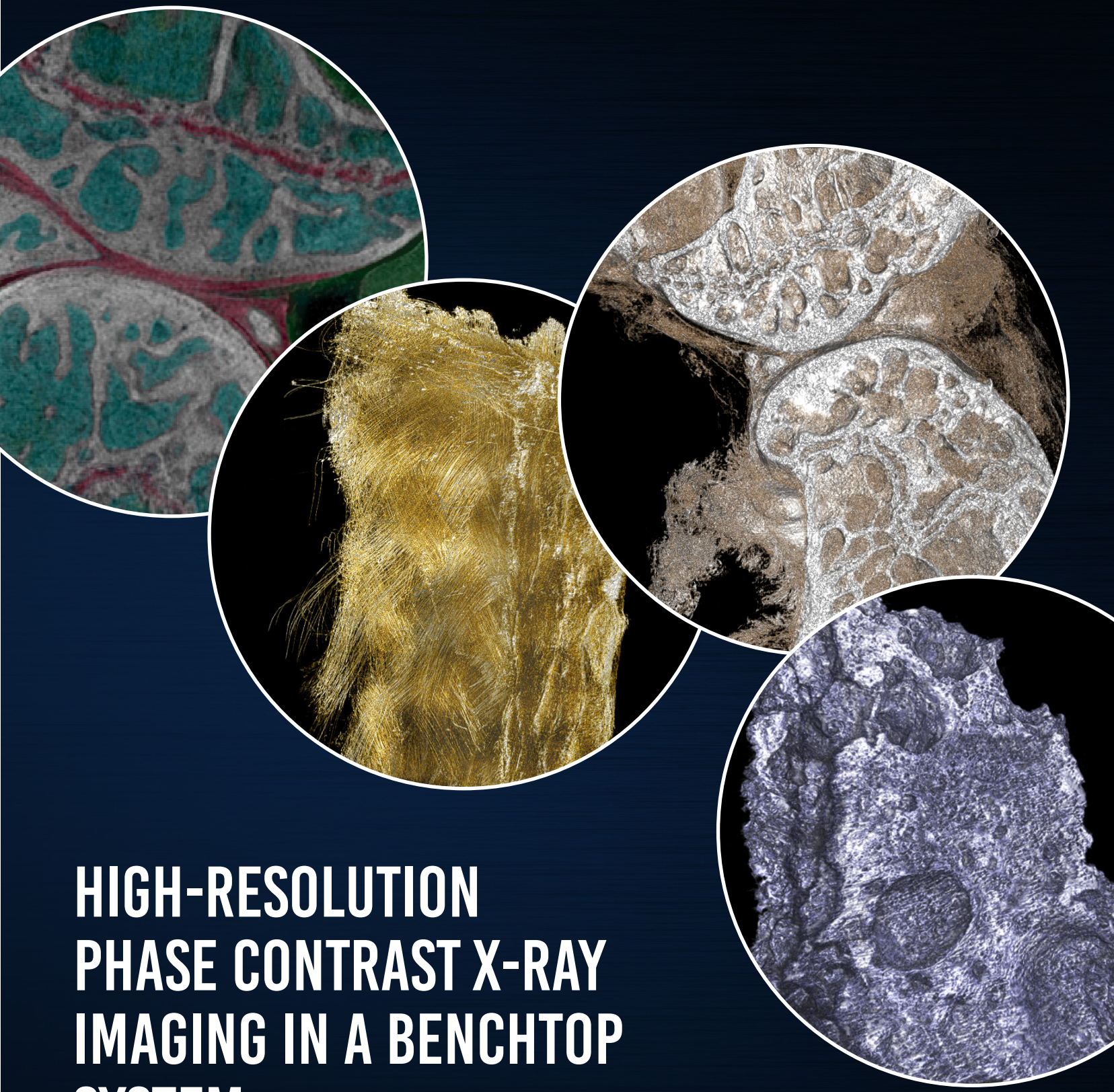
inCiTe™

3D X-Ray Microscope

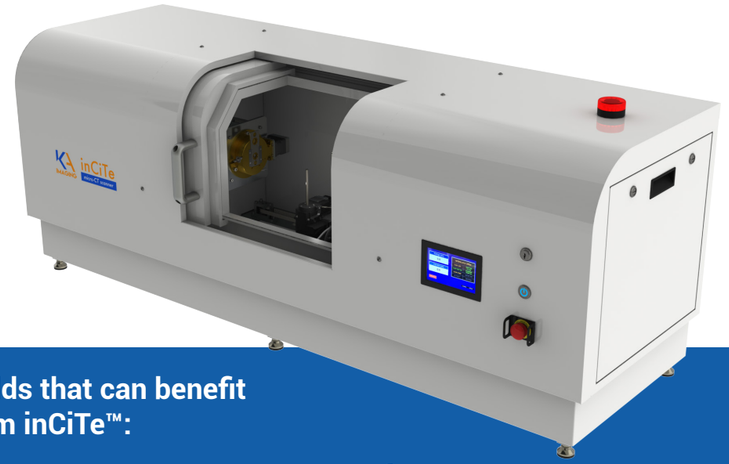
KA IMAGING™



HIGH-RESOLUTION PHASE CONTRAST X-RAY IMAGING IN A BENCHTOP SYSTEM

KA IMAGING'S **inCiTe™ 3D X-RAY MICROSCOPE**

The inCiTe™ 3D X-ray Microscope is the first commercial scanner that utilizes BrillianSe™, a patented high spatial resolution amorphous selenium (a-Se) detector technology exclusively developed by KA Imaging Inc. The high spatial resolution and detection efficiency of the BrillianSe™ X-ray detector enable rapid phase contrast imaging and conventional micro-CT in a portable benchtop system.



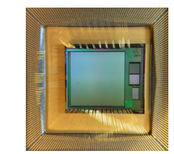
Fields that can benefit from inCiTe™:

- Non-destructive testing (NDT)
- Additive manufacturing
- Electronics
- Agriculture
- Geology
- Preclinical imaging
- Specimen radiography

A DETECTOR WITH **NOVEL TECHNOLOGY**

The BrillianSe™ X-ray Detector provides a unique combination of high spatial resolution using 8 µm pixels, and high Detective Quantum Efficiency (DQE) for energies up to 120 keV. This combination enables efficient imaging at low flux and high energy, as well as propagation-based (grating-less) phase-contrast enhancement for improved sensitivity when imaging low-density materials.

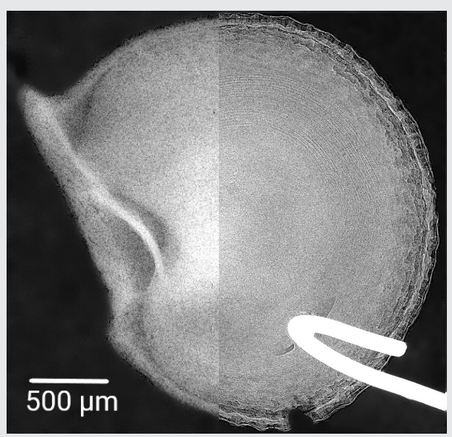
The BrillianSe™ X-ray detector is available in a 16-megapixel format (16M).



- **Suitable for synchrothron applications**
- **Faster scan time**
- **Grating-less phase contrast for better efficiency**
- **Large 32mm x 32mm FOV**

Left: KA Imaging's BrillianSe™ X-ray detector. *Right*: BrillianSe™ sensor at the core of the X-ray detector.

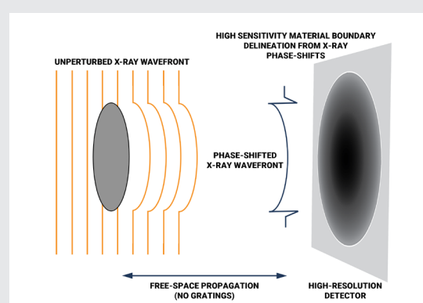
PHASE CONTRAST TECHNOLOGY FOR **SUPERIOR CONTRAST**



WITHOUT/ WITH PHASE CONTRAST

Phase contrast allows for better visualization of the bell pepper seed.

Phase-contrast imaging is complementary to absorption-contrast (conventional) X-ray imaging. Materials with weak X-ray absorption naturally result in low image contrast using conventional X-ray imaging techniques. In such cases, much higher sensitivity is present in X-ray phase changes. inCiTe™ 3D X-ray microscope achieves phase-contrast directly by free-space propagation of the X-ray beam, transforming X-ray phase changes due to the object into X-ray intensity variation at the detector. Propagation phase-contrast X-ray imaging enables orders of magnitude improvement in detectability of features with weak X-ray absorption.

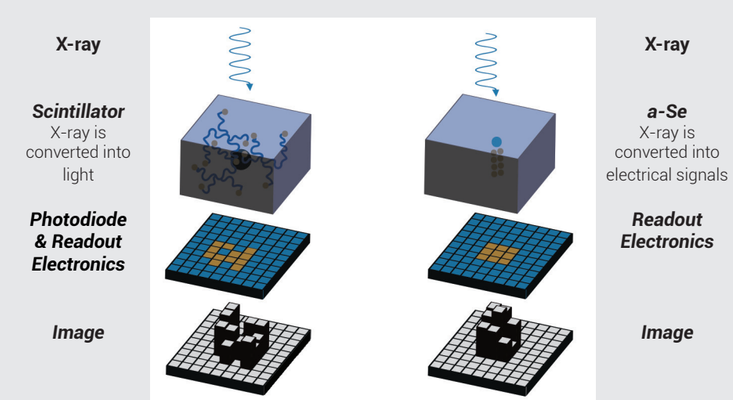


Propagation-based, grating-less phase-contrast.

DIRECT CONVERSION **DETECTOR**

BrillianSe's hybrid a-Se/ CMOS detector uses an a-Se photoconductor with high intrinsic spatial resolution for direct conversion of X-ray photons to electric charge. The electronic signal is then read by a low noise CMOS active pixel sensor (APS). Without the need to first convert X-ray photons to visible light (which is required in indirect scintillator-based approaches), thinning of the conversion layer to minimize optical scatter is not necessary.

X-RAY DETECTION TECHNIQUE: DIRECT VS INDIRECT

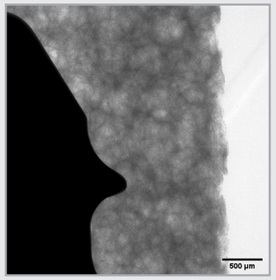


Indirect (L.) and direct (R.) X-ray detection. Note that indirect conversion requires a scintillator to convert X-ray.

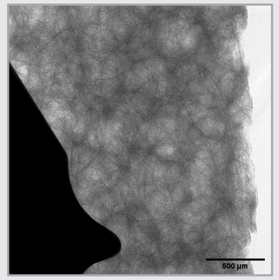
LOW-DENSITY MATERIALS WITH **BETTER VISUALIZATION**

Titanium Implant Sample

The images show an orthopaedic titanium implant in a bone phantom. Note that the phase contrast improves the visualization of the porous (trabecular) bone structure.



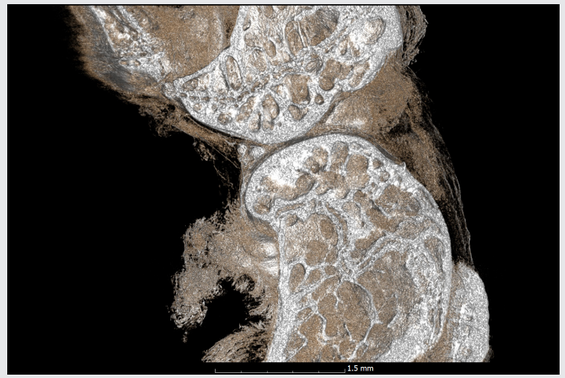
WITHOUT PHASE CONTRAST



WITH PHASE CONTRAST

Biological Sample

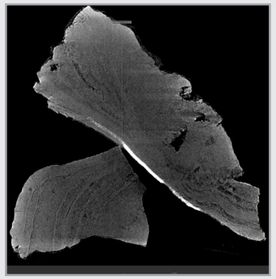
The inCiTe™ 3D X-ray microscope enables high contrast for tissues, like in this mouse stifle joint.



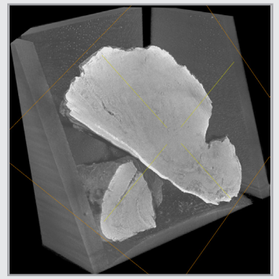
3D RENDERING

Kidney Stone Sample

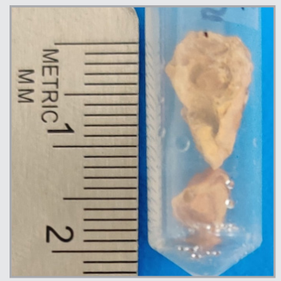
The inCiTe 3D X-ray Microscope was used to analyze the microstructure of a kidney stone. These microstructural characteristics, which are determined by the mineral composition of the stones, offer valuable insights around the pathogenesis.



EXAMPLE SLICE

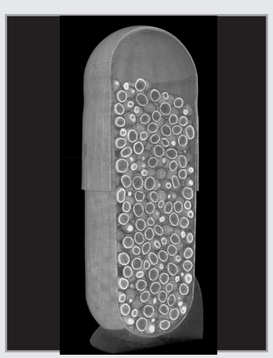


3D RENDERING



PHOTO

Esomeprazole sample



X-ray imaging is utilized in the pharmaceutical industry to ensure product quality, detect contaminants, verify packaging integrity, comply with regulations, and support research and development efforts. By providing a non-invasive and detailed examination of pharmaceutical products, X-rays contribute to the safety, efficacy, and overall quality of medications.

Thanks to the patented technology available in the inCiTe 3D X-ray Microscope, it is possible to achieve a high level of detail.

LOW-DENSITY MATERIALS WITH **BETTER VISUALIZATION** CONTINUED

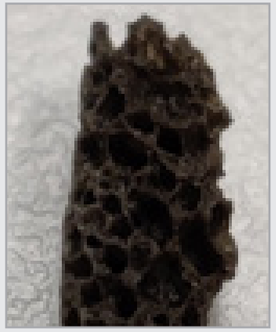
Kevlar Composite Sample

We used the detector to rapidly acquire phase contrast images of a Kevlar composite in seconds. We can see individual fibers on the left, and the layering on the right. The sample is at 4x magnification.

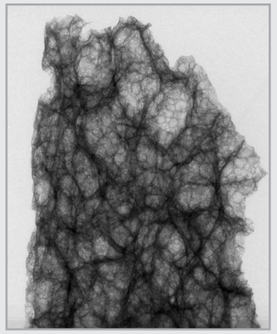
Kevlar Composite 3D Rendering

Approximate Sample Size: 1.5 mm x 2.5 mm x 7.5 mm.

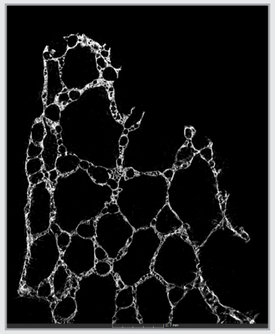
Lightweight Aggregate Concrete Sample



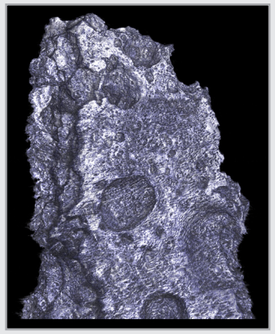
PHOTO



PROJECTION



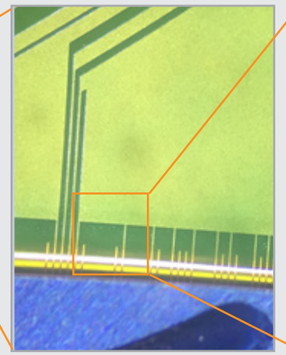
EXAMPLE SLICE

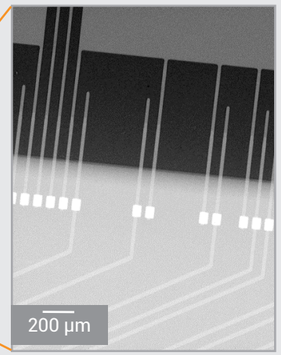


3D RENDERING

Approximate Sample Size: 3.5 mm x 3.5 mm x 13mm.

Electronic Sample

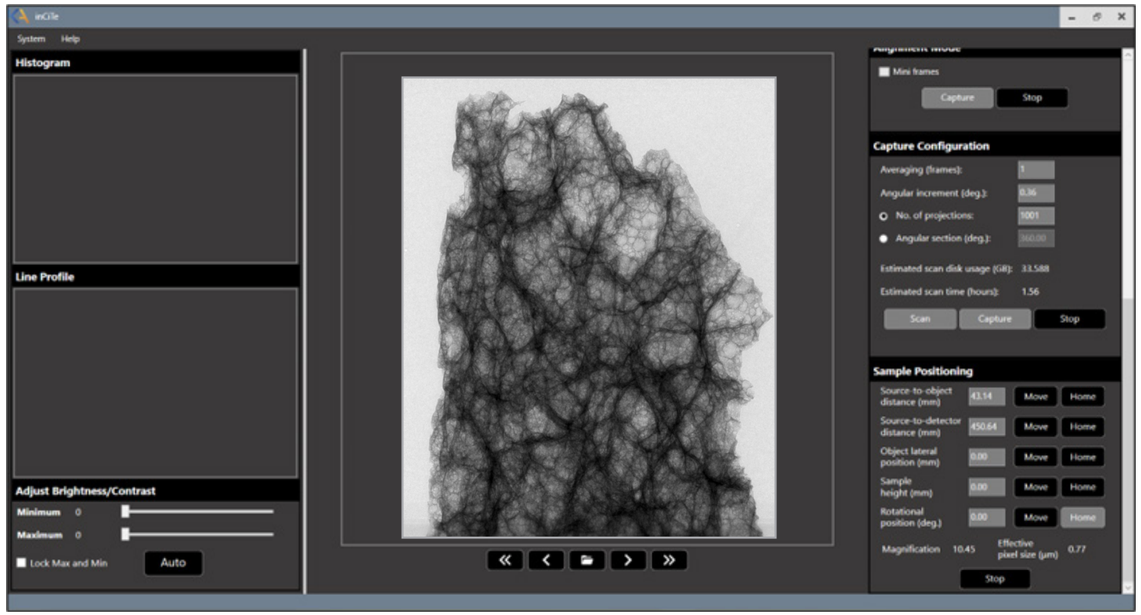




This example highlights the fine pitch trace on a flexible circuit (1 mm trace, 8 µm thick). inCiTe™ can be used for inspection and failure analysis with high contrast for cracks, imperfections and boundaries; and high acquisition speeds due to the use of direct conversion.

FRIENDLY
USER INTERFACE

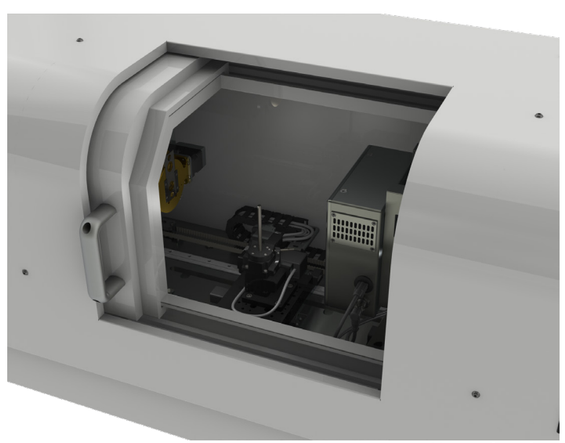
inCiTe 3D X-ray Microscope acquisition software has an intuitive graphical user interface that supports both novice and expert users. The system is quickly initialized, and the user can be scanning the sample within less than 20 minutes after first power-on. inCiTe 3D X-ray Microscope doesn't require any sample preparation, like contrast agents, staining or thin slicing.



System overview.

SIMPLIFIED
WORKFLOW

1. Mount sample
2. Adjust scan geometry for the fastest scan at the desired magnification
3. Calibrate detector
4. Check sample alignment
5. Start scan



X-ray chamber.

HIGH QUALITY IMAGES
FROM ACQUISITION TO RECONSTRUCTION

Following image acquisition, in slices, the slices must be recombined to form a whole— reconstructed— image of the object, using VGSTUDIO MAX from Volume Graphics.

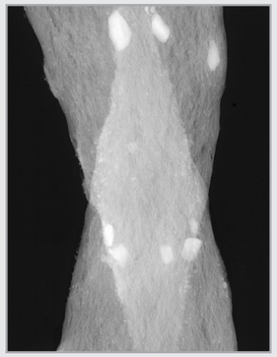
- Characterize material microstructures
- Reverse engineer existing part geometries
- Validate or calibrate simulation workflows
- Apply NDT and GD&T inspection plans
- Monitor production process
- Determine root cause of issues

CASE STUDY:
FOOD SAMPLE

The rapid 2D projection (1.6x mag., ~5.1 µm res., 10 sec. exposure) combines absorption and phase contrast edge enhancement.

The slices (both at 1.6 mag., ~5.1 µm res.) displays salt crystals and void distribution.

The 3D reconstruction, performed with Volume Graphics VG Studio, used 1,000 projections over 360 degrees acquired using KA Imaging Software within 3 hours.



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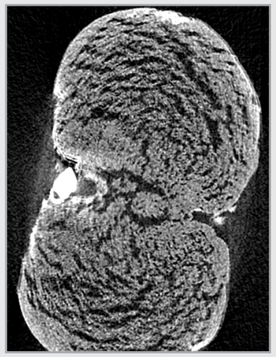

EXAMPLE SLICE

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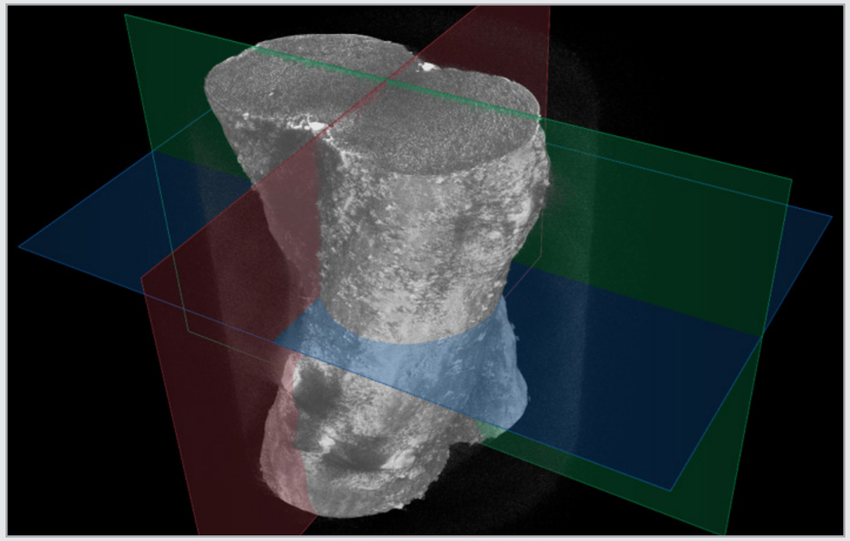

3D RENDERING

ABOUT **KA IMAGING INC.**

KA Imaging, founded in 2015, is a spin-off from the University of Waterloo in Ontario, Canada. The company specializes in developing unique detectors and imaging products that leverage cutting-edge, multi-energy and phase contrast X-ray technologies and systems. KA Imaging successfully developed a line of X-ray imaging products in the areas of micro-computed tomography, high-efficiency X-ray area detection and multi-energy spectral separation detection. KA Imaging revolutionizes X-ray imaging while providing innovative solutions to the medical, veterinary, non-destructive, and scientific imaging customers.

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