Quantum Computing and Data Science
CAMK PAN
Report for 2025

Piotr Gawron

Nicolaus Copernicus Astronomical Center, Polish Academy of Sciences

CAMK PAN reporting meeting
Warsaw, 05 January 2026

Group members

Researchers

- Piotr Gawron (1/5 FTE)
- Tomasz Rybotycki (1/5 FTE)
- Piotr Kalaczyński (1/5 FTE)

Collaborators

- Ryszard Kukulski (IT4I, CZ)
- Sebastian Dziura (PG's PhD student@AGH)
- Dawid Mazur (PG's PhD student@AGH)

LUMI-Q

Large Unified Modern Infrastructure-Quantum

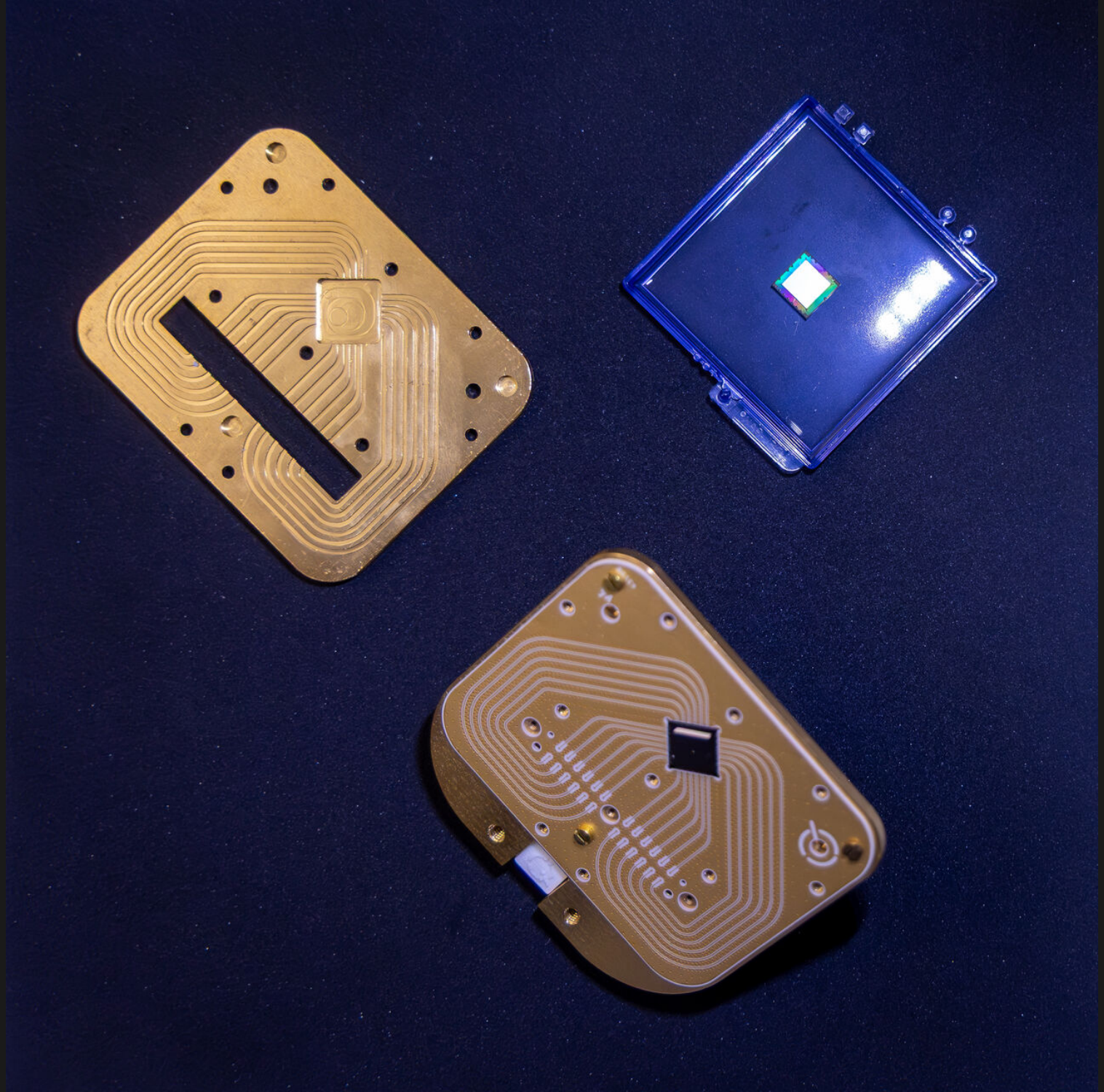
Goal

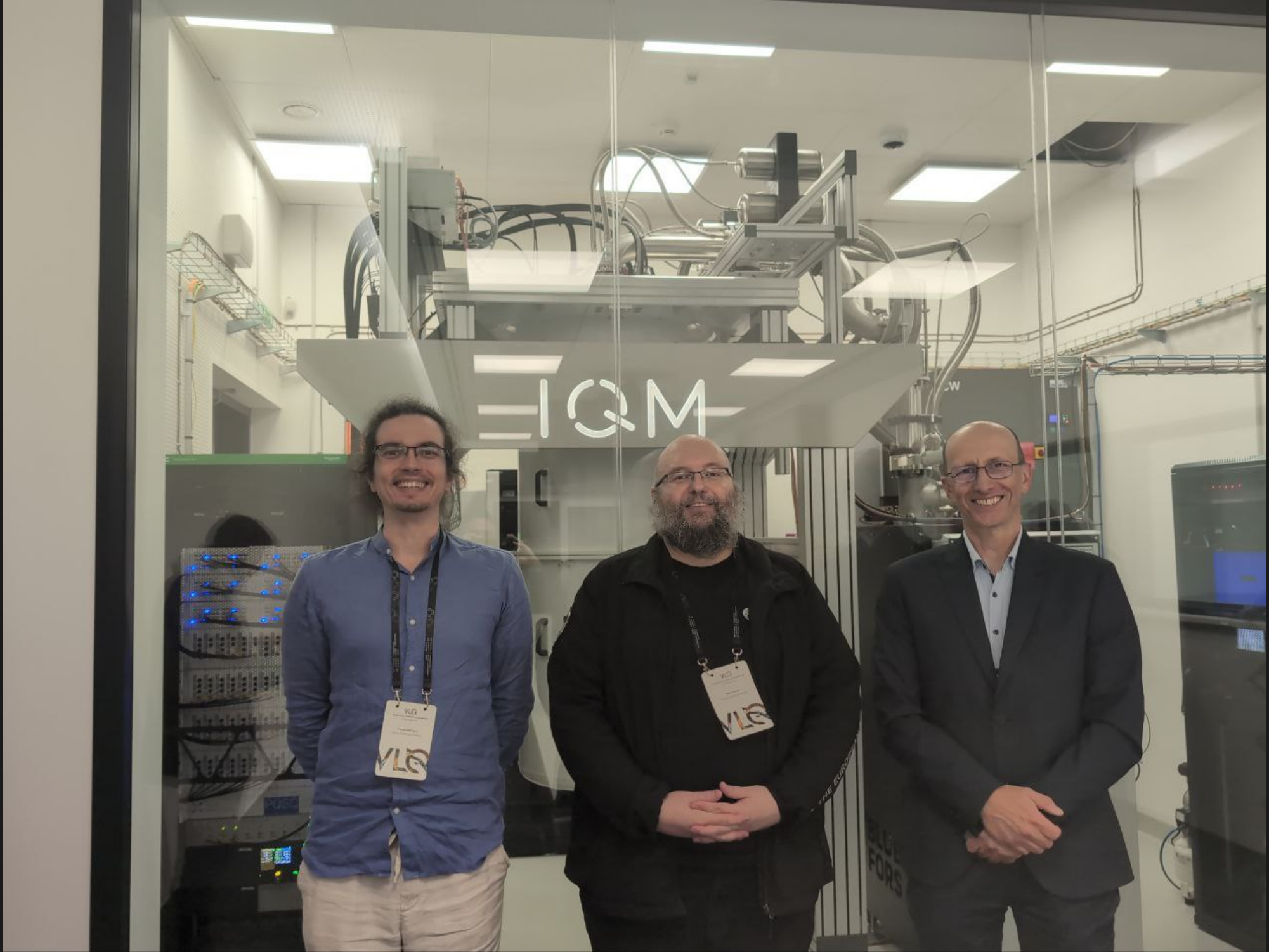
To acquire, operate and integrate with HPC systems a 24-qubit quantum computer.

Location

- VSB — Technical University of Ostrava, IT4Innovations National Supercomputing Center, CZ.


IQM
IQM
BLUEFORS




IQM

EUROQHPC-I

Integration of European quantum computers and simulators into HPC supercomputers

Funding & tasks

- $\approx$ 450K EUR
- use-cases for QC — gravitational waves, Earth observations
- providing manuals, code examples

Partners

- 30 organizations from Europe

DIGITAL-EUROHPC-JU-2022-HPCQC-04-IBA

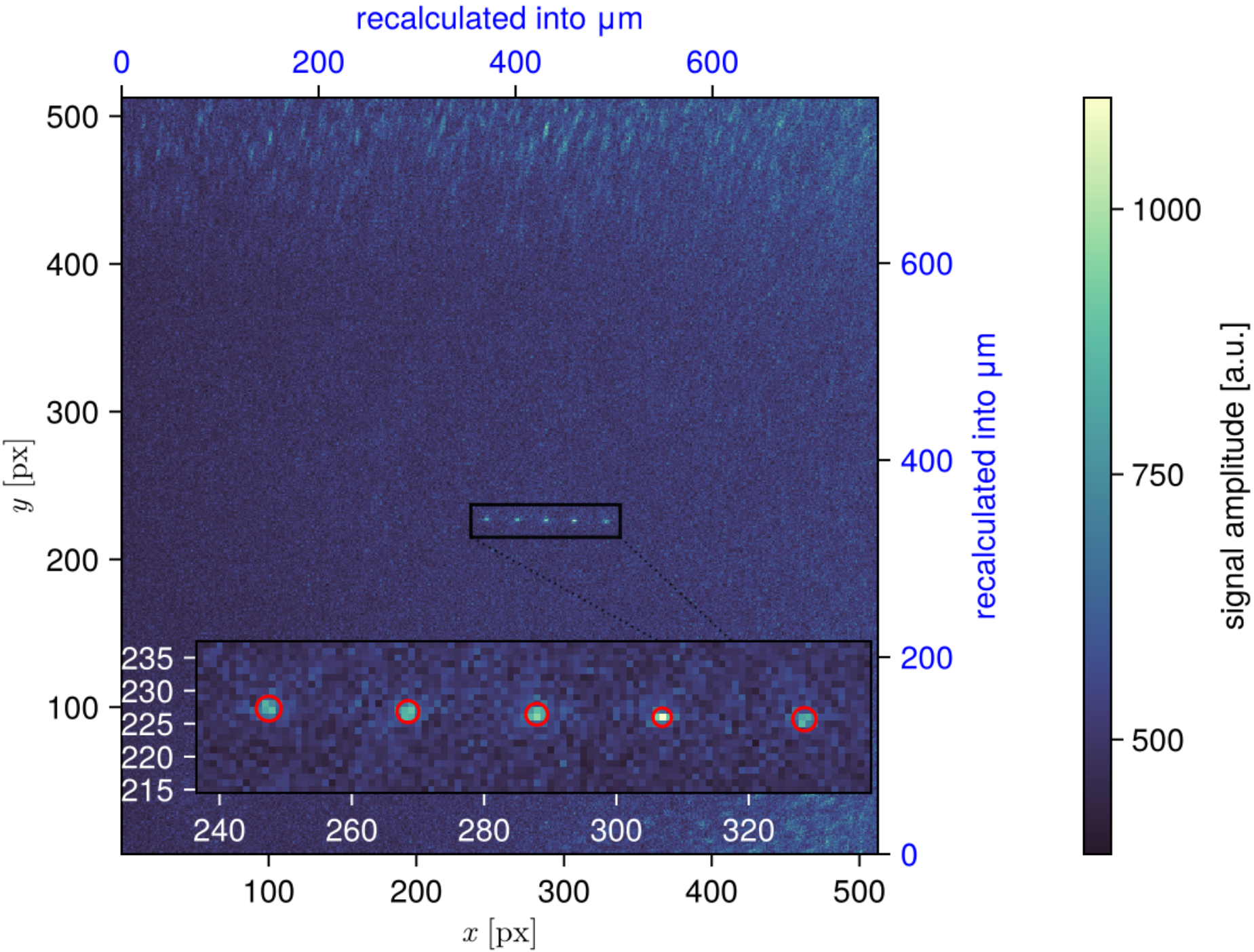
MIKOK — Sonovero R&D, 4Enlight

Goal

To develop compiler software for an ion-trapped quantum computer located in Warsaw.

Components

- Experiment life-cycle management
- Experiment-related data storage and management
- Queue management
- Digital model of the ion trap
- Measurement module


recalculated into µm
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235
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225
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215
240
260
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320
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1000
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500
signal amplitude [a.u.]

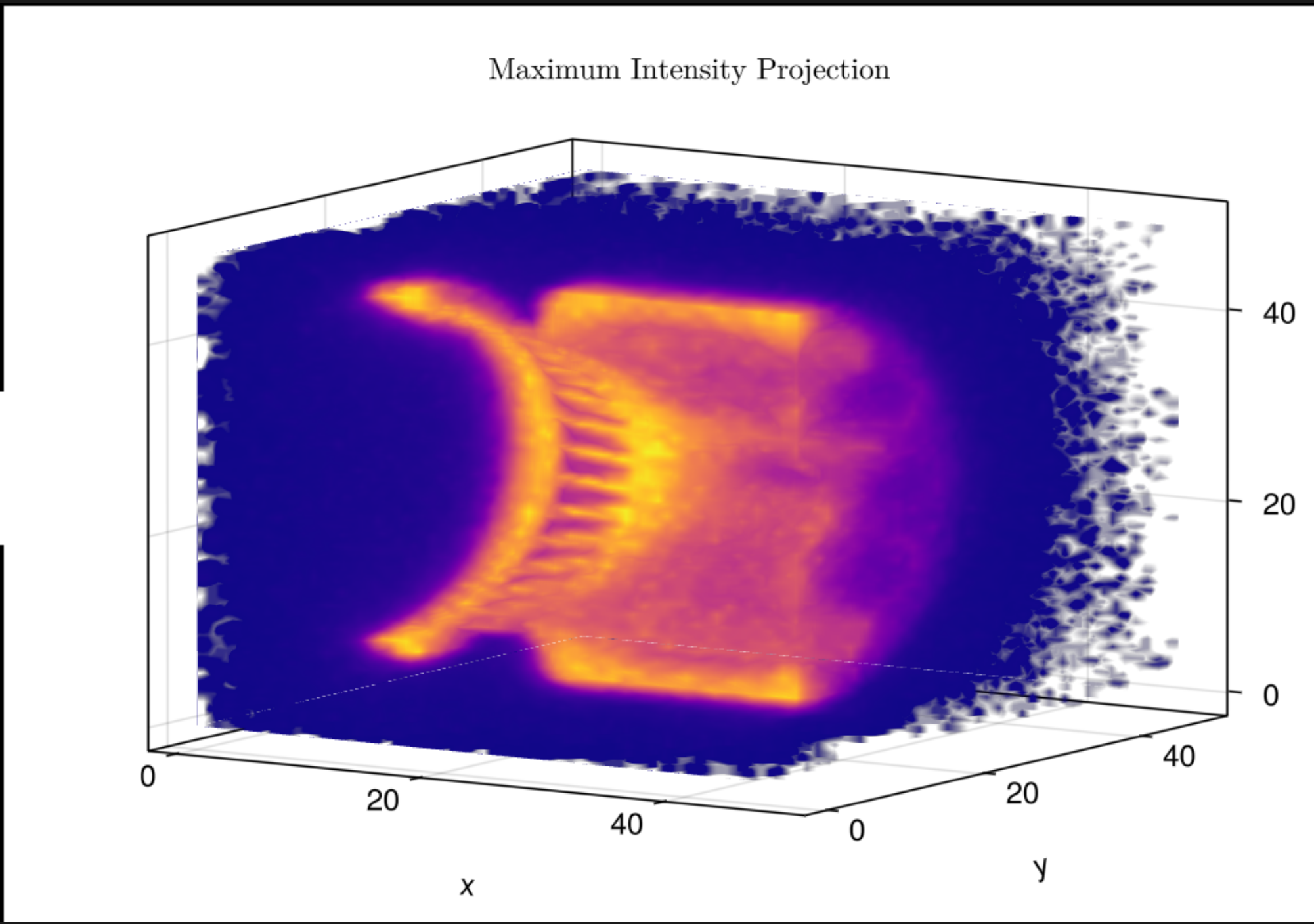
Muography — Muotech Sp. z o.o.

Feasibility study for precision NDT with muon tomography

- muon simulations with Geant4
- muon tomography analysis

Collaboration

- Azam Zabihi
- Marcin Kuźniak


Maximum Intensity Projection
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40
x
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40
y
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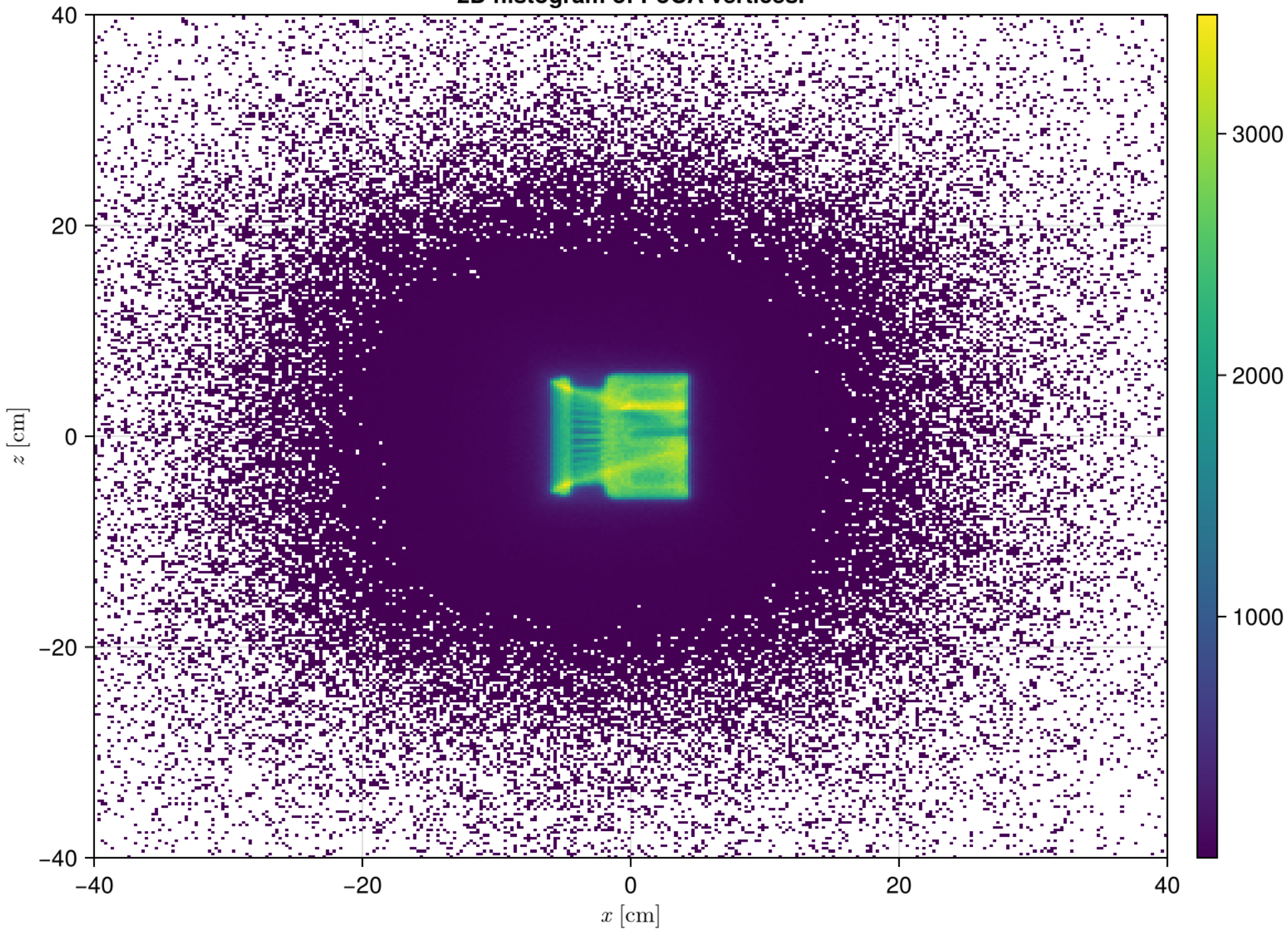
20
40


2D histogram of PoCA vertices.
40
20
0
−20
−40
z [cm]
−40
−20
0
20
40
x [cm]
3000
2000
1000

Spectral Information Processing with Quantum Neural Networks (SIPwQNN) — closed

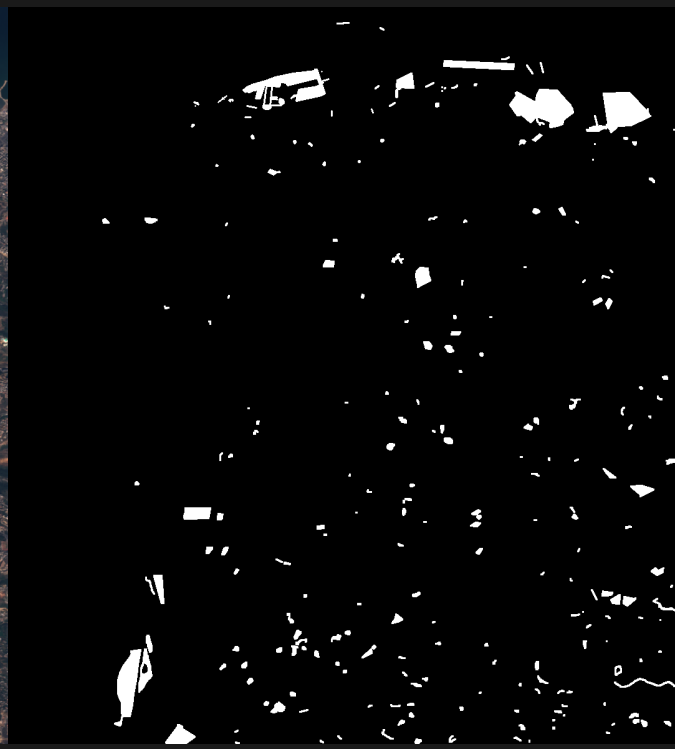
- hyperspectral satellite image change detection using QNNs,
- case study of QML on real machines,
- explainability metrics for QML,
- we're working on using AutoQML to investigate similar approach even further.

esa Φ-lab

Ministry of Science and Higher Education
Republic of Poland

CAMK PAN





Other activities

Projects submited

- GOQART (Goal-Oriented Quantum Architecture Rating and Testing) submitted to the QuantERA 2025.
  Tomek Rybotycki — PI@CAMK
- Research Software Engineering and FAIR Data Training submitted to COST call OC-2025-1.

Papers I

The KM3NeT Collaboration: S. Aiello et al., "gSeaGen code by KM3NeT: An efficient tool to propagate muons simulated with CORSIKA," *Computer Physics Communications*, vol. 314, p. 109660, Sept. 2025.
Important contribution of P. Kalaczyński.

The KM3NeT Collaboration: S. Aiello et al., "Observation of an ultra-high-energy cosmic neutrino with KM3NeT," *Nature*, vol. 638, pp. 376–382, Feb. 2025.
Nature cover!

The KM3NeT Collaboration: S. Aiello et al., "Measurement of the atmospheric ν_μ flux with six detection units of KM3NeT/ORCA," *Eur. Phys. J. C*, vol. 85, p. 871, Aug. 2025.

The KM3NeT Collaboration: S. Aiello et al., "Probing invisible neutrino decay with the first six detection units of KM3NeT/ORCA," *Journal of High Energy Physics*, vol. 2025, p. 105, Apr. 2025.

The KM3NeT Collaboration: S. Aiello et al., "Study of tau neutrinos and non-unitary neutrino mixing with the first six detection units of KM3NeT/ORCA," *Journal of High Energy Physics*, vol. 2025, p. 213, July 2025.

The KM3NeT Collaboration: S. Adriani et al., "Ultrahigh-Energy Event KM3-230213A within the Global Neutrino Landscape," *Physical Review X*, vol. 15, p. 031016, July 2025.

The KM3NeT Collaboration: S. Adriani et al., "On the Potential Cosmogenic Origin of the Ultra-high-energy Event KM3-230213A," *The Astrophysical Journal Letters*, vol. 984, p. L41, May 2025.

P. Kalaczyński, "Reconstruction of muon bundles in km3net detectors using machine learning methods: on behalf of the KM3NeT collaboration," *Computer Science*, vol. 26, Jul. 2025.

T. Rybotycki, T. Białecki, J. Batle, J. Tworzydło, and A. Bednorz, "Cross-platform certification of the qubit space with a minimal number of parameters," *Scientific Reports*, vol. 15, no. 1, p. 43201, 2025.

Papers II

T. Rybotycki, T. Białecki, J. Batle, B. Zglinicki, A. Szereszewski, W. Belzig, and A. Bednorz, "Testing time order and leggett-garg inequalities with noninvasive measurements on public quantum computers," *EPJ Quantum Technology*, vol. 13, no. 1, p. 8, 2026.

T. Rybotycki and P. Gawron, "Aqmlator – an auto quantum machine learning e-platform," *Computer Science*, vol. 26, Jul. 2025.

D. Mazur, T. Rybotycki, and P. Gawron, "Hyperspectral image segmentation with a machine learning model trained using quantum annealer," in *Computational Science – ICCS 2025 Workshops* (M. Paszynski, A. S. Barnard, and Y. J. Zhang, eds.), (Cham), pp. 195–209, Springer Nature Switzerland, 2025.

S. Illésová, T. Rybotycki, P. Gawron, and M. Beseda, "On the importance of fundamental properties in quantum-classical machine learning models," 2025.
Accepted for publication in: International Journal of Parallel, Emergent and Distributed Systems.

J. Batle, T. Białecki, T. Rybotycki, J. Tworzydło, and A. Bednorz, "Efficient discrimination between real and complex quantum theories," *Quantum*, vol. 9, p. 1595, Jan. 2025.

S. Illésová, T. Rybotycki, and M. Beseda, "Qmetric: Benchmarking quantum neural networks across circuits, features, and training dimensions," 2025.

T. Rybotycki, M. K. Gupta, and P. Gawron, "Explainable quantum machine learning for multispectral images segmentation: Case study," 2025.

M. Romaszewski, M. K. Gupta, and P. Gawron, "Potential of quantum machine learning for processing multispectral earth observation data," *Bulletin Of The Polish Academy Of Sciences-Technical Sciences*, vol. 73, no. 5, p. E154279, 2025.

Thank you

This year goals

- Continue to be **self funded** as the group.
- Hire a junior researcher/engineer.
- Extend current collaborations.