

Rolling Bearings and System Solutions for Medical Technology

SCHAEFFLER GROUP
INDUSTRIAL

The Schaeffler Group: Together we move the world ...

The Schaeffler Group ranks among the world's leading international rolling bearing manufacturers and is a renowned supplier to all major automakers. The companies of the Schaeffler Group successfully compete in over 60 industrial sectors, including the medical technology field – a segment in which we have decades of experience.

With our INA and FAG brands, we offer a portfolio of components and system solutions that is unmatched in terms of quality and scope. Our product line encompasses almost 40,000 catalog bearings as well as numerous solutions that are tailored to our customers' specific needs. With regard to medical technology, our formidable brands such as Barden and IDAM complement the Schaeffler Group's vast range of products.

High-volume production runs combined with state-of-the-art manufacturing technology allow for extremely cost-effective production. Our global network of Engineering Centers constantly develops sophisticated yet economical solutions by applying creative ideas to specific customer requirements.



- FAG Plant
- FAG Sales
- INA Plant
- INA Sales

- ① Engineering Center
- ② Engineering Center
- ③ Engineering Center
- ④ Application Engineering

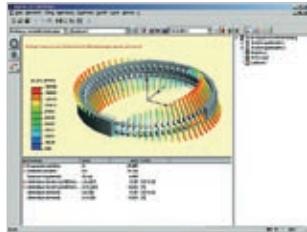
Schaeffler Group Industrial – Medical Technology Segment: “In the market, for the market”

The Schaeffler Group has over 180 locations throughout the world – there's one in your area, too! Wherever possible, we manufacture our products in close proximity to our customers – “In the market, for the market.” Our global network of Engineering Centers is able to draw upon the expertise and resources of the entire Schaeffler Group. We're happy to provide assistance and advice!

...of medical technology. New design perspectives for moving axes



Expert customer support – from the initial design stage right up to delivery of the finished product



On-site calculation support



In-house test rigs – where finished products can be analyzed, too



Chemical and physical labs – for testing lubricants, for example

For over 100 years, our profession has been to develop and supply bearings that safely and efficiently support moving machine parts. When it comes to products that provide movement in medical technology applications, we are an engineering partner as well as a reliable supplier.

What can you expect from us?

- Comprehensive application-focused support and solutions – throughout all stages of the product life cycle
- Exceptional quality and durability
- Superior innovative skills

- Completely new approaches for your designs, thanks to solutions that are often unconventional and remarkably simple
- Solutions designed for easy installation
- Highest levels of operational safety
- High operating speeds combined with low noise levels
- Cutting-edge materials, e.g., non-magnetic, hardened rolling bearing steel
- Radiation-resistant products
- Fulfilling your technical vision is our challenge. Take advantage of our expansive product portfolio and let us become your engineering partner!



Applications in the operating room...



...in ophthalmology



...in dentistry



...in computer tomography and many other areas



New ideas, creative solutions...



Bearing design with BEARINX®: ensuring operational safety by simulating all boundary conditions

Our global Medical-Systems Engineering Teams can provide support in all phases of the product-development process. Take advantage of our proven expertise in a wide variety of sectors and products!

Design

Our strength lies in our ability to develop customer-specific components and system solutions by drawing upon our comprehensive line of products from our INA, FAG, Barden, and IDAM brands. By collaborating with the customer early on in the development process, we can

take full advantage of state-of-the-art CAE-tools, many of which have been developed in-house.

Calculation and bearing selection

BEARINX®, the Schaeffler Group's innovative calculation program, has proven itself for years to be a critical tool in elevating the performance of machines and devices. This program allows us to approach systems from a holistic perspective, thereby producing the best-possible designs that take into account all of the boundary conditions. Only then can the optimal rolling bearing application be determined, which, in turn, maximizes the improvements to the system's efficiency.

BEARINX® allows us to perform a detailed analysis of the rolling bearings, so that the contact pressure acting on each individual rolling element is factored into the calculation – even for the most complex shaft systems. For the design engineer, this level of attention to detail provides an extra measure of security.

All results, including, for example, calculated rating life, can be provided in tabular form or as diagrams, depending on your document needs.

Testing

The new product is tested only after all of the calculations have been optimized. If desired, customer samples can be tested in one of our R&D Centers under all conditions and for all functions – from wear behavior to noise. Once a series of stringent tests under simulated field conditions has been completed, volume production can begin!

Tribology

Lubrication has a significant impact on the reliability and operating life of a bearing. We thoroughly test all the greases used for the initial lubrication of our products in our in-house lubricant laboratory prior to their use. Applications intended for medical technology are also subjected to additional tests, including resistance to radiation. In this product segment, particular attention is paid to "for-life" lubrication.



Steel, brass, plastic: ball cages made from a variety of cutting-edge materials



Acoustic testing laboratory at Schaeffler Group Industrial's Corporate Testing Center



Special filtered greases for precision applications

... utilizing cutting-edge materials

Materials

The application determines the material

– and you determine the application.

Then, we select from a wide range of cutting-edge materials, combining them into the perfect mix for your product:

- Corrosion-resistant special steels, such as Cronitec[®] and Cronidur 30
- Hardened, non-ferromagnetic rolling bearing steels, e.g., X5CrNi1810
- Temperature-resistant high-performance plastics, such as PEEK
- Wear-resistant industrial ceramics (Si_3N_4).

Surface coatings

Coatings can profoundly improve a variety of bearing characteristics, such as wear, corrosion-resistance, run-in behavior, dry-running characteristics, resistance to media, behavior under lubrication-starved conditions, etc. For example, Corrotect[®] electroplated corro-

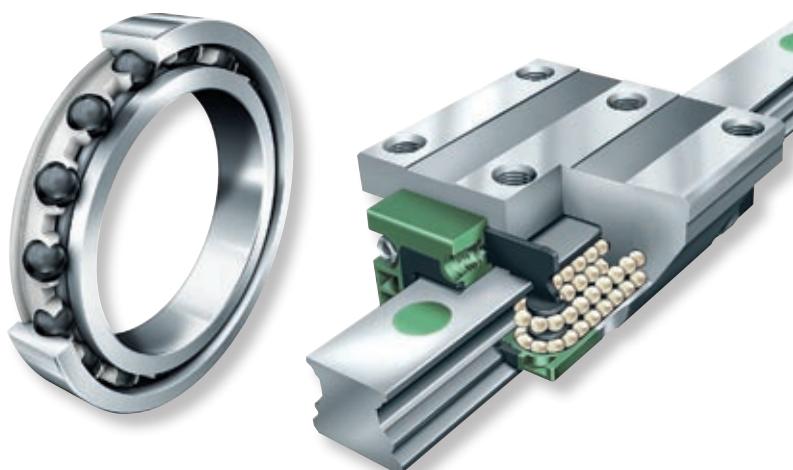
Coatings for Medical Technology Applications			
Corrosion protection for steel and aluminum			
Anti-wear protection for raceways			
Reducing friction Improving running-in behavior			

sion protection is employed whenever especially effective corrosion protection is a priority. Powder coating, on the

other hand, is used if sanitary conditions and aesthetically pleasing design are important considerations.

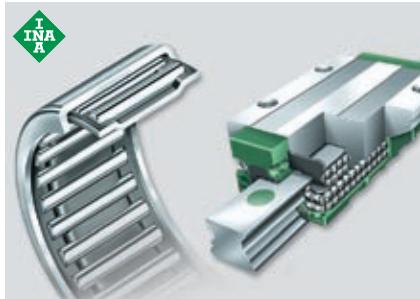


Herzogenaurach: new coatings and the attendant techniques for applying them are developed in our in-house Surface Technology Center



Expertise in materials: a Cronitec[®] hybrid bearing and a linear guidance system made from amagnetic hardened rolling bearing steel with ceramic balls

Our brands – your competitive advantage



Creative Technology: INA rolling bearings and plain bearings, INA linear guidance systems

For decades, INA has been synonymous with creative application engineering, state-of-the-art manufacturing technology, as well as close development partnerships with customers. Our ability to innovate arises from our company's singular philosophy that constantly encourages "outside-the-box" thinking. Because many of our products are manufactured in large production runs through forming (instead of machining), they are particularly economical. In this area, INA's expertise is unrivaled.



FAG precision rolling bearings: "Innovation in Motion"

For over 100 years, FAG has epitomized precision, premium quality and comprehensive service for all things related to rolling bearings. In plants located throughout the world, FAG manufactures ball bearings, rolling bearings, housings and accessories for all industrial sectors. Innovations are methodically planned into this process. A superlative R&D program, creative engineering, and close proximity to our customers guarantee success.



Barden precision ball bearings

Barden is a premium brand that specializes in high-quality and super-precision rolling bearings. Manufactured in the U.S. and Great Britain, these bearings are primarily geared toward aviation and aerospace applications as well as equipment used in dental technologies and x-ray equipment. All Barden bearings – with outer diameters ranging between 3 mm and 300 mm – are assembled under clean-room conditions.



IDAM direct-drive technology

From a technological perspective, IDAM linear and rotary direct drives lead the industry and offer the perfect solution for every application. They are complemented by direct-drive positioning systems with their required control systems and mechatronic assemblies. With increasingly stringent requirements in terms of dynamics, precision and cost effectiveness, direct drives are steadily gaining acceptance in modern medical technology.

Choose from literally thousands of designs!

From a vast array of rolling bearing components and materials, we have created nearly 40,000 different types of bearings. Better yet, all of them are standard solutions, and every one of them can be found in our catalog. If you are searching for the most cost-effective and technologically optimized bearing for your machine parts, this is the first place to look!

The benefit for you: premium quality and reliability – in every bearing. Along with the promise that our products will demand very little of your valuable time during operation. This is because we specialize in solutions that are easy to assemble and require minimal maintenance. Indeed, we often are able to supply entire assemblies that only have to be screwed in place, because the individual components have been perfectly matched to each other and to the mating parts. Our modular architecture is supported by a comprehensive lineup of accessories and service plans, ranging from seals to the most appropriate surface coating for the individual bearing parts to lubrication.

And in that rare event that our standard bearings do not exactly meet your needs, we will be more than happy to develop a customized solution to your specifications.

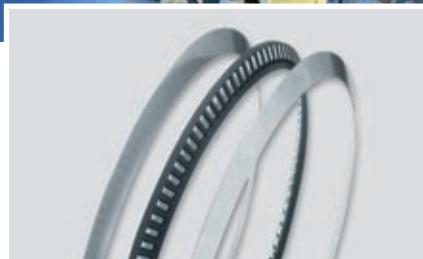


Talk to us!

Reliable and quiet: Rolling bearings from INA and FAG in medical applications



Clever ideas for modern operating rooms: INA's modular needle roller bearing system provides an extra margin of safety for the positioning and support systems in ceiling mounts



From extremely rigid and lightweight axial bearings ...



... to complete units with mounting systems ...



... and a supplementary electromechanical brake

Time-honored mechanical components continue to "carry the load" in the development of medical devices. Ball bearings and roller bearings guide moving parts - even when placed inside powerful magnetic fields. They support virtually all the equipment used in the operating room, or smoothly rotate x-ray cameras – quietly and vibration-free.

A safer operating room – thanks to matched pairs of angular contact needle roller bearings

In today's operating rooms, ceiling mounts have to be able to securely support a growing number of increasingly heavy devices. This is where matched pairs of preloaded INA angular contact needle roller bearings make a significant technical contribution.

In contrast to the ball bearings previously employed in such situations, the bearing cross section of these formed rolling bearings is considerably smaller, while their static load safety factor and tilting rigidity are significantly higher. Thanks to relatively large inside diameters, supply lines and other cables can easily pass through these bearings. A powder coating (specially approved for medical applications) is used to protect the outer rings from corrosion.

Innovation: mechatronic bearing support system for CT scanners

Close collaboration with several renowned computed tomography (CT) manufacturers has yielded a world-class innovation: an integrated mechatronic bearing system that consists of a highly accurate and quiet hybrid thin-section bearing with direct drive along with high-precision mating parts.

The bearing itself is a further development of an idea from FAG's work in aerospace technology. As such, it possesses all of the features that are most important for CT scanners: 100 % operational reliability with the highest level of running accuracy and minimal noise levels. Using our bearing system, it is easily possible to turn the trend toward ever-increasing CT-scanner speeds into reality, as velocities exceeding 400 rpm have already been achieved.



This is where the patient benefits the most: the CT scanners with integrated mechatronic FAG bearing support systems are considerably more precise and operate more quietly. Consequently, the examination takes less time

Another benefit for manufacturers of CT systems: the pre-assembled and pre-tested bearing support and drive

system can be installed as a single unit. This saves time and lowers costs.



Drive units for CT scanners with an integrated mechatronic bearing support system from FAG



Technology transfer with diameters that are measured in meters: an innovative thin section bearing with ceramic balls – originally developed for helicopters, now used in medical equipment applications

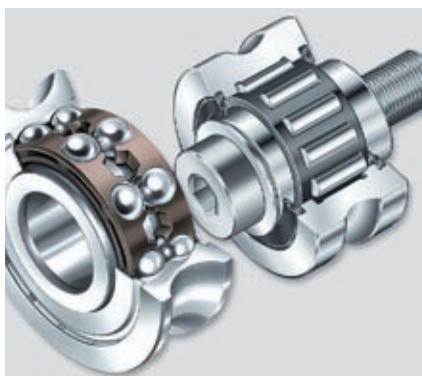
For bearings that securely support longitudinal axes: linear solutions from the Schaeffler Group



The INA brand encompasses the world's most comprehensive portfolio of linear-guidance system products. Thanks to their modular layouts, seemingly disparate solutions to applications can be joined together – quickly and cost-effectively. For years, leading equipment manufacturers have valued the cost savings that these ready-to-install bearing units provide – allowing them to create ever more compact devices that require fewer mechanical components.

From a customer's application: a complete solution for the C-arm

The customer presented us with the following challenge: the highest-possible picture quality with as little stress on the patient as possible. The objective was to find a linear guidance system that enables the x-ray tube to be positioned above the C-arm smoothly and precisely. Resistance to radiation and quiet operation were additional requirements.



Minimal edge pressure – reduced wear of the mating track: smooth-running INA track rollers with optimized outside surface profile

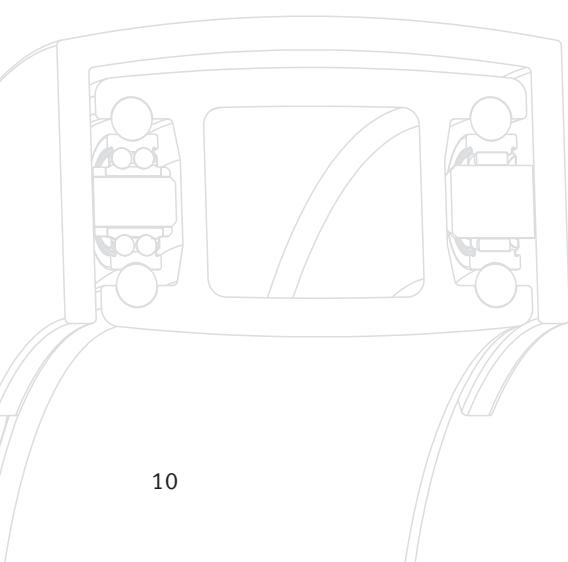
The Schaeffler solution comes ready to install, is technically brilliant, and provides the customer with significant economic benefits. The basis of the new curved guidance system is an aluminum-extruded section with hardened shafts made from corrosion-resistant steel. Particularly innovative: the integrated locating/non-locating bearing solution, which can compensate for any dimensional inaccuracies in the mating component. The non-locating bearing is designed as a profiled track roller with a movable inner ring; in this case, in the form of a needle roller bearing – one of our specialties. The benefit is constant resistance to displacement, regardless of the x-ray tube's position.

Profile rail guides give examination tables a smooth ride

An electronic system enables the examination table to be adjusted and positioned in a smooth and fluid manner.



Ensuring a comfortable and stress-free environment for the patient: we offer a line of low-noise and smooth-running profile rail guides that are specially designed for examination tables



And we supply the appropriate mechatronic assembly – in the form of smooth-running, high-capacity profile rail guides. For those situations where loud noise is unacceptably disruptive, we are pleased to present a truly innovative product, our “silent type”: a 4-row linear ball bearing and guideway assembly whose spacers, strategically placed between the balls, significantly reduce running noise. The bearing’s low rolling resistance allows the examination table to be smoothly and precisely positioned. Another significant benefit is that the guidance system – even in the standard design – is virtually maintenance-free for life, thanks to a lubricant reservoir positioned right next to the raceways’ load zones.

Rugged shaft guidance systems for dentist's chairs

The fluid, uninterrupted motion that patients expect from their dentist's

chair requires a shaft guidance system for the height-adjustment mechanism that is both smooth and rugged. To that end, our customers can expect a sophisticated lineup of linear ball bearings, housings, shafts and accessories.

The bearings are available in lightweight designs that employ either plastic or solid cages; corrosion-resistant versions (with coated surfaces) are also available, if desired. All of these products require minimal installation space and very little maintenance.

Our linear ball bearings are also extremely rigid, an essential prerequisite for ensuring the design's ruggedness. Superior resistance to chemicals used for cleaning and sterilization is an added benefit.

Linear solutions from the Schaeffler Group – economical and reliable.
Test them for yourself!



Shaft guidance system with INA's self-adjusting linear ball bearing: misalignments are easily compensated



“Our silent type”: spacers dampen the noise level of this linear recirculating ball bearing and guideway assembly



For high loads: six rows of balls provide a high level of safety in heavy-load applications



For even higher loads: a flat cage guidance system for limited strokes

**Accurate analysis requires precision mechanisms:
ready-to-install bearing solutions from a single source**



Laboratory testing device using a 3-axis handling system for automatic pipette filling



Effective corrosion protection: linear recirculating ball bearing and guideway assembly with patented Corrotect® rust-proofing



Ready to install: miniature linear module for precise positioning

Constant advances in laboratory automation require continuous improvements in mechatronic machine parts. This calls for smooth-running, compact and sturdy bearing subassemblies that can be easily integrated. For example ...

High-quality bearing units for laboratory automation

One of our customers, a laboratory-equipment manufacturer, was looking to automate the process for analyzing test specimens by using a powered 3-axis motion and positioning system and, in doing so, create a reproducible pipette-handling procedure. The specifications developed by the manufacturer and Schaeffler engineers were quite extensive, calling for:

- Smooth, quiet operation
 - Uniform displacement resistance for continuous sequences of motions
 - Corrosion-resistant design suitable for use in a laboratory environment
 - Precise and repeatable positioning
 - Minimal number of parts, straightforward design of mating components
 - Minimal maintenance requirements.

INA's Linear Technology sector provided the perfect solution for the longitudinal axes in the pipette-handling unit: a 4-row linear recirculating ball bearing and guideway assembly with Corrotect® coating for the main axis, as well as two corrosion-resistant, double-row miniature guidance systems for the y and z axes.

The engineers were also able to rely on a Schaeffler product for the rotary motions: angular contact ball bearing units were employed as spindle bearings in both the main drive as well as in the drive system for the device used for drawing the liquid into the pipette.

Consequently, the primary bearing units as well as the overall technical design support were provided by a single source. As for the customer – he was extremely pleased with the combination of high-quality bearing units, comprehensive support and outstanding delivery quality. Every one of the requirements in the specifications was fulfilled beyond the customer's expectations.



especially since the bearing solutions, including the corrosion-protection requirements, were able to be combined using standard catalog products.

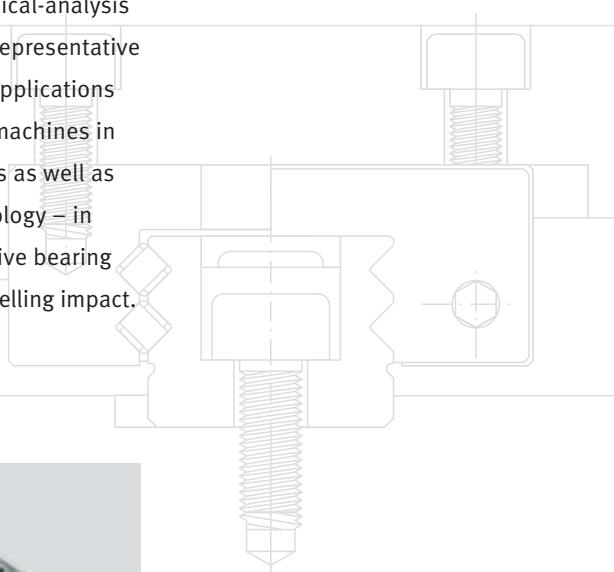
This cost-to-value relationship has become the blueprint for success in lab automation equipment. Thanks to ready-to-install rotary and linear bearing units, the layout of the mechanical components inside the device could be simplified and the unit itself ended up being more compact; consequently, the number of mechanical components could be reduced.

Innovative precision solutions – in all areas of medical technology

The example from the medical-analysis arena described above is representative of a wide variety of other applications – including lens-grinding machines in ophthalmology, phoropters as well as cutting-edge dental technology – in which Schaeffler's innovative bearing solutions have had a compelling impact.



CAD/CAM is revolutionizing dentistry: shown above is a device used for computer-aided ceramic restoration in a dental practice



High-precision and low-friction: INA's linear guidance system used in a scanner unit for eyeglass frames (generates the lens-grinding program)

A single bearing, where once two were needed: INA bearing for rotary and linear movements used inside a milling jig's work spindle

Products from inside the clean room: Barden – a member of the Schaeffler Group



Barden quality: precision rolling bearings are assembled under stringent clean room conditions



Ball bearings can lower your costs: get the longest life out of your dental handpieces with Barden miniature bearings

High speed in dentistry

Among rolling bearing applications, dental handpieces (often also referred to as dental drills) represent one of the greatest challenges. The small ball bearings rotate at speeds of up to 500,000 rpm, often under difficult conditions (consider the debris generated during dental treatments or sterilization in autoclaves). This frequently leads to premature bearing failure.

Barden miniature ball bearings can extend the operating life of handpieces, thereby lowering overall costs. In addition, vibrations are reduced – giving the dentist more control.

Ceramic balls are used in high-speed applications. These balls are harder, lighter and more wear-resistant than steel balls. They generate lower centrifugal forces, thereby reducing loads and wear. A new honing process improves the surface quality of the raceway, which results in a quieter bearing. Improved

end caps reduce the gap between the inner ring and sealing shield by 60%. As a result, less grinding dust enters the bearing and grease retention is improved.

On the cutting edge: x-ray bearing units

Bearing-support assemblies for the spinning x-ray anode can attain speeds in excess of 10,000 rpm under harsh operating conditions: in addition to withstanding high voltage, the bearings must also operate in a vacuum environment at 10–8 torr and at temperatures that can reach 400 to 500 °C.

Barden x-ray bearings have races integrated in the shaft and have a full-complement design. In order to provide effective lubrication under such extreme conditions, we employ coatings that are applied using plasma and ion-beam technology. The performance of our x-ray tube bearings is evaluated and verified in our in-house x-ray bearing test facility under simulated thermal and vacuum test conditions.



Also available in small lot sizes: Barden ball bearings with accuracy that exceeds ISO P4 standards



Innovative x-ray bearing units enable scans with the highest resolution



For high-vacuum applications: bearing unit used in high-speed x-ray tubes

Drives and bearing arrangements from a single source: IDAM direct drives deliver an innovative system solution

IDAM direct drives are particularly appropriate in medical technology applications that require the highest levels of precision and dynamics, long operating life as well as cost-effective performance.

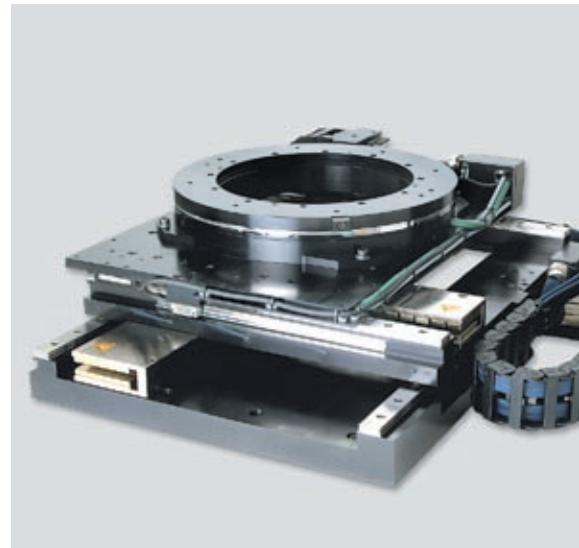
By directly connecting the motor to the moving mass, the number of required components as well as the design space is reduced. Increased dynamic and static rigidity, combined with lower elasticity, enable extremely precise positioning in applications ranging from high-precision motors in collimators for treating tumors to high-performance dynamic drive units for computed tomography to machines used for manufacturing stents, surgical needles, endoscopy components, and many others.

Examples of IDAM system solutions

- HSR and HSRV-series rotary drives are particularly suited to high-speed applications and **CT scanners**. With

special coil adapters, these low-vibration motors achieve relative speeds of 50 m/s.

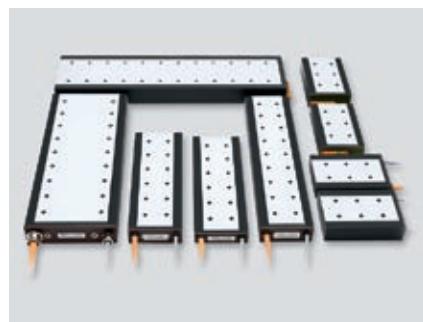
- Medical laboratories are expected to analyze an ever-increasing number of samples in the shortest amount of time possible. Conventional drive systems often lack the performance capabilities to satisfy these requirements. Consequently, mechatronic systems are becoming increasingly common in medical-technical **analysis stations** in which only small masses have to be moved. The perfect combination of high-precision INA linear systems and direct drives from IDAM allow specimens to be positioned to a level of accuracy in the single-digit µm range.
- Combining sophisticated medical technology with modern direct drive technology can produce products that have the ability to save lives. Such was the case when we worked with a customer to develop a direct-drive



Open frame positioning system for testing substrates

laser precision cutting device for manufacturing stents. Uniting new laser beam sources with rotary and linear direct drives from IDAM resulted in an innovative machine concept with superior accuracy and performance.

IDAM direct drives: precise, flexible, efficient. Curious? We'd be happy to prove it to you: sales@ina-dam.de



L1-series linear motors for applications that require high levels of accuracy and performance



Compact 2-axis system for optical scanning



**Schaeffler Technologies****GmbH & Co. KG**

Industriestrasse 1 – 3
91074 Herzogenaurach (Germany)
Phone +49 9132 82-2039
Fax +49 9132 82-4898
Internet www.ina.com
Contact us at:
meditech@schaeffler.com
Publications available at:
info@schaeffler.com

**Schaeffler Technologies****GmbH & Co. KG**

Georg-Schäfer-Strasse 30
97421 Schweinfurt (Germany)
Phone +49 9721 91-6791
Fax +49 9721 91-6424
Internet www.fag.com
Contact us at:
meditech@schaeffler.com
Publications available at:
FAGinfo@schaeffler.com

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