

PRESS RELEASE

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New Machine Tool Robot (MTR) machines very precisely tempered steel, aluminum and fiber-reinforced plastic | EMO 2025

The cutting-edge milling kinematics close the gap between classic industrial robots and machine tools – a milestone for resource-efficient, flexible automated production. It enables versatile, efficient and high-precision machining of fiber composites to aluminum up to tempered steels.

The globally unique new development will be presented live for the first time at the world's leading trade fair for production technology EMO (September 22-26, 2025, Hannover, Germany) by Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, Stade, together with Siemens AG and autonox Robotics GmbH at the Siemens booth F30 in hall 6.

New type of machining robot – maximum precision and dynamics in production

Fraunhofer IFAM in Stade has developed a pioneering technology together with Siemens to improve the dynamics and precision of industrial robots. This technology integrates intelligent, model-based control strategies with innovative drive technologies which are combined with a mechanical robot structure optimized by autonox Robotics. This development enables dynamic errors to be compensated for and vibrations to be effectively damped. This significantly improves path accuracy, even at high feed rates and complex path movements.

A particular advantage is the optimized disturbance rejection which ensures constant precision even with highly dynamic process forces. This drive concept therefore enables machining with higher material removal rates as well as the ability to operate with higher jerk settings, both of which lead to a significant increase in productivity.

Thanks to these properties, the “Machine Tool Robot” (MTR) closes the gap between classic industrial robots and machine tools. It is particularly suitable for demanding manufacturing processes, e.g., in the machining of harder materials, and open up new possibilities for automation technology as well as smart industry.

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Alternative machine concept

Industrial robots enable an alternative machine concept, especially if they are used together with a workspace extension by means of a surface-moving platform or additional translatory axes, such as linear axes, or in combination with other robots.

Compared to gantry systems or machine tools, this machine concept is much more space-saving and not economically tied to individual large components. In addition, there is no need for special foundations, which makes it easier to adapt production lines in future.

Wide range of applications thanks to the combination of linear axis and robot

The combination of serial articulated arm kinematics with a linear axis provides many advantages over large gantry and special machines for processing. The smaller mounting space and the modular design of the linear axis make the system highly flexible. The use of two preloaded rack and pinion drives compensates for reversal effects and achieves a sufficiently high drive stiffness of the linear axis carriage for path-accurate robot processes. Due to the high structural rigidity of the linear axis, the influences on the robot accuracy are low despite the large lever arms to the load application point.

Further potential for increasing precision: "CaliRob" – Model-based calibration of industrial robots and linear axes

A software application for model-based calibration developed at Fraunhofer IFAM in Stade – "CaliRob" – opens up a complementary technology for increasing precision: Due to unavoidable manufacturing tolerances, industrial robots exhibit individual deviations from the ideal system. These deviations can result in errors of up to several millimeters when approaching target positions in robot systems without knowledge of these deviations. In order to achieve the highest possible accuracies, industrial robots must therefore be calibrated according to requirements, for example with "CaliRob". A key element of this application is a very extensive mathematical model that includes over 200 parameters to describe robot kinematics on a linear axis.

Perspectives

In the next step, the experts at Fraunhofer IFAM will test the new robot system together with their R&D partners Siemens AG as well as autonox Robotics GmbH in demanding industrial applications in order to further advance the potential of the technologies. For this, a robot spindle from Weiss Spindeltechnologie is used, which is designed for the high weight requirements.

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Machine Tool Robots can be used for a wide range of applications: In combination with a linear axis, the spectrum ranges from machining tasks from the aerospace industry, such as lighter fiber composite structures and aluminum alloys, to the machining of harder materials, such as steel or titanium which are used, for example, in rail, commercial vehicle and shipbuilding as well as in the energy sector. Until now, it has not been possible to machine such components and materials in an industrially robust manner using industrial robots. In particular, the machining of harder materials using Machine Tool Robots appears to have a promising future.

Project funding

The Niedersachsen Ministry for Economic Affairs, Transport and Housing as well as the NBank funded the LuFo research project "Robots Made in Lower Saxony 2" ("RoMaNi 2"; funding code: ZW1-80155399). On behalf of all project partners, Fraunhofer IFAM would like to thank the Niedersachsen Ministry for Economic Affairs, Transport and Housing and the NBank as well as the German Aerospace Center (DLR) as project management agency for their support.

**Niedersächsisches Ministerium für Wirtschaft,
Verkehr, Bauen und Digitalisierung****NBank**

DLR

**Projektträger
Luftfahrtforschung****Further information**

- **Trade fair**

Find out more – visit us from September 22 to 26 at EMO 2025 in Hannover, Germany, at the Siemens booth F30 in hall 6.

- **Video "New type of machining robot closes the gap between classic industrial robots and machine tools"**

<https://s.fhg.de/Sns3>

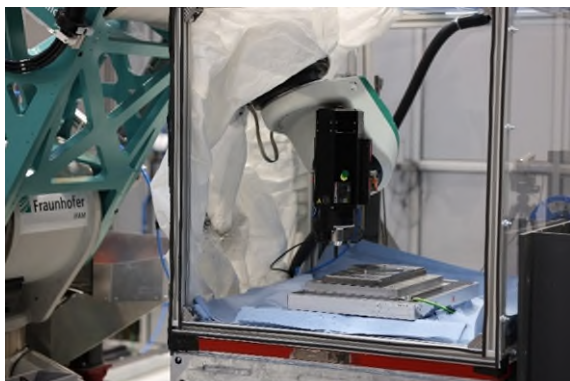
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- **Industrial robots with high path accuracy**
<https://www.ifam.fraunhofer.de/en/technologies/hybrid-drive-for-robots.html>
- **Linear axis for industrial robots**
<https://www.ifam.fraunhofer.de/en/technologies/linear-axis-industrial-robot.html>
- **Model-based calibration of industrial robots I “CaliRob”**
<https://www.ifam.fraunhofer.de/en/technologies/calibration-industrial-robots.html>
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Photos

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**Figure 1 | Caption**

The successful high-precision machining of a steel part shows that the machining robot on the linear axis is able to close the gap between industrial robots and machine tools (© Fraunhofer IFAM).

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**Figure 2 | Caption**

The newly developed flexible milling kinematics on a linear axis machines with high precision a CFRP vertical tail plane of an aircraft on a 1:1 scale at Fraunhofer IFAM in Stade (© Fraunhofer IFAM).

**Figure 3 | Caption**

Technology transfer to industrial applications: In the background the flexible milling kinematics developed at Fraunhofer IFAM, in the foreground the jointly developed product solution from autonox Robotics (© Fraunhofer IFAM).