

STUDY OF ELECTRICAL CHARGE SOURCES: INTERMEDIATE CHECKS AND CALIBRATION OF ELECTROMETERS

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INTRODUCTION

The intermediate checks are described in the ISO/ IEC 17025 standard ⁽¹⁾. The test is used to confirm the equipment’s performance and maintain confidence in the measurement. Associated with an ionization chamber, the electrometer is the instrument used to measure the radiation dose in cancer therapy with radiation sources (radiotherapy). The electric current, produced by ionization inside the chamber, is a signal of small value: pA; that can be measured only by electrometers. Since 2000 the primary laboratories have calibrated only the ionization chamber; giving the electrometer without a calibration factor ⁽²⁾. This situation led LNMRI/ IRD/ CNEN-Brazil to research methods for generate electrical current in the order of pA ^(3, 4, 5, 6).

There are three different methods for generating small values (pA) of electric current: ionization chamber (radiation sources); high resistance (Ohm law) and capacitance (charge). In this electronic poster, we will evaluate the performance of different electrometers using a charge source. At the performance comparisons of electrometers, we had already observed that this instrument has a better performance when tested against an ionization chamber source. However, in terms of cost-benefit, the charge method can bring the most reliable results for intermediate checks; because the charge method is independent of time, so for this reason it should not be necessary to calibrate the chronometer, which is usually an external instrument.

MATERIALS AND METHODS

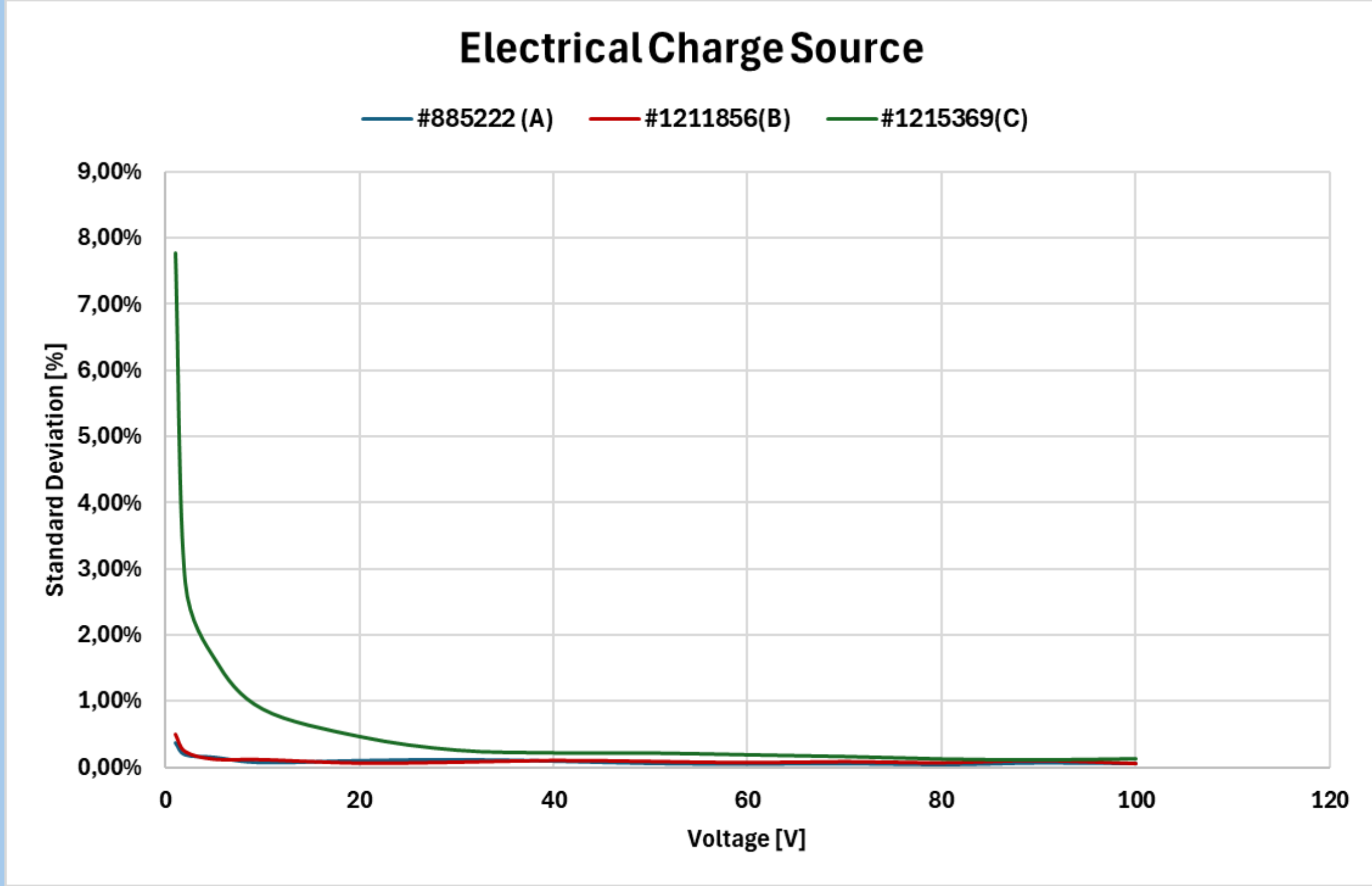
To compose the electrical charge source, we have used a Reference Standard Capacitor QuadTech of 1000 pF, connected to a Fluke 5500A calibrator with the voltage set between 1 V and 100 V. Three Keithley, model 6517, electrometers were used. The standard deviation was used as a parameter for comparing the results. The reason for this choice is that the standard deviation is the reference of stability of measurements.

At this moment of the tests for intermediate checks, we are not preoccupied with verification of reference value and yes of the stability of the measurements, that is the first characteristic to be observed when measuring radiation dose at the laboratory. Note that, since we are using a 1000 pF capacitor, the applied electrical voltage would correspond to the same value in electrical charge, on the nano-Coulomb scale; that is, by applying a voltage of 10 V we would be "injecting" around 10 nC into the electrometer. The electrometers used at the LNMRI/IRD/CNEN-Brazil have scales in the range from 1 nC to 200 nC.

RESULTS

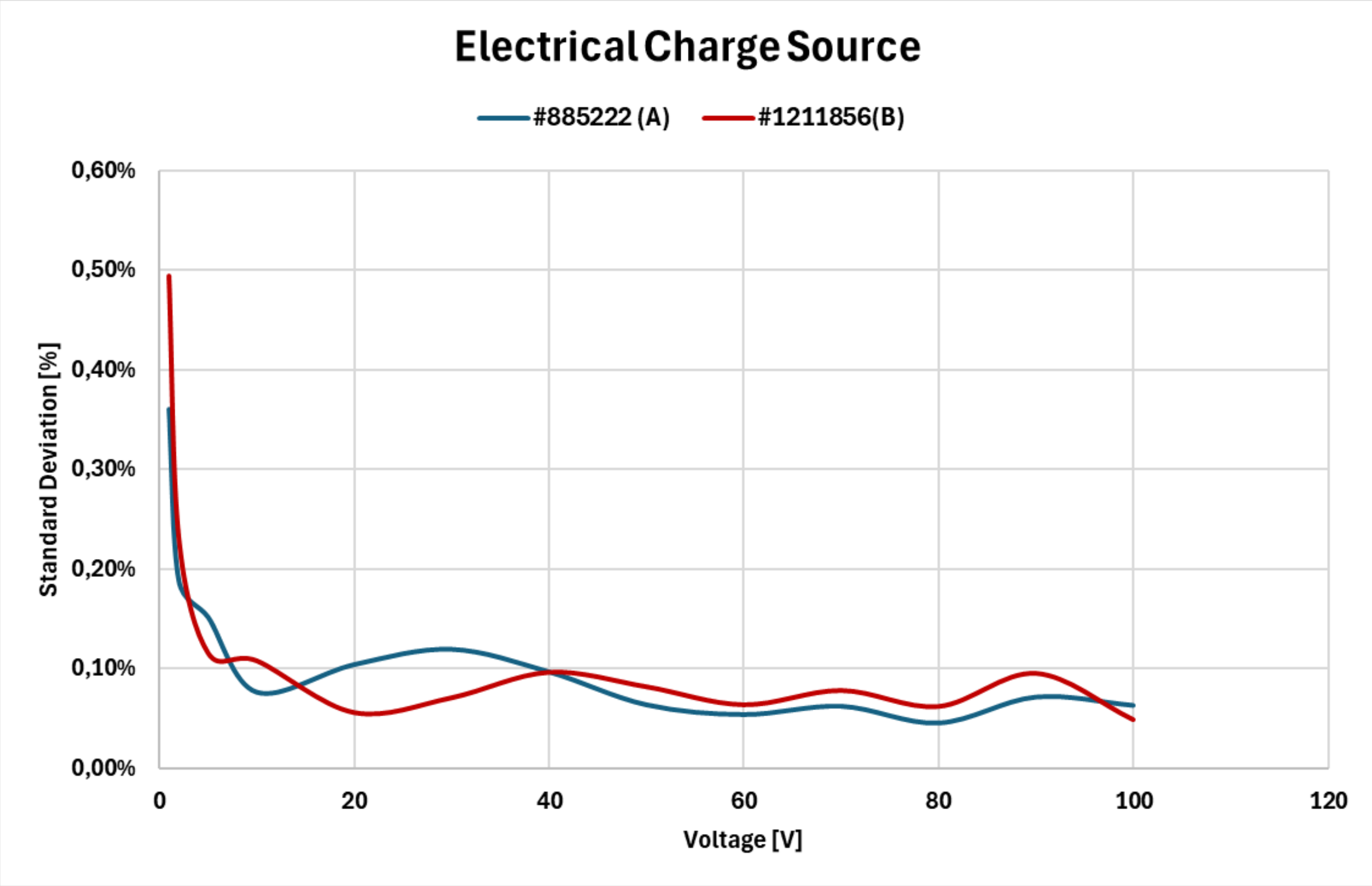
In Figure 1, the results from three electrometers are shown. We can notice that electrometer #1215369 (C) has shown a very different performance from the others. Mainly, in the interval from 1 V to 30 V. The results, from the electrometer #1215369 (C) were confirmed after repeated measurements on several days.

Figure 1 – Results from three electrometers.



On the other hand, in Figure 2, we can see the results from two electrometers with close performance. In this case, we can observe that the performances are practically the same. In the same way, as previously commented, the results were also confirmed through repeated measurements on different days.

Figure 2 – Results from two electrometers with close performance.



The results have shown that the performance of electrometer #885222 (A) has been in the range of 0.04 % to 0.35 % of standard deviation. While the electrometer #1211856 (B) results have been in the range of 0.02 % to 0.29 %. Finally, the electrometer #1215369 (C) has shown results from 0.06 % to 5.38 %. The results covered the range from 1 nC to 100 nC. The limit value for the standard deviation is 0.5 %; that is a value usually obtained at the laboratory.

CONCLUSIONS

The electrometer’s scale used in the tests (from 1 nC to 200 nC) covers the laboratory activities at the LNMRI/ IRD/ CNEN-Brazil. There is technical viability of the charge source method to be used in intermediate checks, since the electrometers #885222 (A) and #1211856 (B) have shown all the results within the limit of 0.5 % of standard deviation. Electrometer #1215369 (C) should be tested only at the scale above 20 nC. The next step of the tests would be the calibration of the capacitor; so that device would be a reference for the determination of the conventional value of radiation dose, which would be the base of evaluating for intermediate checks.

CHALLENGE

It is very difficult to guarantee that the same portion of electrical charge, that goes out the capacitor, will flow inside the electrometer. Few of them are lost on the way; during the electric control key handling for instance. To solve this problem, we will try to develop the automatization of the tests.

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