

Ibon García Gómez

MSc Particle Physics student; physics & machine learning research at IFCA-CSIC

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Education

MSc in Particle Physics

Oct 2025 – Jul 2027 (expected)

University of Cantabria.

Master's Thesis at IFCA-CSIC under Prof. Diego Herranz and Dr. Marcos Cruz, on the science case of the ESA ARRAKIHS mission. I am a member of the ARRAKIHS Science Collaboration. In parallel, a 6 ECTS Research Project at IFCA-CSIC under Prof. Jordi Duarte on hexagonal 3D-trench silicon pixels.

BSc in Physics

2021 – Feb 2026

University of Cantabria, with the English-track Mention (English-taught core curriculum).

Final-year thesis on the numerical simulation of gravitational-wave emission from r-mode instabilities in rapidly rotating neutron stars.

Research Experience

Hexagonal 3D-Pixel Position Reconstruction via HalfHexCNN

2026 – IFCA-CSIC, completed

Research Project, supervised by Prof. Jordi Duarte.

I developed HalfHexCNN, a dual-branch neural network that exploits the D_{6h} point-group symmetry of the hexagonal pixel cell to reduce the reconstruction problem. Instead of regressing positions over the full cell, the model maps every hit into a 30° fundamental domain (one twelfth of the cell) and regresses the position there; the physical coordinates are then recovered by applying the inverse symmetry transform. One branch feeds the raw TPA-TCT current waveforms (2×512 samples) into a CNN; the other passes 323 engineered symmetry features through an MLP. With around 483 000 parameters, the network achieves a median Euclidean error of $1.97 \mu\text{m}$, 97.6 % sextant classification accuracy, and above 99 % mirror-fold accuracy on the held-out test set.

Neural Fast Monte Carlo for Radiotherapy: Proton PBS and Photon EBRT

2025 – present & independent

Self-directed research line. The photon project uses anonymised clinical data kindly shared by a medical physicist at Hospital Universitario de León; the Monte Carlo campaigns ran on the Altamira supercomputer.

Proton (Neural Fast Monte Carlo). I built a differentiable pencil-beam engine (85-energy machine lookup tables, water-equivalent-depth ray-tracing, two-stage Monte Carlo calibration) with a zero-init xLSTM residual corrector, on the open DoseRAD2026 benchmark (around 81 000 Geant4 beamlets). Engine-only validation on held-out patients reaches 89–95 % median $\gamma_{1\%/1\text{ mm}}$ pass rate depending on terrain, with R80 error of about 0.3 mm; the codebase is test-driven (363 tests) and has survived six rounds of adversarial code-and-physics audit.

Photon (dose prediction). A Geant4 / OpenGATE dataset (around 1600 single-beam doses, 9 patients, 3 weeks on Altamira) and a 3D TransUNet+FiLM surrogate that predicts the full 3D dose in about one second. The validation pass rate ($\gamma_{3\%/3\text{ mm}}$) against the clinical treatment planning system is around 76 % on training patients and around 61 % held-out, below clinical-grade thresholds but sufficient to validate the surrogate approach. Next step: plugging the differentiable surrogate into an inverse-planning loop, the direction the IMPT optimizer project below now takes. This project reached the finalist stage of the UCEM innovation call (2026).

Deep U-Net for Faint Stellar Stream Detection amidst Galactic Cirrus

2025 – 2027 – IFCA-CSIC

Master's Thesis, supervised by Prof. Diego Herranz. Member of the ARRAKIHS Science Collaboration (ESA F-class mission, selected 2023, launch ~2030).

The goal is to detect faint stellar streams in images from the ARRAKIHS mission, which is difficult because streams and galactic cirrus have near-identical morphology in any single band. The model is a U-Net trained on official ARRAKIHS simulated images, which keeps the domain shift to real mission data small. On the test split the model reaches a pixel-level IoU of 0.97 and a per-image median IoU of 0.95. An earlier iteration generated its own training data with a physics-informed synthetic pipeline (fractal cirrus noise, Bézier streams over real SDSS/WISE backgrounds); the thesis now trains on the mission's official simulations as part of the ARRAKIHS data analysis chain.

Position Reconstruction in Square 3D-Trench Silicon Pixels

Feb 2026

Predecessor of the hexagonal-pixel project. Multi-domain CNN exploiting the C_{2v} point group.

This network fuses time-domain, frequency-domain and C_{2v} group-theoretic features, and was tuned with multi-seed Bayesian hyperparameter optimisation on TPA-TCT data provided by Prof. Duarte's group. It reaches a median Euclidean error of $2.12 \mu\text{m}$ over the full pixel cell, with 91.1 % quadrant classification accuracy. The dataset is publicly released on Kaggle for reproducibility.

IMPT Inverse Optimizer

2026 – present ù team lead, in development

Multi-objective DVH inverse optimizer for intensity-modulated proton therapy, built on a differentiable fast Monte Carlo dose engine.

I lead a small team building an optimizer that outputs clinically actionable machine parameters (PBS spot monitor-unit weights) under hard machine-deliverability constraints. The codebase is test-driven (578 tests, CI, strict type checking) with claims pre-registered ahead of real-engine validation; in development.

Professional Experience

Machine Learning Engineer (remote)

Jan 2026 – present ù Solvent

Industrial ML for port logistics; the end client operates in the Port of Bilbao.

I design the machine learning that decides where incoming containers are stacked in a container terminal of the Port of Bilbao, with the goal of minimising unproductive re-handling (moves that consume yard and crane time without getting cargo out of the terminal). The scope, data and results are covered by confidentiality agreements.

Publications and Theses

- [1] **I. García-Gómez**, “Deep U-Net for Faint Stellar-Stream Detection amidst Galactic Cirrus.” Master's Thesis, in progress, IFCA-CSIC, expected 2027.
- [2] **I. García-Gómez**, “Gravitational-Wave Emission from R-mode Instabilities in Neutron Stars.” Bachelor's Thesis, 2025.

Teaching and Outreach

President, EUNICE Artificial Intelligence Club

2025 – present

Student AI club for science and engineering, EUNICE European University alliance.

I lead the club and design most of its academic content. The core piece is a four-session Jupyter-notebook mini-course on neural networks built around visual intuition rather than derivations: it opens with a zero-prerequisite demo session and then covers learning, CNNs and applied science, closing with a guided challenge.

Technical Skills

Programming	Python (daily), R, Bash, $\text{\LaTeX}$. Comfortable with Linux, Git, and remote work on shared servers.
Deep learning	PyTorch and TensorFlow / Keras. Distributed data parallel, mixed precision, hyperparameter optimisation with Optuna, graph neural networks (<i>torch_geometric</i>).
Scientific stack	Geant4, OpenGATE 10, ROOT, NumPy, SciPy, SimpleITK, pydicom, AstroPy, FITS and HiPS.
HPC	SLURM-managed clusters (Altamira), multi-GPU training, long-running Monte Carlo jobs.
Languages	Spanish (native). English at C2 effective level, C1 official certification, English-track BSc Mention.