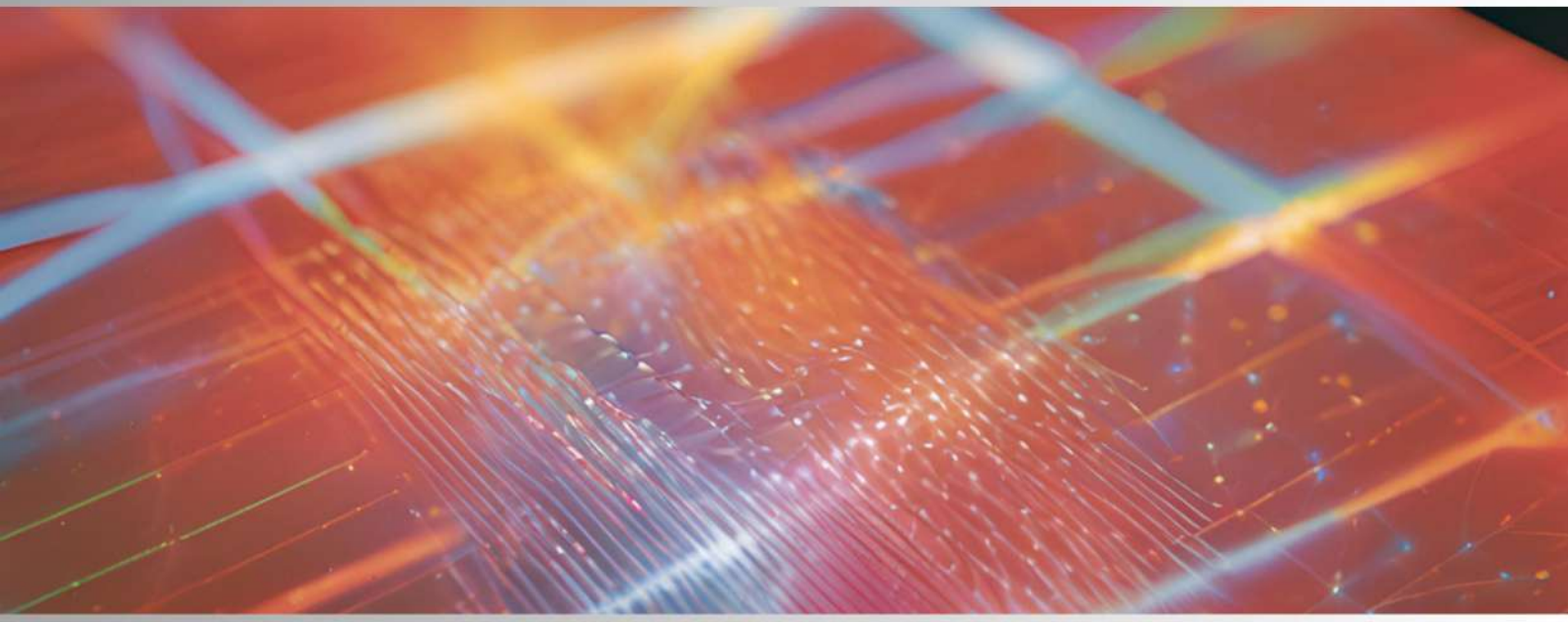
NEWSLETTER #2

Holo-CIM

HOLOGRAPHIC CLOUD ISING MACHINE



Welcome to **Holo-CIM** Newsletter *vol.2*!

The project

HoloCIM (Holographic Cloud Ising Machine) proposes a holography based photonic Ising Machine that utilizes and enhances newly established holographic and nonlinear photonics principles for the efficient solution of combinatorial optimization problems (COPs). The latter cannot be efficiently solved with modern digital computer architectures. HoloCIM aims to create an online user interface to be scientifically and commercially used from interested parties such as research institutions, academia, and industry.

Partners

UBITECH ubiquitous solutions

University of Cyprus

University of Cyprus Department of Computer Science

Laboratory of Ultrafast science

Research & Innovation Foundation

Funded by the European Union NextGenerationEU

Republic of Cyprus

www.holocim.eu

Project CODEVELOP-ICT-HEALTH/0322/0047, is funded by the European Union – NextGenerationEU, through the Research and Innovation Foundation

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Key Achievements

Development of two individual Ising machines:
v1: Up to 1 KHz phase modulation speed using a state of the art LC-SLM
v2: Up to 6 KHz amplitude modulation speed using DMD modulation technology

Development and implementation of novel encoding scheme
A novel Spin-Product Encoding (SPE) method enables on-demand, programmable, and reconfigurable control of Ising Hamiltonian interactions. By encoding only the non-zero couplings, SPE enhances the scalability of SPIMs, making them well-suited for large-scale optimization tasks, including sparse graphs. This allows SPIMs to tackle practical NP-hard problems—such as the Graph Partitioning Problem (GPP)—with performance comparable to classical solvers like METIS.

Enhance the fidelity and computational accuracy of SPIM:

- Interferometric Phase correction protocol: Compensate the wavefront distortions due SLM surface imperfections and light interaction with optical components
- Ensure uniform intensity distribution on the SLM enhancing the encoding precision of the interaction values.

Towards Ising-as-a-Service

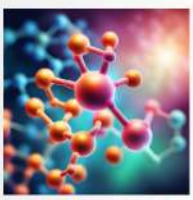
HoloCIM integrates the photonic hardware with:

- A modular control SW suite that orchestrates the optimization process ensuring smooth and reliable operation of SPIM.
- A **web-based portal** allowing remote users to solve optimization problems via a secure web portal.

Combinatorial optimization problems include many every day problems like:

Financial Portfolio Optimization
Find a combination of different stocks with high return and low risk

Molecular Design for Drug Discovery
Identify the molecular makeup of drugs with the desired efficacy



Logistic Optimization
Find a route with the shortest travel distance

Traffic Congestion Alleviation
Determine the route of each vehicle, to minimize congestion

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Event Participation

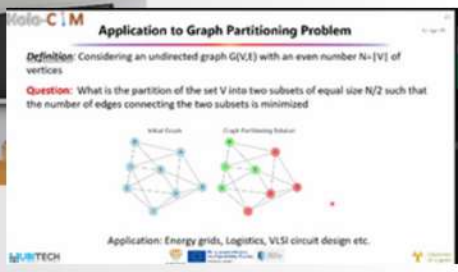
- **Workshop on Quantum Computing and Coherent Ising machines**

A mini-workshop on Quantum Computing and Coherent Ising machines in the context of HoloCIM Project was organized during 4 July 2024, Nicosia, Cyprus, featuring presentations about developments of the HoloCIM project by UBITECH and UCY/CS. The workshop explored applications of Ising machines to solve optimization problems in 6G Networks and in Planning, and finished with a presentation and visit at the University of Cyprus Ising machine developed from UCY/PH.

The HoloCIM project was presented at the **9th Innovation and Entrepreneurship Forum (IEF2024)**, a recurring event designed to foster dialogue and collaboration among academics, industry professionals, policy-makers, and entrepreneurs. During IEF2024, HoloCIM's representatives presented the project and its key functionalities to a wider audience.

- **HoloCIM's Training Workshop**

On April 11, 2025, the UCY/CS along with UBITECH organized an engaging hybrid training workshop showcasing the pioneering advancements of the HoloCIM Project. Participants also had the opportunity to interact with the HoloCIM platform and explore its full range of functionalities through hands-on demonstrations.



Part of the research work performed in the context of HoloCIM project was presented at the **17th IEEE/ACM International Conference on Utility and Cloud Computing (UCC 2024)** by UCY/CS representatives.

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Publications

- Sakellariou, J., Askitopoulos, A., Pastras, G., & Tsintzos, S. I. (2024, July). Encoding arbitrary Ising Hamiltonians on Spatial Photonic Ising Machines. https://doi.org/10.48550/arXiv.2407.09161

- Schetakis, N., Bonfini, P., Alisoltani, N., Blazakis, K., Tsintzos, S. I., Askitopoulos, A., ... & Vlahogianni, E. I. (2025, January). Data re-uploading in Quantum Machine Learning for time series: application to traffic forecasting. https://doi.org/10.48550/arXiv.2501.12776

- Wang, R. Z., Cummins, J. S., Syed, M., Stroev, N., Pastras, G., Sakellariou, J., ... & Berloff, N. G. (2025, March). Efficient computation using spatial-photonic Ising machines with low-rank and circulant matrix constraints. Communications Physics, 8(1), 86. https://www.nature.com/articles/s42005-025-01987-5.pdf

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