October 28, 2022
Quotation # 2202119v01
Confidential

Jutima Simsiriwong
Assistant Professor of Mechanical Engineering
University of Northern Florida
1 UNF Drive
Jacksonville, FL 32224
By E-Mail: j.simsiriwong@unf.edu

Dear Jutima,

We are pleased to be supporting you with a proposal for our ARAMIS Professional 3D DIC system. The ARAMIS 3D system is the most highly capable digital image correlation system in industry, for full field 3D deformation and strain measurement, providing an optical replacement for strain gages, extensometers, and most other contact deformation measurement tools. This system is highly accurate and saves substantial money in time, effectiveness and quality of data.

We understand that you need to measure various specimens in your lab for material characterization, including additive manufacturing.

There are various combinations of camera resolution, frame rate, and sensor mechanics styles available. For these, tests, 12 megapixel resolution is suggested, rather than 2.3 megapixels. A studio stand is a worthwhile upgrade from the heavy duty tripod kit, so is quoted as a highly recommended option. The 12M cameras have a maximum frame rate of 25 fps at full resolution, and can do 100 fps in binning mode at 2048 x 1500 pixels. Our SRX fast 12 megapixel system can do 75 fps at full resolution, and 500 fps at 1920 x 1000 pixel in base mode, or 335 fps at full resolution and 1,000 fps at 1920 x 1000 HD mode. This does not seem to be needed for your applications.

The 3D Camera mechanics style offers much faster and easier setup, and also greater stability than the adjustable base. The industrial sensor is pre-aligned for a set working distance, and fields of view are changed by simply swapping pre-focused lenses, and taking the calibration images. In addition, the light projector provides a much more uniform top-hat intensity profile, and is pre-aligned to the field of view, compared to the Gaussian intensity profile of the LED light pair on flexible arms, on the adjustable base. The adjustable base allows for a much wider range of exact fields of view, using a single pair of lenses, but requires a 15 minute or so alignment process each time the field of view is changed.

The 3D camera sensor costs a little bit more than an adjustable base for a single measuring volume, and costs somewhat more when a wider range of sizes needs to be covered. Each 3D camera measuring volume requires an additional pre-focused pair of lenses and a calibration object, and may also need additional frame lengths as well as a second type of light unit. With the adjustable base system, the lenses can be refocused for a wide range of working distances and thus sizes of fields of view, using the same frame and lighting, and a single calibration panel covers a broader range of sizes. The adjustable base can be set for any exact desired field of view, typically slightly larger than the specimen size. The 3D camera has discrete sizes available, such as 35, 70, 120 and 180 mm. If only the 70 and 180 mm sizes were purchased, and the specimen size is 90 mm, the 180 mm field of view would need to be used. However, given the high resolution of the cameras, with which local strains can be measured for a strip 75 times smaller than the total field of view, this is usually an acceptable compromise.

Line item 1 is for a 12 megapixel adjustable base system, which provides a wide range of fields of view and working distances, but without the greater ease of use of the 3D camera style mechanics. One calibration panel and one pair of lenses are included. The same tripod kit and rack PC in a cart are provided. Line item 2 is for an additional calibration panel.

Line item 2 is for our phase stepping kit, which uses a strobe and precision timing to acquire images representing a complete cycle at any desired phase step.

Pricing includes a Trilion 5% university discount.

Line item 3 is for a studio stand upgrade, which will provide greater ease of use than the heavy duty tripod and pan-tilt head. This is highly recommended for either the 3D camera or adjustable base sensor.

The system is quoted with the standard rack PC in a cart. Full frame rate performance is also available with a laptop PC, at some cost savings, with slightly reduced computation performance.

With each system purchase, we conduct an onsite beginner training workshop for up to 3 primary users. This workshop covers the basic use of the system, the fundamental theory of the DIC technique, and the core concepts required to get the best quality data. Three days of training are included in this quotation.

I. Recommended configuration

Item	Price (USD)

1) ARAMIS Professional 12M Adjustable Base System
• 12 Megapixel camera pair
  ○ 4096 x 3000 pixels
  ○ Frame rate up to 25 Hz at full resolution
  ○ With reduced resolution up to 100 Hz
• 500 mm frame
• Sensor hub with active triggering
• USB3.0 GenICam interface
• ARAMIS Professional software for image acquisition, data analysis and live processing
  ○ Live analysis
  ○ Full automation capabilities
  ○ Automated material characterization analysis
• CP40 MV100 calibration panel
• 50 mm lenses
• GOM Testing controller (8-channel data logger)
• Standard tripod, extension arm, pan-tilt head
• Computer 5820 – Workstation
• Heavy-duty rolling rack with monitor
• Dual LED illumination
• Laser Pointer and Lighting Control
• 1-year Warranty and Trilion Gold support
	$93,900

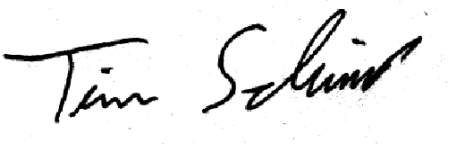
2) Phase Stepping Module • Description was sent separately • Enables measuring high frequency fatigue tests • Strobe, 15Hz, 20 microseconds • Magic Arm, Super Clamp, Mounting Platform • Custom power/trigger cable • Includes Storage Case	**$5,000**
3) Upgrade From Heavy Duty Tripod to Studio Stand • As illustrated • Weighted base, casters, counterweighted lift • Extension arm with bearings	**$2,850**
On-site installation and training workshop (Level I) • Trilion will provide an Applications Engineer for 3 days • Covers the basics of Digital Image Correlation, hardware setup and troubleshooting, post processing and application specific topics	**Included**

TERMS:

1. System delivery estimated to be 6-8 weeks from receipt of order
2. Purchase payment terms are Net 30 days from shipment
3. Price is FOB Destination and includes all shipping from Trilion in King of Prussia, PA and GOM, Braunschweig, Germany
4. Trilion Support will be invoiced annually
5. Quotation is valid for 60 days

We hope this quotation meets your requirements, and we look forward to supporting your needs with advanced optical measuring systems.

Best regards,



Tim Schmidt
Vice President

A. Measuring volumes

Depending on the configuration specified in the quotation, your system will be supplied with one or more camera frame and one or more factory certified measuring volumes (MV). Each MV includes:

- Pair of high-precision measuring lenses
- Factory certified calibration objects
- Adhesive tracking dots set

Preset lens

Calibration panel

Calibration cross

Adhesive tracking dots set
The size will depend on the fields of view specified

Each fixed base camera frame is design for robust use, with minimal need for setup and calibration. It is possible to swap lenses or camera frame if needed to adjust the field of view achievable by the ARAMIS system. Each camera frame has a set Measuring distance from the sensor to the center of the Measuring Volume.

Each frame is compatible with either the Light Projector or the Tracking Spots. The Light Projector, available for camera frames up to 300mm, is a powerful light source with adjustable light beam angle and optional circular polarization, which reduces glare. The Tracking Spots are ring lights positioned around each lens, and providing directional light for point tracking using retro-reflective dots. This technology allows very short exposure times for faster frame rates. For large fields of view, we also provide a wide range of other illumination systems. All illumination options are presented in detail in Section **Error! Reference source not found.** - Illumination Packages.

Full ARAMIS Professional configurations with Tracking Spots typically include a GOM Optical Touch Probe including probe head and calibration bed. The GOM Touch Probe can be used to access points that are not visible to the ARAMIS sensor, to provide precise alignments or measurement points. It is designed to achieve similar accuracy as a CMM touch probe arm.

Adjustable base sensor with 30 degree LEDs on studio stand

B. Sensor stands and holders

Standard Tripod
- Stable tripod
- 0.5 m horizontal arm
- Tilt and swivel head
- Transport bag

Stable Sensor Stand
- Height 1.8 m
- Extension 0.9 m
- Tilt and swivel head

Calibration object holder – table top
- Calibration object holder with swivel head
- For all calibration panels

C. Image acquisition and analysis computers

Computer 7730.L – Mobile

- Intel Core i7, 2.6 GHz, 6 cores
- 64 GB RAM
- NVIDIA Quadro P3200 6GB OpenGL graphics card
- 17" display, resolution 1,920 x 1,080

Computer 5820 – Workstation - Quoted

- Intel Xeon W-2133 Processor
  - 3.6 GHz (3.8 GHz Turbo)
  - 6 Cores, 12 threads
  - 8.25 MB Cache
- 32 GB RAM – 2,666 MHz
- NVIDIA Quadro P1000 4GB OpenGL graphics card
- 24" Dell TFT monitor with built-in USB hub

Computer 7820 – Workstation

- (2 x) Intel Xeon Gold 6136 Processor
  - 3.0 GHz (3.7 GHz Turbo)
  - 12 Cores, 24 threads
  - 24.75 MB L3 Cache
- 128 GB RAM – 2,666 MHz
- NVIDIA Quadro P4000 8GB OpenGL graphics card
- 24" Dell TFT monitor with built-in USB hub

D. GOM Testing Controller

For complex stage acquisition, light management and integration in testing environments

- Analog data acquisition with 8 channels (AD values)
  - Digital resolution: 16 Bit
  - Adjustable voltage range from ±1 V up to ±10 V
  - Sample rate up to 200,000 values/s
- Controlling of image acquisition
- Triggering of image acquisition
  - Via analog inputs
  - 3 trigger inputs (BNC)
    - TTL (opto-decoupled)
    - Endurance: max. +30V
  - Light gate
  - Manual push button
- Triggering with measuring sequences at
  - Specific points in time
  - Required AD values
  - External trigger signals
- Triggering of external devices synchronously to image acquisition
  - With adjustable delay e.g. for pulsed light sources
- Accurate assignment between time, images and analog values (synchronous recording of analog values and images)
- Live data transfer with image processing computer during measurement
- Analog data output for live evaluations (ARAMIS Professional license only)
  - 4 synchronized channels usable
  - 16 Bit
  - -10 V up to +10 V
  - Up to 500 Hz
- Laser and illumination control (optional)
  - Laser diode control for adjustment and positioning of the sensor head
  - Control of illumination
- Communication and data transfer via TCP/IP

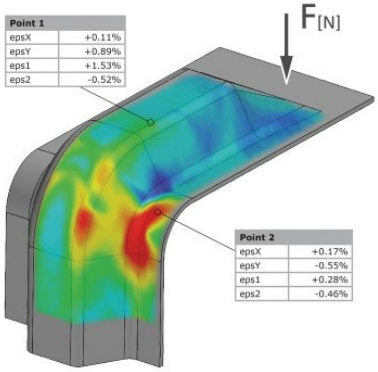
E. Software

Setup and Calibration

- Setup and Calibration wizard
  - Administration of measuring fields and sensor configurations
  - Software-supported sensor adjustment
  - User-guided calibration

Image Acquisition

- Measuring data acquisition and project administration
  - Creating the stereo image stage project
  - Acquisition of analog channels (with GOM Testing Controller only)



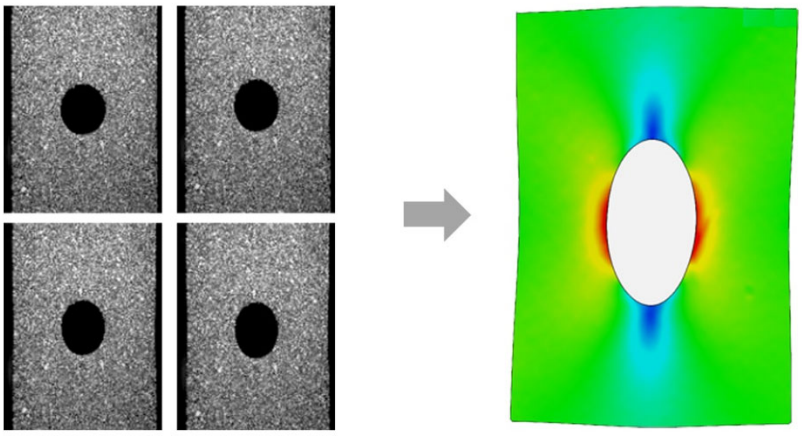
Digital Image Correlation Processing

- Post-processing of stereo image ARAMIS projects

- Import of external images
  - (e.g. generated by microscopes, high-speed cameras etc.)
  - Creation of 2D stage projects
  - Creation of stage projects based on stereo images (only with Professional license)

- Use of generic USB cameras (GenICam) and creation of 2D stage projects

- Image processing and deformation analysis
  - Full-field image point assignment in accordance with the principle of gray value correlation with automatic start point identification
  - Computation of 3D coordinates based on point-based measuring markers
  - Definition of point components and surface components with automatic identification
  - Creation of a surface topology
  - Determination of 3D coordinates and 3D displacements
  - Determination of strains and shears via surface strain tensor
    - Major strain, minor strain (including directions)
    - Thickness change
    - Equivalent total strains (mises, tresca)
    - Epsilon X, Epsilon Y, Epsilon XY, shear angle…
  - Computation of local translations and rotations (6DoF)
  - Color representation of full-field 3D displacement and strain distribution



Mesh Inspection

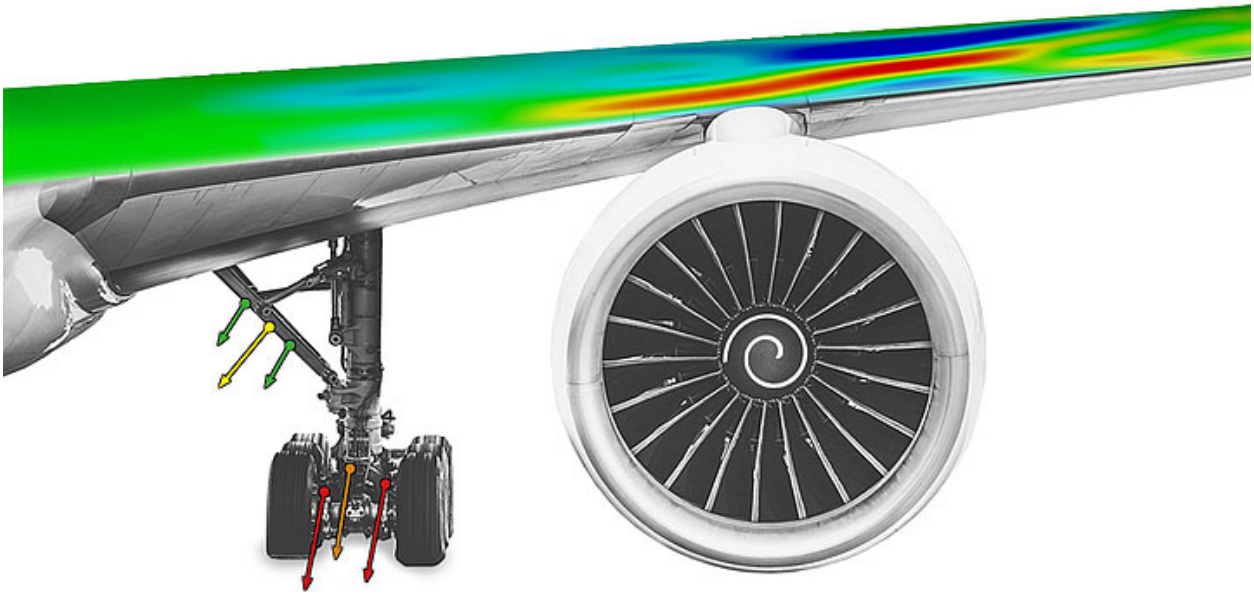
- Editing of polygon meshes
  - Import of point clouds and polygon meshes (STL, ASCII, POL, PLY, PSL, etc.)
  - Import of CT volume data (VGI, VGL, PCR, EXV, REK) as a polygon mesh
  - Polygonization of random point clouds into polygon meshes
  - Filling of holes in the polygon mesh by interpolated freeform surfaces
  - Smoothing, thinning and refining of polygon meshes
  - Regularization and relaxation of polygon meshes
  - Repairing, combining and stitching of mesh areas
  - Inverting, offsetting and scaling of polygon meshes
  - Tracing and evaluation of curvatures and character lines
  - Export of 3D polygon meshes (ASCII, POL or STL)
  - Golden Mesh: Calculation of an average mesh based on series measurements

- Element construction
  - Creation of geometrical elements on CAD data, polygon meshes and components
  - Construction of equidistant multiple points on areas or along curves
  - Fitting elements (maximum inscribed and maximum circumscribed elements, Gaussian and Chebyshev methods)
  - Multisections (axis parallel, radial, along curves and in viewing direction)
  - Derivation of characteristic features for airfoils from profile sections
  - Distances, angles, virtual calipers
  - Intersection, projection (perpendicular or free defined), average
  - Measurement plan import (ASCII, CSV, FTA, CATIA List, …)

- Alignment
  - Automatic prealignment via CAD or reference point clouds
  - Manual prealignment via 3D points
  - Alignment via 3-2-1, best-fit, RPS, local coordinate systems, hierarchically ordered elements
  - Hierarchical order of various alignments
  - Easy switching between the created alignments
  - Compensation of rigid body motions in stage projects

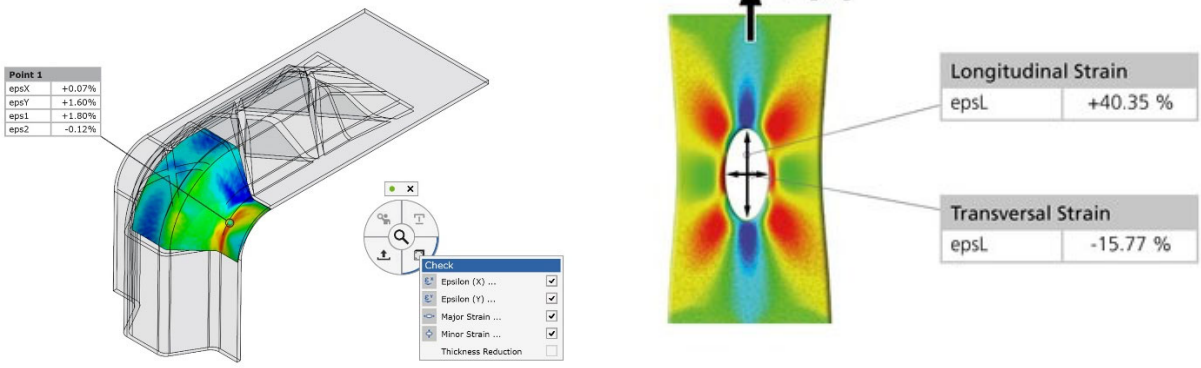
- Inspection
  - Import of CAD data in standard formats: IGES, VDA, STEP, JT Open, STL, PLY
  - Import of CAD data in special formats: CATIA v4/v5/v6, NX/UG, Pro/E, Parasolid, SAT (only with Professional license)
  - Automatic pre-alignment against CAD without 3D interaction
  - Alignment by 3-2-1, Best-Fit, RPS, local coordinate systems

- Definition of tolerances for CAD data and geometric elements
- Nominal/actual comparison of polygon meshes and point clouds with CAD data
- Deviation representation with color plots using free defined legends
- Colored inspection sections with needle plots
- Full-surface computation of material thickness based on polygon meshes
- Calculation of local surface defects based on polygon meshes
- I-Inspect: Simple assignment of measuring principles and inspection instructions
- Dimensioning based on local coordinate systems
- Evaluation of GD&T according to ISO GPS and ASME Y14.5
- Complete traceability of constructions and evaluations



- Stage management with timeline
  - Convenient stage management with adjustable reference stage
  - Transfer of evaluations from one stage to all stages
  - Global orientation and stage coupling
  - Definition of point components with automatic identification
  - Automatic computation of 3D displacement vectors
  - Statistical process control of full-field and point-based features
  - Diagram representation of characteristics via stage index or time
  - Determination of values derived by time, such as speed and acceleration

- Report module
  - Master page concept for uniform report styles
  - Customized measuring point visualization: Labels, needle plots etc.
  - Online tables and diagrams for sections and time-related values
  - Parametric integration of stages and alignments
  - Image mapping: Overlay of 2D and 3D data
  - Visualization of stage evaluations as video sequence or flip book
  - Presentation mode
  - Export as CSV table, PNG, PDF or video file



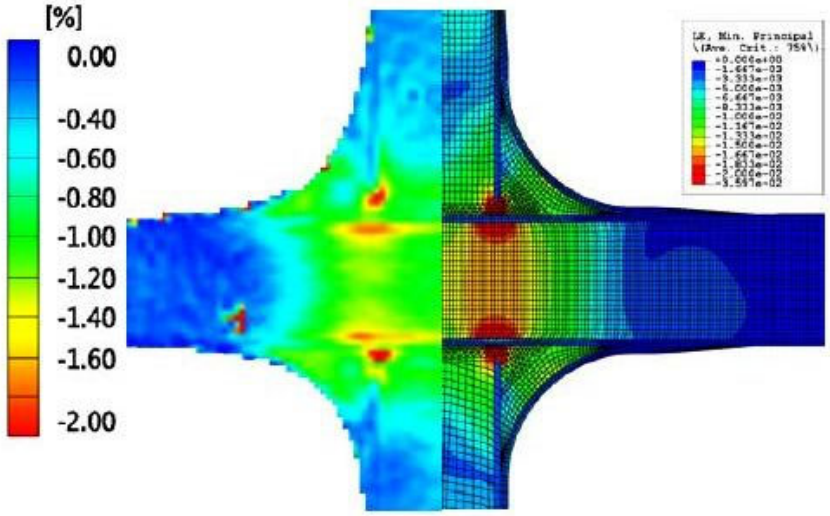
ARAMIS Advanced Capabilities

- Available with ARAMIS Professional and GOM Correlate Professional licenses

- Import of 3D external image series
  - e.g. generated by microscopes, high-speed camera pair etc.
  - Creation of stage projects based on stereo images

- Automated evaluation scripts
  - Determination of forming limit curves based on Nakajima tests (according to ISO 12004)
  - Determination of the yield curve based on bulge test (according to ISO 16808)
  - Evaluation of tensile tests, including the determination of:
    - Young's modulus, $R_{p02,}$ Ag, Poisson's ratio
    - True stress-strain curve
    - N-value and R-value
      incl. visualization of results
  - Vibration analysis script
    - Single point FFT
    - Full-field Mode Shape and Operating Deflection Shape calculation

- Finite Element validation capabilities
  - FEM import of the following standard formats in the form of a surface component:
    - ASCII (GOM format)
    - XML (GOM Format)
    - LS-DYNA (DYNAIN)
    - ANSYS (A2G)
    - AutoForm (AF) (ARAMIS V6.3)
    - PAM-STAMP (M01) (ARAMIS V6.3)
    - NASTRAN (ARAMIS V6.3)
  - Export scripts for ARAMIS/ARGUS compatible export data for
    - ABAQUS
  - Alignment of the measuring data to a FEM data set (coordinate transformation)
  - Full evaluation functionality for FEA data sets equivalent to the measurement
  - Full-field comparative calculation between measurement and FEM or between two measurements
    - Surface (distance between the surfaces)
    - Displacement differences
    - Strain differences



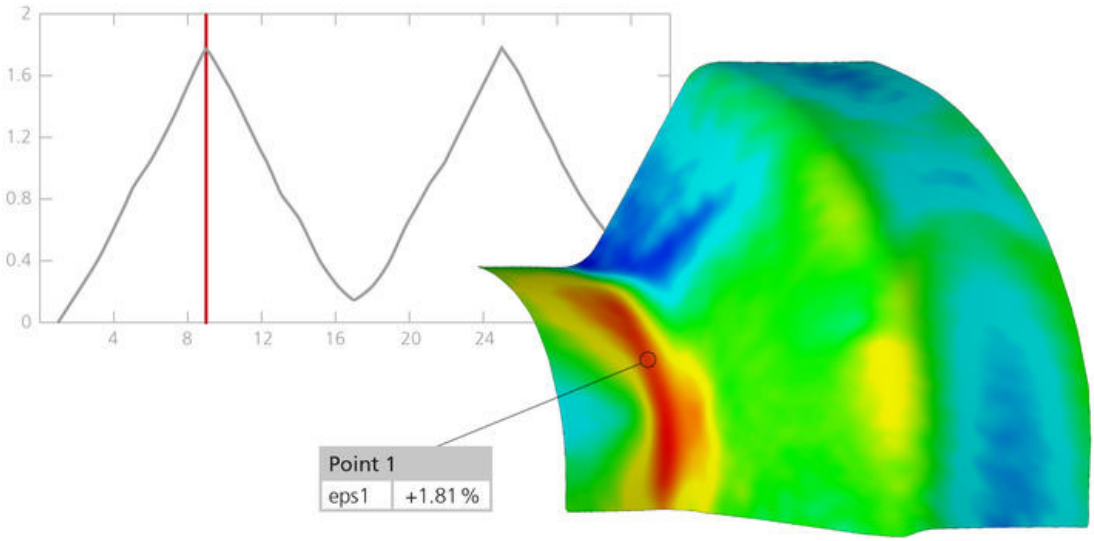
- Process automation
  - „Teaching by Doing" concept for recurring design and inspection workflows
  - Creation of templates for evaluations
  - Integrated macro recording

Live Analysis capabilities

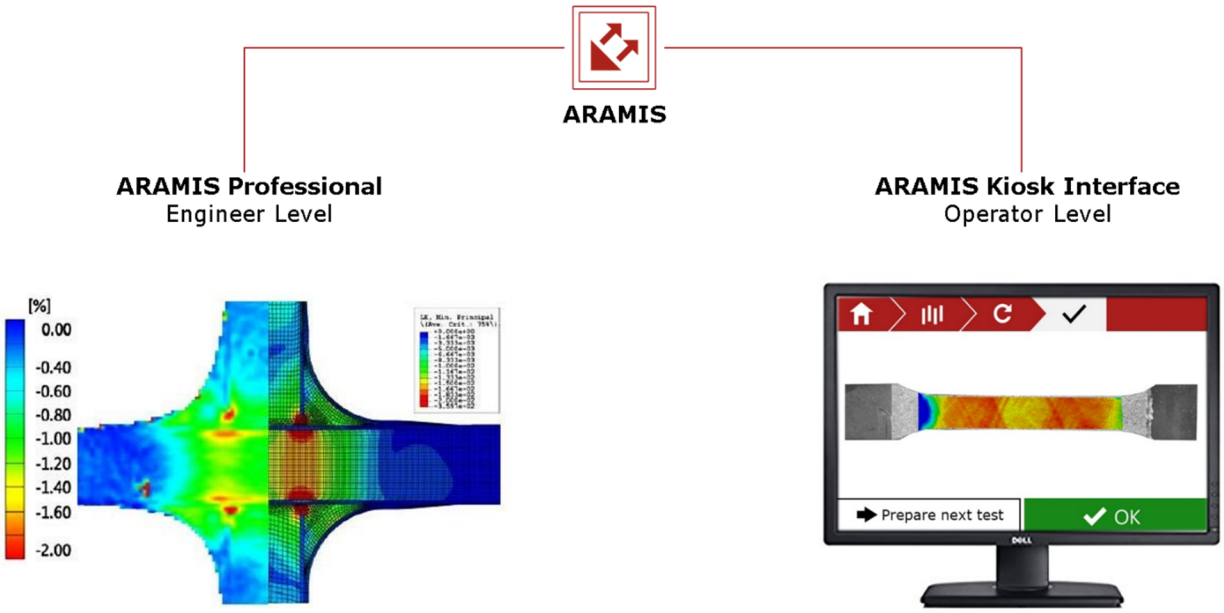
- Available with ARAMIS Professional license

- Comprehensive image acquisition functions
  - Image acquisition via ring buffer mode
    - Preadjustable number of images
    - Variable abort criteria: Start/Mid/Stop-Trigger
  - Image acquisition via user-defined lists
    - Elements: fixed rate, fixed points in time, analog signals, external trigger, light sensor, manual push-button
    - All elements can be combined freely
    - Loop function
    - Abort functions for each single element possible

- Live deformation tracking
  - Live computation of coordinates, result values and complete inspections
  - Result output:
    - Live data streaming with open SCPI protocol to external computers and software respectively (e.g. LabVIEW, MATLAB,…)
    - CSV protocol file
    - Analog data output via GOM Testing Controller



- ARAMIS Kiosk Mode
  - Automated simplified interface for repetitive testing
  - Integrated with material characterization module



F. Training

Proper training, and immediate implementation and use is critical to the success of any advanced system. Our ARAMIS training course is on-site for 2-5 people with 2 people defined as primary operators. These operators should plan on using the system for a week after training to solidify their knowledge.

- Detailed training course on theory and system operation
- Application development training and implementation
- Optional Advanced Training allows us to come back on-site, typically 6 months after installation, to provide advanced training on core operations and applications. The goal is to ensure that customers are able to take full advantage of features.

G. Support and maintenance

Technical support

Our service experts assist users with any technical question on hardware and software on the phone. Uncertainties are resolved, and solutions are explained. This way, process and system safety are guaranteed. We offer support through a variety of medias and platforms:

- Remote support via telephone or online
- Error diagnosis
- Solution database
- Tailored tutorials and screen recordings

E-Support

Regardless of business hours, we provide access to a user-developer online-community. Software downloads are available 24/7 along with our solution database, instructions and tutorials. The GOM Forum enables sharing information with other users.

System maintenance plans

We understand that integration of new and complex technologies requires constant investment to build internal company knowledge and expertise. Although this can be a challenging task, we have tailored our Trilion Gold support package to first and foremost help you make the technology your own and implement it well. With our maintenance plans, we also have your team's back and are here to provide guidance and support. Trilion Gold includes permanent access to current system software, access to technical support and unlimited software updates.

In case of system failures or accidents in your lab, we also include hardware coverage as an insurance against unexpected hardware expenses. Where necessary, defective parts of the measuring system are replaced free of charge. Parts subject to typical wear and tear while also proactively be replaced at their end-of-life.

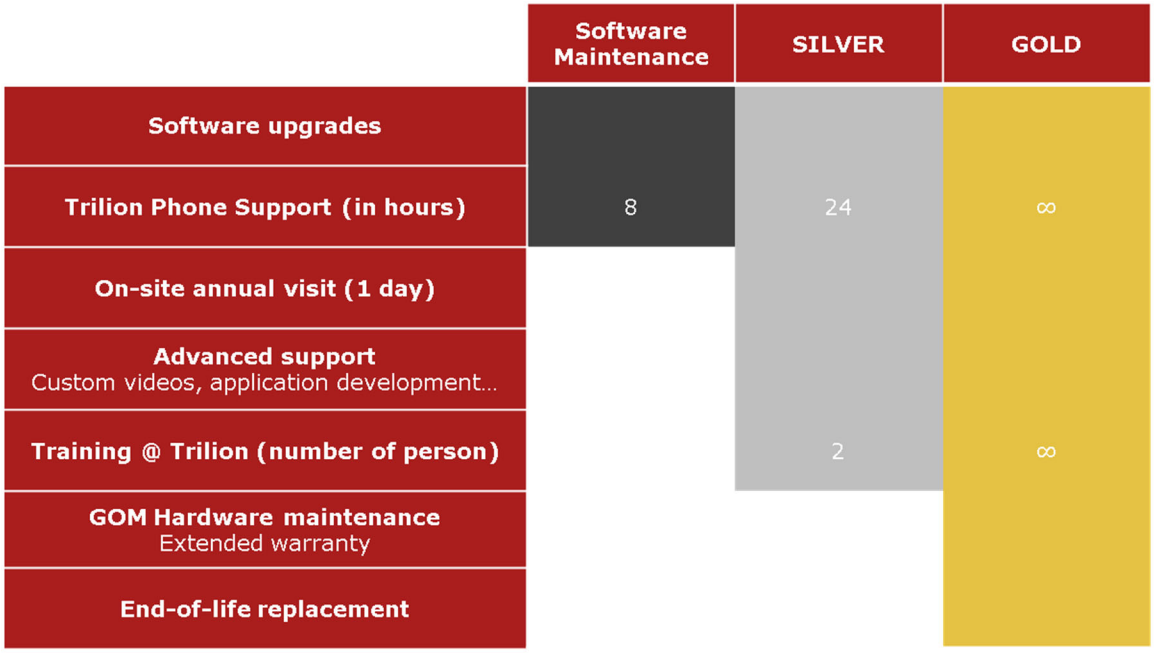
An overview of our different maintenance plans is detailed in the table below.

Continuing education workshops

In an effort to maintain the highest measurement quality of your system and to share the best practices with your team, we will send you, every year, one of our Application Engineer on-site. Their goal is to perform a system check, update your software and firmware as well as verify optimal operating conditions. They will spend the remainder of their time on-site in the form of a workshop with your team for them to achieve the next level of mastery with their applications and, usually, improve their processes and workflows to improve the system's throughput.

Although our experts come to you, your team can also come to us. All our offices are open to customers. As such, we organize education workshops every quarter, called *Training@Trilion*, to teach you the newest functionalities. While some companies leverage those workshops to on-board new users with the technology, others send experienced users to explore new applications outside their current wheelhouse or to perform guided acquisition and analysis.

Overview of Trilion's maintenance plans

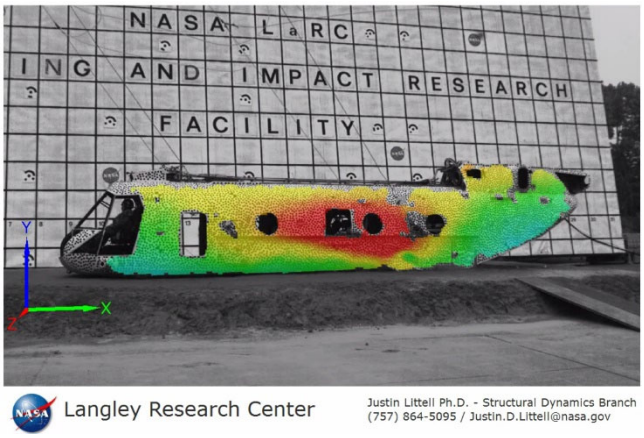


Note: Our software do not expire and continue working forever. However, your system won't be eligible for any of the above benefits. Support will also be limited and can't be guarranted for aging software version as our experts are only trained on the latest software platform.

H. Add-ons available

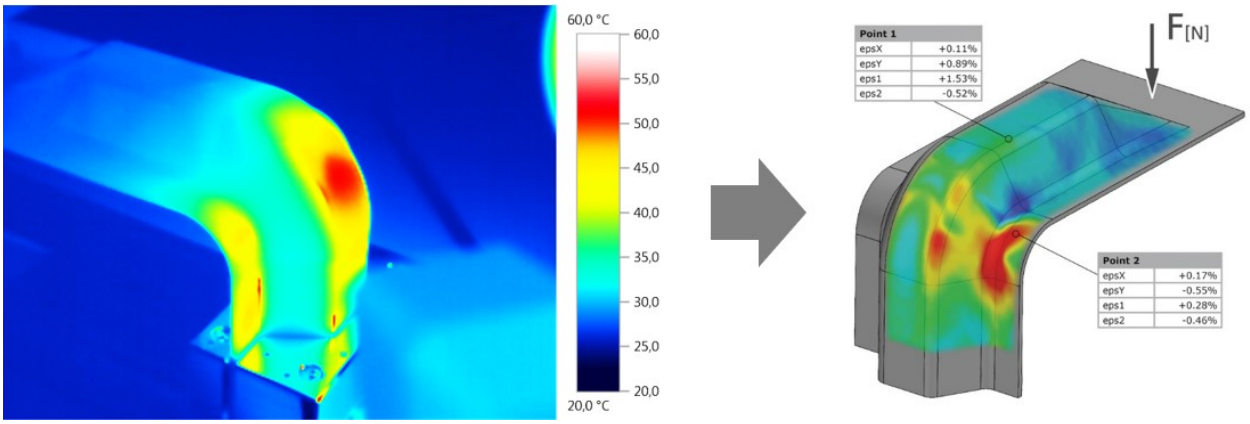
Large area calibration module

This enables calibration of fields of view up to 30 meters, using an array of coded targets and the TRITOP photogrammetry software basic license. Large area calibration typically requires either a longer camera bar (practical limit is 2-3 meters) or use of the cameras on separate tripods. With widest angle lenses, the working distance needs to be slightly more than the width of the field of view, and then the camera separation needs to be roughly one-third to one-half the working distance.



ARAMIS Thermography

The ARAMIS Thermography add-on, developed for the B-2 aircraft by Trilion, integrates precision thermal cameras to the ARAMIS 3D sensor, providing a pixel to pixel coloration of local thermal data with local 3d shape, 3d displacements and surface strains. ARAMIS Thermography calibrates the two camera systems together and brings the thermal data in to the powerful ARAMIS software for analysis and display in true 3D coordinates. ARAMIS Thermography can also uniquely correct strains for thermal expansion automatically, to show the true mechanical strains, corrected for thermal expansion.

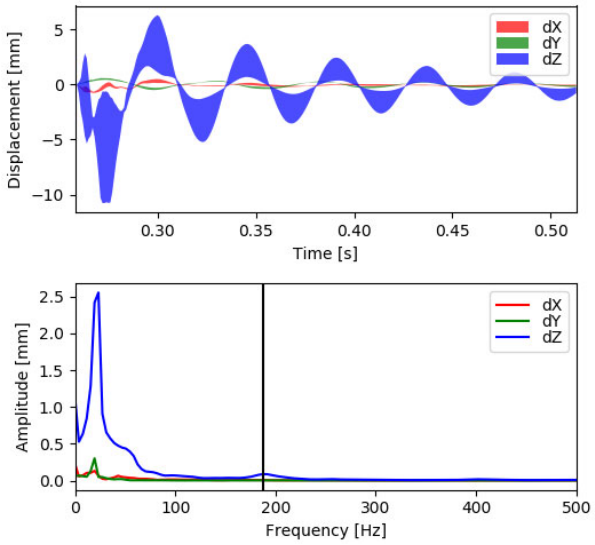


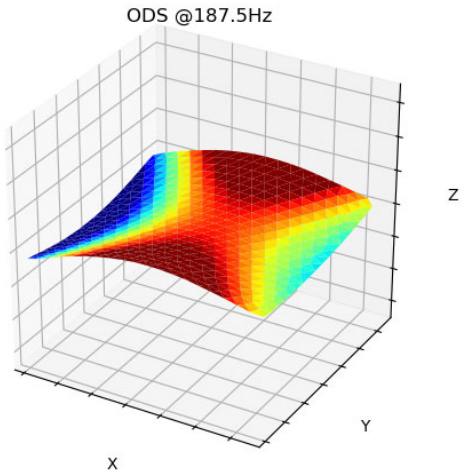
ARAMIS High Speed

Trilion offers a large range of high-speed cameras for applications up to 5 million fps acquisition. Existing ARAMIS systems can easily be upgraded to increase the acquisition capability to high-speed. Our experienced engineers will guide you through the selection process of the appropriate cameras for your applications. Please reach out to discuss your options.

Trilion FAST for Vibration analysis

Leveraging ARAMIS capability to measure surface displacements, FFT and mode shapes can be efficiently isolated with our FAST tool. Whereas accelerometers require tens of data points collected at strategic points of interest on the component, ARAMIS can derive the modal characteristics with a single data set utilizing tens of thousands of data points acquired simultaneously.





I. ARAMIS unique capabilities and features highlights

Project templates. The GOM DIC software suite allows you to create complete analysis and reporting templates to completely automate data processing. Full analysis, specific views, movie outputs, computational parameters and areas of interest can quickly be applied to a multitude of similar tests.

Full versioning capabilities. Just like a text editor, the DIC suite allows you to undo and redo any action, such as a parameter modification or an inadvertent faux-pas. You can easily browse to the complete history of your actions and roll back.

Auto-save. Fully leveraging the project versioning, your work will also constantly be saved in a working copy and even a computer failure won't set you back more than 2 minutes.

Advanced filtering algorithms. The GOM DIC suite has multiple filtering options available including average, median, binomial and smoothing algorithms in the time domain. Both average and median filtering are also available for spatial filtering. A combination of both time and domain filtering can always be applied, all with user selectable length or filter order.

Parametric software. Featuring a full parametric data structure, our software builds the results thru a hierarchical structure. For example, adjusting the computation parameters, editing a region of interest or applying filters will propagate to all the inherited elements and automatically recalculate the results.

Direct reporting. Creating a single document with multiple views and based on fully configurable content layouts (including full-field heat map, graphs and tables in the same page) will allow you to share your results within seconds. Our embedded reporting module provides direct export capabilities to CSV, PDF, MP4, AVI, PNG and windows' system clipboard.

Unlimited analysis and viewer licenses. The GOM Correlate software is available for download online and for free. It can be used to share existing data sets and analyze them on any Windows computer. Creation of new readout points and region of interest as well as computing and exporting statistical results are all available. Creating and exporting reports (see *Direct reporting*) is also available.

User-defined field and scalar data checks. Based on an embedded Python environment, a user can generate custom data representation. For example, using the standard Epsilon X and Epsilon Y maps to create a full field Poisson ratio's mapping. Scalar computation can also be used, for example, to create best-fit slopes and automatically compute material properties (Young's modulus, Poisson ratio, n, r, etc.). User-defined checks can be saved and integrated into the user-interface for repetitive use.

Time ranges. With the definition of a stage range, you can easily focus on a important period of time (i.e. the elastic region of a tensile test or the failure of a specimen), label the steps of your project or create videos with varying speed to slow it down during critical events. A stage range also provides an easy way to scale and maximize graphics (i.e. zoom on one cycle of a repetitive test) and can also be used to limit automatic parameter computation (see *User-defined field and scalar data checks*). Time ranges can be created thru expression definition (i.e. automatically defined between strain values), timeline or graphic user-selection as well as manually.

Customizable user-interface. With drag-and-drop simplicity, you can build your own toolbars and workflows as well as assign customized shortcuts. These modifications can also be saved and spread to your entire organization.

Python environment. You can easily record, edit and run Python scripts within the embedded Python environment. You can effortlessly automate actions, bundle functions, interact with system files and external data, build custom dialog boxes and even create completely new user interfaces for specific users. Building interactive macros and unattended batch processing scripts provide efficiency and simplicity for every user level. External Python libraries can also be called and installed. User-defined scripts can also be embedded in the user interface as native software functions (see *Customizable user-interface*).

Tensile test evaluation module. Thanks to our adaptable environment, we built an entire evaluation module for tensile testing which automatically computes the following important material properties: Young's modulus, Poisson ratio, true stress-true strain curve, yield and ultimate strength, uniform elongation, hardening exponent and anisotropy. Graphs showing the stress-strain curve and linear fit region for the material properties within the elastic range specified by the user are also fully integrated and generated at the end of the computation.

Kiosk mode. Using various previously mentioned unique features, we provide a streamlined user interface for tensile testing. With less than half-a-dozen clicks, this mode takes a baseline reference, aligns the specimen, optimizes lighting conditions, calculates full field strain, generates stress-strain diagrams, computes material properties (see *User-defined field and scalar data checks*), populates a table summary for all specimens and exports a PDF report for each coupon.

CAD Import. Importing numerous CAD models and registering them in 3D space to share their coordinate system with the DIC data set is extremely fast and convenient. After an initial pre-alignment, you can effortlessly optimize the data using our automatic best-fit algorithm. The experimental data is then automatically transformed using the CAD coordinate system. Native CAD formats can directly be imported, such as CATIA V4 and V5, Pro/E, and Unigraphics NX5 and NX6. Standard formats such as IGES, STEP, VDA, STL and JT-Open are also supported.

Geometric Primitives. The GOM DIC software suite includes various best-fit shapes creation such as circles, spheres, planes, curves, section, points, cones, etc. These shapes can be used to generate coordinate system transformations, analyze flatness, necking, radius, and other shape changes. For example, the center of a best-fit hole can serve as the coordinate system origin, and the center axis of a cylinder as the origin for radial displacements.

Multiple coordinate systems. You can easily switch with a single click between multiple coordinate systems and/or rigid body movement corrections. Using the components' parametric definition, the data is automatically recalculated for the chosen alignment without redefining or editing the computation parameters.

Shape analysis. Thanks to our extensive metrology portfolio, meshes created using DIC can be inspected against nominal references such as CAD or geometric primitives (see *CAD Import* and *Geometric Primitives*). A deviation plot, in 3D, can be computed to compare the actual part's shape with the CAD, a primitive or any mesh. Readout points can be created anywhere on the DIC or nominal mesh.

Mesh animation. Effortlessly import CAD or 3D meshes and tack them to a visible DIC component in your measuring area. Not only will the complete assembly be animated, but you can also measure any point on the mesh whether it is visible or not by the cameras. Check clearance, angles and much more with this unique capability.

FEA Import. You can also import FEA models and register them in 3D space to the DIC data set. Automatic best-fit registration and mesh mapping thru distance weighted interpolation between the FEA mesh and the DIC grid are essential capabilities required to perform FEA to DIC comparison. The GOM DIC suite not only does all those, but also provides a full-field deviation map for a number of physical quantities, such as strains and displacements, on the surface shape. FEA formats which are natively supported include LS-DYNA and ANSYS. Custom imports either exists or can be built for ABAQUS, PAM-STAMP and Autoform files as well as ASCII from other FEA packages.

Forming Limit Curve Determination. A special module to calculate forming limit curves from Nakajima tests, in accordance with the procedures and mathematical methods as described in the ISO-12004 Proposal Version 15-8-2005, is also included within the software. The forming limit curves are calculated automatically from multiple parallel section lines and includes automatic quality control for each section and from each geometry. The status of each section line can also manually be toggled for inclusion or exclusion in the FLC computation. The displayed forming limit curve also update immediately after each section status is changed. A detailed user manual provides guidance for test requirements, section line placement, etc.

Trigger lists. Fully integrated triggering capability allows for the creation of simple or very complex trigger sequences thru very simple user input dialogs. Triggering based on the rise or fall of an external signal, based on the value of an analog channel (like load, temperature or displacement) for fatigue, thermal cycling and more, based on a user input or even from a signal variation thru the included light gate; you can now easily vary the frame rate throughout your experiment and certainly improve the quality of your DIC data.

Custom and Standard Report Templates. The GOM DIC system also include a comprehensive reporting module to lay out views and diagrams within the software. Incorporating any combination of full-field color graphics, section line plots, time histories of both analog inputs and ARAMIS results, labels, company logo, and so on, is extremely simple. Any report can not only automatically be updated if computation parameters change without having to redo them, but they can also be exported to common file formats in one click. Compression into MP4, AVI, PNG, PDF, CSV, and more, happens seamlessly and allows for easy publishing or sharing with your colleagues. Video frame rate can also be customized at will to provide slow motion of specific events (i.e. elastic zone or component failure).

Certified Calibration Panels. Every GOM DIC system comes with calibration panel(s) with at least two scalebars and are certified according to international standards. Traceability of the measuring system is therefore possible for every project. This insures the accuracy of absolute distance measurements and supports inclusion of DIC results in quality initiatives. The calibration panels are manufactured from low coefficient of thermal expansion materials such as ceramic or carbon fiber to provide the highest calibration stability. Ambient temperature can also be measured for automatic correction of thermal effects on the scalebars and all adjustments are embedded in the calibration algorithms.

In addition, advanced calibration objects, for which the 3D coordinates of each single dot have been determined and included in a characterization file, are available with certain systems for superior correction of lens distortions.

Coordinate System Transformation. Full control of coordinate system placement is achieved through our extensive list of alignment functions, such as the standard 3-2-1 transformations, based on CAD (see *CAD Import*) or geometric elements (see *Geometric Primitives*) as well as manual rotation and translation of all three axes.

Multi-lingual Software. If English is not your first language, we might have you covered with our multilingual capabilities, including, but not limited to, a complete interface in French, English, German, Chinese and Japanese.

Rigid Body Movement Correction. Similar to our *Multiple coordinate systems* capabilities, we provide interchangeable relative displacement analysis. Effectively fixing a component in the field of view allows the user to first quantify and then correct the analysis for rigid body motion and analyze local displacements. Either all the points or a subset of points can be used for the correction. With this tool, 6-DOF motion of one part against another is possible.

External Data Import. Single column text files can be imported and merged into the DIC project. Test parameters such as pressure, temperature, reference strain, etc. can all be plotted within our software even when they were not directly logged into the integrated analog inputs. Our open data architecture also works with array data such as thermal data from an IR camera or Finite-Element modelling software can be imported and full-field mesh calculations can be computed (see *User-defined field and scalar data checks* and *FEA Import*).