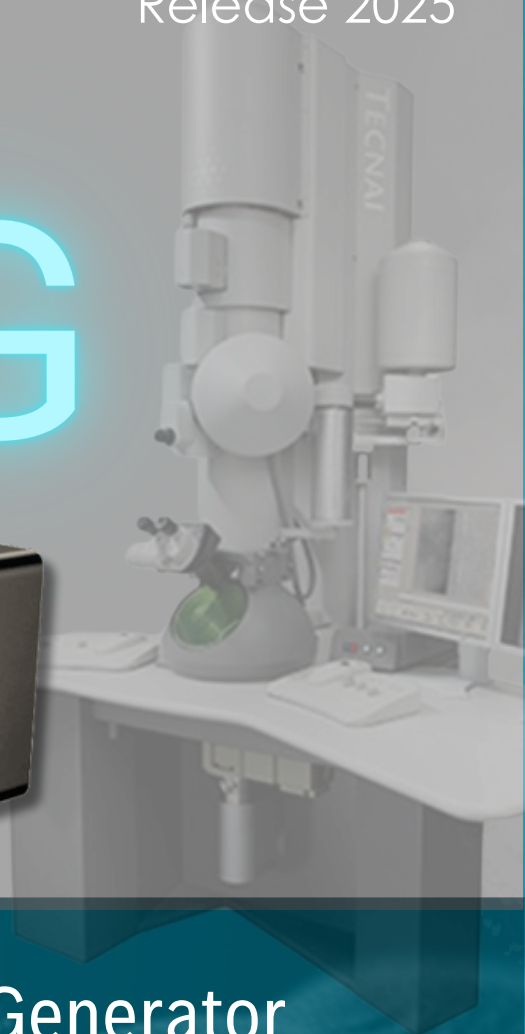


# CSSG



Compressed Sensing Scan Generator

## UPGRADE MODULE FOR SEM & STEM



**STEM**  
*plug & play*



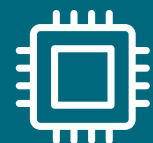
**Lower  
Dose**



**Reduce  
Distortion**



**10x  
Faster**



**4x24bit  
DAC Channels**





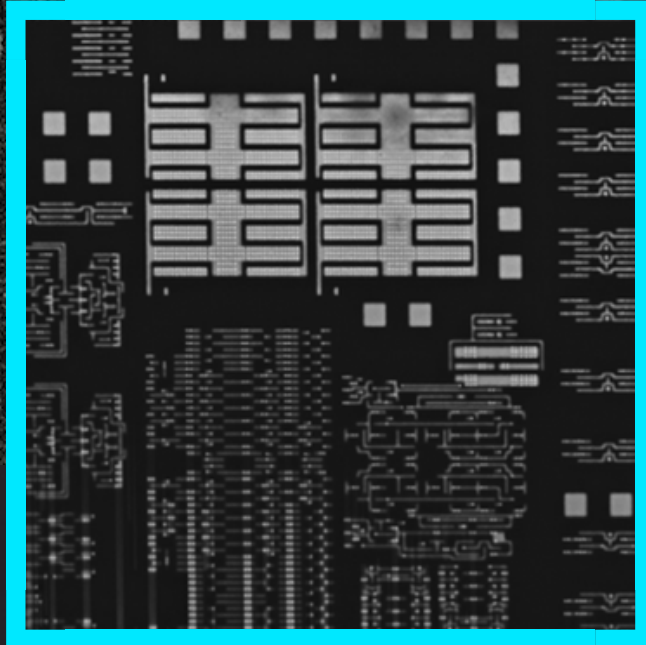


# PANOSCIENTIFIC

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▲ 90% sparse acquisition.

ARTI reconstruction: 150ms



We invent.  
We create.

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[www.panoscientific.com](http://www.panoscientific.com)



# Sparse Sampling Technology

## **Key Principles of Compressed Sensing**

*Sparsity – Most real-world images (except pure noise) contain redundant information, meaning they can be represented with far fewer data points than traditional sampling methods require.*



*Randomized Sampling – Instead of scanning or measuring in a fixed, structured way, CS scans data points non-uniformly.*



# Scientific Papers



## Celebrating Our Achievements

Published in Renowned Scientific Journals

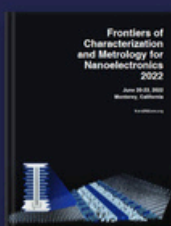
Our dedication to advancing knowledge and contributing to various fields has resulted in publications in scientific journals, our recent articles have been featured in the esteemed journal EDFA (Electronic Device Failure Analysis).

## Our Commitment to Excellence

The publication of our work in high-impact journals is a testament to the significance and quality of our research. Being recognized by journals like EDFA highlights the relevance of our studies and underscores our commitment to excellence in scientific inquiry.

FCMN: June 2022

Turn-Key Compressed  
Sensing for SEM/STEM FCMN  
Abstract



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EDFA: Nov2019

A Dedicated Beamline for  
Integrated Circuits



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EDFA: Aug 2019

Large Area Automated  
Deprocessing of ICs:  
Present and Future



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EDFA: 2017

Steps Toward Automated  
Deprocessing of Integrated  
Circuits



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By visiting our Publications Page, you can explore our extensive collection of scientific articles, including those published in EDFA and other respected journals.







## > Distortion reduced

CSSG patented technology permits faster scanning speeds (i.e. shorter dwell) with little to no scanning distortions inherent in most legacy scan generators. Pre-distortion matrices also can be measured and “learned” from each system to allow automated distortion correction.



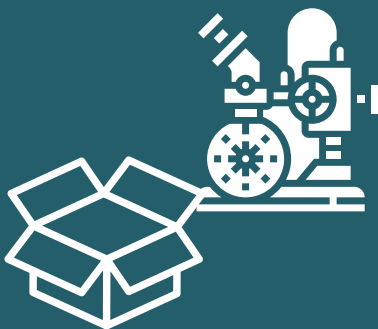
## > Lower Dose

At 90% sparse imaging, **10x less dose is delivered to the sample.** Lower dose leads to less beam damage and less thermal load delivered to the sample (i.e. less thermal strain that results in thermal damage and/or drift)



## > 10x Faster

Utilizing 90% sparse CSSG imaging delivers **10x imaging speeds** with near real time reconstruction versus traditional imaging schemes  
The CSSG can apply any fractional degree of sparsity from 0-99.9%

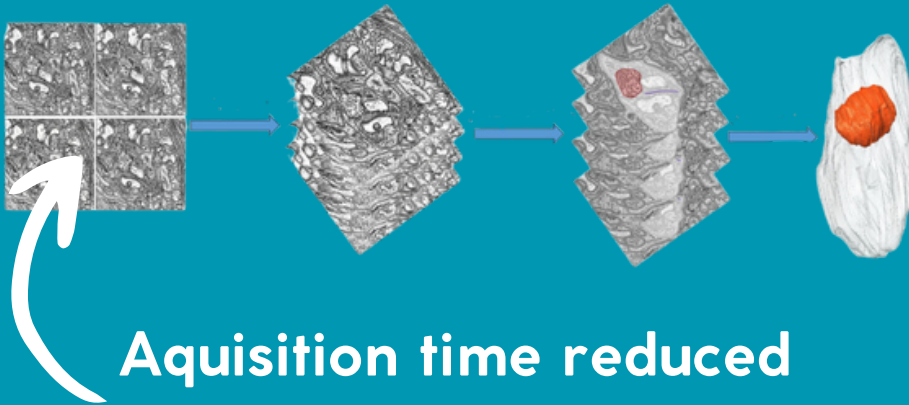


## > STEM plug & play

CSSG is **compatible with virtually any STEM** utilizing external scan generator interfaces similar to EDS. Breathing new life and capabilities into existing systems.

A minimum of three BNC style cables are required:

- 1) X [line] Scan
- 2) Y [frame] Scan
- 3) Detector (1-8 detectors may be interfaced)



For  
tomography

Aquisition time reduced

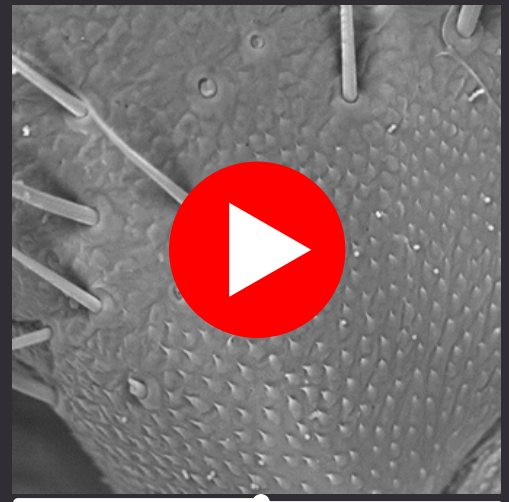
e.g. 600 images reduces from 10hrs to 1hr

## Live View!

Near real-time imaging at 7 FPS

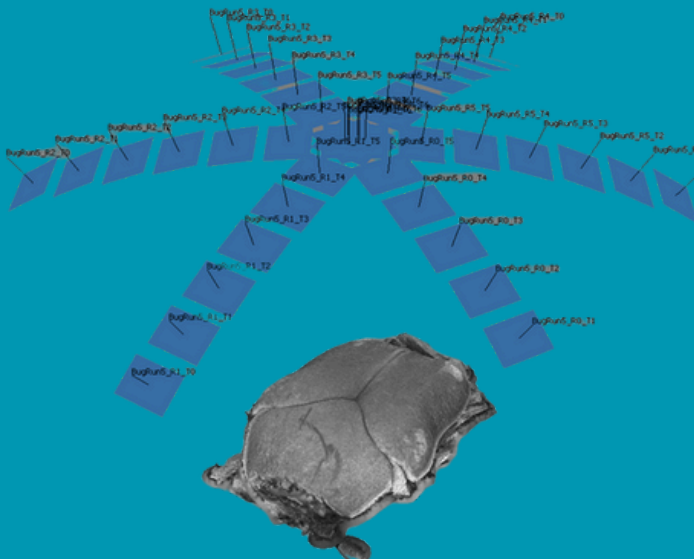
**Semiconductor** market - accelerates failure analysis and defect inspection, providing instant feedback for precision manufacturing.

**Lifescience** market - accelerates observation of biological samples



HD Quality - 7 images/sec

## Automated Python Script to Acquire SEM Image Data

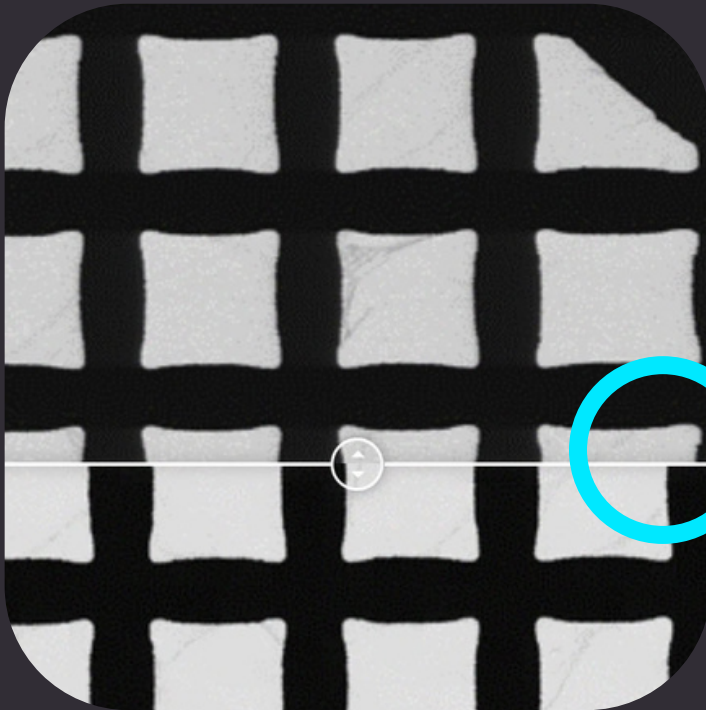


An overnight process  
requiring hundreds of  
images!

e.g. 900 images reduces  
from 13hrs to ~ 1h30mn



# Distortion



## When speed generates distortion

Most legacy OEM STEM scan generators are limited to a simple fly-back X-Y scanning pattern which inherently involves large and fast beam deflections that leads to inherent imaging distortions at fast scan speeds.



The hysteresis in the instrument scan coils for fast scan speeds is significant relative to the pixel dwell. On some instruments, the hysteresis (settling time) for fly-back, may be up to several orders of magnitude larger than the pixel dwell time thus making useful faster and lower dose scanning an impossibility without severe distortions.

The **CSSG avoids these types of distortions at fast scan speeds** with our patented technology. The use of our smooth continuous scan path methods avoids the possibility of these scan distortions due to large beam deflections. The CSSG has been designed to produce distortion free, low dose and high throughput imaging that avoids the systemic hysteresis and natural limitations of scan coils.

# Lower Dose Life science



In life sciences, preserving delicate samples while achieving high-resolution imaging is crucial. The Compressed Sensing Scan Generator (CSSG) offers a solution by significantly reducing the electron dose, minimizing beam damage and thermal strain.

## The Importance of Lower Dose in Life Science Imaging

Biological samples are particularly susceptible to damage from high electron doses used in traditional STEM imaging. Excessive exposure can lead to beam damage, causing physical alterations, chemical changes, and thermal strain that may distort the sample. This not only affects the accuracy of the imaging results but can also destroy valuable samples.

## How CSSG Reduces the Dose

CSSG leverages compressed sensing techniques to achieve sparse imaging, which strategically selects the most informative data points for scanning. At 90% sparse imaging, the CSSG system delivers 10 times less dose to the sample compared to traditional imaging methods. This reduction in dose is achieved without compromising image resolution or fidelity, ensuring high-quality results with minimal sample damage.

Dr. E. C. a cellular biologist, needed to image fragile neuronal cells without causing damage.

By integrating CSSG, Dr. Chen's team utilized 90% sparse imaging, drastically reducing the dose delivered to their samples.

**Reduced Beam Damage:** The lower dose preserved the fine structures of the neuronal cells.

**Less Thermal Load:** Minimal thermal strain prevented damage and drift, ensuring stable imaging.

**High-Quality Data:** Despite the reduced dose, images remained clear and detailed.

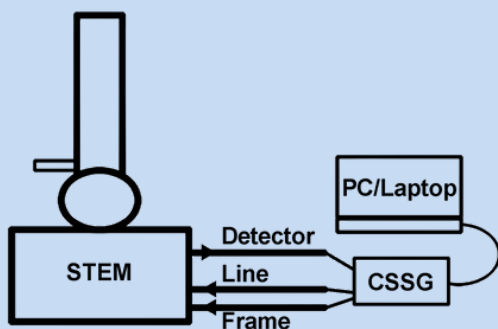


Dr. E. C.'s Neuronal Cell Research



## Integration

Utilizing the CSSG platform is straightforward: connect it to the STEM like any external scan generator. We've developed vendor specific hardware interfaces to allow scan and system control. Upon connecting the CSSG module to your SEM, it integrates seamlessly. Our interface software provides a user-friendly platform for configuring sparse acquisitions to meet custom applications. You can easily establish sparse scanning conditions and STEM imaging parameters.



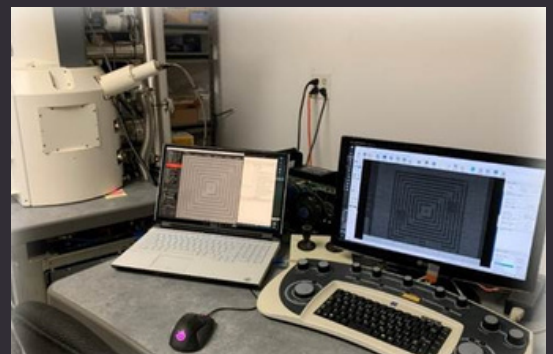
### A trusted accessory

The CSSG module is considered an accessory, and its integration preserves the manufacturer's warranty, where applicable. It complies with all relevant standards and does not require modifications that could impact the original warranty.

### Connection

Three BNC style cables are required:

- 1) X [line] Scan
- 2) Y [frame] Scan
- 3) Detector (1-8 detectors may be interfaced)



The streamlined interface simplifies the CSSG setup for both montage imaging and automated FIB-SEM delayering to enable you to fully exploit its capabilities for advanced analyses and high-quality imaging with your SEM.



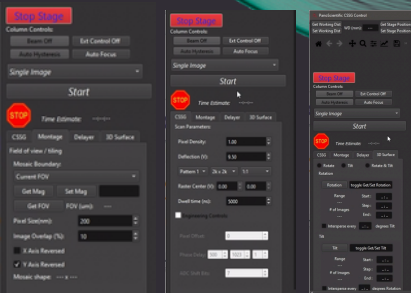
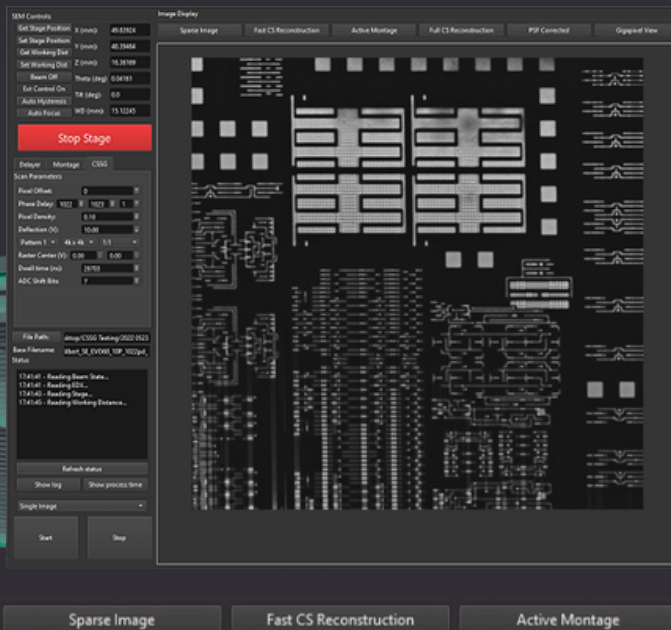
# Software

## CSSG System and Microscope Integration

The patent-pending CSSG system interfaces with the microscope's external scan inputs in a manner similar to an EDS (Energy Dispersive Spectroscopy) system or any other external scan generator.

The software interface allows users to:

- **Select sparsity levels** based on specific requirements.
- Execute **scan patterns, collect data, and reconstruct images**.



Our cutting-edge scanning control software is designed to seamlessly interface with SEM/TEM systems and their dedicated columns, providing users with precise control and enhanced imaging capabilities. This software empowers researchers and scientists to conduct intricate analyses and explore the new capabilities.

Automated montage data collection for acquiring **large-scale datasets** efficiently.

Integration with common microscope control functions for ease of use.



## Technical features

- 4x 24-bit DAC channels
- 8x 12-bit ADC channels
- 12x GPIO ports 24-bit
- 50MHz hardware PCIe data bus
- Python-based GUI Up to 16k X 16k images



- 50MHz FPGA-based vector scan gen
- Add to any SEM, STEM, AFM, LSM
- Thermal stabilized enclosure
- 4x on board temp sensors
- Dwell Time: 20 ns – 20.97 ms
- All scan and data signals synchronized
- Ultra-fast CS Reconstruction ~ 100ms



# Company Profile

Developped by Panoscientific, the CSSG is a **Compress Sensing Scan Generator**.

It is an upgrade to increase the speed and reduce the doee for any Scanning Electron Microscopes

The accuracy has been proven, the microscope can be 10X Faster & 10X Lower Dose.

About Panoscientific:

We enjoy science in all its forms and we love to create using the latest technology.

We specialize in imaging science and electron-ion spectroscopy at the highest level. From routine electron microscopy to atomic scale scanning transmission electron microscopy, been there and done that. We have progressed from applications development through to complex platform design and integration of state-of-art analytical systems at synchrotron facilities.





# PANOSCIENTIFIC



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