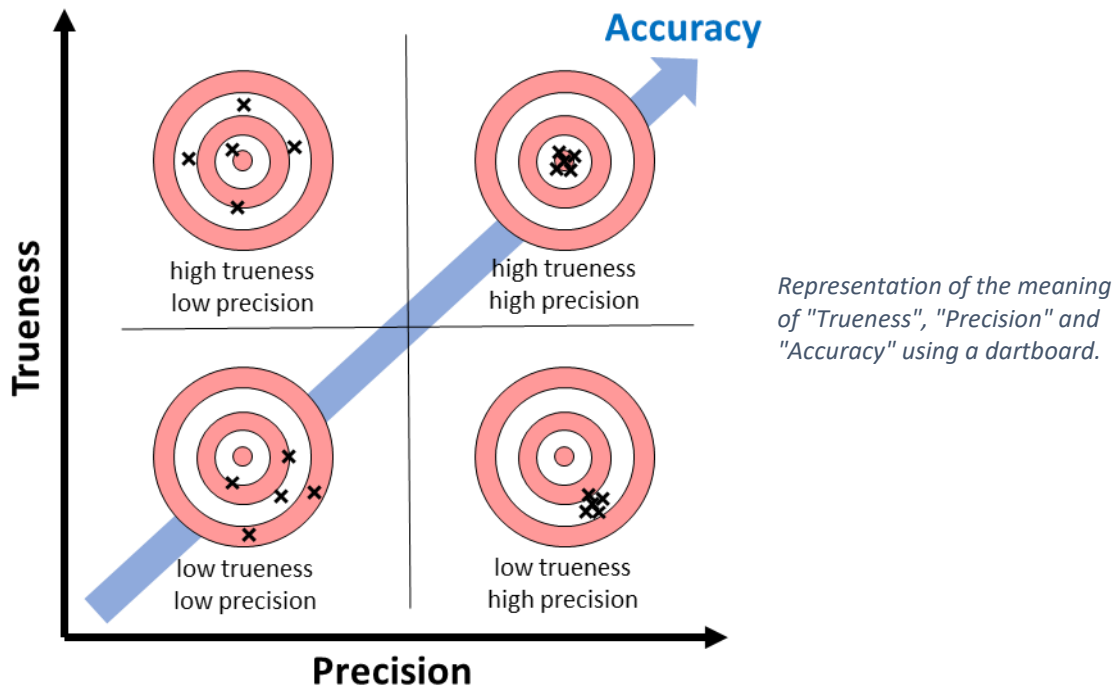
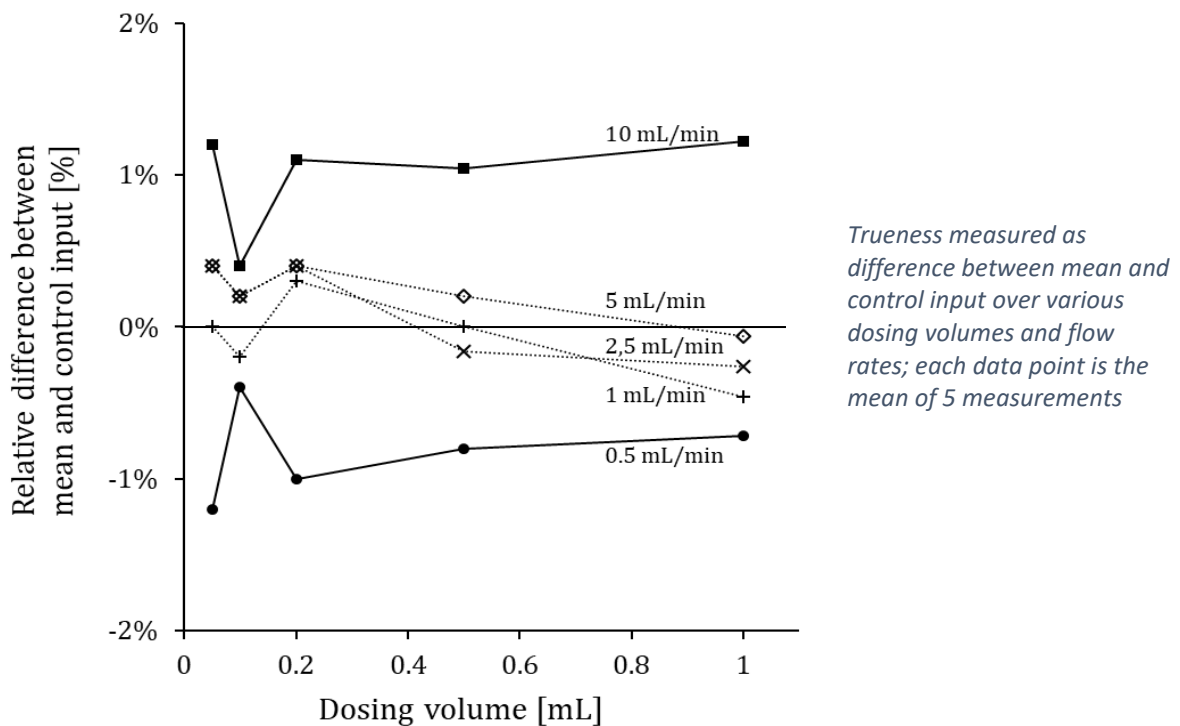


Discussion of Accuracy

In order to test the accuracy of the pump, 125 dosing experiments were performed. Various combinations of volume flow and velocity were tested; each combination was tested five times. The data was evaluated considering both trueness and precision. Here, trueness is a measure of the deviation between the measured mean and the set value. Precision determines the variation of the single experiments around their mean.



The investigation of trueness showed a dependency on the flow rate. The one-point calibration performs 30 rotations within 30 seconds, leading to a flow rate of approx. 3 ml/min with an inner tubing diameter of 0.8 mm. Close to this velocity, the trueness of the pump is +/- 0.5%. For a significantly faster or lower speed, the average value is about 1% higher or lower as the set value.

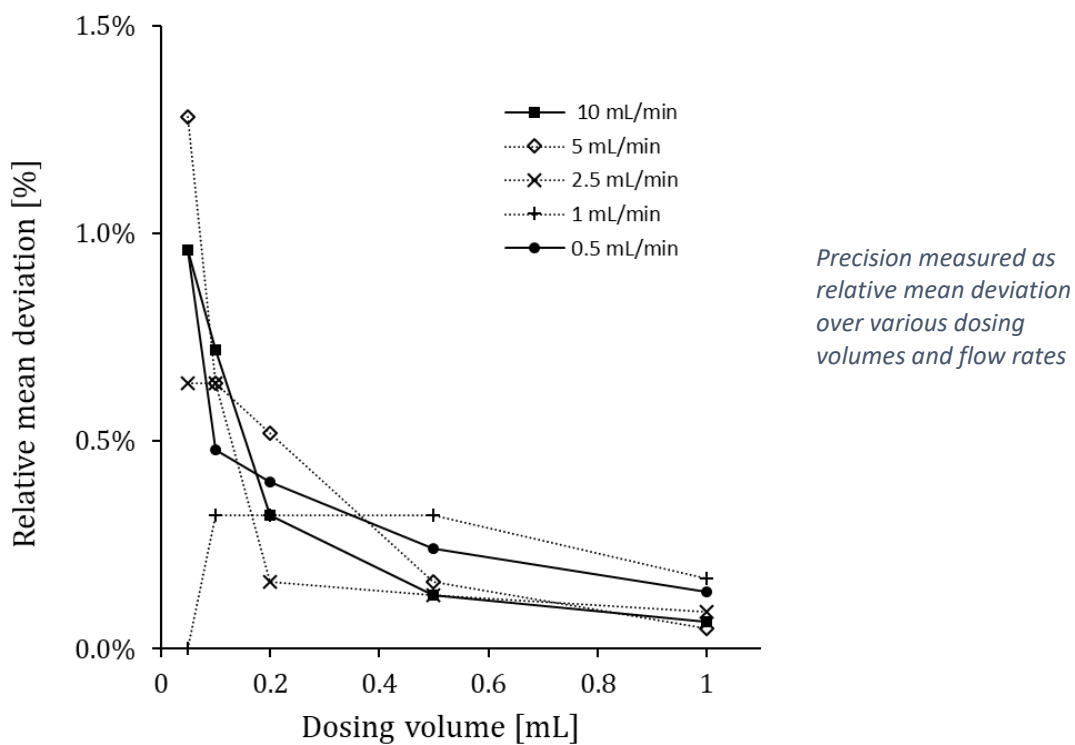


This leads to the conclusion that a good accuracy can be achieved within the whole bandwidth of flow rates. The accuracy can be further improved by calibrating the system at a comparable flow rate. Parameters in the source code can be accordingly adjusted.

```
//CALIBRATION -----  
#define CALIBR_ROTATIONS 30  
#define CALIBR_DURATION 30 // seconds
```

Extract from the source code of our Arduino software, the parameters defining the calibration can be changed without any programming knowledge

Regarding precision, it was shown that the scattering around the mean value increases exponentially with decreasing dosing volume, whereas there is no significant influence by the flow rate. Thereby, dosing is only precise in certain boundaries. In order not exceed a deviation of 2%, a lower border of 50 μL is determined in the specification. However, dosing of smaller quantities is technically possible; but the exponentially increasing error due to variation should be considered.



To test the accuracy of the calibration over long periods of time, an experiment was conducted, where three calibrations were performed before and after 12 hours of continuous pumping with a flow rate of 3 mL/min. The results showed a deviation of 0.73 % from 1.639 to 1.651 mL. This shows that although our pump has lost some accuracy, it still works precisely after long periods of operation.