Mezurit 2: Virtual instrumentation for electronics experiments

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FOSDEM

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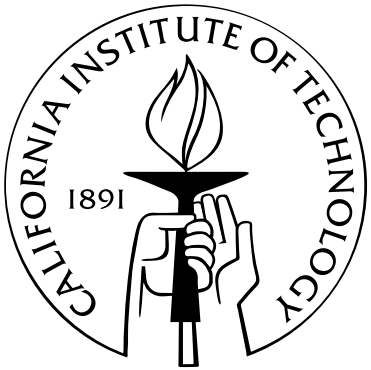

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Origin of Mezurit 2

Problem #1: Acquire, scale, and record data

Problem #2: Sweep a region of parameter space

Problem #3: Find and trigger on rare events

Common hardware:

- Semiconductor parameter analyzer (expensive, inflexible)
- Computer with DAQ and/or GPIB cards

Common software:

- Lab-specific LabVIEW/Matlab/IDL
- Mezurit "1" by Marc Bockrath and David Cobden
- meaSureit by Vera Sazonova

Key features

Virtual channels:

- Arbitrary (Python) functions of hardware ports (and GPIB)
- *Invertible* functions can be outputs

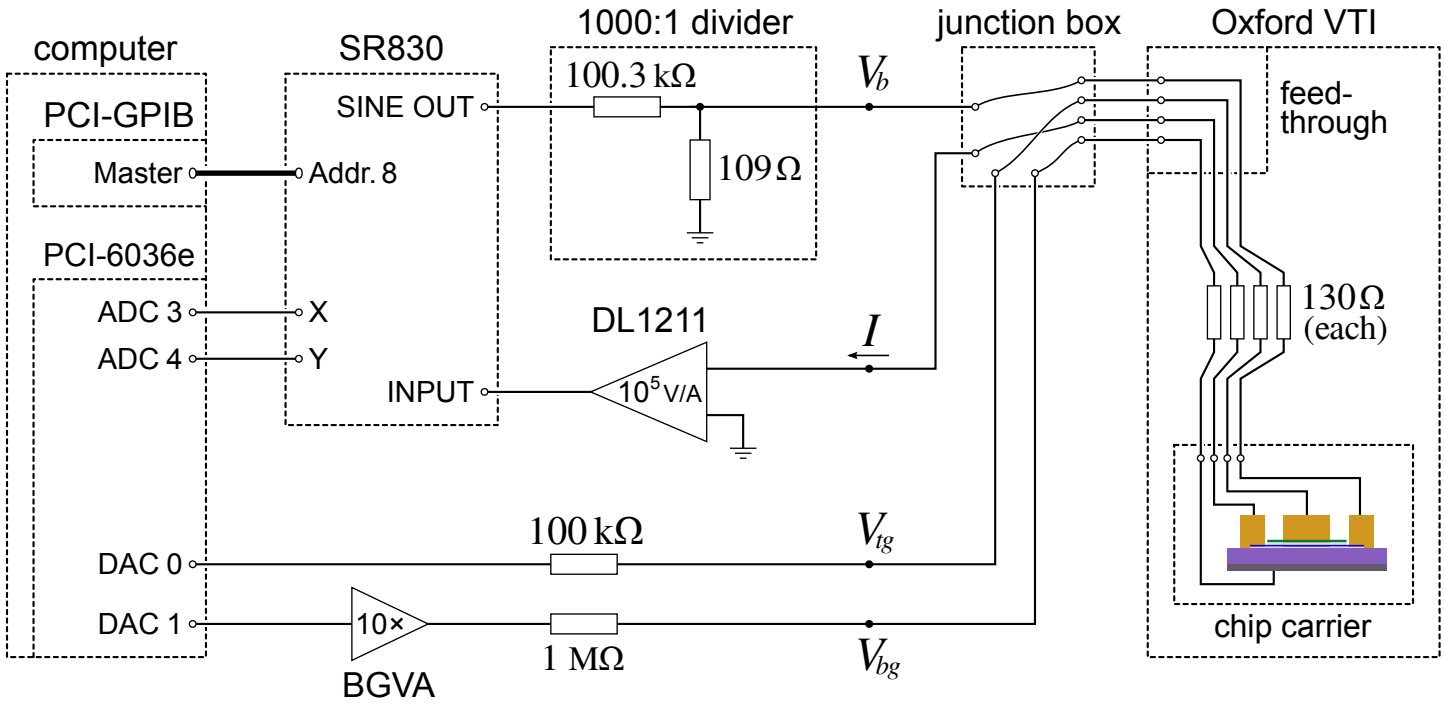
Virtual instruments:

- Acquisition – Data logging up to ~5 kHz
- Scope – Asynchronous acquisition up to hardware limits (~1 MHz)
- Sweeps – Linear or non-linear output ramps
- Triggers – Event detection with predefined responses (also ~5 kHz)

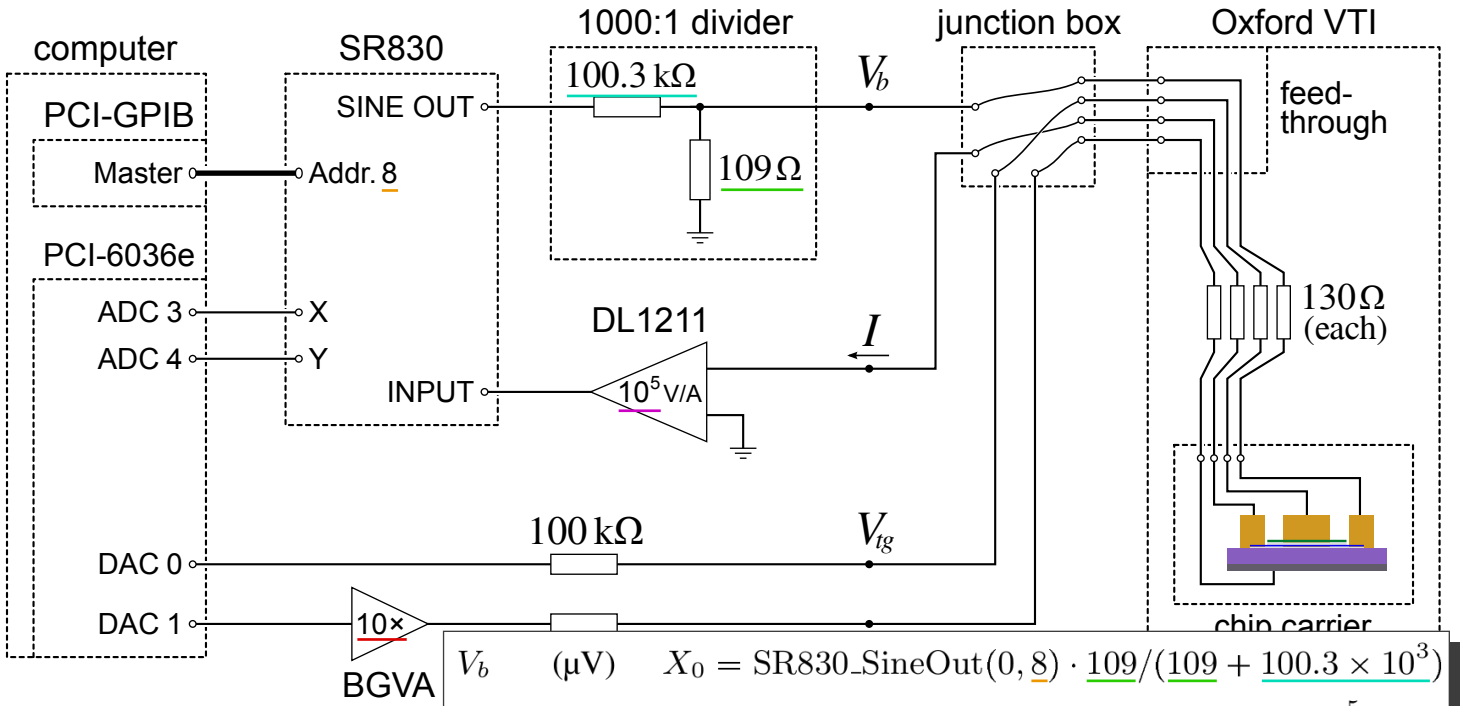
Command-line terminal

Continuously-updated plot and data readout

Example experiment



Example experiment



V_b	(μV)	$X_0 = \text{SR830\_SineOut}(0, 8) \cdot 109/(109 + 100.3 \times 10^3)$
I_x	(nA)	$X_1 = \text{ADC}(0, 3)/10 \cdot \text{SR830\_SensIn}(0, 8) \cdot 10^{-5}$
I_y	(nA)	$X_2 = \text{ADC}(0, 4)/10 \cdot \text{SR830\_SensIn}(0, 8) \cdot 10^{-5}$
V_{tg}	(V)	$X_3 = \text{DAC}(0, 0)$
V_{bg}	(V)	$X_4 = \text{DAC}(0, 1) \cdot 10$

A BRIEF DEMO

Implementation

Code (v0.91):

Language	files	blank	comment	code
C	67	2456	1314	9591
C/C++ Header	37	513	747	1263
Python	3	134	40	333

(Linux) libraries:

- COMEDI
- Linux-GPIB
- C Python API
- Python interpreter
- GTK+ 2
- VTE

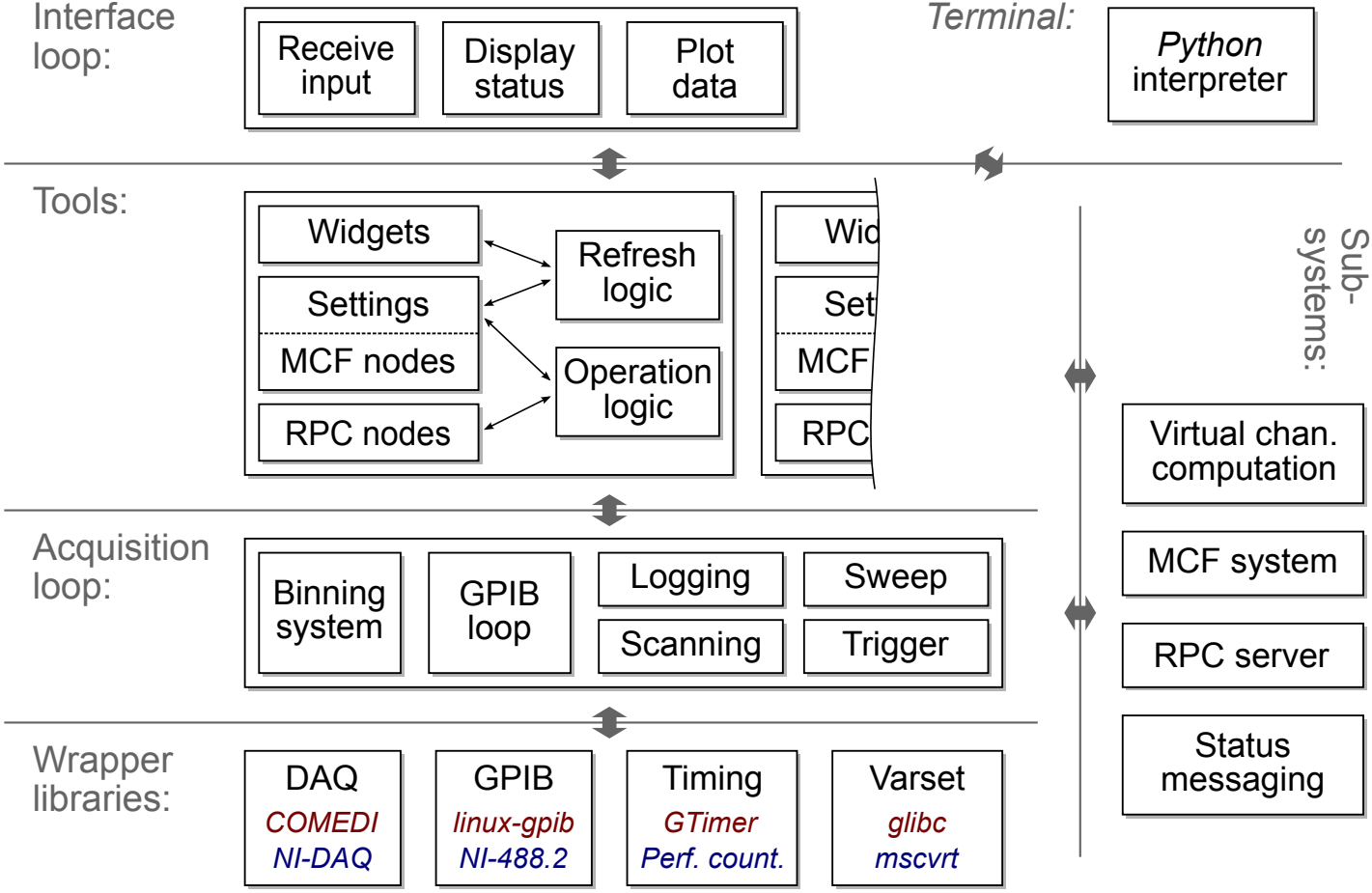
Platforms:

- GNU/Linux
- Windows XP/7 (via MinGW)

License: GPL3

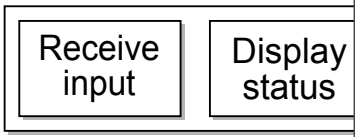
www.ugcs.caltech.edu/~mezurit2/

Architecture

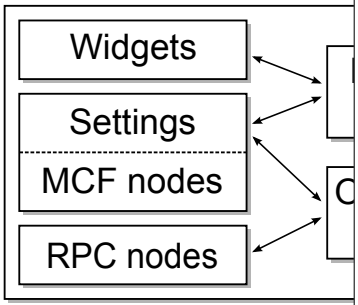


Architecture

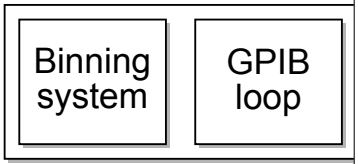
Interface loop:



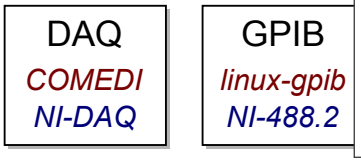
Tools:

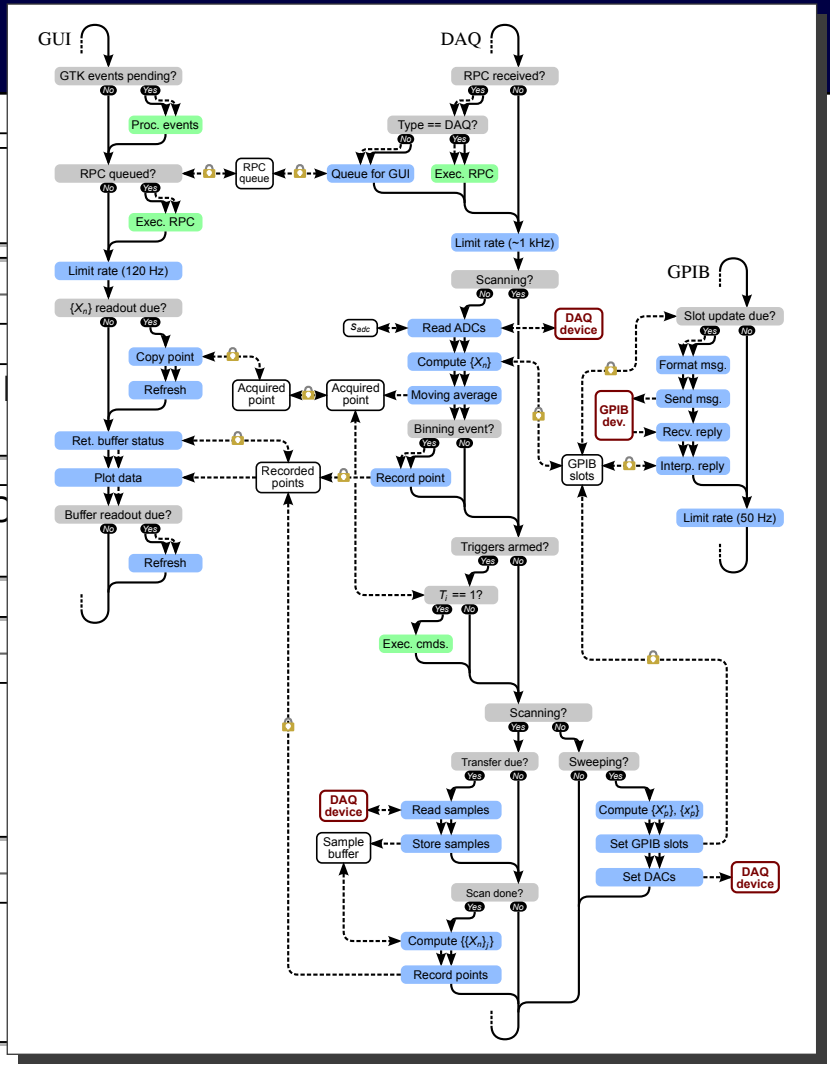


Acquisition loop:



Wrapper libraries:





Configuration system

Text-based config files —
each line maps to an "MCF node":

- String identifier
- Data type
- Pointer to the setting variable
- Callback

Config is scriptable through the "set_var" terminal function.

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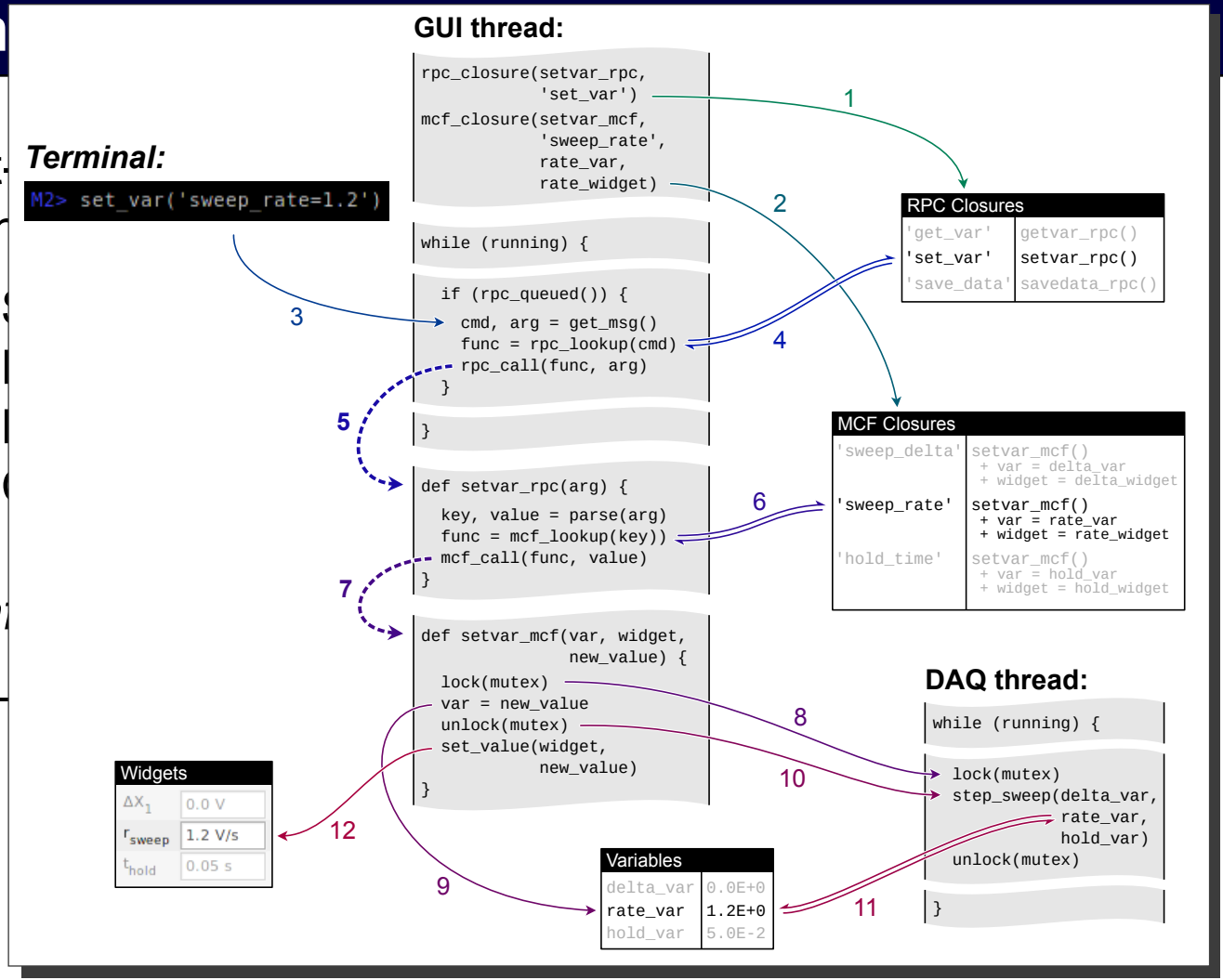

TODO

Ongoing work:

- GTK+ 3 support
- Python 3 support
- Realtime operation (PREEMPT_RT, if possible)
- Incomplete features here and there
- Bug fixes

Future work:

- More users
- >1 developer?

Alternative frameworks

Current alternatives:

- LabVIEW
- Matlab/Simulink
- Scilab/Scicos/RTAI-Lab

A simpler approach?

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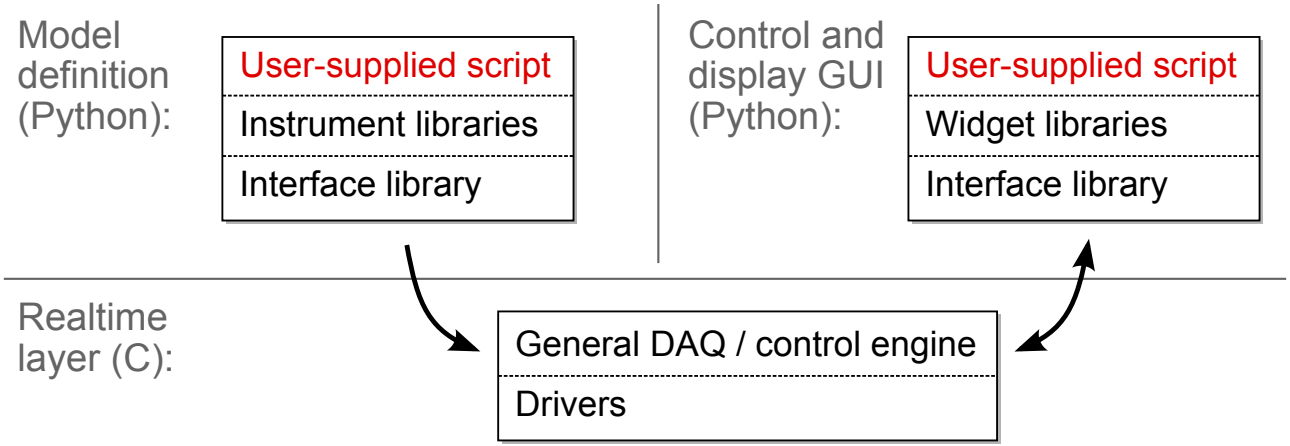

Credits

Helpful discussions:

Prof. Marc Bockrath (UC Riverside)
Prof. Henk Postma (CSU Northridge)

Testing:

Dr. Hang Zhang, Dr. Wenzhong Bao, Dr. Jairo Velasco Jr., Peng Wang, Tengfei Miao, Oleg Martynov

THANKS!

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