EUROMET.EM-S24

(EUROMET Project 830)

Supplementary Comparison of Small Current Sources

REPORT

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1. Introduction

In the last few years, there has been an increased need for calibrations of picoammeters, used e.g. in the field of dosimetry. Therefore, several European and non-European National Measurement Institutes (NMIs) have developed precision DC current sources to be used for traceable calibrations of picoammeters in the current range between about 100 fA and 100 pA. In order to support their calibration and measurement capabilities (CMCs), thirteen participants compared their calibration systems by means of this supplementary comparison EUROMET EM-S24. This is the first international comparison of this scale in the field of small DC currents.

2. Participants and organization of the comparison

2.1 Co-ordinator and members of the support group

The pilot laboratory for the comparison was the Physikalisch-Technische Bundesanstalt (PTB), Germany.

Co-ordinator:

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Support group:

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2.2 List of participants

There were thirteen NMIs participating in this comparison; they are listed in Table 2.1. When the comparison started, it was scheduled for only eleven NMIs, two institutes (KRISS and MIKES) joined later when the comparison was already running.

Table 2.1: List of participants in alphabetical order

Acronym	Institute	Country
CEM	Centro Español de Metrología	Spain
IPQ *)	Instituto Português da Qualidade	Portugal
INRIM **)	Istituto Nazionale di Ricerca Metrologica	Italy
KRISS	Korea Research Institute of Standards and Science	South Korea
LNE	Laboratoire national de métrologie et d'essais	France
METAS	Eidgenössisches Institut für Metrologie	Switzerland
MIKES	Centre for Metrology and Accreditation	Finland
NIS	National Institute for Standards	Egypt
NPL	National Physical Laboratory	United Kingdom
PTB (Pilot)	Physikalisch-Technische Bundesanstalt	Germany
UME	Tübitak / Ulusal Metroloji Enstitüsü	Turkey
VNIIM	D. I. Mendeleyev Scientific and Research Institute for Metrology	Russia
VSL ***)	VSL	Netherlands

*) During the comparison, the responsibilities of INETI Instituto Nacional de Engenharia, Tecnologia e Inovação, have changed to IPQ Instituto Português da Qualidade

**) During the comparison, the formerly named Istituto Electrotecnico Nazionale Galileo Ferraris (IEN) changed its name to Istituto Nazionale di Ricerca Metrologica (INRIM).

***) During the comparison, the formerly named Nederlands Meetinstituut Van Swinden Laboratorium (NMi-VSL) changed its name to VSL.

2.3 Organization and comparison schedule

The comparison was organized in nine loops. In principle, for each laboratory, a period of one month was scheduled including transportation time, but there were some exceptions, e.g., when there were problems with customs or with transportation.
Due to the irregular behavior of one of the travelling standards (Keithley 6430) during the first measurement of the pilot laboratory (see Section 3.5.2.), the first loop was repeated at the end of the circulation scheme.
About 1.5 years after completing the measuring loops, one of the transfer standards (Keithley 6430) was measured again in order to obtain more reliable data for its drift behavior. This auxiliary measurement is denoted below as “PTB-12”.

Table 2.2: Circulation time schedule

Institute	Country	Mean date of measurements	Label used in diagrams or used as an index
PTB (Pilot)	Germany	18.9.2005	PTB-1
VSL	Netherlands	18.10.2005	VSL-1
NPL	United Kingdom	29.12.2005	NPL-1
PTB (Pilot)	Germany	21.1.2006	PTB-2
INRIM	Italy	9.3.2006	INRIM
METAS	Switzerland	4.6.2006	METAS
UME	Turkey	29.8.2006	UME
PTB (Pilot)	Germany	18.9.2006	PTB-3
VNIIM	Russia	9.1.2007	VNIIM
PTB (Pilot)	Germany	15.2.2007	PTB-4
NIS	Egypt	14.4.2007	NIS
PTB (Pilot)	Germany	22.5.2007	PTB-5
IPQ	Portugal	1.7.2007	IPQ
LNE	France	2.8.2007	LNE
PTB (Pilot)	Germany	30.8.2007	PTB-6
CEM	Spain	12.10.2007	CEM
PTB (Pilot)	Germany	14.11.2007	PTB-7
KRISS	South Korea	8.1.2008	KRISS
PTB (Pilot)	Germany	5.2.2008	PTB-8
MIKES	Finland	19.3.2008	MIKES
PTB (Pilot)	Germany	30.4.2008	PTB-9
PTB (Pilot)	Germany	10.2.2009	PTB-10
VSL	Netherlands	2.4.2009	VSL-2
NPL	United Kingdom	15.7.2009	NPL-2
PTB (Pilot)	Germany	31.7.2009	PTB-11
PTB (Pilot) *	Germany	25.1.2011	PTB-12

3. Travelling standards and measurement instructions

3.1 Description of the travelling standards

Two picoamperemeters were used as travelling standards:

- A modified commercial PTW Unidos E S/N T10008 Y-80130. It had been modified by the manufacturer in such a way that it provides a one digit higher resolution than the standard instrument.

- A commercial Keithley 6430 Source Meter S/N 1036593. It came fresh from the factory.

Both instruments were shipped in a single package together with their operating manuals. Since they had very special input connectors, they were accompanied by appropriate adapters with male BNC connectors.

As both instruments were commercial picoamperemeters which were not specifically designed as standards, in the following text they are preferably denoted as transfer instruments or travelling instruments instead of transfer standards or travelling standards.

3.2 Quantities to be measured and conditions of measurements

The measurements were carried out by calibrating the transfer instruments, i.e. by supplying a DC current specified by the participant's current source and recording the instruments' readings. The measurand was then the calibration factor "*Q*" of the transfer instrument, defined as the ratio of the reading of the transfer instrument over the supplied current: $Q = I_{readout} / I_{supplied}$.

The nominal values of the eight measuring points were: +100 fA, -100 fA, +1 pA, -1 pA, +10 pA, -10 pA, +100 pA, and -100 pA. Throughout this document, the current is defined as positive when it is flowing into the picoammeter and it is defined as negative when it is flowing out of the picoammeter. It is important to mention this definition because the measurement data of the Keithley 6430 show the reverse sign. Furthermore, throughout this paper the calibration factors "*Q*" are regarded as being positive, despite the fact that the numerical ratio of the value displayed by the Keithley 6430 over the supplied current always has a negative value.

The measurements were to be carried out at an ambient temperature of (23 ± 0.5) °C.

3.3 Measurement instructions

In order to take full advantage of the transfer instruments' resolution and to avoid internal range switching or overflows, the calibration points had to be slightly below the nominal values. Therefore, the calibration points were to be about 95 % of the nominal values, i.e. 95 fA, 0.95 pA, and so on. Only if for some technical reasons this was proved to be impossible, could the exact nominal values be used.

Both instruments, the Keithley 6430 as well as the modified PTW Unidos E, had to be operated remotely. Both instruments had RS-232 connectors, in addition, the Keithley had a GP-IB connector.

After transportation a minimum settling and warm-up time of one day had to be allowed for the instruments. Ambient temperature, pressure, and humidity had to be recorded and reported.

The transfer instruments had considerable time constants. To take these into account, a settling time of 15 s after each current change had to be allowed for.

3.4 Deviations from the protocol

There were some changes in the circulation time schedule:

a) Due to the timing requirements of some participants, the arrangement of the loops was slightly modified.

b) After starting the comparison, two institutes (KRISS and MIKES) joined the comparison which required two additional loops.

c) Due to the irregular behavior of one of the travelling instruments (as explained in Section 3.5.2), the first loop was repeated at the end of the circulation scheme.

d) While evaluating the results, a drift of the Keithley 6430 was discovered. In order to obtain more reliable data for the drift behavior, an auxiliary measurement was performed by the pilot institute about 1.5 years after the last measuring loop. This measurement is labeled below as "PTB-12".

3.5 Unexpected incidents and effects

3.5.1 PTW Unidos E

3.5.1.1 PTW Unidos E: locking effect

During the measurements at INRIM, an irregular feature of the Unidos E was discovered:
When the current was slowly varied, the instrument's readout stayed on certain preferred values. After reporting these findings to the pilot laboratory, the effect was verified at the pilot laboratory by performing special measurements where the input current was varied continuously. The results for input currents close to 95 pA are shown in Fig. 3.1. It can be seen that the current "I(readout)" indicated by the Unidos is not linear with respect to the supplied current "I(source)". Instead, the graph shows steps with a height of typically 6 in the last digit. This effect was found to be most pronounced at the high currents of nominally 100 pA, while at 10 pA it was smeared out to a larger extent. At currents below 10 pA it was smeared out completely.

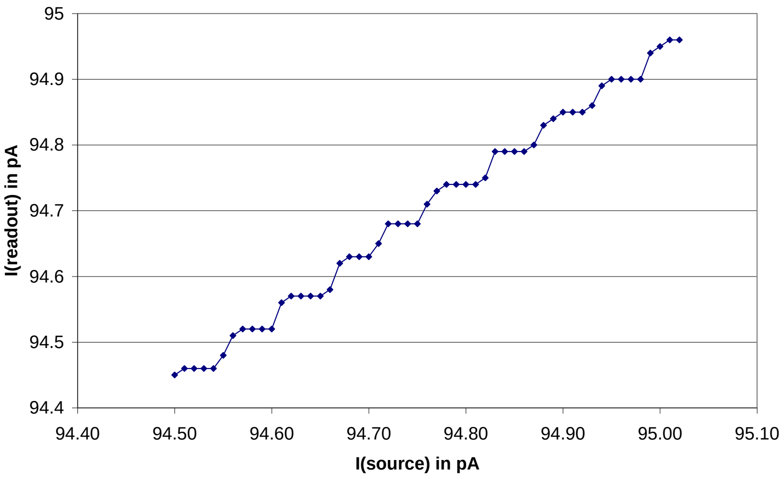

Fig. 3.1: Unidos E: indicated current versus applied current showing "locking" at certain steps

This behavior had not been recognized during the preparation of the comparison, probably because the calibration current was always sufficiently constant.

After contacting the instrument's manufacturer, the pilot laboratory received the explanation that the observed behavior is due to the instrument's specific electronics: the resolution of the analog-to-digital converter (ADC) is limited to about 0.05 % of the range's maximum value (112 pA in the “Low” range), the output of the ADC is then averaged over several measurements by software and the result is rounded to 4 digits. Therefore, the effect depends strongly on the presence of noise: at high currents there is a low relative noise level, hence, the reduced resolution is fully visible while at low currents the quantization is smeared out by a high relative noise level.

This behavior was communicated immediately to the participants in order to enable them to take this effect into account in their error budgets.

3.5.1.2 PTW Unidos E: zero-offset problem

During the compilation of the results, it was found that at nominal current values of 1 pA and above, the calibration factors Q_+ for the positive current direction and Q_- for the negative current direction vary strongly (see Figures 5.2 … 5.4), but a closer look revealed that they vary in a characteristic way: positive excursions of Q_+ correspond to negative excursions of Q_- of about the same amount and vice versa. This happens at least in situations where both values are determined from a simultaneously generated data set for positive and negative currents, which is generally the case when the calibration cycles are arranged as follows: zero current, positive current, zero current, negative current, zero current and so on. In this case, the variation of the mean calibration factor $Q_\pm$ defined as $Q_\pm = (Q_+ + Q_-)/2$ is much smaller than the variation of Q_+ or Q_- alone as shown in Figures 5.1 to 5.4.

As has now been confirmed by the manufacturer, this behavior is explained as follows: the picoammeter uses - in addition to the three current ranges “High”, “Med” and “Low” being accessible from the front panel - four internal gain stages which are selected automatically and which cannot be controlled from the outside. This means that when the applied current is zero, the instrument internally switches to the highest gain stage which is in most cases not identical to the gain stage used for the previously or subsequently applied non-zero current. Therefore, the instrument’s zero-offset value is usually determined in the “wrong” gain stage. As a consequence, Q_+ might be too high by a certain amount and Q_- too low by the same amount, or vice versa.

The effect described above was found after receiving the results at the pilot institute and was not communicated to the participants before the end of the measurements. This effect might be responsible for some participants’ observation that the Unidos is far more unstable than the Keithley.

3.5.2 Keithley 6430

After a first analysis of the comparison data, it became visible that the results obtained for the Keithley 6430 during the first PTB measurement were remarkably low compared to later measurements (see e.g. Fig. 5.8b). In principle, this effect could be due to the PTB calibration set-up, but as this behavior is not visible in the Unidos results, it is more probable that it is due to some kind of aging of the Keithley 6430, since at the beginning of the comparison this instrument was quite new.
As this behavior affects the analysis of the whole first measuring loop (“PTB-1” – “NPL-1” – “VSL-1” – “PTB-1”), it was decided to repeat the first loop at the end of the comparison.

3.5.3 Unexpectedly large ac-dc difference of capacitances

The calibration method described below in Section 4.1 relies on charging a capacitor. After finishing all measuring loops, it was found by NPL, PTB and Nick Fletcher from BIPM (which was not a participant of this comparison), that the dc capacitance effective for the calibration and the ac capacitance measured with an ac capacitance bridge differed more than might be expected before the beginning of the comparison [1]. This was communicated to the participants in spring 2010 and all participants had the opportunity to adjust their uncertainties in the light of these findings until summer 2010.

4. Calibration methods used by the participants

Within this comparison, three basically different calibrating methods were used by the participants:

4.1 Generating the calibrating current by charging/discharging a capacitor

The calibrating current *I* is generated by charging or discharging a gas-filled capacitor *C* with a linearly increasing or decreasing voltage of slope *dV/dt*. The calibrating current is then $I=C\cdot dV/dt$. Thus, it is traced back to the volt, the second and the farad. Typically, a trapezoidal voltage pattern symmetrical to zero voltage is used which allows the eliminating of linear drifts and the influence of leakage currents across the capacitor. This is discussed in more detail in [2].

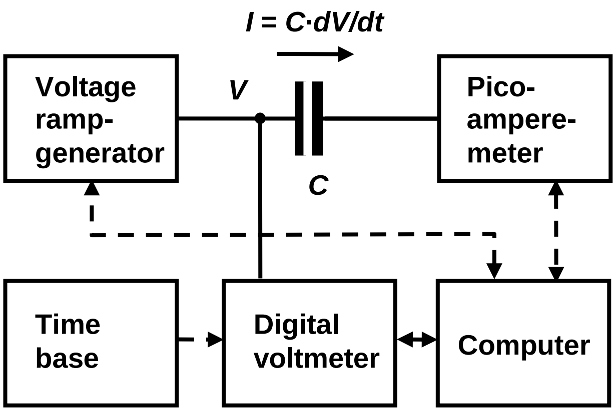

Fig. 4.1: Schematic calibration set-up for using the capacitor-charging method

This method was used by PTB, VSL, NPL, INRIM, METAS, VNIIM, NIS, IPQ, KRISS and MIKES.

4.2 Generating the calibrating current by a voltage source and a resistor

The calibrating current *I* is generated by a voltage source *V* (e.g. a DC calibrator) and a resistor *R*:
It is then $I = V/R$. Thus, the current is traced back to the volt and the ohm.

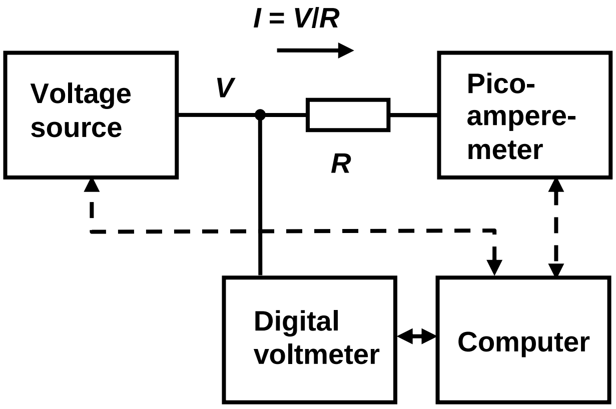

Fig. 4.2: Schematic calibration set-up for using the voltage-resistor method

This method was used by UME and CEM.

4.3 Comparison of the transfer instruments with a traceable picoammeter

In this method used exclusively by LNE, the calibrating current is generated by a current source consisting of a voltage source and a resistor, but, in contrast to the method described above in Section 4.2, the generated current is not directly traced back to the volt and the ohm. Instead, in a second step, the current source is calibrated by a traceable current measuring set-up. This method is described in more detail in Section 5.1.10.

5. Measurements and results of the participants

5.1 Measurements of the participants

In this section, the measuring set-up is briefly described for each laboratory in chronological order. Descriptions of the traceability chains are not given here, since traceability is not a matter of significance if viewed in the light of the uncertainties achieved.

5.1.1 Measurements of PTB (pilot institute)

The measurements were performed by using the capacitor charging method described in Section 4.1.

The voltage ramp was generated by a non-commercial ramp generator based on an electronic integrator, its nonlinearity being compensated by an analog feedback network as described in [3]. The generator delivered a fixed voltage slope of 10 mV/s. The slope could be fine-tuned by using a Kelvin-Varley voltage divider and increased by a factor of ten using an additional amplifier stage.
During the time when this comparison was running, a new ramp generator based on digital-to-analog converters was developed [4], but, for reasons of continuity, it was not used for measurements in the framework of this comparison.
The ramp slope was measured using an Agilent 3458A multimeter (DMM). The DMM's triggering was performed by a precision time base consisting of an oven-stabilized 10 MHz quartz-oscillator and binary divider circuits.
For generating 100 pA and 10 pA, a commercial capacitor of the type GR1404 (1000 pF) was used, for generating 1 pA and 100 fA, two commercial capacitors of the types GR 1403 (100 pF and 10 pF) were used. Their capacitances were measured before and after each run using an Andeen-Hagerling

AH2500 capacitance bridge. The whole set-up was situated in a temperature-controlled electrically shielded room. Humidity and air pressure were not stabilized.
For each current value, the measurement consisted of typically 60 cycles, each of them containing four phases: a) zero current, b) positive current, c) zero current, d) negative current. After the last cycle was completed, an additional zero-current phase was appended.

During the comparison, 11 sets of calibrations were carried out by PTB, denoted by “PTB-1” to “PTB-11”.

5.1.2 Measurements of VSL

The measurements were performed by using the capacitor charging method described in Section 4.1.

The current source was based on a non-commercial voltage ramp generator with a software-controlled non-linearity compensation and a set of air-dielectric capacitors of the type GR1404. The special technique for the non-linearity compensation and the set-up is described in detail in [2].
The nominal current values 100 pA, 10 pA and 1 pA were generated using a voltage ramp rate of 0.1 V/s in combination with a 1000 pF, 100 pF and 10 pF capacitor respectively. The nominal current 100 fA was generated using a ramp rate of 0.01 V/s in combination with a 10 pF capacitor. The ramp time was at least 150 s. The ac-dc difference of the capacitors was verified by a comparison to a current generated by a calibrator applying a voltage to a temperature-controlled 100 GΩ resistor.

Since the Keithley 6430 showed irregular behavior at the beginning of the comparison (as described in Section 3.5.2), the first measuring loop was repeated at the end. Therefore, VSL carried out two series of measurements, one in the first loop of the comparison and one in the final loop, denoted as “VSL-1” and “VSL-2”, respectively.

5.1.3 Measurements of NPL

The measurements were performed by using the capacitor charging method described in Section 4.1.

The voltage ramp was generated by a non-commercial ramp generator based on an electronic integrator. The ramp slope was measured by an Agilent 3458A multimeter. The capacitors used to generate the current were of type HP16381A (1pF), 16382A (10pF) and 16383A (100 pF) for the first set of measurements. These capacitors were of unsealed air-dielectric type, and were subsequently found to have a large frequency dependence. For the second set of measurements, denoted "NPL-2", a GR1404 100 pF sealed-gas capacitor was used for all current values. The capacitors were measured before and after each calibration run using a calibrated AH-2500 capacitance bridge. The triggering was performed by a precision time base consisting of a 10MHz oscillator and binary divider circuits. The transfer instrument as well as the current generating capacitor were situated in a temperature- and humidity-controlled cabinet. The set-up is described in more detail in [5].

Since the Keithley 6430 showed irregular behavior at the beginning of the comparison (as described in Section 3.5.1), the first measuring loop was repeated at the end. Therefore, NPL carried out two series of measurements, one in the first loop of the comparison and one in the final loop, denoted as “NPL-1” and “NPL-2”, respectively. The NPL reference current capability at the time of publication of this report is represented by the measurements NPL-2.

5.1.4 Measurements of INRIM

The measurements were performed by using the capacitor charging method described in Section 4.1.

The voltage ramp was generated by a non-commercial ramp generator based on an electronic integrator circuit, developed by INRIM. The ramp slope was measured by an Agilent 34401 multimeter triggered by a non-commercial time base. A set of commercial capacitors with capacitances of 1 pF, 10 pF, 100 pF and 1000 pF was used for the different current values. A more detailed description of the set-up can be found in [6].

5.1.5 Measurements of METAS

The measurements were performed by using the capacitor charging method described in Section 4.1.

The current source consisted basically of a non-commercial voltage ramp generator developed at METAS and a set of gas-dielectric capacitors with capacitances between 1 pF and 1 nF. The current source was based on an electronic integrator, where a high degree of linearity was achieved by a PID-controller which monitored the generators output slope.

Since METAS is situated about 550 m above sea level, the ambient air pressure was about 960 hPa, a value considerably lower than that of the other participants, with the exception of CEM.

5.1.6 Measurements of UME

The measurements were performed by applying the “voltage source and resistor” method as described in Section 4.2.

The voltage was supplied by a voltage calibrator of type the Fluke 5440B. Two resistors of the type Guildline 65206 with resistances of 100 GΩ and 1 TΩ were used and the voltage was checked using an Agilent 3458A digital multimeter. The resistor in use was situated in a shielded box.

5.1.7 Measurements of VNIIM

The measurements were performed by using the capacitor charging method described in Section 4.1.

Both, the voltage ramp generator as well as the capacitors being charged had been developed and manufactured by VNIIM. The voltage slope was measured by a digital voltmeter of the type SCH1516. It was triggered by a trigger device developed at VNIIM.

The voltage ramp was generated by a non-commercial ramp generator based on an electronic integrator, its nonlinearity being compensated by an analog feedback. The voltage slope could be changed by multiples of ten or fine-tuned by using a voltage divider in the range from 0.001 mV/s to 10 mV/s. A set of capacitors with gas dielectric and sapphire isolation with nominal values between 1 pF and 1000 pF was used. Their capacitance was measured by an Andeen-Hagerling AH2500 bridge before and after the small current measurements. The loss angle of the capacitors did not exceed $5 \cdot 10^{-5}$.

5.1.8 Measurements of NIS

The measurements were performed by using the capacitor charging method described in Section 4.1.

The current source consisted of a single air-dielectric “differentiating” capacitor C_1 of the type GR1404 with a capacitance of 1 nF and a voltage slope generator based on an electronic integrator. The generator’s output voltage slope was defined by its “integrating” capacitor C_2 and the integrated current generated by a 100 MΩ Guildline resistor and a Wavetek 9100 voltage calibrator.

The different calibrating currents were generated by using different “integrating” capacitors C_2 and injecting different currents into the integrator.

5.1.9 Measurements of IPQ

The measurements were performed by using the capacitor charging method described in Section 4.1.

The current was generated by a commercial 16-bit ramp generator and a set of GR1404 capacitors with capacitances of 1 pF, 10 pF and 100 pF. The ramp slope was measured using an Agilent 3458A sampling voltmeter triggered by a 1pps source disciplined from a GPS-based frequency reference.

5.1.10 Measurements of LNE

Within this comparison, the method used by LNE is unique since it uses the two-step procedure mentioned in Section 4.3:

Step 1: the device under test (DUT) was calibrated using a current source consisting of a voltage source and a 100 GΩ resistor. Such a calibration consisted of several cycles each of them containing three phases: a) the voltage was adjusted in such a way that the DUT's readout was a minimum, b) the voltage was changed to a value appropriate for generating the required calibrating current, c) the voltage was adjusted to the same value as in the initial phase a).

Step 2: immediately following step 1, the current source is calibrated at the same current value as before using the special current measuring set-up described in more detail in [7]. That set-up is based on integrating the input current, thus the current is traced back to the volt, the farad and the second. The current measuring set-up acts as a primary standard while the current source used acts as a transfer standard. As in step 1, each measuring cycle consisted of the three phases a), b) and c).
The measurements were carried out in a room with a temperature stabilized to 23.0°C ± 0.5 °C. In addition, the 100 GΩ resistor was placed in a temperature-controlled air bath. The integrating current measuring set-up was situated in a temperature-controlled enclosure stabilized to 23 °C ± 0.001 °C.

5.1.11 Measurements of CEM

The measurements were performed by using the voltage/resistor method described in Section 4.2.

All current values were generated using a Fluke 5720 multifunction calibrator and a single 100 GΩ resistor manufactured by TPYCEA.
Since CEM is situated more than 600 m above sea level, the ambient air pressure was about 940 hPa, a value considerably lower than that of the other participants.

5.1.12 Measurements of KRISS

The measurements were performed by using the capacitor charging method described in Section 4.1.

The voltage ramp was generated by a non-commercial ramp generator based on an electronic integrator, its nonlinearity being compensated by an analog feedback network similar to that described in [3]. The generator delivered a fixed voltage slope of 10 mV/s. The slope could be fine-tuned by using a Kelvin-Varley voltage divider and increased by a factor of ten using an additional amplifier stage.
For generating the currents, a set of commercial gas-dielectric capacitors with nominal values between 1 pF and 1000 pF was used. Their capacitances were measured before and after each run using an Andeen-Hagerling AH2500 capacitance bridge.

5.1.13 Measurements of MIKES

The measurements were performed by using the capacitor charging method described in Section 4.1.

The voltage was generated by a non-commercial ramp generator developed by MIKES [8]. The generator was based on digital-to-analog converters (DACs) controlled by a microcontroller. The ramp slope was measured by an Agilent 3458A multimeter triggered by a digital signal provided by the ramp generator electronics which in turn was checked periodically using a calibrated frequency counter. Three capacitors of the type GR1404 were used with capacitances of 10pF, 100 pF and 1000 pF respectively. The capacitances were determined by an Andeen-Hagerling capacitance bridge traceable to BIPM.

The measurements were performed in a shielded room which was temperature and humidity controlled. The transfer instruments and the capacitors were situated in a special shielded cabinet which was temperature and humidity controlled as well.

5.2 Behavior of the travelling standards

It must be mentioned here again that the travelling instruments used are commercial measuring instruments which were not designed for the use as standards. In this comparison, they were used far beyond their specifications. At the beginning of the comparison, both travelling instruments were rather new. Therefore, there was no knowledge about their individual stabilities and eventual drift behavior.

In the following sections, the behavior of the travelling instruments will be discussed mainly by regarding the measurements of the pilot laboratory alone.

It is clear that measurements of the pilot laboratory reflect both the behavior of the travelling instruments as well as the behavior of the pilot laboratory's calibrating set-up. Nevertheless, the use of two instruments of different types, together with regarding the results of the other participants, helps to separate these effects to a large extent.

At the beginning of the comparison, it was intended to evaluate the temperature coefficients of the travelling instruments from the data obtained during the comparison, but this proved not to be feasible since any correlation with temperature was hidden by the scatter of the results.

5.2.1 PTW Unidos E

As already discussed in Section 3.5.1, the Unidos E suffered from a low internal resolution and a problem with its zero-offset. This led to relatively large uncertainties and to differences in the results for positive and negative current directions. Due to the latter effect, the calibration factors Q_+ for positive current direction and Q_- for negative current direction show strong variations, whereas the variations are strongly reduced when the mean $Q_\pm = (Q_+ + Q_-)/2$ is calculated, at least when Q_+ and Q_- are measured in the same run (see e.g. Fig. 5.2).
Besides these properties, no further systematic effects were found.

MIKES reported a pressure dependence of the Unidos E. This dependence could not be supported by an analysis of the correlation of the participants' results with their associated ambient pressure data. If there were a noticeable pressure dependence, specifically the results of METAS and CEM, which are situated much higher above sea level than the other institutes, should differ significantly from the results of the remaining participants, but no such effect could be observed.

5.2.2 Keithley 6430

The results of the first PTB measurement "PTB-1" were considerably below the results of all succeeding measurements (see Figures 5.5 … 5.8), which was attributed to some kind of aging of the instrument as already discussed in Section 3.5.2. Therefore, the whole first measuring loop containing the measurements of NPL and VSL was repeated at the end of the comparison.

Besides that irregular behavior at the first measurements, at current values of 1 pA, 10 pA and 100 pA a linear drift was observed superimposed by an additional wiggle (see e.g. Fig. 5.8).

5.2.3 Graphical representation of the results of the pilot laboratory

The graphs in this section show the results of only the pilot laboratory in order visualize more clearly the behavior of the travelling standards during the comparison.

Unidos E at 100 fA:

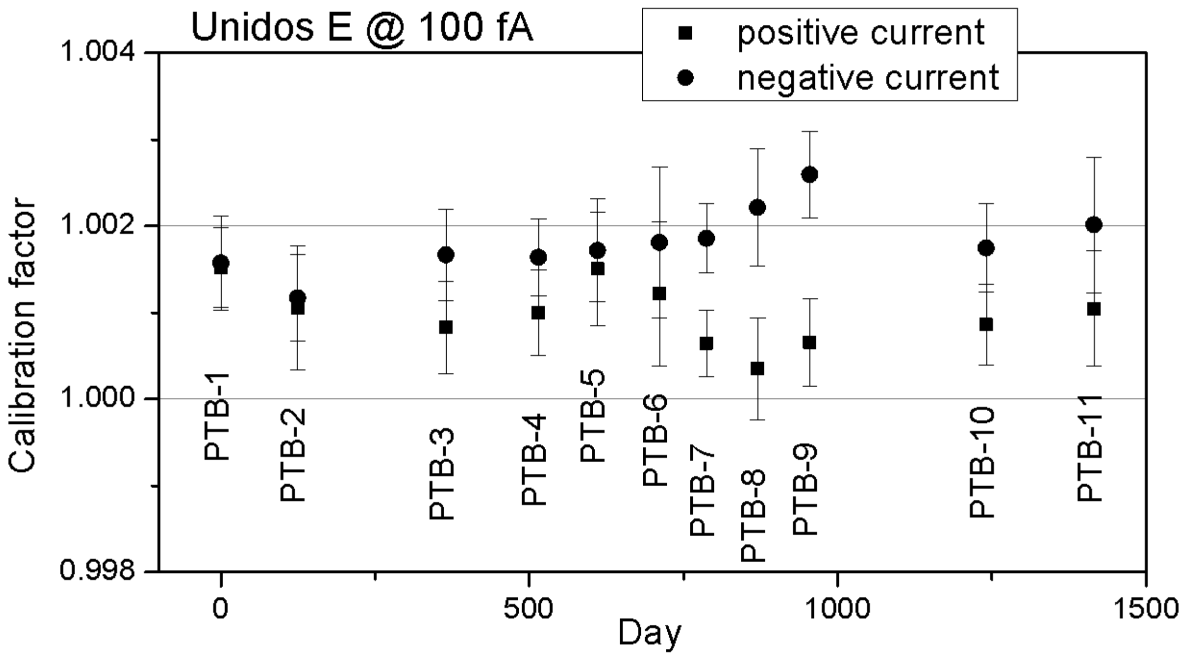

Fig. 5.1: Calibration factors Q_+ and Q_- for the Unidos E at 100 fA, pilot institute only.

Unidos E at 1 pA:

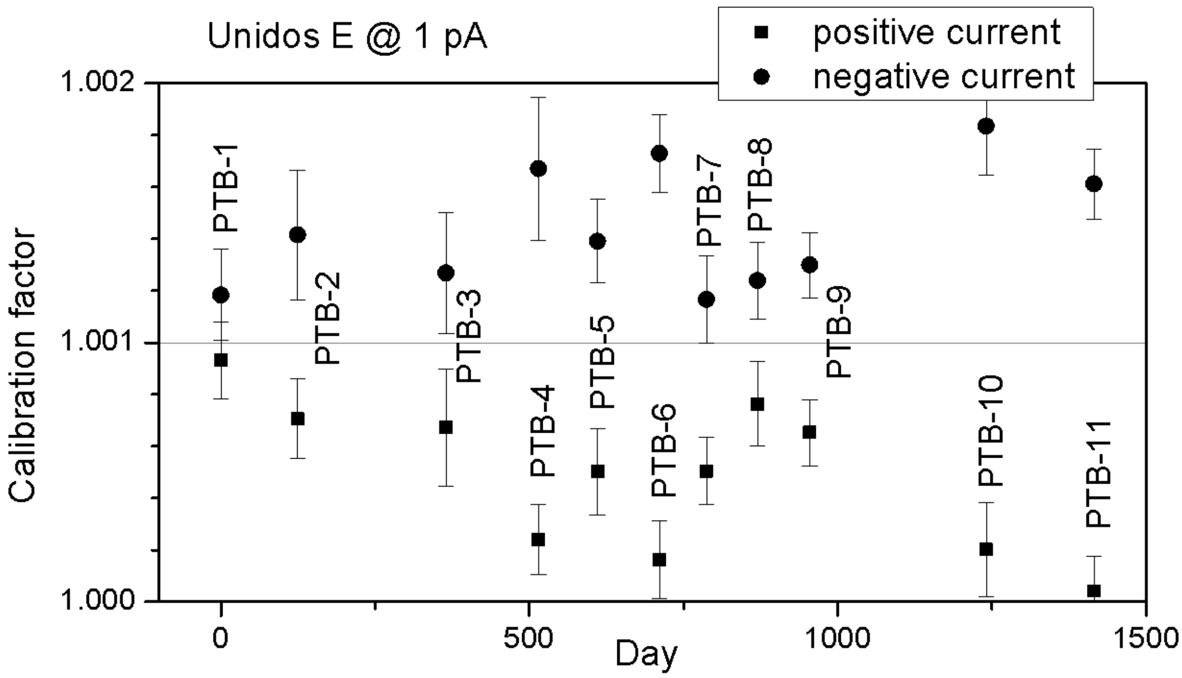

Fig. 5.2: Calibration factors Q_+ and Q_- for the Unidos E at 1 pA, pilot institute only.

Unidos E at 10 pA:

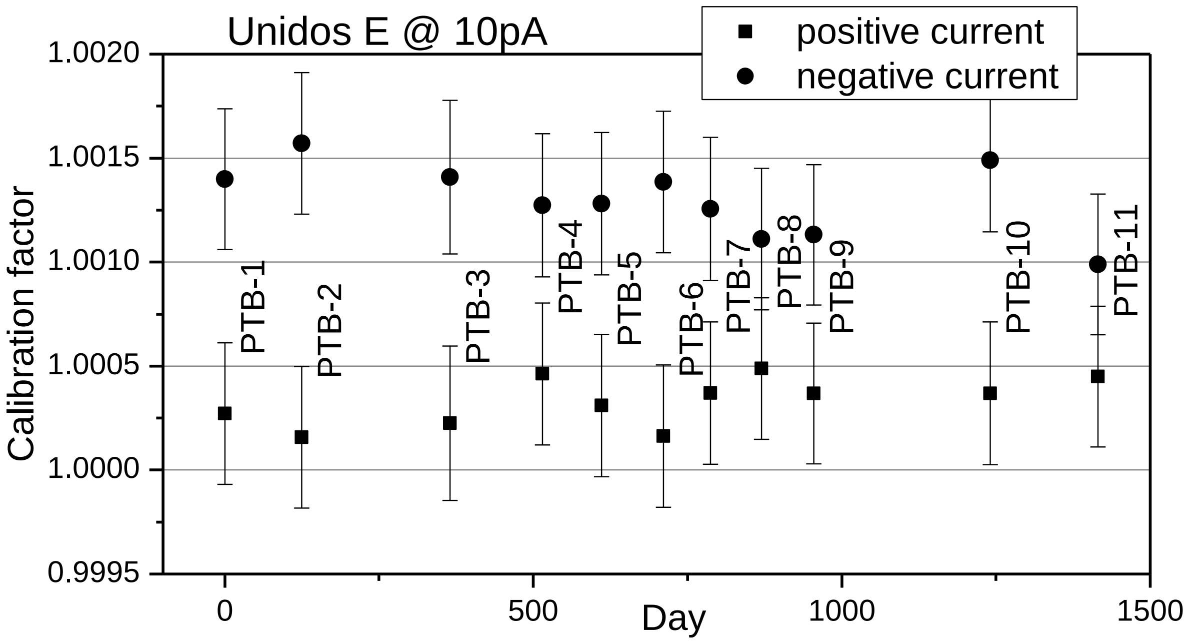

Fig. 5.3: Calibration factors Q_+ and Q_- for the Unidos E at 10 pA, pilot institute only.

Unidos E at 100 pA:

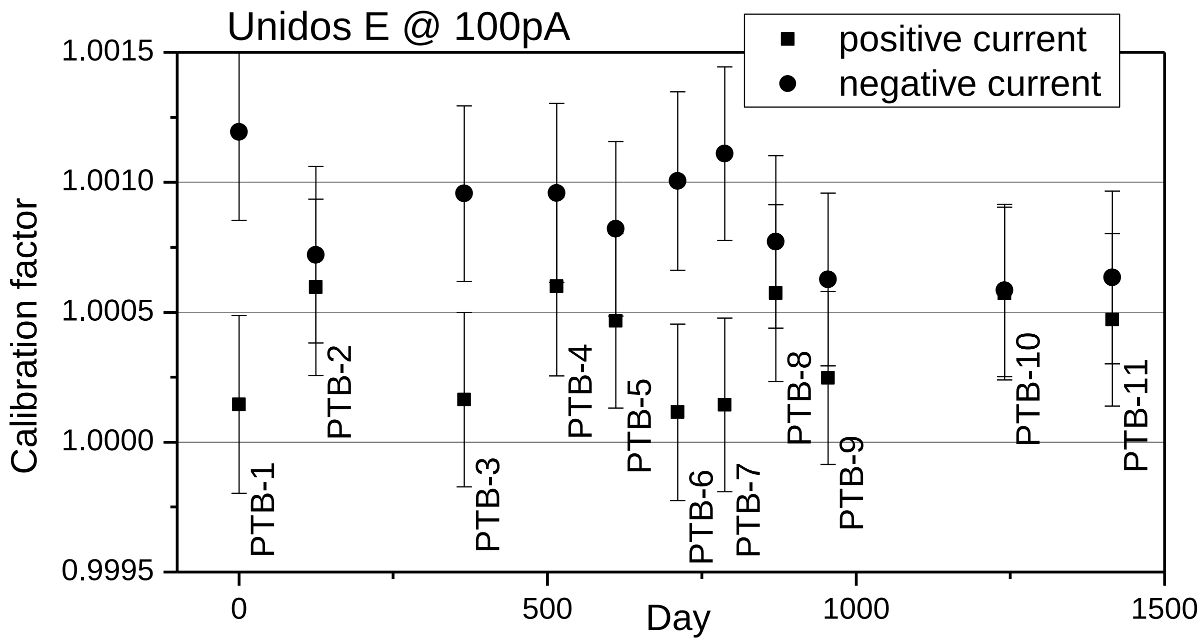

Fig. 5.4: Calibration factors Q_+ and Q_- for the Unidos E at 100 pA, pilot institute only.

Keithley 6430 at 100fA:

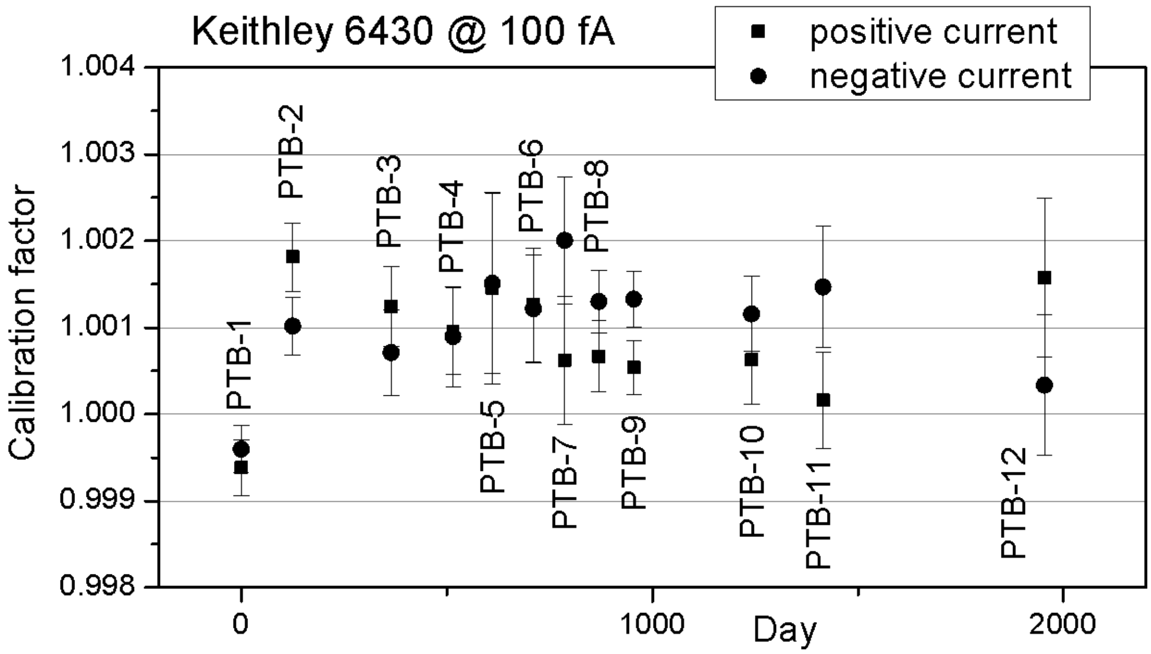

Fig. 5.5: Calibration factors Q_+ and Q_- for the Keithley 6430 at 100 fA, pilot institute only.

Keithley 6430 at 1 pA:

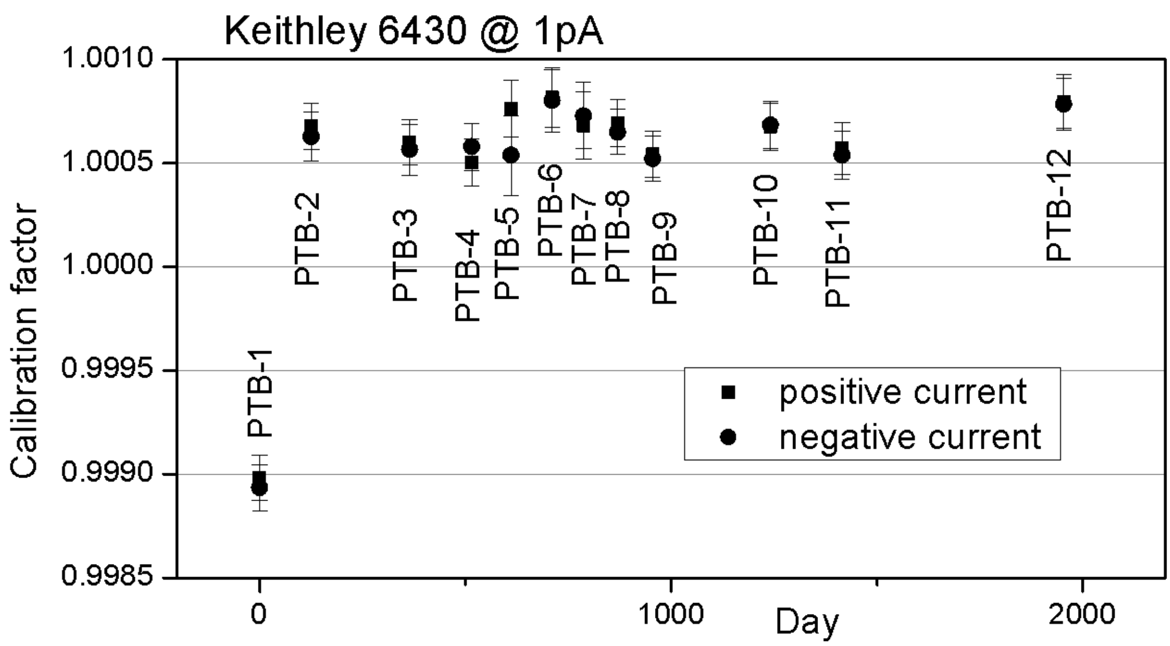

Fig. 5. 6: Calibration factors Q_+ and Q_- for the Keithley 6430 at 1 pA, pilot institute only.

Keithley 6430 at 10 pA:

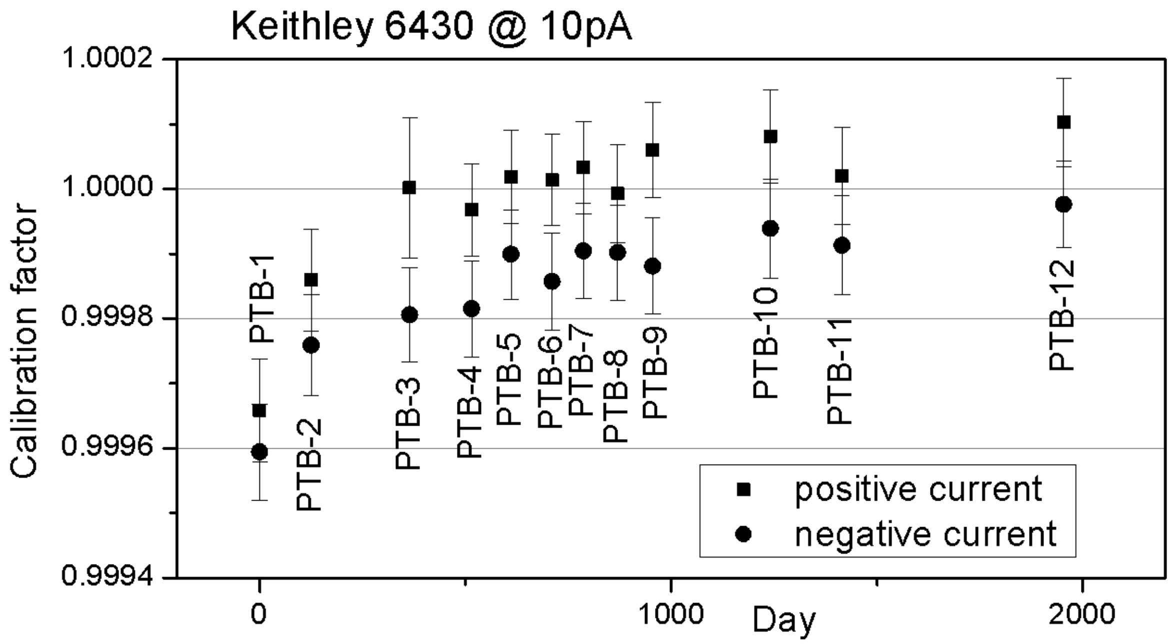

Fig. 5.7: Calibration factors Q_+ and Q_- for the Keithley 6430 at 10 pA, pilot institute only.

Keithley 6430 at 100 pA:

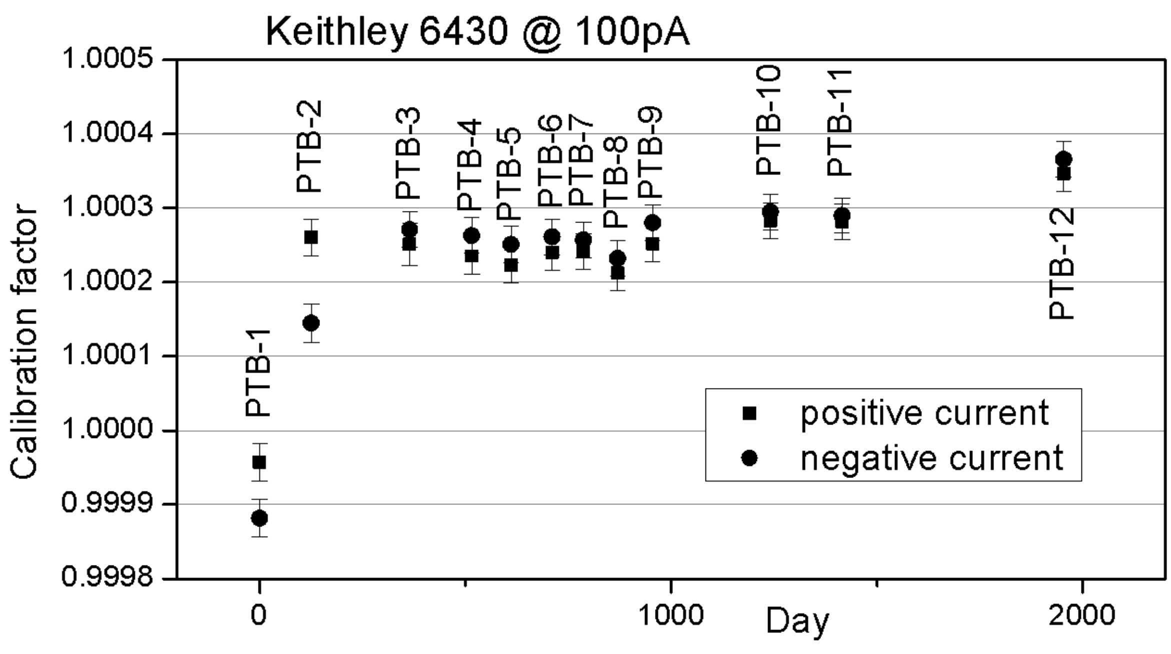

Fig. 5.8: Calibration factors Q_+ and Q_- for the Keithley 6430 at 100 pA, pilot institute only.

6. Analysis of comparison data sets

The data sets reported by the participants (see Appendix A) mainly contain the calibration factors Q_+ (defined as the ratio of the transfer instrument's reading / supplied current) for a current flowing into the transfer instrument and Q_- for a current flowing out of the transfer instrument, accompanied by their standard uncertainties $u(Q_+)$ and $u(Q_-)$ and their effective degrees of freedom.

From these uncertainties and effective degrees of freedom, the pilot laboratory calculated expansion factors k corresponding to a 95% coverage and the corresponding expanded uncertainties $U(Q_+)$ and $U(Q_-)$. These data are also given in the tables of Appendix A.

As already discussed in Section 3.5.1.2, there was a zero-offset problem with the Unidos E leading to relatively large excursions of Q_+ and of Q_- of about the same amount, but in opposite directions. Due to this effect, the mean of Q_+ and Q_- is much more stable than the values themselves. Hence, it was found valuable to consider in addition to Q_+ and Q_- also their mean value $Q_\pm = (Q_+ + Q_-)/2$.

Since typically the sources for type B uncertainties are the same for Q_+ and Q_-, a high degree of correlation can be assumed and the uncertainty of $Q_\pm$ is approximated by $U(Q_\pm) = (U(Q_+) + U(Q_-)) / 2$. In reality, the correlation is not perfect and, therefore, this formula may overestimate the correct uncertainties, especially at the lower current values where the type A uncertainty components may contribute to a larger extent to the overall uncertainty than at the higher current values.

6.1 Method of analysis

The aim of the analysis is to establish
i) for each transfer instrument and for each current value a reference value Q_{ref} and
ii) for each result Q_{i} of a participant a corresponding degree of equivalence (d_{i}, $U(d_{\mathrm{i}})$),
with $d_{\mathrm{i}} = Q_{\mathrm{i}} - Q_{\mathrm{ref}}$ and $U(d_{\mathrm{i}})$ being the expanded uncertainty of d_{i} for a coverage of 95% (see [9]).

In general, the data sets were not completely consistent. Therefore, the method described by Cox in [10] is used to determine the reference values Q_{ref} and the largest consistent data sets. This method is described briefly in Section 6.1.1.

Furthermore, two modifications were necessary in order to take into account the drift behavior of the Keithley 6430 and the additional instability of both transfer instruments. They are described in Sections 6.1.2 and 6.1.3.

6.1.1 Method of determining the reference values and the degrees of equivalence

A reference value Q_{ref} is calculated as a weighted mean of the largest consistent subset of the results Q_{i} ($i = 1\ldots N$) following the procedure described in more detail in [10]:

For each result Q_{i}, a function $e_{\mathrm{i}}(Q_{ref})$ is defined as

$$e_i(Q_{ref}) = \frac{\left(Q_i - Q_{ref}\right)^2}{u^2(Q_i)} \quad , \tag{1}$$

where Q_{ref} is still unknown. The sum F_r over these functions is again a function of Q_{ref}:

$$F_r(Q_{ref}) = \sum_{i=1}^{r} e_i(Q_{ref}) \quad . \tag{2}$$

Q_{ref} is then determined by numerically searching the minimum of $F_r(Q_{ref})$ using the method described in Section 5.2 of [10].

In a first step, all results are taken into account, i.e. $r = N$.

The results are regarded as consistent and the value for Q_{ref} is accepted if

$$F_r(Q_{ref}) \leq \chi^2_{r-1,\alpha} \,, \tag{3}$$

where $\chi^2_{\nu,\alpha}$ denotes the 100α percentage point of the chi-squared distribution with ν degrees of freedom. α was taken here as 0.05.

If the results are not consistent, r is decremented by one, i.e. N-r results with the largest values of e_i are discarded from calculating Q_{ref} and the procedure is restarted at equation (1). This cycle is repeated until consistency is achieved. For a more detailed description of the method of selecting the discarded results see section 2.1 in [10].

After the reference value is determined, it's uncertainty $u(Q_{ref})$ is calculated according to

$$\frac{1}{u^2(Q_{ref})} = \sum_{i=1}^{r} \frac{1}{u^2(Q_i)} \tag{4}$$

For each result Q_i, the degree of equivalence

$$(d_i, U_i) = (Q_i - Q_{ref}, \; k \cdot u(d_i)) \tag{5}$$

is calculated with

$$u^2(d_i) = u^2(Q_i) - u^2(Q_{ref}) \quad \text{for the undiscarded results,} \tag{6}$$

and

$$u^2(d_i) = u^2(Q_i) + u^2(Q_{ref}) \quad \text{for the discarded results,} \tag{7}$$

with the expansion factor k=2.

6.1.2 Modification due to a linear drift of a transfer standard

As mentioned above, the Keithley 6430 showed an obvious drift behavior at currents of 1 pA, 10 pA and 100 pA. This was taken into account by assuming a linear dependence of the reference value with time:

$$Q_{ref}(t) = A + B \cdot t, \tag{8}$$

where t (given in days) is the time of a measurement relative to the arithmetic mean all measurement dates.

Taking this into account, the functions e_i have now to be redefined as:

$$e_i(Q_{ref}) = \frac{(Q_i - A - B \cdot t_i)^2}{u^2(Q_i) + u^2(B) \cdot t_i^2} \,, \tag{9}$$

and the uncertainty $u(Q_{ref})$ is given by

$$\frac{1}{u^2(Q_{ref})} = \sum_{i=1}^{r} \frac{1}{u^2(Q_i) + u^2(B) \cdot t_1^2} \quad . \tag{10}$$

In order to avoid any distortion by possibly differently biased results of the different participants, the drift rate B and its uncertainty $u(B)$ were determined by calculating linear regressions using only the results of the pilot laboratory "PTB-2" to "PTB-11". The results of "PTB-1" were excluded from this calculation due to their irregular behavior as mentioned above.

6.1.3 Modification due to further instabilities of the transfer standards

Even if the linear drift is subtracted, there is a remaining superimposed "wiggle", as can be seen for example in Fig. 5.6. For a proper description of the transfer instruments, this instability has to be taken into account.

This judgment is supported by initial calculations which show that, if this instability is not taken into account, the largest consistent data sets are rather small, i.e. a very high percentage of the results (up to 48% for the Unidos and up to 39 % for the Keithley) would have to be discarded from the calculation of the reference values.

In order to describe this type of instabilitiy of the transfer standards, an additional uncertainty term u_{TS} is defined. It is determined by using the standard deviations $\sigma(Q_+)$ for the positive current direction and $\sigma(Q_-)$ for the negative current direction of the results of "PTB-2" … "PTB-11". In those cases where a drift has to be taken into account, the corresponding standard deviations with respect to the linear regression lines are used. This method is justified by the fact that the variations of the pilot laboratory's results for the Keithley on one side and for the Unidos on the other side are not correlated, which means that these variations are more likely due to the transfer standards and less likely to the pilot laboratory's calibration set-up.

As u_{TS} depends on the same internal components of the transfer instruments, it should be the same for both current directions. It is estimated as

$$u_{TS} = \left[\sigma(Q_+) + \sigma(Q_-)\right]/2 \quad , \tag{11}$$

and the functions e_i have finally to be redefined as

$$e_i(Q_{ref}) = \frac{\left(Q_i - A - B \cdot t_i\right)^2}{u^2(Q_i) + u^2(B) \cdot t_i^2 + u_{TS}^2} \quad . \tag{12}$$

In those cases where no obvious drift is observed, i.e. for the results of the Keithley at 100 fA and for all results of the Unidos , equation (12) is simplified by setting B=0, $u(B)$=0 and $A = Q_{ref}$.

The uncertainty $u(Q_{\mathrm{ref}})$ is now given by

$$\frac{1}{u^2(Q_{ref})} = \sum_{i=1}^{r} \frac{1}{u^2(Q_i) + u^2(B) \cdot t_1^2 + u_{TS}^2} \quad . \tag{13}$$

6.2 Results

6.2.1 Results for the PTW Unidos E

Results for the PTW Unidos E at 100 fA, positive current direction:

Reference value: Q_{ref} = 1.00097982, $u(Q_{ref})$ = 1.18·10^{-4}
Uncertainty describing the instability of the transfer standard: u_{TS} = 3.47·10^{-4}

Table 6.1: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0015230	2.3·10^{-4}	1.71	N	5.5·10^{-4}	8.0·10^{-4}
VSL-1	1.0022500	1.3·10^{-4}	11.76	Y	1.3·10^{-3}	7.8·10^{-4}
NPL-1	1.1388000	5.3·10^{-3}	674.36	Y	1.4·10^{-1}	1.1·10^{-2}
PTB-2	1.0010490	3.6·10^{-4}	0.02	N	7.2·10^{-5}	9.7·10^{-4}
INRIM	1.0007740	1.4·10^{-3}	0.02	N	-2.0·10^{-4}	2.8·10^{-3}
METAS	1.0019420	8.8·10^{-3}	0.01	N	9.6·10^{-4}	1.8·10^{-2}
UME	0.8710000	4.3·10^{-2}	9.28	N	-1.3·10^{-1}	8.5·10^{-2}
PTB-3	1.0008310	2.7·10^{-4}	0.11	N	-1.5·10^{-4}	8.4·10^{-4}
VNIIM	1.0007800	2.6·10^{-4}	0.21	N	-2.0·10^{-4}	8.3·10^{-4}
PTB-4	1.0009960	2.5·10^{-4}	0.00	N	1.9·10^{-5}	8.2·10^{-4}
NIS	0.9833000	4.6·10^{-3}	14.68	Y	-1.8·10^{-2}	9.2·10^{-3}
PTB-5	1.0015030	3.3·10^{-4}	1.21	N	5.3·10^{-4}	9.3·10^{-4}
IPQ	1.0040000	2.4·10^{-2}	0.02	N	3.0·10^{-3}	4.8·10^{-2}
LNE	0.9969000	1.7·10^{-3}	5.52	N	-4.1·10^{-3}	3.5·10^{-3}
PTB-6	1.0012170	4.2·10^{-4}	0.20	N	2.4·10^{-4}	1.1·10^{-3}
CEM	1.0009000	4.2·10^{-4}	0.02	N	-7.7·10^{-5}	1.1·10^{-3}
PTB-7	1.0006460	1.9·10^{-4}	0.70	N	-3.3·10^{-4}	7.6·10^{-4}
KRISS	1.0013280	3.5·10^{-4}	0.51	N	3.5·10^{-4}	9.5·10-4
PTB-8	1.0003500	2.9·10^{-4}	1.90	N	-6.3·10^{-4}	8.8·10^{-4}
MIKES	1.0033790	8.6·10^{-4}	6.71	N	2.4·10^{-3}	1.8·10^{-3}
PTB-9	1.0006540	2.5·10^{-4}	0.56	N	-3.2·10^{-4}	8.3·10^{-4}
PTB-10	1.0008600	2.4·10^{-4}	0.08	N	-1.2·10^{-4}	8.1·10^{-4}
VSL-2	1.0023703	1.2·10^{-4}	14.30	Y	1.4·10^{-3}	7.7·10^{-4}
NPL-2	1.0010700	7.5·10^{-4}	0.01	N	9.3·10^{-5}	1.6·10^{-3}
PTB-11	1.0010450	3.3·10^{-4}	0.02	N	6.8·10^{-5}	9.3·10^{-4}

Number of discarded results = 4, percentage = 16 %.
$F_r = \sum e_i$ = 28.82, summed over the undiscarded contributions.
Degree of freedom $\nu = r$-1 = 20.

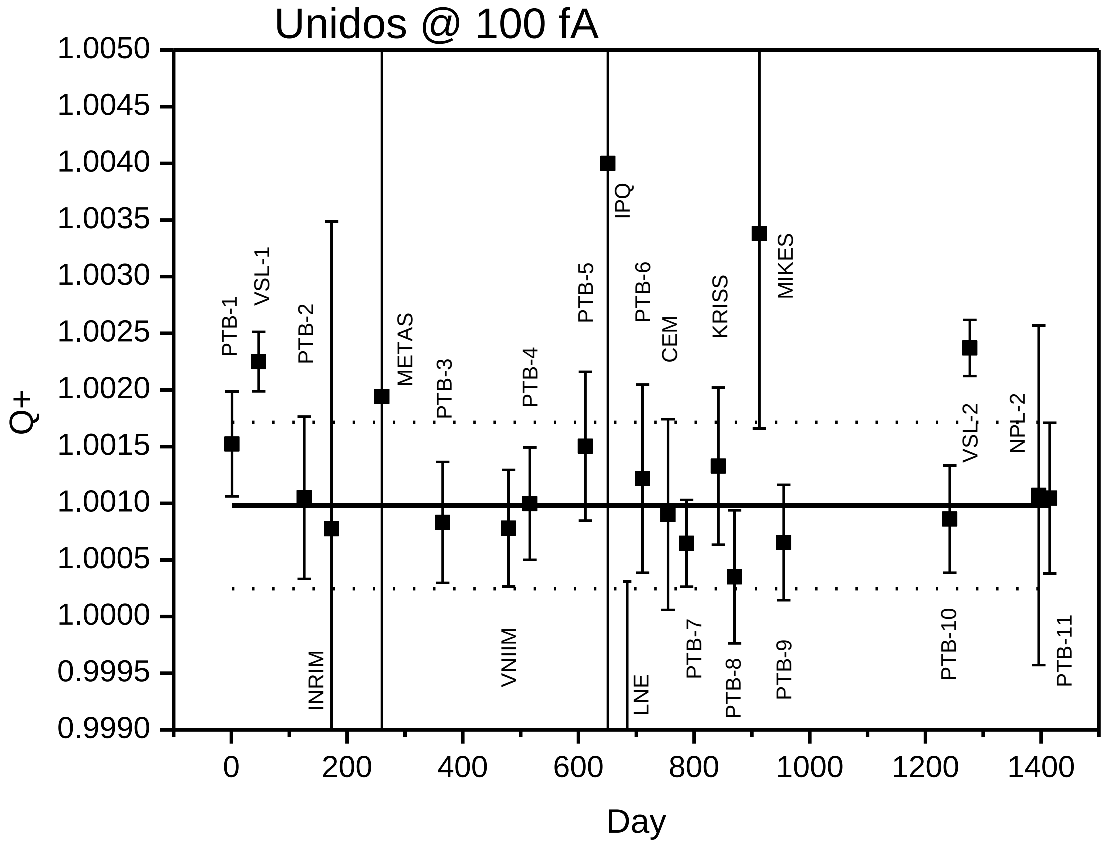

Fig. 6.1: Calibration factors for the Unidos at 100 fA for positive current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 100 fA, negative current direction:

Reference value: Q_{ref} = 1.00164994, $u(Q_{ref})$ = 1.20·10^{-4}
Uncertainty describing the instability of the transfer standard: u_{TS} = 3.47·10^{-4}

Table 6.2: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0015710	2.7·10^{-4}	0.03	N	-8.2·10^{-5}	8.5·10^{-4}
VSL-1	0.9991700	1.3·10^{-4}	44.80	Y	-2.5·10^{-3}	7.8·10^{-4}
NPL-1	0.8654000	3.0·10^{-3}	2063.98	Y	-1.4·10^{-1}	6.0·10^{-3}
PTB-2	1.0011690	2.5·10^{-4}	1.29	N	-4.8·10^{-4}	8.2·10^{-4}
INRIM	1.0008320	1.0·10^{-3}	0.56	N	-8.2·10^{-4}	2.2·10^{-3}
METAS	0.9998170	9.2·10^{-3}	0.04	N	-1.8·10^{-3}	1.8·10^{-2}
UME	1.1250000	1.1·10^{-2}	125.81	Y	1.2·10^{-1}	2.2·10^{-2}
PTB-3	1.0016680	2.6·10^{-4}	0.00	N	1.5·10^{-5}	8.4·10^{-4}
VNIIM	1.0007500	3.4·10^{-4}	3.43	N	-9.0·10^{-4}	9.4·10^{-4}
PTB-4	1.0016360	2.2·10^{-4}	0.00	N	-1.7·10^{-5}	7.9·10^{-4}
NIS	1.0150000	4.4·10^{-3}	9.10	N	1.3·10^{-2}	8.8·10^{-3}
PTB-5	1.0017180	3.0·10^{-4}	0.02	N	6.5·10^{-5}	8.8·10^{-4}
IPQ	1.0010000	2.6·10^{-2}	0.00	N	-6.5·10^{-4}	5.2·10^{-2}
LNE	1.0055000	1.1·10^{-3}	11.12	Y	3.8·10^{-3}	2.3·10^{-3}
PTB-6	1.0018110	4.3·10^{-4}	0.08	N	1.6·10^{-4}	1.1·10^{-3}
CEM	1.0009500	5.2·10^{-4}	1.28	N	-7.0·10^{-4}	1.2·10^{-3}
PTB-7	1.0018580	2.0·10^{-4}	0.26	N	2.0·10^{-4}	7.6·10^{-4}
KRISS	1.0010370	3.6·10^{-4}	1.51	N	-6.2·10^{-4}	9.7·10^{-4}
PTB-8	1.0022140	3.4·10^{-4}	1.34	N	5.6·10^{-4}	9.4·10^{-4}
MIKES	0.9989070	6.0·10^{-4}	15.66	Y	-2.7·10^{-3}	1.4·10^{-3}
PTB-9	1.0025960	2.5·10^{-4}	4.87	N	9.4·10^{-4}	8.2·10^{-4}
PTB-10	1.0017440	2.5·10^{-4}	0.04	N	9.1·10^{-5}	8.3·10^{-4}
VSL-2	0.9993321	1.2·10^{-4}	39.72	Y	-2.3·10^{-3}	7.7·10^{-4}
NPL-2	1.0014500	5.4·10^{-4}	0.10	N	-2.0·10^{-4}	1.3·10^{-3}
PTB-11	1.0020120	3.9·10^{-4}	0.47	N	3.6·10^{-4}	1.0·10^{-3}

Number of discarded results = 6, percentage = 24 %.
$F_r = \sum e_i$ = 24.44, summed only over the undiscarded contributions.
Degree of freedom $v = r$-1 = 18.

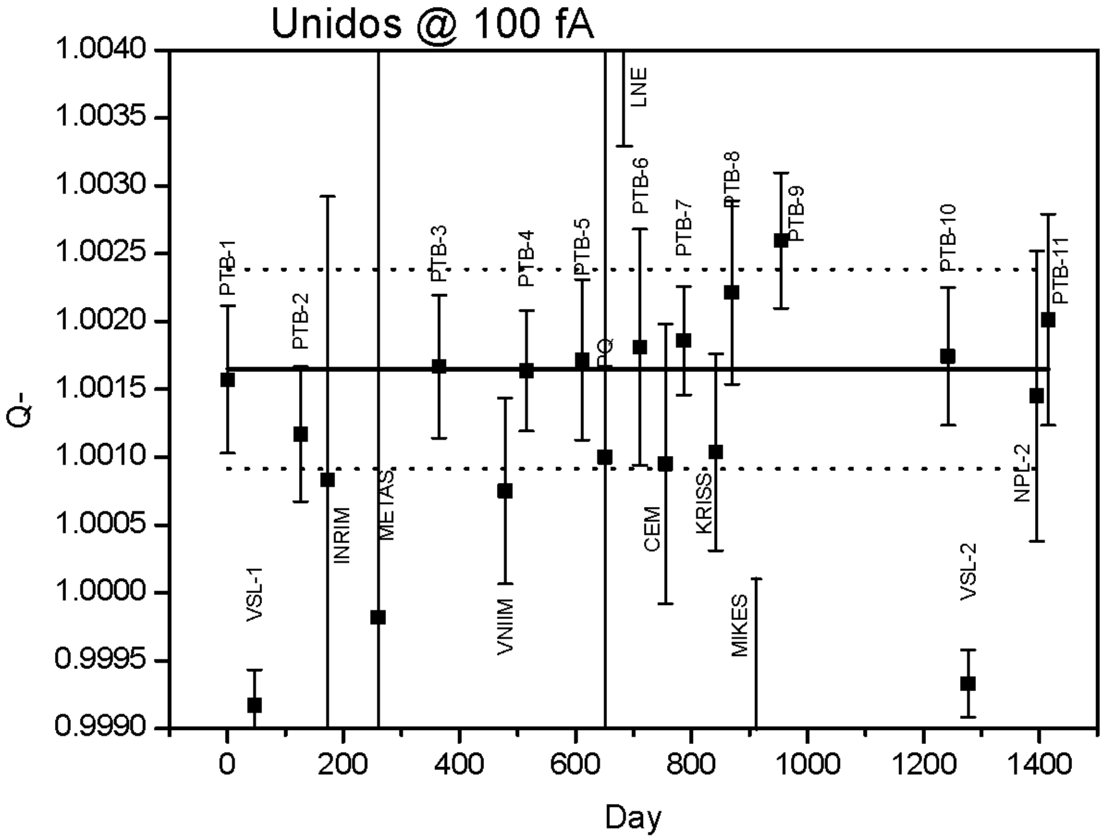

Fig. 6.2: Calibration factors for the Unidos at 100 fA for negative current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 100 fA, mean of both current directions:

Reference value: Q_{ref} = 1.00120970, $u(Q_{ref})$ = $1.08 \cdot 10^{-4}$
Uncertainty describing the instability of the transfer standard: u_{TS} = $3.47 \cdot 10^{-4}$

Table 6.3: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0015470	$2.5 \cdot 10^{-4}$	0.61	N	$3.4 \cdot 10^{-4}$	$8.3 \cdot 10^{-4}$
VSL-1	1.0007100	$1.3 \cdot 10^{-4}$	1.83	N	$-5.0 \cdot 10^{-4}$	$7.1 \cdot 10^{-4}$
NPL-1	1.0021000	$4.1 \cdot 10^{-3}$	0.05	N	$8.9 \cdot 10^{-4}$	$8.3 \cdot 10^{-3}$
PTB-2	1.0011090	$3.0 \cdot 10^{-4}$	0.05	N	$-1.0 \cdot 10^{-4}$	$9.0 \cdot 10^{-4}$
INRIM	1.0008030	$1.2 \cdot 10^{-3}$	0.11	N	$-4.1 \cdot 10^{-4}$	$2.5 \cdot 10^{-3}$
METAS	1.0008795	$9.0 \cdot 10^{-3}$	0.00	N	$-3.3 \cdot 10^{-4}$	$1.8 \cdot 10^{-2}$
UME	0.9980000	$2.7 \cdot 10^{-2}$	0.01	N	$-3.2 \cdot 10^{-3}$	$5.4 \cdot 10^{-2}$
PTB-3	1.0012495	$2.7 \cdot 10^{-4}$	0.01	N	$3.8 \cdot 10^{-5}$	$8.5 \cdot 10^{-4}$
VNIIM	1.0007650	$3.0 \cdot 10^{-4}$	0.95	N	$-4.5 \cdot 10^{-4}$	$8.9 \cdot 10^{-4}$
PTB-4	1.0013160	$2.3 \cdot 10^{-4}$	0.06	N	$1.0 \cdot 10^{-4}$	$8.1 \cdot 10^{-4}$
NIS	0.9991500	$4.5 \cdot 10^{-3}$	0.21	N	$-2.1 \cdot 10^{-3}$	$9.0 \cdot 10^{-3}$
PTB-5	1.0016105	$3.1 \cdot 10^{-4}$	0.73	N	$4.0 \cdot 10^{-4}$	$9.1 \cdot 10^{-4}$
IPQ	1.0025000	$2.5 \cdot 10^{-2}$	0.00	N	$1.3 \cdot 10^{-3}$	$5.0 \cdot 10^{-2}$
LNE	1.0012000	$1.4 \cdot 10^{-3}$	0.00	N	$-1.2 \cdot 10^{-5}$	$2.9 \cdot 10^{-3}$
PTB-6	1.0015140	$4.2 \cdot 10^{-4}$	0.30	N	$3.0 \cdot 10^{-4}$	$1.1 \cdot 10^{-3}$
CEM	1.0009250	$4.7 \cdot 10^{-4}$	0.24	N	$-2.9 \cdot 10^{-4}$	$1.1 \cdot 10^{-3}$
PTB-7	1.0012520	$2.0 \cdot 10^{-4}$	0.01	N	$4.0 \cdot 10^{-5}$	$7.7 \cdot 10^{-4}$
KRISS	1.0011825	$3.5 \cdot 10^{-4}$	0.00	N	$-2.9 \cdot 10^{-5}$	$9.7 \cdot 10^{-4}$
PTB-8	1.0012820	$3.2 \cdot 10^{-4}$	0.02	N	$7.0 \cdot 10^{-5}$	$9.1 \cdot 10^{-4}$
MIKES	1.0011430	$7.3 \cdot 10^{-4}$	0.01	N	$-6.9 \cdot 10^{-5}$	$1.6 \cdot 10^{-3}$
PTB-9	1.0016250	$2.5 \cdot 10^{-4}$	0.93	N	$4.1 \cdot 10^{-4}$	$8.3 \cdot 10^{-4}$
PTB-10	1.0013020	$2.5 \cdot 10^{-4}$	0.05	N	$9.0 \cdot 10^{-5}$	$8.2 \cdot 10^{-4}$
VSL-2	1.0008512	$1.2 \cdot 10^{-4}$	0.96	N	$-3.6 \cdot 10^{-4}$	$7.0 \cdot 10^{-4}$
NPL-2	1.0012600	$6.4 \cdot 10^{-4}$	0.00	N	$4.8 \cdot 10^{-5}$	$1.4 \cdot 10^{-3}$
PTB-11	1.0015285	$3.6 \cdot 10^{-4}$	0.40	N	$3.2 \cdot 10^{-4}$	$9.8 \cdot 10^{-4}$

Number of discarded results = 0, percentage = 0 %.
$F_r = \sum e_i$ = 7.54, summed over the undiscarded contributions.
Degree of freedom $v = r$-1 = 24.

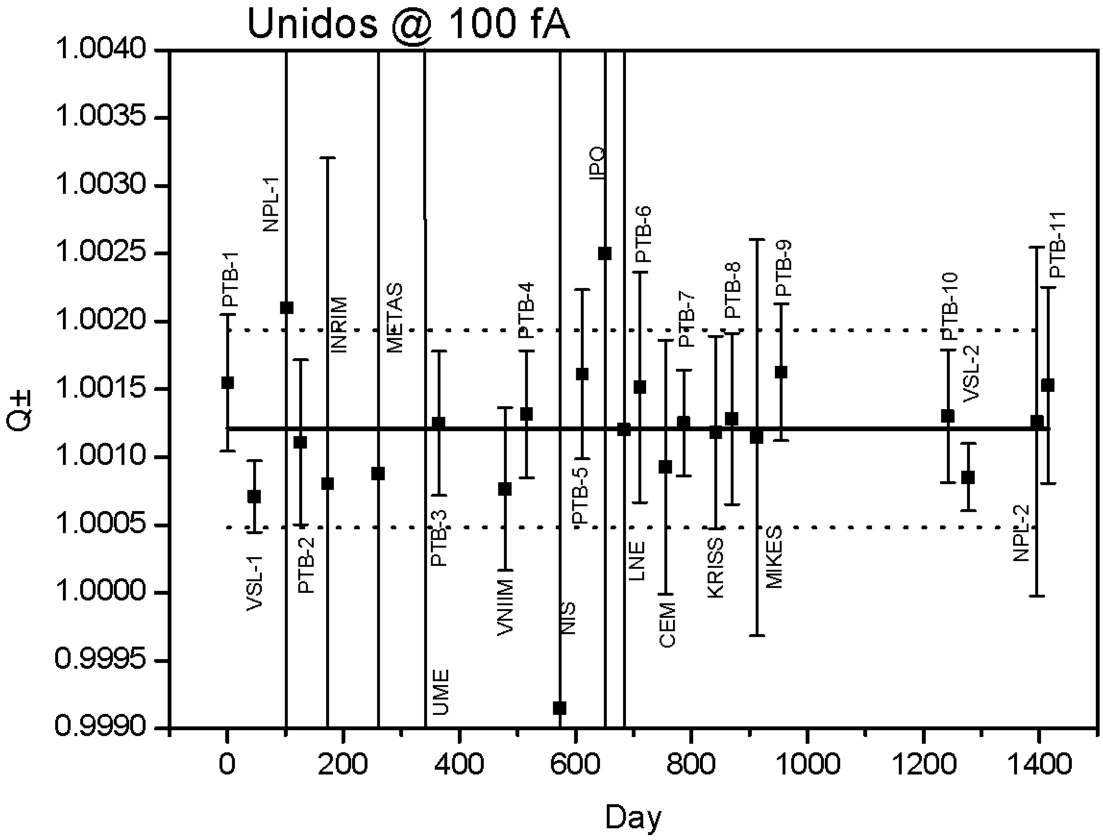

Fig. 6.3: Calibration factors for the Unidos at 100 fA for the mean of both current directions, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 1 pA, positive current direction:

Reference value: Q_{ref} = 1.00053547, $u(Q_{ref})$ = 6.24·10^{-5}
Uncertainty describing the instability of the transfer standard: u_{TS} = 2.52·10^{-4}

Table 6.4: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0009310	7.4·10^{-5}	2.27	N	4.0·10^{-4}	5.1·10^{-4}
VSL-1	1.0003500	6.2·10^{-5}	0.51	N	-1.9·10^{-4}	5.0·10^{-4}
NPL-1	1.0136400	1.3·10^{-3}	101.10	Y	1.3·10^{-2}	2.6·10^{-3}
PTB-2	1.0007060	7.7·10^{-5}	0.42	N	1.7·10^{-4}	5.1·10^{-4}
INRIM	1.0003030	5.5·10^{-4}	0.15	N	-2.3·10^{-4}	1.2·10^{-3}
METAS	0.9999390	9.8·10^{-4}	0.35	N	-6.0·10^{-4}	2.0·10^{-3}
UME	0.9840000	4.8·10^{-3}	12.07	Y	-1.7·10^{-2}	9.5·10^{-3}
PTB-3	1.0006730	1.1·10^{-4}	0.25	N	1.4·10^{-4}	5.4·10^{-4}
VNIIM	1.0004100	1.5·10^{-4}	0.18	N	-1.3·10^{-4}	5.7·10^{-4}
PTB-4	1.0002400	6.7·10^{-5}	1.28	N	-3.0·10^{-4}	5.1·10^{-4}
NIS	0.9885500	3.6·10^{-3}	10.97	Y	-1.2·10^{-2}	7.2·10^{-3}
PTB-5	1.0005030	8.4·10^{-5}	0.01	N	-3.2·10^{-5}	5.2·10^{-4}
IPQ	1.0011000	1.9·10^{-3}	0.08	N	5.6·10^{-4}	3.9·10^{-3}
LNE	1.0011000	2.0·10^{-4}	3.08	N	5.6·10^{-4}	6.3·10^{-4}
PTB-6	1.0001620	7.5·10^{-5}	2.01	N	-3.7·10^{-4}	5.1·10^{-4}
CEM	1.0000100	1.8·10^{-4}	2.93	N	-5.3·10^{-4}	6.0·10^{-4}
PTB-7	1.0005050	6.5·10^{-5}	0.01	N	-3.0·10^{-5}	5.1·10^{-4}
KRISS	1.0004100	5.6·10^{-5}	0.23	N	-1.3·10^{-4}	5.0·10^{-4}
PTB-8	1.0007630	8.1·10^{-5}	0.74	N	2.3·10^{-4}	5.1·10^{-4}
MIKES	1.0011020	3.1·10^{-4}	2.04	N	5.7·10^{-4}	7.8·10^{-4}
PTB-9	1.0006520	6.4·10^{-5}	0.20	N	1.2·10^{-4}	5.0·10^{-4}
PTB-10	1.0002010	9.1·10^{-5}	1.55	N	-3.3·10^{-4}	5.2·10^{-4}
VSL-2	1.0012101	5.0·10^{-5}	6.90	N	6.8·10^{-4}	5.0·10^{-4}
NPL-2	1.0006300	1.5·10^{-4}	0.10	N	9.5·10^{-5}	5.7·10^{-4}
PTB-11	1.0000410	6.7·10^{-5}	3.59	N	-4.9·10^{-4}	5.1·10^{-4}

Number of discarded results = 3, percentage = 12 %.
$F_r = \sum e_i$ = 28.90, summed over the undiscarded contributions.
Degree of freedom $v = r$-1 = 21.

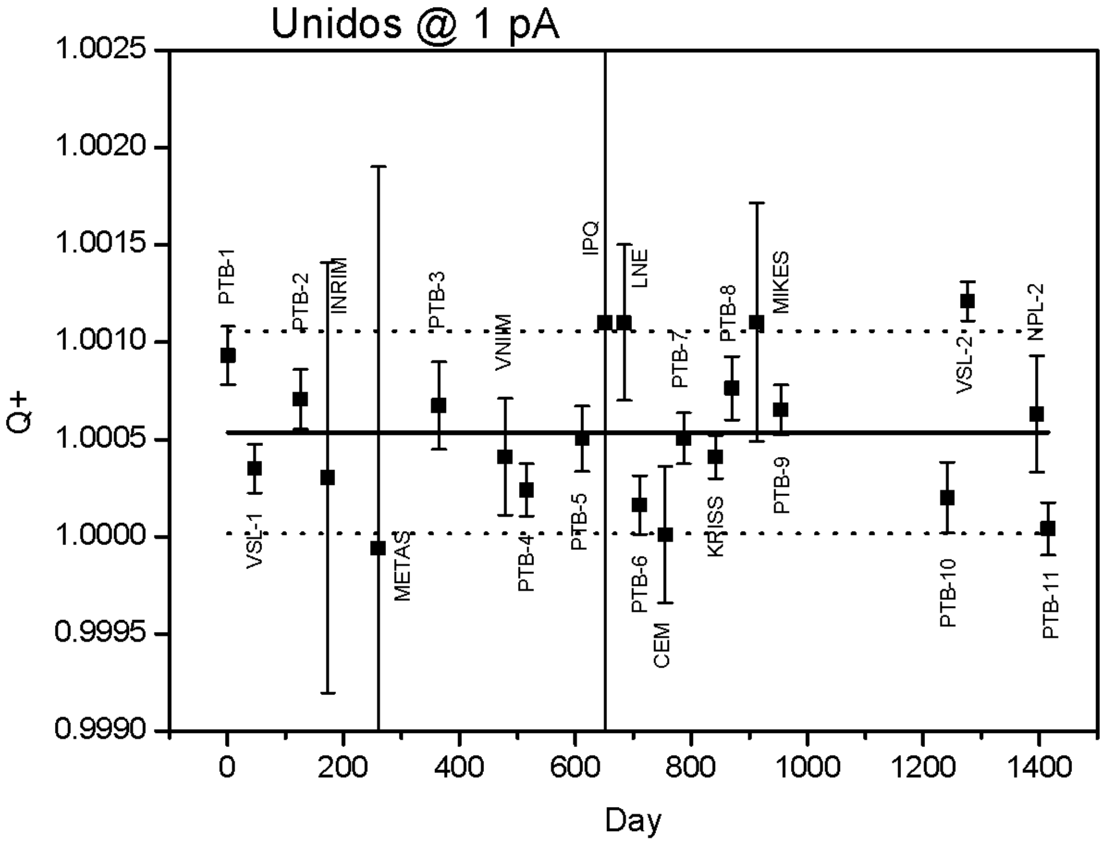

Fig. 6.4: Calibration factors for the Unidos at 1 pA for positive current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 1 pA, negative current direction:

Reference value: Q_{ref} = 1.00135313, $u(Q_{ref})$ = 6.45·10^{-5}
Uncertainty describing the instability of the transfer standard: u_{TS} = 2.52·10^{-4}

Table 6.5: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0011840	$8.7 \cdot 10^{-5}$	0.41	N	$-1.7 \cdot 10^{-4}$	$5.2 \cdot 10^{-4}$
VSL-1	1.0012700	$6.3 \cdot 10^{-5}$	0.11	N	$-8.4 \cdot 10^{-5}$	$5.0 \cdot 10^{-4}$
NPL-1	0.9882700	$1.3 \cdot 10^{-3}$	94.55	Y	$-1.3 \cdot 10^{-2}$	$2.7 \cdot 10^{-3}$
PTB-2	1.0014150	$1.2 \cdot 10^{-4}$	0.05	N	$6.1 \cdot 10^{-5}$	$5.5 \cdot 10^{-4}$
INRIM	1.0014760	$3.0 \cdot 10^{-4}$	0.10	N	$1.2 \cdot 10^{-4}$	$7.8 \cdot 10^{-4}$
METAS	1.0017180	$7.9 \cdot 10^{-4}$	0.19	N	$3.6 \cdot 10^{-4}$	$1.6 \cdot 10^{-3}$
UME	1.0100000	$1.9 \cdot 10^{-3}$	21.06	Y	$8.6 \cdot 10^{-3}$	$3.8 \cdot 10^{-3}$
PTB-3	1.0012680	$1.2 \cdot 10^{-4}$	0.10	N	$-8.6 \cdot 10^{-5}$	$5.4 \cdot 10^{-4}$
VNIIM	1.0004300	$1.5 \cdot 10^{-4}$	9.94	N	$-9.2 \cdot 10^{-4}$	$5.7 \cdot 10^{-4}$
PTB-4	1.0016700	$1.4 \cdot 10^{-4}$	1.21	N	$3.2 \cdot 10^{-4}$	$5.6 \cdot 10^{-4}$
NIS	0.9991400	$3.4 \cdot 10^{-4}$	27.55	Y	$-2.2 \cdot 10^{-3}$	$8.5 \cdot 10^{-4}$
PTB-5	1.0013910	$8.0 \cdot 10^{-5}$	0.02	N	$3.7 \cdot 10^{-5}$	$5.1 \cdot 10^{-4}$
IPQ	1.0008000	$1.4 \cdot 10^{-3}$	0.15	N	$-5.5 \cdot 10^{-4}$	$2.9 \cdot 10^{-3}$
LNE	1.0014700	$2.1 \cdot 10^{-4}$	0.12	N	$1.2 \cdot 10^{-4}$	$6.4 \cdot 10^{-4}$
PTB-6	1.0017300	$7.5 \cdot 10^{-5}$	2.04	N	$3.8 \cdot 10^{-4}$	$5.1 \cdot 10^{-4}$
CEM	1.0015740	$1.7 \cdot 10^{-4}$	0.51	N	$2.2 \cdot 10^{-4}$	$6.0 \cdot 10^{-4}$
PTB-7	1.0011660	$8.5 \cdot 10^{-5}$	0.50	N	$-1.9 \cdot 10^{-4}$	$5.2 \cdot 10^{-4}$
KRISS	1.0016580	$5.2 \cdot 10^{-5}$	1.39	N	$3.0 \cdot 10^{-4}$	$5.0 \cdot 10^{-4}$
PTB-8	1.0012390	$7.4 \cdot 10^{-5}$	0.19	N	$-1.2 \cdot 10^{-4}$	$5.1 \cdot 10^{-4}$
MIKES	1.0008890	$3.1 \cdot 10^{-4}$	1.37	N	$-4.7 \cdot 10^{-4}$	$7.8 \cdot 10^{-4}$
PTB-9	1.0012990	$6.3 \cdot 10^{-5}$	0.05	N	$-5.5 \cdot 10^{-5}$	$5.0 \cdot 10^{-4}$
PTB-10	1.0018340	$9.3 \cdot 10^{-5}$	3.19	N	$4.8 \cdot 10^{-4}$	$5.2 \cdot 10^{-4}$
VSL-2	1.0003789	$8.5 \cdot 10^{-5}$	13.44	Y	$-9.8 \cdot 10^{-4}$	$5.5 \cdot 10^{-4}$
NPL-2	1.0007800	$1.5 \cdot 10^{-4}$	3.84	N	$-5.7 \cdot 10^{-4}$	$5.7 \cdot 10^{-4}$
PTB-11	1.0016110	$6.8 \cdot 10^{-5}$	0.97	N	$2.6 \cdot 10^{-4}$	$5.1 \cdot 10^{-4}$

Number of discarded results = 4, percentage = 16 %.
$F_r = \sum e_i$ = 26.45, summed over the undiscarded contributions.
Degree of freedom $v = r$-1 = 20.

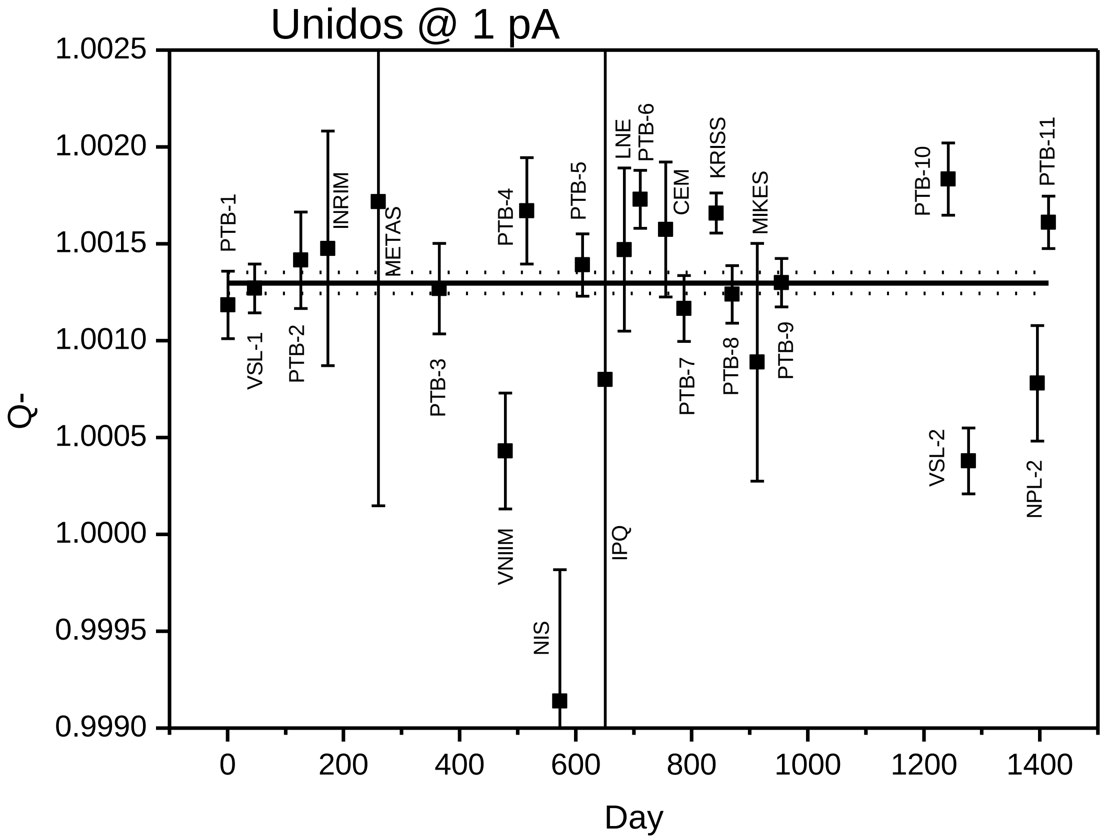

Fig. 6.5: Calibration factors for the Unidos at 1 pA for negative current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 1 pA, mean of both current directions:

Reference value: Q_{ref} = 1.00090691, $u(Q_{ref})$ = 6.25·10^{-5}
Uncertainty describing the instability of the transfer standard: u_{TS} = 2.52·10^{-4}

Table 6.6: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0010575	8.1·10^{-5}	0.33	N	1.5·10^{-4}	5.1·10^{-4}
VSL-1	1.0008100	6.2·10^{-5}	0.14	N	-9.6·10^{-5}	5.0·10^{-4}
NPL-1	1.0009550	1.3·10^{-3}	0.00	N	4.9·10^{-5}	2.6·10^{-3}
PTB-2	1.0010605	1.0·10^{-4}	0.33	N	1.5·10^{-4}	5.3·10^{-4}
INRIM	1.0008895	4.3·10^{-4}	0.00	N	-1.6·10^{-5}	9.8·10^{-4}
METAS	1.0008285	8.8·10^{-4}	0.01	N	-7.7·10^{-5}	1.8·10^{-3}
UME	0.9970000	3.3·10^{-3}	1.38	N	-3.9·10^{-3}	6.6·10^{-3}
PTB-3	1.0009705	1.1·10^{-4}	0.05	N	6.5·10^{-5}	5.4·10^{-4}
VNIIM	1.0004200	1.5·10^{-4}	2.74	N	-4.9·10^{-4}	5.7·10^{-4}
PTB-4	1.0009550	1.0·10^{-4}	0.03	N	4.9·10^{-5}	5.3·10^{-4}
NIS	0.9938450	2.0·10^{-3}	12.59	N	-7.1·10^{-3}	4.0·10^{-3}
PTB-5	1.0009470	8.2·10^{-5}	0.02	N	4.1·10^{-5}	5.2·10^{-4}
IPQ	1.0009500	1.7·10^{-3}	0.00	N	4.4·10^{-5}	3.4·10^{-3}
LNE	1.0012850	2.1·10^{-4}	1.36	N	3.8·10^{-4}	6.4·10^{-4}
PTB-6	1.0009460	7.5·10^{-5}	0.02	N	4.0·10^{-5}	5.1·10^{-4}
CEM	1.0007920	1.7·10^{-4}	0.14	N	-1.1·10^{-4}	6.0·10^{-4}
PTB-7	1.0008355	7.5·10^{-5}	0.07	N	-7.0·10^{-5}	5.1·10^{-4}
KRISS	1.0010340	5.4·10^{-5}	0.25	N	1.3·10^{-4}	5.0·10^{-4}
PTB-8	1.0010010	7.8·10^{-5}	0.13	N	9.5·10^{-5}	5.1·10^{-4}
MIKES	1.0009955	3.1·10^{-4}	0.05	N	9.0·10^{-5}	7.8·10^{-4}
PTB-9	1.0009755	6.3·10^{-5}	0.07	N	7.0·10^{-5}	5.0·10^{-4}
PTB-10	1.0010175	9.2·10^{-5}	0.17	N	1.1·10^{-4}	5.2·10^{-4}
VSL-2	1.0007945	6.8·10^{-5}	0.18	N	-1.1·10^{-4}	5.1·10^{-4}
NPL-2	1.0007050	1.5·10^{-4}	0.47	N	-2.0·10^{-4}	5.7·10^{-4}
PTB-11	1.0008260	6.8·10^{-5}	0.09	N	-8.0·10^{-5}	5.1·10^{-4}

Number of discarded results = 0, percentage = 0 %.
$F_r = \sum e_i$ = 20.65, summed over the undiscarded contributions.
Degree of freedom $v = r$-1 = 24.

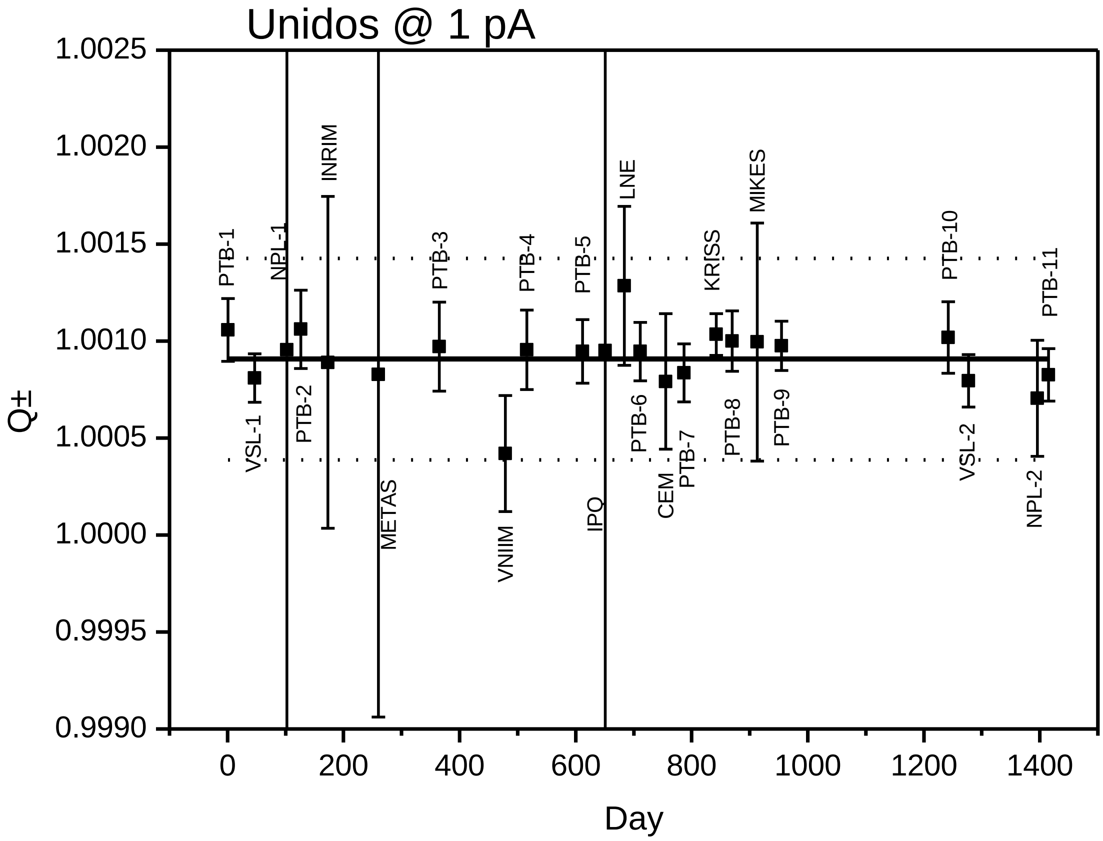

Fig. 6.6: Calibration factors for the Unidos at 1 pA for the mean of both current directions, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 10 pA, positive current direction:

Reference value: Q_{ref} = 1.00038719, $u(Q_{ref})$ = 4.45·10^{-5}
Uncertainty describing the instability of the transfer standard: u_{TS} = 1.38·10^{-4}

Table 6.7: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0002710	1.7·10^{-4}	0.29	N	-1.2·10^{-4}	4.3·10^{-4}
VSL-1	1.0005500	1.5·10^{-4}	0.62	N	1.6·10^{-4}	4.0·10^{-4}
NPL-1	1.0019920	4.5·10^{-4}	11.56	N	1.6·10^{-3}	9.4·10^{-4}
PTB-2	1.0001570	1.7·10^{-4}	1.12	N	-2.3·10^{-4}	4.3·10^{-4}
INRIM	1.0003910	1.4·10^{-4}	0.00	N	2.6·10^{-6}	3.8·10^{-4}
METAS	1.0001480	1.7·10^{-4}	1.18	N	-2.4·10^{-4}	4.3·10^{-4}
UME	0.9960000	5.2·10^{-4}	66.24	Y	-4.4·10^{-3}	1.1·10^{-3}
PTB-3	1.0002250	1.9·10^{-4}	0.50	N	-1.6·10^{-4}	4.5·10^{-4}
VNIIM	1.0006300	8.9·10^{-5}	2.17	N	2.4·10^{-4}	3.2·10^{-4}
PTB-4	1.0004620	1.7·10^{-4}	0.11	N	7.4·10^{-5}	4.3·10^{-4}
NIS	1.0000200	4.3·10^{-4}	0.67	N	-3.7·10^{-4}	9.0·10^{-4}
PTB-5	1.0003100	1.7·10^{-4}	0.13	N	-7.8·10^{-5}	4.3·10^{-4}
IPQ	1.0002900	4.0·10^{-4}	0.06	N	-9.8·10^{-5}	8.3·10^{-4}
LNE	1.0004000	1.5·10^{-4}	0.00	N	1.2·10^{-5}	4.0·10^{-4}
PTB-6	1.0001630	1.7·10^{-4}	1.05	N	-2.3·10^{-4}	4.3·10^{-4}
CEM	1.0007900	1.9·10^{-4}	2.90	N	4.0·10^{-4}	4.6·10^{-4}
PTB-7	1.0003700	1.7·10^{-4}	0.01	N	-1.8·10^{-5}	4.3·10^{-4}
KRISS	1.0000700	2.9·10^{-5}	5.10	N	-3.2·10^{-4}	2.7·10^{-4}
PTB-8	1.0004880	1.7·10^{-4}	0.21	N	1.0·10^{-4}	4.3·10^{-4}
MIKES	1.0008980	2.1·10^{-4}	4.09	N	5.1·10^{-4}	5.0·10^{-4}
PTB-9	1.0003680	1.7·10^{-4}	0.01	N	-2.0·10^{-5}	4.3·10^{-4}
PTB-10	1.0003690	1.7·10^{-4}	0.01	N	-1.9·10^{-5}	4.3·10^{-4}
VSL-2	1.0001974	1.8·10^{-4}	0.70	N	-1.9·10^{-4}	4.5·10^{-4}
NPL-2	1.0005200	1.3·10^{-4}	0.49	N	1.3·10^{-4}	3.7·10^{-4}
PTB-11	1.0004490	1.7·10^{-4}	0.08	N	6.1·10^{-5}	4.3·10^{-4}

Number of discarded results = 1, percentage = 4 %.
$F_r = \sum e_i$ = 33.02, summed over the undiscarded contributions.
Degree of freedom $v = r$-1 = 23.

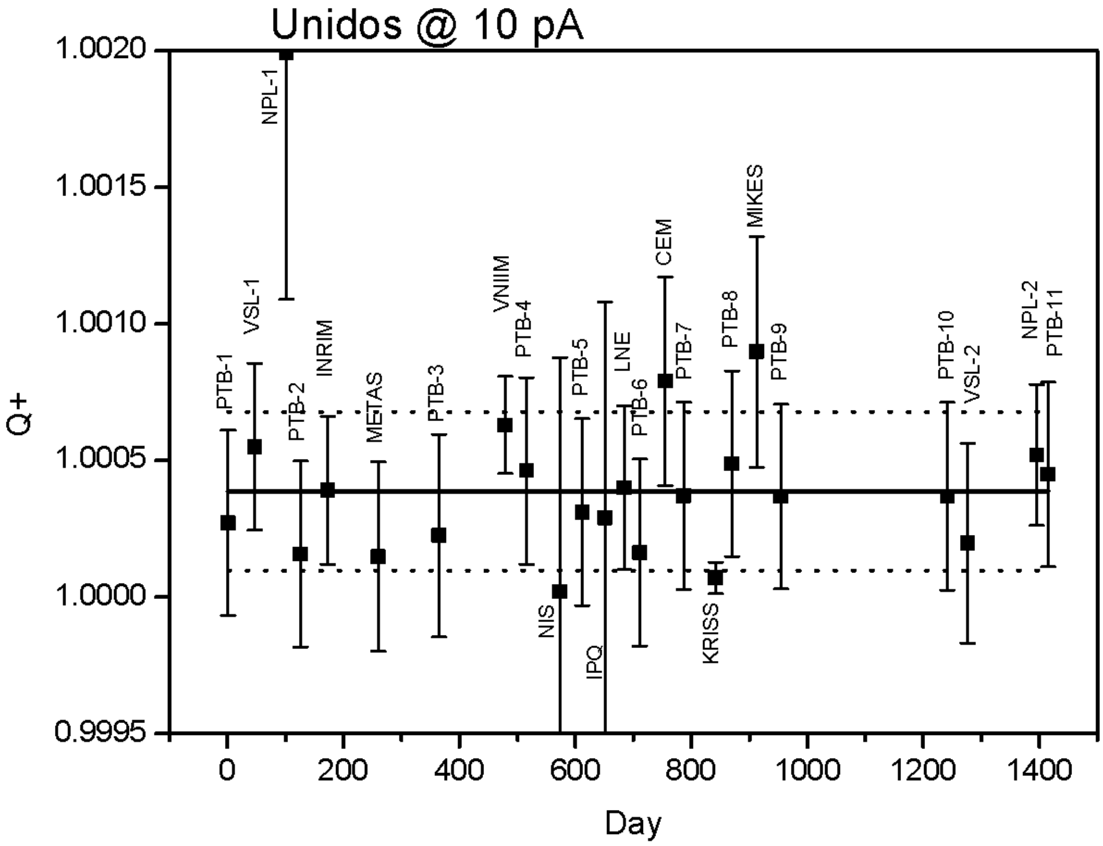

Fig. 6.7: Calibration factors for the Unidos at 10 pA for positive current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 10 pA, negative current direction:

Reference value: Q_{ref} = 1.00123118, $u(Q_{ref})$ = 4.79·10^{-5}
Uncertainty describing the instability of the transfer standard: u_{TS} = 1.38·10^{-4}

Table 6.8: Summary of the results containing: the result Q_i of each participant, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0013990	1.7·10^{-4}	0.59	N	1.7·10^{-4}	4.3·10^{-4}
VSL-1	1.0010300	1.5·10^{-4}	0.96	N	-2.0·10^{-4}	4.0·10^{-4}
NPL-1	0.9998520	5.0·10^{-4}	7.02	N	-1.4·10^{-3}	1.0·10^{-3}
PTB-2	1.0015710	1.7·10^{-4}	2.41	N	3.4·10^{-4}	4.3·10^{-4}
INRIM	1.0013510	1.4·10^{-4}	0.38	N	1.2·10^{-4}	3.7·10^{-4}
METAS	1.0014080	2.6·10^{-4}	0.36	N	1.8·10^{-4}	5.8·10^{-4}
UME	0.9997000	8.2·10^{-4}	3.41	N	-1.5·10^{-3}	1.7·10^{-3}
PTB-3	1.0014090	1.8·10^{-4}	0.60	N	1.8·10^{-4}	4.5·10^{-4}
VNIIM	1.0006400	9.5·10^{-5}	12.44	Y	-5.9·10^{-4}	3.5·10^{-4}
PTB-4	1.0012730	1.7·10^{-4}	0.04	N	4.2·10^{-5}	4.3·10^{-4}
NIS	1.0003000	4.3·10^{-4}	4.28	N	-9.3·10^{-4}	9.0·10^{-4}
PTB-5	1.0012810	1.7·10^{-4}	0.05	N	5.0·10^{-5}	4.3·10^{-4}
IPQ	1.0013100	6.3·10^{-4}	0.01	N	7.9·10^{-5}	1.3·10^{-3}
LNE	1.0019000	1.5·10^{-4}	10.76	Y	6.7·10^{-4}	4.2·10^{-4}
PTB-6	1.0013850	1.7·10^{-4}	0.49	N	1.5·10^{-4}	4.3·10^{-4}
CEM	1.0008000	1.7·10^{-4}	3.85	N	-4.3·10^{-4}	4.3·10^{-4}
PTB-7	1.0012560	1.7·10^{-4}	0.01	N	2.5·10^{-5}	4.3·10^{-4}
KRISS	1.0013590	2.9·10^{-5}	0.82	N	1.3·10^{-4}	2.7·10^{-4}
PTB-8	1.0011100	1.7·10^{-4}	0.31	N	-1.2·10^{-4}	4.3·10^{-4}
MIKES	1.0010810	2.1·10^{-4}	0.35	N	-1.5·10^{-4}	5.0·10^{-4}
PTB-9	1.0011310	1.7·10^{-4}	0.21	N	-1.0·10^{-4}	4.3·10^{-4}
PTB-10	1.0014890	1.7·10^{-4}	1.36	N	2.6·10^{-4}	4.3·10^{-4}
VSL-2	1.0013678	1.8·10^{-4}	0.36	N	1.4·10^{-4}	4.5·10^{-4}
NPL-2	1.0011700	1.3·10^{-4}	0.11	N	-6.1·10^{-5}	3.7·10^{-4}
PTB-11	1.0009890	1.7·10^{-4}	1.23	N	-2.4·10^{-4}	4.3·10^{-4}

Number of discarded results = 2, percentage = 8 %.
$F_r = \sum e_i$ = 29.21, summed over the undiscarded contributions.
Degree of freedom $\nu = r$-1 = 22.

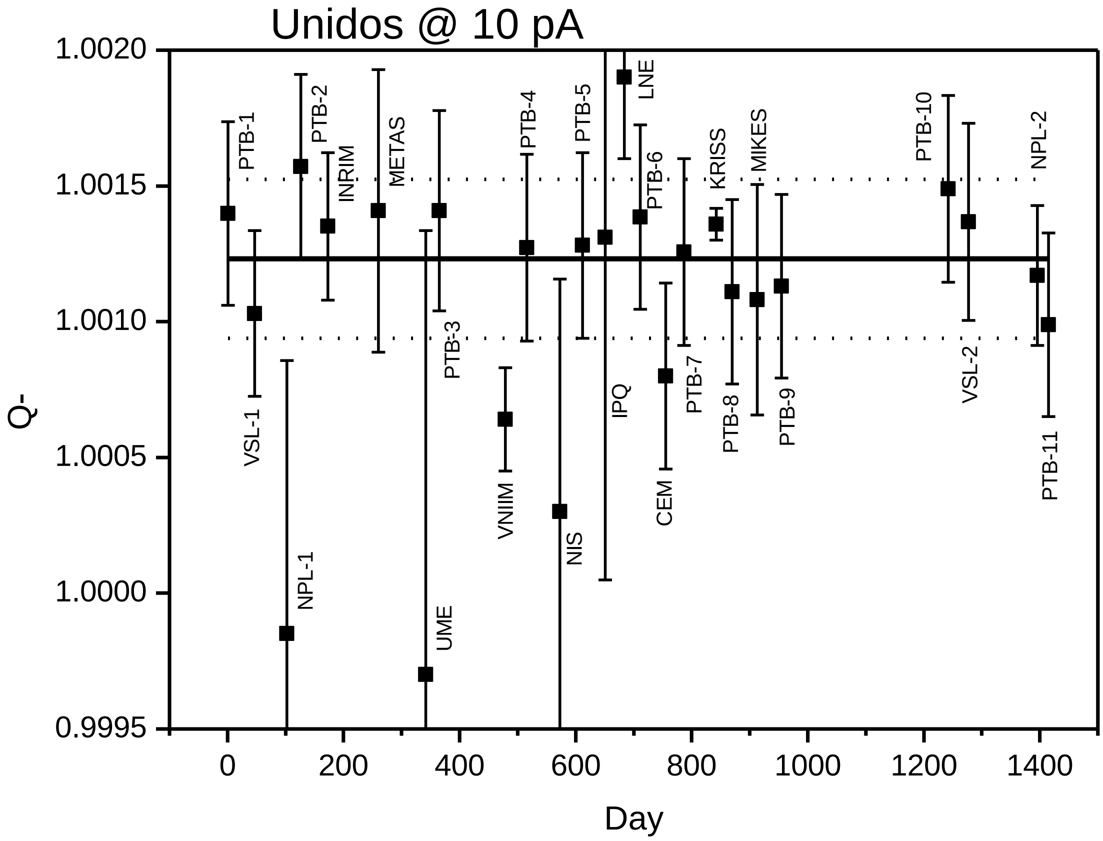

Fig. 6.8: Calibration factors for the Unidos at 10 pA for negative current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 10 pA, mean of both current directions:

Reference value: Q_{ref} = 1.00079514, $u(Q_{ref})$ = 4.47·10^{-5}
Uncertainty describing the instability of the transfer standard: u_{TS} = 1.38·10^{-4}

Table 6.9: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0008350	1.7·10^{-4}	0.03	N	4.1·10^{-5}	4.3·10^{-4}
VSL-1	1.0007900	1.5·10^{-4}	0.00	N	-4.4·10^{-6}	4.0·10^{-4}
NPL-1	1.0009220	4.8·10^{-4}	0.07	N	1.3·10^{-4}	9.9·10^{-4}
PTB-2	1.0008640	1.7·10^{-4}	0.10	N	7.0·10^{-5}	4.3·10^{-4}
INRIM	1.0008710	1.4·10^{-4}	0.16	N	7.7·10^{-5}	3.8·10^{-4}
METAS	1.0007780	2.2·10^{-4}	0.00	N	-1.6·10^{-5}	5.1·10^{-4}
UME	0.9978500	6.7·10^{-4}	18.55	N	-2.9·10^{-3}	1.4·10^{-3}
PTB-3	1.0008170	1.8·10^{-4}	0.01	N	2.3·10^{-5}	4.5·10^{-4}
VNIIM	1.0006350	9.2·10^{-5}	0.92	N	-1.6·10^{-4}	3.2·10^{-4}
PTB-4	1.0008675	1.7·10^{-4}	0.11	N	7.3·10^{-5}	4.3·10^{-4}
NIS	1.0001600	4.3·10^{-4}	1.99	N	-6.3·10^{-4}	9.0·10^{-4}
PTB-5	1.0007955	1.7·10^{-4}	0.00	N	1.1·10^{-6}	4.3·10^{-4}
IPQ	1.0008000	5.1·10^{-4}	0.00	N	5.6·10^{-6}	1.1·10^{-3}
LNE	1.0011500	1.5·10^{-4}	3.04	N	3.6·10^{-4}	4.0·10^{-4}
PTB-6	1.0007740	1.7·10^{-4}	0.01	N	-2.0·10^{-5}	4.3·10^{-4}
CEM	1.0007950	1.8·10^{-4}	0.00	N	6.2·10^{-7}	4.5·10^{-4}
PTB-7	1.0008130	1.7·10^{-4}	0.01	N	1.9·10^{-5}	4.3·10^{-4}
KRISS	1.0007145	2.9·10^{-5}	0.32	N	-8.0·10^{-5}	2.7·10^{-4}
PTB-8	1.0007990	1.7·10^{-4}	0.00	N	4.6·10^{-6}	4.3·10^{-4}
MIKES	1.0009895	2.1·10^{-4}	0.60	N	2.0·10^{-4}	5.0·10^{-4}
PTB-9	1.0007495	1.7·10^{-4}	0.04	N	-4.5·10^{-5}	4.3·10^{-4}
PTB-10	1.0009290	1.7·10^{-4}	0.37	N	1.3·10^{-4}	4.3·10^{-4}
VSL-2	1.0007826	1.8·10^{-4}	0.00	N	-1.2·10^{-5}	4.5·10^{-4}
NPL-2	1.0008450	1.3·10^{-4}	0.07	N	5.1·10^{-5}	3.7·10^{-4}
PTB-11	1.0007190	1.7·10^{-4}	0.12	N	-7.5·10^{-5}	4.3·10^{-4}

Number of discarded results = 0, percentage = 0 %.
$F_r = \sum e_i$ = 26.53, summed over the undiscarded contributions.
Degree of freedom $v = r$-1 = 24.

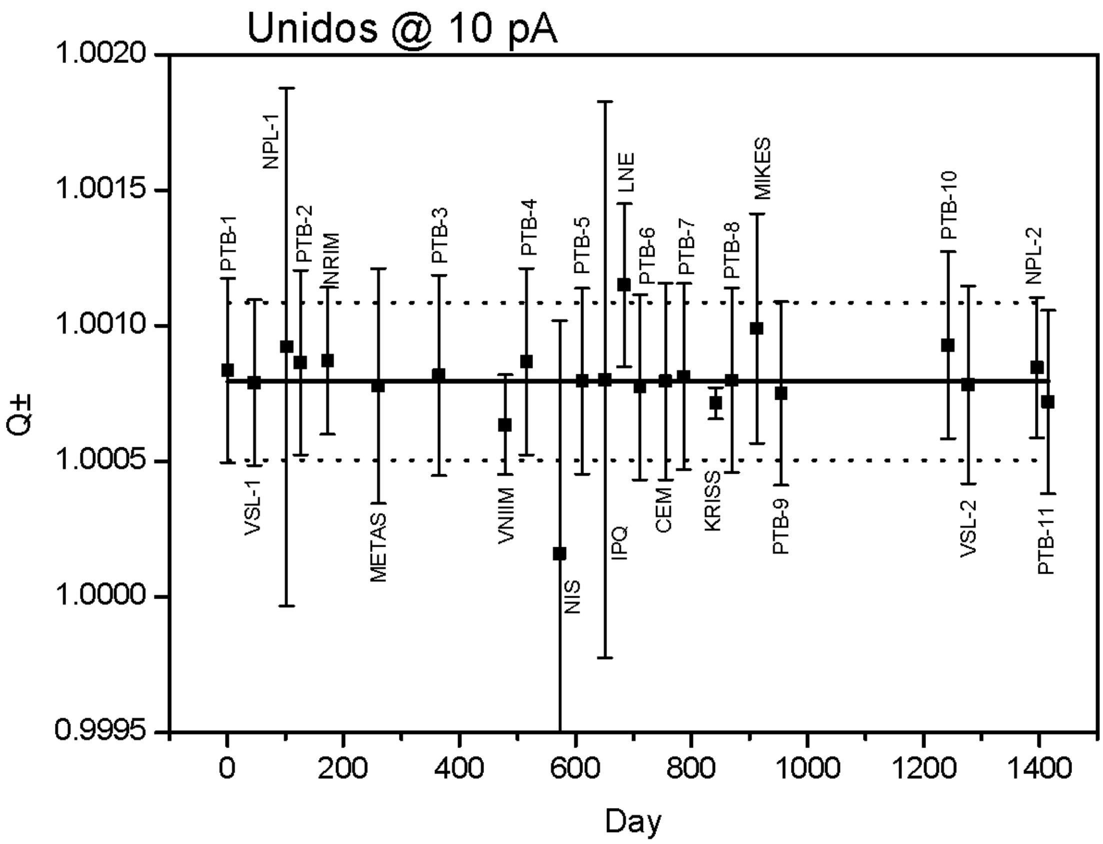

Fig. 6.9: : Calibration factors for the Unidos at 10 pA for the mean of both current directions, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 100 pA, positive current direction:

Reference value: Q_{ref} = 1.00042401, $u(Q_{ref})$ = 5.35·10^{-5}
Uncertainty describing the instability of the transfer standard: u_{TS} = 2.0·10^{-4}

Table 6.10: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0001450	1.7·10^{-4}	1.16	N	-2.8·10^{-4}	5.1·10^{-4}
VSL-1	1.0004200	3.1·10^{-4}	0.00	N	-5.8·10^{-6}	7.3·10^{-4}
NPL-1	1.0007210	4.5·10^{-4}	0.36	N	3.0·10^{-4}	9.8·10^{-4}
PTB-2	1.0005960	1.7·10^{-4}	0.43	N	1.7·10^{-4}	5.1·10^{-4}
INRIM	1.0003110	1.6·10^{-4}	0.21	N	-1.1·10^{-4}	4.9·10^{-4}
METAS	1.0000390	7.4·10^{-5}	3.38	N	-3.9·10^{-4}	4.1·10^{-4}
UME	0.9963000	2.4·10^{-4}	177.87	Y	-4.1·10^{-3}	6.3·10^{-4}
PTB-3	1.0001640	1.7·10^{-4}	1.02	N	-2.6·10^{-4}	5.1·10^{-4}
VNIIM	1.0004170	4.1·10^{-5}	0.00	N	-8.8·10^{-6}	3.9·10^{-4}
PTB-4	1.0005990	1.7·10^{-4}	0.44	N	1.7·10^{-4}	5.1·10^{-4}
NIS	1.0016000	3.4·10^{-4}	8.99	N	1.2·10^{-3}	7.8·10^{-4}
PTB-5	1.0004670	1.7·10^{-4}	0.03	N	4.1·10^{-5}	5.1·10^{-4}
IPQ	1.0002800	3.8·10^{-4}	0.12	N	-1.5·10^{-4}	8.4·10^{-4}
LNE	1.0006400	1.4·10^{-4}	0.79	N	2.1·10^{-4}	4.7·10^{-4}
PTB-6	1.0001150	1.7·10^{-4}	1.43	N	-3.1·10^{-4}	5.1·10^{-4}
CEM	1.0007000	1.7·10^{-4}	1.10	N	2.7·10^{-4}	5.1·10^{-4}
PTB-7	1.0001440	1.7·10^{-4}	1.19	N	-2.8·10^{-4}	5.1·10^{-4}
KRISS	1.0006400	2.9·10^{-5}	1.16	N	2.1·10^{-4}	3.8·10^{-4}
PTB-8	1.0005730	1.7·10^{-4}	0.32	N	1.5·10^{-4}	5.1·10^{-4}
MIKES	1.0005900	1.5·10^{-4}	0.45	N	1.6·10^{-4}	4.8·10^{-4}
PTB-9	1.0002470	1.7·10^{-4}	0.48	N	-1.8·10^{-4}	5.0·10^{-4}
PTB-10	1.0005720	1.7·10^{-4}	0.32	N	1.5·10^{-4}	5.0·10^{-4}
VSL-2	1.0007296	3.6·10^{-4}	0.55	N	3.0·10^{-4}	8.2·10^{-4}
NPL-2	1.0000700	1.2·10^{-4}	2.38	N	-3.6·10^{-4}	4.5·10^{-4}
PTB-11	1.0004710	1.7·10^{-4}	0.03	N	4.5·10^{-5}	5.0·10^{-4}

Number of discarded results = 1, percentage = 4 %.
$F_r = \sum e_i$ = 26.33, summed over the undiscarded contributions.
Degree of freedom $v = r$-1 = 23.

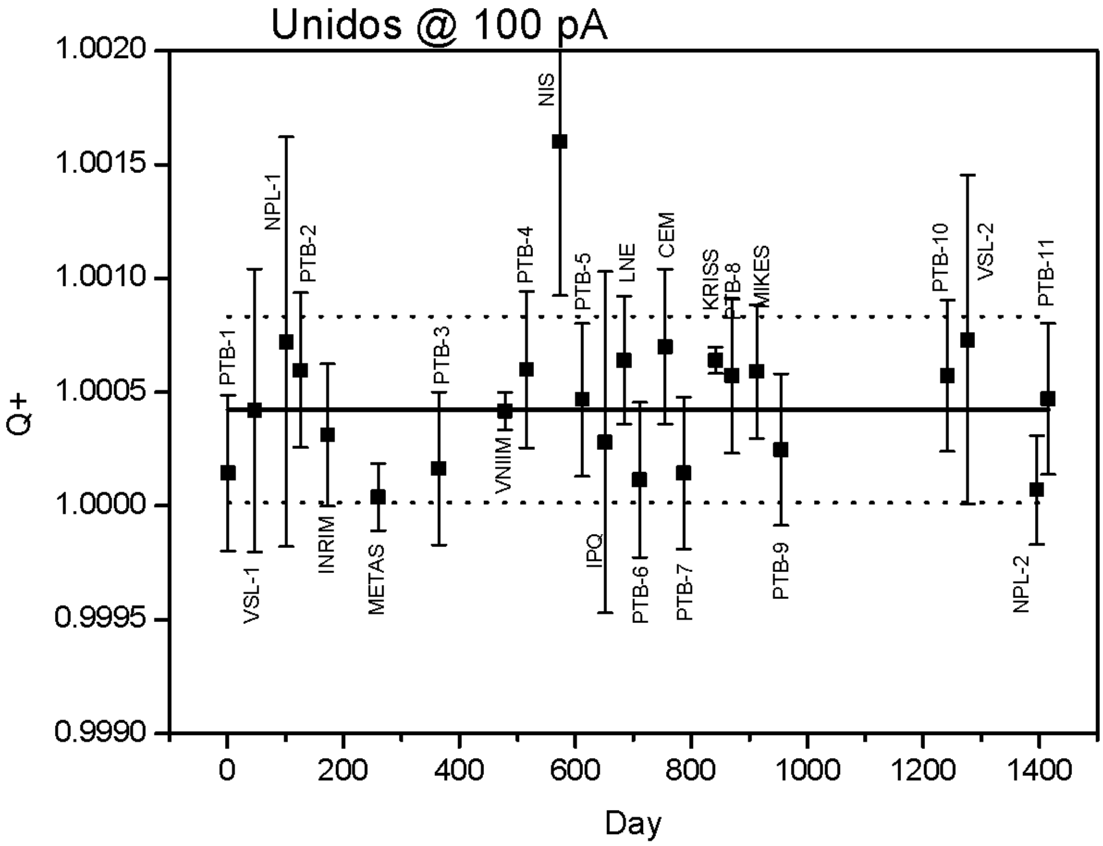

Fig. 6.10: Calibration factors for the Unidos at 100 pA for positive current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 100 pA, negative current direction:

Reference value: Q_{ref} = 1.00080189, $u(Q_{ref})$ = 5.42·10^{-5}
Uncertainty describing the instability of the transfer standard: u_{TS} = 2.0·10^{-4}

Table 6.11: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0011940	1.7·10^{-4}	2.29	N	3.9·10^{-4}	5.1·10^{-4}
VSL-1	1.0008200	3.1·10^{-4}	0.00	N	1.9·10^{-5}	7.2·10^{-4}
NPL-1	1.0005340	4.5·10^{-4}	0.29	N	-2.7·10^{-4}	9.8·10^{-4}
PTB-2	1.0007210	1.7·10^{-4}	0.09	N	-8.0·10^{-5}	5.1·10^{-4}
INRIM	1.0010710	1.5·10^{-4}	1.22	N	2.7·10^{-4}	4.8·10^{-4}
METAS	1.0011010	7.4·10^{-5}	2.04	N	3.0·10^{-4}	4.1·10^{-4}
UME	0.9973000	5.3·10^{-4}	38.68	Y	-3.5·10^{-3}	1.1·10^{-3}
PTB-3	1.0009570	1.7·10^{-4}	0.36	N	1.6·10^{-4}	5.1·10^{-4}
VNIIM	1.0004290	3.8·10^{-5}	3.43	N	-3.7·10^{-4}	3.9·10^{-4}
PTB-4	1.0009590	1.7·10^{-4}	0.37	N	1.6·10^{-4}	5.1·10^{-4}
NIS	0.9990000	3.4·10^{-4}	21.15	Y	-1.8·10^{-3}	7.9·10^{-4}
PTB-5	1.0008210	1.7·10^{-4}	0.01	N	2.0·10^{-5}	5.1·10^{-4}
IPQ	1.0010000	6.9·10^{-4}	0.08	N	2.0·10^{-4}	1.4·10^{-3}
LNE	1.0006500	1.4·10^{-4}	0.39	N	-1.5·10^{-4}	4.7·10^{-4}
PTB-6	1.0010050	1.7·10^{-4}	0.61	N	2.0·10^{-4}	5.1·10^{-4}
CEM	1.0006860	1.7·10^{-4}	0.19	N	-1.1·10^{-4}	5.1·10^{-4}
PTB-7	1.0011100	1.7·10^{-4}	1.44	N	3.1·10^{-4}	5.1·10^{-4}
KRISS	1.0004220	2.9·10^{-5}	3.61	N	-3.8·10^{-4}	3.8·10^{-4}
PTB-8	1.0007710	1.7·10^{-4}	0.01	N	-3.0·10^{-5}	5.0·10^{-4}
MIKES	1.0007090	1.5·10^{-4}	0.14	N	-9.2·10^{-5}	4.8·10^{-4}
PTB-9	1.0006260	1.7·10^{-4}	0.46	N	-1.7·10^{-4}	5.0·10^{-4}
PTB-10	1.0005840	1.7·10^{-4}	0.71	N	-2.2·10^{-4}	5.0·10^{-4}
VSL-2	1.0004756	3.6·10^{-4}	0.63	N	-3.2·10^{-4}	8.1·10^{-4}
NPL-2	1.0012200	1.2·10^{-4}	3.31	N	4.2·10^{-4}	4.5·10^{-4}
PTB-11	1.0006340	1.7·10^{-4}	0.42	N	-1.7·10^{-4}	5.0·10^{-4}

Number of discarded results = 2, percentage = 8 %.
$F_r = \sum e_i$ = 22.09, summed over the undiscarded contributions.
Degree of freedom $v = r$-1 = 22.

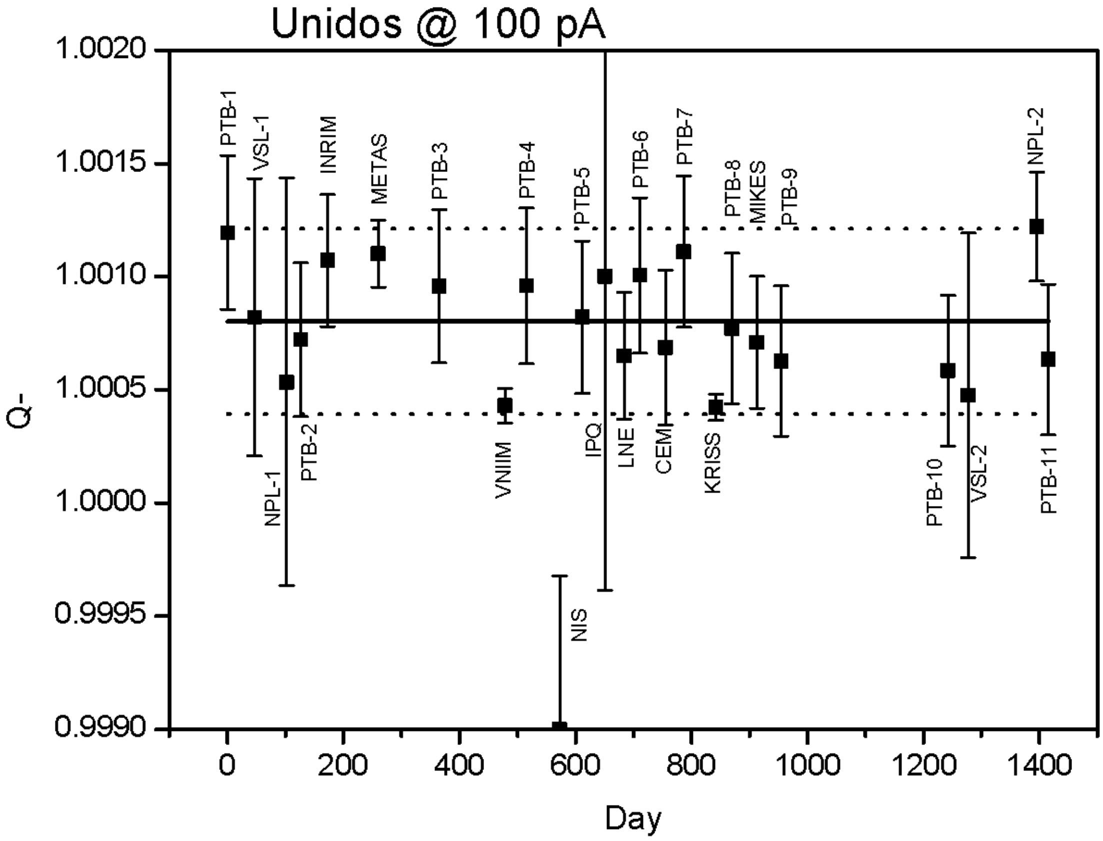

Fig. 6.11: Calibration factors for the Unidos at 100 pA for negative current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the PTW Unidos E at 100 pA, mean of both current direction:

Reference value: Q_{ref} = 1.00059677, $u(Q_{ref})$ = $5.37 \cdot 10^{-5}$
Uncertainty describing the instability of the transfer standard: u_{TS} = $2.0 \cdot 10^{-4}$

Table 6.12: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	1.0006695	$1.7 \cdot 10^{-4}$	0.08	N	$7.2 \cdot 10^{-5}$	$5.1 \cdot 10^{-4}$
VSL-1	1.0006200	$3.1 \cdot 10^{-4}$	0.00	N	$2.2 \cdot 10^{-5}$	$7.2 \cdot 10^{-4}$
NPL-1	1.0006275	$4.5 \cdot 10^{-4}$	0.00	N	$3.0 \cdot 10^{-5}$	$9.8 \cdot 10^{-4}$
PTB-2	1.0006585	$1.7 \cdot 10^{-4}$	0.05	N	$6.1 \cdot 10^{-5}$	$5.1 \cdot 10^{-4}$
INRIM	1.0006910	$1.5 \cdot 10^{-4}$	0.14	N	$9.3 \cdot 10^{-5}$	$4.8 \cdot 10^{-4}$
METAS	1.0005700	$7.4 \cdot 10^{-5}$	0.02	N	$-2.8 \cdot 10^{-5}$	$4.1 \cdot 10^{-4}$
UME	0.9968000	$3.8 \cdot 10^{-4}$	77.78	Y	$-3.8 \cdot 10^{-3}$	$8.7 \cdot 10^{-4}$
PTB-3	1.0005605	$1.7 \cdot 10^{-4}$	0.02	N	$-3.7 \cdot 10^{-5}$	$5.1 \cdot 10^{-4}$
VNIIM	1.0004230	$4.0 \cdot 10^{-5}$	0.75	N	$-1.7 \cdot 10^{-4}$	$3.9 \cdot 10^{-4}$
PTB-4	1.0007790	$1.7 \cdot 10^{-4}$	0.48	N	$1.8 \cdot 10^{-4}$	$5.1 \cdot 10^{-4}$
NIS	1.0003000	$3.4 \cdot 10^{-4}$	0.58	N	$-3.0 \cdot 10^{-4}$	$7.8 \cdot 10^{-4}$
PTB-5	1.0006440	$1.7 \cdot 10^{-4}$	0.03	N	$4.6 \cdot 10^{-5}$	$5.1 \cdot 10^{-4}$
IPQ	1.0006400	$5.3 \cdot 10^{-4}$	0.01	N	$4.2 \cdot 10^{-5}$	$1.1 \cdot 10^{-3}$
LNE	1.0006450	$1.4 \cdot 10^{-4}$	0.04	N	$4.7 \cdot 10^{-5}$	$4.7 \cdot 10^{-4}$
PTB-6	1.0005600	$1.7 \cdot 10^{-4}$	0.02	N	$-3.8 \cdot 10^{-5}$	$5.1 \cdot 10^{-4}$
CEM	1.0006930	$1.7 \cdot 10^{-4}$	0.13	N	$9.5 \cdot 10^{-5}$	$5.1 \cdot 10^{-4}$
PTB-7	1.0006270	$1.7 \cdot 10^{-4}$	0.01	N	$2.9 \cdot 10^{-5}$	$5.1 \cdot 10^{-4}$
KRISS	1.0005310	$2.9 \cdot 10^{-5}$	0.11	N	$-6.7 \cdot 10^{-5}$	$3.8 \cdot 10^{-4}$
PTB-8	1.0006720	$1.7 \cdot 10^{-4}$	0.08	N	$7.4 \cdot 10^{-5}$	$5.1 \cdot 10^{-4}$
MIKES	1.0006495	$1.5 \cdot 10^{-4}$	0.04	N	$5.2 \cdot 10^{-5}$	$4.8 \cdot 10^{-4}$
PTB-9	1.0004365	$1.7 \cdot 10^{-4}$	0.39	N	$-1.6 \cdot 10^{-4}$	$5.0 \cdot 10^{-4}$
PTB-10	1.0005780	$1.7 \cdot 10^{-4}$	0.01	N	$-2.0 \cdot 10^{-5}$	$5.0 \cdot 10^{-4}$
VSL-2	1.0006026	$3.6 \cdot 10^{-4}$	0.00	N	$5.0 \cdot 10^{-6}$	$8.1 \cdot 10^{-4}$
NPL-2	1.0006450	$1.2 \cdot 10^{-4}$	0.04	N	$4.7 \cdot 10^{-5}$	$4.5 \cdot 10^{-4}$
PTB-11	1.0005525	$1.7 \cdot 10^{-4}$	0.03	N	$-4.5 \cdot 10^{-5}$	$5.0 \cdot 10^{-4}$

Number of discarded results = 1, percentage = 4 %.
$F_r = \sum e_i$ = 3.08, summed over the undiscarded contributions.
Degree of freedom $\nu = r$-1 = 23.

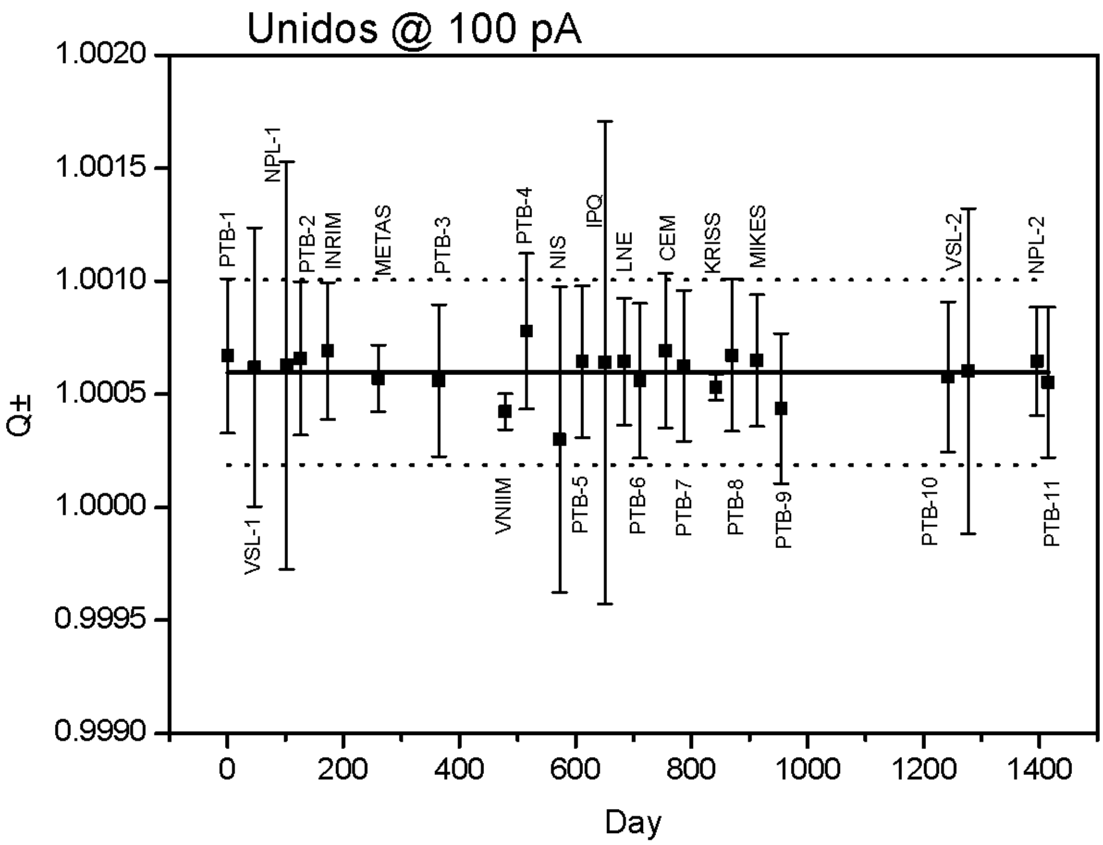

Fig. 6.12: Calibration factors for the Unidos at 100 pA for the mean of both current directions, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

6.2.2 Results for the Keithley 6430

Results for the Keithley 6430 at 100 fA, positive current direction:

Reference value: Q_{ref} = 1.00093470, $u(Q_{ref})$ = $1.32 \cdot 10^{-4}$
Uncertainty describing the instability of the transfer standard: u_{TS} = $4.56 \cdot 10^{-4}$

Table 6.13: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9993851	$1.6 \cdot 10^{-4}$	10.29	Y	$-1.6 \cdot 10^{-3}$	$1.0 \cdot 10^{-3}$
VSL-1	1.0024100	$1.8 \cdot 10^{-4}$	9.03	N	$1.5 \cdot 10^{-3}$	$9.4 \cdot 10^{-4}$
NPL-1	1.0214000	$2.2 \cdot 10^{-3}$	86.58	Y	$2.0 \cdot 10^{-2}$	$4.4 \cdot 10^{-3}$
PTB-2	1.0018130	$2.0 \cdot 10^{-4}$	3.12	N	$8.8 \cdot 10^{-4}$	$9.6 \cdot 10^{-4}$
INRIM	1.0005290	$4.4 \cdot 10^{-4}$	0.41	N	$-4.1 \cdot 10^{-4}$	$1.2 \cdot 10^{-3}$
METAS	1.0002610	$6.5 \cdot 10^{-4}$	0.72	N	$-6.8 \cdot 10^{-4}$	$1.6 \cdot 10^{-3}$
UME	1.0360000	$1.6 \cdot 10^{-2}$	4.89	N	$3.5 \cdot 10^{-2}$	$3.2 \cdot 10^{-2}$
PTB-3	1.0012420	$2.3 \cdot 10^{-4}$	0.36	N	$3.1 \cdot 10^{-4}$	$9.9 \cdot 10^{-4}$
VNIIM	1.0000300	$2.4 \cdot 10^{-4}$	3.12	N	$-9.1 \cdot 10^{-4}$	$9.9 \cdot 10^{-4}$
PTB-4	1.0009550	$2.5 \cdot 10^{-4}$	0.00	N	$1.9 \cdot 10^{-5}$	$1.0 \cdot 10^{-3}$
NIS	1.0180000	$1.9 \cdot 10^{-3}$	74.97	Y	$1.7 \cdot 10^{-2}$	$4.0 \cdot 10^{-3}$
PTB-5	1.0014510	$5.5 \cdot 10^{-4}$	0.52	N	$5.1 \cdot 10^{-4}$	$1.4 \cdot 10^{-3}$
IPQ	1.0038000	$6.1 \cdot 10^{-3}$	0.22	N	$2.9 \cdot 10^{-3}$	$1.2 \cdot 10^{-2}$
LNE	1.0001000	$1.4 \cdot 10^{-3}$	0.32	N	$-8.4 \cdot 10^{-4}$	$2.9 \cdot 10^{-3}$
PTB-6	1.0012600	$3.3 \cdot 10^{-4}$	0.33	N	$3.2 \cdot 10^{-4}$	$1.1 \cdot 10^{-3}$
CEM	0.9999200	$3.3 \cdot 10^{-4}$	3.26	N	$-1.0 \cdot 10^{-3}$	$1.1 \cdot 10^{-3}$
PTB-7	1.0006230	$3.7 \cdot 10^{-4}$	0.28	N	$-3.1 \cdot 10^{-4}$	$1.1 \cdot 10^{-3}$
KRISS	1.0037350	$5.2 \cdot 10^{-4}$	16.54	Y	$2.8 \cdot 10^{-3}$	$1.4 \cdot 10^{-3}$
PTB-8	1.0006660	$2.1 \cdot 10^{-4}$	0.29	N	$-2.7 \cdot 10^{-4}$	$9.6 \cdot 10^{-4}$
MIKES	1.0015260	$2.8 \cdot 10^{-4}$	1.21	N	$5.9 \cdot 10^{-4}$	$1.0 \cdot 10^{-3}$
PTB-9	1.0005380	$1.5 \cdot 10^{-4}$	0.68	N	$-4.0 \cdot 10^{-4}$	$9.3 \cdot 10^{-4}$
PTB-10	1.0006280	$2.6 \cdot 10^{-4}$	0.35	N	$-3.1 \cdot 10^{-4}$	$1.0 \cdot 10^{-3}$
VSL-2	1.0024669	$1.2 \cdot 10^{-4}$	10.59	Y	$1.5 \cdot 10^{-3}$	$9.8 \cdot 10^{-4}$
NPL-2	1.0004600	$1.5 \cdot 10^{-3}$	0.09	N	$-4.8 \cdot 10^{-4}$	$3.2 \cdot 10^{-3}$
PTB-11	1.0001630	$2.8 \cdot 10^{-4}$	2.10	N	$-7.7 \cdot 10^{-4}$	$1.0 \cdot 10^{-3}$
PTB-12	1.0015790	$4.6 \cdot 10^{-4}$	0.99	N	$6.4 \cdot 10^{-4}$	$1.3 \cdot 10^{-3}$

Number of discarded results = 5, percentage = 19%.
$F_r = \sum e_i$ = 32.30, summed over the undiscarded contributions.
Degree of freedom = 20.

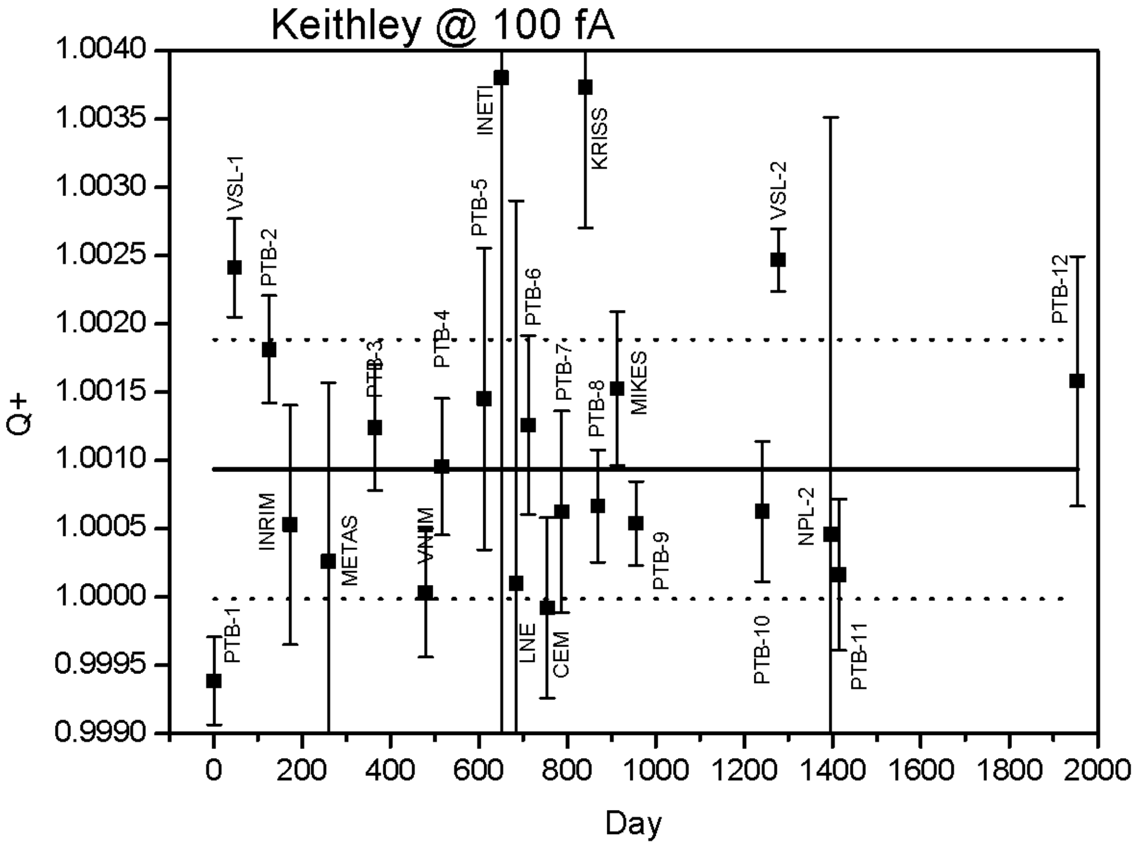

Fig. 6.13: Calibration factors for the Keithley at 100 fA for positive current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 100 fA, negative current direction:

Reference value: Q_{ref} = 1.00089524, $u(Q_{ref})$ = $1.37 \cdot 10^{-4}$
Uncertainty describing the instability of the transfer standard: u_{TS} = $4.56 \cdot 10^{-4}$

Table 6.14: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9995964	$1.4 \cdot 10^{-4}$	7.46	Y	$-1.3 \cdot 10^{-3}$	$9.9 \cdot 10^{-4}$
VSL-1	0.9991000	$1.9 \cdot 10^{-4}$	13.20	Y	$-1.8 \cdot 10^{-3}$	$1.0 \cdot 10^{-3}$
NPL-1	0.9797000	$1.4 \cdot 10^{-3}$	214.47	Y	$-2.1 \cdot 10^{-2}$	$2.9 \cdot 10^{-3}$
PTB-2	1.0010150	$1.7 \cdot 10^{-4}$	0.06	N	$1.2 \cdot 10^{-4}$	$9.3 \cdot 10^{-4}$
INRIM	1.0005050	$4.6 \cdot 10^{-4}$	0.37	N	$-3.9 \cdot 10^{-4}$	$1.3 \cdot 10^{-3}$
METAS	1.0001150	$6.0 \cdot 10^{-4}$	1.08	N	$-7.8 \cdot 10^{-4}$	$1.5 \cdot 10^{-3}$
UME	0.9510000	$1.2 \cdot 10^{-2}$	18.52	Y	$-5.0 \cdot 10^{-2}$	$2.3 \cdot 10^{-2}$
PTB-3	1.0007100	$2.5 \cdot 10^{-4}$	0.13	N	$-1.9 \cdot 10^{-4}$	$1.0 \cdot 10^{-3}$
VNIIM	1.0000200	$2.7 \cdot 10^{-4}$	2.72	N	$-8.8 \cdot 10^{-4}$	$1.0 \cdot 10^{-3}$
PTB-4	1.0008960	$2.9 \cdot 10^{-4}$	0.00	N	$-3.8 \cdot 10^{-7}$	$1.0 \cdot 10^{-3}$
NIS	0.9931000	$3.2 \cdot 10^{-3}$	5.89	N	$-7.8 \cdot 10^{-3}$	$6.4 \cdot 10^{-3}$
PTB-5	1.0015070	$5.2 \cdot 10^{-4}$	0.78	N	$6.1 \cdot 10^{-4}$	$1.4 \cdot 10^{-3}$
IPQ	1.0010000	$3.1 \cdot 10^{-3}$	0.00	N	$1.0 \cdot 10^{-4}$	$6.3 \cdot 10^{-3}$
LNE	1.0040200	$9.6 \cdot 10^{-4}$	8.61	Y	$3.1 \cdot 10^{-3}$	$2.1 \cdot 10^{-3}$
PTB-6	1.0012150	$3.1 \cdot 10^{-4}$	0.33	N	$3.2 \cdot 10^{-4}$	$1.1 \cdot 10^{-3}$
CEM	1.0015900	$5.4 \cdot 10^{-4}$	0.97	N	$6.9 \cdot 10^{-4}$	$1.4 \cdot 10^{-3}$
PTB-7	1.0020040	$3.7 \cdot 10^{-4}$	3.56	N	$1.1 \cdot 10^{-3}$	$1.1 \cdot 10^{-3}$
KRISS	0.9990720	$5.0 \cdot 10^{-4}$	7.32	N	$-1.8 \cdot 10^{-3}$	$1.3 \cdot 10^{-3}$
PTB-8	1.0012990	$1.8 \cdot 10^{-4}$	0.67	N	$4.0 \cdot 10^{-4}$	$9.4 \cdot 10^{-4}$
MIKES	1.0005880	$2.8 \cdot 10^{-4}$	0.33	N	$-3.1 \cdot 10^{-4}$	$1.0 \cdot 10^{-3}$
PTB-9	1.0013280	$1.6 \cdot 10^{-4}$	0.80	N	$4.3 \cdot 10^{-4}$	$9.3 \cdot 10^{-4}$
PTB-10	1.0011560	$2.2 \cdot 10^{-4}$	0.26	N	$2.6 \cdot 10^{-4}$	$9.7 \cdot 10^{-4}$
VSL-2	0.9994004	$1.2 \cdot 10^{-4}$	10.10	Y	$-1.5 \cdot 10^{-3}$	$9.8 \cdot 10^{-4}$
NPL-2	0.9994300	$2.1 \cdot 10^{-3}$	0.48	N	$-1.5 \cdot 10^{-3}$	$4.2 \cdot 10^{-3}$
PTB-11	1.0014660	$3.5 \cdot 10^{-4}$	0.98	N	$5.7 \cdot 10^{-4}$	$1.1 \cdot 10^{-3}$
PTB-12	1.0003340	$4.1 \cdot 10^{-4}$	0.85	N	$-5.6 \cdot 10^{-4}$	$1.2 \cdot 10^{-3}$

Number of discarded results = 6, percentage = 23%.
$F_r = \sum e_i$ = 27.59, summed over the undiscarded contributions.
Degree of freedom =19.

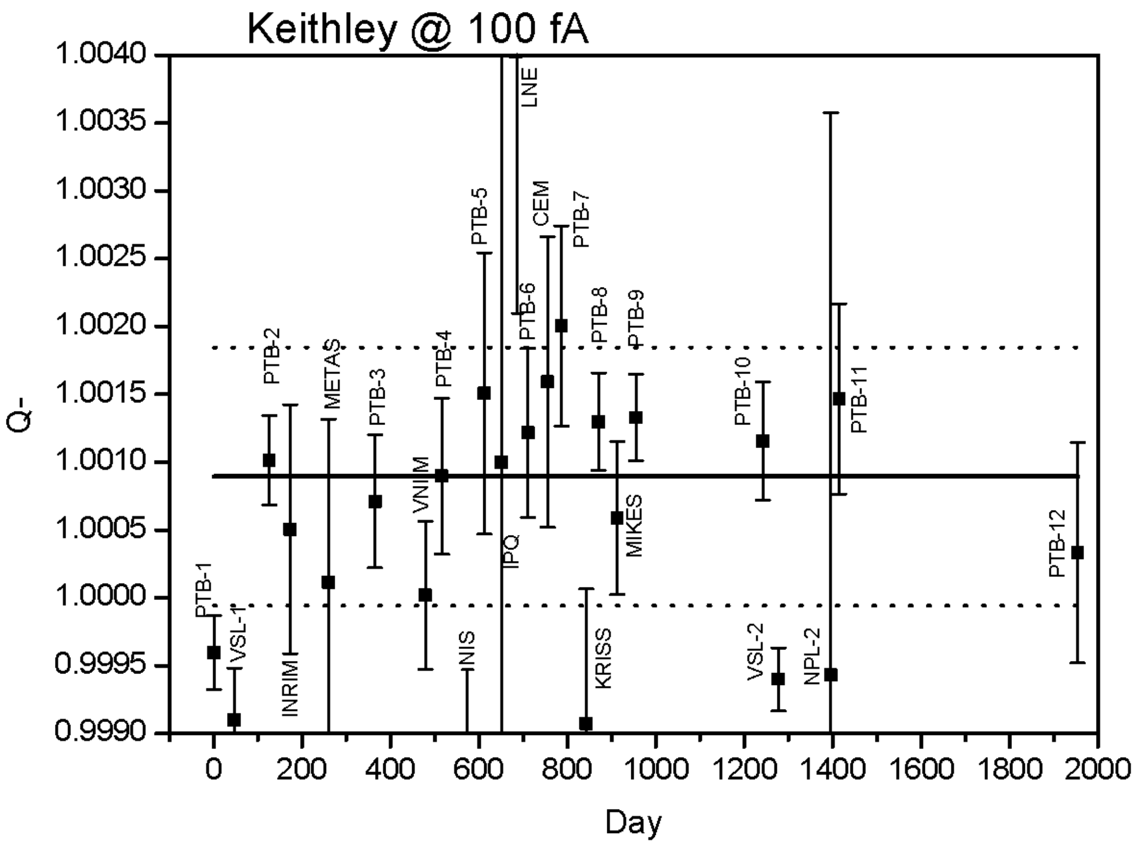

Fig. 6.14: : Calibration factors for the Keithley at 100 pA for negative current direction, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 100 fA, mean of both current directions:

Reference value: Q_{ref} = 1.00094466, $u(Q_{ref})$ = 1.25·10^{-4}
Uncertainty describing the instability of the transfer standard: u_{TS} = 4.56·10^{-4}

Table 6.15: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9994908	1.5·10^{-4}	9.18	Y	-1.5·10^{-3}	9.9·10^{-4}
VSL-1	1.0007550	1.9·10^{-4}	0.15	N	-1.9·10^{-4}	9.5·10^{-4}
NPL-1	1.0005500	1.8·10^{-3}	0.05	N	-3.9·10^{-4}	3.6·10^{-3}
PTB-2	1.0014140	1.8·10^{-4}	0.92	N	4.7·10^{-4}	9.5·10^{-4}
INRIM	1.0005170	4.5·10^{-4}	0.45	N	-4.3·10^{-4}	1.3·10^{-3}
METAS	1.0001880	6.3·10^{-4}	0.95	N	-7.6·10^{-4}	1.5·10^{-3}
UME	0.9935000	1.4·10^{-2}	0.29	N	-7.4·10^{-3}	2.7·10^{-2}
PTB-3	1.0009760	2.4·10^{-4}	0.00	N	3.2·10^{-5}	1.0·10^{-3}
VNIIM	1.0000250	2.5·10^{-4}	3.10	N	-9.2·10^{-4}	1.0·10^{-3}
PTB-4	1.0009255	2.7·10^{-4}	0.00	N	-1.9·10^{-5}	1.0·10^{-3}
NIS	1.0055500	2.5·10^{-3}	3.16	N	4.6·10^{-3}	5.2·10^{-3}
PTB-5	1.0014790	5.4·10^{-4}	0.58	N	5.3·10^{-4}	1.4·10^{-3}
IPQ	1.0024000	4.6·10^{-3}	0.10	N	1.5·10^{-3}	9.2·10^{-3}
LNE	1.0020600	1.2·10^{-3}	0.78	N	1.1·10^{-3}	2.5·10^{-3}
PTB-6	1.0012375	3.2·10^{-4}	0.28	N	2.9·10^{-4}	1.1·10^{-3}
CEM	1.0007550	4.3·10^{-4}	0.09	N	-1.9·10^{-4}	1.2·10^{-3}
PTB-7	1.0013135	3.7·10^{-4}	0.40	N	3.7·10^{-4}	1.1·10^{-3}
KRISS	1.0014035	5.1·10^{-4}	0.45	N	4.6·10^{-4}	1.3·10^{-3}
PTB-8	1.0009825	1.9·10^{-4}	0.01	N	3.8·10^{-5}	9.6·10^{-4}
MIKES	1.0010570	2.8·10^{-4}	0.04	N	1.1·10^{-4}	1.0·10^{-3}
PTB-9	1.0009330	1.6·10^{-4}	0.00	N	-1.1·10^{-5}	9.3·10^{-4}
PTB-10	1.0008920	2.4·10^{-4}	0.01	N	-5.2·10^{-5}	1.0·10^{-3}
VSL-2	1.0009336	1.2·10^{-4}	0.00	N	-1.0·10^{-5}	9.1·10^{-4}
NPL-2	0.9999450	1.8·10^{-3}	0.29	N	-1.0·10^{-3}	3.7·10^{-3}
PTB-11	1.0008145	3.1·10^{-4}	0.05	N	-1.3·10^{-4}	1.1·10^{-3}
PTB-12	1.0009565	4.3·10^{-4}	0.00	N	1.2·10^{-5}	1.2·10^{-3}

Number of discarded results = 1, percentage = 4%.
$F_r = \sum e_i$ = 12.15, summed over the undiscarded contributions.
Degree of freedom =24.

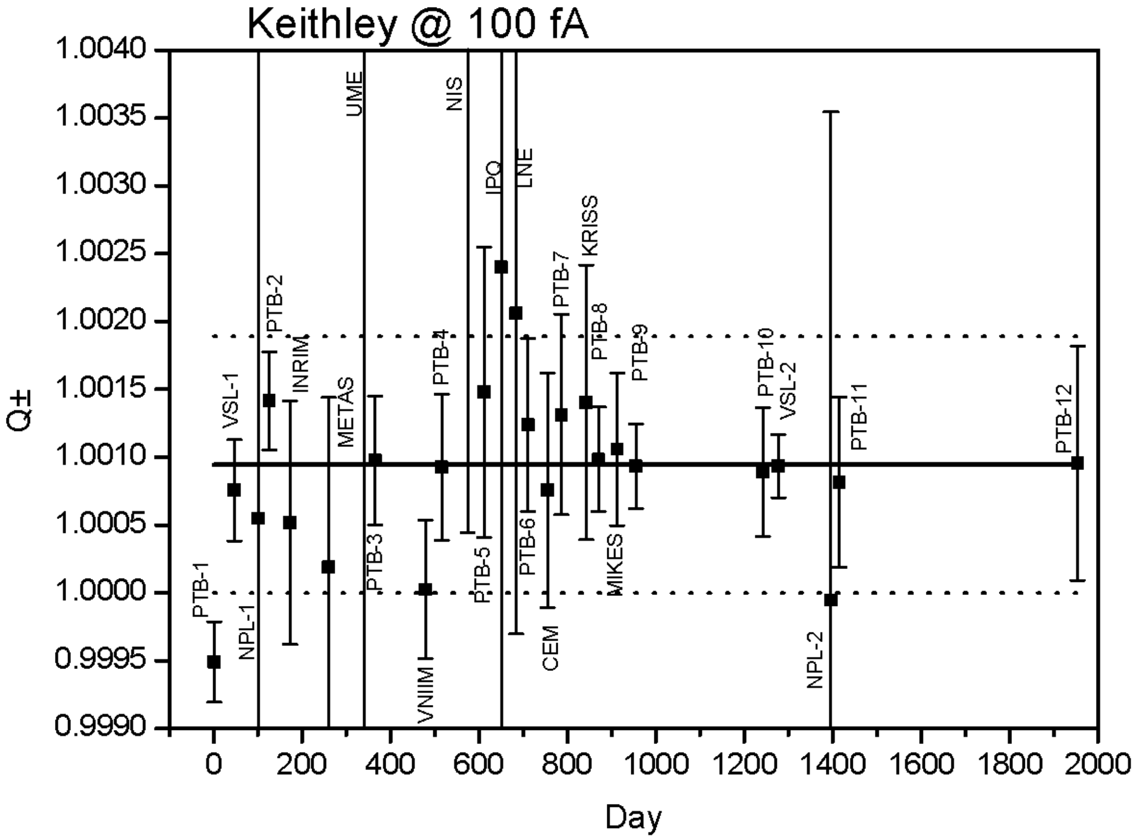

Fig. 6.15: Calibration factors for the Keithley at 100 fA for the mean of both current directions, together with the reference value (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 1 pA, positive current direction:

Reference value: $Q_{ref} = A + B \cdot t$, with:
A = 1.00065496, $u(A)$ = $3.03 \cdot 10^{-5}$
B = $5.27 \cdot 10^{-8}$, $u(B)$ = $3.73 \cdot 10^{-8}$
Uncertainty describing the instability of the transfer standard: u_{TS} = $9.37 \cdot 10^{-5}$

Table 6.16: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9989833	$5.4 \cdot 10^{-5}$	215.32	Y	$-1.6 \cdot 10^{-3}$	$2.3 \cdot 10^{-4}$
VSL-1	1.0010000	$1.2 \cdot 10^{-4}$	5.89	N	$3.8 \cdot 10^{-4}$	$3.1 \cdot 10^{-4}$
NPL-1	1.0043800	$1.7 \cdot 10^{-3}$	5.14	N	$3.8 \cdot 10^{-3}$	$3.3 \cdot 10^{-3}$
PTB-2	1.0006770	$5.6 \cdot 10^{-5}$	0.23	N	$5.3 \cdot 10^{-5}$	$2.1 \cdot 10^{-4}$
INRIM	1.0003950	$7.8 \cdot 10^{-5}$	3.50	N	$-2.3 \cdot 10^{-4}$	$2.4 \cdot 10^{-4}$
METAS	1.0003170	$2.8 \cdot 10^{-4}$	1.10	N	$-3.1 \cdot 10^{-4}$	$6.0 \cdot 10^{-4}$
UME	1.0019000	$3.5 \cdot 10^{-3}$	0.13	N	$1.3 \cdot 10^{-3}$	$6.9 \cdot 10^{-3}$
PTB-3	1.0006000	$5.5 \cdot 10^{-5}$	0.11	N	$-3.7 \cdot 10^{-5}$	$2.1 \cdot 10^{-4}$
VNIIM	0.9999800	$1.2 \cdot 10^{-4}$	19.33	Y	$-6.6 \cdot 10^{-4}$	$3.1 \cdot 10^{-4}$
PTB-4	1.0005010	$5.7 \cdot 10^{-5}$	1.71	N	$-1.4 \cdot 10^{-4}$	$2.1 \cdot 10^{-4}$
NIS	1.0015000	$9.0 \cdot 10^{-5}$	43.12	Y	$8.5 \cdot 10^{-4}$	$2.7 \cdot 10^{-4}$
PTB-5	1.0007620	$6.8 \cdot 10^{-5}$	0.94	N	$1.1 \cdot 10^{-4}$	$2.2 \cdot 10^{-4}$
IPQ	1.0009000	$1.6 \cdot 10^{-3}$	0.02	N	$2.5 \cdot 10^{-4}$	$3.2 \cdot 10^{-3}$
LNE	1.0006700	$1.6 \cdot 10^{-4}$	0.01	N	$1.7 \cdot 10^{-5}$	$3.7 \cdot 10^{-4}$
PTB-6	1.0008160	$7.1 \cdot 10^{-5}$	1.88	N	$1.6 \cdot 10^{-4}$	$2.3 \cdot 10^{-4}$
CEM	1.0005070	$9.4 \cdot 10^{-5}$	1.28	N	$-1.5 \cdot 10^{-4}$	$2.6 \cdot 10^{-4}$
PTB-7	1.0006800	$8.1 \cdot 10^{-5}$	0.03	N	$2.1 \cdot 10^{-5}$	$2.4 \cdot 10^{-4}$
KRISS	1.0013490	$4.2 \cdot 10^{-5}$	44.61	Y	$6.9 \cdot 10^{-4}$	$2.1 \cdot 10^{-4}$
PTB-8	1.0006930	$5.6 \cdot 10^{-5}$	0.07	N	$3.0 \cdot 10^{-5}$	$2.1 \cdot 10^{-4}$
MIKES	1.0009640	$2.6 \cdot 10^{-4}$	1.14	N	$3.0 \cdot 10^{-4}$	$5.6 \cdot 10^{-4}$
PTB-9	1.0005420	$5.6 \cdot 10^{-5}$	1.32	N	$-1.3 \cdot 10^{-4}$	$2.1 \cdot 10^{-4}$
PTB-10	1.0006750	$5.8 \cdot 10^{-5}$	0.00	N	$-7.9 \cdot 10^{-6}$	$2.1 \cdot 10^{-4}$
VSL-2	1.0010540	$6.4 \cdot 10^{-5}$	10.29	Y	$3.7 \cdot 10^{-4}$	$2.4 \cdot 10^{-4}$
NPL-2	1.0008400	$1.0 \cdot 10^{-4}$	1.09	N	$1.5 \cdot 10^{-4}$	$2.8 \cdot 10^{-4}$
PTB-11	1.0005700	$6.2 \cdot 10^{-5}$	1.12	N	$-1.2 \cdot 10^{-4}$	$2.2 \cdot 10^{-4}$
PTB-12	1.0007960	$6.4 \cdot 10^{-5}$	0.38	N	$7.6 \cdot 10^{-5}$	$2.4 \cdot 10^{-4}$

Number of discarded results = 5, percentage = 19%.
$F_r = \sum e_i$ = 27.1, summed over the undiscarded contributions.
Effective degree of freedom =20.

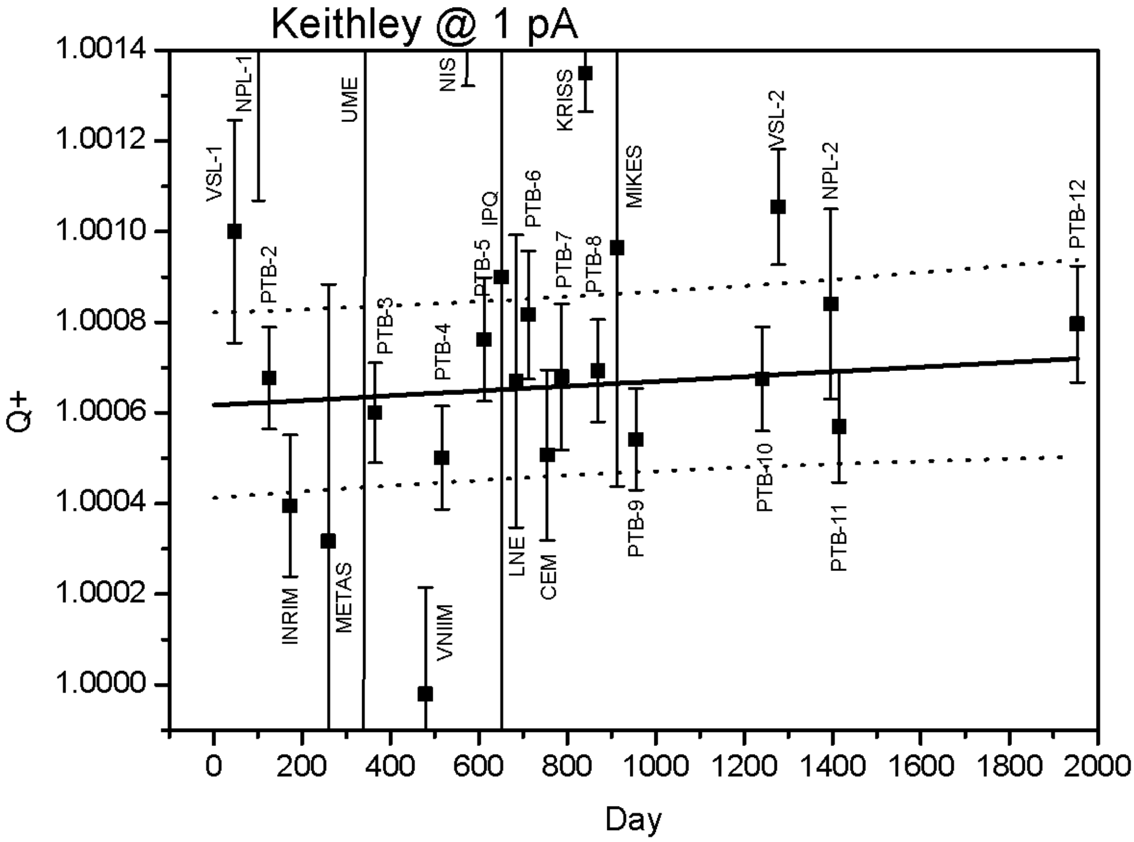

Fig. 6.16: Calibration factors for the Keithley at 1 pA for positive current direction, together with the reference line (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 1 pA, negative current direction:

Reference value: $Q_{ref} = A + B \cdot t$, with:
A = 1.00063836, $u(A)$ = 3.05·10^{-5}
B = 5.27·10^{-8}, $u(B)$ = 3.73·10^{-8}
Uncertainty describing the instability of the transfer standard: u_{TS} = 9.37·10^{-5}

Table 6.17: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9989348	5.5·10^{-5}	221.95	Y	-1.7·10^{-3}	2.3·10^{-4}
VSL-1	1.0007300	1.2·10^{-4}	0.66	N	1.3·10^{-4}	3.1·10^{-4}
NPL-1	0.9978600	1.2·10^{-3}	4.86	N	-2.7·10^{-3}	2.5·10^{-3}
PTB-2	1.0006270	5.9·10^{-5}	0.03	N	2.0·10^{-5}	2.2·10^{-4}
INRIM	1.0002990	6.4·10^{-5}	7.28	Y	-3.1·10^{-4}	2.4·10^{-4}
METAS	1.0002390	2.9·10^{-4}	1.47	N	-3.8·10^{-4}	6.2·10^{-4}
UME	0.9899000	1.6·10^{-3}	43.41	Y	-1.1·10^{-2}	3.3·10^{-3}
PTB-3	1.0005640	6.1·10^{-5}	0.25	N	-5.6·10^{-5}	2.2·10^{-4}
VNIIM	1.0000000	1.3·10^{-4}	15.45	Y	-6.3·10^{-4}	3.2·10^{-4}
PTB-4	1.0005780	5.7·10^{-5}	0.20	N	-5.0·10^{-5}	2.1·10^{-4}
NIS	0.9991200	9.2·10^{-5}	131.45	Y	-1.5·10^{-3}	2.7·10^{-4}
PTB-5	1.0005370	9.6·10^{-5}	0.51	N	-9.6·10^{-5}	2.6·10^{-4}
IPQ	1.0002000	2.5·10^{-3}	0.03	N	-4.3·10^{-4}	5.1·10^{-3}
LNE	1.0002200	1.9·10^{-4}	3.78	N	-4.2·10^{-4}	4.2·10^{-4}
PTB-6	1.0008000	7.4·10^{-5}	1.83	N	1.6·10^{-4}	2.3·10^{-4}
CEM	1.0004560	9.4·10^{-5}	1.93	N	-1.8·10^{-4}	2.6·10^{-4}
PTB-7	1.0007280	8.0·10^{-5}	0.49	N	8.6·10^{-5}	2.4·10^{-4}
KRISS	1.0003460	5.9·10^{-5}	7.29	Y	-3.0·10^{-4}	2.3·10^{-4}
PTB-8	1.0006490	5.5·10^{-5}	0.00	N	2.6·10^{-6}	2.1·10^{-4}
MIKES	1.0009210	2.6·10^{-4}	0.95	N	2.7·10^{-4}	5.6·10^{-4}
PTB-9	1.0005210	5.5·10^{-5}	1.43	N	-1.3·10^{-4}	2.1·10^{-4}
PTB-10	1.0006820	5.7·10^{-5}	0.02	N	1.6·10^{-5}	2.1·10^{-4}
VSL-2	1.0008198	6.2·10^{-5}	1.76	N	1.5·10^{-4}	2.2·10^{-4}
NPL-2	1.0009600	9.9·10^{-5}	4.24	N	2.9·10^{-4}	2.7·10^{-4}
PTB-11	1.0005370	5.8·10^{-5}	1.49	N	-1.4·10^{-4}	2.2·10^{-4}
PTB-12	1.0007830	6.2·10^{-5}	0.43	N	7.9·10^{-5}	2.4·10^{-4}

Number of discarded results = 6, percentage = 23 %.
$F_r = \sum e_i$ = 26.36, summed over the undiscarded contributions.
Degree of freedom =19.

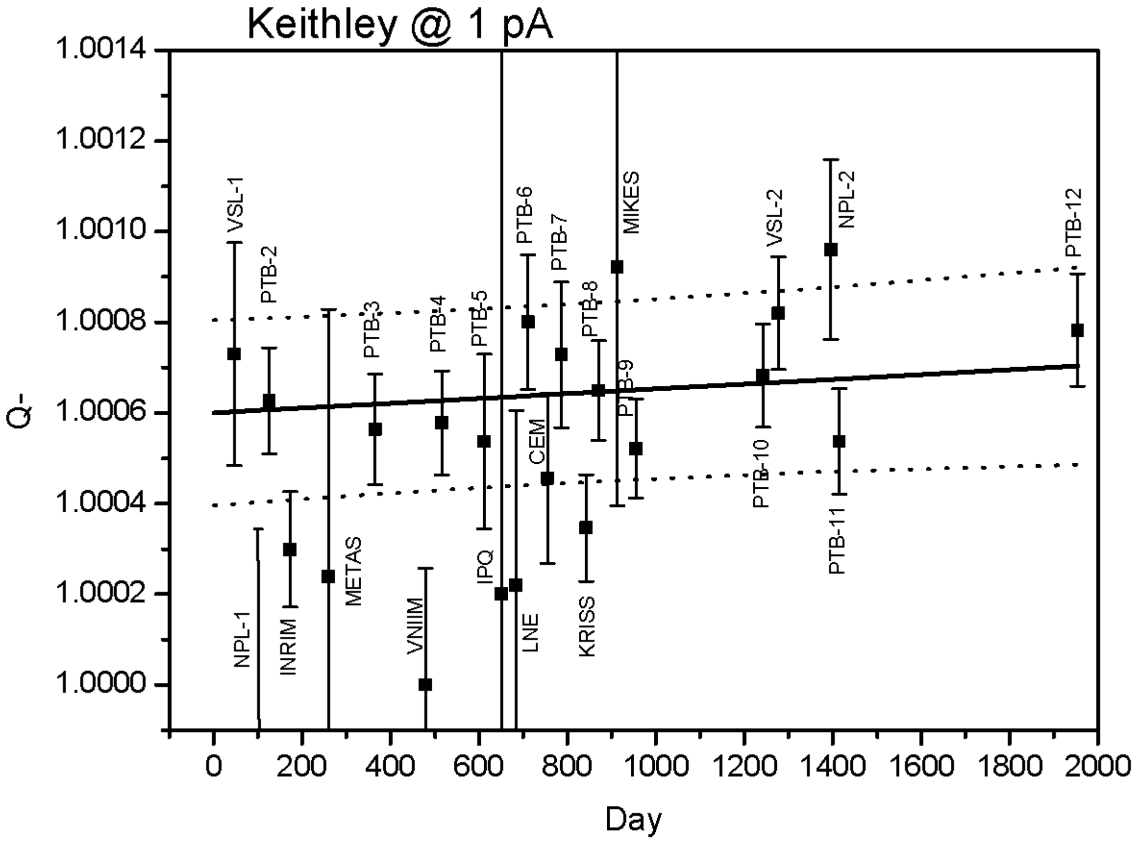

Fig. 6.17: Calibration factors for the Keithley at 1 pA for negative current direction, together with the reference line (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 1 pA, mean of both current directions:

Reference value: $Q_{ref} = A + B \cdot t$, with:
A = 1.00066043, $u(A)$ = 2.84·10^{-5}
B = 5.27·10^{-8}, $u(B)$ = 3.73·10^{-8}
Uncertainty describing the instability of the transfer standard: u_{TS} = 9.37·10^{-5}

Table 6.18: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9989591	5.4·10^{-5}	222.03	Y	-1.7·10^{-3}	2.3·10^{-4}
VSL-1	1.0008650	1.2·10^{-4}	2.36	N	2.4·10^{-4}	3.1·10^{-4}
NPL-1	1.0011200	1.4·10^{-3}	0.12	N	4.9·10^{-4}	2.9·10^{-3}
PTB-2	1.0006520	5.7·10^{-5}	0.04	N	2.4·10^{-5}	2.2·10^{-4}
INRIM	1.0003470	7.1·10^{-5}	5.66	N	-2.8·10^{-4}	2.3·10^{-4}
METAS	1.0002780	2.9·10^{-4}	1.38	N	-3.6·10^{-4}	6.1·10^{-4}
UME	0.9959000	2.5·10^{-3}	3.47	N	-4.7·10^{-3}	5.1·10^{-3}
PTB-3	1.0005820	5.8·10^{-5}	0.28	N	-5.9·10^{-5}	2.1·10^{-4}
VNIIM	0.9999900	1.2·10^{-4}	17.98	Y	-6.6·10^{-4}	3.2·10^{-4}
PTB-4	1.0005395	5.7·10^{-5}	0.99	N	-1.1·10^{-4}	2.1·10^{-4}
NIS	1.0003100	9.1·10^{-5}	6.84	Y	-3.4·10^{-4}	2.7·10^{-4}
PTB-5	1.0006495	8.2·10^{-5}	0.00	N	-4.5·10^{-6}	2.4·10^{-4}
IPQ	1.0005500	2.1·10^{-3}	0.00	N	-1.1·10^{-4}	4.1·10^{-3}
LNE	1.0004450	1.8·10^{-4}	1.13	N	-2.1·10^{-4}	4.0·10^{-4}
PTB-6	1.0008080	7.3·10^{-5}	1.57	N	1.5·10^{-4}	2.3·10^{-4}
CEM	1.0004815	9.4·10^{-5}	1.84	N	-1.8·10^{-4}	2.6·10^{-4}
PTB-7	1.0007040	8.0·10^{-5}	0.11	N	4.1·10^{-5}	2.4·10^{-4}
KRISS	1.0008475	5.1·10^{-5}	2.90	N	1.8·10^{-4}	2.1·10^{-4}
PTB-8	1.0006710	5.6·10^{-5}	0.00	N	3.4·10^{-6}	2.1·10^{-4}
MIKES	1.0009425	2.6·10^{-4}	0.95	N	2.7·10^{-4}	5.6·10^{-4}
PTB-9	1.0005315	5.5·10^{-5}	1.66	N	-1.4·10^{-4}	2.1·10^{-4}
PTB-10	1.0006785	5.7·10^{-5}	0.01	N	-8.8·10^{-6}	2.2·10^{-4}
VSL-2	1.0009369	6.3·10^{-5}	4.66	N	2.5·10^{-4}	2.2·10^{-4}
NPL-2	1.0009000	1.0·10^{-4}	2.11	N	2.0·10^{-4}	2.8·10^{-4}
PTB-11	1.0005535	6.0·10^{-5}	1.56	N	-1.4·10^{-4}	2.2·10^{-4}
PTB-12	1.0007895	6.3·10^{-5}	0.28	N	6.5·10^{-5}	2.4·10^{-4}

Number of discarded results = 3, percentage = 12 %.
$F_r = \sum e_i$ = 33.10, summed over the undiscarded contributions.
Degree of freedom =22.

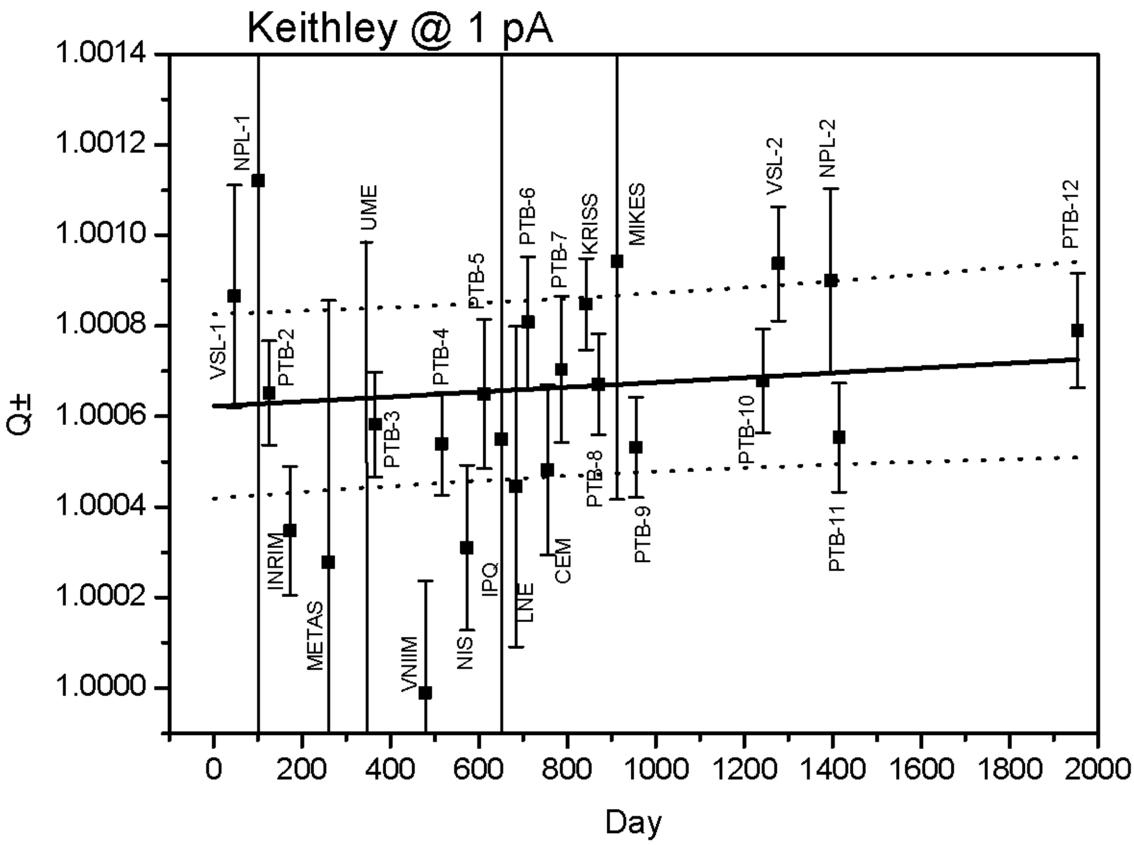

Fig. 6.18: Calibration factors for the Keithley at 1 pA for the mean of both current directions, together with the reference line (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 10 pA, positive current direction:

Reference value: $Q_{ref} = A + B \cdot t$, with:
A = 1.00001214, $u(A)$ = 1.14·10^{-5}
B = 1.03·10^{-7}, $u(B)$ = 2.23·10^{-8}
Uncertainty describing the instability of the transfer standard: u_{TS} = 3.23·10^{-5}

Table 6.19: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9996577	4.5·10^{-5}	27.20	Y	-2.8·10^{-4}	1.1·10^{-4}
VSL-1	0.9998710	1.3·10^{-5}	3.56	N	-7.2·10^{-5}	7.2·10^{-5}
NPL-1	1.0000390	7.4·10^{-4}	0.01	N	9.1·10^{-5}	1.5·10^{-3}
PTB-2	0.9998594	3.9·10^{-5}	3.05	N	-9.1·10^{-5}	1.0·10^{-4}
INRIM	0.9998640	3.7·10^{-5}	3.32	N	-9.2·10^{-5}	9.8·10^{-5}
METAS	0.9998730	5.4·10^{-5}	2.06	N	-9.2·10^{-5}	1.3·10^{-4}
UME	0.9951000	7.1·10^{-4}	47.37	Y	-4.9·10^{-3}	1.4·10^{-3}
PTB-3	1.0000020	5.4·10^{-5}	0.18	N	2.7·10^{-5}	1.2·10^{-4}
VNIIM	1.0002100	2.3·10^{-4}	0.94	N	2.2·10^{-4}	4.6·10^{-4}
PTB-4	0.9999681	3.6·10^{-5}	0.22	N	-2.3·10^{-5}	9.4·10^{-5}
NIS	1.0014900	1.1·10^{-4}	177.88	Y	1.5·10^{-3}	2.3·10^{-4}
PTB-5	1.0000190	3.6·10^{-5}	0.14	N	1.8·10^{-5}	9.4·10^{-5}
IPQ	1.0003600	6.0·10^{-4}	0.35	N	3.6·10^{-4}	1.2·10^{-3}
LNE	1.0001080	2.0·10^{-5}	6.85	N	1.0·10^{-4}	7.3·10^{-5}
PTB-6	1.0000140	3.5·10^{-5}	0.00	N	2.9·10^{-6}	9.2·10^{-5}
CEM	0.9999670	9.3·10^{-5}	0.25	N	-4.9·10^{-5}	1.9·10^{-4}
PTB-7	1.0000330	3.6·10^{-5}	0.09	N	1.4·10^{-5}	9.3·10^{-5}
KRISS	1.0000710	3.1·10^{-5}	1.07	N	4.6·10^{-5}	8.7·10^{-5}
PTB-8	0.9999927	3.8·10^{-5}	0.49	N	-3.5·10^{-5}	9.7·10^{-5}
MIKES	1.0002810	2.6·10^{-4}	0.88	N	2.5·10^{-4}	5.3·10^{-4}
PTB-9	1.0000600	3.6·10^{-5}	0.23	N	2.4·10^{-5}	9.5·10^{-5}
PTB-10	1.0000807	3.6·10^{-5}	0.09	N	1.5·10^{-5}	9.7·10^{-5}
VSL-2	1.0000978	1.3·10^{-5}	0.58	N	2.8·10^{-5}	7.1·10^{-5}
NPL-2	1.0001760	2.7·10^{-5}	4.46	N	9.4·10^{-5}	8.6·10^{-5}
PTB-11	1.0000200	3.7·10^{-5}	1.52	N	-6.4·10^{-5}	1.0·10^{-4}
PTB-12	1.0001030	3.4·10^{-5}	0.45	N	-3.7·10^{-5}	1.1·10^{-4}

Number of discarded results = 3, percentage = 12 %.
$F_r = \sum e_i$ = 30.79, summed over the undiscarded contributions.
Degree of freedom = 22.

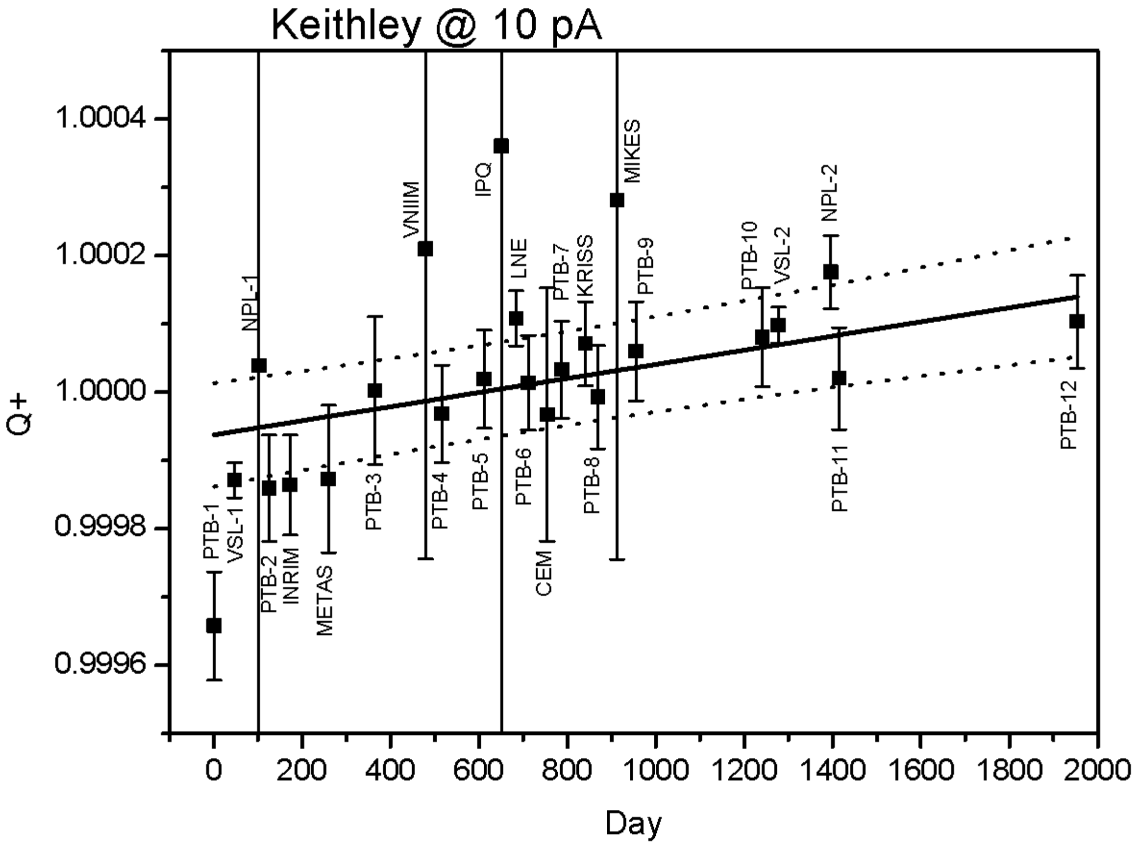

Fig. 6.19: Calibration factors for the Keithley at 10 pA for positive current direction, together with the reference line (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 10 pA, negative current direction:

Reference value: $Q_{ref} = A + B \cdot t$, with:
A = 0.99986889, $u(A)$ = 1.12·10^{-5}
B = 1.03·10^{-7}, $u(B)$ = 2.23·10^{-8}
Uncertainty describing the instability of the transfer standard: u_{TS} = 3.23·10^{-5}

Table 6.20: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9995943	3.7·10^{-5}	14.94	Y	-2.0·10^{-4}	1.1·10^{-4}
VSL-1	0.9997970	1.3·10^{-5}	0.00	N	-2.0·10^{-6}	7.2·10^{-5}
NPL-1	0.9997280	1.0·10^{-3}	0.01	N	-7.7·10^{-5}	2.0·10^{-3}
PTB-2	0.9997588	3.9·10^{-5}	0.86	N	-4.8·10^{-5}	1.0·10^{-4}
INRIM	0.9997630	4.0·10^{-5}	0.87	N	-4.9·10^{-5}	1.0·10^{-4}
METAS	0.9997480	5.4·10^{-5}	1.30	N	-7.3·10^{-5}	1.3·10^{-4}
UME	0.9950000	7.3·10^{-4}	44.17	Y	-4.8·10^{-3}	1.5·10^{-3}
PTB-3	0.9998060	3.6·10^{-5}	0.28	N	-2.6·10^{-5}	9.6·10^{-5}
VNIIM	1.0001400	1.5·10^{-4}	3.50	N	3.0·10^{-4}	3.2·10^{-4}
PTB-4	0.9998149	3.7·10^{-5}	0.44	N	-3.3·10^{-5}	9.6·10^{-5}
NIS	0.9989000	9.9·10^{-5}	83.36	Y	-9.5·10^{-4}	2.1·10^{-4}
PTB-5	0.9998987	3.5·10^{-5}	0.76	N	4.1·10^{-5}	9.2·10^{-5}
IPQ	1.0002800	6.1·10^{-4}	0.47	N	4.2·10^{-4}	1.2·10^{-3}
LNE	0.9998060	1.7·10^{-5}	2.59	N	-5.9·10^{-5}	7.0·10^{-5}
PTB-6	0.9998571	3.7·10^{-5}	0.05	N	-1.1·10^{-5}	9.6·10^{-5}
CEM	0.9998790	9.3·10^{-5}	0.00	N	6.8·10^{-6}	1.9·10^{-4}
PTB-7	0.9999042	3.7·10^{-5}	0.34	N	2.9·10^{-5}	9.5·10^{-5}
KRISS	0.9998260	2.9·10^{-5}	1.62	N	-5.5·10^{-5}	8.4·10^{-5}
PTB-8	0.9999015	3.7·10^{-5}	0.13	N	1.7·10^{-5}	9.5·10^{-5}
MIKES	0.9999950	2.6·10^{-4}	0.16	N	1.1·10^{-4}	5.3·10^{-4}
PTB-9	0.9998808	3.7·10^{-5}	0.06	N	-1.2·10^{-5}	9.6·10^{-5}
PTB-10	0.9999392	3.8·10^{-5}	0.11	N	1.7·10^{-5}	1.0·10^{-4}
VSL-2	0.9999978	1.7·10^{-5}	3.42	N	7.2·10^{-5}	7.4·10^{-5}
NPL-2	1.0000640	2.1·10^{-5}	9.13	N	1.3·10^{-4}	8.0·10^{-5}
PTB-11	0.9999127	3.8·10^{-5}	0.28	N	-2.8·10^{-5}	1.0·10^{-4}
PTB-12	0.9999759	3.4·10^{-5}	0.14	N	-2.0·10^{-5}	1.1·10^{-4}

Number of discarded results = 3, percentage = 12 %.
$F_r = \sum e_i$ = 26.52, summed over the undiscarded contributions.
Degree of freedom = 22.

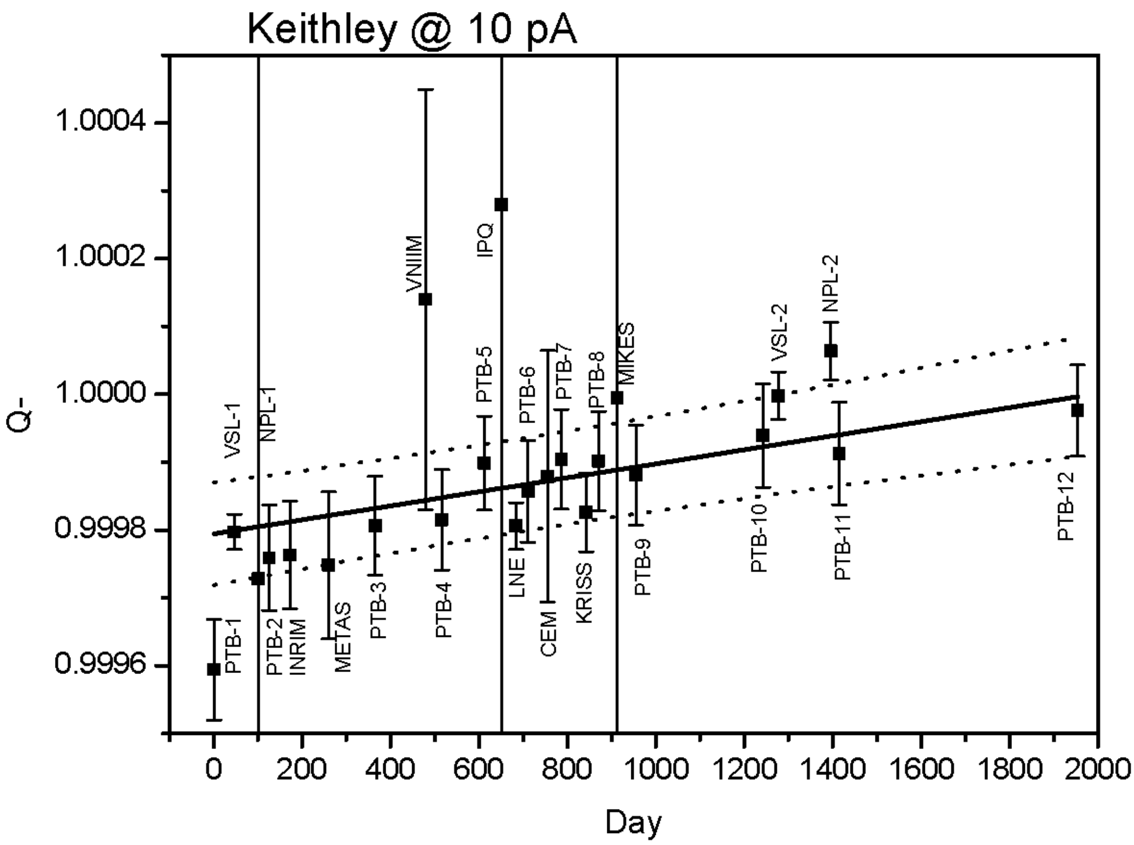

Fig. 6.20: Calibration factors for the Keithley at 10 pA for negative current direction, together with the reference line (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 10 pA, mean of both current directions:

Reference value: $Q_{ref} = A + B \cdot t$, with:
A = 0.99994378, $u(A)$ = $1.12 \cdot 10^{-5}$
B = $1.03 \cdot 10^{-7}$, $u(B)$ = $2.23 \cdot 10^{-8}$
Uncertainty describing the instability of the transfer standard: u_{TS} = $3.23 \cdot 10^{-5}$

Table 6.21: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9996260	$3.8 \cdot 10^{-5}$	21.28	Y	$-2.4 \cdot 10^{-4}$	$1.1 \cdot 10^{-4}$
VSL-1	0.9998340	$1.3 \cdot 10^{-5}$	1.11	N	$-4.0 \cdot 10^{-5}$	$7.2 \cdot 10^{-5}$
NPL-1	0.9998835	$8.8 \cdot 10^{-4}$	0.00	N	$3.9 \cdot 10^{-6}$	$1.8 \cdot 10^{-3}$
PTB-2	0.9998091	$3.9 \cdot 10^{-5}$	1.95	N	$-7.3 \cdot 10^{-5}$	$1.0 \cdot 10^{-4}$
INRIM	0.9998135	$3.8 \cdot 10^{-5}$	2.04	N	$-7.3 \cdot 10^{-5}$	$1.0 \cdot 10^{-4}$
METAS	0.9998105	$5.4 \cdot 10^{-5}$	1.79	N	$-8.5 \cdot 10^{-5}$	$1.3 \cdot 10^{-4}$
UME	0.9950500	$7.2 \cdot 10^{-4}$	45.79	Y	$-4.9 \cdot 10^{-3}$	$1.4 \cdot 10^{-3}$
PTB-3	0.9999040	$4.5 \cdot 10^{-5}$	0.00	N	$-2.7 \cdot 10^{-6}$	$1.1 \cdot 10^{-4}$
VNIIM	1.0001750	$1.9 \cdot 10^{-4}$	1.75	N	$2.6 \cdot 10^{-4}$	$3.9 \cdot 10^{-4}$
PTB-4	0.9998915	$3.6 \cdot 10^{-5}$	0.40	N	$-3.1 \cdot 10^{-5}$	$9.5 \cdot 10^{-5}$
NIS	1.0001950	$1.0 \cdot 10^{-4}$	6.08	N	$2.7 \cdot 10^{-4}$	$2.2 \cdot 10^{-4}$
PTB-5	0.9999589	$3.5 \cdot 10^{-5}$	0.31	N	$2.7 \cdot 10^{-5}$	$9.3 \cdot 10^{-5}$
IPQ	1.0003200	$6.1 \cdot 10^{-4}$	0.40	N	$3.8 \cdot 10^{-4}$	$1.2 \cdot 10^{-3}$
LNE	0.9999570	$1.9 \cdot 10^{-5}$	0.21	N	$1.7 \cdot 10^{-5}$	$7.1 \cdot 10^{-5}$
PTB-6	0.9999356	$3.6 \cdot 10^{-5}$	0.02	N	$-6.9 \cdot 10^{-6}$	$9.4 \cdot 10^{-5}$
CEM	0.9999230	$9.3 \cdot 10^{-5}$	0.06	N	$-2.4 \cdot 10^{-5}$	$1.9 \cdot 10^{-4}$
PTB-7	0.9999686	$3.6 \cdot 10^{-5}$	0.14	N	$1.8 \cdot 10^{-5}$	$9.4 \cdot 10^{-5}$
KRISS	0.9999485	$3.0 \cdot 10^{-5}$	0.03	N	$-7.5 \cdot 10^{-6}$	$8.5 \cdot 10^{-5}$
PTB-8	0.9999471	$3.7 \cdot 10^{-5}$	0.06	N	$-1.2 \cdot 10^{-5}$	$9.6 \cdot 10^{-5}$
MIKES	1.0001380	$2.6 \cdot 10^{-4}$	0.43	N	$1.7 \cdot 10^{-4}$	$5.3 \cdot 10^{-4}$
PTB-9	0.9999704	$3.7 \cdot 10^{-5}$	0.00	N	$2.7 \cdot 10^{-6}$	$9.6 \cdot 10^{-5}$
PTB-10	1.0000100	$3.7 \cdot 10^{-5}$	0.06	N	$1.3 \cdot 10^{-5}$	$9.9 \cdot 10^{-5}$
VSL-2	1.0000478	$1.5 \cdot 10^{-5}$	1.53	N	$4.7 \cdot 10^{-5}$	$7.2 \cdot 10^{-5}$
NPL-2	1.0001200	$2.4 \cdot 10^{-5}$	6.16	N	$1.1 \cdot 10^{-4}$	$8.3 \cdot 10^{-5}$
PTB-11	0.9999664	$3.8 \cdot 10^{-5}$	0.89	N	$-4.9 \cdot 10^{-5}$	$1.0 \cdot 10^{-4}$
PTB-12	1.0000395	$3.4 \cdot 10^{-5}$	0.34	N	$-3.1 \cdot 10^{-5}$	$1.1 \cdot 10^{-4}$

Number of discarded results = 2, percentage = 8 %.
$F_r = \sum e_i$ = 25.76, summed over the undiscarded contributions.
Degree of freedom = 23.

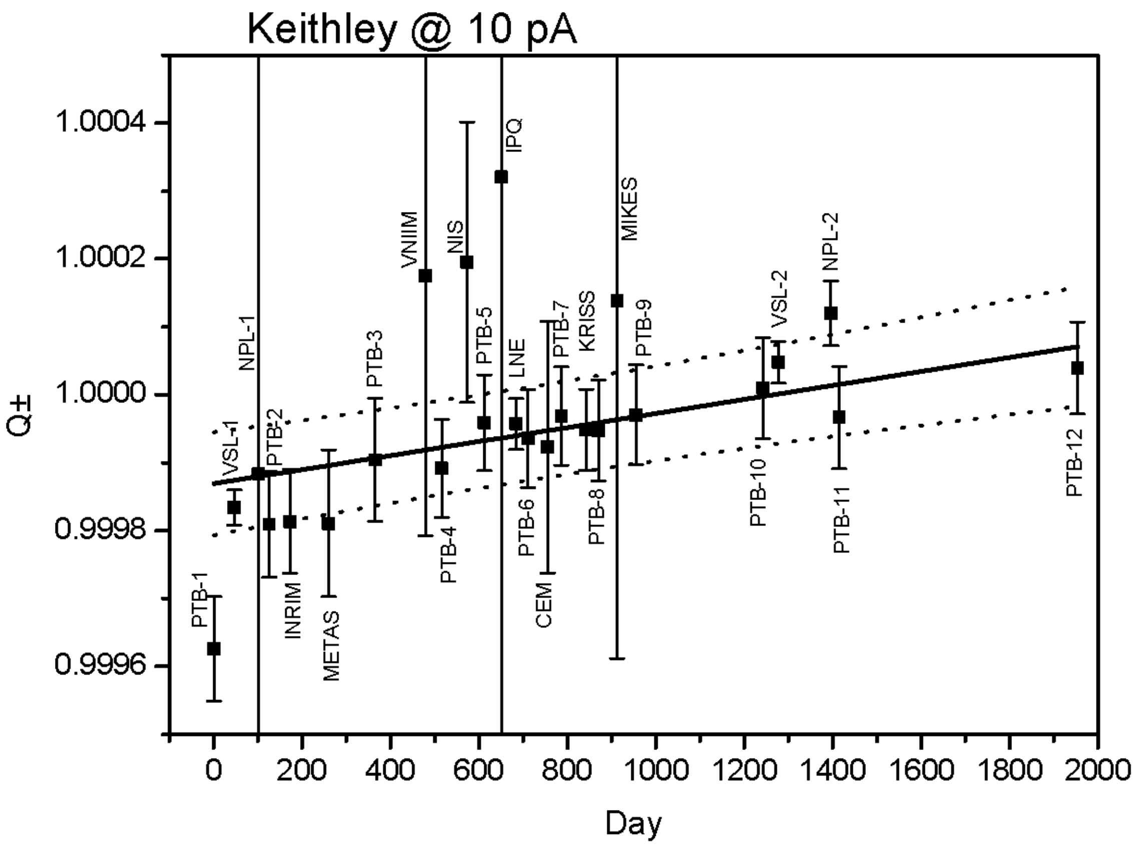

Fig. 6.21: Calibration factors for the Keithley at 10 pA for the mean of both current directions, together with the reference line (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 100 pA, positive current direction:

Reference value: $Q_{ref} = A + B \cdot t$, with:
A = 1.00025007, $u(A)$ = 7.33·10^{-6}
B = 6.94·10^{-8}, $u(B)$ = 7.45·10^{-9}
Uncertainty describing the instability of the transfer standard: u_{TS} = 2.67·10^{-5}

Table 6.22: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9999569	1.3·10^{-5}	65.82	Y	-2.4·10^{-4}	6.2·10^{-5}
VSL-1	1.0002420	1.1·10^{-5}	1.76	N	3.9·10^{-5}	5.7·10^{-5}
NPL-1	1.0002910	5.5·10^{-4}	0.02	N	8.4·10^{-5}	1.1·10^{-3}
PTB-2	1.0002600	1.2·10^{-5}	2.97	N	5.1·10^{-5}	5.8·10^{-5}
INRIM	1.0002100	4.0·10^{-5}	0.00	N	-2.0·10^{-6}	9.5·10^{-5}
METAS	1.0002110	2.6·10^{-5}	0.04	N	-7.0·10^{-6}	7.3·10^{-5}
UME	0.9962000	3.5·10^{-4}	131.06	Y	-4.0·10^{-3}	7.0·10^{-4}
PTB-3	1.0002510	1.4·10^{-5}	0.73	N	2.6·10^{-5}	5.9·10^{-5}
VNIIM	0.9999870	9.9·10^{-5}	5.78	N	-2.5·10^{-4}	2.0·10^{-4}
PTB-4	1.0002350	1.2·10^{-5}	0.00	N	-7.9·10^{-7}	5.7·10^{-5}
NIS	1.0017000	1.0·10^{-4}	198.89	Y	1.5·10^{-3}	2.1·10^{-4}
PTB-5	1.0002230	1.2·10^{-5}	0.44	N	-1.9·10^{-5}	5.7·10^{-5}
IPQ	1.0004400	6.7·10^{-4}	0.09	N	1.9·10^{-4}	1.3·10^{-3}
LNE	1.0002850	1.2·10^{-5}	1.65	N	3.8·10^{-5}	5.7·10^{-5}
PTB-6	1.0002400	1.2·10^{-5}	0.10	N	-9.3·10^{-6}	5.7·10^{-5}
CEM	1.0002530	9.1·10^{-5}	0.00	N	6.3·10^{-7}	1.9·10^{-4}
PTB-7	1.0002410	1.2·10^{-5}	0.22	N	-1.4·10^{-5}	5.7·10^{-5}
KRISS	1.0002000	6.6·10^{-6}	4.50	N	-5.8·10^{-5}	5.3·10^{-5}
PTB-8	1.0002120	1.2·10^{-5}	2.72	N	-4.8·10^{-5}	5.7·10^{-5}
MIKES	1.0003410	1.1·10^{-4}	0.51	N	7.8·10^{-5}	2.2·10^{-4}
PTB-9	1.0002520	1.2·10^{-5}	0.24	N	-1.4·10^{-5}	5.7·10^{-5}
PTB-10	1.0002830	1.2·10^{-5}	0.01	N	-3.2·10^{-6}	5.7·10^{-5}
VSL-2	1.0003364	1.1·10^{-5}	2.71	N	4.8·10^{-5}	5.6·10^{-5}
NPL-2	1.0004210	2.1·10^{-5}	13.11	Y	1.2·10^{-4}	7.0·10^{-5}
PTB-11	1.0002820	1.2·10^{-5}	0.30	N	-1.6·10^{-5}	5.8·10^{-5}
PTB-12	1.0003470	1.2·10^{-5}	0.14	N	1.1·10^{-5}	5.9·10^{-5}

Number of discarded results = 4, percentage = 15%.
$F_r = \sum e_i$ = 24.92, summed over the undiscarded contributions.
Degree of freedom = 21.

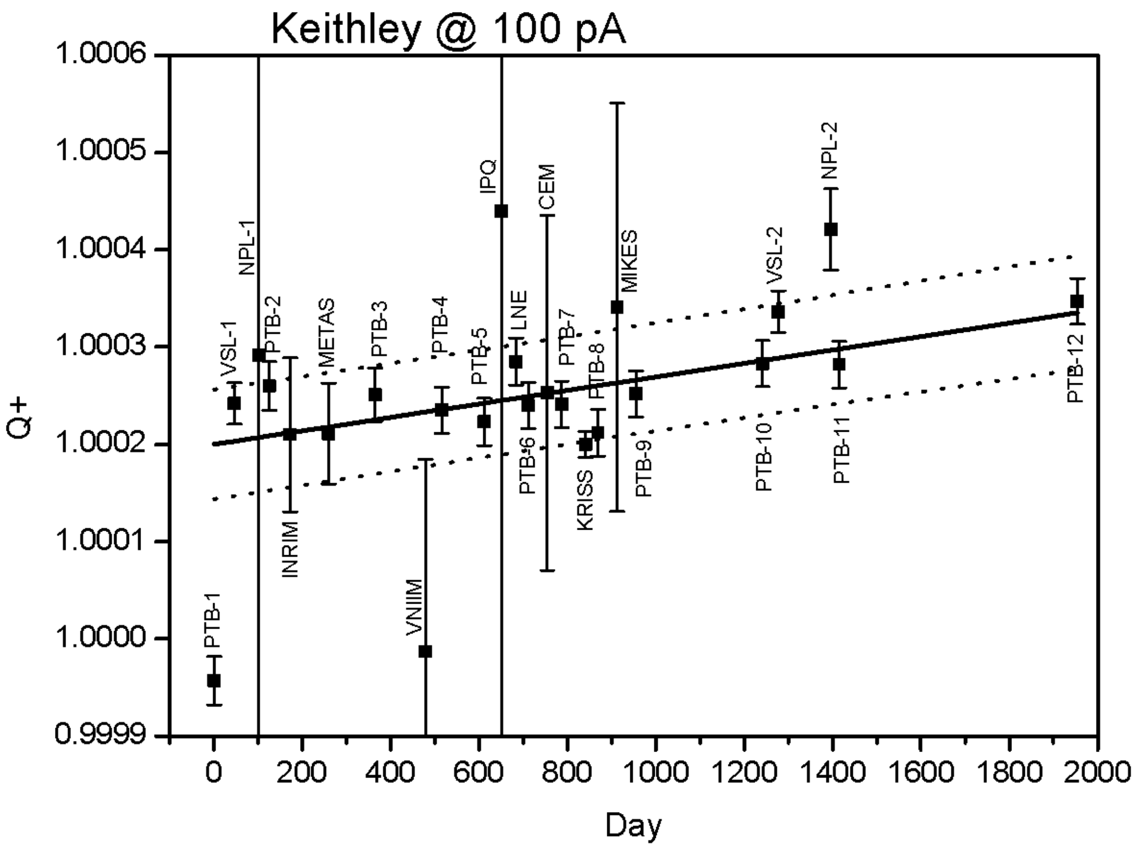

Fig. 6.22: Calibration factors for the Keithley at 100 pA for positive current direction, together with the reference line (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 100 pA, negative current direction:

Reference value: $Q_{ref} = A + B \cdot t$, with:
A = 1.00026826, $u(A)$ = 7.35·10^{-6}
B = 6.94·10^{-8}, $u(B)$ = 7.45·10^{-9}
Uncertainty describing the instability of the transfer standard: u_{TS} = 2.67·10^{-5}

Table 6.23: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9998817	1.2·10^{-5}	126.99	Y	-3.4·10^{-4}	6.2·10^{-5}
VSL-1	1.0002640	1.3·10^{-5}	1.98	N	4.2·10^{-5}	5.8·10^{-5}
NPL-1	1.0002350	4.7·10^{-4}	0.00	N	9.5·10^{-6}	9.5·10^{-4}
PTB-2	1.0001450	1.3·10^{-5}	7.44	N	-8.2·10^{-5}	5.8·10^{-5}
INRIM	1.0002400	3.8·10^{-5}	0.04	N	9.6·10^{-6}	9.1·10^{-5}
METAS	1.0002120	2.6·10^{-5}	0.43	N	-2.4·10^{-5}	7.3·10^{-5}
UME	0.9948000	4.3·10^{-4}	158.80	Y	-5.4·10^{-3}	8.6·10^{-4}
PTB-3	1.0002710	1.2·10^{-5}	0.86	N	2.7·10^{-5}	5.7·10^{-5}
VNIIM	0.9999810	6.2·10^{-5}	16.03	Y	-2.7·10^{-4}	1.4·10^{-4}
PTB-4	1.0002630	1.2·10^{-5}	0.09	N	8.8·10^{-6}	5.7·10^{-5}
NIS	0.9987000	1.1·10^{-4}	191.82	Y	-1.6·10^{-3}	2.3·10^{-4}
PTB-5	1.0002510	1.2·10^{-5}	0.11	N	-9.9·10^{-6}	5.7·10^{-5}
IPQ	1.0004600	6.8·10^{-4}	0.08	N	2.0·10^{-4}	1.4·10^{-3}
LNE	1.0003050	1.2·10^{-5}	1.79	N	3.9·10^{-5}	5.7·10^{-5}
PTB-6	1.0002610	1.2·10^{-5}	0.05	N	-6.8·10^{-6}	5.7·10^{-5}
CEM	1.0002790	9.1·10^{-5}	0.01	N	8.2·10^{-6}	1.9·10^{-4}
PTB-7	1.0002570	1.2·10^{-5}	0.30	N	-1.6·10^{-5}	5.7·10^{-5}
KRISS	1.0002960	6.0·10^{-6}	0.49	N	1.9·10^{-5}	5.3·10^{-5}
PTB-8	1.0002320	1.2·10^{-5}	2.55	N	-4.7·10^{-5}	5.7·10^{-5}
MIKES	1.0003480	1.1·10^{-4}	0.37	N	6.6·10^{-5}	2.2·10^{-4}
PTB-9	1.0002800	1.2·10^{-5}	0.03	N	-4.7·10^{-6}	5.7·10^{-5}
PTB-10	1.0002950	1.2·10^{-5}	0.11	N	-9.6·10^{-6}	5.7·10^{-5}
VSL-2	1.0003571	1.1·10^{-5}	2.92	N	5.0·10^{-5}	5.7·10^{-5}
NPL-2	1.0004510	2.0·10^{-5}	16.25	Y	1.4·10^{-4}	6.9·10^{-5}
PTB-11	1.0002900	1.2·10^{-5}	0.80	N	-2.7·10^{-5}	5.8·10^{-5}
PTB-12	1.0003660	1.2·10^{-5}	0.15	N	1.2·10^{-5}	5.9·10^{-5}

Number of discarded results = 5, percentage = 19 %.
$F_r = \sum e_i$ = 20.60, summed over the undiscarded contributions.
Degree of freedom = 20.

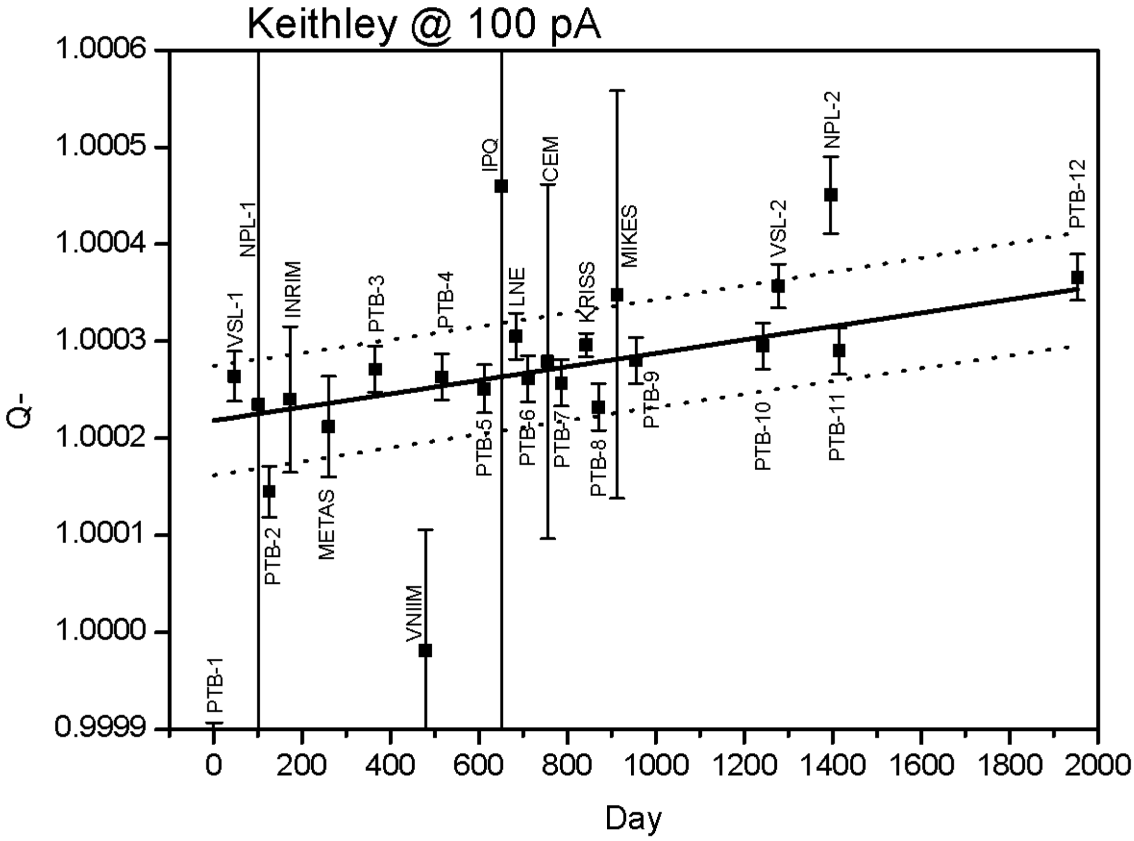

Fig. 6.23: Calibration factors for the Keithley at 100 pA for negative current direction, together with the reference line (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

Results for the Keithley 6430 at 100 pA, mean of both current directions:

Reference value: $Q_{ref} = A + B \cdot t$, with:
A = 1.00025761, $u(A)$ = 7.31·10^{-6}
B = 6.94·10^{-8}, $u(B)$ = 7.45·10^{-9}
Uncertainty describing the instability of the transfer standard: u_{TS} = 2.67·10^{-5}

Table 6.24: Summary of the results, containing each participant's result Q_i, its uncertainty $u(Q_i)$, e_i as defined in equation (12), indication if the result had to be discarded from calculating the reference value due to a too large value of e_i, and the degree of equivalence (d_i, $U(d_i)$).

Institute	Q_i	$u(Q_i)$	e_i	discard	d_i	$U(d_i)$
PTB-1	0.9999193	1.2·10^{-5}	92.91	Y	-2.9·10^{-4}	6.2·10^{-5}
VSL-1	1.0002530	1.2·10^{-5}	2.01	N	4.2·10^{-5}	5.7·10^{-5}
NPL-1	1.0002630	5.1·10^{-4}	0.01	N	4.8·10^{-5}	1.0·10^{-3}
PTB-2	1.0002025	1.3·10^{-5}	0.22	N	-1.4·10^{-5}	5.8·10^{-5}
INRIM	1.0002250	3.9·10^{-5}	0.01	N	5.3·10^{-6}	9.3·10^{-5}
METAS	1.0002115	2.6·10^{-5}	0.15	N	-1.4·10^{-5}	7.3·10^{-5}
UME	0.9955000	3.9·10^{-4}	145.94	Y	-4.7·10^{-3}	7.8·10^{-4}
PTB-3	1.0002610	1.3·10^{-5}	0.88	N	2.8·10^{-5}	5.8·10^{-5}
VNIIM	0.9999840	8.0·10^{-5}	9.18	N	-2.6·10^{-4}	1.7·10^{-4}
PTB-4	1.0002490	1.2·10^{-5}	0.03	N	5.5·10^{-6}	5.7·10^{-5}
NIS	1.0002000	1.0·10^{-4}	0.19	N	-4.7·10^{-5}	2.2·10^{-4}
PTB-5	1.0002370	1.2·10^{-5}	0.20	N	-1.3·10^{-5}	5.7·10^{-5}
IPQ	1.0004500	6.7·10^{-4}	0.09	N	2.0·10^{-4}	1.3·10^{-3}
LNE	1.0002950	1.2·10^{-5}	1.85	N	4.0·10^{-5}	5.7·10^{-5}
PTB-6	1.0002505	1.2·10^{-5}	0.05	N	-6.6·10^{-6}	5.7·10^{-5}
CEM	1.0002660	9.1·10^{-5}	0.00	N	5.9·10^{-6}	1.9·10^{-4}
PTB-7	1.0002490	1.2·10^{-5}	0.21	N	-1.3·10^{-5}	5.7·10^{-5}
KRISS	1.0002480	6.3·10^{-6}	0.44	N	-1.8·10^{-5}	5.3·10^{-5}
PTB-8	1.0002220	1.2·10^{-5}	2.48	N	-4.6·10^{-5}	5.7·10^{-5}
MIKES	1.0003445	1.1·10^{-4}	0.46	N	7.3·10^{-5}	2.2·10^{-4}
PTB-9	1.0002660	1.2·10^{-5}	0.07	N	-8.0·10^{-6}	5.7·10^{-5}
PTB-10	1.0002890	1.2·10^{-5}	0.03	N	-4.9·10^{-6}	5.7·10^{-5}
VSL-2	1.0003468	1.1·10^{-5}	2.99	N	5.0·10^{-5}	5.6·10^{-5}
NPL-2	1.0004360	2.0·10^{-5}	14.96	Y	1.3·10^{-4}	7.0·10^{-5}
PTB-11	1.0002860	1.2·10^{-5}	0.45	N	-2.0·10^{-5}	5.8·10^{-5}
PTB-12	1.0003565	1.2·10^{-5}	0.19	N	1.3·10^{-5}	5.9·10^{-5}

Number of discarded results = 3, percentage = 12 %.
$F_r = \sum e_i$ = 22.19, summed over the undiscarded contributions.
Degree of freedom = 22.

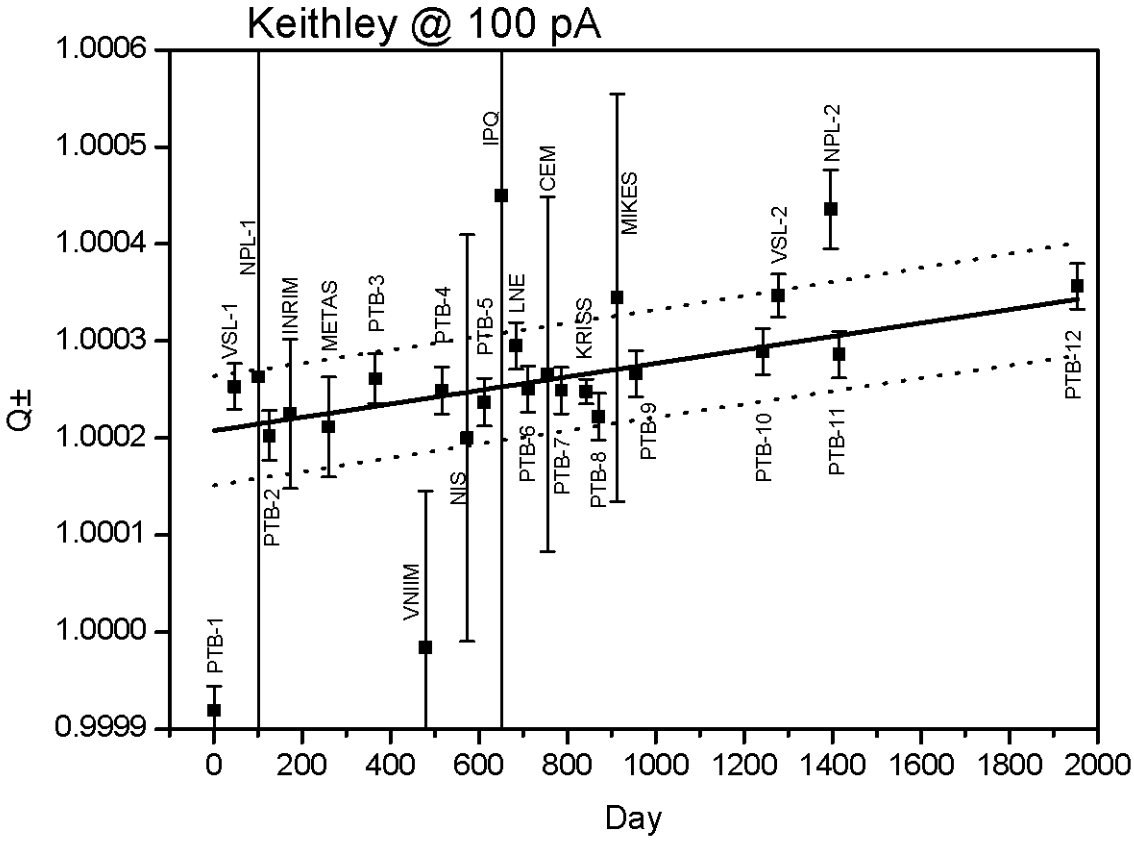

Fig. 6.24: Calibration factors for the Keithley at 100 pA for the mean of both current directions, together with the reference line (solid line) and its uncertainty for k=2 (dashed lines). Results not shown in the graph are located outside of the plotting area.

7. Withdrawals or changes of results

There were no withdrawals or changes of results.

8. Summary and conclusions

For the first time, a EUROMET comparison was performed in the field of small DC currents below 1 nA. The capabilities of thirteen European and non-European NMIs for traceable calibrations of picoammeters have been compared. For that purpose, two different commercial picoammeters were used as travelling instruments. They were calibrated at current values of ±100 fA, ±1 pA, ±10 pA and ±100 pA. The accuracy achieved was to a large extent limited by the stability of the travelling instruments. The expanded relative uncertainty (k=2) of the reference values varied between $2.7 \cdot 10^{-4}$ and $1.9 \cdot 10^{-5}$, depending on the current ranges and the travelling instruments. There was a good agreement between most of the participants.

9. References

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Appendix A: Results of the participants in chronological order

PTB-1

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2005-10-05	23.1	0.5	1014	2	41.2	1	9.6803E-14	1.0E-12	9.6743E-14	0.999385	1.6E-04	34	2.1	3.2E-04
-1.00E-13	2005-10-05	23.1	0.5	1014	2	41.2	1	-9.5417E-14	1.0E-12	-9.5378E-14	0.999596	1.3E-04	40	2.1	2.7E-04
1.00E-12	2005-10-03	23.1	0.5	1018	2	38.5	1	9.6691E-13	1.0E-12	9.6593E-13	0.998983	5.4E-05	1358	2.0	1.1E-04
-1.00E-12	2005-10-03	23.1	0.5	1018	2	38.5	1	-9.5308E-13	1.0E-12	-9.5206E-13	0.998935	5.5E-05	906	2.0	1.1E-04
1.00E-11	2005-09-02	23.1	0.5	1016	2	34.7	1	9.6696E-12	1.0E-11	9.6663E-12	0.999658	3.9E-05	131	2.0	8.0E-05
-1.00E-11	2005-09-02	23.1	0.5	1016	2	34.7	1	-9.5303E-12	1.0E-11	-9.5264E-12	0.999594	3.7E-05	261	2.0	7.4E-05
1.00E-10	2005-09-30	23.0	0.5	1001	2	38.8	1	9.5310E-11	1.0E-10	9.5306E-11	0.999957	1.3E-05	1453	2.0	2.5E-05
-1.00E-10	2005-09-30	23.0	0.5	1001	2	38.8	1	-9.3931E-11	1.0E-10	-9.3920E-11	0.999882	1.2E-05	2224	2.0	2.5E-05
Unidos E															
1.00E-13	2005-09-26	22.9	0.5	1014	2	39.9	1	9.6808E-14	LOW	9.6955E-14	1.001523	2.2E-04	28	2.1	4.6E-04
-1.00E-13	2005-09-26	22.9	0.5	1014	2	39.9	1	-9.5300E-14	LOW	-9.5450E-14	1.001571	2.6E-04	27	2.1	5.4E-04
1.00E-12	2005-09-27	23.1	0.5	1006	2	39.4	1	9.6697E-13	LOW	9.6787E-13	1.000931	7.4E-05	132	2.0	1.5E-04
-1.00E-12	2005-09-27	23.1	0.5	1006	2	39.4	1	-9.5302E-13	LOW	-9.5415E-13	1.001184	8.6E-05	65	2.0	1.7E-04
1.00E-11	2005-09-28	23.0	0.5	1006	2	39.2	1	9.6692E-12	LOW	9.6718E-12	1.000271	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2005-09-28	23.0	0.5	1006	2	39.2	1	-9.5298E-12	LOW	-9.5431E-12	1.001399	1.7E-04	inf	2.0	3.4E-04
1.00E-10	2005-09-29	23.0	0.5	1002	2	37.7	1	9.5306E-11	LOW	9.5320E-11	1.000145	1.7E-04	inf	2.0	3.4E-04
-1.00E-10	2005-09-29	23.0	0.5	1002	2	37.7	1	-9.3932E-11	LOW	-9.4044E-11	1.001194	1.7E-04	inf	2.0	3.4E-04
Mean:		23.0		1010		38.7									
First day	2005-09-02														
Last day	2005-10-05														
Median date of measurements	2005-09-18														

VSL-1

Nominal current	**Date**	**Temp.**	**U (Temp)**	**Press.**	**U (Press)**	**Humid.**	**U (Humid)**	**Current**	**Range**	**Reading**	**Q**	**u(Q), k=1**	**Eff. DOF**	**k**	**U(Q)= k*u(Q)**
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13		23.0	0.2	1016	5	45.0	5	9.4999E-14	1.0E-12	9.5228E-14	1.002410	1.8E-04	182	2.0	3.6E-04
-1.00E-13		23.0	0.2	1016	5	45.0	5	-9.4999E-14	1.0E-12	-9.4913E-14	0.999100	1.9E-04	235	2.0	3.8E-04
1.00E-12		23.0	0.2	1016	5	45.0	5	9.4998E-13	1.0E-12	9.5093E-13	1.001000	1.2E-04	52	2.0	2.5E-04
-1.00E-12		23.0	0.2	1016	5	45.0	5	-9.4999E-13	1.0E-12	-9.5068E-13	1.000730	1.2E-04	52	2.0	2.5E-04
1.00E-11		23.0	0.2	1016	5	45.0	5	9.5001E-12	1.0E-11	9.4989E-12	0.999871	1.2E-05	17	2.2	2.6E-05
-1.00E-11		23.0	0.2	1016	5	45.0	5	-9.5001E-12	1.0E-11	-9.4982E-12	0.999797	1.2E-05	17	2.2	2.6E-05
1.00E-10		23.0	0.2	1016	5	45.0	5	9.4997E-11	1.0E-10	9.5020E-11	1.000242	1.0E-05	19	2.1	2.1E-05
-1.00E-10		23.0	0.2	1016	5	45.0	5	-9.4997E-11	1.0E-10	-9.5022E-11	1.000264	1.2E-05	18	2.1	2.6E-05
Unidos E															
1.00E-13		24.0	1.0	1016	5	45.0	5	9.5000E-14	LOW	9.5214E-14	1.002250	1.3E-04	122	2.0	2.6E-04
-1.00E-13		24.0	1.0	1016	5	45.0	5	-9.5000E-14	LOW	-9.4921E-14	0.999170	1.3E-04	123	2.0	2.6E-04
1.00E-12		24.0	1.0	1016	5	45.0	5	9.5000E-13	LOW	9.5033E-13	1.000350	6.0E-05	35	2.1	1.2E-04
-1.00E-12		24.0	1.0	1016	5	45.0	5	-9.5000E-13	LOW	-9.5121E-13	1.001270	6.0E-05	28	2.1	1.3E-04
1.00E-11		24.0	1.0	1016	5	45.0	5	9.5002E-12	LOW	9.5054E-12	1.000550	1.5E-04	70	2.0	3.1E-04
-1.00E-11		24.0	1.0	1016	5	45.0	5	-9.5002E-12	LOW	-9.5100E-12	1.001030	1.5E-04	69	2.0	3.1E-04
1.00E-10		24.0	1.0	1016	5	45.0	5	9.4998E-11	LOW	9.5038E-11	1.000420	3.0E-04	36	2.1	6.2E-04
-1.00E-10		24.0	1.0	1016	5	45.0	5	-9.4998E-11	LOW	-9.5076E-11	1.000820	3.0E-04	63	2.0	6.1E-04
Mean:		23.5		1016		45.0									
First day	2005-10-18														
Last day	2005-11-21														
Median date of measurements	2005-11-04														

NPL-1

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2006-01-05	23.1	0.3	1021	0.3	36.0	5	9.4802E-14	1.0E-12	9.6832E-14	1.021400	1.3E-03	3	3.3	4.3E-03
-1.00E-13	2006-01-05	23.1	0.3	1021	0.3	36.0	5	-9.4768E-14	1.0E-12	-9.2840E-14	0.979700	8.3E-04	3	3.3	2.7E-03
1.00E-12	2006-01-05	23.0	0.3	1021	0.3	36.0	5	9.4819E-13	1.0E-12	9.5235E-13	1.004380	1.0E-03	3	3.3	3.3E-03
-1.00E-12	2006-01-05	23.0	0.3	1021	0.3	36.0	5	-9.4782E-13	1.0E-12	9.4578E-13	0.997860	7.5E-04	3	3.3	2.5E-03
1.00E-11	2006-01-05	23.1	0.3	1020	0.3	38.0	5	9.4841E-12	1.0E-11	9.4845E-12	1.000039	4.5E-04	3	3.3	1.5E-03
-1.00E-11	2006-01-05	23.1	0.3	1020	0.3	38.0	5	-9.4801E-12	1.0E-11	-9.4775E-12	0.999728	4.5E-04	2	4.5	2.0E-03
1.00E-10	2006-01-05	23.0	0.3	1020	0.3	38.9	5	9.5157E-11	1.0E-10	9.5184E-11	1.000291	4.5E-04	7	2.4	1.1E-03
-1.00E-10	2006-01-05	23.0	0.3	1020	0.3	38.9	5	-9.5120E-11	1.0E-10	-9.5142E-11	1.000235	4.5E-04	26	2.1	9.5E-04
Unidos E															
1.00E-13	2005-12-22	23.0	0.3	1030	0.3	38.8	5	9.4813E-14	LOW	1.0797E-13	1.138800	3.2E-03	3	3.3	1.1E-02
-1.00E-13	2005-12-22	23.0	0.3	1030	0.3	38.8	5	-9.4770E-14	LOW	-8.2014E-14	0.865400	1.8E-03	3	3.3	6.0E-03
1.00E-12	2005-12-22	22.8	0.3	1030	0.3	37.2	5	9.4827E-13	LOW	9.6120E-13	1.013640	8.9E-04	4	2.9	2.6E-03
-1.00E-12	2005-12-22	22.8	0.3	1030	0.3	37.2	5	-9.4784E-13	LOW	-9.3672E-13	0.988270	9.2E-04	4	2.9	2.6E-03
1.00E-11	2005-12-22	23.0	0.3	1031	0.3	37.9	5	9.4844E-12	LOW	9.5032E-12	1.001992	4.5E-04	600	2.0	9.0E-04
-1.00E-11	2005-12-22	23.0	0.3	1031	0.3	37.9	5	-9.4802E-12	LOW	-9.4788E-12	0.999852	4.5E-04	12	2.2	1.0E-03
1.00E-10	2005-12-22	23.0	0.3	1031	0.3	38.6	5	9.5161E-11	LOW	9.5230E-11	1.000721	4.5E-04	inf	2.0	9.0E-04
-1.00E-10	2005-12-22	23.0	0.3	1031	0.3	38.6	5	-9.5119E-11	LOW	-9.5170E-12	1.000534	4.5E-04	inf	2.0	9.0E-04
Mean:		23.0		1025		37.7									
First day	2005-12-22														
Last day	2006-01-05														
Median date of measurements	2005-12-29														

PTB-2

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2006-01-26	22.8	0.5	1011	2	26.6	1	9.6808E-14	1.0E-12	9.6984E-14	1.001813	1.9E-04	24	2.1	3.9E-04
-1.00E-13	2006-01-26	22.8	0.5	1011	2	26.6	1	-9.5430E-14	1.0E-12	-9.5527E-14	1.001015	1.6E-04	27	2.1	3.3E-04
1.00E-12	2006-01-24	22.9	0.5	1010	2	26.1	1	9.6697E-13	1.0E-12	9.6762E-13	1.000677	5.6E-05	549	2.0	1.1E-04
-1.00E-12	2006-01-24	22.9	0.5	1010	2	26.1	1	-9.5318E-13	1.0E-12	-9.5378E-13	1.000627	5.8E-05	309	2.0	1.2E-04
1.00E-11	2006-01-27	22.8	0.5	1000	2	21.0	1	9.6716E-12	1.0E-11	9.6702E-12	0.999859	3.9E-05	160	2.0	7.8E-05
-1.00E-11	2006-01-27	22.8	0.5	1000	2	21.0	1	9.5323E-12	1.0E-11	9.5300E-12	0.999759	3.9E-05	267	2.0	7.8E-05
1.00E-10	2006-01-27	22.8	0.5	1000	2	21.0	1	9.5368E-11	1.0E-10	9.5393E-11	1.000260	1.2E-05	1814	2.0	2.5E-05
-1.00E-10	2006-01-27	22.8	0.5	1000	2	21.0	1	-9.3936E-11	1.0E-10	-9.3950E-11	1.000145	1.3E-05	430	2.0	2.6E-05
Unidos E															
1.00E-13	2006-01-19	22.8	0.5	1014	2	27.8	1	9.6807E-14	LOW	9.6909E-14	1.001049	3.4E-04	20	2.1	7.2E-04
-1.00E-13	2006-01-19	22.8	0.5	1014	2	27.8	1	-9.5418E-14	LOW	-9.5530E-14	1.001169	2.4E-04	22	2.1	5.0E-04
1.00E-12	2006-01-18	22.8	0.5	992	2	29.3	1	9.6689E-13	LOW	9.6757E-13	1.000706	7.6E-05	111	2.0	1.5E-04
-1.00E-12	2006-01-18	22.8	0.5	992	2	29.3	1	-9.5302E-13	LOW	-9.5437E-13	1.001415	1.2E-04	32	2.1	2.5E-04
1.00E-11	2006-01-17	22.7	0.5	1011	2	28.6	1	9.6693E-12	LOW	9.6708E-12	1.000157	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2006-01-17	22.7	0.5	1011	2	28.6	1	-9.5294E-12	LOW	-9.5444E-12	1.001571	1.7E-04	inf	2.0	3.4E-04
1.00E-10	2006-01-16	22.9	0.5	1000	2	28.5	1	9.5300E-11	LOW	9.5357E-11	1.000596	1.7E-04	inf	2.0	3.4E-04
-1.00E-10	2006-01-16	22.9	0.5	1000	2	28.5	1	-9.3935E-11	LOW	-9.4003E-11	1.000721	1.7E-04	inf	2.0	3.4E-04
Mean:		22.8		1005		26.1									
First day	2006-01-16														
Last day	2006-01-27														
Median date of measurements	2006-01-21														

INRIM

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2006-03-09	23.1	0.2	983	50	22.4	4	9.4530E-14	1.0E-12	9.4580E-14	1.000529	4.2E-04	30	2.1	8.8E-04
-1.00E-13	2006-03-09	23.1	0.2	983	50	22.4	4	-9.5440E-14	1.0E-12	-9.5488E-14	1.000505	4.4E-04	30	2.1	9.2E-04
1.00E-12	2006-03-13	23.1	0.2	983	50	22.4	4	9.4530E-13	1.0E-12	9.4567E-13	1.000395	7.5E-05	30	2.1	1.6E-04
-1.00E-12	2006-03-13	23.1	0.2	983	50	22.4	4	9.5360E-01	1.0E-12	9.5389E-01	1.000299	6.1E-05	30	2.1	1.3E-04
1.00E-11	2006-03-08	23.1	0.2	986	50	24.3	7.2	9.4430E-12	1.0E-11	9.4417E-12	0.999864	3.5E-05	30	2.1	7.3E-05
-1.00E-11	2006-03-08	23.1	0.2	986	50	24.3	7.2	-9.5360E-12	1.0E-11	-9.5337E-12	0.999763	3.8E-05	30	2.1	7.9E-05
1.00E-10	2006-03-09	23.1	0.2	982	50	26.3	5.5	9.4450E-11	1.0E-10	9.4470E-11	1.000210	3.8E-05	30	2.1	7.9E-05
-1.00E-10	2006-03-09	23.1	0.2	982	50	26.3	5.5	-9.5350E-11	1.0E-10	-9.5373E-11	1.000240	3.6E-05	30	2.1	7.5E-05
Unidos E															
1.00E-13	2006-03-07	23.0	0.2	983	50	23.1	2.9	9.4510E-14	LOW	9.4583E-14	1.000774	1.3E-03	30	2.1	2.7E-03
-1.00E-13	2006-03-07	23.0	0.2	983	50	23.1	2.9	-9.5430E-14	LOW	-9.5509E-14	1.000832	1.0E-03	30	2.1	2.1E-03
1.00E-12	2006-03-07	23.0	0.2	982	50	25.0	3.3	9.4440E-13	LOW	9.4469E-13	1.000303	5.3E-04	30	2.1	1.1E-03
-1.00E-12	2006-03-07	23.0	0.2	982	50	25.0	3.3	-9.5350E-13	LOW	-9.5491E-13	1.001476	2.9E-04	30	2.1	6.1E-04
1.00E-11	2006-03-06	23.0	0.2	982	50	23.4	2.7	9.4450E-12	LOW	9.4487E-12	1.000391	1.3E-04	30	2.1	2.7E-04
-1.00E-11	2006-03-06	23.0	0.2	982	50	23.4	2.7	-9.5360E-12	LOW	-9.5489E-12	1.001351	1.3E-04	30	2.1	2.7E-04
1.00E-10	2006-03-06	23.0	0.2	982	50	25.1	2.7	9.4430E-11	LOW	9.4459E-11	1.000311	1.5E-04	30	2.1	3.1E-04
-1.00E-10	2006-03-06	23.0	0.2	982	50	25.1	2.7	-9.5340E-11	LOW	-9.5442E-11	1.001071	1.4E-04	30	2.1	2.9E-04
Mean:		23.1		983		24.0									
First day	2006-03-06														
Last day	2006-03-13														
Median date of measurements	2006-03-09														

METAS

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	pA	A					
K6430															
1.00E-13	2006-06-01	24.1	0.5	958	5	43.8	5	9.4998E-14	1.0E-12	9.5022E-14	1.000261	6.0E-04	15	2.2	1.3E-03
-1.00E-13	2006-06-01	24.1	0.5	958	5	43.8	5	9.4998E-14	1.0E-12	9.5008E-14	1.000115	5.5E-04	15	2.2	1.2E-03
1.00E-12	2006-05-31	23.8	0.5	950	5	46.5	5	9.5000E-13	1.0E-12	9.5030E-13	1.000317	2.6E-04	15	2.2	5.7E-04
-1.00E-12	2006-05-31	23.8	0.5	950	5	46.5	5	-9.5000E-13	1.0E-12	-9.5023E-13	1.000239	2.7E-04	15	2.2	5.9E-04
1.00E-11	2006-06-01	23.8	0.5	958	5	45.3	5	9.5000E-12	1.0E-11	9.4988E-12	0.999873	5.0E-05	17	2.2	1.1E-04
-1.00E-11	2006-06-01	23.8	0.5	958	5	45.3	5	-9.5000E-12	1.0E-11	-9.4976E-12	0.999748	5.0E-05	16	2.2	1.1E-04
1.00E-10	2006-06-04	23.4	0.5	959	5	44.8	5	9.5003E-11	1.0E-10	9.5023E-11	1.000211	2.5E-05	37	2.1	5.2E-05
-1.00E-10	2006-06-04	23.4	0.5	959	5	44.8	5	-9.5003E-11	1.0E-10	-9.5023E-11	1.000212	2.5E-05	35	2.1	5.2E-05
Unidos E															
1.00E-13	2006-06-06	23.8	0.5	959	5	44.5	5	9.4999E-14	LOW	9.5183E-14	1.001942	7.9E-03	12	2.2	1.8E-02
-1.00E-13	2006-06-06	23.8	0.5	959	5	44.5	5	-9.4996E-14	LOW	-9.4979E-14	0.999817	8.2E-03	12	2.2	1.8E-02
1.00E-12	2006-06-07	24.0	0.5	960	5	44.7	5	9.5000E-13	LOW	9.4994E-13	0.999939	9.0E-04	15	2.2	2.0E-03
-1.00E-12	2006-06-07	24.0	0.5	960	5	44.7	5	-9.4999E-13	LOW	-9.5163E-13	1.001718	7.2E-04	15	2.2	1.6E-03
1.00E-11	2006-06-08	23.8	0.5	960	5	44.8	5	9.5000E-12	LOW	9.5014E-12	1.000148	1.6E-04	16	2.2	3.5E-04
-1.00E-11	2006-06-08	23.8	0.5	960	5	44.8	5	-9.5000E-12	LOW	-9.5134E-12	1.001408	2.4E-04	16	2.2	5.2E-04
1.00E-10	2006-06-09	23.5	0.5	959	5	45.2	5	9.5004E-11	LOW	9.5007E-11	1.000039	7.0E-05	24	2.1	1.5E-04
-1.00E-10	2006-06-09	23.5	0.5	959	5	45.2	5	-9.5002E-11	LOW	-9.5107E-11	1.001101	7.0E-05	25	2.1	1.5E-04
Mean:		23.8		958		44.9									
First day	2006-05-31														
Last day	2006-06-09														
Median date of measurements	2006-06-04														

UME

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2006-08-24	22.9	0.4	991	1	38.5	1	9.4670E-14	1.0E-12	9.8040E-14	1.036000	7.0E-03	2	4.5	3.2E-02
-1.00E-13	2006-08-24	22.9	0.4	991	1	38.6	1	-9.4670E-14	1.0E-12	-9.0000E-14	0.951000	7.0E-03	3	3.3	2.3E-02
1.00E-12	2006-08-24	22.8	0.4	991	1	40.5	1	9.4978E-13	1.0E-12	9.5160E-13	1.001900	2.1E-03	3	3.3	6.9E-03
-1.00E-12	2006-08-28	22.9	0.4	992	1	39.4	1	-9.4977E-13	1.0E-12	-9.4015E-13	0.989900	1.0E-03	3.1	3.2	3.2E-03
1.00E-11	2006-08-24	22.8	0.4	993	1	39.7	1	9.5134E-12	1.0E-11	9.4669E-12	0.995100	4.0E-04	2.7	3.5	1.4E-03
-1.00E-11	2006-08-24	22.8	0.4	993	1	39.7	1	-9.5133E-12	1.0E-11	-9.4659E-12	0.995000	4.0E-04	2.6	3.6	1.5E-03
1.00E-10	2006-08-23	22.8	0.4	991	1	39.7	1	9.5087E-11	1.0E-10	9.4722E-11	0.996200	3.0E-04	8.65	2.3	7.0E-04
-1.00E-10	2008-08-24	22.8	0.4	993	1	40.2	1	-9.5175E-11	1.0E-10	-9.4682E-11	0.994800	3.0E-04	4	2.9	8.6E-04
Unidos E															
1.00E-13	2006-08-29	23.0	0.4	988	1	37.4	1	9.9600E-14	LOW	8.2000E-14	0.871000	3.0E-02	4.1	2.8	8.5E-02
-1.00E-13	2006-08-29	22.8	0.4	988	1	37.6	1	-9.4700E-14	LOW	-1.0700E-13	1.125000	7.0E-03	3.3	3.1	2.2E-02
1.00E-12	2006-08-29	23.1	0.4	988	1	38.3	1	9.4980E-13	LOW	9.3400E-13	0.984000	2.2E-03	2.1	4.3	9.5E-03
-1.00E-12	2006-08-29	23.0	0.4	988	1	37.7	1	-9.4980E-13	LOW	-9.5900E-13	1.010000	1.0E-03	2.5	3.7	3.7E-03
1.00E-11	2006-08-21	23.2	0.4	990	1	38.3	1	9.5230E-12	LOW	9.4850E-12	0.996000	4.0E-04	5.3	2.6	1.0E-03
-1.00E-11	2006-08-21	23.3	0.4	990	1	38.4	1	-9.5310E-12	LOW	-9.5280E-12	0.999700	6.0E-04	4.6	2.7	1.6E-03
1.00E-10	2006-08-21	23.3	0.4	992	1	41.3	1	9.5400E-11	LOW	9.5040E-11	0.996300	2.0E-04	7.7	2.4	4.8E-04
-1.00E-10	2006-08-21	23.2	0.4	991	1	41.1	1	-9.5320E-11	LOW	-9.5070E-11	0.997300	4.0E-04	5.1	2.6	1.1E-03
Mean:		23.0		991		39.2									
First day	2006-08-21														
Last day	2006-08-30														
Median date of measurements	2006-08-25														

PTB-3

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2006-09-19	23.3	0.5	1000	2	44.7	1	9.6708E-14	1.0E-12	9.6828E-14	1.001242	2.1E-04	17	2.2	4.6E-04
-1.00E-13	2006-09-19	23.3	0.5	1000	2	44.7	1	-9.5313E-14	1.0E-12	-9.5381E-14	1.000710	2.3E-04	16	2.2	4.9E-04
1.00E-12	2006-09-19	23.7	0.5	1005	2	41.3	1	9.6599E-13	1.0E-12	9.6657E-13	1.000600	5.5E-05	618	2.0	1.1E-04
-1.00E-12	2006-09-19	23.7	0.5	1005	2	41.3	1	-9.5208E-13	1.0E-12	-9.5262E-13	1.000564	6.1E-05	143	2.0	1.2E-04
1.00E-11	2006-09-21	23.8	0.5	1005	2	39.8	1	9.6596E-12	1.0E-11	9.6596E-12	1.000002	5.2E-05	37	2.1	1.1E-04
-1.00E-11	2006-09-21	23.8	0.5	1005	2	39.8	1	-9.5204E-12	1.0E-11	-9.5186E-12	0.999806	3.6E-05	336	2.0	7.3E-05
1.00E-10	2006-09-22	23.8	0.5	1005	2	39.8	1	9.5199E-11	1.0E-10	9.5223E-11	1.000251	1.4E-05	194	2.0	2.8E-05
-1.00E-10	2006-09-22	23.8	0.5	1005	2	39.8	1	-9.3830E-11	1.0E-10	-9.3855E-11	1.000271	1.2E-05	6244	2.0	2.4E-05
Unidos E															
1.00E-13	2006-09-18	23.4	0.5	998	2	49.9	1	9.6709E-14	LOW	9.6789E-14	1.000831	2.5E-04	16	2.2	5.3E-04
-1.00E-13	2006-09-18	23.4	0.5	998	2	49.9	1	-9.5307E-14	LOW	-9.5466E-14	1.001668	2.4E-04	16	2.2	5.3E-04
1.00E-12	2006-09-14	23.8	0.5	1001	2	42.8	1	9.6599E-13	LOW	9.6664E-13	1.000673	1.1E-04	28	2.1	2.3E-04
-1.00E-12	2006-09-14	23.8	0.5	1001	2	42.8	1	-9.5206E-13	LOW	-9.5327E-13	1.001268	1.1E-04	26	2.1	2.3E-04
1.00E-11	2006-09-15	23.7	0.5	997	2	42.2	1	9.6598E-12	LOW	9.6620E-12	1.000225	1.9E-04	785	2.0	3.7E-04
-1.00E-11	2006-09-15	23.7	0.5	997	2	42.2	1	-9.5199E-12	LOW	-9.5333E-12	1.001409	1.8E-04	864	2.0	3.7E-04
1.00E-10	2006-09-18	23.6	0.5	997	2	48.2	1	9.7986E-11	LOW	9.8002E-11	1.000164	1.7E-04	8093	2.0	3.4E-04
-1.00E-10	2006-09-18	23.6	0.5	997	2	48.2	1	-9.6554E-11	LOW	-9.6646E-11	1.000957	1.7E-04	7360	2.0	3.4E-04
Mean:		23.6		1001		43.6									
First day	2006-09-14														
Last day	2006-09-22														
Median date of measurements	2006-09-18														

VNIIM

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2006-12-21	23.0	0.1	1014	0.5	27.2	1	9.5000E-14	1.0E-12	9.5003E-14	1.000030	2.2E-04	19	2.1	4.7E-04
-1.00E-13	2006-12-21	23.0	0.1	1014	0.5	27.2	1	-9.5000E-14	1.0E-12	-9.5002E-14	1.000020	2.5E-04	15	2.2	5.5E-04
1.00E-12	2006-12-22	23.1	0.1	1008	1	26.7	0.5	9.5000E-13	1.0E-12	9.4998E-13	0.999980	1.1E-04	19	2.1	2.4E-04
-1.00E-12	2006-12-22	23.1	0.1	1008	1	26.7	0.5	-9.5000E-13	1.0E-12	-9.5000E-13	1.000000	1.2E-04	19	2.1	2.6E-04
1.00E-11	2006-12-26	23.0	0.2	1003	1	18.0	0.5	9.5000E-12	1.0E-11	9.5020E-12	1.000210	2.2E-04	39	2.1	4.5E-04
-1.00E-11	2006-12-26	23.0	0.2	1003	1	18.0	0.5	-9.5000E-12	1.0E-11	-9.5013E-12	1.000140	1.5E-04	39	2.1	3.1E-04
1.00E-10	2007-01-29	23.2	0.2	985	2	21.5	0.5	9.5000E-11	1.0E-10	9.4999E-11	0.999987	9.6E-05	39	2.1	2.0E-04
-1.00E-10	2007-01-29	23.2	0.2	985	2	21.5	0.5	-9.5000E-11	1.0E-10	-9.4998E-11	0.999981	6.0E-05	39	2.1	1.2E-04
Unidos E															
1.00E-13	2007-01-15	23.0	0.1	987	2	26.1	0.1	9.5000E-14	LOW	9.5074E-14	1.000780	2.4E-04	19	2.1	5.1E-04
-1.00E-13	2007-01-15	23.0	0.1	987	2	26.1	0.1	-9.5000E-14	LOW	-9.5071E-14	1.000750	3.2E-04	19	2.1	6.8E-04
1.00E-12	2007-01-16	23.1	0.1	988	1	26.2	0.05	9.5000E-13	LOW	9.5039E-13	1.000410	1.4E-04	19	2.1	3.0E-04
-1.00E-12	2007-01-16	23.1	0.1	988	1	26.2	0.05	-9.5000E-13	LOW	-9.5041E-13	1.000430	1.4E-04	19	2.1	3.0E-04
1.00E-11	2007-01-17	23.2	0.1	986	3	18.0	0.5	9.5000E-12	LOW	9.5060E-12	1.000630	8.3E-05	19	2.1	1.8E-04
-1.00E-11	2007-01-17	23.2	0.1	986	3	18.0	0.5	-9.5000E-12	LOW	-9.5061E-12	1.000640	8.9E-05	19	2.1	1.9E-04
1.00E-10	2007-01-19	22.8	0.1	965	1	26.7	0.2	9.5000E-11	LOW	9.5040E-11	1.000417	3.9E-05	29	2.1	8.2E-05
-1.00E-10	2007-01-19	22.8	0.1	965	1	26.7	0.2	-9.5000E-11	LOW	-9.5041E-11	1.000429	3.6E-05	29	2.1	7.6E-05
Mean:		23.1		992		23.8									
First day	2006-12-21														
Last day	2007-01-29														
Median date of measurements	2007-01-09														

PTB-4

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2007-02-19	23.1	0.5	1005	2	43.3	1	9.6820E-14	1.0E-12	9.6912E-14	1.000955	2.3E-04	16	2.2	5.0E-04
-1.00E-13	2007-02-19	23.1	0.5	1005	2	43.3	1	-9.5430E-14	1.0E-12	-9.5516E-14	1.000896	2.7E-04	16	2.2	5.8E-04
1.00E-12	2007-02-20	23.3	0.5	1001	2	43.0	1	9.6706E-13	1.0E-12	9.6754E-13	1.000501	5.7E-05	336	2.0	1.1E-04
-1.00E-12	2007-02-20	23.3	0.5	1001	2	43.0	1	-9.5321E-13	1.0E-12	-9.5376E-13	1.000578	5.7E-05	299	2.0	1.1E-04
1.00E-11	2007-02-21	23.3	0.5	1000	2	38.4	1	9.6701E-12	1.0E-11	9.6698E-12	0.999968	3.6E-05	493	2.0	7.1E-05
-1.00E-11	2007-02-21	23.3	0.5	1000	2	38.4	1	-9.5320E-12	1.0E-11	-9.5302E-12	0.999815	3.7E-05	281	2.0	7.4E-05
1.00E-10	2007-02-22	23.1	0.5	999	2	39.0	1	9.7034E-11	1.0E-10	9.7057E-11	1.000235	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2007-02-22	23.1	0.5	999	2	39.0	1	-9.5626E-11	1.0E-10	-9.5651E-11	1.000263	1.2E-05	inf	2.0	2.4E-05
Unidos E															
1.00E-13	2007-02-15	23.3	0.5	1008	2	39.1	1	9.6834E-14	LOW	9.6930E-14	1.000996	2.4E-04	62	2.0	5.0E-04
-1.00E-13	2007-02-15	23.3	0.5	1008	2	39.1	1	-9.5421E-14	LOW	-9.5577E-14	1.001636	2.2E-04	64	2.0	4.4E-04
1.00E-12	2007-02-14	23.1	0.5	1004	2	38.2	1	9.6719E-13	LOW	9.6742E-13	1.000240	6.7E-05	522	2.0	1.3E-04
-1.00E-12	2007-02-14	23.1	0.5	1004	2	38.2	1	-9.5312E-13	LOW	-9.5471E-13	1.001670	1.3E-04	51	2.0	2.7E-04
1.00E-11	2007-02-09	23.5	0.5	988	2	39.9	1	9.6728E-12	LOW	9.6773E-12	1.000462	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2007-02-09	23.5	0.5	988	2	39.9	1	-9.5319E-12	LOW	-9.5440E-12	1.001273	1.7E-04	inf	2.0	3.4E-04
1.00E-10	2007-02-12	23.1	0.5	999	2	38.4	1	9.4909E-11	LOW	9.4966E-11	1.000599	1.7E-04	inf	2.0	3.4E-04
-1.00E-10	2007-02-12	23.1	0.5	999	2	38.4	1	-9.3540E-11	LOW	-9.3630E-11	1.000959	1.7E-04	inf	2.0	3.4E-04
Mean:		23.2		1001		39.9									
First day	2007-02-09														
Last day	2007-02-22														
Median date of measurements	2007-02-15														

NIS

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2007-04-10	23.2	0.2	992	2	45.8	1	9.9826E-14	1.0E-12	1.0162E-13	1.018000	1.7E-03	11	2.3	3.8E-03
-1.00E-13	2007-04-11	23.2	0.2	992	2	45.8	1	-9.9830E-14	1.0E-12	-9.9141E-14	0.993100	2.8E-03	11	2.3	6.4E-03
1.00E-12	2007-04-11	23.1	0.2	992	2	46.0	1	9.9820E-13	1.0E-12	9.9970E-13	1.001500	8.0E-05	11	2.3	1.8E-04
-1.00E-12	2007-04-12	23.1	0.2	992	2	46.0	1	-9.9820E-13	1.0E-12	-9.9732E-13	0.999120	8.2E-05	11	2.3	1.8E-04
1.00E-11	2007-04-17	23.2	0.2	992	2	45.8	1	9.9840E-12	1.0E-11	9.9989E-12	1.001490	9.5E-05	11	2.3	2.1E-04
-1.00E-11	2007-04-13	23.2	0.2	992	2	45.8	1	9.9840E-12	1.0E-11	9.9730E-12	0.998900	8.8E-05	11	2.3	2.0E-04
1.00E-10	2007-04-13	23.1	0.2	992	2	45.8	1	9.9840E-11	1.0E-10	1.0001E-10	1.001700	8.9E-05	11	2.3	2.0E-04
-1.00E-10	2007-04-13	23.1	0.2	992	2	45.8	1	-9.9840E-11	1.0E-10	-9.9710E-11	0.998700	9.7E-05	11	2.3	2.2E-04
Unidos E															
1.00E-13	2007-04-14	23.1	0.2	992	2	45.8	1	9.9826E-14	LOW	9.8159E-14	0.983300	4.1E-03	11	2.3	9.2E-03
-1.00E-13	2007-04-14	23.1	0.2	992	2	45.8	1	-9.9826E-14	LOW	-1.0132E-13	1.015000	3.9E-03	11	2.3	8.8E-03
1.00E-12	2007-04-15	23.1	0.2	992	2	46.0	1	9.9821E-13	LOW	9.8678E-13	0.988550	3.2E-03	11	2.3	7.2E-03
-1.00E-12	2007-04-15	23.1	0.2	992	2	46.0	1	9.9820E-13	LOW	9.9734E-13	0.999140	3.0E-04	11	2.3	6.8E-04
1.00E-11	2007-04-16	23.2	0.2	992	2	45.8	1	9.9838E-12	LOW	9.9840E-12	1.000020	3.8E-04	11	2.3	8.6E-04
-1.00E-11	2007-04-17	23.2	0.2	992	2	45.8	1	-9.9838E-12	LOW	-9.9868E-12	1.000300	3.8E-04	11	2.3	8.6E-04
1.00E-10	2007-04-14	23.2	0.2	992	2	45.8	1	9.9840E-11	LOW	1.0000E-10	1.001600	3.0E-04	11	2.3	6.8E-04
-1.00E-10	2007-04-18	23.2	0.2	992	2	45.8	1	-9.9840E-11	LOW	-9.9740E-11	0.999000	3.0E-04	11	2.3	6.8E-04
Mean:		23.2		992		45.9									
First day	2007-04-10														
Last day	2007-04-18														
Median date of measurements	2007-04-14														

PTB-5

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2007-05-25	23.1	0.5	1000	2	41.0	1	9.6793E-14	1.0E-12	9.6933E-14	1.001451	5.4E-04	40	2.1	1.1E-03
-1.00E-13	2007-05-25	23.1	0.5	1000	2	41.0	1	-9.5376E-14	1.0E-12	-9.5520E-14	1.001507	5.0E-04	40	2.1	1.0E-03
1.00E-12	2007-05-24	23.1	0.5	1000	2	41.0	1	9.6680E-13	1.0E-12	9.6754E-13	1.000762	6.8E-05	179	2.0	1.4E-04
-1.00E-12	2007-05-24	23.1	0.5	1000	2	41.0	1	-9.5269E-13	1.0E-12	-9.5320E-13	1.000537	9.5E-05	69	2.0	1.9E-04
1.00E-11	2007-05-29	23.4	0.5	1009	2	40.3	1	9.6651E-12	1.0E-11	9.6653E-12	1.000019	3.6E-05	1045	2.0	7.2E-05
-1.00E-11	2007-05-29	23.4	0.5	1009	2	40.3	1	-9.5256E-12	1.0E-11	-9.5246E-12	0.999899	3.5E-05	2654	2.0	6.9E-05
1.00E-10	2007-05-30	23.4	0.5	1009	2	40.3	1	9.6966E-11	1.0E-10	9.6988E-11	1.000223	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2007-05-30	23.4	0.5	1009	2	40.3	1	-9.5567E-11	1.0E-10	-9.5591E-11	1.000251	1.2E-05	6064	2.0	2.5E-05
Unidos E															
1.00E-13	2007-05-21	22.7	0.5	1000	2	42.2	1	9.6763E-14	LOW	9.6908E-14	1.001503	3.2E-04	64	2.0	6.6E-04
-1.00E-13	2007-05-21	22.7	0.5	1000	2	42.2	1	-9.5355E-14	LOW	-9.5519E-14	1.001718	2.9E-04	65	2.0	5.9E-04
1.00E-12	2007-05-22	22.7	0.5	1000	2	42.2	1	9.6671E-13	LOW	9.6720E-13	1.000503	8.3E-05	299	2.0	1.7E-04
-1.00E-12	2007-05-22	22.7	0.5	1000	2	42.2	1	-9.5253E-13	LOW	-9.5385E-13	1.001391	8.0E-05	354	2.0	1.6E-04
1.00E-11	2007-05-16	22.9	0.5	1002	2	51.7	1	9.6681E-12	LOW	9.6711E-12	1.000310	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2007-05-16	22.9	0.5	1002	2	51.7	1	-9.5264E-12	LOW	-9.5386E-12	1.001281	1.7E-04	inf	2.0	3.4E-04
1.00E-10	2007-05-15	22.5	0.5	999	2	45.1	1	9.6030E-11	LOW	9.6075E-11	1.000467	1.7E-04	inf	2.0	3.4E-04
-1.00E-10	2007-05-15	22.5	0.5	999	2	45.1	1	-9.4641E-11	LOW	-9.4719E-11	1.000821	1.7E-04	inf	2.0	3.4E-04
Mean:		23.0		1002		43.0									
First day	2007-05-15														
Last day	2007-05-30														
Median date of measurements	2007-05-22														

IPQ

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2007-07-05	22.8	0.3	1009	0.3	43.0	3	9.5040E-14	1.0E-12	9.5401E-14	1.003800	6.0E-03	142	2.0	1.2E-02
-1.00E-13	2007-07-05	22.6	0.3	1009	0.3	42.0	3	-9.5040E-14	1.0E-12	-9.5135E-14	1.001000	3.1E-03	179	2.0	6.2E-03
1.00E-12	2007-06-27	23.1	0.3	1008	0.2	39.0	3	9.5018E-13	1.0E-12	9.5104E-13	1.000900	1.5E-03	25	2.1	3.2E-03
-1.00E-12	2007-06-27	23.0	0.3	1008	0.2	39.0	3	-9.5018E-13	1.0E-12	-9.5037E-13	1.000200	2.4E-03	24	2.1	5.1E-03
1.00E-11	2007-06-29	23.1	0.3	1008	0.2	39.0	3	9.5032E-12	1.0E-11	9.5066E-12	1.000360	5.8E-04	35	2.1	1.2E-03
-1.00E-11	2007-06-29	23.1	0.3	1008	0.2	41.0	3	-9.5032E-12	1.0E-11	-9.5059E-12	1.000280	5.9E-04	36	2.1	1.2E-03
1.00E-10	2007-06-28	21.8	0.3	1009	0.2	41.0	3	9.5022E-11	1.0E-10	9.5064E-11	1.000440	6.5E-04	54	2.0	1.3E-03
-1.00E-10	2007-06-28	22.1	0.3	1009	0.2	43.0	3	-9.5022E-11	1.0E-10	-9.5066E-11	1.000460	6.6E-04	51	2.0	1.4E-03
Unidos E															
1.00E-13	2007-07-04	22.8	0.3	1007	0.2	49.0	3	9.5059E-14	LOW	9.5439E-14	1.004000	2.4E-02	297	2.0	4.8E-02
-1.00E-13	2007-07-04	23.3	0.3	1007	0.2	47.0	3	-9.5059E-14	LOW	-9.5154E-14	1.001000	2.6E-02	205	2.0	5.2E-02
1.00E-12	2007-07-03	22.7	0.3	1005	0.2	49.0	3	9.5025E-13	LOW	9.5130E-13	1.001100	1.9E-03	53	2.0	3.9E-03
-1.00E-12	2007-07-04	23.4	0.3	1009	0.2	47.0	3	-9.5034E-13	LOW	-9.5110E-13	1.000800	1.4E-03	56	2.0	2.9E-03
1.00E-11	2007-07-05	23.2	0.3	1007	0.2	47.0	3	9.5043E-12	LOW	9.5071E-12	1.000290	3.9E-04	97	2.0	7.9E-04
-1.00E-11	2007-07-05	22.7	0.3	1007	0.2	48.0	3	-9.5043E-12	LOW	-9.5168E-12	1.001310	6.2E-04	76	2.0	1.3E-03
1.00E-10	2007-07-05	23.7	0.3	1006	0.2	43.0	3	9.5031E-11	LOW	9.5057E-11	1.000280	3.7E-04	92	2.0	7.5E-04
-1.00E-10	2007-07-05	23.0	0.3	1006	0.2	45.0	3	-9.5027E-11	LOW	-9.5122E-11	1.001000	6.8E-04	70	2.0	1.4E-03
Mean:		22.9		1007		43.9									
First day	2007-06-27														
Last day	2007-07-05														
Median date of measurements	2007-07-01														

LNE

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2007-07-24	22.7	0.2	1012	10	52.0	5	9.5495E-14	1.0E-12	9.5505E-14	1.000100	1.4E-03	2700	2.0	2.8E-03
-1.00E-13	2007-07-23	22.8	0.2	1001	10	53.0	5	-9.4882E-14	1.0E-12	-9.5263E-14	1.004020	9.6E-04	598	2.0	1.9E-03
1.00E-12	2007-08-09	23.0	0.2	1019	10	51.0	5	9.4936E-13	1.0E-12	9.5000E-13	1.000670	1.6E-04	128	2.0	3.2E-04
-1.00E-12	2007-08-09	23.1	0.2	1020	10	51.0	5	-9.4986E-13	1.0E-12	-9.5007E-13	1.000220	1.9E-04	89	2.0	3.9E-04
1.00E-11	2007-08-10	23.1	0.2	1017	10	51.5	5	9.4984E-12	1.0E-11	9.4994E-12	1.000108	2.0E-05	156	2.0	4.0E-05
-1.00E-11	2007-08-10	23.0	0.2	1017	10	51.5	5	-9.5019E-12	1.0E-11	-9.5001E-12	0.999806	1.7E-05	303	2.0	3.4E-05
1.00E-10	2007-07-31	23.2	0.2	1022	10	51.0	5	9.4971E-11	1.0E-10	9.4998E-11	1.000285	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2007-07-31	22.9	0.2	1020	10	52.0	5	-9.4971E-11	1.0E-10	-9.5000E-11	1.000305	1.2E-05	inf	2.0	2.4E-05
Unidos E															
1.00E-13	2007-08-13	22.6	0.2	1014	10	51.0	5	9.5046E-14	LOW	9.4751E-14	0.996900	1.7E-03	2700	2.0	3.4E-03
-1.00E-13	2007-08-13	22.6	0.2	1014	10	51.0	5	-9.4595E-14	LOW	-9.5115E-14	1.005500	1.1E-03	4500	2.0	2.2E-03
1.00E-12	2007-08-06	22.6	0.2	1010	10	52.0	5	9.4948E-13	LOW	9.5052E-13	1.001100	2.0E-04	1400	2.0	4.0E-04
-1.00E-12	2007-08-06	22.6	0.2	1013	10	52.0	5	-9.4840E-13	LOW	-9.4979E-13	1.001470	2.1E-04	946	2.0	4.2E-04
1.00E-11	2007-08-02	23.0	0.2	1014	10	52.0	5	9.4957E-12	LOW	9.4995E-12	1.000400	1.5E-04	inf	2.0	3.0E-04
-1.00E-11	2007-08-02	22.9	0.2	1022	10	51.0	5	-9.4823E-12	LOW	-9.5003E-12	1.001900	1.5E-04	inf	2.0	3.0E-04
1.00E-10	2007-08-01	23.2	0.2	1015	10	51.0	5	9.4939E-11	LOW	9.5000E-11	1.000640	1.4E-04	inf	2.0	2.8E-04
-1.00E-10	2007-08-01	23.2	0.2	1012	10	52.0	5	-9.4939E-11	LOW	-9.5000E-11	1.000650	1.4E-04	inf	2.0	2.8E-04
Mean:		22.9		1015		51.6									
First day	2007-07-23														
Last day	2007-08-13														
Median date of measurements	2007-08-02														

PTB-6

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2007-09-07	23.0	0.5	1008	2	51.5	1	9.6614E-14	1.0E-12	9.6736E-14	1.001260	3.2E-04	85	2.0	6.5E-04
-1.00E-13	2007-09-07	23.0	0.5	1008	2	51.5	1	-9.5219E-14	1.0E-12	-9.5335E-14	1.001215	3.1E-04	85	2.0	6.2E-04
1.00E-12	2007-09-05	23.0	0.5	1011	2	39.4	1	9.6506E-13	1.0E-12	9.6585E-13	1.000816	7.1E-05	332	2.0	1.4E-04
-1.00E-12	2007-09-05	23.0	0.5	1011	2	39.4	1	-9.5116E-13	1.0E-12	-9.5192E-13	1.000800	7.4E-05	279	2.0	1.5E-04
1.00E-11	2007-09-04	23.0	0.5	993	2	52.2	1	9.6498E-12	1.0E-11	9.6499E-12	1.000014	3.5E-05	4203	2.0	7.0E-05
-1.00E-11	2007-09-04	23.0	0.5	993	2	52.2	1	-9.5111E-12	1.0E-11	-9.5097E-12	0.999857	3.7E-05	1258	2.0	7.5E-05
1.00E-10	2007-09-03	23.0	0.5	993	2	52.2	1	9.6808E-11	1.0E-10	9.6831E-11	1.000240	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2007-09-03	23.0	0.5	993	2	52.2	1	-9.5422E-11	1.0E-10	-9.5447E-11	1.000261	1.2E-05	inf	2.0	2.4E-05
Unidos E															
1.00E-13	2007-08-23	23.0	0.5	999	2	57.4	1	9.6605E-14	LOW	9.6723E-14	1.001217	4.1E-04	83	2.0	8.3E-04
-1.00E-13	2007-08-23	23.0	0.5	999	2	57.4	1	-9.5230E-14	LOW	-9.5402E-14	1.001811	4.3E-04	82	2.0	8.7E-04
1.00E-12	2007-08-22	22.7	0.5	993	2	56.2	1	9.6492E-13	LOW	9.6508E-13	1.000162	7.5E-05	504	2.0	1.5E-04
-1.00E-12	2007-08-22	22.7	0.5	993	2	56.2	1	-9.5128E-13	LOW	-9.5293E-13	1.001730	7.5E-05	505	2.0	1.5E-04
1.00E-11	2007-08-27	22.9	0.5	1001	2	53.1	1	9.6489E-12	LOW	9.6505E-12	1.000163	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2007-08-27	22.9	0.5	1001	2	53.1	1	-9.5101E-12	LOW	-9.5233E-12	1.001385	1.7E-04	inf	2.0	3.4E-04
1.00E-10	2007-08-30	23.1	0.5	1003	2	39.1	1	9.5748E-11	LOW	9.5759E-11	1.000115	1.7E-04	inf	2.0	3.4E-04
-1.00E-10	2007-08-30	23.1	0.5	1003	2	39.1	1	-9.4375E-11	LOW	-9.4470E-11	1.001005	1.7E-04	inf	2.0	3.4E-04
Mean:		23.0		1000		50.1									
First day	2007-08-22														
Last day	2007-09-07														
Median date of measurements	2007-08-30														

CEM

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2007-10-01	23.0	0.3	937	1	46.5	2	9.5032E-14	1.0E-12	9.5024E-14	0.999920	3.0E-04	14	2.2	6.6E-04
-1.00E-13	2007-10-01	22.5	0.3	940	1	49.1	2	-9.5191E-14	1.0E-12	-9.5342E-14	1.001590	4.8E-04	12	2.2	1.1E-03
1.00E-12	2007-10-03	22.4	0.3	936	1	47.4	2	9.5087E-13	1.0E-12	9.5135E-13	1.000507	8.5E-05	13	2.2	1.9E-04
-1.00E-12	2007-10-03	22.4	0.3	936	1	47.4	2	-9.5083E-13	1.0E-12	-9.5126E-13	1.000456	8.5E-05	13	2.2	1.9E-04
1.00E-11	2007-10-04	22.5	0.3	932	1	49.1	2	9.5036E-12	1.0E-11	9.5033E-12	0.999967	8.3E-05	12	2.2	1.9E-04
-1.00E-11	2007-10-04	22.5	0.3	932	1	49.1	2	-9.5028E-12	1.0E-11	-9.5016E-12	0.999879	8.3E-05	12	2.2	1.9E-04
1.00E-10	2007-10-05	22.7	0.3	939	1	47.8	2	9.5063E-11	1.0E-10	9.5087E-11	1.000253	8.0E-05	10	2.3	1.8E-04
-1.00E-10	2007-10-01	22.7	0.3	939	1	47.8	2	-9.5066E-11	1.0E-10	-9.5092E-11	1.000279	8.0E-05	10	2.3	1.8E-04
Unidos E															
1.00E-13	2007-10-17	22.8	0.3	936	1	41.7	2	9.5124E-14	LOW	9.5210E-14	1.000900	3.9E-04	17	2.2	8.4E-04
-1.00E-13	2007-10-17	22.8	0.3	936	1	41.7	2	-9.5129E-14	LOW	-9.5220E-14	1.000950	4.7E-04	14	2.2	1.0E-03
1.00E-12	2007-10-18	22.4	0.3	936	1	45.6	2	9.5040E-13	LOW	9.5041E-13	1.000010	1.7E-04	215	2.0	3.5E-04
-1.00E-12	2007-10-17	22.4	0.3	936	1	47.4	2	-9.5189E-13	LOW	-9.5339E-13	1.001574	1.7E-04	214	2.0	3.5E-04
1.00E-11	2007-10-18	22.9	0.3	937	1	40.7	2	9.5115E-12	LOW	9.5190E-12	1.000790	1.9E-04	204	2.0	3.8E-04
-1.00E-11	2007-10-19	22.8	0.3	938	1	41.1	2	-9.5116E-12	LOW	-9.5192E-12	1.000800	1.7E-04	206	2.0	3.4E-04
1.00E-10	2007-10-24	22.3	0.3	934	1	42.9	2	9.5106E-11	LOW	9.5172E-11	1.000700	1.7E-04	204	2.0	3.4E-04
-1.00E-10	2007-10-24	22.4	0.3	936	1	39.5	2	-9.5104E-11	LOW	-9.5170E-11	1.000686	1.7E-04	204	2.0	3.4E-04
Mean:		22.6		936		45.3									
First day	2007-10-01														
Last day	2007-10-24														
Median date of measurements	2007-10-12														

PTB-7

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2007-11-22	23.3	0.5	995	2	55.6	1	9.6724E-14	1.0E-12	9.6784E-14	1.000623	3.7E-04	105	2.0	7.4E-04
-1.00E-13	2007-11-22	23.3	0.5	995	2	55.6	1	-9.5317E-14	1.0E-12	-9.5508E-14	1.002004	3.7E-04	107	2.0	7.4E-04
1.00E-12	2007-11-21	23.2	0.5	996	2	47.8	1	9.6609E-13	1.0E-12	9.6675E-13	1.000680	8.0E-05	219	2.0	1.6E-04
-1.00E-12	2007-11-21	23.2	0.5	996	2	47.8	1	-9.5206E-13	1.0E-12	-9.5275E-13	1.000728	8.0E-05	222	2.0	1.6E-04
1.00E-11	2007-11-19	23.1	0.5	998	2	34.0	1	9.6607E-12	1.0E-11	9.6610E-12	1.000033	3.6E-05	2733	2.0	7.1E-05
-1.00E-11	2007-11-19	23.1	0.5	998	2	34.0	1	-9.5205E-12	1.0E-11	-9.5196E-12	0.999904	3.7E-05	1594	2.0	7.3E-05
1.00E-10	2007-11-16	23.1	0.5	998	2	34.0	1	9.6920E-11	1.0E-10	9.6943E-11	1.000241	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2007-11-16	23.1	0.5	998	2	34.0	1	-9.5524E-11	1.0E-10	-9.5549E-11	1.000257	1.2E-05	inf	2.0	2.4E-05
Unidos E															
1.00E-13	2007-11-06	23.4	0.5	1003	2	32.6	1	9.6688E-14	LOW	9.6750E-14	1.000646	1.9E-04	174	2.0	3.8E-04
-1.00E-13	2007-11-06	23.4	0.5	1003	2	32.6	1	-9.5298E-14	LOW	-9.5475E-14	1.001858	2.0E-04	171	2.0	4.0E-04
1.00E-12	2007-11-12	23.0	0.5	995	2	26.6	1	9.6598E-13	LOW	9.6647E-13	1.000505	6.5E-05	1822	2.0	1.3E-04
-1.00E-12	2007-11-12	23.0	0.5	995	2	26.6	1	-9.5204E-13	LOW	-9.5315E-13	1.001166	8.4E-05	288	2.0	1.7E-04
1.00E-11	2007-11-13	23.0	0.5	1001	2	31.0	1	9.6605E-12	LOW	9.6641E-12	1.000370	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2007-11-13	23.0	0.5	1001	2	31.0	1	-9.5210E-12	LOW	-9.5330E-12	1.001256	1.7E-04	inf	2.0	3.4E-04
1.00E-10	2007-11-14	23.0	0.5	1001	2	31.0	1	9.6919E-11	LOW	9.6933E-11	1.000144	1.7E-04	inf	2.0	3.3E-04
-1.00E-10	2007-11-14	23.0	0.5	1001	2	31.0	1	-9.5522E-11	LOW	-9.5628E-11	1.001110	1.7E-04	inf	2.0	3.3E-04
Mean:		23.1		998		36.6									
First day	2007-11-06														
Last day	2007-11-22														
Median date of measurements	2007-11-14														

KRISS

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2008-01-04	23.2	0.3	1017	1.7	35.0	5	9.7909E-14	1.0E-12	9.8280E-14	1.003735	5.0E-04	39	2.1	1.0E-03
-1.00E-13	2008-01-04	23.2	0.3	1017	1.7	35.0	5	-9.7357E-14	1.0E-12	-9.7270E-14	0.999072	4.8E-04	39	2.1	9.9E-04
1.00E-12	2008-01-13	22.9	0.3	1021	1.7	36.0	5	9.7880E-13	1.0E-12	9.8012E-13	1.001349	4.1E-05	41	2.1	8.5E-05
-1.00E-12	2008-01-13	22.9	0.3	1021	1.7	36.0	5	-9.7328E-13	1.0E-12	-9.7362E-13	1.000346	5.7E-05	40	2.1	1.2E-04
1.00E-11	2008-01-09	23.1	0.3	1012	1.7	36.0	5	9.7892E-12	1.0E-11	9.7899E-12	1.000071	3.0E-05	42	2.1	6.2E-05
-1.00E-11	2008-01-09	23.1	0.3	1012	1.7	36.0	5	-9.7340E-12	1.0E-11	-9.7323E-12	0.999826	2.8E-05	43	2.1	5.8E-05
1.00E-10	2008-01-10	23.1	0.3	1013	1.7	36.0	5	9.7869E-11	1.0E-10	9.7889E-11	1.000200	6.6E-06	inf	2.0	1.3E-05
-1.00E-10	2008-01-10	23.1	0.3	1013	1.7	36.0	5	-9.7372E-11	1.0E-10	-9.7401E-11	1.000296	6.0E-06	inf	2.0	1.2E-05
Unidos E															
1.00E-13	2008-01-03	23.0	0.3	1018	1.7	35.0	5	9.7895E-14	1.15E-10	9.8000E-14	1.001328	3.4E-04	40	2.1	6.9E-04
-1.00E-13	2008-01-03	23.0	0.3	1018	1.7	35.0	5	-9.7343E-14	1.15E-10	-9.7400E-14	1.001037	3.5E-04	40	2.1	7.2E-04
1.00E-12	2008-01-12	23.0	0.3	1016	1.7	36.0	5	9.7882E-13	1.15E-10	9.7920E-13	1.000410	5.5E-05	75	2.0	1.1E-04
-1.00E-12	2008-01-12	23.0	0.3	1016	1.7	36.0	5	-9.7330E-13	1.15E-10	-9.7490E-13	1.001658	5.1E-05	84	2.0	1.0E-04
1.00E-11	2008-01-08	23.0	0.3	1012	1.7	36.0	5	9.7891E-12	1.15E-10	9.7900E-12	1.000070	2.9E-05	inf	2.0	5.8E-05
-1.00E-11	2008-01-08	23.0	0.3	1012	1.7	36.0	5	-9.7339E-12	1.15E-10	-9.7470E-12	1.001359	2.9E-05	inf	2.0	5.8E-05
1.00E-10	2008-01-11	23.0	0.3	1013	1.7	36.0	5	9.7866E-11	1.15E-10	9.7930E-11	1.000640	2.9E-05	inf	2.0	5.8E-05
-1.00E-10	2008-01-11	23.0	0.3	1013	1.7	36.0	5	-9.7369E-11	1.15E-10	-9.7410E-11	1.000422	2.9E-05	inf	2.0	5.8E-05
Mean:		23.0		1015		35.8									
First day	2008-01-03														
Last day	2008-01-13														
Median date of measurements	2008-01-08														

PTB-8

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2008-02-11	22.9	0.5	1026	2	30.9	1	9.6858E-14	1.0E-12	9.6923E-14	1.000666	2.0E-04	71	2.0	4.1E-04
-1.00E-13	2008-02-11	22.9	0.5	1026	2	30.9	1	-9.5474E-14	1.0E-12	-9.5598E-14	1.001299	1.8E-04	75	2.0	3.6E-04
1.00E-12	2008-02-07	22.9	0.5	1026	2	30.8	1	9.6743E-13	1.0E-12	9.6810E-13	1.000693	5.6E-05	1633	2.0	1.1E-04
-1.00E-12	2008-02-07	22.9	0.5	1026	2	30.8	1	-9.5359E-13	1.0E-12	-9.5421E-13	1.000649	5.5E-05	2625	2.0	1.1E-04
1.00E-11	2008-02-06	22.9	0.5	1001	2	32.5	1	-9.5358E-12	1.0E-11	-9.5357E-12	0.999993	3.8E-05	859	2.0	7.6E-05
-1.00E-11	2008-02-06	22.9	0.5	1001	2	32.5	1	9.6739E-12	1.0E-11	9.6729E-12	0.999902	3.7E-05	1312	2.0	7.3E-05
1.00E-10	2008-02-05	22.9	0.5	1001	2	32.5	1	9.7061E-11	1.0E-10	9.7082E-11	1.000212	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2008-02-05	22.9	0.5	1001	2	32.5	1	-9.5678E-11	1.0E-10	-9.5700E-11	1.000232	1.2E-05	inf	2.0	2.4E-05
Unidos E															
1.00E-13	2008-01-30	22.9	0.5	1018	2	32.3	1	9.6831E-14	LOW	9.6865E-14	1.000350	2.9E-04	65	2.0	5.9E-04
-1.00E-13	2008-01-30	22.9	0.5	1018	2	32.3	1	-9.5451E-14	LOW	-9.5662E-14	1.002214	3.3E-04	63	2.0	6.8E-04
1.00E-12	2008-01-31	22.9	0.5	1004	2	25.9	1	9.6719E-13	LOW	9.6793E-13	1.000763	8.1E-05	249	2.0	1.6E-04
-1.00E-12	2008-01-31	22.9	0.5	1004	2	25.9	1	-9.5342E-13	LOW	-9.5460E-13	1.001239	7.4E-05	398	2.0	1.5E-04
1.00E-11	2008-02-01	22.9	0.5	1002	2	27.8	1	9.6726E-12	LOW	9.6773E-12	1.000488	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2008-02-01	22.9	0.5	1002	2	27.8	1	-9.5348E-12	LOW	-9.5454E-12	1.001110	1.7E-04	onf	2.0	3.4E-04
1.00E-10	2008-02-04	22.9	0.5	983	2	30.5	1	9.7060E-11	LOW	9.7116E-11	1.000573	1.7E-04	inf	2.0	3.4E-04
-1.00E-10	2008-02-04	22.9	0.5	983	2	30.5	1	-9.5674E-11	LOW	-9.5748E-11	1.000771	1.7E-04	inf	2.0	3.3E-04
Mean:		22.9		1008		30.4									
First day	2008-01-30														
Last day	2008-02-11														
Median date of measurements	2008-02-05														

MIKES

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2008-03-21	22.9	0.1	1004	2	38.6	2	9.5218E-14	1.0E-12	9.5363E-14	1.001526	2.8E-04	3150	2.0	5.6E-04
-1.00E-13	2008-03-21	22.9	0.1	1004	2	38.6	2	-9.5218E-14	1.0E-12	-9.5274E-14	1.000588	2.8E-04	3519	2.0	5.6E-04
1.00E-12	2008-03-13	23.0	0.2	993	2	38.3	2	9.5225E-13	1.0E-12	9.5317E-13	1.000964	2.6E-04	inf	2.0	5.3E-04
-1.00E-12	2008-03-13	23.0	0.2	993	2	38.3	2	-9.5225E-13	1.0E-12	-9.5312E-13	1.000921	2.6E-04	inf	2.0	5.3E-04
1.00E-11	2008-03-08	23.0	0.2	997	2	38.2	2	9.5239E-12	1.0E-11	9.5265E-12	1.000281	2.6E-04	inf	2.0	5.3E-04
-1.00E-11	2008-03-08	23.0	0.1	997	2	38.0	2	-9.5239E-12	1.0E-11	-9.5238E-12	0.999995	2.6E-04	inf	2.0	5.3E-04
1.00E-10	2008-03-08	23.0	0.2	987	2	38.2	2	9.5234E-11	1.0E-10	9.5266E-11	1.000341	1.1E-04	inf	2.0	2.1E-04
-1.00E-10	2008-03-08	23.0	0.2	987	2	38.1	2	-9.5234E-11	1.0E-10	-9.5267E-11	1.000348	1.1E-04	inf	2.0	2.1E-04
Unidos E															
1.00E-13	2008-03-11	23.0	0.2	989	2	38.1	2	9.5230E-14	Low	9.5552E-14	1.003379	8.6E-04	inf	2.0	1.7E-03
-1.00E-13	2008-03-11	23.0	0.2	989	2	38.1	2	-9.5230E-14	Low	-9.5126E-14	0.998907	6.0E-04	9450	2.0	1.2E-03
1.00E-12	2008-03-13	23.1	0.1	991	2	38.1	2	9.5231E-13	Low	9.5336E-13	1.001102	3.1E-04	inf	2.0	6.1E-04
-1.00E-12	2008-03-13	23.0	0.2	991	2	38.1	2	-9.5231E-13	Low	-9.5315E-13	1.000889	3.1E-04	inf	2.0	6.1E-04
1.00E-11	2008-03-17	23.1	0.2	999	2	38.0	2	9.5237E-12	Low	9.5323E-12	1.000898	2.1E-04	inf	2.0	4.2E-04
-1.00E-11	2008-03-17	23.0	0.3	999	2	38.1	2	-9.5237E-12	Low	-9.5340E-12	1.001081	2.1E-04	inf	2.0	4.2E-04
1.00E-10	2008-03-30	22.7	0.1	1023	2	39.0	2	9.5233E-11	Low	9.5289E-11	1.000590	1.5E-04	inf	2.0	2.9E-04
-1.00E-10	2008-03-30	22.7	0.1	1023	2	39.0	2	-9.5233E-11	Low	-9.5301E-11	1.000709	1.5E-04	inf	2.0	2.9E-04
Mean:		23.0		998		38.3									
First day	2008-03-08														
Last day	2008-03-30														
Median date of measurements	2008-03-19														

PTB-9

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2008-05-14	23.1	0.5	1007	2	34.5	1	9.6939E-14	1.0E-12	9.6991E-14	1.000538	1.5E-04	111	2.0	3.1E-04
-1.00E-13	2008-05-14	23.1	0.5	1007	2	34.5	1	-9.5555E-14	1.0E-12	-9.5682E-14	1.001328	1.6E-04	108	2.0	3.2E-04
1.00E-12	2008-04-30	23.3	0.5	993	2	42.9	1	9.6829E-13	1.0E-12	9.6881E-13	1.000542	5.6E-05	1780	2.0	1.1E-04
-1.00E-12	2008-04-30	23.3	0.5	993	2	42.9	1	-9.5441E-13	1.0E-12	-9.5491E-13	1.000521	5.5E-05	3003	2.0	1.1E-04
1.00E-11	2008-04-25	23.2	0.5	998	2	33.6	1	9.6826E-12	1.0E-11	9.6832E-12	1.000060	3.6E-05	1405	2.0	7.3E-05
-1.00E-11	2008-04-25	23.2	0.5	998	2	33.6	1	-9.5439E-12	1.0E-11	-9.5428E-12	0.999881	3.7E-05	1081	2.0	7.4E-05
1.00E-10	2008-04-24	23.3	0.5	1011	2	37.7	1	9.7143E-11	1.0E-10	9.7167E-11	1.000252	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2008-04-24	23.3	0.5	1011	2	37.7	1	-9.5764E-11	1.0E-10	-9.5791E-11	1.000280	1.2E-05	inf	2.0	2.4E-05
Unidos E															
1.00E-13	2008-04-16	23.1	0.5	1011	2	29.5	1	9.6948E-14	LOW	9.7011E-14	1.000654	2.5E-04	90	2.0	5.1E-04
-1.00E-13	2008-04-16	23.1	0.5	1011	2	29.5	1	-9.5551E-14	LOW	-9.5799E-14	1.002596	2.5E-04	90	2.0	5.0E-04
1.00E-12	2008-04-17	23.2	0.5	1001	2	37.2	1	9.6841E-13	LOW	9.6904E-13	1.000652	6.4E-05	1931	2.0	1.3E-04
-1.00E-12	2008-04-17	23.2	0.5	1001	2	37.2	1	-9.5441E-13	LOW	-9.5565E-13	1.001299	6.3E-05	2835	2.0	1.3E-04
1.00E-11	2008-04-22	23.2	0.5	998	2	38.0	1	9.6830E-12	LOW	9.6866E-12	1.000368	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2008-04-22	23.2	0.5	998	2	38.0	1	-9.5434E-12	LOW	-9.5542E-12	1.001131	1.7E-04	inf	2.0	3.4E-04
1.00E-10	2008-04-23	23.2	0.5	998	2	38.0	1	9.7140E-11	LOW	9.7164E-11	1.000247	1.7E-04	inf	2.0	3.3E-04
-1.00E-10	2008-04-23	23.2	0.5	998	2	38.0	1	-9.5761E-11	LOW	-9.5821E-11	1.000626	1.7E-04	inf	2.0	3.3E-04
Mean:		23.2		1002		36.4									
First day	2008-04-16														
Last day	2008-05-14														
Median date of measurements	2008-04-30														

PTB-10

Nominal current	**Date**	**Temp.**	**U (Temp)**	**Press.**	**U (Press)**	**Humid.**	**U (Humid)**	**Current**	**Range**	**Reading**	**Q**	**u(Q), k=1**	**Eff. DOF**	**k**	**U(Q)= k*u(Q)**
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2009-02-02	23.1	0.5	998	2	26.0	1	9.6909E-14	1.0E-12	9.6970E-14	1.000628	2.5E-04	66	2.0	5.1E-04
-1.00E-13	2009-02-02	23.1	0.5	998	2	26.0	1	-9.5542E-14	1.0E-12	-9.5652E-14	1.001156	2.1E-04	69	2.0	4.3E-04
1.00E-12	2009-02-05	23.0	0.5	993	2	21.9	1	9.6909E-14	1.0E-12	9.6974E-14	1.000675	5.8E-05	1171	2.0	1.2E-04
-1.00E-12	2009-02-05	23.0	0.5	993	2	21.9	1	-9.5421E-13	1.0E-12	-9.5486E-13	1.000682	5.7E-05	1452	2.0	1.1E-04
1.00E-11	2009-02-10	22.5	0.5	975	2	24.7	1	9.6814E-12	1.0E-11	9.6822E-12	1.000081	3.6E-05	1501	2.0	7.2E-05
-1.00E-11	2009-02-10	22.5	0.5	975	2	24.7	1	-9.5446E-12	1.0E-11	-9.5440E-12	0.999939	3.8E-05	781	2.0	7.6E-05
1.00E-10	2009-02-11	22.6	0.5	995	2	23.0	1	9.7130E-11	1.0E-10	9.7157E-11	1.000283	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2009-02-11	22.6	0.5	995	2	23.0	1	-9.5764E-11	1.0E-10	-9.5792E-11	1.000295	1.2E-05	inf	2.0	2.4E-05
Unidos E															
1.00E-13	2009-02-19	22.9	0.5	999	2	26.4	1	9.6979E-14	LOW	9.7062E-14	1.000860	2.3E-04	91	2.0	4.7E-04
-1.00E-13	2009-02-19	22.9	0.5	999	2	26.4	1	-9.5540E-14	LOW	-9.5707E-14	1.001744	2.5E-04	90	2.0	5.1E-04
1.00E-12	2009-02-18	23.3	0.5	1007	2	23.2	1	9.6844E-13	LOW	9.6863E-13	1.000201	9.1E-05	170	2.0	1.8E-04
-1.00E-12	2009-02-18	23.3	0.5	1007	2	23.2	1	-9.5423E-13	LOW	-9.5598E-13	1.001834	9.3E-05	160	2.0	1.9E-04
1.00E-11	2009-02-16	23.3	0.5	1007	2	19.6	1	9.6856E-12	LOW	9.6892E-12	1.000369	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2009-02-16	23.3	0.5	1007	2	19.6	1	-9.5411E-12	LOW	-9.5553E-12	1.001489	1.7E-04	inf	2.0	3.4E-04
1.00E-10	2009-02-12	22.9	0.5	1003	2	21.1	1	9.7142E-11	LOW	9.7198E-11	1.000572	1.7E-04	inf	2.0	3.3E-04
-1.00E-10	2009-02-12	22.9	0.5	1003	2	21.1	1	-9.5755E-11	LOW	-9.5811E-11	1.000584	1.7E-04	inf	2.0	3.3E-04
Mean:		23.0		997		23.2									
First day	2009-02-02														
Last day	2009-02-19														
Median date of measurements	2009-02-10														

VSL-2

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13		23.0	0.1	1016	5	42.0	5	9.4999E-14	1.0E-12	-9.5233E-14	1.002467	1.1E-04	84.4	2.0	2.3E-04
-1.00E-13		23.0	0.1	1016	5	42.0	5	-9.4999E-14	1.0E-12	9.4942E-14	0.999400	1.1E-04	85.2	2.0	2.3E-04
1.00E-12		23.0	0.1	1016	5	42.0	5	9.4999E-13	1.0E-12	-9.5099E-13	1.001054	6.2E-05	63.0	2.0	1.3E-04
-1.00E-12		23.0	0.1	1016	5	42.0	5	-9.4999E-13	1.0E-12	9.5077E-13	1.000820	6.1E-05	67.0	2.0	1.2E-04
1.00E-11		23.0	0.1	1016	5	42.0	5	9.5001E-12	1.0E-11	-9.5010E-12	1.000098	1.3E-05	98.0	2.0	2.7E-05
-1.00E-11		23.0	0.1	1016	5	42.0	5	-9.5001E-12	1.0E-11	9.5001E-12	0.999998	1.7E-05	183.0	2.0	3.5E-05
1.00E-10		23.0	0.1	1016	5	42.0	5	9.4997E-11	1.0E-10	-9.5029E-11	1.000336	1.0E-05	40.3	2.1	2.1E-05
-1.00E-10		23.0	0.1	1016	5	42.0	5	-9.4997E-11	1.0E-10	9.5031E-11	1.000357	1.1E-05	51.6	2.0	2.3E-05
Unidos E															
1.00E-13		24.0	1.0	1016	5	42.0	5	9.4999E-14	LOW	9.5224E-14	1.002370	1.2E-04	104	2.0	2.5E-04
-1.00E-13		24.0	1.0	1016	5	42.0	5	-9.4999E-14	LOW	-9.4935E-14	0.999332	1.2E-04	104	2.0	2.5E-04
1.00E-12		24.0	1.0	1016	5	42.0	5	9.4998E-13	LOW	9.5113E-13	1.001210	5.0E-05	121	2.0	1.0E-04
-1.00E-12		24.0	1.0	1016	5	42.0	5	-9.4999E-13	LOW	-9.5035E-13	1.000379	8.5E-05	189	2.0	1.7E-04
1.00E-11		24.0	1.0	1016	5	42.0	5	9.5001E-12	LOW	9.5020E-12	1.000197	1.6E-04	10	2.3	3.7E-04
-1.00E-11		24.0	1.0	1016	5	42.0	5	-9.5001E-12	LOW	-9.5131E-12	1.001368	1.6E-04	10	2.3	3.6E-04
1.00E-10		24.0	1.0	1016	5	42.0	5	9.4997E-11	LOW	9.5066E-11	1.000730	3.1E-04	9	2.3	7.2E-04
-1.00E-10		24.0	1.0	1016	5	42.0	5	-9.4997E-11	LOW	-9.5042E-11	1.000476	3.1E-04	9	2.3	7.2E-04
Mean:		23.5		1016		42.0									
First day	2009-03-02														
Last day	2009-04-02														
Median date of measurements	2009-03-17														

NPL-2

Nominal current	**Date**	**Temp.**	**U (Temp)**	**Press.**	**U (Press)**	**Humid.**	**U (Humid)**	**Current**	**Range**	**Reading**	**Q**	**u(Q), k=1**	**Eff. DOF**	**k**	**U(Q)= k*u(Q)**
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2009-07-14	23.1	0.3	1021	0.3	36.0	5	9.3779E-14	1 pA	9.3821E-14	1.000460	1.4E-03	15	2.2	3.1E-03
-1.00E-13	2009-07-14	23.1	0.3	1021	0.3	36.0	5	-9.3046E-14	1 pA	-9.2993E-14	0.999430	1.9E-03	15	2.2	4.1E-03
1.00E-12	2009-07-14	23.0	0.3	1021	0.3	36.0	5	9.3932E-13	1 pA	9.4011E-13	1.000840	9.6E-05	15	2.2	2.1E-04
-1.00E-12	2009-07-14	23.0	0.3	1021	0.3	36.0	5	-9.3856E-13	1 pA	-9.3946E-13	1.000960	9.1E-05	15	2.2	2.0E-04
1.00E-11	2009-07-14	23.1	0.3	1020	0.3	38.0	5	9.3943E-12	10 pA	9.3960E-12	1.000176	2.5E-05	19	2.1	5.4E-05
-1.00E-11	2009-07-14	23.1	0.3	1020	0.3	38.0	5	-9.3935E-12	10 pA	-9.3941E-12	1.000064	2.0E-05	19	2.1	4.3E-05
1.00E-10	2009-07-14	23.0	0.3	1020	0.3	38.9	5	9.3954E-11	100 pA	9.3993E-11	1.000421	2.0E-05	28	2.1	4.2E-05
-1.00E-10	2009-07-14	23.0	0.3	1020	0.3	38.9	5	-9.3953E-11	100 pA	-9.3996E-11	1.000451	1.9E-05	28	2.1	4.0E-05
Unidos E															
1.00E-13	2009-07-15	23.0	0.3	1030	0.3	39.0	5	9.3790E-14	LOW	9.3890E-14	1.001070	7.0E-04	19	2.1	1.5E-03
-1.00E-13	2009-07-15	23.0	0.3	1030	0.3	38.8	5	-9.3044E-14	LOW	-9.3179E-14	1.001450	5.0E-04	19	2.1	1.1E-03
1.00E-12	2009-07-15	22.8	0.3	1030	0.3	37.2	5	9.3934E-13	LOW	9.3993E-13	1.000630	1.4E-04	19	2.1	3.0E-04
-1.00E-12	2009-07-15	22.8	0.3	1030	0.3	37.2	5	-9.3860E-13	LOW	-9.3934E-13	1.000780	1.4E-04	20	2.1	3.0E-04
1.00E-11	2009-07-15	23.0	0.3	1031	0.3	37.9	5	9.3945E-12	LOW	9.3994E-12	1.000520	1.2E-04	18	2.1	2.6E-04
-1.00E-11	2009-07-15	23.0	0.3	1031	0.3	37.9	5	-9.3937E-12	LOW	-9.4047E-12	1.001170	1.2E-04	18	2.1	2.6E-04
1.00E-10	2009-07-15	23.0	0.3	1031	0.3	38.6	5	9.3955E-11	LOW	9.3961E-11	1.000070	1.2E-04	inf.	2.0	2.4E-04
-1.00E-10	2009-07-15	23.0	0.3	1031	0.3	38.6	5	-9.3954E-11	LOW	-9.4069E-11	1.001220	1.2E-04	inf.	2.0	2.4E-04
Mean:		23.0		1025		37.7									
First day	2009-07-14														
Last day	2009-07-15														
Median date of measurements	2009-07-15														

PTB-11

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2009-07-27	22.9	0.5	997	2	49.3	1	9.6817E-14	1.0E-12	9.6833E-14	1.000163	2.7E-04	87	2.0	5.5E-04
-1.00E-13	2009-07-27	22.9	0.5	997	2	49.3	1	-9.5449E-14	1.0E-12	-9.5589E-14	1.001466	3.5E-04	84	2.0	7.0E-04
1.00E-12	2009-07-29	23.6	0.5	1006	2	44.5	1	9.6702E-13	1.0E-12	9.6757E-13	1.000570	6.2E-05	741	2.0	1.2E-04
-1.00E-12	2009-07-29	23.6	0.5	1006	2	44.5	1	-9.5344E-13	1.0E-12	-9.5395E-13	1.000537	5.8E-05	1338	2.0	1.2E-04
1.00E-11	2009-07-30	23.6	0.5	999	2	46.5	1	9.6690E-12	1.0E-11	9.6692E-12	1.000020	3.7E-05	966	2.0	7.5E-05
-1.00E-11	2009-07-30	23.6	0.5	999	2	46.5	1	-9.5328E-12	1.0E-11	-9.5320E-12	0.999913	3.8E-05	856	2.0	7.6E-05
1.00E-10	2009-08-03	23.6	0.5	1000	2	46.4	1	9.7004E-11	1.0E-10	9.7031E-11	1.000282	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2009-08-03	23.6	0.5	1000	2	46.4	1	-9.5645E-11	1.0E-10	-9.5673E-11	1.000290	1.2E-05	inf	2.0	2.4E-05
Unidos E															
1.00E-13	2009-08-10	23.8	0.5	1001	2	46.1	1	9.6791E-14	LOW	9.6892E-14	1.001045	3.2E-04	42	2.1	6.7E-04
-1.00E-13	2009-08-10	23.8	0.5	1001	2	46.1	1	-9.5406E-14	LOW	-9.5598E-14	1.002012	3.8E-04	41	2.1	7.8E-04
1.00E-12	2009-08-07	23.8	0.5	1000	2	48.1	1	9.6679E-13	LOW	9.6683E-13	1.000041	6.7E-05	915	2.0	1.3E-04
-1.00E-12	2009-08-07	23.8	0.5	1000	2	48.1	1	-9.5304E-13	LOW	-9.5458E-13	1.001611	6.8E-05	856	2.0	1.4E-04
1.00E-11	2009-08-06	23.4	0.5	1006	2	39.0	1	9.6686E-12	LOW	9.6729E-12	1.000449	1.7E-04	inf	2.0	3.4E-04
-1.00E-11	2009-08-06	23.4	0.5	1006	2	39.0	1	-9.5305E-12	LOW	-9.5399E-12	1.000989	1.7E-04	inf	2.0	3.4E-04
1.00E-10	2009-08-04	23.4	0.5	1001	2	42.1	1	9.7004E-11	LOW	9.7050E-11	1.000471	1.7E-04	inf	2.0	3.3E-04
-1.00E-10	2009-08-04	23.4	0.5	1001	2	42.1	1	-9.5638E-11	LOW	-9.5699E-11	1.000634	1.7E-04	inf	2.0	3.3E-04
Mean:		23.5		1001		45.3									
First day	2009-07-27														
Last day	2009-08-10														
Median date of measurements	2009-08-03														

PTB-12

Nominal current	Date	Temp.	U (Temp)	Press.	U (Press)	Humid.	U (Humid)	Current	Range	Reading	Q	u(Q), k=1	Eff. DOF	k	U(Q)= k*u(Q)
A		°C	°C	hPa	hPa	% R.H.	% R.H.	A	A	A					
K6430															
1.00E-13	2011-01-26	22.9	0.5	1001	2	34.9	1	9.4611E-02	1.0E-12	9.4761E-02	1.001579	4.5E-04	100	2.0	9.2E-04
-1.00E-13	2011-01-26	22.9	0.5	1001	2	34.9	1	-9.4611E-02	1.0E-12	-9.4642E-02	1.000334	4.0E-04	99	2.0	8.1E-04
1.00E-12	2011-01-25	22.9	0.5	995	2	36.8	1	9.4505E-01	1.0E-12	9.4580E-01	1.000796	6.4E-05	599	2.0	1.3E-04
-1.00E-12	2011-01-25	22.9	0.5	995	2	36.8	1	-9.4505E-01	1.0E-12	-9.4579E-01	1.000783	6.2E-05	696	2.0	1.2E-04
1.00E-11	2011-01-24	23.1	0.5	993	2	40.9	1	9.4580E+00	1.0E-11	9.4590E+00	1.000103	3.4E-05	inf	2.0	6.8E-05
-1.00E-11	2011-01-24	23.1	0.5	993	2	40.9	1	-9.4580E+00	1.0E-11	-9.4578E+00	0.999976	3.4E-05	inf	2.0	6.7E-05
1.00E-10	2011-01-21	23.2	0.5	1021	2	37.0	1	9.4533E+01	1.0E-10	9.4565E+01	1.000347	1.2E-05	inf	2.0	2.4E-05
-1.00E-10	2011-01-21	23.2	0.5	1021	2	37.0	1	-9.4532E+01	1.0E-10	-9.4567E+01	1.000366	1.2E-05	inf	2.0	2.4E-05
Mean:		23.0		1003		37.4									
First day	2011-01-21														
Last day	2011-01-26														
Median date of measurements	2011-01-23														

Appendix B: Uncertainty budgets of the participants

During this comparison, 25 sets of calibrations, each with 2 instruments, 4 current values and 2 current directions were performed giving 400 results and also 400 uncertainty budgets. It is clear, that in this report it is impossible to present such a large number of uncertainty budgets. Instead, for each participant only two error budgets will be presented, namely those for the Keithley 6430 at the current values +100 fA and +100 pA. This choice was made because these current values are at the extremes and because the Keithley 6430 was the more stable instrument causing fewer problems (see also Section 3.5).

Uncertainty budgets of PTB (pilot institute)

The uncertainty budgets were calculated using the following model equation:

$$Q_{\pm} = \frac{k_{a1} + k_{a2} + k_{a3}}{k_{Cacdc} + k_{c} + k_{us} + k_{ul} + k_{t}} \cdot \overline{Q_{\pm}}$$

where eight "*k*" parameters with values equal to one are introduced in order to describe the different sources of type B uncertainties:

k_{a1}	describes the limited resolution of the transfer instrument in the zero-phase before the current phase.
k_{a2}	describes the limited resolution of the transfer instrument in the current phase.
k_{a3}	describes the limited resolution of the transfer instrument in the zero-phase following the current phase.
k_{C}	describes the uncertainty of the capacitance.
k_{Cacdc}	describes the uncertainty of the capacitance due to ac-dc differences.
k_{us}	describes the short-term uncertainty of the DMM.
k_{ul}	describes the long-term uncertainty of the DMM.
k_{t}	describes the timing uncertainty of the slope measurement.

Generally, k_{a1} and k_{a3} are identical. k_{a1}, k_{a2} and k_{a3} are negligible for the Keithley 6430 while the limited resolution and the "locking effect" of the Unidos E were taken into account by using the one-sigma-uncertainties given in the following table:

Current:	**100 fA**	**1 pA**	**10 pA**	**100 pA**
$u(k_{a1}) = u(k_{a3})$	$1.5{\cdot}10^{-5}$	$1.5{\cdot}10^{-6}$	$1.5{\cdot}10^{-7}$	$1.5{\cdot}10^{-8}$
$u(k_{a2})$	$3.0{\cdot}10^{-5}$	$3.0{\cdot}10^{-5}$	$1.6{\cdot}10^{-4}$	$1.6{\cdot}10^{-4}$

In the following, only two uncertainty budgets are presented, namely those for the last one of the eleven regular PTB runs ("PTB-11").

Example of an uncertainty budget of PTB for the Keithley 6430 at a current of 95 fA:

Quantity	Estimate	Standard uncertainty	Prob. dist.	Type	Sensitivity coefficient	Uncertainty contribution	Degrees of freedom
$\overline{Q_+}$	1.000163	$2.7 \cdot 10^{-4}$	N	A	1	$2.7 \cdot 10^{-4}$	79
k_{a1}	1	$1.5 \cdot 10^{-5}$	R	B	1	$1.5 \cdot 10^{-5}$	∞
k_{a2}	1	$3.0 \cdot 10^{-5}$	R	B	1	$3.0 \cdot 10^{-5}$	∞
k_{a3}	1	$1.5 \cdot 10^{-5}$	R	B	1	$1.5 \cdot 10^{-5}$	∞
k_C	1	$2.3 \cdot 10^{-6}$	R	B	-1	$-2.3 \cdot 10^{-6}$	∞
k_{Cacdc}	1	$4.0 \cdot 10^{-5}$	R	B	-1	$-4.0 \cdot 10^{-5}$	∞
k_{us}	1	$2.4 \cdot 10^{-5}$	R	B	-1	$-2.4 \cdot 10^{-5}$	∞
k_{ul}	1	$2.4 \cdot 10^{-6}$	R	B	-1	$-2.4 \cdot 10^{-6}$	∞
k_t	1	$5.8 \cdot 10^{-8}$	R	B	-1	$-5.8 \cdot 10^{-8}$	∞
$\boldsymbol{Q_+}$	**1.000163**					$\mathbf{2.7 \cdot 10^{-4}}$	**87**

Example of an uncertainty budget of PTB for the Keithley 6430 at a current of 95 pA:

Quantity	Estimate	Standard uncertainty	Prob. dist.	Type	Sensitivity coefficient	Uncertainty contribution	Degrees of freedom
$\overline{Q_+}$	1.000282	$2.6 \cdot 10^{-6}$	N	A	1	$2.6 \cdot 10^{-6}$	59
k_{a1}	1	$1.5 \cdot 10^{-8}$	R	B	1	$1.5 \cdot 10^{-8}$	∞
k_{a2}	1	$3.0 \cdot 10^{-8}$	R	B	1	$3.0 \cdot 10^{-8}$	∞
k_{a3}	1	$1.5 \cdot 10^{-8}$	R	B	1	$1.5 \cdot 10^{-8}$	∞
k_C	1	$2.3 \cdot 10^{-6}$	R	B	-1	$-2.3 \cdot 10^{-6}$	∞
k_{Cacdc}	1	$1.0 \cdot 10^{-5}$	R	B	-1	$1.0 \cdot 10^{-5}$	∞
k_{us}	1	$5.1 \cdot 10^{-6}$	R	B	-1	$-5.1 \cdot 10^{-6}$	∞
k_{ul}	1	$2.4 \cdot 10^{-6}$	R	B	-1	$-2.4 \cdot 10^{-6}$	∞
k_t	1	$5.8 \cdot 10^{-8}$	R	B	-1	$-5.8 \cdot 10^{-8}$	∞
$\boldsymbol{Q_+}$	**1.000282**					$\mathbf{1.2 \cdot 10^{-5}}$	∞

Uncertainty budgets of VSL

The uncertainty budgets were calculated using the following model equations:

$$r = I_{meas} \cdot f_T / I_{DCCS}$$
$$f_T = 1 + \alpha \cdot dT$$
$$I_{DCCS} = C \cdot dVdt \cdot f_C \cdot f_V / f_t - (V_{zero}/R_{leak})$$
$$f_V = 1 + \delta_{Vcal}$$
$$fC = 1 + \delta_{CACDC} + \delta_{CT}$$
$$ft = 1 + \delta_{tcal} + \delta_{ttrig}$$

Quantity	Definition
r	ratio (result)
I_{meas}	current reading of K6430
f_{T}	effect of temperature on the K6430 reading
I_{DCCS}	current generated by the DCCS
α	temperature coefficient (determined)
dT	temperature deviation from nominal
C	ac value of the high quality air-dielectric output capacitor
$dVdt$	voltage ramp as determined by the measurement program
f_{C}	effect of ac-dc difference and temperature on the capacitance value
f_{V}	effect of uncertainty in the voltage measurements on the value of dV/dt
f_{t}	effect of uncertainty in triggering on the value of dV/dt
V_{zero}	voltage mismatch between 0 V and the voltage at the middle of the ramp
R_{leak}	leak resistance of the output capacitor
δ_{Vcal}	effect of the uncertainty of the voltmeter
δ_{CACDC}	effect of the capacitor ac-dc difference
δ_{CT}	effect of temperature on the capacitor
δ_{tcal}	effect of the uncertainty of the time base of the pulse generator
δ_{ttrig}	Effect of jitter in the triggering response of the voltmeter

Uncertainty budget of VSL for the Keithley 6430 at a current of 95 fA:

Quantity	Value	Standard uncertainty	Distribution	Sensitivity coefficient	Uncertainty contribution	Degrees of freedom
I_{meas}	$-95.2271 \cdot 10^{-15}$ A	$11.7 \cdot 10^{-18}$ A	normal	$11 \cdot 10^{12}$	$120 \cdot 10^{-6}$	517
f_T	1.000000	$115 \cdot 10^{-6}$				
α	$1.0 \cdot 10^{-3}$ /K					
dT	0.0 K	0.115 K	rectangular	$-1.0 \cdot 10^{-3}$	$-120 \cdot 10^{-6}$	50
C	$10.000079 \cdot 10^{-12}$ F	$25.0 \cdot 10^{-18}$ F	normal	$100 \cdot 10^{9}$	$2.5 \cdot 10^{-6}$	50
$dVdt$	$9.49978520 \cdot 10^{-3}$ V/s	$2.46 \cdot 10^{-9}$ V/s	normal	110	$260 \cdot 10^{-9}$	520
f_C	1.00000000	$8.16 \cdot 10^{-6}$				
f_V	1.00000000	$2.31 \cdot 10^{-6}$				
f_t	1.000000000	$289 \cdot 10^{-9}$				
V_{zero}	0.0 V	$57.7 \cdot 10^{-6}$ V	rectangular	$-1.1 \cdot 10^{-3}$	$-61 \cdot 10^{-9}$	520
R_{leak}	$10.0 \cdot 10^{15}$ Ω					
δ_{Vcal}	0.0	$2.31 \cdot 10^{-6}$	rectangular	1.0	$2.3 \cdot 10^{-6}$	520
δ_{CACDC}	0.0	$5.77 \cdot 10^{-6}$	rectangular	1.0	$5.8 \cdot 10^{-6}$	8
δ_{CT}	0.0	$5.77 \cdot 10^{-6}$	rectangular	1.0	$5.8 \cdot 10^{-6}$	8
δ_{tcal}	0.0	$289 \cdot 10^{-12}$	rectangular	-1.0	$-290 \cdot 10^{-12}$	1250
δ_{ttrig}	0.0	$289 \cdot 10^{-9}$	rectangular	-1.0	$-290 \cdot 10^{-9}$	1250
r	**1.002405**				$\mathbf{120 \cdot 10^{-6}}$	**182**

Uncertainty budget of VSL for the Keithley 6430 at a current of 95 pA:

Quantity	Value	Standard uncertainty	Distribution	Sensitivity coefficient	Uncertainty contribution	Degrees of freedom
I_{meas}	$95.03127 \cdot 10^{-12}$ A	$366 \cdot 10^{-18}$ A	normal	$11 \cdot 10^{9}$	$3.9 \cdot 10^{-6}$	282
f_T	1.00000000	$3.46 \cdot 10^{-6}$				
α	$30.0 \cdot 10^{-6}$ /K					
dT	0.0 K	0.115 K	rectangular	$-30 \cdot 10^{-6}$	$-3.5 \cdot 10^{-6}$	50
C	$999.9909 \cdot 10^{-12}$ F	$50.0 \cdot 10^{-18}$ F	normal	$1.0 \cdot 10^{9}$	$50 \cdot 10^{-9}$	50
$dVdt$	-0.094998218 V/s	$3.46 \cdot 10^{-9}$ V/s	normal	11	$36 \cdot 10^{-9}$	330
f_C	1.00000000	$8.16 \cdot 10^{-6}$				
f_V	1.000000000	$219 \cdot 10^{-9}$				
f_t	1.000000000	$289 \cdot 10^{-9}$				
V_{zero}	0.0 V	$57.7 \cdot 10^{-6}$ V	rectangular	$-1.1 \cdot 10^{-6}$	$-61 \cdot 10^{-12}$	330
R_{leak}	$100.0 \cdot 10^{15}$ Ω					
δ_{Vcal}	0.0	$219 \cdot 10^{-9}$	rectangular	1.0	$220 \cdot 10^{-9}$	330
δ_{CACDC}	0.0	$5.77 \cdot 10^{-6}$	rectangular	1.0	$5.8 \cdot 10^{-6}$	8
δ_{CT}	0.0	$5.77 \cdot 10^{-6}$	rectangular	1.0	$5.8 \cdot 10^{-6}$	8
δ_{tcal}	0.0	$289 \cdot 10^{-12}$	rectangular	-1.0	$-290 \cdot 10^{-12}$	1250
δ_{ttrig}	0.0	$289 \cdot 10^{-9}$	rectangular	-1.0	$-290 \cdot 10^{-9}$	1250
r	**1.000357**				$\mathbf{9.68 \cdot 10^{-6}}$	**40**

Uncertainty budgets of NPL

The uncertainty budgets were calculated using the following model equation:

Calibration factor:

$$Q = I_m/I_c = I_m/(C \cdot dV/dt)$$

with:

Quantity	Definition
I_m	current indicated by transfer instrument
I_c	$= C \cdot dV/dt$ = calibrated value of current generated by NPL system
C	value of an air-gap capacitor
dV/dt	magnitude of linear voltage ramp measured on a DVM with calibrated time-base.

The uncertainty budget was divided into three terms due to the uncertainties in C, dV/dt and I_m, which are shown in the uncertainty budget tables using bold type. Each term contains several sub-components, which are shown in the uncertainty budget tables in standard type.

$u(C_C)$ = capacitance calibration
$u(C_D)$ = capacitor drift

$u(V_A)$ = type A uncertainty of measuring dV/dt
$u(V_R)$ = type B uncertainty of dV/dt due to a nonlinear ramp
$u(V_S)$ = scale factor of DVM
$u(V_L)$ = linearity of DVM
$u(t)$ = timing uncertainty

$u(I_A)$ = standard deviation of measured current
$u(I_R)$ = describes the limited resolution of the Unidos, it is equal to zero for the Keithley 6430

$u(I_R)$ applies only for the Unidos, for the Keithley it is $u(I) = u(I_A)$.

Uncertainty budget of NPL for the Keithley 6430 at a current of 95 fA:
(it is $u(I) = u(I_A)$, because of $u(I_R) = 0$)

Quantity	Estimate	Standard uncertainty	Prob. dist./ type	Sensitivity coefficient	Uncertainty contribution	Degrees of freedom
		$u(C_C)$=3.2 ppm	B			∞
		$u(C_D)$=0.0 ppm	B			∞
C	**$9.99791 \cdot 10^{-13}$ F**	**$3.2 \cdot 10^{-18}$ F**		**-10^{-12} F^{-1}**	**$-3.2 \cdot 10^{-6}$**	
		$u(V_A)$ = 1.5 ppm	A			3
		$u(V_R)$ = 5.0 ppm	B			∞
		$u(V_S)$ = 1.2 ppm	B			∞
		$u(V_L)$ = 0.1 ppm	B			∞
		$u(t)$ = 0.1 ppm	B			∞
dVdt	**0.0948213V/s**	**$5.4 \cdot 10^{-7}$ V/s**		**-10 s/V**	**$-5.4 \cdot 10^{-6}$**	
I_m	**$9.6832 \cdot 10^{-14}$ A**	**$u(I) = 1.2 \cdot 10^{-16}$A**	**A**	**10^{13} A^{-1}**	**$1.2 \cdot 10^{-3}$**	**3**
Calibration factor Q	**1.0214**				**0.0012**	**3**

Uncertainty budget of NPL for the Keithley 6430 at a current of 95 pA:
(it is $u(I) = u(I_A)$, because of $u(I_R) = 0$)

Quantity	Estimate	Standard uncertainty	Prob. dist./ type	Sensitivity coefficient	Uncertainty contribution	Degrees of freedom
		$u(C_C)$=2.9 ppm	B			∞
		$u(C_D)$=1.7 ppm	B			∞
C	**$1.000123 \cdot 10^{-10}$ F**	**$3.4 \cdot 10^{-16}$ F**		**-10^{-10} F^{-1}**	**$-3.4 \cdot 10^{-6}$**	
		$u(V_A)$ = 3.8 ppm	A			3
		$u(V_R)$ = 5.0 ppm	B			∞
		$u(V_S)$ = 1.2 ppm	B			∞
		$u(V_L)$ = 0.1 ppm	B			∞
		$u(t)$ = 0.1 ppm	B			∞
dVdt	**0.951449V/s**	**$6.4 \cdot 10^{-6}$ V/s**		**-1 s/V**	**$-6.4 \cdot 10^{-6}$**	
I_m	**$9.51843 \cdot 10^{-11}$ A**	**$u(I) = 1.3 \cdot 10^{-15}$A**	**A**	**10^{10} A^{-1}**	**$1.3 \cdot 10^{-3}$**	**4**
Calibration factor Q	**1.000291**				**$1.5 \cdot 10^{-5}$**	**7**

Uncertainty budgets of INRIM

The uncertainty budgets were calculated using the following model equation:

$$Q = 1 + \frac{1}{I^n}\left(I^r - C\,\frac{G_v \Delta V}{T} + I^l \right) + \delta Q$$

Quantity	Definition
T	sampling interval
C	capacitance
I^r	current component nominally equals zero, its uncertainty reflects the resolution of the picoammeter, neglected even for the Unidos, due to the sufficiently large variation of the current
I^n	nominal current, zero uncertainty
I^l	takes into account all effects of leakage currents from the capacitors which has not been compensated by the fitting or averaging process
ΔV	true voltage variation during time T, zero uncertainty
G_v	voltmeter gain
δQ	noise on Q
Q	picoamperemeter gain (the measurand)

Uncertainty budget of INRIM for the Keithley 6430 at a current of +95 fA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$	**Probability distribution / method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
I^r	0 A	negligible	B		negligible	
C	1 pF	31 aF	B	$-1.00\cdot10^{12}$ /F	$3.1\cdot10^{-5}$	∞
G_v	1	$5\cdot10^{-6}$	B	-1	$5.0\cdot10^{-6}$	∞
T	1.047 s	1.047 µs	B	0.955	$1.047\cdot10^{-6}$	∞
I^l	0 A	11 aA	B	$1.05\cdot10^{13}$ /A	$1.1\cdot10^{-4}$	∞
δQ			A	1	$4.0\cdot10^{-4}$	> 30
Calibration factor Q	**1.000529**				$\mathbf{4.2\cdot10^{-4}}$	***effective degree of freedom*** ν_{eff} **= >30**

Uncertainty budget of INRIM for the Keithley 6430 at a current of +95 pA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$	**Probability distribution / method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
I^r	0 A	negligible	B		negligible	
C	1000 pF	31.1 fF	B	$-1.00 \cdot 10^{9}$ /F	$3.01 \cdot 10^{-5}$	∞
G_v	1	$5 \cdot 10^{-6}$	B	-1	$5.0 \cdot 10^{-6}$	∞
T	1.047 s	1.047 µs	B	0.955	$1.047 \cdot 10^{-6}$	∞
I^l	0 A	0.96 fA	B	$1.05 \cdot 10^{10}$ /A	$1.1 \cdot 10^{-5}$	∞
δQ			A	1	$2.1 \cdot 10^{-5}$	> 30
Calibration factor Q	**1.000529**				$\mathbf{3.8 \cdot 10^{-5}}$	***effective degree of freedom*** ν_{eff} **= >30**

Uncertainty budgets of METAS

The uncertainty budgets were calculated using the following model equation:

$$Q = \frac{I \cdot K4}{\left(C_{s\_cal} \cdot K1 \cdot K2\right)\left(\Delta V / \Delta t\right) K3}$$

with:

Quantity	Definition
I	unit under test (UUT) output
C_{s_cal}	C_s value from calibration
$K1$	uncertainty factor on C_s due to temperature
$K2$	uncertainty factor on C_s due to extrapolation to DC
$\Delta V/\Delta t$	voltage ramp slope
$K3$	uncertainty factor due to DVM resolution
$K4$	uncertainty factor due to UUT resolution (applied only for Unidos E)
Q	result

Uncertainty budget of METAS for the Keithley 6430 at a current of +95 fA:

Quantity	Estimate	Standard uncertainty	Prob. dist.	Type	Sensitivity coefficient	Uncertainty contribution	Degrees of freedom
I	$9.502248 \cdot 10^{-14}$ A	$5.64 \cdot 10^{-17}$A	N	A	$1.05 \cdot 10^{13}$ /A	$5.94 \cdot 10^{-4}$	15
C_{S_cal}	$9.999973 \cdot 10^{-12}$ F	$5.04 \cdot 10^{-17}$ F	R	B	$1.00 \cdot 10^{12}$ /F	$5.04 \cdot 10^{-5}$	∞
$K1$	1	$5.00 \cdot 10^{-9}$	R	B	1	$5.00 \cdot 10^{-9}$	∞
$K2$	1	$1.00 \cdot 10^{-5}$	R	B	1	$1.00 \cdot 10^{-5}$	∞
$\Delta V/\Delta t$	0.09500019 V/s	$8.86 \cdot 10^{-7}$	N	A	10.53 s/V	$9.33 \cdot 10^{-6}$	15
$K3$	1	$1.75 \cdot 10^{-6}$	R	B	1	$1.75 \cdot 10^{-6}$	∞
Q	**1.000261**					**$2.57 \cdot 10^{-4}$**	**15**

Uncertainty budget of METAS for the Keithley 6430 at a current of +95 pA:

Quantity	Estimate	Standard uncertainty	Prob. dist.	Type	Sensitivity coefficient	Uncertainty contribution	Degrees of freedom
I	$9.502306 \cdot 10^{-11}$ A	$1.64 \cdot 10^{-15}$A	N	A	$1.05 \cdot 10^{10}$ /A	$1.73 \cdot 10^{-5}$	14
C_{S_cal}	$1.00002954 \cdot 10^{-9}$ F	$1.04 \cdot 10^{-14}$ F	R	B	$1.00 \cdot 10^{9}$ /F	$1.04 \cdot 10^{-5}$	∞
$K1$	1	$2.00 \cdot 10^{-6}$	R	B	1	$2.00 \cdot 10^{-6}$	∞
$K2$	1	$1.00 \cdot 10^{-6}$	R	B	1	$1.00 \cdot 10^{-6}$	∞
$\Delta V/\Delta t$	0.09500024 V/s	$1.75 \cdot 10^{-6}$	N	A	10.53 s/V	$9.53 \cdot 10^{-6}$	14
$K3$	1		R	B	1	$1.75 \cdot 10^{-6}$	∞
Q	**1.000211**					**$2.25 \cdot 10^{-5}$**	**37**

Uncertainty budgets of UME

The uncertainty budgets were calculated using the following model equation:

$$Q = I \cdot k \cdot \frac{R_S + \delta R_{drf} + \delta R_{TempS} + \delta R_{voltS}}{V_{appl} + \delta V_{drf}}$$

with:

Quantity	Definition
R_S	reference resistance value
δR_{drf}	drift of the resistance of the reference since its last calibration. This value is added to the uncertainty calculation as rectangular distribution
δR_{TempS}	temperature related resistance variation of the reference. This value is added to the uncertainty calculation as rectangular distribution
δR_{voltS}	resistance variation of the reference resistor due the to the applied voltage (power coefficient)
V_{appl}	applied voltage value
δV_{drf}	drift of the voltage of the reference since its last calibration. This value is added to the uncertainty calculation as rectangular distribution
k	a factor with nominal value of 1, its uncertainty describes the limited resolution of the digital display
I	the picoamperemeter's readout.
Q	Result

Uncertainty budget of UME for the Keithley 6430 at a current of +98 fA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$	**Probability distribution/ method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
R_S	$9.82 \cdot 10^{11}$ Ω	$1.5 \cdot 10^{7}$ Ω	normal k=2/ A	$-1.05 \cdot 10^{-12}$ Ω^{-1}	$-7.91 \cdot 10^{-6}$	∞
δR_{drf}	0	$1 \cdot 10^{7}$ Ω	rectangular / B	$-1.01 \cdot 10^{-11}$ Ω^{-1}	$-5.84 \cdot 10^{-5}$	5
δR_{TempS}	0	$2 \cdot 10^{7}$ Ω	rectangular / B	$-1.01 \cdot 10^{-11}$ Ω^{-1}	$-1.17 \cdot 10^{-4}$	∞
δR_{voltS}	0	$3 \cdot 10^{5}$ Ω	rectangular / B	$-1.01 \cdot 10^{-11}$ Ω^{-1}	$-1.75 \cdot 10^{-6}$	5
V_{appl}	0.0930 V	$1 \cdot 10^{-7}$ V	normal k=2/ A	$-1.11 \cdot 10^{1}$ V^{-1}	$-5.57 \cdot 10^{-7}$	100
δV_{drf}	0	$1 \cdot 10^{-5}$ V	rectangular / B	$-1.06 \cdot 10^{-1}$ V^{-1}	$-6.15 \cdot 10^{-7}$	200
k	1.0	$2.5 \cdot 10^{-4}$	rectangular / B	-1.0	$-1.49 \cdot 10^{-4}$	∞
I	-9.8035^{-14} A	$7.02 \cdot 10^{-16}$ A	normal / A	$1.05 \cdot 10^{13}$ A^{-1}	$7.42 \cdot 10^{-3}$	2
Calibration factor Q	**-1.036**				$\mathbf{1.7 \cdot 10^{-2}}$	***effective degree of freedom*** ν_{eff} **= 2**

Uncertainty budget of UME for the Keithley 6430 at a current of +95 pA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$	**Probability distribution/ method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
R_S	$9.87 \cdot 10^{10}$ Ω	$1.5 \cdot 10^{7}$ Ω	normal k=2/ A	$-1.01 \cdot 10^{-11}$ Ω^{-1}	$-7.57 \cdot 10^{-5}$	∞
δR_{drf}	0	$1 \cdot 10^{7}$ Ω	rectangular / B	$-1.01 \cdot 10^{-11}$ Ω^{-1}	$-5.84 \cdot 10^{-5}$	5
δR_{TempS}	0	$2 \cdot 10^{7}$ Ω	rectangular / B	$-1.01 \cdot 10^{-11}$ Ω^{-1}	$-1.17 \cdot 10^{-4}$	∞
δR_{voltS}	0	$3 \cdot 10^{5}$ Ω	rectangular / B	$-1.01 \cdot 10^{-11}$ Ω^{-1}	$-1.75 \cdot 10^{-6}$	5
V_{appl}	9.383 V	$1 \cdot 10^{-5}$ V	normal k=2/ A	$-1.065 \cdot 10^{-1}$ V^{-1}	$-5.31 \cdot 10^{-7}$	100
δV_{drf}	0	$1 \cdot 10^{-5}$ V	rectangular / B	$-1.065 \cdot 10^{-1}$ V^{-1}	$-6.15 \cdot 10^{-7}$	200
k	1.0	$2.5 \cdot 10^{-5}$	rectangular / B	-1.0	$-1.44 \cdot 10^{-5}$	∞
I	$-94.722 \cdot 10^{-12}$ A	$2.56 \cdot 10^{-14}$ A	normal / A	$1.05 \cdot 10^{10}$ A^{-1}	$2.70 \cdot 10^{-4}$	5
Calibration factor Q	**-0.9962**				$\mathbf{4 \cdot 10^{-4}}$	***effective degree of freedom*** ν_{eff} **= 8.65**

Uncertainty budgets of VNIIM

The uncertainty budgets were calculated using the following model equation:

$$Q = I \cdot k \,/\, [C \cdot (\Delta V/\Delta t) + \Delta I_P + \Delta I_L]$$

With:

Quantity	Definition
I	the picoamperemeter's readout
k	a factor with nominal value of 1, its uncertainty describes the limited resolution of the readout
ΔV	voltage of 0.95V (for range 10^{-13} – 10^{-11} A) or 9.5V (for range 10^{-10} A)
Δt	time interval (100 s)
C	Capacitance
ΔI_P	parasitic currents, due to e.g. external sources like cosmic rays or piezoelectric effects
ΔI_L	leakage currents, due to possibly imperfect isolation

Uncertainty budget of VNIIM for the Keithley 6430 at a current of +95 fA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$	**Probability distribution/ method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
I	$0.95003 \cdot 10^{13}$ A	$1.5 \cdot 10^{-17}$ A	normal A	$-1.05 \cdot 10^{13}$ A^{-1}	$1.6 \cdot 10^{-6}$	19
k	1.0	$2.9 \cdot 10^{-6}$	rectangular / B	1	$2.9 \cdot 10^{-5}$	∞
ΔV	0.95 V	$5.8 \cdot 10^{-5}$ V	rectangular / B	-1.05 V^{-1}	$-6.1 \cdot 10^{-5}$	∞
Δt	100 s	$5.8 \cdot 10^{-6}$ s	rectangular / B	0.01 s^{-1}	$5.8 \cdot 10^{-8}$	∞
C	$10.00339 \cdot 10^{-12}$ F	$2.9 \cdot 10^{-17}$ F	rectangular / B	$-1.0 \cdot 10^{11}$ F^{-1}	$-2.9 \cdot 10^{-6}$	∞
ΔI_P	00	$5.8 \cdot 10^{-18}$ A	rectangular / B	$1.05 \cdot 10^{13}$ A^{-1}	$6.1 \cdot 10^{-5}$	∞
ΔI_L	-9.8035^{-14} A	$1.2 \cdot 10^{-17}$ A	rectangular / B	$1.05 \cdot 10^{13}$ A^{-1}	$1.3 \cdot 10^{-4}$	∞
Calibration factor Q	**1.00003**				$\mathbf{1.7 \cdot 10^{-2}}$	***effective degree of freedom*** ν_{eff} **= 72**

Uncertainty budget of VNIIM for the Keithley 6430 at a current of +95 pA:

Quantity X_i	Estimate x_i	Standard uncertainty $u(x_i)$	Probability distribution/ method of evaluation (A,B)	Sensitivity coefficient c_i	Uncertainty contribution u_i	Degree of freedom ν_i
I	$0.949987 \cdot 10^{-10}$ A	$9.05 \cdot 10^{-15}$ A	normal A	$1.053 \cdot 10^{10}$ A^{-1}	$9.53 \cdot 10^{-5}$	39
k	1.0	$2.9 \cdot 10^{-6}$	rectangular / B	1	$2.9 \cdot 10^{-6}$	∞
ΔV	9.5 V	$5.8 \cdot 10^{-5}$ V	rectangular / B	-0.10 V^{-1}	$-6.1 \cdot 10^{-6}$	∞
Δt	100 s	$5.8 \cdot 10^{-5}$ s	rectangular / B	0.01 s^{-1}	$5.8 \cdot 10^{-7}$	∞
C	$999.864 \cdot 10^{-12}$ F	$2.9 \cdot 10^{-15}$ F	rectangular / B	$-1.0 \cdot 10^{9}$ F^{-1}	$-2.9 \cdot 10^{-6}$	∞
ΔI_P	0	$4.6 \cdot 10^{-17}$ A	rectangular / B	$1.05 \cdot 10^{10}$ A^{-1}	$4.8 \cdot 10^{-7}$	∞
ΔI_L	0	$3.5 \cdot 10^{-16}$ A	rectangular / B	$1.05 \cdot 10^{10}$ A^{-1}	$3.7 \cdot 10^{-6}$	∞
Calibration factor Q	**0.999987**				**$9.57 \cdot 10^{-5}$**	***effective degree of freedom*** **ν_{eff} = 40**

Uncertainty budgets of NIS

The uncertainty budgets were calculated using the following model equations:

$$Q = K \cdot \frac{I}{I^*} \qquad \text{with } I^* \text{ being the applied current:} \qquad I^* = C_1 \cdot \frac{V}{R \cdot C_2}$$

Quantity	Definition
Q	calibration factor (ratio of readout and applied current)
I	the picoamperemeter's readout
K	a factor of nominal value 1, its uncertainty describes the limited resolution of the digital display.
C_1	capacitance of the "differentiating" capacitor C_1
V	Voltage
R	Resistor
I^*	the applied current
C_2	capacitance of the "integrating" capacitor C_2

Uncertainty budget of NIS for the Keithley 6430 at a current of +101 fA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$	**Probability distribution / method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
I	$101.633 \cdot 10^{-15}$ A	$1.7 \cdot 10^{-16}$ A	normal / A	$1 \cdot 10^{17}$ A^{-1}	$1.67 \cdot 10^{-3}$	11
K	1	$2.88 \cdot 10^{-4}$	rectangular / B	1	$2.88 \cdot 10^{-4}$	∞
C_1	$1.00012 \cdot 10^{-9}$ F	$2 \cdot 10^{-15}$ F	normal / B	$1 \cdot 10^{9}$ F^{-1}	$2 \cdot 10^{-6}$	∞
V	0.10000832 V	$1.5 \cdot 10^{-7}$ V	normal / B	10 V^{-1}	$1.5 \cdot 10^{-6}$	∞
R	$99.9938 \cdot 10^{6}$ Ω	$6.5 \cdot 10^{3}$ Ω	normal / B	$1 \cdot 10^{-8}$ Ω^{-1}	$6.5 \cdot 10^{-5}$	∞
C_2	$10.0201 \cdot 10^{-6}$ F	$5.01 \cdot 10^{-10}$ F	normal / B	$1 \cdot 10^{5}$ F^{-1}	$5.01 \cdot 10^{-5}$	∞
Calibration factor Q	**1.018**				**0.0017**	***effective degree of freedom*** ν_{eff} **= 11.7**

Uncertainty budget of NIS for the Keithley 6430 at a current of +100 pA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$	**Probability distribution / method of evaluation(A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
I	$100.011 \cdot 10^{-12}$ A	$1.7 \cdot 10^{-15}$ A	normal / A	$1 \cdot 10^{14}$ A^{-1}	$1.71 \cdot 10^{-5}$	11
K	1	$2.9 \cdot 10^{-5}$	rectangular / B	1	$2.9 \cdot 10^{-5}$	∞
C_1	$1.00012 \cdot 10^{-9}$ F	$2 \cdot 10^{-15}$ F	normal / B	$1 \cdot 10^{9}$ F^{-1}	$2 \cdot 10^{-6}$	∞
V	10.000264 V	$5 \cdot 10^{-6}$ V	normal / B	0.1 V^{-1}	$5 \cdot 10^{-7}$	∞
R	$99.9938 \cdot 10^{6}$ Ω	$6.5 \cdot 10^{3}$ Ω	normal / B	$1 \cdot 10^{-8}$ Ω^{-1}	$6.5 \cdot 10^{-5}$	∞
C_2	$1.00183 \cdot 10^{-6}$ F	$5.01 \cdot 10^{-11}$ F	normal / B	$1 \cdot 10^{6}$ F^{-1}	$5.01 \cdot 10^{-5}$	∞
Calibration factor Q	**1.0017**				**$8.87 \cdot 10^{-5}$**	***effective degree of freedom*** $\nu_{eff} = \infty$

Uncertainty budgets of IPQ

The uncertainty budgets were calculated using the following model equation:

$$Q = \frac{I \cdot k}{C \cdot \frac{dV}{dt}}$$

with:

Quantity	Definition
I	readout of the instrument
k	a constant value of 1 associated to the readout's limited resolution
C	the capacitance used for the current source
dV	the voltage step used to charge the capacitor
dt	the charging time

For each current value, a set of several (between 8 and 13) measuring runs have been performed. Their results are then combined to a final result. In the text below, the budgets for the worst case are presented.

Uncertainty budget of IPQ for the worst case of calibrating the Keithley 6430 at a current of +96 fA:

Quantity X_i	Estimate xi	Standard uncertainty $u(xi)$	Probability distribution / method of evaluation	Sensitivity coefficient c_i	Uncertainty contribution u_i	Degree of freedom ν_i
I	$9.6 \cdot 10^{-14}$ A	$5.7 \cdot 10^{-16}$ A	normal/A	$1.1 \cdot 10^{13}$ A^{-1}	$6.0 \cdot 10^{-3}$	141
k	1	$2.9 \cdot 10^{-4}$	rectangular/B	1	$2.9 \cdot 10^{-4}$	50
C	$1.0 \cdot 10^{-11}$ F	$5.0 \cdot 10^{-17}$ F	normal/A	$-1.0 \cdot 10^{11}$ F^{-1}	$-5.0 \cdot 10^{-6}$	50
dV	1.6 V	$8.7 \cdot 10^{-6}$ V	rectangular/B	$-6.2 \cdot 10^{-1}$ V^{-1}	$-5.3 \cdot 10^{-6}$	50
dt	170 s	$1.0 \cdot 10^{-12}$ s	rectangular/B	$5.8 \cdot 10^{-3}$ s^{-1}	$5.8 \cdot 10^{-15}$	50
Calibration factor Q	**1.0038**				**$6.0 \cdot 10^{-3}$**	**eff. degree of freedom ν_{eff}=142**

Uncertainty budget of IPQ for the worst case of calibrating the Keithley 6430 at a current of +95 pA:

Quantity X_i	Estimate x_i	Standard uncertainty $u(x_i)$	Probability distribution / method of evaluation	Sensitivity coefficient c_i	Uncertainty contribution u_i	Degree of freedom ν_i
I	$9.5\cdot10^{-11}$A	$5.5\cdot10^{-14}$ A	normal/A	$1.1\cdot10^{10}$ A^{-1}	$5.8\cdot10^{-4}$	36
k	1	$2.9\cdot10^{-4}$	rectangular/B	1	$2.9\cdot10^{-4}$	50
C	$1.0\cdot10^{-9}$ F	$5.0\cdot10^{-15}$ F	normal/A	$-1.0\cdot10^{9}$ F^{-1}	$-5.0\cdot10^{-6}$	50
dV	4.0 V	$9.4\cdot10^{-6}$ V	rectangular/B	$-2.5\cdot10^{-1}$ V^{-1}	$-5.3\cdot10^{-6}$	50
dt	42 s	$1.0\cdot10^{-12}$ s	rectangular/B	$2.4\cdot10^{-2}$ s^{-1}	$2.4\cdot10^{-14}$	50
Calibration factor Q	**1.00044**				**$6.5\cdot10^{-4}$**	**eff. degree of freedom ν_{eff}=54**

Uncertainty budgets of LNE

The uncertainty budgets were calculated using the following model equation:

$$Q = \frac{I_R}{I_{ES} + I_{EGR} - \left(\frac{I_{E0R} + I_{EFR}}{2}\right) + \left(\frac{I_{M0} + I_{MF}}{2}\right) - C_D + C'_D}$$

with:

Quantity	Definition
I_R	in step 1: readout of DUT in phase b) of a calibration cycle
I_{ES}	in step 2: all systematic uncertainty components
I_{EGR}	in step 2: random uncertainty component in phase b)
I_{E0R}	in step 2: random uncertainty component in phase a)
I_{EFR}	in step 2: random uncertainty component in phase c)
I_{M0}	in step 1: readout of DUT in phase a) of a calibration cycle
I_{MF}	in step 1: readout of DUT in phase c) of a calibration cycle
C_D	in step 1: describes the systematic uncertainty component due to nonlinearities of the drift
C'_D	in step 2: describes the systematic uncertainty component due to nonlinearities of the drift

Uncertainty budget of LNE for the Keithley 6430 at a current of +95 fA:

Quantity X_i	Estimate x_i	Standard uncertainty $u(x_i)$	Probability distribution / method of evaluation	Sensitivity coefficient c_i	Uncertainty contribution u_i	Degree of freedom ν_i
I_R	$9.5506 \cdot 10^{-14}$ A	$1.6 \cdot 10^{-17}$ A	normal/A	$1.05 \cdot 10^{13}$ A^{-1}	$1.7 \cdot 10^{-4}$	721
I_{ES}	$9.5538 \cdot 10^{-14}$ A	$5.3 \cdot 10^{-17}$ A	normal/A	$1.05 \cdot 10^{13}$ A^{-1}	$5.6 \cdot 10^{-4}$	∞
I_{EGR}	0 A	$3.1 \cdot 10^{-17}$ A	normal/A	$1.06 \cdot 10^{13}$ A^{-1}	$3.2 \cdot 10^{-4}$	11
I_{E0R}	0 A	$3.9 \cdot 10^{-17}$ A	normal/A	$5.24 \cdot 10^{12}$ A^{-1}	$2.0 \cdot 10^{-4}$	9
I_{EFR}	0 A	$3.3 \cdot 10^{-17}$ A	normal/A	$5.24 \cdot 10^{12}$ A^{-1}	$1.7 \cdot 10^{-5}$	5
I_{M0}	$-1.53 \cdot 10^{-16}$ A	$1.0 \cdot 10^{-17}$ A	normal/A	$5.24 \cdot 10^{12}$ A^{-1}	$5.4 \cdot 10^{-5}$	800
I_{MF}	$6.80 \cdot 10^{-17}$ A	$1.3 \cdot 10^{-17}$ A	normal/A	$5.24 \cdot 10^{12}$ A^{-1}	$6.6 \cdot 10^{-5}$	639
C_D	0 A	$9.2 \cdot 10^{-17}$ A	rectangular/B	$1.05 \cdot 10^{13}$ A^{-1}	$9.6 \cdot 10^{-4}$	∞
C'_D	0 A	$6.4 \cdot 10^{-17}$ A	rectangular/B	$1.05 \cdot 10^{13}$ A^{-1}	$6.7 \cdot 10^{-4}$	∞
Calibration factor Q	**1.0001**				**$1.4 \cdot 10^{-3}$**	**eff. degree of freedom $\nu_i = 2.7 \cdot 10^3$**

Uncertainty budget of LNE for the Keithley 6430 at a current of +95 pA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$	**Probability distribution / method of evaluation**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
I_R	$9.4998463\cdot10^{-11}$ A	$4.0\cdot10^{-17}$ A	normal/A	$1.05\cdot10^{10}$ A^{-1}	$4.3\cdot10^{-7}$	1116
I_{ES}	$9.49706\cdot10^{-11}$ A	$1.1\cdot10^{-15}$ A	normal/A	$1.05\cdot10^{10}$ A^{-1}	$1.2\cdot10^{-5}$	∞
I_{EGR}	0 A	$2.9\cdot10^{-17}$ A	normal/A	$1.05\cdot10^{10}$ A^{-1}	$3.0\cdot10^{-7}$	12
I_{E0R}	0 A	$4.0\cdot10^{-17}$ A	normal/A	$5.27\cdot10^{9}$ A^{-1}	$2.1\cdot10^{-7}$	5
I_{EFR}	0 A	$2.4\cdot10^{-17}$ A	normal/A	$5.27\cdot10^{9}$ A^{-1}	$1.2\cdot10^{-7}$	4
I_{M0}	$8.68\cdot10^{-16}$ A	$2.9\cdot10^{-17}$ A	normal/A	$5.27\cdot10^{9}$ A^{-1}	$1.5\cdot10^{-7}$	930
I_{MF}	$7.17\cdot10^{-16}$ A	$3.3\cdot10^{-17}$ A	normal/A	$5.27\cdot10^{9}$ A^{-1}	$1.8\cdot10^{-7}$	719
C_D	0 A	$4.0\cdot10^{-17}$ A	rectangular/B	$1.05\cdot10^{10}$ A^{-1}	$4.2\cdot10^{-7}$	∞
C'_D	0 A	$4.3\cdot10^{-17}$ A	rectangular/B	$1.05\cdot10^{10}$ A^{-1}	$4.6\cdot10^{-7}$	∞
Calibration factor Q	**1.000285**				$\mathbf{1.2\cdot10^{-5}}$	**eff. degree of freedom** $\boldsymbol{\nu_i=1.5\cdot10^{7}}$

Uncertainty budgets of CEM

The uncertainty budgets were calculated using the following model equation:

$$Q = -\bar{I}_x k k_0 \frac{R}{V_C}$$

with:

Quantity	Definition
Q	calibration factor of the picoammeter for the corresponding current, defined as ratio from measured current to standard current
I_x	average of the readings of the picoammeter for the corresponding current
k	factor with nominal value of 1, whose uncertainty describes the limited resolution of the digital display
k_0	factor with nominal value of 1, whose uncertainty describes the limited resolution of the digital display for zero measurements
V_C	voltage of the calibrator
R	value of the resistance standard. Its uncertainty includes uncertainty components due to calibration, drift, ambient conditions and voltage coefficient

Uncertainty budget of CEM for the Keithley 6430 at a current of +95 fA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u_r(x_i)$	**Probability distribution / method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
I	$95.191 \cdot 10^{-15}$	$4.7 \cdot 10^{-4}$	normal / A	1.0	$4.7 \cdot 10^{-4}$	11
k	1.0	$3 \cdot 10^{-5}$	rectangular / B	1.0	$3 \cdot 10^{-5}$	∞
k_0	1.0	$3 \cdot 10^{-5}$	rectangular / B	1.0	$3 \cdot 10^{-5}$	∞
R	99.9587 GΩ	$80 \cdot 10^{-6}$	normal / A+B	1.0	$80 \cdot 10^{-6}$	10
V_C	-0.0095 V	$2.5 \cdot 10^{-5}$	rectangular / B	1.0	$2.5 \cdot 10^{-5}$	∞
Calibration factor Q	**1.00159**				**$4.8 \cdot e^{-4}$**	***effective degrees of freedom*** **$\nu_{eff} = 12$**

Uncertainty budget of CEM for the Keithley 6430 at a current of +95 pA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u_r(x_i)$	**Probability distribution / method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
I	$95.0658 \cdot 10^{-12}$	$2.9 \cdot 10^{-6}$	normal / A	1.0	$2.9 \cdot 10^{-6}$	23
k	1.0	$3 \cdot 10^{-6}$	rectangular / B	1.0	$3 \cdot 10^{-6}$	∞
k_0	1.0	$3 \cdot 10^{-6}$	rectangular / B	1.0	$3 \cdot 10^{-6}$	∞
R	99.9587 GΩ	$80 \cdot 10^{-6}$	normal / A+B	1.0	$80 \cdot 10^{-6}$	10
V_C	-9.5 V	$1.9 \cdot 10^{-6}$	rectangular / B	1.0	$1.9 \cdot 10^{-6}$	∞
Calibration factor Q	**1.000279**				$\mathbf{80 \cdot 10^{-6}}$	***effective degrees of freedom*** ν_{eff} **= 10**

Uncertainty budgets of KRISS

The uncertainty budgets were calculated using the following model equation:

$$Q = \frac{I_D}{C \cdot \frac{dV}{dt}}$$

The uncertainties were calculated according to:

$$u(Q) = \frac{R_D}{C \cdot \frac{dV}{dt}} \sqrt{u^2(R_D) + k_D^2 + k_v^2 + u^2(C)}$$

with:

Quantity	Definition
I_D	current reading of the DUT
k_D	factor describing the resolution of the DUT
C	capacitance
dV/dt	voltage slope
k_V	factor describing the uncertainty of the voltage measurement
k_t	factor describing the uncertainty of the time interval measurement

Uncertainty budget of KRISS for the Keithley 6430 at a current of +97 fA:

Quantity X_i	Estimate *x*i	Standard uncertainty $u(xi)$	Probability distribution / method of evaluation	Sensitivity coefficient c_i	Uncertainty contribution u_i	Degree of freedom ν_i
I_D	$0.09727 \cdot 10^{-12}$A	$4.68 \cdot 10^{-17}$ A	normal/A	$1.03 \cdot 10^{13}$ A^{-1}	$4.81 \cdot 10^{-4}$	39
k_D	1	$5.77 \cdot 10^{-6}$	rectangular/B	1	$5.77 \cdot 10^{-6}$	∞
C	$10.000242 \cdot 10^{-12}$ F	$2.12 \cdot 10^{-17}$ F	rectangular/B	$1.0 \cdot 10^{11}$ F^{-1}	$2.12 \cdot 10^{-6}$	∞
k_V	1	$2.31 \cdot 10^{-7}$	rectangular/B	1	$2.31 \cdot 10^{-7}$	∞
k_t	1	$5.77 \cdot 10^{-8}$	rectangular/B	1	$5.77 \cdot 10^{-8}$	∞
Calibration factor Q	**0.999072**				**$4.81 \cdot 10^{-4}$**	**eff. degree of freedom ν_{eff}=39**

Uncertainty budget of KRISS for the Keithley 6430 at a current of +98 pA:

Quantity X_i	**Estimate** x**i**	**Standard uncertainty** $u(xi)$	**Probability distribution / method of evaluation**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** ν_i
I_D	$97.889 \cdot 10^{-12}$A	$2.83 \cdot 10^{-16}$ A	normal/A	$1.02 \cdot 10^{10}$ A^{-1}	$2.86 \cdot 10^{-6}$	39
k_D	1	$5.77 \cdot 10^{-6}$	rectangular/B	1	$5.77 \cdot 10^{-6}$	∞
C	$1000.0072 \cdot 10^{-12}$ F	$1.17 \cdot 10^{-15}$ F	rectangular/B	$1.0 \cdot 10^{9}$ F^{-1}	$1.17 \cdot 10^{-6}$	∞
k_V	1	$2.31 \cdot 10^{-7}$	rectangular/B	1	$2.31 \cdot 10^{-7}$	∞
k_t	1	$5.77 \cdot 10^{-8}$	rectangular/B	1	$5.77 \cdot 10^{-8}$	∞
Calibration factor Q	**1.000200**				$\mathbf{6.57 \cdot 10^{-6}}$	**eff. degree of freedom** ν_{eff}**=1000**

Uncertainty budgets of MIKES

The uncertainty budgets were calculated using the following model equation:

$$Q = \frac{I_{meas}}{I_{gen}} = \frac{I_{disp} - I_{sz} + I_{reso}}{\left(C_{cal} + \Delta C_{drift} + \Delta C_T\right)\frac{(dU_{meas} + \Delta U_{cal})}{dt_{meas}} + I_{setup}}$$

with:

Quantity	Definition
Q	result
I_{meas}	current measured by the ammeter under test excluding the ammeter bias
I_{gen}	current generated
I_{disp}	current displayed by the ammeter under test
I_{sz}	"setup zero." Current measured by the ammeter under test during the periods of zero dU/dt. Average of the values with positive and negative voltages
I_{reso}	addition to the measured current representing the limited resolution (only effective for calibrating the Unidos E)
C_{cal}	value of the differentiating capacitor
ΔC_{drift}	addition to the capacitor value representing the expected drift after the last calibration
ΔC_T	the change in capacitor value because of the difference from the nominal temperature
dU_{meas}	the average of the voltage differences of the two sequential DMM recordings during a ramp
ΔU_{cal}	addition to the dU_{meas} representing the difference from the displayed value according to the calibration
dt_{meas}	inverse of the DMM triggering frequency
I_{setup}	additional correction current representing capacitor dependent differences in the results

Uncertainty budget of MIKES for the Keithley 6430 at a current of +95 fA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$ **k=1**	**Probability distribution / method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** v_i
C_{cal}	$1.000028 \cdot 10^{-11}$ F	$1.00 \cdot 10^{-17}$ F	normal, B	$-9.933 \cdot 10^{+10}$ F^{-1}	$-9.933 \cdot 10^{-07}$	∞
ΔC_{drift}	0.0 F	$1.00 \cdot 10^{-17}$ F	square, B	$-9.933 \cdot 10^{+10}$ F^{-1}	$-9.933 \cdot 10^{-07}$	∞
ΔC_T	$8.0831 \cdot 10^{-18}$ F	$1.05 \cdot 10^{-19}$ F	normal, B	$-9.933 \cdot 10^{+10}$ F^{-1}	$-1.043 \cdot 10^{-08}$	∞
dU_{meas}	0.01998950 V	$9.25 \cdot 10^{-08}$ V	normal, A	-49.56 V^{-1}	$-4.585 \cdot 10^{-06}$	1003
ΔU_{cal}	0.0 V	$6.00 \cdot 10^{-08}$ V	normal, B	-49.56 V^{-1}	$-2.972 \cdot 10^{-06}$	∞
dt_{meas}	2.09900 s	$2.10 \cdot 10^{-07}$ s	square, B	$4.720 \cdot 10^{-01}$ s^{-1}	$9.907 \cdot 10^{-08}$	∞
I_{sz}	$1.87 \cdot 10^{-16}$ A	$6.10 \cdot 10^{-18}$ A	normal, A	$-1.030 \cdot 10^{+13}$ A^{-1}	$-6.281 \cdot 10^{-05}$	2349
I_{setup}	0.0 A	$2.50 \cdot 10^{-17}$ A	square, B	$-1.030 \cdot 10^{+13}$ A^{-1}	$-2.574 \cdot 10^{-04}$	∞
I_{disp}	$9.55816 \cdot 10^{-14}$ A	$7.22 \cdot 10^{-18}$ A	normal, A	$1.040 \cdot 10^{+13}$ A^{-1}	$7.508 \cdot 10^{-05}$	1003
Total A Type					**0.000098**	**2407**
Total B Type					**0.000257**	**∞**
Q	**1.001668**				**0.000275**	**150223**

Uncertainty budget of MIKES for the Keithley 6430 at a current of +95 pA:

Quantity X_i	**Estimate** x_i	**Standard uncertainty** $u(x_i)$ **k=1**	**Probability distribution / method of evaluation (A,B)**	**Sensitivity coefficient** c_i	**Uncertainty contribution** u_i	**Degree of freedom** v_i
C_{cal}	$9.999675 \cdot 10^{-10}$ F	$1.00 \cdot 10^{-15}$ F	normal, B	$-1.000 \cdot 10^{+09}$ F^{-1}	$-1.000 \cdot 10^{-06}$	∞
ΔC_{drift}	0.0 F	$1.00 \cdot 10^{-15}$ F	square, B	$-1.000 \cdot 10^{+09}$ F^{-1}	$-1.000 \cdot 10^{-06}$	∞
ΔC_T	$6.1498 \cdot 10^{-17}$ F	$3.75 \cdot 10^{-17}$ F	normal, B	$-1.000 \cdot 10^{+09}$ F^{-1}	$-3.750 \cdot 10^{-08}$	∞
dU_{meas}	0.19990161 V	$8.26 \cdot 10^{-07}$ V	normal, A	-4.978 V^{-1}	$-4.113 \cdot 10^{-06}$	1167
ΔU_{cal}	0.0 V	$4.00 \cdot 10^{-07}$ V	normal, B	-4.978 V^{-1}	$-1.990 \cdot 10^{-06}$	∞
dt_{meas}	2.09900 s	$2.10 \cdot 10^{-07}$ s	square, B	$4.765 \cdot 10^{-01}$ s^{-1}	$1.000 \cdot 10^{-07}$	∞
I_{sz}	$8.54 \cdot 10^{-15}$ A	$1.91 \cdot 10^{-16}$ A	normal, A	$-1.050 \cdot 10^{+10}$ A^{-1}	$2.001 \cdot 10^{-06}$	2388
I_{setup}	0.0 A	$1.00 \cdot 10^{-14}$ A	square, B	$-1.050 \cdot 10^{+10}$ A^{-1}	$1.050 \cdot 10^{-04}$	∞
I_{disp}	$-9.52735 \cdot 10^{-11}$ A	$3.71 \cdot 10^{-16}$ A	normal, A	$1.050 \cdot 10^{+10}$ A^{-1}	$-3.894 \cdot 10^{-06}$	1067
Total A Type					**0.000006**	**2786**
Total B Type					**0.000105**	**∞**
Q	**1.000330**				**0.000105**	**$2.62 \cdot 10^{08}$**