X-Ray Computed Tomography Scanning for Defense Applications

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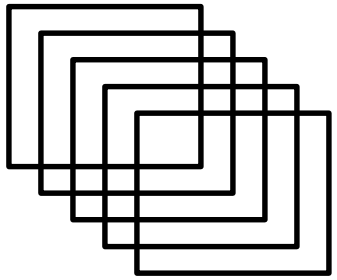
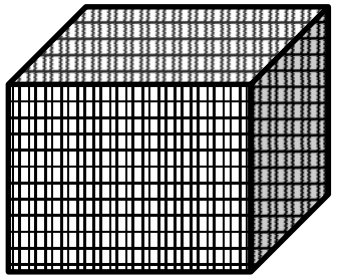
DSIAC is a DoD Information Analysis Center (IAC) sponsored by the Defense Technical Information Center (DTIC) with policy oversight provided by the Office of the Under Secretary of Defense (OUSD) for Research and Engineering (R&E). DSIAC is operated by the SURVICE Engineering Company

Basic Process of CT Scanning: Overview



~20 GB – Raw X-ray Images

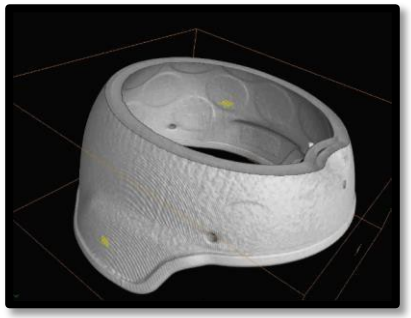


~10 GB – Raw Volumetric Data

Radiographic Data

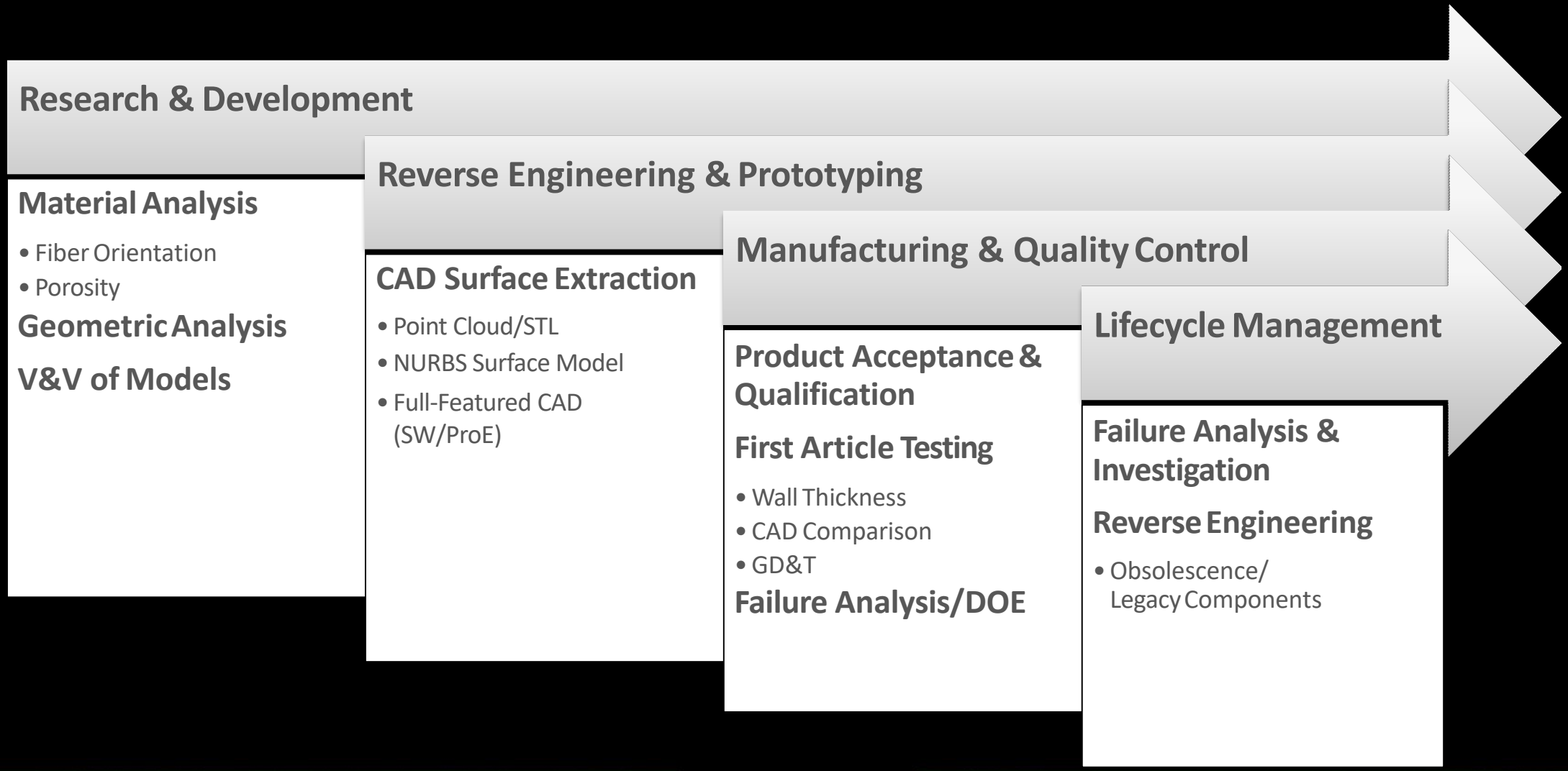
3D Reconstruction

Volumetric Data



- Surface Data
  - Point Cloud/STL
  - Direct Compare to CAD File
  - Wall Thickness
- Material Data
  - Porosity/Inclusion
  - Fiber Orientation

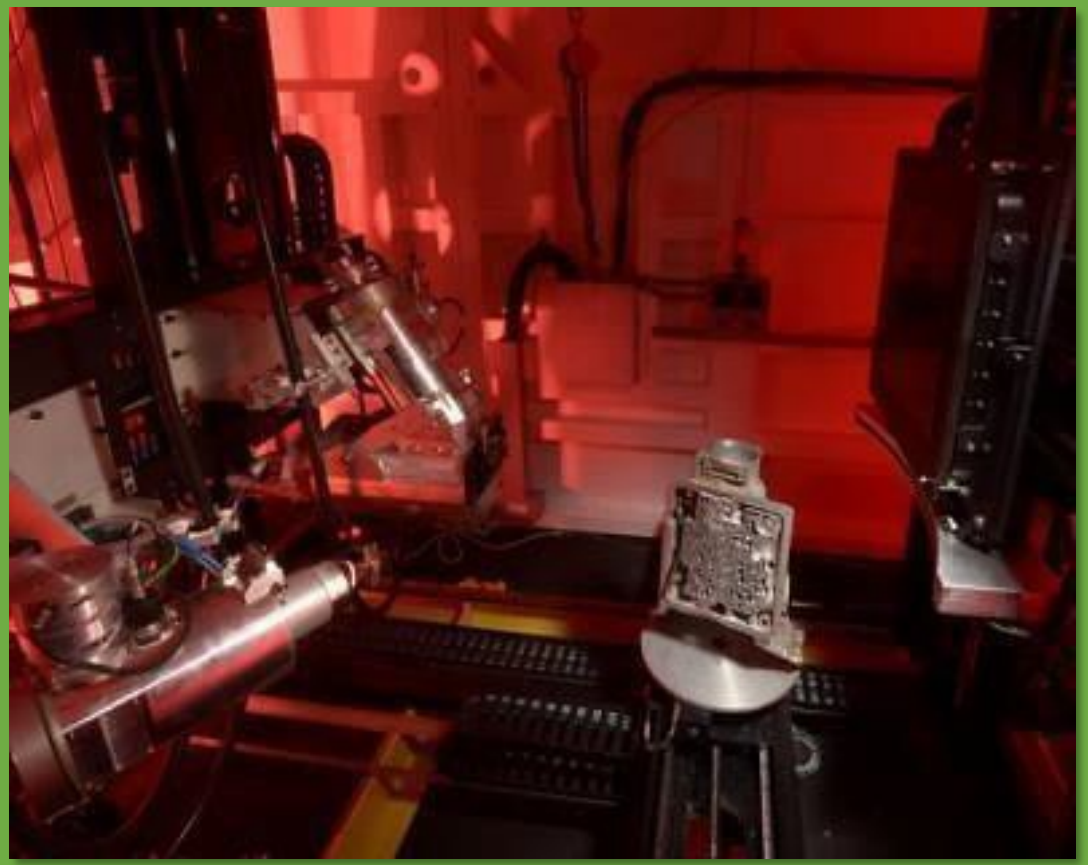
Applications of Industrial CT Scanning



NTS Chesapeake Non-Destructive Testing Facilities

- **225/450-kV microfocus CT scanner**
  - 36-inch working envelope
  - PerkinElmer 1620
  - + custom-built LDA
  - 450-kV max resolution: 70 µm
  - 225-kV max resolution: 2 µm

- **225/320-kV microfocus CT scanner**
  - PerkinElmer 1621ES enhanced sensitivity
  - Imaging panel
  - 20 fps cine-radiography video
  - 320-kV max resolution: 30 µm
  - 225-kV max resolution: 2 µm



450-kV micro-focus CT scanner inside walk-in bay

Major Programs in XCT NDT

- **U.S. Department of Defense**
  - Various branches/agencies – armor, firearms, ammunition, materials research
- **National Transportation Safety Board (NTSB)**
  - Investigation support
  - 787 Dreamliner batteries
- **NASA (Johnson/Langley)**
  - Materials research/batteries
- **Smithsonian Institution**
  - Paleontology – marine mammals
  - Digitization Program Office

New Knowledge From Ancient Specimens Using X-Ray Computed Tomography (CT)

Case Studies, Computed tomography, Metrology CT, X-ray and CT Inspection

The Smithsonian's Natural History Museum together with Chesapeake Testing consulting firm are using computed tomography (micro CT) to not only scan marine mammal fossils, but also make 3D scans and data available for knowledge-seekers around the world.

The mission of the Smithsonian Institution, the world's largest museum and research complex, is admirably brief: "The increase and diffusion of knowledge." The vision statement, a bit longer, is no less cogent: "Shaping the future by preserving our heritage, discovering new knowledge, and sharing our resources with the world." Within those statements is a commitment to finding and using the most effective tools to accomplish these ideals. The following describes how the Smithsonian's Natural History Museum together with an engineering consulting firm known mainly for ballistics and armor testing are using X-ray computed tomography (micro CT) to not only scan marine mammal fossils, but also make 3D scans and all the data they contain available for knowledge-seekers around the world.

CHESAPEAKE TESTING ASSISTING THE NTSB USING ADVANCED X-RAY COMPUTED TOMOGRAPHY TO INSPECT BATTERY UNITS AND COMPONENTS

JANUARY 30, 2013

January 30th, 2013
For Immediate Release – Belcamp, MD

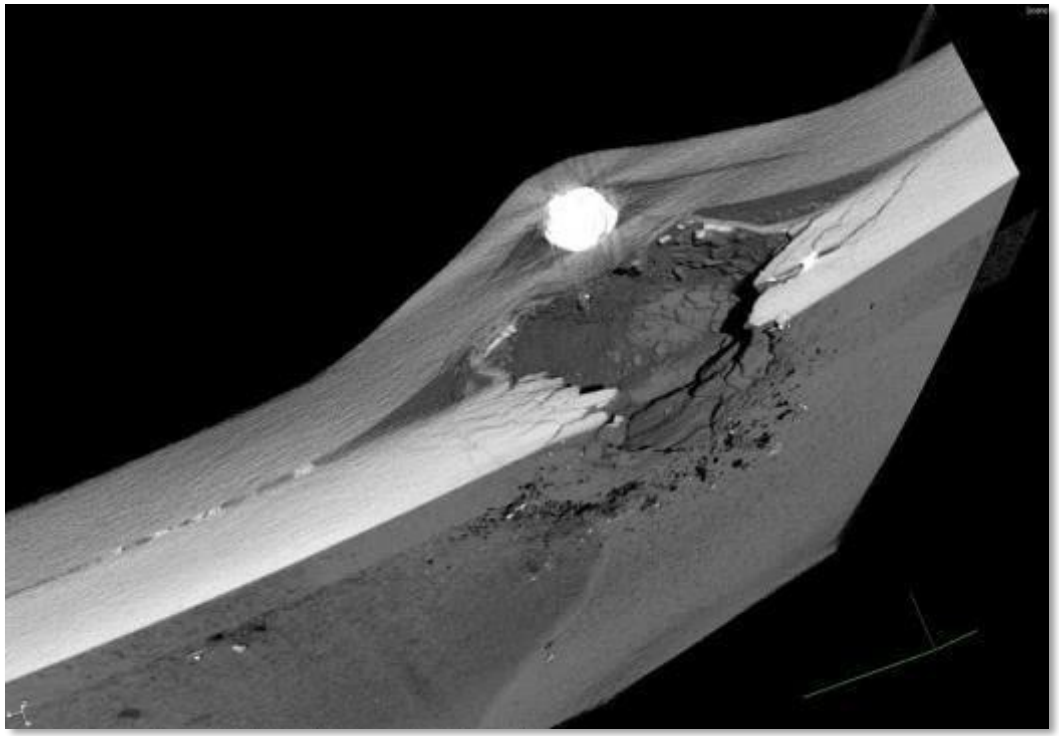
The National Transportation Safety Board (NTSB) has announced the award of a service contract to Chesapeake Testing to provide non-destructive testing in support of an investigation.

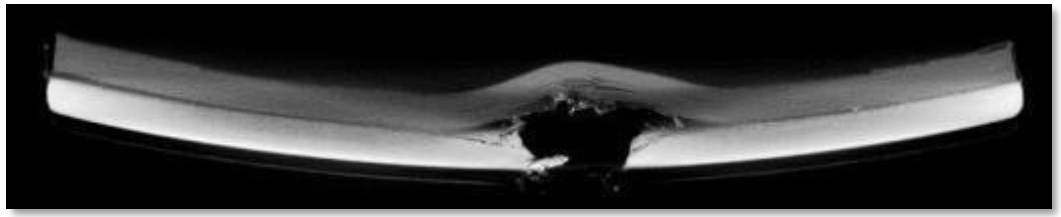
Citing Chesapeake Testing's close proximity to Washington D.C, its unique technical qualifications, and the ability to quickly respond to the required timeframe for this requirement, the NTSB is sending lithium ion-type battery cells to Chesapeake Testing for x-ray computed tomography (CT) scanning.

X-Ray CT Applications

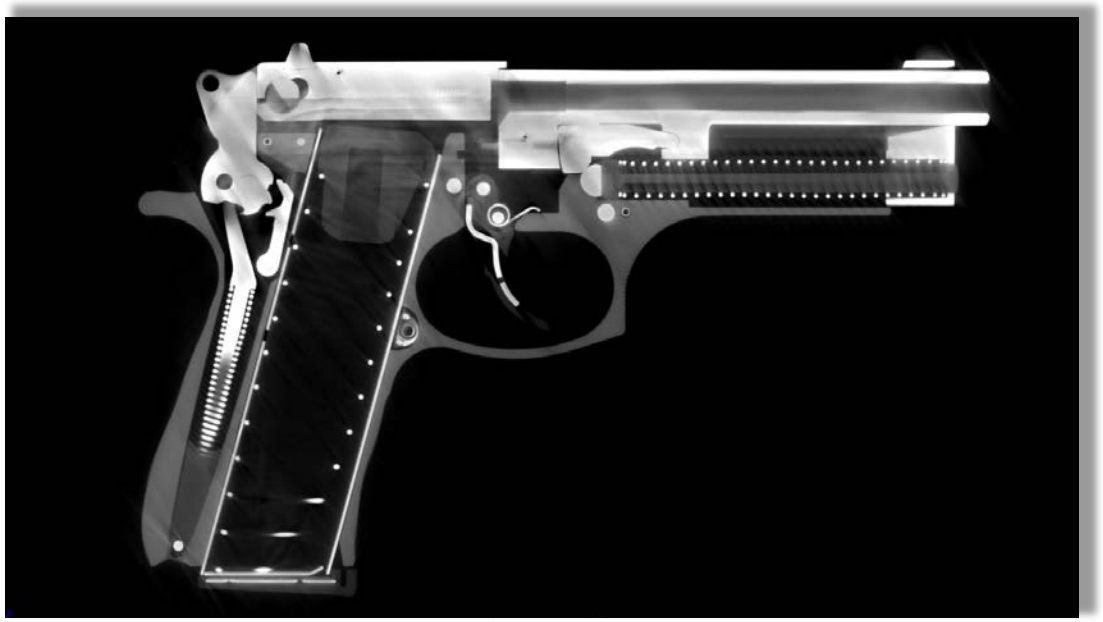
Ballistics: Hard Armor Plate (SiC/B4C)

Quantify post-test damage and evaluate multihit, hard-armor plates



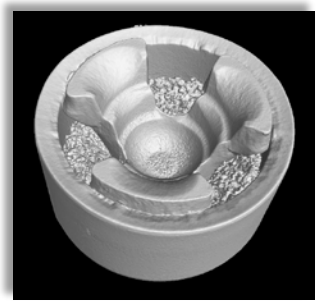


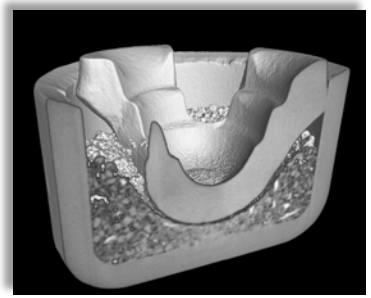
Ballistics: Handgun Testing/Failure Analysis
Beretta M9 9 mm

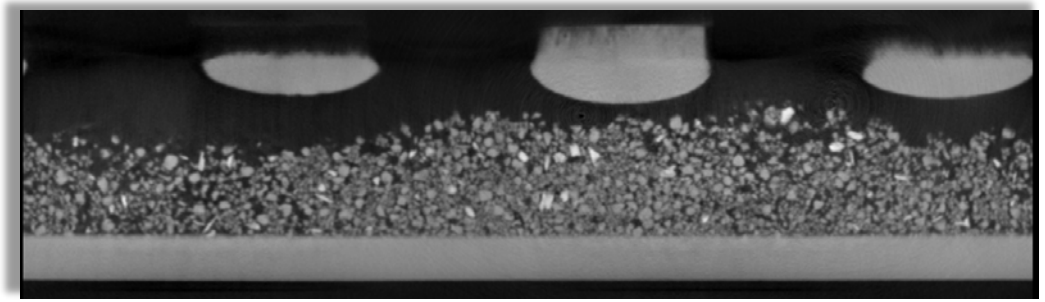


Ballistics / Munitions

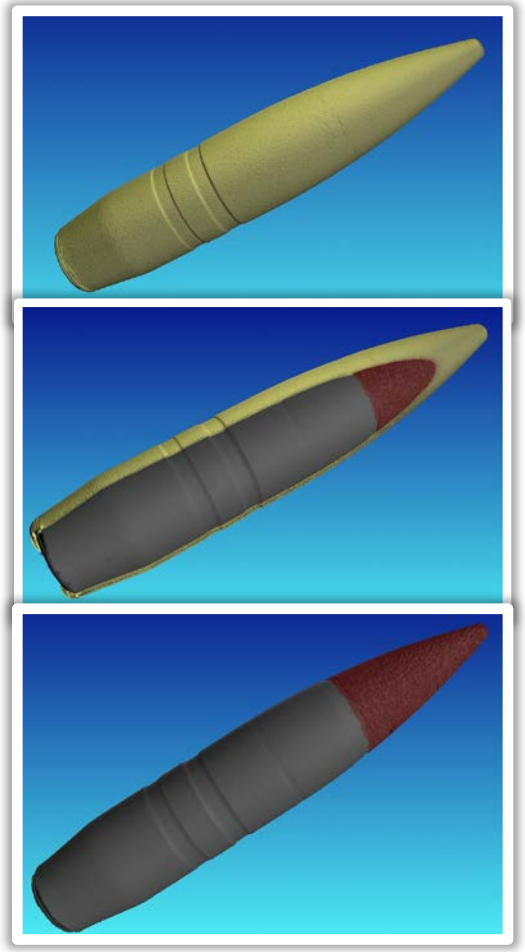
- Ammunition
  - Locate/quantify:
    - Core shape
    - Core volume
    - Propellant fill
    - Propellant volume
    - Incendiary fill
    - Incendiary volume



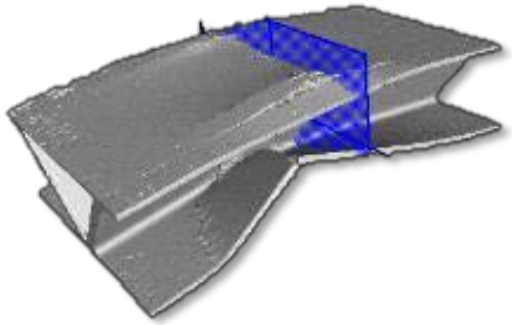


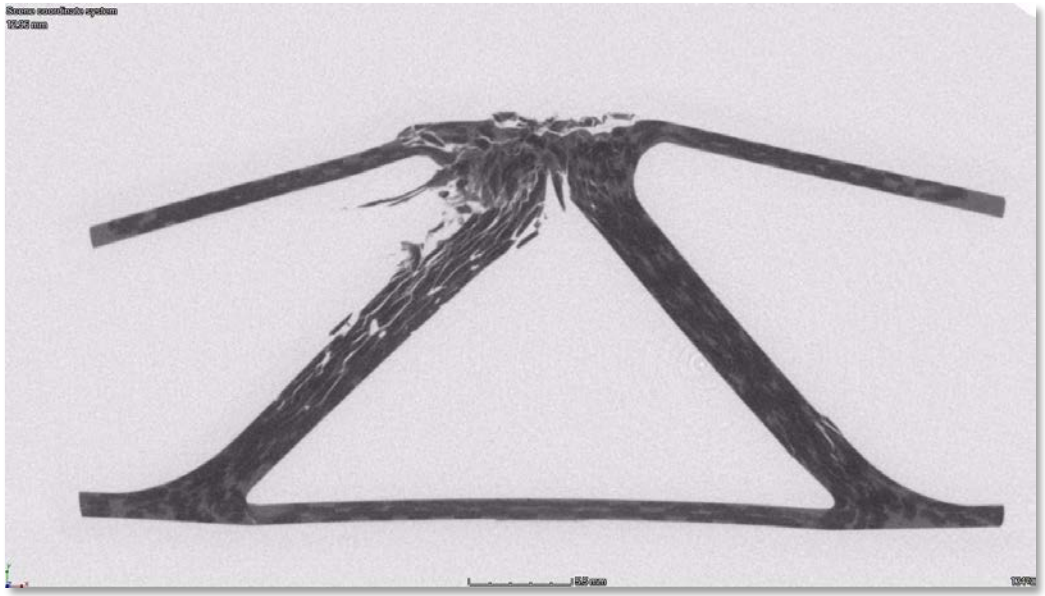


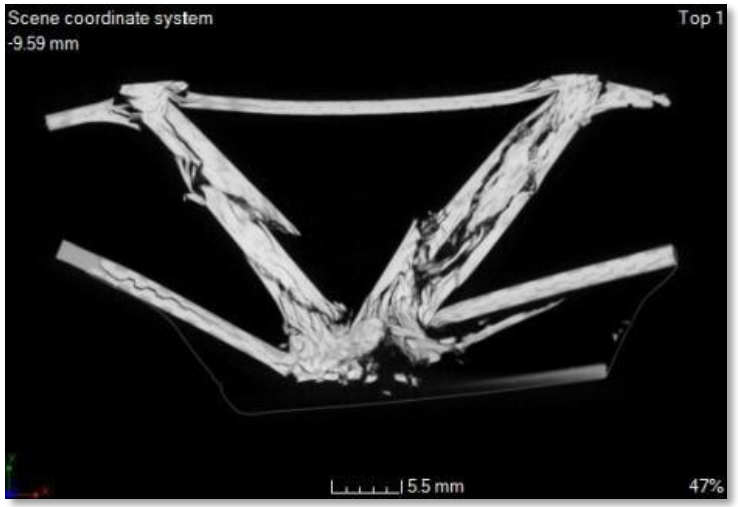
Unroll view of a primer

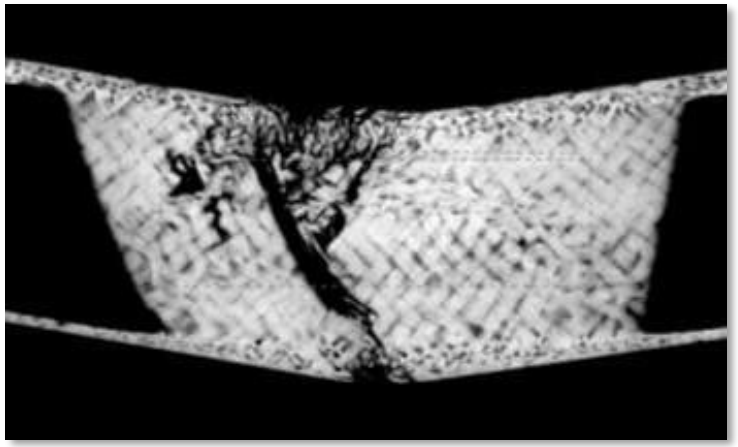


Composites: Truss Structure / Failure Analysis

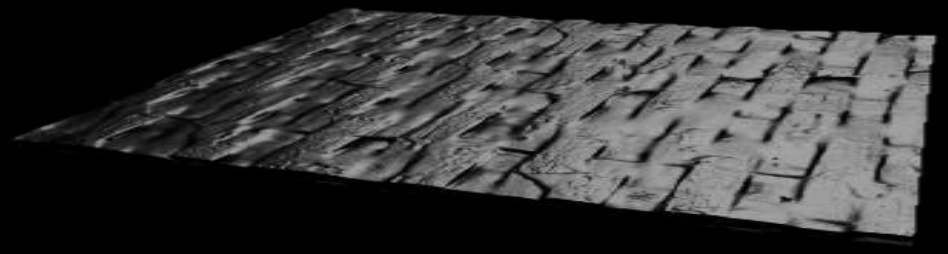


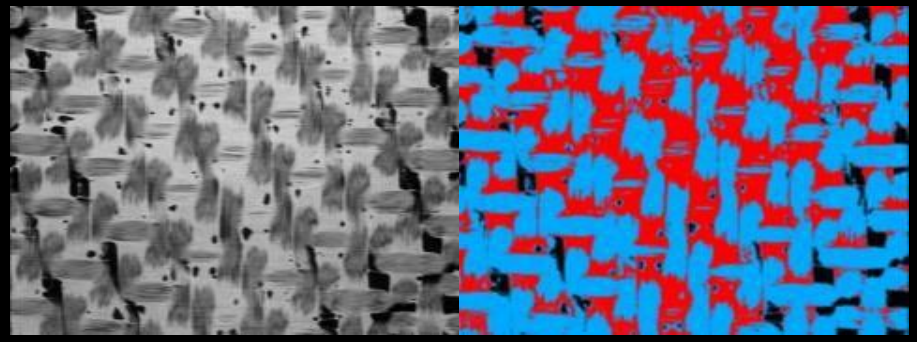


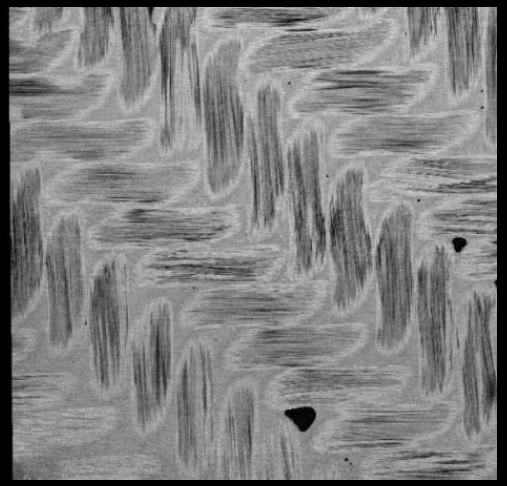


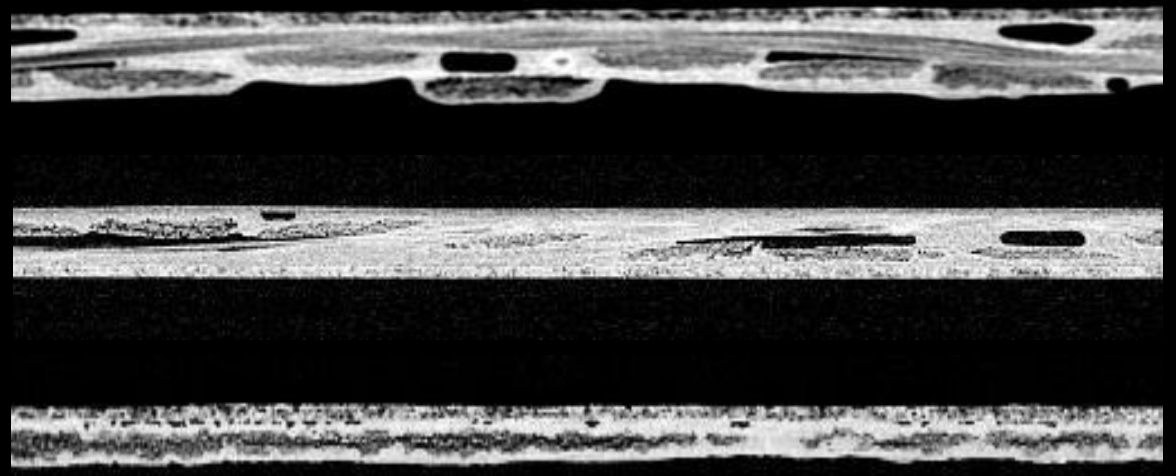


Composites: Void Analysis, Fiber Orientation

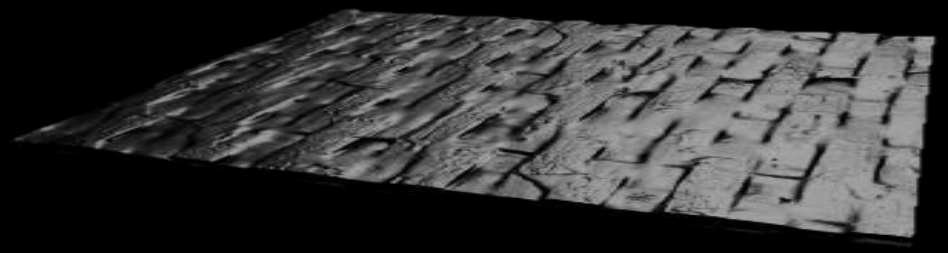


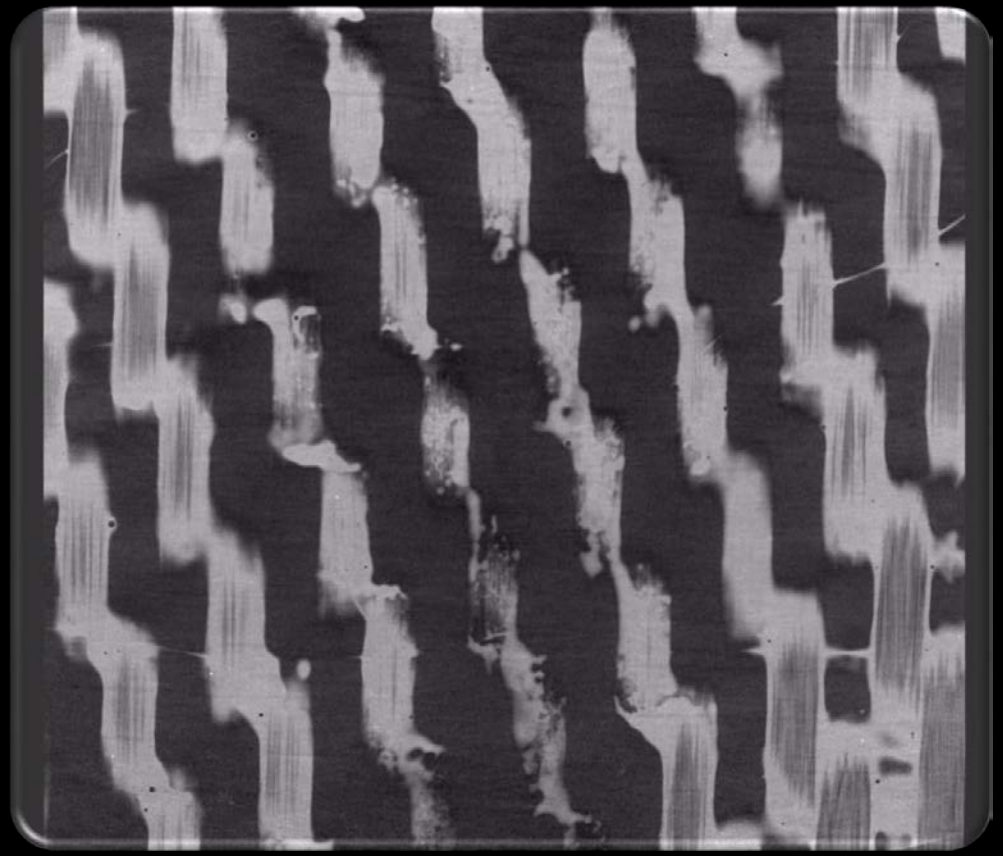






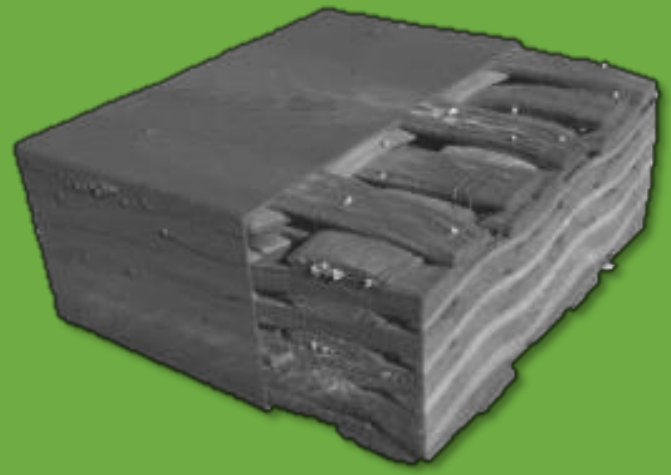
Composites: Void Analysis, Fiber Orientation (cont.)

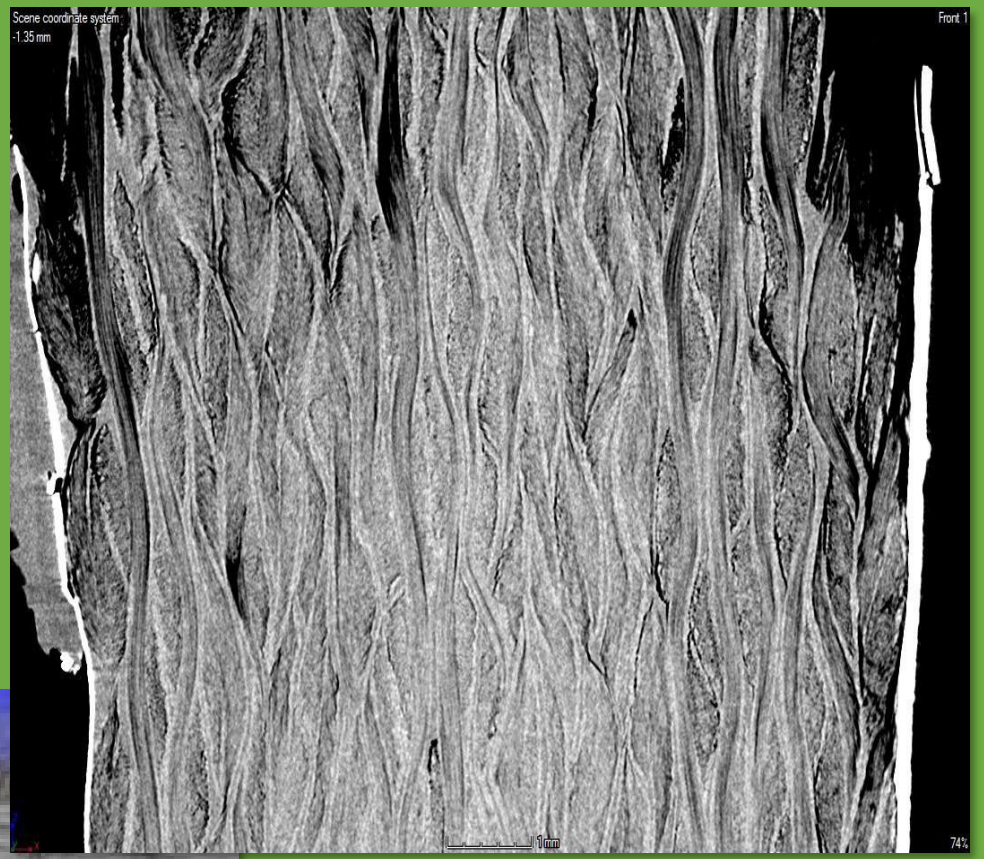


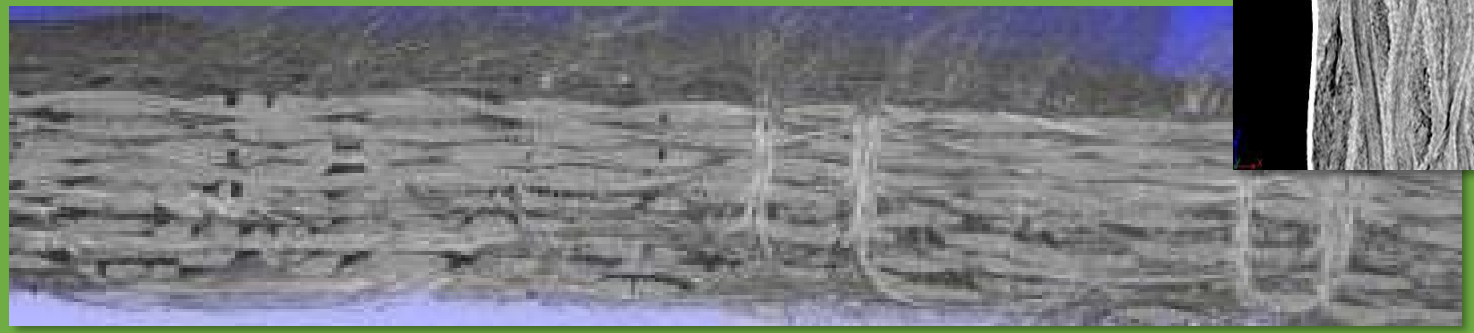


Composites: Woven Fiber Analysis

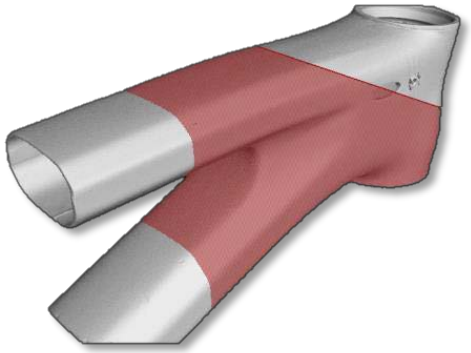
Analyze 3D weave structures, fiber integrity, needle damage, fiber orientation

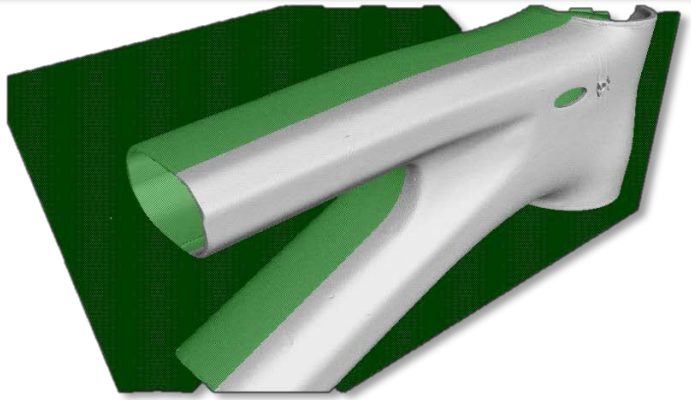


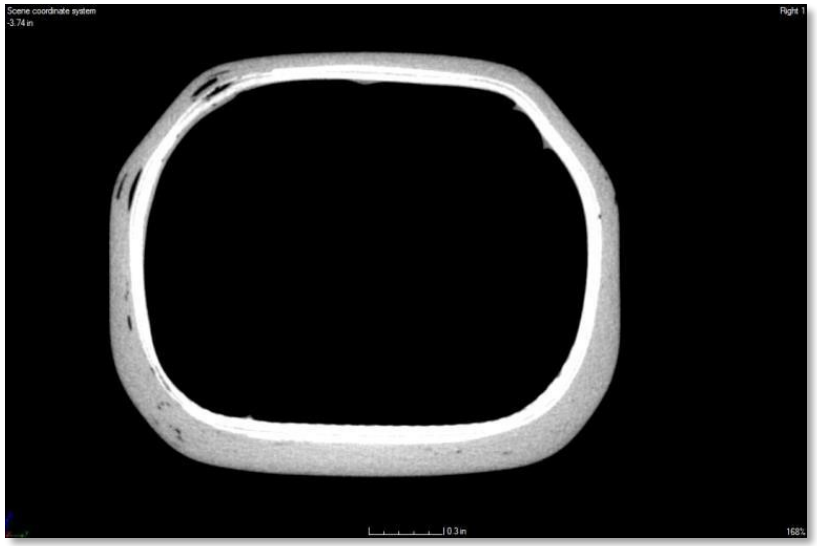




Composites:
Carbon Fiber Bicycle Frame

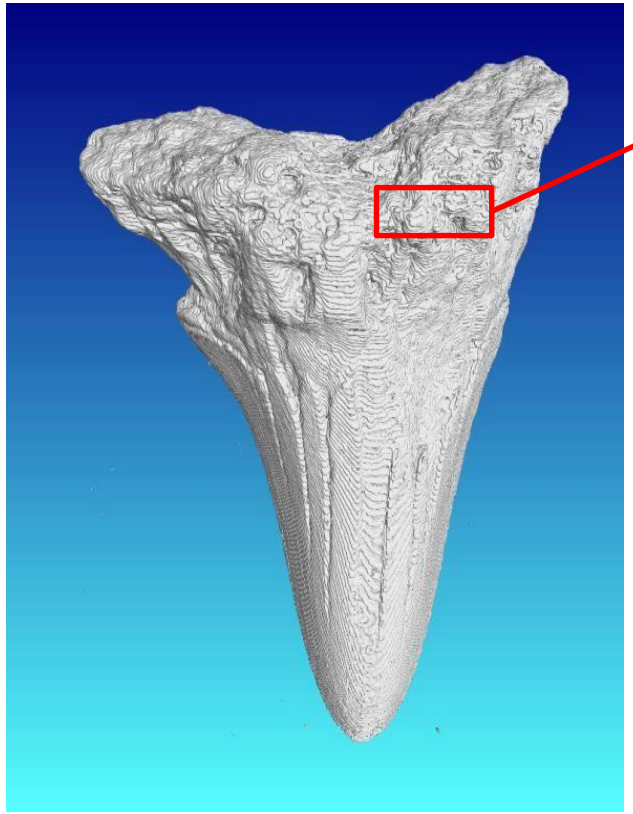


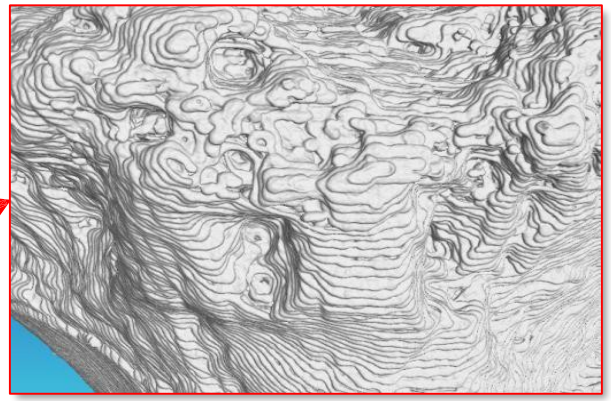


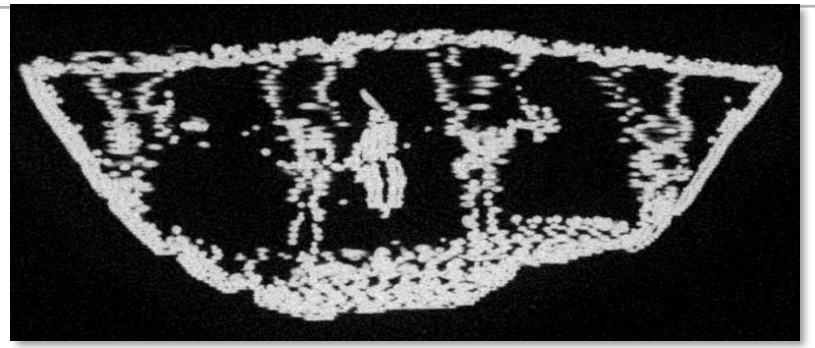


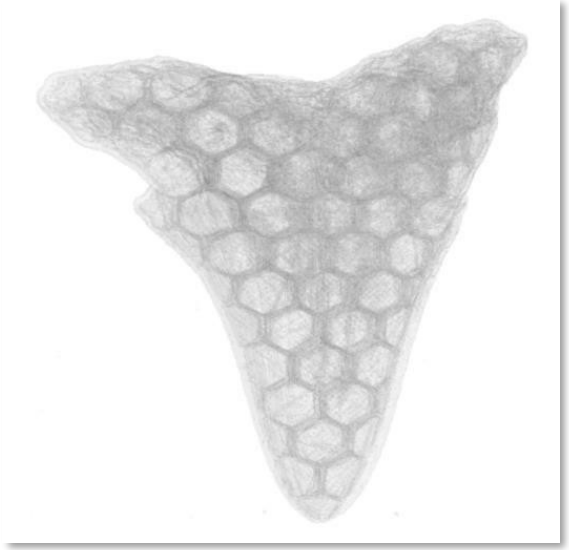
3D Printing / Additive Manufacturing

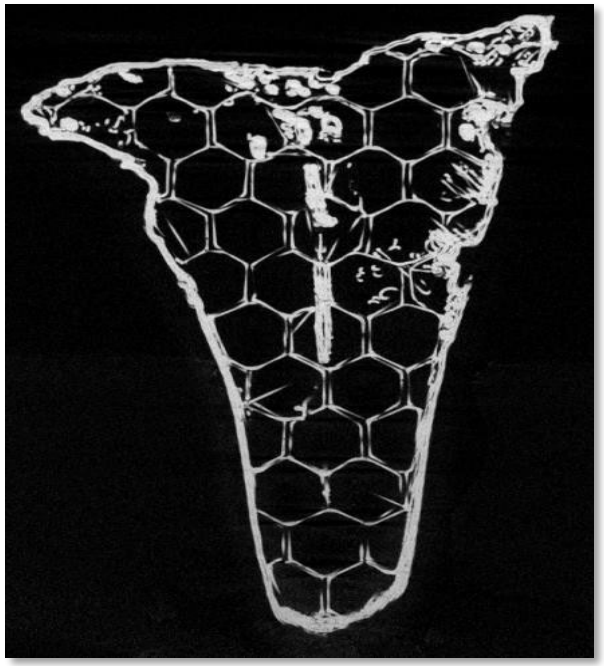
Quality Control, Reverse Engineering





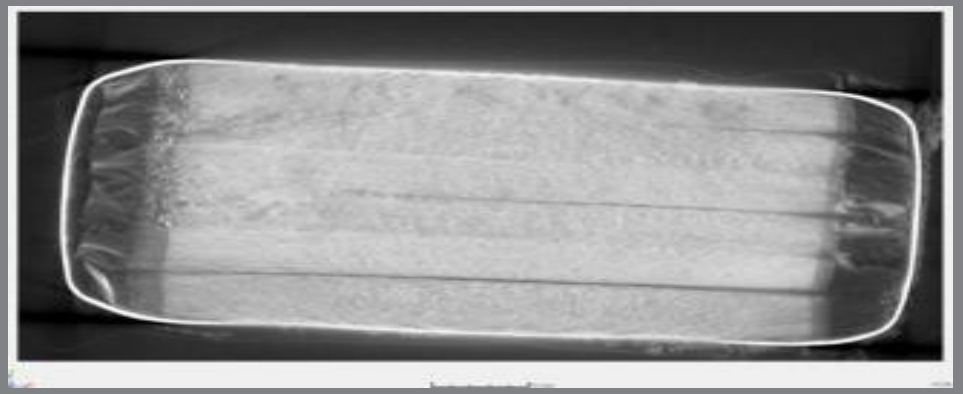




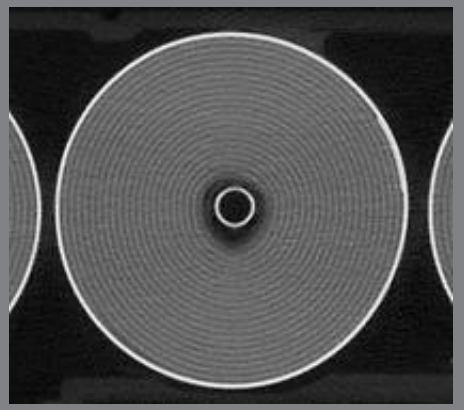


Electronics: Lithium-ion Battery Cells

- **Obtain resolution and contrast to resolve electrodes in roll**
- **Evaluate extent of damage**
  - Thermal damage, deformations, puncture, etc.
- **100% non-destructive**
- **Ability to receive, store, and test live cells**

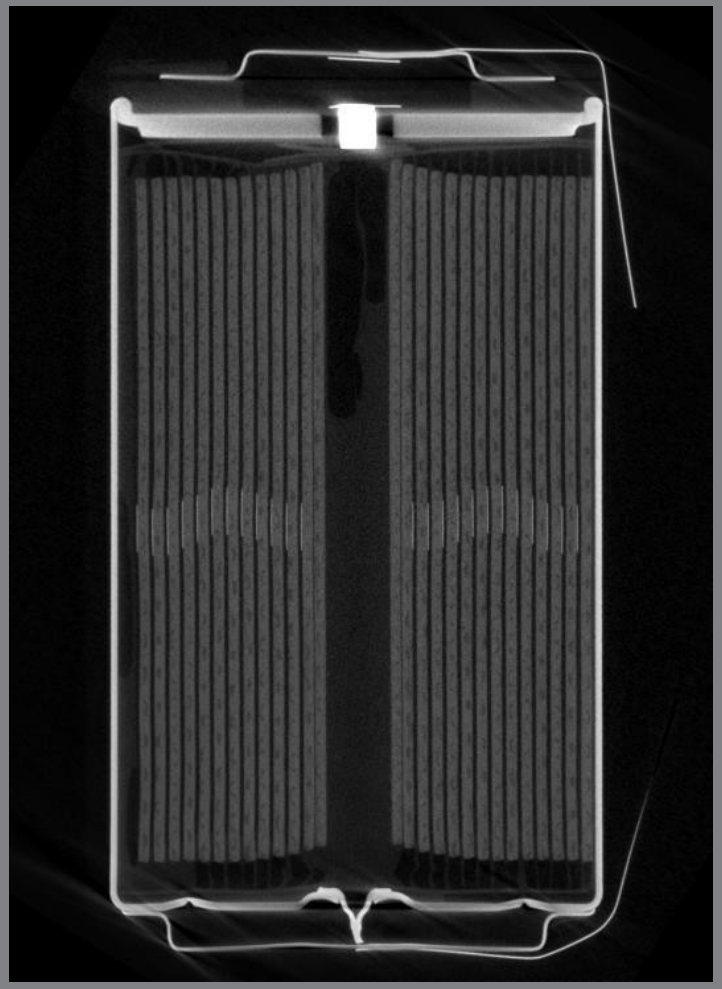


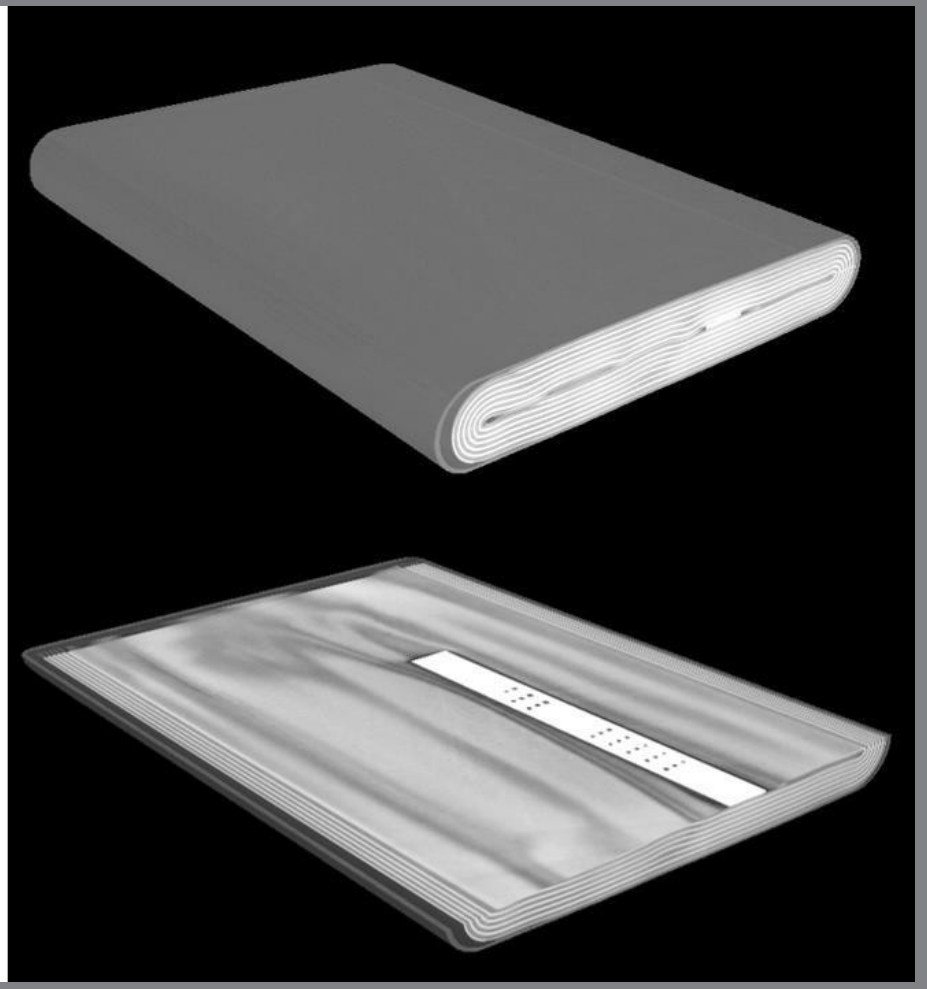
2013-2014: Chesapeake Testing awarded a sole-source contract by the NTSB for urgent non-destructive testing in support of the investigation of lithium-ion battery units.



Left: image from the NTSB Interim Factual Report, dated 7 March 2013

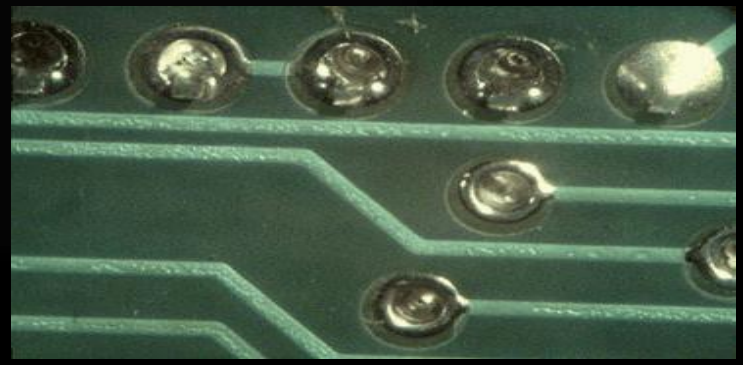
Electronics: Lithium-ion Battery Cells

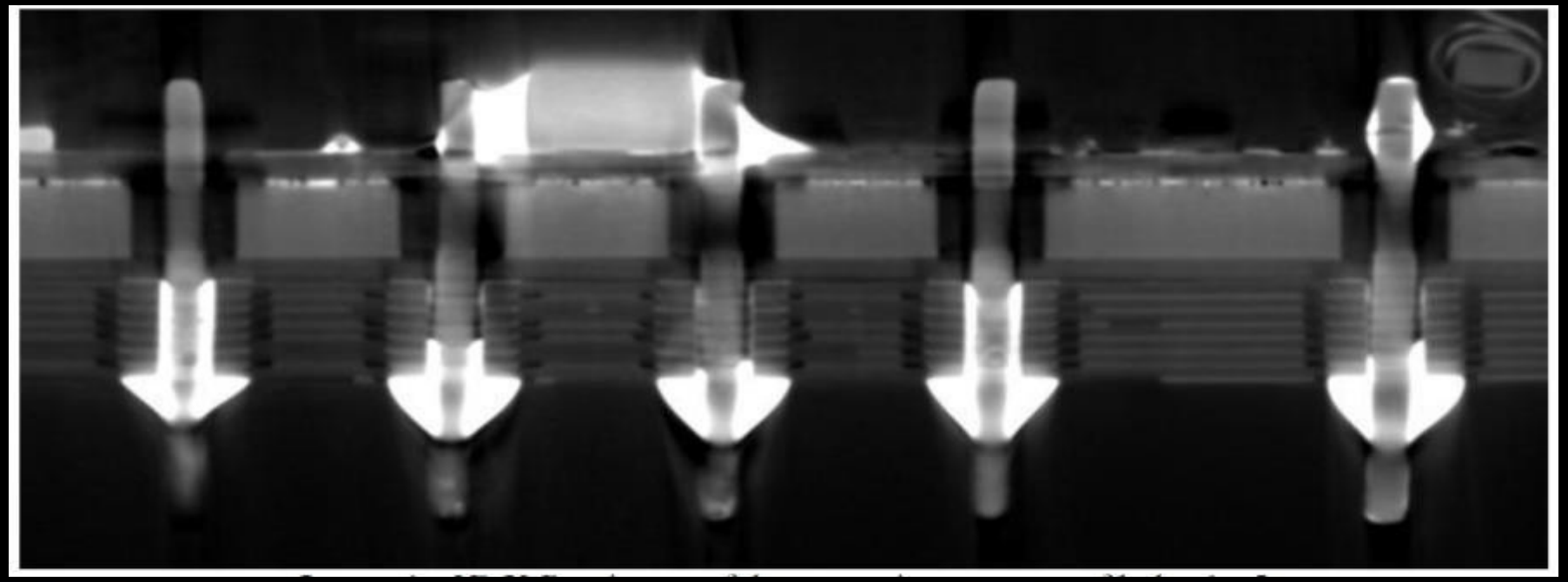




Electronics: Solder Fill & Quality

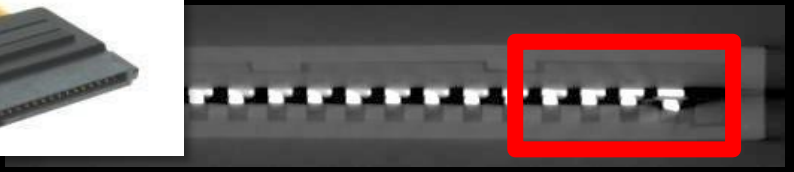
Obtain virtual cross sections to evaluate areas of high/low solder fill & effectively troubleshoot intermittent shorts/opens

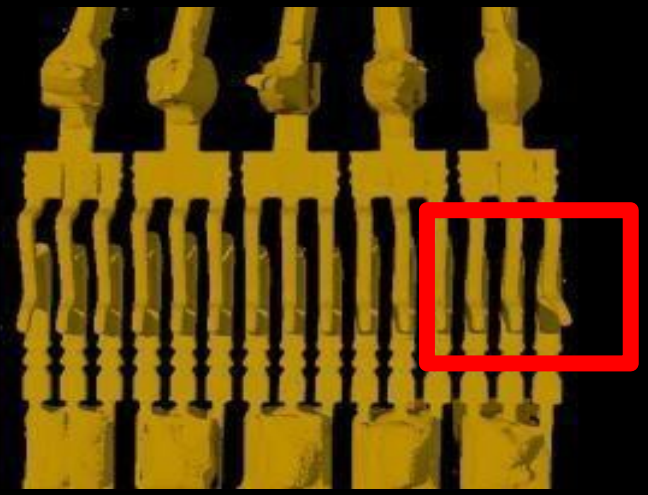


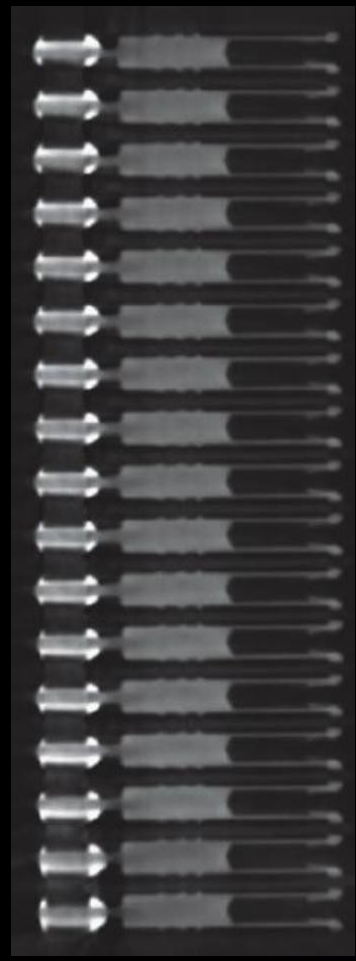


Electronics: Wire/Board Connectors

- Troubleshoot connections
- Assess mating quality under different stress/strain conditions
- Evaluate complex connectors

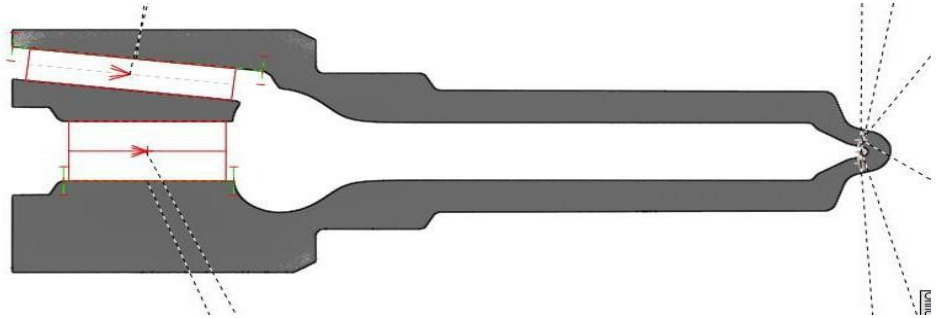


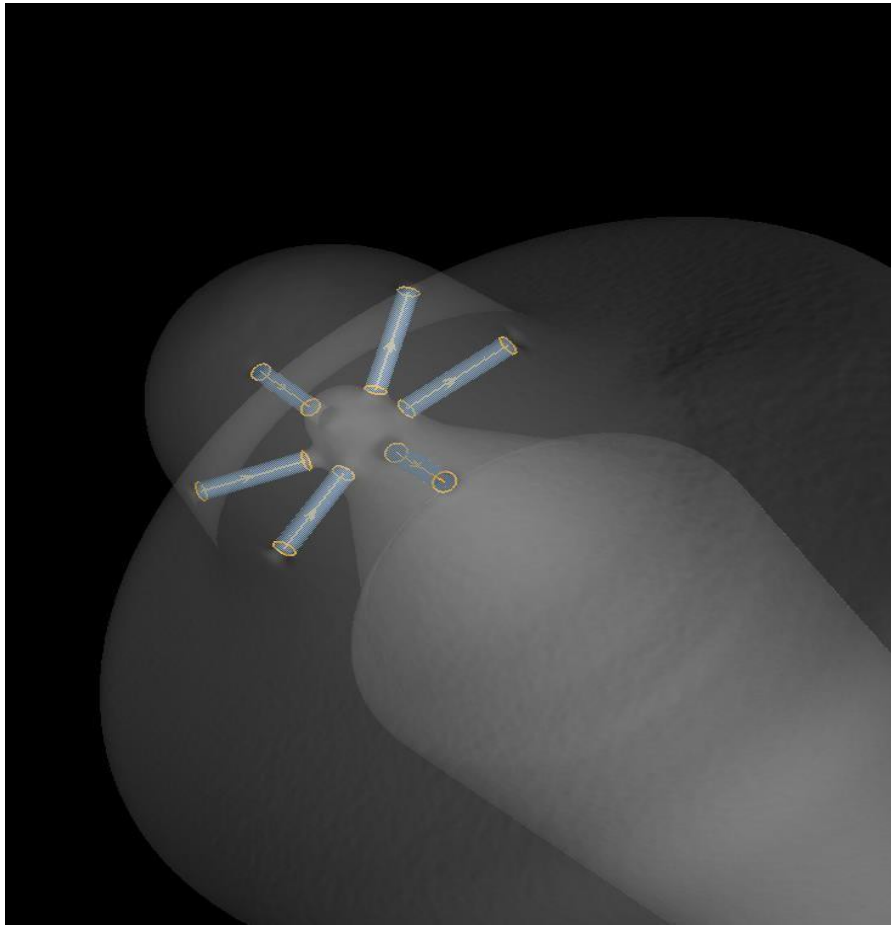




Internal/Hidden Surface Metrology

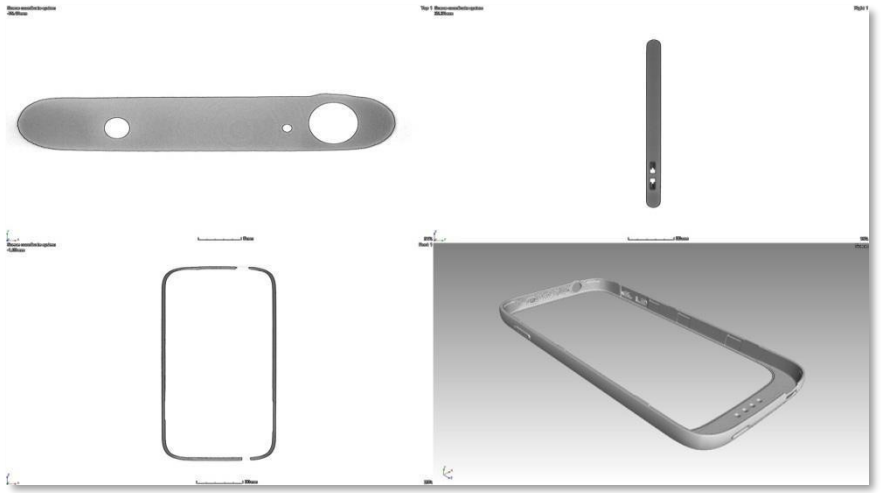
Geometric Dimensioning & Tolerancing, Part-to-CAD

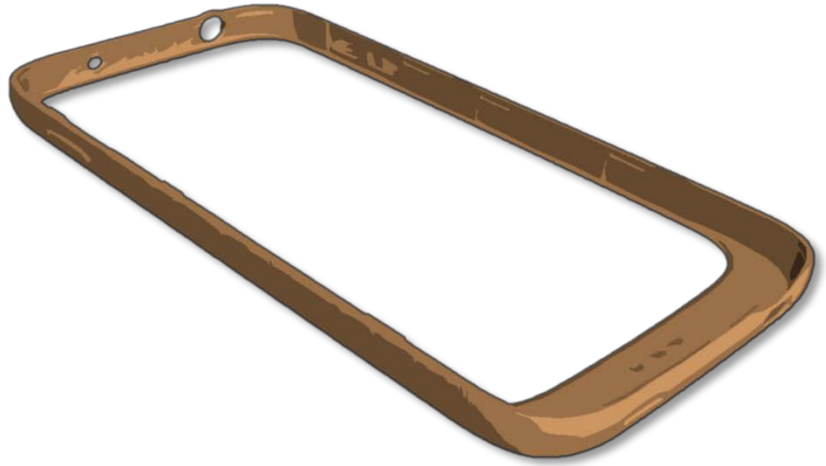




Other Applications
Metrology/Reverse Engineering

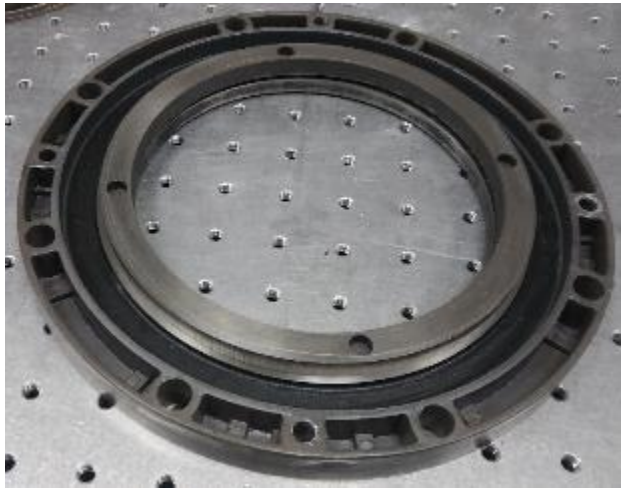
- **Generate surface geometries from complex-shaped parts**
  - Faceplates, bezels, connectors, etc.
- **All geometries captured in single acquisition – no stitching of multiple scans**
  - Reduces time, cost, error
- **Output formats include:**
  - Point Cloud
  - Polygon (STL)
  - IGES
  - STEP
  - Full-featured CAD (SolidWorks, ProE)

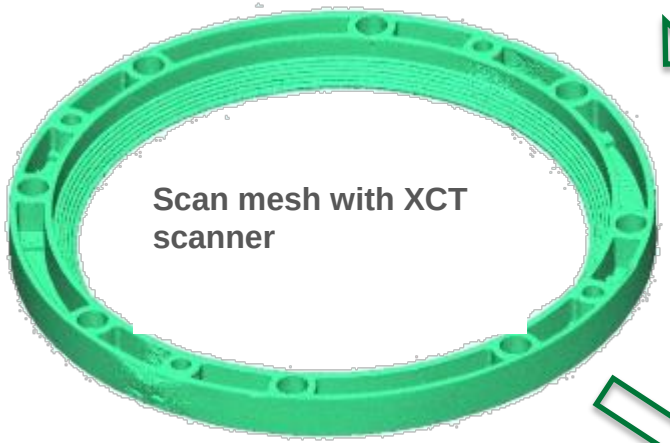




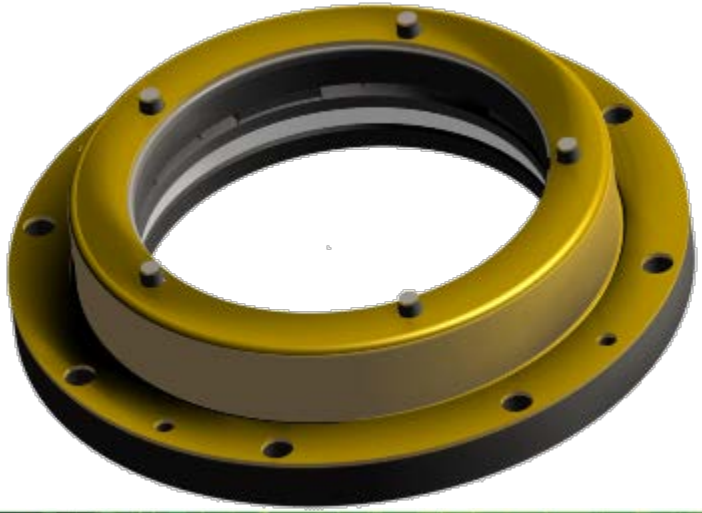
Other Applications
Metrology/Reverse Engineering

Obsolete component used to create TDP for re-manufacture





Scan mesh with XCT scanner



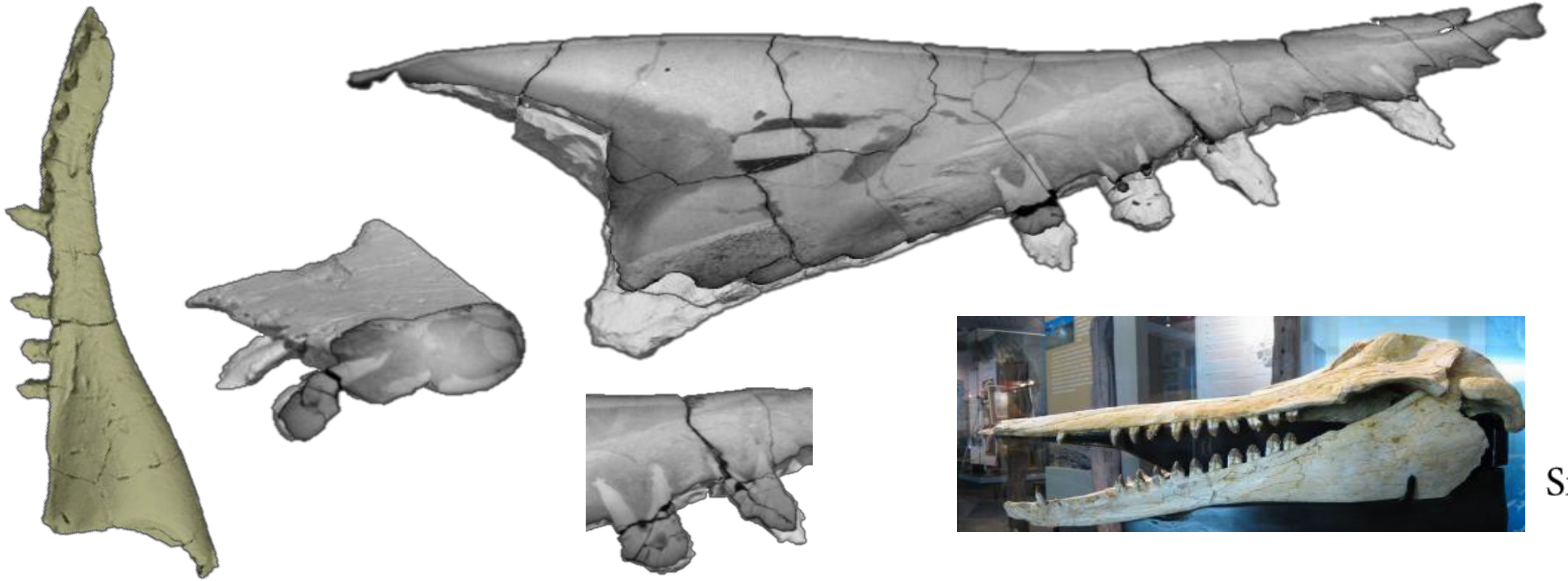
Conservation/Artifacts: Boxwood Prayer Beads

100% Non-destructive Analysis

3D Model Generated From Scan Data

Conservation / Artifacts: Smithsonian Fossils

***Waipatia maerewhenua*,** an archaic Late Oligocene dolphin (~26 million years old)



Smithsonian Institution

Contact Information

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