The Stylcam 200 R, a Rotary Tablet Press Simulator - Optimising the Instrumentation: Characterising the Displacement Measurement System

B. Fretter [(1)], R. F. Lammens [(2)] and K.-J. Steffens [(1)]

(1) Department of Pharmaceutical Technologie, Univercity of Bonn, Gerhard-Domagk-Str. 3, 53121 Bonn, Germany
(2) Technical Service Consult Lammens, Heymannstr. 50, 51373 Leverkusen, Germany

INTRODUCTION

The Stylcam 200 R (Fig. 1) is a single punch press, simulating speed profiles of various rotary tablet presses by controlling the speed of two cams electronically. This press can be used for trouble shooting in production and R&D efficiently by using just the standard force measurement instrumentation of upper and lower punch.

For characterising the compaction behaviour of powders as to their deformation properties, also a high precision in-die tablet height measurement system is required, which will be addressed first in our investigations. Assuming that a precision of ± 2 MPa for compaction pressures is a reasonable requirement, the corresponding maximally allowable error in powder height measurements, being derived from the "force-displacement" curve, is estimated to be at most ± 20 µm for the densification and ± 4 µm for the expansion process [1].

Usually, displacement transducers have a deviation from linearity of about 0.1 to 0.5% of the rated stroke [2]. For a stroke of 40 mm, this corresponds to an error of 40 to 200 µm in the height measurement. In order to reduce this error, common displacement transducers have been investigated in detail.

MATERIALS AND METHODS

Materials

Displacement Measurement System:
Inductive displacement transducers:
SM210 (stroke 10mm $\triangleq \pm 10$ V, accuracy ± 0.25%)
SM260 (stroke 40mm $\triangleq \pm 10$ V, accuracy ± 0.25%)
Amplifier: SM125, all Schreiber, Germany [3]
Micrometer screw:
164-151, Mitutoyo, Germany
Multimeter:
MetraHit 30M, Grossen-Metrawatt, Germany

Methods

For characterising the transducers, they were fixed to the micrometer screw (Fig. 2). The position of the NiFe-core was varied and the corresponding voltage measured. To avoid systematic errors, the transducers were adjusted to the micrometer screw in a spatial orientation which corresponds exactly to the one on the Stylcam. At an output signal of exactly 0.000 V of the displacement measurement system the micometer screw was set to zero, being the reference value for the measurements.
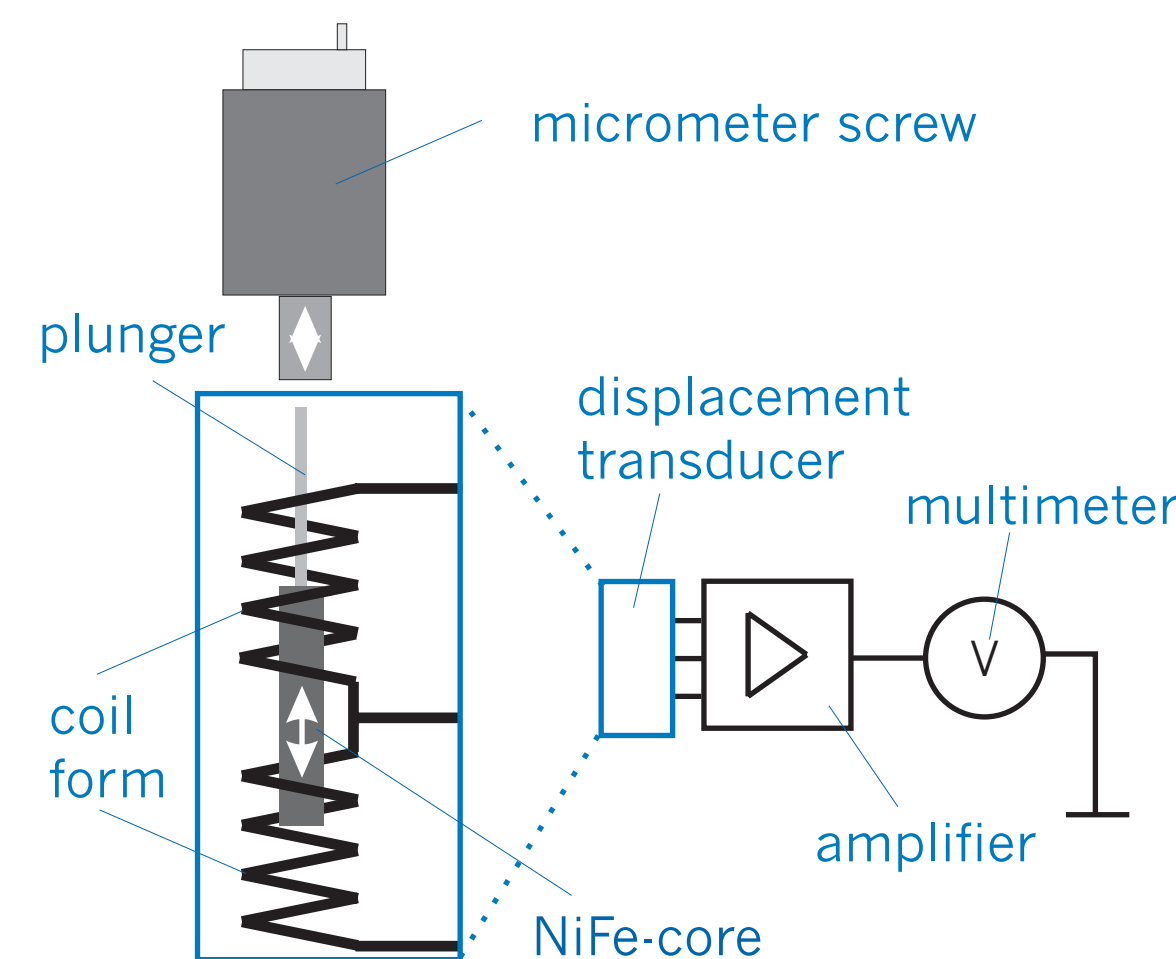

Fig. 1: Stylcam

Fig. 2: schematic drawing of the experimental setup

RESULTS

By plotting voltage versus displacement, a nearly linear correlation is obtained for both displacement transducers. To visualise the deviation of the data points from linearity, the residuals of the linear fit for the SM210 are shown in Fig. 3. As obvious from the deviation from linearity, reproducibility is excellent. The few outliners (blue circles) were likely due to manual documentation errors. Therefore, they were neglected and not included in the evaluation of the measured data. According to the residuals, the deviation from the linearity is about ± 0.025 mm (0.25%) as specified.

For achieving a better accuracy, a polynomial regression analysis was performed. In doing so the polynomial degree is enlarged untill the residuals of the regression vary around zero more or less randomly. Fig. 4 and 5 show the residuals of a polynomial fit for the displacement transducer SM210 and SM260, respectively. Now the residuals vary about ± 2 µm for SM210 and ± 9 µm for SM260. The degree of the fitting polynom is not increased further, firstly because the residuals are equal to the precision of the micrometer screw, which is about ± 2 µm, and secondly because an increase has only little influence on the deviation of the residuals.

The importance of preventing the plunger from rotating is ilustrated in Fig. 6. For measurement one and two, the polynomial fit was performed. Before the third measurement the plunger was rotated randomly. Due to this rotation, this calibration curve differs systematically from the two previous measurements, and so, if unrecognised, might result in an undertaily larger error of up to 30 µm.

The finally achieved results are summerised in Tab.1.

CONCLUSION

It is possible to measure the densification part of "force-displacement" curves with sufficient accuracy, because the relation between core position and output signal of the displacement measurement system being used is far more better than their specified precision. Due to the excellent reproducible deviation from linearity, a polynomial regression may be used for discribing this relation. For the examined displacement transducers, it is necessary to prevent the plunger from rotation.

REFERENCES

[1] Lammens, R. F.: The Evaluation of Force Displacement Measurements During One-sided Powder Compaction in Cylindral Dies, 1980
[2] Watt, P. R.: Tablet Machine Instrumentation in Pharmaceutics: Principles and Practice, Ellis Horwood Limited, England, 1988
[3] Datasheet, Schreiber SM210, SM260, SM12, Internet: www.schreiber-messtechnik.de, 17th October 2007
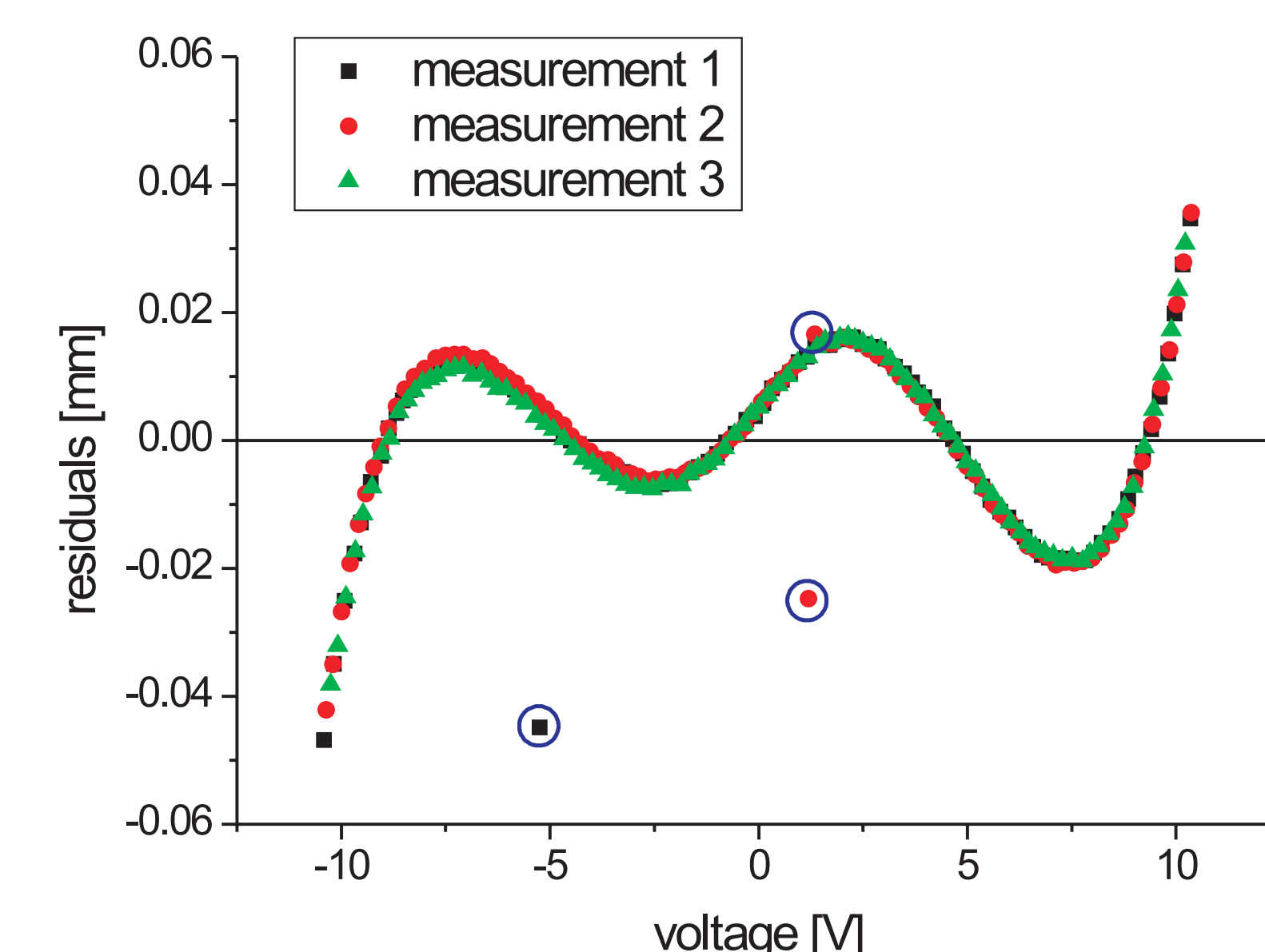
ACKNOWLEDGEMENTS

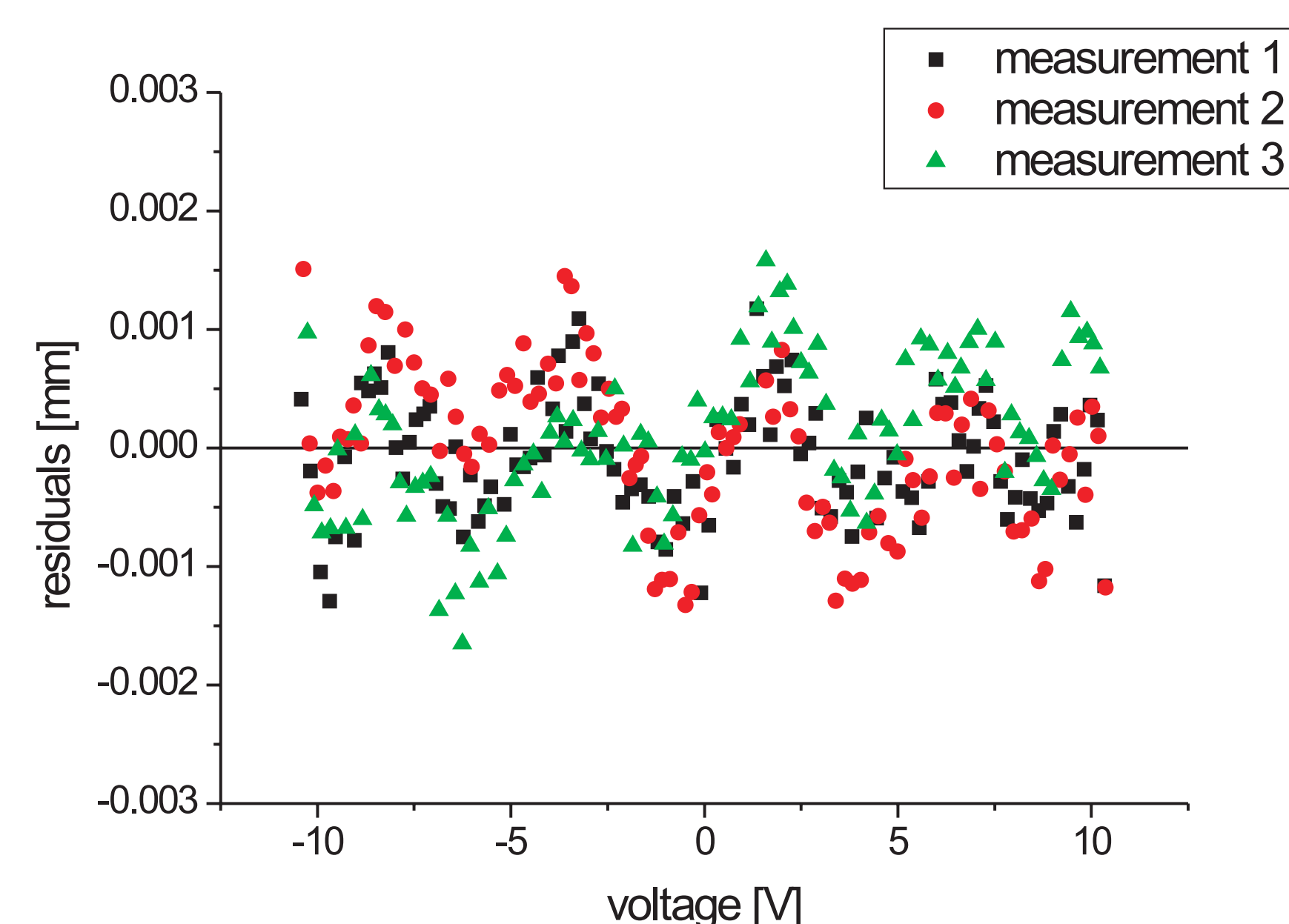Fig. 3: Residuals of the linear fit, SM210

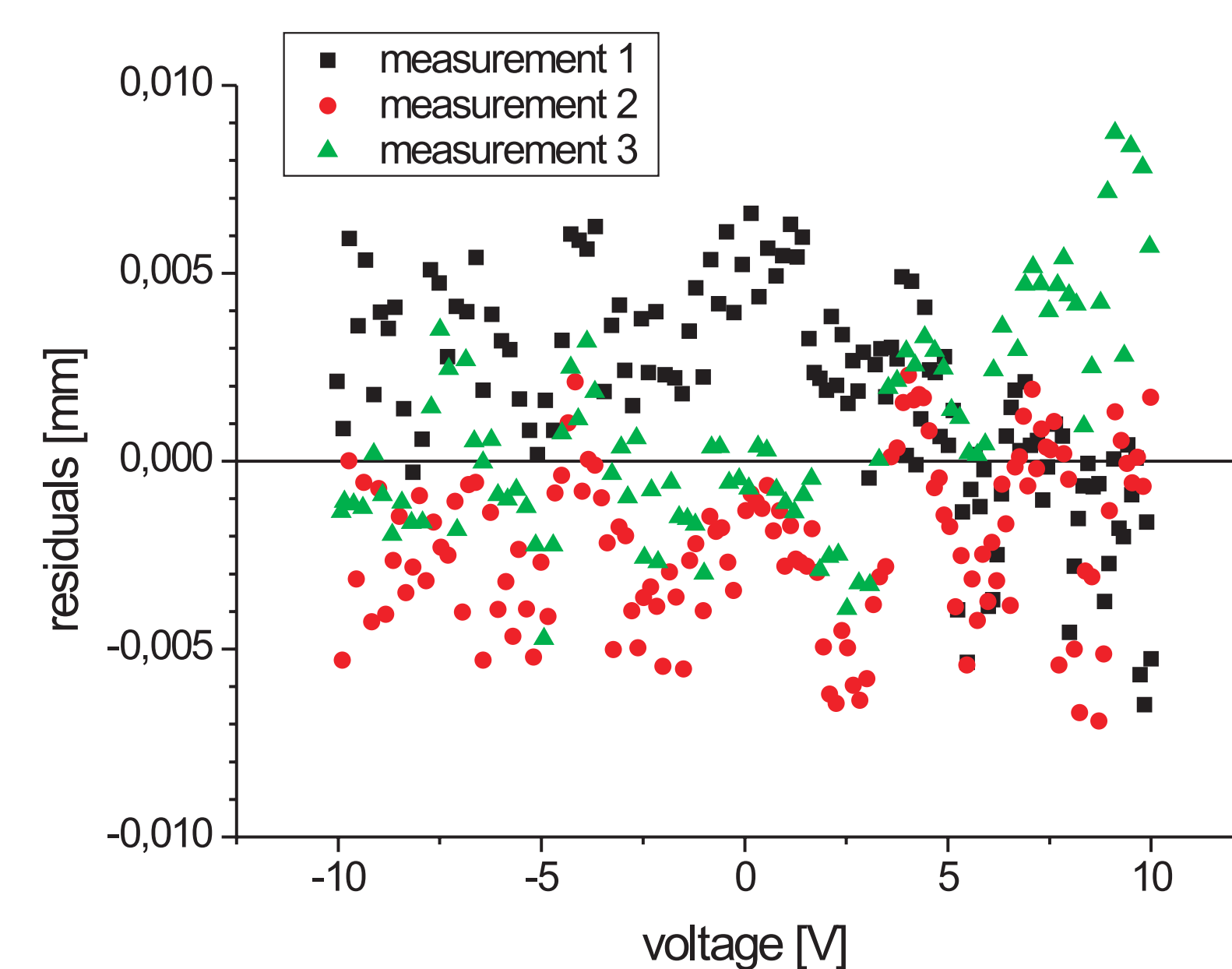Fig. 4: Residuals of the polynomial fit 9th degree, SM210

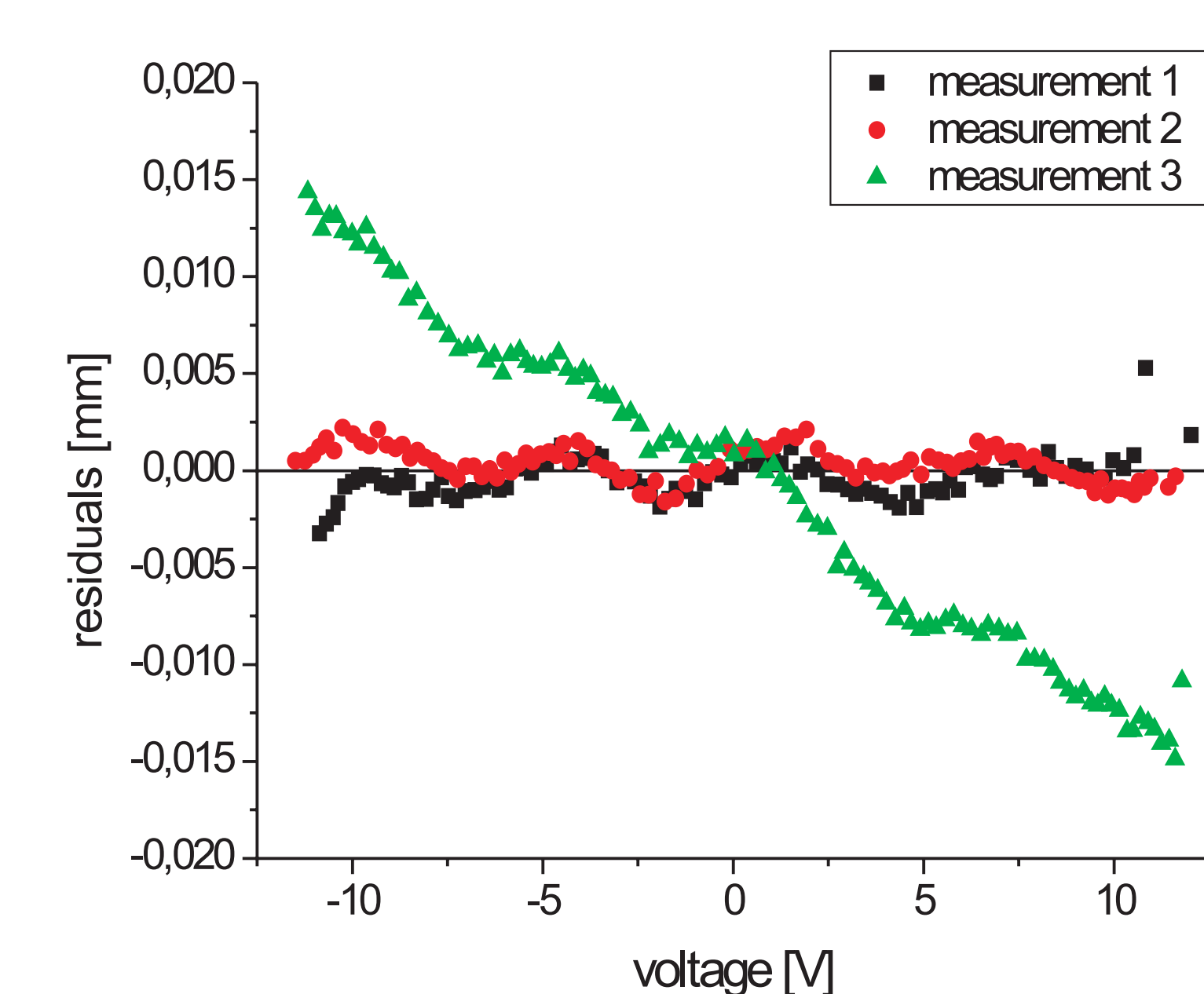Fig. 5: Residuals of the polynomial fit 12th degree, SM260

Fig. 6: Residuals of the polynomial fit, by rotation of the core, SM210

transducer	stroke	deviation from linearity	deviation from polyn. regression
SM210	10 mm	± 25 µm	± 2 µm
SM260	40 mm	± 100 µm	± 9 µm

Tab. 1: Summary improved accuracy