Live TUS Uncertainty Calculation

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Uncertainty is calculated by combining the repeatability (Type A) and fixed systematic (Type B) components:

$$\nu = mn - 1 \quad \text{(degrees of freedom)}$$

$$c_i = c_i^{DaqBook} + c_i^{TC} \quad \text{(cumulative offsets)}$$

$$x'_{i,j} = x_{i,j} + c_i \quad \text{(corrected readings)}$$

$$u_A^2 = \frac{1}{\nu} \sum_{i=1}^{n} \sum_{j=1}^{m} (x'_{i,j} - N)^2 \quad \text{(Type A standard uncertainty squared)}$$

$$u_c = \sqrt{u_A^2 + u_B^2} \quad \text{(combined standard uncertainty)}$$

$$U = k \cdot u_c \quad \text{(expanded uncertainty, } k = t_{0.9545,\,\nu}\text{)}$$

$$\text{Uncertainty} = \max(U, \text{Scope}) \quad \text{(final reported value)}$$

Symbol	Definition
n	Number of thermocouples
m	Number of readings per thermocouple
i	Thermocouple index ($i \in 1, \cdots, n$)
j	Survey time index ($j \in 1, \cdots, m$)
ν	Degrees of freedom ($mn - 1$)
$x_{i,j}$	Raw measured temperature from probe i, reading j
c_i^{DaqBook}	Offset from the DaqBook channel assigned to probe i
c_i^{TC}	Offset from thermocouple wire calibration for probe i
c_i	Total correction offset for probe i
$x'_{i,j}$	Corrected temperature: $x_{i,j} + c_i$
N	Nominal temperature
u_A	Type A standard uncertainty
u_B	Type B standard uncertainty from the MUG
u_c	Combined standard uncertainty
k	Coverage factor (t-distribution, 95.45%)
U	Expanded uncertainty
Scope	CMC limit (minimum allowed uncertainty)