

# WHITE PAPER

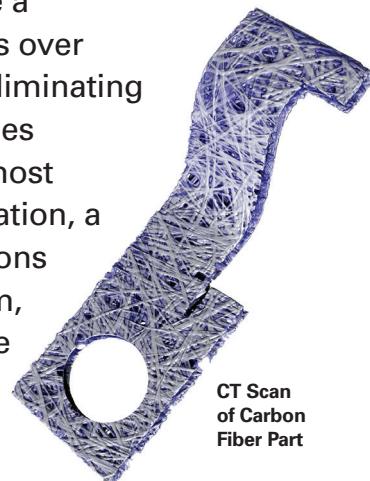
## Are Third-Party Industrial Computed Tomography (CT) and Digital X-ray Inspection Services Right for Your Business?

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## Abstract

Virtually every manufacturer must perform some kind of testing or inspection to ensure their products meet their own internal quality standards, governmental requirements or the standards their customers set. A growing number of industries use some form of nondestructive testing (NDT) to ensure that structural and mechanical components perform their function in a safe, reliable, and cost-effective manner. Given that NDT doesn't alter the article being inspected, it can save both money and time in product evaluation, troubleshooting, and research. Although there are a wide variety of NDT methods, some of the most common ones include ultrasonic testing, visual and optical testing, magnetic particle testing, penetrant testing, eddy-current testing, and low coherence interferometry. Digital radiography, including computed tomography and metrology, has become a particularly popular choice because of the advantages it offers over traditional X-rays, including greater time efficiency through eliminating chemical processing, the ability to transfer and enhance images digitally, and the lower level of radiation required. Once the most appropriate form of NDT is determined for a particular application, a manufacturer must decide whether to perform these inspections in-house with an existing system or to purchase a new system, which can represent a major investment for any company. The other option is to farm them out to a third-party inspection service.



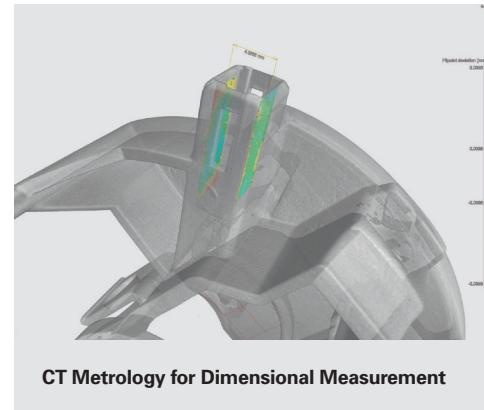
## Buying inspection equipment vs. buying inspection services

In order for a manufacturing operation to make that buy-equipment vs. buy-services decision intelligently, management needs to answer a number of important questions. For the purposes of illustration, we will use digital radiography equipment as an example to examine these questions.

- **How often do you need digital scanning services in order to run your business?**  
If the demand is intermittent and fairly time-insensitive (i.e., if you don't need inspections performed immediately to keep a production line operating), buying inspection services probably makes sense for you. Let's say that you just need to scan some prototypes to ensure they meet your internal specifications before transitioning into full production. Or if a particular application is only seasonal

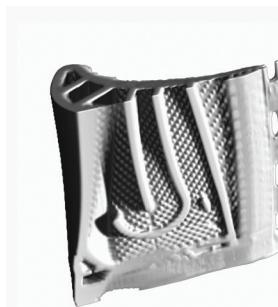
(such as a product that is only manufactured for a limited period), you should also consider buying inspection services rather than investing in a system that will sit idle for most of the year. However, it's important to take all the time necessary to do a careful review of all the radiography applications involved (or parts that could be inspected radiographically) and how frequently they are called for.

- **Do the inspection services you're considering offer the specific capabilities you need?** Not all inspection services can supply the same types and quality of inspections as others. For example, check to make sure the inspection provider has the equipment and qualified personnel necessary to perform the specific services you need, like defect and porosity identification, internal inspection and validation, dimensional measurement capture for metrology or reverse engineering for 3D printing, etc.
- **How much experience does the inspection service have in scanning the kinds of objects you need scanned?** Computed tomography is often applied to scanning objects as diverse as electronics, cast metal parts, cultural/archaeological artifacts, aerospace components, vertebrate anatomy, rock/drilling samples, implants, etc. It's also often applied in research, such as in new materials development. However, getting the clearest, highest resolution image when scanning these objects requires familiarity with both the type of object and the types of equipment and software best suited to scanning it.
- **Are you planning to add new services/products that will demand greater/faster access to digital scanning services?** Changing customer demands are inevitable, so start talking to customers early about their future needs. If their customers are demanding greater verification of part quality, having an in-house system may offer the flexibility you need to supply it. A thorough cost/benefit assessment is essential to justify a system purchase of this type.
- **Are your customers demanding faster turnaround/delivery on parts?** If you discover a major customer is planning on tightening their turnaround time requirements to implement just-in-time manufacturing, purchasing an in-house system might make an important difference in the lead times you can quote. Or if the need is sporadic, third-party inspection service providers can serve as an extension of your production line and help keep you on schedule.



- **Do you plan to introduce any products that will require high-resolution scanning to ensure you are meeting your own in-house specs?** Research and development activities often require the ability to scan objects to gauge the impact of minor changes to a form or design. Having an in-house inspection system with the capability to do dimensional and quantitative measurements on the interior of your product would speed up the trial and review process substantially, reducing time to market. However, if your R&D needs are few and far between, the third-party inspection service provider will likely be a better fit.

- **Are your end-users requiring you to meet a new set of production standards?** New standards can be the result of a variety of factors, such as new governmental requirements, an updated industry standard, a sudden rash of recalled parts, etc. For example, several international aerospace material standards were created by ASTM (American Society for Testing and Materials) for digital radiography. They have been readily adopted and are referred to frequently (such as ASTM E2736, E2699, E2597, E2698 and E2737). Together, they address topics ranging from the long-term stability of digital detector arrays to guidelines on the best way to implement this technology. The benefit of 3rd-party inspection services is that they have these certifications and past experience in testing to these standards.



CT Image of Turbine Blade

- **Are you planning to transition from your current film radiography equipment to digital?** If so, be aware that this transition will require significant planning, time, money and effort. Inspection services might offer a good way to bridge the gap while you are investigating the type of equipment you want to purchase, getting it installed, training personnel, etc. For more information on making this transition, download a free guide, [Managing a Successful Transition from Film to Digital Radiography](#).
- **Are you weighing various scanning options for a future purchase?** Although it may sound counter-intuitive, using an inspection service with a range of equipment offers a good way to evaluate the quality of the output of a particular system before you buy. In this way, you can eliminate surprises after you buy a system and you can be more confident that the results obtained through the inspection service will correlate well with those obtained from your in-house system.

- **How large are the parts that you want to scan?** If your operation will regularly require the ability to scan larger parts, buying an in-house system optimized for larger objects is likely the most economical solution. However, if there will be only a few oversized/unusual scan requirements, it might be best to buy one system that's sized for the work that must be done regularly but "farm out" the ones that are only rarely needed.
- **Is there a competitively priced inspection service provider who can perform the services you need with the quality your process demands and in a workable timeframe?** If not, you'll likely need to invest in an in-house system to keep your own operation on schedule. The following sub-points can help you explore your options.
  - **Compare prices from multiple inspection services that offer the specific set of capabilities you require.** Don't hesitate to request quotes from multiple service providers on the same project to ensure an apples-to-apples comparison.



- **Do a trial project to evaluate the quality of the image that each service provider's equipment is capable of producing.** Again, have scans of the same piece performed by multiple providers in order to make an apples-to-apples comparison.
- **Investigate the level of training of the personnel who will perform the scan.**

Although third-party service providers all generally work within international standards, such as ISO (International Organization for Standardization) and previously mentioned ASTM, all scans are not created equal. Image quality often depends almost as much on the skill of the operator as it does on the



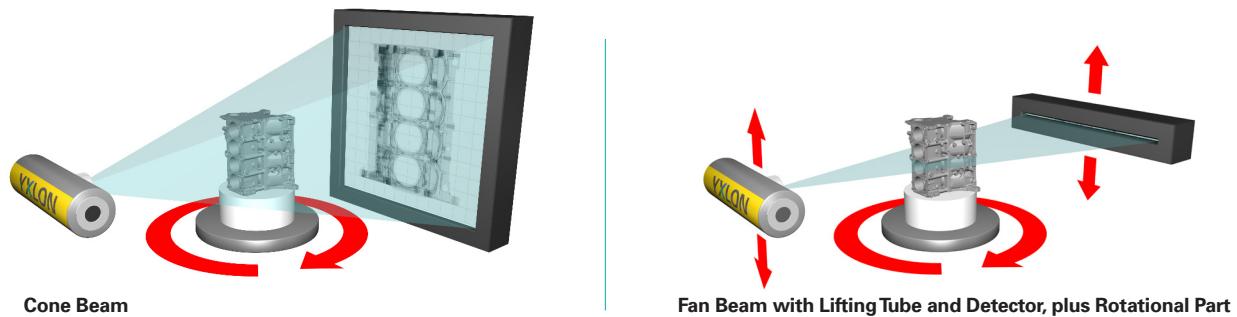
sophistication of the equipment used. Most systems, regardless of manufacturer, are working with much the same third-party software to produce results. That means the true differentiators between one service provider and another is the quality of the system used and the skill of the operator. Although competitive price is important, it's of small comfort when the final result is an image that doesn't capture the part features you need to visualize.

- **What are the quoted turn-around times for the various services?** Don't forget to factor shipping times into this turn-around time. Look for a service provider with multiple locations that is capable of performing the specific scans you need quickly. For consistent quality worldwide, find a trusted player in the global marketplace.
- **How up to date is the equipment that will be used to perform the scans?** In general, the newest systems provide the highest resolution/best image available. A vendor service provider should update their equipment and software on a regular basis, to assure the highest quality results and the most reliable service.

Just as no single digital radiography system is right for every application, no single inspection service is right for every nondestructive X-ray testing need. However, with careful research and the willingness to ask some probing questions, you can make smart decisions about whether in-house equipment or third-party services make the most sense for your organization. For more insights on making that decision, visit our [Inspection Services](#) webpage.

## What Kind of Digital Scanning Does Your NDT Program Require?

The first step of buying either equipment or services is to understand exactly what you are buying. Let's start with a quick overview of one of the most widely used techniques for industrial applications, computed tomography (CT). The word *tomography* comes



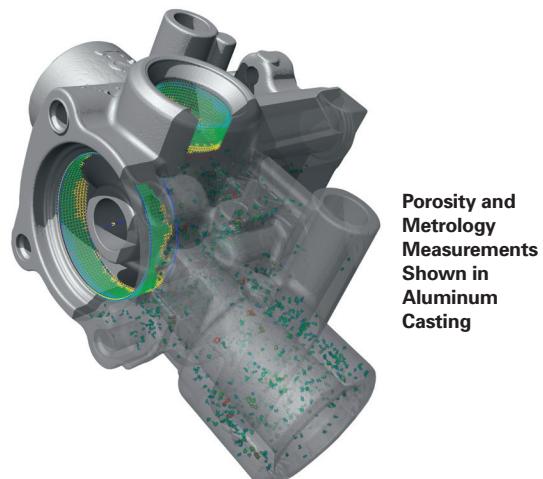
from the Greek words *tomos* (meaning slice) and *graphein* (meaning to write), and the word literally means “imaging by sections.”

This technique allows you to see inside a part or product to view defects, make measurements, and see density changes without damaging the object under inspection. An entire part can be analyzed for both flaws and dimensions in the same scan automatically. To generate a CT data set, a series of 2D x-ray images is taken at specific rotational steps, usually through 360 degrees of rotation. As the 2D images are captured, the reconstruction can begin, and “tomograms” are created for each row of pixels. Tomograms are virtual slices through a three-dimensional object, in which each gray value represents a different density: the brighter the gray value, the denser the material within the object. Black equals empty space or air (in a negative image). Converting this data to create a realistic 3D model is called volume rendering. Volume rendering of the external and internal geometries of the object makes sophisticated, photorealistic visualization possible—with adjustable shadows, opacity, camera angles, video creation, etc.

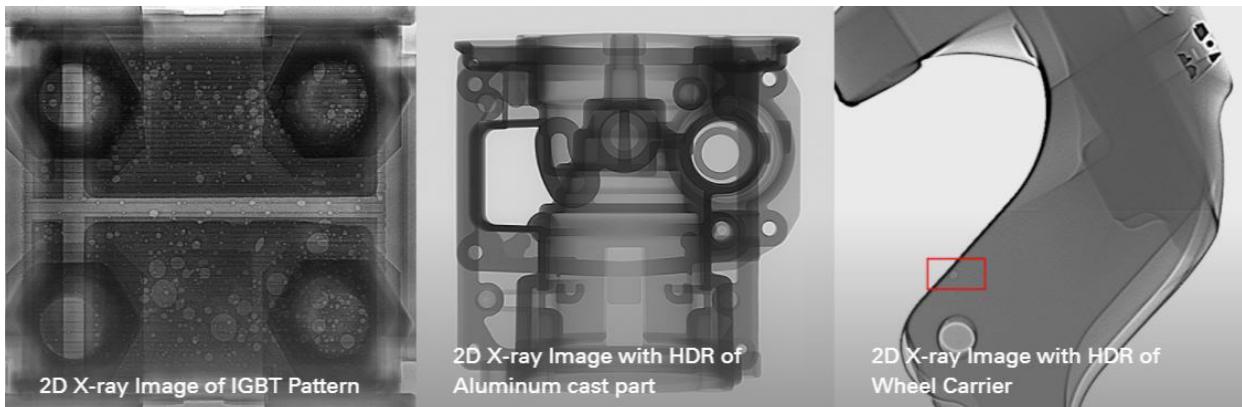
CT techniques are widely used in materials analysis, defect recognition, failure analysis, statistical process control, metrology, assembly analysis, image-based finite element analysis, reverse engineering applications, and the detection of counterfeit board-level electronic components and aircraft components.

CT is also used to provide feedback for “dialing in” production parameters for additive manufacturing methods by making it possible to see internal problems, like porosity, cracks, inclusions, and leftover powder in a cavity.

YXLON is known worldwide and highly respected for their NDT inspection services using their 2D, 3D, high throughput and metrology X-ray systems. CT inspections are among the most popular services offered. YXLON Inspection Services are available worldwide at eight locations -- equipped with radiographic and CT systems ranging from 160 kV to 600 kV and component dimensions up to a diameter of 1,120 mm (44 inches) and a height of 2,200 mm (86 inches). One highlight of the worldwide offering is the linear



accelerator at YXLON in Hattigen, Germany. It is one of the few systems in the world available for services involving high-energy applications up to 9 MeV. In North America, YXLON Inspection Services are available in two locations: Hudson, Ohio and in the Silicon Valley of California. All YXLON facilities are equipped with current YXLON systems, updated regularly, to offer inspection services customers the latest advancements in scanning and imaging. They are staffed by technicians with in-depth experience with both the equipment and the software.



Both facilities offer a variety of inspection services:

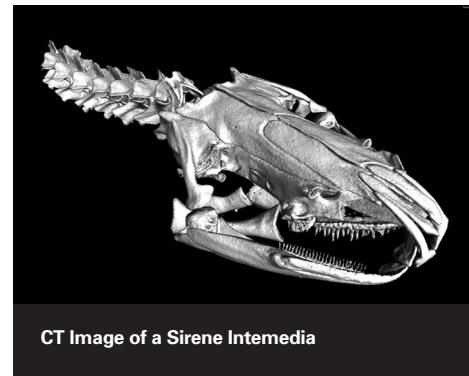
- Consultation to define inspection specifications
- Technical and commercial consultation to identify an optimum inspection solution
- Inspection, analysis, and data processing
- Delivery of inspection results and reports
- Training for CT applications
- Support during periods of peak demand or other constraints

Currently, the facility in Ohio has four systems available to provide inspection services to customers:

- The **FF35 CT** is a high resolution industrial CT System for inspection of small-/medium-size parts, such as electronic components like surface-mount devices, semiconductor packaging, microsystems, medical devices, small metal parts and small castings. It is also useful for applications such as research and development, failure analysis, process control, small series inspection, combined Direct Radiography-CT inspection, defect and material analysis, assembly checks, and



dimensional measurement. The FF35 CT's dual-tube-configuration (nanofocus transmission tube and high power microfocus tube) makes it extremely versatile. Unlike systems that require stitching together different areas of a tested object, the FF35 CT's HeliExtend (YXLON helical CT) function allows automatically composing a single highly accurate image. Ring artifact and beam hardening correction further enhance image quality.



CT Image of a Sirene Intemedia

- The **CT Modular** is a double detector, double tube array system that supports applications ranging from measuring small electromechanical components to analyzing large cast parts or even massive cultural artifacts. Its helical CT capabilities eliminate the need for image stitching for more accurate imaging of tall parts. It incorporates a laminography technique that precisely displays details that can't be distinguished in 2D industrial X-ray images. Laminography allows for a wide application range, so that you can, for example, have flat parts like car doors and circuit boards scanned with permanently high resolution. The CT Modular is well-suited for inspections of heavy metal castings, aluminum and steel components, cylinder heads, engine blocks, transmission housings, fiber-reinforced composites, plastic injection molded parts, mechatronic modules, small aluminum cast parts, art and archeological objects, and geological samples.
- The **MU2000-D with CT** is often used for casting inspections for high volume parts production as well as for R&D. It can detect casting flaws in items such as aluminum castings like engine blocks, cylinders, cylinder heads, pistons, and knuckles. It can also be used for inspections of turbine blades, wheels and tires, fiber-reinforced materials, ceramics, and 3D printed materials. The CT analysis station allows providing detailed casting-flaw information thanks to 3D reconstruction of the CT scan. Its interface generates data to be used in fields such as machine learning, Big Data, the Internet of Things, and machine-to-machine communication. In order to ensure acceptable inspection quality of your safety-critical components, the MU2000-D complies with current industry standards like ASTM and specific car manufacturers' requirements. Proving its wide application and reliability, YXLON recently installed its **600th system** of this type.
- The **Cheetah with CT** is a microfocus and nanofocus X-ray inspection system optimized for the printed circuit board assembly (PCBA) and semiconductors

industries. It's also suitable for inspections of electronic and mechanical modules, electromechanical components and plugs, semiconductor packaging and interconnects, sensors, and MEMS and MOEMS. It combines multiple YXLON innovations: FeinFocus X-ray tube technology, High PowerTarget technology, a finely calibrated, long-life flat-panel detector, and a manipulator with cushioned bearings. A variety of sample tables allow generating 2D and 3D images in extremely high resolution. The microCT module is designed for industrial quality assurance, with in-depth 3D examination of inspection items via virtual cross sections and layers.



YXLON FF20 CT and FF35 CT Nondestructive Test Inspection Systems

The Inspection Services facility in Silicon Valley, [Comet Group Lab One](#), opening in the Fall of 2017, also has four systems:

- An [MU2000-D with CT](#)
- A [Cheetah with CT](#)
- An [FF35 CT](#) or [FF20 CT](#). Like the FF35 CT, the FF20 CT is a high-resolution computed tomography system, perfectly suited for inspection of your small items.
- The [CT Compact](#) system is a highly efficient fan-beam CT inspection system optimized for acquiring high-resolution 3D images for medium to large casting parts, particularly those with high density.

Jorge Martinez, a regular customer of the YXLON facility in Ohio shared his experience with YXLON's Inspection Services:

*I am a Senior Product Engineer with the AeroControlex Group (AeroControlex) and previously with Aero Instruments. My work is primarily in research and development, with considerable emphasis on product evaluation and analysis. AeroControlex manufactures various styles of pitot static tubes, total air temperature sensors, and pressure ports. These products are well known as*



*"speed sensors" for commercial and military avionics and are critical for the aircraft performance and safety. Thanks to YXLON's sophisticated X-ray equipment, technology, and well-trained staff and engineers, we have been successful in identifying, analyzing, and eliminating numerous concerns with our products. I use YXLON to run failure analysis and nondestructive visual radiographic inspections and analysis, assuring the dependability of our products. YXLON's commitment to quality, dependable customer service, plus their dedication to our specific needs and fast turn/response times have been a major contributing factor to the success of my department and product line.*

To learn more about what YXLON's Inspection Services can do for your operation's inspection quality and bottom line, email [inspectionservices@yxlion.com](mailto:inspectionservices@yxlion.com), call 234-284-7849 or find out more at <http://www.yxlion.com/service/yxlion-inspection-services>.





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