MetroVal

Advanced Calibration Software
With Real Time
Uncertainty and Prediction analysis

Newton Metrology Ltd.

Outline

- MetroVal overview
- Procedure
- Uncertainty
- Prediction
- Math capabilities
- Operating
- Reporting
- Providing Services by COM interface
- Running as command line by another program

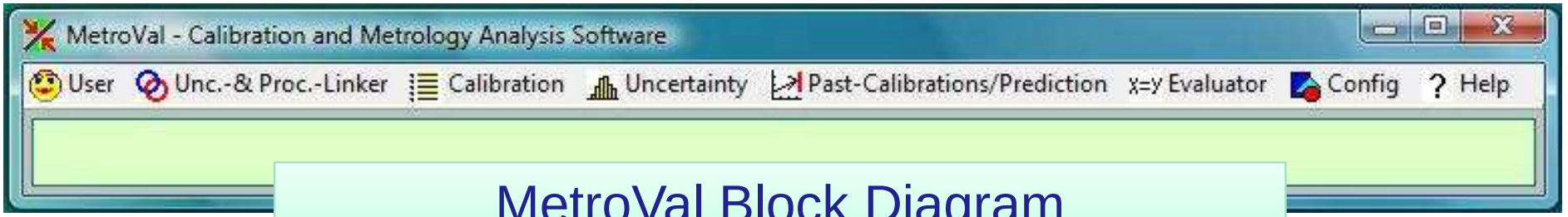
MetroVal
is a general purpose flexible
calibration and **analysis** program
that can fit many situations and requirements
and is utilized in many fields of calibration.

It complies with international metrology standards and recommendations such as

ISO GUM (& supplement 1) = for uncertainty
ISO 17025 = for accreditation
ILAC G8 = for compliance with specification
ILAC G24 / OIML D 10 = for recalibration intervals

and has many capabilities beyond these standards.

MetroVal's features were fine tuned and continue to be, based on users feedback.



MetroVal Block Diagram

Calibration Procedure

Subroutine Sequencer

Automatic

Manual

Cal data Entry Table

Modules

Evaluation

Uncertainty

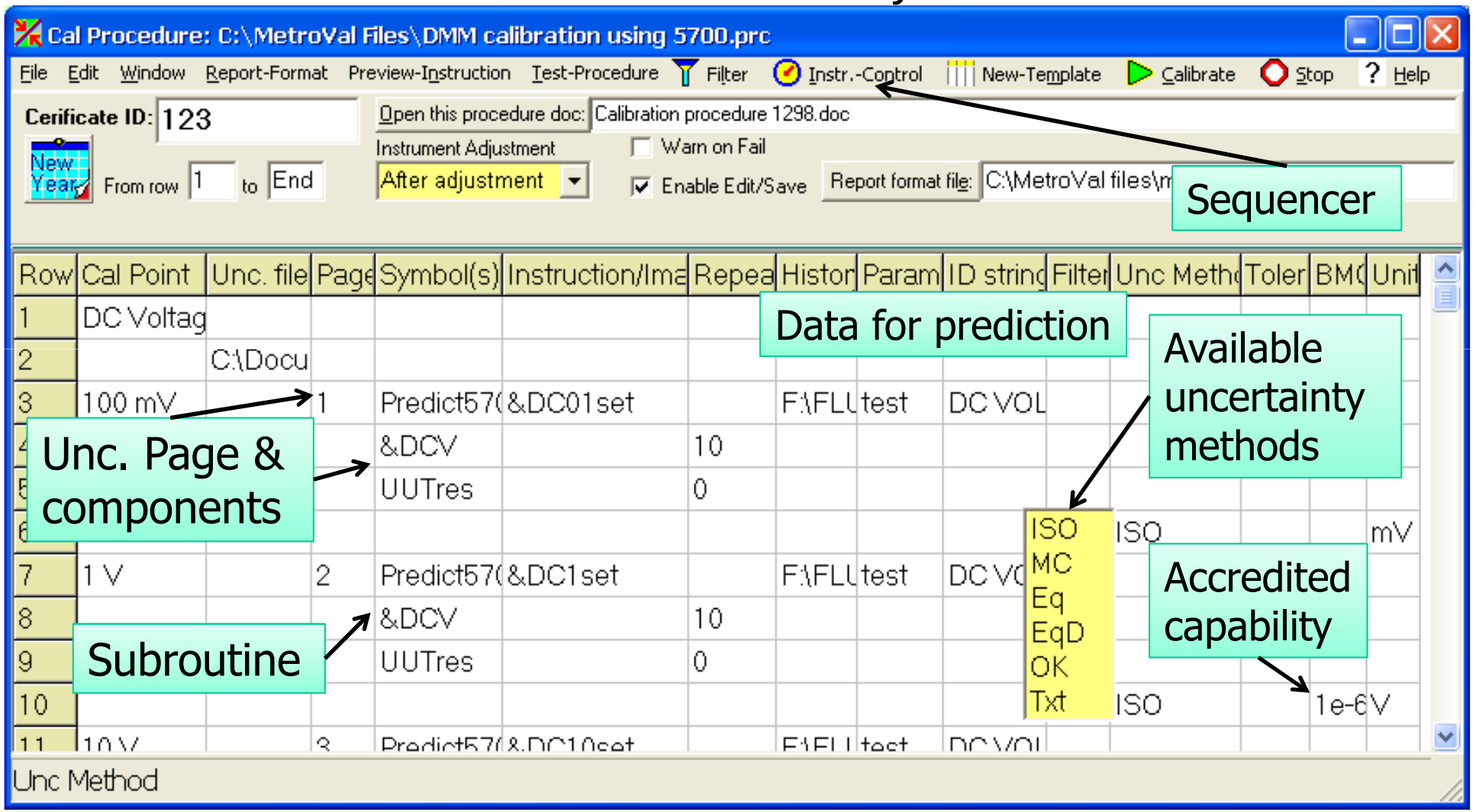
Prediction

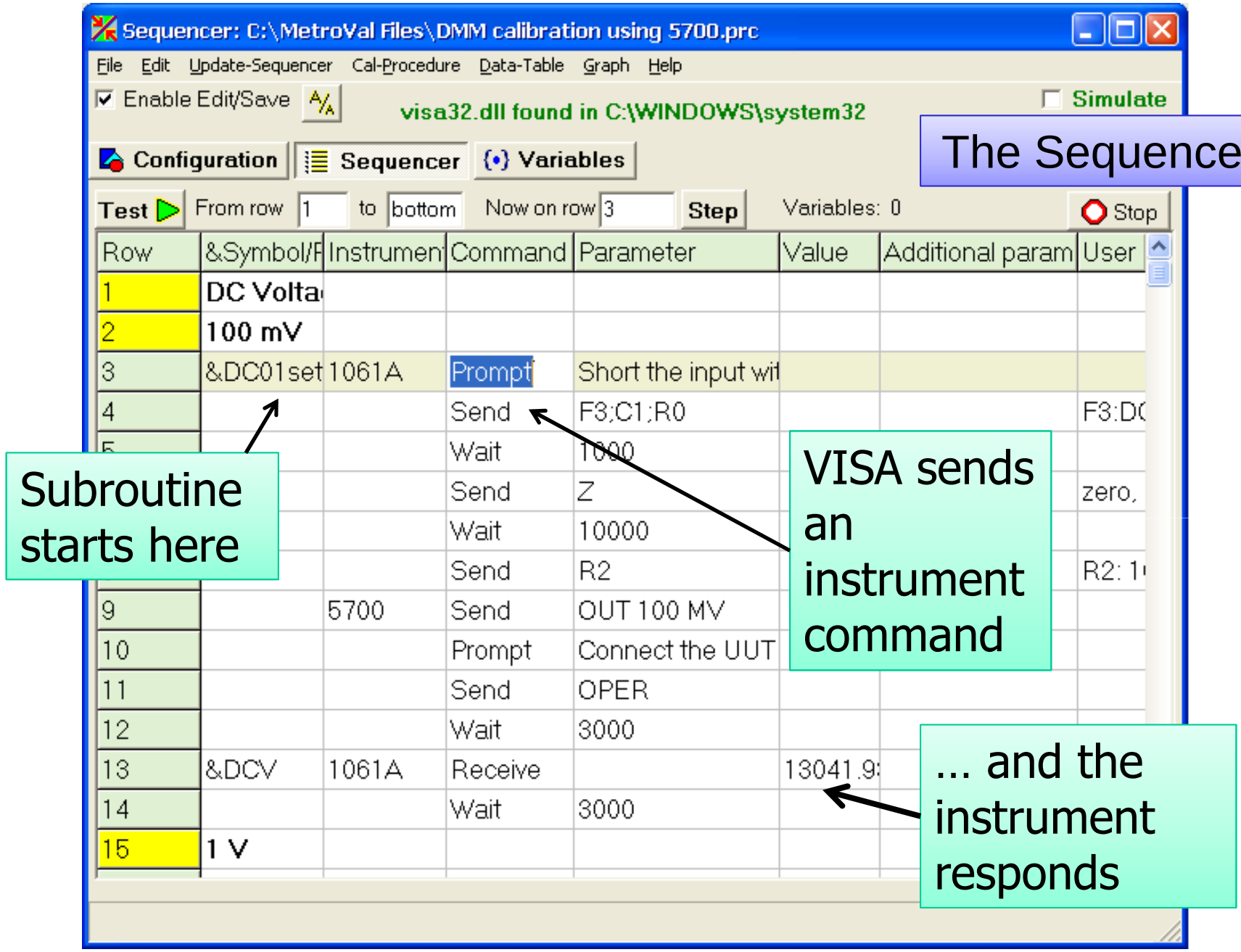
VISA Instrument Communication by IEEE488 USB, LAN, RS232 etc.

Calibration Template

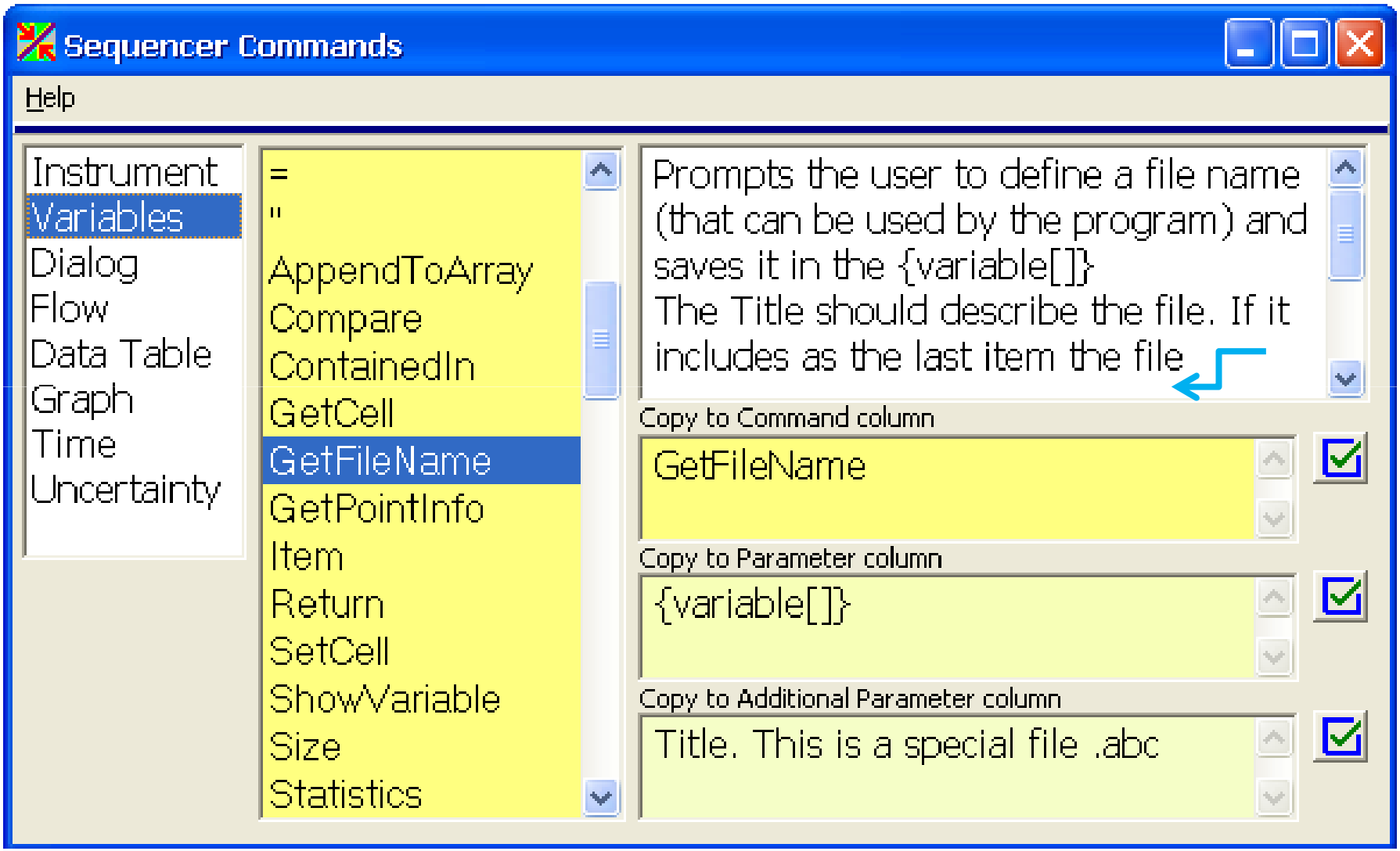
Calibration Report

The calibration procedure is a table written by non-programmers. Each cell contains a parameter, an instruction or a link. The table is executed line by line.




Sequencer: C:\MetroVal Files\DMM calibration using 5700.prc
File Edit Update-Sequencer Cal-Procedure Data-Table Graph Help
Enable Edit/Save
visa32.dll found in C:\WINDOWS\system32
Simulate
Configuration
Sequencer
{•} Variables
Test
From row 1 to bottom
Now on row 3
Step
Variables: 0
Stop
Row | &Symbol/F | Instrumen | Command | Parameter | Value | Additional param | User
1 | DC Volta
2 | 100 mV
3 | &DC01set | 1061A | Prompt | Short the input wit
4 | Send | F3;C1;R0 | F3:D
Wait | 1000
Send | Z | zero,
Wait | 10000
Send | R2 | R2: 1
9 | 5700 | Send | OUT 100 MV
10 | Prompt | Connect the UUT
11 | Send | OPER
12 | Wait | 3000
13 | &DCV | 1061A | Receive | 13041.9
14 | Wait | 3000
15 | 1 V
The Sequencer
Subroutine starts here
VISA sends an instrument command
... and the instrument responds

Right clicking on a Command field in the Sequencer opens a command editor which allows editing commands and variables.



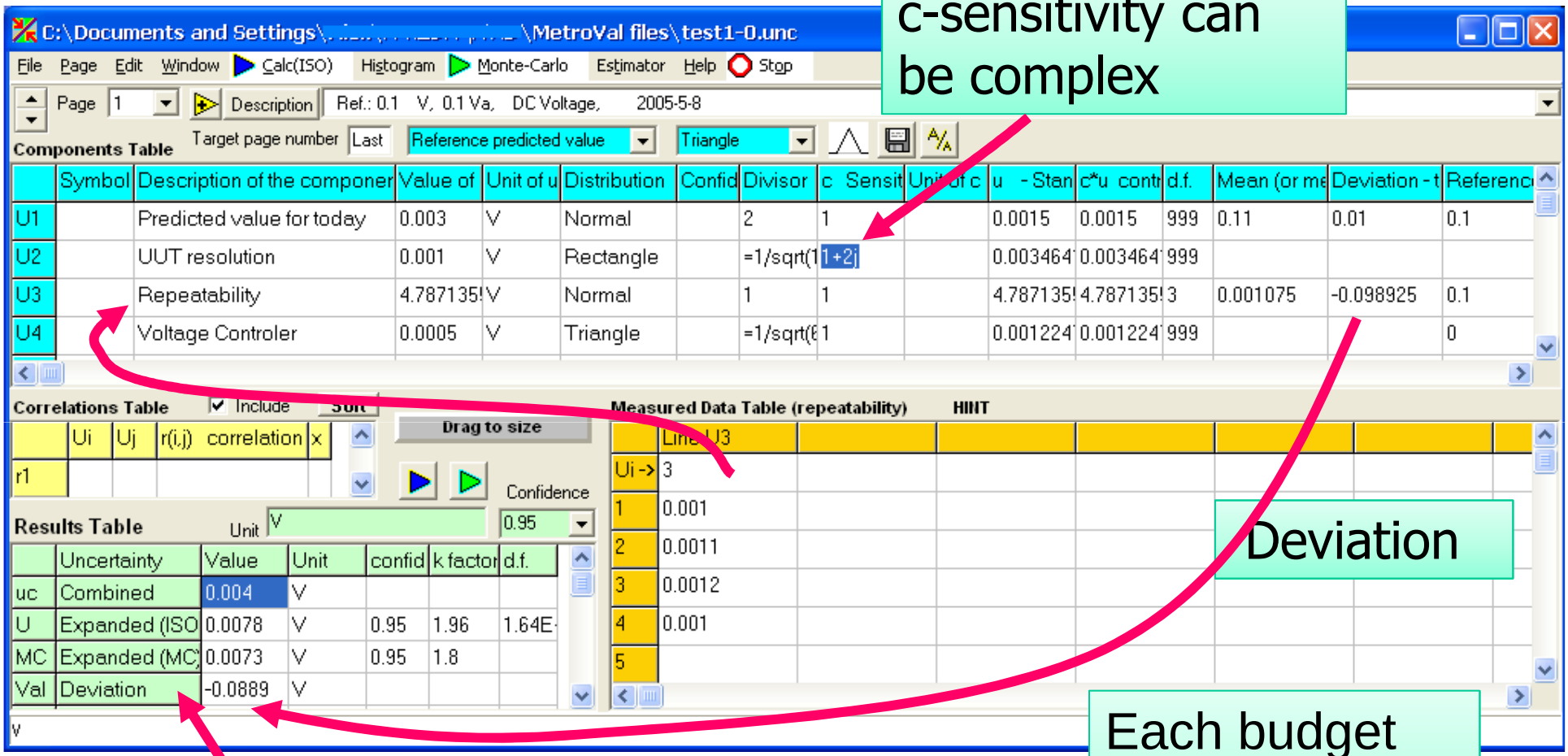
Available Uncertainty Methods

- **GUM** (first order Taylor expansion). Expanded uncertainty computation is extended to include correlations. C-sensitivities and result uncertainties may be complex numbers.

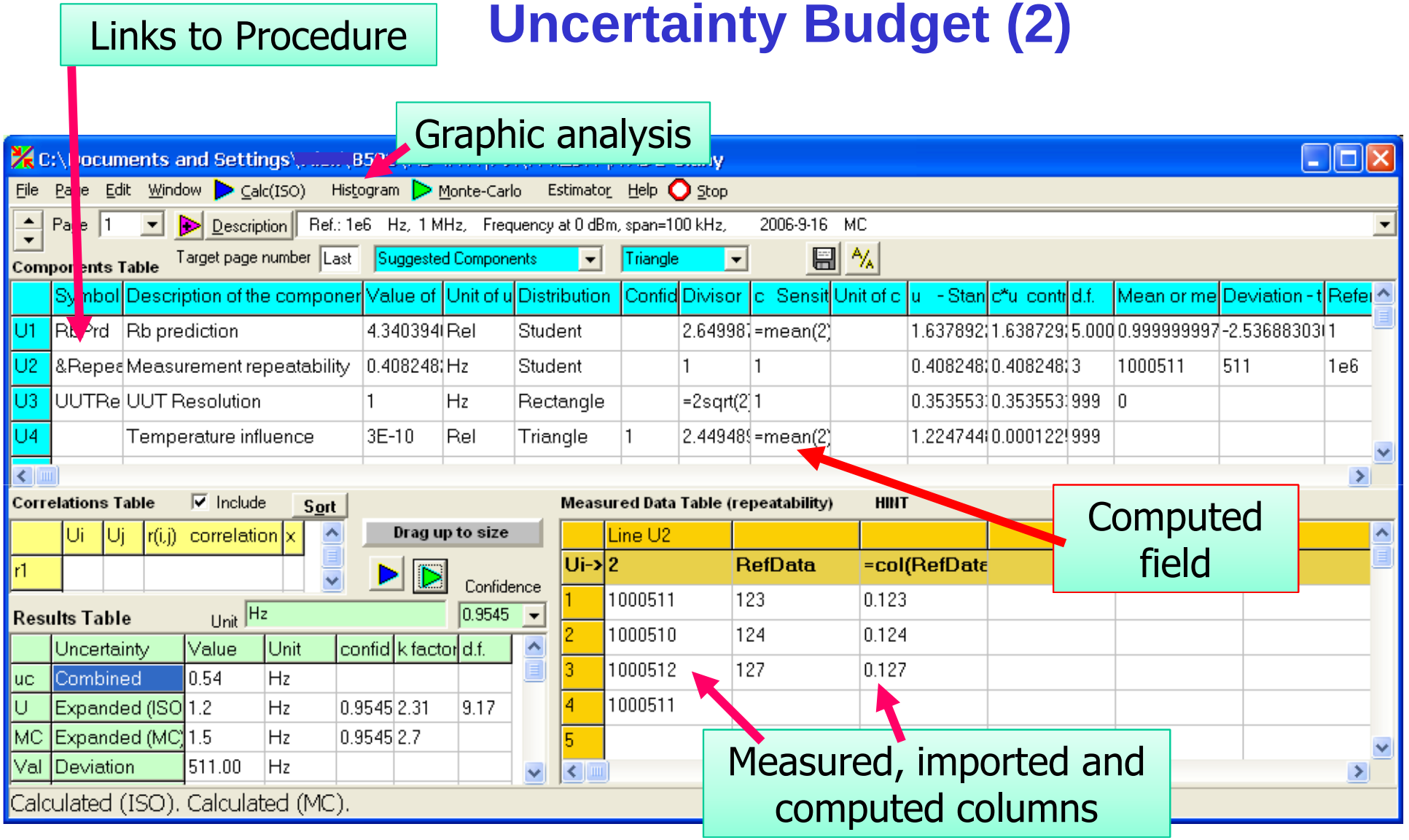
- **Simplified Monte Carlo** (assuming Root-Sum-Squares equation). May use complex numbers as with the GUM method.

- **Monte-Carlo simulation directly from the measurement equation**. The equation may include complex numbers. Distributions and reference values are given in the budget table. It can compute c-sensitivities. Produces the **most correct results**.

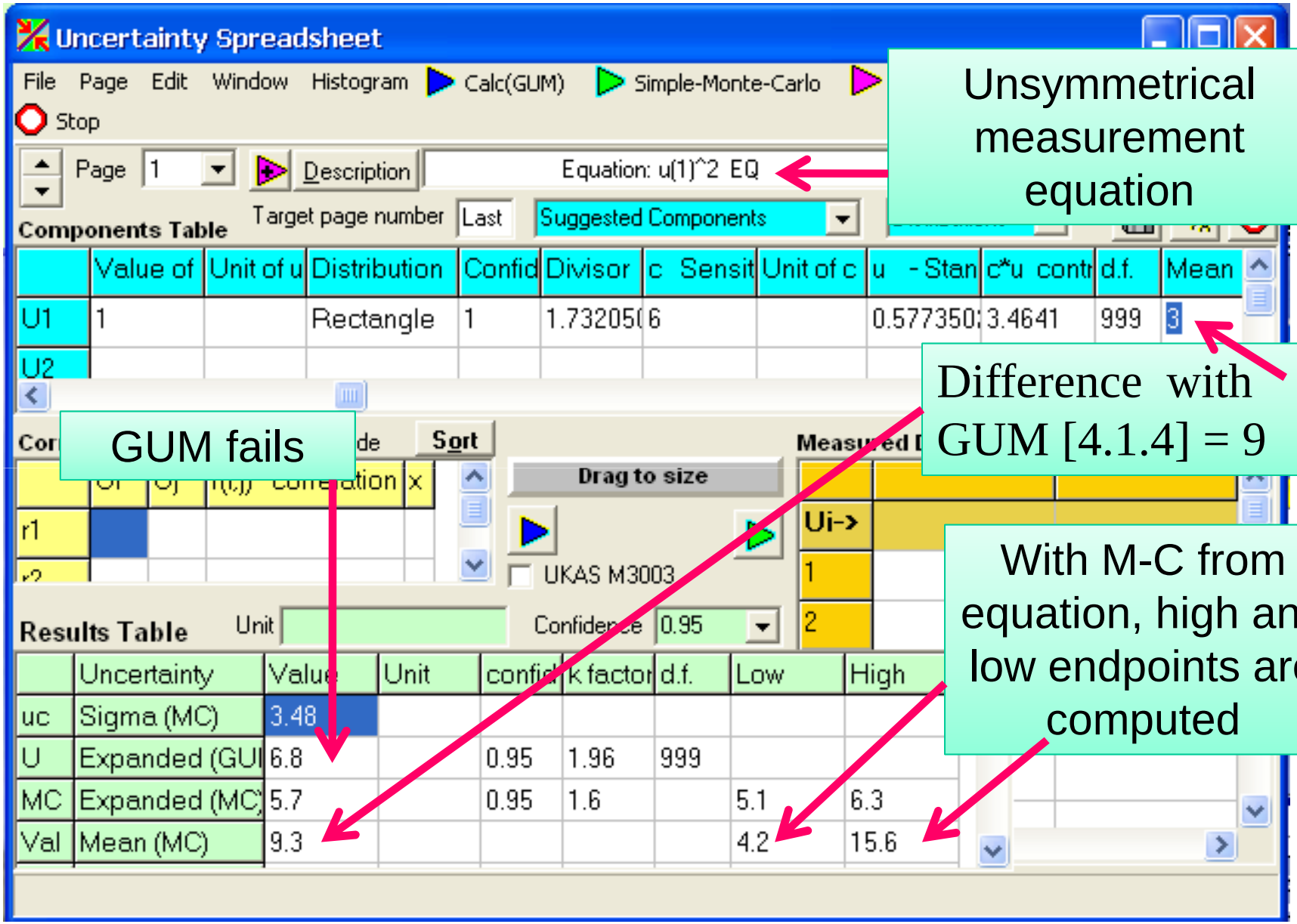
Uncertainty Budget (1)

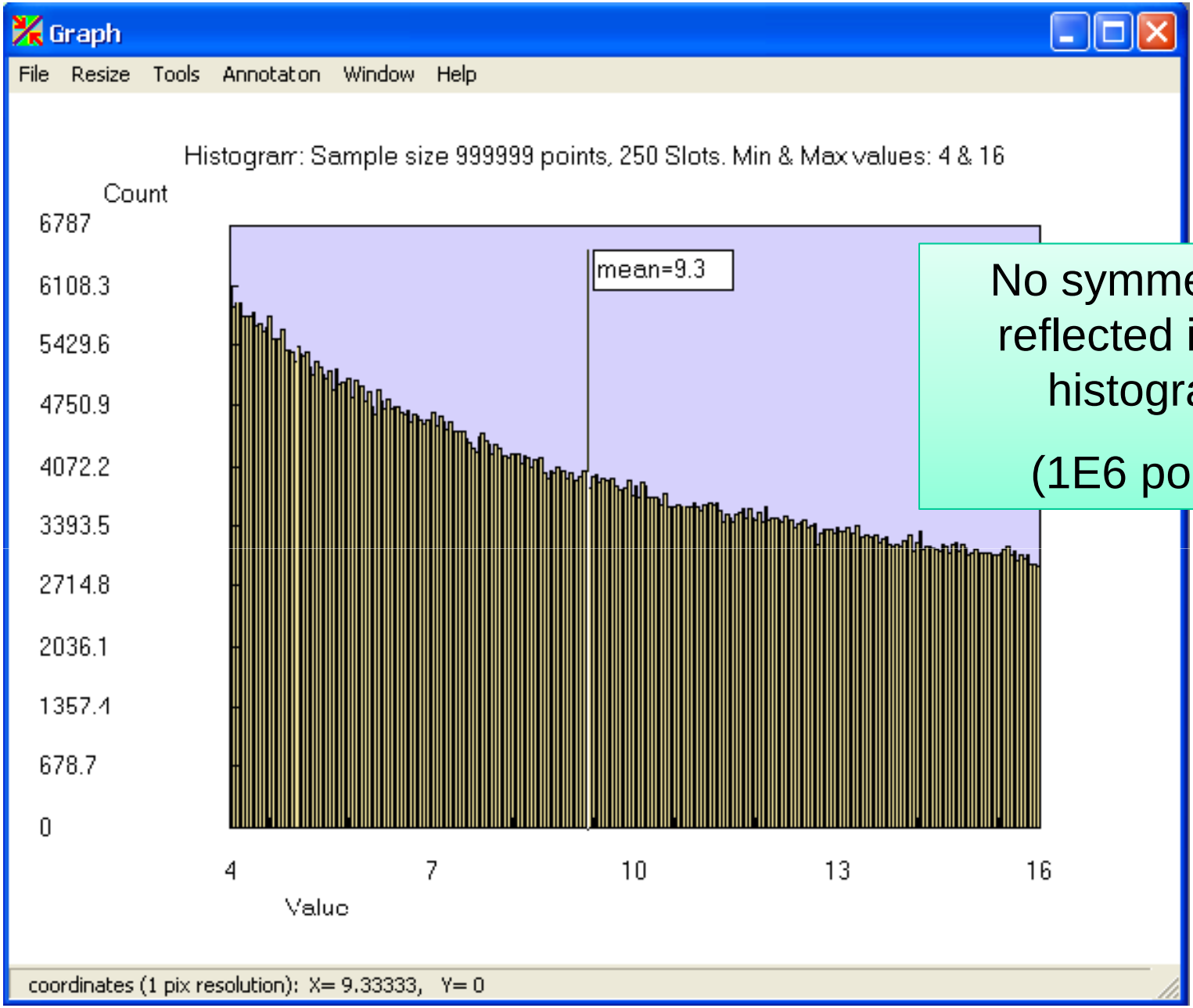


Uncertainty Budget (2)



Uncertainty Budget (3)

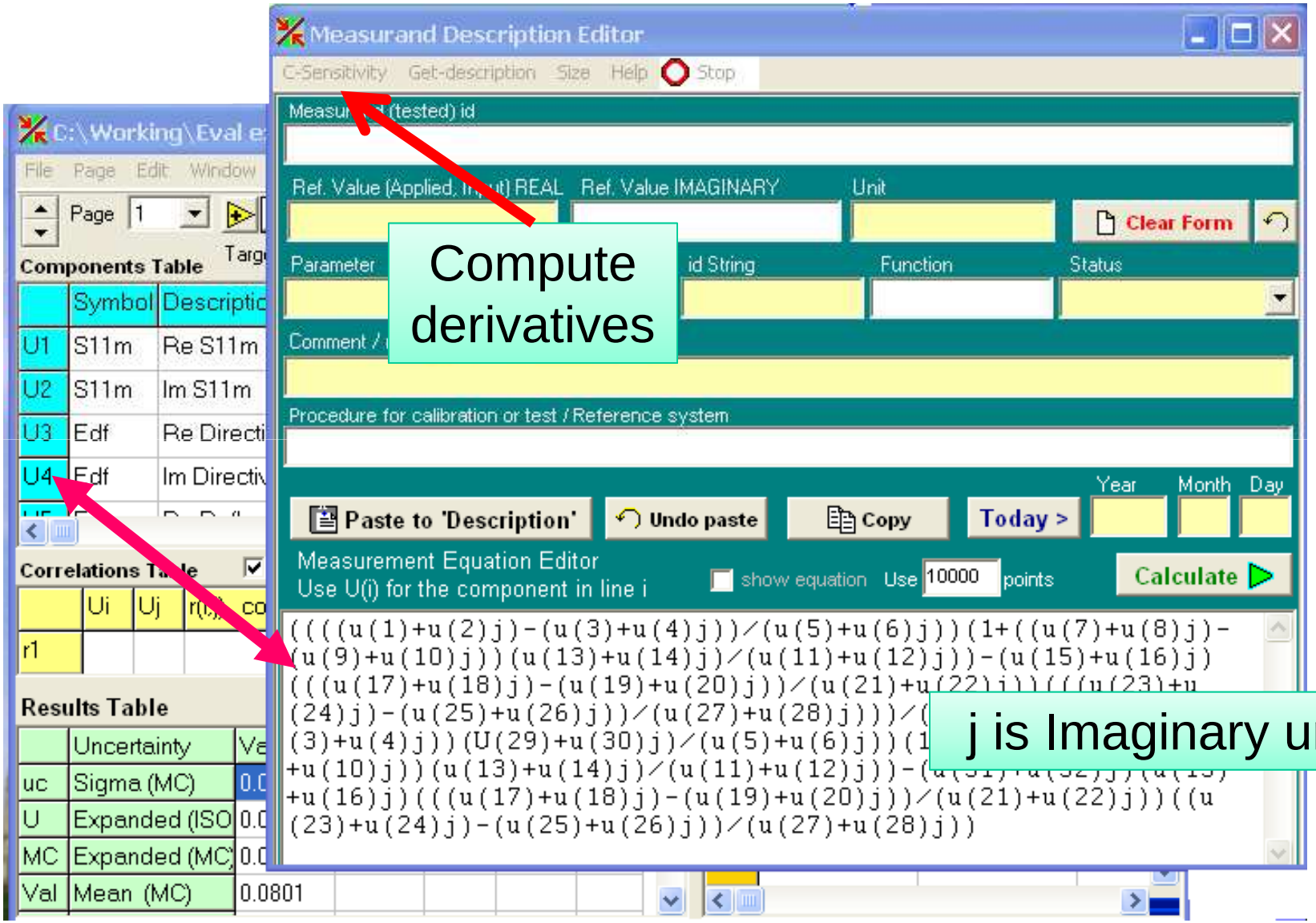




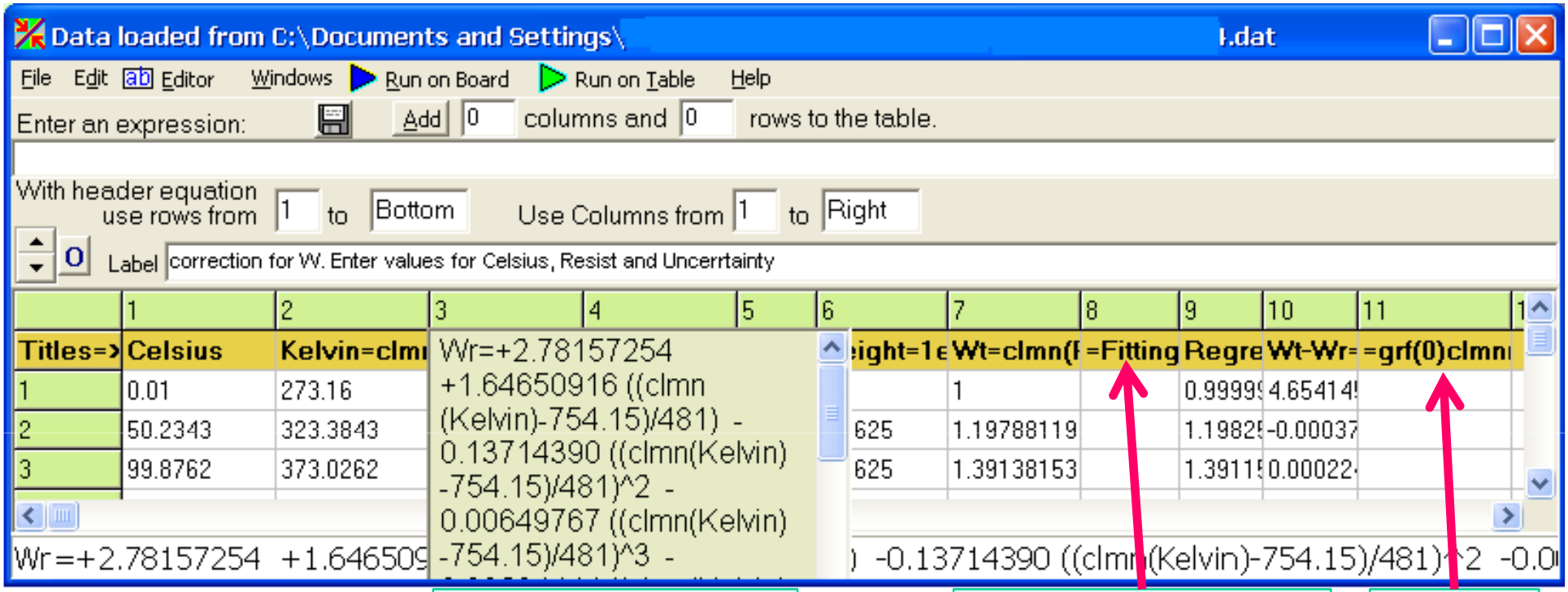
No symmetry is reflected in the histogram

(1E6 points)

Uncertainty from Measurement Equation by Monte-Carlo simulation

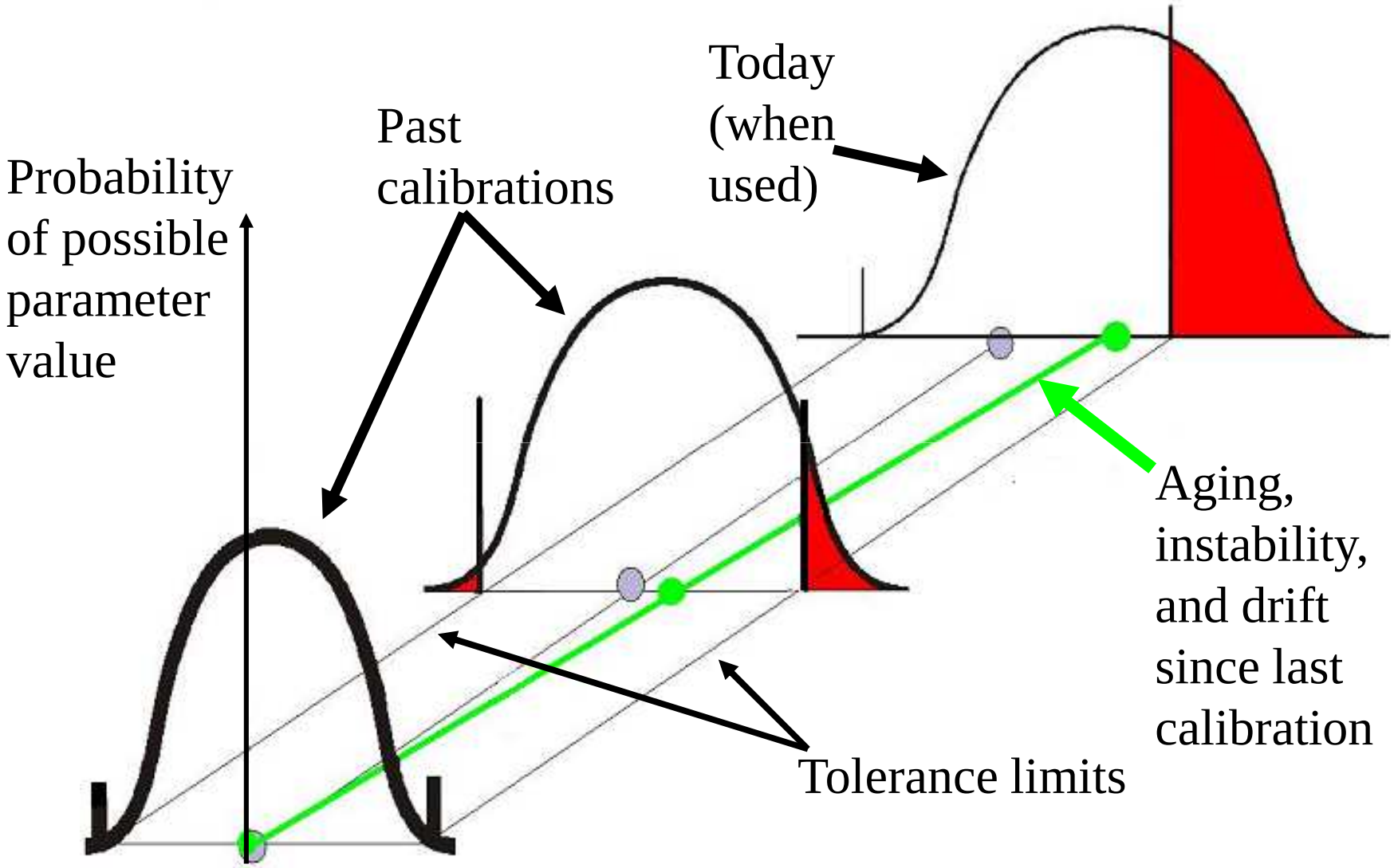


Data Table linked to uncertainty and curve fitting



Calculations are done from left to right. Here, PRT temperature to resistance measurements are fitted by weighted regression and presents results graphically.

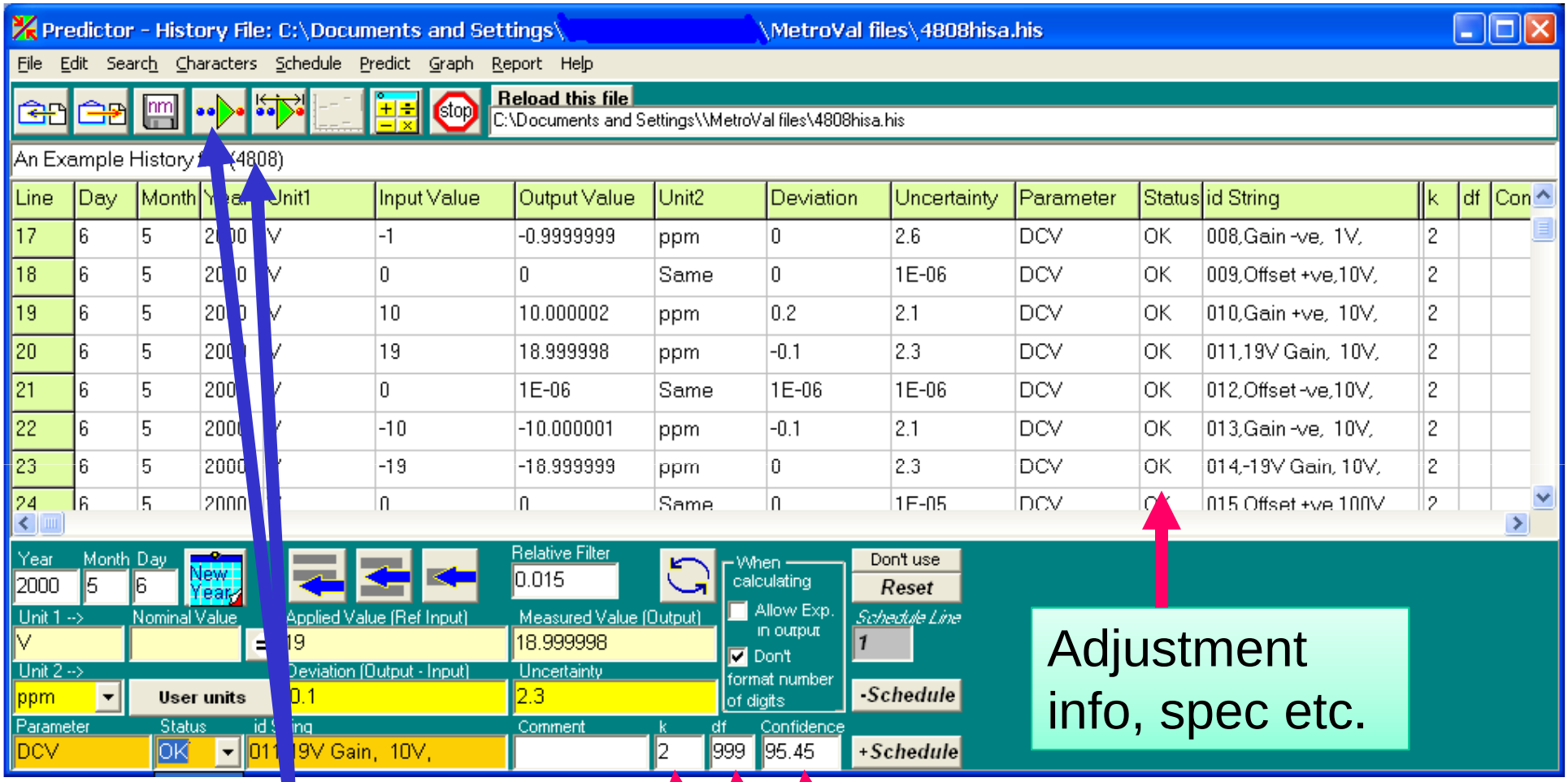
Why use prediction as an uncertainty component?



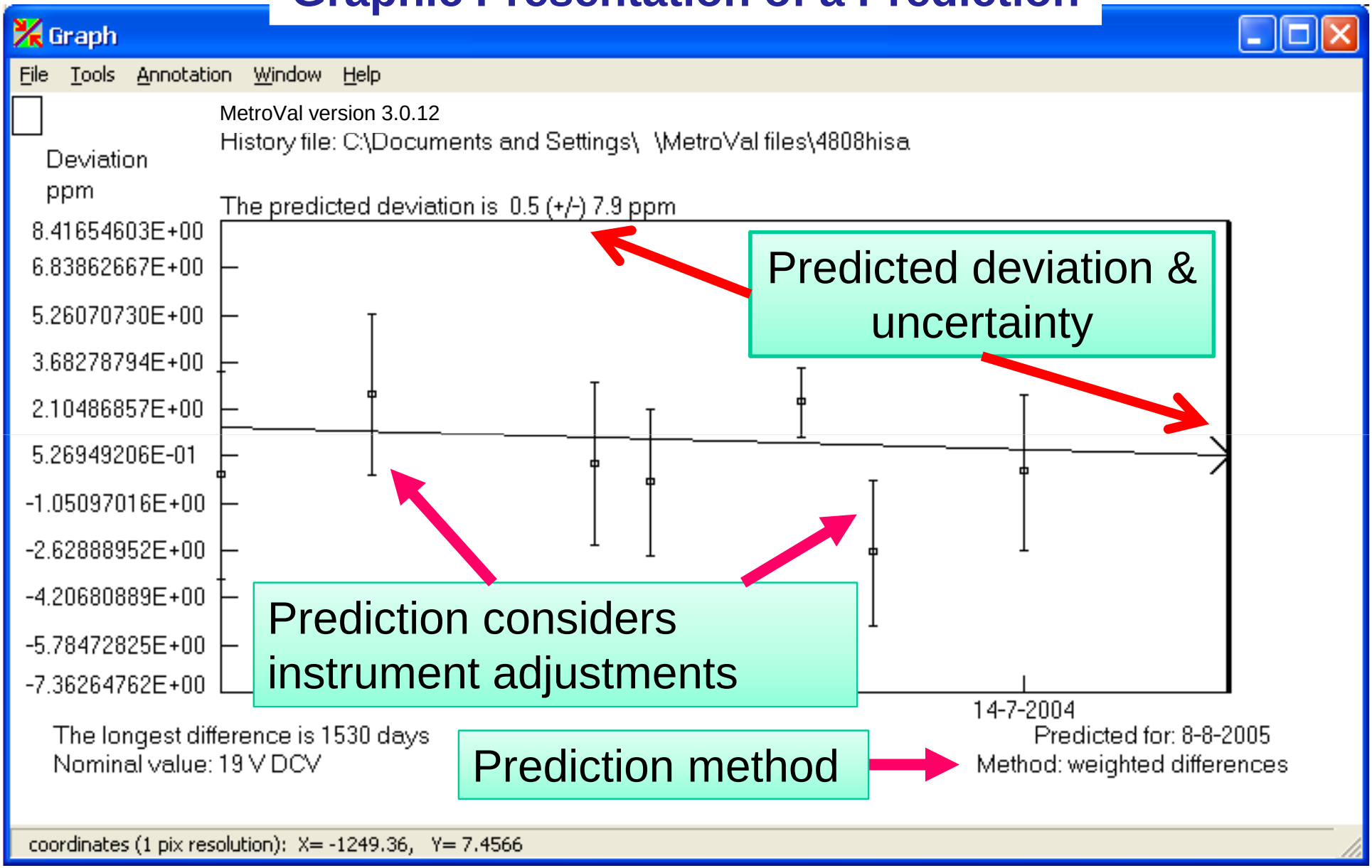
The contribution of reference instrument's aging, drift and instability to the total measurement uncertainty is important. It is especially significant when

- Doing proficiency testing
- Calibrating or comparing reference instruments of similar quality
- Comparing instruments over a long period of time
- Monitoring the quality of reference instruments
- Verifying aging and other instability specifications
- Estimating recalibration intervals

Past Calibrations used for Prediction and Interval Analysis



Graphic Presentation of a Prediction



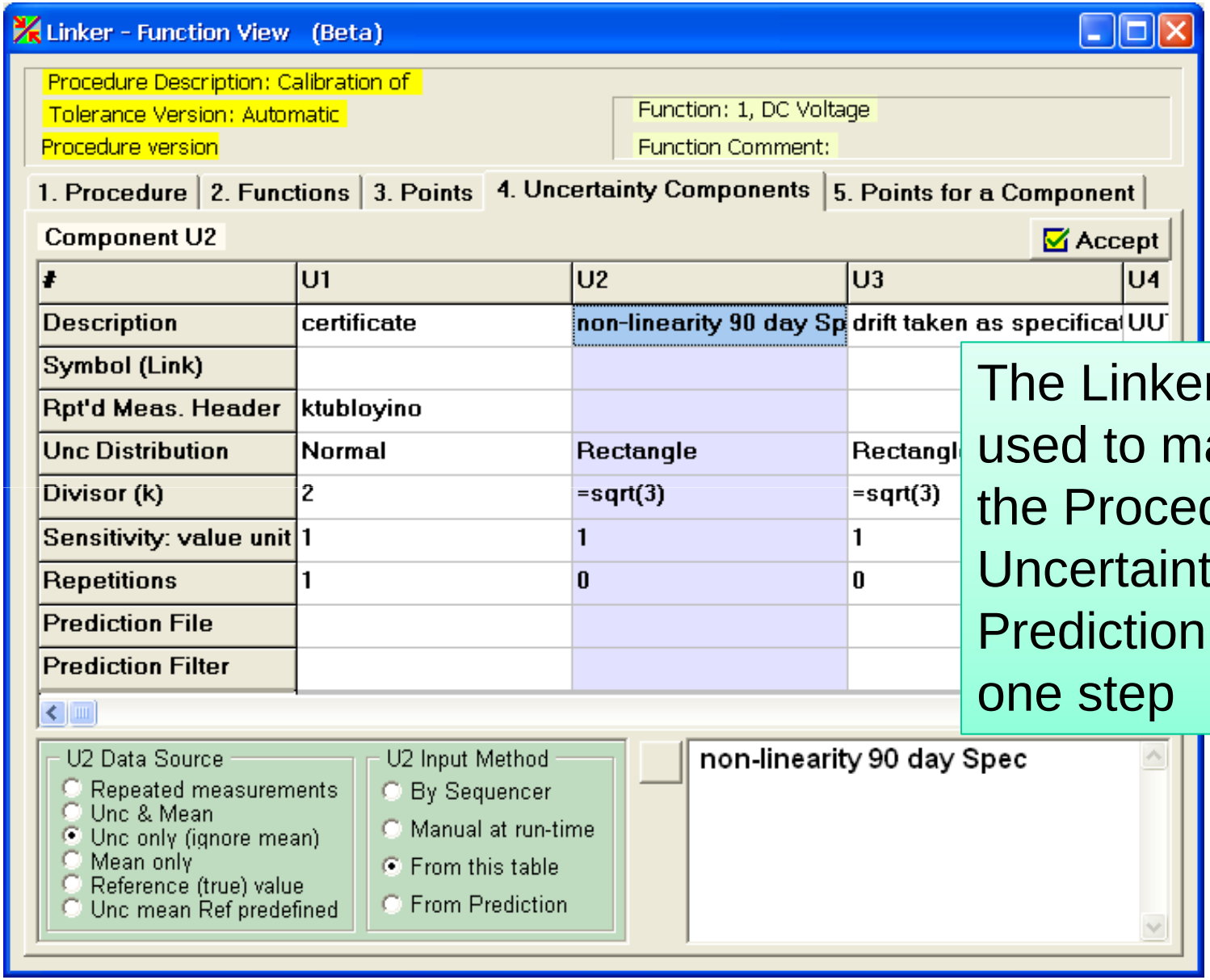
Available Prediction Methods

- **Weighted Linear Regression**. Takes into consideration both **regression statistics** and **measurement uncertainties**. Best for white noise instabilities.

- **Weighted Linear Regression of Differences**. Advantage when instrument passes occasional **adjustments** (“as received” and “as left”). Best for random walk instabilities.

- MetroVal program can chose the best method and use it when in automatic mode.

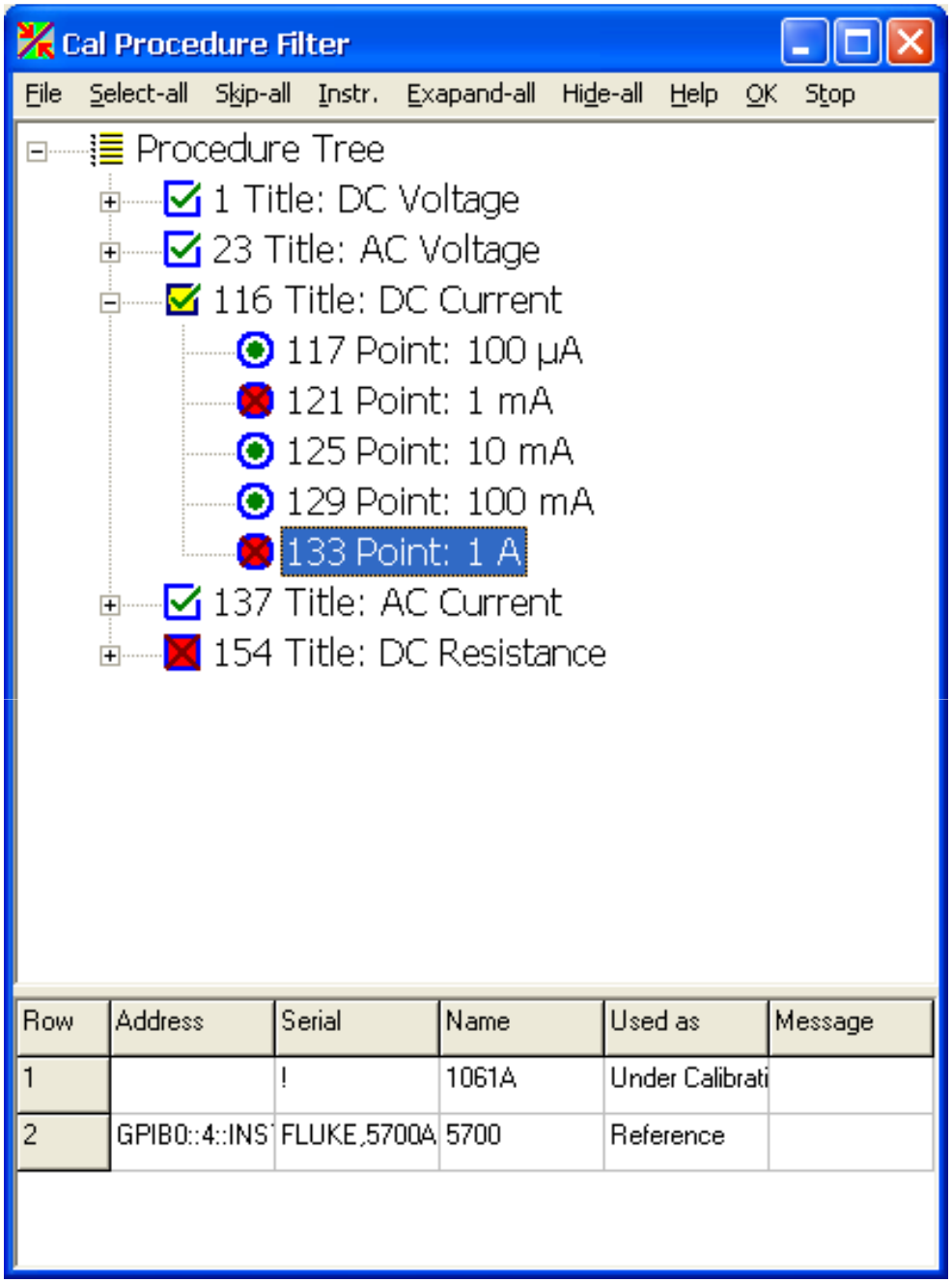
Uncertainty & Procedure Linker (in function view)



The Linker is used to make the Procedure, Uncertainty & Prediction in one step

What is Visible to the Operator?

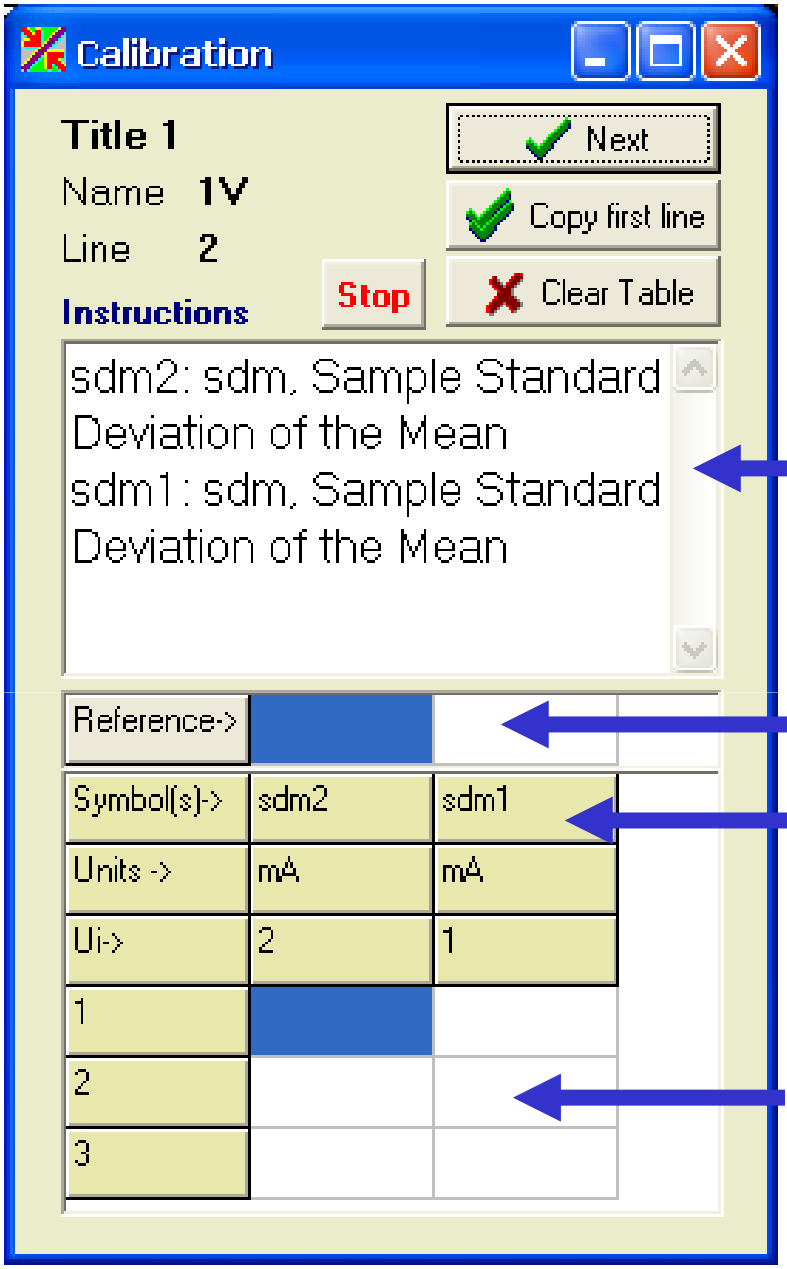
The procedure tree with calibration points to choose for the present job.



Instruments used by VISA for the selected cal points

Calibration

When running calibration manually…

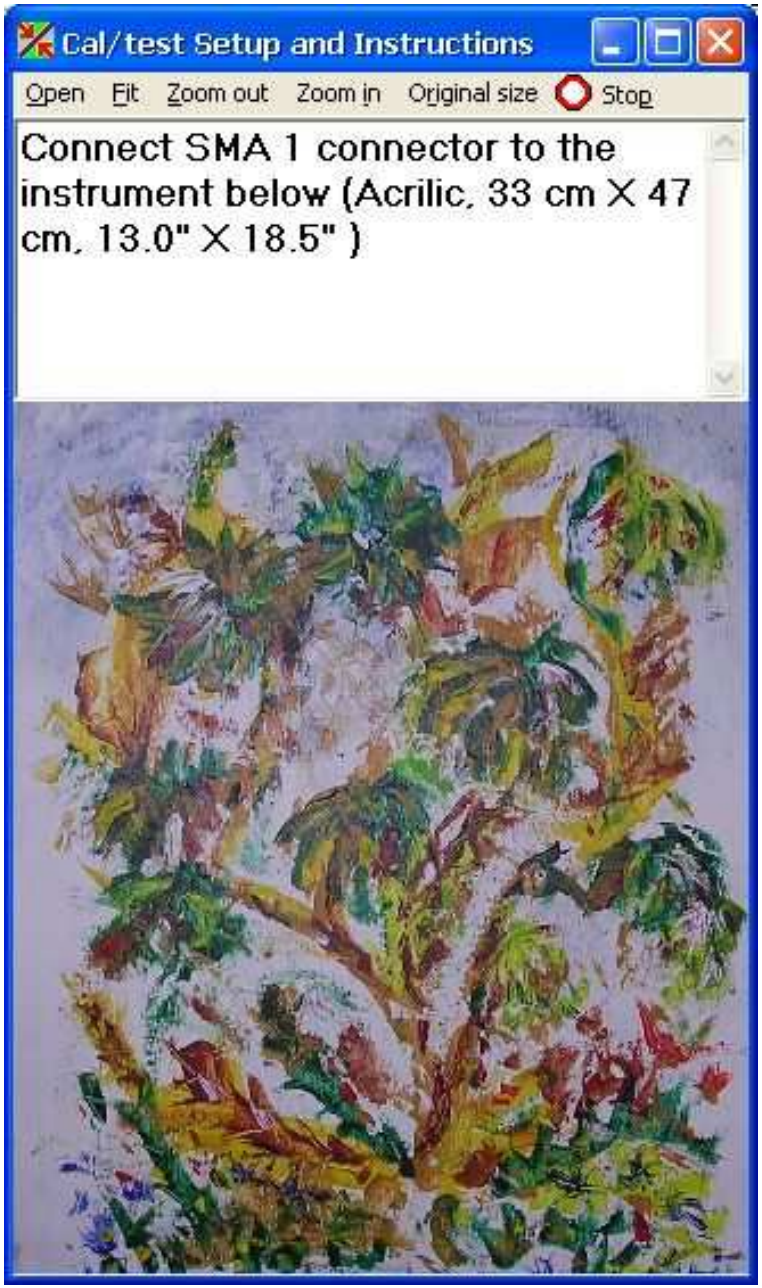


Component description from uncertainty budget

Components reference values

Correlated components measured simultaneously and processed together (e.g. sigma of difference).

Measurements' entry fields. In automatic calibration MetroVal uses VISA for automatic reading & data entry.



Instructions to Operator

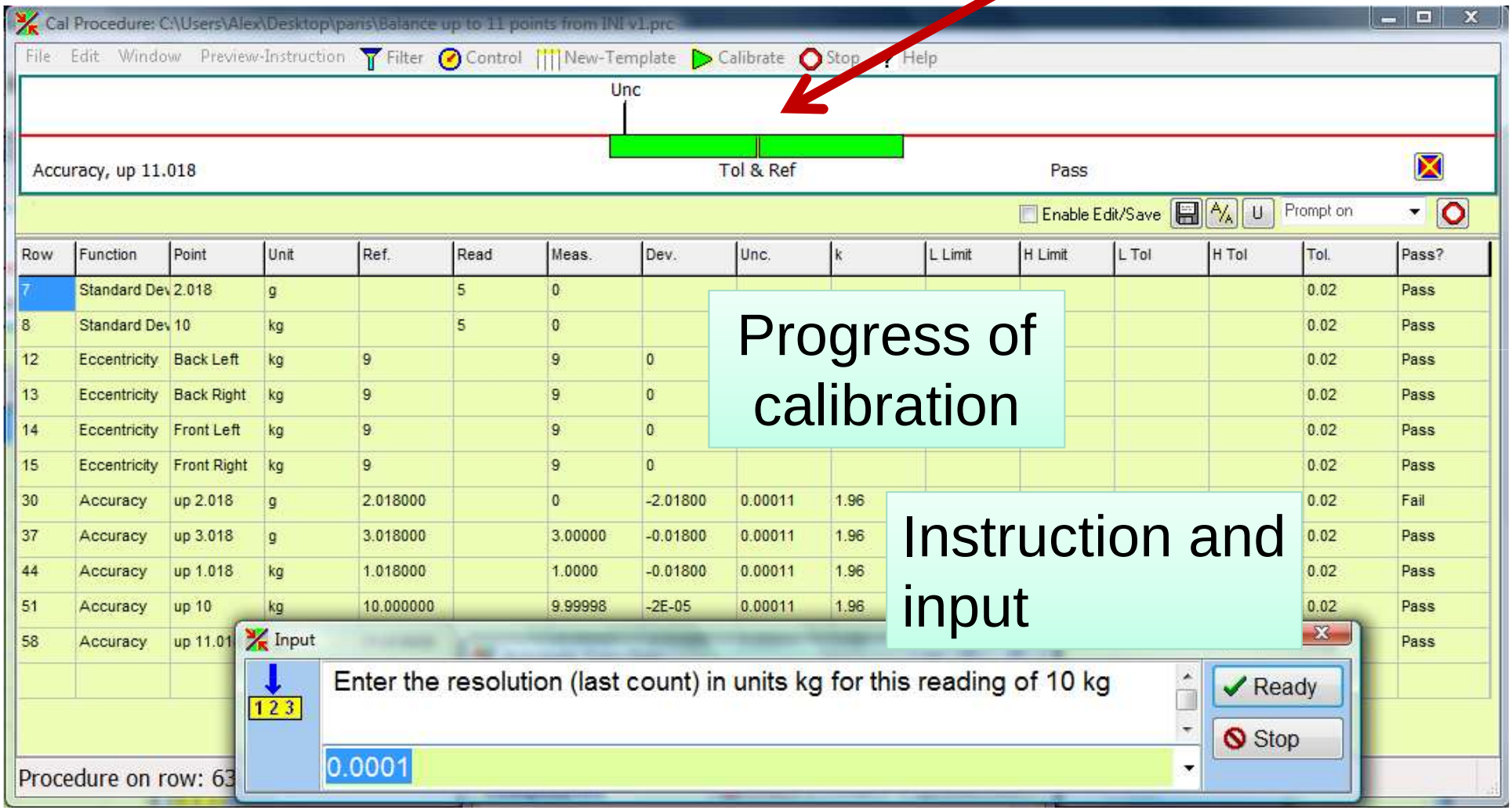
← Text

and

← Graphics

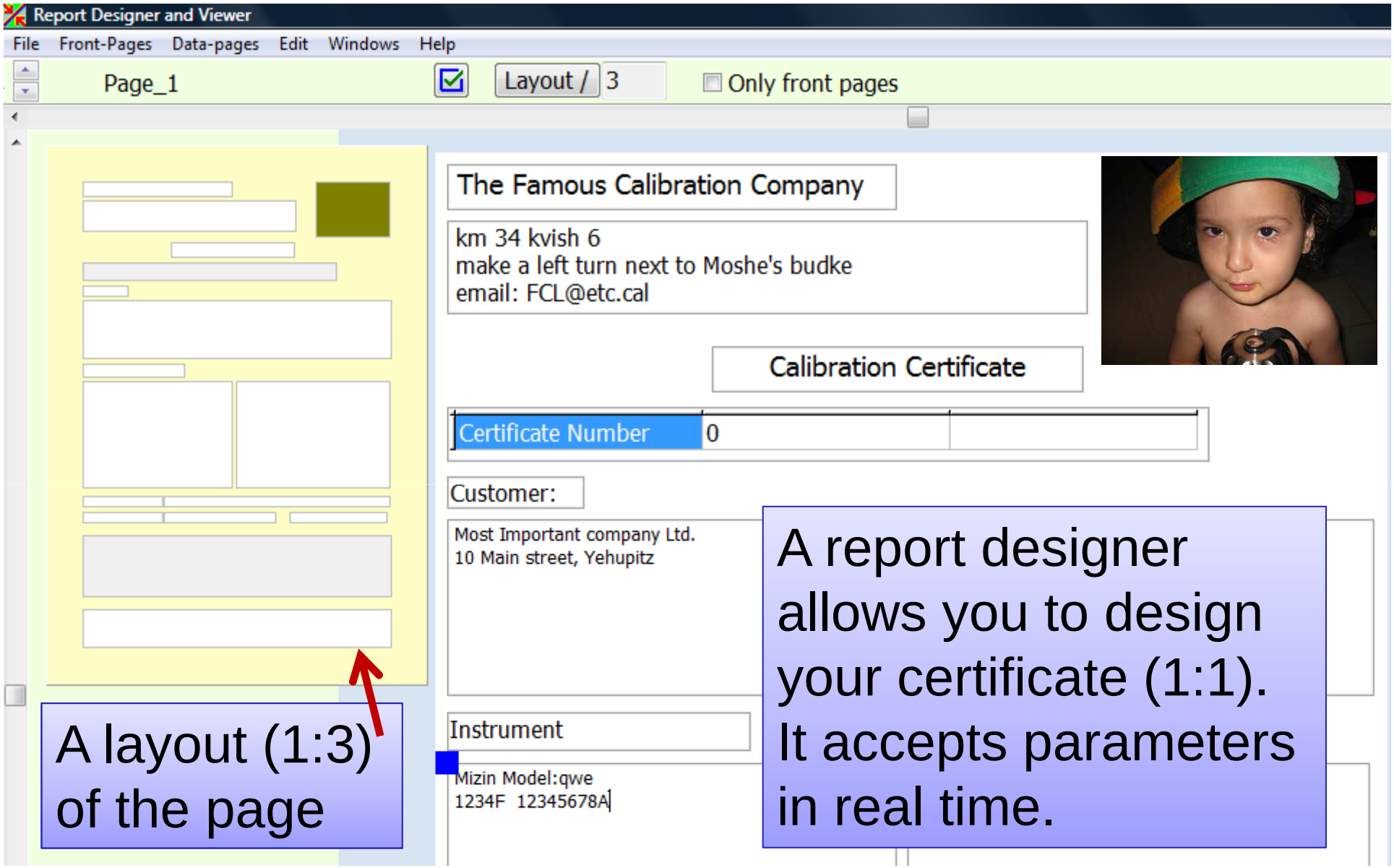
Step by step instructions to operator with optional graphic aids, prompts and inputs.

Graphical presentation of uncertainty, result and spec



Progress of calibration

Instruction and input


Report Designer and Viewer
File
Front-Pages
Data-pages
Edit
Windows
Help
Page_1
Layout / 3
Only front pages
The Famous Calibration Company
km 34 kvish 6
make a left turn next to Moshe's budke
email: FCL@etc.cal
Calibration Certificate
Certificate Number
0
Customer:
Most Important company Ltd.
10 Main street, Yehupitz
Instrument
Mizin Model:qwe
1234F 12345678A
A layout (1:3) of the page
A report designer allows you to design your certificate (1:1). It accepts parameters in real time.

The Famous Calibration Company

Calibration Results Report

Results Report for Certificate 0

Done for fun only during holidays.

Frequency accuracy at 3 dBm input power

Point/ Param.	Unit	Ref.	Measured	Dev.	Unc.	k
1 MHz	Hz	1000000.000	1000500.00	500.00	0.58	1.65
10 MHz	Hz	10000000.000	10000499.93	499.93	0.51	1.66
100 MHz	Hz	100000000	1.0000045E+08	4.5E+02	1.7E+02	3.10
200 MHz	Hz	200000000.000	200000499.45	499.45	0.67	1.77

Power step attenuator at 50 MHz

Point/ Param.	Unit	Ref.	Measured	Dev.	Unc.	k	Tolerance	Pass/NC Fail	Not Accredited
60 dB	%	0	14.3	14.3	3.8	2.81	15	NC	*
50 dB	%	0	4.2	4.2	1.3	2.80	10	Pass	*
40 dB	%	0	3.1	3.1	1.7	2.88	10	Pass	*
30 dB	%	0	1.91	1.91	0.42	2.60	1	Fail	*

*** End Of Report ***

If not otherwise stated, the expanded uncertainties are for the confidence probability of about 95% and k=2.
Pass/NC/Fail based on deviation from nominal plus uncertainty

Page 2 of 2 Pages

Fitted number of significant digits

k factor computed for every point

Possible inclusion of graphs and Data Tables

Pass/Fail per ILAC G8

Automatic indication of not accredited items

The Famous Metrology Conference

Results Report for Certificate 0 , Cal Date: 19-11-2008

All-in-one-universal-instrument, s/n 0987654321

that never needs calibration or adjustment

Pass/NC/Fail depends on asymmetric uncertainties. Extension of ILAC G8

Calibration of artifact 1234, function z

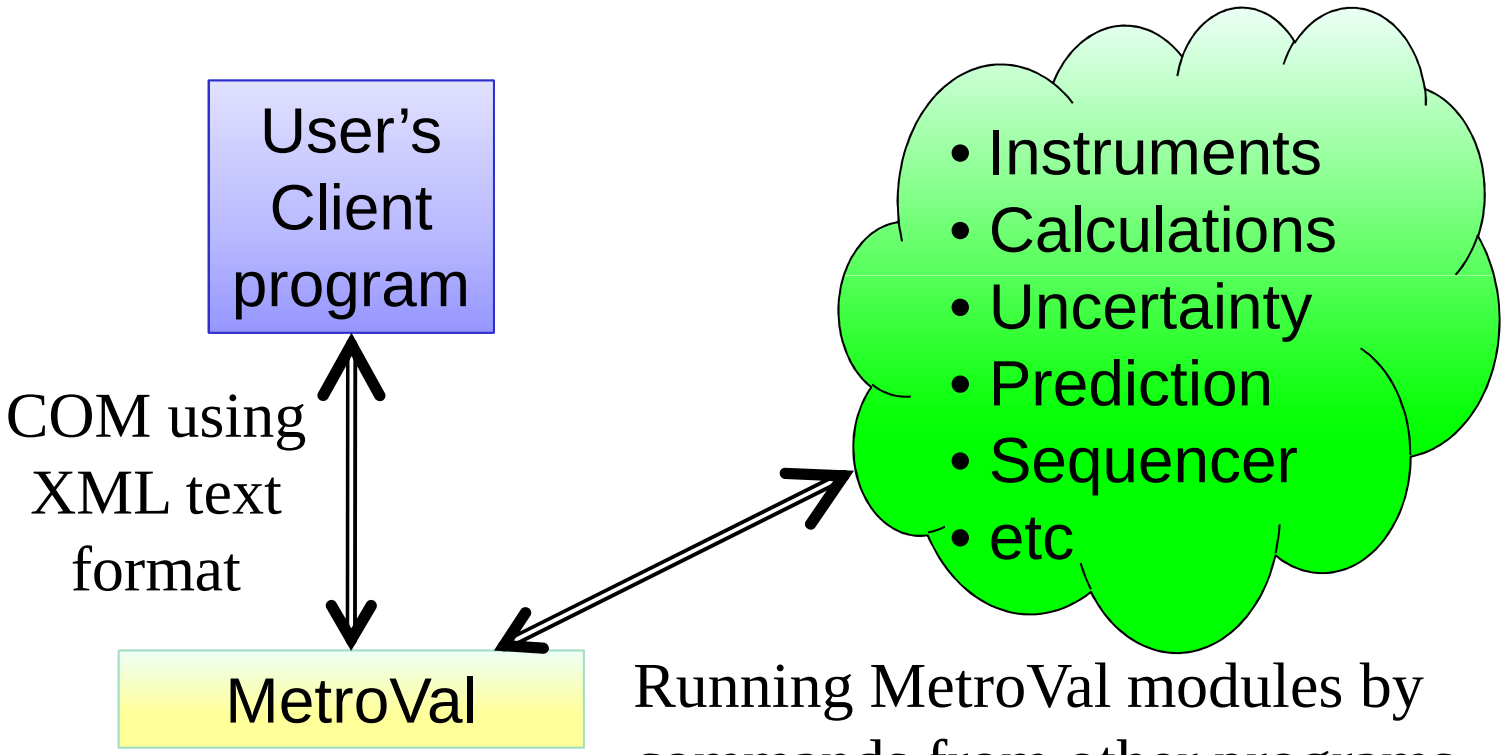
Point Name	Unit	Ref.	Measured	Dev.	Unc.	k	Low Tol.	High Tol.	Pass /Fail	Not Acc
20	mm	20.00052	19.9994	-0.0011	-0.0017 +0.0027	2	-0.01	0.01	Pass	*
100	mm	100.00153	100.0017	0.0002	-0.0023 +0.0016	2	-0.01	0.01	Pass	*

*** End Of Report Data ***

Accreditation should allow for asymmetric BMC

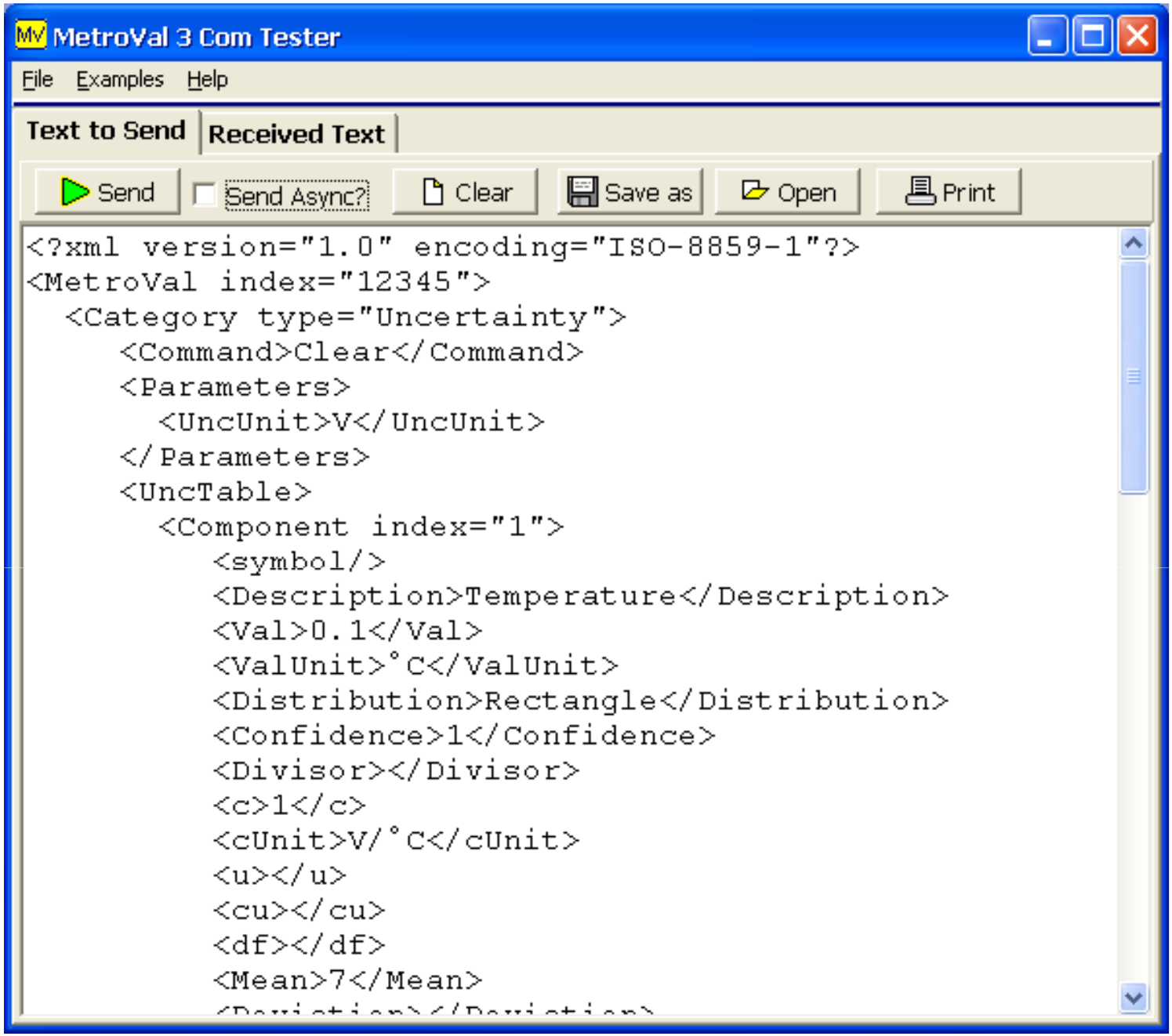
Reporting asymmetric uncertainties

MetroVal can function as a COM server to provide services requested by other programs

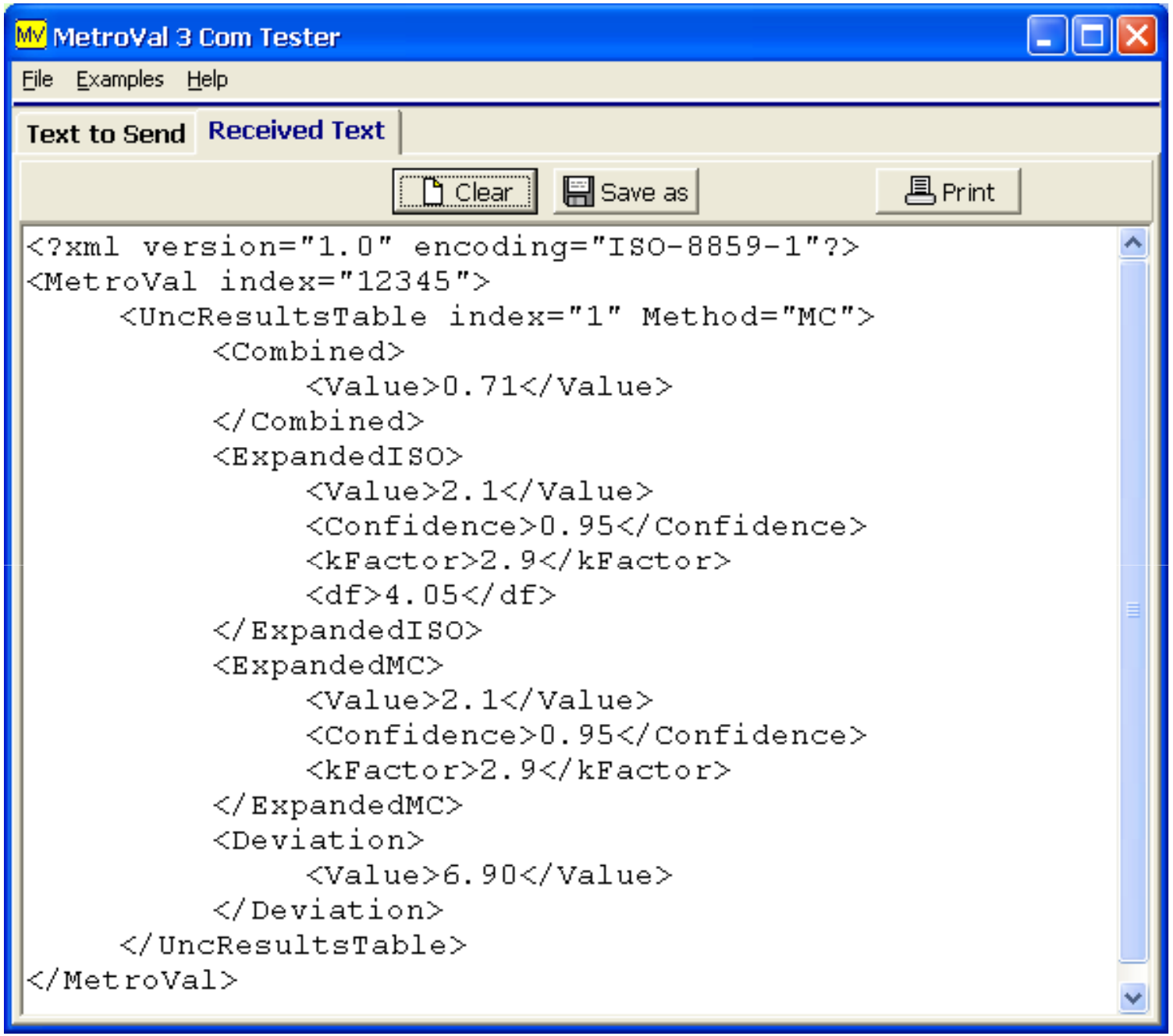


A COM Tester program is provided for free download.

In this example an uncertainty budget is sent to MetroVal using XML format.



And here is the calculated uncertainty sent back by MetroVal also using XML text.



MetroVal can be started by another program (for example MS Access).

The program transfers to MetroVal the name of an INI file as a command line parameter.

MetroVal loads the parameters (eg. cal points) from the INI and executes the calibration.

When calibration is ended, MetroVal closes and the focus is transferred to the calling program.