

WOJCIECH KRZEMIENÍ  
KONRAD KLIMASZEWSKI  
LECH RACZYŃSKI

**PREFACE:  
2ND INTERNATIONAL WORKSHOP  
ON MACHINE LEARNING  
AND QUANTUM COMPUTING  
APPLICATIONS  
IN MEDICINE AND PHYSICS**

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# WMLQ 2024

## PROCEEDINGS OF THE 2ND INTERNATIONAL WORKSHOP ON MACHINE LEARNING AND QUANTUM COMPUTING APPLICATIONS IN MEDICINE AND PHYSICS

### List of topics:

- machine learning in medicine,
- machine learning in high-energy physics and astrophysics,
- AI for fast simulations,
- quantum computing and machine learning,
- quantum simulations,
- novel methods in medical imaging,
- High-Performance Computing (HPC) in physics and medicine.

### Co-chairs:

- Wojciech Krzemień  
(National Centre for Nuclear Research)
- Konrad Klimaszewski  
(National Centre for Nuclear Research)



<https://events.ncbj.gov.pl/event/314/>



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## **Preface**

The articles in this volume are based on selected contributions to the 2nd International Workshop on Machine Learning and Quantum Computing Applications in Medicine and Physics (WMLQ2024 [1]), which took place in Warsaw from June 4 to June 7, 2024. Organized by the National Centre for Nuclear Research (NCBJ) in collaboration with scientists from the University of Vienna, Jagiellonian University, and the Polish National Competence Centre in HPC Phase 2 (EuroCC2), this workshop served as a platform to incite knowledge exchange and interdisciplinary collaboration at the intersection of physics, medicine, and computational sciences.

With the rapid advancement of machine learning (ML) and quantum computing (QC), new opportunities continue to emerge for solving complex problems in diverse fields, including medical imaging, radiotherapy, and fundamental physics. WMLQ2024 brought together leading researchers and practitioners to discuss cutting-edge developments in quantum simulations, quantum algorithms, and both classical and quantum machine learning techniques.

This volume reflects the breadth and depth of research presented at the workshop, covering a wide range of topics, from advances in High-Performance Computing (HPC) such as AI-driven cloud infrastructures for scientific computing [2], platform for quantum machine learning models [7], and artificial intelligence in cybersecurity [5] to AI applications to high-throughput data in medicine in particular transcriptome profiling for disease research [3]. Additional sessions dedicated to advances in computational analysis and machine learning applications in physics and astrophysics were held at the workshop. Notably, contributions to this volume include discussions on muon bundle reconstruction in neutrino detectors [4], astrophysical data analysis [8], and the optimization of time-of-flight resolution in positron emission tomography [6].

The contributions collected here underscore the interdisciplinary nature of modern computational research and its impact on scientific discovery and technological innovation. We hope that this volume will serve as a valuable resource for researchers, engineers, and practitioners interested in the evolving frontiers of machine learning and quantum computing in Medicine and Physics.

We extend our sincere gratitude to all the participants, speakers, and contributors who made WMLQ2024 a success, as well as to the organizing institutions for their dedication and support. We also acknowledge the reviewers for their efforts in ensuring the high quality of the papers included in this volume. We wish to acknowledge the support of the Polish Ministry of Education and Science in the frame of the “Doskonała Nauka II” programme (KONF/SN/0294/2023/01). The project was co-financed by the National Centre for Research and Development in the frame of the European High-Performance Computing Joint Undertaking (JU) programme under grant agreement No 101101903. The JU receives support from the Digital Europe Programme and Germany, Bulgaria, Austria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Lithuania, Latvia, Poland,

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## Affiliations

### Wojciech Krzemień

National Centre for Nuclear Research, High Energy Physics Division,  
05-400 Otwock-Swierk, Poland, wojciech.krzemien@ncbj.gov.pl

### Konrad Klimaszewski

National Centre for Nuclear Research, Department of Complex Systems,  
05-400 Otwock-Swierk, Poland, konrad.klimaszewski@ncbj.gov.pl

### Lech Raczynski

National Centre for Nuclear Research, Department of Complex Systems,  
05-400 Otwock-Swierk, Poland, lech.raczynski@ncbj.gov.pl