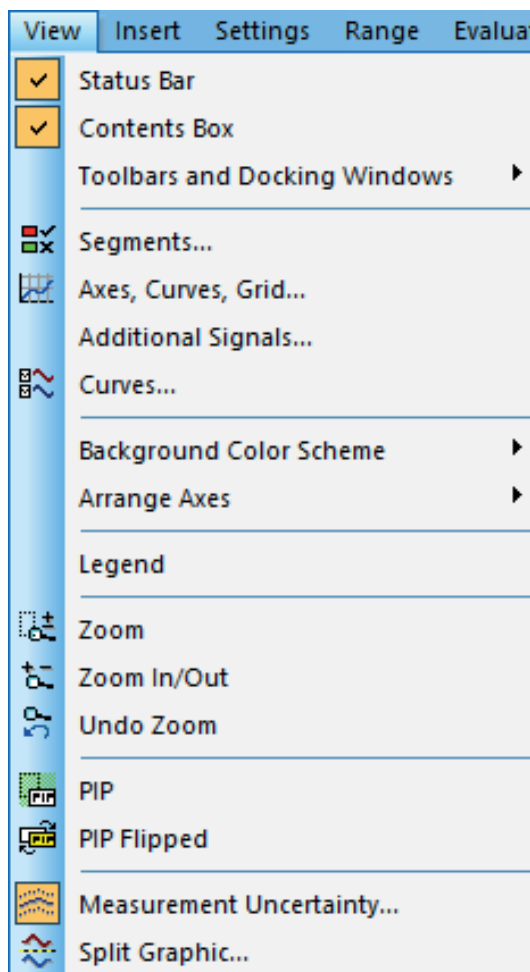


## Measurement Uncertainty of $c_p$ Curves

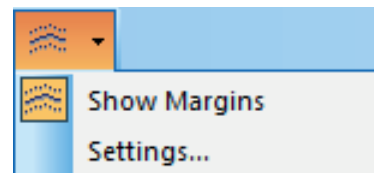
Dr. Alexander Schindler

Available in *Proteus*® analysis version 9.0 and higher, a measurement uncertainty of  $c_p$  curves can be displayed. This functionality can be accessed from the „View“ menu (see figure 1) or the corresponding icon (see figure 2).

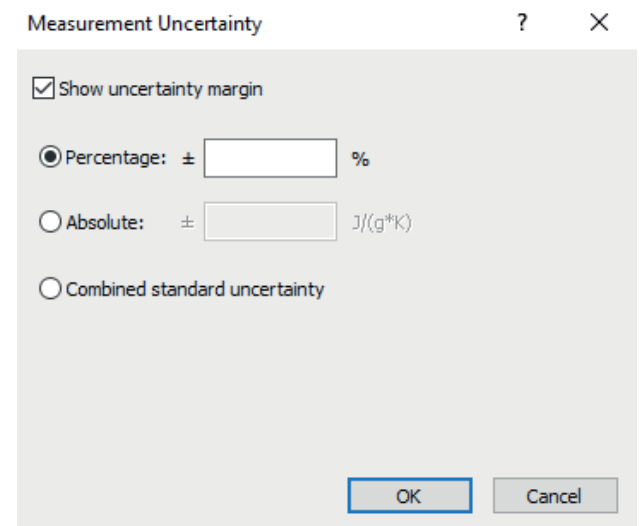
In the Settings, one can either enter  $u$  as a constant percentage or as a constant absolute uncertainty (see figure 3).



1 Menu "View" of *Proteus*® analysis



2 Icon "Measurement Uncertainty" of *Proteus*® analysis



3 Settings of the Measurement Uncertainty

## SOFTWARE INNOVATION Measurement Uncertainty of $c_p$ Curves

In case of the third possibility „Combined Standard Uncertainty“, which exists only for  $c_p$  curves originating from DSC signals,  $u$  is calculated automatically according to the „Guideline of Uncertainty of Measurements“ (GUM). The uncertainty  $u$  of such a curve  $f$  is calculated according to GUM in general in the following way:

$$u^2(f(x_i)) = \sum \left( \frac{df}{dx_i} \right)^2 \cdot u^2(x_i)$$

where  $f(x_i)$  is the calculated specific heat capacity  $c_p$  from DSC signals:

$$c_p^{Sample} = \frac{m^{Std.}}{m^{Sample}} \cdot \frac{(DSC^{Sample} - DSC^{Baseline})}{(DSC^{Std.} - DSC^{Baseline})} \cdot c_p^{Std.}$$

The quantities  $x_i$  refer to  $m^{Std.}$ ,  $m^{Sample}$ ,  $DSC^{Sample}$ ,  $DSC^{Std.}$ ,  $DSC^{Baseline}$  and  $c_p^{Std.}$  which mean the mass of the  $c_p$  standard used, the sample mass, the measured DSC signal of the sample, the measured DSC signal of the  $c_p$  standard, the measured DSC signal of the baseline and the literature data of the  $c_p$  standard used.

For calculation of the combined uncertainty, the following uncertainties are assumed:

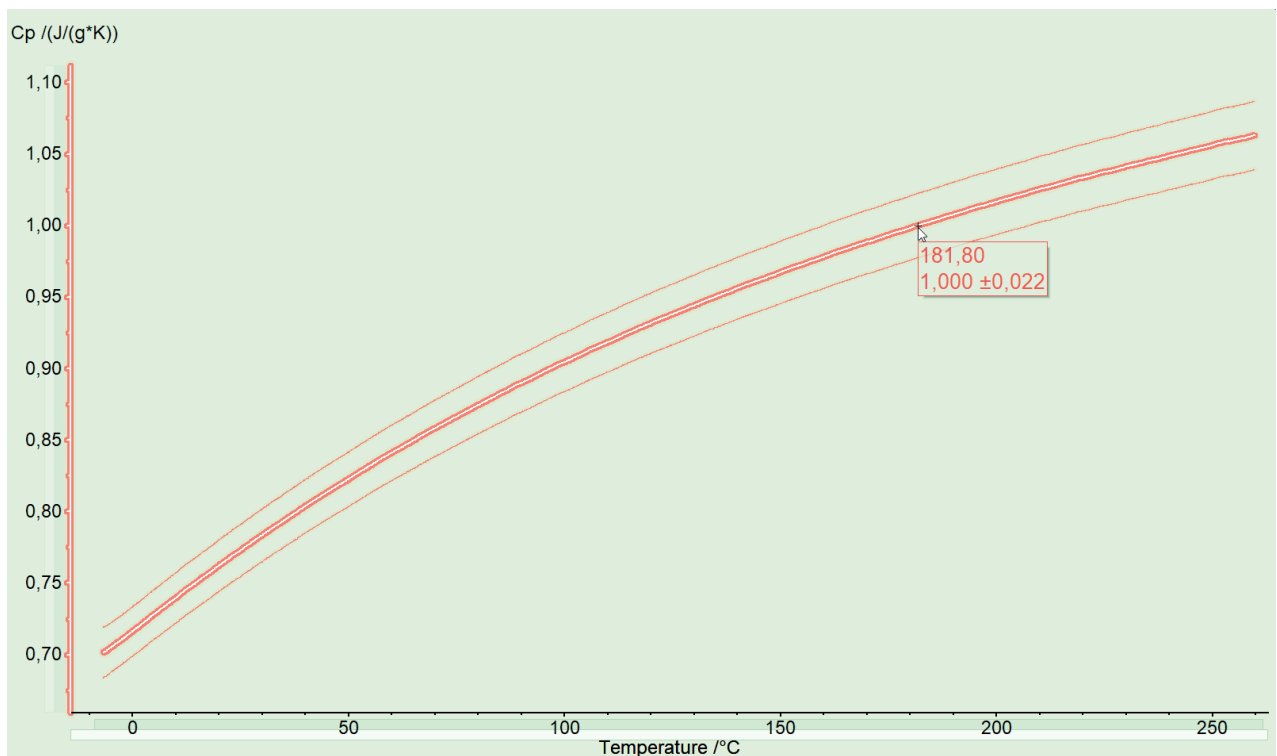
$u(DSC^i)$  ... instrument-dependent, constant, e.g., 0.3  $\mu$ V ( $i = \text{Sample, Std., Baseline}$ )

$u(c_p^{Std.}) = 2\%$

$u(m^i) = 0.01 \text{ mg}$

( $i = \text{Sample, Std.}$ )

The measurement uncertainty  $\pm u$  of a curve is indicated by two additional thin lines, which are located at a distance  $u$  above and below the original curve (see figure 4).



4 Exemplary  $c_p$  curve including the combined standard uncertainty