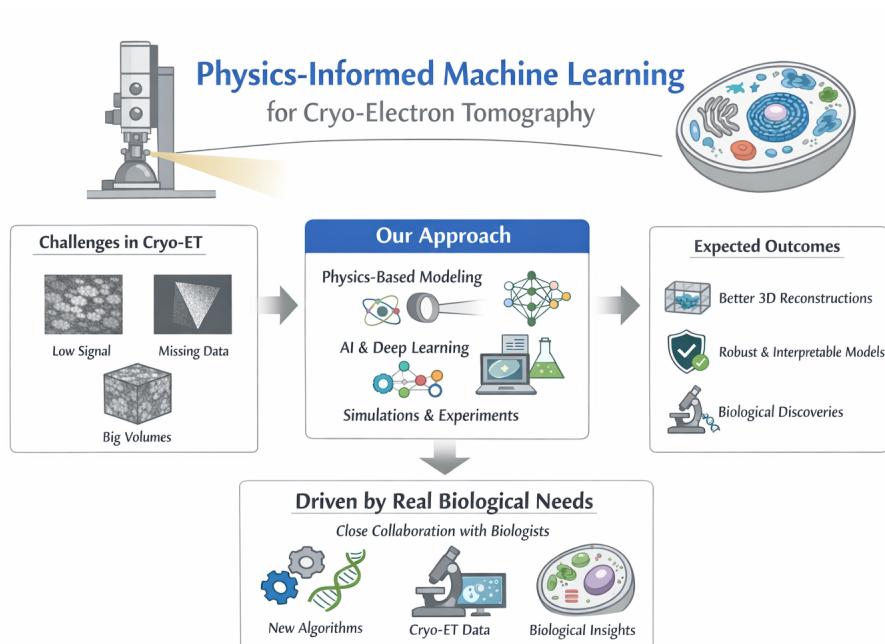


PhD thesis

Physics-Informed Machine Learning for Cryo-Electron Tomography

Supervision:

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Context and objectives

How can we reveal the molecular organization of living cells directly in their native environment? Cryo-electron tomography (cryo-ET) is one of the most powerful imaging techniques available today to answer this question. Yet, despite remarkable progress in microscopy, extracting reliable 3D information from cryo-ET data remains a major scientific challenge.

This PhD project offers the opportunity to tackle this problem by developing next-generation computational methods at the intersection of machine learning, physics, and structural biology. The goal is not only to improve performance, but to rethink how we model the imaging process itself.

A project driven by real biological questions

This work will be guided by concrete challenges faced by biologists. You will collaborate closely with experimentalists and test your ideas on real datasets acquired on state-of-the-art microscopes.

A central ambition of the project is to go beyond “black-box” AI and design approaches that explicitly incorporate the physics of cryo-ET: microscope optics, acquisition geometry, and noise processes [1, 2].

By improving the modeling, we aim to build methods that are more robust, more interpretable, and ultimately more useful for scientific discovery.

Scientific approach and expected skills

During the PhD, you will explore new ways to combine modeling and learning. This includes leveraging realistic simulations, working with partially observed and noisy data, and designing algorithms that scale to large 3D volumes. You will be encouraged to develop original ideas and to connect theory with practice.

The project is highly interdisciplinary, offering a unique opportunity to move across fields while maintaining a strong methodological core.

We are seeking a curious and motivated candidate with a strong background in applied mathematics, machine learning, or signal processing, and a desire to engage with real-world scientific problems. An interest in modeling and interdisciplinary research is essential.

An important part of the work will involve implementing and testing the proposed models. Experience with programming and scientific computing is therefore important. Knowledge of modern deep learning frameworks such as PyTorch, as well as familiarity with GPU computing, will be beneficial.

Why apply?

This PhD offers the opportunity to work on fundamental questions with real-world impact, to connect theory with experimental science, and to grow in a supportive and ambitious research environment. It provides a strong foundation for pursuing a career in academic or industrial research.

Research environment

You will join a collaborative environment where computational scientists and biologists work side by side. The project is supported by a leading structural biology institute equipped with cutting-edge cryo-EM facilities (including Titan Krios and FIB-SEM), providing direct access to high-quality experimental data. This setting ensures that your work will not remain theoretical: it will be continuously confronted with real-world data and scientific questions.

Moreover, you will join a dynamic and collaborative research group at CREATIS (Lyon), where several PhD students and postdoctoral researchers work on closely related topics. This environment provides interactions between machine learning, imaging, and applied mathematics.

You will also have opportunities to supervise master's interns, contribute to open-source scientific software, and participate in collaborative research projects at both national and international levels. The project is supported by funded research programs, ensuring regular participation in major international conferences, as well as opportunities for research stays in France or abroad and interactions with leading international researchers.

How to apply? Please send a curriculum and your academic records to

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This position will remain open until a suitable candidate is found.

References

- [1] Vinith Kishore, Valentin Debarnot, AmirEhsan Khorashadizadeh, Ricardo D Righetto, Benjamin D Engel, and Ivan Dokmanić. Cryolithe: Rapid cryo-et reconstruction via transform-localized deep learning. *arXiv preprint arXiv:2501.15246*, 2026.
- [2] Vinith Kishore, Valentin Debarnot, Ricardo D Righetto, Benjamin D Engel, and Ivan Dokmanić. Icecream: High-fidelity equivariant cryo-electron tomography. *Acta Crystallographica Section D*, pages 2026–03, 2026.