

Characterisation of RRAM arrays at a click of a button

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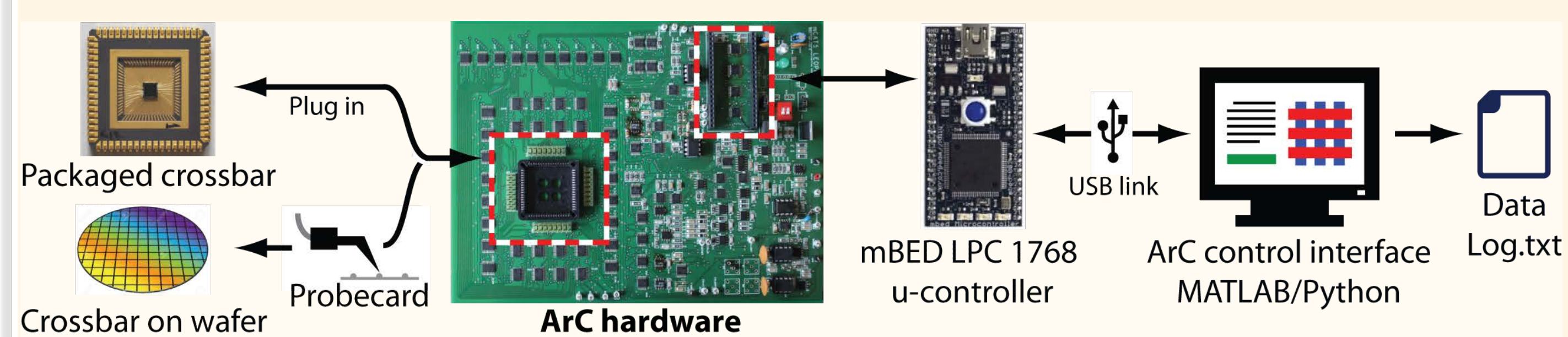
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Introduction:

As RRAM technology matures, the need for automated testing and flexible operability for advanced applications is becoming increasingly important. We present a versatile, user-friendly instrument [1], **ArC One**, designed to access arrays of up to 32x32 devices, equipped with in-built sneak-path mitigation mechanisms for crossbar array handling. The instrument can be used with minimal operator training and features a suite of useful software modules including **I-V sweeping**, pulse-based **electroforming**, **switchability testing** [2] and a state-of-art **memristor biasing parameter optimiser** [3].

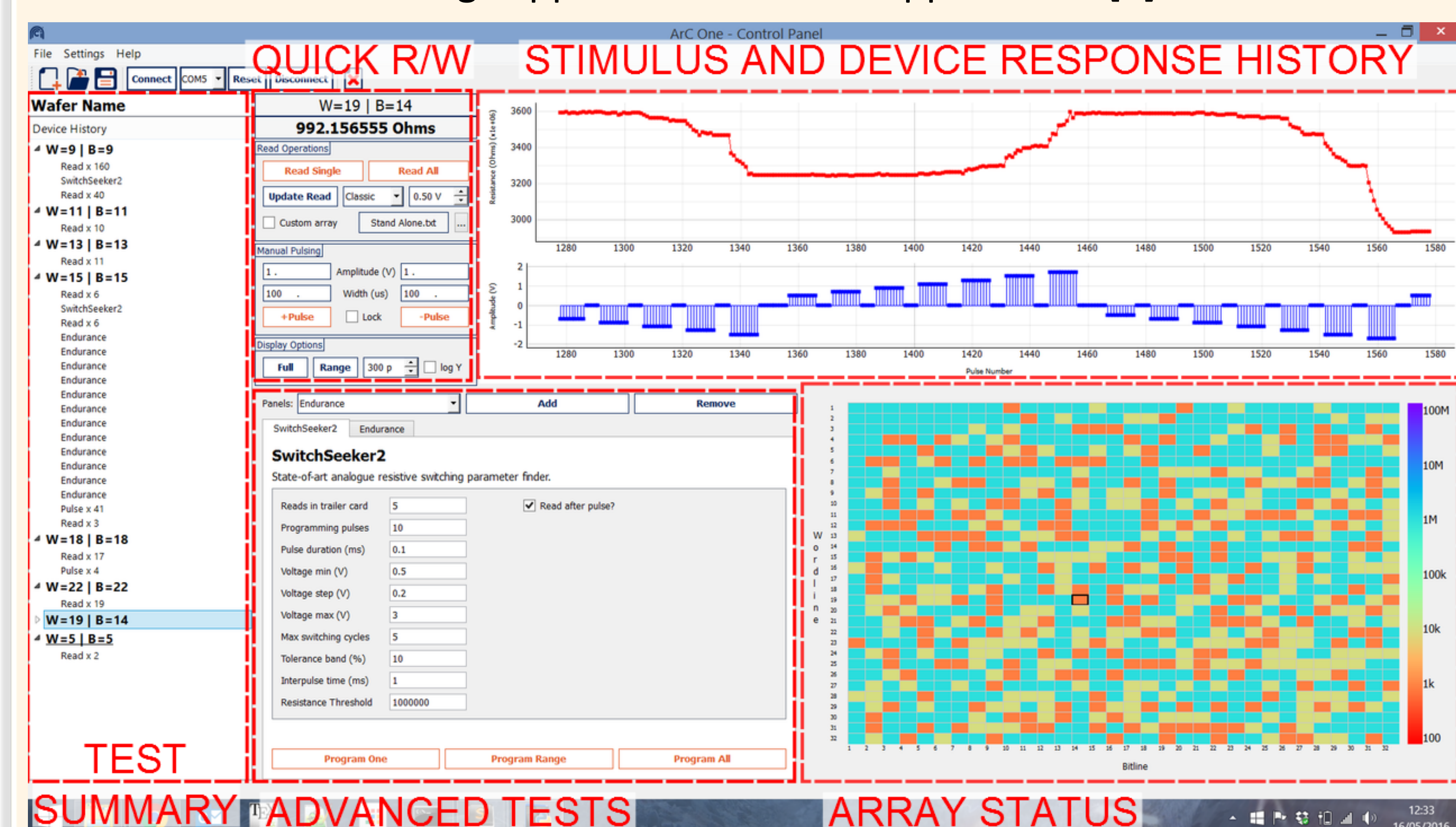
System architecture:

The **ArC One** platform can interface devices either in standard packaging or directly on-wafer through probe card. The system is controlled through a microcontroller linked to a PC via USB.



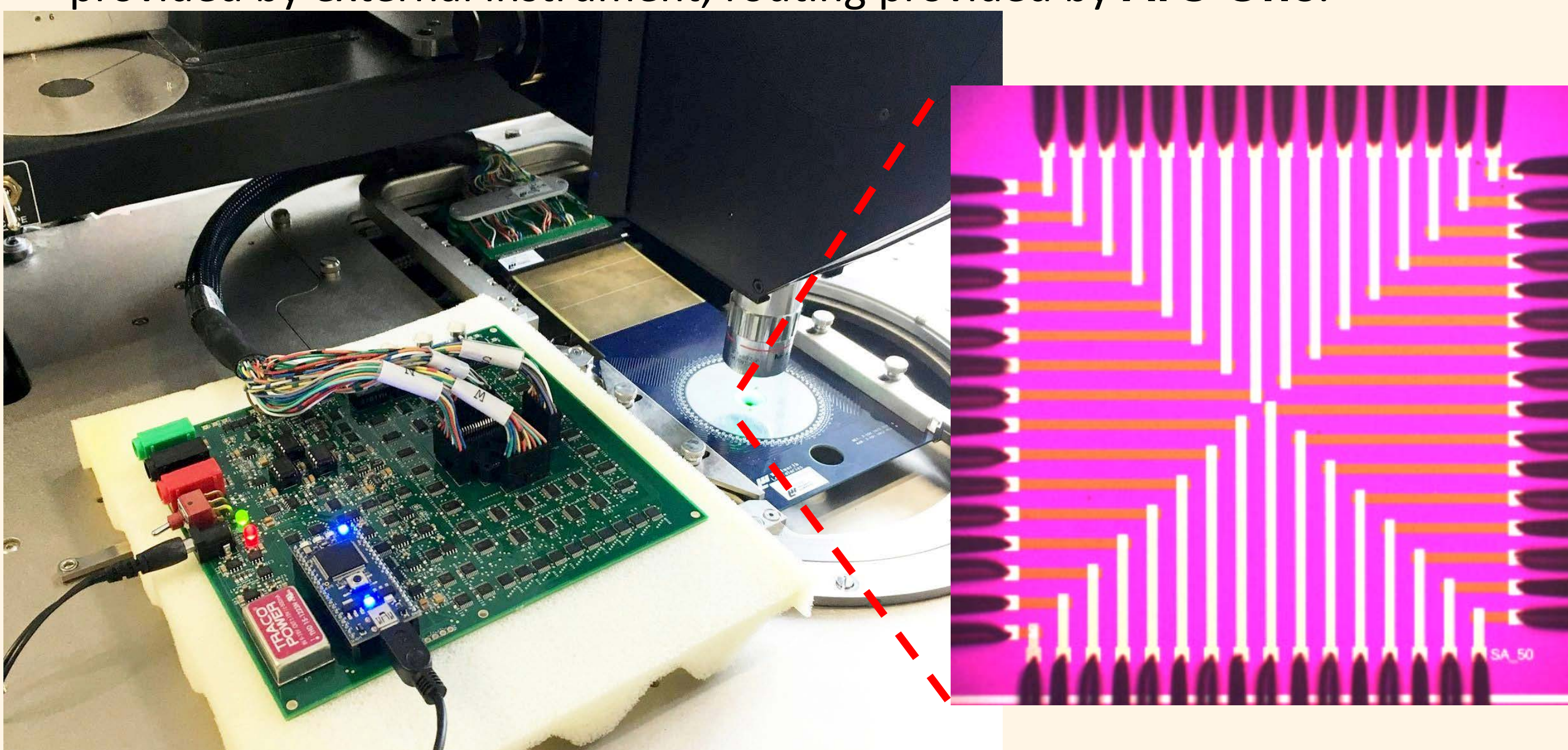
The instrument is operated using a python-based graphical interface allowing:

- Full RRAM array resistive state (RS) status visualisation and monitoring.
- One-click read-out and pulsing of target device or full array RS.
- Live-updating recording of stimulation & RS history for each test device.
- Data logging (.csv files) and device stimulus/RS response plot saving (.eps).
- Easy use of advanced testing modules (see below).
- Memristor interfacing support for advanced applications [4].



The instrument's host PCB board features numerous attractive attributes:

- Small form-factor – fits on a desktop.
- Plug-in jack or banana cable power supply input.
- Standard PLCC68 holder for use with packaged samples.
- Standard 2.56mm pitch 2x8 headers for probe card-accessed samples.
- Four BNC terminals for accessing devices in 'routing only' mode, i.e. biasing provided by external instrument, routing provided by **ArC One**.

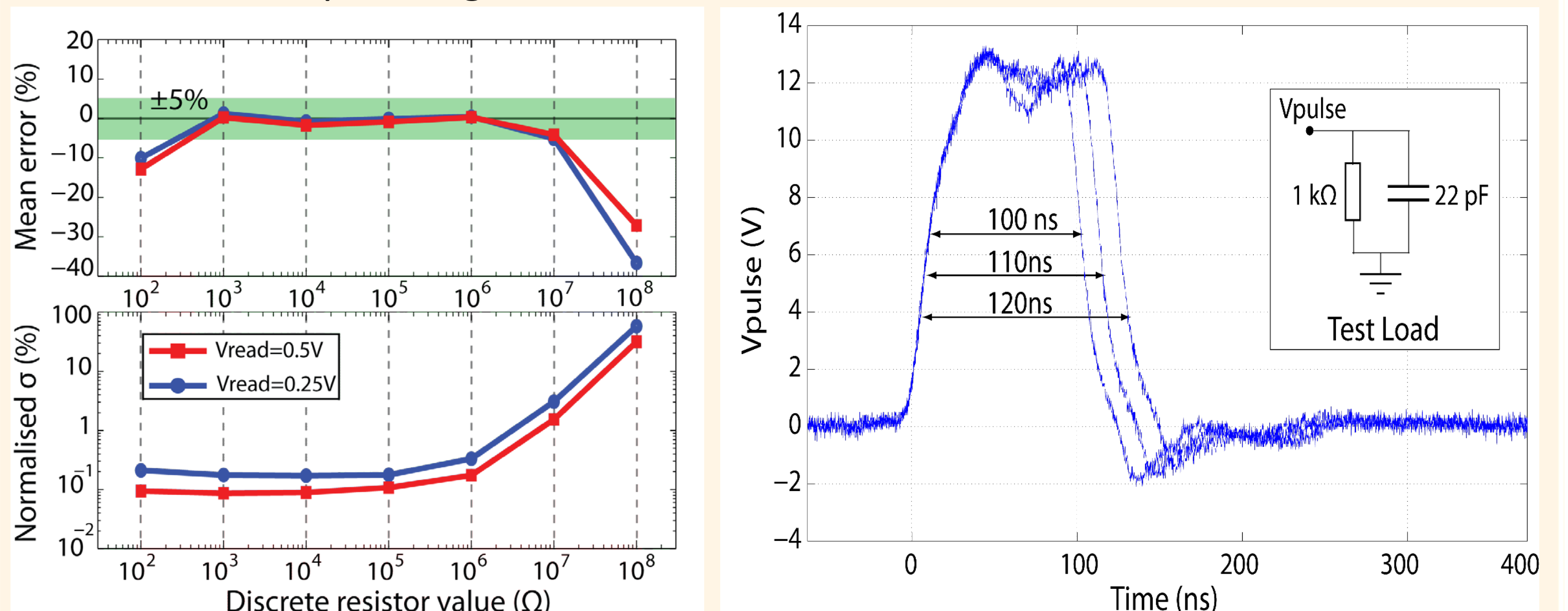


ArC One connected to a 32-device stand-alone array via probe-card.

Read/write performance:

Reading: The **ArC One** employs a trans-impedance amplifier-based read-out technique. When measuring stand-alone devices, it can assess RRAM resistive state at 0.2V read-out voltage between approx. 80Ω and 10MΩ within 10% tolerance. Read-out voltage is fully adjustable between ±12V.

Programming: Can be carried out in pulse mode with pulses spanning the entire ±12V output range of the instrument delivered down to 100ns duration.

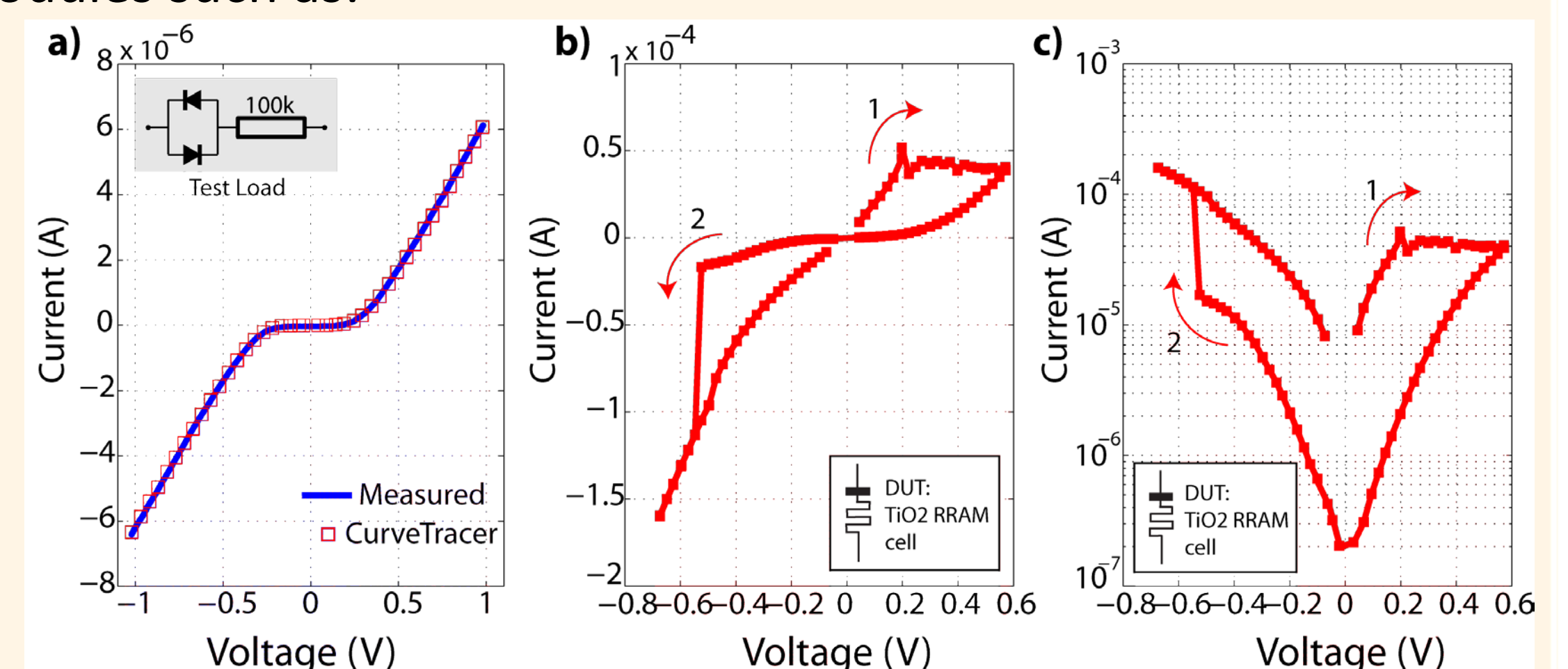


Software suite:

Each **ArC One** ships with a full RRAM characterisation software suite including key modules such as:

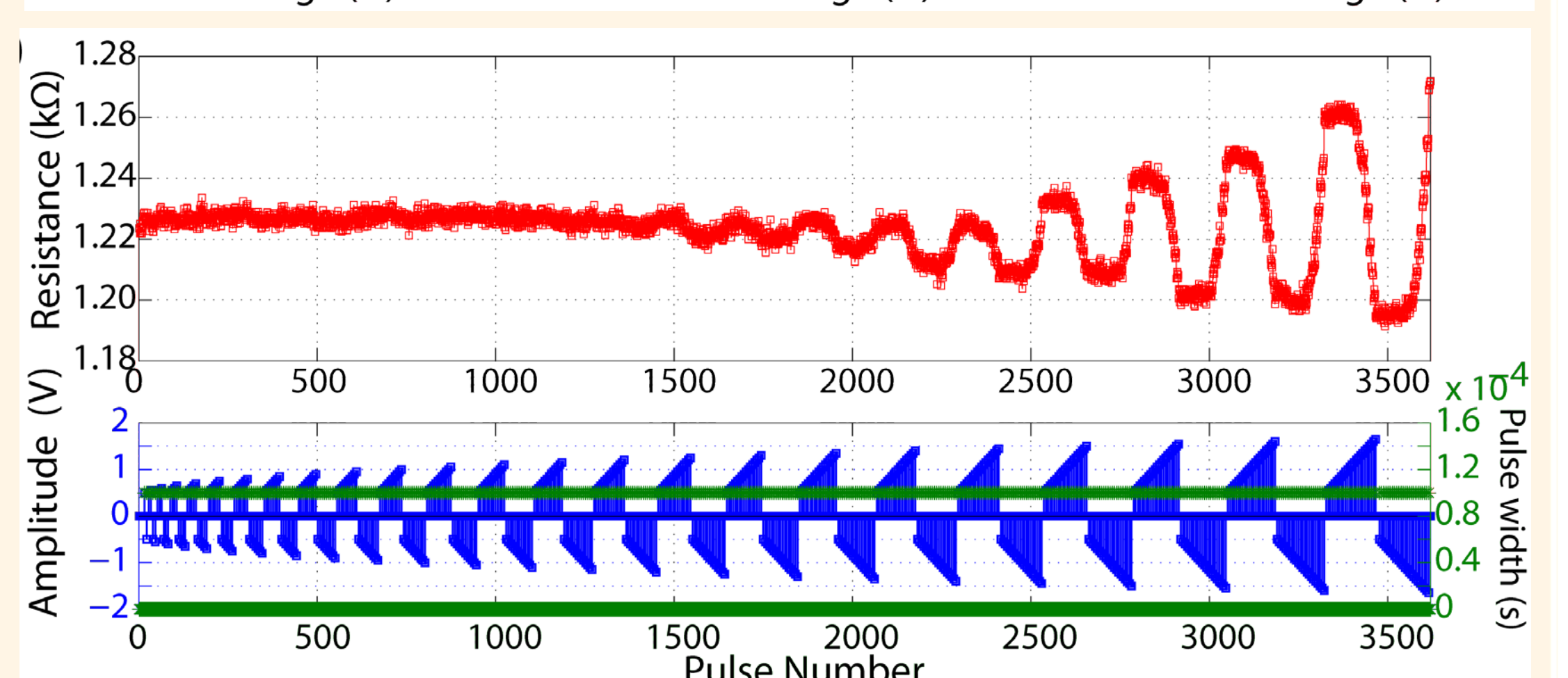
CurveTracer:

Used to extract I-V curves. Supports 'pulse' and 'staircase' stimulation modes.



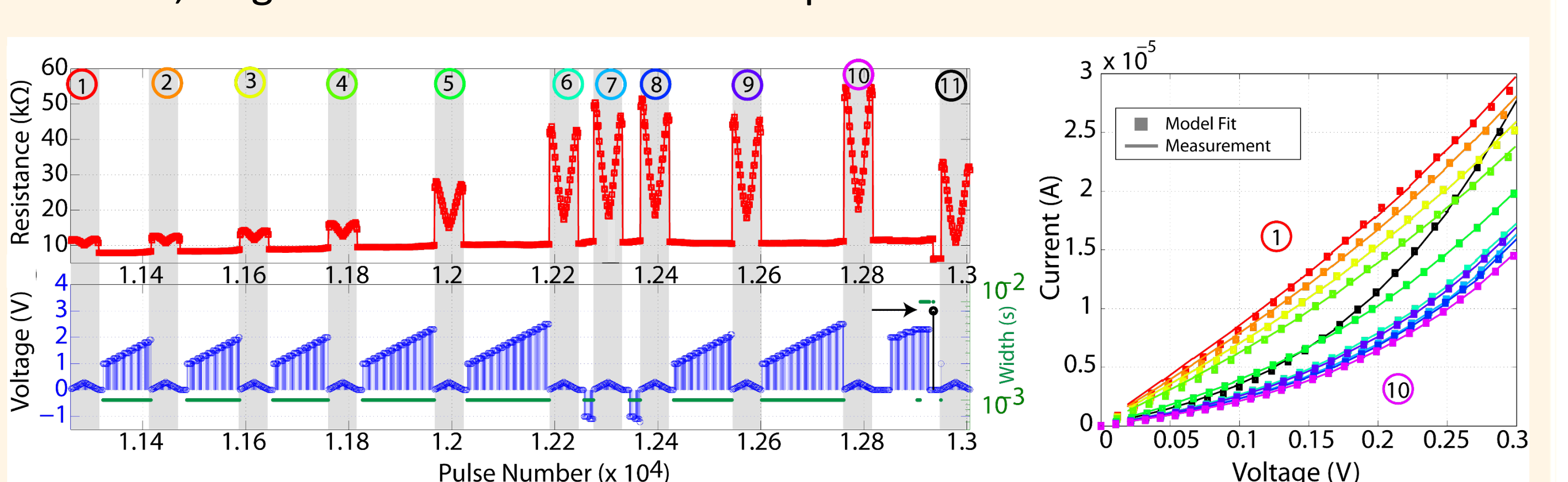
SwitchSeeker:

State-of-art RRAM biasing parameter finder. Suitable for analogue operation.



Application example – switching characterisation:

The capabilities of the **ArC One** were used to gradually set the RS of a test TiO_x-based cell to multiple, analogue levels whilst I-V curves taken between RS programming sequences revealed the underlying RS with more detail than the classical, single-value RS measurements quoted in the literature.



References:

- [1] Berdan, Radu, et al. "A-μController-Based System for Interfacing Selectorless RRAM Crossbar Arrays." *Electron Devices, IEEE Transactions on* 62.7 (2015): 2190-2196.
- [2] Gupta, Isha, et al. "A cell classifier for RRAM process development." *Circuits and Systems II: Express Briefs, IEEE Transactions on* 62.7 (2015): 676-680.
- [3] Serb, Alexander, et al. "A biasing parameter optimiser for RRAM technologies." *IEEE Transactions on Electron Devices* (2015).
- [4] Mostafa, Hesham, et al. "Implementation of a spike-based perceptron learning rule using TiO₂-x memristors." *Frontiers in neuroscience* 9 (2015).

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