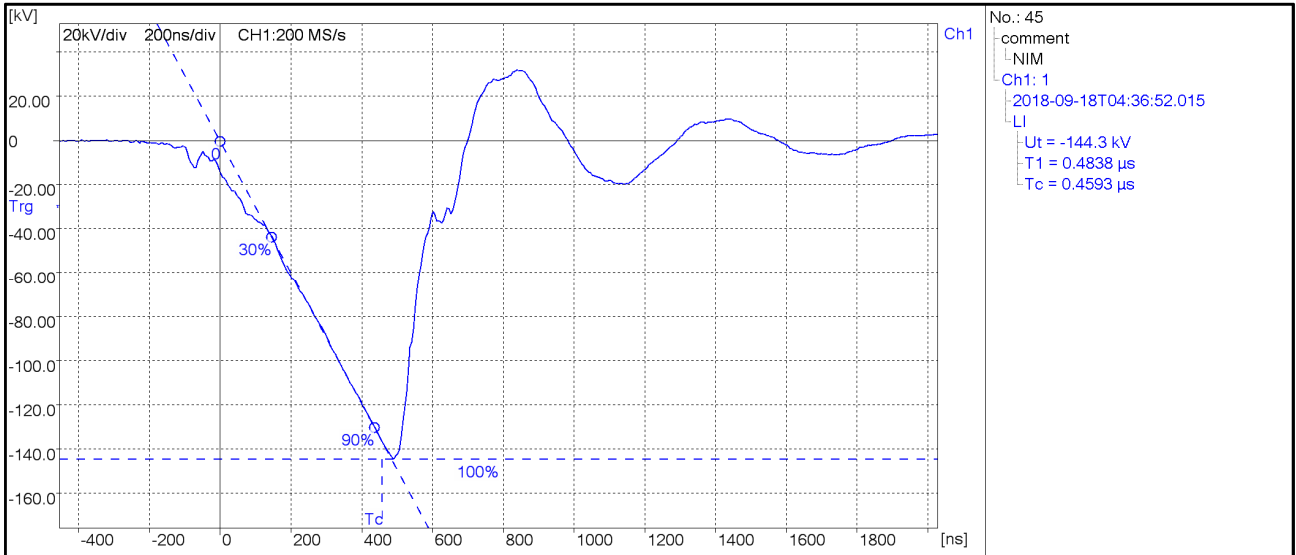












Annex H - Link to intercomparison organized in 1999 - 2002

Introduction

This Annex describes how the transfer reference measuring system of the previous lightning impulse (LI) comparison (EU-SMT4-CT98-2270), arranged between 1999 and 2002, is linked to this comparison. The link is established by comparing VTT MIKES system used 20 years ago with that used in this comparison. The old and new systems use the same voltage divider, but different cable, attenuator, transient recorder and software. Because the systems share the divider, the comparison between the old and new systems was made using a substitution method.

Description of the old system

The old system consists of a 400 kV resistive voltage divider (HUT-400), a cable with an integrated attenuator and a digitizer (Nicolet, Power Pro 610, channel 1). The control and analysis software, "Comparison40.vee", is that used during the old comparison. Some changes were made to simplify the measurements and make it work on newer hardware. However, the analysis part was not changed.

It was found that the impulse attenuator had a contact failure, which needed to be re-soldered.

Calibration of the old system

The 8 V (f.s.d.) range of the digitizer of the old system was calibrated using the calculable impulse voltage calibrators of VTT MIKES. Impulse voltage calibrators delivered impulses with known peak values and time parameters. Readings of the digitizer were compared with these known values. Impulse shapes, peak value and time parameters are as defined in IEC 60060-1 Ed.2:1989. The U_p , T_1 and T_2 calibration agreed within calibrator uncertainties (0.1 % for U_p , 1.0 % for T_1 and 0.5 % for T_2) with those performed between 1999 and 2002.

DC scale factor of the divider, which was used with the attenuator of the old system, was measured with ± 100 V and ± 200 V. Each measurement is an average of these four measurements. Scale factor measurement was repeated six times and the average was (10982 ± 20) ($k = 2$). Difference from the old comparison reference values was -0.16 %.

High-voltage comparison

The impulse voltage was fed from the impulse generator to the internal divider of the impulse generator and to the reference divider. Measurement arrangement is presented in Figure H-1, where HUT400 reference divider on the left and the internal divider of the impulse generator is partly hidden behind it on the right. Sample impulse is shown in Figure H-2.

Both the old transfer reference system and VTT MIKES new reference system were in turn compared to a third system consisting of the internal 200 kV voltage divider of the impulse generator and the second channel of the VTT MIKES new reference digitizer. Only the cable connected to the low-voltage arm of HUT-400 was changed between the two measurements. All other settings and arrangements remained unchanged between the two measurements.

Measurements were performed with two different front times (0.84 and 1.56 μ s) on voltage ± 80 kV voltage.

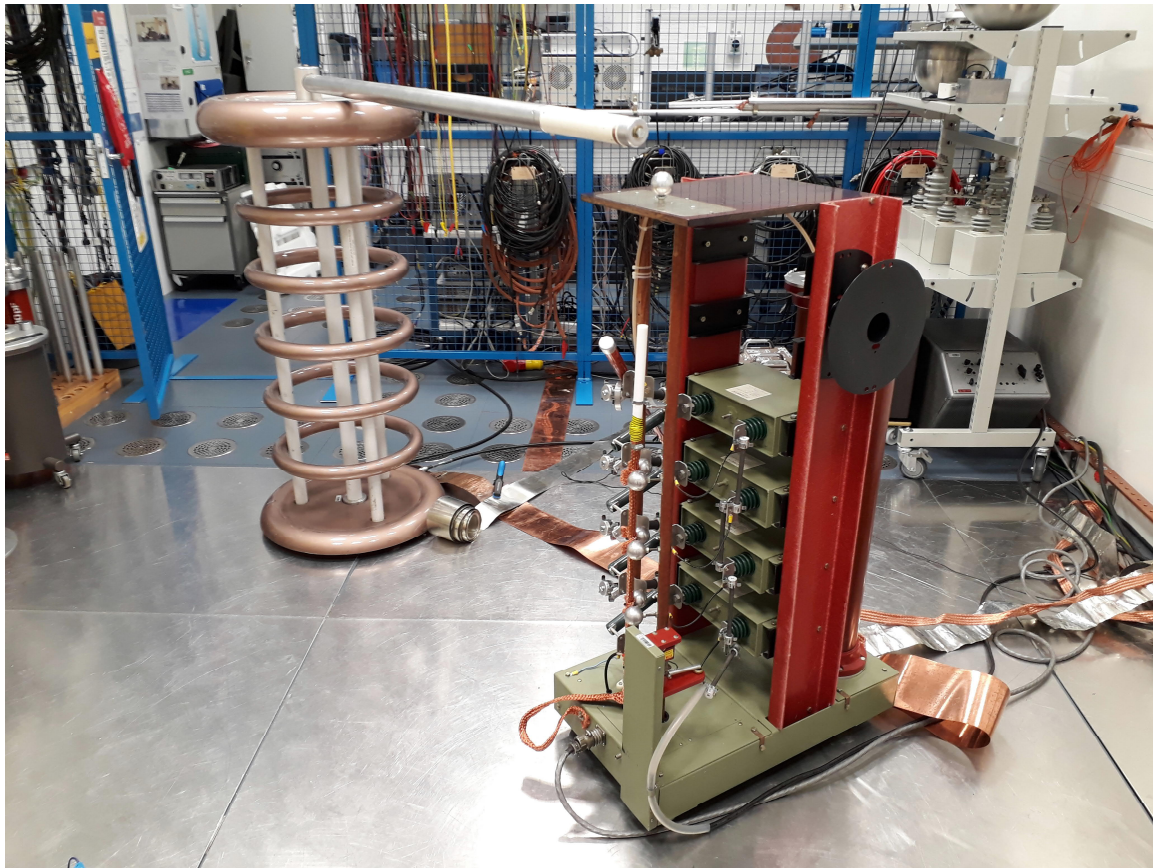


Figure H-1. Arrangement for the lightning impulse voltage comparison.

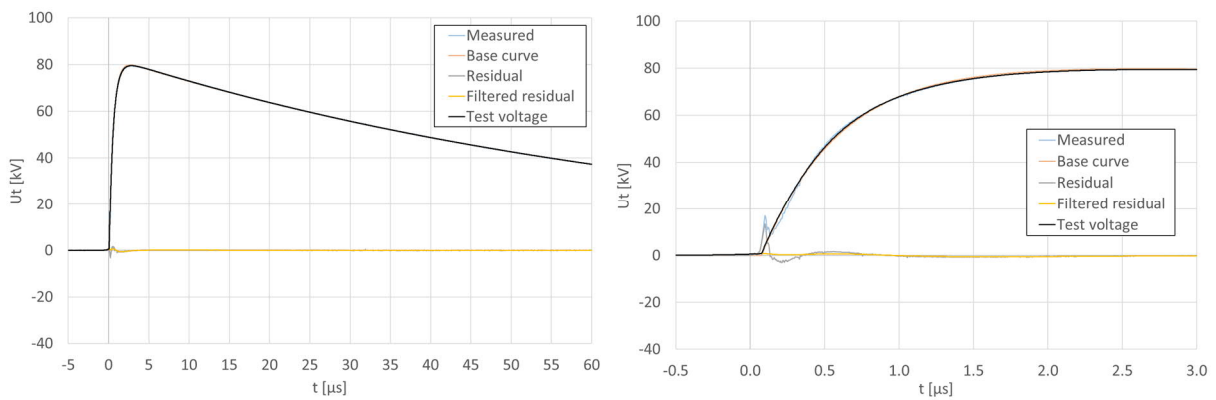


Figure H-2. Sample of positive impulse with 0.84 μs front.

The deviation from the third system reading for each impulse and parameter is calculated by formula

$$E_x = \frac{X_x - X_s}{X_s} * 100\% ,$$

where X_x and X_s are the readings from one of the systems compared and the system used in substitution measurement, respectively, of U_p , U_t , T_1 or T_2 .

For each measurement, ten impulses were delivered to both MIKES reference system and TRMS, and the average deviations were evaluated independently for both sets. The final result of the calibration (error, \bar{E}_{CAL}) is the difference between the average deviations from Hipotronics values measured for TRMS (\bar{E}_{TRMS}) and MIKES reference calibrator (\bar{E}_{VTT}):

$$\bar{E}_{CAL} = \bar{E}_{TRMS} - \bar{E}_{VTT}.$$

Results

The old system provided results according to IEC 60060-1 Ed.2:1989. Both VTT MIKES reference system and the third system were connected to the new digitizer, which provided results according to IEC 60060-1 Ed.3:2010.

The impulse shape was close to double exponential, with average β' below 0.5 % for all four measured impulse shapes. As the overshoot was low, the peak value U_p of the old system was compared with the test voltage value U_t of the new system.

Results are provided as difference of the old system reading from the new reference system of VTT MIKES. Results are presented in Table H-1.

Table H-1. Old system reading difference from VTT new reference system.

| Impulse | Nominal test voltage [kV] | Peak value U_p from test voltage U_t | | Front time T_1 | | Time to half-value T_2 | | Relative overshoot β' | |
|-----------|---------------------------|--|----------------------|-------------------------------|----------------------|-------------------------------|----------------------|-----------------------------|------------------------|
| | | New system reading [kV] | Old system deviation | New system reading [μ s] | Old system deviation | New system reading [μ s] | Old system deviation | New system reading [%] | Standard deviation [%] |
| 1.56 / 55 | 80 | 78.96 | -0.1 % | 1.55 | 0.5 % | 55.48 | -0.2 % | 0.13 | 0.04 |
| | -80 | -77.87 | -0.1 % | 1.55 | 0.5 % | 55.50 | -0.6 % | 0.06 | 0.06 |
| 0.84 / 50 | 80 | 78.62 | -0.3 % | 0.83 | -0.8 % | 52.01 | 0.1 % | 0.33 | 0.06 |
| | -80 | -80.10 | -0.2 % | 0.83 | -1.0 % | 52.09 | -0.2 % | 0.35 | 0.06 |

References

- [1] J. Hällström et al., "Worldwide Comparison of Lightning Impulse Voltage Measuring Systems at the 400-kV Level," in IEEE Transactions on Instrumentation and Measurement, vol. 56, no. 2, pp. 388-391, April 2007. doi: 10.1109/TIM.2007.891048
- [2] J. Hällström, M. Aro, and M.-L. Pykälä, "Traceability and mutual recognizability of impulse voltage measurements," Helsinki University of Technology, Helsinki, Finland, report n:o TKK-SJT-65, 2003

Annex I - Description of IATTE corrective actions

According to IATTE proposal, their re-evaluated results are shown in this report in parallel with their originally submitted results. Their justification for and method of the re-evaluation are presented in this Annex.

Explanation of the reasons for non-compatibilities of the IATTE measurements and reevaluation of the results

After analyzing the original IATTE results (IATTE) as presented in this report, we conclude that the T_1 measured values are incorrect due to:

- a) the calculation of the compared parameters using IEEE Standard 4 (2013) instead of IEC 60060-1:2010 and
- b) the improper use of the measuring system.

To overcome the non-compatibilities in the T_1 measurements, the sources of error have been identified and the results were reevaluated, as explained below:

a) Error introduced by the software for impulse parameters calculation (IEC or IEEE)

The determination of the IATTE impulse parameters was done applying the recommendations of IEEE Std.4 (2013). In clause 8.1, this standard states that when the overshoot is lower than 1 % the recorded curve should be the test voltage curve. In all our tests this condition has been satisfied and the impulse parameters were determined from the recorded curves. We have verified the influence of the method calculating the impulse parameters without (own Strauss routine) and with the application of the k-factor (by using a software made available online by RISE, Research Institutes of Sweden). We have observed a difference for $E_m(T_1) = dT_1/T_1$ comprised between 0.5 and 2.8 % for some impulses of long front-time, increasing with the degree of deformation of the impulse with respect to a double-exponential impulse. No significant differences (< 0.5 %) were found for U_t and T_2 .

The values of the relative difference E_m were calculated and they are shown in Figure 1, where the IATTE values were obtained directly from the Strauss digitizer screen. The IATTE set of results sent after the tests included the expanded uncertainties of the measuring system:

Expanded uncertainties of the IATTE measuring system ($k=2$): $U_t = 0.64 \%$, $T_1 = 2.5 \%$ and $T_2 = 2 \%$

Figure 1 shows the false performance of the IATTE measurement system due to the application of two different standards and an "abnormal" arrangement of the shielding rings.

Figure 2 presents the same comparison calculating the IATTE parameters following IEC 60060-1:2010, where the impulse parameters were obtained by calculation from the raw data files recorded by the Strauss digitizer and using the RISE (Research Institutes of Sweden) on-line software.

Figure 2 still includes the false performance of the IATTE measuring system due to the "abnormal" arrangement of the shielding rings.

The TRMS readings are those informed in the Annex C of the document.

The proof that the software affects the comparison of LI parameters independently of the hardware measuring system is shown by the series "Long-N500", where different software introduces about 3 % of difference in $E_m(T_1) = dT_1/T_1$. Note the dT_1/T_1 value for the series Long-N500, which is the case of full impulse obtained with an appropriate use of the IATTE measuring system, as explained in section b).

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|----------------|----------|---------|--------------|----------------|----------|---------|--------------------|-------|----------------------|-------|----------|-------|----------|-------|
| | U t [kV] | T 1 or Tc [µs] | T 2 [µs] | β ' [%] | U t [kV] | T 1 or Tc [µs] | T 2 [µs] | β ' [%] | dU u/U t | U | dT 1/T 1 or dT c/T c | U | dT 2/T 2 | U | dβ ' [%] | U [%] |
| Short-N700 | | | | | | | | | | | | | | | | |
| Short-N600 | | | | | | | | | | | | | | | | |
| Short-N500 | -499,39 | 0,746 | 47,93 | -0,23 | -497,45 | 0,840 | 47,08 | | 0,39% | 0,64% | -11,19% | 2,50% | 1,81% | 2,00% | | |
| Short-N400 | | | | | | | | | | | | | | | | |
| Short-N300 | | | | | | | | | | | | | | | | |
| Short-N200 | -199,69 | 0,743 | 47,16 | -0,35 | -199,26 | 0,841 | 46,16 | | 0,22% | 0,64% | -11,65% | 2,50% | 2,17% | 2,00% | | |
| Short-N100 | | | | | | | | | | | | | | | | |
| Short-P100 | | | | | | | | | | | | | | | | |
| Short-P200 | 201,07 | 0,745 | 47,18 | -0,35 | 200,65 | 0,840 | 46,36 | | 0,21% | 0,64% | -11,31% | 2,50% | 1,77% | 2,00% | | |
| Short-P300 | | | | | | | | | | | | | | | | |
| Short-P400 | | | | | | | | | | | | | | | | |
| Short-P500 | 501,52 | 0,765 | 47,98 | -0,2 | 499,75 | 0,849 | 47,20 | | 0,35% | 0,64% | -9,89% | 2,50% | 1,65% | 2,00% | | |
| Short-P600 | | | | | | | | | | | | | | | | |
| Short-P700 | | | | | | | | | | | | | | | | |
| Long-N700 | | | | | | | | | | | | | | | | |
| Long-N600 | | | | | | | | | | | | | | | | |
| Long-N500 | -501,76 | 1,393 | 47,05 | -0,11 | -499,91 | 1,350 | 46,11 | | 0,37% | 0,64% | 3,19% | 2,50% | 2,04% | 2,00% | | |
| Long-N400 | | | | | | | | | | | | | | | | |
| Long-N300 | -300,21 | 1,610 | 49,48 | 0,09 | -299,42 | 1,623 | 48,43 | | 0,26% | 0,64% | -0,80% | 2,50% | 2,17% | 2,00% | | |
| Long-N200 | -202,1 | 1,612 | 49,26 | 0,14 | -201,33 | 1,626 | 48,28 | | 0,38% | 0,64% | -0,86% | 2,50% | 2,03% | 2,00% | | |
| Long-N100 | | | | | | | | | | | | | | | | |
| Long-P100 | 99,73 | 1,617 | 49,34 | 0,05 | 99,42 | 1,615 | 48,48 | | 0,31% | 0,64% | 0,12% | 2,50% | 1,77% | 2,00% | | |
| Long-P200 | 202,75 | 1,613 | 49,3 | 0,14 | 201,93 | 1,629 | 48,51 | | 0,41% | 0,64% | -0,98% | 2,50% | 1,63% | 2,00% | | |
| Long-P300 | 300,03 | 1,612 | 49,52 | 0,09 | 299,46 | 1,626 | 48,59 | | 0,19% | 0,64% | -0,86% | 2,50% | 1,91% | 2,00% | | |
| Long-P400 | 403,33 | 1,610 | 49,73 | 0,28 | 402,98 | 1,632 | 48,93 | | 0,09% | 0,64% | -1,35% | 2,50% | 1,63% | 2,00% | | |
| Long-P500 | 500,74 | 1,410 | 47,12 | -0,09 | 500,31 | 1,433 | 46,10 | | 0,09% | 0,64% | -1,61% | 2,50% | 2,21% | 2,00% | | |
| Long-P600 | 550,14 | 1,410 | 47,25 | -0,12 | 548,50 | 1,426 | 46,53 | | 0,30% | 0,64% | -1,12% | 2,50% | 1,55% | 2,00% | | |
| Long-P700 | | | | | | | | | | | | | | | | |
| Chopped-P150 | | | | | | | | | | | | | | | | |
| Chopped-N150 | -136,2 | 0,507 | | | -139,26 | 0,518 | | | -2,20% | 0,70% | -2,12% | 2,50% | | | | |

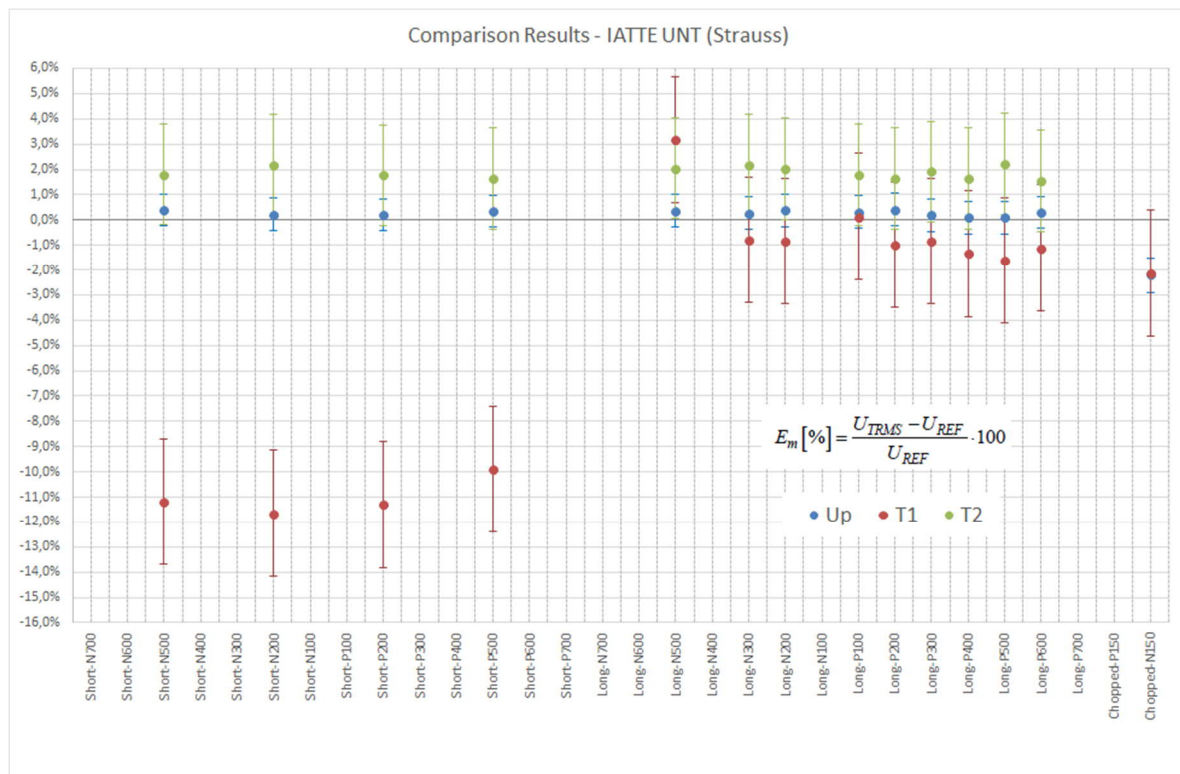


Figure 1 – IATTE values as originally reported for this comparison. Results from the Strauss digitizer screen (Dr. Strauss software, IEEE Std.4 (2013)).

| Impulse shape | TRMS readings | | | | Lab readings | | | | Comparison results | | | | | | | |
|---------------|---------------|----------------|----------|---------|--------------|----------------|----------|------------|--------------------|-------|----------------------|-------|----------|-------|----------|-------|
| | U t [kV] | T 1 or Tc [µs] | T 2 [µs] | β ' [%] | U t [kV] | T 1 or Tc [µs] | T 2 [µs] | β ' [%] | dU /U t | U | dT 1/T 1 or dT c/T c | U | dT 2/T 2 | U | dβ ' [%] | U [%] |
| Short-N700 | | | | | | | | | | | | | | | | |
| Short-N600 | | | | | | | | | | | | | | | | |
| Short-N500 | -499,39 | 0,746 | 47,93 | -0,23 | -499,41 | 0,836 | 46,97 | | 0,00% | 0,64% | -10,71% | 2,50% | 2,05% | 2,00% | | |
| Short-N400 | | | | | | | | | | | | | | | | |
| Short-N300 | | | | | | | | | | | | | | | | |
| Short-N200 | -199,69 | 0,743 | 47,16 | -0,35 | -200,13 | 0,829 | 46,09 | | -0,22% | 0,64% | -10,40% | 2,50% | 2,31% | 2,00% | | |
| Short-N100 | | | | | | | | | | | | | | | | |
| Short-P100 | | | | | | | | | | | | | | | | |
| Short-P200 | 201,07 | 0,745 | 47,18 | -0,35 | 201,35 | 0,829 | 46,23 | | -0,14% | 0,64% | -10,11% | 2,50% | 2,04% | 2,00% | | |
| Short-P300 | | | | | | | | | | | | | | | | |
| Short-P400 | | | | | | | | | | | | | | | | |
| Short-P500 | 501,52 | 0,765 | 47,98 | -0,2 | 501,50 | 0,845 | 47,06 | | 0,00% | 0,64% | -9,47% | 2,50% | 1,96% | 2,00% | | |
| Short-P600 | | | | | | | | | | | | | | | | |
| Short-P700 | | | | | | | | | | | | | | | | |
| Long-N700 | | | | | | | | | | | | | | | | |
| Long-N600 | | | | | | | | | | | | | | | | |
| Long-N500 | -501,76 | 1,393 | 47,05 | -0,11 | -501,88 | 1,388 | 46,05 | | -0,02% | 0,64% | 0,37% | 2,50% | 2,17% | 2,00% | | |
| Long-N400 | | | | | | | | | | | | | | | | |
| Long-N300 | -300,21 | 1,610 | 49,48 | 0,09 | -300,72 | 1,633 | 48,33 | | -0,17% | 0,64% | -1,40% | 2,50% | 2,38% | 2,00% | | |
| Long-N200 | -202,1 | 1,612 | 49,26 | 0,14 | -202,16 | 1,636 | 48,16 | | -0,03% | 0,64% | -1,47% | 2,50% | 2,28% | 2,00% | | |
| Long-N100 | | | | | | | | | | | | | | | | |
| Long-P100 | 99,73 | 1,617 | 49,34 | 0,05 | 99,92 | 1,647 | 48,32 | | -0,19% | 0,64% | -1,81% | 2,50% | 2,12% | 2,00% | | |
| Long-P200 | 202,75 | 1,613 | 49,3 | 0,14 | 202,51 | 1,639 | 48,37 | 6 impulsos | 0,12% | 0,64% | -1,60% | 2,50% | 1,92% | 2,00% | | |
| Long-P300 | 300,03 | 1,612 | 49,52 | 0,09 | 300,53 | 1,636 | 48,42 | | -0,17% | 0,64% | -1,47% | 2,50% | 2,26% | 2,00% | | |
| Long-P400 | 403,33 | 1,610 | 49,73 | 0,28 | 404,44 | 1,639 | 48,79 | | -0,28% | 0,64% | -1,74% | 2,50% | 1,92% | 2,00% | | |
| Long-P500 | 500,74 | 1,410 | 47,12 | -0,09 | 502,02 | 1,447 | 46,08 | | -0,26% | 0,64% | -2,58% | 2,50% | 2,27% | 2,00% | | |
| Long-P600 | 550,14 | 1,410 | 47,25 | -0,12 | 550,48 | 1,446 | 46,43 | | -0,06% | 0,64% | -2,46% | 2,50% | 1,77% | 2,00% | | |
| Long-P700 | | | | | | | | | | | | | | | | |
| Chopped-P150 | | | | | | | | | | | | | | | | |
| Chopped-N150 | -136,2 | 0,507 | | | -139,26 | 0,518 | | | -2,20% | 0,70% | -2,12% | 2,50% | | | | |

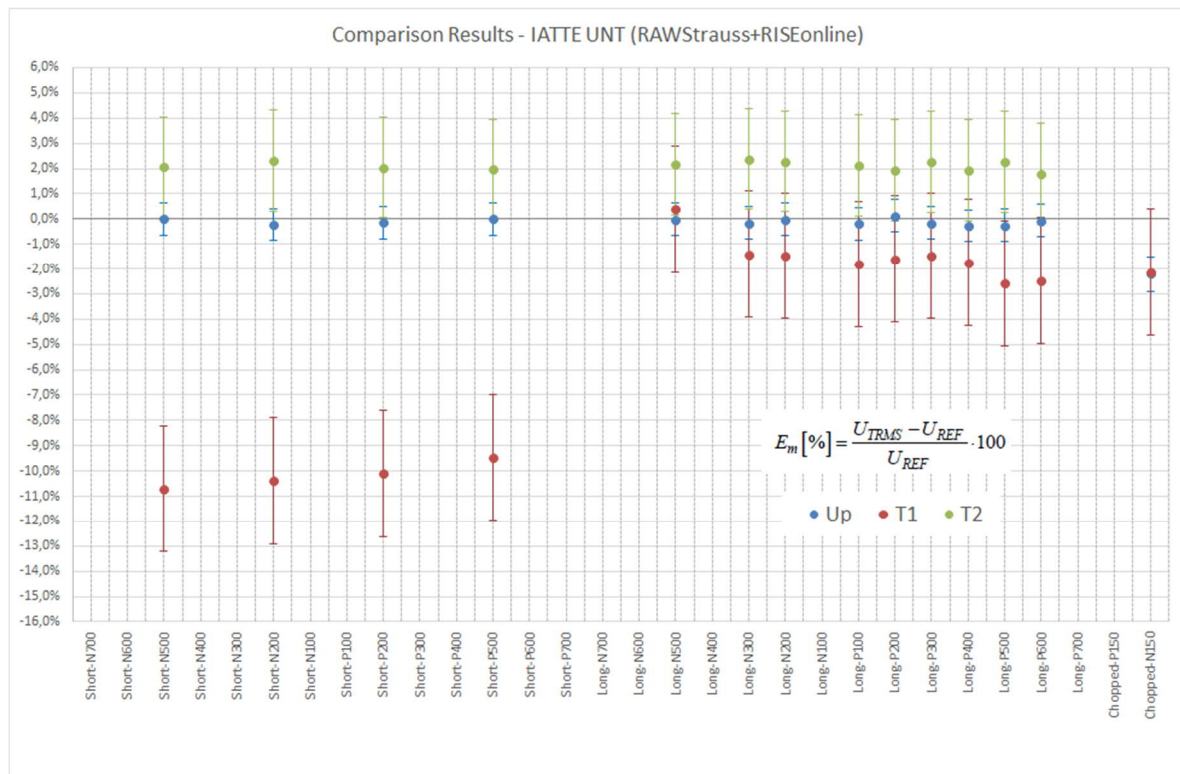


Figure 2 – IATTE values from the Strauss raw data files, impulse parameters calculated with RISE (IEC 60060-1:2010)

b) Error introduced by the modification of the dynamic response of the home voltage divider

The high voltage tests were carried out under very unfavorable atmospheric conditions (high temperature, low pressure and humidity); the IATTE resistive divider had suffered an insulation failure between the shielding rings during the 500 kV positive polarity tests. To overcome this problem in the short time allotted to testing, the distance between the rings was increased 15 cm, modifying the position of the upper ring to an “abnormal” arrangement. Because of the short time available for testing, after that series the divider was not restored to the “normal” arrangement and this led to wrong measuring results in the subsequent series. Although no major deterioration was expected, the dynamic parameters were sharply modified and the divider was no longer acceptable for measuring short-front impulses.

The dynamic response parameters corresponding to the modification of the shielding rings show a large increase of T_N and t_s with respect to the “normal” configuration, as shown in Figure 3, Figure 4 and the following table.

Table of step responses

| | T_N [ns] | t_s [ns] | t_α [ns] | β [%] | t_0 [ns] |
|---|------------|------------|-----------------|-------------|------------|
| “Normal” or nominal step response parameters. Fig. 3 | 6.9 | 108 | 4.3 | 13.1 | 0.7 |
| “Abnormal” step response parameters. Fig. 4 | 41.1 | 224 | 1.1 | 8 | 0.9 |

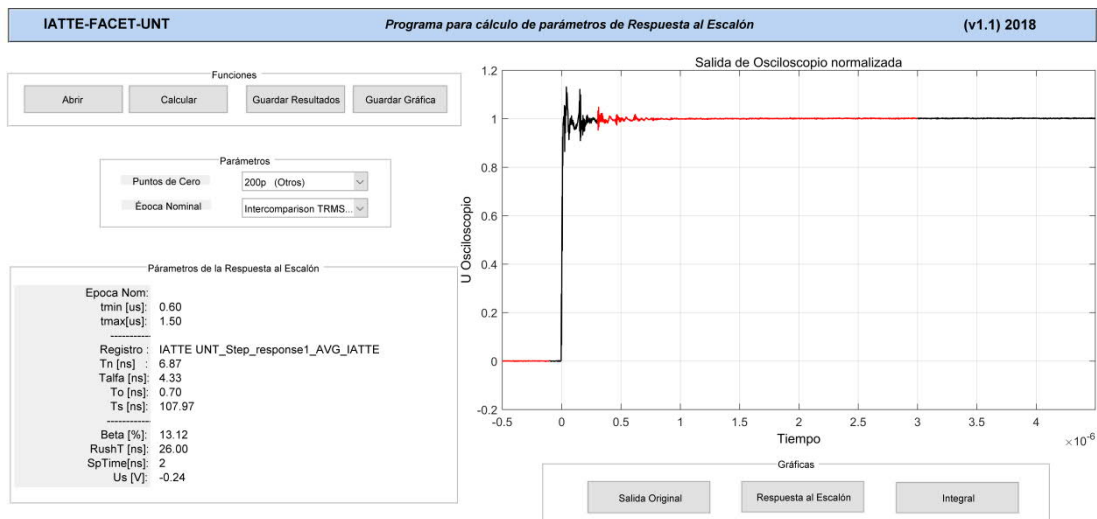


Figure 3 – “Normal” or nominal step response

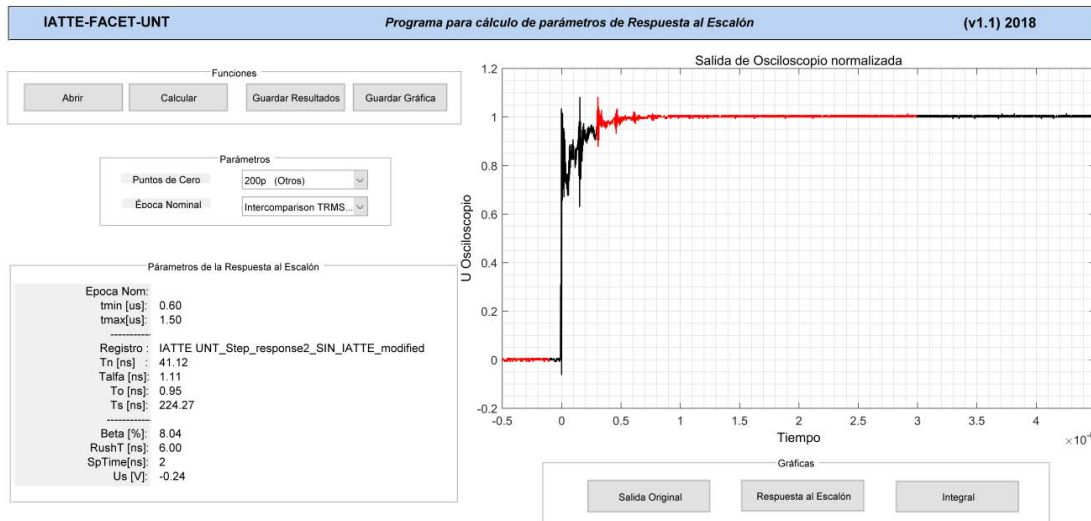


Figure 4 – “Abnormal” step response after increasing rings distance.

Consequently, it is as if the hv tests were carried out with two different dividers, due to the difference in the step response parameters.

The divider with the “normal” step response was only used measuring the Chopped-N150 and Long-N500 series; for all the others series the step response parameters are “abnormal” and have impaired T1 measurements, especially for short-front impulses.

Reconstruction of the hv impulses by a deconvolution/convolution calculation procedure

As it has not been possible to repeat the tests, to overcome the “abnormal” use of the IATTE measuring system, a deconvolution/convolution calculation has been applied on the recorded impulses. In all series the impulses were recorded by the Strauss digitizer during the tests. All the impulses have been reconstructed by deconvolution using the “abnormal” step response and then recalculated by convolution using the “normal” step response, excepting Long-N500 and Chopped-N150.

Figure 5 shows examples of recalculated impulses for long and short front-time series by deconvolution/convolution (D/C) calculation using a script written in MatLab®.

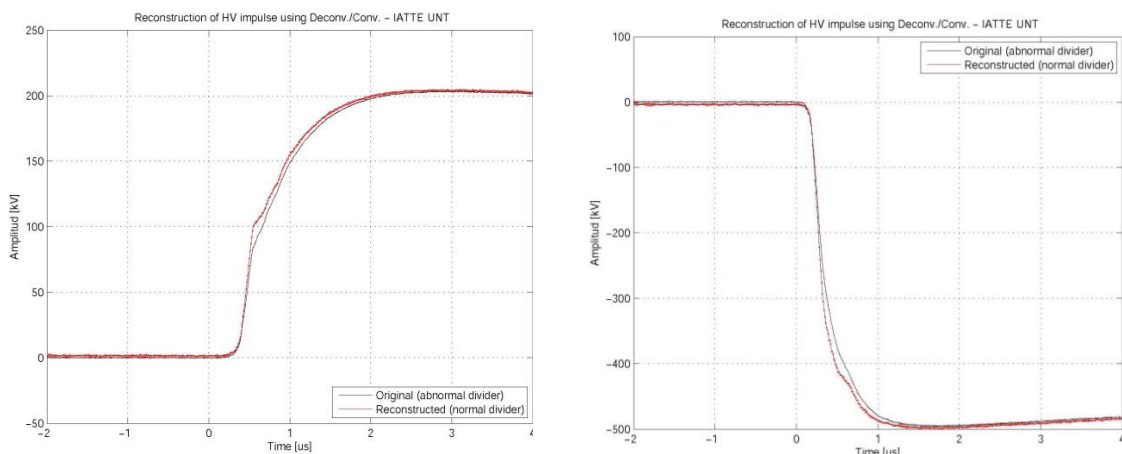


Figure 5. – Examples of the original and recalculated impulses for Long-P200 and Short-N500 series

In order to use the same standard for the calculation of the TRMS and IATTE impulse parameters, the LIVEval3 software provided by VTT MIKES from Finland, which is also in accordance with IEC 60060-1:2010, was used. The uncertainty calculation was performed following the flowchart of Figure 6 and the total uncertainties are shown in the table below.

The uncertainties for the divider scale factor and the D/C calculation procedure are negligible compared with the digitizer uncertainty.

Table of uncertainties

| Sources | individual uncertainty | | | | | | total uncertainty | | | | | |
|---------------------------|------------------------|--------|--------|----------------|-------|-------|-------------------|--------|--------|----------------|-------|-------|
| | combined | | | expanded (k=2) | | | combined | | | expanded (k=2) | | |
| | Up | T1 | T2 | Up | T1 | T2 | Up | T1 | T2 | Up | T1 | T2 |
| Digitizer (Dr. Strauss) | 0.32 % | 1.25 % | 1.00 % | 0.64 % | 2.5 % | 2.0 % | 0.32 % | 1.25 % | 1.00 % | 0.64 % | 2.5 % | 2.0 % |
| Divider Scale Factor | 0.007 % | - | - | 0.014 % | - | - | | | | | | |
| Deconv/Conv process (D/C) | 0.05 % | 0.01 % | 0.06 % | | | | | | | | | |

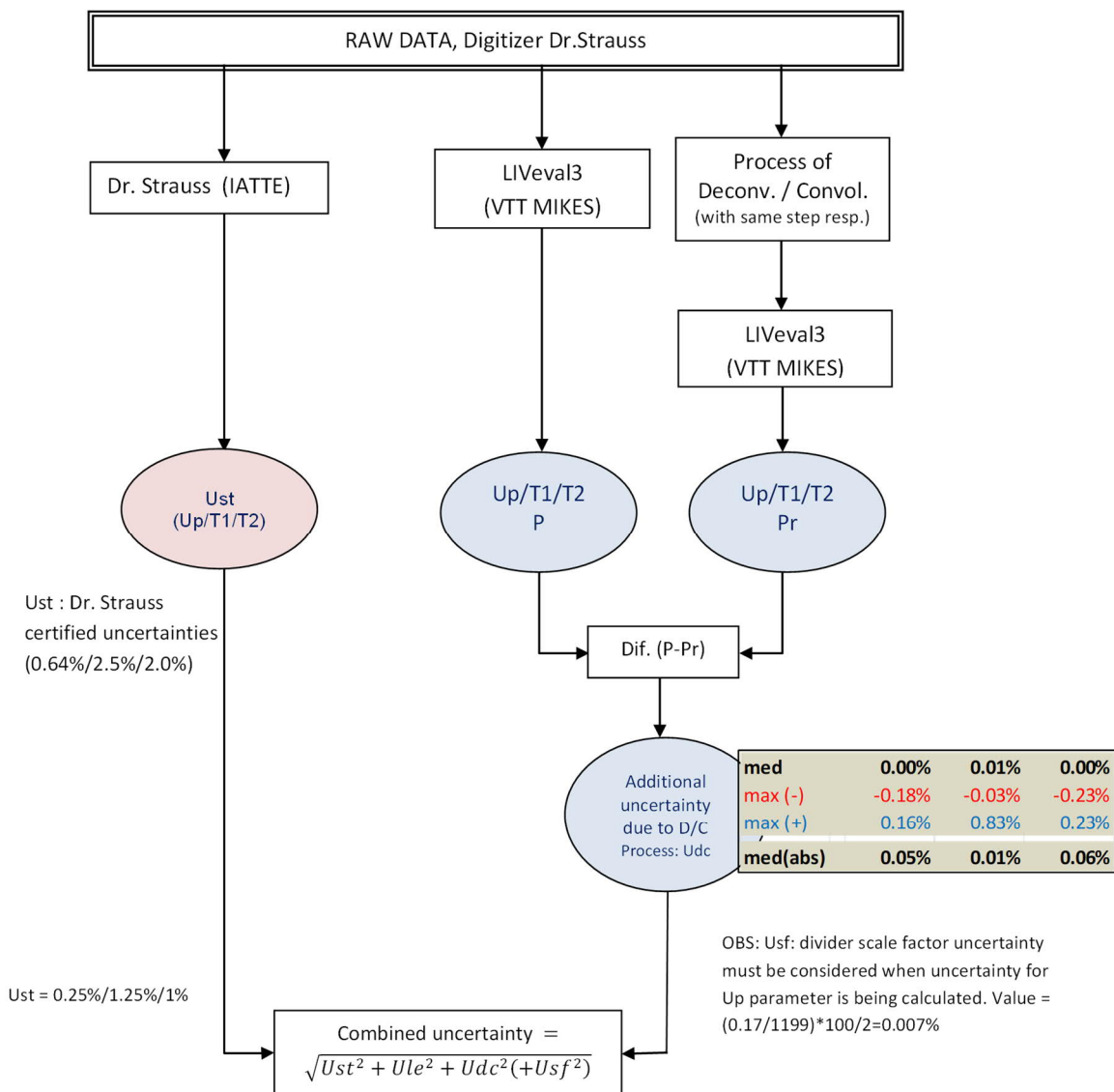


Figure 6 – Uncertainty calculation diagram.

Figure 7 represents the results of the inter-comparison for the impulse parameters in accordance with IEC 60060-1:2010. The impulses of IATTE were recalculated by a deconvolution/convolution calculation procedure.

Figure 7 shows the true performance of the IATTE measuring system.

| Impulse shape | TRMS readings | | | | Lab readings (Strauss reconstr. LIVEval3) | | | | Comparison results | | | | | | | |
|---------------|---------------|----------------|----------|---------|---|----------------|----------|---------|--------------------|-------|----------------------|-------|----------|-------|----------|-------|
| | U t [kV] | T 1 or Tc [µs] | T 2 [µs] | β ' [%] | U t [kV] | T 1 or Tc [µs] | T 2 [µs] | β ' [%] | dU/U t | U | dT 1/T 1 or dT c/T c | U | dT 2/T 2 | U | dβ ' [%] | U [%] |
| Short-N700 | | | | | | | | | | | | | | | | |
| Short-N600 | | | | | | | | | | | | | | | | |
| Short-N500 | -499.39 | 0.746 | 47.93 | -0.23 | -497.75 | 0.736 | | 46.42 | 0.33% | 0.64% | 1.40% | 2.50% | 3.25% | 2.00% | | |
| Short-N400 | | | | | | | | | | | | | | | | |
| Short-N300 | | | | | | | | | | | | | | | | |
| Short-N200 | -199.69 | 0.743 | 47.16 | -0.35 | -199.39 | 0.724 | | 45.54 | 0.15% | 0.64% | 2.63% | 2.50% | 3.56% | 2.00% | | |
| Short-N100 | | | | | | | | | | | | | | | | |
| Short-P100 | | | | | | | | | | | | | | | | |
| Short-P200 | 201.07 | 0.745 | 47.18 | -0.35 | 200.70 | 0.729 | | 45.74 | 0.19% | 0.64% | 2.22% | 2.50% | 3.15% | 2.00% | | |
| Short-P300 | | | | | | | | | | | | | | | | |
| Short-P400 | | | | | | | | | | | | | | | | |
| Short-P500 | 501.52 | 0.765 | 47.98 | -0.2 | 499.87 | 0.746 | | 46.55 | 0.33% | 0.64% | 2.58% | 2.50% | 3.08% | 2.00% | | |
| Short-P600 | | | | | | | | | | | | | | | | |
| Short-P700 | | | | | | | | | | | | | | | | |
| Long-N700 | | | | | | | | | | | | | | | | |
| Long-N600 | | | | | | | | | | | | | | | | |
| Long-N500 | -501.76 | 1.393 | 47.05 | -0.11 | -501.88 | 1.388 | | 46.05 | -0.02% | 0.64% | 0.38% | 2.50% | 2.17% | 2.00% | | |
| Long-N400 | | | | | | | | | | | | | | | | |
| Long-N300 | -300.21 | 1.610 | 49.48 | 0.09 | -299.77 | 1.608 | | 47.77 | 0.15% | 0.64% | 0.14% | 2.50% | 3.58% | 2.00% | | |
| Long-N200 | -202.10 | 1.612 | 49.26 | 0.14 | -201.50 | 1.610 | | 47.62 | 0.30% | 0.64% | 0.13% | 2.50% | 3.45% | 2.00% | | |
| Long-N100 | | | | | | | | | | | | | | | | |
| Long-P100 | 99.73 | 1.617 | 49.34 | 0.05 | 99.63 | 1.610 | | 47.81 | 0.10% | 0.64% | 0.41% | 2.50% | 3.21% | 2.00% | | |
| Long-P200 | 202.75 | 1.613 | 49.3 | 0.14 | 201.88 | 1.614 | | 47.84 | 0.43% | 0.64% | -0.07% | 2.50% | 3.06% | 2.00% | | |
| Long-P300 | 300.03 | 1.612 | 49.52 | 0.09 | 299.60 | 1.611 | | 47.88 | 0.14% | 0.64% | 0.06% | 2.50% | 3.41% | 2.00% | | |
| Long-P400 | 403.33 | 1.610 | 49.73 | 0.28 | 403.22 | 1.613 | | 48.28 | 0.03% | 0.64% | -0.19% | 2.50% | 3.00% | 2.00% | | |
| Long-P500 | 500.74 | 1.410 | 47.12 | -0.09 | 500.18 | 1.412 | | 45.57 | 0.11% | 0.64% | -0.12% | 2.50% | 3.40% | 2.00% | | |
| Long-P600 | 550.14 | 1.410 | 47.25 | -0.12 | 548.74 | 1.411 | | 45.97 | 0.25% | 0.64% | -0.05% | 2.50% | 2.79% | 2.00% | | |
| Long-P700 | | | | | | | | | | | | | | | | |
| Chopped-P150 | | | | | | | | | | | | | | | | |
| Chopped-N150 | -136.20 | 0.507 | | | -139.26 | 0.519 | | | -2.20% | 0.70% | -2.12% | 2.50% | | | | |

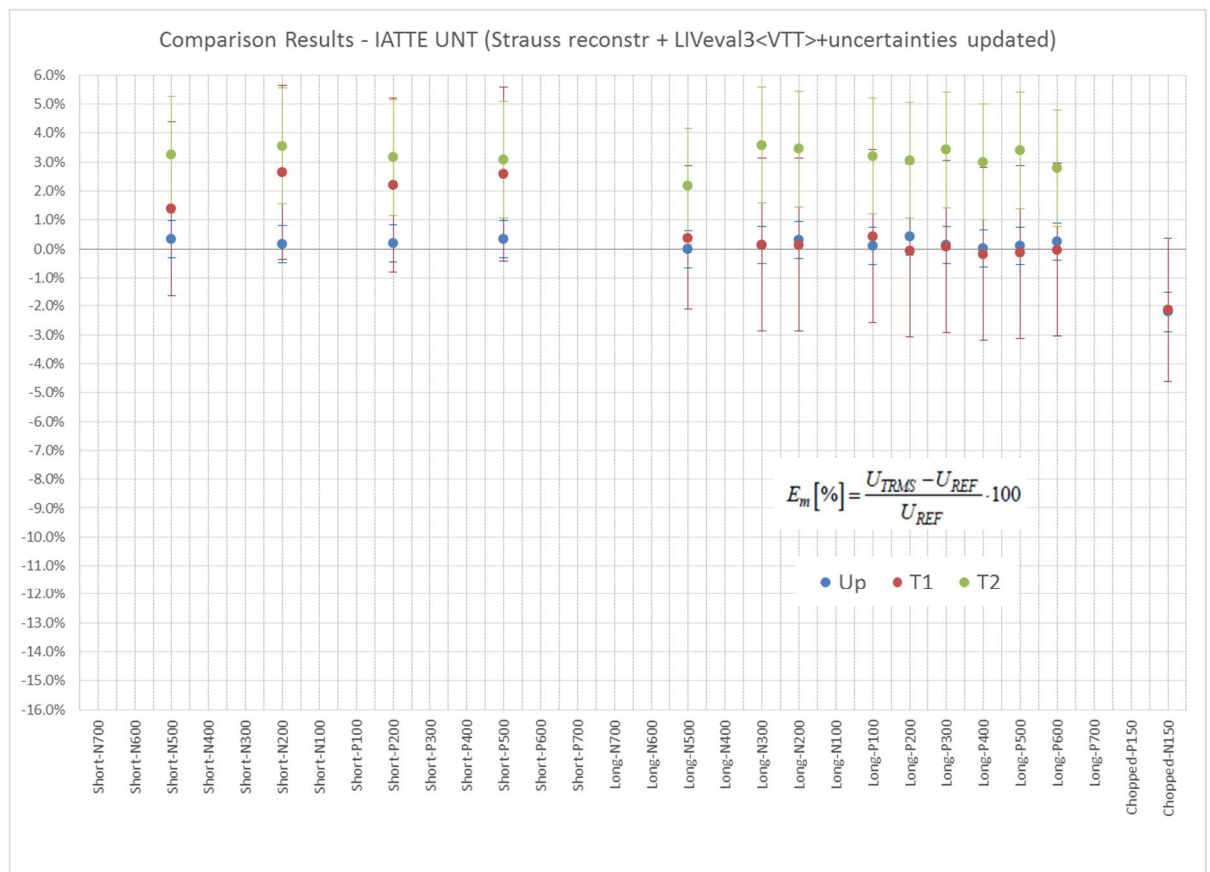


Figure 7 – IATTE values from the Strauss raw data files, recalculated impulses, impulse parameters calculated with LIVEval3.

Conclusions after re-analysis

To overcome the non-compatibilities in the T_1 measurements, the sources of error have been identified and the results were reevaluated:

- a) parameters were recalculated using IEEE Standard 4 (2013) instead of IEC 60060-1:2010, and
- b) the step response of the divider was corrected using convolution techniques.

Note that $E_m(T_2)$ passed from (1.6 – 2.2 %) to (1.8 – 2.4 %) from Figure 1 to 2 showing a negligible influence of the method to calculate the impulse parameters.

From Figure 1 and 7, $E_m(T_2)$ has changed from (1.6 - 2.2 %) to (2.2 - 3.6 %), indicating an influence of the step response close to 1 %.

The changes in $E_m(U_t)$ are negligible (< 0.5 %) in both cases.

The IATTE measuring system has the performance shown in Figure 7, corresponding to the “normal” step response configuration and IEC 60060-1:2010. This performance is available for positive polarity tests up to 550 kV, under restricted atmospheric conditions (relative air density $\delta > 0.95$) for the maximum value of the voltage range.