



Waters™

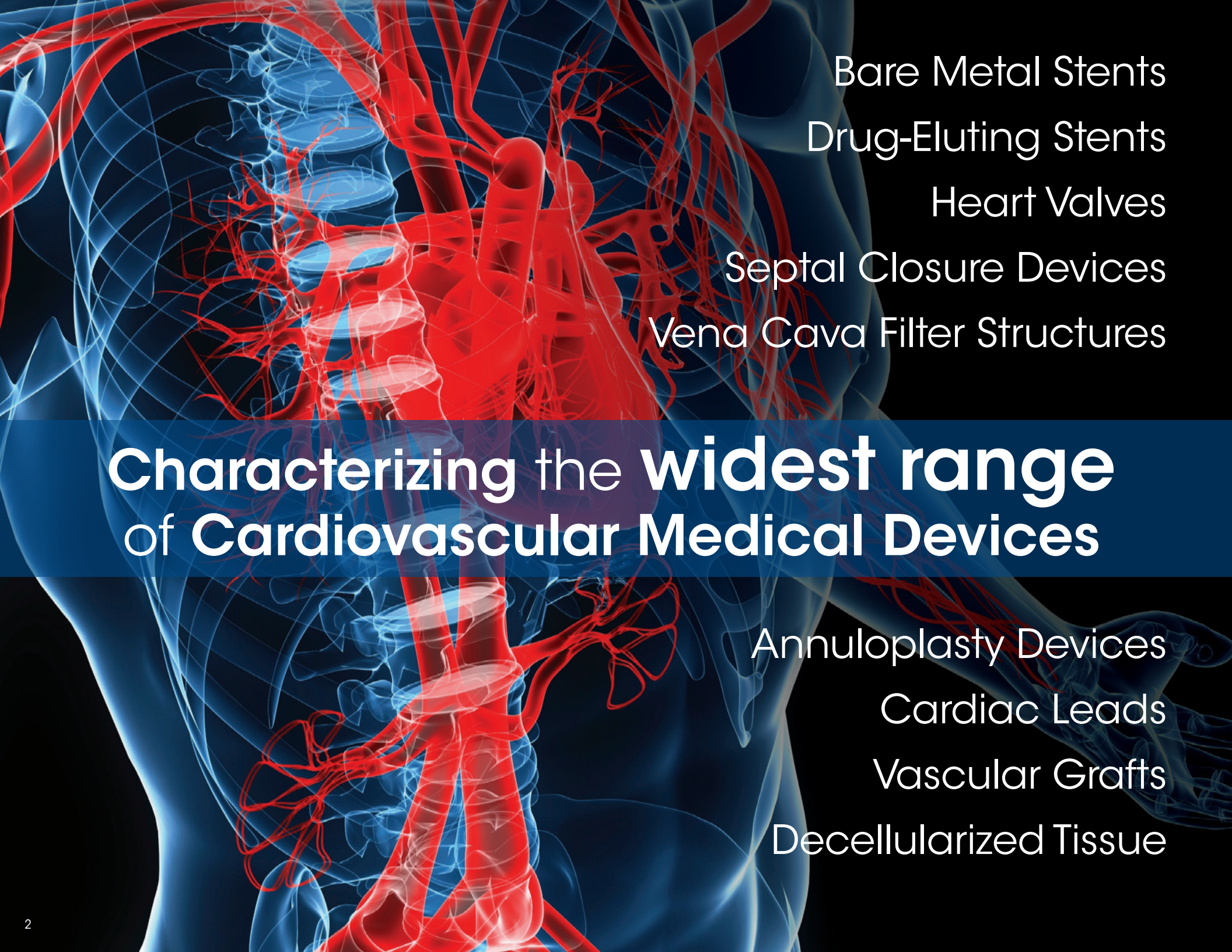


ELECTROFORCE®
CARDIOVASCULAR
TEST INSTRUMENTS



Accelerating development of life-saving technologies

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Bare Metal Stents
Drug-Eluting Stents

Heart Valves

Septal Closure Devices

Vena Cava Filter Structures

Characterizing the **widest range** of **Cardiovascular Medical Devices**

Annuloplasty Devices

Cardiac Leads

Vascular Grafts

Decellularized Tissue

Unrivaled
**dynamic Performance &
proven Reliability**
over **billions of cycles**

ElectroForce® Cardiovascular test instruments comprise the most comprehensive portfolio of testing solutions for endovascular and interventional cardiology medical devices. For over 25 years, our test instruments have been used for research, development, and validation of innovative cardiovascular therapies - supporting hundreds of regulatory submissions and approvals.

Apply physiologic or hyperphysiologic loading under accelerated conditions to multiple samples

Test multiple samples simultaneously to increase throughput and satisfy regulatory requirements for confidence of device success

Engineered for reliability and durability

Designed for long-term testing use and experimental repeatability

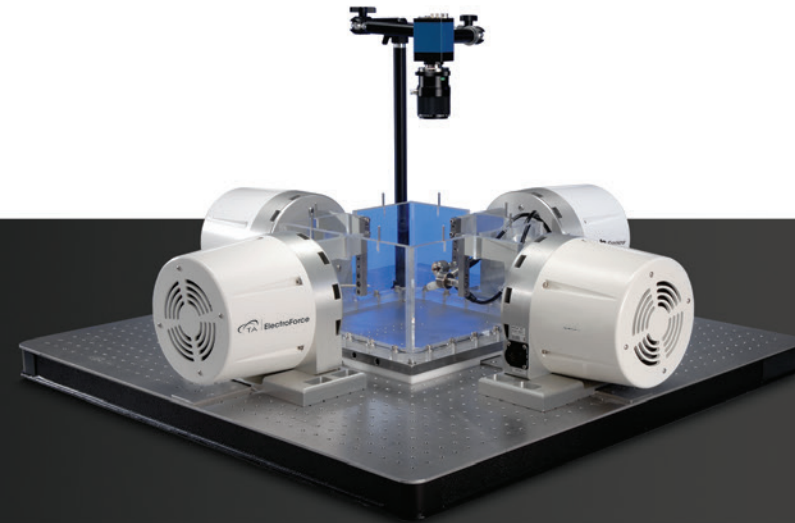
Quickly determine the properties of complete devices or identify the components most likely to fail

Widest range of frequencies using displacement, force or pressure control to meet the most demanding test requirements

ELECTROFORCE® CARDIOVASCULAR SOLUTIONS
TABLETOP & FLOOR-STANDING INSTRUMENTS

AN INSTRUMENT for every
DEVELOPMENT STAGE

Planar Biaxial
TestBench Instrument



DuraPulse™ Heart Valve
Test (HVT) Instrument

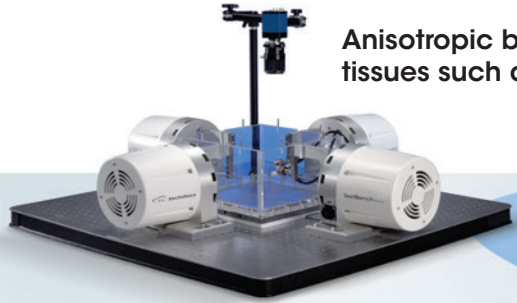


DuraPulse Stent/Graft
Test (SGT) Instrument



MSF16 Multi-Specimen
Fatigue Instrument





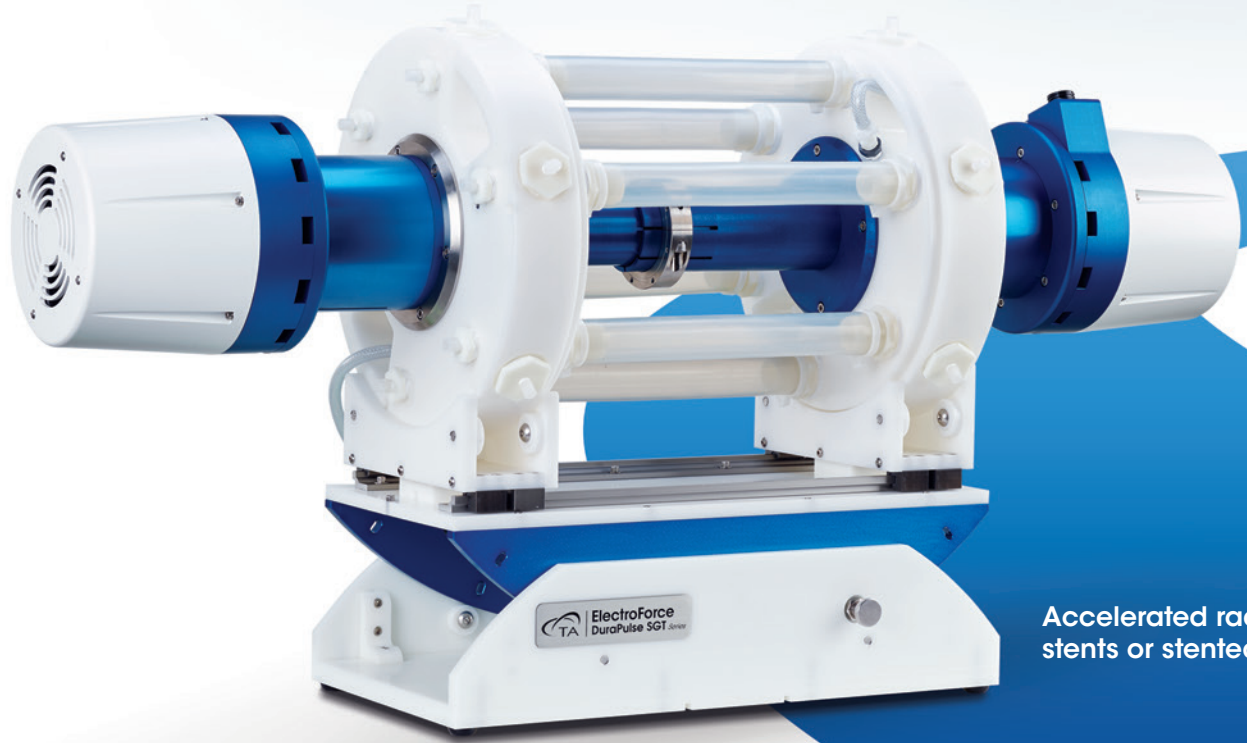
Anisotropic behavior characterization of native tissues such as heart valve leaflet materials



Multi-specimen fatigue of stents, stent-like structures, or heart valve sub-structures

TRUSTED for **TESTING**
along the...

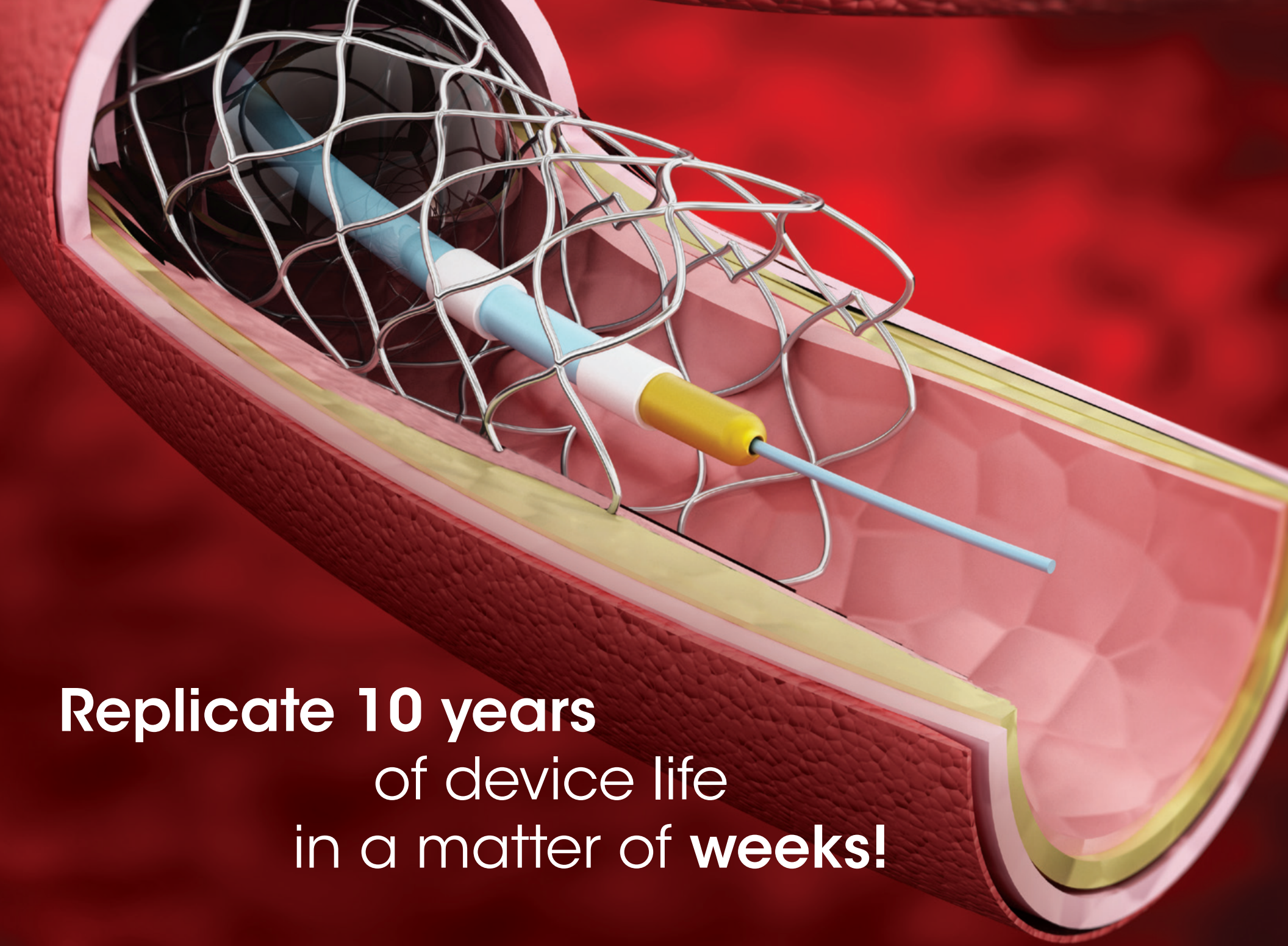
**ENTIRE
DEVELOPMENT
PATHWAY**



Accelerated radial fatigue of entire stents or stented heart valve frames



Accelerated wear testing of complete heart valve device



**Replicate 10 years
of device life
in a matter of weeks!**

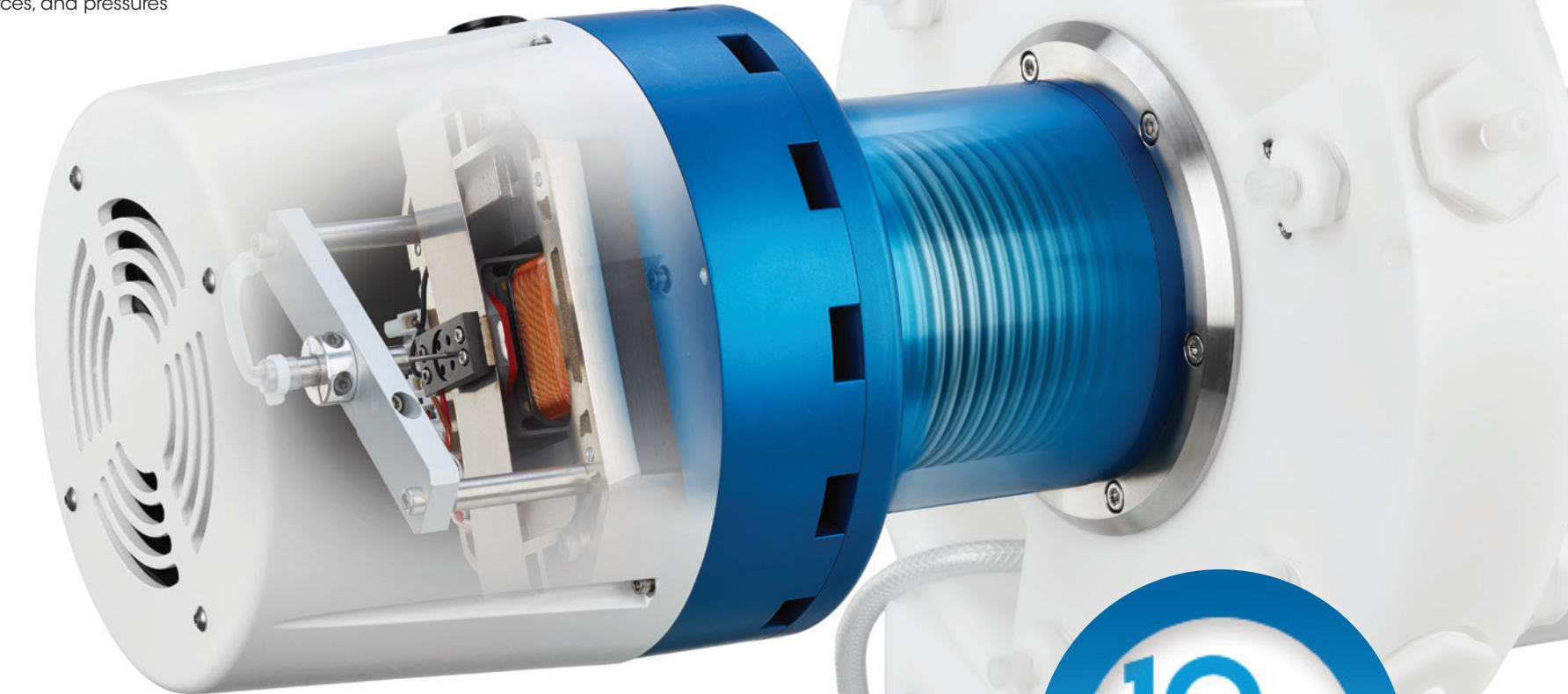
ELECTROFORCE® | TECHNOLOGY

Perform fatigue tests at the highest frequencies

Proprietary electromagnetic motor delivers industry-leading dynamic performance

Unmatched waveform control and repeatability

Friction-free technology provides unmatched responsiveness enabling the precise control of displacements, forces, and pressures



Reliability that won't let you down

ElectroForce® linear motors integrate a flexural suspension eliminating the need for rolling or sliding bearings that wear out during long-term tests

The industry's only 10-year motor warranty

Confidence that your test instrument will continue to perform as device designs evolve



PULSATILE FATIGUE TEST INSTRUMENTS | DURAPULSE™ STENT/GRAFT TEST (SGT) INSTRUMENT

DuraPulse™ stent/graft test (SGT) instruments integrate proprietary ElectroForce® linear motors to apply accelerated pulsatile distentions to stent and stented devices deployed in mock vessels. Meeting or exceeding testing requirements defined by international standards such as **ISO 25539-2**, **ASTM F2477** and **ASTM F3211**, DuraPulse SGTs reduce device time-to-market while providing multi-billion cycle reliability.

Dual-sided pulse generation improves performance and consistency

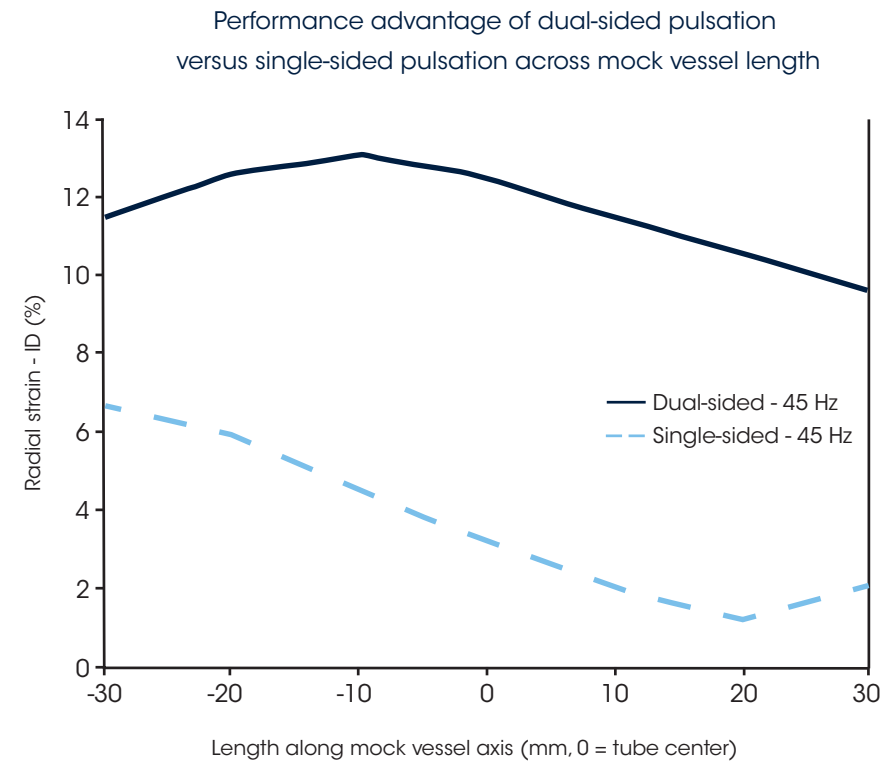
- Purely symmetric pulsation provided by ElectroForce motors exceeds performance provided by single-sided or simulated dual-sided solutions
- Attain higher peak strains – particularly at higher frequencies
- Generate more uniform strain profiles along mock vessels as test frequency increases

Accommodate a variety of stented device geometries and sizes

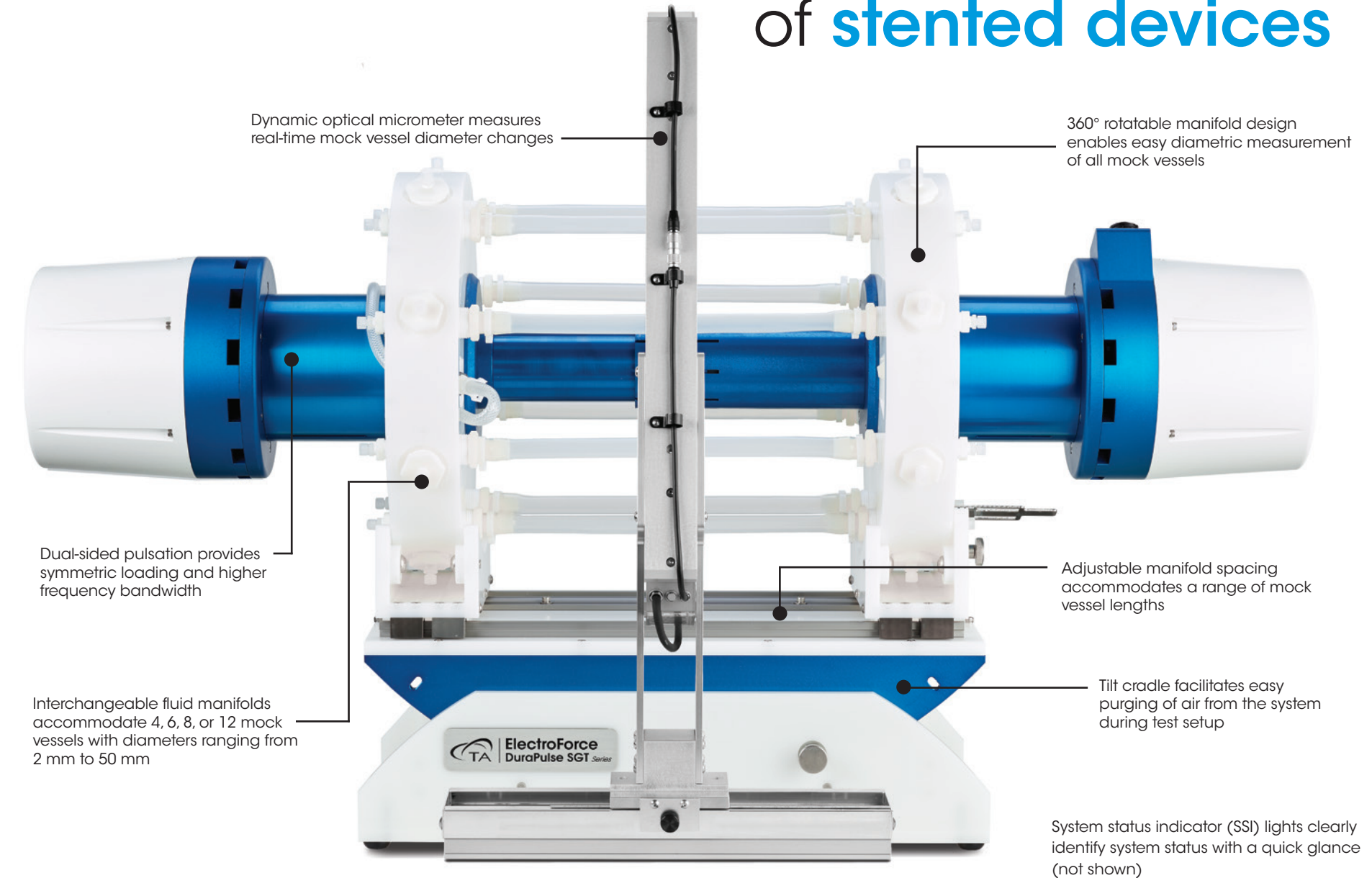
- Device diameters from 2 mm to 50 mm
- Determine the fatigue life of intravascular prostheses such as stents, grafts, heart valve frames, occluders and shunts
- Test with straight and bifurcated tubes, or setup devices across a curvature with the Pulse-on-Bend accessory

Flexible software capabilities enable control over a variety of test parameters

- Select between radial strain or pressure amplitude control
- Calculate mock vessel outer diameter (OD) and inner diameter (ID) strain
- Adjust radial strain and frequency without stopping your test

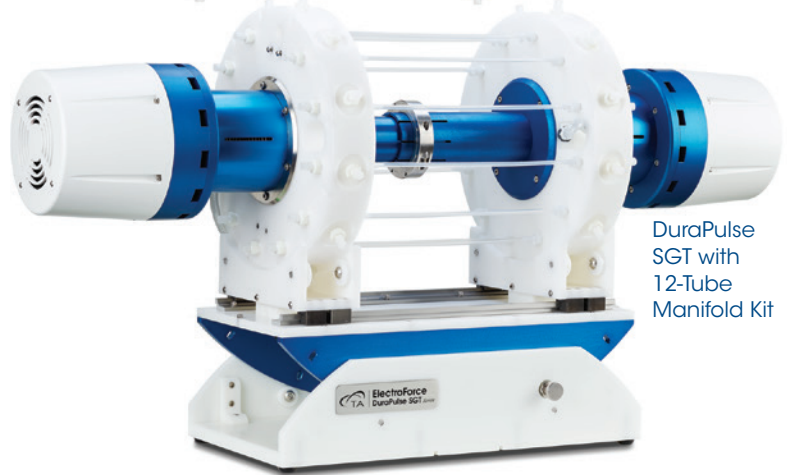
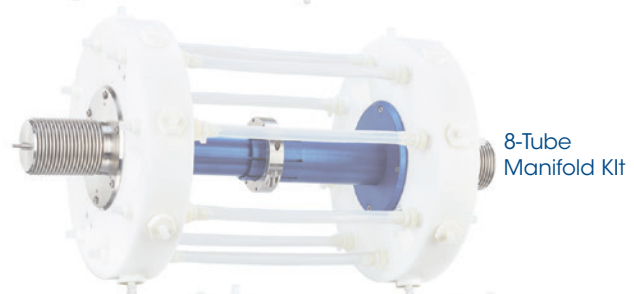


The industry standard for pulsatile fatigue testing of stented devices



PULSATILE FATIGUE TEST INSTRUMENTS |

DURAPULSE™ STENT/GRAFT TEST (SGT) INSTRUMENT

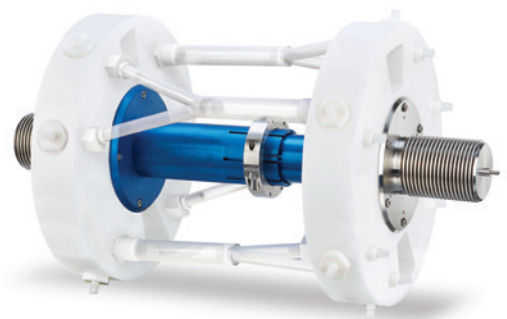
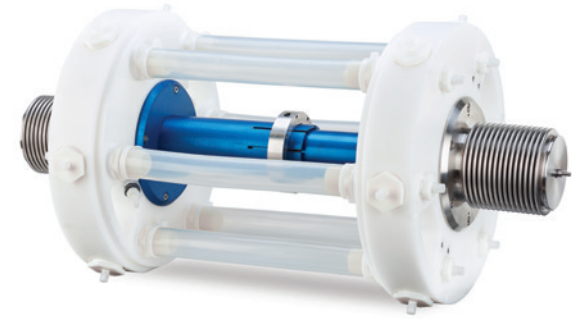
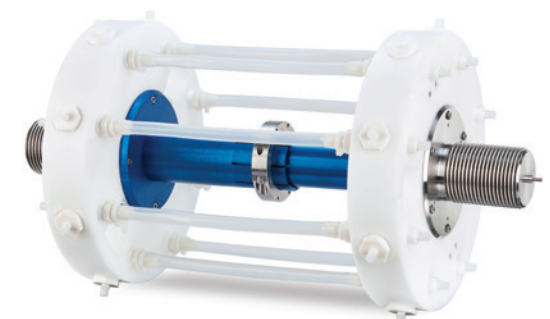
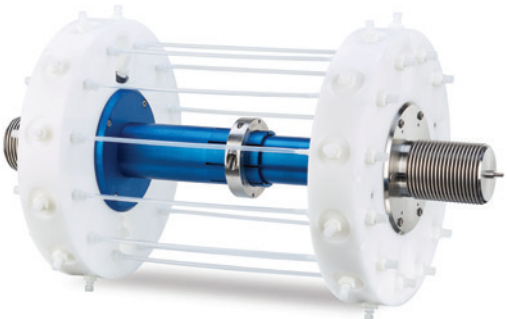


Interchangeable Manifold Design

Increased Flexibility



Reduced Capital Investment



Specifications	12-Tube DuraPulse SGT
Number of Sample Tubes (Mock Vessels)	12
Sample Tube ID Range	2 - 10 mm
Sample Tube Length Range (Fitting-to-Fitting)	96 - 180 mm
Operating Frequency Range	1 - 100 Hz
Operating Pressure Range	0 - 385 mmHg
Dimensions (W x D x H) Includes Micrometer Accessory	1.03 x 0.51 x 0.72 m

8-Tube DuraPulse SGT	6-Tube DuraPulse SGT	4-Tube DuraPulse SGT
8	6	4 (Bifurcated)
10 - 25 mm	25 - 50 mm	10 - 18 mm (Iliacs), 18 - 30 mm (Aorta)
170 - 340 mm	99 - 272 mm	152 - 322 mm
1 - 100 Hz	1 - 100 Hz	1 - 100 Hz
0 - 385 mmHg	0 - 330 mmHg	0 - 385 mmHg
1.21 x 0.51 x 0.72 m	1.24 x 0.48 x 0.73 m	1.21 x 0.51 x 0.72 m

MULTI-SPECIMEN FATIGUE TEST INSTRUMENTS |

3330 MSF16 INSTRUMENT

TA Instrument's MSF16 Multi-Specimen Fatigue Instrument is designed to accelerate fatigue studies for a variety of materials, subcomponents and complete devices. With the capability of simultaneously testing 16 specimens at up to 100 Hz, users can generate S/N curves faster and with higher statistical confidence levels than ever before. In this system, proven and refined technologies come together to quickly and confidently deliver results such as those required by ASTM F3211 F2942, and F3374.

Unequaled waveform control, frequency and fidelity

- Achieve the highest frequencies in the industry and reduce overall test time
- Easily control displacement from micron levels to 25 mm with the frictionless ElectroForce linear motor combined with the high accuracy displacement sensor
- Automated amplitude control ensures desired amplitudes are achieved even at higher test frequencies and with changing specimen response
- Adjust test parameters without interrupting the test

Simultaneously test as many as 16 samples

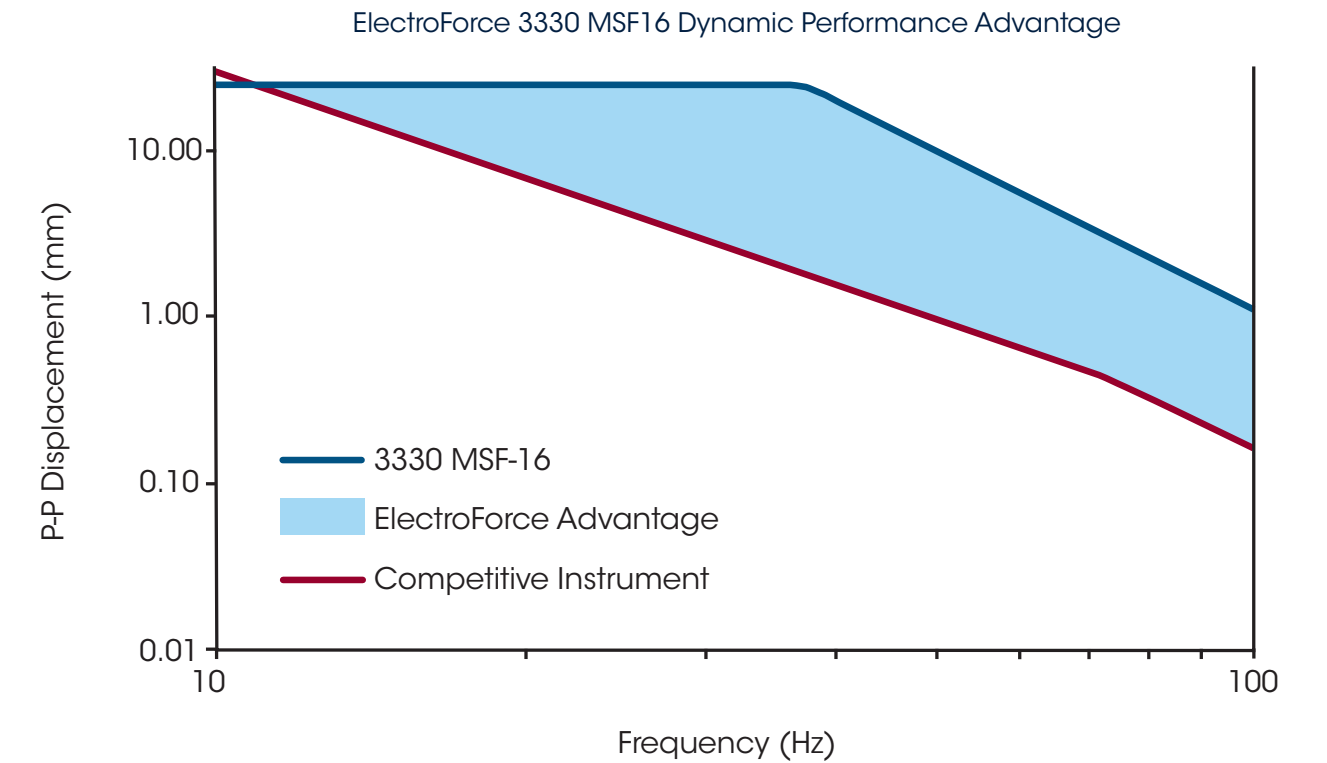
- Sixteen independent load cells monitor force at each loading site to detect sample failure
- Up to 20 mm of test space adjustment at each loading site for easy specimen setup
- 38 mm clearance between loading sites provides sufficient space for device fixtures
- Integrated temperature-controlled bath for testing up to 45° C



The proven workhorse for multi-specimen axial fatigue

The MSF16 offers multiple refinements for ease of use

- Precision specimen-to-specimen preload adjustments
- Tool-less and stable specimen preload clamping
- Mechanical overtravel stop to increase user confidence
- Auto-fill bath to avoid temperature variations from refilling from evaporation
- More accessible and viewable specimens



MULTI-SPECIMEN FATIGUE TEST INSTRUMENTS | MULTI-STATION TESTBENCH INSTRUMENT

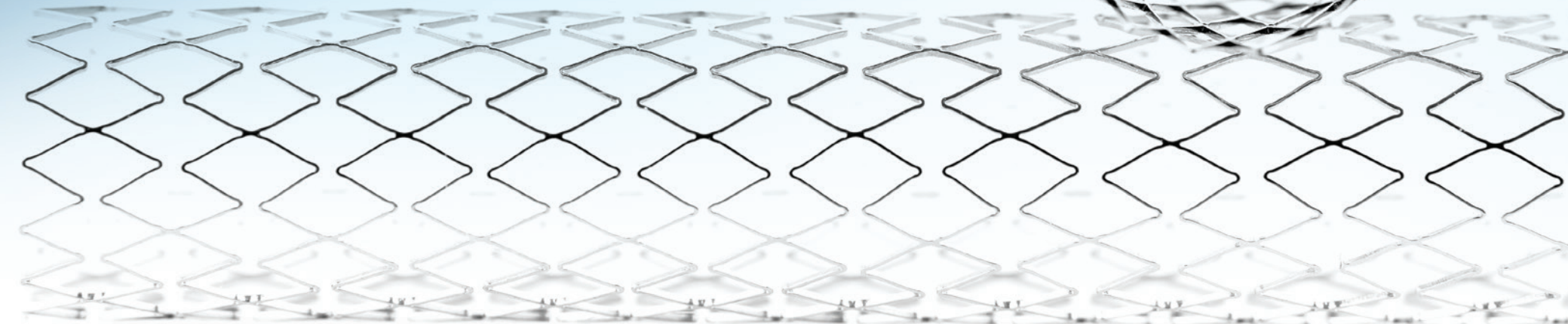
ElectroForce® Multi-Station TestBench instruments combine up to four independently-controlled, compact load frames, controlled from a single computer. Each TestBench station can be operated in either force or displacement control, offering the flexibility needed to perform long-term testing on devices or tissues that require stress or strain test conditions.



Unmatched versatility in a multi-sample testing configuration

- Available in either 2-, 3-, or 4-station configurations with a single shared computer
- Independent control of each station including control mode, waveform, and test frequency
- Position the test instrument vertically or horizontally for additional test setup flexibility
- Optional saline bath available for performing tests at physiologically relevant temperatures

Test at
higher frequencies
to reduce
time to market



Specifications	3330 MSF16 with 40 N Sensors	3330 MSF16 with 100 N Sensors	Multi-Station Test Bench
Number of Samples	16	16	Up to 4
Force Range (per sample)	0.2 - 40 N	0.5 - 100 N	0.02 - 200 N
Displacement Range	0.005 - 25 mm	0.005 - 25 mm	0.025 - 13 mm
Frequency Range	0.00001 to 100 Hz	0.0001 to 100 Hz	0.00001 to 100 Hz
Fluid Bath Temperature Range	Ambient to 45 °C	Ambient to 45 °C	Ambient to 45 °C (Optional)
Instrument Dimensions (HxWxD)	1283 x 686 x 555 mm (50.5 x 27 x 22 in)	1283 x 686 x 555 mm (50.5 x 27 x 22 in)	808 x 305 x 432 mm (31.8 x 54 x 17 in)
Instrument Weight	190 kg (419 lbs)	190 kg (419 lbs)	118 Kg (260 lbs)
Vertical Test Space	100 mm	100 mm	365 mm
Vertical Test Space Adjustment	20 mm	20 mm	365 mm
Maximum Sample Diameter	38.3 mm	38.3 mm	140 mm
Control Mode	Displacement	Displacement	Force or Displacement

HEART VALVE ACCELERATED WEAR TESTING | DURAPULSE™ HEART VALVE TEST (HVT) INSTRUMENT

Setting the standard for accelerated prosthetic heart valve testing according to ISO 5840 test protocols, the DuraPulse™ Heart Valve test (HVT) instrument is capable of testing surgical or transcatheter heart valves at frequencies greater than 30 Hz. Available in 2-, 4- or 6-station configurations, the DuraPulse HVT provides independent sample control, enabling the removal and inspection of a single device without affecting the continued testing of additional devices.

Innovative technology that makes your heart (valve) race

- Accommodates a variety of mechanical and tissue valves, including aortic, mitral, pulmonary and tricuspid valves
- Transparent, quick-open chambers provide valve visibility from all vantage points, facilitating high-speed imaging techniques
- Proprietary PeakIQ™ control algorithm optimizes waveform to minimize pressure overshoot
- Dedicated application software reduces overall set-up time and includes interface for quick definition of test and data acquisition parameters

Specifications

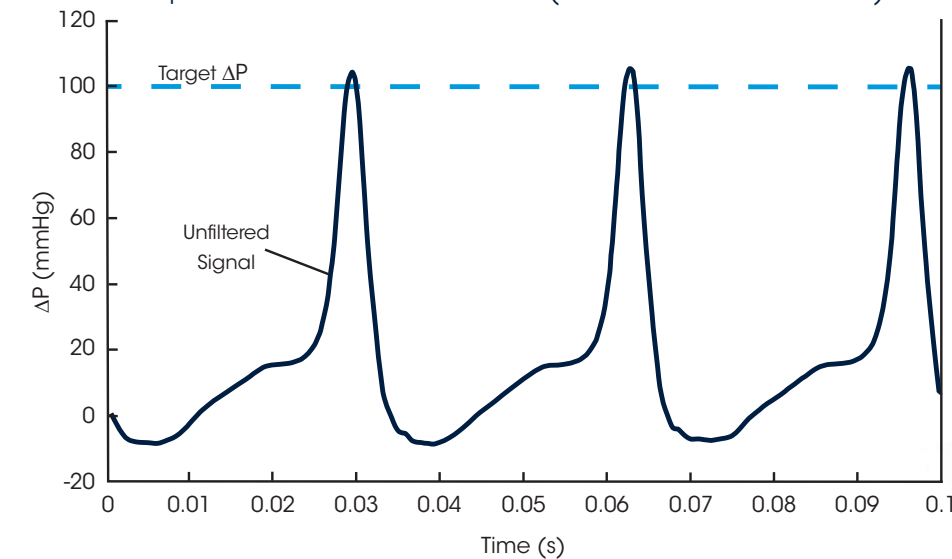
Valve Diameter Range	Up to 40 or 45 mm annulus
Valve Types	Mechanical, Tissue, Biomedical
Frequency Range	15 - 45 Hz
Valve Differential Pressure Range	Up to 500 mm Hg
Number of Samples	2, 4, or 6 samples



**DuraPulse
2-station HVT**

High-frequency performance and pressure control previously unachievable in heart valve durability testing

DuraPulse HVT provides superior pressure control to achieve delta pressure with minimal overshoot (27mm aortic valve at 30 Hz)



**DuraPulse
4-station HVT**

**DuraPulse
6-station HVT**

BIOMATERIAL CHARACTERIZATION | PLANAR BIAxIAL TEST INSTRUMENT

Perhaps the most versatile test instrument available, the ElectroForce® Planar Biaxial can be used to characterize the material properties of biomaterials and medical devices, such as pericardium or heart valve leaflets. Available in 2- and 4-motor configurations, this system can assess the anisotropic behavior of materials to support development of constitutive models, compare the mechanical properties of synthetic materials to biologic tissues, or perform fatigue tests.

Unparalleled performance for biomaterial and soft tissue characterization

- Control each motor independently or easily synchronize opposing motor to apply equivalent loading
- Select the appropriate feedback channel for your test: displacement, force, or strain control

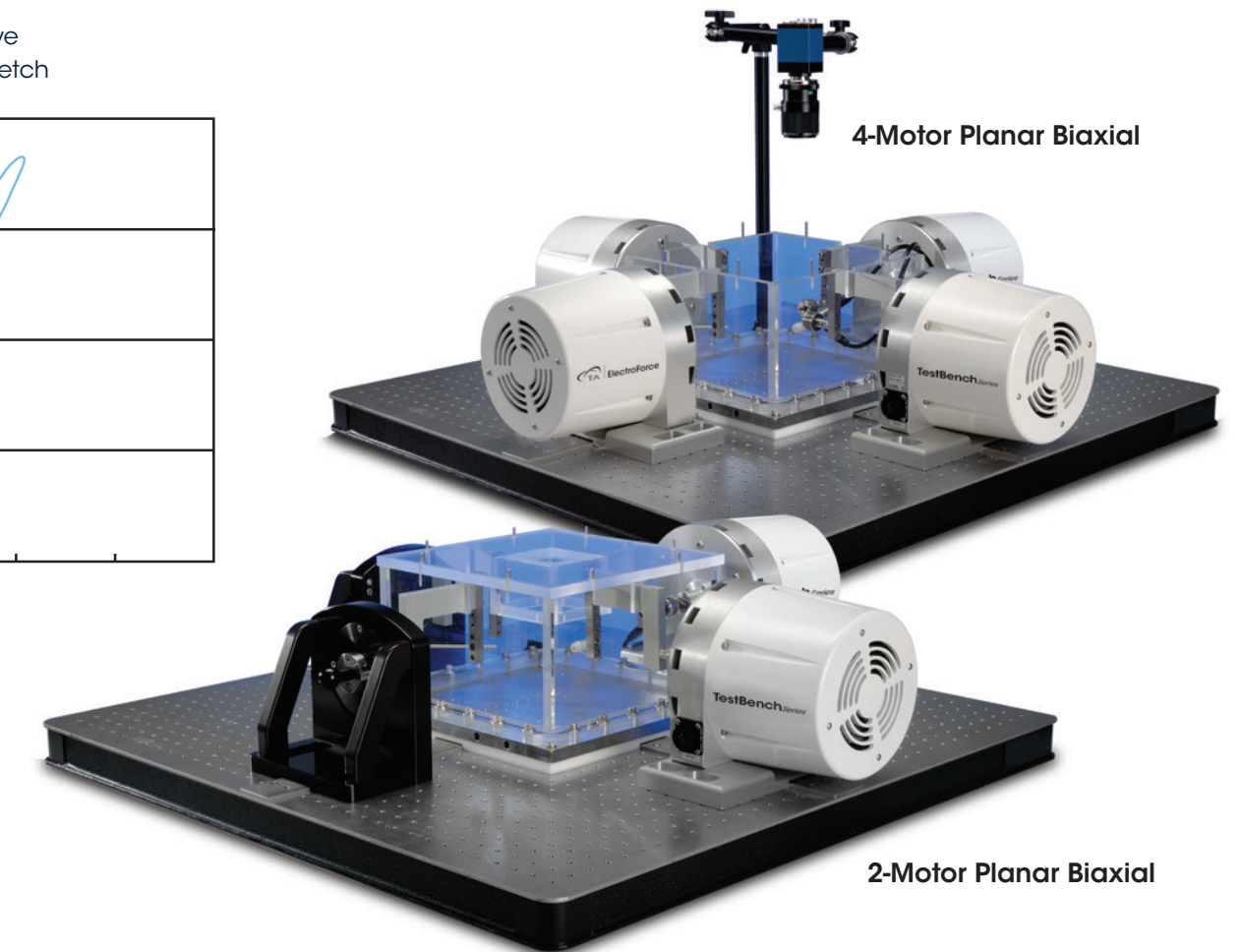
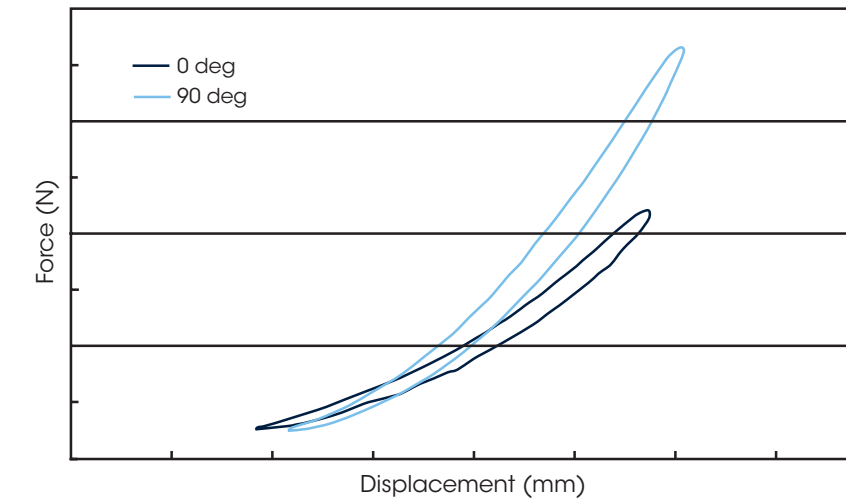
Modular platform and breadth of accessories provide versatility as needs change over time

- Torsion and Extended Stroke (ES) motor can be incorporated to expand available testing modes
- Temperature-controlled baths and sterile bioreactor chambers facilitate testing in appropriate environmental conditions
- Capture non-contact 2D strain measurements via an integrated Digital Video Extensometer (DVE)

Specifications	2 - Motor Planar Biaxial	4 - Motor Planar Biaxial
Force Range	0.002 - 200 N	0.002 - 200 N
Displacement Range	0.025 - 13 mm	0.050 - 26 mm
Frequency Range	0.00001 - 100 Hz	0.00001 - 100 Hz
Instrument Dimensions (HxWxD)	267 x 1000 x 1000 mm (10.5 x 39 x 39 in)	286 x 1086 x 1086 mm (10.5 x 43 x 43 in)
Instrument Weight	102 kg (225 lbs)	110 kg (243 lbs)

Superior control and dynamic performance to characterize anisotropic material behavior

Anisotropic behavior of heart valve leaflet material under equibiaxial stretch



ACCESSORIES

ElectroForce® test instruments can be integrated with a variety of upgrade options, specimen fixtures, and measurement sensors to make your test yield the most physiologically-relevant results.



Pressure Control Assembly (PCA)

Pulsatile Test Instrument

- Manifold Sets (available for DuraPulse™ SGT)
- Silicone Tubes (Mock Vessels) – various geometries available
- Optical Micrometer
- Pressure Control Assembly (PCA)
- Pressure Sensors
- Spare Bellows
- Spare Fittings

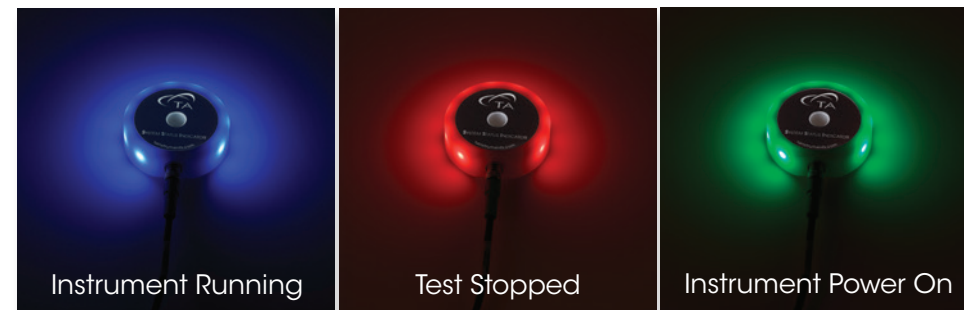
Multi-Specimen Fixture and Planar Biaxial Test Instrument Accessories

- Tension Grips
- Compression Platens
- 3- and 4-Point Bend Fixtures
- Hook Grips ^[1]
- Force Sensors
- Accelerometer ^[1]
- Saline Baths
- Digital Video Extensometer ^[1]
- Torsion Motor ^[1]
- Extended Stroke Motor ^[1]
- Air Bearing

General Accessories

- System Status Indicator (SSI) Lights
- Uninterruptible Power Supply (UPS)

[1] For use on TestBench and Planar Biaxial test instrument only



System Status Indicator (SSI) Lights

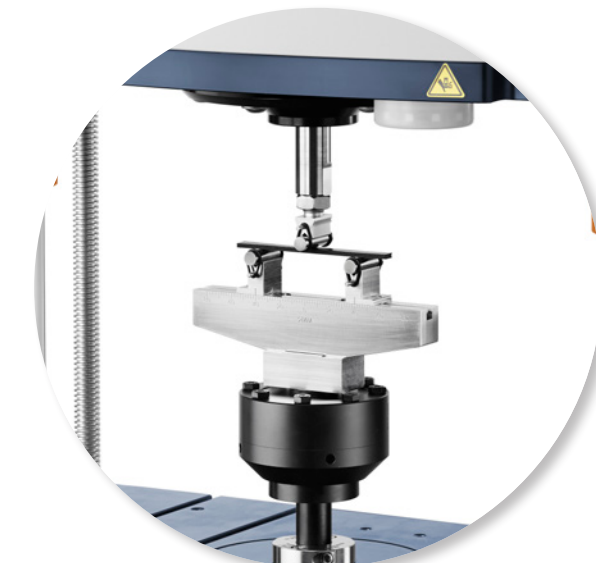
Tensile Grips



DuraPulse SGT Manifold Sets and Mock Vessels



Digital Video Extensometer (DVE)



3300 Extended Stroke with 3pt Bend



Optical Micrometer Assembly

The Most Flexible Control System Available

The WinTest® digital control system is a powerful software package that provides an intuitive user interface, closed-loop waveform control, and data acquisition.

- Powerful waveform generation tools to quickly create periodic waveforms for fatigue tests and block grouping to create more complex tests
- Integrated data acquisition algorithms including timed data acquisition, peak/valley capture, level-crossing and additional techniques
- Advanced controls including multi-channel synchronization of phase and amplitude, and cross-channel compensation
- Calculated channels to provide real-time mathematical calculations for measurement channels
- Additional options include:
 - External Waveform Input
 - Dynamic Mechanical Analysis
 - Dynamic Link Libraries

ElectroForce® cardiovascular device test instruments incorporate software applications that guide you through protocol development, making it easier to define test conditions and reduce set-up time.

DuraPulse™ SGT Application Software

- Select between strain amplitude and pressure amplitude adaptive control modes to ensure the achievement of user-defined end levels
- Measures the OD strain of the tube and determines the minimum/maximum values of the ID of the mock vessel and associated strain percentage in accordance with calculations identified in ISO 25539
- An intuitive data acquisition scheme simplifies collection of maximum and minimum diameter and strain data over a user-defined time for the duration of the test

DuraPulse HVT Application Software

- Independent station windows provide unique setup, status and real-time pressure versus time plot windows for each device being tested
- Real-time scope displays auto-scale on both axes depending on selected test parameters
- Key parameters are displayed per sample, including: % of cycles above target pressure, peak pressure duration %, pressure across the valve, total number of cycles performed, and total number of cycles that pass desired test criteria
- Collect predefined sets of data using the "Timed Snapshot" function or use the "Snapshot Now" feature to instantaneously capture what is shown on the screen

TRIOS

- Real-time plotting of acquired data
- Overlays of WinTest Timed Data and Peak Valley data
- Many analysis tools such as Peak identification and integration, Onset point identification, slope fitting, etc
- User-defined variables

WinTest TuneIQ®

- TuneIQ Software uses advanced proprietary algorithms to simplify the tuning process
- Provides excellent re-creation of system program waveforms, allowing for improved test control and ultimately better test results
- Advanced methods that analyze the dynamic response of the system, sensor and sample for optimal control, superior to a single-point measurement that doesn't factor in sample dynamics

DuraPulse PeakIQ™

- PeakIQ pressure algorithm ensures optimal test conditions as heart valves change over time
- Automatically adjusts command to optimize peak pressure while maintaining desired threshold for peak pressure duration as desired for ISO 5840
- Prevents high-pressure spikes during valve closing that may lead to unnecessary valve damage

HADS (High Accuracy Displacement Sensor)

Included on 3330 MSF test instruments, HADS provides up to 1 nm resolution and micron level of accuracy.

- Class A, ASTM E2309 calibrated accuracy
- Extremely low noise to eliminate the need to filter data
- High responsiveness extends the dynamic performance of system
- Single displacement channel to provide both absolute and high resolution measurements

Industry-Leading Sales & Support

TA Instruments' leadership position results from the fact that we offer the best overall product in terms of technology, performance, quality, and customer support. While each is important, our demonstrated commitment to after-sales support is a primary reason for the continued loyalty of our customers. To provide this level of support, TA Instruments has assembled the largest worldwide team of field technical and service professionals in the industry. Others promise good service. Talk to our customers and learn how TA Instruments consistently delivers on our promise to provide exceptional service.

With direct support staff in **24 countries** and **5 continents**, TA Instruments can extend its exceptional support to you, wherever you are.





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