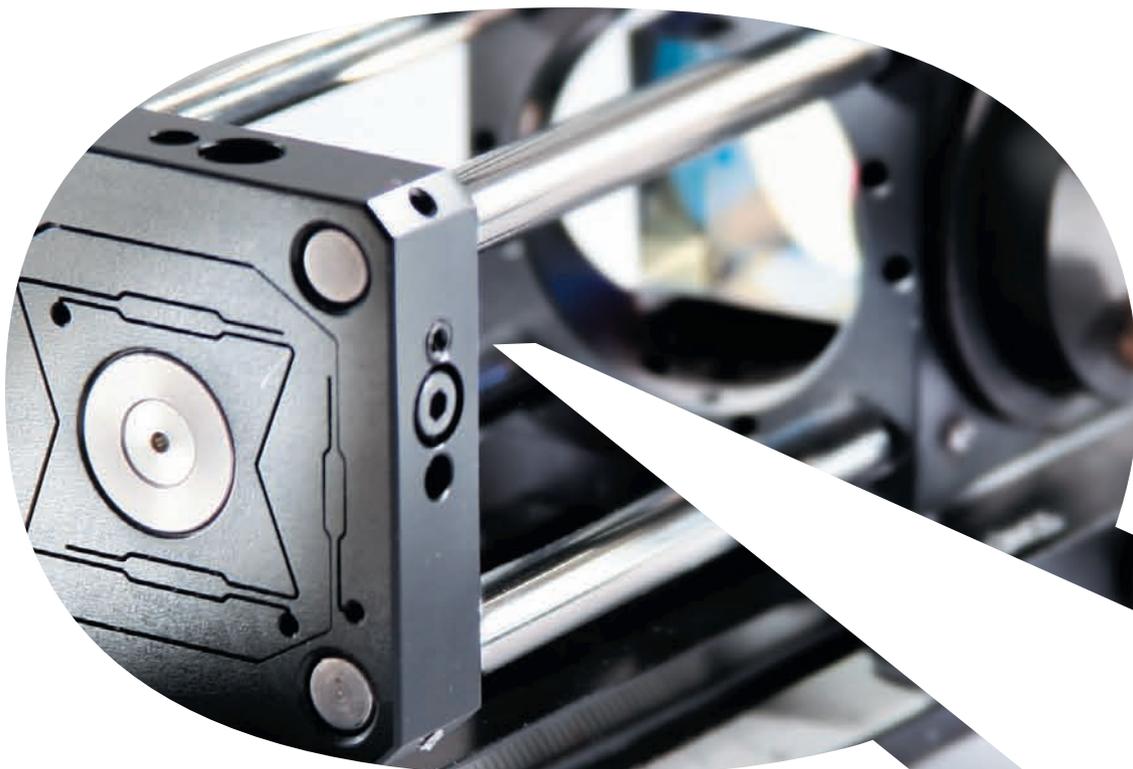


# LINOS Microbench, Bench and Rail Systems



# About this Brochure

We received a lot of positive feedback on previous editions of our brochure describing our Microbench™ and Tube Mounting System C™ products. We are confident that this latest edition, reworked and expanded by the addition of the Nanobench™ and our flat rail and profile systems, lives up to the standard of quality you have come to expect from LINOS products.

Our main objective is to provide you with a clear overview of these systems, including details on their compatibility with one another. Numerous photographs illustrate a variety of applications and setups to help you choose the best combination for your own requirements.

The layout is designed to guide you straight to the information you need, from brief summaries to detailed descriptions and helpful tips.

Special pictograms represent the different LINOS systems to help you find what you need quickly:

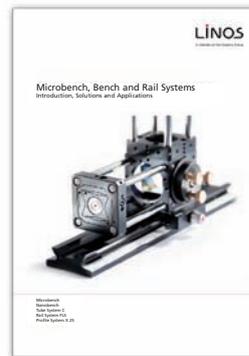
-  Microbench™
-  Nanobench™
-  Tube System C™
-  Rail Systems FLS
-  Profile System X 25



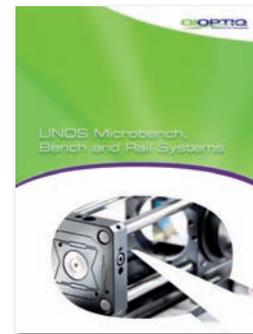
1. 1990 edition (german)



2. edition 2002



Edition 2009



New Q-style edition 2010



Further details are available in the main LINOS catalog of Qioptiq. Visit our website at [www.qioptiq-shop.com](http://www.qioptiq-shop.com) for the latest information on all our products, special offers, and to place orders.

# Table of Contents

The Microbench Concept	4	How Do I Adjust Optics Along the X and Y Axis?	26
Microbench Manufacturing Line	6	What Options are Available for Rotation	
LINOS Bench Systems, Overview	7	of Optics?	27
<b>Microbench™</b>		How Do I Adjust Optics along the Z Axis?	28
Basic Principles	10	What Adapters Are Available?	30
<b>Nanobench™</b>		How Do I Mount My Assembly on	
Basic Principles	12	e.g. Optical Tables?	31
<b>Tube System C™</b>		How Can I Combine Systems?	34
Basic Principles	14	How Do I Mount Bench Systems in	
<b>Flat Rail and Profile Systems</b>		My Instrument?	35
Basic Principles	16	<b>Application Examples of Complex Systems</b>	
<b>Frequently Asked Questions</b>		Creating a Spatial Filter System	36
How Do I Begin My Experiment?	18	Creating an Expansion System	37
How Do I Integrate Spherical Optics?	21	Creating a Fiber Coupler	38
How Do I Integrate Planar Optics?	22	Light Sources for Bench Systems	39
How Do I Apply Adhesives?	23	Motorized Positioners for LINOS Bench Systems	41
How Do I Integrate Optics into Existing Setups?	24	Homogenizers in the Nanobench	42
How Can I Realize Different		<b>Customer Applications</b>	43
Angles in My Setup?	25		

# The Microbench Concept

LINOS (the Catalog line of Qioptiq) – formerly Spindler & Hoyer – and the Microbench system are bound together inseparably, and have been for more than 40 years now. The long-established Spindler & Hoyer company began serial production of the compact 4-rod Microbench system, the innovative successor to the triangular rail system, as early as 1968.



Julius Adolf Hoyer and August Spindler, founders of Spindler & Hoyer (now Qioptiq)

Until well into the 1960s, optical test assemblies were generally set up on triangular profile, or "Zeiss profi 4" optical benches. These were heavy and relatively large constructions that permitted only linear, level optical arrangements. Those systems that did allow spatial expansion were not sufficiently torsion-resistant for metrological applications and

thus were suitable only for demonstration purposes. The dimensions of the accessories for these earlier-model benches made it impossible to achieve the compactness often sought-after in an optical setup. Furthermore, the insertion of microscope assemblies such as polarization, interference or measuring microscopes was exceedingly complex with conventional optical benches. The logical step was the development of a novel micro-optical bench.



Draft design of the Microbench (about 1960): mounting plates, connecting rods and mounts are still recognizable today

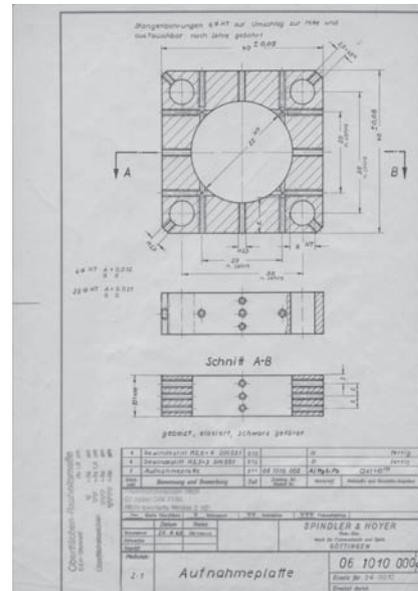
The distinctive feature of the new system was its high stability and precision. Since its introduction, optical and mechanical components of the Microbench system have become indispensable in optical laboratory experiments and are built into a large number of optomechanical devices.



Instruments made up of Microbench components are also ideal for demonstrations and practical training: the exposed design makes it easy not only to observe the entire system but also to alter or expand its most basic workings by simply adding components, such as grids, prisms, mirrors or other accessories.

In the following years the Microbench system has been continually expanded. Numerous mounted optics, specially designed for the Microbench, have been developed. The special  icon has been developed for use in our catalogs to make it easier for you to find mounted optics to add to your Microbench. Now in use both in our main catalog and the on-line shop, this icon shows you at a glance which optics are available in Microbench-compatible mounts.

For the past 40 years the Microbench has stood for the compatibility of all elements. Thanks to our extremely strict production tolerances, we can guarantee that components made today can be used with elements manufactured in the 1970s. And in our further development of the Microbench system, we will continue to ensure that new products are compatible with earlier-model elements.



Production drawing from 1963

### Your advantage using LINOS products

- Decades of experience
- High flexibility thanks to a wide range of components
- High quality ensured by German manufacturing standards



# Microbench Manufacturing Line

## Top-quality materials

- Compliant materials
- Special alloys

meet the highest standards



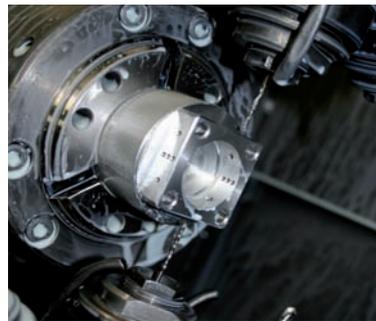
Materials made from highest-quality aluminum alloy, for example: bulk material (round) for mounting plates



## Optimized manufacturing

- Parts manufactured in a single work cycle
- Highest precision to meet our stringent tolerances

for pinpoint accuracy



9-axis CNC milling machine handles all production stages, from aluminum bulk material (round) to finished mounting plate with all drill-holes and threads



## 100% Quality control

- Final inspection of all tolerances
- All components checked for accuracy of fit
- Mutual compatibility of all Microbench components assured

for consistent quality – for more than 40 years



Final inspection of mounting plate tolerances at a coordinate measuring station



## Surface finishing with precision anodizing

- Resistance to wear and tear
- Highest abrasion resistance ensures stringent manufacturing tolerances
- Matt black anodizing prevents reflections

for best surface quality



Microbench cubes mounted after surface finishing in anodizing bath

...and best of all:

All LINOS components are



Made in Germany

and RoHS and WEEE compliant



# Bench Systems, Overview

LINOS bench and rail systems for experimental setups and measuring/inspection equipment offer high precision, excellent mechanical stability and flexibility in use. Our **Microbench** has stood the test of time for more than four decades, and we are constantly expanding the system to make sure all your requirements are met. At the same time, we continue to specialize in trend-setting developments.

Several years ago, in response to the growing demand for smaller systems, LINOS introduced the **Nanobench** line. Compared to the 40-mm edge length of the Microbench system, the Nanobench edge length is just 25 mm.

Another important feature of this product line is our modular component system. The **Tube System C** enables fast set-ups of customized optical systems. The tubes have outer diameters of 30 mm and 35 mm and the system features a wide variety of lens mounts, diaphragms and adjustment units. The universal 1-32 UN mounting unit (C-Mount) enables direct connection to CCD cameras, lasers and microscopes.

In the area of mechanical systems for micro-optical applications, our long established policy of continuous development has brought forth the **Rail System FLS**, available for both the Nanobench (FLS 25) and the Microbench (FLS 40). This is a flat rail system that can be used with individual components, such as mounted optics or positioners or, for example, to fasten complex Microbench and Nanobench structures to optical tables.

Our **Profile System X 25** helps you achieve the best possible stability in your vertical structures. This system is compatible both with our Nanobench as well as the Flat Rail System FLS 25.

No matter which products you choose from our modular LINOS bench and rail systems, excellent compatibility of the systems with one another is guaranteed – and what's more, many other LINOS products, from mounted optics to lasers, can be directly integrated as well. This gives you the advantage of fast implementation, whether for experimental setups or permanent installation of complex measuring equipment. Whatever your application, you can find the optimum system or combination of systems for your particular specifications and spatial conditions within the extensive range of LINOS bench and rail systems.



Microbench



Nanobench



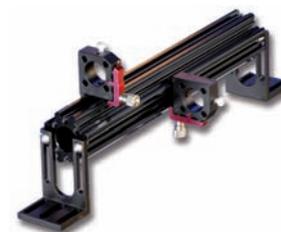
Tube System C



Rail System FLS 25



Rail System FLS 40



Profile System X 25

- Microbench and Nanobench: opto-mechanical systems
- Tube Mounting System C: modular component system
- Rail System FLS: flat rail systems for high-stability structures
- Profile System X 25: for horizontal and vertical setups with maximum stability



## First of its Kind: The Microbench

Microbench is a compact component system for numerous areas of application – from lighting and imaging structures to optical experimental setups, measurement / inspection equipment and interferometric applications, to name just a few.

The outstanding characteristics of the LINOS Microbench products include their high mechanical stability - thanks to the use of highest quality materials - and their easy handling, even for first-time users.

A high degree of flexibility is ensured not only through the wide variety of components available for LINOS Microbench systems, but also by the range of adjustment elements and the system's modular design.

The basic principle lies in the combination of standardized mounting plates for integrating optics of all types, connected by stainless steel rods. Both linear and spatial setups can be implemented quickly and easily.

## Microbench's Little Sister: Nanobench

The Nanobench is an extremely compact construction system for optics with diameters of up to 12.7 mm, and features exceptionally high precision. As with the Microbench system, mounted optics are fastened in mounting plates, which are connected by four rods to ensure extremely precise adherence to the optical axis.

A variety of base plates make it easy to fasten Nanobench components directly onto optical tables, mounting plates and support rods. With its compact dimensions and flexibility in three-dimensional structures, the Nanobench is ideal for applications in micro-optics and fiber optics. Here, too, LINOS offers a broad selection of mounted optics that can be directly attached to the Nanobench. The  icon helps to make it easy to find Nanobench-compatible products and accessories when ordering.

Adapters are available for fitting Microbench and Tube Mounting System C elements to your Nanobench system.



LINOS offers mounted optics developed specially for the Microbench with diameters from 18 mm to 31.5 mm. The special  icon, seen in both our main catalog and the on-line shop, shows you at a glance which optics are available for your Microbench system.

- Ideal system for optics with  $\varnothing$  18 to 31.5 mm
- Modular design ensures greatest flexibility
- Extensive range of optics in Microbench mounts



- The ideal system for optics with  $\varnothing$  3 mm to 12.7 mm
- Compact dimensions
- Modular design ensures greatest flexibility
- Extensive range of optics in Nanobench mounts



## Well-rounded Product Line: Tube System C

The Tube Mounting System C is a modular component construction system for fast and trouble-free set-up of laboratory instruments, prototypes and small-batch production. Tubes are available in diameters of 30 mm and 35 mm. Threaded sockets and threaded rings enable the connection of a wide range of optics, with diameters from 6 mm to 31.5 mm.

With the Tube Mounting System C, creating your own lens and expander systems is a breeze. Adapter rings make this system compatible with the connecting threads on C-Mounts, microscopes and CCD cameras. Fine adjusters and focusing mounts let you make small changes in the length for highly precise focusing. Tube Mounting System and Microbench are excellent in combination; for example, to create a light-tight and dust-tight beam path.



- To realize your laboratory instruments, samples, prototypes and small-batch production, including lenses and expander systems
- Modular component system
- For unmounted optics with  $\varnothing$  6 to 31.5 mm
- Compatible with C-Mount, microscope and CCD cameras threads

9

## Getting on Track: Flat Rail Systems FLS

Our flat rail system FLS includes the FLS 25 and FLS 40 types.: With the FLS 25, you can implement linear and areal structures and fasten 16 mm diameter mounted optics directly on a carrier. Because FLS 25 is fully compatible with the LINOS Nanobench system, you can add construction components and other special elements such as mirror and prism adjusters, positioning units and fiber couplers. The optical axis height is 20 mm.

With the Flat Rail System FLS 40, you can install mounted optics with diameters of 25, 30 or 35 mm, in conjunction with mounting plates or cubes from the Microbench series, on a carrier. With this linear rail design, the optical axis height is 40 mm. Compatibility of the Flat Rail System FLS 40 with the Microbench system enables easy combination with a number of construction components.



- Compatible with Nanobench (FLS 25) or Microbench (FLS 40)
- For mounted optics with  $\varnothing$  16 mm (FLS 25) or 25/30/35 mm (FLS 40)
- Direct installation on breadboards, optical tables, etc.
- Greatest flexibility and compatibility



## High-profile Products: Profile System X 25

Do you require even higher stability? Then you need our Profile System X 25. This octagonal profile system is ideal not only for horizontal structures, but for vertical applications as well.

The Profile System X 25 gives you many attachment options of a universal carrier. Moreover, this system uses the FLR 25 carriers from the FLS 25 system, making it even more universal – and economical.



- Highest stability
- Direct installation on breadboards, optical tables, etc.
- For linear and spatial structures
- Excellent straightness with low torsion

## Basic Principles: Microbench

The Microbench system is based on a small number of elements, such as mounting plates, mounts and cubes, in which optics are installed. These mounts are connected by rods to form extremely compact and sturdy units.

The bore holes for the rods on all mounting plates have identical outer diameters and spacing. The edge length is 40 mm, and thickness is 10 mm. Where not indicated otherwise, the same dimensions apply for other components in the series, such as holders and special mounting plates. The rods are made of corrosion-resistant stainless steel specially for connecting individual Microbench components. They are induction-hardened to prevent marks made by adjustment screws. To ensure there is no play in the guidance of mounting plates and other components, the rods are lapped to fit.

Cubes are multifunctional elements for steering light beams and for integrating various types of optics in holders. Cubes can be combined with rods and mounting plates to create compact, three-dimensional structures. They are available with mounting diameters of 25 mm and 30 mm to fit holders in different sizes.

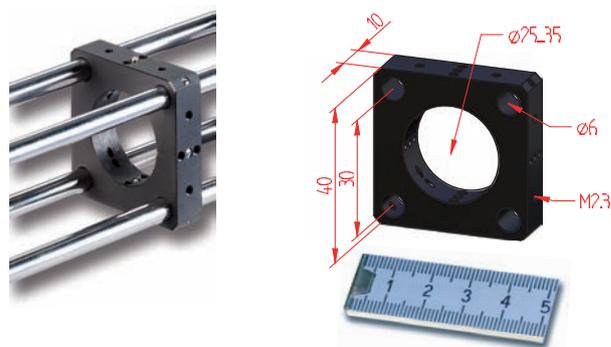
Microbench screws and threaded pins have M2.3 threads and are essential accessories for all mounting plates, holders and cubes.

- For optics from  $\varnothing$  18 to 31.5 mm
- For a large assortment of mounted optics made specially for the Microbench, please see the LINOS catalog or [www.qioptic.com](http://www.qioptic.com) (look for the Microbench icon: )
- Fast integration of Nanobench components using adapters
- Direct attachment of all components in the Tube Mounting System C line with  $\varnothing$  30 mm or 35 mm



## Mounting plates

- Lead-free aluminum alloy
- Matt black anodized surfaces
- Inner diameter: 25, 30 or 35 mm with H7 tolerances
- Four bore holes for mounting the connecting rods. The tolerances for the rod bore holes on the mounting plates, together with the tolerances for the rods, guarantee a system with virtually zero play.



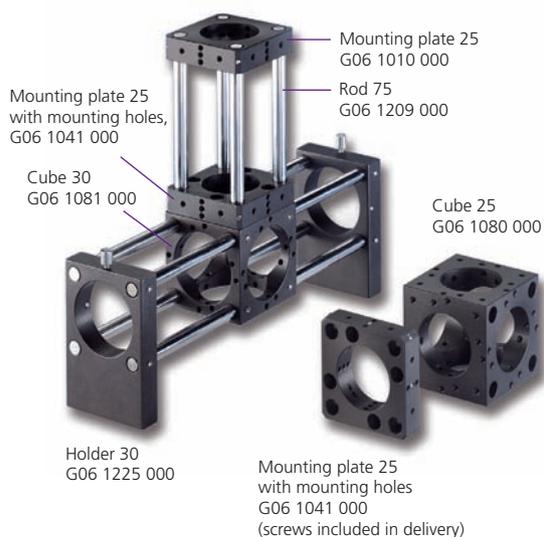
## Rods

- Hardened stainless steel with polished surfaces
- Lapped to fit
- Outer diameter: 6 mm
- Lengths: 20 mm to 450 mm
- Compatible adjustment rings as holders or stops; e.g., for Z-adjustment of individual components



## Cubes

- Multifunctional elements for 3D structures
- Ideal for beam deflectors
- Inner diameter of bore holes: 25 or 30 mm
- Two of the cube sides have bore holes for rods, four sides have threads for mounting plates with tapped holes



### Microbench accessories:

- Threaded pins: M2.3x3, G06 1011 000 (150 pcs) For attaching rods to mounting plates and holders (alternative to mounting without tools: M2.3x4 headed screws (G06 1238 000, 20 pcs))
- Threaded pins: M2.3x6, G06 1012 000 (150 pcs) For attaching mounted optics in mounting plates (alternative to mounting without tools: M2.3x9 headed screws (G06 1239 000, 20 pcs))
- Special screwdriver for all threaded pins: G06 1090 000



# Basic Principles: Nanobench

The functional principle of the Nanobench is identical to that of the Microbench system. The dimensions and tolerances, however, are on a smaller scale, compared to the Microbench's size. A wide range of mounting plates, holders, rods and cubes are available for creating sturdy and extremely compact systems.

The bore holes for the rods on all Nanobench mounting plates have identical outer diameters and spacing. The edge length is 25 mm, and thickness is 10 mm. Where not indicated otherwise, the same dimensions apply for other components in the series.

The rods are made of corrosion-resistant stainless steel specially for connecting the individual Nanobench components. They are induction hardened to prevent marks made by adjustment screws. To ensure there is no play in the guidance of mounting plates and other components, the rods are lapped to fit. They have a diameter of 4 mm and are available in various lengths.

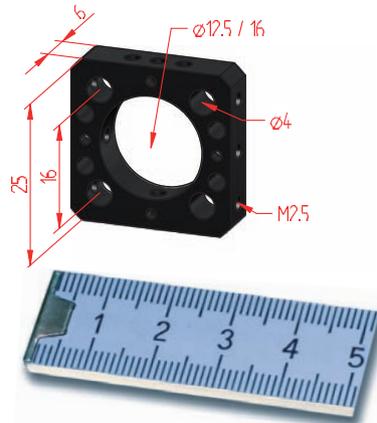
Cube N is a multifunctional element for creating a beam diverter or integrating various optics in optic holders. Combined with rods and mounting plates, it lets you set up extremely compact three-dimensional structures. The mount diameter is 16 mm.

The screws and threaded pins in the Nanobench system have M2.5 threads.

- For optics from  $\varnothing$  3 to 12.7 mm
- For a large assortment of mounted optics made specially for the Nanobench, please see the LINOS catalog or [www.qioptiq-shop.com](http://www.qioptiq-shop.com) (look for the Nanobench icon: )
- Ideal for use in micro- and fiber optics
- Compatible with the Microbench and Tube Mounting System C systems

## Mounting plates

- Lead-free aluminum alloy
- Matt black anodized surfaces
- Inner diameter: 12.5 or 16 mm with H7 tolerances
- Four bore holes for mounting the connecting rods. The tolerances for the rod bore holes on the mounting plates, together with the tolerances for the rods, guarantee a system with virtually zero play.



## Rods

- Hardened stainless steel with polished surfaces
- Lapped to fit
- Outer diameter: 4 mm
- Lengths: 12 mm to 200 mm



## Cubes

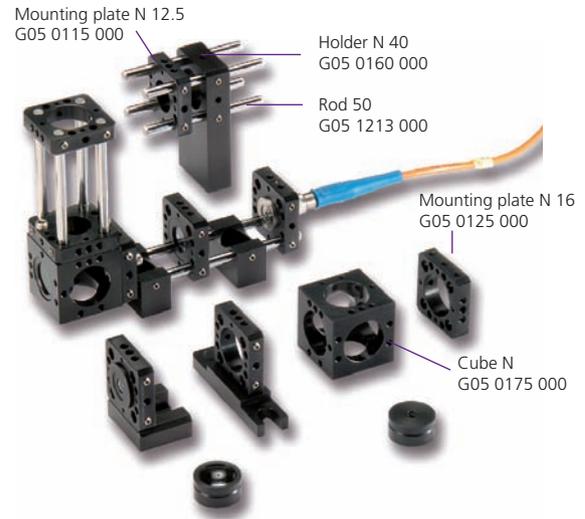
- Multifunctional elements for 3D structures
- Ideal for beam deflectors
- Inner diameter of bore holes: 16 mm
- M2.5 thread for mounting plates

### Nanobench accessories:

- Threaded pins: M2.5x3, G05 1520 000 (20 pcs) or G05 1521 000 (100 pcs) to attach rods and mounted optics.

**Note:** When you order a set of mounting plates (4 pcs) the threaded pins are included in delivery.

- Tool Set N, G05 0501 000



# Basic Principles: Tube System C

Key components of the tube mounting system are the Tubes C, which are available in two diameters and various lengths. All tubes are made of matt black anodized aluminum.

Tubes C30 have an outer diameter of 30 mm and a free inner diameter of 22.4 mm. Each features C-Mount connection threads inside and outside. The inner side has an M23.2x0.75 thread for mounting optics. Tubes C30 are available in lengths from 6 to 85 mm.

Tubes C35 have an outer diameter of 35 mm and a free inner diameter of 31.5 mm, and are available in lengths from 20 mm to 80 mm. These are connected using 6 mm wide threaded rings. The C35 tubes feature an M32.5x0.75 inner thread for mounting optics.

Beam Deflector Cube C lets you connect mirror and prism accessories. These have 30 mm bore holes for prism accessories and three (or five) bore holes with C-Mount inner threads for connecting the tubes. Bore holes not in use can be closed with protective caps.

Unmounted optics can be installed directly in the tube system and affixed using threaded rings.

## Tubes

- Lead-free aluminum alloy
- Matt black anodized surfaces
- Outer diameter: 30/35 mm
- Inner diameter: 22.4/31.5 mm
- C-Mount (1-32 UNC) connection threads



- Light-tight and dust-tight system for use in research, development and industry
- For fast and economical set-up of customized optical systems (prototypes and small-batch production)
- Universal mounting unit enables direct connection to CCD cameras, lasers, microscopes
- Compatible with Microbench



### Beam deflector cubes

- Beam Deflector Cube C with C-Mount connection threads
- Uses range from beam-steering mirrors and beam-splitting cubes to adjustment sets



### Optics mounting

- Integrate unmounted optics with diameters of 22.4 mm and 31.5 mm
- Integrate smaller optics using screw fittings



# Basic Principles: Flat Rail and Profile Systems

Flat rails and carriers compatible with Nanobench and Microbench systems are available with the corresponding dimensions and beam heights. The Flat Rail System FLS 25 has been developed specially for LINOS Nanobench, and FLS 40 for Microbench. Both systems feature excellent straightness and evenness with low torsion. The slotted holes in the rails enable mounting on breadboards and optical tables independent of existing hole patterns.

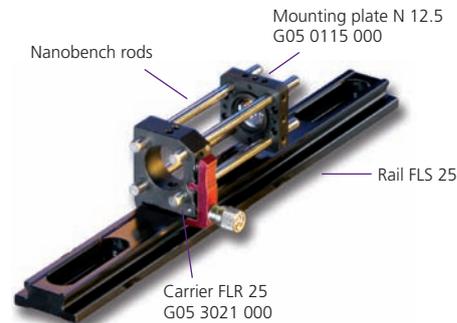
The carriers have a spring-loaded lever. Just loosen the knurled screw, and the spring tension makes it easy to move the carriers smoothly to the desired position. Then tighten the knurled screw again to affix the carrier in position. Precision milling of bearing surfaces together with abrasion-resistant anodizing ensure that components slide smoothly and evenly on the rail.

The Profile System X 25 has an 8-sided aluminum profile and, in addition to horizontal structures, is ideal for vertical applications. This system uses the same carrier as the one used in Flat Rail System FLS.

- For linear and areal structures
- Direct installation on breadboards, optical tables, etc.
- One carrier for two systems – FLS 25 and X 25
- FLS systems feature precise bearing surfaces and spring-loaded clamp on the carrier

## Flat Rail System FLS 25

- Flat micro-optical bench
- Precise bearing surfaces
- Abrasion-resistant anodizing
- Lengths: 50 mm to 500 mm
- Slotted holes on the rail enable table mounting independent of existing hole patterns
- Compatible with Nanobench system
- Carrier with spring-loaded clamp

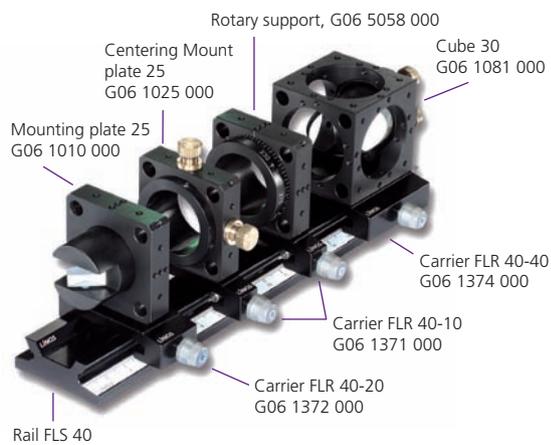


Also available in the Qioptiq on-line shop is the Flat Rail System FLS 65, the latest addition to our comprehensive line of rail systems. Visit our website at [www.qioptiq-shop.com](http://www.qioptiq-shop.com) for detailed information and to place orders.



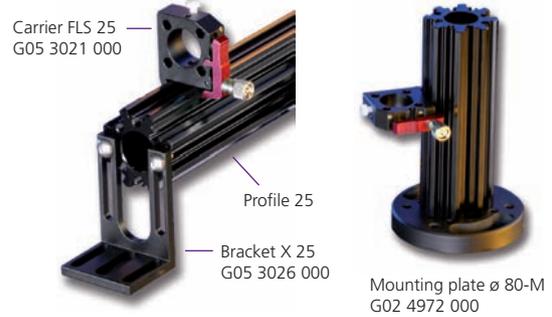
## Flat Rail System FLS 40

- Precise bearing surfaces
- Abrasion-resistant anodizing
- Lengths: 40 mm to 1000 mm
- Scale
- Slotted holes on the rail enable table mounting independent of existing hole patterns
- Compatible with Microbench system
- Carrier with spring-loaded clamp



## Profile System X 25

- Sturdy octagonal profile for three-dimensional structures
- Compatible with FLR 25 carriers
- Horizontal and vertical mounting with angle and mounting plates



# How Do I Begin My Experiment?

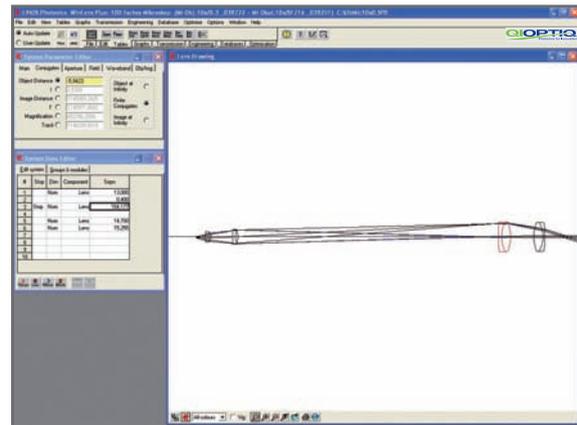
The following pages serve as a checklist for structured planning and design of your setup, to help you reach an optimum, economical solution for your requirements. The first example describes the construction of a basic microscope.

## How do I design my optical assembly?

We recommend using optical design software, such as WinLens™ 3D from Qioptiq, to create a simulation. This can be a tremendous help in preparing your optical assembly. This software lets you simulate the desired beam path and analyze the results directly, so you can optimize the setup as needed before finalizing your design.

Furthermore, WinLens™ 3D comes with an integrated database that contains all of the standard Qioptiq optics, as well as other products. Using standard optics helps to keep costs to a minimum, and mounted optics are ready for direct integration in Qioptiq construction systems.

Example: How to construct a basic microscope?



Simulation of the beam path with Qioptiq WinLens™



For detailed information and a free version of the WinLens™ 3D software, point your browser to [www.winlens.de](http://www.winlens.de).

## What optics do I need and which construction system is best?

Your optic diameters and areas of application will play a role in determining the optimum construction system for your requirements. In our example, the Microbench system was chosen.

The following optics are required for this project: One 10x microscope lens and one 12.5x Kellner eyepiece for viewing the intermediate image.

In this example, we have decided not to enclose the beam path. As an alternative, we can recommend the use of the Tube System for a closed construction.



Microscope objective 10x  
G03 8722 000

Kellner eyepiece 12.5x  
G06 3310 000

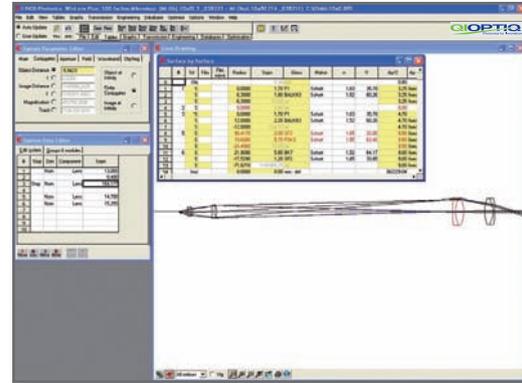
Optical components of microscope construction

## How do I position the optics? And what about adjustment?

After the beam path has been laid out and the optics have been selected, the distance between each of the optics must be determined

You can calculate the distances yourself or use the Qioptiq WinLens™ program for this purpose. In this example, WinLens offers the advantage that it determines the required adjustment range on the Z-axis using its on-line optimization feature. This is important for your choice of adjustment components.

Generally, the adjustment range you require and the desired resolution influence the choice of adjustment options.



Determining distances between optics with LINOS WinLens™

## What mechanical components do I need?

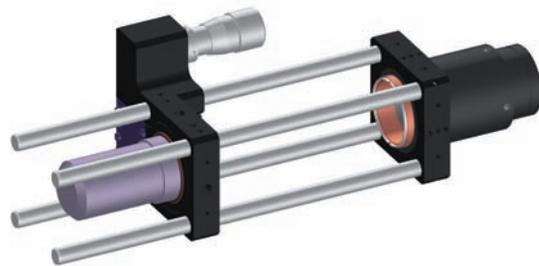
In this example, the length of the structure calls for Microbench rods measuring 150 mm.

In addition, a mounting plate is needed for the Kellner eyepiece. No mounting plate is needed for the microscope lens, since the fine adjuster already has a mount diameter of 25 mm. The threaded ring C-W0.8 is used to fit the microscope lens into the Z-Fine Adjustment M.

The system must have a range of adjustment in order to enable focusing. Adjustment on the Z-axis is possible through simple repositioning of the mounting plate on the rods or, for higher precision, using a Z-Fine Adjustment M as in our example.



Mechanical components for microscope construction

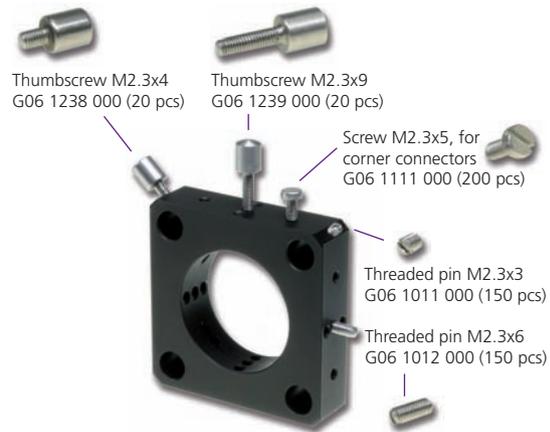


CAD drawing of the construction

You want to design or document the construction in a CAD program? Go to [www.qioptiq-shop.com](http://www.qioptiq-shop.com) for CAD files in DXF or STEP format. Files are listed at each product.

## What accessories do I need?

We recommend ordering the compatible tools, screws, threaded pins, and so forth at the same time you order the system. For the Microbench, for example, we offer special screwdrivers and threaded pins (slotted or headed) that have the Microbench M2.3 thread. The following table shows the accessories used in our example.



Selection options and uses of screws

20

Order No.	Product	Quantity
G06 1011 000	Set of threaded pins, M2.3x3	150 pcs
G06 1012 000	Set of threaded pins, M2.3x6	150 pcs
G06 1090 000	Screwdriver	1 pcs
<b>Alternativ:</b>	<b>For fastening optics in mount without tools</b>	
G06 1238 000	Set of special screws, M2.3x4	20 pcs
G06 1239 000	Set of special screws, M2.3x9	20 pcs

## How should my structure be secured?

Qioptiq offers you a broad range of equipment and methods for fastening your construction to a work surface. You can fasten it to a mounting plate using screws, mount it on an optical table or breadboard, or integrate it into an existing instrument of your own.



The end result in our example:  
A compact microscope assembly  
made from standard LINOS elements

For details on all of these options, please see pages 31 through 35.

# How Do I Integrate Spherical Optics?

## Mounted spherical optics

The easiest way to integrate spherical optics in the Microbench system is by using mounted optics from the extensive Qioptiq range. Depending on the particular optics, the mounts have an outer diameter of 25, 30 or 35 mm and are ready for installation in the compatible mounting plates, holders and adjustment elements. The mounts are fastened using threaded pins.



Mounted lenses, achromatic lenses, cylindrical lenses and color filters

## Mounted spherical optics

For the Nanobench, too, a wide range of mounted optics is available. The outer diameter of the 16 mm mounts corresponds to the mounting diameter of the Nanobench mounting plates, holders, cubes and adjustment elements.

Mounted optics for the Microbench are designated in the catalog and the on-line shop by the special  icon, and Nanobench compatible optics are marked with the  icon.

## Unmounted spherical optics

The Microbench system also offers the option of integrating unmounted optics. For unmounted spherical optics with diameters of 25 mm, 31.5 mm, 0.5" and 1" we offer mounting plates with M35 threads and compatible threaded rings.



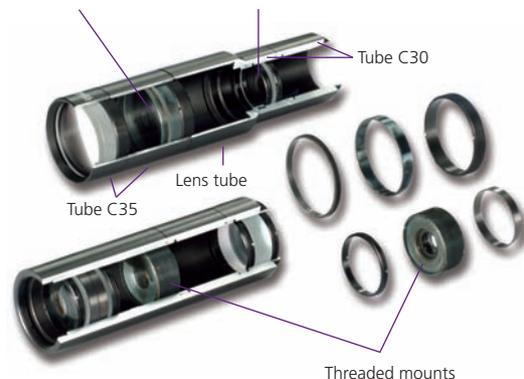
Unmounted spherical optics with diameters of 25 mm, 31.5 mm, 0.5" and 1" in Microbench M35x0.5 mounting plates

 The tube system is constructed for mounting unmounted lenses and achromatic lenses with diameters of 22.4 mm (in Tube C30) or 31.5 mm (in Tube C35). The optics are fixed in the desired position with threaded rings.

For mounting smaller optics with an outer diameter of 6 to 19 mm, you can use threaded mounts. The lens, achromatic or otherwise, is installed in the compatible threaded mount which has outer threads for installing and positioning within the tube. The high precision of the overall system ensures that lenses are centered along the optical axis.

Unmounted optics  $\varnothing$  31.5 fixed with retaining rings M32.5x0.75, G03 6051 014

Unmounted optics  $\varnothing$  22.4 fixed with retaining rings M23.2x0.75, G06 3666 000

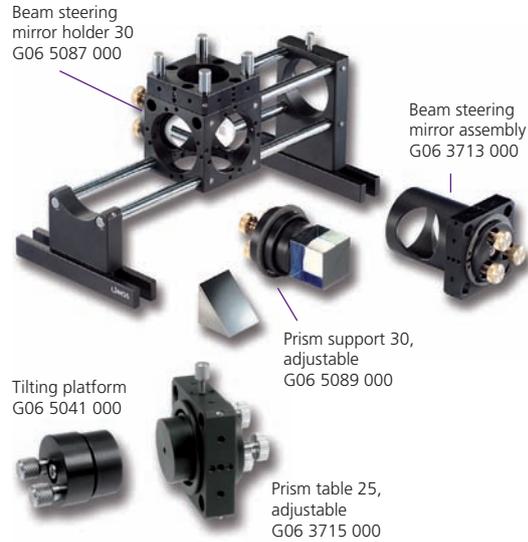


# How Do I Integrate Planar Optics?

## With adjustment options

If you want to install prisms or beamsplitter cubes in Microbench cubes, we recommend Prism support 30. For oval mirrors and beamsplitter plates, we recommend Beam steering mirror holder 30. To mount prisms, mirrors and cubes in mounting plates, use Tilting platform 25. Prism table 25 comes installed in a mounting plate and can be rotated.

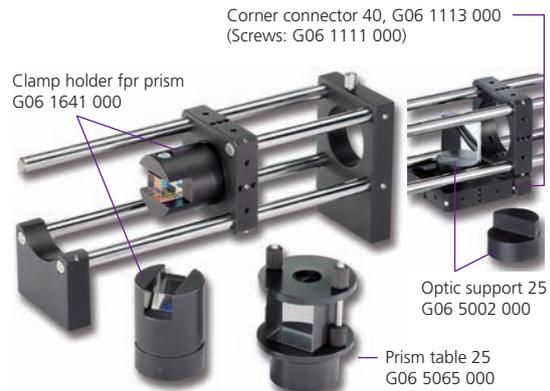
Qioptiq also offers a fully-equipped Beam steering mirror assembly, including front-surface mirror and housing, specially made for adjustment of elliptical mirrors. It is also available with a UV mirror. On all adjustable optics holders, the optics are bonded to the desired holders.



## Without adjustment options

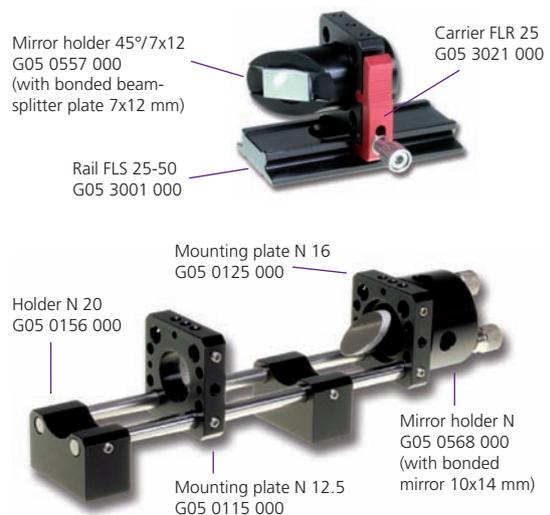
The Clamp holder for prism enables fast and simple mounting of prisms and cubes with a 10 mm edge length. Prism table 25 is the ideal mount for edge lengths of up to 20 mm. On both components, the optics are secured by clamps.

The Optic support 25 is used for mirrors, which are bonded to the guide edge. These mirror mounts can be installed in Mounting plate 25 and in Cube 25.



 For elliptical mirrors of 12.5x18 mm, Mirror holder 45° is the ideal mount, while Mirror mount 45°/ 7x12 is best for beamsplitter plates with dimensions of 7x12 or a mirror diameter of 10 mm. Prisms and cubes that measure 10x10 mm are bonded to the prism carriers.

If you are looking for adjustable optic holders, use our Prism holder N (G05 0569 000) for prisms and cubes and Mirror holder N (G05 0568 000) for mirrors and beamsplitter plates.



# How Do I Apply Adhesives?

## Preparation

**Optics:** Use a bulb blower to remove dust and loose dirt. Put a lens-cleaning cloth or another soft cotton cloth (such as Opto-Wipes™) on the optics and use a pipette to apply several drops of alcohol to the cloth. Make sure the alcohol is chemically pure. Then drag the cloth slowly over the optics. To remove fingerprints or similar impurities, proceed as described above or soak a cotton-tipped stick in alcohol and wipe it across the optics in an "S" shaped motion.

**Optics holder:** The holder must also be cleaned and freed of dust and grease. To do this, wipe it with a soft cloth, using a small amount of a grease-cutting detergent (such as dishwashing liquid) if necessary. Wipe again afterwards with a fresh cloth to remove any residues.

## Adhesives

Which types of adhesives you should use depends on the types of optics you wish to cement. For mirrors, use an elastic two-component adhesive for a uniform curing and tension-free hold. For components such as beamsplitter cubes or plates, a UV adhesive is ideal. As the name indicates, UV light is applied to cure the adhesive.

Two-sided tape strips are commonly used in research and development laboratories. These are well-suited for quick experimental setups, particularly if the optic is removed from the carrier afterwards. They are not recommended, however, for long-term use; due to their elasticity and susceptibility to vibration, it is impossible to ensure that the position of the optics is maintained.

To keep the need for cleaning to a minimum, wear latex gloves or lint-free cotton gloves when unpacking and setting up the equipment and make sure all work surfaces are clean.



Applying adhesive in spots between optics and contact surface of the holder



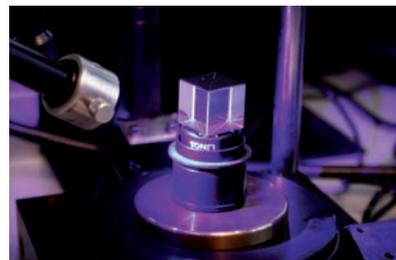
Positioning paper strips as spacers on a mirror mount

## Tips for cementing optics

Even if a liquid adhesive is used, the optics can be removed later only if the adhesive is applied in discrete spots on the edge of the optics. Affix the optics holder to your work surface with adhesive strips, making sure the glued surface is on the horizontal plane to prevent slippage, until the adhesive is cured. To ensure an even layer of adhesive, lay two strips of paper as spacers on the optics carrier and press the optics until the adhesive reaches the paper. Once the adhesive has cured, you can remove the paper. This method also prevents the adhesive from leaking out between the optics and the holder when the parts are pressed together. The use of a cotton swab is recommended to prevent damage when aligning and pressing down on the optics.



Pressing down and repositioning a mirror on the fixed mirror mount



Beamsplitter cube illuminated by a UV light source

# How Do I Integrate Optics into Existing Setups?

 In addition to standard mounting plates as basic components, Qioptiq offers snap-in (latchable) mounting plates and a magnetic version. They are ideal for adding optical components to an existing system, and make it possible to expand a system without having to remove the rods. With the mounting plates, for example, you can quickly replace optics such as lenses, filters, reticules, and others in the beam path. For unmounted optics with diameters of ½", 1", 25 mm and 31.5 mm, we offer the M35x0.5 snap-in mounting plate (G06 1024 000), in which the optics are mounted with compatible threaded rings.

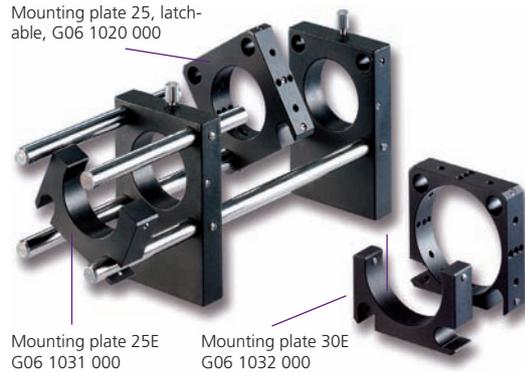
24

By mounting the snap-in (latchable) plate in such a way that it can be swiveled, optics can be removed from the beam path without being removed from the setup. Collars are inserted to fix the position of the plate.

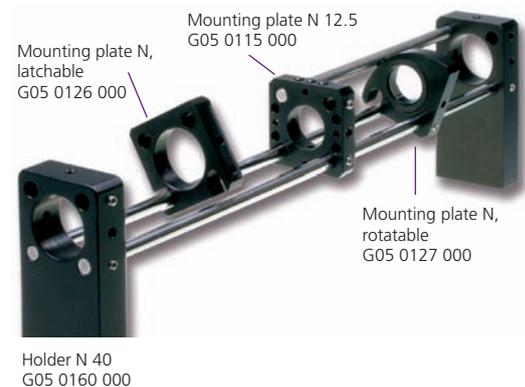
Magnetic mounting plates are easy to fasten between components on a four-rod system. The magnets are strong enough to attach the mount even upside-down.

 For the Nanobench, too, there are a number of options for retrofitting your assembly. Snap-in (latchable) and swiveling (rotatable) mounting plates are the perfect solution for adding mounted optical components to an existing system without having to remove the rods.

With these plates you can quickly switch between different optics in experimental setups. This type of mounting plate is also ideal if you want the option of removing optics from the beam path without removing them from the assembly completely. Simply install the mounting plate so that it can swivel. Collars are inserted to determine the position of the plate.



Use magnetic mounting plates for quickly switching optics.



- Mounting Plate N, snap-in and swiveling versions
- For retroactive installation in 2-rod, 3-rod and 4-rod structures
- For mounted optics with  $\varnothing$  16 mm

# How Can I Realize Different Angles in My Setup?

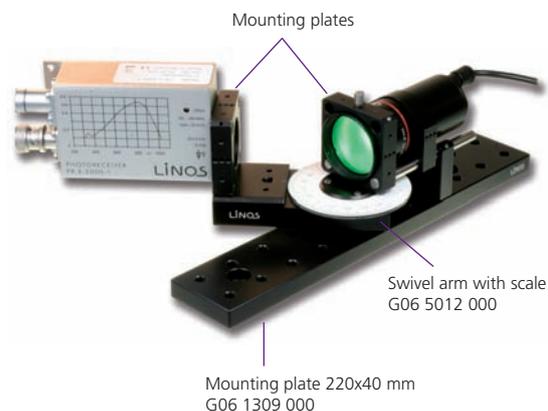
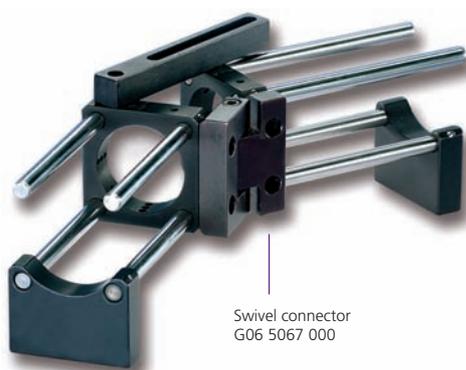
There are a number of options available for setting up angle connections at other than right angles. One is the Connector 80 V, which connects two mounting plates on one level. With this connector you can have the beam branch off diagonally to the axis. The slotted holes enable continuous adjustment of the angle and the mounting plates. The crossed struts help you achieve optimum stability.

Connector 80 V is also ideal for fixing the angle of the swivel connector. The Swivel connector ensures a connection between two mounting plates with no play, and has a pivot range of 120°.

- Connector 80 V for creating variable distances and angled connections
- The Swivel connector has a swivel range of 120° with no play
- Swivel arm with scale for measurable swiveling of Microbench assemblies through  $\pm 90^\circ$ ; direct installation of mounting plates

Another variant for setting up a beam path with a bend is the Swivel arm with scale. This component lets you add angles that you can measure in your Microbench construction. The swivel arm is screwed directly onto an optical table or mounting plate using M6 or 1/4" screws.

This example demonstrates an assembly for measuring the angular intensity distribution of dispersion plates. The dispersion plate, backlit by an LED, is fastened in a Microbench mounting plate in the rotation point of the swivel arm. A photodetector is also installed in a mounting plate and mounted on the mobile part of the swivel arm. This enables quick and easy measurement of any angle.



# How Do I Adjust Optics along the X and Y Axis?

 For adjustment in two spatial directions, the X-Y Precision translation stage is ideal. The X-Y Translation module, on the other hand, is best suited for spatial filters and fiber applications with no play in the spring joints.

The Centering mounting plate 25 (also available as a holder) is equipped with easy-to-turn brass screws with a 0.25 mm pitch, permitting an adjustment range of  $\pm 1$  mm. The rotatable inner ring enables adjustment, for example, of cross-hairs.

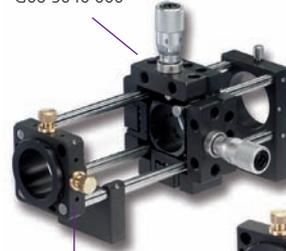
The most precise X-Y adjustment is provided by the X-Y Adjustment plate with an adjustment range of  $\pm 0.25$  mm. It features a solid flexure and excellent long-term stability. The mounting diameter is 12.5 mm.

  Economical yet precise adjustment is possible with the Adjustment plates for Microbench and Nanobench. Two plates connected by springs are adjusted to one another and fixed with two screws. The Slip plate positioner M for Microbench is available with mounting diameters of 25 mm and 30 mm.

 The X-Y Translation stage N is ideal for use in the Nanobench system as well as with Flat rail system FLS 25. The mounting diameter is 16 mm for mounted Nanobench optics and the mount has a clear aperture of 8 mm. The fine-pitch screws have a 0.25 mm pitch and an adjustment range of  $\pm 0.5$  mm.

 Spatial filter module C30x37.5 is specially designed for positioning pinholes. The solid flexure enables high-precision adjustment that is free of backlash. C-Mount connections on both sides and an outer diameter of 30 mm enables versatile use in the Tube mounting system, Microbench, and on the FLS 40 flat rail. Mounted pinholes of various diameters are available to fit M16 inner threads.

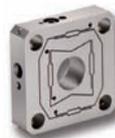
X-Y Precision translation stage  
G06 5040 000



X-Y Translation module  
G06 5095 000



Centering mounting plate 25  
G06 1025 000



Centering mounting holder 25  
G06 1026 000

X-Y Adjustment plate  
G06 7021 000

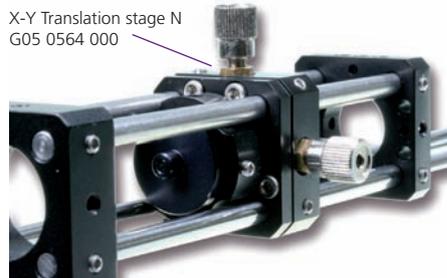


Slip plate positioner 30 M, G06 1027 000



Adjustment plate N  
G05 0563 000

X-Y Translation stage N  
G05 0564 000

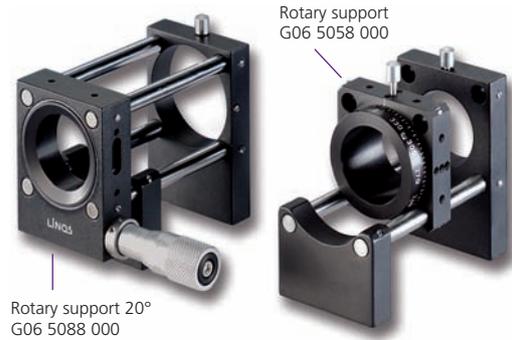


Spatial filter module  
C30x37.5  
G06 5233 000

# What Options Are Available for Rotation of Optics?

 We offer two Rotary supports for mounting components that require rotational alignment, such as slits, reticles and polarizers. The first is a mounting plate with integrated rotary mount (G06 5058 000), which features a scale with 5° intervals and a rotation range of 360°. The inner ring can be fixed with a locking screw.

For higher precision requirements: The Rotary support 20°, with a micrometer screw for adjustment. The adjustment range is ±10° with a sensitivity of 10". Both rotary supports have mounting diameters of 25 mm.



 Motorized rotation mounts are specially designed for fast rotation of construction elements with 25 mm diameter. You can choose from either servomotor or stepper motor models. In the servomotor model, the motor speed can be adjusted from 10 to 200 rpm. The maximum speed of the stepper motor model is 400 rpm, and the smallest step angle is 1.8°. The servomotor requires only 0-12 V for activation, while the stepper motor requires a controller. An optional reflected-light barrier is available separately.



 Rotary support N is made to be used in the Nano-bench system. This Rotary support is designed to be clipped into Mounting Plate N 16 and is tensioned by a disc spring to ensure rotation without backlash. A lateral bore hole (Ø 1.1) is provided for insertion of an optional lever to facilitate turning the support.

Rotary support N can also be used as a quick-change set for optics in mounts with Ø 16 mm, as the mounted optics are simply clipped into place.

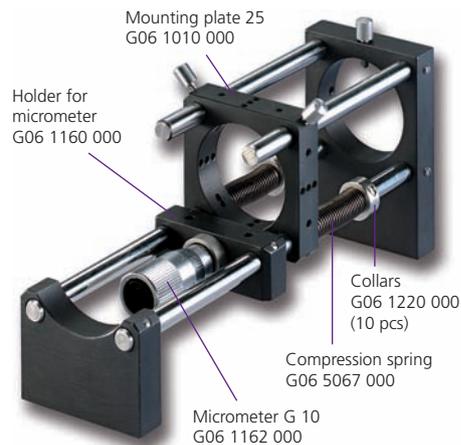


- Rotary Support for 360° rotation and Rotary Support 20° for more stringent requirements
- Motorized rotary mount with stepper motor or servomotor

# How Do I Adjust Optics along the Z Axis?

 You can put together a simple Z-Translation stage made up of a Holder for micrometer, a Micrometer screw, the Mounting plate to be adjusted, Compression springs (2) and Collars. You can use a different construction element in place of the Mounting plate, if desired.

- Simple Z-Translation stage made of Holder with micrometer, Compression springs, Collars and Mounting plate
- Z-Adjustment M for precise fine adjustment with 5 mm adjustment range
- Z-Fine Adjustment M with a 1.5 mm range enables high-precision and backlash-free adjustment of optics, pinholes, fiber connectors, and more

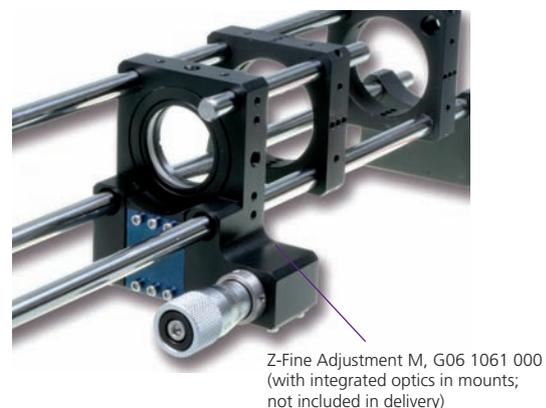


 The Z-Adjustment M is made up of a Fine adjustment screw, a Compression spring and a Collar for high-precision fine adjustment within a 5 mm range. It enables backlash-free adjustment of optics, pinholes, fiber connectors, and more. Since the Z-Adjustment M is extremely compact it can be retroactively integrated into any structure.



 For an extremely high precision adjustment along the Z axis, we recommend the Z-Fine Adjustment M. It enables direct mounting of components with a diameter of 25 mm. The micrometer screw with 0.25 mm pitch ensures backlash-free and high-precision adjustment along the Z axis, with a 1.5 mm range and a 1  $\mu$ m sensitivity. Its integrated 1-32UN inner threads make it compatible with the Tube Mounting System C.

Because it can be accurately centered with virtually no tilt, this precision positioner is well suited, for example, for beam coupling in fibers.



**N** The Z-Adjuster N consists of a Fine adjustment screw, a Collar and a Compression spring. You can combine it with Mounting Plate N to create a simple Z-Translation stage. Rather than a Nanobench Mounting plate, you can use Holder N 40 or Adjustment plate N.

The Z-Adjustment N has a range of 5 mm and provides backlash-free adjustment of optics, pinholes, fiber connectors and more. It is extremely compact and can be retroactively integrated into Nanobench structures.

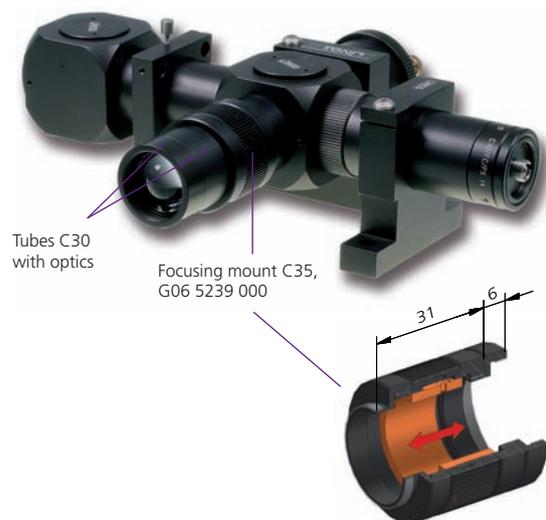


**■** Our Fine adjustment C30 and Focusing mount C35 let you alter the spacing between elements along the Z-axis.

Fine adjustment C30 is available with an adjustment range of 3 or 6 mm (with different thread pitches). The overall length of the Fine adjustment C30 changes with adjustment.

Focusing mount C35 enables linear adjustment of optics in threaded mounts or directly installed optics with a diameter of 22.4 mm, without changing the overall length of the Focusing mount C35. For example, if you wish to adjust the zoom lens in an objective from individual components, the Focusing mount C35 is ideal.

Both Fine adjustment C30 and Focusing mount C35 feature C-Mount threads and thus can be fitted directly between the tubes.



- Fine adjustment C30 for Z-adjustment of optics with a range of 3 mm or 6 mm
- Focusing mount C35 for linear adjustment of optics in threaded mounts with constant length

# What Adapters Are Available?

Because there are so many different optic diameters and threads on the various construction elements, it is not always possible to install the desired components directly in a Microbench, Nanobench or Tube Mounting System. Consult the table below to find the adapters you need.

Order No.	Outer $\varnothing$ (mm) or thread	Inner connector or $\varnothing$ (mm)	Length (mm)
G06 7023 000	12.5	FC	8
G06 7024 000	12.5	SMA	
G05 0310 000	16	FC	8
G05 0311 000	16	SMA	
G03 8855 000	25	23.2	10
G05 0305 000	25	16	10
G06 1626 000	25	15	12
G06 5042 000	25	25	20
G06 7054 000	25	FC	10
G06 7055 000	25	SMA	10
G03 8851 000	30	C-Mount	10
G06 1602 000	30	25	16
G06 1634 000	30	23.2	20
G06 1658 000	30	C-Mount	16
G06 1637 000	35	30	16
G06 1639 000	35	30, tilted 3.5°	16
G06 1674 000	50	For mounting plates	13
G06 1601 000	25/30	Solid material	20
G06 1621 000	25/30	W0.8"x1/36"	20
G06 1622 000	25/30	16	20
G06 1623 000	25/30	19	20
G06 1636 000	25/30	23.2	20
G06 1664 000	25/30	C-Mount	22
G06 1661 000	25/C-Mount	16 / W0.8"x1/36"	34
G06 1669 000	30/C-Mount	M19.5x0.5	34
G06 1659 000	C-Mount	Connector for Microbench rods	21
G06 1667 000	C-Mount	M23.2x0.75	8
G06 1668 000	C-Mount	W0.8"x1/36"	8
G03 8878 000	M17x0.75	C-Mount	11
G06 1638 000	M35x0.5	30	16
G06 1662 000	W0.8"x1/36"	C-Mount	14
G06 1079 000	25 (e.g., for Cube 25)	Solid material	5
G06 1078 000	30 (e.g., for Cube 30)	Solid material	5
G06 1085 000	40x40, Adapter plate for FLS 40 carrier	Solid material	

Selection of adapters from the table



Adapter collar, G06 5042 000



Adapter 1" for W0.8 to  $\varnothing$  25, G06 1661 000



FC fiber adapter, G06 7054 000



Microbench adapter, G05 0305 000



Adapter 30/25, G06 1602 000



Adapter 30/C-Mount, G06 1658 000



Mounting plate FLS, G06 1085 000



Lid 30, G06 1078 000

For details and technical drawings, refer to the listing for the specific system in the LINOS catalog or on our website [www.qioptiq-shop.com](http://www.qioptiq-shop.com).

# How Do I Mount My Assembly on e.g. Optical Tables?

To secure the Microbench system on an optical table or a breadboard, base or mounting plates are needed. These are made of aluminum and available in various sizes and models.

Options such as Mounting base 80x15 and Base plate 80x40, for example, let you install Microbench structures on table tops independent of existing hole patterns. Another option is Rod holder F, for mounting optical structures on surfaces with tapped-hole patterns. With these options, structures are mounted from the top with M6 or ¼" screws.

- Fasten structures onto table tops independent of existing hole patterns with Mounting base 80x15 and Base plate 80x40
- Rod holder F lets you mount structures on surfaces with tapped-hole patterns

Rod holder V (order number G06 1234 000) can be shortened as needed to install Microbench components at the beam height you require. These holders feature through-bore holes to mount them from above with M6 screws; the maximum beam height is 100 mm. To adapt the rod holder for your application, the unneeded length is sawn off the bottom of the holder.

## Advantages of Rod holder V:

- Additional adapter plates not required
- Stringent Qioptiq production tolerances ensure compatibility with other Microbench components; this is extremely difficult to achieve with parts you make yourself



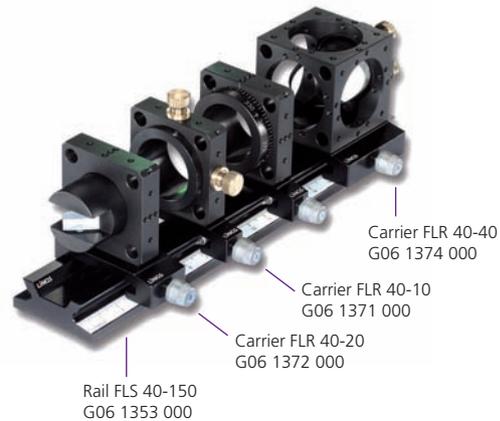
# How Do I Mount My Assembly on e.g. Optical Tables?

 Small Microbench structures can be mounted on Mounting plate 220x40. This plate has countersunk bore holes for M6 screws in a 50 mm pattern, for mounting on table tops.



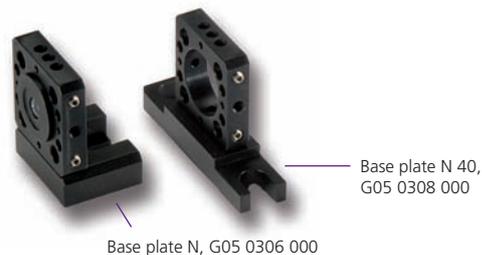
 Microbench components can be mounted on the carriers in Rail Systems FLS 40. This optical bench structure features high stability and, thanks to the slotted holes on the rail, can be fastened to tables and breadboards independent of existing hole patterns.

- Flexible attachment options for optical tables with Rail System FLS 40

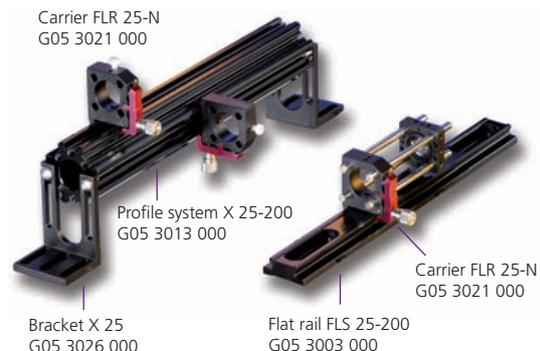


 Nanobench structures can be fastened to optical tables or breadboards as well. Like the Microbench system, the mounting plates for Nanobench are made of aluminum and are available in various sizes and models.

- Base plates N, N 40 and N 50 enable trouble-free installation of mounting plates on optical tables



 Carrier FLR 25-N with a Nanobench mounting plate, is used to combine the Nanobench with the Profile system X 25 or the Flat rail system FLS 25. This carrier is clamped on and fixed in place with a knurled screw. The slotted holes on the flat rail and on Bracket X 25 enable fast mounting on optical tables and breadboards, independent of existing hole patterns.

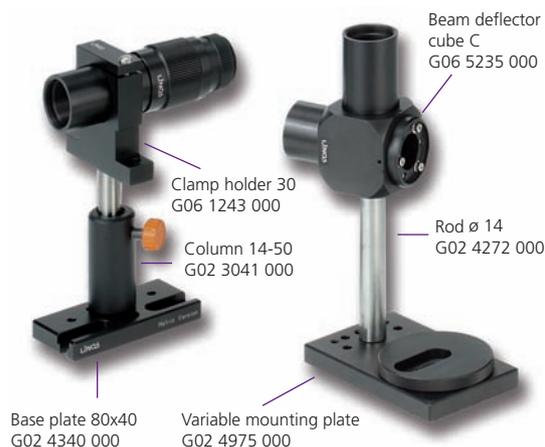


Small Nanobench structures can be mounted on the Mounting plate 220x40 (described above), which has countersunk bore holes for M6 screws.

 The Tube mounting system also gives you multiple options for mounting components. For example, Beam deflector cube C has a tapped bore hole for direct installation of support rods.

Clamp holders 30 and 35 provide a wide range of mounting options as well. They can be mounted directly on an optical table or mounting plate or, using a support rod, on the Variable mounting plate or Base plate 80x40 with column.

Tube system components can be fastened with a Clamp holder or with Beam deflector cube C and a support rod  $\varnothing$  14.



   Clamping fork and Holder A14 serve to connect LINOS bench systems to optical tables. The slotted hole on the Clamping fork means you are not restricted to the existing bore hole pattern for mounting structures on optical tables; M6 or  $\frac{1}{4}$ " threads are the only prerequisite.

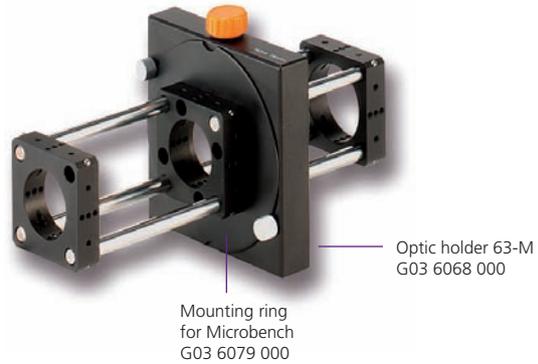
All LINOS components with M6 threads, in particular columns and support rods, are fastened to Holder A14 from below through a countersink. Simply slide the holder into the Clamping fork, position it as desired and then fix it in place from above through the slotted hole on the fork. The special fit of holder and clamping fork lets you lift them as a single unit to reposition the elements as desired. This is a special design feature, called the easy lift system, and is especially practical when space is limited. In the example shown here, a support rod is clamped into Column 14, which gives you the advantage of adjustable height.



# How Can I Combine Systems?

## → Optic Holder 63

With the Mounting ring for Microbench, the Microbench is compatible with Optic holder 63-M and can thus be integrated in this mount system as well.



34

## ↔

The Microbench adapter creates a connection between the Microbench and Nanobench systems by means of Mounting plate 30 and Mounting plate N 16. This adapter has through-bore holes for Nanobench rods.

Adapter 16/25 (G05 0309 000) enables the use of mounted Nanobench optics and Diode laser x.ldm (each with an outer diameter of 16 mm) in Microbench mounting components with a 25 mm inner diameter.



- Microbench adapter (G05 0305 000) adapts  $\varnothing$  16 mm to  $\varnothing$  30 mm
- Adapter 16/25 (G05 0309 000) adapts  $\varnothing$  16 mm to  $\varnothing$  25 mm

## ↔

Adapters are available for the Tube system C as well, such as the Adapter C-Mount/Microbench, for example. You can combine the Tube system with the Microbench, lasers, CCD cameras, fibers and your choice of other instruments.



# How Do I Mount Bench Systems in My Instrument?

Our construction systems are ideal not only for laboratory structures on optical tables but also, thanks to their excellent stability, are increasingly used in measuring systems in both industrial environments and end-user instruments. Components such as the Instrument flange make it possible to connect modules made of Microbench components to your own instruments.

One example of this is laser beam coupling in a microscope. The light of two lasers with different wavelengths is transmitted through fibers, collimated and consolidated through a beamsplitter cube with a structure made from Microbench and fiber optics components, and coupled in the microscope. Each collimator requires one adjustment option for superimposing the laser beams. The structure is connected to the microscope port using the Instrument flange.

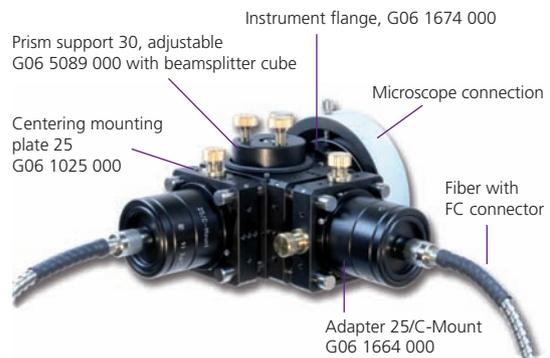
All Holders and Rod holders in the Microbench system have a central M6 bore hole on the bottom and two M4 bore holes that are 20 mm apart. Rod holder F can also be mounted from above if desired, by means of an M6 through-bore hole. These bore holes make it easy to integrate Microbench structures in your own instruments. Thus the Microbench adapter gives you the option of connecting Nanobench components.

Our example shows the assembly of an optical-parametric oscillator (OPO).

With Clamp holders from the Tube System, you can fasten any components with an outer diameter of 30 mm or 35 mm.

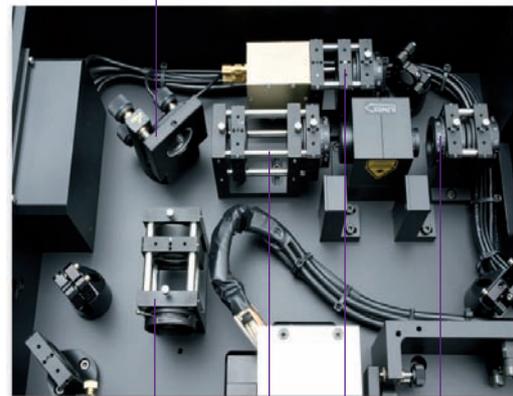


Instrument flange  
G06 1674 000



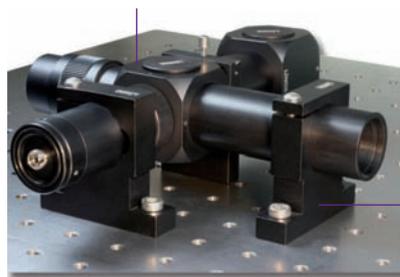
Prism support 30, adjustable  
G06 5089 000 with beamsplitter cube  
Centering mounting plate 25  
G06 1025 000  
Instrument flange, G06 1674 000  
Microscope connection  
Fiber with FC connector  
Adapter 25/C-Mount  
G06 1664 000

Beam deflection with Lees mirror mounts



Microbench components such as holders, mounting plates, rods, rotary supports, and so forth, in use

Beam deflector cube C-5, G06 5236 000



Clamp holder 30,  
G06 1243 000

The following pages describe a number of applications and their implementation with components from our bench systems.

## Creating a Spatial Filter System

Scattered laser light can form interference-patterns with inhomogeneous intensity distribution on dust particles on optical surfaces. Such patterns can create problems with interferometric or holographic applications, because they form a confusing background to the desired information. Spatial filtering is a simple way to eliminate this interference and attain homogenous beam intensity. The scattered light radiates outward from the laser beam in various directions and is thus spatially separate in the focal plane of a lens. By centering a small aperture about the focal point of the direct laser beam, the scattered light can be blocked while permitting the direct beam to pass without interference. The result is a cone of light with an extremely homogenous intensity distribution that can be focused to a highly homogenous beam. As a compromise between ease of adjustment and complete spatial filtering, the best aperture diameter is approximately twice the  $1/e^2$  diameter of the laser beam in focus, or roughly 1.33 times the 99% contour of the laser beam.

For many applications, particularly in holography, spatial intensity variations are inadmissible. Our spatial filter module is ideal for creating a clean gaussian beam.

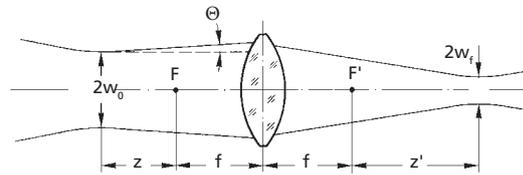
In this example, an Achromatic lens with  $f = 40$  mm is mounted in the Z-Fine adjustment M and the laser beam is focused through the  $50 \mu\text{m}$  pinhole. The Pinhole is in the Spatial filter module, which permits backlash-free XY adjustment thanks to a flexure hinge.

The focusing optics and pinhole size can be adapted to the particular optics used. The diameter of the pinhole should be approximately 30% larger than the calculated diameter of the focal point.

The minimum focal spot radius  $w_f$  is yielded approximately by:

$$w_f \approx \frac{\lambda \cdot f}{\pi \cdot w_0}$$

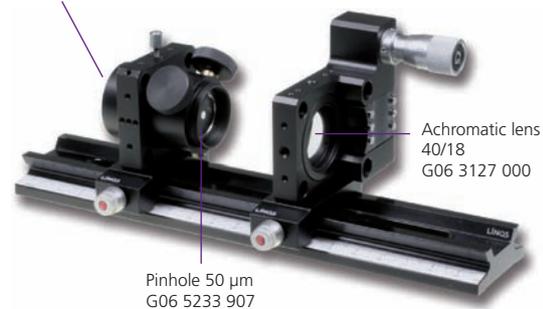
In this equation,  $w_0$  is the beam radius before a lens with focal length  $f$ .



Focusing

Spatial Filter module C30x37.5  
G06 5233 000

Z-Fine adjustment M  
G06 1659 000



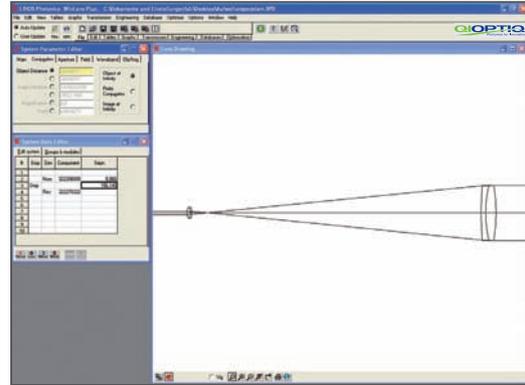
Achromatic lens  
40/18  
G06 3127 000

Pinhole  $50 \mu\text{m}$   
G06 5233 907

# Creating an Expansion System

The Tube mounting system lets you set up simple expansion systems in accordance with the desired expansion ratio. With the Spatial filter module, you can add pinholes to the system as well.

Our example given here demonstrates a 16-fold expansion. The structure of the optical system is simulated using the WinLens™ program from Qioptiq. The expansion system consists of two achromatic lenses,  $f=10\text{ mm}$  and  $f=160\text{ mm}$ . These are positioned at a distance of their focal lengths and form a Kepler telescope. The pinhole is placed in the focal point.



Simulation of beam path with Qioptiq WinLens™



For detailed information and a free version of the WinLens™ 3D software, point your browser to [www.winlens.de](http://www.winlens.de).

Order No.	Product
G32 2206 000	Achromat 10/6
G32 2270 322	Achromat 160/31.5
G06 5223 000	Connecting Tube C20 with Adjustable Mount 6
G06 5233 000	Spatial Filter Modul
G06 5233 905	Pinhole 20 $\mu\text{m}$
G06 5233 902	Tube Wrench
G06 5226 000	Focusing Mount
G06 5241 000	Lens Tube C35x50
G06 5211 000	Tube C30x10
G06 5244 000	Tube 35x30
G06 3668 000	Mount CL 31.5
G06 5251 000	Retaining Ring M32.5x0.75-8



This structure can also be implemented with Qioptiq Microbench components. To do this, use the 4-rod structure, mounted Microbench lenses, a pinhole installed in XY Adjustment plate, and Z-Adjustment M.

# Creating a Fiber Coupler

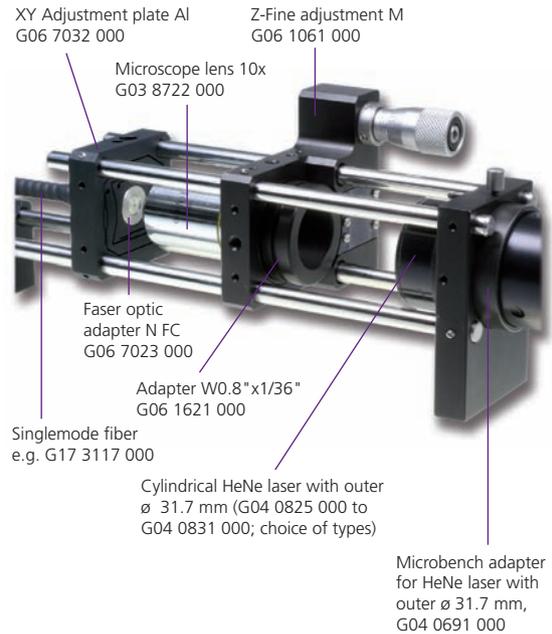
There are a number of methods available for coupling light into a glass fiber. One such technique is presented here. The task in this example involves fiber coupling a free laser beam into a singlemode fiber. The difficulty with singlemode fibers lies in their small core diameter which, depending on the wavelength used, may be just a few  $\mu\text{m}$ . The example illustrated here can solve the problem.

The fiber connector in the singlemode fiber is mounted in a special XY Adjustment plate adapter that permits fine adjustment in the range of  $\pm 0.25$  mm and provides excellent long-term stability. The XY Adjustment plate is a solid plate finished by wire-electro discharge machining. The result is a broad solid-state spring joint that enables extremely precise XY translation with no tilting. Translation is achieved using tension and thrust screws secured against one another by lock-nuts to ensure long-term stability.

A Microscope lens is used for fiber coupling of the laser light. Proper adjustment of the lens along the Z-axis is indispensable for optimum coupling efficiency. In our example, we use Z-Fine adjustment M. With this high-precision, backlash-free positioner, the optimum distance from the microscope lens to the optical fiber is adjusted quickly and high coupling efficiency is attained.

Order No.	Product
G06 7032 000	XY Adjustment Plate AI
G06 7023 000	Fiber Coupler N FC
G03 8722 000	Microscope Lens 10x
G06 1061 000	Z-Fine Adjustment M
G06 1621 000	Adapter W0.8"x1/32"
	Singlemode Fiber
	HeNe-Laser, outer $\varnothing$ 31.7 mm
G04 0691 000	Microbench Adapter for HeNe-Laser, outer $\varnothing$ 31.7 mm

38



# Light Sources for Bench Systems

We offer a wide range of light sources, from bulbs to lasers, which are compatible with our bench systems.

 The adjustable lamp socket permits use of 6V/6 W lamps in Microbench structures. This socket can be installed in the Microbench using Adapter 23.2 (G06 1636 000) in mounting plates, holders, or other elements with a 25 or 30 mm mounting diameter.

 Another option for the integration of halogen lamps is provided by the Holder for halogen lamp with G4 Socket, designed specifically for Microbench. You can connect your choice of mounting plate or Cube 30 to this holder. Halogen lamp 6 V/10 W is available separately, under order number G06 5051 000.

 A series of lamp sockets are available in the form of lamp housings. LINOS offers lamp housings for halogen, spectral and mercury arc lamps. An optional mounting ring for Microbench, also available separately, permits direct mounting of Microbench rods.

Lamps for all LINOS Lamp housings are listed in detail under „Light Sources“ in the LINOS catalog and at [www.qioptiq-shop.com](http://www.qioptiq-shop.com).

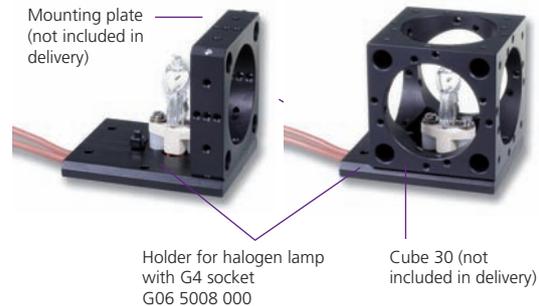
  Our comprehensive line includes LED light sources as well. HighLED, the super-bright light source with adjustable brightness, has a housing diameter of 30 mm for integration into Microbench components without additional adapters. Thanks to the integrated C-Mount connection threads, direct use in the Tube System is another option.

Qioptiq offers these LED light sources in four different wavelength ranges and with comprehensive accessories.



Lamp socket, adjustable  
G06 5043 000 (lamp not included in delivery).

Accessories:  
Lamp 6 V/6 W  
G06 5044 000



Mounting plate (not included in delivery)

Holder for halogen lamp with G4 socket  
G06 5008 000

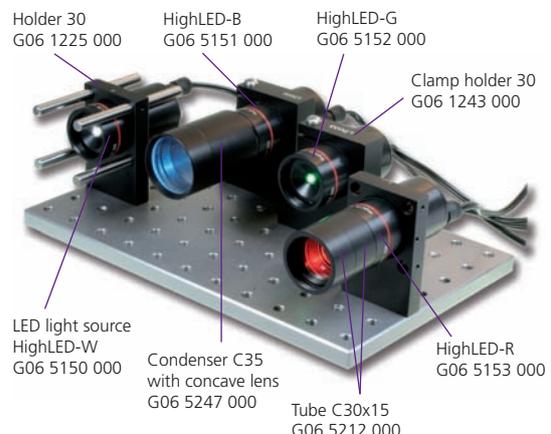
Cube 30 (not included in delivery)



Lamp housing for  
- Halogen lamps, G03 0125 000  
- Spectral lamps, G03 0229 000  
- Mercury arc lamps, G03 0370 000

Mounting ring for Microbench  
G03 6079 000

Microbench rod



Holder 30  
G06 1225 000

HighLED-B  
G06 5151 000

HighLED-G  
G06 5152 000

Clamp holder 30  
G06 1243 000

LED light source  
HighLED-W  
G06 5150 000

Condenser C35 with concave lens  
G06 5247 000

Tube C30x15  
G06 5212 000

HighLED-R  
G06 5153 000

# Light Sources for Bench Systems

 LINOS offers helium-neon, or HeNe, lasers with Microbench-compatible outer diameters for installation in the four-rod system. The laser beam is aligned and centered to fit the outer diameter of the housing. The lasers feature excellent directional stability, even when the ambient temperature is high. No X-Y adjustment is required following installation.

Our HeNe-lasers have an outer diameter of 35 mm (direct installation) or 31.7 mm (using a Microbench adapter).

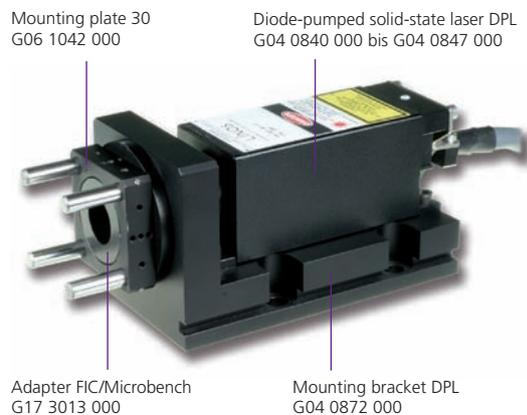
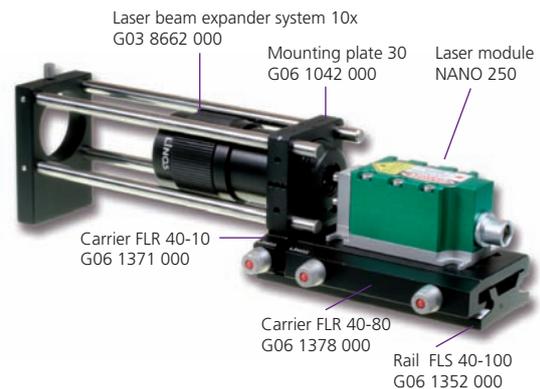
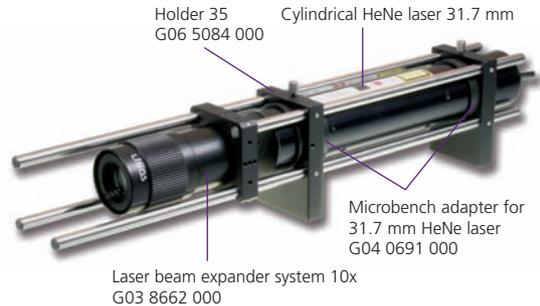
 With Laser adapter C35, you can connect a HeNe-laser with a 31.7 mm diameter to the Tube system.

 The NANO 250 series presents a range of powerful laser modules with wavelengths of 405 to 785 nm and output power from 15 up to 450 mW.

The NANO laser modules feature a bore hole pattern for use with FLS 40 carriers and can be directly integrated in LINOS bench systems with beam heights of 40 mm.

 The LINOS DPL Series offers diode-pumped solid-state lasers for combination with the Microbench. This type of laser can be used in the fields of metrology, bio-analysis, materials testing and sensors, and is used for fluorescence excitation as well.

Our solid-state lasers are available for wavelengths of 473 and 532 nm with output power from 5 to 50 mW. An optional mounting bracket and the Adapter FIC/Microbench are the connecting elements for LINOS Microbench.



Adapter FIC/Microbench also lets you connect the LINOS fiber coupler FIC50 XYZ to our solid-state lasers. For more information, please refer to our on-line shop at [www.qioptiq-shop.com](http://www.qioptiq-shop.com).

# Motorized Positioners for LINOS Bench Systems

Our series of high-precision piezoelectric positioning systems gives you a wide selection of miniature positioners for combination with the LINOS bench systems.

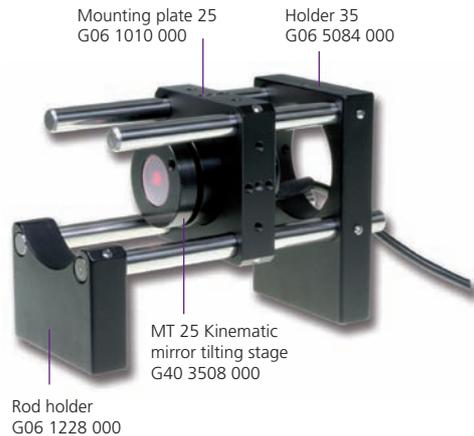
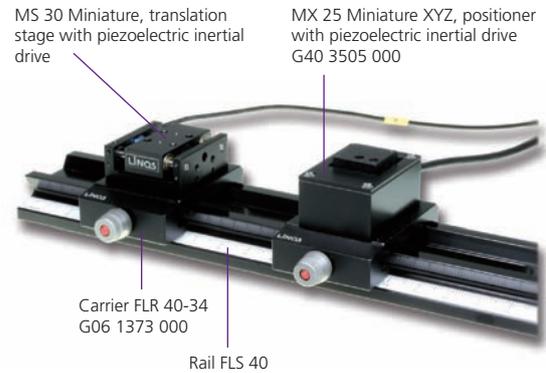
 Positioner MS 30 is a miniature translation stage with an adjustment range of 8, 18 or 30 mm. The MS 30 is made of a warp-resistant aluminum alloy, has precision ball lining channels and can be mounted in an XY or XYZ combination. The Miniature positioner MX 25 is a 3-axis adjustment unit with a 2 mm range. The bore hole patterns of both positioners are made to align with those on FLR 40 carriers (width: 34 mm and up), which means no further components are required to enable use of FLS 40 rails.

 The Kinematic mirror tilting stage MT 25 with its outer diameter of 25 mm can be used in Microbench mounting plates and in cubes with the corresponding mounting diameter. Just depending on your application, the MT 25 can be used for positioning mirrors or beam-splitter cubes.

A free through-bore hole of 9 mm also permits the use of partially transmitting mirrors.

Two types of controllers are available to choose from: Manual controller CN 30 (G40 3513 000) enables adjustment in three speeds using push buttons. Controller CU 30 (G40 3514 000) enables direct control from a computer over a USB interface.

Detailed information on all piezoelectric positioning systems is available in the Chapter entitled „Positioning Systems“ in the LINOS catalog and at [www.qioptiq-shop.com](http://www.qioptiq-shop.com).



MT 25 Kinematic Mirror Tilting Stage in Microbench mounting plate



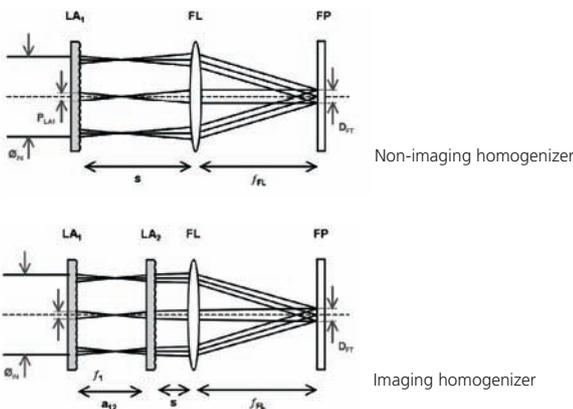
Kinematic Mirror Adjustment MT 25 in Microbench Cubes

# Homogenizers in the Nanobench

Many applications, from microscopy to materials processing, require as homogenous a distribution of light at the object level as possible. Today, homogenizers based on microlens arrays can be used for a variety of light sources, including excimer lasers and high energy LEDs, for example.

In general, a distinction is made between imaging and non-imaging homogenizers. In both types, either arrays with crossed cylindrical lenses or square microlenses split the incident beam into small partial beams. These partial beams are superimposed on the focal plane of a spherical lens, resulting in a homogeneously illuminated field. Because one of the lenses carries out a two-dimensional Fourier transform, it is also referred to as a Fourier lens.

42



In our example a homogenizer is set up in the Nanobench system. The microlens arrays with a 10 mm edge length are cemented into the corresponding mounts. One microlens array is mounted directly in a mounting plate, while the other is mounted in a rotation mount. The Fourier lens is fastened in another mounting plate on the rods.

The microlens arrays and the Fourier lens are selected on the basis of a calculation involving the specified sizes of the flat-top and the operating distance. The following equation applies:

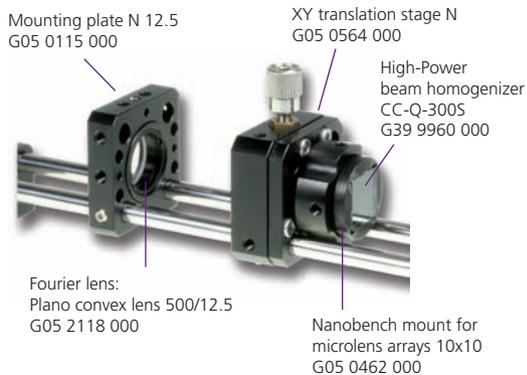
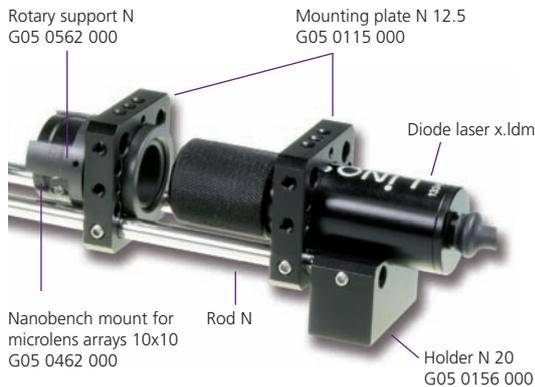
$$D_{FT} = \frac{P_{LA1} \cdot f_{FL}}{f_{LA1} \cdot f_{LA2}} \left[ (f_{LA1} + f_{LA2}) - a_{12} \right] \quad \text{with} \quad f_{LA1} < a_{12} < f_{LA1} + f_{LA2}$$

In this equation,  $D_{FT}$  is the diameter of the homogenous flat-top,  $P_{LA}$  the pitch of the lens arrays,  $f_{FL}$  the focal length of the Fourier lens,  $f_{LA}$  the focal lengths of the arrays and  $a_{12}$  the distance between arrays.

For a detailed introduction to the topic of homogenizers, see section Microlens Arrays in chapter Singlets of the LINOS catalog.



Complete homogenizer structure



In many cases, an economically priced solution can be obtained by selecting standard components.

# Customer Applications

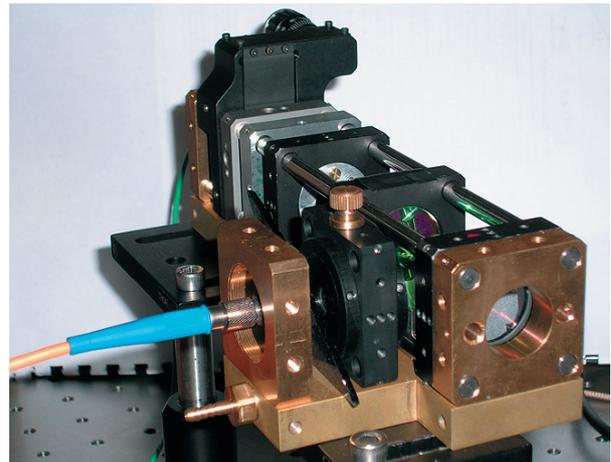
LINOS Microbench has been setting the standards for construction systems in optical laboratories for decades. This page presents a selection of our customers' practical applications.

## High-resolution distance and shape measurements on fast rotating bodies. LDD sensor for dynamic measurements

Authors: Prof. Juergen Czarske, Dr. Thorsten Pfister, Dr. Lars Buettnner; Chair for Measurement and Testing Techniques, Department of Electrical Engineering and Information Technology, Dresden University of Technology

The optical Doppler effect is well established in precise, contact-free measurement of velocities, enabling high temporal resolution in the microsecond range. Transferring the favorable properties of the optical Doppler effect to distance measurements on fast-moving solid body surfaces would mean a major step forward in the field of process control. The following article describes the development of the innovative Laser Doppler Distance (LDD) sensor. Potential areas of application are demonstrated by selected examples, including shape measurements on workpieces and in situ tip-clearance measurements on turbo machines. The LDD sensor was developed with Microbench components from LINOS.

Source: Optolines No. 19, 4th quarter 2008



43

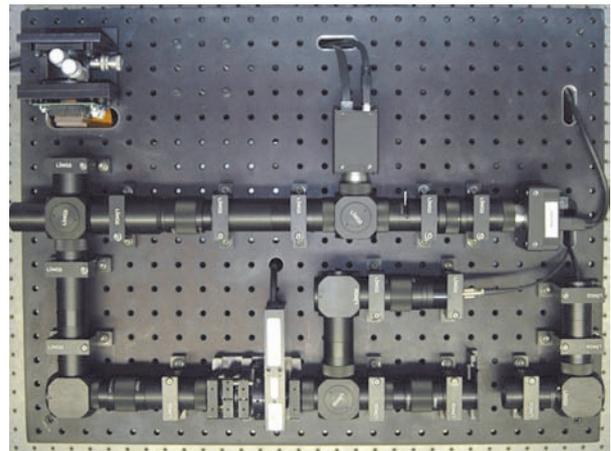
The complete articles are available for download at [www.qioptiq.com/optolines-magazine.html](http://www.qioptiq.com/optolines-magazine.html).

## Image improvement through wavefront correction. Micromirrors for adaptive optic

Authors: Jens Knobbe and Michael Wildenhain, Fraunhofer Institute of Photonic Microsystems, Dresden, Germany

What looks to us like the mere twinkling of stars in the night sky turns out, on closer observation, to be one of the greatest optical challenges facing astronomers: turbulence in the Earth's atmosphere, which makes it impossible to obtain sharply focused images. This phenomenon led to the development of adaptive optics. Although driven by the demands of astronomy, research and development in adaptive optics has opened up applications in other specialized areas as well over the past few years. The resulting demand for miniaturised optical phase control assemblies has led to the development of innovative MEMS components at the Fraunhofer Institute of Photonic Microsystems, or IPMS.

Source: optolines No. 12 / 4th Quarter, 2006





## Think Q!

LINOS Bench and Rail Systems from Qioptiq offer exacting precision, robust stability and the ultimate flexibility for experimental setups and measuring/inspection apparatus. Whatever your application, rely on the extensive range of fully interchangeable LINOS optomechanical bench products to meet your most demanding positioning needs.

## Photonics for Innovation

### For technical information contact:

Qioptiq  
photonics@qioptiq.com  
US/Can: 1 800-429-0257  
Eur: +49 551 69 35-0  
Asia: +65 64 99 77 66  
www.qioptiq.com

