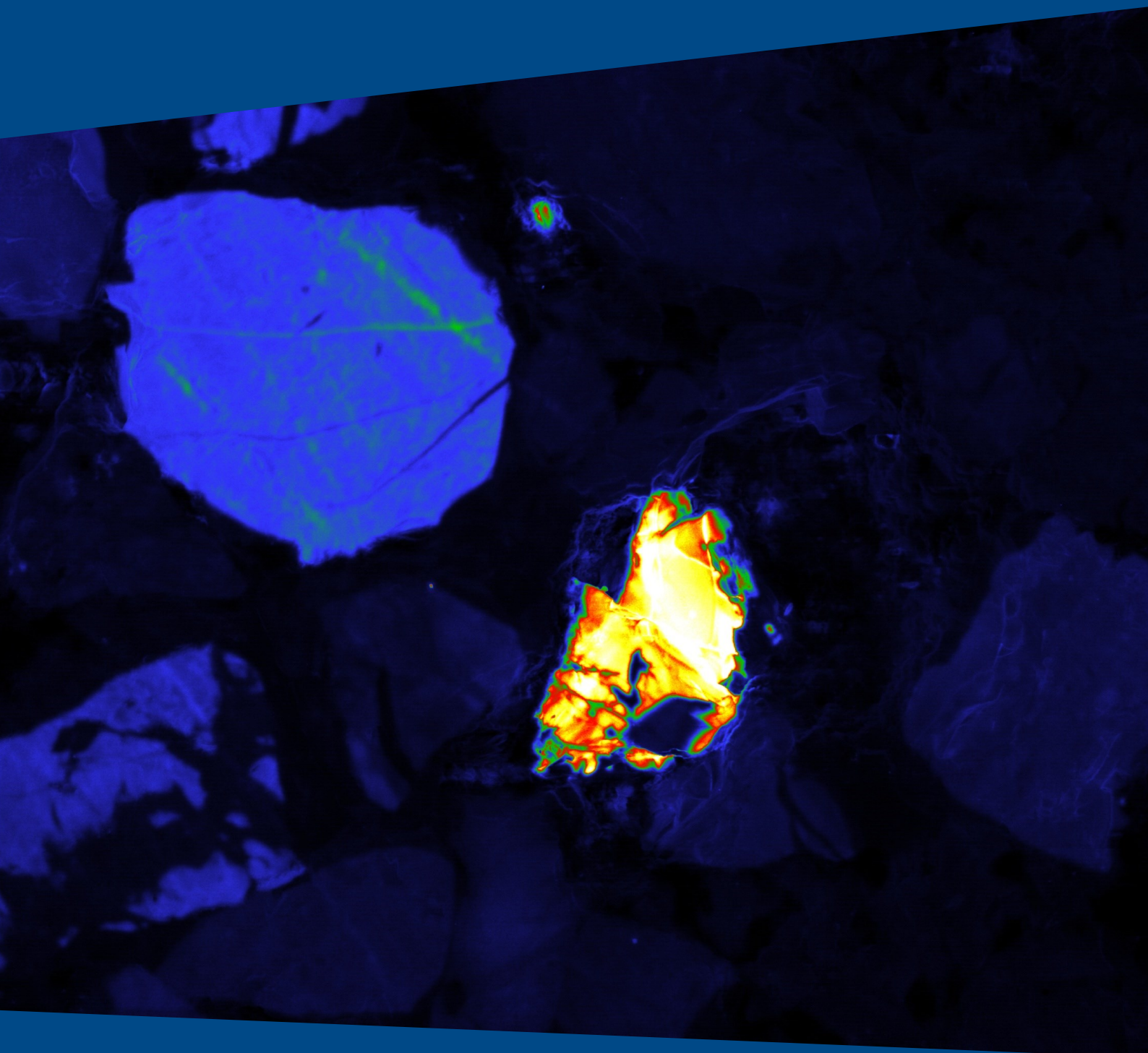
# SPARC

## compact

*Pushing the boundaries of cathodoluminescence detection*



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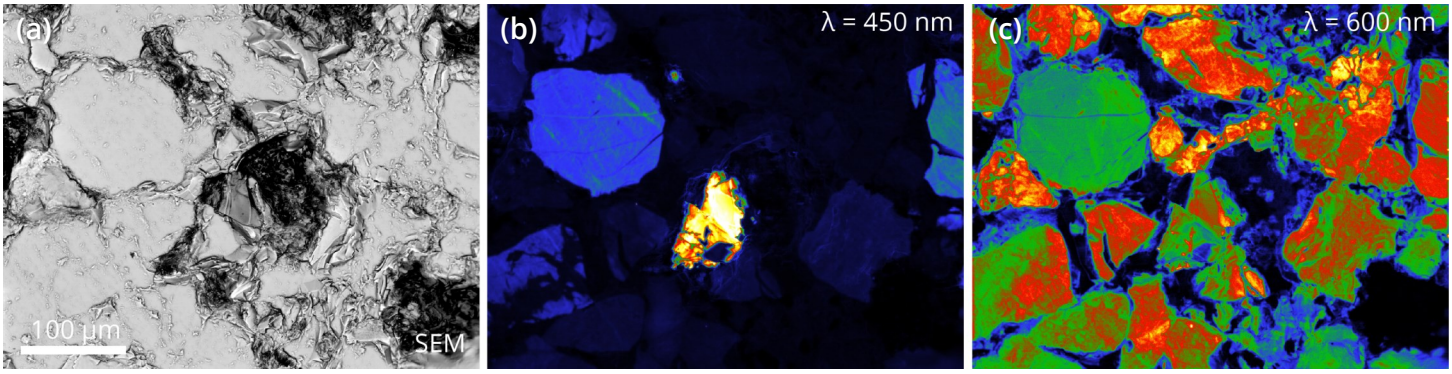


**Figure 1** (a) SEM image corresponding to a region inspected with the PMT. For the PMT measurements we used a (b) 450 and (c) 600 nm band pass filter with 40 nm bandwidth. These measurements were performed at 15 kV acceleration voltage. Sample courtesy of E. Goergen, FEI Company

The SPARC Compact pushes the boundaries of compact cathodoluminescence (CL) imaging performance. It features the proven ease-of-use, high-collection efficiency and fast time-to-image of any DELMIC system. This is also the only CL system that has an automated mirror alignment functionality, ensuring optimal sensitivity at all times.

Over the course of the last few decades it has been demonstrated that CL imaging is a pertinent technique for micro-characterization in many applications in the materials science, such as provenance studies and geochronology, or in the study of doped semiconductors. The color and intensity of the emitted light provide insights into such processes as crystal growth zonation, replacement, deformation, provenance, presence of trace elements in rocks, and defect structures in semiconductors.

In combination with CL, the scanning electron microscope can be used to fingerprint materials down to the nanoscale. CL can also be combined with other SEM-based techniques such as EDS and BSE for a more complete material analysis. Furthermore, it can act as a prescreening tool for more time-consuming and expensive techniques such as mass spectrometry for quantitative isotope analysis.

The SPARC Compact features a range of opportunities that combines ultimate performance with reliability, and enhances the analytical capabilities at the disposal of today's microscopists.

### *SPARC Compact at a glance*

+ Panchromatic and monochromatic imaging with high spatial resolution
+ Spectral response of 200-900 nm
+ Ultra smooth, parabolic mirror, enhancing reflectivity, decreasing measurement time and reducing artifacts
+ 87% collection efficiency from a Lambertian source
+ Automated control and alignment of mirror stage
+ Advanced open-source software for data acquisition and in-depth analysis

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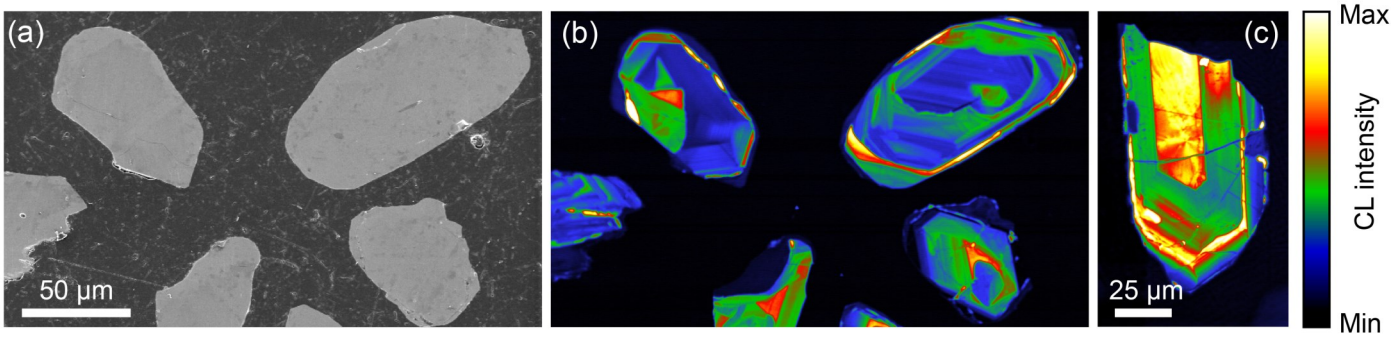


Figure 2 (a) SEM image of zircon grains. (b) Panchromatic PMT intensity image of the same area. (c) Close-up panchromatic PMT image of a single zircon grain. These measurements were taken at 10 kV acceleration voltage and 1 nA current with a 100 µs dwell time. CL images took approx. 1.5 minutes to collect. Samples courtesy of Prof. Jens Jahren (University of Oslo).

**Modular design** – The system is highly modular, meaning that one can extend and add features to the system as research evolves. The optical box on the outside of the SEM contains exchangeable optical plates; optical components may easily be added.

**User-friendly** - The modular approach and our open-source software ODEMIS ensures a user-friendly solution that can serve a broad user base as a workhorse, as well as delivering a system that is a truly unique and an ultimately versatile research instrument.

**Upgradeable** – The SPARC Compact is a system that works out of the box and can easily be upgraded to high-performance angle-resolved CL imaging and hyperspectral CL imaging.

**Seamless integration with your SEM** – CL imaging is beneficial for understanding the structural composition and luminescent properties of optical materials. With the ability to combine CL imaging with other SEM detection modalities, this becomes a truly multifaceted solution.

### *Benefits in a nutshell*

- ✓ High contrast in imaging and fast image collection
- ✓ Reduced artifacts
- ✓ Modular design & easily upgradeable to full angle-resolved and hyperspectral capability
- ✓ Intuitive alignment procedure with automated, motorized mirror stage
- ✓ Wide spectral range
- ✓ Scan large fields of view with field stitching feature
- ✓ High stability
- ✓ Drift correction
- ✓ Motorized retractable mirror stage, compatible with other SEM detection modalities such as BSE and EDS
- ✓ Possibility of fiber coupled (hyper)spectral imaging for small SEMs
- ✓ Free, open-source software package for data acquisition, analysis, and image exporting

### *Possible application areas*

- ✓ Geosciences
- ✓ Oil and gas reservoir rock studies
- ✓ Pharmaceuticals
- ✓ Semiconductors
- ✓ Ceramic and mineral industries
- ✓ Construction materials
- ✓ Phosphor materials

### *On-site installation & demonstration*

The retrofit will be done by an authorized DELMIC Microscopy service engineer and includes:

- ✓ Mounting of system on SEM instrument
- ✓ Alignment of mirror stage
- ✓ Demonstration of operation
- ✓ Two days of on-the-job training

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**Maximum photon yield** – DELMIC's unique and precise automated alignment procedure allows unrivaled user-friendliness and maximizes the photon yield.

**Video-rate scanning** - The efficient light collection and detection system allows the acquisition of CL images with high pixel densities over short time frames with minimal noise.

**Reproducibility** - The precision mirror mount and automated alignment procedure ensures reproducibility between measurements, making it possible to do quantitative measurements from one experiment to the next.

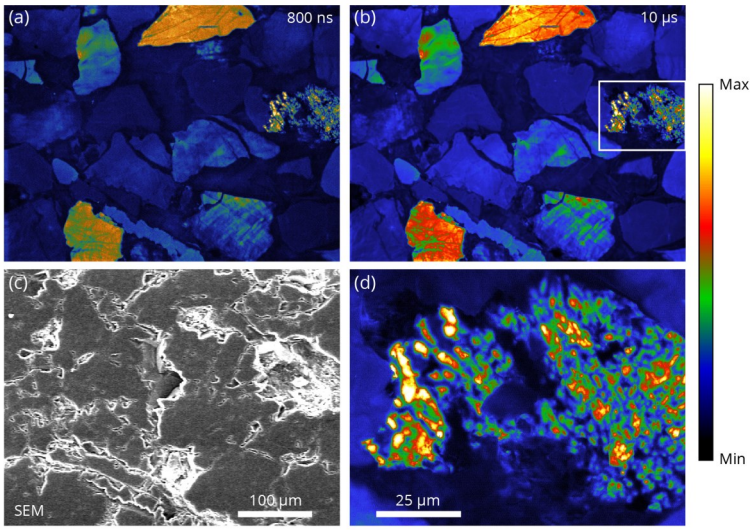


Figure 3 17 megapixel panchromatic PMT image, collected with a dwell time of (a) 800 ns and (b) 10 µs of a 380 × 310 µm area on the sandstone. The color scaling is adjusted to the dynamic range of the image for proper visibility of all the features. (c) Corresponding SEM image for the same area. (d) Close-up of the space in the white square in the in (b),illustrating the high pixel density and spatial resolution (180 nm) in these images. Sample courtesy of E. Goergen, FEI Company

## *Hardware specifications*

**Mirror mount**

+ Precision translation stage with mirror mount
+ Stepper motors with computer-controlled drivers
  ⇒ x, y accuracy < 1 µm
+ Automated mirror alignment
+ Sample dimension 26 x 46 mm (upgrade possible upon request)
+ Controlled waviness diamond-turned, aluminium half-parabolic precision mirror
  ⇒ Collection angle 1.46π sr. (working distance 0.5 mm), surface roughness <20 nm, NA ≧ 0.95

**Optical analysis system**

+ Lightweight optical boards in light-tight enclosure with SEM mounting assembly
+ High-efficiency optics
+ Exchangeable optical boards for added functionality (such as specific UV or IR sensitivity and fiber outcoupling)

## *ODEMIS integrated software*

The DELMIC software suite, ODEMIS, is an open source software suite under the open source license GPL 2. The software is written in Python. ODEMIS outputs files in either HDF5, PNG, OME-TIFF, or raw txt files.

**Data acquisition**

+ Acquisition of intensity maps based on point-by-point scans
+ Photomultiplier tube for fast intensity mapping
  ⇒ Spectral differentiation based on filters in a filter wheel
+ Drift correction

**Data analysis**

+ Visualize intensity data as false color RGB image
+ Overlay of intensity data and SEM images
+ Subtraction/manipulation of image file (such as system response) to view corrected spectra
+ Export of data to software such as MATLAB, Python, Origin, or Excel or imaging processing software for further analysis