AVALON

UnderwAter optical wireless communication network architecture empowered by adVanced opticAl materiaLs for sea bOrder protection and deep-sea exploratioN

NEWSLETTER

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WELCOME

Following the launch of AVALON at the consortium's kick-off meeting, the project has moved firmly into its implementation phase. This second issue brings together the scientific and outreach highlights of the summer months: a peer-reviewed contribution presented at an international conference, and the launch of AVALON's public communication series on LinkedIn, through which the consortium shares the ideas and challenges shaping its research.

PROJECT MILESTONE

AVALON at AES 2026

The AVALON project was represented at the 2026 12th International Conference on Antennas and Electromagnetic Systems (AES), a renowned yearly conference dedicated to antennas, electromagnetics, propagation, and measurements. The contribution, entitled "Retrieving Electric and Magnetic Conductivities of Anisotropic Metasurfaces under Oblique Incidence," showcased recent advances in the analytical modelling of anisotropic metasurfaces and their application to polarization control.

Figure 1 - The AVALON contribution was presented at AES 2026

Figure 2 - Presenting the AVALON contribution to the international electromagnetics community.

The presented work, conducted by partner NHRF, introduces a compact retrieval framework that determines the tensor electric and magnetic surface conductivities of anisotropic metasurfaces directly from plane-wave scattering coefficients under arbitrary incidence angle and polarization. In contrast to existing retrieval approaches, the proposed formulation requires scattering data from only one side of the metasurface, significantly simplifying both numerical characterization and future experimental implementation while retaining a rigorous physical description of the electromagnetic response. The methodology was validated through full-wave simulations of tilted cut-wire and cut-wire-pair metasurfaces, where the retrieved conductivity tensors accurately captured the electric and magnetic resonances, the emergence of off-diagonal conductivity components, and the resulting cross-polarized scattering which enables linear-to-circular polarization conversion.

These results are closely aligned with the objectives of AVALON, which aims to develop advanced optical wireless communication technologies for reliable, secure, and high-capacity underwater networks by exploiting innovative optical materials and metasurfaces. In particular, polarization engineering constitutes an important enabling technology for improving the robustness of optical links

operating in challenging underwater environments, where scattering, turbulence, and obstacles can degrade communication performance. The AES conference also provided the opportunity to exchange ideas with the international electromagnetics community and to establish new scientific connections that can support the project's future developments.

INSIDE AVALON

Building the Foundations for Innovation

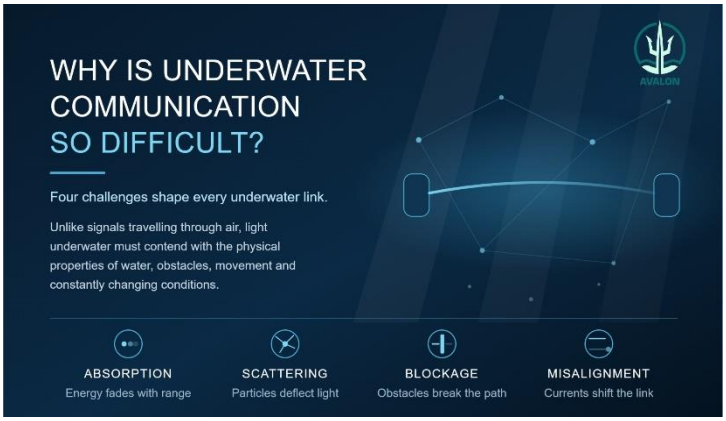
Every ambitious research project begins with a shared vision. AVALON brings together leading European organisations to explore the future of secure underwater optical communications, combining expertise drawn from research institutions, industry, and technology development.

The project addresses one of the most demanding communication environments known to engineering: the underwater domain. Progress here depends not only on scientific excellence, but on strong coordination, clear communication, security awareness, and sustained collaboration across the consortium.

Over the summer the consortium launched Inside AVALON, a public series exploring the scientific challenges, research themes, and innovation pathways that shape the project. The series shares high-level insights into the work carried out within AVALON while fully respecting the security and sensitivity requirements attached to it. It is accompanied by two further strands — AVALON Insights, offering educational explanations of underwater communications, and Behind AVALON, which examines how European collaborative research is conducted in practice.

AVALON INSIGHTS

Why Underwater Communication Is So Difficult



Underwater environments place severe constraints on communication systems. Unlike signals travelling through air, underwater signals must contend with the physical properties of water, with obstacles and movement, and with environmental conditions that change continuously.

Four challenges dominate. **Absorption** causes signal energy to be lost as it travels through water, limiting the distance over which a reliable link can be sustained. **Scattering** occurs when light interacts

with particles suspended in the water, redirecting it away from its intended path, weakening the received signal and degrading performance. **Blockage** arises when obstacles interrupt the direct path between transmitter and receiver — a particular concern in optical communication, where a clear line of sight matters a great deal and an interruption can temporarily sever the link altogether. **Misalignment**, finally, results from water currents, platform movement, and shifts in the position or orientation of underwater devices, any of which can cause optical transmitters and receivers to drift out of alignment.

Taken together, these effects make underwater communication a highly dynamic problem, and explain why it remains such an active field of research. Within AVALON, partners are investigating new optical technologies, intelligent communication strategies, and adaptive systems capable of responding to changing underwater conditions in order to maintain more reliable connections.

BEHIND AVALON

How European Collaborative Research Works

Innovative technologies are rarely the work of a single organisation. Contemporary scientific challenges are increasingly complex, demanding expertise across multiple disciplines and collaboration across countries, sectors, and research communities.

European collaborative research projects bring together universities, research centres, SMEs, and industry so that complementary knowledge and experience can be combined. Each partner contributes a distinct perspective, allowing ideas to develop through continuous discussion, validation, and joint problem-solving. This approach accelerates scientific progress, and it also helps ensure that research outcomes address real operational needs while drawing on expertise and facilities no single organisation could provide alone.

Within AVALON, partners from across Europe are working together on the future of secure underwater optical communications. By combining competencies in communications engineering, photonics, artificial intelligence, underwater systems, and defence technologies, the consortium is addressing scientific challenges that require a genuinely multidisciplinary approach.

WHAT COMES NEXT

Looking Ahead

The consortium will convene for its next in-person meeting on 22–23 October 2026, hosted by UPC at the Vilanova i la Geltrú campus near Barcelona. The autumn months will also see the Inside AVALON, AVALON Insights, and Behind AVALON series continue, with forthcoming topics including the use of light for underwater communications, underwater sensor networks, and the path from laboratory research to operational capability.

Follow AVALON on LinkedIn to keep up with the project as it develops.

PROJECT AT A GLANCE

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CONSORTIUM

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