HEXAGON

Brochure

Tube and wire inspection solutions

Advanced measurement and process control
for the tube and wire production industry





Tube and wire measurement

Any shape, any size, anywhere

Hexagon's comprehensive range of tube and wire measurement systems delivers solutions tailored to a variety of applications in the world of tube production. They combine high-precision hardware engineering with innovative and intuitive software platforms to fully meet the demands of inspection, manufacturing, gauging and reverse engineering processes, whether manual or automated. The result is a product portfolio tailored to support cost-effective production and meet the challenges of every application in the tube and wire manufacturing sector.

Hardware

TubeInspect P8.2 | P8.2 HRC P16.2 | P16.2 HRC

High-accuracy high-speed camera-based tube measurement in a turnkey cell.

TubeInspect automation P8.2 HRC | P16.2 HRC

Innovative measurement cell solution for fully automated 24/7 tube inspection.

Absolute Arm with laser scanning

Advanced manual measurement of complete tube geometries with a laser scanner.

Absolute Arm with tube probe

Well-established manual tube measurement technique with an infrared probe.


BendingStudio XT
Overview
Details
Report
Measuring
Bending correction
Results
Part administration
Part editor
Reverse Engineering
Measurement tools
Materials
Hardware administration
List of result data
Overview
Bending elements
Calculation
Bending coordinates
Inspection "sheath deviation"
General information
3D-view
Colorized view
Deviation pins
Nom.-Act.
Sheath tolerance
adminEN
Details
Deviations
Measurement values
Scope of tolerance
Explanations
Out of tolerance
In tolerance
14,00
12,00
10,00
8,00
6,00
4,00
2,00
0,00
Start length
Straight 1-1
Straight 1-2
Straight 2-1
Straight 2-2
Straight 3-1
Straight 3-2
Straight 4-1
Straight 4-2
Straight 5-1
Straight 5-2
Straight 6-1
Straight 6-2
Straight 7-1
Straight 7-2
End length
Close
Database is up-to-date

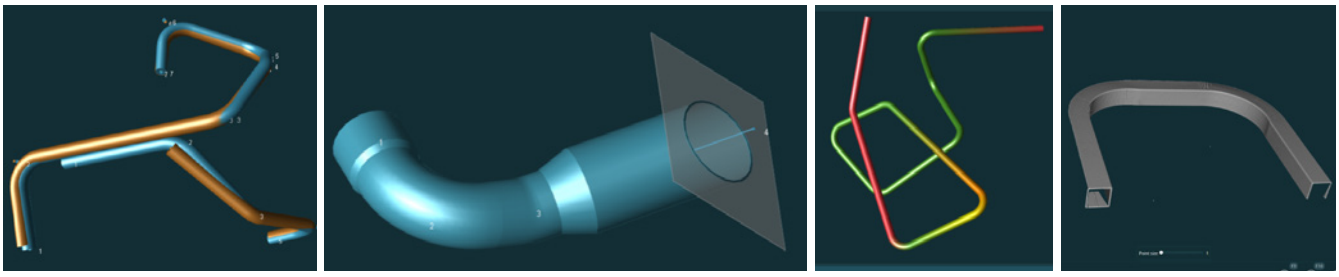
BendingStudio XT

A single hub for complete tube and wire inspection

The BendingStudio XT software platform is a complete end-to-end solution for tube and wire inspection and production control. The software links all data and processes related to the production of bent parts, from design and process planning to manufacturing and quality control. BendingStudio XT is the only tool to meet and combine these requirements with an emphasis on metrological processes.

Evaluate parts quickly with clear actual-nominal value comparison. Implement multiple inspection plans with individual measurement criteria for each part. Enjoy comparable result presentation no matter the origin of the data. Benefit from a unique calculation method for the correction of complex bent parts such as brakelines with end formings or parts with clamping jaws. Make use of overlength compensation, with smart, customisable and part-specific calculation of correction data.

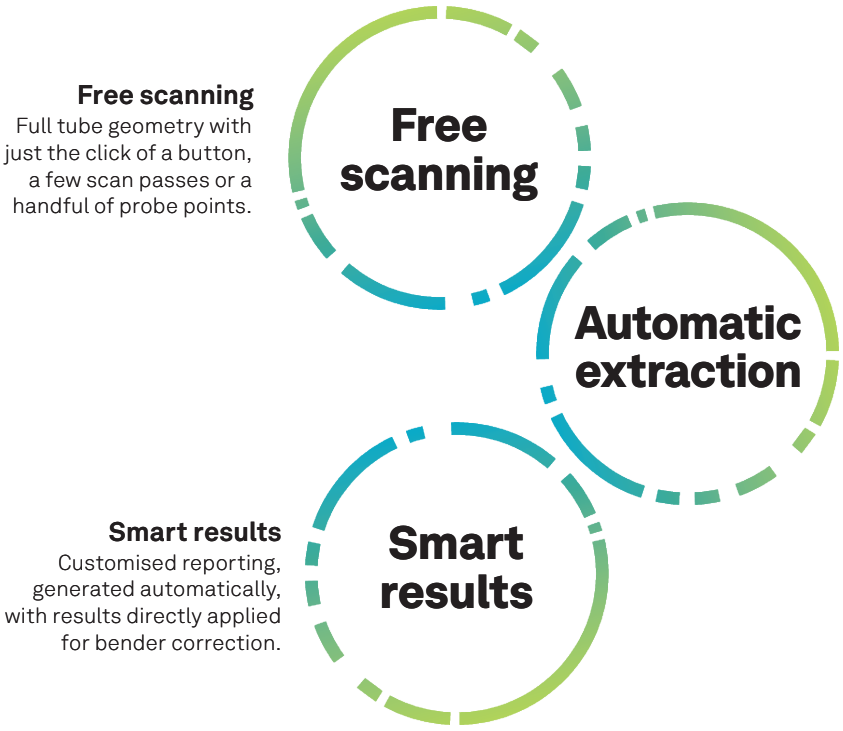
BendingStudio XT is the complete package for complex analysis and management of tube and wire production.



BendXtract technology

Meet the power behind the tube inspection performance of BendingStudio XT

At the centre of the high-performance inspection capability of BendingStudio XT is BendXtract technology – the set of algorithms that allows BendingStudio XT to quickly collect measurement data, interpret that data and turn it into actionable customised reporting.



Free scanning
Full tube geometry with just the click of a button, a few scan passes or a handful of probe points.

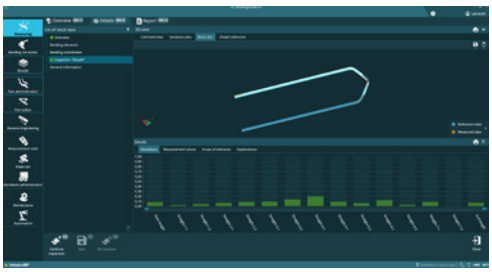
Automatic extraction
Immediate calculation of full tube geometries and centerlines with minimised user interaction.

Smart results
Customised reporting, generated automatically, with results directly applied for bender correction.

BendingStudio XT

Managing bending production and quality control, end-to-end

- Optimised connectivity and data handling across production, quality control and design offices
- One-click functionality for measurement results, data import and export
- Optimise series inspection of parts and improve process reliability with measurement jobs
- Simple and clearly structured handling concept, including interfaces for statistical process control software such as qs-STAT
- Measurement on a wide range of tube types, including branched, freeform or even rectangle cross-section tubes
- Automatic correction of self-weight deformation effects in thin or elastic workpieces
- Smart calculation of correction data for bent parts, for example with pre-cut raw material
- Open tube bender interface for communication of production correction data in real time
- Position and orientation measurement of end holders, fittings and fixtures
- Modern and flexible user interface in multiple languages, adaptable for shop-floor use or for data preparation in office environments
- Powerful reporting with on-the-fly preview including configurable 3D views and extensive item library for report template configuration
- Completely automated measuring and result documentation in combination with TubeInspect systems











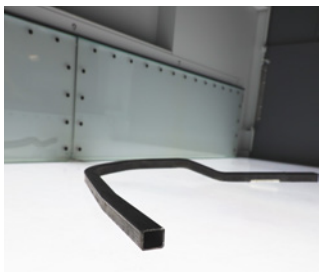
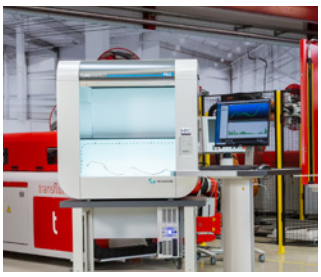
TubeInspect

A turnkey solution for instant high-end tube measurement

TubeInspect is the leading solution for high-speed tube measurement. Based on a multiple-camera optical scanning system built into a turnkey single-piece cell format, TubeInspect represents the height of what's possible with optical scanning in the tube and wire production industry.

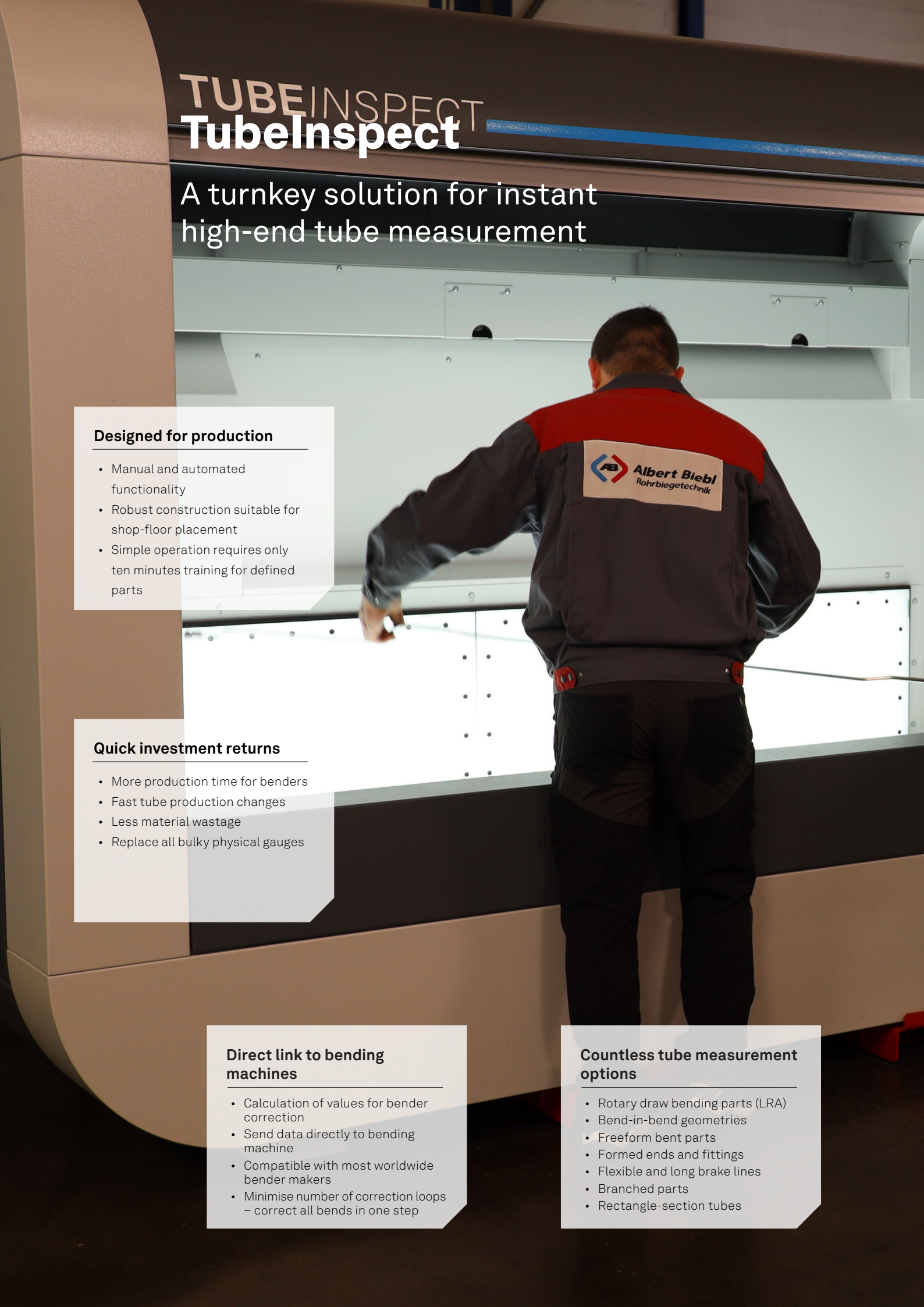
Powered by the dedicated BendingStudio XT software platform, TubeInspect is available in both an industrial-sized TubeInspect P16.2 and a smaller TubeInspect P8.2 variant. Both models are also available in HRC high-resolution camera versions delivering improved detail and feature analysis. High-end models also offer the possibility of integration within a larger robotic production cell, making the tube and wire quality process fully Industry 4.0 compatible.

The system's integrated long-life and low-maintenance LED illumination technology guarantees smooth illumination of the measuring field, automatically controlled through BendingStudio XT. Imaging is fast and detailed with GigE camera technology that ensures synchronic capture of the measuring object within milliseconds. And all this is built on an innovative three-dimensional glass reference surface that is highly precise and offers the reliable stability demanded for shop-floor use.


TubeInspect

A turnkey solution for instant high-end tube measurement



Designed for production

- Manual and automated functionality
- Robust construction suitable for shop-floor placement
- Simple operation requires only ten minutes training for defined parts

Quick investment returns

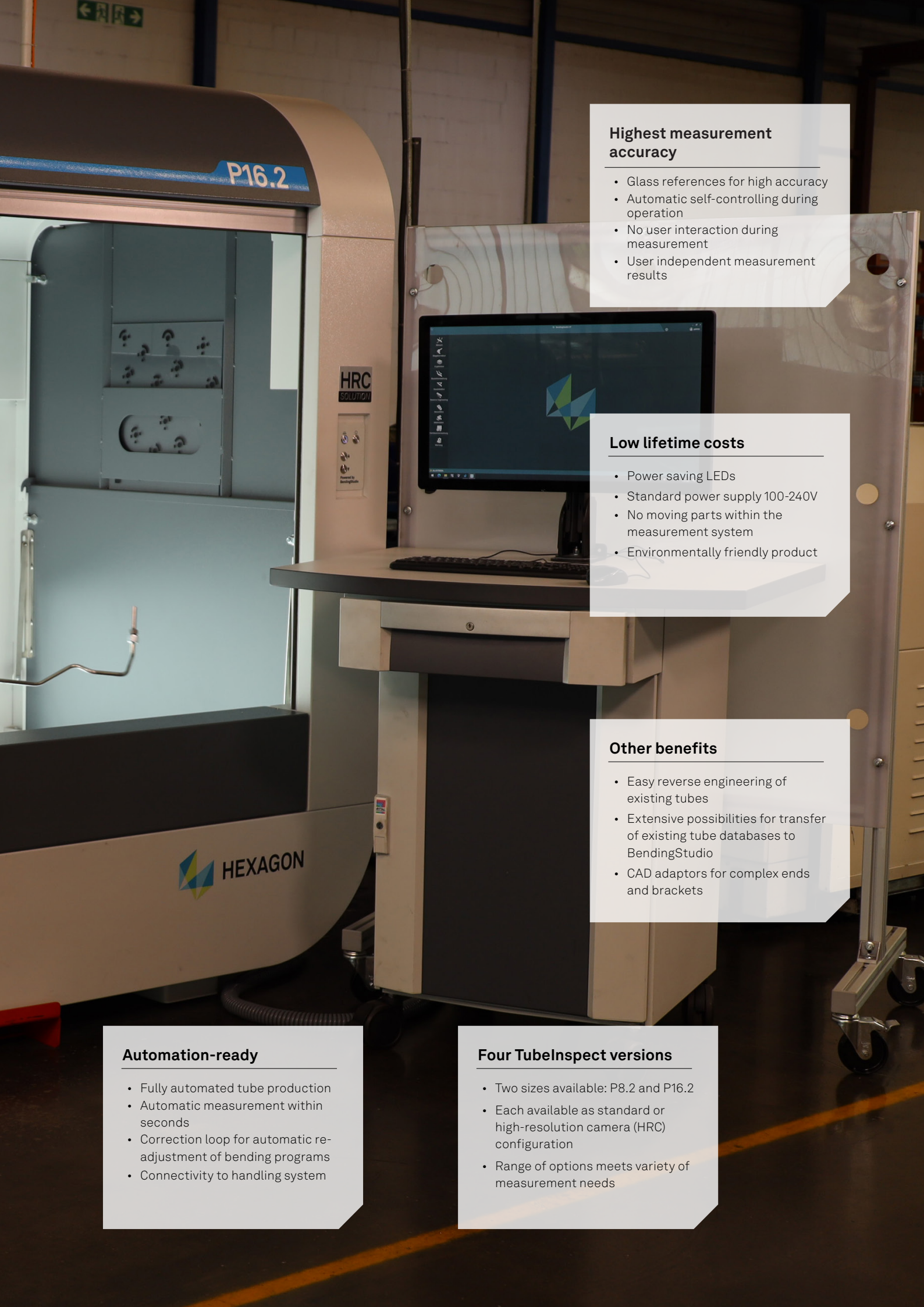
- More production time for benders
- Fast tube production changes
- Less material wastage
- Replace all bulky physical gauges

Direct link to bending machines

- Calculation of values for bender correction
- Send data directly to bending machine
- Compatible with most worldwide bender makers
- Minimise number of correction loops – correct all bends in one step

Countless tube measurement options

- Rotary draw bending parts (LRA)
- Bend-in-bend geometries
- Freeform bent parts
- Formed ends and fittings
- Flexible and long brake lines
- Branched parts
- Rectangle-section tubes



Highest measurement accuracy

- Glass references for high accuracy
- Automatic self-controlling during operation
- No user interaction during measurement
- User independent measurement results

Low lifetime costs

- Power saving LEDs
- Standard power supply 100-240V
- No moving parts within the measurement system
- Environmentally friendly product

Other benefits

- Easy reverse engineering of existing tubes
- Extensive possibilities for transfer of existing tube databases to BendingStudio
- CAD adaptors for complex ends and brackets

Automation-ready

- Fully automated tube production
- Automatic measurement within seconds
- Correction loop for automatic re-adjustment of bending programs
- Connectivity to handling system

Four TubeInspect versions

- Two sizes available: P8.2 and P16.2
- Each available as standard or high-resolution camera (HRC) configuration
- Range of options meets variety of measurement needs

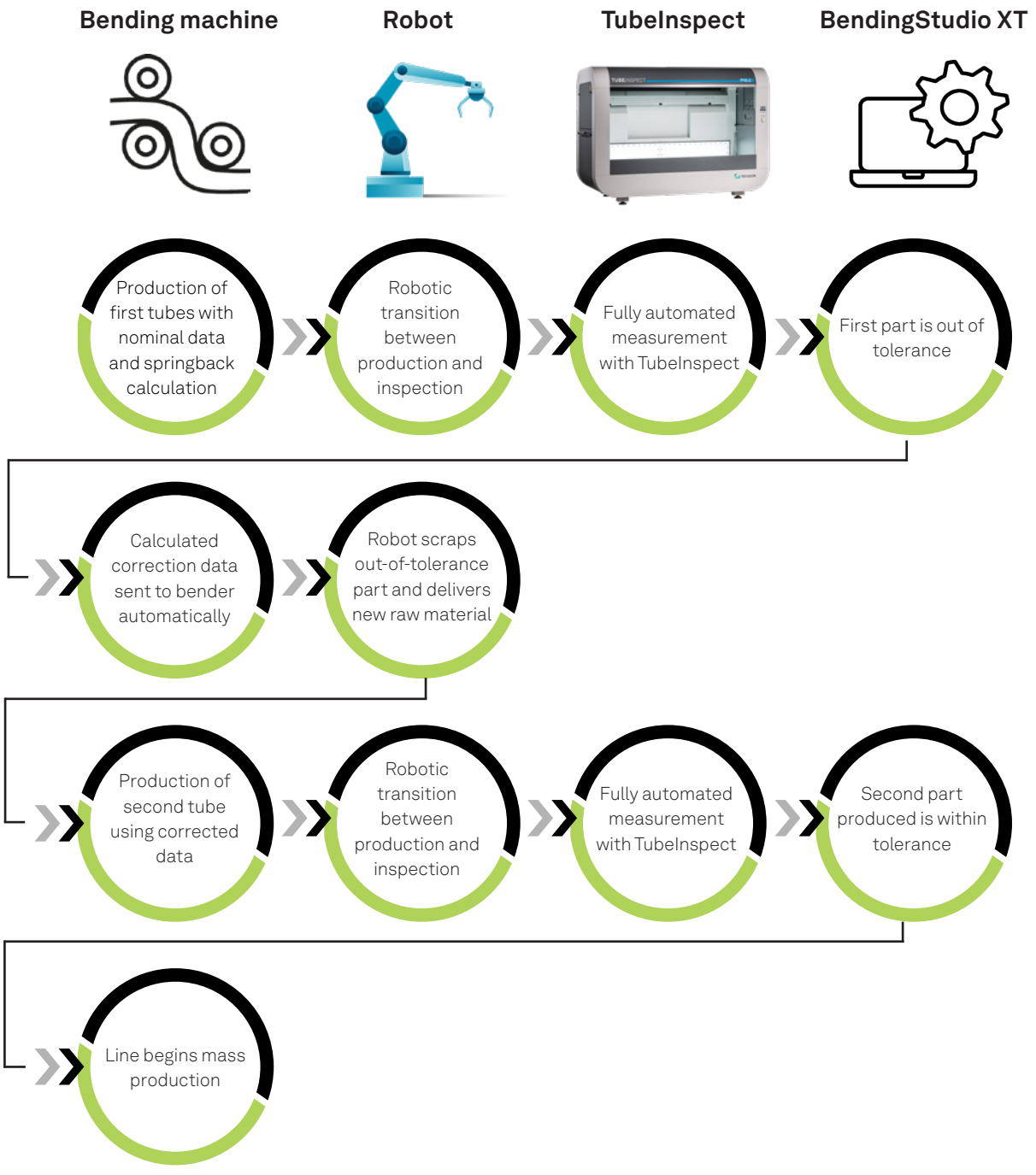


TubeInspect automation

Fully automated tube production-inspection-correction loop

TubeInspect is the leading solution for automating high-speed tube measurement. BendingStudio XT provides a communication protocol for integration in fully automated environments, and the high-speed, high-resolution image capture of the TubeInspect hardware allows it to be placed effectively within any automated production line.

End-to-end robotic tube production





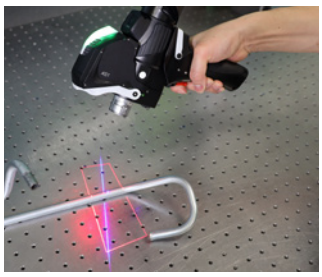
Absolute Arm

Tube measurement on the move

Combining the established laser scanning and infrared probing technology of the Absolute Arm range with the leading tube and wire analysis capabilities of BendingStudio XT, the Absolute Arm is the perfect portable complement to the TubeInspect series.

When working from the same innovative software platform as TubeInspect, the Absolute Arm can deliver high-speed manual collection of high-accuracy data of any tube or wire. Leveraging the leading measurement technology of Hexagon's flagship portable measuring arm compatible laser scanners, full non-contact measurement and geometry definition is quickly achievable with no need for special clamping or alignment procedures, even on shiny surfaces. The system also benefits from a strengthened arm structure and infrared non-contact probe technology custom-designed for tube measurement.

Flexible or rigid, freeform or angular, at the bending machine or in the centre of the production process; the Absolute Arm is a highly adaptable solution for high-quality tube and wire measurement.

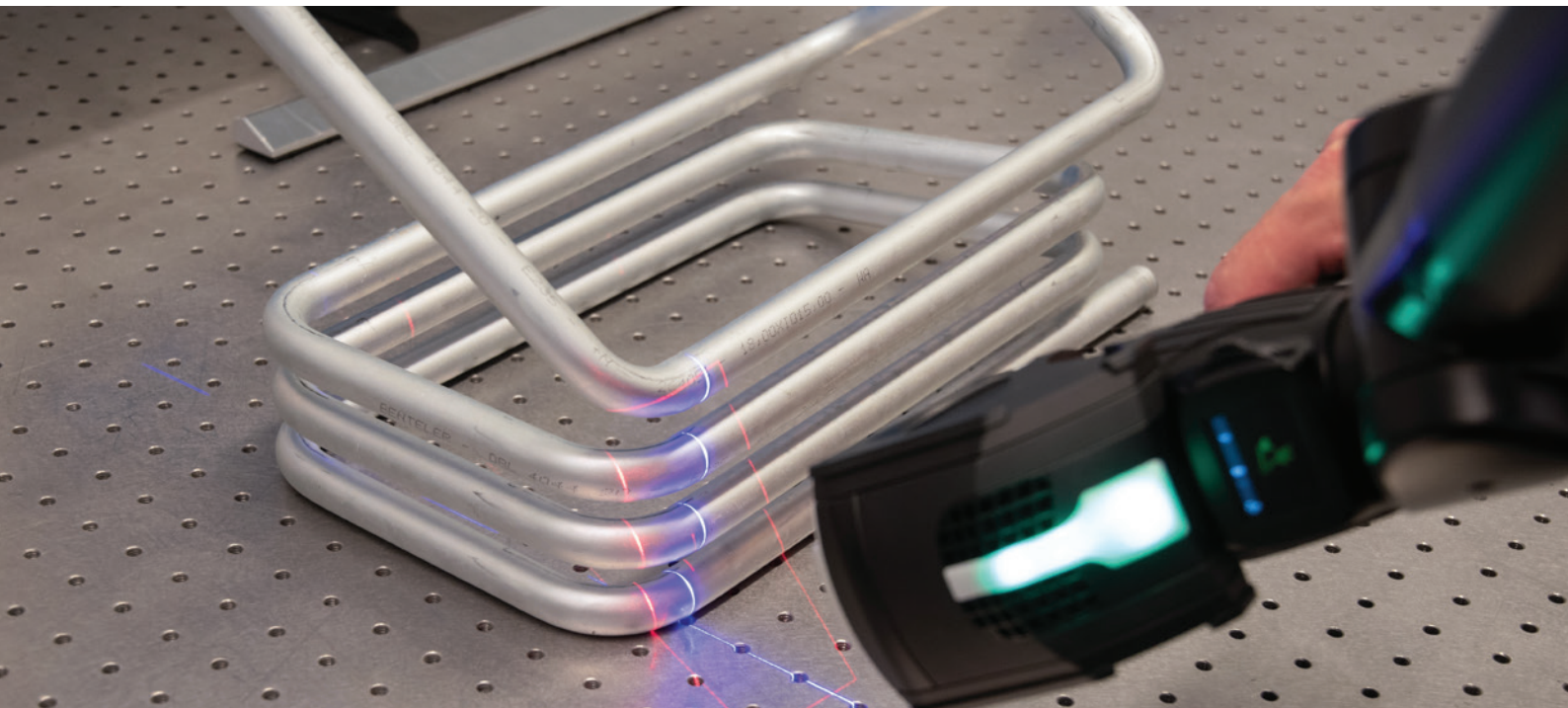





Absolute Arm laser scanning

Unrivalled portable tube and wire analysis through laser scanning

- Fully functional high-end portable measuring arm with laser scanner has the versatility for tube analysis as well as other measuring tasks
- Collect accurate tube and wire geometry data without scanning the entire tube surface or using complex fixturing
- Measure flexible, malleable tubes of any length and of diameter up to 300 millimetres
- Accurate scanning on tubes of a wide variety of materials, colours and surfaces
- Position and orientation measurement of end holders, fittings and fixtures through scanner point cloud analysis with CAD-adaptors
- Highly portable system suitable for tube and wire measurement in any place needed
- Repeatable, user-independent measurement results
- High-definition scanning delivers incredibly fast determination of full tube and wire geometries
- Easy measurement of parts in hard to reach areas
- Full-speed scanning over WiFi and battery power for total portability
- Complete range of accessories includes additional probes, tube clamps, measurement tables and raisers to suit the working environment



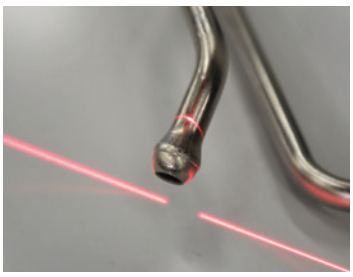
Laser scanner hardware

Absolute Scanner AS1

The Absolute Scanner AS1 is the flagship 3D scanning sensor for Absolute Arm 7-Axis systems. Using cutting-edge blue-laser technology and advanced programming, it combines ‘always-on’ maximum performance with simple usability to deliver high-productivity non-contact 3D measurement.

RS5 Laser Scanner

The RS5 Laser Scanner is a removable 3D scanner designed for use with the Absolute Arm 7-Axis. It delivers high-speed 3D scanning for surfaces and features on a wide range of finishes and materials at a lower cost than a flagship scanner.



Absolute Arm probing

Complete portable tube analysis through infrared and touch probing

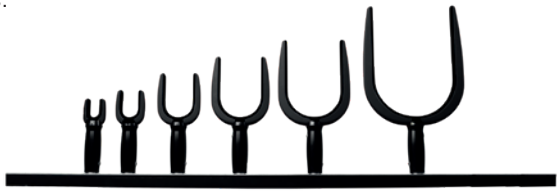
- Infrared non-contact tube probes and touch probes enable basic inspection of almost any tube geometry or material
- Hardware ready for complete GD&T functionality when upgraded with a dedicated metrology software package such as Inspire or PC-DMIS
- Automatic probe recognition and repeatable mounting allows probes to be swapped without recalibration
- Tube probing functionality compatible with every standard Absolute Arm model, as well as with dedicated tube models available in 2.5- or 3-metre measurement volumes
- Absolute Arm tube models have a stronger counterbalance for improved ergonomics, faster measurements and reduced operator fatigue
- Easy-to-use arm requires no warm-up or encoder referencing – simply switch on and measure
- Full WiFi and hot-swappable battery-powered functionality for increased portability
- Complete range of accessories includes additional probes, tube clamps, measurement tables and raisers to suit the working environment



Probing hardware

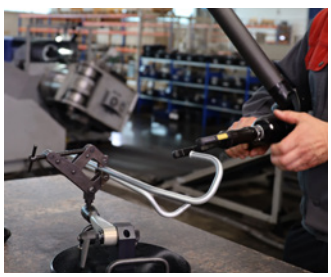
Tube probes

Dedicated tube inspection is provided by a range of infrared non-contact tube probes that can perform fast diameter measurements along key parts of the tube in order to deliver a full picture of the tube geometry. Six sizes of tube probes are available for tube diameters from 4 to 130 millimetres. They are compatible with measurement of almost any tube material, including malleable surfaces.



Touch probes

The touch probe functionality that comes as standard with every Absolute Arm model can also be applied to tube measurement. It allows for measurement of tubes with a greater diameter than is possible with a tube probe, as well as inspection of tube end-forms that cannot be captured by a tube probe, such as bevel-cut ends or ends with expansions.

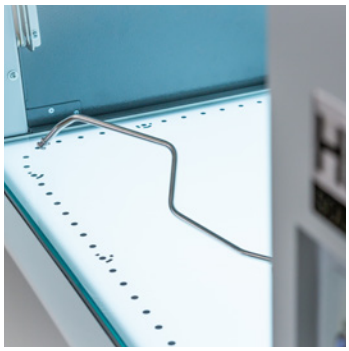





Industries and applications

Tube inspection for every situation

Our range of tube inspection systems has been designed to offer the right solution to every tube and wire manufacturing challenge across the full range of industrial sectors where tube production is needed.



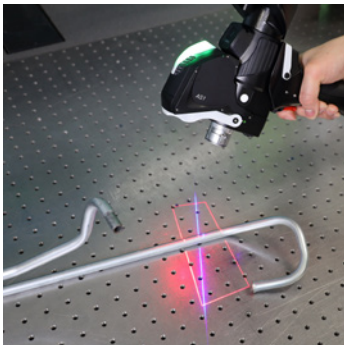


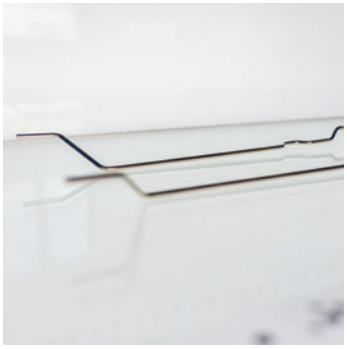
Automotive

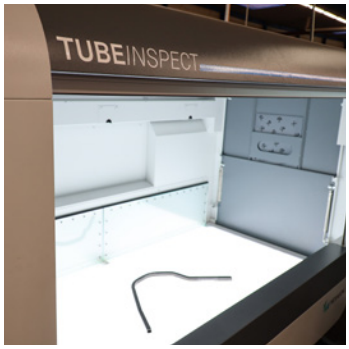
Aerospace

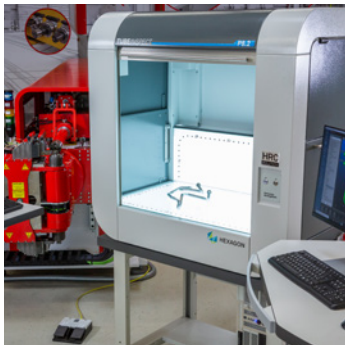
eMobility











Medical

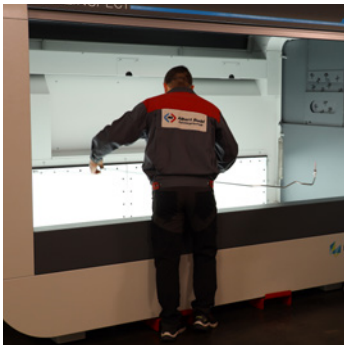
HVAC

Yellow goods











Prototyping

In production

Final assembly

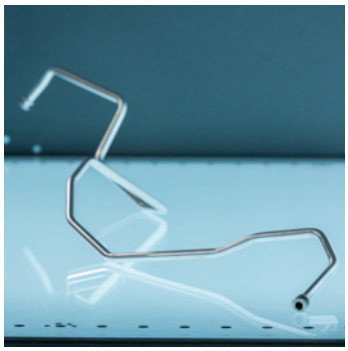




Exhaust tubes

Brake tubes

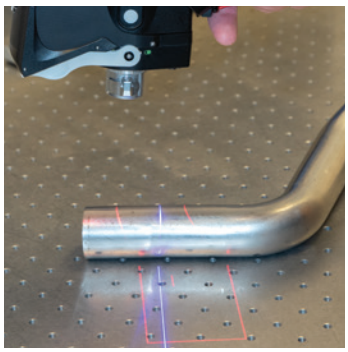
Hairpins

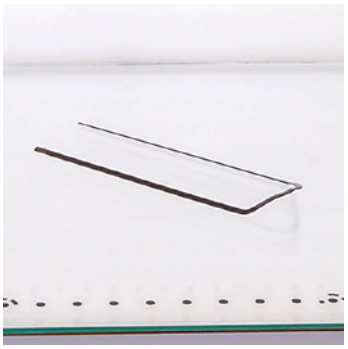












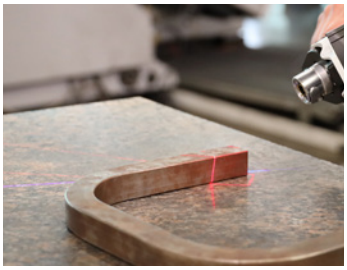
Bus bars

AC systems

Seating



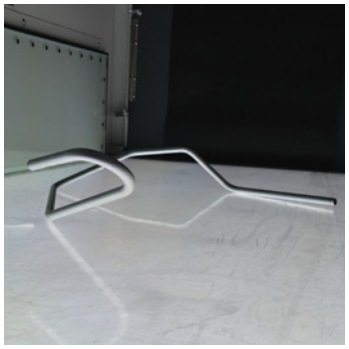












Railings

Hydraulic pipes

Rectangle-section frames



Specifications

BendingStudio XT packages

		Standard	Premium	Automation
Measurement systems	• TubeInspect P8.2, P16.2 • TubeInspect P8.2 HRC and P16.2 HRC • Absolute Arm with TubeProbe • Absolute Arm with AS1/RS5	■ ■ ■ ■	■ ■ ■ ■	□ ■ □ □
Basic functions	Part database; user management; settings for display levels; measurement of tubes and wires, parts with rotationally symmetric formed ends; calculation of bending data (LRA/PBR, XYZ); nominal-to-actual comparison; tolerance envelope inspection (optical gauge); functional dimensions; reverse engineering; measurement jobs; flexible configurable measurement reports	■	■	■
Deflection compensation	Deflection correction for elastic tubes caused by gravity (e.g. long thin tubes or rubber tubes); material data base; not applicable for freeform tubes	■	■	■
Branch	Measurement of branched tube geometries: allows testing of both individual tubes and assembled part; function requires at least one bend for each individual tube; only applicable for cylindrical cross sections	○	■	■
CAD-WIZARD	IMPORT and EXPORT of IGES and STEP files: import by automatic or interactive selection of straight and bended segments of tube components, calculation of bending elements (XYZ/LRA) to prepare a bending program, export of tube geometry in IGES and STEP format	○	■	■
Bevel cut	Functionalities for measurement of parts with bevel cut ends	□	■	■
CAD-adaptors	Measurement function to determine position and direction of features such as mounted holders or attachments; evaluation is done by analysing image or scan data and comparing with reference generated from CAD data	□	○[1)]	■
Diameter changes	Measure positions of diameter changes along the tube	□	■[2)]	■
Profile	Measurement of classic and freeform bent parts with rectangular and oval cross-sections; includes calculation of bending data	□	○[2)]	■
Bender interface STANDARD	Calculation of bending correction data; virtual gauge simulation tool; open bender interface Note: uploading of correction data must be enabled on the bender	■	■	■
Bender interface FREEFORM	Calculation of bending correction data including: bending radii; virtual gauge simulation tool; open bender interface Note: uploading of correction data must be enabled on the bender	□	■	□
Offline licence	License for offline data processing without measuring system for one local seat	○	○	○
Floating licence	Network license for offline data processing without measuring system. Seats extendable	○	○	○
Database server	Simplified BendingStudio XT licence for the administration of the BendingStudio XT parts database on a separate server/computer	○	○	○

All BendingStudio XT packages include a 12-month SMA

■ included □ not included ○ option

[1)] Function only available when using Absolute Arm with AS1/RS6 scanner or TubeInspect HRC models.

[2)] Function only available when using Absolute Arm with scanner or TubeInspect models.

File formats and bending machine compatibility

Data import formats

G-Tube (GTT), TubeShaper (TSP), DOCS (DS), Vector (PRT), CSV, FIF, SV, VDA, XML, $$$; other ASC II formats individually configurable; possible to import multiple files in one batch

Data export formats

CSV, FIF, SV and other ASC II formats individually configurable; DFQ (qs-STAT)

Bending machine brands supported

AddEaton, AIM, Amob, BLM, Comco, Chiyoda, Crippa, CSM, Dengler, Dynobend, GSIE, Herber, Horn, King Mazon, Keins, Keiyo Bend, Lang, OMCG, Pines, Nissin, Numalliance, Schwarze-Robitec, Soco, Transfluid, Unison, UTE, Wafios, YLM and others

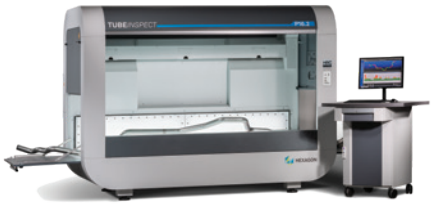
NOTE: individual bending machine must be enabled to load up correction file



Specifications

Solution specifications





	P8.2	P8.2 HRC	P16.2	P16.2 HRC
Measurement technology	High-resolution camera array			
Measurable tube diameter	2-125 mm	0.8-125 mm	3-200 mm	1.5-200 mm
Measurable diagonal for rectangular tubes	8-125 mm	2-125 mm	12-200 mm	8-200 mm
Measuring volume	1000 x 580 x 400 mm		2600 x 1250 x 700 mm	
Max. tube length	Unlimited (with repositioning)			
Bending angle	1-340°			
Min. straight between bends	Bend-in-bend and freeform possible			
Measurement accuracy (tube sheath deviation)	0.035 mm (1σ)		0.085 mm (1σ)	
CAD-adaptors	no	yes	no	yes
Rectangle-section tube measurement	yes			
Automation compatibility	no	yes	no	yes









	AS1	RS5	Tube	Touch
Measurement technology	Blue laser scanner	Red laser scanner	Infrared tube probe	Touch probe
Measurable tube diameter	3-300 mm		4-130 mm	> 50 mm
Measurable diagonal for rectangular tubes	6-300 mm	10-300 mm	n/a	n/a
Measuring volume	2-4.5 m diameter		1.2-4.5 m diameter	
Max. tube length	Unlimited (with repositioning)			
Bending angle	1-340°			
Min. straight between bends	Bend-in-bend and freeform		Bend-in-bend with limitations; freeform not possible	
Measurement accuracy (tube sheath deviation)	0.05 mm (1σ)		0.1 mm (1σ)	
CAD-adaptors	yes	no	no	no
Rectangle-section tube measurement	yes		no	
Automation compatibility	no			

Hardware specifications

	P8.2	P8.2 HRC	P16.2	P16.2 HRC
Measurement speed	> 3 s/measurement			
Camera array	8 high-resolution digital cameras with GigE technology		16 high-resolution digital cameras with GigE technology	
Resolution	3 MP	12 MP	3 MP	12 MP
Reference field	Three-dimensional glass reference surface			
System dimensions (W x D x H)	1140 mm x 746 mm x 1140 mm		2980 mm x 1640 mm x 2300 mm	
Weight	240 kg		1200 kg	
Power requirement	100-240 V 50-60 Hz AC 400 VA		100-240 V 50-60 Hz AC 1300 VA	
Working temperature	5-40°C			
Relative humidity	10-90% not condensing			
Marks of conformity	CE			

	AS1	RS5
Accuracy	0.016 mm ($P_{Form.Sph.1\times25:ODS}$)[1]	0.028 mm (2σ)
Point acquisition rate	up to 1.2 million pts/s	752 000 pts/s
Points per frame	max. 4000	max. 7520
Frame rate	max. 300 Hz	max. 100 Hz
Line width (mid)	150 mm	115 mm
Standoff	165 ± 50 mm	165 ± 50 mm
Minimum point spacing	0.027 mm	0.011 mm
System scanning certification	yes	yes
Laser class	2	2M
Operating temperature	5-40°C	5-40°C
Weight	0.4 kg	0.4 kg

Absolute Arm Tube Model touch probe accuracy and size specifications

Model	E_{UNI}[2]	P_{SIZE}[3]	L_{DIA}[4]	P_{FORM}[5]	Weight[6]	Max. reach
8325T	0.058 mm	0.025 mm	0.066 mm	0.048 mm	8.1 kg	2.73 m
8330T	0.083 mm	0.036 mm	0.089 mm	0.068 mm	8.4 kg	3.23 m

[1] Accuracy Based on a part of the ISO-10360 standard
[2] E_{UNI} Maximum permissible longitudinal error of measurement – according to ISO 10360-12:2016
[3] P_{SIZE} Maximum permissible probe deviation, size – according to ISO 10360-12:2016
[4] L_{DIA} Maximum permissible probe deviation, position – according to ISO 10360-12:2016
[5] P_{FORM} Maximum permissible probe deviation, shape – according to ISO 10360-12:2016
[6] Weight Weight without probe

World-class products to rely on

Drawing on decades of research and development experience, technology from Hexagon's Manufacturing Intelligence division is built on a long history of outperforming technological innovation. Deriving quality from experience to drive productivity is what keeps Hexagon in front and able to deliver first-class solutions for industries around the world.

Along with the assurance of ten years of serviceability, owners of tube and wire solutions from Hexagon benefit from a 24-month factory warranty as standard – our guarantee that our technology will always meet the needs of our users.

World-class support delivered locally

The international presence of Hexagon guarantees comprehensive aftersales support and services across the globe. With the largest dedicated service team of any metrology equipment manufacturer and an emphasis on locally delivered solutions, Hexagon is unmatched from service, repair, certification and calibration through operator training and software maintenance and upgrades.



World-class service made simple

Customer Care Packages

Owners of tube and wire solutions from Hexagon have the opportunity to invest in a Customer Care Package – a standardised after-sale service package designed to ensure equipment remains in top condition and can be relied upon for accurate measurement results.

- Maintenance and warranty plans that ensure top equipment availability
- Trouble-free usage and minimal downtime
- Preferred hotline access at no additional cost
- Access to professional advice whenever it's needed

Customer Care Packages include a selection of the following benefits, depending on the tier chosen.

- Planned annual service
- Hardware support
- Annual maintenance and recertification
- Remote assistance
- Repair parts and labour
- Customised local benefits
- Software maintenance

	Platinum	Gold	Silver	Bronze
Planned annual service	✓	✓	✓	✓
Customer hardware support	✓	✓	✓	
Software support and software updates	✓	✓	✓	
Annual maintenance and recertification	✓	✓		
Remote connected assistance	✓	✓		
Repair parts and labour	✓			
Customised local benefits	✓	✓	✓	✓

For complete details of the benefits of each level of Customer Care Package, please contact a local Hexagon representative.

HEXAGON

Hexagon is a global leader in sensor, software and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Hexagon's Manufacturing Intelligence division provides solutions that utilise data from design and engineering, production and metrology to make manufacturing smarter.

Learn more about Hexagon (Nasdaq Stockholm: HEXA B) at hexagon.com and follow us @HexagonAB.

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