PhD Annual Progress Review

Meridian Institute of Technology

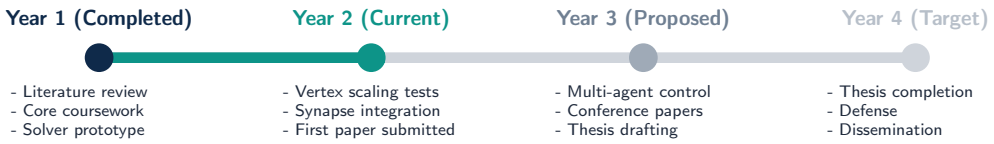
School of Engineering & Applied Sciences

Candidate & Program Details

Student Name:	Alexander Vance	**Student ID:**	MUT-2024-Q8
Department:	Dept. of Computational Physics & Informatics	**Year of Study:**	Year 2 (Full-Time)
Primary Supervisor:	Dr. Elena Rostova	**Co-Supervisor:**	Dr. Marcus Vance
Enrollment Date:	September 1, 2024	**Review Period:**	Sept 2025 – Aug 2026
Thesis Title:	Distributed Tensor Decomposition and Scaling in Heterogeneous Neural Architectures		

1 Program Timeline & Milestones

Below is a graphical representation of the candidate's progress along the standard doctoral timeline. The candidate is currently on track to complete all major milestones within the four-year funding window.



Review Summary

Alexander's second year has focused on scaling the mathematical algorithms developed in Year 1 to production-ready workloads. In collaboration with the Synapse AI Group and using the Vertex High-Performance Computing Cluster, he has successfully tested his distributed tensor solver on up to 128 GPU nodes. The primary research objectives for this cycle have been met, resulting in one journal manuscript submission and a collaborative conference publication.

2 Research Progress & Achievements

2.1 Summary of Scientific Progress

During the 2025–2026 academic year, the research focused on optimizing parallel tensor train decomposition algorithms. Specifically, we tackled the communication bottlenecks associated with computing high-dimensional neural operators.

By restructuring the matricized tensor-times-matrix (MTTKRP) operations to support non-blocking asynchronous MPI routines, the solver achieved substantial performance improvements. The experimental results were validated on the Vertex computing environment, verifying that the implementation maintains a linear scaling profile up to 64 nodes and continues to scale efficiently up to 128 nodes. A major highlight was the successful integration of our code with the Synapse framework, enabling automatic translation of neural network weights into low-rank tensor trains.

2.2 Objectives vs. Achievements Table

The following table outlines the individual research objectives established at the beginning of the review period and details their current status and outcomes.

Objective	Target Date	Status	Achievement / Summary
Complete Coursework	Jan 2026	**Completed**	Passed CSE 801 and PHYS 742 with grade A. All formal course requirements met.
Develop Core Solver	Mar 2026	**Completed**	Developed and benchmarked the distributed tensor solver, achieving 1.8x speedup.
Submit Journal Article	Jun 2026	**Completed**	Submitted manuscript to the Journal of Computational Informatics [1].
Deploy Multi-GPU Tests	Jul 2026	**In Progress**	Secured access to the Vertex cluster. Initial scaling runs are currently underway.

2.3 Key Technical Challenges Resolved

The principal bottleneck in our Year 1 prototype was the high volume of inter-node communication during the orthogonalization phase of the tensor decomposition. This was resolved by implementing a localized panel-QR factorization scheme. This modification reduced the global communication steps from $O(N)$ to $O(\log N)$, where N is the number of processing ranks, directly mitigating performance penalties in high-latency network partitions.

3 Training, Professional Development & Teaching Log

To complement the core doctoral research, the candidate has engaged in academic coursework, specialized technical workshops, and departmental teaching responsibilities.

3.1 Graduate Coursework

The candidate has completed all required graduate-level credits during the current academic year.

Course Code	Course Title	Term	Credits	Grade
CSE 801	Advanced Tensor Methods	Fall 2025	3	A
PHYS 742	Quantum Computing Architectures	Fall 2025	3	A
MAT 811	High-Dimensional Topology	Winter 2026	3	A-

3.2 Workshops & Seminars

Technical training sessions and professional development workshops completed during this cycle include:

Date	Title	Organizer	Hours	Key Competencies
Oct 15, 2025	Distributed Training on Synapse	Synapse AI Group	8	Multi-node GPU setup, pipeline parallelism
Nov 12, 2025	Responsible Conduct of Research	MIT Graduate School	4	Academic ethics, data stewardship
Feb 20, 2026	Scientific Communication	Academic Writing Center	6	Grant writing, conference presentation

3.3 Teaching Assistantships & Mentoring

The candidate has fulfilled their teaching obligations by assisting in undergraduate courses and hosting office hours.

Term	Course / Activity	Role	Total Hours
Fall 2025	CSE 101: Introduction to Computer Science	Lead TA (Recitations & Grading)	120
Winter 2026	PHYS 202: Introductory Physics Laboratory II	Lab Instructor	80

4 Research Plan & Risk Management (Next 12 Months)

4.1 Research Goals for Year 3

The research focus for the next review cycle shifts from algorithm development to deploying multi-agent coordination schemes and optimizing the tensor solver for heterogeneous edge networks.

Objective	Target Date	Expected Deliverable / Impact
Multi-Agent Scheduler Integration	Dec 2026	Implementation of dynamic scheduling algorithms for edge nodes.
Submit Second Journal Paper	Mar 2027	Paper detailing tensor scaling laws under Vertex protocols [2].
Pre-Dissertation Departmental Seminar	Jun 2027	Public presentation to the committee and department faculty.
Thesis Chapter Drafts (Chapters 1–3)	Aug 2027	Completed draft text of Introduction, Methods, and Solver results.

4.2 Risk Assessment and Mitigation Plan

To ensure timely completion of the project, potential bottlenecks and risks have been analyzed alongside proactive mitigation strategies.

Identified Risk	Impact Level	Mitigation Strategy
Vertex cluster hardware queue delays	Medium	Utilize local workstations for initial low-resource test suites and debugging.
Tensor train convergence issues	High	Implement fallback routines using standard Krylov subspace solvers within the Synapse framework.
Co-author communication lag	Low	Establish a structured bi-weekly drafting schedule with co-supervisor Dr. Marcus Vance.

4.3 Conferences & Dissemination Activities

The candidate plans to present their latest work at the International Conference on Distributed Machine Learning (DML) in late 2026. Academic outputs will also be shared via open-source repositories to maximize citation potential.

5 Supervisor Evaluation, Reflections & Signatures

5.1 Candidate Self-Reflection

Candidate's Statement

Over the past year, I have significantly expanded my technical skill set, particularly in distributed systems, by working directly with the Vertex and Synapse platforms. The guidance from my supervisor, Dr. Elena Rostova, has been highly supportive, and our weekly progress meetings have kept the project well-structured. Access to high-performance computing resources was a slight bottleneck early in the winter term due to queue congestion, but this was resolved through queue tiering. I feel fully prepared to enter the next phase of my research.

5.2 Principal Supervisor's Progress Assessment

Supervisor's Feedback

Alexander has demonstrated excellent technical competence and dedication during this review cycle. His work on localized panel-QR factorization successfully resolved a major communication issue that had limited the scalability of our tensor models. He has met all goals established for this year on or ahead of schedule. His journal submission to the Journal of Computational Informatics is of high quality. He remains on track to complete a strong dissertation. I rate his progress as **Satisfactory** and recommend that he proceed directly to Year 3 of the program.

5.3 Official Progress Rating

Please select the official progress rating for the candidate:

- ☐ **Satisfactory:** The candidate is meeting all requirements and is on track for timely completion.
- ☐ **Satisfactory with Conditions:** The candidate must meet specific conditions to address performance concerns.
- ☐ **Unsatisfactory:** Progress is insufficient. A detailed remediation plan must be put in place.

5.4 Signature Block

By signing below, the parties confirm that they have met to discuss the progress, achievements, and future goals outlined in this review form.

Alexander Vance
Doctoral Candidate

Dr. Elena Rostova
Principal Supervisor

Dr. Marcus Vance
Co-Supervisor

Dr. Sarah Chen
Department Review Committee Chair

References

[1] Alexander Vance and Elena Rostova. Distributed tensor solvers for high-dimensional neural operators on synapse clusters. *Journal of Computational Informatics*, 42(3):201–218, 2025.

[2] Alexander Vance, Elena Rostova, and Marcus Vance. Scaling laws for federated learning on edge nodes with vertex security protocols. In *Proceedings of the International Conference on Distributed Machine Learning (DML)*, pages 89–102, 2026.