



Testing the Integral Suspension Pressure method for particle-size analysis with the PARIO device: Accuracy of results

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Introduction

- The particle-size distribution (PSD) is a key property of soils. To determine the proportions of the fine fractions silt and clay, sedimentation experiments are used. Most common are the Pipette and Hydrometer method. Both need manual sampling at specific times. Both are thus time-demanding and rely on experienced operators.
- Durner et al. (2017) recently developed the Integral Suspension Pressure Method (ISP), which is implemented in the device PARIO™ by METER Group AG. This new method estimates continuous PSD's from sedimentation experiments. It requires no manual interaction after start and thus no specialized training of the lab personnel.
- The aim of this study was to test the precision and accuracy of the new method with four soil materials, to answer the following research questions: (1) Are the results obtained by PARIO reliable and stable? (2) Are the results identical to the one that are obtained with the Pipette method as reference method?

The PARIO system



Purpose

- Automated Sedimentation Analysis

Developer

- METER Group AG

Components

- PARIO device (Measurement head with electronics, shaft to pressure sensor and USB connection to PC)
- Two sedimentation cylinders and lid
- PARIO-Software

Measurement and Evaluation Principle

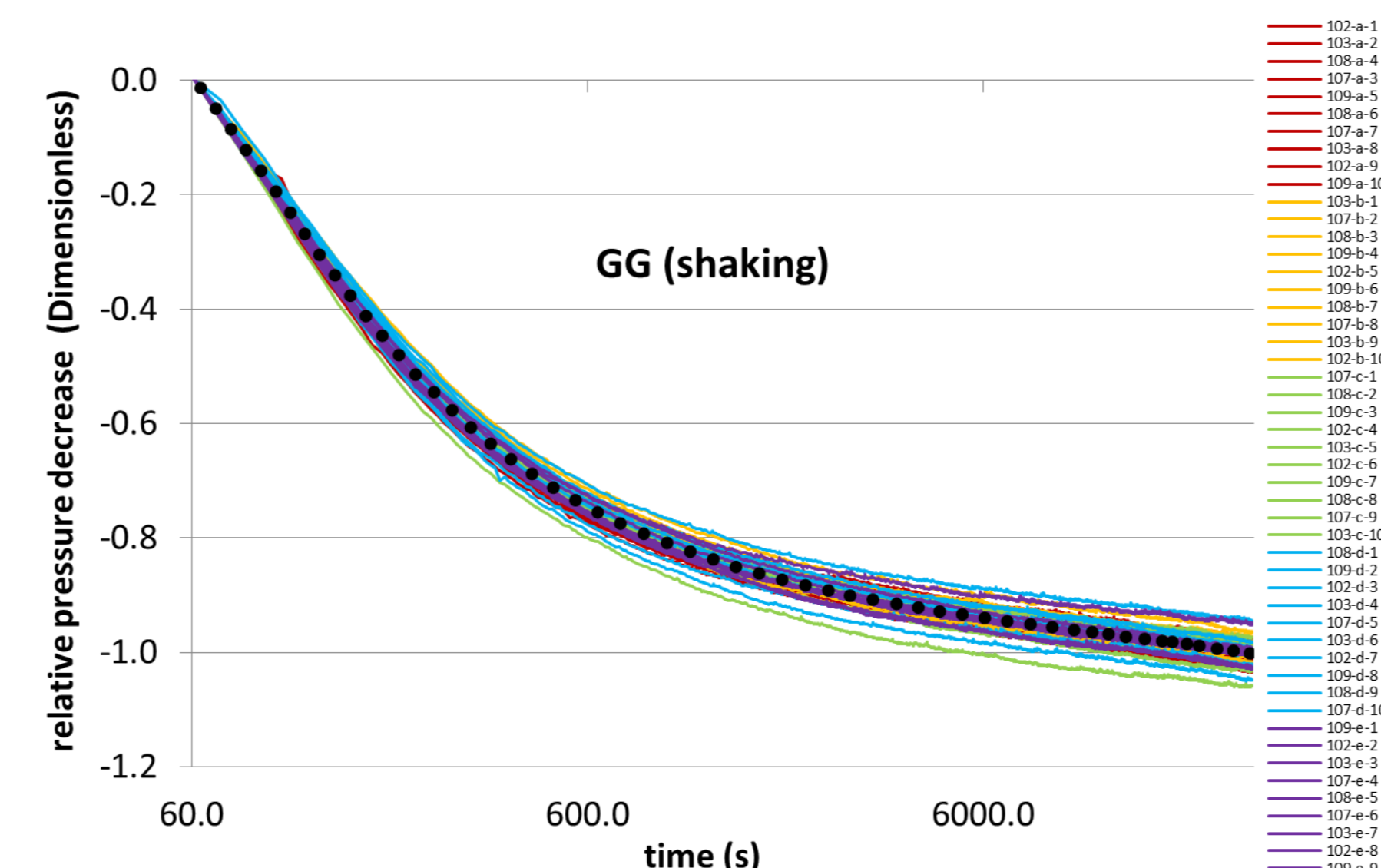
- Integral Suspension Pressure Method (ISP)
- Computation of particle size distribution from pressure decrease in suspension

Experiments

- Four materials: Quartz flower (silt), GG (clay loam), JKI (loamy sand), WE (silty clay)
- Initial homogenization either by vertical stirring or overhead shaking
- Five replicate preparations for each material with 30 g soil in 1 L suspension
- Precision: Ten consecutive measurements with alternating PARIO devices
- Bias: Comparison of mean results with pipette analysis
- Total number of PARIO measurements: 250

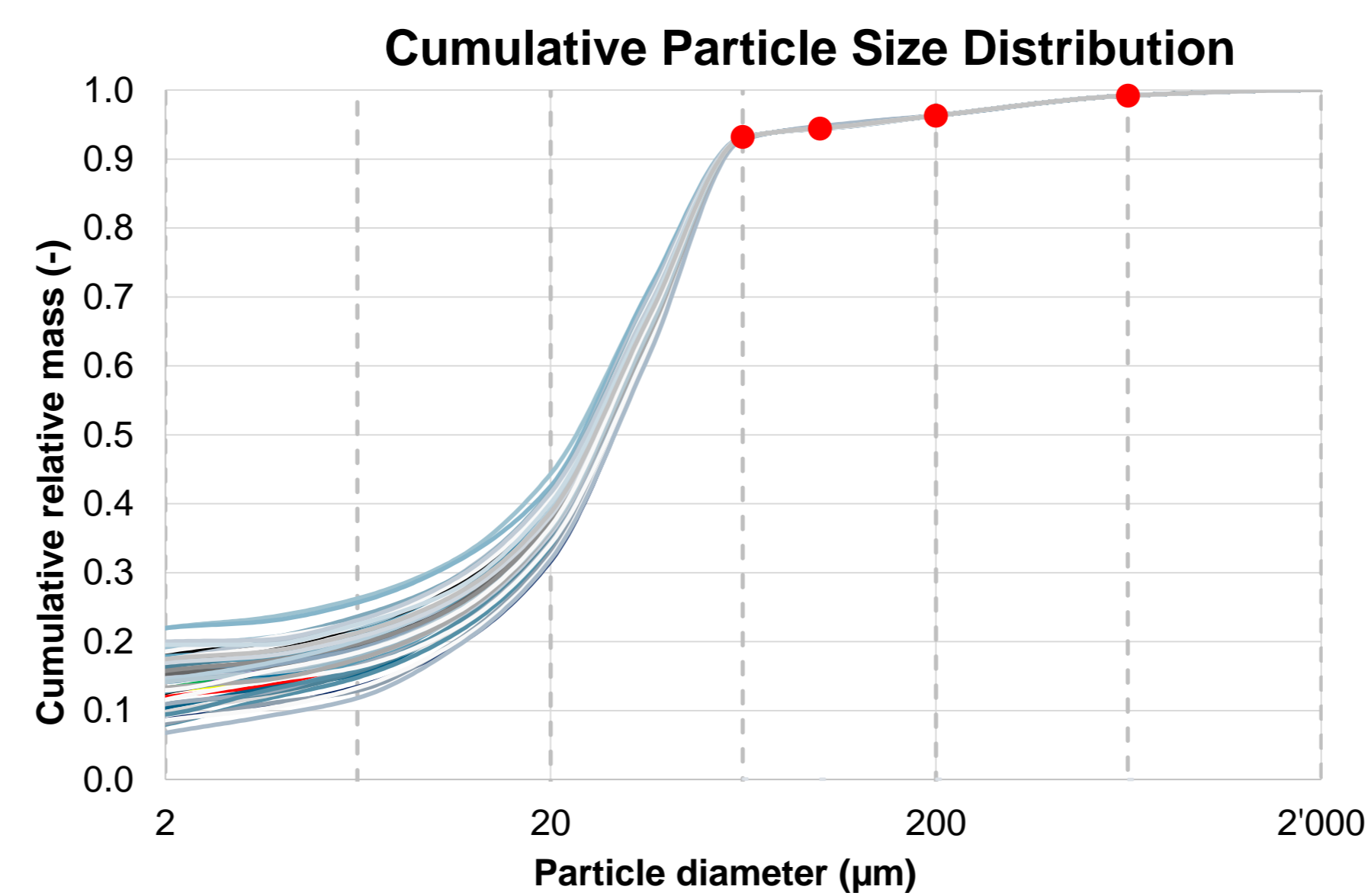
Repeatability

Variability of relative pressure decrease from $t = 60$ s for 50 replicate measurements (soil GG). Data are normalized to insertion depths of PARIOs in different glass cylinders.



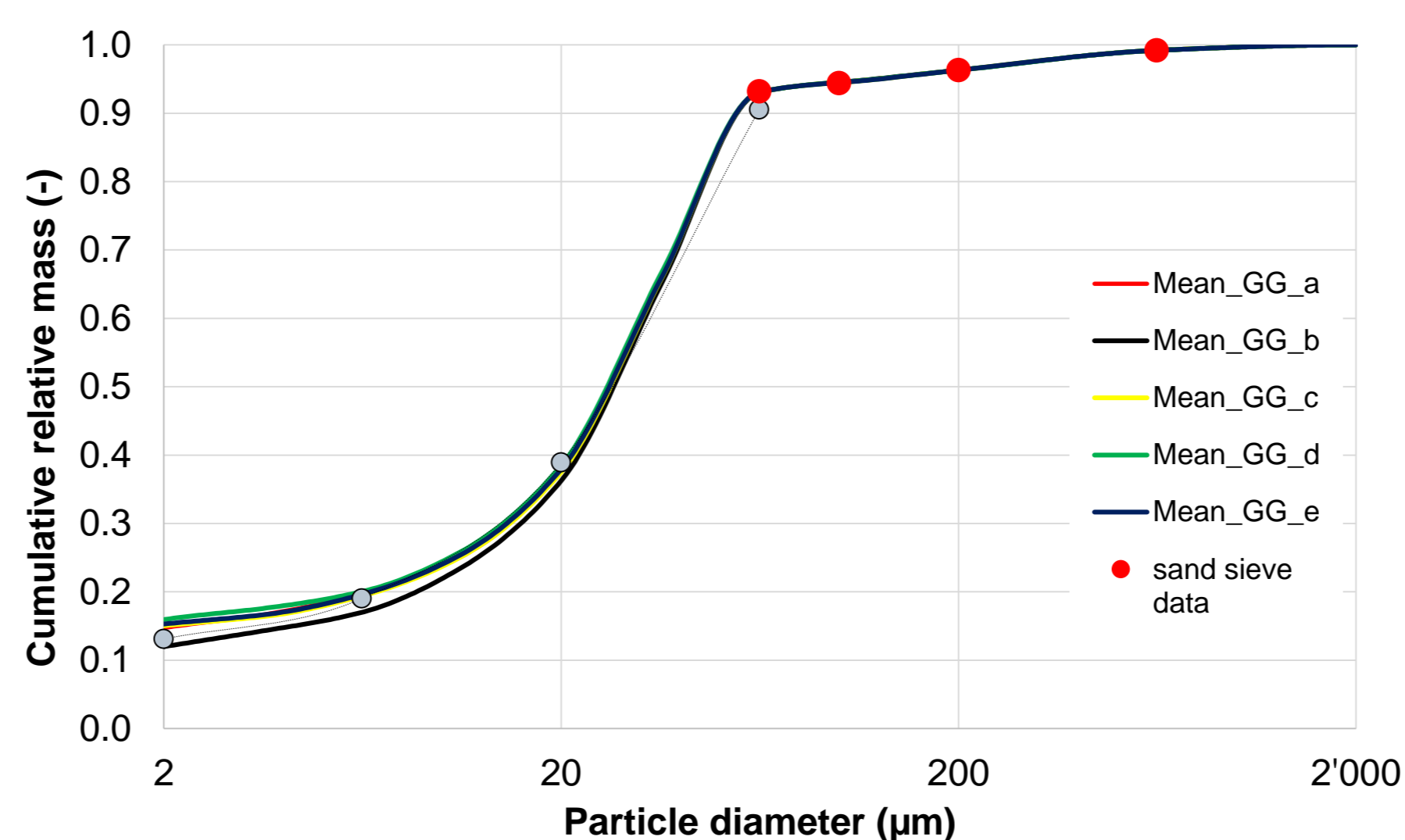
Variability

Identified PSD's for 50 replicate measurements (soil GG). The individual measurements yielded considerably different PSD's.



Bias

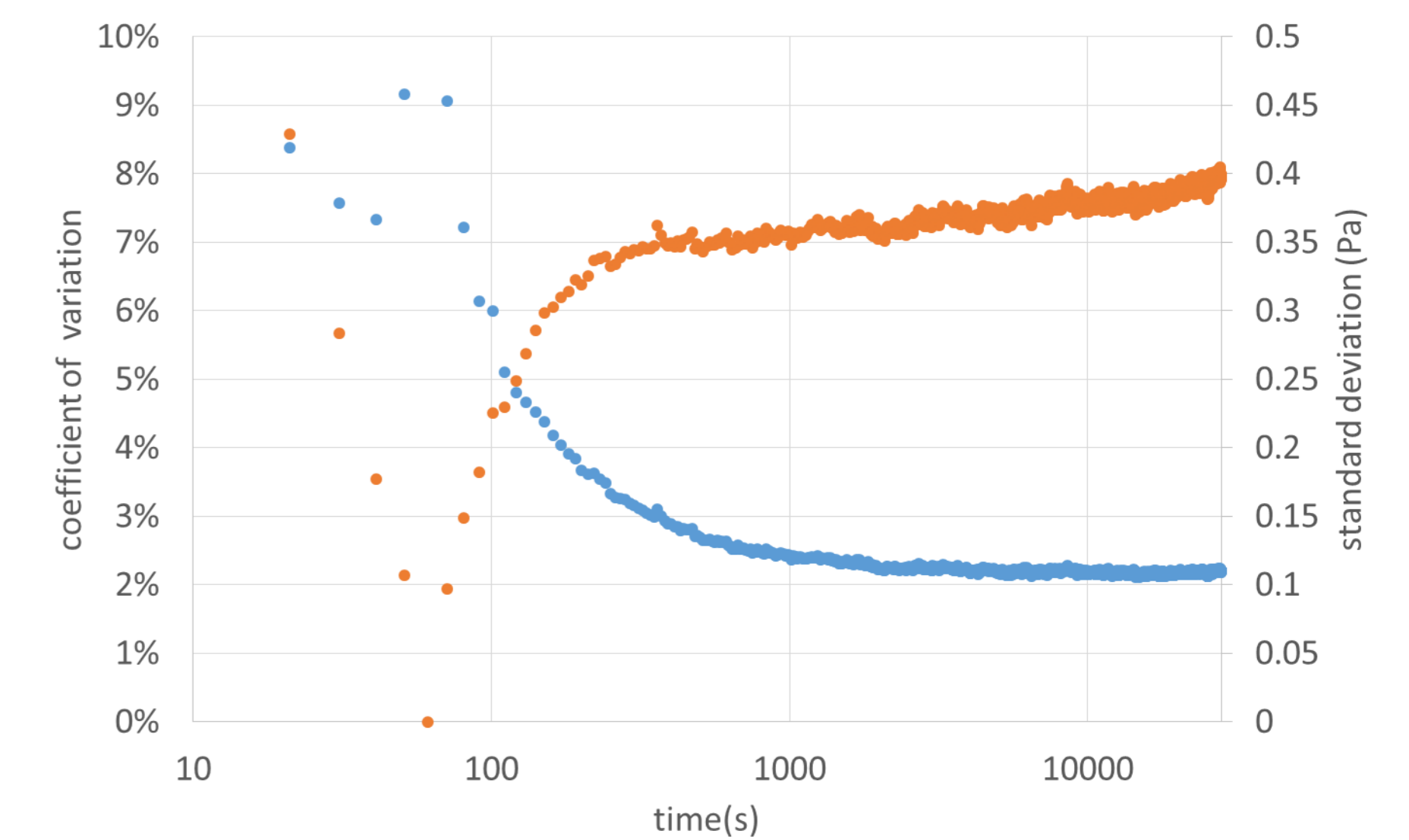
Mean of identified PSD's (N = 10) for the five replicate cylinders. Red dots are the measured sand fractions, blue dots are the independently measured results from the pipette method.



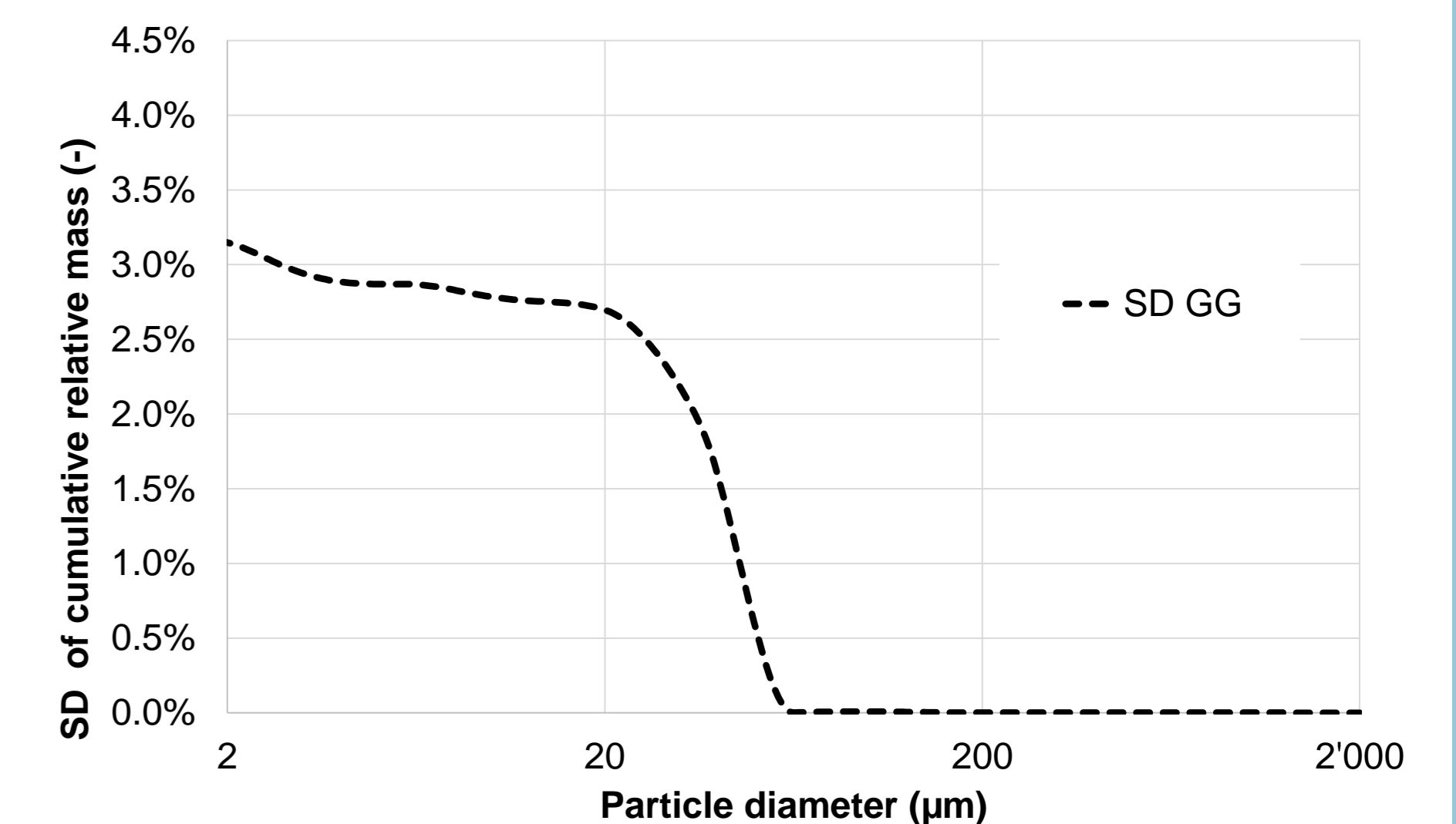
Discussion

The ISP method relies on ultra precisely measured pressure data. Achieving the required precision in practice is a challenge. With PARIO, we observe that the pressure decrease varies with a cv of 3 %, which yields variability of the identified silt fractions of about 3 %. The bias of the mean of 10 measurements from the reference method was up to 3 %.

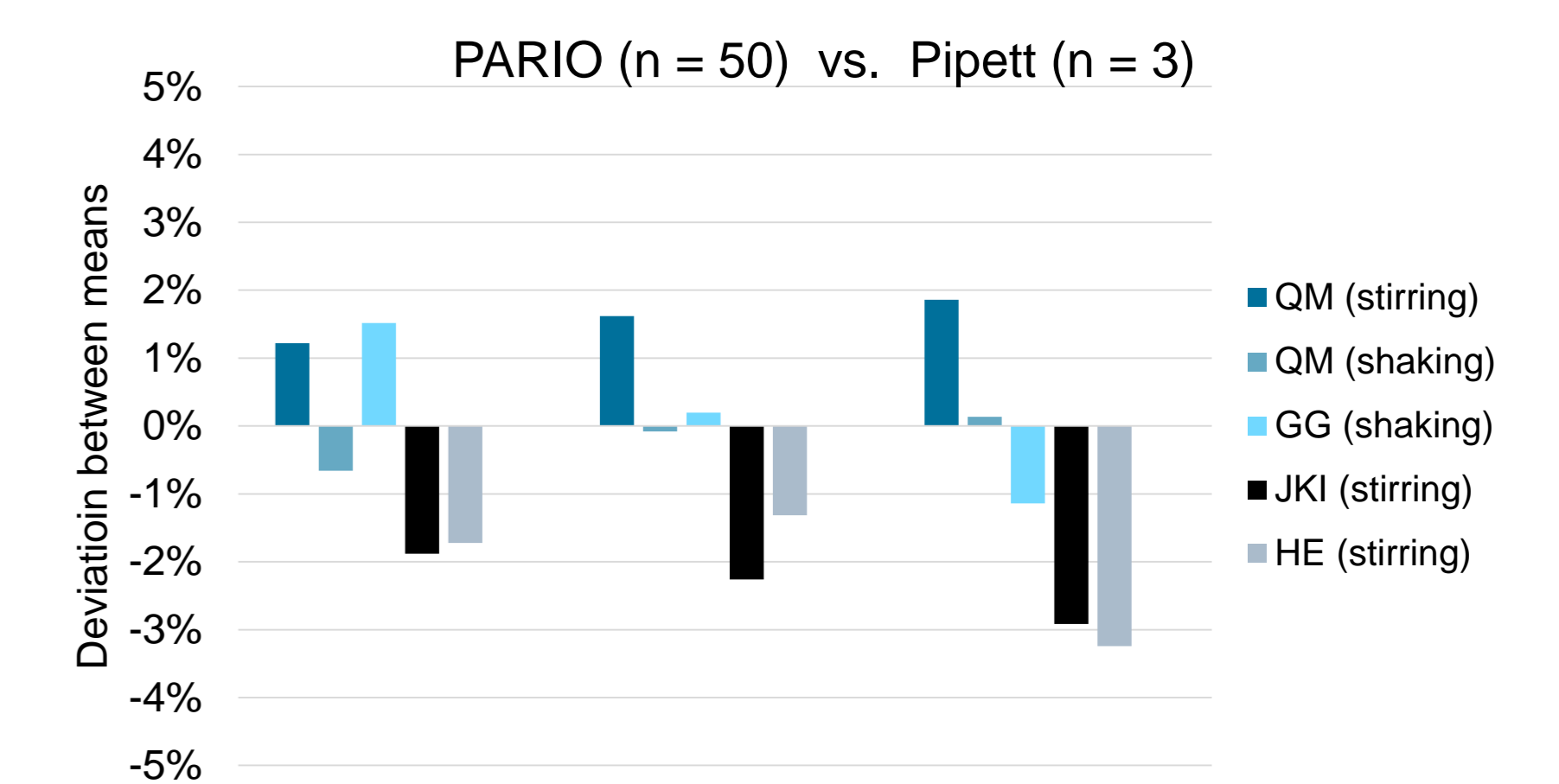
Temporal evolution of the absolute (orange) and relative variability of the replicate measurements.



Standard deviation of the identified particle size distributions (soil GG, n = 50). The silt fractions were determined with a standard deviation of about 3 %.



The deviation between the mean PARIO results and the reference method was in the range from 0 % to 3 %



Conclusions

At current, the uncertainty of a PSD analysis of a single individual measurement with PARIO is still considerable. Further research and testing will help to develop optimal operation protocols and settings to reduce the uncertainty. The gain in comfort, however, is considerable and recommends the method whenever single accuracy is not of highest priority.