



SEMI-AUTOMATED MASK ALIGNER PLATFORM

## **SUSS MA/BA Gen4 *Pro* Series**

SEMI-AUTOMATED MASK/BOND ALIGNER  
FOR INDUSTRIAL RESEARCH AND PRODUCTION





SEMI-AUTOMATED MASK ALIGNER PLATFORM

## SUSS MA/BA Gen4 *Pro* Series

### INNOVATIVE EXCELLENCE

The MA/BA Gen4 *Pro* series represents the latest generation of SUSS MicroTec's semi-automated Mask and Bond Aligner and introduces a new platform concept that consist of an entry-level MA/BA Gen4 and the high-end MA/BA Gen4 *Pro* series. The Gen4 *Pro* series is the high-end model, for industrial research and operator-assisted production, available as MA/BA6 Gen4 *Pro* and MA/BA8 Gen4 *Pro*.

The series has been designed to enable quick and effective development of new technologies and products. Research organizations will benefit from the enhanced capabilities of this machine as it allows them to develop their processes with industry standard equipment.

Because of their ability to easily process all types of wafer and substrate materials, semi-automated aligners are increasingly used in production environments. With the MA/BA Gen4 *Pro* series, SUSS MicroTec addresses the growing demand for tighter process control coupled with high yield.

The MA/BA Gen4 *Pro* series is the benchmark in full-field lithography for MEMS, Advanced Packaging, 3D integration and compound semiconductor markets. It also handles processes like micro & nanoimprint, bond alignment, UV-bonding as well as wafer level microlens imprinting and assembly.

Processes developed on the MA/BA Gen4 *Pro* series can be quickly transferred onto SUSS MicroTec's automated mask aligner platform for high volume production. Both platforms are based on the same SUSS technology.



#### MA/BA Gen4 *Pro* Series HIGHLIGHTS

- + High resolution (HR) optics allows patterning of structures below  $0.5 \mu\text{m}$
- + Operator assisted and auto alignment permits down to  $0.25 \mu\text{m}$  alignment accuracy
- + Advanced automatic functions for maximum process control
- + Process compatibility with automatic equipment
- + Optimized splitfield microscope with direct viewing and/or LCD flat screen options



## TARGET MARKETS

### **MEMS**

The MA/BA Gen4 *Pro* series with its high intensity exposure optics is a very efficient exposure tool for thick resist MEMS applications.

Innovative features or toolsets like infrared alignment system (transmission and reflective), bond alignment or the ability to handle small substrates make the MA/BA Gen4 *Pro* series an enabling lithography tool for the development and low-volume production of MEMS devices.



### **RESEARCH**

A quick changeover between options such as Lithography for thin and thick resists, micro- and nanoimprint, UV Bonding, Bond Alignment and Direct Bonding make the MA/BA Gen4 *Pro* series the perfect tool for the variety

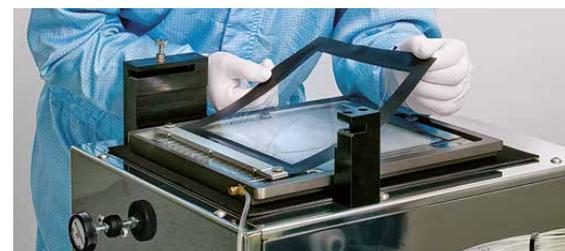
of applications in research. The tool can be equipped as needed from a low cost manual tool for basic studies up to a highly automated tool with automatic alignment for industrial research.



### **IMPRINT**

The MA/BA Gen4 *Pro* series enables with its different options for micro- and nanoimprint to have the right resolution from low to high-resolution and from small up to large-area imprint. For Full wafer imprint up to 150

or 200 mm either SMILE, a nano and micro imprint using soft stamps, or the unique SCIL nanoimprint technique, is the ideal choice for highest resolution.

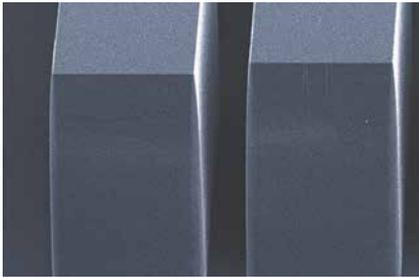




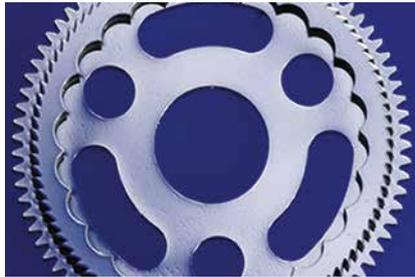
## BREAKING TECHNOLOGY BOUNDARIES

An unmatched alignment precision coupled with high resolution and maximum light uniformity makes the MA/BA Gen4 *Pro* series the tool of

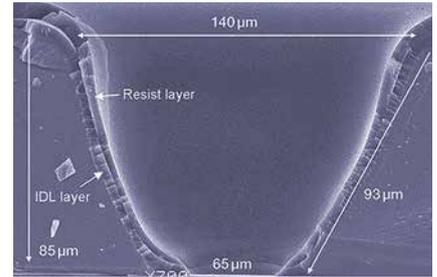
choice for a variety of applications, ranging from MEMS, opto-electronics and 3D Packaging to micro-optics and nanotechnology.



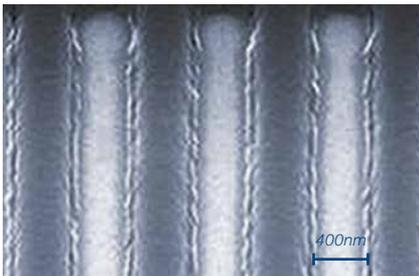
**MEMS**  
Printed in 500µm SU8 structures  
Courtesy: mrt, Berlin



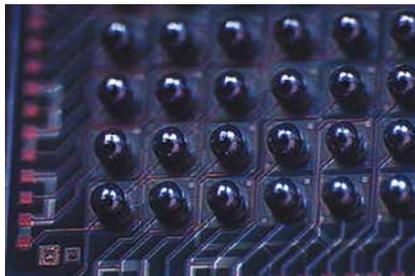
**UV LIGA**  
Micro mechanical watch components  
Courtesy: Mimatoc



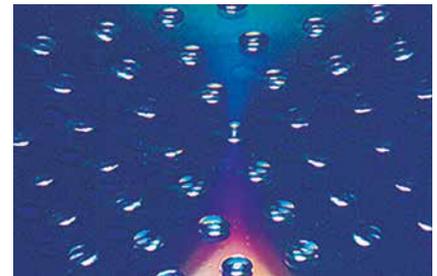
**CMOS Image Sensor Packaging, TSV Lithography**  
Via top and bottom opening  
Courtesy: Schott, IZM



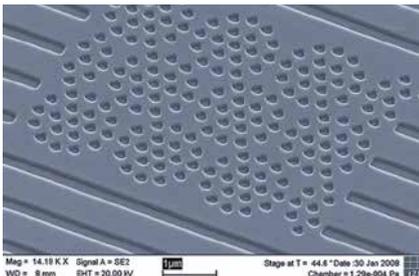
**Submicron Patterning**  
350 nm thick resist AZ6612  
400 nm lines and spaces  
Printed with SUSS UV400 HR Optics  
Courtesy: FH Vorarlberg



**Wafer Level CSP**  
Redistribution layer  
Courtesy: Fraunhofer IZM



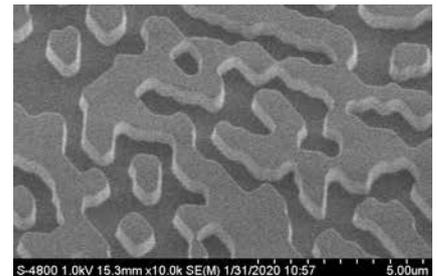
**Microlens Imprint Lithography (SMILE)**  
Microlens array for WLC (lens dimensions:  
30µm thick, 1600µm diameter)  
Courtesy: SMO



**Nanoimprint Lithography (SMILE)**  
160 nm wide holes positioned in concentric rings as used for photonic crystals



**Substrate Conformal Imprint Lithography (SCIL)**  
Large area nanoimprint lithography with soft stamp technology  
Courtesy: Philips Research



**Nanoimprint Lithography**  
DOE (diffractive optical elements) structures, obtained via nanoimprinting.



## CONNECTING INDUSTRIAL RESEARCH AND PRODUCTION

Innovation, high device performance, cost efficiency and short time-to-market are key drivers of product development and research at the beginning of the 21st century. With the new generation of the MA/BA Gen4 *Pro* series SUSS MicroTec has developed an innovative, state-of-the-art manual aligner solution that offers high process flexibility including submicron alignment and optimized thick resist lithography, UV micro- and nanoimprinting, microlens imprinting and assembly, UV bonding and enhanced bond alignment.

Designed for R&D, pilot line and production environments, the MA/BA Gen4 *Pro* series enables production-friendly research. It allows easy and cost-effective process transfer from laboratory to production. Key components such as optics, alignment system and graphical user interface perfectly match with the SUSS production aligner platform.



## INDUSTRY NEEDS RESEARCH – RESEARCH NEEDS EQUIPMENT

The quality of our future lifestyle depends on investments we make in research today. In order to stay in the race, novel technologies and products are in development that later will be produced in large volumes. With their enabling technology, manual mask aligners from SUSS MicroTec contribute to research and development, thereby helping us to shape the future.

Fully automated mask aligners from SUSS MicroTec are found in almost all major advanced packaging, MEMS and compound semiconductor production environments where high yield and cost-effective manufacturing are essential requirements.



## SUPERIOR ALIGNMENT

Highly precise alignment plays a significant role throughout the entire MEMS and semiconductor manufacturing process. The MA/BA Gen4 *Pro* series offers a variety of alignment systems tailored to your specific process requirements.

Depending on the alignment mode and alignment conditions, alignment precisions down to  $0.25\ \mu\text{m}$  (under special conditions) can be achieved.

### ALIGNMENT METHODS

#### TOP SIDE ALIGNMENT (TSA)

The MA/BA Gen4 *Pro* series can be equipped with either a manual or motorized top side alignment system. It can reliably achieve an alignment accuracy down to  $0.25\ \mu\text{m}$  (under special conditions) supported by assisted or auto alignment.

#### BOTTOM SIDE ALIGNMENT (BSA)

allows to pattern the top side of the wafer with features accurately aligned to the bottom side. The MA/BA Gen4 *Pro* series BSA system offers an alignment accuracy of  $< 1\ \mu\text{m}$ .

#### INFRARED ALIGNMENT (IR)

allows the handling of opaque, yet IR-transparent materials such as GaAs, InP, Silicon or adhesives. These are used for thin wafer handling or encapsulation applications.

### TOP SIDE MICROSCOPE OPTIONS

#### VIDEO MICROSCOPE

The microscope with attached CCD cameras present the alignment on a LCD screen for easy and fast operation.

#### SPLITFIELD / VIDEO MICROSCOPE

System with eye-pieces and CCD camera. It combines the advantages of both microscope options in one system. The splitfield microscope offers the operator a larger field of view, a higher depth of focus and a colored image.



## ALIGNMENT MODES

### MANUAL ALIGNMENT

is based on a manual or motorized alignment stage that can be precisely operated either via micrometer screws or joystick by the operator.

### ASSISTED ALIGNMENT

represents the latest development for operator assisted, semi-automated alignment. During manual alignment the COGNEX® based pattern recognition software continuously measures the achieved accuracy and reports it to the operator. With its sub pixel resolution the system supports highest alignment precision, prevents misalignment and maximizes yield.

### AUTO ALIGNMENT

The COGNEX®-based system not only automatically recognizes wafer and mask target locations but also controls the movement of the alignment stage. The alignment runs fully automated without operator intervention.

### DIRECTALIGN®

The software-assisted operation mode works with live images instead of stored alignment targets and reliably achieves accuracies down to 0.25  $\mu\text{m}$ . DirectAlign is recommended where high demands are made on alignment accuracy.





## OPTICS AND LAMP HOUSE

### TAILORED SOLUTIONS FOR ANY REQUIREMENT

#### UV-LED LAMP HOUSE

The LED lamp house concept of the MA/BA Gen4 *Pro* series convinces with efficiency - UV-LED light sources reach many times the service life of conventional mercury vapor lamps. Moreover, they no longer need to warm up and cool down - the LED is only switched on during exposure. These factors significantly contribute to comparatively low energy consumption.

Compared to conventional mercury vapor lamps, LED light sources not only work more efficiently but are also much more flexible to use. The UV-LED lamp house generally covers the same spectral region as mercury vapor lamps. The difference is that the UV-LED can switch specific wavelengths on and off. This eliminates the need to optically filter the light outside of the lamp house. Wavelengths are regulated via programmed formulas which fulfill specific process requirements without filter change or recalibration.

The operation of the MA/BA Gen4 *Pro* series significantly affects the operating costs the system. The service life of an LED exceeds that of conventional lamps many times over, thereby lowering costs generated by changing lamps. Downtimes, acquisition of new lamps, adjustments and disposal of old material have become a thing of the past. Working with the LED lamp house is both safe and environmentally sound and is a major step up in health and occupational safety, as well as in environmental protection.

#### MO EXPOSURE OPTICS® (MOEO)

SUSS MO Exposure Optics is based on unique high-quality microlens arrays that are combined with an exchangeable Illumination Filter Plate (IFP). These simulate changing exposure optics, thus making the use of additional optics components redundant. The optical system excels in light uniformity.

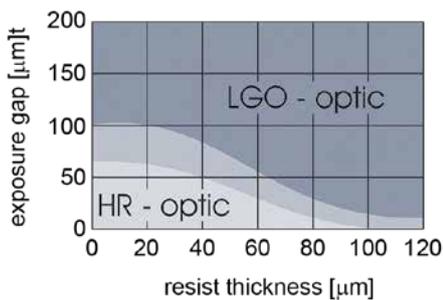
MO Exposure Optics additionally allows customized illumination through modification of the IFP and enables use of enhanced lithography techniques such as Source-Mask Optimization (SMO) or Optical Proximity Correction (OPC).





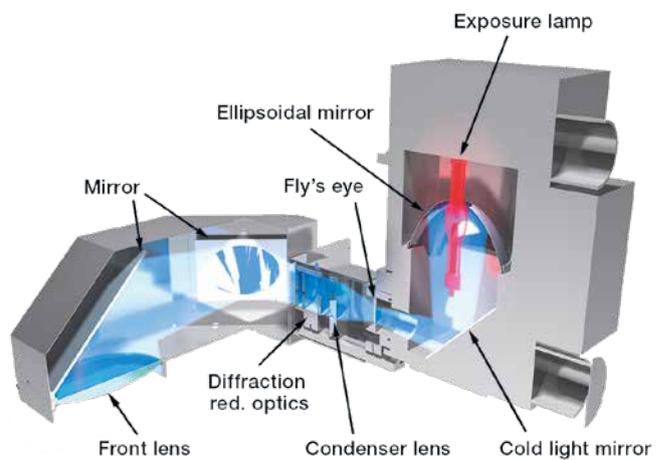
## DEDICATED OPTICS SOLUTIONS

The MA/BA Gen4 *Pro* series is a full-field exposure system capable of exposing wafers and substrates from pieces up to 150 or 200 mm. SUSS MicroTec offers optimized solutions for dedicated spectral ranges such as UV250, UV300 and UV400 to address different resolution requirements. All optics deliver optimum light uniformity of 3.5% depending on the application the user can choose between a High-Resolution (HR) and a Large exposure Gap Optics (LGO). The high resolution optics have been optimized for small exposure gaps or contact exposure to achieve the highest lines and spaces resolution. The SUSS LGO optics have been designed for large exposure gaps typically used for high topography (3D) and thick resist applications.



## STANDARD DIFFRACTION REDUCING EXPOSURE OPTICS

All SUSS Mask Aligners can be equipped with a variety of optical configurations designed to compensate diffraction effects. SUSS Mask Aligners perform exposure not only by one parallel beam, but by several slightly inclined beams to reduce the peak intensity of the secondary diffraction images produced by interference effects. Diffraction reducing exposure optics from SUSS MicroTec significantly improve resolution and sidewall profiles.



### MA/BA GEN4 PRO SERIES RESOLUTION

EXPOSURE MODE	UV400	UV300	UV250
Vacuum Contact	0.8 µm	0.5 µm	0.4 µm
Proximity (20 µm)	3.0 µm	2.5 µm	-

*Achievable resolution depends on optics type, wafer size, wafer flatness, resist type, clean room class and therefore, might vary for different processes. (1 µm thick resist, lines & spaces)*

### EXCELLENT UV UNIFORMITY

	MEAN INTENSITY	WAFER SIZE		
		8"	6"	<4"
i-line*	40 mW/cm <sup>2</sup>	3.5%	3.0%	2.0%
Broadband**	60 mW/cm <sup>2</sup>	3.5%	3.0%	2.0%

\* measured with 365 nm probe

\*\* measured with broadband probe



## OPTIONAL ENHANCEMENTS

### HIGHLY INTEGRATED FUNCTIONALITY

The MA/BA Gen4 *Pro* series is a highly versatile system for R&D and operator-assisted production. In addition it allows easy and fast upgrades to complementary technologies. The MA/BA Gen4 *Pro* series offers you up to five system solutions in one single tool:

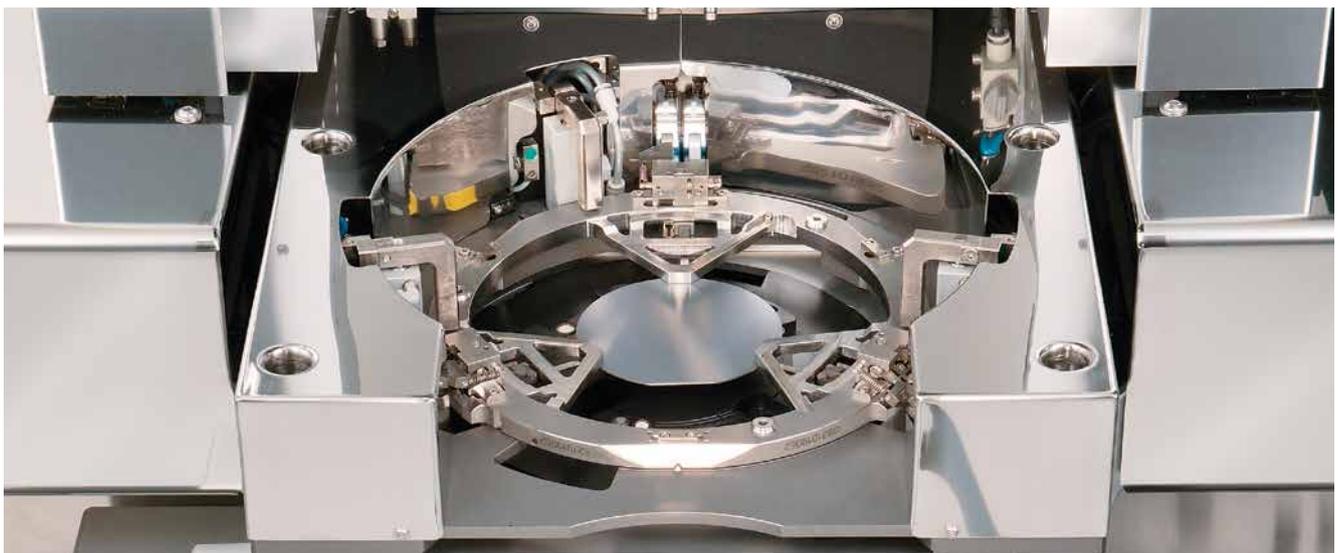
- + Full-field Photo Lithography
- + Bond Alignment: alignment of two substrates for subsequent substrate bonding
- + Imprinting: SCIL and SMILE
- + UV-Bonding: Wafer-level assembly of devices with UV curable material

#### **BOND ALIGNMENT**

The MA/BA Gen4 *Pro* series can be configured as a mask and bond aligner combination or as a bond aligner only. The BA8 Gen4 *Pro* aligns and clamps wafers in fixtures to maintain the position during manual transfer to a SUSS Wafer Bonder. The innovative system meets customer's needs for high precision, flexibility and repeatability, as well as low cost of ownership. In the case of direct bonding processes, the wafers can be prebonded in the aligner as well.

The highly rigid and stable alignment stage of the BA8 Gen4 *Pro* in combination with assisted and Auto-alignment options ensures reliable and accurate alignment of substrates. The proven, patented SUSS MicroTec wedge error compensation system guarantees highest possible planarity between wafers.

The BA8 Gen4 *Pro* accommodates even most demanding alignment processes in MEMS and LED production and growth markets like 3D integration.



# SUSS MA/BA Gen4 Pro Series

## TECHNICAL DATA

### MASK AND WAFER / SUBSTRATE

Wafer Size	1" to 150 or 200mm
Max. Substrate Size	150 x 150 mm or 200 mm x 200 mm
Min. Pieces	5 x 5 mm
Wafer Thickness	max. 10 mm
Mask Size	standard 2" x 2" up to 7" x 7" (SEMI) or up to 9" x 9" (SEMI)

### EXPOSURE MODES

Contact	soft, hard, vacuum
Proximity	exposure gap 1– 300 µm
Gap Setting Accuracy	1 µm
Vacuum Contact	adjustable to -80 kPa
Modes	constant power, constant dose
Options	flood exposure, split exposure

### EXPOSURE OPTICS

Resolution	see page 10
Wavelength Range	UV400 350–450 nm UV300 280–350 nm UV250 240–260 nm
Exposure Source	Hg lamp 350 W – 1000 W (optional 5000 W) UV LED lamp house
Intensity Uniformity	< 3.5 % (200 mm)

### ALIGNMENT METHODS

Top-Side Alignment (TSA)	accuracy < 0.5 µm
Bottom-Side Alignment (BSA)	accuracy < 1.0 µm
TSA Focus Range	1–400 µm (AL400 – motorized focus and image capturing)
Accuracy Bond Aligner	2 µm

### ALIGNMENT STAGE

MA Movement Range	X: ± 5 mm Y: ± 5 mm θ: ± 5°
BA Movement Range	X: ± 3 mm Y: ± 3 mm θ: ± 3°
Resolution	0.1 µm

### TOPSIDE MICROSCOPE (TSA)

Movement Range	6"	8"
	X: 33–152 mm Y: +18–100 mm θ: ± 5°	X: 33–202 mm Y: +18–100 mm θ: ± 5°

### BOTTOMSIDE MICROSCOPE (BSA)

Movement Range	6"	8"
	X: 20–150 mm Y: ± 22 mm focus: 6 mm	X: -20–210 mm Y: ± 22 mm focus: 6 mm

### GRAPHICAL USER INTERFACE

Windows 10
Unlimited Storage of Recipes
Remote Access Available

### UTILITIES

Vacuum	< -0.8 kPa
Compressed Air	0.6–0.8 MPa
Nitrogen	> 0.5 MPa

### POWER REQUIREMENTS

Power	voltage AC 230V ±10 % frequency 50–60 Hz
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### PHYSICAL DIMENSIONS

Width x Depth	1350 x 1000 mm = 1.35 m <sup>2</sup>
Height	1803 mm
Weight	~ 750 kg

### OPERATOR SAFETY AND ERGONOMICS

SEMI S2 Certificate
SEMI S8 Certificate
EMC
CE Compliant

*Data, design and specification depend on individual process conditions and can vary according to equipment configurations. Not all specifications may be valid simultaneously. Illustrations, photos and specifications in this brochure are not legally binding. SUSS MicroTec reserves the right to change machine specifications without prior notice.*

**NORTH AMERICA**

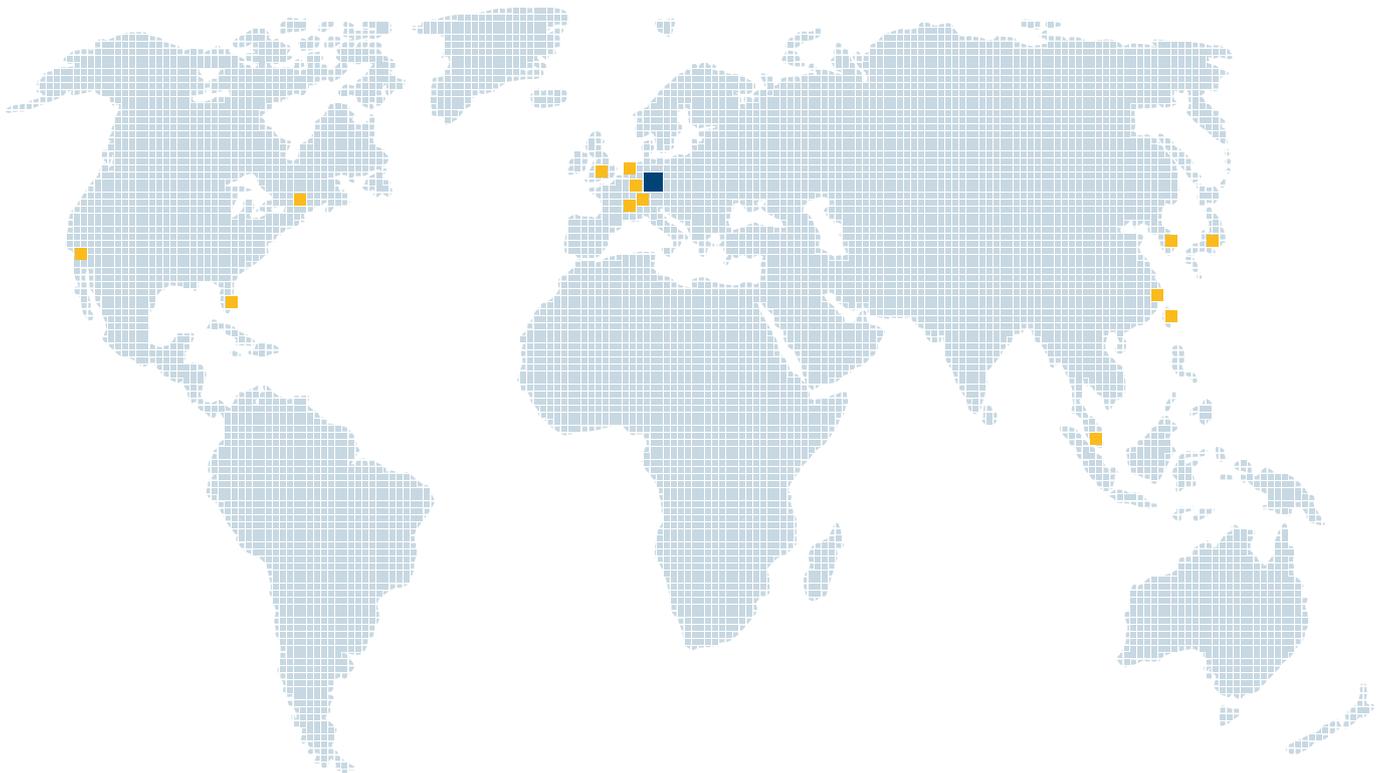
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