

*Smart Features
Smarter Results*

Analytical Tools for Electron Microscopy



2020

AMETEK[®]
MATERIALS ANALYSIS DIVISION

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EDAX[®]
Smart Insights

Material Characterization in Electron Microscopy and Microanalysis Solutions since 1962

EDAX[®]

www.edax.com

Energy Dispersive Analysis of X-Rays



EDAX EDS & EBSD Detector Systems for SEM/FIB



- Element EDS, 30mm², 129eV
- APEX UI (64bit)
- EDS only



- Octane Elect, 30/70mm², 127eV
- APEX UI (64bit)
- EDS & EBSD



- Octane Elite, 30/70mm², 125eV
- TEAM UI (32bit)
- EDS & EBSD & WDS



- Velocity camera,
- Plus > 3000fps
- Super > 4500fps
- APEX UI
- CMOS camera system



- Clarity™ EBSD Analysis System
- Operation down to < 10 pA beam current
- APEX UI
- Direct detection camera



- DigiView V camera, 200fps
- APEX UI
- CCD camera system

EDAX EDS Detector Technology



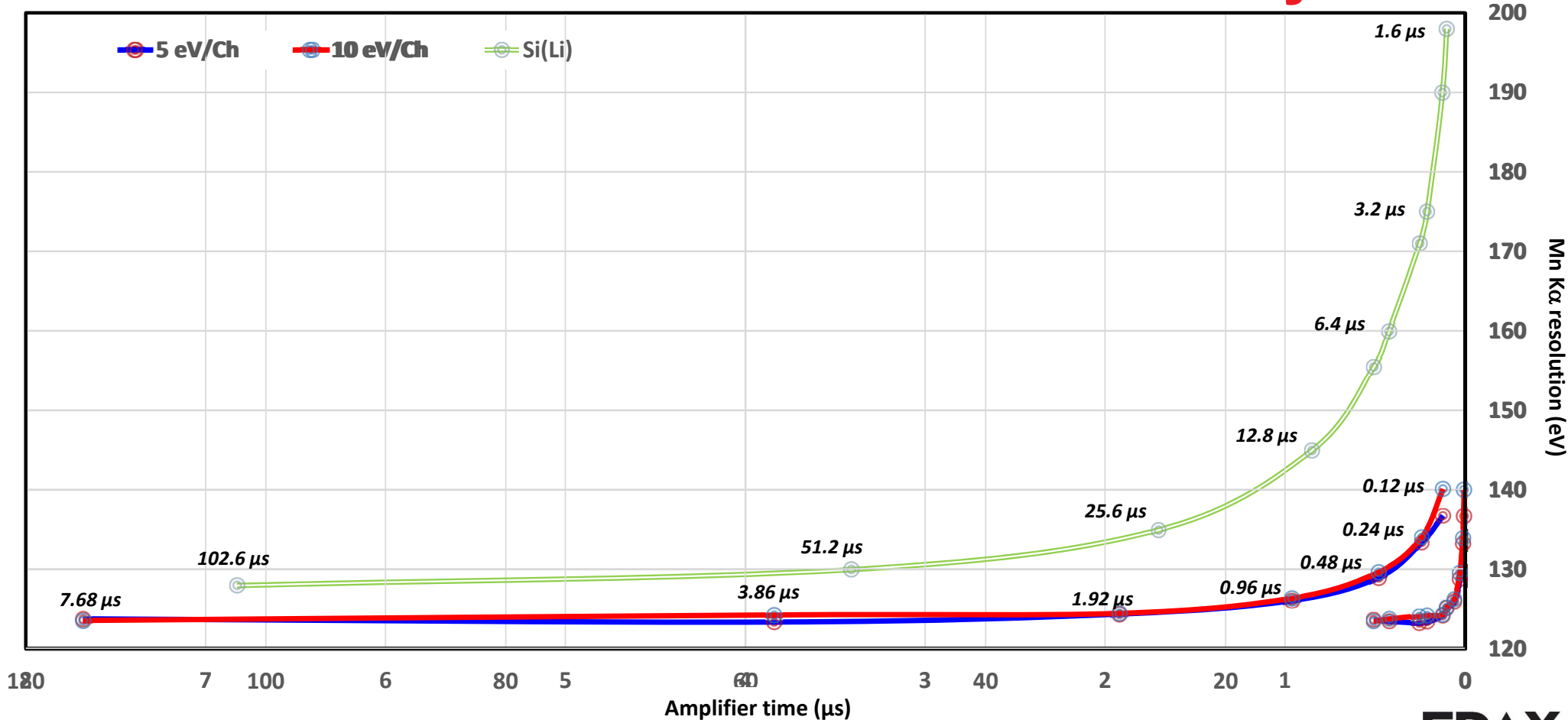
Octane Elect and Elite EDS series



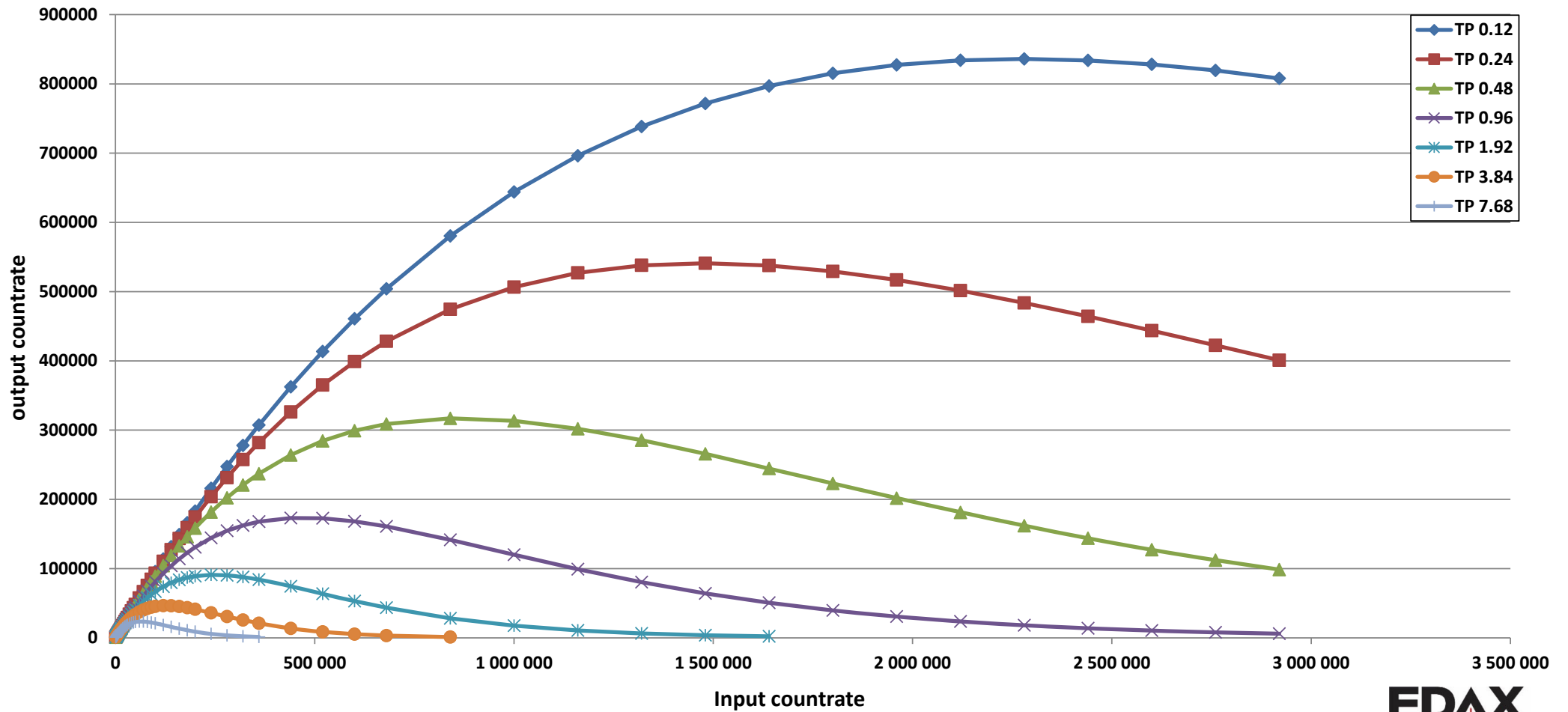
- Improved light element sensitivity with Si_3N_4 window
- High throughput SDD detectors
- High resolution stability at all count rates
- **Octane Elect:**
Ideal for simultaneous EDS – EBSD collection
- **Octane Elite:**
motorized insertion
complete EDS-EBSD-WDS solution with integrated system and 3D compatibility

| Standard Specifications | Octane Elect/Elite |
|-------------------------|--|
| Sensor size | 30, 70 mm ² |
| Energy Resolution | 127 eV (Mn K) 125 eV (Elite) 47 eV (C K) |
| Detection range | Al L - Am |
| Max Output counts | 850 kpcs/acq.ch |
| Max Input counts | 2000 kcps/acq.ch |
| Window | Si_3N_4 (<80nm) |
| Dispersion | 5, 10 eV/Ch |
| Dwell time | 120 ns to 7.68 us |
| SDD Module | CUBE |
| Software | TEAM or APEX UI |

Elite detector – resolution stability



Elite detector – throughput



Si₃N₄ : Reliability- and Transmission Advantage

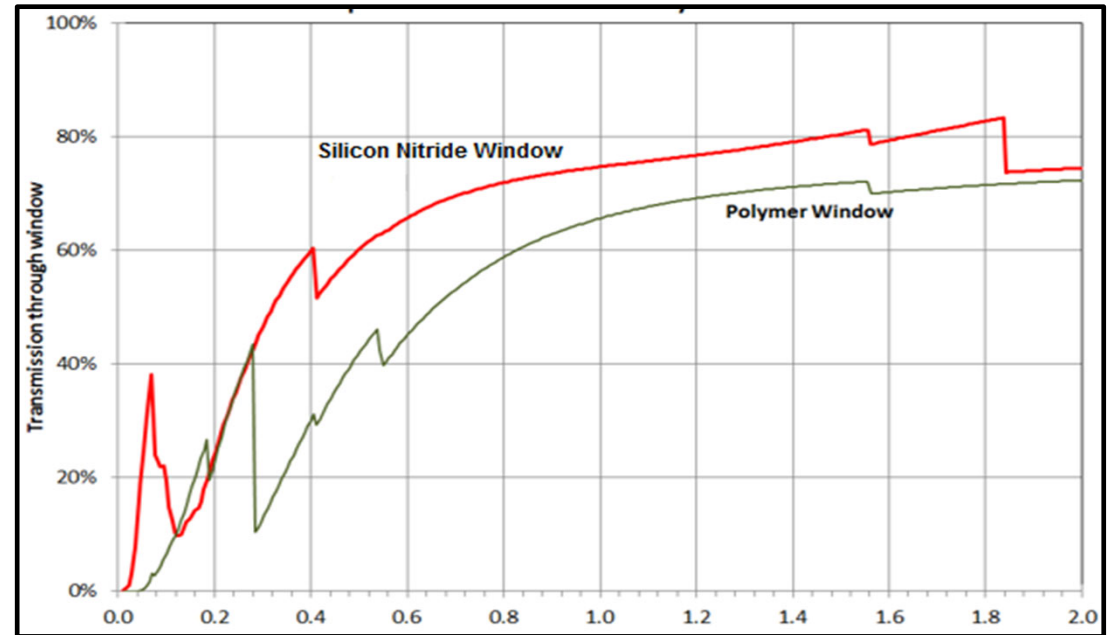
- Toughest Window (resist up to 650°C)
- Plasma Cleaning Compatible
- Impervious To Water
- Window can tolerate 8.3 bar differential front pressure
- Significant higher transmissivity for light element X-Rays



Damage of classical Polymer Window



Si₃N₄ Window,
Impervious to water



Transmission of X-Rays through detector entry windows

Polyurethan versus Si_3N_4

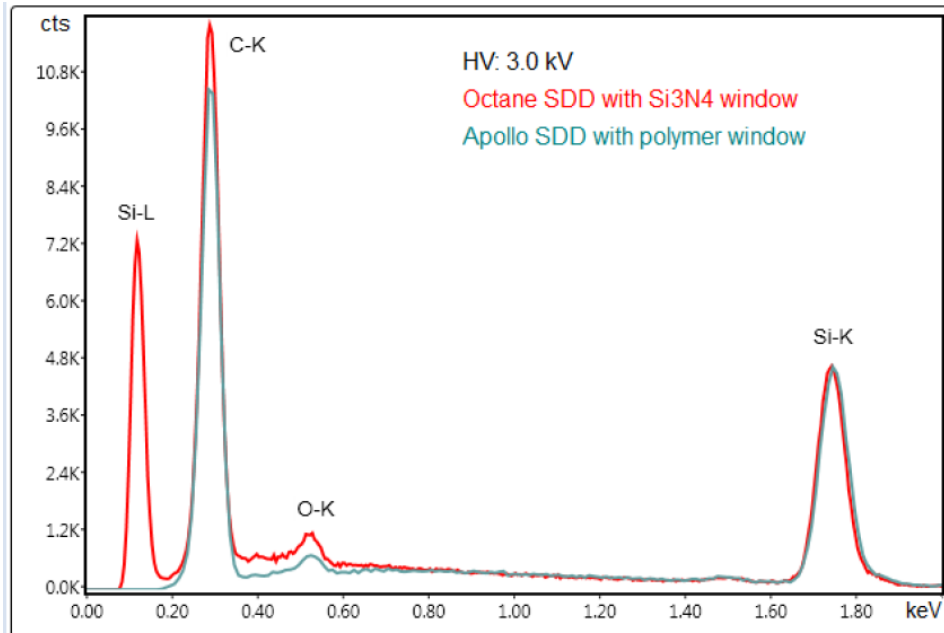


Fig. 2: Sample SiC

The spectrum of the Octane SDD shows a strong Si-L₁-line. Thus, SiC could be analyzed with high surface sensitivity by reducing the accelerating voltage below 1 kV. In contrast the Apollo SDD needs an accelerating voltage of at least 2.5 kV, because only the Si-K-line is detected. The information depths of Si are determined by Monte Carlo simulations to 25 nm and 50 nm respectively.

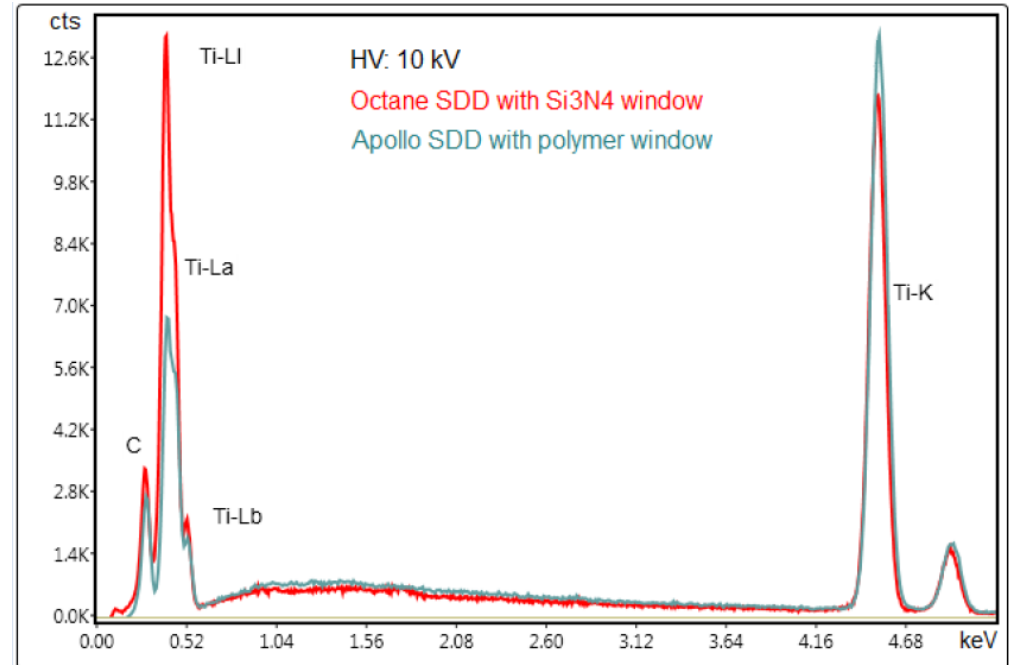
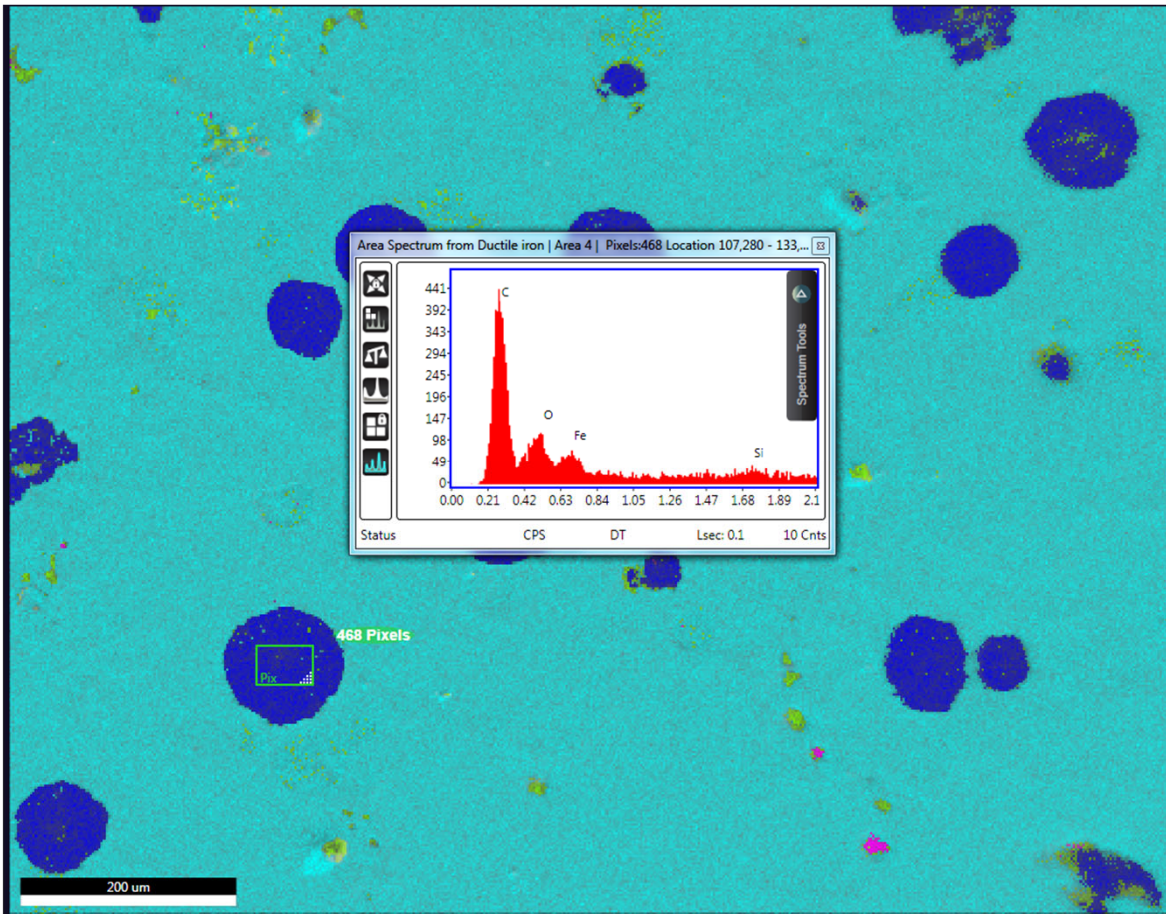


Fig. 5: Sample Ti

For the Ti-L₁-line the sensitivity of the Octane SDD is two times higher compared to the Apollo SDD. The same applies for the analysis of nitrogen, whose K-line (392 eV) has nearly the same energy as Ti-L₁ (395 eV). The high sensitivity is enabled by both, the detector module and the Si_3N_4 -window and leads to better detection limits.

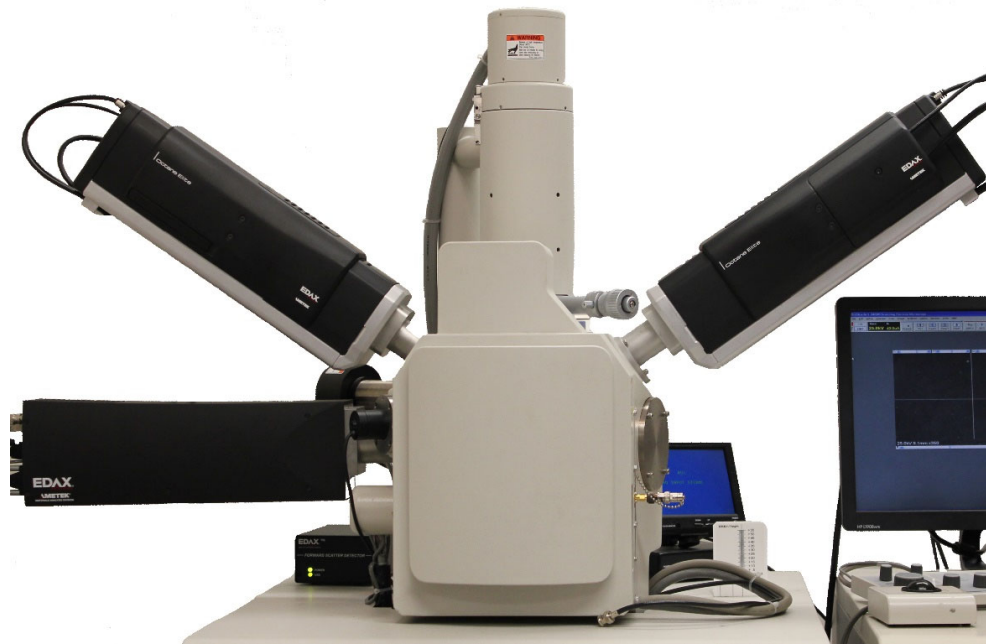
High speed EDS



- High statistics maps with quality data
- Low energy performance and peak resolution has traditionally suffered at high speeds.
- *Mapping example shows detection of carbon at 750,000 CPS with 50% dead time.*

Ductile iron from an underground water pipe with the phase map of the graphite nodules

Dual Octane Elite



Dual detector solution

- Octane Elite Plus and Octane Elite Super
- Velocity EBSD camera system
- APEX™ 2.1 software

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Product Bulletin - EDS

Octane Elite Silicon Drift Detector Series



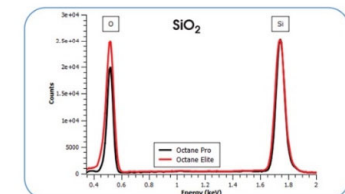
- Light element sensitivity increased up to 35%
- Highly reliable and moisture tolerant
- Outstanding low-energy performance
- New Si_3N_4 window
- Safe for plasma cleaning
- New CUBE technology for high speed data processing
- Highest throughput SDD available
- Unparalleled resolution stability

edax.com

The game changing advancements in the Octane Elite Silicon Drift Detector (SDD) Series take detector technology to the next level. This line of detectors incorporates a new silicon nitride (Si_3N_4) window, which offers remarkable improvements in low energy sensitivity for light element detection and low kV microanalysis. The Octane Elite Series also uses the widely praised CUBE technology, which yields high speed X-ray data processing within a smaller and fully vacuum encapsulated detector device.

Best light element performance

The transmission improvements of the silicon nitride window can be as much as 35% compared to a polymer window, leading to greatly improved light element performance and significantly more critical data for the materials analyst.



The results above show spectra acquired from a silicon dioxide sample at 10 kV. The two spectra have been scaled to the same peak amplitude at the Si K peak to facilitate comparison and a clear improvement for the Si_3N_4 window is seen in the increased oxygen peak intensity.

Low kV performance

The mechanical properties of Si_3N_4 allow the windows to be very thinly fabricated, offering a great benefit in terms of sensitivity, enabling optimal low voltage analysis.

Reliability

The material properties and durability of Si_3N_4 ensure the most robust and reliable detectors available for all EDS applications.

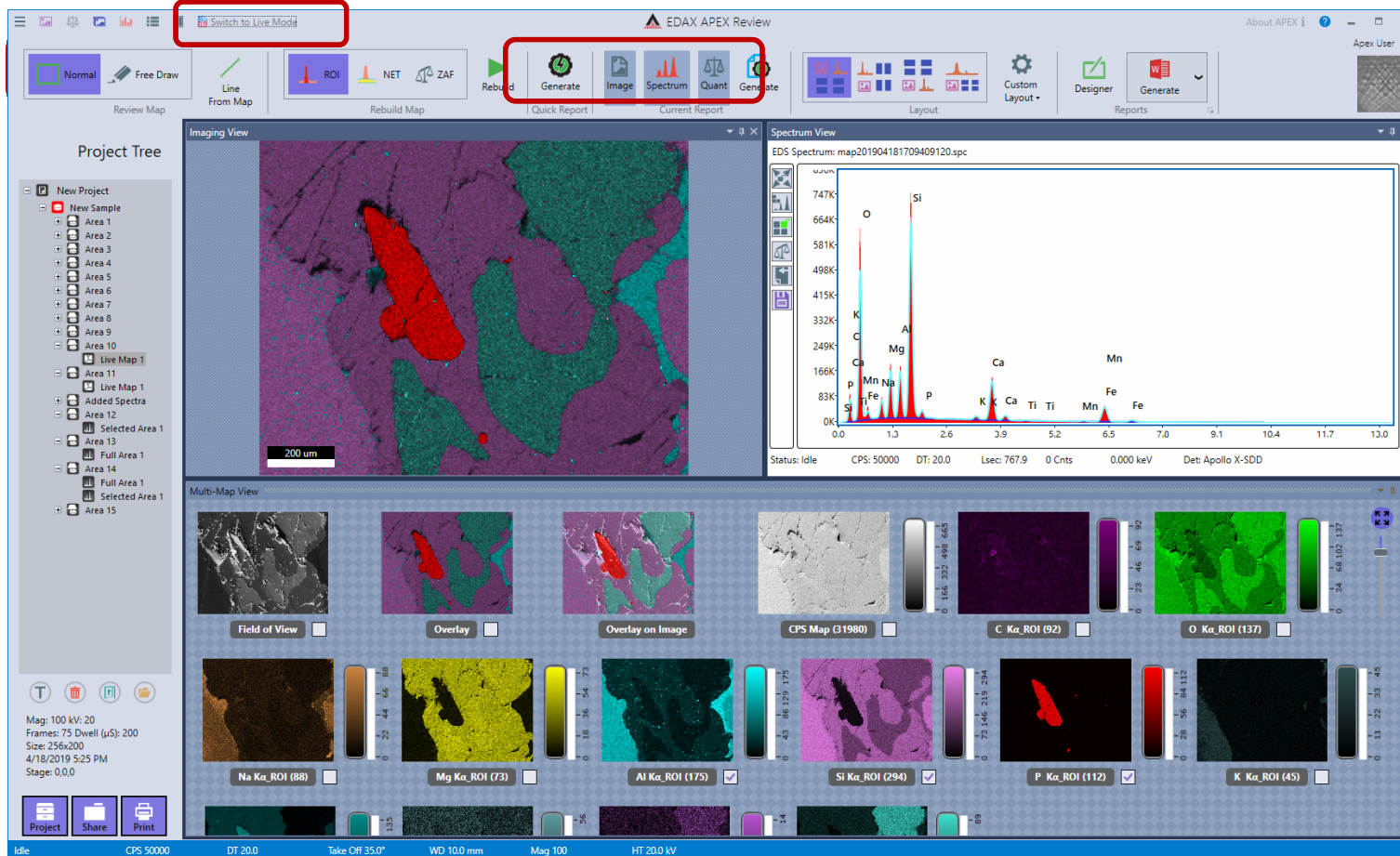
Elite T EDS System for TEM

| | |
|-------------------------------|---|
| Sensor size | Fast SDD, Super 70 mm ² Fast SDD, Ultra 160 mm ² |
| Resolution @ Mn K α | Super < 127 eV, 125 eV Premium Ultra < 130 eV |
| Resolution @ C K | Down to 50 eV |
| Beam shift | < 100 nm |
| Window Material | Windowless |
| Slide | Automated, motorized |
| Shutter | Optional |
| Detection Range | Be-Am |

- **Next Generation SDD from Amptek**
- **Optimized Geometry**
- **Largest Solid angle for single DU**
- **Windowless Design**
- **Excellent Resolution**

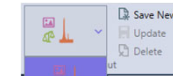
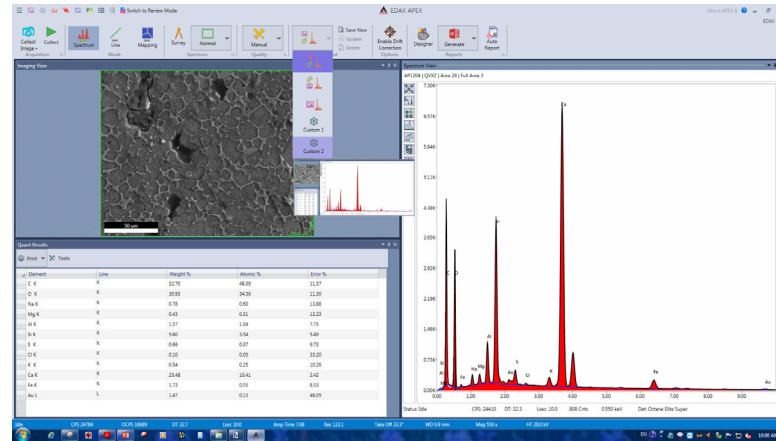
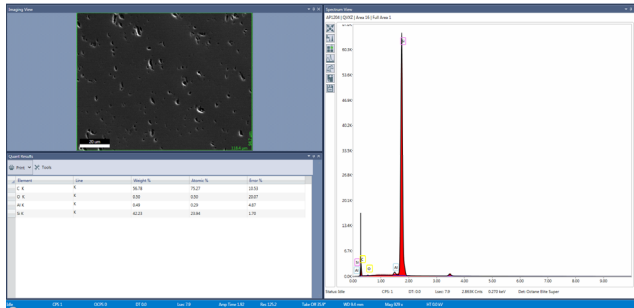
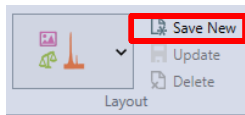


APEX™ Analysis software

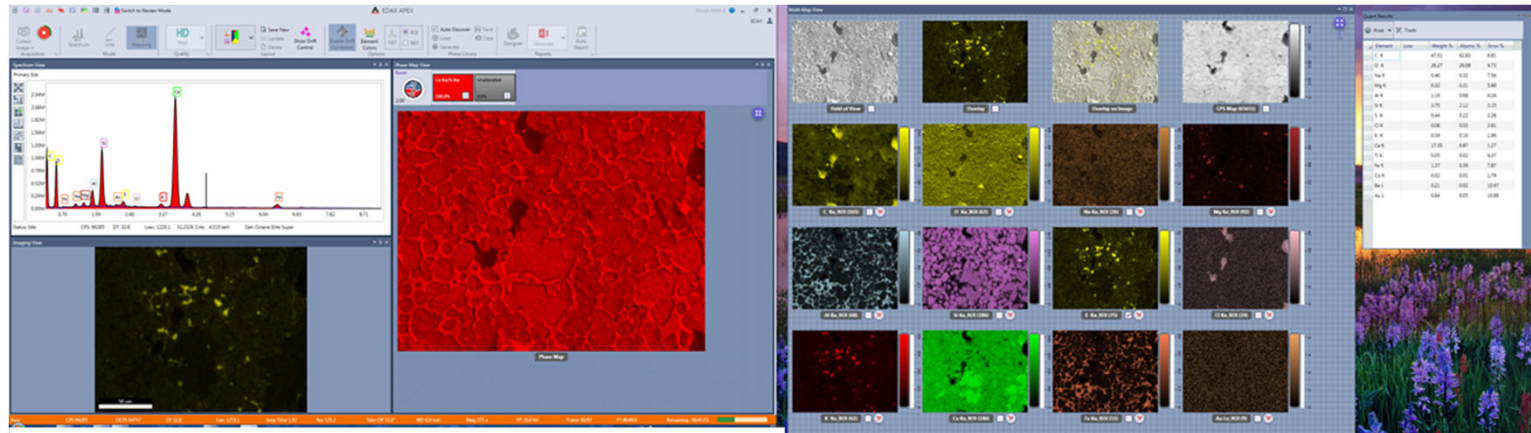
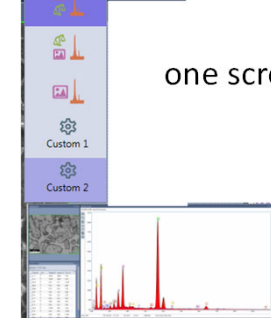


- Ribbon bar for quick access to collection tools
- spectrum, line scan, mapping selection
- Collection parameters
- Customisable screen layout with dockable windows that can be placed on multiple screens
- Review mode to analyse existing data while collection is active

Multiple Custom Layouts

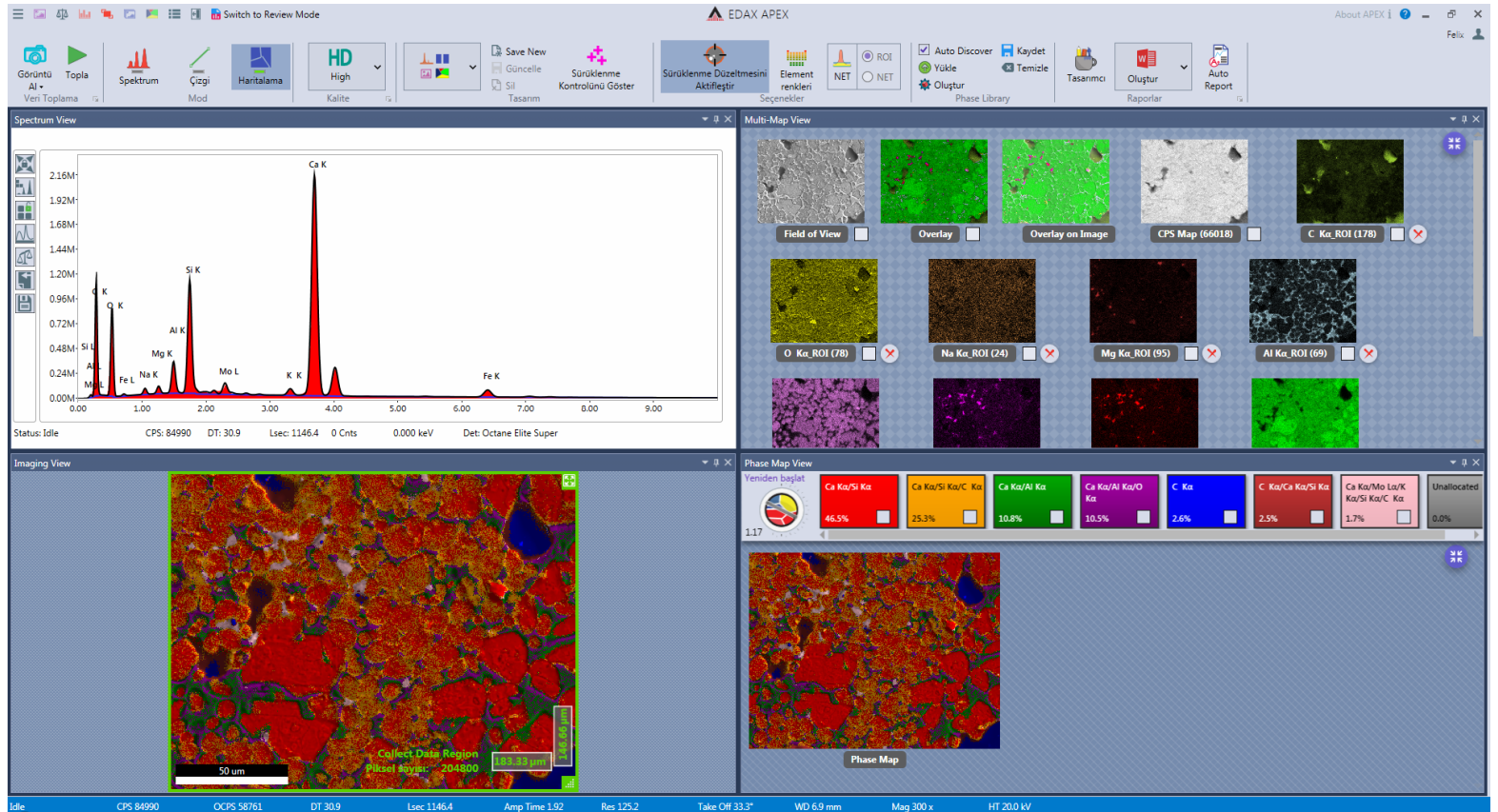
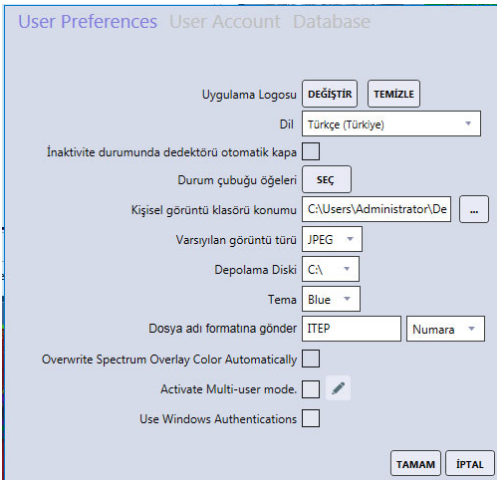
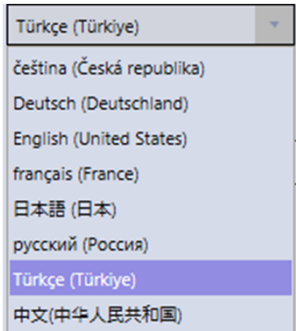


one screen



two screens

Languages



APEX™ Features

| Feature | APEX™ Standard | APEX™ Advanced |
|---|----------------|----------------|
| Analysis | ✓ | ✓ |
| Data Management & Reporting | ✓ | ✓ |
| Smart Quant | ✓ | ✓ |
| Linescan Acquisition | ✓ | ✓ |
| Multipoint Analysis | ✓ | ✓ |
| Smart Touch w/Monitor | ✓ | ✓ |
| Spectra Survey | ✓ | ✓ |
| EDS CPS Mapping | ✓ | ✓ |
| <u>Net Quant Map</u> | ✓ | ✓ |
| Maps Auto Enhance Processing | ✓ | ✓ |
| Spectra Auto Processing | ✓ | ✓ |
| Remote Licensing | | ✓ |
| <u>Drift Correction</u> | | ✓ |
| <u>Dynamic Element Mapping</u> | | ✓ |
| <u>CompoMaps (Live Net Mapping)</u> | | ✓ |
| <u>EDS Advanced Linescan</u> | Option | ✓ |
| Quant Map & Rebuild | Option | ✓ |
| <u>Advanced Reporting</u> | Option | ✓ |
| <u>Spectrum Match</u> | Option | Option |
| <u>Smart Materials & Minerals Library</u> | Option | Option |

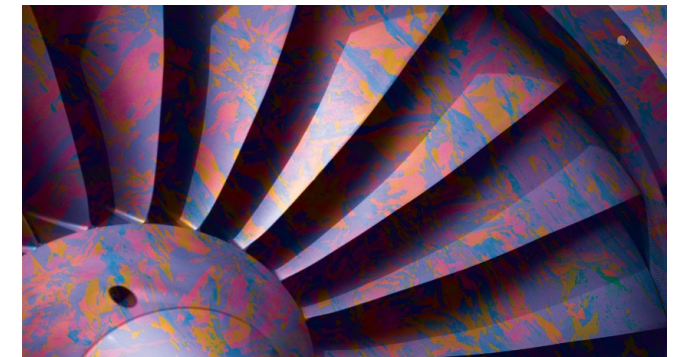


EBSD - Electron BackScatter Diffraction

EDAX EBSD Cameras: DigiView V

DigiView KEY FEATURES

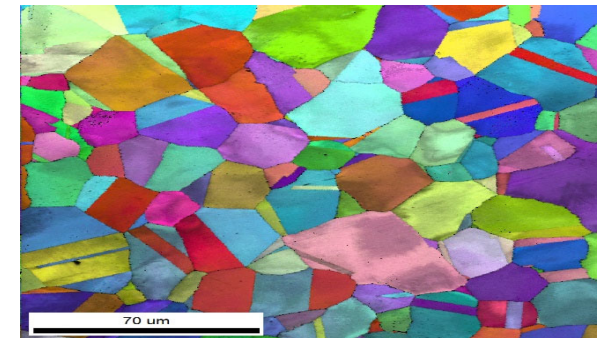
- 200 indexed patterns per second
- Excellent camera sensitivity
- Performance over full range of operating conditions including
 - Beam currents as low as 100 pA
 - Accelerating voltages as low as 5 kV
- High resolution acquisition for flexibility in EBSD applications
- 1.4-megapixel (1392 x 1040) CCD sensor for high resolution patterns
- Optional Forward Scatter Detector



The Velocity CMOS EBSD camera system – Speed Increase without compromise

Velocity KEY FEATURES

- > 4500 indexed Pattern p/sec
- High Sensitivity
 - 99% indexing at 100 pA
 - 99% indexing at 5 kV
- 0.1° Orientation precision
- Integrated in APEX EBSD
- Smart Camera compatible
- Triplet Indexing
- Confidence Index



99% Data from Inconel 600 at > 3,000 IPPS

Velocity™ Super 4,500 Indexed Points per Second – 25nA

- Inconel 600 alloy
- 99.6% Indexing Success Rate (ISR) @ 4500 pps
- 319 μm x 232 μm – 300 nm step size
- 951,318 Points – collection time 210 seconds

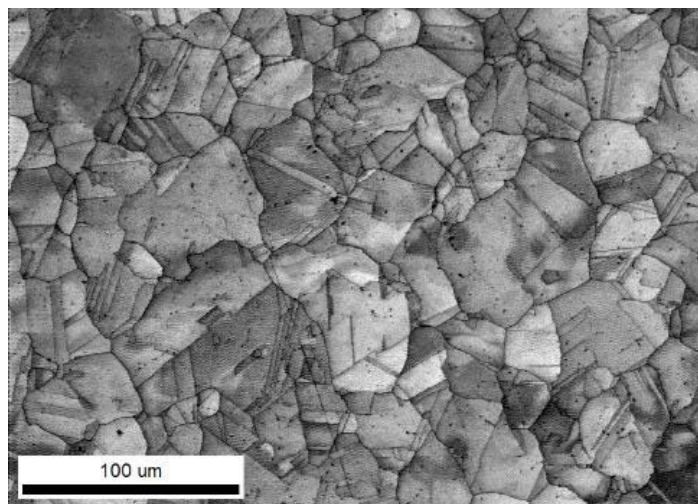
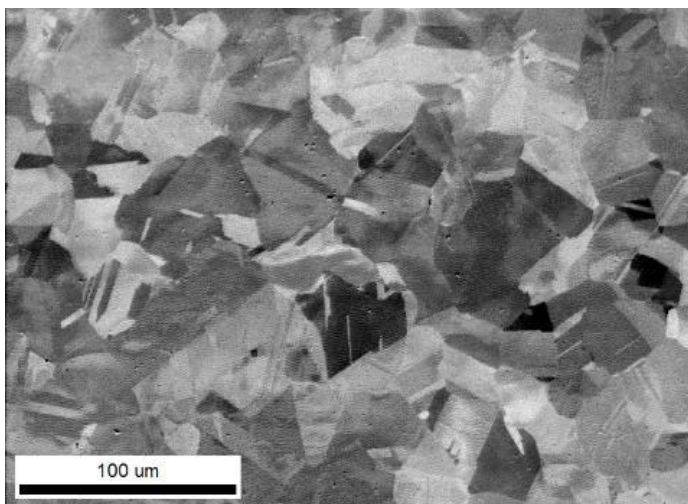
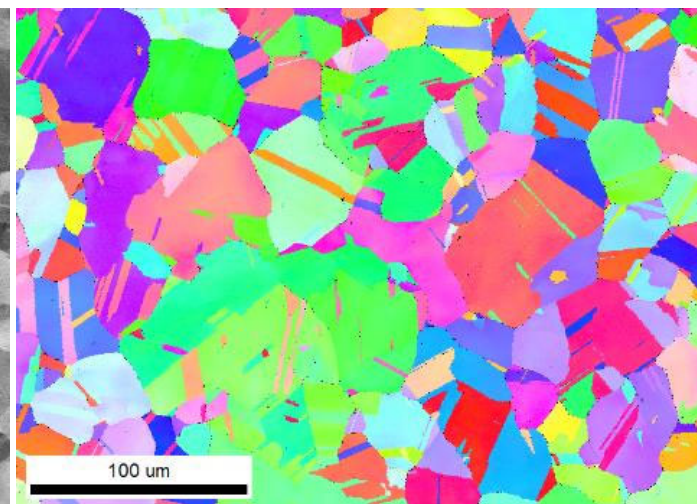


Image Quality (IQ) Map



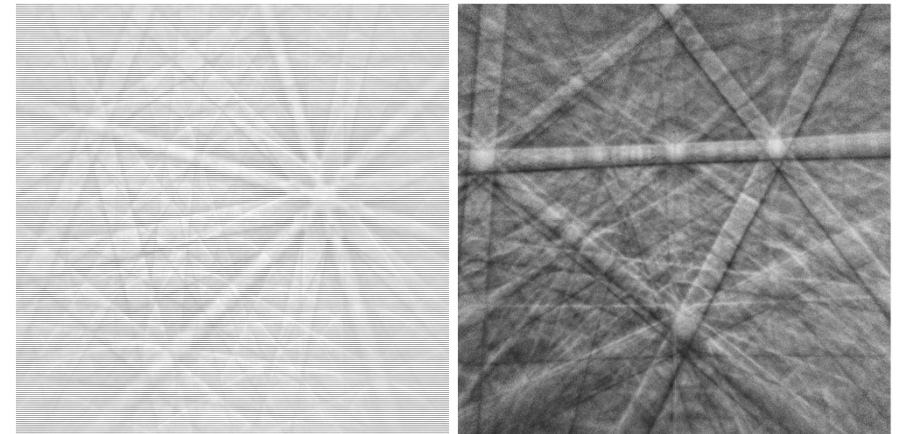
PRIAS™ (Center) Map



Inverse Pole Figure (IPF) – ND
Map

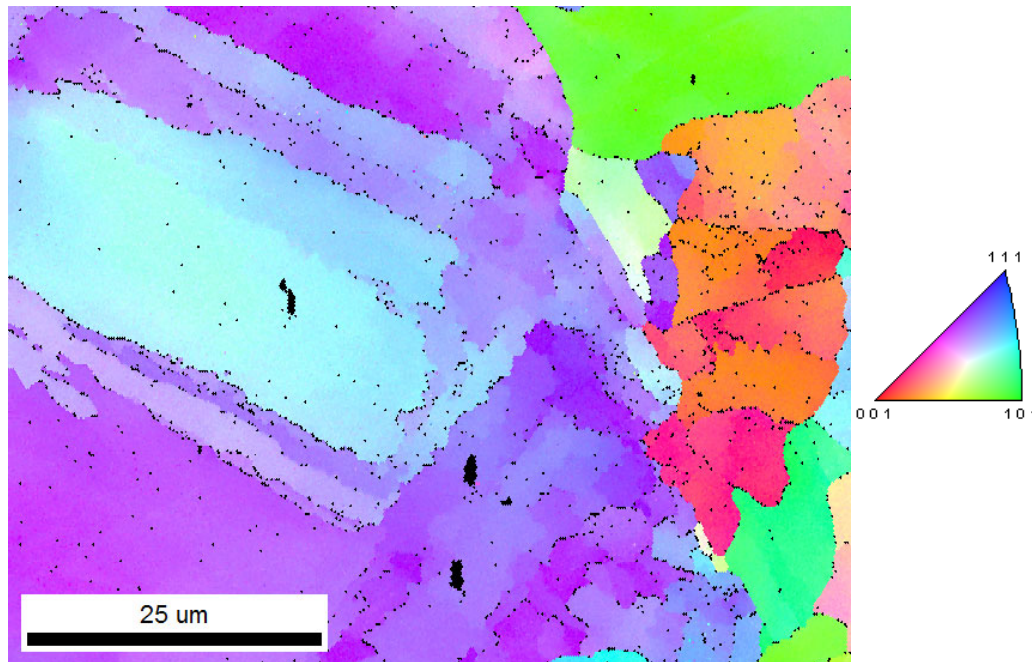
Clarity™ Direct detector for EBSD

- Clarity is the world's first commercial direct detector designed for EBSD
- Provides amazing sensitivity, pattern quality, and performance for EBSD pattern collection and mapping
- Ideal for beam sensitive materials, earlier adopters of technology, and HR-EBSD users
- Clarity provides high dynamic range counting and imaging
- 13.5 Bit Depth
- Works well with the intensity gradients present with EBSD patterns
- Coupled with no noise and no distortion, Clarity provides unparalleled pattern quality and sensitivity

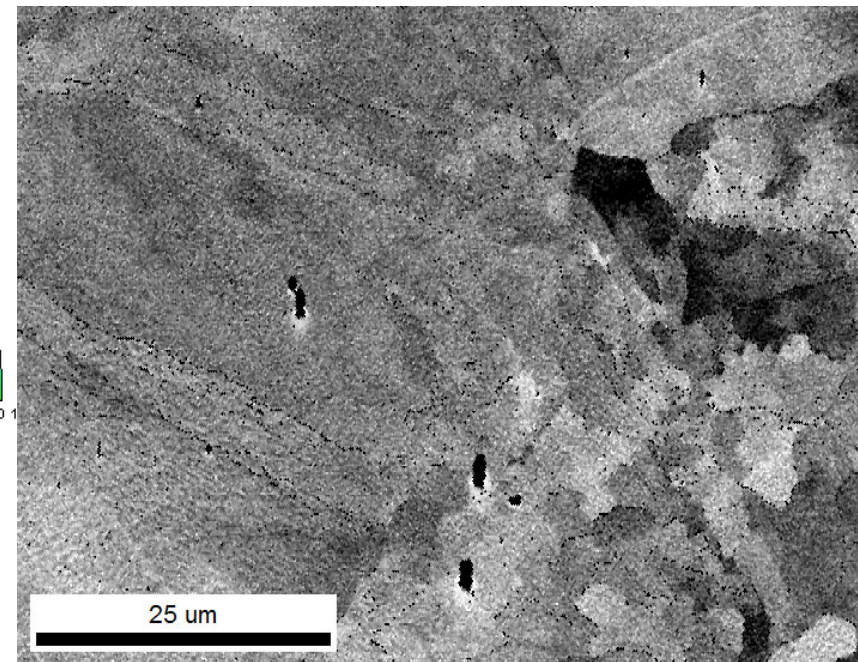


EBSD Mapping with 10 Electrons on Average

IPF Orientation Map – 98% Indexing



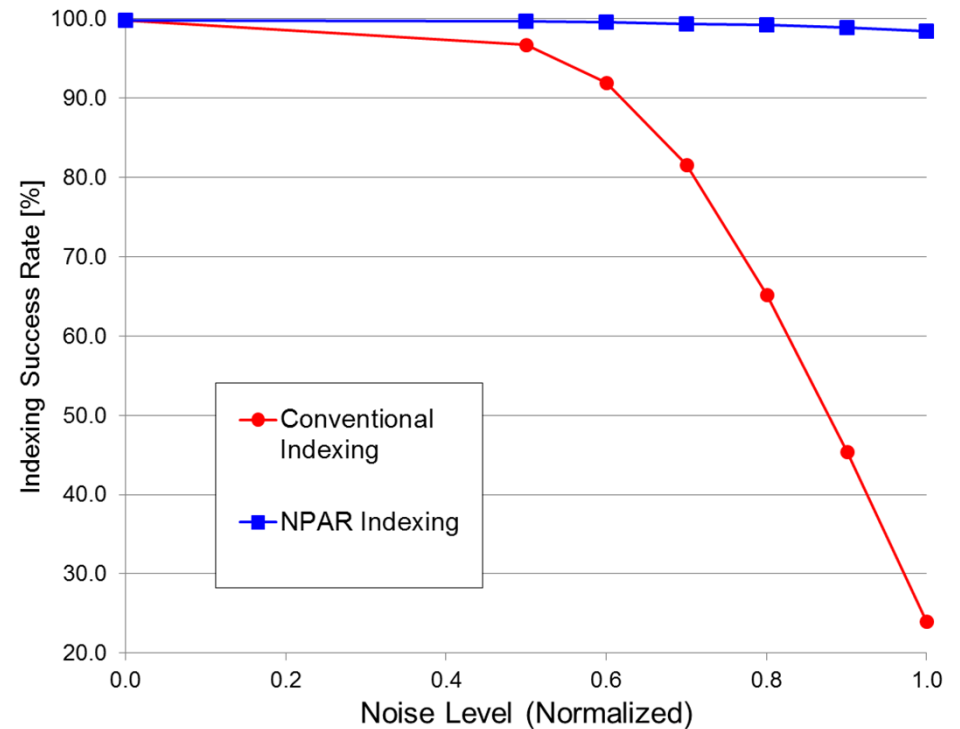
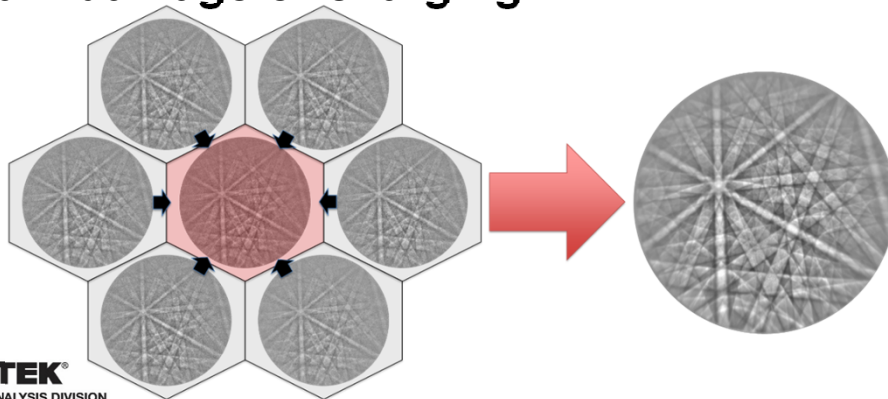
PRIAS™ Map



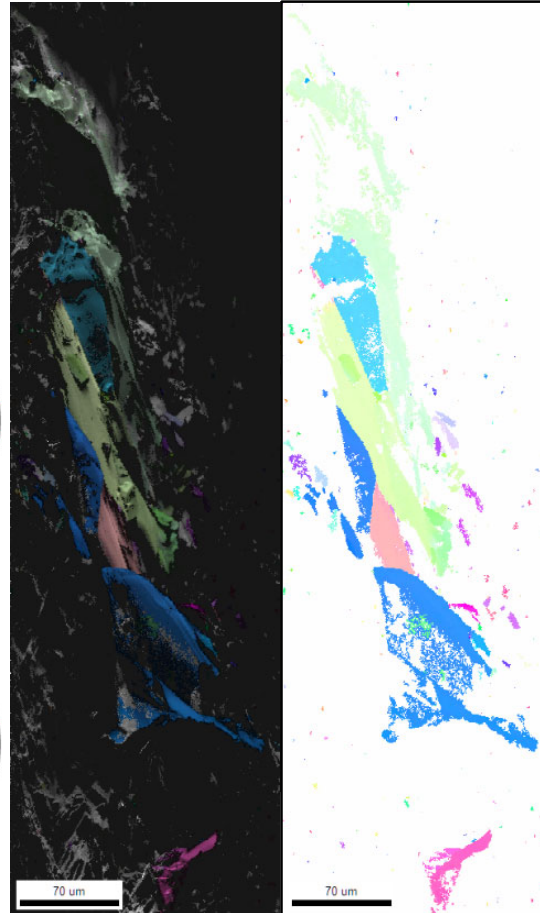
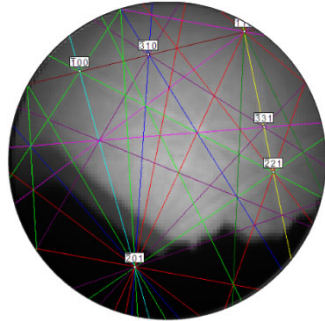
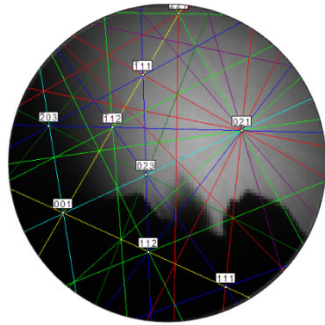
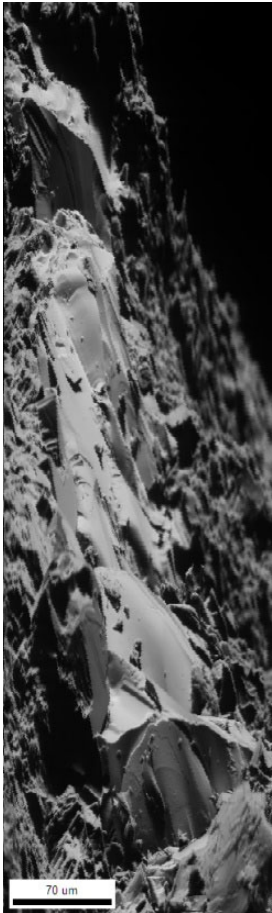
EBSD map collected at 13 pA (yes picoamps) from customer sample –
additively manufactured stainless steel

NPAR™ – Neighbor Pattern Averaging and Reindexing

- Patented NPAR™ technology improves EBSD pattern Signal-to-Noise (SNR) ratio through local spatial averaging.
- Improves SNR results in improved EBSD pattern indexing.
- It is ideal for faster data collection at lower beam currents.
- Ideal for analysis of samples that cannot produce high quality patterns due to e.g. beam damage or charging



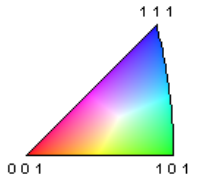
NPAR background improvement on rough surfaces



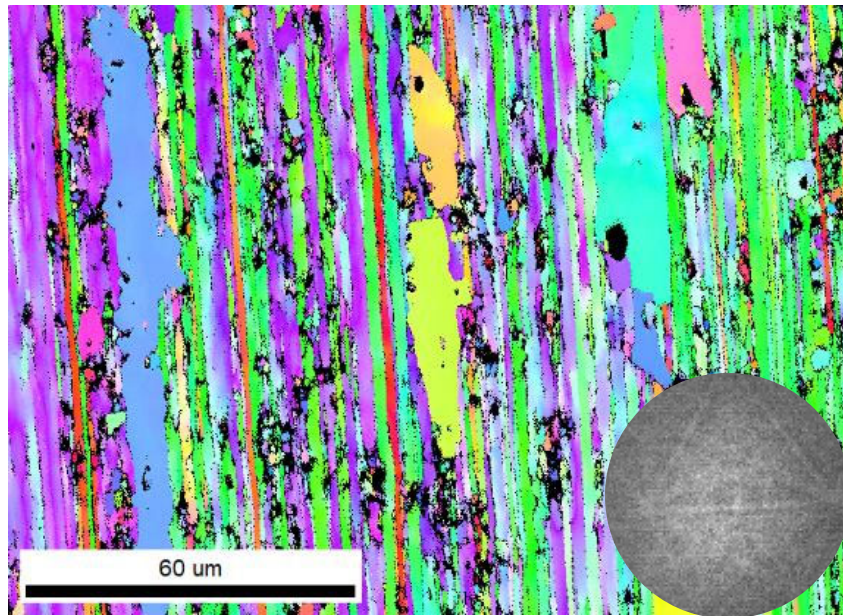
16.5% indexing

- Fracture surface of chalcopyrite (fossil)
- NPAR homogenises the background over a larger area per pixel
- This reduces the sharp edges of shadows on the pattern and the corresponding “artefacts” in the Hough transformation
- NPAR improves indexing from 7.2% to 16.5% which covers most of the sulphide area

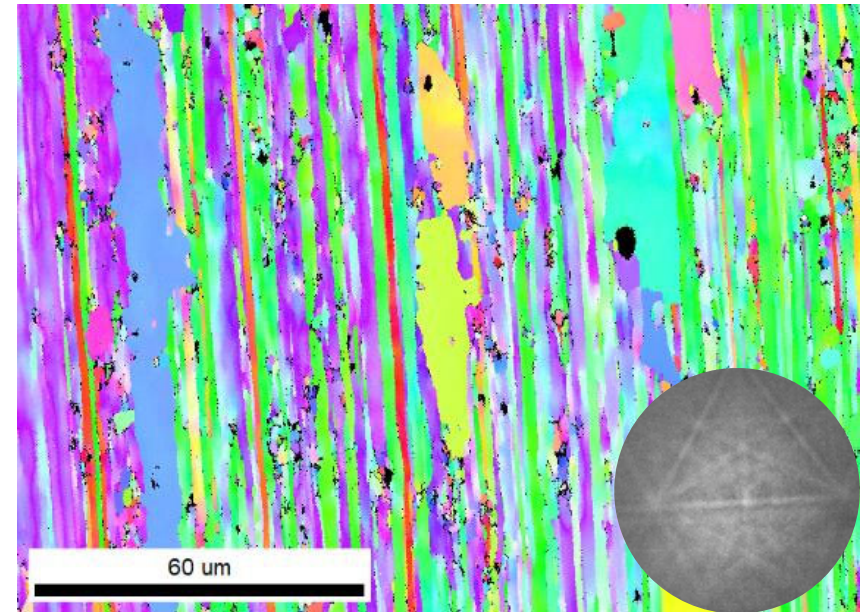
Swaged Aluminum – NPAR improvement



85.0% ISR
Initial Scan



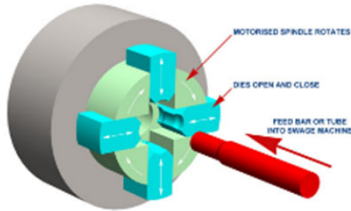
97.1% ISR
After NPAR™ Processing



154 x 111 μm – 100 nm Step Size
1,974,403 Points
NPAR™ is applied only on 15% of low CI points

Image from Brooks Forging/Quora

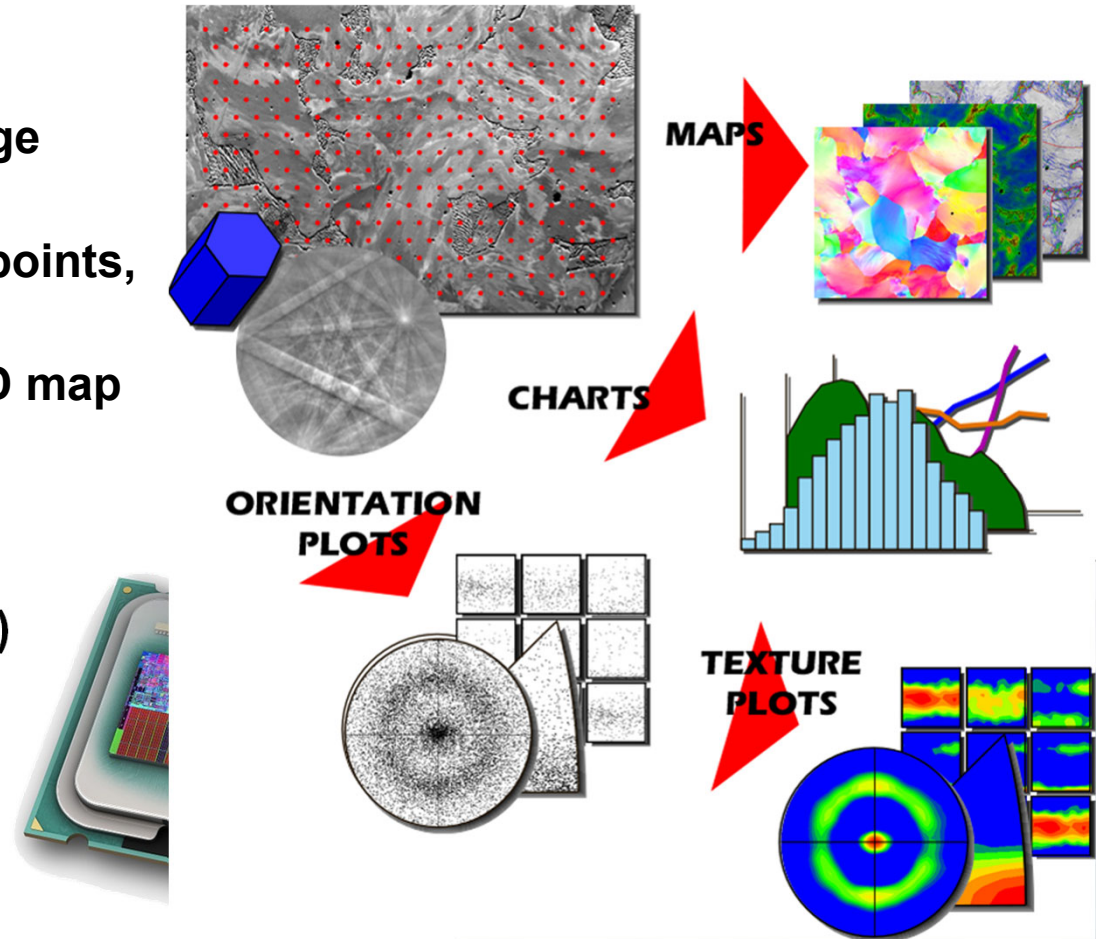
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OIM Analysis™ v8.6

- 64 bit software architecture
- Multithreading to allow processing of large datasets
- Integrated indexing capability for single points, partitions or entire datasets
- Quick generate button for standard EBSD map displays
 - IPF, IQ, Phase, KAM, texture plots, ...
 - OIM Matrix dynamic pattern simulations
- Extensive tools for advanced (interactive) analysis and data export



- René DE KLOE : Application Specialist EDAX

Live Demo from Tilburg !



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