Fraunhofer CML

Newsletter 2.26

Dear readers,

The maritime industry is undergoing a transformation—and with it, the demand for safe, efficient, and sustainable technologies. In this issue of our newsletter, we highlight, among other things, how Fraunhofer CML is working with partners to develop solutions that address these very challenges. You'll learn how astronomical navigation is being reimagined as a resilient alternative to GNSS systems, how autonomous robot fleets can revolutionize general cargo transport in ports, and how AI helps to make port infrastructure safer and more efficient.

In addition, we look ahead to the Hamburg Innovation Summit 2026, where the Fraunhofer institutes in Hamburg will jointly present innovative developments from research and practice.

I hope you enjoy reading this newsletter!

Kind regards,
Prof. Dr.-Ing. Carlos Jahn
Head of Fraunhofer CML

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Resilient navigation on the high seas: MoNaMe demonstrates the potential of modern celestial navigation.

Navigating by the Stars: Fraunhofer CML Tests Astronomical Navigation as a GNSS Alternative at Sea

The maritime shipping industry faces a critical challenge: Modern navigation systems rely heavily on GNSS, the Global Navigation Satellite System—a system that is increasingly vulnerable to cyberattacks such as jamming and spoofing. What happens if the signal fails or is tampered with? The ESA-funded research project MoNaMe (Modern Navigation Methods for Autonomous Alternative Absolute Positioning) offers a promising solution: looking back to the stars—with state-of-the-art technology.

The core component of MoNaMe is a camera-based system for astronomical positioning. An array—in this case, a circular arrangement—of eight cameras captures the starry sky, while intelligent pattern-matching algorithms identify celestial bodies using a star catalog. The position is determined from the right ascension and declination of the detected stars—the celestial equivalents of longitude and latitude—completely independent of GNSS signals.

A particular challenge was the development and construction of an active gimbal. This compensates for the ship's roll and pitch movements in real time and keeps the camera array level at all times—a prerequisite for reliable image capture at sea. The system also responds intelligently to changing sea conditions: in rough weather, the integral gain is automatically reduced to prevent overcompensation. Particularly innovative: The altitude-based positioning method requires no external course reference whatsoever.

In March 2026, the system completed its second test campaign aboard the Joseph von Fraunhofer, the research vessel of Fraunhofer IFAM, in the German Bight. The result: the basic operating principle was successfully validated as a proof of concept. The findings are now being directly incorporated into the next test runs aboard the Elly, operated by project partner SINTEF in Trondheim.

MoNaMe shows that astronavigation is not a relic of the past—it could be a resilient navigation solution for the future.

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Autonomous transport robots from Fraunhofer CML: Using intelligently coordinated model-scale fleets of modules, our researchers are making general cargo handling in ports safer, more flexible, and more efficient. Read on the next page how this technology is paving the way for the automation of general cargo terminals. ▼

Swarm Intelligence in the Port: Fraunhofer CML Revolutionizes General Cargo Transport with Autonomous Robot Fleets

General cargo terminals face a paradoxical challenge: While automated handling and transport solutions are standard practice at container terminals, the handling of crates, metal coils, paper rolls, or wind turbine components remains a manual, labor-intensive process. The enormous variety of cargo—virtually every type of cargo with its own dimensions, specific weight, and individual attachment points—seemed to make automation nearly impossible until now. Researchers at Fraunhofer CML have now addressed this very issue and developed a solution that is as clever as it is scalable: collaborative general cargo transport using mobile robots.

A fleet of custom-designed configurations

At the heart of the concept is a fleet of uniform, autonomous transport modules that dynamically form groups depending on the load requirements. If a single steel coil needs to be transported to the warehouse, one module is sufficient. If, on the other hand, a combined heat and power plant is waiting to be transported further, several modules coordinate to form a customized carrier formation—fully automatically and in real time.

The key feature: The system thinks for itself. Web-based control room software receives the order, accesses a cargo database, and automatically calculates how many transport modules are needed and in what configuration. The starting point and destination are defined on a digital map—the rest happens automatically. The transport modules navigate autonomously, avoid obstacles, and continuously report their status. A central control system monitors the entire formation in real time, corrects deviations, and continuously checks for potential collisions—taking into account not only the vehicles' trajectories but also those of the cargo being transported.

Scalable, secure, future-proof

The distributed software architecture makes it possible to manage multiple transport orders in parallel and scale the solution to entire fleets. For terminal operators, this means no longer having to rely on a multitude of specialized transport solutions, but instead having a transport system that grows with their needs. The benefits are multifaceted: Terminal employees are relieved of dangerous and repetitive transport tasks and can devote themselves to higher-value activities—a decisive factor in light of the growing shortage of skilled workers. Robot-based transport significantly increases workplace safety in an already high-risk environment. At the same time, the predictable movement patterns of the autonomous modules ensure greater process stability and reduce wear and tear as well as service costs.

From the Lab to Real-World Applications

The system's core functions have been successfully developed and tested on a laboratory scale. The results are encouraging: the next stated goal is to move into real-world terminal environments. Researchers at Fraunhofer CML are already working on the challenges ahead—from robust communication solutions and adverse weather conditions to universal load-handling systems.

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Four institutes, two presentations, a thousand ideas: Fraunhofer Hamburg at HHIS 2026

On June 18, 2026, the Gleishalle in Hamburg's Oberhafen district will become a hub for applied research: At the Hamburg Innovation Summit (HHIS), four Fraunhofer Institutes will jointly present their latest developments—and demonstrate how scientific excellence solves real-world problems. From intelligent crane rope monitoring and quantum chemistry to sustainable catalysts and circular 3D printing: the spectrum is as broad as it is relevant.

AI Protects Port Cranes – Fraunhofer CML
Rope breaks on container gantry cranes cost terminal operators up to one million euros annually. With the GRIP demonstrator, Fraunhofer CML shows how AI solves this problem: A compact device with three cameras captures the entire rope surface—manual inspections have so far only been able to view 25%. Algorithms automatically detect wire breaks, wear, and corrosion; all findings are displayed and documented on a dashboard in a traceable manner.

Making Molecules Visible – Fraunhofer ITMP
How does a chemical lead structure become a drug? 3D models of a blood clotting protein and potential drug candidates demonstrate this in real time. Drug repurposing, the targeted development of complex cellular model systems to assess the efficacy and toxicity of drug candidates, and our AI-driven solutions in the field of medical data science refine prioritization—thereby accelerating the development of new therapeutics.

Nano for Green Hydrogen – Fraunhofer IAP
Small particles, big impact: Fraunhofer IAP presents nanoscale catalysts for hydrogen production via electrolysis and the chemical recycling of polymers. Through customized manufacturing, the use of expensive precious metals such as iridium can be significantly reduced—a key factor in the economic viability of green hydrogen technologies.

Circular Economy in 3D Printing – Fraunhofer IAPT
Circular economy and energy efficiency made in Hamburg: Fraunhofer IAPT showcases sustainable plastic 3D printing as well as innovative printed bipolar plates for fuel cells made of stainless steel, thereby demonstrating the potential of additive manufacturing for resource-efficient production.

On Summit and Collaboration Stage
Using quantum power to create more efficient harbor tugs: From 3:10 p.m. to 3:55 p.m., the project consortium of the IFB-funded "Quantum Tug Scheduling" project will present how it is exploring quantum computing approaches to optimize tugboat logistics in the Port of Hamburg. Fraunhofer CML is developing the appropriate optimization algorithms for tugboat scheduling.

Sustainability with Substance
From 3:45 to 4:30 p.m., the four institutes, together with a representative from Fraunhofer Headquarters, will take the Summit Stage. Under the motto "Living Sustainability: Fraunhofer Institutes Deliver Practical Success Stories," experts will discuss climate-neutral shipping, plastic reduction in the lab, more affordable iridium catalysts, and the circular economy in 3D printing. CSR expert Anja Gilch will kick off the session with an overview of sustainability as a guiding principle of the Fraunhofer Society.

Come visit us at HHIS—we look forward to talking with you!

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MII 8: Inspiring ideas and practical insights

In May, the Maritime Innovation Insights event took place for the eighth time at Fraunhofer CML. Under the theme "Maritime Systems in Transition – Intelligent, Connected, Resilient," experts from research and industry discussed current developments in the fields of digitalization, safe navigation, and efficient automation. In addition to informative presentations on autonomous technologies, resilient infrastructure, and AI-supported solutions, demonstrations in the laboratories offered exciting insights into real-world applications. Many thanks to all the speakers and participants for the intensive professional exchange and the successful event!

VEKTOR wows the crowd at the Hamburg Port Anniversary

Fraunhofer CML looks back with great pleasure on the VEKTOR's participation in the 837th Hamburg Port Anniversary. At the Überseebrücke, the research vessel offered exciting insights into maritime research and innovative technologies. A highlight was the visit by Senator Dr. Melanie Leonhard, the VEKTOR's godmother. There was also a fruitful exchange with guests from both civilian and military sectors. The VEKTOR's crew presented smart solutions for generating maritime situational awareness and was available to the public for many stimulating conversations.

Prof. Carlos Jahn and Dr. Ole John from Fraunhofer CML with Senator Dr. Melanie Leonhard (center) next to the VEKTOR during the 837th Port Anniversary.

SMM 2026 & all about ports in Hamburg

At SMM, the leading international trade fair for the maritime industry, we will once again be presenting highlights of maritime research together with other Fraunhofer institutes from **September 1–4, 2026**. Discover our solutions for speech recognition and enhanced situational awareness on the ship's bridge, the transcription of maritime radio communications, and quantum computing solutions for optimizing route planning. Visit us in **Hall B6** at **Booth 230**!

Parallel to SMM, the first edition of all about ports will take place at the Congress Center Hamburg from **September 2–3, 2026**. Stop by our booth to see demonstrations of our solutions for mobile robotics and automated image recognition at the terminal!

Fraunhofer CML

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