# Conclusions

## Summary and Future Prospects

- **The Challenge:** Sparse 3D data from FASERCal demanded methods beyond conventional approaches.
- **The Solution:** *This thesis successfully **developed and validated** a complete deep learning framework, based on a hybrid SCNN-Transformer architecture with self-supervised pre-training.*
  - *Key Breakthroughs*: sensitivity to rare signals, kinematic fidelity reconstruction.
- **Future Prospects**:
  - Bridge Sim-to-Real gap with FASERCal prototype (ETH, 2026).
  - Validation for full detector deployment (2030).
- **Broader Impact:**
  - Results will be presented at *Neutrino Physics & ML 2025* (Tokyo).
  - This work is a foundation for my PhD research at ETH & CERN (Prof. Rubbia, Dr. Alonso-Monsalve)

# Backup