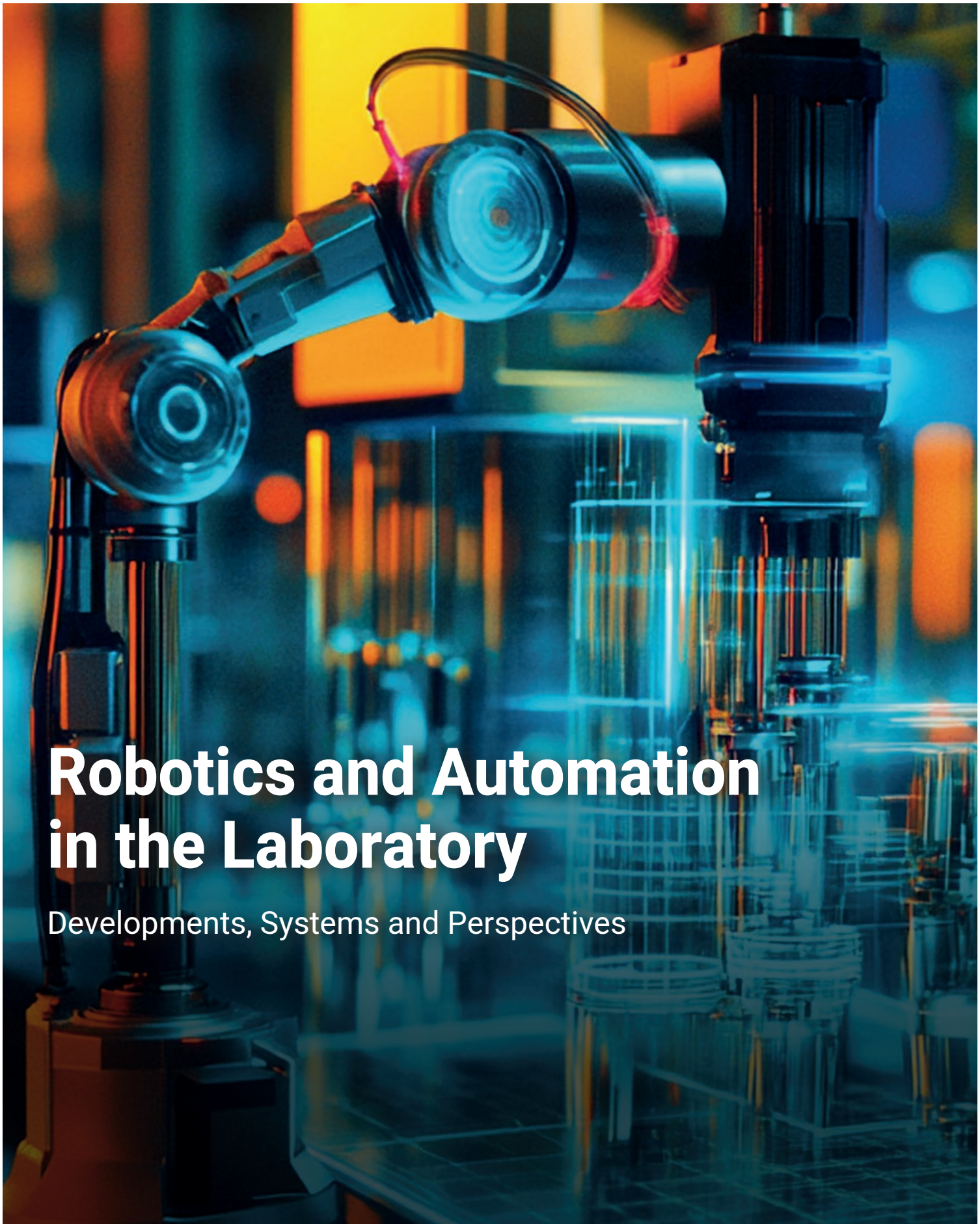

Robotics and Automation in the Laboratory

Developments, Systems and Perspectives

A joint study by

MESSE MÜNCHEN

analytica 2026

SPECTARIS
German Industry Association for Optics, Photonics, Analytical and Medical Technologies

Download study here

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Conceptual note
The term ‘laboratory automation’ is deliberately used in a broad sense in this publication. In addition to software and system solutions, it also encompasses robotics as a central component of automated analytical and quality assurance processes. This refers not only to traditional laboratory environments, but also to production-related and industrial contexts, such as pharmaceutical, chemical or biotechnological manufacturing. The focus is on the automation of analytical workflows along the entire value chain – from sample preparation and analysis to the integration of results into higher-level production and quality systems.

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Automation and robotics
A catalyst for innovation in laboratories

Automation, robotics and artificial intelligence are key technologies that will transform laboratory work in the coming years. Following an initial digitalisation phase focused on software, interfaces and data management, laboratories are now entering a new stage in which automation is becoming more connected and flexible, and increasingly supported by robotics and AI.

Automation has long been an integral part of everyday operations, for instance in high-throughput analysis, sample preparation and standardised workflows. What is new is the convergence of automation, robotics, AI and open interfaces. Together, these technologies enable processes that are more scalable, reproducible and integrated across devices and systems.

Robotic systems are increasingly complementing established automation solutions, ranging from automated liquid handling and sample preparation to mobile robots for logistics tasks and flexible assistance systems. Meanwhile, AI is expanding the possibilities, from process optimisation and predictive maintenance to advanced data analysis that supports research and development.

These developments address key challenges faced by laboratories, such as a shortage of skilled staff, growing sample volumes, regulatory requirements and the need for consistent, high-quality results. Automation and robotics can relieve staff of repetitive and physically demanding tasks, creating more time for interpretation, quality assurance and innovation.

The industries represented by SPECTARIS — namely, analytical, bio- and laboratory technologies, as well as optics and photonics — provide the essential building blocks, including sensors, imaging technologies, precision components, software and system integration. Open communication standards such as LADS OPC UA are crucial for manufacturer-independent connectivity and the creation of modular, future-proof laboratory infrastructures.

As an industry association, SPECTARIS unites manufacturers, technology providers, researchers and laboratory users. We promote cross-industry exchange, support standardisation and provide guidance through publications, services and expert dialogue.

This report shows how automation and robotics are already shaping laboratory work today, and where further development is expected in the coming years, based on contributions from industry experts, insights from research and a survey of manufacturers of analytical, bio- and laboratory technology.

Automation and robotics will not replace laboratory professionals. Instead, they will become an increasingly important part of collaborative, networked laboratory environments, supporting people, enhancing quality and strengthening Europe's position as a location for research and innovation.

JÖRG MAYER

Managing Director of the German Industry Association SPECTARIS

SPECTARIS

Advancing the smart lab together

A fundamental change has been taking place in laboratories for some years now. Robotics and AI-supported automation are no longer promises for the future, but are already shaping everyday life in research, development and analytics. They boost efficiency, improve the reproducibility of experiments and relieve staff of routine tasks, hence freeing them up for more demanding scientific tasks. Automated processes can also reduce the green footprint, for example, through lower material consumption and more efficient use of energy. Ultimately, standardised device interfaces, transparent processes and manufacturer-independent platforms for data exchange are essential for smooth networking in the laboratory. As the organiser of analytica, the world's leading trade fair for laboratory technology, analysis and biotechnology, we experience this change up close and accompany it, both in the exhibition halls and as co-editor of this study.

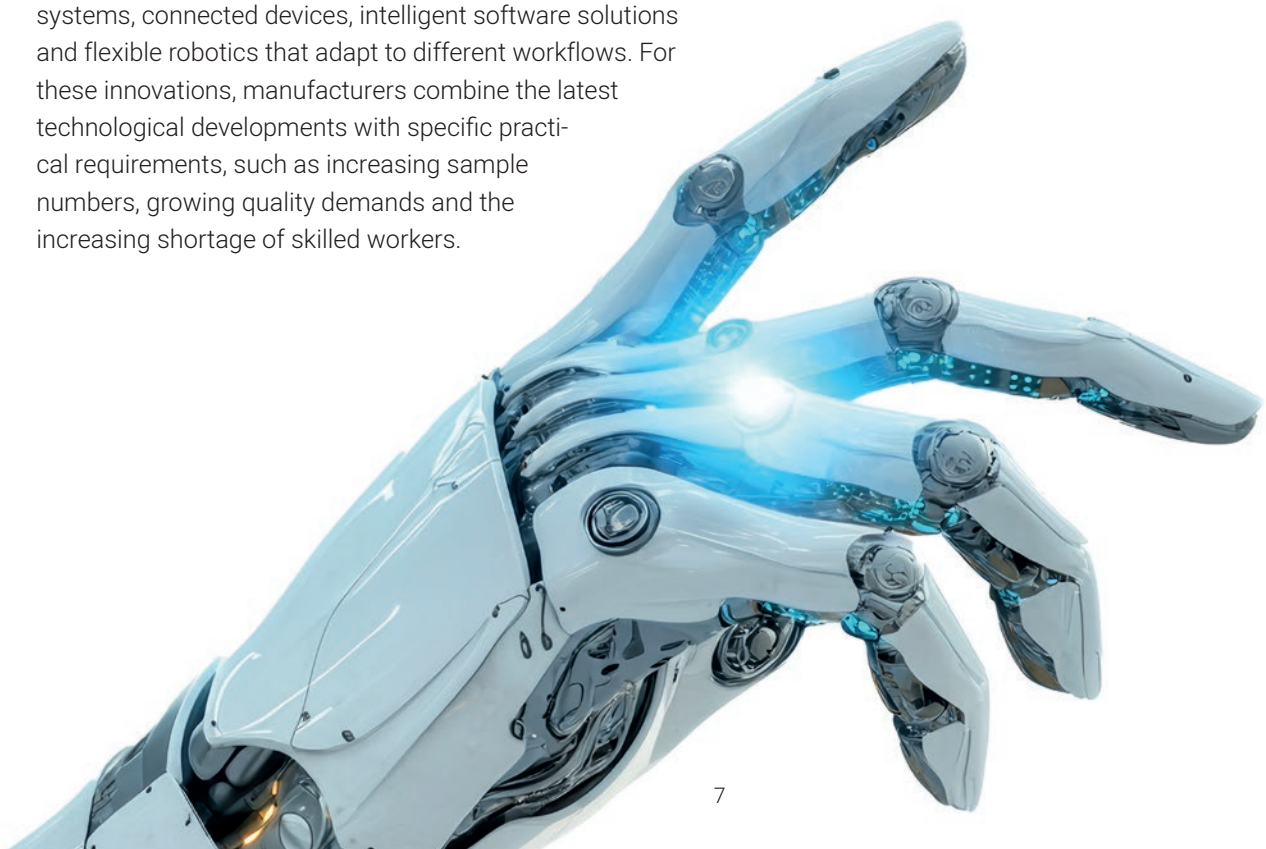
For six decades, analytica has been a platform for presenting the latest products and solutions for the laboratory. Visitors can already experience there today what will be standard in the laboratory of tomorrow: autonomous pipetting systems, connected devices, intelligent software solutions and flexible robotics that adapt to different workflows. For these innovations, manufacturers combine the latest technological developments with specific practical requirements, such as increasing sample numbers, growing quality demands and the increasing shortage of skilled workers.

This change also increases the need for information and discussion on the part of users. Trade fairs such as analytica offer the ideal setting for that. As the world's leading meeting place for the laboratory sector, it brings together international experts from research and industry every two years, bringing robotics and automation to life in the exhibition, in conference and forum lectures, and in special shows. This networking of the industry is crucial for discussing opportunities and challenges, and thus shaping the laboratory of the future together.

DR REINHARD PFEIFFER

CEO Messe München

MESSE MÜNCHEN



Overview, classification and summary

How robotics and automation are changing laboratories

MIKE BÄHREN

Head of Economics and
Market Research SPECTARIS

SPECTARIS

Dynamics and market development

Automation is not a new phenomenon in the laboratory. Automated systems have been used for years in many areas of analytics, biotechnology and laboratory technology, for example in standardised measurement and analysis processes or in high-throughput laboratory environments. These forms of automation are often heavily dependent on specific methods and devices and are characterised by a high degree of maturity.

In recent years, however, a new stage of development has been observed. With the increasing networking of devices, the availability of standardised interfaces and the growing use of robotics and artificial intelligence, the focus is shifting from selective automation to more flexible, integrated and data-driven laboratory processes. Robotics in particular makes it possible to automate less structured tasks and connect processes across device boundaries. Against this backdrop, automation and robotics in the laboratory are currently gaining significant momentum.

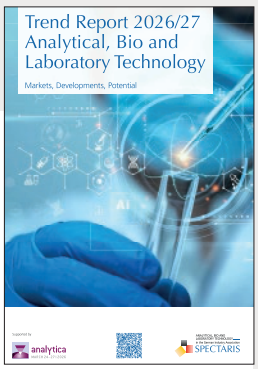
International market analyses also confirm this development. According to Grand View Research, the global market for laboratory robotics was worth around 2.4 billion US dollars in 2023 and is expected to grow to just under 3.9 billion US dollars by 2030, representing an average annual growth rate of around 7%. Growth drivers include automated systems for liquid handling, sample and plate handling, and integrated laboratory automation solutions. On the application side, drug discovery, diagnostics and genomics and biotechnology applications are among the most dynamic areas.[1]

This market dynamic is also reflected in the development of professional service robotics. According to the International Federation of Robotics (IFR), sales of medical robots rose by 91% to around 16,700 units in 2024. Within this segment, robots for diagnostics and medical laboratory analysis recorded particularly strong growth.[2]

In addition to the structural shortage of skilled workers and cost pressures, the need for end-to-end digitisation of analytical processes is also contributing to rising demand. At the same time, new procurement and operating models – such as rental or subscription solutions – can lower barriers to entry and facilitate the gradual introduction of automated systems.

Skills shortage, cost pressure and digitalisation drive investment

The results of a SPECTARIS member survey of manufacturers of analytical, biological and laboratory technology show that investments in automation and robotics in the laboratory are primarily motivated by operational and structural challenges.



The Strategic Framework: SPECTARIS Trend Report 2026/27

The Trend Report for Analytical, Bio- and Laboratory Technology 2026/27 examines the key technological, market and regulatory developments shaping the industry.
It also positions robotics and automation within the broader strategic context of the laboratory world and highlights the dynamics driving the sector as a whole.
Explore the full trend analysis now.

Figure 1: Key drivers for investment in automation and robotics in laboratories

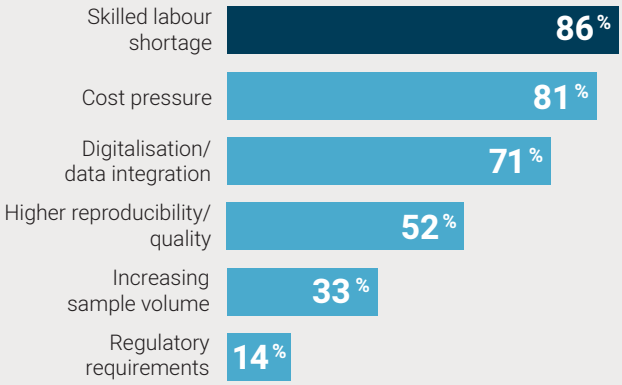
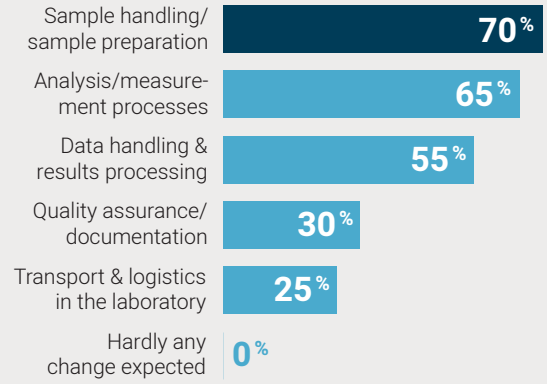


Figure 2: In which areas of laboratory work is the strongest growth expected (3–5 years)?



Source: SPECTARIS survey

From selective automation to integrated laboratory processes

The practical examples presented in this study show that automation and robotics in the laboratory are developing on several levels. One established field is device- and method-related automation, for example through automated sample dispensers, dosing and injection systems or integrated sample preparation modules. These solutions are widely used in standardised applications such as chromatography, mass spectrometry or wet chemistry and deliver reliable efficiency and quality gains.

However, the focus is increasingly shifting to the automation of entire workflows. Instead of individual devices, complete analytical process chains are being considered – from sample preparation and analysis to evaluation and documentation. Especially in quality control, diagnostics and industrial analytics, integrated systems are emerging in which automation, robotics and software are closely interlinked.

Figure 3: Current degree of automation in typical customer laboratories

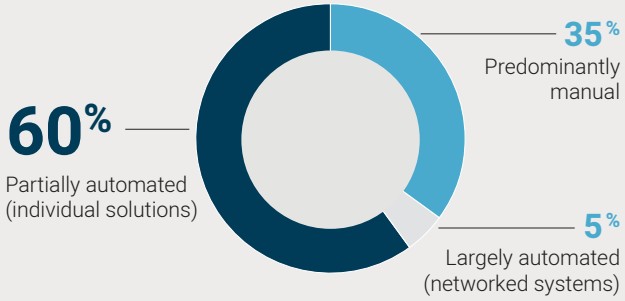
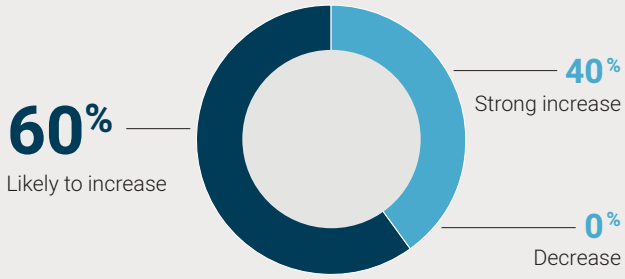


Figure 4: Expected development of automation and robotics by 2030



Source: SPECTARIS survey

The industry association SPECTARIS

Did you know? SPECTARIS is the German industry association with 400 members in the innovative sectors of optics, photonics, analytical and medical technology. Our goal is to strengthen the competitiveness and innovative power of our member companies. We are involved in shaping policy to promote our members' interests. We pool the expertise of our members and take a joint stance on relevant issues.

SPECTARIS
German Industry Association for Optics, Photonics, Analytical and Medical Technologies

www.spectaris.de

The F.O.M. Research Association

Did you know? The non-profit F.O.M Research Association Precision Mechanics, Optics and Medical Technology focuses on networking science and industry. It addresses industrial research needs by conducting innovation-oriented, pre-competitive research projects in fields comprising optics, photonics, optical metrology and robotics, as well as analytical and medical technology.

F.O.M.
Research Association Precision Mechanics, Optics and Medical Technology

www.forschung-fom.de

Figure 5: Areas of application and product segments for automation and robotics in the laboratory

Area of application / segment	Typical tasks	Characteristics	Examples
Device- and method-related automation	Sample injection, dosing, titration, device feed	High degree of maturity, highly standardised	Chromatography sampler, wet chemistry
Automated sample preparation & liquid handling	Pipetting, extraction, dilution, purification	Modular, reproducible	Pipetting platforms, Next generation sequencing (NGS) library preparation
Pre-analytical automation	Identification, sorting, initial processing	High error/time leverage (especially diagnostics)	Clinical & diagnostic laboratories
Workflow automation (end-to-end)	End-to-end process chains	Software-driven	QC & diagnostics workflows
Mobile robotics & laboratory logistics	Transport, device loading	Complementary, flexible	Clinical & diagnostic laboratories
Software & orchestration	Workflow control, data integration	Enabler	LIMS/ELN, LES

Cross-section: artificial intelligence (AI); data analysis, forecasting and simulation models (prospective virtual assays), adaptive process control, quality monitoring, predictive maintenance.

Interfaces, standardisation, research and innovation

With LADS OPC UA, SPECTARIS has established a cross-manufacturer communication standard that facilitates the integration of laboratory equipment, robotics systems and software solutions.[3] The development of such standards requires close cooperation between manufacturers, automation and robotics providers, software companies and users.

Robotics at SPECTARIS

SPECTARIS supports the development of automation and robotics in laboratories and medical technology through publications on current developments and trends, specialist events and expert talks, as well as by fostering cross-industry exchange between industry, technology providers and users.

Classification and outlook

Automation and robotics in the laboratory are evolving from established individual solutions to networked, software- and AI-supported complete systems. As an industry association, SPECTARIS connects device manufacturers, robotics and automation providers, software companies and users, thereby creating the basis for integration, standardisation and market development.

analytica provides a suitable framework for highlighting these developments and classifying current solutions and future prospects in the field of automation and robotics in the laboratory.

Footnotes

1) Grand View Research: Laboratory Robotics Market Report www.grandviewresearch.com/industry-analysis/laboratory-robotics-market-report
2) International Federation of Robotics (IFR): Service Robots See Global Growth Boom www.ifr.org/ifr-press-releases/news/service-robots-see-global-growth-boom
3) SPECTARIS – Networked Laboratory Equipment / LADS OPC UA www.spectaris.de/analysen-und-labortechnik/vernetzte-laborgeraete

GUEST CONTRIBUTION – Fraunhofer IPA

analytica
Hall A3 | Booth 312

Laboratory automation and robotics in transition – why research and innovation are crucial now

Efficiency pressure meets technological maturity: why laboratory automation is now gaining momentum

The development of laboratory automation has gained significant momentum in recent years. Key drivers include the increasing shortage of skilled workers, rising cost pressure and a growing volume of samples and analyses in many laboratories. At the same time, robotics and artificial intelligence have reached a level of technological maturity that makes new automation concepts practicable for the first time. Laboratories are traditionally considered to be open to innovation and technology-savvy – this combination of structural pressure and technological maturity is currently creating the conditions for profound change.

FLORIAN JORDAN

has been a research assistant in the Automation and Robotics research unit since 2018. His focus is on the perception of complex, unknown objects and the planning of robust gripping processes. In several industry-related research projects, he has driven technological developments and accompanied their transfer into real-world applications. Since 2023, he has been focusing increasingly on the use of AI-based algorithms in laboratory environments to increase the flexibility of automation systems and reduce the need for specialised hardware.

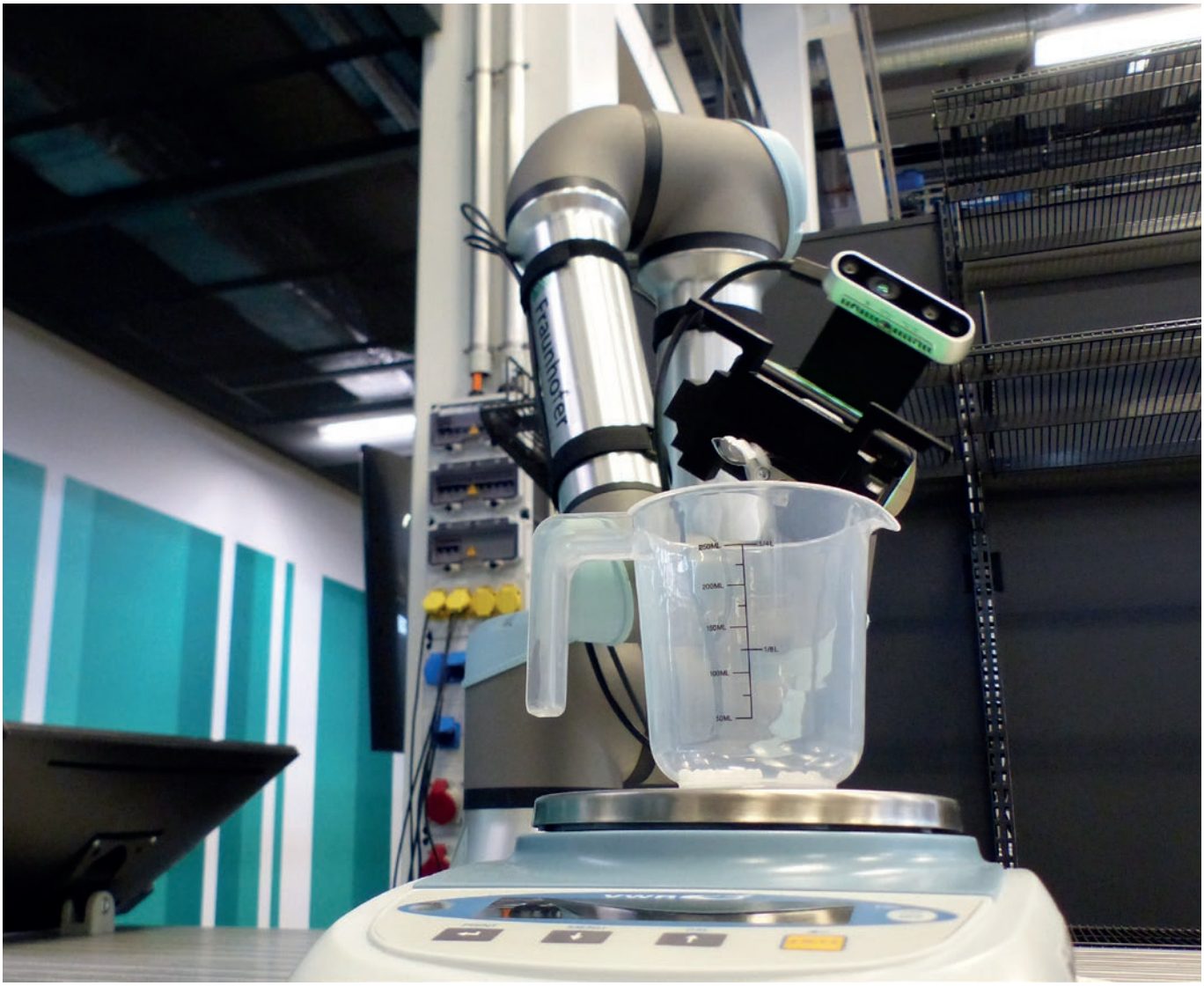
Between mature standard automation and the unresolved flexibility gap

The state of research and development in laboratory automation is highly application-dependent. In standardised areas such as high-throughput liquid handling, automated systems are already very powerful and, in some cases, flexibly reconfigurable. Skill-based and low-code approaches are increasingly being used, enabling skilled personnel to adapt systems to new tasks without in-depth device-specific knowledge.

On the other hand, there are numerous manual, small-scale tasks for which specialised automation solutions are often not economically viable. Here, research is focusing on fundamentally more flexible robot systems. These should be able to work reliably even under demanding conditions, such as when handling transparent or sensitive vessels, with varying chemical properties or in working environments shared with humans. The wide range and variability of laboratory-relevant processes continues to pose a major scientific challenge.

From modular systems to adaptive robotics as the next stage of evolution

A defining element of current research approaches is the modularity of automation systems. This makes it possible to reconfigure systems for new tasks, albeit often with a certain amount of effort involved in the conversion. Flexible robotics, which combines modular concepts with AI methods, goes even further. The aim is to create universally applicable systems that can perform different processes without requiring extensive adjustments to the laboratory environment.



Many of these approaches are still in the prototype and development phase, but the first products are already finding their way into everyday laboratory use. Even though these are currently limited to basic tasks for the most part, they demonstrate that the transfer from research is succeeding. An increasing number of market-ready, turnkey solutions can be expected in the coming years.

Strong research, weak transfer: Germany's ambivalent position in global competition

In international comparison, Germany continues to have a strong research landscape and a number of established laboratory technology manufacturers that work closely with research institutes. At the same time, structural weaknesses are becoming apparent, particularly in terms of funding. As a result of the multiple crises of recent years, suitable funding programmes have become rarer or are focusing on other areas. Technology transfer in particular suffers from a lack of or limited funding instruments, while private investors are more cautious in uncertain times.

Nevertheless, industry interest in innovative automation and robotics solutions remains high, as technological advances are a key lever for overcoming current challenges. With a more targeted funding structure, Germany could exploit this potential more consistently.

High complexity slows down transfer – and makes cooperation indispensable

The transfer of research results into real laboratory and production environments is characterised above all by the high complexity of the applications. Robotic systems must reliably perform precise, robust handling tasks for a wide variety of devices, materials and chemicals in variable environments. There is often still a gap between the state of research and the maturity required for industrial use, which can only be closed by extensive practical testing.

Standards could facilitate this process, but they are difficult to establish given the technological diversity and the use of relatively new AI methods. Interdisciplinary collaboration and long-term cooperation between research and industry are therefore crucial. In the ongoing RoX project ("Enabling AI Robotics"), industrial partners are working together to investigate how viable standardisation approaches can be developed.

Funding logic, infrastructure and certification as decisive levers

In order to strengthen research and innovation in the field of laboratory automation in the long term, open-ended funding programmes for innovation and transfer projects are essential. These must offer sufficient scope for development while also providing suitable control mechanisms. High investment costs, especially for specialised hardware and analysis equipment, often exceed the capabilities of individual research institutions.

Networked research and development centres modelled on ARENA2036 or the Robotics Institute Germany could serve as permanent testing and networking platforms. In addition, independent, standardised support for certification processes would significantly shorten the path to product maturity.

AI, mobile robotics and the "dark lab" as long-term goals

In the next five to ten years, the integration of AI will become increasingly important for making existing systems more flexible. It will enable systems to be adapted to changing requirements without costly retrofitting. At the same time, there will be a growing demand for robotics hardware certified specifically for laboratory use, in particular mobile platforms that create additional flexibility.

Collaborative robotics without large enclosures will become more important in order to use space more efficiently and better integrate existing laboratories. In the long term, the combination of AI-based recipe generation and robot systems will open up new possibilities for the development of materials and medicines, for example in the field of electrolytes or catalysts for the energy transition. The concept of the fully autonomous "dark lab" is also relevant in the long term, but is likely to be feasible in the short term, especially in new buildings and specialised applications.

Fraunhofer Institute for Manufacturing Engineering and Automation IPA

The Fraunhofer Institute for Manufacturing Engineering and Automation IPA develops innovative and sustainable solutions in production engineering and automation for numerous future-oriented industries. Its services range from methods and components to complete machines and systems. The institute's work is guided by the strategic guidelines of "mass sustainability" and "mass personalisation".

The Automation and Robotics research unit has more than 50 years of experience in the development of robot systems and key technologies. Its focus areas include the planning, design, implementation and optimisation of robot-based applications, as well as safety, human-robot collaboration, user-friendliness and application flexibility. Artificial intelligence is a key cross-sectional technology for making automation economically viable even for small batch sizes.

www.ipa.fraunhofer.de

Fraunhofer IPA

euRobotics – the network for robotics innovation in Europe

euRobotics and its role in the European robotics ecosystem

euRobotics is the European network for robotics innovation, acting as a bridge between industry, research and public stakeholders to strengthen Europe's technological leadership and competitiveness in robotics. As an international non-profit association based in Brussels, euRobotics coordinates a broad ecosystem of companies, research organisations and innovation contributors to support cooperation across the entire robotics value chain. A key focus of euRobotics is the strategic alignment of research excellence, industrial needs and European funding and policy frameworks, including Horizon Europe.

Through activities such as strategic roadmapping, structured Topic Groups, and flagship community events like the European Robotics Forum (ERF) and European Robotics Week (ERW), euRobotics enables knowledge exchange, accelerates market-oriented innovation and contributes to the responsible, sustainable and trusted deployment of robotics technologies across Europe. Concrete examples of impact include the development of widely referenced Strategic Research, Innovation and Deployment Agendas (SRIDAs), the active involvement of euRobotics members in European research partnerships and the sustained growth of ERF as Europe's leading robotics event. The next European Robotics Forum (ERF 2026) will further strengthen this role, with an expanded programme addressing deployment, adoption and societal impact alongside technological innovation.

Topic Groups as a strategic instrument

In addition to strategic roadmapping activities, euRobotics operates a structured network of Topic Groups (TGs) that address key application domains and cross-cutting technologies, such as AI, perception and mechantronic systems. Each Topic Group is led by designated coordinators and supported by active members from industry, research organisations and user communities. The TGs maintain an active programme of community engagement and dissemination, with outputs documented through regular public updates. These activities include an annual Topic Group Summit, thematic webinars and workshops, as well as cooperation with external networks and standardisation initiatives. For example, the Analytical Laboratory Robotics Topic Group has contributed to joint webinar activities addressing laboratory automation, interoperability and standards such as SiLA, supporting dialogue between technology providers, system integrators and end users.

Robotics in healthcare and laboratories

The euRobotics Topic Group on Healthcare Robotics addresses the strategic role of robotics across the European healthcare sector. The group focuses on interventional and surgical robotics, diagnostics, rehabilitation and patient and professional support. In addition to clinical and care-oriented applications, the Topic Group explicitly covers laboratory robotics as a critical enabler of modern diagnostics, including automated sample handling, analytical workflows and data-driven laboratory processes.

By bringing together experts from industry, applied research and healthcare innovation, the group develops shared perspectives on technological priorities, market needs and barriers to adoption, contributing to European roadmaps and policy discussions on healthcare robotics. A recent example of the Topic Group's practical impact is its contribution to the European Robotics Forum 2025 (ERF2025), where it played a central role in a dedicated workshop on the future deployment of healthcare and assistive robotics. The session brought together representatives from industry, research and healthcare practice to exchange concrete experiences from real-world deployments, with a focus on adoption barriers, user acceptance and integration into clinical and care workflows.

Analytical laboratory robotics: roadmaps and research priorities

The euRobotics Topic Group on Analytical Laboratory Robotics focuses on the strategic application and adoption of robotic automation in analytical, diagnostic and research laboratories. It addresses the growing demand for efficien-

cy, reproducibility, resilience and digital integration across workflows in medical diagnostics, life sciences, pharmaceutical research and industrial analytics.

A major output of the Topic Group is the development of a dedicated research and innovation roadmap for laboratory robotics. The roadmap consolidates perspectives from industry, research organisations, technology providers and end users, and outlines shared technological priorities, adoption challenges and enabling factors. Key themes include interoperability and standards, digital integration, usability, scalability and the convergence of robotics with data-driven methods such as artificial intelligence. As a common reference point in a fragmented laboratory automation landscape, the roadmap supports alignment between technological development, market needs and European research and funding agendas.

From European research to industrial, healthcare and laboratory impact

A concrete example of how European research funding supports priorities identified in the roadmap is the Horizon 2020 project TraceBot (Traceable Robotic Handling of Sterile Medical Products). The project addressed key challenges in automating analytical and pharmaceutical laboratory environments by developing robotic systems capable of performing complex handling tasks while ensuring traceability, verifiability and regulatory compliance. By combining robotics with advanced sensing of semi-transparent objects, digital-twin concepts and AI-based reasoning, TraceBot directly tackled issues of trust, transparency and auditability in regulated laboratory settings.

Taken together, the priorities and activities emerging from the euRobotics Topic Groups and associated EU-funded projects reinforce key conclusions of earlier SPECTARIS analyses on robotics in healthcare. These relate particularly to diagnostics, laboratory automation, interoperability and trust as enablers for adoption, reflected across both industry-led studies and European-level initiatives. This convergence underlines the robustness of the identified development paths and the relevance of coordinated European action.

Stakeholders are encouraged to consult the euRobotics roadmaps and engage with euRobotics and its Topic Groups to help shape future research and innovation agendas and strengthen coordinated European collaboration in healthcare and laboratory robotics.

DR PATRICK COURTNEY

has 20 years industrial experience in the development of lab technologies. He worked as a director for global firms such as PerkinElmer, as well as at Sartorius and Cap Gemini. He co-leads a European working group on analytical laboratory robotics and AI for science, and is member of the board of directors of SiLA (Standards in Laboratory Automation). He holds an MBA with a PhD in Robotic Engineering/Molecular Biology, has 100 publications and is named on ten patents.

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DR FRANCOISE J. SIEPEL

is an associate professor at the University of Twente and a recognised leader in European healthcare robotics, with extensive international experience across academia, clinical environments and strategic innovation programmes. She leads major initiatives such as **DIH-HERO**, chairs the **Healthcare Topic Group in euRobotics**, and coordinates the **healthcare track within ADRA** (AI, Data and Robotics Association). Her research focuses on **image-guided robotic interventions for oncology**, combining robotics, AI and medical imaging to advance minimally invasive treatment. She has acquired substantial research funding and published widely at the intersection of technology and clinical application.

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Automation and robotics – how analytical laboratories are transforming

5 questions for ...

DR JENCA SCHMITT

Chief Technology Officer
at VELARIS

SPECTARIS: How would you describe the maturity of laboratory automation and robotics today – are we still mainly seeing isolated solutions, or are laboratory workflows already undergoing a more fundamental structural transformation?

Dr Jenca Schmitt: If you look at the current state of laboratory automation and robotics, the biggest challenge isn't just connecting individual systems, but integrating diverse instruments, software platforms and data models into a seamless, reliable process. Vendors often face proprietary interfaces, inconsistent data formats, and older legacy systems while developing software that manages complex experimental workflows. Teams often struggle with skills gaps, organisational processes, and validation requirements, which can make standalone systems feel easier to adopt than fully integrated solutions. Achieving real workflow efficiency requires aligning technology with operations and ensuring that the standards guiding lab practices, such as ISO or DIN, evolve to become more flexible and adaptable, for example, in terms of sample sizes or procedural parameters, so they fit more naturally with automated workflows.

SPECTARIS: Which concrete challenges in everyday laboratory operations are currently driving the adoption of laboratory automation and robotics most strongly – for example skills shortages, increasing sample throughput, requirements for reproducibility or documentation efforts?

Dr Jenca Schmitt: The shift toward laboratory automation isn't just about speed anymore. It's a necessary response to workforce shortages and the complexity of modern workflows. When teams are stretched thin, manual sample handling can become a bottleneck, affecting both throughput and data quality. Automating these repetitive tasks helps ensure results stay reproducible and fully traceable, which is critical for compliance. It also allows scientists to spend more time on discovery and insight, while making lab operations more efficient and reliable.

SPECTARIS: In which areas do laboratory automation and robotics already deliver the greatest measurable benefits in practice, particularly regarding sample preparation and routine analytical workflows?

Dr Jenca Schmitt: The biggest wins for automation typically occur in areas with the highest manual workload, particularly high-volume sample prep or repetitive analytical routines where errors are most likely to happen. Moving liquid handling and plate preparation to automated systems does more than just increase throughput; it removes the inherent variability of manual intervention. Integrated robotic platforms ensure accurate sample tracking, precise dosing and effective contamination

control, improving both data quality and reproducibility. For the lab team, this shift means fewer hours spent on repetitive tasks and more time for the high-level analysis and method development that drive innovation.

SPECTARIS: How do laboratory automation and robotics fit into VELARIS' overall strategy, and in what ways are emerging technologies expected to transform laboratory workflows in the future?

Dr Jenca Schmitt: Laboratory automation and robotics are central to VELARIS' strategy, enabling us to move beyond individual instruments toward a fully connected digital environment that supports chemical workflows from start to finish. By linking data and systems across different sites, we aim to make laboratory work more intuitive. Digital tools, including augmented reality, digital twins and AI-assisted guidance help scientists plan and run experiments with more confidence by providing real-time updates on quality and performance. By reducing routine errors, this approach allows researchers to focus on discovery and solving complex problems. We envision a lab where technology and expertise work together, making every experiment more reliable and workflows smoother.

SPECTARIS: How important are open, standardised, and robotics-ready interfaces for integrating automated systems into existing laboratory environments – and where do you currently see practical limits in terms of interoperability and scalable automation?

Dr Jenca Schmitt: To truly integrate automation across different instruments and digital platforms, including LIMS and ERP systems, we need open, robotic-ready interfaces. Today, many labs are held back by legacy devices with closed APIs and proprietary formats creating isolated 'data islands.' This makes scaling complex and non-linear workflows nearly impossible. By adopting standards like LADS and SiLA 2 for device communication, OPC UA for secure interoperability and AnIML and Allotrope for structured analytical data, labs can finally move beyond these point-to-point connections. Moving to normalised data models and real-time, responsive architectures doesn't just close these technical gaps; it enables end-to-end automation that increases throughput and ensures compliance, while giving scientists more time for discovery rather than routine tasks.

Dr Jenca Schmitt is a pioneering technology executive driving global innovation at the intersection of science, engineering and business to deliver sustainable growth and real-world impact at VELARIS. She has held strategic roles at leading life sciences and diagnostics organisations, including Tecan, Abbott and Roche Diagnostics. Earlier in her career, she advanced medical device and imaging technologies at Becton Dickinson, Photometrics and Hamamatsu Photonics, following her start at the German Aerospace Center. She holds a PhD in physics from Ludwig Maximilians University in Munich and has conducted research at Max Planck and Fraunhofer institutes.

VELARIS

VELARIS is a global provider of laboratory automation and analytical instrumentation, formed by uniting several established brands, including GERSTEL, Skalar, TRACE, and others. Backed by Battery Ventures, VELARIS combines deep expertise in automated sample preparation, chromatography, elemental analysis and robotics, serving major multinational commercial testing laboratories and industrial clients across the food and beverage, environmental, petrochemical and agricultural sectors.

Enabling seamless laboratory connectivity: the role of LADS OPC UA in highly automated labs

DR MATTHIAS ARNOLD

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Dr Matthias Arnold is a leading expert in laboratory digitalisation, semantic data integration and communication standards for life sciences and analytical environments. As Technical Lead of the LADS OPC UA Joint Workgroup at SPECTARIS and the OPC Foundation, he drives the development of interoperable and FAIR-compliant standards for connected laboratories. With more than 25 years of experience as entrepreneur, innovator and digital strategy consultant, he has pioneered bioprocess technologies, connected laboratory platforms and data-driven solutions. Today, he focuses on enabling the next generation of intelligent, integrated and AI-ready laboratory ecosystems.

To bridge digitalisation gaps in laboratory and analytical environments, an open and secure connectivity standard became essential. Manual workflows and inconsistent communication between laboratory devices and analysers highlighted the urgent need for standardised integration. LADS OPC UA was developed to enable industrial-grade interoperability in this domain. Initiated by a SPECTARIS working group of device manufacturers and expanded into an international collaboration, the initiative brought together vendors, software providers, associations and end-users to ensure practical relevance and broad adoption.

OPC UA was selected as the foundation due to its security, scalability and global recognition – from sensors to the cloud. Importantly, OPC UA is also firmly established in industrial robotics and manufacturing automation. This shared technological basis enables smooth integration of robots into laboratory environments and ensures strong ecosystem acceptance across domains.

LADS OPC UA enables the true plug-and-play operation of laboratory devices and analysers, supporting efficient integration, high-quality data and improved compliance. In highly automated laboratories – particularly those involving robotic sample handling – structured real-time information is critical. Robots require standardised access to capabilities, operational states, execution progress and diagnostics to interact safely and deterministically with laboratory devices and analysers.

LADS OPC UA provides this information in a harmonised, machine-readable form. Semantic capability descriptions allow robotic systems to dynamically determine whether a requested operation is supported. Unified command structures and standardised control functions enable vendor-independent orchestration logic, while standardised state models ensure precise synchronisation between robots and instrument processes.

Physical interaction modeling—such as drawers, racks and access points—is not inherently part of LADS itself but can be realised by combining it with additional OPC UA companion specifications. In demonstrated scenarios, the Relative Spatial Locations (RSL) Companion Specification was integrated with LADS OPC UA implementations to describe spatial relationships and dynamic interaction states.This highlights the composability of the OPC UA ecosystem: complementary models can be combined to enable safe and coordinated robotic interaction.

The synergy between LADS OPC UA and robotics was illustrated at OPC Day 2023 and JASIS 2023 through animated 3D visualisations of a virtual laboratory environment.The simulated lab featured LADS OPC UA laboratory devices and analysers extended with RSL-based spatial modelling. These demonstrations showed how standardised device semantics and spatial descriptions enable cross-vendor robotic orchestration without proprietary integration layers.

Adoption was accelerated through collaborative hackathons. A major milestone was the successful integration of the Allotrope Foundation Ontologies (AFO) and the Allotrope Simple Model (ASM) into the OPC UA framework – advancing semantic interoperability and structured, FAIR laboratory data.

By federating open standards such as OPC UA and Allotrope – and by composing complementary companion specifications including RSL and Robotics – the industry is establishing a scalable, semantically rich foundation for the digital laboratory. LADS OPC UA does not merely connect laboratory devices and analysers; it enables orchestrated laboratory ecosystems in which robots, instruments and software systems interact through open, standardised interfaces.

Looking ahead, LADS OPC UA will continue to strengthen robotic integration and cloud-ready architectures, accelerating the transition toward highly automated and ultimately autonomous laboratories.

LADS
Laboratory & Analytical Device Standard

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From manual labour to high-tech: automation and AI in the laboratory

5 questions for ...

DR FELIX LENK

Managing Director &
SmartLab Enthusiast,
SmartLab Solutions GmbH,
Dresden

Dr Felix Lenk studied automation and control engineering at TU Dresden, where he also obtained his doctorate. He is the founder and managing director of SmartLab Solutions GmbH and amensio GmbH – two high-tech start-ups for laboratory digitalisation. He works as an honorary expert and consultant for the Federal Ministry of Research, Technology and Space, the industry association Spectaris e.V. and the Society for Laboratory Automation and Screening (SLAS).

SPECTARIS: SmartLab Solutions supports laboratories in the planning and implementation of digital and automated complete solutions. In your experience, what are currently the biggest hurdles to the introduction of laboratory robotics and automation in practice?

Dr Felix Lenk: First of all, probably one of the biggest hurdles lies in the choice of the process to be automated. We recommend core processes with high throughput. Once this has been identified and well mapped, the system planning is a matter for us professionals.

We see the biggest hurdles in the internal processes of the laboratories, which we usually tackle together with our customers: complex data management requirements, interoperability with existing IT systems, expertise with new technologies and digital solutions and, last but not least, the financing of the projects.

SPECTARIS: Automation is often initially understood as a technical project in laboratories. In your opinion, how important are process design, organisation and user acceptance for the sustainable success of robotics and automation solutions?

Dr Felix Lenk: Laboratory technicians are very open to innovation and, on the whole, have little fear of new technologies. When designing processes, it is essential to document the existing process well and to take laboratory staff with you on the digital journey – after all, they are the experts in the respective analysis or laboratory process and are therefore crucial to the success of the project. However, it is important to move away from the idea that a robot will take over the laboratory technician's work steps 1:1.

Another aspect that is often misunderstood at the start of projects is the assumption that a robot must be faster than the manual process. Depending on the requirements, the decisive advantage here is the gain in quality through repeatability and no fatigue in repetitive processes. The primary aim is to relieve the laboratory staff by maximising 'walk-away' times.

SPECTARIS: In many laboratories, software and hardware solutions are combined to form integrated systems. What requirements does this place on interfaces, data models and the orchestration of complex laboratory workflows?

Dr Felix Lenk: In short, integration requires standardised, bidirectional interfaces, consistent and structured data models and intelligent workflow orchestration to make complex laboratory processes automated, reproducible and scalable.

In our experience, the technology behind this is highly complex, but solvable. The challenge is to understand and translate the different languages of users, software developers, machine builders and stakeholders.

SPECTARIS: Increasing automation is generating large amounts of structured process and quality data. What role do these data already play today in optimising, ensuring transparency and traceability of laboratory processes – and what potential do you see here in the future, for example through the use of AI-based evaluation and control approaches?

Dr Felix Lenk: You raise a very important issue here. Laboratory journals are often still kept by hand. Digital laboratories use electronic laboratory notebooks (ELNs), which is already a big step towards the use of AI tools.

Let's take it one step further. With modern methods of networking laboratory equipment, including the OPC UA communication standard and its Companion Specification Laboratory & Analytical Device Standard (LADS), workflows can be documented down to the individual steps performed by analytical instruments. This creates a well-structured data lake of process parameters that were not previously documented. This wealth of precise, real data is the foundation for feeding models and algorithms.

On this basis, AI algorithms can optimise analyses, predict deviations, detect errors and independently make laboratory processes more efficient – although the full potential of this is still difficult to estimate today.

SPECTARIS: Looking ahead to the next five to ten years, how do you think the interplay between robotics, automation and laboratory digitalisation will develop – do you expect to see further differentiation of highly specialised individual solutions or greater consolidation towards integrated, software-driven platforms? And what structural conditions do you think laboratories need to create in order to exploit this potential?

Dr Felix Lenk: If only I had a crystal ball to tell you for sure... *laughs*

For highly standardised processes, we are already seeing consortia of robotics, analytical equipment and software solution manufacturers forming to develop well-coordinated series products. In view of the hurdles we discussed at the beginning, the answer to the abundance of different specialised devices, some of which require high investments, can only be greater harmonisation. Otherwise, automation will remain the preserve of the courageous pioneers in the industry, as such systems are not financially viable for a large number of laboratories.

SmartLab Solutions
SmartLab Solutions GmbH is a full-service provider for digitalisation and automation in the laboratory. We work to exploit the full potential of laboratory processes and extract the honey from your laboratory workflows. We deliver turnkey solutions by combining professional services with software and hardware development. Based on the iHEX approach, we make laboratories more efficient, more precise and future-proof.
We are at analytica at booth B2.435 and at the special show "Digital Transformation".

SMARTLAB SOLUTIONS
THE GEOMETRY OF VALUE

Why fully autonomous analytical laboratories are no long a vision – they are becoming a reality

DR MARCEL VRANCEANU

Principal Scientist: Laboratory Automation Analytical and Material Science, BASF SE, Ludwigshafen

I studied chemical engineering at the Technical University of Iasi, Romania and obtained my PhD at the Karlsruhe Institute of Technology (KIT). After a brief period at BioNTech in Mainz, I joined BASF in October 2012, where I am now pushing automation and digitalisation topics in analytics.

For decades, automation in analytical laboratories has progressed steadily but cautiously. Individual instruments have become more efficient, sample preparation and analytics steps have been partially automated and digital tools like Laboratory Information Management Systems (LIMS) have improved documentation. Yet the idea of a truly end-to-end, autonomous analytical workflow remained largely aspirational – something discussed at conferences more often than seen in practice. Today, however, that paradigm is shifting rapidly. The accelerating integration of robotics, artificial intelligence, and digital ecosystems is redefining not only what is technically possible, but also what is operationally and economically advantageous. Nowhere is this transformation more tangible than in the developments unfolding at BASF's Analytical and Material Science Department in Ludwigshafen.

A new era: from fragmented automation to integrated autonomy

Traditional laboratory automation has historically focused on isolated tasks such as individual automated pipetting systems, standalone titration units or digestion systems. These standalone solutions improved throughput but did not fundamentally reshape the laboratory as a system. The real breakthrough begins when these discrete steps become interconnected, forming a seamless, end-to-end analytical workflow.

Achieving this requires automating the remaining manual steps and integrating all processes into an uninterrupted chain. Autonomous mobile robots (AMRs) equipped with manipulators play a central role in this evolution. Instead of being confined to fixed workcells, AMRs move freely through laboratories, transporting samples and linking previously siloed devices into a coherent analytical pipeline. Their mobility transforms the laboratory from a scattered collection of instruments into an interconnected, intelligent network – an integrated workflow.

Mobile robots: from experiment to everyday reality

The integration of AMRs at BASF Ludwigshafen is one of the clearest demonstrations that autonomous laboratories have moved far beyond the conceptual stage. In our new analytical building, we fully automated in-house sample transportation using four AMRs seamlessly embedded into daily laboratory logistics. They interact with a dedicated vertical lift for the transport of boxes with samples between floors, multiple transfer stations throughout the labs, and a job management system that assigns tasks automatically while the robots navigate autonomously through the labs and corridors.

Implementing this system meant breaking new ground – these are the first AMRs transporting samples in a BASF laboratory building. No single supplier could provide a complete solution, so systems from three independent vendors were combined into one functional architecture.

At the same time, conventional digital methods for destination selection – touchscreens, scanners, software interfaces – proved too complex, costly and not optimal for everyday laboratory use. The solution was elegantly simple: a mechanical destination selection disc mounted on each transport box, revealing a data matrix code for the desired destination. This analog innovation replaced digital complexity, reduced cost and energy consumption, accelerated implementation, increased operation efficiency and robustness, while working seamlessly for both automated and manual sample transportation.

This approach captures the essence of effective laboratory automation: innovation driven not by technology for its own sake, but by pragmatic, efficient problem solving.

When rethinking processes unlocks automation

One of the key lessons from our automation journey is that true progress often requires rethinking laboratory processes, not just installing new robots. A simple shift from volumetric to gravimetric dilution, for example, could significantly simplify the automation without compromising on analytical precision, while increasing sustainability by reducing organic solvent consumption by more than 90%.[1]

BASF Ludwigshafen's new analytics and material science laboratory building

©BASF SE

On our way towards autonomous labs, there were some steps of sample preparation for which we couldn't find suitable commercially available solutions. In response, we developed a novel weighing robot for powder samples[2], which performs the weighing process in a similar way a human would do it. The robot uses a special spoon[3] to transfer powder into a target container placed on an analytical balance. We also had to develop a robust, flexible and clog free novel powder dosing system[4] that works reliably even with hygroscopic powders and is unaffected by ambient humidity.

These examples illustrate how targeted innovation can remove practical barriers that traditionally limited laboratory automation. This kind of process transformation is essential: automation succeeds when workflows are purposefully redesigned with robotics and digital systems in mind.

Automated sample transportation via AMRs

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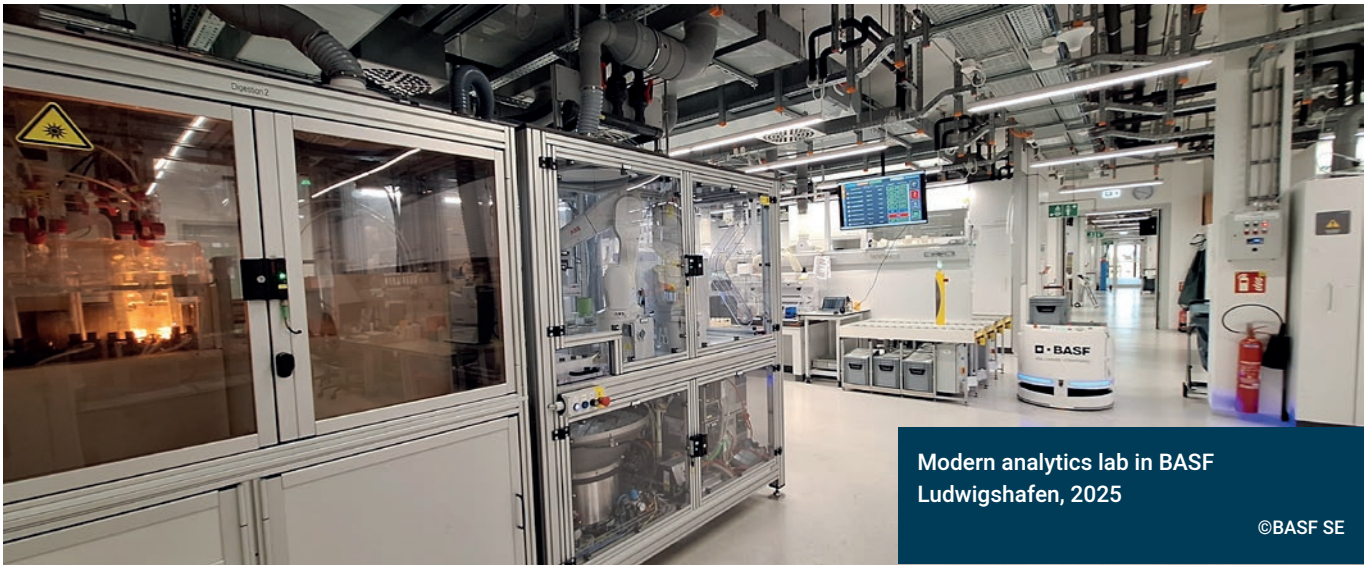
Mobile cobot in the lab of the future, created with Microsoft Copilot



Modern analytics lab in BASF Ludwigshafen, 2025

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The digital backbone: AI, sample tracking, dashboards, orchestration and paperless lab

Automation alone does not create an autonomous lab – the digital layer is equally important.

BASF's first self optimising flow chemistry system for formulation and synthesis screening[5], the so called "AI Reactor" based on Bayesian optimisation as newly implemented in BoFire[6] showed how AI can guide experimental workflows, not just evaluate results. The fast development and expansion of these systems into analytical method optimisation, self-driving labs, and even production plant control shows clearly where the industry is heading.

We are further advancing digitalisation through tools such as:

- The "DispoApp", automating the decision process for assigning preparation and analytical methods for each sample – an essential building block of our autonomous lab concept.
- Smart sample tracking and automated storage systems, now implemented across numerous BASF labs and sites and recognised as a top five digital project in the 2025 BASF "Digital Award" competition.
- Real time dashboards for transparent workflow monitoring, operational planning and optimisation.
- A workflow orchestration system and further paperless lab solutions are currently under evaluation.

Together with the LIMS, these digital components form the nervous system of the autonomous laboratory.

The turning point has arrived

The industry's analytical landscape is at a decisive inflection point. AI, flexible robotics and digital ecosystems are converging into a new operational model – one that is more efficient, more sustainable and more intellectually rewarding for laboratory personnel. The fully autonomous lab is no longer a distant vision; it is taking shape, step by step, in real industrial environments such as at BASF analytical labs in Ludwigshafen.

The remaining challenge is not technological feasibility – it is organisational readiness. Companies that embrace these developments proactively will secure a strong competitive advantage in innovation, speed and quality. Those who hesitate may fall behind in a field evolving faster than ever. If you're curious about what comes next and would like to get in touch, I warmly invite you to join me at the analytica 2026 poster session for my presentation: "Fully autonomous analytical lab of the future – implementation at BASF Ludwigshafen".

Footnotes

1) M. Legelli, M. Vranceanu, M. Wirtz, S. Lamotte, Sustainability in motion: Investigation of automated gravimetric sample preparation in industrial liquid chromatography, Green Anal. Chem. 13 (2025) 100279.

2) M. Vranceanu, et al. (2026). Vorrichtung und Verfahren zur Dosierung feinteiliger Feststoffe. PCT/EP2025/073455. World Intellectual Property Organization

3) M. Vranceanu, et al. (2025). Löffel für eine Vorrichtung zur Dosierung feinteiliger Feststoffe. DE 20 2025 104 781 U1. German Patent and Trademark Office

4) M. Vranceanu, et al. (2026). Dosiervorrichtung für feinteilige Feststoffe. DE 102025109228.1. German Patent and Trademark Office

5) M. Vranceanu, et al. (2021). AI-System for Flow Chemistry. WO 2021/239716 A1. World Intellectual Property Organization.

6) J.P. Dürholt, et al., BoFire: Bayesian Optimization Framework Intended for Real Experiments, Journal of Machine Learning Research 26 (2025) 1-7.

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The special show Digital Transformation 2026 – welcome to the future of the laboratory

In the special show Digital Transformation at analytica 2026, visitors will learn how modern digital solutions are already changing laboratory processes in a sustainable way. In an interactive area, software, hardware and automation solutions from 18 manufacturers will be seamlessly networked with each other – based on open standards such as OPC UA LADS as a cross-manufacturer device standard.

The focus is on five practical use cases that show how robotics, sensor technology, laboratory equipment, software, AI and data platforms interact in modular, realistic laboratory processes. The main areas of focus are robotics & automation, connectivity & system integration, and AI & data analytics. Standardised interfaces demonstrate how consistent communication and flexible integration can be achieved in the laboratory.

Interactive exhibits and hands-on workflows make digitalisation tangible – from traceable sample paths and networked material flows to AI-supported data evaluation. The special show dispels the myth of the 'deserted laboratory': The focus is on hybrid concepts that relieve the burden on skilled workers, automate routine tasks and at the same time leave room for complex manual activities.

The message is clear: digital transformation in the laboratory is no longer a vision of the future, but a reality that can be implemented – made possible by open standards, scalable solutions and intelligent automation. Anyone who wants to experience how networking is redefining the laboratory will find the right answers here.

Visit the special show Digital Transformation – Hall B2.331

https://analytica.de/de/muenchen/programm/sonderschauen-events/digital-transformation-labor-4-0/

Application examples of robotics in laboratory

A portal to another world – automated cell engineering in drug discovery

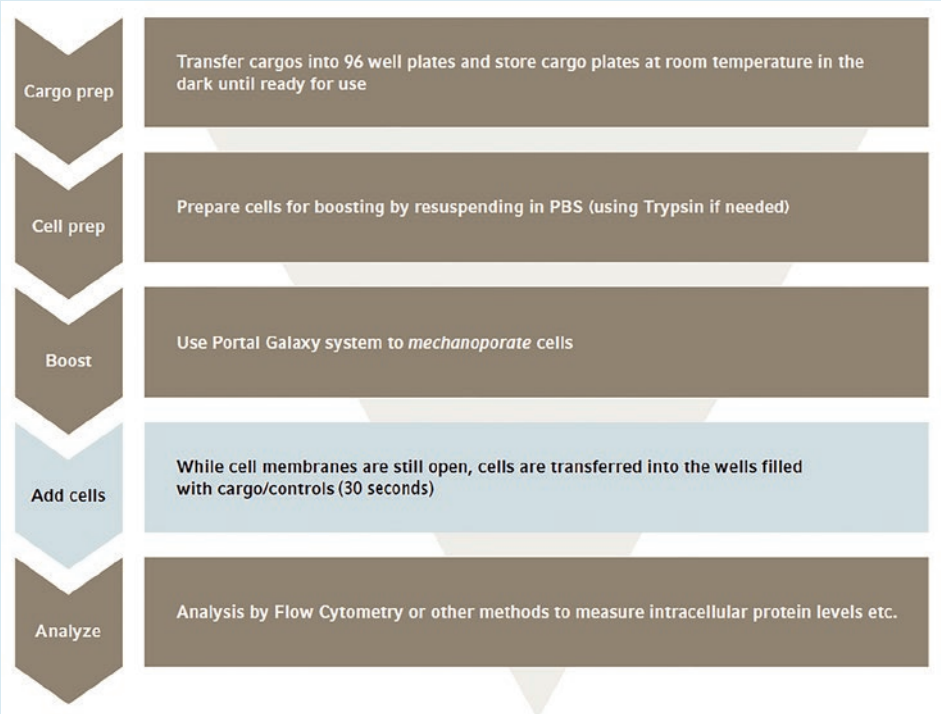
Delivering biomolecules into cells is a paramount challenge in cell engineering and drug discovery. Mechanoporation tackles this need, enabling hitherto hard-to-deliver cargos with high efficiency and cell viability – all the while unlocking scalable, high-throughput workflows.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

The described solution combines the Portal® Galaxy mechanoporation system with the Eppendorf epMotion automated liquid handling platform to enable delivery of diverse molecular cargos – including CRISPR RNPs, mRNA, oligonucleotides, antibodies and small molecules – into mammalian cells such as sensitive primary cells and adherent cell lines.

The method addresses a critical bottleneck in drug discovery and cell engineering: the efficient, scalable and gentle delivery of diverse molecular cargos into living cells. Traditional methods such as electroporation often compromise cell viability, are difficult to automate and lack flexibility for multiplexed (e.g. multi-cargo) delivery.

The described solution achieves up to 95% delivery efficiency for a wide range of cargos, ensuring effective and reproducible results.The combination with the epMotion platform enables automated, parallel processing of multiple samples, significantly reducing manual labour and user error. The system supports the co-delivery of various cargo types to different cell lines, including both primary and engineered cells, making it highly versatile. Its scalability makes it ideal for high-throughput screen-



Schematic overview of the mechanoporation of HeLa cells using the Portal Galaxy system and the Eppendorf epMotion (step performed on the epMotion liquid handler)

The Portal Galaxy System and Eppendorf's epMotion 5073

©Eppendorf SE

The Portal Galaxy system integrated in the Eppendorf epMotion 5073

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ing and drug discovery pipelines, allowing for rapid iteration and data generation. Importantly, mechanoporation preserves cell viability and function, which is essential for downstream applications.

The increasing demand for robust, scalable and flexible cell engineering workflows in drug discovery, cell therapy development and advanced cell analytics leads to accelerated R&D timelines, reduces costs and enables the delivery of complex molecular cargos to a variety of cell types.This makes the presented solution highly attractive for both academic and industrial laboratories. The ability to automate and multiplex delivery steps is particularly valuable for screening applications and the development of next-generation therapeutics.

EFFICIENCY ADVANTAGES

The solution boosts efficiency at all workflow stages, achieving up to 95% delivery efficiency for diverse cargos with high reproducibility. Automation with epMotion enables parallel sample processing, reducing hands-on time and manual labour. Its flexibility supports delivery of various cargos to different cell types, streamlining complex experiments. Scalable for screening and drug discovery, mechanoporation also preserves cell viability, ensuring reliable results for downstream applications.

TECHNOLOGICAL DESCRIPTION

The described method combines mechanoporation using the Portal Galaxy system with automated liquid handling via the Eppendorf epMotion platform to enable high-throughput intracellular delivery. Mechanoporation is achieved by passing cells through microfluidic channels in the Portal Galaxy device, where controlled mechanical forces transiently disrupt the cell membrane, allowing efficient uptake of cargos such as CRISPR RNPs, mRNA, oligonucleotides, proteins and small molecules. Immediately after mechanoporation, the epMotion system automates the transfer of permeabilised cells into 96-well plates preloaded with cargo, supporting parallel processing and precise sample tracking. This integration enables co-delivery of multiple cargo types into various cell lines, including primary and engineered cells, with delivery efficiencies up to 95%. The workflow is fully compatible with downstream analytical techniques such as flow cytometry and cell-based assays. Mechanoporation preserves cell viability and function, making the approach suitable for demanding cell engineering and screening applications.

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Automated sampler, robotics and data analysis – seamless workflows for food contaminant analysis, e.g., mineral oil residues (MOSH/MOAH)

The aim is to design consistent workflows for chromatographic analyses, for example, of mineral oil residues. The approach combines reduced complexity with flexible automation, from sample loading for chromatography through to specific data evaluation.

Components of the workflow for analysis of mineral oil contaminants (MOSH/MOAH) in food samples.

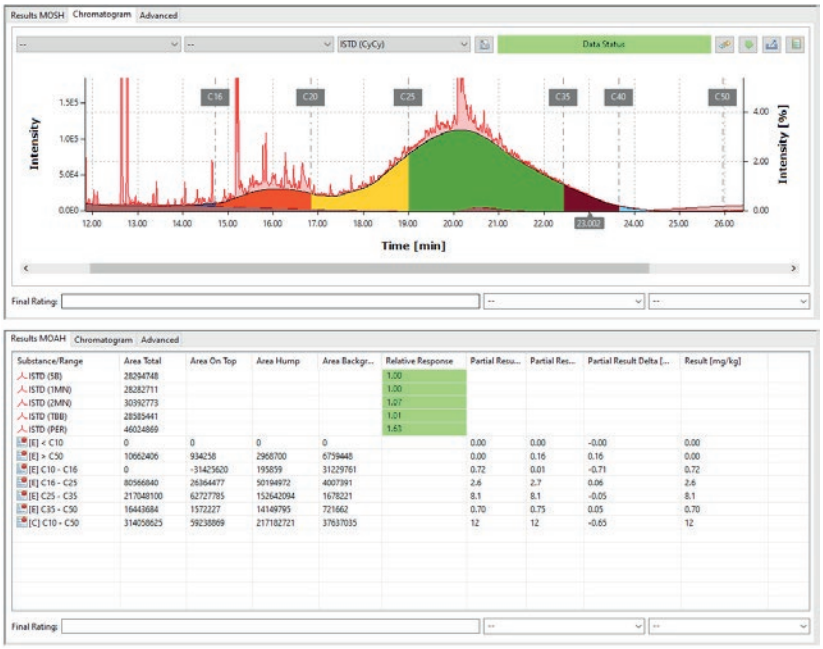
Detailed scheme of the epoxidation step of the workflow for analysis of mineral oil contaminants (MOSH/MOAH) in food samples.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

Integrated solutions for laboratory analysis are typically either developed for specific methods or rely on complex system couplings. Methods for analysing food contaminants often require adjustments depending on the type of sample. This solution therefore employs flexible automation, covering the entire workflow – from sample preparation and chromatography to data evaluation.

The technical basis is a sample injector equipped with one or two tools for handling liquids and transporting objects such as vials or cartridges. Its key feature is reduced complexity combined with broad configurability for a wide range of applications. The sample robot can also inject samples directly into an analysis system, ensuring seamless information transfer through to data evaluation.

One example workflow is the determination of mineral oil residues in food samples (MOSH/MOAH), including automated sample preparation steps such as saponification, epoxidation and purification. While each individual component of this workflow is state-of-the-art, mapping the overall workflow has traditionally been fragmented. This is particularly true because the process required to evaluate MOSH/MOAH data cannot easily be standard-



Specific data analysis for analysis of mineral oil contaminants (MOSH/MOAH) in food samples.
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ised using conventional chromatography data systems, so it must be done manually. Experience shows that user-dependent procedures can lead to non-reproducible results. In the present solution, the special integration of chromatography data evaluation into the workflow was achieved in collaboration with Dr Philip Wenig (Lablicate).

A general obstacle to the integration of automation components is the low prevalence of standardised interfaces. Variations in food samples still necessitate a wide range of manual inspections and decisions based on sample appearance. To increase process reliability, future developments could focus on advanced process sensor technology combined with machine learning.

EFFICIENCY ADVANTAGES

The MOSH/MOAH process saves a significant amount of time: results are available earlier and with less effort, especially for reviewing data. The algorithm-based, autonomous process greatly simplifies evaluation. The combination of robotics, chromatography and automated data analysis improves the quality of results. Uniform sample handling and consistent throughput times from first touching the sample to data analysis improve reproducibility and comparability and enable higher throughput.

TECHNOLOGICAL DESCRIPTION

The MOSH/MOAH Analysis Solution performs fully automated sample preparation and sample introduction for efficient determination of mineral oil residues in extracts of food, packaging, etc. The system is based on an online-coupled HPLC-GC/FID system using the GERSTEL Multi-Purpose Sampler (MPS) for automated sample preparation and introduction. Two fractions result from the initial LC step: mineral oil saturated hydrocarbons (MOSH) and mineral oil aromatic hydrocarbons (MOAH). These fractions are subsequently transferred to two separate GC columns in a combined dual-channel GC system. The solution meets the requirements of ISO 20122, DIN 16995 and the JRC Guideline Standard.

The MOSH/MOAH Sample Prep Solution can be extended to perform additional widely used sample preparation steps: epoxidation to remove interfering naturally occurring olefins, AlOx clean-up to retain and remove long-chain n-alkanes of plant origin or saponification/alkaline digestion to clean up very fatty or protein-rich samples and concentrate the extract for a lower LOD/LOQ.

The entire workflow is processed under one integrated user interface, and one data file is created for the full analysis. For data analysis, dedicated algorithms were developed specifically for hump and peak detection.

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https://www.gerstel.com/de/maerkte-loesungen/loesungen/MOSH-MOAH

End-to-end robotics system for wet chemical analysis

The robotics system automates wet chemical analyses using gravimetry and titration combined with sample handling, dosing and device integration, ensuring high efficiency, reproducibility and audit-proof documentation.

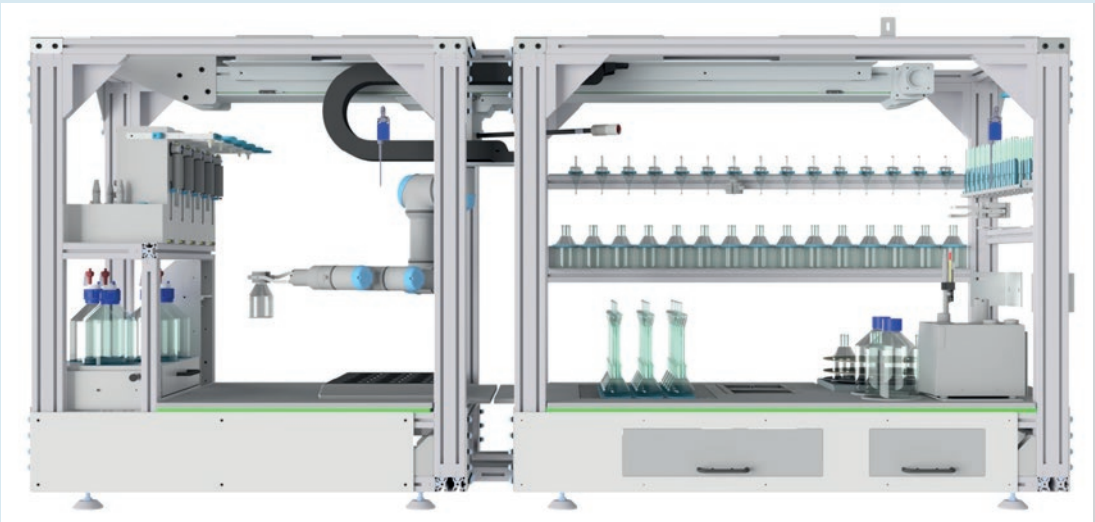
AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

The product focuses on the development of a robotised laboratory system for the end-to-end automation of wet chemical analyses. The system is designed to relieve manual, error-prone work steps of high-frequency analyses for key figure collection and to transfer them to a reproducible, end-to-end digital and scalable workflow.

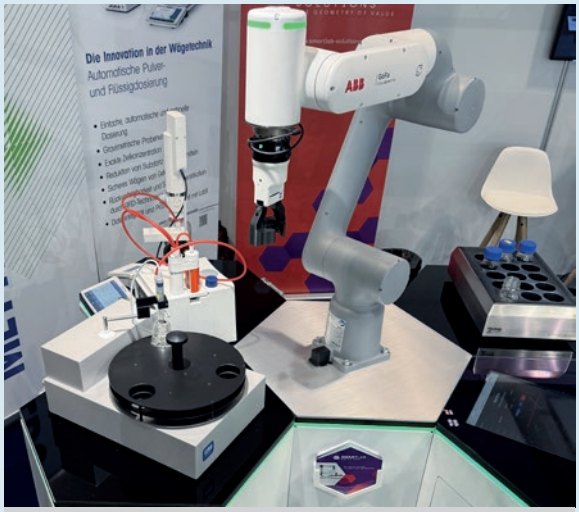
The aim was to establish a stable, digitally controlled and reproducible workflow in gravimetric analysis, particularly for titrations. The focus is on determining hydroxyl and acid values as key parameters for chemical product characterisation, the determination of which currently requires a high level of manual effort and involves a large number of repetitive work steps. The system combines a cobot with networked laboratory equipment and a powerful software architecture. Samples are uniquely identified by barcode and guided through the analysis process fully automatically. Balances, titration systems and other devices are integrated via standardised interfaces into a Laboratory Execution System (LES), which is connected bidirectionally to the LIMS. This creates a fully digital process with complete traceability of all user actions and device data.

Accompanying the planning of the system, alternative vessel designs and reduced volumes were tested, existing devices were checked for interface compatibility, and analysis devices from different suppliers were integrated into the system architecture.

The result is a modular, scalable laboratory system in which robotics, analytics and software merge into a continuous wet chemical workflow, creating a new level of efficiency, data integrity and operator relief.



Fully automated sample preparation. Cobot-guided sample digestion under a laboratory fume cupboard with glass flask, riser tube and condensation bulb
©SmartLab Solutions GmbH



Cobot-assisted sample preparation for automated titration using the modular iHEX system.
©SmartLab Solutions GmbH

LADS) into a Laboratory Execution System (LES) that is connected bidirectionally to the LIMS. The system maps guided, parameterisable workflows and replaces visual operator decisions with defined process criteria and sensor technology. All user interactions and device data are recorded in an audit-proof manner, enabling complete audit trail documentation. Thanks to alternative vessel concepts, reduced volumes and software-supported process control, the system is designed for high throughput, reproducibility and sustainable operation and represents a scalable reference architecture for the automation of complex wet chemical laboratory processes. The system is installed in a standard laboratory fume cupboard and also increases occupational safety by reducing operator exposure.

EFFICIENCY ADVANTAGES

A significant added value of the system lies in the targeted redesign of previously critical manual steps for robotised operation. These include the precise weighing of a wide variety of sample matrices, reproducible sample dissolution without visual operator decisions and the automated handling of glass vessels and reflux coolers, including rinsing and disassembly processes. Employee exposure to chemicals is also minimised, which leads to increased occupational safety.

The solution can also be adapted for other applications. The modular iHEX system consists of hexagonal elements that can be flexibly combined. This creates a dynamic laboratory workstation that can utilise the full potential of the existing infrastructure and be easily adapted to new processes.

Automated high-throughput titration: handling of delicate glassware using a cobot system.
©SmartLab Solutions GmbH

TECHNOLOGICAL DESCRIPTION

The system is designed as a modular, robotised platform for the end-to-end automation of wet chemical analyses, with a focus on gravimetric determinations and titration for hydroxyl and acid number determination. A central handling system takes care of sample logistics, the precise weighing of heterogeneous sample matrices, the dosing of reagents and the automated handling of glass vessels and reflux coolers, including rinsing and dismantling processes. All analytical devices such as balances, titrators and peripherals are integrated via standardised interfaces (e.g. OPC UA

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M.Sc. Ulrike Gerecke
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Lab 4.0 Balance – connected, compliant and ready to integrate

The Sartorius Cubis® II analytical balance features built-in connectivity for seamless, direct integration with LIMS, MES and SCADA systems, while automating complex weighing workflows with lightweight, easy-to-qualify apps.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

Pharmaceutical manufacturing, research and quality control laboratories are undergoing a fundamental transformation towards Lab 4.0 – digitally networked environments where instruments, execution systems and data platforms communicate in real time. Within this architecture, the analytical balance has historically represented one of the most persistent weak points in the laboratory data chain. Most balances still rely on manual data entry, paper printouts or middleware software to transfer weighing data into LIMS, MES or ERP systems — each step introducing transcription risk, data integrity gaps and additional validation burden.

For a balance to function as a genuine node in a digital laboratory infrastructure, connectivity cannot be an afterthought. The instrument must support the communication protocols already in use across the laboratory environment, rather than requiring a dedicated middleware layer to bridge the gap.

OPC UA — the open, machine-to-machine communication standard increasingly adopted across pharmaceutical manufacturing and process automation — enables any compatible client to subscribe to live instrument data, read status information and trigger measurement sequences without driver installation, dedicated PCs or middleware servers. Laboratories whose systems communicate over standard HTTP can alternatively use REST APIs for lightweight, direct integration with modern LIMS platforms. Direct file-based transfer addresses environments where data consumption from shared network

locations is already established. At the network level, LDAP centralises user authentication against existing directory services, while NTP synchronises timestamps across the instrument fleet — a prerequisite for consistent, traceable audit trails.

The Sartorius Cubis® II implements this full protocol stack natively, at the instrument level. For example, integration of a Cubis® II balance into a Biotech MES system was recently achieved thanks to the embedded OPC UA server acting as a “plug-and-play” interface. Consequently, validation of the connection was completed using standardised documentation, requiring no custom engineering effort.

Achieving 21 CFR Part 11 and EU Annex 11 compliance at the balance typically involves a fundamental architectural choice: deploy a centralised management platform — with the associated server infrastructure, software validation, licence costs and revalidation cycles — or accept the compliance risk of paper-based records and manual data handling.

A third approach embeds all required technical controls directly in the instrument's control unit: user authentication with role-based access, electronic signatures and a tamper-evident audit trail. Compliance is generated at the point of measurement, independently of any external software qualification. The validation scope is contained to the instrument itself, and adding further balances to the laboratory network does not expand the compliance infrastructure.

Beyond regulatory compliance, this embedded architecture also changes the cybersecurity profile. Server-dependent platforms introduce a general-purpose software stack requiring regular OS patching, vulnerability monitoring and IT lifecycle management — each representing overhead and potential requalification triggers. In contrast, running compliance logic within hardened, embedded firmware eliminates the OS patch cycle entirely. By removing the application server and limiting network exposure, this approach aligns closely with IEC 62443 security zone principles, offering a significantly smaller attack surface. The Cubis® II natively operates on this secure, embedded model.

As laboratories face growing pressure to do more with fewer resources — skilled personnel are increasingly difficult to recruit and retain, while regulatory requirements continue to rise — the standardisation of analytical workflows directly at the instrument level is becoming operationally relevant.

One mechanism for achieving this is application-level guidance embedded in the balance terminal itself. Rather than relying on the operator to follow external SOPs, the instrument guides the user through a defined procedure, enforcing acceptance criteria automatically and flagging deviations immediately. On the Cubis II, this is implemented through QApps: small, pre-qualified applications running directly on the balance.

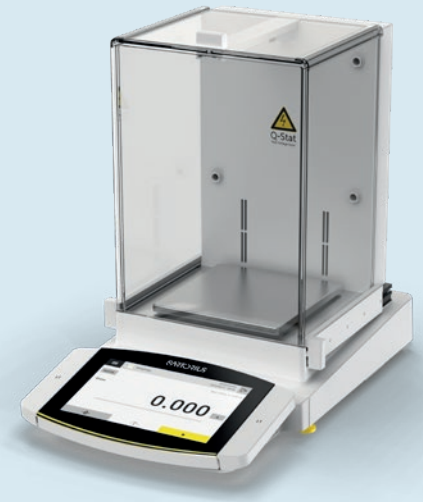
A example of this instrument-driven automation in a compliant way is the Sartorius Linkit® AX, a semi-automated aliquoting solution for bioprocessing. Rather than investing in expensive, fully automated filling lines, facilities can use the Cubis® II as the intelligent control unit. Paired with a dedicated QApp, the balance directly controls a peristaltic pump to fill up to ten single-use bags simultaneously. In a recent cell and gene therapy application, transitioning from manual manifold filling to this balance-controlled process reduced the preparation time for growth media from two full days to approximately four hours. Because the balance actively regulates the pump speed — including capacity ramp-down and reverse runs — and automatically generates 21 CFR Part 11-compliant batch records, the process becomes highly repeatable and fully traceable.

EFFICIENCY ADVANTAGES

The balance automates workflows and eliminates transcription errors by enforcing SOPs directly at the instrument. Cubis® significantly reduces integration effort and costs: native, standadised interfaces replace complex middleware and custom drivers, while drastically lowering ongoing IT overhead and deployment timelines.

TECHNOLOGICAL DESCRIPTION

The Cubis® II functions as an autonomous Lab 4.0 edge device. Built on hardened firmware without a general-purpose OS, it embeds native OPC UA and REST APIs for direct, 21 CFR Part 11-compliant MES/LIMS integration. Utilising pre-qualified QApps, the unit acts as a decentralised controller driving external peripherals (e.g., pumps) and can reliably automate weighing workflows.



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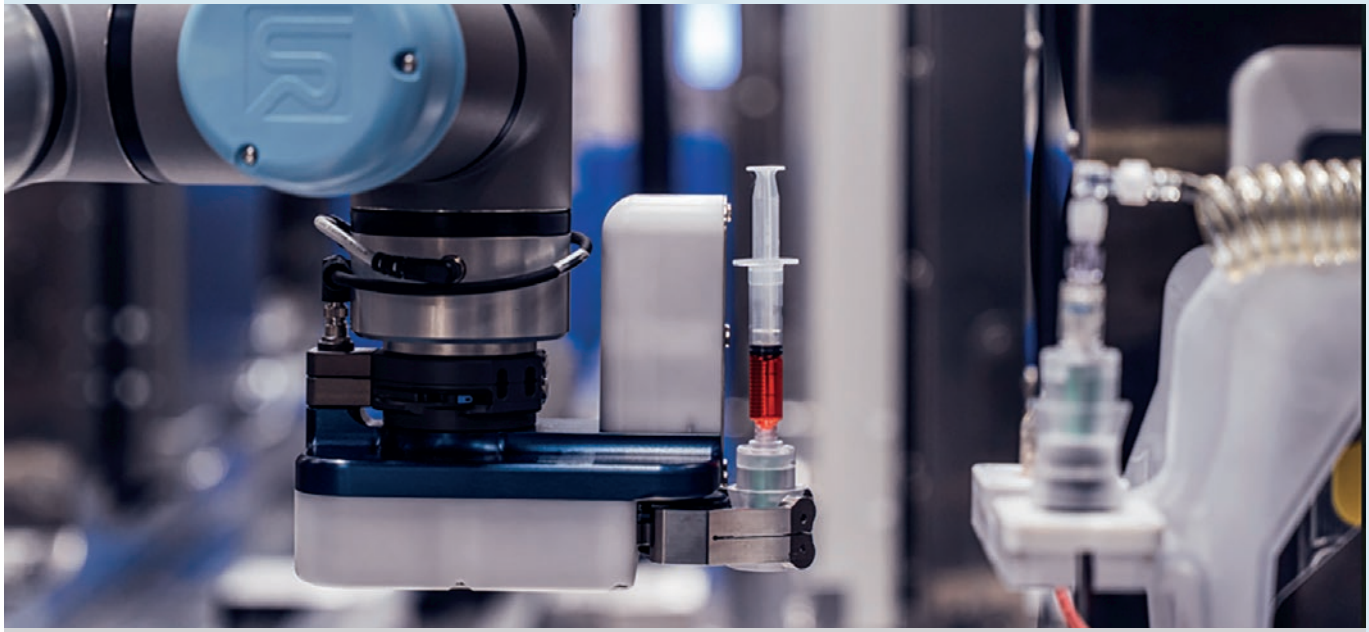
Scalable automation of personalised cell therapies through robotic biomanufacturing

Personalised cell and gene therapies rely on highly manual manufacturing processes that are difficult to scale and reproduce. Multiply Labs has developed a robotic biomanufacturing system for automated cell therapy production.



Multiply Labs embodies a philosophy of "robots for the greater good," building automation with Universal Robots that not only improves processes but directly helps people by making critical therapies more accessible and affordable.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

Personalised cell and gene therapies are highly individualised treatment approaches in which each dose is manufactured from a patient's own cells. As a result, conventional large-batch production is not feasible. Manufacturing therefore involves numerous precise manual handling steps under cleanroom conditions, leading to high labour requirements, limited reproducibility and challenges in scaling production.

To address these limitations, Multiply Labs has developed a robotic biomanufacturing system for automated cell therapy production. The objective is to standardise established manufacturing processes, improve reproducibility and enable scalable production under sterile conditions while remaining compatible with existing GMP requirements.

The solution is based on a modular robotic cluster in which multiple collaborative robots operate in parallel. The robots perform tasks such as pipetting, cell cultiva-

tion and sample handling using existing laboratory equipment and established protocols. Motion sequences are trained using recorded demonstrations of manual expert workflows and are subsequently executed autonomously.

Development of the system was carried out in collaboration with the robotics manufacturer Universal Robots as well as scientific institutions including Stanford University and the University of California, San Francisco. The system is already being used by industrial stakeholders in the field of cell and gene therapy and is being further scaled. Drivers for adoption include the growing demand for personalised therapies and increasing efficiency requirements, while regulatory frameworks influence implementation.

EFFICIENCY ADVANTAGES

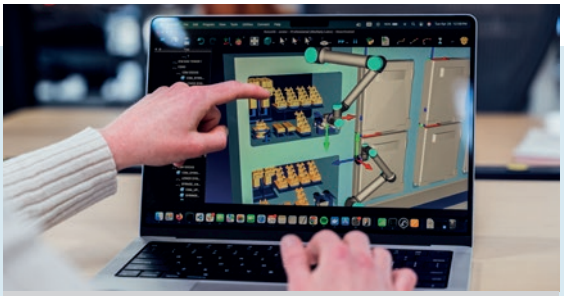
Automating manual manufacturing steps significantly reduces labour requirements while improving process reproducibility. Parallel robotic operation and vertical system architecture increase throughput per cleanroom area and improve utilisation of available space. Comparative studies demonstrated cost reductions of approximately 70% compared to manual processes. In addition, a substantially higher number of patient-specific doses can be produced per square foot of cleanroom area while maintaining consistent process quality.

TECHNOLOGICAL DESCRIPTION

The robotic biomanufacturing system consists of multiple collaborative six-axis robots with sub-millimeter repeatability and integrated force sensing for precise handling of sensitive biological materials. Additional linear axes extend the robots' working range and enable a vertically stacked, modular cluster architecture that supports parallel processing steps.

The system operates using existing laboratory instruments and established manufacturing protocols, facilitating transferability to GMP-compliant processes and minimising regulatory adaptation efforts. Robot control is implemented via open, standardised interfaces, including script-based APIs and industrial communication protocols, enabling seamless integration into existing automation and IT infrastructures.

Robot training is based on imitation learning, in which recorded human expert workflows are translated into reproducible, autonomous motion sequences.



Universal Robots is seamlessly compatible with a wide range of software and simulation tools such as the RoboDK simulation software.

©Universal Robots

One of the features Multiply Labs evaluated was the UR cobots' sub-milimeter repeatability.

©Universal Robots

UR cobots are compact and agile, capable of mounting upside down and performing large motions while ending up in "precisely the right spot". Their lightweight nature allows for quick changeouts (e.g., 20 minutes to swap a robot out of a machine), which is impossible with traditional, heavy industrial robots.

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https://www.universal-robots.com/case-stories/multiply-labs/

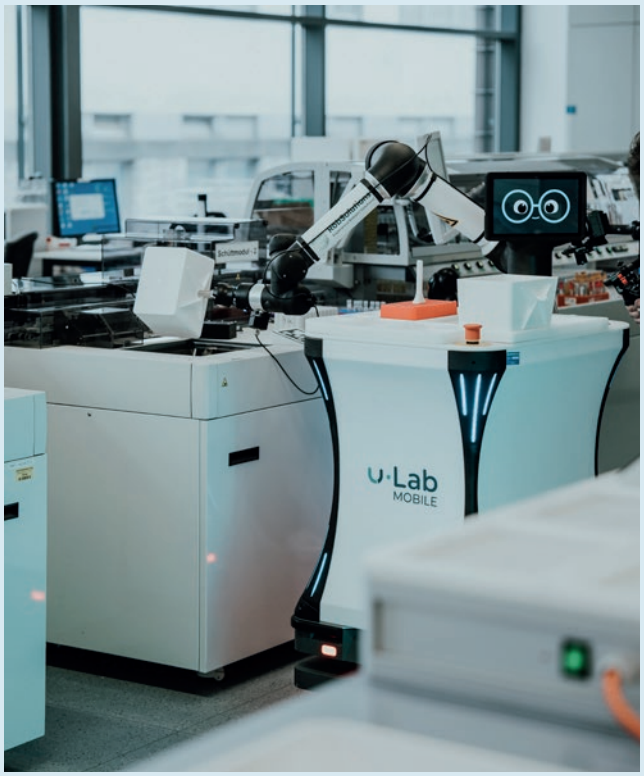
uLab Mobile: from isolated automation solutions to networked laboratory processes

uLab Mobile is an autonomous, mobile robot for automating central laboratory processes such as sample handling, device loading and transport. It integrates into existing laboratory environments and relieves specialist staff in 24/7 operation.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

uLab Mobile addresses a key challenge facing clinical and diagnostic laboratories: increasing sample numbers coupled with a shortage of skilled workers and limited human resources. Traditional automation concepts reach their limits, particularly in laboratories with complex spatial structures, heterogeneous equipment landscapes and highly fluctuating workloads.

As a mobile automation solution, uLab Mobile complements existing laboratory processes without fundamentally changing them. The robot takes over recurring process and transport tasks along the sample flow, such as loading and unloading laboratory equipment, internal sample transport or selected preparation and follow-up steps. The connection to the laboratory information system (LIMS) ensures that procedures, priorities and documentation remain embedded in the existing control processes.



uLab Mobile is developed and offered by the United Robotics Group. It is being introduced gradually and in close consultation with the respective laboratory operators and their IT and process managers. This allows automation to be implemented where it delivers the greatest benefits in ongoing operations.

In many laboratories today, transport and routine activities take up a considerable amount of qualified working time. uLab Mobile shifts these tasks to an autonomous system, freeing up time for more technically demanding activities. Processes become more stable, walking distances are reduced and throughput times become easier to plan.

The United Robotics Group's robotics solutions are already in use in over 50 laboratories. They demonstrate that flexible, mobile automation is not intended to replace existing systems, but rather to serve as a connecting element between devices, processes and people. In the future, this approach will become particularly important in centralised and highly automated diagnostic structures, as it combines efficiency, scalability and adaptability.

EFFICIENCY ADVANTAGES

By automating sample handling, device operation and transport, uLab Mobile significantly reduces manual work steps and running times. Laboratory staff are relieved of repetitive tasks and can concentrate more on skilled work. At the same time, error rates are reduced, throughput times are stabilised and 24/7 operation is supported more efficiently.

TECHNOLOGICAL DESCRIPTION

uLab Mobile is designed as an autonomous, mobile robot system for use in regulated clinical laboratory environments. The platform combines safe human-robot interaction with modular hardware units for sample and material handling and the operation of selected laboratory equipment. Autonomous navigation enables operation in existing laboratory structures, including interaction with automatic doors and lifts.

The system uses integrated sensors, camera systems and barcode readers to identify and track samples. Software-based control allows different laboratory processes to be mapped and workflows to be adapted to local requirements. uLab Mobile is connected directly to existing laboratory information systems (LIS/LIMS) via standardised interfaces, allowing order data, status information and priorities to be transferred.

Processes are configured via a graphical user interface that allows adjustments to be made without in-depth programming knowledge. Security, data protection and compliance requirements are an integral part of the system design and are designed for continuous operation in clinical laboratory environments.

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Laboratory automation robotic cell by ABB Robotics & METTLER TOLEDO

Pre-engineered robotic lab cell integrating ABB robots with METTLER TOLEDO LabX™ software and instruments to automate sample preparation and instrument tending, enabling standardised and traceable quality control and R&D workflows.

ABB Robotics and METTLER TOLEDO provide a ready-to-use robotic laboratory solution that automates sample handling and instrument interaction for faster, more reliable workflows.

©ABB Robotics

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

ABB Robotics and METTLER TOLEDO are working together to bring robotics, laboratory automation and digital data management into a single, ready-to-use solution for modern laboratories. The solution combines ABB's collaborative GoFa™ robots powered by the OmniCore™ controller platform with METTLER TOLEDO laboratory instruments, all connected through LabX™ management software. OmniCore provides precise, high performance robot control and advanced connectivity, enabling cobots to perform tasks such as transferring samples between workflow steps. LabX coordinates the entire laboratory workflow – from sample preparation and instrument operation to secure data recording – ensuring consistent, traceable methods. Its modular design allows new devices or workflow steps to be added easily, adapting the system to changing laboratory requirements. Standardised interfaces and continuous robot operation reduce complexity and simplify setup.

The automated solution is designed for quality control and R&D laboratories in industries such as pharmaceuticals, chemicals, food and beverage, semiconductors and battery production. It supports research, testing and routine lab work where speed, data reliability and full traceability are essential, while helping labs cope with labour shortages and faster development cycles.

By taking over repetitive or physically demanding tasks, the robotic system improves efficiency and safety and allows lab staff to focus on more meaningful work. Automation reduces errors and variation, delivering consistent, high-quality results. LabX documents every step of the process, supporting compliance and confidence

The automated laboratory solution takes over routine tasks, improves data quality and allows lab staff to focus on higher value research and analysis tasks.

©ABB Robotics

Powered by the ABB OmniCore™ controller platform, ABB robots and METTLER TOLEDO instruments work seamlessly together through LabX™ management software to enable flexible and traceable laboratory automation.

©ABB Robotics

in the data, while OmniCore ensures precise, scalable and reliable robotic performance. A typical use case is the automated preparation and handling of samples for analytical testing, delivering reproducible results across laboratories and locations.

EFFICIENCY ADVANTAGES

The automated solution helps laboratories work up to 30 percent faster while reducing errors and manual work. Seamless integration of ABB robots and METTLER TOLEDO software enables smooth, digital workflows that are easy to use and require less specialised automation expertise. Processes become more efficient and safer, delivering reliable and traceable results. By automating routine tasks, the system allows R&D and quality control teams to focus on more valuable work. Its modular architecture enables future scalability, supported by global service capabilities to ensure reliable operation.

TECHNOLOGICAL DESCRIPTION

The solution implements a layered automation architecture combining an ABB 6-axis collaborative GoFa™ robot with an ABB OmniCore™ controller platform and METTLER TOLEDO's LabX™ software. LabX acts as the supervisory orchestration layer, sequencing automated laboratory workflows and managing method logic, instrument commands, metadata and audit trails for connected METTLER TOLEDO instruments. The OmniCore controller executes real-time robot motion and controls low-level interfaces to peripheral devices such as grippers, labellers and other auxiliary equipment, ensuring deterministic and precise task execution. Communication between LabX and the robot controller synchronises workflow logic with physical actions.

An optional automatic gripper-change station enables dynamic tool switching based on consumables or task requirements, allowing a single robotic cell to handle heterogeneous samples and multi-step processes without manual reconfiguration. The modular, interface-based design supports extension with additional devices and skills while maintaining a standardised control concept, enabling scalable and adaptable laboratory automation with clear separation between orchestration, instrument control and motion execution.

Access the new ABB Robotics white paper for an overview of limiting factors in laboratory automation and strategies to address them:

https://search.abb.com/library/Download.aspx?DocumentID=9AKK108472A1826&LanguageCode=en&Doc%E2%80%A6

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https://www.abb.com/global/en/areas/robotics/applications/lab-automation

Automated eluent preparation (Flex EP)

Automate mobile phase preparation with Flex EP.
Eluents are prepared into standard 0.5, 1 or 2 L glass bottles, with organic or aqueous solvents, solid reagents and fully automated pH measurement and adjustment. All preparation steps are digitally documented, providing a complete audit trail. Tools, processes and software are designed to support compliance with GMP requirements and FDA 21 CFR Part 11.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

The Flex EP system automates eluent preparation for HPLC applications. Eluents are prepared directly in standard glass bottles. Up to 16 different eluents can be produced per run, with a total daily throughput of approximately 60-120 L, depending on configuration and complexity of the recipes. Automation replaces manual preparation steps, reduces variability in routine operations and method transfers and enables consistent digital documentation of all processes.

Eluent can be prepared using DI water or organic solvents as base solvents. Solids and additives are dispensed according to predefined recipes, followed by automated pH measurement and adjustment.

System start-up includes integrated tool checks, such as balance verification and pH electrode calibration, to ensure defined operating conditions prior to execution.

Flex EP can be used across different phases of the analytical method life cycle:

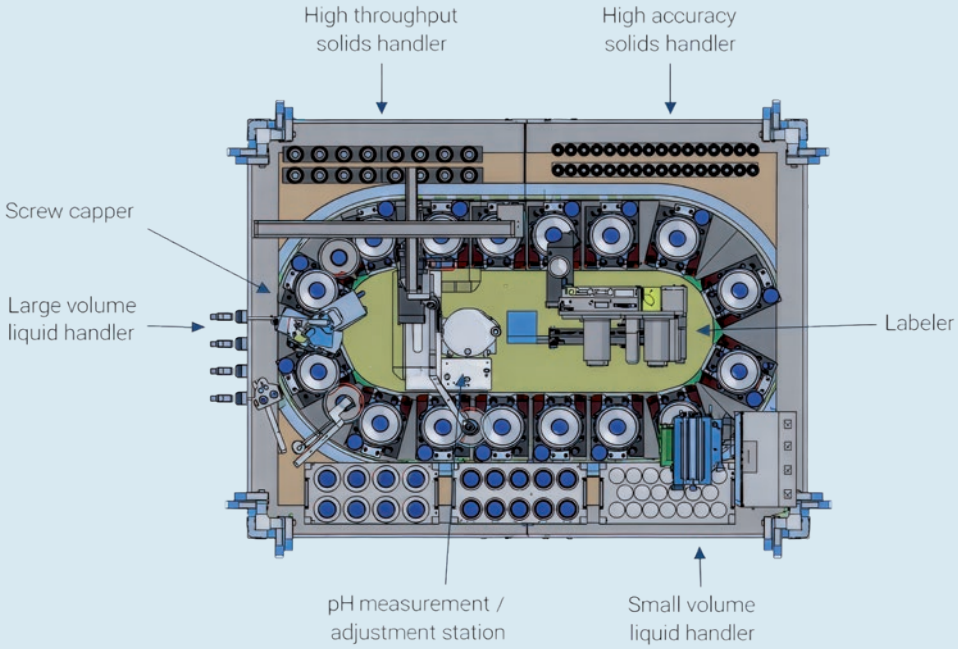
- In R&D and method development as well as in routine QC applications, using the same approved and released methods.
- Across different laboratory sites, supporting consistent implementation of preparation recipes.
- Between pharmaceutical companies and external partners such as CDMOs or CROs, facilitating method transfer.

Available extensions for Flex EP include:

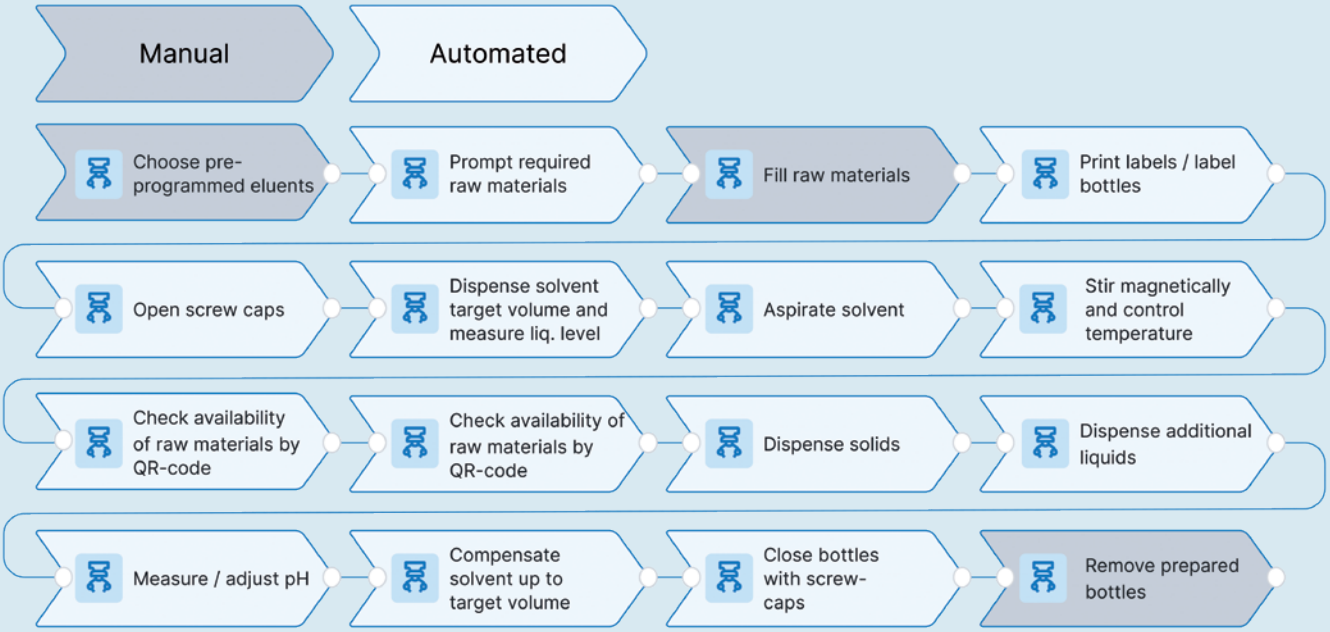
- Automated loading and unloading of eluent bottles;
- Automated filtration of prepared solutions;
- Conductivity measurement;
- Integration with mobile robotic systems.

EFFICIENCY ADVANTAGES

Typical operation requires approximately 0.25 full-time equivalents (FTE) for system setup and unloading of prepared eluents.Depending on the recipe, full eluent cycle time, including documentation, can be reduced 5-10 times compared to manual processes.



TECHNOLOGICAL DESCRIPTION



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https://www.chemspeed.com/example-solutions/flex-ep/

Software-driven automation of pre- and post-analytical workflows for PCR-based diagnostics

A robotic system automates pre- and post-analytical workflows in PCR-based viral diagnostics, combining vision guided handling with a middleware layer that synchronises devices and ensures reproducible process execution.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

To eliminate tedious manual handling and ensure robust performance, this setup automates the critical pre- and post-analytical stages of PCR-based viral diagnostics. The system integrates a robotic platform for tube handling – covering tasks such as barcode detection, swab removal, contamination inspection and rack loading – with vision modules and modular robot skills implemented through ROS (Robot Operating System). A middleware layer based on the zenLAB® framework coordinates these distributed components, exchanges process states and ensures traceable execution across all devices.

The solution was developed jointly by the Chair of Manufacturing Automation and Production Systems at Friedrich-Alexander-Universität Erlangen Nürnberg, Yaskawa Europe GmbH as the robotics partner and infoteam Software AG, which provides the middleware and system integration. Additional clinical partners contributed domain requirements, supported evaluation activities and the Transfusion Medicine Department at the University Hospital Erlangen implemented the system in daily practice, testing the automated workflows under real laboratory conditions.

Before automation, sample preparation steps were largely manual, time-consuming and dependent on operator precision, particularly tasks such as tube opening, organisation and inspection. This limited throughput and increased variability. The automated workflow standardises these steps, reduces the workload for laboratory personnel and improves reproducibility and traceability.

The approach is currently used in research and demonstration environments and illustrates how modular automation can be transferred to various diagnostic workflows involving repetitive sample handling. Increas-

Symbolic image: robotic arm performing vision guided handling of sample tubes as part of an automated pre- and post-analytical workflow in PCR-based diagnostics.

ing requirements for interoperability, digital documentation and reliable throughput act as strong drivers, while integration complexity and laboratory-specific constraints may slow broader adoption. Ongoing work focuses on extending device integration, enhancing vision-based inspection and refining modular robot skills to support additional analytical workflows.

EFFICIENCY ADVANTAGES

The automated workflow significantly reduces manual handling and accelerates pre- and post-analytical steps. Vision-guided routines lower error rates, while standardised robotic actions ensure consistent sample preparation. By coordinating devices through a central middleware, laboratories achieve higher throughput, more reliable documentation and better utilisation of personnel, ultimately reducing time, cost and variability in routine diagnostic workflows.

TECHNOLOGICAL DESCRIPTION

The solution automates pre- and post-analytical PCR workflows by combining an ROS-based robotic cell, a modular vision stack and a device agnostic middleware built on the zenLAB® framework. This layer coordinates process states, device communication and data capture across sub-systems. Robotic skills for tube pick and place, lid handling, swab extraction and rack/tray transfer are encapsulated as actions and sequenced using hierarchical state machines (SMACH), enabling deterministic execution and recoverable error handling.

The vision pipeline provides tube localisation, barcode reading, contamination inspection and swab detection via neural network-based detectors; confidence thresholds govern subsequent actions. Standardised interfaces (OPC UA/HL7) link analytical instruments and higher level systems, while simulation options support offline testing of process logic and communication. By decoupling hardware from workflow logic, the architecture ensures traceable execution, reproducible data flow and scalable integration of additional devices and assays through configuration rather than code changes. This provides a flexible foundation for extending automation workflows to further diagnostic processes.

See the FlexACO research project for practical application (German):

https://www.youtube.com/watch?v=kNDaC_4BhIQ

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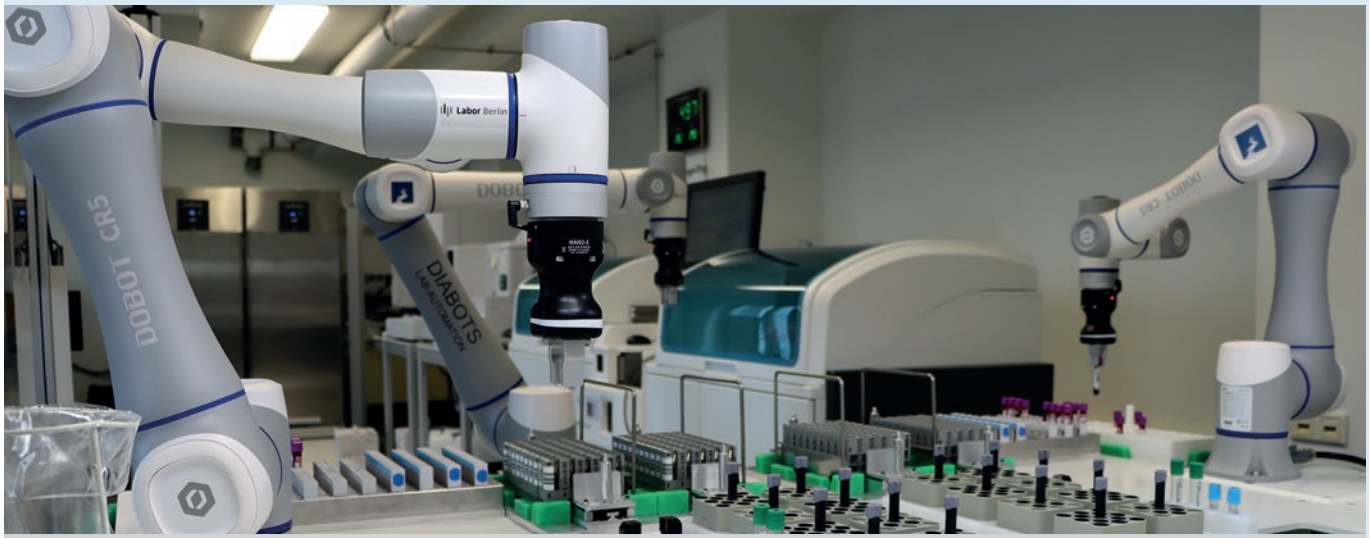
Robots in the laboratory: automated laboratory processes for sustainable diagnostics

Automated solutions optimise laboratory processes, from pre-analysis to post-analysis. They increase productivity, reduce the workload on staff and make a decisive contribution to ensuring diagnostic care despite the shortage of skilled workers.



3 cooperative robots at Labor Berlin, Vivantes Klinikum Friedrichshain

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

Technology instead of bottlenecks – how robotics relieves the burden on laboratory operations: The ongoing shortage of qualified laboratory personnel poses major challenges for medical facilities in the UK and worldwide. Unattractive working hours, stressful shift patterns and a declining number of young professionals are exacerbating the situation. In many regions, the bottlenecks are already noticeable, and forecasts show that the trend will continue to intensify.

Robotics solutions offer a forward-looking answer to this problem. They take over monotonous, time-consuming tasks, freeing up skilled workers to concentrate more on demanding diagnostic activities. At the same time, automation improves working conditions and increases the attractiveness of the profession – an important factor in counteracting the shortage of skilled workers in the long term.

EFFICIENCY ADVANTAGES

From necessity to innovation: The increasing implementation of robotic systems is a direct response to the need to ensure consistent diagnostics even when there is a shortage of personnel. These systems are used in many laboratories fully autonomously during night shifts and on weekends, or during the day in cooperative operation together with staff.

Especially in regions where skilled workers are already in short supply, robotic systems make an indispensable contribution to maintaining laboratory operations. In addition, they counteract the causes of staff shortages by improving working conditions and modernising the professional field.

Added value through intelligent automation: Robotics solutions not only reduce the workload on staff and increase job satisfaction, but also increase the efficiency of processes. Since robots work without breaks, holidays or closing time, they ensure continuous sample processing and operational reliability.

System-independent implementation enables the connection of existing analysis devices from different manufacturers, thus reducing the need for costly new purchases. This flexibility makes laboratory automation equally attractive for small and medium-sized laboratories.

Automation solutions are a crucial step in effectively addressing the challenges posed by the shortage of skilled workers. They not only offer a technological response to growing staff shortages, but also improve working conditions and ensure the quality of patient care.

Positive experiences from previous deployments show that robotic systems bring considerable structural and economic advantages. In view of demographic change and increasing demands in the healthcare sector, the importance of flexible, intelligent automation solutions will continue to grow and have a lasting impact on the laboratory of the future.

TECHNOLOGICAL DESCRIPTION

Technology and workflow at a glance: In addition to the structural advantages, laboratory robotics impresses above all with its precisely coordinated technology, which intelligently complements existing processes. Modern robotic systems automate the entire process – from sample order to archiving.

In the pre-analytical phase, integrated cameras recognise the samples, analyse the cap colour, check the fill level and read barcodes. Based on the cap colour and laboratory specifications, the samples are prioritised and prepared for analysis. Work steps such as centrifugation, decapping and distribution to different racks are carried out in a predefined workflow.

DIATRACK laboratory automation at Labor Berlin, Vivantes Klinikum Friedrichshain

Concept development for DIATRACK laboratory automation

After preparation, the robot transports the samples to the analysers, starts the measurement if necessary and then takes care of the return transport. In the post-analysis phase, samples are archived and can be automatically retrieved from the archive in case of additional requests or disposed of after the archiving period has expired.

One technical advantage is the bidirectional interface to the laboratory information system (LIS). It enables continuous communication, automatically activates orders and processes additional requests without manual intervention. The systems can be individually adapted to the existing device infrastructure, making implementation economical and flexible.

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AuxQ: flexibly integrable robotics solutions in diagnostic laboratories

In today's laboratory world, which is increasingly affected by a shortage of skilled workers, our advanced robotics solutions offer the perfect support. With a high degree of flexibility and manufacturer independence with regard to the analytical devices to be connected, our systems can be easily integrated into existing infrastructures – without any structural modifications.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

The integration of AuxQ IncomingInspection is the gateway to autonomous laboratory operation. It enables the continuous transfer of samples from public areas and ensures their processability right from the start. At the same time, it guarantees a clean and traceable transfer of liability.

The AuxQ Lab Solution automates routine processes in the laboratory by integrating various modules directly into existing laboratory structures. These include AuxQ MobileLabRobotic, which flexibly transports samples and operates the analysis devices. The focus here is on collaboration between staff and robotics. The integrated analysis devices remain available for use by staff, and back-up scenarios in the form of secondary devices can be fully implemented.

Pre- and post-analysis of the samples takes place in the AuxQ CobotProcessing. The station can be configured according to customer specifications. All processes from sample verification, including level determination, centrifugation, decapping and sorting, to archiving can be integrated.

This reduces the workload on specialist staff and increases efficiency in laboratory operations. Depending on the service level selected, our trained team provides prompt support and ensures smooth operation.

The supply landscape in the field of laboratory diagnostics is characterised by a large number of small and medium-sized laboratories with low sample volumes. However, due to their connection to hospitals (e.g. with emergency rooms, stroke units, etc.), 24/7 availability of analytics is often essential. Full automation in the sense of a large laboratory or switching to a POCT laboratory is often not the preferred option in terms of cost and analysis. In view of the shortage of skilled workers, there is a growing need for solutions to reduce the manual workload in the low-throughput segment in the laboratory, as well as a need for solutions for self-sufficient laboratory operation.

AuxQ handles both the pre-analytical preparation of samples and the transport of laboratory samples and sample racks to the analysers within the laboratory. There, the AuxQ MR independently feeds the samples into the analysers and retrieves them again after processing is complete.

The system was developed to actively relieve the workload on staff, for example by processing samples autonomously at night without manual intervention. All interfaces to the hospital or sender are automated. Samples can be transferred to the system via pneumatic tube and pass-through. As an option, the AuxQ II can be placed outside the laboratory and thus accept samples around the clock. This component checks all relevant sample parameters before they are transferred to the AuxQ CP within the laboratory. This ensures the transfer of liability for the samples and increases the autonomy of the entire system.

As a result, there is more time for MTAs to perform more demanding tasks, and laboratories can work efficiently despite staff shortages – without any loss of quality. At the same time, an attractive working environment is created.

The system is used in hospital laboratories with varying sample volumes. Depending on the area of application, the focus is on support during daytime operations, autonomous night-time operations and automatic sample archiving.

The solution is currently in routine use in EMEA.

Driving forces include the shortage of skilled workers, the cost structure of laboratories, laboratory reliability and digitalisation. Fundamentally, close cooperation and staff acceptance are essential.

EFFICIENCY ADVANTAGES

The system is continuously adapted to customer requirements in the field of analytics. In addition, the field of immunohematology is the focus of overall development. Furthermore, areas of application are also being defined in larger laboratories and discussed with customers. Through its supportive role in day-to-day operations, the AuxQ MR enables employees to concentrate on more important tasks, saving valuable working time. It also helps to relieve the team during autonomous night-time operations. The aim is not to replace employees, but to fill gaps and effectively overcome challenges caused by staff shortages.

TECHNOLOGICAL DESCRIPTION

The AuxQ Lab Solution is a modular automation solution for diagnostic laboratories. The mobile robot moves through the laboratory without any structural modifications and takes on transport and handling tasks.

The various components of the AuxQ Lab Solution record sample parameters and perform pre- and post-analytical processes such as decapping or archiving.

The broad portfolio of manufacturer-independent analysers, which can be integrated specifically for each laboratory, gives laboratories the opportunity to diversify their analysis methods and adapt flexibly to changing requirements. Interfaces to the LIS make the robots an integral part of the laboratory workflow. This enables real-time communication between the various analytical components, increasing efficiency and minimising sources of error.

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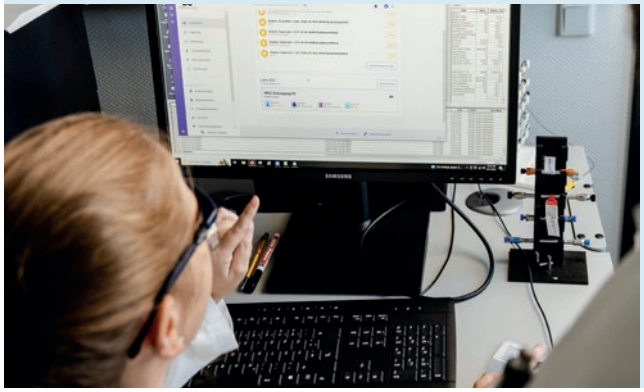
OPC UA-ready HPLC Service Station: automated solvent supply and waste monitoring for stable analytical workflows

An OPC UA-ready HPLC service station monitors solvent supply and waste fill levels with sensors and triggers alerts to prevent downtime and spills. Data can be integrated via OPC UA/REST API or monitored via DÜPERTHAL connect.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

HPLC systems are critical analytical instruments in many laboratories and depend on reliable solvent handling and safe waste disposal close to the workplace. The DÜPERTHAL HPLC Service Station concept combines sensor-based monitoring of solvent and waste containers with automated alerts and optional digital documentation, aiming to reduce manual checks and prevent safety-relevant incidents such as overfilling or spillage. To support integration into automated lab and facility environments, measured parameters can be provided through standard interfaces (e.g., OPC UA) or via a cloud-based monitoring solution, enabling use in both local and centralised digital architectures.

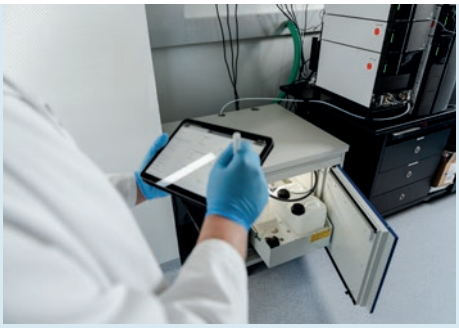
The station is equipped with sensors that detect relevant conditions such as fill levels of waste canisters and (planned) inventory-related states for solvent supply. When defined thresholds are reached, the system generates notifications so that refilling or disposal can be scheduled before an interruption occurs. For digital integration, the gateway can expose sensor data through OPC UA (OPC UA server on the gateway); alternatively, the solution can be connected to a monitoring software (DÜPERTHAL connect) for dashboards, alerts and documentation.



The HPLC monitoring set is developed and validated in collaboration with partners: partners, such as Essentim (hardware/plug-and-play sensor integration) and Institut für Umwelt & Energie, Technik & Analytik e. V. (IUTA) as application environment and validation partner.

The HPLC Service Station concept combines sensor-based monitoring of waste fill levels and solvent supply-related states with automated alerts and optional digital documentation, aiming to reduce manual checks and prevent safety-relevant incidents such as overfilling or spillage. At the same time, the use case is embedded in the broader Smart Safety concept: a holistic monitoring approach for lab infrastructure including safety storage cabinets and additional critical points such as disposal solutions, refrigerators and other storage or process-relevant equipment. Within this concept, sensors can continuously track key parameters such as exhaust air performance (to detect deviations and reduce risks related to insufficient ventilation), door status, fill levels (e.g., solvent waste canisters) and temperature, enabling early warning, improved process stability and audit-ready documentation.

To support integration into automated lab and facility environments, measured parameters can be provided through standardised interfaces such as OPC UA (via an



OPC UA server directly on the gateway, with sensor assignment managed through a gateway configuration that maps sensor serial numbers), REST API, and potential free contacts. This allows connection to building management systems (BMS) and lab IT (e.g., LIMS) and enables scalable, vendor-agnostic monitoring beyond single devices. Optionally, DÜPERTHAL connect (DC) software can be used for cloud-based dashboards, alerting (e-mail/SMS) and continuous documentation, depending on the customer's IT and compliance requirements. Sensor-based monitoring provides earlier detection of critical conditions and supports more stable HPLC workflows by reducing avoidable interruptions. Automatic alerts and optional digital documentation support occupational safety and compliance processes by making checks more reliable and traceable.

Waste fill-level monitoring is already delivered and used within the DÜPERTHAL DISPOSAL line context (HPLC solvent waste handling), providing a proven entry point for broader Smart Safety monitoring and interface-based integration.

Key drivers are improved safety, fewer workflow interruptions (e.g., preventing overfilled waste canisters) and the ability to retrofit monitoring with plug-and-play sensor technology and integrate via standard interfaces (OPC UA/REST API). Key barriers are human factors ("it has always worked like this") and generally low investment readiness in many labs, especially when manual routines appear acceptable until incidents occur.

Next steps focus on data-driven automation: combining historical solvent consumption, waste generation and check-out events from inventory management with sensor data to forecast refill and disposal needs. AI-based models can predict when specific HPLC stations will require solvent replacement or waste canister exchange, enabling proactive scheduling and optimised purchasing. This is complemented by the Smart Safety concept, which can holistically monitor relevant lab infrastructure (e.g., exhaust air, door status, fill levels and temperature) and provide standardised connectivity via OPC UA (OPC UA server on the gateway) as well as REST API or integration into building management or lab IT.

EFFICIENCY ADVANTAGES

At IUTA, sensor-based fill-level monitoring in the HPLC waste disposal process reduced manual checks by about 80% and eliminated unplanned fill-level-related downtime. This frees lab staff time for value-adding tasks and improves planning of disposal cycles through early alerts.

TECHNOLOGICAL DESCRIPTION

The HPLC Service Station follows the DÜPERTHAL Smart Safety concept and is built on a modular sensor-and-gateway architecture to capture safety- and process-relevant states across lab infrastructure (e.g., waste fill level at HPLC disposal points, solvent supply status, door status of safety cabinets, exhaust air performance and temperature). The gateway aggregates sensor signals, and provides standardised connectivity for integration. An OPC UA server can be activated directly on the gateway to expose connected sensors as OPC UA nodes; sensor assignment is managed via a gateway configuration that maps sensor serial numbers. In addition, a REST API supports integration with third-party systems such as lab IT (e.g., LIMS) and data platforms, and a potential free contact supports a connection with the building management (BMS). As an option, DÜPERTHAL connect DC software provides cloud-based dashboards, alerting (e-mail/SMS) and continuous documentation to support auditability and operational transparency, depending on the customer's IT and compliance requirements.

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Intermediate level automation – dual CyBio FeliX setup for efficient NGS library preparation

A dual CyBio FeliX setup enables efficient automation of multiple NGS library preparation steps, increasing walk-away time, improving reproducibility and reducing manual errors through coordinated, parallel liquid handling processes.

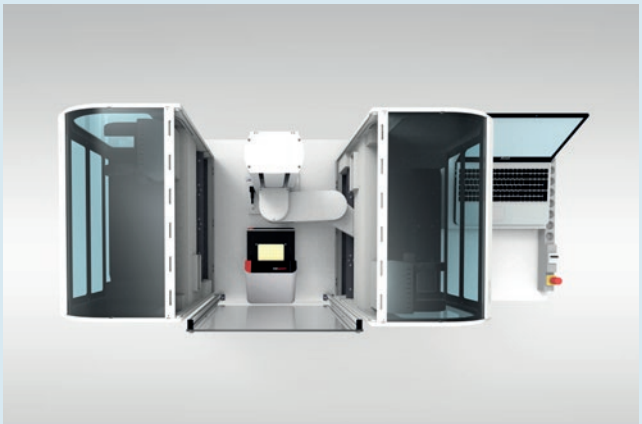
Dual CyBio FeliX Setup “Intermediate”

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

NGS library preparation includes many interconnected steps that require precision and consistent handling. The dual CyBio FeliX setup automates a large part of this workflow by combining two liquid-handling systems connected through plate transfers by robotic arm integration. One unit typically manages early process steps such as extraction, fragmentation and normalisation, while the second unit performs downstream tasks including library preparation, clean-up, dilution and pooling. This separation of pre- and post-PCR processes supports process integrity and reduces contamination risks. Prior to automation, many laboratories relied on manual pipetting and stepwise handling, which demanded significant working time, introduced variability and limited throughput. Through automation, routine operations become more reproducible and users benefit from increased walk-away time as well as reduced manual workload. The system is already applied in genomics and molecular biology laboratories that process medium-throughput sequencing workflows, with expected growth driven by rising sequencing demand and the need for reliable, scalable sample preparation. Drivers for adoption include modular scalability, compatibility with established protocols, and the ability to integrate thermocyclers, readers and additional modules as needed. A commonly perceived barrier to automation is the required upfront investment in fully integrated systems. The modular concept of the CyBio FeliX reduces this challenge by allowing laboratories to start with a single device and expand the level of automation over time. This stepwise approach minimises initial costs and enables users to scale their workflows as needs or throughput increase, without replacing existing equipment. Ongoing development focuses on expanding integration options and extending applicability to additional molecular workflows and NGS library preparation kits to support long-term adaptability.

EFFICIENCY ADVANTAGES

The dual CyBio FeliX setup reduces hands-on time by automating multiple connected steps and enabling parallel processing. This decreases manual pipetting errors, minimises reagent waste through precise liquid handling, and accelerates sample throughput. Laboratories gain higher reproducibility, more walk-away time and optimised resource utilisation.



Top view of the dual CyBio FeliX setup

TECHNOLOGICAL DESCRIPTION

The intermediate-level automation setup consists of two CyBio FeliX liquid handling platforms configured for complementary workflow sections. A robotic arm transfers labware between units, enabling automated execution of pre- and post-PCR steps. Each CyBio FeliX can be equipped with interchangeable pipetting heads, including 96-channel and low-volume options, as well as heating, cooling, magnetic separation and shaking modules.
The system supports integration of thermocyclers (e.g. Biometra TRobot II), barcode readers and fluorescence detection devices (e.g. qPCR thermal cycler qTOWER³ auto). Control is provided through CyBio Composer software, which offers scripting-level access to all hardware functions and supports communication with LIMS and third-party modules. Predefined protocols can be adapted to user-specific requirements, enabling reproducible, scalable NGS library preparation while maintaining spatial separation of sensitive workflow segments.

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Greater efficiency with less manual work thanks to automation in mass spectrometry

Automation has fundamentally changed mass spectrometry (MS). The latest technologies and developments are increasing efficiency in analytics – from sample preparation to integrated, high-throughput workflows.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

In the early days of mass spectrometry, analytical steps such as sample preparation and data evaluation were performed manually. Over the years, especially in the 1980s and 1990s, the spread of electronic data processing significantly accelerated automation. The introduction of automated sample injectors for gas and liquid chromatography increased reproducibility and productivity in contract laboratories, and the coupling of mass spectrometers with GC and LC (GC-MS, LC-MS) became the standard for many analytical applications. In the 2000s, automated sample preparation methods such as solid-phase extraction and standardised dilution workflows, robot-assisted platforms and significantly improved software solutions for qualitative and quantitative data analysis became established. Such technologies are now standard equipment in analytics and it is hard to imagine working without them.

GC-MS single quadrupole system coupled with the multifunctional AOC-6000 Plus autosampler ©Shimadzu

EFFICIENCY ADVANTAGES

A major advantage of automation is the significant increase in laboratory efficiency. Parallel sample processing and the possibility of 24/7 operation significantly increase the number of samples analysed per unit of time, which also leads to cost savings. In addition, standardised steps in sample preparation (e.g. pipetting), consistent extraction conditions and automatic calibration routines improve the accuracy of the results, as variability due to manual intervention is reduced. Another aspect is that employees are protected. Closed systems offer an additional level of safety, especially when working with biological substances or infectious samples.

Dual CyBio FeliX setup “Intermediate” from Analytik Jena

© Shimadzu

TECHNOLOGICAL DESCRIPTION

Typical areas of application for mass spectrometry in combination with automation can be found in all subject areas. One example is its use in therapeutic drug monitoring in clinical diagnostics using LC-MS. With the CLAM-2040, Shimadzu provides a complete solution for this type of analysis. The CLAM-2040 is a sample preparation module that can automate dilutions, precipitations and filtrations, among other things. It is seamlessly connected to the LC-MS system, allowing mass spectrometric analysis to be started directly and independently after sample preparation. Traceability is also ensured with the help of the additionally integrated barcode reader. In the final step, helpful tools are available in the evaluation software, including transfer to a laboratory information system for sample management.

Another example can be found in environmental analysis using GC-MS. Here, the multifunctional AOC-6000 Plus autosampler from Shimadzu provides support. In important fields of application such as the screening of pesticides and contaminants in water or soil, the sampler enables, for example, the creation of dilution series for calibration and the derivatisation of certain components required for analysis.

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Fully automated storage system for pharmacies with KR AGILUS

GPI has developed a fully automated storage system for pharmacies in collaboration with KUKA that intelligently recognises, scans and precisely stores medication packaging. The system increases efficiency, accuracy and speed.

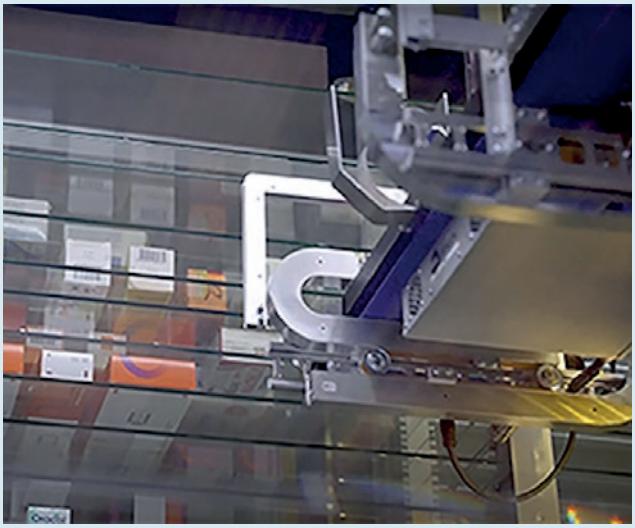
AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

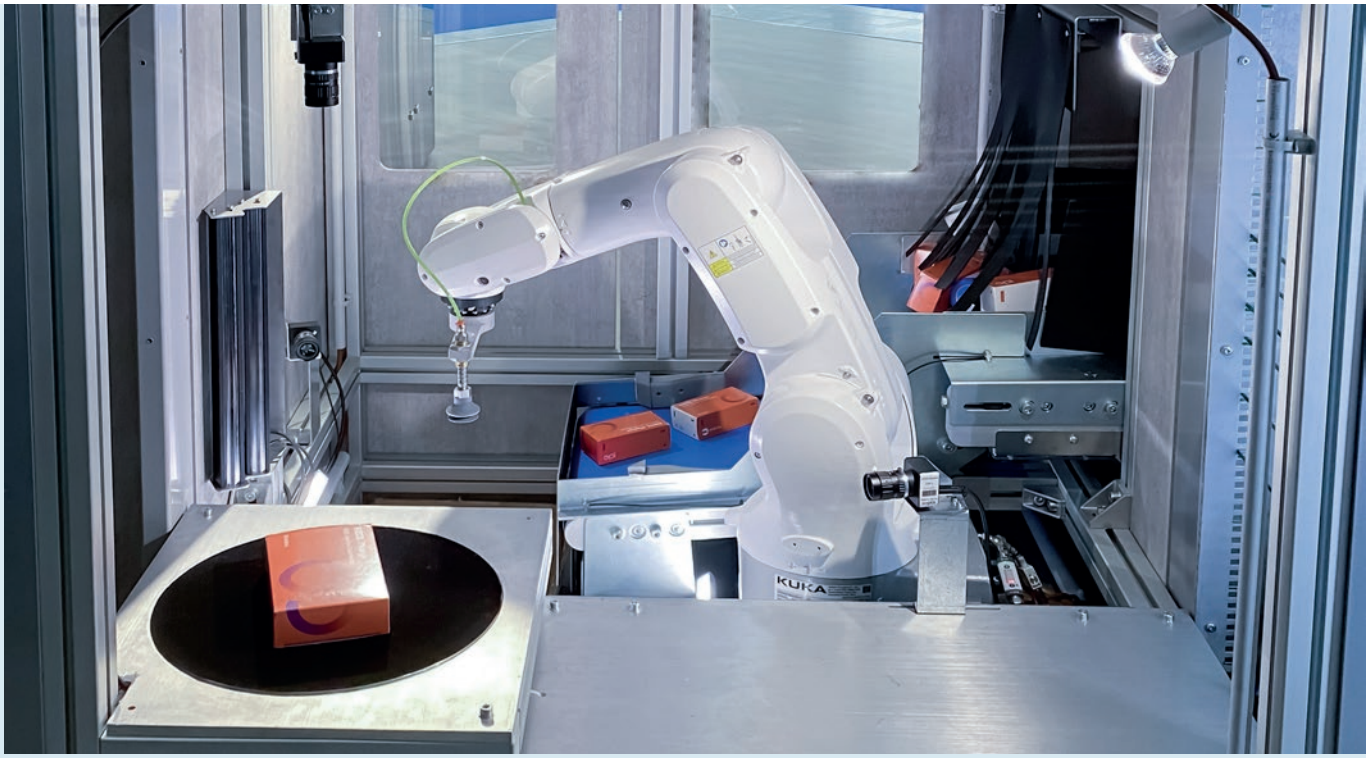
The fully automated storage system is used in pharmacies to reliably, quickly and accurately identify, scan and store medication packaging. An intelligent input system recognises each package, reads the barcode and expiry date and transfers it to a robot-assisted gripper system. The compact KUKA KR AGILUS works precisely with the high-speed RIEDL Phasys gripper, enabling efficient, safe and highly dynamic storage even with varying packaging shapes. As a result, the system reduces errors, optimises logistics processes and increases the availability of medicines.

The system was developed in collaboration with several partners, with the GPI Group acting as lead partner alongside KUKA, the University of Trento and the Bruno Kessler Foundation.

In pharmacies, manual sorting and storage of medicines had previously been time-consuming, prone to errors and heavily dependent on staff availability. Different packaging formats further complicated the process, and delays could have critical implications for patient care and logistics. By fully automating medication logistics, the system increases storage accuracy, reduces errors, boosts efficiency and enables continuous availability. Patients benefit from faster processes and the reliable delivery of important medications, while pharmacies save both time and costs.

The solution is already in use in pharmacies, hospital pharmacies and wholesale warehouses. As healthcare organisations increasingly recognise automation as a key lever for improving efficiency, a significant expansion in its use is expected. Key drivers include rising efficiency pressure, cost savings, legal requirements, shortages of





skilled workers and the need for error prevention. Barriers mainly consist of investment costs and the effort required to integrate the system into existing warehouse infrastructures. Further optimisation potential lies in AI-based packaging recognition, faster sensor technology, fully networked pharmacy logistics and integration into comprehensive hospital and supply chain systems. Research into even more flexible handling scenarios is already underway.

EFFICIENCY ADVANTAGES

The system reduces manual work, speeds up the storage process, minimises errors and increases medication availability. Automation makes more efficient use of resources, reduces downtime and significantly optimises logistical processes.

TECHNOLOGICAL DESCRIPTION

The storage system combines the compact KUKA KR AGILUS with the wireless high-speed gripper RIEDL Phasys. An intelligent input system recognises each package using sensors, reads the barcode and expiry date, and then controls the fully automated handling. The solution is based on precise robotics, modern control technology (KR C5) and machine learning methods that enable flexible adaptation to a wide variety of packaging shapes and handling scenarios. The seamless integration of the robot into the existing storage system ensures optimum speed and operational continuity while maintaining high reliability and energy efficiency.

You can find a detailed application example here:

https://www.kuka.com/automated-pharmacy-warehouse-systems

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Automated benchtop refrigerated centrifuge for the laboratory of the future

The Sigma 4-5KRL automated benchtop centrifuge offers very high throughput in automated lines (Total Lab Automation, TLA) for in vitro diagnostic analyses and, thanks to its compact design, is suitable for a wide range of integration options.

AREA OF APPLICATION, TECHNICAL PROCESS AND EFFECTS

The automated benchtop centrifuge Sigma 4-5KRL is designed for in vitro diagnostic analyses in automated lines (Total Lab Automation, TLA). Its compact design allows flexible integration into existing systems. Compared to conventional laboratory centrifuges, the Sigma 4-5KRL offers three features specifically suited for use in TLA environments:

(i) Connection and remote control via an RS232 interface;
(ii) An additional sliding lid that opens and closes automatically; and
(iii) Defined positioning of the bucket directly beneath the sliding lid.

The remote control function enables integration into automated workflows and allows direct control of the centrifuge, including the sliding lid, rotor position and bucket levelling. The sliding lid reduces process times and requires minimal space within TLA systems.

Precise rotor positioning ensures that each of the four buckets can be placed at a defined location beneath the sliding lid. An additional Sigma-specific feature is the integrated bucket leveling system, which returns the bucket to its initial position and supports reliable process execution.

With its features, Sigma 4-5KRL achieves very high process accuracy and reliability as well as minimal unproductive process times.

EFFICIENCY ADVANTAGES

The automated Sigma 4-5KRL cooling table centrifuge combines very high process accuracy and reliability with very short process times. It thus contributes to increased efficiency in total lab automation and can be used even more universally via the LADS OPC UA laboratory communication standard.

TECHNOLOGICAL DESCRIPTION

For Digital Transformation 2026, the Sigma 4-5KRL is integrated into the automated process chain, from sample preparation to sample processing and measurement data collection to storage, as part of the automated sample journey use case via the universal laboratory communication standard LADS OPC UA.

Note: At Analytica 2026, the Sigma 4-5KRL benchtop refrigerated centrifuge will be presented in the use case “Automated Sample Journey” and will demonstrate its potential for digital transformation in the laboratory of the future.

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www.sigma-zentrifugen.de/de/produkte/zentrifugen/details/sigma-4-5krl

Messe München GmbH

The world's leading trade fair for laboratory technology, analysis and biotechnology

24-27 March 2026

analytica is the world's leading trade fair for laboratory technology, analysis and biotechnology. Spread across five halls, it offers a comprehensive market overview of the laboratory in industry and research – from laboratory planning, equipment and devices to related services. Around 1,100 exhibitors, including all market leaders in the industry, present their innovations. The extensive supporting programme with forums, special shows, live demonstrations and special events places great emphasis on knowledge transfer and practical application. Since it first opened its doors in 1968, analytica has developed into the industry's most important platform, bringing together companies, scientists and lab users from all over the world every two years. The trade fair is complemented by the renowned analytica conference. Over three days, international speakers discuss current topics and the latest findings in analytics, biochemistry and clinical diagnostics in around 190 presentations.

analytica provides an outlook on the laboratory world of tomorrow and focuses on future topics that are driving the industry, such as digital transformation and the Green Lab. It shows how the digitalisation and automation of laboratory processes can be achieved, for example through intelligent analysers, smart laboratory technology and networking solutions, as well as AI-supported workflows and data evaluation. The special show Digital Transformation invites visitors to experience work in a modern laboratory through typical use cases. In terms of sustainability, the trade fair illustrates how energy-efficient devices, intelligent laboratory concepts and bio-based chemicals reduce the ecological footprint in the laboratory.

In addition to being the leading trade fair in Munich, analytica has established the premier trade fair network for the global laboratory industry to support networking and knowledge exchange. There are currently seven local offshoots worldwide – in China, South Africa, the USA and at two locations each in India and Vietnam. At all analytica events worldwide, a total of over 3,600 exhibitors present their products and solutions to around 128,000 laboratory users and decision-makers. Depending on the specific challenges of the country and region, each local trade fair focuses on different topics – from water quality and environmental analysis to food control, the pharmaceutical sector and the smart laboratory of the future.

The next analytica will take place in Munich from 24 to 27 March 2026. For more information, visit analytica.de or contact us:

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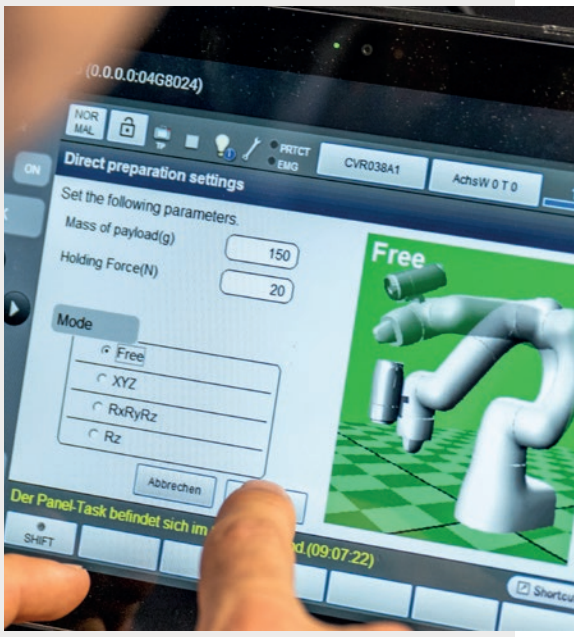

SPECTARIS
German Industry Association
for optics, photonics, analytical and medical technologies

SPECTARIS is the German industry association with 400 members in the innovative sectors of optics, photonics, analytical and medical technology. Our goal is to strengthen the competitiveness and innovative power of our member companies. We are involved in shaping policy to promote our members' interests. We pool the expertise of our members and take a joint stance on relevant issues.

Well-known members include B.Braun / Aesculap, Bruker, Dräger, Eppendorf, Jenoptik, Karl Storz, Leica, Richard Wolf, Rodenstock, Sartorius, Schott, Karl Storz, ThermoFisher and ZEISS. However, the majority of our member companies are medium-sized manufacturers that operate as "hidden champions" in their segments on the global market. Their products are used in many sectors of the economy and provide people with a high quality of life. It is no coincidence that the German government has declared some of these industries to be key technologies for securing Germany's position as a business location.

A medium-sized structure, enormous innovation potential and strong export orientation form the common framework for these companies. In 2025, the SPECTARIS sectors generated total revenue of €91 billion and employed more than 350,000 people, making them an important cornerstone of German industry.

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SPECTARIS: a strong network of decision makers

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